ENGINE PERFORMANCE

Self-Diagnostics - EEC-V - 4.2L

INTRODUCTION

Perform all steps in **BASIC TESTING - 4.2L** article in this section. If no fault is found while performing basic diagnostic procedures, proceed with self-diagnostics. If no diagnostic trouble codes or only pass codes are found during self-diagnostics, proceed to **TESTS W/O CODES - 4.2L** article in this section for diagnosis by symptom.

SELF-DIAGNOSTIC SYSTEM

DIAGNOSTIC FORMATS

QUICK TEST and CIRCUIT TESTS are diagnostic formats used to test and service EEC-V system. **QUICK TEST** allows technician to identify problems and retrieve diagnostic trouble codes. CIRCUIT TESTS check circuits, sensors and actuators.

Before starting any CIRCUIT TEST, follow all steps under QUICK TEST to find correct CIRCUIT TEST. If vehicle passes QUICK TEST and no driveability symptoms or intermittent faults exist, EEC-V system is okay.

DIAGNOSTIC TROUBLE CODES (DTC)

During QUICK TEST, 3 types of diagnostic trouble codes are retrieved: KOEO, KOER and Continuous Memory Codes. See **QUICK TEST** for self-test procedures. Codes may be cleared from PCM memory after they have been recorded or repaired. See **CLEARING CODES** .

KOEO & KOER Codes (Hard Faults)

These codes indicate faults are present at time of testing. A hard fault may cause CHECK ENGINE or Malfunction Indicator Light (MIL) to go on and remain on until fault is repaired. If KOEO or KOER codes are retrieved during **KOEO SELF-TEST** or KOER SELF-TEST, use the **DIAGNOSTIC TROUBLE CODE (DTC) REFERENCE CHARTS** to find correct testing and repair procedures.

Continuous Memory Codes (Intermittent Faults)

These codes are used to diagnose intermittent problems. Continuous Memory Codes are retrieved after **KOEO SELF-TEST** . These codes indicate a fault that may or may not be present at time of testing.

After noting and/or repairing fault, clear codes from memory. See **CLEARING CODES** . Intermittent faults may be caused by a sensor, connector or wiring-related problem. See INTERMITTENTS in **TESTS W/O CODES - 4.2L** article.

CAUTION: Continuous Memory Codes should be recorded when retrieved. These codes may be used to identify intermittent problems that exist after all

KOEO and KOER codes have been repaired. Some Continuous Memory Code faults may not be valid after KOEO and KOER codes are serviced.

RETRIEVING CODES

Fault codes are retrieved from EEC-V system through Data Link Connector (DLC). See **Fig. 1** . Self-diagnostic test procedures are for use with New Generation Star (NGS) scan tester. If a generic scan tester is used, ensure tool is certified ODB-II standard.

DATA LINK CONNECTOR (DLC) LOCATIONS

Application	Location
All Models	Below Instrument Panel To Right Of Steering Wheel

DATA LINK CONNECTOR (DLC) TERMINAL IDENTIFICATION

Terminal No.	Circuit
1	Ignition Control
2	BUS+ SCP
3	Not Used
4	Chassis Ground
5	Signal Return (SIG RTN)
6	Not Used
7	K Line ISO 9141
8	Not Used
9	Not Used
10	BUS- SCP
11	Not Used
12	Not Used
13	FEPS (Flash EEPROM)
14	Not Used
15	L Line ISO 9141
16	Battery Power

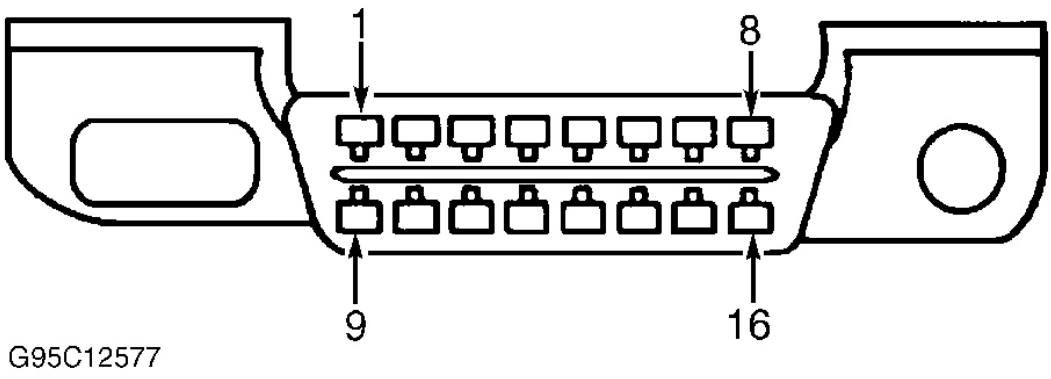


Fig. 1: Data Link Connector (DLC) Terminals
Courtesy of FORD MOTOR CO.

READING CODES

KOEO & KOER SELF-TEST Codes

Record codes in order received. These codes indicate current faults in system and should be serviced in order of appearance. Use **DIAGNOSTIC TROUBLE CODE (DTC) REFERENCE CHARTS** to identify correct CIRCUIT TEST to perform.

NOTE: If self-test will not activate or TOOL COMMUNICATION ERROR is received, go to CIRCUIT TEST QA , step 1).

Pass Codes

SYSTEM PASS indicates no diagnostic trouble codes were recorded in that portion of test. If SYSTEM PASS is not retrieved in **KOEO SELF-TEST** , codes retrieved during KOER SELF-TEST may not be valid.

Continuous Memory Codes

These codes result from information stored by PCM during continuous self-test monitoring. Use these codes for diagnosis only when **KOEO SELF-TEST** and KOER SELF-TEST result in SYSTEM PASS and all steps under **QUICK TEST** are successfully completed. These codes indicate faults previously recorded. Fault may or may not be currently present. See **DIAGNOSTIC TROUBLE CODE (DTC) REFERENCE CHARTS** .

CLEARING CODES

PCM Reset

After a PCM reset procedure, the following conditions will be met:

- All DTCs cleared from PCM memory.
- All freeze frame data cleared from PCM memory.
- All oxygen sensor test data cleared from PCM memory.
- OBD-II system monitor status is reset.
- DTC P1000 set in PCM memory.

To perform PCM reset using NGS scan tester, ensure connectors are properly connected. Program scan tester using the following steps:

- Select vehicle and engine selection menu (optional). See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester (optional).
- Follow operating instructions from scan tester menu.
- Select GENERIC OBD-II FUNCTIONS. Press CONT button if monitors are not complete.
- Turn ignition on.
- Select CLEAR DIAGNOSTIC CODES.

All codes should now be cleared from PCM memory. If problem has not been corrected or fault is still present, hard code will immediately be reset in PCM memory.

CAUTION: DO NOT disconnect vehicle battery to clear trouble codes. This will erase operating information from Keep-Alive Memory (KAM). To clear KAM, disconnect negative battery terminal for at least 5 minutes.

CAUTION: When battery is disconnected, vehicle computer may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

QUICK TEST

Description

Following procedures are functional tests of EEC-V system. These basic test steps must be followed in sequence to avoid misdiagnosis.

- Visual Check
- Equipment Hookup
- KOEO (Key On Engine Off) SELF-TEST
- KOER (Key On Engine Running) SELF-TEST
- Computed Timing Check
- Continuous Memory Self-Test

Diagnostic Aids

After each service or repair procedure has been completed, repeat QUICK TEST to ensure all EEC-V systems work properly and diagnostic trouble codes are no longer present.

VISUAL CHECK

Complete all steps in **BASIC TESTING - 4.2L** article before proceeding to self-diagnostic tests. Ensure vacuum hoses and EEC-V wiring harnesses are properly connected.

Apply parking brake, and place shift lever in Park (A/T) or Neutral (M/T) position. Block drive wheels. Turn off all electrical accessories.

EQUIPMENT HOOKUP

Connect appropriate test equipment to vehicle as follows:

Generic Scan Tester

Ensure scan tester meets or exceeds OBD-II standard. Follow manufacturer's instructions to hook up equipment and record diagnostic trouble codes.

New Generation STAR (NGS) Tester

Turn ignition switch to OFF position. Connect adapter cable lead to diagnostic tester. See **Fig. 2** . Connect service connectors of adapter cable to vehicle Data Link Connector (DLC). Go to **KOEO SELF-TEST** .

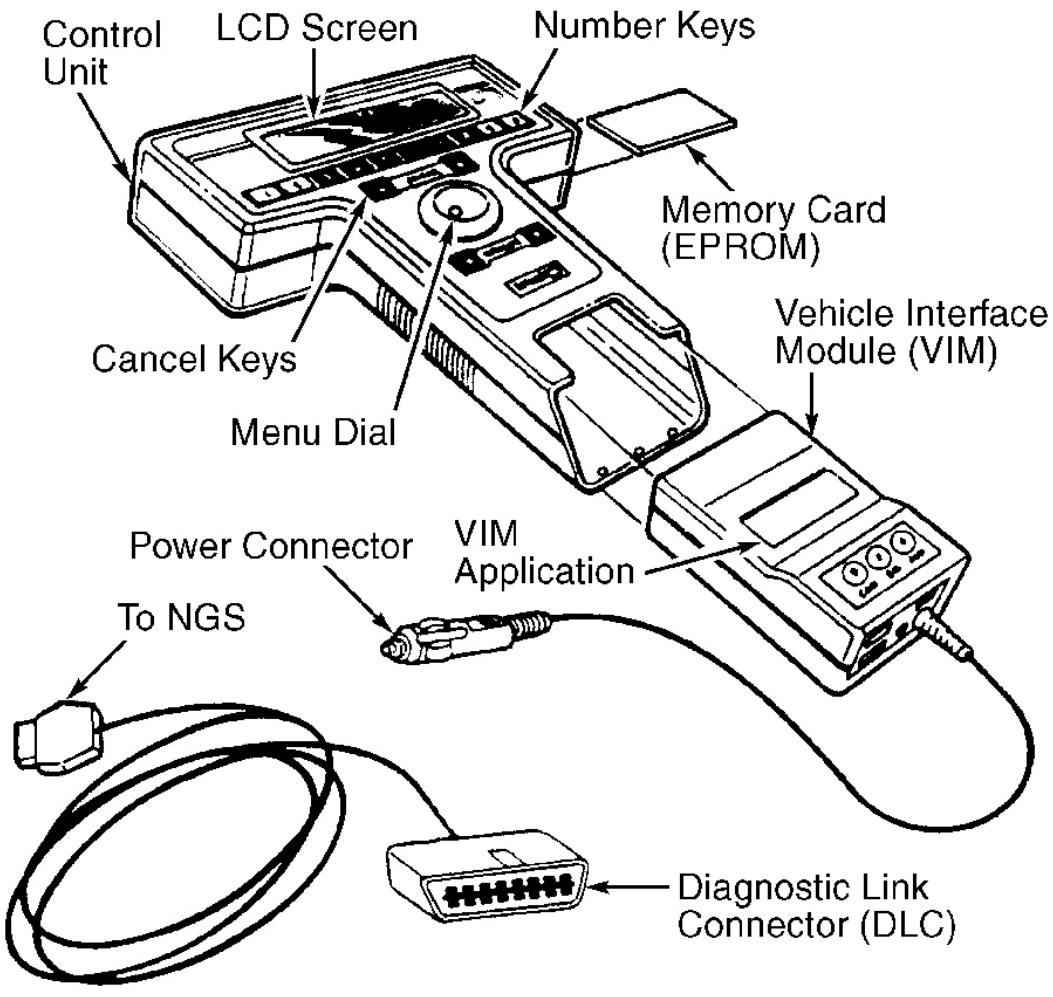


Fig. 2: New Generation Star (NGS) Scan Tester
Courtesy of FORD MOTOR CO.

KOEO SELF-TEST

Ensure engine is warmed to normal operating temperature. If engine does not start (or stalls after starting), continue KOEO SELF-TEST. Turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu. See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester.
- Select DIAGNOSTIC DATA LINK.

- Select PCM - POWERTRAIN CTRL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOEO ON-DEMAND SELF-TEST.
- Turn ignition on.
- Follow operating instructions from scan tester menu.

KOER SELF-TEST

Ensure engine is warmed to normal operating temperature. Turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu. See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester.
- Select DIAGNOSTIC DATA LINK.
- Select PCM - POWERTRAIN CTRL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select KOER ON-DEMAND SELF-TEST.
- Start engine and allow to idle.
- Follow operating instructions from scan tester menu.
- Perform BOO and TCS cycling (if equipped).

SERIES THROTTLE ASSEMBLY INSPECTION

Turn ignition off. Remove air tube from series throttle assembly. Check throttle plate for binding. Repair or replace as necessary. If fault cannot be isolated, go to **CIRCUIT TEST HT** , step 20).

CONTINUOUS MEMORY SELF-TEST (EMISSION RELATED)

Turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu (optional). See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester (optional).
- Select GENERIC OBD-II OPTIONS. Press CONT button if monitors are not complete.
- Select DIAGNOSTIC TROUBLE CODES.
- Turn ignition on.
- Follow operating instructions from scan tester menu.

CONTINUOUS MEMORY SELF-TEST (EXPANDED MODE)

Turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu. See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester.
- Select DIAGNOSTIC DATA LINK.
- Select PCM - POWERTRAIN CTRL MODULE.
- Select DIAGNOSTIC TEST MODES.
- Select RETRIEVE/CLEAR CONTINUOUS DTCs.
- Turn ignition on.
- Follow operating instructions from scan tester menu.

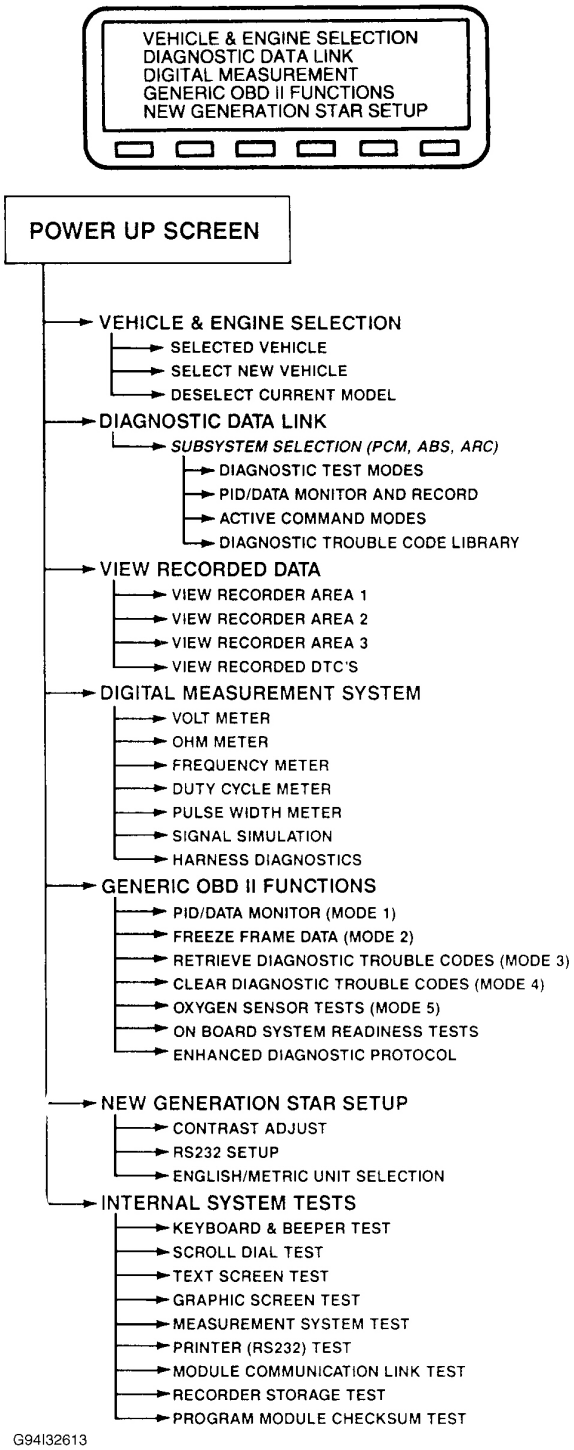


Fig. 3: New Generation Star (NGS) Main Menu & Mode Paths
Courtesy of FORD MOTOR CO.

ADDITIONAL SYSTEM FUNCTIONS

NOTE: Additional diagnostic system features are available to help diagnose driveability problems and service EEC-V systems.

GENERIC OBD-II PARAMETER IDENTIFICATION (PID)

Turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu (optional). See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester (optional).
- Select GENERIC OBD-II OPTIONS. Press CONT button if monitors are not complete.
- Select PID/DATA MONITOR.
- Turn ignition on or start engine and allow to idle.
- Follow operating instructions from scan tester menu.
- Select PIDs and press START.

NON-GENERIC OBD-II PARAMETER IDENTIFICATION (PID)

Turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu. See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester.
- Select GENERIC OBD-II OPTIONS. Press CONT button if monitors are not complete.
- Select DIAGNOSTIC DATA LINK.
- Select PCM - POWERTRAIN CTRL MODULE.
- Select DIAGNOSTIC TEST MODES.
- Select PID DATA MONITOR AND RECORD.
- Turn ignition on or start engine and allow to idle.
- Follow operating instructions from scan tester menu.
- Select PIDs and press START.

ON-BOARD SYSTEM READINESS (OSR) TEST MODE

All OBD-II scan testers must display OSR test. The OSR will display monitors on the vehicle and status of all monitors; complete or not complete. If not complete, the scan tester will display which monitor has not completed.

To enter OSR, turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu (optional). See **Fig. 3** .

- Select year, engine, model and any additional information requested by scan tester.
- Follow operating instructions from scan tester menu.
- Select GENERIC OBD-II FUNCTIONS. Press TEST button if monitors are not complete.
- Start engine and allow to idle.
- Select ON-BOARD SYSTEM READINESS.

FREEZE FRAME DATA MODE

This mode allows access to emission related data values from specific generic PIDs. These values are immediately stored in continuous memory when an emission related fault occurs. This provides a snapshot of the conditions that were present when the fault occurred. Freeze frame will be stored until PCM memory is erased.

To access FREEZE FRAME DATA MODE, turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu (optional). See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester (optional).
- Follow operating instructions from scan tester menu.
- Select GENERIC OBD-II FUNCTIONS. Press CONT button if OBD-II monitors are not complete.
- Turn ignition on.
- Select FREEZE FRAME PID TESTS.

OXYGEN SENSOR TEST MODE

This mode allows access to on-board sensor fault limits and actual values during test cycle. The test cycle has specific engine operating conditions that must be met for completion. This information is used to determine the efficiency of the catalytic converter.

To access OXYGEN SENSOR TEST mode, turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu (optional). See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester (optional).
- Follow operating instructions from scan tester menu.
- Select GENERIC OBD-II FUNCTIONS.
- Select OXYGEN SENSOR TESTS.
- Select appropriate oxygen sensor test and follow menu instructions.

OUTPUT TEST MODE

This mode allows a technician to energize and de-energize most of the system output actuators on command. After accessing OUTPUT TEST MODE, outputs and cooling fans can be turned on and off separately.

To access OUTPUT TEST MODE, turn ignition switch to OFF position. Ensure test equipment is properly attached. Program scan tester using the following steps:

- Select vehicle and engine selection menu. See **Fig. 3** .
- Select year, engine, model and any additional information requested by scan tester.
- Follow operating instructions from scan tester menu.
- Select DIAGNOSTIC DATA LINK.
- Select PCM - POWERTRAIN CTRL MODULE.
- Select DIAGNOSTIC TEST MODE.
- Select ACTIVE COMMAND MODE.
- Select OUTPUT TEST MODE.
- Turn ignition on.
- Follow operating instructions from scan tester menu.
- Select either LOW SPEED FAN, HIGH SPEED FAN or ALL ON mode.
- Select START to turn outputs on. This step may cause link up to PIDs.
- Select STOP to turn outputs off.

FAILURE MODE EFFECTS MANAGEMENT (FMEM)

FMEM mode allows system operation when sensors fail or transmit signals that are out of normal operating range. During FMEM mode, PCM substitutes a mid-range signal for defective sensor while continuing to monitor sensor. If faulty sensor signals return to normal operating range, PCM will use those signals. Depending on specific failure, a fault code may be set in PCM memory.

HARDWARE LIMITED OPERATIONAL STRATEGY (HLOS)

If a number of system or sensor failures are present and PCM is not receiving enough information to operate, PCM will switch to HLOS mode. PCM will output fixed values to allow operation of vehicle. Driveability concerns will be present. PCM will not output diagnostic trouble codes in this mode.

ON BOARD DIAGNOSTIC-II MONITOR

OBD-II OVERVIEW & SENSOR ILLUSTRATION DESCRIPTION

The California Air Resources Board (ARB) began regulation of On Board Diagnostic (OBD) systems for vehicles sold in California beginning with the 1988 model year. The first phase, OBD I, required monitoring of the fuel metering system, Exhaust Gas Recirculation (EGR) system, and additional emission-related components. The Malfunction Indicator Lamp (MIL) was required to light and alert the driver of the malfunction and the need for service of the emission control system. The MIL must be labeled CHECK ENGINE or SERVICE ENGINE SOON. A fault code or Diagnostic Trouble Code (DTC) is associated with the MIL identifying the specific area of the fault.

The OBD system was proposed by the California ARB to improve air quality by identifying vehicles exceeding

emission standards. Passage of the federal Clean Air Act Amendments in 1990 has also prompted the Environmental Protection Agency (EPA) to develop on board diagnostic requirements. California ARB OBD-II regulations will be followed until 1999 when the federal regulations will be used.

The OBD-II system meets government regulations by monitoring the emission control system. When a system or component exceeds emission thresholds or a component operates outside of tolerance, a DTC will be stored and the MIL will be turned on.

The OBD-II monitors detect system faults and initiate DTC setting and MIL activation. Fault detection strategy and MIL operation are associated with drive cycles. See **OBD-II DRIVE CYCLE** . A DTC is stored in the PCM keep alive random access memory when a fault is first detected. In most cases the MIL is turned on after two consecutive drive cycles with the fault existing.

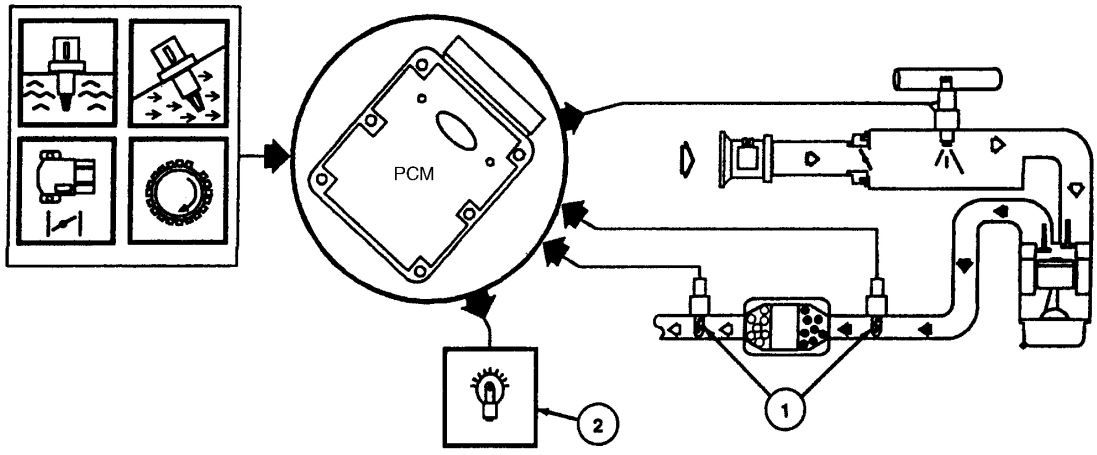
The DTC is cleared after 40 engine warm-up cycles without the fault being detected once the MIL is turned off. Once a monitor turns on the MIL, it will require 3 consecutive drive cycles without a fault for the MIL to turn off. The operation of each of the OBD-II monitors is discussed in detail within this section.

The on board diagnostic computer program in the electronic Engine Control (EC) system Powertrain Control Module (PCM) coordinates the OBD-II self-monitoring system. This program controls all the monitors and interactions, DTC and MIL operation, freeze frame data and scan tool interface. OBD-II Inspection Maintenance (IM) readiness DTC P1000 indicates that not all of the OBD-II monitors have been completed since the PCM's keep alive random access memory was last cleared. In certain states, it may be necessary to operate the vehicle until DTC P1000 is erased from the PCM in order to purchase a vehicle license.

Freeze frame data describes stored engine conditions such as state of the engine, state of fuel control, spark, rpm, load, and warm-up status at the point the first fault is detected. Previously stored conditions will be replaced only if a fuel or misfire fault is detected. This data is accessible with the scan tool to assist in repairing the vehicle.

This section provides a general description of each OBD-II monitor. In these descriptions, the monitor strategy, hardware, testing requirements and methods are presented together to provide an overall understanding of each monitor operation. An illustration for each monitor is also provided to aid in the description. Refer to illustration, see **Fig. 4** . These illustrations should be used as typical examples and are not intended to represent all the possible configurations.

Each illustration depicts the Powertrain Control Module (PCM) as the main focus with the primary inputs and outputs for each monitor. The icons to the left of the PCM represent the inputs (for icon identification, refer to illustration. See **Fig. 5**) used by each of the monitor strategies to enable or activate the monitor. The components and subsystems to the right of the PCM represent the hardware and signals used while performing the tests and the systems being tested. See **Fig. 6** . The catalyst efficiency monitor illustration has numerous components and signals involved and is shown generically. When referring to the illustrations, match the numbers to the corresponding numbers in the monitor descriptions for a better comprehension of the monitor and associated Diagnostic Trouble Codes (DTCs). These monitor descriptions are intended as general information only. See **DRIVE CYCLES** for detailed testing instructions for each monitor. These icons are used in the illustrations of the OBD-II monitors and throughout this section.



1. HO2S(s)
2. Malfunction Indicator Light (MIL)

G00076237

Fig. 4: Identifying Catalyst Efficiency Monitor Components
Courtesy of FORD MOTOR CO.

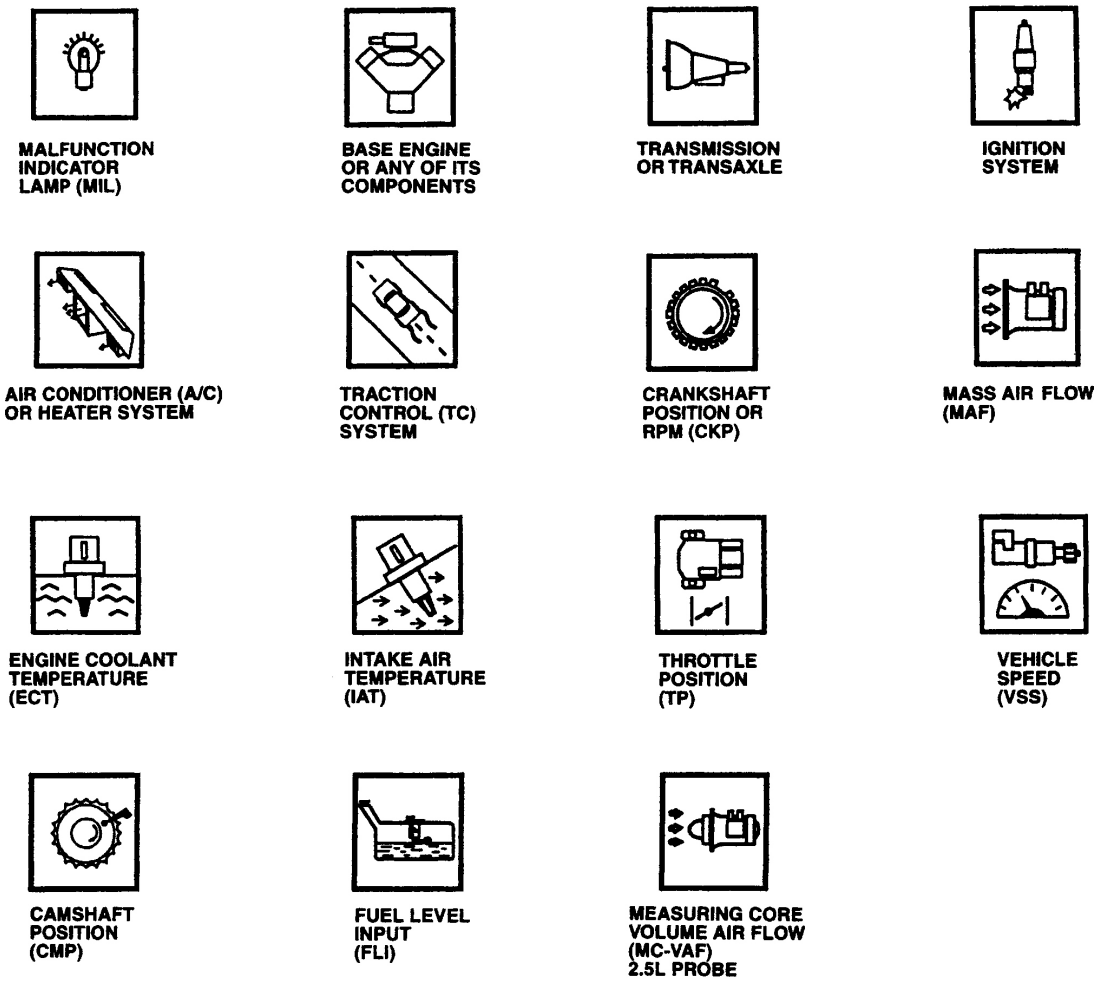


Fig. 5: Identifying Powertrain Control Module Input Sensor Icons
Courtesy of FORD MOTOR CO.

OBD-II DRIVE CYCLE

WARNING: Strict observance of posted speed limits and attention to driving conditions are mandatory when proceeding through the following drive cycles.

Description

The purpose of the OBD-II drive cycle is to execute the OBD-II monitors and identify any concerns with the OBD-II system. The DTC P1000 code will be erased of all OBD-II monitors have completed during the OBD-II drive cycle. The scan tool will be used to observe the status of each OBD-II monitor at the completion of the OBD-II drive cycle. The completion status of the Exhaust Gas Recirculation (EGR), Heated Oxygen Sensor (HO2S), Evaporative Emission (EVAP), Secondary Air Injection (AIR) (if applicable) and catalyst efficiency monitors can be monitored during the OBD-II drive cycle by viewing the ON-BOARD READINESS menu on

the scan tool. For the procedure of each OBD-II drive cycle, see **MONITOR REPAIR VERIFICATION DRIVE CYCLES** under DRIVE CYCLES.

CATALYST EFFICIENCY MONITOR FEDERAL TEST PROCEDURE

The federal test procedure catalyst efficiency monitor is an on-board strategy designed to monitor and determine when a catalytic converter has fallen below the minimum level of effectiveness in its ability to control exhaust emission. It relies mainly on the front and rear Heated Oxygen Sensors (HO2S) to infer catalyst efficiency based upon oxygen storage capacity. The front and rear HO2S switches are counted under specified conditions for the purpose of calculating rear to front HO2S switch ratio. After the switch ratio is calculated, it is compared against an emission threshold value. If the switch ratio is greater than the emission threshold, the catalyst has failed. The oxygen storage capacity of a high efficiency catalyst will have a low switch ratio and high HC efficiencies. As catalyst efficiency deteriorates, its ability to store oxygen declines and it will begin to have a higher switch ratio and low HC efficiencies. In general, as catalyst efficiency decreases, the switch ratio increases. Inputs from the Engine Coolant Temp (ECT) sensor, Intake Air Temp (IAT) sensor, and Throttle Position (TP) sensors are required to enable the federal test procedure catalyst monitor. To aid in monitor descriptions. refer to illustration. See **Fig. 4** .

1. In the federal test procedure catalyst efficiency monitor test, only switches during steady state cruise conditions of a drive cycle are counted. Switches at idle or other drive modes are not counted. The counting of front and rear HO2S switches continues until a drive cycle is completed. At that time, the ratio of total rear switches to total front HO2S switches is calculated. If the switch ratio is greater than the emission threshold, the catalyst has failed and a Diagnostic Trouble Code (DTC) is stored. The DTC associated with this test is DTC P0420.
2. Catalyst Efficiency DTC is stored in memory, and Malfunction Indicator Light (MIL) is turned on after catalyst efficiency monitor detects a malfunction up to 6 consecutive drive cycles.

COMPREHENSIVE COMPONENT MONITOR

The Comprehensive Component Monitor (CCM) is an on-board strategy designed to monitor a malfunction in any electronic component or circuit that provides input or output signal to the Powertrain Control Module (PCM) and is not exclusively monitored by another monitor system. Inputs and outputs are considered malfunctioning when at a minimum a failure exists due to a lack of circuit continuity, out-of-range value, or a failed rationality check.

The CCM covers many components and circuits and tests them in various ways depending on the hardware, function, and type of signal. See **Fig. 6** . For example, analog inputs are typically checked for opens, shorts, and out of range values. This type of monitoring is performed continuously. Some digital inputs rely on rationality checks. These tests may require the monitoring of several components and can only be performed under the appropriate test conditions. Outputs are checked for opens and shorts by monitoring the Output State Monitor (OSM) or circuit associated with the output driver when the output is energized or de-energized. Other outputs, such as relays, require additional OSM circuits to monitor the secondary side of the component. Some outputs are also monitored for the proper function by observing the reaction of the control system to a given change in the output command. An example of this would be the Idle Air Control (IAC) solenoid.

In general, the CCM covers a broad range of individual component and circuit checks and testing is performed under various conditions. The CCM is enabled shortly after the engine is started but requires certain conditions

to occur for some components before it can totally complete. A Diagnostic Trouble Code (DTC) is stored in continuous memory when a fault is determined, and the Malfunction Indicator Lamp (MIL) is activated if the fault detected affects emissions. Most of the CCM monitor tests are also performed during on demand self-test.

The following is an example of some of the input and output components monitored by the CCM. The components monitored may belong to the engine, ignition, transmission, air conditioning, traction control, or any other PCM supported subsystem:

1. Inputs: Mass Air Flow (MAF), Intake Air Temperature (IAT), Engine Coolant Temperature (ECT), Throttle Position Sensor A (TP-A), Throttle Position Sensor B (TP-B), Camshaft Position (CMP), Air Conditioning Pressure Sensor (ACPS).
2. Outputs: Fuel Pump (FP), Wide Open Throttle A/C Cutout (WAC), Idle Air Control (IAC), Shift Solenoid (SS), Torque Converter Clutch (TCC), Inlet Manifold Runner Control (IMRC), Vapor Management Valve (VMV).
3. Comprehensive component DTC is stored in memory, and Malfunction Indicator Light (MIL) is turned on after comprehensive component monitor detects a malfunction on 2 consecutive drive cycles, if the fault detected affects emissions.

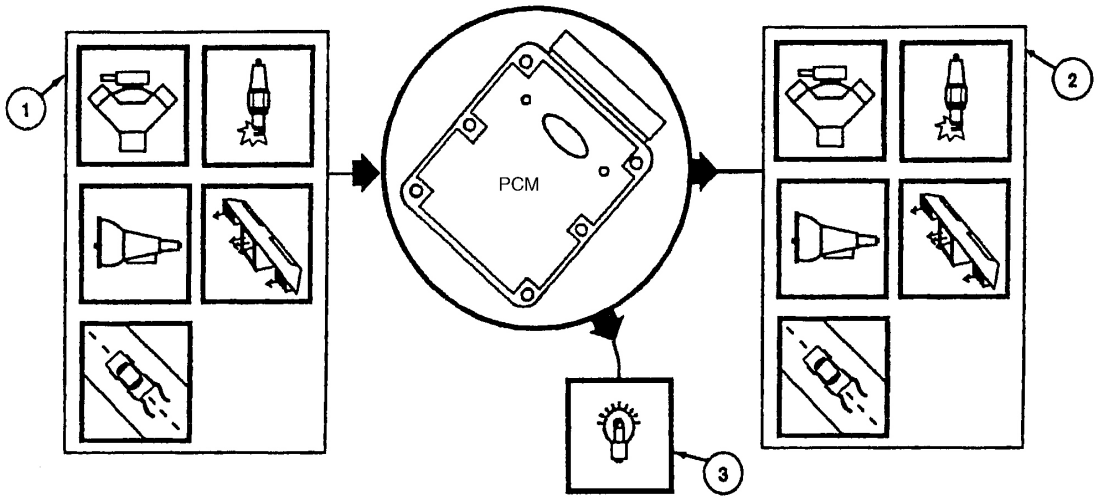


Fig. 6: Identifying Comprehensive Component Monitor Circuits
Courtesy of FORD MOTOR CO.

EVAPORATIVE EMISSION (EVAP) PURGE FLOW SYSTEM MONITOR

NOTE: The flow test will not run if a Purge Flow (PF) sensor or an EVAP canister purge valve malfunction is indicated. The Diagnostic Trouble Codes (DTCs) associated with an electrical fault of the PF sensor are P1444 (PF sensor circuit low input) and P1445 (PF sensor circuit high input). The DTC associated with an electrical fault of the EVAP canister purge valve is P0443 (EVAP canister purge

valve circuit malfunction).

The purpose of the EVAP purge flow system monitor is to verify the flow of fuel vapor from the EVAP canister purge valve to the engine. The electrical function of the Purge Flow (PF) sensor is initially checked before the flow test can begin. Inputs from the Intake Air Temp (IAT) sensor, Mass Air Flow (MAF) sensor and Vehicle Speed Sensor (VSS) are used to enable the flow test.

The flow test will detect a hose blockage or disconnection between the EVAP canister purge valve and the intake manifold. It will not detect a detached hose from either the valve to the EVAP canister or from the EVAP canister to the fuel tank.

The EVAP purge flow test will initiate when a 75% duty cycle is commanded on the EVAP canister purge valve during engine operation. At this time, the Purge Flow (PF) sensor will take a reading while fuel vapor is flowing to the engine. See **Fig. 7** . The EVAP canister purge valve is then commanded closed (from 75% to 0% duty cycle). A second reading will be taken by the PF sensor after a calibrated time period of no fuel vapor flow to the engine. If the PF sensor does not react as expected to the sudden lack of fuel vapor flow to the engine, the PCM generates an EVAP canister purge valve fault DTC. If the difference between the two PF sensor readings taken (flow versus no flow) is not greater than a calibrated threshold, DTC P1443 (EVAP canister purge valve malfunction) will be set.

The Malfunction Indicator lamp (MIL) is activated for DTCs P0433, P1443, P1444 and P1445 after two occurrences of the same fault.

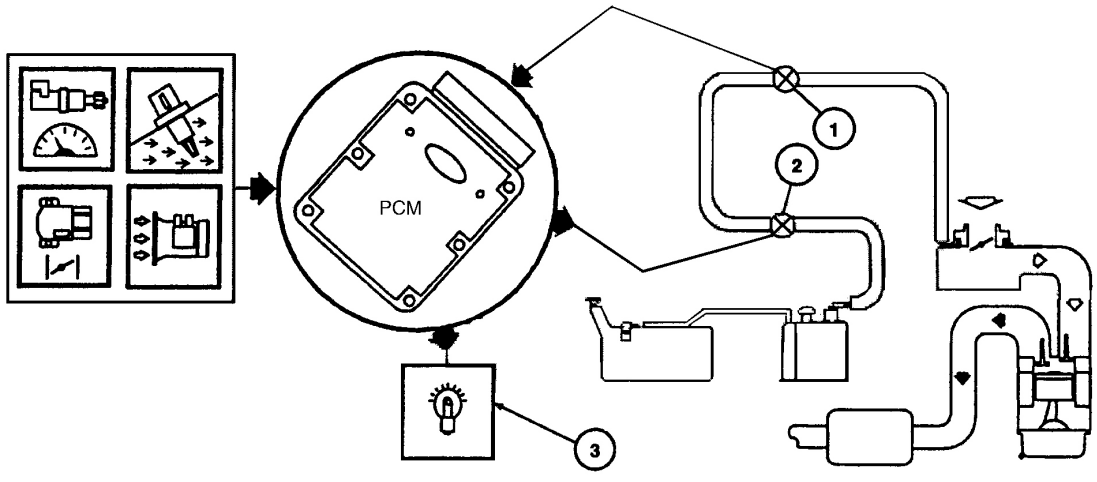


Fig. 7: Identifying Purge System Monitor Components
Courtesy of FORD MOTOR CO.

EVAPORATIVE EMISSION (EVAP) VAPOR MANAGEMENT FLOW SYSTEM MONITOR

NOTE: The Evaporative Emission (EVAP) vapor management flow test will not run if a EVAP canister purge valve malfunction is indicated. The Diagnostic Trouble Code (DTC) associated with an electrical fault of the EVAP canister purge valve is P0443 (EVAP system control valve circuit malfunction).

The EVAP vapor management flow system monitor is designed to verify that the EVAP canister purge valve is functioning properly and to verify the flow of fuel vapor from the EVAP canister purge valve to the engine. See **Fig. 8** . The electrical function of the EVAP canister purge valve is initially checked before the flow test can begin. Inputs from the Engine Coolant Temp (ECT) sensor, Intake Air Temp (IAT) sensor, Mass Air Flow (MAF) sensor and Vehicle Speed Sensor (VSS) are used to enable the flow test.

Before the flow test is performed, the PCM will calculate how much fuel vapor is present while purging under engine operation. If the amount of fuel vapor calculated is above a calibrated threshold, the PCM assumes that there must be fuel vapor flow to the engine and that the EVAP canister purge valve is functioning properly.

If the amount of fuel vapor calculated is below a calibrated threshold, the idle speed portion of the EVAP vapor management flow test must be executed to verify that the EVAP canister purge valve is functioning properly. An assumption of the flow test is that regardless of the fuel vapor in the EVAP canister, some portion of the fuel vapor flow will be air. The flow test will calculate the increase in the idle air requested by the PCM when the duty cycle on the EVAP canister purge valve is reduced from 75% to 0%.

If this condition exists, the idle speed portion of the EVAP vapor management flow test will be bypassed and the test will pass and complete. If the calculated increase in air flow exceeds a calibrated threshold, the PCM assumes the EVAP canister purge valve is functioning properly. If the calculated increase in air flow is negligible, the EVAP canister purge valve is not functioning properly. The DTC associated with this condition is P1443 (EVAP control system purge control valve malfunction).

The Malfunction Indicator Lamp (MIL) is activated for DTCs P0443 and P1443 after two occurrences of the same fault.

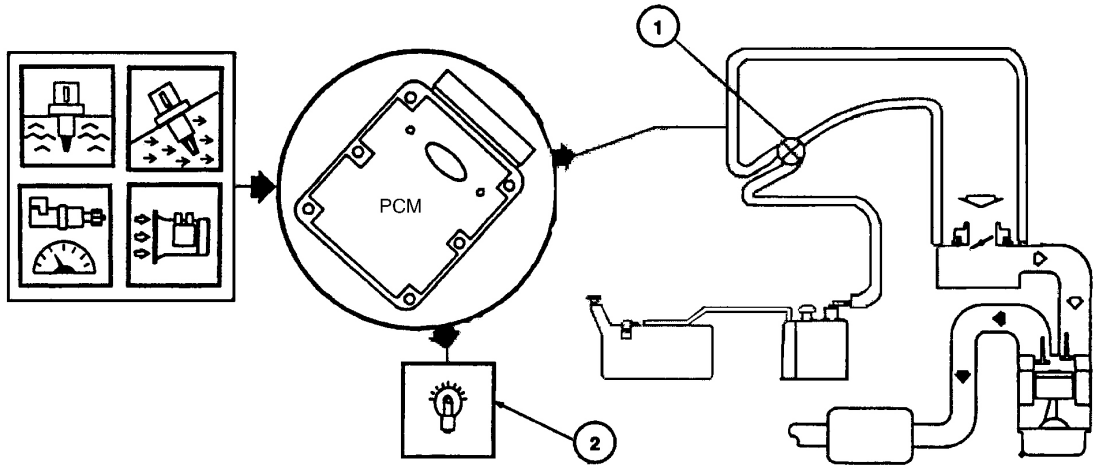


Fig. 8: Identifying EVAP Vapor Management Flow System Monitor Components
Courtesy of FORD MOTOR CO.

EVAPORATIVE EMISSION (EVAP) RUNNING LOSS SYSTEM MONITOR

NOTE: During the Evaporative Emission (EVAP) running loss system monitor repair verification drive cycle a PCM reset with key on, engine off will bypass the minimum soak time required to complete the monitor. The EVAP running loss system monitor will not run if the key is turned off after a PCM reset. The EVAP running loss system monitor will not run if a MAF sensor failure is indicated. The EVAP running loss system monitor will not initiate until the Heated Oxygen Sensor (HO2S) Monitor has completed

The Evaporative Emission (EVAP) running loss system monitor is an on-board strategy designed to detect a leak from a hole (opening) equal to or greater than 1.016 mm (0.040 inch) in the EVAP running loss system. See **Fig. 9** . The proper function of the individual components of the EVAP running loss system as well as its ability to flow fuel vapor to the engine is also examined. The EVAP running loss system monitor relies on the individual components of the EVAP running loss system to apply vacuum to the fuel tank and then seal the entire EVAP running loss system from atmosphere. The fuel tank pressure is then monitored to determine the total vacuum lost (bleed-up) for a calibrated period of time. Inputs from the Engine Coolant Temperature (ECT) sensor, Intake Air Temperature (IAT) sensor, Mass Air Flow (MAF) sensor, Vehicle Speed Sensor (VSS), Fuel Level Input (FLI) and Fuel Tank Pressure (FTP) sensor are required to enable the EVAP running loss system monitor.

The EVAP running loss system monitor is executed by the individual components of the EVAP running loss system as follows:

1. The function of the EVAP canister purge valve is to create a vacuum on the fuel tank. A minimum duty cycle on the EVAP canister purge valve (75%) must be met before the EVAP running loss system

monitor can begin.

2. The Canister Vent (CV) solenoid will close (100% duty cycle) with the EVAP canister purge valve at its minimum duty cycle to seal the EVAP running loss system from atmosphere and obtain a target vacuum on the fuel tank.
3. The Fuel Tank Pressure (FTP) sensor will be used by the EVAP running loss system monitor to determine if the target vacuum on the fuel tank is being reached to perform the leak check. Once the target vacuum on the fuel tank is achieved, the change in fuel tank vacuum for a calibrated period of time will determine if a leak exists.
4. If the initial target vacuum cannot be reached, DTC P0455 (large leak or no purge detected) will be set. The EVAP running loss system monitor will abort and not continue with the leak check portion of the test.

   If the initial target vacuum is exceeded, a system flow fault exists and DTC P1450 (unable to bleed-up fuel tank vacuum) is set. The EVAP running loss system monitor will abort and not continue with the leak check portion of the test.

   If the target vacuum is obtained on the fuel tank, the change in the fuel tank vacuum (bleed-up) will be calculated for a calibrated period of time. The calculated change in fuel tank vacuum will be compared to a calibrated threshold for a leak from a hole (opening) of 1.016 mm (0.040 inch) in the EVAP running loss system. If the calculated bleed-up is less than the calibrated threshold, the EVAP running loss system passes. If the calculated bleed-up exceeds the calibrated threshold, the test will abort and rerun the test up to 3 times.

   If the bleed-up threshold is still being exceeded after 3 tests, a vapor generation check must be performed before DTC P0442 (small leak detected) will be set. This is accomplished by returning the EVAP running loss system to atmospheric pressure by closing the EVAP canister purge valve and opening the CV solenoid. Once the FTP sensor observes the fuel tank is at atmospheric pressure, the CV solenoid closes and seals the EVAP running loss system.

   The fuel tank pressure build-up for a calibrated period of time will be compared to a calibrated threshold for pressure build-up due to vapor generation.

   If the fuel tank pressure build-up exceeds the threshold, the leak test results are invalid due to vapor generation. The EVAP running loss system monitor will pass and complete.

   If the fuel tank pressure build-up does not exceed the threshold, the leak test results are valid and DTC P0442 will be set.

   The Malfunction Indicator Lamp (MIL) is activated for DTCs P0442, P0455 and P1450 (or P446) after two occurrences of the same fault. The MIL can also be activated for any EVAP running loss system component DTCs in the same manner. The EVAP running loss system component DTCs P0443, P0452, P0453 and P1451 are tested as part of the Comprehensive Component Monitor (CCM).

5. The malfunction indicator lamp (MIL) is activated for DTCs P0442, P0455 and P1450 (or P446) after two occurrences of the same fault. The MIL can also be activated for any EVAP running loss system component DTCs in the same manner. The EVAP running loss system component DTCs P0443, P0452,

P0453 and P1451 are tested as part of the Comprehensive Component Monitor (CCM).

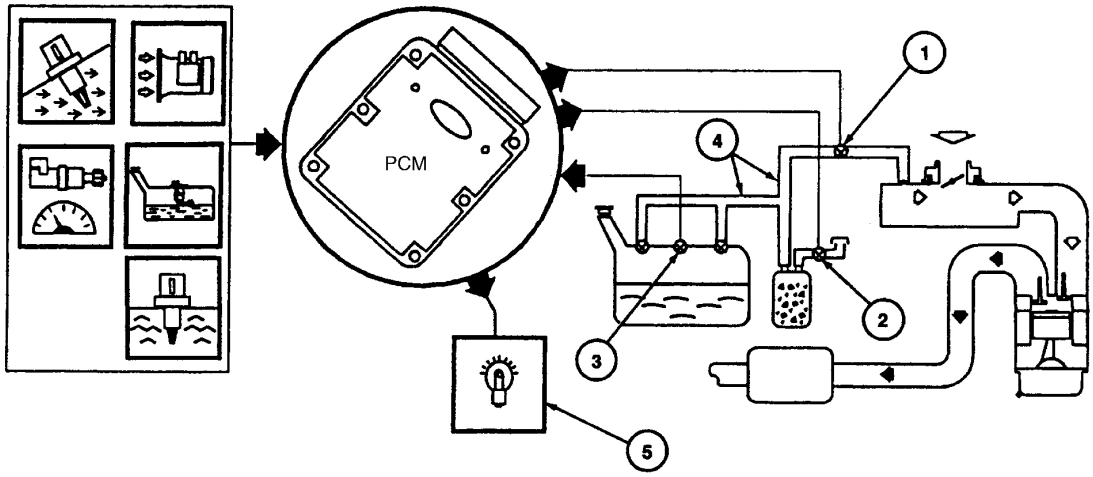


Fig. 9: Identifying EVAP Running Loss System Monitor Components
Courtesy of FORD MOTOR CO.

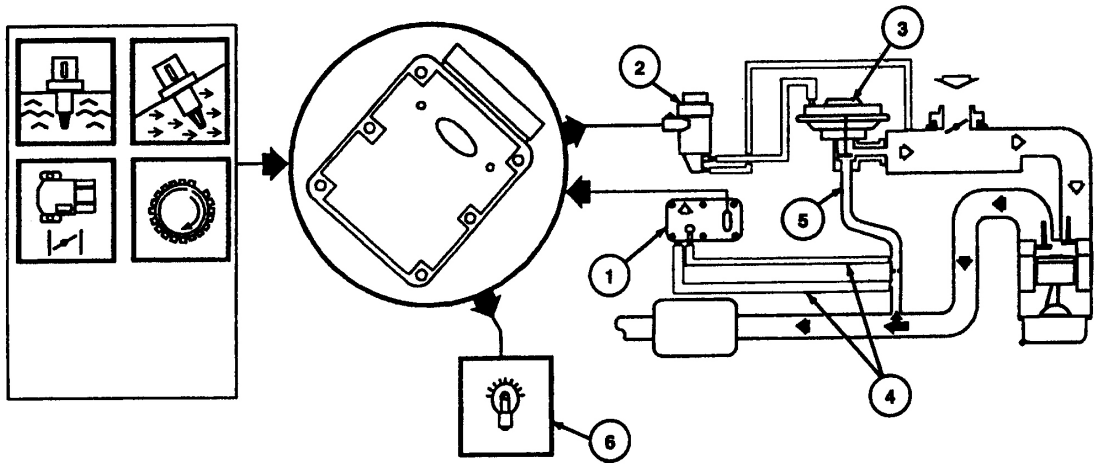
EXHAUST GAS RECIRCULATION MONITOR/DIFFERENTIAL PRESSURE FEEDBACK EGR

The Differential Pressure Feedback (DPF EGR) monitor is an on-board strategy designed to test the integrity and flow characteristics of the EGR system. The monitor is activated during EGR system operation after certain bases engine conditions are satisfied. Inputs from the Engine Coolant Temperature (ECT), Intake Air Temperature (IAT), Throttle Position (TP) and Crank Position (CKP) sensors are required to activate the EGR monitor. Once activated, the EGR monitor will perform each of the tests described below during the engine modes and conditions indicated. Some of the EGR monitor test are also performed during on demand self-test. To aid in monitor definition, refer to illustration. See **Fig. 10** .

1. The differential pressure feedback EGR sensor and circuit are continuously tested for opens and shorts. the monitor looks for the differential pressure feedback EGR circuit voltage to exceed the maximum or minimum allowable limits. The DTCs associated with this test are DTCs P1400 and P1401.
2. The EGR vacuum regulator solenoid is continuously tested for opens and shorts. The monitor looks for an EGR vacuum regulator circuit voltage that is inconsistent with the EGR vacuum regulator circuit commanded output state. The DTC associated with this test is DTC P1409.
3. The test for a stuck open EGR valve or EGR flow at idle is continuously performed whenever at idle (TP sensor indicating closed throttle). The monitor compares the differential pressure feedback EGR circuit voltage at idle to the differential pressure feedback EGR circuit voltage stored during key on engine off to determine if EGR flow is present at idle. The DTC associated with this test is DTC P0402.
4. The differential pressure feedback EGR sensor upstream hose is tested once per drive cycle for disconnect and plugging. The test is performed with EGR valve closed and during a period of acceleration. The PCM will momentarily command the EGR valve closed. The monitor looks for the

differential pressure feedback EGR sensor voltage to be inconsistent for a no flow voltage. A voltage increase or decrease during acceleration while the EGR valve is closed may indicate a fault with the signal hose during this test. The DTC associated with this test is DTC P1405.

5. The EGR flow rate test is performed during a steady state when engine speed and load are moderate and EGR vacuum regulator duty cycle is high. The monitor compares the actual differential pressure feedback EGR circuit voltage to a desired EGR flow voltage for that state to determine if EGR flow rate is acceptable or insufficient. This is a system type test and may trigger a DTC for any fault causing the EGR system to fail. The DTC associated with this test is DTC P0401. DTC P1408 is similar to P0401 but performed during KOER Self-Test conditions.
6. The Malfunction Indicator Light (MIL) is turned on after one of the above test fails on 2 consecutive drive cycles.



1. EGR Sensor
2. EGR Vacuum Regulator Solenoid
3. EGR Valve (DPFE)
4. DPFE Sensor Hoses
5. EGR Recirculation Tube
6. Malfunction Indicator Light (MIL)

G00076223

Fig. 10: Identifying EGR Monitor Components (Differential Pressure Feedback)
Courtesy of FORD MOTOR CO.

FUEL SYSTEM MONITOR

The fuel system monitor is an on-board strategy designed to monitor the adaptive fuel control system. The fuel control system uses adaptive fuel tables stored in Keep Alive Memory (KAM) to compensate for variability in fuel system components due to normal wear and aging. During closed looped vehicle operation, the adaptive fuel strategy learns the corrections needed to correct a "biased" rich or lean fuel system. The correction is stored in the adaptive tables. The fuel adaptive system has two means of adapting; a Long Term Fuel Trim (LONGFT) and a Short Term Fuel Trim (SHRTFT). LONGFT relies on adaptive fuel table, indicating long-term fuel adjustments. SHRTFT refers to the desired air/fuel ratio parameter LAMBSE (LAMBSE is calculated by the PCM from HO2S inputs and helps maintain a 14.7:1 air/fuel ratio during closed-loop operation). SHRTFT indicating short-term fuel adjustments. Inputs from the Engine Coolant Temperature (ECT), Intake Air Temperature (IAT), Measuring Core-Variable Air Flow (MC-VAF) or Mass Air Flow (MAF), sensors are required to activate the adaptive fuel control system, which in turn activates the fuel system monitor. Once activated, the fuel system monitor looks for the adaptive tables to reach the adaptive clip and LAMBSE to

exceed calibrated limit. To aid in monitor definition, refer to illustration. See **Fig. 11** .

The fuel system monitor will store the appropriate DTC when a fault is detected as described:

1. The Heated Oxygen Sensor (HO2S) detects the presence of oxygen in the exhaust and provides the PCM with feedback indicating the air/fuel ratio.
2. A correction factor is added to the fuel injection pulse-width calculation according to the Long and Short Term Fuel Trims as needed to compensate for variations in the fuel system.
3. When deviation in the parameter lambse gets larger and larger air/fuel control suffers and emissions increase. When lambse exceeds a calibrated limit and the adaptive fuel table has clipped, the fuel system monitor sets a Diagnostic Trouble Code (DTC) as follows: The DTCs associated with the monitor detecting a lean shift in fuel system operation are DTCs P0171 and P0174. The DTCs associated with the monitor detecting a rich shift in fuel system operation are DTCs P0172 and P0175.
4. Fuel system DTC is stored in memory, and Malfunction Indicator Light (MIL) is turned on after fuel system monitor detects a malfunction on 2 consecutive drive cycles.

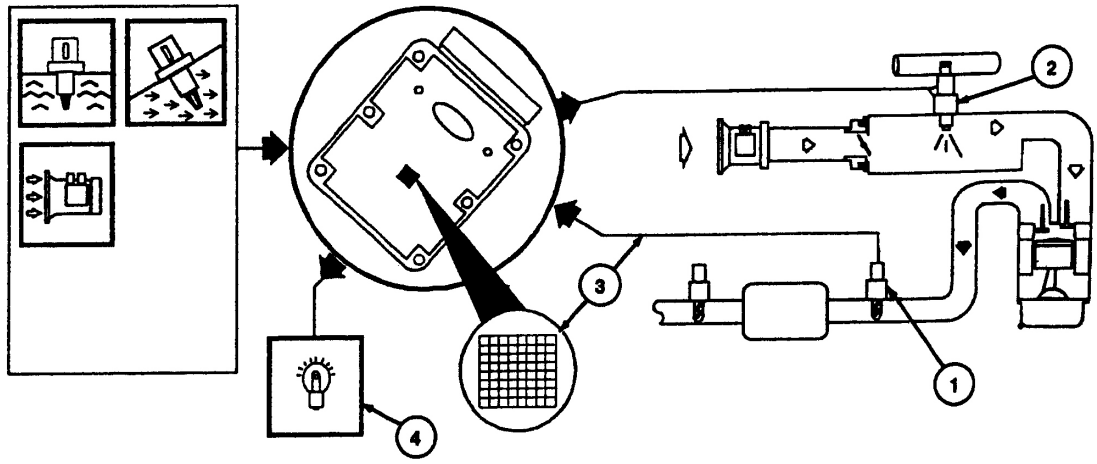


Fig. 11: Identifying Fuel System Monitor Components
Courtesy of FORD MOTOR CO.

HEATED OXYGEN SENSOR MONITOR

The H02S monitor is an on-board strategy designed to monitor the H02S sensors for a malfunction or deterioration which can affect emissions. The fuel control H02S is checked for proper output voltage and response rate (the time it takes to switch from lean to rich and vice versa). The H02S heater circuit is monitored by detecting proper voltage change as the heater is turned on and off. Downstream H02S used for catalyst monitor are also monitored for proper output voltage. The inputs from the Engine Coolant Temperature (ECT), Intake Air Temperature (IAT), Measuring Core-Variable Air Flow (MC-VAF) or Mass Air Flow (MAF), Throttle Position (TP) and Crank Position (CKP) sensors are required to activate the H02S monitor. The fuel system monitor and misfire monitor must also have completed successfully before the H02S monitor is enabled.

Some of the H02S monitor checks are also performed during on demand self-test. To aid in monitor definition, refer to illustration. See **Fig. 12** .

1. The H02S sensor senses the oxygen content in the exhaust flow and outputs a voltage between zero and 1.0 volt. Lean of stoichiometric (air/fuel ratio of approximately 14.7:1), the H02S will generate a voltage between zero and 0.4 volts. Rich of stoichiometric, the H02S will generate a voltage between 0.5 and 1.0 volt. The H02S monitor evaluates both the upstream (fuel control) and downstream (catalyst monitor) H02S for proper function.
2. Once the H02S monitor is enabled, the upstream H02S signal voltage amplitude and response frequency are checked. Excessive voltage is determined by comparing the H02S signal voltage to a maximum calibration threshold voltage. A fixed frequency closed loop fuel control routine and the upstream HO2S voltage amplitude and output response frequency are observed. A sample of the upsteam HO2S signal is evaluated to determine if the sensor is capable of switching or has a slow response rate. A HO2S heater circuit fault is determined by turning the heater on and off and looking for a corresponding change in the Output State Monitor (OSM) and by measuring the current going through the heater circuit. To aid in monitor definition, refer to illustration. See **Fig. 12** .

HO2S monitor DTCs can be categorized as follows:

- The DTCs associated with HO2S/O2S lack of switching are DTCs P1130, P1131, P1132, P1150, P1151 and P1152.
- The DTCs associated with HO2S/O2S slow response rate are DTCs P0133 and P0153.
- The DTCs associated with HO2S/O2S signal circuit malfunction are DTCs P0131, P0136, P0151 and P0156.
- The DTCs associated with a HO2S heater circuit malfunction are DTCs P0135, P0141, P0155 and P0161.
- The DTC associated with the downstream HO2S not running in on-demand is DTC P1127.
- The DTCs associated with swapped HO2S connectors are DTCs P1128 and P1129.

Heated Oxygen Sensor (HO2S) system DTC is stored in memory, and Malfunction Indicator Light (MIL) is turned on after HO2S monitor detects a malfunction on 2 consecutive drive cycles.

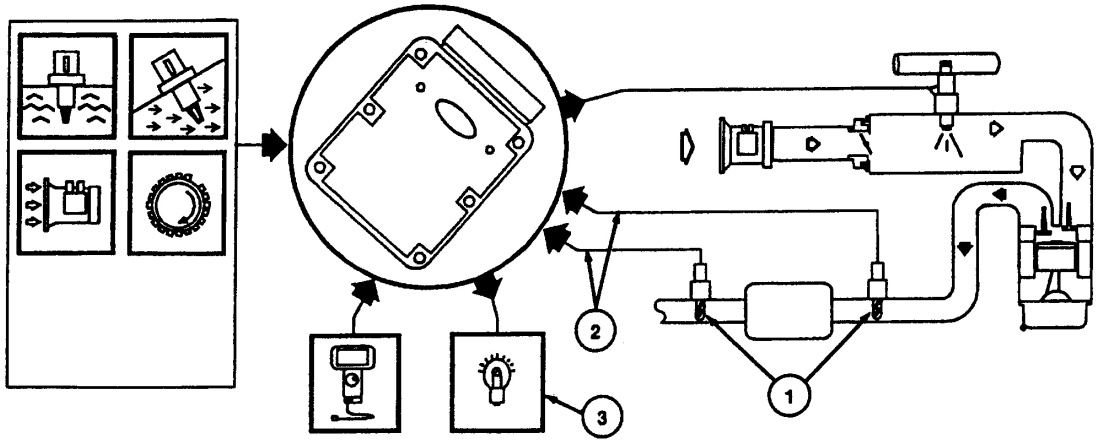


Fig. 12: Identifying Heated Oxygen Sensor Monitor Components
Courtesy of FORD MOTOR CO.

MISFIRE DETECTION MONITOR

The misfire monitor is an on-board strategy designed to monitor engine misfire and identify the specific cylinder in which the misfire has occurred. Misfire is defined as lack of combustion in a cylinder due to absence of spark, poor fuel metering, poor compression, or any other cause. The misfire monitor will be enabled only when certain base engine conditions are first satisfied. Input from the Engine Coolant Temperature (ECT), Measuring Core-Variable Air Flow (MC-VAF) or Mass Air Flow (MAF), and Crank Position (CKP) sensors is required to enable the monitor. The misfire monitor is also performed during on demand self-test. To aid in monitor definition, refer to illustration. See **Fig. 13** .

1. The PCM synchronized ignition spark based on information received from the CKP sensor. The CKP signal generated is also the main input used in determining cylinder misfire.
2. The input signal generated by the CKP sensor is derived by sensing the passage of teeth from crankshaft position wheel mounted on the end of the crankshaft.
3. The input signal to the PCM is then used to calculate the time between CKP edges and also crankshaft rotational velocity and acceleration. By comparing the accelerations of each cylinder event, the power loss of each cylinder is determined. When the power loss of a particular cylinder is sufficiently less than a calibrated value and other criteria is met, then the suspect cylinder is determined to have misfired.
4. Misfire detection types:
    - Misfire Type (A). Upon detection of a Misfire type A: (200 revolutions) which would cause catalyst damage, the MIL will blink once per second during the actual misfire, and a DTC will be stored.
    - Misfire Type (B). Upon detection of a Misfire type B: (1000 revolutions) which will exceed the emissions threshold or cause a vehicle to fail an inspection and maintenance tailpipe emissions test, the MIL will illuminate and a DTC will be stored.

The DTC associated with multiple cylinder misfire for a Type A or Type B misfire is DTC P0300.

The DTCs associated with an individual cylinder misfire for a Type A or Type B misfire are DTCs P0301, P0302, P0303, 0304, 0305, P0306, P0307, and P0308, P0309 and P0310.

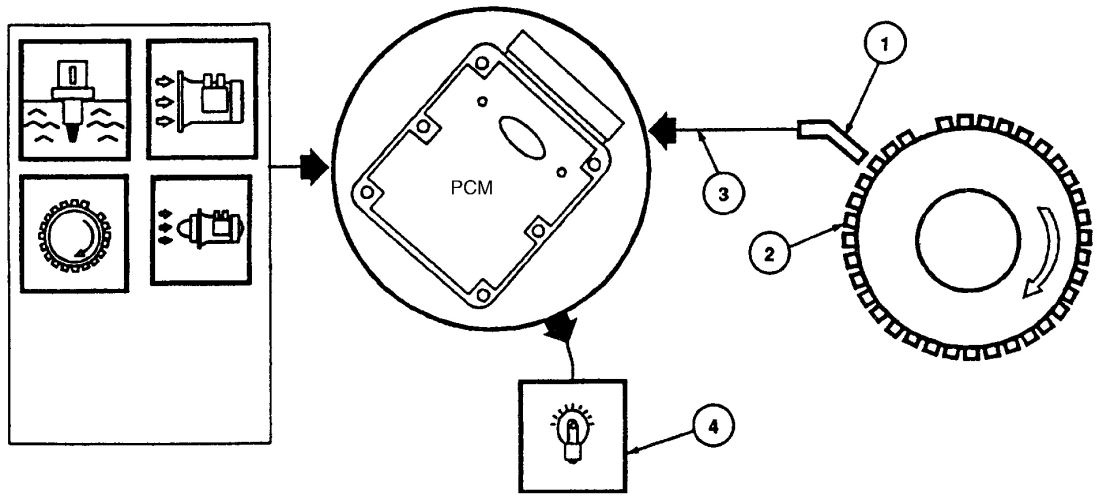


Fig. 13: Identifying Misfire Monitor Components
Courtesy of FORD MOTOR CO.

SECONDARY AIR INJECTION SYSTEM MONITOR (ELECTRIC AIR PUMP SYSTEM)

The Secondary Air Injection (AIR) system monitor is an on-board strategy designed to monitor the proper function of the secondary air system. The AIR monitor for the Electric Air Pump system consists of two monitor circuits: an AIR circuit to diagnose problems with the primary circuit side of the Solid State Relay (SSR), and an AIR monitor circuit to diagnose problems with the secondary circuit side of the Solid State Relay. A functional check is also performed that tests the ability of the AIR system to inject air into the exhaust. The functional check relies upon H02S sensor feedback to determine the presence of air flow. The monitor is enabled during AIR system operation and only after certain base engine conditions are first satisfied. Input is required from the Engine Coolant Temperature (ECT) sensor, Intake Air Temperature (IAT) sensor, Crank Position (CKP) sensor, and the H02S monitor test must also have passed without a fault detection to enable the AIR monitor. The AIR monitor is also activated during on demand self-test. To aid in monitor definition, refer to illustration. See **Fig. 14** .

1. The EAIR circuit is normally held high through the AIR Bypass solenoid and Solid State Relay when the output driver is off. Therefore a low AIR circuit indicates a driver is always on and a high circuit indicates an open in the PCM. The DTC associated with this test is DTC P0412.
2. The AIR monitor circuit is held low by the resistance path through the air pump when the pump is off. If the AIR monitor circuit is high there is either an open circuit to the PCM from the pump or there is power supplied to the Air Pump. If the AIR monitor is low when the pump is commanded on, there is either an open circuit from the SSR or the SSR has failed to supply power to the pump. The DTCs associated with

this test are DTCs P1413 and P1414.

3. The functional check may be done in two parts; at startup when the air pump is normally commanded on, or during a hot idle if the startup test was not able to be performed. The flow test relies upon the H02S sensor to detect the presence of additional air in the exhaust when introduced by the secondary air injection system. The DTC associated with this test is DTC P0411.
4. The Malfunction Indicator Light (MIL) is turned on after one of the above tests fails on 2 consecutive drive cycles.

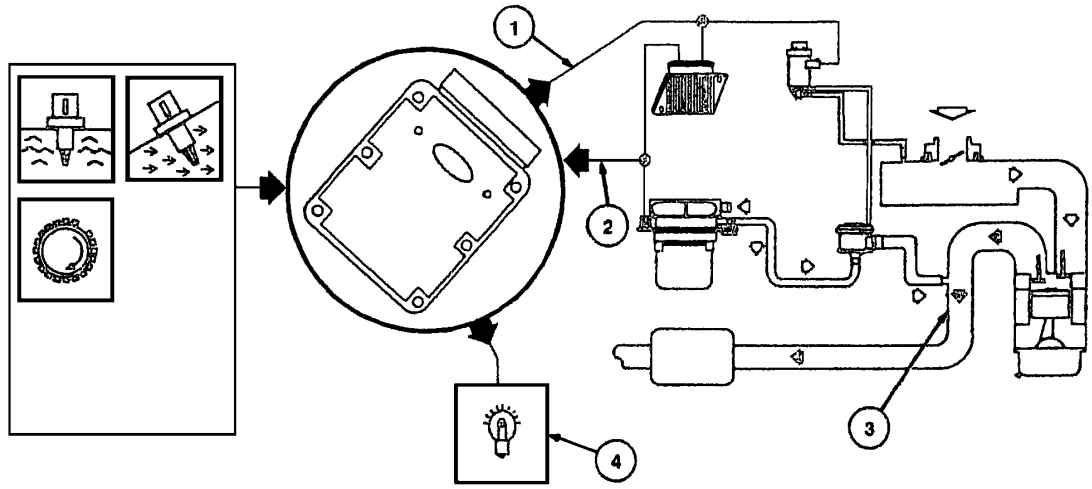


Fig. 14: Identifying Secondary Air Injection System Monitor Components (Electric Air Pump) Courtesy of FORD MOTOR CO.

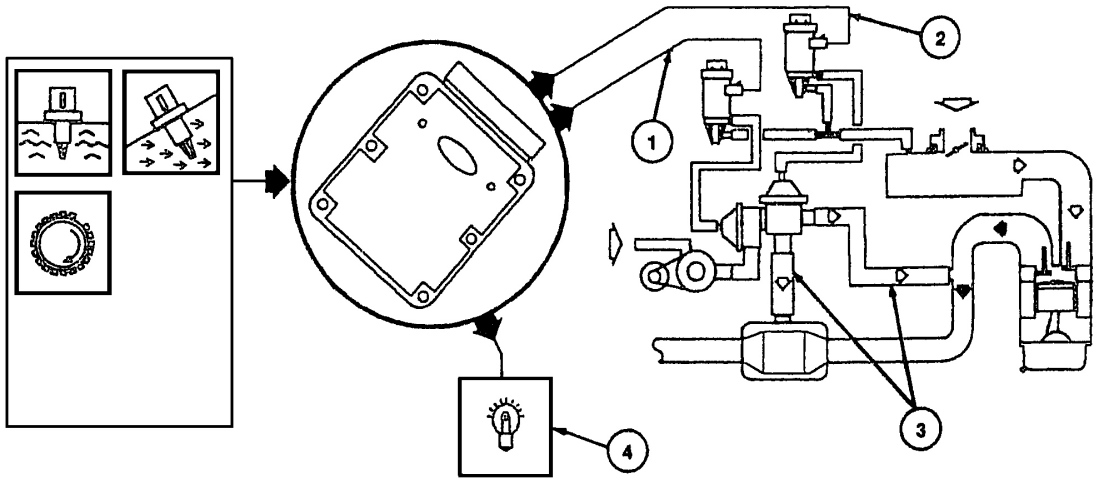
SECONDARY AIR INJECTION SYSTEM MONITOR (BELT DRIVEN AIR PUMP SYSTEM)

The Secondary Air Injection (AIR) system monitor is an on-board strategy designed to monitor the proper function of the secondary air system. The AIR monitor for the belt driven air pump system consists of two Output State Monitor configurations in the Powertrain Control Module (PCM); one circuit monitors the electrical circuit of the Secondary Air Injection Bypass (AIRS) solenoid, the second circuit monitors the electrical circuit of the Secondary Air Injection Diverter (AIRD) solenoid. A functional check is also performed that tests the ability of the AIR system to inject air into the exhaust. The functional check relies upon H02S sensor feedback to determine the presence of air flow. The monitor is enabled during AIR system operation and only after certain base engine conditions are first satisfied. Input is required from the Engine Coolant Temperature (ECT) sensor, Intake Air Temperature (IAT) sensor, Crank Position (CKP) sensor, and the H02S monitor must also have passed without a fault detection to enable the AIR monitor. The AIR monitor is also activated during on demand self-test. To aid in monitor definition, refer to illustration. See **Fig. 15** .

1. The AIRB solenoid circuit is monitored for open and shorted conditions by the AIRB output state monitor. The DTCs associated with this test are DTCs P0413 and P0414.
2. The AIRD solenoid circuit is monitored for open and shorted conditions by the AIRD output state

monitor. The DTCs associated with this test are DTCs P0416 and P0417.

3. An upstream and downstream functional air flow test is performed during idle, once per engine start-up, and only after all H02S monitor tests have been successfully performed. The flow test relies upon the upstream and downstream H02S to detect the presence of additional air in the exhaust when introduced by the secondary air injection system. The DTCs associated with this test are DTCs P0411 and P1411.
4. The Malfunction Indicator Light (MIL) is turned on after one of the above tests fail on 2 consecutive drive cycles.



1. Solenoid (AIRB) Circuit
2. Solenoid (AIRB) Circuit
3. Upstream/Downstream Air Flow
4. Malfunction Indicator Light (MIL)

G00076230

Fig. 15: Identifying Secondary Air Injection System Monitor Components (Belt Driven Air Pump) Courtesy of FORD MOTOR CO.

DRIVE CYCLES

OBD-II MONITOR DISPLAY ON SCAN TOOL

On-board system readiness function is available on New Generation Star (NGS) tester or generic scan tools. Readiness function indicates status of each OBD-II monitor. One Parameter Identification (PID) display on NGS tester, summarizers the status of all monitors.

OBD-II DRIVE CYCLE & DIAGNOSTIC TROUBLE CODES

A Diagnostic Trouble Code (DTC) will be stored in PCM memory after a malfunction is first detected. A DTC will be erased from the PCM's memory after 40 engine warm-up cycles without the malfunction being detected after the MIL is turned off. Once a monitor turns on the MIL, it will require 3 consecutive drive cycles without a fault for the MIL to turn off. Another method of erasing the DTC is by initiating a PCM reset. DTC memory storage requirements vary with each monitor. See appropriate monitor under **ON BOARD DIAGNOSTIC-II MONITOR** .

VEHICLE PREPARATION FOR OBD-II OR MONITOR REPAIR VERIFICATION DRIVE CYCLE

NOTE: Vehicles equipped with Power Take Off (PTO) must have this system disengaged before proceeding. Verify by viewing the PTO PID for OFF status.

1. Attach a scan tool and access the ECT, FLI, IAT PIDs:
   - Verify the IAT PID is between 50-100° F (10-38°C).
   - Verify the FLI PID is between 15% and 85% (only available on EVAP running loss systems).
2. Warm the vehicle until the ECT PID reaches a minimum of 130°F (54° C).
3. Clear all DTC's with the scan tool by pressing clear with the key on engine off. P1000 will remain. Leave the key in the ON position (do not move ignition switch to OFF position), and start the vehicle.
4. Access the ON-BOARD SYSTEM READINESS menu on the scan tool to view the status of the OBD-II monitors.
5. Proceed with the OBD-II drive cycle or selected monitor repair verification drive cycle. Once started, the engine must not be turned off.

OBD-II DRIVE CYCLE

NOTE: The IAT PID must be between 50-100°F (10-38℃) during the OBD II drive cycle to enter into all the OBD II monitors. The FLI PID must be between 15% and 85% at all times.

1. Drive in stop-and-go traffic with at least 4 idle periods (30 seconds each) while observing the status of the OBD II monitor on the scan tool. If the Exhaust Gas Recirculation (EGR), Heated Oxygen sensor (HO2S), Evaporative Emission (EVAP), Secondary Air (AIR) (if applicable) or catalyst efficiency monitor have not completed, drive on the highway at a constant speed over 40 MPH (64 km/hr), not to exceed 65 MPH (104 km/hr) for up to 15 minutes. Heavy accelerations, sudden decelerations and wide open throttles are not recommended. If the scan tool sends out a 3 pulse beep at any time, the OBD II drive cycle has completed.

NOTE: Vehicles equipped with the EVAP purge flow system or EVAP vapor management flow system monitor do not require EVAP monitor completion to clear the DTC P1000. See appropriate monitor under ON BOARD DIAGNOSTIC-II MONITOR . If the Exhaust Gas Recirculation (EGR), Heated Oxygen Sensor (HO2S), Evaporative Emission (EVAP), Secondary Air Injection (AIR) (if applicable) or catalyst efficiency monitor has not completed, perform the corresponding monitor verification drive cycle in this section.

2. Bring the vehicle to a stop and retrieve continuous memory DTCs to verify the DTC P1000 has been erased. See **QUICK TEST** .

MONITOR REPAIR VERIFICATION DRIVE CYCLES

Comprehensive Component Monitor Repair Verification Drive Cycle

1. Refer to and complete the vehicle check and preparation before initiating the following repair verification steps. See **VEHICLE CHECK/PREPARATION** .
2. Start the engine and go through the entire OBD II drive cycle until the comprehensive component monitor shows the completion status by clearing the code P1000 on the scan tool.
3. If the entire OBD II drive cycle has been performed and the comprehensive component monitor check has not completed, rerun quick test. See **QUICK TEST** .

EGR MONITOR REPAIR VERIFICATION DRIVE CYCLE

NOTE: Ambient air temperature or IAT PID must read a minimum of 32°F (0°C) to initiate the EGR monitor.

1. Refer to and complete the vehicle check and preparation before initiating the following repair verification steps. See **VEHICLE CHECK/PREPARATION** .
2. Start the engine and drive the vehicle for 6 minutes:
   - Drive in stop-and-go traffic for 5 minutes with at least 2 idle periods.
   - Accelerate to 45 MPH (72 km/h) at more than 1/2 throttle (35 MPH [56 km/h] on Escort/Tracer). Maintain speed for one minute.
3. Rerun quick test. See **QUICK TEST** .

EVAP RUNNING LOSS MONITOR SYSTEM REPAIR VERIFICATION DRIVE CYCLE

1. Perform the preparation for OBD II drive cycle section. See **VEHICLE PREPARATION FOR OBD-II OR MONITOR REPAIR VERIFICATION DRIVE CYCLE** under DRIVE CYCLES.
2. With the scan tool, verify the FTP V PID reads between 2.4 and 2.8 volts with the gas cap removed. Reinstall gas cap.
3. With the scan tool, view the OBD II monitors through the ON-BOARD SYSTEM READINESS menu.
4. Drive the vehicle at a constant speed between 35 MPH (56 km/hr) and 65 MPH (104 km/hr) with throttle as steady as possible. Observe the HO2S monitor on the scan tool until it completes, or refer to **FUEL MONITOR OR HO2S MONITOR REPAIR VERIFICATION DRIVE CYCLE** .
5. Bring the vehicle to a stop and access the following PIDs with the scan tool:
   - IAT, FLI, FTP, V, EVAPPDC, EVAPCV.
6. Verify the following EVAP monitor entry condition:
   - IAT between 50-100°F (10-38°C).
7. Drive the vehicle on the highway with a constant speed over 64 km/hr (40 MPH) with throttle as steady as possible. During this time, verify the following additional EVAP monitor entry conditions using the FLI and FTPV PIDs:
   - FLI stable +/- 5% between the limits of 15% and 85% tank fill.
   - FTP V stable within +/- 0.1 volt.
8. Prior to running the EVAP monitor, when the EVAPPDC PID is less than 75%, the canister vent solenoid

is open and the system is unsealed. To initiate the EVAP monitor, the EVAPPDC PID must increase to at least 75%. At this time, the EVAPCV PID will then display 100% (canister vent solenoid closed to seal the system and the monitor will begin to run. Continue to drive at steady throttle with light steering until the EVAPCV PID displays 0% (canister vent solenoid open, system unsealed). If this step does not occur as described, proceed to the following note, otherwise proceed to next step.

NOTE: During the drive cycle or hot ambient temperatures, fuel vapor (from the canister and/or tank) may keep the test from starting. The following be observed on the scan tool when either:

- **The EVAPPDC PID never reaches 75% with stable FLI and FTP PID readings.**
- **The EVAPCV PID never goes to 100% (canister vent never closes) when the EVAPPDC PID is above the 75% minimum to start the test.**

9. Bring vehicle to a stop.
10. With the scan tool, view the EVAP monitor for completion through the On-Board System Readiness Menu. Repeat 7 if the EVAP monitor is not complete.

CATALYST MONITOR REPAIR VERIFICATION DRIVE CYCLE

1. Refer to and complete the vehicle check and preparation before initiating the following repair verification steps. See **VEHICLE CHECK/PREPARATION** .
2. Start the engine and drive the vehicle for 25 minutes:
   - Drive in stop-and-go traffic for 20 minutes, include 6 different constant speeds between 25 and 45 MPH (40 and 72 km/h).
   - Drive on expressway or highway for an additional 5 minutes.
3. Rerun quick test. See **QUICK TEST** .

FUEL MONITOR OR HO2S MONITOR REPAIR VERIFICATION DRIVE CYCLE

1. Refer to and complete the vehicle check and preparation before initiating the following repair verification steps. See **VEHICLE CHECK/PREPARATION** .
2. Start the engine and drive the vehicle for 7 minutes:
   - Drive in stop-and-go traffic for 6 minutes, include one idle.
   - Accelerate to 45 MPH (72 km/h) at more than 1/2 throttle (Escort/Tracer 35 MPH [56 km/h]). Maintain speed for one minute.
3. Rerun quick test. See **QUICK TEST** .

MISFIRE MONITOR REPAIR VERIFICATION DRIVE CYCLE

1. For applications with the Fuel Level Input (FLI) circuit to the PCM (pin 12), check the fuel gauge and the FLI PID on the scan tool (if available). The misfire monitor can only be tested if the fuel gauge reads above one quarter full or the FLI PID is above 15% (percentage fuel tank fill).

2. Start the engine and drive the vehicle to a location where speeds can reach 55 to 60 MPH (88 to 97 km/h) and coast down to 40 MPH (64 km/h) without traffic interference.
3. Accelerate at wide-open throttle to allow vehicle to shift at red-line (if equipped with a tachometer). Immediately return to normal speed limits.
4. Perform the following drive procedure 3 consecutive times:
   - Accelerate on highway to 60 MPH (97 km/h). Maintain speed for 30 seconds.
   - Coast down with foot off the accelerator pedal from 60 MPH to 40 MPH (97 km/h to 64 km/h).
5. Rerun quick test. See **QUICK TEST** .

SECONDARY AIR MONITOR REPAIR VERIFICATION DRIVE CYCLE

1. Refer to and complete the vehicle check and preparation before initiating the following repair verification steps. See **VEHICLE CHECK/PREPARATION** .
2. Start the engine and proceed through the entire OBD II drive cycle until the secondary air monitor shows the ON-BOARD READINESS menu completion status on the scan tool.
3. If the entire OBD II drive cycle has been performed and the secondary air monitor check has not completed, rerun quick test. See **QUICK TEST** .

VEHICLE CHECK/PREPARATION

WARNING: Vehicles are equipped with air bag supplemental restraint system. Before attempting any repairs involving steering column, instrument panel or related components, see SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM in appropriate AIR BAG RESTRAINT SYSTEMS article.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

Visual Checks

- Inspect the air cleaner and inlet ducting.
- Check all engine vacuum hoses for damage, leaks, cracks, kinks, proper routing, etc.
- Check electronic Engine Control (EC) system wiring harness for proper connections, bent or broken pins, corrosion, loose wires, proper routing, etc.
- Check the Powertrain Control Module (PCM), sensors and actuators for physical damage.
- Check the engine coolant for proper level and mixture.
- Check the transmission fluid level and quality.
- Make all necessary repairs before continuing with quick test.

Vehicle Preparation

- Perform all safety steps required to start and run vehicle tests. Apply parking brake, place shift lever firmly into PARK position (NEUTRAL on manual transmission), block drive wheels, etc.
- Turn off ALL electrical loads: radios, lamps, A/C, blower, fans, etc. Start engine and bring up to normal operating temperature before running quick test. See **QUICK TEST** .

SUMMARY

If no diagnostic trouble code is present but driveability problem still exists, proceed to **TESTS W/O CODES - 4.2L** article for symptom diagnosis or intermittent diagnostic procedures.

DIAGNOSTIC TROUBLE CODE (DTC) REFERENCE CHARTS

DTC REFERENCE CHART

DTC	Description	Circuit Test/Step: KOEO	Circuit Test/Step: KOER	Circuit Test/Step: CONT.
P0102	Mass Air Flow Circuit Low Input	-	DC/6	DC/6
P0103	Mass Air Flow Circuit High Input	DC/20	DC/20	DC/20
P0112	Intake Air Temperature Circuit Low Input	DA/20	DA/20	DA/90
P0113	Intake Air Temperature Circuit High Input	DA/10	DA/10	DA/90
P0117	Engine Coolant Temperature Circuit Low Input	DA/20	DA/20	DA/90
P0118	Engine Coolant Temperature Circuit High Input	DA/10	DA/10	DA/90
P0121	Throttle Position Circuit Performance Problem	-	DH/22	DH/22
P0122	Throttle Position Circuit Low Input	DH/11	DH/11	DH/11
P0123	Throttle Position Circuit High Input	DH/8	DH/8	DH/8
P0125	Insufficient Coolant Temperature For Closed Loop Fuel Control	-	-	DA/100
P0131	Heated Oxygen Sensor (HO2S-11) Circuit Out Of Range Low Voltage	-	-	H/27
P0133	Heated Oxygen Sensor (HO2S-11) Circuit Slow Response	-	-	H/20
P0135	Heated Oxygen Sensor (HO2S-11) Circuit Malfunction	H/30	H/30	H/30
P0136	Heated Oxygen Sensor (HO2S-	-	-	H/80

	12) Circuit Malfunction			
P0141	Heated Oxygen Sensor (HO2S-12) Circuit Malfunction	H/30	H/30	H/30
P0151	Heated Oxygen Sensor (HO2S-21) Circuit Out Of Range Low Voltage	-	-	H/27
P0153	Heated Oxygen Sensor (HO2S-21) Circuit Slow Response	-	-	H/20
P0155	Heated Oxygen Sensor (HO2S-21) Circuit Malfunction	H/30	H/30	H/30
P0156	Heated Oxygen Sensor (HO2S-22) Circuit Malfunction	-	-	H/80
P0161	Heated Oxygen Sensor (HO2S-22) Circuit Malfunction	H/30	H/30	H/30
P0171	System To Lean (Bank 1)	-	-	H/41
P0172	System To Rich (Bank 1)	-	-	H/41
P0174	System To Lean (Bank 2)	-	-	H/41
P0175	System To Rich (Bank 2)	-	-	H/41
P0222	Throttle Position Sensor B Low Input	HT/1	HT/1	HT/1
P0223	Throttle Position Sensor B High Input	HT/10	HT/10	HT/10
P0230	Fuel Pump Primary Circuit Malfunction	KA/1	KA/1	KA/40
P0231	Fuel Pump Secondary Circuit Low Input	KA/20	KA/20	KA/35
P0232	Fuel Pump Secondary Circuit High Input	KA/10	KA/10	KA/30
P0300	Random Misfire	-	HD/1	HD/1
P0301	Misfire Detection Monitor - Cylinder No. 1	-	HD/1	HD/1
P0302	Misfire Detection Monitor - Cylinder No. 2	-	HD/1	HD/1
P0303	Misfire Detection Monitor - Cylinder No. 3	-	HD/1	HD/1
P0304	Misfire Detection Monitor - Cylinder No. 4	-	HD/1	HD/1
P0305	Misfire Detection Monitor - Cylinder No. 5	-	HD/1	HD/1
P0306	Misfire Detection Monitor - Cylinder No. 6	-	HD/1	HD/1
P0320	Ignition Engine Speed Input Circuit Malfunction	-	-	**NC/1**

P0325	Knock Sensor 1 Circuit Malfunction (Bank 1)	-	DG/1	DG/1
P0326	Knock Sensor 1 Circuit Range/Performance (Bank 1)	-	DG/1	DG/1
P0330	Knock Sensor 2 Circuit Malfunction (Bank 2)	-	DG/1	DG/1
P0330	Knock Sensor 2 Circuit Range/Performance (Bank 2)	-	DG/1	DG/1
P0340	Camshaft Position Sensor Circuit Malfunction	-	DR/1	DR/1
P0350	Ignition Coil Primary/Secondary Circuit Malfunction	-	-	JE/60
P0351	Ignition Coil A Primary/Secondary Circuit Malfunction	-	-	JE/60
P0352	Ignition Coil B Primary/Secondary Circuit Malfunction	-	-	JE/60
P0353	Ignition Coil C Primary/Secondary Circuit Malfunction	-	-	JE/60
P0401	Exhaust Gas Recirculation Flow Insufficient	-	-	HE/70
P0402	Exhaust Gas Recirculation Flow Excessive	-	HE/20	HE/20
P0411	Secondary Air Injection System - Electric Air Pump	HM/7	HM/7	HM/7
P0412	Secondary Air Injection System Circuit Malfunction	HM/1	HM/1	HM/1
P0413	Secondary Air Injection System	HM/75	HM/75	HM/75
P0414	Secondary Air Injection System	HM/75	HM/75	HM/75
P0416	Secondary Air Injection System	HM/75	HM/75	HM/75
P0417	Secondary Air Injection System	HM/75	HM/75	HM/75
P0420	Catalyst System Efficiency Below Threshold (Bank 1)	-	-	HF/1
P0430	Catalyst System Efficiency Below Threshold (Bank 2)	-	-	HF/1
P0442	Evaporative Emission Control System Leak (Small Leak)	-	-	HX/1
P0443	Evaporative Emission Control System Canister Purge Valve Circuit Malfunction	HX/7	HX/7	HX/6
P0446	Evaporative Emission Control System Excessive Fuel Tank	-	-	HX/13

	Vacuum			
P0452	Fuel Tank Pressure Sensor Circuit Low Voltage	HX/22	HX/22	HX/22
P0453	Fuel Tank Pressure Sensor Circuit High Voltage	HX/28	HX/28	HX/28
P0455	Evaporative Emission Control System Leak (No Purge Flow Or Large Leak)	-	-	HX/39
P0500	Vehicle Speed Sensor Malfunction	-	-	DP/1
P0501	Vehicle Speed Sensor Range/Performance	-	-	DP/1
P0503	Vehicle Speed Sensor Intermittent	-	-	DP/20
P0505	Vehicle Speed Sensor Intermittent	-	KE/2	-
P0603	Powertrain Control Module KAM Test Error	QB/1	-	-
P0605	Powertrain Control Module Read Only Memory Error	Replace PCM	Replace PCM	Replace PCM
P0703	Brake Switch Circuit Input Malfunction	-	-	FD/3
P0704	Clutch Pedal Position Switch Malfunction	TA/1	-	TA/1
P0705	Digital Transmission Range Circuit Failure	(1)	-	-
P0708	Digital Transmission Range Sensor/Transmission Range Sensor Circuit High Voltage	-	-	(1)
P0712	Transmission Fluid Temperature Sensor Circuit Grounded	(1)	(1)	(1)
P0713	Transmission Fluid Temperature Sensor Circuit Open	(1)	(1)	(1)
P0720	Insufficient Input From Output Shaft Speed Sensor	-	-	(1)
P0721	Noise Interference On Output Shaft Speed Sensor Signal	-	-	(1)
P0741	Torque Converter Clutch Slippage	-	-	(1)
P0743	Torque Converter Clutch Solenoid Circuit Failure	(1)	(1)	(1)
P0750	Shift Solenoid 1 Circuit Failure	(1)	(1)	(1)
P0751	Shift Solenoid 1 Functional Failure	-	-	(1)
P0755	Shift Solenoid 2 Circuit Failure	(1)	(1)	(1)

P0756	Shift Solenoid 2 Functional Failure	-	-	(1)
P0781	1-2 Shift Error	-	-	(1)
P0782	2-3 Shift Error	-	-	(1)
P0783	3-4 Shift Error	-	-	(1)
P1000	Monitor Testing Not Complete	(2)	(2)	QC/1
P1001	KOER Not Able To Complete, KOER Aborted	-	QA/1	-
P1100	Mass Air Flow Sensor Intermittent	-	-	DC/3
P1101	Mass Air Flow Sensor Out Of Self-Test Range	DC/2	DC/1	-
P1112	Intake Air Temperature Sensor Intermittent	-	-	DA/90
P1116	Engine Coolant Temperature Sensor Out Of Self-Test Range	DA/1	DA/1	-
P1117	Engine Coolant Temperature Sensor Intermittent	-	-	DA/90
P1120	Throttle Position Sensor Out Of Range Low (RATCH Too Low)	DH/3	DH/3	DH/3
P1121	Throttle Position Sensor Inconsistent With MAF Sensor	-	-	DH/15
P1124	Throttle Position Sensor Out Of Self-Test Range	DH/1	DH/1	DH/1
P1125	Throttle Position Sensor Intermittent	-	-	DH/20
P1127	Exhaust Not Warm Enough, Downstream Sensor Not Tested	-	H/100	-
P1128	Upstream Oxygen Sensors Swapped From Bank To Bank (HO2S-11-21)	-	H/110	-
P1129	Downstream Oxygen Sensors Swapped From Bank To Bank (HO2S-12-22)	-	H/110	-
P1130	Lack Of HO2S-11 Switch, Fuel Trim At Limit	-	-	H/40
P1131	Lack Of HO2S-11 Switch, Sensor Indicates Lean	-	H/40	H/40
P1132	Lack Of HO2S-11 Switch, Sensor Indicates Rich	-	H/40	H/40
P1137	Lack Of HO2S-12 Switch, Sensor Indicates Lean	-	H/80	-
P1138	Lack Of HO2S-12 Switch, Sensor	-	H/80	-

	Indicates Rich			
P1150	Lack Of HO2S-21 Switch, Fuel Trim At Limit	-	-	H/40
P1151	Lack Of HO2S-21 Switch, Sensor Indicates Lean	H/40	H/40	H/40
P1152	Lack Of HO2S-21 Switch, Sensor Indicates Rich	-	H/40	H/40
P1157	Lack Of HO2S-22 Switch, Sensor Indicates Lean	-	H/80	-
P1158	Lack Of HO2S-22 Switch, Sensor Indicates Rich	-	H/80	-
P1220	Series Throttle Control System Malfunction	HT/20	HT/20	HT/20
P1224	Throttle Position Sensor B Voltage Out Of Range	HT/40	HT/40	HT/40
P1260	Theft Detected - Vehicle Immobilized	-	-	QD/1
P1270	Engine RPM/Vehicle Speed Limiter	-	-	**ND/1**
P1309	Misfire Monitor Disabled	-	-	HD/40
P1390	Octane Adjust	FG/1	-	-
P1400	Differential Pressure Feedback Exhaust Gas Recirculation Sensor Circuit Low Voltage	HE/1	HE/1	HE/1
P1401	Differential Pressure Feedback Exhaust Gas Recirculation Sensor Circuit High Voltage	HE/10	HE/10	HE/10
P1405	Differential Pressure Feedback Exhaust Gas Recirculation Sensor Upstream Hose Off Or Plugged	-	-	HE/50
P1406	Differential Pressure Feedback Exhaust Gas Recirculation Sensor Downstream Hose Off Or Plugged	-	-	HE/60
P1408	Exhaust Gas Recirculation Flow Out Of Self-Test Range	-	HE/71	-
P1409	Exhaust Gas Recirculation Vacuum Regulator Solenoid Circuit Malfunction	HE/110	HE/110	HE/120
P1411	Secondary Air Injection System Downstream Flow	HM/40	HM/40	HM/40
P1413	Secondary Air Injection System Monitor Circuit Low	HM/18	HM/18	HM/18
P1414	Secondary Air Injection System	HM/25	HM/25	HM/25

	Monitor Circuit High			
P1442	Evaporative Emission Control System Leak (Small Leak)	-	-	HX/1
P1443	Very Small Or No Purge Flow Condition	-	-	HW/6
P1444	Purge Flow Sensor Circuit Low Input	-	-	HW/27
P1445	Purge Flow Sensor Circuit High Input	-	-	HW/33
P1450	Evaporative Emission Control System Excessive Fuel Tank Vacuum	-	-	HX/56
P1451	Evaporative Emission Control System Canister Vent Solenoid Circuit Malfunction	HX/65	HX/65	HX/65
P1452	Evaporative Emission Control System Unable To Bleed Up Fuel Tank Vacuum	-	-	HX/56
P1455	Evaporative Emission Control System Detected A Large Leak Or No Purge Flow	-	-	HX/40
P1460	Wide Open Throttle A/C Cutout Primary Circuit Malfunction	KM/1	KM/1	KM/30
P1464	A/C Demand Out Of Self-Test Range	KM/19	KM/19	-
P1500	Vehicle Speed Sensor Intermittent	-	-	DP/25
P1501	Vehicle Speed Sensor Out Of Self Test Range	-	DP/15	-
P1504	Idle Air Control Circuit Malfunction	KE/2	KE/2	KE/2
P1505	Idle Air Control System Reached Idle Air Trim Limit	KE/25	KE/25	KE/25
P1506	Idle Air Control Overspeed Error	-	KE/20	KE/20
P1507	Idle Air Control Underspeed Error	-	KE/2	KE/2
P1512	Intake Manifold Runner Control Malfunction (Stuck Closed)	-	-	HU/15
P1513	Intake Manifold Runner Control Malfunction (Stuck Closed)	-	-	HU/15
P1516	Intake Manifold Runner Control Input Error	HU/15	-	HU/15
P1517	Intake Manifold Runner Control Input Error	HU/15	-	HU/15
P1518	Intake Manifold Runner Control	HU/15	HU/15	HU/15

	Malfunction (Stuck Open)			
P1519	Intake Manifold Runner Control Malfunction (Stuck Closed)	HU/15	HU/15	HU/15
P1520	Intake Manifold Runner Control Circuit Malfunction	HU/15	HU/15	HU/15
P1537	Intake Manifold Runner Control Malfunction (Stuck Open)	HU/15	HU/15	HU/15
P1538	Intake Manifold Runner Control Malfunction (Stuck Open)	HU/15	HU/15	HU/15
P1549	Intake Manifold Communication Control Circuit Malfunction	HU/65	HU/65	HU/65
P1650	Power Steering Pressure Switch Malfunction	FF/1	FF/1	-
P1651	Power Steering Pressure Switch Signal Malfunction	-	FF/1	FF/1
P1701	Transmission/Transaxle Fault	-	-	(1)
P1703	Brake Switch Out Of Self-Test Range	FD/2	FD/1	-
P1705	Transmission Range Sensor Out Of Self-Test Range	(1)	(1)	-
P1709	Park/Neutral Position Switch Out Of Self-Test Range	TA/1	-	-
P1710	Transmission Fluid Temperature Sensor In Range Malfunction	(1)	(1)	(1)
P1711	Transmission Fluid Temperature Out Of Range	(1)	(1)	(1)
P1714	Shift Solenoid 1 Malfunction	-	-	(1)
P1715	Shift Solenoid 2 Malfunction	-	-	(1)
P1728	Transmission Slippage Error	-	-	(1)
P1731	1-2 Shift Error	-	-	(1)
P1732	2-3 Shift Error	-	-	(1)
P1733	3-4 Shift Error	-	-	(1)
P1740	Torque Converter Clutch Malfunction	-	-	(1)
P1741	Excessive Torque Converter Clutch Engagement Error	-	-	(1)
P1742	Torque Converter Clutch Solenoid Failed ON	-	-	(1)
P1743	Torque Converter Clutch Solenoid Failed ON	-	-	(1)
P1744	Excessive Torque Converter Clutch Slippage	-	-	(1)

P1746	Shorted Powertrain Control Module Output Driver	(1)	-	(1)
P1747	Electronic Pressure Control Solenoid Circuit Failure	(1)	-	(1)
P1751	Shift Solenoid 1 Functional Failure	-	-	(1)
P1756	Shift Solenoid 2 Functional Failure	-	-	(1)
P1767	Torque Converter Clutch Solenoid Circuit Failure	(1)	-	(1)
P1780	Transmission Control Switch Out Of Self-Test Range	-	TB/1	-
P1783	Transmission Fluid Temperature Exceeded	-	-	(1)
U1020	Module Communication Network Failure	-	-	(3)
U1039	Module Communication Network Failure	-	-	(3)
U1051	Module Communication Network Failure	-	-	(3)
U1135	Module Communication Network Failure	-	-	(3)
U1147	Vehicle Security Status Message Missing	-	-	(3)
U1451	Module Communication Network Failure	-	-	(3)

(1) Transmission/transaxle fault is indicated. See appropriate AUTOMATIC TRANSMISSION article.

(2) DTC P1000 indicates that OBD-II drive cycle has not been completed. Disregard this DTC in KOEO and KOER self-test and continue as directed.

(3) Module communication network failure is indicated. See appropriate MODULE COMMUNICATION NETWORK article in ACCESSORIES & EQUIPMENT.

PCM CONNECTOR IDENTIFICATION

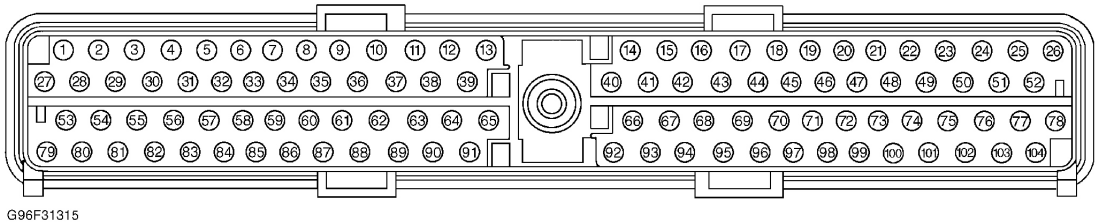


Fig. 16: Powertrain Control Module (PCM) Connector Terminal Identification

Courtesy of FORD MOTOR CO.

CIRCUIT TESTS

NOTE: A breakout box, connected to vehicle harness at PCM, is necessary to perform most circuit tests. References to Test Pin No. found in CIRCUIT TEST steps refer to test terminals on manufacturer's breakout box. Circuit diagrams at beginning of each test identify circuit and wire colors.

HOW TO USE CIRCUIT TESTS

1) Ensure all non-EEC related faults found while performing steps in **BASIC TESTING - 4.2L** article have been corrected. Follow each test step in order until fault is found. DO NOT replace any part unless directed to do so. When more than one code is retrieved, start with first code displayed.

2) CIRCUIT TESTS ensure electrical circuits are okay before sensors or other components are replaced. Always test circuits for continuity between sensor and PCM. Test all circuits for short to power, opens or short to ground. Voltage Reference (VREF) and Voltage Power (VPWR) circuits should be tested with ignition on or as specified in CIRCUIT TESTS.

3) DO NOT measure voltage or resistance at PCM. DO NOT connect any test light unless specified in testing procedure. All measurements are made by probing rear of connector (wiring harness side). Isolate both ends of a circuit and turn ignition off when checking for shorts or continuity, unless instructed otherwise.

4) Disconnect solenoids and switches from harness before measuring continuity and resistance or applying voltage. After each repair, check all component connections and repeat **QUICK TEST** .

5) An open circuit is defined as a resistance reading of greater than 5 ohms. This specification tolerance may be too high for some items in EEC-V system. If resistance approaches 5 ohms, always clean suspect connector and coat it with protective dielectric silicone grease. A short is defined as a resistance reading of less than 10,000 ohms to ground, unless stated otherwise in CIRCUIT TEST.

NOTE: In following tests, circuit diagrams and illustrations are courtesy of Ford Motor Co.

CIRCUIT TEST A - NO START VEHICLE WILL NOT START

CAUTION: Stop this test at first sign of a fuel leak. Do not allow smoking or an open flame in vicinity of vehicle during these tests.

Diagnostic Aids

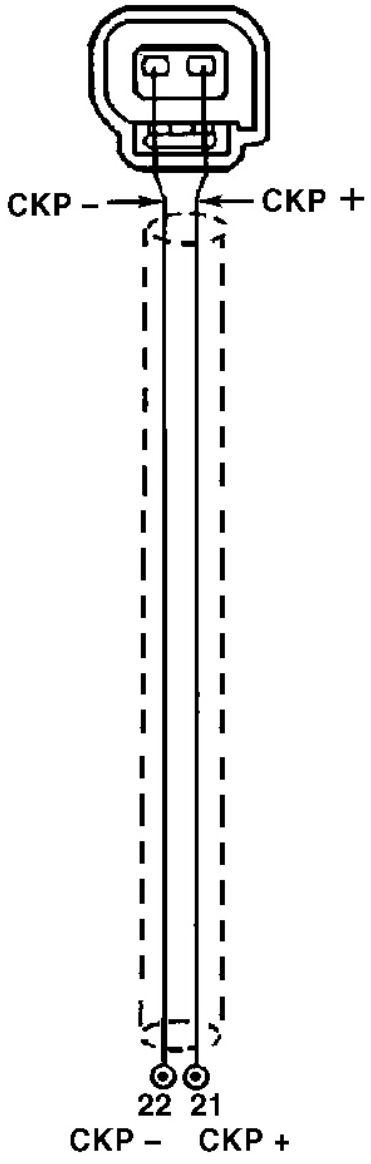
Enter this CIRCUIT TEST only when all steps under **QUICK TEST** have been successfully completed and engine still does not start or if directed here from another test or chart. This test is only intended to diagnose:

- Ignition Control Module (ICM).
- Powertrain Control Module (PCM).

- Spark (PCM-controlled).
- Wiring harness circuits (PIP, IGN GND and VPWR).

To prevent replacement of good components, be aware the following non-EEC related areas and components may be cause of problem:

- Fuel quality and quantity.
- Ignition (general condition).
- Engine mechanical components.
- Starter and battery circuits.
- Crankshaft Position (CKP) sensor.
- Ignition Control Module (ICM).
- Coil packs.



*TEST PINS LOCATED ON BREAKOUT BOX. ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

G95A35923

Fig. 17: Ignition System Test Circuits

1) Starting System Check Ensure Inertia Fuel Shutoff (IFS) switch is closed (button pushed in). Try to start engine. If engine does not crank, check vehicle starting and charging systems. If engine cranks, go to next step.

2) Attempt to start engine. If engine now starts, go to **CIRCUIT TEST Z** , step 50). If engine does not start, go to next step.

3) Check VREF At TP Sensor Turn ignition off. Disconnect TP sensor. Measure voltage between terminal VREF and SIG RTN at TP sensor wiring harness connector. See **Fig. 19** . If voltage is 4-6 volts, go to step 6). If resistance not 4-6 volts, go to **CIRCUIT TEST C** .

4) Check Flash EPROM (FEPS) Circuit For Short To Power With ignition on, measure voltage between negative battery terminal and DLC terminal No. 13. See **Fig. 1** . If voltage is less than 9 volts, go to next step. If voltage is 9 volts or more, repair circuit for a short to power and repeat quick test.

5) Check For Spark At Plugs Disconnect any spark plug wire. Connect spark tester between spark plug wire and ground. Connect Spark Plug Firing Indicator (D89P-6666-A). Crank engine while checking for spark. If spark is okay go to next step. If spark is not okay, go to **CIRCUIT TEST JD** , step 1).

6) Check Fuel Pressure Turn ignition off. Release fuel pressure. Install fuel pressure gauge. With scan tester connected, turn ignition on. Using scan tester, access OUTPUT TEST MODE and operate fuel pump to obtain maximum fuel pressure. For fuel pressure specifications, see **FUEL PRESSURE SPECIFICATIONS** article. If fuel pressure is as specified, go to next step. If fuel pressure is not as specified, go to **CIRCUIT TEST HC** , step 1).

7) Check Fuel Pressure Leakdown Leave fuel pressure gauge installed and ignition on. Turn ignition on. Using scan tester, access OUTPUT TEST MODE and operate fuel pump to obtain maximum fuel pressure. Exit OUTPUT TEST MODE and turn ignition off. If fuel pressure remains within 5 psi of maximum pressure for one minute after turning ignition off, go to next step. If fuel pressure does not remain as specified, go to **CIRCUIT TEST HC** , step 1).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 7) to step 17). NGV test procedures have been omitted.

17) Check PCM Driver To Coils Turn ignition off. Connect 12-volt test light between B+ and coil driver circuit. Crank engine while observing test light. Repeat procedure for each coil driver. Test light should blink brightly, once for each engine revolution. If test light blinks as specified, replace PCM and repeat **QUICK TEST** . If test light does not blink as specified, go to **CIRCUIT TEST JD** , step 4).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 17) to step 20). No test procedures have been omitted.

20) Identify Type Of No-Start Attempt to start engine. If engine now starts, go to **CIRCUIT TEST Z** , step 50). If engine does not start, go to next step.

NOTE: Ensure fuel pump inertia switch is closed (button pushed in).

21) Starting System Check Try to start engine. If engine cranks, go to next step. If engine does not crank, check vehicle starting and charging systems.

22) Check VREF At TP Sensor Turn ignition off. Disconnect TP sensor. Measure resistance between terminal VREF and SIG RTN at TP sensor wiring harness connector. If resistance is 4-6 volts, go to next step. If resistance is not 4-6 volts, go to **CIRCUIT TEST C** .

23) Check For Spark At Plugs Disconnect any spark plug wire. Connect spark tester between spark plug

wire and ground. Crank engine while checking for spark. If spark is okay, go to step 33). If spark is not okay, go to next step.

24) Check For Spark At Coil Disconnect coil secondary wire from distributor. Connect spark tester between wire and ground. Crank engine while checking for spark. If spark is not okay, go to next step. If spark is okay, go to **CIRCUIT TEST JB** , step 1).

25) Check Resistance Of IGN GND Circuit Ensure ignition is turned off. Disconnect Camshaft Position (CMP) sensor. Disconnect PCM 104-pin connector and inspect for damage. Repair as necessary. Install Breakout Box (014-00950) leaving PCM disconnected. Install EI Diagnostic Harness (007-00059) to breakout box. Connect B- to negative battery terminal. Connect ICM tee and CMP tee in-line with wiring harness. Ensure PIP OPEN/NORMAL/SPOUT OPEN switch or diagnostic is in NORMAL position. Install DI overlay. Measure resistance between test pin No. 23 and 35 (IGN GND) at breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

26) Reconnect CMP sensor. Connect PCM to breakout box. Turn breakout box timing switch to DIST position. Try to start engine. If engine starts, go to step 31). If engine does not start, go to next step.

27) Check SPOUT Signal Ensure ignition is off. While cranking engine, measure AC voltage between test pin No. 50 (SPOUT) and negative battery terminal. If voltage is 3-6 volts, go to **CIRCUIT TEST JD** . If voltage is not 3-6 volts, place timing switch in COMPUTED position and go to next step.

28) Check PIP & SPOUT Circuit For Short To Power Turn ignition off. Disconnect CMP, ICM and PCM. Turn ignition on. Measure voltage between test pin No. 49 (PIP) and negative battery terminal. Measure voltage between test pin No. 50 (SPOUT) and negative battery terminal. If voltage is less than 10.5 volts, go to next step. If voltage 10.5 volts or more, repair short to power and repeat **QUICK TEST** .

29) Check PIP & SPOUT Circuit For Short To Ground Turn ignition off. Measure resistance between breakout box test pin No. 49 (PIP) and test pins No. 23, 51, 91 and 103. Measure resistance between breakout box test pin No. 50 (SPOUT) and test pins No. 23, 51, 91 and 103. If resistance each is greater than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short circuit and repeat **QUICK TEST** . If vehicle will not start, go to next step.

30) Isolate Shorts In PCM Ensure ignition is off. Connect PCM to breakout box. Measure resistance between breakout box test pin No. 49 (PIP) and test pins No. 71 and 97 for short to power. Measure resistance between breakout box test pin No. 49 (PIP) and test pins No. 51 and 103 for short to ground. Measure resistance between breakout box test pin No. 50 (SPOUT) and test pins No. 71 and 97 for short to power. Measure resistance between breakout box test pin No. 49 (PIP) and test pins No. 51 and 103 for short to ground.

If resistance each is greater than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, replace PCM and repeat **QUICK TEST** .

31) Check PIP Signal Ensure ignition is off and PCM is connected to breakout box. While cranking engine, measure voltage between test pin No. 49 and test pins No. 51 and 103. If voltage is 3-7 volts, replace PCM and repeat **QUICK TEST** . If voltage is not 3-7 volts, go to next step.

32) Check Resistance Of PIP Circuit Ensure ignition is off. Disconnect PCM from breakout box. Disconnect CMP and ICM. Measure resistance between breakout box test pin No. 49 and EI Diagnostic Harness test pins No. 15 and 34. If resistance is less than 5 ohms, reconnect all components and go to **CIRCUIT TEST JB** . If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

33) Check SPOUT Signal Ensure ignition is off. Connect PCM to breakout box. Ensure breakout box

timing switch is in COMPUTED position. While cranking engine, measure voltage between test pin No. 50 and test pins No. 51 and 103. If voltage is 3-6 volts, go to next step. If voltage is not 3-6 volts, go to step 28).

34) Check Fuel Pressure Turn ignition off. Release fuel pressure. Install fuel pressure gauge. With scan tester connected, turn ignition on. Using scan tester, access OUTPUT TEST MODE and operate fuel pump to obtain maximum fuel pressure. For fuel pressure specifications, see **FUEL PRESSURE SPECIFICATIONS** article. If fuel pressure is as specified, go to next step. If fuel pressure is not as specified, go to **CIRCUIT TEST HC** , step 1).

35) Check Fuel Pressure Leakdown Leave fuel pressure gauge installed and ignition on. Turn ignition on. Using scan tester, access OUTPUT TEST MODE and operate fuel pump to obtain maximum fuel pressure. Exit OUTPUT TEST MODE and turn ignition off. If fuel pressure remains within 5 psi of maximum pressure for one minute after turning ignition off, fuel system is okay and testing is complete. If fuel pressure does not remain as specified, go to **CIRCUIT TEST HC** , step 1).

CIRCUIT TEST B - EEC-V POWER RELAY

This circuit test is only intended to diagnose the following components and circuits:

- Vehicle wiring harness circuits (VPWR, IGNITION START/RUN, B+ and Ground).
- EEC-V power relay.
- Powertrain Control Module (PCM).

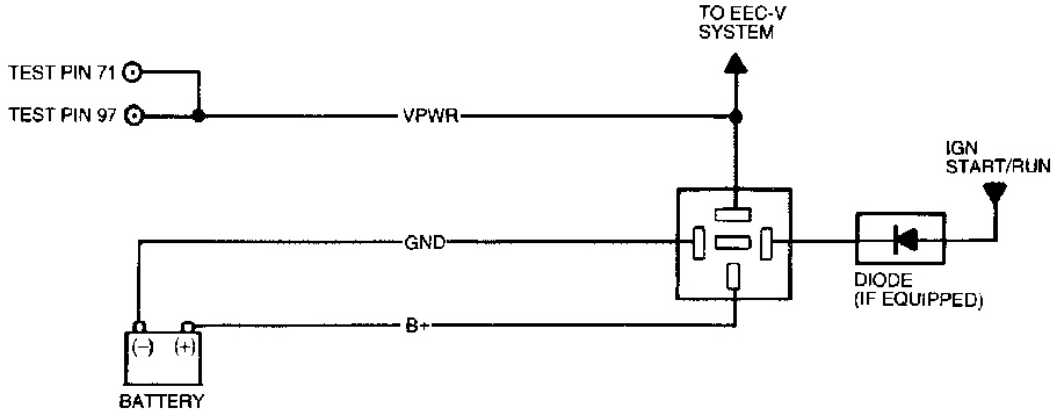


Fig. 18: EEC-V Power Relay Test Circuits

1) Check VPWR Circuit Resistance Turn ignition off. Disconnect Idle Air Control (IAC) solenoid and EEC-V power relay wiring harness connectors. Disconnect scan tool (if applicable). Measure resistance between VPWR terminal of IAC solenoid connector and VPWR terminal of EEC-V power relay. If resistance is less than 5 ohms, reconnect IAC solenoid and go to next step. If resistance is 5 ohms more,

repair open in VPWR circuit between EEC-V power relay and IAC solenoid.

2) Check Voltage To EEC-V Power Relay Leave ignition off and EEC-V power relay disconnected. Connect DVOM negative lead to negative battery terminal. Measure voltage at B+ terminal of EEC-V power relay connector. Turn ignition on. Measure voltage at IGN START/RUN. If voltage is less than 10.5 volts, repair open circuit and repeat **QUICK TEST** . If voltage is more than 10.5 volts, replace EEC-V power relay and repeat QUICK TEST.

3) Check Ground Circuit To EEC-V Power Relay Leave ignition off and EEC-V power relay disconnected. Measure voltage between Ground terminal and B+ terminal of EEC-V power relay. If resistance is more than 10.5 volts, replace EEC-V power relay. If resistance is 10.5 volts or less, repair open in Ground circuit and repeat **QUICK TEST** .

CIRCUIT TEST C - REFERENCE VOLTAGE

Diagnostic Aids

SIG RTN is a dedicated ground used by most EEC-V system sensors. VREF is a 5-volt reference voltage that is continuously output by PCM. This consistent voltage signal is used on all 3-wire sensors.

This circuit test is only intended to diagnose the following components and circuits:

- A/C Pressure sensor, DPFE sensor and TP sensor.
- Vehicle wiring harness circuits (SIG RTN and VREF).
- Powertrain Control Module (PCM).

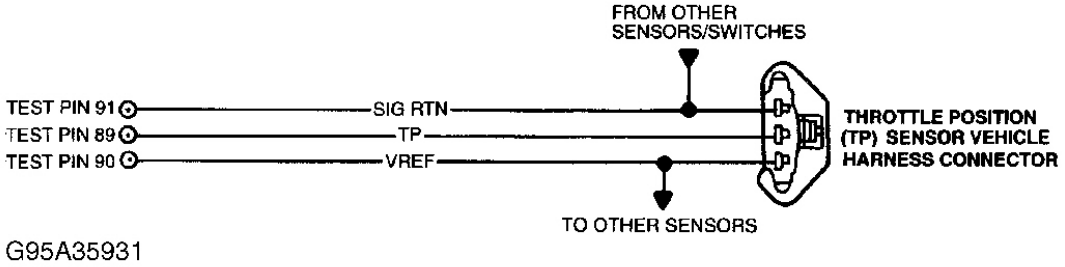


Fig. 19: Reference Voltage Circuits & Connector Terminals

Diagnostic Aids

If VREF voltage is more than 6 volts, go to step 35). If voltage is less than 6 volts, go to step 1).

1) Check Battery Voltage Turn ignition on. Measure voltage between battery terminals. If battery voltage is more than 10.5 volts, go to next step. If voltage is 10.5 volts or less, recharge or replace battery as necessary.

2) Check SIG RTN Circuit Disconnect suspect sensor wiring harness connector. Measure voltage

between SIG RTN terminal of suspect sensor and positive battery terminal. If voltage measurement is more than 10.5 volts and within one volt of battery voltage, go to next step. If voltage is less than 10.5 volts, go to step 25).

3) Check Scan Tool Ability To Access Parameter Identification (PID) PID is area of PCM Random Access Memory (RAM) that holds operating information for input and output data. If scan tool is able to access ECT PID, go to step 20). If scan tool is unable to access ECT PID, go to next step.

4) Check VPWR To Idle Air Control (IAC) Solenoid Turn ignition off. Disconnect TP sensor wiring harness connector. Disconnect IAC solenoid. Turn ignition on. Measure voltage between VPWR terminal (Red wire) at IAC wiring harness connector and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, reconnect wiring harness connector and go to **CIRCUIT TEST B** .

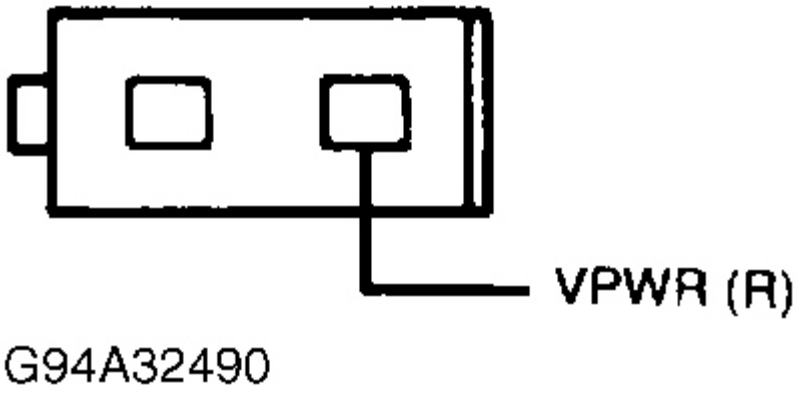


Fig. 20: IAC Wiring Harness Connector Terminals

5) Check For Shorted DPFE Or EGR Valve Position (EVP) Sensor Disconnect TP wiring harness connector. Disconnect DPFE sensor. Turn ignition on. Measure voltage between TP sensor wiring harness connector SIG RTN terminal and VREF terminal. If voltage measurement is 4-6 volts, replace DPFE or EVP sensor and repeat **QUICK TEST** . If voltage measurement is not 4-6 volts, proceed as follows:

- For models with Fuel Tank Pressure (FTP) sensor, go to next step.
- For models with A/C Pressure (ACP) sensor, go to step 7).
- For models with Power Steering Pressure (PSP) sensor, go to step 9).
- For models with Fuel Rail Pressure (FRP) sensor, go to step **10)** .
- For all other vehicles, go to step 15).

6) Check For Shorted Fuel Tank Pressure (FTP) Sensor Leave DPFE and TP sensor disconnected. Disconnect FTP sensor. Turn ignition on. Measure voltage between TP sensor wiring harness connector

SIG RTN terminal and VREF terminal. If voltage measurement is 4-6 volts, replace FTP sensor and repeat **QUICK TEST** . If voltage measurement is not 4-6 volts, proceed as follows:

- For models with A/C Pressure (ACP) sensor, go to next step.
- For all other vehicles, go to step 15).

7) Check For Shorted AC Pressure (ACP) Sensor) Leave DPFE and TP sensor disconnected. Disconnect ACP sensor. Turn ignition on. Measure voltage between TP sensor wiring harness connector SIG RTN terminal and VREF terminal. If voltage measurement is 4-6 volts, replace ACP sensor and repeat **QUICK TEST** . If voltage measurement is not 4-6 volts, proceed as follows:

- For models with Traction Assist, go to next step.
- For models without Traction Assist, go to step 15).

8) Check For Shorted TP-B Sensor Disconnect Throttle Position sensor B (TP-B). Leave ACP, DPFE and TP sensor disconnected. Turn ignition on. Measure voltage between TP sensor wiring harness connector SIG RTN terminal and VREF terminal. If voltage measurement is 4-6 volts, replace TP-B sensor and repeat **QUICK TEST** . If voltage measurement is not 4-6 volts, go to step 15).

9) Check For Shorted Power Steering Pressure (PSP) Sensor Leave DPFE and TP sensor disconnected. Disconnect PSP sensor. Turn ignition on. Measure voltage between TP sensor wiring harness connector SIG RTN terminal and VREF terminal. If voltage measurement is 4-6 volts, replace PSP sensor and repeat **QUICK TEST** . If voltage measurement is not 4-6 volts, go to step 15).

10) Check For Shorted Fuel Rail Pressure (FRP) Sensor Leave DPFE and TP sensor disconnected. Disconnect FPR sensor. Turn ignition on. Measure voltage between TP sensor wiring harness connector SIG RTN terminal and VREF terminal. If voltage measurement is 4-6 volts, replace FPR sensor and repeat **QUICK TEST** . If voltage measurement is not 4-6 volts, go to step 15).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 10) to step 13). No test procedures have been omitted.

13) Check For Shorted EGR Valve Position (EGRP) Sensor Leave TP sensor disconnected. Disconnect EGRP sensor. Turn ignition on. Measure voltage between TP sensor wiring harness connector SIG RTN terminal and VREF terminal. If voltage measurement is 4-6 volts, replace EGRP sensor and repeat **QUICK TEST** . If voltage measurement is not 4-6 volts, go to next step.

14) Check For Shorted EGR Boost (EGRB) Sensor Leave EGRP and TP sensor disconnected. Disconnect EGRB sensor. Turn ignition on. Measure voltage between TP sensor wiring harness connector SIG RTN terminal and VREF terminal. If voltage measurement is 4-6 volts, replace EGRB sensor and repeat **QUICK TEST** . If voltage measurement is not 4-6 volts, go to next step.

15) Check VPWR To PCM Turn ignition off. Leave all previously disconnected sensors disconnected. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install Breakout Box (014-00950) leaving PCM disconnected. Turn ignition on. Measure voltage between test pins No. 71 (VPWR) and 77 (PWR GND). If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit between IAC splice and PCM.

16) Check VREF Circuit For Short To Ground Or SIG RTN Turn ignition off. Leave all previously disconnected sensors disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 90 (VREF) and test pins No. 51 and 103 (PWR GND), and 91 (SIG RTN). If any resistance is less than 10,000 ohms, repair VREF short to ground and repeat **QUICK TEST** . If resistance is 10,000 ohms or more, replace PCM and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 16) to step 20). No test procedures have been omitted.

20) Check VREF Resistance To PCM Turn ignition off. Ensure sensor with failed VREF circuit is disconnected. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install Breakout Box (014-00950) leaving PCM disconnected. Measure resistance between test pin No. 90 (VREF) and VREF terminal at suspect sensor wiring harness connector. If resistance is less than 5 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open in VREF and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 20) to step 25). No test procedures have been omitted.

25) Check Scan Tool Ability To Access Parameter Identification (PID) If scan tool is able to access ECT PID, go to next step. If scan tool is unable to access ECT PID, go to step 28).

26) Check KOEO DTCs If KOEO DTCs are present for 2 or more sensors connected to SIG RTN circuit, go to next step. If KOEO DTCs are not as specified, repair open in SIG RTN to sensor where VREF circuit failed.

27) Check SIG RTN Circuit Resistance To PCM Turn ignition off. Disconnect scan tester from DLC. Disconnect sensor where VREF circuit failed. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install Breakout Box (014-00950) leaving PCM disconnected. Measure resistance between test pin No. 91 (SIG RTN) and SIG RTN terminal of suspect sensor wiring harness connector. If resistance is less than 5 ohms, reconnect sensor and go to next step. If resistance is 5 ohms or more, repair open in SIG RTN circuit and repeat **QUICK TEST** .

28) Check PCM PWR GND Circuits Turn ignition off. Leave scan tester disconnected. Measure resistance between negative battery terminal and test pins No. 51, 77 and 103 (PWR GND). If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

29) Check Ground Circuits In PCM Leave ignition off and scan tester disconnected. Connect PCM to breakout box. Measure resistance between test pin No. 91 (SIG RTN) and test pins No. 51, 77 and 103 (PWR GND). If each resistance is less than 5 ohms, PWR GND and SIG RTN circuits are okay. Return to step 25) to verify results. If any resistance is 5 ohms or more, replace PCM and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 29) to step 35). No test procedures have been omitted.

35) Check VREF Circuit For Short To Power Turn ignition off. Ensure sensor with failed VREF circuit is disconnected. Leave all components connected to VREF circuit disconnected. See **Fig. 21** . Disconnect PCM. Turn ignition on. Measure voltage between VREF terminal at TP sensor wiring harness connector and negative battery terminal. If voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volt or more, repair VREF circuit for a short to power and repeat QUICK TEST.

Applications	TP	EGR	FTP	ACP	PSP	FRP
Probe	X	EGRVP, BARO				
2.5L Contour / Mystique, Thunderbird / Cougar	X	D.P.F. EGR				
Aerostar, Ranger	X	D.P.F. EGR				
Taurus / Sable, Taurus SHO, Town Car, Windstar	X	D.P.F. EGR	X			
Explorer / Mountaineer[a]	X	EGRV / D.P.F. EGR	X			
Crown Victoria (except NGV), Grand Marquis,	X	D.P.F. EGR	X			
5.4L E / F-Series (except NGV),	X	D.P.F. EGR	X			
4.2L F-Series, 4.6L, 5.4L, & 6.8L E / F-Series,	X	D.P.F. EGR	X			
Expedition / Navigator	X	D.P.F. EGR	X			
Continental	X	D.P.F. EGR	X	X		
Continental w / Traction control	X & TP-B	D.P.F. EGR	X	X		
Mark VIII	X	D.P.F. EGR	X	X		
Escort / Tracer	X	D.P.F. EGR		X	X	
2.0L Contour / Mystique	X	D.P.F. EGR			X	
Crown Victoria, 5.4L E / F-Series w / NGV	X	D.P.F. EGR				X

a (Mid model year)

G96H29121

Fig. 21: Components Connected To VREF Circuit

CIRCUIT TEST DA - TEMPERATURE SENSOR TEST (IAT & ECT)

Diagnostic Aids

Perform this test only when directed by QUICK TEST. Ambient air temperature must be at least 50°F (10°C) to receive valid input from IAT sensor. Engine coolant temperature must be more than 50°F (10°C) to pass **KOEO SELF-TEST** and more than 180°F (82°C) to pass KOER SELF-TEST. Voltage values in this test are based on a 5-volt VREF signal. Values may vary up to 15 percent due to sensor and VREF variations.

This circuit test is intended to diagnose the following components and circuits:

- Intake Air Temperature (IAT) sensor.
- Engine Coolant Temperature (ECT) sensor.
- Wiring harness circuits (IAT, ECT and SIG RTN).
- Powertrain Control Module (PCM).

To prevent replacing good components, ensure the following non-EEC areas or components are not cause of problem:

- Coolant level low.
- Cooling system, water pump or fan.
- Engine operating temperature.
- Engine oil level low.
- Thermostat.
- Air cleaner duct.
- Ambient temperature.

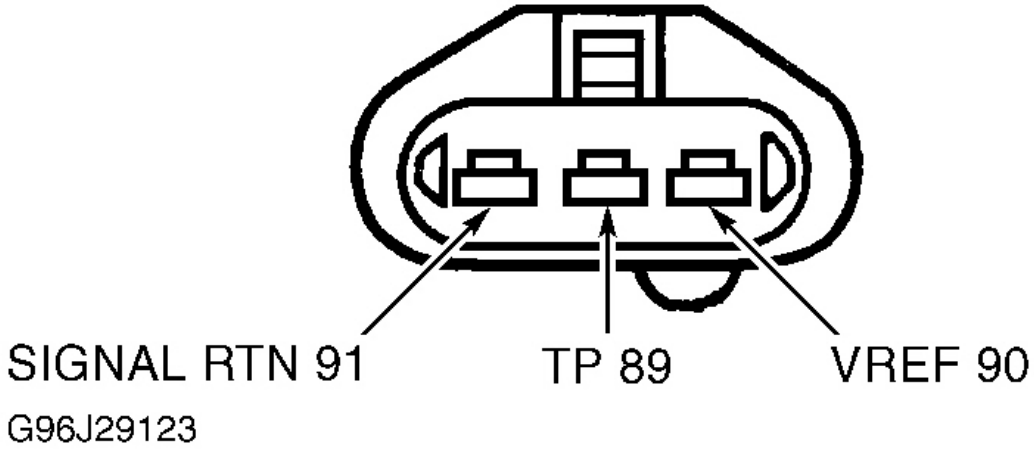


Fig. 22: Throttle Position (TP) Sensor Connector Terminals

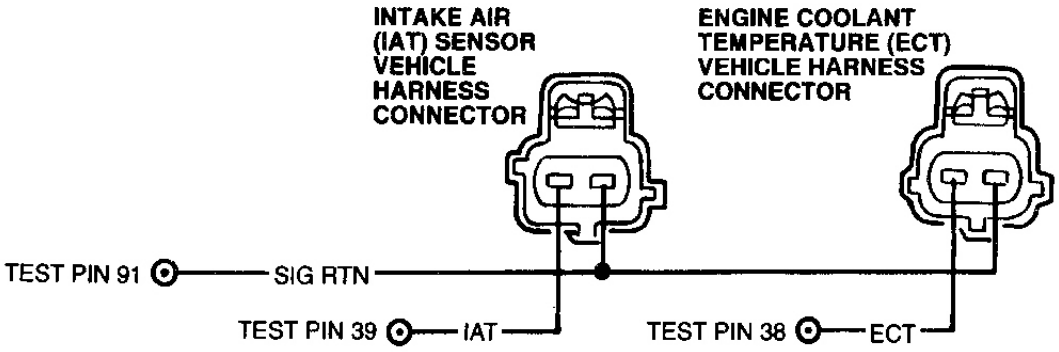


Fig. 23: Temperature Sensor Circuits & Connector Terminals

1) DTC P1116 This trouble code indicates sensor is out of self-test range. Correct range for measurement is .3-3.7 volts. Check for following possible causes:

- Low coolant level.
- Faulty harness connector.
- Faulty sensor.

Start engine and run until engine is at normal operating temperature. If vehicle cannot be started, go to step 3). Ensure upper radiator hose is hot and pressurized. Repeat **QUICK TEST** . If DTC P1116 is present, go to next step. If DTC P1116 is not present, fault is intermittent and cannot be duplicated at this time. testing is complete.

2) Check VREF Circuit Voltage At TP Sensor Turn ignition off. Disconnect Throttle Position (TP) sensor. Turn ignition on. Measure voltage at TP sensor wiring harness connector between VREF and SIG RTN terminal. See **Fig. 19** . If voltage is 4-6 volts, reconnect TP sensor and go to step 3). If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

3) Check Temperature Sensor Resistance (KOEO) Turn ignition off. Disconnect suspect sensor. Measure resistance between signal circuit (ECT or IAT) terminal and SIG RTN terminal at sensor wiring harness connector. See **ACT & ECT SENSOR SPECIFICATIONS** table. If resistance is not within specification, replace suspected sensor and repeat **QUICK TEST** . If resistance is within specification, perform following step as applicable:

- For diagnosing vehicles with ECT sensor related fault and a no-start condition, DO NOT service DTC P1116 at this time. Repair no-start condition and repeat **QUICK TEST** .
- For diagnosing vehicles without a no-start condition, go to next step.

4) Check Temperature Sensor Resistance (KOER) Warm engine to normal operating temperature. Turn ignition off. Disconnect suspect sensor. Start engine and operate at 2000 RPM for 2 minutes. Measure resistance between signal circuit (ECT or IAT) terminal and SIG RTN terminal at sensor wiring

harness connector. See ACT & ECT SENSOR SPECIFICATIONS table. If resistance is within specification, replace PCM, and repeat **QUICK TEST** . If sensor is not within specification replace sensor, and repeat QUICK TEST.

ACT & ECT SENSOR SPECIFICATIONS

Temperature °F (° C)	(1) Volts	(1) Ohms
50 (10)	3.51	58,750
68 (20)	3.07	27,300
86 (30)	2.60	24,270
104 (40)	2.13	16,150
122 (50)	1.70	10,970
140 (60)	1.33	7700
158 (70)	1.02	5370
176 (80)	0.78	3840
194 (90)	0.60	2800
212 (100)	0.46	2070
(1) Values may vary by 15 percent.		

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 4) to step 10). No test procedures have been omitted.

10) DTC P0118 Or P0113: Induce Opposite DTC (117 Or 112) DTC P0118 (ECT) or P0113 (IAT) indicate corresponding sensor signal is more than self-test maximum. Maximum signal voltage for ECT and IAT sensor is 4.6 volts. Possible causes for excess voltage signals are:

- Open circuit in wiring harness (IAT or ECT).
- Faulty connection.
- Faulty sensor.
- Faulty PCM.

Turn ignition off. Disconnect suspect temperature sensor. Connect a jumper wire between signal circuit (ECT or IAT) terminal and SIG RTN terminal at sensor wiring harness connector. With scan tester installed, turn ignition on.

NOTE: If communication link error is displayed, remove jumper wire and go to step 12).

Access ECT V or IAT V PID. If the PID is less than 0.2 volt, replace sensor and repeat **QUICK TEST** . If PID is 0.2 volt or more, remove jumper wire and go to next step.

11) Check Resistance Of Sensor Signal & SIG RTN Circuits Turn ignition off. Ensure suspect temperature sensor is disconnected. Disconnect PCM 104-pin connector. Check for damaged wiring, and repair as necessary. Install Breakout Box (014-00950), leaving PCM disconnected. Measure resistance

between test pin No. 38 (ECT sensor) or test pin No. 39 (IAT sensor) at breakout box and SIG RTN terminal at sensor wiring harness connector. Also, measure resistance between test pin No. 91 (SIG RTN) and SIG RTN circuit at sensor wiring harness connector. If both readings are less than 5 ohms, replace PCM, and repeat **QUICK TEST** . If either reading is 5 ohms or more, repair open circuit and repeat QUICK TEST.

12) Check For Sensor Signal Short To VREF Turn ignition off. Ensure suspect temperature sensor is disconnected. Measure resistance between test pin No. 90 (VREF) and test pin No. 38 (ECT sensor) or test pin No. 39 (IAT sensor) at breakout box. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** . If either resistance is less than 10,000 ohms, repair short circuit to VREF and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 12) to step 20). No test procedures have been omitted.

20) DTC P0117 Or P0112 DTC P0117 (ECT) or P0112 (IAT) indicates sensor signal is less than self-test minimum. Minimum signal for IAT and ECT sensor is 0.2 volt. Possible causes for this fault are:

- Circuit grounded in wiring harness.
- Faulty sensor.
- Faulty connection.
- Faulty PCM.

Turn ignition off. Disconnect wiring harness connector from suspect sensor. Check for damaged wiring, and repair as necessary. With scan tester connected, turn ignition on. Using scan tester, access ECT V of IAT V PID. If PID is less than 4.2 volts, go to next step. If PID is 4.2 volts or more, replace sensor and repeat **QUICK TEST** .

21) Check VREF Circuit Voltage At TP Sensor Turn ignition off. Disconnect TP sensor wiring harness connector. Turn ignition on. Measure voltage between VREF and SIG RTN at TP sensor wiring harness connector. If voltage is 4-6 volts, connect TP sensor and go to next step. If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

22) Check Signal Circuit For Short To Ground Turn ignition off. Disconnect suspect sensor. Disconnect PCM 104-pin connector. Check for damaged wiring, and repair as necessary. Install Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 38 (ECT) or No. 39 (IAT) and test pins No. 24, 51 and 91. If any reading is less than 10,000 ohms, repair short circuit, and repeat **QUICK TEST** . If all readings are 10,000 ohms or more, replace PCM and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 22) to step 90). No test procedures have been omitted.

90) Continuous Memory DTC P0112, P1112, P0113, P0117, P1117 Or P0118: Check Sensor These trouble codes indicate possible intermittent fault. Possible causes for these faults are:

- Faulty sensor.
- Faulty sensor connector.
- Open or grounded circuit in harness.

- Faulty PCM.

With scan tester connected, turn ignition on. Access ECT or IAT PID. While observing PID, tap on sensor to simulate road shock. Wiggle sensor connector. If no change in temperature reading occurs, go to next step. If any change in temperature occurs, isolate fault and repair as necessary.

91) Check EEC-V Wiring Harness While in PID, wiggle and bend small sections of wiring harness working toward PCM. If fault is indicated, isolate fault and repair as necessary. Clear memory, and repeat **QUICK TEST** . If no fault is found, go to step 92).

92) Inspect PCM & Wiring Harness Connectors Turn ignition off. Disconnect PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. If connectors and terminals are damaged, repair as necessary and repeat **QUICK TEST** . If connectors and terminals are okay, fault cannot be duplicated at this time and testing is complete.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 92) to step 100). No test procedures have been omitted.

100) DTC P0125 These DTCs indicate ECT sensor has not reached normal operating temperature. Possible causes for this fault are:

- Insufficient engine warm-up time.
- Thermostat leaking or stuck open.
- Low coolant.

Repair cooling system as necessary. Clear PCM memory, and repeat **QUICK TEST** .

CIRCUIT TEST DB - ENGINE FUEL TEMPERATURE (EFT) SENSOR

Diagnostic Aids

Perform this test only when directed by QUICK TEST. EFT sensor will operate within the range of -40-248°F (-40-120°C). This circuit test is intended to diagnose the following components and circuits:

- EFT sensor.
- Wiring harness circuits (EFT and SIG RTN).
- Powertrain Control Module (PCM).

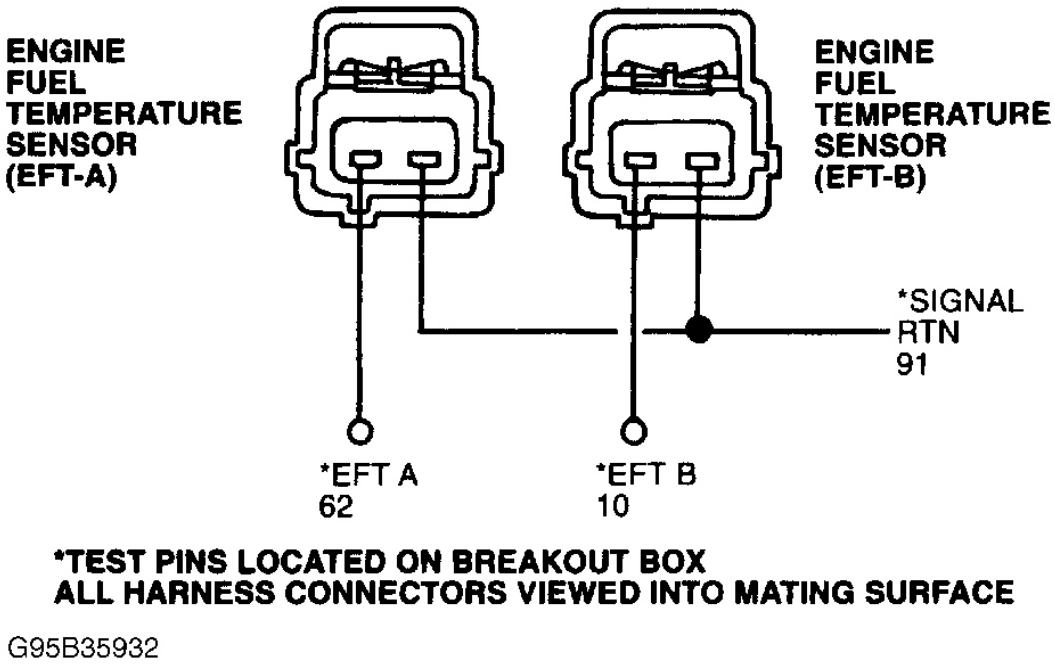


Fig. 24: EFT Connector Terminals

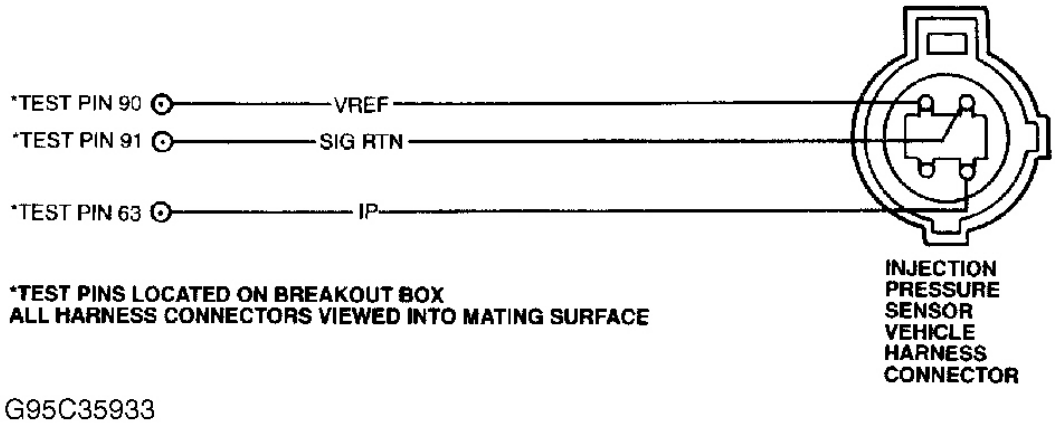


Fig. 25: Injector Pressure (IP) Sensor Connector Terminals

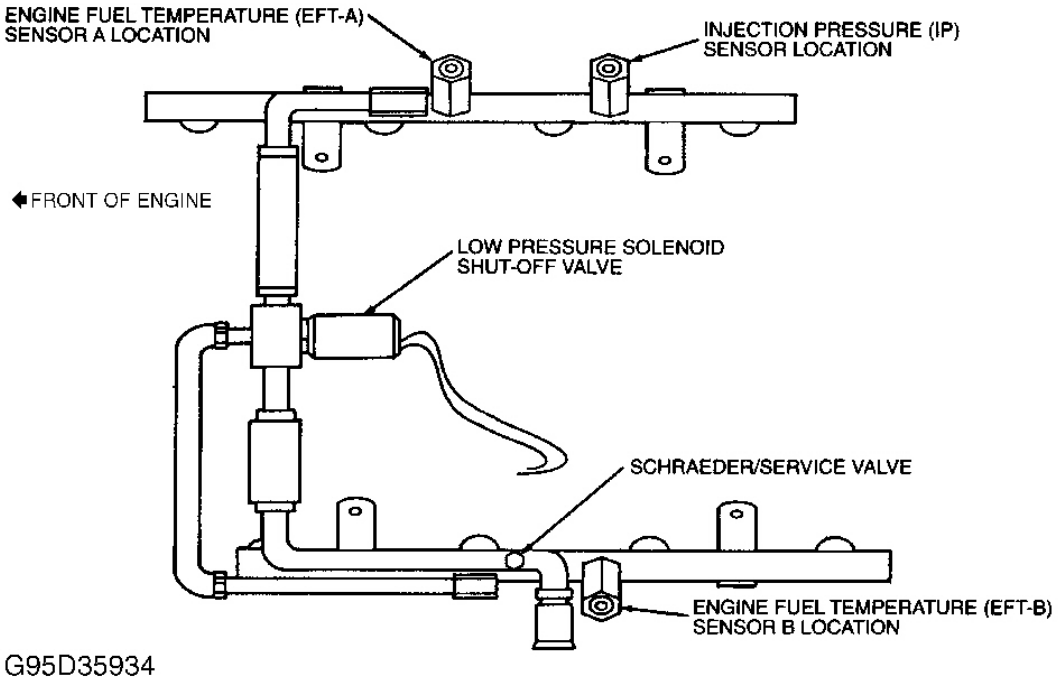


Fig. 26: Fuel Rail Components

EFT SENSOR SPECIFICATIONS

Temperature °F (°C)	(1) Volts	(1) Ohms
50 (10)	3.51	58,750
68 (20)	3.07	27,300
86 (30)	2.60	24,270
104 (40)	2.13	16,150
122 (50)	1.70	10,970
140 (60)	1.33	7700
158 (70)	1.02	5370
176 (80)	0.78	3840
194 (90)	0.60	2800
212 (100)	0.46	2070
248 (120)	0.27	1180
(1) Values may vary by 15 percent.		

1) DTC P0183 (EFT A) Or P0188 (EFT B) This trouble code indicates sensor signal is greater than self-test maximum. Self-test maximum is 4.6 volts. Check for following possible causes:

- Open circuit in wiring harness.

- Faulty harness connector.
- Faulty sensor.
- Faulty PCM.

Turn ignition off. Disconnect suspect temperature sensor. Connect a jumper wire between signal circuit (EFT A or EFT B) terminal and SIG RTN terminal at sensor wiring harness connector. With scan tester installed, turn ignition on.

NOTE: If communication link error is displayed, remove jumper wire and go to step 12).

Access EFT A or EFT B PID. If the PID is less than 0.2 volt, replace sensor and repeat **QUICK TEST** . If PID is 0.2 volt or more, remove jumper wire and go to next step.

2) Check Resistance Of Sensor Signal & SIG RTN Circuits Turn ignition off. Ensure suspect temperature sensor is disconnected. Disconnect PCM 104-pin connector. Check for damaged wiring, and repair as necessary. Install Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 62 (EFT A) or test pin No. 10 (EFT B) at breakout box and SIG RTN terminal at sensor wiring harness connector. Also, measure resistance between test pin No. 91 (SIG RTN) and SIG RTN circuit at sensor wiring harness connector. If both readings are less than 5 ohms, replace PCM, and repeat **QUICK TEST** . If either reading is 5 ohms or more, repair open circuit and repeat QUICK TEST.

3) Check For Sensor Signal Short To VREF Turn ignition off. Ensure suspect temperature sensor is disconnected. Disconnect PCM 104-pin connector. Check for damaged wiring, and repair as necessary. Install Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 90 (VREF) and test pin No. 62 (EFT A) or test pin No. 10 (EFT B) at breakout box. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** . If either resistance is less than 10,000 ohms, repair short circuit to VREF and repeat QUICK TEST.

4) DTC P0182 (EFT A) Or P0187 (EFT B) This trouble code indicates sensor signal is less than self-test minimum. Self-test minimum is 0.2 volts. Check for following possible causes:

- Wiring harness circuit short to ground.
- Faulty harness connector.
- Faulty sensor.
- Faulty PCM.

Turn ignition off. Disconnect suspect temperature sensor. With scan tester connected to DLC, turn ignition on. Access EFT A PID or EFT B PID. If the PID is less than 4.2 volt, replace sensor and repeat **QUICK TEST** . If the PID is 4.2 volt or more, go to next step.

5) Check VREF Circuit Voltage At Injection Pressure (IP) Sensor Turn ignition off. Disconnect IP sensor wiring harness connector. Turn ignition on. Measure voltage between VREF and SIG RTN at IP sensor wiring harness connector. If voltage is 4-6 volts, connect IP sensor and go to next step. If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

6) Check Signal Circuit For Short To Ground Turn ignition off. Disconnect suspect sensor. Disconnect PCM 104-pin connector. Check for damaged wiring, and repair as necessary. Install Breakout

Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 62 (EFT A) or 10 (EFT B) and test pins No. 24, 51 and 91. If any reading is less than 10,000 ohms, repair short circuit, and repeat **QUICK TEST** . If all readings are 10,000 ohms or more, replace PCM and repeat QUICK TEST.

7) Continuous Memory DTC P0182, P0183, P0187 Or P0188 These trouble codes indicate possible intermittent fault. Possible causes for these faults are:

- Faulty sensor.
- Faulty sensor connector.
- Open or grounded circuit in harness.
- Faulty PCM.

With scan tester connected, turn ignition on. Access EFT A or EFT B PID. While observing PID, tap on sensor to simulate road shock. Wiggle sensor connector. If no change in temperature reading occurs, go to next step. If any change in temperature occurs, isolate fault and repair as necessary.

8) Check EEC-V Wiring Harness While in PID, wiggle and bend small sections of wiring harness working toward PCM. If fault is indicated, isolate fault and repair as necessary. Clear memory, and repeat **QUICK TEST** . If no fault is found, go to next step.

9) Inspect PCM & Wiring Harness Connectors Turn ignition off. Disconnect PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. If connectors and terminals are damaged, repair as necessary and repeat **QUICK TEST** . If connectors and terminals are okay, fault cannot be duplicated at this time and testing is complete.

CIRCUIT TEST DC - MASS AIRFLOW (MAF) SENSOR

Diagnostic Aids

Perform this test when directed by QUICK TEST. This CIRCUIT TEST is intended to diagnose the following:

- MAF sensor.
- Wiring harness circuits (VPWR, PWR GND, MAF SIG and MAF RTN).
- Powertrain Control Module (PCM).

To prevent replacement of good components, be aware the following non-EEC related areas may be cause of problem:

- Air cleaner element.
- Inlet air duct.
- Throttle body.

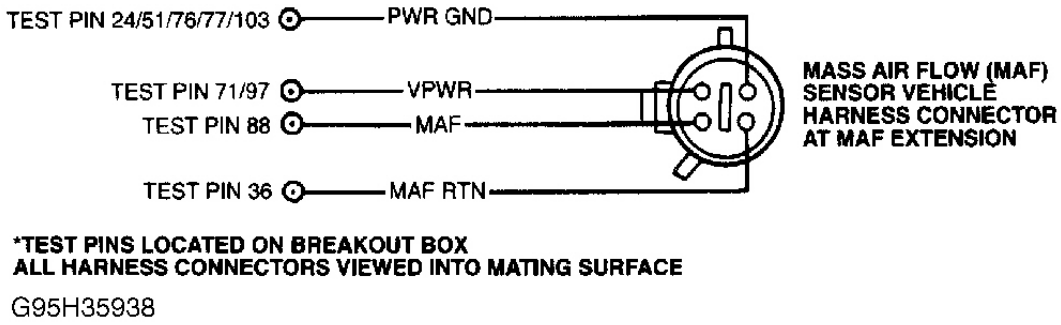


Fig. 27: MAF Sensor Extension Circuits & Connector Terminals

1) KOER DTC P1101: Check MAF Sensor Continuous Memory Codes DTC P1101, retrieved during KOER self-test, indicates MAF signal was not 0.34-1.96 volts during self-test. Drive vehicle for 10 minutes and repeat KOEO and Continuous Memory self-test. If any Continuous Memory DTC is present with KOER P1101, proceed as follows:

- Continuous Memory DTC P0102, go to step 6).
- Continuous Memory DTC P0103, go to step 20).
- All other Continuous Memory DTCs, service as necessary.

If no Continuous Memory DTCs are present with KOER P1101, go to next step.

NOTE: DTC P1101 may be caused by low battery or by use of a garage exhaust ventilation system. Ensure vehicle is vented to outside atmosphere before repeating QUICK TEST .

2) KOEO/KOER DTC P1101: MAF Output Voltage DTC P1101, retrieved during KOEO or KOER self-test, indicates voltage exceeded.2-volt test range. Possible causes for this fault are:

- Air leak before or after MAF sensor.
- Faulty or contaminated MAF sensor.
- Faulty MAF sensor wiring harness connector.
- Open PWR GND or MAF RTN circuit.
- Faulty PCM.

Turn ignition off. Ensure MAF sensor is connected. Disconnect PCM 104-pin connector and inspect for damage. Repair as necessary. Install Breakout Box (014-00950). Leave PCM connected to breakout box. With scan tester connected, turn ignition on. Measure voltage between test pin No. 88 (MAF SIG) and test pins No. 24 and 103 (PWR GND). If voltage is greater than 0.2 volt, go to step 12). If voltage is 0.2 volt or less, go to step 8).

3) Continuous Memory DTC P1100: Check MAF Circuit Intermittent Voltage Input DTC P1100,

retrieved from continuous memory indicates voltage went out of range (0.39-3.90 volts) sometime during previous 40 warm-up cycles. Possible causes for this fault are:

- Faulty MAF sensor.
- Faulty MAF sensor wiring harness circuit or connector.

Start engine and allow to idle. If engine does not idle smoothly, repair cause of rough idle condition before continuing. With scan tester connected, raise engine speed to 1500 RPM for 5 seconds, and return to idle. Access MAF PID. While observing PID, tap on sensor to simulate road shock. Wiggle sensor connector. If MAF PID voltage stays within 0.39-3.90 volt range, go to next step. If volt range is not as specified, check MAF sensor and connector. Repair or replace as necessary.

4) Check MAF Sensor Circuit Integrity Turn ignition off. Disconnect PCM 104-pin connector and inspect for damage. Repair as necessary. Install Breakout Box (014-00950). Connect PCM to breakout box. Turn ignition on. Connect voltmeter between test pin No. 36 (MAF RTN) and No. 88 (MAF SIG). While observing voltmeter, wiggle and bend wiring harness between sensor and dash panel. Wiggle and bend wiring harness between dash panel and PCM. If voltage reading goes out of normal range (0.39-3.90 volts), isolate fault and repair as necessary. Reset KAM and repeat **QUICK TEST** . If voltage does not go out of normal range, fault cannot be duplicated or identified at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 4) to step 6). No test procedures have been omitted.

6) Continuous Memory & KOER DTC P0102: Check MAF Low Input Signal To PCM DTC P0102 indicates MAF signal was less than 0.39 volt sometime during normal engine operation. Possible causes for this fault are:

- Open or closed MAF circuit.
- Open circuit (MAF, MAF RTN, PWR GND, or VPWR).
- MAF circuit shorted to ground.
- Air leak before or after MAF sensor.
- Faulty MAF sensor or connector.
- Faulty TP system.
- Faulty PCM.

Ensure air induction system is okay. Repair if necessary. Start engine and allow to idle. If engine does not idle smoothly, repair cause of rough idle condition before continuing. With scan tester connected, raise engine speed to 1500 RPM and return to idle. Access MAF PID. If MAF PID is less than 0.39 volt, go to next step. If MAF PID is 0.6-1.0 volts, go to step 15). For all other MAF PID readings, go to step 2).

7) Check VPWR Circuit Voltage Turn ignition off. Disconnect MAF sensor. Turn ignition on. Measure voltage between VPWR terminal of MAF sensor wiring harness connector and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit.

8) Check Resistance Of VPWR Circuit Turn ignition off. Leave MAF sensor disconnected. Disconnect PCM 104-pin connector and inspect for damage. Repair as necessary. Install Breakout Box (014-00950),

leaving PCM disconnected. Measure resistance between VPWR terminal of MAF sensor wiring harness connector and test pins No. 71 and 97 (VPWR) at breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in VPWR circuit and repeat **QUICK TEST** .

9) Check MAF Circuit For Short To Ground & MAF RTN Circuit Leave ignition off and MAF disconnected. Ensure PCM is disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 88 (MAF SIG) and test pins No. 36 (MAF RTN), 51 and 103 (PWR GND) at breakout box. If resistance is 10,000 ohms or more, reconnect scan tester and go to next step. If resistance is less than 10,000 ohms, repair circuit short to ground and repeat **QUICK TEST** .

10) Check MAF RTN Circuit For Short To PWR GND Circuit Leave ignition off, PCM and MAF disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 36 (MAF SIG) and test pins No. 51 and 103 (PWR GND) at breakout box. If resistance is 10,000 ohms or more, reconnect scan tester and go to next step. If resistance is less than 10,000 ohms, repair circuit short to ground and repeat **QUICK TEST** .

11) Check Resistance Of MAF SIG Circuit Leave ignition off, PCM and MAF disconnected. Measure resistance between MAF terminal of MAF sensor wiring harness connector and test pin No. 88 (MAF SIG) at breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit in MAF SIG circuit and repeat **QUICK TEST** .

12) Check PWR GND Circuit To MAF Sensor Leave ignition off and MAF disconnected. Connect PCM to breakout box. Turn ignition on. Measure voltage between VPWR and PWR GND terminal of MAF sensor wiring harness connector. If voltage is less than 10.5 volts, go to next step. If voltage is 10.5 volts or more, go to step 14).

13) Check PWR GND Circuit Resistance Leave ignition off and MAF sensor disconnected. Disconnect PCM from breakout box. Disconnect scan tester from DLC (if applicable). Measure resistance between PWR GND terminal of MAF sensor wiring harness connector and negative battery terminal. If resistance is less than 10 ohms, go to next step. If resistance is 10 ohms or more, repair open in PWR GND circuit and repeat **QUICK TEST** .

14) Check MAF RTN Circuit Resistance Leave ignition off, PCM and MAF sensor disconnected. Measure resistance between MAF RTN terminal of MAF sensor wiring harness connector and test pin No. 36 (MAF RTN) at breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in MAF RTN and repeat **QUICK TEST** .

15) Check MAF Circuit For Short To Ground In PCM Leave ignition off and MAF disconnected. Connect PCM to breakout box. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 88 (MAF SIG) and test pins No. 36 (MAF RTN), 51 and 103 (PWR GND) at breakout box. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, replace PCM and repeat **QUICK TEST** .

16) Leave ignition off, PCM and MAF disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 36 (MAF RTN) and test pins No. 51 and 103 (PWR GND) at breakout box. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, replace PCM and repeat **QUICK TEST** .

17) Check MAF Circuit Output Ensure ignition is off. Reconnect MAF sensor. Connect PCM to breakout box. Start engine and allow to idle. If engine does not idle smoothly, repair cause of rough idle condition before continuing. Measure voltage between test pin No. 88 (MAF SIG) and negative battery cable. If voltage is 0.34-1.96 volts, go to next step. If voltage is not 0.34-1.96 volts, replace MAF sensor and repeat **QUICK TEST** .

18) Ensure ignition is off, MAF sensor and PCM are connected. With engine idling, measure voltage

between test pin No. 36 (MAF RTN) and 88 (MAF SIG). If voltage is 0.34-1.96 volts, go to next step. If voltage is not 0.34-1.96 volts, replace MAF sensor and repeat **QUICK TEST** .

19) Check MAF Circuit Output With Scan Tester Start engine and allow to idle. Access MAF PID on scan tester. If PID voltage is 0.34-1.96 volts, fault is intermittent and cannot be identified at this time. Go to **CIRCUIT TEST Z** . If voltage is not 0.34-1.96 volts, replace PCM and repeat **QUICK TEST** .

20) DTC P0103: Check MAF High Input Signal To PCM DTC P0103 indicates MAF signal was more than 4.70 volts sometime during normal engine operation. Possible causes for this fault are as follows:

- Restricted MAF sensor screen.
- MAF SIG circuit shorted to VPWR.
- Faulty MAF sensor or connector.
- Faulty PCM.

Ensure air induction system is okay. Repair if necessary. Start engine and allow to idle. If engine does not idle smoothly, repair cause of rough idle condition before continuing. With scan tester connected, raise engine speed to 1500 RPM and return to idle. Access MAF PID. PID reading should be more than 4.60 volts. Turn ignition off. Disconnect MAF sensor. Start engine and allow to idle. Access MAF PID. If PID voltage reading does not drop to less than 0.39 volt, go to next step. If PID voltage reading does drop to less than 0.39 volt, replace MAF sensor.

21) Check MAF SIG Circuit For Short To Power Leave ignition off and MAF sensor disconnected. Disconnect PCM 104-pin connector and inspect for damage. Repair as necessary. Install Breakout Box (014-00950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 88 (MAF SIG) and test pins No. 24 and 103 at breakout box. If voltage is less than 10.5 volts, go to next step. If voltage is 10.5 volts or more, repair MAF SIG circuit short to power.

22) Check MAF SIG Circuit For Short To Power In PCM Leave ignition off and MAF sensor disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 88 (MAF SIG) and test pins No. 71 and 97 (VPWR) at breakout box. If resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair short between MAF SIG and VREF circuit. Repeat QUICK TEST.

CIRCUIT TEST DF - VEHICLE SPEED CIRCUIT (VSC) CHECK

Diagnostic Aids

Perform this test only when directed by QUICK TEST. This test is intended to diagnose the following:

- Wiring harness circuits (VSC SIG and VSC GND).
- Powertrain Control Module (PCM).

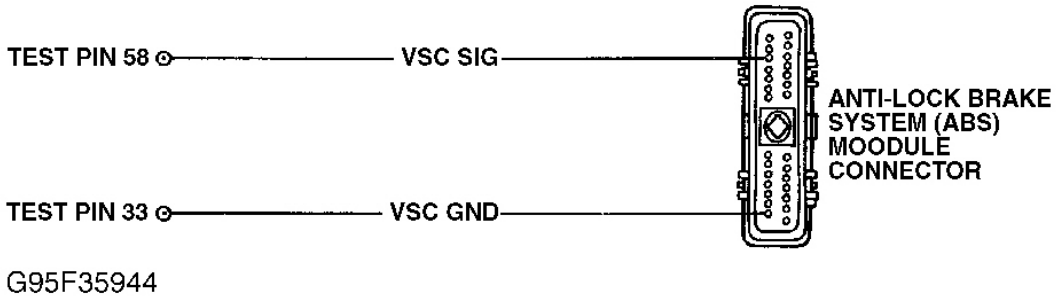


Fig. 28: ABS Module VSC Connector Terminals

1) DTC P0500: Check Vehicle Speed PID DTC P0500 indicates that PCM has detected error in vehicle speed information received from ABS module. Possible causes for this fault are:

- Open or short in harness.
- Faulty ABS module.
- Faulty Powertrain Control Module (PCM).

Turn ignition off. Connect scan tester to Diagnostic Link Connector (DLC). Turn ignition on. Using scan tester, access VSS PID. Road test vehicle as follows:

- Gradually accelerate vehicle to 50 MPH while observing VVV PID MPH.

If VSS PID matches speedometer, fault is intermittent; go to step 4). If VSS PID does not match speedometer, go to next step.

2) Check Circuit Resistance Turn ignition off. Disconnect PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair as necessary. Install EEC-IV Breakout Box (014-00950), leaving PCM disconnected. Disconnect ABS wiring harness connector. Measure resistance between VSC GND terminal of ABS module wiring harness connector and test pin No. 33 at breakout box. Measure resistance between VSC SIG terminal of ABS module wiring harness connector and test pin No. 58 at breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit, and repeat **QUICK TEST** .

3) Check Circuit For Short To Ground Leave PCM and ABS module disconnected. Disconnect scan tester from DLC (if applicable). Turn ignition off. Measure resistance between test pin No. 58 and test pins No. 33 (VSC GND), 51 and 103 (PWR GND) No. 71 (VPWR) and No. 91 (SIG RTN). Measure resistance between test pin No. 33 and test pin No. 71. If any reading is less than 10,000 ohms, repair short circuit, and go to step 5). If all readings are 10,000 ohms or more, check for fault in ABS system. If no faults are present, replace PCM.

4) Visual Inspection Turn ignition off. Visually inspect VSC wiring harness for any of the following conditions:

- Loose or corroded ABS module connector.

- Loose or corroded PCM connector.
- Incorrect routing of VSC wiring harness.

If any faults are present, repair as necessary and go to next step. If all readings are 10,000 ohms or more, check for fault in ABS system.

5) Test Drive Vehicle Ensure engine is warmed to normal operating temperature. Perform the following drive cycle 3 times:

A/T Equipped Vehicles

- Place gear selector in Drive.
- Accelerate heavily to 35 MPH.
- Coast down to idle speed and stop vehicle.

M/T Equipped Vehicles

- Place gear selector in first gear.
- Accelerate heavily to 35 MPH, not shifting higher than second gear.
- Coast down to idle speed and stop vehicle.

After third drive cycle, perform **QUICK TEST** . If any DTCs are present, go to appropriate CIRCUIT TEST. If DTCs are not present, testing is complete.

CIRCUIT TEST DG - KNOCK SENSOR (KS)

Diagnostic Aids

Perform this test only when directed by QUICK TEST. This test is intended to diagnose the following:

- Knock Sensor (KS).
- Wiring harness circuits (KS and SIG RTN).
- Powertrain Control Module (PCM).

To prevent replacement of good components, be aware the following non-EEC related areas may be at fault:

- Poor fuel quality.
- Ignition system.
- Ignition or valve timing.
- Engine mechanical condition.

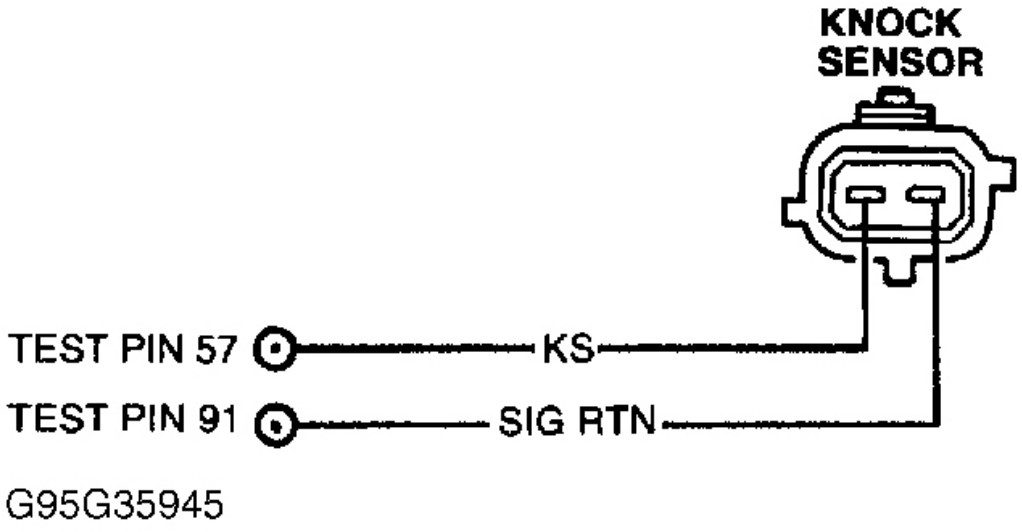


Fig. 29: Single KS Sensor Test Circuits & Connector Terminals

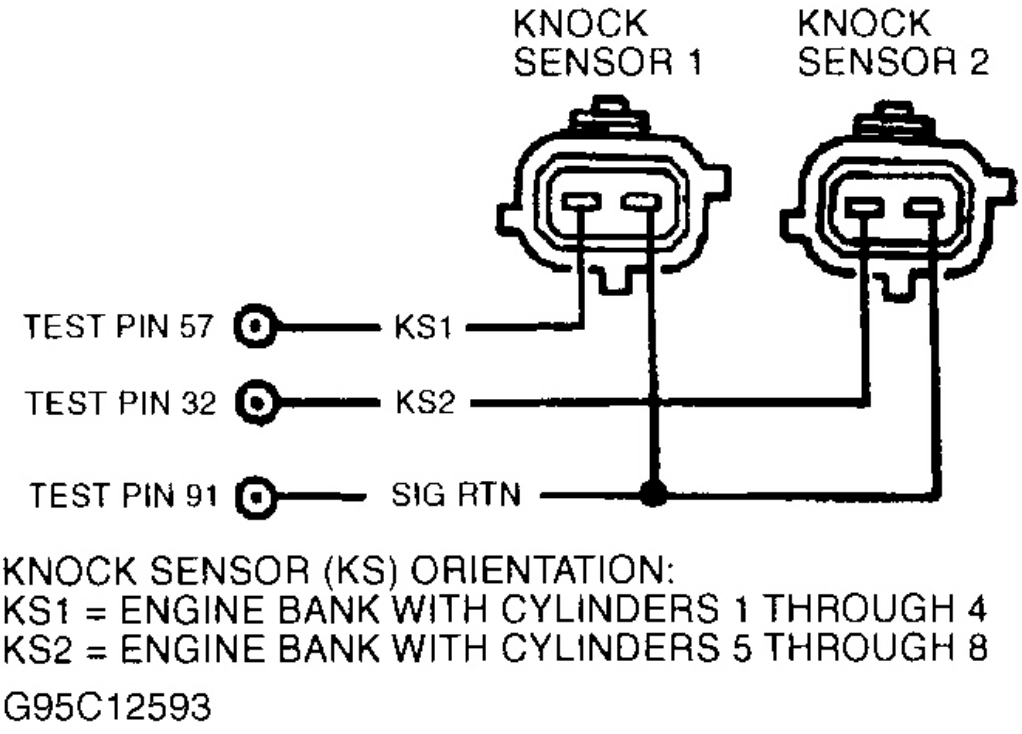


Fig. 30: Dual KS Sensor Test Circuits & Connector Terminals

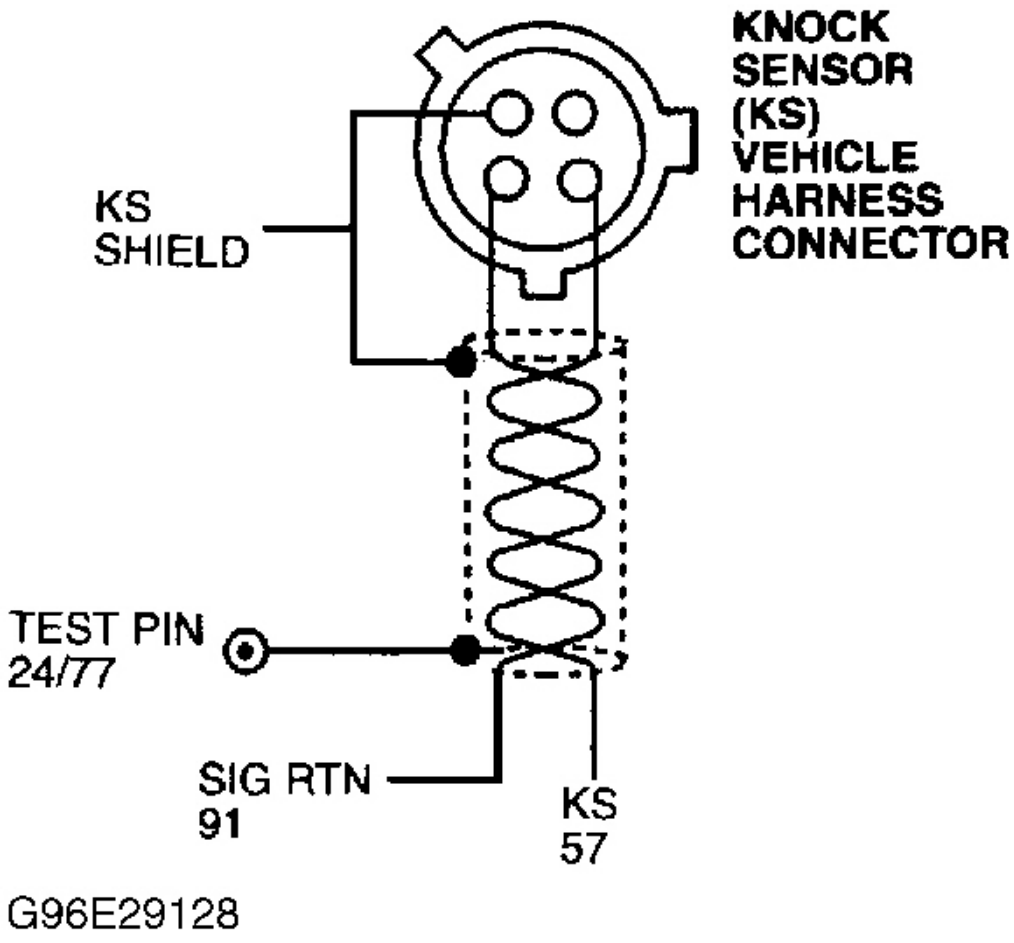


Fig. 31: Quad KS Sensor Test Circuits & Connector Terminals

1) Check Sensor Voltage DTC P0325, P0326, P0330 and P0331 indicate that ignition timing was not adjusted after spark knock has occurred. Possible causes for this fault are:

- High altitude interference.
- Open or short in harness.
- Faulty knock sensor.
- Faulty Powertrain Control Module (PCM).

Turn ignition off. Disconnect PCM 104-pin connector. Inspect connector for damaged and repair as necessary. Install EEC-V Breakout Box (014-00950). Connect PCM to breakout box. Turn ignition on. Measure voltage between suspect sensor test pin and test pin No. 91 (SIG RTN). If voltage is 2.4-2.6 volts, go to next step. If voltage is less than 2.4 volts, go to step 5). If voltage is more than 2.6 volts, go to

step 6).

2) Check For Intermittent Circuit Fault Leave ignition on. Measure voltage between suspect sensor test pin and test pin No. 91. While observing voltmeter, wiggle small sections of wiring harness starting at the knock sensor and going to the PCM. Lightly tap on knock sensor and PCM. If voltmeter reading stays within normal operating range (2.4-2.6 volts), go to next step. If voltmeter reading goes out of range, isolate fault and repair as necessary. Clear PCM memory and repeat **QUICK TEST** .

3) Check For Voltage Increase Turn ignition off. Leave PCM connected to breakout box. Disconnect scan tester from DLC. Set voltmeter on AC scale. Start engine and allow to idle. Measure voltage between suspect sensor test pin and test pin No. 91. Raise engine speed to 3000 RPM. If AC voltage increases, replace PCM and repeat **QUICK TEST** . If AC voltage does not increase, go to next step.

4) Check Circuit Resistance Turn ignition off. Disconnect PCM from breakout box. Disconnect suspect sensor. Measure resistance of KS circuit (KS1 or KS2) between suspect sensor connector terminal and breakout box. Measure resistance of SIG RTN circuit between suspect sensor connector terminal and breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

5) Check Circuit For Short To Ground Leave suspect sensor disconnected. Measure resistance between KS circuit (KS1 and KS2) test pins and test pin No. 91. Measure resistance between KS circuit test pins and the following power ground test pins No. 24, 51, 76, 77 and 103. Measure resistance between KS circuits and ground. If all resistance measurements are 10,000 ohms or more, replace knock sensor and repeat **QUICK TEST** . If any resistance measurement is less than 10,000 ohms, repair short circuit and repeat QUICK TEST.

6) Check Circuit For Short To Power Leave ignition on. Measure voltage between KS circuit (KS1 and KS2) test pins and the following power ground test pins No. 24, 51, 76, 77 and 103. If each voltage measurement is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If any voltage measurement is 0.5 volt or more, repair circuit short to power and repeat QUICK TEST.

7) Check PCM For Short To Ground Turn ignition off. Connect PCM to breakout box. Leave suspect sensor disconnected. Measure resistance between test pin No. 32 or 57 (KS) and test pin No. 91 (SIG RTN). If resistance measurement is 10,000 ohms or more, go to next step. If resistance measurement is less than 10,000 ohms, replace PCM and repeat **QUICK TEST** .

8) Check KS Resistance Leave ignition off. Disconnect PCM from breakout box. Measure resistance between test pin No. 32 or 57 (KS) and test pin No. 91 (SIG RTN) at breakout box. If resistance measurement is 5.11 megaohms or more, replace KS. Perform a complete drive cycle and repeat **QUICK TEST** . If resistance measurement is less than 5.11 megaohm, replace KS and repeat QUICK TEST. If fault is still present, replace PCM.

CIRCUIT TEST DH - THROTTLE POSITION (TP) SENSOR

Diagnostic Aids

Perform this test only when directed by QUICK TEST. This test is intended to diagnose the following:

- TP sensor.
- Wiring harness circuits (PWR GND, SIG RTN, TP, VPWR and VREF).
- Powertrain Control Module (PCM).

Normal range of throttle angle measurement for TP sensor is 0-85 degrees. To pass **QUICK TEST** procedure, range of throttle rotation (in degrees) must be within 3 percent of specification.

To prevent replacement of good components, be aware the following non-EEC related areas may be at fault:

- Idle speed.
- Binding throttle shaft or linkage.
- TP sensor not seated.

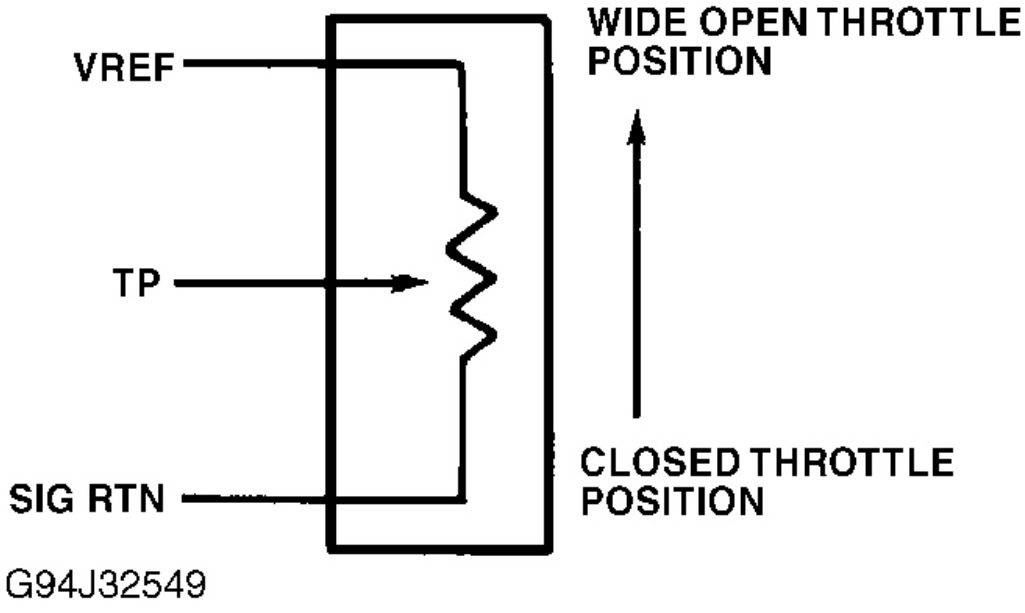


Fig. 32: TP Sensor Schematic

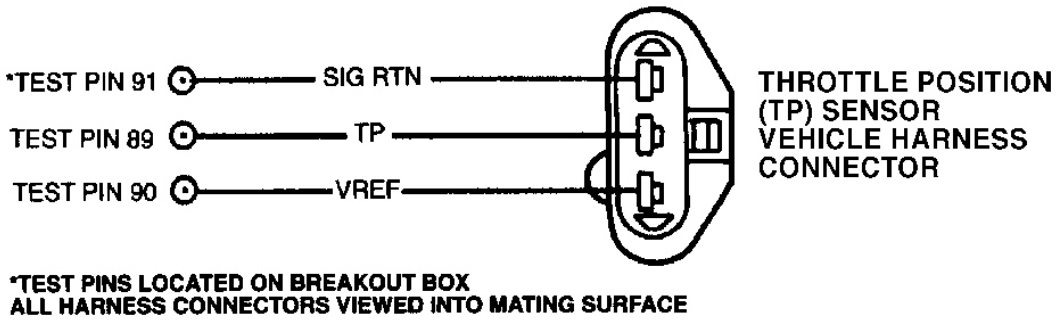


Fig. 33: TP Sensor Circuit & Connector Terminals

1) KOEO/KOER DTC P1124: Check For Other Codes DTC P1124 indicates TP sensor rotational setting may be out of self-test range. Possible causes for this fault are:

- Faulty TP sensor.
- Faulty Powertrain Control Module (PCM).

Perform KOEO and KOER self-test. Check for DTC P1400. If DTC P1400 is present, service code and repeat **QUICK TEST** . If DTC P1400 is not present with DTC P1124, go to next step.

2) Check For Binding Throttle Plate Inspect throttle body for binding. If throttle body is binding, check for binding throttle or cruise control linkage, vacuum line or harness interference. Repair as necessary, and repeat **QUICK TEST** . If no mechanical problem is found, go to step 8).

3) DTC P1120: Check For Binding Throttle Plate DTC P1120 indicates TP sensor closed throttle position is below range of 3.4 percent (.17 volt) Possible causes for this fault are:

- Damaged wiring harness or connectors.
- Open in VREF circuit.
- Faulty TP sensor.
- Faulty Powertrain Control Module (PCM).

Inspect TP sensor connector for damage or corrosion. Inspect wiring harness between TP sensor and PCM for damage or corrosion. Repair as necessary, and repeat **QUICK TEST** . If no mechanical problem is found, go to next step.

4) Check For Stuck TP Sensor Turn ignition off. Connect scan tester to DLC. Access TP PID on scan tester. While observing TP PID, slowly move throttle through range from closed to wide open throttle. If TP PID indicates any sudden drops to below 0.49 volt, go to next step. If TP PID increase and decrease is gradual and smooth, go to step 20).

5) Check VREF Circuit Voltage With TP sensor disconnected, turn ignition on. Measure voltage between VREF and SIG RTN terminals at TP sensor wiring harness connector. If voltage is 4-6 volts, go

to next step. If voltage is not 4-6 volts, reconnect sensor and go to **CIRCUIT TEST C** .

6) Check TP Circuit Resistance Turn ignition off. Leave TP sensor disconnected. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 89 (TP) and TP terminal of TP sensor wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in TP circuit.

7) Check TP Sensor Signal To PCM Turn ignition off. Connect PCM to breakout box. Start engine and idle for 2 minutes. While slowly opening throttle, measure voltage between test pin No. 89 (TP) and 91 (SIG RTN) at breakout box. If at any time voltage enters 0.17-0.40 volt range, replace TP sensor. If voltage does not enter 0.17-0.40 volt range, go to next step.

8) DTC P0123 This code indicates TP signal is more than self-test maximum. Possible causes for this fault are:

- TP sensor not seated correctly.
- Faulty TP sensor.
- TP circuit shorted to VREF or VPWR.
- VREF circuit shorted to VPWR.
- Open in SIG RTN circuit.
- Faulty PCM.

Turn ignition off. Disconnect TP sensor wiring harness connector. Inspect for damage and repair as necessary. Turn ignition on. Access TP PID on scan tester. If PID voltage is 0.17 volt or more, go to step 10). If PID voltage is less than 0.17 volt, go to next step.

9) Check VREF Circuit Voltage With TP sensor disconnected, turn ignition on. Measure voltage between VREF and SIG RTN terminals at TP sensor wiring harness connector. If reading is 4-6 volts, go to next step. If reading is not 4-6 volts, reconnect sensor and go to **CIRCUIT TEST C** .

10) Check TP Circuit For Short To Power Turn ignition off. Leave TP sensor disconnected. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 89 (TP) and test pins No. 71, 90 and 97 (VPWR) at breakout box. If any resistance is less than 10,000 ohms, repair TP circuit short to VREF and repeat **QUICK TEST** . If each resistance is 10,000 ohms or more, replace PCM and repeat QUICK TEST.

11) DTC P0122 This code indicates TP signal is less than self-test minimum of 0.17 volt. Possible causes for this fault are:

- TP sensor not seated correctly.
- Faulty TP sensor.
- Open TP or VREF circuit.
- TP circuit shorted to SIG RTN or PWR GND.
- Faulty PCM.

Turn ignition off. Disconnect TP sensor wiring harness connector. Inspect for damage and repair as necessary. Connect jumper wire between VREF and TP terminals at TP wiring harness connector. Turn ignition on. Access TP PID on scan tester. If PID voltage is more than 4.60 volts, replace TP sensor and

repeat **QUICK TEST** . If PID voltage is 4.60 volts or less, remove jumper wire and go to next step. If scan tester is unable to access TP PID, go to step 14).

12) Check VREF Circuit Voltage With TP sensor disconnected, turn ignition on. Measure voltage between VREF and SIG RTN terminals at TP sensor wiring harness connector. If voltage is 4-6 volts, go to next step. If voltage is not 4-6 volts, reconnect sensor and go to **CIRCUIT TEST C** .

13) Check TP Circuit Resistance Turn ignition off. Leave TP sensor disconnected. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 89 (TP) and TP terminal of TP sensor wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in TP circuit.

14) Check TP Circuit For Short To SIG RTN Or PWR GND Leave ignition off and TP sensor disconnected. Measure resistance between test pin No. 89 (TP) and test pins No. 91 (SIG RTN), 24 and 103 (PWR GND) at breakout box. If any resistance is less than 10,000 ohms, repair TP circuit short to SIG RTN or PWR GND and repeat **QUICK TEST** . If both resistances are 10,000 ohms or more, replace PCM and repeat QUICK TEST.

15) Continuous Memory Code P1121 This code indicates TP signal is inconsistent with MAF sensor signal. Possible causes for this fault are as follows:

- TP sensor not seated correctly.
- Faulty TP sensor.
- Air leak between MAF sensor and throttle body.

If engine will start, go to next step. If engine is a no-start, check for cracks or openings in air induction system between MAF sensor and throttle body. If air induction system is okay, go to **CIRCUIT TEST A** .

16) Check Operation Of TP Sensor Start engine and allow to idle. Access TP PID on scan tester. While observing TP PID, slowly move throttle through range from closed position to wide open throttle. If TP PID indicates any sudden drops to below 0.53 volt, or increases to more than 1.27 volts, replace TP sensor and repeat **QUICK TEST** . If TP PID increase and decrease is gradual and smooth, and within 0.53-1.27 volt range, go to next step.

17) Check Operation Of TP Sensor While Driving Vehicle Connect scan tester to DLC. Drive vehicle while accessing TP PID and LOAD PID. If TP PID is 2.44 volts or less and LOAD PID is more than 25 percent, go to next step. If TP PID is more than 2.44 volts and LOAD PID is less than 25 percent, check for cracks or openings in air induction system between MAF sensor and throttle body. If air induction system is okay, replace TP sensor.

18) Check TP Sensor Low With Engine Under Load Start engine and allow to idle. If engine does not start, go to **CIRCUIT TEST A** . Access TP PID and LOAD PID on scan tester. If TP PID is 0.24 volt or more and LOAD PID is less than 60 percent, fault is intermittent and cannot be located at this time. Testing is complete. If TP PID is less than 0.24 volts and LOAD PID is 60 percent or more, clear PCM memory. Perform test drive utilizing all phases of vehicle operation. Perform **QUICK TEST** . If DTC P1121 is still present, replace MAF sensor.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 18) to step 20). No test procedures have been omitted.

20) Continuous Memory Code P1120 Or P1125 Theses codes indicate TP signal went below 0.49 volt or above 4.60 volts sometime during the last 80 drive cycles. Possible causes for this fault are:

- Faulty TP sensor wiring harness or connector.
- Faulty TP sensor.

With scan tester connected, start engine and allow to idle. Raise engine speed to 1500 RPM for 5 seconds and return to idle. Using scan tester, access TP PID. While observing PID, lightly tap on TP sensor to simulate road shock. Wiggle sensor connector and wiring harness. If TP PID reading stays within normal operating range (0.49-4.60 volts), go to next step. If TP PID reading goes out of range, replace TP sensor.

21) Check Wiring Harness Between TP Sensor & PCM Turn ignition off. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-00950). Connect PCM to breakout box. Connect DVOM between test pin No. 89 (TP) and 91 (SIG RTN). While observing DVOM, wiggle small sections of wiring harness starting at the TP sensor and going to the PCM. If DVOM reading stays within normal operating range (0.49-4.60 volts), problem is intermittent and cannot be identified at this time. Go to **CIRCUIT TEST Z** . If DVOM reading goes out of range, isolate fault and repair as necessary. Clear PCM memory and repeat **QUICK TEST** .

22) DTC P0121: Verify KOER Self-Test Completion Start engine and allow to idle. Using scan tester, enter KOER self test. If DTC P0121 is present or KOER cannot be terminated, go to next step. If specified symptoms are not present, problem is intermittent and cannot be identified at this time.

23) With engine idling, place gear selector in Drive or Reverse. If KOER self-test terminates, go to next step. If KOER self-test does not terminate, turn ignition off and wait for 15 seconds. Start engine and allow to idle. Enter KOER self-test. If DTC P0121 is present or KOER self-test cannot be terminated, go to next step. If specified symptoms are not present, problem is intermittent and cannot be identified at this time.

24) Check Circuit Continuity Turn ignition off. Check continuity in TP circuit between TP sensor connector and PCM connector terminal No. 89. Check continuity in SIG RTN circuit between TP sensor connector and PCM connector terminal No. 91. If continuity is present, replace TP sensor and repeat **QUICK TEST** . If continuity is not present, repair open circuit and repeat QUICK TEST.

CIRCUIT TEST DK - MISFIRE DETECTION (MD) SENSOR

Diagnostic Aids

Perform this test only when directed by QUICK TEST. This test is intended to diagnose the following:

- Wiring harness circuits (MD and SIG RTN).
- Faulty MD sensor.
- Faulty Powertrain Control Module (PCM).

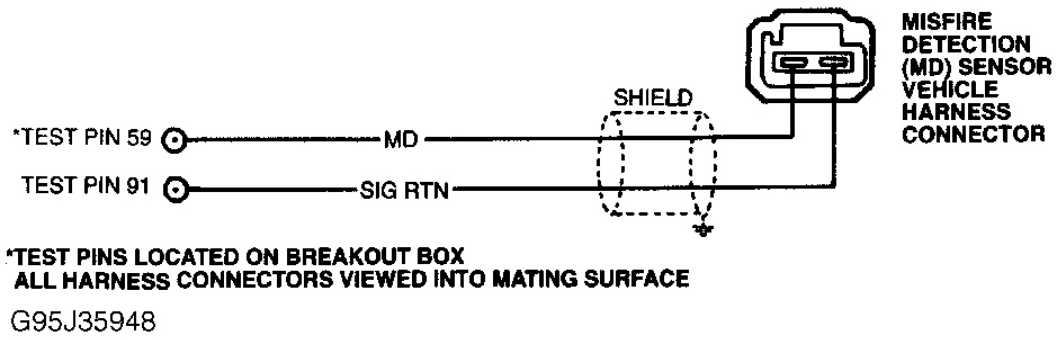


Fig. 34: MD Test Circuits & Connector Terminals

1) DTC P0385 DTC P0385 indicates that self-test has detected a MD sensor/circuit failure. Possible causes for these faults are:

- Wiring harness open (MD or SIG RTN).
- MD circuit shorted to power or ground.
- Faulty MD sensor.
- Powertrain Control Module (PCM).

If engine will start, go to next step. If engine will not start, no-start condition has caused DTC P0385. Service or repair as necessary and repeat **QUICK TEST** .

2) Check For Intermittent Circuit Fault Clear all DTCs from PCM memory. Start engine and raise speed to 1500 RPM for 10 seconds 3 times. Turn ignition off. Connect scan tester to DLC. Using scan tester, retrieve all Continuous Memory DTCs. If DTC P0385 is present, go to step 5). If DTC P0385 is not present, fault is intermittent and cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 2) to step 5). No test procedures have been omitted.

5) Check Circuit Resistance Turn ignition off. Disconnect MD wiring harness connector. Disconnect PCM 104-pin connector. Inspect connector for damaged and repair as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance of MD circuit between wiring harness connector terminal and test pin No. 59 at breakout box. Measure resistance of SIG RTN circuit between wiring harness connector terminal and test pin No. 91 at breakout box. If either resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

6) Check MD Circuit For Short To Power Leave MD sensor and PCM disconnected. Turn ignition on. Measure voltage between test pin No. 59 (MD) and test pins No. 51 and 103 (PWR GND) at breakout box. If both voltage measurements are 1.0 volt or less, go to next step. If either voltage measurement is more than 1.0 volt, repair circuit short to power and repeat **QUICK TEST** .

7) Check MD Circuit For Short To Ground Leave MD sensor and PCM disconnected. Turn ignition

off. Measure resistance between test pin No. 59 (MD) and test pins No. 51, 103 (PWR GND) and 91 at breakout box. If each resistance measurement is 10,000 ohms or more, go to next step. If either resistance measurement is less than 10,000 ohms, repair circuit short and repeat **QUICK TEST** .

8) Check For Short In PCM Leave ignition off and MD sensor disconnected. Connect PCM to breakout box. Measure resistance between test pin No. 59 (MD) and test pins No. 23 (IGN GND), 51, 103 (PWR GND), 71 and 97 (VPWR) and 91 (SIG RTN) at breakout box. If each resistance measurement is 500 ohms or more, go to next step. If either resistance measurement is less than 500 ohms, replace PCM and repeat **QUICK TEST** .

9) Check For Short In PCM Leave ignition off and PCM disconnected. Reconnect MD sensor. Set voltmeter on AC scale. Start engine and allow to idle. With engine idling, measure voltage between test pin No. 59 (MD) and test pins No. 51 and 103 (PWR GND) at breakout box. If AC voltage varies more than 0.1 volt, replace PCM and repeat **QUICK TEST** . If AC voltage does not vary more than 0.1 volt, go to next step.

10) Check MD Sensor Trigger Wheel Turn ignition off. Inspect MD sensor trigger wheel for damage. Ensure trigger wheel is not loose or misaligned. Service or repair as necessary and repeat **QUICK TEST** . If trigger wheel is okay, replace MD sensor and repeat QUICK TEST.

CIRCUIT TEST DP - VEHICLE SPEED SENSOR (VSS)

Diagnostic Aids

Delayed engagement of transmission may be caused by mechanical malfunction. Harsh shifts and/or erratic speedometer reading may be caused by a failed speedometer or an open or intermittent ground within the instrument panel (electronic instrument cluster).

Perform this test when directed by QUICK TEST. This CIRCUIT TEST is intended to diagnose:

- Vehicle Speed Sensor (VSS).
- VSS wiring harness circuits. (VSS+ and VSS-).
- Powertrain Control Module (PCM).

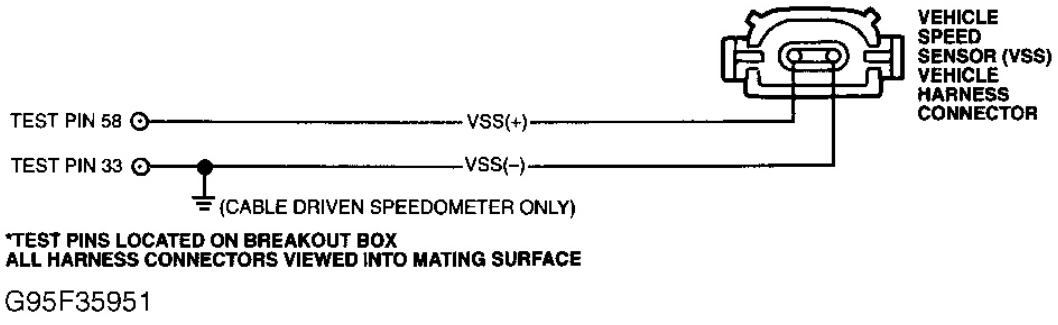


Fig. 35: VSS Circuit & Connector Terminals

1) DTC P0500 Or P0501 These codes indicate PCM detected incorrect output from VSS sometime during vehicle operation. Possible causes for this code are:

- Faulty VSS.
- Open or shorted circuit.
- Faulty PCM.

Turn ignition off. Disconnect VSS sensor. Remove PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 58 and VSS(+) terminal at VSS wiring harness connector. Measure resistance between test pin No. 33 and VSS(-) terminal at VSS wiring harness connector. If resistance readings are less than 5 ohms, go to next step. If either resistance reading is 5 ohms or more, repair open circuit in VSS wiring harness. Clear PCM memory and go to step 27).

2) Check VSS Circuits For Shorts To Power Or Ground Turn ignition off. Ensure PCM and VSS are disconnected. Measure resistance as follows:

- Between test pin No. 33 and test pin No. 58 and 71 (VPWR).
- Between test pin No. 58 and test pins No. 24, 51, 76 and 103 (PWR GND).
- Between test pin No. 58 and test pins No. 71 (VPWR) and 91 (SIG RTN).

If all readings are more than 500 ohms, go to next step. If any reading is 500 ohms or less, repair short in wiring harness. Clear PCM memory and go to step 27).

3) Check VSS Resistance Turn ignition off. Disconnect VSS wiring harness connector. Measure resistance between VSS terminals. If resistance is not 190-250 ohms, replace VSS and go to step 27). If resistance is 190-250 ohms, replace PCM and go to step 27).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 3) to step 5). No test procedures have been omitted.

5) DTC P0500 This code indicates PCM detected incorrect output from VSS sometime during vehicle operation. Possible causes for this code are:

- Faulty VSS.
- Open or shorted circuit.
- Faulty PCM.

Turn ignition off. Disconnect VSS sensor. Remove PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Check voltage between test pins No. 58 and 103 at breakout box while slowly rotating drive wheels. If voltage fluctuates 1.0-5.0 volts as wheels are rotated, replace PCM and go to step 27). If voltage does not fluctuate 1.0-5.0 volts, go to next step.

6) Check VPWR To VSS Turn ignition off. Disconnect VSS wiring harness connector. Turn ignition on. Measure voltage at connector as follows:

- Between VPWR and PWR GND terminals.
- Between VSS+ and VSS- terminals.

If voltage is 10.5 volts or more, go to next step. If voltage is 10.5 volts or less, go to step 10).

7) Check VSS Circuits For Short To Power Turn ignition off. Ensure PCM and VSS are disconnected. Measure voltage between test pins No. 58 and 103 at breakout box. If voltage is 1.0 volt or more, repair short to power and go to step 27). If voltage is less than 1.0 volt, go to next step.

8) Check VSS Circuits For Short To Ground Turn ignition off. Ensure PCM and VSS are disconnected. Measure resistance between test pin No. 58 and 103 at breakout box. If resistance is more than 3000 ohms, go to next step. If resistance is 3000 ohms or less, repair short to ground and go to step 27).

9) Check VSS Circuit Resistance Turn ignition off. Ensure PCM and VSS are disconnected. Measure resistance between test pin No. 58 and the VSS or VSS+ terminal at VSS wiring harness connector. If all resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and go to step 27).

10) Check VSS Ground Circuit Resistance Turn ignition off. Ensure PCM and VSS are disconnected. Measure resistance between chassis ground and PWR GND or VSS(-) terminal at VSS wiring harness connector. If resistance is less than 5 ohms, repair open in power circuit to VSS and go to step 27). If resistance is 5 ohms or more, repair open in ground circuit and go to step 27).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 10) to step 15). No test procedures have been omitted.

15) KOER DTC P1501: Check PCM VSS PID For Input Signal This code indicates VSS input signal is out of range. A DTC 1501 will be set and self-test will abort whenever PCM detects VSS input signal during KOER self-test. Possible causes for this code are:

- Noisy VSS input signal from RFI/EMI external source (ignition wires, charging circuits etc.).

Turn ignition off. Connect scan tester to DLC. Start engine and allow to idle. Using scan tester, access VSS PID and observe vehicle speed input to PCM. While observing VSS PID, increase engine speed to 2000 RPM and decrease to idle several times. If VSS PID reading is less than 3 MPH, fault cannot be duplicated at this time. Testing is complete. If VSS PID reading is 3 MPH or more, go to step 22).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 15) to step 20). No test procedures have been omitted.

20) Continuous Memory P0503: Check For Intermittent Fault This code indicates poor VSS performance. Possible causes for this code are:

- Noisy VSS input signal from RFI/EMI external source (ignition wires, charging circuits etc.).
- Damaged circuit.
- Faulty VSS.
- Faulty VSS gear(s).

Turn ignition off. Disconnect VSS sensor. Visually inspect VSS and VSS circuits for potential faults as follows:

- Loose VSS circuit connectors.
- Loose VSS circuit connector pins.
- Damaged VSS wiring harness insulation.
- Incorrect VSS circuit routing.
- Incorrect VSS installation.

If no faults are found, go to next step. If faults are found, repair or replace as necessary. Clear PCM memory and go to step 27).

21) Check PCM VSS PID For Input Signal Turn ignition off. Connect scan tester to DLC. Test drive vehicle, averaging 30 MPH. While driving at a steady speed, check for VSS PID variations of more than 5 MPH for 10 seconds or more. If any variations occur, go to next step. If variations do not occur, fault cannot be duplicated at this time. Testing is complete.

22) Visually inspect VSS wiring harness. Ensure wiring is not routed near ignition wires or alternator wires. Verify VSS wiring harness is shielded and grounded (if applicable). Repeat step 1) to verify circuit continuity. If faults are found, repair or replace as necessary. Clear PCM memory and go to step 27). If no faults are found, fault cannot be duplicated at this time. Testing is complete.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 22) to step 25). No test procedures have been omitted.

25) DTC P1500 This code indicates PCM detected intermittent input from VSS. Possible causes for this code are:

- Intermittent open or shorted circuit.
- Faulty VSS.
- Faulty PCM.

Turn ignition off. Disconnect VSS sensor. Visually inspect VSS and VSS circuits for potential faults as follows:

- Loose VSS circuit connectors.
- Loose VSS circuit connector pins.
- Damaged VSS wiring harness insulation.
- Incorrect VSS circuit routing.
- Incorrect VSS installation.

If no faults are found, go to **CIRCUIT TEST Z** . If faults are found, repair or replace as necessary. Clear PCM memory and go to step 27).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips

from step 25) to step 27). No test procedures have been omitted.

27) VSS Drive Cycle Record and clear continuous memory codes. Warm engine to normal operating temperature. Perform appropriate drive cycle as follows:

- On models with A/T, place gear selector in Drive position. Accelerate hard to 35 MPH and coast down to a stop. Repeat procedure 3 times. Shut off engine. Repeat **QUICK TEST** . Service codes as necessary. If no codes are present, testing is complete.
- On models with M/T, start in first gear, shifting no higher than second gear. Accelerate moderately to 40 MPH. Coast down to idle, and stop. Repeat procedure 3 times. Shut engine off. Repeat **QUICK TEST** . Service codes as necessary. If no codes are present, testing is complete.

CIRCUIT TEST DR - CYLINDER IDENTIFICATION (CID) CIRCUIT

Diagnostic Aids

CID signal provides PCM information for fuel injector synchronization. The CID signal originates from Camshaft Position (CMP) sensor.

Enter this CIRCUIT TEST only when instructed during QUICK TEST. This test is only intended to diagnose the following:

- CID, PWR GND, SIG RTN and VPWR wiring harness circuits.
- Faulty Camshaft Position (CMP) sensor.
- Faulty Powertrain Control Module (PCM).

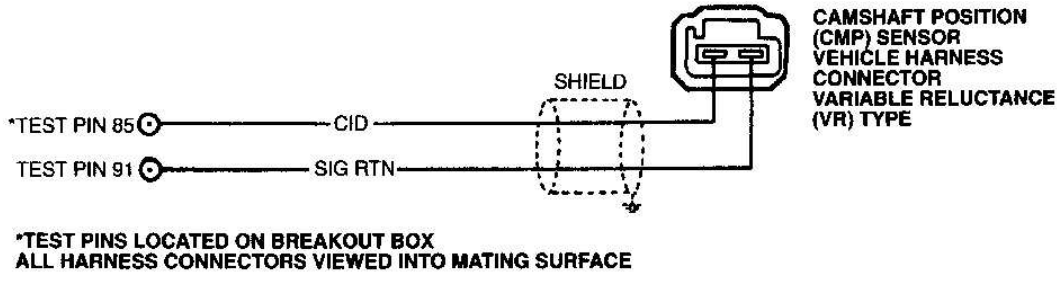


Fig. 36: CMP Test Circuit & Connector Terminals (2-Terminal Applications)

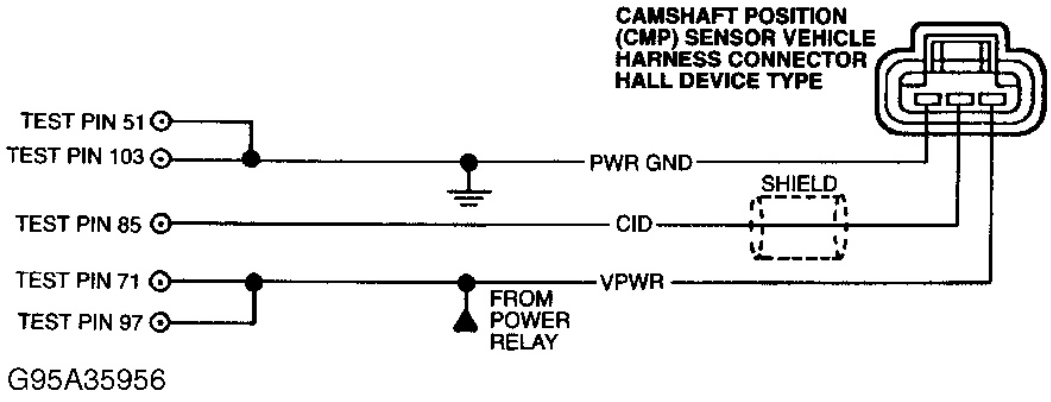


Fig. 37: CMP Test Circuit & Connector Terminals (3-Terminal Applications)

1) DTC P0340 This code indicates error has been detected in CMP sensor circuit. Possible causes for this fault are:

- CID circuit open or shorted wiring harness.
- PWR GND or VPWR circuit open (Hall Type CMP).
- SIG RTN circuit open (Variable Reluctance Type CMP).
- Faulty CMP sensor.
- Faulty ICM.
- Faulty PCM.

If engine starts, go to step 2). If engine does not start, go to **CIRCUIT TEST A** .

2) Attempt To Generate DTC P0340 Clear PCM memory. Start engine. Raise engine speed to 1500 RPM for 10 seconds. Return to idle speed. Raise speed to 1500 RPM for 10 seconds again. Turn ignition off. Perform QUICK-TEST to retrieve Continuous Memory DTCs. If DTC P0340 is not present, go to **CIRCUIT TEST Z** . If DTC P0340 is present, go to next step for Hall Type CMP or step 5) for Variable Reluctance Type CMP.

3) Check VPWR Circuit Voltage Turn ignition off. Disconnect CMP wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal at CMP sensor wiring harness connector and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VREF circuit. Clear PCM memory and repeat **QUICK TEST** .

4) Check PWR GND To CMP Sensor Turn ignition off. Ensure CMP sensor is disconnected. Measure resistance between PWR GND circuit at CMP sensor wiring harness connector and negative battery terminal. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in PWR GND circuit. Clear PCM and repeat **QUICK TEST** .

5) Check Resistance Of CID Circuits Leave ignition off. Disconnect PCM 104-pin connector. Inspect for damaged terminals and repair if necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 85 (CID) at breakout box and CID terminal at

CMP sensor wiring harness connector. Also measure resistance between test pin No. 91 (SIG RTN) and SIG RTN terminal at CMP sensor wiring harness connector.

If each resistance measurement is less than 5 ohms, go to next step. If either resistance is 5 ohms or more, repair open circuit. Clear PCM memory and repeat **QUICK TEST** .

6) Check CID Circuit For Short To Power Leave CMP sensor disconnected. Turn ignition on. Measure voltage between test pin No. 85 and test pins No. 51 and 103 (PWR GND) at breakout box. If voltage is less 1.0 volt, go to next step. If voltage is 1.0 volt or more, repair CID circuit short to power. Clear PCM memory and repeat **QUICK TEST** .

7) Check CID Circuit For Short To Ground Turn ignition off. Leave CMP sensor and PCM disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 85 and test pins No. 51, 103 (PWR GND) and 91 (SIG RTN) at breakout box. If resistance is 10,000 or more, go to next step. If any resistance measurement is less than 10,000 ohms, repair short to ground or SIG RTN in CID circuit. Clear PCM memory and repeat **QUICK TEST** .

8) Check For Short In PCM Leave ignition off and CMP sensor disconnected. Connect PCM to breakout box. Measure resistance between test pin No. 85 and test pins No. 23, 51, 71, 91, 97 and 103 at breakout box. If each resistance measurement is 500 ohms or more, go to next step for Variable Reluctance type CMP or step 10) for Hall type CMP. If any resistance measurement is less than 500 ohms, replace PCM and repeat **QUICK TEST** .

9) Check CMP Sensor Output Turn ignition off. Reconnect CMP sensor wiring harness connector. Set DVOM on AC scale to monitor less than 5 volts. Start engine. Measure voltage between test pins No. 85 and test pins No. 51 and 103 while varying engine speed. If voltage varies more than 0.1 volt, replace PCM and repeat **QUICK TEST** . If voltage does not vary more than 0.1 volt, replace CMP sensor and repeat QUICK TEST.

10) Check CMP Sensor Output Turn ignition off. Disconnect PCM. Ensure CMP sensor is installed properly. Reconnect CMP sensor wiring harness connector. Using starter, bump engine (do not allow engine to start) for at least 10 engine revolutions. Measure voltage between test pins No. 85 and test pins No. 51 and 103. If voltage switches from below 2 volts to more than 8 volts, replace PCM and repeat **QUICK TEST** . If voltage does not switch as specified, replace CMP sensor and repeat QUICK TEST.

CIRCUIT TEST FB - POWER TAKE OFF (PTO)

Diagnostic Aids

Perform this test when directed by QUICK TEST. This CIRCUIT TEST is intended to diagnose:

- PTO wiring harness circuit.
- Powertrain Control Module (PCM).

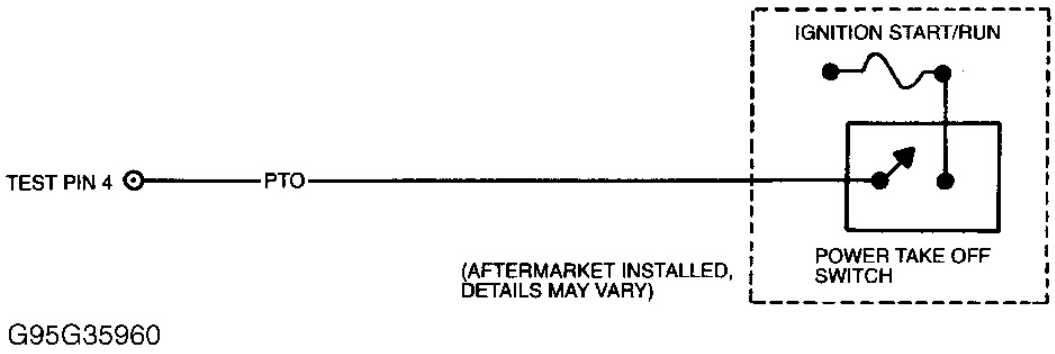


Fig. 38: PT0 Test Circuit & Switch Schematic

1) Check PTO Switch For Short To Power PTO signals PCM that additional load is being applied to engine. If PTO circuit failure occurs, a fault code may be set. Possible causes for this code are:

- PTO circuit shorted to power.
- Faulty Powertrain Control Module (PCM).

Turn ignition off. Disconnect PTO switch wiring harness connector. Connect scan tester to DLC. Turn ignition on. Access PTO STAT PID. If PTO STAT PID is on, go to next step. If PTO STAT PID is off, repair or replace switch as necessary. Road test vehicle and repeat **QUICK TEST** .

2) Check PTO Circuit For Short To Power Leave ignition off and PTO switch disconnected. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Measure voltage test pin No. 4 and test pins No. 51 and 103 at breakout box. If voltage is less than one volt, replace PCM and repeat **QUICK TEST** . If voltage is one volt or more, repair circuit short to power and repeat QUICK TEST.

3) MIL On: Check PTO PID Turn ignition off. Connect scan tester to DLC. Turn ignition on. Access PTO STAT PID. If PTO STAT PID is available and displaying on or off, go to next step. If PTO STAT PID is not as specified, go to step 9).

4) Check PTO Circuit With Scan Tester With ignition on and PTO STAT PID accessed, cycle PTO switch. If PTO STAT PID cycles on, delays, and then cycles off, PTO input is okay and testing is complete. If PTO STAT PID does not cycle as specified, go to next step.

5) Check PTO Circuit For Short To Ground Turn ignition off. Leave PTO switch disconnected. Disconnect scan tester from DLC. Measure resistance between chassis ground and PTO circuit terminal at PTO switch connector. If resistance is 10,000 ohms or less, go to next step. If resistance is more than 10,000 ohms, go to step 7).

6) Isolate Short To Chassis Ground Leave ignition off and PTO sensor disconnected. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 4 (PTO) and test pins No. 77 and 103 at breakout box. If resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair PTO circuit short to chassis ground and repeat QUICK

TEST.

7) Leave ignition off and PTO sensor disconnected. Connect scan tester to DLC. Connect jumper wire between positive battery terminal and PTO terminal at PTO switch wiring harness connector. Turn ignition on. Access PTO STAT PID. If PTO STAT PID is on, PTO input is okay and testing is complete. Check switch for malfunction and repair as necessary. If PTO STAT PID is off, go to next step.

8) Check Circuit Resistance Leave ignition off and PTO sensor disconnected. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 4 (PTO) and PTO circuit terminal at PTO switch connector. If resistance is less than 5 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open in PTO circuit and repeat QUICK TEST.

9) Perform KOEO and KOER self-test. If any DTCs are present, repair as necessary. If no DTCs are present, go to next step.

10) Road test vehicle under various conditions. Retrieve all Continuous Memory DTCs and service as necessary. If no DTCs are present, fault cannot be duplicated at this time. If symptom is still present, go to **CIRCUIT TEST Z** .

CIRCUIT TEST FD - BRAKE ON-OFF (BOO) SWITCH

Diagnostic Aids

Perform this test when directed by QUICK TEST. This test is intended to diagnose a faulty BOO switch, circuit or PCM. To prevent replacement of good components, be aware following non-EEC related areas may be at fault:

- Brakelight bulb.
- Brakelight switch or brakelight fuse.

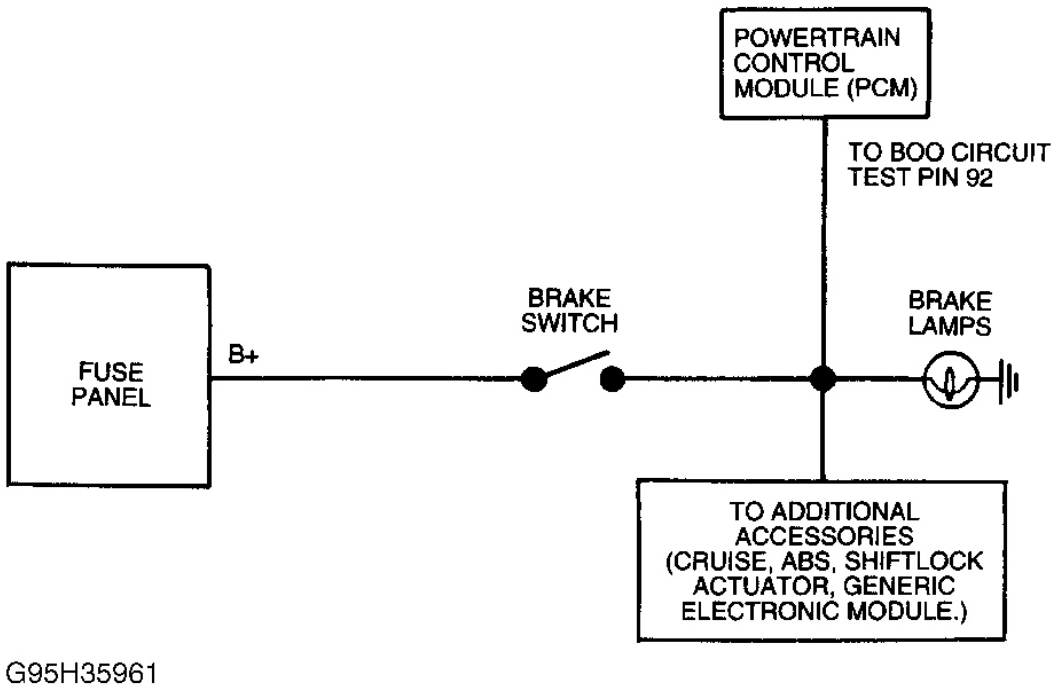


Fig. 39: BOO Switch Circuit

1) DTC P1703: Verify Brake Pedal Was Depressed This code indicates that when brake pedal is applied during KOER SELF-TEST, BOO signal did not cycle high and low. Possible causes for this fault are as follows:

- Brake pedal not applied during self-test.
- Brake pedal applied during entire self-test.
- Open brakelight circuit.
- Short to ground or power.
- Faulty brakelight switch.
- Faulty Powertrain Control Module (PCM).

If brake was not applied during KOER SELF-TEST, repeat test. Depress and release brake pedal only once during test. If pedal was depressed, go to next step.

2) DTC P1703 This code indicates that voltage was present at BOO circuit during **KOEO SELF-TEST** . Possible causes for this fault are as follows:

- Brake pedal applied during KOEO SELF-TEST.
- BOO circuit short to power.
- Faulty brakelight switch.

If brake was applied during **KOEO SELF-TEST** , repeat test. If pedal was not depressed, go to next step.

3) Check Operation Of Brakelights With ignition on, check operation of brakelights. If brakelights operate normally, go to next step. If brakelights do not operate, go to step 5). If brakelights are always on, go to step 7).

4) Check For BOO PID Cycling Turn ignition off. Connect scan tester to DLC. Using scan tester, access BOO PID. Apply and release brake several times while observing BOO PID. If BOO PID voltage does not cycle on and off, go to step 10). If BOO PID voltage cycles, go to step 10) under **CIRCUIT TEST Z** .

5) Check For Power To Brakelight Switch Ensure related fuses and brakelight bulbs are in good condition. Turn ignition off. Disconnect brakelight switch (located on brake pedal). Measure voltage between B+ input to brakelight switch and ground. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open in B+ circuit to brakelight switch and repeat **QUICK TEST** .

6) Check Brakelight Switch With brakelight switch disconnected, measure resistance between switch terminals. If resistance is 5 ohms or more, replace brakelight switch and repeat **QUICK TEST** . If resistance is less than 5 ohms, repair open circuit between switch and stoplight ground and repeat QUICK TEST.

7) Verify Brake Switch Is Not Always Closed Turn ignition off. Disconnect brakelight switch (located on brake pedal). Turn ignition on. If brakelights are still on, go to next step. If brakelights are not on, verify correct installation of brakelight switch. If installation is okay, replace brakelight switch and repeat **QUICK TEST** .

8) Check For Short To Power In PCM Turn ignition off. Disconnect PCM. Turn ignition on. Check brakelights. If brakelights are on, go to next step. If brakelights are off, replace PCM and repeat **QUICK TEST** .

9) Check For Short To Power In Shift Lock Actuator Turn ignition off. Ensure PCM and brakelight switch are disconnected. Disconnect shift lock actuator, cruise control module, ABS module and Generic Electronic Module (if equipped). Turn ignition on. If brakelights are still on, repair short to power in BOO circuit and repeat **QUICK TEST** . If brakelights are off, repair short circuit in shift lock actuator circuit, cruise control system circuit or ABS circuit. Reconnect all components and repeat QUICK TEST.

10) Check For BOO PID Cycling Turn ignition off. Disconnect PCM 104-pin connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Using DVOM, measure voltage between test pin No. 92 and test pins No. 51 and 77 while applying and releasing brake. If voltage cycles on and off, replace PCM and repeat **QUICK TEST** . If voltage does not cycle, repair open in BOO circuit between PCM and BOO circuit connection splice to B+ circuit.

CIRCUIT TEST FE - ELECTRICAL LOAD INPUTS

Diagnostic Aids

Electrical load inputs are used for idle speed control strategy so correct idle can be maintained regardless of electrical demands on engine. PCM uses blower motor, headlights, rear window defroster, and daytime running lights (if equipped) to determine electrical load status.

Perform this test when directed by QUICK TEST, CIRCUIT TEST S or if directed by other test procedures.

This CIRCUIT TEST is intended to diagnose:

- Blower (BLR) motor input circuit.
- Daytime Running Lights (DRL) input circuit.
- Headlight (HDL) input circuit.
- Rear window Defroster (DEF) input circuit.
- Powertrain Control Module (PCM).

SWITCH CIRCUIT LOGIC

Application	Switch Position	Voltage
Blower Motor	1 Or 2	10-17
	3 Or 4	Less Than 1.5
Daytime Running Lights	Off	10-17
	On	Less Than 1.5
Headlights	Off	Less Than 1.5
	On	10-17
Rear Window Defroster	Off	10-17
	On	Less Than 3.0

1) Isolate Faulty System If idle speed fault occurs when blower motor is on, go to step 10). If idle speed fault occurs when daytime running lights are on, go to step 20). If idle speed fault occurs when headlights are on, go to step 30). If idle speed fault occurs when rear window defroster is on, go to step 40).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 1) to step 10). No test procedures have been omitted.

10) Check Blower Motor Switch (Low Speed) Turn ignition and all accessories off. Remove PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair as necessary. Install EEC-IV Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Turn climate control motor switch to low-speed position "1" or "2". Measure voltage between chassis ground and test pin No. 10 at breakout box. If voltage is not 10-17 volts, go to step 13). If voltage is 10-17 volts, go to next step.

11) Check Blower Motor Switch (High Speed) Turn ignition and all accessories off. Turn climate control motor switch to high-speed position "3" or "4". Turn ignition on. Measure voltage between chassis ground and test pin No. 10 at breakout box. If voltage is less than 1.5 volts, replace PCM and confirm idle speed fault has been corrected. If voltage is 1.5 volts or more, go to next step.

12) Check Blower Circuit For Short To Power Turn ignition off. Disconnect high speed blower motor relay connector. Relay is located behind right side of instrument panel on blower assembly. Measure resistance between test pin No. 10 and test pins No. 71 and 91 at breakout box. If all readings are more than 10,000 ohms, check for damaged blower motor switch or relay. If any reading is 10,000 ohms or less, repair short circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

13) Check Blower Circuit Resistance Turn ignition off. Disconnect blower motor relay. Measure resistance between BLR terminal at power distribution box and test pin No. 10 at breakout box. If

resistance is 5 ohms or more, repair open circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected. If resistance is less than 5 ohms, go to next step.

14) Check Blower Circuit For Short To Ground Turn ignition off. Disconnect high speed blower motor relay. Measure resistance between test pin No. 10 and test pins No. 23, 76 and 91 at breakout box. If all readings are more than 10,000 ohms, check for damaged blower motor switch or relay. If any reading is 10,000 ohms or less, repair short circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 14) to step 20). No test procedures have been omitted.

20) Check DRL Circuit Voltage (Headlights On) Turn ignition off. Disconnect PCM 60-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair as necessary. Install EEC-IV Breakout Box (014-000950), leaving PCM disconnected. Apply parking brake. Turn ignition on. Turn headlights on. Turn accessories off. Measure voltage between chassis ground and test pin No. 14 at breakout box. If voltage is not 10-17 volts, go to step 23). If voltage is 10-17 volts, go to next step.

21) Check DRL Circuit Voltage (Headlights Off) Turn headlights off. Release parking brake. Turn ignition on. Measure voltage between chassis ground and test pin No. 14 at breakout box. If voltage is less than 1.5 volts, replace PCM. Remove breakout box and confirm idle speed fault has been corrected. If voltage is 1.5 volts or more, go to next step.

22) Check DRL Circuit For Short To Power Turn ignition off. Ensure PCM is disconnected. Disconnect daytime running lights relay. Measure resistance between test pin No. 14 and test pins No. 71 and 97 at breakout box. If all readings are more than 10,000 ohms, check daytime running lights module for malfunction. If any reading is 10,000 ohms or less, repair short circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

23) Check DRL Circuit Resistance Turn ignition off. Disconnect daytime running lights relay. Measure resistance between DRL circuit terminal at DRL wiring harness connector and test pin No. 14 at breakout box. If resistance is 5 ohms or more, repair open circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected. If resistance is less than 5 ohms, go to next step.

24) Check DRL Circuit For Short To Ground Turn ignition off. Measure resistance between test pin No. 14 and test pins No. 23, 76 and 91 at breakout box. If all readings are more than 10,000 ohms, check daytime running lights module for malfunction. If any reading is 10,000 ohms or less, repair short circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 24) to step 30). No test procedures have been omitted.

30) Check Headlight Circuit Voltage (Headlights Off) Turn ignition off. Remove PCM 60-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair as necessary. Install EEC-IV Breakout Box (014-000950), leaving PCM disconnected. Turn all accessories off. Turn ignition on. Measure voltage between chassis ground and test pin No. 49 at breakout box. If voltage is 1.5 volts or more, go to step 34). If voltage is less than 1.5 volts, go to next step.

31) Check Headlight Circuit Voltage (Headlights On) Turn all accessories off. Turn ignition on. Turn headlights on. Measure voltage between chassis ground and test pin No. 49 at breakout box. If voltage is 10-17 volts, replace PCM. Remove breakout box and confirm idle speed fault has been corrected. If

voltage is not 10-17 volts, go to next step.

32) Check HDL Circuit Resistance Turn ignition off. Disconnect headlight relay. Relay is located in engine compartment relay box. Measure resistance between HDL circuit terminal at power distribution box and test pin No. 49 at breakout box. If resistance is 5 ohms or more, repair open circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected. If resistance is less than 5 ohms, go to next step.

33) Check HDL Circuit For Short To Ground Turn ignition off. Disconnect headlight relay. Measure resistance between test pin No. 49 and test pins No. 23, 76 and 91 at breakout box. If all readings are more than 10,000 ohms, check headlight switch for malfunction. If any reading is 10,000 ohms or less, repair short circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

34) Check HDL Circuit For Short To Power Turn ignition off. Disconnect headlight relay. Measure resistance between test pin No. 49 and test pins No. 71 and 97 at breakout box. If all readings are more than 10,000 ohms, check headlight switch for malfunction. If any reading is 10,000 ohms or less, repair short circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 34) to step 40). No test procedures have been omitted.

40) Check Rear Window Defroster Turn ignition off. Disconnect rear window defroster coil connector. Turn ignition on. Using DVOM, measure voltage between coil connector and defroster coil. If voltage is 10-127 volts when defroster on and less than one volt with defroster off, go to next step. If voltage is not as specified, repair rear window defroster.

41) Check DEF Circuit Voltage (Defrost Off) Turn ignition off. Turn all accessories off. Remove PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair as necessary. Install EEC-IV Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between chassis ground and test pin No. 66 at breakout box. If voltage is 10-17 volts, go to next step. If voltage is not 10-17 volts, go to step 44).

42) Check DEF Circuit Voltage (Defrost On) Turn ignition on. Turn rear window defroster on. Measure voltage between chassis ground and test pin No. 66 at breakout box. If voltage is less than 3 volts, replace PCM. Remove breakout box and confirm idle speed fault has been corrected. If voltage is 3 volts or more, go to next step.

43) Check DEF Circuit For Short To Power Turn ignition off. Disconnect rear window defroster relay. Relay is located in left side of trunk. Measure resistance between test pin No. 66 and test pins No. 71 and 97 at breakout box. If all readings are more than 10,000 ohms, check DEF switch or relay for malfunction. If any reading is 10,000 ohms or less, repair short circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

44) Check DEF Circuit Resistance Leave ignition off and rear window defroster switch disconnected. Measure resistance between DEF circuit terminal at power distribution box connector and test pin No. 23 at breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

44) Check DEF Circuit For Short To Ground Leave ignition off and rear window defroster switch disconnected. Measure resistance between test pin No. 66 and test pins No. 23, 76 and 91 at breakout box.

If all readings are more than 10,000 ohms, check DEF switch and relay circuit for malfunction. If any reading is 10,000 ohms or less, repair short circuit. Remove breakout box, reconnect all components, and confirm idle speed fault has been corrected.

CIRCUIT TEST FF - POWER STEERING PRESSURE (PSP) SWITCH

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. Some vehicles may not have power steering, but PCM may be equipped with PSP switch software strategy. If a KOEO DTC P1650 or P1651 is displayed, check if vehicle is equipped with power steering. If vehicle is not equipped with power steering, disregard DTC P1650 or P1651. This test is only intended to diagnose:

- Wiring harness circuits (SIG RTN and PSP).
- PSP switch.
- Powertrain Control Module (PCM).

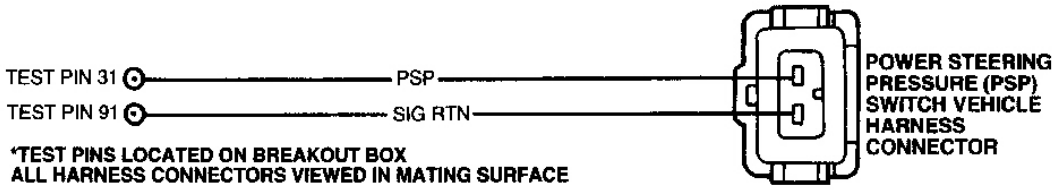


Fig. 40: PSP Test Circuit & Connector Terminals

1) DTC P1650 Or P1651 DTC P1650 indicates PSP signal is out of self-test range. DTC P1651 indicates PSP signal malfunction. Possible causes for this fault are as follows:

- Open or short in wiring harness.
- Faulty PSP switch.
- Faulty PSP switch/shorting bar damage.
- Faulty Powertrain Control Module (PCM).

Start engine and allow to idle. Using scan tester, access PSP PID (if scan tester cannot access PSP PID, go to next step). Turn steering wheel left, then right. If scan tester does not indicate on/off switching, go to step 3). If scan tester indicates on/off switching, go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 1) to step 3). No test procedures have been omitted.

3) Check PSP Switch Operation Turn ignition off. Install tachometer. Start engine and allow to idle.

Disconnect PSP switch. Connect jumper wire between PSP terminal and SIG RTN terminal of connector. If engine speed increases when switch is disconnected, replace switch and repeat **QUICK TEST** . If engine speed does not increase when switch is disconnected, go to next step.

4) Check PSP Circuit Resistance Turn ignition off. Leave PSP switch disconnected. Turn ignition off. Disconnect 104-pin PCM connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 31 (PSP) at breakout box and PSP terminal of PSP switch connector. Measure resistance between test pin No. 91 (SIG RTN) at breakout box and SIG RTN terminal of PSP switch connector. If both resistance measurement are less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

5) Check For Short In PSP Circuit Leave ignition off and PSP switch disconnected. Measure resistance between test pin No. 31 (PSP) and 91 at breakout box. Measure resistance between test pin No. 31 and chassis ground. If both resistance measurements are 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, repair short circuit and repeat **QUICK TEST** .

6) Check Switch Resistance Turn ignition off. Start engine and allow to idle. Disconnect PSP switch. Measure resistance between PSP switch signal and chassis ground while turning steering wheel. If resistance is less than 10 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10 ohms or more, replace PSP switch and repeat QUICK TEST.

CIRCUIT TEST FG - OCTANE ADJUST

Diagnostic Aids

Enter this test when directed by QUICK TEST. This test is only intended to diagnose:

- Harness circuits (SIG RTN and OCT ADJ).
- Octane adjust shorting bar connector.

Purpose of Octane Adjust Shorting Bar is to provide optimum spark advance for fuel used. If engine detonates (spark knock), remove Octane Shorting Bar. This retards spark advance about 3-4 degrees. If engine continues to detonate, use fuel with a higher octane rating.

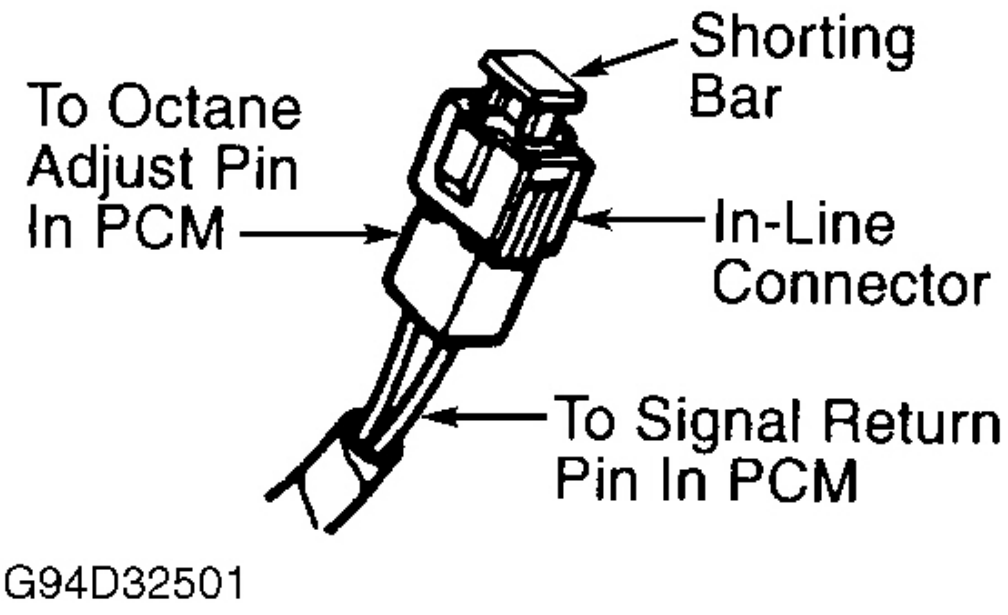


Fig. 41: Octane Adjust Components

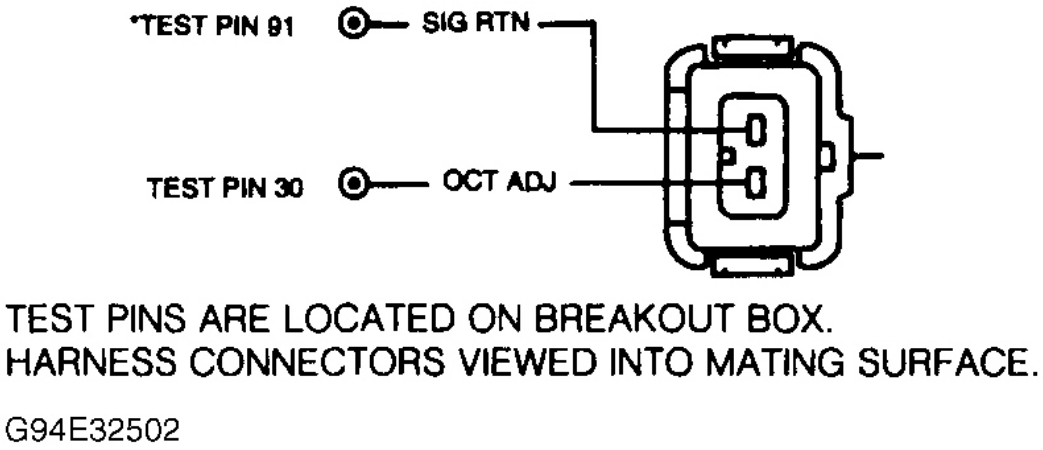


Fig. 42: Octane Adjust Circuit

1) DTC P1390 This code indicates Octane Adjust (OCT ADJ) shorting bar is not in place or OCT ADJ

circuit is open. Turn ignition off. Inspect Octane Adjust in-line connector. If shorting bar has been removed, go to next step. If shorting bar is in place, go to step 4).

2) Check For Modification Decal If vehicle has modification decal indicating OCT ADJ shorting bar was removed as a factory authorized procedure, testing is complete. If engine is detonating, go to **TESTS W/O CODES - 4.2L** article. If vehicle does not have modification decal, go to next step.

3) Check For DTC P1390 Replace OCT ADJ shorting bar. Perform **KOEO SELF-TEST** . If DTC P1390 is present, go to next step. If DTC P1390 is not present, testing is complete. If there are no codes and driveability faults are present, go to **TESTS W/O CODES - 4.2L** article.

4) Check Octane Adjust Circuit Resistance Continuity should exist from OCT ADJ circuit, through in-line connector and shorting bar, to SIG RTN circuit. Turn ignition off. Disconnect 104-pin PCM connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 30 (OCT ADJ) and 91 (SIG RTN) at breakout box. If resistance is less than 5 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open OCT ADJ circuit, shorting bar or SIG RTN circuit. Repeat QUICK TEST.

5) Check For DTC P1390 Start engine. Warm it to normal operating temperature. Turn ignition off. Perform **KOEO SELF-TEST** . If DTC P1390 is not present, go to next step. If DTC P1390 is present, return to step 1).

6) Verify In-Line Shorting Bar Is Installed Turn ignition off. Inspect OCT ADJ in-line connector. If shorting bar is installed, go to step 8). If shorting bar is not installed, go to next step.

7) Check For Modification Decal If vehicle has modification decal indicating OCT ADJ shorting bar was removed as a factory authorized procedure, go to step 10). If vehicle does not have a modification decal, replace shorting bar. If engine is detonating, go to **TESTS W/O CODES - 4.2L** article.

8) Check For Technical Service Bulletin (TSB) If a TSB authorizing removal of OCT ADJ shorting bar exists, go to next step. If authorizing TSB does not exist, testing is complete. If engine is detonating, go to **TESTS W/O CODES - 4.2L** article.

9) Remove OCT ADJ Shorting Bar Turn ignition off. Remove OCT ADJ shorting bar. Test drive vehicle to verify complaint. If detonation is present, go to next step. If detonation is not present, testing is complete.

10) Check Octane Adjust Circuit For Short To Ground Turn ignition off. Disconnect 104-pin PCM connector. Inspect connector for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between OCT ADJ terminal at in-line connector and test pins No. 51, 91 and 103 at breakout box. If each resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short circuit. If engine is still detonating, go to **TESTS W/O CODES - 4.2L** article.

11) Check PCM Turn ignition off. Disconnect OCT ADJ shorting bar. Connect PCM to breakout box. Turn ignition on. Measure voltage between breakout box OCT ADJ terminal of in-line connector and test pins No. 51 and 103. If voltage is less than 4 volts, replace PCM. If voltage is 4 volts or more, remove breakout box. If engine is still detonating, go to **TESTS W/O CODES - 4.2L** article.

CIRCUIT TEST H - FUEL CONTROL

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. Only use this test

to diagnose the following:

- HO2S and sensor connection.
- Vacuum systems.
- Fuel injector and/or fuel injector circuitry.
- Powertrain Control Module (PCM).
- Electrical circuits (HO2S, HO2S GND, INJ 1-8, VPWR and SIG RTN).

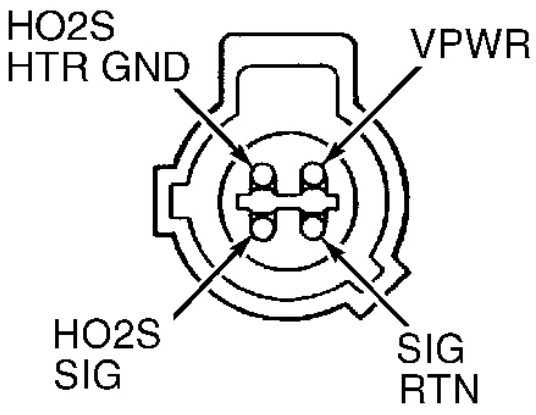
NOTE: HO2S may be displayed on scan tester as 02S.

To prevent replacement of good components, be aware the following non-EEC areas may be cause of driveability concerns:

- Ignition system.
- Faulty evaporative emission system.
- EGR and/or PCV system.
- Air intake system.
- Engine oil contamination.
- Fuel system.
- Exhaust system leaks or restriction.
- Engine cooling system.

CIRCUIT TEST ACRONYMS

Acronym	Definition
DLC	Data Link Connector
HO2S	Heated Oxygen Sensor
PID	Parameter Identification



NOTE: Location of the small index tabs may differ from illustration. Use large index tabs as your reference. Some connectors may not have small index tabs.

G95E35968

Fig. 43: HO2S Connector Terminals

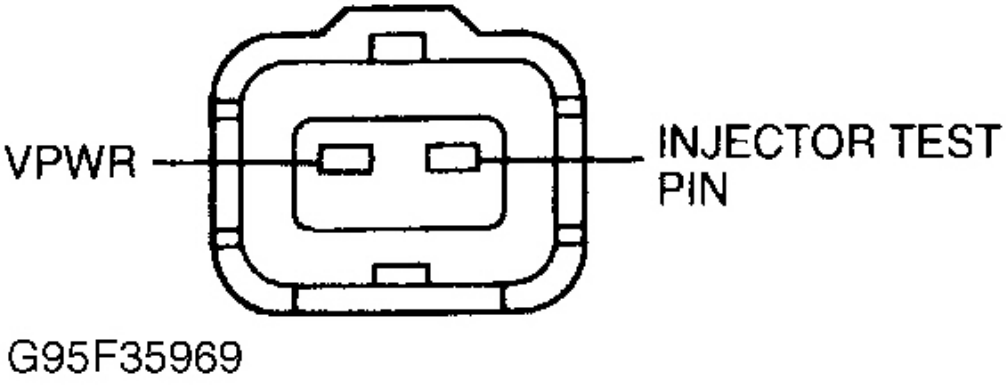


Fig. 44: Fuel Injector Connector Terminals

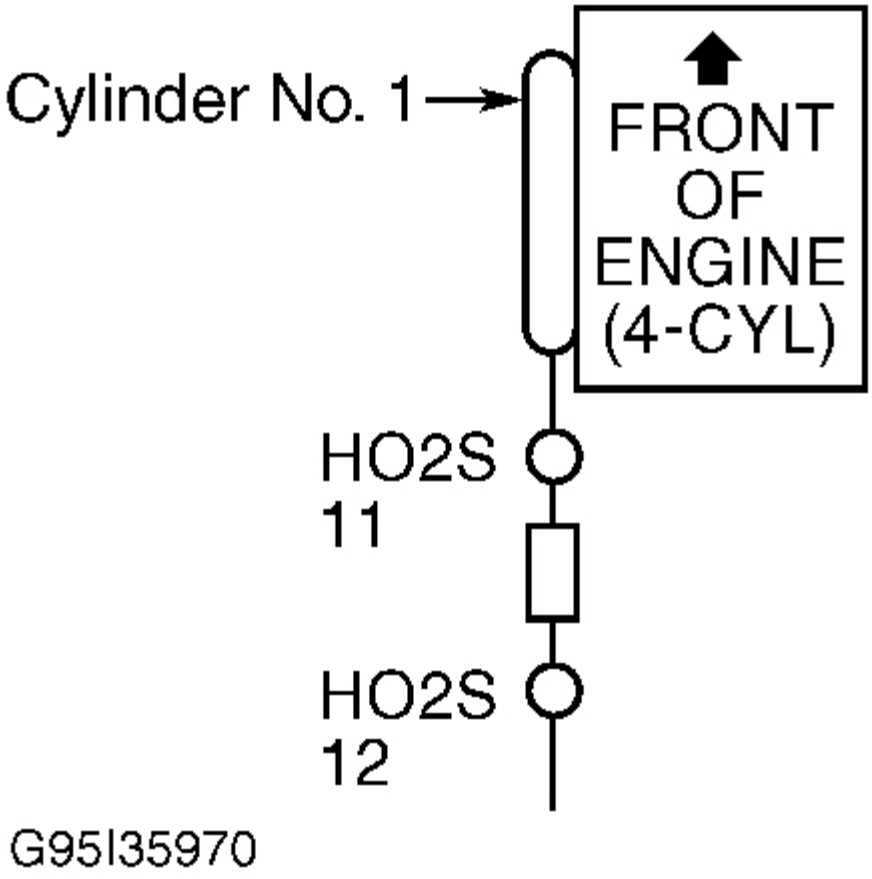


Fig. 45: Locating HO2S (4-Cylinder)

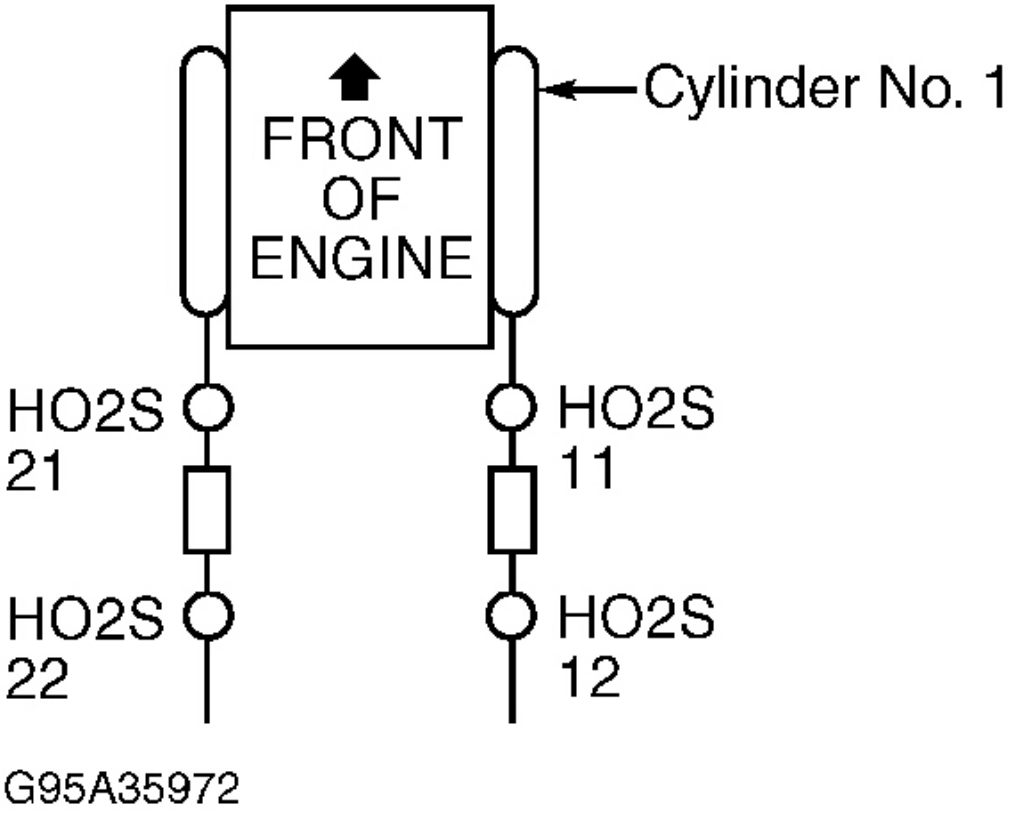


Fig. 46: Locating HO2S (V8 Or V6 With Dual Exhaust)

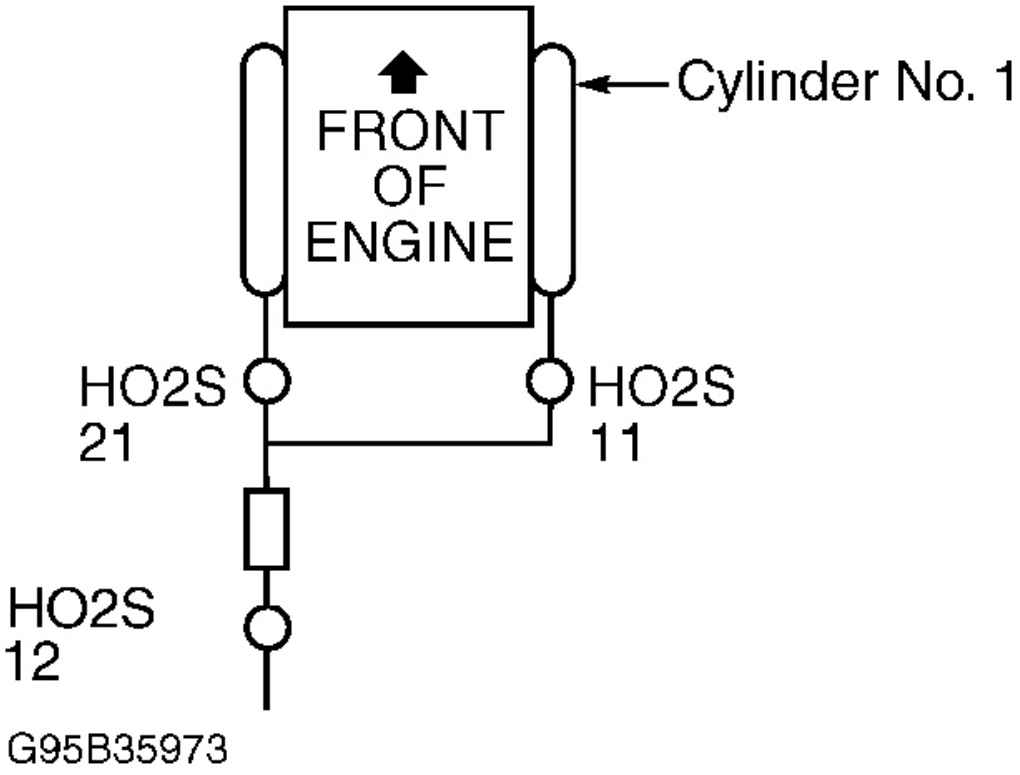


Fig. 47: Locating HO2S (V8 Or V6 With Single Exhaust)

HO2S TEST PIN IDENTIFICATION(1)

HO2S Pin No.	HO2S SIG	HO2S HTR
11	60	93
12	35	95
21	87	94
22	61	96

(1) On all models, SIG RTN is test pin No. 91. VPWR is test pin No. 71 and 97.

NOTE: Test procedure begins with step 20). No test procedures have been omitted.

20) Perform KOER Self-Test If DTC P1127, P1128 or P1129 are present, service before proceeding. If specified DTCs are not present, go to next step.

21) DTC P0133 & P0153 This code indicates that response rate is below calibration in HO2S as follows:

- DTC P0133 for right front (or front, except V8) HO2S.

- DTC P0153 for left front (or rear, except V8) HO2S.

Possible causes are as follows:

- Open or shorted circuit.
- Exhaust leak.
- Excessive fueling.
- HO2S coated with contaminants.
- Faulty MAF sensor.
- Leak in air induction system.

With scan tester connected, turn ignition on. Access Generic OBD-II functions and enter. Select Diagnostic Monitoring Test Results and enter. Scroll to Test ID: 01 and enter. Press Start. If measured value is 614 or more, fault cannot be duplicated or identified at this time and testing is complete. If measurement fault is less than 614, go to next step.

22) Check For HO2S Contamination Check following possibilities as potential source of contamination:

- Use of unapproved silicon sealers.
- Use of unapproved cleaners.
- Fuel contaminated by silicon additives.
- Fuel contaminated by lead.
- Excessive oil burning.
- Antifreeze leaking internally.

If any of these conditions are present, repair or replace as necessary. Replace HO2S. Change oil, filter and repeat **QUICK TEST** . If none of these conditions are present, go to next step.

23) Check For Unmetered Air Leaks Vacuum or air leaks in non-EEC-V areas could cause fault code to set. Check the following as potential source of air leak:

- Leaking vacuum hoses.
- Leaking intake manifold gasket.
- EGR system.
- PCV system.
- Poorly seated oil dip stick and/or dipstick tube.

If any of these conditions are present, repair or replace as necessary. Perform drive cycle and repeat **QUICK TEST** . If none of these conditions are present, go to next step.

24) Check HO2S Circuits Turn ignition off. Disconnect PCM and suspect HO2S wiring harness connector. Inspect connectors for damage and repair as necessary. Connect jumper wire between HO2S SIG and VPWR at sensor wiring harness connector. With scan tester connected to DLC, turn ignition on.

Access HO2S PID. If PID voltage is less than 1.5 volts, go to next step. If PID voltage is 1.5 volts or more, replace HO2S and change engine oil. Test drive vehicle and repeat **QUICK TEST** .

25) Check HO2S Signal Circuit Resistance Turn ignition off. Disconnect PCM 104-pin connector. Inspect connector for damage and repair if necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between suspect HO2S test pin at breakout box and HO2S terminal at wiring harness connector. Measure resistance between suspect SIG RTN test pin at breakout box and SIG RTN terminal at wiring harness connector. If either resistance is 5 ohms or more, repair open circuit. Drive vehicle at 55 MPH for 5 minutes and repeat **QUICK TEST** . If each resistance is less than 5 ohms, go to next step.

26) Check HO2S For Short Circuit Ensure ignition is off and PCM is disconnected. Disconnect scan tester from DLC. Measure resistance between suspect HO2S test pin and test pins No. 71 and 97 (VPWR) at breakout box. Measure resistance between suspect HO2S test pin and test pin No. 91 (SIG RTN) at breakout box. If either resistance is less than 10,000 ohms, repair short circuit. Drive vehicle for 5 miles at 55 MPH and repeat **QUICK TEST** . If each resistance is 10,000 ohms or more, replace PCM.

27) DTC P0131 & P0151: Contaminated HO2S/Voltage Shift These DTCs are set when HO2S generates negative voltage. Possible causes are as follows:

- Crossed HO2S SIG / SIG RTN circuit.
- HO2S contaminated with water, fuel, etc.

Check for moisture in HO2S connector and repair if necessary. If connector is okay, go to next step.

28) Check HO2S For Short Circuit Ensure ignition is off. Disconnect suspect HO2S. Disconnect PCM 104-pin connector. Inspect connectors for damage and repair if necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between suspect sensor HO2S SIGNAL and SIG RTN terminal and test pins indicated as follows:

- DTC P0131, test pin No. 60.
- DTC P0151, test pin No. 87.

If resistance is less than 5 ohms, replace HO2S and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair circuit and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 28) to step 30). No test procedures have been omitted.

30) DTC P0135, P0141, P0155 Or P0161: Check HO2S Heater Signal Circuit DTCs P0135, P0141, P0155 and P0161 received separately indicate a short to ground or open in HO2S heater circuit. DTCs received in pairs, such as P0135 and P0155 or P0141 and P0161, indicate HO2S heater signal circuit shorted to a power source greater than 2.0 volts.

DTCs received in pairs with one downstream heater code and one upstream heater code are treated as the following separate codes.

- DTC P0135 for right front HO2S.
- DTC P0155 for left front HO2S.

- DTC P0141 for right rear HO2S.
- DTC P0161 for left rear HO2S.

Possible causes are as follows:

- Signal shorted in wiring harness or HO2S.
- Water in connectors.
- Cut or pulled wires.
- Open in PWR GND or VPWR circuit.

Inspect HO2S connectors for damage or poor connection. Repair or replace connectors as necessary. If HO2S connectors are okay, go to next step.

31) Perform KOEO SELF-TEST Start engine and operate at 2000 RPM for 5 minutes. Turn ignition off. Perform KOEO SELF-TEST. If DTC P0135, P0141, P0155 or P0161 are present, go to next step. If specified DTCs are not present, go to **CIRCUIT TEST Z** .

32) Check For Voltage At HO2S Heater Wiring Harness Connector Turn ignition off. Disconnect suspect HO2S. Inspect wiring harness for damage and repair as necessary. Turn ignition on. Measure voltage between SIG RTN and VPWR terminal at HO2S wiring harness connector. If voltage is 10.5 volts or less, go to next step. If voltage is more than 10.5 volts, go to step 34).

33) Turn ignition off. With suspect sensor disconnected, measure resistance between VPWR terminal at HO2S wiring harness connector and test pins No. 71 and 97 at breakout box. If resistance is less than 4 ohms, go to next step. If resistance is 4 ohms or more, check circuit fuse. If fuse is okay, repair open circuit and repeat **QUICK TEST** .

34) Check HO2S Heater Resistance Turn ignition off. With suspect sensor disconnected, measure resistance between HO2S HEATER GND terminal and VPWR terminal at HO2S wiring harness connector. If resistance is 3-30 ohms, go to next step. If resistance is not 3-30 ohms, replace HO2S sensor and repeat **QUICK TEST** .

35) Leave ignition off and suspect sensor disconnected. Measure resistance between HO2S HEATER GND terminal at HO2S wiring harness connector and HO2S case. Measure resistance between HO2S HEATER GND terminal and SIG RTN terminal at HO2S wiring harness connector. Measure resistance between VPWR terminal at HO2S wiring harness connector and HO2S case. If each resistance measurement is more than 10,000 ohms, go to next step. If any resistance is 10,000 ohms or less, replace HO2S and repeat **QUICK TEST** .

36) Check For Short Circuit Leave ignition off and sensor disconnected. Disconnect scan tester from DLC (if applicable). Disconnect PCM 104-pin connector. Inspect connector for damage and repair if necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between suspect sensor and test pins indicated as follows:

- DTC P0135 (RF), test pin No. 93 and test pins No. 24, 91, 97 and 103.
- DTC P0141 (RR), test pin No. 95 and test pins No. 24, 91, 97 and 103.
- DTC P0155 (LR), test pin No. 94 and test pins No. 24, 91, 97 and 103.
- DTC P0161 (LR), test pin No. 96 and test pins No. 24, 91, 97 and 103.

If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short in circuit and repeat **QUICK TEST** .

37) Leave ignition off and sensor disconnected. Measure resistance between HO2S HEATER GND terminal at HO2S wiring harness connector and appropriate test pin as follows:

- Right front (or front) HO2S sensor; test pin No. 93.
- Left front HO2S sensor; test pin No. 94.
- Right rear (or rear) HO2S sensor; test pin No. 95.
- Left rear HO2S sensor; test pin No. 96.

If resistance is 4 ohms or more, repair open circuit or excessive resistance in wiring harness and repeat **QUICK TEST** . If resistance is less than 4 ohms, replace PCM and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 37) to step 40). No test procedures have been omitted.

40) DTC P1130, P1150, P1131, P1151, P1132 Or P1152: HO2S Not Switching DTCs P1131 and P1151 indicate air/fuel ratio is correcting rich for an overly lean condition. DTCs P1132 and P1152 indicate air/fuel ratio is correcting lean for an overly rich condition.

DTCs P1130 and P1150 indicate fuel system has reached maximum compensation and HO2S is not switching at the adaptive limits.

Possible causes are as follows:

- Fuel system malfunction.
- EGR system malfunction.
- Air intake or vacuum system leak.
- Engine oil level too high.
- Excessive internal engine wear.

Inspect engine for obvious defects in specified systems. Repair or replace as necessary. If no faults are found, go to next step.

41) DTC P0171, P0172, P0174 Or P0175: HO2S Not Switching DTCs P0171 and P0174 indicate air/fuel ratio is correcting rich for an overly lean condition. DTCs P0172 and P0175 indicate air/fuel ratio is correcting lean for an overly rich condition.

Possible causes are as follows:

- Fuel system malfunction.
- EGR system malfunction.
- Air intake or vacuum system leak.

- Engine oil level too high.
- Excessive internal engine wear.

Inspect engine for obvious defects in specified systems. Repair or replace as necessary. If no faults are found, go to next step.

42) Perform KOER Self-Test With ignition off, connect scan tester to DLC. Disconnect fuel vapor hose from intake manifold. Plug fitting at intake manifold. Start engine, and operate at 2000 RPM for one minute. Perform KOER self-test and proceed as follows:

- If DTCs P1127, P1128 or P1129 are present, go to appropriate CIRCUIT TEST.
- If DTCs P0131 or P0151 are present in continuous memory, go to step 27).
- If DTCs P1131, P1130 or P1151, P1150 are present, go to step **43)** .
- If DTCs P1130, P1132 or P1150, P1152 are present, go to step **49)** .

If none of these DTCs are present, proceed as follows:

- If diagnosing DTCs P1130, P1150, P1171, P1172, P1174 or P1175, go to step 52).
- If diagnosing DTCs P1132 or P1152, go to **CIRCUIT TEST HW** , step 13).
- If diagnosing any other DTCs, go to **CIRCUIT TEST Z** .

43) Disconnect suspect HO2S. Turn ignition on. Using scan tool, access HO2S PID of suspect sensor. Connect jumper wire between HO2S SIG and VPWR circuit at HO2S harness connector. If spark occurs, remove jumper wire and go to step 47). If HO2S voltage is more than 1.3 volts, go to next step. If voltage is 1.3 volts or less, go to step 46).

44) Check Circuit Resistance Turn ignition off. Connect PCM to breakout box. Measure resistance between battery ground terminal and SIG RTN terminal of HO2S harness connector. If resistance is less than 5 ohms, go to step 52). If resistance is 5 ohms or more, go to next step.

45) Turn ignition off. Disconnect PCM from breakout box. Measure resistance between test pin No. 91 (SIG RTN) at breakout box and SIG RTN terminal of HO2S harness connector. If resistance is less than 5 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open circuit and repeat QUICK TEST.

46) Check Resistance Of HO2S Ground Circuits Turn ignition off. Install breakout box, leaving PCM disconnected. Disconnect suspect HO2S wiring harness connector. Inspect connector for damage and repair as necessary. Measure resistance between HO2S test pin at breakout box and HO2S terminal at sensor wiring harness connector. If resistance is less than 5 ohms, go to next step. If any resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

47) Check HO2S Circuit For Short To Ground Turn ignition off. Leave breakout box installed and PCM disconnected. Disconnect HO2S. Measure resistance between HO2S SIG circuit test pin and test pins No. 24, 51, 77, 91 and 103 at breakout box. If all readings are 10,000 ohms or more, go to next step. If any reading is less than 10,000 ohms, repair short circuit and repeat **QUICK TEST** .

48) Check HO2S For Short To Ground Ensure ignition is off and PCM is disconnected. Reconnect HO2S to wiring harness connector. Measure resistance between HO2S SIG RTN test pin and test pin No. 91 at breakout box. If resistance measurement is less than 10,000 ohms, replace HO2S and repeat **QUICK TEST** . If resistance is 10,000 ohms or more, replace PCM.

49) Check HO2S PID Leave ignition off and HO2S disconnected. Turn ignition on. Using scan tool, access HO2S PID of suspect sensor. If HO2S PID voltage is more than 0.2 volts, go to next step. If HO2S voltage is 0.2 volts or less, go to step 51).

50) Check For Short To Power Turn ignition off. Disconnect scan tester from DLC (if applicable). Disconnect PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair wiring as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Leave suspect HO2S disconnected. Measure resistance between HO2S terminal of wiring harness connector and following test pins at breakout box:

- DTC P01130 and P01132; test pin No. 60 and test pins No. 71, 93 and 97.
- DTC P01150 and P01152; test pin No. 87 and test pins No. 71, 94 and 97.

If each resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If any resistance is 10,000 ohms or less, repair short to power and repeat QUICK TEST.

51) Turn ignition off. Disconnect suspect HO2S. Turn ignition on. Using scan tool, access HO2S PID of suspect sensor. If HO2S voltage is more than 0.45 volts, replace HO2S and repeat **QUICK TEST** . If voltage is 0.45 volts or less, go to next step.

52) Check Fuel Pressure Release fuel system pressure. With ignition off, install fuel pressure gauge. Ensure manifold vacuum is connected to fuel pressure regulator. Start engine and operate at 2500 RPM. If vehicle will not start, cycle key on and off. For fuel pressure specifications, see **FUEL PRESSURE SPECIFICATIONS** article. If fuel system pressure is as specified, go to next step. If fuel system pressure is not as specified, go to **CIRCUIT TEST HC** .

53) Check System Ability To Hold Fuel Pressure With fuel pressure gauge installed, cycle ignition from OFF to ON position 3-4 times to pressurize fuel system (DO NOT start engine). If fuel pressure does not remain at specification for 60 seconds, go to step 4) under **CIRCUIT TEST HC** . If fuel pressure remains within 5 psi of highest fuel pressure reading for 60 seconds, proceed as follows:

- For no-start vehicles, go to step 55).
- For DTCs P1130, P01150, P0171, P0172, P0174 and P0175, go to step 54).
- For HO2S DTCs displayed with misfire DTCs, go to step 56).
- For all other DTCs, go to step 60).

54) Check Ability To Hold Fuel Pressure With fuel pressure gauge installed, cycle ignition from OFF to ON position 3-4 times to pressurize fuel system (DO NOT start engine). Note fuel pressure. If fuel pressure remains within 5 psi of original pressure for at least 10 seconds, go to step 56). If fuel pressure drops more than 5 psi, go to step 58).

55) Check Ability Of Injectors To Deliver Fuel With fuel pressure gauge installed, cycle ignition from OFF to ON position 3-4 times to pressurize fuel system (DO NOT start engine). Note fuel pressure. Disconnect Inertia Fuel Switch (IFS). Crank engine for 5 seconds. If fuel pressure remains within 5 psi (34 kPa) of original pressure, reconnect IFS switch and go to next step. If fuel pressure drops more than 5 psi (34 kPa), repair fuel system as necessary. See FUEL SYSTEM in **SYSTEM/COMPONENT TESTS - 4.2L** article.

56) Check Fuel Injector & Circuit Resistance Turn ignition off. Disconnect PCM 104-pin connector. Inspect connector for damage or corrosion and repair as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure and record resistance between suspected fuel injector circuit test pin and test pin No. 71 and 97 at breakout box. Refer to FUEL INJECTOR INJ CIRCUIT

IDENTIFICATION table. Resistance should be 11-18 ohms. If resistance is not correct, go to next step. If resistance is correct, go to step 59).

FUEL INJECTOR INJ CIRCUIT IDENTIFICATION

Injector No.	Test Pin No.
1	75
2	101
3	74
4	100
5 (1)	73
6 (1)	99
7 (1)	72
8 (1)	98
9 (1)	68
10 (1)	42
(1) If equipped.	

57) Check Resistance Of Fuel Injector Circuit Turn ignition off. Disconnect suspect fuel injector wiring harness connector. Measure resistance between test pins No. 71 and 97 at breakout box and fuel injector VPWR terminal at wiring harness connector. Measure resistance between fuel injector signal test pin(s) at breakout box and same fuel injector circuit terminal at each fuel injector wiring harness connector. If each resistance is less than 5 ohms, go to next step. If each resistance is 5 ohms or more, repair open circuit. and repeat **QUICK TEST** .

58) Check Fuel Injector Circuit For Short To Power Or Ground Turn ignition off. Disconnect suspect fuel injector wiring harness connector. Measure resistance between fuel injector test pin and test pins No. 24, 71, 97 and 103 at breakout box. Also, measure resistance between fuel injector test pin(s) at breakout box and chassis ground. If each resistance is 10,000 ohms or more, go to next step. If any resistance is less than 10,000 ohms, repair short circuit and repeat **QUICK TEST** .

59) Check Fuel Injector Drive Signal With ignition off, connect PCM to breakout box. Connect non-powered 12-volt test light between suspect fuel injector and test pins No. 71 and 97. Crank or start engine. If test light glows dimly, go to next step. If test light does not glow dimly (no light/bright light), replace PCM and repeat **QUICK TEST** .

60) Check Fuel Injector Flow & Leakage Turn ignition off. Remove breakout box. Reconnect PCM. Use Rotunda Injector Tester (113-00001) to flow test fuel injectors. If fuel injector flow or leakage rate is not okay, replace fuel injector, and repeat **QUICK TEST** . If flow rate for each fuel injector is okay, proceed as follows:

- For DTCs P1131 and P1151, go to next step.
- For DTCs P0171, P0174, P1130, and P1150, go to step 62).
- For DTCs P1132 and P1152, go to step 65).
- For DTCs P1172 and P1175, go to **CIRCUIT TEST Z** .

61) Check Secondary Air Injection If vehicle is not equipped with secondary air injection, go to next

step. Turn ignition off. Disconnect secondary air injection hoses. Plug air injection ports. With engine at operating temperature, perform KOER self-test. If DTC P1131 or P01151 are present, reconnect hose and go to next step. If specified DTCs are not present, go to step 7) under **CIRCUIT TEST HM** .

62) Check air induction system for leaks or restrictions. Check PCV system for leaks or restrictions. Check vacuum hoses for damage and tight connection. Repair or replace as necessary. If no faults are found, go to next step.

63) Check Cylinder Compression Using compression gauge, check cylinder compression. If cylinder compression is not okay, repair engine as necessary. Clear PCM memory and repeat **QUICK TEST** . If compression is okay, go to next step (DTCs P1130, P1150, P1131 and P1151) or step 65) (DTCs P1132 and P1152). If misfire DTCs are displayed with fuel control DTCs, go to **CIRCUIT TEST HD** , step 20).

64) Check HO2S Integrity DTCs P0130, P0150, P0131, and P0151 indicate HO2S switches slow or doesn't switch, is always lean or fuel is at adaptive limit. Possible causes are as follows:

- Moisture inside HO2S causing short to ground.
- HO2S coated with contaminates.
- HO2S circuit open or shorted to ground.

Turn ignition off. Inspect HO2S and circuit for damage or contamination. Repair or replace HO2S or wiring as necessary. Start engine and operate at 2000 RPM for 3 minutes. Turn ignition off. Connect scan tool to DLC. Perform KOER self-test while monitoring HO2S voltage. If HO2S voltage is 0.5 volt or more at the end of test, go to step 70). If voltage is less than 0.5 volt, replace HO2S sensor and repeat **QUICK TEST** .

65) Perform KOER Self-Test Start engine, and warm it to normal operating temperature. Turn ignition off. Disconnect suspect HO2S. Using a jumper wire, connect HO2S terminal of wiring harness connector to negative battery terminal. Perform KOER self-test. If DTC P1131 or P1151 is present, remove jumper wire and go to next step. If DTC P1131 or P1151 is not present, check PCM connector and service if necessary. If connector is okay, replace PCM. Repeat **QUICK TEST** .

66) HO2S Check Leave HO2S disconnected. Connect DVOM between HO2S SIG terminal and SIG RTN terminal of HO2S wiring harness connector. Disconnect any vacuum hose from vacuum tree. Start engine and operate at 2000 RPM. If DVOM reads less than 0.4 volt within 30 seconds, go to step 70). If DVOM does not read as specified, replace HO2S and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 66) to step 70). No test procedures have been omitted.

70) Monitor HO2S PID Connect scan tester to DLC. Start engine and allow to idle. Using scan tester, access HO2S PID. Observe HO2S PID while shaking and bending wiring harness between HO2S and PCM. If HO2S voltage stays at 0.45 volt, go to next step. If HO2S voltage is more than 0.45 volt or less than 0.45 volt, isolate fault and repair as necessary.

71) Monitor HO2S PID During Test Drive Leave scan tester connected to DLC. Using an assistant, test drive vehicle under various conditions while observing HO2S PID. If HO2S voltage switches from about 0.4 to 0.6 volt, system is okay and testing is complete. If voltage does not switch, replace HO2S and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 71) to step 80). No test procedures have been omitted.

80) DTC P0136, P1137, P1138, P0156, P1157 & P1158 DTCs P0136 and P0156 indicate that output voltage of downstream HO2S is not within a functional window. If DTC P0136/P0156 is present, go to next step. If DTC P0136/P0156 is not present, go to step 82).

KOER DTCs P1137, P1138, P1157 and P0158 indicate fuel control malfunction monitored as voltage change downstream HO2S. Possible causes are as follows:

- Damaged wiring harness or connector.
- Exhaust system leaks.
- Contaminated or defective HO2S.

Inspect for faults. Repair or replace as necessary. If no faults are found, go to next step.

81) Perform KOER Self-Test Start engine, and operate at 2000 RPM for 3 minutes. With scan tester connected, perform KOER self-test. If DTCs P1137 P1138, P1157 or P1158 are present, go to next step. If specified DTCs are not present, fault is intermittent. Go to **CIRCUIT TEST Z** .

82) Check Exhaust System Leaks in exhaust system can cause DTCs P0136 and P0156. Possible causes are as follows:

- Incorrect HO2S torque.
- Exhaust system leaks.

Inspect entire exhaust system including catalyst and HO2S. Repair or replace as necessary. Clear PCM memory and repeat **QUICK TEST** . If not faults are present, go to next step.

83) Check HO2S Circuit For Short Circuit Leave ignition off and suspect HO2S disconnected. Disconnect scan tester from DLC. Disconnect PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair circuit as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between HO2S test pin and test pins No. 24, 71, 90 (VREF), 91 (SIG RTN), 97 (VPWR), and 103 (PWR GND) at breakout box. Measure resistance between HO2S test pin and VPWR test pin at breakout box. If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short circuit in wiring harness. Clear PCM memory. Drive vehicle for 5 miles and repeat **QUICK TEST** .

84) Check Ground Circuit Resistance Leave ignition off and suspect HO2S disconnected. Measure resistance between HO2S SIG test pin at breakout box and HO2S SIG terminal at wiring harness connector. Measure resistance between SIG RTN test pin at breakout box and SIG RTN terminal at wiring harness connector. If resistance is 5 ohms or more, repair open circuit in wiring harness and repeat **QUICK TEST** . If resistance is less than 5 ohms, go to next step.

85) Check HO2S Circuit Turn ignition off. Connect scan tester to DLC. Ensure suspect HO2S and PCM are connected. Turn ignition on. Access HO2S PID of suspect sensor. If voltage reading is 1.5 or more, go to step 88). If voltage is less than 1.5 volts, go to next step.

86) Check Circuit Resistance Turn ignition off. Connect PCM to breakout box. Measure resistance between PWR GND test pin and SIG RTN test pin at breakout box. If resistance is less than 5 ohms, go to

next step. If resistance is 5 ohms or more, replace PCM and repeat **QUICK TEST** .

87) Check HO2S PID Leave ignition off and HO2S disconnected. Using jumper wire, connect VPWR and HO2S signal terminal of wiring harness connector. Turn ignition on. Using scan tool, access HO2S PID of suspect sensor. If HO2S PID voltage is more than 1.5 volts, replace HO2S. Clear PCM memory. Drive vehicle for 5 miles and repeat **QUICK TEST** . If HO2S PID voltage is 1.5 volts or less, replace PCM. Clear PCM memory. Drive vehicle for 5 miles and repeat QUICK TEST.

88) Check PCM Voltage Leave suspect HO2S disconnected. Turn ignition on. Measure voltage between SIG RTN terminal at HO2S wiring harness connector and negative battery terminal. Measure voltage between HO2S SIG terminal at wiring harness connector and negative battery terminal. If voltage is 1.5 volts or more, replace PCM and repeat **QUICK TEST** . If voltage is less than 1.5 volts, replace HO2S and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 88) to step 100). No test procedures have been omitted.

100) KOER DTC P0127 DTC P0127 indicates that HO2S heater was not on during KOER self-test and testing of HO2S did not occur. Possible cause is cool exhaust system. Connect scan tester to DLC. Using scan tester, access all HO2S HEATER. If all PIDs indicate ON, repeat **QUICK TEST** . If any PIDs are off, operate engine until all PIDs are on; repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 100) to step 110). No test procedures have been omitted.

110) Check For Crossed HO2S Circuit Turn ignition off. Disconnect suspect HO2S. Inspect connector for indication of crossed wires or incorrect installation. Repair or replace if necessary and repeat KOER self-test. If no faults are found, go to next step.

111) Leave ignition off and suspect HO2S disconnected. Disconnect PCM 104-pin connector. Inspect connector for damaged pins, corrosion and loose wires. Repair circuit as necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between suspect circuit terminal at wiring harness connector and corresponding test pin at breakout box. If resistance is less than 5 ohms, fault is intermittent and cannot be duplicated at this time. Repeat **QUICK TEST** to verify DTC is present. If resistance is 5 ohms or more, repair circuit. Clear PCM memory. Drive vehicle for 5 miles and repeat QUICK TEST.

CIRCUIT TEST HC - FUEL DELIVERY SYSTEM

Diagnostic Aids

Perform this test when directed by QUICK TEST or if directed by other test procedures. This test is used to diagnose:

- Fuel pressure.
- Fuel filter.
- Fuel return.
- Fuel supply.

- Fuel injector.
- Engine vacuum systems.
- Chassis components.

WARNING: Fuel system remains under high pressure even when engine is not running. To avoid injury, release fuel pressure before disconnecting any fuel system hose or component.

CIRCUIT TEST ACRONYMS

Acronym	Definition
DLC	Data Link Connector
PID	Parameter Identification

1) Check System Integrity Turn ignition off. Inspect fuel system for leaks, damage or kinked hoses. Inspect wiring harness for damage or loose connectors. Ensure battery is fully charged and fuses are okay. Ensure fuel filter has been serviced in the previous 1000 miles. If vehicle does not start, ensure vehicle has fuel in tank and inertia switch is set correctly. Repair or replace as necessary. If no faults are found, go to next step.

2) Check Fuel Pressure Release fuel system pressure. Turn ignition off. Install fuel pressure gauge. Connect scan tester to DLC. Turn ignition on. Access scan tester Output Test Mode. Operate fuel pump at maximum fuel pressure for 8 seconds. For fuel pressure specifications, see **FUEL PRESSURE SPECIFICATIONS** article. If fuel pressure is as specified, go to next step. If fuel pressure is more than specified, go to step 8). If fuel pressure is less than specified, go to step 11).

3) Check System Ability To Hold Fuel Pressure With fuel pressure gauge installed, turn ignition off. Exit Output Test Mode. If fuel pressure remains within 5 psi of specification for 60 seconds, go to step 5). If fuel pressure does not remain within 5 psi of specification for 60 seconds, go to next step.

4) Check Pressure Regulator Diaphragm With fuel pressure gauge installed, start engine and operate for 10 seconds. Turn ignition off and wait 10 seconds. Start engine again and operate for 10 seconds. Turn ignition off. Disconnect and inspect hose from fuel pressure regulator. If hose is wet with fuel, replace fuel pressure regulator. If hose is dry, go to step 10).

5) Check Fuel Pressure; Test Drive Vehicle With fuel pressure gauge installed, disconnect and plug fuel pressure regulator hose. Ensure fuel pressure gauge can be seen by vehicle operator. Drive vehicle while noting gauge reading during heavy acceleration. If gauge reading stays within 3 psi of original pressure reading, go to next step. If gauge reading does not stay within 3 psi of original pressure reading, go to step 11).

6) Check Fuel Pressure Regulator; Test Drive Vehicle With fuel pressure gauge installed, reconnect fuel pressure regulator hose. Install vacuum gauge to intake manifold. Ensure both gauges can be seen by vehicle operator. Drive vehicle while noting gauges during heavy acceleration. Gauge readings should be as follows:

- Fuel pressure gauge reading increases and vacuum gauge reading decreases.
- Fuel pressure gauge reading decreases and vacuum gauge reading increases.

If gauge readings are correct, fuel system is okay and testing is complete. If gauge readings are not correct, go to next step.

7) Check Vacuum Supply Turn ignition off. Disconnect and plug fuel pressure regulator hose. Install vacuum pump to fuel pressure regulator. Start engine and operate at idle. Observe fuel pressure gauge while applying vacuum to regulator. If fuel pressure changes as vacuum changes, repair restriction in vacuum system. If fuel pressure does not change as vacuum changes, replace fuel pressure regulator.

8) Check Fuel Pressure Regulator Leave ignition off and scan tester connected to DLC. Release fuel system pressure. Disconnect fuel hose at fuel rail. Connect hose to fuel rail and put opposite end of hose in clean, one quart container. Turn ignition on. Enter Output Test Mode (OTM) to turn fuel pump on. Note fuel pressure and fuel returning to container. For fuel pressure specifications, see **FUEL PRESSURE SPECIFICATIONS** article. Exit OTM to turn fuel pump off. If fuel pressure is as specified with fuel returning to container, go to next step. If fuel pressure is not as specified with fuel returning to container, replace fuel pressure regulator. If fuel pressure is zero, go to step 12).

9) Check Fuel Pressure & Return Release fuel system pressure. Turn ignition off. Connect scan tester to DLC. Remove fuel return line at the fuel rail. Connect a hose from fuel rail to a container with a capacity of 1 quart or more. Turn ignition on. Using scan tester, access Output Test Mode. Note fuel pressure and flow into container. For fuel pressure specifications, see **FUEL PRESSURE SPECIFICATIONS** article. If fuel pressure is as specified and flowing steadily into container, go to next step. If fuel pressure is more than specified, replace fuel pressure regulator. If fuel pressure is less than specified, go to step 11).

10) Check Fuel Return System Turn ignition off. Release fuel system pressure. Disconnect fuel hose at fuel pressure regulator. Check fuel return system for kinked or restricted hoses. Disconnect fuel return hose near fuel tank. Apply 3-5 psi to fuel hose from pressure regulator side. If air flows freely, replace fuel pump. If air does not flow freely, repair or replace hose as necessary.

11) Check Fuel Injector Flow & Leakage Turn ignition off. Use Rotunda Injector Tester (113-00001) to flow test fuel injectors. If flow rate for each fuel injector is within specification, system is okay and testing is complete. If flow rate for any fuel injector is not within specification, replace defective fuel injector and repeat **QUICK TEST** .

12) Check Fuel Pump Voltage Turn ignition off. Ensure scan tester is connected to DLC. Ensure IFS switch is set correctly. Disconnect fuel pump wiring harness connector. Check connector terminals for damage and repair as necessary. Turn ignition on. Using scan tester, enter Output Test Mode (OTM) and activate fuel pump circuit. Check voltage at fuel pump connector terminals. If voltage is 10.5 volts or more, check fuel pump ground connection. Repair as necessary. If ground connector is okay, replace fuel pump. If voltage is less than 10.5 volts, isolate source of low voltage and repair as necessary.

13) Check Fuel Supply System Turn ignition off. Release fuel system pressure. Check fuel return system for kinked or restricted hoses. Disconnect fuel supply hose at fuel rail and at the fuel pump. Apply 3-5 psi to fuel hose from fuel rail. If air flows freely, replace fuel module. If air does not flow freely, repair or replace hose as necessary.

CIRCUIT TEST HD - MISFIRE DETECTION MONITOR

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. Only use this test to diagnose:

- Ignition system.

- Fuel pressure.
- Fuel injectors.
- Engine vacuum system.
- Evaporative system.
- Canister purge solenoid.
- Internal engine wear.

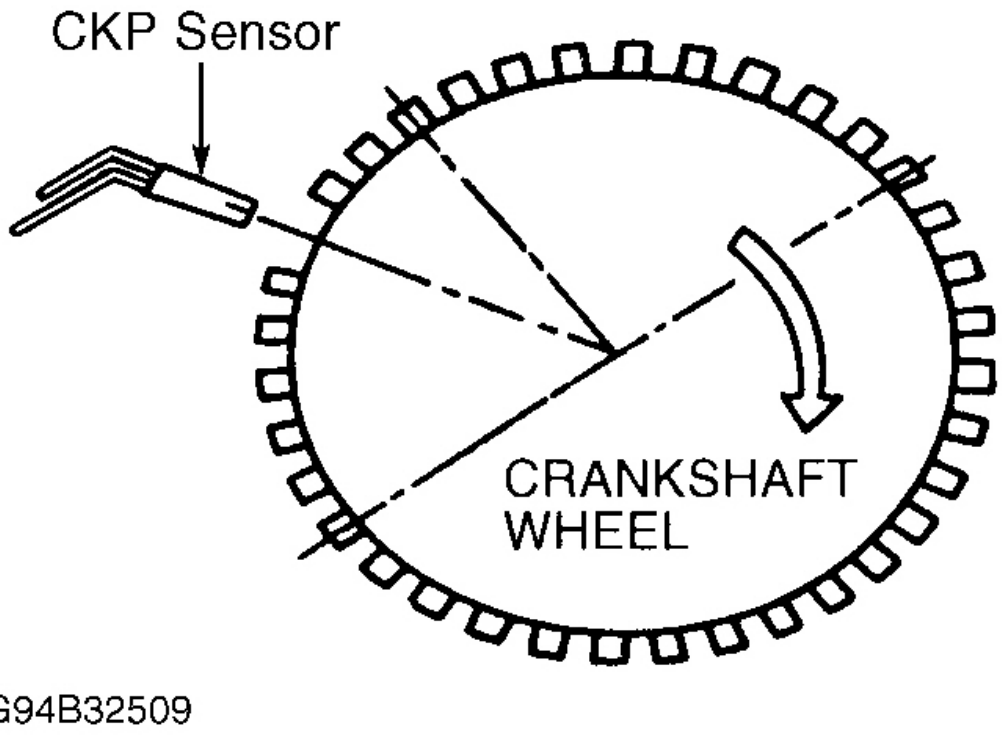


Fig. 48: CKP Sensor & Crankshaft Wheel

MISFIRE TROUBLE CODES

Service DTC	Application
P0301	Cylinder No. 1 (Test Pin No. 75)
P0302	Cylinder No. 2 (Test Pin No. 101)
P0303	Cylinder No. 3 (Test Pin No. 74)
P0304	Cylinder No. 4 (Test Pin No. 100)
P0305	Cylinder No. 5 (Test Pin No. 73)
P0306	Cylinder No. 6 (Test Pin No. 99)

P0307	Cylinder No. 7 (Test Pin No. 72)
P0308	Cylinder No. 8 (Test Pin No. 98)
P0300	Multiple Cylinder Misfire Or Defective CKP Sensor

1) Check Possible Cause Of Misfire If vehicle runs out of fuel, a trouble code may be stored in PCM memory. Ensure vehicle has not recently run out of fuel. Clear PCM memory and repeat **QUICK TEST** if necessary. If vehicle is equipped with crankshaft pulley-mounted pulse ring, go to next step. If vehicle is not equipped with crankshaft pulley-mounted pulse ring, go to step 3).

2) Check Crankshaft Pulley Turn ignition off. Remove front cover if necessary. Check crank pulley and pulse ring for damage or looseness. Repair or replace as necessary. If no faults are found, go to next step.

3) Check For Continuous DTCs If continuous codes are present, service as necessary. Disregard misfire codes at this time. If no other misfire codes are present, go to next step.

4) Check For KOEO DTCs If any KOEO DTCs are present, service as necessary. Disregard misfire codes at this time. If any other DTCs are present, proceed to appropriate CIRCUIT TEST. If no KOEO DTCs are present, check spark plugs and spark plug wires. If spark plugs and spark plug wires are okay, go to next step.

5) Check For KOER DTCs If any KOER DTCs except P1131 or P1151 are present, service as necessary. Disregard misfire codes at this time. If KOER DTCs P1131 or P1151 are present, go to step 8). If no KOER DTCs are present, check spark plugs and spark plug wires. If spark plugs and spark plug wires are okay, go to next step.

6) Check/Compare PID Values Turn ignition and all accessories off. Connect scan tester to DLC. Ensure engine is warmed to operating temperature. Turn ignition on. Using scan tester, access and record DPFEGR PID. Start engine and allow to idle. Record DPFEGR PID. If both DPFEGR PID voltage values are within 0.15 volts of each other, go to step 8). If DPFEGR PID voltage is not as specified, go to **CIRCUIT TEST HE** , step 100).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 6) to step 8). No test procedures have been omitted.

8) Check Fuel Injector & Circuit Resistance Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Install EEC-V Breakout Box (014-00959), leaving PCM disconnected. Measure and record resistance between suspected fuel injector test pin and test pin No. 71 and 97 at breakout box. If resistance is 11-18 ohms, go to step 9). If resistance is not 11-18 ohms, go to step 56) under **CIRCUIT TEST H** .

9) Check Fuel Injector Drive Signal With ignition off, connect PCM to breakout box. Connect a non-powered 12-volt test light between test pin No. 71 or 97 and suspect fuel injector test pin at breakout box. Crank or start engine. If test light glows dimly, system is operating correctly. Go to next step. If test light does not glow dimly (no light/bright light), replace PCM and repeat **QUICK TEST** .

10) Check Fuel Pressure Turn ignition off. Release fuel pressure. Install fuel pressure gauge. Start engine and allow to idle. Note fuel pressure gauge reading. Increase engine speed to 2500 RPM and maintain for one minute. For fuel pressure specifications, see **FUEL PRESSURE SPECIFICATIONS** article. If fuel pressure is as specified, go to next step. If fuel pressure is not as specified, go to **CIRCUIT TEST HC** .

11) Check System Ability To Hold Fuel Pressure Start engine and allow to idle. Note fuel pressure

gauge reading. Increase engine speed to 2500 RPM and maintain for one minute. Check for fuel leaking from around fuel injectors, fuel pressure regulator and fuel hoses. Repair if necessary. Turn ignition off. Turn ignition on and note fuel pressure gauge reading. If fuel pressure remains at specification for one minute, go to next step. If fuel pressure does not remain at specification for one minute, go to step 3) under **CIRCUIT TEST HC** .

12) Check Fuel Injector Flow & Leakage Turn ignition off. Use Rotunda Injector Tester (113-00001) to flow test fuel injectors. If flow rate for each fuel injector is okay, go to step 20). If flow rate for any fuel injector is not okay, replace defective fuel injector and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 12) to step 20). No test procedures have been omitted.

20) Check Vacuum System Inspect all vacuum hoses for kinks or damage. Ensure all vacuum connections are clean and tight. Repair or replace as necessary. If vacuum system is okay, go to next step.

NOTE: The misfire monitor can be affected by the evaporative emission system.

21) Check Evaporative Emission System Inspect carbon canister. Replace carbon canister if it contains liquid fuel. If carbon canister is okay, go to next step.

22) Pressure Test Evaporative System Remove vapor line from canister and install vacuum tee. Connect a pressure gauge to one side of tee and low pressure air pump to other side of tee. Apply 0.75 psi (5.2 kPa). If evaporative emission system holds pressure, reconnect vapor line and go to next step. If system does not hold pressure, isolate fault and repair as necessary.

23) Check Vacuum In Evaporative System Inspect vacuum hoses between engine and carbon canister for restrictions or damage. Ensure all vacuum connections are clean and tight. Repair or replace as necessary. If system is okay, go to next step for vehicles with EVAP canister purge solenoid, or step 26) for vehicles equipped with Vapor Management Valve (VMV).

24) Check Canister Purge Solenoid (CANP) Turn ignition off. Disconnect CANP solenoid wiring harness connector. Inspect connector for damaged pins and repair as necessary. Using jumper wire, apply 12 volts to VPWR (Red wire) terminal of CANP wiring harness connector. Connect CANP (Gray/Yellow wire) terminal to ground. Connect vacuum pump to manifold side of CANP solenoid and apply 16 in. Hg. When 12 volts is applied, solenoid should open and pass air freely. Replace solenoid if it does not function correctly. If solenoid does function correctly, go to next step.

25) Check Engine Condition Inspect engine for obvious faults. Ensure compression is even and within specification. Check PCV system for restrictions or leaks. Repair or replace as necessary. If no faults can be found, misfire trouble code is intermittent. Go to **CIRCUIT TEST Z** .

26) Check Vapor Management Valve (VMV) Housing Turn ignition off. Ensure vehicle is at room temperature. Connect vacuum pump to fuel vapor port of VMV and apply 16 in. Hg. If vacuum is held, go to next step. If vacuum is not held, replace VMV and repeat **QUICK TEST** .

27) Leave ignition off. Disconnect hose from vacuum input port of VMV. Connect vacuum pump to VMV vacuum input port and apply 10-15 in. Hg. If little or no vacuum is lost, service VMV filter. If filter is okay, replace VMV. Repeat **QUICK TEST** . If vacuum is not as specified, go to step 25).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips

from step 27) to step 30). No test procedures have been omitted.

30) Check For Additional Misfire DTCs If any DTCs except P0300 are present, go to step 1). If no other DTCs are present, go to next step.

31) Check For Continuous DTCs If continuous codes are present, service as necessary. If no other misfire codes are present, go to next step.

32) Check/Compare PID Values Turn ignition and all accessories off. Connect scan tester to DLC. Ensure engine is warmed to operating temperature. Turn ignition on. Using scan tester, access and record DPFEGR PID. Start engine and allow to idle. Record DPFEGR PID. If both DPFEGR PID voltage values are within 0.15 volts of each other, go to step 8). If DPFEGR PID voltage is not as specified, go to **CIRCUIT TEST HE** , step 100).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 32) to step 40). No test procedures have been omitted.

40) DTC P1309 This fault indicates misfire detection monitor malfunction. Turn ignition and all accessories off. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Install EEC-V Breakout Box (014-00959), leaving PCM disconnected. Connect DVOM between test pins No. 85 and No. 51 or 103. Using starter, bump engine in short bursts for at least 10 revolutions. DO NOT allow engine to start. If voltage switches from below 0.2 volts to over 8.0 volts, check CMP sensor for correct installation. If sensor is correctly installed, replace PCM and repeat **QUICK TEST** . If voltage does not switch from below 0.2 volts to over 8.0 volts, replace CMP sensor and repeat QUICK TEST.

CIRCUIT TEST HE - EGR SYSTEM

Diagnostic Aids

Perform this test when instructed by QUICK TEST. This test is only intended to diagnose:

- Differential Pressure Feedback Electronic (DPFE) sensor.
- DPFE sensor hoses.
- Electronic Vacuum Regulator (EVR).
- Orifice tube assembly.
- Faulty EGR valve.
- Wiring harness circuits (DPFE SIG, EVR, EVR PWR, SIG RTN and VREF).
- Faulty Powertrain Control Module (PCM).

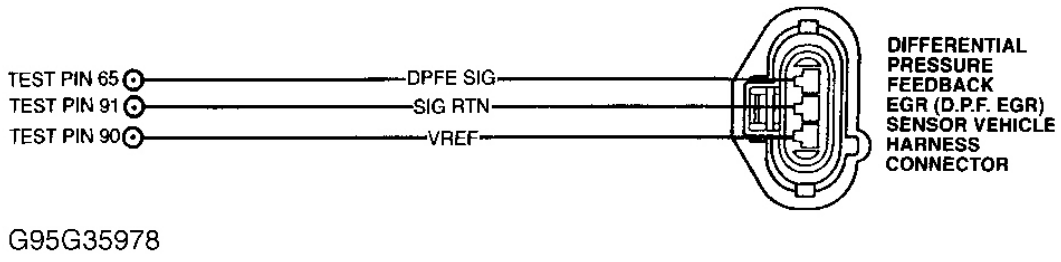


Fig. 49: DPFE Sensor Wiring Harness Connector Terminals

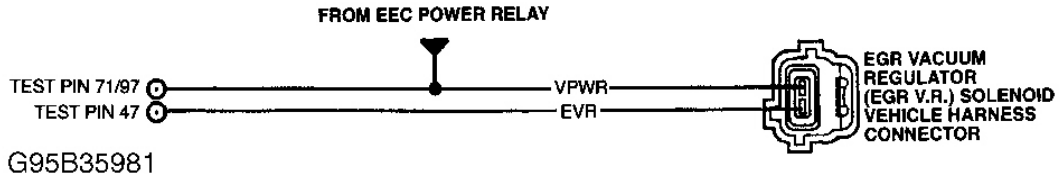


Fig. 50: EVR Solenoid Wiring Harness Connector Terminals

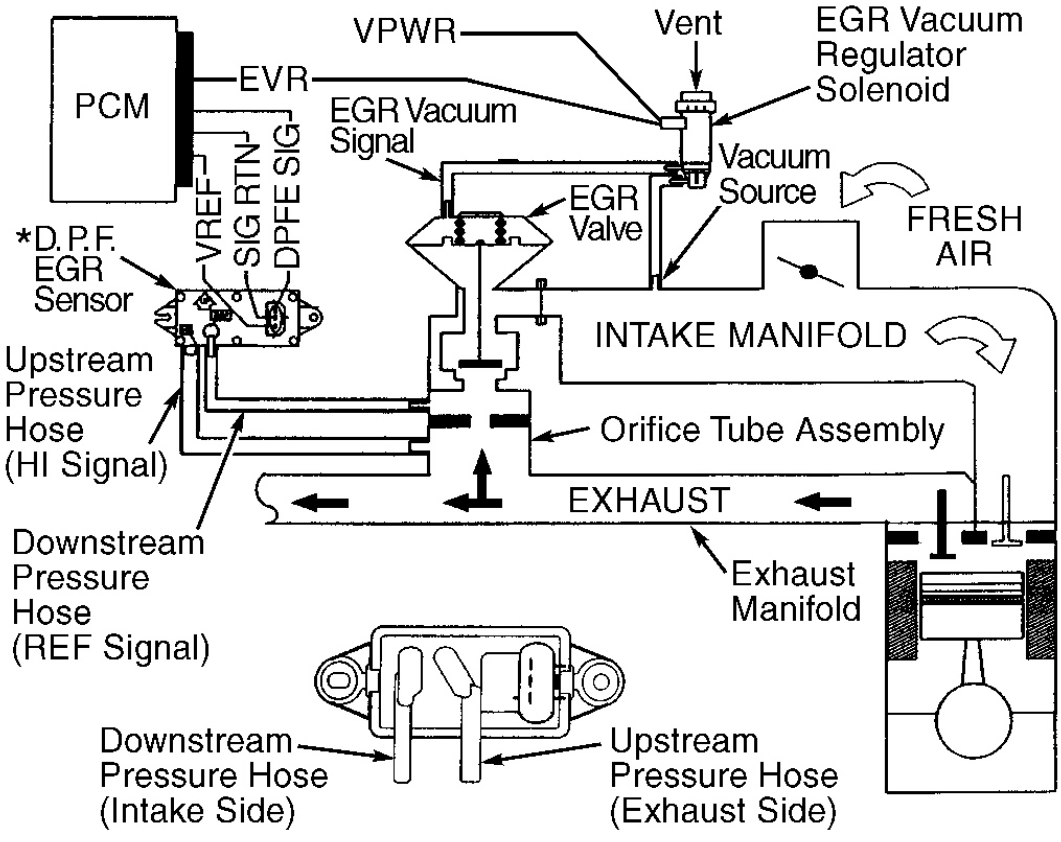


Fig. 51: DPFE System Components

1) DTC P1400: Check DPFE Voltage This code indicates open in DPFE SIG circuit. Possible causes for this fault are:

- Leaking upstream pressure hose.
- DPFE SIG shorted to GND or SIG RTN circuit.
- VREF shorted to GND or SIG RTN circuit.
- Faulty DPFE sensor.
- Faulty PCM.

Turn ignition off. Connect scan tester to DLC. Turn ignition on. Using scan tester, access DPFEGR PID. If voltage is less than 0.2 volt, go to next step. If voltage is 0.2 volt or more, go to step 6).

2) Generate Opposite DPFE Signal Turn ignition off. Disconnect DPFE wiring harness connector. Using a jumper wire, connect DPFE SIG and VREF terminals at wiring harness connector. Turn ignition on. Using scan tester, access DPFE SIG PID. If scan tester error occurs, disconnect jumper wire and go to

step 3). If DPFEGR PID value is not 4-6 volts, go to step 3). If DPFEGR PID value is 4-6 volts, replace DPFE sensor and repeat **QUICK TEST** .

3) Measure VREF Voltage At DPFE Sensor Leave DPFE sensor disconnected. Turn ignition on. Measure voltage between SIG RTN terminal and VREF terminal at DPFE wiring harness connector. If voltage is 4-6 volts, go to step 4). If VREF voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

4) Check DPFE SIG For Short To Ground Leave DPFE sensor disconnected. Turn ignition off. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 65 (DPFE SIG) and 91 (SIG RTN) and test pins No. 51 and 103 (PWR GND). If each measurement is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** . If any measurement is less than 10,000 ohms, repair short circuit and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 4) to step 6). No test procedures have been omitted.

6) Wiggle Test Sensor & Harness With ignition off, connect scan tester to DLC. Turn ignition on. Access DPFE PID with scan tester. Observe DPFE PID for indication of fault while shaking and bending DPFE sensor wiring harness and connector. Tap lightly on DPFE sensor to simulate road shock. An indication of fault is a sudden change in DPFE PID voltage. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 6) to step 10). No test procedures have been omitted.

10) DTC P1401: Check DPFE Signal Voltage This code indicates PCM has detected DPFE SIG circuit input above maximum. Possible causes for this fault are:

- Open circuit in DPFE SIG or SIG RTN circuit.
- DPFE SIG shorted to VREF or PWR circuit.
- VREF shorted to PWR circuit.
- Faulty DPFE sensor.
- Faulty PCM.

With ignition off, connect scan tester to DLC. Turn ignition on. Access DPFEGR PID. If DPFEGR PID voltage is more than 4.0 volts, go to next step. If DPFEGR PID voltage is 4.0 volts or less, go to step 19).

11) Check DPFE SIG For Short To Power Turn ignition off. Disconnect DPFE wiring harness connector. Turn ignition on. Measure voltage between DPFE SIG terminal at wiring harness connector and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, go to step 13).

12) Leave ignition off and DPFE sensor disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 65 (DPFE SIG) and test pins No. 51 and 103 (PWR GND) at breakout box. If voltage is 10.5 volts or more, repair short between DPFE SIF and PWR circuit. Repeat **QUICK TEST** . If voltage is less than 10.5 volts, replace PCM and repeat

QUICK TEST.

13) Generate Opposite DPFE Signal Turn ignition off. Disconnect DPFE wiring harness connector. Using a jumper wire, connect DPFE SIG and SIG RTN terminals at wiring harness connector. Turn ignition on. Using scan tester, access DPFEGR SIG PID. If scan tester error occurs, disconnect jumper wire and go to step 18). If DPFEGR PID value is .05 volt or more, go to step 16). If DPFEGR PID value is less than .05 volt, disconnect jumper wire and go to next step.

14) Verify VREF Is Within Range Leave DPFE sensor disconnected. Turn ignition on. Measure voltage between SIG RTN terminal and VREF terminal at DPFE wiring harness connector. If voltage is 4-6 volts, go to next step. If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

15) Check DPFE SIG For Short To VREF Leave DPFE sensor disconnected. Turn ignition off. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 65 (DPFE SIG) and 90 (VREF) at breakout box. If resistance is 10,000 ohms or more, replace DPFE sensor and repeat **QUICK TEST** . If resistance is less than 10,000 ohms, repair short circuit and repeat QUICK TEST.

16) Check DPFE SIG For Open Circuit Leave ignition off and DPFE sensor disconnected. Measure resistance between test pin No. 65 (DPFE SIG) and DPFE SIG terminal at DPFE sensor wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

17) Check SIG RTN For Open Circuit Leave ignition off and DPFE sensor disconnected. Measure resistance between test pin No. 91 (SIG RTN) and SIG RTN terminal of DPFE sensor wiring harness connector. If resistance is less than 5 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open in SIG RTN circuit and repeat QUICK TEST.

18) Check DPFE SIG For Short To VREF Leave ignition off and DPFE sensor disconnected. Measure resistance between test pin No. 65 (DPFE SIG) and 90 (VREF) at breakout box. If resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair short between DPFE SIG and VREF circuit. Repeat QUICK TEST.

19) Wiggle Test Sensor & Harness With ignition off, connect scan tester to DLC. Turn ignition on. Access DPFE PID with scan tester. Observe DPFE PID for indication of fault while shaking and bending DPFE sensor wiring harness and connector. An indication of fault is a sudden change in DPFE PID voltage. Tap lightly on DPFE sensor to simulate road shock. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

20) DTC P0402: Check EGR Flow At Idle This code indicates PCM has detected EGR flow at idle. Possible causes for this fault are:

- EGR valve stuck open.
- EVR solenoid vent plugged.
- EVR circuit shorted to ground.
- Excessively worn or damaged vacuum hose.
- Faulty EVR solenoid.
- Faulty PCM.

NOTE: If Continuous Memory Code P1405 is present, go to step 50).

With ignition off, disconnect and plug EGR vacuum hose. Perform KOER self-test. If DTC P0402 is present, service or replace EGR valve. If DTC P0402 is not present or vehicle will not start/run, go to next step.

21) Turn ignition off. Reconnect EGR vacuum hose. Perform KOER self-test. If DTC P0402 is present, go to next step. If DTC P0402 is not present or vehicle will not start/run, go to step 30).

22) Check EGR System Using vehicle's vacuum diagram label, check EGR system vacuum hoses for damage, tight connections and correct routing. If hoses are okay, go to next step. If hoses are not okay, repair as necessary. Clear PCM memory and repeat **QUICK TEST** .

23) Check DPFE Sensor Output Turn ignition off. Disconnect pressure hoses at DPFE sensor. Connect vacuum pump to DPFE sensor downstream port marked REF. Turn ignition on. Using scan tester, access DPFEGR PID. PID voltage should be 0.35-1.25 volts. Using vacuum pump, apply 8-9 in. Hg. PID voltage should be more than 4 volts. When vacuum is quickly released, PID voltage should drop to less than one volt. If PID voltage is not as specified, replace DPFE sensor and repeat **QUICK TEST** . If PID voltage is as specified, go to next step.

24) Check EGR Flow At Idle With EVR Solenoid Disconnected Turn ignition off. Disconnect EGR valve vacuum hose. Connect vacuum gauge to hose. Start engine and allow to idle. While observing vacuum gauge, disconnect EVR solenoid. If vacuum gauge reads 1.6 in. Hg or more, go to next step. If vacuum gauge reads less than 1.6 in. Hg, go to step 26).

25) Check EVR Vent Turn ignition off. Disconnect EVR solenoid vent cap and vacuum hoses. Remove EVR filter and inspect for restriction. Using a vacuum pump, apply 15 in. Hg to EVR vent. If EVR solenoid is plugged or restricted, repair or replace as necessary. Clear PCM memory and repeat **QUICK TEST** . If solenoid is not plugged or restricted, replace EVR solenoid. Clear PCM memory and repeat QUICK TEST.

26) Check EVR Solenoid Coil Resistance Turn ignition off. Disconnect EVR solenoid wiring harness connector. Measure resistance between EVR terminals. If resistance is 26-40 ohms, go to next step. If resistance is not 26-40 ohms, replace EVR solenoid. Clear PCM memory and repeat **QUICK TEST** .

27) Check EVR Circuit For Short To Ground Leave ignition off and EVR solenoid disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 47 (EVR) and test pins No. 51 and 103 (PWR GND) at breakout box. If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short between EVR circuit and ground.

28) Check EVR Circuit For Short To VREF Leave ignition off and EVR solenoid disconnected. Measure resistance between test pin No. 47 (EVR) and test pins No. 90 (VREF) at breakout box. If resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 28) to step 30). No test procedures have been omitted.

30) Check DPFE Sensor Output Leave ignition off. Connect scan tester to DLC. Disconnect pressure hoses at DPFE sensor. Connect vacuum pump to DPFE sensor port marked REF. Turn ignition on. Using scan tester, access DPFEGR PID. PID voltage should be 0.35-1.25 volt. Apply 9 in. Hg to DPFE sensor. PID voltage should be more than 4.0 volts. Release vacuum from sensor. PID voltage should drop to less than one volt in less than 3 seconds. If voltage readings are as specified, go to next step. If voltage readings are not as specified, replace DPFE sensor. Clear PCM memory and repeat **QUICK TEST** .

31) Check DPFE SIG Voltage Leave ignition on. Using scan tester, access DPFEGR PID. PID voltage should be 0.35-1.25 volt. Connect vacuum hose to EGR valve and plug hose. Start engine and allow to idle. Observe DPFEGR PID voltage at idle and compare to KOEO voltage. If voltage is higher at idle, apply 2-3 in. Hg to EGR valve and release vacuum. Repeat several times while observing DPFEGR PID voltage on scan tool. DPFEGR PID voltage should increase as valve begins to open and return to initial value as vacuum is released. A slow to return voltage is an indication of a slow closing EGR valve. If DPFEGR PID does not indicate fault, go to next step. If fault is indicated by DPFE PID, service or replace EGR VALVE. Clear PCM memory and repeat **QUICK TEST** .

32) Check EGR Valve Vacuum While Wiggling EVR Circuit Turn ignition off. Disconnect vacuum hose at EGR valve and connect to vacuum gauge. Turn ignition on. Observe vacuum gauge for indication of fault while wiggling EVR wiring harness and connector. Fault is indicated by a sudden jump in vacuum reading. Tap lightly on sensor to simulate road shock. If no faults are indicated, go to next step. If fault is indicated, isolate and repair as necessary. Clear PCM memory and repeat **QUICK TEST** .

33) Check EVR Solenoid For Restriction Turn ignition off. Disconnect EVR solenoid vent filter. Inspect for contamination or water. Remove EGR vacuum hose and inspect for restriction. Repair or replace as necessary. If no faults can be found, problem is intermittent and cannot be identified at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 33) to step 40). No test procedures have been omitted.

40) DTC P1403: Check For Reversed Pressure Hoses Check hoses for proper connection. DPFE port marked HI should connect to exhaust side of orifice tube. DPFE port marked REF should connect to intake side of orifice tube. See **Fig. 50** . If hoses are not routed correctly, repair as necessary. Clear PCM memory and repeat **QUICK TEST** . If hoses are routed correctly, problem cannot be identified at this time. Clear PCM memory and repeat QUICK TEST.

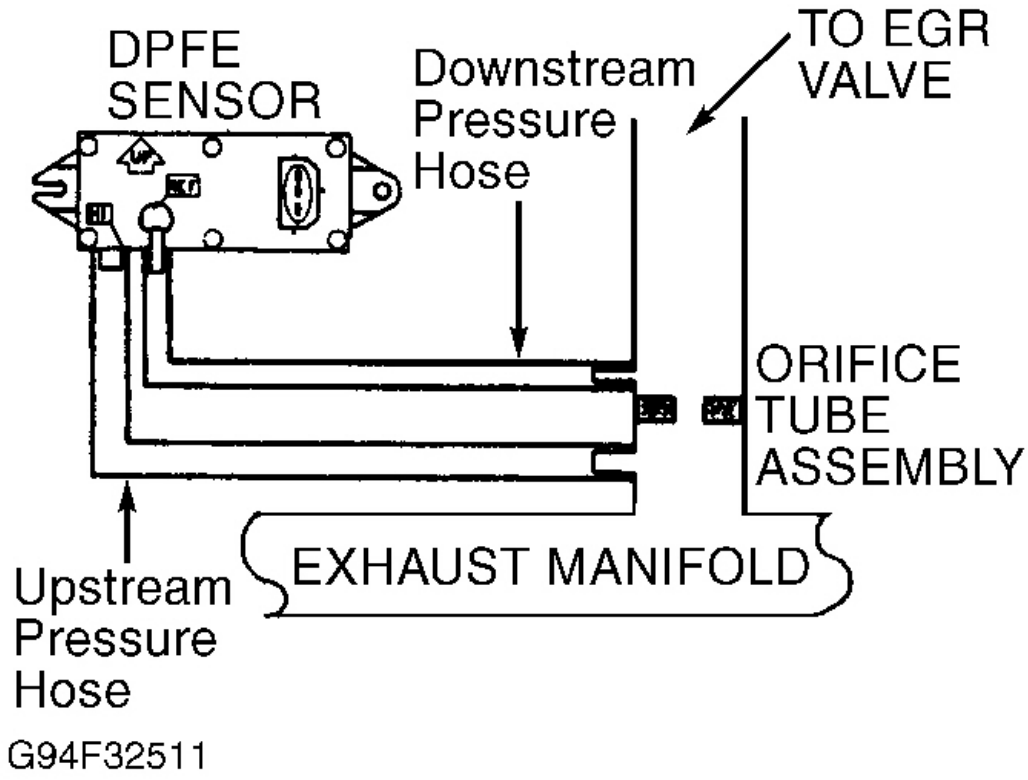


Fig. 52: DPFE Vacuum Circuit

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 40) to step 50). No test procedures have been omitted.

50) DTC P1405: Check For Upstream Pressure Hose Connection Check upstream hose for clean, tight connection. See **Fig. 52** . Repair as necessary. Clear PCM memory and repeat **QUICK TEST** . If hose is okay, go to next step.

51) Inspect Upstream Pressure Hose Check upstream hose for clean, tight connection. Ensure hose is not pinched, wet or contaminated. Repair as necessary. Clear PCM memory and repeat **QUICK TEST** . If hose is okay, go to next step.

52) Inspect Orifice Tube Assembly & DPFE Sensor Check DPFE sensor port for restriction or damage. Inspect exhaust manifold side pressure pick-up tube at the orifice tube assembly for restriction or damage. Repair as necessary. Clear PCM memory and repeat **QUICK TEST** . If no faults are found, clear PCM memory and repeat QUICK TEST. If hose is okay, go to next step.

53) Check DPFE Sensor Output Leave ignition off. Connect scan tester to DLC. Disconnect pressure hoses at DPFE sensor. Connect vacuum pump to DPFE sensor port marked REF. Turn ignition on. Using scan tester, access DPFEGR PID. PID voltage should be 0.35-1.25 volt. Apply 9 in. Hg to DPFE sensor.

PID voltage should be more than 4.0 volts. Release vacuum from sensor. PID voltage should drop to less than one volt in less than 3 seconds. If voltages are not as specified, replace DPFE sensor and repeat **QUICK TEST** . If voltage readings are as specified, fault is intermittent and cannot be duplicated at this time. Clear PCM memory and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 53) to step 60). No test procedures have been omitted.

60) DTC P1406: Check For Downstream Pressure Hose Connection Check downstream hose for clean, tight connection. See **Fig. 50** . Repair as necessary. Clear PCM memory and repeat **QUICK TEST** . If hose is okay, go to next step.

61) Inspect Downstream Pressure Hose Check downstream hose for clean, tight connection. Ensure hose is original equipment. Ensure hose is not pinched, wet or contaminated. Repair as necessary. Clear PCM memory and repeat **QUICK TEST** . If hose is okay, go to next step.

62) Inspect Orifice Tube Assembly & DPFE Sensor Check DPFE sensor port for restriction or damage. Inspect intake manifold side pressure pick-up tube at the orifice tube assembly for restriction or damage. Repair as necessary. Clear PCM memory and repeat **QUICK TEST** . If no faults are found, go to next step.

63) Check DPFE Sensor Output Leave ignition off. Connect scan tester to DLC. Disconnect pressure hoses at DPFE sensor. Connect vacuum pump to DPFE sensor port marked REF. Turn ignition on. Using scan tester, access DPFEGR PID. PID voltage should be 0.35-1.25 volt. Apply 9 in. Hg to DPFE sensor. PID voltage should be more than 4.0 volts. Release vacuum from sensor. PID voltage should drop to less than one volt in less than 3 seconds. If voltages are not as specified, replace DPFE sensor and repeat **QUICK TEST** . If voltage readings are as specified, fault is intermittent and cannot be duplicated at this time. Clear PCM memory and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 63) to step 70). No test procedures have been omitted.

70) DTC P0401 These codes indicate self-test has detected no EGR flow. Possible causes are as follows:

- EGR valve stuck closed.
- EGR valve diaphragm leak.
- EGR flow plugged or restricted.
- Faulty EGR hose.
- EVR VPWR circuit open.
- EVR VPWR circuit to PCM open or shorted to PWR.
- DPFE sensor VPWR circuit open.
- DPFE sensor hoses faulty.
- Faulty DPFE sensor.
- Faulty EVR solenoid.
- Faulty PCM.

If fault is currently present, KOER code P1408 should be present. Perform KOER self-test. If DTC P1408

is present, go to next step. If DTC P1408 is not present, go to step 90).

71) DTC P1408 This code indicates KOER self-test has detected EGR flow out of range. Possible causes are as follows:

- EGR valve stuck closed.
- EGR valve diaphragm leak.
- EGR flow plugged or restricted.
- Faulty EGR hose.
- EVR VPWR circuit open.
- EVR VPWR circuit to PCM open or shorted to PWR.
- DPFE sensor VPWR circuit open.
- DPFE sensor hoses faulty or reversed.
- Downstream pressure hoses plugged or removed.
- Faulty orifice tube assembly.
- Faulty DPFE sensor.
- Faulty EVR solenoid.
- Faulty PCM.

Retrieve Continuous Memory DTCs. If any codes except DTCs P1403 or P1406 are present, service as necessary before continuing. If DTC 1406 is present, go to step 60). If no codes are present, go to next step.

72) Perform KOER SELF-TEST While Monitoring EGR Vacuum Disconnect vacuum hose from EGR valve. Connect hose to vacuum gauge. Perform KOER self-test while monitoring gauge. Disregard DTCs set during this test. During test, if EGR vacuum should rise to 3.0 in. Hg or more, go to next step. If vacuum stays below 3.0 in. Hg, go to step 80).

73) Inspect DPFE Pressure Hoses Check both hoses for correct routing. Ensure hoses are not restricted or plugged or leaking. Inspect DPFE sensor and orifice tube assembly for restriction or damage at pick-up tube. If no faults are found, go to next step. If faults are found, repair or replace as necessary. Clear PCM memory and repeat **QUICK TEST** .

74) Check VREF Voltage At DPFE Sensor Turn ignition off. Disconnect DPFE sensor wiring harness connector. Turn ignition on. Measure voltage between VREF terminal and SIG RTN terminal at DPFE sensor wiring harness connector. If voltage is 4-6 volts, reconnect DPFE sensor and go to next step. If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

75) Vacuum Check DPFE Sensor Output Turn ignition off. Connect scan tester to DLC. Disconnect pressure hoses at DPFE sensor. Connect vacuum pump to DPFE sensor port marked REF. Turn ignition on. Using scan tester, access DPFEGR PID. PID voltage should be 0.35-1.25 volt. Apply 8-9 in. Hg to DPFE sensor. PID voltage should be more than 4.0 volts. Release vacuum from sensor. PID voltage should drop to less than one volt in less than 3 seconds. If voltage readings are not as specified, replace DPFE sensor. Clear PCM memory and repeat **QUICK TEST** . If voltages are as specified, go to next step.

76) Check EGR Valve Function Turn ignition off. Leave scan tester connected to DLC. Disconnect and plug hose at EGR valve. Connect vacuum pump to EGR valve. Start engine and allow to idle. Using scan

tester, access DPFEGR and RPM PIDs. Slowly apply 5-10 in. Hg to EGR valve and hold for 10 seconds. It may be necessary to increase engine speed to obtain 800 RPM. As vacuum increases, PID voltage should rise (up to 2.5 volts). When vacuum is held steady, PID voltage should hold steady. If vacuum is as specified, reconnect all components and go to step 85). If vacuum is not as specified, service or replace EGR valve. Clear PCM memory and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 76) to step 80). No test procedures have been omitted.

80) Check EVR Solenoid Vacuum Inspect EVR solenoid and EGR vacuum hoses for leaks, restrictions, damage or incorrect routing. Repair as necessary. Disconnect vacuum hoses at EVR solenoid. Connect vacuum pump to EVR solenoid vacuum supply hose. Start engine and allow to idle. If vacuum gauge reading is 15 in. Hg or more, go to next step. If vacuum gauge reading is less than 15 in. Hg, isolate fault and repair as necessary. Clear PCM memory and repeat **QUICK TEST** .

81) Check VPWR To EVR Solenoid Turn ignition off. Disconnect EVR solenoid wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal at EVR solenoid wiring harness connector and chassis ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit. Clear PCM memory and repeat **QUICK TEST** .

82) Check Resistance At EVR Solenoid Turn ignition off. Leave EVR solenoid wiring harness connector disconnected. Measure resistance across EVR solenoid terminals. If resistance is 26-40 ohms, go to next step. If resistance is not 26-40 ohms, replace EVR solenoid. Clear PCM memory and repeat **QUICK TEST** .

83) Check EVR For Short To PWR Leave EVR solenoid disconnected. Turn ignition off. Disconnect PCM 104-pin connector. Inspect for damage pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 47 (EVR) at breakout box and chassis ground. If voltage is less than one volt, go to next step. If voltage is one volt or more, repair EVR circuit short to PWR. Clear PCM memory and repeat **QUICK TEST** .

84) Check EVR Circuit For Open In Harness Leave ignition off and EVR solenoid disconnected. Measure resistance between test pin No. 47 (EVR) and EVR terminal at EVR solenoid wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in EVR circuit. Clear PCM memory and repeat **QUICK TEST** .

85) Check EVR Solenoid Vacuum Output Capability Leave ignition off. Connect EVR solenoid to wiring harness connector. Connect PCM to breakout box. Disconnect hose from EGR valve. Connect EGR vacuum hose to vacuum gauge. Start engine and allow to idle. Connect test pin No. 47 (EVR) at breakout box to chassis ground. If vacuum gauge reading is 4 in. Hg or more, replace PCM and repeat **QUICK TEST** . If vacuum gauge is less than 4 in. Hg, replace EVR solenoid. Clear PCM memory and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 85) to step 90). No test procedures have been omitted.

90) Check EGR System Leave ignition off. Check entire EGR system for deterioration or signs of failure. Repair or replace as necessary. If system is okay, go to next step.

91) Check EGR Valve Operation Leave ignition off. Disconnect EGR valve. Connect vacuum pump to EGR valve. Connect scan tester to DLC. Disconnect and plug hose at EGR valve. Connect vacuum pump

to EGR valve. Start engine and allow to idle. Using scan tester, access DPFEGR PIDs. Slowly apply 5-10 in. Hg to EGR valve and hold for 5 seconds. It may be necessary to increase engine speed to avoid stalling. When vacuum increases, PID voltage should increase as EGR valve opens. EGR operation should be smooth with no binding. If EGR valve opens smoothly and holds vacuum, go to next step. If EGR valve is not as specified, service or replace EGR valve. Clear PCM memory and repeat **QUICK TEST** .

NOTE: In cold climate, EGR valve may freeze shut and thaw when engine warms, causing intermittent trouble code to be set in PCM memory.

92) Check EVR For Short To PWR Turn ignition off. Leave EGR valve hose connected to vacuum gauge. Disconnect PCM 104-pin connector. Inspect for damage pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Connect jumper wire between test pin No. 47 (EVR) at breakout box and chassis ground to turn EVR on. Vacuum gauge reading should be more than 4.0 in. Hg. Observe vacuum gauge for fault while tapping lightly on EVR solenoid. Fault will be indicated by a sudden drop of vacuum. Wiggle EVR vacuum hoses, wiring harness and connector. If fault is indicated, isolate and repair as necessary. Clear PCM memory and repeat **QUICK TEST** . If no faults are indicated, symptom cannot be identified at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 92) to step 100). No test procedures have been omitted.

100) Check EGR Valve & Vacuum Supply Perform **QUICK TEST** and service any other DTCs if present. If no other DTCs are present, disconnect and plug EGR vacuum supply hose. Turn ignition on. Using scan tester, access DPFEGR PID. PID voltage should be 0.35-1.25 volt. Start engine and allow to idle. DPFEGR PID voltage should increase about 1.5 volts. If voltage is as specified, service or replace EGR valve. If voltage is not as specified, inspect EGR vacuum regulator solenoid vent and vent filter. If no faults are found, replace EGR vacuum regulator solenoid.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 100) to step 110). No test procedures have been omitted.

110) DTC P1409 This code indicates self-test has detected electrical malfunction in EVR circuit. Possible causes are as follows:

- EVR circuit open or shorted.
- Faulty EVR solenoid.
- Faulty PCM.

Turn ignition off. Leave EVR solenoid wiring harness connector disconnected. Measure resistance across EVR solenoid terminals. If resistance is 26-40 ohms, go to next step. If resistance is not 26-40 ohms, replace EVR solenoid. Clear PCM memory and repeat **QUICK TEST** .

111) Check VPWR To EVR Solenoid Turn ignition off. Disconnect EVR solenoid wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal at EVR solenoid wiring harness

connector and chassis ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit. Clear PCM memory and repeat **QUICK TEST** .

112) Check EVR Circuit Continuity Leave ignition off and EVR solenoid disconnected. Disconnect PCM 104-pin connector. Inspect for damage pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 47 (EVR) and EVR terminal at EVR solenoid wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in EVR circuit. Clear PCM memory and repeat **QUICK TEST** .

113) Check EVR For Short To PWR Leave EVR solenoid disconnected. Turn ignition off. Turn ignition on. Measure resistance between test pin No. 47 (EVR) and test pins No. 71 and 97 (VPWR) at breakout box. Measure resistance between test pin No. 47 (EVR) and test pins No. 24 and 103 (PWR GND) at breakout box. If each resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If any resistance is less than 10,000 ohms, repair EVR circuit short to PWR or PWR GND and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 113) to step 120). No test procedures have been omitted.

120) Continuous Memory DTC P1409 This continuous DTC indicates self-test has detected electrical malfunction in EVR circuit. Possible causes are as follows:

- EVR circuit open or shorted.
- Faulty EVR solenoid.
- Faulty PCM.

Turn ignition off. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 47 (EVR) and No. 24 (PWR GND) at breakout box. Voltage should be more than 10.5 volts. Observe voltmeter for indication of fault while wiggling EVR wiring harness and connector. Fault is indicated by a sudden jump in voltage reading. Tap lightly on sensor to simulate road shock. If fault is indicated, isolate and repair as necessary. If no faults are indicated, symptom cannot be identified at this time. Go to **CIRCUIT TEST Z** .

CIRCUIT TEST HF - CATALYST EFFICIENCY MONITOR & EXHAUST SYSTEMS

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the exhaust system and downstream HO2S.

Internal damage of a catalytic converter is usually caused by abnormal engine operation upstream of catalyst. Conditions that produce higher than normal temperatures in the catalytic converter, such as cylinder misfire, are likely suspects.

MISFIRE DIAGNOSTIC TROUBLE CODES

DTC	Application
P0300	(1)

P0301	Cylinder No. 1 (Test Pin No. 75)
P0302	Cylinder No. 2 (Test Pin No. 101)
P0303	Cylinder No. 3 (Test Pin No. 74)
P0304	Cylinder No. 4 (Test Pin No. 100)
P0305	Cylinder No. 5 (Test Pin No. 73)
P0306	Cylinder No. 6 (Test Pin No. 99)
P0307	Cylinder No. 7 (Test Pin No. 72)
P0308	Cylinder No. 8 (Test Pin No. 98)
(1) Multiple cylinder misfire or faulty CKP sensor.	

1) DTC P0420, P0421, P0430 & P0431: Check Possible Cause Of Misfire DTC P0420 and P0421 indicates bank one catalyst system efficiency is minimum requirement. DTC P0430 and P0430 indicates bank 2 catalyst system efficiency is minimum requirement. Possible causes are as follows:

- Use of leaded fuel.
- Oil contamination.
- Cylinder misfire.
- Fuel pressure too high.
- HO2S sensor improperly connected.
- Damaged exhaust system component.
- Faulty ECT sensor.
- Faulty HO2S.

Ensure ignition timing is correct. Retrieve all Continuous Memory DTCs. If misfire code(s) is not present, go to next step. If misfire code(s) is present, isolate cylinder and repair as necessary.

2) Check HO2S Monitor DTCs If DTCs P0136, P0138, P0140, P0141, P0156, P0158, P0160, or P0161 were present in step 1), service as necessary before continuing. If none of these codes are present in step 1), go to next step.

3) Check ECT Sensor DTCs If DTCs P0117, P0118, P0125 or P1117 were present in step 1), service as necessary before continuing. If none of these codes are present in step 1), go to next step.

4) If any codes except P0420, P0421, P0430 and/or P0430 were present in step 1), service as necessary before continuing. If no codes except P0420 and/or P0430 were present in step 1), go to next step.

5) Check Rear HO2S Wiring Harness Turn ignition off. Ensure HO2S wiring harness is correctly routed and connectors are tight. Repair or replace as necessary. If wiring harness and connectors are okay, go to next step.

6) Check Fuel Pressure Turn ignition off. Release fuel pressure. Install fuel pressure gauge. Start engine and allow to idle. Note fuel pressure gauge reading. Increase engine speed to 2500 RPM and maintain for one minute. For fuel pressure specifications, see **FUEL PRESSURE SPECIFICATIONS** article. If fuel pressure is as specified, go to next step. If fuel pressure is not as specified, go to **CIRCUIT TEST HC** .

7) Check For Exhaust System Leaks If exhaust system leaks, it may cause catalyst monitor efficiency test to fail. Inspect exhaust system for cracks, loose connections or punctures. Repair or replace as necessary. If exhaust system is okay, go to next step.

8) Check For Exhaust System Restrictions Inspect exhaust system for collapsed areas, dents or excessive bending. Repair or replace as necessary. If exhaust system is okay, go to next step.

9) Check Manifold Vacuum Install tachometer. Connect vacuum gauge to intake manifold vacuum source. Start engine and raise engine speed to 2000 RPM. Manifold vacuum should rise to more than 16 in. Hg. If manifold vacuum is okay, go to next step. If manifold vacuum is low, go to step 11).

10) Leave tachometer and vacuum gauge connected. Start engine and raise engine speed to 2000 RPM. On a non-restricted system, manifold vacuum should quickly rise to normal range as increased RPM is maintained. On a restricted system, manifold vacuum will slowly rise to normal range as increased RPM is maintained. If manifold vacuum is okay, no indication of exhaust leak or restriction has been detected and testing is complete. If manifold vacuum is low or slow to respond, go to next step.

11) Leave tachometer and vacuum gauge connected. Remove exhaust pipe from exhaust manifold. Start engine and raise engine speed to 2000 RPM. If manifold vacuum is now okay, fault is downstream from exhaust manifold. Reconnect exhaust pipe to exhaust manifold and go to next step. If manifold vacuum is still low or slow to respond, fault is in exhaust manifold or intake manifold gasket. Repair or replace as necessary and repeat **QUICK TEST** .

12) Leave tachometer and vacuum gauge connected. Disconnect muffler/tailpipe assembly from rear of catalytic converter. Start engine and raise engine speed to 2000 RPM. If manifold vacuum is now okay, fault is in muffler/tailpipe assembly. Repair or replace as necessary and test drive vehicle to verify elimination of symptom. If manifold vacuum is still not okay, fault is in catalytic converter. Repair or replace as necessary. Check tailpipe/muffler assembly for debris from catalytic converter. Test drive vehicle to verify elimination of symptom.

CIRCUIT TEST HG - PCV SYSTEM

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. Use this test to diagnose Positive Crankcase Ventilation (PCV) valve and related vacuum hoses.

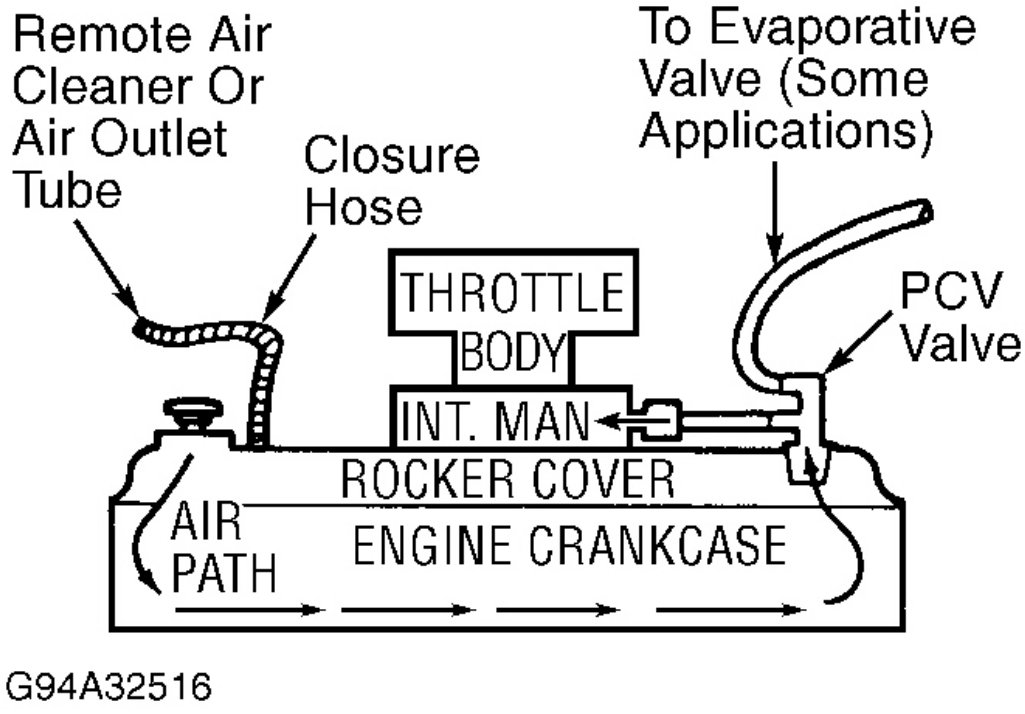


Fig. 53: PCV System Schematic

1) Check PCV Valve Remove PCV valve. Shake valve and listen for rattle. If PCV valve rattles when shaken, go to next step. Replace PCV valve if it does not rattle when shaken.

2) Check PCV System Start engine and warm to normal operating temperature. Disconnect hose from remote air cleaner or outlet tube. Place a stiff piece of paper over end of hose. If vacuum from hose does not hold paper in place for one minute, go to next step. If vacuum from hose holds paper in place for one minute, PCV system is okay and testing is complete.

3) Check Evaporative Emission System Disconnect evaporative emission hose from PCV system and plug connector. Place a stiff piece of paper over end of hose. If vacuum from hose does not hold paper in place for one minute, isolate vacuum leak or restriction and repair as necessary. If vacuum from hose holds paper in place for one minute, proceed as follows:

- On models equipped with Fuel Tank Pressure (FTP) sensor, go to step 47) of **CIRCUIT TEST HX** .
- On models not equipped with Fuel Tank Pressure (FTP) sensor, go to step 10) of **CIRCUIT TEST HW** .

CIRCUIT TEST HM - SECONDARY AIR INJECTION (AIR) SYSTEM

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Wiring harness circuits (BATT+, EAIR, EAIR MONITOR and Ground).
- Solid State Relay (SSR).
- Electric Air Pump (EAP).
- Air injection by-pass solenoid.
- Air injection diverter solenoid.
- Air injection diverter valve.
- Air injection by-pass solenoid.
- Powertrain Control Module (PCM).

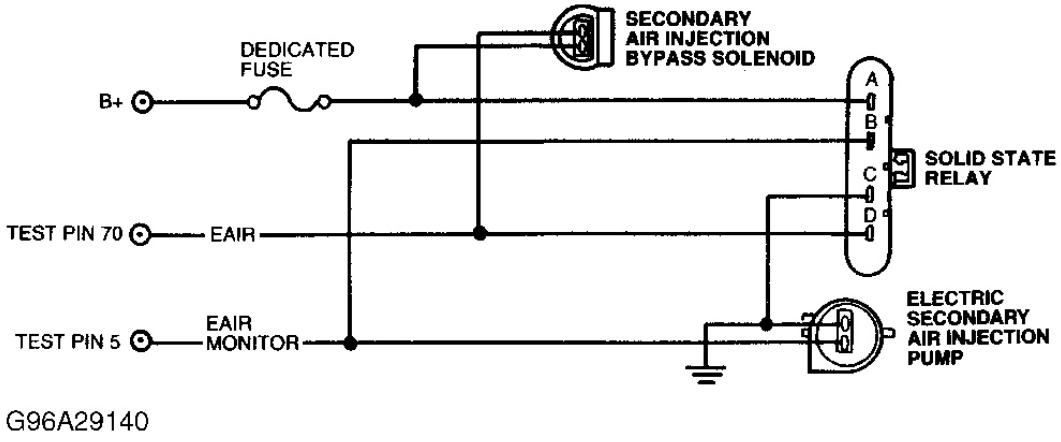


Fig. 54: Electric AIR Test Circuit & Connector Terminals

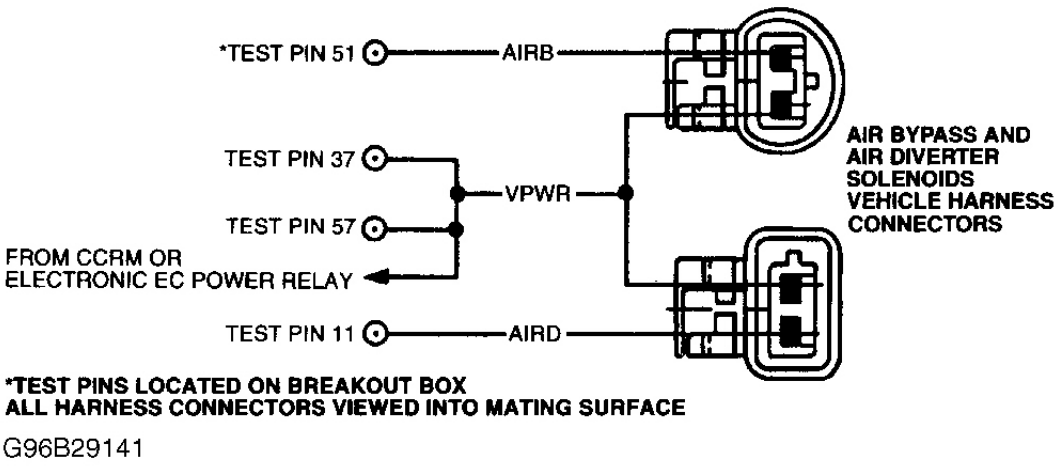


Fig. 55: Mechanical AIR Test Circuit & Connector Terminals

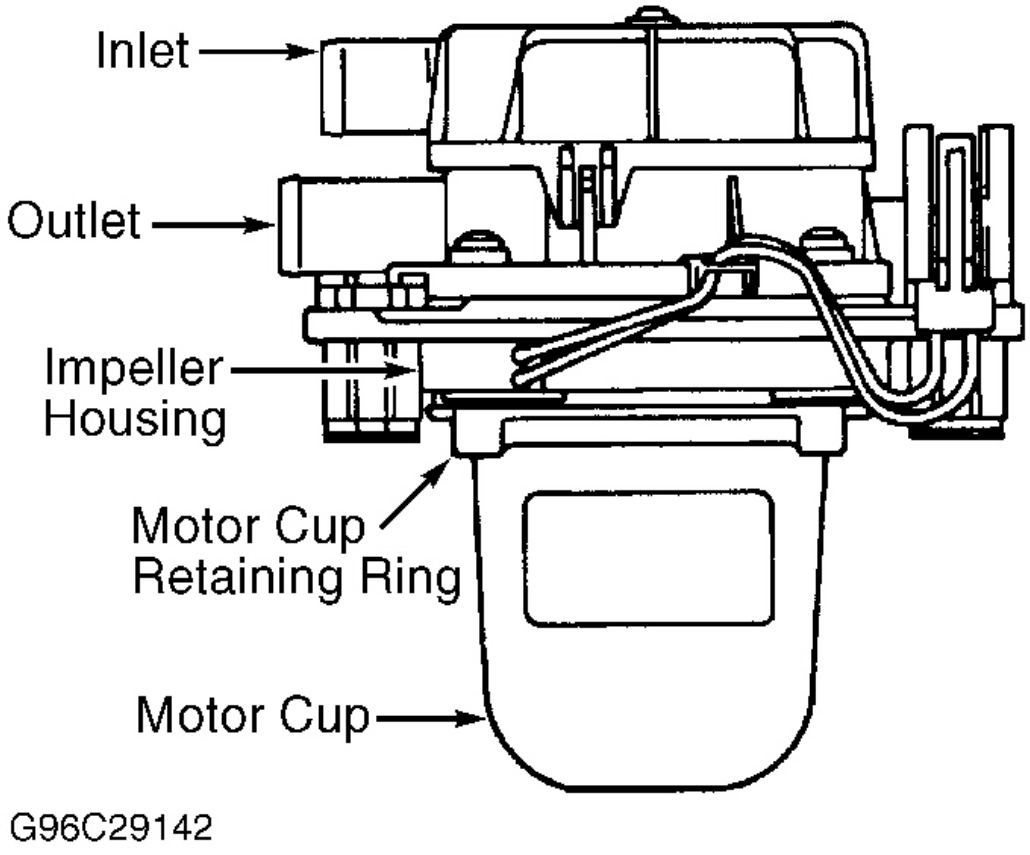


Fig. 56: Electric AIR Pump Components

1) DTC P0412: Check BATT+ At SSR This DTC indicates EAIR primary circuit failure. Possible causes are as follows:

- EAIR circuit open or short to power.
- AIR by-pass solenoid failure.
- Faulty Solid State Relay (SSR).
- Faulty PCM.

Turn ignition off. Disconnect SSR. Turn ignition on. Measure voltage between SSR connector BATT+ terminal and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, go to step 6).

2) Check EAIR Circuit Resistance Turn ignition off. Leave SSR disconnected. Disconnect AIR by-pass solenoid. Temporarily remove secondary air dedicated fuse. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM

disconnected. Measure resistance between test pin No. 70 (EAIR) at breakout box and EAIR terminal at SSR connector. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** . If resistance is less than 5 ohms, go to next step.

3) Check EAIR Circuit Short To Power Leave ignition off. Measure resistance between test pin No. 70 and test pins No. 51, 71, 90, 97 and 103 at breakout box. If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short circuit and repeat **QUICK TEST** .

4) Leave ignition off. Reconnect AIR by-pass solenoid. Measure resistance between test pin No. 70 and test pins No. 51, 71, 90, 97 and 103 at breakout box. If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, replace AIR by-pass solenoid and repeat **QUICK TEST** .

5) Leave ignition off. Reconnect SSR. Measure resistance between test pin No. 70 and test pins No. 51, 71, 90, 97 and 103 at breakout box. If resistance is more than 10,000 ohms, go to step 14) if DTC P0411 or P1411 is present or step 9) if specified DTCs are not present. If resistance is 10,000 ohms or less, repair EAIR circuit and repeat **QUICK TEST** .

6) Check BATT+ Circuit Resistance Leave ignition off. Disconnect SSR. Measure resistance between SSR connector terminal "A" and AIR system dedicated fuse. If resistance is less than 5 ohms, replace dedicated fuse and go to step 8). If resistance is 5 ohms or more, repair open in BATT+ circuit and repeat **QUICK TEST** .

7) DTC P0411 Or P1411 Check secondary air hoses for damage, wear or poor connections. Repair or replace as necessary. If all hoses are okay, go to next step.

8) Check Electric Pump Operation Turn ignition off. Disconnect air hoses from AIR diverter valve(s). Start engine and allow to idle. After a 5 second delay, airflow should be present for 30-90 seconds. If airflow is present, go to step 15). If airflow is not present, go to step 11).

9) Check For Vacuum At Diverter Valve Turn ignition off. Reconnect PCM. Disconnect vacuum hose from diverter valve. Start engine and allow to idle. After a 5 second delay, vacuum should be present for 30-90 seconds. If vacuum is present, go to next step. If vacuum is not present, go to step 30).

10) Check Diverter Valve Turn ignition off. Reconnect vacuum hose at diverter valve. Disconnect and plug air tube from diverter valve outlet side. Check diverter valve for damage and repair if necessary. Start engine and allow to idle. After a 5 second delay, vacuum should be present for 30-90 seconds. If vacuum is present, go to next step. If vacuum is not present, go to step 30).

11) Check EAIR MONITOR Circuit Voltage Turn ignition off. Disconnect electric air pump. Turn ignition on. Measure voltage between EAIR MONITOR circuit at the connector and chassis ground. Voltage should be 10.5 volts or more for 20-30 seconds after a 5-10 second delay. If voltage is as specified, go to step 13). If voltage is not as specified, go to next step.

12) Check Ground Circuit Leave ignition off and air pump disconnected. Measure resistance between air pump connector ground terminal and chassis ground. If resistance is less than 5 ohms, go to step 19). If resistance is 5 ohms or more, repair open in ground circuit and repeat **QUICK TEST** .

13) Check Air Pump Hoses Turn ignition off. Inspect hoses between air pump and air control valves. If hoses are damaged or restricted, repair or replace as necessary and repeat **QUICK TEST** . If hoses are okay, replace electric AIR pump and repeat QUICK TEST.

14) Check For Voltage At SSR Turn ignition off. Reconnect AIR bypass solenoid and SSR. With breakout box installed and PCM connected, turn ignition on. Measure voltage between chassis ground and test pin No. 5 at breakout box. Also, measure voltage between chassis ground and test pin No. 70 at breakout box. If voltage is less than 10.5 volts, replace PCM and repeat **QUICK TEST** . If voltage is 10.5 volts or more, replace SSR and repeat QUICK TEST.

15) Check Air Pump For Water Turn ignition off. Disconnect electric AIR hoses and wiring harness connector. Check air pump for water. If water is present, repair or replace as necessary. If water is not present, go to step 9).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 15) to step 18). No test procedures have been omitted.

18) DTC 1413: Check For Voltage At SSR Leave ignition off. Disconnect SSR. Turn ignition on. Measure voltage between SSR connector BATT+ terminal and chassis ground. If voltage is less than 10.5 volts, go to step 24). If voltage is 10.5 volts or more, go to next step.

19) Check EAIR MONITOR Circuit Voltage Leave ignition off. Reconnect SSR. Disconnect electric AIR pump wiring harness connector. Turn ignition on. Measure voltage between connector EAIR MONITOR terminal and chassis ground. If voltage is less than 10.5 volts and DTC P0411 is present, replace AIR pump. If voltage is less than 10.5 volts and DTC P0411 is not present, go to next step. If voltage is 10.5 volts or less, go to step 23).

20) Check EAIR MONITOR Circuit For Short To Power Turn ignition off. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 5 at breakout box and chassis ground. If voltage is 10.5 volts or less, go to next step. If voltage is more than 10.5 volts, replace PCM and repeat **QUICK TEST** .

21) Check EAIR MONITOR Circuit Continuity Turn ignition off. Disconnect SSR. Measure resistance between test pin No. 5 at breakout box and EAIR MONITOR terminal at SSR connector. Measure resistance between EAIR MONITOR terminal at SSR connector and EAIR MONITOR terminal at air pump connector. If both resistance measurements are 5 ohms or more, repair open in EAIR MONITOR circuit and repeat **QUICK TEST** . If resistance is less than 5 ohms, go to next step.

22) Check EAIR MONITOR Circuit For Short To Ground Turn ignition off. Leave SSR and air pump disconnected. Measure resistance between test pin No. 5 and test pins No. 51, 76 and 91 at breakout box. If each resistance measurement is more than 10,000 ohms, replace SSR and repeat **QUICK TEST** . If any resistance measurement is 10,000 ohms or less, repair EAIR MONITOR circuit short to ground and repeat QUICK TEST.

23) Check EAIR MONITOR Circuit Voltage Leave ignition off. Reconnect air pump. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Start engine and allow to idle. Measure voltage between test pin No. 5 and chassis ground. After about 5 seconds, voltage should be 10.5 volts or more. If voltage is as specified, replace PCM and repeat **QUICK TEST** . If voltage is not as specified, repair open in EAIR MONITOR circuit and repeat QUICK TEST.

24) Check BATT+ Circuit Continuity Turn ignition off. Leave SSR disconnected. Measure resistance between SSR connector terminal "A" and AIR system dedicated fuse. If resistance is less than 5 ohms, replace dedicated fuse and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open in BATT+ circuit and repeat QUICK TEST.

25) DTC P1414: Check EAIR MONITOR Circuit Continuity Turn ignition off. Disconnect air pump and SSR wiring harness connectors. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 5 at breakout box and EAIR MONITOR terminal at air pump connector. If resistance is 5 ohms or more, repair open in EAIR MONITOR circuit and repeat **QUICK TEST** . If

resistance is less than 5 ohms, go to next step.

26) Leave ignition off, SSR relay and AIR pump disconnected. Disconnect PCM wiring harness connector. Measure resistance between pump terminals. If resistance is 0.5-5.0 ohms, go to next step. If resistance is not 0.5-5.0 ohms, replace AIR pump and repeat **QUICK TEST** .

27) Check EAIR MONITOR Circuit For Short To Power Turn ignition off. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 5 at breakout box and chassis ground. If voltage is 10.5 volts or less, go to next step. If voltage is more than 10.5 volts, replace PCM and repeat **QUICK TEST** .

28) Leave ignition on. Measure voltage between test pin No. 5 at breakout box and chassis ground. Measure voltage between test pin No. 70 at breakout box and chassis ground. If either voltage measurements is 10.5 volts or less, replace PCM and repeat **QUICK TEST** . If both voltage measurements are more than 10.5 volts, replace SSR and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 28) to step 30). No test procedures have been omitted.

30) Check Air Pump Hoses Turn ignition off. Inspect air inlet hose. If hose is damaged or restricted, repair or replace as necessary and repeat **QUICK TEST** . If hose is okay, go to next step.

31) Check Air By-Pass Solenoid Disconnect air injection by-pass solenoid wiring harness connector. Connect scan tester to DLC. Turn ignition on. Using scan tester, access Output Test Mode (OTM). Connect voltmeter to air injection by-pass solenoid connector. Observe voltmeter while cycling outputs on and off. If voltage cycles 0.5 volt or more, go to next step. If voltage does not cycle 0.5 volt or more, go to step 33).

32) Remain in OTM. Reconnect air injection by-pass solenoid wiring harness connector. Disconnect vacuum hose from air injection by-pass solenoid. Connect vacuum hose to vacuum pump. Apply 16 in Hg. to solenoid. Observe voltmeter while cycling outputs on and off. If vacuum releases as outputs cycle, repair vacuum hose between solenoid and air control valve. If vacuum does not release as throttle cycles, replace air injection by-pass solenoid hose.

33) Check Air By-Pass Solenoid Resistance Turn ignition off. Disconnect air injection by-pass solenoid wiring harness connector. Measure resistance between connector terminals. If resistance is 50-100 ohms, go to next step. If resistance is not 50-100 ohms, replace air injection by-pass solenoid.

34) Check BATT+ Circuit Voltage Leave air injection by-pass solenoid disconnected. Turn ignition on. Measure voltage between connector BATT+ terminal and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in BATT+ circuit and repeat **QUICK TEST** .

35) Check EAIR Circuit Continuity Leave air injection by-pass solenoid disconnected. Turn ignition off. Disconnect SSR wiring harness connector. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 70 at breakout box and EAIR terminal at air pump connector. If resistance is 5 ohms or more, repair open in EAIR circuit and repeat **QUICK TEST** . If resistance is less than 5 ohms, go to next step.

36) Check EAIR Circuit For Short To Ground Turn ignition off. Leave air injection by-pass solenoid and SSR disconnected. Measure resistance between test pin No. 70 and test pins No. 51, 76 and 91 at breakout box. If each resistance measurement is 10,000 ohms or more, go to next step. If any resistance

measurement is less than 10,000 ohms, repair EAIR circuit short to ground and repeat **QUICK TEST** .

37) Check EAIR Circuit For Short To Power Leave ignition off. Leave air injection by-pass solenoid and SSR disconnected. Measure resistance between test pin No. 70 and test pins No. 71 and 97 at breakout box. If each resistance measurement is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 37) to step 40). No test procedures have been omitted.

40) DTC P0411 Check vacuum hoses for restrictions, damage or improper routing. Check AIR pump condition. If belt is broken or loose, go to step 81). If any other faults are found, repair as necessary. If no faults are found, go to next step.

41) Check For Vacuum At Diverter Valve Turn ignition off. Disconnect control vacuum hose from diverter valve. Start engine and allow to idle. If vacuum is present at hose, go to next step. If vacuum is not present, go to step 63).

42) Check Diverter Valve Turn ignition off. Disconnect vacuum hose at diverter valve outlet. Check diverter valve outlet for heat damage and repair if necessary. If no damage is present, go to next step.

43) Connect vacuum pump to AIR diverter valve. Apply 10 in Hg. If vacuum is held, go to next step. If vacuum is not held, replace AIR diverter valve and verify symptom is not present.

44) Start engine and allow to idle. Increase engine speed to 1500 RPM. If air flow is present at valve outlet, go to next step. If air flow is not present, go to step 71).

45) Vent auxiliary vacuum source. Ensure air flow switches from valve outlet to dump port or silencer port. If air flow does not switch, replace AIR diverter valve. If air flow switches, go to next step.

46) Turn ignition off. Disconnect vacuum hose from AIR bypass valve outlet. Check bypass valve outlet for heat damage and repair if necessary. If no damage is present, go to next step.

47) Remove vacuum supply hose from valve. While checking vacuum, start engine and allow to idle. Vacuum should be present after a 10 second delay. If vacuum is as specified, go to next step. If vacuum is not as specified, go to step 63).

48) Connect vacuum pump to AIR bypass valve. Apply 10 in Hg. and hold. If vacuum is held, go to next step. If vacuum is not held, replace AIR bypass valve and verify symptom is not present.

49) Start engine and allow to idle. Check for vacuum at AIR bypass valve supply hose. If air flow is present, go to next step. If air flow is not present, go to step 71).

50) Connect vacuum pump to AIR bypass valve. Start engine and allow to idle. Apply 10 in Hg to valve. Increase engine speed to 1500 RPM. If air flow is present at valve outlet, go to next step. If air flow is not present, replace AIR diverter valve and verify symptom is not present.

51) Allow engine to idle. Vent auxiliary vacuum source. Ensure air flow switches from valve outlet to dump port or silencer port. If air flow does not switch, replace AIR diverter valve. If air flow switches, go to step 63).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 51) to step 63). No test procedures have been omitted.

63) Check Air By-Pass & Air Diverter Solenoid Turn ignition off. Disconnect suspect solenoid wiring

harness connector. Connect scan tester to DLC. Using scan tester, access Output Test Mode (OTM). Connect DVOM positive lead to VPWR circuit terminal of connector. Connect negative lead to signal terminal of connector. Observe voltmeter while cycling outputs on and off. If voltage cycles, go to next step. If voltage does not cycle, remove DVOM and go to step 76).

64) Check Vacuum To AIR Diverter Or AIR Bypass Solenoid Leave ignition off. Remove vacuum hose from suspect solenoid. Start engine and allow to idle. If vacuum is present, replace solenoid. If vacuum is not present, go to next step.

65) Check Vacuum Supply To Reservoir Turn ignition off. Remove vacuum inlet hose at reservoir marked MAN or VAC. Start engine and allow to idle. If vacuum is present at hose, go to next step. If vacuum is not present, go to step 69) (if vehicle has check valve) or repair vacuum hose (if vehicle does not have check valve).

66) Check Reservoir Turn ignition off. Connect vacuum gauge to outlet hose at reservoir (not marked MAN or VAC). Start engine and allow to idle for 30 seconds. If vacuum increases 15-20 in Hg., replace reservoir outlet hose. If vacuum is not as specified, replace reservoir

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 66) to step 69). No test procedures have been omitted.

69) Check Air Flow At Check Valve Turn ignition off. Mark check valve for installation reference. Remove check valve. Connect vacuum pump to Black side of check valve. Connect vacuum gauge to opposite end of valve. Apply 16 in Hg. and hold. If vacuum is held, go to next step. If vacuum is not held, replace check valve.

70) Leave ignition off. Remove vacuum pump from check valve. If vacuum is held, no faults are present and testing is complete. If vacuum is not held, replace check valve.

71) Check Belt Tension Ensure belt tension is correct. If belt tension is correct, go to next step. If belt tension is not correct, go to step 81).

72) Check Air Pump Operation Leave ignition off. Disconnect air supply hose from AIR diverter valve. Start engine and allow to idle. Check air flow at pump outlet while varying engine speed. If air flow does not increase as engine speed increases, go to next step. If air flow increases as engine speed increases, no faults are present and testing is complete.

73) Check Silencer & Filter Remove inlet hose (if equipped). Inspect inlet port for restriction or blockage and repair as necessary. If no faults are found, replace AIR pump.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 73) to step 75). No test procedures have been omitted.

75) DTC P0413, DTC P0414, P0416 Or P0417; Voltage For AIR Solenoid Does Not Change Turn ignition off. Disconnect AIR bypass or diverter solenoid connector. Turn ignition on. Measure voltage between VPWR terminal at connector and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open circuit and repeat **QUICK TEST** .

76) Check AIR By-Pass & Diverter Solenoid Resistance Turn ignition off. Disconnect AIR by-pass and diverter solenoid wiring harness connector. Measure resistance between connector terminals. If resistance is 50-100 ohms, go to next step. If resistance is not 50-100 ohms, replace solenoid and repeat **QUICK TEST** .

77) Check AIRB & AIRD Circuit Resistance Leave ignition off and solenoids disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 11 at breakout box and AIRD terminal at solenoid connector. Measure resistance between test pin No. 51 at breakout box and AIRB terminal at solenoid connector. If either resistance measurement is 5 ohms or more, repair open circuit and repeat **QUICK TEST** . If both resistance measurements are less than 5 ohms, go to next step.

78) Check AIRB & AIRD Circuit For Short To Ground Leave ignition off and solenoids disconnected. Measure resistance between test pin No. 11 (AIRD) and test pins No. 51, 91 and 103 at breakout box. Measure resistance between test pin No. 51 (AIRB) and test pins No. 51, 91 and 103 at breakout box. If each resistance measurement is 10,000 ohms or more, go to next step. If any resistance measurement is less than 10,000 ohms, repair circuit short to ground and repeat **QUICK TEST** .

79) Check AIRB & AIRD Circuit For Short To Power Leave ignition off and solenoids disconnected. Measure resistance between test pin No. 11 and test pins No. 71 and 97 at breakout box. Measure resistance between test pin No. 51 and test pins No. 71 and 97 at breakout box. If any resistance measurement is less than 10,000 ohms, repair short to power and repeat **QUICK TEST** . If each resistance measurement is 10,000 ohms or more, replace PCM and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 79) to step 81). No test procedures have been omitted.

81) Excessive Belt Noise Check belt tension. If belt is loose, tighten as necessary. If belt is not loose, check pulley and mounting brackets. Check for seized AIR pump or broken bolts. Repair or replace as necessary. If no faults are present, testing is complete.

CIRCUIT TEST HT - TRACTION ASSIST (TA) SYSTEM

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- TA series throttle.
- Series throttle stepper motor.
- Series throttle controller.
- Wiring harness circuits (TP-B, VREF, SIG RTN, VPWR, PWR GND, TAPW, TA-B1, TA-B2, BCOMM, TA-A1, TA-A2 & ACOMM).
- Throttle Position Sensor B (TP-B).
- Powertrain Control Module (PCM).

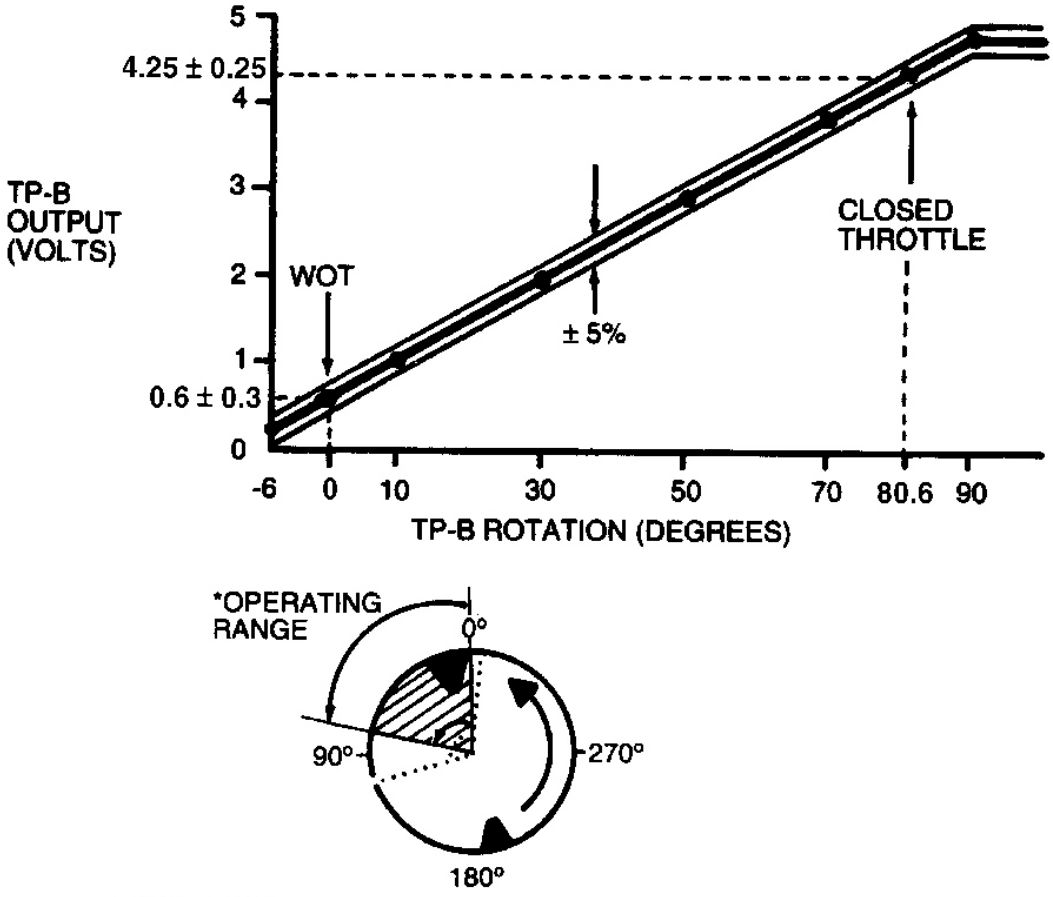


Fig. 57: TP-B Operational Range

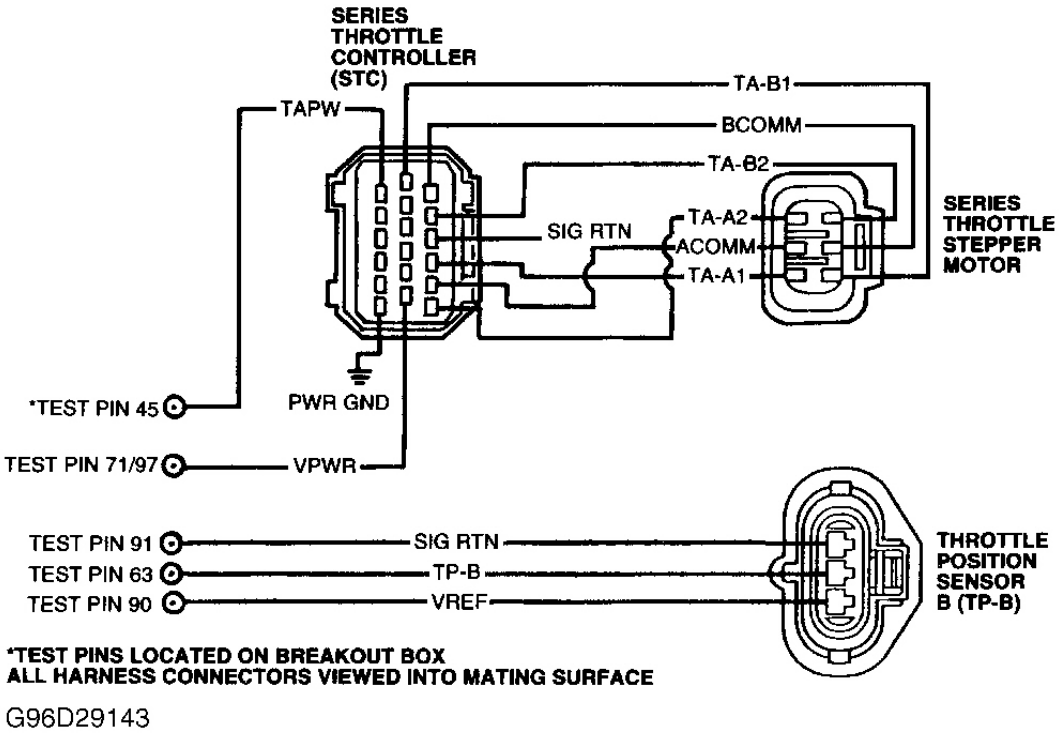


Fig. 58: TA System Connectors & Test Circuits

1) DTC P0222: Verify TP-B Voltage This DTC indicates TP-B voltage was below minimum during self-test. Possible causes are as follows:

- Open or shorted TP-B circuit.
- Open or shorted VREF circuit.
- Faulty TP-B.
- Faulty PCM.

Turn ignition off. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access TPB PID. If TPB PID voltage is less than 0.2 volts, go to next step. If TPB PID voltage is 0.2 volt or more, go to step 6).

2) Turn ignition off. Disconnect TP-B wiring harness connector. Inspect connector for damage and repair if necessary. Connect jumper wire between connector terminals TP-B (Yellow/White wire) and VREF (Brown/White wire). Turn ignition on. Using scan tester, access TPB PID. If PID cannot be accessed, go to step 5). If PID voltage is 4-6 volts, replace TP-B and repeat **QUICK TEST** . If voltage is not 4-6 volts, go to next step.

3) Leave TP-B disconnected. Turn ignition on. Measure voltage between terminals SIG RTN and VREF at TP-B connector. If voltage is 4-6 volts, go to next step. If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

4) Check TP-B For Open Circuit Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 63 (TP-B) at the breakout box and TP-B terminal of TP-B wiring harness connector. If resistance is 5 ohms or more, repair open in TP-B circuit and repeat **QUICK TEST** . If resistance is less than 5 ohms, go to next step.

5) Check TP-B Circuit For Short To Ground Or SIG RTN Turn ignition off. Disconnect scan tool from DLC (if applicable). Measure resistance between test pin No. 63 (TP-B) and test pins No. 51, 91 and 103 (PWR GND) at the breakout box. If each resistance measurement is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** . If any resistance measurement is less than 10,00 ohms, repair TP-B circuit short to ground or SIG RTN and repeat **QUICK TEST** .

6) Wiggle Test Turn ignition on. Using scan tester, access TPB PID. Observe PID for signs of fault. A fault will be indicated by change in PID voltage. Lightly tap on sensor. Wiggle wiring harness between TP-B and PCM. If fault is indicated, isolate and repair as necessary. If no faults are indicated, go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 6) to step 10). No test procedures have been omitted.

10) DTC P0223: Verify TP-B Voltage This DTC indicates TP-B voltage was above maximum during self-test. Possible causes are as follows:

- TP-B circuit shorted to VREF.
- TP-B circuit shorted to PWR.
- SIG RTN circuit open.
- Faulty TP-B.
- Faulty PCM.

Turn ignition off. Disconnect TP-B wiring harness connector. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access TPB PID. If PID voltage is more than 4 volts, go to next step. If voltage is 4 volts or less, go to step 16).

11) Check TP-B For Short To Power Turn ignition off. Disconnect TP-B sensor wiring harness connector. Inspect connector for damage and repair if necessary. Turn ignition on. Measure voltage between TP-B terminal at connector and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, go to step 13).

12) Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 63 (TP-B) and test pins No. 51 and 103 (PWR GND) at the breakout box. If voltage is 10.5 volts or more, repair short between PWR and TP-B circuit. Repeat **QUICK TEST** . If voltage is less than 10.5 volts, replace PCM and repeat QUICK TEST.

13) Leave TP-B wiring harness connector disconnected. Turn ignition on. Using scan tester, access TPB PID. If PID voltage is less than 0.1 volt, go to next step. If voltage is 0.1 volt or more, go to step 15).

14) Leave TP-B disconnected and ignition on. Measure voltage between SIG RTN and VREF terminals at connector. If voltage is 4-6 volts, replace TP-B sensor and repeat **QUICK TEST** . If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

15) Check TP-B Circuit For Short To VREF Leave TP-B disconnected and ignition on. Measure resistance between test pin No. 63 (TP-B) and 90 (VREF) at the breakout box. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** . If resistance is less than 10,000 ohms, repair TP-B circuit short to VREF and repeat QUICK TEST.

16) Wiggle Test Turn ignition on. Using scan tester, access TPB PID. Observe PID for signs of fault. A fault will be indicated by change in PID voltage. Lightly tap on sensor. Wiggle wiring harness between TP-B and PCM. If fault is indicated, isolate and repair as necessary. If no faults are indicated, go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 16) to step 20). No test procedures have been omitted.

20) DTC P1220: Inspect Series Throttle (ST) System This DTC indicates series throttle control malfunctioned during self-test. Possible causes are as follows:

- Stepper motor circuit fault.
- PWR GND circuit open to Series Throttle Controller (STC).
- SIG RTN circuit open to STC.
- VPWR circuit open to STC.
- TAPW circuit open or shorted.
- Faulty Series Throttle (ST).
- Faulty ST stepper motor.
- Faulty STC.
- Faulty PCM.

Turn ignition off. Remove air tube from ST. Inspect ST assembly for loose components or restrictions. Check throttle plate for binding. If throttle plate binds, go to next step. If throttle does not bind, go to step 22).

21) Inspect ST Motor Turn ignition off. Remove TA assembly (do not separate ST from main throttle body). Remove ST stepper motor. Cycle throttle plate through full range of travel. Throttle plate should travel freely and throttle gear should contact stop screws in both directions. If throttle plate binds, replace ST stepper motor and repeat **QUICK TEST** . If throttle does not bind, replace series throttle and repeat QUICK TEST.

22) Turn ignition on. Using scan tester, access TPB PID. If PID voltage is less than 4.5 volts, go to next step. If voltage is 4.5 volts or more, go to step 33).

23) Measure ST Stepper Motor Coil Resistance Turn ignition off. Disconnect ST stepper motor wiring harness connector. Check for 1-5 ohms resistance at the following ST stepper motor terminals:

- TA-B1 and BCOMM.
- TA-B2 and BCOMM.
- TA-A1 and ACOMM.
- TA-A2 and ACOMM.

If each coil measurement is 1-5 ohms, go to next step. If any measurement is not 1-5 ohms, replace ST stepper motor and repeat **QUICK TEST** .

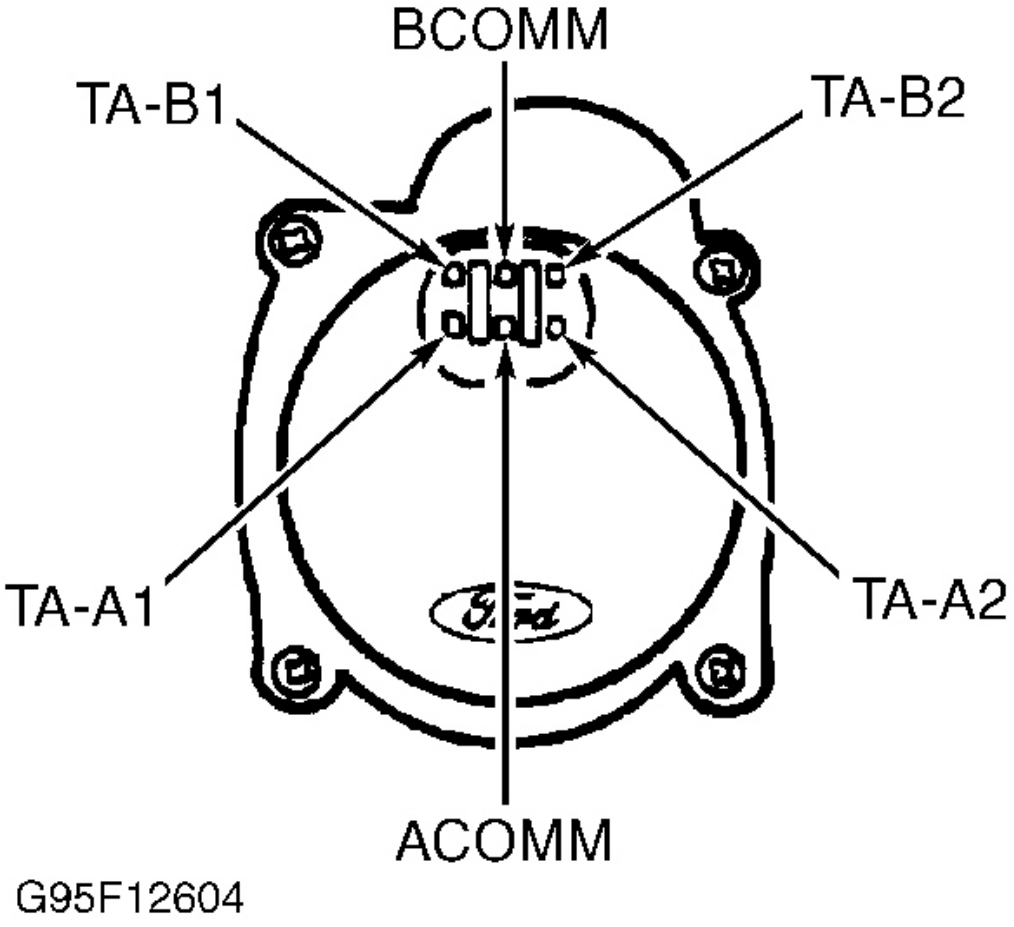


Fig. 59: Stepper Motor Terminals

24) Check ST Stepper Motor Coil For Short Circuit Leave ignition off and ST stepper motor disconnected. Measure resistance between ST stepper motor terminals ACOMM and BCOMM. Measure resistance between ST stepper motor terminals ACOMM/BCOMM and motor housing. If either resistance measurement is 10,000 ohms or less, replace ST stepper motor and repeat **QUICK TEST** . If all resistance measurements are 10,000 ohms or more and DTC P1220 is present, go to next step. If DTC P1220 is not present, check brake system mechanical components for malfunction and repair as necessary.

25) Check ST Stepper Motor Circuit Continuity Leave ignition off and ST stepper motor disconnected. Disconnect Series Throttle Controller (STC). Measure resistance of each circuit between

ST stepper motor connector and STC connector. If any resistance measurement is 5 ohms or more, repair open circuit and repeat **QUICK TEST** . If all resistance measurements are less than 5 ohms, go to next step.

26) Check ST Stepper Motor Circuit For Short Leave ignition off. Disconnect scan tester from DLC (if applicable). Measure resistance of each terminal of ST stepper motor connector and all other terminals of ST stepper motor connector. Measure resistance of each terminal of ST stepper motor connector and negative battery terminals. If all resistance measurements are 10,000 ohms or more, go to next step. If any resistance measurements is 10,000 ohms or less, repair short circuit and repeat **QUICK TEST** .

27) Check Circuit Voltage To STC Leave STC disconnected. Turn ignition on. Measure voltage between VPWR terminal of STC connector and chassis ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit and repeat **QUICK TEST** .

28) Turn ignition off. Leave STC disconnected. Measure resistance between SIG RTN terminal of STC connector and chassis ground. Measure resistance between PWR GND terminal of STC connector and chassis ground. If both resistance measurements are less than 5 ohms, go to next step. If either resistance measurements are 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

29) Leave ignition off and STC disconnected. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 45 (TAPW) and TAPW terminal of STC wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in TAPW circuit and repeat **QUICK TEST** .

30) Leave STC disconnected. Turn ignition on. Measure voltage between test pin No. 45 and negative battery terminal. If voltage is less than .05 volt, go to next step. If voltage is .05 volt or more, repair TAPW circuit short to power and repeat **QUICK TEST** .

31) Turn ignition off. Leave STC disconnected. Measure resistance between test pin No. 45 (TAPW) and test pins No. 51, 91 and 103 at the breakout box. If resistance is less than 10,000 ohms, repair short circuit and repeat **QUICK TEST** . If resistance is 10,000 ohms or more and DTC P1220 is present, go to next step. If resistance is 10,000 ohms or more and DTC P1220 is not present, fault is intermittent and cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

Diagnostic Aid

On every power-up, the series throttle is commanded to self-test from the PCM. To verify this signal, go to next step.

32) Leave ignition off and STC disconnected. Connect DVOM between test pin No. 45 (TAPW) and 91 (SIG RTN) at the breakout box. While observing DVOM, turn ignition on. If DVOM indicates a brief change of voltage (2.0 volt minimum) as ignition is turned on, replace STC and repeat **QUICK TEST** . If DVOM does not indicate a brief change of voltage, replace PCM and repeat QUICK TEST.

33) Turn ignition off. Disconnect TP-B sensor wiring harness connector. Measure voltage between connector terminals SIG RTN and VREF. If voltage is 4-6 volts, replace TP-B and repeat **QUICK TEST** . If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 33) to step 40). No test procedures have been omitted.

40) DTC P1224: Check ST Assembly This DTC should be disregarded if any other DTCs are present. DTC P1224 indicates TP-B voltage was out of range during self-test. Possible causes are as follows:

- TP-B sensor binding or sticking.
- Throttle stop screw misadjusted.
- Faulty TP-B.
- Faulty ST.

Disconnect air tube from ST assembly. Check throttle linkage for binding or sticking. Repair if necessary. If throttle linkage is okay, go to next step.

41) Turn ignition off. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access TPB PID. While observing PID voltage, push throttle plate shut and then release. Throttle plate should not bind or stick. If TPB-PID is 0.3-0.9 volt at wide open throttle, go to next step. If TPB-PID is not 0.3-0.9 volt at wide open throttle, check ST stepper motor and TP-B for damage. If no damage is present, replace TP-B and repeat **QUICK TEST** .

42) Measure VREF At TP-B Sensor Turn ignition off. Disconnect TP-B wiring harness connector. Inspect connector for damage and repair if necessary. Turn ignition on. Measure voltage between SIG RTN and VREF terminal of TP-B wiring harness connector. If voltage is 4-6 volts, replace TP-B and repeat QUICK TEST. If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

CIRCUIT TEST HU - AIR INTAKE SYSTEM

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Accelerator linkage.
- Air cleaner assembly.
- Air inlet tube.
- Clean air tube and resonator.
- Throttle body assembly.
- IMRC actuator assembly.
- Intake Manifold Runner Control (IMRC) assembly.
- Wiring harness circuits (IMRC, IMRC MONITOR, SIG RTN, PWR GND and VPWR).
- Powertrain Control Module (PCM).

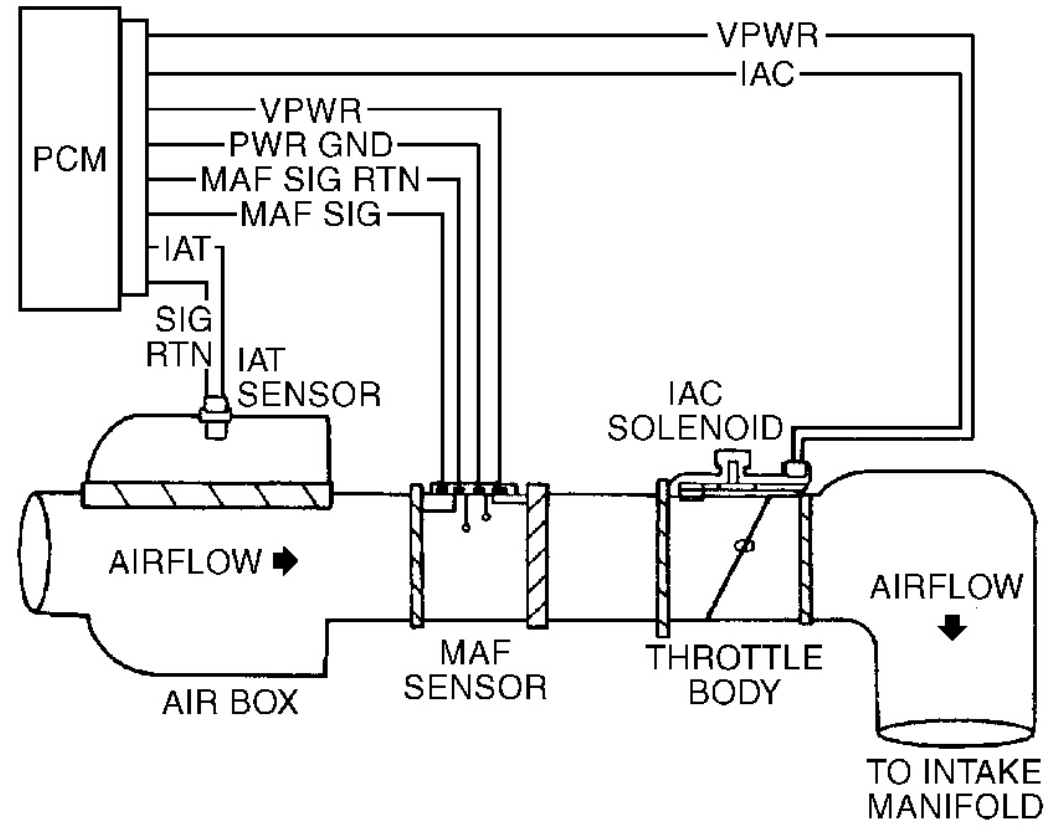


Fig. 60: Air Intake Circuit & Components Schematic

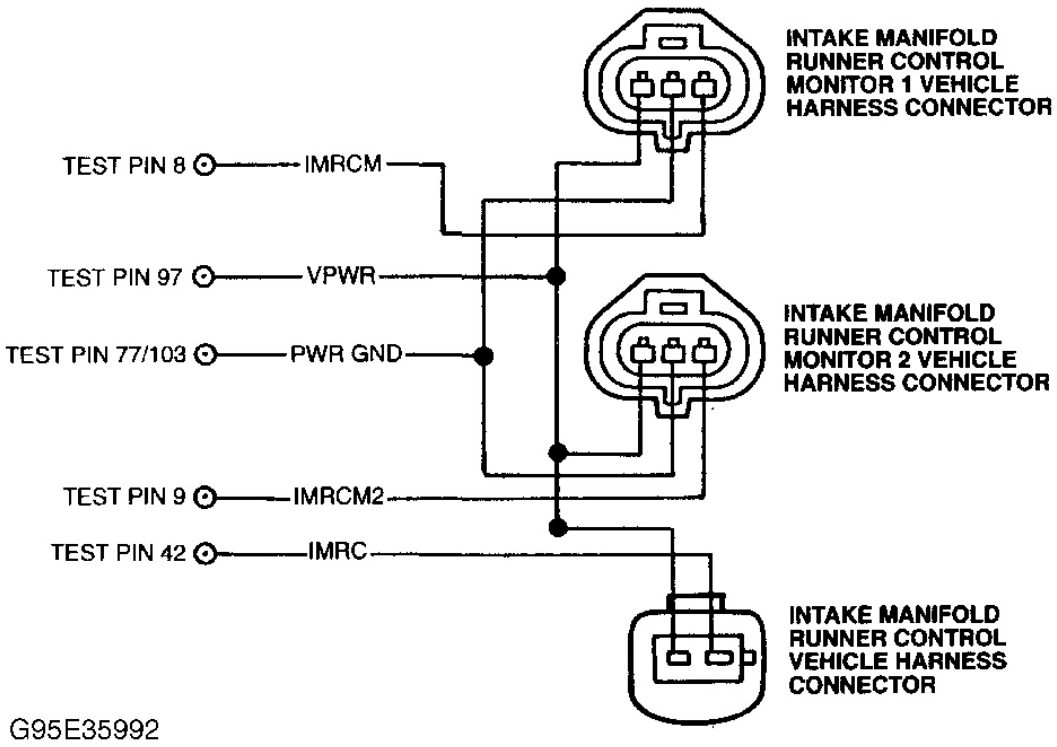


Fig. 61: IMRC Connector Terminals

1) Confirm Drive Symptom Test drive vehicle. Check for any of the following symptoms:

- Accelerator pedal sticking or binding.
- Hard start/long cranking.
- Hesitation or stalls at idle.
- Rough idle.
- Lack of power.

If symptom is present, go to next step. If symptom is not present, fault cannot be duplicated or identified at this time and testing is complete.

2) Check Accelerator Linkage If linkage sticks, binds or grabs, go to next step. If linkage operation is okay, go to step 7).

3) Turn ignition off. Disconnect accelerator linkage from throttle body. Inspect cable for freedom of travel from accelerator pedal to throttle body linkage cable connector. If cable moves freely, go to next step. If cable does not move freely, repair or replace as necessary.

4) Check Throttle Return Screw Leave ignition off and accelerator linkage disconnected from throttle body. Remove clean air tube from throttle body. Inspect clean air tube for dirt or contamination and repair as necessary. Check throttle return screw. If throttle return screw is in contact with throttle linkage lever

arm when throttle is fully closed, go to step 6). If throttle screw is not as specified, place a .002" (.05 mm) feeler gauge between throttle return screw and lever arm. Turn screw until it contacts feeler gauge. Remove feeler gauge. Turn throttle adjust screw 1/2 turn clockwise and go to next step.

5) Check TP Sensor Range Turn ignition off. Connect scan tester to DLC. Turn ignition on. Using scan tester, access TP PID. While observing TP PID, slowly move throttle from closed to open position. TP PID reading changes should be smooth while rotating throttle. At closed position, TP PID reading should be 0.53-1.27 volts (11-25%). If TP PID is as specified, remove scan tester and go to next step. If TP PID is not as specified, replace throttle body assembly.

6) Check Throttle Body Turn ignition off. Disconnect cable from throttle body. Remove clean air tube. Snap throttle from wide open to closed position several times. Slowly cycle throttle from closed to wide open position. Check for freedom of travel especially during initial throttle opening. If throttle moves freely, fault cannot be duplicated or identified at this time and testing is complete. If throttle does not rotate freely, replace throttle body assembly.

7) Check Air Filter Check air filter and element. Clean or replace as necessary. If air filter and element are okay, go to next step.

8) Check Engine Operation Ensure that the following engine systems are in good operating condition before continuing:

- Engine cooling system.
- Exhaust system.
- Fuel pressure.
- PCV system.

If systems are operating correctly, go to next step. If systems are not operating correctly, go to CIRCUIT TEST as indicated:

- Exhaust system; **CIRCUIT TEST HF** .
- Fuel pressure; **CIRCUIT TEST HC** .
- PCV system; **CIRCUIT TEST HG** .
- Engine cooling system; repair as necessary.

9) Check For Vacuum Leaks Start engine and allow to idle. Inspect inlet air system from MAF sensor to intake manifold for cracks, loose connections or faulty gaskets. Inspect intake manifold, EGR diaphragm and vacuum hoses for leaks. Repair or replace as necessary. If no faults are found, go to next step.

10) Check Idle Speed Turn all accessories off. Start engine and warm to normal operating temperature. Connect scan tester to DLC. Using scan tester, access IAC PID, idle air percent duty cycle. IAC PID reading should be approximately 20-45 percent at idle speed. If IAC PID values are as specified, go to next step. If IAC PID values are not as specified, go to step 12).

11) Check Idle Control Pressure Leave accessories off. With engine operating at idle, goose throttle and return to idle position. If engine stalls or engine speed fluctuates excessively before returning to idle, go to next step. If engine does not stall or fluctuate, air intake system is okay and testing is complete.

12) Check IAC Solenoid Function Leave accessories off. With engine operating at idle, disconnect IAC solenoid wiring harness connector. If engine speed does not change, replace IAC solenoid and clear Keep Alive Memory (KAM). If engine speed changes, proceed as follows:

- For vehicles without fast idle symptom, go to next step.

- For vehicles with fast idle symptom, go to step 14).

13) Check Throttle Body Turn ignition off. Remove throttle body. With throttle fully closed, ensure light cannot be seen between throttle bore and plate. Snap throttle from wide open to closed position several times. Slowly cycle throttle from closed to wide open position. Check for freedom of travel especially during initial throttle opening. If throttle body is okay, fault cannot be duplicated or identified at this time and testing is complete. If faults are present, replace throttle body and clear Keep Alive Memory (KAM).

14) Check IAC Circuit For Short To Ground Leave accessories off and IAC solenoid disconnected. Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 83 (IAC) and test pins No. 51 and 103 (PWR GND) at the breakout box. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** . If resistance is less than 10,000 ohms, repair short circuit and repeat QUICK TEST.

15) DTC P1512, P1513, P1516, P1517, P1518, P1519, P1520, P1537 & P1538 DTCs P1516 and P1517 indicate control circuit failure. DTCs P1518, P1537 and P1538 indicate IMRC stuck open. DTCs P1512, P1513 and P1519 indicate IMRC stuck closed. DTC P1520 indicates control circuit failure. Possible causes are as follows:

- Cables improperly routed, binding or seized.
- Damaged or disconnected IMRC housing return springs.
- Lever return stop obstructed or bent.
- Lever wide open stop obstructed or bent.
- IMRC actuator cable or gears seized.

Visually inspect IMRC cables for correct routing. Ensure cable core wire has slack at IMRC housing and stop screw contacts plate. If adjustment is required, see INTAKE MANIFOLD RUNNER CONTROL (IMRC) in **ADJUSTMENTS - 4.2L** article. Operate IMRC plates while checking for binding or sticking. If any faults are found, repair as necessary. If no faults are found, go to next step.

16) Check IMRC Function If IMRC is vacuum controlled, start engine and allow to idle for 20 seconds. Turn ignition off. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access Output Test Mode (OTM). Turn all outputs on. When IMRC is turned on, both levers should contact wide open stop. One or both levers should contact wide open stop (one lever being slightly off is acceptable). IRMC levers should cycle fully from closed to open position. If faults are present, go to next step. If no faults are present proceed as follows:

- With DTC P1512 and/or P1513, go to step 41).
- With DTC P1516 and/or P1517, go to step 64).
- With DTC P1518, go to step 26).
- With DTC P1519, go to step 29).
- With DTC P1537 and/or P1538, go to step 52).

17) Check IMRC Operation Start engine and allow to idle. Apply parking brake. Raise engine speed to more than 3500 RPM. When engine speed exceeds 3500 RPM, one or both levers should contact wide open stop (one lever being slightly off is acceptable). When engine speed drops to less than 3000 RPM, one or both levers should contact closed plate stop screw. If levers do not cycle, go to next step. If levers

cycle as specified, proceed as follows:

- With DTC P1512 and/or P1513, go to step 41).
- With DTC P1516 and/or P1517, go to step 64).
- With DTC P1518, go to step 26).
- With DTC P1519, go to step 29).
- With DTC P1537 and/or P1538, go to step 52).

18) Turn ignition off. Disconnect cables from IMRC assembly. Operate both levers while checking for binding or sticking. If any faults are found, repair as necessary. If no faults are found, proceed as follows:

- With DTC P1512 and/or P1513, go to step 41).
- With DTC P1516 and/or P1517, go to step 64).
- With DTC P1518, go to step 26).
- With DTC P1519, go to step 29).
- With DTC P1537 and/or P1538, go to step 52).

19) Verify IMRC Circuit Fault Possible causes are as follows:

- IMRC control circuit open or shorted to PWR GND or SIG RTN.
- VREF circuit open or shorted to IMRC control circuit.
- Faulty IMRC module.
- Faulty Powertrain Control Module (PCM).

Turn ignition off. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access IMRCF PID. If IMRCF PID display is on, go to next step. If IMRCF PID display is not on, go to step 36).

20) Check IMRC Voltage Turn ignition off. Disconnect IMRC module wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal at IMRC wiring harness connector and negative battery terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit. Clear PCM memory and repeat **QUICK TEST** .

21) Measure voltage between PWR GND terminal and VPWR terminal at IMRC wiring harness connector. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in PWR GND circuit. Clear PCM memory and repeat **QUICK TEST** .

22) Check IMRC Circuit Driver For Short To Ground Turn ignition off. Measure resistance between IMRC terminal at wiring harness connector and negative battery terminal. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, go to step 39).

23) Check IMRC Circuit Driver For Short To Ground Leave ignition off and IMRC module disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure voltage between test pin No. 42 and test pins No. 51 and 103 (PWR GND) at breakout box. If voltage is less than one volt, go to next step. If either voltage is more than one volt, repair short circuit and repeat **QUICK TEST** .

24) Check IMRC Circuit Driver For Open Circuit Leave ignition off and IMRC module disconnected. Measure resistance between IMRC test at breakout box and IMRC terminal at wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

25) Verify PCM IMRC Driver Reconnect IMRC module. Turn ignition on. Connect jumper wire between test pin No. 42 and test pin No. 51 or 103 at breakout box. If IMRC plates open, replace PCM and repeat **QUICK TEST** . If IMRC plates do not open, replace IMRC module and repeat QUICK TEST.

26) DTC P1518: Check IMRC MONITOR Circuit DTC P1518 indicates low circuit voltage. Possible causes are as follows:

- IMRC control circuit shorted.
- Faulty IMRC module.
- Faulty Powertrain Control Module (PCM).

Ensure IMRC plates are closed. If IMRC plates are open, go to step 20). Turn ignition off. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access IMRCM PID. If PID voltage is 1.6 volts or more, go to step 34). If PID voltage is less than 1.6 volts, go to next step.

27) Turn ignition off. Disconnect IMRC module wiring harness connector. Turn ignition on. Using scan tester, access IMRCM PID. If PID voltage is 1.6 volts or more of what PID was with IMRC module disconnected, replace IMRC module. If PID voltage is less than 1.6 volts of what PID was with IMRC module disconnected, go to next step.

28) Turn ignition off. Leave IMRC module disconnected. Measure resistance between IMRC terminal at wiring harness connector and negative battery terminal. Measure resistance between IMRC terminal and SIG RTN terminal at wiring harness connector. If resistance is 10,000 ohms or more, replace PCM. If resistance is less than 10,000 ohms, repair short in IMRCM circuit and repeat **QUICK TEST** .

29) DTC P1519 DTC P1519 indicates IMRC input is greater than expected. Possible causes are as follows:

- IMRC circuit open.
- IMRC circuit shorted to ground or VREF.
- SIG RTN circuit open.
- Faulty IMRC module.
- Faulty Powertrain Control Module (PCM).

Turn ignition off. Disconnect IMRC wiring harness connector. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Connect jumper wire between IMRC wiring harness connector terminal IMRCM and terminal PWR GND or SIG RTN. Using scan tester, access IMRCM PID (if scan tester communication exists, remove jumper wire and go to step 38). If IMRCM PID voltage is 0.2 volt or less, go to step 40). If IMRCM PID voltage is more than 0.2 volt, remove jumper wire and go to next step.

30) Turn ignition off. Leave IMRC module disconnected. Disconnect scan tester from DLC. Measure resistance between SIG RTN terminal at IMRC wiring harness connector and negative battery terminal. If resistance is 5 ohms or less, go to next step. If resistance is more than 5 ohms, repair open in SIG RTN circuit and go to step 33).

31) Check IMRCM Circuit Continuity Leave ignition off and IMRC module disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 8 (IMRCM) and

IMRCM terminal at wiring harness connector. If resistance is less than 5 ohms, replace PCM and go to step 33). If resistance is 5 ohms or more, repair open in IMRCM circuit and go to step 33).

32) Check Circuit Operation Turn ignition off. Reconnect all components. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access Output Test Mode (OTM). While in OTM, access IMRCM PID and IMRC PID voltage. Connect DVOM between test pin No. 8 and test pins No. 51 and 103. If PID voltage and DVOM voltage are less than 1.6 volts, go to step 34). If either voltage is more than 1.6 volts, replace IMRC module and go to next step.

33) IMRC Drive Cycle Clear PCM memory. Using scan tester, access IMRC PID, IMRCM PID and RPM PID. Test drive vehicle with transmission in Overdrive. Complete 3 cycles from complete stop to speed requiring engine speed in excess of 3500 RPM. Stop vehicle. Repeat **QUICK TEST** and retrieve all DTCs. If any DTCs are present, go to appropriate CIRCUIT TEST. If any other DTCs are present, service as necessary. If no DTCs are present, testing is complete.

34) Wiggle Test Turn ignition off. Disconnect IMRC module. Connect jumper wire between IMRC wiring harness connector terminals IMRCM and SIG RTN. Turn ignition on. Using scan tester, access IMRCM PID. Observe PID for signs of fault. A fault will be indicated by change in PID voltage from less than 0.2 volt to more than 1.6 volts. Wiggle wiring harness between IMRC connector and PCM connector. If fault is indicated, isolate and repair as necessary. If no faults are indicated, remove jumper wire and go to next step.

35) Leave IMRC module disconnected. Turn ignition on. Using scan tester, access IMRCM PID. Observe PID for signs of fault. A fault will be indicated by change in PID voltage to less than 1.6 volt. Wiggle wiring harness between IMRC connector and PCM connector. If fault is indicated, isolate and repair as necessary. If no faults are indicated, go to **CIRCUIT TEST Z** .

36) Continuous Memory DTC P1520: Intermittent Circuit Malfunction Turn ignition off. Reconnect all components. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access Output Test Mode (OTM). While in OTM, access IMRCM PID and IMRC PID. Connect DVOM between test pin No. 42 and test pins No. 51 and 103. Command outputs on. Observe PID for signs of fault. A fault will be indicated by sudden change in PID voltage. Wiggle wiring harness between IMRC connector and PCM connector. If fault is indicated, isolate and repair as necessary. If no faults are indicated, go to next step.

37) Turn ignition on. While observing IMRC plates, wiggle wiring harness between IMRC module and PCM connector. If IMRC plates move while wiggling harness, fault is indicated. Isolate and repair if necessary. If no faults are indicated, go to **CIRCUIT TEST Z** .

38) Leave ignition off and IMRC disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 8 (IMRCM) and 90 (VREF) at breakout box. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** . If resistance is less than 10,000 ohms, repair short between IMRCM and VREF circuit.

39) Leave ignition off and IMRC disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 42 and test pins No. 51 and 103 (PWR GND) at breakout box. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** . If resistance is less than 10,000 ohms, repair short to PWR GND in IMRC control circuit.

40) Check IMRC Circuit Turn ignition off. Reconnect all components. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access Output Test Mode (OTM). While in OTM, turn all outputs on. Observe IMRC levers. If levers cycle open during output command, go to step 32). If

levers do not cycle open during output command, go to step 20).

41) Check IMRC Actuator DTC P1512, P1513, P1516 and P1517 indicates IMRC plates are stuck open. Possible causes are as follows:

- Broken or restricted vacuum hoses.
- IMRC circuit open.
- IMRC circuit shorted to ground or VREF.
- SIG RTN circuit open.
- Faulty IMRC module.
- Faulty Powertrain Control Module (PCM).

For vacuum operated systems, start engine and allow to idle for 20 seconds. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access IMRCM PID and IMRC2M PID (if applicable). Manually rotate IMRC levers. If PID voltage is 1.0 volts or more as levers are rotated, go to step 47). If PID voltage is not as specified, go to next step.

42) Check IMRC Monitor Signal For vacuum operated systems, start engine and allow to idle for 20 seconds. With scan tester connected to DLC, turn ignition on. Using scan tester, access IMRCM PID and IMRC2M PID. Disconnect both IMRC actuator wiring harness connectors. Using jumper wire, connect IMRCM and IMRC2M connector terminals to ground. If PID voltage change is less than 1.0 volt, go to next step. If PID voltage change is 1.0 volt or more, go to step 44).

43) Check IMRC Monitor Resistance Turn ignition off. Leave both IMRC actuator wiring harness connectors disconnected. Measure resistance between IMRC terminal and PWR GND terminal at actuator. Measure resistance between IMRC terminal and VPWR terminal at actuator. If resistance is not 100-10,000 ohms, replace IMRC actuator and go to step 33). If resistance is 100-10,000 ohms, fault cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

44) Check IMRC Monitor Power Ground Leave ignition off and both IMRC actuator wiring harness connectors disconnected. Measure resistance between PWR GND terminal at actuator and chassis ground. If resistance is less than 100 ohms, go to next step. If resistance is 100 ohms or more, repair open circuit go to step 33).

45) Check IMRC Monitor Signal Short To Power Leave ignition off and both IMRC actuator wiring harness connectors disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Connect negative lead of DVOM to test pin No. 77 or 103 (PWR GND) at breakout box. Check voltage at test pin No. 8. and 9. If voltage is less than 1.0 volt, go to next step. If voltage is 1.0 volt or more, repair circuit short to VPWR and go to step 33).

46) Check IMRC Monitor Signal Return Turn ignition off. Leave both IMRC actuator wiring harness connectors disconnected. Measure resistance between IMRCM terminal at actuator and test pin No. 8 and 9. If resistance is less than 5 ohms, replace PCM and go to step 33). If resistance is 5 ohms or more, repair open in IMRCM circuit and go to step 33).

47) Check IMRC Output Test Mode Connect scan tester to DLC. Turn ignition on. Using scan tester, access IMRCM PID and IMRC2M PID. Observe PID values. Start engine and allow to idle. Access IMRCM PID and IMRC2M PID. If PID values change, fault is intermittent and cannot be duplicated at this time. Go to **CIRCUIT TEST Z** . If PID values do not change, go to next step.

48) Check Bank One IMRC Vacuum Signal Turn ignition off. Disconnect left IMRC actuator vacuum

hose. Ensure hose is not damaged or restricted. Connect vacuum hose to vacuum gauge. Start engine and allow to idle. If vacuum reading is less than 10 in. Hg, go to next step. If vacuum reading is 10 in. Hg or more, replace IMRC actuator and go to step 33).

49) Check Bank 2 IMRC Vacuum Signal Turn ignition off. Disconnect right IMRC actuator vacuum hose. Ensure hose is not damaged or restricted. Connect vacuum hose to vacuum gauge. Start engine and allow to idle. If vacuum reading is less than 10 in. Hg, go to next step. If vacuum reading is 10 in. Hg or more, replace IMRC actuator and go to step 33).

50) Check IMRC Circuit To PCM Turn ignition off. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 42 and test pins No. 77 and 103 at breakout box. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, repair IMRCM circuit short to PWR GND and go to step 33).

51) Check IMRC Circuit For Short Turn ignition off. Connect PCM to breakout box. With vacuum gauge connected to IMRC actuator vacuum hose, start engine and allow to idle. Connect jumper wire between test pin No. 42 and test pin No. 77 or 103 (PWR GND) at breakout box. If vacuum reading is less than 10 in. Hg, replace PCM and go to step 33). If vacuum reading is 10 in. Hg or more, replace IMRC actuator and go to step 33).

52) Check IMRC Actuator DTC P1516, P1517, P1537 and P1538 indicates IMRC plates are stuck open. Possible causes are as follows:

- Broken or restricted vacuum hoses.
- IMRC circuit open.
- IMRC circuit shorted to ground or VREF.
- SIG RTN circuit open.
- Faulty IMRC module.
- Faulty Powertrain Control Module (PCM).

For vacuum operated systems, start engine and allow to idle for 20 seconds. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access IMRCM and IMRC2M PID. If PID voltage is less than 1.0 volt, go to next step. If PID voltage is 1.0 volts or more, fault is intermittent. Go to step 54).

53) Check IMRC PID Reading For vacuum operated systems, start engine and allow to idle for 20 seconds. With ignition on, use scan tester to access IMRCM PID and IMRC2M PID. Proceed as follows:

- Disconnect left IMRC actuator connector and note PID voltage.
- Disconnect right IMRC actuator connector and note PID voltage.
- Reconnect right IMRC actuator connector and note PID voltage.
- Reconnect left IMRC actuator connector and note PID voltage.

If PID values increase is 1.0 volt or more, isolate and replace defective IMRC actuator. Go to step 33). If PID values do not increase more than 1.0 volt, go to step 55).

54) Wiggle Test For vacuum operated systems, start engine and allow to idle for 20 seconds. After about 30 seconds, vacuum will bleed off and PID values will change. Restart engine if necessary. With ignition

on, use scan tester to access IMRCM PID and IMRC2M PID. Turn ignition ON. Wiggle IMRC wiring harness between actuator and PCM. Observe PID for signs of fault. A fault will be indicated by a sudden drop in PID voltage. Wiggle wiring harness between IMRC connector and PCM connector. If fault is indicated, isolate and repair as necessary. Go to step 33). If no faults are indicated, fault cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

55) Check IMRC Vacuum Supply Turn ignition off. Disconnect IMRC actuator vacuum hose. Ensure hose is not damaged or restricted. Connect vacuum hose to vacuum gauge. Start engine and allow to idle. If vacuum reading is 10 in. Hg or more, go to next step. If vacuum reading is less than 10 in. Hg, repair vacuum circuit and go to step 33).

56) Turn ignition off. Disconnect left IMRC actuator vacuum hose. Ensure hose is not damaged or restricted. Connect vacuum hose to vacuum gauge. Start engine. Raise engine speed to 3500 RPM. If vacuum reading is less than 10 in. Hg, go to next step. If vacuum reading is 10 in. Hg or more, go to step 60).

57) Check VPWR Circuit Turn ignition off. Disconnect IMRC actuator wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal of connector and chassis ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open circuit and go to step 33).

58) Check IMRC Circuit For Open Turn ignition off. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 42 at breakout box and IMRC terminal at actuator wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in IMRC circuit and go to step 33).

59) Check IMRC Circuit To PCM Turn ignition on. Measure voltage between test pin No. 42 and test pins No. 77 and 103 at breakout box. If voltage is 10.5 volts or more, repair IMRC circuit short to VREF or VPWR. If voltage is less than 10.5 volts, replace IMRC vacuum actuator. Go to step 33).

60) Check VPWR Circuit Turn ignition off. Disconnect both IMRC sensor wiring harness connectors. Turn ignition on. Measure voltage between VPWR terminal of each connector and chassis ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit and go to step 33).

61) IMRCM Circuit Check For Short To Ground Turn ignition off. Leave both IMRC sensor wiring harness connectors disconnected. Disconnect scan tester from DLC. Measure resistance between IMRCM terminal at both connectors and chassis ground. If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, go to step 63).

62) IMRC Sensor Check Leave ignition off and both IMRC sensor wiring harness connectors disconnected. Measure resistance between IMRC terminal and PWR GND terminal at both sensors. If resistance is 1000-10,200 ohms, reconnect all components and go to step 33). If resistance is not 1000-10,200 ohms, replace IMRC sensor and go to step 33).

63) Check PCM For Internal Short Leave ignition off and both IMRC sensor wiring harness connectors disconnected. Measure resistance between test pin No. 8 and test pins No. 77 and 103 at breakout box.

64) Determine IMRC Fault Path DTC P1516 or P1517 indicate IMRC plates are open or closed time exceeded PCM program. For vacuum operated systems, start engine and allow to idle for 20 seconds. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access IMRCM PID. Access IMRC2M PID. If PID voltage is less than 3.0 volts, go to step 29) for electronic controlled systems or step 41) for vacuum controlled systems. If PID voltage is 3.0 volts or more, go to step 26) for electronic controlled systems or step 55) for vacuum controlled systems.

65) Check IMT Valve & Vacuum Actuator Connection Turn ignition off. Disconnect IMT valve and vacuum actuator wiring harness connector. Inspect for damaged or loose pins and repair if necessary. If no faults are found, go to next step.

66) Check IMT Valve & Vacuum Actuator VPWR Circuit For Open Turn ignition off. Measure resistance between chassis ground and VPWR terminal at IMT valve wiring harness connector. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VREF circuit.

67) Check IMT Valve & Vacuum Actuator Circuit For Open Turn ignition off. Leave IMT valve wiring harness connector disconnected. Disconnect PCM 104-pin connector. Inspect for damaged pins and repair if necessary. Connect EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 46 at breakout box and IMT VALVE terminal at harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in IMT VALVE circuit.

68) Check IMT Valve & Vacuum Actuator Circuit For Short To PWR GND Leave ignition off. Disconnect scan tester from DLC (if applicable). Leave PCM and IMT valve wiring harness connector disconnected. Measure resistance between test pin No. 46 and test pins No. 77 and 103 at breakout box. If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair IMT VALVE circuit short to PWR GND circuit.

69) Check IMT VALVE Circuit Short To VREF Or VPWR Leave PCM and IMT valve wiring harness connector disconnected. Turn ignition on. Measure voltage between test pin No. 46 and test pins No. 77 and 103 at breakout box. If voltage is 10.5 volts or more, repair IMT VALVE circuit short to VREF or VPWR. If voltage is less than 10.5 volts, go to next step.

70) Check IMT Valve Actuator Internal Resistance Turn ignition off. Reconnect IMT valve wiring harness connector. Leave breakout box installed and PCM disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between test pins No. 46 and 97 (VPWR) at breakout box. If resistance is 65-85 ohms (SOHC engine) or 5-300 ohms (all except SOHC engine), replace PCM. If resistance is not as specified, replace IMT VALVE.

71) Perform IMRC Wiggle Test Turn ignition off. Connect scan tester to DLC. Turn ignition on. Using scan tester, access IMRCM PID. Observe PID values while wiggling wiring harness between IMRC monitor connector and PCM. If PID value fluctuates, isolate fault and repair as necessary. If PID value does not fluctuate, replace PCM and go to step 38).

CIRCUIT TEST HW - EVAPORATIVE EMISSION PURGE FLOW SYSTEM

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Leaks in fuel tank, filler cap or vapor hoses.
- Wiring harness circuits (CANP SIG, PF, PWR GND, VMV and VPWR).
- Faulty Canister Purge (CANP) solenoid.
- Faulty Purge Flow (PF) Sensor.
- Faulty Vapor Management Valve (VMV).
- Faulty carbon canister.

- Faulty PCM.

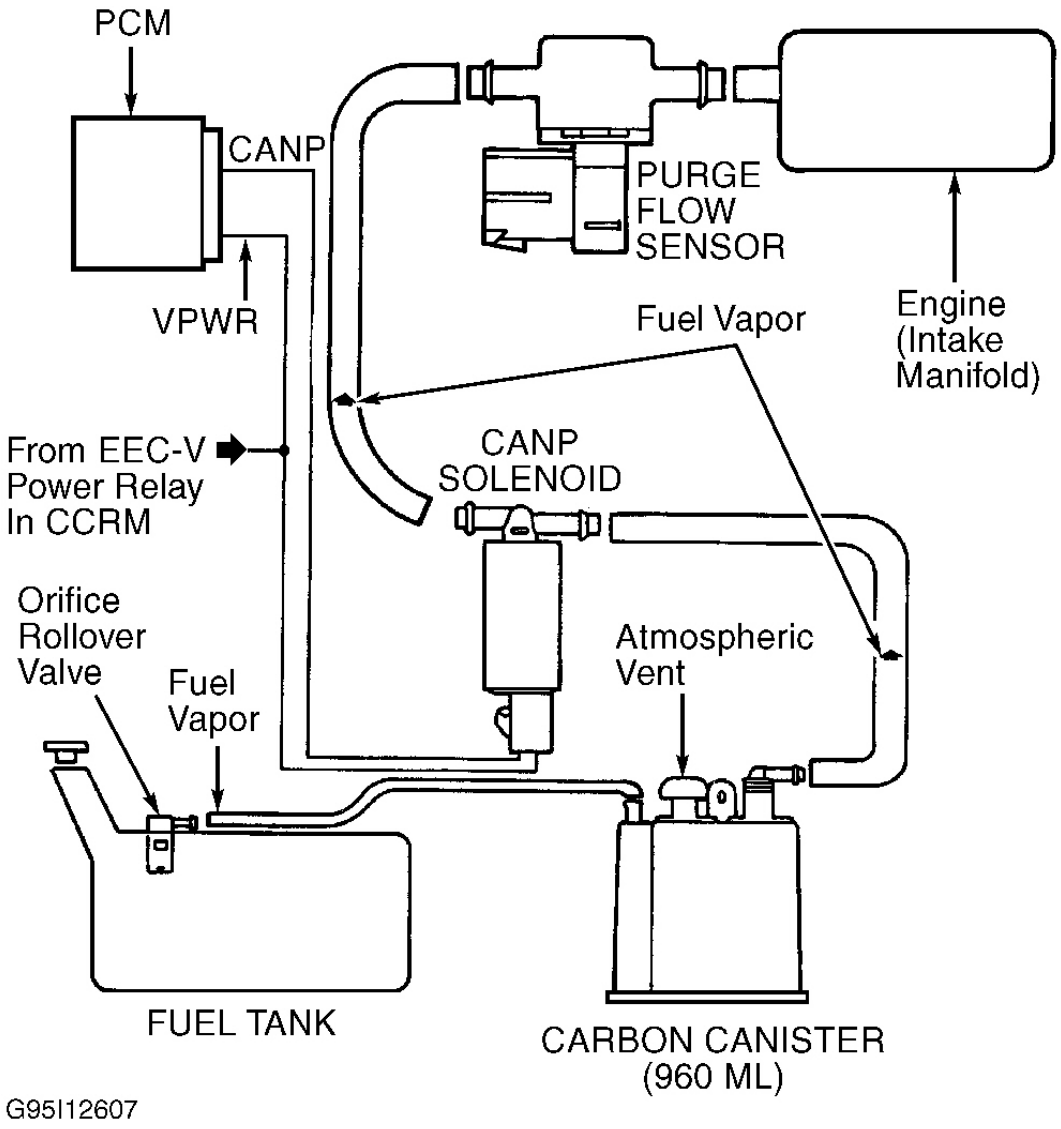


Fig. 62: EVAP Components Using Purge Flow System

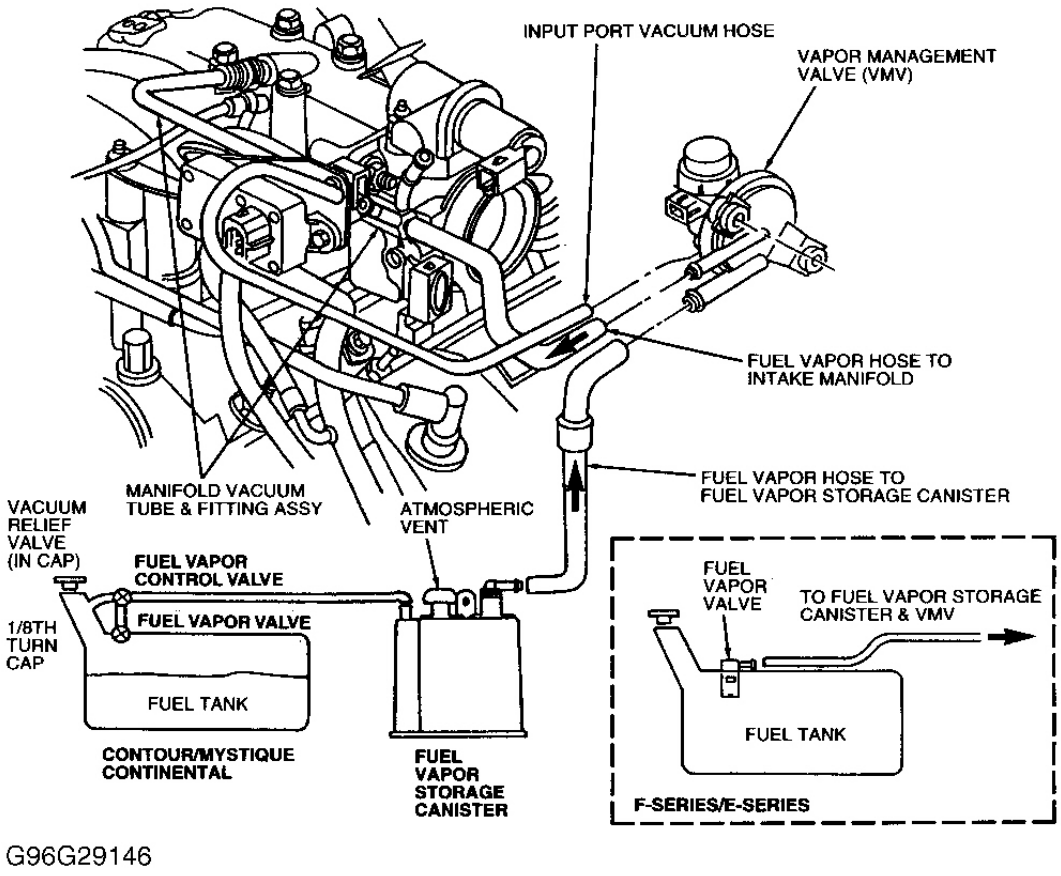


Fig. 63: EVAP Components Using Vapor Management System

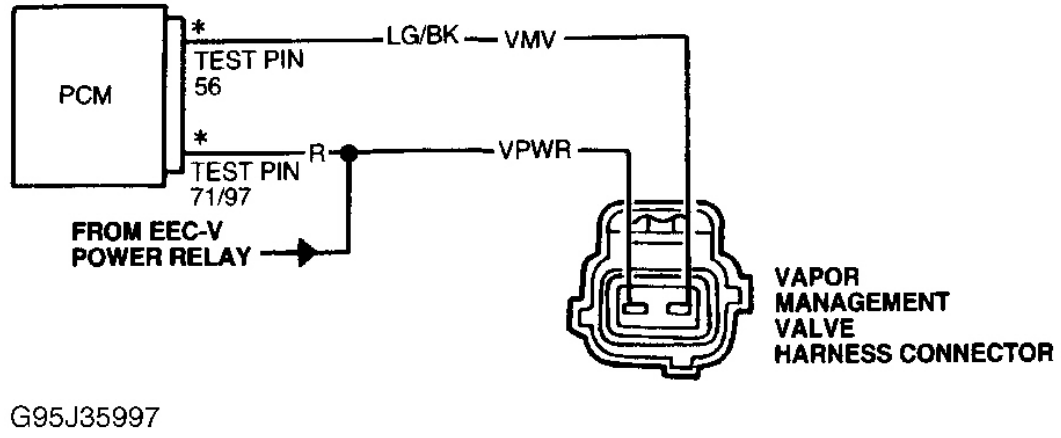


Fig. 64: VMV Test Circuit & Connector Terminals

1) DTC P0443: Check VPWR Circuit Voltage Disconnect Canister Purge (CANP) solenoid or Vapor Management Valve (VMV) wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal of CANP solenoid or VMV wiring harness connector and battery ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit and repeat **QUICK TEST** .

2) Check Component Resistance Turn ignition off. Leave CANP or VMV wiring harness connector disconnected. Measure resistance between CANP solenoid or VMV terminals. For CANP solenoid, if resistance is 30-90 ohms, go to next step. For VMV, if resistance is 30-36 ohms, go to step 4). If resistance is not as specified, replace CANP solenoid or VMV. Clear PCM memory and repeat **QUICK TEST** .

3) Check CANP Solenoid For Internal Short Turn ignition off. Leave wiring harness connector disconnected. Measure resistance between each solenoid terminal and CANP solenoid housing. If each resistance measurement is more than 90 ohms, CANP solenoid is okay. Go to next step. If resistance is not as specified, replace CANP solenoid. Clear PCM memory and repeat **QUICK TEST** .

4) Check VMV Circuit Continuity Leave ignition off and CANP or VMV wiring harness connector disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance as follows:

- For CANP solenoid, between test pin No. 67 at breakout box and EVAP CANP terminal of CANP solenoid wiring harness connector.
- For VMV, between test pin No. 56 at breakout box and VMV terminal of VMV wiring harness connector.

If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

5) Check Circuit For Short To PWR GND Leave ignition off. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 67 (CANP solenoid) or 56 (VMV) and test pins No. 24 and 103. If each resistance is more than 10,000 ohms, go to step 17). If resistance is 10,000 ohms or less, repair EVAP CANP/VMV circuit short to PWR GND circuit. Clear PCM memory and repeat **QUICK TEST** .

6) Continuous Memory DTC P1443 This DTC can set by Idle Air Control (IAC) valve speed error during vehicle operation. If Continuous Memory DTC P1507 is also present, go to **CIRCUIT TEST KE** , step 30). Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access IAC PID, TP PID and RPM PID. Turn all accessories off. Start engine and allow to idle. IAC duty cycle should be 20-45%. Observe IAC PID and RPM PID for indication of fault while shaking and bending IAC valve wiring harness and connector. A fault will be indicated by sudden increase of engine speed and decrease in IAC duty cycle. If fault is indicated, isolate and repair as necessary. If no fault is go to step 8).

7) Check Purge Flow (PF) Sensor Connect scan tester to Data Link Connector (DLC). Start engine and allow to idle. Disconnect PF sensor wiring harness connector. Inspect connector for damage and repair if necessary. Using scan tester, access PF PID. If voltage fluctuates, go to step 9). If voltage does not fluctuate as specified, go to next step.

8) Continuous Memory DTC P1443; Visually Inspect EVAP System Leave ignition off. Ensure fuel fill cap is installed correctly. Check vacuum hose between fuel tank and carbon canister for faults. Check for carbon canister cracks or damage. Check for fuel tank damage. Check for damaged orifice rollover valve. Repair or replace as necessary. If no faults are found on models equipped with CANP solenoid, go to next step. If no faults are found on models equipped with VMV, go to step 21).

9) Check CANP Solenoid For Vacuum Leak Leave ignition off. Disconnect CANP solenoid wiring harness connector. Disconnect hoses from CANP solenoid. Connect vacuum pump to intake manifold side of CANP solenoid. Using vacuum pump, apply 16 in. Hg to solenoid. If vacuum is held for 20 seconds, leave pump connected and go to next step. If vacuum is not held for 20 seconds, replace CANP solenoid and repeat **QUICK TEST** .

10) Leave ignition off and CANP solenoid wiring harness connector disconnected. Connect scan tester to DLC. Turn ignition on. Using scan tester, access Output Test Mode and command CANP solenoid on. Using vacuum pump, apply 16 in. Hg to solenoid. When CANP solenoid is commanded on, vacuum should be released. If solenoid does not operates as specified, replace CANP solenoid and repeat **QUICK TEST** .

If solenoid operates as specified, check fuel vapor hoses between carbon canister and CANP solenoid for damage or restriction. Repair as necessary.

11) Check For Vacuum At Purge Flow (PF) Sensor Turn ignition off. Ensure PF sensor is connected. Reconnect CANP solenoid. Remove hose from manifold vacuum at PF sensor and attach vacuum gauge to hose. Start engine and allow to idle. If vacuum is 10 in Hg. or more, check for small vacuum leak between PF sensor and intake manifold. Repair as necessary and repeat **QUICK TEST** . If vacuum is less than 10 in Hg., repair large vacuum leak or blockage in hose between PF sensor and intake manifold. Repair as necessary and repeat QUICK TEST. If DTC P1443 is still present, go to next step.

12) Check CANP Solenoid Resistance Turn ignition off. Leave CANP wiring harness connector disconnected. Measure resistance between CANP solenoid terminals. If resistance is 30-90 ohms, go to next step. If resistance is not as specified, replace CANP solenoid. Clear PCM memory and repeat **QUICK TEST** .

13) Check Circuit For Short To VPWR Leave ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 67 (CANP solenoid) or 56 (VMV) and test pins No. 71 and 97 at breakout box. If each resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair EVAP CANP/VMV circuit short to VPWR circuit. Clear PCM memory and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 13) to step 21). No test procedures have been omitted.

21) Check VMV Housing Turn ignition off. Reconnect VMV wiring harness connector. Disconnect VMV fuel vapor hose from intake manifold port at VMV. Disconnect VMV fuel vapor hose from vapor canister port at VMV. Attach vacuum pump with gauge to intake manifold port at VMV. Using vacuum pump, apply 16 in. Hg to VMV. If vacuum is not held, replace VMV and repeat **QUICK TEST** . If vacuum is held, go to next step.

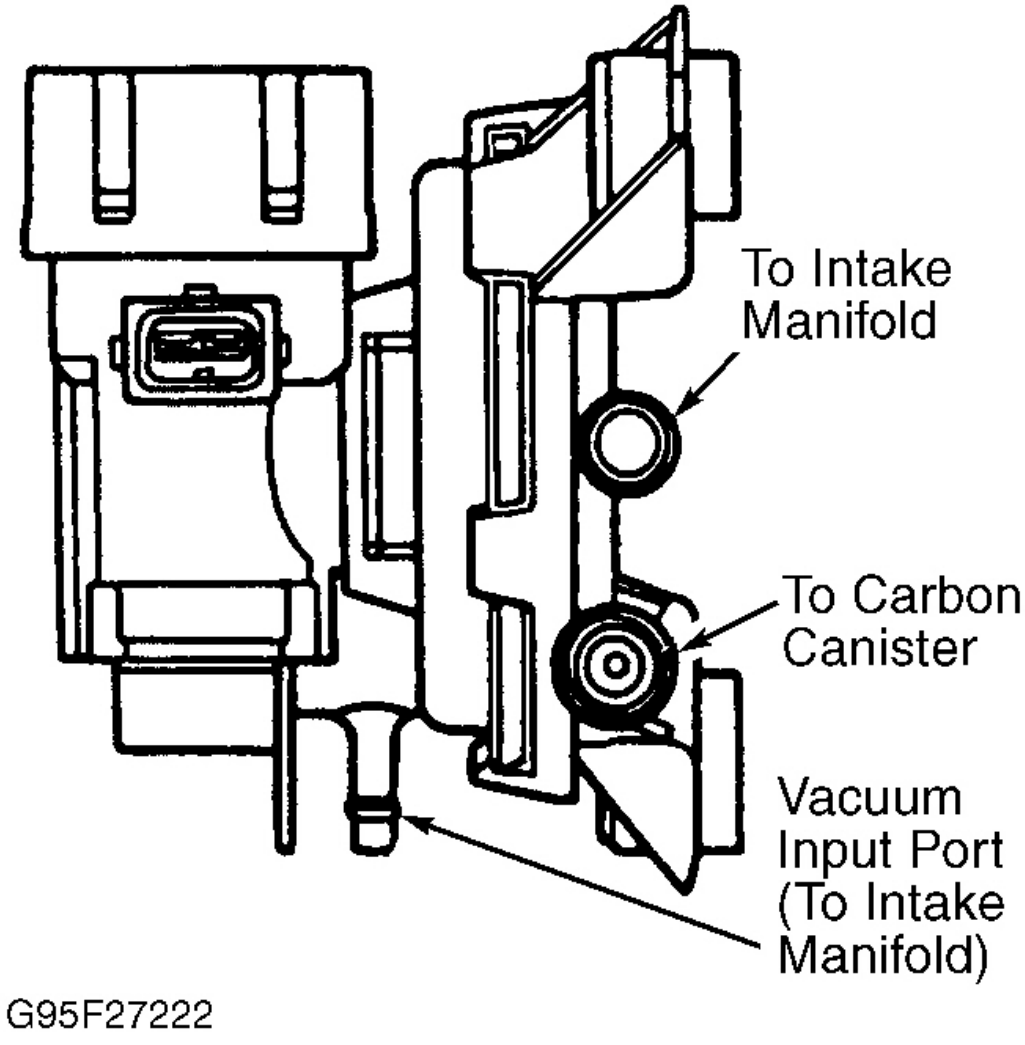


Fig. 65: VMV Hose Ports

22) Check VMV Filter Turn ignition off. Disconnect vacuum input hose from VMV. Using a vacuum pump, apply 15 in. Hg to VMV. If vacuum is not held, remove vacuum pump and go to next step. If vacuum is held or bleeds off slowly, service VMV filter. If filter cannot be serviced, replace VMV.

23) Check VPWR Circuit Voltage Turn ignition off. Connect PCM to breakout box. Disconnect VMV wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal of VMV wiring harness connector and battery ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit and repeat **QUICK TEST** .

24) Check VMV Turn ignition off. Ensure PCM is connected to breakout box. Reconnect VMV vacuum input hose. Disconnect fuel vapor to carbon canister hose. Connect vacuum gauge to vacuum port. Start

engine and allow to idle for 5 minutes. Vacuum gauge should read zero. Connect jumper wire between test pin No. 56 (VMV) and test pin No. 51 or 103 at breakout box. Vacuum should be about engine manifold vacuum. If vacuum is not as specified, replace VMV and repeat **QUICK TEST** . If vacuum is as specified, remove vacuum gauge and jumper wire. Go to next step.

25) Turn ignition off. Reconnect VMV wiring harness connector. Disconnect upper and lower hose from VMV. Start engine and allow to idle. Check for vacuum at open end of hoses. If vacuum is present, leave hoses disconnected and go to next step. If vacuum is not present, check hoses for correct routing. Ensure hoses are not damaged or restricted. Repair or replace as necessary.

26) Turn ignition off. Ensure VMV wiring harness connector is connected. Disconnect vacuum input hose from VMV. Using a vacuum pump, apply 16 in. Hg to VMV. If vacuum bleeds off immediately, fault is intermittent and cannot be duplicated at this time. Testing is complete. If vacuum is not bled off immediately, check hoses for damage or restriction. Repair or replace as necessary and repeat **QUICK TEST** .

27) Continuous Memory DTC P1444 Turn ignition off. Disconnect PF sensor wiring harness connector. Inspect pins for damage and repair as necessary. Reconnect PF sensor wiring harness connector. Connect scan tester to Diagnostic Link Connector (DLC). Turn ignition on. Using scan tester, access PF PID. If PF PID voltage is 0.4 volt or less, go to next step. If PF PID voltage is 0.2 volt or less, go to step 30). If voltage is more than 0.4 volt or more, fault is intermittent. Go to step 32).

28) Turn ignition off. Disconnect PF sensor wiring harness connector. Ensure PF sensor temperature is 55-80°F (13-27°C). Measure resistance between PF sensor terminal No. 1 and No. 2. Resistance should be less than 160 ohms. Measure resistance between PF sensor terminal No. 1 and No. 3. Resistance should be less than 190 ohms. If resistance is as specified, go to next step. If resistance is not as specified, replace PF sensor and repeat **QUICK TEST** .

29) Check For Open In VPWR Circuit Leave ignition off and PF sensor disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between pin No. 1 at PF sensor and test pins No. 71 and 91 at breakout box. If resistance is less than 5 ohms, go to next step for DTC P1444 or step 34) for DTC P1445. If resistance is 5 ohms or more, repair open in VPWR and repeat **QUICK TEST** .

30) Leave ignition off and PF sensor disconnected. Ensure PF sensor temperature is 55-80°F (13-27°C). Measure resistance between PF sensor terminal No. 2 and No. 3. If resistance is more than 25.5 ohms, go to next step. If resistance is not as specified, replace PF sensor and repeat **QUICK TEST** .

31) Check PF Circuit For Short To VPWR Leave ignition off and PF sensor disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between breakout box test pin No. 11 and test pins No. 24 and 103. If each resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If any resistance is 10,000 ohms or less, repair PF circuit short to PWR GND. Clear PCM memory and repeat QUICK TEST.

32) Wiggle Test Solenoid & Harness Turn ignition off. Using scan tester, access PF PID. Observe PF PID for indication of fault while shaking and bending PF sensor wiring harness and connector. A fault will be indicated by sudden change of voltage. Tap lightly on PF sensor to simulate road shock. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

33) Continuous DTC P1445 Turn ignition off. Disconnect PF sensor wiring harness connector. Inspect pins for damage and repair as necessary. Reconnect PF sensor wiring harness connector. Connect scan tester to Diagnostic Link Connector (DLC). Turn ignition on. Using scan tester, access PF PID. If PF PID

voltage is more than 4.8 volts, go to step 28). If voltage is 4.8 volts or less, go to step 39).

34) Check Purge Flow (PF) Sensor Turn ignition off. Disconnect PF sensor wiring harness connector. Allow sensor to cool to room temperature. Measure resistance between terminal No. 1 and No. 2. If resistance is 40-230 ohms, go to next step. If resistance is not 40-230 ohms, replace PF sensor and repeat **QUICK TEST** .

35) Check PF Circuit Short To VPWR Leave PF sensor disconnected. Turn ignition on. Measure voltage between PF terminal of sensor wiring harness connector and battery ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, go to step 37).

36) Turn ignition off. Leave PF sensor disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between breakout box test pin No. 11 and test pins No. 24 and 103. If voltage is greater than 10.5 volts, repair PF circuit short to VPWR and repeat **QUICK TEST** . If voltage is 10.5 volts or less, replace PCM and repeat QUICK TEST.

37) Check PF Circuit For Open in Harness Turn ignition off. Leave PF sensor disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between breakout box test pin No. 11 and PF terminal at sensor wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in PF circuit. Clear PCM memory and repeat **QUICK TEST** .

38) Check PWR GND Circuit For Open in Harness Leave ignition off and PF sensor disconnected. Measure resistance between breakout box test pins No. 24 and 103. If resistance is less than 5 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open in PWR GND circuit and repeat QUICK TEST.

39) Wiggle Test Solenoid & Harness Turn ignition off. Connect scan tester to DLC. Using scan tester, access PF PID. Observe PF PID for indication of fault while shaking and bending PF sensor wiring harness and connector. A fault will be indicated by sudden change of voltage. Tap lightly on PF sensor to simulate road shock. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

40) Continuous Memory DTC P0443: Check VMV Circuit For Intermittent Failure Repeat **QUICK TEST** . If Continuous Memory DTC P0443 is still present, go to next step. If Continuous Memory DTC P0443 is not present, go to step 1).

41) Wiggle Test Solenoid & Harness Turn ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Using DVOM, measure resistance between test pin No. 67 (CANP solenoid) or 56 (VMV) and test pins No. 71 and 97. Observe DVOM for indication of fault while shaking and bending VMV wiring harness and connector. A fault will be indicated by resistance measurement of less than 30 ohms or more than 36 ohms (VMV) or 90 ohms (CANP solenoid). Tap lightly on VMV to simulate road shock. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

CIRCUIT TEST HX - EVAPORATIVE EMISSION (EVAP) MONITOR & SYSTEM

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used

to diagnose the following:

- Leaks in fuel tank, filler cap or vapor hoses.
- Faulty Canister Vent (CV) solenoid.
- Faulty Fuel Tank Pressure (FTP) Sensor.
- Faulty fuel vapor valve.
- Faulty fuel vapor control valve (if equipped).
- Faulty carbon canister.
- Wiring harness circuits (CV, FTP, PWR GND, VMV, VPWR and VREF).
- Faulty PCM.

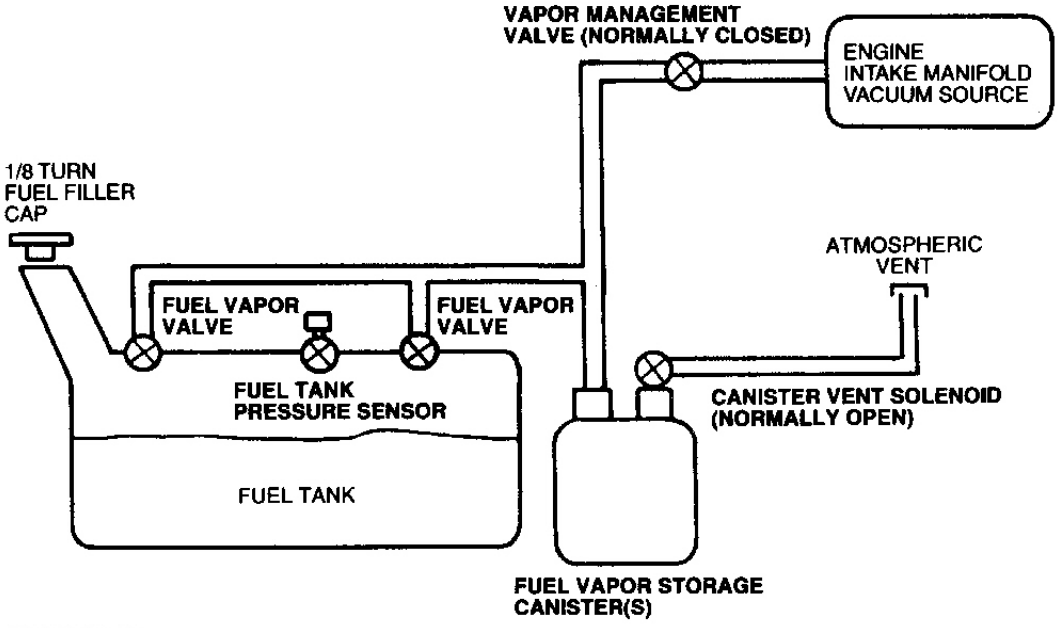


Fig. 66: EVAP Components

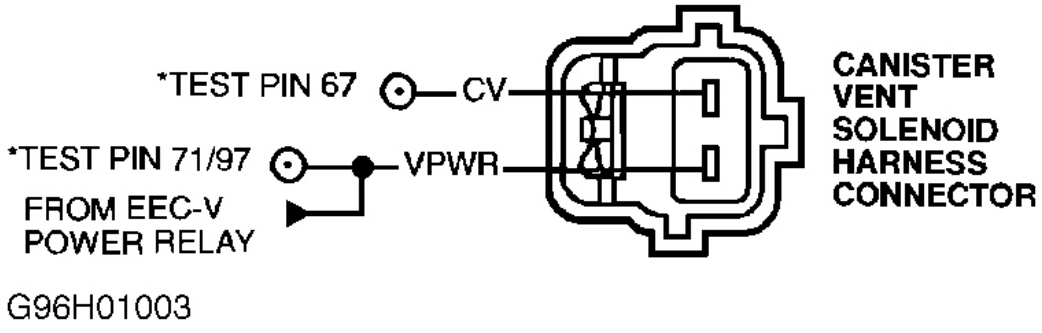


Fig. 67: CV Solenoid Connector & Test Circuit

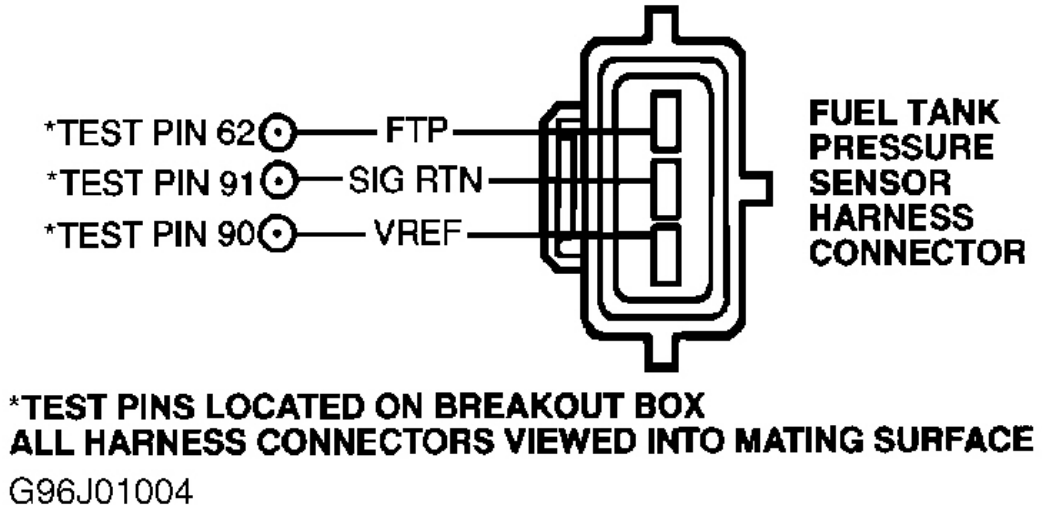


Fig. 68: FTP Connector & Test Circuit

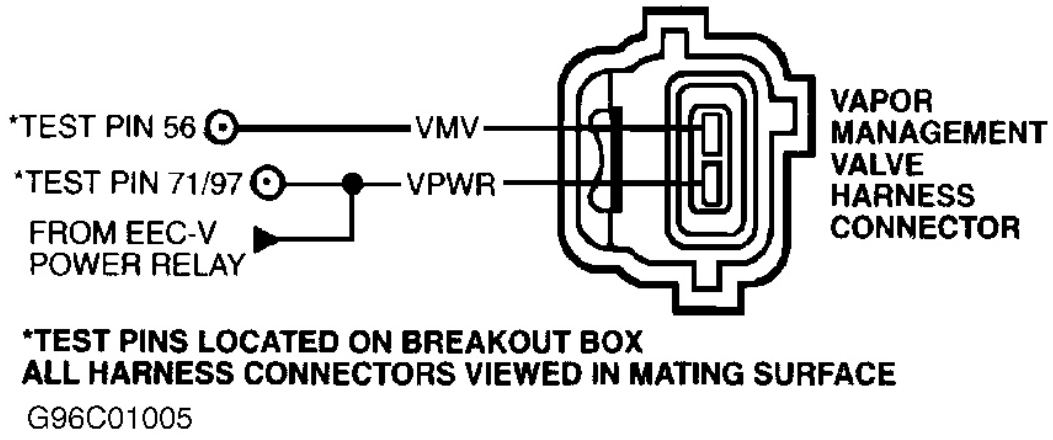


Fig. 69: VMV Connector & Test Circuit

1) Continuous Memory DTC P0442 Or P1442 Turn ignition off. Ensure fuel fill cap is correctly installed. Ensure cap is not damaged or excessively worn. Service or replace as necessary and verify symptom is repaired. If fuel fill cap is okay, go to next step.

2) Leave ignition off. Check all fuel vapor hoses for damage or restrictions. Ensure hose connections are tight. Service or replace as necessary and verify symptom is repaired. If fuel vapor hoses are okay, go to step 61).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 2) to step 6). No test procedures have been omitted.

6) Continuous Memory DTC P0443 Perform **QUICK TEST** . If DTC P0443 is present in Continuous Memory only, go to step 12). If DTC P0443 is present in KOEO or KOER self-test, go to next step.

7) DTC P0443: Check VPWR Circuit Voltage Turn ignition off. Disconnect Vapor Management Valve (VMV) wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal of VMV wiring harness connector and battery ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit and repeat **QUICK TEST** .

8) Check VMV Resistance Turn ignition off. Leave VMV wiring harness connector disconnected. Measure resistance between CANP solenoid or VMV terminals. If resistance is 30-36 ohms, go to next step. If resistance is not as specified, replace VMV and repeat **QUICK TEST** .

9) Check VMV Circuit Resistance Leave ignition off and VMV wiring harness connector disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 56 at breakout box and VMV terminal of VMV wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

10) Check Circuit For Short To PWR GND Leave ignition off and VMV wiring harness connector disconnected. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No.

56 (VMV) and test pins No. 24 and 103. If resistance is 10,000 ohms or less, repair VMV circuit short to PWR GND circuit. Clear PCM memory and repeat **QUICK TEST** . If each resistance is more than 10,000 ohms, go to step 57) if DTC P1450 is present or go to next step if DTC P1450 is not present.

11) Leave ignition off and VMV disconnected. Turn ignition on. Measure voltage between breakout box test pin No. 56 and test pins No. 51 and 103. If voltage is greater than 10.5 volts, repair VMV circuit short to VPWR and repeat **QUICK TEST** . If voltage is 10.5 volts or less, replace PCM and repeat QUICK TEST.

12) Wiggle Test VMV & Harness Turn ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Using DVOM, measure resistance between test pin No. 56 (VMV) and test pins No. 71 and 97. Observe DVOM for indication of fault while shaking and bending VMV wiring harness and connector. A fault will be indicated by resistance measurement of less than 30 ohms or more than 36 ohms. Tap lightly on VMV to simulate road shock. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

13) Continuous Memory DTC P0446 Turn ignition off. Remove fuel fill cap. Connect scan tester to DLC. Turn ignition on. Using scan tester, access FTP V PID. Record FTP V PID voltage. Install fuel fill cap to first click. If FTP V PID voltage is 2.4-2.8 volts, go to step 15). If FTP V PID voltage is not 2.4-2.8 volts, go to next step.

14) Check VREF At FTP Connector Turn ignition off. Disconnect FTP wiring harness connector. Turn ignition on. Measure voltage between VREF terminal and SIG RTN terminal at wiring harness connector. If voltage is 4-6 volts, replace FTP sensor and repeat **QUICK TEST** . If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

15) Check Carbon Canister Check for restrictions at carbon canister atmosphere vent port. Check for restrictions in purge air inlet tube (large diameter hose) between CV solenoid and atmosphere. Repair or replace as necessary. If no faults are found, go to next step.

16) Check CV Solenoid Filter Port Disconnect purge air inlet tube (large diameter hose) from CV solenoid. If vehicle is not equipped with purge air inlet tube, go to next step. Locate opposite end of tube (in fuel filter housing). Drop a 3/8" ball bearing into tube. If ball bearing passes through tube, go to next step. If ball bearing does not pass through tube, service or replace tube as necessary and repeat **QUICK TEST** .

17) Check CV Solenoid Mechanical Operation Remove CV solenoid hose. Connect vacuum pump to solenoid. Using vacuum pump, apply 16 in. Hg to solenoid. If vacuum is held for one minute, replace CV solenoid and repeat **QUICK TEST** . If vacuum is not held for one minute, go to step 8) for Pickup or go to next step for all models except Pickup.

18) DTC P0446 Turn ignition off. Connect scan tester to DLC. Turn ignition on. Using scan tester, access EVAPCVF PID. If scan tester indicates YES, go to next step. If scan tester does not indicate YES, go to step 21).

19) Check CV Solenoid Resistance Turn ignition off. Disconnect CV solenoid wiring harness connector. Measure resistance between CV and VPWR terminal at solenoid. If resistance is less than 45 ohms, replace CV solenoid and repeat **QUICK TEST** . If resistance is 45 ohms or more, go to next step.

20) Check Circuit For Short To PWR GND Leave ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 67 (CV) and test pins No. 51 and 103. If each resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair CV circuit short to PWR GND circuit. Clear PCM memory and repeat

QUICK TEST.

21) Wiggle Test CV Solenoid & Harness Turn ignition on. Using scan tester, access EVAPCVF PID. Observe EVAPCVF PID for indication of fault while shaking and bending CV solenoid wiring harness and connector. A fault will be indicated by a change in EVAPCVF PID voltage. Tap lightly on CV solenoid to simulate road shock. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

22) DTC P0452; Check For Fuel Saturation Of FTP Sensor Turn ignition off. Connect scan tester to DLC. Check FTP wiring harness connector for damage or fuel contamination. Repair or replace if necessary. If connector is okay, go to next step.

23) Verify FTP Signal Voltage Leave ignition off. Connect scan tester to DLC. Turn ignition on. Using scan tester, access FTP V PID. If FTP V PID is less than 0.22 volts, go to next step. If FTP V PID is 0.22 volts or more, go to step 27).

24) Induce Opposite FTP Signal Leave ignition off. Disconnect FTP wiring harness connector. Connect jumper wire between FTP terminal and VREF terminal at connector. Turn ignition on. Using scan tester, access FTP V PID. If scan tester error occurs, go to next step. If FTP V PID is 4-6 volts, replace FTP and repeat **QUICK TEST** . If FTP V PID is not 4-6 volts, remove jumper wire and go to next step.

25) Check VREF At FTP Connector Turn ignition off. Disconnect FTP wiring harness connector. Turn ignition on. Measure voltage between VREF terminal and SIG RTN terminal at wiring harness connector. If voltage is 4-6 volts, go to next step. If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

26) Check Circuit For Short To PWR GND Or SIG RTN Leave ignition off and FTP disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Disconnect scan tester from DLC. Measure resistance between test pin No. 62 (FTP) and test pins No. 51, 91 and 103. If each resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair FTP circuit short to SIG RTN or PWR GND circuit. Clear PCM memory and repeat QUICK TEST.

27) Wiggle Test CV Solenoid & Harness Turn ignition on. Using scan tester, access FTP V PID. Observe FTP V PID for indication of fault while shaking and bending FTP sensor wiring harness and connector. A fault will be indicated by a change in FTP V PID voltage. Tap lightly on FTP sensor to simulate road shock. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

28) DTC P0453 Turn ignition off. Connect scan tester to DLC. Turn ignition on. Using scan tester, access FTP V PID. If FTP V PID is 4.5 volts or less, go to step 37). If FTP V PID is more than 4.5 volts, go to next step.

29) Check FTP Signal For Short To Power Leave ignition off. Disconnect FTP wiring harness connector. Turn ignition on. Measure voltage between negative battery terminal and FTP terminal at wiring harness connector. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, go to step 31).

30) Check FTP Circuit For Short To VPWR Leave FTP disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 62 (FTP) and test pins No. 51 and 103 at breakout box. If either voltage is less than 10.5 volts, replace PCM and repeat **QUICK TEST** . If all voltages are 10.5 volts or more, repair FTP circuit short to VPWR. Clear PCM memory and repeat QUICK TEST.

31) Induce Opposite FTP Signal Turn ignition off. Leave FTP wiring harness connector disconnected. Connect jumper wire between FTP terminal and SIG RTN terminal at connector. Turn ignition on. Using

scan tester, access FTP V PID. If scan tester error occurs, go to step 36). If FTP V PID is less than 0.1 volt, remove jumper wire and go to next step. If FTP V PID is 0.1 volts or more, go to step 34).

32) Check VREF At FTP Connector Leave ignition off. Disconnect FTP wiring harness connector. Measure voltage between SIG RTN terminal and VREF terminal at wiring harness connector. If voltage is 4-6 volts, go to next step. If voltage is not 4-6 volts, go to CIRCUITTEST C.

33) Check FTP Circuit For Short To VREF Leave ignition off and FTP disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Disconnect scan tester from DLC. Measure resistance between test pins No. 62 (FTP) and 90 (VREF) at breakout box. If resistance is more than 10,000 ohms, replace FTP sensor and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair FTP circuit short to VREF. Clear PCM memory and repeat QUICK TEST.

34) Check FTP Circuit Resistance Leave ignition off and FTP disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Disconnect scan tester from DLC. Measure resistance between test pin No. 62 (FTP) and FTP terminal at FTP wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in FTP circuit. Clear PCM memory and repeat **QUICK TEST** .

35) Check SIG RTN Circuit Resistance Leave ignition off and FTP disconnected. Measure resistance between test pin No. 91 and SIG RTN terminal at FTP wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in SIG RTN circuit. Clear PCM memory and repeat **QUICK TEST** .

36) Check FTP Circuit For Short To VREF Leave ignition off and FTP disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pins No. 62 (FTP) and 90 (VREF) at breakout box. If resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair FTP circuit short to VREF. Clear PCM memory and repeat QUICK TEST.

37) Wiggle Test CV Solenoid & Harness Turn ignition on. Using scan tester, access FTP V PID. Observe FTP V PID for indication of fault while shaking and bending FTP sensor wiring harness and connector. A fault will be indicated by a change in FTP V PID voltage. Tap lightly on FTP sensor to simulate road shock. If fault is indicated, isolate and repair as necessary. If no fault is indicated, go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 37) to step 40). No test procedures have been omitted.

40) Continuous Memory P0455 Or P1455 Turn ignition off. Ensure fuel fill cap is correctly installed and in good condition. Check carbon canister for damage. Check fuel vapor hoses for correct routing. Check fuel tank and fill pipe for damage. Repair or replace as necessary. If no faults are present, go to step 44) for models with VMV or next step for models with CV solenoid.

41) Check CV Circuit Resistance Turn ignition off. Disconnect CV solenoid wiring harness connector. Disconnect PCM from breakout box. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 67 at breakout box and CV terminal at CV solenoid wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in CV circuit. Clear PCM memory and repeat

QUICK TEST .

42) Check CV Circuit For Short To Power Turn ignition on. Measure voltage between test pin No. 67 and test pin No. 51 or 103 at breakout box. If voltage is more than 10.5 volts, repair CV circuit short to VPWR. If voltage is 10.5 volts or less, go to next step.

43) Check VPWR Circuit Voltage Turn ignition off. Connect PCM to breakout box. Disconnect CV solenoid wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal of CV solenoid wiring harness connector and battery ground. If voltage is 10.5 volts or more, replace CV solenoid. If voltage is less than 10.5 volts, repair open in VPWR circuit and repeat **QUICK TEST** .

44) Check Intake Manifold Vacuum At VMV Leave ignition off. Connect VMV wiring harness connector. Disconnect hoses from VMV at intake manifold. Start engine and allow to idle. Check for vacuum at intake manifold. If vacuum is present, go to next step. If vacuum is not present, isolate fault and repair as necessary.

45) Check VMV Ability To Hold Vacuum Leave ignition off. Connect vacuum pump to disconnected end of VMV hose. Using vacuum pump, apply 16 in. Hg. If vacuum bleeds off immediately, go to next step. If vacuum does not bleed off immediately, isolate hose restriction and repair as necessary.

46) Check VMV Turn ignition off. Reconnect VMV wiring harness connector. Disconnect VMV fuel vapor hose from intake manifold port at VMV. Attach vacuum pump with gauge to intake manifold port at VMV. Using vacuum pump, apply 16 in. Hg to VMV. If vacuum bleeds off immediately, go to next step. If vacuum is not bled off immediately, replace VMV.

47) Check VMV Turn ignition off. Ensure PCM is connected to breakout box. Reconnect VMV vacuum input hose. Disconnect fuel vapor to carbon canister hose. Connect vacuum gauge to vacuum port. Start engine and allow to idle for 5 minutes. Vacuum gauge should read zero. Connect jumper wire between test pin No. 56 (VMV) and test pin No. 51 or 103 at breakout box. Vacuum should be about engine manifold vacuum. If vacuum is not as specified, replace VMV. If vacuum is as specified, remove vacuum gauge and jumper wire. Go to next step.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 47) to step 56). No test procedures have been omitted.

56) DTC P1450 Or P1452 Turn ignition off. Remove input vacuum hose from VMV. Connect vacuum pump to VMV. Using vacuum pump, apply 10 in. Hg to solenoid. If vacuum is held for one minute, replace VMV and go to step 61). If vacuum is not held for one minute, remove vacuum pump and go to step 15).

57) Check VREF Connectors Leave ignition off. Check VREF circuit terminal at FTP sensor and PCM. If terminal connectors are okay, go to next step. If terminal connectors are faulty, go to step 61).

58) Check CV Circuit Resistance Turn ignition off. Disconnect FTP solenoid wiring harness connector. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 90 at breakout box and VREF terminal at FTP sensor wiring harness connector. If resistance is less than 5 ohms, replace FTP sensor and go to next step. If resistance is 5 ohms or more, repair open in VREF circuit and go to next step.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 58) to step 61). No test procedures have been omitted.

61) Verify EVAP System Repair With ignition on and scan tester connected to DLC, clear PCM memory. Start engine and allow to idle for at least 4 minutes. Drive vehicle 45-60 MPH in high gear for about 8 minutes. Drive vehicle in city traffic condition averaging 25-40 MPH. Ensure at least 5 stop with idle periods of 10 seconds or more. Accelerate vehicle to 45-60 MPH and operate in high gear for about 8 minutes. Stop vehicle and repeat **QUICK TEST** . If DTC P1000 is present, repeat this step. If any other DTCs are present, service as necessary. See **DIAGNOSTIC TROUBLE CODE (DTC) REFERENCE CHARTS** . If no DTCs are present, testing is complete.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 61) to step 65). No test procedures have been omitted.

65) Continuous Memory DTC P1451: Check VPWR To CV Solenoid Turn ignition off. Disconnect CV solenoid wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal of CV solenoid wiring harness connector and negative battery terminal. If voltage is greater than 10.5 volts, go to next step. If voltage is 10.5 volts or less, replace PCM and repeat **QUICK TEST** .

66) Check CV Solenoid Resistance Turn ignition off. Disconnect CV solenoid wiring harness connector. Measure resistance between CV and VPWR terminal at solenoid. If resistance is 45-65 ohms, go to next step. If resistance is 45 ohms or more, replace CV solenoid and repeat **QUICK TEST** .

67) Check CV Circuit Resistance Leave ignition off and CV solenoid disconnected. Disconnect PCM 104-pin wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 67 at breakout box and CV terminal at CV solenoid wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in CV circuit and repeat **QUICK TEST** .

68) Check CV Circuit Short To PWR GND Leave ignition off and CV solenoid disconnected. Disconnect scan tester (if applicable). Measure resistance between test pin No. 67 and test pins No. 51 and 103 at breakout box. If resistance is less than 10,000 ohms, repair CV circuit to PWR GND and repeat **QUICK TEST** . If resistance is 10,000 ohms or more, reconnect scan tester and go to next step.

69) Check CV Circuit Short To PWR Leave CV solenoid disconnected. Turn ignition on. Measure voltage between chassis ground and test pin No. 67 at breakout box. If voltage is less than 1.0 volt, go to next step. If voltage is 1.0 volt or more, repair CV circuit to PWR, VREF, VPWR or chassis ground.

70) Check CV Signal From PCM Turn ignition off. Reconnect CV solenoid. Connect PCM to breakout box. Start engine and allow to idle. Measure voltage between test pin No. 67 and test pins No. 51 and 103 at breakout box. If voltage is 10-14 volts, replace CV solenoid and repeat **QUICK TEST** . If voltage is not 10-14 volts, replace PCM and repeat QUICK TEST.

CIRCUIT TEST JB - IGNITION MISFIRE UNDER LOAD

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Spark plugs.
- Spark plug wires.

MISFIRE TROUBLE CODES

Service Code	Application
90	Pass
P0301	Cylinder No. 1 (Test Pin No. 75)
P0302	Cylinder No. 2 (Test Pin No. 101)
P0303	Cylinder No. 3 (Test Pin No. 74)
P0304	Cylinder No. 4 (Test Pin No. 100)
P0305	Cylinder No. 5 (Test Pin No. 73)
P0306	Cylinder No. 6 (Test Pin No. 99)
P0307	Cylinder No. 7 (Test Pin No. 72)
P0308	Cylinder No. 8 (Test Pin No. 98)

1) Check Possible Cause Of Misfire Connect engine oscilloscope to vehicle. View parade pattern of ignition secondary system. Go to next step.

NOTE: Damaged or contaminated secondary ignition components may cause high catalyst temperatures. Check areas near catalyst and muffler for heat damage.

2) Start engine. Normal spark output voltage is 20,000 volts. Maximum spark output variation is 8000 volts. If spark output is not as specified, go to next step. If spark output voltage is as specified, testing is complete. Go to step 8) under **CIRCUIT TEST HD** .

3) If average spark output voltage is more than 20,000 volts with spark output variation less than 8000 volts, check spark plugs for wear and spark plug wires for 7000 ohms per foot maximum resistance. If spark output voltage is not as specified, go to next step.

4) If spark output voltage variation is more than 8000 volts, check spark plugs for wide gap or worn electrode. If spark output voltage variation is less than 8000 volts, go to next step.

5) If spark output voltage is consistently high in selected cylinders only, check for defective spark plug or wire. If spark output voltage is not as specified, go to next step.

6) If spark output voltage is consistently low in all cylinders, check spark plugs for narrow gap and spark plug wires for grounding. If spark output voltage is not as specified, go to next step.

7) If average spark output voltage is 15,000 volts or less with spark output variation less than 5000 volts, testing is complete. Go to **CIRCUIT TEST HD** , step 8). If spark output voltage is not as specified, go to next step.

8) If average spark output voltage is more than 15,000 volts with spark output variation less than 5000 volts, check spark plugs for wear and spark plug wire for 7000 ohms per foot maximum resistance. If spark output voltage is not as specified, go to next step.

9) If spark output voltage variation is more than 5000 volts, check spark plugs for wide gap or worn electrode. If spark output voltage variation is less than 5000 volts, go to next step.

10) If spark output voltage is consistently high in selected cylinders only, check for defective spark plug or wire. If spark output voltage is not as specified, go to next step.

11) If spark output voltage is consistently low in all cylinders, check spark plugs for narrow gap and spark plug wires for grounding. If spark output voltage is not as specified, ignition secondary system is

okay and testing is complete.

CIRCUIT TEST JD - INTEGRATED IGNITION-NO START

Diagnostic Aids

When making a voltage check, a ground reading is a value of less than one volt. A power reading is a value of battery voltage, or up to 2 volts less than battery voltage.

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Crankshaft Position (CKP) sensor.
- CKP wiring harness or connector(s).
- Spark plug wires.
- Faulty Powertrain Control Module (PCM).

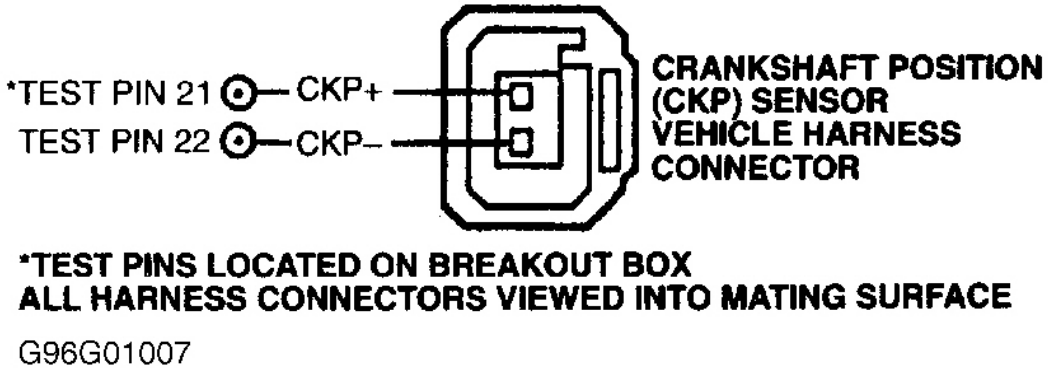


Fig. 70: CKP Sensor Connector Terminals & Test Circuits

1) Check Spark Plugs & Wires Remove and check spark plugs. Check all spark plug wires for damaged insulation or poor connectors. Check primary ignition wiring. Check CKP sensor connector. Repair or replace if necessary. If no faults are found, go to next step.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 1) to step 4). No test procedures have been omitted.

4) Check CKP+ Circuit To PCM Turn ignition off. Disconnect scan tester from DLC. Disconnect PCM. Check PCM wiring harness connector for damage and repair if necessary. Install Breakout Box (014-000950). Connect PCM wiring harness connector to breakout box. Turn ignition on. Measure voltage between pin No. 21 (CKP+) at breakout box and negative battery terminal. If voltage is not 1-2 volts, go

to next step. If voltage is 1-2 volts, go to step 10).

5) Check CKP Sensor Turn ignition off. Disconnect CKP wiring harness connector. Turn ignition on. Measure voltage between pin No. 21 (CKP+) at breakout box and negative battery terminal. If voltage is 1-2 volts, go to next step. If voltage is not 1-2 volts, go to step 18).

6) Leave ignition on. Measure voltage between pin No. 22 (CKP-) at breakout box and negative battery terminal. If voltage is 1-2 volts, replace CKP sensor and repeat **QUICK TEST** . If voltage is not 1-2 volts, go to next step.

7) If voltage in step 6) was less than 1.0 volt, go to next step. If voltage in step 6) was more than 1.0 volts, go to step 9).

8) Turn ignition off. Disconnect PCM from breakout box. Measure resistance between pin No. 22 (CKP-) at breakout box and negative battery terminal. If resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or less, repair CKP- circuit short to ground.

9) Leave PCM disconnected from breakout box. Turn ignition on. Measure voltage between pin No. 22 (CKP-) at breakout box and negative battery terminal. If voltage is less than 0.5 volts, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volts or more, repair CKP sensor short to power and repeat QUICK TEST.

10) Set DVOM on AC voltage scale. Crank starter while measuring voltage between pin No. 21 (CKP+) and No. 22 (CKP-) at breakout box. After stabilizing, if AC voltage is less than 0.4 volt, go to next step. If AC voltage is 0.4 volt or more, go to step 60) under **CIRCUIT TEST JE** .

11) Turn ignition off. Disconnect PCM from breakout box. Set DVOM on AC voltage scale. Crank starter while measuring voltage between pin No. 21 (CKP+) and No. 22 (CKP-) at breakout box. After stabilizing, if voltage is less than 0.4 volt, go to next step. If voltage is 0.4 volt or more, replace PCM and repeat **QUICK TEST** .

12) Turn ignition off. Measure resistance between pin No. 21 (CKP+) and No. 22 (CKP-) at breakout box. If resistance is 300-800 ohms, go to step 16). If resistance is not 300-800 ohms, go to next step.

13) If resistance in step 12) was more than 300 ohms, go to next step. If resistance in step 12) was 300 ohms or less, go to step 17).

14) Check CKP Sensor Turn ignition off. Install EI Diagnostic Harness (007-00059) to Breakout Box (014-000950). Connect EI Diagnostic Harness between CKP sensor and wiring harness connector. Use appropriate overlay. Connect diagnostic harness negative lead to battery negative terminal. Leave positive lead disconnected. Set diagnostic harness box type switch to "4/6" or "8" cylinder position. Measure resistance between breakout box test pins No. 21 (CKP+I) and J31 (CKP+S). If resistance is less than 1050 ohms, go to next step. If resistance is 1050 ohms or more, repair open in CKP+ circuit and repeat **QUICK TEST** .

15) Leave ignition off. Measure resistance between breakout box pin No. 22 (CKP-I) and No. J32 (CKP-S). If resistance is less than 1050 ohms, replace CKP sensor and repeat **QUICK TEST** . If resistance is 1050 ohms or more, repair open in CKP- circuit.

16) Check CKP Sensor & Trigger Wheel Leave ignition off. Check CKP sensor and trigger wheel for damage. Repair or replace as necessary. If CKP sensor and trigger wheel are not damaged, ignition system is okay and testing is complete. If symptom is still present, go to **TESTS W/O CODES - 4.2L** article.

17) Leave ignition off. Disconnect CKP sensor from wiring harness connector. Measure resistance between breakout box pin No. 21 (CKP+I) and No. J22 (CKP-I). If resistance is more than 1000 ohms, replace CKP sensor and repeat **QUICK TEST** . If resistance is 1000 ohms or less, repair CKP- circuit

short to CKP+ circuit.

18) If voltage in step 5) was less than 1.0 volt, go to next step. If voltage in step 5) was 1.0 volt or more, go to step 20).

19) Check CKP Sensor For Short To Ground Turn ignition off. Disconnect PCM from PCM breakout box. Measure resistance between breakout box test pins 21 (CKP+I) and negative battery terminal. If resistance is less than 10,000 ohms, repair CKP+ circuit short to ground and repeat **QUICK TEST** . If resistance is 10,000 ohms or more, replace PCM and repeat QUICK TEST.

20) Check CKP Sensor For Short To Power Turn ignition on. Measure voltage between breakout box test pins 21 (CKP+I) and negative battery terminal. If voltage is more than 0.5 volt, repair CKP+ circuit short to power and repeat **QUICK TEST** . If resistance is 0.5 volt or less, replace PCM and repeat QUICK TEST.

CIRCUIT TEST JE - INTEGRATED IGNITION COIL FAILURE

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Ignition coil packs.
- Ignition coil wiring harness.
- Powertrain Control Module (PCM).

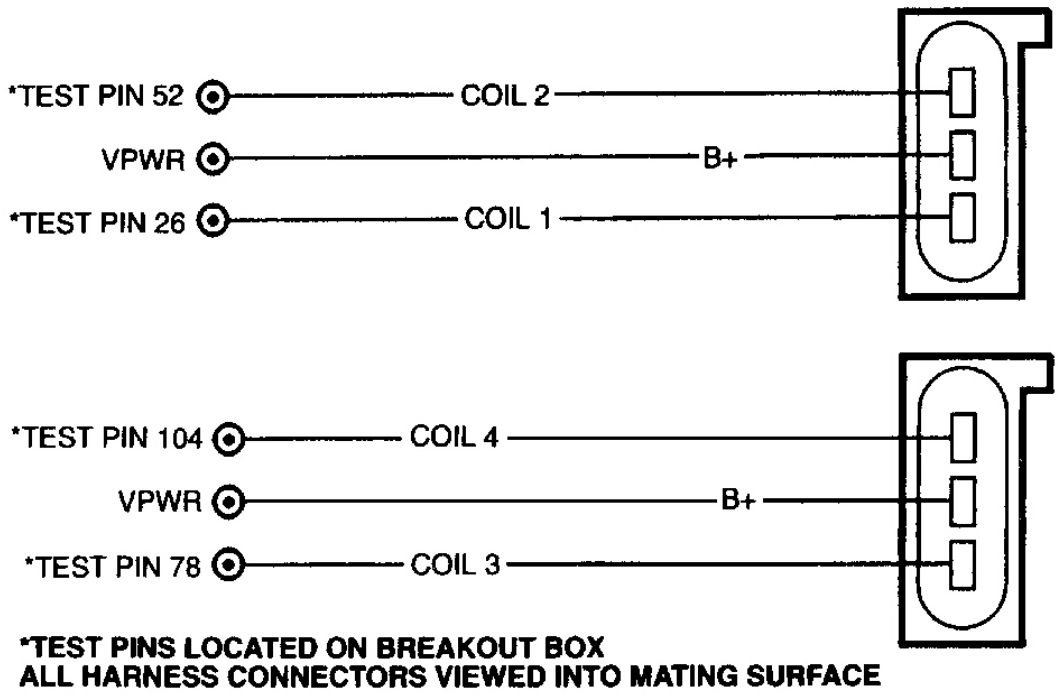


Fig. 71: 4-Tower Coil Pack Test Circuits & Connector Terminals

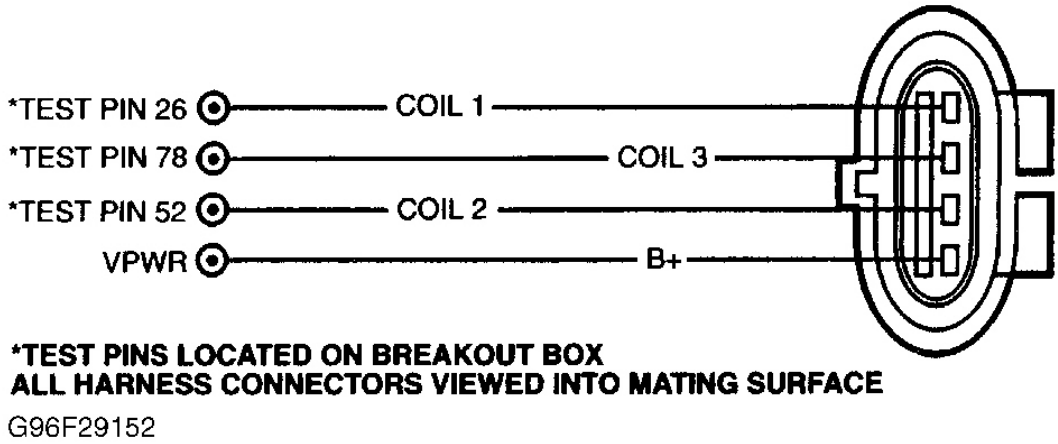


Fig. 72: Horizontal 6-Tower Coil Pack Test Circuits & Connector Terminals

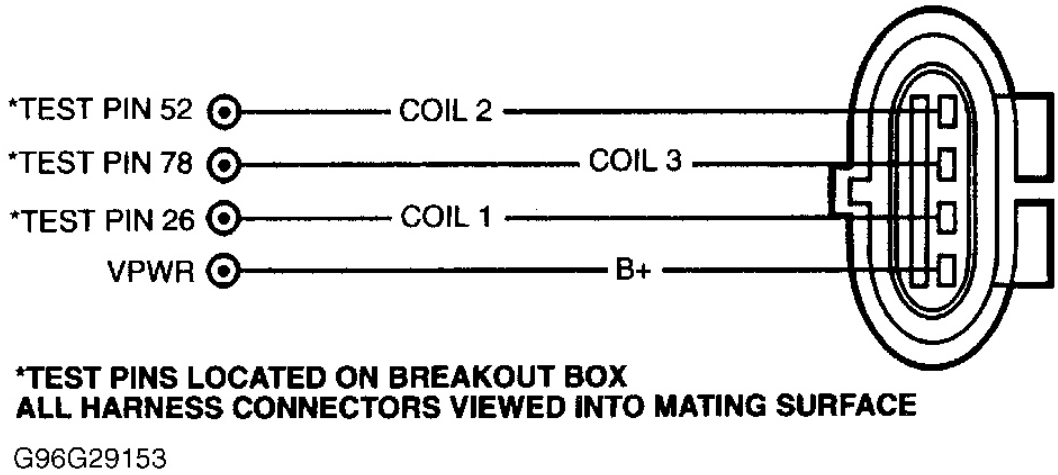


Fig. 73: Vertical 6-Tower Coil Pack Test Circuits & Connector Terminals

1) DTC P0350, P0351 & P0352 Using a spark tester, check for spark at all spark plug wires while cranking engine. If consistent spark is present at all spark plug wires, system is okay, go to step 50) of **CIRCUIT TEST Z** . If consistent spark is not present, go to next step.

2) Check Secondary Ignition Check spark plugs, spark plug wires and coils for damage, looseness or shorting. Repair or replace as necessary. If secondary ignition looks okay, go to next step.

3) Check For COIL PWR At Coil Turn ignition off. Install EI Diagnostic Harness (007-00059) to Breakout Box (014-000950) and ICM. Use appropriate overlay. Connect right (Blue) coil tee. Connect diagnostic harness negative lead to battery negative terminal. Leave positive lead disconnected. Set diagnostic harness box type switch to "4/6" cylinder position. Turn ignition on. Measure voltage between breakout box test pins J5 (COIL PWR) and J7 (B-). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair open in COIL PWR circuit. Clear PCM memory and repeat **QUICK TEST** .

WARNING: Unless otherwise instructed, PCM must not be connected to breakout box when performing ignition system testing.

4) Check C1C Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J3 (C1C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, go to step 12).

5) Check C2C Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J6 (C2C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, go to step 14).

6) Check C1I Circuit At PCM Turn ignition off. Connect PCM wiring harness connector to breakout box. Turn ignition on. Measure voltage between breakout box test pins J7 (B-) and J26 (C1I). If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C1I circuit.

7) Check C2 Circuit At ICM Leave ignition on. Measure voltage between breakout box test pins J7 (B-) and J52 (C2). If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C2 circuit.

8) Check C1 Circuit At Coil Turn ignition off. Disconnect coil from diagnostic harness coil tee. Turn ignition on. Measure voltage between breakout box test pins J3 (C1) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 16).

9) Check C2 Circuit At Coil Leave ignition on. Measure voltage between breakout box test pins J6 (C2) and J7 (B-). If DC voltage is 0.5 volt or more, go to step 17). If DC voltage is less than 0.5 volt, go to next step.

10) Check C1C Circuit At Coil While Cranking Connect positive lead of EI Diagnostic Harness (007-00059) to battery positive terminal. Connect incandescent test light between breakout box test pins J1 (B+) and J3 (C1). Crank engine. If test light blinks brightly once every engine revolution, go to next step. If test light does not blink as indicated, replace PCM and repeat **QUICK TEST** .

11) Check C2C Circuit At Coil While Cranking Connect incandescent test light between breakout box test pins J1 (B+) and J6 (C2C). Crank engine. If test light blinks brightly once every engine revolution, replace coil pack and repeat **QUICK TEST** . If test light does not blink as indicated, replace PCM and repeat QUICK TEST.

12) Check Right Coil Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J3 (C1C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace right coil pack. Clear PCM memory and repeat **QUICK TEST** .

13) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J3 (C1C) and J7(B-). If resistance is less than 10,000 ohms, repair short to ground in C1 circuit. If resistance is 10,000 ohms or more, replace PCM. Repeat **QUICK TEST** .

14) Check Coil No. 2 Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J6 (C2C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace coil pack. Clear PCM memory and repeat **QUICK TEST** .

15) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J6 (C2C) and J7(B-). If resistance is less than 10,000 ohms, repair C2C circuit short to ground. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** .

NOTE: If C2 circuit is shorted to ground, coil damage may occur.

16) Check Coil No. 1 Turn ignition off. Disconnect PCM from vehicle harness connector. Turn ignition on. Measure voltage between breakout box test pins J3 (C1C) and J7 (B-). If DC voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volt or more, repair C1C circuit short to power. Clear PCM memory and repeat **QUICK TEST** .

17) Check Coil No. 2 Turn ignition on. Measure voltage between breakout box test pins J6 (C2C) and J7 (B-). If DC voltage is less than 0.5 volt, replace PCM. Clear PCM memory and repeat **QUICK TEST** . If voltage is 0.5 volt or more, repair C2C circuit short to power. Clear PCM memory and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips

from step 17) to step 20). No test procedures have been omitted.

20) DTC P0350, P0351, P0352, P0353 & P0354 Using a spark tester, check for spark at all spark plug wires while cranking engine. If consistent spark is present at all spark plug wires, system is okay and testing is complete. If consistent spark is not present, go to next step.

21) Check For Spark At Right Spark Plugs If spark is present at right spark plugs, go to next step. If spark is not present at right spark plugs, go to step 38).

22) Check Left Spark Plugs & Wires Turn ignition off. Check left side spark plugs and wires for damage or wear. Check all wiring harnesses and connectors damage, burned insulation or poor connections. Repair or replace as necessary. If no faults are found, go to next step.

23) Check For COIL PWR At Left Coil Turn ignition off. Install EI Diagnostic Harness (007-00059) to Breakout Box (014-000950) and ICM. Use appropriate overlay. Connect left (Yellow) coil tee. Connect diagnostic harness negative lead to battery negative terminal. Leave positive lead disconnected. Set diagnostic harness box type switch to 8-cylinder position. Turn ignition on. Measure voltage between breakout box test pins J7 (B-) and J11 (COIL VBAT). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair open in COIL PWR circuit to front coil. Clear PCM memory and repeat **QUICK TEST** .

WARNING: Unless otherwise instructed, PCM must not be connected to breakout box when performing ignition system testing.

24) Check C3 Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J10 (LC3C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, go to step 32).

25) Check C4 Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J18 (LC4C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, go to step 34).

26) Check C3 Circuit At PCM Turn ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install a second EEC-V Breakout Box (014-000950). Connect PCM to second breakout box. Turn ignition on. Measure voltage between breakout box test pins J7 (B-) and test pin No. 78 at second breakout box. If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C3 circuit.

27) Check C4 Circuit At PCM Leave ignition on. Measure voltage between breakout box test pins J7 (B-) and test pin No 104 at second breakout box. If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C4 circuit.

28) Check C3 Circuit At Coil Turn ignition off. Disconnect left coil from diagnostic harness coil tee. Turn ignition on. Measure voltage between breakout box test pins J10 (LC3C) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 36).

29) Check C4 Circuit At Coil Leave ignition on. Measure voltage between breakout box test pins J18 (LC4C) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 37).

30) Check C3 Circuit At Coil While Cranking Connect positive lead of EI Diagnostic Harness (007-00059) to battery positive terminal. Connect incandescent test light between breakout box test pins J1 (B+) and J10 (LC3C). Crank engine. If test light blinks brightly once every engine revolution, go to next

step. If test light does not blink as indicated, replace PCM and repeat **QUICK TEST** .

31) Check C4 Circuit At Coil While Cranking Connect incandescent test light between breakout box test pins J1 (B+) and J18 (LC4C). Crank engine. If test light blinks brightly once every engine revolution, replace left coil pack and repeat **QUICK TEST** . If test light does not blink as indicated, replace PCM and repeat QUICK TEST.

32) Check Left Coil Pack Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J10 (C3C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace front coil pack. Clear PCM memory and repeat **QUICK TEST** .

33) Check C3 Circuit Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J10 (C3C) and J7 (B-). If resistance is less than 10,000 ohms, repair short to ground in C3 circuit. If resistance is 10,000 ohms or more, replace PCM. Repeat **QUICK TEST** .

NOTE: If C3 circuit is shorted to ground, coil damage may occur.

34) Check C4 Circuit Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J18 (LC4C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace front coil pack. Clear PCM memory and repeat **QUICK TEST** .

35) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J18 (LC4C) and J7(B-). If resistance is less than 10,000 ohms, repair C4 circuit short to ground. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** .

NOTE: If C4 circuit is shorted to ground, coil damage may occur.

36) Turn ignition on. Measure voltage between breakout box test pins J10 (LC3C) and J7 (B-). If voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volts or more, repair C3 circuit short to power and repeat QUICK TEST.

37) Check C3 Circuit Turn ignition off. Disconnect PCM from vehicle harness connector. Turn ignition on. Measure voltage between breakout box test pins J18 (LC4C) and J7 (B-). If DC voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volt or more, repair C4 circuit short to power. Clear PCM memory and repeat QUICK TEST.

38) Check Right Spark Plugs & Wires Turn ignition off. Check right side spark plugs and wires for damage or wear. Check all wiring harnesses and connectors damage, burned insulation or poor connections. Repair or replace as necessary and repeat **QUICK TEST** . If no faults are found, go to next step.

39) Check For COIL PWR At Right Coil Turn ignition off. Connect EI Diagnostic Harness (007-00059) to Breakout Box (014-000950). Use appropriate overlay. Connect right coil tee. Connect diagnostic harness negative lead to battery negative terminal. Leave positive lead disconnected. Set diagnostic harness box type switch to 8-cylinder position. Turn ignition on. Measure voltage between breakout box test pins J5 (COIL VBAT) and J7 (B-). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair open in COIL PWR circuit. Clear PCM memory and repeat **QUICK TEST** .

WARNING: Unless otherwise instructed, PCM must not be connected to breakout box when performing ignition system testing.

40) Check C1 Circuit At Right Coil Pack Turn ignition on. Measure voltage between breakout box test pins J3 (RC1C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, go to step 48).

41) Check C2 Circuit At Right Coil Pack Turn ignition on. Measure voltage between breakout box test pins J6 (RC2C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, go to step 50).

42) Check C1 Circuit At PCM Turn ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install a second EEC-V Breakout Box (014-000950). Connect PCM to second breakout box. Turn ignition on. Measure voltage between breakout box test pin J7 (B-) and test pin No. 26 (RC1) at second breakout box. If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C1 circuit.

43) Check C2 Circuit At PCM Leave ignition on. Measure voltage between breakout box test pins J7 (B-) and test pin No. 52 (RC2) at second breakout box. If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C2 circuit.

44) Check C1 Circuit At Coil Turn ignition off. Disconnect rear coil from diagnostic harness coil tee. Turn ignition on. Measure voltage between breakout box test pins J23 (RC1C) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 52).

45) Check C2 Circuit At Coil Leave ignition on. Measure voltage between breakout box test pins J6 (RC2C) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 53).

46) Check C1 Circuit At Coil While Cranking Connect positive lead of EI Diagnostic Harness (007-00059) to battery positive terminal. Connect incandescent test light between breakout box test pins J1 (B+) and J3 (RC1C). Crank engine. If test light blinks brightly once every engine revolution, go to next step. If test light does not blink as indicated, replace PCM and repeat **QUICK TEST** .

47) Check C2 Circuit At Coil While Cranking Connect incandescent test light between breakout box test pins J1 (B+) and J6 (RC2C). Crank engine. If test light blinks brightly once every engine revolution, replace rear coil pack and repeat **QUICK TEST** . If test light does not blink as indicated, replace PCM and repeat QUICK TEST.

48) Check C1 Circuit Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J3 (RC1C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace rear coil pack. Clear PCM memory and repeat **QUICK TEST** .

49) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J3 (RC1C) and J7 (B-). If resistance is less than 10,000 ohms, repair short to ground in C1 circuit. If resistance is 10,000 ohms or more, replace PCM. Repeat **QUICK TEST** .

NOTE: If C1 circuit is shorted to ground, coil damage may occur.

50) Check C2 Circuit Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J6 (RC2C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace rear coil pack. Clear PCM memory and repeat

QUICK TEST .

51) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J6 (RC2C) and J7 (B-). If resistance is less than 10,000 ohms, repair C2 circuit short to ground. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** .

NOTE: If C2 circuit is shorted to ground, coil damage may occur.

52) Check C1 Circuit Turn ignition on. Measure voltage between breakout box test pins J3 (RC1C) and J7 (B-). If voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volts or more, repair C1 circuit short to power and repeat QUICK TEST.

53) Check C2 Circuit Turn ignition off. Disconnect PCM from vehicle harness connector. Turn ignition on. Measure voltage between breakout box test pins J6 (RC2C) and J7 (B-). If DC voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volt or more, repair C2 circuit short to power. Clear PCM memory and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 53) to step 60). No test procedures have been omitted.

60) DTC P0350, P0351, P0352 & P0353 Using a spark tester, check for spark at all spark plug wires while cranking engine. If consistent spark is present at all spark plug wires, system is okay and testing is complete. If consistent spark is not present, go to next step.

61) Check Secondary Ignition Check spark plugs, spark plug wires and coils for damage, looseness or shorting. Repair or replace as necessary. If secondary ignition looks okay, go to next step.

62) Check For COIL PWR At Coil Turn ignition off. Install EI Diagnostic Harness (007-00059) to Breakout Box (014-000950) and ICM. Use appropriate overlay. Connect (Blue) coil tee. Connect diagnostic harness negative lead to battery negative terminal. Leave positive lead disconnected. Set diagnostic harness box type switch to 4/6-cylinder position. Turn ignition on. Measure voltage between breakout box test pins J5 (COIL PWR) and J7 (B-). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair open in COIL PWR circuit. Clear PCM memory and repeat **QUICK TEST** .

WARNING: Unless otherwise instructed, PCM must not be connected to breakout box when performing ignition system testing.

63) Check C1 Circuit At Coil Pack Turn ignition on. Measure voltage as follows:

- For horizontal connector coil pack, between breakout box test pins J3 (C1C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J6 (C1C) and J7 (B-).

If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, go to step 75).

64) Check C2 Circuit At Coil Pack Turn ignition on. Measure voltage as follows:

- For horizontal connector coil pack, between breakout box test pins J6 (C2C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J3 (C2C) and J7 (B-).

If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, go to step 77).

65) Check C3 Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J10 (C3C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, go to step 79).

66) Check C1 Circuit At PCM Turn ignition off. Connect PCM wiring harness connector to breakout box. Turn ignition on. Measure voltage between breakout box test pins J7 (B-) and J26 (C1). If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C1 circuit and repeat **QUICK TEST** .

67) Check C2 Circuit At PCM Leave ignition on. Measure voltage between breakout box test pins J7 (B-) and J52 (C2). If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C2 circuit.

68) Check C3 Circuit At PCM Leave ignition on. Measure voltage between breakout box test pins J7 (B-) and J78 (C3). If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C3 circuit.

69) Check C1 Circuit At Coil Turn ignition off. Disconnect coil from diagnostic harness coil tee. Turn ignition on. Measure voltage as follows:

- For horizontal connector coil pack, between breakout box test pins J3 (C1C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J6 (C1C) and J7 (B-).

If DC voltage is less than 0.5 volts, go to next step. If voltage is 0.5 volts or more, go to step 81).

70) Check C2 Circuit At Coil Leave ignition on. Measure voltage as follows:

- For horizontal connector coil pack, between breakout box test pins J6 (C2C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J3 (C2C) and J7 (B-).

If DC voltage is less than 0.5 volts, go to next step. If voltage is 0.5 volts or more, go to step 82).

71) Check C3 Circuit At Coil Leave ignition on. Measure voltage between breakout box test pins J10 (C3C) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 83).

72) Check C1 Circuit At Coil While Cranking Connect positive lead of EI Diagnostic Harness (007-00059) to battery positive terminal. Connect incandescent test light as follows:

- For horizontal connector coil pack, between breakout box test pins J1 (B+) and J3 (C1C).
- For vertical connector coil pack, between breakout box test pins J1 (B+) and J6 (C1C).

Crank engine. If test light blinks brightly once every engine revolution, go to next step. If test light does not blink as indicated, replace PCM and repeat **QUICK TEST** .

73) Check C2 Circuit At Coil While Cranking Connect incandescent test light as follows:

- For horizontal connector coil pack, between breakout box test pins J1 (B+) and J6 (C2C).
- For vertical connector coil pack, between breakout box test pins J1 (B+) and J3 (C2C).

Crank engine. If test light blinks brightly once every engine revolution, go to next step. If test light does not blink as indicated, replace PCM and repeat **QUICK TEST** .

74) Check C3 Circuit At Coil While Cranking Connect incandescent test light between breakout box test pins J1 (B+) and J10 (C3C). Crank engine. If test light blinks brightly once every engine revolution, replace coil pack and repeat **QUICK TEST** . If test light does not blink as indicated, replace PCM and repeat QUICK TEST.

75) Check C1 Circuit For Short To Ground Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins as follows:

- For horizontal connector coil pack, between breakout box test pins J3 (C1C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J6 (C1C) and J7 (B-).

If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace coil pack. Clear PCM memory and repeat **QUICK TEST** .

76) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins as follows:

- For horizontal connector coil pack, between breakout box test pins J3 (C1C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J6 (C1C) and J7 (B-).

If resistance is less than 10,000 ohms, repair short to ground in C1 circuit. If resistance is 10,000 ohms or more, replace PCM. Repeat **QUICK TEST** .

NOTE: If C1 circuit is shorted to ground, coil damage may occur.

77) Check Coil No. 2 Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance as follows:

- For horizontal connector coil pack, between breakout box test pins J6 (C2C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J3 (C2C) and J7 (B-).

If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace coil pack. Clear PCM memory and repeat **QUICK TEST** .

78) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance as follows:

- For horizontal connector coil pack, between breakout box test pins J6 (C2C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J3 (C2C) and J7 (B-).

If resistance is less than 10,000 ohms, repair C2 circuit short to ground. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** .

NOTE: If C1 circuit is shorted to ground, coil damage may occur.

79) Check C3 Circuit Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J7 (B-) and J10 (C3C). If resistance is less than 2000 ohms, go

to next step. If resistance is 2000 ohms or more, replace coil pack. Clear PCM memory and repeat **QUICK TEST** .

80) Turn ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J7 (B-) and J10 (C3C). If resistance is less than 10,000 ohms, repair C3 circuit short to ground. If resistance is 10,000 ohms or more, replace PCM. Clear PCM memory and repeat **QUICK TEST** .

81) Check C1 Circuit Turn ignition off. Disconnect PCM wiring harness connector. Turn ignition on. Measure voltage as follows:

- For horizontal connector coil pack, between breakout box test pins J3 (C1C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J6 (C1C) and J7 (B-).

If voltage is 0.5 volts or more, repair C1 circuit short to power. If DC voltage is less than 0.5 volts, replace PCM. Clear PCM memory and repeat **QUICK TEST** .

82) Check C2 Circuit Turn ignition off. Disconnect PCM wiring harness connector. Turn ignition on. Measure voltage as follows:

- For horizontal connector coil pack, between breakout box test pins J6 (C2C) and J7 (B-).
- For vertical connector coil pack, between breakout box test pins J3 (C2C) and J7 (B-).

If voltage is 0.5 volts or more, repair C2 circuit short to power. If DC voltage is less than 0.5 volts, replace PCM. Clear PCM memory and repeat **QUICK TEST** .

83) Check C3 Circuit Turn ignition off. Disconnect PCM wiring harness connector. Measure voltage between breakout box test pins J7 (B-) and J10 (C3C). If voltage is 0.5 volts or more, repair C3 circuit short to power. If DC voltage is less than 0.5 volts, replace PCM. Clear PCM memory and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 83) to step 90). No test procedures have been omitted.

90) DTC P0350, P0351, P0352, P0353 & P0354 Using a spark tester, check for spark at all spark plug wires while cranking engine. If consistent spark is present at all spark plug wires, ignition system is okay. Go to step 50) of **CIRCUIT TEST Z** . If consistent spark is not present, go to next step.

91) Check For Spark At Right Spark Plugs If spark is present at right spark plugs, go to next step. If spark is not present at right spark plugs, go to step 108).

92) Check Left Spark Plugs & Wires Turn ignition off. Check left side spark plugs and wires for damage or wear. Check all wiring harnesses and connectors damage, burned insulation or poor connections. Check sensor shield connector. Repair or replace as necessary. If no faults are found, go to next step.

93) Check For COIL PWR At Left Coil Turn ignition off. Install EI Diagnostic Harness (007-00059) to Breakout Box (014-000950) and ICM. Use appropriate overlay. Connect left (Yellow) coil tee. Connect diagnostic harness negative lead to battery negative terminal. Leave positive lead disconnected. Set diagnostic harness box type switch to 8-cylinder position. Turn ignition on. Measure voltage between breakout box test pins J11 (COIL VBAT) and J7 (B-). If voltage is 10 volts or more, go to next step. If

voltage is less than 10 volts, repair open in COIL PWR circuit. Clear PCM memory and repeat **QUICK TEST** .

94) Check C3 Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J10 (LC3C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, go to step 102).

95) Check C4 Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J18 (LC4C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, go to step 104).

96) Check C3 Circuit At PCM Turn ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install a second EEC-V Breakout Box (014-000950). Connect PCM to second breakout box. Turn ignition on. Measure voltage between breakout box test pins J7 (B-) and test pin No. 78 at second breakout box. If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C3 circuit.

97) Check C4 Circuit At PCM Leave ignition on. Measure voltage between breakout box test pins J7 (B-) and test pin No 104 (LC4) at second breakout box. If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, repair open in C4 circuit.

98) Check C3 Circuit At Coil Turn ignition off. Disconnect left coil from diagnostic harness coil tee. Turn ignition on. Measure voltage between breakout box test pins J10 (LC3) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 106).

99) Check C4 Circuit At Coil Leave ignition on. Measure voltage between breakout box test pins J18 (LC4C) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go tostep 107).

100) Check C3 Circuit At Coil While Cranking Connect positive lead of EI Diagnostic Harness (007-00059) to battery positive terminal. Connect incandescent test light between breakout box test pins J1 (B+) and J10 (LC3C). Crank engine. If test light blinks brightly once every engine revolution, go to next step. If test light does not blink as indicated, replace PCM and repeat **QUICK TEST** .

101) Check C4 Circuit At Coil While Cranking Connect incandescent test light between breakout box test pins J1 (B+) and J18 (LC4C). Crank engine. If test light blinks brightly once every engine revolution, replace cylinder No. 2 coil pack and repeat **QUICK TEST** . If test light does not blink as indicated, replace PCM and repeat QUICK TEST.

102) Check Left Coil Pack Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J10 (C3C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace cylinder No. 2 coil pack. Clear PCM memory and repeat **QUICK TEST** .

103) Check C3 Circuit Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J10 (C3C) and J7 (B-). If resistance is less than 10,000 ohms, repair short to ground in C3 circuit. If resistance is 10,000 ohms or more, replace PCM. Repeat **QUICK TEST** .

NOTE: If C3 circuit is shorted to ground, coil damage may occur.

104) Check C4 Circuit Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J18 (LC4C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace cylinder No. 2 coil pack. Clear PCM memory

and repeat **QUICK TEST** .

105) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J18 (LC4C) and J7(B-). If resistance is less than 10,000 ohms, repair C4 circuit short to ground. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** .

NOTE: If C4 circuit is shorted to ground, coil damage may occur.

106) Check C3 Circuit Turn ignition off. Disconnect PCM from vehicle harness connector. Turn ignition on. Measure voltage between breakout box test pins J10 (LC3C) and J7 (B-). If DC voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If DC voltage is 0.5 volt or more, repair C3 circuit short to power. Clear PCM memory and repeat QUICK TEST.

107) Check C4 Circuit Turn ignition off. Disconnect PCM wiring harness connector. Turn ignition on. Measure voltage between breakout box test pins J18 (LC4C) and J7 (B-). If voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volts or more, repair C4 circuit short to power and repeat QUICK TEST.

108) Check Right Spark Plugs & Wires Turn ignition off. Check right side spark plugs and wires for damage or wear. Check all wiring harnesses and connectors damage, burned insulation or poor connections. Repair or replace as necessary and repeat **QUICK TEST** . If no faults are found, go to next step.

109) Check For COIL PWR At Right Coil Turn ignition off. Connect right coil tee. Turn ignition on. Measure voltage between breakout box test pins J5 (COIL VBAT) and J7 (B-). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair open in COIL PWR circuit to right coil. Clear PCM memory and repeat **QUICK TEST** .

WARNING: Unless otherwise instructed, PCM must not be connected to breakout box when performing ignition system testing.

110) Check C1 Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J3 (RC1C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, go to step 118).

111) Check C2 Circuit At Coil Pack Turn ignition on. Measure voltage between breakout box test pins J6 (RC2C) and J7 (B-). If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, go to step 120).

112) Check C1 Circuit At PCM Turn ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install a second EEC-V Breakout Box (014-000950). Connect PCM to second breakout box. Turn ignition on. Measure voltage between breakout box test pins J7 (B-) and test pin No. 26 (RC1) at second breakout box. If DC voltage is more than 10.0 volts, go to next step. If DC voltage is 10.0 volts or less, repair open in C1 circuit.

113) Check C2 Circuit At PCM Leave ignition on. Measure voltage between breakout box test pins J7 (B-) and test pin No. 52 (RC2) at second breakout box. If DC voltage is more than 10.0 volts, go to next step. If voltage is 10.0 volts or less, repair open in C2 circuit.

114) Check C1 Circuit At Coil Turn ignition off. Disconnect right coil from diagnostic harness coil tee. Turn ignition on. Measure voltage between breakout box test pins J3 (RC1C) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 122).

115) Check C2 Circuit At Coil Leave ignition on. Measure voltage between breakout box test pins J6 (RC2C) and J7 (B-). If DC voltage is less than 0.5 volt, go to next step. If DC voltage is 0.5 volt or more, go to step 123).

116) Check C1 Circuit At Coil While Cranking Turn ignition off. Reconnect coil lead. Connect positive lead of EI Diagnostic Harness (007-00059) to battery positive terminal. Connect incandescent test light between breakout box test pins J1 (B+) and J3 (RC1C). Using starter, crank engine. If test light blinks brightly once every engine revolution, go to next step. If test light does not blink as indicated, replace PCM and repeat **QUICK TEST** .

117) Check C2 Circuit At Coil While Cranking Connect incandescent test light between breakout box test pins J1 (B+) and J6 (RC2). Using starter, crank engine. If test light blinks brightly once every engine revolution, replace cylinder No. 1 coil pack and repeat **QUICK TEST** . If test light does not blink as indicated, replace PCM and repeat QUICK TEST.

118) Check C1 Circuit Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J3 (RC1C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace cylinder No. 1 coil pack. Clear PCM memory and repeat **QUICK TEST** .

119) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J3 (RC1C) and J7 (B-). If resistance is less than 10,000 ohms, repair short to ground in C1 circuit. If resistance is 10,000 ohms or more, replace PCM. Repeat **QUICK TEST** .

NOTE: If C1 circuit is shorted to ground, coil damage may occur.

120) Check C2 Circuit Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J6 (RC2C) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace cylinder No. 1 coil pack. Clear PCM memory and repeat **QUICK TEST** .

121) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J6 (RC2C) and J7 (B-). If resistance is less than 10,000 ohms, repair C2 circuit short to ground. If resistance is 10,000 ohms or more, replace PCM and repeat **QUICK TEST** .

NOTE: If C2 circuit is shorted to ground, coil damage may occur.

122) Check C1 Circuit Turn ignition off. Disconnect PCM wiring harness connector.Turn ignition on. Measure voltage between breakout box test pins J3 (RC1C) and J7 (B-). If voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volts or more, repair C1 circuit short to power and repeat QUICK TEST.

123) Check C2 Circuit Turn ignition off. Disconnect PCM from vehicle harness connector. Turn ignition on. Measure voltage between breakout box test pins J6 (RC2C) and J7 (B-). If DC voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volt or more, repair C2 circuit short to power. Clear PCM memory and repeat QUICK TEST.

CIRCUIT TEST JF - INTEGRATED IGNITION COIL ON PLUG FAILURE

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Ignition Coils.
- Ignition Coils Harness.
- Powertrain Control Module (PCM).

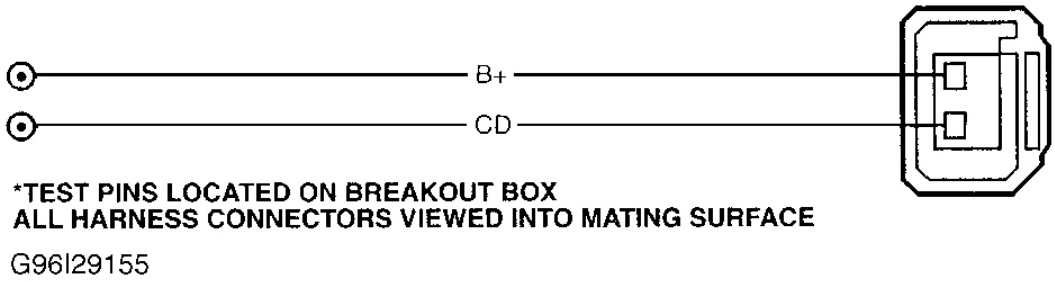


Fig. 74: Coil On Plug Ignition Coil Test Circuit & Connector Terminals

1) Continuous Memory DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P0359 & P0360 Check spark plug and connectors for damage, looseness or shorting. Check coils and coil boots for damage, looseness or shorting. Repair or replace as necessary. If no faults are found, go to next step.

2) Check Resistance Between Coil Pins & Spring Terminal Turn ignition off. Remove suspect ignition coil. Measure resistance between B+ circuit terminal and coil spring. Measure resistance between CD circuit terminal and coil spring. If both resistance measurements are 4000-10,000 ohms, go to next step. If resistance is not as specified, replace coil and repeat **QUICK TEST** .

3) Check Resistance Between Coil Pins Leave ignition off. Measure resistance between coil terminals. If resistance is 0.3-0.8 ohms, go to next step. If resistance is not as specified, replace coil and repeat **QUICK TEST** .

4) Check Coil B+ Circuit Signal Leave ignition off. Disconnect PCM 104-pin connector. Turn ignition on. Measure voltage between ground and suspect coil B+ terminal. If voltage is 10 volts or more, turn ignition off. Reconnect PCM harness connector and go to next step. If voltage is less than 10 volts, check fuses and B+ circuit for open or short. Repair as necessary and repeat **QUICK TEST** .

5) Perform QUICK TEST If DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P0359 or P0360 are present, go to step 7). If specified DTCs are not present, go to next step.

6) If DTC P0340 and P0350 are present, go to step 1) of **CIRCUIT TEST DR** . If specified DTCs are not present, go to step 5) of **CIRCUIT TEST HD** .

7) Check For Power To Coil Turn ignition off. Install EI Diagnostic Harness (007-00059) to Breakout Box (014-000950). Use appropriate overlay. Connect coil tee. Connect diagnostic harness negative lead to battery negative terminal. Leave positive lead disconnected. Set diagnostic harness box type switch to "8" cylinder position. Turn ignition on. Measure voltage between breakout box test pins J31 (COIL+) and J7 (B-). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair open in COIL PWR circuit. Clear PCM memory and repeat **QUICK TEST** .

8) Measure voltage between breakout box test pins J32 (COIL-) and J7 (B-). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, go to step 11).

9) Check For Coil At Connector Turn ignition off. Disconnect coil tee. Turn ignition on. Measure voltage between breakout box test pins J32 (COIL-) and J7 (B-). If voltage is 0.5 volts or less, go to next step. If voltage is more than 0.5 volts, go to step 13).

10) Check Coil While Cranking Connect positive lead of EI Diagnostic Harness (007-00059) to battery positive terminal. Connect incandescent test light between breakout box test pins J1 (B+) and J32 (COIL-). Crank engine. If test light blinks brightly once every engine revolution, go to next step. If test light does not blink as indicated, replace PCM and repeat **QUICK TEST** .

11) Check For Coil Short To Ground Turn ignition off. Disconnect coil from diagnostic harness coil tee. Measure resistance between breakout box test pins J32 (COIL-) and J7 (B-). If resistance is less than 2000 ohms, go to next step. If resistance is 2000 ohms or more, replace coil pack. Clear PCM memory and repeat **QUICK TEST** .

12) Leave ignition off. Disconnect PCM wiring harness connector. Measure resistance between breakout box test pins J32 (COIL-) and J7 (B-). If resistance is less than 10,000 ohms, repair short to ground in C1 circuit. If resistance is 10,000 ohms or more, replace PCM. Repeat **QUICK TEST** .

13) Check Coil For Short To Power Turn ignition off. Disconnect PCM from vehicle harness connector. Turn ignition on. Measure voltage between breakout box test pins J32 (Coil-) and J7 (B-). If DC voltage is less than 0.5 volt, replace PCM and repeat **QUICK TEST** . If voltage is 0.5 volt or more, repair circuit short to power. Clear PCM memory and repeat QUICK TEST.

CIRCUIT TEST KA - FUEL PUMP RELAY

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Fuel pump relay.
- Inertia Fuel Shutoff (IFS) switch.
- Wiring harness circuits (B+, FUEL PUMP, FPM, POWER-TO-PUMP and VPWR).
- Powertrain Control Module (PCM).

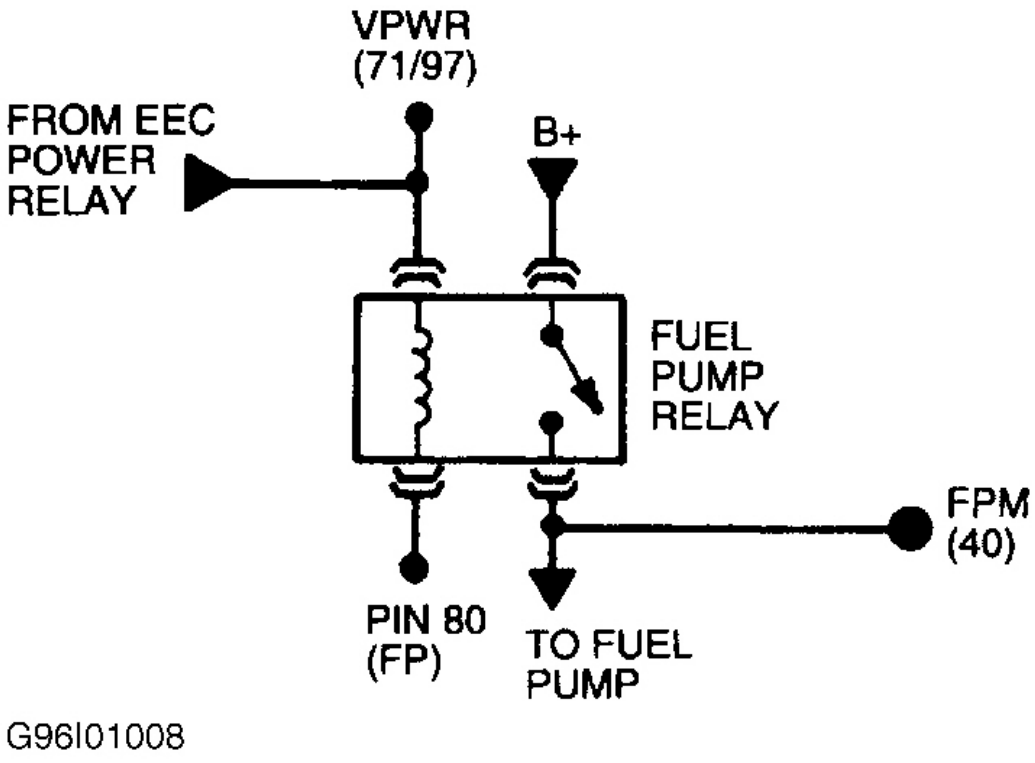


Fig. 75: Typical Fuel Pump Relay Schematic

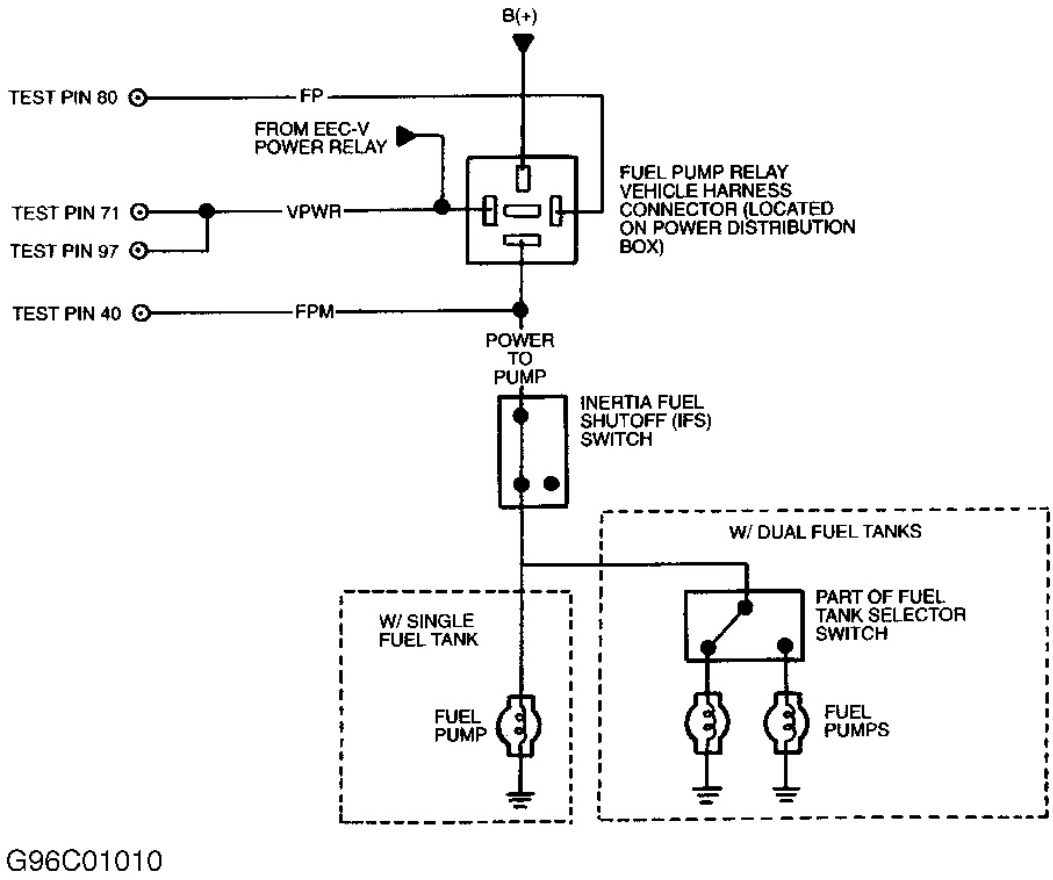


Fig. 76: Fuel System Test Circuit & Connector Terminals

1) KOEO & KOER DTC P0230 Fuel pump primary circuit has been indicated. Possible causes are as follows:

- Open or shorted circuit.
- Faulty fuel pump relay.
- Faulty PCM.

For Continuous Memory DTC P0230, go to step 40). Disconnect fuel pump relay wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal at connector and chassis ground. If 10.5 volts or more are present, go to next step. If less than 10.5 volts are present, repair open in VPWR circuit between EEC power relay and fuel pump relay.

NOTE: To Identify fuel pump relay terminals, refer to numbers molded on relay.

2) Check Fuel Pump Relay Turn ignition off. Leave fuel pump relay disconnected. Measure resistance between terminals No. 1 or No. 85 and all other terminals.

Resistance should be either 40-120 ohms, or greater than 10,000 ohms. Replace fuel pump relay if resistance is not as specified. If resistance is okay, go to next step.

3) Check Fuel Pump Circuit Leave ignition off and fuel pump relay disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 80 and chassis ground. If voltage is one volt or less, go to next step. If voltage is more than one volt, repair short to power in FUEL PUMP circuit and repeat **QUICK TEST** .

4) Leave ignition off and fuel pump relay disconnected. Disconnect scan tester from Data Link Connector (DLC). Measure resistance between test pin No. 80 and test pins No. 51, 91 and 103. If each resistance measurement is more than 10,000 ohms, go to next step. If any resistance measurement is 10,000 ohms or less, repair short circuit and repeat **QUICK TEST** .

5) Leave ignition off and fuel pump relay disconnected. Measure resistance between FUEL PUMP terminal at fuel pump relay wiring harness connector and test pin No. 80 at breakout box. If resistance is less than 5 ohms and DTC P0231 or P0232 is present with DTC P0230, go to next step. If resistance is less than 5 ohms and specified DTCs are not present, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open circuit and repeat QUICK TEST.

6) Check PCM Fuel Pump Circuit Leave ignition off. Reconnect PCM and fuel pump relay. Connect scan tester to DLC. Turn ignition on. Using scan tester, access FPA PID or FPF PID. If scan tester indicates YES or ON, replace PCM and repeat **QUICK TEST** . If scan tester does not indicate YES or ON, go to next step.

7) Leave scan tester accessed to FPA PID or FPF PID. Using starter, crank engine. If scan tester indicates YES or OFF during crank, replace PCM and repeat **QUICK TEST** . If scan tester does not indicate YES or ON during crank, fuel pump primary circuit is okay. If DTC P0231 is present, go to step 20). If DTC P0232 is present, go to step 10).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 7) to step 10). No test procedures have been omitted.

10) KOEO & KOER DTC P0232 If engine starts, go to next step. If engine does not start, go to step 15). For Continuous Memory DTC P0232, go to step 30).

11) Check Fuel Pump Turn ignition on for 5 seconds. Listen for operational noise from fuel pump. If fuel pump can be heard, go to next step. If fuel pump cannot be heard, go to step 13).

12) Check Fuel Pump Relay Turn ignition off. Disconnect fuel pump relay. Turn ignition on. Listen for operational noise from fuel pump. If fuel pump operates, repair short to power in FPM or POWER-TO-PUMP circuit and repeat **QUICK TEST** . If fuel pump still does not operate, replace fuel pump relay and repeat QUICK TEST.

13) Check FPM Circuit Turn ignition off. Leave fuel pump relay disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 40 and POWER-TO-PUMP terminal at fuel pump relay wiring harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

14) Check PCM Fuel Pump Circuit Leave ignition off. Reconnect PCM and fuel pump relay. Connect scan tester to DLC. Turn ignition on. Using scan tester, access FPM PID. If scan tester indicates OFF, fuel pump primary circuit is okay and testing is complete. If scan tester does not indicate OFF, replace

PCM and repeat **QUICK TEST** .

15) Check IFS Switch Turn ignition off. Locate IFS switch in trunk near left hinge. Measure resistance between terminals "C" and NC of IFS switch. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, reset or replace IFS switch and repeat **QUICK TEST** .

16) Leave ignition off and IFS switch disconnected. Disconnect fuel pump relay. Measure resistance between POWER-TO-PUMP terminal at fuel pump relay connector and POWER-TO-PUMP terminal at IFS connector. If resistance is less than 7 ohms, go to next step. If resistance is 7 ohms or more, repair open in POWER-TO-PUMP circuit and repeat **QUICK TEST** .

17) Leave ignition off, fuel pump relay and IFS switch disconnected. Measure resistance between fuel pump motor ground circuit at connector and chassis ground. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in fuel pump motor ground circuit and repeat **QUICK TEST** .

18) Leave ignition off, fuel pump relay and IFS switch disconnected. Measure resistance between POWER-TO-PUMP terminal at fuel pump connector and POWER-TO-PUMP terminal at IFS connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in POWER-TO-PUMP circuit and repeat **QUICK TEST** .

19) Leave ignition off, fuel pump relay and IFS switch disconnected. Measure resistance between fuel pump motor terminals. If resistance is less than 10 ohms, fuel pump circuits are okay and testing is complete. If resistance is 10 ohms or more, replace fuel pump and repeat **QUICK TEST** .

20) KOEO & KOER DTC P0231 If engine starts, replace PCM and repeat **QUICK TEST** . If engine does not start, go to next step.

21) Check B+ To Fuel Pump Relay Turn ignition off. Disconnect fuel pump relay wiring harness connector. Measure voltage between chassis ground and B+ terminal at fuel pump relay wiring harness connector. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, check circuit fuse. If fuse is okay, repair open in B+ circuit and repeat **QUICK TEST** .

22) Check POWER-TO-PUMP Circuit Resistance Leave ignition off and fuel pump relay disconnected. Measure resistance between negative battery terminal and POWER-TO-PUMP terminal at fuel pump relay wiring harness connector. If resistance is less than 10 ohms, replace fuel pump relay and repeat **QUICK TEST** . If resistance is 10 ohms or more, repair open in POWER-TO-PUMP circuit and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 22) to step 30). No test procedures have been omitted.

30) Continuous Memory DTC P0232 Turn ignition off. Connect scan tester to Data Link Connector. Using scan tester, access FRM PID. Observe PID for indication of fault while wiggling and bending POWER-TO-PUMP circuit between fuel pump relay and fuel pump. Fault will be indicated by FPM PID turning on. Wiggle and bend FPM circuit between PCM and POWER-TO-PUMP circuit splice. Wiggle and bend fuel pump ground circuit at fuel pump. Check connectors for clean tight connection. If any faults are found, isolate and repair as necessary. If no faults are found, fault cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 30) to step 35). No test procedures have been omitted.

35) Continuous Memory DTC P0231 Turn ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Connect jumper wire between test pins No. 77 (PWR GND) and 80 (FP). Connect DVOM between test pins No. 40 (FPM) and 51 (GND). Voltage should be 10 volts or more. Observe DVOM for indication of fault while wiggling and bending B+ circuit to fuel pump relay. Fault will be indicated by sudden change in DVOM voltage. Wiggle and bend POWER-TO-PUMP circuit between fuel pump relay and FPM circuit splice. Lightly tap on fuel pump relay. Check connectors for clean tight connection. If any faults are found, isolate and repair as necessary. If no faults are found, fault cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 35) to step 40). No test procedures have been omitted.

40) Continuous Memory DTC P0230 Turn ignition off. Connect scan tester to Data Link Connector. Turn ignition on and wait 5 seconds. Using scan tester, access FPA PID. Observe PID for indication of fault while wiggling and bending FUEL PUMP circuit between fuel pump relay and PCM. Fault will be indicated by FPA PID turning on. Wiggle and bend FPM circuit between PCM and POWER-TO-PUMP circuit splice. Wiggle and bend VPWR circuit between fuel pump relay and EEC-V power relay. Check connectors for clean tight connection. If any faults are found, isolate and repair as necessary. If no faults are found, fault cannot be duplicate

CIRCUIT TEST KC - FUEL SHUTOFF VALVE RELAY

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Fuel shutoff valve relay.
- Inertia Fuel Shutoff (IFS) switch.
- Wiring harness circuits (B+, FSV, FSVM, Ground, POWER-TO-FUEL SHUTOFF VALVE and VPWR).
- Powertrain Control Module (PCM).

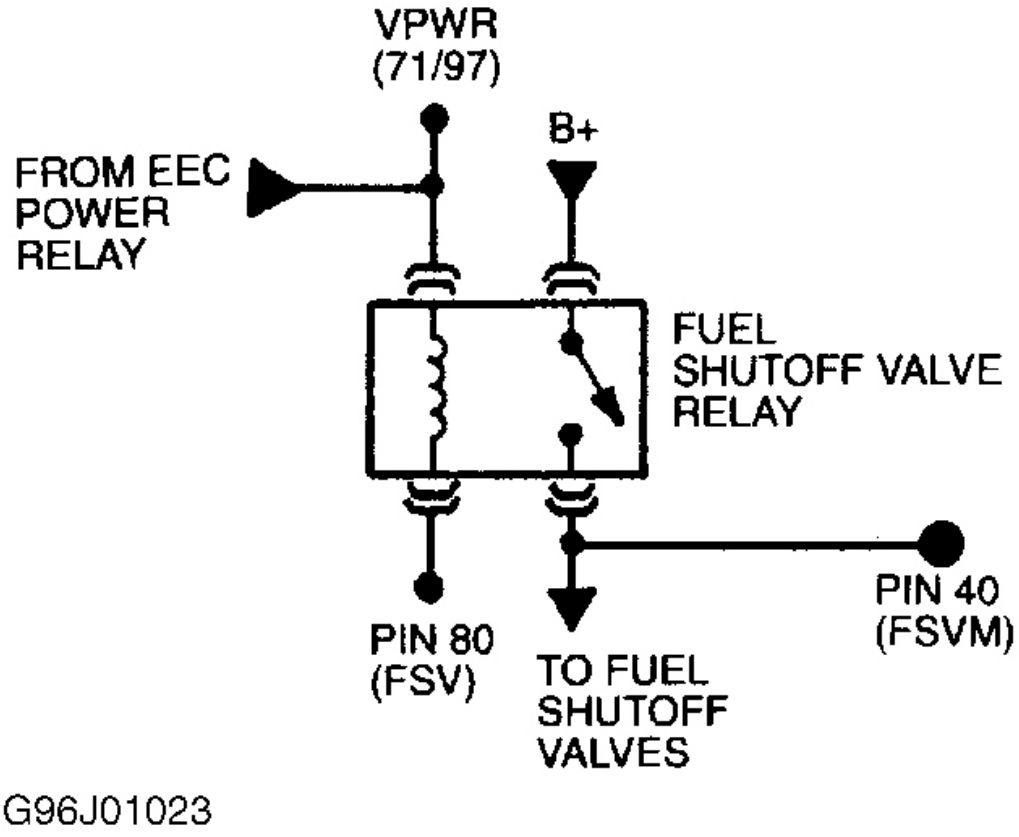


Fig. 77: Typical Fuel Pump Relay Schematic

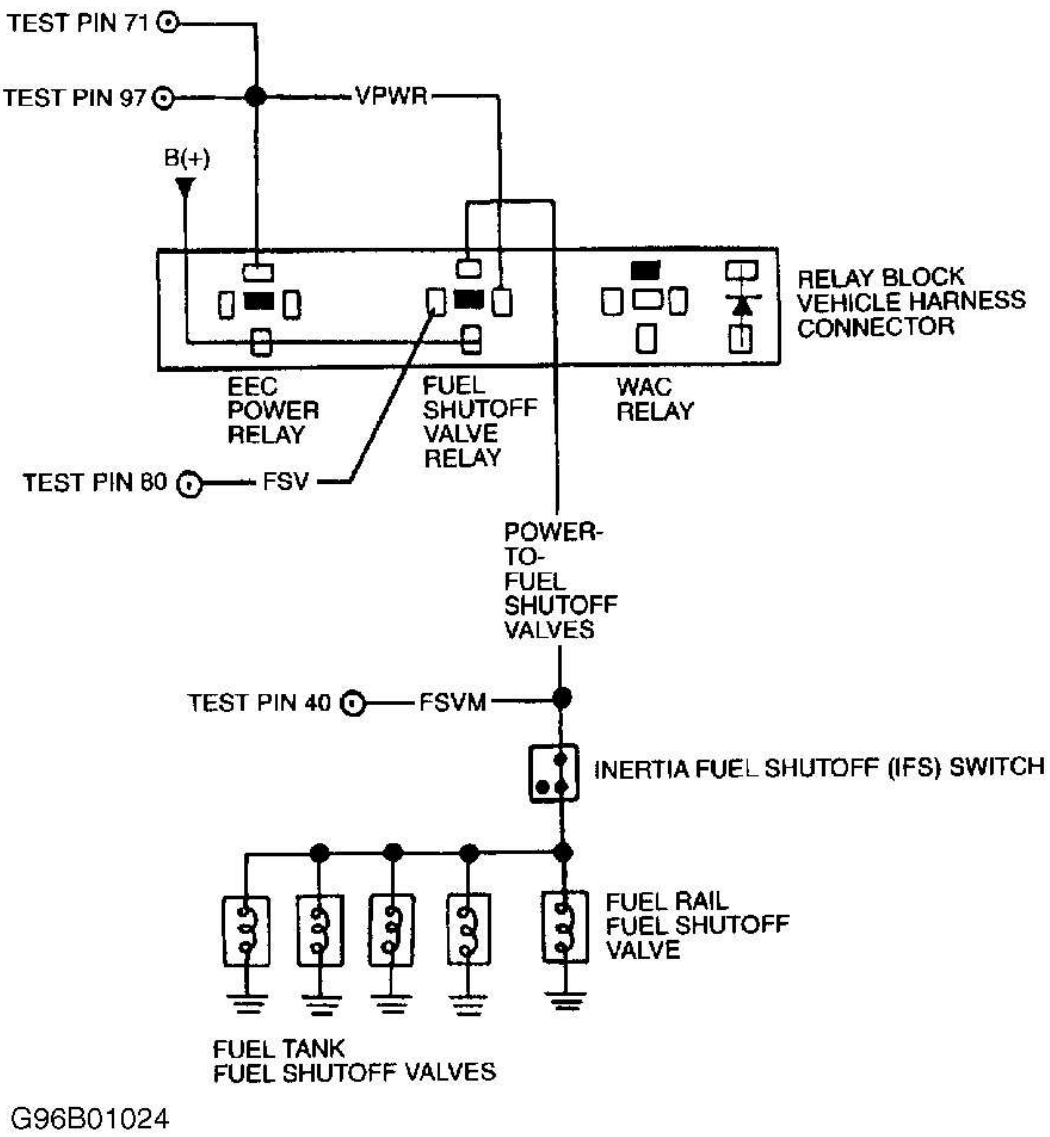


Fig. 78: Fuel Shutoff System Test Circuit & Connector Terminals

1) KOEO & KOER DTC P0230 Fuel shutoff valve primary circuit has been indicated. Possible causes are as follows:

- Open or shorted circuit.
- Faulty fuel shutoff valve relay.
- Faulty PCM.

For Continuous Memory DTC P0230, go to step 40). Disconnect fuel shutoff valve relay wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal at connector and chassis ground.

If 10.5 volts or more are present, go to next step. If less than 10.5 volts are present, repair open in VPWR circuit between EEC power relay and fuel shutoff valve relay.

2) Check Fuel Shutoff Valve Relay Turn ignition off. Leave fuel shutoff valve relay disconnected. Measure resistance between terminals No. 85 and 86 at fuel shutoff valve relay. Resistance should be 40-120 ohms. Measure resistance between terminals No. 30 and 87 at fuel shutoff valve relay. Resistance should be more than 10,000 ohms. If resistance is not as specified, replace fuel shutoff valve relay. If resistance is as specified, go to next step.

3) Check Fuel Shutoff Valve Circuit Leave ignition off and fuel shutoff valve relay disconnected. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 80 (FSV) and chassis ground. If voltage is one volt or less, go to next step. If voltage is more than one volt, repair short to power in FSV circuit and repeat **QUICK TEST** .

4) Leave ignition off and fuel shutoff valve relay disconnected. Disconnect scan tester from Data Link Connector (DLC). Measure resistance between test pin No. 80 (FSV) and test pins No. 51, 103 (PWR GND) and 91 (SIG RTN). If each resistance measurement is more than 10,000 ohms, go to next step. If any resistance measurement is 10,000 ohms or less, repair short circuit and repeat **QUICK TEST** .

5) Leave ignition off and fuel shutoff valve relay disconnected. Measure resistance between FSV terminal at fuel shutoff valve relay wiring harness connector and test pin No. 80 at breakout box. If resistance is less than 5 ohms and DTC P0231 or P0232 is present with DTC 230, go to next step. If resistance is less than 5 ohms and specified DTCs are not present, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open circuit and repeat QUICK TEST.

6) Check PCM Fuel Shutoff Valve Circuit Leave ignition off. Remove breakout box. Reconnect PCM and fuel shutoff valve relay. Connect scan tester to DLC. Turn ignition on. Using scan tester, access FSVF PID. If scan tester indicates YES, replace PCM and repeat **QUICK TEST** . If scan tester does not indicate YES, go to next step.

7) Leave scan tester accessed to FSV PID. Using starter, crank engine. If scan tester indicates YES during crank, replace PCM and repeat **QUICK TEST** . If scan tester does not indicate YES during crank, fuel shutoff valve primary circuit is okay. If DTC P0231 is present, go to step 20). If DTC P0232 is present, go to step 10).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 7) to step 10). No test procedures have been omitted.

10) KOEO & KOER DTC P0232 If engine starts, go to next step. If engine does not start, go to step 15). For Continuous Memory DTC P0232, go to step 30).

11) Check Power To Fuel Shutoff Valve Turn ignition and all accessories off. Disconnect scan tester from DLC (if applicable). Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 40 (FSVM) and 51 (PWR GND) at breakout box. If voltage is more than 1.5 volts, go to next step. If voltage is 1.5 volts or less, go to step 13).

12) Check Fuel Shutoff Valve Relay Turn ignition off. Disconnect fuel shutoff valve relay. Turn ignition on. Measure voltage between test pin No. 40 (FSVM) and 51 (PWR GND) at breakout box. If voltage is less than 1.5 volts, replace fuel shutoff valve relay and repeat **QUICK TEST** . If voltage is 1.5 volts or more, repair short to power in FSVM or POWER-TO-FUEL SHUTOFF VALVE circuit and

repeat QUICK TEST.

13) Check FSVM Circuit Turn ignition off. Leave fuel shutoff valve relay disconnected. Measure resistance between test pin No. 40 and POWER-TO-FUEL SHUTOFF VALVE circuit at fuel pump relay wiring harness connector. If resistance is less than 5 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open circuit and repeat QUICK TEST.

14) Check IFS Switch Turn ignition off. Locate IFS switch in trunk near left hinge. Measure resistance between terminals "C" and NC of IFS switch. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, reset or replace IFS switch and repeat **QUICK TEST** .

15) Check Circuit Continuity Leave ignition off, IFS switch and fuel shutoff valve relay disconnected. Measure resistance of POWER-TO-FUEL SHUTOFF VALVE circuit between fuel shutoff valve relay connector and IFS connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in POWER-TO-FUEL SHUTOFF VALVE circuit between IFS switch and FSVM connection. Clear PCM memory and repeat **QUICK TEST** .

16) Leave ignition off, fuel shutoff valve relay and IFS switch disconnected. Measure resistance between POWER-TO-FUEL SHUTOFF VALVE circuit at IFS connector and chassis ground. If resistance is less than 10 ohms, fault cannot be located and testing is complete. If resistance is 10 ohms or more, repair open circuit and repeat **QUICK TEST** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 16) to step 20). No test procedures have been omitted.

20) DTC P0231 If engine starts, replace PCM and repeat **QUICK TEST** . If engine does not start, go to next step. For Continuous Memory DTC P0231, go to step 35).

21) Check B+ To Fuel Shutoff Valve Relay Turn ignition off. Disconnect fuel shutoff valve relay wiring harness connector. Measure voltage between chassis ground and B+ terminal at wiring harness connector. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, check circuit fuse. If fuse is okay, repair open in B+ circuit and repeat **QUICK TEST** .

22) Check POWER-TO-FUEL SHUTOFF VALVES Circuit Resistance Leave ignition off and fuel shutoff valve relay disconnected. Measure resistance between negative battery terminal and POWER-TO-FUEL SHUTOFF VALVES terminal at wiring harness connector. If resistance is less than 10 ohms, replace fuel shutoff valve relay and repeat **QUICK TEST** . If resistance is 10 ohms or more, repair open in POWER-TO-FUEL SHUTOFF VALVES circuit and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 22) to step 30). No test procedures have been omitted.

30) Continuous Memory DTC P0232 Turn ignition off. Connect scan tester to Data Link Connector (DLC). Using scan tester, access FSVM PID. Observe PID for indication of fault while wiggling and bending POWER-TO-FUEL SHUTOFF VALVES circuit. Fault will be indicated by FSVM PID turning on. Wiggle and bend fuel shutoff valve ground circuit. Check connectors for clean tight connection. If any faults are found, isolate and repair as necessary. If no faults are found, fault cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 30) to step 35). No test procedures have been omitted.

35) Continuous Memory DTC P0231 Turn ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Connect jumper wire between test pins No. 77 (PWR GND) and 80 (FSV). Connect DVOM between test pins No. 40 (FSVM) and 51 (PWR GND). Voltage should be 10 volts or more. Observe DVOM for indication of fault while wiggling and bending B+ circuit to fuel shutoff valve relay. Fault will be indicated by sudden change in DVOM voltage. Wiggle and bend POWER-TO-FUEL SHUTOFF VALVES circuit between fuel shutoff valve relay and FSVM circuit splice. Lightly tap on fuel shutoff valve relay. Check connectors for clean tight connection. If any faults are found, isolate and repair as necessary. If no faults are found, fault cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 35) to step 40). No test procedures have been omitted.

40) Continuous Memory DTC P0230 Turn ignition off. Connect scan tester to Data Link Connector. Turn ignition on and wait 5 seconds. Using scan tester, access FSVF PID. Observe PID for indication of fault while wiggling and bending FUEL shutoff valve circuit between fuel shutoff valve relay and PCM. Fault will be indicated if FSVF PID switches to YES. Wiggle and bend FSV circuit between PCM and fuel shutoff valve relay. Wiggle and bend VPWR circuit between fuel shutoff valve relay and EEC-V power relay. Check connectors for clean tight connection. If any faults are found, isolate and repair as necessary. If no faults are found, fault cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

CIRCUIT TEST KE - IDLE AIR CONTROL (IAC) VALVE

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Throttle linkage.
- Wiring harness circuits (IAC and VPWR).
- Faulty Idle Air Control (IAC) valve.
- Faulty throttle body.
- Faulty Powertrain Control Module (PCM).

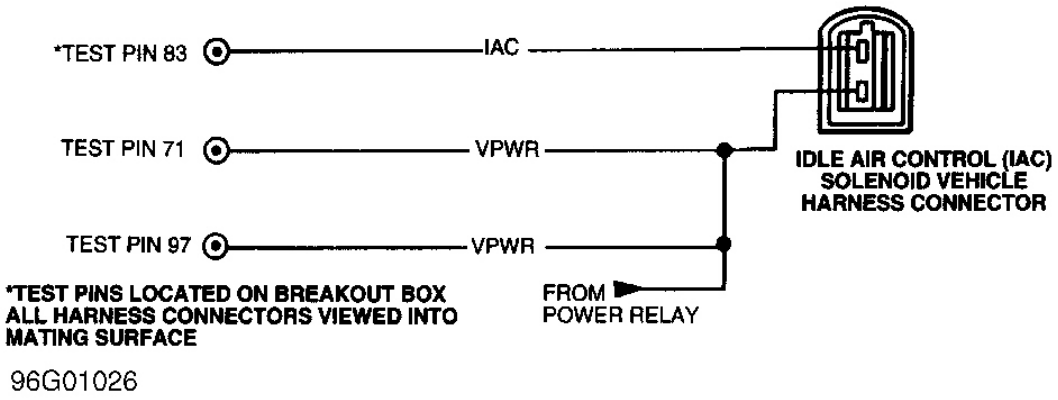


Fig. 79: IAC Circuit & Connector Terminals

1) DTC P0505, P1504 Or P1507 Perform KOER self-test. If DTC P0505, P1504 or P1507 is present, go to next step. If DTC P0505 or P1507 is not present, IAC system is okay and testing is complete.

2) DTC P0505 & P1507 DTC P0505 indicates that IAC system malfunction has been detected. DTC P1504 indicates that IAC circuit malfunction has been detected. DTC P1507 indicates that IAC system under speed fault has been detected. Possible causes are as follows:

- IAC circuit open or shorted to PWR.
- VPWR circuit open.
- Contaminated IAC valve assembly.
- Damaged throttle body.
- Faulty PCM.

Turn ignition off. Disconnect IAC solenoid. Turn ignition on. Measure voltage between VPWR terminal of IAC solenoid wiring harness connector and battery ground terminal. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open VPWR circuit and repeat **QUICK TEST** .

3) Check IAC Solenoid Resistance Turn ignition off. Connect DVOM positive lead to VPWR terminal of IAC solenoid wiring harness connector. Connect DVOM negative lead to IAC terminal. If resistance is 6-13 ohms, go to next step. If resistance is not 6-13 ohms, replace IAC valve assembly and repeat **QUICK TEST** .

4) Check IAC Solenoid Internal Short To Case Turn ignition off. Measure resistance between each wiring harness connector terminal and IAC housing. If each resistance is 10,000 ohms or more, go to next step. If either resistance is less than 10,000 ohms, replace IAC solenoid assembly and repeat **QUICK TEST** .

5) Check Air Inlet System Turn ignition off. Remove air filter. Inspect air filter, MAF sensor and air inlet system for excessive dirt or contamination. Repair or replace as necessary and repeat **QUICK TEST** . If air filter is okay, go to next step.

6) Check For Vacuum Leaks Start engine and allow to idle. Inspect air inlet system any of the following

possible faults:

- Cracked or punctured air inlet tube.
- Loose inlet air tube or air cleaner housing.
- Loose or damaged throttle body.
- Contaminated or damaged IAC valve assembly.
- Faulty EGR valve or gasket.
- Faulty PCV valve or hose.

Check entire system for vacuum leaks. Repair or replace as necessary. If no vacuum leaks are found, go to next step.

7) Check IAC Circuit Continuity Leave ignition off. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between breakout box test pin No. 83 (IAC) and IAC terminal at IAC solenoid wiring harness connector. If resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** . If resistance is less than 5 ohms, go to next step.

8) Check IAC Circuit For Short To Power Turn ignition on. Measure voltage between breakout box test pin No. 83 (IAC) and chassis ground. If voltage is one volt or more, repair circuit short to power and repeat **QUICK TEST** . If voltage is less than one volt, go to next step.

9) Check IAC Circuit For Short To Ground Turn ignition off. Measure resistance between test pin No. 83 (IAC) and test pins No. 51 and 103 (PWR GND) at breakout box. If resistance is more than 10,000 ohms, go to next step. If resistance is less than 10,000 ohms, repair circuit short to ground and repeat **QUICK TEST** .

10) Check IAC Signal From PCM Leave ignition off. Connect PCM to breakout box. Connect IAC solenoid to wiring harness connector. Connect DVOM between test pin No. 83 (IAC) and test pin No. 51 (PWR GND) at breakout box. Start engine and slowly increase speed to 3000 RPM. If voltage is 3.0-11.5 volts, remove IAC solenoid and check throttle body. If throttle body is okay, replace IAC assembly and repeat **QUICK TEST** . If voltage is not 3.0-11.5 volts, replace PCM and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 10) to step 20). No test procedures have been omitted.

20) DTC P1506 This code indicates that IAC system has reached over speed malfunction. Possible causes are as follows:

- IAC circuit short to ground.
- IAC assembly stuck open.
- Air intake leaks or restrictions.
- Damaged throttle body.
- Contaminated or damaged IAC valve assembly.
- Faulty Powertrain Control Module (PCM).

Check entire system for vacuum leaks. Repair or replace as necessary. If no vacuum leaks are found, go to next step.

21) Check EVAP System Turn ignition off. Disconnect hoses from EVAP canister purge valve or solenoid. Attach vacuum pump with gauge to carbon canister hose port. See **Fig. 80** . Using vacuum pump, apply 16 in. Hg to port. If vacuum bleeds off within 20 seconds, replace EVAP canister purge valve or solenoid and repeat **QUICK TEST** . If vacuum is not bled off immediately, go to next step.

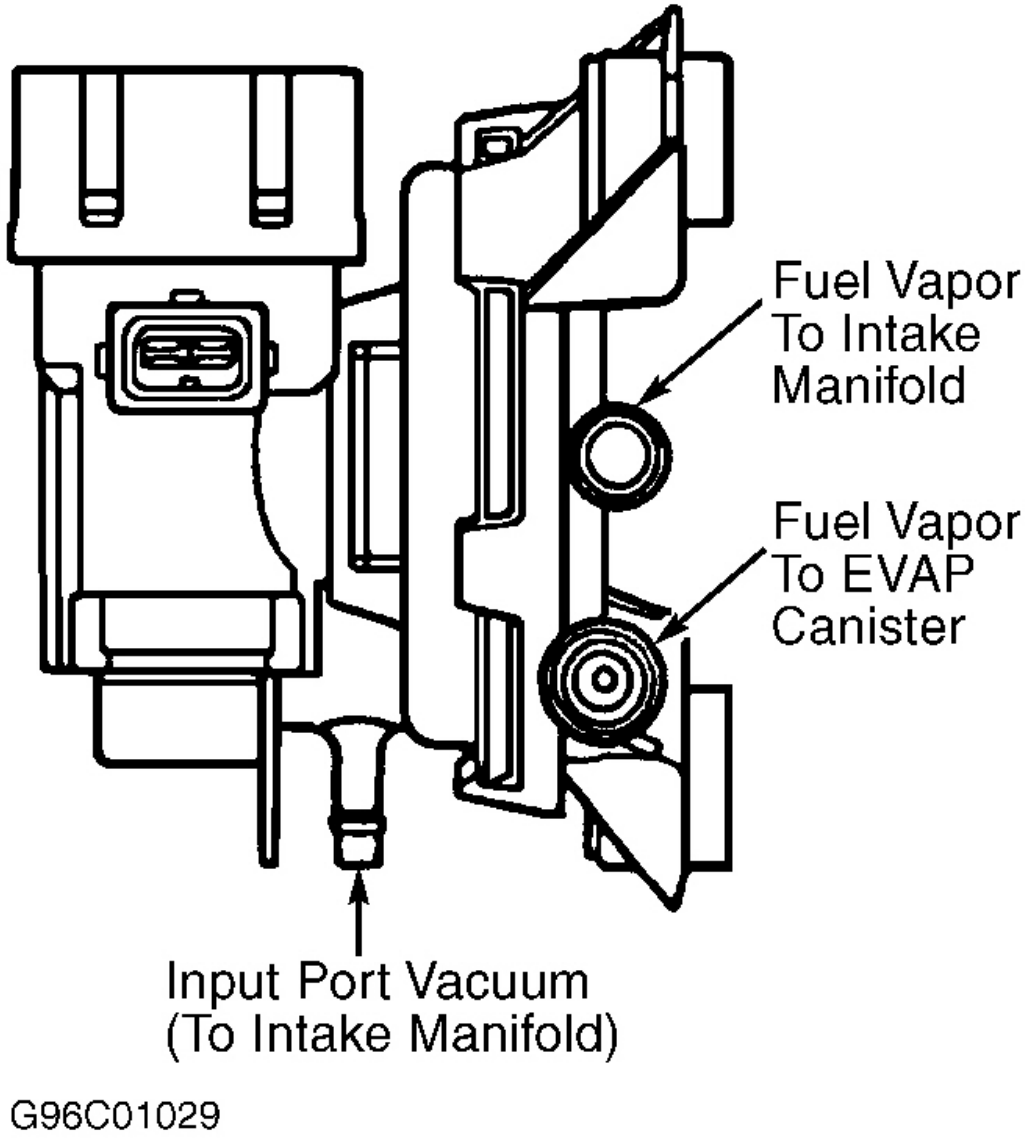


Fig. 80: EVAP Canister Purge Hose Ports

22) Check IAC Solenoid Function Start engine and allow to idle. Ensure transmission is in Park or Neutral and engine is warmed to normal operating temperature. Disconnect IAC solenoid wiring harness

connector. If engine speed drops, go to next step. If engine speed does not drop, check throttle body for damage. If throttle body is okay, replace IAC solenoid and repeat **QUICK TEST** .

23) Check IAC Circuit For Short To Ground Turn ignition off. Disconnect scan tester from DLC. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 83 (IAC) and test pins No. 51 and 103 (PWR GND) at breakout box. If resistance is more than 10,000 ohms and idle speed is normal, go to step 30). If resistance is more than 10,000 ohms and high idle speed is present, replace PCM and repeat **QUICK TEST** . If resistance is less than 10,000 ohms, repair circuit short to ground and repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 23) to step 25). No test procedures have been omitted.

25) DTC P1505: Check Inlet Air Supply DTC P1505 indicates that IAC system has reached the adaptive learning limit. Possible causes are as follows:

- Air intake leaks or restrictions.
- Throttle body linkage binding.
- Contaminated or damaged IAC valve assembly.
- Damaged throttle body.

Inspect air intake system for leaks. Repair or replace as necessary. If air intake system is okay, go to next step.

26) Check Air Inlet System Turn ignition off. Remove air filter. Inspect air filter, MAF sensor and air inlet system for excessive dirt or contamination. Repair or replace as necessary and repeat **QUICK TEST** . If air filter is okay, go to next step.

27) Check Throttle Body Leave ignition off. Disconnect accelerator cable and air cleaner tube from throttle body. Check cable and throttle body linkage for binding or interference. If faults are present, go to step 3) under **CIRCUIT TEST HU** . If no faults are present, go to step 8) under **CIRCUIT TEST HU** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 27) to step 30). No test procedures have been omitted.

30) Check IAC System For Intermittent Open Or Short Circuit Connect scan tester to DLC. Ensure all accessories are off and engine is warmed to normal operating temperature. Turn ignition on. Access IAC PID and RPM PID. IAC duty cycle should be 20-45 percent. Observe IAC PID and RPM PID for indication of fault while wiggling and bending wiring harness between IAC solenoid and PCM. Fault will be indicated by sudden change in IAC PID or RPM PID value. If any faults are found, isolate and repair as necessary. Repeat **QUICK TEST** . If no faults are found, problem cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

CIRCUIT TEST KL - SHIFT INDICATOR LIGHT (SIL)

Diagnostic Aids

Perform this test only when directed here by a driveability symptom. This test is only intended to diagnose:

- Wiring harness circuits (SIL).
- Top gear switch.
- SIL dimmer relay.
- SIL bulb and SIL circuit fuse.
- Powertrain Control Module (PCM).

1) Check SIL Operation Inspect SIL while driving vehicle. SIL should turn on when optimum-shift RPM for each gear is reached. Light should be off in top gear. If SIL light is always on, check for short to ground in SIL circuit. If light is always off, check for open in SIL circuit. If light is always on, go to step 4). If light is not always on, go to next step.

2) Check SIL Circuit Fuse Turn ignition off. Remove and inspect SIL fuse. If fuse is okay, go to next step. Replace fuse if blown. If fuse blows again, repair short to ground between fuse and SIL bulb. Check SIL operation.

3) Check SIL Bulb Turn ignition off. Remove and inspect SIL bulb. If bulb is burned out, replace bulb and check SIL operation. If bulb is okay, go to step 5).

4) Check SIL Circuit For Short To Ground Turn ignition off. Put transmission in high gear. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pins No. 53 and 60 at breakout box. If resistance is 10,000 ohms or less, repair short between top gear switch and PCM. Reconnect all components, and repeat **QUICK TEST** . If resistance is more than 10,000 ohms, replace PCM and repeat QUICK TEST.

5) Check For Voltage To SIL Socket Turn ignition off. Remove SIL bulb. Place transmission in any gear except top gear. Turn ignition on. Measure voltage between power contact at SIL socket and chassis ground. If voltage is more than 10.5 volts, go to step 7). If voltage is 10.5 volts or less, connect SIL bulb and go to next step.

6) Check Operation Of Top Gear Switch Top gear switch is normally closed and should only be open when vehicle is shifted into top gear. Turn ignition off. Disconnect top gear switch. Place transmission in any gear except top gear. Measure resistance between top gear switch terminals. If resistance is less than 5 ohms, repair open in IGNITION RUN circuit to SIL bulb socket. Check SIL operation. If resistance is 5 ohms or more, replace top gear switch. Check SIL operation.

7) Check Continuity Of SIL Circuit Turn ignition off. Remove SIL bulb. Disconnect PCM wiring harness connector. Inspect pins for damage and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Measure resistance between test pin No. 72 and SIL power contact at SIL bulb socket. If resistance is less than 5 ohms, replace PCM. Check SIL operation. If resistance is 5 ohms or more, repair open circuit. Remove breakout box, reconnect all components and check SIL operation.

CIRCUIT TEST KM - WOT A/C CUT-OFF (WAC)

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Wiring harness circuits (ACCS, POWER-TO-CLUTCH, VPWR and WAC).
- Faulty WAC relay.
- Faulty Powertrain Control Module (PCM).

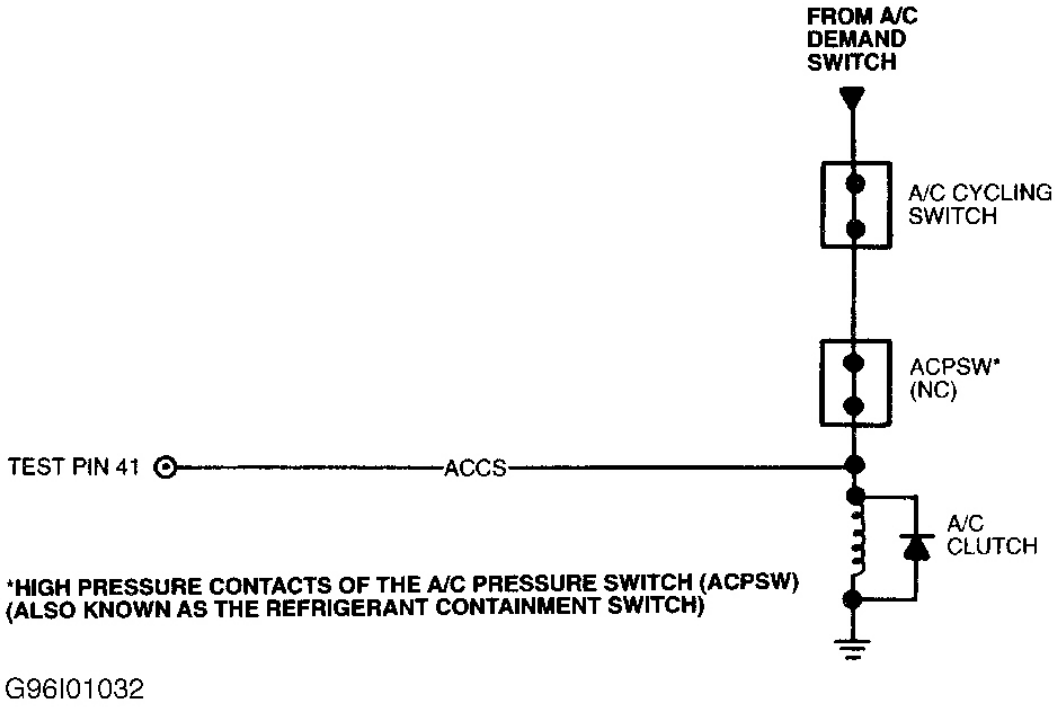


Fig. 81: WAC Test Circuits & Connector Terminals

1) DTC P1460: Verify ACCS PID Is Off Turn ignition off. Ensure A/C and defroster are off. Connect scan tester to Data Link Connector (DLC). Start engine and allow to idle. Using scan tester, access ACCS PID. If ACCS PID is off, go to next step. If ACCS PID is on, go to step 20).

2) Check VPWR Circuit Turn ignition off. Disconnect WAC relay wiring harness connector. Turn ignition on. Measure voltage between VPWR terminal at connector and chassis ground. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in VPWR circuit. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** .

3) Check WAC Relay Leave ignition off and WAC relay disconnected. Check resistance between relay terminals No. 85 and 86.

Replace WAC relay if resistance is not 40-120 ohms. If resistance is okay, check resistance between relay terminals No. 85 and 30, No. 85 and 87, No. 85 and 87A.

If resistance is okay, go to next step. If resistance less than 10,000 ohms, replace WAC relay. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** .

4) Check WAC Circuit Turn ignition off. Leave WAC relay disconnected. Disconnect PCM wiring harness connector. Inspect connector for damage or corrosion, and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 69 (WAC) at breakout box and chassis ground. If voltage is less than one volt, go to next step. If voltage is one volt or more, repair circuit short to power. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** .

5) Turn ignition off. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 69 (WAC) and test pins No. 51, 91 and 103 (PWR GND) at breakout box. If resistance is more than 10,000 ohms, go to next step. If resistance is less than 10,000 ohms, repair circuit short to ground. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** .

6) Leave ignition off and relay disconnected. Measure resistance between breakout box test pin No. 69 and WAC terminal at relay harness connector. If resistance is less than 5 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 5 ohms or more, repair open circuit. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat QUICK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 6) to step 10). No test procedures have been omitted.

10) Check For Voltage To A/C Cycling Switch Turn ignition off. Disconnect A/C cycling switch. Turn A/C switch on. Measure voltage between chassis ground and A/C Demand terminal of A/C cycling switch. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, check for fault in A/C demand switch, EATC module or related wiring harness. See the A/C-HEATER SYSTEM article in the AIR CONDITIONING & HEAT section.

11) Check Continuity Of ACPSW Contacts Turn ignition off. Leave A/C switch on. Measure resistance between ACPSW high pressure contacts. If resistance is less than 5 ohms, reconnect ACPSW and go to next step. If resistance is 5 ohms or more, check for low refrigerant charge.

12) Check For Voltage To A/C Pressure Switch (ACPSW) Leave ignition off and A/C cycling switch disconnected. Disconnect ACPSW. Turn A/C switch on. Measure voltage between chassis ground and A/C Demand terminal at the ACPSW wiring harness connector. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, check for fault in A/C demand switch, EATC module or related wiring harness. See A/C-HEATER SYSTEM in the AIR CONDITIONING & HEAT section.

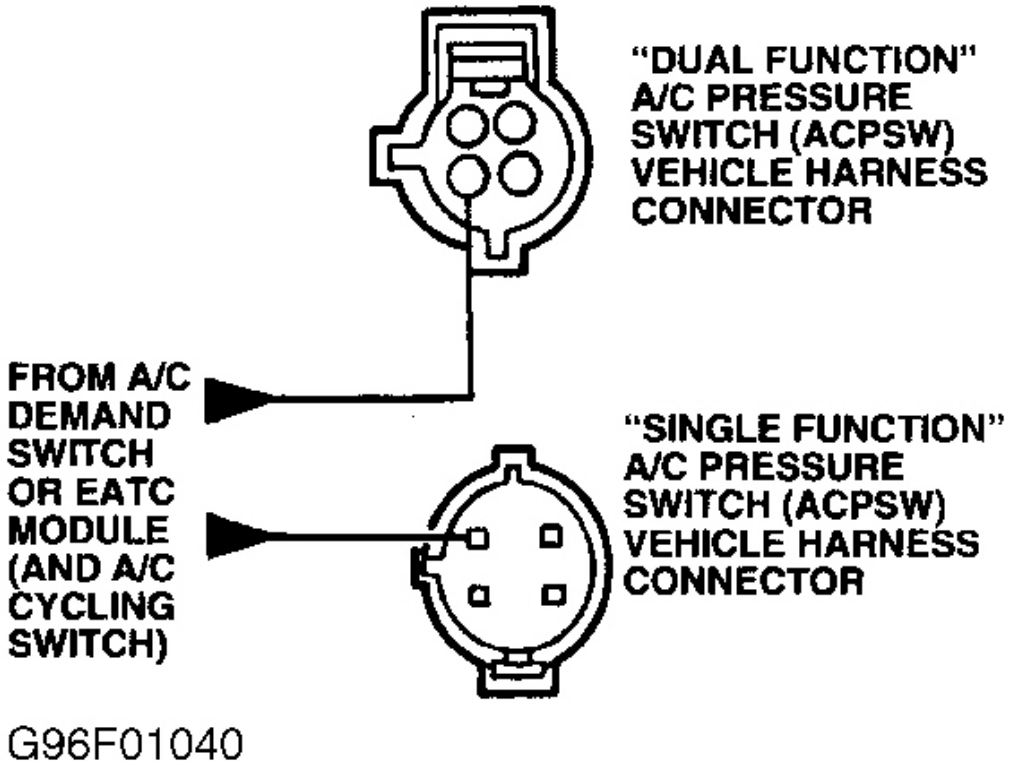


Fig. 82: ACPSW Connector Terminals

13) Check For Voltage To PCM Leave A/C switch on. Turn ignition off. Reconnect ACPSW. Disconnect PCM wiring harness connector. Inspect connector for damage or corrosion, and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 41 (ACCS) and test pin No. 77 (PWR GND) at breakout box. If voltage is one volt or more, repair open circuit between ACPSW and PCM. If voltage is more than 10.5 volts, replace PCM and verify symptom is corrected.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 13) to step 19). No test procedures have been omitted.

19) DTC P1464: Check ACCS PID Turn ignition off. Ensure A/C and defroster are off. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access ACCS PID. If ACCS PID is on, go to next step. If ACCS PID is off, verify self-test results. Leave A/C and defroster off and repeat **QUICK TEST** .

20) Turn ignition off. Disconnect ACPSW. Turn ignition on. Using scan tester, access ACCS PID. If ACCS PID is off, check for fault in A/C demand switch, EATC module or related wiring harness. See

A/C-HEATER SYSTEM article in the AIR CONDITIONING & HEAT section. If ACCS PID is on, go to step 22).

21) Check For Short To Power Turn ignition off. Disconnect WAC relay. Turn ignition on. Measure voltage between chassis ground and POWER-TO-CLUTCH terminal of WAC relay connector. If voltage is less than one volt, go to next step. If voltage is one volt or more, repair circuit short to power. Verify symptom is corrected.

22) Check ACCS Circuit For Short To Power Turn ignition off. Leave ACPSW and WAC relay disconnected. Disconnect PCM wiring harness connector. Inspect connector for damage or corrosion, and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 41 (ACCS) and test pins No. 51 and 103 (PWR GND) at breakout box. If voltage is more than one volt, repair circuit short to power. If voltage is one volt or less, proceed as follows:

- For vehicles without WAC relay, replace PCM and repeat QUICK TEST.
- For all other models, go to next step.

23) Check ACCS Circuit Voltage To PCM Turn ignition off. Reconnect WAC relay. Leave ACPSW disconnected. Turn ignition on. Measure voltage between test pin No. 41 (ACCS) and test pins No. 51 and 103 (PWR GND) at breakout box. If voltage is more than one volt, replace WAC relay and verify symptom is corrected. If voltage is one volt or less, replace PCM and verify symptom is corrected.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 23) to step 30). No test procedures have been omitted.

30) Continuous Memory DTC P1460 This DTC indicates WAC circuit failure. If vehicle is not equipped with A/C, disregard this DTC. Turn ignition off. Disconnect A/C cycling switch or low pressure switch. Connect jumper wire between switch terminals. Turn ignition and A/C switch on. Check for indication of fault while wiggling and bending WAC circuit between WAC relay and PCM. Fault will be indicated by A/C clicking on. Wiggle and bend WAC circuit between PCM (terminal No. 69) and WAC relay. Lightly tap on WAC relay. Check connectors for clean tight connection. If any faults are found, isolate and repair as necessary. If no faults are found, go to next step.

31) Turn ignition off. Connect scan tester to Data Link Connector (DLC). Leave A/C switch on. Turn ignition on. Using scan tester, access Output Test Mode. Turn all outputs off. Check for indication of fault while wiggling and bending WAC or ACON circuit between PCM (terminal No. 69) and WAC and A/C relay. Fault will be indicated by A/C clicking on. Check connectors for clean tight connection. If any faults are found, isolate and repair as necessary. If no faults are found, fault cannot be duplicated at this time. Go to **CIRCUIT TEST Z** .

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 31) to step 50). No test procedures have been omitted.

50) Check Voltage To A/C Clutch Turn ignition off. Disconnect A/C clutch. Connect scan tester to DLC. Turn ignition on. Using scan tester, access Output Test Mode. Command outputs on. Measure voltage between A/C clutch connector terminals. If voltage is 10.5 volts or less, check for fault in A/C demand switch, EATC module or related wiring harness. See the A/C-HEATER SYSTEM article in the AIR CONDITIONING & HEAT section.

51) Check Voltage To A/C Relay Turn ignition off. Disconnect A/C relay. Turn ignition on. Measure

voltage between chassis ground and B+ terminal of A/C relay connector. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, check for damaged fuse. If fuse is okay, repair open in circuit.

52) Check Circuit Resistance Turn ignition off. Leave A/C relay and A/C clutch disconnected. Measure resistance between power terminal of A/C relay and A/C clutch harness connectors. Measure resistance between ground terminal of A/C relay and A/C clutch harness connectors. If each resistance measurement is less than 5 ohms, replace A/C relay. If either resistance measurement is 5 ohms or more, repair open circuit.

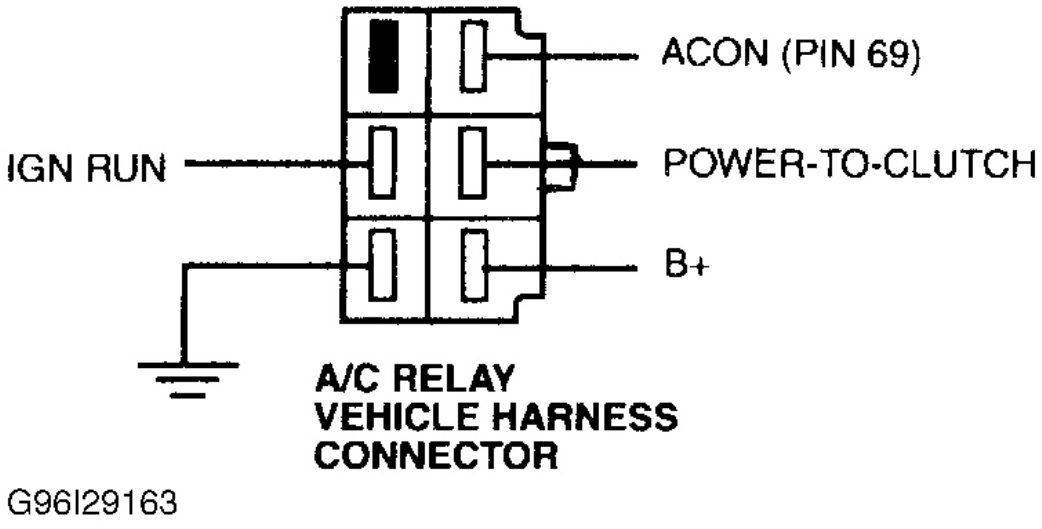


Fig. 83: A/C Relay Connector Terminals

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 52) to step 60). No test procedures have been omitted.

60) KOEO/KOER DTC P1460; Check Voltage To A/C Relay Turn ignition off. Disconnect A/C relay. Turn ignition on. Measure voltage between chassis ground and IGN RUN terminal of A/C relay connector. If voltage is 10.5 volts or more, go to next step. If voltage is less than 10.5 volts, repair open in IGN RUN circuit. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** .

61) Check ACON Circuit For Short To Power Turn ignition off. Leave A/C relay disconnected. Disconnect PCM wiring harness connector. Inspect connector for damage or corrosion, and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between chassis ground and test pin No. 69 (ACON) at breakout box. If voltage is one volt or less, go to next step. If voltage is more than one volt, repair circuit short to power. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** .

62) Check ACON Circuit For Short To Ground Turn ignition off. Disconnect scan tester from DLC (if

applicable). Measure resistance between chassis ground and test pin No. 69 (WAC) at breakout box. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, repair circuit short to ground. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** .

63) Check ACON Circuit Continuity Leave ignition off and A/C relay disconnected. Measure resistance between test pin No. 69 at breakout box and ACON terminal at A/C relay connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** .

64) Check A/C Relay Leave ignition off. Reconnect A/C relay. Turn ignition on. While observing A/C clutch, connect and remove jumper wire between ground and breakout box test pin No. 69 (ACON). If A/C clutch does not engage and disengage when jumper wire is connected and removed, replace A/C relay.

If A/C clutch engages and disengages when jumper wire is connected and removed, remove jumper wire and breakout box. Start engine and allow to idle for 15 seconds with A/C on. Turn ignition and A/C off. Repeat **QUICK TEST** . If DTC P1460 is still present, replace PCM.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 64) to step 70). No test procedures have been omitted.

70) DTC P1464: Check ACCS PID Turn ignition off. Ensure A/C and defroster are off. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access ACCS PID. If ACCS PID is off, go to next step. If ACCS PID is on, go to step 72).

71) Check Low Pressure (LP) Switch Turn ignition off. Disconnect LP switch. Measure resistance between chassis ground and both terminals of LP switch. If each resistance measurement is 10,000 ohms or more, check for faulty A/C demand switch. See A/C-HEATER SYSTEM article in the AIR CONDITIONING & HEAT section. If switch is okay, repair circuit short to ground between LP switch and A/C demand switch. If resistance is less than 10,000 ohms, replace LP switch and verify symptom is corrected.

72) Check ACD Circuit To PCM For Short To Ground Leave ignition off and LP switch disconnected. Disconnect PCM wiring harness connector. Measure resistance between chassis ground and PCM side of LP switch. If resistance is 10,000 ohms or more, replace PCM and verify symptom is corrected. If resistance is less than 10,000 ohms, repair short to ground and verify symptom is corrected.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 72) to step 75). No test procedures have been omitted.

75) Check Power To A/C Clutch Circuit For Short To Power Ensure that A/C relay and A/C clutch are disconnected. Turn ignition on. Measure voltage between negative battery terminal and power side of A/C clutch harness connector. If voltage is one volt or less, go to next step. If voltage is more than one volt, repair circuit short to power and verify symptom is corrected.

76) Check A/C Relay Turn ignition off. Measure resistance between POWER-TO-CLUTCH terminal and IGN RUN terminal at A/C relay. Measure resistance between POWER-TO-CLUTCH terminal and B+ terminal at A/C relay. If either resistance measurement is less than 10,000 ohms, replace A/C relay and verify symptom is corrected. If both resistance measurements are more than 10,000 ohms, no faults

are present. Testing is complete.

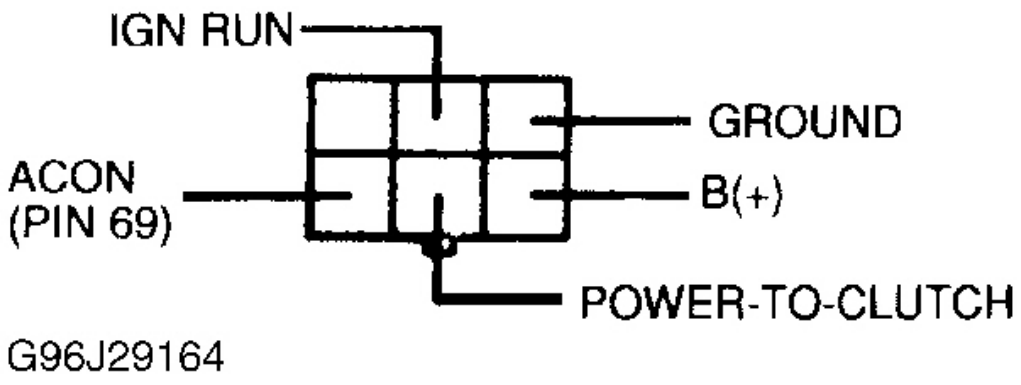


Fig. 84: A/C Relay Terminals

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 76) to step 80). No test procedures have been omitted.

80) Check WOT A/C Cutoff Relay Turn ignition off. Disconnect WOT A/C cutoff relay. Measure resistance between relay terminals No. 3 and 4. If resistance is 5 ohms or more, replace WOT A/C cutoff relay. If resistance is less than 5 ohms, go to next step.

81) Check Voltage To A/C Clutch Relay Turn ignition off. Disconnect A/C clutch relay. Turn ignition on. Measure voltage between negative battery terminal and IGN RUN terminal of relay. If voltage is less than 10.5 volts, check fuse. If fuse is okay, repair open or short in IGN RUN circuit. If voltage is 10.5 volts or more, go to next step.

82) Check Ground To A/C Clutch Relay Turn ignition off. Measure resistance between negative battery terminal and GROUND terminal of relay. If resistance is more than 5 ohms, repair open in ground circuit. If resistance is 5 ohms or less, go to next step.

83) Check A/C Demand Circuit Turn ignition off. Measure resistance of A/C demand circuit between A/C clutch relay connector and WOTA/C cutoff relay connector. If resistance is more than 5 ohms, repair open in circuit. If resistance is 5 ohms or less, go to next step.

84) Check A/C Clutch Circuit Turn ignition off. Disconnect A/C clutch harness connector Measure resistance of A/C demand circuit between A/C clutch relay connector and WOT A/C cutoff relay connector. If resistance is more than 5 ohms, repair open in circuit. If resistance is 5 ohms or less, replace A/C clutch relay.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 84) to step 90). No test procedures have been omitted.

90) Check ACCS PID Turn ignition off. Disconnect A/C clutch relay and A/C Pressure Switch (ACPSW). Turn ignition on. Using scan tester, access ACCS PID. If ACCS PID is off, replace A/C clutch relay and verify symptom is corrected. If ACCS PID is on, go to next step.

91) Check A/C Demand Circuit With ignition on, measure voltage between negative battery terminal and A/C demand circuit at WOT A/C cutoff relay harness connector. If voltage is more than 1.0 volt, repair circuit short to power. If resistance is 5 ohms or less, replace A/C clutch relay.

92) Turn ignition off. Disconnect WOT A/C cutoff relay. Using scan tester, access ACCS PID. If ACCS PID is off, replace WOT A/C cutoff relay and verify symptom is corrected. If ACCS PID is on, go to next step.

93) Check ACCS Circuit To PCM For Short To Power Turn ignition off. Leave ACPSW, A/C relay and WAC relay disconnected. Disconnect PCM wiring harness connector. Inspect connector for damage or corrosion, and repair as necessary. Install EEC-V Breakout Box (014-000950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 41 (ACCS) and test pins No. 51 and 103 (PWR GND) at breakout box. If voltage is more than 1.0 volt, repair circuit short to power and verify symptom is corrected. If voltage is 1.0 volt or less, replace PCM and verify symptom is corrected.

CIRCUIT TEST MB - OUTPUT TEST MODE NOT FUNCTIONING

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Connection between scan tester and PCM.
- Connection between scan tester and battery power supply.
- Correct key sequence executed for outputs.

1) Check Scan Tester Installation Turn ignition off. Check connection between scan tester and Data Link Connector (DLC) for damage or contamination. Service or adjust as necessary. If connector is okay, go to next step.

2) Check connector and wiring harness cable between scan tester and battery power supply for correct installation, damage or poor connection. Repair as necessary. Ensure correct key sequence for outputs is executed. See scan tester manufacturer instructions.

CIRCUIT TEST NB - MALFUNCTION INDICATOR LIGHT (MIL)

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Wiring harness circuit (MIL).
- Faulty Powertrain Control Module (PCM).

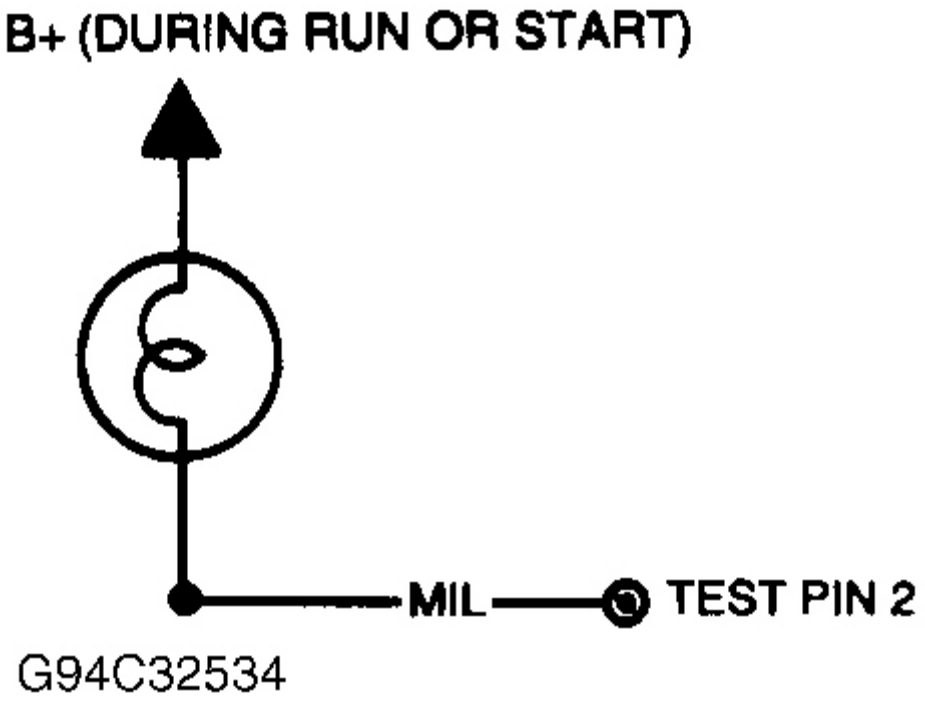


Fig. 85: MIL Circuit Schematic

1) MIL Always On Perform KOEO SELF-TEST. If any trouble codes are present, service as necessary before continuing. If no trouble codes are present, turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure and record resistance between test pins No. 2 and No. 51 and 103 (PWR GND). If resistance is less than 5 ohms, repair short circuit between test pin No. 2 and MIL. If resistance is 5 ohms or more, replace PCM.

2) MIL Does Not Come On Turn ignition on. Measure voltage between ground side of MIL fuse and negative battery terminal. If voltage is 10.5 volts or less, go to next step. If voltage is more than 10.5 volts, go to step 4).

3) Check For B+ At Fuse Leave ignition on. Measure voltage between positive side of MIL fuse and negative battery terminal. If voltage is 10.5 volts or less, repair open in MIL or B+ circuit. If voltage is more than 10.5 volts, replace MIL fuse.

4) Check For B+ At MIL Bulb Leave ignition on. Measure voltage between instrument cluster connector terminal B+ and negative battery terminal. If voltage is 10.5 volts or less, repair open in fuse, MIL bulb or B+ circuit. If voltage is more than 10.5 volts, go to next step.

5) Check Continuity Of MIL Circuit Turn ignition off. Measure resistance between instrument cluster connector MIL terminal and test pin No. 2 of breakout box. If resistance is less than 5 ohms, replace PCM. If MIL is still on, fault is in instrument cluster. If resistance is 5 ohms or more, repair open in MIL

circuit.

CIRCUIT TEST NC - IGNITION DIAGNOSTIC MONITOR (IDM)

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Faulty Powertrain Control Module (PCM).

Continuous Memory DTC P0320

This code indicates that (2) successive erratic Profile Ignition Pulses (PIP) have occurred. Possible causes are as follows:

- Loose wires and/or connectors.
- Short circuit to ground in ignition secondary system.
- Incorrect 2-way radio installation.

If any of the specified causes were present, repair or replace as necessary. If vehicle will not start, go to **CIRCUIT TEST A** . If fault is intermittent, go to step 50) of **CIRCUIT TEST Z** . If vehicle will start and none of the specified causes were present, replace PCM and repeat **QUICK TEST** .

CIRCUIT TEST ND - ENGINE RPM/VEHICLE SPEED LIMITER

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures.

DTC P1270

This DTC indicates that engine or vehicle speed has exceeded calibrated limit. Possible causes are as follows:

- Wheel slippage caused by mud, ice, water, snow, etc.
- Over revved engine.
- Vehicle driven at excessive rate of speed.

If any of the specified causes have occurred, system is okay. Clear PCM memory. If none of specified causes have occurred, clear PCM memory. If no other faults are present, testing is complete.

CIRCUIT TEST QA - UNABLE TO ACTIVATE SELF-TEST/SCP COMMUNICATION ERROR CODE NOT LISTED

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Standard Corporate Protocol (SCP) communication circuits BUS (+) and BUS (-).
- Wiring harness circuits (CHASSIS GROUND, PWR GND and VBAT).
- Faulty Powertrain Control Module (PCM).

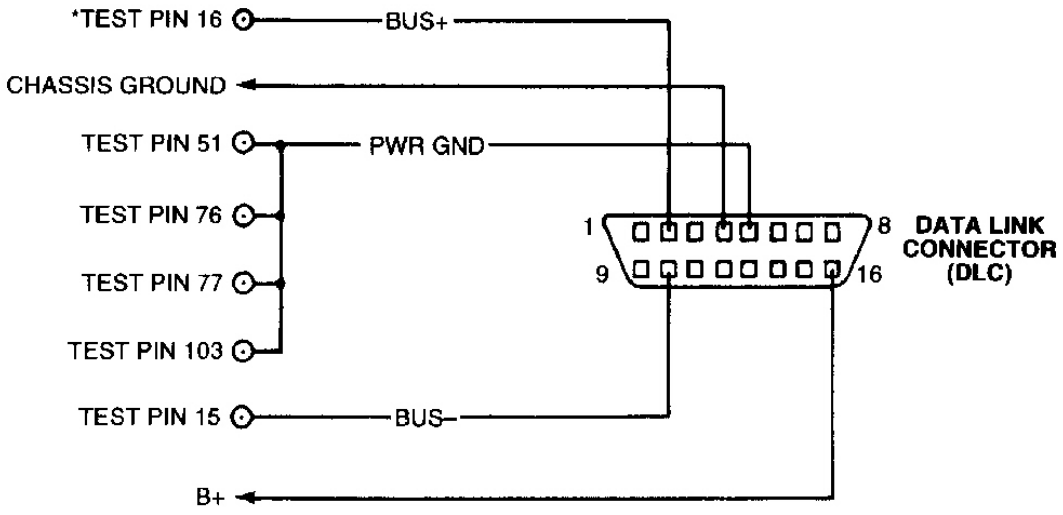


Fig. 86: Data Link Connector (DLC) Test Circuit & Connector Terminals

1) Verify Self-Test Procedure Is Correct Ensure scan tester is correctly attached to DLC located under dash panel. Ensure scan tester is not damaged or defective. Verify correct self-test procedure is used. Correct as necessary. If no faults are found, go to next step.

2) Check For VREF At TP Sensor Turn ignition off. Disconnect TP sensor. Turn ignition on. Measure voltage between SIG RTN terminal and VREF terminal at TP wiring harness connector. See **Fig. 87** . If voltage is 4-6 volts, go to next step. If voltage is not 4-6 volts, go to **CIRCUIT TEST C** .

NOTE: KOER self-test failure or Communication Error message could result if a failure is present in MAF sensor, MLP sensor, VSS or related circuits.

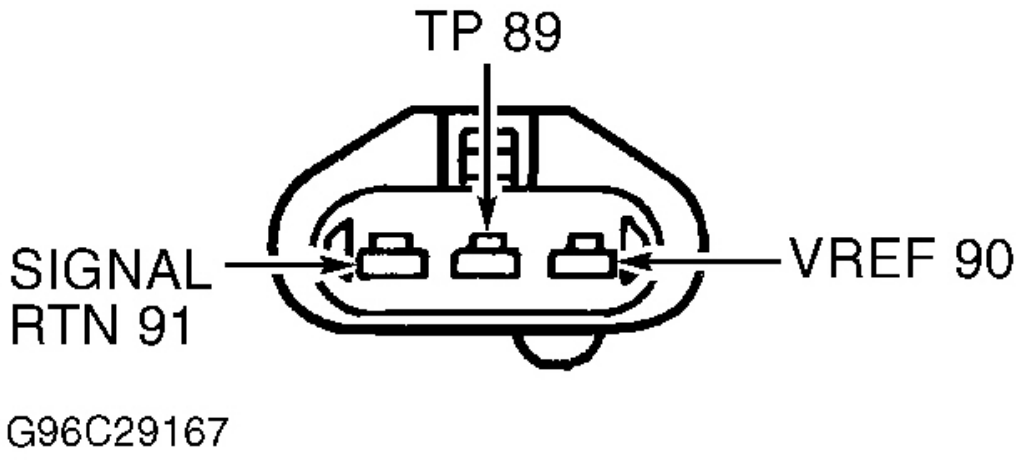


Fig. 87: TP Sensor Harness Connector Terminals

3) Ability To Access Continuous Memory DTCs If Continuous Memory DTCs were accessible, go to next step. If Continuous Memory DTCs were not accessible, go to step 7).

4) Ability To Activate KOEO SELF-TEST If KOEO SELF-TEST was entered, go to next step. If KOEO SELF-TEST was not entered, go to step 6).

5) Ability To Activate KOER Self-Test If KOER self-test was entered, DTC is false. Obtain PCM part number and check manufacturer for correct PCM application. If KOER self-test was not entered, go to next step for alternative fuel models or step 7) for all other models.

6) If self-test was performed using gasoline, go to next step. If self-test was performed on alternative fuel, repeat **QUICK TEST** using gasoline. If still unable to retrieve trouble codes, go to next step.

7) Perform **QUICK TEST** . If any DTCs are present, service as necessary before continuing. If unable to retrieve trouble codes, go to next step.

8) Check For Voltage At Data Link Connector (DLC) Inspect DLC for damage and repair as necessary. Turn ignition on. Measure voltage between B+ terminal of DLC and engine ground. If 10.5 volts or more are present, go to next step. If less than 10.5 volts are present, repair open in B+ circuit and repeat **QUICK TEST** .

9) Check DLC Ground Circuit Continuity Turn ignition off. Measure resistance between CHASSIS GROUND terminal of DLC and engine ground. If less than 5 ohms are present, go to next step. If 5 ohms or more are present, repair open in CHASSIS GROUND circuit and repeat **QUICK TEST** .

10) Check DLC PWR GND Circuit Continuity Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pins No. 51 and 103 (PWR GND) at the breakout box and PWR GND terminal of DLC. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in PWR GND circuit to DLC and repeat **QUICK TEST** .

11) Check BUS(-) Circuit Leave ignition off. Measure resistance between test pin No. 15 (BUS-) at the

breakout box and BUS(-) terminal of DLC. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in BUS(-) circuit to DLC and repeat **QUICK TEST** .

12) Leave ignition off. Disconnect scan tester from DLC (if applicable). Measure resistance between test pin No. 15 at the breakout box and engine ground. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, repair short to ground in BUS(-) circuit and repeat **QUICK TEST** .

13) Turn ignition on. Measure voltage between test pin No. 15 and test pins No. 51 and 103 (PWR GND) at the breakout box and engine ground. If voltage is less than 6.0 volts, go to next step. If voltage is 6.0 volts or more, repair short to power in BUS(-) circuit and repeat **QUICK TEST** .

14) Check BUS(+) Circuit Continuity Turn ignition off. Measure resistance between test pin No. 16 (BUS+) at the breakout box and BUS(+) terminal of DLC. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in BUS(+) circuit to DLC and repeat **QUICK TEST** .

15) Check BUS(+) Circuit For Short To Ground Leave ignition off and scan tester disconnected from DLC. Measure resistance between chassis ground and test pin No. 16 (BUS+) at the breakout box. If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair BUS(+) circuit short to ground and repeat **QUICK TEST** .

16) Check BUS(+) Circuit For Short To Power Turn ignition on. Measure voltage between test pin No. 16 and test pins No. 51 and 103 (PWR GND) at the breakout box. If voltage is less than 1.0 volt, go to next step. If voltage is 1.0 volt or more, repair short to power in BUS(+) circuit and repeat **QUICK TEST** .

17) Power Take Off (PTO) Applications If vehicle is equipped with PTO, go to next step. If vehicle is not equipped with PTO, replace PCM and repeat **QUICK TEST** .

18) Check PTO On/Off Input Turn ignition off. While toggling switch, measure voltage between test pin No. 4 (PTO) and test pins No. 51 and 103 (PWR GND) at the breakout box. If voltage is less than 1.0 volt with PTO off, and 1.0 volt or more with PTO on, PTO circuit is okay. Replace PCM and repeat **QUICK TEST** . If voltage is not as specified, go to **CIRCUIT TEST FB** .

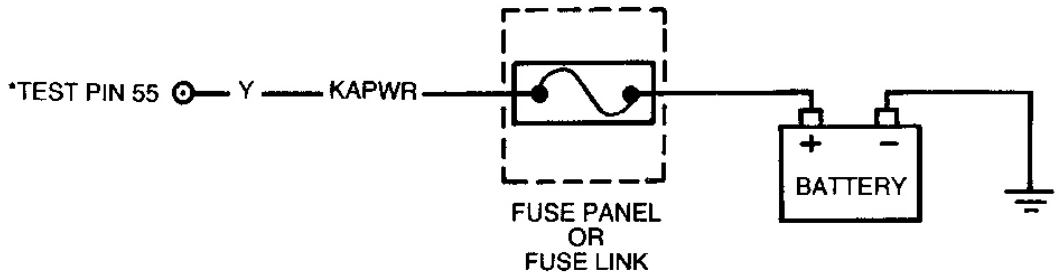
CIRCUIT TEST QB - DIAGNOSTIC TROUBLE CODE P0603

Diagnostic Aids

KAPWR is interrupted when PCM or battery is disconnected. DTC P0603 may be generated during the next PCM power-up.

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Battery terminal condition.
- Keep Alive Power (KAPWR) circuit routing.
- KAPWR circuit condition.
- Faulty Powertrain Control Module (PCM).



*TEST PIN LOCATED ON BREAKOUT BOX
ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE

G96D29168

Fig. 88: Keep Alive Power (KAPWR) Circuit Schematic

1) DTC P0603: Check Battery Terminals Inspect battery terminals for corrosion or loose connection. Service or replace as necessary. If battery terminals are okay, go to next step.

2) Check Wiring Harness Inspect wiring harness and connectors for damage or corrosion. Ensure wiring harness is not improperly routed too close to ignition or exhaust components. Service or replace if necessary. If wiring harness looks okay, go to next step.

3) Check KAPWR Circuit Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Connect DVOM between test pin No. 55 (KAPWR) and test pins No. 51 and 103 (PWR GND) at breakout box. Shake and bend small sections of wiring harness between PCM and dash panel. If voltage is continuously 10.5 volts or more, go to next step. If voltage drops to less than 10.5 volts, isolate open in KAPWR circuit and repair as necessary. Repeat **QUICK TEST** .

4) Check For DTC P0603 Perform KOEO SELF-TEST. If DTC P0603 is present, replace PCM and repeat **QUICK TEST** . If any other DTCs are present, service as necessary. If no trouble codes are present, testing is complete.

CIRCUIT TEST QC - DIAGNOSTIC TROUBLE CODE P1000

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This code indicates that On Board Diagnostics II (OBD II) system self-testing has not been completed. To erase DTC P1000, a complete drive cycle, with successful OBD II system self-test, must occur.

A drive cycle consists of vehicle warmed to normal engine temperature and operated in all speed ranges. After self-test successfully completes, SYSTEM PASS can be obtained from PCM.

DTC P1000 will set in PCM memory when any of the following conditions occur:

- Battery or PCM has been disconnected.

- An OBD II monitor has failed before completion of drive cycle.
- PCM memory has been erased with a scan tester.

1) Check For Other DTCs If any trouble codes are present, service as necessary. If no trouble codes are present, and vehicle is equipped with PTO, go to next step. If no trouble codes are present, and vehicle is not equipped with PTO, go to step 3).

2) Check PTO PID Turn ignition off. Connect scan tester to Data Link Connector (DLC). Start engine and allow to idle. Using scan tester, access PTO STAT PID. Cycle PTO switch/activator on and off. If PTO STAT PID does not cycle on and off, go to **CIRCUIT TEST FB** . If PTO STAT PID cycles on, pauses, and then cycles off, PTO is okay. Go to next step.

3) Attempt To Remove DTC P1000 Test drive vehicle to complete drive cycle. Cruise at 20-45 MPH for at least 4 minutes. Cruise at 30-40 MPH for at least 60 seconds. Cruise at 40-65 MPH for at least 80 seconds. If DTC P1000 is still present, go to next step. If DTC P1000 is not present, testing is complete.

4) Check VSS PID Turn ignition off. Connect scan tester to Data Link Connector (DLC). Using scan tester, access VSS PID. Test drive vehicle to complete drive cycle. If VSS PID is more than zero, go to next step. If VSS PID is zero, repair open in VSS circuit and repeat **QUICK TEST** .

5) Check ECT Temperature Ensure engine is at operating temperature. Using scan tester, access ECT PID. If ECT PID is more than 180°F (82°C), repeat step 3). If ECT PID is less than 180°F (82°C), repair cooling system fault and repeat **QUICK TEST** .

CIRCUIT TEST QD - DIAGNOSTIC TROUBLE CODE P1260

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This code indicates that anti-theft system has been activated. When activated, anti-theft system will disable fuel system. To disarm anti-theft system, use key or remote keyless entry to unlock door.

1) Check For Other DTCs If any other DTCs are present, service as necessary. If no DTCs other than P1260 are present, go to next step.

2) Use key or remote keyless entry to disarm anti-theft system. Clear PCM memory. Start engine. If engine starts, testing is complete. If engine does not start, go to next step.

3) Perform **QUICK TEST** . If DTC P1260 is still present, fault is in anti-theft system.

CIRCUIT TEST TA - PARK & NEUTRAL POSITION (PNP) SWITCH/CLUTCHPEDAL POSITION (CPP) SWITCH

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Wiring harness circuits (CPP, PNP and SIG RTN).
- Faulty Clutch Pedal Position (CPP) switch.

- Faulty Park & Neutral Position (PNP) switch.
- Faulty Powertrain Control Module (PCM).

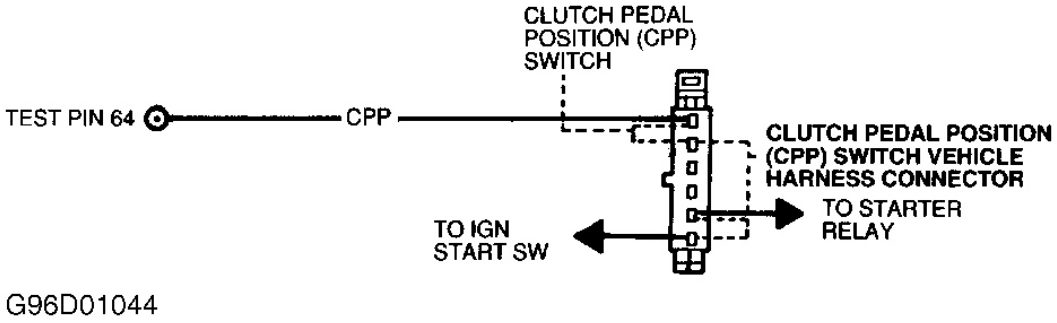


Fig. 89: CPP Switch Test Circuit & Connector Terminals

1) DTC P0704 & P1709: Check CPP/PNP Switch Function These DTCs indicate CPP/PNP switch malfunction. Possible causes are as follows:

- Starter relay disconnected during KOER self-test.
- CPP/PNP switch circuit damage.
- Faulty CPP/PNP switch.
- Faulty Powertrain Control Module (PCM).

Turn ignition off. Connect scan tester to Data Link Connector (DLC). Ensure shift lever is in Neutral. Turn ignition on. Using scan tester, access CPP/PNP PID. While observing CPP/PNP PID, apply and release clutch pedal. If CPP/PNP PID does not cycle on and off, go to next step. If CPP/PNP PID cycles on and off, check PCM connector. If connector is okay, replace PCM.

2) Check CPP/PNP Switch Turn ignition off. Locate CPP switch near clutch pedal or PNP switch near transmission shift linkage. Inspect switch and bracket for damage and repair if necessary. Disconnect CPP/PNP switch wiring harness connector. Inspect terminals for damage and repair if necessary. Measure resistance between switch terminals. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, replace CPP/PNP switch and repeat **QUICK TEST** .

3) Check CPP Circuit Turn ignition off. Disconnect scan tester. Disconnect PCM 104-pin connector. Inspect pins for damage. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 64 (CPP) at breakout box and CPP terminal at CPP switch wiring harness connector. Measure resistance between test pin No. 91 (SIG RTN) at breakout box and SIG RTN terminal at CPP/PNP switch wiring harness connector. If both resistance measurements are less than 5 ohms, go to next step. If either resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

4) Leave ignition off and CPP switch disconnected. Measure resistance between chassis ground and test pins No. 64 and 91 (SIG RTN) at breakout box. If resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or more, repair short circuit and repeat QUICK

TEST.

5) DTC P0704 & P1709: Check CPP/PNP Switch Function These DTCs indicate CPP/PNP switch malfunction. Possible causes are as follows:

- Starter relay disconnected during KOER self-test.
- CPP/PNP switch circuit damage.
- Faulty CPP/PNP switch.
- Faulty Powertrain Control Module (PCM).

Turn ignition off. Ensure shift lever is in Neutral. Connect scan tester to Data Link Connector (DLC). Turn ignition on. Using scan tester, access CPP/PNP PID. While observing CPP/PNP PID, apply and release clutch pedal; place shift lever in gear then return to Neutral. If CPP/PNP PID does not cycle on and off, go to next step. If CPP/PNP PID cycles on and off, check PCM connector. If connector is okay, replace PCM.

6) Check CPP/PNP Switch Turn ignition off. Locate CPP switch near clutch pedal or PNP switch near transmission shift linkage. Inspect switch and brackets for damage and repair if necessary. Disconnect CPP/PNP switch wiring harness connector. Inspect terminals for damage and repair if necessary. Measure resistance between CPP switch terminals with clutch pedal down. Measure resistance between PNP switch terminals with shift lever in Neutral. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, replace CPP/PNP switch and repeat **QUICK TEST** .

7) Check CPP/PNP Circuit Turn ignition off. Disconnect scan tester. Disconnect PCM 104-pin connector. Inspect pins for damage. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Measure resistance between test pin No. 64 (CPP) at breakout box and CPP/PNP terminal at CPP/PNP switch wiring harness connector. Measure resistance between test pin No. 91 (SIG RTN) at breakout box and SIG RTN terminal at CPP/PNP switch wiring harness connector. If both resistance measurements are less than 5 ohms, go to next step. If either resistance is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

8) Leave ignition off and CPP/PNP switch disconnected. Measure resistance between chassis ground and test pins No. 64 and 91 (SIG RTN) at breakout box. If resistance is more than 10,000 ohms, replace PCM and repeat **QUICK TEST** . If resistance is 10,000 ohms or more, repair short circuit and repeat QUICK TEST.

CIRCUIT TEST TB - TRANSMISSION CONTROL SWITCH (TCS)/TRANSMISSION CONTROL INDICATOR LAMP (TCIL)

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Wiring harness circuits (TCIL and TCS).
- Faulty Powertrain Control Module (PCM).

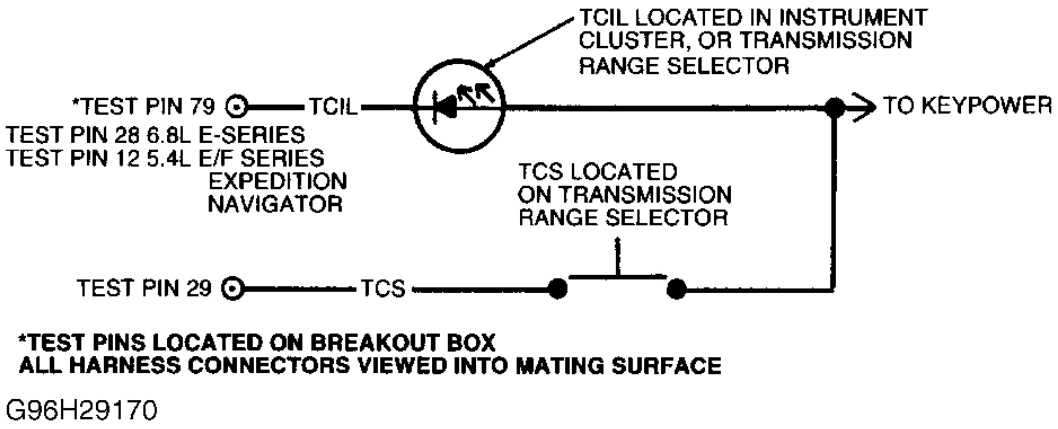


Fig. 90: TCIL & TCS Circuit Schematic

1) DTC P1780 Turn ignition off. Connect scan tester to Data Link Connector (DLC). Start engine and allow to idle. Using scan tester, access TCS PID. Cycle TCS switch, then hold depressed. If TCS PID is on, go to next step. If TCS PID is off, repeat KOER self-test to cycle TCS.

2) Check TCS Circuit Voltage Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Turn ignition on. Measure voltage between test pin No. 29 (TCS) and test pins No. 24 and 77 (PWR GND) at breakout box while cycling TCS. If voltmeter reading does not cycle when TCS is cycled, go to next step. If voltmeter reading cycles when TCS is cycled, replace PCM and repeat **QUICK TEST** .

3) Check Circuit For Short To Ground Turn ignition off. Disconnect TCS. Inspect pins for damage and repair if necessary. Measure resistance between breakout box test pin No. 29 (TCS) and test pins No. 24 and 77 (PWR GND). If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, repair short circuit and repeat **QUICK TEST** .

4) Check Continuity Of TCS Circuits Leave ignition off. Connect ohmmeter positive lead to TCS key power at the fuse panel. Connect negative lead to power terminal of TCS wiring harness connector. Note resistance measurement. Measure resistance between breakout box test pin No. 29 (TCS) and TCS terminal of TCS connector. If both resistance measurements are less than 5 ohms, go to next step. If either resistance measurement is 5 ohms or more, repair open circuit and repeat **QUICK TEST** .

5) Check Circuit For Short To Power Leave ignition off. Measure resistance between breakout box test pin No. 29 (TCS) and test pins No. 71 and 97 (VPWR). If resistance is 10,000 ohms or more, replace TCS switch and repeat **QUICK TEST** . If resistance is less than 10,000 ohms, repair short circuit and repeat QUICK TEST.

6) Check TCIL PID Turn ignition off. With scan tester connected to Data Link Connector (DLC), access TCIL PID. Cycle TCS switch. If TCIL PID changes from ON to OFF, fault is intermittent. Go to **CIRCUIT TEST Z** . If TCIL PID does not change as specified, go to next step.

7) Check For Short to Ground In TCIL Circuit Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Turn ignition on. If TCIL goes off, replace PCM. If TCIL remains on, repair TCIL circuit short to ground.

8) Check For DTC P1780 Perform KOER self-test. If DTC P1780 is not present, go to next step. If DTC P1780 is present, go to step 1).

9) Turn ignition on. Measure voltage between TCIL test pin and test pins No. 24 and 76 (PWR GND) at breakout box. If voltage is 2 volts or more, replace PCM. If voltage is less than 2 volts, check indicator bulb and fuse. If bulb and fuse are okay, repair open circuit between test pin No. 79 and ignition switch.

CIRCUIT TEST TG - 4X4 LOW (4X4L) RANGE

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. This test is used to diagnose the following:

- Generic electronic module wiring harness circuits.
- Powertrain Control Module (PCM).

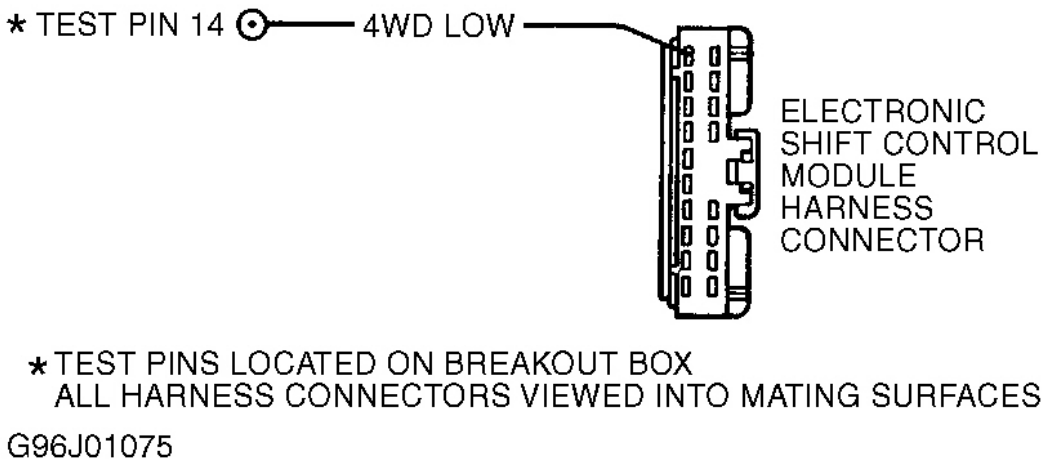


Fig. 91: Electronic Shift Control Module Test Circuit (Electronic Shift)

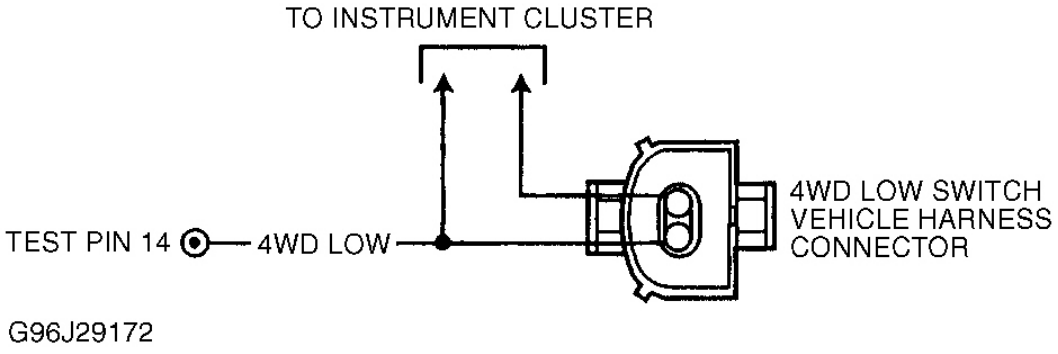


Fig. 92: 4x4 Low Switch Test Circuit & Connector Terminals (Mechanical Shift)

1) DTC P1729 & P1781 DTC P1729 indicates 4x4 switch open or short circuit. DTC P1781 indicates 4x4L switch position closed during QUICK TEST. If switch position was not 4x2 or 4x4H during KOEO QUICK TEST, select 4x2 or 4x4H and repeat QUICK TEST. If switch position was as specified, go to next step.

2) Check Intermittent Circuit Failure Turn ignition off. Connect scan tester to DLC. Using scan tester, access 4x4L PID. Turn ignition on. Cycle switch to 4x2. Shake and bend sections of wiring harness between generic electronic module and transfer case wiring harness connector. Shake and bend sections of wiring harness between generic electronic module PCM. Tap wiring harness connector to simulate road shock. If scan tester voltage fluctuates, isolate fault and repair as necessary. If scan tester voltage does not fluctuate, go to next step.

3) Check Signal From PCM Turn ignition off. Disconnect PCM 104-pin connector. Inspect pins for damage and repair if necessary. Install EEC-V Breakout Box (014-00950), leaving PCM disconnected. Turn ignition on. While cycling switch, measure voltage between breakout box test pin No. 14 and No. 24 (PWR GND). If voltage cycles, replace PCM and repeat **QUICK TEST** . If voltage does not cycle, go to next step.

4) Check Circuit Continuity Turn ignition off. Disconnect electronic shift control module. Inspect pins for damage and repair if necessary. Measure resistance between breakout box test pin No. 14 and 4X4L terminal at module wiring harness connector. If resistance is 5 ohms or less, go to next step. If resistance is more than 5 ohms, repair open circuit and repeat **QUICK TEST** .

5) Check For Short To Power Or Ground Leave ignition off. Reconnect electronic shift control module. Measure resistance between breakout box test pin No. 14 and No. 24. Measure resistance between breakout box test pin No. 14 and test pins No. 71 and 97 (VPWR). If any resistance measurement is more than 10,000 ohms, repair transfer case mechanical fault. If any resistance measurement is 10,000 ohms or less, repair short circuit and repeat **QUICK TEST** .

CIRCUIT TEST Z - INTERMITTENT

Diagnostic Aids

Perform this test when instructed during QUICK TEST or if directed by other test procedures. Before

continuing with this circuit test, ensure that the following areas are in good condition:

- Air induction system.
- Vacuum hoses and connections.
- Wiring harness connectors.
- Fuel level and quality.
- Added aftermarket equipment.
- Base engine.

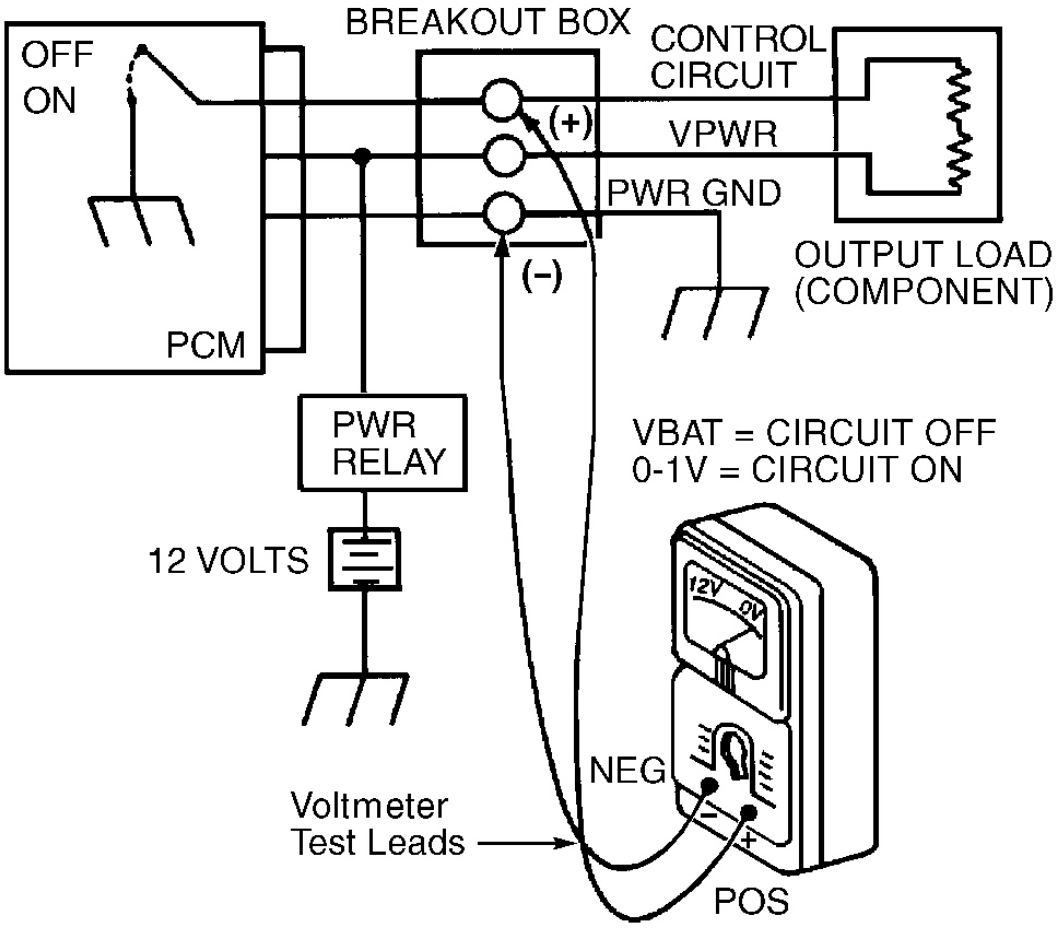


Fig. 93: Testing Typical PCM Output Control Circuit

1) Intermittent Test Procedure Proceed to the appropriate circuit test as follows:

INPUT CIRCUIT TEST PRIORITY

Circuit	(1) Step 10)	(2) Step 30)	(3) Step 40)
ACCS	1st	3rd	2nd
BOO	1st	3rd	2nd
CMP (4)	1st	2nd	3rd
DPFEGR	1st	2nd	3rd
ECT	1st	2nd	3rd
FP	1st	3rd	2nd
IAT	1st	2nd	3rd
IMRCM	1st	2nd	3rd
MAF	1st	2nd	3rd
OCTADJ	1st	3rd	2nd
O2S	1st	3rd	2nd
PF	1st	2nd	3rd
PSP	1st	3rd	2nd
TCS	1st	N/A	2nd
TFT	1st	3rd	2nd
TP	1st	3rd	2nd
TPB	1st	3rd	2nd
TR	1st	3rd	2nd
VSS	1st	3rd	2nd

(1) Input test (sensor) procedure.

(2) Water soak check procedure.

(3) Road test procedure.

(4) Go to step 50) before performing WATER SOAK TEST.

OUTPUT CIRCUIT TEST PRIORITY

Circuit	(1) Step 20)	(2) Step 30)	(3) Step 40)
ACP	1st	3rd	2nd
AIR	1st	3rd	2nd
EVAPCVA	1st	3rd	2nd
EVAPCP	1st	3rd	2nd
EPC	1st	3rd	2nd
EVRVR	1st	3rd	2nd
FPM	1st	3rd	2nd
HFC	1st	3rd	2nd
HTR11A	1st	3rd	2nd
HTR12A	1st	3rd	2nd
HTR21A	1st	3rd	2nd

HTR22A	1st	3rd	2nd
IAC	1st	3rd	2nd
IMRC	1st	3rd	2nd
INJ	1st	3rd	2nd
LFC	1st	3rd	2nd
MIL	1st	N/A	2nd
SS1	1st	3rd	2nd
SS2	1st	3rd	2nd
SS3	1st	3rd	2nd
TCTC (4)	1st	3rd	2nd
TCC	1st	3rd	2nd
TCIL	1st	N/A	2nd
WAC	1st	3rd	2nd
4X4L	1st	3rd	2nd

(1) Output test (actuator) procedure.

(2) Water soak check procedure.

(3) Road test procedure.

(4) Go to step 50) before performing WATER SOAK TEST.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 1) to step 10). No test procedures have been omitted.

10) Intermittent Input Test (Sensor) Procedure Turn ignition off. Connect scan tester to DLC. Access PIDs from the area of suspected wiring or component fault. Turn ignition on. While observing PID value, wiggle and pull on component wiring and connector. See PIN VOLTAGE/PID VALUE CHARTS article. Lightly tap on component. If PID value(s) is okay, go to next step. If sudden change occurs in PID value or PID value drops out of sensor range, isolate fault and repair as necessary. If fault cannot be located, replace suspect component. If replacement component does not repair fault, install original component and go to next step.

11) Leave ignition on with PIDs accessed. While observing PID value, wiggle and pull on wiring harness between suspect component and PCM. Lightly tap on component. If PID value(s) remain within specification, go to next step. If sudden change occurs in PID value or PID value drops out of sensor range, isolate fault and repair as necessary. If fault cannot be located, replace PCM. If replacement PCM does not repair fault, install original PCM. Return to step 1) and choose another procedure.

12) Intermittent Input KOER Wiggle Test Leave ignition on with PIDs accessed. Access PIDs from the area of suspected wiring or component fault. Start engine and allow to idle. While observing PID value, wiggle and pull on component wiring and connector. See PIN VOLTAGE/PID VALUE CHARTS article. Lightly tap on component. If PID value(s) is okay, go to next step. If sudden change occurs in PID value or PID value drops out of sensor range, isolate fault and repair as necessary. If fault cannot be located, replace suspect component. If replacement component does not repair fault, install original component and go to next step.

13) Leave engine running at idle speed with PIDs accessed. While observing PID value, wiggle and pull on wiring harness between suspect component and PCM. Lightly tap on component. If PID value(s) remain within specification, fault cannot be identified with this procedure. Return to step 1) and choose another procedure. If sudden change occurs in PID value or PID value drops out of sensor range, isolate fault and repair as necessary. If fault cannot be located, replace PCM. If replacement PCM does not repair fault, install original PCM. Return to step 1) and choose another procedure.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 13) to step 20). No test procedures have been omitted.

20) Intermittent Output Test (Actuator) Procedure If no symptoms or trouble codes are present, perform road test procedure specified insteps 40) through 43). Turn ignition off. Connect scan tester to DLC. Access PIDs from the area of suspected wiring or component fault. Record trouble codes in PCM memory, if present. Disconnect 104-pin connector from PCM. Install Breakout Box (014-000959). Connect PCM to breakout box. Connect positive lead of voltmeter to output control circuit of suspect component. See **Fig. 93** . Connect negative lead to ground. Turn ignition on. Using scan tester, enter Output Test Mode. Activate suspect component. While observing voltmeter reading and PID value, lightly tap on component. Compare readings to specification. See PIN VOLTAGE/PID VALUE CHARTS article. If readings are correct and remain stable within one volt, go to next step. If readings are incorrect or unstable within one volt, replace component. If replacement component does not repair fault, install original component and go to next step.

21) Leave ignition on with PIDs accessed. While observing voltmeter reading and PID value, wiggle and pull on wiring harness between suspect component and PCM. Lightly tap on component. Compare readings to specification. See PIN VOLTAGE/PID VALUE CHARTS article. If readings are correct and remain stable within one volt, fault cannot be identified with this procedure. Return to step 1) and choose another procedure. If readings are incorrect or unstable within one volt, isolate fault and repair as necessary.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 21) to step 30). No test procedures have been omitted.

30) Intermittent Water Soak Check Procedure Turn ignition off. Connect scan tester to DLC. Access PIDs from the area of suspected wiring or component fault. Start engine and allow to idle. Spray water on suspect component, circuit and connector. Watch for fault indicated by incorrect PID value, sudden change in PID value or fluctuating engine speed. If no faults occur, go to next step. If fault occurs, isolate and repair as necessary.

31) With engine running, spray water on spark plugs, spark plug wires, ICM, CKP sensor and CMP sensor. Watch for fault indicated by incorrect PID value, sudden change in PID value or fluctuating engine speed. See PIN VOLTAGE/PID VALUE CHARTS article. If no faults occur, fault cannot be identified with this procedure. Return to step 1) and choose another procedure. If fault occurs, isolate and repair as necessary.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 31) to step 40). No test procedures have been omitted.

40) Intermittent Road Test Procedure This procedure will monitor PIDs and components using a scan tester on a road test. An assistant is necessary for some procedures.

This procedure is performed under 4 different conditions; KOEO, engine running at idle speed, 30 MPH and 55 MPH. Compare information with specifications listed in PIN VOLTAGE/PID VALUE CHARTS article.

Turn ignition off. Connect scan tester to DLC. Access PIDs from the area of suspected wiring or fault. Compare values to KOEO values given in PIN VOLTAGE/PID VALUE CHARTS article. Watch for fault indicated by PID value out of specification. If no faults occur, go to next step. If fault occurs, go to step 10) for input system fault or step 20) for output system fault.

41) With scan tester connected to DLC, remain in PID access mode. Start engine and allow to idle. With engine warmed to operating temperature, watch for fault indicated by incorrect PID value, sudden change in PID value or fluctuating engine speed. Compare values to HOT IDLE values given in PIN VOLTAGE/PID VALUE CHARTS article. If values remain within specification, go to next step. If values do not remain within specification, go to step 10) for input system fault or step 20) for output system fault.

42) Leave scan tester connected to DLC in PID access mode. Ensure all accessories are off. Using an assistant, test drive vehicle at 30 MPH. Watch for fault indicated by incorrect PID value, sudden change in PID value or fluctuating engine speed. Compare values to 30 MPH values given in PIN VOLTAGE/PID VALUE CHARTS article. If values remain within specification, go to next step. If values do not remain within specification, go to step 10) for input system fault or step 20) for output system fault.

43) Leave scan tester connected to DLC in PID access mode. Test drive vehicle at 55 MPH. Watch for fault indicated by incorrect PID value, sudden change in PID value or fluctuating engine speed. Compare values to 55 MPH values given in J- PIN VOLTAGE/PID VALUE CHARTS article. If values remain within specification, fault cannot be identified with this procedure. Return to step 1) and choose another procedure. If values do not remain within specification, go to step 10) for input system fault or step 20) for output system fault.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 43) to step 50). No test procedures have been omitted.

50) Intermittent Ignition Test Procedure Ensure all accessories are off. Perform **QUICK TEST** . If trouble codes are present, service as necessary before continuing. If no trouble codes are present, connect Intermittent Ignition Analyzer (007-000075) and go to next step. If intermittent ignition analyzer is not available, return to step 1) and choose another procedure.

51) Turn ignition off. Ensure all accessories are off. Install correct overlay on front of tester panel. Install program cartridge in slot. Connect EI HIGH DATA RATE harness adapter to DIST tester. Ensure that CKP SIMULATION switch and WIGGLE TEST switch are off. Disconnect ICM wiring harness connector. Check connector terminals for damage or contamination and repair as necessary. Attach male ICM connector of tester to ICM wiring harness connector. Attach female ICM connector of tester to ICM. Turn ignition on and press tester RESET button. If tester performs self-test and VPWR LED comes on, go to step 53). If tester does not perform self-test or VPWR LED does not come on, go to next step.

52) Scan Tester Check Turn ignition off. Disconnect intermittent ignition analyzer. Connect jumper wire

between VPWR terminal of tester and positive battery terminal. Connect jumper wire between PWR GND terminal of tester and negative battery terminal. If tester passes self-test, go to step 220). If tester does not pass self-test, repair or replace as necessary and go to next step.

53) Recreate Fault Turn ignition on. Check Fault Memory and System Status LEDs. If LEDs are not on, go to next step. If LEDs are on, go to step 270).

54) Test drive vehicle. If vehicle will not start, crank engine for 5-10 seconds. If FAULT MEMORY or SYSTEM STATUS are not on, go to step 1). If FAULT MEMORY or SYSTEM STATUS LEDs are on, go to step 270).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 54) to step 190). No test procedures have been omitted.

190) Check For VPWR Turn ignition on. Measure voltage between VPWR jack of intermittent ignition analyzer and negative battery terminal. If voltage is 6 volts or more, go to next step. If voltage is less than 6 volts, repair open in VPWR circuit to ICM.

191) Check PWR GND Circuit Turn ignition off. Measure resistance between PWR GND jack of intermittent ignition analyzer and negative battery terminal. If resistance is less than 5 ohms, go to next step. If voltage is 5 ohms or more, repair open in PWR GND circuit to ICM.

192) Wiggle Check Connect jumper wire between PWR GND jack of intermittent ignition analyzer and negative battery terminal. Shake and bend wiring harness and connectors. If the intermittent ignition analyzer performs reset, repair open in VPWR circuit to ICM. If the intermittent ignition analyzer does not perform reset, repair open in PWR GND circuit to ICM.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 192) to step 220). No test procedures have been omitted.

220) Check For Coil Faults Turn ignition on. Press ignition analyzer RESET button. If COIL FAULT MEMORY LED is off, go to next step. If COIL FAULT MEMORY LED is on or flashing, go to step 229).

221) Check CASE GND/CKP SHIELD Turn ignition on. If CASE GND/CKP SHIELD FAULT MEMORY LED is off, go to next step. If CASE GND/CKP SHIELD FAULT MEMORY is on or flashing, go to step 253).

222) Check CKP BIAS Leave ignition on. If CKP BIAS SYSTEM STATUS LED is on, go to next step. If CKP BIAS SYSTEM STATUS LED is off, go to step 243).

223) Test drive vehicle. If vehicle will not start, crank engine for 5-10 seconds. If COIL FAULT MEMORY LEDs are not on, go to next step. If COIL FAULT MEMORY LEDs are on, go to step 229).

224) Leave ignition on. If CASE GND/CKP SHIELD FAULT MEMORY LEDs are not on, go to next step. If CASE GND/CKP SHIELD FAULT MEMORY LEDs are on, go to step 253).

225) Leave ignition on. If CKP FAULT MEMORY LEDs are not on, go to next step. If CKP FAULT MEMORY LEDs are on, go to step 247).

226) Leave ignition on. If CTO FAULT MEMORY LEDs are not on, go to next step. If CTO FAULT MEMORY LEDs are on, go to step 239).

227) Leave ignition on. If CKP SIGNAL SYSTEM STATUS LEDs are on, ignition system is okay and testing is complete. If CKP SIGNAL SYSTEM STATUS LEDs are not on, go to step 247).

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 227) to step 229). No test procedures have been omitted.

229) VBATC Circuit Check Turn ignition off. Disconnect ignition coil packs. Connect Intermittent Ignition Analyzer (007-000075). Turn ignition on. Measure voltage between B+ terminal at ignition coil pack wiring harness connector and PWR GND jack of ignition analyzer. If voltage is 10-14 volts, go to next step. If voltage is not 10-14 volts, repair open in B+ circuit.

230) Check For Short Turn ignition off. Measure resistance between PWR GND jack and COIL jack of ignition analyzer. Measure resistance between VPWR jack and COIL jack of ignition analyzer. If resistance is 6000 ohms or more, go to next step. If resistance is less than 6000 ohms, go to step 236).

231) Check Coil Line Resistance Turn ignition off. Measure resistance between each COIL jack of ignition analyzer and same terminal at ignition coil harness connector. If resistance is 5000 ohms or less, go to next step. If resistance is more than 5000 ohms, repair circuit and retest system.

232) Check Coil Line For Short Leave ignition off. Measure resistance between each COIL jack of ignition analyzer. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, go to step 237).

233) Check For Hard Faults Reconnect coil packs. Turn ignition on. Press ignition analyzer RESET button. Wait for initialization and coil test. If COIL FAULT MEMORY LED is off, go to next step. If CKP SHD LED is on or flashing, go to step 238).

234) Wiggle Test Mode B Turn intermittent ignition analyzer WIGGLE TEST switch on. Turn MODE switch to "B". Press RESET button and wait 5 seconds for initialization. If fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

235) Turn ignition off. Disconnect coil packs. Turn ignition on. Press RESET button and wait 5 seconds for initialization. If fault memory LEDs are off, replace PCM. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

236) Circuit Check Turn ignition off. Disconnect PCM. Reconnect DIST to vehicle harness. Measure resistance between each COIL jack and PWR GND jack of ignition analyzer. Measure resistance between COIL jack and VPWR jack. If resistance is 10,000 ohms or more, replace PCM. If resistance is less than 10,000 ohms, repair open in COIL circuit.

237) Turn ignition off. Disconnect PCM. Measure resistance between each COIL jack and all other COIL jacks of intermittent ignition analyzer. If each resistance is 10,000 ohms or more, replace PCM. If resistance is less than 10,000 ohms, repair open in COIL circuit.

238) System Visual Check Leave ignition off. Check ignition system for damage, loose connections or corrosion. Repair if necessary. If ignition system looks okay, replace ignition coil pack(s).

239) Circuit Check Turn ignition off. Measure resistance between CTO jack and PWR GND jack of ignition analyzer. Measure resistance between CTO jack and VPWR jack. If resistance is 1000 ohms or less, go to next step. If resistance is more than 1000 ohms, go to step 241).

240) Leave ignition off. Disconnect PCM. Reconnect DIST to vehicle harness. Measure resistance between CTO jack and PWR GND jack of ignition analyzer. Measure resistance between CTO jack and VPWR jack. If resistance is 1000 ohms or more, replace PCM. If resistance is less than 1000 ohms, repair fault in CTO circuit.

241) Wiggle Test Mode B Turn ignition on. Turn WIGGLE TEST switch on. Set MODE switch to "B". Press intermittent ignition analyzer RESET button and wait 5 seconds for initialization. If all fault

memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

242) For 4 or 6 cylinder models, set MODE switch to "A". For 8 cylinder models, set MODE switch to "C". Press intermittent ignition analyzer RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, replace PCM and retest. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

243) Check CKP BIAS Turn ignition off. Disconnect CKP sensor harness connector. Turn ignition on. Press ignition analyzer RESET button and wait 5 seconds for initialization. If CKP BIAS SYSTEM STATUS LEDs are off, go to next step. If CKP BIAS SYSTEM STATUS LEDs are on, go to step 245).

244) Turn ignition off. Disconnect PCM. Reconnect DIST to vehicle harness. Measure resistance between CKP+ jack and PWR GND jack of ignition analyzer. Measure resistance between CKP+ jack and VPWR jack. If resistance is 10,000 ohms or more, replace PCM. If resistance is less than 10,000 ohms, repair fault in CKP circuit.

245) Circuit Check Leave ignition off. Measure resistance between CKP- jack and PWR GND jack of ignition analyzer. Measure resistance between CKP- jack and VPWR jack. If resistance is 10,000 ohms or less, go to next step. If resistance is more than 10,000 ohms, replace CKP sensor and retest.

246) Turn ignition off. Disconnect PCM. Reconnect DIST to vehicle harness. Measure resistance between CKP- jack and PWR GND jack of ignition analyzer. Measure resistance between CKP- jack and VPWR jack. If resistance is 10,000 ohms or more, replace PCM. If resistance is less than 10,000 ohms, repair fault in CKP circuit.

247) Check CKP Signal Press ignition analyzer RESET button and wait 5 seconds for initialization. Crank or start engine. If CKP SIGNAL SYSTEM STATUS LEDs are off, go to next step. If CKP SIGNAL SYSTEM STATUS LEDs are on, go to step 252).

248) Circuit Check Turn ignition off. Disconnect CKP sensor. Measure resistance between CKP+ terminal of CKP sensor wiring harness connector and CKP+ jack of intermittent ignition analyzer. Measure resistance between CKP- terminal of CKP sensor wiring harness connector and CKP- jack of intermittent ignition analyzer. If both resistance measurements are less than 5000 ohms, go to next step. If resistance is 5000 ohms or more, repair CKP circuit and retest.

249) Leave ignition off. Measure resistance between CKP+ jack and CKP- jack of ignition analyzer. If resistance is less than 10,000 ohms, go to next step. If resistance is 10,000 ohms or more, go to step 251).

250) Leave ignition off. Disconnect PCM. Reconnect DIST to vehicle harness. Measure resistance between CKP+ jack and CKP- jack of ignition analyzer. If resistance is less than 10,000 ohms, repair CKP circuit and retest. If resistance is 10,000 ohms or more, replace PCM and retest.

251) Sensor Check Turn ignition off. Inspect CKP sensor and data wheel for damage, correct alignment and air gap. Service sensor and data wheel as necessary. If no problems are found, replace CKP sensor.

252) Wiggle Test Mode B Turn ignition on. Turn WIGGLE TEST switch on. Set MODE switch to "B". Press intermittent ignition analyzer RESET button and wait 5 seconds for initialization. If any fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

253) Check CKP SHD For Short To Power Measure resistance between CASE GND/CKP SHD jack and VPWR jack of ignition analyzer. If resistance is less than 10,000 ohms, go to next step. If resistance is 10,000 ohms or more, go to step 255).

254) Isolate Short Leave ignition off. Disconnect PCM. Reconnect DIST to vehicle harness. Measure resistance between CASE GND/CKP SHD jack and VPWR jack of ignition analyzer. If resistance is less

than 10,000 ohms, repair CASE GND/CKP SHD circuit and retest. If resistance is 10,000 ohms or more, replace PCM and retest.

255) Wiggle Test Mode B Turn ignition on. Turn WIGGLE TEST switch on. Set MODE switch to "B". Press intermittent ignition analyzer RESET button and wait 5 seconds for initialization. If any fault memory LEDs are off, repair CASE GND/CKP SHD circuit and retest. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

NOTE: A break in step numbering sequence occurs at this point. Procedure skips from step 255) to step 270). No test procedures have been omitted.

270) Check For Coil Fault If COIL FAULT MEMORY LED is off, go to next step. If COIL FAULT MEMORY LED is on, go to step 277).

271) Check For IDM Fault If IDM FAULT MEMORY LED is off, go to next step. If IDM FAULT MEMORY is on or flashing, go to step 287).

272) Check PIP Active Fault If PIP ACTIVE SYSTEM STATUS LED is on, go to next step. If PIP ACTIVE SYSTEM STATUS LED is off, go to step 291).

273) If PIP FAULT MEMORY LED is off, go to next step. If PIP FAULT MEMORY LED is on, go to step 291).

274) If PIP DUTY FAULT MEMORY LED is off, go to next step. If PIP DUTY FAULT MEMORY LED is on, go to step 291).

275) Check For Base Timing Fault If BASE TIMING SYSTEM STATUS LED is off, go to next step. If BASE TIMING SYSTEM STATUS LED is on, go to step 302).

276) Check For SPOUT Fault If SPOUT FAULT MEMORY LED is off, go to step 59). If SPOUT FAULT MEMORY LED is on, go to step 310).

277) Check Coil Voltage Turn ignition on. Measure voltage between COIL jack and IGN GND jack of ignition analyzer. If voltage is 10-14 volts, go to next step. If voltage is not 10-14 volts, go to step 280).

278) Check For Short To PWR Turn ignition off. Disconnect ignition coil. Measure resistance between COIL jack and ICM PWR jack of ignition analyzer. If resistance is 2000 ohms or less, go to next step. If resistance is more than 2000 ohms, go to step 284).

279) Turn ignition off. Disconnect ICM. Measure resistance between COIL jack and ICM PWR jack of ignition analyzer. If resistance is 10,000 ohms or less, repair circuit and retest. If resistance is less than 2000 ohms, replace ICM.

280) Check Coil Pack PWR Turn ignition off. Disconnect ignition coil. Turn ignition on. Measure voltage between COIL jack and IGN GND jack of ignition analyzer. If voltage is 10-14 volts, go to next step. If voltage is not 10-14 volts, repair circuit and retest.

281) Check For Short To GND Turn ignition off. Measure resistance between COIL jack and ICM GND jack of ignition analyzer. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, go to step 283).

282) Check Harness Resistance Turn ignition off. Measure resistance between COIL jack of ignition analyzer and COIL terminal of harness connector. If resistance is 5 ohms or more, repair circuit. If resistance is less than 5 ohms, replace ignition coil.

283) Check Harness For Short To GND Turn ignition off. Disconnect ICM. Measure resistance between COIL jack and ICM GND jack of ignition analyzer. If resistance is 10,000 ohms or more,

replace ICM. If resistance is less than 10,000 ohms, repair circuit.

284) Check Coil Reconnect coil. Turn ignition on. Press ignition analyzer RESET button and wait 5 seconds for initialization. If COIL FAULT MEMORY LED is on, replace coil. If COIL FAULT MEMORY LED is off, go to next step.

285) Wiggle Test Mode B Turn ignition on. Turn WIGGLE TEST switch on. Set MODE switch to "B". Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

286) Turn ignition off. Disconnect coil. Turn ignition on. Press ignition analyzer RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, replace ICM and retest. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

287) Perform QUICK TEST If any KOEO or KOER DTCs are present, go to appropriate CIRCUIT TEST. If Continuous Memory DTC P1351 is present, go to step 289). If no DTCs are present, go to next step.

288) Wiggle Test Mode B Turn ignition on. Turn WIGGLE TEST switch on. Set MODE switch to "B". Press RESET button and wait 5 seconds for initialization. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located. If all fault memory LEDs are off, fault cannot be duplicated at this time. Go to step 1) and choose another procedure.

289) Turn ignition off. Install EEC-V Breakout Box (014-00950) leaving PCM disconnected. Measure resistance between IDM/START jack of intermittent ignition analyzer test pin No. 48 at the breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open circuit and retest.

290) Wiggle Test ROVING Turn ignition off. Connect PCM to breakout box. Using jumper wire, connect ROVING jack of intermittent ignition analyzer to test pin No. 48 at the breakout box. Turn WIGGLE TEST switch on. Set MODE switch to "B". Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, fault cannot be duplicated at this time. Go to step 1) and choose another procedure.

291) Check For Short Turn ignition off. Measure resistance between IGN GND jack and PIP jack of intermittent ignition analyzer. Measure resistance between ICM PWR jack and PIP jack of intermittent ignition analyzer. If both resistance measurements are 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, go to step 294).

292) Check Circuit Resistance Turn ignition off. Disconnect distributor connector. Measure resistance between PIP jack of ignition analyzer and PIP terminal of distributor connector. If resistance is 5 ohms or more, repair circuit and retest. If resistance is less than 5 ohms, go to next step.

293) Wiggle Test Mode B Turn ignition off. Reconnect distributor connector. Turn ignition on. Turn WIGGLE TEST switch on. Set MODE switch to "B". Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

294) Wiggle Test Mode A Leave ignition on. Set MODE switch to "A". Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

295) Wiggle Test Mode C Leave ignition on. Set MODE switch to "C". Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

296) Wiggle Test ROVING Turn ignition off. Using jumper wire, connect ROVING jack and PIP jack of intermittent ignition analyzer. Turn ignition on. Set MODE switch to "B". Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

297) Wiggle Test ROVING At PCM Turn ignition off. Install EEC-V Breakout Box (014-00950) leaving PCM disconnected. Using jumper wire, connect ROVING jack of intermittent ignition analyzer to test pin No. 49 at the breakout box. Turn ignition on. Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

298) PIP Sensor Check Turn ignition off. Remove distributor cap. Inspect PIP sensor and pulse wheel for damage, correct mounting and alignment. Service sensor and data wheel as necessary. If no problems are found, go to next step.

299) Check For Short Turn ignition off. Disconnect PCM. Measure resistance between IGN GND jack and PIP jack of ignition analyzer. Measure resistance between ICM PWR jack and PIP jack of ignition analyzer. If both resistance measurements are 10,000 ohms or more, replace PCM. If either resistance measurement is less than 10,000 ohms, go to next step.

300) Leave ignition off. Disconnect ICM. Measure resistance between IGN GND jack and PIP jack of ignition analyzer. Measure resistance between ICM PWR jack and PIP jack of ignition analyzer. If both resistance measurements are 10,000 ohms or more, replace ICM. If either resistance measurement is less than 10,000 ohms, go to next step.

301) Leave ignition off. Disconnect distributor harness connector. Measure resistance between IGN GND jack and PIP jack of ignition analyzer. Measure resistance between ICM PWR jack and PIP jack of ignition analyzer. If both resistance measurements are 10,000 ohms or more, repair or replace PIP sensor harness. If either resistance measurement is less than 10,000 ohms, go to next step.

302) Check Base Timing Status If BASE TIMING LED is on continuously with no FAULT MEMORY LEDs, replace ICM. If LEDs are not as specified, go to next step.

303) Turn ignition off. Measure resistance between IGN GND jack and SPOUT jack of ignition analyzer. Measure resistance between ICM PWR jack and SPOUT jack of ignition analyzer. If both resistance measurements are 10,000 ohms or more, go to next step. If either resistance measurement is less than 10,000 ohms, go to step 310).

304) Check SPOUT Circuit Resistance Turn ignition off. Disconnect PCM. Measure resistance between SPOUT jack of ignition analyzer and test pin No. 50 at the breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair circuit and retest.

305) Check PIP Circuit Resistance Leave ignition off. Measure resistance between PIP jack of ignition analyzer and test pin No. 50 at the breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair circuit and retest.

306) Check IGN GND Circuit Resistance Leave ignition off. Measure resistance between IGN GND jack of ignition analyzer and test pin No. 23 at the breakout box. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair circuit and retest.

307) Wiggle Test Mode B With ignition off, reconnect PCM. Turn ignition on. Turn WIGGLE TEST switch on. Set MODE switch to "B". Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

308) Wiggle Test Mode C Leave ignition on. Set MODE switch to "C". Press RESET button and wait 5

seconds for initialization. If all fault memory LEDs are off, go to next step. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

309) Wiggle Test ROVING At PCM Turn ignition off. Install EEC-V Breakout Box (014-00950) leaving PCM disconnected. Using jumper wire, connect ROVING jack of intermittent ignition analyzer to test pin No. 36 at the breakout box. Turn ignition on. Press RESET button and wait 5 seconds for initialization. If all fault memory LEDs are off, replace PCM. If any fault memory LEDs are on, press RESET button and continue to test until intermittent is located.

310) Check Harness & PCM For Shorts Turn ignition off. Disconnect ICM. Measure resistance between IGN GND jack and SPOUT jack of ignition analyzer. Measure resistance between ICM PWR jack and SPOUT jack of ignition analyzer. If both resistance measurements are 10,000 ohms or more, replace ICM and retest. If either resistance measurement is less than 10,000 ohms, go to step 310).

311) Check Harness & PCM For Shorts Turn ignition off. Disconnect PCM. Measure resistance between IGN GND jack and SPOUT jack of ignition analyzer. Measure resistance between ICM PWR jack and SPOUT jack of ignition analyzer. If both resistance measurements are 10,000 ohms or more, replace PCM and retest. If either resistance measurement is less than 10,000 ohms, repair or replace harness and retest.

312) Check ICM GND Turn ignition off. Measure resistance between negative battery terminal and IGN GND jack of ignition analyzer. If resistance is 5 ohms or less, go to next step. If resistance is more than 5 ohms, go to step 315).

313) Check ICM PWR Turn ignition on. Measure voltage between negative battery terminal and IGN PWR jack of ignition analyzer. If voltage is 6 volts or more, go to next step. If voltage is less than 6 volts, repair ICM PWR circuit and retest.

314) Turn ignition off. Connect jumper wire between negative battery terminal and IGN GND jack of ignition analyzer. Turn ignition on. Press RESET button and wait 5 seconds for initialization. If ignition analyzer resets, repair ICM PWR circuit and retest. If ignition analyzer does not reset, repair IGN GND circuit and retest.

315) Check Circuit Resistance Turn ignition off. Disconnect distributor connector. Measure resistance between IGN GND jack of ignition analyzer and IGN GND terminal of distributor connector. If resistance is 5 ohms or more, repair circuit and retest. If resistance is less than 10,000 ohms, go to next step.

316) Check Distributor Ground Leave ignition off. Measure resistance between negative battery terminal and metal surface of distributor. If resistance is 5 ohms or more, check distributor for correct mounting, negative battery cable ground connection and distributor ground circuit. If resistance is less than 5 ohms, service or replace PIP sensor or harness.

1997 ENGINES

4.2L V6

ENGINE IDENTIFICATION

Engine model may be identified by eighth character of Vehicle Identification Number (VIN). VIN is stamped on a plate located on top of instrument panel, near lower left of windshield. VIN number is also stamped on vehicle certification label, located on left front door pillar.

ENGINE IDENTIFICATION CODES

Engine	Code
4.2L SFI	2

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

Hydraulic valve tappets are used. Valve adjustment is not required.

TROUBLE SHOOTING

NOTE: To trouble shoot engine mechanical components, see ENGINE MECHANICAL in BASIC TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.

FUEL PRESSURE RELEASE

WARNING: Fuel system is under pressure. Release pressure before servicing fuel system components.

1. Remove fuel cap to release fuel tank pressure. Remove relief valve cap. Relief valve (service port) is

located on fuel supply manifold. Using Fuel Pressure Gauge (T80L-9974-B), release fuel pressure from relief valve (Schrader valve).

2. If fuel pressure gauge is not available, disconnect electrical connector to Inertia Fuel Shut Off (IFS) switch. IFS switch is located behind passenger side kick panel. Crank engine for 15 seconds to reduce system pressure.
3. To disconnect fuel lines, remove retaining clip from fuel line coupling. Use Spring Lock Coupling Remover (D87L-9280-A) for 3/8" line and (D87L-9280-B) for 1/2" line. Install spring lock coupling remover on fuel line coupling so it enters cage opening. See **Fig. 1**.
4. Push spring lock coupling remover into cage opening to release female fitting from garter spring. Pull couplings apart. Remove spring lock coupling remover.
5. When installing fuel lines, install NEW "O" rings on fuel lines. Use only specified fuel-resistant "O" rings (Brown). Before installing, lightly coat "O" rings with clean engine oil. Clean fittings, and replace garter spring (if necessary).
6. Install female fitting to male fitting and push until garter spring snaps over flared end of female fitting. Ensure lines are locked together and garter spring is over flared end of female fitting. Install retaining clip. Ensure horseshoe portion of clip is over coupling. DO NOT install retaining clip over rubber fuel line.

NOTE: Install Black retaining clip on fuel supply line and Gray clip on fuel return line.

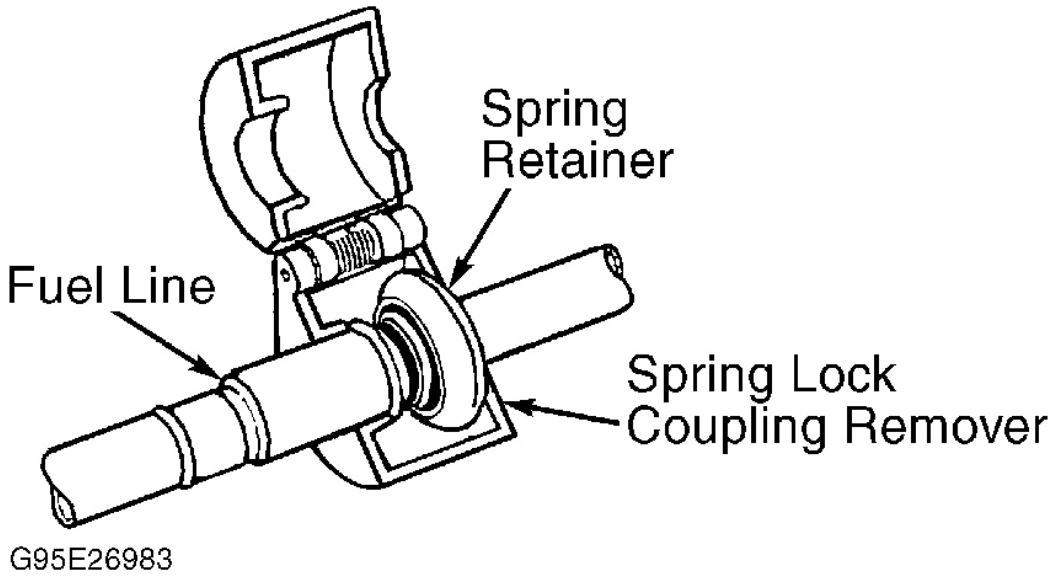


Fig. 1: Disconnecting Fuel Lines
Courtesy of FORD MOTOR CO.

ENGINE

Removal (Pickup)

1. Disconnect negative and positive battery cable. Mark hinges and remove hood. Drain cooling system. Discharge A/C system using approved refrigerant recovery/recycling equipment. Release fuel pressure and disconnect fuel lines. See **FUEL PRESSURE RELEASE**.
2. Remove upper front air deflector. Remove air cleaner outlet tube. Remove radiator. Remove fan blade and fan shroud. Disconnect throttle body control cables. Disconnect throttle control cable bracket and position aside.
3. Disconnect necessary vacuum and water lines. Disconnect necessary harness connectors and ground cables. Unbolt power steering reservoir and position aside. Disconnect A/C manifold line at compressor and position aside. Remove power steering pump retaining bolts and position pump aside.
4. Remove upper intake manifold. See **INTAKE MANIFOLD**. Remove fuel injector supply manifold and injectors. Raise and support vehicle. Disconnect exhaust pipes from exhaust manifold. Remove starter.
5. Remove transmission. For A/T (E4OD), see **REMOVAL & INSTALLATION - A/T (E40D)** article in TRANSMISSION SERVICING. For A/T (4R70W), see **SERVICING - A/T (4R70W)** article in TRANSMISSION SERVICING. For M/T, see appropriate article in CLUTCHES.
6. Remove right and left engine mount through-bolt. Lower vehicle. Install engine lifting equipment. Remove transmission-to-engine retaining bolts. Remove engine.

Installation

1. To install, reverse removal procedure. Tighten all bolts to specification. See **TORQUE SPECIFICATIONS**.
2. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Lightly coat "O" rings with clean engine oil before installing. Clean fittings, and replace garter spring (if necessary).
3. Adjust all control cables and fluid levels. Refill cooling system. Evacuate and recharge A/C system.

Removal (Van)

1. Disconnect negative and positive battery cable(s). Discharge A/C system using approved refrigerant recovery/recycling equipment. Release fuel pressure and disconnect fuel lines. See **FUEL PRESSURE RELEASE**. Remove air cleaner assembly and throttle body inlet tube.
2. Remove radiator air deflector. Remove radiator, fan shroud and cooling fan. Remove radiator inner grille. Remove radiator grille reinforcement panel. Remove stone deflector.
3. Remove headlight and side marker assemblies. Remove power steering cooler and auxiliary transmission cooler. Remove power steering cooler mounting brackets. Remove A/C condenser and plug openings. Disconnect hood latch cable and remove hood latch assembly.
4. Disconnect positive battery cable from power distribution box and position aside. Remove power steering reservoir retaining bolts and position aside. Remove upper and lower core support. Remove oil dipstick tube. Remove upper and lower intake manifold. See **INTAKE MANIFOLD**.
5. Disconnect necessary harness and ground connections. Remove accessory drive belt. Disconnect low-pressure hose at power steering pump. Unbolt power steering pump and position aside. Remove lower radiator hose. Disconnect A/C manifold at compressor and position aside, plug openings. Disconnect A/C high-pressure hose at evaporator and plug openings.

6. Raise and support vehicle. Drain engine oil. Remove starter. Remove torque converter nuts. Remove oil pan-to-transmission bolts. Disconnect exhaust pipes at exhaust manifolds. Disconnect shift cable bracket. Remove engine mount nuts.
7. Lower vehicle. Support transmission. Remove transmission dipstick tube. Install engine lifting equipment. Remove transmission-to-engine retaining bolts. Remove engine.

Installation

1. To install, reverse removal procedure. Replace torque converter nuts with NEW ones. Tighten all bolts to specification. See **TORQUE SPECIFICATIONS**.
2. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Lightly coat "O" rings with clean engine oil before installing. Clean fittings, and replace garter spring (if necessary).
3. Adjust all control cables and fluid levels. Refill cooling system. Evacuate and recharge A/C system.

INTAKE MANIFOLD

Removal

1. Disconnect negative battery cable. Remove air cleaner outlet tube. Disconnect spark plugs wires and harness connectors at ignition coil. Disconnect control cables from throttle body. Remove throttle body control cable bracket and position aside.
2. Disconnect necessary vacuum and water lines. Disconnect necessary harness connectors and ground cables. Remove engine vacuum regulator from intake manifold. Remove upper intake manifold retaining bolts. Remove upper intake manifold and gasket.
3. Disconnect fuel injector harness connectors. Disconnect EGR manifold from EGR valve. Remove IMRC. Release fuel pressure and disconnect fuel lines. See **FUEL PRESSURE RELEASE**.
4. Mark position for installation, remove lower intake manifold retaining bolts in reverse order. See **Fig. 2**. Remove lower intake manifold and gaskets.

Installation

1. To install, reverse removal procedure. Use NEW gaskets and "O" rings. Lubricate fuel injector "O" rings with Light Grade Oil (ESE-M2C39-F) before installing.
2. Ensure alignment tabs on intake manifold gaskets align with holes in cylinder head. Tighten intake manifold bolts to specification in sequence. See **Fig. 2**. See **TORQUE SPECIFICATIONS** table.

CAUTION: Intake manifold bolts must be retightened to specification after engine has reached normal operating temperature.

3. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Lightly coat "O" rings with clean engine oil before installing. Clean fittings, and replace garter spring (if necessary).
4. To install remaining components, reverse removal procedure. Adjust all control cables and fluid levels. Refill cooling system. When installing spark plug wires, ensure wires are in correct position on coils. See **SPECIFICATIONS - 4.2L** article in ENGINE PERFORMANCE.

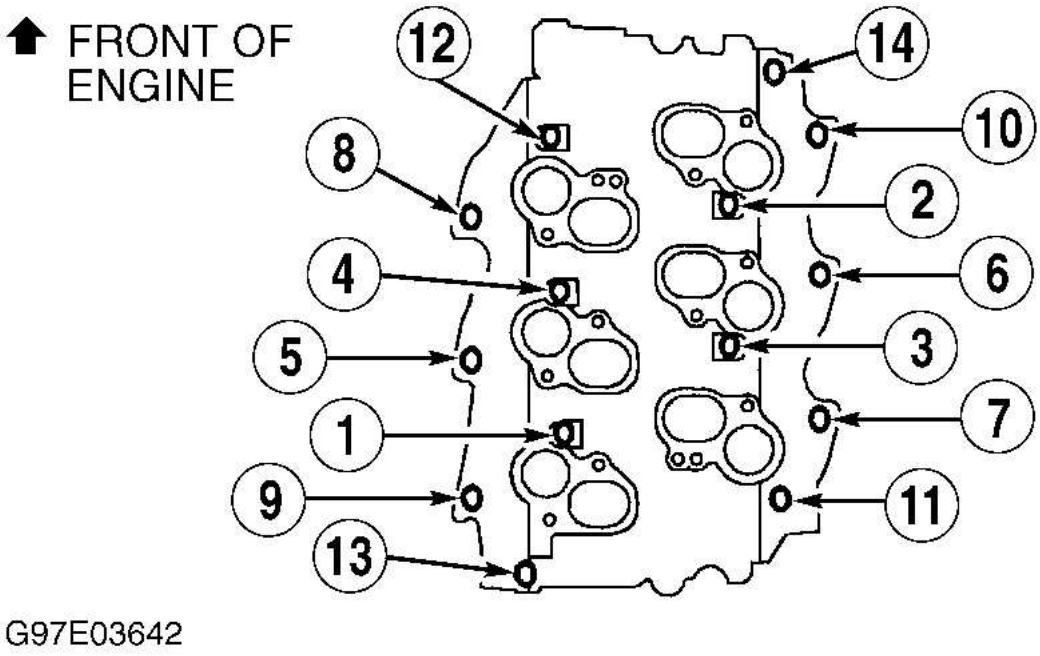


Fig. 2: Intake Manifold Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.

EXHAUST MANIFOLD

Removal

On left manifold, remove oil dipstick tube. On right manifold, remove EGR manifold tube. On both sides, disconnect oxygen sensor. Disconnect exhaust pipe from exhaust manifold. Remove exhaust manifold retaining bolts in reverse order. See **Fig. 3**. Remove exhaust manifold and gasket.

Installation

To install, reverse removal procedure. Tighten exhaust manifold nuts to specification in sequence. See **Fig. 3**. See **TORQUE SPECIFICATIONS** table.

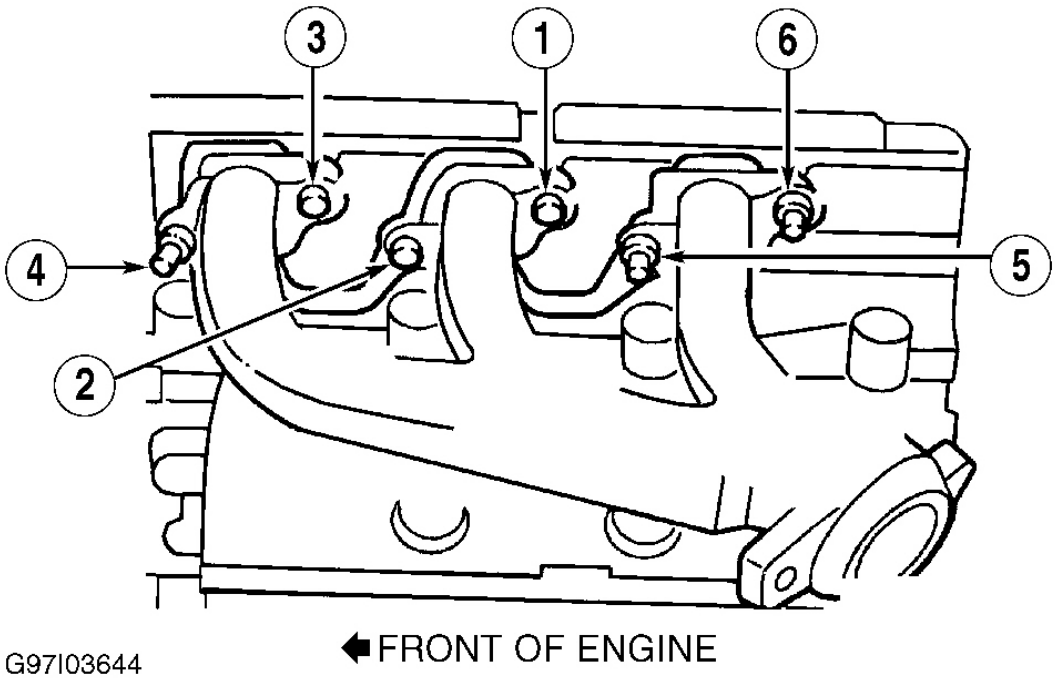


Fig. 3: Exhaust Manifold Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.

CYLINDER HEAD

Removal

1. Disconnect negative battery cable. Remove upper and lower intake manifolds. See **INTAKE MANIFOLD**. Remove valve cover. Remove exhaust manifold. See **EXHAUST MANIFOLD**. Remove accessory drive belt.
2. If removing left cylinder head, unbolt power steering reservoir and position aside. Remove A/C compressor, with hoses attached, and position aside. Remove power steering bracket, with pump and hoses attached, and position aside.
3. If removing right cylinder head, remove generator. Remove accessory drive belt idler pulley. Remove generator bracket.

CAUTION: Mark location of rocker arms and push rod if they are to be reused. Ensure they are installed in there original location.

4. If removing either cylinder head, remove rocker arms and push rods. Remove and discard cylinder head retaining bolts in reverse sequence. See **Fig. 4**. Remove cylinder head and gasket.

Inspection

Check cylinder head for warpage, cracks and damage. Maximum warpage information is not available from manufacturer.

CAUTION: DO NOT reuse cylinder head bolts.

Installation

1. Install NEW cylinder head gaskets on block with small hole at front of engine. Always use NEW cylinder head bolts. Lubricate cylinder head bolts with engine oil prior to installation.
2. Install cylinder head and tighten bolts to 14 ft. lbs. (19 N.m), in sequence. See **Fig. 4**. Repeat sequence again, tightening bolts to 29 ft. lbs. (39 N.m). Repeat sequence again, tightening bolts to 36 Ft. Lbs.

CAUTION: DO NOT loosen all cylinder head bolts at one time. Loosen and tighten each cylinder head bolt before preceding to next.

3. Working in order and on one bolt at a time, loosen bolt 3 revolutions and tighten to specification. See **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure.

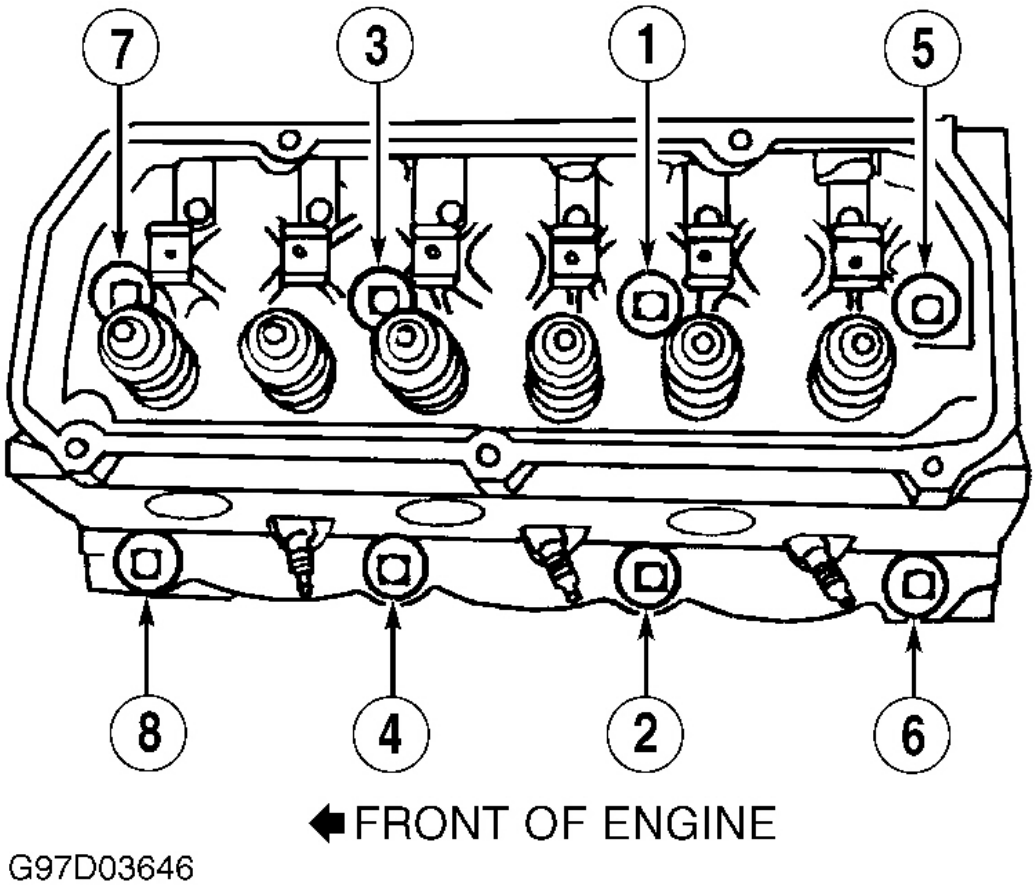


Fig. 4: Cylinder Head Tightening Sequence
Courtesy of FORD MOTOR CO.

FRONT COVER OIL SEAL

Removal

1. Disconnect negative battery cable. Remove accessory drive belt. Remove cooling fan and fan shroud. Raise and support vehicle. Mark pulley and damper position. Remove crankshaft pulley. Remove damper bolt.
2. Install Crankshaft Damper Remover (T58P-6316-D) and Crankshaft Damper Remover Adapter (T82P-6316-D). Remove damper. Using Seal Remover (T92C-6700-CH), remove oil seal from front cover.

Installation

To install, reverse removal procedure. Lubricate oil seal bore and seal lip with engine oil before installing. Apply silicone sealant to keyway of crankshaft damper before installing. Install seal. Tighten bolts to

specification. See **TORQUE SPECIFICATIONS**.

FRONT COVER

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

Removal

1. Disconnect the battery ground cable, remove air cleaner assembly.
2. Raise vehicle, drain coolant from radiator, drain the engine oil.
3. Lower vehicle, remove upper radiator hose. Remove the fan shroud and the lower radiator hose.
4. Raise vehicle, remove 2 nuts holding the Crankshaft (CKP) sensor shield in place and remove the shield. Disconnect both the Knock sensor and (CKP) sensor harness connectors. Position wiring harness aside.
5. Remove transmission line support bracket bolt. Remove power steering support bracket bolts. Remove the A/C compressor mounting bracket nuts and position the A/C compressor aside.
6. Mark crankshaft pulley and damper position. Remove crankshaft pulley and damper. See **FRONT COVER OIL SEAL**.
7. Remove front oil pan bolts that intersect with the front cover.
8. Lower vehicle, remove the supply tube heater hoses. Detach wiring harness from the outlet tube and position aside.
9. Remove the heater water outlet tube (remove bolt). Remove water pump. See **WATER PUMP**.
10. Remove Cam Position Synchronizer. See **CAMSHAFT SYNCHRONIZER**.
11. Remove front cover crankshaft oil seal. See **FRONT COVER OIL SEAL**.
12. Remove the 4 water pump mounting studs.

CAUTION: Failure to remove Cap Screw which may be over looked, may damage the cover if not removed.

13. Remove engine front cover stud bolts and cover bolt, remove CAP SCREW. See **Fig. 5**
14. Slide the front cover off the dowels, remove the gasket and discard.

Installation

CAUTION: Failure to prevent foreign material from entering the engine block or front engine cover. Will result in engine damage. To prevent damage to engine components, seal coolant and oil passages. Prevent foreign material from entering the oil pan.

CAUTION: DO NOT use a surface conditioning pad or any other type of fibrous abrasive disc to clean gasket surfaces. Failure to follow these directions will result in engine damage.

1. Clean off surfaces of the block, front engine cover and exposed oil pan flange.

NOTE: If sealant (F6AZ-19562-A) is exposed for longer than 7 minutes, wipe off sealant and re-apply.

2. Install front engine cover gasket, apply sealant (F6AZ-19562-A) to base of gasket where oil pan and block come together. Apply a bead of sealant in center of oil pan flange and around bolt holes. Apply a thin layer of sealant to front cover gasket mating surface (DO NOT over apply the sealant).

NOTE: There are 13 fasteners securing the front engine cover. The CAP SCREW will be identified as fastener No. 12. DO NOT tighten the CAP SCREW (No. 12) in the first tightening sequence.

3. Tighten fasteners in 3 stages, as follows:
   - Starting with bolt at about the 6 o'clock position (identified as bolt No. 1), tighten fasteners 1-11 and 13 in sequence to 16 Ft. lbs. (22 N.m). See **Fig. 5**.

NOTE: Apply a small amount of loctite® to threads of cap screw (do not over apply compound).

   - Tighten CAP SCREW (No. 12) to 89 INCH. lbs. (10 N.m).
   - Tighten all fasteners (except Cap Screw No. 12) an additional 90 degrees, in sequence.
4. Install Cam Position Synchronizer. See **CAMSHAFT SYNCHRONIZER**.
5. Install the heater water outlet tube, tighten to 71-97 INCH. lbs. (8-11 N.m).
6. Attach the wiring to the outlet tube, install both supply tube heater hoses.
7. Raise vehicle, install oil pan bolts, tighten to 80-106 INCH. lbs. (9-12 N.m).
8. Install NEW front cover crankshaft oil seal. See **FRONT COVER OIL SEAL**.
9. Install crankshaft pulley and damper. See **FRONT COVER OIL SEAL** and **TORQUE SPECIFICATIONS**.
10. Connect (CKP) sensor and Knock sensor harness connectors. Install the (CKP) sensor shield (if removed).
11. Lower vehicle.
12. Install A/C compressor mounting bracket nuts, tighten to 30-40 Ft. lbs. (40-45 N.m).
13. Install power steering support bracket bolts, tighten to 30-40 Ft. lbs. (40-45 N.m).
14. Install accessory drive belt.
15. Install the lower radiator hose, the fan shroud and upper radiator hose.
16. Refill coolant system, refill the engine oil. Ensure oil drain plug has been tightened.

17. Reconnect the battery ground cable, install air cleaner assembly.
18. Start vehicle and check for leaks.

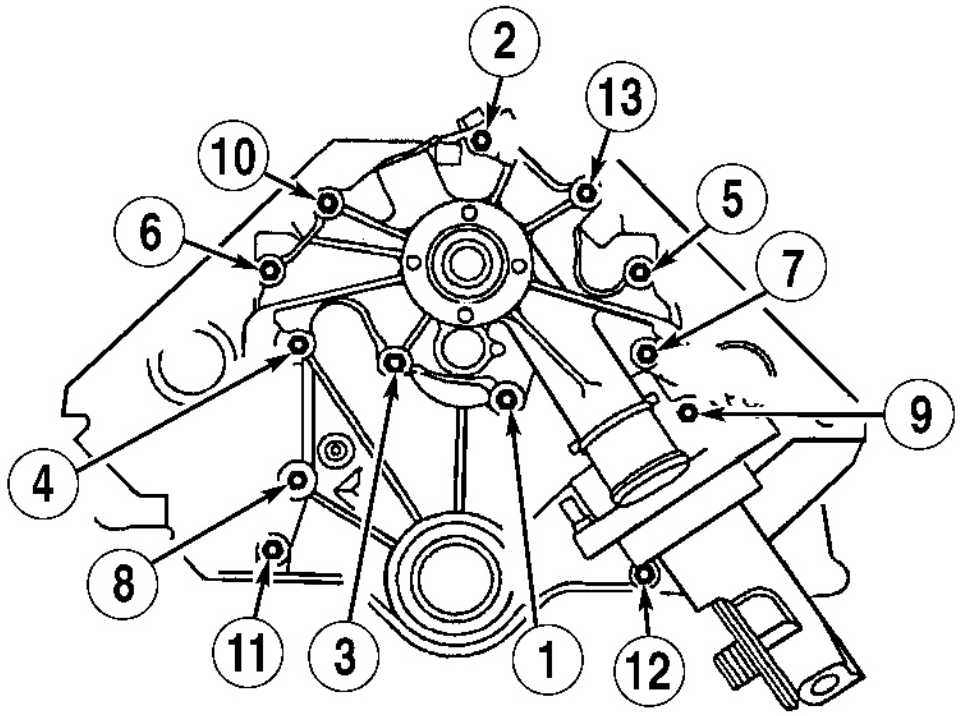


Fig. 5: Front Cover Tightening Sequence
Courtesy of FORD MOTOR CO.

TIMING CHAINS

CAUTION: DO NOT rotate engine with timing chain removed. Damage to valve/piston may result.

Removal

Remove front cover. See **FRONT COVER**. Remove camshaft synchronizer. See **CAMSHAFT SYNCHRONIZER**. Rotate crankshaft until timing marks and keyways align. See **Fig. 6**. Compress and install retaining pin to timing chain tensioner. See **Fig. 7**. Remove timing chain and gears as an assembly. Remove timing chain tensioner.

Inspection

Inspect components for damage. Inspect friction surfaces on tensioner arms and chain guides for wear. Replace components if necessary. If tensioner arms or guides are worn or damaged, remove and clean oil pan. Also, replace oil pump screen cover and tube.

Installation

To install, reverse removal procedure. Ensure all timing marks are properly aligned. See **Fig. 6**. Tighten all nuts and bolts to specification. See **TORQUE SPECIFICATIONS**.

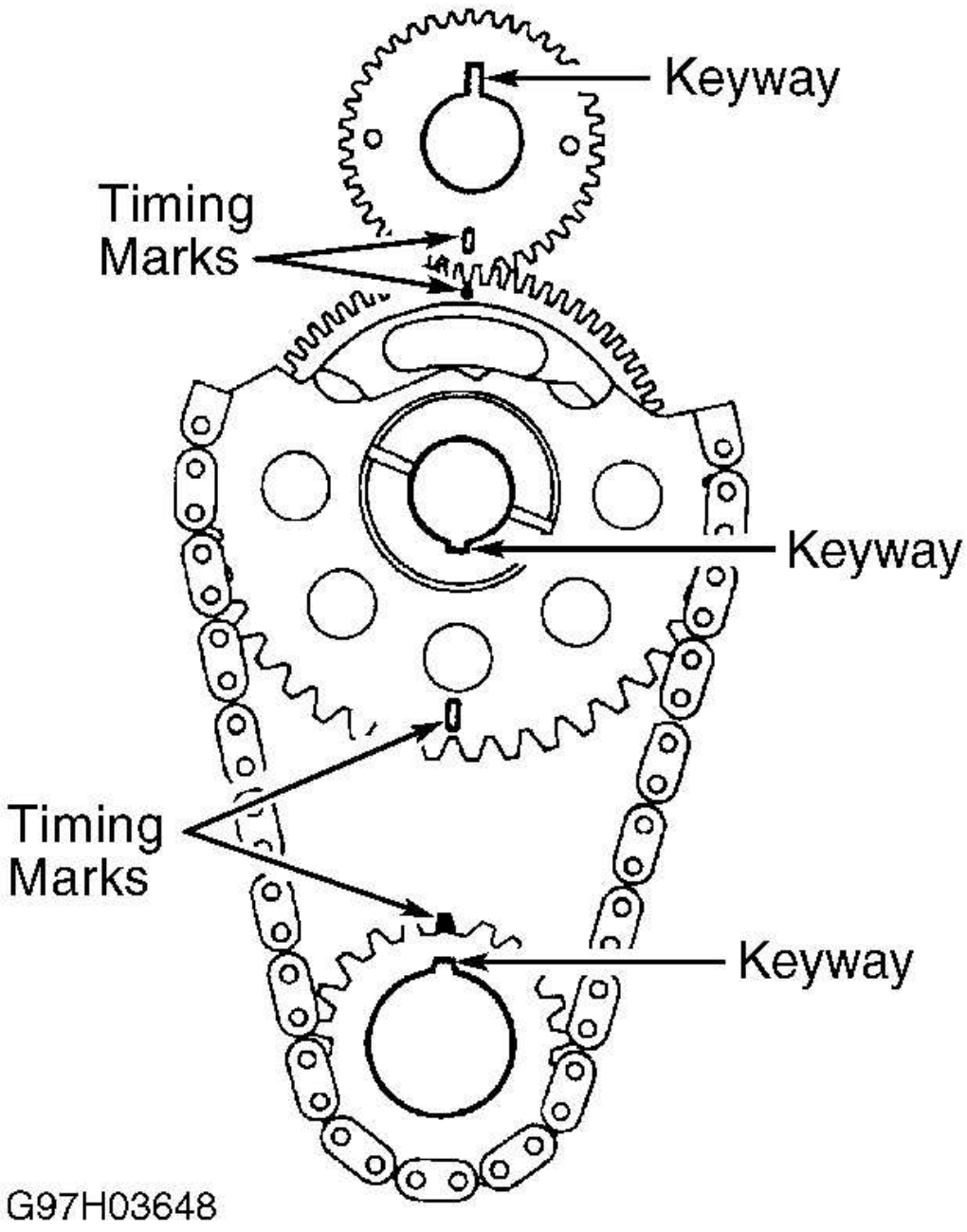


Fig. 6: Identifying Timing Marks
Courtesy of FORD MOTOR CO.

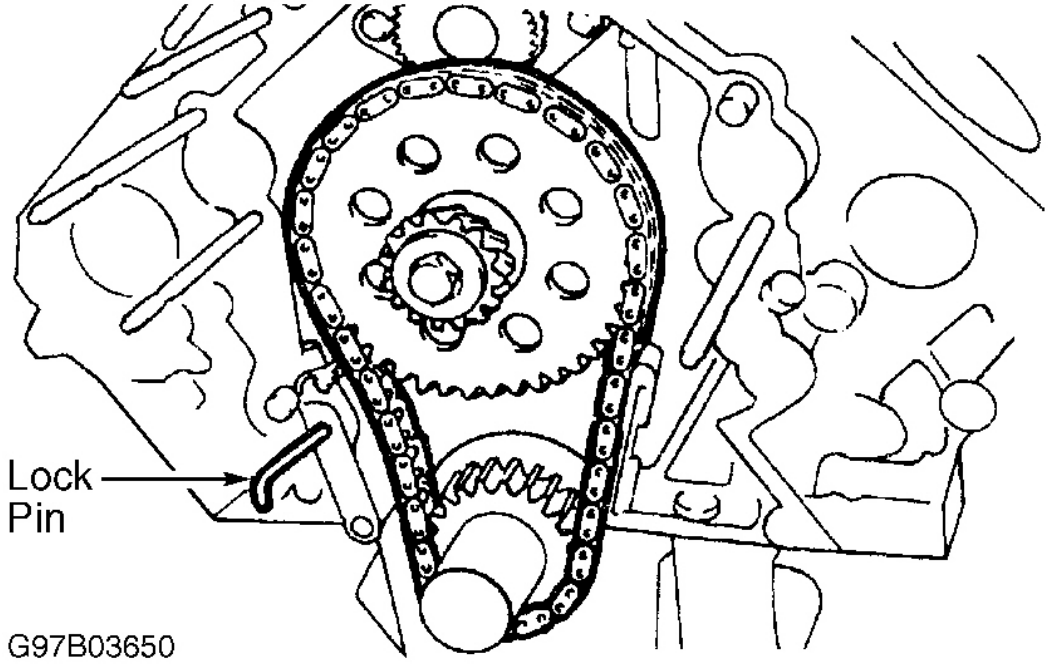


Fig. 7: Installing Timing Chain Tensioner Lock Pin
Courtesy of FORD MOTOR CO.

LIFTER

Removal

Remove upper and lower intake manifolds. See **INTAKE MANIFOLD**. Remove valve covers. Mark position of rockers push rods and lifters for installation reference. Remove rockers and push rods. Remove lifter retainer plates. Remove lifters.

Inspection

Inspect components for damage. Measure lash adjuster O.D. and oil clearance. Replace components if damaged or measurements are not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Installation

To install, reverse removal procedure. Coat components with engine oil before installing. Tighten all nuts and bolts to specifications. See **TORQUE SPECIFICATIONS**.

CAMSHAFT

Removal

Remove lifters. See **LIFTER**. Remove timing chains. See **TIMING CHAINS**. Remove balance shaft drive gear from camshaft. Remove camshaft thrust plate. Remove camshaft.

Inspection

Measure camshaft bore I.D., journal O.D., oil clearance and lobe lift. Replace camshaft if measurements are not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Installation

Coat camshaft bearings, journals and lobes with Engine Assembly Lubrication (D9AZ-19579-D). Install camshaft. To complete installation, reverse removal procedures. Tighten all nuts and bolts to specification. See **TORQUE SPECIFICATIONS**.

CAMSHAFT SYNCHRONIZER

CAUTION: DO NOT rotate crankshaft or camshaft during removal and installation procedure or fuel system timing will be out of time. Possible engine damage may occur.

Removal

1. Disconnect negative battery cable(s). Position crankshaft at TDC No. 1 compression stroke. Partially drain cooling system. Remove air cleaner assembly. Disconnect EGR vacuum hose from EGR valve. Remove EGR valve and adapter. Disconnect heater outlet tube and position aside.
2. Disconnect camshaft position sensor harness connector. Mark orientation of camshaft position sensor electrical connector. Remove camshaft position sensor. Remove camshaft synchronizer retaining bolt. Remove camshaft synchronizer.

NOTE: Oil pump driveshaft might come out with camshaft synchronizer. If so, retrieve oil pump driveshaft before proceeding.

CAUTION: Synchro Positioner (T89P-12200-A) must be used during installation of synchronizer assembly. Failure to do so will result in fuel system to be out of time and possible engine damage may occur.

Installation

1. Ensure crankshaft is still at TDC No. 1 compression stroke. Install synchro positioning tool on camshaft synchronizer by rotating tool until it engages notch in camshaft synchronizer housing.

NOTE: During installation, arrow on synchro positioning tool will rotate clockwise as gears engage.

2. Install camshaft synchronizer so arrow on synchro positioning tool is 54 degrees from centerline of

engine. See **Fig. 8**. Install camshaft synchronizer retaining bolt.

3. Remove synchro positioning tool. Install camshaft position senor. To complete installation, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS**.

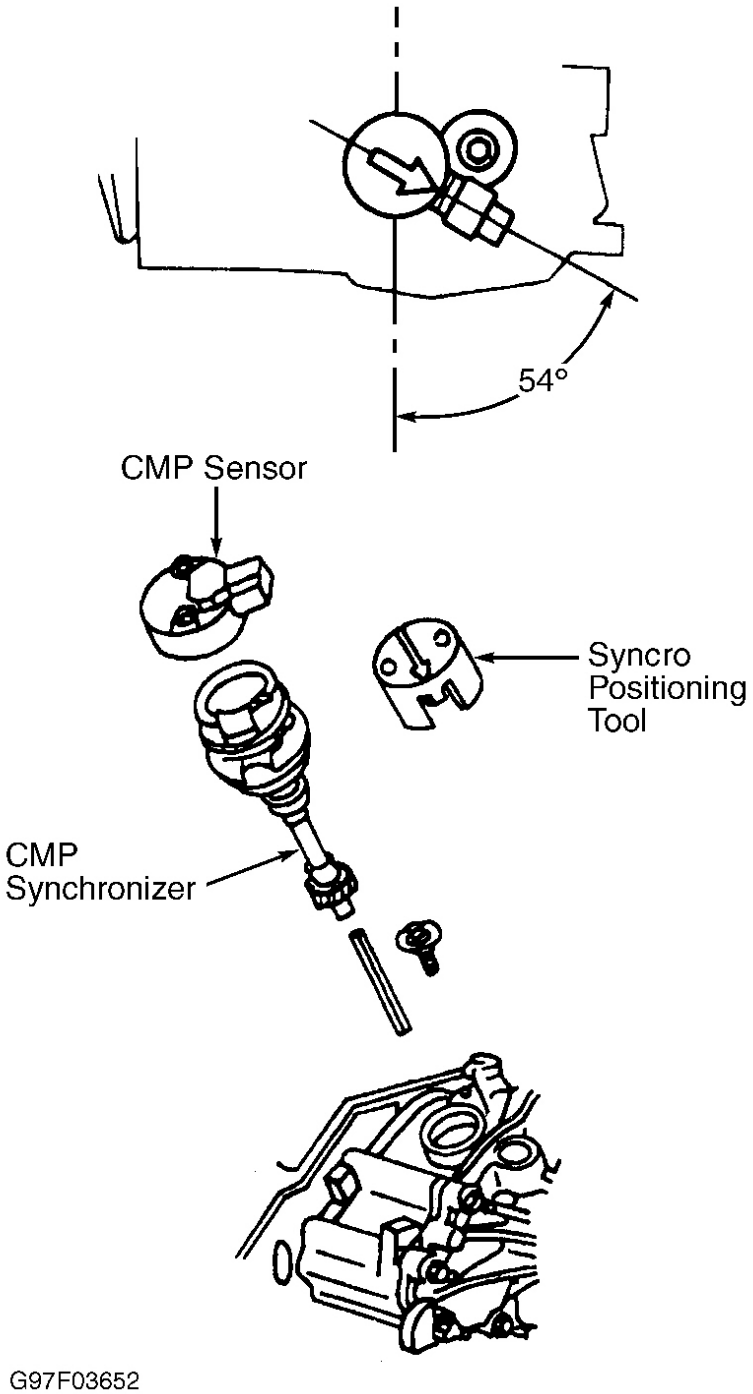


Fig. 8: Aligning Camshaft Synchronizer
Courtesy of FORD MOTOR CO.

BALANCE SHAFTS

Removal

Remove timing chain. See **TIMING CHAINS**. Remove balance shaft drive gear from camshaft. Remove balance shaft thrust plate retaining bolts. Remove balance shaft.

Installation

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATION**. Ensure all timing mark are aligned. See **Fig. 6**.

CRANKSHAFT REAR OIL SEAL

Removal

Remove transmission. For A/T (E4OD), see **REMOVAL & INSTALLATION - A/T (E40D)** article in TRANSMISSION SERVICING. For A/T (4R70W), see **SERVICING - A/T (4R70W)** article in TRANSMISSION SERVICING. For M/T, see appropriate article in CLUTCHES. Remove flywheel. Using Rear Crankshaft Slinger Remover (T95P-6701- EH) and Slide Hammer (T50T-100-A), remove oil seal.

Installation

Clean and inspect all mating surface. Using Rear Seal Replacer (T82L-6701-A), install oil seal. To complete installation, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS**.

WATER PUMP

Removal & Installation

Drain cooling system. Remove cooling fan and shroud. Remove radiator. Remove accessory drive belt. Remove water pump pulley. Disconnect lower radiator hose from water pump. Disconnect water by-pass tube and engine harness clamp from water pump. Remove A/C support bracket from water pump. Remove water pump retaining bolts. Remove water pump and gasket. To install, reverse removal procedure. Tighten all nut and bolts to specifications. See **TORQUE SPECIFICATIONS**.

OIL PAN

Removal (4x2 Pickup)

The oil pan on a 4x2 vehicle cannot be removed in-vehicle. Remove engine. See **ENGINE**. Remove oil pan retaining bolts in reverse sequence. See **Fig. 9**. Remove oil pan and gasket.

Removal (4x4 Pickup)

1. With transmission in Neutral, raise and support vehicle. Mark front drive shaft and differential flange for installation. disconnect front drive shaft from differential and support drive shaft. Disconnect front halfshafts from differential, and support.
2. Disconnect vacuum lines from front axle tube. Using Hi-Lift Jack (014-00210) support front differential. Remove front differential support. Remove front differential mounting bolts. Lower front differential and position aside. Remove oil pan retaining bolts in reverse sequence. See **Fig. 9**. Remove oil pan and gasket.

Removal (Van)

1. Disconnect negative battery cable(s). Drain cooling system. Remove engine cover. Remove air cleaner and outlet tube assembly. Remove cooling fan and fan shroud. Remove oil indicator tube. Remove upper intake manifold. See **INTAKE MANIFOLD**. Raise and support vehicle.
2. Drain engine oil. Loosen transmission mount-to-rear crossmember nuts. Disconnect exhaust pipe at exhaust manifolds. Remove motor mount-to-subframe nuts. Remove flywheel inspection plate. Raise engine about 13" and position blocks between motor mounts and subframe. Remove oil pan retaining bolts. Remove oil pan and gasket.

Installation

To install, reverse removal procedure. Apply silicone sealant on front cover and seal retainer-to-cylinder block areas before installing gasket and oil pan. Tighten all bolts to specification. See **TORQUE SPECIFICATIONS**.

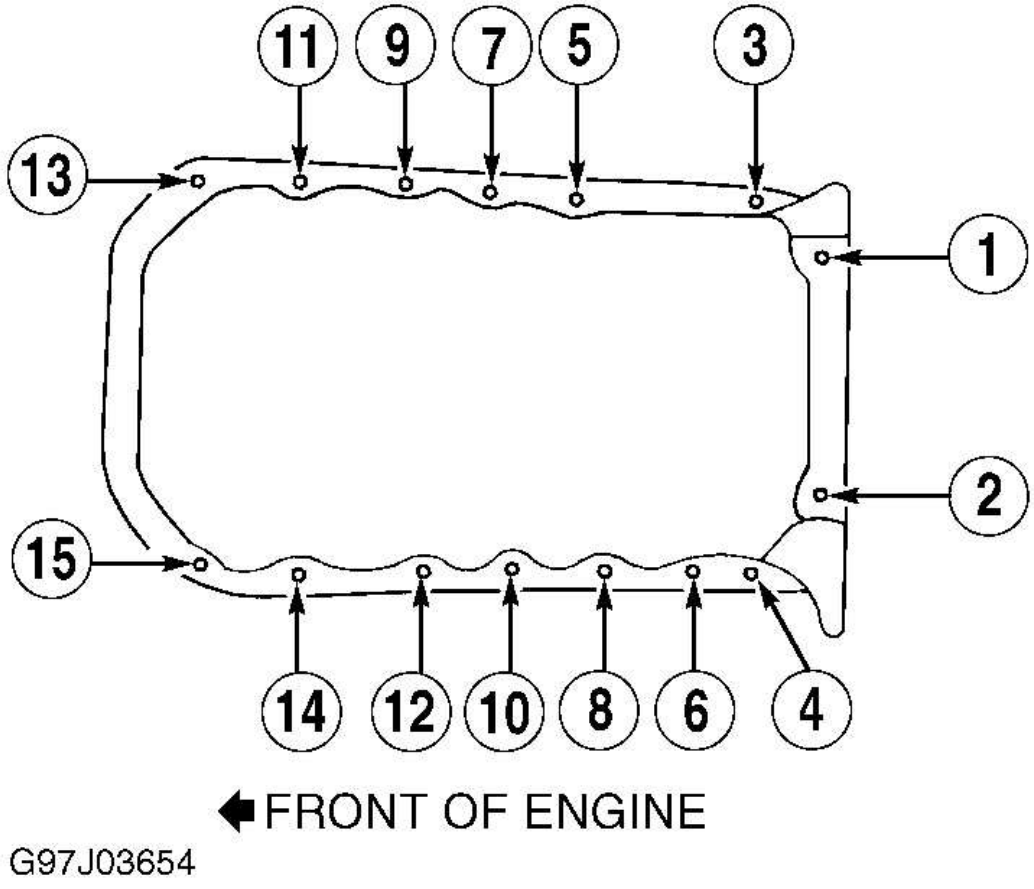


Fig. 9: Oil Pan Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.

OVERHAUL

CYLINDER HEAD

Cylinder Head

1. Clean head gasket mating surface. Clean carbon from combustion chambers. DO NOT damage surfaces. Check cylinder head for cracks, burrs, nicks and warpage.
2. DO NOT machine more than .010" (.25 mm) from original cylinder head surface to correct warpage. Replace cylinder head as necessary. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

Valve Springs

1. Measure valve spring installed height from top of spring seat to underside of spring retainer. Ensure installed height is within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.
2. If installed height is not within specification, a spacer can be installed between cylinder head and valve spring to obtain correct height. Inspect valve spring free length and pressure. Replace valve spring if free length and pressure are not within specification. See **VALVES & VALVE SPRINGS** table.

CAUTION: DO NOT install valve spring spacers unless necessary. Using more spacers than required can result in spring breakage or worn camshaft lobes.

Valve Stem Oil Seals

When installing NEW valve stem seals, ensure oil seal bottoms on valve guide. Oversized valve stem seals must be installed when oversized valves are used.

Valve Guides

1. Valve guides must be reamed for an oversized valve if valve stem oil clearance exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Valves are available in .015" (.38 mm) and .030" (.76 mm) oversize.
2. If oversized valves or oversized valve stem oil seals are not available, valve guide may be replaced with NEW guide. Always use reamers in proper sequence (smallest first).

NOTE: Always grind valve seat after valve guide has been reamed or new guide has been installed.

Valve Seat

1. Grind valve seat to 45 degrees. If seat width is too wide after grinding, use a 30-degree stone to lower seat or a 75-degree stone to raise seat. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.
2. Ensure valve seat angle, seat width and seat runout are within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Valve seats must be ground when valve guide is reamed or replaced. Replacement information is not available from manufacturer.

Valves

Ensure head diameter, valve face runout, stem diameter and valve margin are within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.

CAUTION: DO NOT remove more than .010" (.25 mm) from end of valve stem when resurfacing tip of valve.

CYLINDER BLOCK ASSEMBLY

Piston & Rod Assembly

Ensure pistons and rods are installed in cylinder from which they were removed. Ensure arrow on piston top is pointing toward front of engine.

NOTE: Take measurements with components at a stabilized room temperature of about 70°F (21°C).

Fitting Pistons

Check piston-to-bore clearance. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS. If clearance is not within specification, replace pistons and/or block. Oversize pistons are not available at this time.

Piston Rings

1. Select rings for bore diameter. Place ring in cylinder bore in which it will be installed. Use piston to square ring in bore and place ring below normal ring wear area. Measure ring end gap. If ring gap is too small, file end of ring until within specification. If ring gap exceeds specification, try another ring set. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.
2. Check side clearance of rings after installing on piston. Ensure clearance is within specification around entire circumference. Replace piston and/or rings if clearance is not within specification. See **PISTONS, PINS & RINGS** table. Ensure rings are properly spaced on piston before installing pistons into cylinder.

Rod Bearings

Use Plastigage to check rod bearing clearance. If proper oil clearance cannot be obtained, machine or replace crankshaft as necessary. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Crankshaft & Main Bearings

1. When checking main bearing clearance in vehicle, position a jack under adjoining bearing counterweight being checked. Remove only one main bearing cap at a time.
2. Use Plastigage to check main bearing clearance. If proper oil clearance cannot be obtained, machine or replace crankshaft as necessary. Always replace bearings in pairs. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.
3. Install all bearing caps except thrust bearing cap (No. 3 from front of engine). Tighten main bearing cap bolts to specification. See **TORQUE SPECIFICATIONS**. Install No. 3 bearing cap and tighten bolts finger tight.
4. Pry crankshaft forward and pry No. 3 bearing cap to rear of engine to align thrust bearing. While retaining forward pressure on crankshaft, tighten bearing cap to specification. See **TORQUE SPECIFICATIONS**.
5. Ensure crankshaft end play is within specification. Replace thrust bearing if end play is not within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table.

Cylinder Block

1. Using a feeler gauge and straightedge, check cylinder block head gasket surface for warpage. Check cylinder bore for wear, taper, out-of-round and piston fit. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS.

CAUTION: DO NOT machine more than .010" (.25 mm) of material from original cylinder block head surface.

2. Install all main bearing caps and tighten to specification before honing cylinder bore. See **TORQUE SPECIFICATIONS**. Ensure bearing caps are installed in their original location, with arrow on cap pointing towards front of engine.
3. Use ONLY a spring-loaded type cylinder hone. After honing, thoroughly clean bore with detergent and water solution. Rinse solution from bore thoroughly with clean water. Wipe bore clean with lint-free cloth. Lubricate cylinder bores with engine oil.

ENGINE OILING

ENGINE LUBRICATION SYSTEM

Engine lubrication system is a force-feed type. Oil is supplied under full pressure to crankshaft, connecting rods, camshaft bearing and valve lifters. A controlled volume of oil is supplied to rocker arms and push rods. All other moving parts are lubricated by splash or gravity flow. Oil flows through oil filter before entering main oil gallery.

Crankcase Capacity

Crankcase capacity is 5 qts. (4.75L). Add one additional qt. (.95L) when replacing oil filter.

Oil Pressure

Oil pressure specification is 40-125 psi at 2500 RPM at normal operating temperature.

Oil Pressure Test

Disconnect and remove the oil pressure switch from the engine. The oil pressure switch is located at left front of engine, below A/C compressor. Connect the Engine Oil Pressure Gauge (T73L-6600-A) and Transmission Test Adapter (D87C-77000-A), or equivalent, to the oil pressure switch oil galley port. Run the engine until normal operating temperature is reached. Run the engine at 2500 RPM and record the gauge reading. The oil pressure should be 40-125 psi. If the pressure is not 40-125 psi, check the following possible sources:

- Insufficient oil.
- Oil leakage.
- Worn or damaged oil pump.
- Oil pump screen cover and tube.

- Excessive main bearing clearance.
- Excessive connecting rod bearing clearance.

OIL PUMP

Removal

Raise and support vehicle. Drain engine oil. Remove oil filter. Remove oil pump retaining bolts. Remove oil pump and "O" ring.

Inspection

Inspect components for damage and wear. Measure gear end height and radial clearance. Replace oil pump assembly if measurements are not within specifications. See **OIL PUMP SPECIFICATIONS** table.

OIL PUMP SPECIFICATIONS

Application	In. (mm)
Gear End Height	.0004-.0033 (.010-.083)
Gear Radial Clearance	.002-.006 (.05-.15)

NOTE: Oil pump is serviced as an assembly only. Replace assembly if measurements are not to specifications.

Reassembly & Installation

1. To reassemble, reverse disassembly procedure. Ensure components are installed in original location. To install, prime oil pump by filling inlet opening with oil, and rotating pump shaft until oil emerges from outlet opening.
2. Install and tighten oil pump-to-front cover bolts to specification. See **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure.

CAUTION: If pump and drive shaft do not seat readily, DO NOT force into position. Realign oil pump hex drive with oil pump drive shaft and reinstall.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Camshaft Sprocket Bolt	30-36 (41-49)
Connecting Rod Cap Bolt (1)	
Step 1	15-18 (20-24)
Step 2	29-33 (39-45)
Step 3	Additional 90-120 Degrees

Crankshaft Damper Bolt	103-117 (140-159)
Crankshaft Pulley Bolt	20-28 (27-38)
Cylinder Head Bolt (1)(2)	
Step 1	14 (19)
Step 2	29 (39)
Step 3	36 (49)
Step 4 (3)	Loosen 3 Revolutions
Step 5	
Short Bolt	15-32 (20-43)
Long Bolt	30-36 (41-49)
Step 6	Additional 175-185 Degrees
Engine Mount Through-Bolt	51-67 (69-91)
Engine-To-Transmission Bolts	50-65 (68-88)
Exhaust Manifold Bolt	15-22 (20-30)
Flexplate-To-Torque Converter Bolt	20-34 (27-46)
Flywheel-To-Crankshaft Bolt	54-64 (73-87)
Front Cover Bolt (4)	15-22 (20-30)
Front Engine Mounting Bolts/Nuts	50-70 (68-95)
Idler Pulley Bolt	35-46 (47-62)
Main Bearing Cap Bolt (5)	
Standard Bolt	81-88 (110-119)
Torque-To-Yield Bolt	
Step 1	37 (50 N.m)
Step 2	Additional 115-125 Degrees
Main Bearing Brace Nut	30-40 (41-54)
Oil Baffle Plate Bolt	30-37 (41-50)
Oil Pan-To-Transmission Bolt	28-38 (38-52)
Oil Pump Inlet Tube	30-40 (41-54)
Oil Pump-To-Front Cover	
Inner	15-22 (20-30)
Outer	(4)
Rocker Arm Fulcrum Bolt	23-29 (31-39)
Water Pump Bolts	15-22 (20-30)
	INCH Lbs. (N.m)
Balance Shaft Thrust Plate Bolt	72-120 (8-14)
Camshaft Thrust Plate Bolt	72-120 (8-14)
Intake Manifold Bolts & Stud	
Lower (6)	
Step 1	44 (5)

Step 2	72-101 (8-11)
Upper	59 (7)
Oil Pan-To-Cylinder Block (7)	
Step 1	36-44 (4-5)
Step 2	80-106 (9-12)
Timing Chain Tensioner Bolt	72-120 (8-14)
Timing Pointer	72-106 (8-12)
Valve Cover Bolt	72-101 (8-11)

(1) DO NOT reuse bolts.

(2) Tighten in sequence. See **Fig. 4**.

(3) DO NOT loosen all bolts at same time. Loosen and torque to specification one bolt at a time.

(4) Tighten in sequence. See **INSTALLATION** under FRONT COVER.

(5) Main bearing cap bolts may come from the factory with standard type bolts or torque-to-yield bolts. Torque-to-yield bolts will have a flange on the bolt head. Identify bolts used and use the appropriate torque specification.

(6) Tighten in sequence. See **Fig. 2**.

(7) Tighten in sequence. See **Fig. 9**.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Specification
Displacement	256 Cu. In. (4.2L)
Bore	3.81" (96.8 mm)
Stroke	3.74" (95.0 mm)
Compression Ratio	9.17:1
Fuel System	SFI
Net Horsepower	205
Torque	255 Ft. Lbs.

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

Application	In. (mm)
Crankshaft	
End Play	.0003-.008 (.008-.20)
Main Bearings	

Journal Diameter	2.5190-2.5198 (63.983-64.003)
Journal Out-Of-Round	.0012 (.030)
Journal Taper	.0006 (.015)
Journal Runout	.002 (.05)
Oil Clearance	.0011-.0026 (.028-.066)
Connecting Rod Bearings	
Journal Diameter	2.3103-2.3111 (58.682-58.702)
Journal Out-Of-Round	.0012 (.030)
Journal Taper	.0006 (.015)
Oil Clearance	.0011-.0027 (.028-.069)

CONNECTING RODS

CONNECTING RODS

Application	Specification
Bore Diameter	
Pin Bore	N/A
Crankpin Bore	2.4266-2.4273" (61.636-61.653 mm)
Center-To-Center Length	N/A
Maximum Bend	.0015" Per .97" (.038 mm Per 25 mm)
Maximum Twist	.002" Per .97" (.051 mm Per 25 mm)
Side Play	
Standard	.004-.014" (.10-.36 mm)
Service Limit	.019" (.48 mm)

PISTONS, PINS & RINGS

PISTONS, PINS & RINGS

Application	In. (mm)
Pistons	
Clearance	.0007-.0017 (.018-.043)
Diameter	3.8108 (96.794)
Pins	
Diameter	.9055-.9056 (23.000-23.002)
Length	N/A
Piston Fit	N/A
Rod Fit	N/A

Rings	
End Gap	
No. 1	.007-.013 (.017-.33)
No. 2	.01-.02 (.3-.55)
No. 3	.006-.026 (.15-.65)
Side Clearance	.0012-.0031 (.030-.080)

CYLINDER BLOCK

CYLINDER BLOCK

Application	In. (mm)
Cylinder Bore	
Standard Diameter	3.8123 (96.8324)
Maximum Taper	.010 (.25)
Maximum Out-Of-Round	.002 (.051)
Maximum Deck Warpage (1)	.003 (.08)
(1) Specification is within a 6" (152 mm) area. Overall warpage is .006" (.15 mm). DO NOT machine more than .010" (.25 mm) from original gasket surface.	

VALVES & VALVE SPRINGS

VALVES & VALVE SPRINGS

Application	Specification
Face Angle	45°
Face Runout	.....
Head Diameter	N/A Stem Diameter
Stem Diameter	
Intake	.3415-.3423" (8.674-8.694 mm)
Exhaust	.3410-.3418" (8.661-8.682 mm)
Valve Margin	.031" (.79 mm)
Valve Springs	
Free Length	
Intake	1.99" (50.5 mm)
Exhaust	1.99" (50.5 mm)
Installed Height	1.567-1.638" (39.8-41.6 mm)
Out-Of-Square	2 Degrees
	Ft. Lbs. @ In. (N.m @ mm)
Pressure	277 @ 1.65 (375 @ 41.9)

CYLINDER HEAD

CYLINDER HEAD

Application	Specification
Maximum Warpage (1)	.003" (.08 mm)
Valve Seats	
Seat Angle	44.75°
Seat Width	.055-.063" (1.4-1.6 mm)
Maximum Seat Runout	.001" (.025 mm)
Valve Guides	
Intake Valve	
Valve Guide Bore I.D.	.3433-.3443" (8.720-8.745 mm)
Valve Stem-To-Guide Oil Clearance	.0010-.0027" (.025-.069 mm)
Exhaust Valve	
Valve Guide Bore I.D.	.3433-.3443" (8.720-8.745 mm)
Valve Stem-To-Guide Oil Clearance	.0015-.0032" (.038-.081 mm)

(1) Specification listed is within 6" (152 mm). Overall warpage is .006" (.15 mm). DO NOT machine more than .010" (.25 mm) from original gasket surface.

CAMSHAFT

CAMSHAFT

Application	In. (mm)
Bearing I.D. Diameter	N/A
End Play	.001-.006 (.03-.15)
Journal Diameter	2.0515-2.0505 (52.108-52.083)
Journal Runout	.002 (.05)
Lobe Lift	
Intake	.245 (6.22)
Exhaust	.259 (6.58)
Lobe Wear Limit	.005 (.13)
Oil Clearance	.0006-.0010 (.015-.025)

1998 DRIVE AXLES

Front Axle - Dana 50 IFS - Pickup F250 Heavy Duty

DESCRIPTION & OPERATION

NOTE: On 1998 F250 Heavy Duty 4WD models, front differential may be a Dana 50 differential with Independent Suspension (IFS) or Dana 50/60 with a solid axle housing. If vehicle has a Dana 50 or 60 front differential with a solid axle housing, go to FRONT & REAR - DANA 50, 60 & 80 DIFFERENTIALS - "F" SUPER DUTY article. Differential can also be identified by axle code on Safety Certification Label. See AXLE RATIO & IDENTIFICATION.

An Independent Front Suspension (IFS) front axle is of integral carrier housing, hypoid gear type. Centerline of drive pinion is mounted above centerline of ring gear. Drive pinion and ring gear bearing adjustments are all accomplished with shims.

Dana 50 IFS axle housing is equipped with front leaf springs and automatic or manual locking hubs. Power is transmitted through transfer case driveshaft to the drive pinion located in the differential carrier housing. See **Fig. 3** . Drive pinion shaft is supported by 2 opposed tapered roller bearings. Power is transmitted from pinion gear through ring gear and differential pinion gears to axle shafts and wheels.

AXLE RATIO & IDENTIFICATION

Axle application can be determined through the axle code on the Safety Certification Label on left door pillar. Additionally, a metal identification tag stamped with gear ratio and diameter is secured to carrier housing.

LUBRICATION

CAPACITY

DIFFERENTIAL LUBRICATION CAPACITY

Application	Pts. (Liters)
Dana 50 IFS	3.8 (1.8)

FLUID TYPE

All models use Hypoid Gear Lubricant (F1TZ-19580-A).

TROUBLE SHOOTING

NOTE: See appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

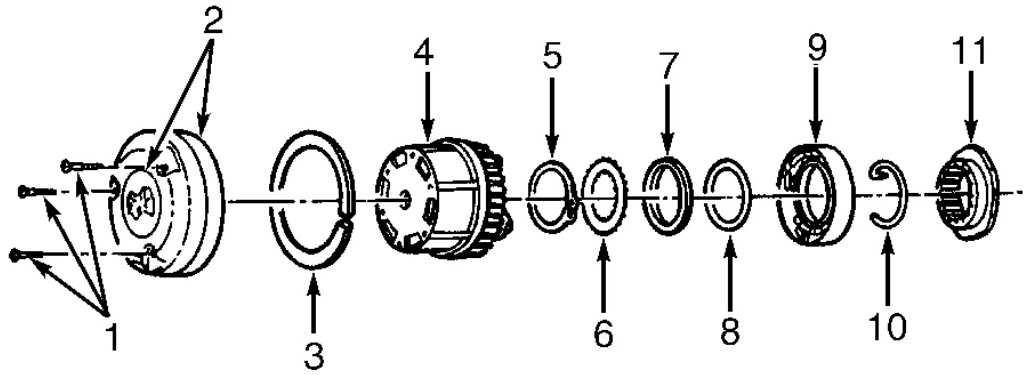
REMOVAL & INSTALLATION

HUBS & BEARINGS

Removal (With Automatic Locking Hubs)

WARNING: Use care in aligning spindle nut lug with center of spindle keyway. Damage to locking key may allow wheel assembly to come off vehicle while in motion.

1. Raise and support front of vehicle. Remove wheels. Using T25 Torx bit, remove locking hub cap assembly screws. Remove cap assembly. Remove lock ring (seated in groove of wheel hub). Remove locking hub assembly from hub and brake rotor assembly. Remove caliper with brake line attached, and wire aside.
2. Remove snap ring. Noting position of thrust washers, remove 3 thrust washers and cam assembly from end of axle shaft (spindle). See **Fig. 1** . Remove wheel bearing retainer key. Using Spanner Lock Nut Wrench (T85T-1197-B), remove wheel bearing retainer nut.
3. Remove hub and brake rotor assembly. Outer bearing will slide off with hub. Remove grease seal and inner bearing. If bearings require replacement, remove races from hub with Internal Puller (T77F-1102-A) and attached slide hammer.



1. Screws
2. Cap
3. Lock Ring
4. Locking Hub Assembly
5. Snap Ring
6. Splined Thrust Washer
7. Plastic Thrust Washer
8. Steel Thrust Washer
9. Cam Assembly
10. Wheel Bearing Retainer Key
11. Wheel Bearing Retainer Nut

99G02785

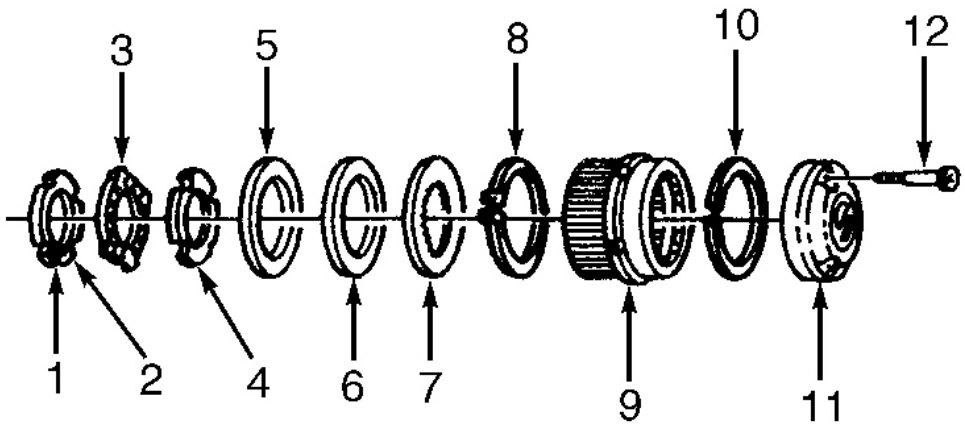
Fig. 1: Identifying Automatic Locking Hub Components
Courtesy of FORD MOTOR CO.

Installation & Adjustment

1. If bearings are replaced, drive NEW races into hub. Install inner bearing and seal into hub. Install hub on spindle. Install outer bearing and wheel bearing retainer nut. Using Spanner Lock Nut Wrench (T85T-1197-B), tighten wheel bearing retainer nut to 50 ft. lbs. (68 N.m) while rotating hub.
2. Back off retainer nut about 1/4 turn (90 degrees) and tighten nut to 16 INCH lbs. (1.8 N.m). If necessary, tighten nut to next slot to allow installation of wheel bearing retainer key. Install wheel bearing retainer key by inserting short leg of retainer key into aligned slot of nut. Install cam assembly. Install thrust washers in noted order during removal procedure (metal washer, plastic washer then splined washer). Install lock ring.
3. Align legs of cam assembly for installation of locking hub assembly. Check hub and rotor assembly end play. End play should be 0-.002" (0-.05 mm). Install locking hub assembly. To complete installation, reverse removal procedure.

Removal (With Manual Locking Hubs)

1. Raise and support front of vehicle. Remove front wheels. Remove 3 Torx screws securing locking hub cap assembly. Remove lock ring (seated in groove of wheel hub). Remove locking hub assembly from hub and brake rotor assembly. Remove brake caliper with brake line attached, and wire aside.
2. Remove snap ring. Noting position of thrust washers, remove 3 thrust washers from end of spindle (axle shaft). See **Fig. 2** . Using Spanner Lock Nut Wrench (T85T-1197-A), remove hub bearing outer lock nut, lock washer and inner lock nut. Remove hub and brake rotor assembly. Outer bearing will slide off with hub. Remove grease seal and inner bearing. If bearings require replacement, remove races from hub with Internal Puller (T77F-1102-A) and attached slide hammer.



1. Pin
2. Inner Lock Nut
3. Lock Washer
4. Outer Lock Nut
5. Steel Thrust Washer
6. Plastic Thrust Washer
7. Splined Thrust Washer
8. Snap Ring
9. Locking Hub Assembly
10. Lock Ring
11. Cap
12. Screws

99A02787

Fig. 2: Identifying Manual Locking Hub Components
Courtesy of FORD MOTOR CO.

Installation & Adjustment

1. If bearings are replaced, drive NEW races into hub. Lubricate bearings with lithium base multipurpose wheel bearing grease. Install inner bearing and seal into hub. Install hub and rotor assemble on spindle.
2. Install inner lock nut. Using torque wrench and Spanner Lock Nut Wrench (T85T-1197-A) tighten inner lock nut to 50 ft. lbs. (68 N.m) while turning hub back and forth. Back off inner lock nut about 1/4 turn (90 degrees).
3. Install lock washer so key is positioned in front spindle groove. Tighten inner lock nut, aligning pin into nearest lock washer hole. Install outer lock nut and tighten to 160-205 ft. lbs. (217-278 N.m). Check hub and rotor assembly end play. End play should be 0-.002" (0-.05 mm). To complete installation, reverse removal procedure.

SPINDLES & AXLE SHAFTS

Removal

1. Raise and support vehicle. Remove locking hub assemblies and hub and rotor. See **HUB BEARINGS**

under REMOVAL & INSTALLATION. Unbolt spindle from knuckle studs. See **Fig. 3** . It may be necessary to tap spindle with soft mallet to break spindle loose.

2. Remove splash shield. On left side, remove axle shaft and joint assembly by pulling assembly through steering knuckle. On right side, remove keystone clamps holding rubber boot onto right axle shaft and stub shaft. Slide rubber boot onto stub shaft.
3. Pull right axle shaft and joint assembly from splined stub shaft. Clamp spindle in soft-jaw vise on spindle second step. Using slide hammer and seal remover, remove grease seal and needle bearing from spindle. Remove oil seal from axle.

Inspection

Inspect sealing surfaces of spindle for corroded, pitted, worn or galled sealing surfaces. Replace spindle if damaged. Inspect outer shaft of axle for pitted, corroded, worn or galled surfaces in inner oil seal and/or needle bearing areas. Replace outer shaft as necessary.

Installation

1. Clean spindle bearing bores thoroughly. Place bearing into bore with manufacturer's identification facing outward. Drive bearing into spindle using spindle bearing driver and driver handle.
2. Position NEW needle bearing seal with seal lip facing away from spindle. Using driver handle and Seal Replacer (T80T-4000-T), install seal. Coat seal lip and axle shaft splines with multipurpose grease. Install NEW axle shaft oil seal.
3. Slide left axle shaft and joint assembly through knuckle. Ensure shaft splines engage properly inside differential carrier. Install NEW axle shaft seal on right axle if removed.
4. On right stub shaft, install rubber boot with NEW keystone clamps. Install right axle shaft and joint assembly. Ensure wide male spline on axle shaft is aligned with wide tooth space in stub shaft slip yoke. Ensure splines fully engage.
5. Slide rubber boot over assembly junction. Crimp clamps with Keystone Clamp Pliers (T63P-9171-A). Install splash shield and spindle onto knuckle. Tighten spindle retaining nuts to specification. See **TORQUE SPECIFICATIONS** .
6. Pack wheel bearings with lithium base multipurpose wheel bearing grease. Install inner wheel bearing and grease seal into rotor. Position rotor on spindle and install bearing, lock nut, thrust bearing, snap ring and locking hub. Install wheel and tire. Adjust wheel bearings. See **HUBS & BEARINGS** .

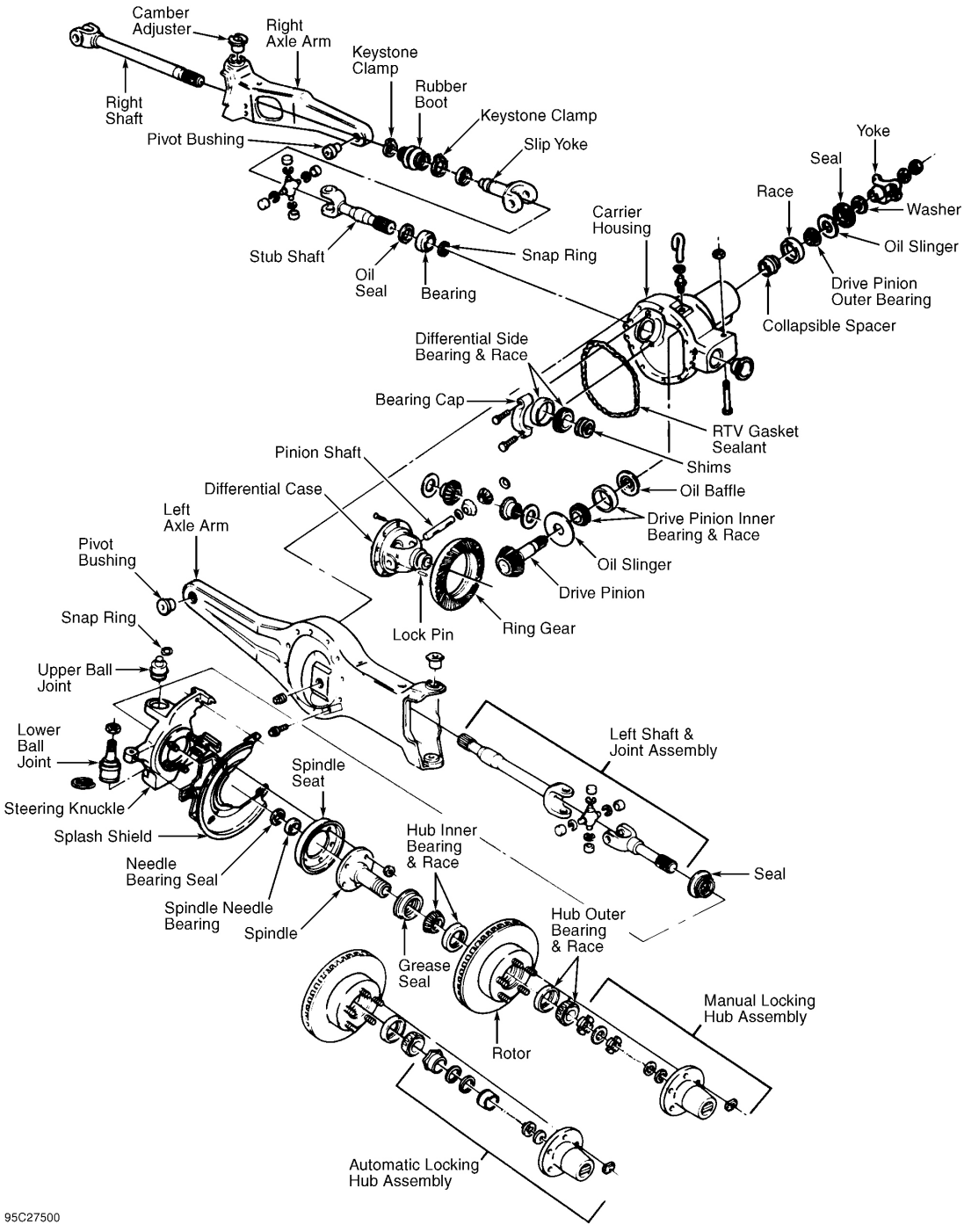


Fig. 3: Exploded View Of Dana IFS Front Drive Axle Assembly
Courtesy of FORD MOTOR CO.

STUB SHAFT & SLIP YOKE, CARRIER & BEARING

Removal

1. Mark pinion yoke and drive shaft alignment for reassembly reference. Disconnect drive shaft from yoke and wire aside. Remove both spindles and axle shaft assemblies. See **SPINDLES & AXLE SHAFTS** .
2. Support differential carrier and remove bolts holding carrier to support arm. Separate carrier from support arm and drain lubricant. Remove carrier from vehicle. Install carrier into Holding Fixture (T57L-500-B) using Adapter (T90T-4000-A) and Adaptor (T80-4000-B).
3. Rotate slip yoke and stub shaft until open side of snap ring on inner end of stub shaft can be reached. Remove snap ring. Remove stub shaft and slip yoke from carrier assembly. Remove oil seal and caged needle bearings together, using slide hammer and Collet (D80L-100-A).

Installation

1. Ensure bearing bore is clean and has no nicks. Place needle bearing on Needle Bearing Installer (T83T-1244-A). Bearing manufacturer's name and part number should face toward tool when installed into carrier bore.
2. Coat lip of seal with multipurpose grease. Drive seal into carrier. Install slip yoke and stub shaft so that groove on shaft is visible inside differential case.

NOTE: Carrier must be installed on support arm within 5 minutes after applying RTV sealant.

3. Locate screwdriver into snap ring notch and push snap ring into place. DO NOT tap on center of snap ring as ring will be damaged. Clean all sealant, oil and dirt from carrier and support arm. Apply continuous bead of RTV sealant 1/4-3/8" wide on carrier. Bead should not pass over or outside holes.
4. Using jack, install carrier on support arm with guide pins to align carrier. Install and tighten bolts in clockwise pattern to specification. See **TORQUE SPECIFICATIONS** . Install and tighten support arm-to carrier bolts to specification.
5. Install both spindles. Install left and right axle shaft assemblies. See **SPINDLES & AXLE SHAFTS** . Align marks made previously and install drive shaft. Allow RTV sealant to cure for one hour before filling assembly with hypoid gear lubricant.

AXLE PIVOT BUSHING

Removal

Remove carrier housing assembly. See **CARRIER HOUSING ASSEMBLY** . Install Forcing Screw (T78P-5638-A1), Bushing Remover (T80T-5638-A2) and Receiver Cup (T78P-5638-A3) on pivot bushing. Turn forcing screw to remove pivot bushing.

Installation

Place NEW pivot bushing into carrier housing. Using Receiver Cup (T78P-5638-A2), forcing screw and Bushing Replacer (T80T-6538-A2), install bushing. To complete installation, reverse removal procedure.

CARRIER HOUSING ASSEMBLY

Removal & Installation

1. Raise and support vehicle. Mark drive shaft position for installation reference. Disconnect drive shaft at pinion yoke, and wire aside. Remove tires and wheels. Remove brake calipers. Wire caliper aside without tension on brake hose. Remove stabilizer front stabilizer bar and links from radius arm bracket. Place jack under right axle arm assembly. Remove 2 "U" bolts holding shock absorber mounting plate and leaf springs to tube and yoke assembly.
2. Disconnect vent tube. Remove vent fitting and install 1/8" pipe plug. Remove pivot bolt holding right axle arm to crossmember. Remove keystone clamps from rubber boot. Move rubber boot off axle shaft assembly onto slip joint. Remove right axle arm assembly.
3. Pull right axle shaft out of slip joint. Place jack under left axle arm assembly. Remove 2 "U" bolts holding shock absorber mounting plate and leaf springs to tube and yoke assembly. Place jack under differential housing. Remove pivot bolt holding left axle arm assembly to crossmember. Remove left axle arm assembly. To install, reverse removal procedure. Check alignment and adjust, if necessary.

OVERHAUL

DIFFERENTIAL ASSEMBLY

Disassembly

1. With carrier housing removed from vehicle, remove differential carrier from axle arm. Note matched numbers or letters on differential bearing caps for reassembly reference. Remove bearing caps. Install Housing Spreader (4000-E) and Spreader Adapter (T80T-4000-B). See **Fig. 4** .

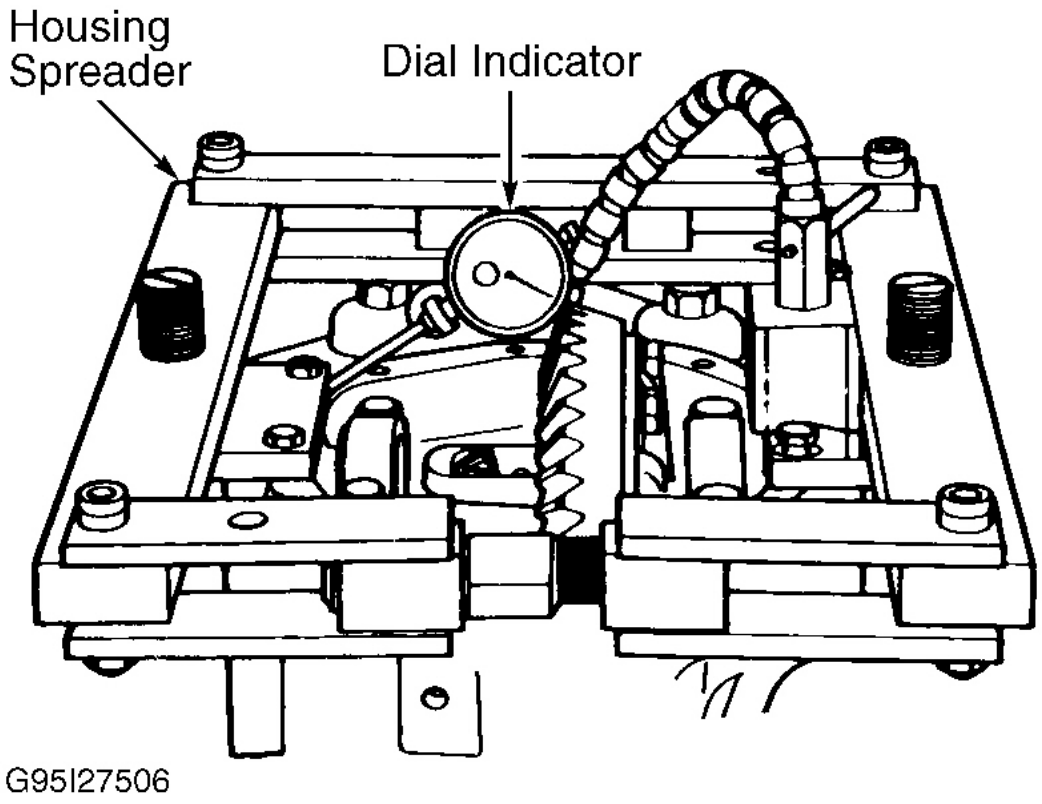


Fig. 4: Spreading Differential Carrier Housing
Courtesy of FORD MOTOR CO.

2. Rotate slip yoke and shaft assembly so open side of snap ring on shaft is exposed. Remove snap ring from shaft. Remove slip yoke and shaft assembly from carrier. Mount dial indicator on carrier housing to measure amount of spread.

CAUTION: DO NOT spread carrier housing more than .010" (.25 mm). Permanent damage to housing could result.

3. Spread carrier housing to a maximum of .010" (.25 mm). Remove dial indicator. Carefully pry differential assembly out of housing. Remove spreader immediately so housing does not distort permanently. Place carrier assembly into holding device. Using Yoke Holder (T78P-4851-A), hold yoke while removing drive pinion nut and washer.

NOTE: Pinion bearing adjusting shims may remain on pinion shaft, stick to bearing or fall loose. Collect shims and save for reassembly.

4. Using Yoke Remover (T65L-4851-B), remove yoke from drive pinion. If yoke shows wear in seal contact area, replace yoke. Remove drive pinion by tapping with soft-face mallet. Remove and discard drive pinion oil seal. Remove pinion outer bearing and oil slinger. Drive out drive pinion inner bearing race using pinion bearing race remover and driver handle.

NOTE: If oil baffle or slinger is damaged during disassembly procedure, measure them and replace with NEW units during reassembly. Baffle and slinger affect pinion depth and preload adjustments and are included in shim pack thickness.

5. Remove shims and oil baffle from bearing bore. Mark and keep shims and baffle together. Turn carrier over and drive out pinion outer bearing race using bearing race remover and driver handle. Place Universal Bearing Remover (D81L-4220-A) in vise to secure tool while removing differential side bearings.
6. Use Step Plate (D80L-630-5) under bearing to protect bearing from puller. Keep bearings, bearing races and shims in sets, marked as to location on carrier. Place differential case in vise with rags underneath to protect ring gear. Remove and discard ring gear bolts.
7. Tap ring gear with soft-faced mallet to remove ring gear from case. Using drift and hammer, drive out pinion shaft lock pin. Remove pinion shaft. Rotate side gears until pinion gears are aligned with case opening. Remove pinion gears and spherical washers. Remove side gears with thrust washers.

Cleaning & Inspection

1. Clean all components in solvent. Allow bearings to air dry. DO NOT spin bearings under air pressure. Damage will occur. Inspect all machined surfaces for smoothness or raised edges. Inspect all gear teeth for wear or chipping and replace as necessary.
2. Check all bearings and races for nicks, roller end wear, grooves or other damage. Replace as needed. Check pinion yoke for wear in seal contact area. Replace as necessary. Check differential pinion shaft, pinion gears, side gears and thrust washers for wear or damage. Replace all defective parts. Pinion gears must be replaced as sets.

Reassembly & Adjustments

1. When reassembling ring and pinion assembly, pinion depth, pinion bearing preload, side bearing preload and backlash between ring and pinion must be adjusted.

NOTE: Old pinion shaft shim pack dimensions MUST be determined accurately to use PINION DEPTH SHIM ADJUSTMENT CHART in illustration. See Fig. 6 . If original shim pack dimension cannot be determined or if the carrier housing is new, see DRIVE PINION DEPTH .

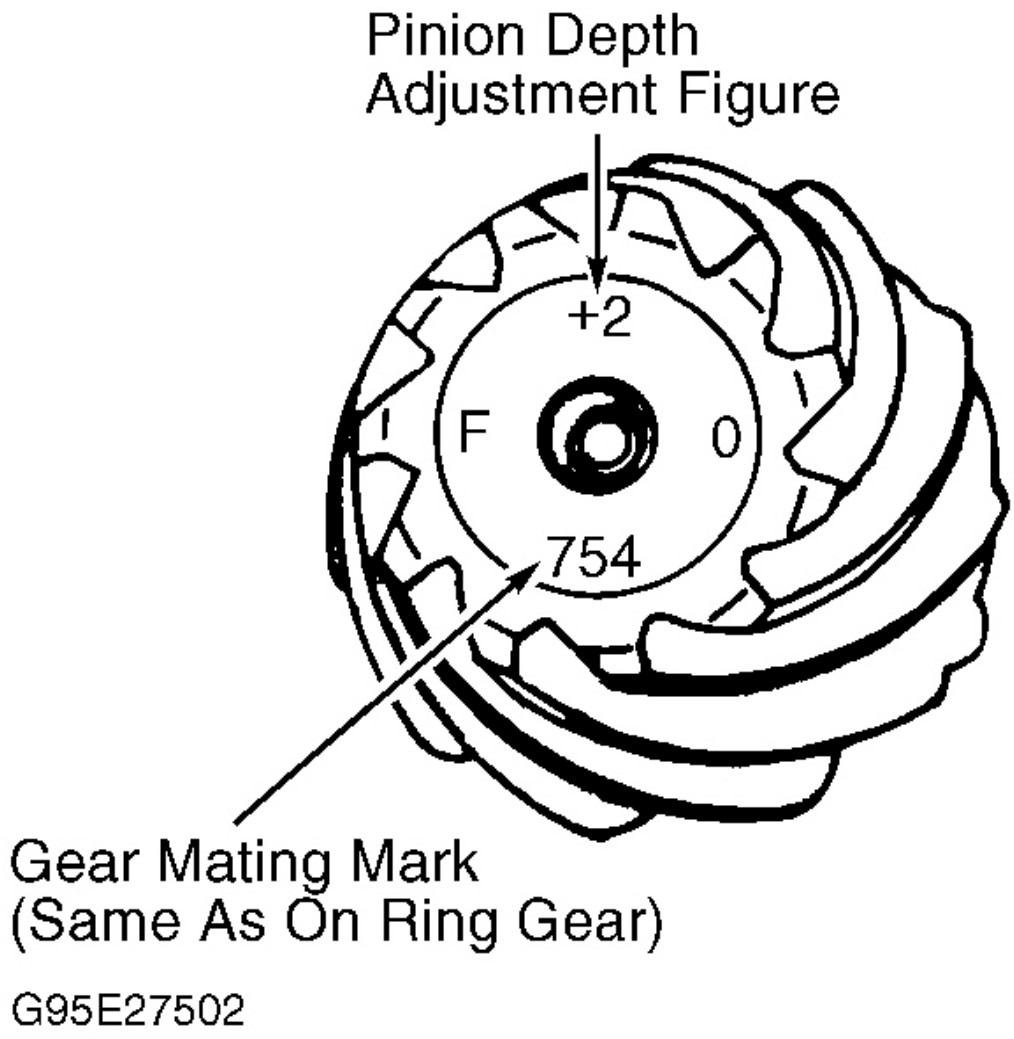


Fig. 5: Locating Pinion Gear Markings
Courtesy of FORD MOTOR CO.

PINION DEPTH SHIM ADJUSTMENT CHART (INCHES)

Old Pinion Marking	New Pinion Marking								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

G97G28890

Fig. 6: Pinion Depth Shim Adjustment Chart
Courtesy of FORD MOTOR CO.

2. If only pinion shaft and ring gear are to be replaced and carrier housing can be reused, compare pinion depth adjustment numbers etched into faces of old and NEW pinion heads. See **Fig. 5** . Using PINION DEPTH SHIM ADJUSTMENT CHART, select correct shims for new pinion shaft depth adjustment. See **Fig. 6** .
3. Pinion depth adjustment number is determined by manufacturer at time of assembly. Number represents nominal distance that pinion shaft deviates from distance between pinion gear face and centerline of axle. Nominal distance is measured from centerline of ring gear to face of gear on drive pinion shaft.
4. Ring gear and pinion gear are supplied in matched sets only. Matching numbers are etched on ring and pinion gears. If new gear set is being used, verify matching gear set numbers. See **Fig. 5** . Pinion Depth Gauge Set (T80T-4020-A) allows shim pack adjustment without having to remove and replace differential bearings when setting up shim packs. See **Fig. 7** .

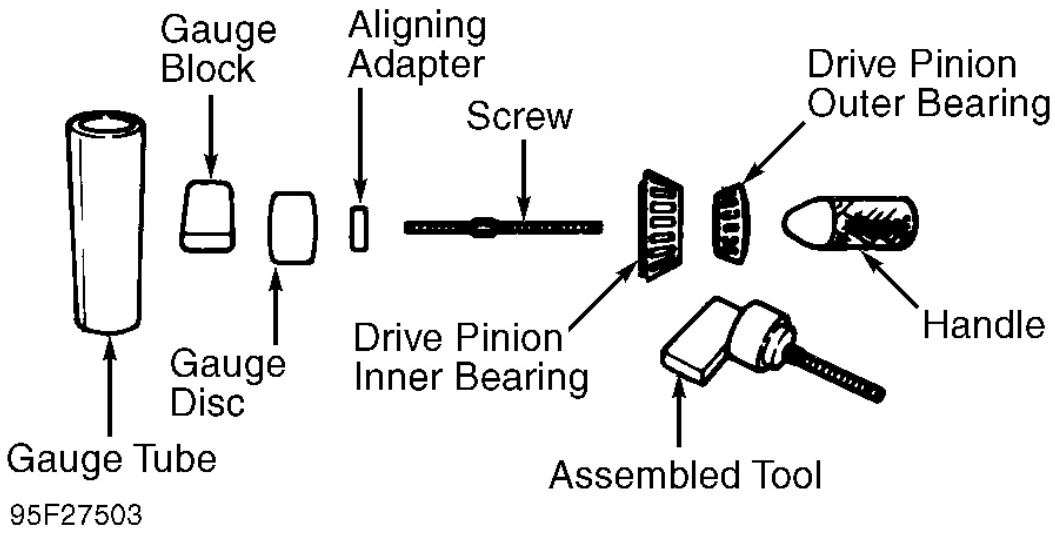


Fig. 7: Identifying Pinion Depth Gauge Set (T80T-4020-A)
Courtesy of FORD MOTOR CO.

DIFFERENTIAL CASE

1. Place differential case into vise. Use multipurpose grease to lubricate side gears, pinion gears and all thrust washers. Install components into differential case. Rotate side gears until holes in pinion gears and washers line up with holes in case.
2. Install differential pinion shaft. Install lock pin. Using a punch and hammer, peen metal of differential case over lock pin at 2 locations, 90 degrees to the left and right of lock pin slot.
3. Install ring gear and tighten NEW bolts evenly to specification. See **TORQUE SPECIFICATIONS** . Install Master Differential Bearings (D81T-4222-C) on differential case.
4. Install case (without shims) into carrier housing. Install side bearing caps. Mount dial indicator with indicator tip at 90 degrees to flat surface on head of ring gear bolt or flat machined surface of ring gear. Measure and record amount of end play of differential case by moving case back and forth with screwdriver. See **Fig. 8** .
5. This measurement is total differential case end play and will be used later to determine proper shim pack dimension. Remove case from housing. Leave master bearings on case at this time.

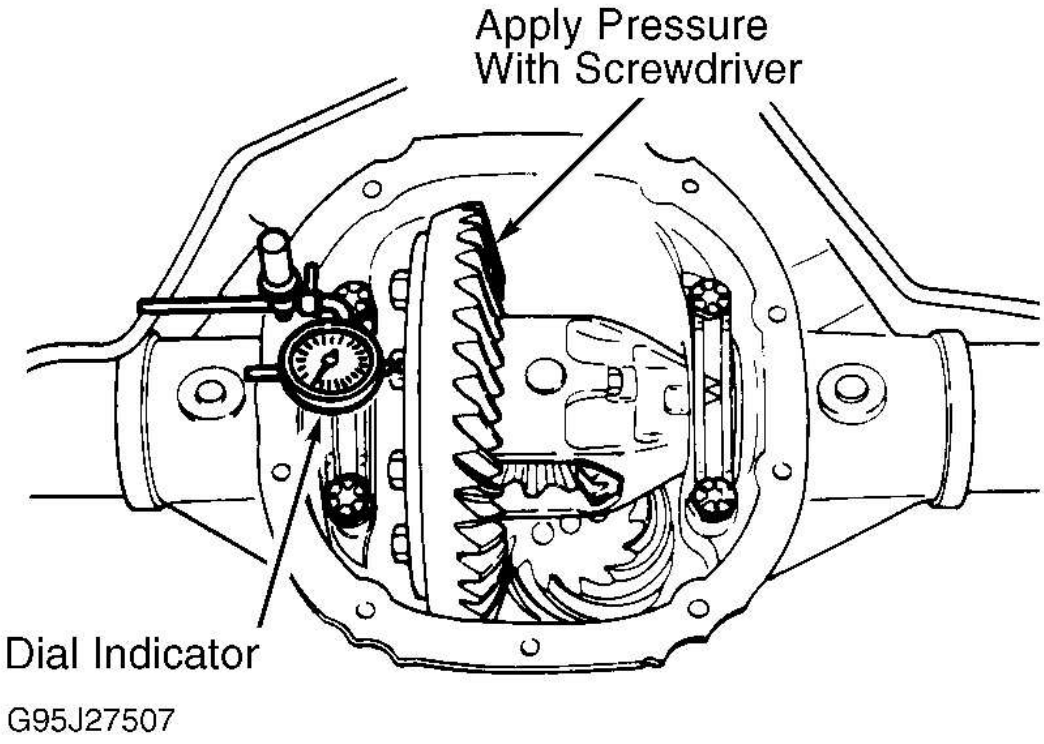


Fig. 8: Measuring Differential Case End Play
Courtesy of FORD MOTOR CO.

DRIVE PINION BEARING RACE INSTALLATION

1. Place pinion inner and outer bearing races into bores of carrier. Place inner race installer on inner bearing race. See **Fig. 9** . See **PINION BEARING RACE INSTALLER & FORCING SCREW** table.
2. Place outer race installer on outer bearing race. Install forcing screw through bearings. Tighten screw until both bearing races are seated in carrier bore.

PINION BEARING RACE INSTALLER & FORCING SCREW

Application	Tool Number
Forcing Screw	T75T-1176-A
Pinion Bearing Race Installer	
Inner Bearing Race	T80T-4000-F
Outer Bearing Race	T80T-4000-E

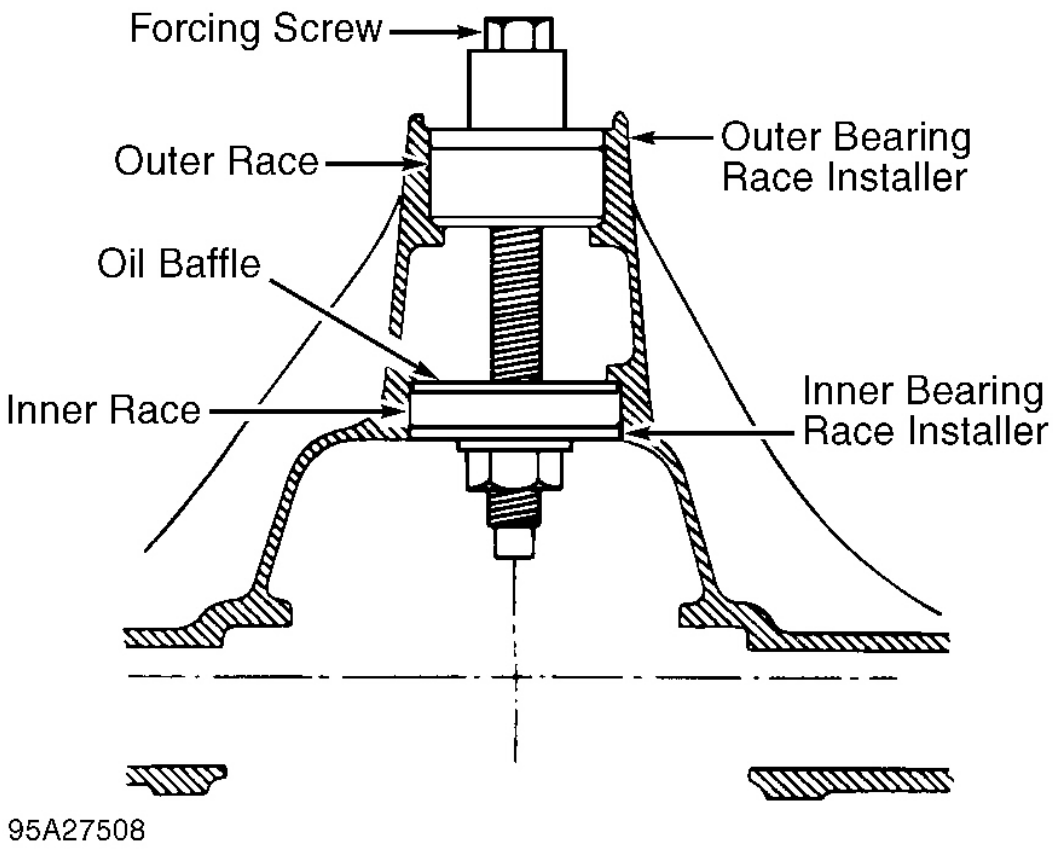


Fig. 9: Identifying Pinion Bearing Race Installer
Courtesy of FORD MOTOR CO.

DRIVE PINION DEPTH

1. Place NEW drive pinion inner bearing on aligning adapter and assemble using gauge disc. See **Fig. 6** . See **PINION DEPTH GAUGE** table. Place pinion outer bearing (new or good used) into race. Place depth gauge assembly into housing with screw extending through outer bearing.

NOTE: Tools in Pinion Depth Gauge Set (T80T-4020-A) must be checked before each use for nicks or damage. Any high spots on tools must be removed to ensure accurate readings.

PINION DEPTH GAUGE

Application	Tool Number
Aligning Adapter	T75P-4020-A2
Gauge Block	T80T-4020-F42

Gauge Disc	T80T-4020-F40
Gauge Tube	T80T-4020-F41
Handle	T76P-4020-A11
Screw	T80T-4020-F43

2. Thread handle onto screw finger tight. Using 3/8" drive torque wrench in square drive on handle, tighten handle until preload on bearings is 20-40 INCH lbs. (2.3-4.5 N.m). Center gauge tube in side bearing bore. Install side bearing caps and tighten bolts to specification. See **TORQUE SPECIFICATIONS** .
3. Place gauge block on top face of drive pinion underneath gauge tube. Determine clearance between gauge block and gauge tube using feeler gauge. Correct feeler gauge will give feeling of slight drag as gauge passes between tube and block.

NOTE: Pinion inner bearing used during depth measurement procedure must be used for final assembly. Oil slinger and/or baffle (if equipped) are to be measured as part of shim pack.

4. Thickness of correct feeler gauge is thickness of shim pack to be installed under inner bearing race, if drive pinion has zero marking. If drive pinion has plus (+) marking on face, subtract that number from thickness dimension. If drive pinion has minus (-) marking on face, add that number to thickness dimension.
5. Remove pinion inner bearing race and install shim pack with oil baffle (if equipped) into carrier bearing bore. Reinstall inner bearing race into carrier. Press drive pinion inner bearing and oil slinger (if equipped) on drive pinion, using axle bearing/seal plate, appropriate pinion bearing replacer and arbor press.

DRIVE PINION BEARING PRELOAD & FINAL DEPTH CHECK

CAUTION: Always use NEW collapsible spacer when reassembling drive pinion. DO NOT tighten pinion yoke nut more than 350 ft. lbs. (475 N.m), as collapsible spacer will be compressed too far.

1. Measure original preload shim pack and replace with NEW shims of equal thickness. Install drive pinion into carrier. Install NEW preload shim pack on pinion shaft. Install outer bearing and oil slinger. Install drive pinion yoke with washer, deflector, slinger and NEW nut using Yoke Installer (T78T-4851-A).
2. Tighten pinion yoke nut to 180-200 ft. lbs. (244-271 N.m). Using Torque wrench, check rotational torque necessary to turn drive pinion. Torque reading should be 20-40 INCH lbs. (2.3-4.5 N.m) if preload is correct. If preload reading is too low, remove preload shims from drive pinion. If preload reading is too high, add preload shims to drive pinion.
3. Install appropriate gauge tube. Install side bearing caps and tighten bolts to specification. See **TORQUE SPECIFICATIONS** . With drive pinion at correct depth, remove pinion yoke with holder and yoke remover. Coat pinion yoke oil seal with hypoid gear oil. Install seal using Oil Seal Replacer (T80T-4000-C).
4. Ensure spring behind lip of seal does not jump out while seal is being installed. If spring does jump out, remove and replace seal. Install drive pinion yoke and tighten nut.

RING & PINION GEAR BACKLASH

1. With drive pinion depth and preload adjustments properly made, install differential case into housing. Differential master bearings should still be on case. Ensure differential case is fully seated in carrier bores. Set dial indicator so that tip is against head of ring gear mounting bolt at 90-degree angle to bolt.
2. Rock ring gear so that teeth of ring gear mesh fully with drive pinion gear teeth. Force ring gear teeth against drive pinion gear teeth and zero dial indicator. Force ring gear and case away from drive pinion gear. Note dial indicator reading. Repeat this procedure until same reading is obtained each time.
3. This reading is thickness of shim pack that must go under differential side bearing on ring gear side of case. Remove master bearings. Place shim pack of correct thickness on ring gear hub.
4. Drive side bearing onto case using Side Bearing Installer (T80T-4000-J). Subtract thickness of shim pack installed on ring gear side of case from total differential case end play. Total differential case end play was recorded in step 4 under DIFFERENTIAL CASE.
5. Add .010" (.25 mm) preload to remaining end play figure obtained in previous step. Total is thickness of shim pack that is to be installed on hub of differential case opposite ring gear (drive pinion side of case).
6. Place shim pack on case hub and drive side bearing onto case using side bearing installer. Support case with Step Plate (D80L-630-5) to protect side bearing already installed on ring gear side of case. Install housing spreader and dial indicator on carrier housing. Spread housing maximum of .010" (.25 mm). Remove dial indicator.
7. Place side bearing races on side bearings. Install case into carrier housing. Use soft-face hammer to seat case assembly in carrier bore. If partial and non-hunting/partial ring and pinion gear set is being used, line up mating marks on gears. Remove housing spreader and dial indicator.
8. Install side bearing caps. Ensure letters stamped on caps match letters stamped on housing. Tighten bearing cap bolts to specification. See **TORQUE SPECIFICATIONS** . Check ring and pinion gear backlash in 3 places equally spaced around ring gear. Backlash range is .005-.009" (.13-.23 mm) with maximum variation between 3 measurements of .003" (.08 mm).
9. To change backlash readings, move shims from one side of differential case to other. Total thickness of end play shim packs must not change. When backlash adjustment is completed, check tooth contact pattern. See GEAR TOOTH CONTACT PATTERNS article in GENERAL INFORMATION.
10. When backlash is correct, apply bead of sealant to mating surfaces of carrier mounting face support arm. Bead should be 1/8" to 1/4" high and 1/4" to 1/2" wide. Using 2 guide pins, install carrier on left axle arm assembly.
11. Use NEW carrier bolts with adhesive-treated threads or clean old bolts and apply locking compound. Tighten carrier bolts. Install and tighten support arm tab bolts on side of carrier. Allow one hour curing time for sealant. Fill assembly with hypoid lubricant.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Axle Pivot Bolt	120-150 (163-203)
Axle Pivot Bracket-To-Frame Nut	70-92 (95-125)
Differential Carrier-To-Carrier Housing Bolt	30-40 (41-54)

Drive Shaft Nut	8-15 (11-20)
Pinion Shaft Yoke Nut	180-200 (244-271)
Ring Gear Bolt	95-105 (129-142)
Side Bearing Cap Bolt	80-90 (108-122)
Spindle-To-Knuckle Nut	60 (81)
Support Arm-To-Carrier Housing Bolt	100 (136)
Tie Rod Nut	50-75 (68-102)
Wheel Lug Nuts	140 (190)

1996-99 ENGINES

7.3L V8 Turbo Diesel

ENGINE IDENTIFICATION

NOTE: This article also applies to Cab & Chassis.

WARNING: Ensure negative battery cables are disconnected before disconnecting engine wiring harness. The Injector Driver Module (IDM) supplies 115-volts DC into each fuel injector connected to engine wiring harness. Severe electrical shock hazard exists. DO NOT pierce wires.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

The Power Stroke 7.3L diesel engine may be identified by eighth character of Vehicle Identification Number (VIN). VIN is stamped on a metal tab located near lower left corner of windshield. VIN is also located on Vehicle Safety Compliance Certification Label on driver's side door, or on driver's side door pillar post.

Engine serial number is stamped on driver's side of cylinder block, just behind the oil filter. Engine calibration code is stamped on engine calibration code label. Engine calibration code label is located on driver's side door pillar post. Engine serial number and engine calibration code may be required when ordering replacement components.

ENGINE IDENTIFICATION CODE

Application	Code
7.3L Turbo Diesel	F

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

NOTE: Hydraulic valve lifters are used. No adjustment is required.

FUEL INJECTION TIMING

NOTE: The amount of time each fuel injector is energized for delivering fuel into cylinder is electronically controlled by Powertrain Control Module (PCM).

TROUBLE SHOOTING

NOTE: To trouble shoot mechanical engine components, see appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

COOLING SYSTEM BLEEDING

Fill radiator until coolant level is 1.5" (38 mm) below cap seal in filler neck on radiator. Install radiator cap. Start engine and warm engine to normal operating temperature. Shut off engine. Allow engine to cool. Remove radiator cap and recheck coolant level. Add coolant if necessary.

FUEL LINE DISCONNECT FITTINGS

CAUTION: Fuel system is under pressure. Use care when servicing any fuel system components.

NOTE: Fuel lines may contain spring lock coupling or a push lock coupling. See Fig. 1 and Fig. 2 . Determine type of disconnect fitting used and use proper procedure for proper disconnect fitting.

Relieving Fuel Pressure

Place container under fuel filter/water separator drain hose. Open drain valve on fuel filter/water separator and allow fuel to drain into container. When filter is drained, close drain valve.

Removal (Spring Lock Coupling)

1. Relieve fuel pressure. See **RELIEVING FUEL PRESSURE**. Remove retaining clip from spring lock coupling. See **Fig. 1**. DO NOT use screwdriver or sharp object when removing retaining clip, as spring lock coupling may be damaged.
2. Twist both fuel lines to release seal adhesion on "O" rings. Spring Lock Coupling Remover (T81P-19623-G1 for 3/8" fuel line) or (T81P-19623-G2 for 1/2" fuel line) is used to release spring lock coupling.
3. Install spring lock coupling remover ontospring lock coupling so spring lock coupling remover enters cage opening ontospring lock coupling. See **Fig. 1**. This allows garter spring in spring lock coupling to be

released.

4. Push spring lock coupling remover into cage opening to release female fitting ontofuel line from garter spring in spring lock coupling. Pull fuel lines apart. Remove spring lock coupling remover.

Installation

1. Ensure garter spring is installed in cage on spring lock coupling. If garter spring is damaged, replace garter spring.

CAUTION: Use only specified type "O" rings on fuel lines, as they are made of special material. Use of improper type "O" rings may result in a fuel leak.

2. Ensure fuel lines and spring lock coupling are clean. Replace any missing or damaged "O" rings. Lubricate "O" rings and inside of female fitting with clean engine oil.
3. Push fuel lines together. Pull on both fuel lines to ensure spring lock coupling is properly locked together. Visually check that garter spring is positioned over flared end of female fitting on fuel line. Install retaining clip. Ensure retaining clip is fully seated and horseshoe portion of retaining clip is installed over spring lock coupling.

Removal (Push Lock Coupling)

1. Relieve fuel pressure. See **RELIEVING FUEL PRESSURE**. Lift retaining clip upward from push lock coupling. See **Fig. 2**. Push Lock Coupling Remover (T90T-9550-B) for 5/16" fuel line, or (T90T-9550-C) for 3/8" fuel line is used to release push lock coupling.
2. Install push lock coupling remover ontofuel line. See **Fig. 2**. Slide push lock remover into female fitting on push lock coupling to release retaining fingers on push lock coupling. See **Fig. 2**. Pull fuel lines apart. Remove push lock coupling remover.

Installation

1. Inspect push lock coupling for any internally damaged components before installing. If any internal components are damaged, replace fuel line.
2. Ensure fuel lines and push lock coupling are clean. Push fuel lines together until click sound is heard. Pull on both fuel lines to ensure push lock coupling is properly locked together. Push retaining clip downward onto push lock coupling.

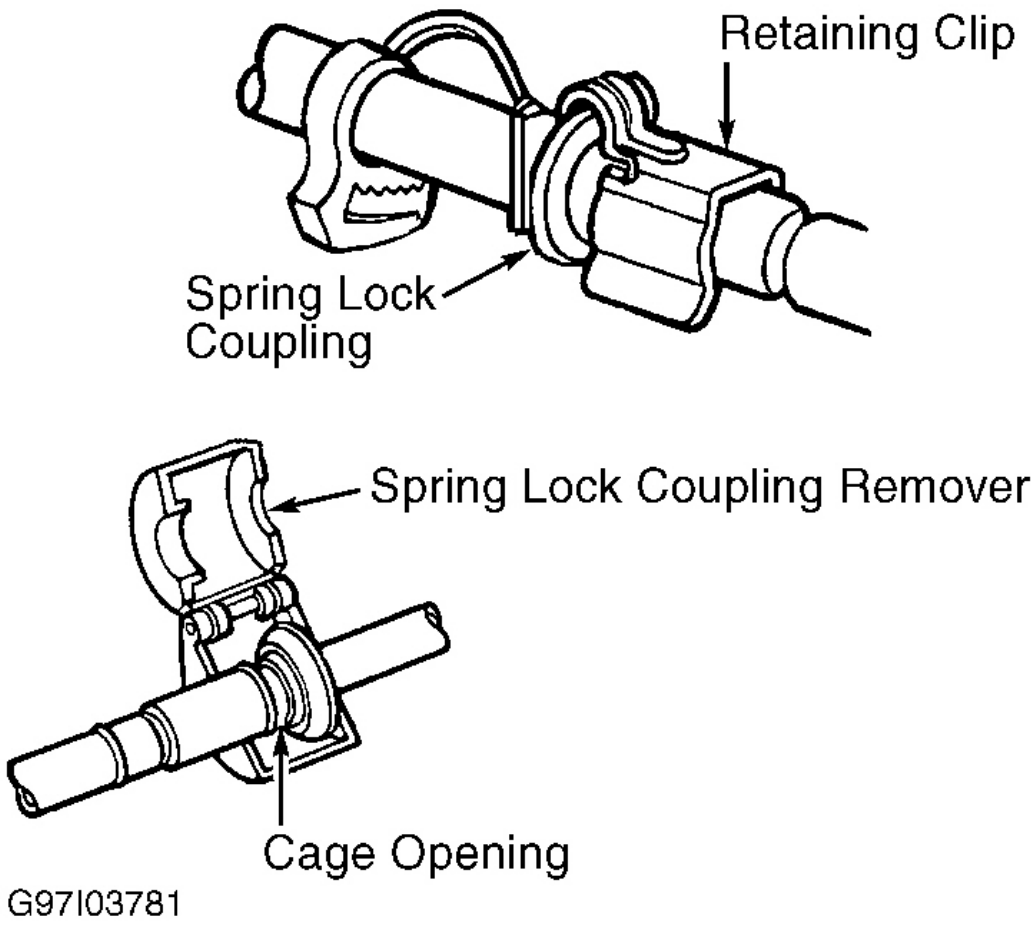


Fig. 1: Identifying, Removing & Installing Spring Lock Coupling
Courtesy of FORD MOTOR CO.

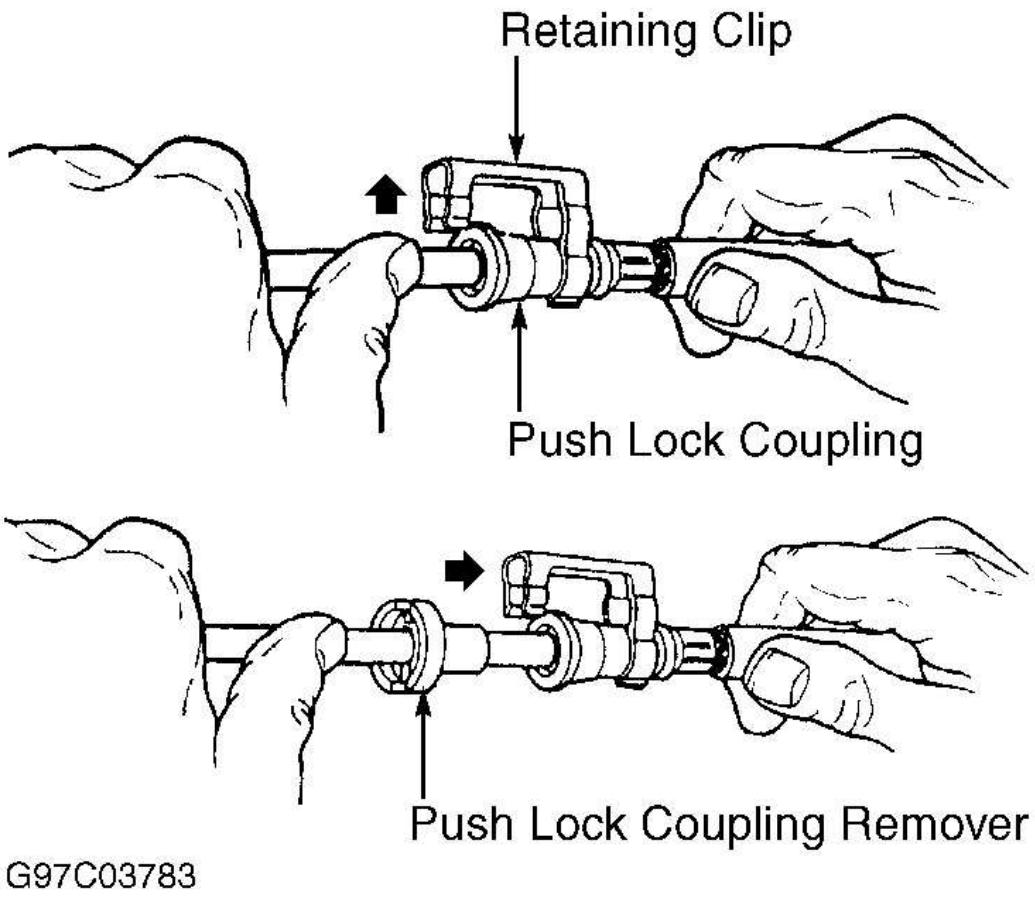


Fig. 2: Identifying, Removing & Installing Push Lock Coupling
Courtesy of FORD MOTOR CO.

ENGINE

Removal (F250 HD, F350 & F250-F550 Super Duty)

1. Disconnect negative battery cables. Remove hood. Remove engine cover. Remove turbocharger. See **TURBOCHARGER**. Remove air inlet duct assembly.
2. Drain cooling system. On A/C equipped models, discharge A/C system using approved refrigerant recovery/recycling equipment. On all models, disconnect upper radiator hose and coolant recovery reservoir hose at radiator.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly onto water pump.

3. Using Fan Clutch Holder (T84T-6312-C) and Fan Clutch Nut Wrench (T9T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud.
4. Remove fan shroud along with fan and fan clutch assembly. Disconnect remaining coolant hoses from radiator. On A/T models, disconnect transmission oil cooler lines from radiator. On all models, remove radiator.
5. Loosen clamps on charge air cooler ducts and remove ducts. Remove 2 stud bolts and remove charge air cooler. Note direction of drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt.
6. On A/C equipped models, disconnect electrical connector from A/C compressor clutch. Disconnect A/C refrigerant lines from A/C compressor and plug line openings. Disconnect A/C refrigerant lines from condenser, and plug line openings. Position A/C refrigerant lines aside. Remove condenser.
7. Remove parking lamp and headlight assemblies. Remove grille, grille opening panel and upper and lower radiator supports. Remove front bumper. Disconnect electrical connectors from generator. Disconnect MAP sensor hose. Remove generator retaining bolt, and position heater hose aside. Remove generator mounting bracket and generator as an assembly. Remove ground cable from engine block.
8. Disconnect power steering lines from power steering pump. Disconnect engine control sensor electrical connector. Disconnect heater hoses.
9. Disconnect necessary fuel lines using proper procedure. See **FUEL LINE DISCONNECT FITTINGS**.
10. On A/T models, remove transmission sensor harness retaining bolt and harness. On all models, remove fuel line retaining bolt at front of engine block. Install Engine Lift Adapters (D83T-6000-B) onto front of engine block. Install Engine Lifting Eye (D94T-6000-C) onto right cylinder head.
11. Raise and support vehicle. Disconnect wiring for starter, and position aside. Remove starter. On A/T models, remove flywheel housing cover. Remove torque converter-to-flywheel nuts. On all models, drain engine oil, and remove oil filter.
12. Disconnect electrical connector at cylinder block heater. Cylinder block heater is located on driver's side rear corner of cylinder block, just below exhaust manifold, near oil filter.
13. On A/T models, support transmission with transmission jack. Remove transmission-to-cylinder block bolts. Remove transmission oil filler tube. On all models, lower vehicle
14. Install suitable engine lifting device onto engine. Raise engine enough to clear No. 1 crossmember. Pull engine forward, and remove from vehicle.

Installation

1. To install, reverse removal procedure. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**. On A/T models, use NEW torque converter-to-flexplate nuts when installing transmission. Fill transmission with Motorcraft Mercon ATF.
2. On all models, use proper procedure when installing fuel lines. See **FUEL LINE DISCONNECT FITTINGS**. Refill power steering system with Motorcraft Mercon ATF. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. On A/C equipped models, evacuate and recharge A/C system.

Removal (Van)

1. Disconnect negative battery cables. Remove hood. On A/C equipped models, discharge A/C system using approved refrigerant recovery/recycling equipment. Remove air cleaner housing and duct assembly.

2. On all models, drain cooling system. Remove front bumper, grille, air deflector and gravel deflector.
3. Remove headlight and park light assemblies. Position transmission oil cooler out of way. On A/C equipped models, disconnect A/C refrigerant lines from condenser, and plug line openings. Remove condenser.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly onto water pump.

4. On all models, remove support bracket located on top of radiator. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud.
5. Remove fan shroud along with fan and fan clutch assembly. Disconnect transmission oil cooler lines and coolant hoses from radiator. Remove radiator.
6. Remove brackets for headlight assemblies. Remove radiator support and oil filler tube. Note direction of accessory drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt.
7. On A/C equipped models, disconnect electrical connector from A/C compressor clutch. Disconnect A/C refrigerant lines from A/C compressor, and plug line openings. Remove A/C compressor mounting bracket.
8. On all models, disconnect vacuum hose from vacuum pump. Disconnect power steering lines from power steering pump. Disconnect electrical connectors from generator. Remove generator mounting bracket and generator as an assembly.

WARNING: Ensure negative battery cables are disconnected before disconnecting engine wiring harness. The Injector Driver Module (IDM) supplies 115 volts DC into each fuel injector connected to engine wiring harness.

9. Disconnect plug for engine wiring harness from driver's side of engine compartment. Lay engine wiring harness back over engine.
10. Disconnect necessary ground cables from cylinder block. Disconnect vacuum hose for Manifold Absolute Pressure (MAP) sensor from passenger's side intake manifold cover. Disconnect remaining coolant hoses from engine.
11. Remove turbocharger. See **TURBOCHARGER**. Disconnect necessary fuel lines using proper procedure. See **FUEL LINE DISCONNECT FITTINGS**.
12. Disconnect remaining electrical connectors and hoses for engine removal. Disconnect electrical connectors from transmission. Remove transmission oil fill tube.
13. Raise and support vehicle. Remove starter. Remove engine mount nuts. Remove torque converter cover. Remove torque converter-to-flywheel nuts. Drain engine oil, and remove oil filter.
14. Disconnect electrical connector at cylinder block heater. Cylinder block heater is located on driver's side rear corner of cylinder block, just below exhaust manifold, near oil filter. Lower vehicle. Support transmission with transmission jack.
15. Remove transmission-to-engine bolts. Install Engine Lifting Fixture (D83T-6000-B) onto engine. Raise

engine high enough to clear No. 1 crossmember. Pull engine forward and remove engine.

Installation

1. To install, reverse removal procedure. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**. Use NEW torque converter-to-flexplate nuts when installing transmission. Fill transmission with Motorcraft Mercon ATF.
2. Use proper procedure when installing fuel lines. See **FUEL LINE DISCONNECT FITTINGS**. Refill power steering system with Motorcraft Mercon ATF. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. On A/C equipped models, evacuate and recharge A/C system.

FUEL FILTER/WATER SEPARATOR

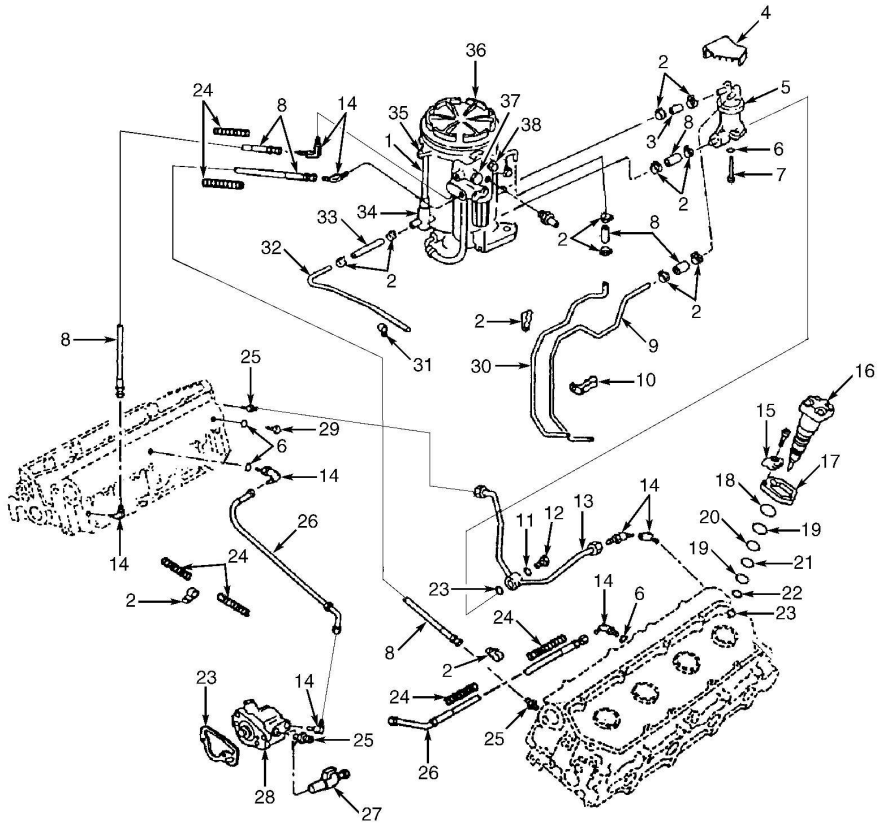
Removal

1. Disconnect negative battery cables. Remove necessary air intake and turbocharger components for access to fuel filter/water separator as necessary. Fuel filter/water separator is located on top of engine, between valve covers. See **Fig. 3** and **Fig. 4** .
2. Place container below water drain line at bottom of fuel filter/water separator housing. Rotate water drain lever away from fuel filter/water separator housing and allow fuel to drain. Disconnect fuel supply and return lines from filter/separator.
3. Remove 2 fuel supply hoses connecting regulator block onto both cylinder heads. Disconnect clip for wiring harness from side of fuel filter/water separator housing. Disconnect necessary electrical connectors for removal of fuel filter/water separator housing. Remove bolts and fuel filter/water separator housing.

NOTE: Ensure fuel filter/water separator filter is properly installed into housing or engine will not operate properly.

Installation

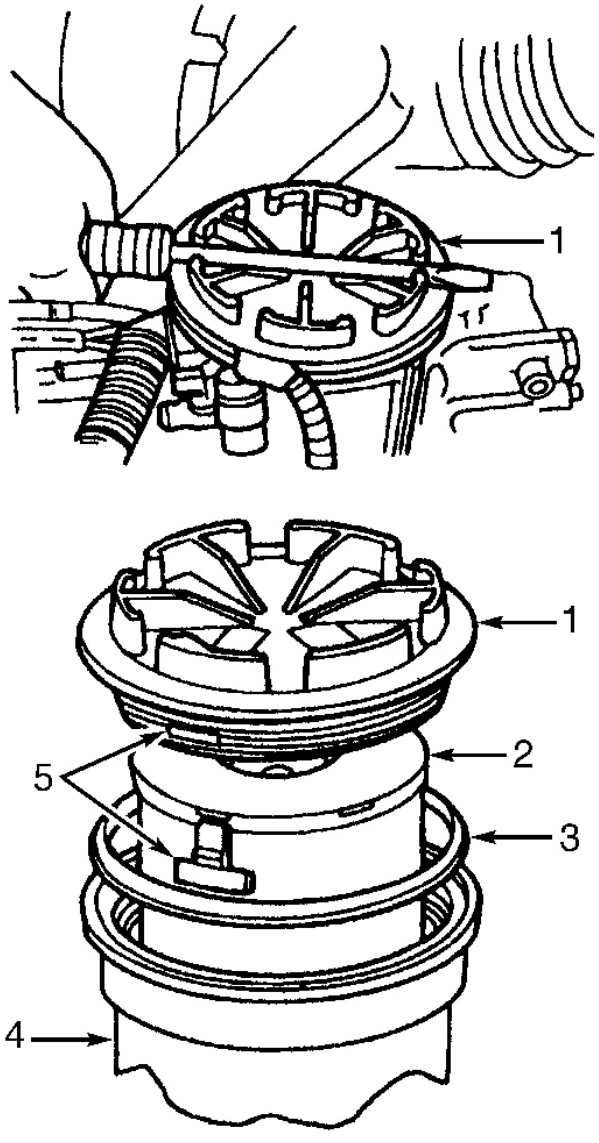
1. To install, reverse removal procedure using NEW seal ring. Apply diesel fuel onto seal ring before installing. Ensure seal ring is installed with beveled area facing original direction.
2. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. Ensure fuel/filter water separator filter is securely locked onto cap.
3. Fill fuel/filter water separator housing with diesel fuel before installing cap and fuel/filter water separator filter. Tighten cap until cap just contacts fuel/filter water separator housing. Ensure water drain lever is fully closed.



1. Fuel Filter/Water Separator Housing
2. Clamp
3. Fuel Supply Hose
4. Shield
5. Fuel Pump
6. "O" Ring
7. Fuel Pump Tappet
8. Fuel Return Hose
9. Fuel Supply Line
10. Fuel Supply Line Clamp
11. Gasket
12. Banjo Bolt
13. Fuel Line Assembly
14. Elbow
15. Oil Deflector
16. Fuel Injector
17. Fuel Injector Hold-Down Plate
18. Back-Up Ring
19. Cushion Ring
20. Upper Seal
21. Middle Seal
22. Lower Seal
23. Copper Washer
24. Sleeve
25. Connector
26. High-Pressure Oil Pump Supply Line
27. Pressure Regulator
28. High-Pressure Oil Pump
29. Plug
30. Fuel Return Line
31. Clip
32. Water Drain Line
33. Water Drain Hose
34. Water Drain Valve
35. Water Drain Lever
36. Cap
37. Fuel Pressure Regulator
38. Fuel Control Manifold

97E03755

Fig. 3: Locating Fuel System Components
Courtesy of FORD MOTOR CO.



1. Fuel Filter Cap
2. Fuel Filter Element
3. Fuel Filter Bevel Cut Gasket
4. Fuel Filter Housing & Gland
5. Fuel Filter Element & Cap Locking Tabs

G50C16685

Fig. 4: Fuel Filter Assembly
Courtesy of FORD MOTOR CO.

FUEL HEATER

Removal & Installation

1. Fuel heater is located inside fuel filter/water separator housing, just below fuel filter/water separator filter. Remove fuel filter/water separator filter from fuel filter/water separator housing. See **FUEL FILTER/WATER SEPARATOR**.
2. Remove 2 attaching screws and remove filter heater thermostat from housing. Disconnect electrical connector for fuel heater. Remove fuel heater from bottom of fuel filter/water separator housing.
3. To install, reverse removal procedure. Ensure proper procedure is followed when installing fuel filter/water separator filter. See **FUEL FILTER/WATER SEPARATOR**.

FUEL INJECTOR

WARNING: Ensure negative battery cables are disconnected before disconnecting engine wiring harness. The Injector Driver Module (IDM) supplies 115-volts DC into each fuel injector connected to engine wiring harness. Severe electrical shock hazard exists. DO NOT pierce wires.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

Removal

1. Disconnect negative battery cables. Loosen drain plugs at rear of each cylinder head and drain fuel from heads. Remove necessary components for access to valve covers. Remove valve covers. Note location of wires on fuel injector for installation reference. Disconnect engine wiring harness wires from fuel injector. DO NOT pierce any wires in engine wiring harness.

CAUTION: Remove oil rail drain plugs from cylinder head before removing fuel injector. Oil rail drain plugs are located inside cylinder head. See Fig. 5.

2. Remove oil rail drain plugs from cylinder head. Oil rail drain plugs are located on inside of cylinder head, near push rods. See **Fig. 5**.
3. Remove oil deflector retaining bolt and oil deflector from cylinder head. See **Fig. 6**. Remove fuel injector retaining bolt. See **Fig. 5**.

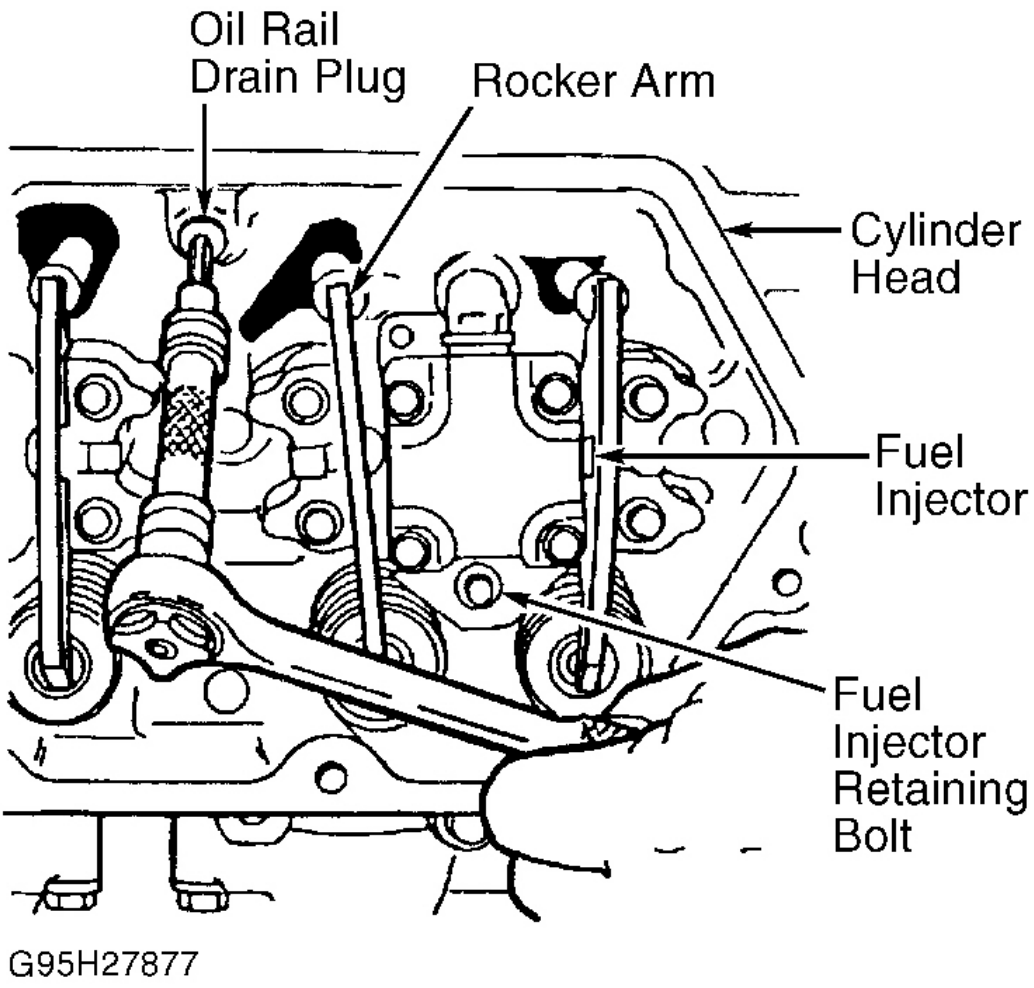


Fig. 5: Locating Oil Rail Drain Plug & Fuel Injector Retaining Bolt
Courtesy of FORD MOTOR CO.

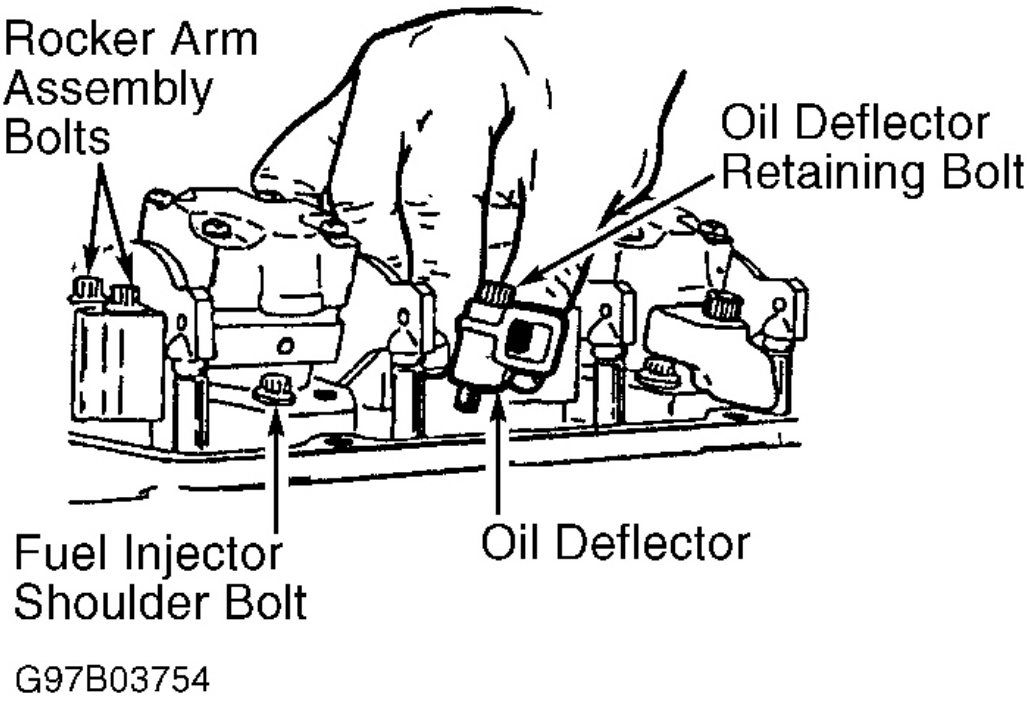


Fig. 6: Locating Oil Deflector, Oil Deflector Retaining Bolt Fuel Injector Shoulder Bolt & Rocker Arm Bolts
Courtesy of FORD MOTOR CO.

4. Using Fuel Injector Remover (T94T-9000-AH1), remove fuel injector from cylinder head. See **Fig. 7**. Ensure all cushion rings, seals and copper washer are still on fuel injector. See **Fig. 8**. Remove any cushion rings, seals or copper washer from fuel injector sleeve in cylinder head if they are not on fuel injector.

CAUTION: DO NOT disassemble fuel injector. If fuel injector is disassembled, fuel injector calibration will be incorrect.

NOTE: Remove cylinder head for servicing of fuel injector sleeve. See CYLINDER HEAD.

5. If removing fuel injector sleeve from cylinder head, install plug from Fuel Injector Sleeve Tap (D94T-9000B) in fuel injector sleeve to prevent debris from falling into cylinder. Install tap and tap pilot into fuel injector sleeve and tighten 1 1/2 - 2 full turns.
6. Install slide hammer onto fuel injector sleeve tap. Using slide hammer, pull fuel injector sleeve from cylinder head. Remove fuel injector sleeve tap from fuel injector sleeve.

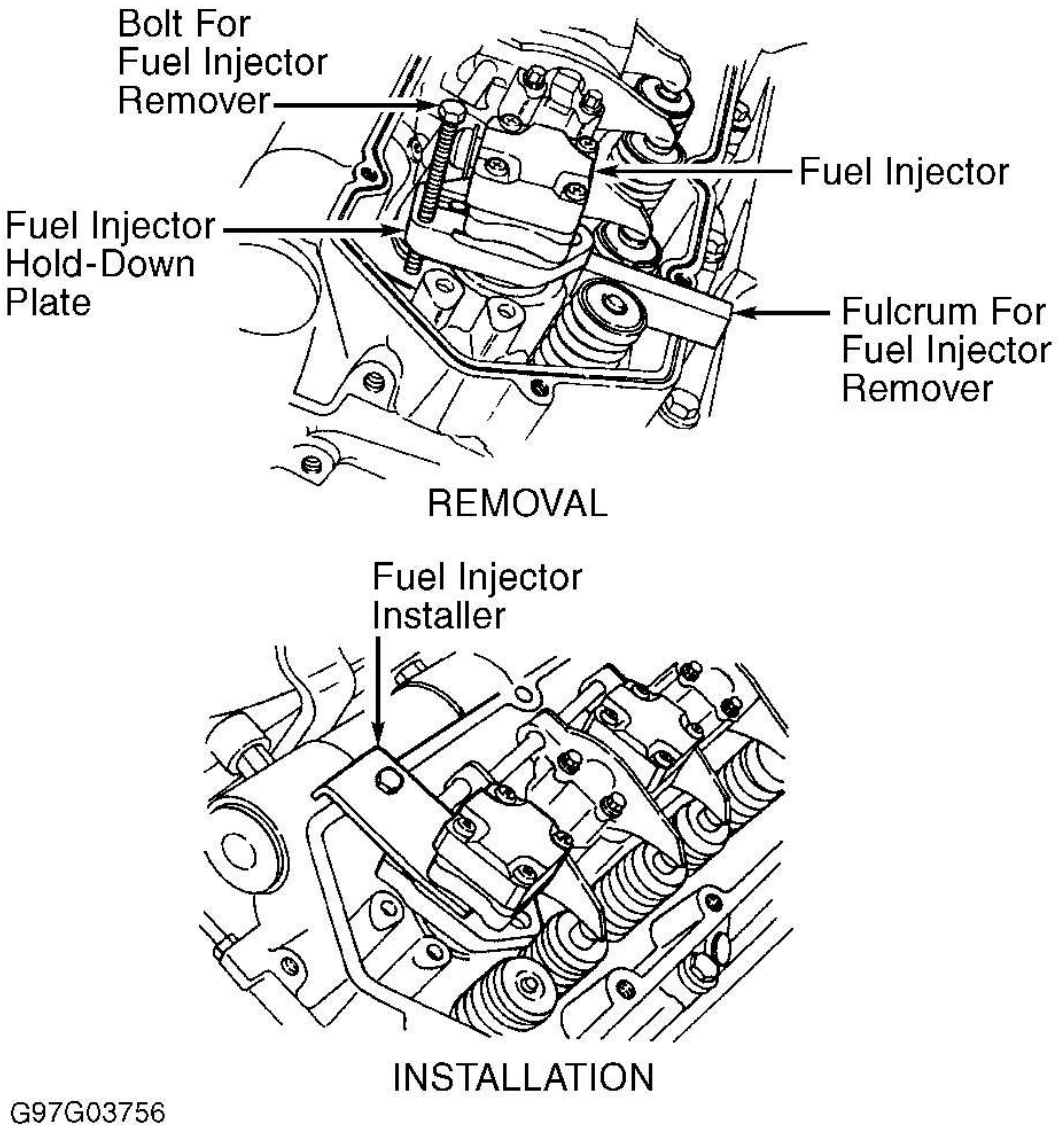


Fig. 7: Removing & Installing Fuel Injector
Courtesy of FORD MOTOR CO.

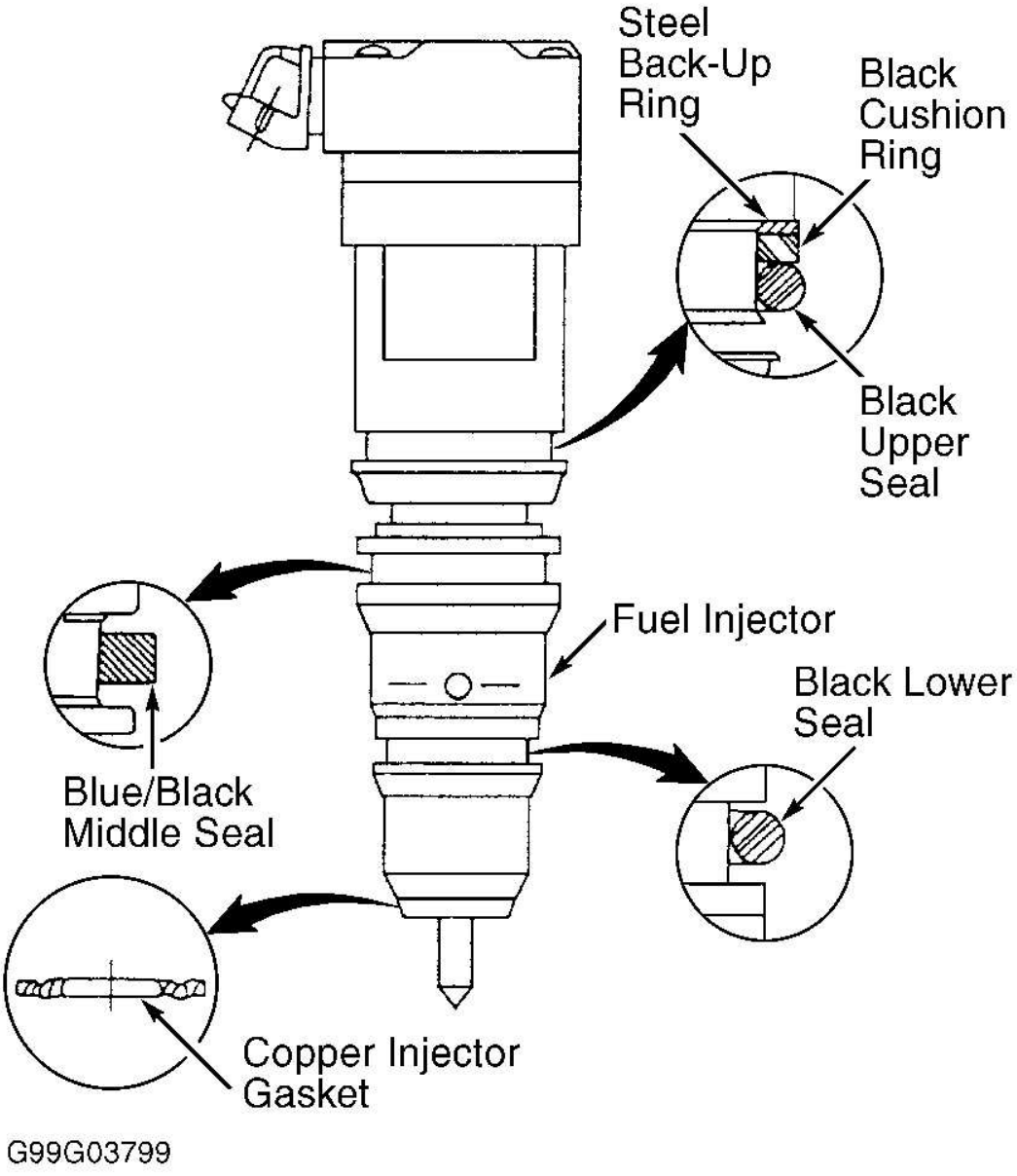


Fig. 8: Locating Back-Up Ring, Cushion Rings, Seals & Copper Washer On Fuel Injector
Courtesy of FORD MOTOR CO.

Installation

1. If fuel injector sleeves are not being installed, go to step **3)** . If installing fuel injector sleeve in cylinder head, use Fuel Injector Sleeve Brush (D94T-9000-D) and clean bore in cylinder head for fuel injector sleeve. Ensure all debris are cleaned from bore.

2. Apply Threadlock® Sealant 262 at designated areas onto fuel injector sleeve. See **Fig. 9**. Using rubber hammer and Fuel Injector Sleeve Installer (D94T-9000-C), tap fuel injector sleeve into cylinder head. Remove fuel injector sleeve installer.

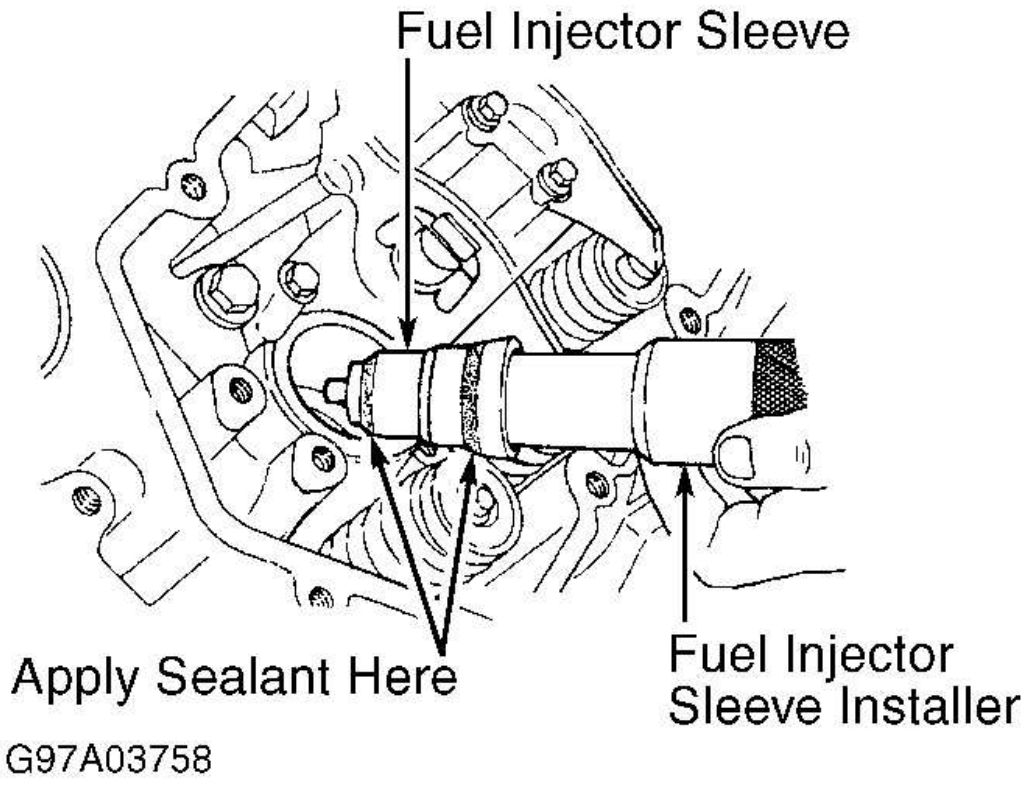


Fig. 9: Applying Sealant On Fuel Injector Sleeve
Courtesy of FORD MOTOR CO.

CAUTION: Two different fuel injectors may be available, a 49 state fuel injector and a California fuel injector. These fuel injectors MUST NOT be interchanged, as Powertrain Control Module (PCM) is calibrated for specified fuel injector. Before replacing any fuel injectors, refer to Vehicle Emission Control Information decal for proper fuel injector application. Decal is located under hood. Improper fuel injector application may result in poor engine performance, high emission levels and/or damage to engine.

CAUTION: Remove all fuel and oil from cylinders before installing fuel injectors. Failure to ensure cylinders are clean may result in engine damage

caused by hydrostatic lock.

3. Using proper size brush from Brush Set (D94T-9000-D), clean bore for fuel injector in fuel injector sleeve. Ensure seating area at end of fuel injector sleeve is clean.
4. Ensure fuel and oil are removed from cylinders before installing fuel injectors. Install NEW back-up ring, cushion rings, seals and copper washer on fuel injector. Ensure components are installed in correct location. See **Fig. 8**.

CAUTION: DO NOT tap on top of fuel injector to seat fuel injector in fuel injector sleeve or fuel injector will be damaged. Ensure copper washer does not fall from fuel injector during fuel injector installation.

5. Lubricate fuel injector, back-up ring, cushion rings and seals with clean engine oil. Using Fuel Injector Installer (D94T-9000-AH2), install fuel injector in cylinder head until fuel injector is fully seated. See **Fig. 7**.
6. Remove fuel injector installer. Install oil deflector. Tighten oil deflector retaining bolt to specification. See **TORQUE SPECIFICATIONS**. Install and tighten fuel injector retaining bolt and oil rail drain plugs to specification.
7. Reinstall engine wiring harness wires onto fuel injector. DO NOT pierce any wires in engine wiring harness. To install remaining components, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**.

FUEL PUMP

Removal

1. Fuel pump is located behind fuel filter/water separator in between cylinder heads. Remove turbocharger. See **TURBOCHARGER**.
2. Remove fuel filter/water separator. See **FUEL FILTER/WATER SEPARATOR**. Remove fuel pump banjo bolt and seal rings at rear of fuel pump. Remove fuel line assembly-to-cylinder head fittings at rear of each cylinder head. Remove fuel line assembly.
3. Remove bolts from fuel pump. Remove fuel pump, "O" ring and fuel pump tappet from cylinder block.

CAUTION: Ensure camshaft lobe for fuel pump is on base circle with lobe facing away from fuel pump to prevent damage to fuel pump during installation.

Installation

1. To install, reverse removal procedure using NEW "O" ring on fuel pump and seal rings on banjo bolt and fuel line assembly. Rotate engine until camshaft lobe for fuel pump is on base circle and lobe is facing away from fuel pump before installing fuel pump. Ensure fuel pump bolts are tightened evenly to prevent damage to fuel pump.
2. When installing fuel line assembly, ensure fuel line assembly-to-fuel pump banjo bolt and fuel line assembly-to-cylinder head fittings are all loosely installed before tightening banjo bolt to specification.

Tighten fuel line assembly-to-fuel pump banjo bolt to specification. See **TORQUE SPECIFICATIONS**.

HIGH-PRESSURE OIL PUMP

NOTE: High-pressure oil pump is used in high-pressure oil system which supplies oil pressure for fuel injector operation. See Fig. 10.

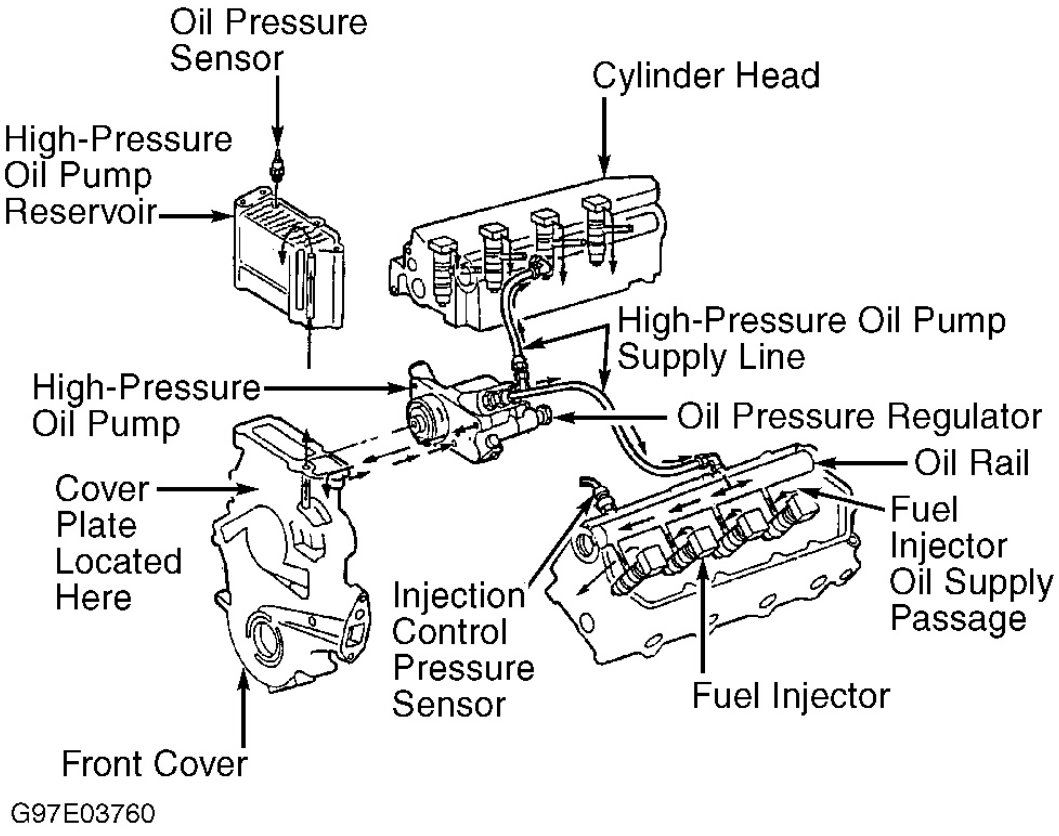


Fig. 10: High-Pressure Oiling System
Courtesy of FORD MOTOR CO.

Removal

1. On Van models, remove air cleaner housing and air inlet duct. Remove accessory drive belt and belt idler pulley, if required.
2. On all models, loosen clamps and remove compressor manifold from turbocharger for access to high-pressure oil pump. Remove fuel filter/water separator housing. See **FUEL FILTER/WATER SEPARATOR**. Remove plug from top of high-pressure oil pump reservoir and use vacuum pump to remove oil from high-pressure oil pump reservoir.
3. Disconnect high-pressure oil pump supply lines from high-pressure oil pump. Disconnect necessary

electrical connectors for removal of high-pressure oil pump.

4. Remove cover plate to access high-pressure oil pump drive gear bolt. Cover plate is bolted onto front cover, just below high-pressure oil pump reservoir.
5. Remove high-pressure oil pump drive gear bolt and washer. Remove retaining bolts, high-pressure oil pump and gasket.

Installation

1. Using NEW gasket, install high-pressure oil pump. Install and tighten bolts to specification. See **TORQUE SPECIFICATIONS**.

CAUTION: Ensure high-pressure oil pump drive gear is fully seated onto shaft of high-pressure oil pump before installing high-pressure oil pump drive gear bolt and washer. End of shaft should be even with front edge of high-pressure oil pump drive gear.

2. Ensure high-pressure oil pump drive gear is fully seated onto shaft of high-pressure oil pump. End of shaft should be even with front edge of high-pressure oil pump drive gear. Ensure washer is installed onto high-pressure oil pump driver gear bolt.
3. Install and tighten high-pressure oil pump drive gear bolt to specification. See **TORQUE SPECIFICATIONS**. Apply RTV sealant onto front cover at cover plate sealing surface. Install cover plate and tighten bolts.
4. To install remaining components, reverse removal procedure. Ensure seal is properly seated when installing compressor manifold onto turbocharger. Tighten high-pressure oil pump supply line fittings at high-pressure oil pump to specification. See **TORQUE SPECIFICATIONS**.

CAUTION: Fill high-pressure oil pump reservoir with engine oil.

5. Fill high-pressure oil pump reservoir with clean engine oil. Install plug. Ensure proper procedure is used when installing fuel filter/water separator housing. See **FUEL FILTER/WATER SEPARATOR**.

HIGH-PRESSURE OIL PUMP DRIVE GEAR

Removal

1. On Van, remove air cleaner housing and air inlet duct. Remove accessory drive belt and belt idler pulley, if required.
2. On all models, loosen clamps and remove compressor manifold from turbocharger for access to high-pressure oil pump. Remove fuel filter/water separator housing. See **FUEL FILTER/WATER SEPARATOR**. Remove plug from top of high-pressure oil pump reservoir, and use vacuum pump to remove oil from high-pressure oil pump reservoir.
3. Disconnect high-pressure oil pump supply lines from high-pressure oil pump. Disconnect necessary electrical connectors for removal of high-pressure oil pump.

4. Remove bolts/nuts, high-pressure oil pump reservoir and gasket. Using dial indicator, check gear backlash on high-pressure oil pump drive gear while moving gear back and forth by hand. Replace high-pressure oil pump drive gear if gear backlash is not .0055-.0101" (.140-.256 mm).
5. Remove high-pressure oil pump for removal of high-pressure oil pump drive gear. See **HIGH-PRESSURE OIL PUMP**. Remove high-pressure oil pump drive gear from front cover.

Installation

1. To install, reverse removal procedure. Ensure sealing surfaces on high-pressure oil pump reservoir and front cover are clean. Install NEW gasket onto front cover and apply RTV sealant onto front cover before installing high-pressure oil pump reservoir.
2. Ensure high-pressure oil pump reservoir is filled with clean engine oil. Ensure seal is properly seated when installing compressor manifold onto turbocharger.

TURBOCHARGER

Removal (F250 HD, F350 & F250-F550 Super Duty)

1. Disconnect negative battery cables. Remove charge air cooler intake and outlet ducts from compressor manifold. Disconnect pressure lines and pressure valve electrical connector. Loosen turbocharger-to-compressor manifold clamps. Remove compressor manifold.
2. Loosen exhaust outlet pipe-to-turbocharger clamp. On A/T models, remove bolts retaining left turbocharger exhaust inlet pipe-to-turbocharger exhaust inlet adapter. On all models, pull exhaust outlet pipe away from turbocharger. Slide retaining clip away from exhaust backpressure valve actuator lever. Pull actuator rod free of actuator lever.
3. Loosen air inlet tube clamps. Disconnect pressure line from inlet tube. Remove air inlet tube. Loosen turbocharger clamps. Remove turbocharger attaching bolts.
4. Disconnect exhaust backpressure solenoid electrical connector. Remove turbocharger pedestal assembly-to-cylinder block bolts. See **Fig. 11**. Remove turbocharger and pedestal. Remove "O" rings located between cylinder block and turbocharger pedestal assembly.

Inspection

For inspection and overhaul procedures, see **TURBOCHARGER** under OVERHAUL.

Installation

To install, reverse removal procedure using NEW "O" rings. Ensure seal is properly seated when installing compressor manifold onto turbocharger. Tighten all bolts/nuts to specification. See **TORQUE SPECIFICATIONS**.

Removal (Van)

1. Disconnect negative battery cables. Remove interior engine cover. Remove heat shield from turbocharger. Disconnect air intake hose from turbocharger.
2. Remove front exhaust pipe-to-turbocharger clamp. Remove exhaust inlet pipes for turbocharger. Exhaust

inlet pipes fit between exhaust manifolds and exhaust inlet adapter on turbocharger. Loosen clamp and remove inlet hose.

3. Loosen clamps and remove compressor manifold from rear of turbocharger. See **Fig. 11**. Disconnect electrical connectors. Remove turbocharger pedestal assembly-to-cylinder block bolts. See **Fig. 11**. Remove turbocharger assembly. Remove "O" rings located between cylinder block and turbocharger pedestal assembly.

Inspection

For inspection and overhaul procedures, see **TURBOCHARGER** under OVERHAUL.

Installation

1. Ensure right rear turbocharger pedestal assembly-to-cylinder block bolt is installed before installing turbocharger onto cylinder block. To install, reverse removal procedure using NEW "O" rings. Ensure seal is properly seated when installing compressor manifold onto turbocharger.
2. Ensure all bolts/nuts are loosely installed in exhaust inlet pipes before tightening to specification. Tighten all bolts/nuts to specification. See **TORQUE SPECIFICATIONS**.

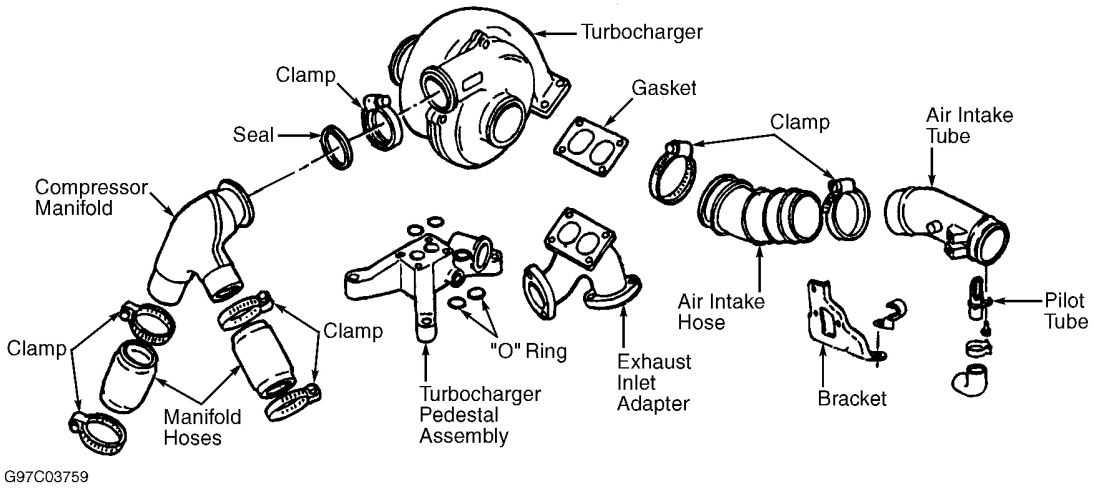


Fig. 11: Exploded View Of Turbocharger
Courtesy of FORD MOTOR CO.

EXHAUST MANIFOLD

Removal (F250 HD, F350 & F250-F550 Super Duty)

1. Disconnect negative battery cables. On A/T models, when removing passenger's side exhaust manifold, remove transmission fill tube bracket bolts. Rotate transmission fill tube and bracket aside.
2. On all applications, raise and support vehicle. Remove exhaust inlet pipe-to-exhaust manifold bolt/nuts. Exhaust inlet pipe fits between exhaust manifold and exhaust inlet adapter on turbocharger. Remove bolts

and exhaust manifold.

Inspection

Using feeler gauge and straightedge, check exhaust manifold warpage. Resurface exhaust manifold if warpage exceeds .005" (.13 mm) between ports on exhaust manifold or .010" (.25 mm) overall. DO NOT machine more than .010" (.25 mm) from exhaust manifold.

Installation

To install, reverse removal procedure. Apply anti-seize onto threads of exhaust manifold bolts before installing. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**.

Removal (Van)

1. Disconnect negative battery cables. Remove interior engine cover. Drain cooling system. When removing passenger's side exhaust manifold, remove air cleaner assembly. Remove oil level indicator tube and retaining nut.
2. Remove upper radiator hose and coolant recovery hose. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud. Remove fan shroud. Remove drive belt. Remove generator.
3. On all applications, raise and support vehicle. Remove exhaust inlet pipe-to-exhaust manifold bolt/nuts. Exhaust inlet pipe fits between exhaust manifold and exhaust inlet adapter on turbocharger. On right side, disconnect exhaust backpressure line from manifold. On both sides, remove bolts and exhaust manifold.

Inspection

Using feeler gauge and straightedge, check exhaust manifold warpage. Resurface exhaust manifold if warpage exceeds .005" (.13 mm) between ports on exhaust manifold or .010" (.25 mm) overall. DO NOT machine more than .010" (.25 mm) from exhaust manifold.

Installation

To install, reverse removal procedure. Apply anti-seize onto threads of exhaust manifold bolts before installing. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**.

CYLINDER HEAD

WARNING: When servicing cylinder head, use care when working with engine wiring harness for fuel injectors, as Injector Driver Module (IDM) supplies 115 volts DC into each fuel injector connected to engine wiring harness. DO NOT pierce any wires in engine wiring harness. Ensure negative battery cables are disconnected before servicing engine components in which contact with engine wiring harness for fuel injectors may exist.

Removal (F250 HD, F350 & F250-F550 Super Duty)

1. Disconnect negative battery cables. Drain cooling system. Place container below water drain line at bottom of fuel filter/water separator housing.
2. Rotate water drain lever away from fuel filter/water separator housing and allow fuel to drain. Water drain lever is located near top of fuel filter/water separator housing.
3. Disconnect fuel line assembly from rear of cylinder heads. This fuel line runs between fuel pump and cylinder heads. DO NOT bend fuel line. For driver's side cylinder head, go to step **6)** .
4. On passenger's side cylinder head, note direction of accessory drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt. Remove turbocharger compressor manifold. Disconnect electrical connectors from generator. Remove engine ground cable. Remove generator mounting bracket and generator as an assembly. Remove A/T oil dipstick and dipstick tube. Remove screws from Manifold Absolute Pressure (MAP) sensor and position sensor aside.
5. Discharge A/C system (if equipped) using approved refrigerant recovery/recycling equipment. Disconnect electrical connector from A/C compressor clutch. Disconnect A/C refrigerant lines from A/C compressor and plug line openings. Remove A/C compressor and mounting bracket. Go to step **7)** .
6. On driver's side, disconnect lines at power steering pump. Remove generator mounting bracket, if equipped. Disconnect high pressure line. Disconnect injection pressure sensor connector.

WARNING: The Injector Driver Module (IDM) supplies 115 volts DC into each fuel injector connected to engine wiring harness. DO NOT pierce any wires in engine wiring harness when servicing valve cover gasket and fuel injector.

7. On all applications, disconnect engine wiring harness wires from valve cover gasket connector. DO NOT pierce any wires in engine wiring harness. Remove valve cover. Disconnect engine wiring harness wires from fuel injectors and glow plugs. Remove valve cover gasket from cylinder head.
8. Remove fuel injectors from cylinder head. See **FUEL INJECTOR**. Remove glow plugs from cylinder head.
9. Remove rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**. Remove exhaust manifold. See **EXHAUST MANIFOLD**.
10. Disconnect necessary ground straps at cylinder head. Disconnect fuel return line from cylinder head. Remove 4 fuel injector shoulder bolts. Remove cylinder head bolts, cylinder head and cylinder head gasket.

CAUTION: DO NOT resurface cylinder head. If cylinder head warpage exceeds specification, replace cylinder head.

Inspection

1. Check cylinder head for cracks and warpage at cylinder head gasket surface. Replace cylinder head if warpage exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. DO NOT resurface cylinder head.
2. Measure cylinder head height from top of valve cover gasket surface on cylinder head to cylinder head

gasket surface. Replace cylinder head if cylinder head height is not within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

3. Check cylinder block deck surface for warpage at cylinder head gasket surface. Resurface cylinder block if warpage exceeds specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. DO NOT remove more than .010" (.25 mm) of material from cylinder block if resurfacing cylinder block.

CAUTION: Remove all fuel and oil from cylinders before installing cylinder head and fuel injectors. Failure to ensure cylinders are clean may result in engine damage caused by hydrostatic lock.

Installation

1. Ensure fuel and oil are removed from cylinders before installing cylinder head. To install, reverse removal procedure using NEW cylinder head gasket. Lightly coat threads of cylinder head bolts with engine oil before installing.

CAUTION: DO NOT apply excessive amount of engine oil onto threads of cylinder head bolts or threads and/or sealing surfaces may be damaged. DO NOT use any other lubricants on threads of cylinder head bolts except engine oil.

2. Install and tighten cylinder head bolts to specification in 3 steps. See **Fig. 12**. See **TORQUE SPECIFICATIONS**.
3. To install remaining components, reverse removal procedure. Install fuel injectors using proper procedure. See **FUEL INJECTOR**.
4. Ensure proper procedure is used when installing rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**.
5. Adjust all fluid levels. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. On A/C equipped models, evacuate and recharge A/C system if system was discharged.

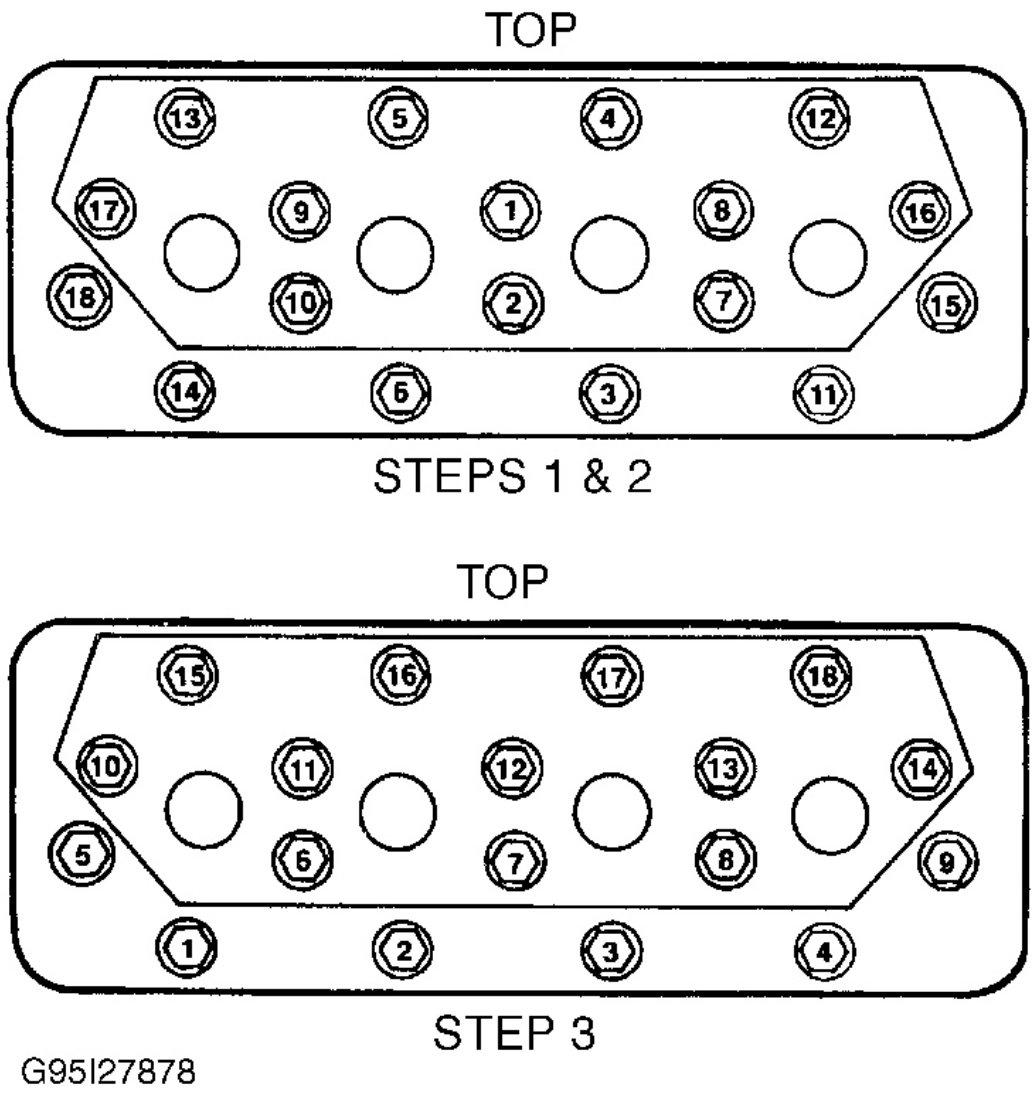


Fig. 12: Cylinder Head Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.

Removal (Van)

1. Disconnect negative battery cables. Remove interior engine cover. Remove air cleaner assembly. Remove headlight and park light assemblies.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly onto water pump.

2. Drain cooling system. Remove air deflector located above radiator. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud.
3. Remove fan shroud along with fan and fan clutch assembly. Disconnect transmission oil cooler lines and coolant hoses from radiator. Remove radiator.
4. On A/C equipped models, discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect A/C refrigerant lines from condenser and plug line openings. Remove condenser.
5. Remove grill, grill opening panel and upper radiator support. Loosen clamps and remove compressor manifold from turbocharger. See **Fig. 11**. Disconnect necessary coolant hoses, clamps and brackets for cylinder head removal. Remove accessory drive belt. Disconnect vacuum lines. Disconnect generator electrical connectors. Remove ground cable. Remove generator mounting bracket bolts and remove mounting bracket. Remove generator.

WARNING: The Injector Driver Module (IDM) supplies 115 volts DC into each fuel injector connected to engine wiring harness. DO NOT pierce any wires in engine wiring harness when servicing valve cover gasket and fuel injector.

6. Disconnect engine wiring harness wires from valve cover gasket connector. Use care not to pierce any wires in engine wiring harness. Remove valve cover. Disconnect engine wiring harness wires from fuel injectors and glow plugs. Remove valve cover gasket from cylinder head.
7. On passenger's side cylinder head applications, remove glow plug relay. On all cylinder head applications, disconnect fuel line assembly from rear of cylinder heads. This fuel line runs between fuel pump and cylinder heads. Use care not to bend fuel line.
8. Disconnect high-pressure oil pump supply line from cylinder head. Remove fuel injectors from cylinder head. See **FUEL INJECTOR**.
9. Remove rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**. It may be necessary to remove exhaust manifold for cylinder head removal. See **EXHAUST MANIFOLD**.
10. Disconnect fuel return line from cylinder heads. Remove 4 fuel injector shoulder bolts. See **Fig. 6**. Remove cylinder head bolts, cylinder head and cylinder head gasket.

CAUTION: DO NOT resurface cylinder head. If cylinder head or cylinder block surface warpage exceeds specification, replace component.

Inspection

1. Check cylinder head for warpage at cylinder head gasket surface. Replace cylinder head if warpage exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. DO NOT resurface cylinder head.
2. Measure cylinder head height from top of valve cover gasket surface on cylinder head to cylinder head gasket surface. Replace cylinder head if cylinder head height is not within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.
3. Check cylinder block deck surface for warpage at cylinder head gasket surface. Resurface cylinder block

if warpage exceeds specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. DO NOT remove more than .010" (.25 mm) of material from cylinder block if resurfacing cylinder block.

Installation

1. Ensure fuel and oil are removed from cylinders before installing cylinder head. To install, reverse removal procedure using NEW cylinder head gasket. Lightly coat threads of cylinder head bolts with engine oil before installing.

CAUTION: DO NOT apply excessive amount of engine oil onto threads of cylinder head bolts or threads and/or sealing surfaces may be damaged. DO NOT use any other lubricants on threads of cylinder head bolts except engine oil.

2. Install and tighten cylinder head bolts to specification in 3 steps. See **Fig. 12**. See **TORQUE SPECIFICATIONS**.
3. To install remaining components, reverse removal procedure. Install fuel injectors using proper procedure. See **FUEL INJECTOR**.
4. Ensure proper procedure is used when installing rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**.
5. Adjust all fluid levels. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. On A/C equipped models, evacuate and recharge A/C system.

CRANKSHAFT FRONT SEAL

Removal

1. Disconnect negative battery cables. Drain cooling system. Disconnect upper radiator hose and coolant recovery reservoir hose at radiator. Remove necessary components for access to radiator. Note direction of accessory drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly onto water pump.

2. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud.
3. Remove fan shroud along with fan and fan clutch assembly. Disconnect remaining coolant hoses from radiator. On A/T models, disconnect transmission oil cooler lines from radiator. On all models, remove radiator.
4. On A/T models, remove flywheel housing cover. On all models, remove vibration damper bolt and washer. Using puller, remove vibration damper. Wear ring on seal area on rear of vibration damper should be replace anytime vibration damper is removed.
5. Using Step Plate Adapter (D80L-630-A), Wear Ring Remover (T94T-6379-AH1), Bearing Collet Sleeve

(T77F-7025-C), Remover Tube (T77J-7025-B) and Forcing Screw (T84T-7025-B), remove wear ring from rear of vibration damper.

6. Using Seal Remover (T86P-70001) and slide hammer, pull crankshaft front seal from front cover. Use care not to scratch sealing surfaces on crankshaft and front cover.

CAUTION: DO NOT clean vibration damper in petroleum based solvent or rubber dampening element in vibration damper will be damaged.

Installation

1. Ensure all sealing surfaces are clean. Coat outside sealing surface of seal with multipurpose grease. Using Seal Installer (T94T-6700-AH), Thread Adapter (T94T-6379-AH3), Driver Sleeve (T79T-6316-A4) and Driver/Puller Screw (T79T-6316-A), install seal until seal is fully seated in front cover. Ensure seal installer aligns with key in crankshaft when installing seal.
2. Apply Loctite No. 271 into inside diameter of NEW wear ring. Using Driver Handle (T80T-4000-W) and Damper Wear Ring Installer (T94T-6379-AH2), install NEW wear ring onto vibration damper. Ensure wear ring is fully seated onto vibration damper.

CAUTION: RTV sealant should be applied onto crankshaft keyway before installing vibration damper.

3. Apply RTV sealant onto crankshaft keyway. Using Driver/Puller Screw (T79T-6316-A1), Driver Sleeve (T79T-6316-A4) and Thread Adapter (T94T-6379-AH3), install vibration damper. Install vibration damper bolt with washer and tighten to specification. See **TORQUE SPECIFICATIONS**
4. To install remaining components, reverse removal procedure. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. Add engine oil if necessary.

ROCKER ARM ASSEMBLY & PUSH ROD

WARNING: The Injector Driver Module (IDM) supplies 115 volts DC into each fuel injector connected to engine wiring harness. Ensure negative battery cables are disconnected before servicing rocker arm assembly and push rod.

Removal (F250 HD, F350 & F250-F550 Super Duty)

1. Disconnect negative battery cables. Remove charge air cooler inlet tube. Remove oil dipstick and dipstick tube. On driver side of engine, remove air cleaner-to-air inlet duct. Loosen clamp and remove crankcase breather hose. Remove 2 mounting bolts and remove air intake tube.

WARNING: The Injector Driver Module (IDM) supplies 115 volts DC into each fuel injector connected to engine wiring harness. Use care not to pierce any wires in engine wiring harness when servicing valve cover gasket and fuel injector.

2. On both sides of engine, disconnect fuel injector/glow plug jumper 9-pin electrical connector. On driver side, disconnect engine control sensor connector. On both sides of engine, remove 10 valve cover attaching bolts, and remove valve covers.
3. Disconnect engine wiring harness wires from fuel injectors and glow plugs. Use care not to pierce any wires in engine wiring harness. Remove valve cover gasket from cylinder head.
4. Remove rocker arm assembly bolts. See **Fig. 6**. Remove rocker arm assembly. Note direction of push rod installation, as Copper end of push rod should be facing upward, toward rocker arm. Remove push rod. Mark rocker arm assembly and push rod location for installation reference.
5. If disassembling rocker arm assembly, note location of components on rocker arm assembly. See **Fig. 13**.

NOTE: When disassembling rocker arm assembly, DO NOT lose steel ball.

6. Remove retaining clip from rocker arm assembly. Remove rocker arm and steel ball from rocker arm pedestal. DO NOT lose steel ball from rocker arm.

Installation

1. If assembling rocker arm assembly, place steel ball in cup area on rocker arm. Lubricate steel ball with engine oil. Install rocker arm pedestal onto steel ball and rocker arm. Install retaining clip. Ensure retaining clip is fully snapped into position.

CAUTION: Ensure push rods are installed with copper end facing upward, toward rocker. Position timing mark on vibration damper at 11 o'clock position before installing rocker arm assembly to prevent bent valves and engine damage when installing rocker arm assembly.

2. Lubricate ends of push rods with engine oil. Install push rods in original location. Ensure Copper end of push rod is facing upward. Rotate engine until timing mark on vibration damper is at 11 o'clock position. To prevent bent valves and engine damage when installing rocker arm assembly.
3. Install rocker arm assembly. Install and tighten rocker arm assembly bolts to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Tighten bolts to specification.

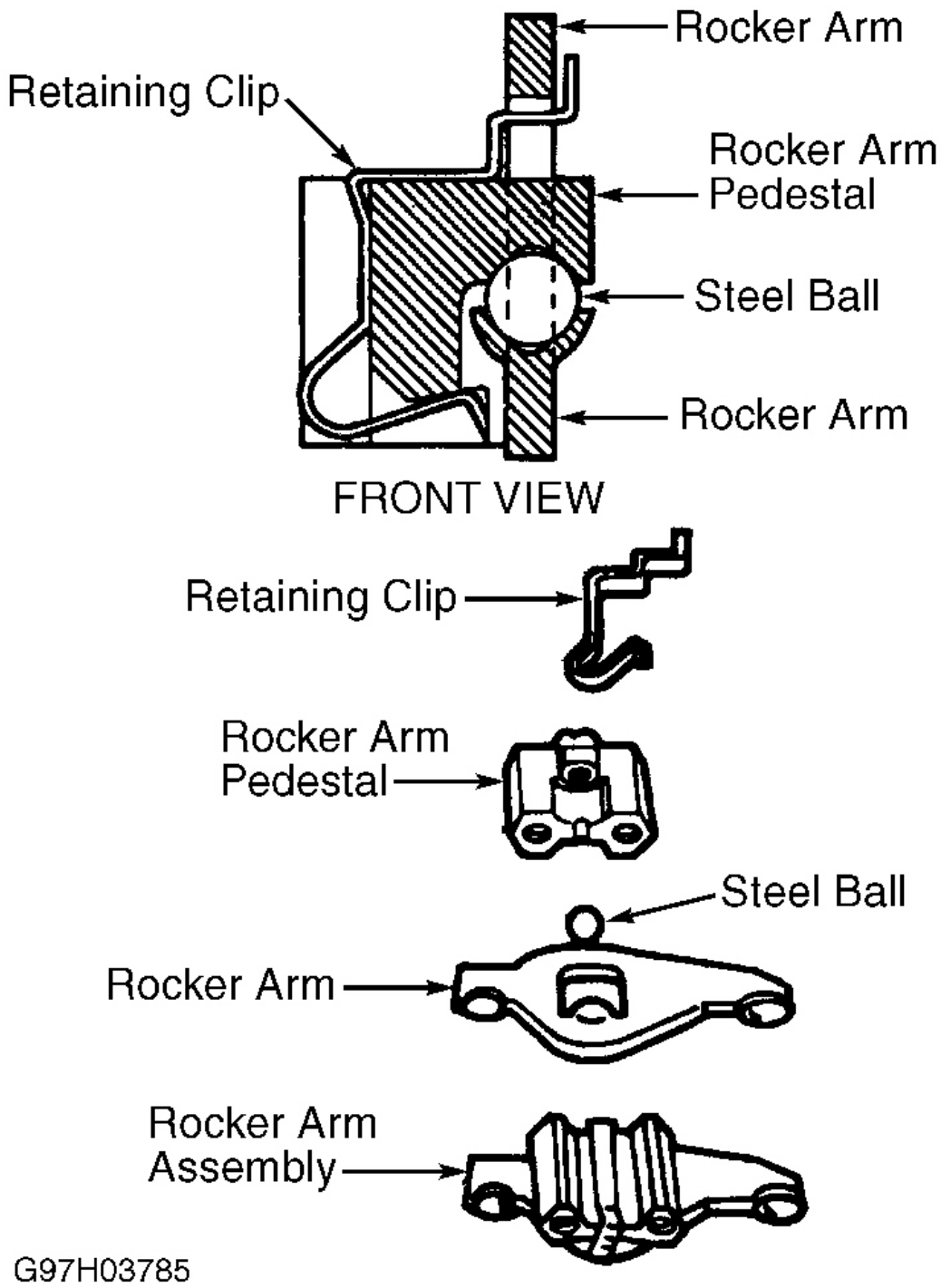


Fig. 13: Identifying Rocker Arm Assembly Components
Courtesy of FORD MOTOR CO.

Removal (Van)

1. Disconnect negative battery cables. Remove air cleaner assembly. Remove interior engine cover. When servicing rocker arm and push rod on passenger's side cylinder head, remove oil dipstick tube mounting bracket. Remove remaining components for access to valve cover. Go to step **3)** .
2. When servicing rocker arm and push rod on driver's side cylinder head, remove air intake tube and oil fill tube for access to valve cover.

WARNING: Injector Driver Module (IDM) supplies 115 volts DC into each fuel injector connected to engine wiring harness. DO NOT pierce any wires in engine wiring harness when servicing valve cover gasket and fuel injector.

3. On all applications, disconnect engine wiring harness wires from valve cover gasket connector. DO NOT pierce any wires in engine wiring harness.
4. Remove valve covers. Disconnect engine wiring harness wires from fuel injectors and glow plugs. Use care not to pierce any wires in engine wiring harness. Remove valve cover gasket from cylinder head.
5. Remove rocker arm assembly bolts. See **Fig. 6**. Remove rocker arm assembly. Note direction of push rod installation, as Copper end of push rod should be facing upward, toward rocker arm. Remove push rod. Mark rocker arm assembly and push rod location for installation reference.
6. If disassembling rocker arm assembly, note location of components on rocker arm assembly. See **Fig. 13**.

NOTE: When disassembling rocker arm assembly, DO NOT lose steel ball.

7. Remove retaining clip from rocker arm assembly. Remove rocker arm and steel ball from rocker arm pedestal. Use care not to lose steel ball from rocker arm.

Installation

1. If assembling rocker arm assembly, place steel ball in cup area on rocker arm. Lubricate steel ball with engine oil. Install rocker arm pedestal onto steel ball and rocker arm. Install retaining clip. Ensure retaining clip is fully snapped into position.

CAUTION: Install push rods with Copper end facing upward, toward rocker. Rotate engine with timing mark on vibration damper at 11 o'clock position before installing rocker arm assembly to prevent bent valves and engine damage when installing rocker arm assembly.

2. Lubricate ends of push rods with engine oil. Install push rods in original location. Ensure Copper end of push rod is facing upward. Rotate engine until timing mark on vibration damper is at 11 o'clock position. To prevent bent valves and engine damage when installing rocker arm assembly.
3. Install rocker arm assembly. Install and tighten rocker arm assembly bolts to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Tighten bolts to specification.

VALVE LIFTER

NOTE: Mark valve lifters reference and re-installation into original location.

Removal

1. Remove appropriate cylinder head. See **CYLINDER HEAD**.
2. Remove retaining bolt and camshaft follower guide. See **Fig. 14**.
3. Mark valve lifter location for installation reference. Remove valve lifter from cylinder block. If necessary to disassemble valve lifter, remove retainer and components from valve lifter body. See **Fig. 15**.

Inspection

1. Ensure roller rotates smoothly and without excessive play. Inspect all components for damage. Ensure plunger moves freely in plunger body. Replace valve lifter if plunger fails to move freely in plunger body or if any components are damaged. Replace valve lifter as an assembly.
2. Measure valve lifter outside diameter and valve lifter bore diameter in cylinder block. determine oil clearance. Replace valve lifter if oil clearance is not within specification. See **VALVE LIFTERS** table under ENGINE SPECIFICATIONS.

Installation

1. If assembling valve lifter, coat all components with engine oil and reassemble. To install, reverse removal procedure. Ensure valve lifter and valve lifter bore in cylinder block are coated with engine oil before installing. Install valve lifter into original location.
2. Install cylinder head using proper procedure. See **CYLINDER HEAD**.

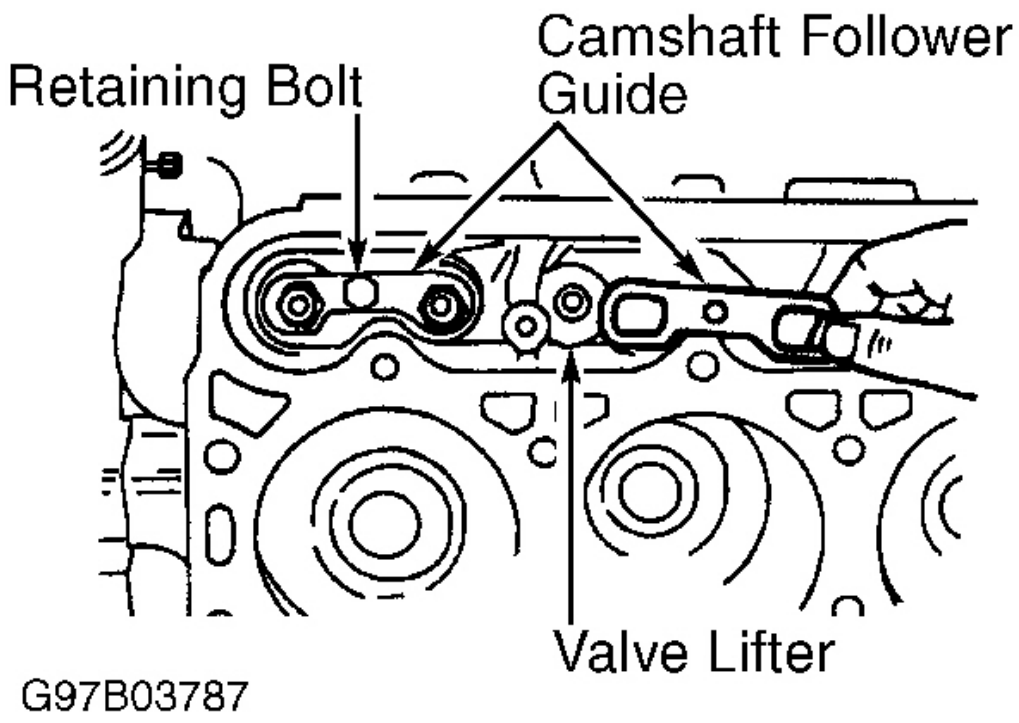


Fig. 14: Locating Camshaft Follower Guide
Courtesy of FORD MOTOR CO.

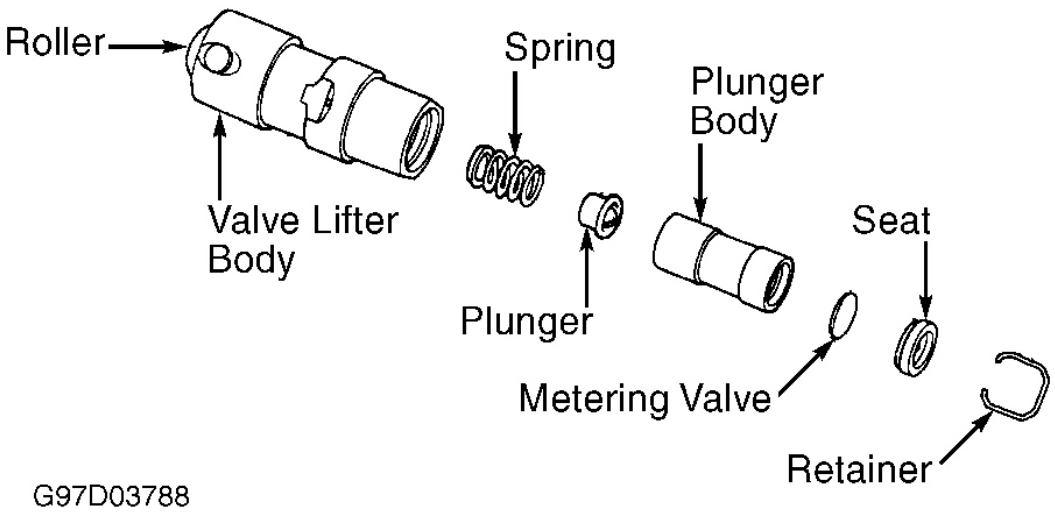


Fig. 15: Exploded View Of Valve Lifter
Courtesy of FORD MOTOR CO.

FRONT COVER

Removal

1. Manufacturer recommends removing engine for servicing front cover. Remove engine. See **ENGINE**. Remove water pump. Remove vibration damper bolt and washer. Using puller, remove vibration damper.

NOTE: If necessary to remove high-pressure oil pump or high-pressure oil pump reservoir, see HIGH-PRESSURE OIL PUMP and HIGH-PRESSURE OIL PUMP DRIVE GEAR .

2. Remove oil pan and oil pump pick-up tube. Remove front cover retaining bolts. See **Fig. 16**. Remove front cover and gaskets.

Installation

1. Ensure sealing surfaces on cylinder block and front cover are clean. Install NEW gaskets onto front cover and apply silicone sealant into sealing grooves on front cover. See **Fig. 17**.
2. Install front cover onto cylinder block with retaining bolts finger tight. Using NEW gasket, install water pump. Tighten water pump bolts to specification. See **TORQUE SPECIFICATIONS**.
3. Tighten front cover retaining bolts to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Ensure proper procedure is used when installing vibration damper. See **CRANKSHAFT FRONT SEAL**.

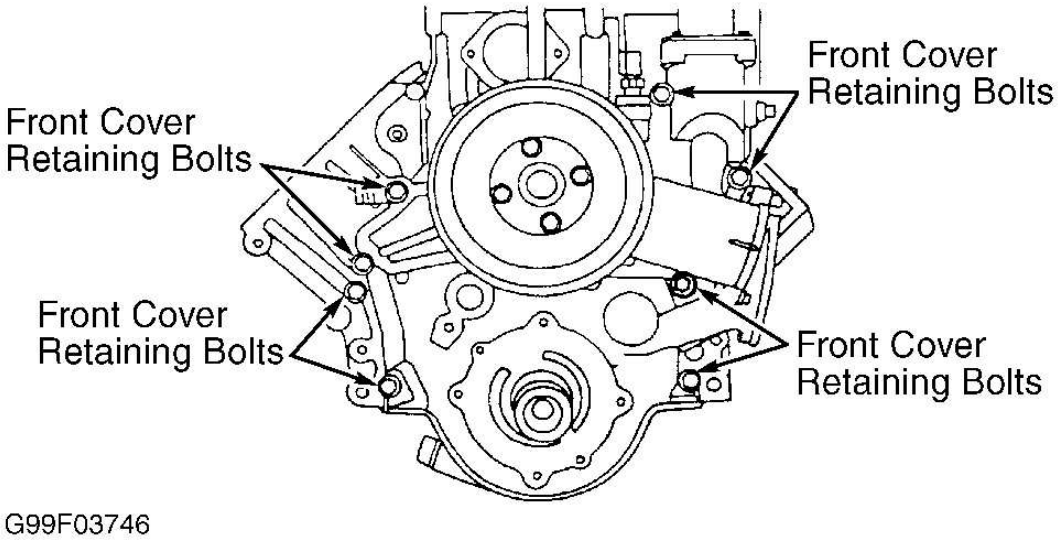


Fig. 16: Locating Front Cover Retaining Bolts
Courtesy of FORD MOTOR CO.

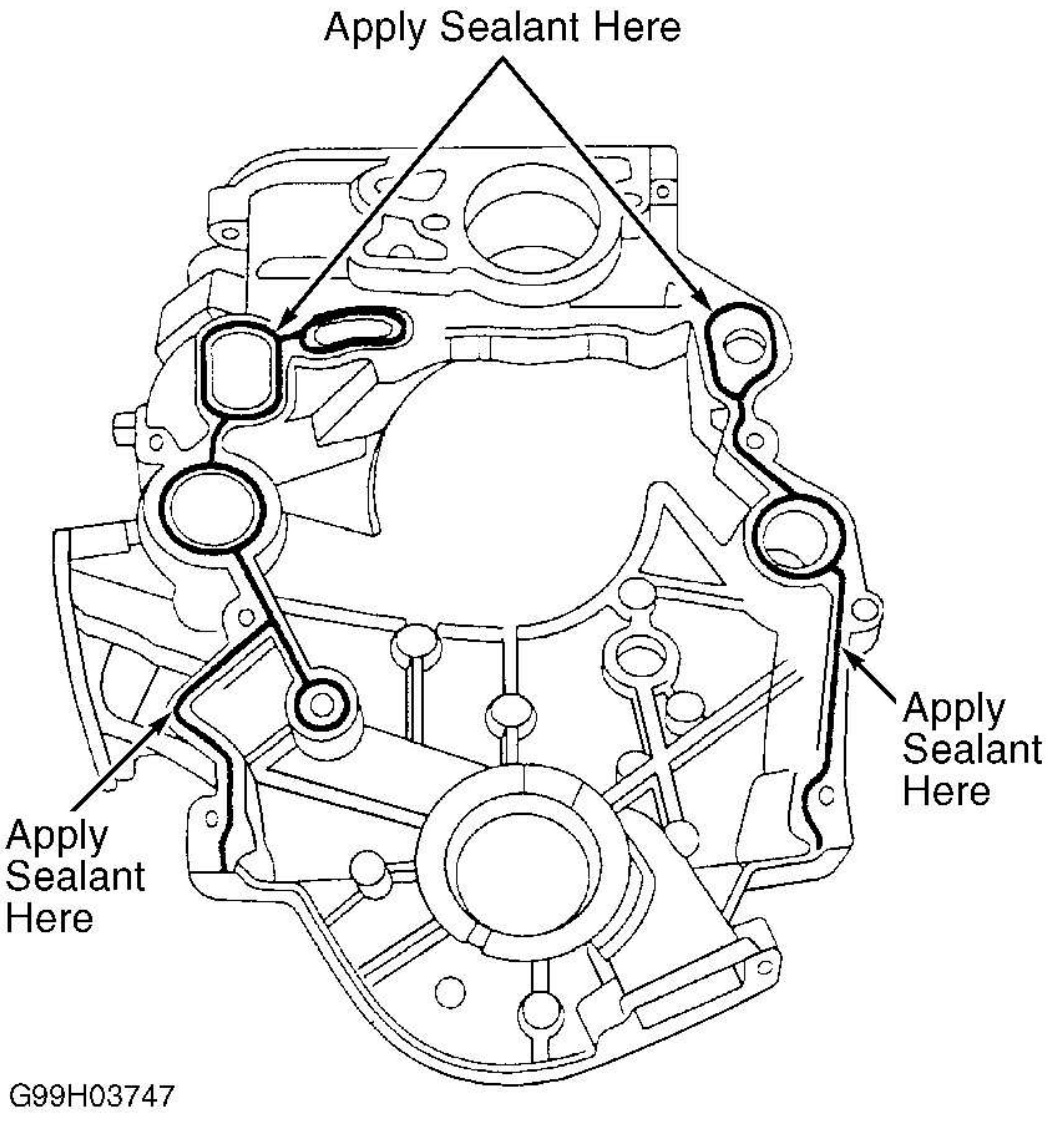


Fig. 17: Applying Sealant On Front Cover
Courtesy of FORD MOTOR CO.

CAMSHAFT

Removal

1. Remove front cover. See **FRONT COVER**. Using dial indicator check gear backlash on camshaft gear. Replace camshaft gear if gear backlash exceeds specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.
2. Remove rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**.

Remove valve lifters. See **VALVE LIFTER**.

3. Using dial indicator, check camshaft end play. Replace camshaft thrust plate if camshaft end play exceeds specification. **See CAMSHAFT** table under ENGINE SPECIFICATIONS.
4. Rotate crankshaft so camshaft timing mark and crankshaft timing mark are aligned. See **Fig. 18**. Remove camshaft thrust plate bolts. See **Fig. 18**. Remove camshaft, camshaft gear and camshaft thrust plate as an assembly.
5. If necessary to remove camshaft gear or camshaft thrust plate from camshaft, use press and support blocks to press camshaft from camshaft gear. Remove camshaft thrust plate from camshaft.

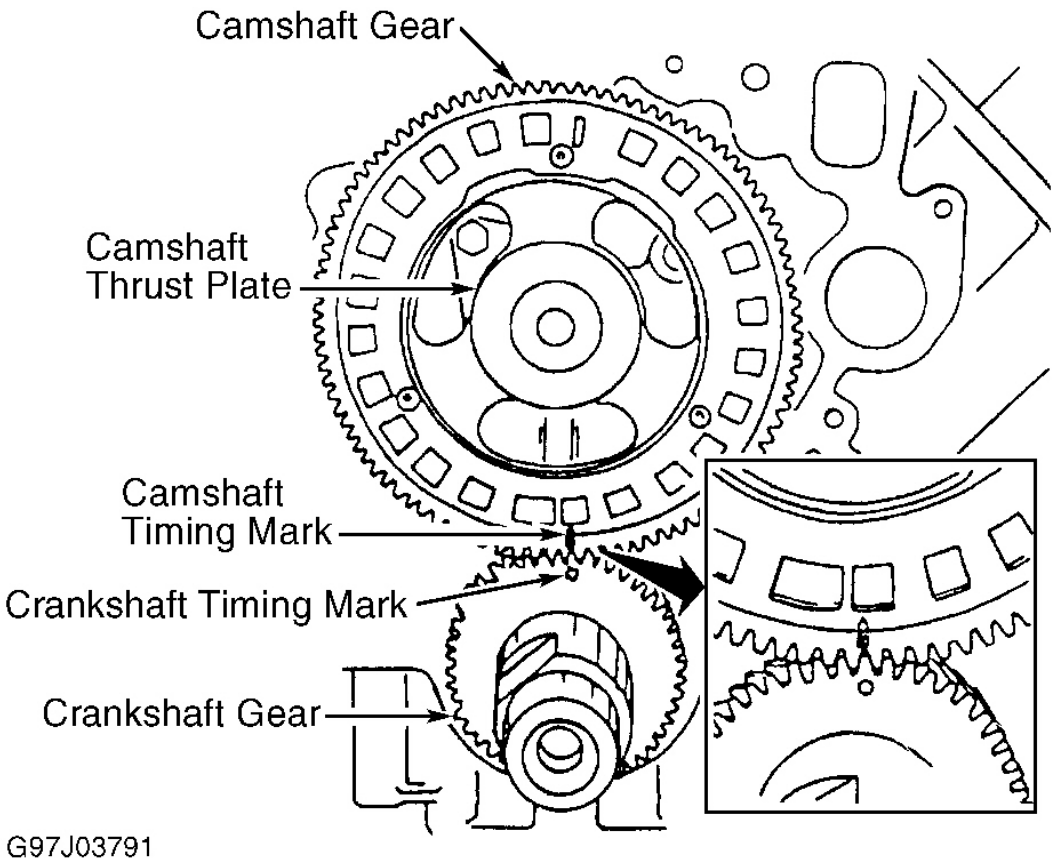


Fig. 18: Aligning Timing Marks & Locating Camshaft Thrust Plate
Courtesy of FORD MOTOR CO.

Inspection

1. Inspect camshaft for wear. Ensure camshaft journal diameter is within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.
2. Inspect camshaft bearings for damage. Measure camshaft bearing inside diameter. Replace camshaft bearing if inside diameter is not within specification. See **CAMSHAFT** table under ENGINE

SPECIFICATIONS. If necessary to replace camshaft bearings, see **CAMSHAFT BEARINGS**.

3. Using micrometer, measure thickness of camshaft thrust plate if removed from camshaft. Replace camshaft thrust plate if thickness is not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Installation

1. If installing camshaft thrust plate and camshaft gear onto camshaft, install camshaft thrust plate onto camshaft. Ensure key is installed in camshaft and camshaft gear keyway and key are free of burrs.

CAUTION: DO NOT heat camshaft gear at more than 500°F (260°C) or camshaft gear will be distorted.

2. Heat camshaft gear to 500°F (260°C). DO NOT exceed specified temperature of camshaft gear will be distorted. Press heated camshaft gear onto camshaft with timing mark facing away from camshaft. Ensure camshaft gear is seated against shoulder on camshaft.
3. To install, lubricate camshaft journals with engine oil and camshaft lobes with multipurpose grease. Install camshaft so camshaft timing mark and crankshaft timing mark are aligned. See **Fig. 18**. Install and tighten camshaft thrust plate bolts to specification. See **TORQUE SPECIFICATIONS**.
4. To install remaining components, reverse removal procedure. Ensure proper procedure is used when installing front cover, rocker arm assemblies and push rods.

CAMSHAFT BEARINGS

NOTE: Manufacturer recommends removing crankshaft when servicing camshaft bearings. All camshaft bearings are interchangeable except front camshaft bearing which is wider than others.

Removal

1. Remove camshaft from cylinder block. See **CAMSHAFT**. Remove flywheel. See **FLYWHEEL**.
2. Remove crankshaft with pistons and connecting rods remaining in cylinder block. See **CRANKSHAFT & MAIN BEARINGS** under CYLINDER BLOCK ASSEMBLY under OVERHAUL.

CAUTION: Place protective tubing onto connecting rod bolts to prevent damaging crankshaft during crankshaft removal and installation. Push pistons upward toward top of cylinder bore when servicing camshaft bearings. DO NOT allow piston to contact piston cooling oil jets when pushing piston into top of cylinder bore.

3. Push piston upward toward top of cylinder bore. Use care not to damage piston cooling oil jets when pushing piston upward in cylinder bore. Using Camshaft Bearing Remover/Installer (T65L-6250-A), remove camshaft bearings from cylinder block.

Installation

1. To install, reverse removal procedure. Ensure oil hole in camshaft bearing aligns with oil hole in cylinder block.

CAUTION: Install front camshaft bearing to specified installed depth to prevent damage to engine components.

2. Install front camshaft bearing in cylinder block so front camshaft bearing installed depth is .020-.050" (.51-1.27 mm). Front camshaft bearing installed depth is measured from face of cylinder block to front edge of front camshaft bearing. Install NEW cylinder block camshaft core plug. To install remaining components, reverse removal procedure.

CRANKSHAFT GEAR

Removal & Installation

Crankshaft and crankshaft gear are serviced as an assembly. DO NOT attempt to remove crankshaft gear from crankshaft, as crankshaft gear and crankshaft will be damaged.

FLYWHEEL

Removal

1. On A/T models, a standard type flywheel is used. On M/T models a dual mass flywheel is used. Dual mass flywheel is consists of 2 flywheels. See **Fig. 19**. On all models, remove transmission. For A/T, see TRANSMISSION REMOVAL & INSTALLATION article in TRANSMISSION SERVICING. For M/T, see appropriate article in CLUTCHES.
2. On A/T models, remove flywheel-to-crankshaft bolts and flywheel. On M/T models, remove clutch assembly from flywheel. Remove 2 flywheel-to-crankshaft bolts and install guide studs. Remove remaining flywheel-to-crankshaft bolts. Remove reinforcing plate, secondary flywheel and primary flywheel. Remove secondary flywheel bolts and separate primary flywheel from secondary flywheel.

Inspection

1. On A/T models, inspect flywheel and starter ring for damage. Replace flywheel if damaged.
2. On M/T models, inspect secondary flywheel for grooves or damaged areas in clutch disc area. Resurface secondary flywheel as necessary. Replace secondary flywheel if secondary flywheel thickness is less than 1.41" (35.8 mm) after machining, or more than .060" (1.52 mm) is machined from original thickness on secondary flywheel.

CAUTION: DO NOT use secondary flywheel if secondary flywheel thickness is less than 1.41" (35.8 mm) after machining, as this may cause damage to primary flywheel.

Installation

1. To install, reverse removal procedure. On M/T models, install primary flywheel onto secondary flywheel. Install and tighten secondary flywheel bolts to specification. See **TORQUE SPECIFICATIONS**. Apply Threadlock® sealant onto threads on flywheel-to-crankshaft bolts before installing.
2. On all models, install and tighten flywheel-to-crankshaft bolts to specification. See **TORQUE SPECIFICATIONS**.

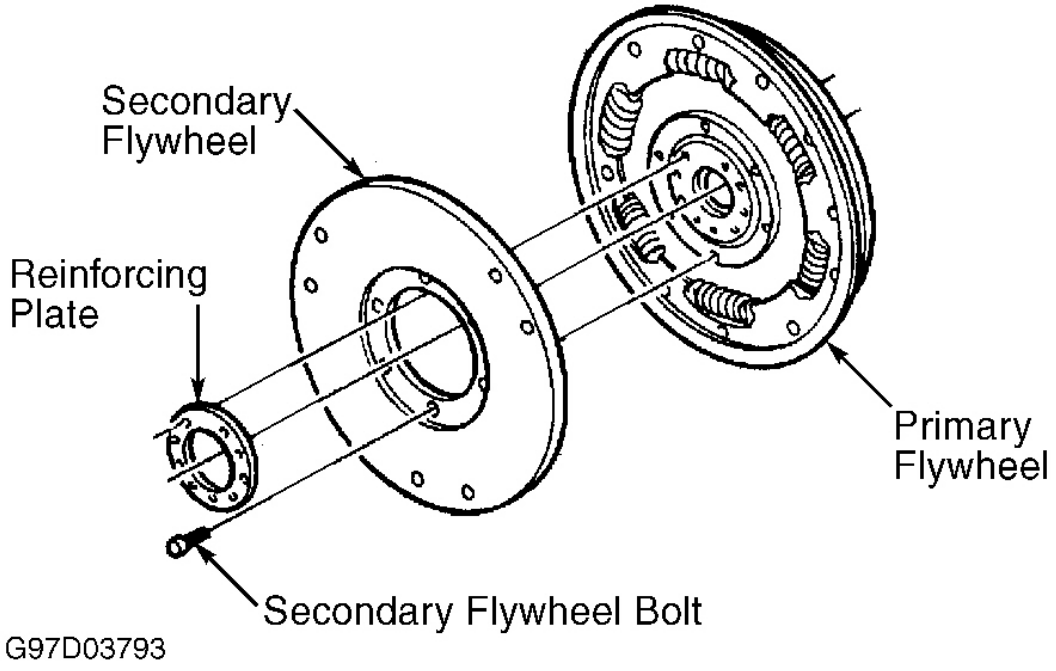


Fig. 19: Identifying Dual Mass Flywheel Components (F250 HD, F350 & & F250-F550 Super Duty M/T Models)
Courtesy of FORD MOTOR CO.

CRANKSHAFT REAR OIL SEAL

Removal

1. Remove transmission. See appropriate article in CLUTCHES. On M/T models, remove flywheel. See **FLYWHEEL**. On A/T models, remove bolts, spacer and flexplate. On all models, remove flywheel adapter housing retaining rings. Remove flywheel front adapter, using care not to damage alignment dowel pins.
2. Remove crankshaft rear oil seal retaining bolts from rear of cylinder block. Remove crankshaft rear oil seal. Remove engine rear cover retaining bolts and rear cover. Clean cover sealing surfaces. Clean crankshaft rear oil seal surfaces. If equipped with crankshaft wear sleeve, remove crankshaft wear sleeve using Crankshaft Service Set (T94T-6701-AH) and Handle (T80T-4000-W).

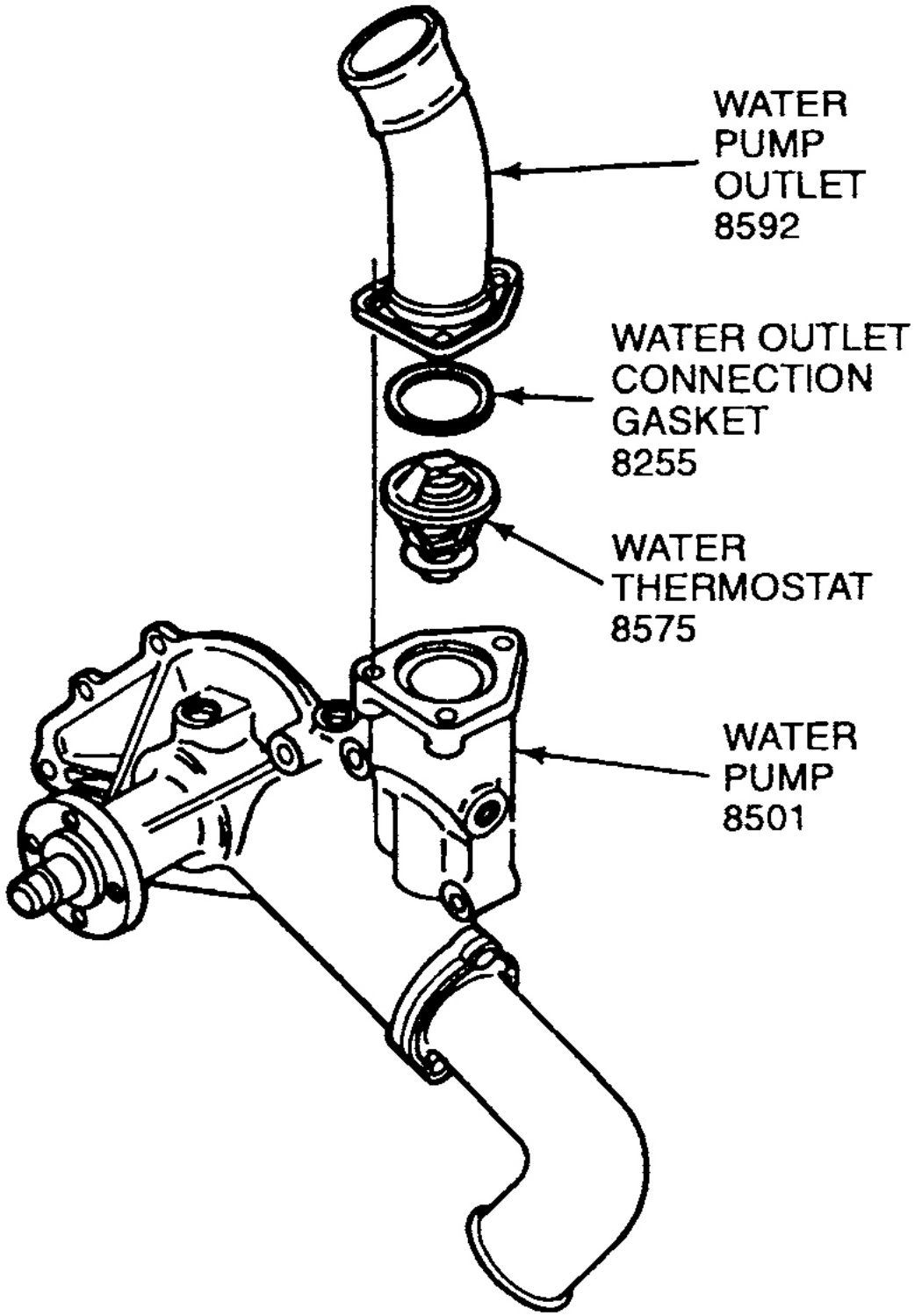
Installation

1. Ensure sealing surfaces are clean and all silicone sealant is removed. Apply silicone sealant onto engine rear cover sealing surface. Install rear engine cover. Apply silicone sealant onto crankshaft rear oil seal retaining ring and threads of crankshaft rear oil seal retaining bolts.
2. Using Crankshaft Seal Replacer (T94T-6701-AH3), Crankshaft Seal Replacer (T94T-6701-AH4), Handle (T80T-4000-W) and guide pins, install crankshaft wear ring (if equipped) and crankshaft rear oil seal.
3. Install and tighten crankshaft rear oil seal retaining bolts. To install remaining components, reverse removal procedure.

THERMOSTAT

Removal

Partially drain the cooling system. Disconnect the drive belt at the drive belt tensioner pulley. Remove the upper radiator hose clamp at the water pump outlet and disconnect the upper radiator hose from the water pump outlet. Remove retaining screws and the water pump outlet. Remove the water hose connection gasket and water thermostat. See **Fig. 20**.


WATER
PUMP
OUTLET
8592
WATER OUTLET
CONNECTION
GASKET
8255
WATER
THERMOSTAT
8575
WATER
PUMP
8501

G00264190

Fig. 20: Locating Thermostat
Courtesy of FORD MOTOR CO.

Installation

Install the water thermostat and the water hose connection gasket in the water pump outlet. Install the water pump outlet and install water pump outlet retaining bolts. Tighten screws to 15 ft. lbs. (20 N.m). Connect the upper radiator hose to the water pump outlet and install hose clamp. Install the drive belt at the drive belt tensioner pulley. Refill and bleed the engine cooling system.

WATER PUMP

Removal

1. Disconnect negative battery cables. Partially drain cooling system. Remove upper radiator hose. Disconnect coolant recovery hose from radiator.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly onto water pump.

2. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud. Remove bolts, fan shroud along with fan and fan clutch assembly.
3. Loosen water pump pulley bolts. Note direction of accessory drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt.
4. Remove bolts and water pump pulley. Disconnect necessary electrical connectors and coolant hoses for removal of water pump. Note water pump bolt location for installation reference. Remove bolts, water pump and gasket.

Installation

To install, reverse removal procedure using NEW gasket. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**.

OIL PAN

Removal

1. Manufacturer recommends removing engine for servicing oil pan. Remove engine. See **ENGINE**. Remove oil pan bolts. It may be necessary to cut silicone sealant on each side of oil pan. Pry upward on one side of oil pan to break seal on silicone sealant. Remove oil pan.
2. If necessary to remove oil pump pick-up tube, remove oil pump pick-up tube-to-front cover bolts. Remove oil pump pick-up tube support bracket nut at top of main bearing cap. Remove oil pump pick-up tube and gasket.

Installation

1. Using NEW gasket, install oil pump pick-up tube if removed. Install and tighten oil pump pick-up tube-to-front cover bolts and oil pump pick-up tube support bracket nut at top of main bearing cap to specification. See **TORQUE SPECIFICATIONS**.
2. Apply a 1/8" (3.2 mm) bead of RTV sealant onto sealing surfaces on sides of oil pan with sealant located on inside of bolt holes. Apply a 1/4" (6.35 mm) bead of RTV sealant onto oil pan sealing surfaces at front and rear of oil pan.
3. Install oil pan using guide studs. Ensure all oil pan bolts are installed before tightening. To install remaining components, reverse removal procedure.

OIL COOLER ASSEMBLY

For servicing of oil cooler assembly, see **OIL COOLER ASSEMBLY** under ENGINE OILING.

OVERHAUL

CYLINDER HEAD

Cylinder Head

1. Check cylinder head for cracks and warpage at cylinder head gasket surface. Replace cylinder head if warpage exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. DO NOT resurface cylinder head.
2. Measure cylinder head height from top of valve cover gasket surface on cylinder head to cylinder head gasket surface. Replace cylinder head if cylinder head height is not within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.
3. If removing intake manifold covers from cylinder head, remove bolts and intake manifold cover. Intake manifold cover is located on side of cylinder head. Use care not to bend intake manifold cover, as RTV sealant retains cover on cylinder head. To install, apply RTV sealant onto sealing surfaces of intake manifold cover. Install intake manifold cover. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**.
4. Remove injector control pressure sensor and "O" ring from cylinder head if necessary. Injector control pressure sensor is located on driver's side cylinder head. Before installing injector control pressure sensor, apply Threadlock® sealant onto threads of injector control pressure sensor. Install injector control pressure sensor using NEW "O" ring. Tighten injector control pressure sensor to specification. See **TORQUE SPECIFICATIONS**.
5. If necessary to replace fuel injector sleeve in cylinder head, see **FUEL INJECTOR** under REMOVAL & INSTALLATION.

Valve Springs

1. Check valve spring free length, out-of-square and pressure. Replace valve spring if not within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.
2. Measure valve spring installed height from bottom of spring seat in cylinder head to bottom of surface of spring retainer. Ensure valve spring installed height is within specification.

Valve Stem Oil Seals

Valve stem seals are used on intake and exhaust valves. No special installation procedure is required for valve stem oil seals.

Valve Guides

Check valve stem-to-guide oil clearance. Ensure valve stem diameter is within specification. Replace cylinder head if oil clearance exceeds specification, as valve guides are not serviceable. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

Valve Seat

Check valve seat width and runout. Grind valve seat if not within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Ensure valve spring installed height is correct after grinding valve seats.

Valves

1. Ensure valve stem diameter and valve margin are within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS. Resurface tip of valve stem if necessary. DO NOT grind more than .010" (.25 mm) from tip of valve stem.

CAUTION: DO NOT grind more than .010" (.25 mm) from tip of valve stem when resurfacing tip of valve stem.

2. Once valves are re-ground, install valve in cylinder head. Using dial indicator, measure valve head recession by measuring distance from deck surface on cylinder head to valve head. Valve head recession should be within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.

VALVE TRAIN

Rocker Arm Assembly

For disassembly and reassembly of rocker arm assembly, see **ROCKER ARM ASSEMBLY & PUSH ROD** under REMOVAL & INSTALLATION.

Valve Lifters

1. Ensure roller rotates smoothly and without excessive play. Measure valve lifter outside diameter and valve lifter bore diameter in cylinder block. Determine oil clearance. Replace valve lifter if oil clearance is not within specification. See **VALVE LIFTERS** table under ENGINE SPECIFICATIONS.
2. If necessary to disassemble valve lifter, remove retainer and components from valve lifter body. See **Fig. 15**. Inspect all components for damage. Ensure plunger moves freely in plunger body. Replace valve lifter if plunger fails to move freely in plunger body or if any components are damaged. Replace valve lifter as an assembly.

CYLINDER BLOCK ASSEMBLY

Piston & Rod Assembly

1. Ensure connecting rod and connecting rod cap are marked with corresponding cylinder number before removing. If removing piston from connecting rod, remove snap rings from piston. Tap piston pin from piston.
2. Ensure crankpin bore diameter, out-of-round and taper are within specification. See **CONNECTING ROD** table under ENGINE SPECIFICATIONS. Replace connecting rod if not within specification. Check connecting rod center-to-center length, bend and twist. Replace connecting rod if not within specification. See **CONNECTING ROD** table under ENGINE SPECIFICATIONS.
3. Measure piston pin bushing bore diameter on connecting rod. Bushing may be replaced if diameter exceeds specification. See **CONNECTING ROD** table under ENGINE SPECIFICATIONS. If bushing is to be replaced, press bushing from connecting rod. Install NEW bushing and ream to obtain correct inside diameter. See **CONNECTING ROD** table under ENGINE SPECIFICATIONS.
4. For measuring piston diameter, see **FITTING PISTONS** under CYLINDER BLOCK ASSEMBLY under OVERHAUL.

Fitting Pistons

1. Measure piston diameter 1.68" (42.7 mm) below lower land of oil ring at 90-degree angle to piston pin. Replace piston if piston diameter is not within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.
2. Measure cylinder bore diameter at top, middle and bottom of cylinder bore parallel with crankshaft and at a 90 degree angle to crankshaft. Ensure cylinder bore diameter, out-of-round and taper are within specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS.
3. Ensure piston clearance is within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS. If piston clearance is not within specification, hone or bore cylinders on cylinder block for oversize pistons. Pistons are available in .010" (.25 mm), .020" (.51 mm) and .030" (.76 mm) oversize.

Piston Rings

1. Ring end gap should be measured with piston ring positioned in cylinder bore at area where no piston ring wear exists. Ensure ring end gap is within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.
2. To check side clearance on No. 1 and 2 (upper) compression rings, use feeler gauge to measure clearance between piston ring and piston. Ensure side clearance is within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.

NOTE: **No. 1 (upper) compression ring contains one identification mark and No. 2 (lower) compression rings contains 2 identification marks. Ensure compression rings are installed in correct location with identification mark toward top of piston.**

3. Install piston rings onto piston with identification mark on piston ring toward top of piston. Ensure piston ring end gaps are properly positioned. See **Fig. 21**.

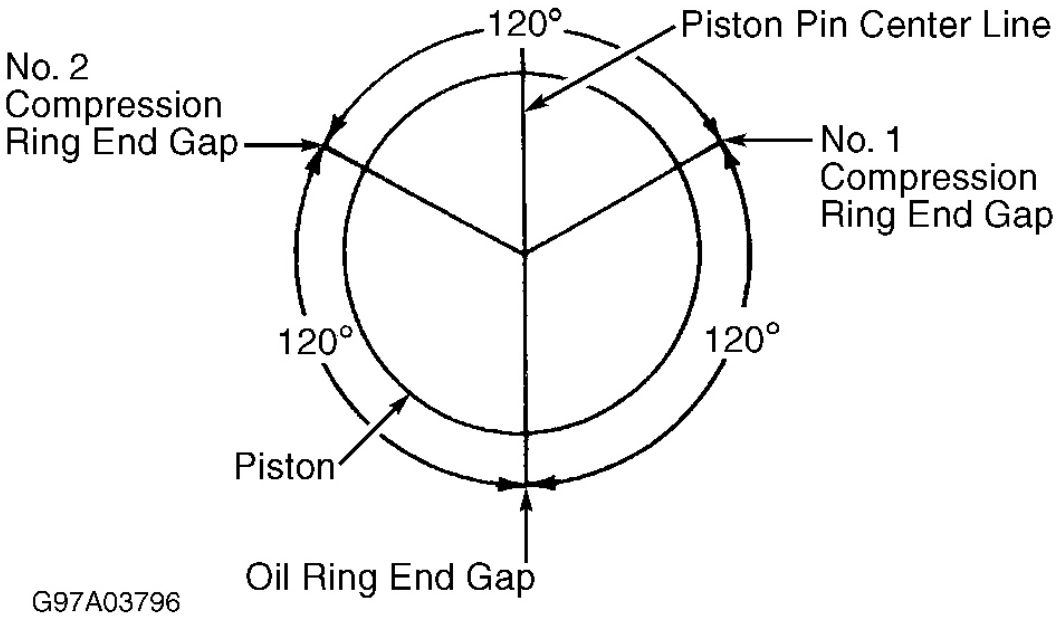


Fig. 21: Positioning Piston Rings
Courtesy of FORD MOTOR CO.

CAUTION: If rod bearing failure exists, replace oil cooler and check turbocharger. For replacement of oil cooler, see OIL COOLER ASSEMBLY under REMOVAL & INSTALLATION.

Rod Bearings

1. Ensure connecting rod and connecting rod cap are marked with corresponding cylinder number before removing.
2. Use Plastigage to check rod bearing clearance. Apply light coat of engine oil onto connecting rod bolt threads before tightening nut to specification. See **TORQUE SPECIFICATIONS**.
3. Ensure oil clearance and side play are within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** and CONNECTING RODS tables under ENGINE SPECIFICATIONS.

CAUTION: If main bearing failure exists, replace oil cooler and check turbocharger. For replacement of oil cooler, see OIL COOLER ASSEMBLY under REMOVAL & INSTALLATION.

Crankshaft & Main Bearings

1. Ensure main bearing caps are marked or location and direction of installation before removing from cylinder block. Ensure connecting rod journals, crankshaft main bearing journal diameter, taper and out-of-round are within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.
2. Apply light coat of engine oil onto main bearing cap bolt threads before tightening bolt to specification. See **TORQUE SPECIFICATIONS**. Ensure oil clearance and end play are within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Thrust Bearing

Thrust bearing is located on No. 5 (rear) main bearing. Replace thrust bearing if crankshaft end play is not within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Cylinder Block

1. Check cylinder block deck surface for warpage at cylinder head gasket surface. Resurface cylinder block if warpage exceeds specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. DO NOT remove more than .010" (.25 mm) of material from cylinder block if resurfacing cylinder block.
2. Measure cylinder bore diameter at top, middle and bottom of cylinder bore parallel with crankshaft and at a 90 degree angle to crankshaft. Ensure cylinder bore diameter, out-of-round and taper are within specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS.
3. If cylinder bore diameter, out-of-round or taper exceeds specification, hone or bore cylinders on cylinder block for oversize pistons. Pistons are available in .010" (.25 mm), .020" (.51 mm) and .030" (.76 mm) oversize.

CAUTION: Ensure piston cooling oil jets are removed before honing or boring cylinder bores to prevent damage to cooling jet.

TURBOCHARGER

Preliminary Inspection

1. Disconnect air intake tube and exhaust pipe from turbocharger. Rotate turbine wheel, shaft assembly and compressor wheel inside turbocharger. Shaft assembly should rotate smoothly. Perform STEP 1. See **Fig. 22**.
2. Push compressor wheel and shaft assembly as far in one direction as possible while rotating shaft assembly. Ensure compressor wheel does not contact compressor housing while rotating shaft assembly. Push turbine wheel and shaft assembly as far in one direction as possible while rotating shaft assembly. Ensure turbine wheel does not contact turbine housing while rotating shaft assembly.
3. If compressor wheel or turbine wheel does not contact housing while rotating shaft assembly, bearings in turbocharger are okay. Go to next step. If compressor wheel or turbine wheel contacts housing while

rotating shaft assembly, bearings in turbocharger are defective. Replace turbocharger.

4. Install dial indicator so stem on dial indicator contacts end of shaft assembly at compressor wheel. Perform STEP 2. See **Fig. 22**. Push shaft assembly as far in one direction as possible and zero dial indicator. Push shaft assembly as far in opposite direction and note shaft end play. Replace turbocharger if shaft end play is not .0008-.0040" (.020-.10 mm).

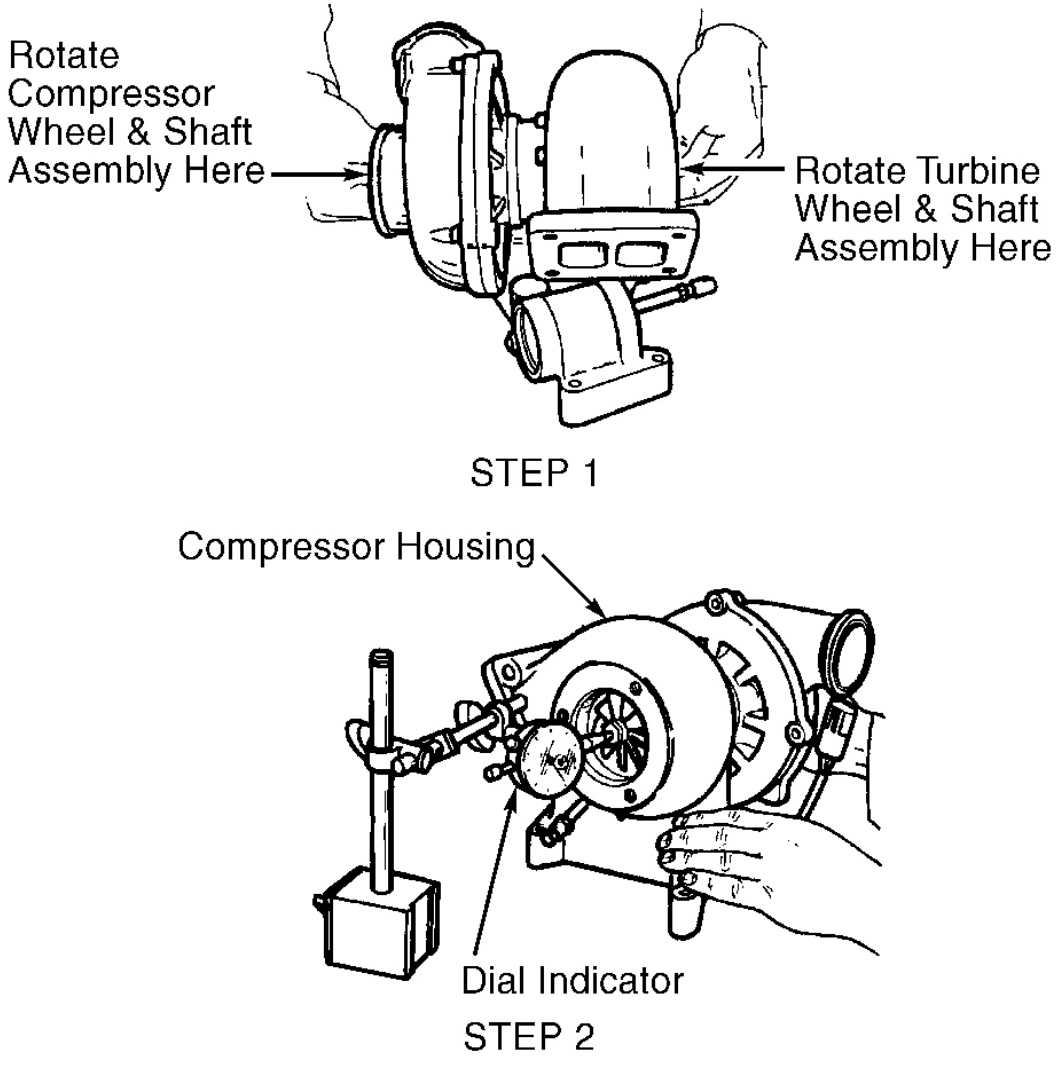


Fig. 22: Checking Turbocharger
Courtesy of FORD MOTOR CO.

ENGINE OILING

ENGINE LUBRICATION SYSTEM

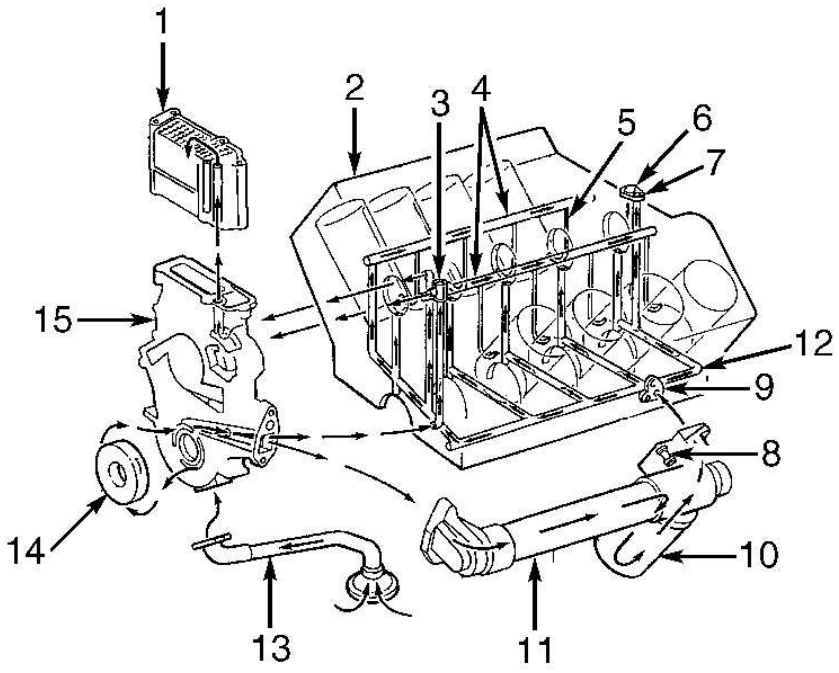
NOTE: Engine contains a high-pressure oiling system and a low-pressure oiling system.

High-Pressure Oiling System

High-pressure oiling system supplies oil pressure for fuel injector operation. See **Fig. 10**. During initial start or cold start, gear-driven high-pressure oil pump receives unfiltered engine oil from driver's side valve lifter oil galley through anti-drain check ball. Once engine starts, or during warm engine starts, anti-drain check ball closes and high-pressure oil pump receives filtered engine oil from high-pressure oil pump reservoir. High-pressure oil pump delivers engine oil through oil rail in cylinder head at pressures of 600-3000 psi (42.19-210.93 kg/cm^2) to fuel injectors.

Low-Pressure Oil System

Crankshaft-driven low-pressure oil pump supplies pressurized lubrication for engine oiling system. See **Fig. 23**. Oil cooler is used cooling of engine oil.



1. High-Pressure Oil Pump Reservoir
2. Cylinder Block
3. Anti-Drain Check Ball
4. Valve Lifter Oil Galley
5. Piston Cooling Oil Jet
6. Turbocharger Oil Return Galley
7. Turbocharger Oil Supply Galley
8. Pressure Relief/Regulator Valve
9. Oil Filter By-Pass Drain
10. Oil Filter
11. Oil Cooler Assembly
12. Main Oil Galley
13. Oil Pump Pick-Up Tube
14. Low-Pressure Oil Pump
15. Front Cover

G97A03800

Fig. 23: Engine Low-Pressure Engine Oiling System
Courtesy of FORD MOTOR CO.

Crankcase Capacity

Crankcase capacity is 14 qts. (13.2L) with oil filter.

Oil Pressure

Oil pressure should be 40-70 psi (2.8-4.9 kg/cm^2) at 3300 RPM with engine at normal operating temperature.

HIGH-PRESSURE OIL PUMP

For servicing of high-pressure oil pump, see **HIGH-PRESSURE OIL PUMP** under REMOVAL & INSTALLATION.

LOW-PRESSURE OIL PUMP

Removal & Disassembly

1. Low-pressure oil pump is located on front cover. See **Fig. 23**. Remove vibration damper. See **CRANKSHAFT FRONT SEAL** under REMOVAL & INSTALLATION.
2. Remove bolts, low-pressure oil pump body, outer gerotor and inner gerotor. See **Fig. 24**.

Inspection

1. Inspect components for damage and wear. Install inner and outer rotors in low-pressure oil pump body. Place straightedge across low-pressure oil pump body so it is above both rotors. Using feeler gauge, measure rotor end clearance between rotor and straightedge. Rotor end clearance should be .0010-.0030" (.025-.076 mm).
2. With both rotors installed in low-pressure oil pump body, use feeler gauge to measure clearance between outer edge of outer gerotor and oil pump body. Outer gerotor-to-oil pump body clearance should be .028-.032" (.71-.81 mm). Replace low-pressure oil pump if any measurement is not within specification.

Reassembly & Installation

1. To reassemble, reverse disassembly procedure. Ensure components are installed in original location.
2. To install, reverse removal procedure using "O" ring. Ensure outer gerotor is lubricated with engine oil before installing low-pressure oil pump body. Install and tighten low-pressure oil pump body-to-front cover bolts.
3. Manufacturer recommends installing NEW crankshaft front seal any time vibration damper is removed. For proper installation procedure of crankshaft front seal, see **CRANKSHAFT FRONT SEAL** under REMOVAL & INSTALLATION.

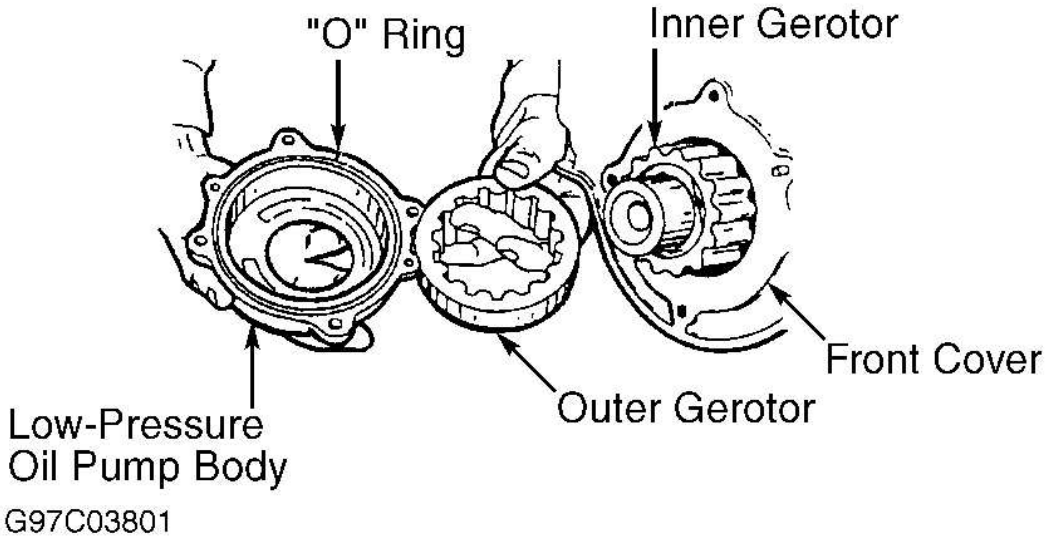


Fig. 24: Locating Low-Pressure Oil Pump Components
Courtesy of FORD MOTOR CO.

OIL COOLER ASSEMBLY

CAUTION: If main bearing or rod bearing failure exists, replace oil cooler.

Removal & Disassembly

1. Disconnect negative battery cable(s). Drain cooling system. Raise and support vehicle.
2. Disconnect exhaust pipe at turbocharger for access to oil cooler if necessary. Remove oil cooler front header-to-cylinder block bolts. See **Fig. 25**. Drain engine oil and remove oil filter.
3. Disconnect retainer and cable from cylinder block heater. Cylinder block heater is located on driver's side rear corner of cylinder block, just below exhaust manifold, near oil filter.
4. Remove oil cooler rear header-to-cylinder block bolts. See **Fig. 25**. Remove oil cooler assembly and gaskets. Perform oil cooler leakage test to ensure oil cooler is not defective.

Oil Cooler Leakage Test

1. Using NEW gaskets, install Oil Cooler Leakage Tester (014-00944), on 1996 models or (014-00726) on 1997 models, onto oil cooler assembly. Apply 40 psi (2.8 kg./cm^2) of air pressure on fitting on coolant side of oil cooler front header.
2. Inspect for air leakage at plastic tubes and at oil cooler front and rear header cover plates. If no air leakage exists, place plastic tubes into a cup of water and check for bubbles.

3. If no bubbles exist, no internal leak exists and oil cooler is okay. If bubbles exist, an internal leak exists in oil cooler. If internal leak exists, disassemble oil cooler assembly and replace oil cooler.
4. Release air pressure. Remove oil cooler leakage tester.

Disassembly & Cleaning

1. Using soft-faced hammer, tap on oil cooler front and rear headers to loosen "O" rings. Remove oil cooler front and rear headers from oil cooler by using twisting motion.
2. Thoroughly clean all components with solvent. Ensure oil cooler is thoroughly flushed to ensure all residue is cleaned from oil cooler. Dry components with compressed.

Reassembly

1. Apply engine oil onto NEW "O" rings and "O" ring mating surfaces. Install large "O" rings and then small "O" rings onto oil cooler.
2. Install oil cooler front and rear headers onto oil cooler. Ensure locating clips align in slots and headers are installed evenly onto oil cooler. Perform oil cooler leakage test to ensure oil cooler is properly sealed.

Installation

1. Using NEW gaskets, install oil cooler assembly onto cylinder block. Install and tighten oil cooler rear header-to-cylinder block bolts until bolts are snug. Install and tighten oil cooler front header-to-cylinder block bolts to specification. See **TORQUE SPECIFICATIONS**.
2. Lower engine. Install driver's side engine mount. Tighten oil cooler rear header-to-cylinder block bolts to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Adjust engine oil level. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING** under REMOVAL & INSTALLATION.

NOTE: If engine oil leaked into cooling system due to defective oil cooler, drain and flush cooling system as necessary. If coolant leaked into crankcase due to defective oil cooler, change engine oil and oil filter.

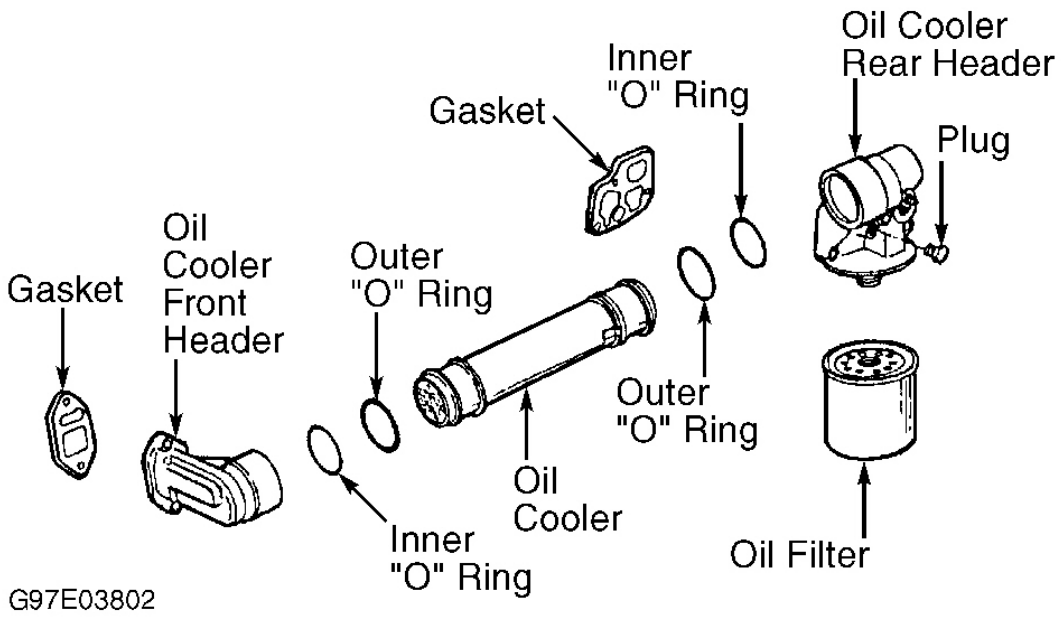


Fig. 25: Exploded View Of Oil Cooler Assembly
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
A/C Compressor Mounting Bracket Bolt	30-40 (40-55)
A/C Line Manifold-To-A/C Compressor Bolt	13-17 (18-23)
A/T Flexplate Bolt	89 (121)
Camshaft Thrust Plate Bolt	18 (24)
Connecting Rod Nut	80 (108)
Step 1	52 (71)
Step 2	80 (108)
Crankshaft Oil Seal Bolt	30-47 (40-64)
Cylinder Head Bolt (1)	
Step 1	65 (88)
Step 2	85 (115)
Step 3	105 (142)
Engine Mount Nut	71-94 (96-127)
Engine Rear Cover Bolts	15 (20)
Exhaust Inlet Pipe-To-Exhaust Inlet Adapter Bolt	36 (49)

Exhaust Inlet Pipe-To-Exhaust Manifold Bolt/Nut	36 (49)
Exhaust Manifold Bolt	45 (61)
Fan Clutch Assembly-To-Water Pump Nut	84-113 (114-153)
Flywheel-To-Crankshaft Bolt	
F250 HD, F350 & F250-F550 Super Duty	
A/T	89 (121)
M/T [2]	89 (121)
Van	23-39 (31-53)
Front Cover Retaining Bolt	15 (20)
Fuel/Filter Water Separator Housing Bolt	23 (31)
Fuel Line Assembly-To-Fuel Pump Banjo Bolt	40 (54)
Generator Mounting Bracket Bolt	30-40 (41-54)
Generator Retaining Bolt	30-40 (41-54)
Glow Plug	14 (19)
High-Pressure Oil Pump Drive Gear Bolt	95 (129)
High-Pressure Oil Pump Retaining Bolt	16-20 (22-27)
High-Pressure Oil Pump Supply Line-To-Cylinder Head	19 (26)
High-Pressure Oil Pump Supply Line-To-High-Pressure Oil Pump Fitting	19 (26)
Injector Control Pressure Sensor	21 (29)
Intake Manifold Cover Bolt	18 (24)
Main Bearing Cap Bolt	
Step 1	75 (102)
Step 2	95 (129)
Oil Cooler Front Header-To-Cylinder Block Bolt	18 (24)
Oil Cooler Rear Header-To-Cylinder Block Bolt	18 (24)
Oil Pan Drain Plug	27 (37)
Oil Pressure Regulator-To-High-Pressure Oil Pump	35 (47)
Oil Pump Pick-Up Tube Support Bracket Nut	30 (41)
Oil Pump Pick-Up Tube-To-Front Cover Bolt	18 (24)
Power Steering Pressure Line-To-Power Steering Pump Fitting	22-29 (30-39)
Rocker Arm Assembly Bolt	20 (27)
Starter Bolt	15-20 (20-27)
Torque Converter-To-Flexplate Nut (A/T)	22-30 (30-41)
Transmission-To-Clutch Housing Bolt (M/T)	39-53 (53-72)
Transmission-To-Cylinder Block Bolt (A/T)	39-53 (53-72)
Turbocharger Pedestal Assembly-To-Cylinder Block Bolt	18 (24)
Turbocharger Pedestal Assembly-To-Turbocharger Center Housing Bolt	18 (24)
Vibration Damper Bolt	212 (287)
Water Pump Bolt	15 (20)
Water Pump Outlet Bolts	15 (20)

Water Pump Pulley Bolt	12-18 (16-24)
	INCH Lbs. (N.m)
Exhaust Backpressure Control Valve-To-Compressor Housing Bolt	62-80 (7.0-9.0)
Fuel Injector Retaining Bolt	108 (12.2)
Fuel Injector Shoulder Bolt	108 (12.2)
Oil Deflector Retaining Bolt	108 (12.2)
Oil Rail Drain Plug	53 (6.0)
Piston Cooling Jet Bolts	98 (11)
Valve Cover Bolt	97 (11.0)

(1) Tighten bolts to specification in sequence. See **Fig. 12**.

(2) Apply Threadlock® sealant onto bolt threads.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Specification
Displacement	444 Cu. In. (7.3L)
Bore	4.11" (104.4 mm)
Stroke	4.18" (106.2 mm)
Compression Ratio	17.5:1
Fuel System	Direct Injection

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

Application	In. (mm)
Crankshaft	
End Play	
Standard	.0025-.0085 (.064-.216)
Wear Limit	.020 (.51)
Main Bearings	
Journal Diameter	3.1228-3.1236 (79.319-79.339)
Journal Out-Of-Round	.0002 (.005)
Journal Taper	.00015 (.0038) Per 1.0 (25 mm)
Oil Clearance	
Standard (1)	.0018-.0036 (.046-.091)
Wear Limit	.0046 (.117)
Connecting Rod Bearings	
Journal Diameter	2.4980-2.4990 (63.449-63.475)
Journal Out-Of-Round	.0002 (.005)
Journal Taper	.00026 (.0066) Per 1.0 (25 mm)
Oil Clearance	.0015-.0045 (.038-.114)

(1) 1998 engines. 1999 clearance is .0018-.0046" (.046-.117 mm).

CONNECTING RODS

Application	In. (mm)
Bore Diameter	
Pin Bushing Bore	1.3085-1.3088 (33.236-33.244)
Crankpin Bore	2.6905-2.6915 (68.339-68.364)
Crankpin Bore Maximum Out-Of-Round	.0005 (.013)
Crankpin Bore Maximum Taper	.0005 (.013)
Center-To-Center Length	7.130 (181.10)
Maximum Bend	.001 (.03) Per 1.0 (25 mm)
Maximum Twist	.002 (.05) Per 1.0 (25 mm)
Side Play	.012-.024 (.30-.61)

PISTONS, PINS & RINGS

Application	In. (mm)
Pistons	
Diameter	4.1069-4.1076 (104.315-104.333)
Clearance	.0045-.0059 (.1143-.1498)
Piston Height Above Cylinder Block	.010-.031 (.25-.79)
Pins	
Diameter	1.3079-1.3081 (33.220-33.226)
Piston Fit	.0003-.0007 (.007-.018)
Rod Fit	.0004-.0009 (.010-.023)
Rings	
No. 1	
End Gap	.014-.024 (.36-.61)
Side Clearance	(1)
No. 2	
End Gap	.062-.072 (1.57-1.83)
Side Clearance	.002-.004 (.05-.10)
No. 3 (Oil)	
End Gap	.012-.024 (.30-.61)

(1) For measuring of side clearance, see **PISTON RINGS** under CYLINDER BLOCK ASSEMBLY under OVERHAUL.

CYLINDER BLOCK

Application	In. (mm)
Cylinder Bore	
Standard Diameter	4.1096-4.1103 (104.384-104.402)
Maximum Taper	.003 (.076)
Maximum Out-Of-Round	.0002 (.051)
Maximum Deck Warpage	(1)

(1) Warpage should not exceed .0030" (.076 mm) within a 6.0" (152 mm) area or .0060" (.152 mm) overall. Cylinder block may be resurfaced. DO NOT remove more than .010" (.25 mm) of material from cylinder block if resurfacing cylinder block.

VALVES & VALVE SPRINGS

Application	Specification
Intake Valves	
Face Angle	30°
Minimum Margin	.066" (1.67 mm)
Stem Diameter	.31185-.31255" (7.9210-7.9388 mm)
Valve Head Recession	.046-.058" (1.17-1.47 mm)
Exhaust Valves	
Face Angle	37.5°
Minimum Margin	.054" (1.37 mm)
Stem Diameter	.31185-.31255" (7.9210-7.9388 mm)
Valve Head Recession	.052-.064" (1.32-1.63 mm)
Valve Springs	
Free Length	1.925-2.225" (48.90-56.52 mm)
Installed Height	
Intake	1.767" (44.88 mm)
Exhaust	1.833" (46.56 mm)
Out-Of-Square	.078" (1.98 mm)
	Lbs. @ In. (kg @ mm)
Pressure	
Valve Closed	71-79 @ 1.833 (32-36 @ 46.56)

CYLINDER HEAD

Application	Specification
Cylinder Head Height	5.095-5.105" (129.41-129.67 mm)
Maximum Warpage	(1)
Valve Seats	

Intake Valve	
Seat Angle	30°
Seat Width	.065-.095" (1.65-2.41 mm)
Maximum Seat Runout	.002" (.05 mm)
Exhaust Valve	
Seat Angle	37.5°
Seat Width	.065-.095" (1.65-2.41 mm)
Maximum Seat Runout	.002" (.05 mm)
Valve Guides	
Intake & Exhaust	
Valve Guide I.D.	.3736-.3746" (9.490-9.514 mm)
Valve Stem-To-Guide Maximum Oil Clearance	.0055" (.140 mm)

(1) Warpage should not exceed .0010" (.025 mm) within a 2.0" (51 mm) area or .0040" (.102 mm) overall. Replace cylinder head if warpage exceeds specification. DO NOT resurface cylinder head.

CAMSHAFT

Application	In. (mm)
End Play	.002-.008 (.051-.203)
Journal Diameter	(1)
Camshaft Bearing I.D.	2.102-2.105 (53.39-53.47)
Oil Clearance	.002-.006 (.05-.15)
Front Camshaft Bearing Installed Depth (2)	.020-.050 (.51-1.27)
Gear Backlash	.010-.0055 (.140-.256)
Camshaft Thrust Plate Thickness	
In Thrust Area	.154-.156 (3.91-3.96)
Outside Thrust Area	.149-.157 (3.78-3.98)

(1) Information not available.

(2) Specification listed is distance from face of cylinder block to front edge of front camshaft bearing.

VALVE LIFTERS

Application	In. (mm)
Lifter Diameter	.9209-.9217 (23.391-23.411)
Oil Clearance	.0011-.0034 (.028-.086)
Collapsed Lifter Clearance	.185 (4.70)

1996-97 ENGINES

7.5L V8 - VIN [G]

ENGINE IDENTIFICATION

The eighth character of Vehicle Identification Number (VIN) identifies engine. VIN is located near windshield on left side of instrument panel. VIN number is also on Safety Compliance Certification Label attached to left door lock pillar.

VIN ENGINE CODE

Engine	Code
7.5L MFI	G

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

1. Rotate crankshaft to TDC of No. 1 piston's compression stroke. Perform steps 2) and 3) for appropriate valves. See **VALVE CLEARANCE ADJUSTMENT** table.
2. Using Lifter Bleed-Down Wrench (T71P-6513-B), apply pressure to push rod end of appropriate rocker arm. Slowly bleed down lifter until lifter plunger is completely bottomed.
3. While holding lifter in this position, check clearance between rocker arm and valve stem tip using feeler gauge. If clearance is less than specified, install a .060" (1.52 mm) shorter push rod. If clearance is greater that specified, install a .060" (1.52 mm) longer push rod. See **VALVE LIFTERS** table under ENGINE SPECIFICATIONS.
4. Rotate crankshaft 360 degrees to TDC of No. 6 piston's compression stroke. Repeat steps 2) and 3) for appropriate valves.

VALVE CLEARANCE ADJUSTMENT

Crankshaft Position	Check Intake Valves No.	Check Exhaust Valves No.
TDC No. 1	1, 3, 7 & 8	1, 4, 5 & 8
TDC No. 6	2, 4, 5 & 6	2, 3, 6 & 7

TROUBLE SHOOTING

NOTE: For trouble shooting mechanical components, see appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other

major assemblies before removal.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

FUEL PRESSURE RELEASE

Remove fuel cap to release fuel tank pressure. Remove relief valve cap. Relief valve is located on fuel rail. Connect Fuel Pressure Gauge (T80L-9974-B) to relief valve. Release pressurized fuel into a suitable container. Normal fuel pressure is 40 psi (2.8 kg/cm^2).

COOLING SYSTEM BLEEDING

WARNING: When engine is operating, DO NOT remove radiator cap under any conditions. Failure to obey warning could damage cooling system or engine, and cause personal injury. Always shield radiator cap with protective material to avoid injury from steam or hot coolant.

1. Fill cooling system with 50/50 mixture of water and coolant. Pause several minutes for circulation. Fill radiator to filler neck seat. Disconnect heater outlet hose at water pump to bleed off trapped air. Fill radiator until coolant begins to escape.
2. Connect heater outlet hose. Fill radiator until coolant is between cap seal in filler neck to 1.5" (38 mm) below cap seal. Install radiator cap. Start engine and allow to warm-up. Shut engine off. Allow engine to cool. Remove radiator cap and check coolant level. Top off radiator coolant as necessary.

ENGINE

Removal (Pickup)

1. Disconnect negative battery cable. Drain cooling system and crankcase. Mark hood hinges and remove hood. Disconnect secondary air injection manifold tube at right-hand side of air cleaner.
2. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Using Spring Lock Coupling Remover (T81P-19623-G1) for 3/8" line or (T81P-19623-G2) for 1/2" line, disconnect fuel supply and return lines. See **Fig. 1** .
3. Remove air cleaner and intake duct assembly with crankcase ventilation and carbon canister hoses attached. Disconnect radiator hoses. Disconnect transmission cooler lines (if equipped). Disconnect oil cooler lines at oil filter adapter (if equipped).

CAUTION: DO NOT attempt to disconnect engine oil cooler lines at quick-disconnect fittings behind or at oil cooler. Damage to fittings will occur.

4. On models with A/C, discharge A/C system using approved refrigerant recovery/recycling equipment. Remove condenser and disconnect hoses at compressor.
5. Remove fan shroud, spacer, pulley and radiator. Remove and position generator aside. Disconnect oil pressure sending unit wire.
6. Disconnect accelerator cable, transmission shift rod and speed control linkages from throttle body. Disconnect throttle bracket from upper intake manifold, and set aside with cables attached. Remove EGR manifold tube. Mark and disconnect vacuum lines, carbon canister hose, heater hoses and electrical wiring from engine.
7. Disconnect brake booster hose. Remove bellhousing-to-engine upper bolts. Remove oil dipstick and tube. Raise and support vehicle. Remove starter. Separate exhaust pipes from manifolds. Disconnect engine mounts from frame brackets. On A/T models, remove torque converter inspection plate and flexplate-to-torque converter bolts.
8. Remove remaining bellhousing-to-engine bolts. Lower vehicle and support transmission. Attach engine hoist and carefully separate engine from transmission. Lift engine from vehicle, DO NOT damage rear cover plate.

Installation

To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Check and top off all engine fluids. Fill cooling system. Bleed air from system. See **COOLING SYSTEM BLEEDING** . Evacuate and recharge A/C system (if equipped).

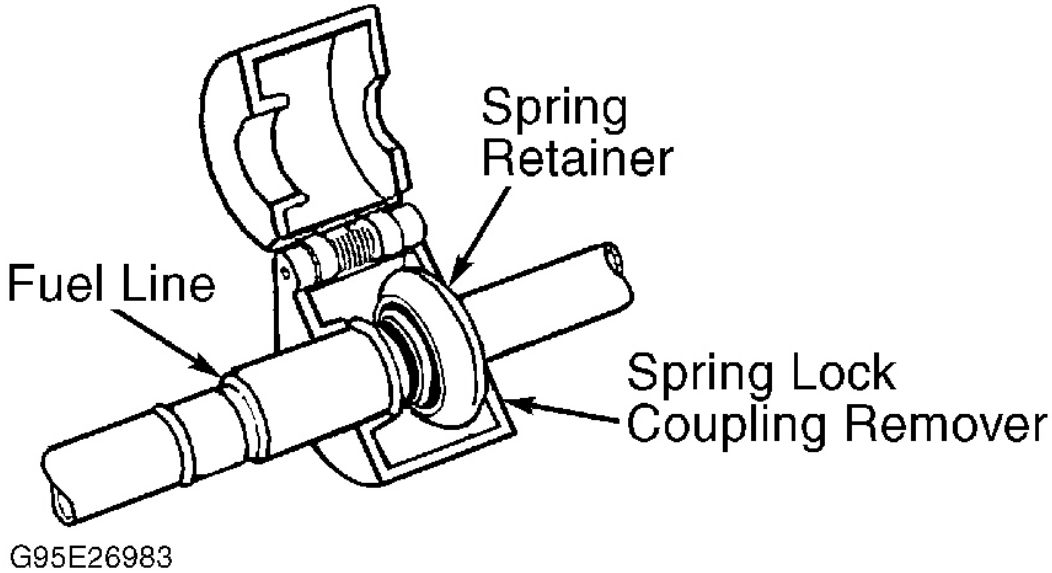


Fig. 1: Disconnecting Fuel Lines
Courtesy of FORD MOTOR CO.

INTAKE MANIFOLDS

NOTE: On F250/F350 Pickup, it is possible to remove upper and lower intake manifolds as an assembly.

Removal (Upper)

1. Disconnect negative battery cable(s). Remove air cleaner outlet tube. Disconnect throttle and A/T linkage (if equipped) from throttle body. Remove 2 bracket-to-intake manifold bolts. Move bracket and cables aside.
2. Disconnect electrical connectors and upper manifold vacuum hose connections as necessary. Disconnect EGR and PCV systems. Disconnect clean air supply hose of idle by-pass valve. Remove 4 upper intake manifold bolts. Remove upper intake manifold and throttle body as an assembly.

Installation

Clean all gasket surfaces. Position NEW gasket on lower intake manifold. Ensure NEW gasket is aligned. To complete installation, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

Removal (Lower)

1. Disconnect negative battery cable(s). Remove upper intake manifold as previously described. Position No. 1 piston on TDC of compression stroke. Remove distributor cap and wires. Mark distributor location for installation reference. Remove distributor.
2. Remove air cleaner and duct assembly. Release fuel system pressure. See **FUEL PRESSURE RELEASE** . Using Spring Lock Coupling Remover (T81P-19623-G1) for 3/8" line or (T81P-19623-G2) for 1/2" line, disconnect fuel supply and return lines. See **Fig. 1** .
3. Remove upper radiator hose. Disconnect coolant hoses at intake manifold and water pump. Label and disconnect vacuum hoses as necessary. Remove both thermactor exhaust air supply tubes. Remove ignition coil and mounting bracket.
4. Disconnect wiring harness from main wiring. Label and disconnect all other electrical wiring from intake manifold. Remove attaching bolts, and remove lower intake manifold.

Installation

1. Clean all gasket surfaces. Apply 1/8" (3 mm) bead of silicone sealer to 4 corners of cylinder block seal mounting surface. Install manifold gasket, front seal and rear seal. Apply 1/16" (1.5 mm) bead silicone sealer along full width of front and rear seal ends.
2. Install intake manifold within 15 minutes of applying sealer. Position intake manifold over 4 studs in cylinder heads. Check gasket and seal alignment before tightening.
3. Install manifold attaching bolts, studs and nuts. Tighten bolts in sequence to specification. See **Fig. 2** . See **TORQUE SPECIFICATIONS** . Install fuel lines, electrical connectors and vacuum hoses. To install remaining components, reverse removal procedure.
4. Fill cooling system. Bleed air from system. See **COOLING SYSTEM BLEEDING** . Check and adjust

ignition timing as necessary. Start engine and allow it to reach operating temperature. Turn off engine. Retighten bolts and nuts sequentially to 22-35 ft. lbs. (30-47 N.m) to complete installation.

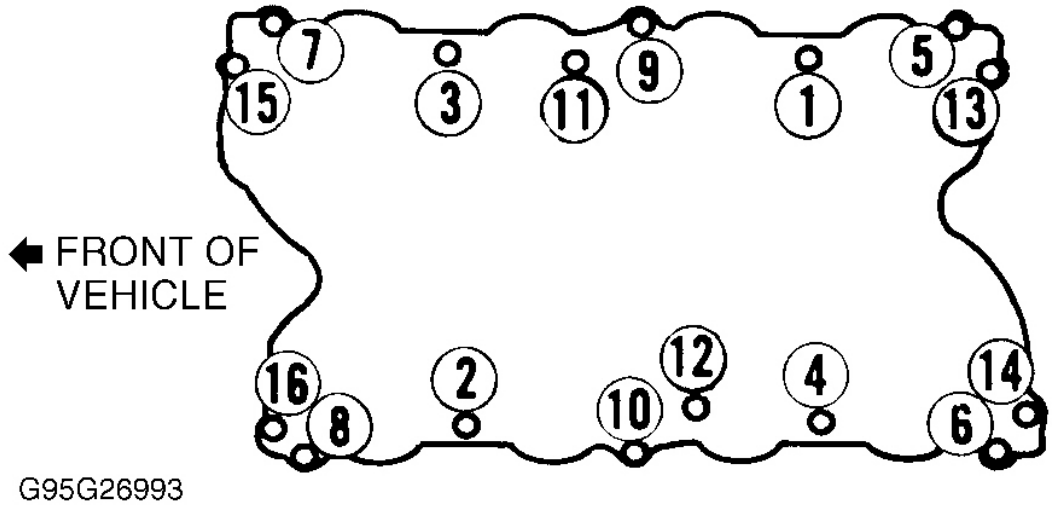


Fig. 2: Lower Intake Manifold Tightening Sequence
Courtesy of FORD MOTOR CO.

EXHAUST MANIFOLD

Removal

1. If removing right exhaust manifold, remove secondary air injection check valve tube. If removing left exhaust manifold, remove EGR manifold tube and oil dipstick tube.
2. Disconnect spark plug wires. Remove spark plug heat shield. Disconnect exhaust pipe(s) from manifold (s). Remove exhaust manifold-to-cylinder head bolts. Remove exhaust manifold(s).

NOTE: If exhaust manifold has been surface, exhaust manifold bolts MUST be shortened. Failure to shorten manifold bolts will result in exhaust leaks at manifold.

Installation

1. Inspect manifold(s) for cracks, damaged sealing surfaces, or other wear or damage. Replace manifold(s) as necessary. Clean cylinder head and manifold mating surfaces.
2. Clean mounting flange of manifold and exhaust pipe. Apply light film of graphite grease to manifold-machined surface. Position spark plug wire heat shields and exhaust manifold on cylinder head.
3. Install attaching bolts, starting at fourth bolt hole from front of each manifold. Tighten bolts to specification, starting at center and working outward. See **TORQUE SPECIFICATIONS** .

CYLINDER HEAD

Removal

1. Disconnect negative battery cable(s). Drain cooling system. Remove upper and lower intake manifolds. See **INTAKE MANIFOLDS** . Disconnect exhaust pipes at manifolds. Remove accessory drive belts. Remove secondary air pump and bracket from right cylinder head. Remove generator.
2. On models with A/C, discharge A/C system using approved refrigerant recovery/recycling equipment. Remove A/C manifold from compressor. Remove A/C compressor support bracket nuts from water pump. Remove and position compressor aside. Remove compressor mounting bracket from cylinder head and position aside with power steering pump and hoses attached.
3. On models without A/C, remove power steering pump bracket-to-left cylinder head bolts. Position pump and bracket aside. Remove valve covers.
4. Mark location for installation reference, and remove rocker arm assemblies and push rods. Remove cylinder head and exhaust manifold assemblies. Discard cylinder head gasket.

Inspection

Measure cylinder head and cylinder block mating surfaces for warpage. If cylinder head or cylinder block warpage exceeds specification, DO NOT remove more than .010" (.25 mm) material from original surface of cylinder head or block to correct warpage. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

Installation

1. Clean gasket mating surfaces. Check flatness of cylinder head and block mating surfaces. If exhaust manifolds were removed, coat cylinder head and manifold port areas with a thin film of graphite grease, and install manifold on cylinder head.
2. Place 2 long head bolts in 2 rear lower bolt holes of left cylinder head. Place one long head bolt in rear lower bolt hole of right cylinder head. Keep bolts in position above head-to-block mating surface with rubber bands until heads are installed.
3. Position NEW head gaskets on block. DO NOT apply sealer to head gasket surfaces. Install cylinder head bolts. Tighten bolts in sequence to specification. See **Fig. 3** . See **TORQUE SPECIFICATIONS** .
4. To complete installation, reverse removal procedure. Fill cooling system. Bleed air from system. See **COOLING SYSTEM BLEEDING** . Evacuate and recharge A/C system (if equipped).

CAUTION: If valves/seats were serviced, check and adjust valve clearance. See VALVE CLEARANCE ADJUSTMENT under ADJUSTMENTS.

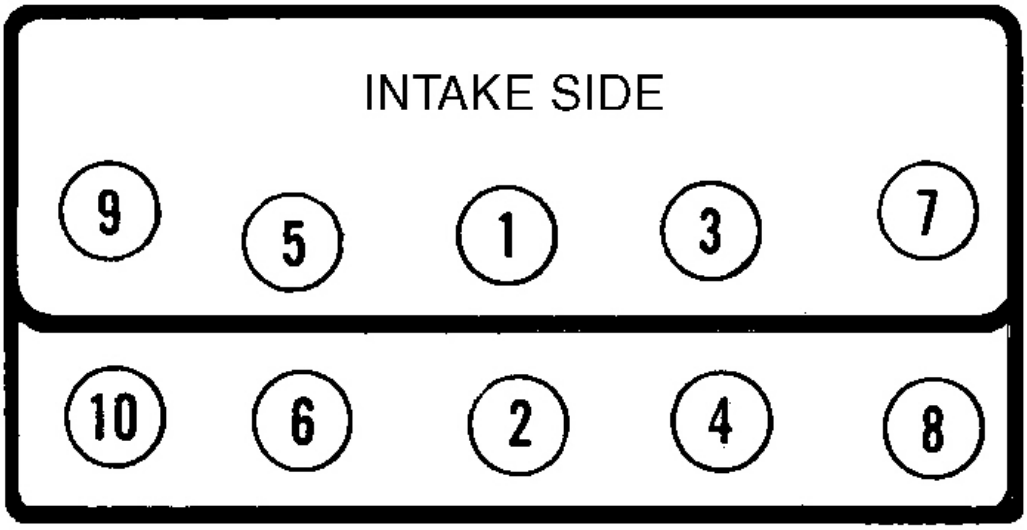


Fig. 3: Cylinder Head Tightening Sequence
Courtesy of FORD MOTOR CO.

HYDRAULIC VALVE LIFTERS

NOTE: Before replacing a noisy hydraulic valve lifter, ensure valve clearance is correct. See VALVE CLEARANCE ADJUSTMENT under ADJUSTMENTS.

Removal

1. Remove upper and lower intake manifolds. See **INTAKE MANIFOLDS** . Remove valve covers. Loosen rocker arm fulcrum bolts and turn to one side.
2. Mark location for installation reference and remove push rods. Mark lifter location for installation reference. Remove valve lifters with a magnet. If lifters are stuck in bores, use Hydraulic Lifter Puller (T70L-6500-A).

Inspection

1. Service lifters as an assembly only. Disassemble and clean lifters before testing. Test lifters with hydraulic lifter test fluid. DO NOT interchange parts between lifters.
2. Leak-down rate on hydraulic lifters is 10-50 seconds with 1/16" (1.6 mm) plunger travel under 50 lbs. (23 kg) load. Replace lifter if it fails leak-down test, or if it is worn or damaged.

Installation

Clean outside of valve lifters. Lubricate lifters and bores with engine oil before installation. Install lifters in their original bores. If any NEW lifters are installed, ensure lifter moves freely in bore. To complete installation, reverse removal procedure. Fill cooling system. Bleed air from system. See **COOLING SYSTEM BLEEDING** .

FRONT CRANKSHAFT OIL SEAL

NOTE: Front crankshaft seal can be replaced without removing timing chain cover.

Removal

Remove radiator fan shroud, fan blade and fan clutch. Remove accessory drive belts. Remove crankshaft pulley. Using Crankshaft Damper Remover (T58P-6316-D), remove crankshaft vibration damper. Place Seal Remover (T70P-6B070-B) onto timing chain cover plate over front seal. Tighten 2 through-bolts, forcing seal remover under seal flange. Alternately tighten 4 puller bolts, one-half turn at a time, until seal is removed from engine.

Installation

Coat NEW seal with multipurpose grease and install seal using Seal Installer/Aligner (T88T-6701-A). Ensure seal is fully seated. To install remaining components, reverse removal procedure.

TIMING CHAIN COVER

NOTE: Front crankshaft oil seal should be replaced whenever timing chain cover is removed.

Removal

1. Disconnect negative battery cable(s). Drain cooling system and crankcase. Remove fan blade, fan clutch and fan shroud. Disconnect radiator hoses at engine. Disconnect transmission oil cooler lines (if equipped) at radiator. Remove upper radiator support and remove radiator.
2. Remove accessory drive belts and water pump pulley. Remove alternator and air pump assemblies with brackets. Remove A/C compressor and support bracket (if equipped), with power steering pump attached. Disconnect heater hose from water pump.
3. Remove crankshaft pulley. Using Vibration Damper Remover (T58P-6316-D), remove vibration damper and Woodruff key from crankshaft. Remove timing chain cover-to-cylinder block bolts. Remove timing chain cover and water pump as an assembly.
4. Cut oil pan gasket even with cylinder block face. Discard timing chain cover gasket and pan gasket. Carefully remove old seal using a pin punch; DO NOT damage front crankshaft seal recess.

Installation

1. Install NEW timing chain cover oil seal. Coat gasket surface of oil pan with gasket sealer. Cut and position NEW gasket on oil pan. Apply silicone sealer at block-to-oil pan junction. Apply gasket sealer to timing chain cover and cylinder block gasket surfaces. Position NEW timing chain cover gasket in place.

2. Position timing chain cover on cylinder block. Install Timing Chain Cover Aligner (T68P-6019-A) on crankshaft. See **Fig. 4** . Coat threads of cover bolts with oil-resistant sealer and install bolts. It may be necessary to push cover downward to compress pan gasket.
3. While pushing in on Timing Chain Cover Aligner (T68P-6019-A), tighten oil pan-to-cover bolts. Tighten timing chain cover-to-cylinder block bolts and remove timing chain cover aligner. To complete installation, reverse removal procedure. Fill engine crankcase with proper grade oil. Fill cooling system. Bleed air from system. See **COOLING SYSTEM BLEEDING** .

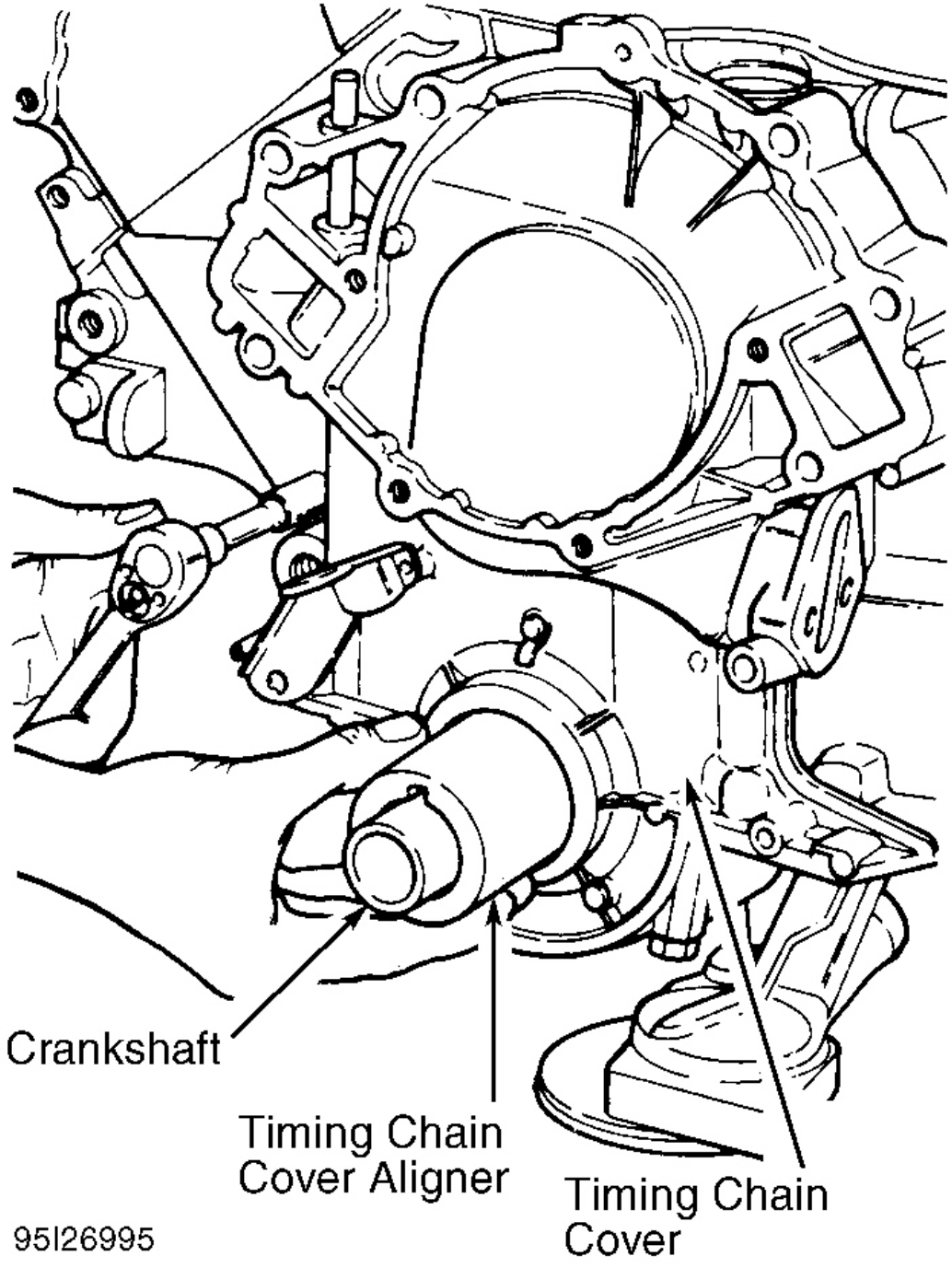


Fig. 4: Aligning Timing Chain Cover
Courtesy of FORD MOTOR CO.

TIMING CHAIN & SPROCKET

Removal

1. Position No. 1 piston on TDC of compression stroke. Remove timing chain cover. See **TIMING CHAIN COVER** . Check alignment of camshaft gear and crankshaft gear timing marks. See **Fig. 5** .
2. Check timing chain deflection (stretch) for excessive wear. See **CAMSHAFT** table under ENGINE SPECIFICATIONS. Remove camshaft sprocket bolt and washer. Slide timing chain and sprockets forward and remove as an assembly.

Installation

Assemble and align timing chain and sprockets. See **Fig. 5** . Install chain and sprockets as an assembly. Lubricate timing chain with engine oil. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . To complete installation, reverse removal procedure.

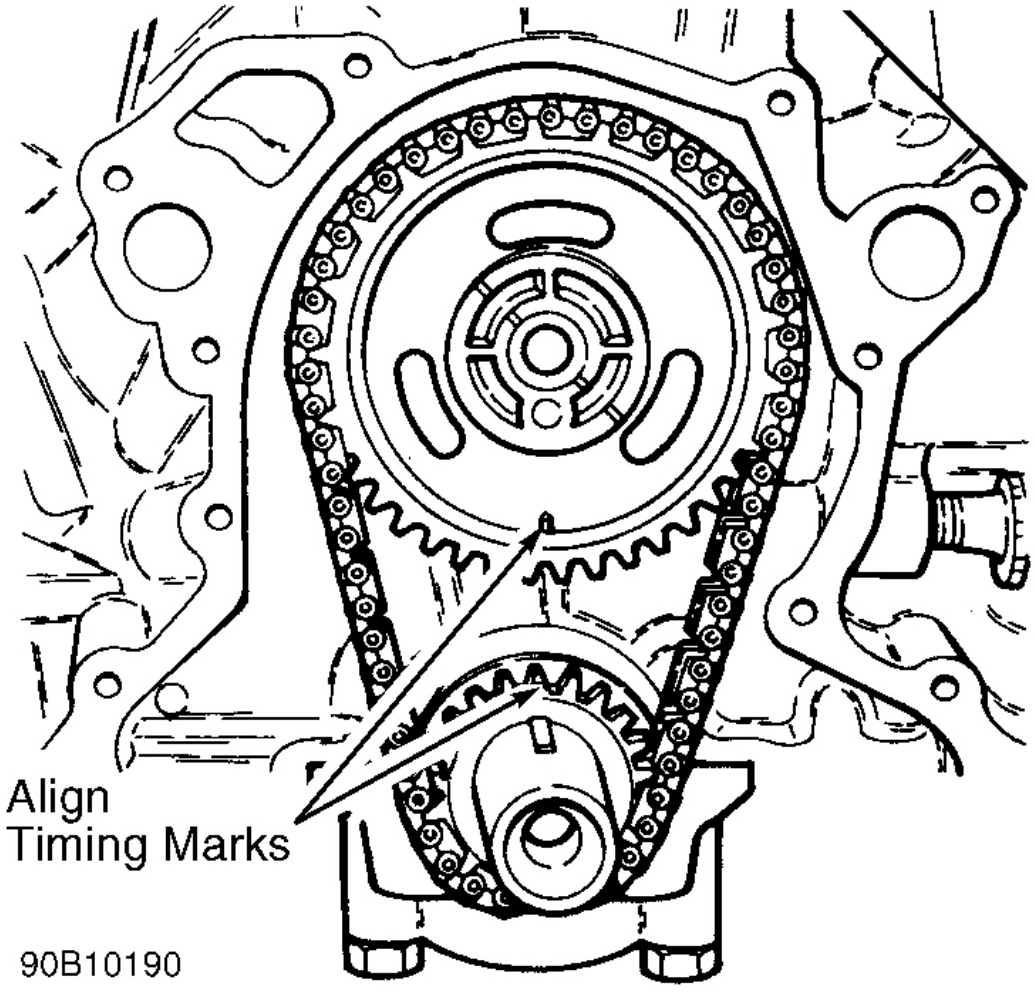


Fig. 5: Aligning Timing Marks
Courtesy of FORD MOTOR CO.

CAMSHAFT

Removal

1. Remove timing chain cover, timing chain and sprockets. See **TIMING CHAIN COVER** and **TIMING CHAIN & SPROCKET** . Remove intake manifolds. See **INTAKE MANIFOLDS** . Remove valve covers.
2. Loosen all rocker arm bolts and rotate rocker arms aside. Remove push rods and valve lifters, keeping them in order for installation in original locations.

NOTE: Use Hydraulic Lifter Puller (T70L-6500-A) to remove stuck lifters.

3. Remove A/C condenser-to-chassis bolts (if equipped) and set condenser aside. Remove front grille. Check camshaft end play. If not within specification, replace thrust plate. See **CAMSHAFT** table under ENGINE SPECIFICATIONS. Remove camshaft thrust plate. Carefully remove camshaft without damaging bearings or journals.

Inspection

Measure camshaft bearing journals and lobes for wear. If measurements are not within specification, replace camshaft and valve lifters. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Installation

1. Oil camshaft journals and apply multipurpose grease to camshaft lobes. Carefully slide camshaft into position. Install and tighten thrust plate. Recheck camshaft end play. Lubricate lifters with engine oil and install.
2. Install timing chain and sprockets and ensure timing marks are properly aligned. See **Fig. 5** . Lubricate rocker arms, fulcrum seats, valve stem tips and push rods with multipurpose grease before installing. Rotate crankshaft until No. 1 piston is on TDC of compression stroke.
3. Install rocker arm, fulcrum seats, oil deflection and fulcrum bolts to appropriate valves. See **VALVE CLEARANCE ADJUSTMENT** table under ADJUSTMENTS. Rotate crankshaft 360 degrees and install rocker arm components on remaining valves.
4. Ensure fulcrum seat base is inserted into slot on cylinder head before tightening fulcrum bolts. To complete installation, reverse removal procedure. Use NEW gaskets where required.

CAMSHAFT BEARINGS

NOTE: It may be necessary to remove crankshaft for access to camshaft bearings.

Removal

Remove engine from vehicle. See **ENGINE** . Remove camshaft. See **CAMSHAFT** . Remove flywheel. Push pistons to top of cylinders. Remove camshaft rear bearing bore plug. Using Camshaft Bearing Remover/Installer Set (T65L-6250-A), remove camshaft bearings.

Installation

Using camshaft bearing remover/installer, install bearings into place. Ensure oil holes in bearings and cylinder block are aligned. Install front bearing .002-.003" (.051-.076 mm) below front face of cylinder block. Coat NEW rear bore plug with sealer and install. To complete installation, reverse removal procedure.

REAR CRANKSHAFT OIL SEAL

Removal

1. Remove oil pan. See **OIL PAN** . Loosen all main bearing cap bolts to slightly lower crankshaft. DO NOT lower more than 1/32" (.79 mm). Remove rear main bearing cap and lower oil seal half. Use seal remover to remove upper seal.
2. If seal remover is not available, install a small metal screw in one end of seal. Carefully pull on screw to remove seal without damaging sealing surface.

Installation

1. Carefully clean oil seal grooves in bearing cap and block. Coat split-lip seal halves with engine oil. Carefully install upper seal into groove in cylinder block, with undercut side of seal toward front of engine.

NOTE: DO NOT damage outside surface of seal when installing in groove. DO NOT allow oil on area where sealer is applied.

2. Rotate seal on crankshaft journal until about 3/8" (9.5 mm) of seal protrudes below parting face. See **Fig. 6** . Tighten all main bearing cap bolts except rear main. Install lower seal in rear main bearing cap, with undercut side of seal toward front of engine.
3. Allow seal to protrude about 3/8" (9.5 mm) above parting surface to mate with upper seal when cap is installed. Apply 1/16" (1.5 mm) bead of silicone sealer to both sides of cylinder block-to-cap mating surface and both sides of bearing cap. See **Fig. 7** .
4. Install and tighten rear main bearing cap before sealer sets (about 15 minutes). To complete installation, reverse removal procedure.

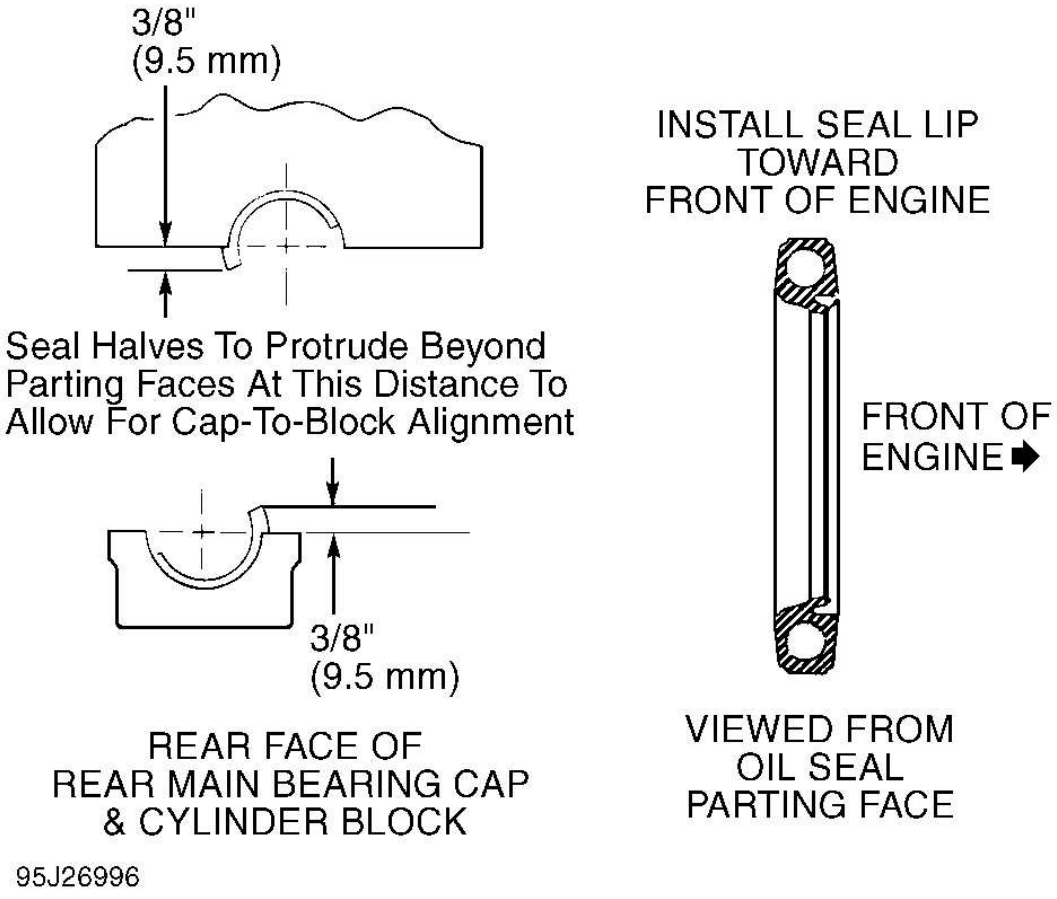


Fig. 6: Installing Rear Crankshaft Oil Seal
Courtesy of FORD MOTOR CO.

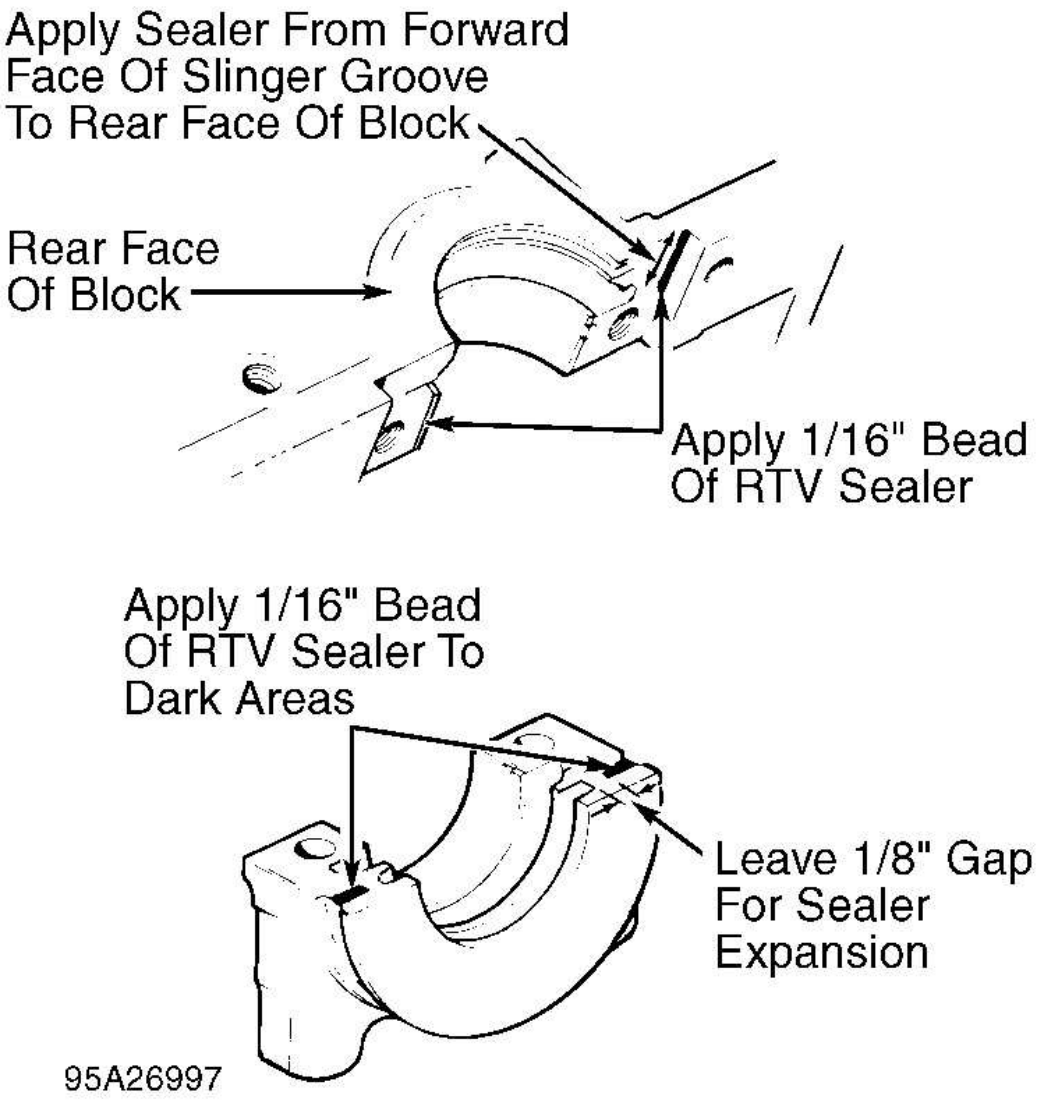


Fig. 7: Identifying Silicone Sealer Application Points
Courtesy of FORD MOTOR CO.

WATER PUMP

Removal

1. Remove negative battery cable(s). Drain cooling system. Remove fan shroud, fan clutch and fan blade. Loosen power steering pump attaching bolts. Remove A/C compressor (if equipped). Remove A/C compressor and power steering bracket.
2. Remove all drive belts. Remove air pump, generator and bracket. Disconnect all hoses from water pump

and loosen by-pass hose clamp at pump. Remove remaining bolts and remove water pump. Remove separator plate from water pump and discard gaskets.

Installation

Clean all gasket surfaces. To install, reverse removal procedure. Use NEW gaskets coated on both sides with water-resistant sealer. Fill cooling system. Bleed air from system. See **COOLING SYSTEM BLEEDING** .

OIL PAN

Removal

1. Disconnect negative battery cable(s). Drain cooling system. Disconnect upper and lower radiator hoses. Disconnect and remove air cleaner assembly. Release fuel pressure. See **FUEL PRESSURE RELEASE** .
2. Using Spring Lock Coupling Remover (T81P-19623-G1) for 3/8" line or (T81P-19623-G2) for 1/2" line, disconnect fuel supply and return lines. See **Fig. 1** . On A/T models, disconnect transmission cooler lines at radiator.
3. On all models, disconnect engine cooler lines at oil filter adapter (if equipped). Remove fan assembly and shroud. Remove power steering pump. Remove front engine mount through-bolts.
4. Remove dipstick tube retaining nuts, and remove dipstick and tube. Remove oil filler tube and bracket (if equipped). On models with A/C, discharge A/C system using approved refrigerant recovery/recycling equipment. Rotate or remove A/C lines at rear of compressor to clear dash.
5. On all models, raise and support vehicle. Drain engine oil and remove oil filter. Disconnect and remove muffler inlet pipe assembly. Disconnect control linkage at transmission. On A/T models, remove transmission dipstick assembly. On all models, remove drive shaft assembly.
6. Raise engine. Engine and transmission assembly will pivot around rear engine mount. Engine and transmission assembly must be raised approximately 4" (measure at front engine mounts), and remain centered in engine compartment. Support engine with wooden blocks.
7. Remove oil pan bolts and lower oil pan. Remove oil pump bolts and pick-up tube nut. Lower oil pump assembly into pan. Remove oil pan.

Installation

To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Fill or top off all fluids. Fill cooling system. Bleed air from system. See **COOLING SYSTEM BLEEDING** . Start engine and check for leaks.

OVERHAUL

CYLINDER HEAD

Cylinder Head

1. Clean head gasket mating surface. Clean carbon from combustion chambers. DO NOT damage surfaces.

Check cylinder head for cracks, burrs, nicks and warpage.

2. DO NOT machine more than .010" (.25 mm) from original cylinder head surface to correct warpage. Repair or replace cylinder head as necessary. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

Valve Springs

1. Measure valve spring installed height from top of spring seat to underside of spring retainer. Ensure installed height is within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.
2. If installed height is not within specification, a spacer can be installed between cylinder head and valve spring to obtain correct height. Inspect valve spring free length and pressure. Replace valve spring if free length and pressure are not within specification. See **VALVES & VALVE SPRINGS** table.

CAUTION: DO NOT install valve spring spacers unless necessary. Using more spacers than required will coil bind springs, and result in spring breakage or worn camshaft lobes.

Valve Stem Oil Seals

Umbrella-type oil seals are used on all valves. Intake and exhaust valve stem seals are not interchangeable. Seals are identified with IN for intake and EX for exhaust. Lubricate valve stem with engine oil and install NEW seal with cup side down over valve guide.

Valve Guides

1. Valve guides must be reamed for an oversized valve if valve stem-to-guide oil clearance exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Valves are available with .015" (.38 mm) and .030" (.76 mm) oversize stems.
2. If oversized valves or oversized valve stem oil seals are not available, valve guide may be bored out to install a service bushing. Always use reamers in proper sequence (smallest first).

NOTE: Always grind valve seat after valve guide has been reamed or service bushing installed.

Valve Seat

1. Grind valve seat to a 45-degree angle. If seat width is too wide after grinding, use a 30-degree stone to lower seat or a 60-degree stone to raise seat. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.
2. Ensure valve seat angle, seat width and seat runout are within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Valve seats must be ground when valve guide is reamed or replaced. Replacement information is not available from manufacturer.

Valves

Ensure head diameter, valve face runout, stem diameter and valve margin are within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.

CAUTION: DO NOT remove more than .010" (.25 mm) from end of valve stem when resurfacing tip.

CYLINDER BLOCK ASSEMBLY

Pistons & Rod Assembly

Ensure pistons and rods are installed in their original cylinder. Ensure notch on piston top faces forward, and numbered side of rod faces outward. See **Fig. 8** . Check side play of connecting rod. See **CONNECTING RODS** table under ENGINE SPECIFICATIONS.

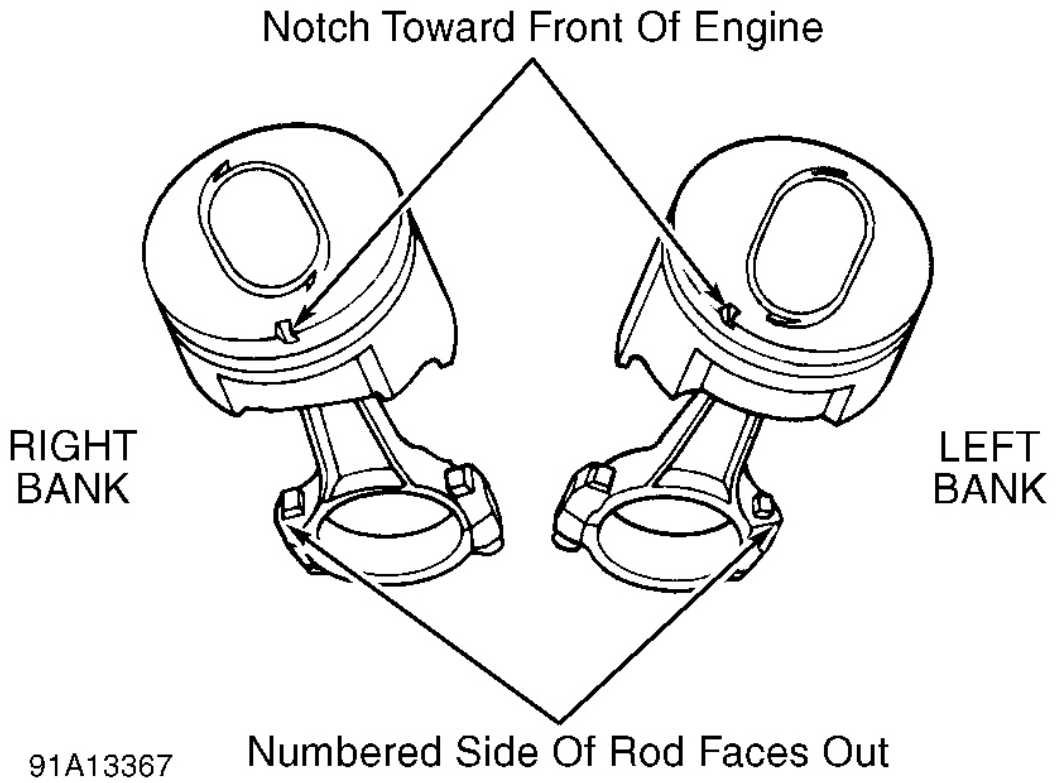


Fig. 8: Positioning Piston & Rod
Courtesy of FORD MOTOR CO.

Fitting Pistons

1. Check piston-to-bore clearance. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS. Standard size pistons are color-coded Red, Blue or Yellow on piston dome. Oversize pistons are also available.
2. If bore diameter is in lower one-third of specification, use a Red coded piston. If bore diameter is in middle one-third of specification, use a Blue coded piston. If bore diameter is in upper one-third of specification, use Yellow coded piston. Use proper size piston to obtain specified clearance. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.

Piston Rings

1. Select rings for bore diameter. Place ring in cylinder bore in which it will be installed. Use piston to square ring in bore and place ring below normal ring wear area. Measure ring end gap. If ring end gap is not within specification, try another ring set. See **PISTONS, PINS & RINGS** table.
2. Check side clearance of rings after installing on piston. Ensure clearance is within specification around entire circumference. Replace piston and/or rings if clearance is not within specification. See **PISTONS, PINS & RINGS** table. Ensure rings are properly spaced on piston before installing pistons into cylinder. See **Fig. 9** .

Piston Pin Replacement

1. Using an arbor press and Piston Pin Remover/Installer (T68P-6135-A), press piston pin from piston and connecting rod. See **Fig. 10** . Ensure connecting rod piston pin bore and piston pin are within specification. See **CONNECTING RODS** and **PISTONS, PINS & RINGS** tables under ENGINE SPECIFICATIONS.
2. Apply light coat of engine oil to all parts to be assembled. Assemble piston to connecting rod, with numbered side of rod toward outside of engine and notch in piston head toward front of engine. See **Fig. 8** .
3. Position piston pin in piston and connecting rod. Using arbor press and pin remover/installer, press pin into piston and connecting rod until end of pin is 1/16 - 1/8" (1.6-3.2 mm) below chamfer of piston pin bore.

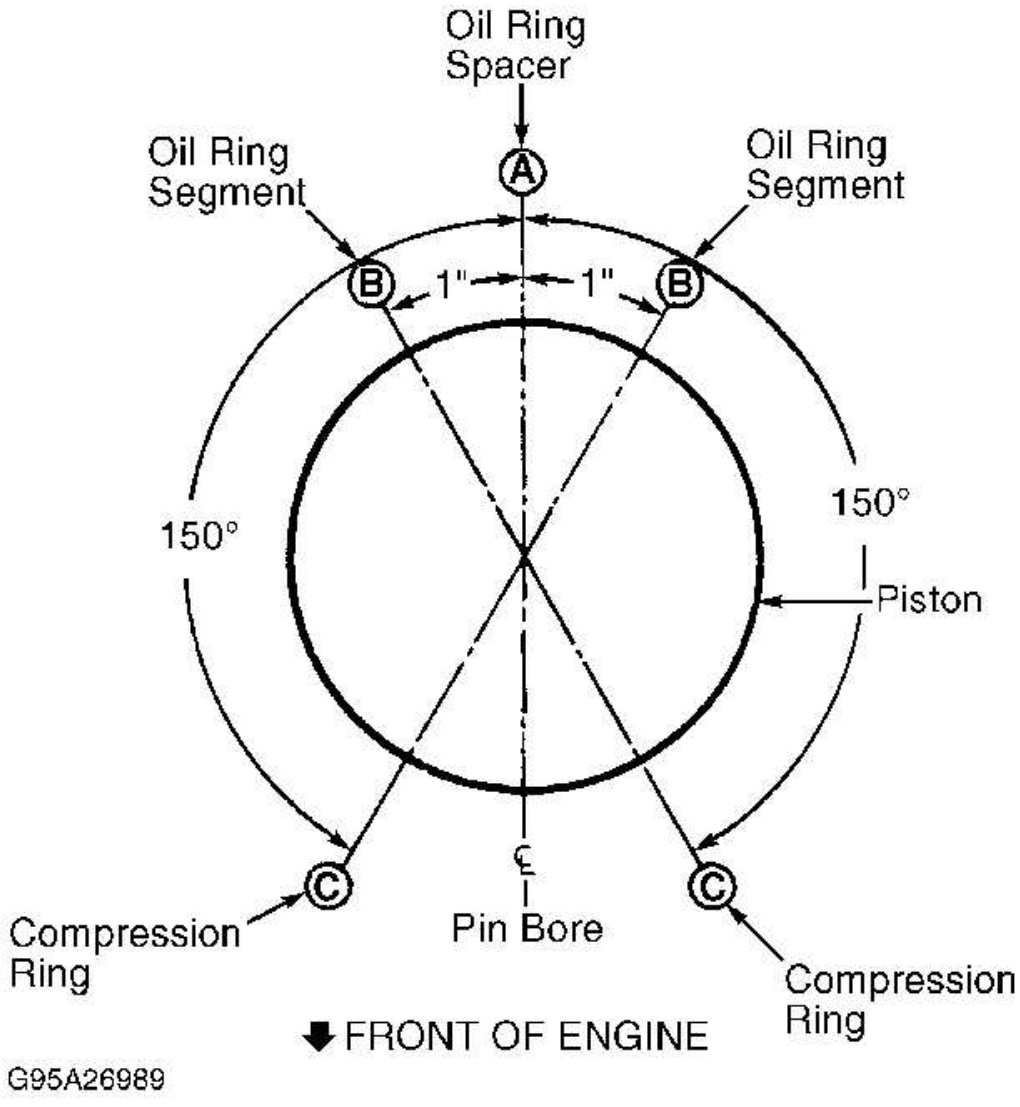


Fig. 9: Positioning Rings On Piston
Courtesy of FORD MOTOR CO.

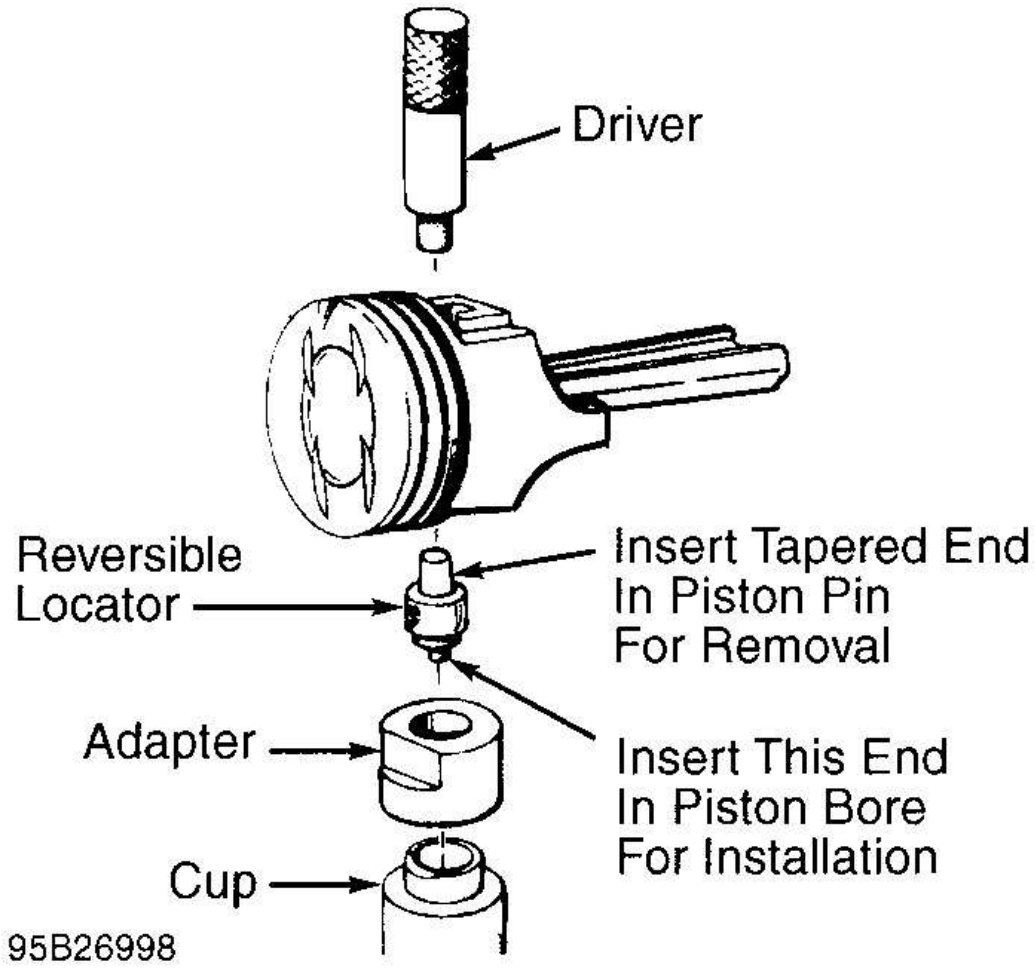


Fig. 10: Removing & Installing Piston Pin
Courtesy of FORD MOTOR CO.

Rod Bearings

1. Use Plastigage to check rod bearing clearance. If proper oil clearance cannot be obtained with standard bearings, try a combination of undersize bearings. DO NOT use any bearing combination other than those listed. See **UNDERSIZE MAIN & ROD BEARING COMBINATIONS** table.
2. If use of bearing combinations does not bring clearance within specification, machine or replace crankshaft as necessary. Always replace bearings in pairs. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

UNDERSIZE MAIN & ROD BEARING COMBINATIONS (1)

Excess Bearing Clearance In. (mm)	Use Upper Bearing In. (mm)	Use Lower Bearing In. (mm)
.0-.0005 (.0-.013)	.001 (.025)	(2)
.0005-0010 (.013-.025)	.001 (.025)	.001 (.025)
.0010-.0015 (.025-.039)	.002 (.050)	.001 (.025)
.0015-.0020 (.039-.050)	.002 (.050)	.002 (.050)

(1) DO NOT use any bearing combination other than those listed. If use of bearing combinations does not bring clearance within specification, machine or replace crankshaft as necessary.

(2) Use standard bearing.

Crankshaft & Main Bearings

1. When checking main bearing clearance in vehicle, position a jack under adjoining bearing counterweight being checked. Remove only one main bearing cap at a time.
2. Use Plastigage to check main bearing clearance. If proper oil clearance cannot be obtained with standard bearings, try a combination of undersize bearings. DO NOT use any bearing combination other than what is listed. See **UNDERSIZE MAIN & ROD BEARING COMBINATIONS** table.
3. If use of bearing combinations does not bring clearance within specification, machine or replace crankshaft as necessary. Always replace bearings in pairs. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

NOTE: Ensure main bearing oil holes are aligned with cylinder block oil holes.

4. Install all bearing caps except thrust bearing cap (No. 3 from front of engine). Tighten main bearing cap bolts to specification. See **TORQUE SPECIFICATIONS** . Install No. 3 bearing cap and tighten bolts finger tight.
5. Pry crankshaft forward and pry No. 3 bearing cap to rear of engine to align thrust bearing. While retaining forward pressure on crankshaft, tighten bearing cap to specification. See **TORQUE SPECIFICATIONS** .
6. Ensure crankshaft end play is within specification. Replace thrust bearing if end play is not within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table.

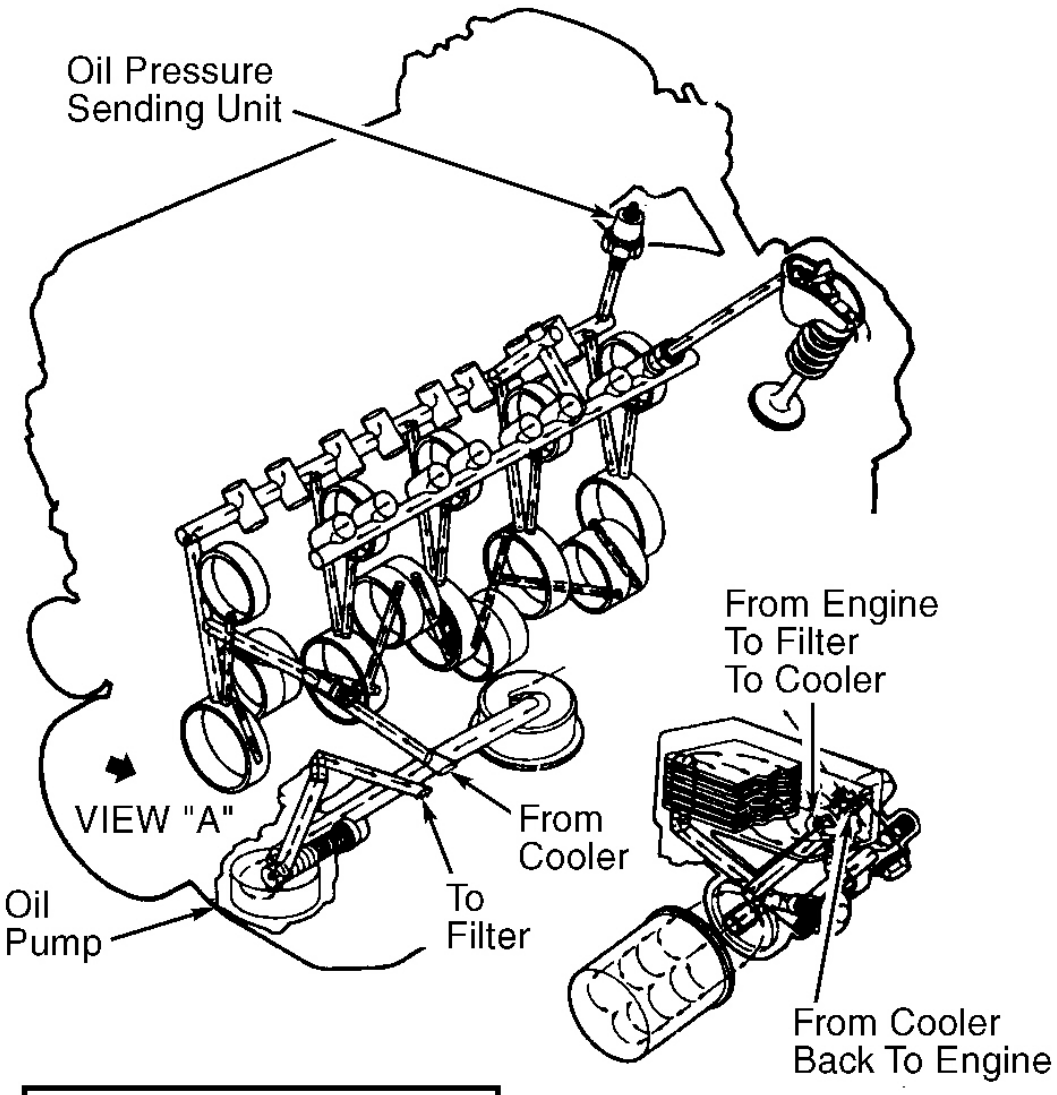
Cylinder Block

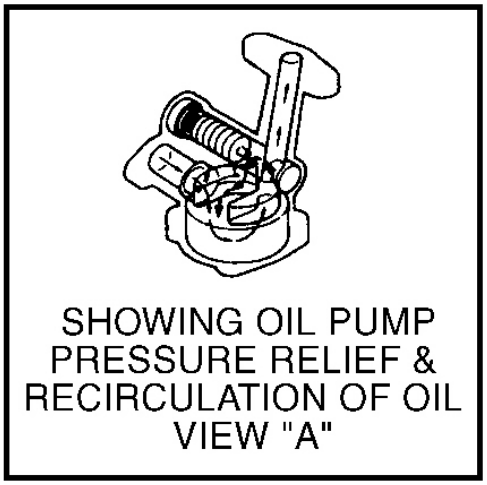
1. Using a feeler gauge and straightedge, check cylinder block head gasket surface for warpage. Check cylinder bore for wear, taper, out-of-round and piston fit. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS.

CAUTION: DO NOT machine more than .010" (.25 mm) of material from original cylinder block-to-head surface.

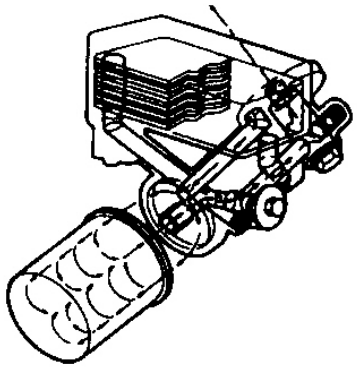
2. Install all main bearing caps and tighten to specification before honing cylinder bore. Ensure bearing caps are installed in their original location, with arrow on cap pointing toward front of engine.

3. Use ONLY a spring-loaded type cylinder hone. After honing, thoroughly clean bore with detergent and water solution. Rinse solution from bore thoroughly with clean water. Wipe bore clean with lint-free cloth. Lubricate cylinder bores with engine oil.





SHOWING OIL PUMP PRESSURE RELIEF & RECIRCULATION OF OIL VIEW "A"



VIEW SHOWING OIL COOLER BY-PASS FEATURE

93C75913

Fig. 11: Cross-Sectional View Of Engine Oil Circuit
Courtesy of FORD MOTOR CO.

ENGINE OILING

ENGINE LUBRICATION SYSTEM

Engine lubrication is a force-feed system. Oil is supplied under full pressure to oil filter/oil cooler, main gallery, crankshaft, connecting rods, camshaft bearings and valve lifters. A controlled volume of oil is supplied to rocker arms through push rods. All other moving parts are lubricated by splash or gravity flow. See **Fig. 11** .

Crankcase Capacity

Crankcase capacity is 5 qts. (4.75L). Add one additional quart (.95L) when replacing oil filter.

Oil Pressure

Normal oil pressure at 2000 RPM should be 40-88 psi (2.8-6.2 kg/cm^2) with engine at operating temperature.

Oil Pressure Relief Valve

Nonadjustable oil pressure regulator valve is located in pump body.

OIL PUMP

Removal & Disassembly

Oil pump and oil pan must be removed together. See OIL PAN under **REMOVAL & INSTALLATION** . Disassemble oil pump. Note direction of component installation for reassembly reference.

Inspection

1. Clean all parts thoroughly. Check pump housing, outer rotor, inner rotor, shaft and pump cover for damage, scoring or excessive wear. See **OIL PUMP SPECIFICATIONS** table. Remove rotor assembly from pump housing. Using feeler gauge, measure inner-to-outer rotor tip clearance.
2. Install rotor assembly in pump housing. Place a straightedge over rotor assembly and housing. Insert feeler gauge between straightedge and housing to measure rotor end play. Using a feeler gauge, measure clearance between outer rotor and pump housing.

OIL PUMP SPECIFICATIONS

Application	In. (mm)
Inner-To-Outer Rotor Tip Clearance	.012 (.30)
Outer Rotor-To-Housing Clearance	.001-.013 (.03-.33)
Relief Valve Spring Tension	(1)
Relief Valve-To-Bore Clearance	.0015-.0030 (.038-.076)

Rotor End Play	.004 (.10) Max.
Shaft-To-Housing Clearance	.0015-.0030 (.038-.076)
(1) Spring tension should be 20.6-22.6 Lbs. @ 2.49" (9.3-10.3 kg. @ 63.2 mm).	

Reassembly & Installation

1. To reassemble, reverse disassembly procedure. Ensure components are installed in original location. Ensure oil pump spins freely after reassembly. To install, prime oil pump by filling inlet opening with oil and rotating pump shaft until oil emerges from outlet opening.
2. Install oil pump assembly and pan. To complete installation, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Bellhousing-To-Engine Bolt	38-52 (51-70)
Camshaft Sprocket Bolt	40-50 (54-68)
Connecting Rod Nut	45-50 (61-68)
Crankshaft Pulley Bolt	40-53 (54-72)
Cylinder Head Bolt (1)	
Step 1	70-80 (95-108)
Step 2	100-110 (136-149)
Step 3	130-140 (176-190)
Exhaust Manifold Bolt	25-35 (34-47)
Flexplate-To-Converter Bolt	25-34 (34-46)
Flywheel-To-Crankshaft Bolt	75-85 (103-115)
Front Engine Mount Nut	60-80 (81-108)
Front Engine Mount Through-Bolt	40-58 (54-78)
Lower Intake Manifold Bolts/Nuts (2)	
Step 1	8-12 (11-16)
Step 2	12-22 (16-30)
Step 3	22-35 (30-47)
Step 4	(3)
Main Bearing Cap Bolt	95-105 (129-142)
Oil Pan-To-Engine Block Bolt	(4)
Oil Pump Attaching Bolt	22-32 (30-43)
Rocker Arm Fulcrum Bolt	18-25 (25-34)
Timing Chain Cover	12-18 (16-24)
Upper Intake Manifold Bolt	12-18 (16-24)

Vibration Damper-To-Crankshaft Bolt	70-90 (95-122)
Water Pump Bolt	12-18 (16-24)
	INCH Lbs. (N.m)
Camshaft Thrust Plate Bolt	89-133 (10-15)
Valve Cover Bolt (5)	108-132 (12-15)

(1) Tighten in sequence. See **Fig. 3** .

(2) Tighten in sequence. See **Fig. 2** .

(3) Allow engine to reach normal operating temperature. Retighten lower exhaust manifold bolts/nuts to 22-35 ft. lbs. (30-47 N.m).

(4) Tighten bolts to 71-108 INCH lbs. (8-12 N.m).

(5) Tighten in sequence, from rear to front of engine.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	**Specification**
Displacement	460 Cu. In. (7.5L)
Bore	4.36" (110.7 mm)
Stroke	3.85" (97.8 mm)
Compression Ratio	8.5:1
Fuel System	MFI
Horsepower @ RPM	
Except F350 Super Duty	245 @ 4000
F350 Super Duty	255 @ 4000
Torque Ft. Lbs. @ RPM	
Except F350 Super Duty	397 @ 2400
F350 Super Duty	405 @ 2400

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

Application	**In. (mm)**
Crankshaft	
End Play	
Standard	.004-.008 (.10-.20)
Service Limit	.012 (.30)
Main Bearings	
Journal Diameter	2.9994-3.0002 (76.185-76.205)
Journal Taper	.0005 (.013)
Journal Runout	
Standard	.002 (.05)

Service Limit	.005 (.13)
Maximum Journal Out-Of-Round	.0006 (.02)
Oil Clearance	
Bearing No. 1	.0004-.0022 (.010-.056)
All Others	.0009-.0027 (.023-.069)
Connecting Rod Bearings	
Journal Diameter	2.4992-2.5000 (63.480-63.500)
Journal Taper	.0006 (.02)
Maximum Journal Out-Of-Round	.0006 (.02)
Oil Clearance	
Desired	.0008-.0015 (.020-.038)
Allowable	.0008-.0025 (.020-.064)

CONNECTING RODS

Application	**In. (mm)**
Bore Diameter	
Pin Bore	1.0386-1.0393 (26.380-26.398)
Crankpin Bore	2.6522-2.6530 (67.366-67.386)
Center-To-Center Length	6.6035-6.6065 (167.729-167.805)
Maximum Bend (1)	.012 (.30)
Maximum Twist (1)	.024 (.61)
Side Play	
Standard	.010-.020 (.25-.51)
Service Limit	.023 (.058)
(1) Specification listed is measured at ends of an 8" (203 mm) bar, 4" (102 mm) on each side of rod center line.	

PISTONS, PINS & RINGS

Application	**In. (mm)**
Pistons	
Clearance	.0014-.0022 (.036-.056)
Diameter (1)	
Red Piston	4.3585-4.3595 (110.706-110.731)
Blue Piston	4.3595-4.3605 (110.731-110.757)
Yellow Piston	4.3605-4.3615 (110.757-110.782)

Pins	
Diameter	1.0398-1.0403 (26.411-26.424)
Length	3.29-3.31 (83.6-84.3)
Piston Fit	.0002-.0005 (.005-.013)
Rod Fit	Press Fit
Rings	
No. 1 & 2	
End Gap	
Ring 1	.010-.015 (.25-.38)
Ring 2	.011-.021 (.28-.53)
Side Clearance (2)	.0012-.0022 (.030-.056)
No. 3 (Oil)	
End Gap (Steel Rail)	.010-.030 (.25-.76)
Side Clearance (2)	Snug

(1) Standard pistons are color-coded Red, Blue and Yellow on piston dome.

(2) .002" maximum increase in clearance.

CYLINDER BLOCK

Application	**In. (mm)**
Cylinder Bore	
Diameter	
Red	4.3600-4.3612 (110.744-110.744)
Blue	4.3612-4.3624 (110.744-110.805)
Yellow	4.3624-4.3636 (110.805-110.835)
Maximum Out-Of-Round	
Standard	.0015 (.038)
Service Limit	.005 (.13)
Maximum Taper	.010 (.25)
Maximum Deck Warpage (1)	.003 (.08)

(1) Specification is within any 6" (152 mm) area. Overall warpage is .006" (.15 mm). DO NOT machine more than .010" (.25 mm) from original gasket surface.

VALVES & VALVE SPRINGS

Application	**Specification**
Face Angle	44°
Face Runout	.002" (.051 mm)
Head Diameter	

Intake	2.075-2.090" (52.7-53.1 mm)
Exhaust	1.646-1.661" (41.81-42.19 mm)
Stem Diameter	.3415-.3421" (8.674-8.689 mm)
Valve Margin	.031" (.79 mm)
Valve Springs	
Free Length	2.06" (52.3 mm)
Installed Height	1.78-1.84" (45.2-46.7 mm)
Out-Of-Square	.078" (1.98 mm)
	Lbs. @ In. (kg @ mm)
Pressure (Intake & Exhaust)	
Closed	76-84 @ 1.81 (34-38 @ 46)
Open	218-240 @ 1.33 (99-109 @ 34)

CYLINDER HEAD

Application	**Specification**
Maximum Warpage (1)	.003" (.08 mm)
Valve Seats	
Seat Angle	45°
Seat Width	.060-.080" (1.52-2.03 mm)
Maximum Seat Runout	.002" (.05 mm)
Valve Guides	
Valve Guide Bore I.D.	.3433-.3443" (8.720-8.745 mm)
Valve Stem-To-Guide	
Standard	.0010-.0027" (.025-.069 mm)
Service Limit	.0055" (.140 mm)

(1) Specification is taken within any 6" (152 mm) area. Overall warpage is .006" (.15 mm). DO NOT machine more than .010" (.25 mm) from original cylinder head thickness.

CAMSHAFT

Application	**In. (mm)**
Camshaft Bearing I.D.	2.1258-2.1268 (53.995-54.021)
Journal Diameter	2.1238-2.1248 (53.945-53.970)
End Play	
Standard	.001-.006 (.03-.15)
Service Limit	.009 (.23)
Lobe Lift	
Intake	.252 (6.40)
Exhaust	.278 (7.06)
Lobe Wear	.005 (.13)
Maximum Journal Runout	.005 (.13)

Oil Clearance	
Standard	.001-.003 (.03-.08)
Service Limit	.006 (.15)
Timing Chain Deflection	.500 (12.7)

VALVE LIFTERS

Application	**In. (mm)**
Lifter Diameter	.8740-.8745 (22.200-22.212)
Oil Clearance	
Standard	.0007-.0027 (.018-.069)
Service Limit	.005 (.13)
Collapsed Lifter Clearance	
Desired	.100-.150 (2.54-3.81)
Allowable	.075-.175 (1.91-4.45)

AIR BAG RESTRAINT SYSTEM (F150 & F250 LD)

1997 ACCESSORIES/SAFETY EQUIPMENT Ford Motor Co. - Air Bag Restraint System

IDENTIFICATION

WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all WARNINGS and SERVICE PRECAUTIONS .

Vehicle is equipped with driver-side air bag which is identified by a letter "L" in fourth position of Vehicle Identification Number (VIN). VIN is located on top of instrument panel, near lower left corner of windshield. VIN is also stamped on Vehicle Certification (VC) label, mounted on left front door pillar.

The words Supplemental Restraint System (SRS) are embossed on steering wheel center hub. A label denoting that vehicle is equipped with air bag is affixed to driver-side sun visor.

DESCRIPTION & OPERATION

The Supplemental Restraint System (SRS) is designed to provide increased accident protection for driver and passenger by deploying air bags in a front-end collision. The air bags, stored in center of steering wheel and in instrument panel above glove box, deploy in about 40 milliseconds after impact sensors close. SRS is designed to be used with 3-point safety belts.

During a front-end collision of sufficient force, both a front impact sensor and a safing sensor will activate simultaneously to inflate air bag. When a front impact sensor and safing sensor are closed at same time, electrical current will flow, igniting the driver-side and passenger-side air bag module.

SRS includes following components: diagnostic monitor, driver-side air bag module, passenger-side air bag module and deactivation switch, SRS readiness light (AIR BAG warning light), front impact sensor and safing sensor, ignitor assemblies (in air bag modules), clockspring and associated wiring harnesses. See **Fig. 1** .

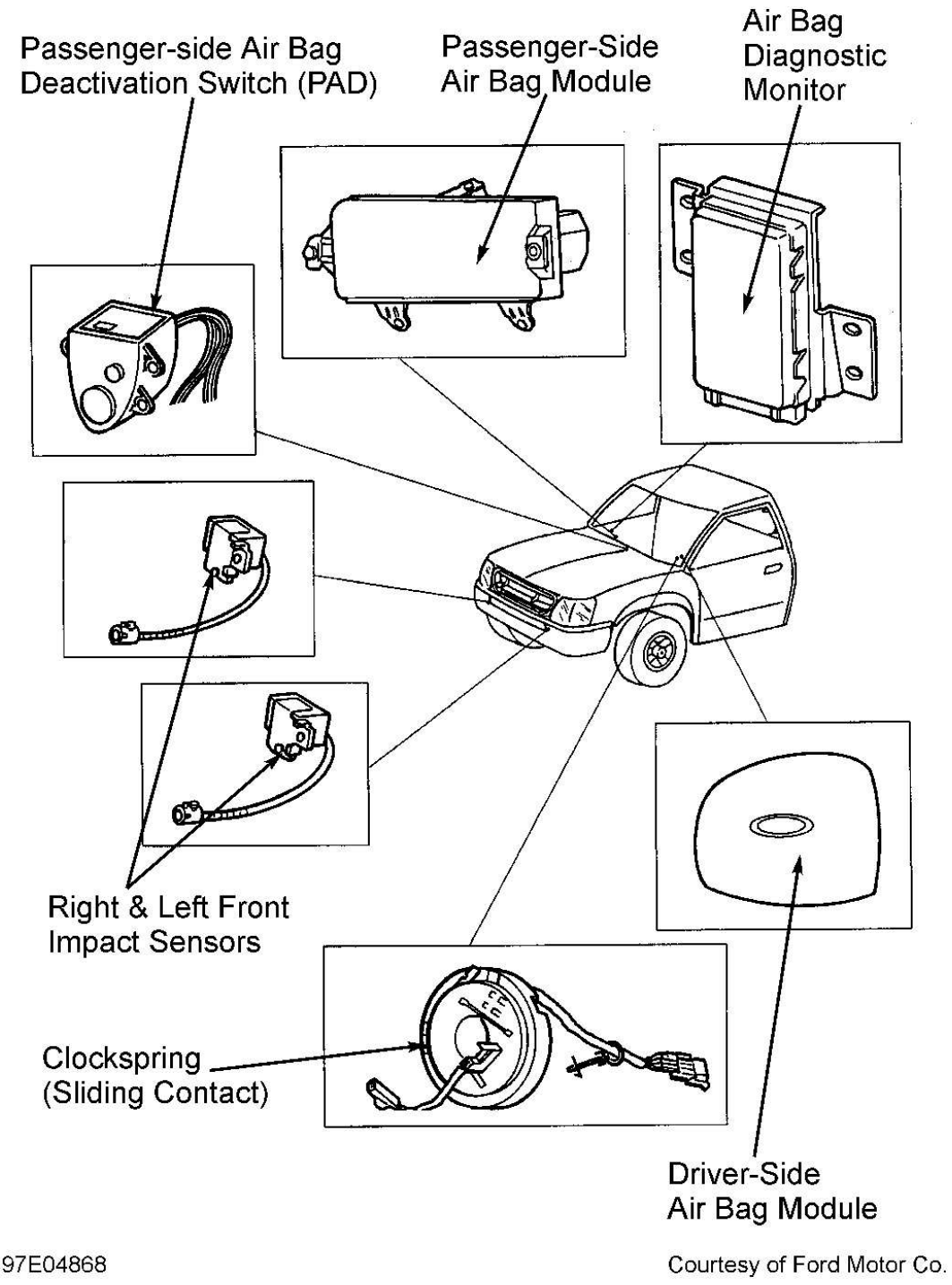


Fig. 1: Locating SRS Components
Courtesy of FORD MOTOR CO.

BACK-UP POWER SUPPLY

A back-up power supply is used on all models and is located inside diagnostic monitor. If battery or battery cables are damaged in a collision before front impact sensors close circuit, back-up power supply will deploy air bag. Back-up power supply will hold a deployment charge for approximately one minute after positive battery cable is disconnected.

CLOCKSPRING

The steering column contains a clockspring to transfer electrical signals from steering column wiring harness to driver-side air bag module. Clockspring is mounted to steering column behind steering wheel.

DIAGNOSTIC MONITOR

The diagnostic monitor (located on left side of steering column underneath instrument panel) contains a microcomputer, which monitors electrical system components and connections. Diagnostic monitor performs a system self-check of SRS internal circuits every time ignition switch is turned to RUN position. Monitor also energizes SRS readiness indicator light (AIR BAG warning light) during initial system self-check and whenever a fault is detected. Faults are translated into flash codes and are displayed through AIR BAG warning light.

If a system fault exists and/or AIR BAG warning light is malfunctioning, an audible tone will sound, indicating need for service. See **TONE GENERATOR** . Diagnostic monitor can also disarm SRS if certain faults occur.

The air bag diagnostic monitor does not deploy air bags in the event of a collision. The right or left front impact sensors and safing sensor determine air bag deployment. The safing sensor is internal to air bag diagnostic monitor and is not replaced separately.

DRIVER-SIDE AIR BAG MODULE

The driver-side air bag module is mounted on center of steering wheel, covered by steering wheel trim cover. When a front impact sensor and safing sensor close, signaling an impact, ignitor triggers inflator. During ignition, sodium azide reacts with copper oxide, producing nitrogen gas, which inflates air bag.

When air bag deploys, tear-seams molded into steering wheel trim cover separate, allowing inflation of air bag assembly. Driver-side air bag module is not serviceable and must be replaced as a complete assembly.

PASSENGER-SIDE AIR BAG MODULE

The passenger-side air bag module is mounted in right side of instrument panel, above glove box. When a front impact sensor and safing sensor close, signaling an impact, air bag igniters trigger inflator.

Since passenger-side air bag is larger than driver-side air bag, inflator contains more gas generant in a different configuration to produce more gas. When air bag is activated, instrument panel trim cover tears at seams and hinges, allowing inflation. Passenger-side air bag module is only serviced as a complete assembly.

PASSENGER-SIDE AIR BAG DEACTIVATION SWITCH

The Passenger-side Air bag Deactivation (PAD) switch is located on center instrument panel, below climate control vent, and contains a light diode (LED) that indicates when PAD switch is activated. This switch allows the passenger-side air bag deployment circuit to be disabled by inserting ignition key into PAD switch lock cylinder and turning key. It should be used whenever child safety seat is being used in front passenger-side seating position.

ELECTRICAL SYSTEM

SRS is powered directly from battery and can function with ignition switch in any position, including OFF and LOCK. System can also function when driver-side seat is unoccupied. The 3 main functions performed by electrical subsystem are: detecting an impact, switching electric power to igniters for air bag, and monitoring readiness of SRS.

FRONT IMPACT SENSORS

Front impact sensors are located at right and left sides of radiator support. Each impact sensor reacts to impacts according to direction and force. It discriminates between impacts that require air bag inflation and impacts that do not.

When an impact occurs requiring air bag inflation, impact sensor contacts close, completing electrical circuit necessary for system operation. At least 2 sensors, safing sensor and one front impact sensor, must be activated simultaneously to inflate air bag.

TONE GENERATOR

AIR BAG warning light is prime means of determining SRS condition; however, a series of 5 audible tones, indicating that system requires servicing, will sound if AIR BAG warning light is out, and a fault occurs in system. Unless serviced, SRS may not function properly in an accident. Tone generator is located within diagnostic monitor.

SYSTEM OPERATION CHECK

1. When checking SRS operation, and upon completion of each diagnostic test, check for faults in SRS. To check system, turn ignition switch to RUN position. If AIR BAG warning light illuminates for 4-8 seconds and then goes out, SRS is functioning properly and no fault codes exist.
2. If a fault code is detected in SRS during initial system check, AIR BAG warning light will either fail to light, stay on continuously, or flash a code sequence. If AIR BAG warning light flashes, indicating a fault in system, count number of flashes after fault code has cycled twice. Number of flashes represents a code number used to diagnose SRS. See **DIAGNOSIS & TESTING** .
3. If a system fault exists and AIR BAG warning light fails to light, an audible tone will be heard, indicating AIR BAG warning light is out and service is required. See **TONE GENERATOR** under DESCRIPTION & OPERATION.

SERVICE PRECAUTIONS

These precautions should be observed when working with SRS:

- Disable SRS before servicing any SRS or steering column components. Failure to do so may result in accidental air bag deployment and personal injury. See procedures under **DISABLING & ACTIVATING AIR BAG SYSTEM** .
- Wait one minute after disabling SRS before working on vehicle. Back-up power supply holds a deployment charge for approximately one minute after positive battery cable is disconnected. Servicing SRS before one minute may cause accidental air bag deployment and possible personal injury.
- Because of critical system operating requirements, DO NOT service impact sensors, clockspring, diagnostic monitor or air bag module. Repairs are made by replacement only.
- Always wear safety glasses whenever servicing an air bag equipped vehicle or handling an air bag.
- When carrying a live air bag module, ensure air bag module and trim cover are pointed away from your body. This minimizes chance of injury in event of an accidental deployment.
- When placing a live air bag module on a bench or other surface, always face air bag module and trim cover facing up and away from surface. This will reduce motion of module if it is accidentally deployed.
- After deployment, air bag surface may contain deposits of sodium hydroxide, which may irritate skin. Sodium hydroxide is a product of gas generant combustion. Always wear gloves and safety glasses when handling a deployed air bag. Wash your hands using mild soap and water. Follow correct disposal procedures. See **DISPOSAL PROCEDURES** .
- If scrapping a vehicle with an undeployed air bag module, air bag must be deployed. See **DISPOSAL PROCEDURES** .
- If a part is replaced and new part does not correct condition, reinstall original part and perform diagnostic procedure again.
- Never probe connectors on air bag module. Doing so may cause air bag deployment and/or personal injury.
- Instruction to disconnect always refers to connector. DO NOT remove component from vehicle if instructed to disconnect.
- After any servicing, ensure AIR BAG warning light does not indicate any fault codes. See **SYSTEM OPERATION CHECK** .
- Replace air bag module if trim cover (deployment doors) is marred or damaged. DO NOT repaint trim cover. Paint may degrade cover material. Replace air bag module as necessary. See PROCEDURE 1 under **SCRAPPED VEHICLE** under DISPOSAL PROCEDURES.

DISABLING & ACTIVATING AIR BAG SYSTEM

WARNING: Wait one minute after disabling SRS before working on vehicle. Back-up power supply holds a deployment charge for approximately one minute after positive battery cable is disconnected. Servicing SRS before one minute may cause accidental air bag deployment and possible personal injury.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES in GENERAL INFORMATION before DISCONNECTING

BATTERY.

DISABLING SYSTEM

NOTE: Following disabling procedure should be used for component replacement purposes only. If vehicle was involved in a collision and air bag did not deploy or if SRS is not functioning properly, and vehicle needs to be driven, complete system deactivation is required. See COMPLETE SYSTEM DEACTIVATION .

Disconnect ground battery cable. SRS contains a back-up power supply built into air bag diagnostic monitor. Wait at least one minute before servicing any air bag components. System is now disabled. To activate SRS, see **ACTIVATING SYSTEM** .

ACTIVATING SYSTEM

Connect ground battery cable. System is now activated. From outside of vehicle (driver-side), turn ignition switch to RUN position. Check AIR BAG warning light for system fault codes. Perform system operation check to ensure SRS is functioning properly. See **SYSTEM OPERATION CHECK** .

COMPLETE SYSTEM DEACTIVATION

WARNING: Back-up power supply will hold a deployment charge for approximately one minute after positive battery cable is disconnected. Servicing SRS before one minute may cause accidental air bag deployment and possible personal injury. Always deactivate driver-side module before attempting any service procedures.

NOTE: Complete system deactivation sequence is required for following situations:

- Vehicle was involved in a collision, air bag did not deploy, and vehicle needs to be driven.
- SRS is not functioning properly, and vehicle needs to be driven.
- Diagnosis and testing purposes.

1. Disconnect ground battery cable. Wait at least one minute to deplete charge in back-up power supply. Remove driver-side air bag module. See **DRIVER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION. Connect Air Bag Simulator (105-00010) to harness at top of steering column.
2. Remove passenger-side air bag module. See **PASSENGER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION. Connect Air Bag Simulator (105-00010) to harness in place of air bag module. Reconnect ground battery cable. To reactivate SRS, see **COMPLETE SYSTEM REACTIVATION** .

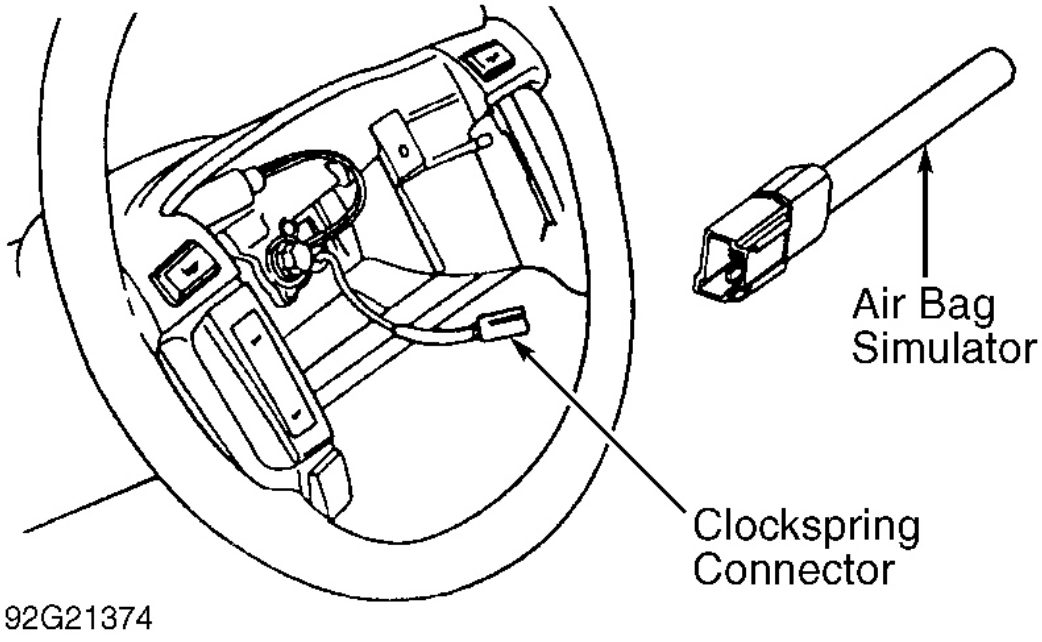


Fig. 2: Installing Air Bag Simulator
Courtesy of FORD MOTOR CO.

COMPLETE SYSTEM REACTIVATION

1. Disconnect ground battery cable. Wait at least one minute to deplete charge in back-up power supply. Remove Air Bag Simulator (105-00010) from harness connector at steering wheel. Install driver-side air bag module. See **DRIVER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION.
2. Remove Air Bag Simulator (105-00010) from harness connector on passenger-side. Install passenger-side air bag module. See **PASSENGER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION. Reconnect ground battery cable. System is now reactivated. Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** .

DISPOSAL PROCEDURES

WARNING: Refer to SERVICE PRECAUTIONS before proceeding.

Air bag disposal may be necessary in following situations:

- Scrapping vehicle with deployed air bag.
- Scrapping vehicle with live air bag.

- Disposal of a live but electrically faulty air bag module.
- Disposal of a deployed air bag module.

AIR BAG DISPOSAL PROCEDURES

Condition	Instructions
Module Replacement	
Deployed Air Bag	(1) Dispose Of In Usual Manner
Faulty But Live Air Bag Module	(2) Return For Disposal
Vehicle To Be Scrapped	
Deployed Air Bag	(1) Dispose Of In Usual Manner
Live Air Bag	(3) Deploy Air Bag Using PROCEDURE 1

(1) See **DEPLOYED AIR BAG** .

(2) See **UNDEPLOYED AIR BAG** .

(3) See **SCRAPPED VEHICLE** .

DEPLOYED AIR BAG

Dispose of deployed air bag module as any other part. Air bag module components are not reusable.

UNDEPLOYED AIR BAG - FAULTY UNIT

If an undeployed air bag module is diagnosed as faulty, remove air bag module and return intact to Ford Motor Company for proper disposal. Return carton for warranty claim credit. Air bag must be packaged and shipped according to U.S. Department of Transportation. Retain replacement packaging including label. DO NOT deploy air bag.

SCRAPPED VEHICLE

CAUTION: DO NOT dispose of undeployed air bag module without first deploying air bag. If this is not possible through procedures outlined, contact vehicle manufacturer for further instructions.

If vehicle is to be scrapped, undeployed air bag module must first be deployed. Use one of following procedures for deployment of air bag.

Procedure 1: Remote Deployment Of Air Bag

This procedure is to be used when a vehicle with a live driver-side air bag is to be scrapped, but a problem in air bag electrical system prevents deployment with air bag still installed in vehicle. This procedure can also be used

if PROCEDURE 1 was unsuccessful.

WARNING: Perform remote deployment outdoors. Keep all personnel at least 20 feet away to ensure physical and hearing safety from projected objects and loud noise of air bag deployment.

1. Before proceeding, see **SERVICE PRECAUTIONS** . Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Remove driver-side and/or passenger-side air bag module. See DRIVER-SIDE AIR BAG MODULE and PASSENGER-SIDE AIR BAG MODULE under **REMOVAL & INSTALLATION** .
2. With air bag module removed, cut air bag connector from wiring harness near air bag module. Strip 1" of insulation from wire ends. Obtain 2 wires at least 20 feet long. Connect one end of each 20-foot wire to one end of each air bag module wire.

WARNING: When placing a live air bag on a bench or other surface, always face air bag and trim cover up and away from surface. This will reduce motion of air bag module if it is accidentally deployed.

3. Place air bag module with trim cover facing upward on a flat surface, in remote area such as parking lot or field. Remain at least 20 feet away from air bag module. Deploy air bag by touching loose ends of both wires to 12-volt battery terminals.
4. If successful, a loud noise will be heard and bag material will be visible. Allow at least 10 minutes for cooling and dissipation of air bag effluents before approaching air bag. Air bag is now inoperative. If air bag does not deploy, air bag module is faulty. Contact vehicle manufacturer for further instructions on disposal procedures.

POST-COLLISION INSPECTION

When a vehicle has been involved in a collision, certain components of the passive restraint system must be inspected or replaced. See **PASSIVE RESTRAINT SYSTEM INSPECTION** article in the GENERAL INFORMATION section for post-collision inspection information.

ADJUSTMENTS

CLOCKSPRING

Rotate clockspring rotor counterclockwise until it stops, then rotate clockwise two revolutions. Clockspring is now aligned.

WIRE REPAIR

To repair damage to sensor wiring and wiring harnesses, note the following conditions and proceed to REPAIR PROCEDURE.

- All wire splice connections must be staggered at least 2" (50 mm) apart.

- Use appropriate solder (rosin core) and proper size heat shrink tubing for size of wire being spliced.
- All repaired connections must be waterproofed using heat shrink tubing.

Repair Procedure

Cut shrink tubing about 2" long. Slide shrink tubing onto one wire end first. Strip wire ends and twist firmly together. Solder connection using rosin core, mildly activated solder. Flatten connection against wires, and slide heat shrink tubing over solder joint leaving 1/2" of tubing on each side of connection. See **Fig. 3** . Using heat gun, hair dryer, or match, heat tubing until it shrinks and adhesive oozes from each end of tubing. Connection is now waterproofed.

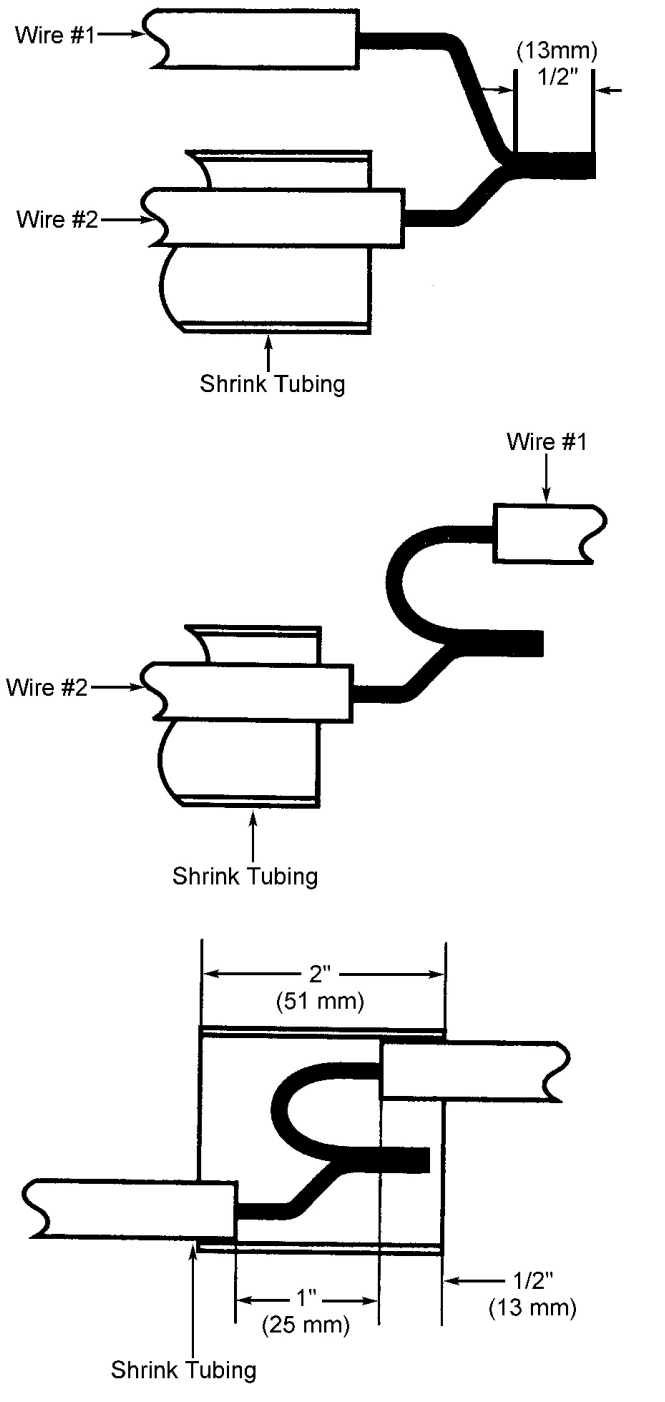


Fig. 3: Repairing & Waterproofing Wiring Connections
Courtesy of FORD MOTOR CO.

REMOVAL & INSTALLATION

WARNING: Failure to follow service precautions may result in air bag deployment and personal injury. See SERVICE PRECAUTIONS . After component replacement, ensure proper system operation. See SYSTEM OPERATION CHECK .

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES in GENERAL INFORMATION before disconnecting battery.

CLOCKSPRING

Removal

1. Before proceeding, read and carefully follow all air bag service precautions. See **SERVICE PRECAUTIONS** . Disable air bag system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Ensure vehicle front wheels are in straight-ahead position and steering column shaft alignment mark is at 12 o'clock position.
2. Remove driver-side air bag module. See **DRIVER-SIDE AIR BAG MODULE** . Twist tilt wheel handle and shank and remove, if equipped. Remove lower steering column shroud. Remove ignition switch lock cylinder by inserting key into ignition and turn to RUN position, then push in release tab while pulling out ignition switch.
3. Carefully pry to release clips and remove steering column opening cover. Remove upper steering column shroud. Clockspring contains lock to prevent rotation during steering wheel removal. If lock is missing, apply two tape strips across clockspring and housing to prevent rotation. See **Fig. 4** .
4. Remove the key-in ignition warning light switch. Disconnect clockspring electrical connector and separate connector from bracket. Pry retaining clips loose and separate wire from two retaining clips holding wire to column. Remove clockspring, feeding wiring harness through instrument panel.

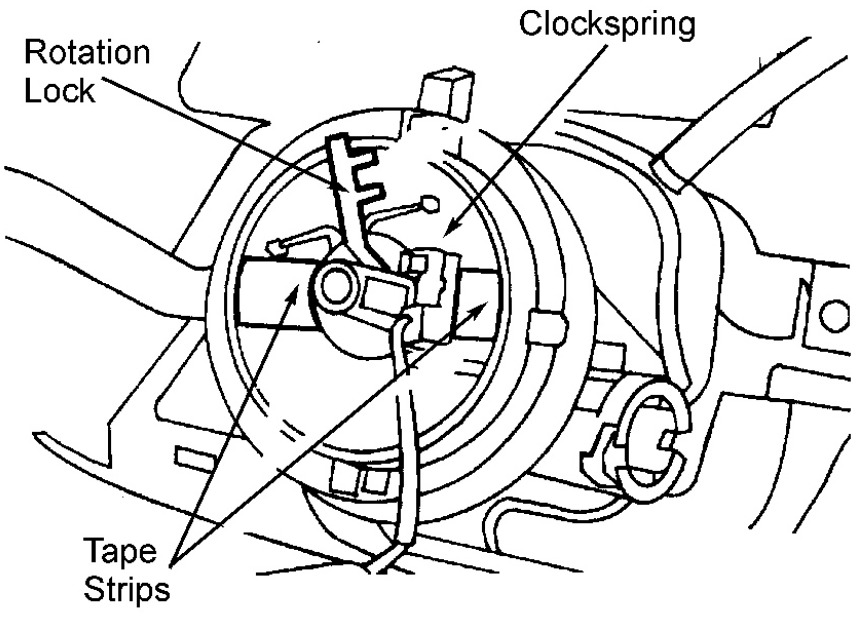


Fig. 4: Preventing Clockspring Rotation
Courtesy of FORD MOTOR CO.

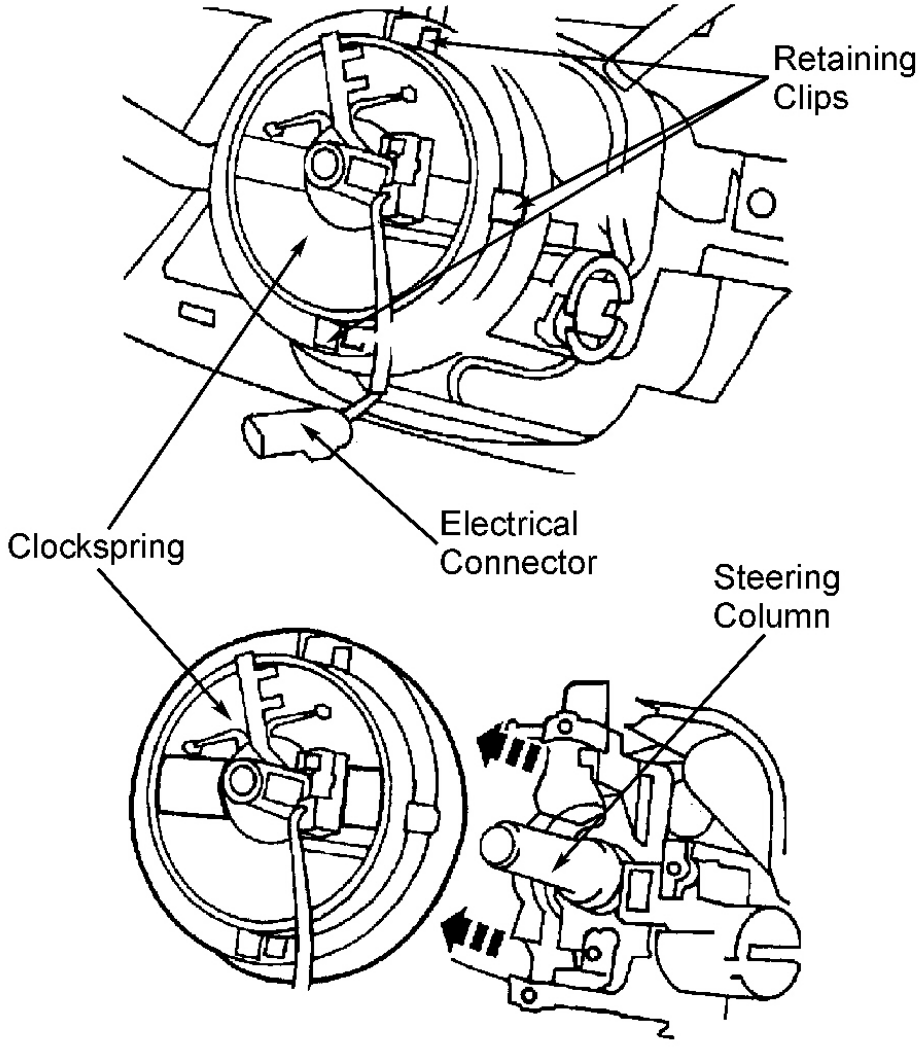


Fig. 5: Removing Clockspring From Steering Column
Courtesy of FORD MOTOR CO.

Installation

1. Ensure vehicle front wheels are in straight-ahead position and steering column shaft alignment mark is at 12 o'clock position. Clockspring contains lock to prevent rotation during steering wheel removal. If lock is missing clockspring must be realigned. See CLOCKSPRING under **ADJUSTMENTS** .
2. Properly orientate clockspring: air bag electrical pigtail should point to three o'clock position, and dot on steering shaft should be at nine o'clock position. Press at six, twelve, and three o'clock positions to install clockspring. Rotate wiring and secure into two wire clips.

3. Connect two clockspring electrical connectors and snap into bracket. Install key-in ignition warning light switch. If installing new clockspring, remove Yellow anti-rotation tab. Install upper and lower steering column shroud and opening cover. Install tilt wheel handle and shank, if equipped.
4. Install steering wheel. See **STEERING WHEEL** . Install driver-side air bag module. See **DRIVER-SIDE AIR BAG MODULE** . Reactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** .

DIAGNOSTIC MONITOR

CAUTION: When replacing air bag diagnostic monitor, with blown internal thermal fuse all short circuits and damaged wiring has been repaired. Diagnostic portion of diagnostic monitor is still intact, and must be used to diagnose and verify repairs before diagnostic monitor replacement.

Removal

1. Before proceeding, read and carefully follow all air bag service precautions. See **SERVICE PRECAUTIONS** . Disable SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .
2. Remove right cowl side trim panel. Disconnect diagnostic monitor electrical connectors. Remove screws retaining diagnostic monitor to bracket. Remove diagnostic monitor. See **Fig. 6** .

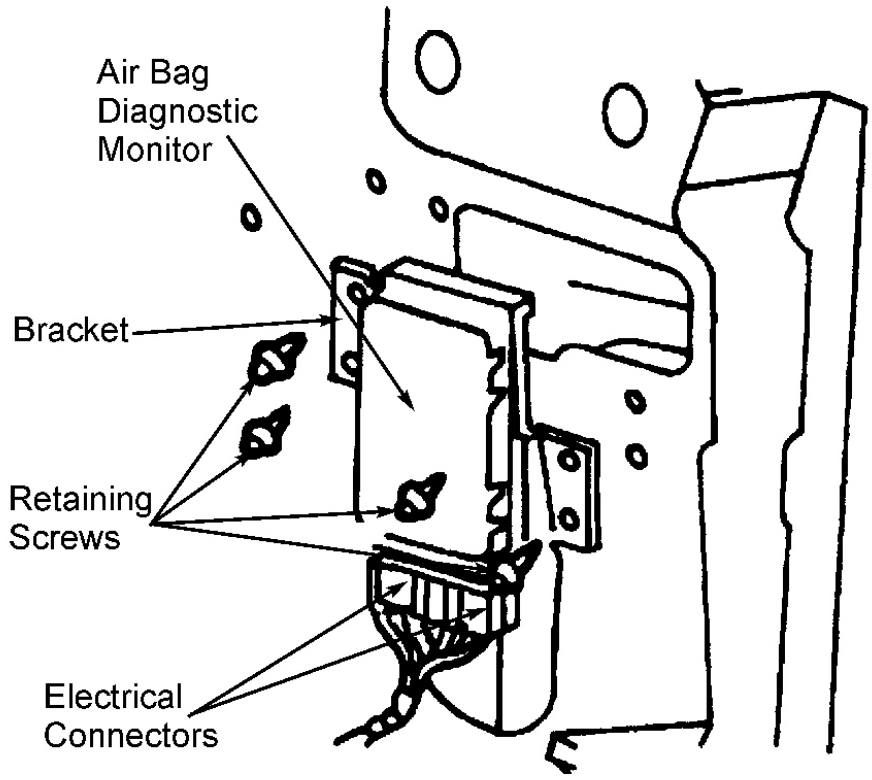


Fig. 6: Removing Air Bag Diagnostic Monitor
Courtesy of FORD MOTOR CO.

Installation

To install diagnostic monitor, reverse removal procedure. Activate air bag system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** .

DRIVER-SIDE AIR BAG MODULE

Removal

1. Before proceeding, read and carefully follow all air bag service precautions. See **SERVICE PRECAUTIONS** . Disable air bag system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .
2. Remove cover plugs on back side of steering column to access and remove screws retaining air bag module to steering wheel. See **Fig. 7** . Disconnect horn and clockspring electrical connectors from air bag module. Remove air bag module from steering wheel.

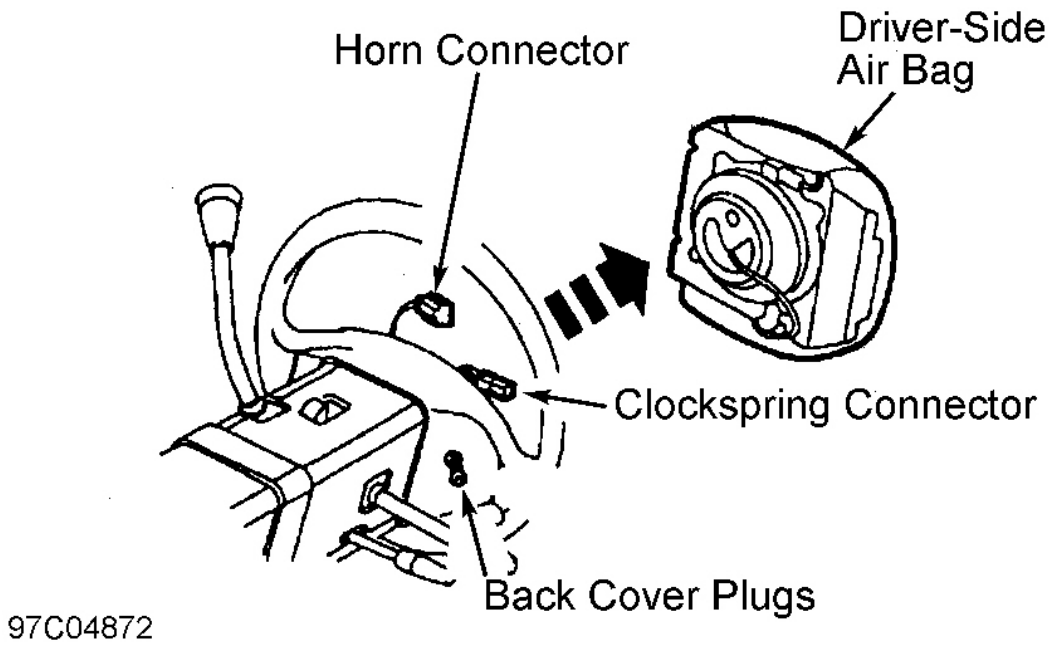


Fig. 7: Removing Driver-Side Air Bag Module
Courtesy of FORD MOTOR CO.

Installation

To install, reverse removal procedure. Tighten screws to specification. See **TORQUE SPECIFICATIONS** . Activate SRS. See procedures under **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** .

PASSENGER-SIDE AIR BAG MODULE

Removal

1. Before proceeding, read and carefully follow all air bag service precautions. See **SERVICE PRECAUTIONS** . Disable air bag system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .
2. Remove instrument panel relay cover. Remove three air bag module retaining screws. Disconnect passenger-side air bag module electrical connector. Remove air bag module. See **Fig. 8** .

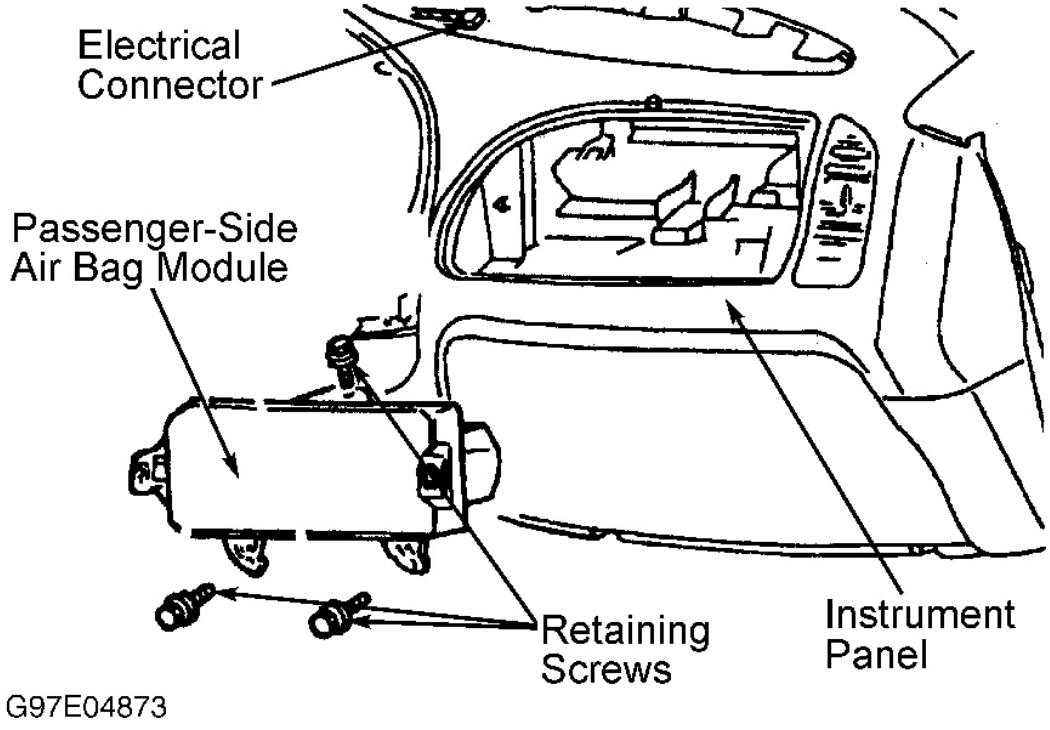


Fig. 8: Removing Passenger-Side Air Bag Module
Courtesy of FORD MOTOR CO.

Installation

To install, reverse removal procedure. Tighten air bag module retaining screws to specification. See **TORQUE SPECIFICATIONS** . Activate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** .

PAD SWITCH

Removal

1. Before proceeding, read and carefully follow all air bag service precautions. See **SERVICE PRECAUTIONS** . Disable air bag system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .
2. Remove center instrument panel finish and relay cover. Disconnect two passenger-side air bag deactivation (PAD) switch electrical connectors. Remove three screws retaining PAD switch and PAD switch.

Installation

To install, reverse removal procedure. Tighten screws to specification. See **TORQUE SPECIFICATIONS** .

Activate SRS. See procedures under **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** .

FRONT IMPACT SENSORS

Removal

1. Before proceeding, read and carefully follow all air bag service precautions. See **SERVICE PRECAUTIONS** . Disable SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .
2. Front impact sensors are located on right and left of radiator support. Remove eight push clips on radiator shield and radiator air deflector. Disconnect right and/or left front impact sensor electrical connector(s). Remove sensor retaining screws from bracket. Remove right and/or left front impact sensor. See **Fig. 9** .

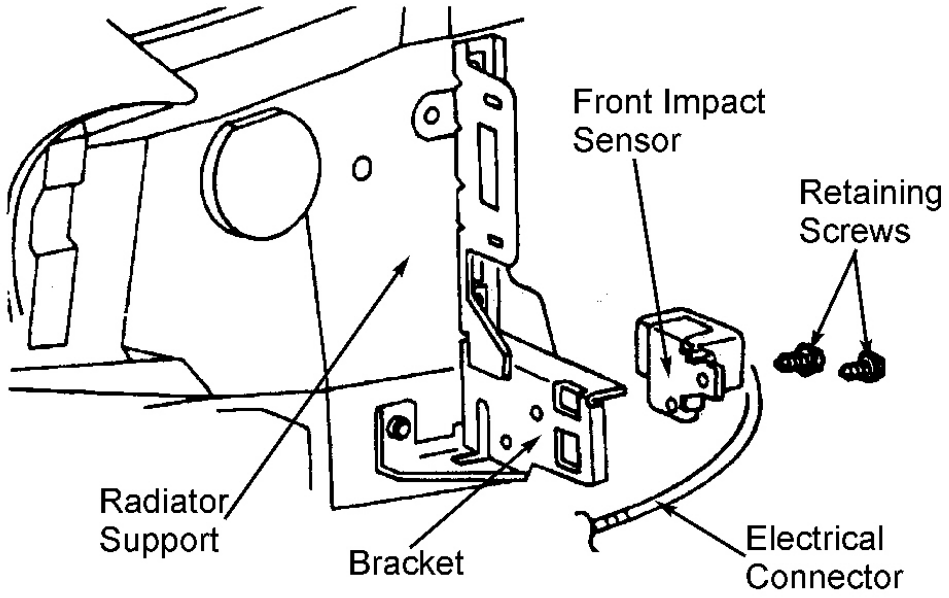


Fig. 9: Removing Front Impact Sensors
Courtesy of FORD MOTOR CO.

Installation

To install, reverse removal procedure. Tighten screws to specification. See **TORQUE SPECIFICATIONS** . Activate SRS. See procedures under **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** .

STEERING WHEEL

Removal

1. Center front wheels to straight-ahead position. Before proceeding, read and carefully follow all air bag service precautions. See **SERVICE PRECAUTIONS** . Disable air bag system. See procedures under **DISABLING & ACTIVATING AIR BAG SYSTEM** . Remove air bag module from steering wheel. See **DRIVER-SIDE AIR BAG MODULE** .
2. Disconnect horn and clockspring electrical connector from steering wheel. Remove steering wheel retaining bolt. Mark steering wheel hub and steering shaft for installation reference. Remove steering wheel using steering wheel puller. Route clockspring (contact assembly) wiring harness through steering wheel as wheel is lifted from steering shaft.

Installation

1. Ensure front wheels are in straight-ahead position. Route clockspring wiring harness through steering wheel opening at 3 o'clock position. Position steering wheel on steering shaft and align marks made during removal procedure.
2. Ensure air bag clockspring wire is not pinched when positioning steering wheel. Install new steering wheel retaining bolt, and tighten to specification. See **TORQUE SPECIFICATIONS** . Connect horn/speed control wiring harness (if equipped) to steering wheel and snap connector assembly into steering wheel clip.
3. Install air bag module. Reconnect positive, then negative battery cable. Activate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** .

DIAGNOSIS & TESTING

WARNING: Failure to follow service precautions may result in air bag deployment and personal injury. See SERVICE PRECAUTIONS . After component replacement, ensure proper system operation. See SYSTEM OPERATION CHECK .

SELF-DIAGNOSTICS

During vehicle operation, air bag diagnostic monitor detects and stores both intermittent and hard failure codes in non-volatile memory. The DTCs can be retrieved with the New Generation Star (NGS) tester using the retrieve/clear continuous codes option. If no DTCs are present, NGS Tester will display SYSTEM PASSED message. Once a fault code is logged in air bag diagnostic monitor memory, it will stay in memory until 80 ignition cycles have been recorded or until NGS is used to erase the DTCs.

The on-demand self test can be used to verify there are no electrical faults within SRS. During this test air bag diagnostic monitor will check of each electrical component in system. If fault is detected, DTC is displayed on New Generation Star (NGS) tester with brief description of fault. Faults detected during self test are not stored in memory, unless same fault was detected during normal vehicle operation. Self test should be run after service to verify operation.

USING NGS TESTER

1. Connect New Generation Star Tester (007-00500) or equivalent to Data Link Connector (DLC), located under instrument panel, to retrieve continuous diagnostic trouble codes (DTCs) and run self test diagnostics. See RETRIEVING FAULT CODES or **DATA LINK DIAGNOSTIC TEST** .
2. If self test is passed and no DTCs are retrieved, or there is a module communication error, refer to **DIAGNOSTIC SYMPTOMS** table. If DTCs are retrieved, see **FAULT CODE IDENTIFICATION** table.

RETRIEVING FAULT CODES

1. To retrieve and/or clear DTCs, follow these step: Connect NGS to Data Link Connector (DLC), located under instrument panel. Turn ignition switch to RUN position. Select MODEL YEAR and VEHICLE. Select DIAGNOSTIC DATA LINK. Select IABM-INTEGRATED AIR BAG MONITOR. Select DIAGNOSTIC TEST MODES. Select RETRIEVE/CLEAR CONTINUOUS DTCs.
2. After pressing START, all continuous DTCs will be displayed open screen. Before proceeding with clearing operation, make note of DTCs displayed. See **FAULT CODE IDENTIFICATION** table under DIAGNOSTIC TESTS. Once cleared, DTCs cannot be retrieved.
3. To clear all DTCs, press C ALL. Clearing of individual DTCs (C ONE) is not supported by air bag diagnostic monitor. The NGS will retrieve DTCs again after clearing DTCs, and if any remain they will be displayed. Hard DTCs will be redisplayed after clearing DTCs since they cannot be cleared from air bag diagnostic monitor.

ON-DEMAND SELF-TEST

Connect NGS to data link connector, located under instrument panel. Turn ignition switch to RUN position. Select MODEL YEAR and VEHICLE. Select DIAGNOSTIC DATA LINK. Select IABM-INTEGRATED AIR BAG MONITOR. Select DIAGNOSTIC TEST MODES. Select ON-DEMAND SELF TEST. Press START and then TRIGGER. Air bag diagnostic monitor will run on demand self test and display ON-DEMAND DTCs on the screen.

DATA LINK DIAGNOSTIC TEST

Connect NGS to data link connector, under instrument panel. Turn ignition switch to RUN position. Rotate dial to DIAGNOSTIC DATA LINK and press TRIGGER. If results of circuit 70, 914, or 915 is SYSTEM PASSED, the ISO 9141 communication link test has passed (air bag diagnostic monitor). If air bag diagnostic monitor is listed after results of these circuits, followed by NO RESPONSE/NOT EQUIPPED, test failed, refer to DIAGNOSTIC SYMPTOMS table.

DIAGNOSTIC SYMPTOMS

Condition	Test
Module Communication Error	**TEST A**
No Air Bag Warning Light	**TEST B**
Continuous Air Bag Warning Light	**TEST C**
Rapid Continuous Flashing Air Bag Warning Light	**TEST D**
Data Link Diagnostic Test Failure\Air Bag Diagnostic Monitor Communication Fault	**TEST E**

FAULT CODE IDENTIFICATION

Fault Code	Flash Code	Description
B1342	24	Internal Microprocessor Fault On-Demand Self-Test Only)
B1867	12/52	Low Battery Voltage
B1869	--	No Indicator/Inoperative Circuit
B1913	13/53	Air Bag Circuit Shorted To Ground
B1914	14/54	Impact Sensor Short To Ground
B1921	21	Diagnostic Monitor Not Mounted To Vehicle Properly
B1922	22	Safing Sensor Shorted To Battery Voltage
B1924	24	System Disarm Failure Or Internal Diagnostic Monitor Fault
B1932	32	High Resistance Or Open In Driver-Side Air Bag Circuit
B1933	33	High Resistance Or Open In Passenger-Side Air Bag Circuit
B1934	34	Low Resistance Or Short In Driver-Side Air Bag Circuit
B1935	35	Low Resistance Or Short In Passenger-Side Air Bag Circuit
B1941	41	Right Front Impact Sensor Feed/Return Circuit Open
B1942	42	Left Front Impact Sensor Feed/Return Circuit Open
B1944	44	Right Front Impact Sensor Not Mounted To Vehicle Properly
B1945	45	Left Front Impact Sensor Not Mounted To Vehicle Properly

DIAGNOSTIC TESTS

TEST A - MODULE COMMUNICATION ERROR

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

Perform this test only if condition remains after checking to ensure NGS tester is properly connected to DLC (check connection for damaged or loose terminals), ignition switch is turned to RUN position, and battery is properly charged.

Possible Causes

Module communication error might be caused by faulty NGS tester, data link connector (DLC), air bag diagnostic monitor, or related circuitry.

Test Procedure

1. **Check For Ignition Voltage**

   Turn ignition switch to OFF position. Deactivate system. See **DISABLING & ACTIVATING AIR**

BAG SYSTEM . Disconnect air bag diagnostic monitor. Turn ignition switch to ON position. Measure voltage between air bag diagnostic monitor C209-6, circuit 298 (Purple/Orange wire) and ground. If voltage is greater than 10 volts, go to next step. If voltage is not as specified, repair circuit 298 (Purple/Orange wire) and go to step 6).

2. **Check Circuit 549 (Black/Orange) For Open**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor connector. Measure resistance between air bag diagnostic monitor C209-18, circuit 549 (Black/Orange wire) and ground. If resistance is less than 5 ohms, go to next step. If resistance is not as specified, repair circuit 549 (Black/Orange wire) and go to step 6).

3. **Check For Battery Voltage**

   Measure voltage between air bag diagnostic monitor C209-14, circuit 937 (Red/White wire) and ground. If voltage is greater than 10 volts, go to step 6). If voltage is not as specified, go to next step.

4. **Check Battery Fuse**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check fuse No. 2 (10A). If fuse is open, go to next step. If fuse is not OK, repair circuit 937 (Red/White wire) and go to next step 6).

   WARNING: Certain fault conditions (DTC B1913 or B1914) may cause air bag diagnostic monitor to intentionally open fuse No. 2 (10A) to disarm SRS. DO NOT substitute another fuse value for 10A fuse. Any other fuse value may cause future disarming failure and danger to occupants of vehicle. Once air bag diagnostic monitor has disarmed SRS, it will not attempt to do so again until appropriate fault code (DTC B1913 or B1914) has been cleared. Do not reactivate system until all fault codes have been repaired and cleared.

5. **Check For Short In Harness**

   Replace open fuse. If fuse does not open again, go to next step. If fuse opens again, repair circuit 937 (Red/White wire) and go to next step.

6. **Check Module Communication**

   Turn ignition switch to OFF position. Reconnect system components. Turn ignition switch to ON position. If air bag diagnostic monitor communicates, reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Check AIR BAG warning light for proper system function. See **SYSTEM OPERATION CHECK** . If air bag diagnostic monitor does not communicate, go to **TEST E** - DATA LINK DIAGNOSTIC TEST FAILURE/AIR BAG DIAGNOSTIC MONITOR COMMUNICATION FAULT.

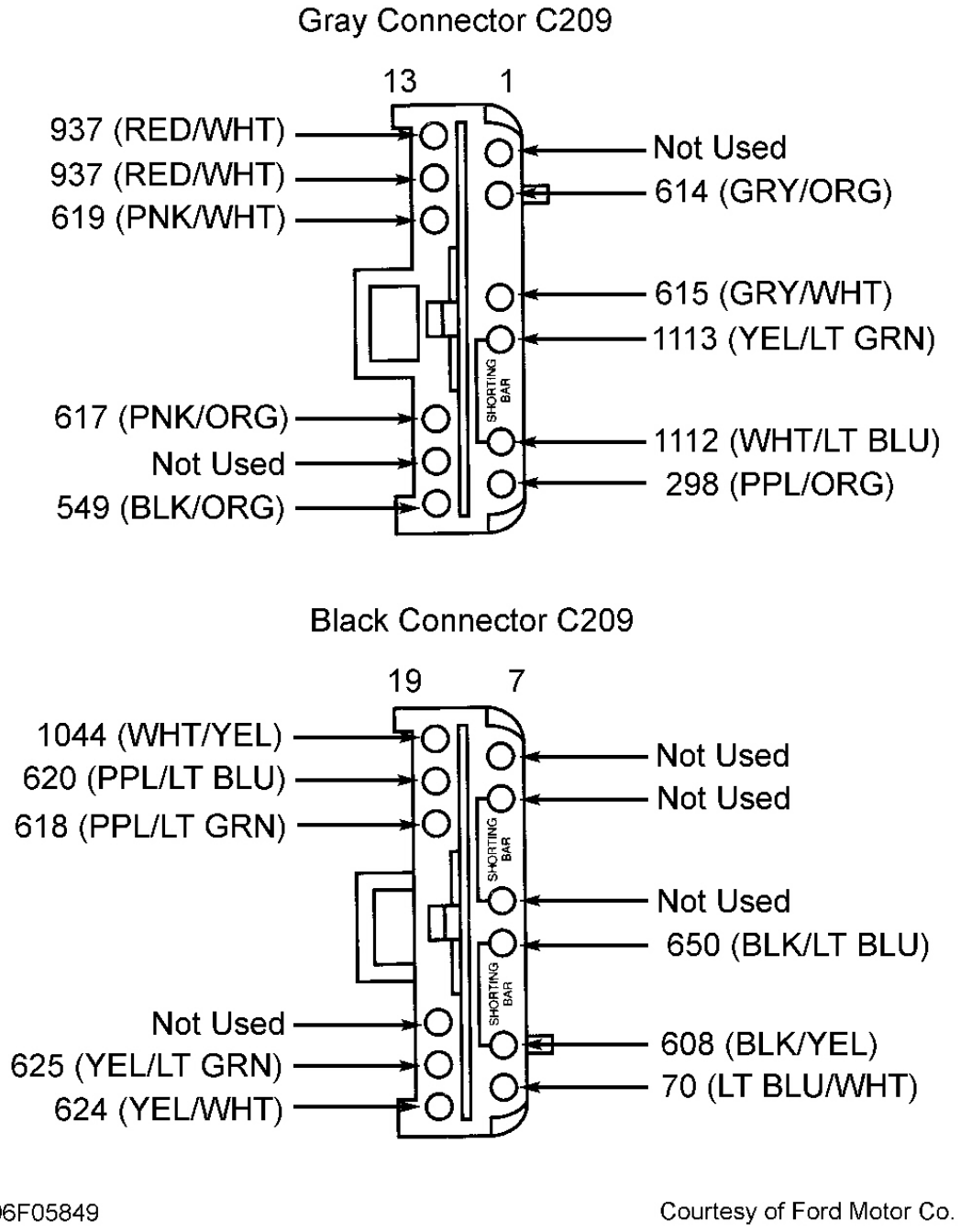


Fig. 10: Air Bag Diagnostic Monitor Connector Terminal ID
Courtesy of FORD MOTOR CO.

TEST B/DTC B1869 - NO AIR BAG WARNING LIGHT

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The AIR BAG warning light is designed to light for 4-8 seconds when ignition switch is turned to ON position. This initial 4-8 seconds is normal operation for warning light, indicating SRS is functioning properly. If there is an open in circuit C208-11, circuit 608 (Black/Yellow wire), the air bag warning light will not light.

If air bag diagnostic monitor detects open in AIR BAG warning light circuit and another fault in system exists, the tone generator in diagnostic monitor will activate and five sets of five beeps will occur every 30 minutes while ignition switch is in ON position. The beeps do not indicate Code 55 or any other code. The air bag warning light circuitry must be repaired before DTCs can be retrieved.

The air bag diagnostic monitor requires power at terminal C209-6, circuit 298 (Purple/Orange wire) to charge AIR BAG warning light circuit properly. If there is an open in light circuit at terminal C208-11, circuit 608 (Black/Yellow wire), the AIR BAG warning light will not light.

Possible Causes

An inoperative AIR BAG warning light may be caused by a burned out bulb or open wiring in air bag warning light circuit.

Test Procedure

1. **Understand Function**

   Read description for this test and examine wiring diagram for schematic. See **WIRING DIAGRAM** . If DTC operation is well understood, go to next step. If not, re-examine description and schematic.

2. **Check For Other Warning Indicators**

   Turn ignition switch to ON position. If any other warning lights on instrument cluster are inoperative, check instrument cluster. If no other warning lights are inoperative, go to next step.

3. **Check Supply To Air Bag Diagnostic Monitor**

   Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect air bag diagnostic monitor connectors. Measure resistance between air bag diagnostic monitor C208-11, circuit 608 (Black/Yellow wire) and instrument cluster C238-6, circuit 608 (Black/Yellow wire). If resistance is less than 5 ohms, check circuit 650 (Black/Light Blue for open. If not, check air bag indicator for operation.

4. **Check Bulb Operation**

   Turn ignition switch to ON position. Connect jumper wire from terminal C208-11, circuit 608

(Black/Yellow wire) to ground. If AIR BAG warning light comes on, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect and reactivate system. If warning light does not come on, repair circuit 608 (Black/Yellow wire). Reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

TEST C - CONTINUOUS AIR BAG WARNING LIGHT

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The AIR BAG warning light is designed to light for 4-8 seconds when ignition switch is turned to ON position. This initial 4-8 seconds is normal operation for warning light, indicating SRS is functioning properly. The air bag diagnostic monitor incorporates a solid state circuit which shorts air bag warning light line, circuit 608 (Black/Yellow wire), to ground to turn on AIR BAG warning light. When Black diagnostic monitor harness connector C208 is disconnected from air bag diagnostic monitor, a shorting bar within harness connector shorts terminal C208-11, circuit 608 (Black/Yellow wire) and C208-10, circuit 650 (Black/Light Blue wire) together, causing continuous AIR BAG warning light.

The air bag diagnostic monitor requires power at terminal C209-6, circuit 298 (Purple/Orange wire) to charge AIR BAG warning light circuit properly. Loss of ignition voltage at this terminal due to an open circuit or short to ground will result in continuous air bag warning light, due to ignition voltage applied to terminal C208-19, circuit 1044 (White/Yellow wire).

Possible Causes

Continuous AIR BAG warning light may be caused by a DTC which has flashed five times after ignition was turned to ON and has timed out, a disconnected, poorly connected, or damaged air bag diagnostic monitor, shorted air bag warning light wiring, or loss of ignition voltage at terminal C209-6, circuit 298 (Purple/Orange wire) of air bag diagnostic monitor.

Test Procedure

1. **Understand Function**

   Read description for this test and examine wiring diagram for schematic. See **WIRING DIAGRAM** . If DTC operation is well understood, go to next step. If not, re-examine description and schematic.

2. **Check Circuit 608 (Black/Yellow) For Short To Ground**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor connectors. Remove plastic locking wedge from connector C208. Turn ignition switch to ON position. If AIR BAG warning light is not on, go to next step. If warning light is on, repair circuit 608 (Black/Yellow wire). Reconnect and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

3. **Check For Short To Battery Voltage**

   Turn ignition switch to OFF position. Measure voltage between air bag diagnostic monitor C209-6, circuit 298 (Purple/Orange wire) and ground. If voltage is less than 1 volt, go to next step. If voltage is not as specified, repair circuit 298 (Purple/Orange wire) for short to B+. Check for aftermarket circuit attachments. Reconnect and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

4. **Inspect Shorting Bars**

   Inspect shorting bars on plastic locking wedge for damage or poor connection. If shorting bars are in good condition, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. If shorting bars are not in good condition, replace plastic locking wedge. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

TEST D - RAPID CONTINUOUS FLASHING AIR BAG WARNING LIGHT/ ALL FRONT IMPACT SENSORS DISCONNECTED

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

An air bag diagnostic monitor which has yet to be powered up in an electrically complete system will remain in assembly plant mode until it is powered up in good system for period of time. While air bag diagnostic monitor is in assembly plant mode: if both front impact sensors are disconnected, the diagnostic monitor will flash AIR BAG warning light continuously at rapid rate; if fault exists in system, DTC will flash on warning light but will not be stored in memory. When air bag diagnostic monitor is not in assembly plant mode: if both front impact sensors are disconnected the air bag diagnostic monitor will store DTCs B1941, B1942, B1944, B1945, and any other applicable fault code.

Possible Causes

Rapid continuous flashing AIR BAG warning light may be caused by both front impact sensors are disconnected from wiring harness, or main wiring harness is not connected to engine compartment wiring harness.

Test Procedure

- **Reference To DTCs**

  To diagnose and repair this condition refer to DTCs B1941, B1942, B1944, or B1945.

TEST E - DATA LINK DIAGNOSTIC TEST FAILURE/AIR BAG DIAGNOSTIC MONITOR COMMUNICATION FAULT

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

Test A - Module Communication Error must be performed to verify power and ground to suspect module before performing the following test. Do not perform test unless instructed. This test assumes a fault has been detected in system with direction to enter a specific diagnostic routine. Performing this test without direction may produce incorrect results and replacement of working components. Correct test results are dependent on proper operation of related components and systems.

Possible Causes

Data link test failure due to air bag diagnostic monitor communication fault may be caused by a faulty diagnostic monitor, data link connector, or circuits on applicable wiring.

Test Procedure

- **Check Resistance Between DLC And Diagnostic Monitor C208**

  Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor connector C208. Inspect diagnostic monitor C208 and data link connector C228 for damage. Measure resistance from terminal C208-12, circuit 70 (Light Blue/White wire) to DLC connector terminal C228-7. If connectors are OK and resistance is less than 5 ohms, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Test system for normal operation. See **SYSTEM OPERATION CHECK** . If resistance is not as specified, repair connectors and/or repair circuit 70 (Light Blue/White wire). Test system for normal operation.

DTC B1342/B1924 - SYSTEM DISARM FAILURE/INTERNAL DIAGNOSTIC MONITOR FAULT

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

When air bag diagnostic monitor detects DTC B1342 or B1924, it attempts to disarm SRS to prevent inadvertent air bag deployment by opening fuse No. 2 (10A) feeding air bag diagnostic monitor terminals C209-13 and C209-14. It attempts to open fuse No. 2 (10A) by activating an internal solid state switch which shorts battery feed at terminal C209-13 to sheet metal ground at air bag diagnostic monitor bracket.

The air bag diagnostic monitor performs several self-tests every time ignition switch is turned to ON position. If any of these tests fail, AIR BAG warning light will flash Code 24. If conditions resume normal operation, DTC B1924 will be stored in memory. The failure will either set DTC B1342 or B1924, depending on cause of failure. DTC B1342 can only be retrieved by running **ON-DEMAND SELF-TEST** and indicates an internal microprocessor fault exists in air bag diagnostic monitor. DTC B1924 is retrieved like any other DTC and

indicates other diagnostic monitor faults.

Possible Causes

System disarm failure or internal diagnostic failure can be caused by an improper fuse value at terminal C209-13 and C209-14, or excessive resistance or opens in battery feed circuit or C209-13 due to damaged wiring. This fault can also be caused by vehicle charging system problem, internal air bag diagnostic monitor failure on diagnostic or system disarm, or resistance to ground in normally open front impact sensor circuits 617 (Pink/Orange wire), 619 (Pink/White wire), 624 (Yellow/White wire), and 625 (Yellow/Light Green wire).

Test Procedure

1. **Check For Hard Or Intermittent DTC**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1342/B1924 is retrieved, fault is hard, go to next step. If DTC B1342 is not retrieved, fault is intermittent, go to step 7).

2. **Check For Module Failure**

   Using results from step 1), if self test did not respond with DTC B1342, go to next step. If self test did respond with DTC B1342, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 14).

3. **Check Primary Sensor Feed**

   Turn ignition switch to OFF position. Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect air bag diagnostic monitor. Measure resistance between air bag diagnostic monitor C209-18, circuit 549 (Black/Orange wire) and C209-15, circuit 619 (Pink/White wire) (left), C209-16, circuit 617 (Pink/Orange wire) (right), C208-23, circuit 625 (Yellow/Light Green wire) (left), and C208-24, circuit 624 (Yellow/White wire) (right). If resistance readings are infinite (open), go to step 6). If resistance is not as specified, go to next step.

4. **Determine If Sensor Or Wire Is Shorted**

   Disconnect suspect primary crash sensor found in step 3). Measure resistance between suspect front impact sensor terminals No. 2 and 4. If resistance reading is infinite (open), go to next step. If resistance is not as specified, replace front impact sensor. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Reconnect system. Go to step 14).

5. **Check For Shorted Sensor Circuit**

   Measure resistance between air bag diagnostic monitor C209-15, circuit 619 (Pink/White wire) and ground. If resistance is greater than 10 Kohms, repair circuit 625 (Yellow/Light Green wire) or 624 (Yellow/White wire). Reconnect, verify, and reactivate system. Go to step 14). If resistance is not as specified, repair circuit 619 (Pink/White wire) or 617 (Pink/Orange wire). Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 14).

6. **Check For Incorrect Wiring**

   Examine air bag diagnostic monitor harness connector C208-22. This terminal should not be used. If a wire is connected at terminal C208-22, correct improper wiring and reconnect air bag diagnostic monitor. Go to step 14). If a wire is not connected at terminal C208-22, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 14).

7. **Check For Serviced DTCs**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1342/B1924 was retrieved, go to next step. If DTC B1342/B1924 was not retrieved, go to step 14).

8. **Check Front Impact Sensor Circuits**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor. Measure resistance between air bag diagnostic monitor C209-18, circuit 549 (Black/Orange wire) and C209-15, circuit 619 (Pink/White wire) (left), C209-16, circuit 617 (Pink/Orange wire) (right), C208-23, circuit 625 (Yellow/Light Green wire) (left), and C208-24, circuit 624 (Yellow/White wire) (right). If resistance readings are infinite (open), go to step 11). If resistance is not as specified, go to next step.

9. **Identify Shorted Circuit**

   Disconnect suspect primary crash sensor found in step 8). Measure resistance between suspect front impact sensor terminals No. 2 and 4. If resistance reading is infinite (open), go to next step. If resistance is not as specified, replace front impact sensor. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Reconnect system. Go to step 14).

10. **Check Sensor Circuits**

    Measure resistance between air bag diagnostic monitor C209-15, circuit 619 (Pink/White wire) and ground. If resistance is greater than 10 Kohms, repair circuit 625 (Yellow/Light Green wire) or 624 (Yellow/White wire). Reconnect, verify, and reactivate system. Go to step 14). If resistance is not as specified, repair circuit 619 (Pink/White wire) or 617 (Pink/Orange wire). Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 14).

11. **Confirm Battery Connection**

    Turn ignition switch to OFF position. Measure resistance between air bag diagnostic monitor C209-13, circuit 937 (Red/White wire) and C209-18, circuit 549 (Black/Orange wire). If voltage is greater than 10 volts, go to next step. If voltage is not as specified, repair circuit 937 and reconnect diagnostic monitor. Go to step 14).

WARNING: Certain fault conditions (DTC B1913 or B1914) may cause air bag diagnostic monitor to intentionally open fuse No. 2 (10A) to disarm SRS. DO NOT substitute another fuse value for 10A fuse. Any other

fuse value may cause future disarming failure and danger to occupants of vehicle. Once air bag diagnostic monitor has disarmed SRS, it will not attempt to do so again until appropriate fault code (DTC B1913 or B1914) has been cleared. Do not reactivate system until all fault codes have been repaired and cleared.

12. **Check Fuse No. 2 (10A)**

    Ensure fuse No. 2 (10A), located in power distribution box, is correct value (10A). If fuse is correct value, go to next step. If fuse is not correct value, replace fuse No. 2 with correct fuse value (10A). Do not use substitutions. Reconnect air bag diagnostic monitor connectors and go to step 14).

13. **Check For Short To Power**

    Turn ignition switch to OFF position. Measure voltage between air bag diagnostic monitor C209-13, circuit 937 (Red/White wire) and C209-18, circuit 549 (Black/Orange wire). If voltage is zero volts, replace fuse No. 2 (10A). Do not use substitutions. Replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect and reactivate system. Go to next step. If voltage is not as specified, repair circuit 937 and reconnect air bag diagnostic monitor connectors. Go to next step.

14. **Check For Other DTCs**

    Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1867 - LOW BATTERY VOLTAGE

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The air bag diagnostic monitor measures voltage at terminal C209-14, circuit 937 (Red/White) of air bag diagnostic monitor connector. Voltage at this terminal should be equal to battery voltage. If voltage at C209-14, circuit 937 (Red/White) drops below 8 volts, diagnostic monitor will flash Code 12 on AIR BAG warning light. If voltage at this terminal drops below 5 volts, DTC B1867 will be stored in memory. If the loss of battery voltage at terminal C209-14, circuit 937 (Red/White) is intermittent or repaired, air bag diagnostic monitor will flash Code 52 (or higher priority code if exists) on next ignition cycle.

Possible Causes

Low voltage at air bag diagnostic monitor terminal C209-14, circuit 937 (Red/White) may be caused by an open in battery circuit, a short to ground on battery feed circuit, or a problem in charging system.

Test Procedure

1. **Check For Hard Or Intermittent DTC**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1867 is retrieved, go to next step. If DTC B1867 is not retrieved, go to step 7).

2. **Check Power Supply**

   Connect NGS to DLC. Select IABM. Select Pid/Data Monitor and Record. Select Pid VBATIAB. If voltage is less than 5 volts, go to step 4). If voltage is not as specified, go to next step.

3. **Check Charging System**

   Measure charging system voltage. If voltage is more than 9 volts, deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. Go to step 10). If voltage is not as specified, repair charging system. Go to step 10).

4. **Check Fuse No. 2 (10A)**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect air bag diagnostic monitor connectors. Check fuse No. 2 (10A) in fuse junction panel. If fuse is OK, go to next step. If fuse is not OK, repair circuit 937 (Red/White wire). Connect diagnostic monitor. Go to step 10).

   WARNING: Certain fault conditions (DTC B1913 or B1914) may cause air bag diagnostic monitor to intentionally open fuse No. 2 (10A) to disarm SRS. DO NOT substitute another fuse value for 10A fuse. Any other fuse value may cause future disarming failure and danger to occupants of vehicle. Once air bag diagnostic monitor has disarmed SRS, it will not attempt to do so again until appropriate fault code (DTC B1913 or B1914) has been cleared. Do not reactivate system until all fault codes have been repaired and cleared.

5. **Check Circuit 937 (Red/White wire) For Short To Ground**

   Replace open fuse No. 2 (10A). Do not use any substitutions. If fuse does not blow, go to next step. If fuse opens again, repair short to ground on circuit 937 (Red/White wire). Connect air bag diagnostic monitor. Go to step 10).

6. **Confirm Condition**

   Reconnect air bag diagnostic monitor connectors. If fuse does not open, go to step 10). If fuse opens, replace diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Replace fuse No. 2 (10A). Do not use substitutions. Reconnect and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 10).

7. **Check If repaired**

Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1867 was retrieved, check fuse No. 2 (10A) for correct value. Go to step 10). If DTC B1867 was not retrieved, go to next step.

8. **Check Charging System**

   An intermittent charging system problem could cause DTC B1867. If there is a charging system problem, repair problem. Check fuse No. 2 (10A) for correct value. Go to step 10). If there is not a charging system problem, go to next step.

9. **Check Battery Feed**

   Inspect all crimps, terminals, fuses, wires, etc. in circuit 937 (Red/White wire) feeding terminals C209-13 and C209-14 of air bag diagnostic monitor. See **Fig. 5** . Look for poor connections, etc. If problems are noted, repair circuit 937, check fuse No. 2 (10A) for correct value and go to step 10). If no problems are noted, recheck fault code. Look for causes of intermittent low battery voltage at terminal C209-13 circuit 937 (Red/White wire). See **Fig. 5** . Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Correct intermittent fault and go to step 10).

10. **Check For Other DTCs**

    Connect NGS to DLC. Perform **ON-DEMAND SELF-TEST** . If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1913 - AIR BAG CIRCUIT SHORT TO GROUND

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The air bag diagnostic monitor measures voltage at terminal C209-2, C209-3, C209-4, and C209-5 of air bag diagnostic monitor connector. Voltage at these terminals are set by diagnostic monitor and vary with charging system voltage. If air bag diagnostic monitor detects low voltage at any of these terminals, DTC B1913 will be stored in memory and AIR BAG warning light will flash Code 13 to indicate possible short to ground on these circuits.

At the same time air bag diagnostic monitor begins flashing Code 13, it attempts to disarm SRS to prevent inadvertent air bag deployment by opening fuse No. 2 (10A) feeding air bag diagnostic monitor terminal C209-13 and C209-14. It attempts to open fuse by activating solid state switch which shorts battery feed at terminal C209-13, circuit 937 (Red/White) to sheet metal ground at air bag diagnostic monitor bracket.

VOLTAGE SPECIFICATIONS

Voltage At Terminal C209-2, C209-3, C209-4 or C209-5	System Voltage
1.5	9.0
1.6	9.5
1.7	10.0
1.8	10.5
1.9	11.0
2.0	11.5
2.1	12.0
2.2	12.5
2.3	13.0
2.4	13.5
2.5	14.0
2.6	14.5
2.7	15.0
2.8	15.5
2.9	16.0

Possible Causes

Low voltage at air bag diagnostic monitor terminal C209-2, C209-3, C209-4, or C209-5 may be caused by a short to ground on circuits 607 (Light Blue/Orange wire), 614 (Gray/Orange wire), 615 (Gray/White wire), 616 (Pink/Black wire), or 1112 (White/Light Blue wire), or by resistance to ground on circuits 617 (Pink/Orange wire), 619 (Pink/White wire), 624 (Yellow/White wire), 625 (Yellow/Light Green wire), or internal resistance to ground in either of front impact sensors. Low voltage at specified terminals may also be caused by an internal short to ground within air bag clockspring, or an internal short to ground within driver-side or passenger-side air bag module.

Test Procedure

1. **Verify Condition**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1913 is retrieved, go to next step. If DTC B1913 is not retrieved, go to step 13).

2. **Check Passenger-Side Air Bag Deactivation Switch Position**

   Ensure passenger-side air bag deactivation (PAD) switch is in ON position. If the PAD switch is in ON position, go to step 4). If PAD switch is not in ON position, turn switch to ON position and go to next step.

3. **Recheck System**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1913 was retrieved, go to next step. If DTC B1913 was not retrieved, replace PAD switch and go to step 19).

4. **Check For Shorted Air Bag**

   Turn ignition switch to OFF position. Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Carefully disconnect air bag modules during deactivation. Turn ignition switch to ON position. Connect NGS to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1913 was retrieved, go to next step. If DTC B1913 was not retrieved, go to step 12).

5. **Check Driver-Side Air Bag Circuit**

   Turn ignition switch to OFF position. Disconnect diagnostic monitor. Inspect clockspring wiring harness connector at base of steering column for damaged, chafed or pinched wires. Repair as necessary. Measure resistance between air bag diagnostic monitor C209-2, circuit 614 (Gray/Orange wire) and C209-18, circuit 650 (Black/Orange wire). If resistance is less than 10 Kohms, go to next step. If resistance is not as specified, go to step 7).

6. **Check Circuit 614 For Short To Ground**

   Disconnect clockspring connector at base of steering column. Measure resistance between air bag diagnostic monitor C209-2, circuit 614 (Gray/Orange wire). If resistance is greater than 10 Kohms, replace clockspring. See **CLOCKSPRING** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. Go to step 19). If resistance is not as specified, repair circuit 614 or 615. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 19).

7. **Check Passenger-Side Air Bag Module Circuits For Short**

   Examine passenger-side air bag module wiring harness connector. Check for pinched or chafed wires. Ensure PAD switch is in ON position. Measure resistance between air bag diagnostic monitor C209-5, circuit 1112 (White/Light Blue wire) and C209-18, circuit 549 (Black/Orange wire). If resistance is greater than 10 Kohms, go to step 11). If resistance is not as specified, go to next step.

8. **Check Circuit 1112 And 1113 For Short To Ground**

   Disconnect PAD switch connector C213. Measure resistance between PAD switch C213-3, circuit 1112 (White/Light Blue wire) and ground. If resistance is greater than 10 Kohms, go to next step. If resistance is not as specified, repair circuit 1112 (White/Light Blue wire) or 1113 (Yellow/Light Green wire) and go to step 19).

9. **Check Circuit 607 And 616 For A Short To Ground**

   Disconnect PAD switch connector C214. Measure resistance between PAD switch C214-1, circuit 607 (Light Blue/Orange wire) and ground. If resistance is greater than 10 Kohms, replace PAD switch and go to step 19). See **PAD SWITCH** under REMOVAL & INSTALLATION. If resistance is not as specified, go to next step.

10. **Check Circuit 607 For A Short To Ground**

Disconnect passenger-side Air Bag Simulator (105-00010). Measure resistance between PAD switch C214-1, circuit 607 (Light Blue/Orange wire) and ground. If resistance is greater than 10 Kohms, repair circuit 616 (Pink/Black wire) and go to step 19). If resistance is not as specified, repair circuit 607 (Light Blue/Orange wire) and go to step 19).

11. **Check Front Impact Sensors**

Measure resistance between air bag diagnostic monitor C209-15, circuit 619 (Pink/White wire) and ground, and between air bag diagnostic monitor C209-16, circuit 617 (Pink/Orange wire) and ground. If resistance readings are less than 10 Kohms, go to next step. If resistance is not as specified, replace diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. Go to step 19).

12. **Check For Shorted Front Impact Sensor**

Turn ignition switch to OFF position. Disconnect right and left front impact sensor connectors. Check suspect impact sensor found in step 11). Measure resistance between air bag diagnostic monitor C209-16, circuit 617 (Pink/Orange wire) and C208-21, circuit 618 (Purple/Light Green wire), for right front impact sensor. Measure resistance between air bag diagnostic monitor C209-15, circuit 619 (Pink/White wire) and C208-20, circuit 620 (Purple/Light Blue wire), for left front impact sensor. If resistance is less than 10 Kohms, go to next step. If resistance is not as specified, replace front impact sensor in question. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. Go to step 19).

13. **Check For Shorted Front Impact Sensor Circuit**

Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor connectors. Measure resistance between air bag diagnostic monitor C209-15, circuit 619 (Pink/White wire) and ground (left sensor), or between C209-16, circuit 617 (Pink/Orange wire) and ground (right sensor). If resistance is greater than 10 Kohms, repair circuit 625 (Yellow/Light Green wire) (left sensor) or 624 (Yellow/White wire) (right sensor). Reconnect, verify, and reactivate system. Go to step 19). If resistance is not as specified, repair circuit 619 (Pink/White wire) (left sensor) or 617 (Pink/Orange wire) (right sensor). Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 19).

WARNING: Use a hand held digital multimeter with less than 10MA short circuit current on the lowest resistance scale possible (200 ohm setting). Failure to use a meter of this type may cause personal injury due to air bag deployment.

14. **Determine Which Bag is Shorted**

Inspect wiring and connector where clockspring mates to main vehicle harness under steering column. Check for pinched or chafed wires. Make sure shorting bar is properly installed in passenger side air bag connector. Measure resistance between either of the terminals in passenger-side air bag connector and metal case of air bag module. If resistance is infinite (open), replace driver-side air bag module. See **DRIVER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION. Reconnect, verify, and

reactivate system. Go to step 19). If resistance is not as specified, replace passenger-side air bag module. See **PASSENGER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. Go to step 19).

15. **Check For DTC Service**

    Reactivate system. See **COMPLETE SYSTEM DEACTIVATION** . Perform **ON-DEMAND SELF-TEST** . If DTC B1913 was retrieved, check fuse No. 2 (10A) for correct value and go to step 19). If DTC B1913 was not retrieved, deactivate system and go to next step.

16. **Check For Intermittent Shorts**

    Inspect circuits 614 (Gray/Orange wire), 615 (Gray/White wire), 607 (Light Blue/Orange wire), 616 (Pink/Black wire), 1112 (White/Light Blue wire), and 1113 (Yellow/Light Green wire) for pinched or chafed wires or other problems. If problems are noted, repair wiring, check fuse No. 2 (10A) for correct value. Reconnect, verify, and reactivate system. Go to step 19). If no problems are noted, go to next step.

17. **Check Clockspring And Air Bag Modules**

    Inspect clockspring wiring at harness connector. Inspect steering wheel hub where clockspring mates to driver-side air bag connector. Inspect wiring where passenger-side air bag module mates to harness connector. If any problems are noted, repair problem, check fuse No. 2 (10A) for correct value. Reconnect, verify, and reactivate system. Go to step 19). If no problems are noted, go to next step.

18. **Check Front Impact Sensors**

    Inspect front impact sensors and associated circuits 617 (Pink/Orange wire), 624 (Yellow/White wire), 619 (Pink/White wire), and 625 (Yellow/Light Green wire). Look for signs of corrosion or resistance to ground. If problems are noted, replace front impact sensor and check fuse No. 2 (10A) for correct value. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. Go to next step. If no problems are noted, re-examine fault code and check for causes of intermittent shorts or resistance to ground. Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Repair intermittent problems and go to next step.

19. **Check For Other DTCs**

    Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1914 - FRONT IMPACT SENSOR SHORTED TO GROUND

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The air bag diagnostic monitor measures voltage at terminal C208-23, circuit 625 (Yellow/Light Green wire) and C208-24, circuit 624 (Yellow/White wire) of air bag diagnostic monitor connector. Voltage at these terminals are set by diagnostic monitor and vary with charging system voltage. If air bag diagnostic monitor detects low voltage at either of these terminals, DTC B1914 will be stored in memory and AIR BAG warning light will flash Code 14 to indicate possible short to ground on these circuits.

At the same time air bag diagnostic monitor begins flashing Code 13, it attempts to disarm SRS to prevent inadvertent air bag deployment by opening fuse No. 2 (10A) feeding air bag diagnostic monitor terminal C209-13, circuit 937 (Red/White) and C209-14, circuit 937 (Red/White). It attempts to open fuse by activating solid state switch which shorts battery feed at terminal C209-13, circuit 937 (Red/White) to sheet metal ground at air bag diagnostic monitor bracket.

VOLTAGE SPECIFICATIONS

Voltage At Terminal C208-23 & C208-24	System Voltage
8.6	9.0
9.1	9.5
9.6	10.0
10.1	10.5
10.6	11.0
11.1	11.5
11.6	12.0
12.1	12.5
12.6	13.0
13.1	13.5
13.6	14.0
14.1	14.5
14.6	15.0
15.1	15.5
15.6	16.0

WARNING: Certain fault conditions may cause diagnostic monitor to intentionally blow AIR BAG fuse. DO NOT use any other fuse value except a 10-amp fuse. Substituting any other fuse value may cause future disarming failure and may result in danger to vehicle occupants.

Possible Causes

Low voltage at air bag diagnostic monitor terminal C208-23, C209-15, C209-16, or C208-24 may be caused by a short to ground on circuits 617 (Pink/Orange wire), 619 (Pink/White wire), 624 (Yellow/White wire), 625 (Yellow/Light Green wire), or internal short to case ground within either of front impact sensors.

Test Procedure

1. **Verify Condition**

Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1914 is retrieved, go to next step. If DTC B1914 is not retrieved, go to step 5).

2. **Identify Shorted Circuit**

   Deactivate air bag system. See **COMPLETE SYSTEM DEACTIVATION** under DISABLING & ACTIVATING AIR BAG SYSTEM. Disconnect diagnostic monitor. Using an multimeter set to 200k/ohm scale or Auto, measure resistance between terminal C209-18, circuit 549 (Black/Orange wire) of air bag diagnostic monitor and terminal C209-15, circuit 619 (Pink/White wire) and C208-23, circuit 625 (Yellow/Light Green wire) of left front impact sensor, and terminal C209-16, circuit 617 (Pink/Orange wire) and C208-24, circuit 624 (Yellow/White wire) of right front impact sensor. If one or more resistance reading is not infinite, go to next step. If all resistance readings are infinite (open), replace diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

3. **Determine If Sensor Or Wire Is Shorted**

   Disconnect impact sensor where resistance reading was not infinite in step 2). Measure resistance between air bag diagnostic monitor C209-16, circuit 617 (Pink/Orange wire) and C208-21, circuit 618 (Purple/Light Green wire), for right front impact sensor. Measure resistance between air bag diagnostic monitor C209-15, circuit 619 (Pink/White wire) and C208-20, circuit 620 (Purple/Light Blue wire), for left front impact sensor. If resistance reading is infinite (open), go to next step. If resistance reading is not infinite, replace front impact sensor in question. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Reconnect system and go to step 7).

4. **Check For Shorted Sensor Circuit**

   Disconnect suspected front impact sensor. Measure resistance between ground and terminal C209-15, circuit 619 (Pink/White wire) and C208-23, circuit 625 (Yellow/Light Green wire) of left front impact sensor, and terminal C209-16, circuit 617 (Pink/Orange wire) and C208-24, circuit 624 (Yellow/White wire) of right front impact sensor. If resistance is greater than 10 Kohms, repair short between circuit 619 (Pink/White wire) or 625 (Yellow/Light Green wire) and circuit 620 (Purple/Light Blue wire) for left sensor, or between circuit 617 (Pink/Orange wire) or 624 (Yellow/White wire) and circuit 618 (Purple/Light Green wire) for right sensor. Reconnect, verify, and reactivate system. Go to step 7). If resistance is not as specified, repair circuit 619 (Pink/White wire) or 625 (Yellow/Light Green wire) for left sensor, or 617 (Pink/Orange wire), or 624 (Yellow/White wire) for right sensor. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 7).

5. **Check For DTC Service**

   Deactivate system. See **COMPLETE SYSTEM DEACTIVATION** . Perform **ON-DEMAND SELF-TEST** . If DTC B1914 was retrieved, go to next step. If DTC B1914 was not retrieved, check fuse No. 2 (10A) for correct value and go to step 7).

6. **Check Front Impact Sensors**

Inspect circuits 617 (Pink/Orange wire), 624 (Yellow/White wire), 619 (Pink/White wire) and 625 (Yellow/Light Green wire) for pinched or chafed wires or other problems. If problems are noted, replace front impact sensor and repair wiring problems. Check fuse No. 2 (10A) for correct value, go to next step. If no problems are noted, reexamine fault code and look for causes of intermittent shorts or resistance to ground. Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Repair intermittent problems and go to next step.

7. **Check For Other DTCs**

   Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1921 - DIAGNOSTIC MONITOR NOT MOUNTED TO VEHICLE PROPERLY/GROUND CIRCUIT OPEN

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The air bag diagnostic monitor measures resistance between ground connection at its bracket and reference ground at terminal C209-18, circuit 549 (Black/Orange wire). If air bag diagnostic monitor measures difference of more than 3.0 ohms between ground at terminal C209-18, circuit 549 (Black/Orange wire) and the ground at its bracket, the air bag diagnostic monitor will store DTC B1921 in memory and AIR BAG warning light will flash Code 21. If condition is repaired or corrected, air bag diagnostic monitor will store DTC B1921 in memory.

Possible Causes

A high resistance reading at air bag diagnostic monitor bracket ground can be caused by a poor attachment of air bag diagnostic monitor due to loose mounting, dirt, corrosion, or a poor reference ground at terminal C208-10, circuit 650 (Black/Light Blue wire) and C209-18, circuit 549 (Black/Orange wire) of air bag diagnostic monitor.

Test Procedure

1. **Verify Condition**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1921 is retrieved, go to next step. If DTC B1921 is not retrieved, go to step 5).

2. **Measure Resistance**

   Connect NGS to DLC. Select IABM. Select PID/Data Monitor and Record. Select PID BRACKET. If resistance is more than 5 ohms, deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Remove air bag diagnostic monitor and bracket. See **DIAGNOSTIC MONITOR** under

REMOVAL & INSTALLATION. Thoroughly clean mounting surfaces. Reinstall air bag diagnostic monitor and go to next step. If resistance is less than 5 ohms, go to step 4).

3. **Recheck Resistance**

   Repeat procedure in step 2). If resistance is greater than 5 ohms, go to next step. If resistance is not as specified, install air bag diagnostic monitor. Go to step 8).

4. **Check Reference Ground**

   Check attachment of ground connections in C209-18 circuit 549 (Black/Orange wire) feeding diagnostic monitor C209, and C208-10 circuit 650 (Black/Light Blue wire) feeding diagnostic monitor C208. If poor connections are noted, repair circuit as necessary. Add ground strap from circuit 549 (Black/Orange wire) or 650 (Black/Light Blue wire) to one of the air bag diagnostic monitor mounting fasteners. Reinstall air bag diagnostic monitor and go to step 8). If no poor connections are noted, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 8).

5. **Check For DTC Service**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1921 was retrieved, go to next step. If DTC B1921 was not retrieved, go to step 8).

6. **Check For Bracket Corrosion**

   Inspect diagnostic monitor bracket and mounting surfaces. Look for signs of corrosion or poor contact. If there is no corrosion, go to next step. If significant corrosion is found, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Verify and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 8).

7. **Check Circuit 549 And 650**

   Check attachment of ground connections in C209-18 circuit 549 (Black/Orange wire) feeding diagnostic monitor C209, and C208-10 circuit 650 (Black/Light Blue wire) feeding diagnostic monitor C208. If poor connections are noted, repair circuit 549. If necessary, add ground strap from circuit 549 (Black/Orange wire) or 650 (Black/Light Blue wire) to one of the air bag diagnostic monitor mounting fasteners. Install diagnostic monitor and go to next step. If no poor connections are noted, remove air bag diagnostic monitor and bracket from vehicle and thoroughly clean mounting surfaces. Replace air bag diagnostic monitor. Re-examine fault code and look for causes of high resistance in diagnostic monitor bracket ground. Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Repair any intermittent faults and go to next step.

8. **Check For Other DTCs**

   Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1922 - SAFING SENSOR OUTPUT CIRCUIT SHORTED TO BATTERY VOLTAGE

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The air bag diagnostic monitor measures voltage at terminal C209-2, circuit 614 (Gray/Orange wire), C209-3, circuit 615 (Gray/White wire), C209-4, circuit 1113 (Yellow/Light Green wire), and C209-5, circuit 1112 (White/Light Blue wire) of air bag diagnostic monitor connector. Voltage at these terminals are set by diagnostic monitor and vary with charging system voltage. If air bag diagnostic monitor measures more than 5 volts at any of these terminals, DTC B1922 will be stored in memory and AIR BAG warning light will flash Code 22. If condition is repaired or intermittent, air bag diagnostic monitor will store DTC B1922 in memory.

VOLTAGE SPECIFICATIONS

Voltage At Terminal C209-2, C209-3, C209-4 or C209-5	System Voltage
1.5	9.0
1.6	9.5
1.7	10.0
1.8	10.5
1.9	11.0
2.0	11.5
2.1	12.0
2.2	12.5
2.3	13.0
2.4	13.5
2.5	14.0
2.6	14.5
2.7	15.0
2.8	15.5
2.9	16.0

Possible Causes

High voltage at air bag diagnostic monitor terminal C209-2, C209-3, C209-4, or C209-5 may be caused by a short to battery or ignition on terminal C209-5, circuit 1112 (White/Light Blue wire), C209-2, circuit 614 (Gray/Orange wire), C209-3, circuit 615 (Gray/White wire), or C209-4, circuit 1113 (Yellow/Light Green wire). High voltage at specified terminals may also be caused by a short in air bag clockspring, or an internal air bag diagnostic monitor failure.

Test Procedure

1. **Verify Condition**

Turn ignition switch to OFF position. Connect NGS tester to DLC. Ensure PAD switch is in ON position. Perform **ON-DEMAND SELF-TEST** . If DTC B1922 is retrieved, go to next step. If DTC B1922 is not retrieved, go to step 3).

2. **Check PAD Switch For Hard Fault**

   Turn PAD switch to OFF position. Perform **ON-DEMAND SELF-TEST** . If DTC B1922 was retrieved, go to step 4). If DTC B1922 was not retrieved, replace PAD switch and go to step 14). See **PAD SWITCH** under REMOVAL & INSTALLATION.

3. **Check PAD Switch**

   Turn PAD switch to OFF position. Perform **ON-DEMAND SELF-TEST** . If DTC B1922 was retrieved, replace PAD switch and go to step 14). See **PAD SWITCH** under REMOVAL & INSTALLATION. If DTC B1922 was not retrieved, fault is intermittent and not present. Go to step 11).

4. **Check Driver-Side Air Bag Module Circuit For Short**

   Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Inspect driver-side air bag wiring for potential short to speed control and/or horn wiring. Disconnect air bag diagnostic monitor. Turn ignition switch to ON position. Measure voltage between terminals C209-2, circuit 614 (Gray/Orange wire) and C209-18, circuit 549 (Black/Orange wire). If voltage is greater than zero volts, go to next step. If voltage is zero volts, go to step 6).

5. **Check Circuit 614 For Short To Power**

   Turn ignition switch to OFF position. Carefully remove the connector locking wedge and shorting bar diagnostic monitor connector C1, terminal No. 2. Remove driver-side Air Bag Simulator (105-00011). Measure resistance between air bag diagnostic monitor C209-2, circuit 614 (Gray/Orange wire) and C209-18, circuit 549 (Black/Orange wire). If voltage is greater than zero volts, repair circuit 614 (Gray/Orange wire). Reconnect and verify system. Go to step 14). If voltage is not as specified, repair circuit 615 (Gray/White wire). Reconnect and verify system. Go to step 14).

6. **Check Passenger-Side Air Bag Module Circuits For Short**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor connector. Turn PAD switch to ON position. Measure voltage between diagnostic monitor harness connector terminal C209-5, circuit 1112 (White/Light Blue wire) and C209-18, circuit 549 (Black/Orange wire). If voltage is more than zero volts, go to next step. If voltage is not as specified, replace air bag diagnostic monitor. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Reconnect and verify system. Go to step 14).

7. **Check Circuit 607 For Short To Power**

   Turn ignition switch to OFF position. Disconnect passenger-side Air Bag Simulator (105-00011) and PAD switch connector C214. Measure voltage between PAD switch C214-1, circuit 607 (Light Blue/Orange wire) and ground. If voltage is greater than zero volts, go to next step. If voltage is not as

specified, go to step 10).

8. **Check Circuit 1112 And 1113 For Short To Power**

   Disconnect PAD switch connector C213. Measure voltage between PAD switch C213-3, circuit 1112 (Light Green/Purple wire) on harness side of connector and ground. If voltage is greater than zero volts, go to next step. If voltage is not as specified, replace PAD switch. See **PAD SWITCH** under REMOVAL & INSTALLATION. Go to step 14).

9. **Check Circuit 1112 For Short To Power**

   Remove shorting bar from PAD switch C213. Measure voltage between PAD switch C213-3, circuit 1112 (Light Green/Purple wire) on harness side of connector and ground. If voltage is greater than zero volts, repair circuit 1112 (White/Light Blue wire) and go to step 14). If voltage is not as specified, repair circuit 1113 (Yellow/Light Green wire) and go to step 14).

10. **Check Circuit 607 For Short To Power**

    Remove shorting bar from harness side of Black connector. Measure voltage between PAD switch C214-1, circuit 607 (Light Blue/Orange wire) and ground. If voltage is greater than zero volts, repair circuit 607 (Light Blue/Orange wire) and go to step 14). If voltage is not as specified, repair circuit 616 (Pink/Black wire) and go to step 14).

11. **Check For DTC Service**

    Deactivate system. See **COMPLETE SYSTEM DEACTIVATION** . Perform **ON-DEMAND SELF-TEST** . If DTC B1922 was retrieved, go to next step. If DTC B1922 was not retrieved, go to step 14).

12. **Check For Steering Column Shorts**

    Inspect driver-side air bag wiring harness for shorts to speed control or horn wiring. If problems are noted, repair as necessary and go to step 14). If no problems are noted, go to next step.

13. **Check For Intermittent Wire Shorts**

    Inspect circuit 614 (Gray/Orange wire) and 615 (Gray/White wire) to driver-side air bag module and circuits 607 (Light Blue/Orange wire) and 616 (Pink/Black wire), 1112 (White/Light Blue wire), 1113 (Yellow/Light Green wire) for wire-to-wire shorts. If problems are noted, repair as necessary and go to next step. If wiring is OK, re-examine fault code and look for causes of intermittent shorts to battery voltage. Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Repair intermittent problems and go to next step.

14. **Check For Other DTCs**

    Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1932 - HIGH RESISTANCE OR OPEN IN DRIVER-SIDE AIR BAG CIRCUIT

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

While the ignition is in ON position, air bag diagnostic monitor runs periodic checks on resistance of driver-side and passenger-side air bag circuits. Normal resistance from terminal C209-2, circuit 614 (Gray/Orange wire) (driver-side air bag feed) to terminal C209-3, circuit 615 (Gray/White wire) (driver-side air bag return) is 1.4-2.0 ohms. This resistance total results from the sum of components in the circuit. If resistance across these two terminals exceeds 3.0 ohms, DTC B1932 will be stored in memory and AIR BAG warning light will flash Code 32. If condition is repaired or corrected, DTC B1932 will be stored in memory.

Possible Causes

High resistance across terminal C209-2, circuit 614 (Gray/Orange wire) and C209-3, circuit 615 (Gray/White wire) may be caused by a poor connection or corrosion where clockspring connects into main wiring harness, or an open circuit or high resistance in clockspring, driver-side air bag module or wiring harness in either circuit 614 (Gray/Orange wire) or 615 (Gray/White wire).

Test Procedure

1. **Verify Condition**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1932 is retrieved, go to next step. If DTC B1932 is not retrieved, go to step 6).

2. **Check Air Bag Module Resistance**

   Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1932 is retrieved, go to next step. If DTC B1932 is not retrieved, inspect clockspring wiring and connector that mates to driver-side air bag for damage. Reactivate system. If DTC B1932 is retrieved, replace driver-side air bag module and go to step 9). See **DRIVER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION.

3. **Verify Condition**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor. Set multimeter to lowest scale (200k/ohms or AUTO). Zero multimeter by touching leads together and record resistance reading. Measure resistance between diagnostic monitor harness connector terminal C209-2, circuit 614 (Gray/Orange wire) and C209-3, circuit 615 (Gray/White wire). Subtract reading found when zeroing multimeter. If resistance is greater than 3 ohms, go to next step. If resistance is less than 3 ohms, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 9).

4. **Isolate Air Bag Module Resistance**

   Disconnect clockspring connector. Connect Air Bag Simulator (105-00011) to harness connector at base of steering column. Zero multimeter by touching leads together and record reading. Measure resistance between diagnostic monitor harness connector terminal C209-2, circuit 614 (Gray/Orange wire) and C209-3, circuit 615 (Gray/White wire). Subtract reading found when zeroing multimeter. If resistance is greater than 2.2 ohms, go to next step. If resistance is less than 2.2 ohms, replace clockspring. See **CLOCKSPRING** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. Go to step 9).

5. **Check Circuit 614 For Open**

   Measure resistance between clockspring C233-1, circuit 614 (Gray/Orange wire) and air bag diagnostic monitor C209-2, circuit 614 (Gray/Orange wire). If resistance is less than 3 ohms, repair circuit 615 (Gray/White wire). Reconnect, verify, and reactivate system. Go to step 9). If resistance is more than 3 ohms, repair circuit 614 (Gray/Orange wire) for open. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 9).

6. **Check For DTC Service**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1932 was retrieved, go to next step. If DTC B1932 was not retrieved, go to step 9).

7. **Check Air Bag Connections**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor. Set multimeter to lowest scale (200K ohms or AUTO). Zero multimeter by touching leads together and record reading. Remove plastic locking wedge from Gray harness side connector at base of steering column. Measure resistance between diagnostic monitor harness connector terminals C209-2, circuit 614 (Gray/Orange wire) and C209-3, circuit 615 (Gray/White wire) while wiggling wires at driver-side air bag module connector where it mates to clockspring. Subtract reading found when zeroing multimeter. Visually inspect wiring at driver-side air bag connector where it mates to clockspring for signs of corrosion in connectors and poor crimps or bad connections. If resistance is less than 3 ohms or no wiring problems present, go to next step. If resistance is greater than 3 ohms or other problems present, replace clockspring or driver-side air bag module if wiring problems or high resistance is found. Go to step 9).

8. **Check Circuits 614 and 615**

   Inspect circuit 614 (Gray/Yellow wire) and 615 (Gray/White wire) for pinched or chafed wires leading to high resistance. If problems are noted, repair as necessary and go to next step. If no problems are noted, re-examine fault code and look for causes of intermittent high resistance or open in appropriate circuits. Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Repair intermittent problems and go to next step. If no problems are noted, go to next step.

9. **Check For Other DTCs**

Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1933 - HIGH RESISTANCE OR OPEN IN PASSENGER-SIDE AIR BAG CIRCUIT

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

While the ignition is in ON position, air bag diagnostic monitor runs periodic checks on resistance of driver-side and passenger-side air bag circuits. Normal resistance from terminal C209-5, circuit 1112 (White/Light Blue wire) (passenger-side air bag feed) to terminal C209-4, circuit 1113 (Yellow/Light Green wire) (passenger-side air bag return) is 0.9-1.2 ohms. This resistance total results from the sum of components in the circuit. If resistance across these two terminals exceeds 3.0 ohms, DTC B1933 will be stored in memory and AIR BAG warning light will flash Code 33. If condition is repaired or corrected, DTC B1933 will be stored in memory.

Possible Causes

High resistance across terminal C209-5, circuit 1112 (White/Light Blue wire) and C209-4, circuit 1113 (Yellow/Light Green wire) may be caused by an open circuit or high resistance is wiring harness in either terminal C209-5 or C209-4, passenger-side air bag module, or PAD switch.

Test Procedure

1. **Verify Condition**

   Turn ignition switch to OFF position. Connect NGS tester to DLC. Change position of PAD switch. Perform **ON-DEMAND SELF-TEST** . If DTC B1933 is retrieved, go to next step. If DTC B1933 is not retrieved, go to step 5).

2. **Check Air Bag Module Resistance**

   Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1932 is retrieved, go to next step. If DTC B1933 is not retrieved, replace passenger-side air bag module and go to step 8). See **PASSENGER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION.

3. **Verify Condition**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor. Remove plastic locking wedge at diagnostic module connector. Zero multimeter by touching leads together and record resistance reading. Measure resistance between diagnostic monitor C209-5, circuit 1112 (White/Light Blue wire) and C209-4, circuit 1113 (Yellow/Light Green wire). Subtract reading found when zeroing multimeter. If resistance is greater than 3 ohms, go to next step. If resistance is less than 3 ohms, replace air bag

diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Go to step 8).

4. **Check Circuits For Open**

   Disconnect passenger-side Air Bag Simulator (105-00011) and PAD switch connector. Remove diagnostic module locking wedge. Measure resistance between PAD switch C213-3, circuit 1112 (Light Green/Purple wire) and diagnostic monitor C209-5, circuit 1112 (White/Light Blue wire). Measure resistance between PAD switch C213-1, circuit 1113 (Yellow/Light Green wire) and diagnostic monitor C209-4, circuit 1113 (Yellow/Light Green wire). Measure resistance between PAD switch C214-1, circuit 607 (Light Blue/Orange wire) and passenger-side air bag module C215-1, circuit 607 (Light Blue/Orange wire). Measure resistance between PAD switch C214-3, circuit 616 (Pink/Black wire) and passenger-side air bag module C215-3, circuit 616 (Pink/Black wire). If resistance readings are less than 3 ohms, replace PAD switch. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect, verify, and reactivate system. Go to step 8). If resistance is not as specified, repair circuit 607 (Light Blue/Orange wire), 616 (Pink/Black wire), 1112 (Light Green/Purple wire), or 1113 (Yellow/Light Green wire). Reconnect, verify, and reactivate system. Go to step 8).

5. **Check For DTC Service**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1933 was retrieved, go to next step. If DTC B1933 was not retrieved, go to step 8).

6. **Check Air Bag Connections**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor. Set multimeter to lowest scale (200K ohms or AUTO). Zero multimeter by touching leads together and record reading. Remove plastic locking wedge from Gray harness side connector at base of steering column. Measure resistance between diagnostic monitor harness connector terminals C209-4, circuit 1112 (White/Light Blue wire) and C209-5, circuit 1113 (Yellow/Light Green wire). Subtract reading found when zeroing multimeter. Change position of PAD switch and perform resistance check again. Visually inspect wiring at passenger-side air bag connector where it mates to clockspring for signs of corrosion in connectors and poor crimps or bad connections. If resistance is less than 3 ohms or no wiring problems present, go to next step. If resistance is more than 3 ohms or other problems present, replace passenger-side air bag module if wiring problems or high resistance is found. Go to step 8).

7. **Check Circuits 607, 616, 1112, & 1113**

   Inspect circuit 607 (Light Blue/Orange wire), 616 (Pink/Black wire), 1112 (White/Light Blue wire), and 1113 (Yellow/Light Green wire) for pinched or chafed wires leading to high resistance. If problems are noted, repair as necessary and go to next step. If no problems are noted, re-examine fault code and look for causes of intermittent high resistance or open in appropriate circuits. Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Repair intermittent problems and go to next step. If no problems are noted, go to next step.

8. **Check For Other DTCs**

   Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1934 - LOW RESISTANCE OR SHORT IN DRIVER-SIDE AIR BAG CIRCUIT

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

While the ignition is in ON position, air bag diagnostic monitor runs periodic checks on resistance of driver-side and passenger-side air bag circuits. Normal resistance from terminal C209-2, circuit 614 (Gray/Orange wire) (driver-side air bag feed) to terminal C209-3, circuit 615 (Gray/White wire) (driver-side air bag return) is 1.4-2.0 ohms. This resistance total results from the sum of components in the circuit. If resistance across these two terminals is less than 1.0 ohm, DTC B1934 will be stored in memory and AIR BAG warning light will flash Code 34. If condition is repaired or corrected, DTC B1934 will be stored in memory.

Possible Causes

Low resistance across terminal C209-2, circuit 614 (Gray/Orange wire) and 615 (Gray/White wire) may be caused by a poorly mated air bag connector, diagnostic monitor harness connector, or clockspring connector, a damaged or worn shorten bar, a short in clockspring or wiring harness, or a short circuit or low resistance in driver-side air bag module.

Test Procedure

1. **Verify Condition**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1934 is retrieved, go to next step. If DTC B1934 is not retrieved, go to step 5).

2. **Check Air Bag Module Resistance**

   Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1932 is retrieved, go to next step. If DTC B1934 is not retrieved, examine shorting bars on driver-side air bag module connector and inspect clockspring wiring circuits 614 and 615 for damage or shorts. Replace driver-side air bag module if shorting bars are normal and no wiring damage is found. See **DRIVER-SIDE AIR BAG MODULE** under REMOVAL & INSTALLATION. Go to step 9).

3. **Verify Condition**

   Turn ignition switch to OFF position. Disconnect Air Bag Simulator (105-00011) from driver-side air bag connector. Disconnect air bag diagnostic monitor. Remove plastic locking wedge from Gray harness

connector C209 at air bag diagnostic monitor. Measure resistance between diagnostic monitor harness connector terminal C209-2, circuit 614 (Gray/Orange wire) and C209-3, circuit 615 (Gray/White wire) while turning steering wheel. If resistance reading is less than 10 Kohms, go to next step. If resistance is not as specified, examine shorting bars on driver-side air bag module connector. Replace diagnostic monitor if shorting bars are normal. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect and verify system. Go to step 9).

4. **Check For Short Between Circuit 614 And 615**

   Disconnect clockspring connector at base of steering column. Measure resistance between diagnostic monitor harness connector terminal C209-2, circuit 614 (Gray/Orange wire) and C209-3, circuit 615 (Gray/White wire). If resistance reading is greater than 10 Kohms, examine shorting bars on driver-side air bag module connector. Replace clockspring if shorting bars are normal. See **CLOCKSPRING** under REMOVAL & INSTALLATION. Reconnect system. Go to step 9). If resistance is not as specified, repair short between circuit 614 (Gray/Orange wire) and 615 (Gray/White wire). Reconnect and verify system. Go to step 9).

5. **Check For DTC Service**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1934 was retrieved, go to next step. If DTC B1934 was not retrieved, go to step 9).

6. **Check Shorting Bars**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor. Zero multimeter by touching leads together and record reading. Remove plastic locking wedge from Gray harness side connector at base of steering column. Measure resistance between diagnostic monitor harness connector terminals C209-2, circuit 614 (Gray/Orange wire) and C209-3, circuit 615 (Gray/White wire) while wiggling wires at driver-side air bag module connector where it mates to clockspring. Subtract reading found when zeroing multimeter. Visually inspect shorting bars at driver-side air bag module, clockspring connector at main harness, and diagnostic monitor for signs of poor operation. If resistance is more than 1 ohm or no wiring problems present, go to next step. If resistance is more than 1 ohm or other problems present, repair as necessary. Go to step 9).

7. **Check Clockspring**

   Remove Air Bag Simulator (105-00011) from steering wheel. Measure resistance between air bag diagnostic monitor harness connector terminal C209-2, circuit 614 (Gray/Orange wire) and C209-3, circuit 615 (Gray/White wire) while turning steering wheel. If resistance reading is not infinite (open), go to next step. If resistance is infinite (open), replace clockspring if resistance reading jumps while turning steering wheel. See **CLOCKSPRING** under REMOVAL & INSTALLATION. Go to step 9).

8. **Check Circuits 614 and 615**

   Inspect circuit 614 (Gray/Yellow wire) and 615 (Gray/White wire), clockspring wires where it mates to main harness, and where clockspring mates to driver-side air bag module for potential intermittent shorts

between circuits. If problems are noted, repair as necessary and replace clockspring and driver-side air bag if wiring is damaged. Go to next step. If no problems are noted, re-examine fault code and look for causes of intermittent high resistance or open in appropriate circuits. Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Repair intermittent problems and go to next step.

9. **Check For Other DTCs**

   Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1935 - LOW RESISTANCE OR SHORT IN PASSENGER-SIDE AIR BAG CIRCUIT

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The air bag diagnostic monitor runs periodic checks on resistance of driver-side and passenger-side air bag module, while ignition switch is in ON position. Normal resistance from terminal C209-5, circuit 1112 (White/Light Blue wire) (passenger-side air bag feed) to terminal C209-4, circuit 1113 (Yellow/Light Green wire) (passenger-side air bag return) is between 0.9-1.2 ohms. If resistance at these terminals is less than 0.7 ohms, DTC B1935 will be stored in memory and AIR BAG warning light will flash Code 35. If condition is repaired or corrected, DTC B1935 will be stored in memory.

Possible Causes

Low resistance across C209-5, circuit 1112 (White/Light Blue wire) and C209-4, circuit 1113 (Yellow/Light Green wire) may be caused by a poorly mated passenger-side air bag or diagnostic monitor harness connector, damaged or worn shorting bar, short in harness wires across specified circuits, or short or low resistance in passenger-side air bag module or PAD switch.

Test Procedure

1. **Verify Condition**

   Turn ignition switch to OFF position. Connect NGS tester to DLC. Ensure PAD switch is in ON position. Perform **ON-DEMAND SELF-TEST** . If DTC B1935 is retrieved, go to next step. If DTC B1935 is not retrieved, go to step 8).

2. **Check PAD Switch Position**

   Ensure PAD switch is in ON position. If PAD switch is in ON position, go to step 4). If PAD switch is in OFF position, use key to turn PAD switch to ON position and go to next step.

3. **Recheck System**

Perform **ON-DEMAND SELF-TEST** . If DTC B1935 was retrieved, go to next step. If DTC B1935 was not retrieved, replace PAD switch and go to step 12). See **PAD SWITCH** under REMOVAL & INSTALLATION.

4. **Check Air Bag Module Resistance**

   Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Connect NGS to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1935 is retrieved, go to next step. If DTC B1935 is not retrieved, examine shorting bars on passenger-side air bag connector. Replace passenger-side air bag module if shorting bars are normal. Go to step 7).

5. **Verify Condition**

   Turn ignition switch to OFF position. Disconnect Air Bag Simulator (105-00011) from passenger-side air bag connector. Disconnect air bag diagnostic monitor. Remove plastic locking wedge from Gray harness connector C209 at air bag diagnostic monitor. Measure resistance between diagnostic monitor harness connector terminal C209-4, circuit 1113 (Yellow/Light Green wire) and C209-5, circuit 1112 (White/Light Blue wire). If resistance reading is not infinite (open), go to next step. If resistance reading is infinite (open), examine shorting bars on air bag diagnostic connector C209. Replace air bag diagnostic monitor if shorting bars are normal. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect and verify system. Go to step 12).

6. **Check For Short Between Circuit 1112 And 1113**

   Disconnect PAD switch connector C213. Measure resistance between PAD switch C213-1, circuit 1112 (White/Light Blue wire) and C213-3, circuit 1113 (Yellow/Light Green wire). If resistance is infinite (open), go to next step. If resistance is not as specified, repair circuit 1112 and/or 1113. Reconnect system and inspect diagnostic monitor harness connector C209 for shorted terminals. Go to step 12).

7. **Check For Short Between Circuit 607 And 616**

   Disconnect PAD switch connector C214. Measure resistance between PAD switch C214-1, circuit 607 (Light Blue/Orange wire) and C214-3, circuit 616 (Pink/Black wire). If resistance is infinite (open), replace PAD switch. See **PAD SWITCH** under REMOVAL & INSTALLATION. Reconnect system and inspect diagnostic monitor harness connector C209 for shorted terminals. Go to step 12). If resistance is not as specified, repair circuit 607 and/or 616. Reconnect, verify, and reactivate system. Go to step 12).

8. **Check For DTC Service**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1935 was retrieved, go to next step. If DTC B1935 was not retrieved, go to step 12).

9. **Check Shorting Bars**

   Turn ignition switch to OFF position. Disconnect passenger-side Air Bag Simulator (105-00011) and air bag diagnostic monitor. Ensure PAD switch is in ON position. Zero multimeter by touching leads

together and record reading. Remove plastic locking wedge from Gray harness side connector at base of steering column. Measure resistance between diagnostic monitor C209-4, circuit 1113 (Yellow/Light Green wire) and C209-5, circuit 1112 (White/Light Blue wire) while wiggling wires at passenger-side air bag module connector where it mates to harness. Subtract reading found when zeroing multimeter. Visually inspect shorting bars at passenger-side air bag and clockspring Gray harness connector for signs of poor operation. If resistance is not infinite (open) or no wiring problems present, go to next step. If resistance is infinite (open) or other problems present, repair as necessary and go to step 12).

10. **Check PAD Switch Connections**

    Disconnect PAD switch connector C213. Zero multimeter by touching leads together and record reading. Remove shorting bars from PAD switch connector C213. Measure resistance between PAD switch C213-1, circuit 1112 (White/Light Blue wire) and C213-3, circuit 1113 (Yellow/Light Green wire), while wiggling wires on PAD switch pigtail and turning PAD switch off and on. Subtract reading found when zeroing multimeter. Inspect shorting bars on PAD switch pigtail connector C213, for signs of poor operation. If any wiring problems are found or resistance reading is infinite (open), go to next step. If no wiring problems are found and resistance reading is not infinite (open), replace PAD switch if wiring problem is found or high resistance measured. See **PAD SWITCH** under REMOVAL & INSTALLATION. Go to step 12).

11. **Check Circuit 607, 616, 1112 And 1113**

    Inspect wiring and connections in circuits 607 (Light Blue/Orange wire), 616 (Pink/Black wire), 1112 (White/Light Blue wire), and 1113 (Yellow/Light Green wire) for potential intermittent shorts between circuits. Examine harness connection air bag wires for same condition. If problems are noted, repair as necessary and replace passenger-side air bag if wiring is damaged. Go to next step. If no problems are noted, re-examine fault code and look for causes of intermittent high resistance or open in appropriate circuits. Attempt to recreate hard faults by driving vehicle, flexing wiring harnesses, etc. Repair intermittent problems and go to next step.

12. **Check For Other DTCs**

    Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1941 - RIGHT FRONT IMPACT SENSOR FEED/RETURN CIRCUIT OPEN

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

Voltage at terminal C209-16, circuit 617 (Pink/Orange wire) is set by air bag diagnostic monitor to be slightly less than battery voltage. This circuit is connected to circuit 624 (Yellow/White wire) inside right front impact sensor. Voltage at circuit 624 and diagnostic monitor C208-24 should be same as voltage at diagnostic monitor circuit 617. The air bag diagnostic monitor periodically pulls voltage at terminal C209-16, circuit 617

(Pink/Orange wire) low to verify connection to terminal C208-24, circuit 624 (Yellow/White wire). If voltage at circuit 624 does not pull low as result of test, DTC B1941 will be stored in memory and AIR BAG warning light will flash Code 41. If condition is repaired or corrected, DTC B1941 will be stored in memory.

Possible Causes

Failure to achieve low voltage at terminal C208-24, circuit 624 (Yellow/White wire) during test may be caused by an open in wiring harness in either specified circuits, an open circuit inside right front impact sensor, or a short to battery or ignition voltage in circuits 617 (Pink/Orange wire), 619 (Pink/White wire), 624 (Yellow/White wire), or 625 (Yellow/Light Green wire).

Test Procedure

1. **Verify Condition**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1941 is retrieved, go to next step. If DTC B1941 is not retrieved, go to step 6).

2. **Measure Resistance**

   Turn ignition switch to OFF position. Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect air bag diagnostic monitor. Zero multimeter by touching leads together and record resistance reading. Measure resistance between air bag diagnostic monitor harness connector terminals C209-16, circuit 617 (Pink/Orange wire) and C208-24, circuit 624 (Yellow/White wire). Subtract reading found when zeroing multimeter. If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, go to step 4).

3. **Check For Short To Battery**

   Disconnect air bag diagnostic monitor connector. Turn ignition switch to ON position. Measure voltage between air bag diagnostic monitor C209, C208, ground and terminals C209-15, C209-16, C208-23, and C208-24. If any of voltage readings is greater than zero volts, repair appropriate circuit and go to step 10). If voltages are zero, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect and verify system. Go to step 10).

4. **Verify Concern**

   Turn ignition switch to OFF position. Disconnect right front impact sensor connector. Measure resistance between circuits 617 (Pink/Orange wire) and 624 (Yellow/White wire) on right front impact sensor. If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, replace right front impact sensor. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Verify system and go to step 10).

5. **Check Circuit 617 For Open**

   Turn ignition switch to OFF position. Disconnect air bag diagnostic monitor. Disconnect right front impact sensor. Measure resistance between right front impact sensor C140-2, circuit 617 (Pink/Orange

wire) and air bag diagnostic monitor C209-16, circuit 617 (Pink/Orange wire). If resistance is less than 5 ohms, repair circuit 624 (Yellow/White wire) for an open. Reconnect, verify, and reactivate system. Go to step 10). If resistance is not as specified, repair circuit 617 (Pink/Orange wire). Reconnect, verify, and reactivate system. Go to step 10).

6. **Check For DTC Service**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1941 was retrieved, go to next step. If DTC B1941 was not retrieved, go to step 10).

7. **Check Wires**

   Inspect wires, crimps, connectors, etc. on circuits 617 (Pink/Orange wire) and 624 (Yellow/White wire) for signs of poor connection. If problems are noted, repair and go to step 10). If not, go to next step.

8. **Check For Short To Battery**

   Inspect circuits 617 (Pink/Orange wire), 619 (Pink/White wire), 624 (Yellow/White wire), and 625 (Yellow/Light Green wire) for signs of wire shorts, shorts to battery or ignition, or high voltage. If any problems are noted, repair and go to step 10). If not, go to next step.

9. **Check Sensor**

   Inspect right front impact sensor. Look for signs of corrosion. If problem or corrosion is noted, replace right front impact sensor. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Go to next step. If no problems are noted, re-examine fault code and look for causes of intermittent faults or high resistance in applicable circuits. Attempt to recreate hard fault codes by driving vehicle, flexing wiring harness, cycling ignition switch, etc. Service intermittent problems. Go to next step.

10. **Check For Other DTCs**

    Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1942 - LEFT FRONT IMPACT SENSOR FEED/RETURN CIRCUIT OPEN

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

Voltage at terminal C209-15, circuit 619 (Pink/White wire) is set by air bag diagnostic monitor to be slightly less than battery voltage. This circuit is connected to circuit 625 (Yellow/Light Green wire) inside left front impact sensor. Voltage at circuit 625 and diagnostic monitor C208-23 should be same as voltage at diagnostic monitor circuit 619. The air bag diagnostic monitor periodically pulls voltage at terminal C209-15, circuit 619

(Pink/White wire) low to verify connection to terminal C208-23, circuit 625 (Yellow/Light Green wire). If voltage at circuit 625 does not pull low as result of test, DTC B1942 will be stored in memory and AIR BAG warning light will flash Code 42. If condition is repaired or corrected, DTC B1942 will be stored in memory.

Possible Causes

Failure to achieve low voltage at terminal C208-23, circuit 625 (Yellow/Light Green wire) during test may be caused by an open in wiring harness in either specified circuits, an open circuit inside left front impact sensor, or a short to battery or ignition voltage in circuits 617 (Pink/Orange wire), 619 (Pink/White wire), 624 (Yellow/White wire), or 625 (Yellow/Light Green wire).

Test Procedure

1. **Verify Condition**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1942 is retrieved, go to next step. If DTC B1941 is not retrieved, go to step 6).

2. **Measure Resistance**

   Turn ignition switch to OFF position. Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect air bag diagnostic monitor. Zero multimeter by touching leads together and record resistance reading. Measure resistance between air bag diagnostic monitor harness connector terminals C209-15, circuit 619 (Pink/White wire) and C208-23, circuit 625 (Yellow/Light Green wire). Subtract reading found when zeroing multimeter. If resistance is less than 5 ohms, to next step. If resistance is greater than 5 ohms, go to step 4).

3. **Check For Short To Battery**

   Disconnect air bag diagnostic monitor connector. Turn ignition switch to ON position. Measure voltage between air bag diagnostic monitor C209, C208, ground and terminals C209-15, C209-16, C208-23, and C208-24. If any of voltage readings is greater than zero volts, repair appropriate circuit and go to step 10). If voltages are zero, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect and verify system. Go to step 10).

4. **Verify Concern**

   Disconnect left front impact sensor connector. Measure resistance between left front impact sensor terminals No. 1 and 2. If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, replace left front impact sensor. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Verify system and go to step 10).

5. **Check Circuit 619 For Open**

   Measure resistance between left front impact sensor C141-2, circuit 619 (Pink/White wire) and air bag diagnostic monitor C209-15, circuit 619 (Pink/White wire). If resistance is less than 5 ohms, repair circuit 625 (Yellow/Light Green wire) for an open. Reconnect, verify, and reactivate system. Go to step 10). If

resistance is not as specified, repair circuit 619 (Pink/White wire). Reconnect, verify, and reactivate system. Go to step 10).

6. **Check For DTC Service**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1942 was retrieved, go to next step. If DTC B1942 was not retrieved, go to step 10).

7. **Check Wires**

   Inspect wires, crimps, connectors, etc. on circuits 619 (Pink/White wire) and 625 (Yellow/Light Green wire) for signs of poor connection. If problems are noted, repair and go to step 10). If not, go to next step.

8. **Check For Short To Battery**

   Inspect circuits 617 (Pink/Orange wire), 619 (Pink/White wire), 624 (Yellow/White wire), and 625 (Yellow/Light Green wire) for signs of wire shorts, shorts to battery or ignition, or high voltage. If any problems are noted, repair and go to step 10). If not, go to next step.

9. **Check Sensor**

   Inspect left front impact sensor. Look for signs of corrosion. If problem or corrosion is noted, replace left front impact sensor. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Go to next step. If no problems are noted, re-examine fault code and look for causes of intermittent faults or high resistance in applicable circuits. Attempt to recreate hard fault codes by driving vehicle, flexing wiring harness, cycling ignition switch, etc. Service intermittent problems. Go to next step.

10. **Check For Other DTCs**

    Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1944 - RIGHT FRONT IMPACT SENSOR NOT MOUNTED TO VEHICLE PROPERLY/GROUND CIRCUIT OPEN

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The air bag diagnostic monitor measures resistance between C208-21, circuit 618 (Purple/Light Green wire) and reference ground at terminal C209-18, circuit 549 (Black/Orange wire). If diagnostic monitor measures difference of more than 3 ohms between ground at C209-18 and ground at C208-21, DTC B1944 will be stored in memory and AIR BAG warning light will flash Code 44. If condition is repaired or corrected, DTC B1944 will be stored in memory.

Possible Causes

High resistance at terminal C208-21, circuit 618 (Purple/Light Green wire) to ground may be caused by a poor attachment of right front impact sensor due to loose mounting, dirt or corrosion, an open or damaged wire in circuit 618, an open wire or loose rivet inside right front impact sensor, or a poor reference ground at applicable circuits.

Test Procedure

1. **Verify Condition**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1944 is retrieved, go to next step. If DTC B1944 is not retrieved, go to step 6).

2. **Check Circuit 618**

   Turn ignition switch to OFF position. Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect air bag diagnostic monitor. Measure resistance between terminal C208-21, circuit 618 (Purple/Light Green wire) and ground. If resistance is greater than 3 ohms, go to next step. If resistance is less than 3 ohms, go to step 5).

3. **Check Front Impact Sensor Ground**

   Disconnect right front impact sensor connector. Zero multimeter by touching leads together and record reading. Measure resistance between right front impact sensor terminal No. 4 and ground. Subtract reading found when zeroing multimeter. If resistance is greater than 3 ohms, remove screws retaining sensor, clean mounting surface, and install sensor. Go to next step. If resistance is not as specified, repair circuit 618 (Purple/Light Green wire). Reconnect system and go to step 10).

4. **Check Right Front Impact Sensor**

   Zero multimeter by touching leads together and record reading. Measure resistance between right front impact sensor terminal No. 4 and ground. If resistance is less than 3 ohms, reconnect system and go to step 10). If resistance is greater than 3 ohms, replace right impact sensor. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Reconnect system. Go to step 10).

5. **Check Reference Ground**

   Check attachment of ground connections and splices in feeding air bag diagnostic monitor C209-18, circuit 549 (Black/Orange wire) and C208-10, circuit 650 (Black/Light Blue wire). If any poor connections are noted, check poor grounding of circuit 549 and 650. If necessary, add ground strap from circuit 549 to one of diagnostic monitor mounting fasteners. Connect air bag diagnostic monitor and verify system. Go to step 10). If no poor connections are noted, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect and verify system. Go to step 10).

6. **Check For DTC Service**

Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1944 was retrieved, go to next step. If DTC B1944 was not retrieved, go to step 10).

7. **Check Wires**

   Inspect wires, crimps, connectors, etc. on circuits 618 (Purple/Light Green wire) and 649 (Black/Orange wire) for signs of poor connection. Connect NGS to DLC. Select IABM. Select Pid/Data Monitor and Record. Select Pid CRSHSN1. Wiggle wires while watching PID. If reading goes greater than 3 ohms or other problems are noted, repair and go to step 10). If not, go to next step.

8. **Check Sensor**

   Inspect right front impact sensor for signs of corrosion. Connect NGS to DLC. Select IABM. Select Pid/Data Monitor and Record. Select Pid CRSHSN1. Wiggle wires while watching PID. If reading goes greater than 3 ohms or other problems are noted, replace front impact sensor and repair problems. Go to step 10). If not, go to next step.

9. **Check Circuit 549 And 650**

   Check attachment of ground connections feeding air bag diagnostic monitor C209-18, circuit 549 (Black/Orange wire) and C208-10, circuit 650 (Black/Light Blue wire). If any poor ground connections are found, check poor grounding of circuits 549 and 650. If necessary, add ground strap from circuit 549 to one of air bag diagnostic monitor mounting fasteners. Connect air bag diagnostic monitor and verify system. Go to next step. If no poor ground connections are found, remove front impact sensor retaining screws and clean mounting surface of sensor and chassis. Install sensor and tighten screws. Go to next step.

10. **Check For Other DTCs**

    Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

DTC B1945 - LEFT FRONT IMPACT SENSOR NOT MOUNTED TO VEHICLE PROPERLY/GROUND CIRCUIT OPEN

NOTE: Before proceeding, see SERVICE PRECAUTIONS . After servicing has been performed, recheck AIR BAG warning light. If system is okay, install air bag modules and reactivate air bag system.

Description

The air bag diagnostic monitor measures resistance between C208-20, circuit 620 (Purple/Light Blue wire) and reference ground at terminal C209-18, circuit 549 (Black/Orange wire). If diagnostic monitor measures difference of more than 3 ohms between ground at C209-18 and ground at C208-20, DTC B1945 will be stored in memory and AIR BAG warning light will flash Code 45. If condition is repaired or corrected, DTC B1945

will be stored in memory.

Possible Causes

High resistance at terminal C208-20, circuit 620 (Purple/Light Blue wire) to ground may be caused by a poor attachment of left front impact sensor due to loose mounting, dirt or corrosion, an open or damaged wire in circuit 620, an open wire or loose rivet inside left front impact sensor, or a poor reference ground at applicable circuits.

Test Procedure

1. **Verify Condition**

   Connect NGS tester to DLC. Perform **ON-DEMAND SELF-TEST** . If DTC B1945 is retrieved, go to next step. If DTC B1945 is not retrieved, go to step 6).

2. **Measure Resistance**

   Turn ignition switch to OFF position. Deactivate SRS. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect air bag diagnostic monitor. Measure resistance of terminal C209-20, circuit 620 (Purple/Light Blue wire) to ground. If resistance is greater than 3 ohms, go to next step. If resistance is less than 3 ohms, go to step 5).

3. **Check Front Impact Sensor Ground**

   Disconnect left front impact sensor connector C141. Zero multimeter by touching leads together and record reading. Measure resistance between left front impact sensor terminal No. 4 and ground. Subtract reading found when zeroing multimeter. If resistance is less than 3 ohms, repair circuit 620 and reconnect system. Go to step 10). If resistance is not as specified, remove left front impact sensor retaining screws and clean mounting surface of sensor and chassis. Install sensor and tighten screws. Go to step 10).

4. **Check Left Front Impact Sensor**

   Zero multimeter by touching leads together and record reading. Measure resistance between left front impact sensor terminal No. 4 and ground. If resistance is less than 3 ohms, reconnect system and go to step 10). If resistance is greater than 3 ohms, replace left impact sensor. See **FRONT IMPACT SENSORS** under REMOVAL & INSTALLATION. Reconnect system. Go to step 10).

5. **Check Reference Ground**

   Check attachment of ground connections and splices in circuit 549 (Black/Orange wire) feeding air bag diagnostic monitor harness connector terminals C208-10 and C209-18. If any poor connections are noted, correct problem and if necessary add a ground strap from circuit 549 (Black/Orange wire) to one of the diagnostic monitor mounting fasteners. Connect air bag diagnostic monitor. Verify system and go to step 10). If connections are OK, replace air bag diagnostic monitor. See **DIAGNOSTIC MONITOR** under REMOVAL & INSTALLATION. Reconnect and verify system. Go to step 10).

6. **Check For DTC Service**

   Deactivate system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Perform **ON-DEMAND SELF-TEST** . If DTC B1945 was retrieved, go to next step. If DTC B1945 was not retrieved, go to step 10).

7. **Check Wires**

   Inspect wires, crimps, connectors, etc. on circuits 620 (Purple/Light Blue wire) for signs of poor connection. Connect NGS to DLC. Select IABM. Select Pid/Data Monitor and Record. Select Pid CRSHSN1. Wiggle wires while watching PID. If reading goes greater than 3 ohms or other problems are noted, repair and go to step 10). If not, go to next step.

8. **Check Sensor**

   Inspect left front impact sensor for signs of corrosion. Connect NGS to DLC. Select IABM. Select Pid/Data Monitor and Record. Select Pid CRSHSN1. Wiggle wires while watching PID. If reading goes greater than 3 ohms or other problems are noted, repair and go to step 10). If not, go to next step.

9. **Check Circuit 549 And 650**

   Check attachment of ground connections feeding air bag diagnostic monitor C209-18, circuit 549 (Black/Orange wire) and C208-10, circuit 650 (Black/Light Blue wire). If any poor ground connections are found, check poor grounding of circuits 549 and 650. If necessary, add ground strap from circuit 549 to one of air bag diagnostic monitor mounting fasteners. Connect air bag diagnostic monitor and verify system. Go to next step. If no poor ground connections are found, remove front impact sensor retaining screws and clean mounting surface of sensor and chassis. Install sensor and tighten screws. Go to next step.

10. **Check For Other DTCs**

    Connect NGS to DLC. If other DTCs are retrieved go to proper DTC test. If no other DTCs are retrieved, reactivate system and clear all DTCs. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Steering Wheel Bolt	23-32 (31-44)
	INCH Lbs. (N.m)
Driver-Side Air Bag Module	90-123 (10-13)
Front Sensors	10-123 (10-13)
PAD Switch	17-26 (2-3)
Passenger-Side Air Bag Module	87-92 (8-10)

WIRING DIAGRAM

1997 Ford Pickup F150

AIR BAG RESTRAINT SYSTEM (F150 & F250 LD) 1997 ACCESSORIES/SAFETY EQUIPMENT Ford Motor Co. - Air Bag Restraint System

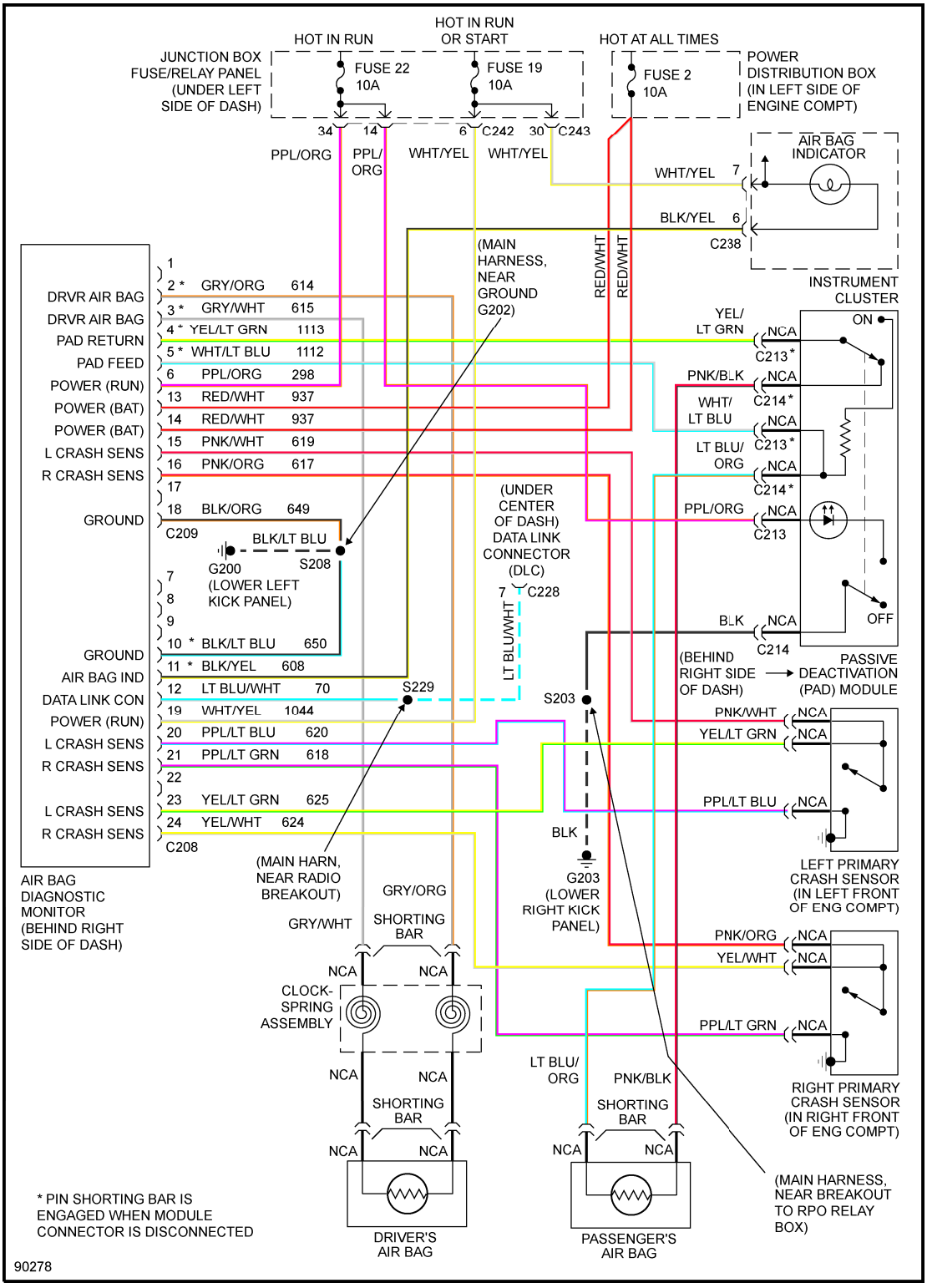


Fig. 11: SRS Wiring Diagram

ANTI-LOCK BRAKE SYSTEM - 4-WHEEL

1997 BRAKES Ford Motor Co. - Anti-Lock - 4WAL

DESCRIPTION

CAUTION: See ANTI-LOCK BRAKE SAFETY PRECAUTIONS article in the GENERAL INFORMATION section.

The 4-wheel Anti-Lock Brake System (ABS) is designed to allow vehicle to stop in the shortest possible distance while maintaining full steering control. ABS system consists of Electronic Hydraulic Control Unit (EHCU), master cylinder, power brake booster, front wheel speed sensors, rear wheel speed sensor (mounted on differential). ABS uses electronic and hydraulic components to prevent wheels from locking up during brake application. ABS does not function during normal (light) braking applications.

The EHCU consists of an Electronic Control Module (ECM) attached to a Hydraulic Control Unit (HCU). If service is required, ECM can be replaced if inoperative. If HCU is inoperative, entire EHCU must be replaced as an assembly.

NOTE: For more information on brake system, see BRAKE SYSTEM article in the BRAKES section.

OPERATION

ABS control module receives a signal from each speed sensor. This information is translated into calculated wheel speed. When ABS control module determines wheel lock-up is about to occur, the hydraulic control unit is activated and deactivated to vary hydraulic pressure to prevent wheel lock-up.

ABS does not operate during normal braking conditions. ABS is self-monitoring. ABS has a self-diagnostic system to obtain trouble codes for testing purposes. See **DIAGNOSIS & TESTING** .

BLEEDING BRAKE SYSTEM

CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, immediately wash it with water.

Bleed hydraulic system whenever air has been introduced into system. Bleed master cylinder and brakes at all 4 wheels if master cylinder lines have been disconnected or master cylinder has run dry. Bleed brakes with pressure bleeding equipment or by manually pumping brake pedal while using bleeder tubes. Always bleed brakelines in sequence. See **BLEEDING SEQUENCE** .

CAUTION: See ANTI-LOCK BRAKE SAFETY PRECAUTIONS article in the GENERAL INFORMATION section.

CAUTION: Bleed anti-lock brake system using following procedure. If this procedure is not followed, air will be trapped in Hydraulic Control Unit (HCU), resulting in a spongy pedal.

NOTE: DO NOT allow reservoir to run dry during bleeding operation.

MASTER CYLINDER BLEEDING (BENCH)

1. Support brake master cylinder body in a vise and fill brake master cylinder reservoir with DOT 3 brake fluid. Install plugs in front and rear brake outlet ports. Bleed front brake system first. Loosen plug in front brake outlet port and depress primary piston slowly to force air out of master cylinder.
2. Tighten plug while piston is depressed or air will enter brake master cylinder. Repeat procedure until no air bubbles are present. Repeat bleeding procedure for rear brake outlet port with front brake outlet plugged. Tighten plugs and try to depress piston. Piston will not depress if all air is out of master cylinder.

MASTER CYLINDER BLEEDING (ON VEHICLE)

1. Using a tubing wrench, remove brake tubes from master cylinder. Install short brake tubes in master cylinder and position them so they curve into master cylinder reservoir. Ensure ends of tubes are submerged in brake fluid.
2. Fill master cylinder reservoir with new DOT 3 brake fluid. Have an assistant pump brakes until clear, bubble-free fluid flows from both brake tubes. Remove short brake tubes and reinstall brake tubes on master cylinder. Bleed each brake tube at master cylinder by having and assistant pump brake pedal 10 times and hold firm pressure on brake pedal.
3. Loosen rear-most brake tube fittings until a stream of brake fluid comes out. Have an assistant maintain pressure on brake pedal until brake tube fitting is tightened again. Repeat procedure until clear, bubble-free fluid comes out from around tube fitting. Refill master cylinder reservoir as necessary. Repeat this bleeding operation at front brake tube fittings.

CONVENTIONAL MANUAL BLEEDING

1. Remove dust cap from right rear wheel bleeder fitting. Connect hose to bleeder fitting. Submerge other end of hose in container of clean brake fluid.
2. Loosen bleeder fitting while an assistant presses brake pedal through its full travel. Close bleeder fitting. Wait 5 seconds. Repeat procedure until air bubbles are no longer present at submerged end of hose.
3. Repeat procedure at left rear, right front and left front wheels. Refill reservoir after each wheel is bled. When complete, adjust fluid level.

CONVENTIONAL PRESSURE BLEEDING

1. Clean reservoir cap area. Connect pressure bleeder, following manufacturer's instructions. Remove dust cap from right rear wheel bleeder fitting. Attach hose to bleeder fitting. Submerge other end of hose in container of clean brake fluid.

CAUTION: Never exceed 50 psi (3.5 kg/cm^2) during bleeding.

2. Open valve on bleeder tank to pressurize system. Maintain system pressure at 10-30 psi (.7-2.1 kg/cm^2). With brake pedal released, open bleeder fitting until air bubbles no longer emerge from submerged end of hose.
3. Repeat procedure at left rear, right front and left front wheels. When complete, close pressure bleeder tank valve, remove adapter and adjust fluid level.

HYDRAULIC CONTROL UNIT (HCU) BLEEDING

1. Bleed brake system using conventional bleeding procedure. Connect New Generation Star (NGS) tester to Data Link Connector (DLC). Turn ignition on. Enter vehicle identification information. Choose DIAGNOSTIC DATA LINK from menu selection.
2. Next, choose ABS MODULE, FUNCTION TEST, and SERVICE BLEED FUNCTION. Follow scan tester instructions until SERVICE BLEED PROCEDURE COMPLETE message is displayed. Repeat conventional bleeding procedure again. If brake pedal feels spongy, repeat complete procedure.

BLEEDING SEQUENCE

BLEEDING SEQUENCE

Application	Sequence
Expedition & F150/250 Pickup	RR, LR, RF, LF

TROUBLE SHOOTING

ANTI-LOCK WARNING LIGHT

The ABS and BRAKE warning lights alert vehicle operator of problems in braking system. Red BRAKE warning light monitors master cylinder fluid level and parking brake status. Yellow ABS warning light alerts vehicle operator to problems in ABS system.

DIAGNOSIS

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery. Vehicle may need to be driven more than 10 miles to relearn strategy.

RETRIEVING TROUBLE CODES

NOTE: It is imperative that SYSTEM PRECHECK be performed before attempting any

further diagnosis. Failure to do so could result in improper diagnosis.

1. Turn ignition off. Locate Data Link Connector (DLC) under dash, to right of steering column. Following manufacturer's instructions, connect New Generation Star (NGS) Tester (007-00500) to DLC.
2. Turn ignition on. Follow instructions on scan tester menu. Record codes in order received. These codes indicate current faults in system and should be serviced in order of appearance. See **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table.

DIAGNOSTIC TROUBLE CODE (DTC) INDEX

DTC	Definition	Proceed To
C1220	Yellow ABS Warning Indicator Failure	**TEST A**
C1225/C1226	Red BRAKE Warning Indicator Failure	**TEST B**
C1265	Shorted Red BRAKE Indicator Relay	**TEST B**
C1198/C1200	Left Front Isolation Valve	**TEST C**
C1194/C1196	Left Front Dump Valve	**TEST C**
C1214/C1216	Right Front Isolation Valve	**TEST C**
C1210/C1212	Right Front Dump Valve	**TEST C**
C1206/C1208	Rear Isolation Valve	**TEST C**
C1202/C1204	Rear Dump Valve	**TEST C**
C1155	Left Front Wheel Speed Sensor, Static	**TEST D**
C1158/C1233	Left Front Wheel Speed Sensor, Dynamic	**TEST E**
C1145	Right Front Wheel Speed Sensor, Static	**TEST F**
C1148/C1234	Right Front Wheel Speed Sensor, Dynamic	**TEST G**
C1230	Rear Wheel Speed Sensor, Static	**TEST H**
C1229/C1237	Rear Wheel Speed Sensor, Dynamic	**TEST J**
No Code	Soft/Excessive Pedal Travel (EHCU)	**TEST K**
C1095/C1096	Pump Motor	**TEST L**
C1113/C1115	Internal Power Relay	**TEST M**
C1185	Open Internal Power Relay	**TEST M**
No Code	No Module Commuications	**TEST N**
C1184	ABS System Timeout	**TEST P**
C1222	Wheel Speed Error, Dynamic	**TEST P**
C1169	Excessive Dump Time	**TEST R**
B1342	ECU Failure	(1)

(1) Temporarily substitute a known-good EHCU.

CLEARING TROUBLE CODES

DTCs can be cleared using the NGS tester. After 80 ignition cycles, provided vehicle has reached at least 15 MPH between each cycle, the control module clears DTCs automatically. Stored DTCs should be cleared. If DTCs do not clear, check for additional stored DTCs.

SYSTEM PRECHECK

NOTE: It is imperative that this procedure be performed before attempting any further diagnosis. Failure to do so could result in improper diagnosis.

1. Verify all electrical connectors are connected to EHCU and wheel speed sensors are secure and free of contamination or corrosion. Ensure fuse No. 14 (60-amp) located in engine compartment fuse panel is intact and fully seated. Ensure fuses No. 13 (15-amp) and No. 25 (5-amp) located in interior fuse panel are intact and fully seated. Inspect system ground located at left front radiator support is clean and tight. If all connections are secure and fuses are fully seated, go to next step. If all connections are not secure and/or fuses are not fully seated, correct condition and go to next step.
2. Ensure ignition is off. Ensure parking brake is released. Turn ignition on. If both Red and Yellow warning indicators come on and go off, go to next step. If one or both warning indicators stay on, go to next step. If Yellow warning indicator never comes on, go to step 6 . If Red warning indicator never comes on, go to step 8 . If both warning indicators never come on, replace fuse No. 25.
3. Turn ignition off. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Retrieve and record all DTC's. If DTC's are retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under DIAGNOSIS. If system pass is obtained and concern is still present, go to **SYMPTOM DIAGNOSIS** . If system pass is obtained and no further information is available, go to **DRIVE CYCLE TEST** . If no response is obtained, go to next step.
4. Remove and inspect fuse No. 14 (60-amp) located in engine compartment fuse panel. If fuse is okay, go to next step. If fuse is not okay, replace fuse and/or repair short to ground in Orange/Yellow wire between fuse panel and ECU.
5. Ensure ignition is off. Disconnect negative battery cable. Measure resistance between negative battery cable connector (battery end) and EHCU ground eyelet located at left front radiator support. If resistance is less than one ohm, go to **TEST N: NO MODULE COMMUNICATIONS** . If resistance is more than one ohm, repair ground circuit as necessary. See **WIRING DIAGRAMS** .
6. Connect 60-pin breakout box to EHCU with ABS adapter cable. Reconnect negative battery cable. Connect fused jumper wire between ground and breakout box test terminal No. 1. Turn ignition on and observe Yellow ABS warning indicator. If warning indicator comes on, temporarily substitute a known-good EHCU and retest. If warning indicator does not come on, go to next step.
7. With ignition still on, measure voltage between ground and breakout box test terminal No. 1. If voltage is less than 10 volts, repair Dark Green or Red/Yellow wire between EHCU and fuse No. 29. See **WIRING DIAGRAMS** . If voltage is more than 10 volts, repeat step 6 .
8. Engage parking brake and observe Red BRAKE warning indicator. If warning indicator comes on, go to **TEST B: RED BRAKE WARNING INDICATOR FAILURE** . If warning indicator does not come on, go to next step.
9. Remove and inspect Red BRAKE warning indicator bulb. If bulb is blown, replace bulb and go to step 2 . If bulb is okay, repair open in Red/Yellow wire between bulb and fuse No. 29. See **WIRING DIAGRAMS** .

DRIVE CYCLE TEST

NOTE: Use drive cycle test to verify a repair, recreate an intermittent problem or

attempt to detect symptom when DTC or concern is unknown.

NOTE: Wetting down area where stop is to be performed will aid in performing this test. Have an assistant monitor wheels during ABS stop. Momentary lockup is permissible.

1. Drive vehicle at about 10 MPH. Press brake pedal hard enough to lock all 4 wheels. If one wheel locks consistently and Yellow ABS warning indicator does not come on, go to **SYMPTOM DIAGNOSIS** . If one wheel locks consistently and Yellow ABS warning indicator comes on and stays on, go to step 7 . If one wheel does not lock consistently and Yellow ABS warning indicator does not come on, go to next step.
2. Drive vehicle at about 20 MPH. Perform light to medium (normal traffic) stop. If pump motor turns on and pedal pulsations are felt and Yellow ABS warning indicator does not come on, go to ABS MISFIRE, ABS TOO SENSITIVE, ABS FIRES ON NORMAL STOP under **SYMPTOM DIAGNOSIS** . If pump motor turns on and pedal pulsations are felt and Yellow ABS warning indicator comes on and stays on, go to step 7 . If pump motor does not turn on and pedal pulsations are not felt and no other symptoms are detected, go to step 6 . If pump motor does not turn on and pedal pulsations are not felt and Yellow ABS warning indicator does not come on, go to next step.
3. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Turn ignition off. Start engine and place transmission selector in 1 position. Allow vehicle to creep forward at idle for at least 45 seconds. If Yellow ABS warning indicator comes on, go to step 8 . If warning indicator does not come on, turn ignition off and go to next step.
4. Using NGS tester, clear all DTCs. Turn ignition off. Start vehicle and accelerate to 25 MPH. Let at least 45 seconds elapse before reaching 25 MPH. If Yellow ABS warning indicator comes on, go to step 8 . If warning indicator does not come on, go to next step.
5. If concern has been addressed and corrected by previous actions, ABS function has been verified. If concern has been addressed and corrected by previous actions, go to **SYMPTOM DIAGNOSIS** .
6. Check for the following conditions: Lack of sufficient vehicle deceleration upon brake application. Vehicle pulling during braking and pump motor does not come on. If any of these symptoms are present, go to **SYMPTOM DIAGNOSIS** . If these symptoms are not present, concern is not in ABS system. Check base brake system.
7. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, retrieve and record all DTCs. If DTC is the same as before and the test for the DTC is completed, go to **INTERMITTENT FAILURES** . If DTC is not the same as before and the test for the DTC is not completed, return to last completed step in test. If DTC is not the same, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If EHCU does not respond, go to **SYSTEM PRECHECK** .
8. Using NGS tester, retrieve and record all DTCs. If sensor code is present, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES for appropriate test. If sensor code is not present, and system pass was not obtained, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES and perform indicated test. If no code or system pass was obtained, go to **SYSTEM PRECHECK** .

SYMPTOM DIAGNOSIS

NOTE: It is imperative that SYSTEM PRECHECK be performed before attempting any further diagnosis. Failure to do so could result in improper diagnosis.

ABS Misfire, ABS Too Sensitive, ABS Fires On Normal Stop

Possible source of problem may be:

- Damaged rear sensor ring. Remove rear sensor from differential and inspect sensor ring.
- Damaged front sensor ring. Inspect both front sensor rings for damaged or missing teeth.
- Sensor output out of sync. If left front sensor output is out of sync, go to **TEST E** . If right front sensor output is out of sync, go to **TEST G** . If rear sensor output is out of sync, go to **TEST J** .
- Sensor circuit. Go to **INTERMITTENT FAILURES** to test sensor circuits.
- Wire insulation. Inspect wiring harness from front sensor knuckle to frame for worn of chafed wire insulation.
- Rear brake adjustment, brake linings. Eliminate base brake system as cause of problem.
- Loose sensors. Tighten sensors.

Wheels Lock Up

Possible source of problem may be:

- Hydraulic outlet (dump) valve. Go to **TEST K** .
- Leaky inlet (isolation) valve. Go to **TEST K** .
- Rear brake adjustment, linings, wheel cylinders, parking brake rear axle seal. Eliminate base brake system as cause of problem.

Hard Or Soft Brake Pedal

Possible source of problem may be:

- Hydraulic inlet valve (hard pedal) or outlet valve (soft pedal). Go to **TEST K** .
- Brake line or hose, master cylinder, wheel cylinder, caliper, air in system, power brake booster. Eliminate base brake system as cause of problem.

Lack Of Deceleration During Medium/Hard Brake Application

Possible source of problem may be:

- Shut inlet (isolation) valve, outlet (dump) valve (rear axle only). Go to **TEST K** .
- Brake line or hose, master cylinder, wheel cylinder, caliper, air in system, power brake booster. Eliminate base brake system as cause of problem.

Vehicle Pulls During Braking

Possible source of problem may be:

- Rear brake adjustment, faulty caliper, brake pads or shoes, brakeline or hose. Eliminate base brake system as cause of problem.
- Front inlet (isolation) valve. Temporarily substitute a known-good EHCU and retest.

Yellow ABS Warning Indicator On With System Pass

Possible source of problem may be:

- Electrical circuit. Disconnect 24-pin connector from EHCU. If indicator is on, repair short to ground in Dark Green wire between EHCU and indicator. If indicator is off, temporarily substitute a known-good EHCU and retest.

TEST A: YELLOW ABS WARNING INDICATOR FAILURE

NOTE: This test is associated with DTC C1220.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Turn ignition off then on. Observe Yellow ABS warning indicator prove out. If warning indicator proves out properly, problem is intermittent; go to step 4 . If warning indicator does not prove out properly and problem is repeatable, turn ignition off and go to next step.
2. Connect 60-pin breakout box to EHCU with ABS adapter cable. Remove fuse No. 29 located in interior fuse panel. Turn ignition on. Connect voltmeter between ground and breakout box test terminal No. 1. Observe voltmeter while wiggling circuit. Start at circuit end points or splices and work toward middle. See **WIRING DIAGRAMS** . If voltage is more than zero volt at any time, repair short to voltage in Dark Green wire between EHCU connector and Yellow ABS warning indicator and go to step 4 . If voltage is not more than zero volt at any time, check fuse, Dark Green wire and/or bulb. Repair as necessary and go to next step.
3. Turn ignition off. Reinstall fuse No. 29. Connect fused jumper wire between ground and breakout box test terminal No. 1. Turn ignition on. If Yellow ABS warning indicator comes on brightly, temporarily substitute a known-good EHCU and go to next step. If warning indicator comes on dimly, replace bulb and go to next step. If warning indicator does not come on at all and fuse No. 29 is open, repair short to ground in Dark Green wire and/or replace and go to next step.
4. Using NGS tester, clear all DTCs. Run on-demand self-test and retrieve DTCs. If DTC C1220 is retrieved and step 2) is complete, temporarily substitute a known-good EHCU and retest. If another DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES and perform appropriate test. If no DTCs are retrieved, system is functioning properly.

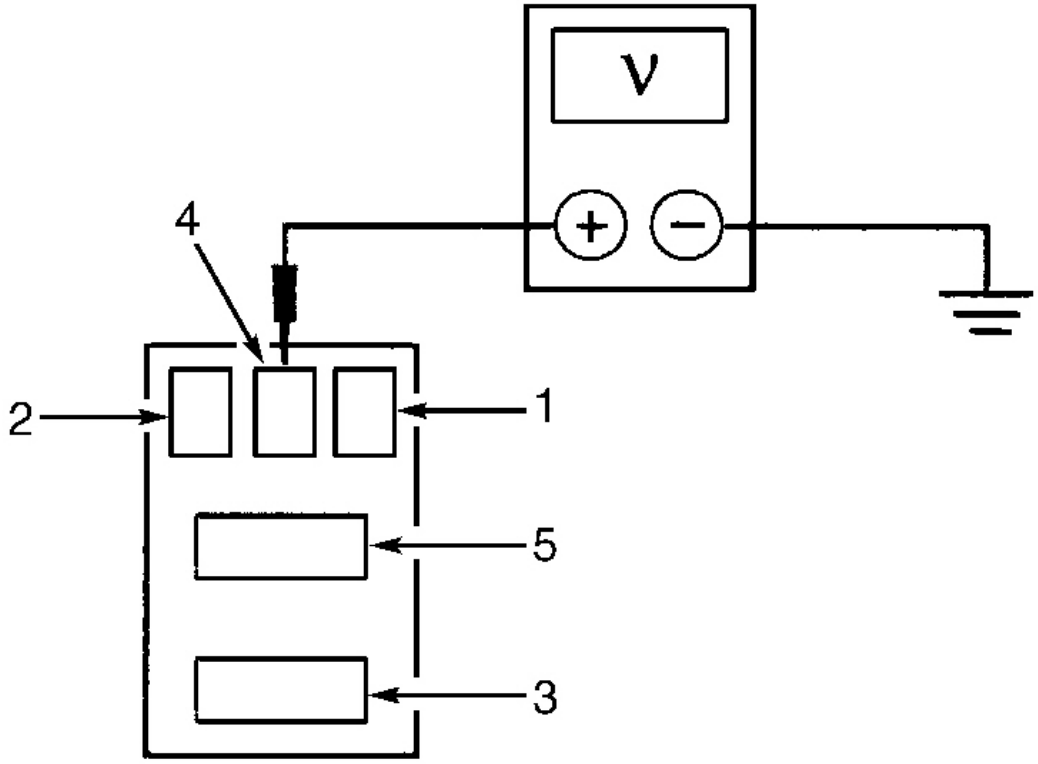
TEST B: RED BRAKE WARNING INDICATOR FAILURE

NOTE: This test is associated with DTCs C1225 and C1226.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester,

clear all DTCs. Disconnect NGS tester. Turn ignition on and observe Red BRAKE warning indicator. If warning indicator proves out properly, problem is intermittent, go to **INTERMITTENT FAILURES** . If warning indicator comes on continuously and concern is repeatable, go to step 6 . If both warning indicators are on continuously, go to next step. If Red BRAKE warning indicator never comes on, go to step 13 .

2. If DTC is C1225, problem is electrical, go to next step. If DTC is C1226, problem is related to base brake system, go to step 6 . If both DTC C1225 and C1226 are set, diagnose base brake system first then go to step 6 .
3. Ensure ignition is off. Unplug Red brake warning relay located in engine compartment power distribution box. Remove fuse No. 29 located in interior fuse panel. Turn ignition on. Measure voltage between ground and Red brake warning relay connector terminal No. 4 (Purple/White wire). See **Fig. 1** . If voltage is more than 10 volts, repair short to voltage in Purple/White wire. See **WIRING DIAGRAMS** . If voltage is less than 10 volts, go to next step.
4. Measure voltage between ground and Red brake warning relay connector terminal No. 2 (Black/Yellow wire). See **Fig. 1** . If voltage is more than 10 volts, repair short to voltage in Black/Yellow wire, reconnect relay, and go to step 19 . See **WIRING DIAGRAMS** . If voltage is less than 10 volts, go to next step.



97I03724

Fig. 1: Identifying Red Brake Warning Relay Connector Terminals
Courtesy of FORD MOTOR CO.

5. Measure resistance between Red brake warning relay terminals No. 1 and 2. See **Fig. 1** . If resistance is 50-70 ohms, temporarily substitute a known-good EHCU and go to step 19 . If resistance is not 50-70 ohms, replace relay and go to step 19 .
6. Park vehicle on level surface with parking brake released. Inspect fluid level in brake master cylinder reservoir. If fluid level is within limits, go to next step. If fluid level is not within limits, check base brake system for leaks. Repair as necessary and go to step 19 .
7. Ensure ignition is off. Disconnect brake master cylinder reservoir fluid level switch. Turn ignition on. If Red BRAKE warning indicator is on, go to next step. If warning indicator is not on, replace brake master cylinder reservoir and go to step 19 .
8. Turn ignition off. Connect 60-pin breakout box to EHCU with ABS adapter cable. Connect fused jumper wire between ground and breakout box test terminal No. 2. Turn ignition on. If Red BRAKE warning indicator is on, go to step 10 . If warning indicator is not on, go to next step.
9. Turn ignition off. Measure resistance between ground and breakout box test terminal No. 7. If resistance is less than 10 k/ohms, repair short to ground in Dark Green/Yellow wire between fluid level switch and EHCU and go to step 19 . If resistance is more than 10 k/ohms, temporarily substitute a known-good EHCU and go to step 19 .
10. Turn ignition off. Unplug Red brake warning relay located in engine compartment power distribution box. Turn ignition on. If Red BRAKE warning indicator is on, repair short to ground in Purple/White or Light Green/Red wire and go to step 19 . See **WIRING DIAGRAMS** . If warning indicator is not on, go to next step.
11. Turn ignition off. Measure resistance between breakout box test terminal No. 2 and Red brake warning relay connector terminal No. 2 (Black/Yellow wire). See **Fig. 1** . If resistance is less than 2 ohms, go to next step. If resistance is more than 2 ohms, repair open in Black/Yellow wire between relay connector and EHCU and go to step 19 .
12. Turn ignition on. Measure voltage between ground and Red brake warning relay connector terminal No. 1 (Tan/Red wire). See **Fig. 1** . If voltage is more than 10 volts, replace Red brake warning relay and go to step 19 . If voltage is less than 10 volts, repair open in Tan/Red wire between relay connector and fuse No. 25. Reconnect relay and go to step 19 . See **WIRING DIAGRAMS** .
13. Turn ignition off. Connect 60-pin breakout box to EHCU with ABS adapter cable. Turn ignition on. If Red BRAKE warning indicator is on, temporarily substitute a known-good EHCU and go to step 19 . If warning indicator is not on, go to next step.
14. Turn ignition off. Unplug Red brake warning relay located in engine compartment power distribution box. Measure resistance between ground and Red brake warning relay connector terminal No. 2 (Black/Yellow wire). See **Fig. 1** . If resistance is less than 5 ohms, repair short to ground in Black/Yellow wire between relay connector and EHCU and go to step 19 . If resistance is more than 5 ohms, go to next step.
15. Measure resistance between ground and Red brake warning relay connector terminal No. 3 (Black wire). See **Fig. 1** . If resistance is than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in Black wire between relay connector and ground and go to step 19 .
16. Turn ignition on. Measure voltage between ground and Red brake warning relay connector terminal No. 4 (Purple/White wire). See **Fig. 1** . If voltage is more than 10 volts, replace relay and go to step 19 . If voltage is less than 10 volts, go to next step.

17. Turn ignition off. Disconnect instrument cluster 12-pin connector. Measure resistance of Purple/White wire between instrument cluster connector and Red brake warning relay connector terminal No. 4. If resistance is less than 5 ohms, reconnect relay and go to next step. If resistance is more than 5 ohms, repair open in Purple/White wire between instrument cluster connector and relay connector and go to step 19 .
18. Remove and check Red BRAKE warning indicator bulb. If bulb is okay, repair instrument cluster as necessary. If bulb is blown, replace bulb and go to next step.
19. Using NGS tester, clear all DTCs. Turn ignition off then on. Run on-demand self-test. If DTC C1225 is present, go to step 3 . If DTC C1226 is present, go to step 6 . If a different DTC is present, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTCs are present, problem has been corrected.

TEST C: ISOLATION DUMP VALVE

NOTE: This test is associated with DTCs C1194, C1196, C1198, C1200, C1202, C1204, C1206, C1208, C1212, C1214 and C1216.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Run on-demand self-test. Retrieve and record DTCs. If a single valve DTC is retrieved, temporarily substitute a known-good EHCU and go to next step. If multiple valve DTCs are retrieved, go to next step. If no DTCs are retrieved, go to step 4 .

   NOTE: A blown fuse may be an indication of some other wiring or component failure.

2. Turn ignition off. Disconnect EHCU 2-pin connector. Measure voltage between ground and EHCU 2-pin connector Orange/Yellow wire. If voltage is more than 10 volts, temporarily substitute a known-good EHCU and go to step 4 . If voltage is less than 10 volts, reconnect EHUC connector and go to next step.
3. Remove and inspect fuse No. 14 (60-amp) located in engine compartment power distribution box. If fuse is okay, repair open in Orange/Yellow wire between fuse and EHCU and go to next step. If fuse is blown, replace fuse and/or short to ground in Orange/Yellow wire between fuse and EHCU and go to next step.
4. Using NGS tester, clear all DTCs. Run on-demand self-test. Retrieve and record DTCs. If original DTC is retrieved, repeat step 1 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTCs are present, problem has been corrected.

TEST D: LEFT FRONT WHEEL SPEED SENSOR, STATIC TEST

NOTE: This test is associated with DTC C1155.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Drive vehicle at least 10 MPH. Retrieve DTCs. If DTC C1155 is present, go to next step. If DTC C1155 is not present, go to step 4 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES.

2. Turn ignition off. Connect 60-pin breakout box to EHCU with ABS adapter cable. Measure resistance between breakout box test terminals No. 11 and 23. On 2WD vehicles, resistance should be 2000-4000 ohms. On 4WD vehicles, resistance should be 300-500 ohms. If resistance is as specified, go to step 4 . If resistance is less than specified, replace left front wheel speed sensor and go to step 7 . If resistance is more than specified, go to next step.
3. Disconnect left front wheel speed sensor connector. Measure resistance between terminals of wheel speed sensor. If resistance is more than 4000 ohms on 2WD vehicles or more than 500 ohms on 4WD vehicles, replace left front wheel speed sensor and go to step 7 . If resistance is less than 4000 ohms on 2WD vehicles or less than 500 ohms on 4WD vehicles, repair Tan/Black wire and/or Tan/Orange wire and go to step 7 . See **WIRING DIAGRAMS** .
4. Measure resistance between ground and breakout box test terminals No. 11 and 23. If resistance is less than 100 k/ohms, go to next step. If resistance is more than 100 k/ohms, go to step 6 .
5. Disconnect left front wheel speed sensor connector. Measure resistance between ground and each terminal of wheel speed sensor. If resistance is less than 100 k/ohms, replace wheel speed sensor and go to step 7 . If resistance is more than 100 k/ohms, repair Tan/Black wire and/or Tan/Orange wire and go to step 7 .
6. Conduct **SENSOR FAILURE TEST** for left front wheel speed sensor under INTERMITTENT FAILURES. If sensor passed test, reconnect sensor and go to next step. If sensor did not pass test, replace sensor and go to next step.
7. Turn ignition off. Using NGS tester, clear all DTCs. Test drive vehicle over rough road. Perform on-demand self-test. Retrieve DTCs. If original DTC is retrieved, repeat step 1 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTC is retrieved, repair is complete.

TEST E: LEFT FRONT WHEEL SPEED SENSOR, DYNAMIC TEST

CAUTION: Turn air suspension (if equipped) off before hoisting, jacking or towing vehicle. Air suspension switch is located on right kick panel. Failure to do so may result in unexpected inflation or deflation of air springs which may result in shifting of the vehicle.

NOTE: This test is associated with DTCs C1158 and C1233.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, retrieve all DTCs. If DTC C1155 is retrieved, diagnose DTC C1155 first. Ignore all other DTCs. If DTC C1155 is not retrieved, go to next step.

NOTE: Some variation between all 3 sensors is expected on hard turns.

2. Using NGS tester, monitor all 3 wheel speed sensors while driving vehicle at various speeds. If left front wheel speed sensor consistently matches other 2 sensors, go to step 7 . If left front wheel speed sensor does not match other 2 sensors, go to next step.
3. Turn air suspension off (if equipped). Raise vehicle on hoist. Carefully inspect left front sensor ring for damage and/or missing teeth. Rotate ring to be sure all teeth are checked. If sensor ring is damaged or has

missing teeth, replace ring and go to step 9 . If sensor ring is okay, go to next step.

4. Wiggle wheel speed sensor at wheel end. If any looseness is detected, tighten sensor to 63-80 INCH lbs. (7-9 N.m). Go to step 9 . If sensor is not loose, go to next step.
5. Turn ignition off. Disconnect left front wheel speed sensor connector. Measure resistance between ground and each terminal of wheel speed sensor. If resistance is less than 100 k/ohms, replace wheel speed sensor and go to step 9 . If resistance is more than 100 k/ohms, go to next step.
6. Connect 60-pin breakout box to EHCU with ABS adapter cable. Measure resistance between breakout box test terminals No. 11 and 23. If resistance is less than 100 k/ohms, repair short to ground in Tan/Black and/or Tan/Orange wire and go to step9 . See **WIRING DIAGRAMS** . If resistance is more than 100 k/ohms. go to next step.
7. Turn ignition off. Conduct **SENSOR FAILURE TEST** for left front wheel speed sensor under INTERMITTENT FAILURES. If sensor passed test, reconnect sensor and go to step 9 . If sensor did not pass test, replace sensor and go to next step.
8. Remove left front wheel speed sensor. Inspect sensor housing for stress cracks or breaks. Inspect sensor connector for evidence of water entry, pin corrosion or excessive debris. If any condition is present, correct condition as necessary and go to next step. If sensor and connector are okay, reconnect sensor and go to next step.
9. Disconnect breakout box and reactivate air suspension (if equipped). Using NGS tester, clear all codes. Turn ignition off and on. Drive vehicle completing at least one hard left and one hard right turn. Travel over rough road at normal speed. Perform one hard and normal acceleration from dead stop. Retrieve DTCs. If original DTC is retrieved, go to step 2 . If a different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTC is retrieved, repair is complete.

TEST F: RIGHT FRONT WHEEL SPEED SENSOR, STATIC TEST

NOTE: This test is associated with DTC C1145.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Drive vehicle at least 10 MPH. Retrieve DTCs. If DTC C1145 is present, go to next step. If DTC C1145 is not present, go to step 6 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES.
2. Turn ignition off. Connect 60-pin breakout box to EHCU with ABS adapter cable. Measure resistance between breakout box test terminals No. 10 and 22. On 2WD vehicles, resistance should be 2000-4000 ohms. On 4WD vehicles, resistance should be 300-500 ohms. If resistance is as specified, go to step 4 . If resistance is less than specified, replace left front wheel speed sensor and go to step 7 . If resistance is more than specified, go to next step.
3. Disconnect right front wheel speed sensor connector. Measure resistance between terminals of wheel speed sensor. If resistance is more than 4000 ohms on 2WD vehicles or more than 500 ohms on 4WD vehicles, replace left front wheel speed sensor and go to step 7 . If resistance is less than 4000 ohms on 2WD vehicles or less than 500 ohms on 4WD vehicles, repair Yellow/Red wire and/or Yellow/Black wire and go to step 7 . See **WIRING DIAGRAMS** .
4. Measure resistance between ground and breakout box test terminals No. 10 and 22. If resistance is less than 100 k/ohms, go to next step. If resistance is more than 100 k/ohms, go to step 6 .

5. Disconnect right front wheel speed sensor connector. Measure resistance between ground and each terminal of wheel speed sensor. If resistance is less than 100 k/ohms, replace wheel speed sensor and go to step 7 . If resistance is more than 100 k/ohms, repair Yellow/Red wire and/or Yellow/Black wire and go to step 7 .
6. Conduct **SENSOR FAILURE TEST** for right front wheel speed sensor under INTERMITTENT FAILURES. If sensor passed test, reconnect sensor and go to next step. If sensor did not pass test, replace sensor and go to next step.
7. Turn ignition off. Using NGS tester, clear all DTCs. Test drive vehicle over rough road. Perform on-demand self-test. Retrieve DTCs. If original DTC is retrieved, repeat step 1 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTC is retrieved, repair is complete.

TEST G: RIGHT FRONT WHEEL SPEED SENSOR, DYNAMIC TEST

CAUTION: Turn air suspension (if equipped) off before hoisting, jacking or towing vehicle. Air suspension switch is located on right kick panel. Failure to do so may result in unexpected inflation or deflation of air springs which may result in shifting of the vehicle.

NOTE: This test is associated with DTCs C1148 and C1234.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, retrieve all DTCs. If DTC C1145 is retrieved, diagnose DTC C1145 first. Ignore all other DTCs. If DTC C1145 is not retrieved, go to next step.

NOTE: Some variation between all 3 sensors is expected on hard turns.

2. Using NGS tester, monitor all 3 wheel speed sensors while driving vehicle at various speeds. If right front wheel speed sensor consistently matches other 2 sensors, go to step 7 . If right front wheel speed sensor does not match other 2 sensors, go to next step.
3. Turn air suspension off (if equipped). Raise vehicle on hoist. Carefully inspect right front sensor ring for damage and/or missing teeth. Rotate ring to be sure all teeth are checked. If sensor ring is damaged or has missing teeth, replace ring and go to step 8 . If sensor ring is okay, go to next step.
4. Wiggle wheel speed sensor at wheel end. If any looseness is detected, tighten wheel speed sensor to 63-80 INCH lbs. (7-9 N.m) and go to step 9 . If sensor is not loose, go to next step.
5. Turn ignition off. Disconnect right front wheel speed sensor connector. Measure resistance between ground and each terminal of wheel speed sensor. If resistance is less than 100 k/ohms, replace wheel speed sensor and go to step 9 . If resistance is more than 100 k/ohms, go to next step.
6. Connect 60-pin breakout box to EHCU with ABS adapter cable. Measure resistance between breakout box test terminals No. 10 and 22. If resistance is less than 100 k/ohms, repair short to ground in Yellow/Red wire and/or Yellow/Black wire and go to step 9 . See **WIRING DIAGRAMS** . If resistance is more than 100 k/ohms. go to next step.
7. Turn ignition off. Conduct **SENSOR FAILURE TEST** for right front wheel speed sensor under INTERMITTENT FAILURES. If sensor passed test, reconnect sensor and go to step 9 . If sensor did not

pass test, replace sensor and go to next step.

8. Remove right front wheel speed sensor. Inspect sensor housing for stress cracks or breaks. Inspect sensor connector for evidence of water entry, pin corrosion or excessive debris. If any condition is present, correct condition as necessary and go to next step. If sensor and connector are okay, reconnect sensor and go to next step.
9. Disconnect breakout box and reactivate air suspension (if equipped). Using NGS tester, clear all codes. Turn ignition off and on. Drive vehicle completing at least one hard left and one hard right turn. Travel over rough road at normal speed. Perform one hard and normal acceleration from dead stop. Retrieve DTCs. If original DTC is retrieved, go to step 2 . If a different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTC is retrieved, repair is complete.

TEST H: REAR WHEEL SPEED SENSOR, STATIC TEST

NOTE: This test is associated with DTC C1230.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Drive vehicle at least 10 MPH. Retrieve DTCs. If DTC C1230 is present, go to next step. If DTC C1230 is not present, go to step 6 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES.
2. Turn ignition off. Connect 60-pin breakout box to EHCU with ABS adapter cable. Measure resistance between breakout box test terminals No. 9 and 21. If resistance is 900-1500 ohms, go to step 4 . If resistance is less than 900 ohms, replace rear wheel speed sensor and go to step 7 . If resistance is more than 1500 ohms, go to next step.
3. Disconnect rear wheel speed sensor connector. Measure resistance between terminals of wheel speed sensor. If resistance is more than 1500 ohms, replace rear wheel speed sensor and go to step 7 . If resistance is less than 900 ohms, repair Light Green/Black wire and/or Red/Pink wire and go to step 7 . See **WIRING DIAGRAMS** .
4. Measure resistance between ground and breakout box test terminals No. 9 and 21. If resistance is less than 100 k/ohms, go to next step. If resistance is more than 100 k/ohms, go to step 6 .
5. Disconnect rear wheel speed sensor connector. Measure resistance between ground and each terminal of wheel speed sensor. If resistance is less than 100 k/ohms, replace wheel speed sensor and go to step 7 . If resistance is more than 100 k/ohms, repair Light Green/Black wire and/or Red/Pink wire and go to step 7 .
6. Conduct **SENSOR FAILURE TEST** for rear wheel speed sensor under INTERMITTENT FAILURES. If sensor passed test, reconnect sensor and go to next step. If sensor did not pass test, replace sensor and go to next step.
7. Turn ignition off. Using NGS tester, clear all DTCs. Test drive vehicle over rough road. Perform on-demand self-test. Retrieve DTCs. If original DTC is retrieved, repeat step 1 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTC is retrieved, repair is complete.

TEST J: REAR WHEEL SPEED SENSOR, DYNAMIC

CAUTION: Turn air suspension off (if equipped) before hoisting, jacking or towing vehicle. Air suspension switch is located on right kick panel. Failure to do so may result in unexpected inflation or deflation of air springs which may result in shifting of the vehicle.

NOTE: This test is associated with DTCs C1229 and C1237.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, retrieve all DTCs. If DTC C1230 is retrieved, diagnose DTC C1230 first. Ignore all other DTCs. If DTC C1230 is not retrieved, go to next step.

NOTE: Some variation between all 3 sensors is expected on hard turns.

2. Using NGS tester, monitor all 3 wheel speed sensors while driving vehicle at various speeds. If rear wheel speed sensor consistently matches other 2 sensors, go to step 7 . If rear wheel speed sensor does not match other 2 sensors, go to next step.
3. Turn air suspension off (if equipped). Raise vehicle on hoist. Carefully inspect rear sensor ring for damage and/or missing teeth. Rotate ring to be sure all teeth are checked. If sensor ring is damaged or has missing teeth, replace ring and go to step 9 . If sensor ring is okay, go to next step.
4. Wiggle wheel speed sensor at differential case. If any looseness is detected, tighten sensor to 18-21 ft. lbs. (25-29 N.m) and go to step 9 . If sensor is not loose, go to next step.
5. Turn ignition off. Disconnect rear wheel speed sensor connector. Measure resistance between ground and each terminal of wheel speed sensor. If resistance is less than 100 k/ohms, replace wheel speed sensor and go to step 9 . If resistance is more than 100 k/ohms, go to next step.
6. Connect 60-pin breakout box to EHCU with ABS adapter cable. Measure resistance between breakout box test terminals No. 9 and 21. If resistance is less than 100 k/ohms, repair short to ground in Light Green/Black wire and/or Red/Pink wire and go to step 9 . If resistance is more than 100 k/ohms. go to next step.
7. Turn ignition off. Conduct **SENSOR FAILURE TEST** for rear wheel speed sensor under INTERMITTENT FAILURES. If sensor passed test, reconnect sensor and go to step 9 . If sensor did not pass test, go to next step.
8. Remove rear wheel speed sensor. Inspect sensor housing for stress cracks or breaks. Inspect sensor connector for evidence of water entry, pin corrosion or excessive debris. If any condition is present, correct condition as necessary and go to next step. If sensor and connector are okay, reconnect sensor and go to next step.
9. Disconnect breakout box and reactivate air suspension (if equipped). Using NGS tester, clear all codes. Turn ignition off and on. Drive vehicle completing at least one hard left and one hard right turn. Travel over rough road at normal speed. Perform one hard and normal acceleration from dead stop. Retrieve DTCs. If original DTC is retrieved, go to step 2 . If a different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTC is retrieved, repair is complete.

TEST K: SOFT/EXCESSIVE PEDAL TRAVEL

NOTE: This test is not associated with any DTC.

1. Visually inspect brakelines from EHCU to each wheel cylinder. Visually inspect calipers and brake components. If any damage is found, replace and/or repair as necessary and go to **SYSTEM PRECHECK** . If no damage is found, go to next step.

   NOTE: A leaky dump valve is similar to a master cylinder bypass condition. Press brake pedal quickly and forcefully to rule out master cylinder bypass.

2. Remove rubber boots from EHCU Low Pressure Accumulators (LPA). Insert clean paper clip into each LPA port. See **Fig. 2** . Have an assistant press hard on brake pedal while observing paper clips. If any of the paper clips move significantly, replace EHCU. If paper clips do not move significantly, remove paper clips, reinstall rubber boots and go to next step.

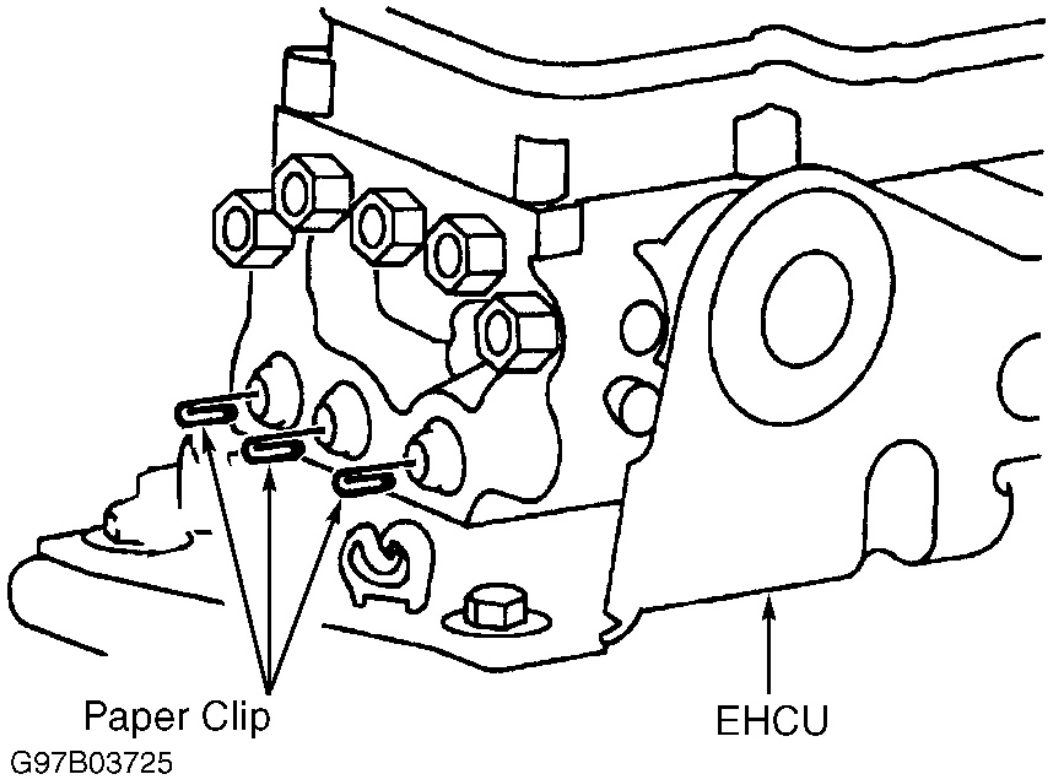


Fig. 2: Checking Dump Valves For Leakage
Courtesy of FORD MOTOR CO.

3. Remove fuse No. 14 (60-amp) located in engine compartment power distribution box. Test drive vehicle at about 20 MPH. Perform light to medium (normal) traffic stop. If any one wheel locks consistently, go to **SYMPTOM DIAGNOSIS** . If any one wheel does not lock consistently, go to **SYSTEM**

PRECHECK .

TEST L: PUMP MOTOR

NOTE: This test is associated with DTCs C1095 and C1096.

1. Verify ABS pump motor pigtail is connected to ABS control module. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Run on-demand self-test. Retrieve DTCs. If DTC C1095 is retrieved, temporarily substitute a known-good EHCU and retest. If DTC C1096 is retrieved, go to next step. If no DTCs are retrieved, go to step 4 . If a different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES.
2. Turn ignition off. Disconnect 2-pin EHCU harness connector. Measure voltage between ground and EHCU 2-pin harness connector Orange/Yellow wire. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open in Orange/Yellow wire between EHCU and fuse No. 14 (60-amp) located in engine compartment power distribution box, reconnect EHCU and go to step 4 .
3. Measure resistance between ground and EHCU 2-pin harness connector Light Green/Yellow wire. If resistance is more than one ohm, repair open in Light Green/Yellow wire between EHCU and ground located at left front radiator support, reconnect EHCU and go to next step. If resistance is less than one ohm, temporarily substitute a known-good EHCU and go to next step.
4. Using NGS tester, clear all DTCs. Drive vehicle over rough road and through car wash. Run on-demand self-test. Retrieve DTCs. If original DTC is retrieved, go to step 1 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTCs are retrieved, repair is complete.

TEST M: INTERNAL POWER RELAY

NOTE: This test is associated with DTCs C1113, C1115 and C1185.

1. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Run on-demand self-test. Retrieve DTCs. If DTC C1113 or C1115 is retrieved, temporarily substitute a known-good EHCU and go to step 4 . If DTC C1185 is retrieved, go to next step. If no DTCs are retrieved, go to step 4 .
2. Turn ignition off. Remove and inspect fuse No. 14 (60-amp) located in engine compartment power distribution box. If fuse is okay, go to next step. If fuse is blown, replace fuse and/or repair short to ground in Orange/Yellow wire between EHCU and fuse No. 14 and go to step 4 .
3. Reinstall fuse No. 14. Disconnect 2-pin EHCU harness connector. Measure voltage between ground and EHCU 2-pin harness connector Orange/Yellow wire. If voltage is more than 10 volts, temporarily substitute a known-good EHCU and go to next step. If voltage is less than 10 volts, repair open in Orange/Yellow wire between fuse No. 14 and EHCU and go to next step.
4. Using NGS tester, clear all DTCs. Turn ignition off. Drive vehicle over rough road and through car wash. If fault is repeatable, run on-demand self-test. Retrieve DTCs. If original DTC is retrieved, go to step 2 . If different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTCs are retrieved, repair is complete.

TEST N: NO MODULE COMMUNICATIONS

NOTE: This test is not associated with any DTCs.

1. Turn ignition off. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, retrieve DTCs. If DTCs are obtained, go to **SYSTEM PRECHECK** step 4). If no DTCs are obtained, go to next step.
2. Turn ignition off. Connect 60-pin breakout box to EHCU with ABS adapter cable. Turn ignition on. Measure voltage between ground and breakout box test terminal No. 14. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, replace fuse No. 25 (5-amp) located in interior fuse panel and/or repair short in Tan/Red wire between fuse No. 25 and 4WABS relay located in engine compartment power distribution box.
3. Turn ignition off. Disconnect negative battery cable. Measure resistance between ground and breakout box test terminal No. 2. If resistance is 5 ohms or less, go to next step. If resistance is more than 5 ohms, repair open in Light Green/Yellow wire between EHCU and ground located at left front radiator support and go to next step.
4. Measure resistance between breakout box test terminal No. 5 and Data Link Connector (DLC) Light Blue/White wire. If resistance is less than 5 ohms, temporarily substitute a known-good EHCU and go to **SYSTEM PRECHECK** step 4). If resistance is more than 5 ohms, repair open in Light Blue/White wire between EHCU and DLC and go to **SYSTEM PRECHECK** step 4).

TEST P: ABS SYSTEM TIME OUT/WHEEL SPEED SENSOR ERROR, DYNAMIC

NOTE: This test is associated with DTCs C1184 and C1222.

1. Turn ignition off. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Drive vehicle at various speeds. Using NGS tester, retrieve DTCs. If DTC C1184 is retrieved and ABS does not activate during normal stops, temporarily substitute a known-good EHCU and recheck. If ABS activates on normal stops, go to next step. If DTC C1222 is retrieved, inspect tires for mismatched sizes. Inspect sensor rings for damage. If inspections are normal, temporarily substitute a known-good EHCU and go to **SYSTEM PRECHECK** . If a different DTC is retrieved, go to **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If no DTCs are retrieved, repeat **SYSTEM PRECHECK** .

   NOTE: When monitoring wheel speed signals, monitor one wheel at a time. Information will be recorded faster and likelihood of diagnosing faulty signal is greater.

2. Clear all DTCs. Monitor wheel speeds while driving vehicle at various speeds. If one wheel speed signal drops out while driving or braking, go to appropriate WHEEL SPEED SENSOR, DYNAMIC TEST. See **DIAGNOSTIC TROUBLE CODE (DTC) INDEX** table under RETRIEVING TROUBLE CODES. If one wheel speed signal does not drop out while driving or braking, repeat monitoring as intermittent signals may not be recorded the first time. Inspect sensor rings and sensor wiring for damage and repair as necessary. In no damage is found, go to **INTERMITTENT FAILURES** to test suspect sensor and repeat **SYSTEM PRECHECK** .

TEST R: EXCESSIVE DUMP TIME

NOTE: This test is associated with DTC C1169.

1. Turn ignition off. Connect New Generation Star (NGS) tester, following manufacturer's instructions. Using NGS tester, clear all DTCs. Retrieve DTCs. If DTC C1169 is retrieved, temporarily substitute a known-good EHCU and go to **SYSTEM PRECHECK** . If DTC C1169 is not retrieved, go to next step.

   NOTE: Wet down area where stop is to be preformed. Have an assistant monitor wheels during ABS stop. Momentary lock-up is permissible.

2. Drive vehicle at about 10 MPH. Apply brakes hard enough to lock all 4 wheels. If one wheel locks-up consistently, go to ABS MISFIRE under **SYMPTOM DIAGNOSIS** . If one wheel does not lock-up consistently, go to **SYSTEM PRECHECK** .

INTERMITTENT FAILURES

EHCU POWER & GROUND TEST

Fuse Failure

If fuse has failed, check weather packing for 2-pin EHCU connector. Remove fuse No. 14 (60-amp) located in engine compartment power distribution box. Connect an ohmmeter between ground and outside pin of fuse connector (Orange/Yellow wire). Spray with water and wiggle wiring between power distribution box and EHCU. If any continuity is observed, repair/replace wiring as necessary.

Check For Open Circuit In Wiring

1. Disconnect 2-pin EHCU connector. Connect a voltmeter between EHCU 2-pin connector Orange/Yellow wire and negative battery cable. Observe voltmeter while wiggling wiring between power distribution box and EHCU. If voltage momentarily drops below 10 volts while harness is wiggled, repair/replace wiring as necessary.
2. Connect an ohmmeter between ground and 2-pin EHCU connector Light Green/Yellow wire. Observe ohmmeter while wiggling wiring between EHCU connector and ground located at left front radiator support. If resistance momentarily goes above 5 ohms while wiggling harness, repair/replace wiring as necessary.

INDICATOR FAILURE TEST

No Prove Out

Connect 60-pin breakout box to EHCU with ABS adapter cable. Connect breakout box test terminal No. 1 (for Yellow ABS warning indicator) or No. 4 (for Red BRAKE warning indicator) to ground. Turn ignition on. Wiggle wiring harness at several points between EHCU and instrument cluster. Repair/replace wiring harness at location that warning indicator flickered off indicating an open circuit.

Indicator Always On

With ignition on, wiggle wiring harness at several points between EHCU and instrument cluster. Repair/replace wiring harness at location that warning indicator flickered on indicating a short to ground.

SENSOR FAILURE TEST

NOTE: A digital multimeter with minimum/maximum hold feature is required for the following tests.

Check For Short To Ground

1. Connect 60-pin breakout box to EHCU with ABS adapter cable. Disconnect suspect sensor. Enable minimum resistance hold feature.
2. For left front wheel speed sensor, monitor resistance between ground and breakout box test terminals No. 11 (Tan/Orange wire) and No. 23 (Tan/Black wire). Drive vehicle over rough roads at various speeds. If there is continuity between either circuit and ground, repair circuit for short to ground.
3. For right front wheel speed sensor, monitor resistance between ground and breakout box test terminals No. 10 (Yellow/Red wire) and No. 22 (Yellow/Black wire). Drive vehicle over rough roads at various speeds. If there is continuity between either circuit and ground, repair circuit for short to ground.
4. For rear wheel speed sensor, monitor resistance between ground and breakout box test terminals No. 9 (Red/Pink wire) and No. 21 (Light Green/Black wire). Drive vehicle over rough roads at various speeds. If there is continuity between either circuit and ground, repair circuit for short to ground.

Check For Open Circuit

1. Connect 60-pin breakout box to EHCU with ABS adapter cable. Disconnect suspect sensor and connect jumper wire between sensor harness connector terminals. Enable maximum resistance hold feature.
2. For left front wheel speed sensor, monitor resistance between breakout box test terminals No. 11 (Tan/Orange wire) and No. 23 (Tan/Black wire). Drive vehicle over rough roads at various speeds. If there is an open between either circuit, repair circuit for an open.
3. For right front wheel speed sensor, monitor resistance between breakout box test terminals No. 10 (Yellow/Red wire) and No. 22 (Yellow/Black wire). Drive vehicle over rough roads at various speeds. If there is an open between either circuit, repair circuit for open.
4. For rear wheel speed sensor, monitor resistance between breakout box test terminals No. 9 (Red/Pink wire) and No. 21 (Light Green/Black wire). Drive vehicle over rough roads at various speeds. If there is an open between either circuit, repair circuit for open.

Check Sensor Pigtail

1. Enable maximum resistance hold feature. Monitor resistance between suspect wheel speed sensor terminals while wiggling pigtail. See **SENSOR MAXIMUM RESISTANCE** table. If resistance does not remain within specification, replace sensor.

SENSOR MAXIMUM RESISTANCE

Sensor	Resistance (Ohms)
Front	
2WD	4000
4WD	500
Rear	1500

2. Enable minimum resistance hold feature. Monitor resistance between suspect wheel speed sensor terminals while wiggling pigtail. See **SENSOR MINIMUM RESISTANCE** table. If resistance does not remain within specification, replace sensor.

SENSOR MINIMUM RESISTANCE

Sensor	Resistance (Ohms)
Front	
2WD	2000
4WD	300
Rear	900

3. Monitor resistance between ground and suspect wheel speed sensor terminals while wiggling pigtail. If meter indicates anything but an open circuit, replace sensor.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery. Vehicle may need to be driven more than 10 miles to relearn strategy.

ELECTRONIC CONTROL MODULE (ECM)

CAUTION: If replacing ABS ECM, ensure correct model application is identified on ECU identification sticker.

Removal & Installation

Disconnect negative battery cable. Disconnect ABS ECM harness connectors. Disconnect pump motor electrical connector from bottom of ABS ECM. Remove 4 ABS ECM screws and remove ECM. To install, reverse removal procedure. Tighten ECM screws to specification. See **TORQUE SPECIFICATIONS** .

HYDRAULIC CONTROL UNIT (HCU)

CAUTION: Plug each open port and pipe to prevent brake fluid from spilling.

Removal & Installation

1. Disconnect negative battery cable. Disconnect ABS ECM harness connectors. Disconnect pump motor electrical connector from bottom of ABS ECM. Remove 4 ABS ECM screws and remove ECM. Disconnect and plug 2 inlet and 3 outlet brakelines from HCU. Remove HCU mounting bolts and remove HCU.
2. To install reverse removal procedure. Tighten bolts, screws and brakeline fittings to specification. See **TORQUE SPECIFICATIONS** . Bleed brakes and EHCU. See **BLEEDING BRAKE SYSTEM** .

FRONT WHEEL SPEED SENSOR

Removal & Installation (2WD)

Disconnect front wheel speed sensor harness connector. Separate sensor pigtail from brake hose clips. Remove wheel speed sensor attaching bolt and remove sensor. To install, reverse removal procedure. Tighten sensor bolt to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (4WD)

Disconnect front wheel speed sensor harness connector. Remove front disc brake caliper, rotor and rotor shield. Remove 2 wheel speed sensor attaching bolts and remove sensor. To install, reverse removal procedure. Tighten sensor bolts to specification. See **TORQUE SPECIFICATIONS** .

REAR WHEEL SPEED SENSOR

CAUTION: Remove all dirt from rear axle mounting surface and sensor to prevent contamination of rear axle lubricant.

Removal & Installation

Disconnect rear wheel speed sensor harness connector. Remove sensor mounting bolt and remove sensor. To install, clean axle mounting surface. Inspect and clean magnetized sensor pole piece. Inspect sensor "O" ring and replace as necessary. Light lubricate "O" ring with engine oil and install sensor in axle housing. Tighten mounting bolt to specification. See **TORQUE SPECIFICATIONS** .

FRONT SENSOR RING

Removal & installation (2WD)

Remove front disc brake caliper and rotor. Using 3-jaw puller, remove sensor ring from hub. Discard old sensor ring. To install, position new sensor ring on hub. Using an appropriate size cylinder and press, install sensor ring on hub. To complete installation, reverse removal procedure.

Removal & Installation (4WD)

Front sensor ring is an integral part of hub and must be replaced as an assembly.

REAR SENSOR RING

Removal & Installation

Rear sensor ring is incorporated into rear differential. See appropriate differentials article in the DRIVE AXLES section.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Brakeline Fittings	
1/2 - 20	15-21 (21-29)
7/16 - 24	11-15 (15-20)
EHCU Bracket Bolts	13-13 (17-23)
EHCU Mounting Bolts	22-30 (30-40)
Rear Wheel Speed Sensor Bolt	25-30 (34-40)
	INCH Lbs. (N.m)
Control Module Screws	35-44 (4-5)
Front Wheel Speed Sensor Bolt	63-80 (7-9)

WIRING DIAGRAMS

1997 Ford Pickup F150

ANTI-LOCK BRAKE SYSTEM - 4-WHEEL 1997 BRAKES Ford Motor Co. - Anti-Lock - 4WAL

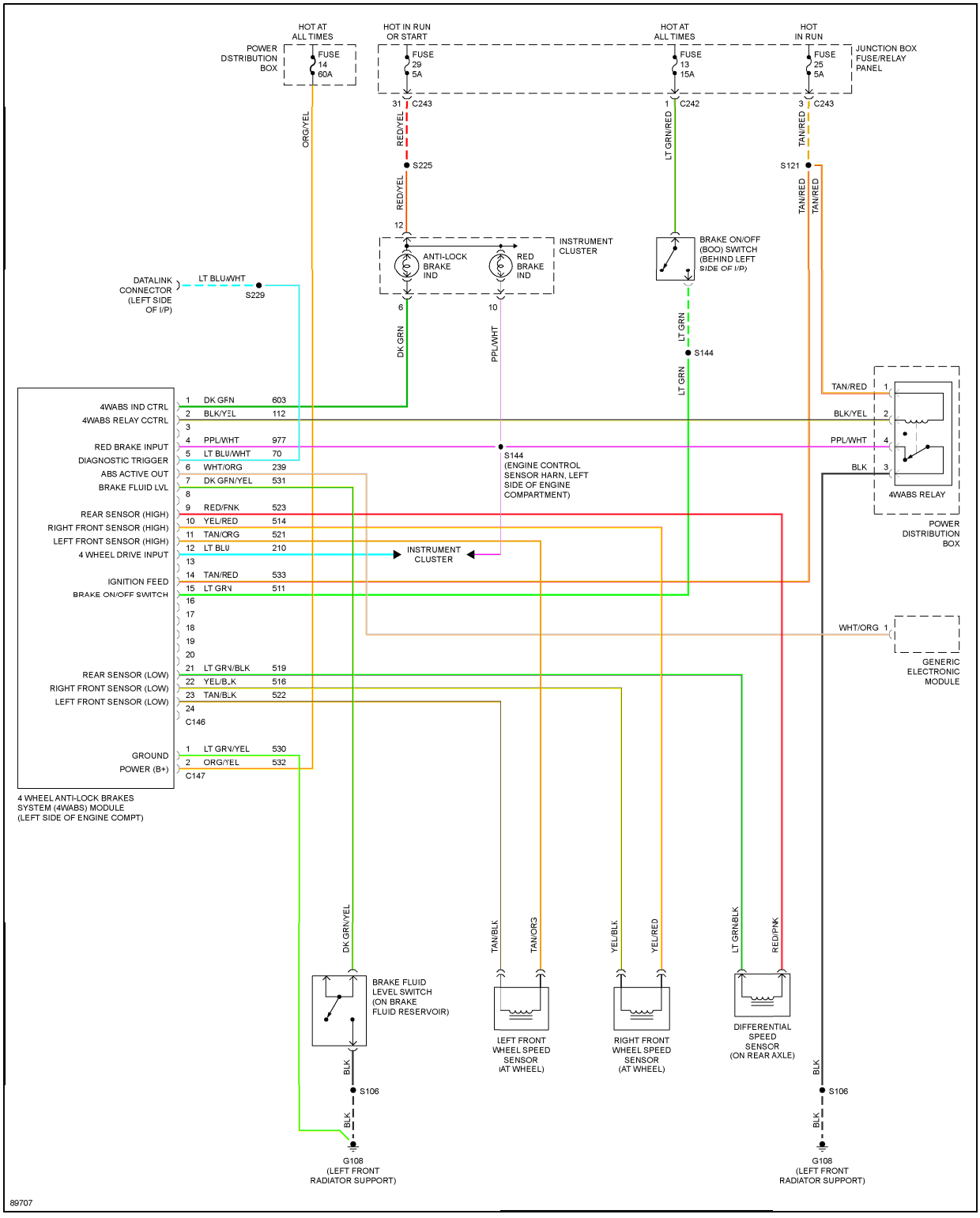


Fig. 3: Anti-Lock Brake System Wiring Diagram (Expedition)

1997 Ford Pickup F150

ANTI-LOCK BRAKE SYSTEM - 4-WHEEL 1997 BRAKES Ford Motor Co. - Anti-Lock - 4WAL

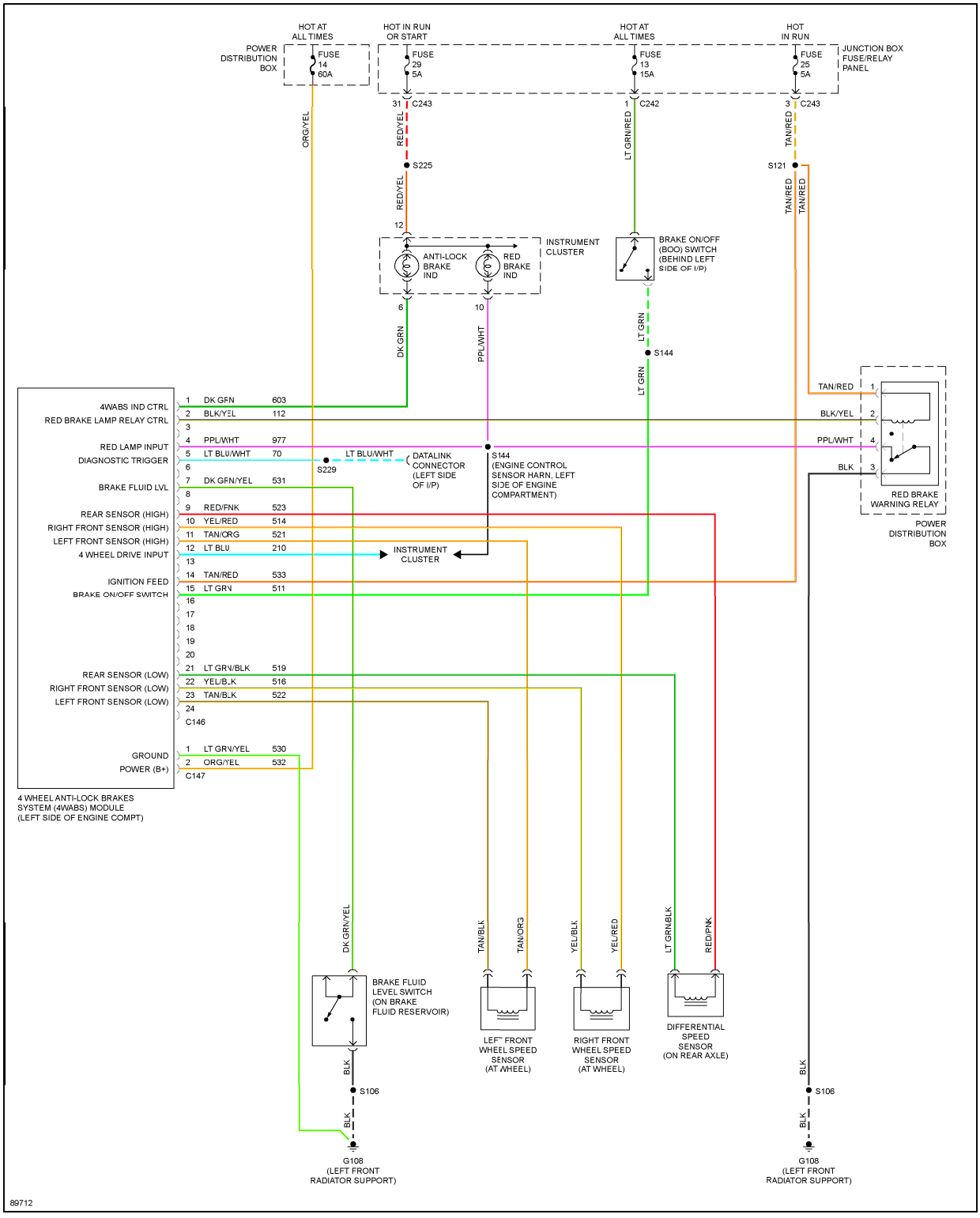


Fig. 4: Anti-Lock Brake System Wiring Diagram (F150/250 Pickup)

1997 ANTI-LOCK BRAKE SYSTEM

Anti-Lock - RABS II - "F" Series Pickup

DESCRIPTION & OPERATION

CAUTION: See ANTI-LOCK BRAKE SAFETY PRECAUTIONS article in the GENERAL INFORMATION section.

NOTE: For more information on brake system, see BRAKE SYSTEM article in the BRAKES section.

The Rear Anti-Lock Brake System II (RABS II) is designed to prevent rear brake lock-up by controlling hydraulic fluid pressure to the rear wheel cylinders. The system consists of 2 warning lights (Red BRAKE and Yellow ABS), an anti-lock electronic control unit, an electrohydraulic RABS valve, stoplight switch, fluid level sensor, speed sensor and exciter ring.

ABS CONTROL MODULE

The ABS control module continuously monitors rear (axle mounted) wheel speed sensor input. It compares the rate of deceleration with programed normal stopping distance. If impending lock-up occurs, the control module energizes the RABS valve.

RABS VALVE

The RABS valve contains an isolation and a dump valve operated by solenoids controlled by the ABS control module. The isolation valve prevents additional pressure from being fed to rear brake system and dump valve releases pressure from rear brake system.

The RABS valve will store "dumped" brake fluid until brake pressure is released and then releases it back to brake master cylinder reservoir.

RABS SELF-TEST CAPABILITY

The anti-lock electronic control module performs a system test during start-up and normal operation. Red BRAKE warning light indicates low fluid level, parking brake applied or low vacuum (diesel models). If a problem is detected, the control module will be deactivated and a Yellow ABS warning light will be illuminated. Both warning lights should come on for about 2 seconds when ignition is turned on or when cranking engine.

When Yellow ABS warning light illuminates during normal operation, the system has detected a problem and stored a trouble code. Loss of power to control module will cause system to be deactivated and Yellow ABS light to be illuminated, but will not set a trouble code.

SYSTEM DIODE/RESISTOR

System diode together with an associated resistor are used to prevent a false Code 12 from being set when parking brake is applied.

BLEEDING BRAKE SYSTEM

Hydraulic system bleeding is necessary whenever air enters system. If master cylinder lines have been disconnected or master cylinder has run dry, bleed master cylinder and brakes at all 4 wheels. Bleed brakes with pressure bleeding equipment or by pumping brake pedal. Always bleed brakelines in sequence. See **BLEEDING SEQUENCE**.

MANUAL BLEEDING

CAUTION: DO NOT allow reservoir to run dry during bleeding operation. If brake fluid is spilled onto vehicle paint, rinse off immediately using water.

Master Cylinder Bleeding (On Vehicle)

1. Using a line wrench, remove front brake line and master cylinder rear outlet brake line from master cylinder. Install short tubes in master cylinder and position them so they curve into master cylinder reservoir, and ends of tubes are submerged in brake fluid.
2. Fill master cylinder reservoir with new brake fluid. Have an assistant pump brakes until clear, bubble-free fluid flows from both brake tubes. Remove short brake tubes and reinstall front brake line and master cylinder rear outlet line on master cylinder. Bleed each brake line at master cylinder by having and assistant pump brake pedal 10 times and then hold firm pressure on brake pedal.
3. Loosen rear-most brake line fittings until a stream of brake fluid comes out. Have an assistant maintain pressure on brake pedal until brake line fitting is tightened again. Repeat procedure until clear, bubble-free fluid comes out from around fitting. Refill master cylinder reservoir as necessary. Repeat this bleeding operation at front brake line fittings.

Gravity Bleeding

Fill brake master cylinder with new brake fluid. Loosen both wheel cylinder bleeder screws and leave them open until clear brake fluid flows. Be sure to check master cylinder reservoir fluid level often and do not let it run dry. Tighten wheel cylinder bleeder screws. One at a time, loosen caliper bleeder screws. Leave bleeder screws open until clear fluid flows. Check fluid level often. Tighten caliper bleeder screws.

Manual Bleeding

1. Clean master cylinder cap and surrounding area. Remove cap. Vehicles are equipped with dual-type master cylinder. Bleed primary and secondary systems separately. Loosen primary or secondary master cylinder hydraulic line fitting.
2. Wrap a shop towel around brake lines to absorb escaping brake fluid. Slowly push brake pedal down to force out air. With pedal fully depressed, tighten fittings to prevent air from being sucked into master cylinder when pedal is released. Release brake pedal.
3. Repeat procedure until air is completely purged from master cylinder. When all air has escaped, tighten

fittings with pedal down. Release pedal, and depress again. If pedal is not firm, repeat bleeding procedure.

4. Repeat procedure at bleeder fitting on RABS electrohydraulic valve (if equipped), each wheel cylinder and caliper. See **BLEEDING SEQUENCE** table under BLEEDING SEQUENCE. When bleeding is complete, fill master cylinder to proper level.

PRESSURE BLEEDING

NOTE: The use of ABS Bleeder Box Adapter (T90P-50-ALA) and Jumper (T93T-50-ALA) is required in conjunction with pressure bleeding to bleed system when Hydraulic Control Unit (HCU) is replaced.

1. Clean master cylinder cap and surrounding area. Remove cap. With pressure tank at least 1/2 full of specified brake fluid and charged between 10-30 psi (.7-2.0 kg/cm^2), use adapters to connect tank to master cylinder. Follow equipment manufacturer's instructions.

CAUTION: Never exceed 50 psi (3.5 kg/cm^2) during bleeding.

2. Open pressure bleeder valve. Bleed master cylinder primary and secondary hydraulic lines individually. Put shop towels in place to catch brake fluid.
3. Open lines and allow brake fluid to flow out until all air is purged. Close bleed fitting and hydraulic line. Close pressure bleeder valve. Attach rubber drain hose to first wheel cylinder bleeder valve to be serviced. See **BLEEDING SEQUENCE** table under BLEEDING SEQUENCE.
4. Place other end of hose in clean glass jar partially filled with clean brake fluid so end of hose is submerged in fluid. Open pressure bleeder valve. Open bleeder fitting. Close bleeder fitting when fluid flow is free of bubbles. Repeat procedure on remaining wheel cylinder and calipers in sequence. See **BLEEDING SEQUENCE**.
5. When bleeding operation is complete, close pressure bleeder valve, and remove tank hose from adapter fitting. Check brake pedal operation. Ensure master cylinder is full of fluid.

SERVICE TOOL BLEEDING

NOTE: The use of ABS Bleeder Box Adapter (T90P-50-ALA) and Jumper Cable (T93T-50-ALA) is required in conjunction with pressure bleeding, to bleed system when Hydraulic Control Unit (HCU) is replaced.

1. Connect ABS Bleeder Box Adapter (T90P-50-ALA) and Jumper Cable (T93T-50-ALA) to HCU.
2. Depress brake pedal and depress VALVES button on bleeder box adapter. Brake pedal height should drop. Release VALVES button and release brake pedal.
3. Repeat step 2) one more time. Depress MOTOR START button allow pump motor to operate for one minute, then proceed with pressure bleeding the brake system. See **BLEEDING BRAKE SYSTEM**.

BLEEDING SEQUENCE

Before bleeding system, remove all vacuum from power unit by depressing brake pedal several times. Bleed master cylinder first, followed in sequence by rear wheel cylinders, anti-lock system components and calipers. See **BLEEDING SEQUENCE** table.

BLEEDING SEQUENCE

Application	(1) Sequence
All Models	RR, LR, RF, LF
(1) Bleed master cylinder first, then specified wheel.	

DIAGNOSIS

NOTE: Always disconnect negative battery cable before checking resistance on RABS II system. Inaccurate measurements will result if battery remains connected. Before condemning circuit, check connectors for dirty or corroded terminals.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

COMPONENT LOCATIONS

COMPONENT LOCATIONS

Component	Location
ABS Control Module	Behind Center Of Dashboard
Diode/Resistor Element	On Wiring Harness, At Windshield Washer Reservoir
RABS Diagnostic Test Connector	Under Right Side Of Dash, Near Or Behind Kick Panel
Speed Sensor	Threaded Into Front Of Differential Housing
RABS Valve Assembly	Under Master Cylinder
Sensor Test Connector	On Firewall, Above Master Cylinder

SYSTEM PRELIMINARY CHECK

Vehicle Setup

Before retrieving trouble codes, ensure vehicle is on a level area. Shift 4WD models into 2-wheel drive. On all models, transmission should be in Park (A/T) or Neutral (M/T). Turn ignition off. Set parking brake. Turn running lights on. Block front and rear wheels to prevent vehicle from moving. Release parking brake.

Red BRAKE Warning Light Check

Turn ignition switch to START position. Red BRAKE warning light should be on. If light is not on, go to **TEST A** under PRELIMINARY TESTS. Allow ignition switch to return to RUN position. Red BRAKE warning light should turn off. If light does not turn off, check parking brake switch. Repair/replace switch as necessary. If light remains on and parking brake switch is functioning properly, go to **TEST B** under PRELIMINARY TESTS.

Yellow ABS Warning Light Check

1. Follow procedure for RED BRAKE WARNING LIGHT CHECK. When ignition switch returns to RUN from START position, Yellow light should stay on for 2 seconds and then turn off. If Yellow light turns back on but does not flash, check for stored trouble codes. See **RETRIEVING TROUBLE CODES**. If Yellow light does not turn on, go to **TEST C** under PRELIMINARY TESTS.
2. Depress brake pedal 1-2 seconds, then release. Yellow light should not flash. If Yellow light begins to flash, go to **TEST D** under PRELIMINARY TESTS.

PRELIMINARY TESTS

Test A - Red BRAKE Warning Light Does Not Self-Check

1. Turn ignition on. Engage parking brake. If Red BRAKE warning light comes on, release parking brake and go to next step. If Red BRAKE warning light does not come on, repair open in circuit or fuse to Red BRAKE warning light. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
2. Disconnect brake fluid warning switch harness connector. Using a jumper wire, jumper brake fluid level warning switch terminal No. 3 (Dark Green/Yellow wire) to ground. If Red BRAKE warning light comes on, go to next step. If Red BRAKE warning light does not come on, repair circuit between switch and warning light or circuit to diode/resistor element. See **WIRING DIAGRAM**. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
3. Jumper brake fluid level switch harness connector terminals No. 2 (Tan/Light Green wire) and No. 3 (Dark Green/Yellow wire). See **WIRING DIAGRAM**. If Red BRAKE warning light comes on, replace brake fluid level warning switch. If Red BRAKE warning light does not come on, check for open in Tan/Light Green wire circuit. If circuit is okay, replace ignition switch. After repairs, perform **SYSTEM PRELIMINARY CHECK**.

Test B - Red BRAKE Warning Light Stays On When Ignition Is In RUN Position

1. Ensure parking brake is disengaged. Turn ignition switch on. If both Red BRAKE and Yellow ABS warning light stays on after bulb-check, retrieve codes. See **RETRIEVING TROUBLE CODES** and diagnose affected code(s). If both warning lights turn off after bulb-check, go to next step.
2. Disconnect parking brake switch. If Red BRAKE warning light comes on, repair short to ground in Purple/White wire or Light Green/Red wire circuits. See **WIRING DIAGRAM**. After repairs, perform **SYSTEM PRELIMINARY CHECK**. If Red BRAKE warning light did not come on, replace parking brake switch. After replacing switch, perform **SYSTEM PRELIMINARY CHECK**.

Test C - Yellow ABS Warning Light Does Not Self-Check

1. Check ABS warning light fuse. If fuse is okay, go to next step. If fuse is blown, replace fuse and check for short to ground in circuit No. 640 (Red/Yellow wire). See **WIRING DIAGRAM**. After repairs, perform **SYSTEM PRELIMINARY CHECK**.

NOTE: Always disconnect battery cable to starter relay when checking resistance in ABS system.

2. Disconnect negative battery cable. Disconnect ABS control module harness connector. Check resistance between ground and ABS control module harness connector terminal No. 4 (Light Green/Yellow wire). See **Fig. 1**. If resistance is less than 5 ohms, reconnect battery cable and then go to next step. If resistance is not less than 5 ohms, repair Light Green/Yellow wire circuit. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
3. Check voltage between ground and ABS control module harness connector terminal No. 7 (Dark Green wire). If voltage is not greater than 10 volts, go to next step. If voltage is greater than 10 volts, replace control module. After replacing control module, perform **SYSTEM PRELIMINARY CHECK**.
4. Disconnect instrument cluster harness connector. Check resistance on Dark Green wire between instrument cluster harness connector terminal and ABS control module harness connector terminal. See **WIRING DIAGRAM**. If resistance is less than 5 ohms, diagnose instrument cluster. See INSTRUMENT PANEL article in the ACCESSORIES & EQUIPMENT section. If resistance is not less than 5 ohms, repair Dark Green wire circuit. After repairs, perform **SYSTEM PRELIMINARY CHECK**.

Test D - Yellow ABS Warning Light Self-Checks Okay, But Automatically Begins Flashing

1. Observe if Yellow ABS light is flashing a DTC (short and long pulses). If DTC is being flashed, diagnose affected DTC(s). If DTC is not being flashed, go to next step.
2. Turn ignition off. Disconnect ABS control module harness connector. Turn ignition on. Check voltage between ground and ABS control module harness connector terminal No. 12 (Black/Orange wire), while wiggling harness. See **Fig. 1**. If voltage is greater than 10 volts, go to step 3). If voltage is not greater than 10 volts, repair Black/Orange wire circuit. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
3. On all models, turn ignition off. Disconnect negative battery cable. Check resistance between ground and ABS control module harness connector terminal No. 4 (Light Green/Yellow wire), while wiggling harness.
4. If resistance is 5 ohms or less and steady, replace control module harness connector. After repairs, perform **SYSTEM PRELIMINARY CHECK**. If resistance is not steady and greater than 5 ohms, repair Light Green/Yellow wire. After repairs, perform **SYSTEM PRELIMINARY CHECK**.

Test E - Yellow ABS Warning Light Self-Checks Okay, But No DTCs Retrieved When Diagnostics Are Started

1. Turn ignition on. Depress brake pedal and observe stoplights. If stoplights come on, go to next step. If stoplights do not come on, replace stoplight bulbs or brake switch. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
2. Turn ignition off. Disconnect ABS control module. Depress brake pedal. Check voltage between ground and ABS control module harness connector terminal No. 11. See **Fig. 1**. If voltage is 10 volts or greater, go to next step. If voltage is less than 10 volts, repair open in Light Green wire. See **WIRING**

DIAGRAM.

3. Turn ignition on. Check voltage between ground and ABS control module harness connector terminals No. 1 (Light Blue Pink wire) and No. 9 (Light Blue/Pink wire). If voltage is 10 volts or greater, go to next step. If voltage is less than 10 volts, repair Light Blue/Pink wire circuit. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
4. Observe Yellow ABS warning light. If Yellow ABS warning light is on, repair short to ground in Dark Green wire between ABS light and control module. See **WIRING DIAGRAM**. After repairs, perform **SYSTEM PRELIMINARY CHECK**. If Yellow ABS warning light is not on, go to next step.
5. Turn ignition off. Check resistance between ground and ABS control module harness connector terminal No. 12 (Black/Orange wire). If resistance is 5 ohms or less, replace ABS control module. After replacing module, perform **SYSTEM PRELIMINARY CHECK**. If resistance is greater than 5 ohms, repair Black/Orange wire between control module and fuse block. See **WIRING DIAGRAM**. After repairs, perform **SYSTEM PRELIMINARY CHECK**.

RETRIEVING TROUBLE CODES

NOTE: When retrieving trouble codes, connect only the Black/Orange wire to ground. Connecting mating connector wire to ground will blow fuse.

1. Turn ignition on, with engine off. Locate Black RABS test connector. See **COMPONENT LOCATIONS**. Connector has 2 mating halves. One has a Black/Orange wire; other has a Red wire. Disconnect connector. Connect jumper wire to connector terminal with Black/Orange wire. Ground other end of jumper wire for at least one second. When ground circuit is completed and then broken, Yellow ABS warning light will flash trouble code.
2. Code will repeat until ignition is turned off. Trouble code consists of a number of short flashes followed by one long flash. Count each flash, short and long, to determine code number. For example: short, short, long, is Code 3. Perform appropriate code test after retrieving code. A Code 16 indicates system is operating properly. If Yellow light does not flash, go to **TEST E** under PRELIMINARY TESTS.

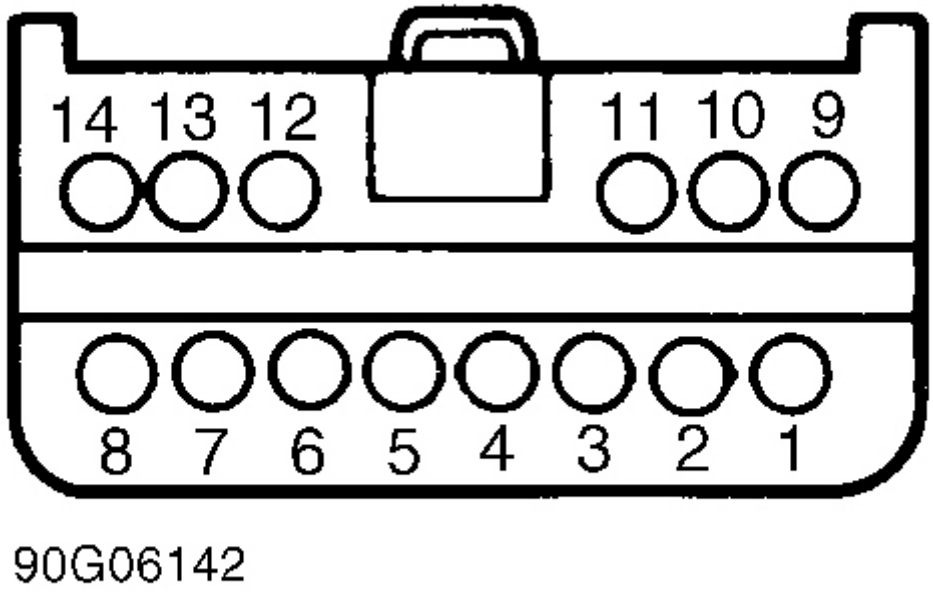


Fig. 1: Identifying ABS Control Module Connector Terminals
Courtesy of FORD MOTOR CO.

CLEARING CODES

To clear codes stored in Keep Alive Memory (KAM), turn ignition off, while ABS test connector halves Black/Orange wire and Red wire are separated. Reconnect ABS test connector to provide power to KAM.

TROUBLE CODE DIAGNOSIS

NOTE: After disconnecting battery, drive vehicle 10 miles in order to allow Powertrain Control Module to relearn its adaptive strategy.

CODE 2

1. Turn ignition off. Disconnect and reconnect diagnostic connector (Black/Orange wire) and its mating half (Red). Turn ignition on. If Yellow ABS warning light comes on, go to next step. If Yellow ABS warning light does not come on, DTC is an intermittent fault, go to **INTERMITTENT DIAGNOSIS**.
2. Turn ignition off. Disconnect RABS valve and ABS control module harness connector. Check resistance between ABS control module harness connector terminal No. 13 (Pink/Light Green wire) and RABS valve harness connector terminal No. 4 (Pink/Light Green wire). See **Fig. 1**. If resistance is 5 ohms or less, go to next step. If resistance is not 5 ohms or less, repair open in Pink/Light Green wire circuit. After

repairs, perform **SYSTEM PRELIMINARY CHECK**.

3. Check resistance between RABS valve terminals No. 3 and 4. See **WIRING DIAGRAM**. If resistance is 3-6 ohms, go to next step. If resistance is not 3-6 ohms, replace RABS valve. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
4. Check resistance between RABS valve terminal No. 4 and RABS valve housing. If resistance is greater than 10,000 ohms, replace ABS control module. After replacing module, perform **SYSTEM PRELIMINARY CHECK**. If resistance is not greater than 10,000 ohms, replace RABS valve. After replacing valve, perform **SYSTEM PRELIMINARY CHECK**.

CODE 3

1. Turn ignition off. Disconnect and reconnect ABS diagnostic test connector. Turn ignition on. If Yellow ABS warning light comes on, go to next step. If Yellow ABS warning light does not come on, fault is intermittent. Go to **INTERMITTENT DIAGNOSIS**.
2. Turn ignition off. Disconnect ABS and RABS valve harness connectors. Check resistance between RABS valve harness connector terminal No. 1 and ABS control module harness connector terminals No. 8 and then No. 14. See **Fig. 1**. If resistance is 5 ohms or less, go to next step. If resistance is not as specified, repair open in Yellow/Light Green wire circuit between ABS control module and RABS valve. See **WIRING DIAGRAM**.
3. Check resistance between RABS valve terminals No. 1 and 3. If resistance is 5 ohms or less, replace ABS control module. After replacing module, perform **SYSTEM PRELIMINARY CHECK**. If resistance is greater than specified, replace RABS valve. After replacing valve, perform **SYSTEM PRELIMINARY CHECK**.
4. Check resistance between RABS valve terminal No. 1 and valve housing. If resistance is greater than 10,000 ohms, replace ABS control module. If resistance is not greater than 10,000 ohms, replace RABS valve. After repairs, perform **SYSTEM PRELIMINARY CHECK**.

CODE 4

1. Turn ignition off. Disconnect and reconnect diagnostic test connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. If Yellow ABS warning light comes on, go to next step. If Yellow warning light does not come on, DTC is an intermittent fault, go to **INTERMITTENT DIAGNOSIS**.
2. Turn ignition off. Disconnect ABS control module and RABS valve harness connectors. Check resistance between ABS control module harness connector terminal No. 6 (Light Blue/Red wire) and RABS valve harness connector terminal No. 2 (Light Blue/Red wire). See **Fig. 1**. If resistance is 5 ohms or less, go to next step. If resistance is not 5 ohms or less, repair open in Light Blue/Red wire between control module and RABS valve. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
3. Check resistance between ground and RABS valve harness connector terminal No. 3 (Black/White wire). If resistance is 5 ohms or less, go to next step. If resistance is not 5 ohms or less, repair open in Black/White wire between control module and RABS valve. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
4. Check resistance between ground and ABS control module harness connector terminal No. 6 (Light Blue/Red wire). If resistance is greater than 10,000 ohms, go to next step. If resistance is not greater than 10,000 ohms, repair short in Light Blue/Red wire between ABS control unit and RABS valve. After

repairs, perform **SYSTEM PRELIMINARY CHECK**.

5. Check resistance between ground and RABS valve harness connector terminal No. 2 (Light Blue/Red wire). If resistance is 10,000 ohms or greater, replace ABS control module. After replacing module, perform **SYSTEM PRELIMINARY CHECK**. If resistance is not 10,000 or greater, replace RABS valve. After replacing valve, perform **SYSTEM PRELIMINARY CHECK**.

CODE 5

1. Turn ignition off. Disconnect and then reconnect diagnostic connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. If Yellow ABS warning light comes on, go to next step. If Yellow ABS warning light does not come on, go to **INTERMITTENT DIAGNOSIS**.
2. On 4WD models, place vehicle in 4WD mode. On all models, check voltage between ground and ABS control module harness connector terminal No. 5. See **Fig. 1**. If voltage is one volt or less, go to next step. If voltage is not one volt or less, repair or replace 4WD indicator switch (4WD models) or check for short in Light Blue wire between ABS control module and transmission. See **WIRING DIAGRAM**. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
3. Turn ignition off. Turn off air suspension system (if equipped). Raise and support vehicle. Ensure all wheels are off the ground. Connect DVOM between ABS control module harness connector terminals No. 3 and 10. Manually turn wheels at about 5 MPH. Voltage reading should be greater than 650 millivolts AC RMS and steady. If voltage reading is as specified, reconnect ABS control module harness connector and go to next step. If voltage reading is not as specified, go to **CODE 6**. After repairs, perform **SYSTEM PRELIMINARY CHECK**.
4. Start engine while observing Yellow ABS warning light. If Yellow ABS light will self-test properly, go to next step. If Yellow ABS light does not self-test properly, go to **TEST C** under PRELIMINARY CHECK TESTS.
5. Activate air suspension system (if equipped) and lower vehicle. Disconnect ABS control module harness connector. Drive vehicle at about 20 MPH. Perform normal traffic stops. If rear wheels lock-up, go to **SYMPTOM DIAGNOSIS**. If rear wheels do not lock-up, go to next step.
6. Drive vehicle at about 10 MPH on dry pavement. Apply brakes hard enough to lock-up all 4 wheels. Observe left rear wheel through side mirror. If rear wheels lock-up (momentary lock-up is okay), replace RABS valve. Reconnect ABS control module and test drive vehicle. If rear wheels do not lock-up, go to next step.
7. Turn off air suspension system (if equipped). Raise and support vehicle on axle hoist. Ensure wheels are off the ground and vehicle is in 2WD mode (4WD vehicles). Start engine. Place transmission in low (A/T) or first gear (M/T). Accelerate to about 10 MPH. Apply brakes hard enough until wheels lock-up. If wheels first locks up and then spins, repeat **SYSTEM PRELIMINARY CHECK**. If wheels do not lock-up or locks up but does not spin after locking up, replace ABS control module. After repairs, reactivate air suspension (if equipped) and test drive vehicle.

CODE 6

1. Turn ignition off. Disconnect and then reconnect diagnostic connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. If Yellow ABS warning light comes on, go to next step. If Yellow ABS warning light does not come on, go to **INTERMITTENT DIAGNOSIS**.
2. Turn ignition off. Check ABS sensor wire routing and inspect for damage. Repair as necessary. After

repairs, perform **SYSTEM PRELIMINARY CHECK**. If circuit is okay, go to next step.

3. Disconnect ABS control module harness connector. Check resistance between control module harness connector terminals No. 3 and 10 while wiggling harness. See **Fig. 1**. If resistance reading is steady and at 900-2500 ohms, go to next step. If resistance is not 900-2500 ohms, replace rear ABS sensor. After replacing sensor, perform **SYSTEM PRELIMINARY CHECK**.
4. Check resistance between ground and control module harness connector terminals No. 3 and 10. If an open circuit is not indicated in either circuit, repair short to ground in affected circuit. After repairs, perform **SYSTEM PRELIMINARY CHECK**. If an open is indicated on both circuits, go to next step.
5. Remove rear ABS sensor from differential case. Check for metal shavings and chips on sensor magnetic pole. If metal shavings/chips are present, drain and clean differential and then go to next step. If metal shavings/chips are not present, go to next step.
6. Turn off air suspension system (if equipped). Raise and support vehicle on axle hoist. Ensure wheels are off the ground. Manually turn wheels about 5 MPH. Check voltage at ABS control module harness connector terminals No. 3 and 10. If voltage reading is steady and at 650 millivolts AC RMS, go to next step. If voltage reading is not as specified, replace ABS sensor. After replacing sensor, activate air suspension system (if equipped) and perform **TEST DRIVE**.
7. Drain differential and remove case cover. Carefully inspect each tooth on ABS sensor ring, behind ring gear. If any sensor ring tooth is missing, replace sensor ring. After repairs, reactivate air suspension system (if equipped) and repeat **SYSTEM PRELIMINARY CHECK**. If sensor ring is okay, replace ABS control module. After repairs, reactivate air suspension system (if equipped) and repeat **SYSTEM PRELIMINARY CHECK**.

CODE 7

1. Turn ignition off. Disconnect and reconnect diagnostic connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. Observe if Yellow ABS warning light comes on, go to next step. If Yellow ABS warning light does not come on, go to **INTERMITTENT DIAGNOSIS**.
2. Turn ignition off. Disconnect ABS control module harness connector. Check resistance between ground and control module harness connector terminal No. 13. See **Fig. 1**. If resistance is 3-6 ohms, replace ABS control module. After replacing module, repeat **SYSTEM PRELIMINARY CHECK**. If resistance is not 3-6 ohms, check Pink/Light Green wire circuit between control module and ABS control valve. See **WIRING DIAGRAM**. If circuit is okay, replace ABS control valve.

CODE 8

1. Turn ignition off. Disconnect and reconnect diagnostic connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. Observe Yellow ABS warning light. If warning light comes on, go to next step. If warning light does not come on, go to **INTERMITTENT DIAGNOSIS**.
2. Turn ignition off. Disconnect ABS control module harness connector. Check resistance between ground and control module harness connector terminals No. 8 and 14. See **Fig. 1**. If resistance is 1-3 ohms on both terminals, replace ABS control module and repeat **SYSTEM PRELIMINARY CHECK**. If resistance is not 1-3 ohms on either terminal, go to next step.
3. Disconnect RABS valve harness connector. Check resistance between RABS valve terminals No. 1 and 3. If resistance is 3-6 ohms, go to next step. If resistance is not 3-6 ohms, replace RABS valve and repeat **SYSTEM PRELIMINARY CHECK**.

4. Check resistance between ABS control module harness connector terminal No. 14 and RABS valve terminal No. 1 (Yellow/Light Green wire). If resistance is less than 5 ohms, repeat **SYSTEM PRELIMINARY CHECK**. If resistance is not less than 5 ohms, repair Yellow/Light Green wire circuit. After repairs, repeat **SYSTEM PRELIMINARY CHECK**.

CODE 9

1. Turn ignition off. Disconnect and reconnect diagnostic connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. Observe Yellow ABS warning light. If warning light comes on, go to next step. If warning light does not come on, go to **INTERMITTENT DIAGNOSIS**.
2. Inspect circuit for damage. Ensure wires are properly routed. Repair as necessary. After repairs, repeat **SYSTEM PRELIMINARY CHECK**. If circuit and wire routing are okay, go to next step.
3. Turn ignition off. Disconnect ABS control module harness connector. Check resistance between control module harness connector terminals No. 3 and 10, while wiggling harness. See **Fig. 1**. If resistance is 900-2500 ohms and steady, go to next step. If resistance is not 900-2500 ohms, replace ABS sensor and go to step 5).
4. Check resistance between ground and ABS control module harness connector terminals No. 3 and 10. If resistance on both pins and ground is 10,000 ohms or greater, replace ABS control module. After repairs, repeat **SYSTEM PRELIMINARY CHECK**. If resistance is less than 10,000 ohms, repair short to ground in Red/Pink wire or Light Green/Black wire. After repairs, repeat **SYSTEM PRELIMINARY CHECK**.
5. Turn ignition off. Disconnect ABS sensor harness connector. Check resistance between sensor terminals. If resistance is 900-2500 ohms, repair open in Light Green/Black wire or Red/Pink wire. After repairs, repeat **SYSTEM PRELIMINARY CHECK**. If resistance is not 900-2500 ohms, replace ABS sensor.

CODE 10

1. Turn ignition off. Disconnect and reconnect diagnostic connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. Observe Yellow ABS warning light. If warning light comes on, go to next step. If warning light does not come on, go to **INTERMITTENT DIAGNOSIS** for all affected circuits.
2. Turn ignition off. Disconnect ABS sensor and control module harness connectors. Check resistance between ABS control module harness connector terminals No. 3 and 10. See **Fig. 1**. If resistance is indicated, repair short between Light Green/Black wire and Red/Pink wire. After repairs, repeat **SYSTEM PRELIMINARY CHECK**. If resistance is not indicated, go to next step.
3. Check resistance between ground and ABS control module harness connector terminal No. 3 (Light Green/Black wire) and No. 10 (Red/Pink wire). If a resistance value is indicated, repair short to ground in either Red/Pink wire or Light Green/Black wire. After repairs, repeat **SYSTEM PRELIMINARY CHECK**. If a resistance value is not indicated, go to next step.
4. Check resistance between ABS sensor terminals. If resistance is 900-2500 ohms, go to next step. If resistance is not 900-2500 ohms, replace ABS sensor and then repeat **SYSTEM PRELIMINARY CHECK**.
5. Check resistance between ground and either of the ABS sensor terminals. If a resistance value is indicated, replace sensor. After replacing sensor, repeat **SYSTEM PRELIMINARY CHECK**. If a resistance value is not indicated, replace ABS control module. After replacing control module, repeat

SYSTEM PRELIMINARY CHECK.

CODE 11

1. Turn ignition off. Disconnect and then reconnect diagnostic test connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. Observe Yellow ABS warning light. If warning light comes on, go to next step. If warning light does not come on, fault is intermittent. Go to **INTERMITTENT DIAGNOSIS**.
2. Turn ignition off. Depress brake pedal and observe stoplights. If stoplights come on, go to step 5). If stoplights do not come on, go to next step.
3. Check stoplight bulbs. Replace as necessary and then repeat **SYSTEM PRELIMINARY CHECK**. If light bulbs are okay, go to next step.
4. Check stoplight fuse. Replace as necessary and check/repair short in brake switch circuit. See **WIRING DIAGRAM**. If fuse is okay, go to next step.
5. Disconnect ABS control module harness connector. Depress brake pedal. Check voltage between ground and ABS control module harness connector terminal No. 11 (Light Green wire). See **Fig. 1**. If voltage reading is 10 volts or greater, replace control module. After replacing control module, repeat **SYSTEM PRELIMINARY CHECK**. If voltage reading is less than 10 volts, repair Light Green wire circuit. See **WIRING DIAGRAM**. After repairs, repeat **SYSTEM PRELIMINARY CHECK**.

CODE 12

1. Turn ignition off. Disconnect and then reconnect diagnostic test connector (Black/Orange wire) from its mating half (Red wire). Turn ignition on. Observe Yellow ABS warning light. If warning light comes on, go to next step. If warning light does not come on, fault is intermittent. Go to **INTERMITTENT DIAGNOSIS**.
2. Turn ignition off. Check master cylinder brake fluid reservoir. If fluid level is okay, go to next step. If brake fluid is low, check for leaks in brake system and repair as necessary. After repairs or refilling brake fluid, repeat **SYSTEM PRELIMINARY CHECK**.
3. Remove master cylinder cap and push reservoir float to bottom of reservoir. Float should return to top of reservoir. If float returns to top, go to next step. If float does return to top, replace master cylinder reservoir. Bleed brake system and repeat **SYSTEM PRELIMINARY CHECK**.
4. On all models, disconnect brake fluid level switch harness connector. Check resistance between ground and brake fluid level switch terminal No. 3 (Dark Green/Yellow wire). If resistance is 5 ohms or less repair Dark Green/Yellow wire circuit and then repeat **SYSTEM PRELIMINARY CHECK**. If resistance is greater than 5 ohms, go to next step.
5. Apply parking brakes. Check resistance between ground and brake fluid level switch terminal No. 3 (Dark Green/Yellow wire). See **WIRING DIAGRAM**. If resistance is 5 ohms or less, replace resistor/diode element. After repairs, repeat **SYSTEM PRELIMINARY CHECK**. If resistance is greater than 5 ohms, go to next step.
6. Disconnect ignition switch harness connector. Check resistance between ground and brake fluid level switch harness connector terminal No. 2 (Tan/Light Green wire). If resistance is 5 ohms or less, repair Tan/Light Green wire circuit. See **WIRING DIAGRAM**. After repairs, repeat **SYSTEM PRELIMINARY CHECK**. If resistance is greater than 5 ohms, reconnect ignition switch harness connector and go to next step.

7. Disconnect ABS control module harness connector. Check resistance between ground and control module harness connector terminal No. 2 (Tan/Light Green wire). See **Fig. 1**. If resistance is 5 ohms or less, replace ignition switch. After replacing switch, repeat **SYSTEM PRELIMINARY CHECK**. If resistance is not 5 ohms or less, reconnect brake fluid level switch and go to next step.
8. Check resistance between ground and ABS control module harness connector terminal No. 2 (Tan/Light Green wire). If resistance is 5 ohms or less, replace brake fluid level switch. If resistance is not 5 ohms or less, replace ABS control module. After replacing control module, repeat **SYSTEM PRELIMINARY CHECK**.

CODE 16 - System Okay

This code should be used to verify if system is okay. If Keep Alive Memory (KAM) fuse is blown, Yellow ABS warning light will flash Code 16 or another trouble code is set. Check KAM fuse when diagnosing complaints of Yellow ABS warning light flashing.

TEST DRIVE

Verification

This test drive is a generic test used to verify repair of system, attempt to recreate an intermittent problem or attempt to detect a symptom when trouble code or symptom is not known.

1. Turn ignition on. Observe Yellow ABS light self-check. If ABS light self-checks normally (turns on and then off after ignition on), go to next step. If Yellow ABS light does not self-check (light off), check light bulb or replace Keep Alive Memory (KAM) fuse. After repairs, repeat **SYSTEM PRELIMINARY CHECK**.
2. Wet an area where stop is to be performed. Drive vehicle at about 10 MPH. Drive over wet area and apply brakes hard enough to lock all 4 wheels while observing rear wheels. If one or both of rear wheels lock-up (momentary lock-up is permissible), go to next step. If no other symptoms are detected, go to **SYMPTOM DIAGNOSIS**. If Yellow ABS warning light does not come on, go to step 4). If Yellow ABS warning light comes on and stays on, repeat **PRELIMINARY TESTS**.
3. Ensure wipers are turned off during this test. Drive vehicle at about 20 MPH on dry pavement. Perform a normal traffic stop. Feel for pulsation in brake pedal anytime during the stop or within 10 seconds after vehicle has stopped. If pulsation was felt, repeat **SYSTEM PRELIMINARY CHECK**. If Yellow ABS warning light did not come on, go to next step. If ABS warning light comes on and stays on, repeat **PRELIMINARY TESTS**.
4. Turn ignition on. Depress brake pedal. Check if stoplights come on. If stoplights come on, repeat **SYSTEM PRELIMINARY CHECK**. If stoplights do not come on, go to **CODE 11**.

SYMPTOM DIAGNOSIS

Symptom "A" - Unwarranted RABS Activity

1. If a premature loss of speed sensor signal during deceleration is suspected, check for:
    - Metal chips on pole piece.

- Gap between speed sensor and sensor ring greater than 0.050" (1.27 mm).
- Gap between speed sensor and sensor ring less than 0.005" (0.13 mm).
- Missing or damaged speed sensor ring teeth.

2. If intermittent speed sensor signal to control module during deceleration is suspected, check for:
   - Intermittent open or short in speed sensor circuit.
   - Intermittent open speed sensor circuit at intermediate connections, specially at firewall.
   - Chafed wire insulation or pinched wire due to improper routing, causing intermittent short.
   - Underhood RABS data link connector shorted.
3. If misadjusted rear brakes or grabby brake linings are suspected, check for:
   - Rear brake adjustment too tight.
   - Linings are grabby.

Symptom "B" - One Or Both Rear Wheels Lock-Up

1. If valve assembly failure is suspected, check for:
   - Damaged valve assembly reset switch.
   - Leaky dump valve.
   - Hydraulically inoperative valve assembly.
2. If speed sensor output low or loss at lower vehicle speeds is suspected, check for:
   - Gap between speed sensor and sensor ring greater than 0.050" (1.27 mm).
   - Speed sensor or speed sensor ring does not produce sufficient voltage (650 millivolt AC RMS) output.
3. If basic brake mechanical problem is suspected, check for:
   - Brake related problems such as damp or contaminated rear brake linings, stuck or leaking wheel cylinder, or overadjusted rear brakes.
   - Hung-up parking brake.
   - Leaking rear axle seal.
4. If a 4WD system mechanical/electrical problem is suspected, check for:
   - Hubs engaged although shift lever is in 2WD position.
   - Faulty 4WD indicator switch or short to battery voltage in 4WD circuit.
5. If a vehicle electrical problem is suspected, check for:
   - Stoplight input to control module missing.
   - Stoplights inoperative.

Symptom "C" - Hard Or Soft Brake Pedal

1. If valve assembly problem is suspected, check for:
   - Stuck closed isolation valve (hard pedal).
   - Leaky dump valve (soft pedal).

2. If vehicle electrical problem is suspected, check for:
    - Brakelight switch always on while vehicle is driven.
3. If basic brake hydraulic problem (soft pedal) is suspected, check for:
    - Hydraulic leak in brakeline or hose, fitting, master cylinder, wheel cylinder, or caliper.
    - Air in brake system.
4. If basic brake mechanical problem (hard pedal) is suspected, check for:
    - Brake related problems such as little or no vacuum boost, stuck or inoperative wheel cylinder or caliper, or pinched or crimped brakeline or hose.

Symptom "D" - Lack Of Deceleration During Medium/Hard Brake Applications

1. If valve assembly inoperative problem is suspected, check for:
    - Leaky dump valve.
    - Stuck closed isolation valve.
2. If speed sensor input to control module is intermittent or problem is suspected, check for:
    - Short or open in frame or instrument panel harness, control module connector (terminals No. 3 and 10), speed sensor connector, bulkhead connector or other connection, pinched or worn wires, or shorted data link connector.
    - Metal chips on speed sensor.
    - Borderline high speed sensor-to-sensor ring gap, excessive speed sensor ring radial runout, or damaged or missing speed sensor ring gear teeth.
3. If vehicle electrical problem is suspected, check for:
    - Low vacuum switch inoperative (diesel engine only).
4. If basic brake hydraulic problem is suspected, check for:
    - Hydraulic leak in brakeline or hose, fitting, master cylinder, wheel cylinder, or caliper.
    - Air in brake system.
5. If basic brake mechanical problem is suspected, check for:
    - Little or no vacuum boost, stuck or inoperative wheel cylinder or caliper, pinched or crimped brakeline or hose, or ineffective brake shoe or pad linings.

INTERMITTENT DIAGNOSIS

1. Reinstall any components previously removed. Reconnect any connectors previously disconnected. Clear all codes. See **CLEARING CODES**. Turn ignition on. If Yellow ABS light does not self-check or stays on, go next step. If Yellow ABS light does self-check, go step 3).
2. Check all component connectors for bent terminals, damaged connector terminal locks or damaged connector wedge. Repair as necessary. If any of these conditions are found, check affected circuit wire length. If wire length is short, repair as necessary to prevent problem from recurring.
3. Ensure ignition is on. Observe Yellow ABS warning light. Starting at one component, wiggle connector by connector until whole circuit has been tested. If Yellow ABS warning light does not come on, go to next step. If Yellow ABS warning light comes on, repair wire terminal or connector as necessary. After

repairs, go to step 5).

4. If a trouble code is being serviced, perform step 3) on all circuits affected. If all affected circuits have been tested, go to step 6).
5. Retrieve trouble codes. See **RETRIEVING TROUBLE CODES**. If code is different than one being serviced, go to appropriate code under **TROUBLE CODE DIAGNOSIS**. If code is not different than one being serviced, repair wire, terminal or connector as necessary and go to step 7).
6. Verify all appropriate diagnostic procedures have been performed. If **SYSTEM PRELIMINARY CHECK** tests have been completed and a code received, and all tests for that code under TROUBLE CODE DIAGNOSIS have been performed, repeat test for appropriate code under **TROUBLE CODE DIAGNOSIS**. If **PRELIMINARY TESTS** or test for appropriate code have not been completed, return to procedure not yet performed.
7. Clear all codes. See **CLEARING CODES**. Turn ignition off. Retrieve trouble codes. See **RETRIEVING TROUBLE CODES**. If Code 16 is present, problem has been corrected. If previous code still exists, go to step 4). If a different code is present, go to appropriate test under **TROUBLE CODE DIAGNOSIS**.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

ABS CONTROL MODULE

Removal

1. Disconnect battery ground cable.
2. Remove the center instrument panel finish panel.

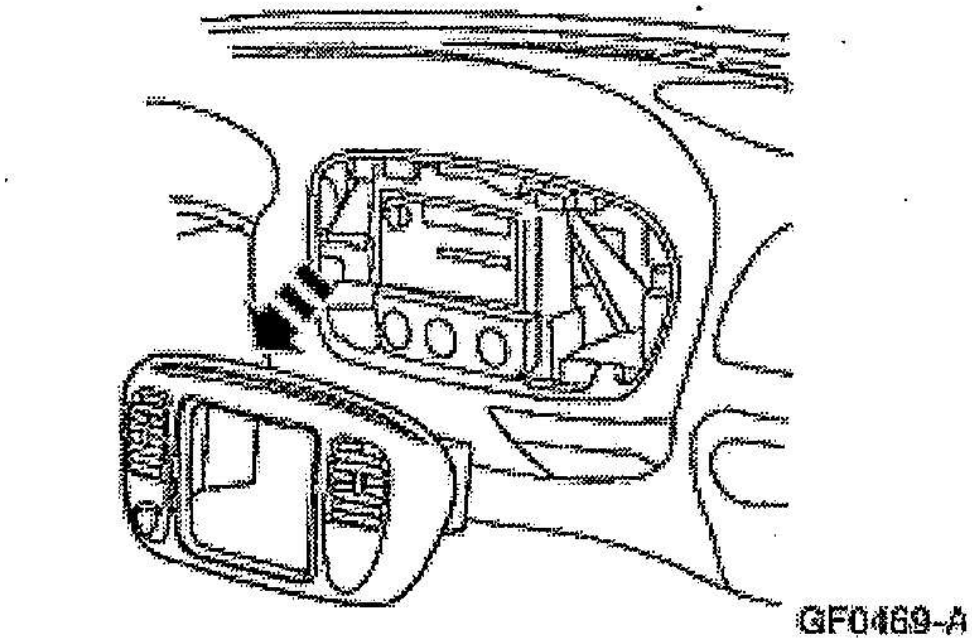


Fig. 2: Removing Center Finish Panel
Courtesy of FORD MOTOR CO.

3. If equipped disconnect the transfer case rotary control switch electrical connector.

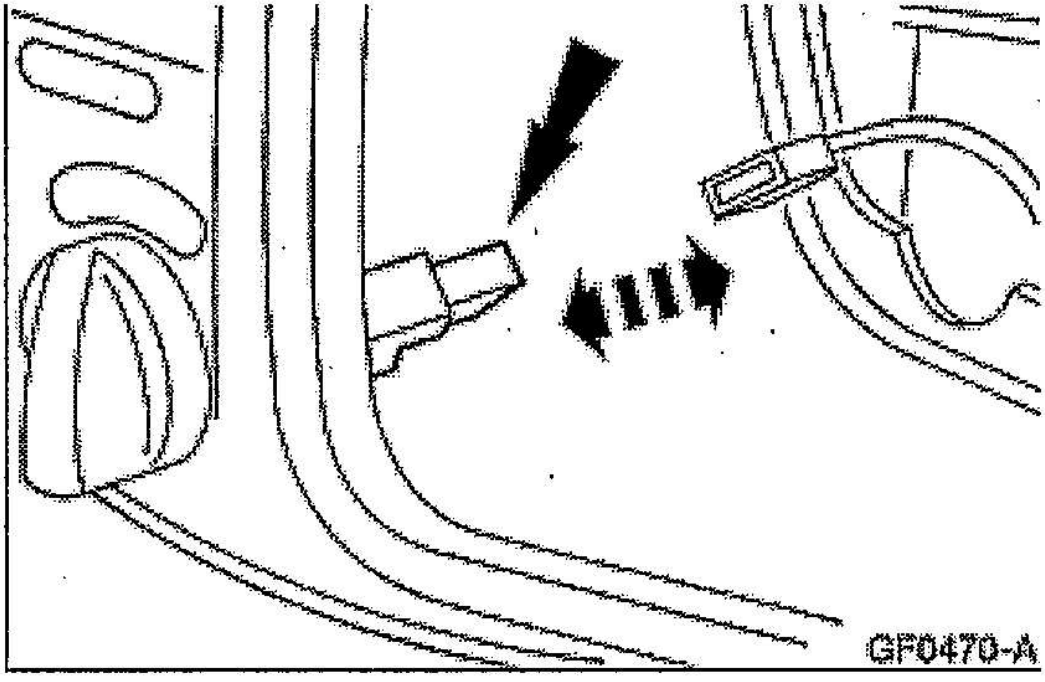


Fig. 3: Disconnecting Rotary Control Switch Electrical Connector
Courtesy of FORD MOTOR CO.

4. Disconnect the two passenger air bag defeat switch electrical connectors.

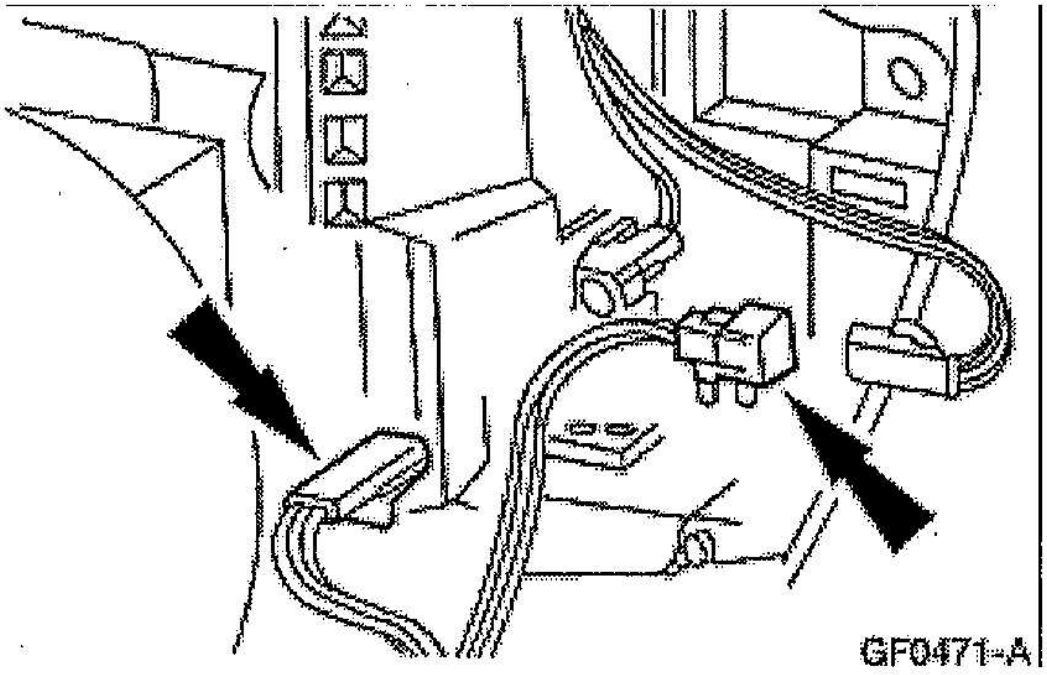


Fig. 4: Identifying Two Passenger Air Bag Defeat Switch Electrical Connectors
Courtesy of FORD MOTOR CO.

5. Remove the steering column cover trim panel.

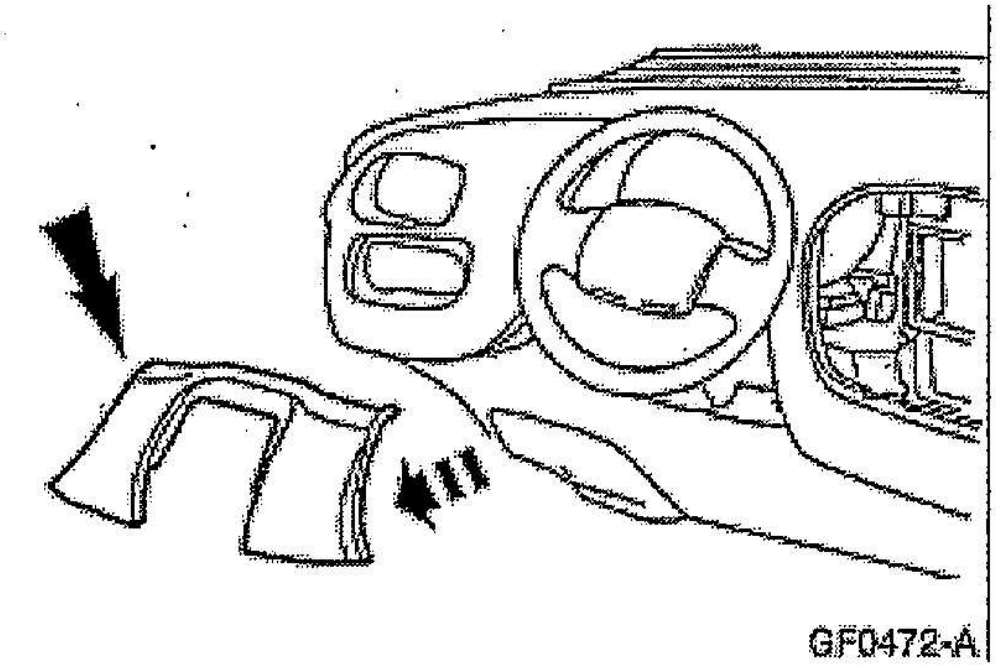


Fig. 5: Removing Steering Column Cover Trim Panel
Courtesy of FORD MOTOR CO.

6. Remove the headlamp switch. Refer to **HEADLIGHT SWITCH** under REMOVAL & INSTALLATION in INSTRUMENT PANEL - ANALOG article in ACCESSORIES & EQUIPMENT.
7. Remove the LH instrument panel finish panel.
    1. Remove the screws.
    2. Remove the instrument panel finish panel.

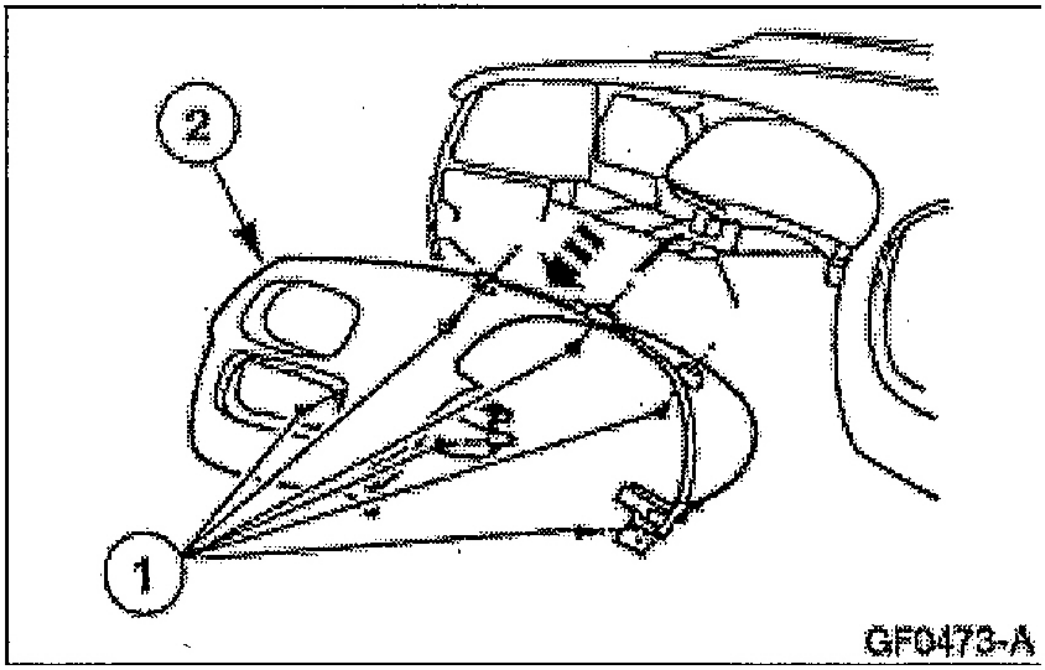


Fig. 6: Identifying LH Instrument Panel Finish Panel
Courtesy of FORD MOTOR CO.

8. Remove the instrument cluster panel.
    1. Remove the screws.
    2. Remove the instrument cluster panel.

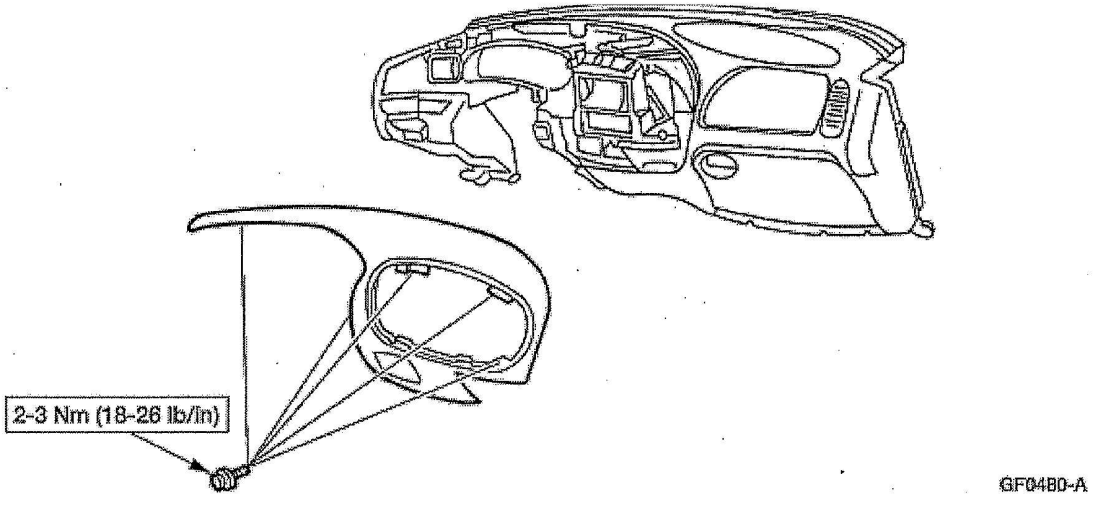


Fig. 7: Removing Instrument Cluster Panel - (1 Of 2) With Torque Specifications
Courtesy of FORD MOTOR CO.

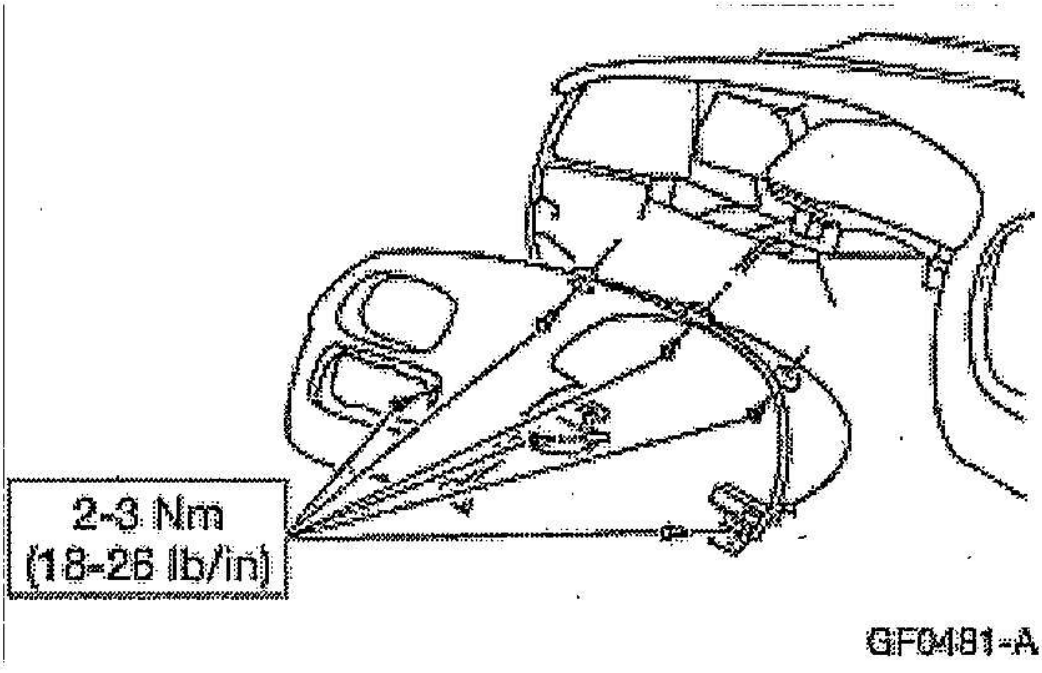


Fig. 8: Removing Instrument Cluster Panel - (2 Of 2) With Torque Specifications
Courtesy of FORD MOTOR CO.

9. Remove the anti-lock electronic control module.
    1. Remove the two anti-lock electronic control module bolts.
    2. Remove the anti-lock electronic control module.
    3. Disconnect the anti-lock electronic control module electrical connector.

Installation

1. To install, reverse the removal procedure.

ABS SPEED SENSOR

Removal & Installation

Disconnect ABS speed sensor harness connector. See **COMPONENT LOCATIONS** under DIAGNOSIS. Remove hold-down bolt and sensor. To install, clean axle mounting surface. Ensure "O" ring is positioned on sensor, and sensor tip is clean of all metal particles. Lightly lubricate "O" ring with engine oil. Install sensor. DO NOT use force to install sensor. Install hold-down bolt. Ensure air gap is between .005-.045" (.127-1.14

mm). Tighten hold-down bolt to specifications. See **TORQUE SPECIFICATIONS**.

EXCITER/SENSOR RING

Removal & Installation

Remove differential case from axle housing. See appropriate article in the DRIVE AXLES section. Press exciter/sensor ring from differential ring gear. Discard exciter/sensor ring. To install, reverse removal procedure. Use a NEW exciter/sensor ring.

RABS VALVE

Removal & Installation

Disconnect and plug brakelines connected to RABS valve. See **COMPONENT LOCATIONS** under DIAGNOSIS. Unplug harness connector. Remove retaining bolts. Remove RABS valve. To install, reverse removal procedure. Tighten to specifications. See **TORQUE SPECIFICATIONS**. Bleed brakes. See **BLEEDING BRAKE SYSTEM**.

ADJUSTMENTS

MASTER CYLINDER PUSH ROD

Remove master cylinder. See BRAKE SYSTEM article in the BRAKES section. Fabricate a gauge with dimensions shown. See **Fig. 9**. Ensure vacuum hose remains connected to brake booster. Start engine. Place gauge against booster. Turn push rod adjuster screw until end of screw just touches gauge.

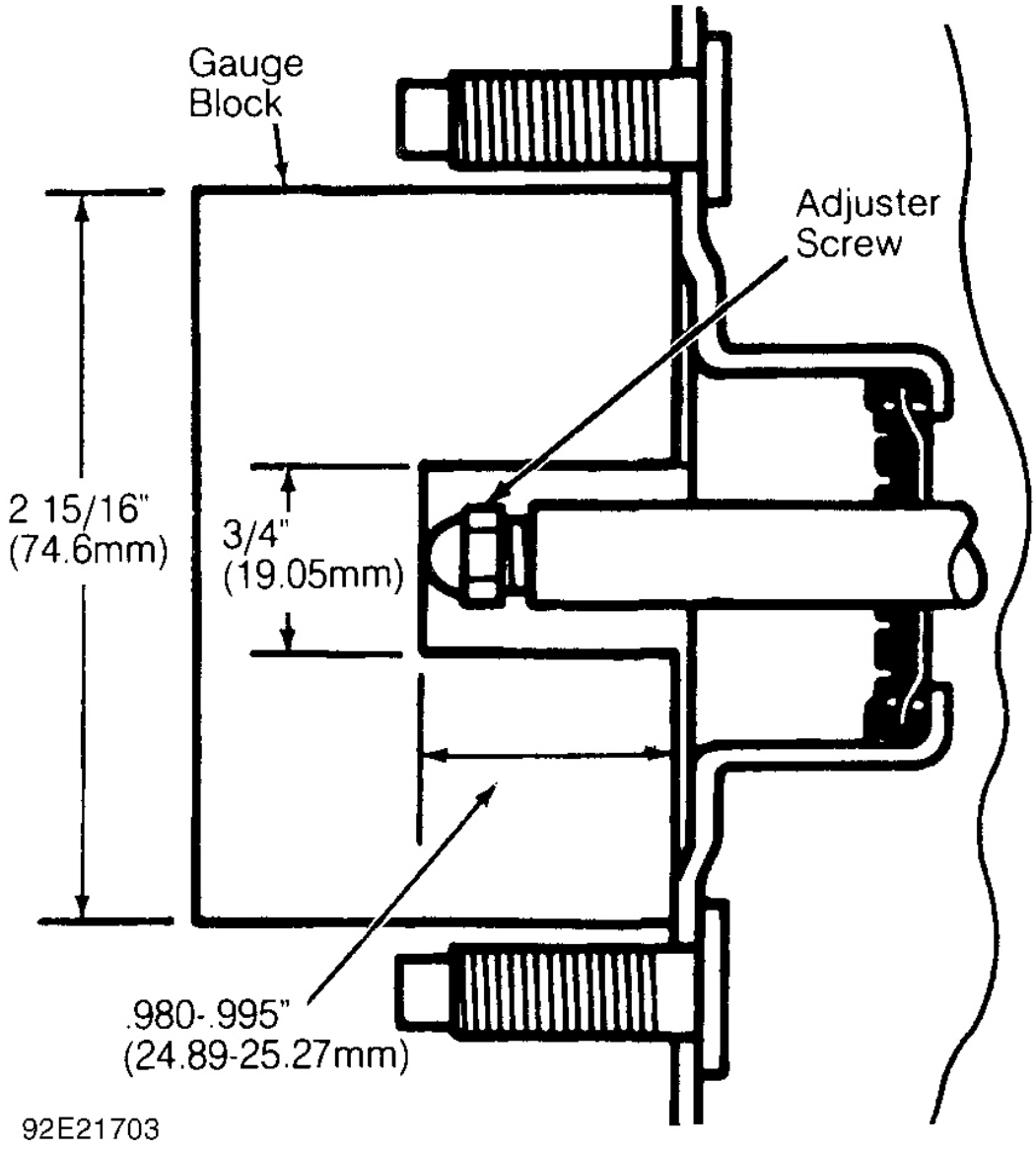


Fig. 9: Adjusting Push Rod
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Speed Sensor Hold-Down Bolt	25-30 (34-41)
Hydraulic Fittings	

1/2"-20	10-17 (14-23)
7/16"-24	10-15 (14-20)
3/8"-24	10-15 (14-20)
RABS Valve Mounting Bolts	12-17 (16-23)

WIRING DIAGRAMS

1997 Ford Pickup F150

1997 ANTI-LOCK BRAKE SYSTEM Anti-Lock - RABS II - "F" Series Pickup

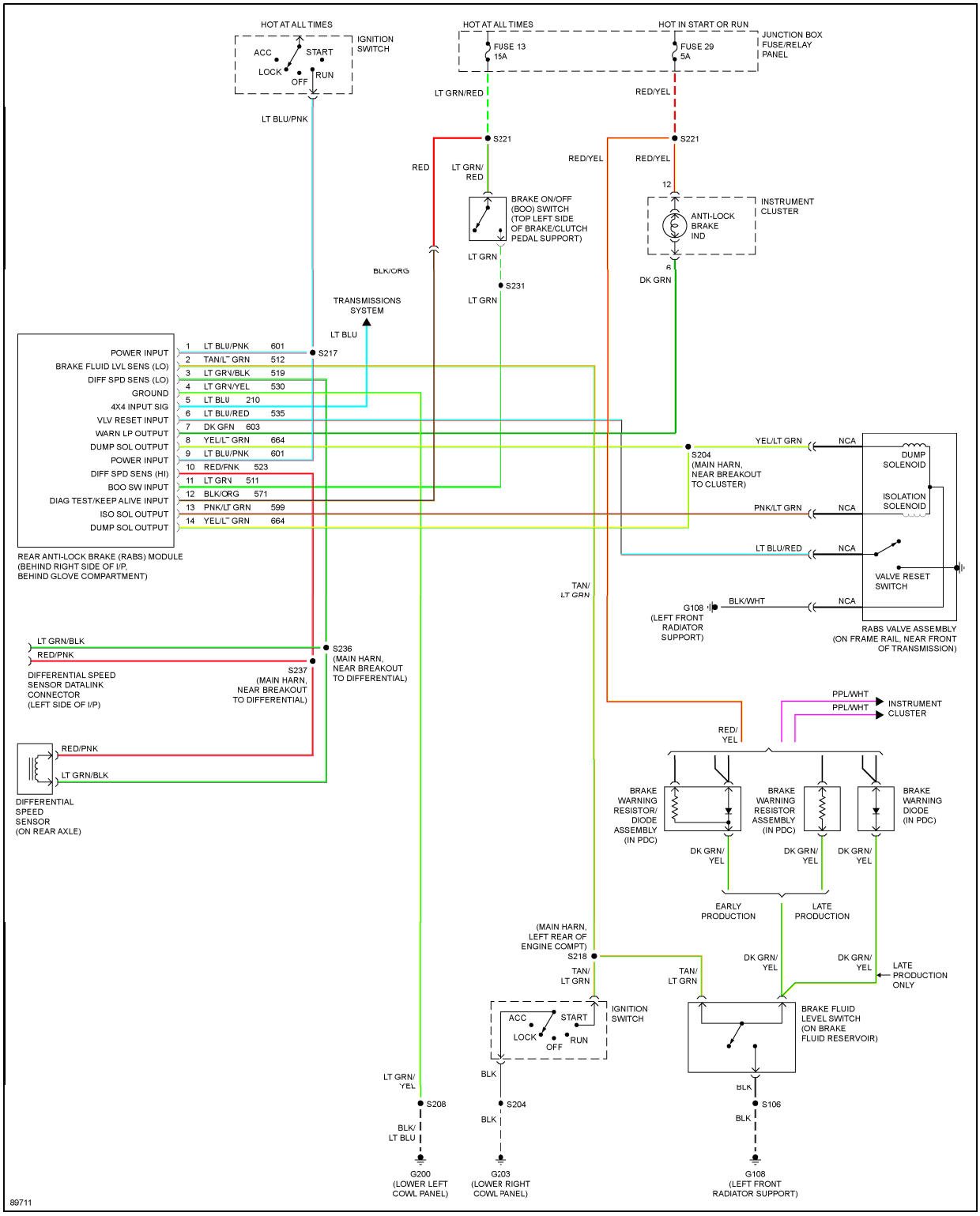


Fig. 10: Rear Anti-Lock Brake System Wiring Diagram (F150 & F250 Light-Duty - Rear Wheel) Courtesy of FORD MOTOR CO.

1997 Ford Pickup F150

1997 ANTI-LOCK BRAKE SYSTEM Anti-Lock - RABS II - "F" Series Pickup

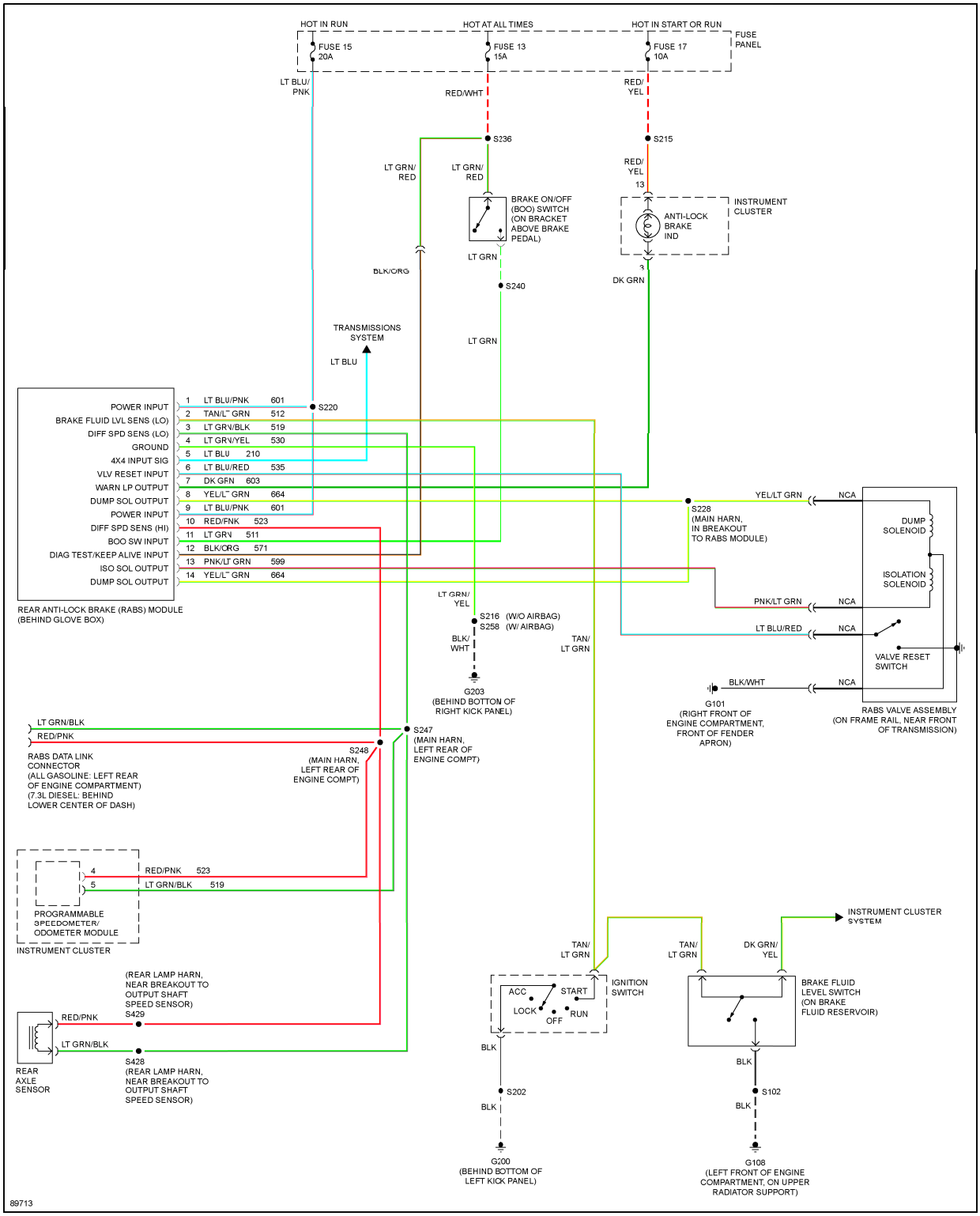


Fig. 11: Rear Anti-Lock Brake System Wiring Diagram (F250 Heavy-Duty & F350 - Rear Wheel)
Courtesy of FORD MOTOR CO.

TRANSMISSION SERVICING - A/T (4R70W)

1997 AUTOMATIC TRANSMISSION SERVICING Ford Motor Co. - 4R70W

APPLICATION

TRANSMISSION APPLICATION

Model	Transmission
4.2L, 4.6L, 5.0L	4R70W

LUBRICATION

SERVICE INTERVALS

Transmission

Check fluid level at every engine oil change. Filter change and band adjustments are not required under normal operation. Fluid change is recommended every 30,000 miles. If vehicle is operated under following conditions, replace transmission fluid every 21,000 miles:

- In hot weather with temperature greater than 90°F (32°C), carrying heavy loads and/or in hilly terrain.
- Towing a trailer or using a car top carrier.
- In police, taxi or door-to-door delivery service.

Transfer Case

Under normal driving conditions, replace transfer case fluid every 60,000 miles. Under severe driving conditions, per-form this service more frequently.

CHECKING FLUID LEVEL

NOTE: F350 Super Duty commercial chassis has a parking brake assembly mounted on rear of transmission. Parking brake assembly contains a separate reservoir; fluid level must be checked separately from transmission. See PARKING BRAKE ASSEMBLY under CHECKING FLUID LEVEL.

Transmission

1. Transmission or transaxle must be at normal operating temperature with vehicle on level ground. Apply parking brake, and run engine at curb idle. Shift gear selector lever through all positions, ending in PARK.

WARNING: On 4WD models, ensure transfer case is in any gear range EXCEPT Neutral before checking transmission fluid level.

2. Fluid level should be in crosshatch area on dipstick if checked at operating temperature. If transmission is at room temperature, fluid level should be between 2 dimples on bottom of dipstick.
3. DO NOT overfill. Check condition of fluid for contamination and burned smell. Fully reseat dipstick.

Transfer Case

Remove fill plug. If fluid drains out or is level with opening, reinstall drain plug. If not, fill until level.

RECOMMENDED FLUID

NOTE: For recommended transfer case fluid, see the AUTO TRANS OVERHAUL article in AUTO TRANS OVERHAUL section.

TRANSMISSION FLUID APPLICATION

Application	Fluid Type
4R70W	Mercon (XT-2-QDX)

FLUID CAPACITIES

NOTE: Transmission fluid capacities in TRANSMISSION FLUID CAPACITIES table are approximate quantities. Correct fluid level should be determined using dipstick. See CHECKING FLUID LEVEL.

TRANSMISSION FLUID CAPACITIES

Application	(1) Qts. (L)
4R70W	13.9 (13.2)
(1) Includes oil cooler (if equipped).	

TRANSFER CASE REFILL CAPACITIES

Application	Pts. (L)
Borg-Warner 13-54	2.5 (1.2)
Borg-Warner 13-56	
With PTO	12.2 (5.8)
Without PTO	4.0 (1.9)
Borg-Warner 44-05	2.5 (1.2)
Borg-Warner 44-06	(1)
Borg-Warner 44-07	(1)
Borg-Warner 44-72	2.7 (1.3)
Dana TC-28	4.5 (2.1)
(1) Refill capacity not available at time of publication. Fill until fluid is level with filler plug opening.	

DRAINING & REFILLING

WARNING: On vehicles with electrical air suspension, power to air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel area. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during these operations.

Transmission

1. Raise and support vehicle. Place drain pan under transmission. Loosen oil pan retaining bolts. Drain fluid from transmission. Remove oil pan bolts individually. This allows remaining fluid to drain slowly to prevent spillage. Remove oil pan and gasket.
2. Drain torque converter by removing torque converter drain plug. Remove and clean filter screen. Reinstall or replace filter screen using NEW "O" rings. Install torque converter drain plug and tighten to specification. See **TORQUE SPECIFICATIONS** .
3. Clean oil pan, Install pan using NEW pan gasket. Fill transmission through filler tube. Start engine and engage all gears. Check fluid level and add as required.

Transfer Case

Remove drain plug from transfer case. Remove fill plug for easier draining. With fluid fully drained, reinstall drain plug. Fill transfer case to fill plug opening with Mercon ATF.

NOTE: Transmission oil cooler and lines should be thoroughly flushed if transmission is removed for any reason. Use appropriate line disconnecting tool when disconnecting cooler lines.

ADJUSTMENTS

WARNING: On vehicles with electrical air suspension, power to air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel area. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during these operations.

BAND

CAUTION: DO NOT allow adjustment screw to back out. Band strut could fall inside transmission assembly.

SHIFT CABLE/LINKAGE

1. Place shift control selector in "OD" position. Hold shift lever against rear of stop with a constant force of

about 3 lbs. (1.4 kg). Raise and support vehicle. Remove shift cable from control lever ball stud on transmission.

2. Pull down lock tab on shift cable body. Move shift cable back and forth the full adjustment length a few times to remove any dirt. Ensure adjuster body moves freely.
3. Position manual control lever in "OD" position. This is 3 detents from front-most position with front position counting as one. Holding cable end, push cable rearward until end lines up with ball stud. Connect cable to ball stud.
4. Push up on lock tab to lock adjustment sleeve in position. Ensure shift cable is clipped to floor pan at White mark on cable and cable is routed into tunnel. Lower vehicle. Adjust shift indicator cable while still in OVERDRIVE position. See **SHIFT INDICATOR CABLE** .
5. Remove pressure from shift control selector. Check PARK engagement. Start engine and ensure transmission shifts through all gears. Verify vehicle only starts in "P" and "N" position and backup lights work. If not, check transmission range sensor adjustment. See **TRANSMISSION RANGE (TR) SENSOR/SWITCH** .

SHIFT INDICATOR CABLE

"E" Van, Expedition, "F" Pickup

1. Remove lower steering column cover. Move shift control selector until in lowest gear position. Move shift control lever up 3 detent positions.
2. Hold shift lever against rear of stop with a constant force of about 3 lbs. (1.4 kg). Center pointer in middle of "OD" position, by rotating thumbwheel located on right side of steering column. Remove pressure from shift control selector and install lower steering column cover.

Mountaineer

1. Remove upper and lower steering column covers. Place shift control selector in lowest gear. Move shift control selector up to detents. Hold shift lever against rear of stop with a constant force of about 3 lbs. (1.4 kg).
2. Rotate thumbwheel until pointer is centered in appropriate position. Cycle shift control selector through all gears to ensure proper operation. Install upper and lower steering column covers.

TRANSMISSION RANGE (TR) SENSOR/SWITCH

1. Place shift control selector in NEUTRAL. NEUTRAL is 2 detents back from PARK. Loosen 2 transmission range sensor retaining bolts. Install appropriate transmission range sensor alignment tool. Tighten 2 sensor retaining bolts.
2. Check PARK engagement. Start engine and ensure transmission shifts through all gears. If not, check shift cable adjustment. See **SHIFT CABLE/LINKAGE** . Verify vehicle only starts in "P" and "N" positions and backup lights work.

SHIFT INTERLOCK SYSTEMS

NOTE: For information on shift interlock systems, see the SHIFT INTERLOCK SYSTEM

article in AUTO TRANS DIAGNOSIS section.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Transmission	**Ft. Lbs. (N.m)**
Manual Lever-To-TR Sensor Nut	20-29 (27-39)
Torque Converter Drain Plug	21-23 (28-31)
	INCH Lbs. (N.m)
Filter Screen	80-124 (9-14)
Transmission Range (TR) Sensor/Switch Bolts	80-106 (9-12)
Oil Pan	71-124 (8-14)

TRANSMISSION SERVICING - A/T (E4OD)

1997 AUTOMATIC TRANSMISSION SERVICING Ford Motor Co. - E4OD

APPLICATION

TRANSMISSION APPLICATION

Model	Transmission
5.4L, 5.8L, 6.8L, 7.3L, 7.5L	E4OD

LUBRICATION

SERVICE INTERVALS

Transmission

Check fluid level at every engine oil change. Filter change and band adjustments are not required under normal operation. Fluid change is recommended every 30,000 miles. If vehicle is operated under following conditions, replace transmission fluid every 21,000 miles:

- In hot weather with temperature greater than 90°F (32°C), carrying heavy loads and/or in hilly terrain.
- Towing a trailer or using a car top carrier.
- In police, taxi or door-to-door delivery service.

Transfer Case

Under normal driving conditions, replace transfer case fluid every 60,000 miles. Under severe driving conditions, per-form this service more frequently.

CHECKING FLUID LEVEL

NOTE: F350 Super Duty commercial chassis has a parking brake assembly mounted on rear of transmission. Parking brake assembly contains a separate reservoir; fluid level must be checked separately from transmission. See PARKING BRAKE ASSEMBLY under CHECKING FLUID LEVEL.

1. Transmission or transaxle must be at normal operating temperature with vehicle on level ground. Apply parking brake, and run engine at curb idle. Shift gear selector lever through all positions, ending in PARK.

WARNING: On 4WD models, ensure transfer case is in any gear range EXCEPT Neutral before checking transmission fluid level.

2. Fluid level should be in crosshatch area on dipstick if checked at operating temperature. If transmission is

at room temperature, fluid level should be between 2 dimples on bottom of dipstick.

3. DO NOT overfill. Check condition of fluid for contamination and burned smell. Fully reseat dipstick.

Parking Brake Assembly (F350 Super Duty Commercial Chassis)

Check lubricant level at filler plug hole on side of parking brake assembly mounted on rear of transmission. Fluid level should be even with bottom of filler plug hole. Add lubricant as needed.

Transfer Case

Remove fill plug. If fluid drains out or is level with opening, reinstall drain plug. If not, fill until level.

RECOMMENDED FLUID

NOTE: For recommended transfer case fluid, see the AUTO TRANS OVERHAUL article in AUTO TRANS OVERHAUL section.

TRANSMISSION FLUID APPLICATION

Application	Fluid Type
E4OD	Mercon (XT-2-QDX)

FLUID CAPACITIES

NOTE: Transmission fluid capacities in TRANSMISSION FLUID CAPACITIES table are approximate quantities. Correct fluid level should be determined using dipstick. See CHECKING FLUID LEVEL.

TRANSMISSION FLUID CAPACITIES

Application	(1) Qts. (L)
2WD	15.9 (15.0)
4WD	16.4 (15.5)
(1) Includes oil cooler (if equipped).	

TRANSFER CASE REFILL CAPACITIES

Application	Pts. (L)
Borg-Warner 13-54	2.5 (1.2)
Borg-Warner 13-56	
With PTO	12.2 (5.8)
Without PTO	4.0 (1.9)
Borg-Warner 44-05	2.5 (1.2)
Borg-Warner 44-06	(1)
Borg-Warner 44-07	(1)

Borg-Warner 44-72	2.7 (1.3)
Dana TC-28	4.5 (2.1)
(1) Refill capacity not available at time of publication. Fill until fluid is level with filler plug opening.	

DRAINING & REFILLING

WARNING: On vehicles with electrical air suspension, power to air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel area. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during these operations.

E4OD

1. Raise and support vehicle. Place drain pan under transmission pan. Remove rear and side drain pan bolts. Loosen front drain pan bolt to allow fluid to drain. Remove front drain pan bolts. Remove drain pan and gasket.
2. Remove and discard oil screen and seal. If seal remains in bore, carefully remove using a screwdriver. Install NEW oil screen and seal, using clean ATF to lubricate seal. Clean oil pan, and install pan using NEW gasket. Fill transmission through filler tube. Start engine and engage all gears. Check fluid level and add as required.

Transfer Case

Remove drain plug from transfer case. Remove fill plug for easier draining. With fluid fully drained, reinstall drain plug. Fill transfer case to fill plug opening with Mercon ATF.

NOTE: Transmission oil cooler and lines should be thoroughly flushed if transmission is removed for any reason. Use appropriate line disconnecting tool when disconnecting cooler lines.

ADJUSTMENTS

WARNING: On vehicles with electrical air suspension, power to air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel area. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during these operations.

BAND

CAUTION: DO NOT allow adjustment screw to back out. Band strut could fall inside transmission assembly.

SHIFT CABLE/LINKAGE

1. Place shift control selector in "OD" position. Hold shift lever against rear of stop with a constant force of about 3 lbs. (1.4 kg). Raise and support vehicle. Remove shift cable from control lever ball stud on transmission.
2. Pull down lock tab on shift cable body. Move shift cable back and forth the full adjustment length a few times to remove any dirt. Ensure adjuster body moves freely.
3. Position manual control lever in "OD" position. This is 3 detents from front-most position with front position counting as one. Holding cable end, push cable rearward until end lines up with ball stud. Connect cable to ball stud.
4. Push up on lock tab to lock adjustment sleeve in position. Ensure shift cable is clipped to floor pan at White mark on cable and cable is routed into tunnel. Lower vehicle. Adjust shift indicator cable while still in OVERDRIVE position. See **SHIFT INDICATOR CABLE** .
5. Remove pressure from shift control selector. Check PARK engagement. Start engine and ensure transmission shifts through all gears. Verify vehicle only starts in "P" and "N" position and backup lights work. If not, check transmission range sensor adjustment. See **TRANSMISSION RANGE (TR) SENSOR/SWITCH** .

SHIFT INDICATOR CABLE

1. Remove lower steering column cover. Move shift control selector until in lowest gear position. Move shift control lever up 3 detent positions.
2. Hold shift lever against rear of stop with a constant force of about 3 lbs. (1.4 kg). Center pointer in middle of "OD" position, by rotating thumbwheel located on right side of steering column. Remove pressure from shift control selector and install lower steering column cover.

TRANSMISSION RANGE (TR) SENSOR/SWITCH

1. Remove nut securing manual control lever to Transmission Range (TR) sensor. Turn manual lever to NEUTRAL position. Loosen bolts securing TR sensor to transaxle. Using appropriate TR sensor alignment tool, align TR sensor slots. Tighten TR sensor mounting bolts.
2. Install manual lever retaining nut. Tighten nut to specification. See **TORQUE SPECIFICATIONS** . Check PARK engagement. Start engine and ensure transmission shifts through all gears. If not, check shift cable adjustment. See **SHIFT CABLE/LINKAGE** . Verify vehicle only starts in "P" and "N" positions and backup lights work.

SHIFT INTERLOCK SYSTEMS

NOTE: For information on shift interlock systems, see the SHIFT INTERLOCK SYSTEM article in AUTO TRANS DIAGNOSIS section.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Transmission	**Ft. Lbs. (N.m)**
Manual Lever-To-TR Sensor Nut	20-29 (27-39)
Torque Converter Drain Plug	18-20 (24-27)
	INCH Lbs. (N.m)
Transmission Range (TR) Sensor/Switch Bolts	53-71 (6-8)
Oil Pan	(1)

(1) Tighten bolts to 10-12 ft. lbs.

1997-98 AUTOMATIC TRANSMISSIONS

4R70W Overhaul

APPLICATION

TRANSMISSION APPLICATION

Model	Engine Application
Cougar, Thunderbird	3.8L SFI
Cougar, Thunderbird	4.6L SFI
Crown Victoria	4.6L SFI
Expedition, Navigator	
2WD	4.6L SFI
4WD	4.6L SFI
Explorer, Mountaineer	
2WD	5.0L SFI
4WD	5.0L SFI
Grand Marquis	4.6L SFI
Mark VIII	4.6L SFI
Mustang	3.8L SFI
Mustang GT	4.6L SFI
Town Car	4.6L SFI
E-Series	4.2L SFI
E-Series	4.6L SFI
F-Series	
2WD	4.2L & 4.6L
4WD	4.2L & 4.6L

IDENTIFICATION

NOTE: For electronic component diagnostic procedures, see appropriate DIAGNOSIS article. AODE is mechanically identical to 4R70W.

NOTE: When working on Navigator or Mountaineer, refer to information given for Expedition and Explorer respectively, unless otherwise noted. 4R70W transmission is identified by a code letter on lower line of Vehicle Certification Label. This code can be found directly under the TR designation. Label is attached to driver's door lock post. See TRANSMISSION IDENTIFYING CODE LETTER CHART . Transmission model may be identified by service identification tag attached to right side of transmission case or fluid pan. Tag shows transmission model, assembly number, serial number and engine size. See Fig. 1 .

TRANSMISSION IDENTIFYING CODE LETTER CHART

Application	Letter Identification
1997	
Cougar, Thunderbird	L
All Other Models	U
1998 (All Models)	U

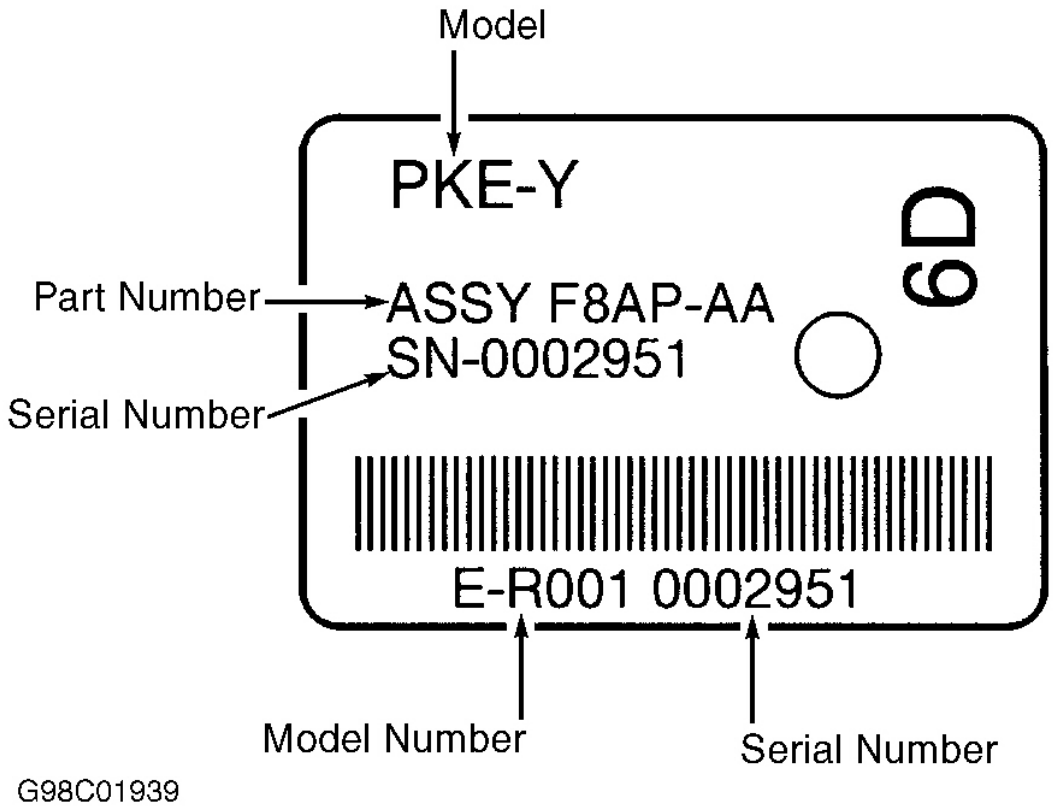


Fig. 1: Service Identification Tag
Courtesy of FORD MOTOR CO.

DESCRIPTION

4R70W is a 4-speed, automatic with electronic shift, converter clutch and line pressure controls. It uses a double-pinion compound gearset to produce 4 forward speeds and reverse. It uses 2 bands, 2 one-way roller clutches and 4 friction clutches to hold or drive the planetary gearset members. See **Fig. 2** .

Shift control solenoids provide gear selection and are controlled by the EEC microprocessor. For additional information on the EEC system, refer to appropriate TESTS W/CODES article in ENGINE PERFORMANCE

section.

The EEC system has self-diagnostic capabilities. Fault codes for faulty engine and transmission sensors, switches and circuits are stored in the PCM and may be retrieved to aid diagnosis and repair.

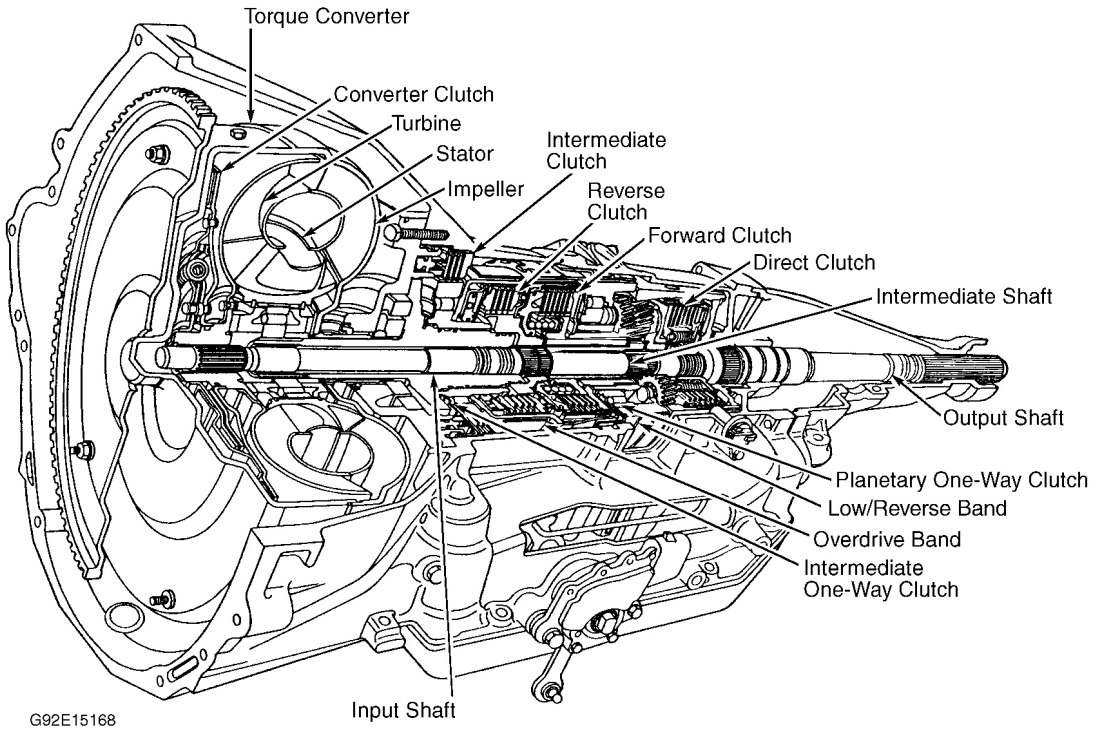


Fig. 2: Cross-Sectional View Of 4R70W
Courtesy of FORD MOTOR CO.

LUBRICATION & ADJUSTMENTS

See appropriate TRANSMISSION SERVICING - A/T article in AUTOMATIC TRANSMISSION SERVICING.

ON-VEHICLE SERVICE

VALVE BODY ASSEMBLY

NOTE: If valve body removal is necessary, ensure correct gasket is used.

Removal

1. Raise and support vehicle. Loosen oil pan retaining bolts and allow transmission fluid to drain. Remove oil pan and gasket. Discard gasket. Remove transmission oil filter. Disconnect all solenoid and sensor

harness connectors.

2. Remove manual lever detent spring. Remove EPC solenoid bracket. Remove valve body bolts. Note position lengths of bolts for reassembly reference. Remove valve body and gasket from transmission.

Installation

1. Using 2 alignment bolts as guides, position valve body (with new gasket) in case. Ensure check balls are in proper locations. Loosely install remaining valve body bolts. Install EPC solenoid bracket. Install manual valve detent spring.
2. Tighten valve body bolts to specification. See TORQUE SPECIFICATIONS. Connect all solenoid and sensor harness connectors. Install filter and grommet. Install pan gasket and oil pan. To complete installation, reverse removal procedure. Refill with fluid.

TRANSMISSION RANGE (TR) SENSOR

Removal

Raise and support vehicle. Disconnect linkage and electrical connector from sensor. Remove bolts and TR sensor from case.

Installation

1. Install TR sensor and 2 shims onto manual control lever shaft. Install bolts but do not tighten. Place TR sensor in Neutral position (2 detent positions back from Park).
2. Insert Transmission Range Sensor Alignment tool (T97L-70010-A) into slots. See **Fig. 3** . Align the three slots on TR sensor with tabs on adjuster. Tighten bolts to specification. See TORQUE SPECIFICATIONS.

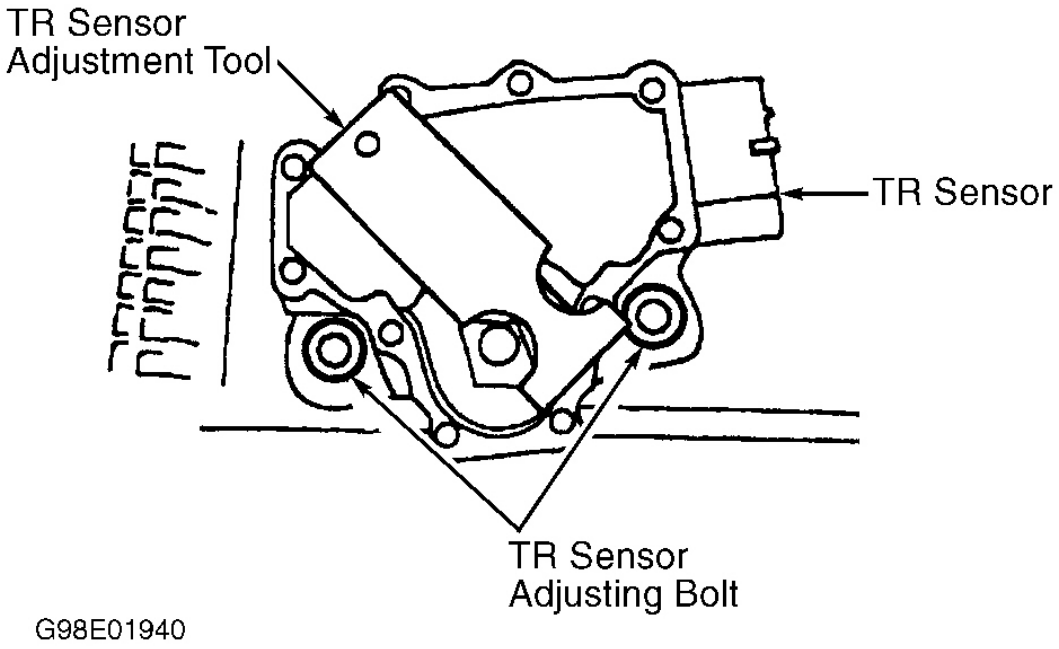


Fig. 3: Adjusting Transmission Range (TR) Sensor
Courtesy of FORD MOTOR CO.

OVERDRIVE SERVO ASSEMBLY

Removal

Remove valve body. See VALVE BODY ASSEMBLY. Locate overdrive servo. See **Fig. 4** . Using Servo Piston Compressor (T92P-70023-A), depress overdrive servo piston and remove retaining ring. See **Fig. 5** . Remove piston assembly and spring.

Installation

1. Ensure .020" (.51 mm) overdrive servo bleed hole clear. Using ATF, lubricate overdrive servo bore in transmission case. Assemble spring to piston. Install assembly into case bore. Ensure servo rod contacts overdrive band apply bore.
2. Using compressor tool, depress piston and install retaining ring. See **Fig. 5** . Install valve body. To complete installation, reverse removal procedure.

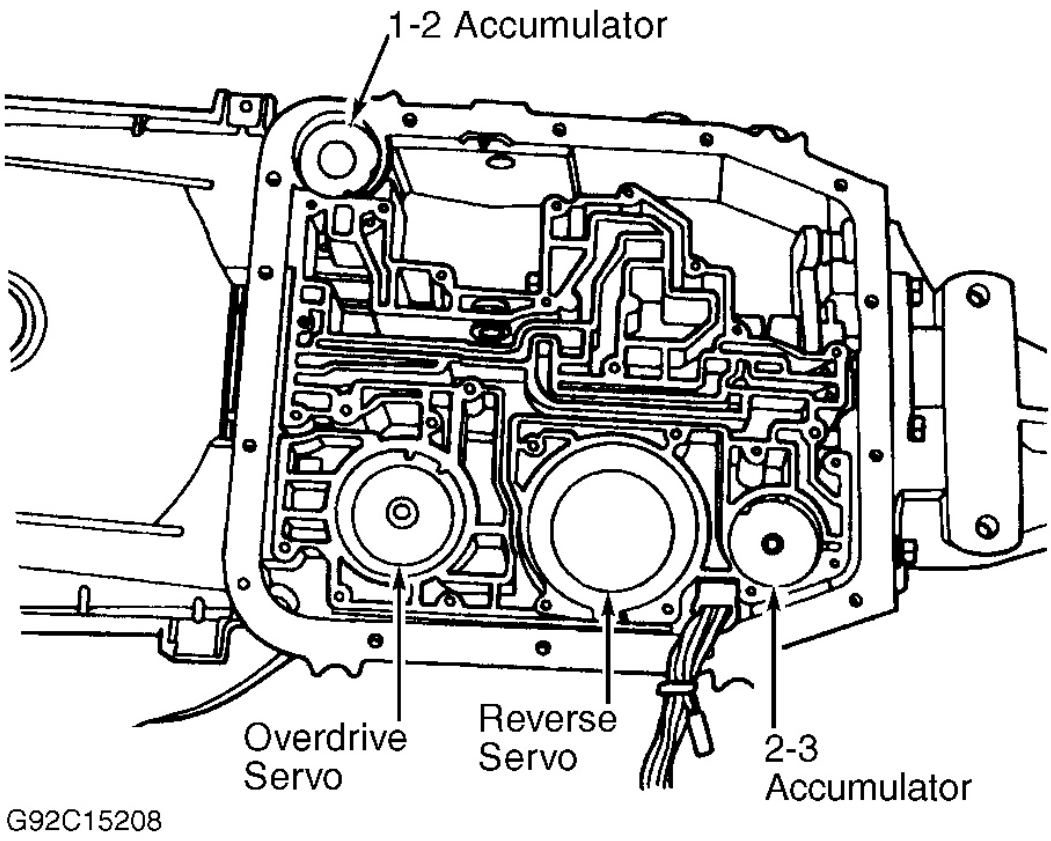


Fig. 4: Identifying Accumulator & Servo Locations
Courtesy of FORD MOTOR CO.

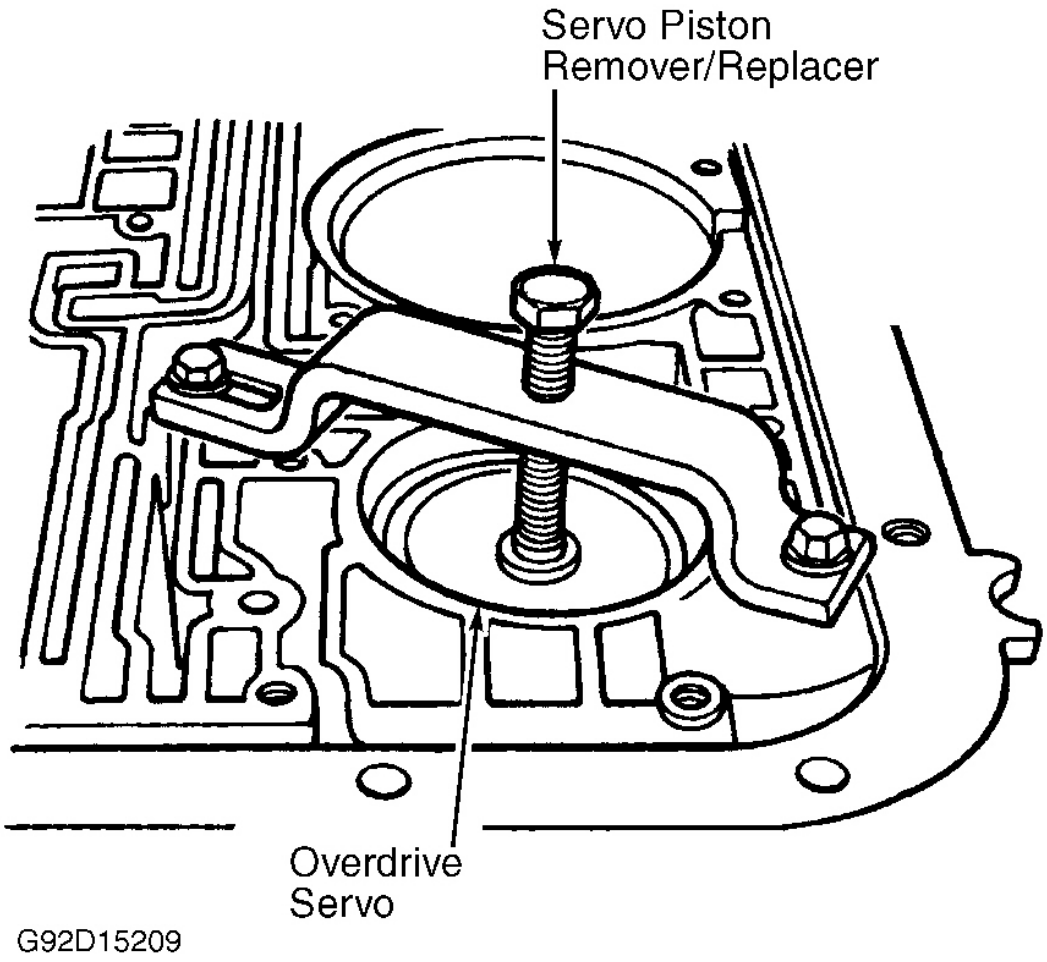


Fig. 5: Removing & Replacing Overdrive Servo
Courtesy of FORD MOTOR CO.

REVERSE SERVO ASSEMBLY

Removal

Remove valve body, see VALVE BODY ASSEMBLY. Locate reverse servo. See **Fig. 4** . Using servo piston compressor tool, depress reverse servo piston cover and remove retaining snap ring and cover. Remove piston and spring from case.

Installation

1. Install return spring, reverse servo piston and Servo Piston Selection Tool (T80L-77030-A). See **Fig. 6** . Do not install piston cover and retaining ring at this time. Tighten adjusting bolt to 50 INCH lbs. (5.6 N.m). Install dial indicator with rod touching piston top. Zero dial indicator. Back out adjusting bolt until

piston touches bottom of tool.

2. Note dial indicator reading. Normal piston travel should be .112-.237" (2.85-6.02 mm). If piston travel is out of specification, replace with appropriate rod to obtain specification. See REVERSE SERVO PISTON ROD SPECIFICATIONS table.
3. Remove piston selection tool and replace piston and rod (if necessary). To complete installation, reverse removal procedure. Ensure servo piston is installed with the same length rod as was removed.

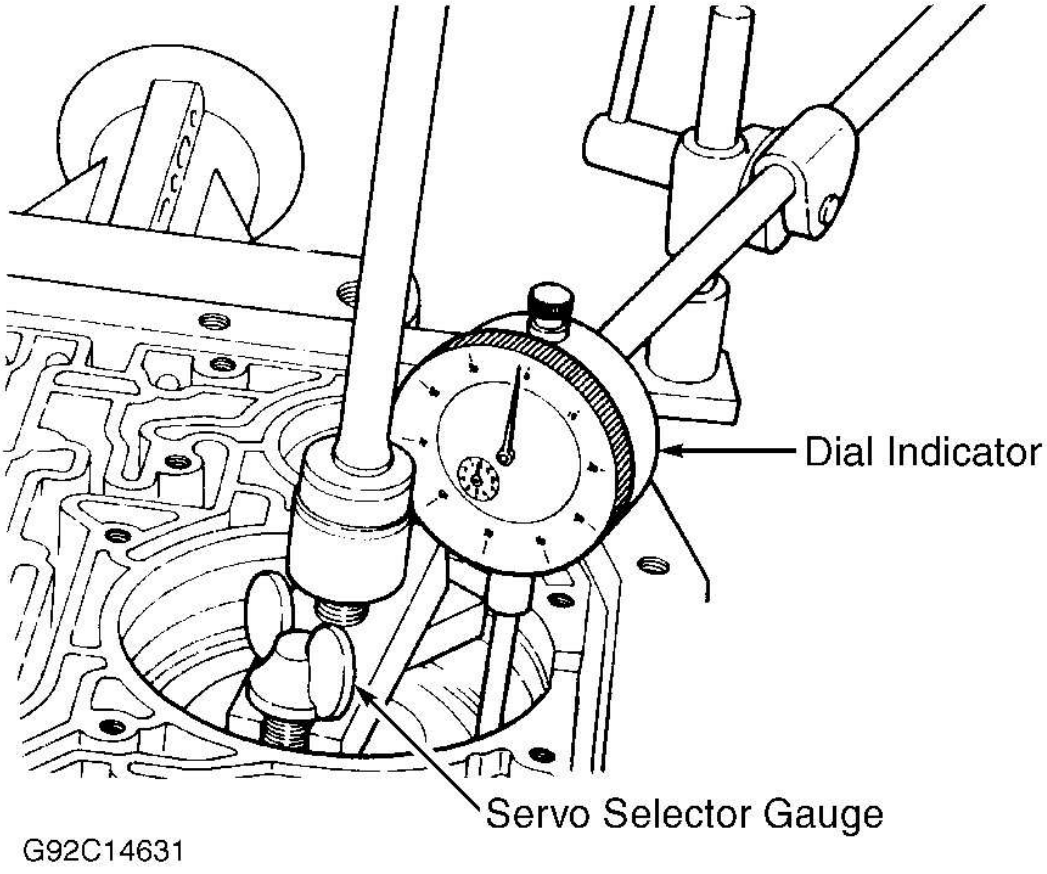


Fig. 6: Measuring Reverse Servo Pin Travel
Courtesy of FORD MOTOR CO.

REVERSE SERVO PISTON ROD SPECIFICATIONS

Identification	Length In. (mm)
1 Groove	2.936 (74.56)
2 Grooves	2.989 (75.92)
3 Grooves	3.043 (77.29)

1-2 & 2-3 ACCUMULATOR PISTON

NOTE: Note location and number of springs during removal for reassembly reference.

Removal

1. Remove valve body, see VALVE BODY ASSEMBLY. Locate 1-2 or 2-3 accumulator. See **Fig. 4** . Using servo piston compressor tool, depress piston cover and remove retaining snap ring and cover or remove spring cover.
2. Remove spring(s) and related components. Remove accumulator piston (reverse snap ring pliers can be used, if necessary). Remove accumulator seals from piston.

Installation

To install, reverse removal procedure. Using ATF, lubricate piston seals and piston pocket in case prior to installation.

EXTENSION HOUSING BUSHING & REAR OIL SEAL

Removal

1. Disconnect negative battery cable. Raise and support vehicle on hoist. Mark drive shaft yoke and axle companion flange for reassembly reference. Disconnect drive shaft from transmission. Remove oil seal using appropriate puller.
2. Remove bushing using appropriate puller, taking care not to damage output shaft splines.

Installation

Install new bushing into extension housing. Install new seal into housing using appropriate seal installer. Coat inside diameter of rubber portion of seal and yoke splines with lubricant. Install drive shaft.

EXTENSION HOUSING

Removal

1. Raise and support vehicle. Remove exhaust system components as necessary for access. Drain transmission fluid. Mark drive shaft yoke and axle companion flange for reassembly reference. Remove drive shaft. Disconnect and remove Vehicle Speed Sensor (VSS) from extension housing.
2. Remove engine rear support-to-extension housing retaining bolts. Raise transmission just enough to remove weight from rear support. Remove rear support-to-crossmember retaining bolts. Remove crossmember-to-frame side support bolts and remove rear support.
3. Lower transmission and remove extension housing retaining bolts. Slide housing off output shaft. Remove and discard extension housing-to-case gasket.

Installation

Clean mating surface on transmission and extension housing. Position new gasket on transmission. Slide extension housing into place. Install bolts and tighten to specification. See TORQUE SPECIFICATIONS. To

complete installation, reverse removal procedure.

TROUBLE SHOOTING

NOTE: After verifying driveability complaint, perform trouble shooting and testing procedures in this article. For electronic diagnostics and testing, see 4R70W ELECTRONIC CONTROLS article. When fault codes are retrieved, all engine related codes MUST be repaired first. For engine trouble code repair and diagnostic information, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.

NOTE: Always check fluid level and condition. Ensure linkage is correctly adjusted and not damaged. Ensure electronic component connectors are tight and free from damage or contamination.

SYMPTOM DIAGNOSIS

No Forward Engagement

Fluid level and condition, shift linkage, low forward clutch pressure, low line pressure, filter (plugged or damaged), valve body (3-4 shift valve, main regulator valve, manual valve), incorrectly tightened valve body (cross-leaks), 2-3 accumulator, pump assembly, forward clutch assembly, low one-way clutch assembly (planetary) and output shaft.

No Reverse Engagement

Fluid level and condition, shift linkage, low reverse clutch pressure, low reverse band pressure, low line pressure, filter (plugged), valve body (No. 6 shuttle ball, manual valve, main regulator valve), 1-2 accumulator, incorrectly tightened valve body (cross-leaks), low reverse servo, pump assembly, reverse clutch assembly and low reverse band.

Harsh Reverse Engagement

Fluid level and condition, shift linkage, high line pressure, high Electronic Pressure Control (EPC) pressure, oil filter (plugged), valve body (No. 6 shuttle ball, No. 5 check ball, manual valve, main regulator valve), incorrectly tightened valve body (cross-leaks), low reverse servo, pump assembly, reverse clutch assembly and low reverse band.

Harsh Forward Engagement

Fluid level and condition, high forward clutch pressure, high line pressure, high Electronic Pressure Control (EPC) pressure, valve body (main regulator valve, 2-3 accumulator), incorrectly tightened valve body (cross-leaks), pump assembly and forward clutch assembly.

Delayed/Soft Reverse Engagement

Fluid level and condition, shift linkage, low reverse clutch pressure, low reverse band pressure, low line pressure, filter (plugged), valve body (No. 6 shuttle ball, 1-2 accumulator, manual valve, main regulator valve), incorrectly tightened valve body (cross-leaks), low reverse servo, pump assembly, reverse clutch assembly and low reverse band.

Delayed/Soft Forward Engagement

Fluid level and condition, shift linkage, low forward clutch pressure, low line pressure, low Electronic Pressure Control (EPC) pressure, filter (plugged), valve body (3-4 shift valve, main regulator valve), incorrectly tightened valve body (cross-leaks), 2-3 or 1-2 accumulator, pump assembly and forward clutch assembly.

Some Or All Shifts Missing

Fluid level and condition, shift linkage and Transmission Range (TR) sensor (misadjusted or damaged).

Early/Late Shift Speeds

Incorrect tire size, incorrect axle ratio, fluid level and condition, line pressure, Electronic Pressure Control (EPC) pressure and valve body (EPC solenoid, miscellaneous components stuck, blocked solenoid screen).

Erratic/Hunting Shifting

Fluid level and condition, valve body (miscellaneous valves, accumulators-stuck), blocked valve body solenoid screen and Torque Converter Clutch (TCC).

Soft/Slipping Shift Feel

Fluid level and condition, low line pressure, Low Electronic Pressure Control (EPC) pressure, valve body (1-2 accumulator, main regulator valve, overdrive servo regulator) and EPC solenoid (stuck).

Harsh Shift Feel

Fluid level and condition, high line pressure, high Electronic Pressure Control (EPC) pressure, valve body (1-2 accumulator, main regulator valve, overdrive servo regulator) and EPC solenoid (stuck).

No 1st Gear In Drive, Engages In Higher Gear

Shift linkage, Transmission Range (TR) sensor, low reverse clutch pressure, low reverse band pressure, low line pressure and miscellaneous internal failures.

No Manual Low Gear

Shift linkage, Transmission Range (TR) sensor, low reverse clutch pressure, low reverse band pressure, low line pressure, low Electronic Pressure Control (EPC) pressure, filter (plugged), valve body (No. 6 shuttle ball, manual valve, main regulator valve, low servo modulator valve), incorrectly tightened valve body (cross-leaks) and low reverse servo.

No Manual 2nd Gear

Shift linkage or cable, Transmission Range (TR) sensor, valve body (3-4 shift valve, 1-2 and 2-3 shift valve, 3-4 capacity modulator valve) and incorrectly tightened valve body (cross-leaks).

No 1-2 Automatic Shift

Shift linkage, Transmission Range (TR) sensor, intermediate clutch pressure, line pressure, valve body (1-2 shift valve, 1-2 accumulator valve), Shift Solenoid No. 1 (SS1) failure, damaged No. 8 check ball, incorrectly tightened valve body (cross-leaks), pump assembly, intermediate clutch assembly, intermediate one-way clutch assembly and low one-way clutch assembly.

No 2-3 Automatic Shift

Shift linkage, direct clutch pressure, valve body (2-3 shift valve, No. 3 or No. 9 check ball, solenoid pressure regulator valve, 2-3 modulator valve), Shift Solenoid No. 2 (SS2) failure, output shaft seals, missing or leaking cup plug, 2-3 accumulator, blocked valve body solenoid screen, intermediate overrunning clutch assembly, direct clutch assembly and case (damaged output shaft seal area).

No 3-4 Automatic Shift

Shift linkage, Transmission Range (TR) sensor, forward clutch pressure, direct clutch pressure, line pressure, valve body (3-4 shift valve, solenoid pressure regulator valve, OD servo regulator, 3-4 capacity modulator valve, 1-2 and 2-3 shift valves), incorrectly tightened valve body (cross-leaks), Shift Solenoid No. 1 or 2 (SS1 or SS2) failure, OD servo cover, OD rod and piston cushion spring, No. 2, 4, 7 and/or 9 valve body check balls, blocked valve body solenoid screen, pump assembly, OD Band and/or reverse clutch drum assembly, intermediate overrunning clutch assembly, forward clutch assembly and input shaft.

No 4-3 Automatic Downshift

Forward clutch pressure, line pressure, valve body (3-4 shift valve, solenoid pressure regulator valve, OD servo regulator, 3-4 capacity modulator valve, 2-3 backout valve, 1-2 and 2-3 shift valves), incorrectly tightened valve body (cross-leaks), Shift Solenoid No. 1 (SS1) failure, OD servo, No. 2, 7, and/or 9 valve body check balls, blocked valve body solenoid screen, pump assembly, OD Band and/or reverse clutch drum assembly, intermediate overrunning clutch assembly, forward clutch assembly and input shaft.

No 3-2 Automatic Downshift

Direct clutch pressure, valve body (2-3 shift valve, check balls damage or missing), Shift Solenoid No. 2 (SS2) failure, intermediate one-way clutch assembly and direct clutch assembly.

No 2-1 Automatic Downshift

Intermediate clutch pressure, valve body (1-2 shift valve, 1-2 accumulator solenoid pressure regulator valve), Shift Solenoid No. 1 (SS1) failure, incorrectly tightened valve body (cross-leaks), pump assembly, intermediate clutch assembly, intermediate one-way clutch assembly and low one-way clutch assembly.

No Torque Converter Clutch Application

Shift linkage, low line pressure, low Electronic Pressure Control (EPC) pressure, valve body (solenoid pressure

regulator valve, manual valve, bypass clutch control valve and plunger, converter pressure limit valve, drain back valve), incorrectly tightened valve body (cross-leaks), blocked valve body solenoid screen, TCC solenoid failure, pump assembly, input shaft and torque converter assembly.

Torque Converter Clutch Always Applied

Valve body (drain back valve, TCC valve and plunger), incorrectly tightened valve body (cross-leaks), TCC solenoid failure, No. 7 valve body check ball, pump assembly, input shaft and torque converter assembly.

Torque Converter Clutch Cycling/Shudder/Chatter

Fluid condition, valve body (solenoid pressure regulator valve, No. 7 check ball, bypass clutch control valve and plunger, converter pressure limit valve), incorrectly tightened valve body (cross-leaks), blocked valve body solenoid screen, TCC solenoid failure, pump assembly, input shaft and torque converter.

MISCELLANEOUS FAULTS

No Engine Braking In 2nd Gear, Manual 2nd Or 1st Gear

Shift linkage, valve body (3-4 shift valve, 1-2 and 2-3 shift valve, 3-4 capacity modulator valve), OD band, reverse clutch drum assembly and intermediate overrunning clutch assembly.

Poor Vehicle Performance

Shift linkage, Transmission Range (TR) sensor, incorrect shift speed or engagement, TCC always applied and torque converter.

Transmission Overheating

Fluid level and condition, poor fluid flow (cooler lines, auxiliary oil cooler, engine performance, valve body (drain back valve, TCC control valve, converter limit valve) and torque converter.

CLUTCH & BAND APPLICATION CHART

CLUTCH & BAND APPLICATION CHART

Selector Lever Position	Elements In Use
"OD" (Overdrive)	
1st Gear	Forward Clutch, Planetary One-Way Clutch
2nd Gear	Intermediate Clutch, Forward Clutc & Intermediate One-Way Clutch
3rd Gear	Forward Clutch, Intermediate Clutch & Direct Clutch
4th Gear	Overdrive Band, Intermediate Clutch & Direct Clutch
"D" (Drive)	
1st Gear	Forward Clutch, Planetary One-Way Clutch

2nd Gear	Interediate Clutch, Forward Clutch & Intermediate One-Way Clutch
3rd Gear	Forward Clutch, Intermediate Clutch & Direct Clutch
"2" (Manual)	Forward Clutch, Intermediate Clutch, Intermediate One-Way Clutch & Overdrive Band
"1" (Manual)	Forward Clutch, Planetary One-Way Clutch & Low Reverse Band
"R" (Reverse)	Reverse Clutch & Low Reverse Band

TESTING

ROAD TEST

1. Drive vehicle with transmission in "OD" position to normal operating temperature. Check minimum throttle upshifts in "OD". Transmission should start in 1st gear, shift to 2nd, 3rd, and 4th gear at approximately the speeds shown in SHIFT SPEEDS SPECIFICATIONS tables.
2. With transmission in 4th gear (Overdrive), press Transmission Control Switch (TCS). Transmission should downshift to 3rd gear. Release accelerator pedal. Engine braking should occur.
3. Press accelerator pedal to WOT. Transmission should shift from 3rd to 2nd gear, or 3rd to 1st gear depending on vehicle speed. See appropriate SHIFT SPEED SPECIFICATIONS table. Torque converter clutch should disengage and then reapply.
4. With transmission in "D" position, and vehicle speed more than 50 MPH, move transmission selector lever to manual "2" position. Release accelerator pedal. Transmission should immediately downshift to 2nd gear. Move transmission selector lever to manual "1" position. Transmission should downshift to 1st gear at speeds less than 30-35 MPH.
5. If transmission fails to operate normally or torque converter does not apply, diagnose problem by symptom. See SYMPTOM DIAGNOSIS under TROUBLE SHOOTING.

NOTE: Shift speeds shown are approximate. All shift speeds may vary due to production tolerances and emission control equipment.

SHIFT SPEED SPECIFICATIONS (1997 COUGAR & THUNDERBIRD)

Operating Condition	Shift Speed MPH (3.8L)	Shift Speed MPH (4.6L)
Light Throttle		
1-2	8-14	10-13
2-3	18-23	19-23
3-4	28-36	32-37
4-3	28-32	29-33
3-2	12-16	18-19
2-1	6-10	9-12
Full Throttle (WOT)		
1-2	34-44	38-47

2-3	62-72	71-83
3-2	25-62	62-69
2-1	10-25	30-35

SHIFT SPEED SPECIFICATIONS(1997 CROWN VICTORIA,GRAND MARQUIS/TOWN CAR)

Operating Condition	Shift Speed MPH (2.73 Axle Ratio)	Shift Speed MPH (3.08 Axle Ratio)	Shift Speed MPH (3.27 Axle Ratio)(1)
Light Throttle			
1-2	10-15	10-12	8-11
2-3	22-26	21-24	19-22
3-4	40-44	35-40	33-37
4-3	33-35	29-31	27-29
3-2	13-15	12-14	12-14
2-1	8-10	7-9	6-8
Full Throttle (WOT)			
1-2	44-49	40-46	36-41
2-3	86-93	73-81	71-76
3-2	78 Max.	70 Max.	66 Max.
2-1	34 Max.	30 Max.	28 Max.

(1) These shift speeds apply to Crown Victoria Police Special models and vehicles equipped with trailer towing or limousine packages.

SHIFT SPEED SPECIFICATIONS (1997-98 EXPEDITION 4.6L)

Operating Condition	Shift Speed MPH (3.31 Axle Ratio)	Shift Speed MPH (3.55 Axle Ratio)
Light Throttle		
1-2	10-14	9-13
2-3	21-25	20-24
3-4	32-36	31-35
4-3	24-26	23-25
3-2	16-18	15-17
2-1	10-12	10-12
WOT		
1-2	48-52	46-50
2-3	74-78	71-75
3-2	65-67	62-64
2-1	29-31	28-30

SHIFT SPEED SPECIFICATIONS (1997-98 EXPLORER 5.0L (1))

Operating Condition	Shift Speed MPH
Light Throttle	

1-2	9-13
2-3	19-23
3-4	38-42
4-3	22-24
3-2	12-14
2-1	4-8
Full Throttle (WOT)	
1-2	36-40
2-3	66-70
3-2	60-62
2-1	26-28
(1) Applies to 2WD and 4WD models.	

SHIFT SPEED SPECIFICATIONS (1997-98 MARK VIII)

Operating Condition	**(1) Shift Speed MPH**
Light Throttle	
1-2	7-12
2-3	18-22
3-4	33-37
4-3	30-32
3-2	12-16
2-1	5-9
Full Throttle (WOT)	
1-2	50-55
2-3	94-100
3-2	76 Max.
2-1	40 Max.
(1) Applies to all axle ratios.	

SHIFT SPEED SPECIFICATIONS (1997 MUSTANG 3.8L)

Operating Condition	**Shift Speed MPH**
Light Throttle	
1-2	9-11
2-3	21-23
3-4	41-43
4-3	29-31
3-2	14-16
2-1	7-9
Full Throttle (WOT)	
1-2	40-45

2-3	N/A
3-2	69 Max.
2-1	29 Max.

SHIFT SPEED SPECIFICATIONS (1997 MUSTANG GT 4.6L)

Operating Condition	Shift Speed MPH (3.08 Axle Ratio)	Shift Speed MPH (3.27 Axle Ratio)
Light Throttle		
1-2	9-11	8-11
2-3	26-30	25-29
3-4	39-44	37-42
4-3	27-29	25-27
3-2	14-16	13-15
2-1	7-9	7-9
WOT		
1-2	40-45	37-42
2-3	74-79	69-74
3-2	72 Max.	68 Max.
2-1	35 Max.	33 Max.

SHIFT SPEED SPECIFICATIONS (1997 E-150 4.2L)

Operating Condition	Shift Speed MPH (3.31 Axle Ratio)	Shift Speed MPH (3.55 Axle Ratio)	Shift Speed MPH (3.73 Axle Ratio)	Shift Speed MPH (4.09 Axle Ratio)
Light Throttle				
1-2	11-15	9-13	10-14	10-14
2-3	15-19	13-17	18-22	13-17
3-4	36-40	34-38	38-42	34-38
4-3	22-24	21-23	23-25	23-25
3-2	13-15	12-14	12-14	10-12
2-1	6-8	5-7	6-8	6-8
Full Throttle (WOT)				
1-2	37-41	34-38	40-44	35-39
2-3	70-74	69-73	70-74	65-69
4-3	88-90	83-85	78-80	73-75
3-2	65-67	61-63	60-62	54-56
2-1	31-33	29-31	33-35	31-33

SHIFT SPEED SPECIFICATIONS (1997 E-150 4.6L)

Operating Condition	Shift Speed MPH (3.31 Axle Ratio)	Shift Speed MPH (3.55 Axle Ratio)
Light Throttle		

1-2	7-11	7-11
2-3	18-22	17-21
3-4	38-42	36-40
4-3	24-26	22-24
3-2	11-13	11-13
2-1	4-6	4-6
WOT		
1-2	40-44	37-41
2-3	73-77	69-73
4-3	88-90	83-85
3-2	67-69	63-65
2-1	33-35	31-33

SHIFT SPEED SPECIFICATIONS (1997-98 F-150 4.2L)

Operating Condition	(1) Shift Speed MPH
Light Throttle	
1-2	7-11
2-3	16-20
3-4	24-28
4-3	20-24
3-2	12-16
2-1	4-8
Full Throttle (WOT)	
1-2	36-40
2-3	65-76
3-4	88-100
4-3	76-92
3-2	57-67
2-1	29-34
(1) Applies to all axle ratios.	

SHIFT SPEED SPECIFICATIONS(1998 CROWN VICTORIA,GRAND MARQUIS/TOWNCAR)

Operating Condition	Shift Speed MPH (2.73 Axle Ratio)	Shift Speed MPH (3.08 Axle Ratio)	Shift Speed MPH (3.27 Axle Ratio)(1)
Light Throttle			
1-2	7-9	6-8	6-8
2-3	19-22	17-20	16-19
3-4	34-38	31-35	29-33
4-3	31-33	28-30	26-28
3-2	13-15	12-14	12-14

2-1	4-6	4-6	4-6
Full Throttle (WOT)			
1-2	40-46	37-42	39-44
2-3	77-83	70-75	72-77
3-2	78 Max.	70 Max.	70 Max.
2-1	31 Max.	28 Max.	35 Max.
(1) These shift speeds apply to Crown Victoria Police Special models and vehicles equipped with trailer towing or limousine packages.			

SHIFT SPEED SPECIFICATIONS (1998 E-150 & E-250 4.2L)

Operating Condition	Shift Speed MPH (3.31 Axle Ratio)	Shift Speed MPH (3.55 Axle Ratio)	Shift Speed MPH (3.73 Axle Ratio)	Shift Speed MPH (4.09 Axle Ratio)
Light Throttle				
1-2	10-13	9-12	10-15	10-15
2-3	17-27	16-25	15-25	14-23
3-4	36-45	33-42	36-45	34-38
4-3	22-24	21-23	23-25	23-25
3-2	13-15	12-14	12-14	10-12
2-1	6-8	5-7	6-8	6-8
Full Throttle (WOT)				
1-2	37-41	34-38	38-44	35-39
2-3	70-74	69-73	68-74	65-69
4-3	88-90	83-85	77-80	73-75
3-2	65-67	61-63	60-62	54-56
2-1	31-33	29-31	30-32	27-29

SHIFT SPEED SPECIFICATIONS (1998 E-150 4.6L)

Operating Condition	Shift Speed MPH (3.31 Axle Ratio)	Shift Speed MPH (3.55 Axle Ratio)
Light Throttle		
1-2	7-13	7-13
2-3	17-27	16-26
3-4	38-55	36-52
4-3	24-26	22-24
3-2	11-13	11-13
2-1	4-6	4-6
WOT		
1-2	40-44	37-41
2-3	73-77	69-73
4-3	88-90	83-85
3-2	67-69	63-65

2-1	33-35	31-33

SHIFT SPEED SPECIFICATIONS (1998 MUSTANG 3.8L)

Operating Condition	Shift Speed MPH
Light Throttle	
1-2	6-10
2-3	20-22
3-4	39-43
4-3	24-26
3-2	13-15
2-1	5-7
Full Throttle (WOT)	
1-2	40-45
2-3	N/A
3-2	69 Max.
2-1	29 Max.

SHIFT SPEED SPECIFICATIONS (1998 MUSTANG GT 4.6L)

Operating Condition	Shift Speed MPH (3.08 Axle Ratio)	Shift Speed MPH (3.27 Axle Ratio)
Light Throttle		
1-2	7-10	7-10
2-3	14-18	14-18
3-4	24-27	23-28
4-3	23-25	22-24
3-2	12-14	12-14
2-1	5-7	5-7
WOT		
1-2	40-45	37-42
2-3	74-79	69-74
3-2	72 Max.	68 Max.
2-1	35 Max.	33 Max.

SHIFT SPEED SPECIFICATIONS (1998 F-150 4.6L)

Operating Condition	Shift Speed MPH
Light Throttle	
1-2	8-12
2-3	16-24
3-4	30-35
4-3	22-29
3-2	13-15

2-1	6-7
Full Throttle (WOT)	
1-2	36-41
2-3	64-74
3-4	94-100
4-3	78-90
3-2	57-62
2-1	30-31

SHIFT SPEED SPECIFICATIONS (1997-98 F-250 4.6L)

Operating Condition	Shift Speed MPH (3.31 Axle Ratio)	Shift Speed MPH (3.73 Axle Ratio)
Light Throttle		
1-2	7-11	7-11
2-3	18-22	15-20
3-4	32-36	28-32
4-3	23-29	22-26
3-2	14-17	11-13
2-1	6-10	5-9
WOT		
1-2	40-44	37-41
2-3	75-79	66-70
4-3	88-90	83-85
3-2	65-67	61-63
2-1	31-33	29-31

HYDRAULIC PRESSURE TEST

CAUTION: Perform line pressure test before stall speed test. If line pressure is low at stall, DO NOT perform stall speed test or transmission damage will occur.

Line Pressure Test

1. Connect a 0-300 psi (0-21.1 kg/cm^2) pressure gauge to line pressure port tap on left side of transmission case forward of control lever. See **Fig. 7** . Gauge hose must be long enough to read gauge while operating engine.
2. With engine at normal operating temperature, apply parking and service brakes. Check line pressure at idle and WOT stall in all ranges. See HYDRAULIC PRESSURE SPECIFICATIONS TABLE. If pressure is not as specified, perform EPC PRESSURE CHECK.

EPC Pressure Check

1. Connect a 0-100 psi (0-7.0 kg/cm^2) pressure gauge to EPC pressure tap at right side of transmission case. See **Fig. 7** . Gauge hose must be long enough to read gauge while operating engine.
2. With engine at normal operating temperature, apply parking and service brakes. Check EPC pressure at idle and WOT stall in all ranges. See HYDRAULIC PRESSURE SPECIFICATIONS table. If pressure is not as specified, go to PINPOINT TEST E in 4R70W ELECTRONIC CONTROLS article, to diagnose EPC operation. If EPC operation is okay, go to LINE PRESSURE TEST RESULTS.

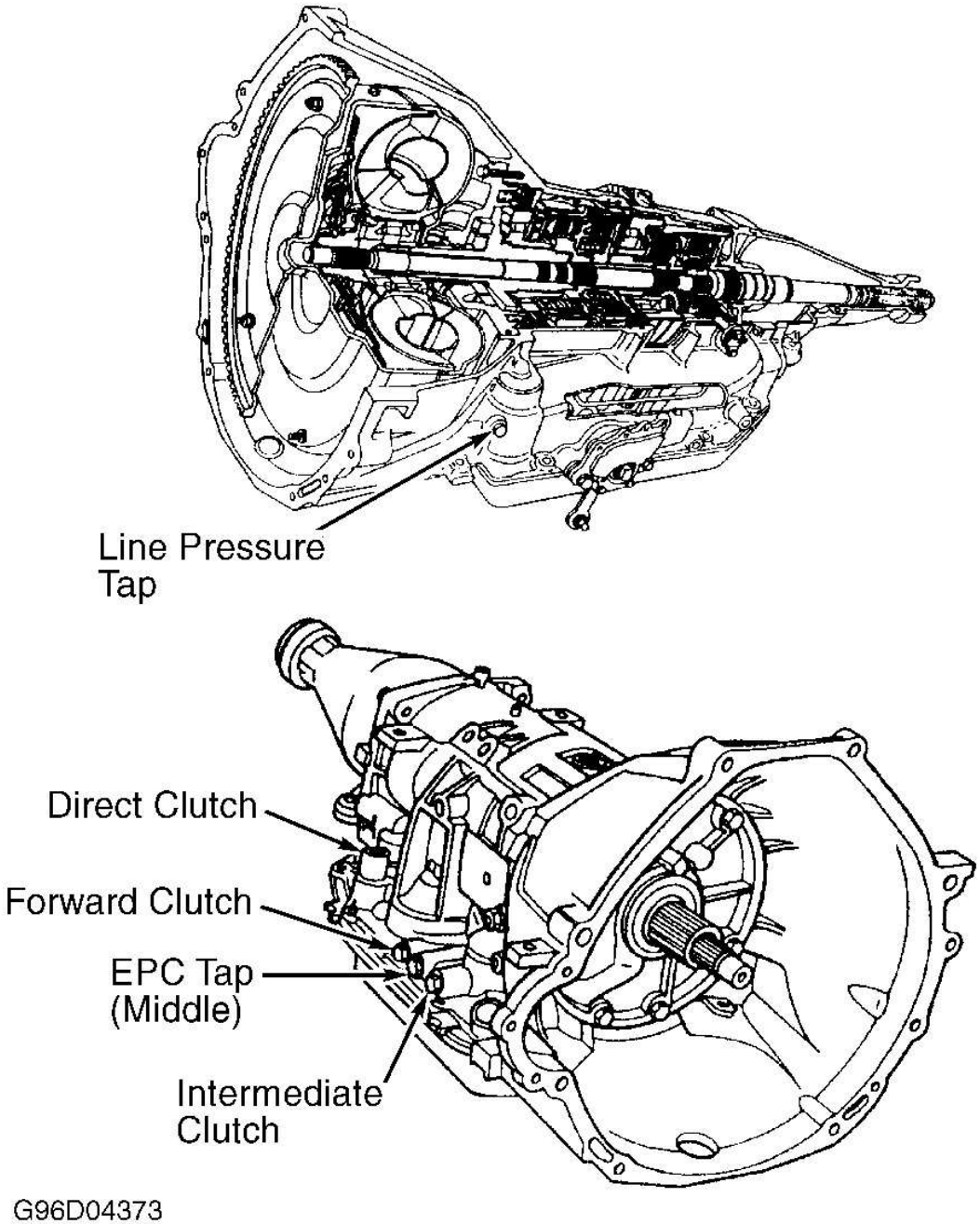


Fig. 7: Identifying Hydraulic Pressure Taps
Courtesy of FORD MOTOR CO.

NOTE: Pressure test at idle position must be taken with engine at normal operating temperature. Pressure test at WOT position should be taken at full stall

conditions. Run engine at a fast idle in "N" for 15 seconds to cool fluid between tests.

1997 HYDRAULIC PRESSURE SPECIFICATIONS

Throttle Position	Line Pressure PSI	EPC Pressure PSI
Idle		
Reverse Range		
Crown Victoria Grand Marquis, Town Car	84-128	15-25
Cougar, T-Bird (3.8L)	60-104	3-13
Cougar, T-Bird (4.6L)	68-112	7-17
Expedition	54-96	0-9
Explorer	64-108	5-15
Mark VIII	54-92	0-7
Mustang (3.8L)	60-104	3-13
Mustang (4.6L)	54-92	0-7
"E" & "F" Series	54-96	0-9
All Other Ranges		
Crown Victoria Grand Marquis, Town Car	55-94	15-25
Cougar, T-Bird (3.8L)	55-94	15-25
Cougar, T-Bird (4.6L)	43-81	7-17
Expedition	31-69	0-9
Explorer	39-78	5-15
Mark VIII	31-65	0-7
Mustang (3.8L)	49-88	11-21
Mustang (4.6L)	31-65	0-7
"E" & "F" Series	31-69	0-9
WOT@Stall		
Reverse Range		
All Models	207-267	83-93
All Other Ranges		
All Models	160-210	83-93

1998 HYDRAULIC PRESSURE SPECIFICATIONS

Throttle Position	Line Pressure PSI	EPC Pressure PSI
Idle		
Reverse Range		
Crown Victoria Grand Marquis, Town Car	70-114	8-18
Expedition, "F" Series	54-96	0-9

Explorer, "E" Series	64-98	5-15
Mark VIII	54-92	0-7
Mustang (3.8L)	67-109	0-9
Mustang (4.6L)	64-99	5-15
All Other Ranges		
Crown Victoria Grand Marquis, Town Car	55-94	15-25
Expedition, "F" Series	31-69	0-9
Explorer, "E" Series	39-78	5-15
Mark VIII	55-94	15-25
Mustang (3.8L)	47-86	10-20
Mustang (4.6L)	63-102	20-30
WOT@Stall		
Reverse Range		
All Models	207-267	83-93
All Other Ranges		
All Models	160-210	83-93

LINE PRESSURE TEST RESULTS

High At Idle In All Ranges

Main regulator valve sticking, EPC solenoid sticking. Check transmission wiring harness. Perform QUICK TEST. See 4R70W ELECTRONIC CONTROLS article.

Low At Idle In All Ranges

Low fluid level, restricted inlet filter or damaged filter inlet seal, loose valve body bolts, damaged gaskets or separator plate, pump leakage, case leakage, faulty valve body, excessively low engine idle, fluid too hot or main regulator valve sticking. Low In "P"

Valve body loose, faulty main oil regulator valve sticking or low-reverse servo leakage.

Low In "R"

Separator plate, reverse clutch or low-reverse servo leakage. Valve body loose.

Low In "N"

Loose valve body or main oil regulator valve sticking.

Low In "D"

Faulty forward clutch, main oil regulator valve or loose valve body.

Low In "2nd"

Forward clutch, intermediate clutch or valve body leakage.

Low In "1st"

Forward clutch, low-reverse servo or valve body leakage.

DIRECT CLUTCH PRESSURE TEST

NOTE: Shift quality is affected when test gauges are attached to transmission. DO NOT accelerate or decelerate rapidly during test. Transmission failure could result.

1. Attach pressure gauges capable of reading 300 psi (21.1 kg/cm^2) to the forward clutch pressure tap and the direct clutch pressure tap. See **Fig. 7** . Mount gauges inside vehicle.
2. Drive vehicle. When pressure is applied to the direct clutch, note pressure difference between forward clutch pressure reading and direct clutch pressure reading.
3. If the difference is less than 15 psi (1.05 kg/cm^2), direct clutch circuit is okay. If difference is greater than specification, there is a leak in direct clutch pressure circuit. Repair as necessary.

STALL SPEED TEST

CAUTION: Perform line pressure test before stall speed test. If line pressure is low at stall, DO NOT perform stall speed test or transmission damage will occur.

Testing Precautions

When performing stall test, do not hold throttle open longer than 5 seconds. Allow a cooling period of 15 seconds with transmission in "N" and engine speed at 1000 RPM between each test. If engine speed exceeds maximum limits shown, release accelerator immediately, as this is an indication of clutch or band slippage.

Testing Procedure

Bring engine to normal operating temperature. Apply parking and service brakes. Stall test transmission in each driving range at WOT. Note maximum RPM obtained. Engine speed should be within limits. See STALL SPEED SPECIFICATIONS table. If maximum RPM obtained is not within specifications, see STALL SPEED TEST RESULTS.

STALL SPEED SPECIFICATIONS

Application	RPM
1997	
Cougar, T-Bird (3.8L)	1880-2210
Cougar, T-Bird (4.6L)	2012-2375
Crown Victoria, Grand Marquis	2038-2383

Crown Victoria (Police)	2063-2431
Expedition	2200-2500
Explorer	2438-2838
Mark VIII	2355-2746
Mustang (3.8L)	1869-2193
Mustang (4.6L)	2324-2757
Town Car	2053-2412
E-150, 250 & F-150 (4.2L)	1975-2317
E-150 (4.6L)	2135-2492
E-250 HD (4.2L)	2008-2342
F-150, 250 (4.6L)	2200-2500
1998	
Crown Victoria, Grand Marquis	2094-2447
Town Car	2116-2471
Town Car (Tow)	2350-2763
Expedition	2200-2500
Explorer	2478-2901
Mark VIII	2336-2718
Mustang (3.8L)	2197-2567
Mustang (4.6L)	2362-2807
E-150, 250 & F-150 (4.2L)	1975-2317
E-150, 250 (4.6L)	2135-2492
E-250 & F-250 HD (4.2L)	2008-2342
F-150, 250 (4.6L)	2200-2500

STALL SPEED TEST RESULTS

Low In All Ranges

Check engine tune-up. Check torque converter using bench test for stator one-way clutch slippage.

High In "D" Position

Check planetary one-way clutch.

High In "D", "2" & "1" Position

Check forward clutch or intermediate clutch.

High In "D", "2", "1" & "R" Position

Perform HYDRAULIC PRESSURE TEST.

High In "R" Position

Check reverse clutch and/or low-reverse band or servo.

AIR PRESSURE TESTS

Test Procedures

1. A no-drive condition can exist even with correct transmission fluid pressure, because of inoperative clutches or bands. The inoperative units can be located by substituting air pressure for fluid pressure to determine location of malfunction.
2. Remove pan and drain fluid. Remove main control (valve body) assembly from transmission. See ON-VEHICLE SERVICE. Using attaching screws, install Transmission Test Plate (T92P-7006-A) and gasket. Tighten bolts to 89-106 INCH lbs. (10-12 N.m)
3. With a rubber-tipped air nozzle, apply air pressure into the appropriate locations specified in the following tests. See **Fig. 8** . If servo or accumulator does not move when air is applied, clean and inspect to locate cause. If during test, 2 clutches apply or clutch fails to operate, check fluid passages in case and front pump for blockage or damage.

NOTE: **Air pressure should be regulated to 40 psi (2.8 km/cm^2) maximum. Compressed air used for test should be filtered and dry to avoid contaminating transmission fluid.**

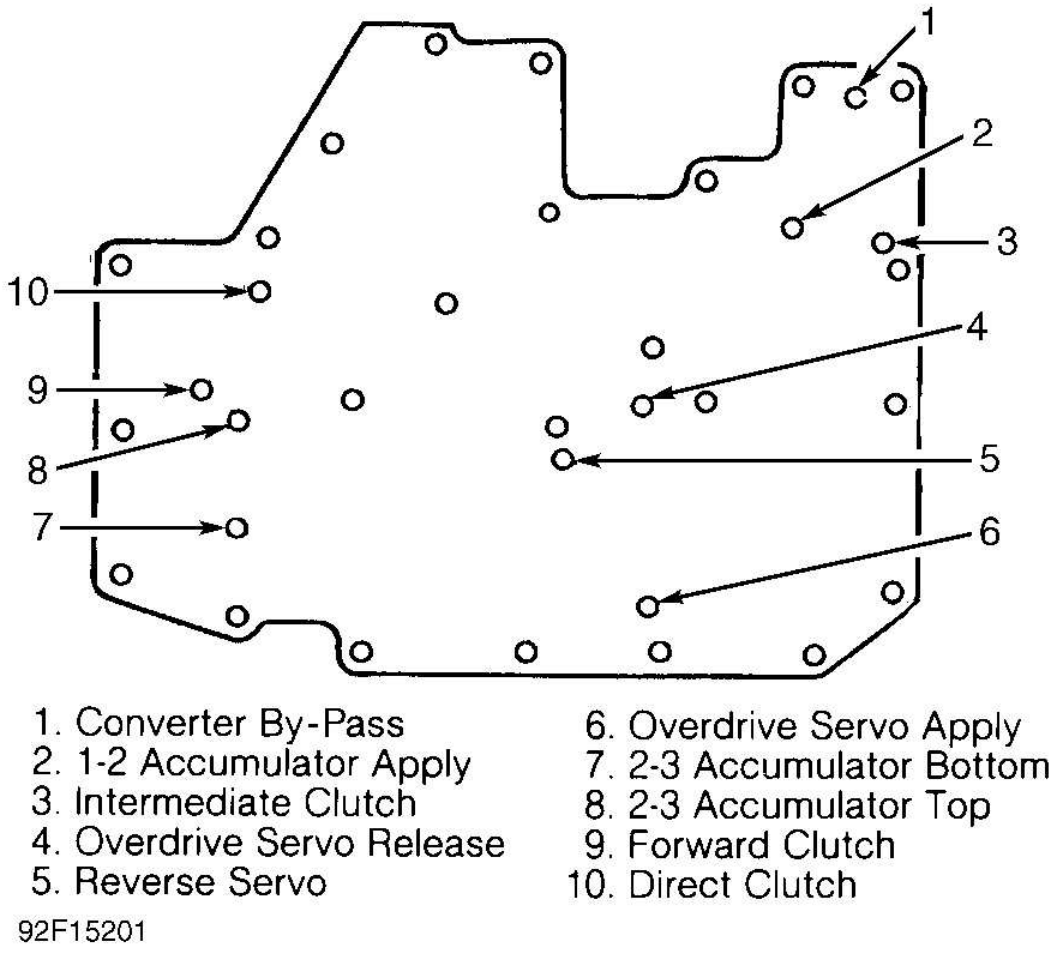


Fig. 8: Identifying Air Pressure Test Ports On Adapter Plate
Courtesy of FORD MOTOR CO.

Reverse Clutch

Apply air pressure to reverse clutch passage. A dull thud can be heard when clutch piston is applied, or movement can be felt by placing fingertips on clutch drum.

Forward Clutch

Apply air pressure to the forward clutch apply passage in the adapter plate. A dull thud can be heard when clutch piston is applied, or movement can be felt by placing fingertips on input shell.

Intermediate Clutch

Apply air pressure to intermediate clutch apply passage in the adapter plate. A dull thud can be heard or felt if

clutch is operating properly.

Overdrive Servo

Apply air pressure to overdrive servo apply passage. Operation of the band is indicated by tightening of the band around reverse clutch drum. A thud can be felt on the servo cover when the servo returns to the release position as a result of spring force from the release spring. The band will then relax.

Low-Reverse Servo

Apply air pressure to low-reverse servo apply passage. A dull thud can be heard when the low-reverse band tightens around the planetary drum. Movement of the ring gear should also be detected.

Direct Clutch

Apply air pressure to direct clutch passage in the adapter plate. A dull thud can be heard or felt on the drive shaft if clutch is operating properly.

2-3 Accumulator

Apply air pressure to 2-3 accumulator passage. Accumulator piston should unseat and can be detected by inserting a metal rod into 2-3 piston hole. When piston unseats, rod will move.

TORQUE CONVERTER

NOTE: Torque converter is a sealed unit and cannot be disassembled for service. Replace if found to be defective. The following tests will identify a defective converter.

FLUSHING

Whenever transmission has been disassembled to replace worn or damaged parts or because valve body sticks due to foreign material, converter and oil cooler must be cleaned using a mechanically operated agitating cleaner. Under no conditions should converter or oil cooler be cleaned by hand agitation using solvent.

LEAK TEST

If torque converter welds indicate leakage, attach Torque Converter Leak Detector (Rotunda 014-R1067) to converter and follow detector kit instructions.

END-PLAY CHECK

1. Insert Tester (T80L-7902-A) into converter pump drive hub until hub bottoms. Expand sleeve in turbine spline by tightening threaded inner post of tester until sleeve is securely locked into spline. See **Fig. 9** .
2. Attach a dial indicator to tool with button on indicator positioned on converter pump drive hub. Zero dial face. Lift tool upward as far as tool will go and note indicator reading.

3. Reading is total end play of turbine and stator. If end play exceeds specification, replace torque converter assembly. See TORQUE CONVERTER END PLAY SPECIFICATIONS table.

TORQUE CONVERTER END PLAY SPECIFICATIONS

Application	In. (mm)
New or Rebuilt Converter	.041 (1.04)
Used Converter	.074 (1.88)

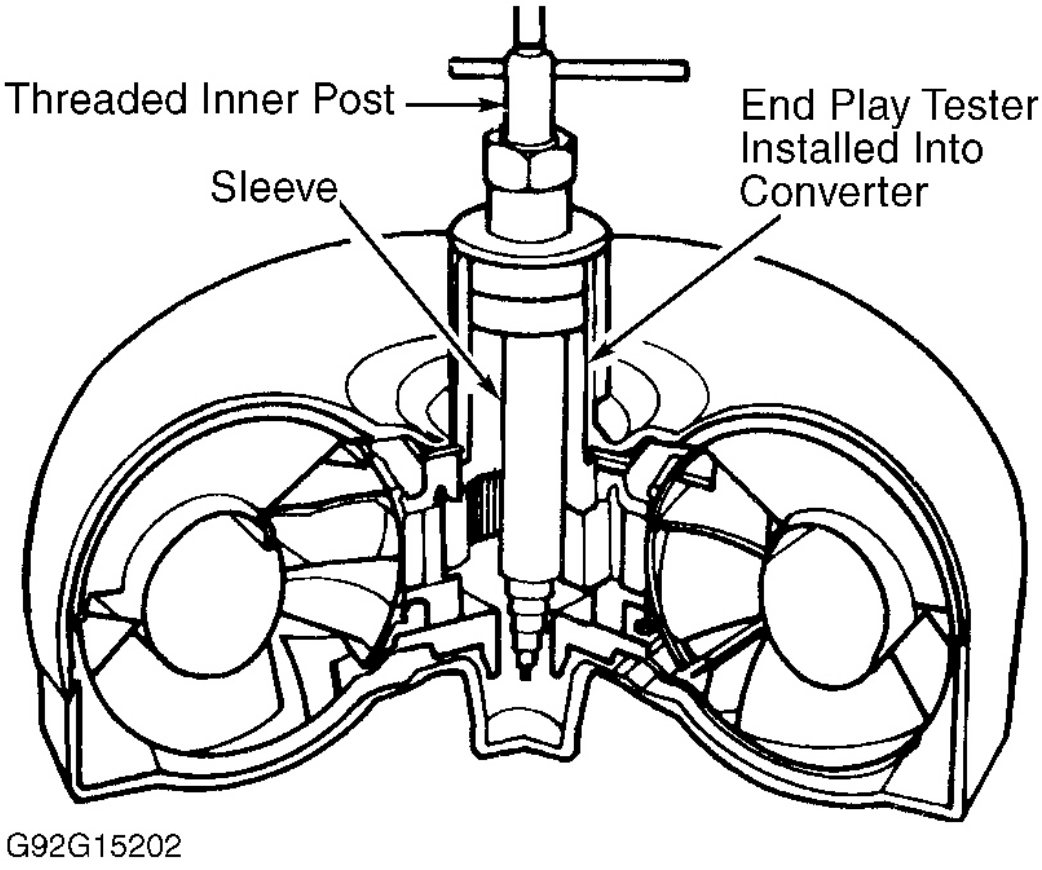


Fig. 9: Installing Torque Converter End Play Tester
Courtesy of FORD MOTOR CO.

ONE-WAY CLUTCH CHECK

1. Insert one-way Clutch Holder (T77L-7902-R) into one of the grooves in the stator thrust washer. Insert Torque Adapter (T76L-7902-C) into converter impeller hub so as to engage one-way clutch inner race.
2. Attach a torque wrench to torque adapter. With clutch holder held stationary, turn torque wrench

counterclockwise. See **Fig. 10** . Converter one-way clutch should lock-up and hold at 10 Ft. Lbs. (14 N.m). One-way clutch should rotate freely in a clockwise direction.

3. Repeat lock-up test in at least 5 different locations around torque converter. If clutch fails to lock-up and hold, replace torque converter.

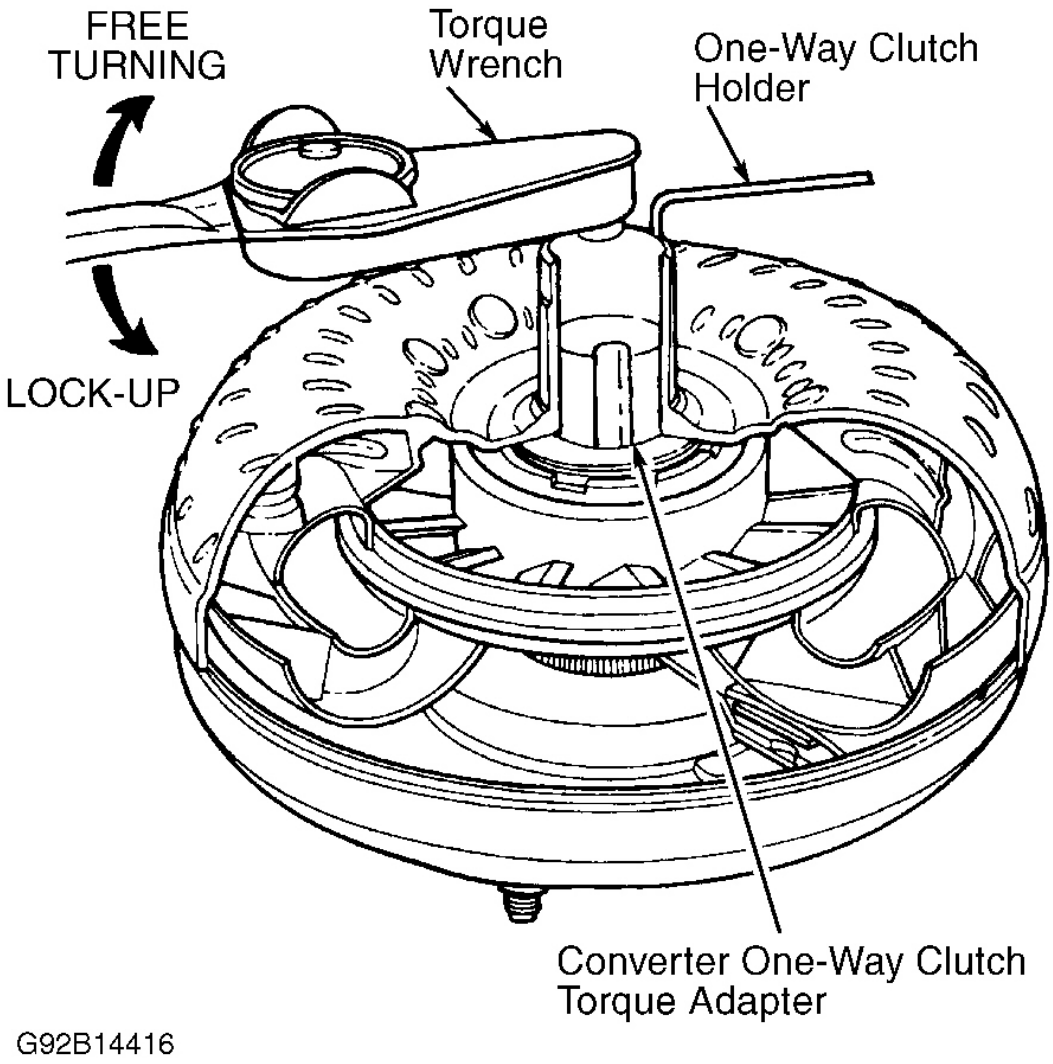


Fig. 10: Checking Converter One-Way Clutch
Courtesy of FORD MOTOR CO.

STATOR INTERFERENCE CHECK

Stator-To-Impeller Interference Check

1. Position stator support shaft on bench with spline end pointing up. Mount converter vertically onto shaft

so support shaft splines engage one-way clutch splines. See **Fig. 11** .

2. While holding support shaft stationary, rotate converter counterclockwise. Converter should rotate freely without interference or scraping within assembly. Should interference or a scraping condition within converter exist or if converter does not rotate freely, replace converter unit.

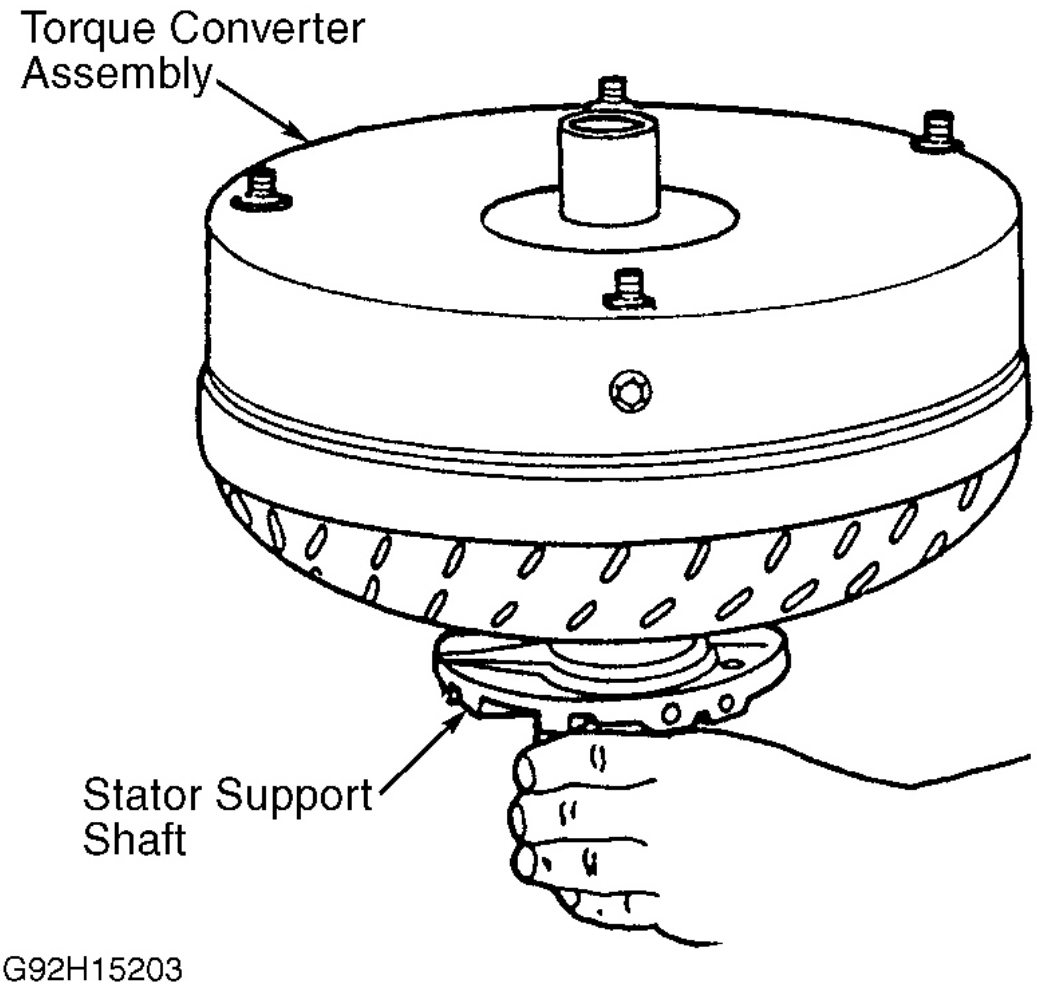


Fig. 11: Checking For Stator-To-Impeller Interference
Courtesy of FORD MOTOR CO.

Stator-To-Turbine Interference Check

1. Place converter on bench, front side down. Install stator support to engage mating splines of stator support shaft.
2. Install input shaft, engaging the splines with turbine hub. While holding stator shaft stationary, rotate turbine with input shaft.

3. Turbine should rotate freely in both directions without interference or noise. Torque required to turn shaft should not exceed 84 INCH lbs. (9.5 N.m) If interference or noise exists, stator front thrust washer may be worn and the converter should be replaced.

REMOVAL & INSTALLATION

See appropriate AUTOMATIC TRANSMISSION REMOVAL article.

TRANSMISSION DISASSEMBLY

NOTE: See Fig. 25 and Fig. 26 for exploded view of internal parts, thrust washer and needle bearing locations.

1. Remove torque converter. Mount transmission in holding fixture. Remove oil pan and gasket. Remove oil filter, grommet, and gasket. Disconnect all solenoid and sensor harness connectors. Unbolt and remove Output Shaft Sensor (OSS).
2. Remove outer nut and manual control lever. Remove TR sensor. Remove manual valve detent spring. Remove 24 valve body retaining bolts and lift off valve body and gasket. Note bolt positions for reassembly. Using diagonal cutters, remove retaining roll pin from manual shaft lever. Remove inner nut, manual lever shaft, detent lever and parking lever actuating rod.
3. Slide out Electronic Pressure Control (EPC) solenoid and remove. Remove 2-3 accumulator assembly, low-reverse servo assembly, overdrive servo and 1-2 accumulator assembly by pushing down on servo covers and removing retaining snap rings. Note length of low-reverse servo piston rod, 1-2 shift accumulator piston and 1-2 shift springs for reassembly reference. See **Fig. 4** and **Fig. 12** .

   NOTE: Length of low-reverse piston rod may vary. Three possible rod lengths are available.

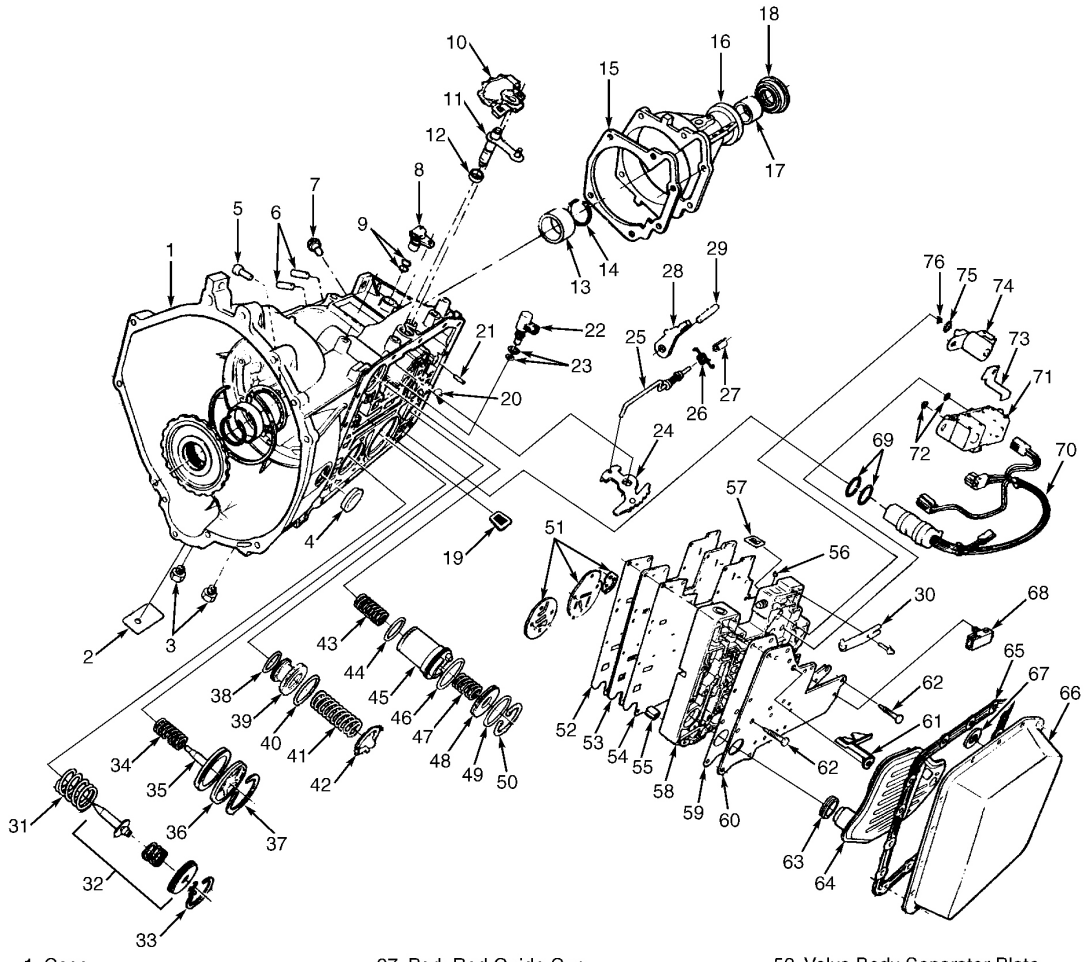
4. Remove oil screen. See **Fig. 12** . Remove extension housing seal and bushing. Remove retaining bolts and slide extension housing from transmission. Remove and discard housing-to-case gasket. Remove parking pawl shaft, parking pawl and return spring. Push transmission harness connector out through bottom of case.

   NOTE: The output shaft may have shipping seal still attached. Remove and discard seal. Seal is not required for assembly.

5. Remove front torque converter-to-pump seal. Remove pump body retaining bolts. Remove pump from case using 2 slide hammers installed in opposite pump retaining bolt holes. Remove pump-to-case gasket.
6. Grasp forward clutch cylinder and shaft and pull intermediate clutch pack, intermediate one-way clutch, reverse clutch, and forward clutch from transmission case as an assembly. Disconnect overdrive band from anchor pins and remove band from case.
7. Remove forward clutch hub and No. 3 needle bearing as an assembly. Remove intermediate shaft. Rotate reverse clutch gear and shell to align indent with overdrive band anchor pin. Remove forward sun gear, No. 5 needle bearing, reverse sun gear and drive shell, and No. 4 needle bearing from case as an

assembly.

8. Note position of center support snap ring tangs for installation reference. Remove snap ring. Using a screwdriver, pry case center support spring from between center support and case. Prior to removal, note position of case center support spring to ensure it is reinstalled correctly.
9. Remove center support and planetary carrier from case as an assembly. Remove reverse band from case. If direct clutch hub did not come out with planetary carrier, remove it from direct clutch.
10. Remove output shaft, ring gear, and direct clutch as an assembly through front of case. Remove output shaft No. 9 needle bearing from rear of case. Remove intermediate clutch pack from one-way clutch. Remove reverse clutch assembly from forward clutch assembly.



1. Case
2. Identification Tag
3. Oil Line Connectors
4. Plug
5. Overdrive Band Pin
6. Reverse Band Pin
7. Case Vent
8. Output Shaft Speed Sensor
9. "O" Rings
10. Manual Lever Position Sensor
11. Manual Control Lever
12. Manual Lever Oil Seal
13. Output Shaft Sleeve
14. Retainer Ring
15. Gasket
16. Extension Housing
17. Bushing
18. Seal
19. Main Control Pump Screen
20. Oil Screen
21. Manual Lever Shaft Pin
22. Pressure Control Solenoid
23. "O" Rings
24. Manual Valve Detent Lever
25. Parking Pawl Actuator Rod
26. Parking Pawl Return Spring
27. Park Rod Guide Cup
28. Parking Brake Pawl
29. Parking Pawl Shaft
30. Manual Valve Detent Spring
31. Overdrive Servo Spring
32. Overdrive Servo Assembly
33. Retainer Ring
34. Reverse Band Servo Spring
35. Reverse Band Servo Assembly
36. Reverse Band Servo Cover
37. Retainer Ring
38. 2-3 Accumulator Upper Seal
39. 2-3 Accumulator Piston
40. 2-3 Accumulator Lower Seal
41. 2-3 Accumulator Piston Spring
42. Retainer Spring
43. 1-2 Accumulator Spring
44. 1-2 Accumulator Upper Seal
45. 1-2 Accumulator Piston
46. 1-2 Accumulator Lower Seal
47. 1-2 Accumulator Spring
48. 1-2 Accumulator Cover
49. 1-2 Accumulator Retainer Seal
50. 1-2 Accumulator Retainer Ring
51. Valve Body Reinforcing Plate
52. Separator Plate Upper Gasket
53. Valve Body Separator Plate
54. Separator Plate Lower Gasket
55. Converter Drainback Valve
56. Coast Booster Valve Shuttle Ball
57. Solenoid Pressure Supply Screen
58. Main Control Assembly (Valve Body)
59. Valve Body Cover Plate Gasket
60. Valve Body Cover Plate
61. Solenoid Retainer
62. Guide Bolts
63. Grommet
64. Filter
65. Oil Pan Gasket
66. Oil Pan
67. Magnet
68. Oil Temperature Sensor
69. "O" Rings
70. Wiring Connector Harness
71. Shift Control Solenoid
72. "O" Rings
73. Shift Control Solenoid Bracket
74. Modulated Converter Clutch Solenoid
75. "O" Rings
76. "O" Rings

G92I15204

Fig. 12: Exploded View Of 4R70W Valve Body, Servos, Accumulators & Case Components
Courtesy of FORD MOTOR CO.

COMPONENT DISASSEMBLY & REASSEMBLY

NOTE: See Fig. 25 and Fig. 26 for exploded view of internal parts, thrust washer and needle bearing locations.

PLANETARY GEAR SUPPORT & PLANETARY ONE-WAY CLUTCH

NOTE: If a roller from planetary one-way clutch is lost or damaged, entire one-way clutch assembly must be replaced.

Disassembly

Remove center support from planetary carrier by lifting up on center support while rotating it counterclockwise. Carefully remove planetary one-way clutch from planetary assembly.

Inspection

Check planet support bushing, clutch inner and outer race, band surface, pinion gears, bearings and thrust washer for roughness. Check one-way clutch for damaged rollers or broken springs.

Reassembly

Assemble one-way clutch. Lubricate clutch races and clutch assembly with petroleum jelly to aid in assembly. Install one-way clutch in planetary carrier. Install center support into one-way clutch by rotating center support counterclockwise.

DIRECT CLUTCH ASSEMBLY

Disassembly

1. Remove direct clutch hub. Remove No. 7 direct clutch hub inner needle bearing and bearing support. Using a screwdriver, remove clutch pack selective retaining snap ring and lift out clutch pack. See **Fig. 13** .
2. Using appropriate compressor, compress piston return springs and remove retaining snap ring. Remove tool and lift spring retainer assembly and piston from clutch drum.
3. If necessary, piston can be removed by applying compressed air to lubrication hole in clutch drum. Note position and direction of lip seals. Remove seals from drum and piston.

Inspection

1. Check piston check ball for freedom of movement. Check for leakage by turning piston upside down (flat side up), allowing check ball to seat in piston.
2. Pour small quantity of solvent over check ball. If solvent drips past check ball, replace piston.

Reassembly

1. Using appropriate seal protector, install inner seal on clutch drum hub with sealing lip facing down into drum. Lubricate seals and seal protector with petroleum jelly prior to installation. Ensure inner seal is positioned in groove. Install outer seal on piston with lip pointing away from spring posts.
2. Coat piston seals, clutch drum sealing area, and piston inner seal area with petroleum jelly. Install piston into clutch drum using seal protector, prevent damaging seals.
3. Position piston spring and retainer assembly in clutch drum. Compress assembly and install retaining snap ring. Install clutch pack into drum. Install pressure plate on top of clutch pack. Install clutch pack selective retaining ring.
4. Using a feeler gauge, measure clearance between clutch pack retaining ring and pressure plate with pressure plate held down. See DIRECT CLUTCH CLEARANCE SPECIFICATIONS table. If clearance is not as specified, install correct size snap ring to obtain specification and recheck clearance. Selective snap rings are available in the following sizes: .050-.054" (1.27-1.37 mm), .064-.068" (1.63-1.73 mm), .078-.082" (1.98-2.08 mm) and .092-.096" (2.34-2.44 mm).
5. Install No. 7 bearing support with Black side up. Install No. 7 direct clutch inner needle bearing with chamfer down. Install direct clutch hub.

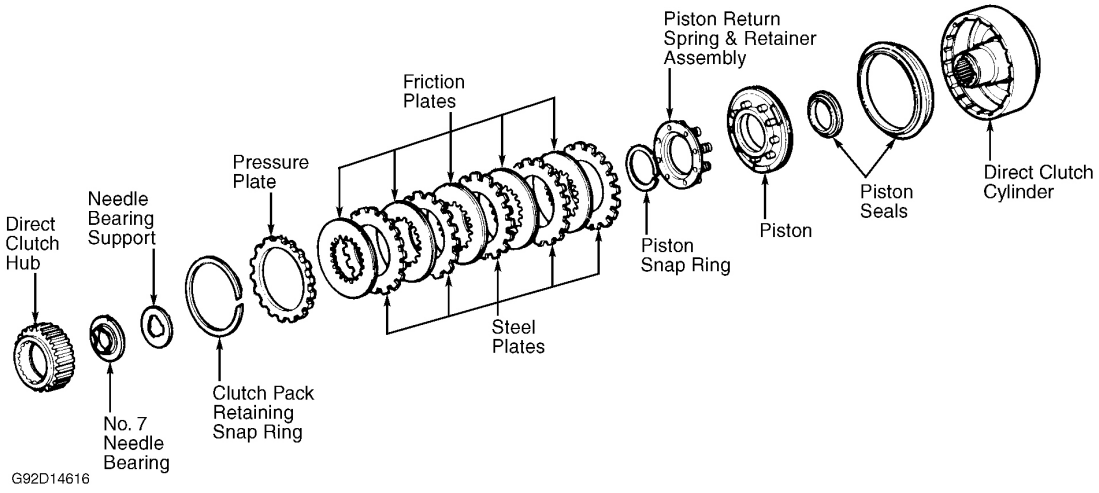


Fig. 13: Exploded View Of Direct Clutch Assembly
Courtesy of FORD MOTOR CO.

DIRECT CLUTCH CLEARANCE SPECIFICATION

Engine Size	No. Of Plates	Clearance In. (mm)
3.8L	5	.050-.071 (1.27-1.80)
4.2L & 4.6L	6	.062-.085 (1.57-2.16)

FORWARD CLUTCH

Disassembly

1. Lift clutch hub and No. 3 needle bearing from forward clutch assembly. Using a screwdriver, pry clutch

pack selective retaining snap ring from drum. Remove clutch pack, pressure plate and wave spring. See **Fig. 14** .

2. Using appropriate compressor, compress piston return spring and remove retaining snap ring. Lift out retainer and return spring. Remove clutch piston from drum.
3. Note position of inner and outer piston seals, then remove seals. Ensure input shaft Teflon seals are not damaged. Ensure check balls in piston move freely.

Reassembly

1. Lubricate and install inner and outer seals on piston with sealing edge facing into clutch drum. Lubricate piston seals and drum sealing area with petroleum jelly. Install piston into drum using appropriate seal protector to prevent damaging seals.
2. Position return spring and retainer on piston. Compress return spring and install retaining snap ring. Install clutch pack into clutch drum starting with waved spring. Install a steel plate and then a friction plate. Alternately install remaining plates in clutch pack. Install pressure plate and snap ring.
3. Install dial indicator and bracketry with stem touching pressure plate. See **Fig. 15** . Press down on pressure plate and zero indicator. Pull up on pressure plate until plate touches selective snap ring and note reading on dial indicator. If clearance is not .050-.089" (1.27-2.26 mm), install correct size snap ring to obtain specification and recheck clearance. Selective snap rings are available in the following sizes: .060-.064" (1.52-1.73 mm), .074-.078" (1.88-1.98 mm), .086-.092" (2.23-2.34 mm) and .102-.106" (2.59-2.69 mm).

NOTE: Solid shaft seals may be replaced with scarf-cut seals if necessary. Ensure new scarf-cut seals are installed so edges do not overlap.

4. If original seals are damaged or missing, install NEW input shaft seals. Install No. 3 needle bearing. Install forward clutch hub into forward clutch cylinder and shaft. Ensure forward clutch hub is against No. 3 needle bearing.

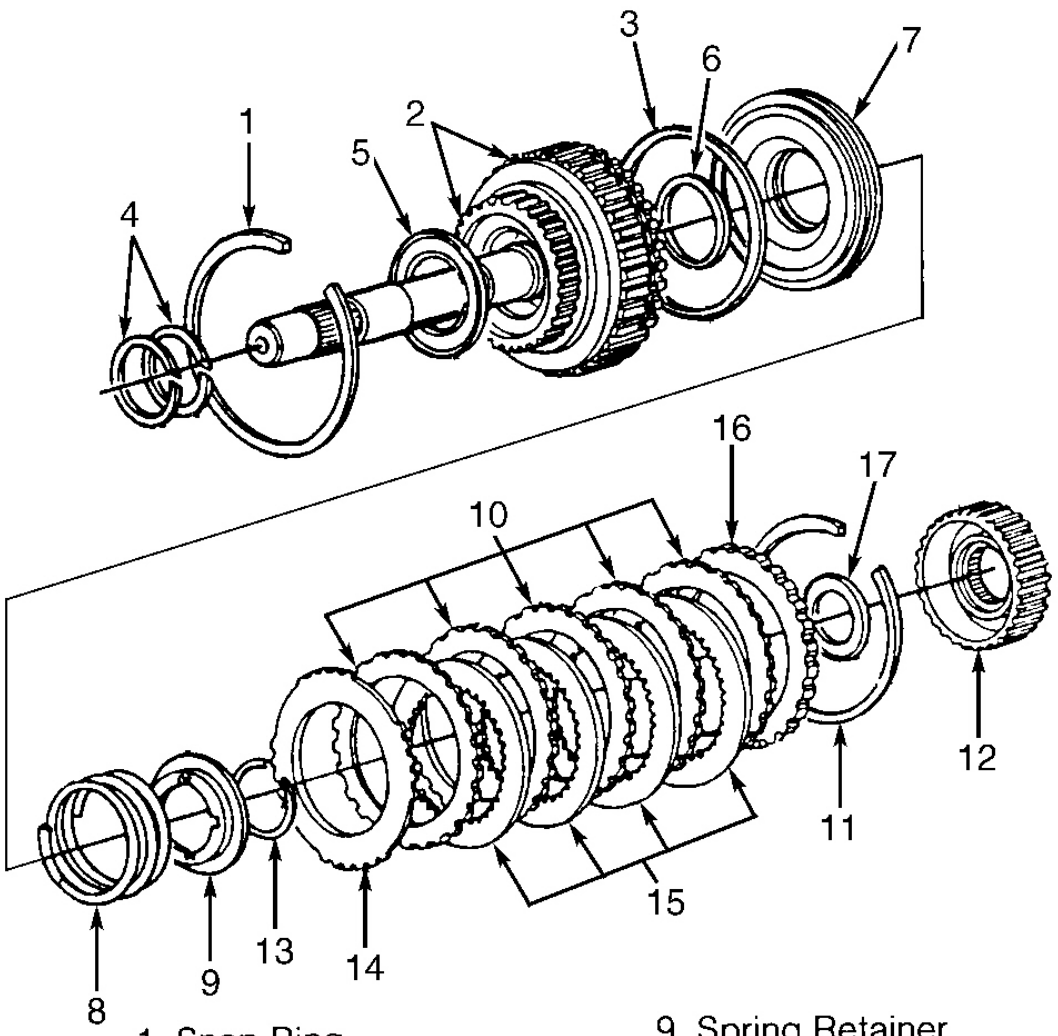


Fig. 14: Exploded View Of Forward Clutch Assembly
Courtesy of FORD MOTOR CO.

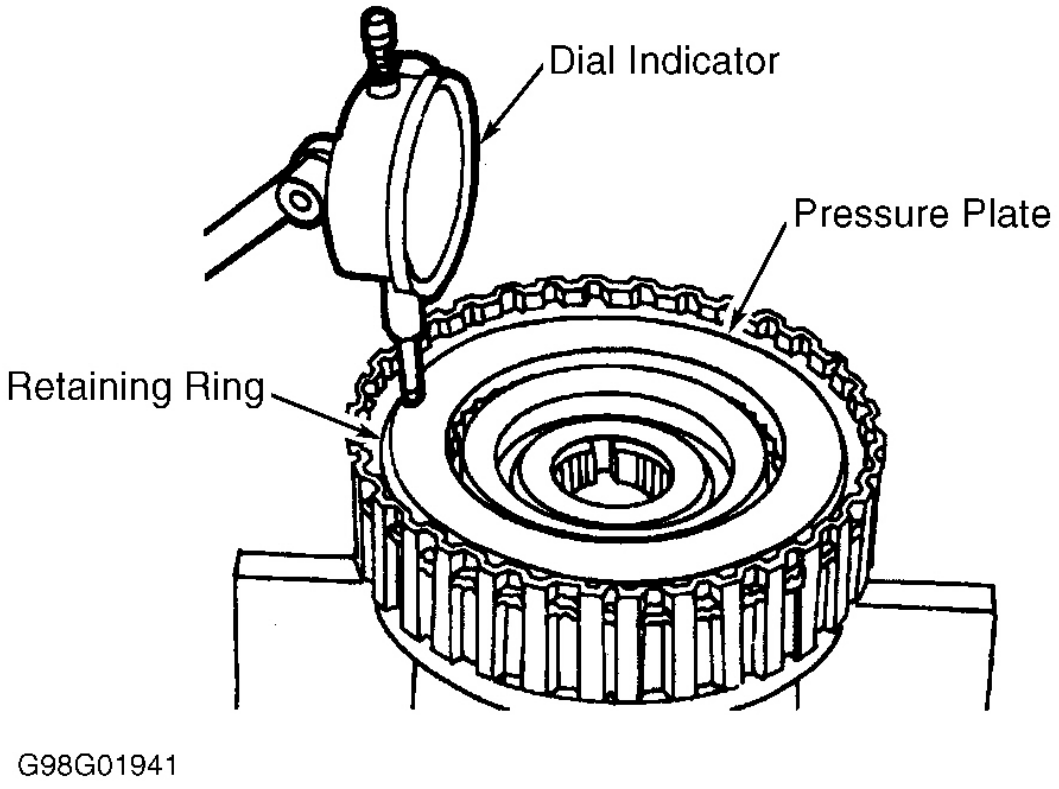


Fig. 15: Measuring Clutch Pack Clearance
Courtesy of FORD MOTOR CO.

INTERMEDIATE ONE-WAY CLUTCH

Disassembly & Reassembly

Remove clutch retaining ring and lift off clutch retaining plate. Remove clutch outer race by lifting on race while turning counterclockwise. Carefully lift one-way clutch from inner race. See **Fig. 16** . To reassemble, reverse disassembly procedure. Ensure chamfer o n outer clutch race faces up. One-way clutch must rotate counterclockwise when installed on reverse clutch drum.

NOTE: If a roller is damaged or lost, entire one-way clutch assembly must be replaced.

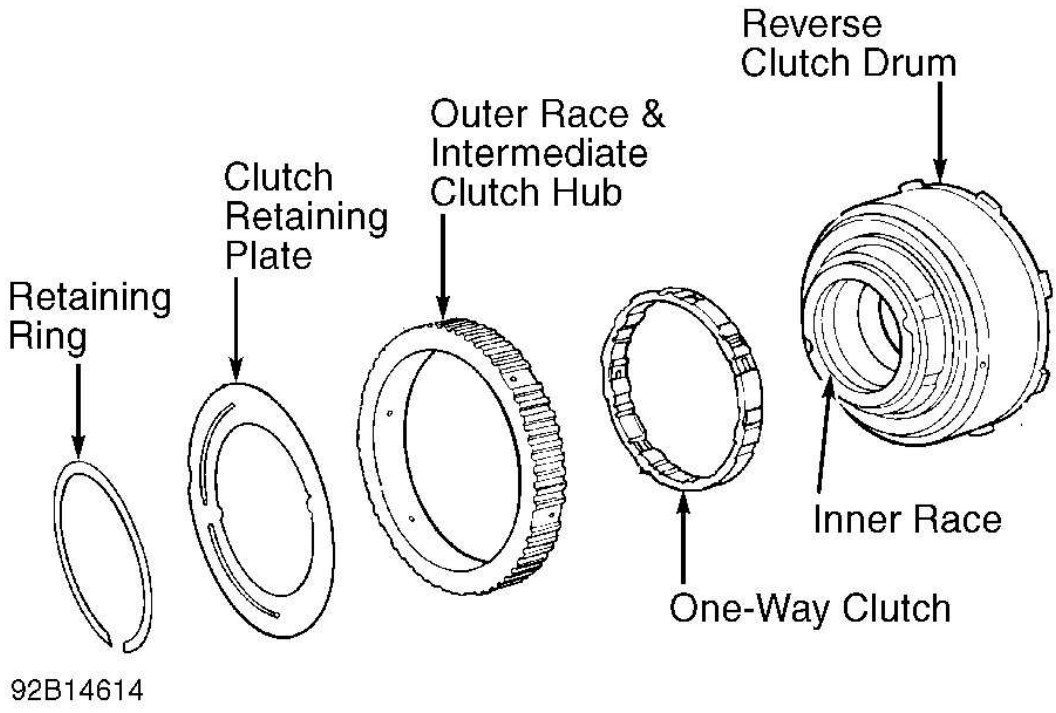


Fig. 16: Exploded View Of Intermediate One-Way Clutch Assembly
Courtesy of FORD MOTOR CO.

OIL PUMP & INTERMEDIATE CLUTCH PISTON

Disassembly

1. Lift No. 1 thrust washer from stator support. Remove retaining bolts and separate stator support from pump body. Remove 4 seal rings from stator support. Remove inner and outer gerotor gears from pump body.
2. Remove spring retainer assembly by carefully dislodging the tabs. Lift intermediate clutch piston from pump assembly. Remove pump body-to-case seal and discard. See **Fig. 17** .

NOTE: Reverse clutch seal rings on stator support are larger than forward clutch seal rings.

Reassembly

1. Install front pump seal. Install NEW seals on intermediate clutch piston. Coat piston seal and pump body sealing area with petroleum jelly. Use appropriate seal protector and install piston in pump body, ensuring piston bleed hole is located at 12 o'clock position (toward top of transmission case).
2. Snap spring retainer assembly into place on pump body using even pressure. Install inner and outer

Gerotor gear into pump body with chamfer on both gears facing into pump body. Install seal rings on stator support. Install 2 larger rings closer to pump.

3. Position stator support on pump body. Install and tighten retaining bolts to specification. See TORQUE SPECIFICATIONS. Install pump body-to-case seal around outer diameter of pump body.

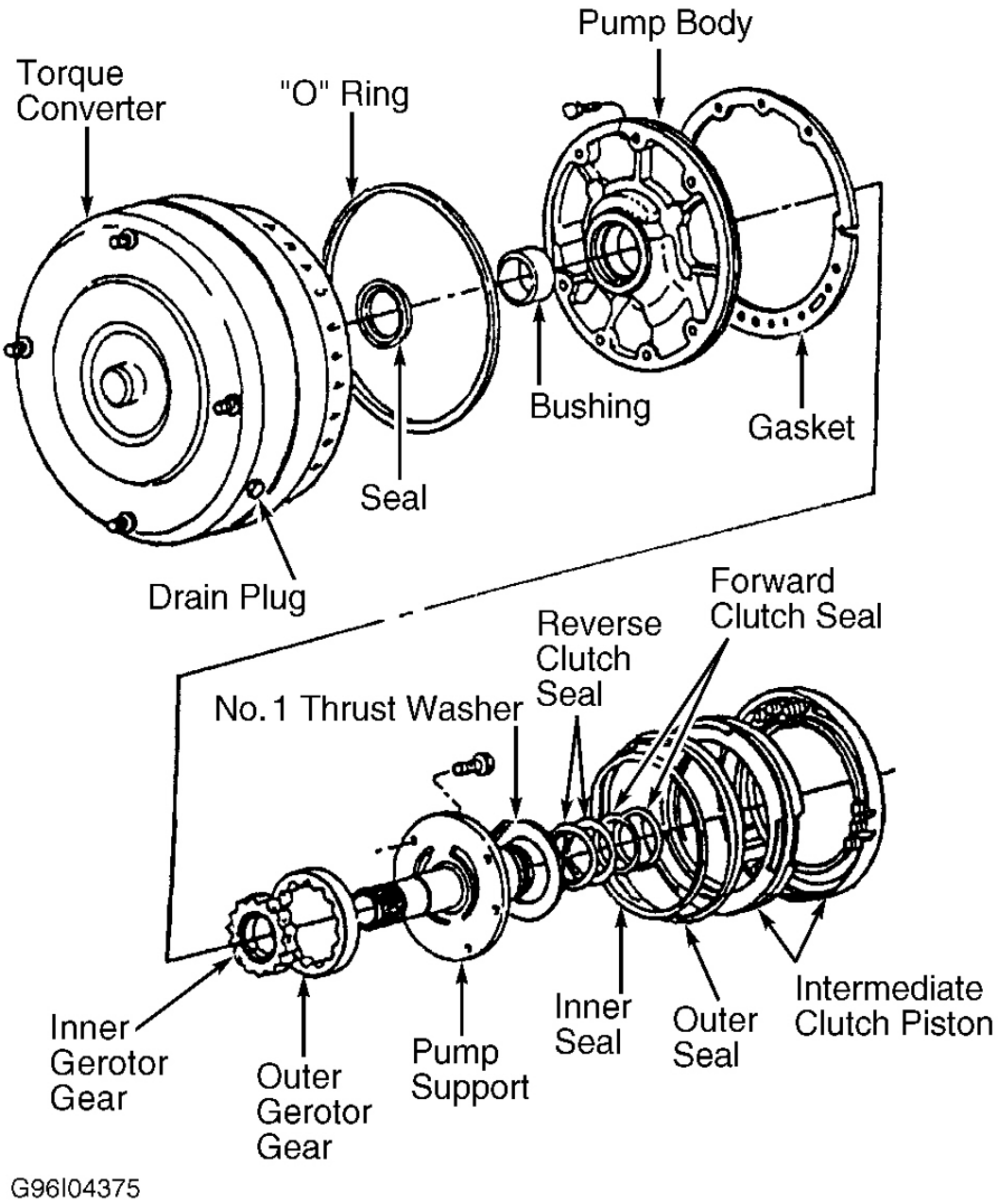
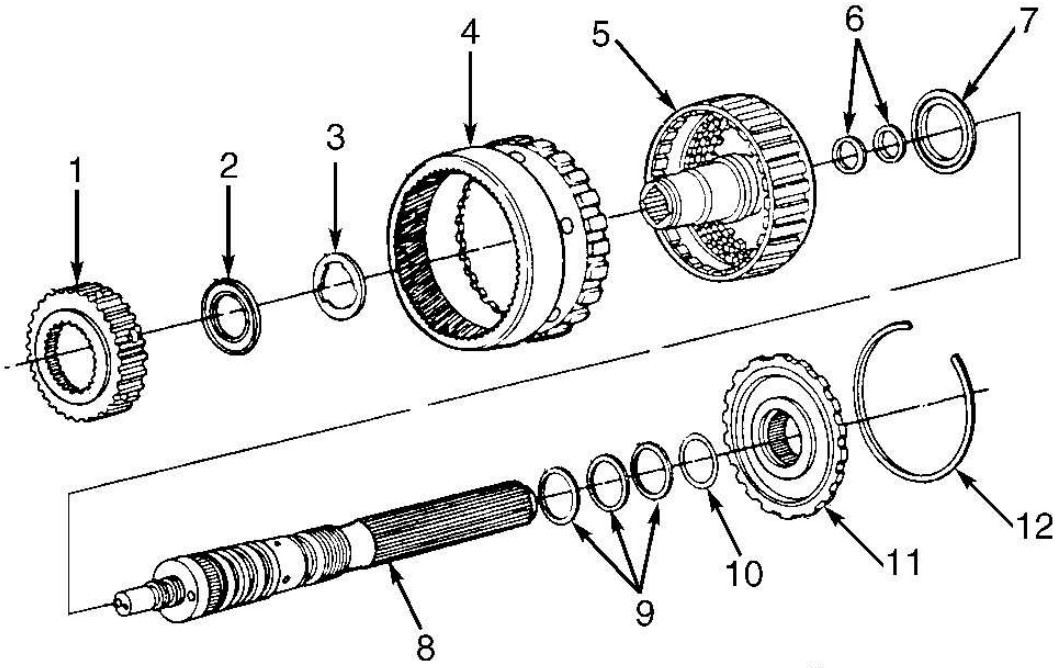


Fig. 17: Exploded View Of Oil Pump & Intermediate Clutch
Courtesy of FORD MOTOR CO.

OUTPUT SHAFT ASSEMBLY

Disassembly & Reassembly

1. Remove retaining ring and separate output hub assembly from ring gear. Remove direct clutch from ring gear and No. 8 needle bearing from rear of direct clutch.
2. Remove 4 output shaft seal rings and hub-to-shaft retaining ring. Separate hub from output shaft. Remove 2 direct clutch seal rings from end of output shaft. See **Fig. 18** . To reassemble, reverse disassembly procedure.



1. Direct Clutch Hub
2. Bearing
3. Washer
4. Ring Gear
5. Clutch Cylinder
6. Seals
7. Bearing/Race
8. Output Shaft
9. Seals
10. Seal
11. Hub
12. Snap Ring

G94E38780

Fig. 18: Exploded View Of Output Shaft Assembly
Courtesy of FORD MOTOR CO.

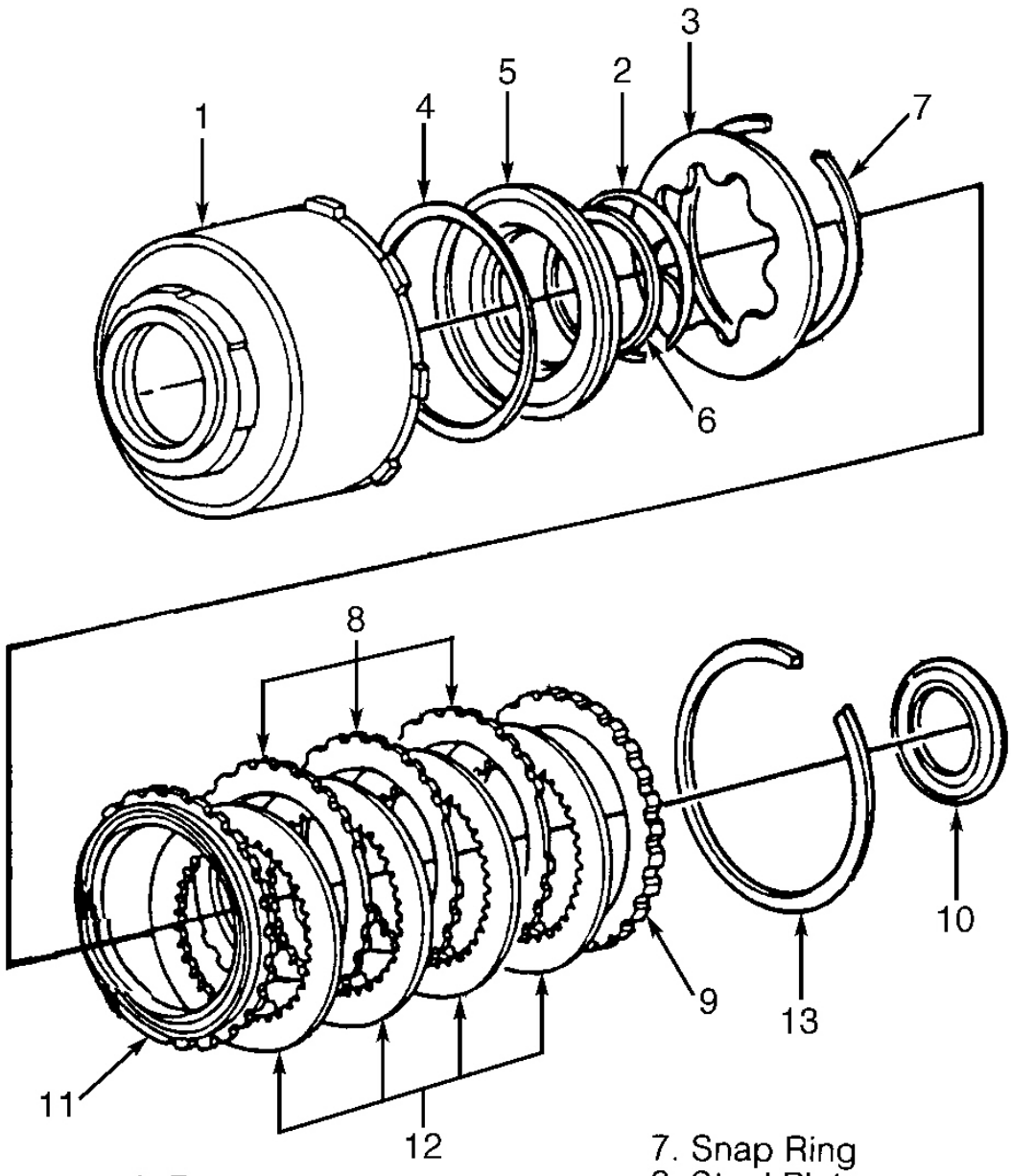
REVERSE CLUTCH

Disassembly

1. Remove No. 2 needle bearing. Using a screwdriver, pry clutch pack retaining snap ring from clutch drum. Lift out clutch pack. See **Fig. 19** .
2. Compress return spring and remove snap ring. Remove return spring and thrust ring. Remove piston from drum. Remove seals from piston.
3. It may be necessary to apply compressed air to clutch drum lubrication hole to remove piston. Block remaining hole with finger.

Reassembly

1. Ensure check ball in inner piston is free. Install NEW oil seals on piston. Coat seals and sealing surface in clutch drum with petroleum jelly.
2. Install piston into clutch drum using appropriate seal protectors to prevent damaging seals. Seals used on reverse clutch piston are square cut; direction of installation is not important.
3. Install thrust ring and return spring. Compress return spring and install snap ring with points facing downward. Install apply plate into clutch drum with dished side facing piston. Install clutch pack and retaining snap ring.
4. Install dial indicator and bracketry with stem touching pressure plate. See **Fig. 15** . Press down on pressure plate and zero indicator. Pull up on pressure plate until plate touches selective snap ring and note reading on dial indicator. If clearance is not .040-.060" (1.02-1.52 mm), install correct size snap ring and recheck clearance.
5. Selective snap rings are available in sizes; .060-.064" (1.52-1.73 mm), .074-.078" (1.88-1.98 mm), .088-.092" (2.24-2.34 mm) and .102-.106" (2.59-2.69 mm).
6. With reverse clutch reassembly completed, check clutch operation using compressed air. Ensure clutch applies smoothly and without leakage. Install No. 2 needle bearing.



1. Drum
2. Pressure Ring
3. Piston Spring
4. Outer Seal
5. Piston
6. Inner Seal
7. Snap Ring
8. Steel Plates
9. Pressure Plate
10. Bearing
11. Apply Plate
12. Friction Plates
13. Snap Ring

Fig. 19: Exploded View Of Reverse Clutch Assembly

Courtesy of FORD MOTOR CO.

SUN GEAR & DRIVING SHELL

Disassembly

Remove No. 4 needle bearing from driving shell. Remove forward sun gear and No. 5 needle bearing from shell. Remove No. 5 needle bearing from forward sun gear.

Reassembly

Sun gear and driving shell will be reassembled as part of TRANSMISSION REASSEMBLY.

VALVE BODY ASSEMBLY

NOTE: As valves are removed from each valve body bore, place individual parts in correct order and in relative position to valve body for reassembly reference. Tag all springs as they are removed for reassembly reference.

Disassembly

1. Remove and discard valve body gasket. Remove retaining bolts. Remove separator plate, reinforcement plates, and separator plate gasket. Discard gasket.
2. Remove 8 check balls from valve body. See **Fig. 20** . Remove retaining plates, valves and springs. Keep all valves and springs in original order for reassembly reference. See **Fig. 21** .

Cleaning & Inspection

1. Clean all parts thoroughly in clean solvent, and blow dry with compressed air. Inspect all valves and plug bores for scoring. Check all fluid passages for obstructions.
2. Inspect all mating surfaces, plugs, and valves for burrs and scoring. If necessary, use crocus cloth to polish valves and plugs.
3. Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall of their own weight within their respective bores.

CAUTION: Avoid rounding off sharp edges of valves and plugs with crocus cloth. These edges perform a cleaning action.

Reassembly

1. Install all valves into their respective bores using illustration as guide. Ensure notch in plugs face bottom of bore.
2. Install valve body check balls. See **Fig. 20** . Install guide pin bolts into holes. These 2 holes align valve body gasket and valve body assembly with case. Using a NEW separator plate gasket, slide plate and gasket over alignment pins. Position 3 reinforcement plates and loosely install retaining bolts. Tighten

retaining bolts to specification in correct order. See **Fig. 22** . See TORQUE SPECIFICATIONS.

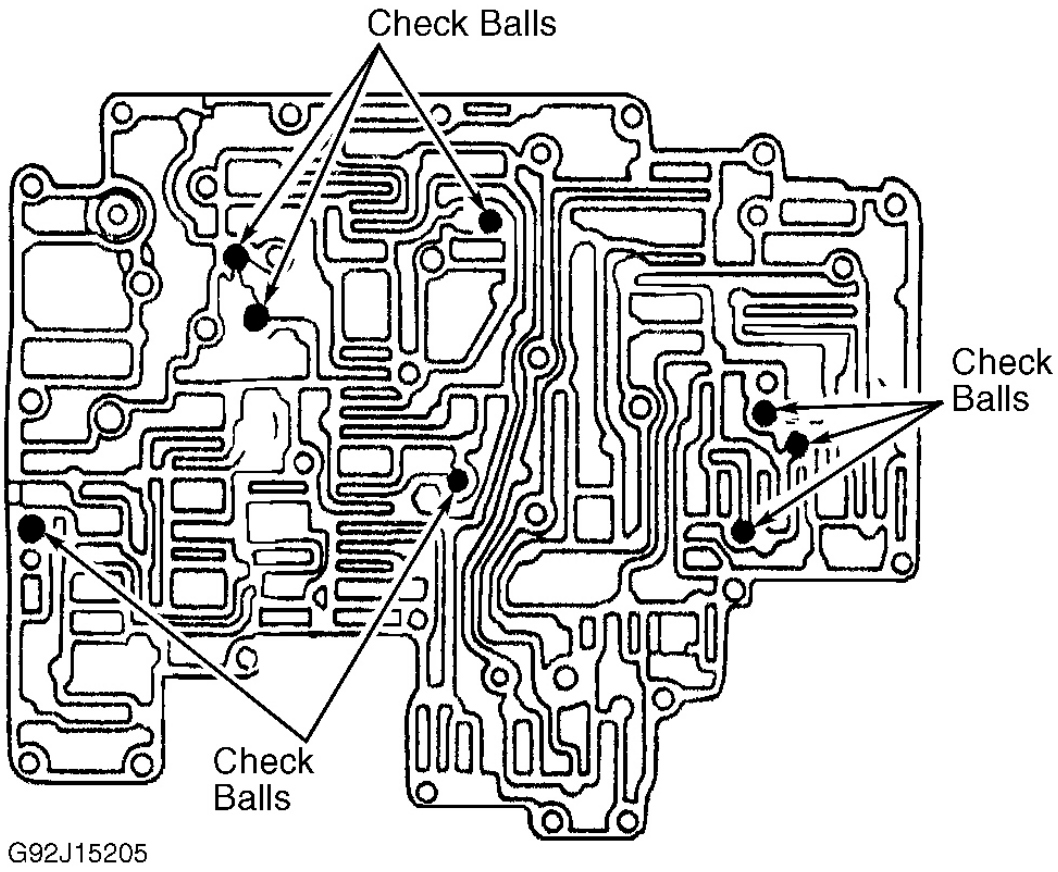


Fig. 20: Locating Check Balls In Valve Body
Courtesy of FORD MOTOR CO.

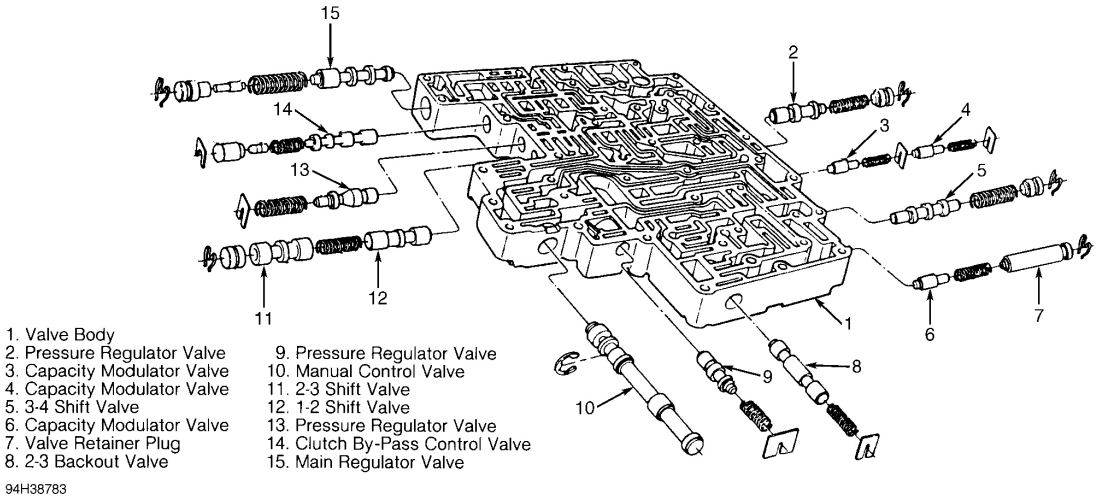


Fig. 21: Exploded View Of Valve Body Components
Courtesy of FORD MOTOR CO.

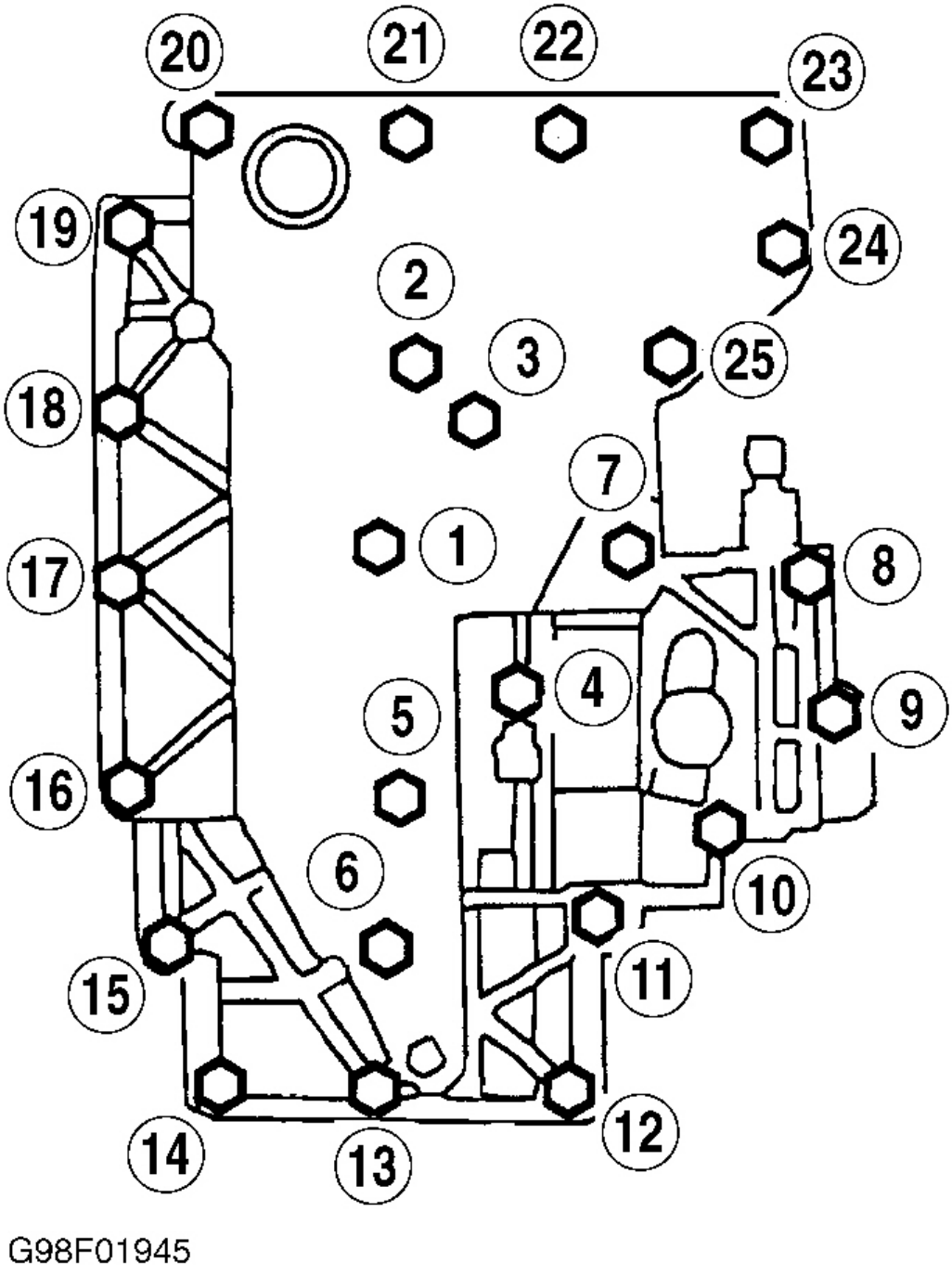


Fig. 22: Tightening Sequence For Valve Body
Courtesy of FORD MOTOR CO.

TRANSMISSION REASSEMBLY

NOTE: See Fig. 25 and Fig. 26 for exploded view of internal parts, thrust washer and needle bearing locations. Lubricate all parts with ATF. Use petroleum jelly on gaskets, thrust washers, and needle bearings to retain in place. Use NEW gaskets and seals.

Reassembly

1. Using appropriate installer, install rear case bushing. Install No. 9 output shaft needle bearing in transmission case. Install output shaft, output shaft ring gear and direct clutch as an assembly. Ensure No. 7 needle bearing and direct clutch hub are installed correctly.
2. Install reverse band support retaining ring. Install reverse band into transmission case and ensure band is seated on anchor pins. When properly installed, center of band actuating rod seat can be seen through servo piston bore.
3. Align notch in planetary gear support with overdrive band anchor pin. Install center support and planetary assembly into case. If necessary, rotate output shaft to align planet carrier splines with direct clutch hub splines. Install center support spring using a hammer handle or wooden dowel. Spring tabs must face out. Install center support retaining ring.
4. Install forward clutch sun gear, No. 5 needle bearing reverse sun gear and No. 4 forward clutch needle bearing as an assembly. Rotate output shaft to aid in engaging sun gear with planetary gears. Install intermediate shaft.
5. Install forward clutch hub and No. 3 needle bearing. Install forward clutch assembly. Install reverse clutch on forward clutch. Ensure No. 2 needle bearing is in position in reverse clutch. Wiggle input shaft while engaging reverse clutch splines. Ensure reverse clutch cylinder lugs are fully seated in notches of reverse sun gear.
6. Install overdrive band into case and around drive shell assembly. Ensure band anchor is properly positioned on anchor pin. Using a screwdriver to hold overdrive band in position, lubricate and install overdrive servo piston return spring and servo piston. Using appropriate compressor, compress overdrive servo piston and install retaining ring. Ensure .020" (.51 mm) overdrive servo bleed hole is clear.
7. With overdrive servo installed, inspect band and apply pin for proper position and engagement. If band anchor and apply pin are not properly engaged, remove servo piston and re-position band as necessary.
8. Install intermediate clutch pack pressure plate with chamfer down, clutch pack (starting with a friction plate and alternating steel and friction plates) and selective steel plate in order. Measure intermediate clutch clearance.
9. Intermediate clutch clearance is measured using a depth micrometer and appropriate end play straight bar. Set end play bar across pump case mounting surface. Place micrometer on end play bar and read depth to selective steel plate. See **Fig. 23** .

NOTE: A downward pressure must be applied to clutch pack while measuring intermediate clutch clearance.

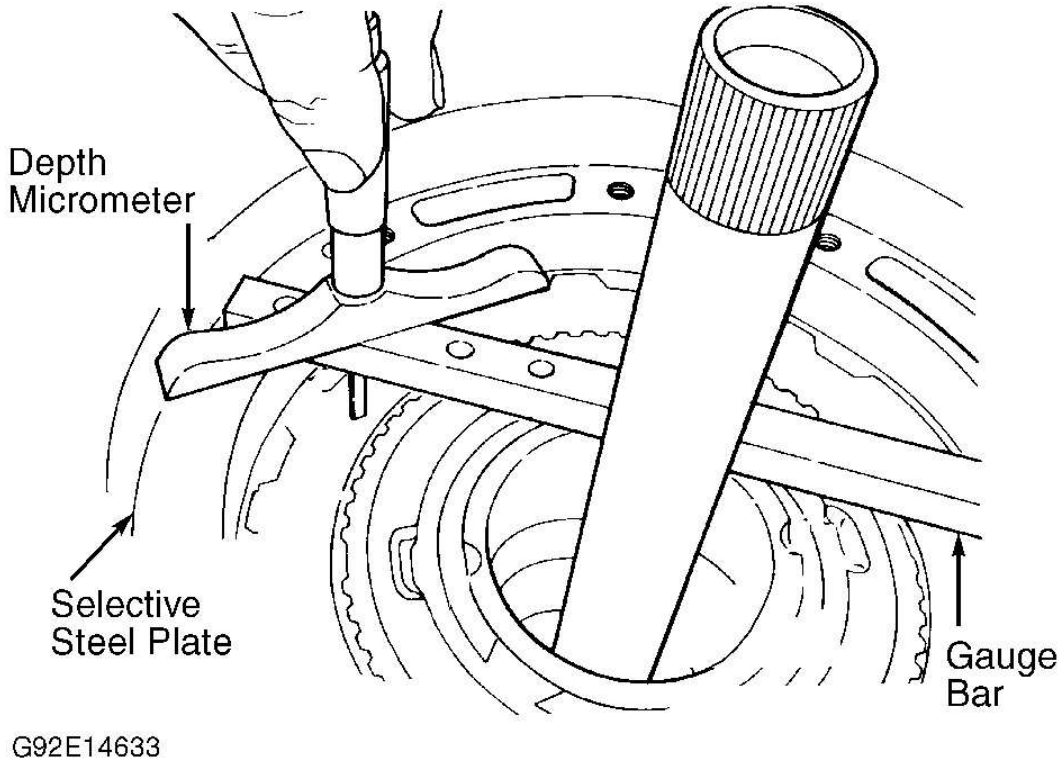


Fig. 23: Measuring Intermediate Clutch Clearance
Courtesy of FORD MOTOR CO.

10. Check depth again with micrometer 180 degrees opposite from previous measurement. Ensure depth at intermediate clutch selective steel plate is 1.643-1.670" (41.7-42.4 mm). Ensure average of the 2 measurements is within this range.
11. If intermediate clutch clearance (depth) is not within tolerance, select correct thickness selective steel plate to obtain specified depth. Selective plates are available in the following thicknesses: .067-.071" (1.70-1.80 mm), .077-.081" (1.95-2.05 mm), .087-.091" (2.20-2.31 mm) and .97-.101 (2.46-2.56 mm). Install correct plate and recheck clearance.
12. Check transmission end play by locating depth micrometer on end play straight bar. Ensure depth is measured at reverse clutch drum thrust face. See **Fig. 23** . Standard end play is .004-.044" (.101-1.11 mm).
13. Check end play 180 degrees opposite end of reverse clutch drum thrust face to determine average depth. Thrust washer controlling transmission end play is located on stator support which is attached to back of pump housing.
14. Transmission end play can be adjusted using one of selective thrust washers available for service. After measuring depth, select required thrust washer. See NO. 1 THRUST WASHER SELECTION table.

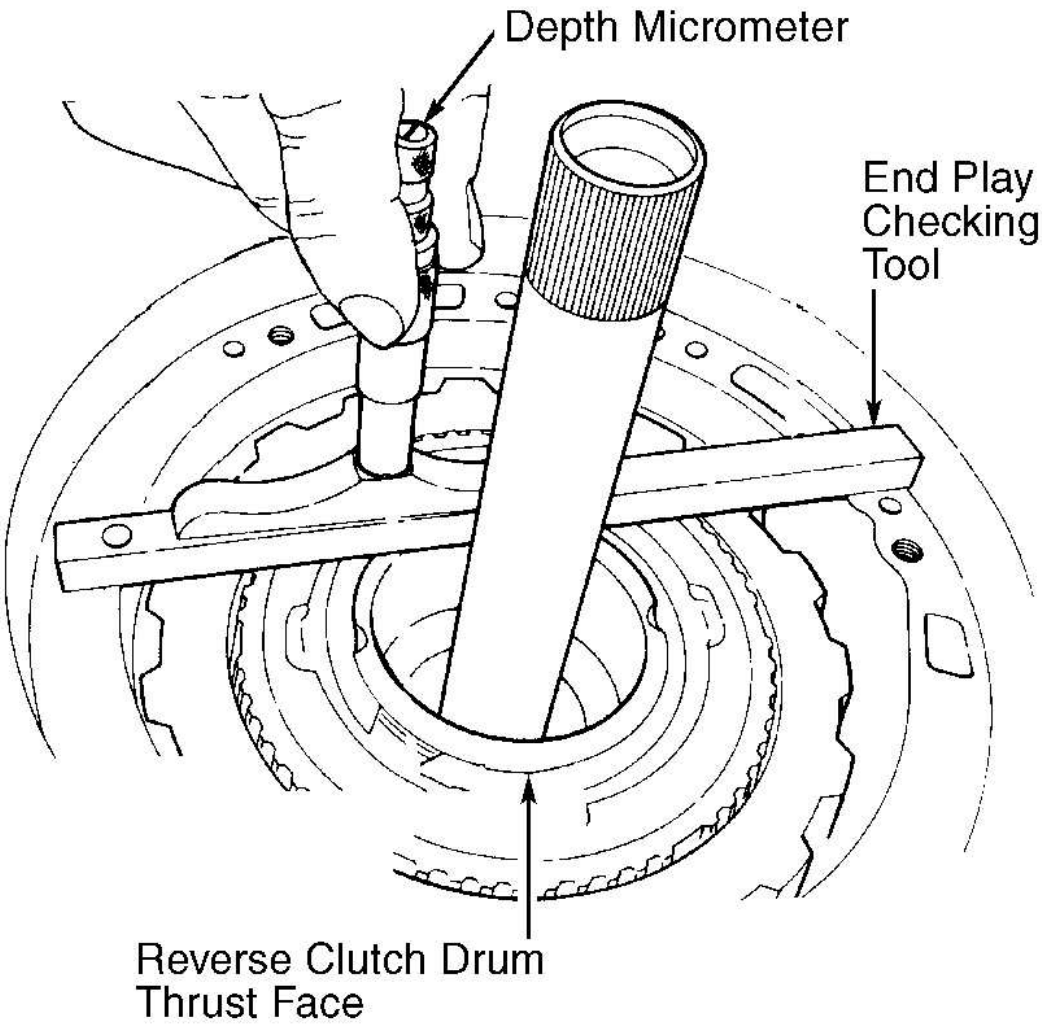


Fig. 24: Measuring Transmission End Play
Courtesy of FORD MOTOR CO.

15. Install selected transmission end play thrust washer on stator support. Use petroleum jelly to hold it in place. Install pump alignment dowel, made by cutting the head from a M8 x 1.25 bolt, into pump mounting bolt hole at 12 o'clock position.
16. Install new pump gasket into case. Ensure case passages are covered. Apply petroleum jelly to pump-to-case seal surfaces. Install pump assembly into case. Wiggle input shaft while pressing down on pump. Remove alignment dowel and install pump-to-case bolts.
17. Alternately tighten bolts a few turns at a time to draw pump into case. Tighten bolts to specification. See TORQUE SPECIFICATIONS. Install parking pawl shaft, parking pawl and return spring. Install Output

Shaft Sensor (OSS). Tighten bolt to specification.

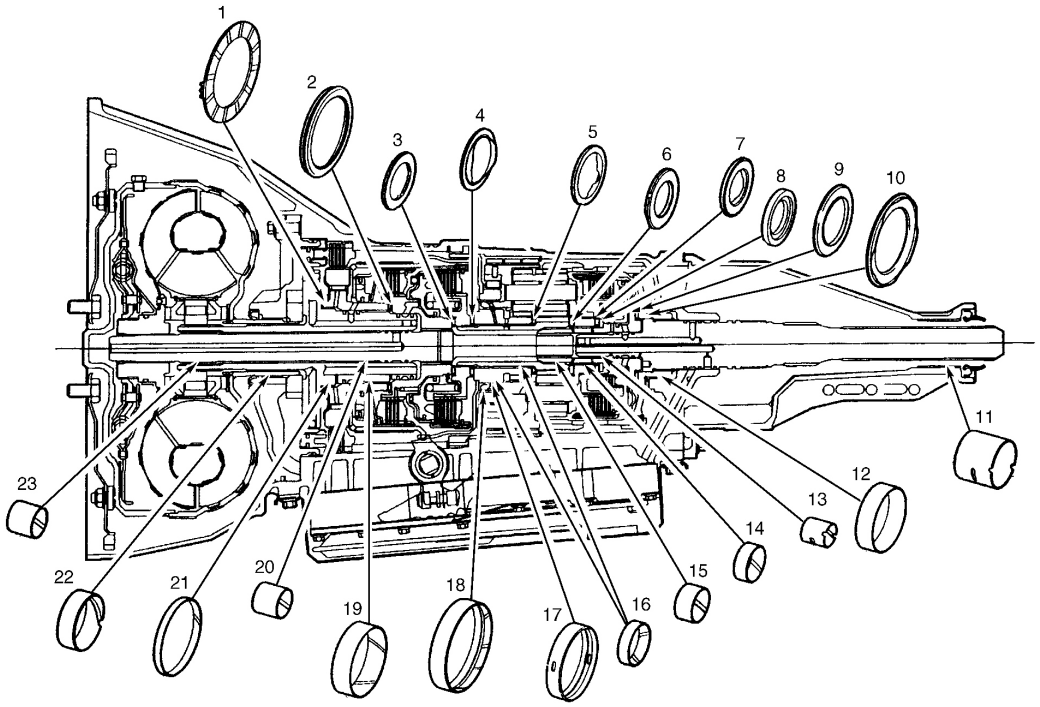
18. If removed, install manual control lever shaft seal. Install EPC solenoid. If removed, install extension housing bushing. Position new gasket on transmission. Slide extension housing into place. Install bolts and tighten to specification. Using appropriate seal installer, install extension housing rear seal.
19. Position manual valve detent lever and parking lever actuating rod into case. Parking lever actuating rod must be positioned over parking pawl. Slide manual control lever shaft into case and position through detent. Install inner nut and tighten to specification. Install manual lever shaft retaining roll pin. Install oil screen into case.
20. If low-reverse servo piston and rod replacement is necessary or if reverse band has been replaced, perform REVERSE SERVO ASSEMBY under ON-VEHICLE SERVICE installation procedures.

NOTE: Transmissions with a spacer installed between low-reverse servo cover and retaining ring require a special selection procedure for low-reverse servo piston.

21. Install low-reverse servo spring, piston and rod. Install servo cover and cover retaining snap ring. Install 2-3 accumulator spring, piston, cover and seal. Install accumulator piston retaining ring. Install 1-2 accumulator spring, piston, cover and seal. Install accumulator piston retaining ring.
22. Install wiring harness connector into case. Replace "O" ring on wiring harness connector (if necessary). Install valve body gasket and valve body assembly using 2 alignment bolts as guide. Ensure coasting booster valve check balls in correct locations.
23. Install EPC solenoid bracket. Loosely install valve body retaining bolts. Install manual valve detent spring. Tighten bolts to specification. See **Fig. 22** . See **TORQUE SPECIFICATIONS** .
24. Connect all solenoid and sensor harness connectors. Install filter grommet, new filter gasket, and filter on valve body. Install filter attaching bolts and tighten. Install TR sensor onto transmission case and install bolts but do not tighten.
25. Place manual lever in Neutral position (2 detent positions back from Park). Insert Transmission Range Sensor Alignment tool (T97L-70010-A) into slots. See **Fig. 3** . Align the 3 slots on TR sensor with tabs on adjuster. Tighten bolts to specification. Install manual control lever and outer nut. Tighten nut to specification.
26. Position new pan gasket on case and install oil pan. Tighten bolts to specification. Install torque converter. Ensure torque converter is properly installed. When installation is correct, measurement between torque converter pilot nose and front face of bellhousing will be approximately .403-.568" (10.23-14.43 mm).

NO. 1 THRUST WASHER SELECTION

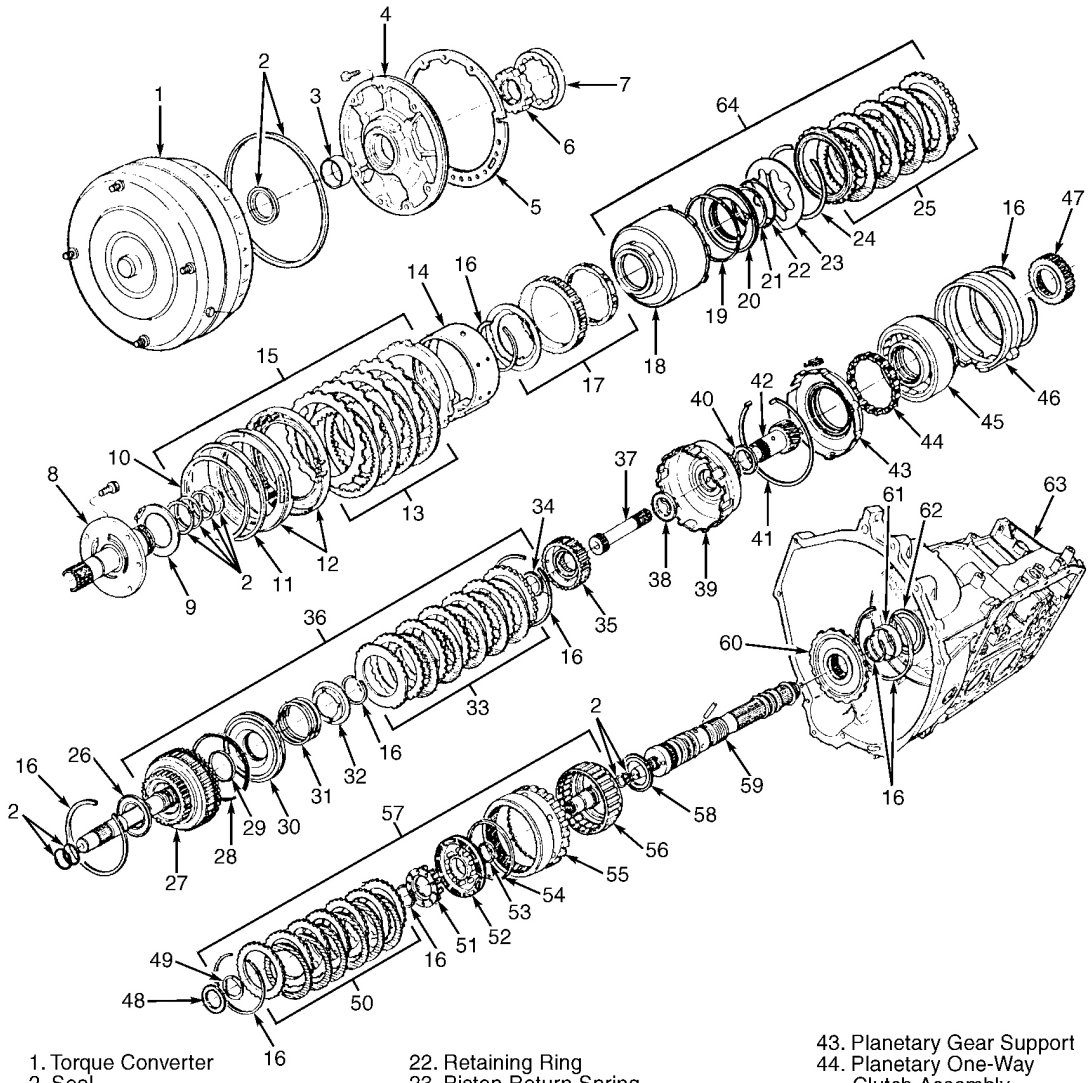
Measured Depth In. (mm)	Washer Thickness In. (mm)	Color Code
1.485-1.503 (37.72-38.17)	.050-.054 (1.27-1.37)	Green
1.504-1.521 (38.20-38.63)	.068-.072 (1.73-1.83)	Yellow
1.522-1.538 (38.65-39.07)	.085-.089 (2.16-2.26)	Natural
1.539-1.555 (39.09-39.50)	.102-.106 (2.59-2.69)	Red
1.556-1.581 (39.52-40.16)	.119-.123 (3.02-3.12)	Blue



1. No. 1 Pump Assembly Selective Thrust Washer
2. No. 2 Forward Clutch Needle Bearing
3. No. 3 Forward Clutch Needle Bearing
4. No. 4 Forward Clutch Sun Gear Needle Bearing
5. No. 5 Forward Clutch Sun Gear Needle Bearing
6. No. 6 Planetary Needle Bearing
7. No. 7 Direct Clutch Needle Bearing
8. Direct Clutch Needle Bearing Support
9. No. 8 Direct Clutch Needle Bearing
10. No. 9 Case Rear Needle Bearing
11. Extension Housing Bushing
12. Case Bushing
13. Output Shaft Bushing
14. Rear Planetary Carrier Bushing
15. Forward Clutch Sun Gear Bushing
16. Reverse Clutch Sun Gear Bushing
17. Front Carrier Bushing
18. Planetary Support Bushing
19. Reverse Clutch Drum Rear Bushing
20. Front Drum Support Bushing
21. Reverse Clutch Drum Front Bushing
22. Front Pump Bushing
23. Front Pump Support Bushing

G96A04376

Fig. 25: Locating Needle & Thrust Bearings
Courtesy of FORD MOTOR CO.



1. Torque Converter
2. Seal
3. Pump Bushing
4. Pump
5. Pump Gasket
6. Inner Gerotor
7. Outer Gerotor
8. Pump Support
9. No. 1 Thrust Washer
10. Inner Intermediate Clutch Piston Seal
11. Outer Intermediate Clutch Piston Seal
12. Intermediate Clutch Piston
13. Intermediate Clutch Pack
14. Overdrive Band
15. Intermediate Clutch Assembly
16. Retaining Ring
17. Intermediate One-Way Clutch Assembly
18. Reverse Clutch Drum
19. Outer Reverse Clutch Piston Seal
20. Reverse Clutch Piston
21. Inner Reverse Clutch Piston Seal
22. Retaining Ring
23. Piston Return Spring
24. Retaining Ring
25. Reverse Clutch Pack
26. No. 2 Thrust Bearing
27. Input Shaft & Forward Clutch Assembly
28. Outer Forward Clutch Piston Seal
29. Inner Forward Clutch Piston Seal
30. Forward Clutch Piston
31. Forward Clutch Piston Return Spring
32. Return Spring Retaining Ring
33. Forward Clutch Pack
34. No. 3 Thrust Bearing
35. Forward Clutch Hub
36. Forward Clutch Assembly
37. Intermediate Shaft
38. No. 4 Thrust Bearing
39. Reverse Clutch Sun Gear
40. No. 5 Thrust Bearing
41. Center Support Retaining Ring
42. Forward Clutch Sun Gear
43. Planetary Gear Support
44. Planetary One-Way Clutch Assembly
45. Planetary Assembly
46. Reverse Band
47. Direct Clutch Hub
48. No. 7 Thrust Washer
49. Washer
50. Direct Clutch Pack
51. Direct Clutch Piston Return Spring
52. Direct Clutch Piston
53. Inner Direct Clutch Piston Seal
54. Outer Direct Clutch Piston Seal
55. Output Shaft Ring Gear
56. Direct Clutch Cylinder
57. Direct Clutch Assembly
58. No. 8 Thrust Bearing
59. Output Shaft
60. Output Shaft Hub
61. Rear Case Bushing
62. No. 9 Thrust Bearing
63. Transmission Case
64. Reverse Clutch Assembly

98H01946

Fig. 26: Exploded View Of 4R70W Transmission
Courtesy of FORD MOTOR CO.

TRANSMISSION SPECIFICATIONS

TRANSMISSION SPECIFICATIONS

Application	In. (mm)
Converter End Play	
New or Rebuilt Converter	.014-.041 (.355-1.04)
Used Converter	.014-.074 (.355-1.88)
Direct Clutch Pack Clearance	
3.8L	.050-.071 (1.27-1.80)
4.2L & 4.6L	.062-.085 (1.57-2.16)
Forward Clutch Pack Clearance	.050-.089 (1.27-2.26)
Intermediate Clutch Pack Clearance	1.634-1.646 (41.50-41.81)
Reverse Clutch Pack Clearance	.040-.060 (1.02-1.52)

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft Lbs. (N.m)
Converter-To-Flywheel Nut	20-34 (27-46)
Converter Housing Cover-To-Converter Housing	12-16 (16-22)
Converter Drain Plug	21-22 (28-30)
Cooler Line-To-Case	15-19 (20-26)
Extension Housing-To-Case Bolt	18-22 (25-30)
Flexplate-To-Crankshaft Bolt	54-64 (73-87)
Manual Lever Shaft Inner/Outer Nut	19-27 (26-37)
Pump-To-Case Bolt	15-19 (20-26)
Stator Support-To-Pump Bolt	15-19 (20-26)
Transmission-To-Engine Bolt	41-50 (55-68)
	INCH Lbs. (N.m)
Detent Spring Attaching Bolt	80-120 (9-14)
Filter-To-Valve Body	80-120 (9-14)
TR Sensor-To-Case Bolt	62-89 (7-10)
Oil Pan-To-Case Bolt	106-130 (12-15)
Output Shaft Speed Sensor Bolt	62-89 (7-10)
Pressure Plug-To-Case	72-144 (8-16)
Reinforcing Plate-To-Valve Body Bolt	80-97 (9-11)
Separator Plate-To-Valve Body Bolt	80-97 (9-11)
Valve Body-To-Case Bolt	80-97 (9-11)

1997-98 AUTOMATIC TRANSMISSIONS

E4OD Overhaul

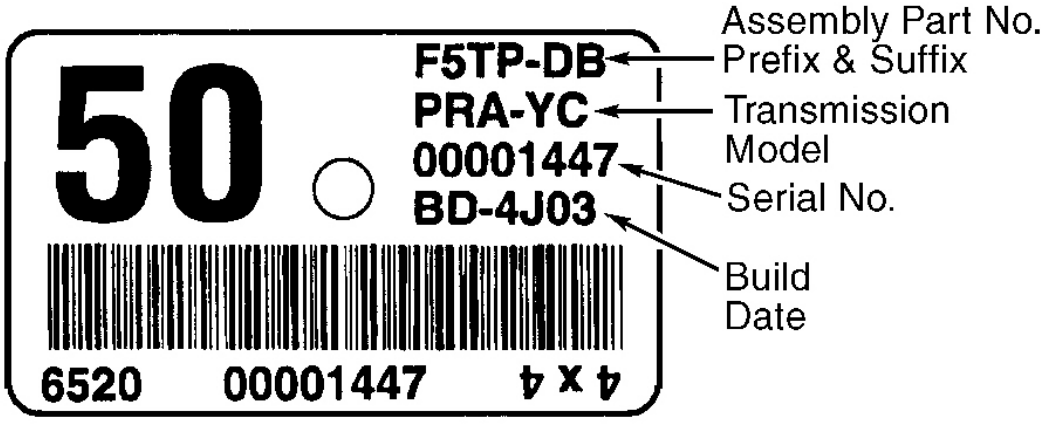
APPLICATION

APPLICATION

Application	Transmission
Expedition/Navigator	5.4L SFI
E150/250/350	5.4L SFI
E350	6.8L SFI
E350	7.3L Diesel
F150/250	5.4L SFI
F250	5.4L CNG
F250/350	5.8L SFI
F250/350	7.3L Diesel
Super Duty	7.3L Diesel
F250/350	7.5L SFI
Super Duty	7.5L SFI

IDENTIFICATION

The E4OD automatic transmission is identified by a tag located on left side of case, to rear of Transmission Range (TR) sensor. Top line of tag shows assembly part number and serial number. Second line on tag shows model number. Last line of tag shows build date. See **Fig. 1** .



G98D01336

Fig. 1: Identification Tag
Courtesy of FORD MOTOR CO.

DESCRIPTION

The E4OD is a fully automatic, electronically controlled, 4-speed automatic overdrive transmission. Transmission consists of torque converter clutch, 6 multiple-disc friction clutches, one band, 2 sprag one-way clutches, a roller one-way clutch and 3 planetary gearsets. See **Fig. 2** .

Shift control solenoids provide gear selection and are controlled by the EEC microprocessor. For additional information on the EEC system, refer to appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.

The EEC system has self-diagnostic capabilities. Fault codes for faulty engine and transmission sensors, switches and circuits are stored in the PCM and may be retrieved to aid diagnosis and repair.

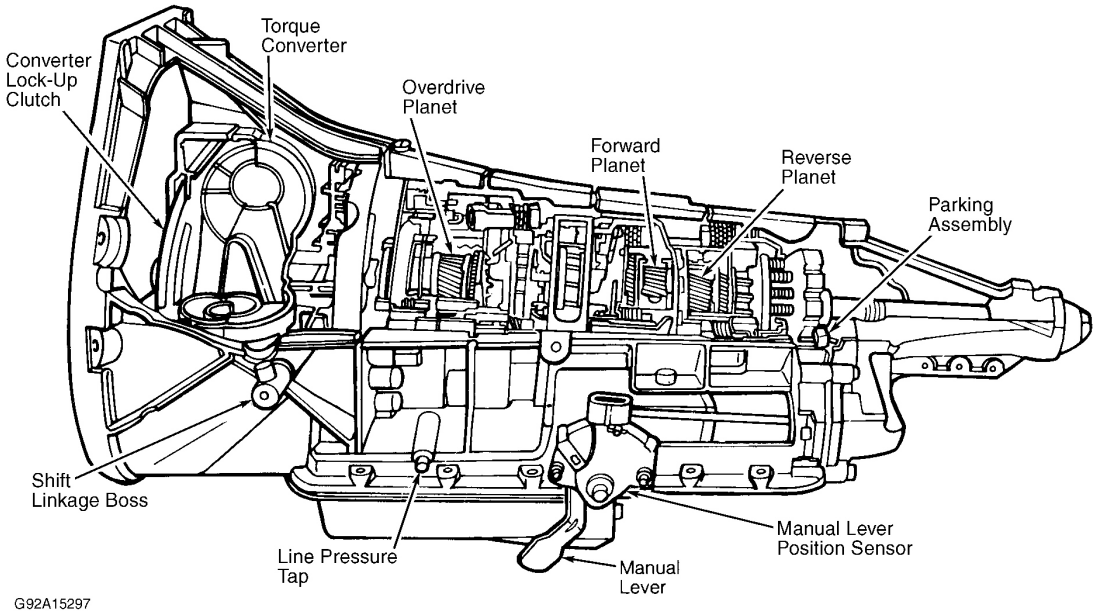


Fig. 2: Cross-Sectional View Of E4OD Automatic Transmission
Courtesy of FORD MOTOR CO.

LUBRICATION & ADJUSTMENTS

See appropriate TRANSMISSION SERVICING - A/T article in AUTOMATIC TRANSMISSION SERVICING section.

ON-VEHICLE SERVICE

EXTENSION HOUSING SEAL & BUSHING

Removal

Raise and support vehicle. Index and remove rear drive shaft. Remove extension seal, using appropriate seal remover. Using appropriate bushing remover, remove extension housing bushing. Ensure extension housing is not scored.

Installation

1. Inspect extension housing bushing bore for burrs and remove burrs with an oil stone, as necessary. Install extension housing bushing, aligning lubrication slot to 6 o'clock position.
2. Install extension housing seal, aligning drain hole to 6 o'clock position. Ensure seal is seated against extension housing. Install drive shaft, aligning index marks.

EXTENSION HOUSING GASKET

Removal

Raise and support vehicle. Index and remove drive shaft(s). Remove parking brake assembly. On 4WD vehicles, remove transfer case. See appropriate TRANSMISSION REMOVAL - A/T article under AUTOMATIC TRANSMISSION SERVICING. Remove transmission mount-to-transmission retaining bolts. Position transmission jack under transmission, and remove transmission mount-to-crossmember bolts. Remove 9 extension housing bolts. Remove extension housing and discard gasket.

Installation

Install NEW housing gasket and position extension housing on case. Ensure parking pawl spring is properly seated in case. Install and tighten bolts to specification. See **TORQUE SPECIFICATIONS** . To complete installation, reverse removal procedure.

PARKING MECHANISM

Removal

Remove extension housing. See **EXTENSION HOUSING GASKET** . Remove parking rod guide plate retaining bolts. Remove parking pawl return spring, parking pawl and parking pawl shaft from case. Remove and discard Torx head bolt (40A) and parking pawl abutment (if required). See **Fig. 3** .

Installation

For installation, reverse removal procedure. Ensure return spring end rests on inside surface of case, and parking rod guide plate dimple is facing inward. Install NEW Torx bolt (if removed). Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

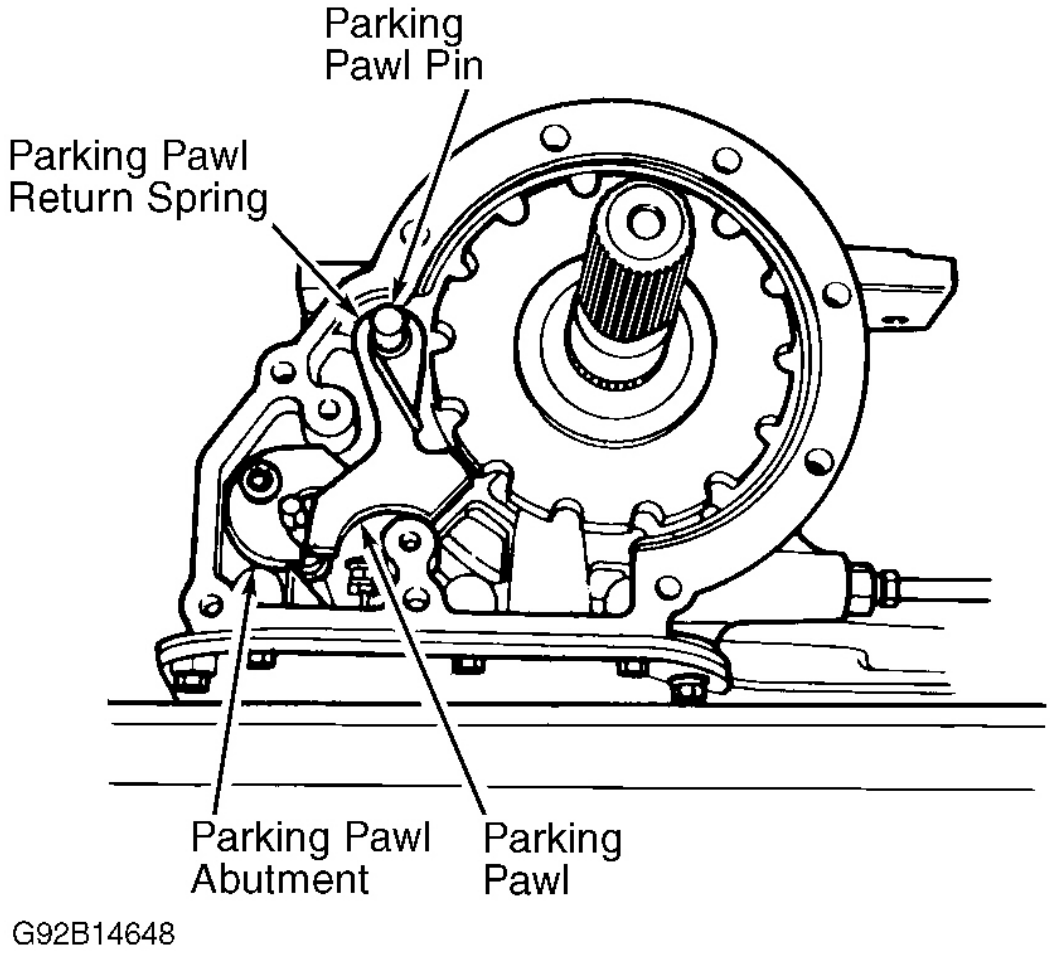


Fig. 3: Removing Parking Mechanism
Courtesy of FORD MOTOR CO.

VALVE BODY & INTERMEDIATE BAND SERVO

NOTE: As valve body is disassembled, place individual parts in correct order and relation to valve body for reassembly. Tag all springs as they are removed.

Removal

1. Remove solenoid body connector heat shield. Remove solenoid body connector by pushing on center tab and pulling on wire harness. DO NOT attempt to pry tab with pry bar or screwdriver. Check electrical connector condition.
2. Loosen oil pan bolts and drain fluid. Remove oil pan, filter and "O" ring. DO NOT scratch or damage aluminum pump bore when removing "O" ring. Remove accumulator body. Remove main control body

retaining bolts. Do not remove center 2 bolts. See **Fig. 4** . This keeps upper and lower valve body together during disassembly. Remove main control body.

3. Remove solenoid body Torx retaining bolts and one nut. Push down on solenoid body connector and remove solenoid body. Remove solenoid screen by rotating and pulling out. See **Fig. 5** . Remove reinforcing plate. Carefully lower separator plate and gasket so check balls, EPC ball and spring are retained.

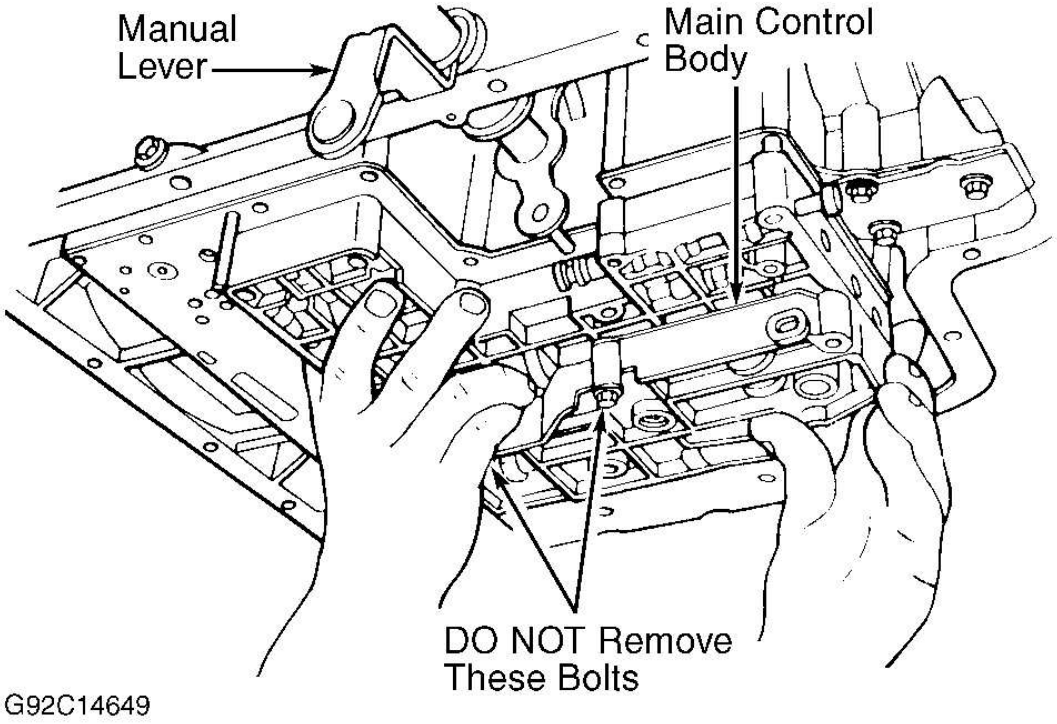


Fig. 4: Removing Main Control Valve Body
Courtesy of FORD MOTOR CO.

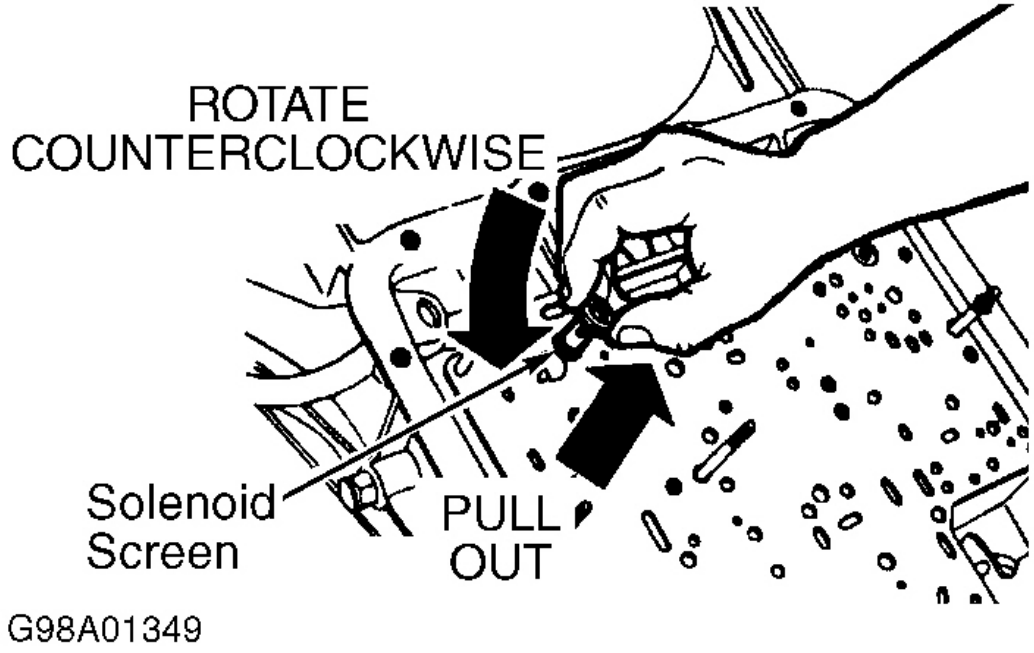


Fig. 5: Removing Solenoid Screen
Courtesy of FORD MOTOR CO.

Installation

1. Clean and inspect valve body thoroughly. DO NOT clean non-metallic check balls with solvent.
2. Install servo spring, servo piston and rod assembly. See **Fig. 6** . Lubricate valve body pockets with petroleum jelly.
3. Place 8 rubber check balls, Electronic Pressure Control (EPC) spring and EPC ball in position. See **Fig. 7** . Install separator plate and gaskets. Tighten retaining bolts to specifications. See TORQUE SPECIFICATIONS. Stamped UP on reinforcing plate MUST be visible.
4. Install solenoid screen and lock in place. Install valve body over studs. Align manual valve with manual lever. Install and tighten retaining bolts to specification. Install accumulator body retaining bolts. Tighten to specification. Coat case connector bore with grease and install solenoid body retaining bolts and nut. Tighten to specification.
5. Install NEW filter and seal assembly. Install oil pan and NEW gasket. Check condition and placement of pan magnet. Tighten pan bolts to specification. Position solenoid body connector into receptacle. Audible click indicates full connection. Install solenoid body connector heat shield with offset bending inward.
6. Add transmission fluid and start engine. Fill transmission to proper level. Test vehicle for proper operation and ensure no leakage is present.

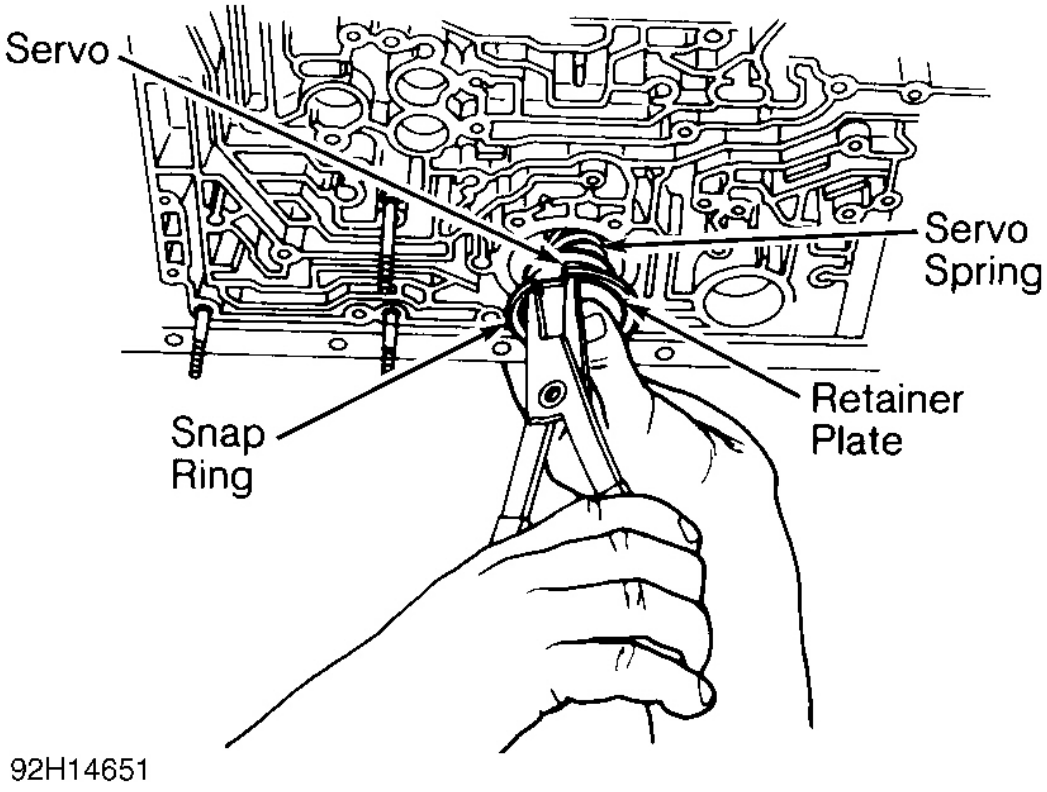


Fig. 6: Installing Intermediate Band Servo
Courtesy of FORD MOTOR CO.

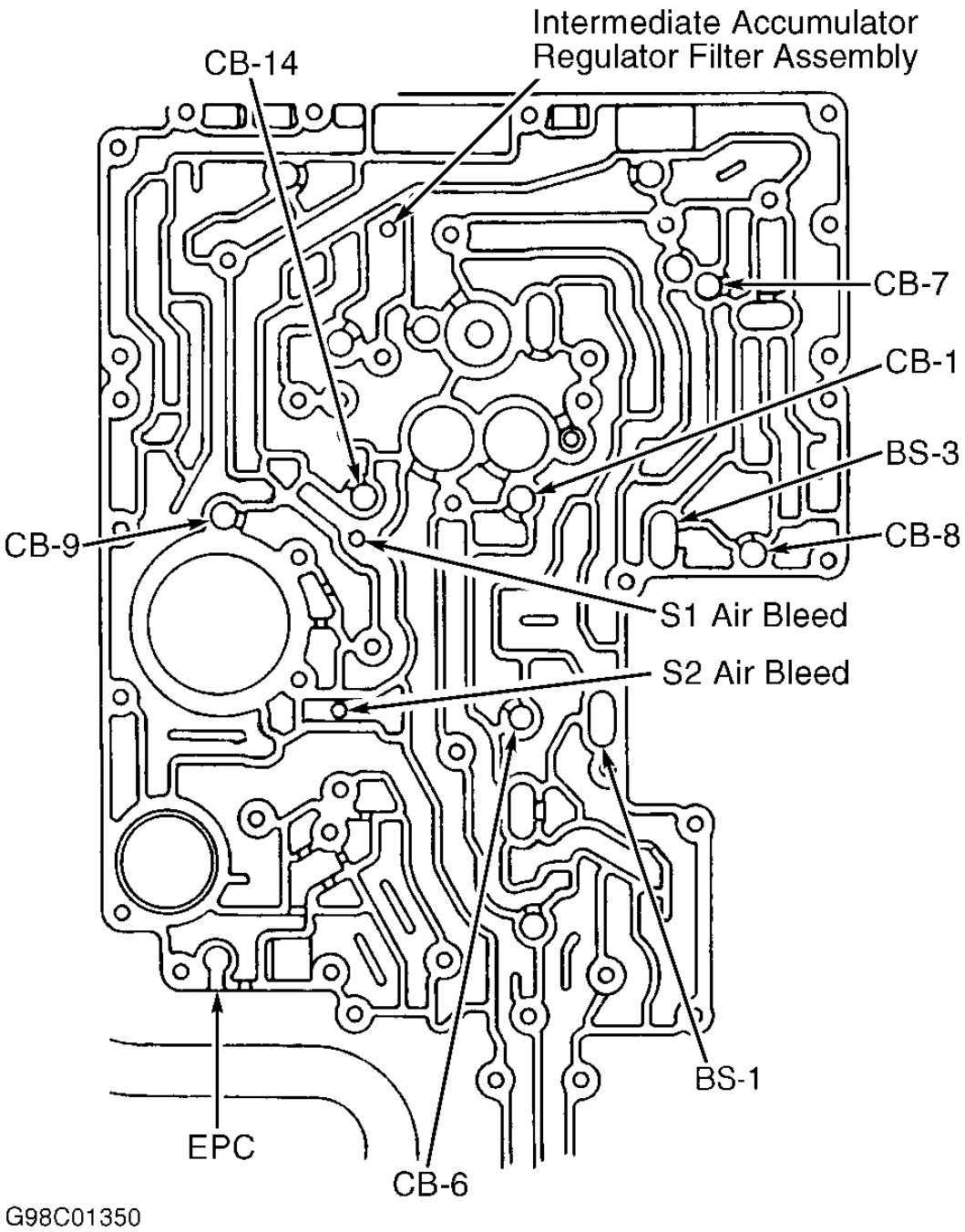


Fig. 7: Locating Valve Body Check Balls
Courtesy of FORD MOTOR CO.

MANUAL LEVER SEAL

Removal

1. Remove manual lever position sensor connector. Remove shift cable from transmission manual lever, using a large screwdriver, pry control cable and fitting from lever ball and stud.
2. Loosen oil pan bolts and drain transmission fluid. Remove oil pan, filter and "O" ring. Discard filter and "O" ring. DO NOT scratch or damage aluminum pump bore.
3. Using Lock Nut Pin Remover (T78P-3504-N), remove manual lever roll pin. See **Fig. 8** . Using a 21-mm box wrench, remove inner detent lever nut. Hold lever with crescent wrench. Remove inner detent lever and park actuating rod assembly from manual lever.
4. Using a 15-mm open end wrench remove and discard outer manual lever shaft nut. Hold lever with crescent wrench. Remove manual lever. Remove sensor retaining bolts. Remove sensor, manual lever shaft and seal.

Installation

1. Clean seal bore opening with solvent. Using appropriate seal driver, install seal. Install manual lever shaft, inner detent lever, park actuating rod assembly and nut. Ensure inner detent lever is seated on flats of shaft, and rod assembly is through guide plate. Inner lever pin MUST BE aligned with manual valve.
2. Tighten inner detent lever nut to specification. See **TORQUE SPECIFICATIONS** . Ensure manual valve detent spring is on inner detent lever and aligned with inner detent.
3. Install manual lever shaft roll pin. Install manual lever position sensor finger tight. Use Gear Position Sensor Adjustor (T92P-70010-AH) to align manual lever position sensor for Neutral gear position. Tighten bolts to specification.
4. Install manual lever and NEW nut. Ensure manual lever is seated on flats of shaft. Tighten manual lever nut to specification. Install manual lever position sensor connector. Install shaft linkage and adjust. See appropriate TRANSMISSION SERVICING - A/T article in AUTOMATIC TRANSMISSION SERVICING.
5. Install NEW filter and "O" ring assembly. Install oil pan and NEW gasket. Check condition and placement of pan magnet. Tighten oil pan retaining bolts to specifications.

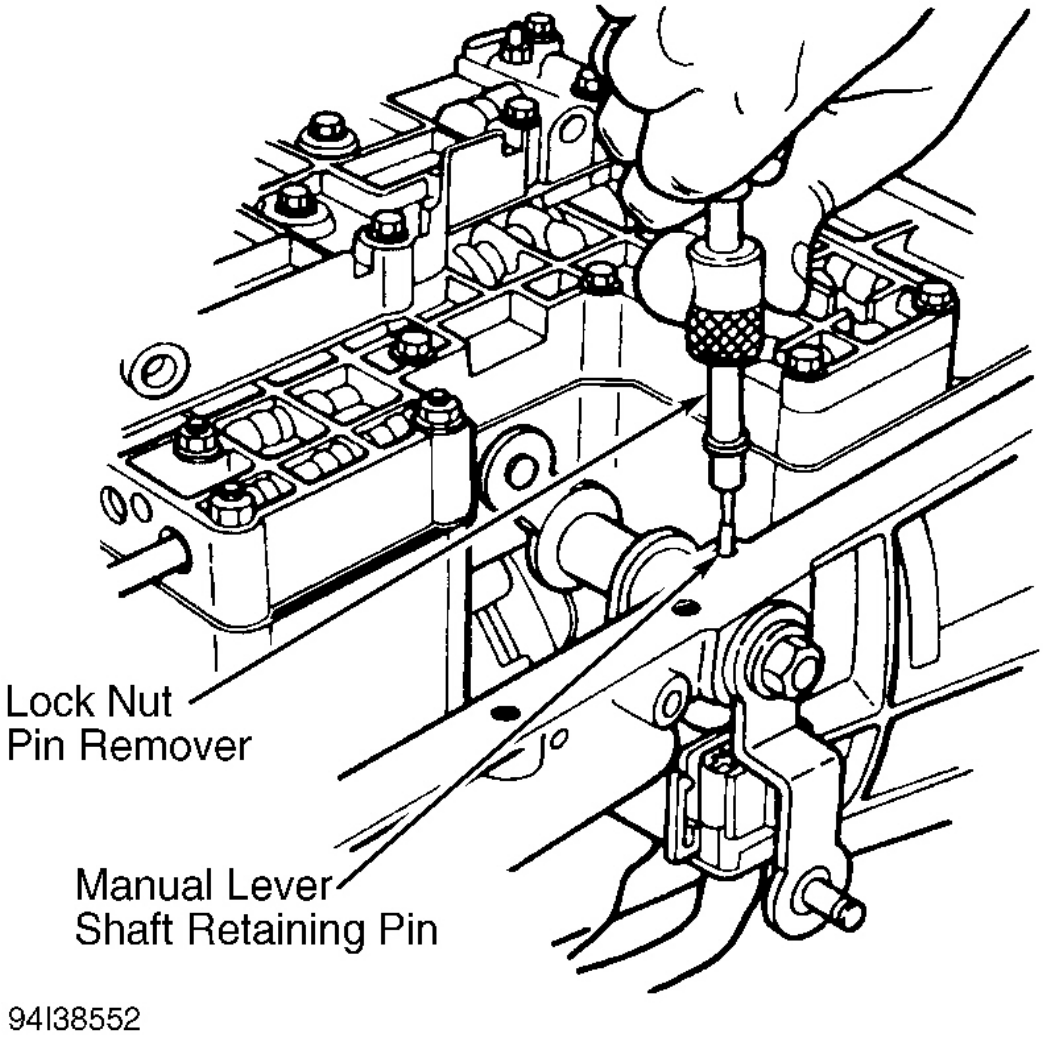


Fig. 8: Removing Manual Lever Shaft Retaining Pin
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

NOTE: **After verifying driveability complaint, perform trouble shooting and testing procedures in this article. For electronic diagnostics and testing, see AUTO TRANS DIAGNOSIS - E4OD ELECTRONIC article.**

NOTE: **For engine-related DTCs, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section. These DTCs pertain to engine performance and must be repaired first, as engine performance and related component signals will**

affect transmission operation and diagnosis.

ENGAGEMENT FAULTS

No Forward Engagement

Fluid level, shift linkage or cable, low line pressure, pump inlet filter and seal assembly, manual valve (stuck or damaged), valve body leakage (gasket damage), improperly torqued valve body bolts, forward clutch assembly (damaged stator support, damaged check ball, loose feed bolt, damaged center support, worn clutch components), forward/reverse sun gear damaged, front planetary assembly damaged, output shaft splines and low one-way clutch assembly.

No Reverse Engagement

Fluid level, shift linkage or cable, low line pressure, pump inlet filter and seal assembly, manual valve (stuck or damaged), valve body leakage (gasket damage), improperly torqued valve body bolts, coast clutch assembly, direct clutch assembly (only if 3rd gear is also inoperative), forward planetary assembly, reverse clutch assembly, reverse planet assembly and reverse ring gear.

Harsh Reverse Engagement

High line pressure, valve body leakage (gasket damage), improperly torqued valve body bolts, Electronic Pressure Control (EPC) solenoid stuck, stuck valve body components (direct clutch accumulator valve and plunger, engagement control valve, direct clutch accumulator regulator valve, springs), pump assembly and direct clutch assembly.

Harsh Forward Engagement

High line pressure, valve body leakage (gasket damage), improperly torqued valve body bolts, Electronic Pressure Control (EPC) solenoid stuck, valve body engagement control valve stuck, pump assembly, direct clutch assembly and forward clutch assembly.

Delayed/Soft Reverse Engagement

Shift linkage or cable, improperly torqued valve body bolts, valve body components (direct clutch accumulator regulator valve, low reverse modulator valve, springs), coast clutch assembly, direct clutch assembly and reverse clutch assembly.

Delayed/Soft Forward Engagement

Fluid level, shift linkage or cable, low line pressure, pump inlet filter or seal assembly, improperly torqued valve body bolts, center support assembly and forward clutch assembly.

No Forward & No Reverse Engagement

Fluid level, internal or external shift linkage, low line pressure, pump inlet filter and seal assembly, manual valve, valve body leakage (improperly torqued bolts), pump assembly (main regulator/booster valve), center

support assembly, forward/reverse sun gear, forward planetary assembly, input shaft, center shaft, output shaft, overdrive carrier assembly and overdrive overrunning clutch (shift selector in OD with OD switch in cancel mode).

Harsh Forward & Reverse Engagement

High line pressure, valve body bolts improperly torqued, EPC solenoid stuck, valve body components (engagement control valve) and pump assembly (main regulator/booster valve).

Delayed/Soft Forward & Reverse Engagement

Shift linkage or cable, fluid level, low line pressure, pump inlet filter and seal assembly, valve body bolts improperly torqued (gasket damage) and torque converter drainback (initial engagement only).

SHIFTING FAULTS

No Shifts

Fluid level, internal or external shift linkage, pump inlet filter/seal assembly and valve body components.

Early/Late Shift Timing

Incorrect tire size, incorrect speedometer gear, mismatched axle ratio, poor engine performance and valve body components.

Erratic Or Hunting Shift Timing

Fluid level, pump inlet filter and seal assembly, valve body components and torque converter clutch.

Soft Or Slipping Shift Feel

Fluid level, low line pressure, valve body bolts improperly torqued (gasket damage, leaks), EPC solenoid, valve body components (line modulator valve, accumulator assembly) and pump assembly.

Harsh Shift Feel

Fluid level, high line pressure, valve body bolts improperly torqued (gasket damage), EPC solenoid, accumulator assembly, valve body components (line modulator valve) and pump assembly.

No 1st Gear, Engages In Higher Gear

Internal or external shift linkage, transmission range sensor (misadjusted/damaged), valve body bolts improperly torqued (gasket damage), shift solenoid 1 and/or 2, valve body components (solenoid regulator valve, 2-3 shift valve, 3-4 shift valve, D2 valve), air bleeds for S1 or S2 circuits missing, damaged band servo or clutches, reverse ring gear and low/reverse one-way clutch.

No Low Gear (Manual 1st)

Internal or external shift linkage, valve body bolts improperly torqued (gasket damage), shift solenoid No. 1, valve body components (manual control valve, low reverse modulator valve, 1-2 shift valve, 2-3 shift valve, BS1 check ball, 4-3-2 timing valve) and low/reverse one-way clutch assembly.

No 2nd Gear (Manual 2nd)

Internal or external shift linkage, improperly torqued valve body bolts, valve body components (2-3 shift valve, 3-4 shift valve, manual 1-2 transition valve, BS1 or BS6 check ball), and intermediate clutch assembly and intermediate one-way clutch assembly.

No 1-2 Shift

Internal or external shift linkage, transmission range sensor (misadjusted/damaged), improperly torqued valve body bolts, valve body components (D2 valve, 1-2 shift valve, 1-2 manual transition valve, intermediate clutch accumulator regulator valves, springs), shift solenoid No. 2, intermediate clutch assembly and intermediate one-way clutch assembly.

No 2-3 Shift

Improperly torqued valve body bolts, valve body components (2-3 shift valve, direct clutch accumulator regulator valves, springs), shift solenoid No. 1, direct clutch assembly and center support assembly.

No 3-4 Shift

Improperly torqued valve body bolts (gasket damage), shift solenoid No. 1, shift solenoid No. 2, valve body components (overdrive accumulator regulator valve, 3-4 shift valve, overdrive one-way clutch assembly, overdrive clutch assembly and overdrive planetary assembly.

No 4-3 Shift

Improperly torqued valve body bolts (gasket damaged), shift solenoid No. 2 and valve body components (check ball BS2, 3-4 shift valve).

No 3rd To 2nd Shift

Improperly torqued valve body bolts (gasket damaged), shift solenoid No. 1 and valve body components (3-2 shift valve).

No 2-1 Shift

Improperly torqued valve body bolts (gasket damaged), shift solenoid No. 2 and valve body components (D2 shift valve).

Soft/Slipping 1-2 Shift

Improperly torqued valve body bolts (gasket damaged), valve body components (intermediate clutch accumulator regulator valve or plunger) and intermediate clutch assembly.

Soft/Slipping 2-3 Shift

Improperly torqued valve body bolts (gasket damaged), valve body components (direct clutch accumulator regulator valve or plunger), center support assembly and direct clutch assembly.

Soft/Slipping 3-4 Shift

Improperly torqued valve body bolts (gasket damaged), valve body components (overdrive accumulator regulator valve and spring, overdrive accumulator plunger and springs) and overdrive clutch assembly.

Soft/Slipping Downshifts

Improperly torqued valve body bolts (gasket damaged) and valve body components (check ball CB7, damage valve body separator plate).

Harsh 1-2 Shift

Improperly torqued valve body bolts (gasket damaged), valve body components (intermediate clutch accumulator regulator valve or plunger springs) and intermediate clutch assembly.

Harsh 2-3 Shift

Improperly torqued valve body bolts (gasket damaged), valve body components (direct clutch accumulator valve or plunger), center support assembly and direct clutch assembly.

Harsh 3-4 Shift

Improperly torqued valve body bolts (gasket damaged), valve body components (overdrive accumulator regulator valve or plunger) and overdrive clutch assembly.

Harsh 4-3 Shift

Improperly torqued valve body bolts (gasket damaged), check ball CB7 missing and separator plate damaged.

Harsh 3-2 Shift

Improperly torqued valve body bolts (gasket damaged), check ball CB6 missing and separator plate damaged.

Harsh 2-1 Shift

Improperly torqued valve body bolts (gasket damaged), check ball CB14 missing and separator plate damaged.

No Torque Converter Clutch Application

Improperly torqued valve body bolts (gasket damaged), torque converter clutch solenoid, transmission oil temperature sensor, pump assembly (converter clutch control valve and regulator valve stuck), stator support and torque converter assembly.

Torque Converter Clutch Always Applied (Stalls Vehicle In

Drive & Manual 2nd Gear Only)

Low line pressure, improperly torqued valve body bolts (gasket damaged), torque converter clutch solenoid, pump assembly (converter clutch control valve) and torque converter assembly.

Torque Converter Clutch Cycling/Shudder/Chatter

Fluid condition, improperly torqued valve body bolts (gasket damaged), torque converter clutch solenoid, pump assembly, stator support and torque converter assembly.

MISCELLANEOUS FAULTS

No Park Range

Misadjusted internal or external shift linkage, park mechanism components and transfer case and linkages (4WD).

Transmission Overheating

Fluid level and condition, transmission cooling system, poor engine performance and torque converter clutch.

No Engine Braking In Manual 2nd Gear

Improperly torqued valve body bolts (gasket damaged), check balls BS1, BS2 and BS6 missing or damaged, check balls BS1, BS6 and CB1 missing or damaged, valve body separator plate, valve body components (4-3-2 timing valve, D2 valve, 2-3 shift valve, coast clutch shift valve, 1-2 manual transition valve, 3-4 shift valve), coast clutch assembly and intermediate servo/band assembly.

No Engine Braking In Manual 1st Gear

Improperly torqued valve body bolts (gasket damaged), check balls BS1 and CB1 missing or damaged, valve body components (3-4 shift valve, low reverse clutch modulator valve, D2 valve, 4-3-2 timing valve, 2-3 shift valve, coast clutch shift valve), valve body separator plate, coast clutch assembly and low reverse clutch assembly.

No Engine Braking With Overdrive Switch Cancelled (Manual 1st & Manual 2nd Have Engine Braking)

Improperly torqued valve body bolts (gasket damaged) and valve body components (coast clutch solenoid, check ball BS3, separator plate, 3-4 shift valve).

Fluid Venting/Foaming

Blocked or damaged vent, overfilled, fluid contamination (coolant or water), overheating, pump inlet filter and seal, and pump to case gasket damage.

CLUTCH & BAND APPLICATION

CLUTCH & BAND APPLICATION

Selector Lever Position	Elements In Use
"OD" (Overdrive)	
1st Gear	Forward Clutch, Planetary One-Way Clutch
2nd Gear	Intermediate Clutch, Forward Clutch & Intermediate One-Way Clutch
3rd Gear	Forward Clutch, Intermediate Clutch Direct Clutch & Overdrive One-Way Clutch
4th Gear	Forward Clutch, Intermediate Clutch Overdrive Clutch & Direct Clutch
"2"	Coast Clutch, Forward Clutch, Intermediate Clutch, Intermediate Band, Intermediate One-Way Clutch & Overdrive One-Way Clutch
"1"	Coast Clutch, Forward Clutch, Low/Reverse Clutch, Overdrive One-Way Clutch & Low Reverse One-Way Clutch
"R"	Coast Clutch, Direct Clutch, Low Reverse Clutch & Overdrive One-Way Clutch

TESTING

Check fluid level and correct if necessary. See appropriate TRANSMISSION SERVICING - A/T article in AUTOMATIC TRANSMISSION SERVICING. Use initial road test to verify transmission malfunction. Ensure engine is operating properly.

ROAD TEST

1. Check minimum throttle upshifts in overdrive. Transmission should start in 1st gear and shift automatically into and through each gear at pre-determined specifications. See appropriate **SHIFT SPEEDS SPECIFICATIONS (MPH)** .
2. With transmission in 4th gear (overdrive), depress overdrive cancel switch. Transmission should downshift to 3rd gear.
3. Depress accelerator pedal to floor (WOT). Transmission should downshift from 3rd to 2nd or 1st gear, depending on vehicle speed. See appropriate **SHIFT SPEEDS SPECIFICATIONS (MPH)** .
4. When traveling above 50 MPH at less than half throttle, move transmission from Overdrive to 2nd gear and release accelerator pedal. Transmission should immediately downshift into 2nd gear. With vehicle in 2nd gear, move selector to 1st gear and release accelerator pedal. Transmission should downshift to 1st gear at less than 30-35 MPH.

SHIFT SPEEDS SPECIFICATIONS (MPH)

NOTE: Shift speeds are approximate. All shift speeds may vary somewhat due to

production tolerances, rear axle ratios or emission control equipment. Ensure all tires are factory recommended sizes.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.08②	3.31③	3.55②	3.73③
Light Throttle	Ⓓ or D	1-2	16-19	15.5-18	13.5-17	13.5-16
	Ⓓ or D	2-3	28-32	27.5-30.5	24-29	24-27
	Ⓓ	3-4	48-54.5	47-51.5	42-49.5	42-45.5
	Ⓓ	4-3	42-47.5	41-42.5	36.5-43	36.5-40
	Ⓓ or D	3-2	17.5-21	17.5-20	15.5-19	15.5-17.5
	Ⓓ or D	2-1	9	8.5-10.5	8-10	7.5-9.5
Wide Open Throttle (WOT)	Ⓓ or D	1-2	44-50	43-47	38-45	38-41.5
	Ⓓ or D	2-3	77-86	75-81	66.5-77.5	66.5-72
	Ⓓ	3-4	106-118	103.5-111	92-106.5	92-98.5
	Ⓓ	4-3	97-108.5	95-102	84.5-98	84.5-90.5
	Ⓓ or D	3-2	70.5-79	69-74.5	61-71.5	61-66
	Ⓓ or D	2-1	35-40	35-37.5	30-36	30-33.5

① Nominal shift speed at sea level is shown. Actual shift speed will depend on tire brand and size.
② F-150
③ F-250
G98F01337

Fig. 9: 5.4L F150/250
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.55②	3.73③
Light Throttle	Ⓓ or D	1-2	13.5-16.5	13-15.7
	Ⓓ or D	2-3	22-26	21.5-25.5
	Ⓓ	3-4	44.5-51	44-50
	Ⓓ	4-3	34-39	33.5-38
	Ⓓ or D	3-2	17-20	16.5-19.5
	Ⓓ or D	2-1	9-11.5	9-11
Wide Open Throttle	Ⓓ or D	1-2	37-42.5	36.5-41.5
	Ⓓ or D	2-3	66.5-75	65.5-73
	Ⓓ	3-4	94.5-106	93.5-103.5
	Ⓓ	4-3	79.5-89.5	78.5-87
	Ⓓ or D	3-2	62-70	61.5-68.5
	Ⓓ or D	2-1	33-38	32.5-37

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.
② E-350
③ E-250
G98H01338

Fig. 10: 5.4L E150/250/350
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.55	Vehicle Speed① Axle Ratios 4.10
Light Throttle	Ⓓ or D	1-2	14-16.5	12.5-14
	Ⓓ or D	2-3	23-26.5	20.5-22
	Ⓓ	3-4	46.5-52.5	42-43.5
	Ⓓ	4-3	35.5-40	31.5-33.5
	Ⓓ or D	3-2	17.5-20.5	15.5-17
	Ⓓ or D	2-1	9.5-11.5	8.5-10
Wide Open Throttle	Ⓓ or D	1-2	38.5-43.5	35-36.5
	Ⓓ or D	2-3	69-77	62-64
	Ⓓ	3-4	98-108.5	88.5-90.5
	Ⓓ	4-3	82.5-91.5	74.5-90.5
	Ⓓ or D	3-2	64.5-72	58-60
	Ⓓ or D	2-1	34-39	30.5-32.5

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.

98J01339

Fig. 11: 5.4L E250/350
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.31	Vehicle Speed① Axle Ratios 3.73
Light Throttle	Ⓓ or D	1-2	15.5-18	13.5-16.5
	Ⓓ or D	2-3	27-30	24-28
	Ⓓ	3-4	46.5-51	41-47.5
	Ⓓ	4-3	40.5-44.5	35.3-41.5
	Ⓓ or D	3-2	17-19.5	15.3-18.5
	Ⓓ or D	2-1	8.5-10.5	7.5-10
Wide Open Throttle (WOT)	Ⓓ or D	1-2	42.5-46.5	37.5-43.5
	Ⓓ or D	2-3	74-81	65.5-75
	Ⓓ	3-4	102.5-111	90.5-103.5
	Ⓓ	4-3	94-102	83-95
	Ⓓ or D	3-2	68-74	60-69
	Ⓓ or D	2-1	33.5-37.5	30-35

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.

98B01340

Fig. 12: 5.4L Expedition & Navigator
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratio 3.73
Light Throttle	Ⓓ or D	1-2	19.5-23
	Ⓓ or D	2-3	33-38.5
	Ⓓ	3-4	47.5-55
	Ⓓ	4-3	38-44
	Ⓓ or D	3-2	17-21
	Ⓓ or D	2-1	7.5-10
Wide Open Throttle	Ⓓ or D	1-2	36.5-42
	Ⓓ or D	2-3	61.5-70.5
	Ⓓ	3-4	85.5-97
	Ⓓ	4-3	75.5-86
	Ⓓ or D	3-2	47-54.5
	Ⓓ or D	2-1	21.5-25.5

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.
98D01341

Fig. 13: 5.4L CNG F250
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratio 3.73
Light Throttle	Ⓓ or D	1-2	17-21
	Ⓓ or D	2-3	32-39
	Ⓓ	3-4	45.5-53
	Ⓓ	4-3	35-44
	Ⓓ or D	3-2	17-21
	Ⓓ or D	2-1	7-9.5
Wide Open Throttle	Ⓓ or D	1-2	34-41
	Ⓓ or D	2-3	59-64
	Ⓓ	3-4	82-86
	Ⓓ	4-3	75-85
	Ⓓ or D	3-2	47-54.5
	Ⓓ or D	2-1	38-34

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.
98F01342

Fig. 14: 5.4L CNG E250/350
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.55	4.10
Light Throttle	Ⓓ or D	1-2	13.5-16.5	12.5-15
	Ⓓ or D	2-3	25-29	23-27
	Ⓓ	3-4	42-47.5	40-45.5
	Ⓓ	4-3	34.5-39.5	32.5-37.5
	Ⓓ or D	3-2	15.5-18.5	23-27
	Ⓓ or D	2-1	8-10	7-9
Wide Open Throttle (WOT)	Ⓓ or D	1-2	34-39.5	32.5-37.5
	Ⓓ or D	2-3	62-69.5	59-66.5
	Ⓓ	3-4	85-94.5	79-88.5
	Ⓓ	4-3	79-88.5	74.5-83.5
	Ⓓ or D	3-2	56.5-73.5	51.5-58
	Ⓓ or D	2-1	29-33	26-30

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.

G98H01343

Fig. 15: 5.8L F250/350
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.73②	4.10②	4.63③
Light Throttle	Ⓓ or D	1-2	11-12	10-11	8.5-9.5
	Ⓓ or D	2-3	19.5-20.5	17.5-18.5	14.5-15.5
	Ⓓ	3-4	36-37	32.5-33.5	29-30
	Ⓓ	4-3	35-36	31.5-32.5	27.5-28.5
	Ⓓ or D	3-2	17.5-18.5	16.5-17.5	13.5-14.5
	Ⓓ or D	2-1	10-11	9-10	7.5-8.5
Wide Open Throttle (WOT)	Ⓓ or D	1-2	36.5-37.5	36.5-37.5	29.5-31.5
	Ⓓ or D	2-3	65.5-66.5	64.5-65.5	53-54
	Ⓓ	3-4	91.5-92.5	94.5-95.5	76.5-77.5
	Ⓓ	4-3	89.5-90.5	85.5-86.5	71.5-72.5
	Ⓓ or D	3-2	63.5-64.5	60-61	47.5-48.5
	Ⓓ or D	2-1	34.5-35.5	31.5-32.5	25.5-26.5

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.
② E-350
③ E-Series Super Duty

G98J01344

Fig. 16: 6.8L E350 & "E" - Series Super Duty
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.55③	4.10②③
Light Throttle	Ⓓ or D	1-2	11.5-14	10-12.5
	Ⓓ or D	2-3	20.5-24	18-21
	Ⓓ	3-4	37.5-42.5	32.5-37
	Ⓓ	4-3	35.5-40	30.5-34.5
	Ⓓ or D	3-2	18.5-21.5	16-19
	Ⓓ or D	2-1	9.5-11.5	8-10.5
Wide Open Throttle (WOT)	Ⓓ or D	1-2	24.5-28.5	21-24.5
	Ⓓ or D	2-3	49-54.5	42-47.5
	Ⓓ	3-4	74.5-83	64.5-72
	Ⓓ	4-3	69-77	59.5-66.5
	Ⓓ or D	3-2	43-48.5	37.5-42
	Ⓓ or D	2-1	18.5-21.5	16-19

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.
② E-Super Duty
③ E-350
G98C01345

Fig. 17: 7.3L Diesel E350 & "E" - Series Super Duty
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.55③	4.10③	4.63②	5.13②
Light Throttle	Ⓓ or D	1-2	12-14.5	10.5-13	9.5-11.5	8.5-10.5
	Ⓓ or D	2-3	21.5-25	18.5-21.5	17-19.5	15.5-17.5
	Ⓓ	3-4	39-44	33.5-38	31-34	28-30.5
	Ⓓ	4-3	36.5-41.5	31.5-36	29-32	26-29
	Ⓓ or D	3-2	19-22.5	16.5-19.5	15-17.5	13.5-15.5
	Ⓓ or D	2-1	9	8.5-10.5	7.5-9.5	7-8.5
Wide Open Throttle (WOT)	Ⓓ or D	1-2	25.5-29.5	22-25.5	20-22.5	18-20.5
	Ⓓ or D	2-3	50.5-57	43.5-49.5	40.5-43.5	36.5-39.5
	Ⓓ	3-4	77-86	66.5-74.5	61.5-66	55.5-60
	Ⓓ	4-3	71.5-80	61.5-69	57-61.5	51.5-55.5
	Ⓓ or D	3-2	44.5-50.5	38.5-44	35.5-39	32-35
	Ⓓ or D	2-1	19-22.5	16.5-19.5	15-17.5	13.5-15.5

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.
② F Super Duty
③ F-250HD, F-350
G98E01346

Fig. 18: 7.3L Diesel F250/350 "F" - Series Super Duty
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 3.55	4.10	5.13②
Light Throttle	Ⓓ or D	1-2	13-15.5	10.5-13	8-10.5
	Ⓓ or D	2-3	22.5-26	18-21	14-17
	Ⓓ	3-4	42-47.5	34-38.5	27-31
	Ⓓ	4-3	39-44	31.5-36	25-29
	Ⓓ or D	3-2	19.5-22.5	15.5-18.5	12-15
	Ⓓ or D	2-1	12-14.5	8-10.5	6.5-8.5
Wide Open Throttle (WOT)	Ⓓ or D	1-2	39.5-45	33-38	26-30.5
	Ⓓ or D	2-3	69.5-78	58.4-66	46.5-53
	Ⓓ	3-4	99.5-111	85-94.5	67.5-76
	Ⓓ	4-3	94-104.5	79.5-88.5	63.5-71.5
	Ⓓ or D	3-2	61-68.5	52-58.5	41.5-47
	Ⓓ or D	2-1	34-39	28-32.5	22.5-26

① Nominal shift speed at sea level is shown. Actual shift speed will depend on the tire brand and size.
② F-Series Cab/Motorhome only.
98G01347

Fig. 19: 7.5L F250/350 & "F" - Series Super Duty (Greater Than 8500 GVW)
Courtesy of FORD MOTOR CO.

Throttle Opening	Drive Range	Shift	Vehicle Speed① Axle Ratios 4.63	5.13
Light Throttle	Ⓓ or D	1-2	9.5-11.5	8.5-10.5
	Ⓓ or D	2-3	16.5-19	15-16.5
	Ⓓ	3-4	31-34	28-30
	Ⓓ	4-3	29-32	26.5-28
	Ⓓ or D	3-2	14-16.5	13-14.5
	Ⓓ or D	2-1	7.5-9.5	6.5-8.5
Wide Open Throttle (WOT)	Ⓓ or D	1-2	30.5-33.5	27.5-29.5
	Ⓓ or D	2-3	54.5-58.5	49-51
	Ⓓ	3-4	78.5-84	71-72.5
	Ⓓ	4-3	74-79	66.5-68.5
	Ⓓ or D	3-2	48-52	43.5-45
	Ⓓ or D	2-1	26-29	23.5-25

98I01348

Fig. 20: 7.5L "F" - Series Super Duty
Courtesy of FORD MOTOR CO.

CAUTION: Perform line pressure test before stall speed test. If line pressure is low at stall, do not perform stall speed test or transmission damage will occur. Do not maintain Wide Open Throttle (WOT) in any gear for more than 5 seconds. If engine RPM exceeds maximum specified stall speed, release accelerator immediately. Clutch or band slippage is indicated.

LINE PRESSURE TEST

1. Connect a 0-300 psi (0-21.1 kg/cm^2) pressure gauge to line pressure tap on left side of transmission case just forward of control lever. See **Fig. 21** .
2. With engine at normal operating temperature, apply parking and service brakes. Check line pressure in all

ranges. Pressure should be approximately as specified. See **LINE PRESSURE SPECIFICATIONS** .

LINE PRESSURE SPECIFICATIONS

Drive Range	Idle psi (kg/cm^2)	WOT Stall psi (kg/cm^2)
"P", "N"	50-65 (3.5-4.6)	(Not Applicable)
"R"	70-100 (4.9-7.0)	245-290 (17.2-20.4)
"OD", "2"	50-65 (3.5-4.6)	165-185 (11.6-13.0)
"1"	70-100 (4.9-7.0)	175-210 (12.3-14.8)

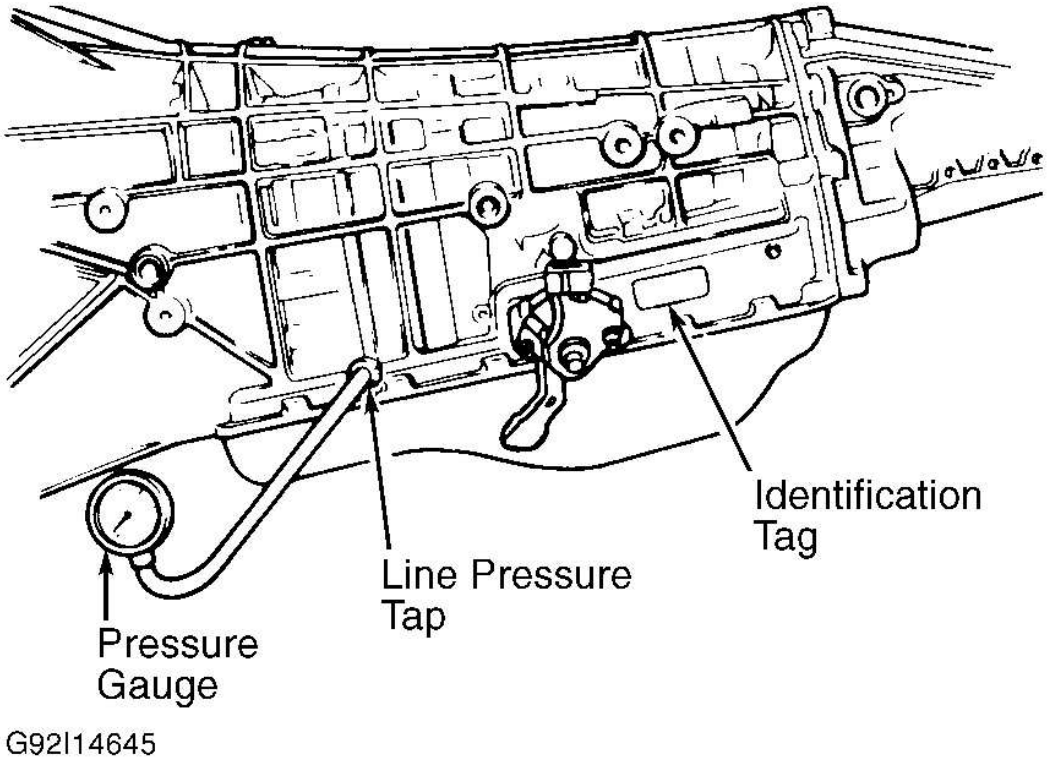


Fig. 21: Testing With Pressure Gauge
Courtesy of FORD MOTOR CO.

LINE PRESSURE TEST RESULTS

Compare recorded line pressures with. See **LINE PRESSURE SPECIFICATIONS** under LINE PRESSURE TEST. If line pres-sures are outside of specified ranges, use following list to determine cause of trouble.

High At Idle In All Ranges

Check main regulator valve, solenoid body and wiring harness.

Low At Idle In All Ranges

Check for low fluid level, restricted intake filter, loose main body, solenoid body or accumulator body-to-case bolts. Excessive leakage in pump, case control bodies, sticking main regulator valve or damaged inlet tube seal.

Low In "P" Or "N"

Check valve body.

Low In "OD"

Check forward clutch and valve body.

Low In "2"

Check forward clutch, coast clutch, intermediate band servo and valve body.

Low In "1"

Check forward clutch, low-reverse clutch, coast clutch and valve body.

Low In "R"

Check separator plate, coast clutch, low-reverse clutch, direct clutch and valve body.

CONVERTER CLUTCH TEST

NOTE: Due to the difficulty of feeling converter clutch shift, a tachometer and/or vacuum gauge MUST be connected to engine.

1. To check converter for engagement and disengagement, drive vehicle at approximately 50 MPH in overdrive and lightly tap brake pedal. Engine RPM and vacuum should increase when clutch disengages. Engine RPM will decrease about 5 seconds after pedal is released. If this does not occur, see AUTO TRANS DIAGNOSIS - E4OD ELECTRONIC article.
2. Stop vehicle. If vehicle stalls at idle in overdrive, shift transmission to 1st gear. If vehicle stalls in 1st gear, repair or replace converter control valve in pump. If vehicle does not stall in 1st gear, see AUTO TRANS DIAGNOSIS - E4OD ELECTRONIC article.

STALL SPEED TEST

CAUTION: Do not maintain Wide Open Throttle (WOT) in any gear for more than 5 seconds. If engine RPM exceeds maximum specified stall speed, release accelerator immediately. Clutch or band slippage is indicated.

Testing Precautions

1. Engine coolant and transmission fluid MUST be at proper level and operating temperature. Hold accelerator down long enough to stabilize tachometer. DO NOT hold at WOT for more than 5 seconds.
2. DO NOT exceed maximum specified RPM for vehicle. After testing each range, run engine in Neutral at 1000 RPM for 15 seconds to cool torque converter. If engine speed exceeds specification, release accelerator immediately, as this indicates clutch or band slippage.

Testing Procedure

Connect tachometer to engine. Apply parking and service brakes firmly. Stall test transmission in each driving range at WOT. Note maximum RPM obtained. Engine speed should be within limits. See **STALL SPEED SPECIFICATIONS** . If maximum RPM obtained is not within specifications, see **STALL SPEED TEST RESULTS** .

STALL SPEED SPECIFICATIONS

Vehicle Application	Engine Size	Stall Speeds (RPM)
1997 Models		
E150, Expedition, F150/250	5.4L SFI	2258-2652
E250/350 (8550 GVW)	5.4L SFI	2250-2633
F250/350 (8550 GVW)	5.8L SFI	2256-2705
E350/Super Duty	6.8L SFI	1866-2253
F250/350/Super Duty	7.3L Diesel	1951-2282
E350/Super Duty	N/A	N/A
F250/350/Super Duty	7.5L	1972-2350
1998 Models		
E150, Expedition, F150/250	5.4L SFI	2248-2631
E250/350, F250/350	5.4L SFI	2238-2613
F250/350 (8550 GVW)	5.8L SFI	2256-2705
E350/Super Duty	6.8L SFI	1911-2283
E250/350/Super Duty	7.3L Diesel	1950-2285
F250/350/Super Duty	7.3L Diesel	2048-2380
F250/350/Super Duty	7.5L	1972-2350

STALL SPEED TEST RESULTS

Low In All Ranges

Poor engine performance. Faulty torque converter reactor one-way clutch.

High In All Ranges

General transmission problems are indicated. Perform control pressure tests.

High In "OD" Only

Forward clutch, overdrive one-way clutch or low-reverse one-way clutch faulty.

High In "2" Only

Forward clutch, or overdrive one-way clutch and coast clutch faulty.

High In "1" Only

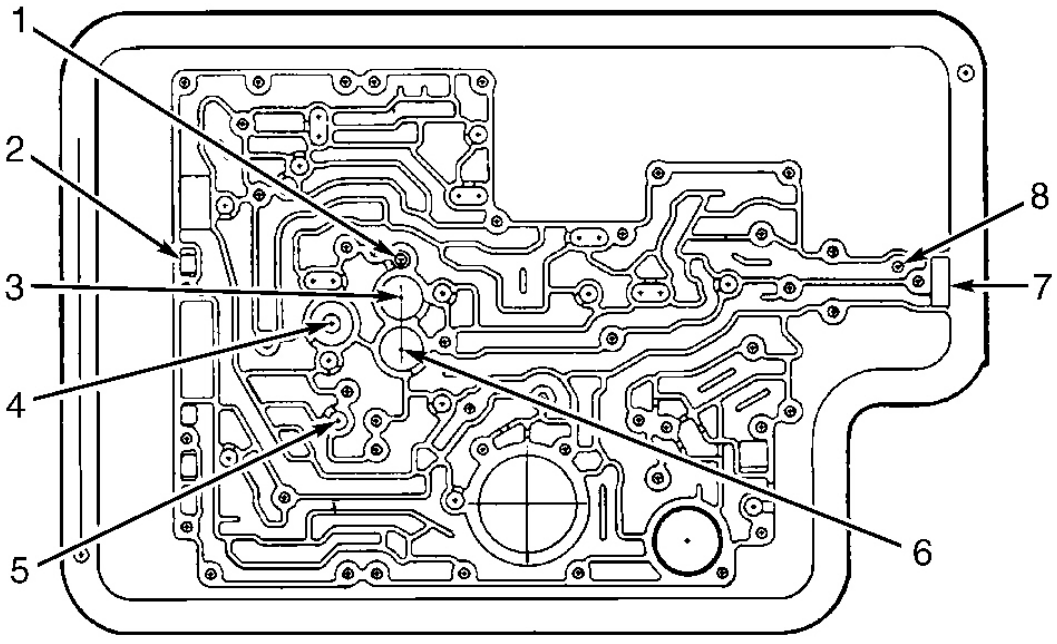
Forward clutch, or reverse clutch and low-reverse one-way clutch, or coast clutch and overdrive one-way clutch faulty.

High In "R" Only

Direct clutch, or overdrive one-way clutch and coast clutch, or low-reverse clutch faulty.

AIR PRESSURE CHECKS

1. A "No Drive" condition can exist, even with correct transmission fluid pressure, due to inoperative clutches or bands. Inoperative units can be located by substituting air pressure for fluid pressure to determine location of malfunction.
2. To check unit, drain transmission fluid. Remove oil pan, filter, seal assembly, solenoid body and valve body.
3. Forward, coast, reverse, overdrive, direct and intermediate clutch operation may be checked as follows: Using shop air, apply air to proper points. See **Fig. 22** . A dull thud can be heard when clutch piston is applied. If no thud is heard, movement of piston can be felt by placing finger tips on input shell. If seals are leaking, a hissing sound will be heard.



1. Direct Clutch Feed
2. Coast Clutch Feed
3. Forward Clutch Feed
4. Overdrive Clutch Feed
5. Intermediate Clutch Feed
6. Intermediate Lube
7. Rear Lube
8. Low-Reverse Clutch Feed

G92J14646

Fig. 22: Locating Air Pressure Test Points
Courtesy of FORD MOTOR CO.

COMPONENT TESTS

TORQUE CONVERTER

Whenever transmission has been disassembled to replace worn or damaged parts, converter and oil cooler MUST BE cleaned using a mechanically agitated cleaner. Under NO conditions should converter or oil cooler be cleaned by hand agitation using solvent.

Leak Test

If torque converter welds indicate leakage, attach appropriate torque converter leak detector to converter and follow detector kit instructions.

Turbine & Stator End Play Check

1. Insert End Play Tester (T80L-7902-D) into converter pump drive hub until tester bottoms. Expand sleeve in turbine spline by tightening threaded inner post of tester until tester is securely locked into spine.
2. Attach a dial indicator to tool with indicator button on converter housing. See **Fig. 23** . Zero dial face. Lift tool upward as far as possible and note indicator reading.
3. Reading is total end play of turbine and stator. Replace torque converter assembly if end play exceeds specification. See **TORQUE CONVERTER END PLAY SPECIFICATIONS** .

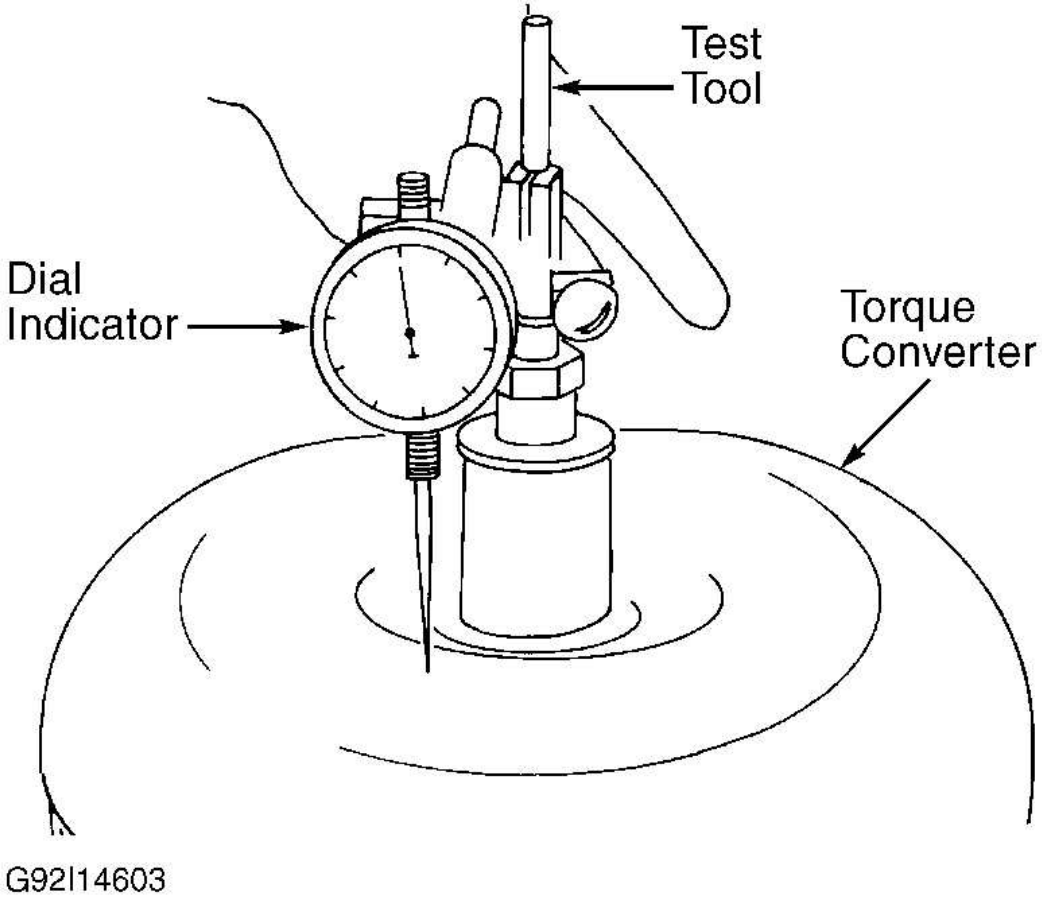


Fig. 23: Checking Torque Converter End Play
Courtesy of FORD MOTOR CO.

TORQUE CONVERTER END PLAY SPECIFICATIONS

Application	In. (mm)
Gas Engine	
New Or Rebuilt Convertor	.038 (.96)
Used Converter	.071 (1.8)

Diesel Engine	
New Or Rebuilt Convertor	.048 (1.21)
Used Converter	.079 (2.0)

Converter One-Way Clutch Check

1. Insert One-Way Clutch Holding Tool (T77L-7902-R) in one of stator thrust washer grooves. Insert Converter Clutch Torquing Tool (T76L-7902-C) with torque wrench in converter pump drive hub to engage one-way clutch inner race. See **Fig. 24** .
2. Hold holding tool stationary. Turn torque wrench counterclockwise. Converter one-way clutch should lock up and hold force of 10 ft. lbs. (13 N.m). One-way clutch should turn freely clockwise. Repeat procedure with holding tool in at least 5 locations. Replace converter if it fails testing.

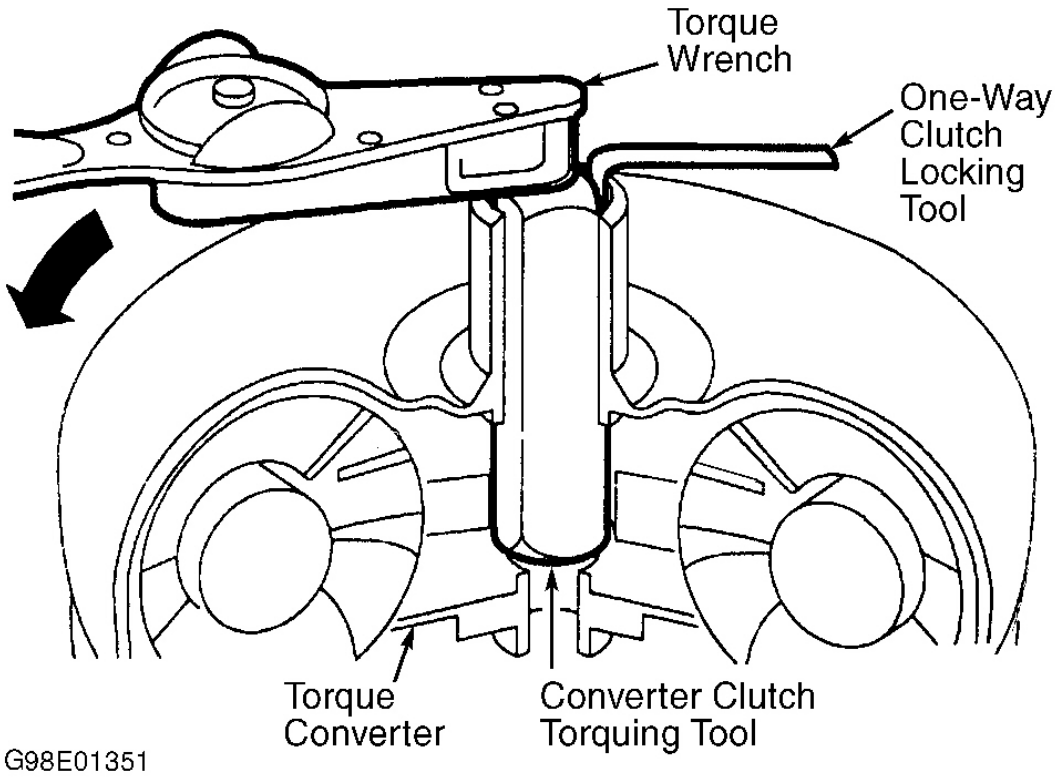


Fig. 24: Checking Stator One-Way Clutch
Courtesy of FORD MOTOR CO.

Stator-To-Impeller Interference Check (Gas Engine Only)

NOTE: Stator support may remain in pump assembly during check.

1. Position stator support on bench with spline end of stator shaft pointing up. Mount converter on stator support so splines of one-way clutch inner race engage splines of stator support.
2. While holding pump stationary, rotate converter counterclockwise. Converter should rotate freely without interference or scraping within assembly. Should interference or a scraping condition within converter exist or converter does not rotate freely, replace converter unit.

Stator-To-Turbine Interference Check (Gas Engine Only)

1. Place converter on bench, front side down. Install stator support to engage mating splines of stator support shaft.
2. Install input shaft, engaging splines with turbine hub. While holding stator shaft stationary, rotate turbine with input shaft.
3. Turbine should rotate freely in both directions without interference or noise. If interference or noise exists, stator front thrust washer may be worn and converter should be replaced.

REMOVAL & INSTALLATION

See appropriate TRANSMISSION REMOVAL - A/T article in AUTOMATIC TRANSMISSION SERVICING.

TRANSMISSION DISASSEMBLY

NOTE: Exploded views of internal parts, thrust washer and needle bearing locations can be found in Figs. Fig. 43 -Fig. 45 .

1. Remove torque converter. Remove transfer case (if equipped). Mount transmission in appropriate holding fixture. Remove input shaft. Thoroughly clean solenoid body connector area to avoid contamination. Remove oil pan and gasket. Remove filter and "O" ring assembly. DO NOT damage aluminum pump bore.
2. Remove accumulator body and valve body retaining bolts. Note bolt positions for reassembly. Do not remove center 2 bolts. See **Fig. 4** . This secures upper and lower valve body together during disass embly. Remove solenoid body Torx retaining bolts and one nut.
3. Push up on solenoid body connector while removing solenoid body. Remove solenoid screen, by rotating and pulling out. See **Fig. 5** . Remove reinforcing plate. EPC ball is spring loaded under separator plate. Remove separator plate and two gaskets. Remove EPC ball and spring. Discard gasket.
4. Remove one steel and 8 rubber check balls. DO NOT damage rubber check balls. See **Fig. 7** . Remove servo snap ring, retaining plate, piston and rod assembly and servo spring. Remove 3 feed bolts and discard.

CAUTION: DO NOT use a screwdriver to pry out oil pump. This may cause severe damage to transmission case. See TECHNICAL SERVICE BULLETINS.

5. Rotate transmission so bellhousing is facing upward. Remove 9 pump retaining bolts. Discard washers.

Using 2 slide hammers, remove pump, gasket and pump support thrust washer. Remove needle bearing assembly between front pump and sun gear. Lift out coast clutch assembly.

6. Remove large snap ring. Remove overdrive pressure plate and clutch pack. Tag for reassembly. Remove overdrive ring gear, center shaft assembly, overdrive planet and one-way clutch. Remove center shaft needle bearing assembly.
7. Install Clutch Spring Compressor (T89T-70010-C) into case. See **Fig. 25** . Tighten center bolt to 65 INCH lbs. (7 N.m). Remove large snap ring. Remove spring compressor. Remove intermediate-overdrive cylinder assembly. Remove intermediate return spring, center support and center support thrust washer.

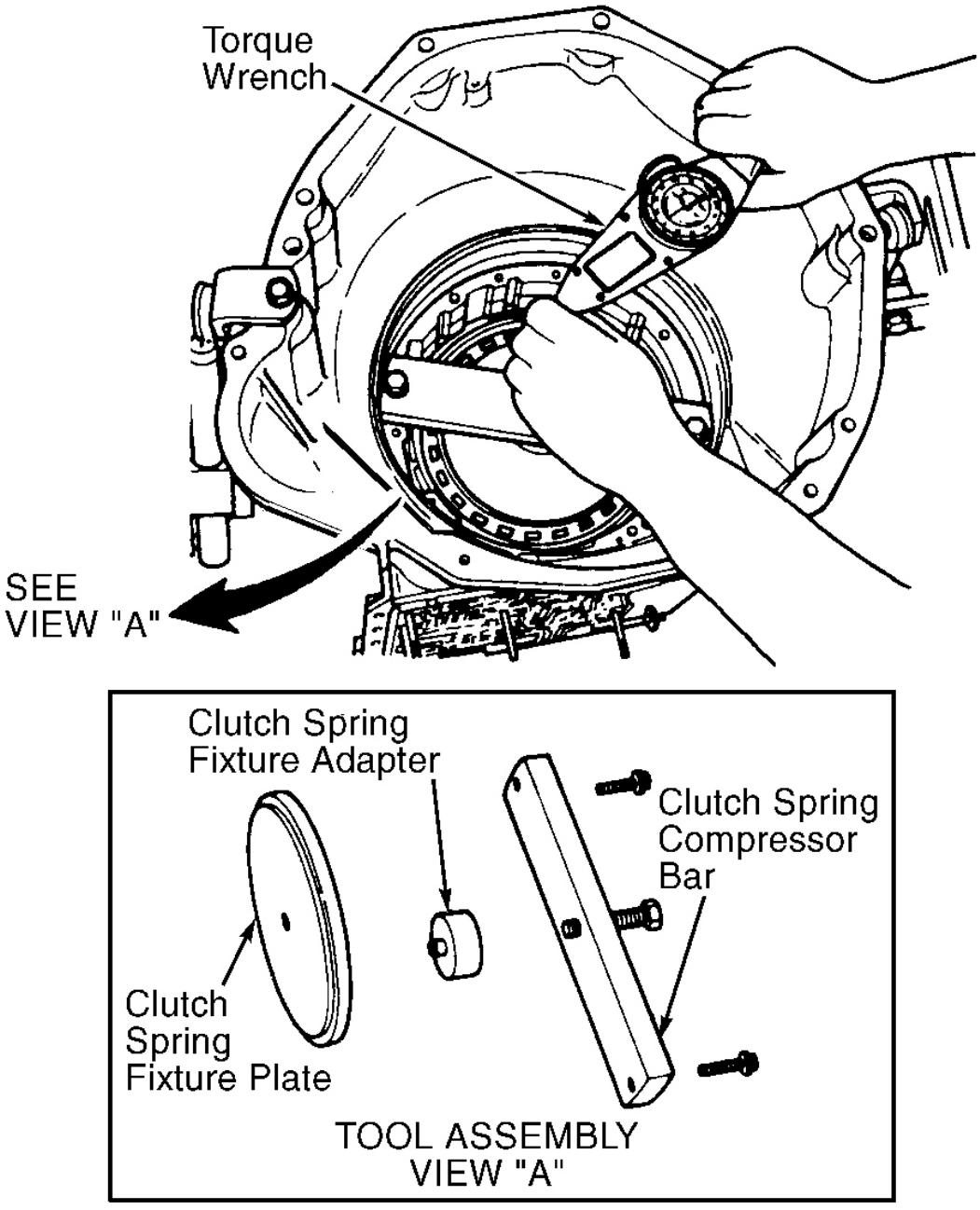


Fig. 25: Compressing Intermediate/Overdrive Cylinder Assembly
Courtesy of FORD MOTOR CO.

8. Remove Intermediate pressure plate and clutch plates. Tag clutch plates for reassembly. Remove intermediate band. Using appropriate clutch remover/installer, remove direct clutch, forward clutch and

shell. Hooks on crossbar MUST be rotated into notches on input shell. See **Fig. 36** .

9. Using large screwdriver, remove reverse planet assembly snap ring. Remove reverse planetary assembly and 2 planetary carrier thrust washers. Remove and discard output shaft snap ring.
10. Remove ring gear, hub assembly and needle bearing assembly. Remove reverse hub and one-way clutch assembly. Using large screwdriver, remove reverse clutch snap ring. Remove reverse pressure plate and clutch pack, tag for reassembly.
11. Rotate transmission so pan surface faces up. Remove 8 extension housing bolts. Remove extension housing and gasket and discard gasket.
12. Remove output shaft, park gear and output shaft thrust washer. Remove 5 retaining bolts from low-reverse one way clutch inner race. Remove reverse clutch return spring assembly and inner race.

NOTE: Reinstall reverse clutch pressure plate and snap ring to restrain reverse clutch piston during removal.

13. Using shop air in reverse clutch feed port, blow out reverse clutch piston against pressure plate. See **Fig. 22** . Remove snap ring, reverse clutch pressure plate and piston from case.

NOTE: If Torx head bolt is removed, it must be discarded and replaced with NEW bolt.

14. Rotate transmission so pan surface faces downward. Remove parking pawl return spring, pin and parking pawl from case. Remove parking rod guide plate. Remove Torx head bolt and parking pawl abutment (if necessary).
15. Using side cutters or remover tool, remove manual lever shaft roll-pin from case. Remove inner detent lever nut, while holding lever with crescent wrench. Remove inner detent lever and parking pawl actuating rod assembly from manual lever.
16. Remove Transmission Range (TR) sensor and manual lever. Discard manual lever outer nut. Remove manual valve detent spring. Using slide hammer, remove manual lever seal. If required, remove short lube inlet tube, using channel lock pliers.

COMPONENT DISASSEMBLY & REASSEMBLY

COAST CLUTCH ASSEMBLY

NOTE: All models use 2 steel and 2 friction plates on coast clutch cylinder assembly.

Disassembly

1. Remove sun gear. Remove selective retaining ring. Remove pressure and clutch plates, and tag for reassembly. Using appropriate spring compressor, remove and discard return spring retaining ring. Remove spring compressor.
2. Remove piston return spring and apply plate. See **Fig. 26** . Remove piston from coast clutch cylinder. Remove outer seal from piston. Remove inner seal from cylinder.

Inspection

Inspect all parts for wear, damage and effects of overheating. Inspect coast clutch cylinder for damage and wear. Replace as necessary.

Reassembly

1. Apply transmission fluid to "O" rings before install-ing. Soak all friction plates in ATF for 15 minutes before installing.
2. Install inner and outer seals with lips facing down in cylinder and piston respectively.
3. Install piston, piston apply plate and piston return spring. Use spring compressor and compress springs. Install NEW retaining ring. Carefully remove spring compressor.
4. Alternately install a steel plate and then a friction plate. See **Fig. 26** . Install pressure plate and secure pack with retaining ring.
5. Using a feeler gauge, check clearance between retaining ring and pressure plate. Ensure clearance is .030-.050" (.76-1.27 mm). If clearance is not within specifications, install correct thickness snap ring. Selective snap rings are available in thicknesses of .053-.057" (1.35-1.45 mm), .069-.073" (1.75-1.85 mm) and .085-.089" (2.15-2.25 mm).
6. Install correct size snap ring and recheck clearance. Install overdrive sun gear assembly with short end down into cylinder.

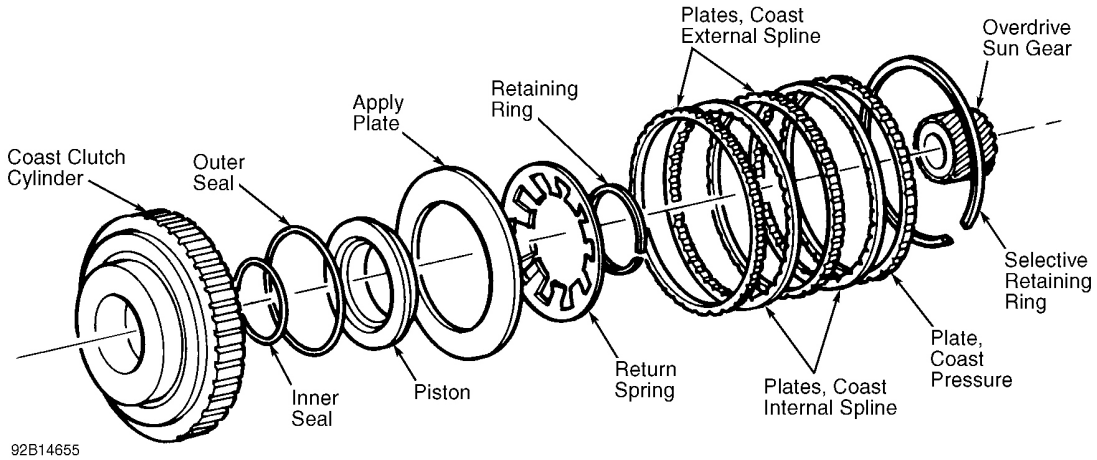


Fig. 26: Exploded View Of Coast Clutch Cylinder Assembly
Courtesy of FORD MOTOR CO.

DIRECT CLUTCH ASSEMBLY

Disassembly

1. Remove outer race, intermediate one-way clutch and top end cap. Remove large thrust washer from rear face of cylinder. Remove small thrust washer from front face of cylinder. See **Fig. 27** .

2. Using a screwdriver, remove retaining ring. Remove pressure plate and clutch pack. Tag for reassembly.
3. Install appropriate spring compressor. Remove return spring retainer ring and return spring. Remove piston from intermediate brake drum. Remove inner and outer seals from drum.

Reassembly

1. Install inner and outer seals in cylinder with seal lips facing down into cylinder. Inspect piston check ball for freedom of movement. Install piston into drum.
2. Ensure piston rotates freely in cylinder. Install return spring. Ensure protrusions on spring retainer are properly engaged with lugs on clutch piston. Use spring compressor and compress springs. Install retaining ring.
3. Install clutch pack, first using a steel plate and then a friction plate. Install pressure plate and secure pack with selective retaining ring.
4. Using a feeler gauge, check clearance between retaining ring and pressure plate. Ensure clearance is .045-.081" (1.15-2.06 mm).
5. If clearance is not within specifications, install correct snap ring. Selective snap rings are available in thicknesses of .056-.060" (1.42-1.53 mm), .065-.069" (1.65-1.75 mm), .074-.078" (1.88-1.98 mm) and .083-.087" (2.11-2.21 mm). Install correct size snap ring and recheck clearance.
6. Install small thrust washer and large thrust washer on face of cylinder. Install intermediate one-way clutch end cap, one-way clutch assembly, and bottom end cap into outer race. Lip faces upward on one-way clutch.
7. Install outer race and one-way clutch assembly onto inner race to ensure race turns counterclockwise. Install thrust washer on intermediate brake drum face.

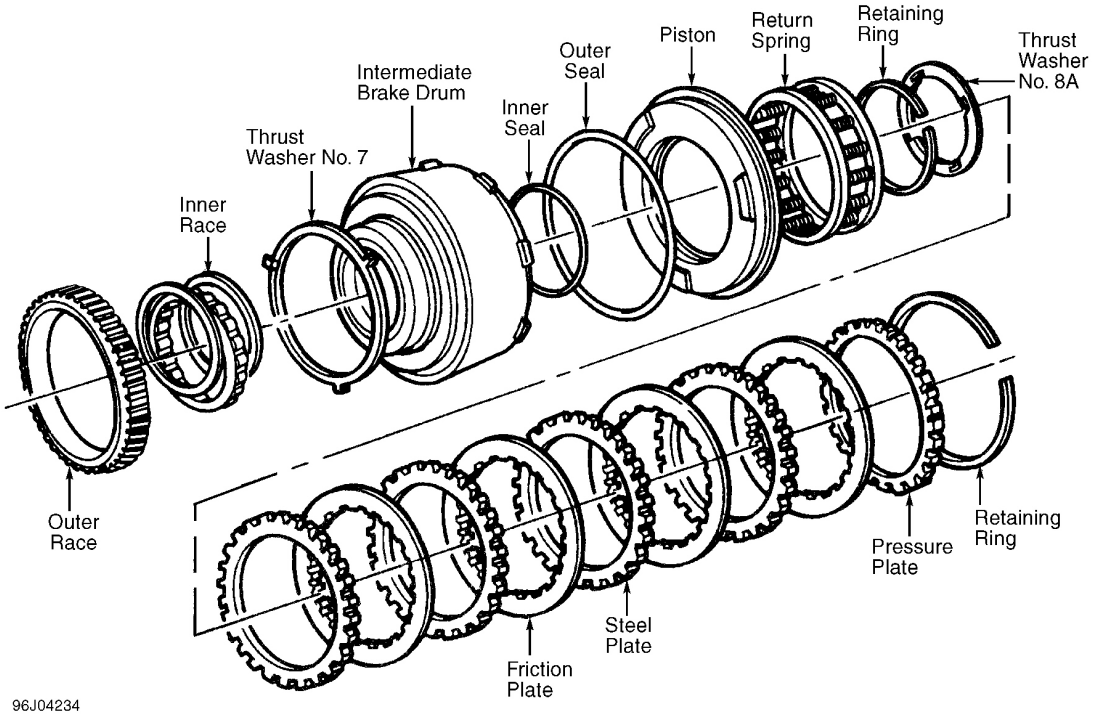


Fig. 27: Exploded View Of Direct Clutch Assembly
Courtesy of FORD MOTOR CO.

FORWARD CLUTCH ASSEMBLY

Disassembly

1. Remove both needle bearings and both Teflon seal rings. Remove retaining ring and rear pressure plate. Remove 3 or 4 plate clutch pack (depending on model), cushion spring and forward pressure plate. Tag for reassembly.
2. Remove spring retainer and piston return spring. Remove piston apply ring from piston groove. Remove cylinder piston with compressed air. Remove outer seal from cylinder piston. Remove inner seal from clutch cylinder.

Reassembly

1. Install inner seal in cylinder and outer seal on cylinder piston with seal lip facing up. Inspect piston check ball for freedom of movement. Using appropriate lip seal protector, install piston into cylinder. Install piston apply ring into groove on piston. Install piston return spring with fingers against piston and steel ring. Ensure both ends of piston apply ring are visible between fingers of piston return spring. Install spring retainer.
2. Install rear pressure plate and cushion spring. Install 3 or 4 steel plates, and 3 or 4 friction plates (depending on model). Alternately install a steel plate and then a friction plate. See **Fig. 28** . Install forward pressure plate and secure pack with retaining ring.

3. Using a feeler gauge, check clearance between selective retaining ring and pressure plate. Ensure clearance is .030-.055" (.76-1.40 mm). If clearance is not within specifications, install correct snap ring. Selective snap rings are available in thicknesses of .056-.060" (1.42-1.52 mm), .074-.078" (1.88-1.98 mm), .092-.096" (2.34-2.44 mm), .110-.114" (2.79-2.90 mm) and .128-.132" (3.25-3.35 mm). Install correct size snap ring and recheck clearance.
4. Install 2 Teflon seal rings, ensuring scarf cuts at ring ends are properly aligned and placed 180 degrees apart. Install needle bearing over Teflon seal hub. Install needle bearing assembly on inner face of cylinder with large outside diameter radius facing inward.

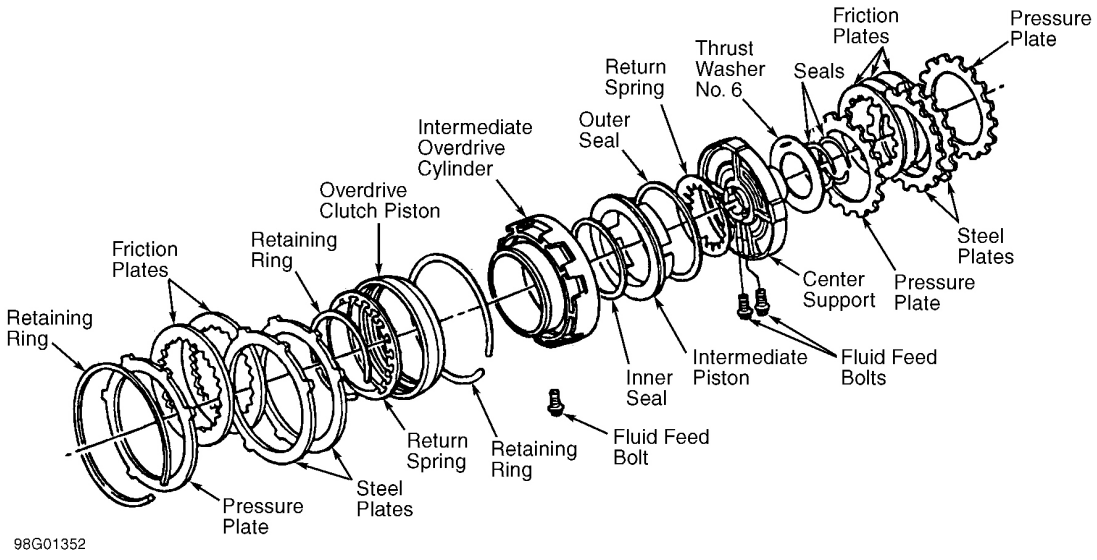


Fig. 28: Exploded View Of Forward Clutch
Courtesy of FORD MOTOR CO.

INPUT SHELL

Disassembly & Reassembly

Remove and discard forward/reverse sun gear retaining ring. Remove input shell thrust washer. Remove forward/reverse sun gear from input shell. To reassemble, reverse disassembly procedure. Ensure lube hole in sun gear is between standoff pads on input shell.

INTERMEDIATE/OVERDRIVE CYLINDER ASSEMBLY

Disassembly

1. Using appropriate spring compressor, compress overdrive return spring. Remove retaining ring. Remove spring compressor. Remove return spring.
2. Remove overdrive piston. Remove outer and inner seals and intermediate piston. See **Fig. 29** . Remove intermediate-overdrive inner seal from cylinder bore. Remove outer seal from intermediate piston.

Remove 2 cast iron outer seal rings and thrust washer from center support.

3. Remove thrust washer from front face of forward hub and ring gear. Using a screwdriver remove retaining ring. Remove forward hub from ring gear.

Reassembly

To reassemble, reverse disassembly procedure. Outer and inner seals are installed with lips facing down toward cylinder. Return spring fingers face up. Ensure piston rotates freely in cylinder.

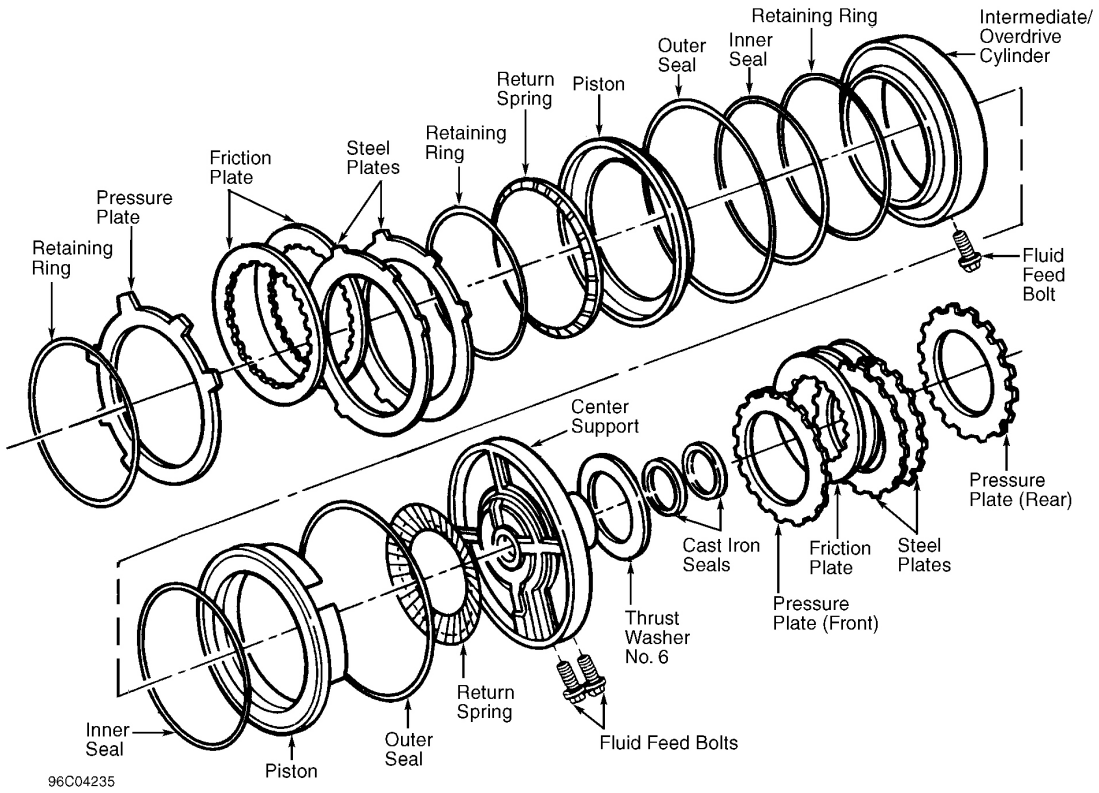


Fig. 29: Exploded View Of Intermediate-Overdrive Cylinder
Courtesy of FORD MOTOR CO.

LOW-REVERSE ONE-WAY CLUTCH HUB

Disassembly

Remove snap ring and bushing from rear of low-reverse clutch hub. Remove rollers from spring assembly. Lift spring assembly from hub. Remove snap ring from hub. See **Fig. 30** .

Reassembly

1. Install snap ring in forward groove of low-reverse clutch hub. Place hub on bench with forward end down. Install clutch spring assembly on top of snap ring.

2. Install a roller into each spring assembly compartment. Install bushing on top of spring assembly. Install remaining snap ring at rear of clutch hub to secure assembly.

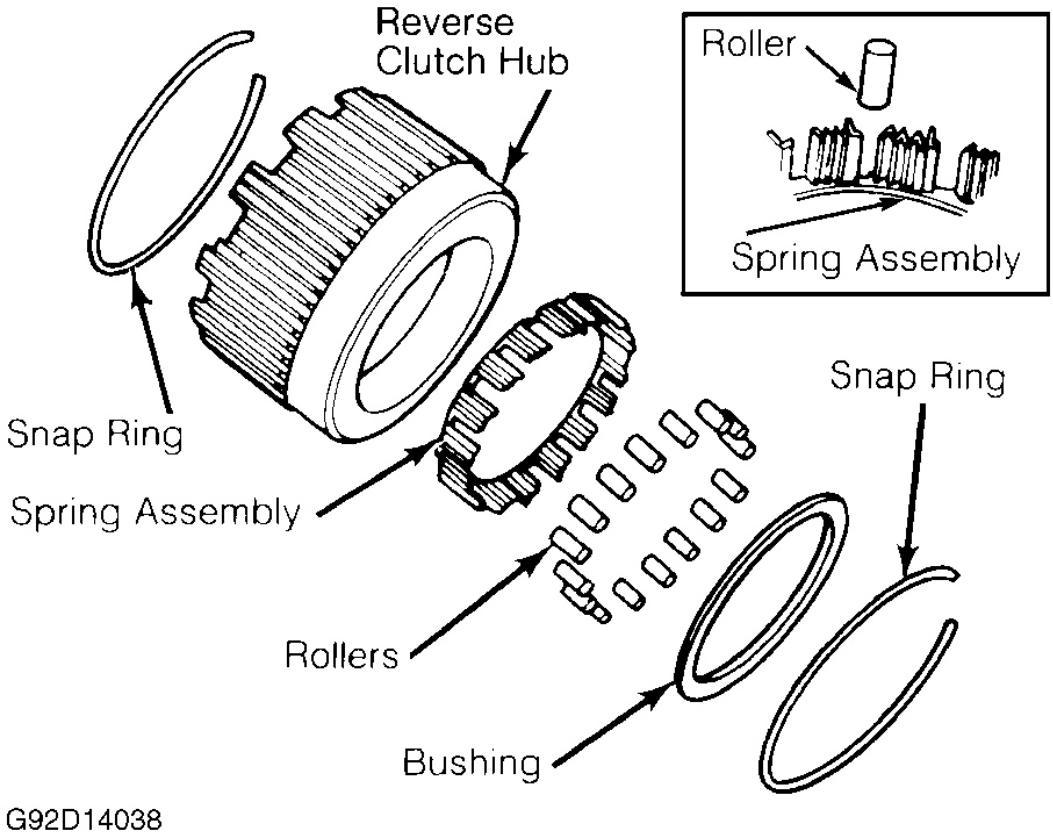


Fig. 30: Exploded View Of Low-Reverse One-Way Clutch Hub
Courtesy of FORD MOTOR CO.

OIL PUMP ASSEMBLY

Disassembly

1. Remove coast clutch seals from stator support. Remove large square cut seal from outside diameter of pump housing. Using internal puller, remove converter hub seal from pump body. Remove and discard orifice cup plug, spring and stop assembly.
2. Remove 11 pump control-to-pump body bolts. Separate pump control body from pump body. Apply pressure to main regulator booster sleeve. Remove internal retaining ring. Remove main regulator valve train.
3. Remove converter regulator valve and converter clutch valve assemblies by applying pressure to end plug and removing retainer clip with small screwdriver or tweezers. DO NOT remove any cup plugs unless

damaged or leaking. See **Fig. 31** . Remove gerotor gear set from pump body.

NOTE: To prevent distortion of control body surface, DO NOT remove stator support from control body.

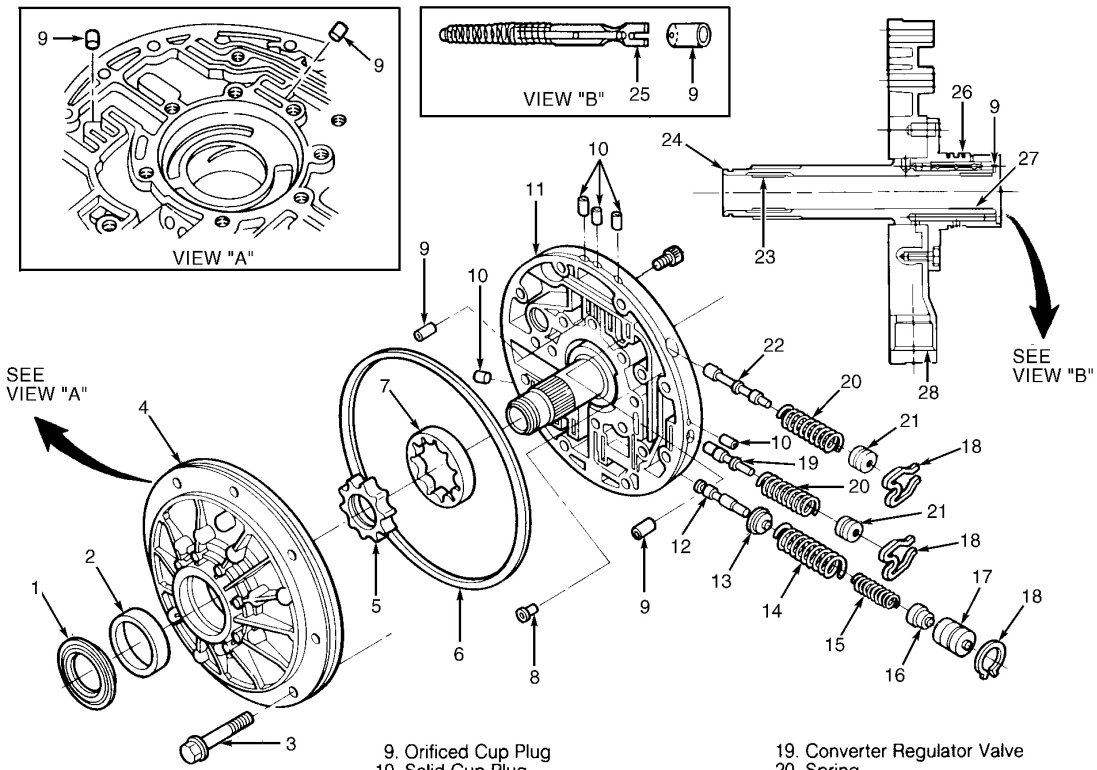


Fig. 31: Exploded View Of Pump Assembly
Courtesy of FORD MOTOR CO.

Inspection

Thoroughly clean and inspect all components for damage, wear or scoring. Carefully check all teeth on gears. Replace pump assembly if any part is damaged or worn. Inspect converter hub bushing. Replace if defective. Stake bushing at notches. Inspect stator input shaft bushings. Replace control body assembly if bushings are worn. If necessary, use crocus cloth to polish components. Use caution to avoid rounding sharp edges of valves and plugs. Replace defective parts.

Reassembly

1. Install main regulator valve. Apply pressure to booster sleeve and install internal retainer ring. Install converter shift and regulator valves. Lightly coat gerotor gears with transmission fluid and install in pump housing. Dot on inner gerotor gear faces control body.
2. Using depth micrometer, measure clearance between each gear and pump housing. Clearance should be .001-.002" (.025-.051 mm). Replace parts as needed. Lower control body and stator into pump body. Align 28-mm round holes in control body and pump body.
3. Loosely install 11 pump body bolts. Install alignment bolt. See **Fig. 32** . Using appropriate banding tool, align outer bolt holes. Tighten retaining bolts to specification. See **TORQUE SPECIFICATIONS** . Remove banding tool. Ensure outer edges of control body and pump body are completely aligned.
4. Install coast clutch seals. Ensure seals are fully seated in grooves with gaps 180 degrees apart. Install pump outer diameter seal. Lubricate seal with transmission fluid before installing pump into case.
5. Install NEW spring and stop assembly, place end with rubber stop into bore first. Install NEW cup plug. Ensure cup plug edges are below stator support surface. Install converter hub seal. Install pump thrust washer and overdrive sun gear needle bearing into stator support.

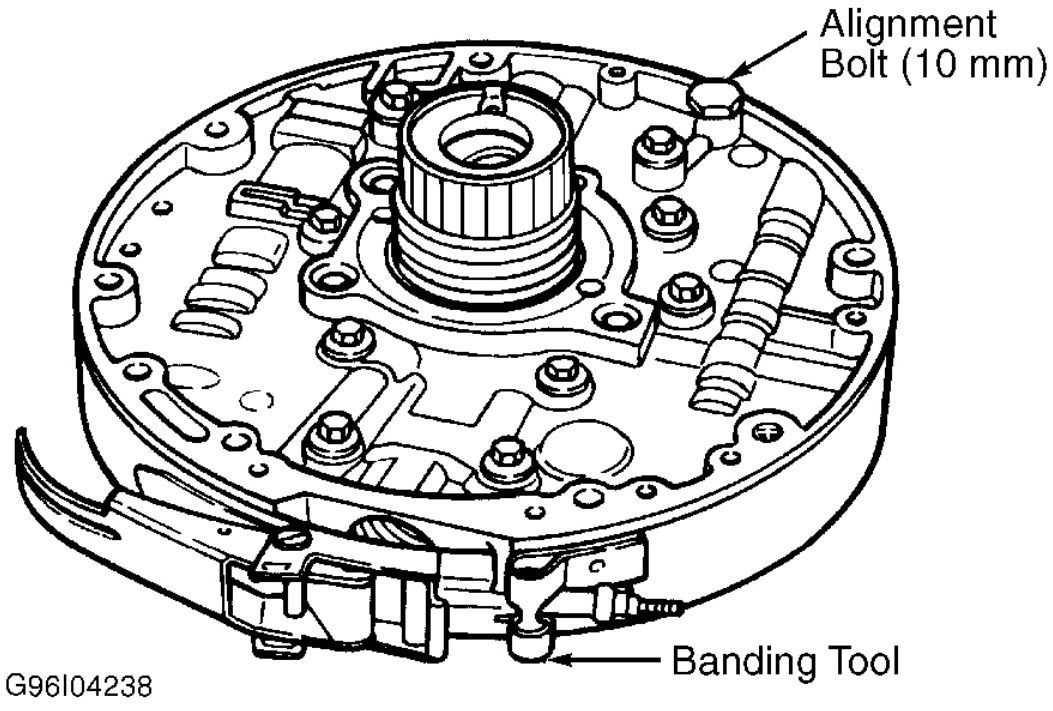


Fig. 32: Aligning Pump Body & Support Assembly
Courtesy of FORD MOTOR CO.

OVERDRIVE RING GEAR & CENTER SHAFT ASSEMBLY

Disassembly

1. Remove outer race-to-ring gear retaining ring. Remove one-way clutch assembly with inner and outer races. Remove one-way clutch assembly with inner race from outer race. See **Fig. 33** .
2. Remove inner race from one-way clutch assembly. Remove thrust washer from front of overdrive planet assembly. Remove overdrive planet assembly from ring gear assembly.
3. Remove needle bearing assembly from rear of overdrive planet assembly. Remove center shaft-to-ring gear retaining ring and center shaft from ring gear.

Reassembly

To reassemble, reverse disassembly procedure. Ensure thrust washers and needle bearings are installed in their original locations. Install retaining ring and plastic cage into outer race. Install inner race into one-way clutch. Inner race undercut must face toward small retaining ring. Install clutch into ring gear with small retaining ring facing up.

NOTE: Inner race MUST rotate counterclockwise.

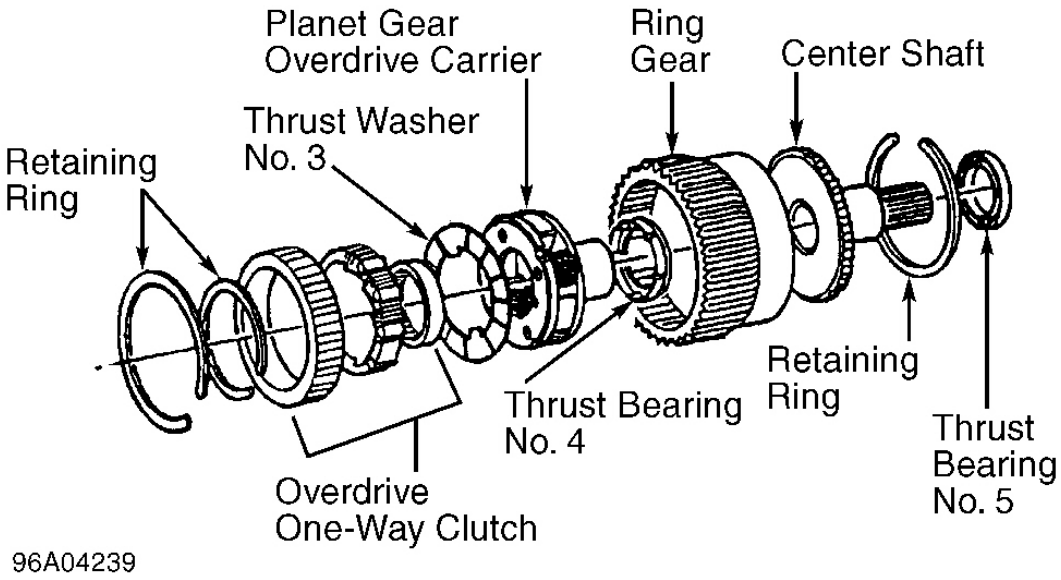


Fig. 33: Exploded View Of Overdrive Ring Gear & Center Shaft
Courtesy of FORD MOTOR CO.

VALVE BODY

Disassembly

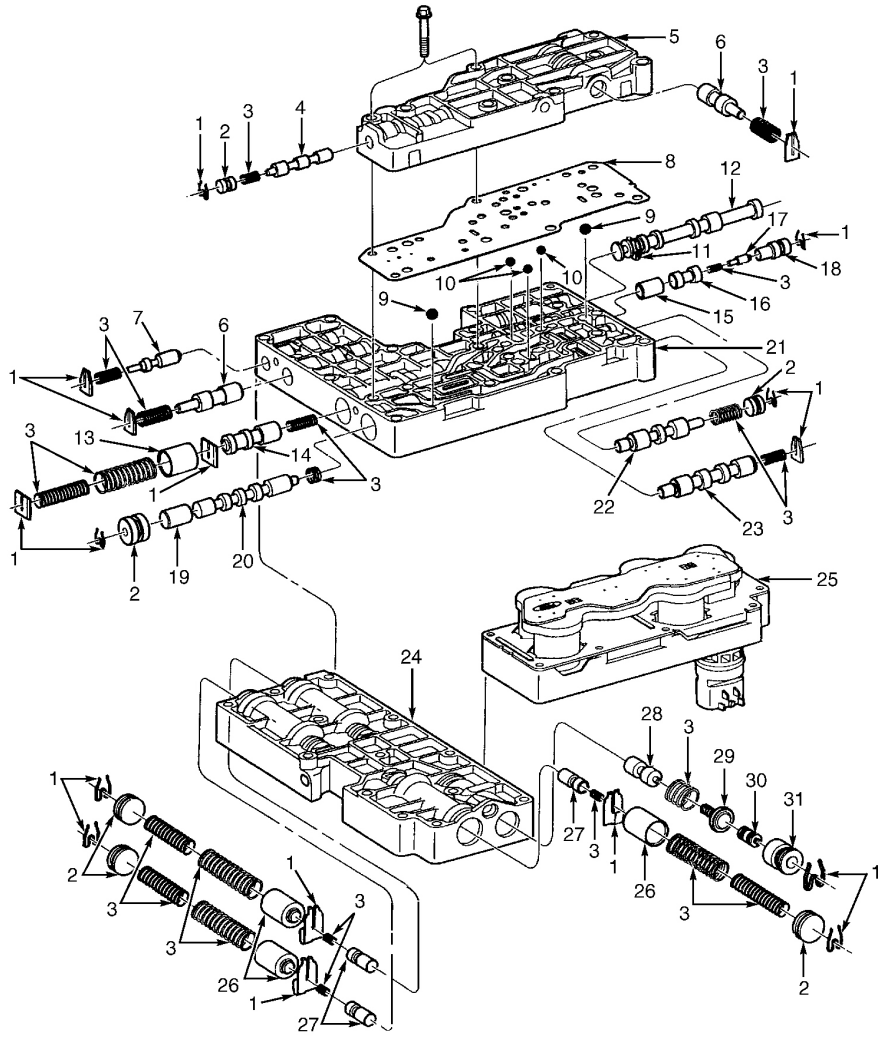
Disassemble valve body. See **VALVE BODY & INTERMEDIATE BAND SERVO** under ON-VEHICLE SERVICE. Remove all valves, plungers, plugs and springs from control valve and accumulator bodies. See **Fig. 34** .

Inspection

1. Clean all parts, except non-metallic check balls, in clean solvent. Blow dry with compressed air.
2. Inspect all valve and plunger bores for scores. Check all fluid passages for obstructions. Inspect all mating surfaces for burrs and scores. If necessary, use crocus cloth to polish valves and plungers. Avoid rounding sharp edges of valves and plungers with crocus cloth.
3. Inspect all springs for distortion. Check all valves and plungers for free movement in their respective bores. Valves and plungers, when dry, should fall by their own weight in their respective bores. Roll manual valve on a flat surface to check for bending.

Reassembly

Install all valves, plungers, plugs and springs into control valve and accumulator bodies. See **Fig. 34** . To complete reassembly, reverse disassembly procedure. See **VALVE BODY & INTERMEDIATE BAND SERVO** under ON-VEHICLE SERVICE.



1. Retainer
2. Plug
3. Spring
4. Engagement Control Valve
5. Lower Control Valve Body
6. Coast Clutch Shift Valve
7. Solenoid Regulator Valve
8. Separator Plate
9. Check Ball (.3125")
10. Check Ball (.250")
11. Retaining Ring
12. Manual Control Valve
13. Control Valve Shift Timing Plunger
14. 4-3-2 Manual Timing Valve
15. Low/Reverse Modulator Valve
16. Low Servo Modulator Valve
17. Low/Reverse Modulator Valve Plunger
18. Low/Reverse Modulator Valve Sleeve
19. 1-2 Shift Valve
20. D2 Shift Valve
21. Upper Control Valve Body
22. 3-4 Shift Valve
23. 2-3 Shift Valve
24. Accumulator Control Valve Body
25. Solenoid Body Assembly
26. Accumulator Regulator Plunger
27. Accumulator Regulator Valve
28. Line Pressure Modulator Valve
29. Spring & Retainer Assembly
30. Line Pressure Modulator Plunger
31. Line Pressure Modulator Sleeve

96B04372

Fig. 34: Exploded View Of Valve Body
Courtesy of FORD MOTOR CO.

CLUTCH & DRUM SUBASSEMBLIES

1. Install thrust washer on intermediate brake drum. Install forward clutch on intermediate brake drum and rotate until fully seated. Install needle bearing on intermediate brake drum and forward clutch assembly. Ensure Black side of needle bearing is facing up.

2. Install thrust washer on forward clutch hub. See **Fig. 35** . Insert forward clutch hub into intermediate brake drum and forward clutch assemblies. Place thrust washer on forward planet assembly. Insert planet assembly into clutch assembly. Install needle bearing into forward planet assembly. Ensure Black side of needle bearing is facing up.
3. Align input shell notches with intermediate brake drum. Install input shell on assembly and rotate until fully seated. See **Fig. 36** . Install needle bearing into front end of forward clutch assemb ly. Install Remover/Installer (T89T-70010-E) onto intermediate brake drum, forward clutch and input shell. See **Fig. 37** .

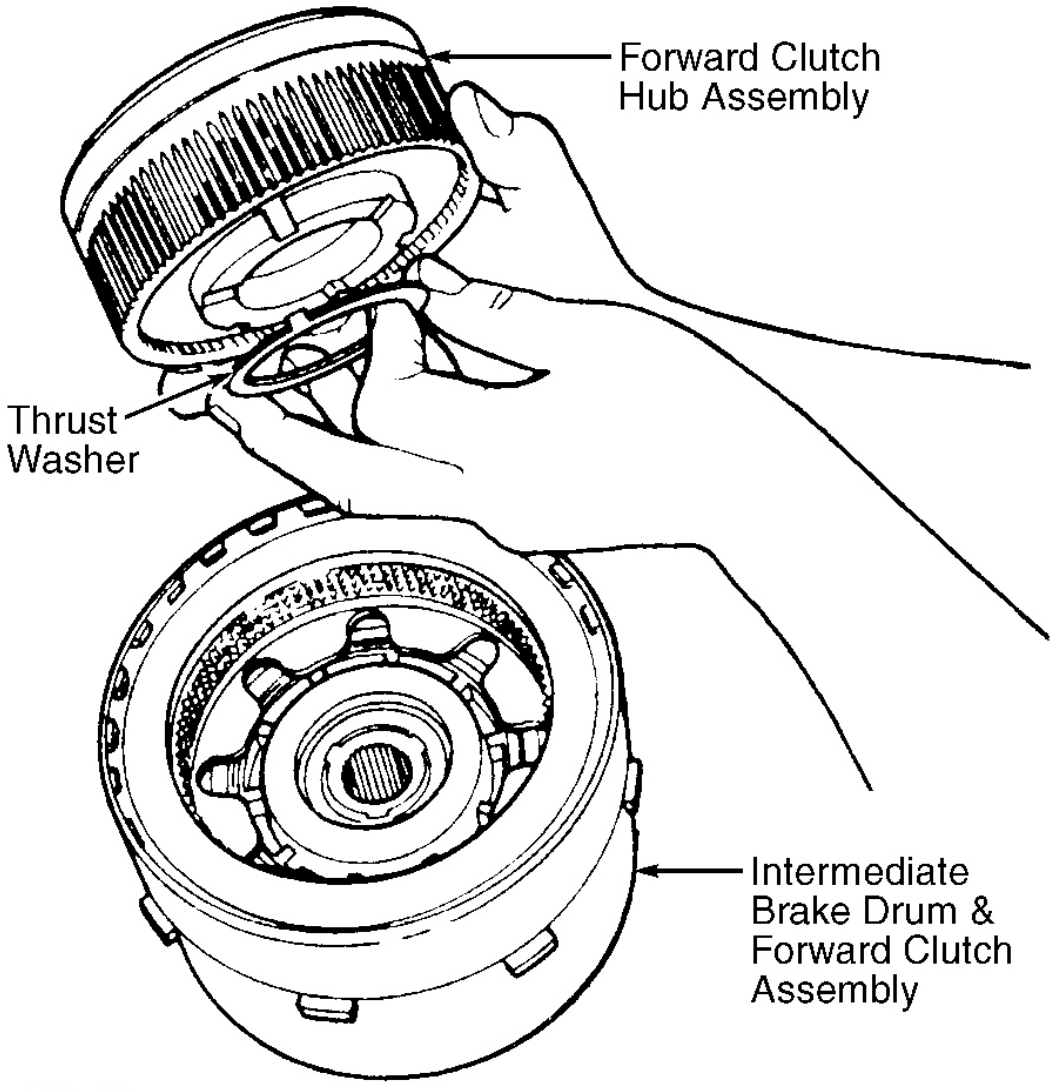


Fig. 35: Installing Thrust Washer On Forward Clutch Hub
Courtesy of FORD MOTOR CO.

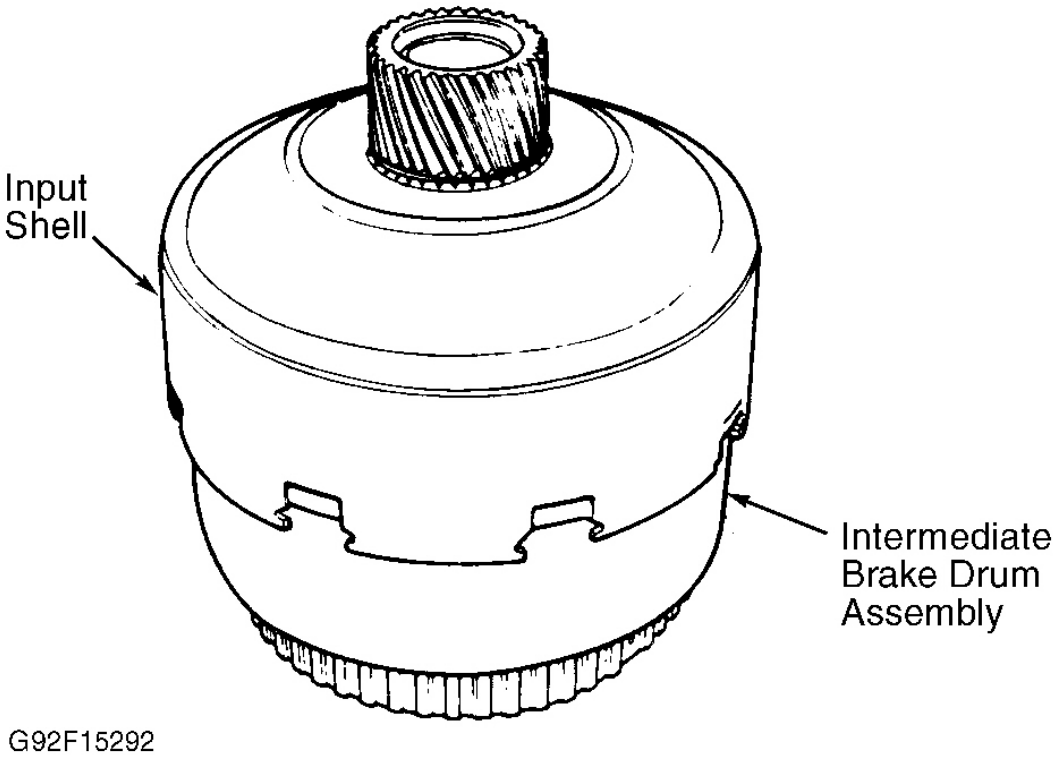


Fig. 36: Assembling Direct Clutch, Forward Clutch & Input Shell
Courtesy of FORD MOTOR CO.

TRANSMISSION REASSEMBLY

NOTE: Exploded views of internal parts, thrust washer and needle bearing locations can be found in Figs. Fig. 43 -Fig. 45 . Lubricate all parts with transmission fluid during reassembly. Thrust washers and gaskets should be held in place with petroleum jelly.

1. With transmission mounted in fixture, rotate bellhousing to face upward. Install inner and outer seals on reverse clutch piston. Using appropriate spring compressor, install reverse clutch piston. Remove spring compressor.
2. Install reverse piston return spring assembly, output shaft hub and inner race. Ensure lubrication hole of inner race is in 5 o'clock position. See **Fig. 37** and **Fig. 38** . Using 2 5 / 16-24, 3 inch long bolts with nuts, compress low/reverse piston spring. See **Fig. 39** . Install 3 bolts in remaining one-way clutch inner race bolt holes and remove 2 compression bolts. Install remaining 2 bolts and tighten to specification. See **TORQUE SPECIFICATIONS** .
3. Install cushion spring. Install reverse clutch pack (5 or 6 plate assembly depending on model) starting with an external spline steel plate. Alternate external spline steel plates with internal spline friction plates.

Install reverse clutch pressure plate and retaining ring. Ensure retaining ring is installed with opening between 12 and 3 o'clock. Clearance measurement is not required.

4. Rotate transmission to horizontal position. Lubricate steel side of thrust washer, and place on rear of case bronze side outward. Slide park gear onto shaft with thrust surface forward. Install output shaft. Install reverse hub and low-reverse one-way clutch. Install output shaft hub and reverse ring gear with needle bearing on rear surface of hub.
5. Install NEW retaining ring on output shaft. Rotate transmission with bellhousing facing upward. Install reverse planet into hub with front and rear thrust washers. Install reverse planet retaining ring into low-reverse hub. Ensure retaining ring is securely seated in groove.
6. Using Clutch Remover-Installer (T89T-70010-E), install intermediate brake drum assembly, forward clutch assembly and input shell assembly into case as a unit. See **Fig. 40** . It may be necessary to rotate output shaft to seat reverse sun gear. Remove installer.

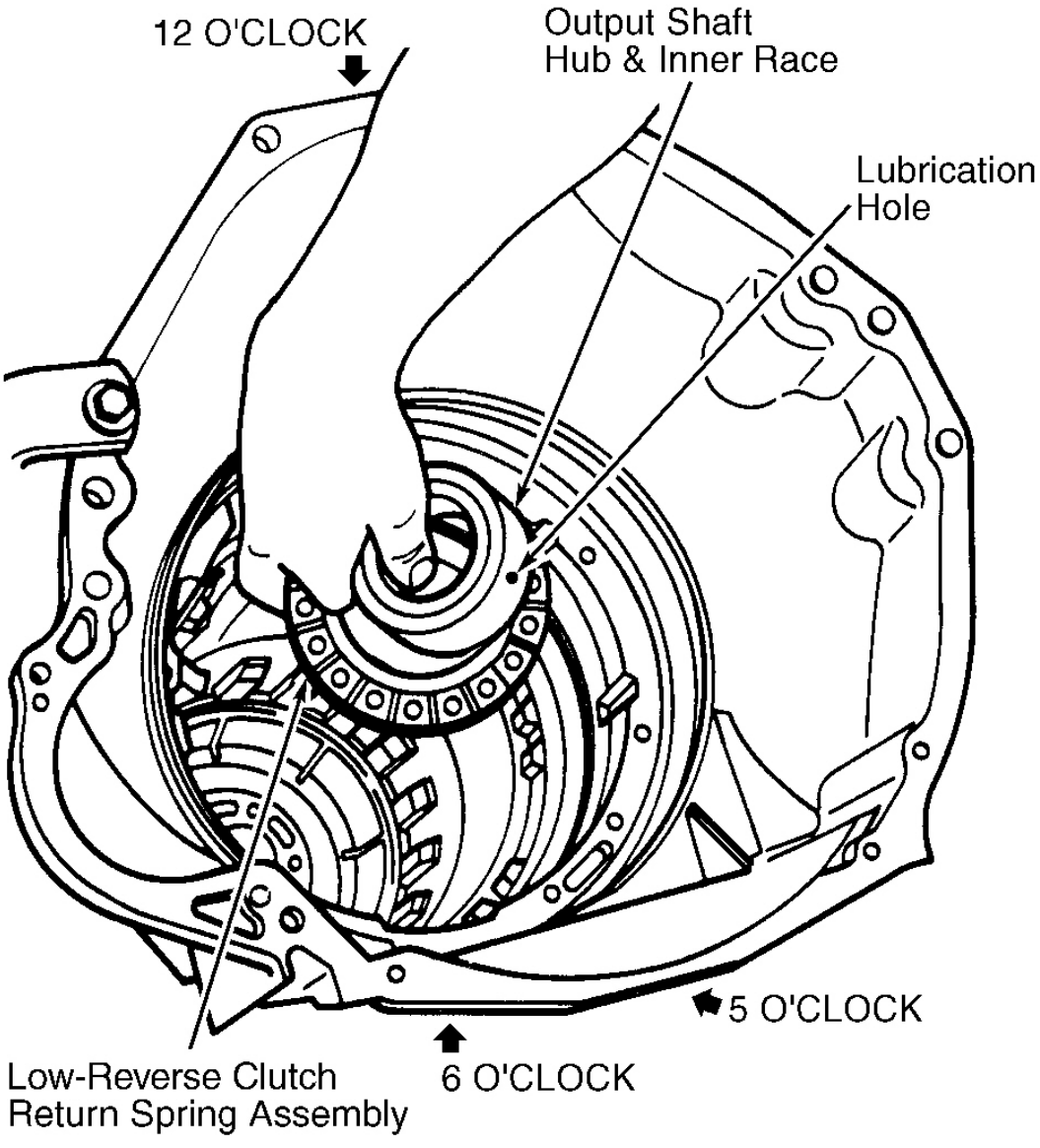


Fig. 37: Locating Inner Race Lubrication Hole
Courtesy of FORD MOTOR CO.

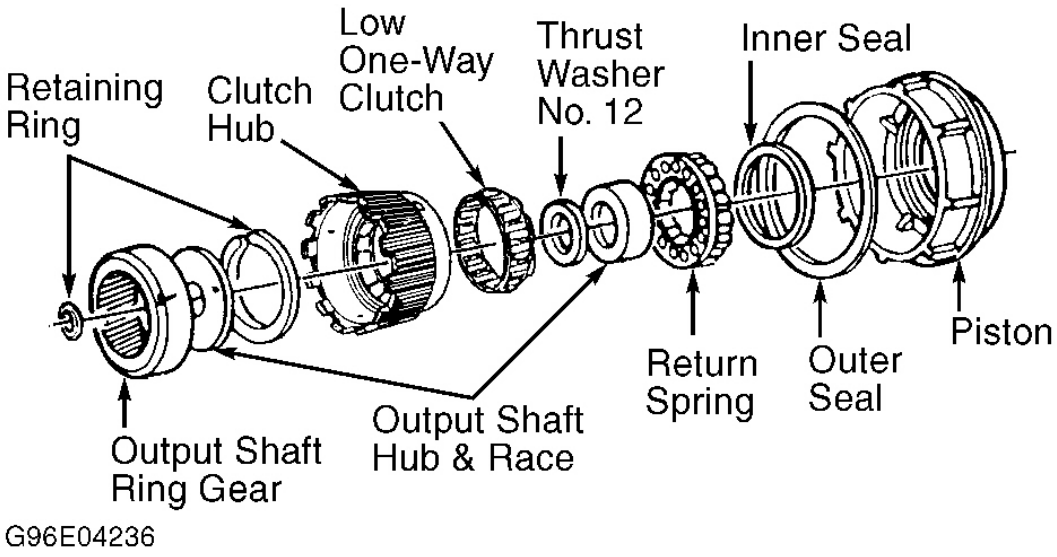


Fig. 38: Exploded View Of Low-Reverse One-Way Clutch
Courtesy of FORD MOTOR CO.

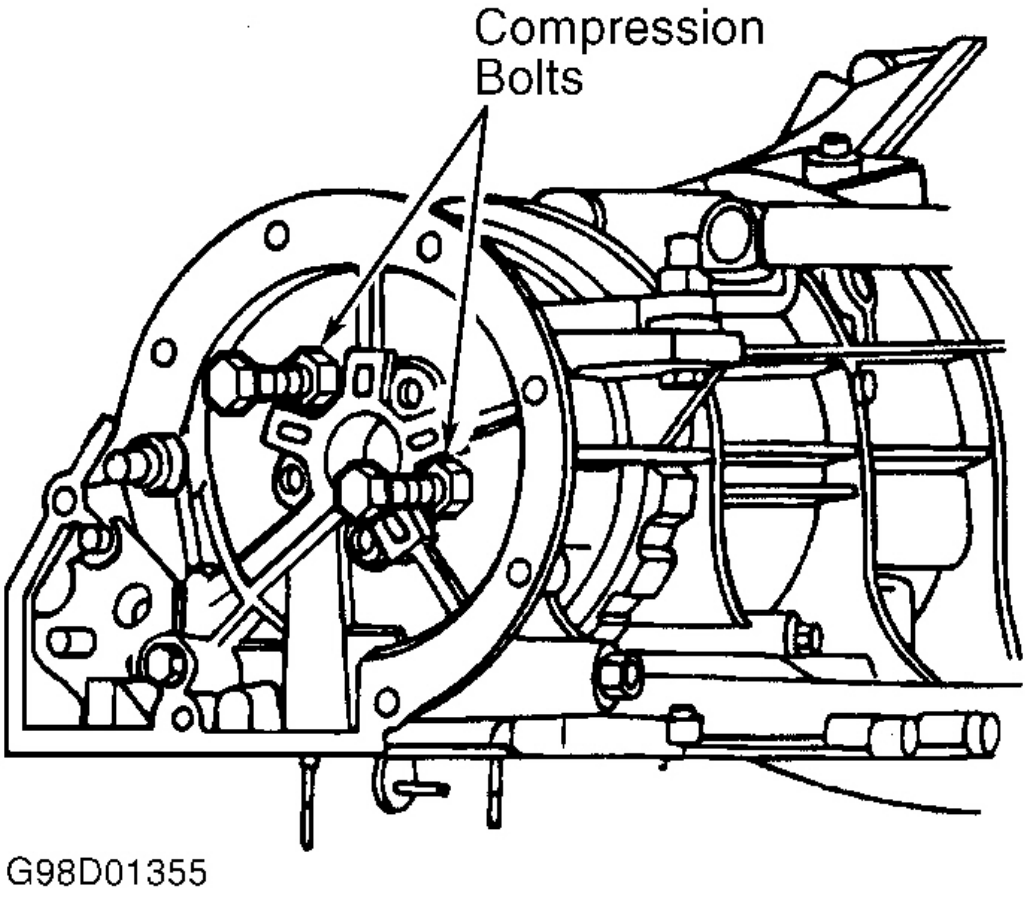


Fig. 39: Compressing Low-Reverse Piston Return Spring
Courtesy of FORD MOTOR CO.

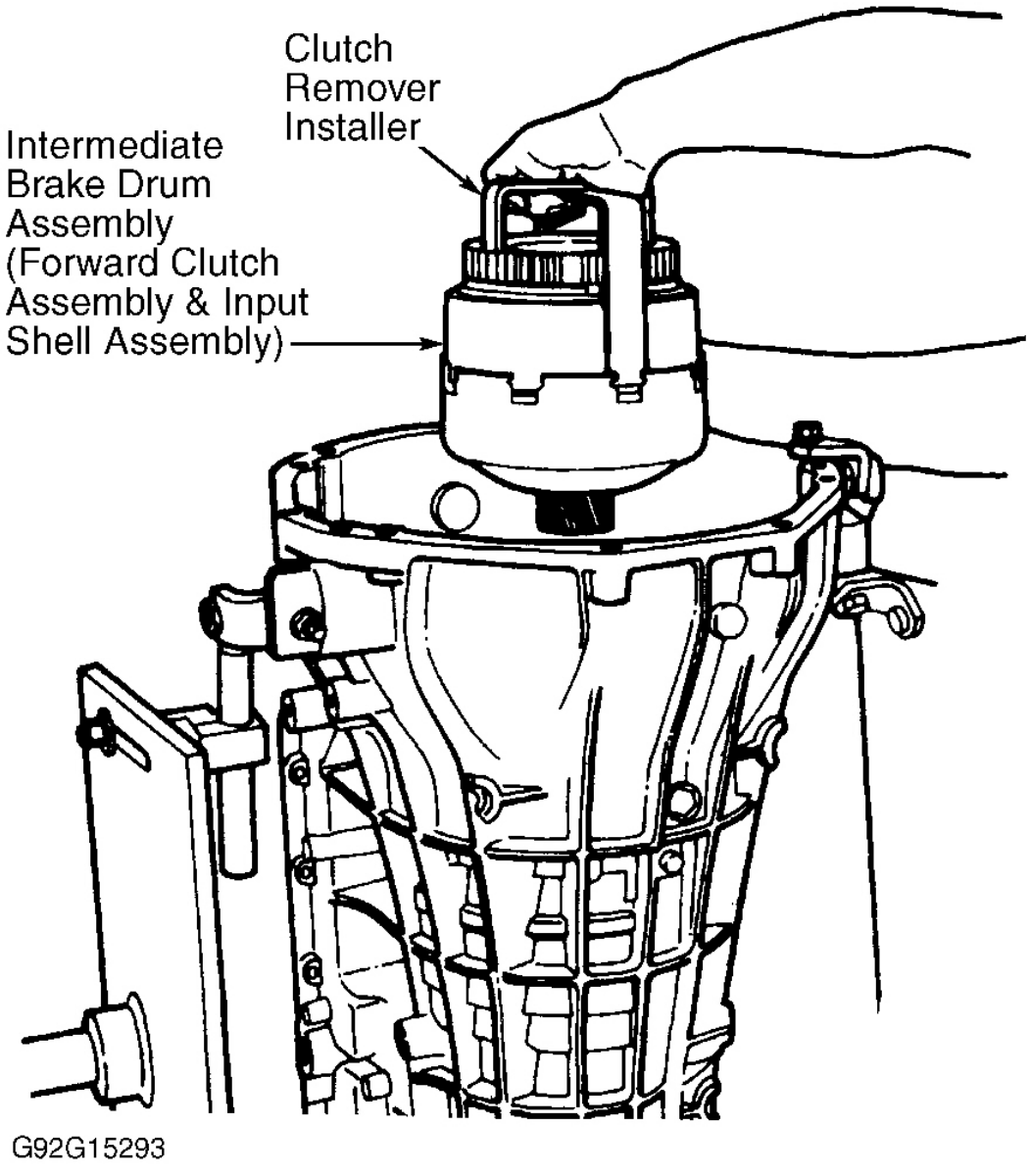


Fig. 40: Removing & Installing Input Shell
Courtesy of FORD MOTOR CO.

7. Install intermediate band with one ear on anchor pin. Install servo retaining ring, retaining plate, piston and rod assembly, and servo spring. Install rear intermediate pressure plate. Install clutch pack starting with internal spline plate. Install front intermediate pressure plate with blank area (no teeth) at 6 and 12 o'clock positions.
8. Measure clearance between center support and intermediate brake drum. Ensure clearance is .032-.081" (.81-2.06 mm). This verifies components are correctly installed to this point.

NOTE: Remove cast iron seals from center support to allow easy insertion into intermediate brake drum.

9. To determine center support thickness, hold thrust washer against center support. Place depth micrometer over drilled hole. Extend micrometer probe until flush with thrust washer surface and note reading. See **Fig. 41** .
10. Install center support and thrust washer into intermediate brake drum. Ensure center support is fully seated. Place depth micrometer over drilled hole. Extend micrometer probe until probe bottoms against thrust washer surface. See **Fig. 41** . Note reading. Subtract first reading from second reading.
11. If thrust washer clearance is not within specification, this indicates improper assembly, missing parts or parts out of specification. Correct before continuing reassembly. If clearance is within specifications, remove center support. Reinstall cast iron seal rings.

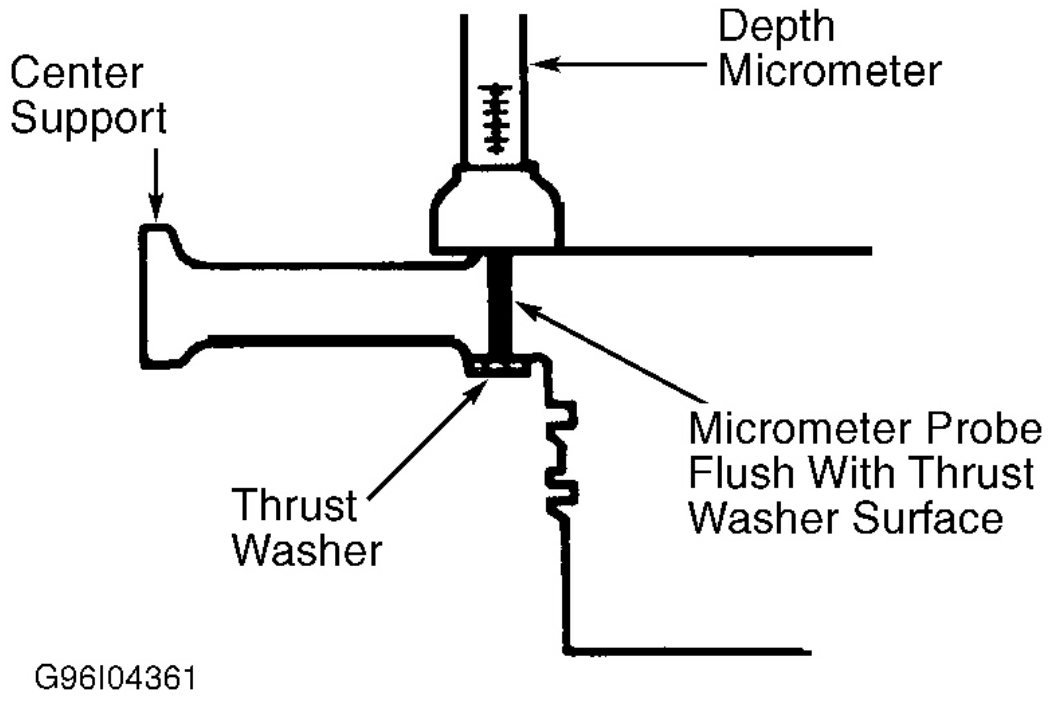


Fig. 41: Measuring Center Support Thickness
Courtesy of FORD MOTOR CO.

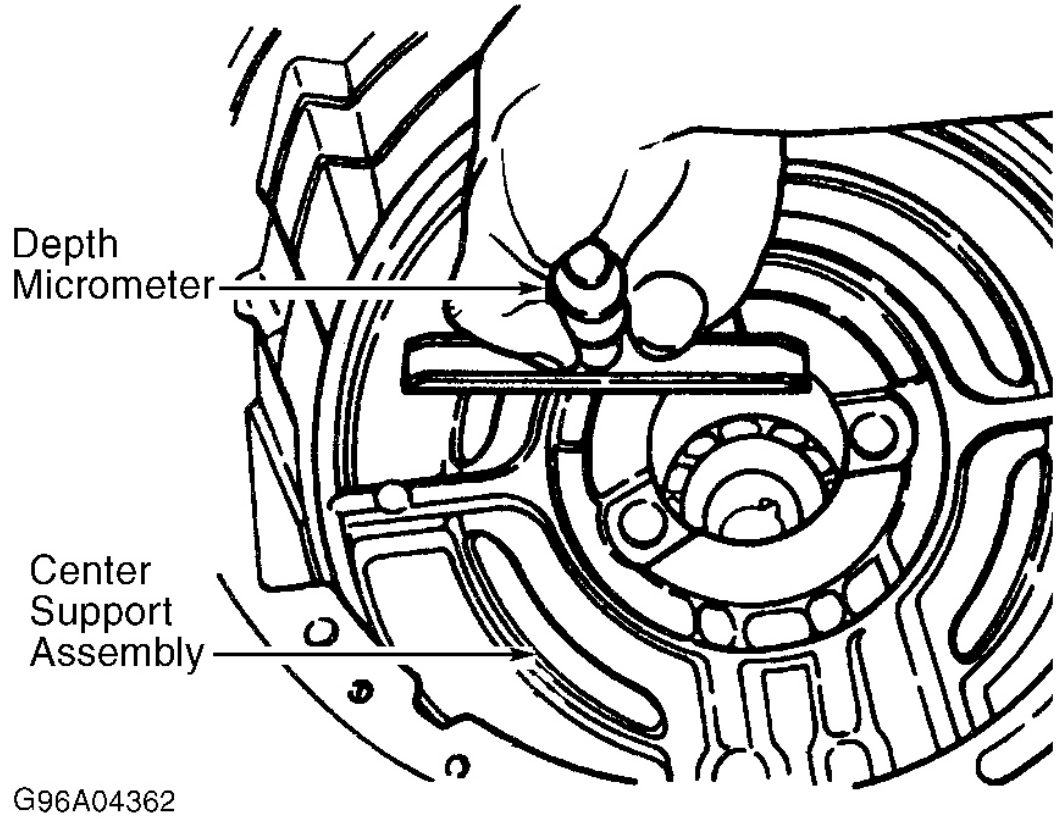


Fig. 42: Measuring Thrust Washer Clearance
Courtesy of FORD MOTOR CO.

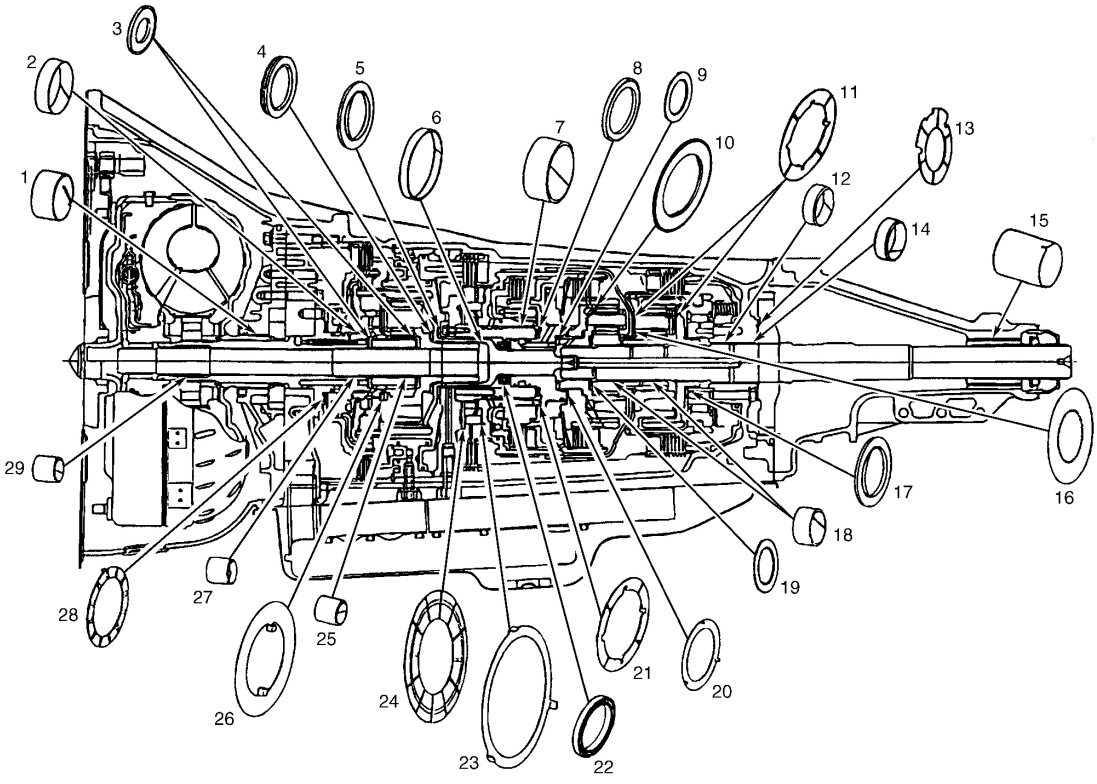
12. Install center support, and align with holes in feed port. Install 2 NEW rear feed bolts finger tight. Install intermediate clutch return spring with dish surface inward. Ensure spring locator legs are properly located in center support circular coast rib.
13. Install intermediate-overdrive cylinder. DO NOT cock cylinder when installing. Align cylinder threaded feed hole with hole in case. Install retaining ring over intermediate clutch cylinder with ring opening at bottom of case for proper oil drainback. Install Spring Compressor Plate (T89T-70010-F) and Spring Fixture (T89T-70010-C) onto intermediate clutch cylinder, tighten center bolt to 65 INCH lbs. (7 N.m). See **Fig. 25** .
14. Seat retaining ring in case ring groove. Remove spring compressor. No clearance measurement is required. Install NEW feed bolt finger tight. Coat needle bearing with grease and install on rear face of overdrive center shaft. Install center shaft, overdrive ring gear, overdrive planetary gear set and coast clutch cylinder as an assembly.
15. Install overdrive clutch pack, starting with a steel plate. Install pressure plate with dot facing outward and toward top of case. Install selective retaining ring with opening at bottom of case. Using a feeler gauge, measure clearance of clutch pack. Ensure clearance is .027-.052" (.68-1.32 mm) on 2-plate clutch. On 3-plate clutch clearance should be .032-.058" (.81-1.47 mm).

16. If clearance is not within specifications, install correct snap ring. Selective snap rings are available in thicknesses of .057-.061" (1.45-1.55 mm), .077-.081" (1.95-2.05 mm), .098-.102" (2.50-2.60 mm), .118-.122" (3.00-3.10 mm) and .138-.142" (3.50-3.60 mm).
17. Install pump gasket into case. Install input shaft long splined end first into case. Install thrust washer and needle bearing on pump. Install appropriate alignment pin to aid pump installation. Install pump, orient filter inlet tube bore toward 6 o'clock position.
18. Fully seat pump into case using hand pressure only. DO NOT use bolts to draw pump into case. Remove alignment pin. Install pump bolts and NEW seal washers. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Remove input shaft.
19. Using appropriate seal driver, install manual lever seal. Install manual lever shaft and roll pin, with pin just below case surface. Install manual lever position sensor with 2 bolts and washer. DO NOT tighten bolts at this time. Install manual lever detent spring. Tighten bolt to specification.
20. Install manual detent lever, park lever actuating rod and nut. Tighten nut to specification. Ensure manual valve detent spring is installed on inner detent lever. Using appropriate sensor adjuster, align sensor to neutral gear position. Tighten bolts to specification. Install outer manual lever. Install NEW manual lever shaft nut and tighten to specification.
21. Install parking pawl, parking pawl shaft and parking pawl return spring on rear face. Ensure parking pawl return spring end rests on inside surface of case. If removed, install parking pawl abutment with NEW Torx bolt and tighten to specification. Attach parking rod guide plate with 2 bolts and washers. Tighten bolts to specification. Ensure plate dimple is facing inward and parking rod is in guide plate slot.
22. Install gasket on extension housing. Ensure parking pawl return spring is properly located on inside surface of case when installing extension housing. Install extension housing and wiring bracket on rear case. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . The 2 bottom bolts are longer on 4WD vehicles.

CAUTION: Front fluid feed bolt torque is lower than rear feed bolts. Ensure proper torque specification is used. See TORQUE SPECIFICATIONS .

23. Rotate transmission with pan surface facing upward. Front feed bolt should be tightened to 71-120 INCH lbs. (8-14 N.m) and 2 rear feed bolts to 97-144 INCH lbs. (11-16 N.m). Install 8 rubber check balls, and steel EPC check ball and spring into case pockets. See **Fig. 7** .
24. Install case-to-separator plate gasket. Check placement of EPC check ball. Install separator plate. Attach reinforcing plate with 3 bolts. Ensure stamped UP on reinforcing plate faces up. Tighten bolts to specification. Install NEW separator-to-control gasket.
25. Install solenoid screen into separator plate. Turn and lock solenoid screen. Install accumulator body over studs. Install 2 nuts and 11 bolts finger tight. Lower main valve body over studs. Align manual valve with manual lever. Install 2 nuts and 14 bolts finger tight.
26. Ensure case connector bore is coated with grease prior to install-ing solenoid body. Install solenoid body over stud. Install 9 Torx bolts and one nut finger tight. Tighten all accumulator body, upper and lower control body and solenoid body nuts and bolts to specification.
27. Install NEW filter and seal assembly. Lubricate seal with ATF. Press filter into place. Install pan magnet on dimple in bottom of pan. Install NEW pan gasket on pan. Attach pan with bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

28. If necessary, install short fluid inlet tube. Use stripe or rib on side of tube for alignment. Stripe should be farthest outboard when installed. Rib should face toward front. Reinstall input shaft, long splined end first. Install torque converter. Using straightedge, ensure converter crankshaft pilot is below converter housing.



1. Front Oil Pump Bushing
2. Coast Clutch Bushing
3. Overdrive Sun Gear Thrust Bearing
4. Overdrive Carrier-To-Center Shaft Thrust Bearing
5. Center Shaft-To-Center Support Thrust Bearing
6. Intermediate Brake Drum Front Bushing
7. Intermediate Brake Drum Rear Bushing
8. Forward Clutch Hub-To-Center Support Hub Thrust Bearing
9. Forward Carrier Thrust Bearing
10. Planet Carrier Needle Bearing
11. Planet Carrier Thrust Washer
12. Front Case Bushing
13. Output Shaft Thrust Washer
14. Rear Case Bushing
15. Extension Housing Bushing
16. Input Shell Washer
17. Output Shaft Hub Rear Thrust Bearing
18. Forward/Reverse Sun Gear Bushing
19. Forward Carrier Thrust Bearing
20. Forward Clutch Hub Thrust Washer
21. Intermediate Brake Drum Thrust Washer
22. Center Shaft Ball Bearing
23. One-Way Clutch-To-Intermediate Brake Drum Thrust Washer
24. Center Support Thrust Washer
25. Overdrive Sun Gear Bushing
26. One-Way Clutch-To-Overdrive Carrier Thrust Washer
27. Front Pump Support Rear Bushing
28. Front Pump Support Thrust Washer
29. Front Pump Support Front Bushing

Fig. 43: Locating Thrust Washers & Bearings
Courtesy of FORD MOTOR CO.

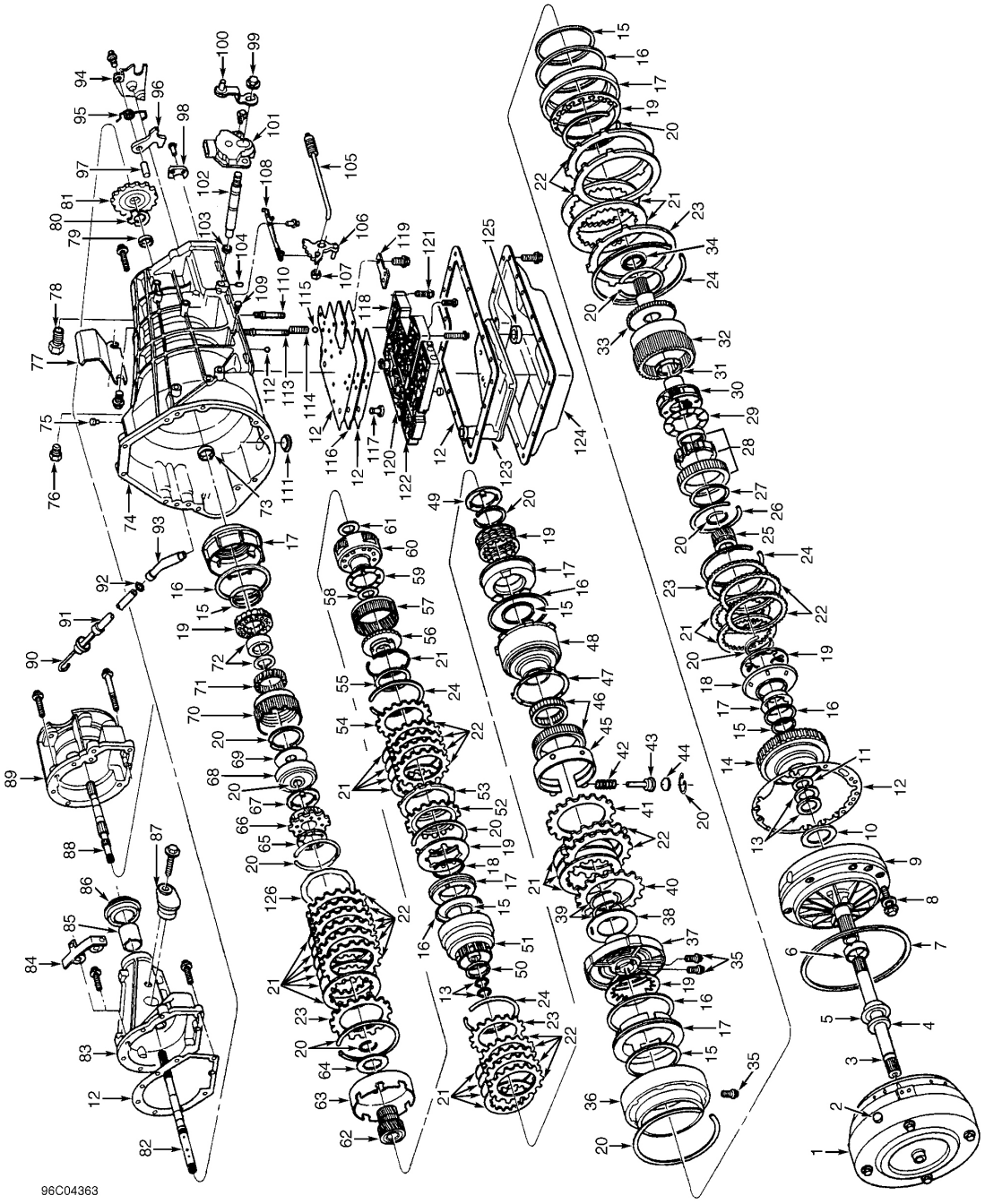


Fig. 44: Exploded View Of E4OD Automatic Transmission (1 Of 2)
Courtesy of FORD MOTOR CO.

1. Torque Converter
2. Converter Drain Plug
3. Input Shaft
4. Pump Support Seal
5. Converter Hub Seal
6. Converter Hub Bushing
7. Pump Seal
8. Seal Washer
9. Pump Assembly
10. Thrust Washer No. 1
11. Thrust Bearing No. 2A
12. Gasket
13. Seal Ring
14. Coast Clutch Cylinder
15. Inner Seal
16. Outer Seal
17. Piston
18. Piston Apply Ring
19. Piston Return Spring
20. Retaining Ring
21. Internal Spline Plate (Friction)
22. External Spline Plate (Steel)
23. Pressure Plate
24. Selective Fit Retaining Ring
25. Overdrive Sun Gear
26. Retaining Ring (Large)
27. Retaining Ring (Small)
28. Overdrive One-Way Clutch
29. Thrust Washer No. 3
30. Planet Gear Overdrive Carrier
31. Thrust Bearing No. 4
32. Overdrive Ring Gear
33. Center Shaft
34. Thrust Bearing No. 5
35. Fluid Feed Bolt
36. Intermediate/Overdrive Cylinder
37. Center Support
38. Thrust Washer No. 6
39. Direct Clutch Cast Iron Seal
40. Pressure Plate (Front)
41. Pressure Plate (Rear)
42. Servo Piston Spring
43. Servo Piston
44. Servo Cover Plate
45. Intermediate Band
46. Intermediate One-Way Clutch
47. Thrust Washer No. 7
48. Intermediate Brake Drum
49. Thrust Washer No. 8
50. Thrust Bearing No. 8B
51. Forward Clutch Cylinder
52. Pressure Plate (Bottom)
53. Cushion Spring
54. Pressure Plate (Top)
55. Thrust Washer No. 8C
56. Forward Hub
57. Forward Ring Gear
58. Thrust Bearing No. 9A
59. Thrust Washer No 10A
60. Forward Planet
61. Thrust Bearing No. 9B
62. Forward/Reverse Sun Gear
63. Input Shell
64. Input Shell Thrust Washer
65. Thrust Washer No.10B
66. Reverse Planet
67. Thrust Washer No. 11
68. Output Shaft Ring Gear
69. Output Shaft Hub & Race
70. Reverse Clutch Hub
71. Low One-Way Clutch
72. Thrust Washer No. 12
73. Front Case Bushing
74. Case Assembly
75. Vent
76. Oil Tube Inlet Connector
77. Heat Shield
78. Oil Cooler Check Valve
79. Rear Case Bushing
80. Thrust Washer No. 13
81. Parking Gear
82. Output Shaft (2WD)
83. Extension Housing
84. Wiring Bracket
85. Extension Housing Bushing
86. Extension Housing Seal
87. Extension Housing Plug
88. Output Shaft (4WD)
89. Extension Housing (4WD & Super Duty)
90. Dipstick
91. Oil Filler Tube
92. Oil Filler Tube Seal
93. Lube Inlet Short Tube
94. Parking Rod Guide Plate
95. Parking Pawl Return Spring
96. Parking Pawl
97. Parking Pawl Shaft
98. Parking Pawl Abutment
99. Manual Control Lever Nut
100. Manual Control Lever
101. Manual Lever Position Sensor
102. Manual Lever Shaft
103. Manual Lever Seal
104. Manual Lever Shaft Retaining Pin
105. Parking Pawl Actuating Rod
106. Inner Detent Lever
107. Inner Detent Lever Nut
108. Manual Valve Detent Spring
109. Line Pressure Test Port
110. Case-To-Control Assembly Stud
111. Converter Access Plug
112. Rubber Check Ball
113. Case-To-Solenoid Body Stud
114. EPC Blow-Off Spring
115. EPC Blow-Off Ball
116. Separator Plate
117. Solenoid Screen
118. Main Control Body
119. Separator Plate Reinforcement
120. Solenoid Body
121. Torx Head Bolt
122. Accumulator Body
123. Filter & Seal
124. Oil Pan
125. Pan Magnet
126. Cushion Spring

98A01354

Fig. 45: Legend For Exploded View Of E4OD Transmission (2 Of 2)
Courtesy of FORD MOTOR CO.

TRANSMISSION SPECIFICATIONS

TRANSMISSION SPECIFICATIONS

Application	In. (mm)
Coast Clutch Pack Clearance	.030-.050 (.76-1.27)
Direct Clutch Pack Clearance	.045-.081 (1.15-2.06)
Forward Clutch Pack Clearance	.030-.055 (.76-1.40)
Gear-To-Housing Clearance (1)	.0015-.0022 (.0254-.0510)
Overdrive Clutch Pack Clearance	
2-Disc Clutch	.027-.052 (.68-1.32)
3-Disc Clutch	.032-.058 (.81-1.47)
Torque Converter End Play	
Diesel Engine	
New Or Rebuilt	.024-.048 (.60-1.21)
Used	.079 (2.0)
Gas Engine	
New Or Rebuilt	.014-.038 (.35-96)
Used	.071 (1.8)
(1) Oil pump inner/outer gerotor gear.	

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Connector-To-Case Cooler Line Nut	18-23 (24-31)
Control Assembly-To-Pump Body Bolts	18-23 (24-31)
Converter Drain Plug	21-23 (29-31)
Cooler Bypass Hose/Valve	
Case Inlet Bolt	24-29 (33-39)
Case Outlet Bolt	20-24 (27-33)
Extension Housing-To-Case Bolts	
2WD	20-29 (27-39)
4WD	24-40 (33-54)
Inner One-Way Clutch Race-To-Case Bolts	18-25 (24-34)
Manual Lever Nut	
Inner	30-40 (41-54)
Outer	20-29 (27-39)
Oil Pan-To-Case Bolts	10-12 (14-16)
Oil Pump Body-To-Case Bolts	18-23 (24-31)
Parking Pawl Abutment-To-Case Bolts	16-20 (22-27)
Parking Rod Guide Plate-To-Case Bolts	16-20 (22-27)
Transmission Mount-To-Crossmember Bolts	60-80 (81-108)
	INCH Lbs. (N.m)
Center Support Fluid Feed Bolts	
Front Bolt	71-120 (8-14)
Rear Bolt	97-144 (11-16)
Detent Spring-To-Case Bolt	80-97 (9-11)
Lower Body-To-Main Body Bolts	80-97 (9-11)
Main Accumulator & Solenoid Body-To-Case Bolts	80-97 (9-11)
Main And Lower Body-To-Case Bolts	80-100 (9-11)
MLP Sensor-To-Case Bolts	55-71 (6-8)
Overdrive Cylinder Fluid Feed Bolts	
Front Bolt	71-120 (8-14)
Rear Bolts	97-144 (11-16)
Plug Line Pressure Case	72-144 (8-16)
Reinforcing Plate-To-Case Bolts	80-97 (9-11)
Solenoid Body-To-Case Bolts	80-97 (9-11)
Stator Support-To-Pump Body Bolts	80-97 (9-11)
Valve Body-To-Case Long Stud	80-97 (9-11)
Valve Body-To-Case Nut	80-97 (9-11)
Valve Body-To-Case Short Stud	80-97 (9-11)

GENERAL INFORMATION

Trouble Shooting - Basic Procedures

* PLEASE READ THIS FIRST *

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

ACCESSORIES & ELECTRICAL

CHARGING SYSTEM TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC CHARGING SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Vehicle Will Not Start	
Dead battery	Check battery cells, alternator belt tension and alternator output
Loose or corroded battery connections	Check all charging system connections
Ignition circuit or switch malfunction	Check and replace as necessary
Alternator Light Stays On With Engine Running	
Loose or worn alternator drive belt	Check alternator drive tension and condition, See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Loose alternator wiring connections	Check all charging system connections

Short in alternator light wiring	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Defective alternator stator or diodes	See Bench Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Alternator Light Stays Off With Ignition Switch ON	
Blown fuse	See WIRING DIAGRAMS
Defective alternator	See Testing in ALTERNATOR article
Defective indicator light bulb or socket	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Alternator Light Stays OFF With Ignition Switch ON	
Short in alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective rectifier bridge	See Bench Tests in ALTERNATOR article
Lights or Fuses Burn Out Frequently	
Defective alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Defective battery	Check and replace as necessary
Ammeter Gauge Shows Discharge	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Defective wiring	Check all wires and wire connections
Defective alternator or regulator	See Bench Tests and On-Vehicle Tests in ALTERNATOR article
Defective ammeter, or improper ammeter wiring connection	See Testing in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Noisy Alternator	
Loose drive pulley	Tighten drive pulley attaching nut

Loose mounting bolts	Tighten all alternator mounting bolts
Worn or dirty bearings	See Bearing Replacement ALTERNATOR article
Defective diodes or stator	See Bench Test in ALTERNATOR article
Battery Does Stay Charged	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in appropriate TUNE-UP article in the TUNE-UP section
Loose or corroded battery connections	Check all charging system connections
Loose alternator connections	Check all charging system connections
Defective alternator or battery	See On-Vehicle Tests and Bench Tests in ALTERNATOR article
Add-on electrical accessories exceeding alternator capacity	Install larger alternator
Battery Overcharged-Uses Too Much Water	
Defective battery	Check alternator output and repair as necessary
Defective alternator	See On-Vehicle Test and Bench Tests in ALTERNATOR article
Excessive alternator voltage	Check alternator output and repair as necessary

IGNITION SYSTEM TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

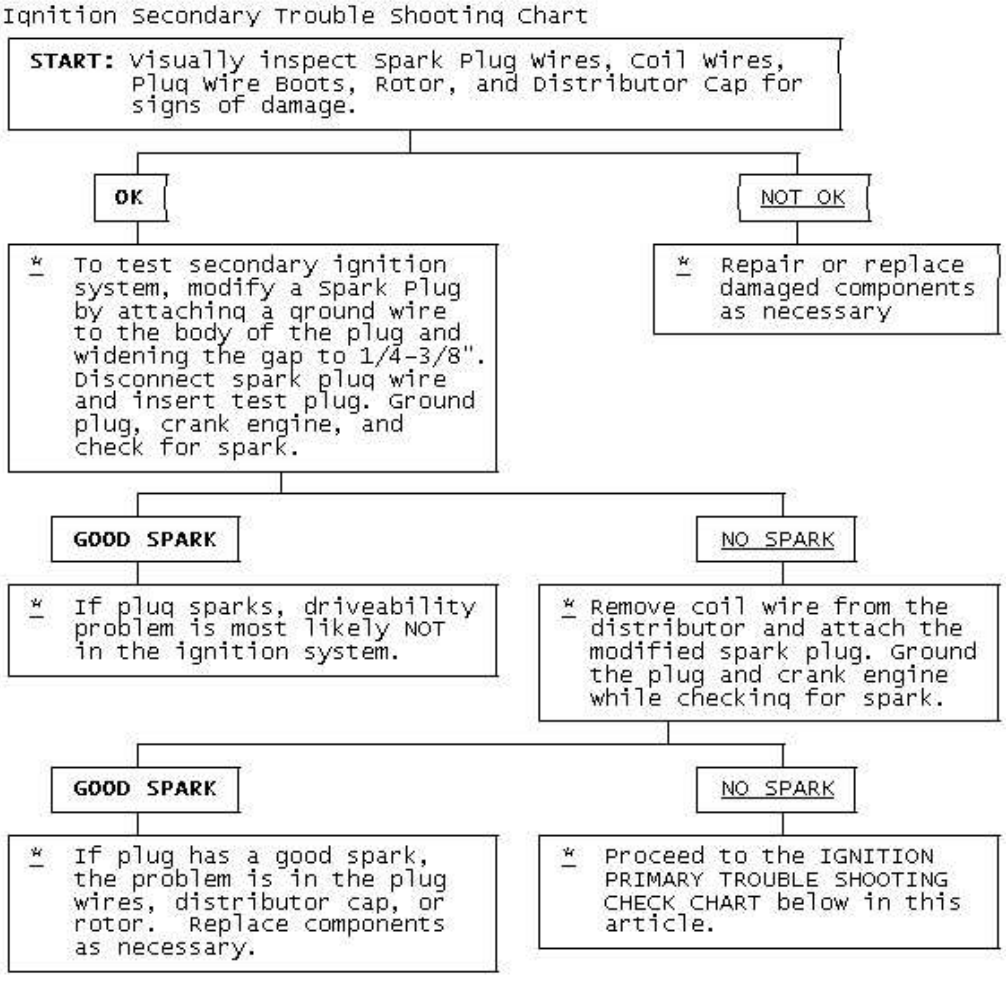


Fig. 1: Ignition Secondary Trouble Shooting Chart

Ignition Primary Trouble Shooting Chart

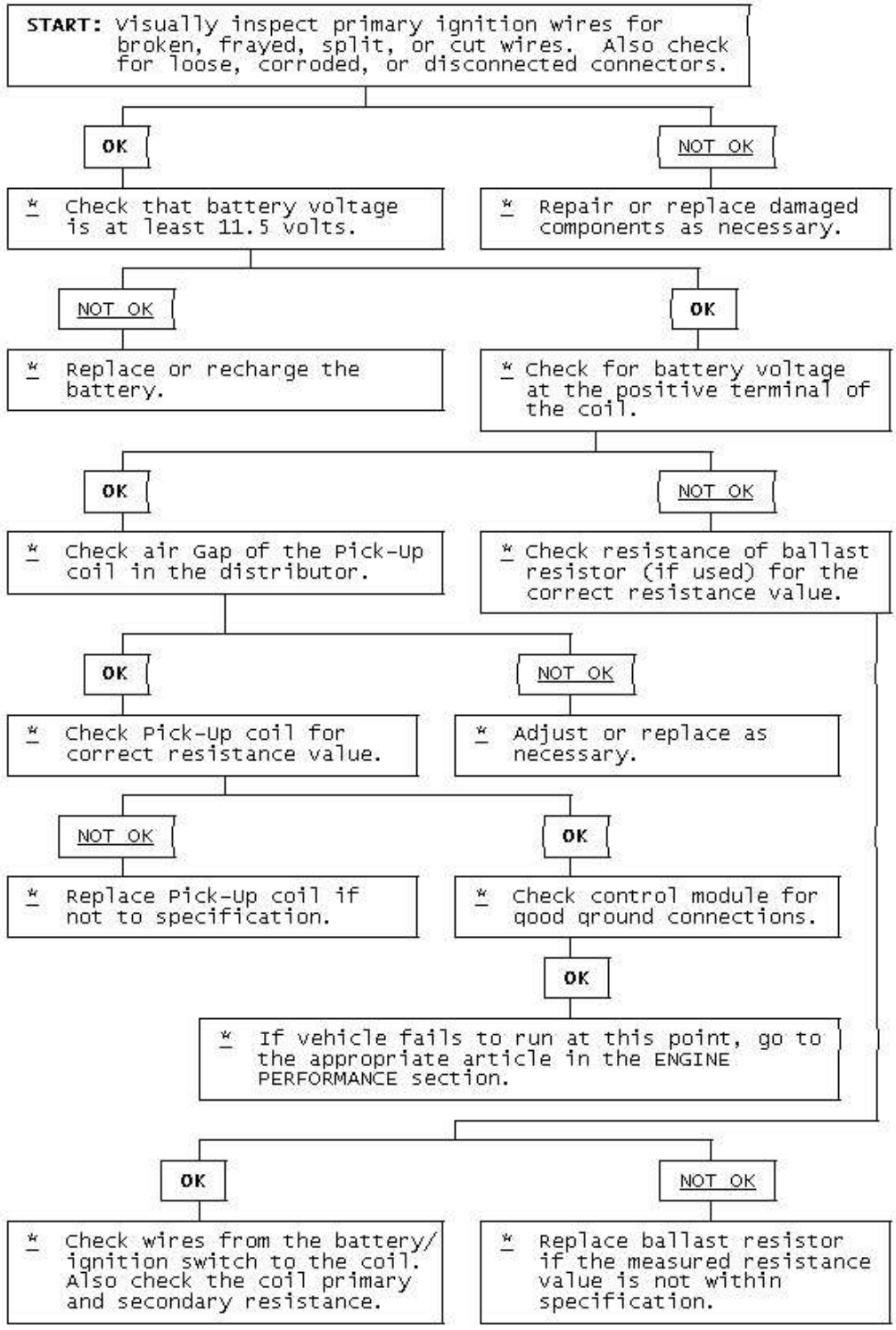


Fig. 2: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole	See STARTER article shoes
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	
Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article

Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearing	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	

Dead battery	Charge or replace battery as necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch	Replace ignition switch contacts sticking
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	solenoid
Low Current Draw	
Worn brushes or weak brush springs	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to

	the intermittent nature

AIR CONDITIONING & HEAT

AIR CONDITIONING TROUBLE SHOOTING

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC AIR CONDITIONING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Compressor Not Working	Compressor clutch circuit open.
.....	Compressor clutch coil inoperative.
.....	Poor clutch ground connection.
.....	Fan belts loose.
.....	Thermostatic switch inoperative.
.....	Thermostatic switch not adjusted.
.....	Ambient temperature switch open.
.....	Superheat fuse blown.
Excessive Noise or Vibration	Missing or loose mounting bolts.
.....	Bad idler pulley bearings.
.....	Fan belts not tightened correctly.
.....	Compressor clutch contacting body.
.....	Excessive system pressure.
.....	Compressor oil level low.
.....	Damaged clutch bearings.
.....	Damaged reed valves.
.....	Damaged compressor.
Insufficient or No Cooling; Compressor Working	Expansion valve inoperative.
.....	Heater control valve stuck open.
.....	Low system pressure.
.....	Blocked condenser fins.
.....	Blocked evaporator fins.
.....	Vacuum system leak.
.....	Vacuum motors inoperative.
.....	Control cables improperly adjusted.
.....	Restricted air inlet.

.....	Mode doors binding.
.....	Blower motor inoperative.
.....	Temperature above system capacity.

HEATER SYSTEM TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC HEATER SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Insufficient, Erratic, or No Heat	Low Coolant Level
.....	Incorrect thermostat.
.....	Restricted coolant flow through core.
.....	Heater hoses plugged.
.....	Misadjusted control cable.
.....	Sticking heater control valve.
.....	Vacuum hose leaking.
.....	Vacuum hose blocked.
.....	Vacuum motors inoperative.
.....	Blocked air inlet.
.....	Inoperative heater blower motor.
.....	Oil residue on heater core fins.
.....	Dirt on heater core fins.
Too Much Heat	Improperly adjusted cables.
.....	Sticking heater control valve.
.....	No vacuum to heater control valve.
.....	Temperature door stuck open.
Air Flow Changes During Acceleration	Vacuum system leak.
.....	Bad check valve or reservoir.
Air From Defroster At All Times	Vacuum system leak.
.....	Improperly adjusted control cables.
.....	Inoperative vacuum motor.
Blower Does Not Operate Correctly	Blown fuse.
.....	Blower motor windings open.
.....	Resistors burned out.
.....	Motor ground connection loose.

.....	Wiring harness connections loose.
.....	Blower motor switch inoperative.
.....	Blower relay inoperative.
.....	Fan binding or foreign object in housing.
.....	Fan blades broken or bent.

BRAKES

BRAKE SYSTEM TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BRAKE SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Brakes Pull Left or Right	
Incorrect tire pressure	Inflate tires to proper pressure
Front end out of alignment	See WHEEL ALIGNMENT
Mismatched tires	Check tires sizes
Restricted brake lines or hoses	Check hose routing
Loose or malfunctioning caliper	See DISC BRAKES or BRAKE SYSTEM
Bent shoe or oily linings	See DRUM BRAKES or BRAKE SYSTEM
Malfunctioning rear brakes	See DRUM, DISC BRAKES or BRAKE SYSTEM
Loose suspension parts	See SUSPENSION
Noises Without Brakes Applied	
Front linings worn out	Replace linings
Dust or oil on drums or rotors	See DRUM, DISC BRAKES or BRAKE SYSTEM
Noises With Brakes Applied	
Insulator on outboard shoe damaged	See DISC BRAKES or BRAKE SYSTEM
Incorrect pads or linings	Replace pads or linings
Brake Rough, Chatters or Pulsates	
Excessive lateral runout	Check rotor runout
Parallelism not to specifications	Reface or replace rotor
Wheel bearings not adjusted	See SUSPENSION

Rear drums out-of-round	Reface or replace drums
Disc pad reversed, steel against rotor	Remove and reinstall pad
Excessive Pedal Effort	
Malfunctioning power unit	See POWER BRAKES or BRAKE SYSTEM
Partial system failure	Check fluid and pipes
Worn disc pad or lining	Replace pad or lining
Caliper piston stuck or sluggish	See DISC BRAKES or BRAKE SYSTEM
Master cylinder piston stuck	See MASTER CYLINDERS or BRAKE SYSTEM
Brake fade due to incorrect pads for linings	Replace pads or linings
Linings or pads glazed	Replace pads or linings
Worn drums	Reface or replace drums
Excessive Pedal Travel	
Partial brake system failure	Check fluid and pipes
Insufficient fluid in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Air trapped in system	See BRAKE BLEEDING or BRAKE SYSTEM
Rear brakes not adjusted	See Adjustments in DRUM BRAKES or BRAKE SYSTEM
Bent shoe or lining	See DRUM BRAKES or BRAKE SYSTEM
Plugged master cylinder cap	See MASTER CYLINDERS or BRAKE SYSTEM
Improper brake fluid	Replace brake fluid
Pedal Travel Decreasing	
Compensating port plugged	See MASTER CYLINDERS or BRAKE SYSTEM
Swollen cup in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Master cylinder piston not returning	See MASTER CYLINDERS or BRAKE SYSTEM
Weak shoe retracting springs	See DRUM BRAKES BRAKE SYSTEM
Wheel cylinder piston sticking	See DRUM BRAKES or BRAKE SYSTEM
Dragging Brakes	
Master cylinder pistons not returning	See MASTER CYLINDERS BRAKE SYSTEM
Restricted brake lines or hoses	Check line routing

Incorrect parking brake adjustment	See DRUM BRAKES BRAKE SYSTEM
Parking Brake cables frozen	See DRUM BRAKES BRAKE SYSTEM
Incorrect installation of inboard disc pad	Remove and replace correctly
Power booster output rod too long	See POWER BRAKE UNITS BRAKE SYSTEM
Brake pedal not returning freely	See DISC, DRUM BRAKES BRAKE SYSTEM
Brakes Grab or Uneven Braking Action	
Malfunction of combination valve	See CONTROL VALVE or BRAKE SYSTEM
Malfunction of power brake unit	See POWER BRAKE UNITS or BRAKE SYSTEM
Binding brake pedal	See DISC, DRUM BRAKES or BRAKE SYSTEM
Pulsation or Roughness	
Uneven pad wear caused by caliper	See DISC BRAKES or BRAKE SYSTEM
Uneven rotor wear	See DISC BRAKES or BRAKE SYSTEM
Drums out-of-round	Reface or replace drums

ENGINE MECHANICAL

COOLING SYSTEM TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

COOLING SYSTEM TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Overheating	
Coolant Leak	Fill/Pressure Test System
A/C Condenser Fins Clogged	Remove/Clean Condenser
Radiator Fins Clogged	Remove/Clean Radiator
Thermostat Stuck Closed	Replace Thermostat
Clogged Cooling System Passages	Clean/Flush Cooling System
Water Pump Malfunction	Replace Water Pump
Fan Clutch Malfunction	Replace Fan Clutch

Retarded Ignition Timing	Reset Ignition Timing
Cooling Fan Malfunction	Test Cooling Fan/Circuit
Cooling Fan Motor Malfunction	Test Fan Motor
Cooling Fan Relay Malfunction	Test Fan Relay
Faulty Radiator Cap	Replace Radiator Cap
Broken/Slipping Fan Belt	Replace Fan Belt
Restricted Exhaust	Repair Exhaust System
Corrosion	
Impurities In Coolant	Clean/Flush System
Coolant Leakage	
Damaged hose	Replace Hose
Leaky Water Pump	Replace Water Pump
Damaged Radiator Seam	Replace/Repair Radiator
Leaky Thermostat Cover	Replace Thermostat Cover
Cylinder Head Problem	Check Head/Head Gasket
Leaky Freeze Plugs	Replace Freeze Plugs
Recovery System Inoperative	
Loose and/or Defective Radiator Cap	Replace Radiator Cap
Overflow Tube Clogged and/or Leaking	Repair Tube
Recovery Bottle Vent Restricted	Clean Vent
No Heater Core Flow	
Collapsed Heater Hose	Replace Heater Hose
Plugged Heater Core	Clean/Replace Heater Core
Faulty Heater Valve	Replace Heater Valve

GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Lopes At Idle	
Intake manifold-to-head leaks	Replace manifold gasket, See ENGINES
Blown head gasket	Replace head gasket, See ENGINES
Worn timing gears, chain or sprocket	Replace gears, chain or sprocket

Worn camshaft lobes	Replace camshaft, See ENGINES
Overheated engine	Check cooling system, See COOLING
Blocked crankcase vent valve	Remove restriction
Leaking EGR valve	Repair leak and/or replace valve
Faulty fuel pump	Replace fuel pump
Engine Has Low Power	
Leaking fuel pump	Repair leak and/or replace fuel pump
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Sticking valves or weak valve springs	Check valve train components, See ENGINES
Incorrect valve timing	Reset valve timing, See ENGINES
Worn camshaft lobes	Replace camshaft, See ENGINES
Blown head gasket	Replace head gasket. See ENGINES.
Clutch slipping	Adjust pedal and/or replace components, See ENGINES
Engine overheating	Check cooling system, See COOLING
Auto. Trans. pressure regulator valve faulty	Replace pressure regulator valve
Auto. Trans. fluid level too low	Add fluid as necessary
Improper vacuum diverter valve operation	Replace vacuum diverter valve
Vacuum leaks	Inspect vacuum system and repair as required
Leaking piston rings	Replace piston rings, See ENGINES
Faulty High Speed Operation	
Low fuel pump volume	Replace fuel pump
Leaking valves or worn	Replace valves and/or springs, See ENGINES
Incorrect valve timing	Reset valve timing,See ENGINES
Intake manifold restricted	Remove restriction
Worn distributor shaft	Replace distributor
Faulty Acceleration	

Improper fuel pump stroke	Remove pump and reset pump stroke
Incorrect ignition timing	Reset ignition timing, See TUNE-UP
Leaking valves	Replace valves, See ENGINES
Worn fuel pump diaphragm or piston	Replace diaphragm or piston
Intake Backfire	
Improper ignition timing	Reset ignition timing, See TUNE-UP
Faulty accelerator pump discharge	Replace accelerator pump
Improper choke operation	Check choke and adjust as required
Defective EGR valve	Replace EGR valve
Fuel mixture too lean	Reset air/fuel mixture, See TUNE-UP
Choke valve initial clearance too large	Reset choke valve initial clearance
Exhaust Backfire	
Vacuum leak	Inspect and repair vacuum system
Faulty vacuum diverter valve	Replace vacuum diverter valve
Faulty choke operation	Check choke and adjust as required
Exhaust system leak	repair exhaust system leak
Engine Detonation	
Ignition timing too far advanced	Reset ignition timing, See TUNE-UP
Faulty ignition system	Check ignition timing, See TUNE-UP
Spark plugs loose or faulty	Retighten or replace plugs
Fuel delivery system clogged	Inspect lines, pump and filter for clog
EGR valve inoperative	Replace EGR valve
PCV system inoperative	Inspect and/or replace hoses or valve
Vacuum leaks	Check vacuum system and repair leaks
Excessive combustion chamber deposits	Remove built-up deposits
Leaking, sticking or broken valves	Inspect and/or replace valves
External Oil Leakage	
Fuel pump improperly seated or worn gasket	Remove pump, replace gasket

	and seat properly
Oil pan gasket broken or pan bent	Straighten pan and replace gasket
Timing chain cover gasket broken	Replace timing chain cover gasket
Rear main oil seal worn	Replace rear main oil seal
Oil pan drain plug not seated properly	Remove and reinstall drain plug
Camshaft bearing drain hole blocked	Remove restriction
Oil pressure sending switch leaking	Remove and reinstall sending switch
Excessive Oil Consumption	
Worn valve stems or guides	Replace stems or guides, See ENGINES
Valve "O" ring seals damaged	Replace "O" ring seals, See ENGINES
Plugged oil drain back holes	Remove restrictions
Improper PCV valve operation	Replace PCV valve
Engine oil level too high	Remove excess oil
Engine oil too thin	Replace thicker oil
Valve stem oil deflectors damaged	Replace oil deflectors
Incorrect piston rings	Replace piston rings, See ENGINES
Piston ring gaps not staggered	Reinstall piston rings, See ENGINES
Insufficient piston ring tension	Replace rings, See ENGINES
Piston ring grooves or oil return	slots clogged Replace piston rings, See ENGINES
Piston rings sticking in grooves	Replace piston rings, See ENGINES
Piston ring grooves excessively worn	Replace piston and rings, See ENGINES
Compression rings installed upside down	Replace compression rings correctly, See ENGINES
Worn or scored cylinder walls	Rebore cylinders or replace block
Mismatched oil ring expander and rail	Replace oil ring expander and rail, See ENGINES
Intake gasket dowels too long	Replace intake gasket dowels
Excessive main or connecting rod bearing clearance	Replace main or connecting rod bearings, See ENGINES
No Oil Pressure	
Low oil level	Add oil to proper level

Oil pressure sender or gauge broken	Replace sender or gauge
Oil pump malfunction	Remove and overhaul oil pump, See ENGINES
Oil pressure relief valve sticking	Remove and reinstall valve
Oil pump passages blocked	Overhaul oil pump, See ENGINES
Oil pickup screen or tube blocked	Remove restriction
Loose oil inlet tube	Tighten oil inlet tube
Loose camshaft bearings	Replace camshaft bearings, See ENGINES
Internal leakage at oil passages	Replace block or cylinder head
Low Oil Pressure	
Low engine oil level	Add oil to proper level
Engine oil too thin	Remove and replace with thicker oil
Excessive oil pump clearance	Reduce oil pump clearance, See ENGINES
Oil pickup tube or screen blocked	Remove restrictions
Main, rod or cam bearing clearance excessive	Replace bearing to reduce clearance, See ENGINES
High Oil Pressure	
Improper grade of oil	Replace with proper oil
Oil pressure relief valve stuck closed	Eliminate binding
Oil pressure sender or gauge faulty	Replace sender or gauge
Noisy Main Bearings	
Inadequate oil supply	Check oil delivery to main bearings
Excessive main bearing clearance	Replace main bearings, See ENGINES
Excessive crankshaft end play	Replace crankshaft, See ENGINES
Loose flywheel or torque converter	Tighten attaching bolts
Loose or damaged vibration damper	Tighten or replace vibration damper
Crankshaft journals out-of-round	Re-grind crankshaft journals
Excessive belt tension	Loosen belt tension
Noisy Connecting Rods	
Excessive bearing clearance or missing bearing	Replace bearing, See ENGINES
Crankshaft rod journal out-of-round	Re-grind crankshaft journal
Misaligned connecting rod or cap	Remove rod or cap and

	realign
Incorrectly tightened rod bolts	Remove and re-tighten rod bolts
Noisy Pistons and Rings	
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Bore tapered or out-of-round	Rebore block
Piston ring broken	Replace piston rings, See ENGINES
Piston pin loose or seized	Replace piston pin, See ENGINES
Connecting rods misaligned	Realign connecting rods
Ring side clearance too loose or tight	Replace with larger or smaller rings
Carbon build-up on piston	Remove carbon
Noisy Valve Train	
Worn or bent push rods	Replace push rods, See ENGINES
Worn rocker arms or bridged pivots	Replace push rods, See ENGINES
Dirt or chips in valve lifters	Remove lifters and remove dirt/chips
Excessive valve lifter leak-down	Replace valve lifters, See ENGINES
Valve lifter face worn	Replace valve lifters, See ENGINES
Broken or cocked valve springs	Replace or reposition springs
Too much valve stem-to-guide clearance	Replace valve guides, See ENGINES
Valve bent	Replace valve, See ENGINES
Loose rocker arms	Retighten rocker arms, See ENGINES
Excessive valve seat run-out	Reface valve seats, See ENGINES
Missing valve lock	Install new valve lock
Excessively worn camshaft lobes	Replace camshaft, See ENGINES
Plugged valve lifter oil holes	Eliminate restriction or replace lifter
Faulty valve lifter check ball	Replace lifter check ball, See ENGINES
Rocker arm nut installed upside down	Remove and reinstall correctly
Valve lifter incorrect for engine	Remove and replace valve

	lifters
Faulty push rod seat or lifter plunger	Replace plunger or push rod
Noisy Valves	
Improper valve lash	Re-adjust valve lash, See ENGINES
Worn or dirty valve lifters	Clean and/or replace lifters
Worn valve guides	Replace valve guides, See ENGINES
Excessive valve seat or face run-out	Reface seats or valve face
Worn camshaft lobes	Replace camshaft, See ENGINES
Loose rocker arm studs	Re-tighten rocker arm studs, See ENGINES
Bent push rods	Replace push rods, See ENGINES
Broken valve springs	Replace valve springs, See ENGINES
Burned,Sticking or Broken Valves	
Weak valve springs or warped valves	Replace valves and/or springs, See ENGINES
Improper lifter clearance	Re-adjust clearance or replace lifters
Worn guides or improper guide clearance	Replace valve guides, See ENGINES
Out-of-round valve seats or improper seat width	Re-grind valve seats
Gum deposits on valve stems, seats or guide	Remove deposits
Improper spark timing	Re-adjust spark timing
Broken Pistons/Rings	
Undersize pistons	Replace with larger pistons, See ENGINES
Wrong piston rings	Replace with correct rings, See ENGINES
Out-of-round cylinder bore	Re-bore cylinder bore
Improper connecting rod alignment	Remove and realign connecting rods
Excessively worn ring grooves	Replace pistons, See ENGINES
Improperly assembled piston pins	Re-assemble pin-to-piston, See ENGINES
Insufficient ring gap clearance	Install new rings, See ENGINES
Engine overheating	Check cooling system
Incorrect ignition timing	Re-adjust ignition timing, See

	TUNE-UP
Excessive Exhaust Noise	
Leaks at manifold to head, or to pipe	Replace manifold or pipe gasket
Exhaust manifold cracked or broken	Replace exhaust manifold, See ENGINES

ENGINE PERFORMANCE

CARBURETOR TROUBLE SHOOTING:

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC COLD START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Choke not closing	Check choke operation, see FUEL SYSTEMS
Choke linkage bent	Check linkage, see FUEL SYSTEM
Engine Starts, Then Dies	
Choke vacuum kick setting too wide	Check setting and adjust see, FUEL SYSTEMS
Fast idle RPM too low	Reset RPM to specification, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Vacuum leak	Inspect vacuum system for leaks
Low fuel pump outlet	Repair or replace pump, see FUEL SYSTEMS
Low carburetor fuel level	Check float setting see FUEL SYSTEM
Engine Quits Under Load	
Choke vacuum kick setting incorrect	Reset vacuum kick setting,see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEM
Incorrect hot fast idle speed RPM	Reset fast idle RPM, see

	TUNE-UP
Engine Starts, Runs Up, Then Idles, Slowly With Black Smoke	
Choke vacuum kick set too narrow	Reset vacuum kick, see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Hot fast idle RPM too low	Reset fast idle RPM, see TUNE-UP

BASIC HOT START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Engine flooded	Allow fuel to evaporate

BASIC COLD ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Stalls in Gear	
Choke vacuum kick setting incorrect	Reset choke vacuum kick, see FUEL SYSTEMS
Fast idle RPM incorrect	Reset fast idle RPM, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam see FUEL SYSTEMS
Acceleration Sag or Stall	
Defective choke control switch	Replace choke control switch
Choke vacuum kick setting incorrect	Reset choke vacuum kick see, FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, FUEL SYSTEMS
Accelerator pump defective	Repair or replace pump see FUEL SYSTEMS
Secondary throttles not closed	Inspect lockout adjustment, see FUEL SYSTEMS
Sag or Stall After Warmup	
Defective choke control switch	Replace choke control switch, see FUEL SYSTEMS
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, see FUEL SYSTEMS
Backfiring & Black Smoke	
Plugged heat crossover system	Remove restriction

BASIC WARM ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Hesitation With Small Amount of Gas Pedal Movement	
Vacuum leak	Inspect vacuum lines
Accelerator pump weak or inoperable	Replace pump, see FUEL SYSTEMS
Float level setting too low	Reset float level, see,FUEL SYSTEMS
Metering rods sticking or binding	Inspect and/or replace rods, see FUEL SYSTEMS
Carburetor idle or transfer system plugged	Inspect system and remove restriction
Frozen or binding heated air inlet	Inspect heated air door for binding
Hesitation With Heavy Gas Pedal Movement	
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Metering rod carrier sticking or binding	Remove restriction
Large vacuum leak	Inspect vacuum system and repair leak
Float level setting too low	Reset float level, see FUEL SYSTEMS
Defective fuel pump, lines or filter	Inspect pump, lines and filter
Air door setting incorrect	Adjust air door setting, see FUEL

DIESEL ENGINE TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

BASIC DIESEL ENGINE TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Crank	
Bad battery connections or dead batteries	Check connections and/or replace batteries

Bad starter connections or bad starter	Check connections and/or replace starter
Engine Cranks Slowly, Won't Start	
Bad battery connections or dead batteries	Check connections and/or replace batteries
Engine oil too heavy	Replace engine oil
Engine Cranks Normally, But Will Not Start	
Glow plugs not functioning	Check glow plug system, see FUEL SYSTEMS
Glow plug control not functioning	Check controller, see FUEL SYSTEMS
Fuel not injected into cylinders	Check fuel injectors, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Fuel filter blocked	Replace fuel filter
Fuel tank filter blocked	Replace fuel tank filter
Fuel pump not operating	Check pump operation and/or replace pump
Fuel return system blocked	Inspect system and remove restriction
No voltage to fuel solenoid	Check solenoid and connections
Incorrect or contaminated fuel	Replace fuel
Incorrect injection pump timing	Re-adjust pump timing, see FUEL SYSTEMS
Low compression	Check valves, pistons, rings, see ENGINES
Injection pump malfunction	Inspect and/or replace injection pump
Engine Starts, Won't Idle	
Incorrect slow idle adjustment	Reset idle adjustment, see TUNE-UP
Fast idle solenoid malfunctioning	Check solenoid and connections
Fuel return system blocked	Check system and remove restrictions
Glow plugs go off too soon	See glow plug diagnosis in FUEL SYSTEMS
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Incorrect or contaminated fuel	Replace fuel
Low compression	Check valves, piston, rings,

	see ENGINES
Injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Fuel solenoid closes in RUN position	Check solenoid and connections
Engines Starts/Idles Rough W/out Smoke or Noise	
Incorrect slow idle adjustment	Reset slow idle, see TUNE-UP
Injection line fuel leaks	Check lines and connections
Fuel return system blocked	Check lines and connections
Air in fuel system	Bleed air from system
Incorrect or contaminated fuel	Replace fuel
Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engines Starts and Idles Rough W/out Smoke or Noise, But Clears After Warm-Up	
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Engine not fully broken in	Put more miles on engine
Air in system	Bleed air from system
Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engine Idles Correctly, Misfires Above Idle	
Blocked fuel filter	Replace fuel filter
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Incorrect or contaminated fuel	Replace fuel
Engine Won't Return To Idle	
Fast idle adjustment incorrect	Reset fast idle, see TUNE-UP
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
External linkage binding	Check linkage and remove binding
Fuel Leaks On Ground	
Loose or broken fuel line	Check lines and connections
Internal injection pump seal leak	Replace injection pump, see FUEL SYSTEMS
Cylinder Knocking Noise	
Injector nozzles sticking open	Test injectors, see FUEL SYSTEMS
Very low nozzle opening pressure	Test injectors and/or replace
Loss of Engine Power	
Restricted air intake	Remove restriction
EGR valve malfunction	Replace EGR valve

Blocked or damaged exhaust system	Remove restriction and/or replace components
Blocked fuel tank filter	Replace filter
Restricted fuel filter	Remove restriction and/or replace filter
Block vent in gas cap	Remove restriction and/or replace cap
Tank-to-injection pump fuel supply blocked	Check fuel lines and connections
Blocked fuel return system	Remove restriction
Incorrect or contaminated fuel	Replace fuel
Blocked injector nozzles	Check nozzle for blockage, see FUEL SYSTEMS
Low compression	Check valves, rings, pistons, see ENGINES
Loud Engine Noise With Black Smoke	
Basic timing incorrect	Reset timing, see FUEL SYSTEMS
EGR valve malfunction	Replace EGR valve
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Incorrect injector pump housing pressure	Check pressure, see FUEL SYSTEMS
Engine Overheating	
Cooling system leaks	Check cooling system and repair leaks
Belt slipping or damaged	Check tension and/or replace belt
Thermostat stuck closed	Remove and replace thermostat, see ENGINE COOLING
Head gasket leaking	Replace head gasket
Oil Light on at Idle	
Low oil pump pressure	Check oil pump operation, see ENGINES
Oil cooler or line restricted	Remove restriction and/or replace cooler
Engine Won't Shut Off	
Injector pump fuel solenoid does not return fuel valve to OFF position	Remove and check solenoid and replace if needed

VACUUM PUMP DIAGNOSIS

CONDITION & POSSIBLE CAUSE	CORRECTION

Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

FUEL INJECTION TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC FUEL INJECTION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start (Cranks Normally)	
Cold start valve inoperative	Test valve and circuit
Poor connection;vacuum or wiring	Check vacuum and electrical connections
Contaminated fuel	Test fuel for water or alcohol
Defective fuel pump relay or circuit	Test relay and wiring
Battery too low	Charge and test battery
Low fuel pressure	Test pressure regulator and fuel pump, check for restricted lines and filters
No distributor reference pulses	Repair ignition system as necessary
Open coolant temperature sensor circuit	Test sensor and wiring
Shorted W.O.T. switch in T.P.S.	Disconnect W.O.T. switch, engine should start
Defective ECM	Replace ECM
Fuel tank residual pressure valve leaks	Test for fuel pressure drop after shut down
Hard Starting	
Disconnected hot air tube to air cleaner	Reconnect tube and test control valve
Defective Idle Air Control (IAC) valve	Test valve operation and circuit
Shorted, open or misadjusted T.P.S.	Test and adjust or replace T.P.S.

EGR valve open	Test EGR valve and control circuit
Poor Oxygen sensor signal	Test for shorted or circuit
Incorrect mixture from PCV system	Test PCV for flow, check sealing of oil filter cap
Poor High Speed Operation	
Low fuel pump volume	Faulty pump or restricted fuel lines or filters
Poor MAP sensor signal	Test MAP sensor, vacuum hose and wiring
Poor Oxygen sensor signal	Test for shorted or open sensor or circuit
Open coolant temperature sensor circuit	Test sensor and wiring
Faulty ignition operation	Check wires for cracks or poor con- nections, test secondary voltage with oscilloscope
Contaminated fuel	Test fuel for water or alcohol
Intermittent ECM ground	Test ECM ground connection for resistance
Restricted air cleaner	Replace air cleaner
Restricted exhaust system	Test for exhaust manifold back pressure
Poor MAF sensor signal	Check leakage between sensor and manifold
Poor VSS signal	If tester for ALCL hook-up is available check that VSS reading matches speedometer
Ping or Knock on Acceleration	
Poor Knock sensor signal	Test for shorted or open sensor or circuit
Poor Baro sensor signal	Test for shorted or open sensor or circuit
Improper ignition timing	See VEHICLE EMISSION CONTROL LABEL (where applicable)
Check for engine overheating problems	Low coolant, loose belts or electric cooling fan inoperative

NOTE: For additional electronic fuel injection trouble shooting information, see the appropriate article in the ENGINE PERFORMANCE section (not all vehicles have Computer Engine Control articles). Information is provided there for diagnosing fuel system problems on vehicles with electronic fuel injection.

IGNITION SYSTEM TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

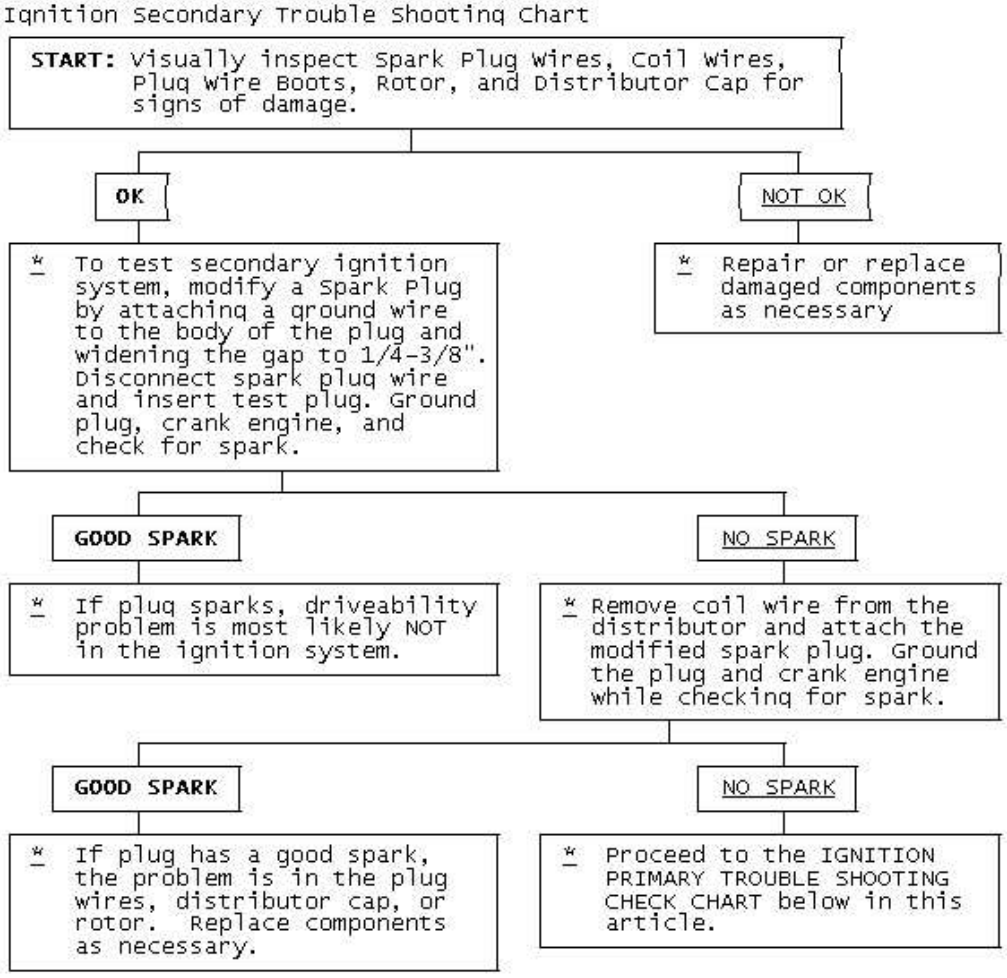


Fig. 3: Ignition Secondary Trouble Shooting Chart

Ignition Primary Trouble Shooting Chart

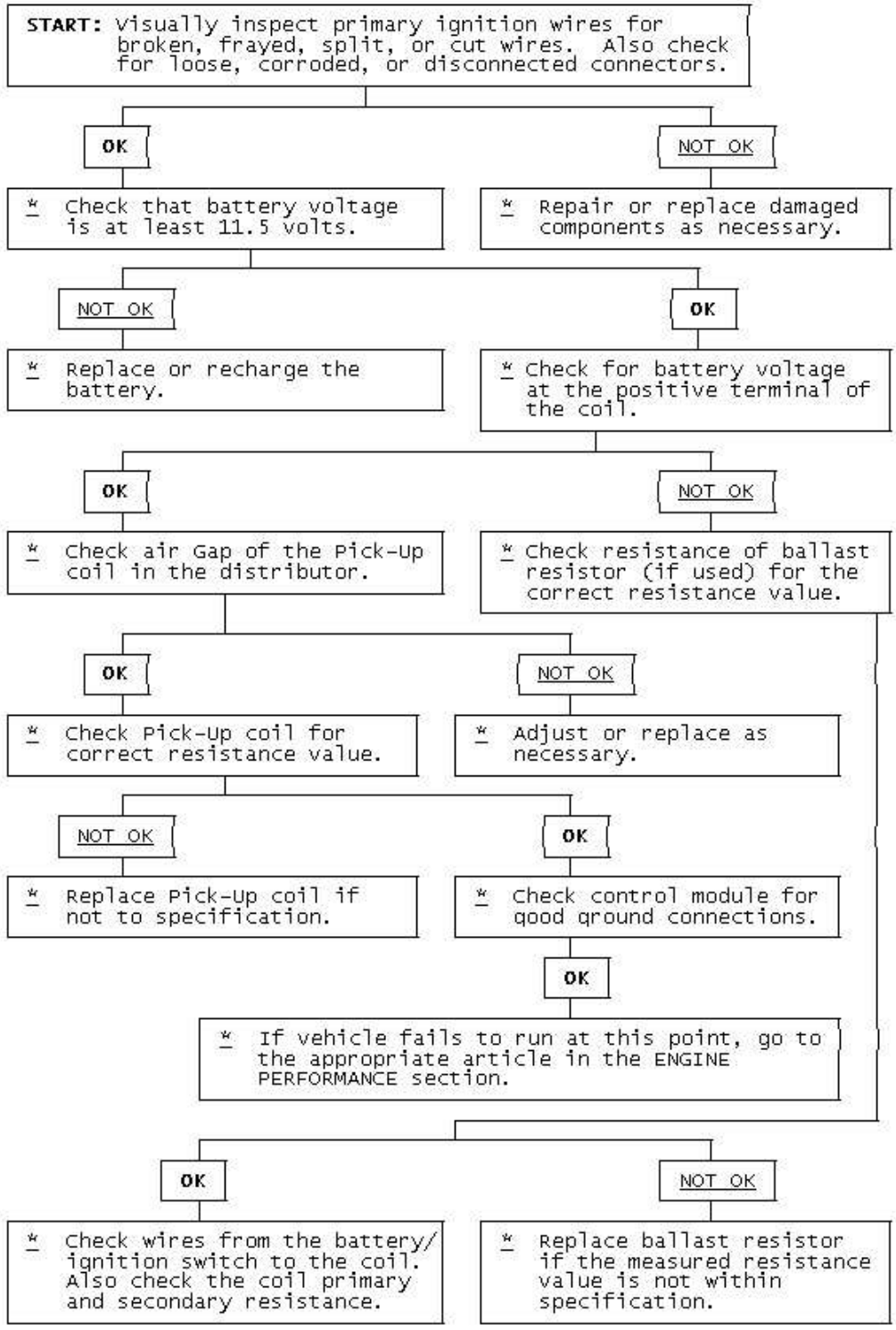


Fig. 4: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole shoes	See STARTER article
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	

Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearings	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	

Defective point assembly	See Testing in STARTER article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	Replace solenoid
Low Current Draw	
Worn brushes or weak	Replace brushes or brush springs as necessary

High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

TUNE-UP TROUBLE SHOOTING - GAS ENGINE VEHICLES

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC SPARK PLUG TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Normal Spark Plug Condition	
Light Tan or Gray deposits	No Action
Electrode not burned or fouled	No Action
Gap tolerance not changed	No Action
Cold Fouling or Carbon Deposits	
Overrich air/fuel mixture	Adjust air/fuel mixture, see ENGINE PERFORMANCE section
Faulty choke	Replace choke assembly, see ENGINE PERFORMANCE section
Clogged air filter	Clean and/or replace air filter
Incorrect idle speed or dirty carburetor	Reset idle speed and/ or clean carburetor
Faulty ignition wires	Replace ignition wiring
Prolonged operation at idle	Shut engine off during long idle
Sticking valves or worn valve guide seals	Check valve train
Wet Fouling or Oil Deposits	
Worn rings and pistons	Install new rings and pistons
Excessive cylinder wear	Rebore or replace block
Excessive valve guide clearance	Worn or loose bearing
Gap Bridged	
Deposits in combustion chamber becoming fused to electrode	Clean combustion chamber of deposits

Blistered Electrode	
Engine overheating	Check cooling system
Wrong type of fuel	Replace with correct fuel
Loose spark plugs	Retighten spark plugs
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Pre-Ignition or Melted Electrodes	
Incorrect type of fuel	Replace with correct fuel
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Burned valves	Replace valves
Engine Overheating	Check cooling system
Wrong type of spark plug, too hot	Replace with correct spark plug, see ENGINE PERFORMANCE
Chipped Insulators	
Severe detonation	Check for over-advanced timing or combustion
Improper gapping procedure	Re-gap spark plugs
Rust Colored Deposits	
Additives in unleaded fuel	Try different fuel brand
Water In Combustion Chamber	
Blown head gasket or cracked head	Repair or replace head or head gasket

NOTE: Before diagnosing an electronic ignition system, ensure that all wiring is connected properly between distributor, wiring connector and spark plugs. Ignition problem will show up either as: Engine Will Not Start or Engine Runs Rough.

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Open circuit between distributor and bulkhead connector	Repair circuit
Open circuit between bulkhead connector and ignition switch	Repair circuit
Open circuit between ignition switch and starter solenoid	Repair circuit
Engine Runs Rough	
Fuel lines leaking or clogged	Tighten fitting, remove restriction
Initial timing incorrect	Reset ignition timing see ENGINE PERFORMANCE
Centrifugal advance malfunction	Repair distributor advance

Defective spark plugs or wiring	Replace plugs or plug wiring
Component Failure	
Spark arc-over on cap, rotor or coil	Replace cap, rotor or or coil
Defective pick-up coil	Replace pick-up coil
Defective ignition coil	Replace ignition coil
Defective vacuum unit	Replace vacuum unit
Defective control module	Replace control module

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS - USING OSCILLOSCOPE PATTERNS

CONDITION & POSSIBLE CAUSE	CORRECTION
Firing Voltage Lines are the Same, but Abnormally High	
Retarded ignition timing	Reset ignition timing, see ENGINE PERFORMANCE section
Fuel mixture too lean	Readjust carburetor, see ENGINE PERFORMANCE
High resistance in coil wire	Replace coil wire
Corrosion in coil tower terminal	Clean and/or replace coil
Corrosion in distributor coil terminal	Clean and/or replace distributor cap
Firing Voltage Lines are the Same but Abnormally Low	
Fuel mixture too rich	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in coil wire causing arcing	Replace coil wire
Cracked coil tower causing arcing	Replace coil
Low coil output	Replace coil
Low engine compression	Determine cause and repair
One or More, But Not All Firing Voltage Lines are Higher Than Others	
Carburetor idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
EGR valve stuck open	Clean and/or replace valve
High resistance in spark plug wires	Replace spark plug wires
Cracked or broken spark plug insulator	Replace spark plugs
Intake vacuum leak	Repair leak
Defective spark plugs	Replace spark plugs
Corroded spark plug terminals	Replace spark plugs
One or More, But Not All Firing Voltage Lines Are Lower Than Others	
Curb idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in plug wires	Replace plug wires causing arcing

Cracked coil tower causing arcing	Replace coil
Low compression	Determine cause and repair
Defective spark plugs	Replace spark plugs
Corroded spark plugs	Replace spark plugs
Cylinders Not Firing	
Cracked distributor cap terminals	Replace distributor cap
Shorted spark plug wire	Determine cause and repair
Mechanical problem in engine	Determine cause and repair
Defective spark plugs	Replace spark plugs
Spark plugs fouled	Replace spark plugs

BASIC DRIVEABILITY PROBLEMS TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Hard Starting	
Binding carburetor linkage	Eliminate binding
Binding choke linkage	Eliminate binding
Binding choke piston	Eliminate binding
Restricted choke vacuum	Check vacuum lines for blockage
Worn or dirty needle valve and seat	Clean carburetor, see ENGINE PERFORMANCE
Float sticking	Readjust or replace float see the ENGINE PERFORMANCE section
Incorrect choke adjustment	Reset choke adjustment see ENGINE PERFORMANCE
Defective coil	Replace coil
Improper spark plug gap	Regap spark plugs
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Detonation	
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective spark plugs	Replace spark plugs
Fuel lines clogged	Clean fuel lines
EGR system malfunction	Check and repair EGR system
PCV system malfunction	Repair PCV system
Vacuum leaks	Check and repair vacuum system
Loose fan belts	Tighten or replace fan belts, see ENGINE PERFORMANCE

Restricted airflow	Remove restriction
Vacuum advance malfunction	Check distributor operation
Dieseling	
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate blinding
Binding choke linkage or fast idle cam	Eliminate binding
Defective idle solenoid	Replace idle solenoid see ENGINE PERFORMANCE
Improper base idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Incorrect idle mixture setting	Reset idle mixture, see ENGINE PERFORMANCE
Faulty Acceleration	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Engine cold and choke too lean	Adjust choke and allow engine to warm-up
Defective spark plugs	Replace spark plugs
Defective coil	Replace coil
Faulty Low Speed Operation	
Clogged idle transfer slots	Clean idle transfer slots, see FUEL
Restricted idle air bleeds and passages	Disassemble and clean carburetor, see FUEL
Clogged air cleaner	Replace air filter
Defective spark plugs	Replace spark plugs
Defective ignition wires	Replace ignition wire see ENGINE PERFORMANCE
Defective distributor cap	Replace distributor cap
Faulty High Speed Operation	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective distributor centrifugal advance	Replace advance mechanism
Defective distributor vacuum advance	Replace advance unit
Incorrect spark plugs or plug gap	Check gap and/or replace spark plugs
Faulty choke operation	Check choke and repair as required
Clogged vacuum passages	Remove restrictions
Improper size or clogged main jet	Check jet size and clean, see

	FUEL
Restricted air cleaner	Check filter and replace as necessary
Defective distributor cap, rotor or coil	Replace cap, rotor or coil
Misfire at All Speeds	
Defective spark plugs	Replace spark plugs
Defective spark plug wires	Replace spark plug wires
Defective distributor cap, rotor, or coil	Replace cap, rotor, or coil
Cracked or broken vacuum hoses	Replace vacuum hoses
Vacuum leaks	Repair vacuum leaks
Fuel lines clogged	Remove restriction
Hesitation	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair Vacuum leaks
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate binding
Binding choke linkage or fast idle cam	Eliminate binding
Improper float setting	Readjust float setting, see FUEL
Cracked or broken ignition wires	Replace ignition wires
Rough Idle, Missing or Stalling	
Incorrect curb idle or fast idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect basic timing	Reset ignition timing see ENGINE PERFORMANCE
Improper idle mixture adjustment	Reset idle mixture, see ENGINE PERFORMANCE
Improper feedback system operation	Check feedback system see ENGINE PERFORMANCE
Incorrect spark plug gap	Reset spark plug gap, see ENGINE PERFORMANCE
Moisture in ignition components	Dry components
Loose or broken ignition wires	Replace ignition wires
Damaged distributor cap or or rotor	Replace distributor cap or rotor
Faulty ignition coil	Replace ignition coil
Fuel filter clogged or worn	Replace fuel filter
Damaged idle mixture screw	Replace idle mixture screw, see FUEL
Improper fast idle cam adjustment	Reset fast idle cam adjustment, see TUNE- see ENGINE PERFORMANCE

Improper EGR valve operation	Replace EGR valve
Faulty PCV valve air flow	Replace PCV valve
Choke binding or improper choke setting	Reset choke or eliminate binding
Vacuum leak	Repair vacuum leak
Improper float bowl fuel level	Reset float adjustment, see FUEL
Clogged air bleed or idle passages	Clean carburetor passages, see FUEL
Clogged or worn air cleaner filter	Replace air filter
Faulty choke vacuum diaphragm	Replace diaphragm, see ENGINE PERFORMANCE
Exhaust manifold heat valve inoperative	Replace heat valve
Improper distributor spark advance	Check distributor operation
Leaking valves or valve components	Check and repair valvetrain
Improper carburetor mounting	Remove and remount carburetor
Excessive play in distributor shaft	Replace distributor
Loose or corroded wiring connections	Repair or replace as required
Engine Surges	
Improper PCV valve airflow	Replace PCV valve
Vacuum leaks	Repair vacuum leaks
Clogged air bleeds	Remove restriction
EGR valve malfunction	Replace EGR valve
Restricted air cleaner filter	Replace air filter
Cracked or broken vacuum hoses	Replace vacuum hoses
Cracked or broken ignition wires	Replace ignition wires
Vacuum advance malfunction	Check unit and replace as necessary
Defective or fouled spark plugs	Replace spark plugs
Ping or Spark Knock	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Distributor centrifugal or vacuum advance malfunction	Check operation and replace as necessary
Carburetor setting too lean	Readjust mixture setting, see ENGINE PERFORMANCE
Vacuum leak	Eliminate vacuum leak
EGR valve malfunction	Replace EGR valve
Poor Gasoline Mileage	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair vacuum leaks

Defective ignition wires	Replace wires
Incorrect choke setting	Readjust setting, see ENGINE PERFORMANCE
Defective vacuum advance	Replace vacuum advance
Defective spark plugs	Replace spark plugs
Binding carburetor power piston	Eliminate binding
Dirt in carburetor jets	Clean and/or replace jets
Incorrect float adjustment	Readjust float setting, see FUEL
Defective power valve	Replace power valve, see ENGINE PERFORMANCE
Incorrect idle speed	Readjust idle speed
Engine Stalls	
Improper float level	Readjust float level
Leaking needle valve and seat	Replace needle valve and seat
Vacuum leaks	Eliminate vacuum leaks

VACUUM PUMP - DIESEL TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

VACUUM PUMP (DIESEL) TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

MANUAL TRANSMISSION

MANUAL TRANSMISSION TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	Low gear oil level, Loose bell housing bolts, Worn bearings or gears
Clunk On Deceleration (FWD Only)	Loose engine mounts, Worn inboard CV joints, Worn differential pinion shaft, Side gear hub counterbore in case worn oversize
Gear Clash When Shifting Forward Gears	Clutch Out Of Adjustment, Shift linkage damaged or out of adjustment, Gears or synchronizers damaged, Low gear oil level
Transmission Noisy When Moving (RWD Only) Quiet In Neutral With Clutch Engaged	Worn rear outputshaft bearing
Gear Rattle	Worn bearings, Wrong gear oil, Low gear oil, Worn gears
Steady Ticking At Idle (Increases With RPM)	Broken tooth on gear
Gear Clash When Shifting Forward Gears	Worn or broken synchronizers
Loud Whine In Reverse	Normal condition (1)
Noise When Stepping On Clutch	Bad release bearing, Worn pilot bearing
Ticking Or Screeching As Clutch Is Engaged	Faulty release bearing, Uneven pressure plate fingers
Click Or Snap When Clutch Is Engaged	Worn clutch fork, Worn or broken front bearing retainer
Transmission Shifts Hard	Clutch not releasing, Shift mechanism binding, Clutch installed backwards
Will Not Shift Into One Gear, Shifts Into All Others	Bent shift fork, Worn detent balls
Locked Into Gear, Cannot Shift	Clutch adjustment, Worn detent balls
Transmission Jumps Out Of Gear	Pilot bearing worn, Bent shift fork, Worn gear teeth or face, Excessive gear train end play, Worn synchronizers, Missing detent ball spring, Shift mechanism worn or out of adjustment, Engine or transmission mount bolts loose or out of adjustment, Transmission not aligned
Shift Lever Rattle	Worn shift lever or detents, Worn shift forks, Worn synchronizers sleeve
Shift Lever Hops Under Acceleration	Worn engine or transmission mounts

(1) Most units use spur cut gears in reverse and are noisy

POWERTRAIN

CLUTCH TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC CLUTCH TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Chattering or Grabbing	
Incorrect clutch adjustment	Adjust clutch
Oil, grease or glaze on facings	Disassemble and clean or replace
Loose "U" joint flange	See DRIVE AXLES article
Worn input shaft spline	Replace input shaft
Binding pressure plate	Replace pressure plate
Binding release lever	See CLUTCH article
Binding clutch disc hub	Replace clutch disc
Unequal pressure plate contact	Replace worn/misaligned components
Loose/bent clutch disc	Replace clutch disc
Incorrect transmission alignment	Realign transmission
Worn pressure plate, disc or flywheel	Replace damaged components
Broken or weak pressure springs	Replace pressure plate
Sticking clutch pedal	Lubricate clutch pedal & linkage
Incorrect clutch disc facing	Replace clutch disc
Engine loose in chassis	Tighten all mounting bolts
Failure to Release	
Oil or grease on clutch facings	Clean or replace clutch clutch disc
Incorrect release lever or pedal adjustment	See CLUTCH article
Worn or broken clutch facings	Replace clutch disc
Bent clutch disc or pressure plate	Replace damaged components
Clutch disc hub binding on input shaft	Clean or replace clutch disc and/or input shaft
Binding pilot bearing	Replace pilot bearing
Sticking release bearing sleeve	Replace release bearing and/or

	sleeve
Binding clutch cable	See CLUTCH article
Defective clutch master	Replace master cylinder
Defective clutch slave	Replace slave cylinder
Air in hydraulic system	Bleed hydraulic system
Rattling	
Weak or broken release lever spring	Replace spring and check alignment
Damaged pressure plate	Replace pressure plate
Broken clutch return spring	Replace return spring
Worn splines on clutch disc or input shaft	Replace clutch disc and/or input shaft
Worn clutch release bearing	Replace release bearing
Dry or worn pilot bearing	Lubricate or replace pilot bearing
Unequal release lever contact	Align or replace release lever
Incorrect pedal free play	Adjust free play
Warped or damaged clutch disc	Replace damaged components
Slipping	
Pressure springs worn or	Release pressure plate
Oily, greasy or worn facings	Clean or replace clutch disc
Incorrect clutch alignment	Realign clutch assembly
Warped clutch disc or pressure plate	Replace damaged components
Binding release levers or clutch pedal	Lubricate and/or replace release components
Squeaking	
Worn or damaged release	Replace release bearing
Dry or worn pilot or release bearing	Lubricate or replace assembly
Pilot bearing turning in crankshaft	Replace pilot bearing and/or crankshaft
Worn input shaft bearing	Replace bearing and seal
Incorrect transmission alignment	Realign transmission
Dry release fork between pivot	Lubricate release fork and pivot
Heavy and/or Stiff Pedal	
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Dry or binding clutch pedal hub	Lubricate and align components
Floor mat interference with pedal	Lay mat flat in proper area
Dry or binding ball/fork pivots	Lubricate and align components
Faulty clutch cable	Replace clutch cable
Noisy Clutch Pedal	
Faulty interlock switch	Replace interlock switch

Self-adjuster ratchet noise	Lubricate or replace self-adjuster
Speed control interlock switch	Lubricate or replace interlock switch
Clutch Pedal Sticks Down	
Binding clutch cable	See CLUTCH article
Springs weak in pressure plate	Replace pressure plate
Binding in clutch linkage	Lubricate and free linkage
Noisy	
Dry release bearing	Lubricate or replace release bearing
Dry or worn pilot bearing	Lubricate or replace bearing
Worn input shaft bearing	Replace bearing
Transmission Click	
Weak springs in pressure	Replace pressure plate plate
Release fork loose on ball stud	Replace release fork and/or ball stud
Oil on clutch disc damper	Replace clutch disc
Broken spring in slave cylinder	Replace slave cylinder

DRIVE AXLE - NOISE DIAGNOSIS

Unrelated Noises

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. Ensure cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any of its parts.

Non-Drive Axle Noises

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and wheel trim rings.

In certain conditions, the pitch of the exhaust gases may e gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings also can cause a whistling or whining noise. Ensure none of these components are causing the noise before disassembling the drive axle.

Gear Noise

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear ke sure that tires, exhaust, and vehicle trim have been checked as possible causes.

Chuckle

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused ive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough the cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

Knock

This is very similar to a chuckle, though it may be louder, and occur on acceleration or deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

Clunk

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1. Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.
2. On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in Drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in Drive condition.
3. Measure the length of the chalk mark, which is the total axle backlash. If backlash is one inch or less, drive axle is not the source of clunk noise.

Bearing Whine

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at drive shaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of drive shaft speed.

Chatter On Turns

This is a condition where the entire front or rear of vehicle vibrates when vehicle is moving. The vibration is plainly felt as well as heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates this chatter.

Axle Shaft Noise

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (Drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect parts, replace wheel seals and install a new set of bearings. Re-evaluate vehicle for noise before removing any internal components.

Vibration

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and can occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can d into 3 main groups:

- Vibrations of various unbalanced rotating parts of the vehicle.
- Resonance vibrations of the body and frame structures caused by rotating of unbalanced parts.
- Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

DRIVE AXLE - RWD TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing. For definitions of listed noises or sounds, see DRIVE AXLE - NOISE DIAGNOSIS under POWERTRAIN.

DRIVE AXLE (RWD) TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Knocking or Clunking	
Differential Side Gear Clearance	Check Clearance

Worn Pinion Shaft	Replace Pinion Shaft
Axle Shaft End Play	Check End Play
Missing Gear Teeth	Check Differential/Replace Gear
Wrong Axle Backlash	Check Backlash
Misaligned Driveline	Realign Driveline
Clinking During Engagement	
Side Gear Clearance	Check Clearance
Ring and Pinion Backlash	Check Backlash
Worn/Loose Pinion Shaft	Replace Shaft/Bearing
Bad "U" Joint	Replace "U" Joint
Sticking Slip Yoke	Lube Slip Yoke
Broken Rear Axle Mount	Replace Mount
Loose Drive Shaft Flange	Check Flange
Click/Chatter On Turns	
Differential Side Gear Clearance	Check Clearance
Wrong Turn On Plates (1)	Replace Clutch Plates
Wrong Differential Lubricant (1)	Change Lubricant
Knock Or Click	
Flat Spot on Rear Wheel Bearing	Replace Wheel Bearing
Low Vibration At All Speeds	
Faulty Wheel Bearing	Replace Wheel Bearing
Faulty "U" Joint	Replace "U" Joint
Faulty Drive Shaft	Balance Drive Shaft
Faulty Companion Flange	Replace Flange
Faulty Slip Yoke Flange	Replace Flange
(1) Limited slip differential only.	

FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Grease Leaks	CV boot torn or cracked
Clicking Noise on Cornering	Damaged outer CV
Clunk Noise on Acceleration	Damaged inner CV

Vibration or Shudder on Acceleration	Sticking, damaged or worn CV Misalignment or spring height

STEERING & SUSPENSION

MANUAL STEERING GEAR TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC MANUAL STEERING GEAR TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise in Rack and Pinion	
Rack and pinion mounting bracket loose	Tighten all mounting bolts
Lack of/or incorrect lubricant	Correct as necessary
Steering gear mounting bolts loose	Tighten all mounting bolts
Excessive Play	
Front wheel bearing improperly adjusted	See FRONT SUSPENSION article
Loose or worn steering linkage	See STEERING LINKAGE article
Loose or worn steering gear shift	See MANUAL STEERING GEAR article
Steering arm loose on gear shaft	See MANUAL STEERING GEAR article
Steering gear housing bolts loose	Tighten all mounting bolts
Steering gear adjustment too loose	See MANUAL STEERING GEAR article
Steering arms loose on knuckles	Tighten and check steering linkage
Rack and pinion mounting loose	Tighten all mounting bolts
Rack and pinion out of adjustment	See adjustment in STEERING article
Tie rod end loose	Tighten and check steering linkage
Excessive Pitman shaft-to-ball nut lash	Repair as necessary
Poor Returnability	
Lack of lubricant in ball joint or linkage	Lubricate and service systems
Binding in linkage or ball joints	See STEERING LINKAGE and SUSPENSION article

Improper front end alignment	See WHEEL ALIGNMENT article
Improper tire pressure	Inflate to proper pressure
Tie rod binding	Inflate to proper pressure
Shaft seal rubbing shaft	See STEERING COLUMN article
Excessive Vertical Motion	
Improper tire pressure	Inflate to proper pressure
Tires, wheels or rotors out of balance	Balance tires then check wheels and rotors
Worn or faulty shock absorbers	Check and replace if necessary
Loose tie rod ends or steering	Tighten or replace if necessary
Loose or worn wheel bearings	See SUSPENSION article
Steering Pulls to One Side	
Improper tire pressure	Inflate to proper pressure
Front tires are different sizes	Rotate or replace if necessary
Wheel bearings not adjusted properly	See FRONT SUSPENSION article
Bent or broken suspension components	See FRONT SUSPENSION article
Improper wheel alignment	See WHEEL ALIGNMENT article
Brakes dragging	See BRAKES article
Instability	
Low or uneven tire pressure	Inflate to proper pressure
Loose or worn wheel bearings	See FRONT SUSPENSION article
Loose or worn idler arm bushing	See FRONT SUSPENSION article
Loose or worn strut bushings	See FRONT SUSPENSION article
Incorrect front wheel alignment	See WHEEL ALIGNMENT article
Steering gear not centered	See MANUAL STEERING GEARS article
Springs or shock	Check and replace if necessary
Improper cross shaft	See MANUAL STEERING GEARS article

POWER STEERING TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble

Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC POWER STEERING TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise	
Pressure hoses touching engine parts	Adjust to proper clearance
Loose Pitman shaft	Adjust or replace if necessary
Tie rods ends or Pitman arm loose	Tighten and check system
Rack and pinion mounts loose	Tighten all mounting bolts
Free play in worm gear	See POWER STEERING GEAR article
Loose sector shaft or thrust bearing adjustment	See POWER STEERING GEAR
Free play in pot coupling	See STEERING COLUMN article
Worn shaft serrations	See STEERING COLUMN article
Growl in Steering Pump	
Excessive pressure in hoses	Restricted hoses, see POWER STEERING GEAR article
Scored pressure plates	See POWER STEERING GEAR article
Scored thrust plates or rotor	See POWER STEERING GEAR article
Extreme wear of cam ring	See POWER STEERING GEAR article
Rattle in Steering Pump	
Vanes not installed	See POWER STEERING PUMP article
Vanes sticking in rotor	See POWER STEERING PUMP article
Swish noise in Pump	
Defective flow control valve	See POWER STEERING PUMP article
Groan in Steering Pump	
Air in fluid	See POWER STEERING PUMP article
Poor pressure hose connection	Tighten and check, replace if necessary
Squawk When Turning	
Damper "O" ring on valve spool cut	See POWER STEERING

	PUMP article
Moan or Whine in Pump	
Pump shaft bearing scored	Replace bearing and fluid
Air in fluid or fluid level low	See POWER STEERING PUMP article
Hose or column grounded	Check and replace if necessary
Cover "O" ring missing or damaged	See POWER STEERING PUMP article
Valve cover baffle missing or damaged	See POWER STEERING PUMP article
Interference of components in pump	See POWER STEERING PUMP article
Loose or poor bracket alignment	Correct or replace if necessary
Hissing When Parking	
Internal leakage in steering gear	Check valved assembly first
Chirp in Steering Pump	
Loose or worn power steering belt	Adjust or replace if necessary
Buzzing When Not Steering	
Noisy pump	See POWER STEERING PUMP article
Free play in steering shaft bearing	See STEERING COLUMN article
Bearing loose on shaft serrations	See STEERING COLUMN article
Clicking Noise in Pump	
Pump slippers too long	See POWER STEERING PUMP article
Broken slipper springs	See POWER STEERING PUMP article
Excessive wear or nicked rotors	See POWER STEERING PUMP article
Damaged cam contour	See POWER STEERING PUMP article
Poor Return of Wheel	
Wheel rubbing against turn signal	See STEERING COLUMN SWITCHES article
Flange rubbing steering gear adjuster	See STEERING COLUMN article
Tight or frozen steering shaft bearing	See STEERING COLUMN article
Steering gear out of adjustment	See POWER STEERING GEAR article

Sticking or plugged spool valve	See POWER STEERING PUMP article
Improper front end alignment	See WHEEL ALIGNMENT article
Wheel bearings worn or loose	See FRONT SUSPENSION article
Ties rods or ball joints binding	Check and replace if necessary
Intermediate shaft joints binding	See STEERING COLUMN article
Kinked pressure hoses	Correct or replace if necessary
Loose housing head spanner nut	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Sector shaft adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Worm thrust bearing adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Reaction ring sticking in cylinder	See POWER STEERING GEAR article
Reaction ring sticking in housing head	See POWER STEERING GEAR article
Steering pump internal leakage	See POWER STEERING PUMP article
Steering gear-to-column misalignment	See STEERING COLUMN article
Lack of lubrication in linkage	Service front suspension
Lack of lubrication in ball joints	Service front suspension
Increased Effort When Turning Wheel Fast Foaming, Milky Power Steering Fluid, Low Fluid Level or Low Pressure	
High internal pump leakage	See POWER STEERING PUMP article
Power steering pump belt slipping	Adjust or replace if necessary
Low fluid level	Check and fill to proper level
Engine idle speed to low	Adjust to correct setting
Air in pump fluid system	See POWER STEERING PUMP article
Pump output low	See POWER STEERING PUMP article
Steering gear malfunctioning	See POWER STEERING

	GEAR article
Wheel Surges or Jerks	
Low fluid level	Check and fill to proper level
Loose fan belt	Adjust or replace if necessary
Insufficient pump pressure	See POWER STEERING PUMP article
Sticky flow control valve	See POWER STEERING PUMP article
Linkage hitting oil pan at full turn	Replace bent components
Kick Back or Free Play	
Air in pump fluid system	See POWER STEERING PUMP article
Worn poppet valve in steering gear	See POWER STEERING PUMP article
Excessive over center lash	See POWER STEERING GEAR article
Thrust bearing out of adjustment	See POWER STEERING GEAR article
Free play in pot coupling	See POWER STEERING PUMP article
Steering gear coupling loose on shaft	See POWER STEERING PUMP article
Steering disc mounting bolts loose	Tighten or replace if necessary
Coupling loose on worm shaft	Tighten or replace if necessary
Improper sector shaft adjustment	See POWER STEERING GEAR article
Excessive worm piston side play	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Universal joint loose	Tighten or replace if necessary
Defective rotary valve	See POWER STEERING GEAR article
No Power When Parking	
Sticking flow control valve	See POWER STEERING PUMP article
Insufficient pump pressure output	See POWER STEERING PUMP article
Excessive internal pump leakage	See POWER STEERING PUMP article

Excessive internal gear leakage	See POWER STEERING PUMP article
Flange rubs against gear adjust plug	See STEERING COLUMN article
Loose pump belt	Adjust or replace if necessary
Low fluid level	Check and add proper amount of fluid
Engine idle too low	Adjust to correct setting
Steering gear-to-column misaligned	See STEERING COLUMN article
No Power, Left Turn	
Left turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Left turn reaction seal damaged/missing	See POWER STEERING GEAR article
Cylinder head "O" ring damaged	See POWER STEERING PUMP article
No Power, Right Turns	
Column pot coupling bottomed	See STEERING COLUMN article
Right turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Right turn reaction seal damaged	See POWER STEERING GEAR article
Internal leakage through piston end plug	See POWER STEERING GEAR article
Internal leakage through side plugs	See POWER STEERING GEAR article
Lack of Effort in Turning	
Left and/or right reaction seal sticking in cylinder head	Replace, see POWER STEERING GEAR article
Wanders to One Side	
Front end alignment incorrect	See WHEEL ALIGNMENT article
Unbalanced steering gear valve	See POWER STEERING GEAR article
Low Pressure Due to Steering Pump	
Flow control valve stuck or inoperative	See POWER STEERING PUMP article
Pressure plate not flat against cam ring	See POWER STEERING PUMP article
Extreme wear of cam ring	Replace and check adjustments

Scored plate, thrust plate or rotor	See POWER STEERING PUMP article
Vanes not installed properly	See POWER STEERING PUMP article
Vanes sticking in rotor slots	See POWER STEERING PUMP article
Cracked/broken thrust or pressure plate	See POWER STEERING PUMP article

STEERING COLUMN TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC STEERING COLUMN TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Noise in Steering	
Coupling pulled apart	See STEERING COLUMNS article
Column not correctly aligned	See STEERING COLUMNS article
Broken lower joint	Replace joint
Horn contact ring not	See STEERING COLUMN article
Bearing not lubricated	See STEERING COLUMN article
Shaft snap ring not properly seated	Reseat or replace snap ring
Plastic spherical joint not lubricated	See STEERING COLUMN article
Shroud or housing loose	Tighten holding screws
Lock plate retaining ring not seated	See STEERING COLUMN article
Loose sight shield	Tighten holding screws
High Steering Shaft Effort	
Column assembly misaligned	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Tight steering universal joint	See STEERING COLUMN article
High Shift Effort	

Column is out of alignment	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Seals or bearings not lubricated	See STEERING COLUMNS article
Mounting bracket screws too long	Replace with new shorter screws
Burrs on shift tube	Remove burrs or replace tube
Lower bowl bearing assembled wrong	See STEERING COLUMN article
Shift tube bent or broken	Replace as necessary
Improper adjustment of shift levers	See STEERING COLUMN article
Improper Trans. Shifting	
Sheared shift tube joint	Replace as necessary
Sheared lower shaft lever	Replace as necessary
Improper shift lever adjustment	See STEERING COLUMN article
Improper gate plate adjustment	See STEERING COLUMN article
Excess Play in Column	
Instrument panel bracket bolts loose	Tighten bolts and check bracket
Broken weld nut on jacket	See STEERING COLUMN article
Instrument bracket capsule sheared	See STEERING COLUMN article
Column bracket/jacket bolts loose	Tighten bolts and check bracket
Steering Locks in Gear	
Release lever mechanism	See STEERING COLUMN article

SUSPENSION TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC SUSPENSION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION

Front End Noise	
Loose or worn wheel	See Wheel Bearing Adjustment in SUSPENSION
Worn shocks or shock mountings	Replace struts or strut mountings
Worn struts or strut mountings	Replace struts or strut mountings
Loose or worn lower control arm	See SUSPENSION
Loose steering gear-to-frame bolts	See STEERING
Worn control arm bushings	See SUSPENSION
Ball joints not lubricated	Lubricate ball joints & see Ball Joint Checking in SUSPENSION
Front Wheel Shake, Shimmy, or Vibration	
Tires or wheels out of balance	Check tire balance
Incorrect wheel alignment	See WHEEL ALIGNMENT
Drive shaft unbalanced	Check drive shaft balance
Loose or worn wheel bearings	See WHEEL ALIGNMENT
Loose or worn tie rod ends	See SUSPENSION
Worn upper ball joints	See Ball Joint Checking in SUSPENSION
Worn shock absorbers	Replace shock absorbers
Worn strut bushings	Replace strut bushings
Car Pulls to One Side	
Mismatched or uneven tires	Check tire condition
Broken or sagging springs	See SUSPENSION
Loose or worn strut bushings	See SUSPENSION
Improper wheel alignment	See WHEEL ALIGNMENT
Improper rear axle alignment	Check rear axle alignment
Power steering gear unbalanced	See STEERING
Front brakes dragging	See BRAKES
Abnormal Tire Wear	
Unbalanced tires	Check tire balance & rotation
Sagging or broken springs	See SUSPENSION
Incorrect front end alignment	See WHEEL ALIGNMENT
Faulty shock absorbers	Replace chock absorbers
Scuffed Tires	
Toe-In incorrect	See WHEEL ALIGNMENT
Suspension arm bent or twisted	See appropriate SUSPENSION article
Springs Bottom or Sag	
Bent or broken springs	See SUSPENSION

Leaking or worn shock absorbers	Replace shock absorbers
Frame misalignment	Check frame for damage
Spring Noises	
Loose "U" Bolts	See SUSPENSION
Loose or worn bushings	See SUSPENSION
Worn or missing interliners	See SUSPENSION
Shock Absorber Noise	
Loose shock mountings	Check & tighten mountings
Worn bushings	Replace bushings
Air in system	Bleed air from system
Undercoating on shocks	Remove undercoating
Car Leans or Sways on Corners	
Loose stabilizer bar	See SUSPENSION
Faulty shocks or mountings	Replace shocks or mountings
Broken or sagging springs	See SUSPENSION
Shock Absorbers Leaking	
Worn seals or reservoir tube crimped	See SUSPENSION
Broken Springs	
Loose "U" bolts	See SUSPENSION
Inoperative shock absorbers	Replace shock absorbers

WHEEL ALIGNMENT TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC WHEEL ALIGNMENT TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Premature Tire Wear	
Improper tire inflation	Check tire pressure
Front alignment out of tolerance	See ALIGNMENT SPECS in WHEEL ALIGNMENT section
Suspension components worn	See SUSPENSION section
Steering system components worn	See STEERING section
Improper standing height	See WHEEL ALIGNMENT
Uneven or sagging springs	See SUSPENSION section
Bent wheel	See WHEEL ALIGNMENT
Improper torsion bar adjustment	See SUSPENSION section

Loose or worn wheel bearings	See WHEEL BEARING ADJ. in SUSPENSION section
Worn or defective shock	Replace shock absorbers
Tires out of balance	Check tire balance
Pulls to One Side	
Improper tire inflation	Check tire pressure
Brake dragging	See BRAKE section
Mismatched tires	See WHEEL ALIGNMENT
Broken or sagging spring	See SUSPENSION section
Broken torsion bar	See SUSPENSION section
Power steering valve not centered	See STEERING section
Front alignment out of tolerance	See WHEEL ALIGNMENT section
Defective wheel bearing	See WHEEL BEARINGS in SUSPENSION section
Uneven sway bar links	See SUSPENSION section
Frame bent	Check for frame damage
Steering system bushing worn	See STEERING section
Hard Steering	
Idler arm bushing too tight	See STEERING LINKAGE in STEERING section
Ball joint tight or seized	See SUSPENSION section
Steering linkage too tight	See STEERING LINKAGE in STEERING section
Power steering fluid low	Add proper amount of fluid
Power steering drive belt loose	See STEERING section
Power steering pump defective	See STEERING section
Steering gear out of adjustment	See STEERING section
Incorrect wheel alignment	See WHEEL ALIGNMENT
Damaged steering gear	See STEERING section
Damaged suspension	See SUSPENSION section
Bent steering knuckle or supports	See SUSPENSION section
Vehicle "Wanders"	
Strut rod or control arm bushing worn	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARINGS in SUSPENSION section
Improper tire inflation	Check tire pressure
Stabilizer bar missing or defective	See SUSPENSION section
Wheel alignment out of tolerance	See Adjustment in WHEEL ALIGNMENT section
Broken spring	See SUSPENSION section
Defective shock absorber	Replace shock absorbers

Worn steering & suspension components	See SUSPENSION section
Front End Shimmy	
Tire out of balance/round	Check tire balance
Excessive wheel runout	See WHEEL ALIGNMENT
Insufficient or improper caster	See WHEEL ALIGNMENT section
Worn suspension or steering components	See SUSPENSION section
Defective shock absorbers	Replace shock absorber
Wheel bearings worn or loose	See WHEEL BEARING ADJ. in SUSPENSION section
Power steering reaction Bracket loose	See STEERING section
Steering gear box (rack) mounting loose	See STEERING section
Steering gear adjustment loose	See STEERING section
Worn spherical joints	See SUSPENSION section
Toe-In Not Adjustable	
Lower control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Camber Not Adjustable	
Control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Hub & bearing not seated properly	See SUSPENSION section

BRAKE SYSTEM

1996-97 BRAKES Ford Motor Co. - Disc & Drum

DESCRIPTION & OPERATION

BRAKE SYSTEM TYPE IDENTIFICATION

Brake Code (1)	Brake Type
Pickup F150/250/350, F Super Duty	
"B"	Front Disc, Rear Drum With 2-Wheel (Rear) ABS
"1"	4-Wheel Disc
(1) Brake code is located on Vehicle Certification Label attached to driver's side door or door jam.	

BRAKE BOOSTER

Vehicles are equipped with a vacuum booster. Vehicles may use either a single or dual-diaphragm vacuum booster. The single and dual-diaphragm (tandem) vacuum boosters are self-contained, vacuum power brake units. Booster assists in actuating master cylinder push rod.

Booster contains either a single or dual vacuum-suspended diaphragm which uses engine manifold vacuum or atmospheric pressure for power. Diesel models use a belt-driven vacuum pump to provide vacuum for booster actuation.

A mechanically-operated booster check valve controls power brake application and release in relation to foot pressure applied to check valve operating rod. Booster check valve is the only serviceable component of brake booster assembly.

An equalizer valve links 2 chambers of brake booster. When valve opens, vacuum in chambers can equalize. When it closes, chambers are separated. A vacuum bleed valve functions to reduce amount of vacuum in chamber "B" when boost is required. See **Fig. 1** .

F Super Duty uses a Hydro-Boost system. Hydro-Boost is hydraulically operated by power steering pump and provides a variable power assist regulated by brake pedal pressure. Hydro-Boost has a reserve system (compressed gas accumulator) which stores enough fluid under pressure to provide at least 2 power-assisted brake applications if power steering pump fluid flow stops. Brakes can also be operated manually if reserve system is lost.

Hydro-Boost power units in normal condition produce certain noises. These noises occur when brakes are used more than usual. In general, these noises are hissing, clunks, clicks and chattering. Hydro-Boost hisses when greater than normal braking effort is used. Hissing increases when pedal effort and operating temperatures increase. Loud hissing at normal pedal effort of 25-35 lbs. (11-16 kg) or less should be investigated. Clunk, chatter and clicking noises are heard when brake pedal is quickly released from hard braking.

WARNING: Hydro-Boost unit should not be carried by accumulator. DO NOT drop

Hydro-Boost on accumulator. Snap ring should be checked for proper seating before booster is used. Accumulator contains high-pressure nitrogen gas and can be dangerous if mishandled. Before disposing of boosters, drill a 1/16" (1.6 mm) hole in end of accumulator to relieve gas pressure.

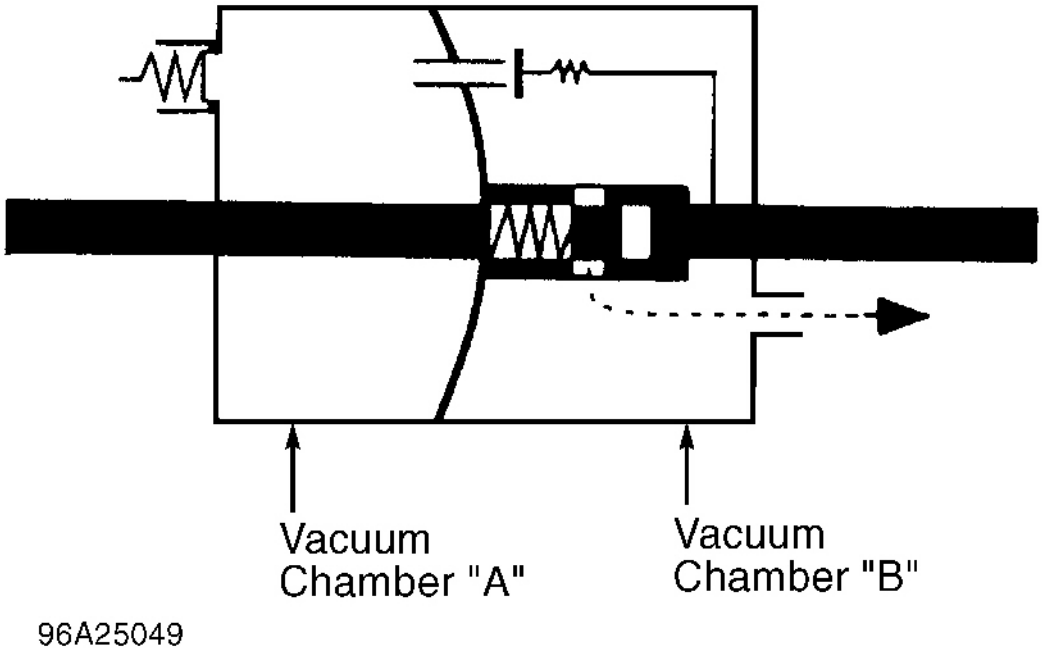


Fig. 1: Identifying Power Booster Vacuum Chambers & Diaphragm (Single Diaphragm Typical)
Courtesy of FORD MOTOR CO.

FRONT DISC BRAKES

Front disc brakes are standard. A single-anchor, dual piston brake assembly is used on F250 (heavy-duty) and F350. All other models use a single-piston, pin-rail, sliding caliper front disc brake system. On all models, caliper is secured to steering knuckle by 2 caliper retaining pins.

REAR DISC BRAKES

F Super Duty has standard equipment rear disc brakes. A single-anchor, dual-piston brake assembly is used on rear. F Super Duty uses as cable-actuated, transmission-mounted parking brake. Transmission mounted parking brake, located on transmission extension housing, consists of a case assembly and cable actuated 9" x 3" Bendix brake assembly. See **Fig. 2** . Case assembly consists of roller bearings, companion flange and mainshaft, assembled in a one-piece aluminum housing. Case assembly has a lubrication supply separate from transmission.

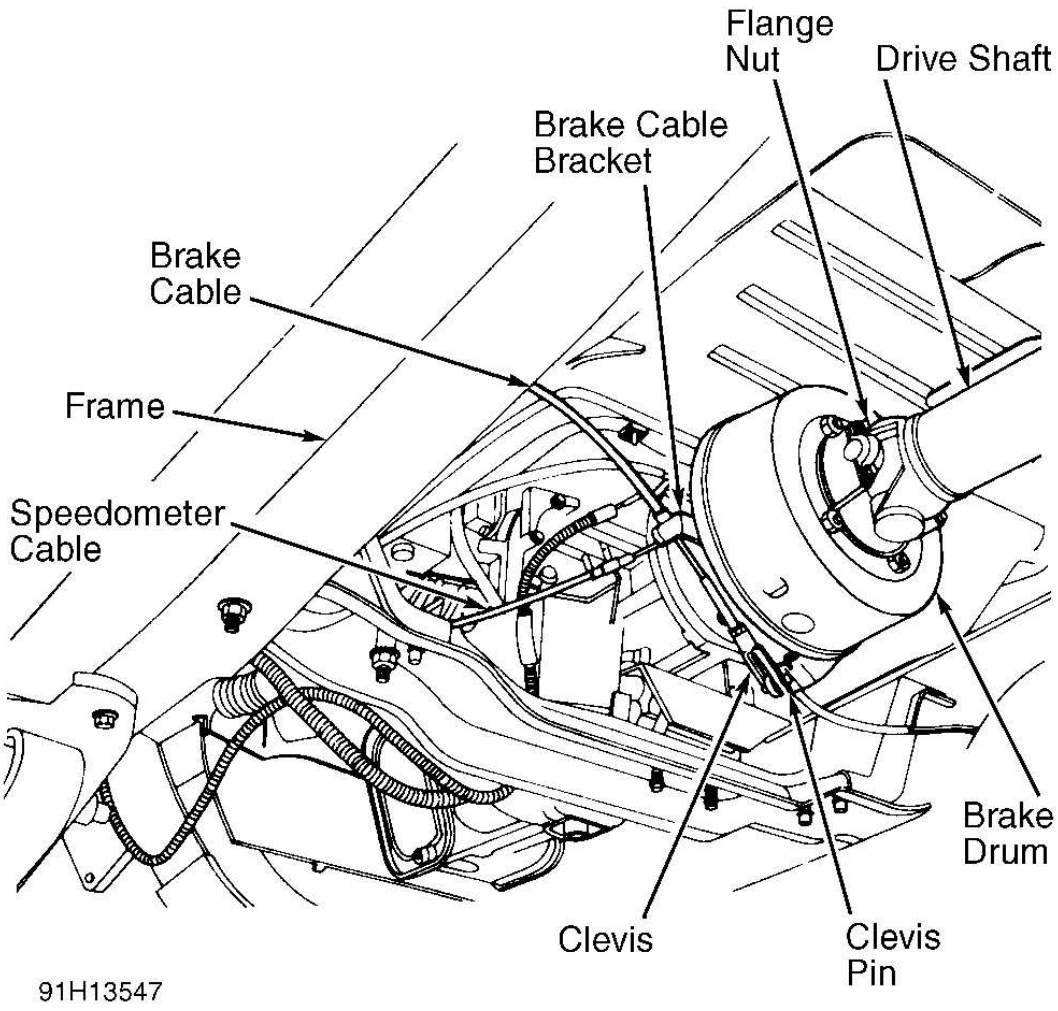


Fig. 2: Locating Transmission Mounted Parking Brake (F Super Duty)
Courtesy of FORD MOTOR CO.

REAR DRUM BRAKES

Rear drum are standard on all models except F Super Duty. On rear drum brake models, parking brake is actuated by a cable, which pulls the parking brake lever located inside rear brake assembly. The lever pivots parking brake strut between brake shoes. This movement pushes outward on brake shoes. Brake shoe linings are made of asbestos-free, fiberglass material. Rear drum brake assembly consists of a support plate, 2 brake shoes, return springs, automatic adjuster components and one dual-piston wheel cylinder.

MASTER CYLINDER

Vehicles are equipped with dual master cylinder. Dual master cylinder has primary and secondary pistons and separate primary and secondary fluid reservoirs.

VACUUM PUMP (DIESEL)

Vacuum is supplied from a belt-driven vacuum pump. Diesel equipped vehicles use a low vacuum indicator switch. Indicator switch is located on left side of engine compartment, near vacuum pump. Indicator switch will turn on brake warning lamp when a low vacuum situation occurs.

PROPORTIONING VALVE

Vehicles use a proportioning valve screwed into rear outlet port of master cylinder. See. **Fig. 3** . This proportioning valve has a by-pass feature. The proportioning valve restricts hydraulic pressure to rear brakes to prevent lock-up. The by-pass feature allows full hydraulic pressure to rear brakes in case of front brake system failure.

F Super Duty is equipped with a height sensing proportioning valve. See **Fig. 4** . Height sensing proportioning valve monitors changes in vehicle height. This valve automatically provides optimum front-to-rear brake balance, regardless of vehicle load. The valve controls pressure to rear brakes by sensing vehicle load conditions through movement between rear axle and body. As vehicle load increases (resulting in decreased vehicle height), higher brakeline pressure to rear brakes is allowed. Valve is located on No. 5 crossmember.

CAUTION: If height sensing proportioning valve linkage is disconnected, proper indexing will be lost. A NEW sensing valve must be installed. The new sensing valve will have shaft preset and secured internally. If shaft turns freely, DO NOT USE.

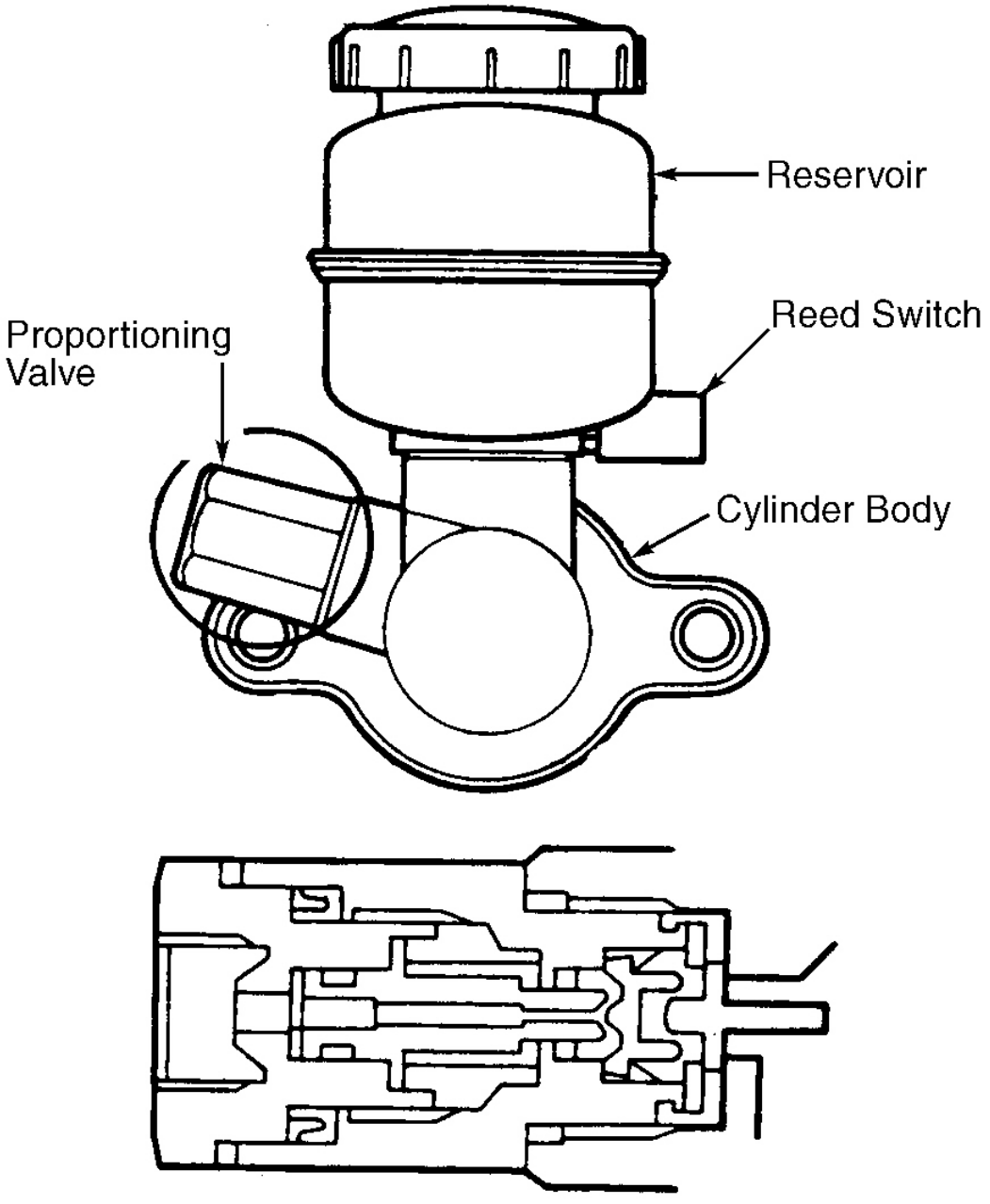


Fig. 3: Examining Master Cylinder & Proportioning Valve
Courtesy of FORD MOTOR CO.

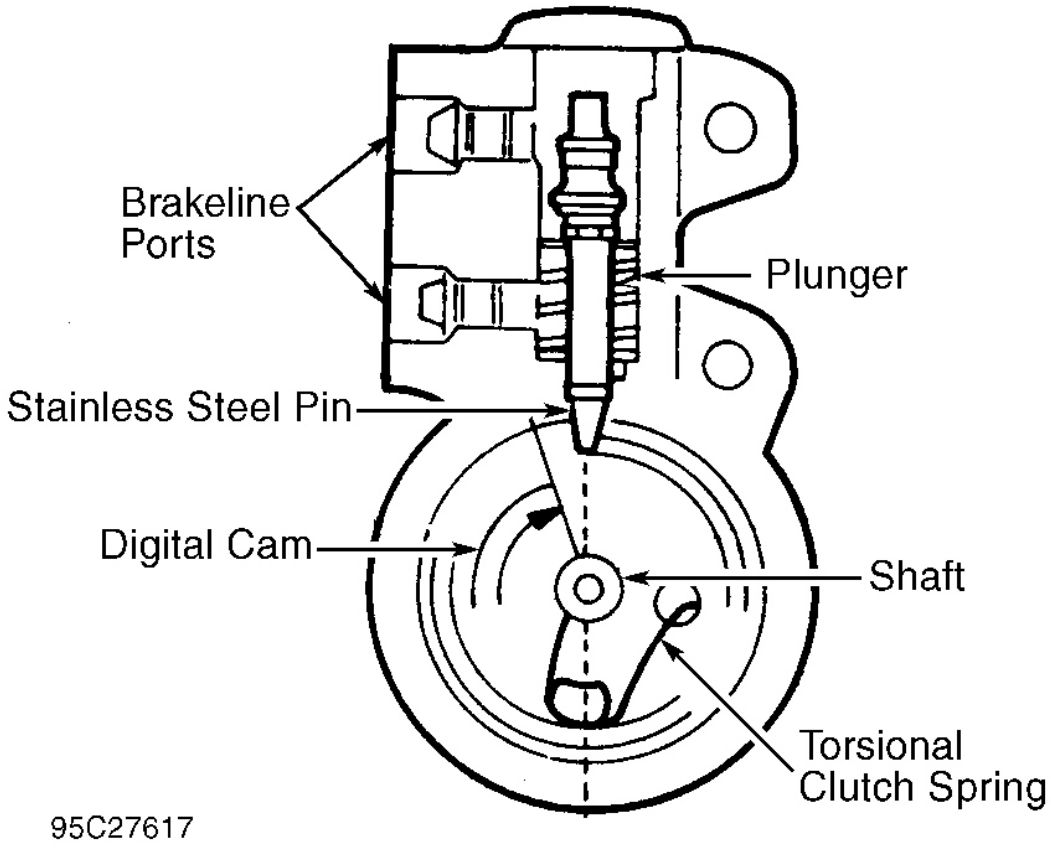


Fig. 4: Examining Height Sensing Proportioning Valve (F Super Duty)
Courtesy of FORD MOTOR CO.

CAUTION: Aftermarket load leveling kits, air shocks or modifications which change curb ride height and/or spring deflection rate provide false readings to height sensing proportioning valve. These modifications may result in unsatisfactory brake performance, which in turn could result in an accident.

BLEEDING BRAKE SYSTEM

CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, immediately wash it with water.

Bleed hydraulic system whenever air has been introduced into system. Bleed master cylinder and brakes at all 4 wheels if master cylinder lines have been disconnected or master cylinder has run dry. Bleed brakes with pressure bleeding equipment or by manually pumping brake pedal while using bleeder tubes. Always bleed

brakelines in sequence. See **BLEEDING SEQUENCE** .

NOTE: DO NOT allow reservoir to run dry during bleeding operation.

MANUAL BLEEDING

Master Cylinder Bleeding (Bench)

1. Support brake master cylinder body in a vise, and fill both fluid brake master cylinder reservoirs with brake fluid. Install plugs in front and rear brake outlet ports. Bleed front brake system first. Loosen plug in front brake outlet port and depress primary piston slowly to force air out of master cylinder.
2. Tighten plug while piston is depressed or air will enter brake master cylinder. Repeat procedure until no air bubbles are present. Repeat bleeding procedure for rear brake outlet port with front brake outlet plugged. Tighten plugs and try to depress piston. Piston will not depress if all air is out of master cylinder.

Master Cylinder Bleeding (On-Vehicle)

1. Using a tubing wrench, remove front brake tube and master cylinder outlet rear tube from master cylinder. Install short brake tubes in master cylinder and position them so they curve into master cylinder reservoir, and ends of tubes are submerged in brake fluid.
2. Fill master cylinder reservoir with new brake fluid. Have an assistant pump brakes until clear, bubble-free fluid flows from both brake tubes. Remove short brake tubes and reinstall front brake tube and master cylinder inlet rear tube on master cylinder. Bleed each brake tube at master cylinder by having and assistant pump brake pedal 10 times and then hold firm pressure on brake pedal.
3. Loosen rear-most brake tube fittings until a stream of brake fluid comes out. Have an assistant maintain pressure on brake pedal until brake tube fitting is tightened again. Repeat procedure until clear, bubble-free fluid comes out from around tube fitting. Refill master cylinder reservoir as necessary. Repeat this bleeding operation at front brake tube fittings.

Gravity Bleeding

Fill brake master cylinder with new brake fluid. Loosen both of wheel cylinder bleeder screws and leave them open until clear brake fluid flows. Be sure to check master cylinder reservoir fluid level often and do not let it run dry. Tighten wheel cylinder bleeder screws. One at a time, loosen caliper bleeder screws. Leave bleeder screws open until clear fluid flows. Check fluid level often. Tighten caliper bleeder screws.

Manual Bleeding

1. Clean master cylinder cap and surrounding area. Remove cap. Vehicles are equipped with dual-type master cylinder. Bleed primary and secondary systems separately. Loosen primary or secondary master cylinder hydraulic line fitting. See **Fig. 5** .

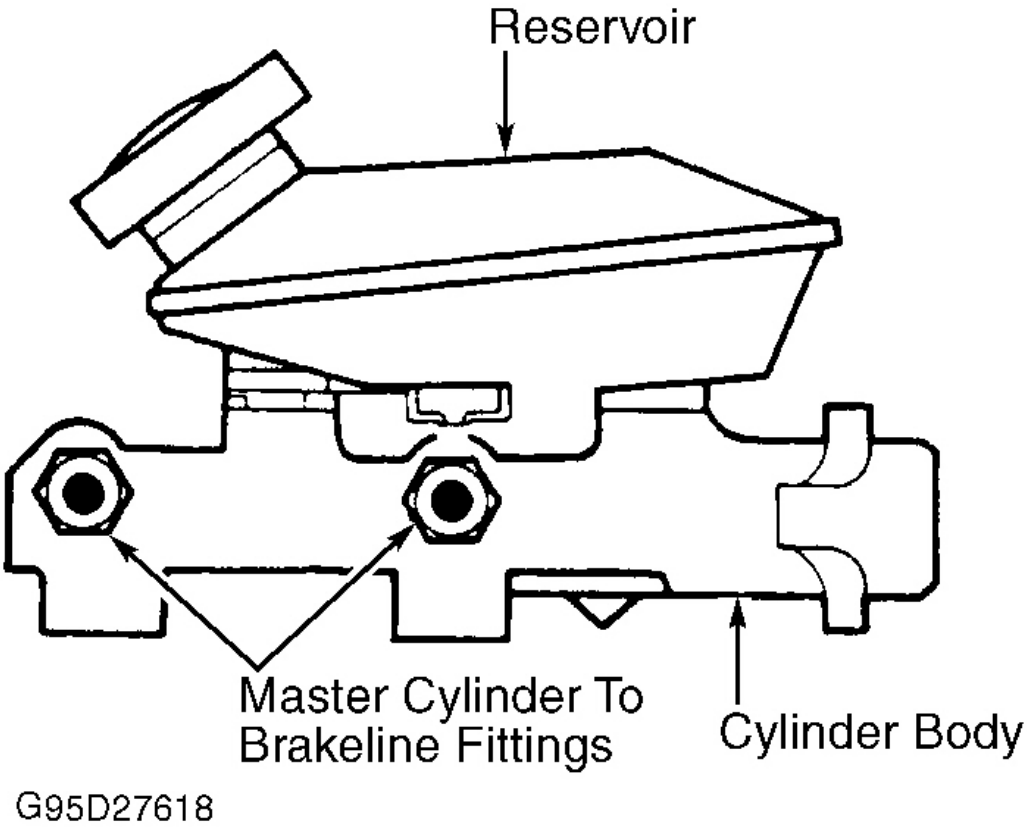


Fig. 5: Identifying Master Cylinder (Typical)
Courtesy of FORD MOTOR CO.

2. Wrap a cloth around brakelines to absorb escaping brake fluid. Slowly push brake pedal down to force out air. With pedal fully depressed, tighten fittings to prevent air from being sucked into master cylinder when pedal is released. Release pedal.
3. Repeat procedure until air is completely purged from master cylinder. When all air has escaped, tighten fittings with pedal down. Release pedal, and depress again. If pedal is not firm, repeat bleeding procedure.
4. Repeat procedure at bleeder fitting on rear anti-lock brake electrohydraulic RABS Valve, each wheel cylinder and caliper. See **Fig. 6** . See **BLEEDING SEQUENCE** table under BLEEDING SEQUENCE. When bleeding is complete, fill master cylinder to proper level.

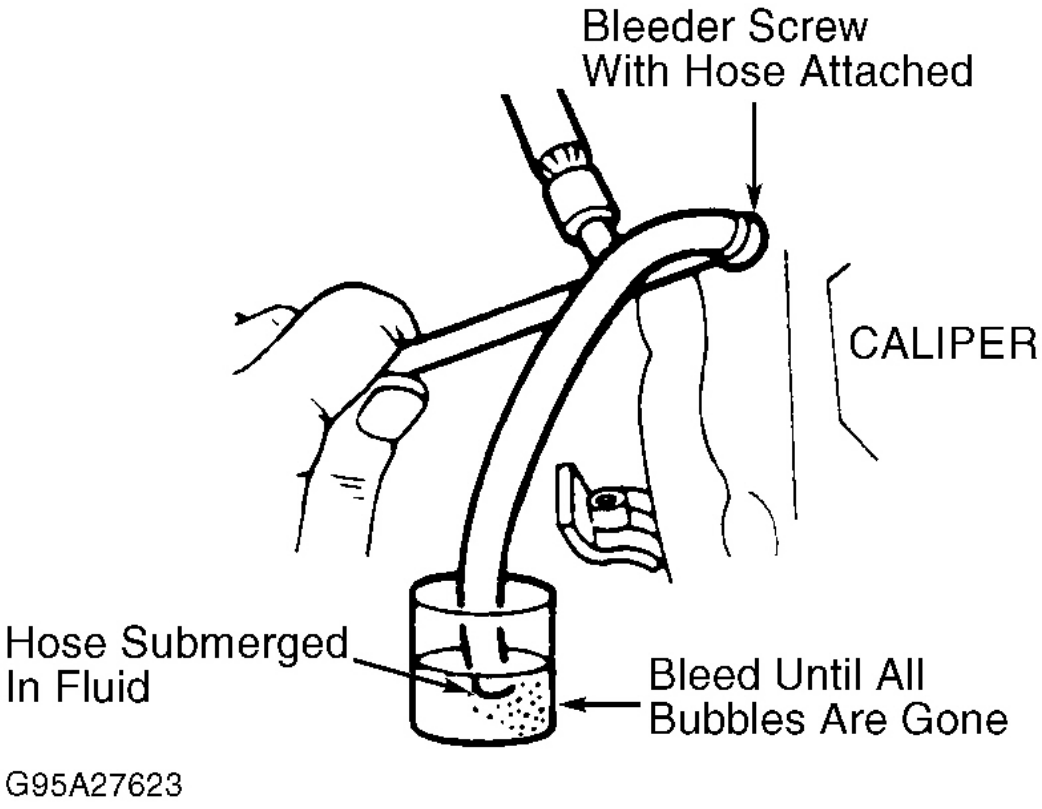


Fig. 6: Bleeding Wheel Cylinders (Typical)
Courtesy of FORD MOTOR CO.

PRESSURE BLEEDING

1. Clean master cylinder cap and surrounding area. Remove cap. With pressure tank at least 1/2 full of specified fluid and charged between 10-30 psi (.7-2.0 kg/cm^2), use adapters to connect tank to master cylinder. Follow equipment manufacturer's pressure instructions.

CAUTION: Never exceed 50 psi (3.5 kg/cm^2) during bleeding.

2. Open pressure bleeder valve. Bleed master cylinder primary and secondary hydraulic lines individually. Put shop towels in place to catch brake fluid.
3. Open lines. Allow brake fluid to flow out until all air is purged. Close bleed fitting and hydraulic line. Close pressure bleeder valve. Attach rubber drain hose to first wheel cylinder bleeder valve to be serviced. See **Fig. 6** . See **BLEEDING SEQUENCE** table under BLEEDING SEQUENCE.
4. Place other end of hose in clean glass jar partially filled with clean brake fluid so end of hose is

submerged in fluid. Open pressure bleeder valve. Open bleeder fitting. Close bleeder fitting when fluid flow is free of bubbles. Repeat procedure on remaining wheel cylinder and calipers in sequence. See **BLEEDING SEQUENCE** .

5. When bleeding operation is complete, close pressure bleeder valve, and remove tank hose from adapter fitting. Check brake pedal operation. Ensure master cylinder is full of fluid.

BLEEDING SEQUENCE

Before bleeding system, remove all vacuum from power unit by depressing brake pedal several times. Bleed master cylinder first, followed in sequence by rear wheel cylinders, anti-lock system components (if equipped) and calipers. See **BLEEDING SEQUENCE** table.

BLEEDING SEQUENCE

Application	Sequence
Except Anti-Lock)	RR, LR, RF, LF
Anti-Lock Brakes	RR, LR, (1) , RF, LF
(1) Anti-Lock brake control module.	

BLEEDING HYDRO-BOOST UNIT

NOTE: Hydro-Boost is generally self-bleeding. Listed procedure will normally bleed air from system. Normal vehicle operation will remove any additional air.

F Super Duty

1. Fill power steering pump reservoir with Motorcraft MERCON multipurpose automatic transmission fluid. Crank engine several seconds with coil wire disconnected. Check and add fluid if necessary. Start engine. Turn wheels from lock-to-lock twice.
2. Turn engine off. Depress brake pedal several times to discharge accumulator. Start engine, and turn wheels from lock-to-lock twice. If foaming occurs, stop engine, and allow foam to dissipate. Repeat lock-to-lock procedure until all air is removed from system.

ADJUSTMENTS

WARNING: Shut air suspension off, prior to hoisting vehicle. This can be accomplished by turning off air suspension switch located on right kick panel.

VACUUM POWER BOOSTER PUSH ROD

1. Push rod has an adjustment screw to maintain correct distance between booster push rod and master cylinder piston. If push rod is adjusted too long, it prevents master cylinder piston from completely releasing hydraulic pressure, causing brakes to drag. If push rod is adjusted too short, it causes excessive pedal travel and an undesirable groaning noise in booster area.

2. Remove master cylinder to access push rod. To check screw adjustment, fabricate a gauge. See **Fig. 7** . With engine running, place gauge against master cylinder mounting surface of booster. Adjust push rod screw by turning it until end of screw just touches inner edge of gauge slot.

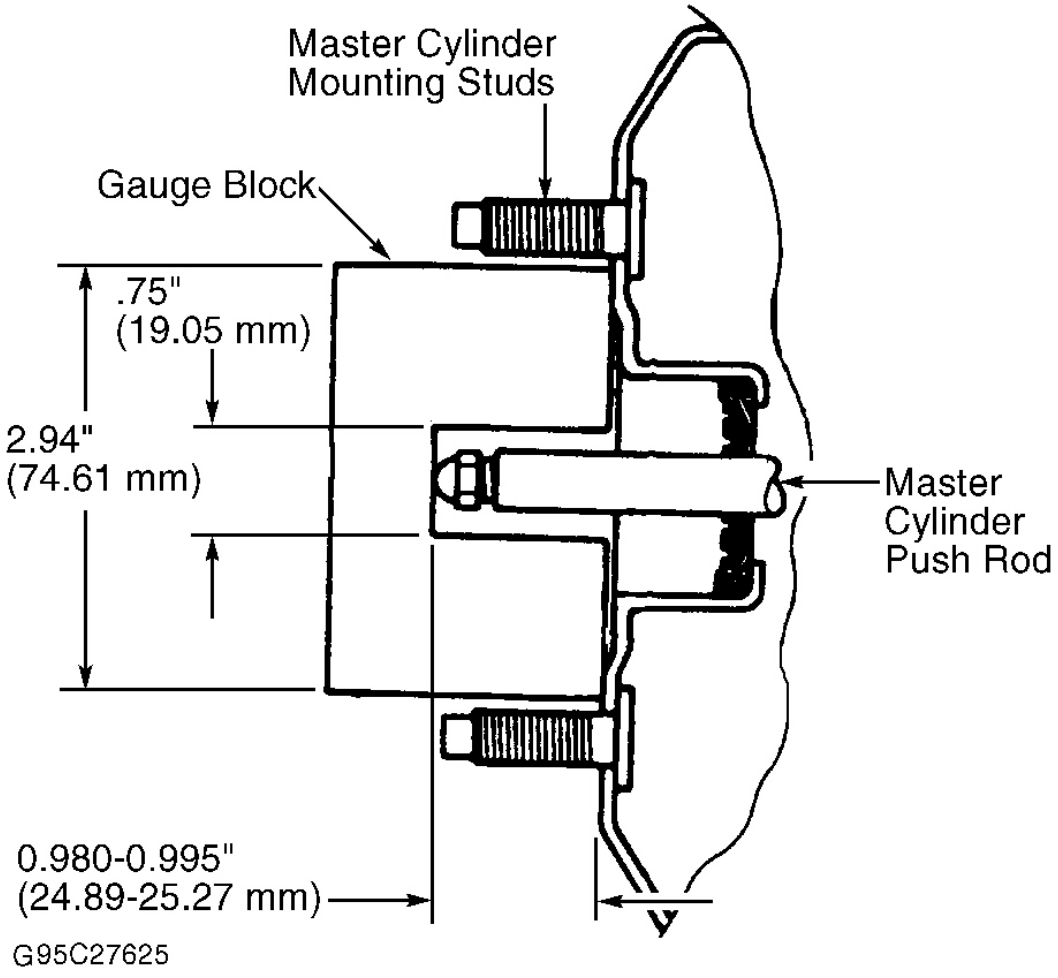


Fig. 7: Adjusting Brake Booster Push Rod (All Models Except F Super Duty
Courtesy of FORD MOTOR CO.

BRAKE PEDAL LINKAGE

F Super Duty

Remove spring clip and washer from lower end of brake pedal rod. Remove lower end of rod from bellcrank pin. Loosen jam nut. Hold brake pedal against rubber stop. Turn brake rod into clevis until lower hole lines up with pin on bellcrank. Slide brake rod onto pin of bellcrank, and attach washer and spring clip. See **Fig. 8** .

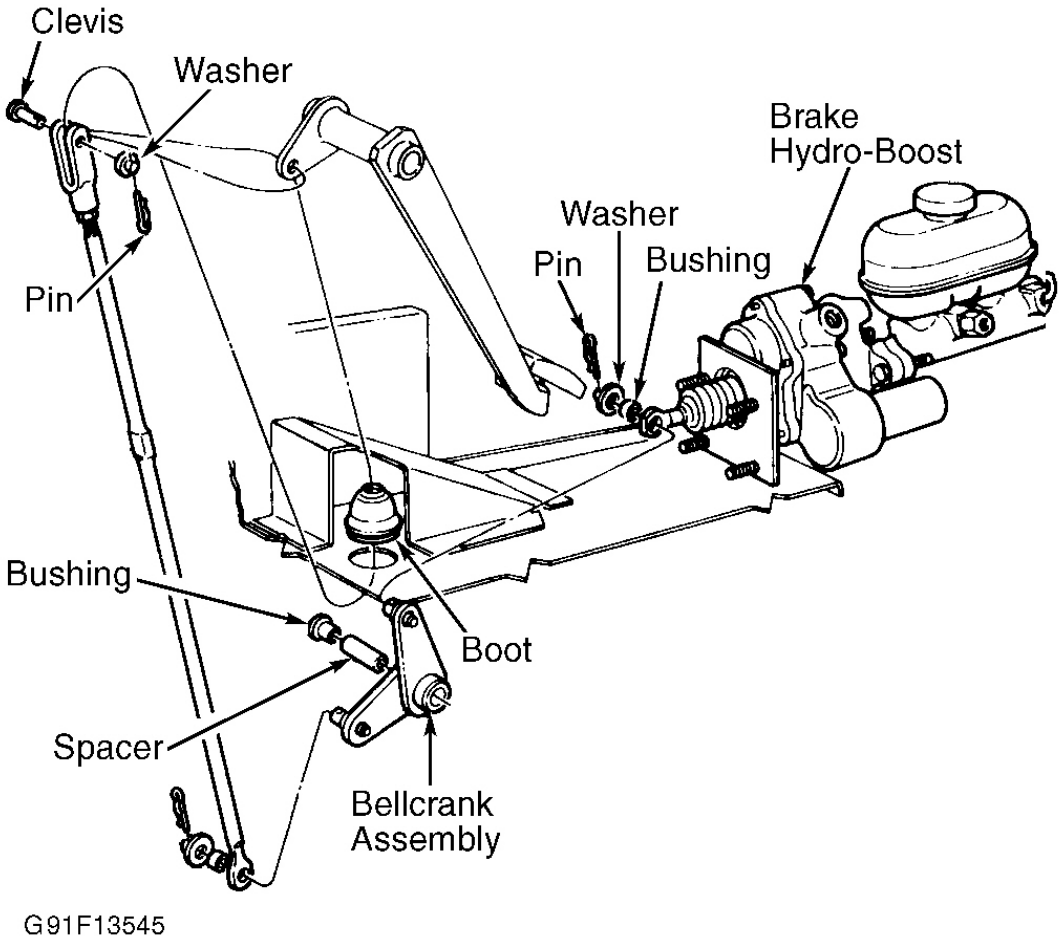


Fig. 8: Adjusting Brake Pedal Linkage (F Super Duty)
Courtesy of FORD MOTOR CO.

HEIGHT SENSING PROPORTIONING VALVE

F Super Duty

1. Raise rear of vehicle using body jacks to gain a clearance of 6 5/8" (168 mm) between bottom surface of each rubber jounce bumper and rear axle housing. See**Fig. 9** . Remove nut from valve shaft. Remove leading arm.

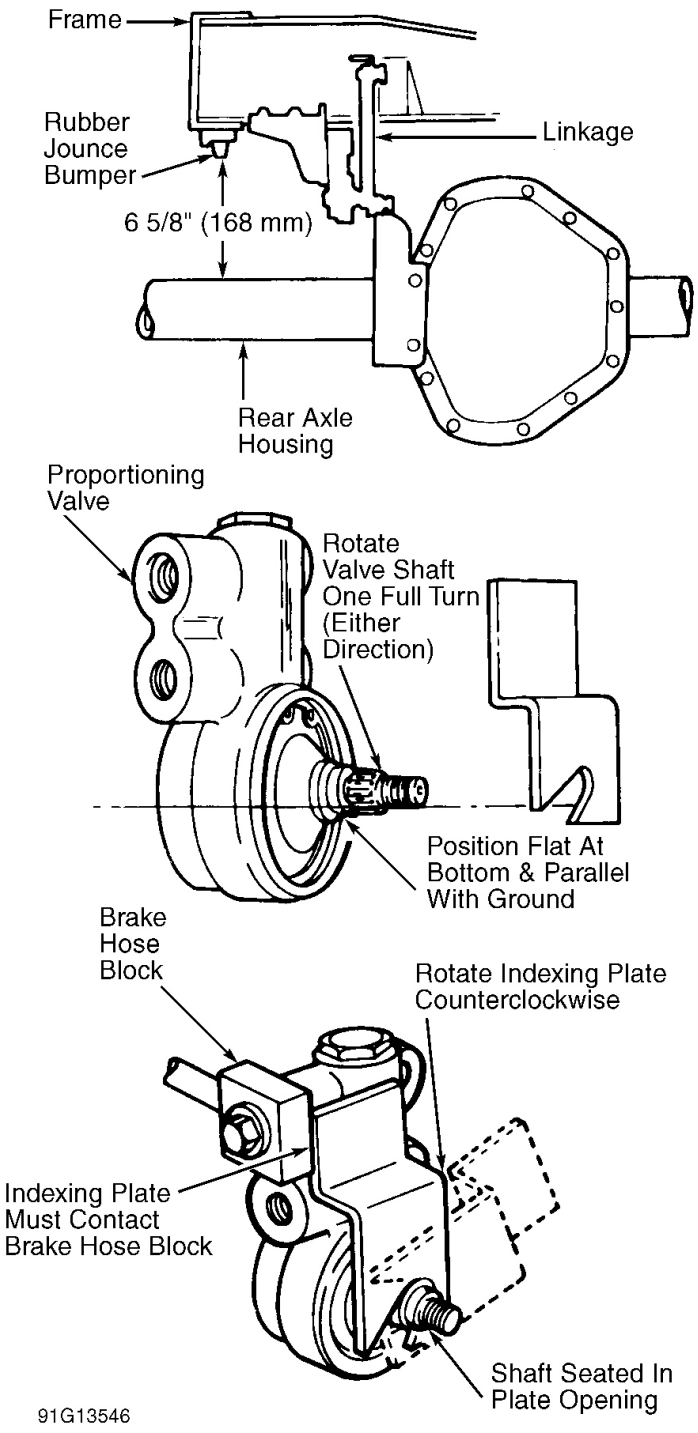


Fig. 9: Adjusting Height Sensing Proportioning Valve (F Super Duty)
Courtesy of FORD MOTOR CO.

2. Remove bushing and clip from leading arm. Install NEW bushing and clip from linkage kit (E8TZ-2L

193-A). Rotate valve shaft one full turn in either direction. Position valve shaft with flat at bottom and parallel with ground. See **Fig. 9** .

3. Install Indexing Plate (T90T-2588-A) on valve shaft. Install so flat on indexing plate is aligned with flat on valve shaft. Indexing plate slot must be fully seated on valve shaft. Upper surface of indexing plate must rest on valve body.
4. Rotate indexing plate counterclockwise until edge of indexing plate touches brake hose block. See **Fig. 9** . While holding indexing plate in position, install leading arm of linkage over splined part of valve shaft. Fully seat leading arm onto splines. Reinstall valve shaft nut. Remove indexing plate.

PARKING BRAKE

NOTE: On all models except F Super Duty, parking brake system is self-adjusting and does not require adjustment.

Transmission Mounted Parking Brake Field Adjustment (F Super Duty)

1. Use this procedure to correct excess parking brake actuation lever travel. Raise vehicle and set on jack stands. Shift transmission to Neutral, and release parking brake. Loosen parking brake clevis adjusting jam nut several turns.
2. Remove lock pin and clevis pin from clevis. See **Fig. 10** . Hold lever and cable, removing slack. Screw adjusting clevis onto threaded end of cable until parking brake lever hole and clevis hole align. Rotate clevis about 10 turns. Tighten jam nut. Rotate driveshaft to ensure rear brakes are not dragging. Lower vehicle to ground. Check parking brake for proper operation.
3. On vehicles with Orschein hand-actuated parking brake lever, turn handle adjustment knob to obtain 1" of travel. See **Fig. 10** . Release parking brake. Loosen parking brake clevis adjusting jam nut several turns. Install parking brake cable into parking brake mounting bracket.
4. Hold parking brake actuation lever in applied position. Screw adjusting clevis onto threaded end of cable until parking brake lever hole and clevis hole align. Rotate clevis about 10 turns. Tighten jam nut. Assemble clevis to parking brake actuation lever. Check parking brake for proper operation. Turn adjustment knob on parking brake actuation lever for additional adjustment.

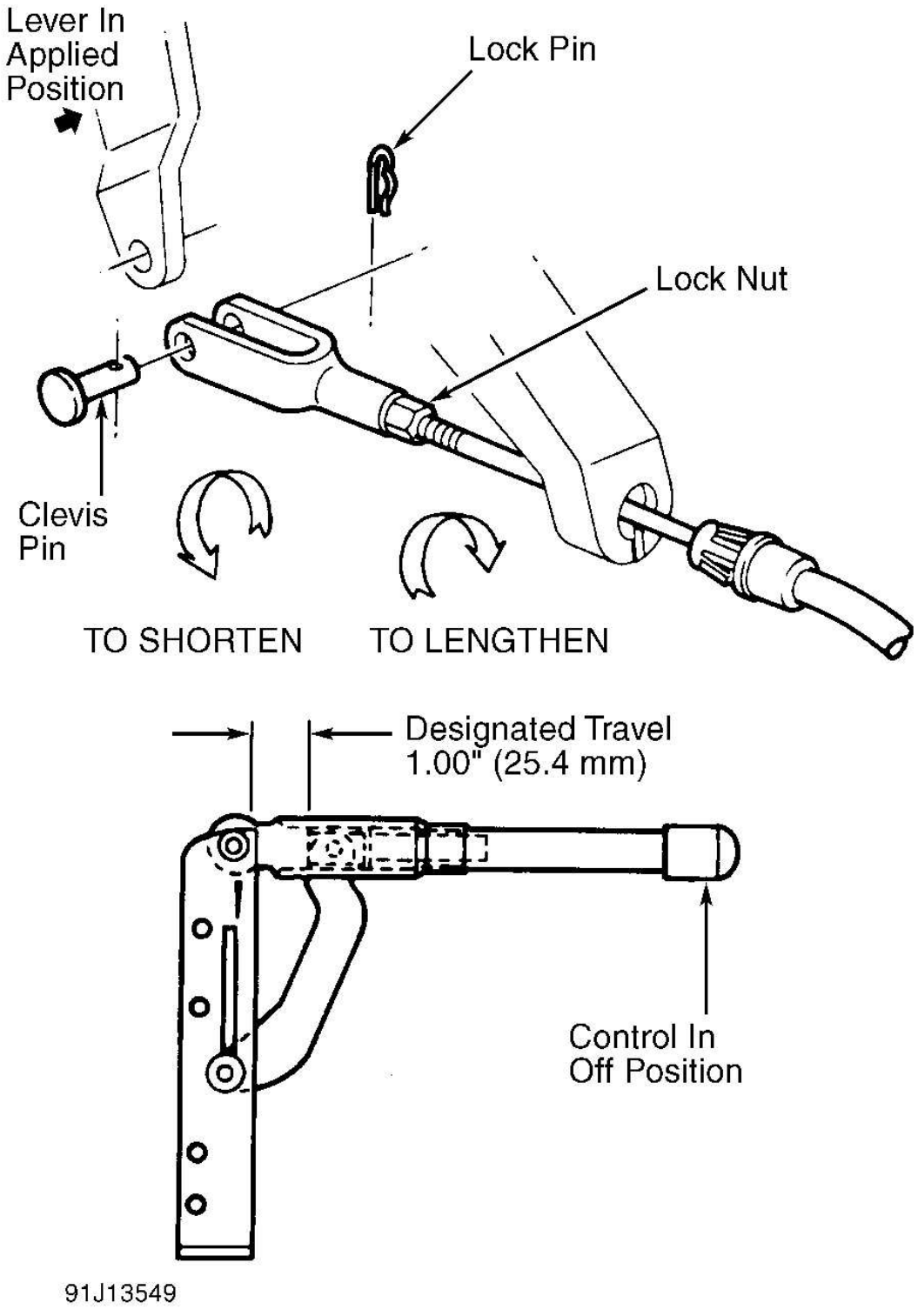


Fig. 10: Adjusting Parking Brake (F Super Duty)

Courtesy of FORD MOTOR CO.

BRAKE SHOES

NOTE: Rear brake shoes are automatically adjusted when vehicle is driven forward and backward and brakes are applied sharply. Manual adjustment is required if brakes do not self-adjust or after brake shoes have been removed or replaced.

Drums Removed

1. Adjust with brake drums cold and parking brake correctly adjusted. Measure brake drum inside diameter using brake shoe adjustment gauge. See **Fig. 11** .

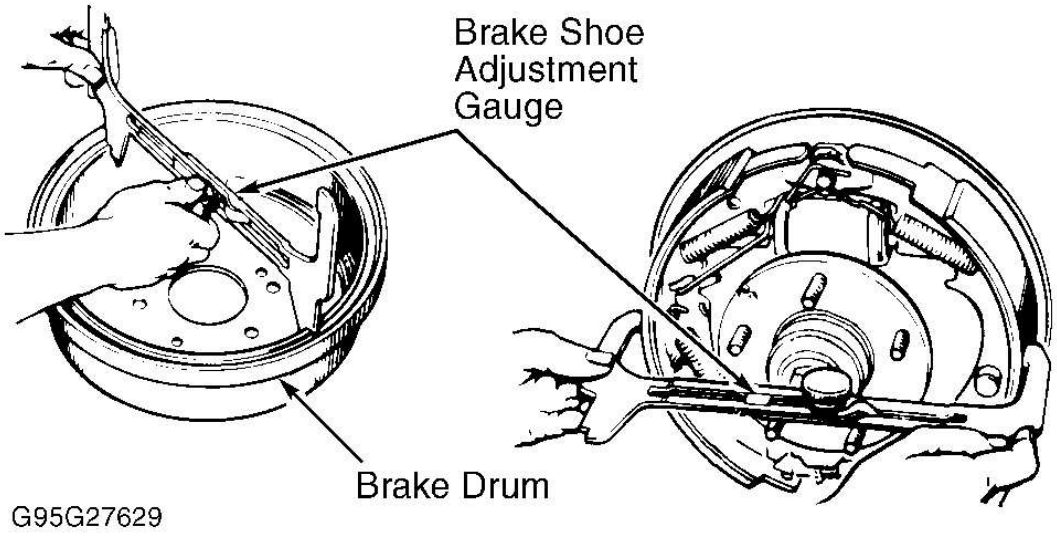


Fig. 11: Measuring Brake Drum & Shoe Diameter
Courtesy of FORD MOTOR CO.

2. Reverse adjustment gauge. Apply gauge to brake shoes on a line parallel to ground and through center of axle. Hold adjusting lever away from adjusting screw. Turn screw until outside diameter of shoes contacts gauge. See **Fig. 11** .
3. Install brake drum and wheel assembly. Complete adjustment by applying brakes quickly several times while driving vehicle alternately forward and backward. Check brake operation by stopping often while driving forward.

Drums Installed

1. Raise vehicle, and support with safety stands. Remove adjusting hole cover rubber plug. Turn adjusting screw and expand brake shoes until drag is felt against brake drum.

2. Loosen adjusting screw 10-12 notches. Drum should rotate freely without drag. If drum does not rotate freely, remove wheel and drum. Lubricate brake shoe contact areas on backing plate.
3. Reinstall wheel and drum. Install adjusting hole cover. Apply brakes. If brake pedal travels more than halfway to floor, clearance between brake shoes and drums is too great. Additional adjustment is required.

DISC PADS

As brake pads wear, caliper piston remains in constant contact with brake pad, eliminating need for adjustment.

TROUBLE SHOOTING

NOTE: Occasional brake squeal can be caused by environmental conditions such as cold ambient temperatures, heat, rain, snow salt, mud, hot ambient temperatures or high humidity. This occasional squeal is not a functional problem and does not indicate any loss in brake effectiveness.

INSPECTION

1. Visually examine front and rear tire and wheel assemblies for damage such as uneven wear, tread washouts, or side-wall damage. Make sure tires are of same size, type and same manufacturer (where possible). Any tire or wheel that is damaged should be replaced. Wheels and tires must be cleared of any foreign matter and tire pressures adjusted to correct specifications.
2. If tires exhibit uneven wear or feathering, cause must be corrected. Check steering and suspension components for damage or wear and check and adjust steering alignment (if necessary). Check hydraulic hoses and tubes for leaks, cracks, chaffing and distortions. Check fasteners that hold these components in place should also be checked.

NOTE: DO NOT pry under or otherwise disturb dust boot.

3. Check drum brakes for loose or worn parts. Check rear wheel cylinder for leakage around dust boot. Check for proper component installation, leakage, caliper slide lubrication and excessive wear along caliper supports. Check instrument cluster brake warning light.
4. Check that link from brake load sensor proportioning valve to frame is properly connected. Brake load sensor proportioning valve is calibrated for particular vehicle it is installed on. If modifications are made to rear suspension system, brake load sensor proportioning valve will not work properly and must be deactivated.

MASTER CYLINDER

Changes in brake pedal feel or travel signal something could be wrong in brake system. When diagnosing brake system problems, use brake warning light, pedal feel/travel and fluid level as indicators. Following symptoms indicate brake trouble:

Pedal goes down fast.

- Check for leaks or air in system.

Pedal goes down slowly.

- Check for external or internal leaks.

Pedal is low and/or feels spongy.

- Check for empty master cylinder reservoir, reservoir cap vent holes clogged, rear brakes out of adjustment or air in system.

Pedal effort too high.

- Check for binding or obstruction in pedal linkage. Check for poor booster assist.

Brake warning light is on.

- Check for low fluid level, ignition wires too close to fluid level indicator assembly, damaged indicator float, low vacuum (diesel) or applied parking brake.

HYDRO-BOOST UNIT

Use following list of symptoms to aid in diagnosing Hydro-Boost problems:

Brake pedal returns slowly.

- Check for restriction in return line between Hydro-Boost and power steering reservoir.
- Check for incorrectly connected return line.
- Reposition brake pedal or add return spring.
- Replace Hydro-Boost.

Brakes grab.

- Tighten power steering belt.
- Flush steering system while pumping brake pedal.
- Replace Hydro-Boost.

Hydro-Boost chatter/Pedal vibration.

- Tighten power steering belt.
- Check for low fluid level.

Accumulator leaks down/No reserve brake application.

- Replace Hydro-Boost.

High brake pedal effort.

- Tighten or replace power steering belt.
- Low fluid level.
- Replace Hydro-Boost.

Brakes apply by themselves.

- Restriction in return line.
- Return line not connected correctly.
- Replace Hydro-Boost.

TESTING

POWER BRAKE FUNCTION TEST

1. With engine stopped, remove vacuum in system by pumping brake pedal several times. Push pedal down as far as it will go. If pedal moves downward slowly, hydraulic system is leaking. Check hydraulic system for leaks.
2. With pedal pushed down as far as it will go, start engine. If pedal moves downward, vacuum system is okay. If pedal does not change position, a problem exists in vacuum system. Check vacuum system for leaks.

MASTER CYLINDER

1. To check master cylinder for internal leak, fill reservoir as necessary. If fluid level remains constant after several brake applications, measure wheel turning torque necessary to rotate wheels with brakes applied.
2. To measure, shift transmission into Neutral, and raise front wheels. Apply brakes with a minimum force of 100 lbs. (45 kg), and hold about 15 seconds. With brakes applied, attempt to rotate front wheels with 75 ft. lbs. (102 N.m) of torque. If either wheel rotates, check front chamber of master cylinder, and replace parts as necessary. Repeat test for rear wheels.

BRAKE WARNING LIGHT

1. Brake warning light should only come on when ignition is in START position or when ignition is on with parking brake applied or fluid level low. On diesel vehicles, brake warning light should also come on when vacuum is low.
2. If brake warning light does not come on when brake fluid is low, manually push reservoir float to bottom of reservoir. If light still does not come on, check fuse, wiring and bulb. Repair as necessary. If bulb and related circuitry are okay, replace reservoir assembly.
3. If brake warning light does not come on when parking brake is applied, check parking brake switch, wiring and bulb. Repair as necessary. With parking brake released and master cylinder reservoir full, turn

ignition on. If warning light is on, check for shorted, grounded or defective warning switches or wiring. Repair as necessary. Turn ignition switch to Start position. If brake warning light does not come on as a bulb check function, check fuse, bulb and wiring. Repair as necessary.

BRAKE PEDAL RESERVE

1. If complaint is low or bottoming out brake pedal, run engine at idle with transmission in Park or Neutral. Lightly depress brake pedal 3 or 4 times. Wait 15 seconds for vacuum to build in booster. Depress brake pedal until it stops moving downward.
2. While holding pedal down, raise engine speed to about 2000 RPM. Release accelerator pedal. Brake pedal should move downward as engine speed returns to idle. If results are correct, system has proper pedal reserve. If results are not correct, check for adequate vacuum. If vacuum is okay, replace vacuum booster.

VACUUM PUMP (DIESEL)

1. Turn key off, disconnect vacuum line and connect a vacuum gauge with a "T" fitting to lower part of dash mounted plastic check valve. See **Fig. 12** . Start engine and allow to run at idle until vacuum reaches 17-21 in. Hg.
2. Turn ignition off and observe vacuum gauge for one minute. If vacuum drops more than one in. Hg, replace power brake booster check valve. If vacuum does not drop more than one in. Hg, go to next step.
3. Reconnect vacuum gauge in same point as in step 1), but leave rest of system connected. Start engine and allow engine to run at idle until vacuum reaches 17-21 in. Hg. Turn key off and observe vacuum gauge for one minute.
4. If vacuum drops more than one in. Hg, disconnect each component one at a time and repeat test procedures in step 3 until leaking component is found. Plug disconnected vacuum line while performing test procedures. Repair or replace defective component as required. On diesel engine with dash mounted power brake booster, replace power brake booster check valve also. If vacuum does not drop more than one in. Hg, go to next step.
5. Start engine and run engine until vacuum reaches 17-21 in. Hg. Turn ignition off and push down on brake pedal for a few seconds and release. If vacuum pressure drops to zero in. Hg, replace power brake booster. If vacuum pressure does not drop to zero in. Hg, system is okay. Remove vacuum gauge and reconnect all vacuum lines.

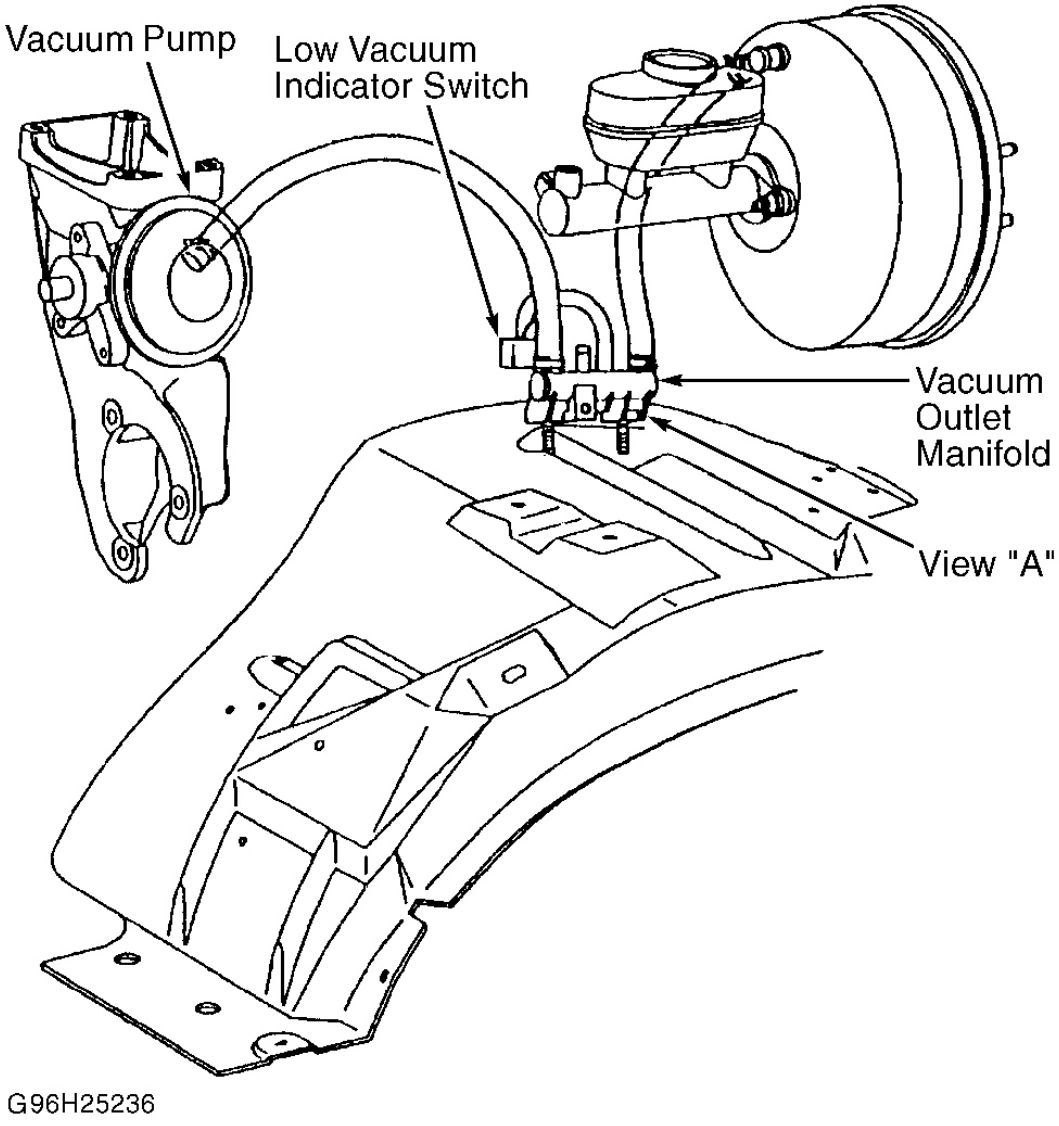


Fig. 12: Identifying Vacuum Pump Components (7.3L Diesel)
Courtesy of FORD MOTOR CO.

HYDRO-BOOST

Reserve

Charge system with pressure by holding steering wheel on steering stop or by holding brake pedal down with 100 lbs. (45 kg) of force for 5 seconds with engine idling. Turn engine off. After 8-12 hours, depress brake pedal with engine off. If power reserve is not present, replace Hydro-Boost unit.

CAUTION: DO NOT hold brake pedal with 100 lbs. (45 kg) of force for longer than 5 seconds at a time.

Hydraulic Pressure Tests

1. Check for hydraulic leaks in system. Check power steering pump does not exhibit sustained failure or internal damage that may contaminate fluid in system. If there is a possibility of burned fluid or metal particles in fluid, brake system should be purged before connecting power steering analyzer.
2. Connect Power Steering System Analyzer (014-00230). Follow installation procedure supplied with analyzer. Fully open shutoff valve, start engine and purge air from brake system by applying brakes several times. Shut off engine and check connections for leaks.
3. Check for proper fluid level at reservoir and add or remove fluid as required. Recheck for air in system by restarting engine, partially close shutoff valve and view pressure gauge. If gauge needle vibration is excessive, too much air remains in system. Install thermometer in reservoir and connect tachometer to engine.
4. Fully open analyzer shutoff valve. Start engine and run at 2000 RPM. When fluid temperature reaches 130°F (55°C), record flow and pressure. If flow is less than 3.1 Gal/Min (11.7 L/Min), check to see if correct pump is installed. If correct pump is installed, continue testing. If pressure exceeds 25 psi (172 kPa), check lines for kinks or obstructions.
5. Check pump for minimum efficiency flow. Decrease engine speed to 750-850 RPM. Slowly close shutoff valve to build pressure to 1200 psi (8400 kPa). Record flow with temperature at least 130°F (55°C). If flow is less than 1.3 Gal/Min (5 L/Min), check if correct pump is installed. Pump may require repair or replacement, especially if flow in step 4) was also less than value indicated.

CAUTION: DO NOT hold valve closed for more than 5 seconds. Damage to pump will result.

6. Check pump for pressure relief valve operation. Run engine at 750-850 RPM. Completely close and partially open shutoff valve 3 times. Read pressure when valve is fully closed. If pressure is less than 1230 psi (8480 kPa), or greater than 1350 psi (9307 kPa), clean or replace pressure relief valve. If pressure is between 1230-1350 psi, pump is operating normally and other areas should be investigated.

VACUUM POWER BOOSTER

1. With a "T" fitting, connect vacuum gauge into vacuum line between engine and power brake booster. With engine at operating temperature, gauge should read 15-19 in. Hg vacuum at idle with transmission in Neutral. If reading is less than specification, stop engine, disconnect vacuum hose at power brake booster and cap open end of hose and open port of vacuum "T".
2. Start engine, and allow it to idle. If reading is still less than 15-19 in. Hg vacuum, engine is producing low vacuum and mechanical problem must be corrected. If vacuum is to specification, check plastic check valve, rubber grommet and vacuum hose connection at power brake booster.
3. With low engine vacuum corrected and/or leaking components replaced, start engine, and allow it to idle. Stop engine, and depress brake pedal for a few seconds. If vacuum drops to zero, booster is leaking and requires replacement.

VACUUM BOOSTER CHECK VALVE

1. Remove vacuum booster hose from power brake booster and check valve connection. Manifold vacuum should be available at check valve end of vacuum booster hose with engine idling and transmission in Neutral.
2. Operate engine a minimum of 10 seconds at fast idle. Stop engine, and let vehicle stand for 10 minutes. Apply brake pedal with about 20 lbs. (9 kg) of force. Brake pedal feel should be same as that noted with engine operating. If brake pedal feels hard, replace check valve and retest.

REMOVAL & INSTALLATION

WARNING: Shut air suspension off, prior to hoisting vehicle. This can be accomplished by turning off air suspension switch located on right kick panel.

BRAKE BOOSTER VACUUM PUMP

NOTE: Vacuum pump is serviced only as a unit. Vacuum pump pulley can be replaced separately.

Removal & Installation (Diesel)

Remove hose from vacuum pump outlet. Remove vacuum pump belt. Remove pivot and adjustment bolts. Remove vacuum pump. To install, reverse removal procedure. Brake warning light comes on until vacuum builds up to normal level.

See **Fig. 12** .

BRAKE ROTOR

Removal & Installation (2WD Models)

1. Raise vehicle and support with safety stands. Remove wheel and caliper assemblies. Remove dust cap, cotter pin, nut, washer and outer bearing. Carefully remove hub and rotor assembly. Remove inner bearing and seal.
2. To install, reverse removal procedure. Adjust front wheel bearings. While rotating rotor, tighten adjusting nut to 17-25 ft. lbs. (23-34 N.m). Back off adjusting nut 120-180 degrees. Install bearing retainer and NEW cotter pin.

Removal (F150 4WD W/Automatic & Manual Locking Hubs, F250 Light-Duty, F250 Heavy-Duty & F350 4WD W/Manual Locking Hubs)

1. Raise vehicle, and support with safety stands. Remove wheel assembly and caliper. On F150 with automatic locking hubs, separate hub cap from hub body assembly by removing 5 Torx (T25) head cap screws. Remove cap. DO NOT drop spring, ball bearing, bearing race or retainer.

NOTE: Information for rotor removal on F250 Heavy-Duty and F350 with automatic locking hubs is not available from manufacturer at time of publication.

2. Remove rubber seal and seal bridge from retainer ring space. Remove retainer ring by squeezing ends together. Remove hub body assembly. Remove "C" washer and splined spacer from spindle. On vehicles with manual locking hubs, separate hub cap from hub body assembly by removing 6 Allen head screws.
3. Remove snap ring attaching hub body assembly to spindle. Remove lock ring seated in groove of hub. See **Fig. 14** . Remove hub body assembly. If hub body does not come out easily, install 2 hub cap screws into hub body, and pull hub body out of hub.
4. On F150 with automatic locking hubs and on F250 Heavy-Duty and F350 with manual locking hubs, use Spanner Lock Nut Wrench (D85T-1197-A) to remove outer lock nut. See **Fig. 15** . Remove lock washer. Using spanner lock nut wrench, remove inner lock nut. Remove outer wheel bearing and rotor.
5. On F150/F250 Light-Duty with manual locking hubs, use Spanner Lock Nut Wrench (T86T-1197-A) to remove wheel bearing adjusting nut. Remove outer wheel bearing, and then rotor.

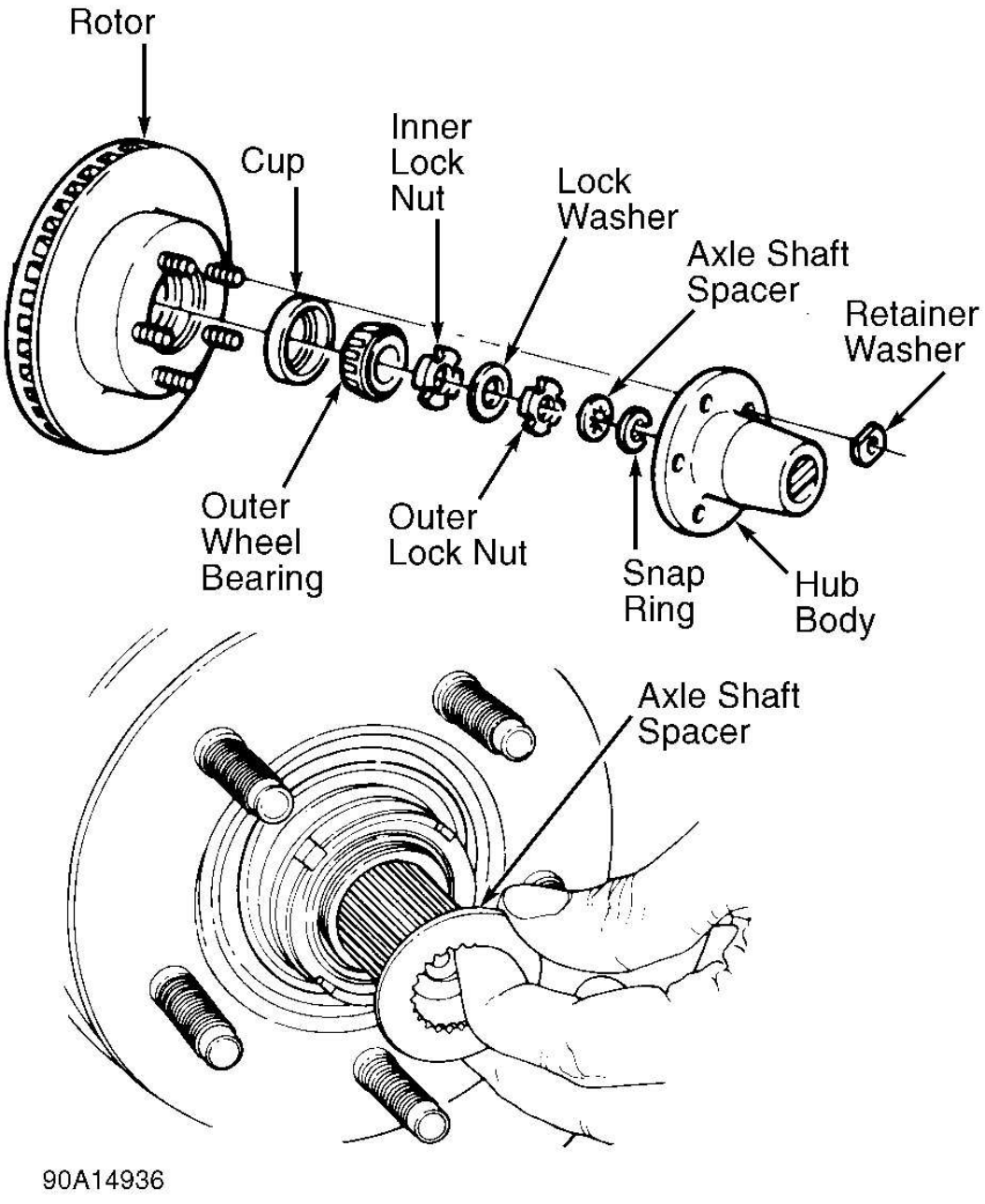


Fig. 13: Removing Front Rotor (Typical; 4WD W/Manual Locking Hubs)
Courtesy of FORD MOTOR CO.

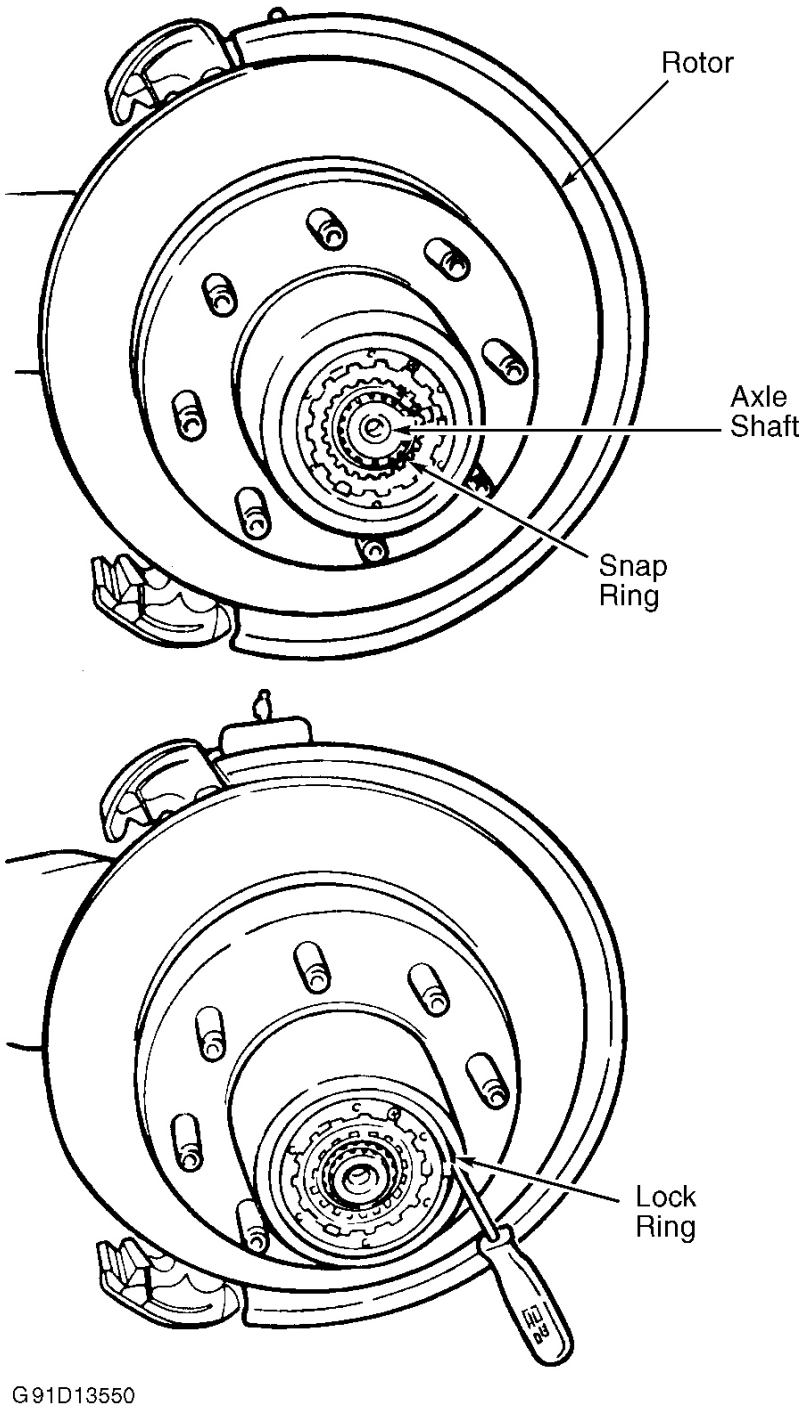


Fig. 14: Removing Front Hub (4WD)
Courtesy of FORD MOTOR CO.

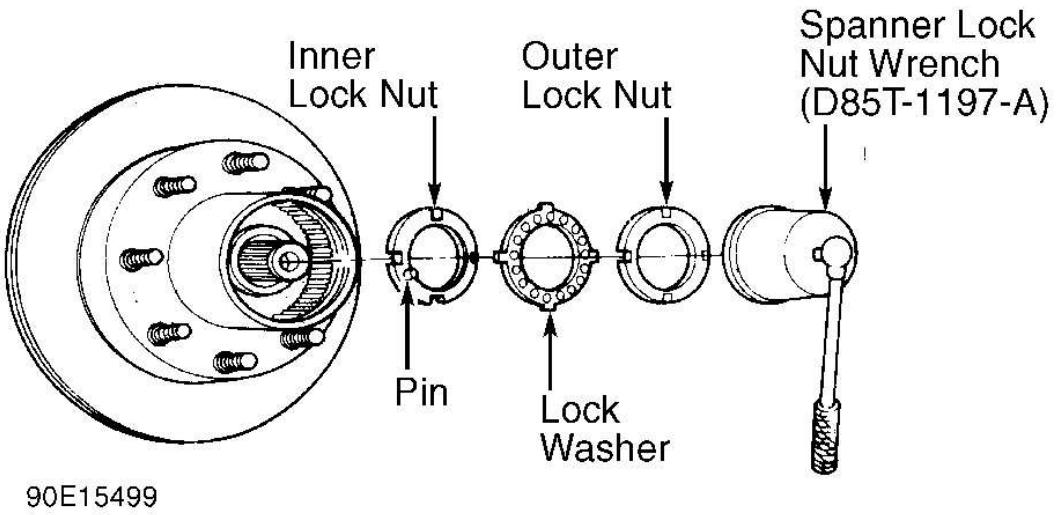


Fig. 15: Removing Outer Lock Nut (F150 W/Automatic Locking Hubs, F250 Heavy-Duty & F350 W/Manual Locking Hubs)
Courtesy of FORD MOTOR CO.

Installation

1. On F150 with automatic locking hubs and on F250 Heavy-Duty and F350 with manual locking hubs, install rotor and outer wheel bearing. Install inner lock nut. While rotating disc back and forth, seat bearing by using Spanner Lock Nut Wrench (D85T-1197-A) to tighten inner lock nut to 50 ft. lbs. (68 N.m). Back off inner lock nut, and retighten to 30-40 ft. lbs. (41-54 N.m).
2. Install lock washer so key is in spindle groove. Tighten inner lock nut to engage lock nut pin in nearest lock washer hole. Install outer lock nut, and tighten to 160-205 ft. lbs. (217-278 N.m). Spindle end play should be less than .004" (.10 mm).
3. On F150/250 Light-Duty with manual locking hubs, install rotor and outer wheel bearing. Install adjusting nut. While rotating disc back and forth, seat bearing by using Spanner Lock Nut Wrench (T86T-1197-A) to tighten adjusting nut to 70 ft. lbs. (95 N.m).
4. Back off adjusting nut 90 degrees, and retighten to 15-20 ft. lbs. (20-27 N.m). Spindle end play should be zero. To install remaining hub body components, reverse removal procedure. See **Fig. 13** .

NOTE: Hub nuts are right-hand thread on both sides. Each hub is stamped RH to show thread direction. DO NOT use power impact tools to remove or install hub nuts. Hub nuts will ratchet unless Hub Wrench (T88T-4252-A) is used for removal and installation.

Removal (F Super Duty)

1. Set parking brake, and loosen axle shaft bolts. Raise rear of vehicle, and place on jack stands. Release

parking brake. Remove and discard axle shaft attaching bolts and washers. Use heavy-duty wheel dolly to lift wheel, taking weight off wheel bearings.

2. If dolly is not available, remove wheel assembly. Remove axle shaft, and discard gasket. Remove disc brake caliper. See **DISC BRAKE CALIPERS & PADS** under REMOVAL & INSTALLATION. Using Hub Wrench (T88T-4252-A), remove wheel bearing hub nut. See **Fig. 16** . Remove outer bearing. Remove hub and rotor assembly. To remove rotor from hub, remove 10 External Torx (E-18) head machine screws.

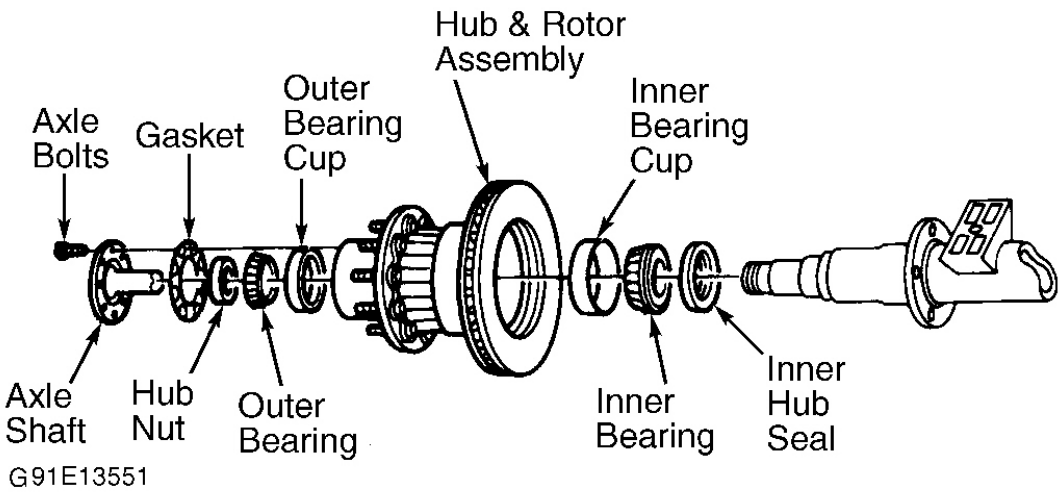


Fig. 16: Removing Hub & Rotor Assembly (F Super Duty)
Courtesy of FORD MOTOR CO.

Installation

1. Put electrical tape over axle housing spindle to prevent damage. Apply sealant to hub-to-rotor screws. Place hub and rotor assembly onto axle housing spindle. Remove electrical tape. Install outer wheel bearing race and bearing. Install hub nut, ensuring hub nut tab is in hub tab slot before starting threads.
2. Use Hub Wrench (T88T-4252-A) to tighten hub nut. Push inward on socket to prevent ratcheting action of hub nut. Rotate hub while tightening hub nut to 50-60 ft. lbs. (68-81 N.m). Back off hub nut 90 degrees, and retighten to 30-40 ft. lbs. (41-54 N.m). End play of hub and rotor should be zero. To install remaining hub body components, reverse removal procedure.

BRAKE SHOES R & I

Removal (F150)

1. Remove wheel assembly and drum. If brake drum is difficult to remove, use a narrow screwdriver and brake adjustment tool to retract brake shoes. Place a wheel cylinder clamp over ends of wheel cylinder. Disengage adjusting lever from adjusting screw by pulling backward on lever cable. See **Fig. 17** .

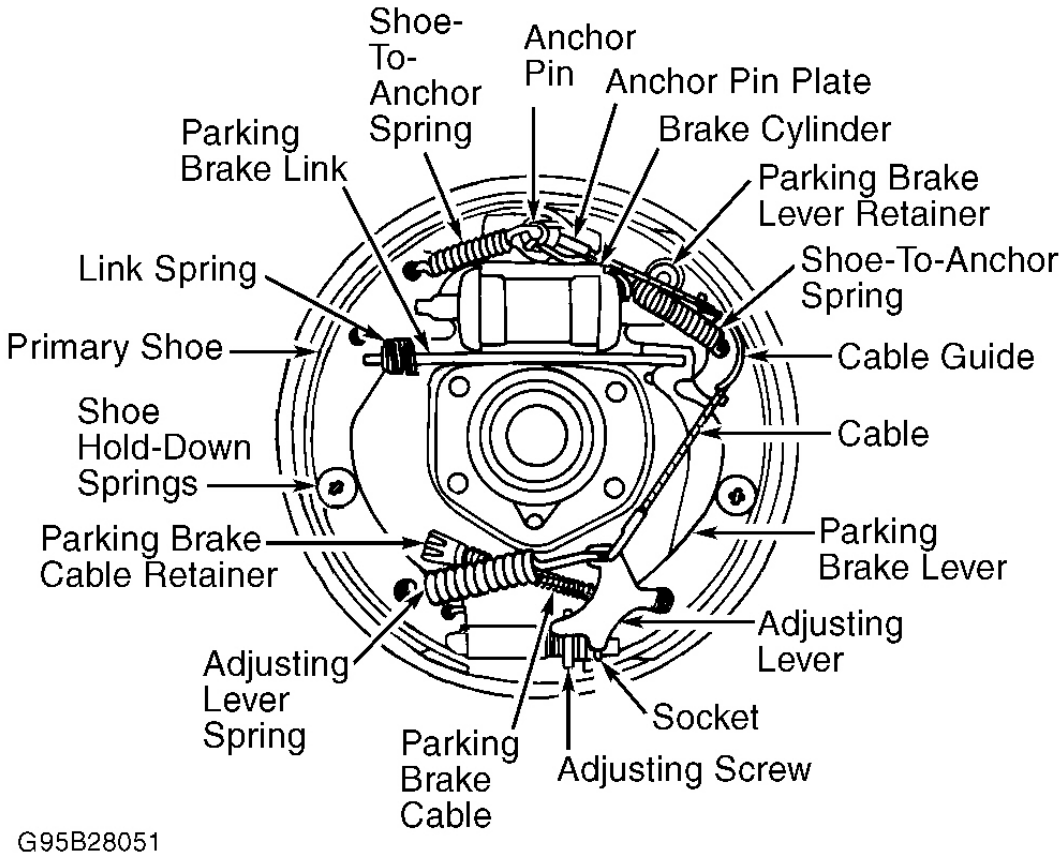


Fig. 17: Examining Rear Brake Assemblies (F150)
Courtesy of FORD MOTOR CO.

2. Move outboard side of adjusting screw upward, and back off pivot nut as far as possible. Pull adjusting lever, cable and adjusting spring down and toward rear to unhook pivot hook from large hole in secondary shoe. DO NOT pry pivot hook from hole.
3. Remove adjusting spring and adjusting lever. Remove secondary shoe-to-anchor spring. Remove primary shoe-to-anchor spring. Unhook cable anchor, and remove anchor pin plate.
4. Remove cable guide, shoe hold-down springs, brake shoes, adjusting screw, pivot nut and socket. Remove parking brake link spring and link. Note color and position of springs for reassembly.
5. Disconnect parking brake cable from lever. Remove secondary shoe. Disassemble parking brake lever from shoe by removing lever retainer and spring washer.

Removal (F250/350)

Remove wheel assembly and brake drum. If brake drum is difficult to remove, use a narrow screwdriver and brake adjustment tool to retract brake shoes. Remove parking brake lever assembly retaining bolt from backing plate. Remove parking brake lever assembly. See **Fig. 18** . Remove adjusting cable assembly from anchor pin,

cable guide and adjusting lever. Remove brake shoe return springs, hold-down springs and brake shoes. Remove and disassemble adjusting screw assembly.

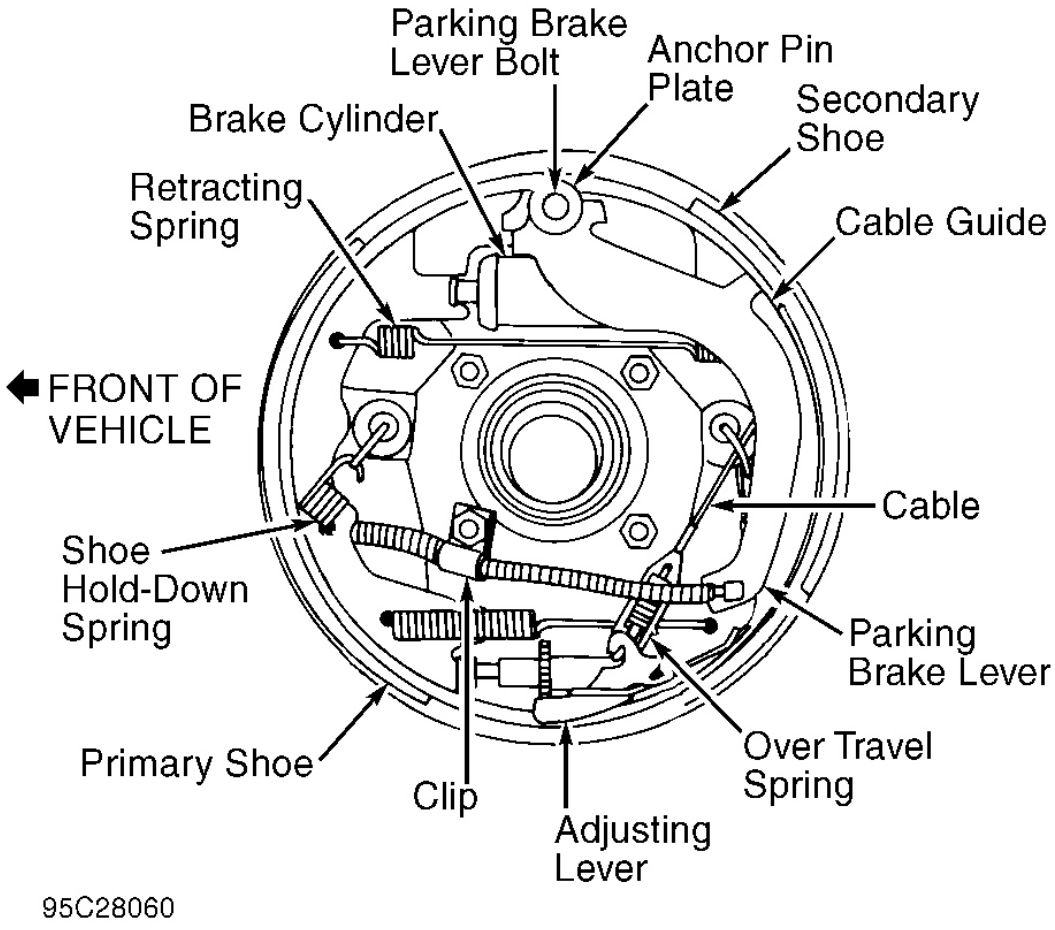


Fig. 18: Examining Brake Assemblies (F250/350)
Courtesy of FORD MOTOR CO.

Installation

1. Clean and sand brake shoe contact points on backing plate. Apply a light coating of lithium base grease to contact points. Lubricate adjusting cable eye and anchor pin area. Lubricate adjusting screw, pivot and socket. Ensure brake shoe adjusting lever cable is positioned in groove and not between cable guide and shoe web.
2. Ensure cable end is not cocked or binding on anchor pin when installed. All parts should be flat on anchor pin. Ensure brake adjuster screw is installed in same location from which it was removed.
3. Brake adjusting screw nuts can also be distinguished by number lines machined around body or nut. One line indicates left-hand nut and 2 lines indicates right-hand nut. Another way to identify adjusters is to

check thread pitch. Right side adjuster has right-hand threads while left side adjuster has left-hand threads. To install, reverse removal procedure.

DISC BRAKE CALIPERS & PADS

NOTE: On rear brake calipers DO NOT remove caliper guide pin or caliper guide pin boots unless a problem is suspected. Caliper guide pins are meant to be sealed for life and are not repairable.

Removal

1. To prevent master cylinder overflow when caliper piston is depressed, remove and discard some brake fluid from master cylinder. Raise vehicle, and support with safety stands. Remove front wheel assembly. Place a large "C" clamp on caliper. Tighten clamp to bottom piston in cylinder bore. Remove clamp.
2. Remove dirt around caliper pin tabs. Tap upper caliper pin toward inboard side of vehicle until pin tabs touch spindle face. Insert screwdriver into slot provided behind pin tabs on inboard side of pin. Using pliers, compress end of pin while using screwdriver to pry until tabs slip into spindle groove.
3. Place a 7/16" diameter punch on end of pin, and drive caliper pin out of caliper slide groove. Repeat procedure for lower pin. Remove caliper from rotor. Remove outer brake pad. Compress anti-rattle spring clip, and remove inner brake pad. Support caliper aside.
4. On F150, replace pads if lining is less than .06" (1.5 mm) above backing plate at any point. On F250/350 and F Super Duty, replace pads if lining thickness is less than .03" (.8 mm) above backing plate at any point.

CAUTION: During installation, DO NOT tap caliper pin too far into spindle groove. If this happens, tap pin in other direction until tabs snap back into place. Tabs on each end of caliper pin must be free to catch on spindle flanks.

Installation

Lubricate caliper pin and pad contact surfaces. Use "C" clamp to push caliper piston into piston bore until it bottoms out. To install, reverse removal procedure. Bleed air from brake system (if necessary).

MASTER CYLINDER

Removal & Installation

1. On F Super Duty, with engine off, pump brake pedal several times to discharge Hydro-Boost accumulator. On all others, disconnect brake warning light indicator wire from indicator switch. With engine off, depress brake pedal to bleed vacuum from brake booster.
2. On all models, disconnect brakelines at master cylinder. Remove nuts retaining master cylinder to brake booster. Remove master cylinder. To install, reverse removal procedure. Bleed brake system. See **BLEEDING BRAKE SYSTEM** .

STOPLIGHT SWITCH

Removal

Disconnect wire harness from connector. Remove pin. Slide stoplight switch, brake pedal rod, spacer and bushing away from brake pedal arm. Since stoplight switch side plate nearest brake pedal arm is slotted, brake pedal rod and one spacer from pedal arm do not need removal. See **Fig. 19** .

Installation

Position switch so slotted side is facing pedal arm. Swing switch up and down, trapping brake pedal rod between switch side plates. Push switch and rod firmly against pedal arm. Install remaining parts, and check stoplight operation.

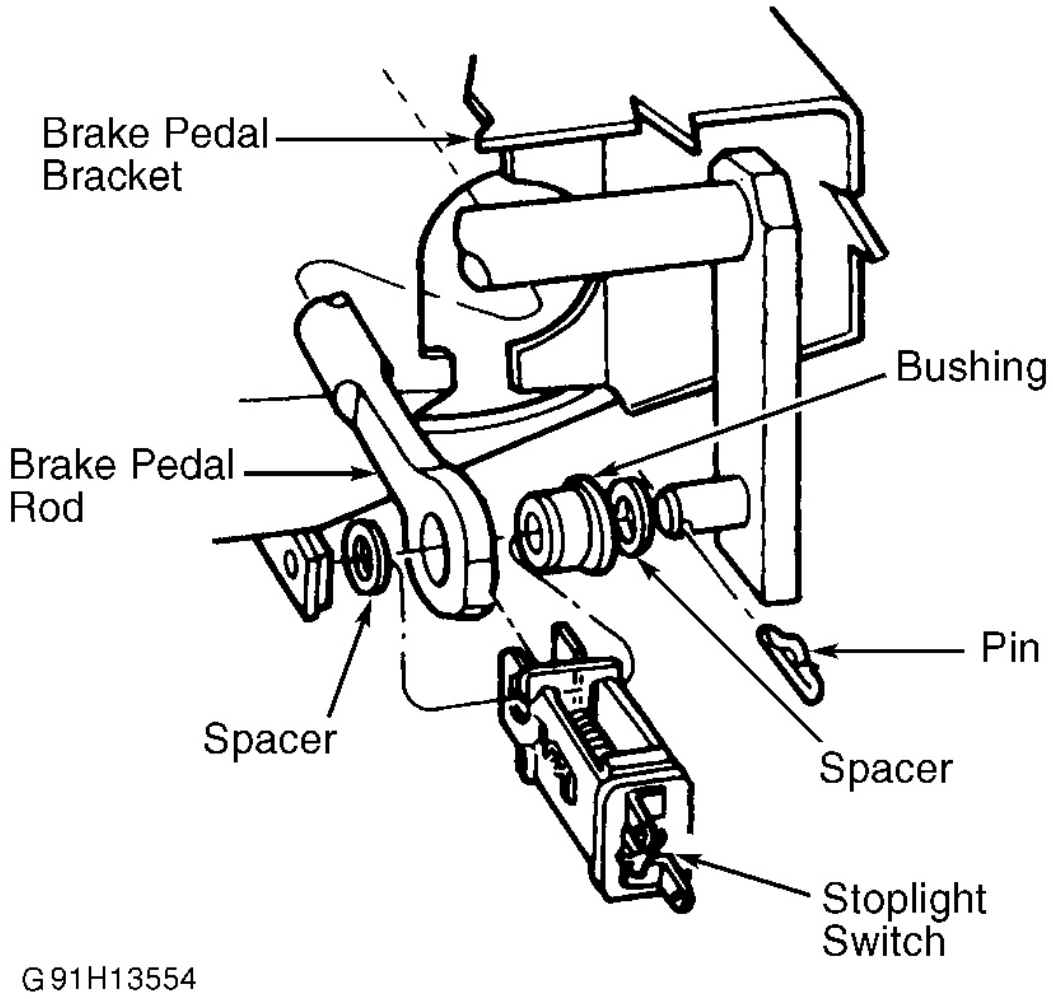


Fig. 19: Removing Stoplight Switch
Courtesy of FORD MOTOR CO.

TRANSMISSION MOUNTED PARKING BRAKE R & I

Removal (F Super Duty)

1. Shift transmission into gear, and disconnect parking brake cable. Pedal or lever must be in fully released position. Set vehicle on jack stands. Disconnect speedometer cable. Remove bolts attaching drive shaft to parking brake assembly output flange.
2. Remove drive shaft, and secure aside. Remove bolts attaching parking brake assembly to transmission extension housing. See **Fig. 20** . Remove assembly from transmission.

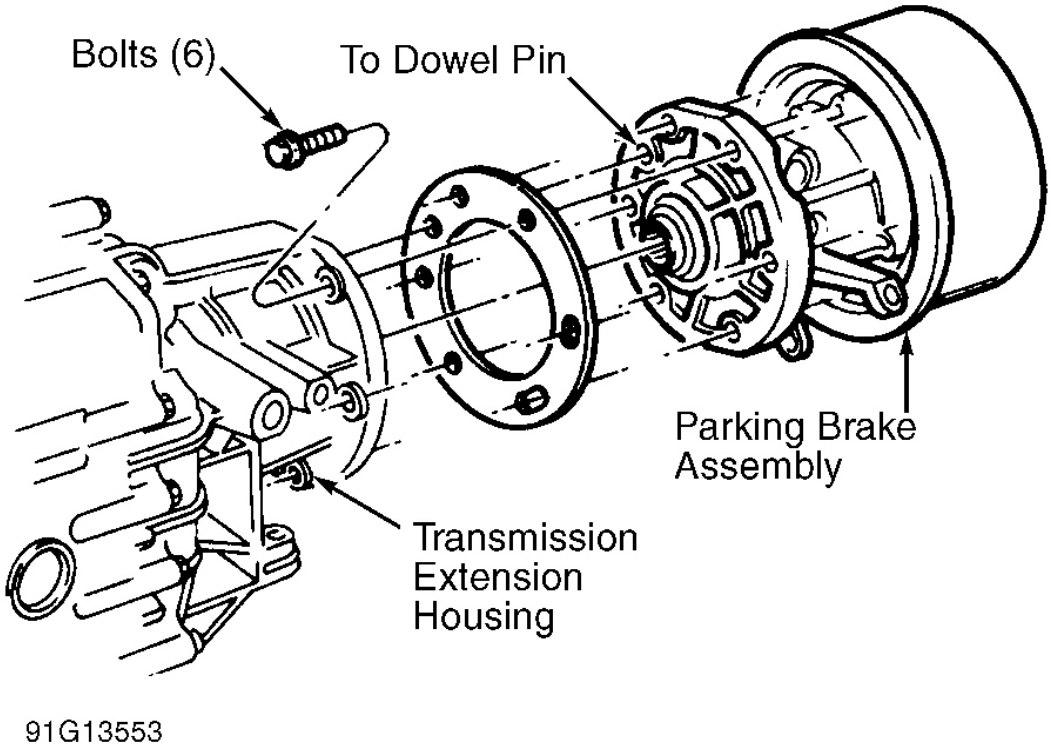


Fig. 20: Removing Transmission Mounted Parking Brake (F Super Duty)
Courtesy of FORD MOTOR CO.

Installation

Using 6 NEW bolts, attach parking brake assembly to transmission extension housing. Fill parking brake assembly to bottom of fill hole with Motorcraft MERCON multipurpose automatic transmission fluid. To complete installation, reverse removal procedure.

VACUUM POWER BOOSTER

Removal & Installation (Except F Super Duty)

1)Disconnect stoplight switch to prevent battery discharge. Support master cylinder. Remove vacuum hose from booster check valve. Remove master cylinder mount nuts. Pull master cylinder away from booster to allow booster removal.

2) From inside cab, remove cotter pin holding stoplight switch to brake pedal arm. See **Fig. 21** . Remove bushing and spacers. Remove booster mount nuts, and then remove booster. To install, reverse removal procedure.

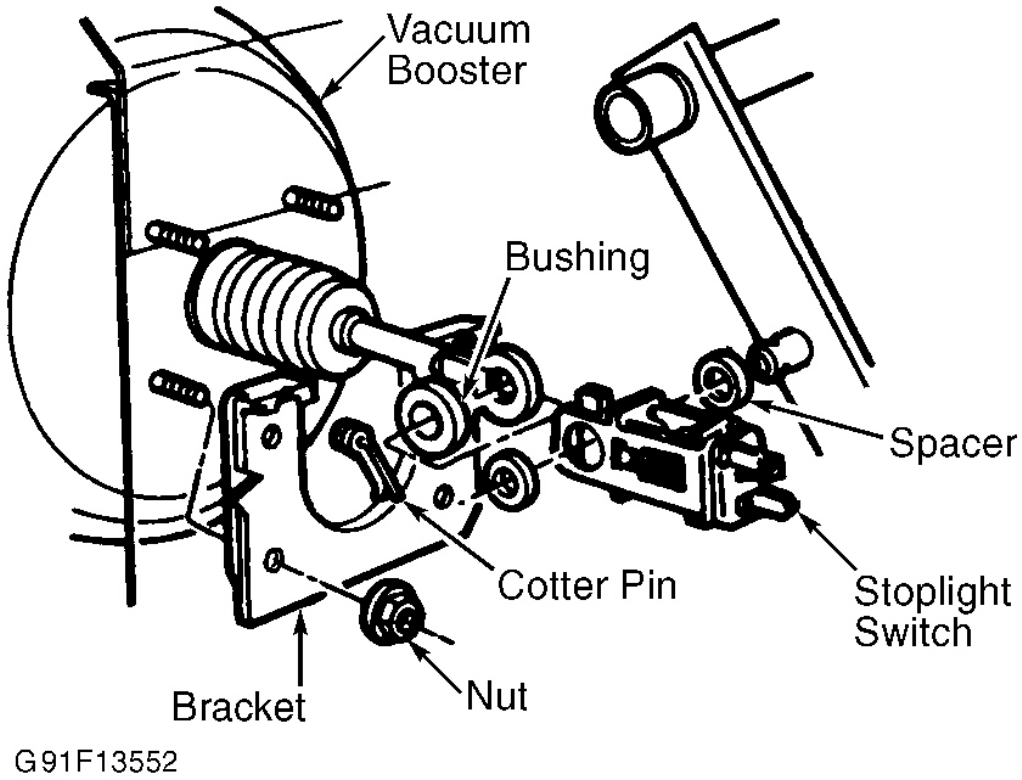


Fig. 21: Removing Vacuum Power Booster (Typical)
Courtesy of FORD MOTOR CO.

WHEEL CYLINDERS

Removal & Installation

Remove wheel assembly, drum and brake shoes. Remove wheel cylinder connecting links. Disconnect hydraulic brakeline from cylinder. Remove wheel cylinder retaining bolts and lock washers. Remove wheel cylinder from backing plate. To install, reverse removal procedure. Adjust brakes, and bleed hydraulic system. See **BLEEDING BRAKE SYSTEM** .

OVERHAUL

DISC BRAKE CALIPER

NOTE: Use same disassembly procedures for single and dual piston calipers.

Disassembly

1. Remove caliper. See **DISC BRAKE CALIPERS & PADS** under REMOVAL & INSTALLATION. Drain fluid from caliper. Secure caliper in a vise. Place a block of wood between caliper and piston(s). See **Fig. 22** . Apply low air pressure to brake hose inlet. Air pressure forces piston(s) outward.

WARNING: DO NOT place fingers between wood and piston as piston leaves caliper.

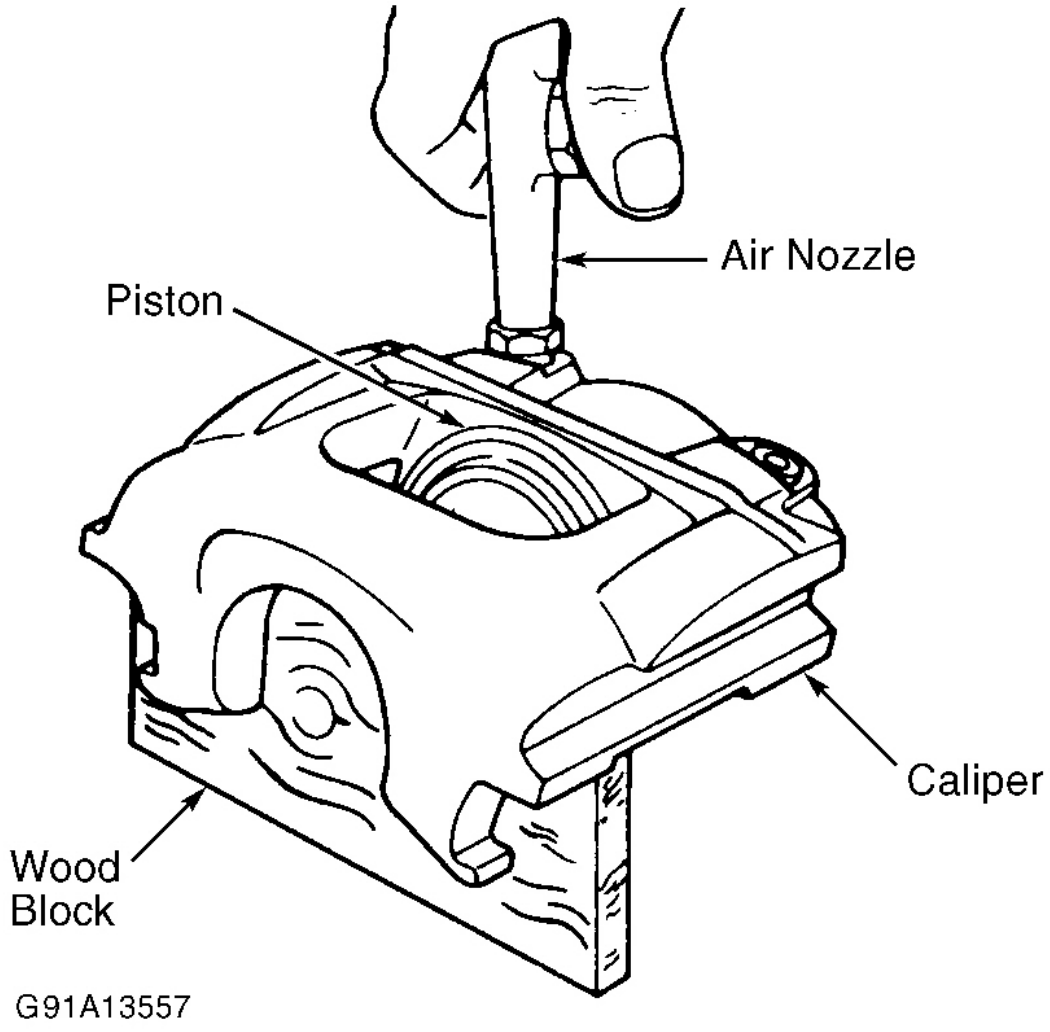


Fig. 22: Removing Caliper Piston
Courtesy of FORD MOTOR CO.

2. If piston is jammed or seized and does not come out easily, use a brass hammer to lightly tap caliper while applying air pressure. DO NOT pry piston from bore. After piston comes out, remove seal and dust boot. Discard seals and boots.

Cleaning & Inspection

1. Carefully clean rust and corrosion from caliper machined surfaces using a wire brush. DO NOT use wire brush in caliper bores. Clean all components with isopropyl alcohol and dry with compressed air.
2. Inspect caliper bore, seal grooves and boot grooves for wear or damage. If bores are scored, corroded or worn, replace caliper. Replace anti-rattle clip, caliper support spring and key.

Reassembly

1. Lubricate NEW piston seal with clean brake fluid, and install in caliper bore groove. Lubricate caliper bore with clean brake fluid. Coat piston and outside beads of dust boot with clean brake fluid.
2. Push piston through boot until boot is around bottom (closed end) of piston. See **Fig. 23** and **Fig. 24** . Position piston and boot directly over caliper bore. Spread dust boot over piston as it is installed.
3. With bead seated in groove, carefully press straight down on piston until it bottoms in caliper bore. DO NOT cock or jam piston in caliper bore. If necessary, use a "C" clamp and a block of wood to bottom piston in caliper bore.

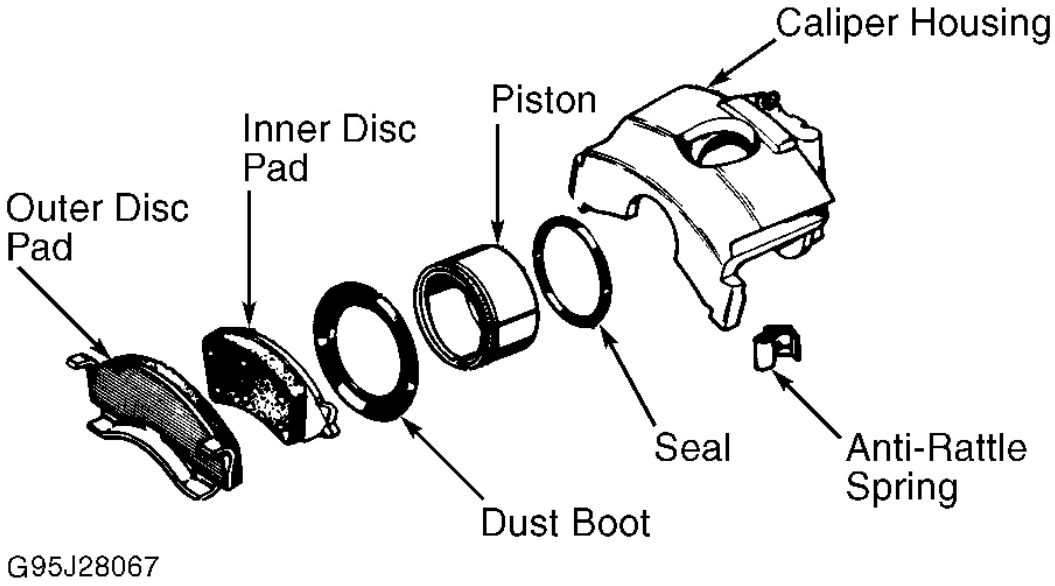


Fig. 23: Exploded View Of Single Piston Caliper (F150 Shown; Others Models Are Similar)
Courtesy of FORD MOTOR CO.

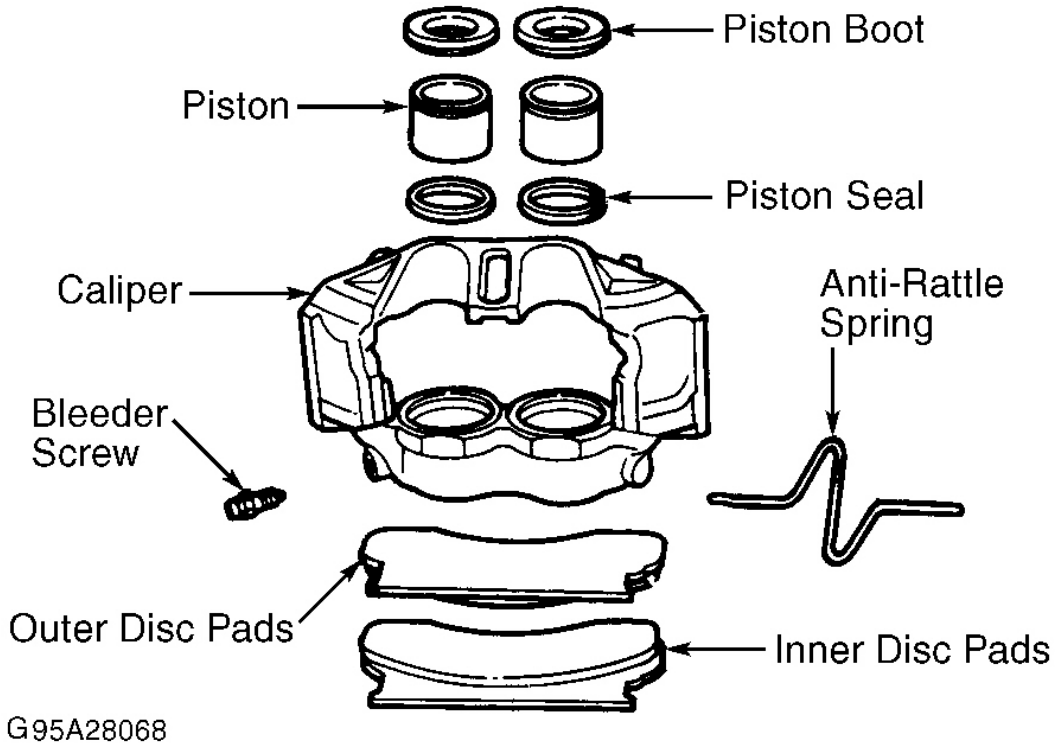


Fig. 24: Exploded View Of Dual Piston Caliper (E250/350 & F250/350; F Super Duty Similar)
Courtesy of FORD MOTOR CO.

MASTER CYLINDER

Disassembly

1. Remove master cylinder. Clean outside of master cylinder. Remove filler cap and diaphragm. Drain any remaining fluid from cylinder. On dual master cylinder, remove stop bolt from bottom of master cylinder.
2. On all models, remove proportioning valve (if equipped). Depress pinion, and remove snap ring from end of master cylinder bore. See **Fig. 25** . Remove piston assembly from cylinder bore. Carefully apply air pressure in outlet port of cylinder to remove remaining piston assembly from bore.

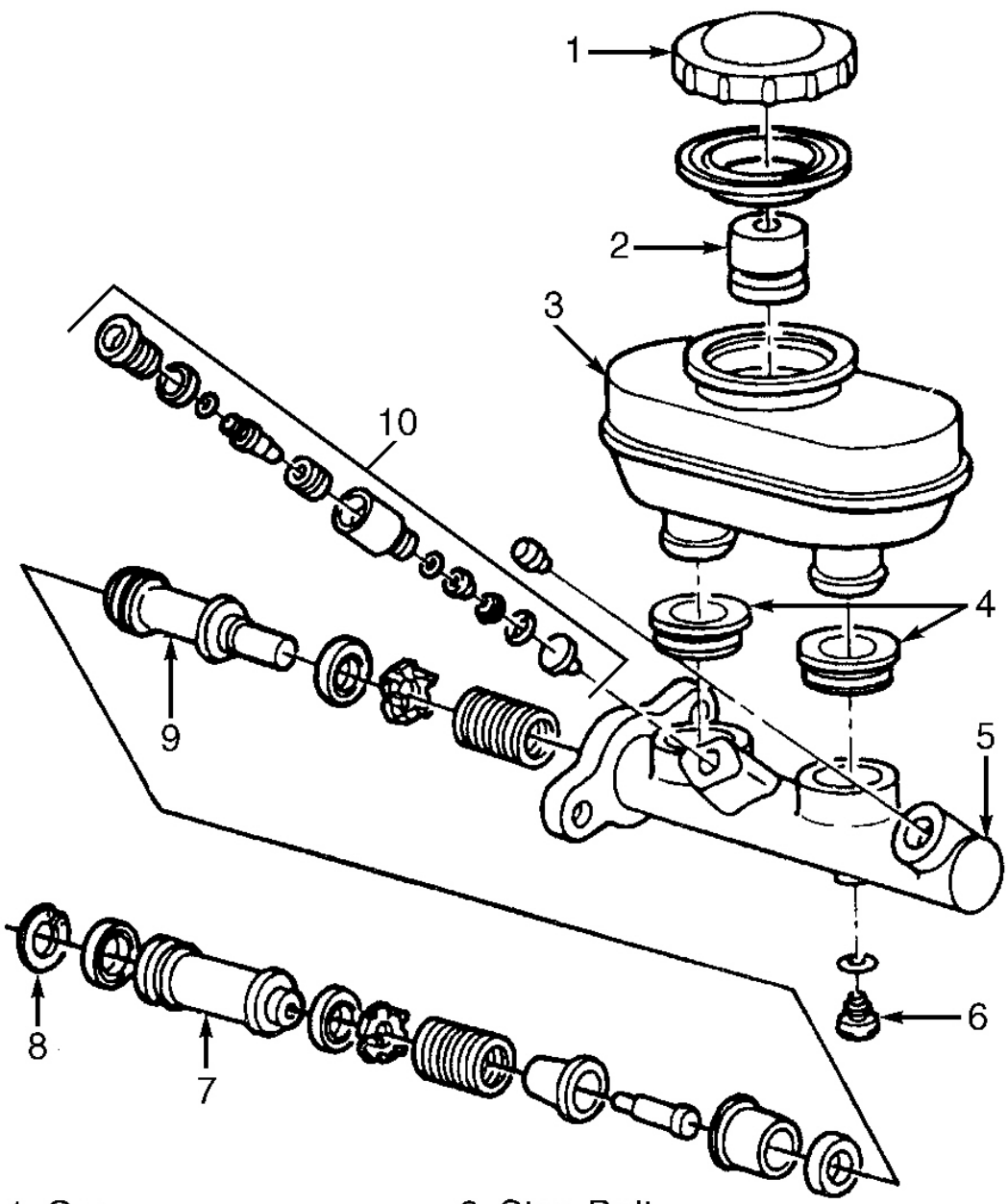
NOTE: Manufacturer does not recommend honing of cylinder bore.

Inspection

Clean all parts with isopropyl alcohol and blow dry with compressed air. Ensure all ports and vents are open and free of foreign matter. Inspect master cylinder bore and all parts for excessive wear or damage. If bore is damaged, replace master cylinder.

Reassembly

Lubricate all components, including cylinder bore, with clean brake fluid. Install NEW grommets and plastic reservoir. Carefully insert piston assembly into master cylinder bore. If cylinder is equipped with piston stop pin, depress piston and install pin. Install other piston assembly into cylinder. Depress piston and install snap ring in groove.



1. Cap
2. Float
3. Reservoir
4. Grommets
5. Master Cylinder
6. Stop Bolt
7. Primary Piston
8. Snap Ring
9. Secondary Piston
10. Fluid Control Valve

95H28073

Fig. 25: Exploded View Of Master Cylinder Assembly

Courtesy of FORD MOTOR CO.

ROTOR

Lateral Runout (Front & Rear Disc)

1. On front disc brakes, tighten wheel bearing adjusting nut to eliminate bearing end play. Ensure rotor can be rotated by hand. When checking runout on rear disc brakes (F Super Duty only), make sure rear axle bearings are adjusted properly.
2. Once adjusted, DO NOT change rear bearing setting. Attach dial indicator to suspension, with indicator tip set 1" from outer edge of rotor face. Set dial indicator to zero, and slowly turn rotor. Take reading within a 6.00" (152.4 mm) radius on rotor. Runout must not exceed specification. See **DISC BRAKE SPECIFICATIONS** . Resurface or replace rotor as required.

Parallelism

1. Parallelism can be tested by 2 testing procedures. Using a micrometer, measure rotor thickness at 12 points, approximately 30 degrees apart and 1.00" (25.4 mm) from outer edge of rotor. Difference must not exceed specification. See **DISC BRAKE SPECIFICATIONS** . Resurface or replace rotor as required.
2. Mount rotor on a brake lathe. Attach 2 dial indicators, one on each side of rotor, with tip of indicators contacting rubbing surface of rotor directly opposite each other and 1.00" (25.4 mm) from outer edge of rotor. Zero both indicators, and rotate rotor. Note indicator reading. If reading exceeds specification, resurface or replace as required. See **DISC BRAKE SPECIFICATIONS** tables.

Discard Thickness

Using micrometer, measure thickness of rotor. Disc brake rotors have a minimum wear thickness. Minimum wear thickness is not refinishing dimension. See **DISC BRAKE SPECIFICATIONS** .

CAUTION: Never refinish a rotor down to minimum wear or discard thickness.

Maximum Allowable Stock Removal

1. To measure maximum allowable stock remaining for refinishing on inner rotor face, use Disc Rotor Surface Gauge And Ball (T71P-1102-A). See **Fig. 26** . Remove inner grease seal and bearing from rotor. Wipe inner and outer bearing cups clean.

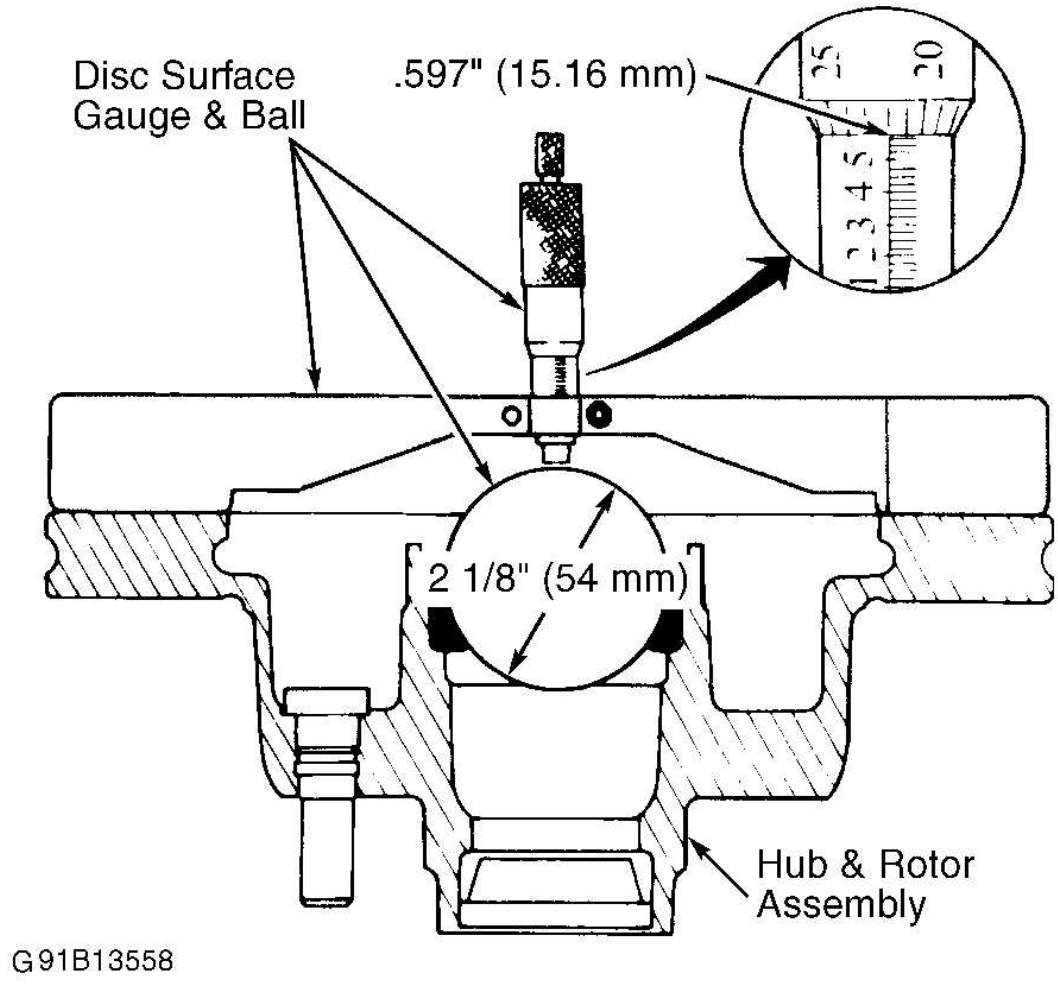


Fig. 26: Measuring Maximum Allowable Refinishing Stock
Courtesy of FORD MOTOR CO.

2. Carefully place gauge ball in inner bearing cup. DO NOT drop. Set micrometer at base line setting number. Using a 2 1/8" (54 mm) gauge ball, base line setting is .256" (6.50 mm). Position micrometer gauge bar on inner rotor face with micrometer centered over gauge ball.
3. To measure distance between micrometer base line setting and gauge ball, turn micrometer down to touch top of ball. Calculate difference between reading and base line setting; difference is maximum allowable stock which can be removed from inner rotor face.
4. When micrometer is set at base line setting and micrometer end touches top of ball, no additional material may be removed from rotor. If micrometer must be retracted from base line setting to allow gauge bar legs to rest on rotor face, rotor has been refinished beyond allowable limit. Replace rotor.

TRANSMISSION MOUNTED PARKING BRAKE

Disassembly (F Super Duty)

1. Remove parking brake assembly. See **TRANSMISSION MOUNTED PARKING BRAKE R & I** . Mount parking brake assembly in vise using brass jaw protectors. Using Lock Nut Socket (T70T-4252-D), remove lock nut from mainshaft. Using a 3-jaw puller or a press with adapter, remove mainshaft, brake drum and output flange. See **Fig. 27** .

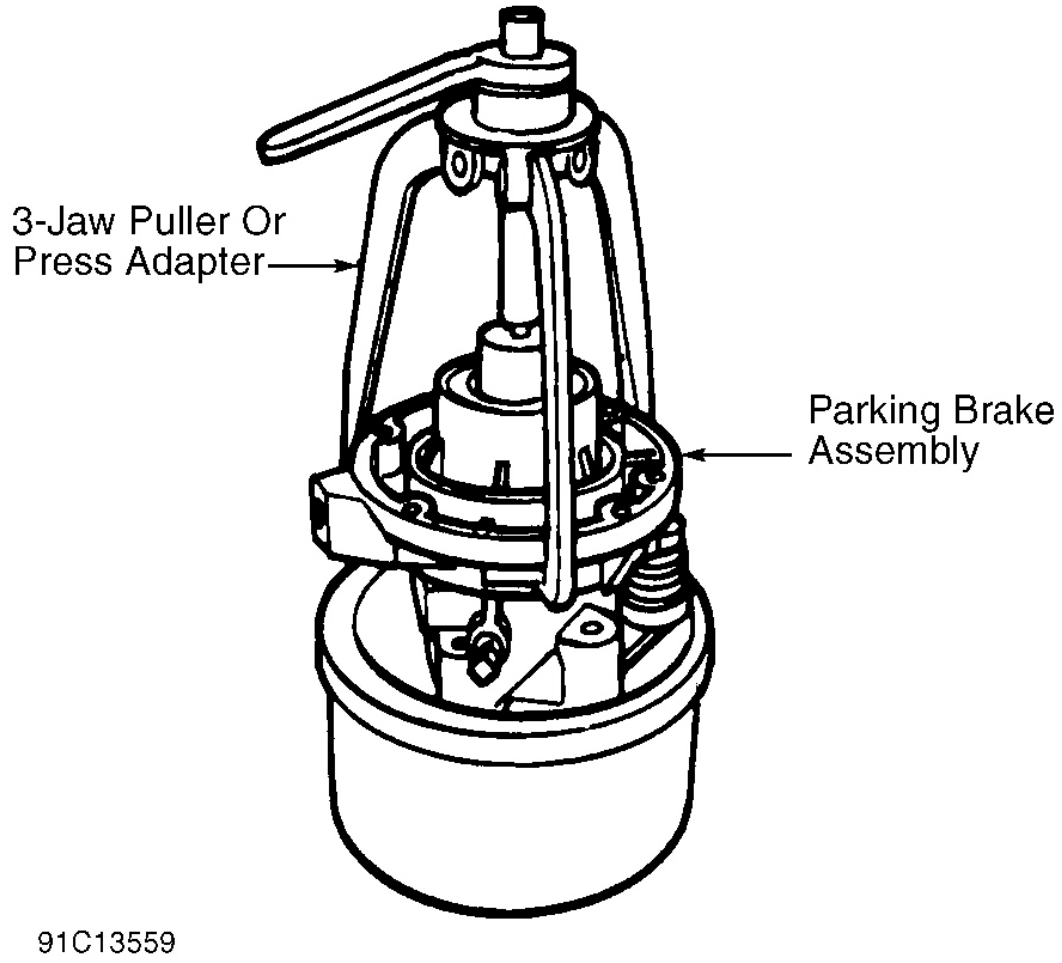


Fig. 27: Removing Lock Nut, Mainshaft, Brake Drum & Output Flange (F Super Duty)
Courtesy of FORD MOTOR CO.

2. Remove snap ring holding speedometer drive gear onto shaft, and then remove speedometer drive gear. Using Puller (D80L-1002-L) with Bearing Cone Remover (D79L-4621-A) and Step Plate (D80L-630-6), remove inner bearing cone from mainshaft.
3. Remove parking brake assembly from vise. Turn brake assembly over, and mount threaded end of mainshaft in vise using brass jaw protectors. Remove 4 nuts attaching output flange and brake drum to

output shaft. Remove brake drum and flange from output shaft.

NOTE: Drum, flange and mainshaft are balanced as a unit. They must be marked to ensure parts are assembled in same position.

4. Using Bearing Cup Puller (T77F-1102-A), remove output shaft oil seal, spacer, "O" ring, bearing and bearing cup from input shaft end of case. Remove splash shield and brake assembly from case. See **Fig. 28** . Remove brake actuating lever and lever spring from case. Using Bearing Cup Puller (T77F-1102-A), remove outer bearing cup. Unscrew and remove vent from case.

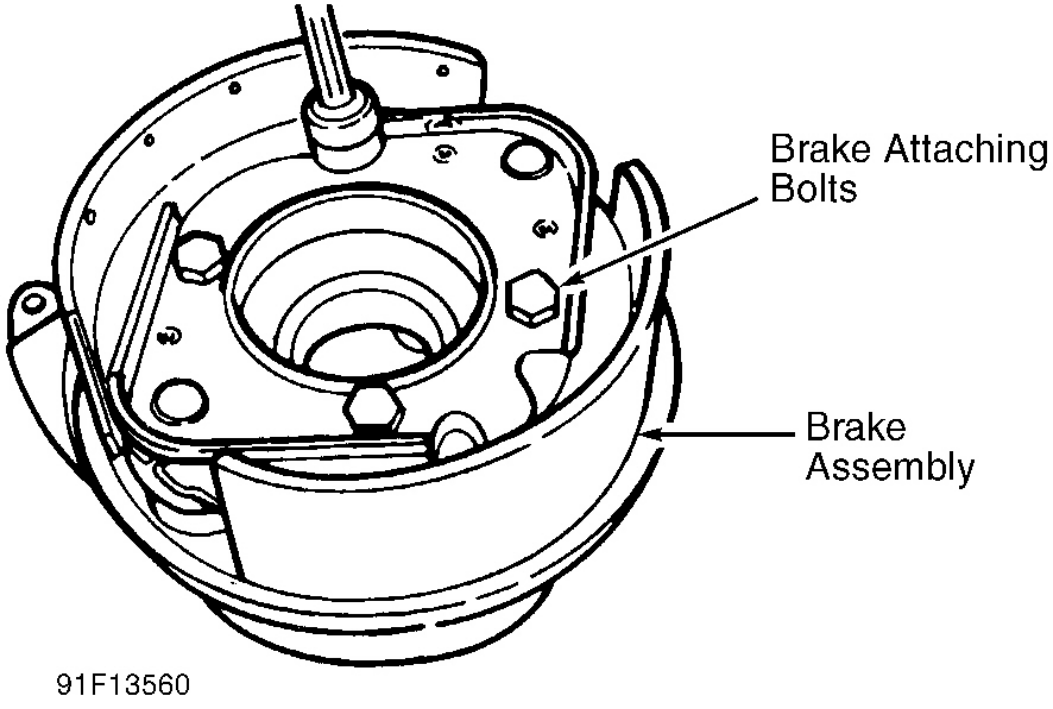


Fig. 28: Removing Splash Shield & Brake Assembly (F Super Duty)
Courtesy of FORD MOTOR CO.

Reassembly

1. Using Bearing Cup Installer (T88T-2598-E), install bearing cup into case. Install inner bearing. Apply a light coat of sealer to outer edge of oil seal. Place oil seal in case with sealing lip facing inward. Press seal into case flush with bore surface using Seal Installer (T88T-2598-C).
2. Install actuating lever spring on boss in case. See **Fig. 29** . Apply a light coat of lithium base grease to actuating lever ball. Install ball end of lever into hole in boss through coiled end of spring. Position backing plate and brake assembly onto case.

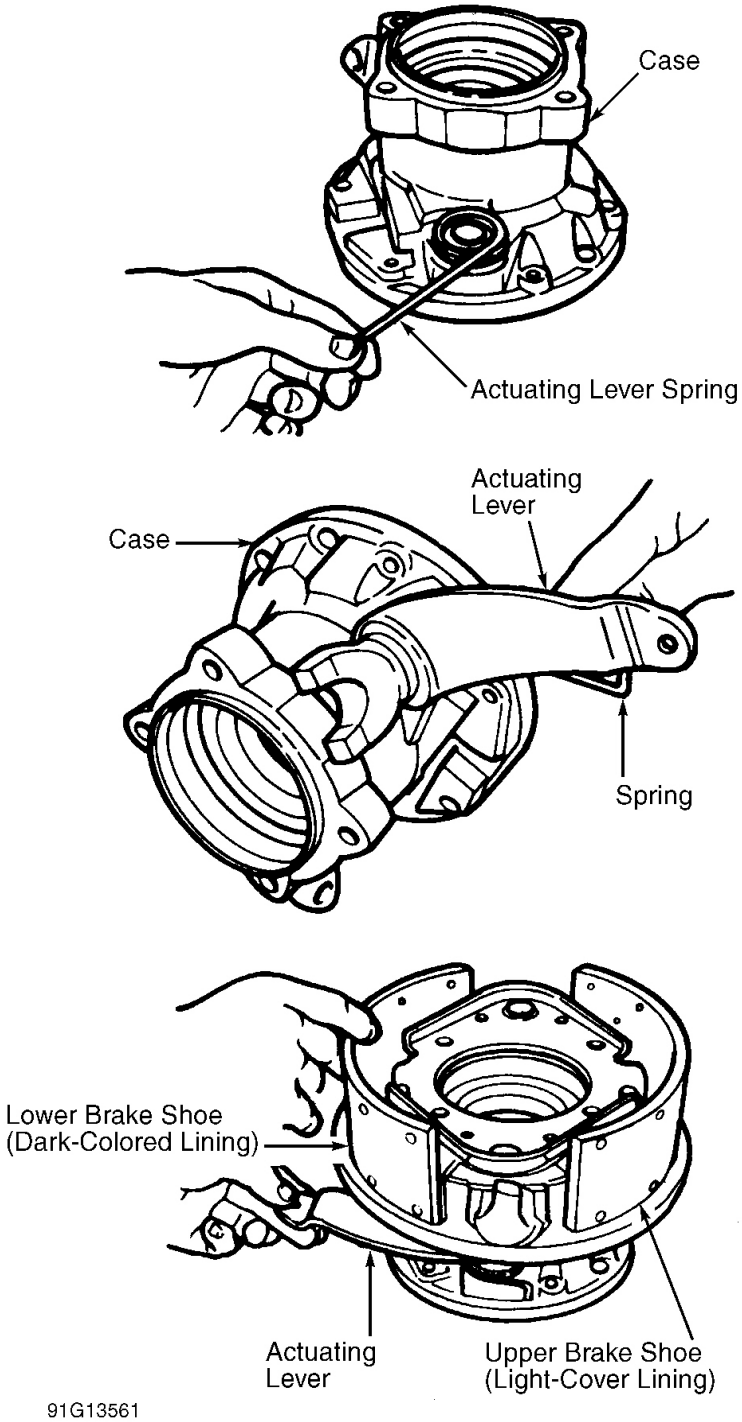


Fig. 29: Installing Lever Spring, Actuating Lever, Backing Plate & Brake Assembly (F Super Duty) Courtesy of FORD MOTOR CO.

3. Insert actuating lever (cam end) into position in brake assembly. Install and tighten brake assembly mount

bolts. Attach return spring to actuating lever, and bend long end of spring to snap over lever. Place mainshaft with flanged end up in vise using brass jaw protectors.

4. Install brake drum and output flange onto flanged end of mainshaft. Install output flange onto brake drum, aligning marks made during disassembly. Proper installation maintains proper component balance. Install and tighten output flange mount nuts. Remove mainshaft and drum assembly from vise. Turn assembly over, and clamp in vise again.
5. Install case onto mainshaft, guiding shaft through oil seal and bearing. Using Bearing Installer (T88T-2598-F), seat output bearing onto mainshaft. Install speedometer drive gear and snap ring onto mainshaft. Using Bearing Cup Installer (T88T-2598-D), install input bearing cup into housing.

NOTE: Mainshaft shim determines end play. Shims are available in thicknesses increments of .0019" (.048 mm).

6. Install shim on mainshaft. Install inner bearing onto mainshaft. To measure end play, install bearing spacer, without "O" ring, onto mainshaft. Clamp case assembly and mainshaft in vise. Use Lock Nut Socket (T70T-4252-D) to screw hex nut onto mainshaft.
7. Mount a dial indicator between mainshaft and case. While rotating case assembly on mainshaft to center bearings, apply up and down pressure to take end play reading. End play should be .0019-.0039" (.048-.099 mm). Select proper shim to reach specified end play.
8. Coat outer surface of NEW input oil seal with sealant. Install oil seal into case with sealing lip facing inward. Press seal in until it is fully seated. Install a NEW "O" ring in notch of bearing spacer. See **Fig. 30** . Install "O" ring and bearing spacer onto mainshaft until spacer butts against input bearing.

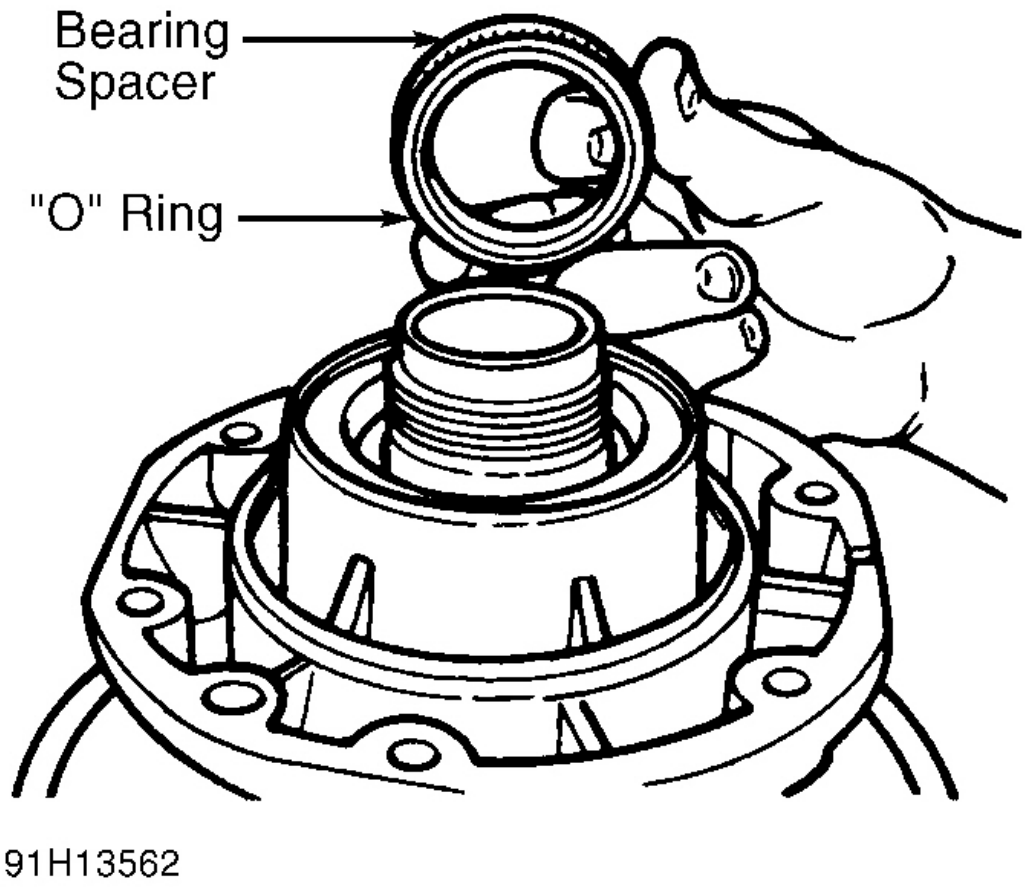


Fig. 30: Installing "O" Ring & Bearing Spacer (F Super Duty)
Courtesy of FORD MOTOR CO.

9. Use Lock Nut Socket (T70T-4252-D) to install a NEW lock nut onto shaft. Screw vent into case. Remove parking brake assembly from vise. Install onto vehicle. Fill case with Motorcraft MERCON multipurpose automatic transmission fluid. Fill to bottom of fill hole. To install remaining components, reverse removal procedure.

WHEEL CYLINDERS

Disassembly

With wheel cylinder removed from vehicle, remove rubber boots from ends of cylinders. Remove pistons, piston cups and return spring from cylinder. Remove bleeder screw. Inspect cylinder bore for damage.

Reassembly

If cylinder bore is lightly pitted or scratched, hone or replace as necessary. DO NOT hone cylinders more than .003" (.08 mm). Coat all parts with clean brake fluid. To assemble, reverse disassembly procedure. Clamp brake cylinder pistons against ends of cylinder.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Backing Plate-To-Axle Nuts/Bolt	
F150	20-40 (27-54)
F250/350	50-70 (68-95)
Caliper Bleeder Screws	13-18 (17-24)
Caliper Hose Flow Bolt	22-29 (30-39)
Front Brake Hose Attachment	22-30 (30-40)
Front Caliper Mounting Bolts	
F150	23-26 (30-36)
F250/350	126-169 (170-230)
Front Caliper Pins (F Super Duty)	74-89 (100-120)
Front Rotor Shield	
F150/250/350	7-10 (9-13)
F Super Duty	5-12 (7-16)
Master Cylinder Brake Line Nuts	
Rear	11-14 (15-19)
Front	16-21 (21-28)
Master Cylinder-To-Hydro Boost Nuts	15-21 (21-28)
Parking Brake Cable Bracket Bolt	51-67 (68-92)
Parking Brake Case Bolts	25-42 (34-57)
Rotor-To-Rear Hub Bolts	84-112 (113-153)
Vacuum Booster-To-Firewall Nuts	15-21 (21-28)
Wheel Lug Nuts	(1) 83-112 (112-152)

(1) Failure to retighten wheel lug nuts at 500 miles after installation, may result in wheel coming loose and loss of vehicle control.

DISC BRAKE SPECIFICATIONS

FRONT DISC BRAKE SPECIFICATIONS

Application	In. (mm)
Lateral Runout	
F150 Integral (4WD)	.003 (.08)
F150 2-Piece (4WD)	.005 (.13)
F150 (2WD)	.003 (.08)

F250/350 (2WD) Integral (Single Rear Wheels)	.003 (.08)
F350 (2WD) 2-Piece (Dual Rear Wheels)	.005 (.13)
F250/350 (4WD)	.005 (.13)
F Super Duty	.008 (.20)
Parallelism	
F150 Integral (4WD)	.0005 (.013)
F150 2-Piece (4WD)	.0007 (.018)
F150 (2WD)	.0005 (.013)
F250/350 (2WD) Integral (Single Rear Wheels)	.0005 (.013)
F350 (2WD) 2-Piece (Dual Rear Wheels	.0010 (.025)
F250/350 (4WD)	.0010 (.025)
F Super Duty	.0010 (.025)
Discard Thickness	
F150	.96 (24.5)
F250/350 (2WD)	1.10 (28.0)
F250/350 (4WD)	1.12 (28.5)
F Super Duty	1.43 (36.3)

REAR DISC BRAKE SPECIFICATIONS (F Super Duty)

Application	In. (mm)
Lateral Runout	.008 (.20)
Parallelism	.0010 (.025)
Discard Thickness	1.43 (36.3)

DRUM BRAKE SPECIFICATIONS

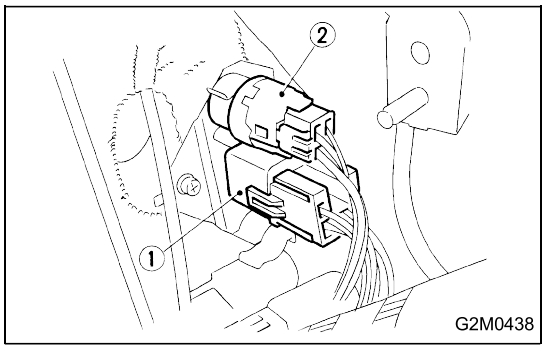
NOTE: Maximum drum diameter is stamped on outside of brake drum.

DRUM BRAKE SPECIFICATIONS

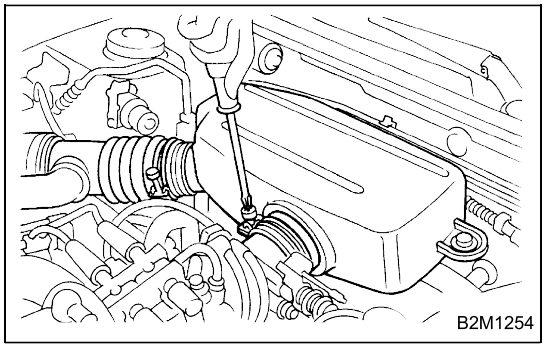
Application	In. (mm)
Drum Diameter	
F150	11.03 (280.2)
F250/350 (Single Rear Wheels) (1)	12.00 (304.8)
F350 (2) (Dual Rear Wheels)	12.13 (308.0)
Maximum Drum Refinish Diameter	
F150	11.060 (280.92)
F250 (1) /350 (2)	12.060 (306.32)
Discard Thickness	
F150	11.090 (281.69)
F250 (1) /350 (2)	12.090 (307.09)

(1) Includes Heavy Duty.

(2) Includes F Super Duty.



10) Installation is in the reverse order of removal.
① Main relay
② Fuel pump relay

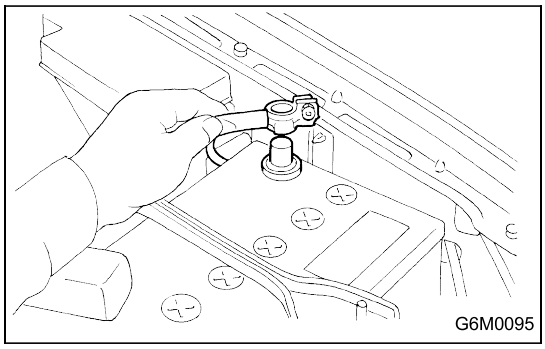


18. Air Intake Chamber

A: REMOVAL AND INSTALLATION

1) Loosen clamps which connect air intake chamber to throttle body and air intake duct.
2) Disconnect air hoses from air intake chamber.
3) Remove bolts which secure air intake chamber to stays.
4) Remove air intake chamber.
5) Installation is in the reverse order of removal.

Tightening torque:
4.9±0.5 N·m (0.5±0.05 kg-m, 3.6±0.4 ft-lb)

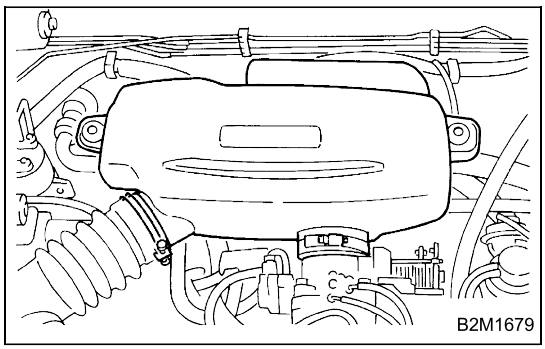


19. Knock Sensor

A: REMOVAL

1. 2200 cc MODEL

1) Disconnect battery ground cable from battery ground terminal.



2) Remove air intake chamber.
<Ref. to 2-7 [W18A0].>

1996-97 CLUTCHES

"F" Series Pickup

DESCRIPTION

NOTE: Unless otherwise specified, references to Pickup include the F350 Super Duty commercial chassis.

The hydraulic clutch control system consists of the hydraulic master cylinder, slave cylinder, reservoir, clutch pedal position switch, and connecting hydraulic lines. The clutch disc and pressure plate are single-disc type. The clutch release bearing or bearing arm is activated by hydraulic pressure. The clutch linkage or pedal position requires no adjustments. This system uses 2 types of clutch slave cylinders; an internally-mounted (concentric) clutch slave cylinder, and an externally-mounted clutch slave cylinder.

TRANSMISSION APPLICATION

Vehicle Model	Transmission Model
F150	Mazda M50D 5-Speed O/D
F250, F350 & F350 Super Duty	(1) Ford S5-47 ZF 5-Speed
(1) Used on vehicles with Gross Vehicle Weight Rating (GVWR) over 8500 lbs. (3855 kg).	

TRANSFER CASE APPLICATION

Vehicle Model	Transfer Case Model
F150	(1) Borg-Warner 44-06
F250, F350 & F350 Super Duty	Borg-Warner 44-07
(1) Equipped with manual or electronic shift.	

ADJUSTMENTS

CLUTCH PEDAL FREE PLAY ADJUSTMENT

NOTE: Clutch pedal is self-adjusting. When clutch system is serviced clutch pedal must be pumped at least 5 times to set tension.

CLUTCH MASTER CYLINDER PUSH ROD LENGTH ADJUSTMENT

1. Disconnect clutch master cylinder push rod from clutch push rod bracket pin. When push rod is disconnected, fully retract clutch master cylinder piston. Clutch pedal blade should contact rubber stop. If components are in alignment, adjustment is okay.
2. If components are not in alignment, ensure attaching nut on left side of clutch pedal is tight. Reinstall push rod to clutch push rod bracket pin. Pump clutch pedal several times to reset position of shaft to pedal slot.

3. Remove clutch master cylinder push rod from lever pin and evaluate alignment. If push rod is aligned with pin, adjustment is okay. If components are still not in alignment, replace clutch push rod bracket.

CLUTCH RELEASE BEARING TRAVEL MEASUREMENT

Externally Mounted Slave Cylinder

1. Remove slave cylinder dust shield. With clutch pedal fully depressed, measure external slave cylinder push rod travel.
2. Push rod should travel a minimum of 0.43" (10.9 mm). DO NOT replace clutch hydraulic system if measurement exceeds specification. If slave cylinder travel is less than specification, check hydraulic reservoir fluid level.

Internally Mounted Slave Cylinder

1. Remove rubber plug from inspection port in transmission bellhousing. Position Bearing Travel Measurement Tool (D87T-4201-A) through opening and against slave cylinder. See **Fig. 1** .
2. Using rear edge of Black plastic bearing retainer as an indicator, take a reading with clutch pedal fully released. With clutch pedal fully depressed, take another measurement.
3. Difference between 2 readings is total bearing travel.
4. On all Pickups, if bearing travel is less than .425" (10.8 mm), check hydraulic reservoir fluid level and inspect hydraulic system for leaks.
5. If leak is found, repair leak and bleed system. If no leak is found, bleed system. See **HYDRAULIC SYSTEM BLEEDING** under BLEEDING HYDRAULIC SYSTEM. Recheck bearing travel after repairs have been completed.

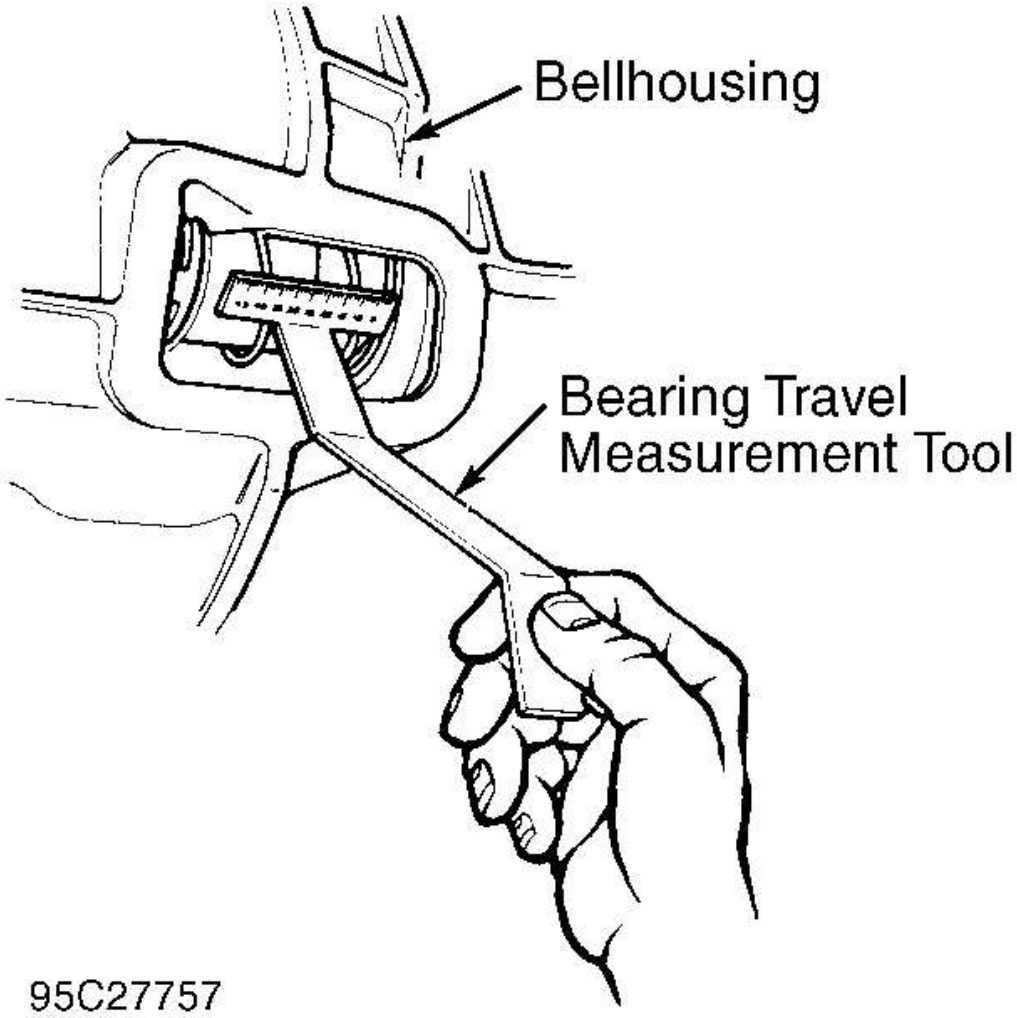


Fig. 1: Measuring Clutch Release Bearing Travel
Courtesy of FORD MOTOR CO.

CLUTCH PRESSURE PLATE (OFF-VEHICLE)

NOTE: Clutch pressure plate is adjustable on F150. F250, F350 and F350 Super Duty are equipped with a conventional pressure plate, which are not adjustable.

Using a suitable adapter and a press, depress pressure plate fingers until adjusting ring moves freely. See **Fig. 2** and **Fig. 3** . Adjust pressure plate by rotating adjusting ring counterclockwise until tension springs are compressed to a width of 0.55" (14 mm). Hold adjusting ring while releasing pressure on pressure plate fingers.

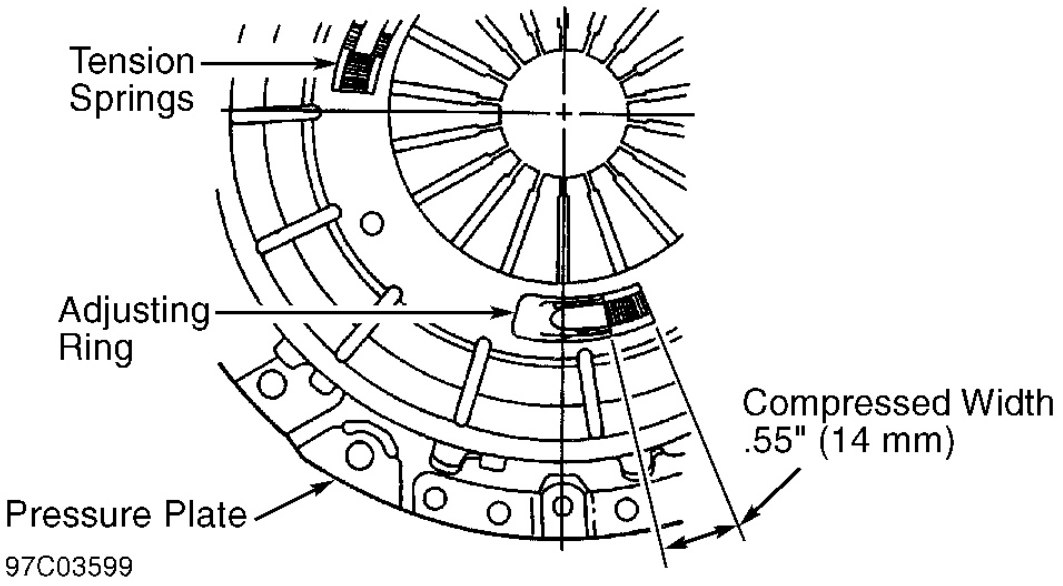


Fig. 2: Adjusting Clutch Pressure Plate (Off-Vehicle) Identifying Adjusting Ring
Courtesy of FORD MOTOR CO.

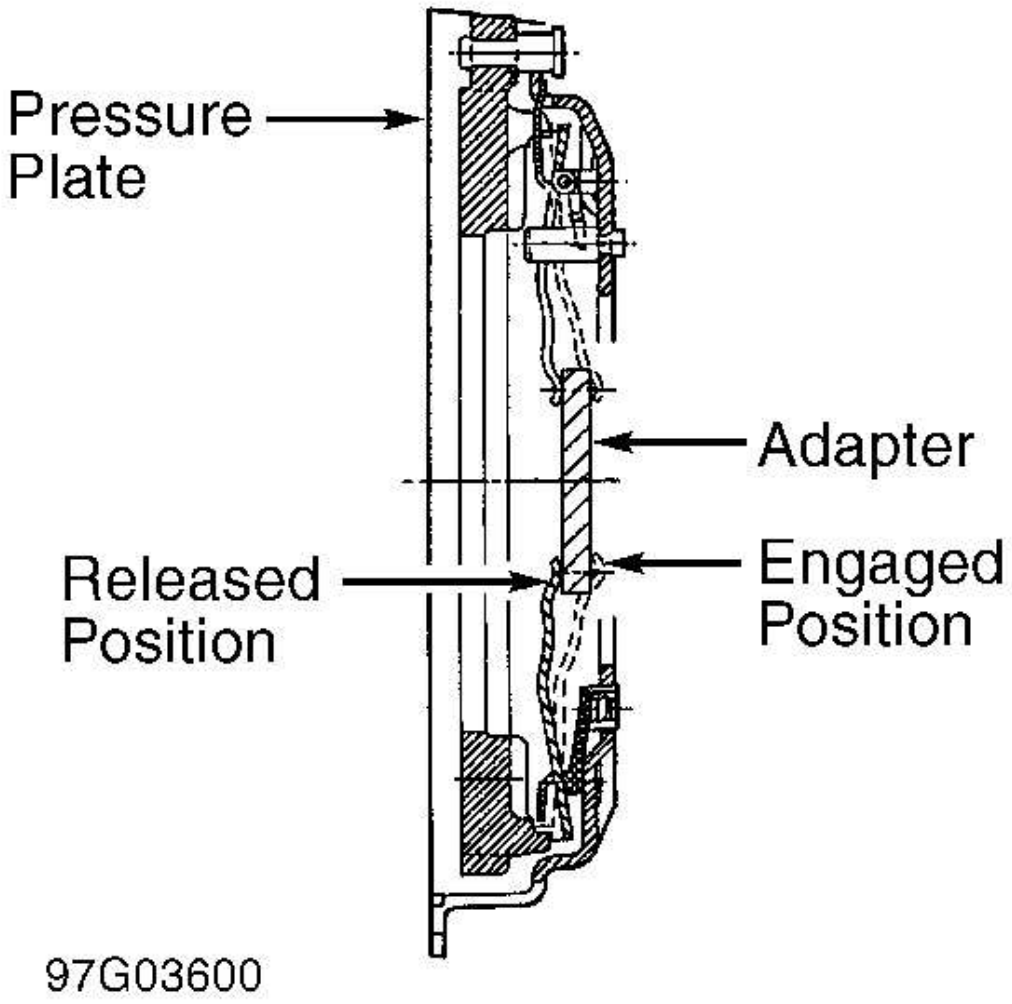


Fig. 3: Adjusting Clutch Pressure Plate (Off-Vehicle) Identifying Adapter
Courtesy of FORD MOTOR CO.

BLEEDING HYDRAULIC SYSTEM

BENCH BLEEDING (MASTER CYLINDER)

1. With reservoir and hydraulic line attached to master cylinder, lightly clamp reservoir in a vise. Fill reservoir. Hold master cylinder vertically below reservoir. Ensure clutch line quick connect is below master cylinder. Using a small screwdriver, depress internal mechanism of male quick connect coupling to open valve. Pump and hold master cylinder push rod. Close quick connect valve. Release master

cylinder push rod. Fill reservoir. Repeat this step 9 times.

2. With master cylinder in same position and quick connector closed, pump master cylinder several times quickly to expel any remaining air. Then, using fingers, pinch reservoir supply hose 2 or 3 times to help move air into reservoir. Check push rod stroke length. If stroke is .160" (4 mm) or less, reinstall clutch master cylinder. If push rod stroke length is not as specified repeat bench bleeding procedure.

HYDRAULIC SYSTEM BLEEDING

Externally Mounted Slave Cylinder

1. If bleeding new (dry) replacement master cylinder, bench bleed master cylinder first. See **BENCH BLEEDING (MASTER CYLINDER)** . Remove slave cylinder from transmission bellhousing. Using a 3/32" diameter punch, remove pin that holds hydraulic line in slave cylinder. Remove hydraulic line from slave cylinder. Place end of hydraulic line into container.
2. Hold slave cylinder so hydraulic line port is at highest point. Fill slave cylinder through hydraulic line port with DOT 3 brake fluid. Gently push on slave cylinder push rod to expel all air.
3. When all air has been expelled, install slave cylinder. Remove clutch master cylinder reservoir cap and diaphragm. While maintaining fluid level in reservoir, observe hydraulic line until all air has been expelled, a steady stream of fluid is flowing, and fluid is level with step in clutch master cylinder reservoir.
4. Install reservoir cap and diaphragm. Install hydraulic line and retaining pin. Remove slave cylinder. Ensure reservoir is full. Hold slave cylinder so hydraulic line port is at highest point. Slowly push pushrod into cylinder and let it return. Repeat 2 more times. Install slave cylinder.
5. Rapidly depress clutch pedal 10 times. Top off with brake fluid. With transmission in Neutral and parking brake set, start vehicle. Shift vehicle into Reverse. If gears grind, check for air in system. Repeat bleeding procedure if necessary. If no air is found and gears grind, clutch components may be defective or worn out.

Internally Mounted (Concentric) Slave Cylinder

1. Using Disconnect Tool (T88T-70522-A), disconnect coupling at transmission by lightly tugging on clutch tube while sliding White plastic sleeve toward slave cylinder. See **Fig. 7** . Clean area around reservoir cap. Fill reservoir with DOT 3 brake fluid. Using hand pressure, apply 10-15 lbs. (4.5-6.8 kg) to clutch pedal. If pedal is hard and moves 0.25-0.50" (6-13 mm), go to step 3). If pedal is spongy, go to next step.
2. Using a screwdriver, open valve of male coupling. Slowly depress clutch pedal to floor and hold. Remove screwdriver to close valve, and release clutch pedal. Ensuring reservoir is full, repeat this step. If pedal is no longer spongy, go to next step.
3. Close reservoir and reconnect coupling. Rapidly depress clutch pedal 5-10 times and wait 1-3 minutes. Repeat this step 3 more times. Place hose on bleeder screw to prevent brake fluid from entering bellhousing. Loosen bleeder screw.
4. Place light pressure on clutch pedal and open bleeder screw. Maintain pressure until pedal contacts floor. Close bleeder screw while pedal is fully depressed. DO NOT allow pedal to return before bleeder screw is fully closed. Recheck fluid level. Apply 27-44 lbs. (12-20 kg) of pressure to clutch pedal while tightening bleed screw.
5. Test system operation by starting vehicle, depressing clutch and placing gearshift in Reverse. Depress

clutch pedal to within 1/2" (13 mm) of floor. If grinding noise is heard, check for air in system. Repeat bleeding procedure if necessary.

TROUBLE SHOOTING

NOTE: For trouble shooting not covered in this article, see appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

TESTING

CLUTCH PEDAL POSITION (CPP) SWITCH

Disconnect the wiring harness from the CPP switch. Using an ohmmeter, check for continuity between the appropriate terminals. Refer to the **CLUTCH PEDAL POSITION (CPP) SWITCH TESTING** table. Also, see **Fig. 4** . Switch should be open (infinity) when pedal is up and clutch is engaged. Switch should be closed (zero ohms) when clutch pedal is pressed to floor. If switch does not function as specified, replace switch.See **Fig. 5** .

CLUTCH PEDAL POSITION (CPP) SWITCH TESTING

Vehicle Model	Measure Between Terminals No. (Wire Color)
Pickups	No. 1 (White/Pink) & No. 2 (Dark Blue)

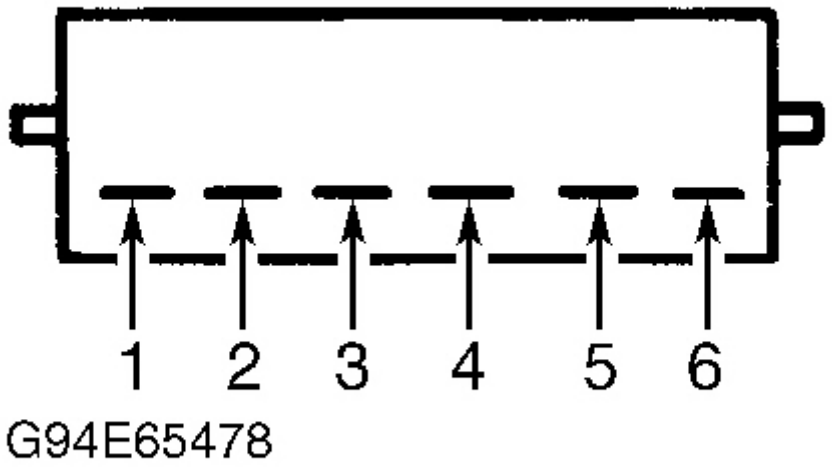


Fig. 4: Identifying Clutch Pedal Position (CPP) Switch Pins
Courtesy of FORD MOTOR CO.

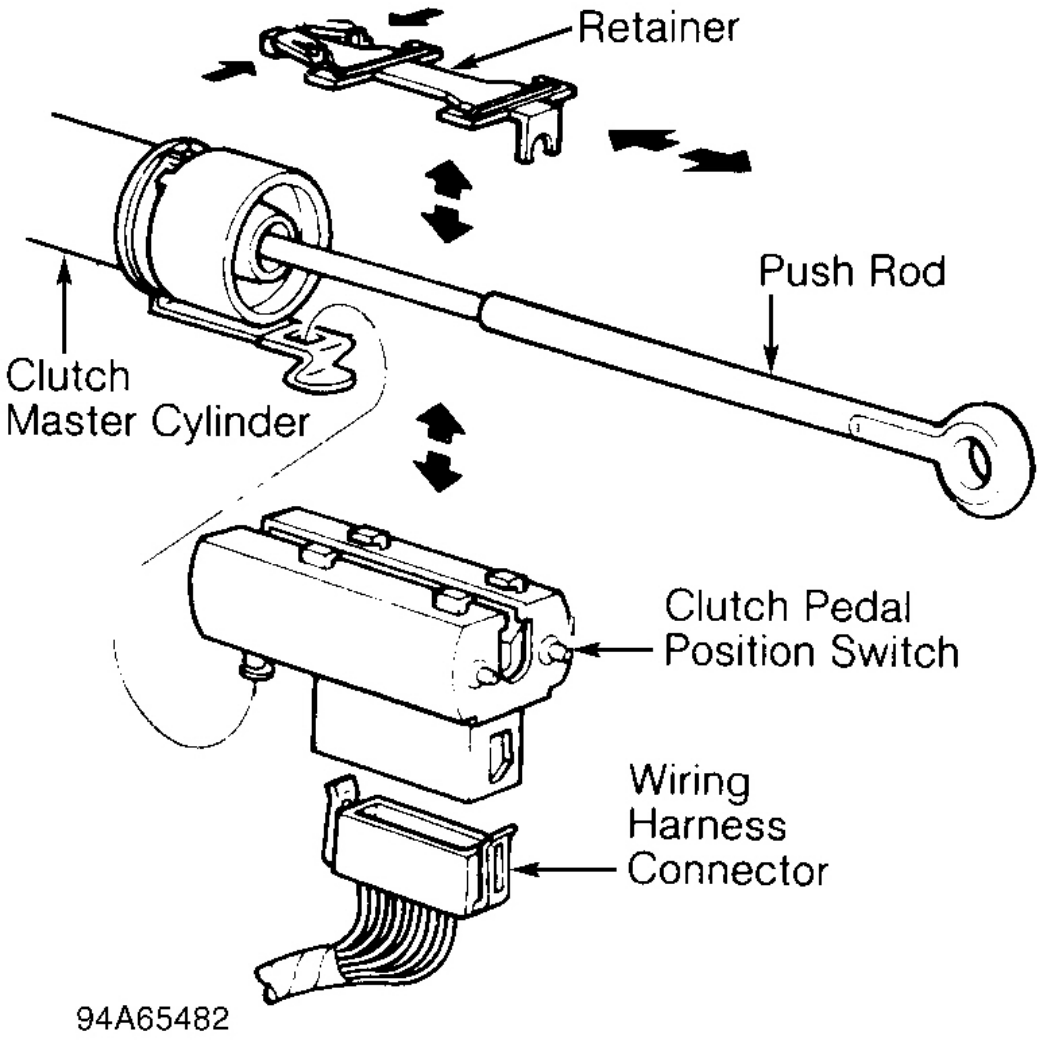


Fig. 5: Identifying Clutch Pedal Position Switch & Components
Courtesy of FORD MOTOR CO.

REMOVAL & INSTALLATION

WARNING: On vehicle equipped with air suspension, prior to raising vehicle, shut off electrical power supply to air suspension system. Air suspension switch is located in rear jack storage area. Failure to do so may result in unexpected inflation or deflation of air springs which may result in shifting of vehicle.

CAUTION: When battery is disconnected, vehicle computer and memory systems

may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

TRANSFER CASE

Removal

1. Raise and support vehicle. Remove skid plate (if equipped). If disassembling transfer case, drain fluid from transfer case. Install plug. Mark drive-shafts for reassembly. Disconnect transfer case vent hose.

CAUTION: On 4WD F350 Super Duty, DO NOT damage gearshift lever when removing control rod from gearshift lever.

2. Disconnect rear drive shaft from transfer case output shaft yoke. Remove front drive-shaft shield. Disconnect front drive shaft. Remove torsion bars and rear torsion bar support. On vehicles equipped with manual shift, use Shift Linkage Insulator Tool (T67P-7341-A) to disconnect shift rod.
3. Disconnect speed sensor electrical connector. Disconnect 4WD indicator switch electrical connector and transfer case coil electrical connector. On electrical shift vehicles, disconnect electric shift motor electrical connector. On F350 Super Duty, disconnect control rod between transfer case shift lever and gearshift lever. On all models, support transfer case and remove transfer case-to-extension housing bolts. Lower transfer case.

Installation

Clean transmission and extension housing gasket mating surfaces. Install NEW extension housing gasket. To complete installation, reverse removal procedure. Tighten transfer case-to-extension housing bolts in sequence. See **Fig. 6** . Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Fill transfer case to bottom of filler hole with Mercon ATF (XT-2-QDX or DDX).

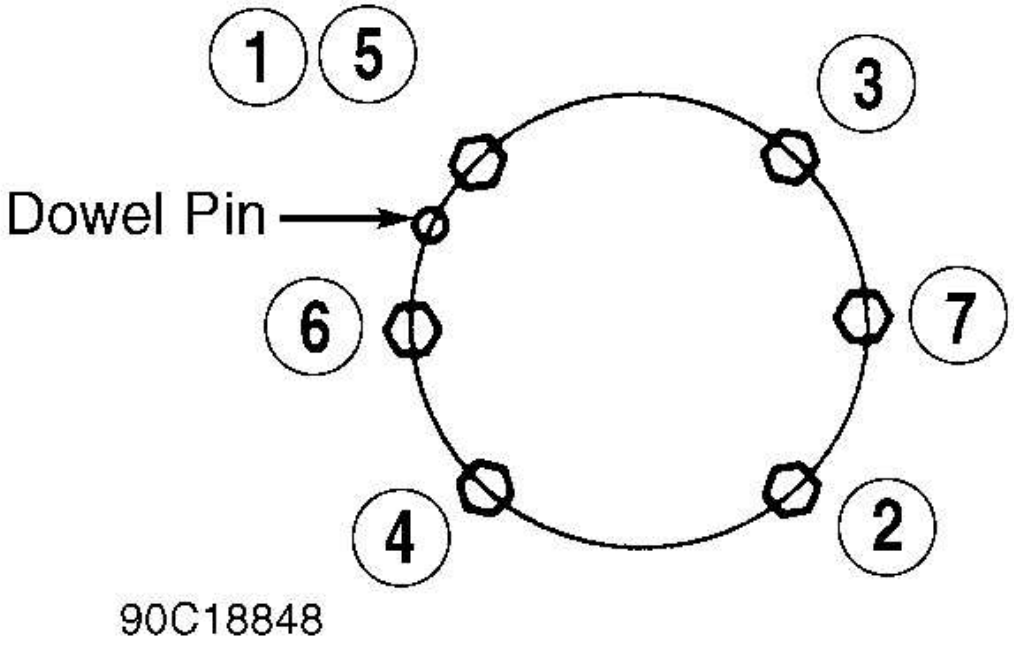


Fig. 6: Transfer Case-To-Extension Housing Tightening Sequence (Pickup)
Courtesy of FORD MOTOR CO.

TRANSMISSION

Removal (F150 Pickup)

1. Disconnect negative battery cable. Shift transmission to Neutral. Remove boot assembly-to-floor bolts. Remove boot from shift lever assembly.
2. Remove shift lever retaining bolt. Remove shift lever, ball and boot assembly. Disconnect transmission harness electrical connector. Raise and support vehicle. Disconnect HO2S connectors. If transmission disassembly is required, drain transmission fluid. Mark drive shaft and rear axle flange for installation reference.
3. Remove drive shaft. Cap transmission extension housing to prevent lubricant spillage.
4. Using Disconnect Tool (T88T-70522-A), disconnect clutch slave cylinder hydraulic line at transmission case. See **Fig. 7** . Cap end of line to prevent fluid leakage and contamination. Remove starter electrical connectors and starter.
5. Remove heat shield. Remove exhaust pipe bracket. Remove fuel line bracket.
6. Position jack under engine, protecting oil pan with wood block. On 4WD models, remove transfer case. See **TRANSFER CASE** .

7. Position transmission jack under transmission. Remove 2 transmission mount nuts. Remove crossmember. Remove transmission mount. On 4.2L, remove 3 oil pan-to-transmission bolts. Remove 6 engine-to-transmission bolts. Remove exhaust pipe from exhaust manifold.
8. On all vehicles, slide transmission rearward to separate bellhousing from dowel pins. When spline on input shaft clears clutch disc, lower transmission from vehicle.

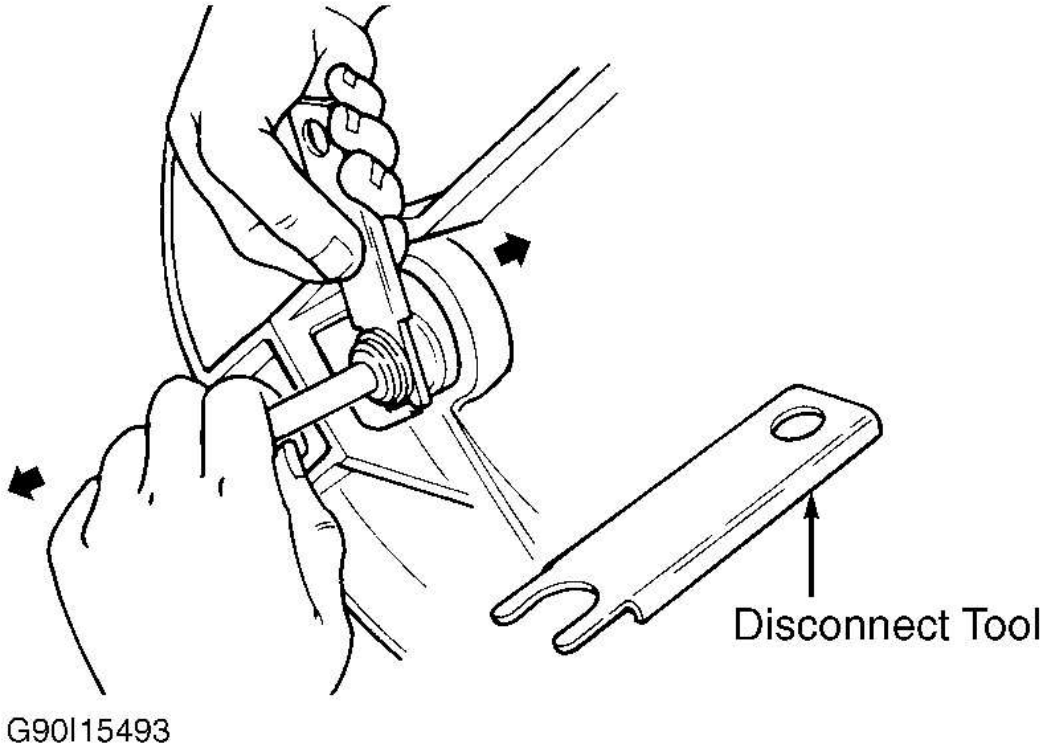


Fig. 7: Removing Clutch Hydraulic Line (Internally Mounted Slave Cylinder)
Courtesy of FORD MOTOR CO.

Installation

1. Ensure mating surfaces and locating dowels are clean and free of burrs. Ensure transmission input shaft splines are clean. Place transmission on transmission jack and position under vehicle.
2. Raise transmission into position and start input shaft into clutch disc. Align splines on input shaft with splines on clutch disc. Move transmission forward until case seats on locating dowels.
3. Install bellhousing-to-engine block bolts. To complete installation, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Bleed hydraulic clutch system. See **HYDRAULIC SYSTEM BLEEDING** under BLEEDING HYDRAULIC SYSTEM. Fill transfer case to bottom of filler hole with Mercon ATF (XT-2-QDX or DDX).

Removal (F250, F350 & F350 Super Duty Pickup)

1. Shift transmission into Neutral. Remove carpet or floor mat. Remove 4 screws and remove boot and bezel assembly from transmission opening cover. Remove 2 bolts and upper shift lever from lower shift lever. Raise and support vehicle.
2. On models with IDI turbo diesel engines, loosen clamp at wastegate housing exhaust outlet. Remove engine charge exhaust pipe-to-transmission housing bolt. Remove engine charge exhaust pipe and extension pipe.
3. On all models, if disassembling transmission, drain transmission and transfer case. Install drain plug. Mark rear and front drive shaft for reassembly. Disconnect rear and front drive shafts from transfer case, and wire aside.
4. Disconnect back-up light switch. Remove speedometer cable from transfer case, if necessary. Disconnect clutch linkage from transmission. Remove skid plate (if equipped). Position transmission jack under transfer case. On F350 Super Duty, remove transmission parking brake from transmission. See appropriate **DISC & DRUM** article in BRAKES. Keep parking brake in upright position to avoid fluid leakage.
5. On 4WD, remove transfer case. See **TRANSFER CASE** . On all models, remove transmission rear insulator and lower retainer. Remove crossmember. Remove transmission-to-engine bolts. Remove transmission. Lower transmission from vehicle.

Installation

1. Ensure transmission input shaft splines are clean and free of rust. Place transmission on transmission jack. Install guide studs in engine block. Raise transmission until input shaft splines are aligned with clutch disc splines.
2. Slide transmission forward into position on guide studs. Remove guide studs. Install transmission-to-engine bolts and tighten to specification. See **TORQUE SPECIFICATIONS** .
3. Bleed hydraulic system. See **HYDRAULIC SYSTEM BLEEDING** under BLEEDING HYDRAULIC SYSTEM. To complete installation, reverse removal procedure. Tighten retaining bolts to specification. See **TORQUE SPECIFICATIONS** . Fill transfer case to bottom of filler hole with Mercon ATF (XT-2-QDX or DDX).

CLUTCH DISC, FLYWHEEL, PILOT BEARING & PRESSURE PLATE

NOTE: Replace clutch disc and pressure plate as an assembly. Replace pilot bearing only if it is damaged.

CAUTION: DO NOT use cleaners with a petroleum base or immerse pressure plate in solvent.

Removal (F150 Pickup)

1. Disconnect negative battery cable. Disconnect clutch master cylinder push rod. Raise and support vehicle. Remove starter. Disconnect clutch slave cylinder hydraulic line by pressing White retainer bushing with Disconnect Tool (T88T-70522-A) while pulling on line. See **Fig. 7** .

2. Remove transmission. On 4WD vehicles, remove transfer case. See **TRANSFER CASE** . Check pressure plate finger height variations before removing pressure plate. If finger height variations exist, replace pressure plate. Place reference mark on pressure plate and flywheel for reassembly reference. Loosen pressure plate-to-flywheel bolts evenly until springs are expanded. Remove pressure plate and clutch disc.
3. Remove all but 2 flywheel bolts. Loosen last 2 bolts. Install 2 flywheel bolts in threaded holes in flywheel. Using puller, remove flywheel and then pilot bearing.

Inspection

1. Inspect clutch pressure plate diaphragm fingers for wear. Inspect clutch plate for oil or grease saturation, worn or loose facings, warpage, loose rivets at hub and broken springs. Also inspect for wear or rust on splines.
2. Using a slide caliper, measure depth to rivet heads. Minimum rivet depth is 0.012" (0.3 mm). Using a dial indicator, check clutch plate runout. Maximum clutch plate runout is 0.0276" (0.700 mm). Inspect flywheel for cracks, heat damage, wear and scoring. Machine flywheel if scored or worn. Using a dial indicator, measure flywheel runout. Maximum flywheel runout is 0.008" (0.2 mm).
3. Check crankshaft for misalignment and looseness. Check pilot bearing needle rollers for scoring, discoloration, wear, breakage and inadequate grease. Check rear main seal for leakage. Inspect pressure plate for burn marks, scores, flatness and ridges. Install NEW clutch plate on transmission input shaft and ensure clutch plate slides freely.

Installation

1. Clean pressure plate and flywheel surface with alcohol-based solvent. Pilot bearing is prelubed and does not require additional lubrication. Install pilot bearing with seal facing transmission. Using Pilot Bearing Replacer (T85T-7137-A), install pilot bearing. On all models except 4.0L engines, adjust pressure plate. See **CLUTCH PRESSURE PLATE (OFF-VEHICLE)** under ADJUSTMENTS.
2. Using Truck Clutch Alignment Shaft (D79T-7550-A), position clutch disc on flywheel. Position pressure plate assembly on flywheel. Align pressure plate and clutch disc with reference mark, and install retaining bolts.
3. Apply Threadlock/Sealer (EOAZ-19554-AA) to flywheel bolt threads. Tighten bolts evenly in a crisscross sequence. See **Fig. 8** . Remove clutch input shaft or clutch aligner. To complete installation, reverse removal procedure. Tighten bolts to specification. Refer to the **TORQUE SPECIFICATIONS** .

Removal (F250, F350 & F350 Super Duty Pickup)

1. Disconnect negative battery cable. Remove external slave cylinder or disconnect clutch slave cylinder hydraulic line by pressing White retainer bushing with Disconnect Tool (T88T-70522-A) while pulling on line. See **Fig. 7** .
2. Remove clutch release shaft and dust cover (if equipped). Remove transmission. See **TRANSMISSION** . On 4WD, remove transfer case. See **TRANSFER CASE** .
3. Place mark on pressure plate and flywheel for reassembly reference. Some vehicles are equipped with orange paint on clutch pressure plate and flywheel for reassembly reference. Remove pressure plate and clutch disc. Using puller, remove pilot bearing (if replacement is necessary).

Inspection

1. Inspect clutch pressure plate diaphragm fingers for wear. Inspect clutch plate for oil or grease saturation, worn or loose facings, warpage, loose rivets at hub and broken springs. Also inspect for wear or rust on splines.
2. Using a slide caliper, measure depth to rivet heads. Minimum rivet depth is 0.012" (0.3 mm). Using a dial indicator, check clutch plate runout. Maximum clutch plate runout is 0.0276" (0.700 mm). Inspect flywheel for cracks, heat damage, wear and scoring. Machine flywheel if scored or worn. Using a dial indicator, measure flywheel runout. Maximum flywheel runout is 0.008" (0.2 mm).
3. Check crankshaft for misalignment and looseness. Check pilot bearing needle rollers for scoring, discoloration, wear, breakage and inadequate grease. Check rear main seal for leakage. Inspect pressure plate for burn marks, scores, flatness and ridges. Install NEW clutch plate on transmission input shaft and ensure clutch plate slides freely.

Installation

1. Using Truck Clutch Alignment Shaft (D79T-7550-A), position clutch disc on flywheel. Position pressure plate assembly on flywheel. Align pressure plate and clutch disc with reference mark, and install retaining bolts.

NOTE: Pressure plate assembly bolts for 7.3L and 7.5L differ in length (.75" for 7.3L and .92" for 7.5L). DO NOT use longer bolt on 7.3L, as it will extend beyond secondary flywheel and interfere with primary flywheel.

2. On 7.3L diesel and 7.5L models, clean and lubricate pilot bearing, clutch release lever stud and fingers of clutch release shaft. To complete installation, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

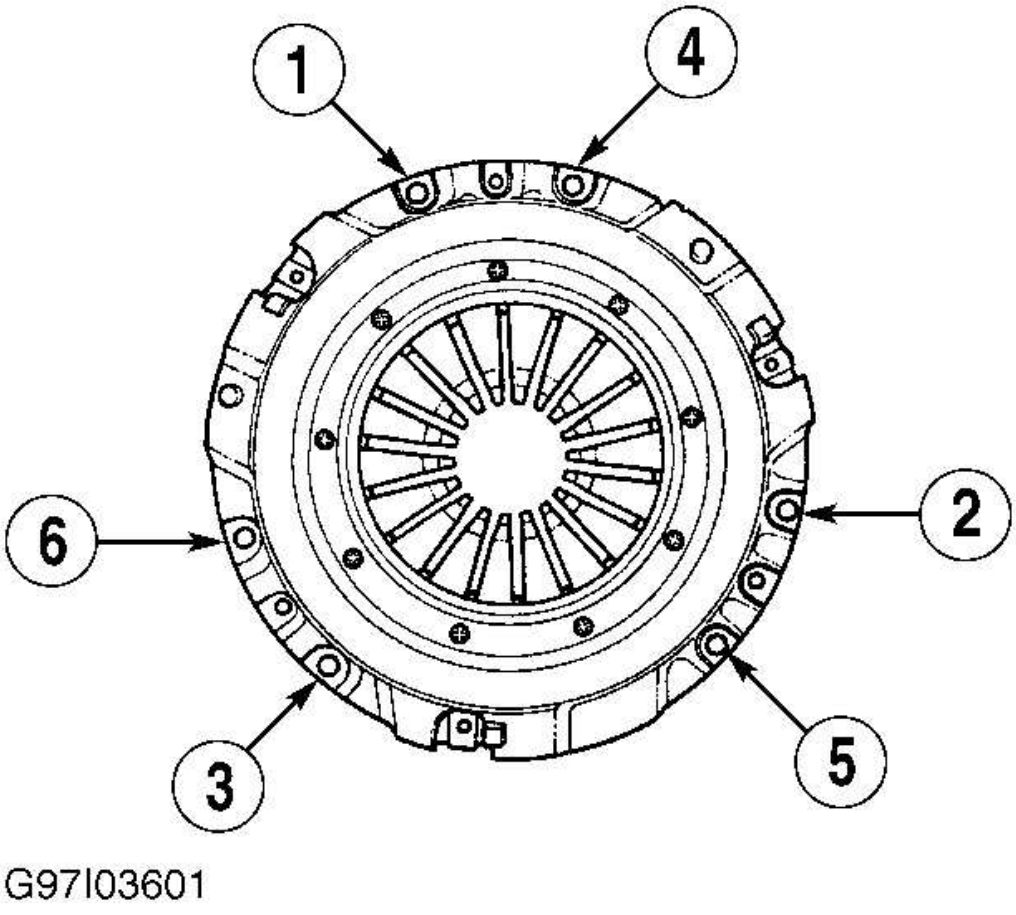


Fig. 8: Identifying Pressure Plate Tightening Sequence
Courtesy of FORD MOTOR CO.

CLUTCH MASTER CYLINDER & RESERVOIR

CAUTION: On F250, F350 and F350 Super Duty Pickup, install NEW clutch and brake pedal pivot shaft lever whenever performing any service on clutch master cylinder or clutch pedal assembly. See CLUTCH PEDAL PIVOT SHAFT LEVER . Failure to do so can result in improper master cylinder push rod initialization, leading to premature clutch failure.

Removal (F150 Pickup)

1. Prying retainer bushing and push rod off clutch pedal pin, disconnect master cylinder push rod from clutch pedal. Remove Clutch Pedal Position (CPP) switch. See **CLUTCH PEDAL POSITION (CPP)**

SWITCH .

2. Remove clutch master cylinder reservoir. Raise and support vehicle. Disconnect clutch slave cylinder hydraulic line by pressing White retainer bushing with Disconnect Tool (T88T-70522-A) while pulling on line. See **Fig. 7** . Plug line to prevent leakage.
3. Disconnect line from mounting clips. Lower vehicle. Rotate master cylinder 45 degrees clockwise and remove clutch master cylinder.

Inspection

Inspect master cylinder for weak spring, damage to reservoir components and damaged cups. Also check master cylinder for scored piston.

Installation

1. When installing NEW master cylinder, bench bleed master cylinder. See **BENCH BLEEDING (MASTER CYLINDER)** under BLEEDING HYDRAULIC SYSTEM. To install, reverse removal procedure. Clean all rubber parts with DOT 3 brake fluid. Replace clutch master cylinder push rod retainer bushing if worn or damaged.
2. Ensure retainer and push rod are installed on clutch pedal pin with flange portion of bushing facing away from pedal blade of clutch pedal. Bleed hydraulic system. See **HYDRAULIC SYSTEM BLEEDING** under BLEEDING HYDRAULIC SYSTEM. Depress clutch pedal at least 10 times to check for proper release and smooth operation.

Removal (F250, F350 & F350 Super Duty Pickup)

1. Carefully pry push rod and retainer bushing from cross-shaft lever pin. Disconnect Clutch Pedal Position (CPP) switch connector. Remove 2 nuts and bracket holding clutch master cylinder and reservoir to firewall.
2. On models equipped with external slave cylinders, disconnect clutch slave cylinder hydraulic line. On all other models, disconnect clutch slave cylinder hydraulic line by pressing White retainer bushing with Disconnect Tool (T88T-70522-A) while pulling on line. See **Fig. 7** . Plug line to prevent leakage.
3. On all models, remove clutch master cylinder and reservoir. When master cylinder studs are free of dash panel, rotate cylinder 105 degrees counterclockwise to permit CPP switch to clear dash panel.

Installation

Replace the clutch and brake pedal pivot shaft lever. Refer to **CLUTCH PEDAL PIVOT SHAFT LEVER** . To complete installation, reverse removal procedure. Bleed hydraulic system, if necessary. Refer to **HYDRAULIC SYSTEM BLEEDING** under BLEEDING HYDRAULIC SYSTEM. Depress clutch pedal at least 10 times to check for proper release and smooth operation. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

INTERNAL (CONCENTRIC) CLUTCH SLAVE CYLINDER & RELEASE BEARING

CAUTION: Clutch release bearing is prelubed and should not be cleaned with solvent. Clutch release hub and bearing are replaced as an assembly. DO NOT

disassemble for inspection or replacement.

Removal

1. Disconnect clutch slave cylinder hydraulic line by pressing White retainer bushing with Disconnect Tool (T88T-70522-A) while pulling on line. See **Fig. 7** . Plug line to prevent leakage. Raise and support vehicle. Remove transmission. See **TRANSMISSION** .
2. Remove 2 internal (concentric) clutch slave cylinder bolts. Remove concentric clutch. Push clutch release hub and bearing against spring. Remove retainer ring. Remove clutch release hub and bearing, and spring. See **Fig. 9** .

Inspection

Check internal (concentric) clutch slave cylinder for leakage. Replace slave cylinder as necessary. Also check slave cylinder for weak spring, worn or damaged piston and worn or damaged boot. Rotate outer race while applying pressure. If bearing rotation is rough, replace clutch release hub and bearing. Check for any surface scoring or burrs that may impede sliding motion of clutch release hub and bearing.

Installation

Prior to installation, lubricate bearing bore and bearing carrier with multipurpose grease. On clutch release hub, polish any scoring or burrs with fine grade of emery paper. To complete installation, reverse removal procedure. Bleed hydraulic system. Refer to **HYDRAULIC SYSTEM BLEEDING** under BLEEDING HYDRAULIC SYSTEM. Tighten bolts to specification. Refer to the **TORQUE SPECIFICATIONS** .

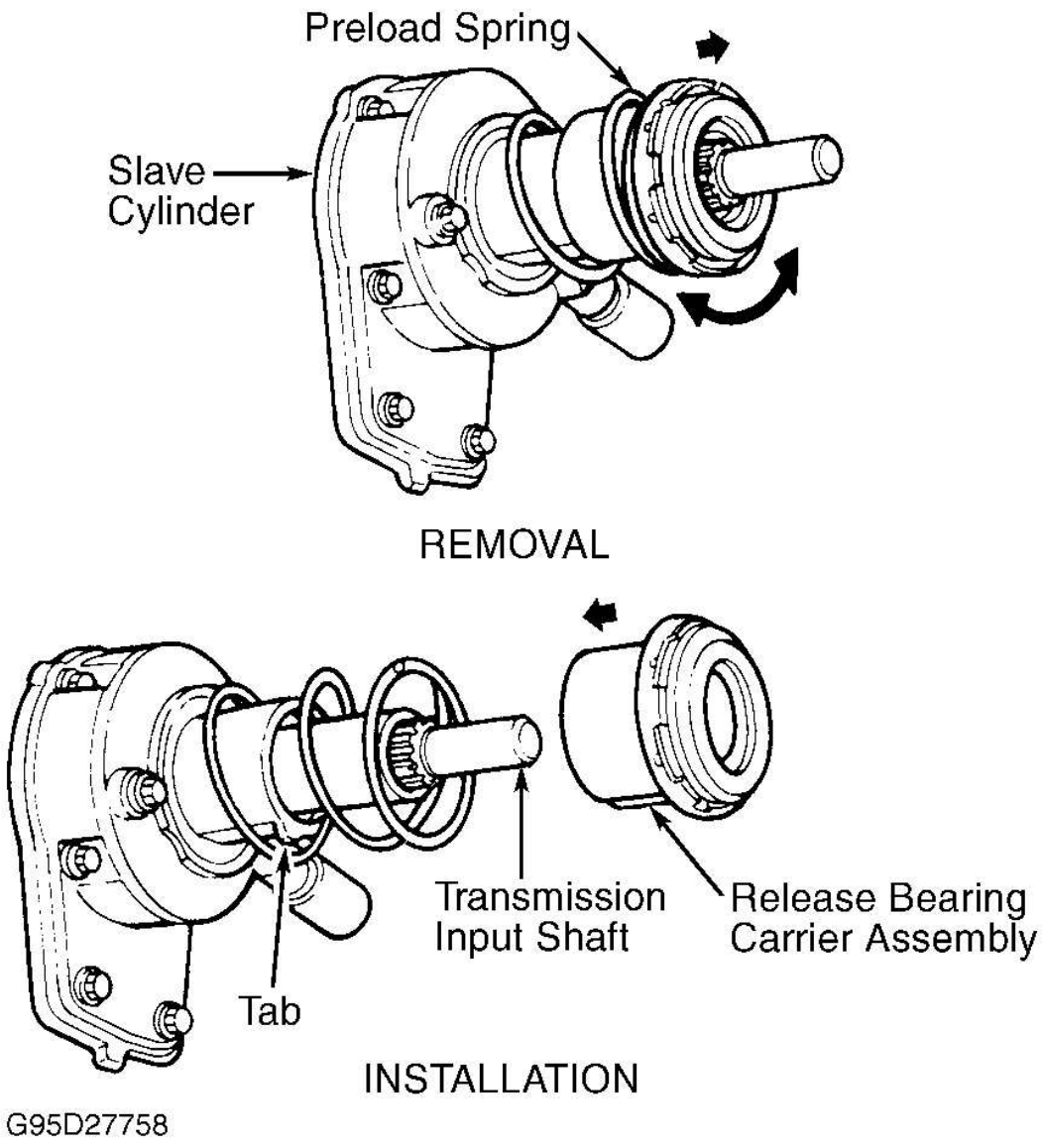


Fig. 9: Servicing Clutch Release Bearing
Courtesy of FORD MOTOR CO.

EXTERNAL CLUTCH SLAVE CYLINDER

CAUTION: On vehicles equipped with external slave cylinders, the master cylinder pushrod must be disconnected from clutch pedal prior to removal of slave cylinder. Permanent damage to master cylinder will occur if master cylinder is activated with slave cylinder disconnected.

Removal

Raise and support vehicle. Push release lever forward to compress clutch slave cylinder. Remove clutch slave cylinder by prying on clip to disengage tangs while pulling clutch slave cylinder free of bracket. Remove clutch release lever dust shield from opening in clutch housing portion of case. Remove clutch release lever by pulling outward.

Inspection

Check clutch slave cylinder for leakage. Replace slave cylinder as necessary. Also check slave cylinder for weak spring, worn or damaged piston and worn or damaged boot.

Installation

Clean and lubricate the clutch release shaft pivot stud, push rod pockets and fingers of clutch release lever. To complete installation, reverse removal procedure. Bleed the hydraulic system. Refer to **HYDRAULIC SYSTEM BLEEDING** under BLEEDING HYDRAULIC SYSTEM. Depress clutch pedal 10 times to fill clutch slave cylinder and to seat components.

CLUTCH PEDAL

CAUTION: On F250, F350 and F350 Super Duty Pickup, install NEW clutch and brake pedal pivot shaft lever whenever performing any service on clutch master cylinder or clutch pedal assembly. See CLUTCH PEDAL PIVOT SHAFT LEVER . Failure to do so can result in improper master cylinder push rod initialization, leading to premature clutch failure.

Removal & Installation

1. Disconnect clutch pedal retracting spring from clutch pedal and bracket. Remove nut holding clutch pedal to clutch and brake pedal pivot shaft. Remove clutch pedal.
2. To install, reverse removal procedure. Replace pivot shaft lever. Compress retracting spring in a vise and secure with wire until it is in place. Ensure spring engages in clutch pedal and bracket slots.

CLUTCH PEDAL POSITION (CPP) SWITCH

Removal & Installation

1. Disconnect wiring harness from CPP switch. Pull orientation clip away from switch to separate it from locating pin. See **Fig. 5** . Rotate switch until White plastic retainer is exposed.
2. Push tabs together and slide retainer toward push rod eye to separate it from switch. Remove switch from push rod. To install, reverse removal procedure.

CLUTCH PEDAL PIVOT SHAFT LEVER

Removal

Disconnect clutch master cylinder push rod from clutch and brake pedal pivot shaft lever pin. Use a small screwdriver or putty knife to wedge between lever and snap-in bushing. Remove retaining nut. Pry lever from clutch and brake pedal pivot shaft.

Installation

Snap new lever to clutch master cylinder push rod bushing. Install lever onto clutch and brake pedal pivot shaft. Tighten clutch master cylinder and pedal bracket. Install retaining nut finger-tight. Ensure clutch pedal position is against up stop. Tighten retaining nut to proper specification, allowing knurled teeth on clutch and brake pedal pivot shaft to cut matching teeth in lever for correct positioning.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Center Support Bracket-To-Crossmember	30-47 (40-64)
Clutch Housing-To-Engine	40-50 (54-67)
Clutch Pedal Pivot Shaft Nut	50-68 (68-92)
Crossmember-To-Frame Bolts/Nuts	
Mazda M50D 5-Speed O/D	
2WD	58-75 (78-103)
4WD	39-53 (53-72)
S5-42 ZF	
F250	43-57 (58-77)
F350	32-42 (43-57)
Drive Shaft "U" Joint-To-Rear Yoke Bolt	91-110 (123-149)
Exhaust Pipe Bolts/Nuts	25-33 (34-46)
Front & Rear Output Yokes-To-Transfer Case	120-150 (163-203)
Insulator/Retainer Bolt	45-60 (60-80)
Pressure Plate-To-Flywheel Bolts (1)	
4.9L, 5.0L & 5.8L	20-29 (27-39)
7.3L (Except Turbo)	19-26 (26-35)
7.3L Turbo	17-24 (23-32)
7.5L	15-20 (21-27)
Rear Drive Shaft-To-Rear Output Case Yoke	
Bolt (Bronco)	21-24 (28-33)
Nut (Pickup 4WD)	8-15 (11-20)
Rear Engine Support-To-Insulator/Retainer Nut	50-70 (68-94)
Shift Lever Bolt/Nut	
Mazda M50D 5-Speed O/D	12-18 (16-24)
S5-42 ZF	20-28 (27-38)
Starter Bolt	20-34 (27-46)

Transfer Case-To-Extension Housing (2)	25-43 (34-58)
Transmission Mount Bolts/Nuts	64-80 (87-110)
Transmission-To-Engine Bolt	50-68 (68-92)
Transmission-To-Transfer Case Bolts	30-40 (40-54)

(1) Tighten in a crisscross pattern.

(2) Tighten in sequence. See **Fig. 6** .

1996-97 ENGINE COOLING

Cooling System Specifications & Drive Belt Routing

BLEEDING

COOLING SYSTEM

Aerostar, Explorer, Mountaineer, Ranger & Windstar

1. Fill cooling system with 50/50 mixture of coolant and water. Pause several minutes for circulation. Fill radiator to filler neck seat. Install radiator cap fully, then back off to first stop.

> **WARNING: When engine is operating, NEVER remove radiator cap under any conditions. Failure to follow instruction may damage cooling system or engine, or cause personal injury. Always wrap protective material around radiator cap to avoid injury from hot coolant.**

2. Turn heater controls to maximum. Start engine and operate at 2000 RPM for approximately 3-4 minutes. Turn engine off. Using a protective rag, carefully remove radiator cap. Add coolant to filler neck seat.
3. Install radiator cap fully, then back off to first stop. Start engine and allow to operate at 2000 RPM until upper radiator hose is warm. Check heater output. Turn engine off. Using a rag, carefully remove radiator cap. Add coolant to filler neck seat if necessary.
4. Tightly install radiator cap. Remove small cap (large cap is for windshield washer reservoir) on coolant recovery reservoir. Add 1.1 Qts. (1L) of 50/50 mixture of water and coolant to reservoir. Install reservoir cap.

Bronco, Pickup & Van

1. To bleed trapped air from cooling system, disconnect heater hose from water pump. Using 50/50 mixture of coolant and water, fill radiator until coolant flows from heater hose fitting at water pump. Reconnect heater hose.
2. Fill radiator until coolant is 1.5" (38 mm) below radiator cap seal. Install radiator cap. Run engine until warm. Turn engine off. Carefully remove radiator cap and check level. Fill as necessary.

Expedition

1. Turn heater controls to maximum and set air discharge to instrument panel vents. Turn blower to high. Fill cooling system with 50/50 mixture of coolant and water. Pause several minutes for circulation. Start engine and allow to idle. While engine is idling, feel for hot air at instrument panel vents. If air discharge remains cool and coolant temperature gauge does not move, coolant level is low.
2. Stop engine and allow it to cool. Top off coolant as necessary. Start engine and allow it to idle until normal operating temperature is reached. Hot air should discharge from instrument panel vents. Coolant temperature gauge should maintain a stable reading in middle of range. Upper radiator hose should feel hot to touch. Stop engine and allow it to cool. Top off coolant as necessary. Check for coolant leaks.

Villager

1. Loosen engine and radiator air relief plugs. Remove heater pipe air relief cap. See **Fig. 1** . Connect one end of 40" clear, heat resistant hose to heater pipe relief. Fill coolant reservoir to MAX mark and place hose from heater pipe air relief into coolant reservoir. Ensure hose is below coolant level at all times.
2. Slowly add coolant through radiator filler neck, allowing several minutes for air to escape. When coolant starts to drip from radiator air relief plug, close plug. Tighten plug to 15-19 ft. lbs. (20-26 N.m).
3. Continue adding coolant while gently moving upper radiator hose up and down until coolant level no longer drops in filler neck. Place wire under radiator filler cap negative pressure relief valve. See **Fig. 2** . DO NOT install cap at this time.
4. Start engine and run at 2000 RPM for 10-15 minutes or until lower radiator hose becomes hot. If coolant comes out of engine air relief plug, close plug. Tighten plug to 15-19 ft. lbs. (20-26 N.m). If coolant in radiator neck lowers, add coolant. If coolant overflows filler neck, install radiator cap (with wire installed).
5. Close engine air relief plug if not already done. Stop engine and allow to cool down completely. Refill radiator and reservoir as necessary. Ensure radiator cap (with wire) is installed. Start engine and warm to operating temperature. If engine temperature raises above normal, stop engine and repeat this step.

NOTE: Ensure coolant level in reservoir tank is maintained at MAX mark for the following steps.

6. On vehicles without rear heater, ensure temperature control lever is in full HOT position. Select any fan speed and mode except OFF. Run engine at 3000 RPM for 5 minutes or until outlet air is hot. Repeat this step at least 3 times. Ensure no water noise is present in heater core.
7. On vehicles with rear heater, run engine at 3000 RPM with front temperature control lever in full COLD position. Move rear temperature control lever to full HOT position. Select any fan speed except OFF. Run engine 5 minutes or until rear outlet air is hot.
8. Move rear temperature control lever to full COLD position. Move front temperature control lever to full HOT position. Select any fan speed and mode except OFF. Run engine 5 minutes or until front outlet air is hot. Repeat steps 7) and 8) at least 3 times. Ensure no water noise is present in front or rear heater core.
9. On models equipped with automatic A/C, operate engine at 3000 RPM with front climate control set at 60°F and rear A/C control unit temperature switch to full WARM position and fan on for 5 minutes or until rear outlet air is hot. Turn rear control unit to full COOL position and set front climate control to 90° F until front outlet air is hot. Repeat process at least 3 times until no water noise is heard at heater core.
10. On all models, stop engine. Fill coolant reservoir to MAX mark. Let engine cool down. Remove radiator cap and remove wire from negative pressure valve. Fill radiator as necessary and reinstall radiator cap. Remove hose from heater pipe relief and quickly install cap on pipe. Fill reservoir as necessary and install reservoir cap.

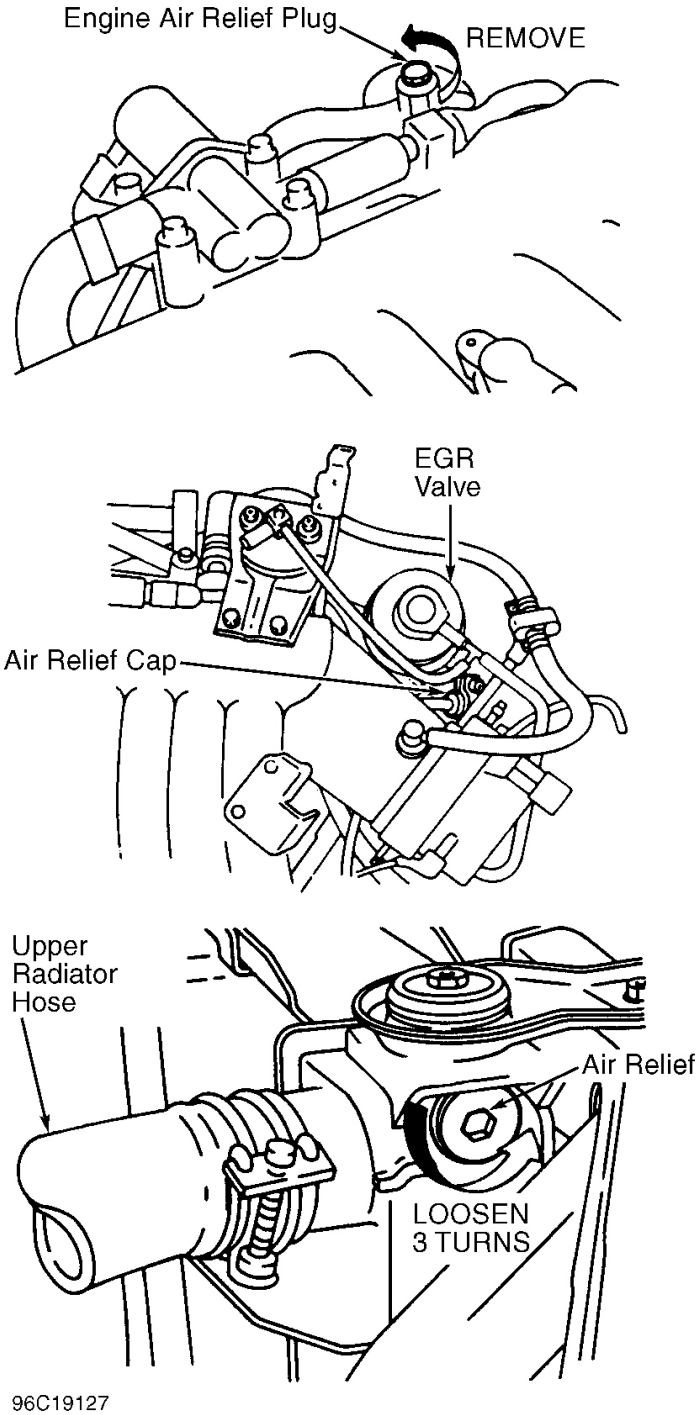


Fig. 1: Locating Air Relief Plug (Villager)
Courtesy of NISSAN MOTOR CO., U.S.A.

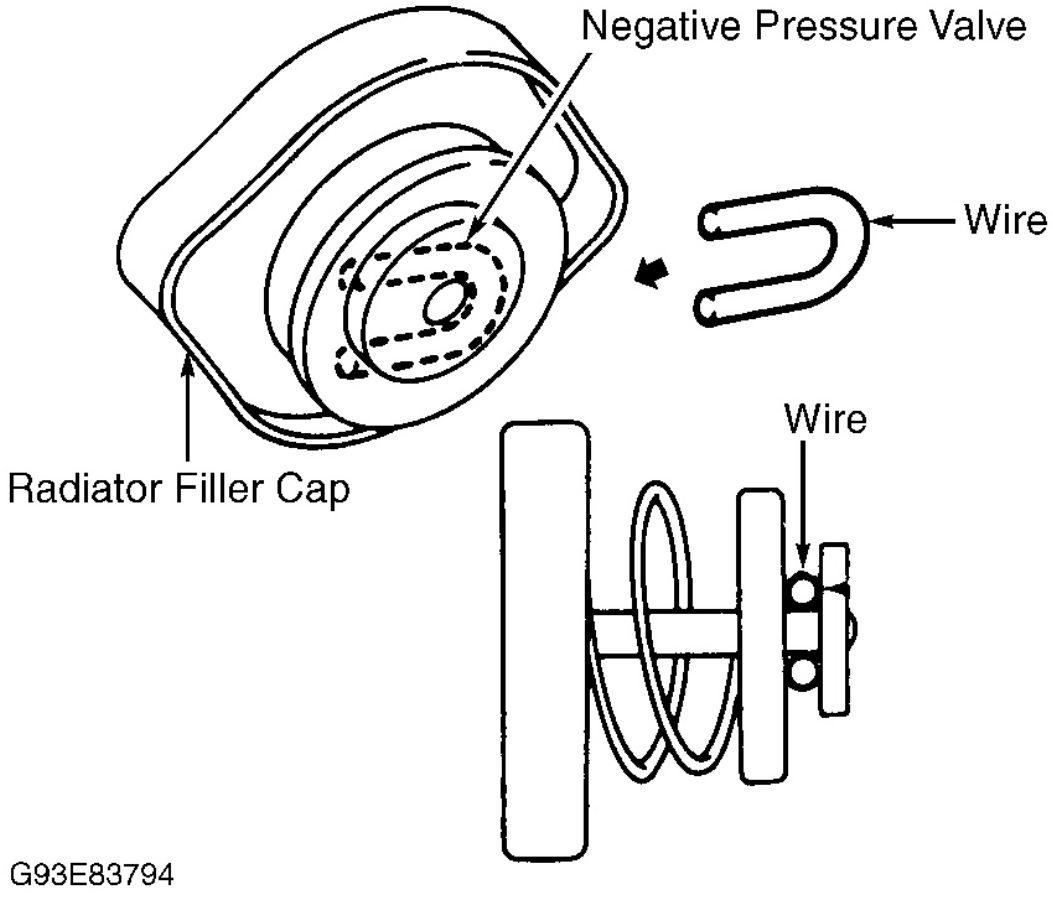


Fig. 2: Holding Negative Pressure Relief Valve Open
Courtesy of NISSAN MOTOR CO., U.S.A.

BELT ADJUSTMENT

Inspect belt for fraying. If fraying has occurred, ensure belt and tensioner are aligned properly. See **Fig. 3** . If tensioner has reached its limit of travel, belt is excessively stretched and replacement of belt is required. If excessive noise is noticed from tensioner or idler, check for possible bearing failure. Belt tension adjustment is not required on vehicles with automatic belt tensioners. DO NOT apply belt dressing or any other additive to belt(s). Ensure belts are properly installed. See **Fig. 4** -**Fig. 27** . See **BELT TENSION ADJUSTMENT SPECIFICATIONS** table.

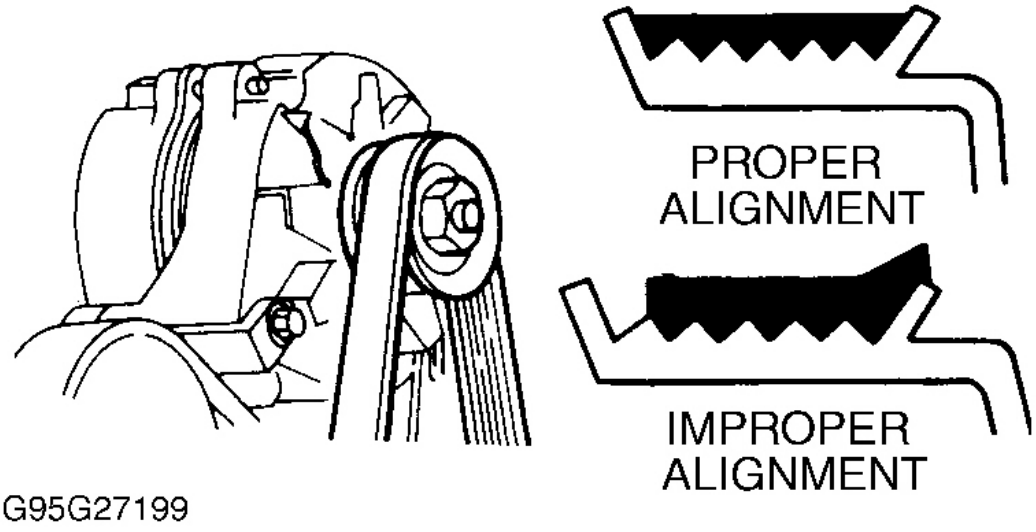


Fig. 3: Aligning Serpentine Belt
Courtesy of FORD MOTOR CO.

BELT TENSION ADJUSTMENT SPECIFICATIONS

Application	New Belt Lbs. (kg)	(1) Used Belt Lbs. (kg)
2.3L, 4.0L, 4.2L, 4.6L, 4.9L, 5.0L, 5.4L, 5.8L, 6.8L & 7.3L		
All Models	(2)	(2)
3.0L		
Aerostar & Ranger	150-190 (68-87)	140-160 (64-73)
Villager		
Generator	150-170 (68-77)	130-140 (59-64)
A/C & P/S	140-150 (64-68)	110-130 (50-59)
Windstar	(3)	(3)
3.8L	160-190 (73-87)	130-160 (50-73)
7.5L		
W/ Tensioner	(2)	(2)
W/O Tensioner		
Alternator & Air Pump	160-200 (73-91)	110-130 (50-59)

(1) Any belt operated for 5 minutes.

(2) No adjustment required for serpentine belt with automatic tensioner. Tension is correct if indicator is within limit marks.

(3) Information is not available from manufacturer.

DRIVE BELT ROUTING

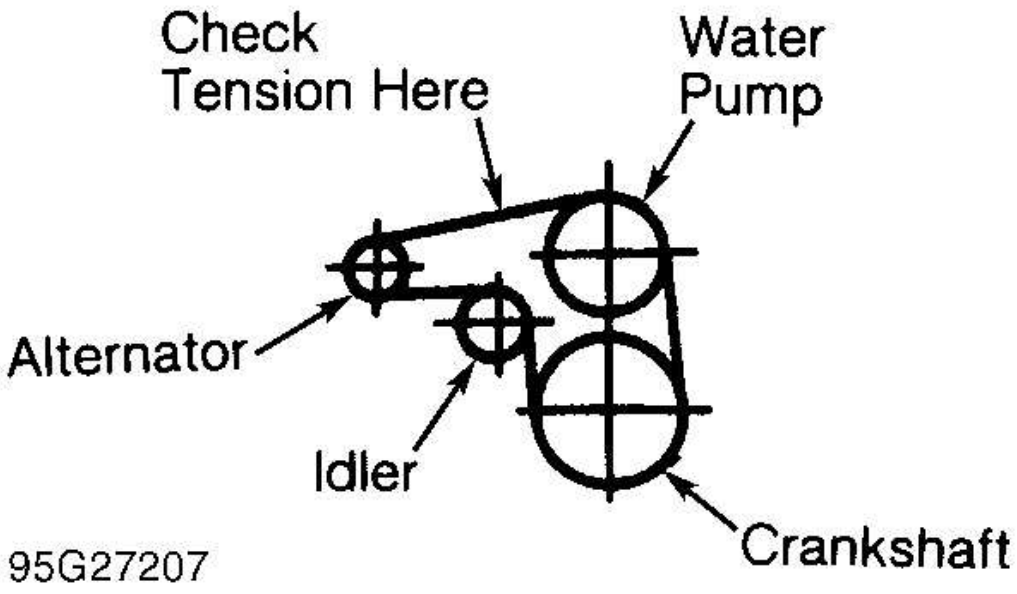


Fig. 4: Drive Belt Routing (2.3L Without A/C Or P/S)
Courtesy of FORD MOTOR CO.

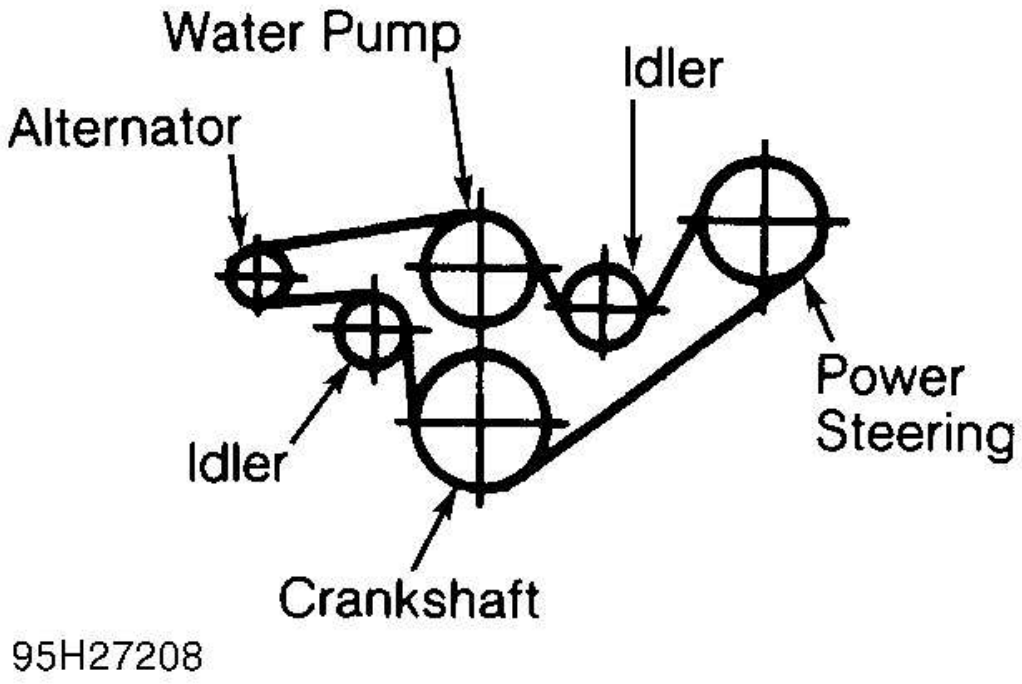


Fig. 5: Drive Belt Routing (2.3L With P/S)
Courtesy of FORD MOTOR CO.

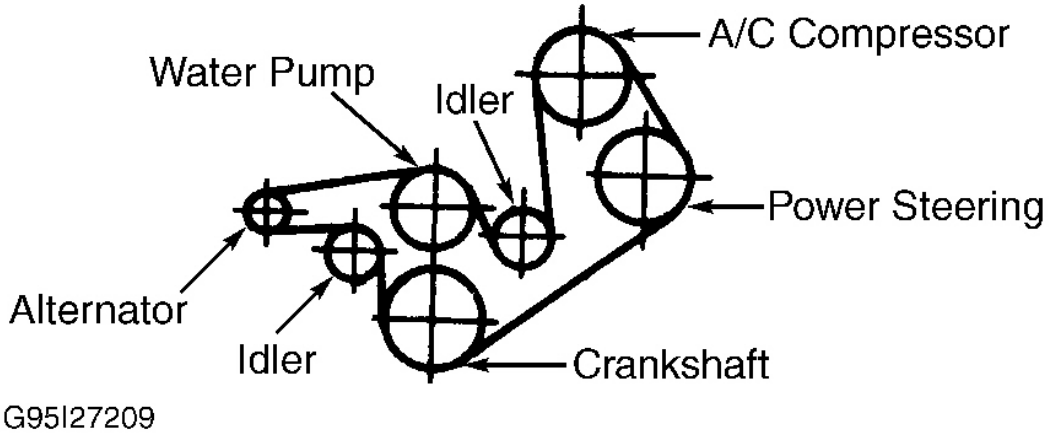


Fig. 6: Drive Belt Routing (2.3L With A/C & P/S)

Courtesy of FORD MOTOR CO.

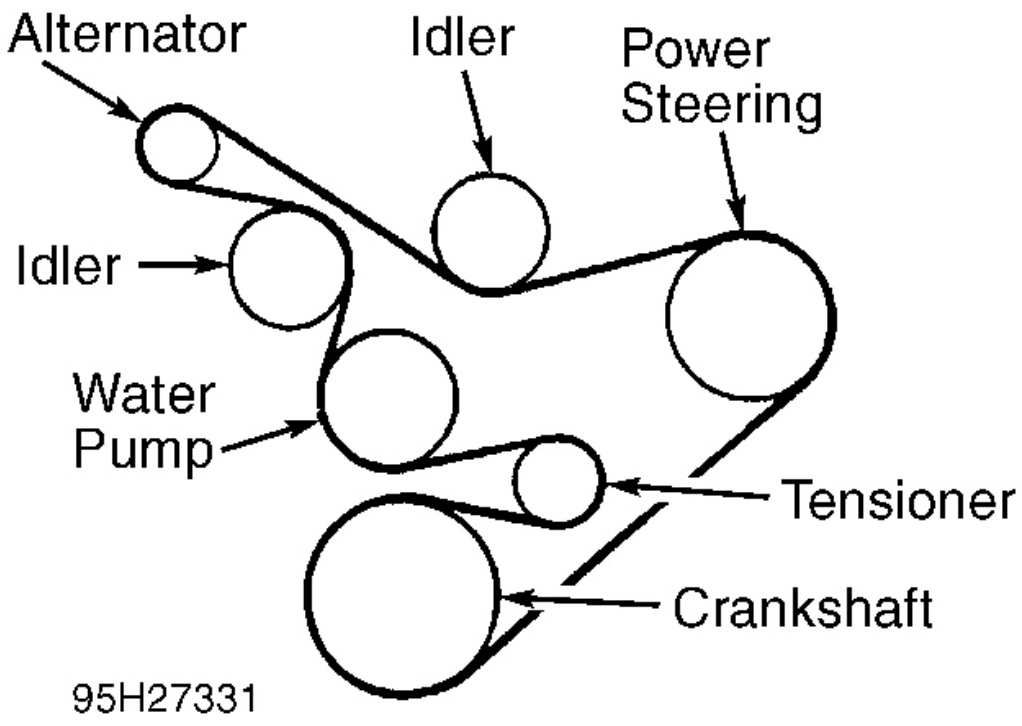


Fig. 7: Drive Belt Routing (3.0L Aerostar & Ranger With P/S)
Courtesy of FORD MOTOR CO.

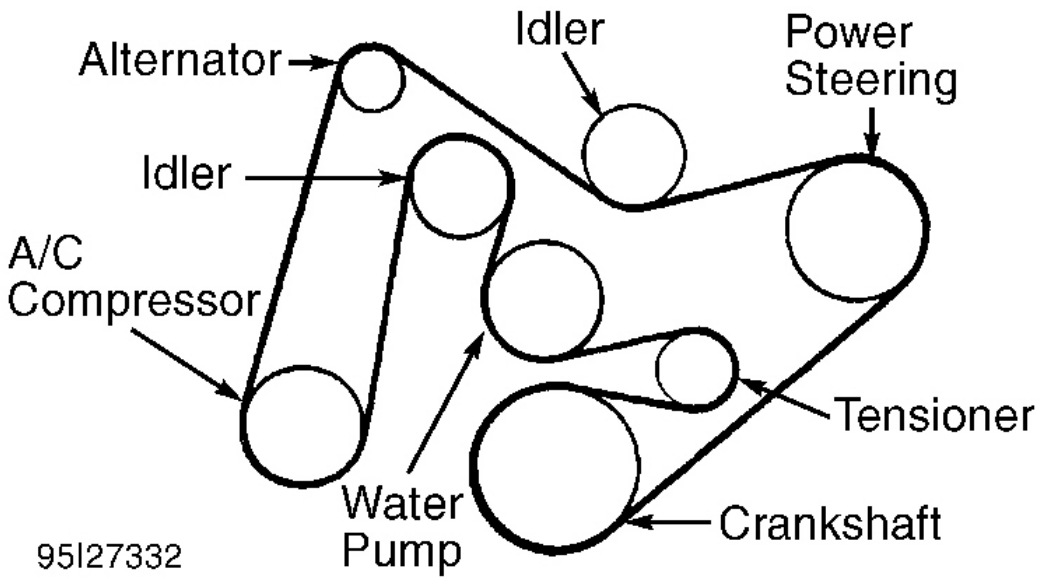


Fig. 8: Drive Belt Routing (3.0L Aerostar & Ranger With A/C & P/S)
Courtesy of FORD MOTOR CO.

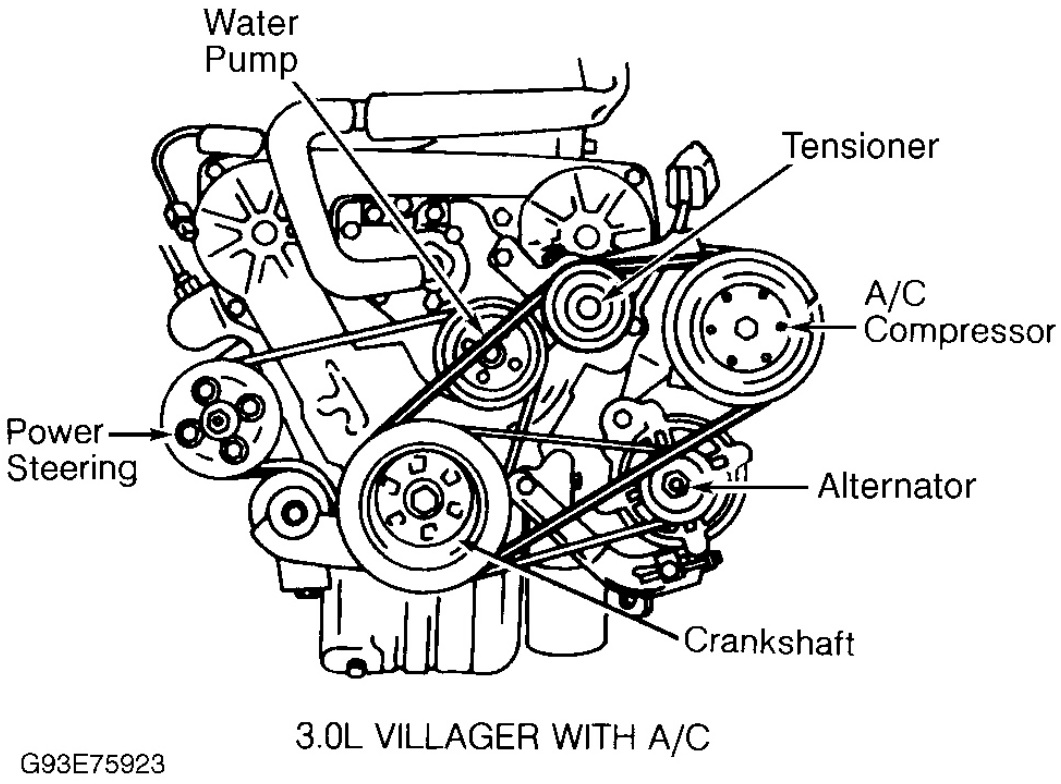


Fig. 9: Drive Belt Routing (3.0L Villager)
Courtesy of FORD MOTOR CO.

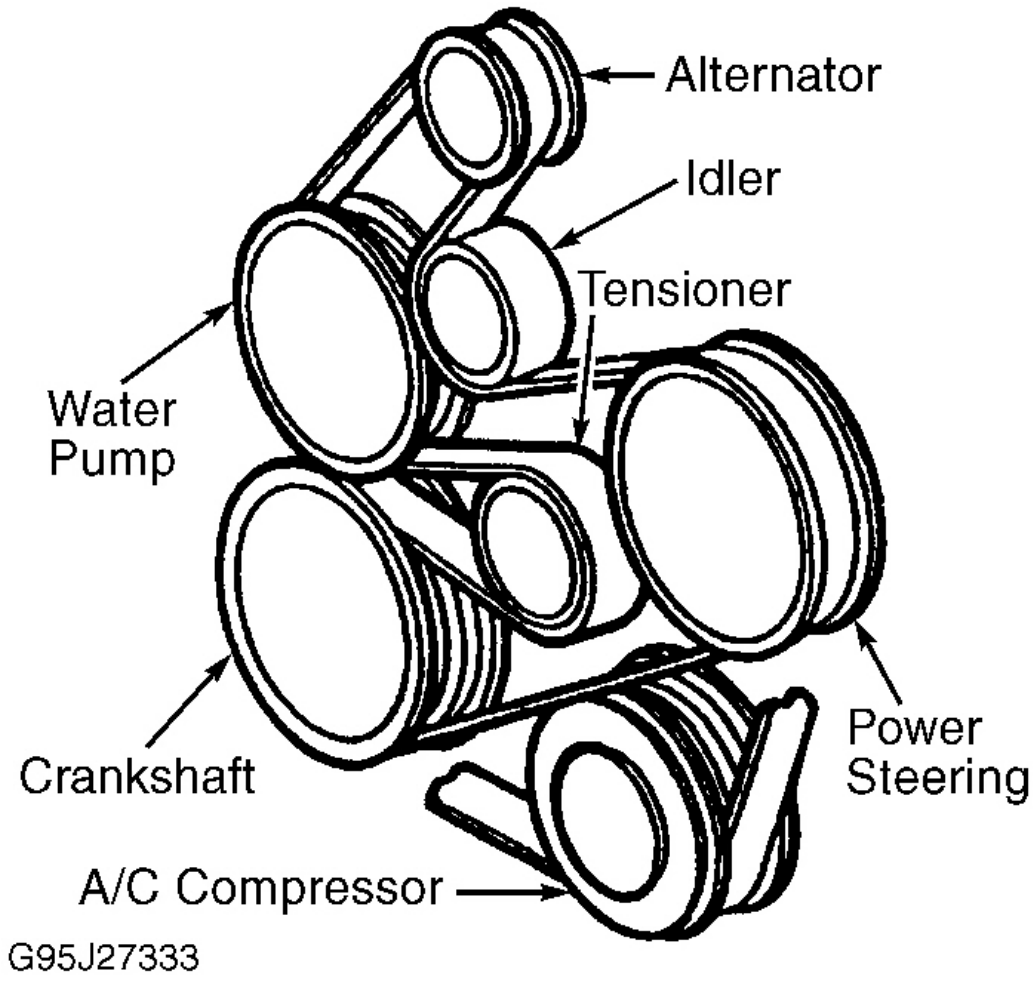


Fig. 10: Drive Belt Routing (3.0L Windstar)
Courtesy of FORD MOTOR CO.

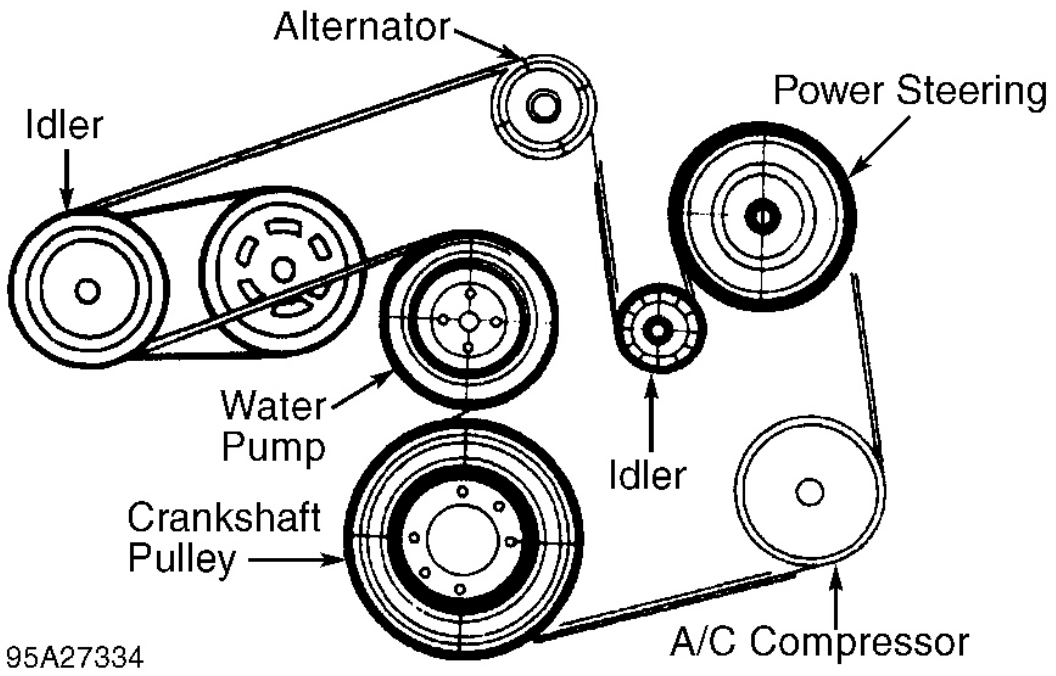
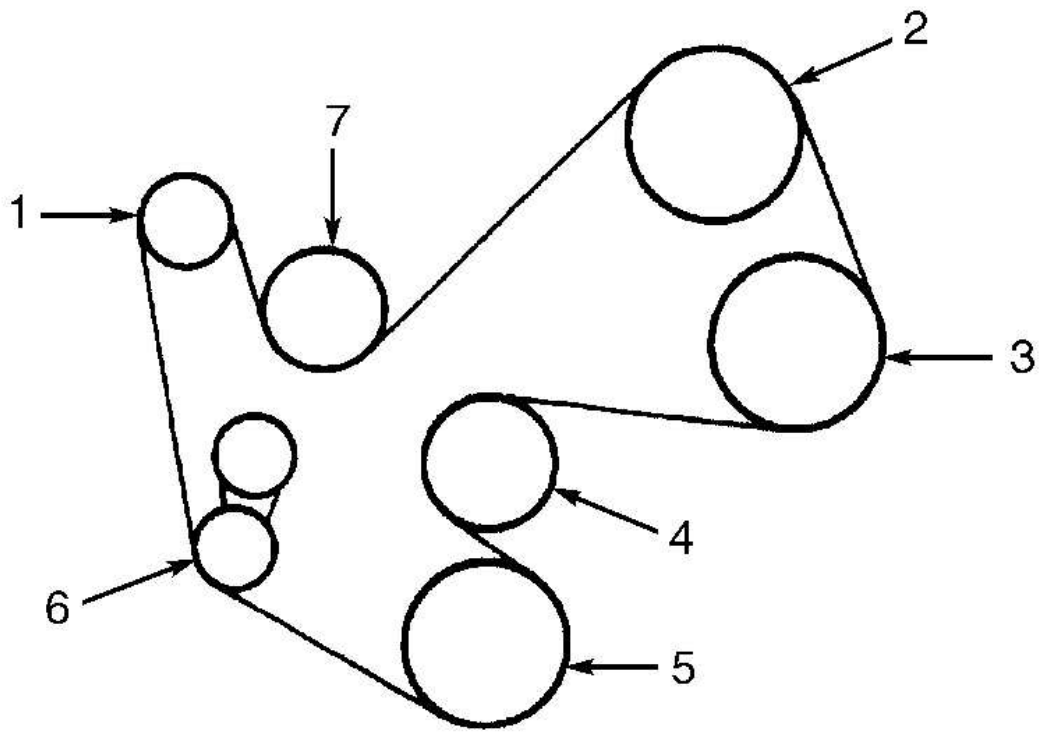


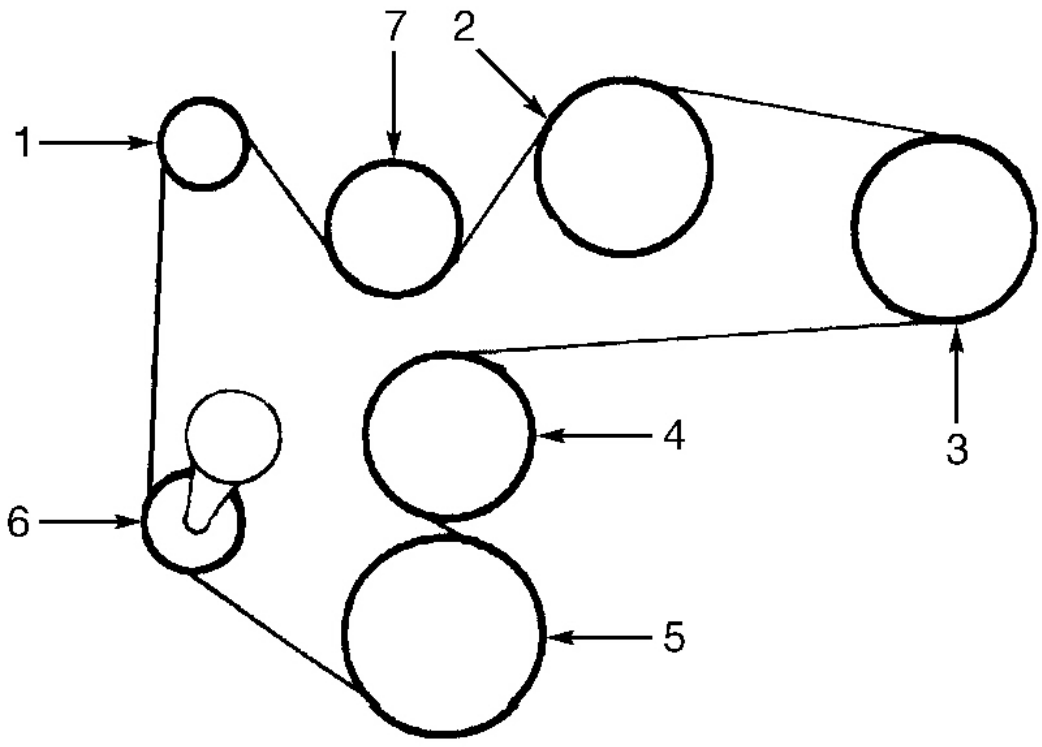
Fig. 11: Drive Belt Routing (3.8L Windstar)
Courtesy of FORD MOTOR CO.



1. Generator
2. Power Steering Pump
3. A/C Compressor
4. Water Pump
5. Crankshaft Pulley
6. Tensioner
7. Idler

G97I28900

Fig. 12: Drive Belt Routing (4.0L OHV Explorer)
Courtesy of FORD MOTOR CO.



1. Generator
2. Power Steering Pump
3. A/C Compressor
4. Water Pump
5. Crankshaft Pulley
6. Tensioner
7. Idler

G97J28901

Fig. 13: Drive Belt Routing (4.0L SOHC Explorer)
Courtesy of FORD MOTOR CO.

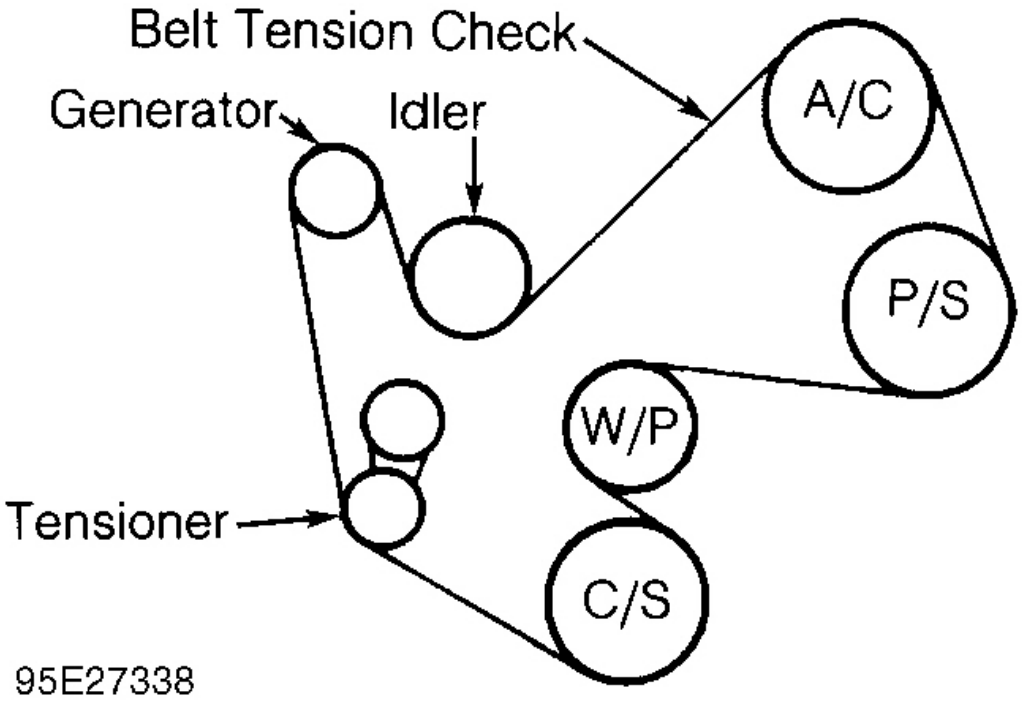


Fig. 14: Drive Belt Routing (4.0L Ranger With A/C & P/S)
Courtesy of FORD MOTOR CO.

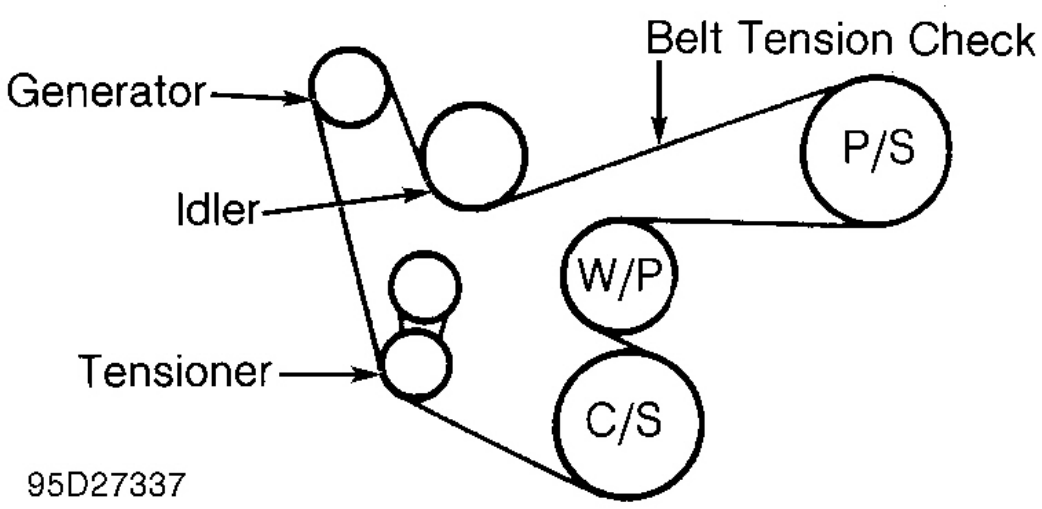


Fig. 15: Drive Belt Routing (4.0L Ranger With P/S)
Courtesy of FORD MOTOR CO.

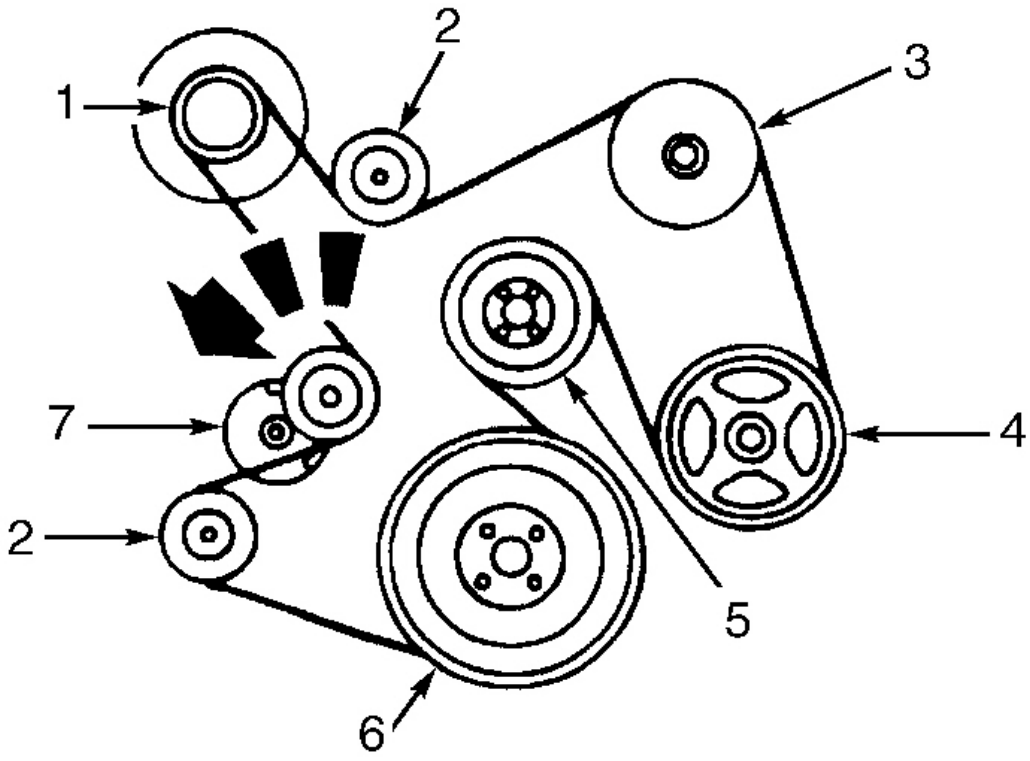


Fig. 16: Drive Belt Routing (4.2L Pickup & Van With A/C - 1997)
Courtesy of FORD MOTOR CO.

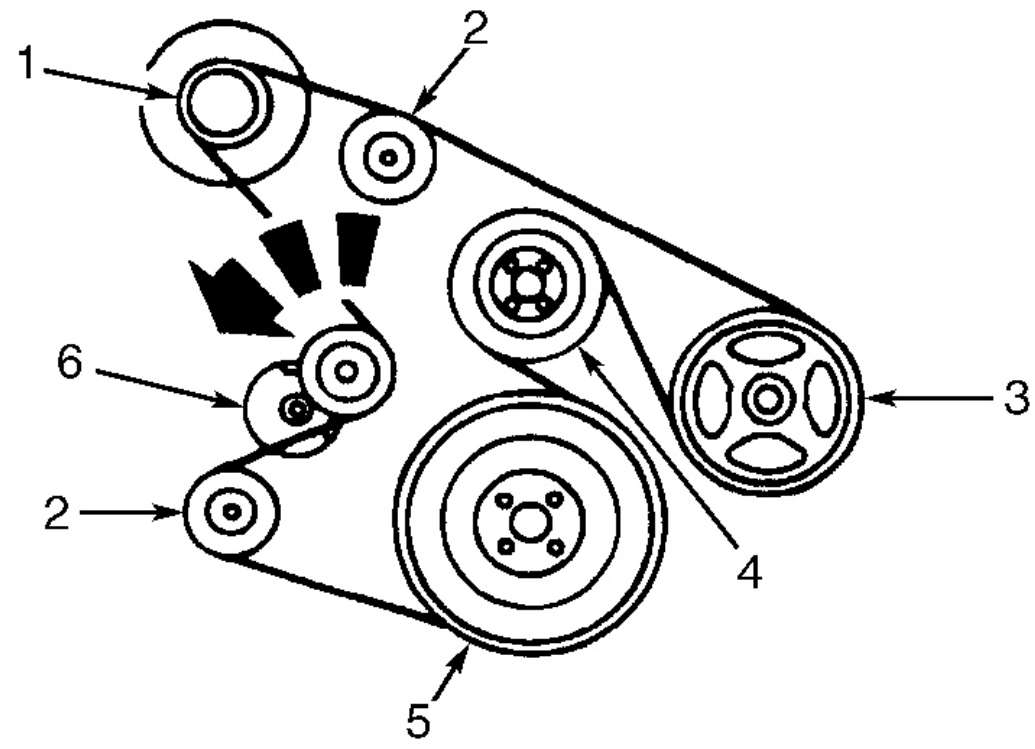
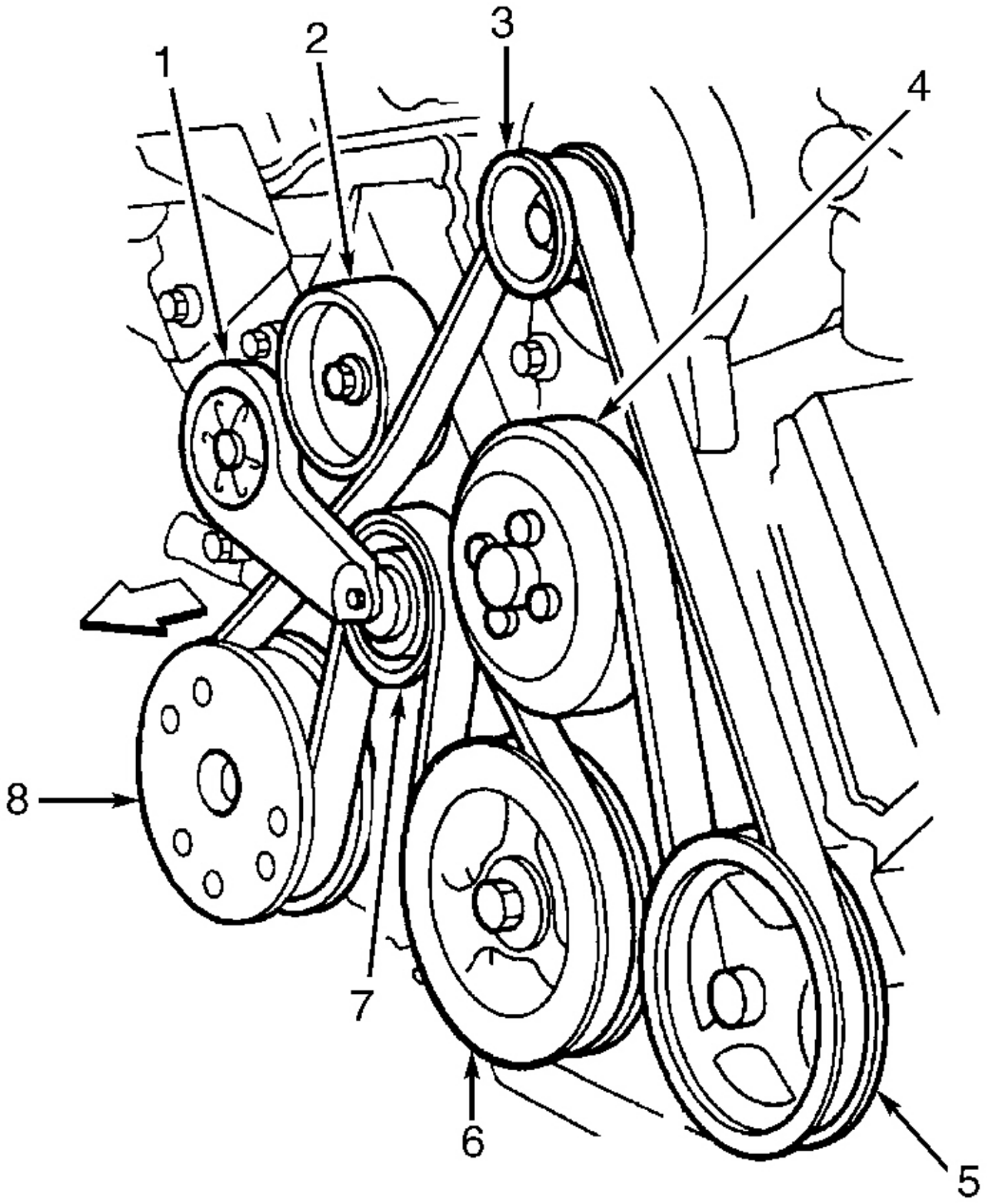


Fig. 17: Drive Belt Routing (4.2L Pickup & Van Without A/C - 1997)
Courtesy of FORD MOTOR CO.



1. Tensioner
2. Idler
3. Generator
4. Water Pump
5. Power Steering
6. Crankshaft Pulley
7. Tensioner
8. A/C Compressor

G97C28904

Fig. 18: Drive Belt Routing (4.6L Expedition)
Courtesy of FORD MOTOR CO.

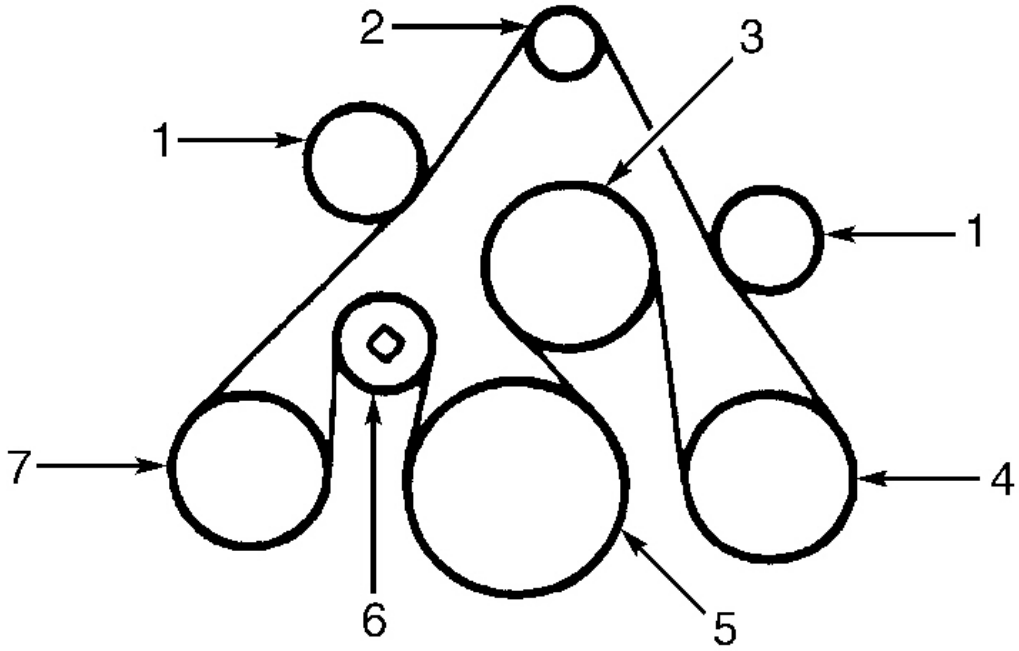


Fig. 19: Drive Belt Routing (4.6L, 5.4L & 6.8L Pickup & Van With A/C - 1997)
Courtesy of FORD MOTOR CO.

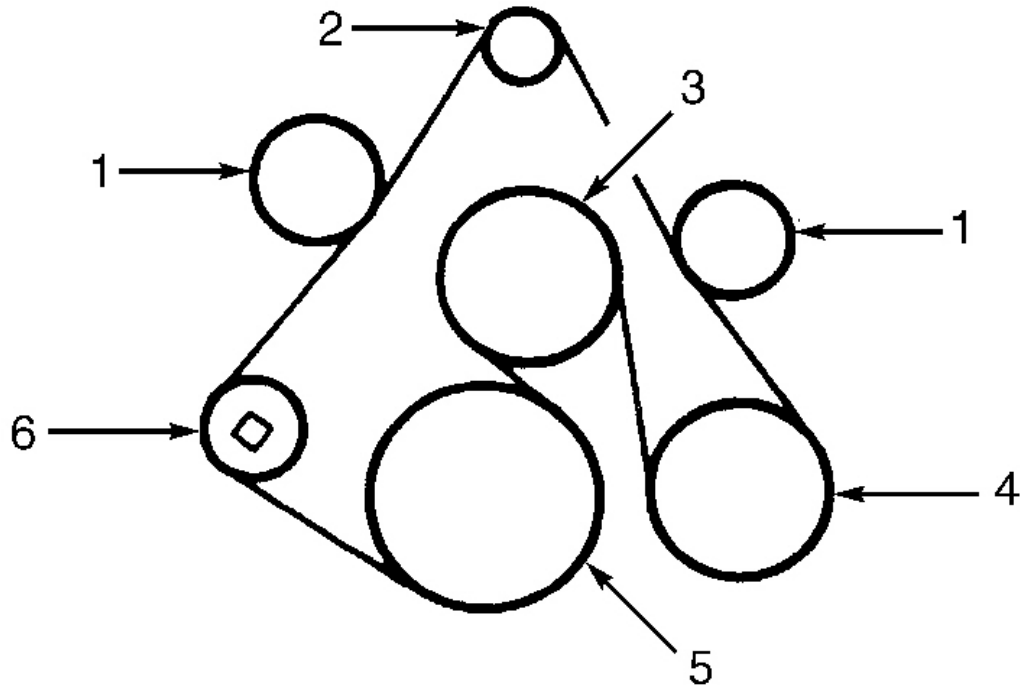


Fig. 20: Drive Belt Routing (4.6L, 5.4L & 6.8L Pickup & Van Without A/C - 1997)
Courtesy of FORD MOTOR CO.

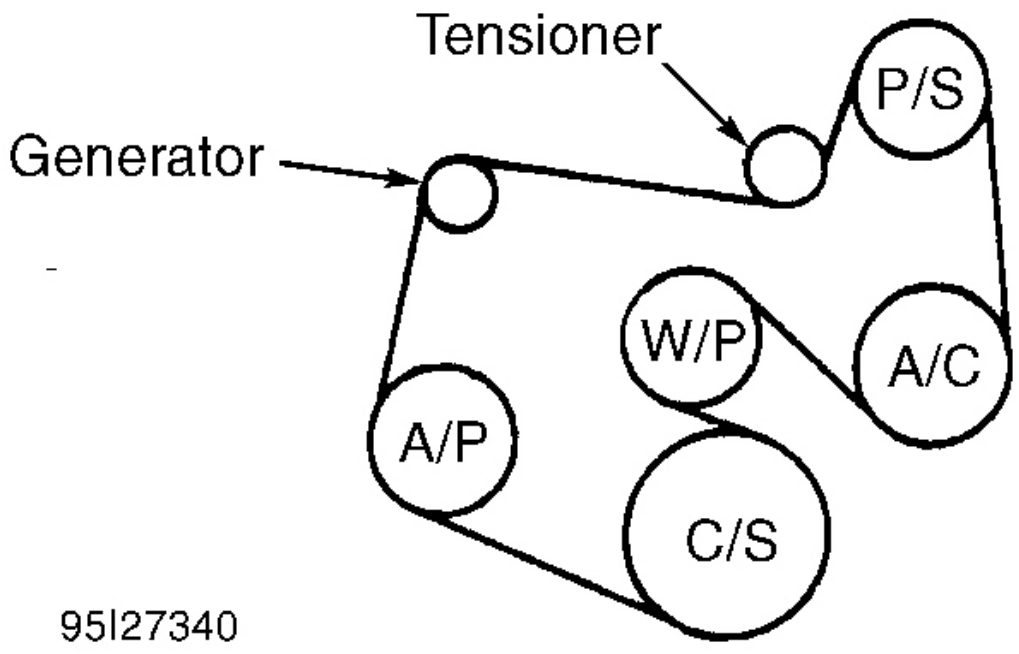


Fig. 21: Drive Belt Routing (4.9L Pickup & Van With A/C & P/S - 1996)
Courtesy of FORD MOTOR CO.

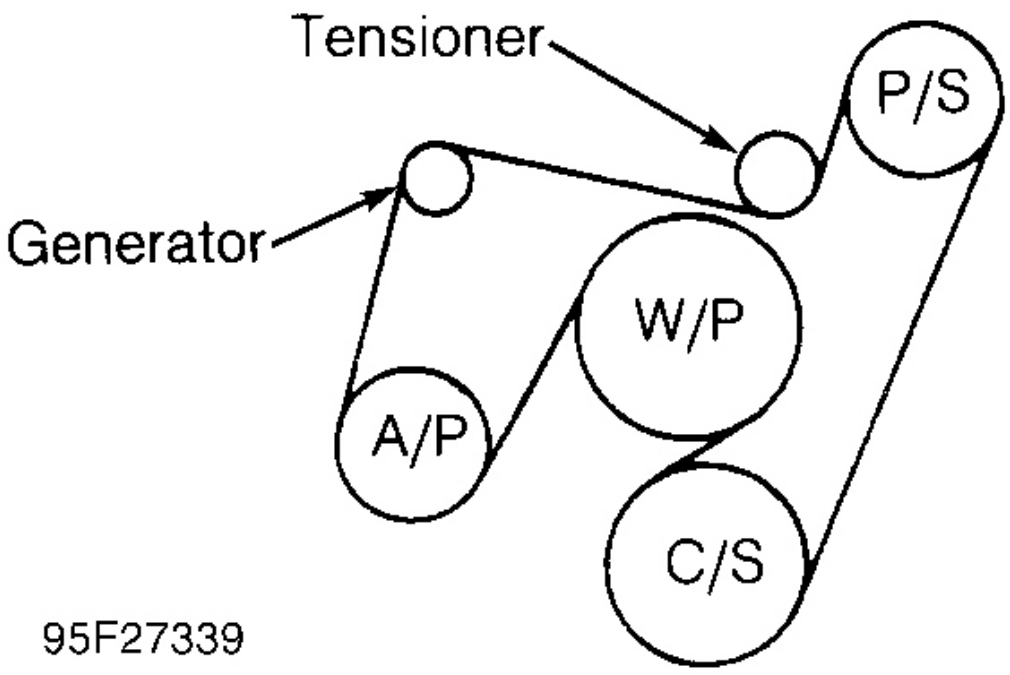
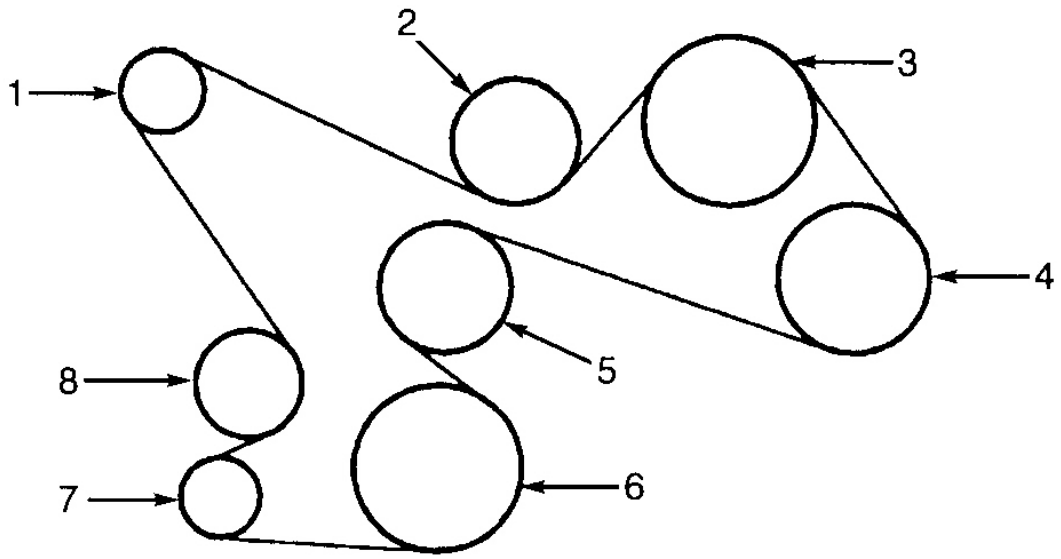


Fig. 22: Drive Belt Routing (4.9L Pickup & Van With P/S - 1996)
Courtesy of FORD MOTOR CO.



1. Generator
2. Idler
3. Power Steering
4. A/C Compressor
5. Water Pump
6. Crankshaft Pulley
7. Idler
8. Tensioner

G97G28908

Fig. 23: Drive Belt Routing (5.0L Explorer & Mountaineer)
Courtesy of FORD MOTOR CO.

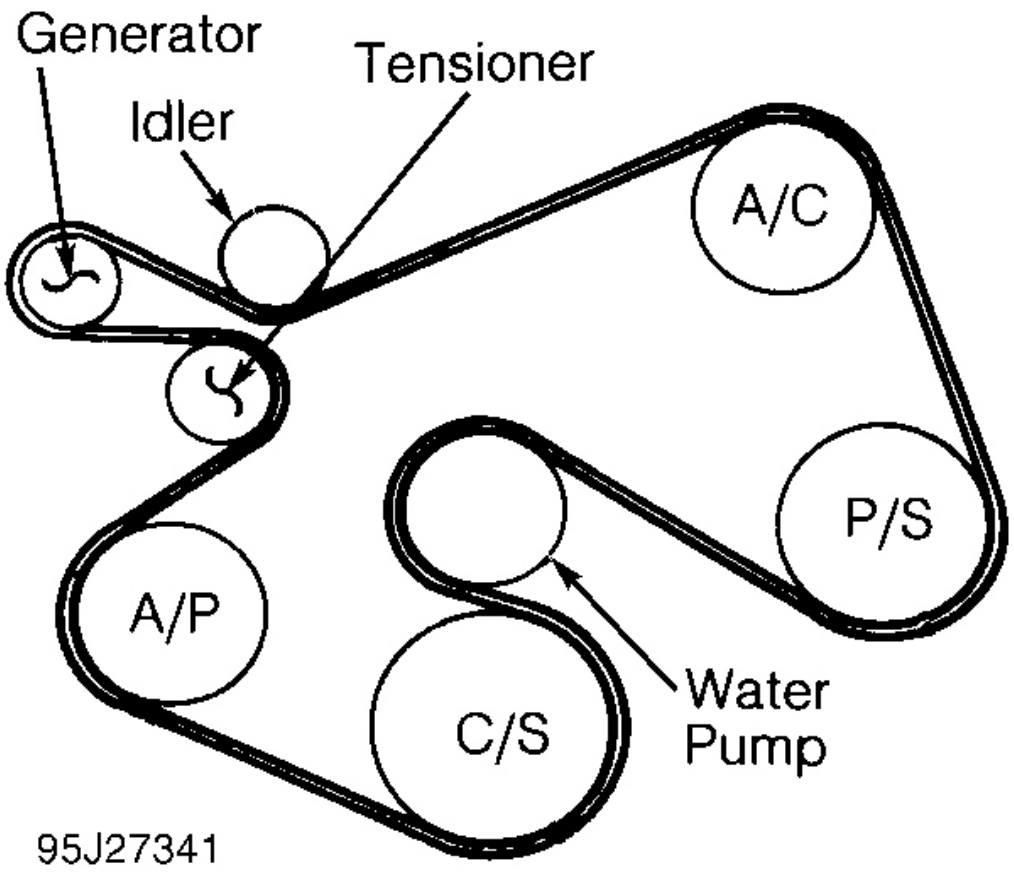
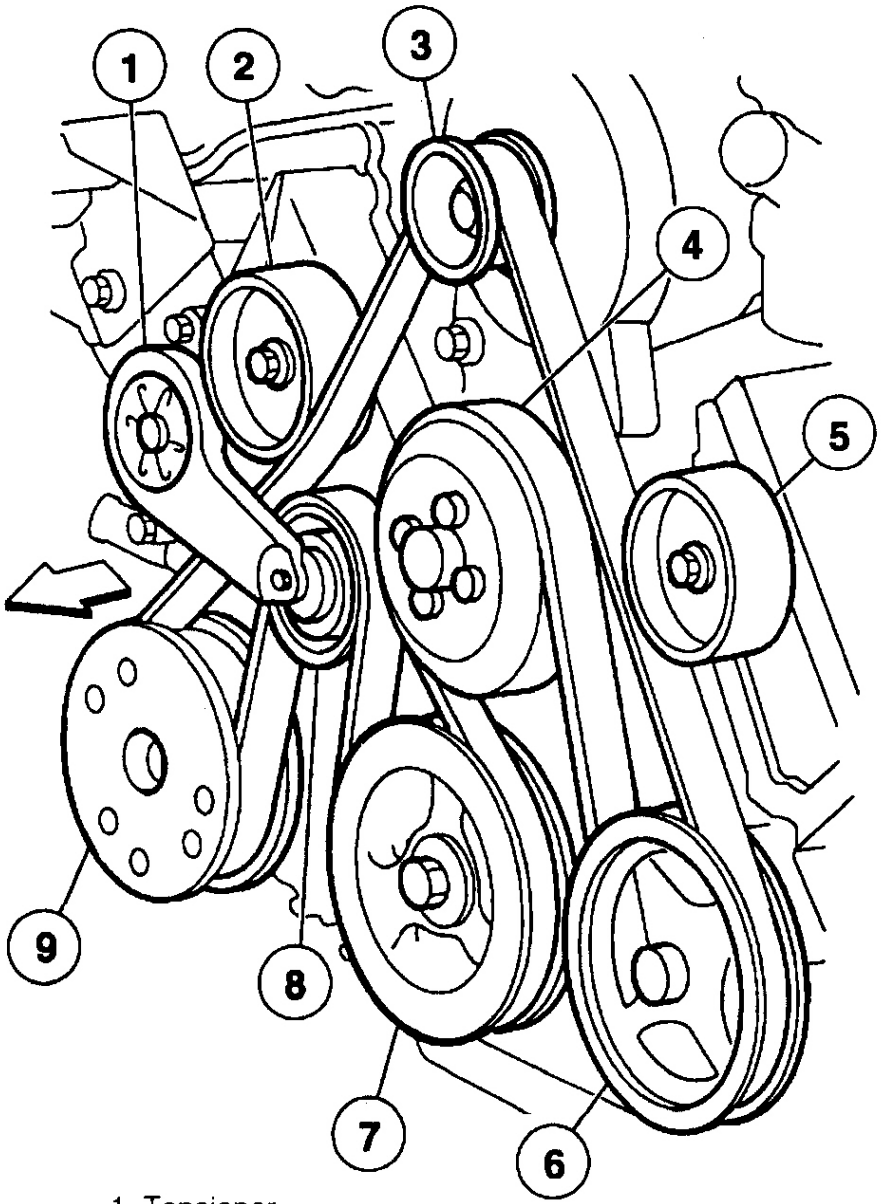


Fig. 24: Drive Belt Routing (5.0L - 1996 & 5.8L Pickup & Van)
Courtesy of FORD MOTOR CO.



1. Tensioner
2. Idler
3. Generator
4. Water Pump
5. Idler
6. Power Steering
7. Crankshaft Pulley
8. Tensioner
9. A/C Compressor

97D28905

Fig. 25: Drive Belt Routing (5.4L Expedition)
Courtesy of FORD MOTOR CO.

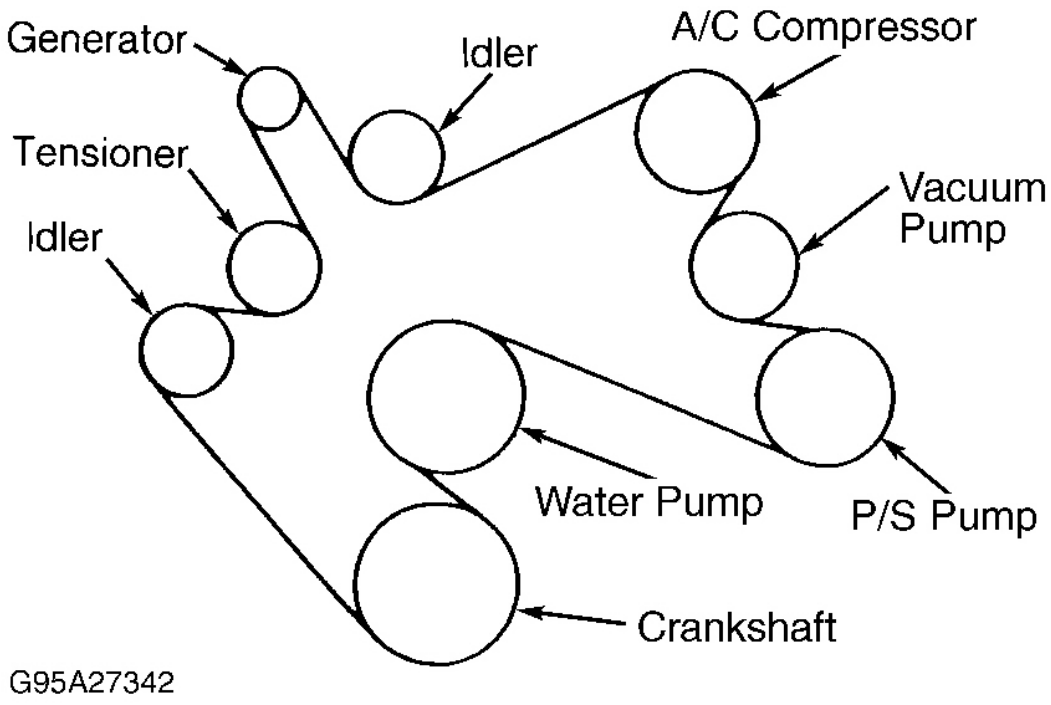


Fig. 26: Drive Belt Routing (7.3L Diesel)
Courtesy of FORD MOTOR CO.

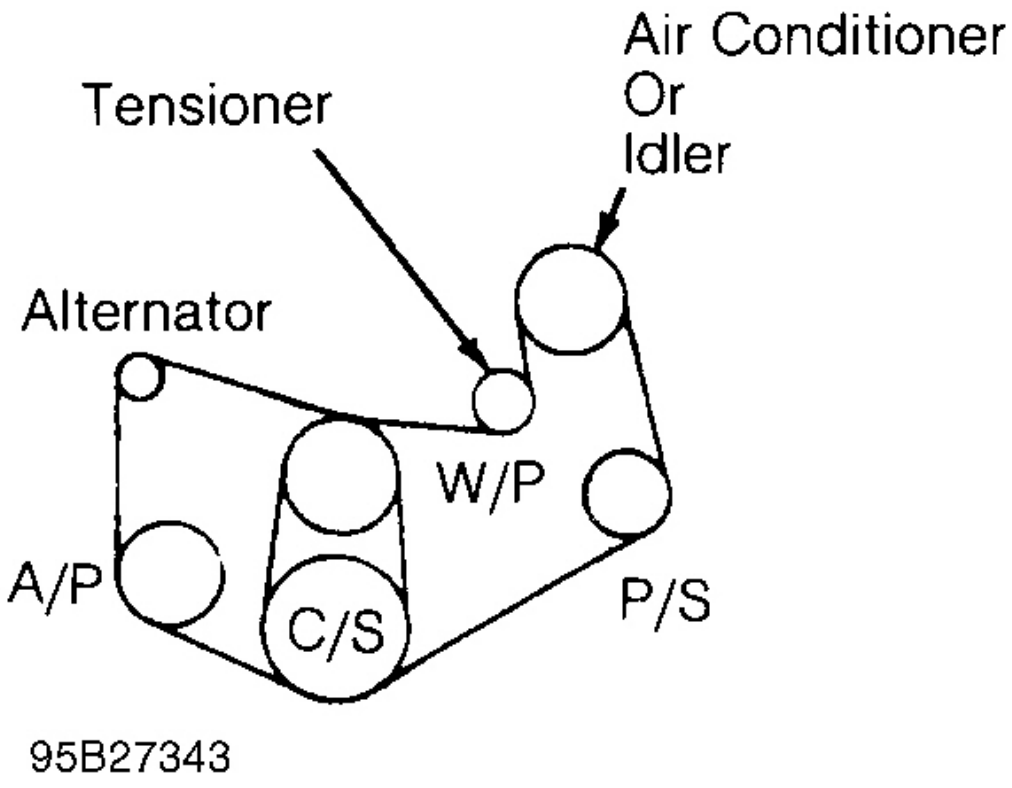


Fig. 27: Drive Belt Routing (7.5L)
Courtesy of FORD MOTOR CO.

SPECIFICATIONS

COOLING SYSTEM SPECIFICATIONS

COOLING SYSTEM SPECIFICATIONS

Application	Specification
Coolant Replacement Interval	
All Models	30,000 Miles Or 36 Months
Coolant Capacity	
Aerostar, Explorer & Ranger	
2.3L	7.2 Qts. (6.8L)
3.0L	11.8 Qts. (11.2L)
4.0L	

Automatic Transmission	
Standard Cooling	7.8 Qts. (7.4L)
A/C & Super Cooling	8.3 Qts. (7.9L)
Manual Transmission	7.8 Qts. (7.4L)
Bronco (1) & Pickup	
4.2L (2)	17.3 Qts. (16.4L)
4.6L & 5.4L (2)	19.4 Qts. (18.4L)
4.9L & 5.0L (1)	13.0-15.0 Qts. (12.0-14.0L)
5.8L	15.0-17.0 Qts. (14.0-16.0L)
7.3L	(3) 29.0 Qts. (27.0L)
7.5L	18.0 Qts. (17.0L)
Expedition (2)	
4.6L	19.2 Qts. (18.2L)
5.4L	(4)
Van	
4.2L (2)	17.3 Qts. (16.4L)
4.9L (1)	17.0 Qts. (16.0L)
4.6L & 5.4L (2)	19.4 Qts. (18.4L)
5.0L (1)	20.0 Qts. (19.0L)
5.8L	
Standard Cooling	20.0 Qts. (19.0L)
A/C Or Super Cooling	23.0 Qts. (20.0L)
6.8L (2)	(4)
7.3L	(3) 31.0 Qts. (29.0L)
7.5L	28.0 Qts. (22.0L)
Villager	
With Rear Heater	12.8 Qts. (12.1L)
Without Rear Heater	11.4 Qts. (10.7L)
Windstar	12.1 Qts. (11.5L)
Pressure Cap	
Econoline & Pickup (1)	(4)
Expedition & Pickup (2)	16 psi (1.1 Kg/cm^2)
Explorer, Mountaineer & Ranger	13-18 psi (.9-1.3 kg/cm^2)
Villager	12-16 psi (.8-1.1 kg/cm^2)
Windstar	16-18 psi (1.1-1.3 kg/cm^2)
All Other Models	13 psi (.9 kg/cm^2)
Thermostat Opens	

All Models (Except Villager)	
Starts	180-195°F (82-91°C)
Fully Open	200-215°F (93-102°C)
Villager	
Starts	180°F (82°C)
Fully Open	195°F (91°C)

(1) For 1996 model year only.

(2) For 1997 model year only.

(3) Includes 5 Qts. (4.7L) in coolant reservoir bottle.

(4) Information is not available from manufacturer.

CRUISE CONTROL SYSTEM

1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Cruise Control Systems

DESCRIPTION

The cruise control system consists of control switches (ON, OFF, SET-ACCEL, COAST and RESUME), servo/actuator assembly, Vehicle Speed Sensor (VSS), deactivator switch and wiring.

OPERATION

ENGAGING & DISENGAGING SYSTEM

System is operational at speeds greater than 30 MPH. When ON and SET-ACCEL switches have been pressed, vehicle speed will be maintained until new speed is set, brake pedal is pressed or OFF switch is pressed.

ADJUSTMENTS

ACTUATOR CABLE

Remove cable retaining clip. Set throttle plate to closed position. Pull actuator cable lightly to take up slack. Back off at least one notch so that there is 0.04" (1.0 mm) slack in cable. While holding cable, insert cable retaining clip. Check throttle operation.

DIAGNOSIS

NOTE: If Malfunction Indicator Light (MIL) is lit or flashes, check PCM for stored Diagnostic Trouble Codes (DTCs). See appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.

Before trouble shooting system, perform complete visual inspection of system. Check all fuses. Check operation of stoplights including high mounted stoplight. Check speedometer operation. Repair as necessary.

SERVO CONNECTOR PIN IDENTIFICATION

The following test procedures make numerous references to various signals on the servo harness connector. See **Fig. 1** . Signal names, pin numbers and wire colors are identified in SERVO CONNECTOR PIN IDENTIFICATION TABLE.

SERVO CONNECTOR PIN IDENTIFICATION

Pin No.	Signal	Wire Color
Expedition		
1	Not Used	Not Used
2	Not Used	Not Used

3	Vehicle Speed Input	GRY/BLK
4	Brake Input (1)	LT GRN
5	Command Switch Signal (2)	LT BLU/BLK
6	Command Switch Return (3)	DK GRN/ORG
7	Vehicle Power	LT BLU/PNK
8	Not Used	Not Used
9	Deactivator Switch (4)	BLK/YEL
10	Ground	BLK
F150/250		
1	Not Used	Not Used
2	Not Used	Not Used
3	Vehicle Speed Input	GRY/BLK
4	Brake Input (1)	TAN/LT BLU
5	Command Switch Signal (2)	LT BLU/BLK
6	Command Switch Return (3)	DK GRN/ORG
7	Vehicle Power	LT BLU/PNK
8	Not Used	Not Used
9	Deactivator Switch (4)	BLK/YEL
10	Ground	BLK

(1) This signal may also be called "brake on/off switch input".

(2) This signal may also be called "speed control switch input".

(3) This signal may also be called "speed control switch ground".

(4) This signal may also be called "brake pressure input".

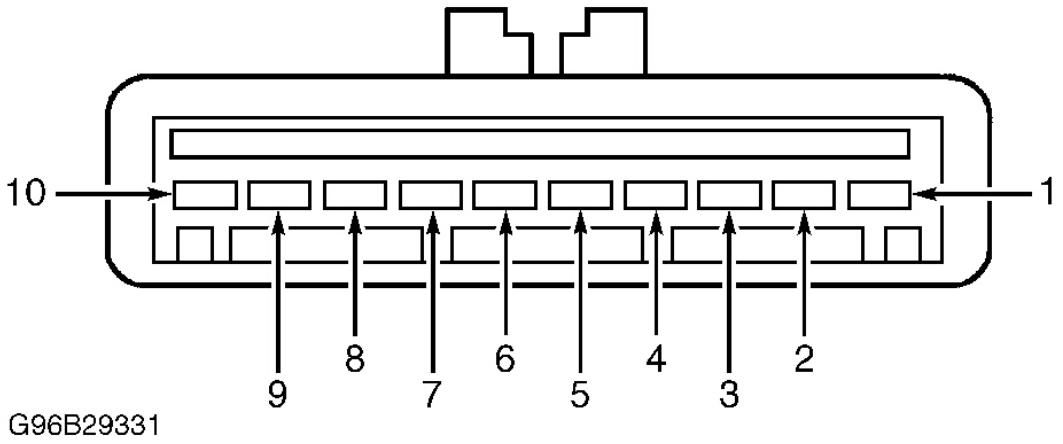


Fig. 1: Identifying Servo/Actuator Harness Connector Terminals

SPEED CONTROL INOPERATIVE

1. **Check Actuator Cable** - Remove snow shield from throttle linkage. Ensure actuator cable is properly connected to throttle body. Correct as necessary and test operation.
2. **Check Servo Power Circuit** - Unplug harness connector from servo located near master cylinder. Turn ignition on. Test for battery voltage between servo harness connector pins No. 7 and 10. See **Fig. 1** . If battery voltage exists, go to step 4). If battery voltage does not exist, check fuse No. 5. Replace fuse if necessary If fuse is okay, go to next step.
3. **Check Servo Ground Circuit** - Turn ignition off. Measure resistance between harness connector pin No. 10 and ground. If resistance is less than 5 ohms, go to next step. If resistance is not less than 5 ohms, repair Black wire to ground.
4. **Check Stoplight Switch** - With brake pedal released, test for voltage between servo harness connector pins No. 4 and 10. If voltage is zero, stoplight switch is okay. Go to next step. If battery voltage exists, replace stoplight switch (switch stuck on).
5. **Check Brake/Clutch Circuit** - Turn ignition off. Measure resistance between servo harness connector pins No. 4 and 10. If resistance is less than 20 ohms, go to next step. If resistance is greater than 20 ohms, check stoplight bulbs (including high mounted stoplight). Replace bulb(s) if necessary. If bulbs are okay, repair stoplight circuit.
6. **Check Deactivator Circuit** - With ignition off and brake pedal released, measure voltage between servo harness connector pins No. 9 and 10. If battery voltage does not exist, go to next step. If battery voltage exists, go to step 10).
7. **Check Deactivator Switch** - Unplug connector from deactivator switch located on or near master cylinder. Measure resistance between switch terminals with brake pedal released. If resistance is less than 5 ohms, go to next step. If resistance is not less than 5 ohms, replace switch, then repeat step 5).
8. **Check Power To Deactivator Switch** - Test for battery voltage at pin No. 1 (Light Green/Red wire) at deactivator switch connector. If battery voltage exists, go to next step. If battery voltage does not exist,

repair open Light Green/Red wire from fuse panel. See appropriate wiring diagram in **WIRING DIAGRAMS** .

9. **Check Deactivator Circuit** - Measure resistance between deactivator switch connector pin No. 2, and pin No. 9 at servo harness connector (Black/Yellow wire). If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, repair Black/Yellow wire.
10. **Check For Stuck ON Switch** - With no steering wheel switches pressed, measure voltage between servo harness connector pins No. 5 and 10. If voltage is less than 10 volts, go to next step. If voltage is greater than 10 volts, replace speed control command (ON/OFF) switch.
11. **Check Command Switch Operation** - With speed control ON switch depressed, measure voltage between servo harness connector pins No. 5 and 10. If voltage is less than 10 volts, go to next step. If voltage is greater than 10 volts, go to step 13).
12. **Check ON Circuit** - Press horn switch while measuring voltage between servo connector pin No. 6 (Dark Green/Orange wire) and ground. If battery voltage exists, replace ON switch. If battery voltage does not exist, repair open power feed wire from power distribution box or open switch ground wire. See **WIRING DIAGRAMS** .
13. **Check For Stuck Command Switches** - Measure resistance between servo connector Pins No. 5 (Light Blue/Black wire) and 6 (Dark Green/Orange wire). If resistance is greater than 3000 ohms, go to next step. If resistance is less than 3000 ohms, repair or replace stuck command switch(es).
14. **Check SET/ACCEL Switch** - With SET-ACCEL switch pressed, measure resistance between servo harness connector pins No. 5 (Light Blue/Black wire) and No. 6 (Dark Green/Orange wire). If resistance is 640-720 ohms, SET-ACCEL switch is okay. Go to next step. If resistance is not 640-720 ohms, replace SET-ACCEL switch.
15. **Check VSS Circuit** - Disconnect Vehicle Speed Sensor (VSS). Measure resistance of Gray/Black wire between servo harness connector terminal No. 3 and VSS harness connector. If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, repair open Gray/Black wire.
16. **Check For Broken Actuator Cable** - Disengage throttle actuator cable from servo. Inspect for broken cable by pulling end of cable and observing throttle movement. Replace cable if broken or binding. If cable is okay, replace servo.

SET SPEED FLUCTUATES

1. **Check Speedometer Operation** - Test drive vehicle. If speedometer needle does not waver, go to next step. If speedometer needle wavers more than 2 MPH from true speed, fault may exist in Vehicle Speed Sensor (VSS).
2. **Check Actuator Cable** - Inspect actuator cable and throttle linkage for binding. Repair as necessary. If no binding exists, replace servo.

CRUISE DOES NOT TURN OFF WHEN BRAKES ARE APPLIED

1. **Check Actuator Cable** - Turn ignition off. Inspect actuator cable and throttle linkage for binding. Repair as necessary. If no binding exists, go to next step.
2. **Check Stoplight Circuit** - Disconnect servo harness connector. While applying brake pedal, test for battery voltage between servo harness connector pins No. 4 and 10. If battery voltage exists, temporarily substitute known-good servo, then retest system. If battery voltage does not exist, repair stoplight switch circuit.

COAST FUNCTION INOPERATIVE

1. **Check COAST Switch** - Turn ignition off. Unplug 10-pin connector from servo. While pressing COAST switch, measure resistance between servo harness connector pins No. 5 and 6. Rotate steering wheel through full range while making measurement. If resistance is 114-126 ohms, switch is okay. Go to next step. If resistance is not 114-126 ohms, replace switch. If resistance fluctuates while turning steering wheel, replace clockspring assembly.
2. **Check Switch Return Circuit For Short** - Measure resistance between servo harness connector pins No. 6 and 10. If resistance is less than 10 k/ohms, repair Dark Green/Orange wire for short to ground. If resistance is greater than 10 k/ohms, replace servo.

ACCEL FUNCTION INOPERATIVE

1. **Check SET/ACCEL Switch** - Turn ignition off. Unplug 10-pin connector from servo. While pressing ACCEL switch, measure resistance between servo harness connector pins No. 5 and 6. Rotate steering wheel through full range while making measurement. If resistance is 646-714 ohms, switch is okay. Go to next step. If resistance is not 646-714 ohms, replace switch. If resistance fluctuates while turning steering wheel, replace clockspring assembly.
2. **Check Switch Return Circuit For Short** - Measure resistance between servo harness connector pins No. 6 and 10. If resistance is less than 10 k/ohms, repair Dark Green/Orange wire for short to ground. If resistance is greater than 10 k/ohms, replace servo.

RESUME FUNCTION INOPERATIVE

1. **Check RESUME Switch** - Turn ignition off. Unplug 10-pin connector from servo. While pressing RESUME switch, measure resistance between servo harness connector pins No. 5 and 6. Rotate steering wheel through full range while making measurement. If resistance is 2090-2310 ohms, switch is okay. Go to next step. If resistance is not 2090-2310 ohms, replace switch. If resistance fluctuates while turning steering wheel, replace clockspring assembly.
2. **Check Switch Return Circuit For Short** - Measure resistance between servo harness connector pins No. 6 and 10. If resistance is less than 10 k/ohms, repair Dark Green/Orange wire for short to ground. If resistance is greater than 10 k/ohms, replace servo.

SPEED CONTROL WILL NOT TURN OFF WITH OFF SWITCH

Turn ignition off. Unplug 10-pin connector from servo. While pressing OFF switch, measure resistance between servo harness connector pins No. 5 and 6. Rotate steering wheel through full range while making measurement. If resistance is less than 4 ohms, replace servo. If resistance is greater than 4 ohms, replace switch.

REMOVAL & INSTALLATION

WARNING: Disable air bag system before working around steering column or removing any air bag system component. See appropriate AIR BAG RESTRAINT SYSTEM article.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

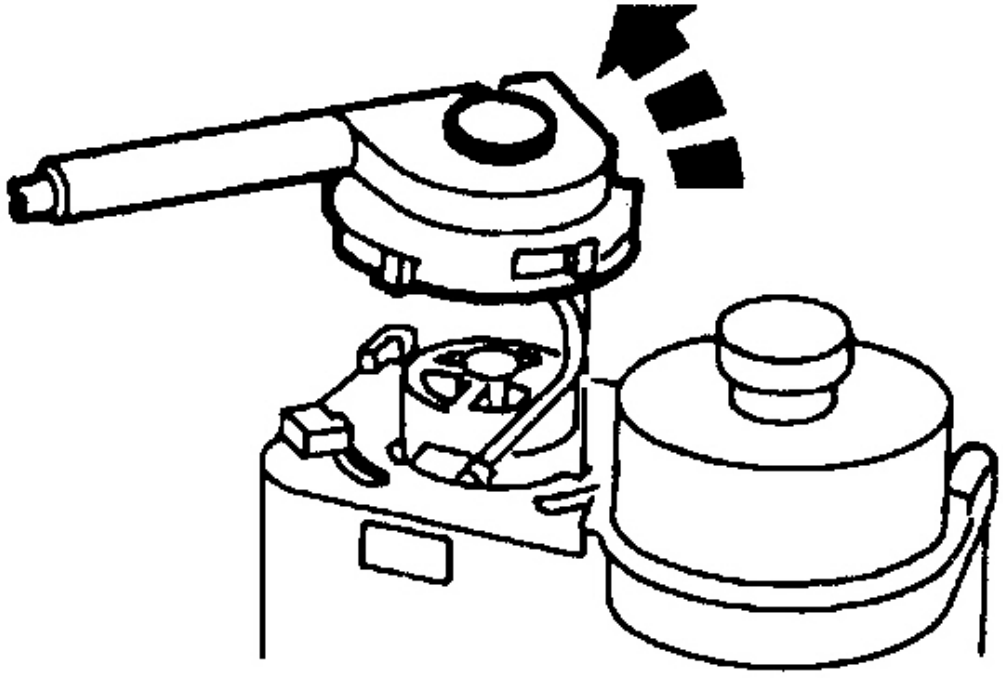
SERVO

Removal

Remove speed control bracket mounting screws. Unplug connector from servo. Push and rotate servo cable cap counterclockwise. See **Fig. 2** . Disengage cable ball from servo pulley. If necessary, disconnect cable from throttle body.

Installation

Connect wire harness. While pressing accelerator pedal, lock cable ball into servo pulley. Insert locking tabs into servo. Install actuator and bracket. To complete installation, reverse removal procedure. Adjust cable. See **ACTUATOR CABLE** under ADJUSTMENTS.



G96C29332

Fig. 2: Removing Cable From Servo
Courtesy of FORD MOTOR CO.

COMMAND SWITCHES

WARNING: Observe all air bag service precautions. Disable air bag system. See SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM in appropriate AIR BAG RESTRAINT SYSTEM article.

Removal

1. Disable air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM in appropriate AIR BAG RESTRAINT SYSTEM article. Remove air bag nuts and washers from steering wheel. Unplug air bag connector from clockspring (contact assembly). Remove air bag module.

WARNING: Place air bag module on bench with trim cover facing upward.

2. Unplug horn/speed control harness connector from clockspring. Release retaining clips from switches. Disconnect switch harness connectors. Remove switches.

Installation

Install switches in steering wheel. Connect air bag module wiring connector to clockspring (contact assembly). Position air bag module onto steering wheel. Install air bag module nuts and washers. Activate air bag system. Observe AIR BAG warning light to verify system is functioning properly. See SYSTEM OPERATION CHECK in appropriate AIR BAG RESTRAINT SYSTEM article.

DEACTIVATOR (BRAKE PRESSURE) SWITCH

Removal & Installation

Deactivator switch is located near left frame rail, below floor pan, or beneath master cylinder. Unplug harness connector. Unscrew switch. To install, reverse removal procedure. Bleed brake system. See BRAKE SYSTEM article in BRAKES system.

WIRING DIAGRAMS

1997 Ford Pickup F150

CRUISE CONTROL SYSTEM 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Cruise Control Systems

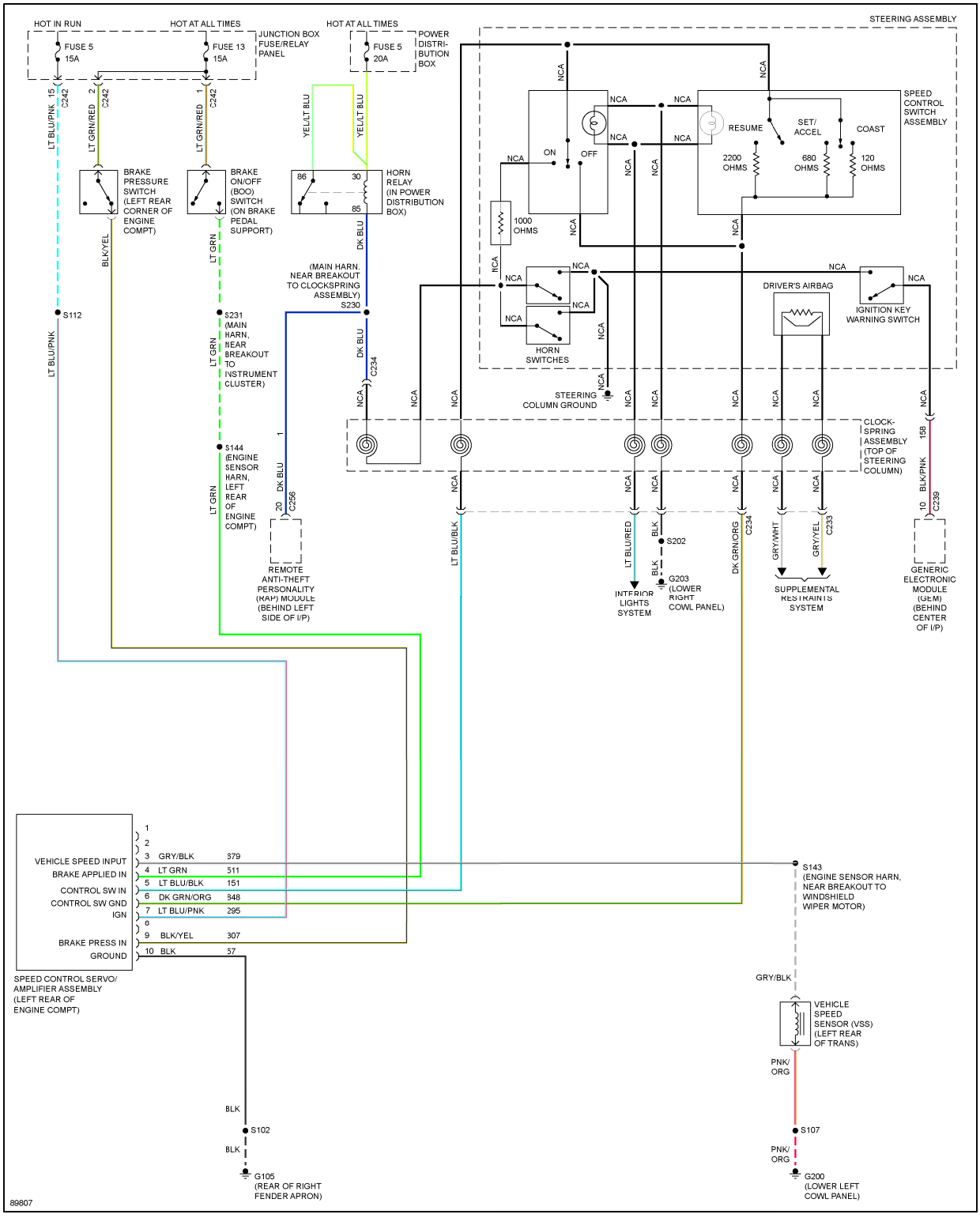


Fig. 3: Cruise Control System Wiring Diagram (Expedition)

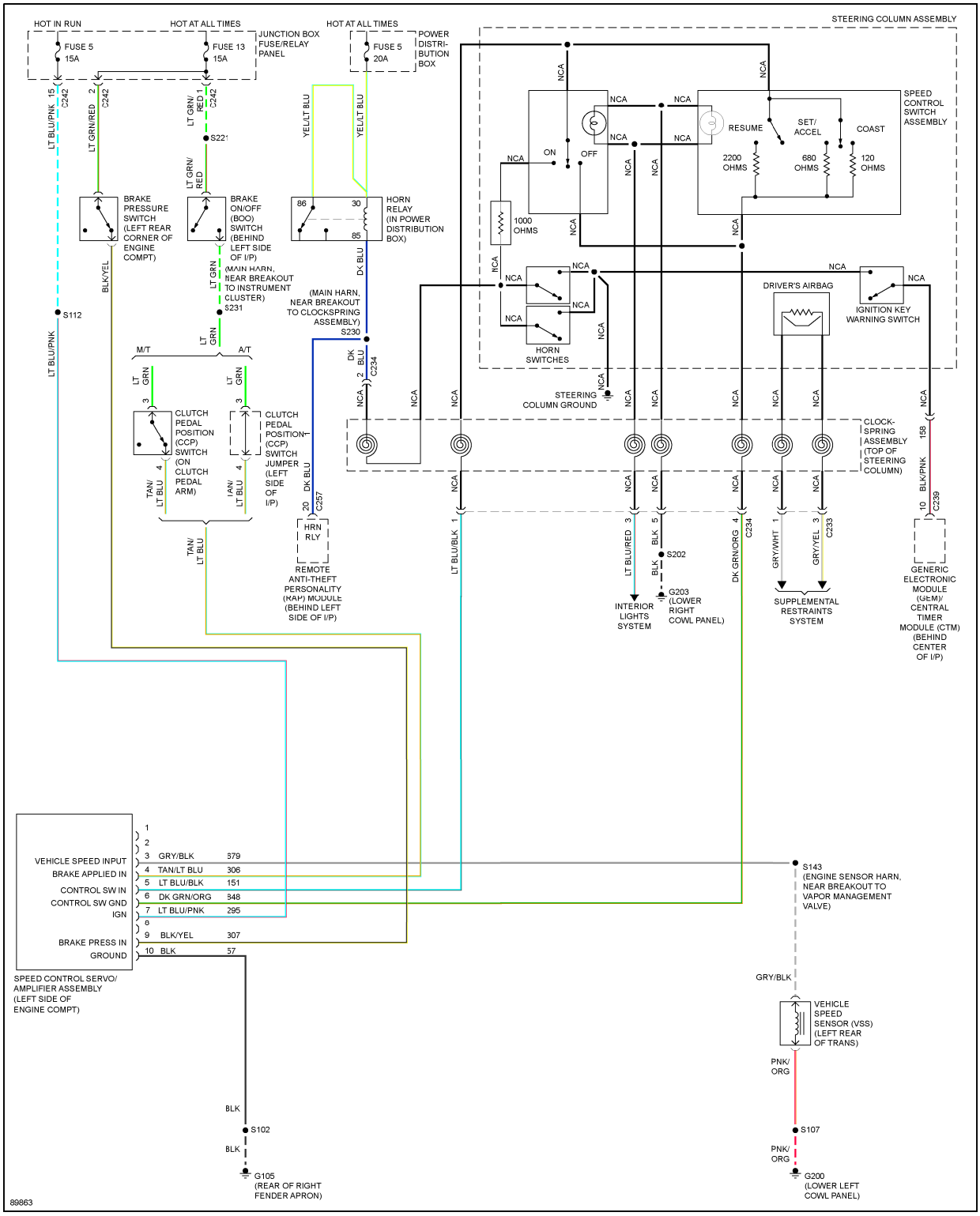

HOT IN RUN
HOT AT ALL TIMES
JUNCTION BOX FUSE/RELAY PANEL
FUSE 5 15A
FUSE 13 15A
HOT AT ALL TIMES
POWER DISTRI-BUTION BOX
FUSE 5 20A
STEERING COLUMN ASSEMBLY
SPEED CONTROL SWITCH ASSEMBLY
RESUME
SET/ ACCEL
COAST
ON
OFF
2200 OHMS
680 OHMS
120 OHMS
1000 OHMS
NCA
LT BLU/PNK
LT GRN/RED
LT GRN/ RED
YEL/LT BLU
BRAKE PRESSURE SWITCH (LEFT REAR CORNER OF ENGINE COMPT)
BRAKE ON/OFF (BOO) SWITCH (BEHIND LEFT SIDE OF I/P)
HORN RELAY (IN POWER DISTRIBUTION BOX)
(MAIN HARN, NEAR BREAKOUT TO INSTRUMENT CLUSTER)
(MAIN HARN, NEAR BREAKOUT TO CLOCKSPRING ASSEMBLY)
BLK/YEL
DK BLU
LT GRN
S112
S221
S231
S230
M/T
A/T
CLUTCH PEDAL POSITION (CCP) SWITCH (ON CLUTCH PEDAL ARM)
CLUTCH PEDAL POSITION (CCP) SWITCH JUMPER (LEFT SIDE OF I/P)
TAN/ LT BLU
HRN RLY
REMOTE ANTI-THEFT PERSONALITY (RAP) MODULE (BEHIND LEFT SIDE OF I/P)
HORN SWITCHES
STEERING COLUMN GROUND
DRIVER'S AIRBAG
IGNITION KEY WARNING SWITCH
CLOCK-SPRING ASSEMBLY (TOP OF STEERING COLUMN)
BLK/PNK
LT BLU/BLK
LT BLU/RED
BLK
S202
G203 (LOWER RIGHT COWL PANEL)
INTERIOR LIGHTS SYSTEM
DK GRN/ORG
GRY/WHT
GRY/YEL
SUPPLEMENTAL RESTRAINTS SYSTEM
GENERIC ELECTRONIC MODULE (GEM)/ CENTRAL TIMER MODULE (CTM) (BEHIND CENTER OF I/P)
VEHICLE SPEED INPUT
BRAKE APPLIED IN
CONTROL SW IN
CONTROL SW GND
IGN
BRAKE PRESS IN
GROUND
GRY/BLK 579
TAN/LT BLU 306
LT BLU/BLK 151
DK GRN/ORG 548
LT BLU/PNK 295
BLK/YEL 307
BLK 57
SPEED CONTROL SERVO/ AMPLIFIER ASSEMBLY (LEFT SIDE OF ENGINE COMPT)
S143 (ENGINE SENSOR HARN, NEAR BREAKOUT TO VAPOR MANAGEMENT VALVE)
GRY/BLK
VEHICLE SPEED SENSOR (VSS) (LEFT REAR OF TRANS)
PNK/ ORG
S102
S107
G105 (REAR OF RIGHT FENDER APRON)
G200 (LOWER LEFT COWL PANEL)
89863

Fig. 4: Cruise Control System Wiring Diagram (F150 & F250 Light-Duty)

DOOR LOCKS & TRUNK RELEASE - POWER

1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Door Locks & Trunk Release

DESCRIPTION & OPERATION

NOTE: Unless specified otherwise, references to F350 include F350 Super Duty.

Power door lock system consists of power door lock switches, door lock actuators, and necessary wiring. Switches are located in front door trim panels. To lock all doors, press switch on either door to lock position. To unlock all doors, press switch to unlock position.

TROUBLE SHOOTING

Manufacturer's sequence for diagnosing and repairing power door lock system is as follows:

- Verify customer's complaint.
- Perform visual inspection.
- Perform INITIAL CHECKS.
- If symptom remains after performing initial checks, determine symptom(s) and go to **SYMPTOM TESTS** .

INITIAL CHECKS

Check all system related fuses. See **WIRING DIAGRAMS** . Operate all switches. Check battery condition and battery terminals. Check connectors for loose or corroded terminals. Check for good clean connections at chassis ground point locations. See **WIRING DIAGRAMS** . Correct any obvious problems before performing **SYMPTOM TESTS** .

SYMPTOM TESTS

F150 & F250 LIGHT-DUTY

SYMPTOM-TO-TEST MENU CHART (F150 & F250 LIGHT-DUTY)

Symptom	Perform Symptom Test
One Power Door Lock Inoperative	A
All Power Door Locks Inoperative	B
All Power Door Locks Operate From One Switch Only	D
Power Door Locks Operate Only With Engine Running	H

F250 HEAVY-DUTY & F350

SYMPTOM-TO-TEST MENU CHART (F250 HEAVY-DUTY & F350)

Symptom	Perform Symptom Test
One Power Door Lock Inoperative	A
All Power Door Locks Inoperative	C
All Power Door Locks Operate From One Switch Only	E
Power Door Locks Operate In One Direction Only	F
Power Door Locks Operate Intermittently	G

NOTE: Door lock actuator may also be referred to as door lock motor.

TEST A: ONE POWER DOOR LOCK INOPERATIVE

1. Manually operate inoperative door lock and check for binding or sticking lock. If door lock is not binding or sticking, go to next step. If door lock is binding or sticking, repair as necessary and recheck system operation.
2. Remove door trim panel and disconnect suspect door lock actuator connector. Connect a test light between ground and Pink/Black wire at door lock actuator connector. Press door lock switch to lock position. If test light is on, remove test light and go to next step. If test light is off, repair open in Pink/Black wire. See **WIRING DIAGRAMS** . Recheck system operation.
3. Connect a test light between ground and Pink/Orange wire at door lock actuator connector. Press door lock switch to unlock position. If test light is on, remove test light and go to next step. If test light is off, repair open in Pink/Orange wire. See **WIRING DIAGRAMS** . Recheck system operation.
4. Using jumper wires (10-gauge wire), apply battery voltage to door lock actuator. Reverse actuator jumper wires to reverse actuator direction. If actuator functions properly, go to next step. If actuator does not function properly, replace actuator. Recheck system operation.
5. Repeat step 4) and measure door lock actuator current draw. Reverse leads at actuator terminals to measure reverse current draw. If current draw is more than 6 amps, replace door lock actuator. Recheck system operation. If current draw is less than 6 amps, no problem is indicated at this time.

TEST B: ALL POWER DOOR LOCKS INOPERATIVE (F150 & F250 LIGHT DUTY)

1. Remove and inspect fuse No. 26 (20-amp) in Power Distribution Center (PDC). PDC is located in engine compartment. Replace fuse as necessary and recheck system operation. If fuse is okay, go to next step.
2. Disconnect right power door lock switch connector. Measure voltage between ground and Black/White wire at right door lock switch connector. If battery voltage is present, go to next step. If battery voltage is not present, repair power circuit (Black/White wire) between right door lock switch and PDC. Recheck system operation.
3. Disconnect right power door lock switch actuator connector. Measure resistance of Pink/Black wire between right door lock actuator connector and right door lock switch connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in Pink/Black wire. Recheck system operation.
4. Measure resistance of Pink/Orange wire between right door lock actuator connector and right door lock switch connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in Pink/Orange wire. Recheck system operation.
5. Disconnect left power door lock switch connector. Measure resistance of Pink/Yellow wire between right

door lock switch connector and left door lock switch connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair open in Pink/Yellow wire. Recheck system operation.

6. Measure resistance of Pink/Light Green wire between right door lock switch connector and left door lock switch connector. If resistance is less than 5 ohms, replace right door lock switch. Recheck system operation. If resistance is 5 ohms or more, repair open in Pink/Light Green wire. Recheck system operation.

TEST C: ALL POWER DOOR LOCKS INOPERATIVE (F250 HEAVY-DUTY & F350)

1. Remove left power door lock switch connector. Measure voltage between ground and Black/White wire at left door lock switch connector. If battery voltage is present, go to step 4). If battery voltage is not present, go to next step.
2. Remove circuit breaker No. 12 (20-amp) from instrument panel fuse block. Measure resistance of Black/White wire between output side of circuit breaker No. 12 holder and left door lock switch connector. If resistance is 5 ohms or less, go to next step. If resistance is more than 5 ohms, repair open in Black/White wire. See **WIRING DIAGRAMS** . Recheck system operation.
3. Measure resistance between ground and Black/White wire at left door lock switch connector. If resistance is 5 ohms or less, repair short to ground in Black/White wire. Recheck system operation. If resistance is more than 5 ohms, replace circuit breaker No. 12. Recheck system operation.
4. Measure resistance between ground and Black wires at left door lock switch connector. If resistance is 5 ohms or less at both terminals, go to next step. If resistance is more than 5 ohms at one or both terminals, repair open in Black wire between left door lock switch connector and ground location behind bottom of left cowl panel. Recheck system operation.
5. Partially remove right power door lock switch connector. Measure voltage between ground and Pink/Black wire at right door lock switch connector. Press right door lock switch to lock position. If battery voltage is present, go to next step. If battery voltage is not present, replace right door lock switch. Recheck system operation.
6. Measure voltage between ground and Pink/Orange wire at right door lock switch connector. Press right door lock switch to unlock position. If battery voltage is present, go to next step. If battery voltage is not present, replace right door lock switch. Recheck system operation.
7. Remove right door trim panel. Disconnect right power door lock actuator connector. Using a test light connected to ground, check for voltage at Pink/Black wire at right door lock actuator connector. Press right door lock switch to lock position. If test light is on, repair open in Pink/Orange wire between right door lock switch and right door lock actuator. Recheck system operation. If test light is off, repair open in Pink/Black wire between right door lock switch and right door lock actuator. Recheck system operation.

TEST D: ALL POWER DOOR LOCKS OPERATE FROM ONE SWITCH ONLY (F150 & F250 LIGHT DUTY)

1. Disconnect suspect power door lock switch. Measure voltage between ground and Black/White wire at disconnected suspect door lock connector. If battery voltage is present, go to next step. If battery voltage is not present, repair power circuit (Black/White wire) between suspect door lock switch and power distribution center in engine compartment. Recheck system operation.
2. Disconnect opposite power door lock switch connector. Measure resistance between ground and Pink/Yellow wire at door lock switch connector. If resistance is more than 10,000 ohms, go to next step.

If resistance is 10,000 ohms or less, repair short to ground in Pink/Yellow wire. See **WIRING DIAGRAMS** . Recheck system operation.

3. Measure resistance between ground and Pink/Light Green wire at door lock switch connector. If resistance is more than 10,000 ohms, replace suspect door lock switch. Recheck system operation. If resistance is 10,000 ohms or less, repair short to ground in Pink/Light Green wire. See **WIRING DIAGRAMS** . Recheck system operation.

TEST E: ALL POWER DOOR LOCKS OPERATE FROM ONE SWITCH ONLY (F250 HEAVY-DUTY & F350)

1. Remove suspect power door lock switch. Test switch. See **COMPONENT TESTING** . Replace switch as necessary and recheck system operation. If switch is okay, go to next step.
2. Using a test light connected to ground, check for voltage at Black/White wire at suspect door lock switch connector. If test light is on, go to next step. If test light is off, repair open in Black/White wire. Recheck system operation.
3. Remove opposite door lock switch. Check continuity of Pink/Yellow wire between left door lock switch connector and right door lock switch connector. If continuity exists, go to next step. If continuity does not exist, repair open in Pink/Yellow wire. Recheck system operation.
4. Check continuity of Pink/Light Green wire between left door lock switch connector and right door lock switch connector. If continuity exists, no problem is indicated at this time. Fault is intermittent. Check wiring harness and connectors. Repair as necessary. If continuity does not exist, repair open in Pink/Light Green wire. Recheck system operation.

TEST F: POWER DOOR LOCKS OPERATE IN ONE DIRECTION ONLY (F250 HEAVY-DUTY & F350)

1. Press either door lock switch to lock position. If doors lock, go to next step. If doors do not lock, go step 5).
2. Disconnect right power door lock switch connector. Check for continuity between ground and Pink/Orange wire at right door lock switch connector. If continuity does not exist, go to next step. If continuity exists, repair short to ground in Pink/Orange wire. See **WIRING DIAGRAMS** . Recheck system operation.
3. Disconnect left power door lock switch connector. Ensure right power door lock switch is still disconnected. Check for continuity between ground and Pink/Light Green wire at right door lock switch connector. If continuity does not exist, go to next step. If continuity exists, repair short to ground in Pink/Light Green wire. Recheck system operation.
4. Check for continuity between ground and Black wires at left door lock switch connector. If continuity exists at both terminals, replace left door lock switch. Recheck system operation. If continuity does not exists at one or both terminals, repair open in Black wire between left door lock switch connector and ground location behind bottom of left cowl panel. Recheck system operation.
5. Disconnect right power door lock switch connector. Check for continuity between ground and Pink/Black wire at right door lock switch connector. If continuity does not exist, go to next step. If continuity exists, repair short to ground in Pink/Black wire. See **WIRING DIAGRAMS** . Recheck system operation.
6. Disconnect left power door lock switch connector. Ensure right power door lock switch is still disconnected. Check for continuity between ground and Pink/Yellow wire at right door lock switch

connector. If continuity does not exist, go to step 4). If continuity exists, repair short to ground in Pink/Yellow wire. Recheck system operation.

TEST G: POWER DOOR LOCKS OPERATE INTERMITTENTLY (F250 HEAVY-DUTY & F350)

1. Check all power door lock system connectors for corroded, loose or damaged terminals. Repair as necessary and recheck system operation. If connectors are okay, go to next step.
2. Measure resistance between ground and Black wires at left door lock switch. If resistance is 5 ohms or less at both terminals, check door lock switch. See **COMPONENT TESTING** . Replace switch as necessary and recheck system operation. If resistance is more than 5 ohms at one or both terminals, repair open in Black wire between left door lock switch and ground location behind bottom of left cowl panel. See **WIRING DIAGRAMS** . Recheck system operation.

TEST H: POWER DOOR LOCKS OPERATE ONLY WITH ENGINE RUNNING (F150 & F250 LIGHT DUTY)

1. Turn ignition off. Measure voltage at battery terminals. If voltage is 12.5 volts or more, go to next step. If voltage is less than 12.5 volts, check and repair charging system as necessary.
2. Manually lock and unlock door lock and check for binding or sticking lock. If door lock is not binding or sticking, no problem is indicated at this time. If door lock is binding or sticking, repair as necessary and recheck system operation.

COMPONENT TESTING

NOTE: Component testing is for F250 Heavy-Duty and F350 models only. Component testing for F150 and F250 Light-Duty models is not available from manufacturer.

DOOR LOCK ACTUATOR

CAUTION: When performing the following test, use a circuit protected DVOM and do not hold power to solenoid more than 5 seconds.

1. Using jumper wires, apply battery power and ground to door lock actuator terminals. Actuator solenoid should operate. Actuator rod should complete its travel in less than one second. Reverse leads to actuator solenoid. Solenoid should operate in reverse direction at same speed.
2. Repeat step 1) and test actuator solenoid current draw. Reverse leads to check reverse current draw. Current draw should not exceed 6 amps.

POWER DOOR LOCK SWITCH

1. Remove door lock switch. With switch in neutral position, continuity should exist between terminals No. 1 and 2 and between switch terminals No. 2 and 3. See **Fig. 1** . Continuity should not exist between terminal No. 5 and any other terminal. With switch in lock position, continuity should exist between terminals No. 1 and 5 and between terminals No. 3 and 4. Continuity should not exist between terminal No. 2 and any other terminal.

2. With switch in unlock position, continuity should exist between terminals No. 1 and 2 and between terminals No. 4 and 5. Continuity should not exist between terminal No. 3 and any other terminal. If continuity is not as specified, replace switch.

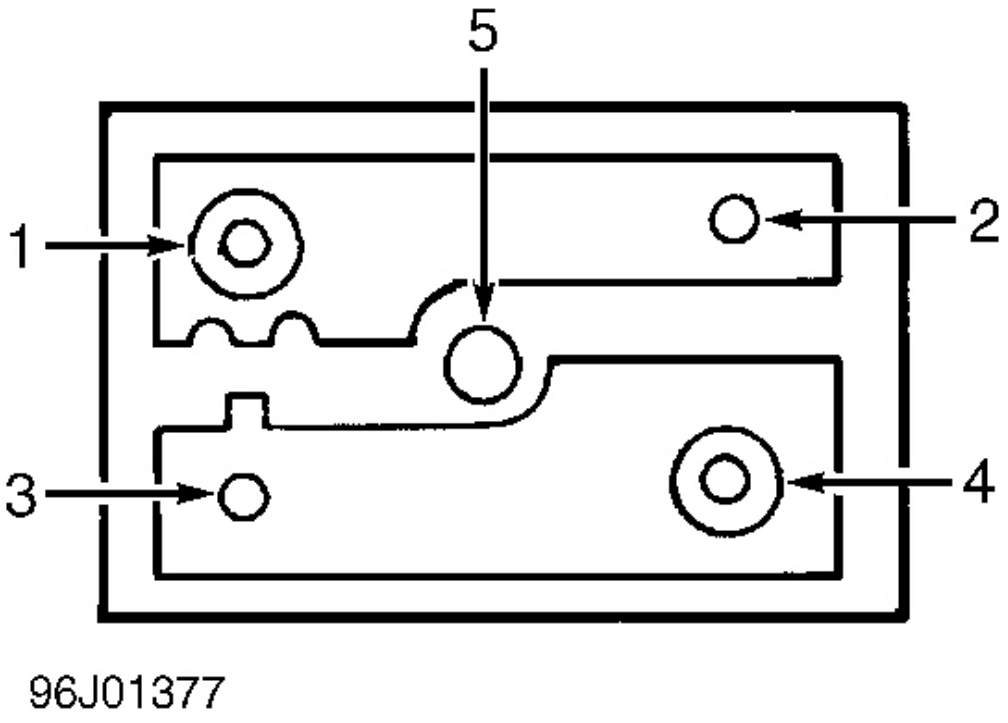


Fig. 1: Identifying Door Lock Switch Terminals (F250 Heavy-Duty & F350)
Courtesy of FORD MOTOR CO.

REMOVAL & INSTALLATION

DOOR LOCK ACTUATOR

Removal & Installation

Position window to full up position. Remove door trim panel and peel back watershield. Drill out rivet(s) securing actuator assembly. Disconnect control rod. Disconnect electrical connector. Remove actuator assembly. To install, reverse removal procedure. Secure actuator assembly with NEW rivet(s). Replace old actuator bracket with new bracket supplied with replacement actuator.

DOOR LOCK SWITCH

Removal & Installation (F250 Heavy-Duty & F350)

Insert thin-bladed screwdriver into spring tab slots at front and rear of power door lock switch housing. Gently pry housing from trim panel. Remove wiring connector screws. Pry wiring connector from switch and remove switch. To install, reverse removal procedure.

WIRING DIAGRAMS

1997 Ford Pickup F150

DOOR LOCKS & TRUNK RELEASE - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Door Locks & Trunk Release

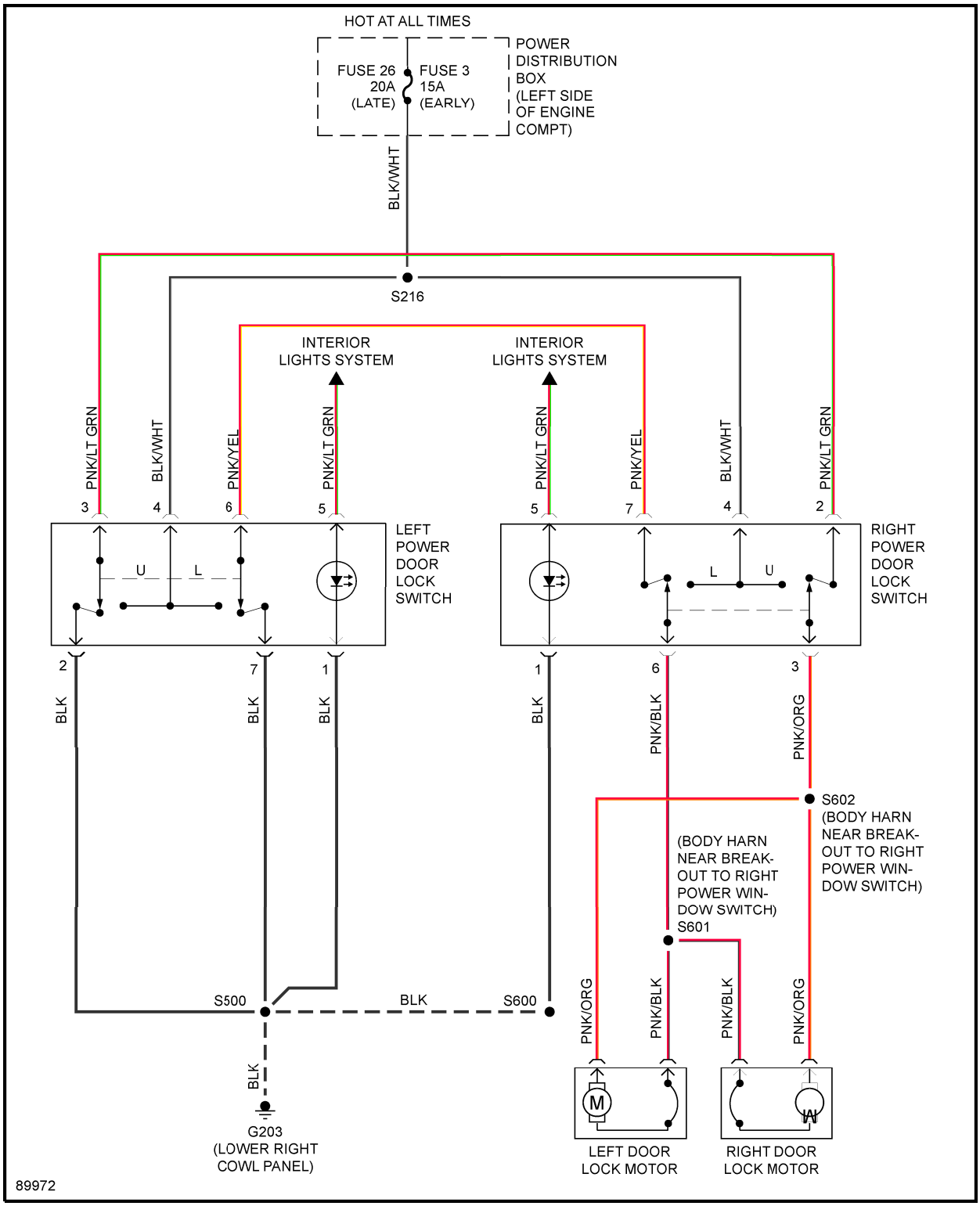


Fig. 2: Power Door Lock System Wiring Diagram (F150 & F250 Light-Duty)

1997 Ford Pickup F150

DOOR LOCKS & TRUNK RELEASE - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Door Locks & Trunk Release

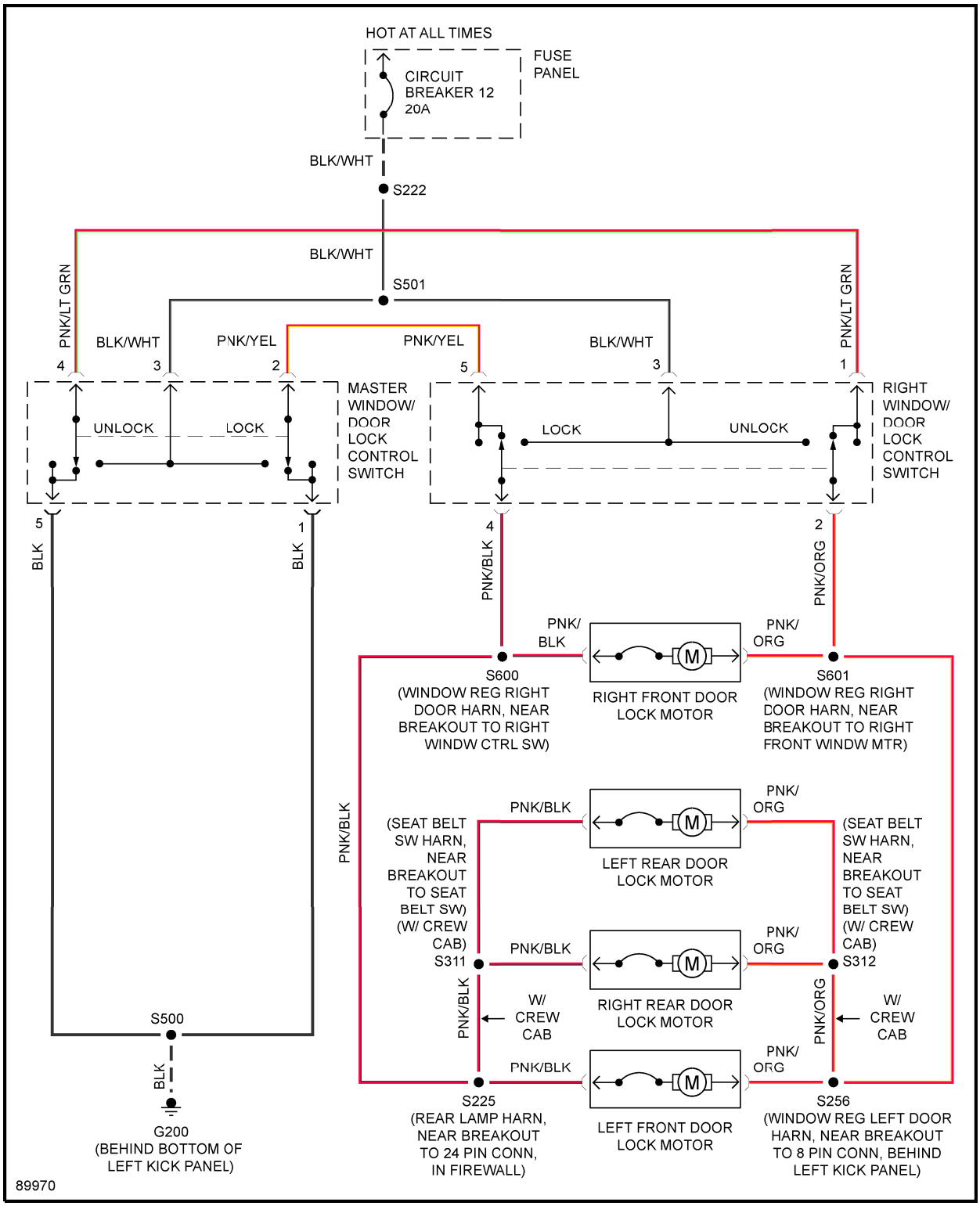


Fig. 3: Power Door Lock System Wiring Diagram (F250 Heavy Duty & F350)

1996-97 DRIVE AXLES

Drive Shafts

DESCRIPTION

NOTE: References to Econoline include Cutaway and RV Cutaway. References to Pickup include Cab & Chassis and F-Super Duty vehicles.

Drive shaft assemblies may have one, 2 or 3 shafts, depending on application. Locations of slip joints vary with model application. Solid tube type drive shafts have slip joints on outside of "U" joint flange/yoke. This slip joint slides in and out on transmission's splined main shaft.

Drive shafts are balanced, tubular shafts with "U" joints attached at each end. Flanges or yokes are used to connect drive shaft "U" joints to rear differential pinion flange or to transmission output shaft. "U" joint bearing caps are bolted to shaft flanges, or are pressed into shaft yokes. Drive shafts can be steel or aluminum.

INSPECTION

WARNING: On vehicles with electronic air suspension, suspension system MUST be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

If abnormal vibration or driveline noise is present, check the following:

Drive Shaft

Check drive shaft for damage or dents that could affect balance. Remove any undercoating adhering to shaft. Check for index marks on yoke and companion flange. If marks are not aligned, disconnect shaft and align index marks so they are as close as possible. Check for missing balance weight(s) or improperly seated or defective universal joint(s).

Center Bearing

Check for loose drive shaft center bearing mounting bolts. Replace bearing insulator if deteriorated or oil soaked.

Universal Joints

Check for foreign material stuck in joints. Check for play between bearing races and cross. Check for loose bolts and worn or seized bearings.

Engine & Transmission Mounts

Ensure transmission mounting bolts are tight. If mounts are deteriorated, replace mounts as necessary.

Tires & Wheels

Check tire inflation and wheel balance. Check for foreign objects in tread, damaged tread, mismatched tread patterns, or incorrect tire size.

MAINTENANCE

Whenever drive shaft is removed from vehicle, clean yoke with solvent. Lubricate inside diameter of seal with hydraulic seal lubricant, and outside diameter of seal with transmission fluid.

DISABLING ELECTRONIC AIR SUSPENSION

On vehicles with electronic air suspension, suspension system must be disabled prior to hoisting, jacking or towing. This can be accomplished by turning off air suspension switch located behind right kick panel. Failure to do so may result in unexpected inflation or deflation of air spring. This may result in shifting of vehicle during servicing.

ADJUSTMENTS

DRIVE SHAFT PHASING

WARNING: On vehicles with electronic air suspension, suspension system must be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

Except 2-Piece Shafts

Ensure yoke on each end of drive shaft is in same plane. Check for arrows on slip joint and drive shaft to aid in alignment. When drive shaft is correctly installed, center line of yokes at each end of individual shafts will be parallel. See **Fig. 2** . If center lines are not in same plane, remove drive shaft. Install drive shaft with center lines aligned.

2-Piece Shafts

This type drive shaft has a "blind" spline on the slip joint which makes it impossible to assemble shaft with incorrect phasing.

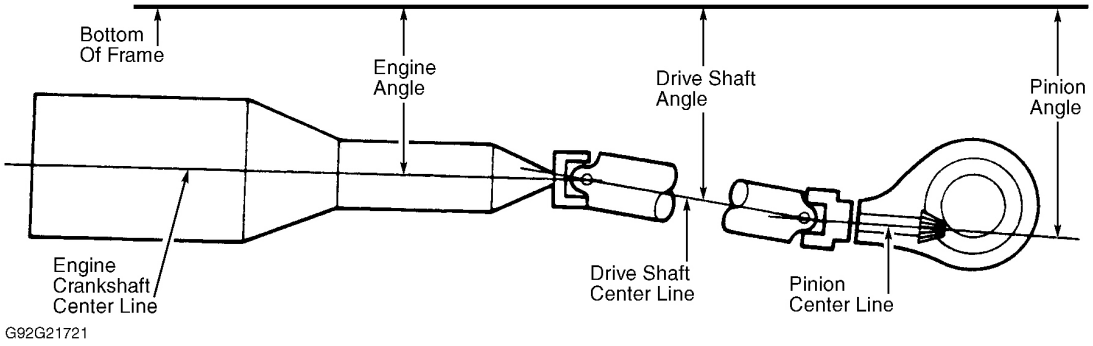


Fig. 1: Identifying Drive Line Angles
Courtesy of FORD MOTOR CO.

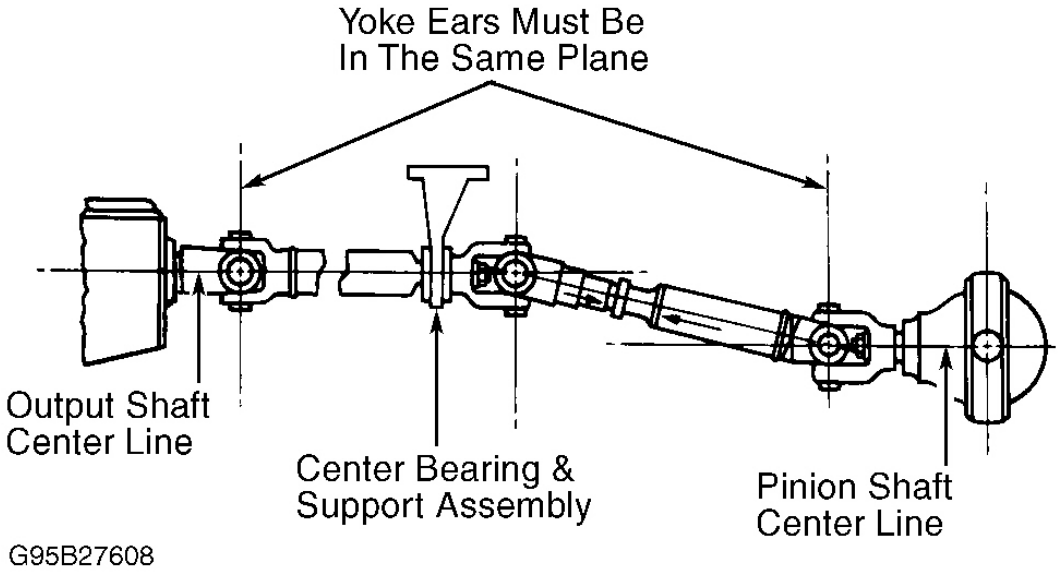


Fig. 2: Aligning Typical Drive Shaft
Courtesy of FORD MOTOR CO.

DRIVE SHAFT BALANCE

WARNING: On vehicles with electronic air suspension, suspension system must be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

1. Raise and support vehicle. Remove drive wheels. Reinstall lug nuts. Rotate shaft by turning brake drum or rotor. Use dial indicator to measure runout. If runout at front and/or center of shaft exceeds .035" (.89

mm), replace drive shaft.

2. If runout at front and/or center is okay but rear runout exceeds .035" (.89 mm), rotate and mark high spot on drive shaft. Scribe index mark on drive shaft. Disconnect drive shaft at rear flange.
3. Rotate shaft 180 degrees. Reconnect shaft. Repeat runout check. If runout is now less than .035" (.89 mm), but vibration persists, go to step 5 . If runout still exceeds .035" (.89 mm), rotate shaft and scribe another mark on high spot of shaft.
4. If the 2 marks made are approximately 1" (25 mm) apart, replace drive shaft. If the 2 marks made are approximately 180 degrees apart, replace companion flange or yoke. See **Fig. 3** .
5. If no faults were found, or have been repaired, but still vibrates, place 4 marks approximately 6" forward of weld at rear end of shaft, spaced equally around shaft. Label marks 1, 2, 3 and 4. Place screw-type hose clamp so clamp head is in No. 1 position. Start engine. Spin drive shaft at road speed.
6. If there is little or no change, move clamp head to No. 2 position, and repeat test. Continue procedure until vibration is at lowest level. If no difference is noted with clamp head moved to all 4 positions, vibration may not be drive shaft imbalance.
7. If vibration is lessened but not completely gone, place 2 clamps at that point, and run test again. Combined weight of clamps in one position may increase vibration. If vibration is increased, rotate clamps about 1/2" (13 mm) apart, above and below best position, and repeat test.
8. Continue to rotate clamps as necessary, until vibration is at lowest point. If vibration level is still unacceptable, leave rear clamp(s) in position and repeat procedure at front end of drive shaft. If vibration cannot be reduced to acceptable range using this procedure, replace drive shaft.

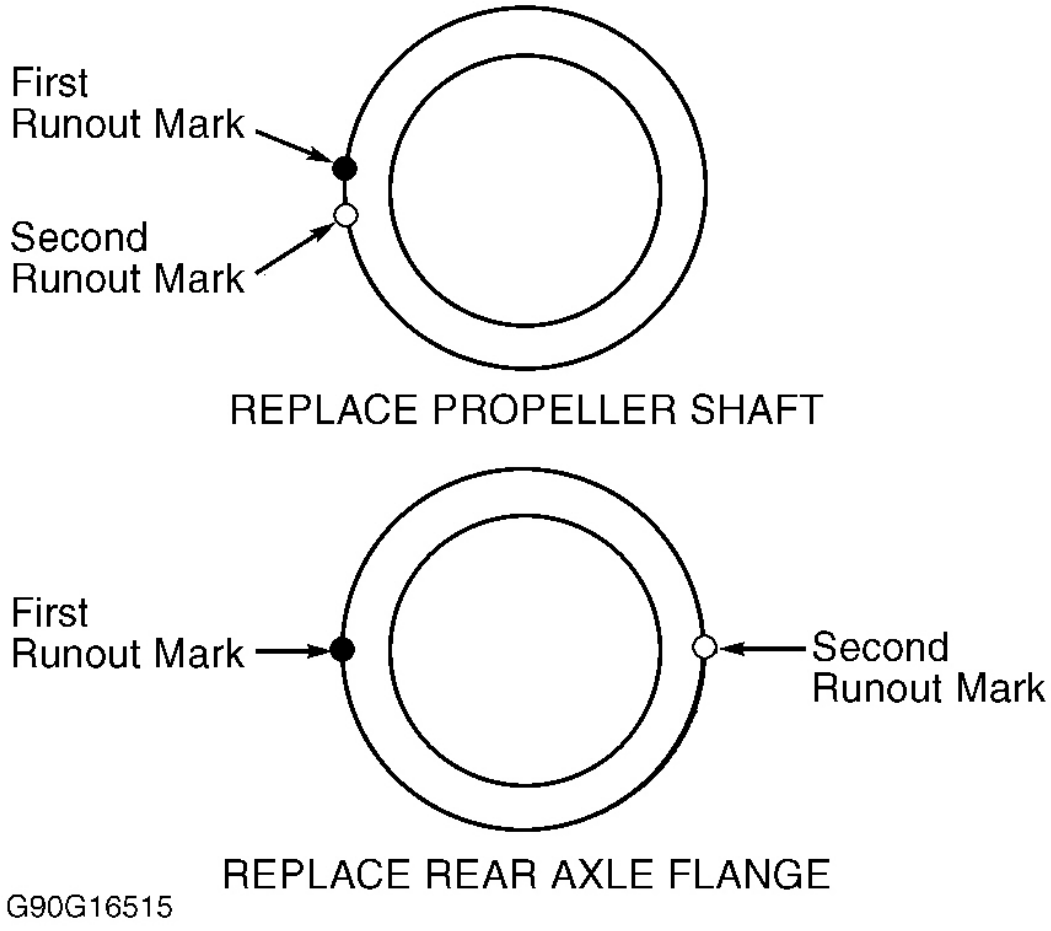


Fig. 3: Reading Drive Shaft Runout Marks
Courtesy of FORD MOTOR CO.

DRIVELINE ANGULARITY

Driveline angularity is angular relationship between engine crankshaft, drive shaft, and drive axle pinion. Driveline angles are given in relation to a zero-degree frame rail angle and are specified for individual components and models. See **Fig. 1** .

RIDE HEIGHT

Measure distance between points specified. See **RIDE HEIGHT MEASUREMENT LOCATIONS** table. This distance is ride height. Ensure measurement is within specification. See **RIDE HEIGHT SPECIFICATIONS** table. If measurement is not within specification, repair suspension as necessary. See appropriate article in SUSPENSION below.

- **SUSPENSION - FRONT (4WD)** (for Bronco)
- **SUSPENSION - FRONT (2WD)** (for 1996 & 1997 Pickup)
- **SUSPENSION - FRONT (4WD)** (for 1996 Pickup)
- **SUSPENSION - FRONT (4WD EXCEPT F250 HD & F350)** (for 1997 Pickup)
- **SUSPENSION - FRONT (4WD F250 HD & F350)** (for 1996 & 1997 Pickup)
- **ELECTRONIC - REAR AIR (F150 & F250 LD)** (for 1997 Pickup)

RIDE HEIGHT SPECIFICATIONS

Application (1)	**In. (mm)**
F150/F250	
Front	
4WD Base Suspension	3.9-5.1 (99-130)
Rear	
2WD Base Suspension	6.0-8.5 (152-216)
2WD Air Suspension (Ign. Off)	3.6 (91)
4WD Base Suspension	5.9-8.1 (150-206)
4WD Air Suspension (Ign. Off)	3.4 (86)
(1) For specifications not contained in this table, see appropriate illustration. See **Fig. 5** -**Fig. 27** .	

RIDE HEIGHT MEASUREMENT LOCATIONS

Models	**Measurement Location**
Bronco	
Front	Top Of Front Axle Tube And Bottom Of Spring Tower, Measured At Center Face Of Jounce Bumper
Rear	Top Of Rear Axle Tube And Top Of Jounce Bumper
Pickup	
Front	
2WD, F150 4WD	Top Of Front Axle Tube And Bottom Of Spring Tower, Measured At Center Face Of Jounce Bumper
F250 4WD	Top Of Front Axle Tube And Bottom Of Frame
F350 4WD	Top Of Front Spring Spacer Plate And Bottom Of Jounce Stop Metal
Super Duty	Top Of Front Spring Plate At Center Of Spring And Bottom Of Frame

Rear	Top Of Rear Axle Tube And Top Of Jounce Bumper
Van	
Front	Top Of "A" Frame To Bottom Of Spring Tower
Rear	Top Of Rear Axle Tube And Top Of Jounce Bumper

FRAME ANGLE

NOTE: Ensure that ride height is with in specifications. See RIDE HEIGHT .

Install bubble protractor (spirit level) on bottom of level portion of frame. On van, use area below driver seat. On F-Series Pickup, use area next to center drive shaft bearing. Measure angle. Repeat measurement on other side of vehicle. Average readings from both sides to obtain a more accurate reading. Average of both readings is frame angle.

ENGINE ANGLE

WARNING: On vehicles with electronic air suspension, suspension system MUST be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

NOTE: Ensure that all engine and transmission mounts are in good condition before performing this procedure.

1. Rotate drive shaft until transmission yoke ear is parallel to floor. Place protractor flush against ear on yoke. If slip yoke is not machined, place protractor against bottom of starter. See **Fig. 4** . Measure and record reading. Subtract frame angle from reading obtained in this step to obtain engine angle.
2. If engine angle is greater than specification by one degree or more, loosen but DO NOT remove engine and transmission mount fasteners. See **Fig. 5** -**Fig. 27** . Tighten engine and transmission mount fasteners. Repeat step 1 . If angle is still out of specification, install shims under transmission mount and rear crossmember until correct angle is obtained.

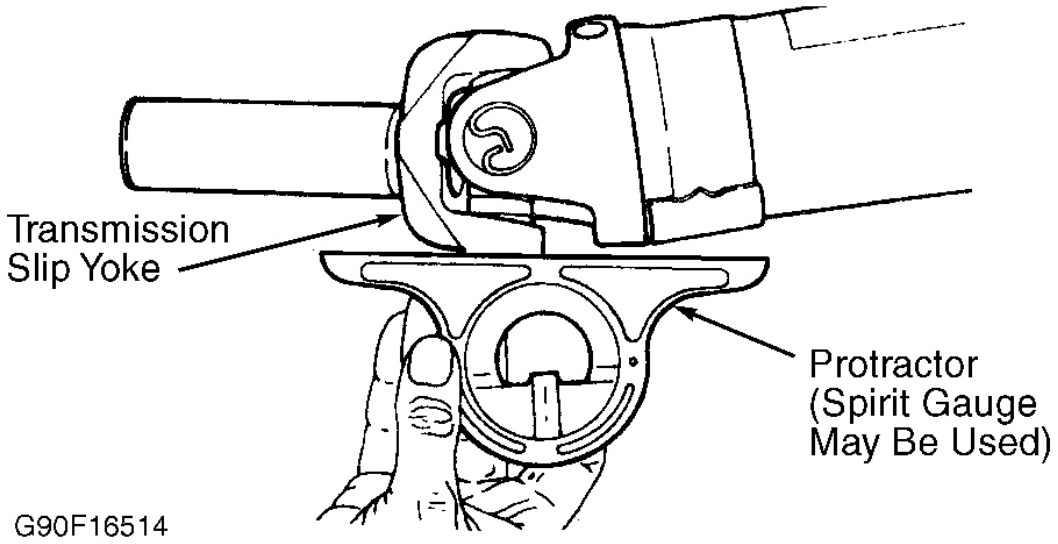


Fig. 4: Measuring Engine Angle
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Trans-mission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
				Axle Ratio	GVW Capacity					
2660	5.0/5.8	M5OD	F4TA-DSE	3.55/4.10	3800	155.65	5.5	—	11.9	10.8
2660	4.9/5.0/5.8	E4OD	F4TA-DSE	3.08/3.55	3800	155.65	5.5	—	12.5	10.8

97H03832

Fig. 5: Determining Rear Driveline Angles (1996 4WD Bronco)
Courtesy of FORD MOTOR CO.

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
					Axle Ratio	GVW Capacity					
REG. CAB	2967	4.9/5.0	M5OD	F4TA-RA	2.73 3.08 3.55	3800	185.8	5.5	—	8.4	6.0
REG. CAB	2967	4.9/5.8	E4OD	F4TA-RA	2.73 3.08 3.55	3800	185.8	5.5	—	8.9	6.0
REG. CAB	2967	5.0	4R70W	F4TA-RA	2.73 3.08 3.55	3800	185.8	5.5	—	8.4	6.0
REG. CAB	3378	4.9/5.0	M5OD	F4TA-NB	2.73 3.08 3.55	3800	185.8	5.5	—	6.4	6.0
REG. CAB	3378	4.9/5.0	M5OD	F4TA-NB	2.73 3.08 3.55	3800	185.8	5.5	5.0	7.6	6.0
REG. CAB	3378	4.9	M5HD	F4TA-NB	2.73 3.08 3.55	3800	185.8	5.5	5.1	7.6	6.0
REG. CAB	3378	4.9/5.0/ 5.8	E4OD	F4TA-NB	2.73 3.08 3.55	3800	185.8	5.5	—	6.5	6.0
REG. CAB	3378	5.0	4R70W	F4TA-NB	2.73 3.08 3.55	3800	185.8	5.5	—	6.4	6.0
REG. CAB	3378	4.9/5.0	M5OD	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	—	6.6	6.1
REG. CAB	3378	4.9/5.0	M5OD	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	5.0	7.9	6.1
REG. CAB	3378	4.9	M5HD	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	5.1	7.9	6.1
REG. CAB	3378	4.9/5.0/ 5.8	E4OD	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	—	6.7	6.1
REG. CAB	3378	5.0	4R70W	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	—	6.6	6.1
SUPER CAB	3526	4.9/5.0	M5OD	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	6.6	7.6	6.1
SUPER CAB	3526	4.9/5.0/ 5.8	E4OD	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	6.6	7.7	6.1
SUPER CAB	3526	5.0	4R70W	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	6.6	7.6	6.1
SUPER CAB	3937	4.9/5.0	M5OD	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	3.4	6.7	6.1
SUPER CAB	3937	4.9/5.0/ 5.8	E4OD	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	3.1	7.4	6.1
SUPER CAB	3937	5.0	4R70W	F4TA-GA	2.73 3.08 3.55	3800	192.1	5.5	3.4	7.3	6.1

97D03854

Fig. 6: Determining Rear Driveline Angles (1996 F150 2WD)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
				Axle Ratio	GVW Capacity					
2967	4.9/5.0	M5OD	F4TA-LB	3.08/3.55	3800	186.08	5.5	—	13.7	4.9
2967	4.9/5.0/5.8	E4OD	F4TA-LB	3.55	3800	186.08	5.5	—	14.3	4.9
2967	5.0	4R70W	F4TA-LB	3.31/3.55	3800	186.08	5.5	—	13.6	4.9
3378	4.9/5.0	M5OD	F4TA-LB	3.08/3.55	3800	186.08	5.5	—	9.3	4.9
3378	5.0	4R70W	F4TA-LB	3.31/3.55	3800	186.08	5.5	—	9.0	4.9
3378	4.9/5.0/5.8	E4OD	F4TA-LB	3.08/3.55	3800	186.08	5.5	—	9.5	4.9
3378	4.9/5.0	M5OD	F4TA-JB	3.08/3.55	3800	181.52	5.5	—	9.1	4.9
3378	5.0	4R70W	F4TA-JB	3.31/3.55	3800	181.52	5.5	—	9.0	4.8
3378	4.9/5.0/5.8	E4OD	F4TA-JB	3.08/3.55	3800	181.52	5.5	—	9.3	4.8
3526	4.9/5.0	M5OD	F4TA-JB	3.08/3.55	3800	181.52	5.5	—	8.2	4.8
3526	5.0	4R70W	F4TA-JB	3.31/3.55	3800	181.52	5.5	—	8.1	4.8
3526	5.0/5.8	E4OD	F4TA-JB	3.08/3.55	3800	181.52	5.5	—	8.3	4.8
3937	4.9/5.0	M5OD	F4TA-JB	3.08/3.55	3800	181.52	5.5	4.7	7.8	4.8
3937	5.0	4R70W	F4TA-JB	3.31/3.55	3800	181.52	5.5	4.8	7.8	4.8
3937	5.0/5.8	E4OD	F4TA-JB	3.08/3.55	3800	181.52	5.5	4.6	7.8	4.8

97I03856

Fig. 7: Determining Rear Driveline Angles (1996 F150 4WD)
Courtesy of FORD MOTOR CO.

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
					Axle Ratio	GVW Capacity					
REG. CAB	3378	4.9/5.0	M5OD	F4TA-KB	3.55 4.10	5300	190.64	5.5	—	7.0	7.2
REG. CAB	3378	4.9/5.0	M5OD	F4TA-KB	3.55 4.10	5300	190.64	5.5	5.3	8.3	7.2
REG. CAB	3378	4.9	M5HD[a]	F4TA-KB	3.55 4.10	5300	190.64	5.5	5.4	8.3	7.2
REG. CAB	3378	4.9/5.8	E4OD	F4TA-KB	3.55 4.10	5300	190.64	5.5	—	7.1	7.2
REG. CAB	3378	5.0	4R70W	F4TA-KB	3.55 4.10	5300	190.64	5.5	—	7.0	7.2
HD REG. CAB	3378	4.9/5.8/ 7.5	M5HD[a]	F3TA-TA	3.55 4.10	6250	199.07	5.5	5.4	10.0	6.3
HD REG. CAB	3378	7.3	M5HD[b]	F3TA-TA	3.55 4.10	6250	199.07	5.5	5.4	10.3	6.3
HD REG. CAB	3378	5.0/7.3/ 7.5	E4OD	F3TA-TA	3.55 4.10	6250	199.07	5.5	—	8.1	6.3
HD REG. CAB	3378	4.9/5.8	C6	F3TA-TA	3.55 4.10	6250	199.07	5.5	—	8.0	6.3
HD REG. CAB	3378	5.8/7.5	M5HD[a]	E4TA-SA	3.55 4.10	6250	173.35	5.5	5.4	9.5	5.9
HD REG. CAB	3378	7.3	M5HD[b]	E4TA-SA	3.55 4.10	6250	173.35	5.5	5.4	9.5	5.9
SUPER CAB	3937	5.8/7.3/ 7.5	E4OD	F3TA-TA	3.55 4.10	6250	199.07	5.5	4.4	8.2	6.3
SUPER CAB	3937	4.9/5.8	C6	F3TA-TA	3.55 4.10	6250	199.07	5.5	4.5	8.0	6.3
SUPER CAB	3937	5.8/7.5	M5HD[a]	F3TA-TA	3.55 4.10	6250	199.07	5.5	4.6	8.0	6.3
SUPER CAB	3937	7.3	M5HD[b]	F3TA-TA	3.55 4.10	6250	199.07	5.5	4.7	8.0	6.3
SUPER CAB	3937	5.8/7.5	M5HD[a]	E4TA-SA	3.55 4.10	6250	173.35	5.5	4.6	7.7	5.9
SUPER CAB	3937	7.3	M5HD[b]	E4TA-SA	3.55 4.10	6250	173.35	5.5	4.7	7.7	5.9

a Wide ratio / close ratio.
b Close ratio.

97C03858

Fig. 8: Determining Rear Driveline Angles (1996 F250 2WD)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
				Axle Ratio	GVW Capacity					
3937	5.8/7.3/7.5	E4OD	F2TA-VB	3.55/4.10[a]	6250	229.7	5.5	7.9	9.2	7.0
3937	5.8	M5HD[b]	F2TA-VB	3.55/4.10[a]	6250	229.7	5.5	7.7	9.2	7.0
3937	7.3/7.5	M5HD[c]	F2TA-VB	3.55/4.10[a]	6250	229.7	5.5	7.5	9.4	6.7
3937	5.8/7.5	C6	F2TA-VB	3.55/4.10[a]	6250	229.7	5.5	7.4	9.3	6.7
3378	5.8/7.5	M5HD[b]	E3TA-TA	3.55/4.10[a]	6250	213.4	5.5	—	11.4	6.7
3378	5.0/7.3/7.5	E4OD	E3TA-TA	3.55/4.10[a]	6250	213.4	5.5	—	11.8	6.7
3378	5.8/7.5	C6	F3TA-TA	3.55/4.10[a]	6250	213.4	5.5	—	11.1	6.7
3378	7.3	M5HD[b]	F3TA-TA	3.55/4.10[a]	6250	213.4	5.5	—	11.2	6.7

a 7.3D-4.10 only.
b Wide ratio/close ratio.
c Close ratio.

97G03860

Fig. 9: Determining Rear Driveline Angles (1996 F250 4WD)
Courtesy of FORD MOTOR CO.

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
					Axle Ratio	GVW Capacity					
REG. CAB	3378	5.8/7.3/7.5	E4OD	E4TA-SA	4.10	7400	173.35	5.5	—	8.0	5.9
REG. CAB	3378	5.8/7.5	C6	E4TA-SA	4.10	7400	173.35	5.5	—	7.9	5.9
REG. CAB	3378	5.8/7.5	M5HD[a]	E4TA-SA	4.10	7400	173.35	5.5	5.4	9.3	5.9
REG. CAB	3378	7.3	M5HD[b]	E4TA-SA	4.10	7400	173.35	5.5	5.4	9.3	5.9
CREW CAB	4278	5.8/7.3/7.5	E4OD	F3TA-TA	4.10	6250	199.07	5.5	4.4	6.1	6.3
CREW CAB	4278	4.9/5.8	C6	F3TA-TA	3.55/4.10	6250	199.07	5.5	4.5	6.1	6.3
CREW CAB	4278	5.8/7.3/7.5	M5HD	F3TA-TA	4.10	6250	199.07	5.5	4.6	6.0	6.3
CHAS. CAB	3475	4.9/5.8/7.3/7.5	M5HD[a]	F4TA-HA	4.10	8250	156.74	5.5	5.3	7.3	4.6
CHAS. CAB	3475	4.9/5.8	C6	F4TA-HA	3.55/4.10	8250	156.74	5.5	5.3	7.3	4.6
CHAS. CAB	3475	5.8/7.3/7.5	E4OD	F4TA-HA	4.10	8250	156.74	5.2	5.2	7.4	4.6
CHAS. CAB	3475	7.3	M5HD[b]	F4TA-HA	4.10	8250	156.74	5.5	5.4	7.3	4.6
CHAS. CAB	4085	4.9/5.0/7.3/7.5	M5HD[a]	F4TA-HA	4.10	8250	156.74	5.5	4.4	5.7	4.6
CHAS. CAB	4085	4.9/5.8	C6	F4TA-HA	3.55/4.10	8250	156.74	5.5	4.1	5.8	4.6
CHAS. CAB	4085	5.8/7.3/7/5	E4OD	F4TA-HA	4.10	8250	156.74	5.5	4.0	5.8	4.6
CHAS. CAB	4085	7.3	M5HD[b]	F4TA-HA	4.10	8250	156.74	5.5	4.4	5.7	4.6
SUPER CAB	3937	7.3/7.5	E4OD	F3TA-TA	4.10	7400	199.07	5.5	4.4	8.2	6.3
SUPER CAB	3937	7.3	M5HD[b]	F3TA-TA	4.10	7400	199.07	5.5	4.7	8.1	6.3
SUPER CAB	3937	7.3/7.5	M5HD[a]	F3TA-TA	4.10	7400	199.07	5.5	4.8	8.1	6.3
SUPER CAB	3937	7.3/7.5	C6	F3TA-TA	4.10	7400	199.07	5.5	4.5	8.7	6.3

a Wide ratio.
b Close ratio.

97I03861

Fig. 10: Determining Rear Driveline Angles (1996 F350 2WD)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
				Axle Ratio	GVW Capacity					
3378	5.8/7.3/7.5	E4OD	F3TA-TA	3.55/4.10	6250	183.92	5.5	—	11.2	5.9
3378	5.8/7.5	C6	F3TA-TA	3.55/4.10	6250	183.92	5.5	—	10.5	5.9
3378	5.8/7.5	M5HD[a]	F3TA-TA	3.55/4.10	6250	183.92	5.5	—	10.9	5.9
3378	7.3	M5HD[b]	F3TA-TA	3.55/4.10	6250	183.92	5.5	—	10.7	5.9

a Wide ratio/close ratio.
b Close ratio.

97C03863

Fig. 11: Determining Rear Driveline Angles (1996 F350 4WD)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
				Axle Ratio	GVW Capacity					
3475	7.3	M5HD	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	—	—	4.6
3475	7.3/7.5	E4OD	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	—	—	4.6
4085	7.3	M5HD	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	—	—	4.6
4085	7.3/7.5	E4OD	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	4.0	5.6	4.6
3475	7.5	M5HD[a]	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	5.3	7.3	4.6
4085	7.5	M5HD[b]	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	4.4	5.4	4.6

a Close ratio.
b Wide ratio/close ratio.

97H03865

Fig. 12: Determining Rear Driveline Angles (1996 F-Super Duty)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	1st Coupling Shaft Angle (Deg.)	2nd Coupling Shaft Angle (Deg.)	Rear Driveshaft Angle (Deg.)	Pinion Angle (Deg.)
				Ring Gear	GVW Capacity						
178	7.5	E4OD	E9TD-AE	11.25	11000	171	5.5	4.4	N/A	5.7	3.4
190	7.5	E4OD	E9TD-AE	11.25	11000	171	5.5	4.4	N/A	4.6	3.4
208	7.5	E4OD	E9TD-AE	11.25	11000	171	5.5	4.1	3.0	4.8	3.4
228	7.5	E4OD	E9TD-AE	11.25	11000	171	5.5	3.7	2.3	4.3	3.4

97B03867

Fig. 13: Determining Rear Driveline Angles (1996 Motorhome)
Courtesy of FORD MOTOR CO.

Model	Wheelbase	Engine (L)	Transmission	Front Axle		Engine Angle (Degrees)	Front Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
				Type	GVW Capacity			
Bronco and F-150 (4x4)	All	All	C6 ZF-HD 4R70W ZF-LD/R2 E4OD	Twin I-Beam W/Coil Spring	3800 Lb.	5.5 5.5 5.5 5.5 5.5 5.5	0.03 0.01 -0.04 -0.14 -0.46 -0.09	4.39 4.39 4.39 4.39 4.39 4.39
F-250 (4x4)	All	All	C6 ZF-HD 4R70W ZF-LD/R2 E4OD	Twin I-Beam w/Leaf Spring	4600 Lb.	5.5 5.5 5.5 5.5 5.5 5.5	2.79 2.77 2.69 2.54 2.06 2.45	6.73 6.73 6.73 6.73 6.73 6.73
F-350 (4x4)	All	All	All	Mono-Beam	5000 Lb.	5.5	2.50	4.50

97F03869

Fig. 14: Determining Front Driveline Angles (1996 Bronco & F-Series)
Courtesy of FORD MOTOR CO.

				Rear Axle						
Wheel Base	Engine (L)	Trans-mission	Rear Spring	Axle Ratio	GVW Capacity (Lbs)	Engine Angle (Deg)	Trans Joint Angle (Deg)	Center Joint Angle (Deg)	Rear Driveshaft Angle (Deg)	Pinion Angle (Deg)
3045	4.2/4.6	M50D	F65A-GD	3.08/3.31 3.55/3L55 3.73/3L73	5550	4.5	2.4	—	6.8	3.2
3045	4.2/4.6	4R70W	F65A-GD	3.08/3.31 3.55/3L55 3.73/3L73	5550	4.5	2.4	—	6.8	3.2
3045	5.4	E4OD		3.08/3.31 3.55/3L55 3.73/3L73						
3518	4.2/4.6	M50D	F65A-FC	3.08/3.31 3.55/3L55 3.73/3L73	6000	4.5	1.2	—	5.7	4.5
3518	4.2/4.6	4R70W	F65A-FC	3.08/3.31 3.55/3L55 3.73/3L73	6000	4.5	1.2	—	5.7	4.5
3518	5.4	E4OD		3.08/3.31 3.55/3L55 3.73/3L73						
3990	4.2/4.6	M50D	F65A-MA	3.08/3.31 3.55/3L55 3.73/3L73	6000	4.5	—	2.0	6.5	3.8
3990	4.2/4.6	4R70W	F65A-MA	3.08/3.31 3.55/3L55 3.73/3L73	6000	4.5	—	2.0	6.5	3.8
3990	5.4	E4OD		3.08/3.31 3.55/3L55 3.73/3L73						

97J03871

Fig. 15: Determining Rear Driveline Angles (1997 F150/250 2WD)
Courtesy of FORD MOTOR CO.

				Rear Axle						
Wheel Base	Engine (L)	Trans-mission	Rear Spring	Axle Ratio	GVW Capacity (Lbs)	Engine Angle (Deg)	Trans Joint Angle (Deg)	Center Joint Angle (Deg)	Rear Driveshaft Angle (Deg)	Pinion Angle (Deg)
3045	4.2/4.6	M50D/ 4R70W	F65A-PB	3.08/3.31 3.55/3L55 3.73/3L73	6000	4.5	4.2	—	8.7	4.0
3045	5.4	E4OD		3.08/3.31 3.55/3L55 3.73/3L73						
3518	4.2/4.6	M50D/ 4R70W	F65A-DD	3.08/3.31 3.55/3L55 3.73/3L73	6000	4.5	4.4	—	8.9	4.8
3518	5.4	E4OD		3.08/3.31 3.55/3L55 3.73/3L73						
3990	4.2/4.6	M50D/ 4R70W	F65A-DD	3.08/3.31 3.55/3L55 3.73/3L73	6000	4.5	4.3	—	8.7	4.0
3990	5.4	E4OD		3.08/3.31 3.55/3L55 3.73/3L73						

97D03873

Fig. 16: Determining Rear Driveline Angles (1997 F150/250 4WD)
Courtesy of FORD MOTOR CO.

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
					Axle Ratio	GVW Capacity					
REG. CAB	3378	4.9/5.0	M5OD	F4TA-KB	3.55 4.10	5300	190.64	5.5	—	7.0	7.2
REG. CAB	3378	4.9/5.0	M5OD	F4TA-KB	3.55 4.10	5300	190.64	5.5	5.3	8.3	7.2
REG. CAB	3378	4.9	M5HD[a]	F4TA-KB	3.55 4.10	5300	190.64	5.5	5.4	8.3	7.2
REG. CAB	3378	4.9/5.8	E4OD	F4TA-KB	3.55 4.10	5300	190.64	5.5	—	7.1	7.2
REG. CAB	3378	5.0	4R70W	F4TA-KB	3.55 4.10	5300	190.64	5.5	—	7.0	7.2
HD REG. CAB	3378	4.9/5.8/ 7.5	M5HD[a]	F3TA-TA	3.55 4.10	6250	199.07	5.5	5.4	10.0	6.3
HD REG. CAB	3378	7.3	M5HD[b]	F3TA-TA	3.55 4.10	6250	199.07	5.5	5.4	10.3	6.3
HD REG. CAB	3378	5.0/7.3/ 7.5	E4OD	F3TA-TA	3.55 4.10	6250	199.07	5.5	—	8.1	6.3
HD REG. CAB	3378	5.8/7.5	M5HD[a]	E4TA-SA	3.55 4.10	6250	173.35	5.5	5.4	9.5	5.9
HD REG. CAB	3378	7.3	M5HD[b]	E4TA-SA	3.55 4.10	6250	173.35	5.5	5.4	9.5	5.9
SUPER CAB	3937	5.8/7.3/ 7.5	E4OD	F3TA-TA	3.55 4.10	6250	199.07	5.5	4.4	8.2	6.3
SUPER CAB	3937	5.8/7.5	M5HD[a]	F3TA-TA	3.55 4.10	6250	199.07	5.5	4.6	8.0	6.3
SUPER CAB	3937	7.3	M5HD[b]	F3TA-TA	3.55 4.10	6250	199.07	5.5	4.7	8.0	6.3
SUPER CAB	3937	5.8/7.5	M5HD[a]	E4TA-SA	3.55 4.10	6250	173.35	5.5	4.6	7.7	5.9
SUPER CAB	3937	7.3	M5HD[b]	E4TA-SA	3.55 4.10	6250	173.35	5.5	4.7	7.7	5.9

a Wide ratio / close ratio.
b Close ratio.

97I03875

Fig. 17: Determining Rear Driveline Angles (1997 F250 Heavy Duty 2WD)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
				Axle Ratio	GVW Capacity					
3937	5.8/7.3/7.5	E4OD	F2TA-VB	3.55/4.10[a]	6250	229.7	5.5	7.9	9.2	7.0
3937	5.8	M5HD[b]	F2TA-VB	3.55/4.10[a]	6250	229.7	5.5	7.7	9.2	7.0
3937	7.3/7.5	M5HD[c]	F2TA-VB	3.55/4.10[a]	6250	229.7	5.5	7.5	9.4	6.7
3378	5.8/7.5	M5HD[b]	E3TA-TA	3.55/4.10[a]	6250	213.4	5.5	—	11.4	6.7
3378	7.3/7.5	E4OD	E3TA-TA	3.55/4.10[a]	6250	213.4	5.5	—	11.8	6.7
3378	7.3	M5HD[b]	F3TA-TA	3.55/4.10[a]	6250	213.4	5.5	—	11.2	6.7

a 7.3L Diesel — 4.10 only.
b Wide ratio / close ratio.
c Close ratio.

97C03877

Fig. 18: Determining Rear Driveline Angles (1997 F250 Heavy Duty 4WD)
Courtesy of FORD MOTOR CO.

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
					Axle Ratio	GVW Capacity					
REG. CAB	3378	5.8/7.3/7.5	E4OD	E4TA-SA	4.10	7400	173.35	5.5	—	8.0	5.9
REG. CAB	3378	5.8/7.5	M5HD[a]	E4TA-SA	4.10	7400	173.35	5.5	5.4	9.3	5.9
REG. CAB	3378	7.3	M5HD[b]	E4TA-SA	4.10	7400	173.35	5.5	5.4	9.3	5.9
CREW CAB	4278	5.8/7.3/7.5	E4OD	F3TA-TA	4.10	6250	199.07	5.5	4.4	6.1	6.3
CREW CAB	4278	5.8/7.3/7.5	M5HD	F3TA-TA	4.10	6250	199.07	5.5	4.6	6.0	6.3
CHAS. CAB	3475	5.8/7.3/7.5	M5HD[a]	F4TA-HA	4.10	8250	156.74	5.5	5.3	7.3	4.6
CHAS. CAB	3475	5.8/7.3/7.5	E4OD	F4TA-HA	4.10	8250	156.74	5.2	5.2	7.4	4.6
CHAS. CAB	3475	7.3	M5HD[b]	F4TA-HA	4.10	8250	156.74	5.5	5.4	7.3	4.6
CHAS. CAB	4085	7.3/7.5	M5HD[a]	F4TA-HA	4.10	8250	156.74	5.5	4.4	5.7	4.6
CHAS. CAB	4085	5.8/7.3/7/5	E4OD	F4TA-HA	4.10	8250	156.74	5.5	4.0	5.8	4.6
CHAS. CAB	4085	7.3	M5HD[b]	F4TA-HA	4.10	8250	156.74	5.5	4.4	5.7	4.6
SUPER CAB	3937	7.3/7.5	E4OD	F3TA-TA	4.10	7400	199.07	5.5	4.4	8.2	6.3
SUPER CAB	3937	7.3	M5HD[b]	F3TA-TA	4.10	7400	199.07	5.5	4.7	8.1	6.3
SUPER CAB	3937	7.3/7.5	M5HD[a]	F3TA-TA	4.10	7400	199.07	5.5	4.8	8.1	6.3

a Wide ratio.
b Close ratio.

97G03879

Fig. 19: Determining Rear Driveline Angles (1997 F350 2WD)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
				Axle Ratio	GVW Capacity					
3378	5.8/7.3/7.5	E4OD	F3TA-TA	3.55/4.10	6250	183.92	5.5	—	11.2	5.9
3378	5.8/7.5	M5HD[a]	F3TA-TA	3.55/4.10	6250	183.92	5.5	—	10.9	5.9
3378	7.3	M5HD[b]	F3TA-TA	3.55/4.10	6250	183.92	5.5	—	10.7	5.9

a Wide ratio/close ratio.
b Close ratio.

97A03881

Fig. 20: Determining Rear Driveline Angles (1997 F350 4WD)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear Drive-shaft Angle (Deg.)	Pinion Angle (Deg.)
				Axle Ratio	GVW Capacity					
3475	7.3	M5HD	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	—	—	4.6
3475	7.3/7.5	E4OD	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	—	—	4.6
4085	7.3	M5HD	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	—	—	4.6
4085	7.3/7.5	E4OD	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	4.0	5.6	4.6
3475	7.5	M5HD[a]	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	5.3	7.3	4.6
4085	7.5	M5HD[b]	F4TA-HA	4.10 4.63 5.13	11000	156.74	5.5	4.4	5.4	4.6

a Close ratio.
b Wide ratio/close ratio.

97E03883

Fig. 21: Determining Rear Driveline Angles (1997 F-Super Duty)
Courtesy of FORD MOTOR CO.

Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle Degree	1st Coupling Shaft Angle (Deg.)	2nd Coupling Shaft Angle (Deg.)	Rear Driveshaft Angle (Deg.)	Pinion Angle (Deg.)
				Ring Gear	GVW Capacity						
178	7.5	E4OD	E9TD-AE	11.25	11000	171	5.5	4.4	N/A	5.7	3.4
190	7.5	E4OD	E9TD-AE	11.25	11000	171	5.5	4.4	N/A	4.6	3.4
208	7.5	E4OD	E9TD-AE	11.25	11000	171	5.5	4.1	3.0	4.8	3.4
228	7.5	E4OD	E9TD-AE	11.25	11000	171	5.5	3.7	2.3	4.3	3.4

97J03885

Fig. 22: Determining Rear Driveline Angles (1997 Motorhome)
Courtesy of FORD MOTOR CO.

Model	Wheelbase	Engine (L)	Transmission	Front Axle		Engine Angle (Degrees)	Front Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
				Type	GVW Capacity			
F-250 Heavy Duty	All	All	E4OD S5-47ZF	Twin I-Beam w/Leaf Spring	4600 Lb	5.5 5.5 5.5 5.5 5.5	2.79 2.77 2.69 2.54 2.06 2.45	6.73 6.73 6.73 6.73 6.73
F-350	All	All	All	Mono-Beam	5000 Lb	5.5	2.50	4.50

97D03887

Fig. 23: Determining Front Driveline Angles (1997 F250 Heavy Duty & F350)
Courtesy of FORD MOTOR CO.

Model	Wheelbase		Engine	Axle Ratio	Transmission	Angle
	mm	Inches				
E-350	4013	158	4.9L 5.8L	4.10 3.54/4.10	C6	3-1/2°
E-350	4013	158	7.3L 7.5L	3.54/4.10 3.07/3.54/4.10	E4OD	3-1/4°
E-350	4470	176	7.3L 7.5L	3.54/4.10	C6 E4OD	3-1/2° 3-1/4°
E-Super Duty	4013	158	7.3L 7.5L	4.63	E4OD	3-1/4°
E-Super Duty	4470	176	7.3L 7.5L	4.63	E4OD	3-1/4°

97H03889

Fig. 24: Determining Coupling Shaft Angle (1996 Van)
Courtesy of FORD MOTOR CO.

Model	Wheelbase		Engine	Rear Axle	Transmission	Spring Rating at Pad (Lbs.)	Curb Load Empty Angle	Empty Rear Ride Height (Axle to Frame)[a]	
	mm	Inches						Inch	mm
E-150	3505	138	4.9L 5.0L 5.8L	All Ford 8.8	4R70W C6/E4OD	1250 1685	4-1/2° 4-3/4°	5.08 5.51	129 140
E-250	3505	138	4.9L 5.8L	5400 Dana	C6/E4OD	1830 2353	5-1/8° 5-1/4°	6.02 6.18	155 156
E-350	3505	138	All	6340 Dana	C6/E4OD	2452 2777 3461	6° 6-1/2° 6°	6.02 6.57 5.98	153 167 183
E-350	3505	138	All	7800 Dana	C6/E4OD	3461 3307	7-1/8° 6-1/2°	5.98 6.57	183 167
E-350	4013	158	All	6340 Dana	C6/E4OD	3461	6-7/8°[b]	5.98	183
E-350	4013	158	All	7800 Dana	C6/E4OD	3461	6-7/8°	5.98	183
E-350	4470	176	All	7800 Dana	C6/E4OD	3461	5°[b]	5.98	183
E-Super Duty	4013	158	All	8250 Dana	E4OD	4250	7.78°	8.47	215
E-Super Duty	4470	176	All	8250 Dana	E4OD	4250	5.68°	8.47	215

a Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration below.
b Two-piece drivelines.

97B03891

Fig. 25: Determining Drive Shaft Angle (1996 Van)
Courtesy of FORD MOTOR CO.

Model	Wheelbase		Spring Capacity at Pad		Spring Part No. (5560)	Curb Load Empty	
	mm	Inches	Lbs.	(Kg)		Ratio	Angle
E-150	3505	138	1250	566	F4UA-DB	3.55	5°
E-150	3505	138	1685	764	F2UA-CA	3.55	6°
E-250	3505	138	1825	828	F2UA-DF	3.54/3.73	5-1/2°
E-250	3505	138	2365	1072	F2UA-FF	3.07/3.54/4.10	5-1/2°
E-350	3505	138	2450	1111	F2UA-GF	3.07/3.54/4.10	5-3/4°
E-350	3505	138	2770	1256	F2UA-HF	3.07/3.54/4.10	6-1/2°
E-350	3505	138	3300	1496	F3UA-MA	3.07/3.54/4.10	5-1/4°
E-350	3505	138	3460	1569	F3UA-MA	3.07/3.54/4.10	5°
E-350	4013	158	3460	1569	F3UA-MA	3.07/3.54/4.10	5°
E-350	4470	176	3460	1569	F3UA-MA	3.54/4.10	5°
E-Super Duty	4013	158	4250	1928	FGUS-AA	4.63	5.67°
E-Super Duty	4470	176	4250	1928	FGUS-AA	4.63	5.67°

97F03893

Fig. 26: Determining Pinion Angles (1996 Van)
Courtesy of FORD MOTOR CO.

Wheel Base (mm) Inches	Engine (L)	Transmission	Ring Gear	Axle Ratio	Engine Angle (Deg.)
3505 (138)	4.2/4.6	4R70W	8.8/9.75	3.31/3.55/3.73	4.1
3505 (138)	5.4	E40D	9.75	3.55/3.73/4.10/4.10 LS	4.1
3505 (138)	6.8	E40D	9.75	3.73/4.10/4.10 LS	4.1
3505 (138)	7.3	E40D	9.75	3.55/4.10	4.1

97A03895

Fig. 27: Determining Engine Angle To Horizontal (1997 Van)
Courtesy of FORD MOTOR CO.

DRIVE SHAFT ANGLE

WARNING: On vehicles with electronic air suspension, suspension system must be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

NOTE: Ensure that all engine and transmission mounts are in good condition before performing this procedure.

1. Measure ride height. See **RIDE HEIGHT** table. Vehicle must be at curb weight (unloaded) condition. Specified pinion angles correspond to measured ride height. See **Fig. 5** - . Place protractor at any location along bottom of drive shaft. See **Fig. 28** .
2. Read and record angle. Subtract frame angle to obtain drive shaft angle. Adjust drive shaft angle by installing tapered shims between rear springs and rear spring seats.

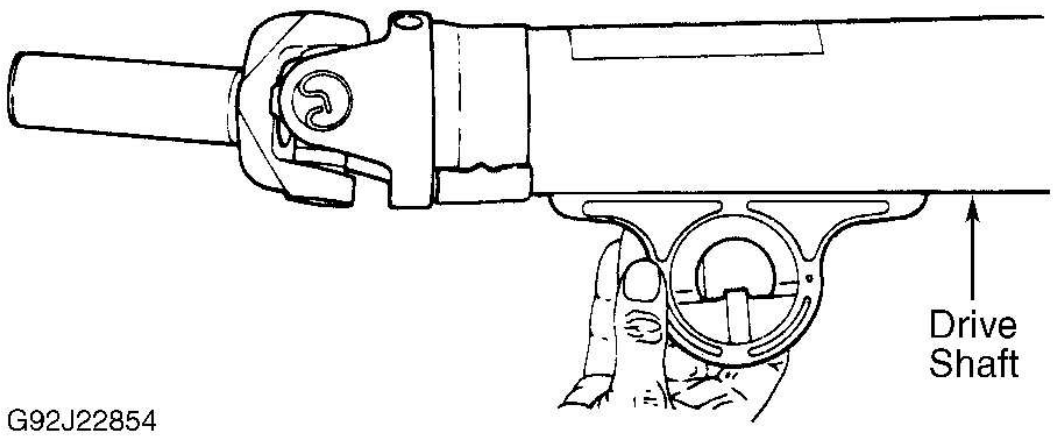


Fig. 28: Measuring Drive Shaft Angle
Courtesy of FORD MOTOR CO.

PINION ANGLE

WARNING: On vehicles with electronic air suspension, suspension system must be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

1. Place protractor in vertical position, flush against 2 differential cover retaining bolts. Rotate protractor bubble indicator so that 90-degree mark aligns with indexing mark.
2. Read protractor and calculate pinion angle. For example, if protractor indicates 85 degrees, pinion angle is 5 degrees. If pinion angle is not as specified, inspect rear suspension mounting.

COUPLING SHAFT ANGLE

WARNING: On vehicles with electronic air suspension, suspension system must be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

NOTE: Ensure that all engine and transmission mounts are in good condition before performing this procedure.

Inspect drive line center support. Check engine angle. See **ENGINE ANGLE** . Place protractor at any location along bottom of coupling shaft. Read and record angle. Subtract frame angle to obtain drive shaft angle. To decrease angle, shim drive shaft center support. To increase angle, shim rear transmission mount.

OVERHAUL

NOTE: DO NOT disassemble universal joints unless external leakage or damage has occurred.

CAUTION: DO NOT clamp drive shaft in vise or similar holding fixture; damage may occur.

SINGLE CARDAN UNIVERSAL JOINTS

WARNING: On vehicles with electronic air suspension, suspension system must be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

Removal & Disassembly

NOTE: DO NOT use pry bar to hold drive shaft while loosening bolts; damage to bearing seals may result.

1. Mark drive shaft and differential companion flange or yoke for reassembly reference. Remove drive shaft from vehicle. Scribe alignment marks on yoke and shaft for reassembly reference. If joints are rusted or corroded, apply penetrating oil before pressing out bearing races or trunnion pin. Disconnect yoke or flange bolts.
2. Remove retaining strap (if equipped). Remove bushing retainers from yoke. Press out rollers and bearings. Remove last roller and bushing assembly by pressing on end of cross.
3. Remove cross from yoke. DO NOT remove seal retainers from cross. Cross and retainers are serviced as an assembly.

Reassembly & Installation

1. Coat roller and bearing assemblies with lubricant, and fill reservoirs in ends of cross. Install cross into drive shaft yoke. Install roller and bushing assemblies into position.
2. Press both bushing assemblies into yoke until retainers can be installed, keeping cross aligned in center of bushings. Install retainers. Repeat procedure for remaining bushings. Install strap (if equipped). Install drive shaft into vehicle, aligning scribe marks.

DOUBLE CARDAN UNIVERSAL JOINTS

WARNING: On vehicles with electronic air suspension, suspension system must be disabled prior to hoisting or jacking. See DISABLING ELECTRONIC AIR SUSPENSION under MAINTENANCE.

NOTE: When handling drive shaft after removal, support shafts on both sides when moved horizontally. DO NOT allow shaft to hang freely or bend at sharp angle.

Removal & Disassembly

1. Mark drive shaft and differential companion flange or yoke for reassembly reference. Remove drive shaft from vehicle. If joints are rusted or corroded, apply penetrating oil before pressing out bearing races or cross.

NOTE: To obtain correct clearance, cross must be installed onto bosses in original positions.

2. Place drive shaft assembly onto workbench. Mark position of cross, center yoke and centering socket yoke in relation to drive shaft tube. See **Fig. 29** . Cross MUST be installed with bosses in original position to provide proper clearance.
3. Remove snap rings. Using "U" Joint Remover/Installer (T745P-4635-C), press cross until bearing protrudes 3/8" (10 mm). Clamp protruding part of bearing in vise. Tap center yoke with hammer until bearing is free of yoke.

NOTE: Centering ball is located inside center yoke socket. If centering ball replacement is required, replace center yoke socket.

4. Using this method, remove all bearings from cross. Remove cross from center yoke. Remove centering socket yoke and seal from centering ball stud. Remove snap rings from center yoke and drive shaft yokes.
5. Install "U" Joint Remover/Installer. Press bearing outward until inside of center yoke almost contacts slinger ring. Clamp exposed end of bearing in vise. Tap center yoke with soft mallet until bearing is free.
6. Press cross to remove remaining bearing. Remove center yoke from cross. Clean all serviceable parts in solvent.

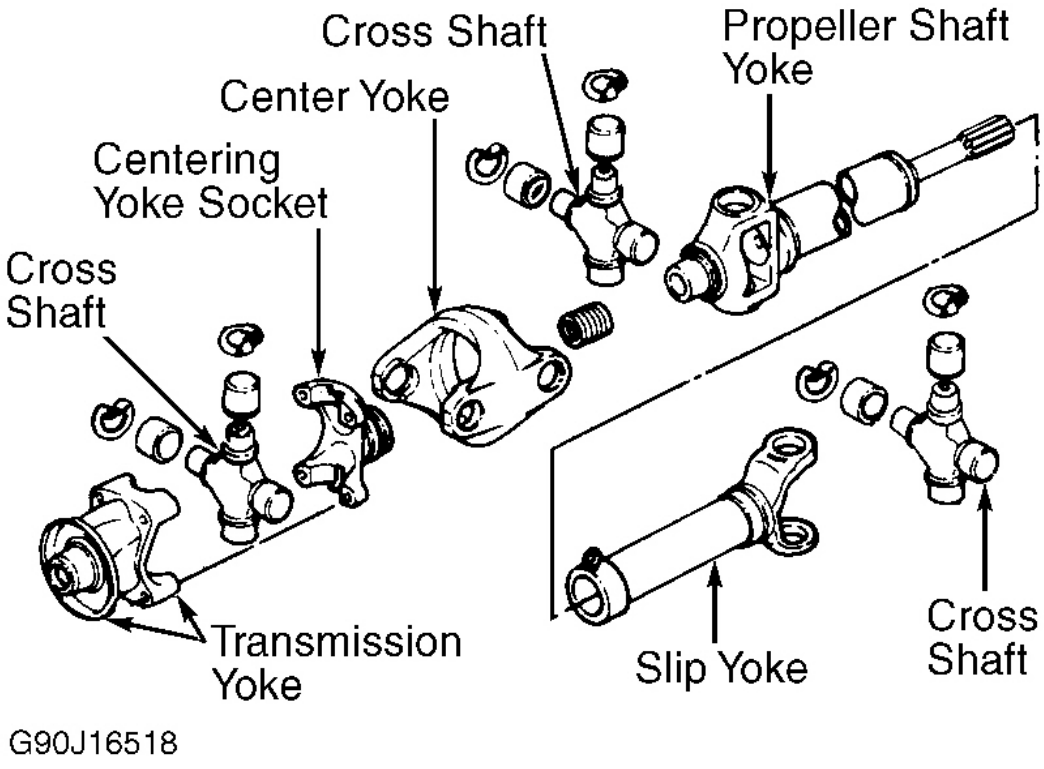


Fig. 29: Exploded View Of Double Cardan Universal Joint
Courtesy of FORD MOTOR CO.

Reassembly

1. Install cross into drive shaft yoke. Ensure cross bosses (or lubrication plugs in kits) are installed in original position. Using "U" Joint Remover and Installer, press in bearings. Install snap rings. Fill center socket and coat centering ball with grease.
2. Position center yoke over cross. Press in bearings. Install snap rings. Install NEW seal onto centering ball stud. Install centering socket over stud. Install front cross into yoke. Ensure cross bosses (or lubrication plugs) are installed in original position.
3. Position cross loosely onto center stop. Press first set of bearings into center yoke, then install second set. Install snap rings. Apply pressure to center yoke socket and install remaining bearing cup. If replacement kit is used, remove plugs, lubricate "U" joints, and reinstall plugs.

Installation (1-Piece Shaft Front)

NOTE: Install drive shaft assembly so yoke ears at each end of shaft are on same plane.

1. Clean yoke. Inspect machined surface for scratches, nicks, or burrs. Check for arrows on slip joint and drive shaft to aid in alignment.
2. Connect single end of drive shaft to front axle. Install "U" bolts and tighten nuts. Connect double Cardan joint end to transfer case. Install "U" bolts.

Installation (1-Piece Shaft Rear)

1. Clean yoke. Inspect machined surface for scratches, nicks, or burrs. Check for arrows on slip joint and drive shaft to aid in alignment. Lubricate yoke splines and install into transmission output shaft.
2. Connect drive shaft to rear companion flange. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

Installation (2-Piece & 3-Piece Shafts)

1. Rotate transmission until yoke ears are on a horizontal plane. Clean yoke. Inspect machined surface for scratches, nicks or burrs. Lubricate splines.
2. Provide support for drive shaft during installation to prevent damage to universal joints. Align marks noted during removal. Connect front joint coupling shaft to transmission yoke. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .
3. Ensure center bearing does not twist in support plate. Connect front and rear coupling shaft (if equipped). Attach universal joint to rear axle flange. Tighten nuts to specification.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Center Bearing Bracket Support Bolt	
Bronco, F-Series & Van	39-53 (53-72)
Motorhome Chassis	50-70 (68-95)
Coupling Shaft-To-Yoke Nut	
F-Series & Van	
5/8"	148-164 (201-222)
3/4"	175-240 (237-325)
7/8"	250-300 (339-407)
1"	160 (217)
Drive Shaft-To-Front Axle Yolk Bolt	
1996	
F350	20-28 (27-38)
All Others	8-15 (11-20)
1997	
F150/250	22-30 (30-41)
F250 Heavy Duty, F350 & F-Super Duty	8-15 (11-20)
Drive Shaft-to-Parking Brake Assembly	

Van	15-21 (20-28)
Drive Shaft-To-Rear Axle Bolt	
1996	
Flange Type	
Bronco, F-Series	65-87 (88-118)
Van	61-87 (83-118)
Strap Type	
Bronco & F-Series	25-40 (34-54)
Van (Super Duty)	15-21 (20-28)
1997	
F150/250	70-95 (102-129)
F250 Heavy Duty, F350 & F-Super Duty	25-40 (34-54)
Van	
One-Piece Drive Shaft	61-87 (83-118)
2-Piece Drive Shaft	15-21 (20-28)
Drive Shaft-To-Transmission	
Bronco & F-Series	25-40 (34-54)
Van (Super Duty)	15-21 (20-28)
Front Drive Shaft-To-Transfer Case Bolt	
1996	
Bronco & F350	20-28 (27-38)
F150/250	
Flange Type	65-87 (88-118)
Strap Type	8-15 (11-20)
1997	
F150/250	65-88 (88-119)
F250 Heavy Duty, F350 & F-Super Duty	20-28 (27-38)
Rear Drive Shaft-To-Transfer Case	
1996	
Bronco & F-Series	61-87 (83-118)
F150/250	65-88 (88-119)
"U" Bolts	
5/16"	8-15 (11-20)
3/8"	18-26 (24-35)
7/16"	30-40 (41-54)

1997 FORD

F150 & F250 Light Duty

BUZZERS, RELAYS & TIMERS

WARNING: When working on vehicles equipped with Supplemental Restraint System (SRS), never apply electrical voltage to the system. This could cause the SRS (air bag) to be deployed.

BUZZERS, RELAYS & TIMERS

Component	Component Location
ACC Delay Relay	Behind left side of dash, on junction box fuse/relay panel.
All Lock Relay	Behind right side of dash.
All Unlock Relay	Behind right side of dash.
Battery Saver Relay	Behind left side of dash, on junction box fuse/relay panel.
Blower Relay	Behind center of dash, on blower/flasher relay block.
Driver's Unlock Relay	Behind right side of dash.
Flasher Relay	Behind center of dash, on blower/flasher relay block.
Fog Lamp Relay	On left side of engine compartment, in power distribution box.
Fuel Pump Relay	On left side of engine compartment, in power distribution box.
Headlight Relay	Behind right side of dash, on RPO Relay Block.
Horn Relay	On left side of engine compartment, in power distribution box.
Interior Lamp Relay	Behind left side of dash, on junction box fuse/relay panel.
One Touch Down Relay	Behind left side of dash, on junction box fuse/relay panel.
PCM Power Relay	On left side of engine compartment, in power distribution box.
Rear Air Suspension Compressor Relay	On left side of engine compartment.
Red Brake Lamp Warning Relay	On left side of engine compartment, in power distribution box.
Shift On The Fly Relay	Behind right side of dash, on RPO relay block.
Starter Interrupt Relay	Behind right side of dash, on RPO relay block.
Starter Motor Relay (4.2L)	In right rear of engine compartment. See **Fig. 1** .
Starter Motor Relay (4.6L)	In right rear of engine compartment. See **Fig. 2** .

Starter Motor Relay (5.4L)	In right rear of engine compartment. See **Fig. 3** .
Trailer Tow Back-Up Lamp Relay	On left side of engine compartment, in power distribution box.
Trailer Tow Battery Charge Relay	On left side of engine compartment, in power distribution box.
Trailer Tow Left Turn Relay	On left side of engine compartment, in power distribution box.
Trailer Tow Right Turn Relay	On left side of engine compartment, in power distribution box.
Trailer Tow Running Lamp Relay	On left side of engine compartment, in power distribution box.
Transfer Case Shift Relays (Early Production)	Behind center of dash. See **Fig. 4** .
Washer Pump Relay	On left side of engine compartment, in power distribution box.
Wiper Hi/Lo Relay	On left side of engine compartment, in power distribution box.
Wiper Run/Park Relay	On left side of engine compartment, in power distribution box.

CIRCUIT PROTECTION DEVICES

CIRCUIT PROTECTION DEVICES

Component	Component Location
Engine Fuse Module (4.2L)	In engine compartment, near power distribution box. See **Fig. 1** .
Engine Fuse Module (4.6L)	In engine compartment, near power distribution box. See **Fig. 2** .
Engine Fuse Module (5.4L)	In engine compartment, near power distribution box. See **Fig. 3** .
Junction Box Fuse/Relay Panel (Early Production)	Under left side of dash. See **Fig. 4** .
Junction Box Fuse/Relay Panel (Late Production)	Under left side of dash. See **Fig. 5** .
Mega Fuse (Alternator)	In right rear of engine compartment.
Mega Fuse Power Distribution Box (PDB)	In right rear of engine compartment.
Power Distribution Box (PDB) (4.2L)	In left side of engine compartment. See **Fig. 1** .
Power Distribution Box (PDB) (4.6L)	In left side of engine compartment. See **Fig. 2** .
Power Distribution Box (PDB) (5.4L)	In left side of engine compartment. See **Fig. 3** .

CONTROL UNITS

CONTROL UNITS

Component	Component Location
Air Bag Diagnostic Monitor (Early Production)	Behind right side of dash. See **Fig. 4** .

Air Bag Diagnostic Monitor (Late Production)	Behind right side of dash. See **Fig. 5** .
Autolamp Module (Early Production)	Behind center of dash. See **Fig. 4** .
Autolamp Module (Late Production)	Behind center of dash. See **Fig. 5** .
Central Timer Module (Early Production)	Under left side of dash. See **Fig. 4** .
Central Timer Module (Late Production)	Under left side of dash. See **Fig. 5** .
Daytime Running Lamps (DRL) Module (4.2L)	On left front of engine compartment. See **Fig. 1** .
Daytime Running Lamps (DRL) Module (4.6L)	On left front of engine compartment. See **Fig. 2** .
Daytime Running Lamps (DRL) Module (5.4L)	On left front of engine compartment. See **Fig. 3** .
Generic Electronic Module (GEM) (Early Production)	Under left side of dash. See **Fig. 4** .
Generic Electronic Module (GEM) (Late Production)	Under left side of dash. See **Fig. 5** .
Intake Manifold Runner Control Monitor No. 1 (4.2L)	On rear of engine. See **Fig. 1** .
Intake Manifold Runner Control Monitor No. 2 (4.2L)	On right side of engine. See **Fig. 1** .
Passive De-activation Module (Early Production)	Behind right side of dash. See **Fig. 4** .
Passive De-activation Module (Late Production)	Behind right side of dash. See **Fig. 5** .
Powertrain Control Module (PCM) (4.2L)	On right side of engine compartment. See **Fig. 1** .
Powertrain Control Module (PCM) (4.6L)	On right side of engine compartment. See **Fig. 2** .
Powertrain Control Module (PCM) (5.4L)	On right side of engine compartment. See **Fig. 3** .
Rear Air Suspension (RAS) Module (Late Production)	Behind center of dash. See **Fig. 5** .
Rear Anti-Lock Brake System (RABS) Module (Early Production)	Behind right side of dash. See **Fig. 4** .
Rear Anti-Lock Brake System (RABS) Module (Late Production)	Behind right side of dash. See **Fig. 5** .
Remote Anti-Theft Personality Module	Behind left side of dash.
Transfer Case Shift Relay Module (Late Production)	Behind center of dash. See **Fig. 5** .
4-Wheel Anti-Lock Brake System (4WABS) Module (4.2L)	On left side of engine compartment. See **Fig. 1** .
4-Wheel Anti-Lock Brake System (4WABS) Module (4.6L)	On left side of engine compartment. See **Fig. 2** .
4-Wheel Anti-Lock Brake System (4WABS) Module (5.4L)	On left side of engine compartment. See **Fig. 3** .

MOTORS

MOTORS

Component	Component Location
Blower Motor	On right side if engine compartment.
Windshield Wiper Motor (4.2L)	On left rear side of engine compartment. See **Fig. 1** .

Windshield Wiper Motor (4.6L)	On left rear side of engine compartment. See **Fig. 2** .
Windshield Wiper Motor (5.4L)	On left rear side of engine compartment. See **Fig. 3** .

SENDING UNITS & SENSORS

SENDING UNITS & SENSORS

Component	Component Location
Camshaft Position (CMP) Sensor (4.2L)	On front of engine. See **Fig. 1** .
Camshaft Position (CMP) Sensor (4.6L)	On front of engine. See **Fig. 2** .
Camshaft Position (CMP) Sensor (5.4L)	On front of engine. See **Fig. 3** .
Crankshaft Position (CKP) Sensor (4.2L)	On lower front of engine. See **Fig. 1** .
Crankshaft Position (CKP) Sensor (4.6L)	On lower front of engine. See **Fig. 2** .
Crankshaft Position (CKP) Sensor (5.4L)	On lower front of engine. See **Fig. 3** .
Cylinder Head Temperature Sensor (4.6L)	On top front of engine. See **Fig. 2** .
Cylinder Head Temperature Sensor (5.4L)	On top front of engine. See **Fig. 3** .
Differential Pressure Feedback EGR (DPFE) Sensor (4.2L)	On right side of engine. See **Fig. 1** .
Differential Pressure Feedback EGR (DPFE) Sensor (4.6L)	On left side of engine. See **Fig. 2** .
Differential Pressure Feedback EGR (DPFE) Sensor (5.4L)	On left side of engine. See **Fig. 3** .
Differential Speed Sensor	On rear axle.
Digital Transmission Range Sensor	On left side of transmission.
Engine Coolant Temperature Sender (4.2L)	On top front of engine. See **Fig. 1** .
Engine Coolant Temperature Sender (4.6L)	On top right front of engine. See **Fig. 2** .
Engine Coolant Temperature Sender (5.4L)	On top front of engine. See **Fig. 3** .
Engine Coolant Temperature (ECT) Sensor (4.2L)	On top front of engine. See **Fig. 1** .
Engine Coolant Temperature (ECT) Sensor (4.6L)	On top front of engine. See **Fig. 2** .
Fuel Tank Pressure Sensor	On fuel tank.
Heated Oxygen Sensor (HO2S) No. 11 (4.2L)	On engine exhaust pipe. See **Fig. 1** .
Heated Oxygen Sensor (HO2S) No. 11 (4.6L)	On engine exhaust pipe. See **Fig. 2** .
Heated Oxygen Sensor (HO2S) No. 11 (5.4L)	On engine exhaust pipe. See **Fig. 3** .
Heated Oxygen Sensor (HO2S) No. 12	On engine exhaust pipe
.	
Heated Oxygen Sensor (HO2S) No. 21 (4.2L)	On engine exhaust pipe. See **Fig. 1** .
Heated Oxygen Sensor (HO2S) No. 21 (4.6L)	On engine exhaust pipe. See **Fig. 2** .
Heated Oxygen Sensor (HO2S) No. 21 (5.4L)	On engine exhaust pipe. See **Fig. 3** .
Heated Oxygen Sensor (HO2S) No. 22	In engine exhaust pipe.
Height Sensor (Left Rear)	In left rear of vehicle.
Height Sensor (Right Rear)	In right rear of vehicle.
Intake Air Temperature (IAT) Sensor (4.2L)	On intake manifold. See **Fig. 1** .

Intake Air Temperature (IAT) Sensor (4.6L)	On intake manifold See **Fig. 2** .
Intake Air Temperature (IAT) Sensor (5.4L)	On intake manifold. See **Fig. 3** .
Knock Sensor (KS) (4.2L)	On right front of engine. See **Fig. 1** .
Knock Sensor (KS) (4.6L)	On right side of engine. See **Fig. 2** .
Knock Sensor (KS) (5.4L)	On right side of engine. See **Fig. 3** .
Mass Air Flow (MAF) Sensor (4.2L)	In air cleaner assembly. See **Fig. 1** .
Mass Air Flow (MAF) Sensor (4.6L)	In air cleaner assembly. See **Fig. 2** .
Mass Air Flow (MAF) Sensor (5.4L)	In air cleaner assembly. See **Fig. 3** .
Output Shaft Speed Sensor	On left side of transmission.
Primary Crash Sensor (Left) (4.2L)	In left front of engine compartment. See **Fig. 1** .
Primary Crash Sensor (Left) (4.6L)	In left front of engine compartment. See **Fig. 2** .
Primary Crash Sensor (Left) (5.4L)	In left front of engine compartment. See **Fig. 3** .
Primary Crash Sensor (Right) (4.2L)	In right front of engine compartment. See **Fig. 1** .
Primary Crash Sensor (Right) (4.6L)	In right front of engine compartment. See **Fig. 2** .
Primary Crash Sensor (Right) (5.4L)	In right front of engine compartment. See **Fig. 3** .
Throttle Position (TP) Sensor (4.2L)	On throttle body. See **Fig. 1** .
Throttle Position (TP) Sensor (4.6L)	On throttle body. See **Fig. 2** .
Throttle Position (TP) Sensor (5.4L)	On throttle body. See **Fig. 3** .
Transmission Range Sensor	On left side of transmission.
Vehicle Speed Sensor	On left rear of transmission.
Wheel 4WABS Sensor (Left Front) (4.2L)	Behind left front wheel. See **Fig. 1** .
Wheel 4WABS Sensor (Left Front) (4.6L)	Behind left front wheel. See **Fig. 2** .
Wheel 4WABS Sensor (Left Front) (5.4L)	Behind left front wheel. See **Fig. 3** .
Wheel 4WABS Sensor (Right Front) (4.2L)	Behind right front wheel. See **Fig. 1** .
Wheel 4WABS Sensor (Right Front) (4.6L)	Behind right front wheel. See **Fig. 2** .
Wheel 4WABS Sensor (Right Front) (5.4L)	Behind right front wheel. See **Fig. 3** .

SOLENOIDS & SOLENOID VALVES

SOLENOIDS & SOLENOID VALVES

Component	Component Location
A/C Compressor Clutch Solenoid (4.2L)	On left side of engine compartment. See **Fig. 1** .
A/C Compressor Clutch Solenoid (4.6L)	In right front of engine compartment. See **Fig. 2** .
A/C Compressor Clutch Solenoid (5.4L)	In right front of engine compartment. See **Fig. 3** .
Air Spring Solenoid (Left Rear)	In left rear of vehicle, above axle.
Air Spring Solenoid (Right Rear)	In right rear of vehicle, above axle.
Blend Door Actuator (Early Production)	Behind center of dash. See **Fig. 4** .
Blend Door Actuator (Late Production)	Behind center of dash. See **Fig. 5** .
Canister Vent Solenoid	In rear of vehicle, near fuel tank.
EGR Vacuum Regulator Solenoid (4.2L)	On right front of engine. See **Fig. 1** .
EGR Vacuum Regulator Solenoid (4.6L)	On left side of engine. See **Fig. 2** .

EGR Vacuum Regulator Solenoid (5.4L)	On left side of engine. See **Fig. 3** .
Idle Air Control (IAC) Valve (4.2L)	On left side of intake manifold. See **Fig. 1** .
Idle Air Control (IAC) Valve (4.6L)	On left side of intake manifold. See **Fig. 2** .
Idle Air Control (IAC) Valve (5.4L)	On left side of intake manifold. See **Fig. 3** .
Intake Manifold Tuning Valve (4.2L)	On right side of engine. See **Fig. 1** .
Intake Manifold Tuning Valve (4.6L)	On right side of engine.
Intake Manifold Tuning Valve (5.4L)	On left side of engine. See **Fig. 3** .
Rear Air Suspension Compressor Motor & Vent Solenoid (4.2L)	In right front of engine compartment. See **Fig. 1** .
Rear Air Suspension Compressor Motor & Vent Solenoid (4.6L)	In right front of engine compartment. See **Fig. 2** .
Rear Air Suspension Compressor Motor & Vent Solenoid (5.4L)	In right front of engine compartment. See **Fig. 3** .
Shift Lock Actuator (Early Production)	In steering column. See **Fig. 4** .
Shift Lock Actuator (Late Production)	In steering column. See **Fig. 5** .
Vapor Management Valve (4.2L)	In left rear corner of engine compartment. See **Fig. 1** .
Vapor Management Valve (4.6L)	In left rear corner of engine compartment. See **Fig. 2** .
Vapor Management Valve (5.4L)	In left rear corner of engine compartment. See **Fig. 3** .
4x2 Hub Solenoid (4.2L)	On right side of engine compartment. See **Fig. 1** .
4x2 Hub Solenoid (4.6L)	On right side of engine compartment. See **Fig. 2** .
4x2 Hub Solenoid (5.4L)	On right side of engine compartment. See **Fig. 3** .
4x4 Hub Solenoid (4.2L)	On right side of engine compartment. See **Fig. 1** .
4x4 Hub Solenoid (4.6L)	On right side of engine compartment. See **Fig. 2** .
4x4 Hub Solenoid (5.4L)	On right side of engine compartment. See **Fig. 3** .

SWITCHES

SWITCHES

Component	Component Location
A/C Clutch Cycling Pressure Switch (4.2L)	In right rear of engine compartment. See **Fig. 1** .
A/C Clutch Cycling Pressure Switch (4.6L)	In right rear of engine compartment. See **Fig. 2** .
A/C Clutch Cycling Pressure Switch (5.4L)	In right rear of engine compartment. See **Fig. 3** .
A/C Pressure Cutoff Switch (4.2L)	In right side of engine compartment. See **Fig. 1** .
A/C Pressure Cutoff Switch (4.6L)	In right side of engine compartment. See **Fig. 2** .
A/C Pressure Cutoff Switch (5.4L)	In right side of engine compartment. See **Fig. 3** .
Back-Up Lamp Switch (M/T)	On left side of transmission.
Brake Fluid Level Indicator Switch (4.2L)	On brake fluid reservoir. See **Fig. 1** .
Brake Fluid Level Indicator Switch (4.6L)	On brake fluid reservoir. See **Fig. 2** .
Brake Fluid Level Indicator Switch (5.2L)	On brake fluid reservoir. See **Fig. 3** .

Brake ON/OFF (BOO) Switch (Early Production)	Under left side of dash. See **Fig. 4** .
Brake ON/OFF (BOO) Switch (Late Production)	Under left side of dash. See **Fig. 5** .
Brake Pressure Switch (4.2L)	In left rear corner of engine compartment. See **Fig. 1** .
Brake Pressure Switch (4.6L)	In left rear corner of engine compartment. See **Fig. 2** .
Brake Pressure Switch (5.2L)	In left rear corner of engine compartment. See **Fig. 3** .
Clutch Pedal Position Switch (Early Production)	On clutch pedal arm. See **Fig. 4** .
Clutch Pedal Position Switch (Late Production)	On clutch pedal arm. See **Fig. 5** .
Engine Oil Pressure Switch (4.2L)	On left front of engine. See **Fig. 1** .
Engine Oil Pressure Switch (4.6L)	On left front of engine. See **Fig. 2** .
Engine Oil Pressure Switch (5.2L)	On left front of engine. See **Fig. 3** .
Inertia Fuel Shut-Off Switch (Early Production)	Under right side of dash. See **Fig. 4** .
Inertia Fuel Shut-Off Switch (Late Production)	Under right side of dash. See **Fig. 5** .
Park Brake Switch	On right side of parking brake lever.
Rear Air Suspension Service Switch (Late Production)	Under right side of dash. See **Fig. 5** .
Seat Belt Warning Switch	In driver's seat belt buckle.
Transmission Control Switch	At end of transmission selector lever.
4x4 Low Indicator Switch	On left side of transmission.

MISCELLANEOUS

MISCELLANEOUS

Component	Component Location
A/C Clutch Diode	Taped to harness, near A/C compressor clutch.
Blower/Flasher Relay Block (Early Production)	Behind center of dash. See **Fig. 4** .
Blower/Flasher Relay Block (Late Production)	Behind center of dash. See **Fig. 5** .
Blower Motor Resistor	Near blower motor.
Brake Warning Diode No. 1	On left side of engine compartment, in power distribution box.
Brake Warning Resistor Assembly	On left side of engine compartment, in power distribution box.
Brake Warning Resistor/Diode Assembly	On left side of engine compartment, in power distribution box.
Clutch Pedal Position Switch Jumper (Late Production)	Under left side of dash. See **Fig. 5** .
Data Link Connector (DLC) (Early Production)	Under left side of dash. See **Fig. 4** .
Data Link Connector (DLC) (Late Production)	Under left side of dash. See **Fig. 5** .
Differential Speed Sensor Diagnostic Connector (Late Production)	Under left side of dash. See **Fig. 5** .

Octane Adjust (Shorting Bar) (4.2L)	In right rear corner of engine compartment. See **Fig. 1** .
Octane Adjust (Shorting Bar) (4.6L)	In right rear corner of engine compartment. See **Fig. 2** .
Octane Adjust (Shorting Bar) (5.4L)	In right rear corner of engine compartment. See **Fig. 3** .
Premium Sound Amplifier (Early Production)	Behind center of dash. See **Fig. 4** .
Premium Sound Amplifier (Late Production)	Behind center of dash. See **Fig. 5** .
RABS Data Link Connector (Early Production)	Under right side of dash. See **Fig. 4** .
RABS Data Link Connector (Late Production)	Under right side of dash. See **Fig. 5** .
Radio Noise Capacitor No. 1 (4.2L)	On top of engine. See **Fig. 1** .
Radio Noise Capacitor No. 1 (4.6L)	In right front of engine compartment. See **Fig. 2** .
Radio Noise Capacitor No. 1 (5.4L)	On top right side of engine. See **Fig. 3** .
Radio Noise Capacitor No. 2 (4.2L)	In right front of engine.
Radio Noise Capacitor No. 2 (4.6L)	In left front of engine. See **Fig. 2** .
Radio Noise Capacitor No. 2 (5.4L)	On top left side of engine. See **Fig. 3** .
Rear Air Suspension Data Link Connector (Late Production)	Under right side of dash. See **Fig. 5** .
Rear Anti-Lock Brake System (RABS) Proportioning Valve Switch Assembly (4.2L)	In left side of engine compartment. See **Fig. 1** .
Rear Anti-Lock Brake System (RABS) Proportioning Valve Switch Assembly (4.6L)	In left side of engine compartment. See **Fig. 2** .
Rear Anti-Lock Brake System (RABS) Proportioning Valve Switch Assembly (5.4L)	In left side of engine compartment. See **Fig. 3** .
RPO Relay Block (Early Production)	Behind right side of dash. See **Fig. 4** .
RPO Relay Block (Late Production)	Behind right side of dash. See **Fig. 5** .
Speed Control Servo/Amplifier Assembly (4.2L)	In left side of engine compartment. See **Fig. 1** .
Speed Control Servo/Amplifier Assembly (4.6L)	In left side of engine compartment. See **Fig. 2** .
Speed Control Servo/Amplifier Assembly (5.4L)	In left side of engine compartment. See **Fig. 3** .

CONNECTORS

CONNECTORS

Component	Component Location
C119 (4.2L) (Black, 8 Pin)	At right rear of engine compartment. See **Fig. 1** .
C119 (4.6L) (Black, 8 Pin)	At right rear of engine compartment. See **Fig. 2** .
C119 (5.4L) (Black, 8 Pin)	At right rear of engine compartment. See **Fig. 3** .
C120 (4.2L) (Black, 42 Pin)	At right rear of engine compartment. See **Fig. 1** .
C120 (4.6L) (Black, 42 Pin)	At right rear of engine compartment.
C120 (5.4L) (Black, 42 Pin)	At right rear of engine compartment. See **Fig. 3** .
C124 (Black, 4 Pin)	At top front of engine. See **Fig. 3** .
C139 (4 Pin)	In right rear of engine compartment.

C148 (4.2L) (Black, 16 Pin)	At left side of engine compartment. See **Fig. 1** .
C148 (4.6L) (Black, 16 Pin)	At left side of engine compartment. See **Fig. 2** .
C148 (5.4L) (Black, 16 Pin)	At left side of engine compartment. See **Fig. 3** .
C149 (4.2L) (Black, 4 Pin)	At left side of engine compartment. See **Fig. 1** .
C149 (4.6L) (Black, 4 Pin)	At left side of engine compartment. See **Fig. 2** .
C149 (5.4L) (Black, 4 Pin)	At left side of engine compartment. See **Fig. 3** .
C150 (4.2L) (Gray, 16 Pin)	At left side of engine compartment. See **Fig. 1** .
C150 (4.6L) (Gray, 16 Pin)	At left side of engine compartment. See **Fig. 2** .
C150 (5.4L) (Gray, 16 Pin)	At left side of engine compartment. See **Fig. 3** .
C151 (Black, 2 Pin)	At left rear of engine compartment.
C158 (4.2L) (Black, 40 Pin)	At left rear of engine compartment. See **Fig. 1** .
C158 (Black, 40 Pin)	At left rear of engine compartment. See **Fig. 2** .
C158 (5.4L) (Black, 40 Pin)	At left rear of engine compartment. See **Fig. 3** .
C159 (4.2L) (Black, 40 Pin)	At left rear of engine compartment. See **Fig. 1** .
C159 (4.6L) (Black, 40 Pin)	At left rear of engine compartment. See **Fig. 2** .
C159 (Black, 40 Pin)	At left rear of engine compartment. See **Fig. 3** .
C160 (4.2L) (Gray, 40 Pin)	At left rear of engine compartment. See **Fig. 1** .
C160 (4.6L) (Gray, 40 Pin)	At left rear of engine compartment. See **Fig. 2** .
C160 (5.4L) (Gray, 40 Pin)	At left rear of engine compartment. See **Fig. 3** .
C169 (4.2L) (Black, 4 Pin)	At right side of engine compartment. See **Fig. 1** .
C169 (4.6L) (Black, 4 Pin)	At right side of engine compartment. See **Fig. 2** .
C169 (Black, 4 Pin)	At right side of engine compartment. See **Fig. 3** .
C171 (4.6L) (Black, 4 Pin)	At right side of engine compartment. See **Fig. 2** .
C171 (5.4L)	At right side of engine compartment. See **Fig. 3** .
C172 (4.2L) (Gray, 38 Pin)	At right rear of engine compartment. See **Fig. 1** .
C172 (4.6L) (Gray, 38 Pin)	At right rear of engine compartment. See **Fig. 2** .
C200 (Black, 16 Pin)	Behind left side of dash. See **Fig. 5** .
C202 (Gray, 2 Pin)	Behind right side of dash. See **Fig. 5** .
C203 (Black, 16 Pin)	Behind right side of dash. See **Fig. 5** .
C206 (Gray, 16 Pin)	Behind right side of dash. See **Fig. 5** .
C207 (Black, 1 Pin)	Behind right side of dash.
C210 (Gray, 6 Pin)	Behind right side of dash. See **Fig. 5** .
C224 (Black, 8 Pin)	Behind center of dash.
C225 (Black, 8 Pin)	Behind center of dash.
C232 (Gray, 6 Pin)	Behind left side of dash. See **Fig. 5** .
C247 (Gray, 16 Pin)	Behind left side of dash. See **Fig. 5** .
C248 (Black, 8 Pin)	Behind left side of dash. See **Fig. 5** .
C253 (black, 16 Pin)	Behind left side of dash.
C265 (Black, 10 Pin)	Behind right side of dash.
C270	In main harness, near radio.
C272 (2 Pin)	In center of steering wheel hub.

C278	At right side of dash. See **Fig. 5** .
C300 (Gray, 4 Pin)	At center of vehicle, on left side rail.
C305 (Gray, 2 Pin)	Under driver seat.
C312 (Gray, 2 Pin)	At right lower side of cab.
C403 (Black, 8 Pin)	At left rear of vehicle.
C411 (Gray, 4 Pin)	At left rear of vehicle.
C412 (Black, 12 Pin)	At left rear of vehicle.
C416 (2 Pin)	In 13A625, near C913, right cargo light.

GROUNDS

GROUNDS

Component	Component Location
G100	At lower right rear of engine, on starter motor mounting bolt.
G101 (4.2L)	At rear of engine compartment, right side of cowl panel. See **Fig. 1** .
G101 (4.6L)	At rear of engine compartment, right side of firewall. See **Fig. 2** .
G101 (5.4L)	At rear of engine compartment, right side of firewall. See **Fig. 3** .
G102 (4.2L)	At rear of right fender apron. See **Fig. 1** .
G102 (4.6L)	At rear of right fender apron. See **Fig. 2** .
G102 (5.4L)	At rear of right fender apron. See **Fig. 3** .
G103 (4.2L)	At right front radiator support. See **Fig. 1** .
G103 (5.4L)	At right front radiator support. See **Fig. 3** .
G104 (4.6L)	At left front radiator support. See **Fig. 2** .
G104 (5.4L)	At left front radiator support. See **Fig. 3** .
G200	At right lower kick panel. See **Fig. 5** .
G201	At left lower kick panel. See **Fig. 5** .
G202	At upper left kick panel. See **Fig. 5** .
G400	At left rear of frame.

SPLICES

SPLICES

Component	Component Location
S100	In engine control sensor harness, near breakout to powertrain control module.
S101	In engine control sensor harness, near breakout to powertrain co ntrol module.
S102	In engine control sensor harness, near breakout to

	starter motor relay.
S103	In fuel charge harness, near breakout to C120.
S104	In engine control sensor harness, 195 mm from breakout to right headlight.
S105	In engine control sensor harness, in breakout to power distribution box.
S106	In engine control sensor harness, near breakout to G104.
S107	In engine control sensor harness, near breakout to starter motor relay.
S108	In engine control sensor harness, near breakout to power distribution box.
S109	In engine control sensor harness, near breakout to C150M.
S110	In engine control sensor harness, near breakout to engine fuse module.
S111	In engine control sensor harness, near breakout to engine fuse module.
S112	In engine control sensor harness, near breakout to power distribution box.
S113	In engine control sensor harness, near breakout to C159.
S114	In engine control sensor harness, near breakout to left headlight.
S115	In engine control sensor harness, near breakout to C148.
S116	In engine control sensor harness, near breakout to C160.
S117 (4.2L)	In fuel charge harness, near breakout to idle air control valve.
S117 (4.6L)	In fuel charge harness, near breakout to C120.
S117 (5.4L)	In fuel charge harness, near breakout to C120.
S118 (4.6L)	In fuel charge harness, near breakout to radio noise capacitor, C115.
S119 (4.6L)	In fuel charge harness, near breakout to radio noise capacitor, C114.
S120	In engine control sensor harness, in breakout to C160.
S121	In engine control sensor harness, near breakout to 4-wheel anti-lock brake system module.
S122	In engine control sensor harness, near breakout to right headlight.
S123	In engine control sensor harness, near breakout to

	starter motor relay.
S124	In engine control sensor harness, near breakout to 4-wheel anti-lock brake system module.
S125	In heater blower motor feed harness, in breakout to blower motor resistor.
S126	In engine control sensor harness, near breakout to mega fuse power distribution box.
S127	In engine control sensor harness, near breakout to vapor management valve.
S128	In engine control sensor harness, near breakout to powertrain control module.
S129 (4.2L)	In fuel charge harness, between breakout for C126, coil on pug No. 2 and C123, throttle body.
S129 (4.6L)	In fuel charge harness, near breakout to fuel injector No. 3.
S129 (5.4L)	In fuel charge harness, near breakout to coil on plug No. 3.
S130	In engine control sensor harness, near breakout to C120.
S131 (4.2L)	In fuel charge harness, near breakout to intake manifold runner control monitor No. 1.
S131 (4.6L)	In fuel charge harness, near breakout to fuel injector No. 8.
S131 (5.4L)	In fuel charge harness, near breakout to coil on lug No. 7.
S132	In fuel charge harness, in breakout to intake manifold runner control monitor No. 2.
S133	In fuel charge harness, near breakout to intake manifold runner control monitor No. 1.
S134	In engine control sensor harness, near breakout to G101.
S135 (4.2L)	In fuel charge harness, near breakout to fuel injector No. 4.
S135 (4.6L)	In fuel charge harness, near breakout to knock sensor.
S135 (5.4L)	In fuel charge harness, near breakout to radio noise capacitor.
S136 (4.2L)	In fuel charge harness, near breakout to fuel injector No. 2.
S136 (4.6L)	In fuel charge harness, near breakout to C131, fuel injector No. 7.
S136 (5.4L)	In fuel charge harness, near breakout to knock sensor.
S137	In engine control sensor harness, near breakout to

	starter motor relay.
S138	In engine control sensor harness, near breakout to C139.
S139	In engine control sensor harness, near breakout to C158.
S140	In back-up light switch to rear light feed harness, in breakout to C172.
S141	In back-up light switch to rear light feed harness, in breakout to C172.
S142	In engine control sensor harness, near breakout to mega fuse power distribution box.
S143	In engine control sensor harness, near breakout to vapor management valve.
S144	In engine control sensor harness, near breakout to power distribution box,
S145	In engine control sensor harness, near breakout to horns.
S146	In engine control sensor harness, near breakout to C159.
S147	In engine control sensor harness, near breakout to left foglight.
S148	In engine control sensor harness, near breakout to C149M.
S149	In engine control sensor harness, in breakout to C149M.
S150	In engine control sensor harness, near breakout to C160.
S151	In engine control sensor harness, near breakout to wiper motor.
S152	In engine control sensor harness, near breakout to C151.
S153	In fuel charge harness, near breakout to C120.
S156	In engine control sensor harness, near breakout to vapor management valve.
S157	In engine control sensor harness, near breakout to vapor management valve.
S158	In engine control sensor harness, near breakout to C150.
S159	In engine control sensor harness, near breakout to C165, windshield wiper motor.
S161	In fuel charge harness, near breakout to fuel injector No. 3.
S162	In fuel charge harness, near breakout to fuel injector No. 7.

S199	In fuel charge harness near breakout to C120.
S200	In main harness, near breakout to C210.
S201	In main harness, near breakout to transfer case shift relay.
S202	In main harness, in breakout to blower/flasher relay block.
S203	In main harness, near breakout to passenger air bag.
S204	In main harness, near breakout to instrument cluster.
S205	In main harness, near breakout to radio.
S206	In radio speaker jumper harness, on breakout to C261, radio.
S207	In main harness, near breakout to junction box fuse/relay panel.
S208	In main harness, near breakout to G202.
S209	In radio speaker jumper harness, in breakout to premium sound amplifier.
S210	In radio speaker jumper harness, near breakout to radio.
S211	In main harness, near breakout to main light switch.
S212	In main harness, near breakout to brake pedal position switch.
S213	In main harness, near breakout to transfer case shift relays.
S214	In main harness, near breakout to brake pedal position switch.
S215	In main harness, near breakout to ignition switch.
S216	In body main harness, near breakout to C254, park brake switch.
S217	In main harness, near breakout to rear anti-lock brake system module.
S219	In main harness, near breakout to transfer case shift relay module.
S220	In body main harness, near breakout to park brake switch.
S221	In main harness, near breakout to C210.
S222	In main harness, near breakout to instrument cluster.
S223	In main harness, near breakout to instrument cluster.
S224	In main harness, near breakout to main light switch.
S225	In main harness, near breakout to instrument cluster.
S226	In main harness, near breakout to passenger air bag.
S227	In main harness, near breakout to clutch pedal position switch.
S228	In main harness, near breakout to junction box

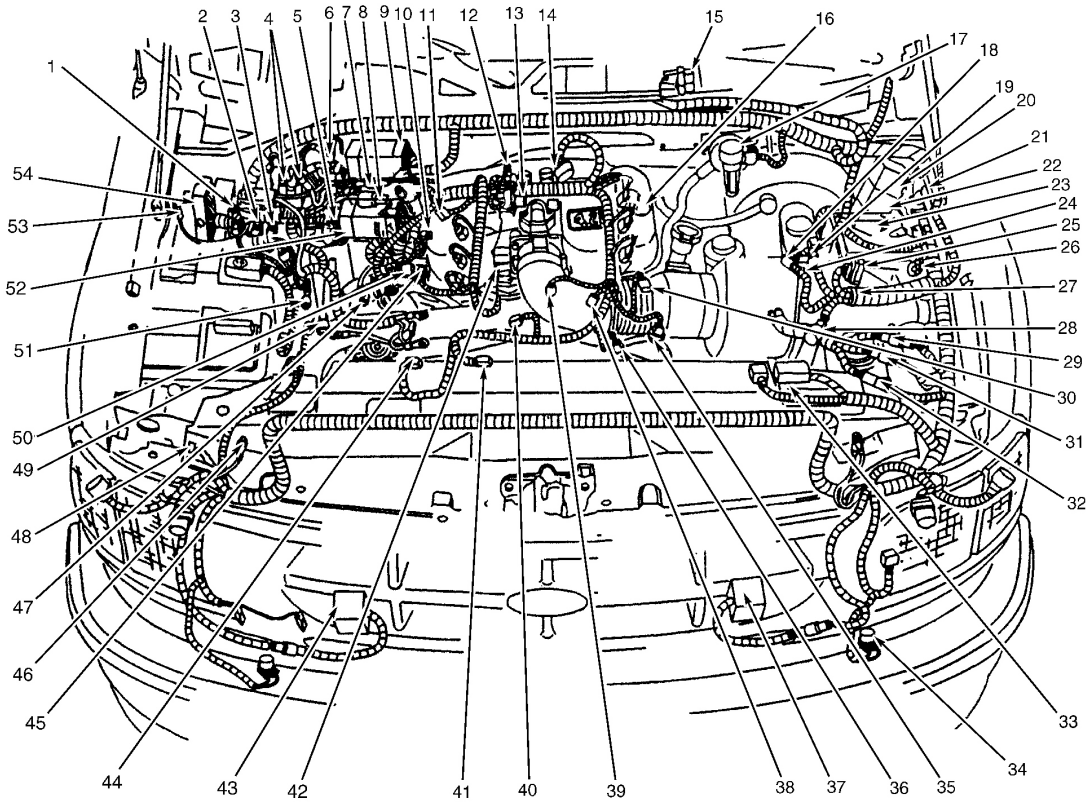
	fuse/relay panel.
S229	In main harness, near breakout to radio.
S230	In main harness, in breakout to clockspring assembly
S231	In main harness, near breakout to instrument cluster.
S232	In main harness, near breakout to instrument cluster.
S234	In body main harness, near breakout to remote anti-theft personality module.
S235	In body main harness, near remote anti-theft personality module.
S238	In main harness, near breakout to C239, generic electronic module.
S239	In body main harness, near breakout to C206.
S240	In main harness, near breakout to ashtray illumination.
S242	In main harness, near breakout to clutch pedal position switch.
S243	In body main harness, 400 mm from left door grommet.
S244	In main harness, near breakout to main light switch.
S245	In main harness, near breakout to passenger air bag.
S246	In main harness, near breakout to C253.
S247	In main harness, near breakout to C253.
S248	In body main harness, near breakout to park brake switch.
S249	In body main harness, near breakout to remote anti-theft personality module.
S252	In radio speaker jumper harness, near breakout to C265.
S253	In radio amplifier harness, near breakout to C265.
S256	In body main harness, near breakout to lock relays.
S265	In main harness, near breakout to C242, junction box/fuse panel.
S268	In main harness, near breakout to C240, generic electronic module.
S278	In main harness, near breakout to C247.
S286	In main harness, near breakout to C246, main light switch.
S287	In main harness, near breakout to C163.
S288	In main harness, near breakout to C163
S290	In main harness, near breakout to C236, instrument cluster.
S291	In main harness, near breakout to rear anti-lock

	brake system module.
S293	In main harness, near breakout to passenger air bag.
S294	In main harness, near breakout to air bag diagnostic monitor.
S295	In main harness, near breakout to air suspension connector.
S296	In main harness, near breakout to air suspension connector.
S300	In seat belt retractor switch right harness, in breakout to dome light.
S301	In fuel tank sender harness, near breakout to fuel tank solenoid valve No. 2.
S302	In fuel tank sender harness, near breakout to fuel tank solenoid valve No. 2.
S303	In fuel tanks sender harness, near C316.
S304	In seat belt retractor switch harness, near breakout to right rear speaker.
S400	In rear light harness, near breakout to fuel pump assembly.
S401	In rear light connector harness, near breakout to C400M.
S402	In socket assembly-rear license assembly, in breakout to C403.
S403	In rear light connector harness, near breakout to C403.
S404	In socket assembly-rear license assembly, in breakout to license light.
S405	In rear light harness, near breakout to C404, left stop/park/turn light.
S406	In rear light harness, near breakout to differential speed sensor.
S407	In rear light harness, near breakout to differential speed sensor.
S409	In rear light harness, near breakout to fuel pump module.
S410	In rear light harness, near breakout to fuel pump module.
S411	In rear light harness, in breakout to C911, center cargo/high mount stoplight.
S500	In body main harness, near breakout to left power door lock switch.
S501	In body main harness, near breakout to left power door lock switch.

S502	In body main harness, near breakout to left power window motor.
S503	In body main harness, near breakout to left power window motor.
S504	In body main harness, near breakout to lock relays.
S600	In body main harness, near breakout to right power window switch.
S601	In body main harness, near breakout to right power window switch.
S602	In body main harness, near breakout to right power window switch.
S604	In body main harness, 550 mm from left door grommet.
S911	In high mount stoplight harness, near breakout to C416.

COMPONENT LOCATION GRAPHICS

NOTE: Figures may show multiple component locations. Refer to appropriate table for proper figure references.

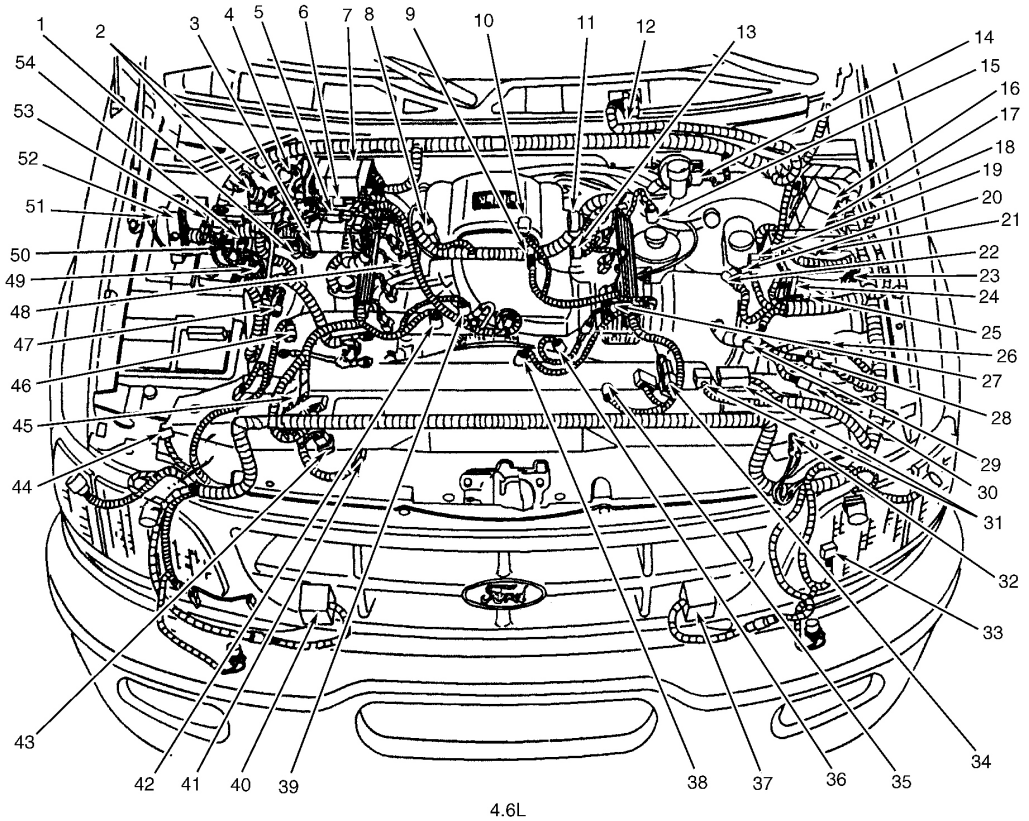


4.2L

1. Octane Adjust (Shorting Bar)
2. 4x4 Hub Solenoid
3. 4x2 Hub Solenoid
4. Starter Motor Relay
5. A/C Clutch Pressure Cycling Switch
6. G101
7. C169
8. C119
9. C172
10. Intake Manifold Tuning Valve
11. Intake Manifold Runner Control Monitor No. 1
12. Radio Noise Capacitor No. 1
13. Idle Air Control (IAC) Valve
14. Intake Manifold Runner Control Monitor No. 2
15. Windshield Wiper Motor
16. Heated Oxygen Sensor (HO2S) No. 21
17. Vapor Management Valve
18. Brake Pressure Switch
19. Brake Fluid Level Indicator Switch
20. C158
21. Engine Fuse Module
22. C159
23. C160
24. Wheel 4WABS Sensor (Left Front)
25. Speed Control Servo/Amplifier Assembly
26. Power Distribution Box
27. Rear Anti-Lock Brake System (RABS) Proportioning Valve Switch Assembly
28. Mass Air Flow (MAF) Sensor
29. C150
30. Intake Air Temperature (IAT) Sensor
31. C149
32. C148
33. 4 Wheel Anti-Lock Brake System (4WABS) Module
34. Daytime Running Lamps (DRL) Module
35. A/C Compressor Clutch Solenoid
36. Engine Oil Pressure Switch
37. Primary Crash Sensor (Left)
38. Engine Coolant Temperature Sender
39. Engine Coolant Temperature (ECT) Sensor
40. Camshaft Position (CMP) Sensor
41. Crankshaft Position (CKP) Sensor
42. Throttle Position (TP) Sensor
43. Primary Crash Sensor (Right)
44. Knock Sensor
45. Differential Pressure Feedback EGR (DPFE) Sensor
46. G103
47. EGR Vacuum Regulator Solenoid
48. Rear Air Suspension Compressor Motor & Vent Solenoid
49. A/C Pressure Cutoff Switch
50. Heated Oxygen Sensor (HO2S) No. 11
51. Wheel 4WABS Sensor (Right Front)
52. C120
53. G102
54. Powertrain Control Module (PCM)

G00102578

Fig. 1: Engine Compartment (4.2L)

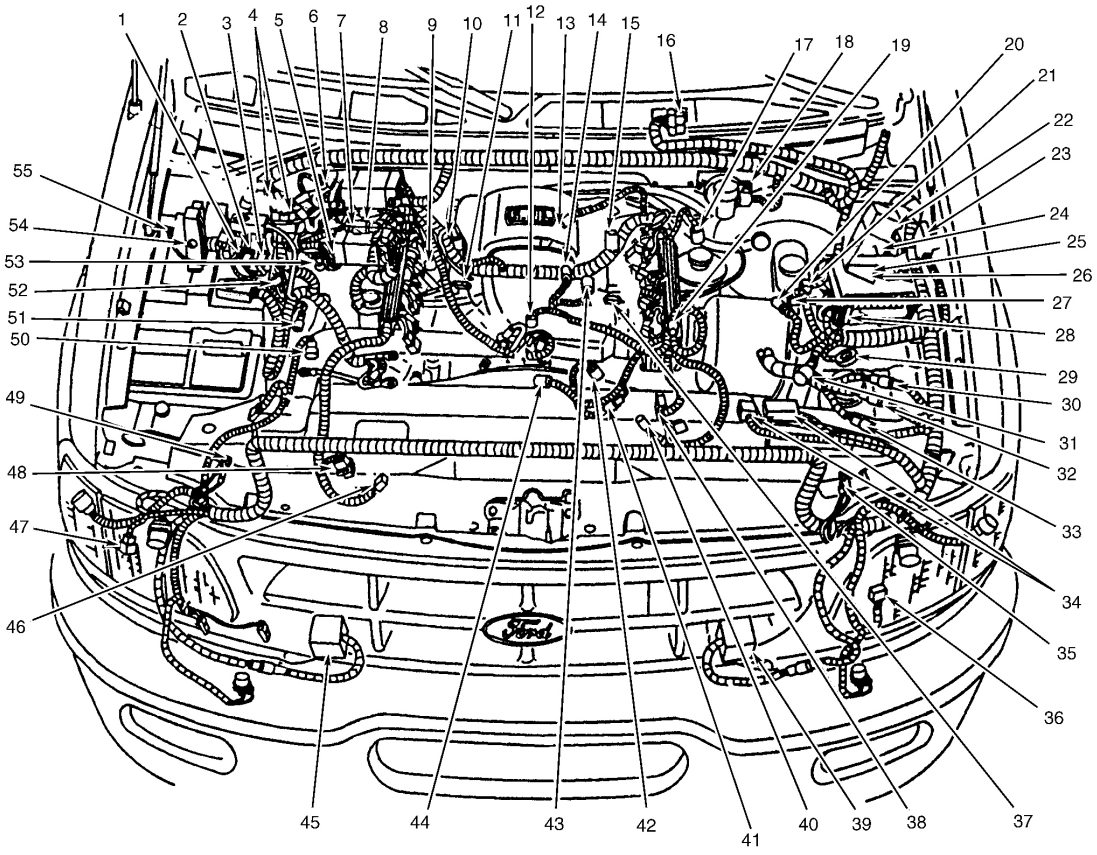


4.6L

1. A/C Clutch Cycling Pressure Switch
2. Starter Motor Relay
3. C120
4. G101
5. C119
6. C169
7. C172
8. Heated Oxygen Sensor (HO2S) No. 11
9. Throttle Position (TP) Sensor
10. Idle Air Control (IAC) Valve
11. Differential Pressure Feedback EGR (DPFE) Sensor
12. Windshield Wiper Motor
13. EGR Vacuum Regulator Solenoid
14. Vapor Management Valve
15. Heated Oxygen Sensor (HO2S) No. 21
16. C158
17. C159
18. Engine Fuse Module
19. Brake Fluid Level Indicator Switch
20. Brake Pressure Switch
21. C160
22. Wheel 4WABS Sensor (Left Front)
23. Power Distribution Box
24. Speed Control Servo/Amplifier Assembly
25. Rear Anti-Lock Brake System (RABS) Proportioning Valve Switch Assembly
26. C150
27. Intake Air Temperature (IAT) Sensor
28. C149
29. Mass Air Flow (MAF) Sensor
30. C148
31. 4 Wheel Anti-Lock Brake System (4WABS) Module
32. G104
33. Daytime Running Lamps (DRL) Module
34. Radio Noise Capacitor No. 2
35. Camshaft Position (CMP) Sensor
36. Cylinder Head Temperature Sensor
37. Primary Crash Sensor (Left)
38. Engine Oil Pressure Switch
39. Engine Coolant Temperature (ECT) Sensor
40. Primary Crash Sensor (Right)
41. Crankshaft Position (CKP) Sensor
42. Engine Coolant Temperature Sender
43. A/C Compressor Clutch Solenoid
44. Rear Air Suspension Compressor Motor & Vent Solenoid
45. Radio Noise Capacitor No. 1
46. A/C Pressure Cutoff Switch
47. Wheel 4WABS Sensor (Right Front)
48. Knock Sensor
49. C171
50. 4x2 Hub Solenoid
51. G102
52. Powertrain Control Module (PCM)
53. Octane Adjust (Shorting Bar)
54. 4x4 Hub Solenoid

G00102579

Fig. 2: Engine Compartment (4.6L)

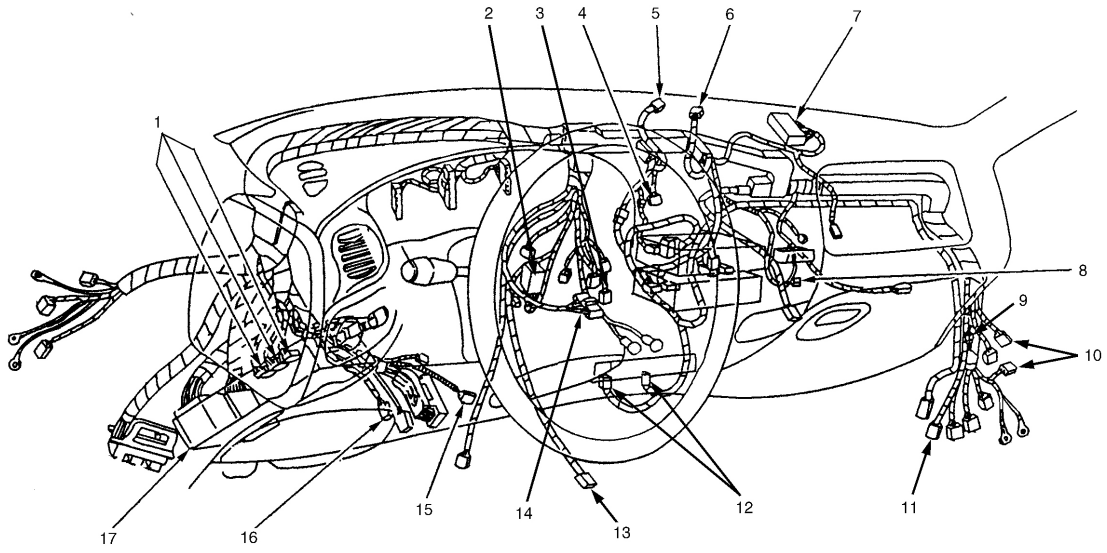


5.4L

1. Octane Adjust (Shorting Bar)
2. 4x4 Hub Solenoid
3. 4x2 Hub Solenoid
4. Starter Motor Relay
5. C120
6. G101
7. C119
8. C169
9. Knock Sensor
10. Heated Oxygen Sensor (HO2S) No. 11
11. Radio Noise Capacitor No. 1
12. Engine Coolant Temperature Sender
13. Idle Air Control (IAC) Valve
14. EGR Vacuum Regulator Solenoid
15. Differential Pressure Feedback EGR (DPFE) Sensor
16. Windshield Wiper Motor
17. Heated Oxygen Sensor (HO2S) No. 21
18. Vapor Management Valve
19. Intake Manifold Tuning Valve
20. Wheel 4WABS Sensor (Left Front)
21. Brake Fluid Level Indicator Switch
22. C158
23. Engine Fuse Module
24. C159
25. Power Distribution Box
26. C160
27. Brake Pressure Switch
28. Speed Control Servo/Amplifier Assembly
29. Rear Anti-Lock Brake System (RABS) Proportioning Valve Switch Assembly
30. C150
31. Mass Air Flow (MAF) Sensor
32. C149
33. C148
34. 4 Wheel Anti-Lock Brake System (4WABS) Module
35. G104
36. Daytime Running Lamps (DRL) Module
37. Radio Noise Capacitor No. 2
38. Camshaft Position (CMP) Sensor
39. Primary Crash Sensor (Left)
40. Engine Oil Pressure Switch
41. C124
42. Cylinder Head Temperature Sensor
43. Throttle Position (TP) Sensor
44. Intake Air Temperature (IAT) Sensor
45. Primary Crash Sensor (Right)
46. Crankshaft Position (CKP) Sensor
47. Rear Air Suspension Compressor Motor & Vent Solenoid
48. A/C Compressor Clutch Solenoid
49. G103
50. A/C Pressure Cutoff Switch
51. Wheel 4WABS Sensor (Right Front)
52. C171
53. A/C Clutch Cycling Pressure Switch
54. Powertrain Control Module (PCM)
55. G102

G00102580

Fig. 3: Engine Compartment (5.4L)

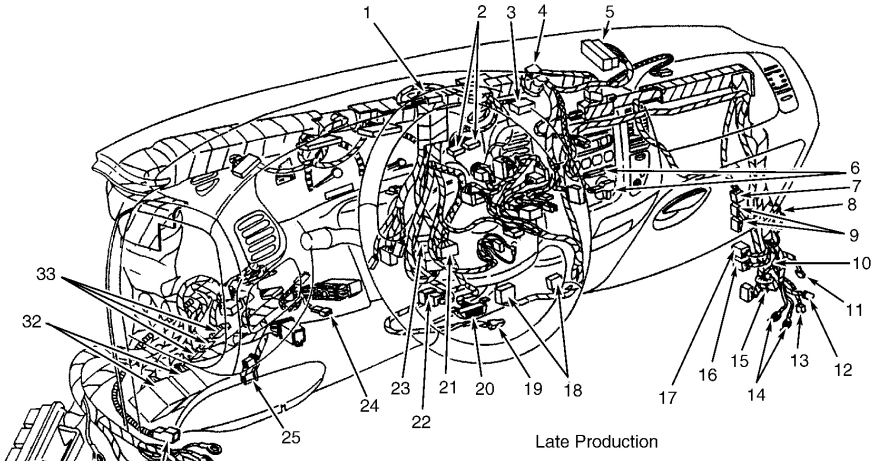


Early Production

1. Generic Electronic Module (GEM) & Central Timer Module
2. Blower/Flasher Relay Block
3. Blend Door Actuator
4. Rear Anti-Lock Brake System (RABS) Module
5. Transfer Case Shift Relays
6. Autolamp Module
7. RPO Relay Block
8. Passive De-activation Module
9. RABS Data Link Connector
10. Air Bag Diagnostic Monitor
11. Inertia Fuel Shut-Off Switch
12. Premium Sound Amplifier
13. Data Link Connector (DLC)
14. Clutch Pedal Position Switch
15. Shift Lock Actuator
16. Brake On/Off (BOO) Switch
17. Junction Box Fuse/Relay Panel

97E00004

Fig. 4: Dash (Early Production)



1. Transfer Case Shift Relay Module
2. Rear Air Suspension (RAS) Module
3. Rear Anti-Lock Brake System (RABS) Module
4. Autolamp Module
5. RPO Relay Block
6. Passive De-activation Module
7. C210
8. RABS Data Link Connector
9. Air Bag Diagnostic Monitor
10. C278
11. Inertia Fuel Shut-Off Switch
12. C202
13. Rear Air Suspension Service Switch
14. G200
15. Rear Air Suspension Data Link Connector
16. C203
17. C206
18. Premium Sound Amplifier
19. Blend Door Actuator
20. Data Link Connector (DLC)
21. Clutch Pedal Position Switch & Clutch Pedal Position Switch Jumper
22. C232
23. Blower/Flasher Relay Block
24. Shift Lock Actuator
25. Brake On/Off (BOO) Switch
26. C200
27. G201
28. C248
29. Differential Speed Sensor Diagnostic Connector
30. C247
31. G202
32. Junction Box Fuse/Relay Panel
33. Generic Electronic Module (GEM) & Central Timer Module

G00102581

Fig. 5: Dash (Late Production)

1997 SUSPENSION -

Electronic Rear Air Suspension - F150 & F250 (Light Duty)

DESCRIPTION

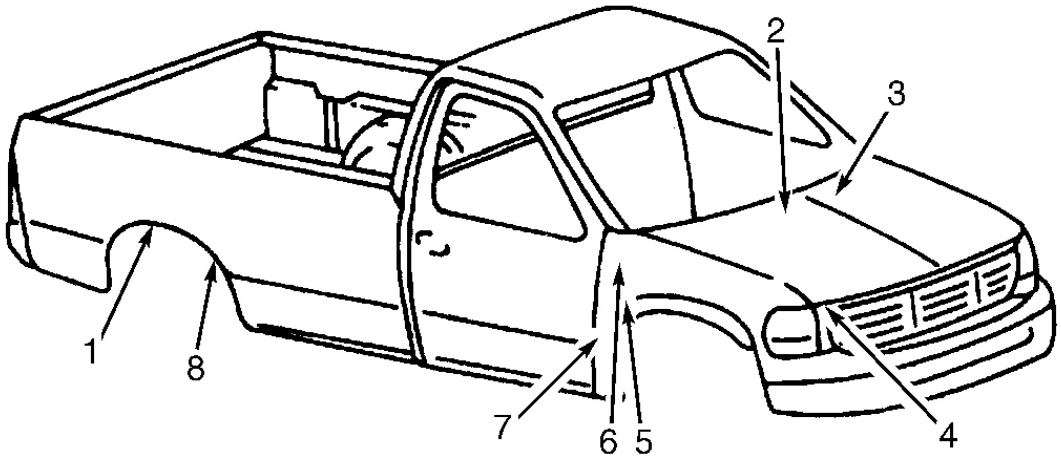
Rear air load leveling suspension is an air operated, microprocessor controlled, suspension system. Air spring supplements conventional rear leaf spring suspension. This provides low spring rates for improved ride and automatic rear load leveling.

OPERATION

Rear air suspension system is operational with ignition switch in RUN position and has limited operation for 40 minutes after ignition is turned off. The air suspension switch, located behind right side kick panel, MUST be turned off when vehicle is being hoisted, towed or jump-started.

A CHECK AIR SUSPENSION warning light is located in instrument, to right of tachometer. Warning light stays on when air suspension switch is turned off or a system malfunction is detected.

Air required for leveling vehicle is distributed from air compressor to the air springs by nylon air line, which runs from compressor drier through a "T" fitting to each individual air spring.



1. Air Spring
2. Suspension Control Module
3. Suspension Warning Light
4. Air Compressor/Drier Assembly
5. Air Suspension Test Connector
6. Air Suspension Switch
7. Compressor Relay
8. Height Sensor

97B03886

Fig. 1: Locating Rear Air Suspension Components
Courtesy of FORD MOTOR CO.

AIR COMPRESSOR

NOTE: Air compressor contains a thermal overload circuit breaker. Circuit breaker automatically resets if tripped by excessive heat.

Air compressor assembly, mounted on core support and right side fender well, consists of compressor, air drier and vent solenoid. Air compressor is powered by compressor relay that is controlled by suspension control module. Air drier is the only part of compressor assembly that can be serviced separately.

AIR SPRING

Air spring assemblies are mounted between axle spring seats and frame spring seats. The 2 air springs supplement conventional leaf springs. Air springs receive compressed air from air compressor to raise rear of vehicle via nylon air lines. Rear of vehicle is lowered by releasing air from air springs through air drier via air spring solenoid, nylon air lines and vent solenoid.

HEIGHT SENSOR

Height sensors are connected between frame and anti-wind bar. Height sensors send signal to suspension control module to control riding height. When height sensors are compressed, rear of vehicle has been lowered and this will cause air compressor to pump air to air springs. When height sensors are extended, rear of vehicle has been raised and will cause air to be vented to lower vehicle.

Height sensor sends 4 differing vehicle height signals to control module, when:

- Vehicle is at trim height (measured from ball stud to ball stud).
- Vehicle is below trim height.
- Vehicle is above trim height.
- Incorrect height information.

AIR SUSPENSION SWITCH

Air suspension switch is located in passenger compartment, behind right kick panel. This switch interrupts height sensor signal to suspension control module, which disables rear air suspension system. This switch MUST be turn off before lifting, towing or repairing any air suspension components.

SUSPENSION CONTROL MODULE

Suspension control module is located behind instrument panel to left of radio. Control module keeps rear of vehicle at predetermined riding height. Control module uses a 45 second averaging interval to determine when rear of vehicle should be adjusted. This eliminates unnecessary correction due to bumps. Control module does not start operation until ignition has been in RUN position for at least 45 seconds.

ADJUSTMENTS

Adjustment procedures are not available from manufacturer. If riding height is not within specification, check for worn, bent or broken components and repair as necessary. If components are all in good condition and riding height is still not within specifications, see TROUBLE SHOOTING.

TROUBLE SHOOTING

AIR SUSPENSION SYMPTOM DIAGNOSIS

Rear suspension does not respond to load changes.

Check for fault in wiring harness, compressor, compressor inlet tube, air drier, control module and/or height sensor. Perform auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

Rear suspension rides to high or to low.

Check for fault in wiring harness, control module, air spring solenoid, air spring and/or height sensor. Perform auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

Unable to enter auto test.

Check for fault in wiring harness, control module and/or tester. Perform TEST X. See TEST X under **SYSTEM TESTING** .

Poor ride quality.

Check for fault in wiring harness, suspension components and/or air spring. Perform auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

Air suspension warning light on.

Check for fault in wiring harness, air suspension switch off, instrument cluster problem and/or air suspension malfunction. Ensure air suspension switch is on. Perform auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

TESTING & DIAGNOSIS

NOTE: Air suspension diagnostics require using Super Star II Tester (007-0041B). DO NOT use Super Star Tester (007-00019).

TESTING PRECAUTIONS

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

CAUTION: Electrical power supply to air suspension system must be turned off prior to hoisting, jacking or towing vehicle. This can be done by disconnecting battery or turning OFF air suspension switch, located behind right side kick panel.

AUTO TEST

Description

This part of testing procedure uses diagnostic capability of air suspension control module. There are 3 steps in this routine, they are as follows:

- **Step 1**

  Suspension control module is made to search the system for any hard codes. Suspension control module will display a code 13 on tester if hard codes are found. If no codes were found, control module continues on to Step 2.

- **Step 2**

Suspension control module will raise and lower vehicle to check function af all electronic components. If there is a problem, suspension control module will display a code 13 on tester screen and end test. If system passed this portion of test, suspension control module will display code 12 on tester screen and will enter Step 3.

- **Step 3**

  Raise and push TEST button on tester. Tester will display any codes or a pass code (CODE 11) until TEST button is pressed again.

Auto Test Procedure

1. Turn ignition switch to OFF position. Remove all extra loads from vehicle. Turn air suspension switch OFF then ON. Connect Super Star II Tester to air suspension test connector, located behind right side kick panel next to air suspension switch.
2. Set Super Star II tester to EEC/MCU mode. Also set Super Star II tester to FAST mode. Release tester button to HOLD (up) position and turn on tester. If battery is weak, connect battery charger to maintain battery level. Turn ignition switch to ON position. Wait 2 seconds, then depress Super Star II tester button so it remains in TEST (down) position. If any code is displayed, go to next step. If no codes are displayed, go to TEST X under **SYSTEM TESTING** .
3. If CODE 10 is displayed, wait 2 minutes for test to run, then press center button twice to retrieve codes. If CODE 80 is displayed, go to TEST W under **SYSTEM TESTING** . If CODE 15 or 55 is displayed, repair Gray/Yellow wire between power distribution box and suspension control module. If any other code is displayed, see CODE REFERENCE CHART TABLE.

CODE REFERENCE CHART

Code	Description	Test
10	Diagnostics Entered, Auto Test In Progress	
11	Vehicle Passes	
12	Auto Test Passed	
13	Auto Test Failed	
15	No Drive Cycle Errors Detected	
35	Drive Cycle Error Codes Erased	
37	Right Spring Solenoid Short To Ground Or Open	**A**
38	Right Spring Solenoid Short To Power	**B**
39	Air Compressor Relay Control Short To Power	**C**
40	Air Compressor Relay Control Short To Ground	**C**
42	Left Spring Solenoid Short To Ground Or Open	**D**
43	Left Spring Solenoid Short To Power	**E**
44	Vent Solenoid Short To Power	**F**
45	Vent Solenoid Short To Ground Or Open	**G**
46	Height Sensor Short To Power Or Ground	**H**
49	Unable To Detect Lowering Right Rear	**J**

51	Unable To Detect Lowering Left Rear	**K**
52	Unable To Detect Raising Right Rear	**L**
54	Unable To Detect Raising Left Rear	**M**
60	Air Suspension Switch hort To Power	Q
61	Air Suspension Switch Short To Ground Or Open	R
66	Right Height Sensor Short Circuit	S
68	Left Height Sensor Short Circuit	T
69	Right Height Sensor Open Circuit	U
70	Control Module Failure	(1)
71	Left Height Sensor Open Circuit	V
80	Control Module Detects Voltage Out Of Range	W
Unable To Enter Auto Test		X
(1) Replace suspension control module		

FUNCTION TEST

CAUTION: Excessive use of function test could overheat compressor, damage air springs or system electronics.

1. After auto test, release and press the TEST button. Wait 20 seconds. Function test codes 23 through 33 should be displayed, each for approximately 15 seconds as long as TEST button is down.

NOTE: As long as TEST button is in HOLD position, selected test will run. See FUNCTION CODE REFERENCE CHART TABLE. Also while a function test is running, tester display may change. Any change in display will have no effect on running test.

2. Within 4 seconds after desired function test code is displayed, press START button and place it in HOLD position to execute function test for that code. See FUNCTION CODE REFERENCE CHART TABLE. To exit that function test, press button to place it in TEST position. Function codes will start to cycle again.

FUNCTION CODE REFERENCE CHART

Code	Description
23	Vent Right Spring
24	Vent Left Spring
25	Vent Both Springs (4 Second Stagger)
26	Fill Right Spring
27	Fill Left Spring
28 (1)	Fill Both Springs (4 Second Stagger)
31 (2)	Toggle Compressor On & Off Repeatedly

32	Toggle Vent On & Off Repeatedly
33	Toggle Spring Solenoid On & Off Repeatedly

(1) This function test is normally used to inflate air springs after repairs have been done to system.

(2) Extended use of this function test can cause circuit breaker in air compressor to open. If this happens, allow air compressor to cool down for 15 minutes. Then restart test.

SYSTEM TESTING

TEST A: CODE 37 - RIGHT SPRING SOLENOID SHORT TO GROUND OR OPEN

1. **Check Tan/White Wire For Short**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C276. See **Fig. 2** . Disconnect right spring solenoid harness connector. Measure resistance between ground and terminal No. 23 (Tan/White wire) at suspension control module harness connector. If resistance is greater than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short to ground in Tan/White wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

2. **Check Right Spring Solenoid**

   Measure resistance between spring solenoid terminals. If resistance is 15-18 ohms, connect suspension control module and go to next step. If resistance is not 15-18 ohms, replace spring solenoid and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

3. **Check Tan/White Wire For Open**

   Measure resistance in Tan/White wire between spring solenoid harness connector and terminal No. 23 at suspension control module harness connector. If resistance is 5 ohms or less, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is greater than 5 ohms, repair open in Tan/White wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

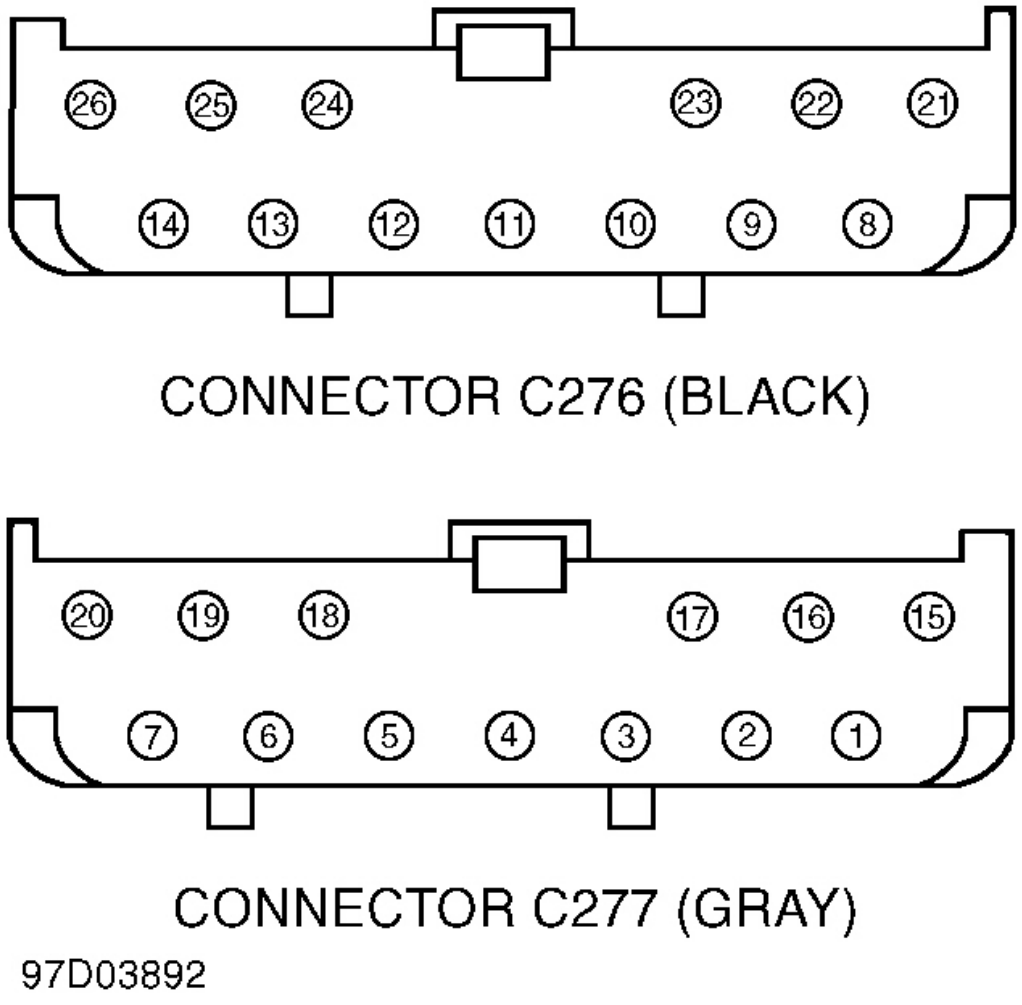


Fig. 2: Identifying Suspension Control Module Harness Terminals
Courtesy of FORD MOTOR CO.

TEST B: CODE 38 - RIGHT SPRING SOLENOID SHORT TO POWER

1. **Check Tan/White Wire For Short To Power**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C276. See **Fig. 2** . Disconnect right spring solenoid harness connector. Turn ignition switch to RUN position. Measure voltage between ground and terminal 23 (Tan/White wire) at suspension control module harness connector. If voltage does not exist, go to next step. If voltage exists, repair short to voltage in Tan/White wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

2. **Check Right Spring Solenoid**

   Measure resistance between spring solenoid terminals. If resistance is 15-18 ohms, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is not 15-18 ohms, replace spring solenoid and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

TEST C: CODE 39 OR 40 - AIR COMPRESSOR RELAY CONTROL SHORT TO POWER OR GROUND

1. **Check Dark Blue/Yellow Wire For Short To Power**

   Remove air compressor relay from power distribution box. Turn ignition switch to RUN position. Measure voltage between ground and terminal No. 86 (Dark Blue/Yellow wire) at power distribution box. See **Fig. 3** . If greater than 4 volts exists, install compressor relay and go to next step. If 4 volts or less exists, go to step 3).

2. **Check Dark Blue/Yellow Wire For Open**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C276. See **Fig. 2** . Measure resistance between ground and terminal No. 14 (Dark Blue/Yellow wire) at suspension control module harness connector. If resistance is 40 ohms or less, replace air compressor relay and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is greater than 40 ohms, repair open in Dark Blue/Yellow wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

3. **Check Dark Blue/Yellow Wire For Short**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C276. See **Fig. 2** . Measure resistance between ground and terminal No. 14 (Dark Blue/Yellow wire) at suspension control module harness connector. If resistance is 10,000 ohms or less, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is greater than 10,000 ohms, repair short in Dark Blue/Yellow wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

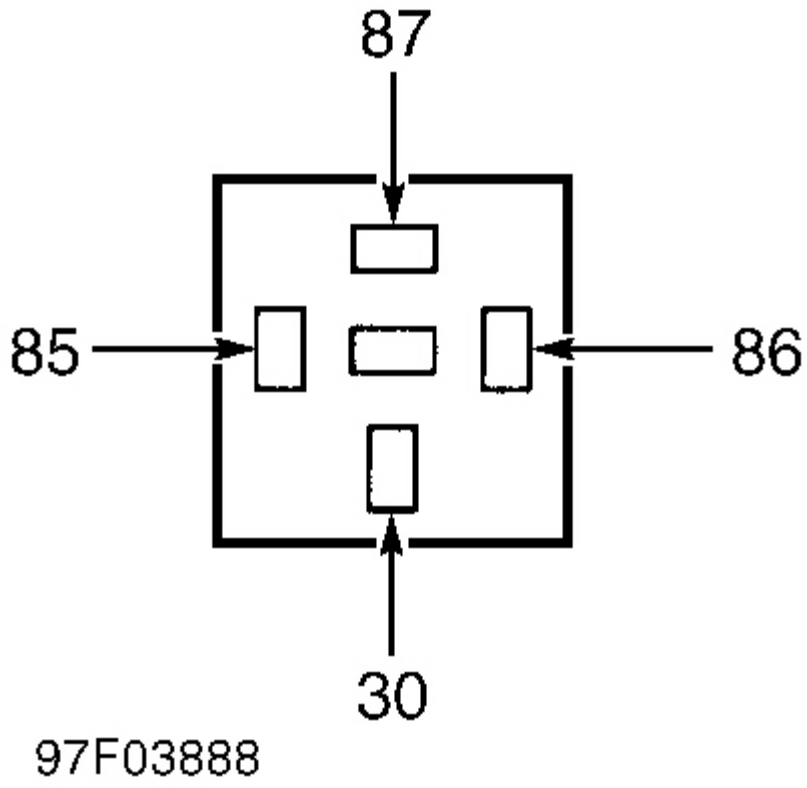


Fig. 3: Identifying Relay Terminals at Power Distribution Box
Courtesy of FORD MOTOR CO.

TEST D: CODE 42 - LEFT SPRING SOLENOID SHORT TO GROUND OR OPEN

1. **Check Brown/Pink Wire For Short**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C276. See **Fig. 2** . Disconnect left spring solenoid harness connector. Measure resistance between ground and terminal No. 13 (Brown/Pink wire) at suspension control module harness connector. If resistance is greater than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short to ground in Brown/Pink wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

2. **Check Left Spring Solenoid**

   Measure resistance between spring solenoid terminals. If resistance is 15-18 ohms, go to next step. If resistance is not 15-18 ohms, replace spring solenoid and repeat auto test. See **AUTO TEST** under

TESTING & DIAGNOSIS.

3. **Check Brown/Pink Wire For Open**

   Measure resistance in Brown/Pink wire between spring solenoid harness connector and terminal No. 13 at suspension control module harness connector. If resistance is 5 ohms or less, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is greater than 5 ohms, repair open in Brown/Pink wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

TEST E: CODE 43 - LEFT SPRING SOLENOID SHORT TO POWER

1. **Check Brown/Pink Wire For Voltage**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C276. See **Fig. 2** . Disconnect right spring solenoid harness connector. Turn ignition switch to RUN position. Measure voltage between ground and terminal 23 (Brown/Pink wire) at suspension control module harness connector. If voltage does not exist, go to next step. If voltage exists, repair short to voltage in Brown/Pink wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

2. **Check Left Spring Solenoid**

   Measure resistance between spring solenoid terminals. If resistance is 15-18 ohms, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is not 15-18 ohms, replace spring solenoid and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

TEST F: CODE 44 - VENT SOLENOID SHORT TO POWER

1. **Check Pink Wire For Voltage**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C276. See **Fig. 2** . Disconnect air compressor harness connector. Turn ignition switch to RUN position. Measure voltage between ground and Pink wire at air compressor harness connector. If voltage does not exist, go to next step. If voltage exists, repair short to voltage in Pink wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

2. **Check Vent Solenoid**

   Measure resistance between terminal No. 2 and No. 3 at air compressor. See **Fig. 4** . If resistance is greater than 19 ohms, check air compressor assembly electrical connections, repair as necessary. If air compressor electrical connections are okay, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is 19 ohms or less, replace air compressor assembly and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If CODE 44 is repeated, replace suspension control module and repeat auto test.

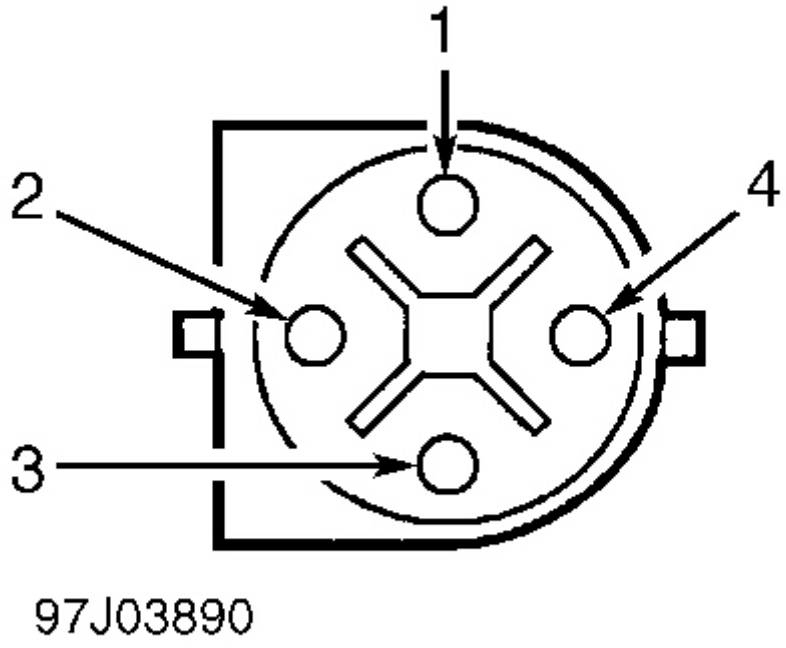


Fig. 4: Identifying Air Compressor Terminals
Courtesy of FORD MOTOR CO.

TEST G: CODE 45 - VENT SOLENOID SHORT TO GROUND OR OPEN

1. **Check Pink Wire For Short**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C277. See **Fig. 2** . Remove fuse No. 4 (15-amp) from power distribution box. Measure resistance between ground and terminal No. 24 (Pink wire) at suspension control module harness connector. If resistance is 10,000 ohms or less, go to next step. If resistance is greater than 10,000 ohms, go to step 3).

2. **Check Pink Wire For Short**

   Disconnect air compressor harness connector. Measure resistance between ground and terminal No. 24 (Pink wire) at suspension control module harness connector. If resistance is 10,000 ohms or less, repair short to ground in Pink wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is greater than 10,000 ohms, check air compressor electrical connection, repair as necessary. If air compressor electrical connections are okay, replace air compressor assembly and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

3. **Check Pink Wire For Open**

   Measure resistance between output side of fuse No. 4 (closest terminal to fuse No. 3) and terminal No. 24 (Pink wire) at suspension control module harness connector. If resistance is greater than 10,000 ohms, go to next step. If resistance is 10,000 ohm or less, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

4. **Check Pink Wire For Open**

   Disconnect air compressor harness connector. Measure resistance in Pink wire between air compressor harness connector and terminal No. 24 at suspension control module harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Pink wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

5. **Check Vent Solenoid**

   Measure resistance between terminal No. 2 and No. 3 at air compressor. See **Fig. 4** . If resistance is 19 ohms or less, replace air compressor assembly and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is greater than 19 ohms, repair open in Purple/Orange wire between power distribution box and air compressor harness connector. Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

TEST H: CODE 46 - HEIGHT SENSOR SHORT TO POWER OR GROUND

1. **Check Height Sensor**

   Turn ignition switch to OFF position. Disconnect right and left height sensor harness connectors. Turn ignition switch to RUN position. Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If CODE 46 is retrieved, go to step 3). If CODE 46 is not retrieved, connect left height sensor and go to next step.

2. **Check Left Height Sensor**

   Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If CODE 46 is retrieved, replace left height sensor and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If CODE 46 is not retrieved, replace right height sensor and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

3. **Check Purple/Light Green Wire For Voltage**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C276. See **Fig. 2** . Turn ignition switch to RUN position. Measure voltage between ground and terminal No. 22 (Purple/Light Green wire) at suspension control module harness connector. If voltage does not exist, go to next step. If voltage exists, repair short to power in Purple/Light Green wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

4. **Check Purple/Light Green Wire For Open**

Turn ignition switch to OFF position. Disconnect air suspension switch harness connector. Measure resistance in Purple/Light Green wire between air suspension switch harness connector and suspension control module harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Purple/Light Green wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

5. **Check Purple/Light Green Wire For Short To Ground**

   Measure resistance between ground and terminal No. 22 (Purple/Light Green wire) at suspension control module harness connector. If resistance is greater than 300 ohms, go to next step. If resistance is 300 ohms or less, repair short to ground in Purple/Light Green wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

6. **Check Dark Green/Light Green Wire For Short To Ground**

   Measure resistance between ground and terminal No. 11 (Dark Green/Light Green wire) at suspension control module harness connector. If resistance is 10,000 ohms or less, repair short to ground in Dark Green/Light Green wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If resistance is greater than 10,000 ohms, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

TEST J: CODE 49 - UNABLE TO DETECT LOWERING OF RIGHT REAR

1. **Perform Auto Test**

   Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If only CODE 49 was retrieved, go to step 5). If any other code(s) were retrieved, go to appropriate procedure. See PROCEDURE REFERENCE TABLE.

   PROCEDURE REFERENCE

Code	Go To
37	Test A
38	Test B
44	Test F
45	Test G
51	Step 2)
52	Step 3)
54	Test N
Any Other	Step 5)

2. **Check Vent Solenoid Operation**

   Enter FUNCTION TEST 32. See **FUNCTION TEST** under TESTING & DIAGNOSIS. Vent solenoid should start cycling. If vent solenoid is cycling, exit function test and go to TEST N. If solenoid is not cycling, replace air compressor assembly and repeat auto test. See **AUTO TEST** under TESTING &

DIAGNOSIS.

3. **Check Red/Black Wire For Short To Ground**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C277. See **Fig. 2** . Disconnect right height sensor harness connector. Measure resistance between ground and Red/Black wire at height sensor harness connector. If resistance is greater than 10,000 ohms go to next step. If resistance is 10,000 ohms or less, repair short to ground in Red/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

4. **Check Right Air Line For Blockage**

   Check air line between air spring and "T" junction for blockage. If air line is blocked, repair air line as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If air line is not blocked, repair open in Red/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

5. **Check Mounting Of Right Rear Height Sensor**

   Check upper and lower mounting points of height sensor. Check height sensor for damage. If no problem is found, go to next step. If any damage is found, repair as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

6. **Check Red/Black Wire For Open**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C277. See **Fig. 2** . Disconnect right height sensor. Measure resistance in Red/Black wire between height sensor harness connector and terminal No. 18 at suspension control module harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

7. **Check Red/Black Wire For Short**

   Measure resistance between ground and terminal No. 18 (Red/Black wire) at suspension control module harness connector. If resistance is greater than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short to ground in Red/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

8. **Check Right Height Sensor**

   Swap right and left height sensors. Turn ignition switch to RUN position. Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If CODE 49 was retrieved again, replace suspension control module and repeat auto test. If CODE 51 was retrieved, replace original right height sensor and repeat auto test.

TEST K: CODE 51 - UNABLE TO DETECT LOWERING OF LEFT REAR

1. **Perform Auto Test**

   Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If only CODE 51 was retrieved, go to step 5). If any other code was retrieved, go to appropriate procedure. See PROCEDURE REFERENCE TABLE.

   PROCEDURE REFERENCE

Code	Go To
37	Test A
38	Test B
44	Test F
45	Test G
49	Step 2)
52	Step 3)
54	Test N
Any Other	Step 5)

2. **Check Vent Solenoid Operation**

   Enter FUNCTION TEST 32. See **FUNCTION TEST** under TESTING & DIAGNOSIS. Vent solenoid should start cycling. If vent solenoid is cycling, exit function test and go to TEST N. If solenoid is not cycling, replace air compressor assembly and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

3. **Check Pink/Black Wire For Short To Ground**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C277. See **Fig. 2** . Disconnect left height sensor harness connector. Measure resistance between ground and Pink/Black wire at height sensor harness connector. If resistance is greater than 10,000 ohms go to next step. If resistance is 10,000 ohms or less, repair short to ground in Pink/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

4. **Check Left Air Line For Blockage**

   Check air line between air spring and "T" junction for blockage. If air line is blocked, repair air line as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If air line is not blocked, repair open in Pink/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

5. **Check Mounting Of Left Height Sensor**

   Check upper and lower mounting points of height sensor. Check height sensor for damage. If no problem is found, go to next step. If any damage is found, repair as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

6. **Check Pink/Black Wire For Open**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C277. See **Fig. 2** . Disconnect left height sensor. Measure resistance in Pink/Black wire between height sensor harness connector and terminal No. 17 at suspension control module harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Pink/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

7. **Check Pink/Black Wire For Short**

   Measure resistance between ground and terminal No. 17 (Pink/Black wire) at suspension control module harness connector. If resistance is greater than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short to ground in Pink/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

8. **Check Left Height Sensor**

   Swap right and left height sensors. Turn ignition switch to RUN position. Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If CODE 51 was retrieved again, replace suspension control module and repeat auto test. If CODE 49 was retrieved, replace original left height sensor and repeat auto test.

TEST L: CODE 52 - UNABLE TO DETECT RAISING OF RIGHT REAR

1. **Perform Auto Test**

   Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If only CODE 52 was retrieved, go to step 7). If any other code was retrieved, go to appropriate procedure. See PROCEDURE REFERENCE TABLE.

   PROCEDURE REFERENCE

Code	Go To
37	Test A
38	Test B
30 OR 40	Test C
51	Test N
49	Step 2)
54	Step 4)
Any Other	Step 7)

2. **Check Red/Black Wire For Short To Ground**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C277. See **Fig. 2** . Disconnect right height sensor harness connector. Measure resistance between ground and Red/Black wire at height sensor harness connector. If resistance is greater than 10,000 ohms, go to next

step. If resistance is 10,000 ohms or less, repair short to ground in Red/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

3. **Check Left Air Line For Blockage**

   Check air line between air spring and "T" junction for blockage. If air line is blocked, repair air line as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If air line is not blocked, replace right spring solenoid and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

4. **Check Air Compressor Operation**

   Perform FUNCTION TEST 31. See FUNCTION TEST under **TESTING & DIAGNOSIS** . If air compressor cycles on and off, stop function test and go to next step. If air compressor does not cycle, stop function test and go to TEST P.

5. **Check Air Flow From Drier**

   Disconnect air line from drier. Repeat FUNCTION TEST 31. If air does not flow from drier while compressor is running, stop function test and go to next step. If air flows from drier while compressor is running, repair air line as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

6. **Check For Blocked Drier**

   Remove drier from compressor assembly. Repeat FUNCTION TEST 31. If air does not flow from compressor while compressor is running, replace air compressor assembly and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If air flows from compressor while compressor is running, replace drier and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

7. **Check Operation Of Air Compressor**

   Run FUNCTION TEST 26. See **FUNCTION TEST** under TESTING & DIAGNOSIS. If air compressor operates, go to next step. If compressor does not operate, stop function test and go to TEST P.

8. **Check Right Spring Solenoid For Leaks**

   Repeat FUNCTION TEST 26. While function test is running check for air leaks at spring solenoid. If leaks are detected, repair or replace spring solenoid as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If no leak are detected, replace suspension control module and repeat auto test. See AUTO TEST under TESTING & DIAGNOSIS.

TEST M: CODE 54 - UNABLE TO DETECT RAISING OF LEFT REAR

1. **Perform Auto Test**

   Repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If only CODE 54 was retrieved, go

to step 7). If any other code was retrieved, go to appropriate procedure. See PROCEDURE REFERENCE TABLE.

PROCEDURE REFERENCE

Code	Go To
37	Test A
38	Test B
30 OR 40	Test C
49	Test N
51	Step 2)
52	Step 4)
Any Other	Step 7)

2. **Check Pink/Black Wire For Short To Ground**

   Turn ignition switch to OFF position. Disconnect suspension control module harness connector C277. See **Fig. 2** . Disconnect left height sensor harness connector. Measure resistance between ground and Pink/Black wire at height sensor harness connector. If resistance is greater than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short to ground in Pink/Black wire and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

3. **Check Left Air Line For Blockage**

   Check air line between air spring and "T" junction for blockage. If air line is blocked, repair air line as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If air line is not blocked, replace left spring solenoid and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

4. **Check Air Compressor Operation**

   Perform FUNCTION TEST 31. See **FUNCTION TEST** under TESTING & DIAGNOSIS. If air compressor cycles on and off, stop function test and go to next step. If air compressor does not cycle, stop function test and go to TEST P.

5. **Check Air Flow From Drier**

   Disconnect air line from drier. Repeat FUNCTION TEST 31. If air does not flow from drier while compressor is running, stop function test and go to next step. If air flows from drier while compressor is running, repair air line as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

6. **Check For Blocked Drier**

   Remove drier from compressor assembly. Repeat FUNCTION TEST 31. If air does not flow from compressor while compressor is running, replace air compressor assembly and repeat auto test. See **AUTO TEST** under TESTING AND DIAGNOSIS. If air flows from compressor while compressor is

running, replace drier and repeat auto test. See **AUTO TEST** under TESTING AND DIAGNOSIS.

7. **Check Operation Of Air Compressor**

   Run FUNCTION TEST 26. See **FUNCTION TEST** under TESTING & DIAGNOSIS. If air compressor operates, go to next step. If compressor does not operate, stop function test and go to TEST P.

8. **Check Left Spring Solenoid For Leaks**

   Repeat FUNCTION TEST 26. While function test is running check for air leaks at spring solenoid. If leaks are detected, repair or replace spring solenoid as necessary and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS. If no leak are detected, replace suspension control module and repeat auto test. See **AUTO TEST** under TESTING & DIAGNOSIS.

REMOVAL & INSTALLATION

For information on removal and installation of suspension components, see **REAR -- F-150, F-250, LIGHT DUTY PICKUP** article.

1997-99 DRIVE AXLES

Differential - Front - 8.8" Ring Gear - Expedition, "F" Series Light Duty, Mountaineer & Navigator

DESCRIPTION & OPERATION

A half-shaft type front axle is used. Axle is of integral carrier housing, hypoid gear type. Drive pinion and ring gear bearing adjustments are all accomplished with shims. Power is transmitted through transfer case driveshaft to the drive pinion located in the axle housing. Drive pinion shaft is supported by 2 opposed tapered roller bearings. Power is transmitted from pinion gear through ring gear and differential pinion gears to axle shafts and wheels.

On all models except 1999 Expedition and Navigator, a vacuum operated clutch engages front axle. 1999 Expedition and Navigator is an all wheel drive vehicle. Front axle is engaged at all time. See **Fig. 1** or **Fig. 2** .

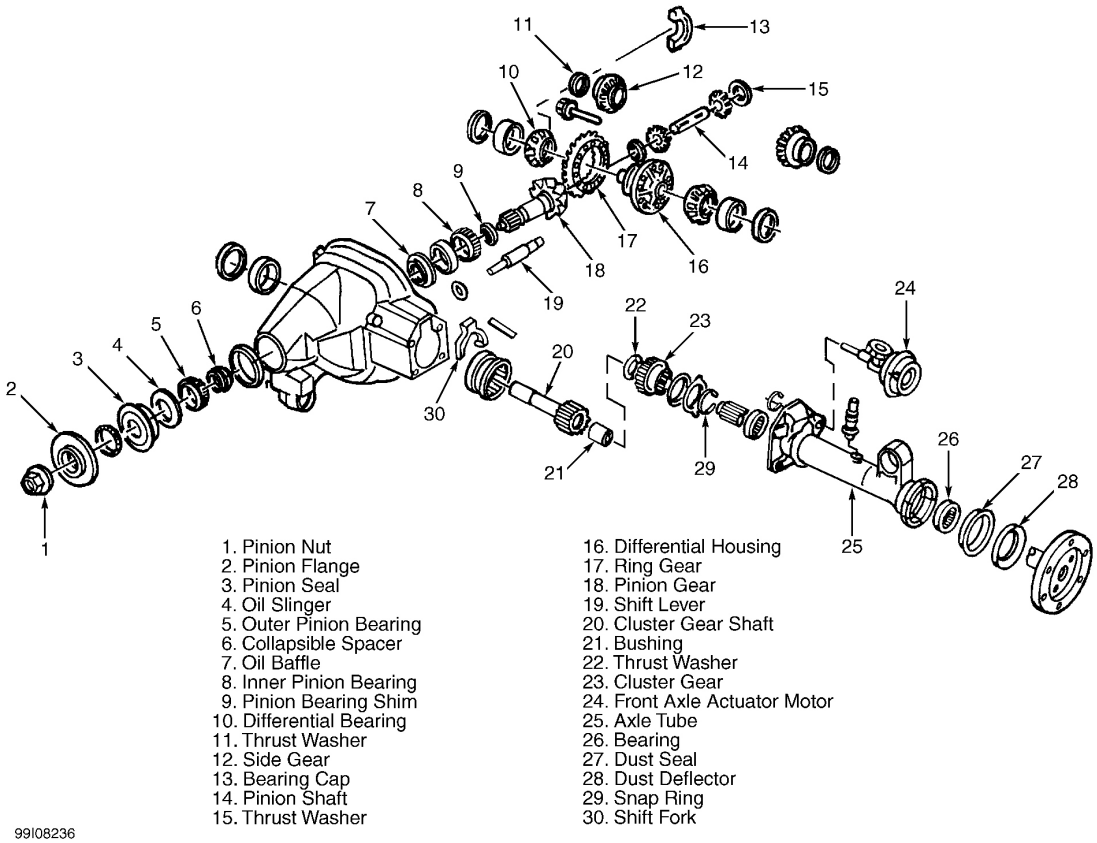


Fig. 1: Exploded View Of Front Axle Housing Assembly (Except 1999 Expedition & Navigator)
Courtesy of FORD MOTOR CO.

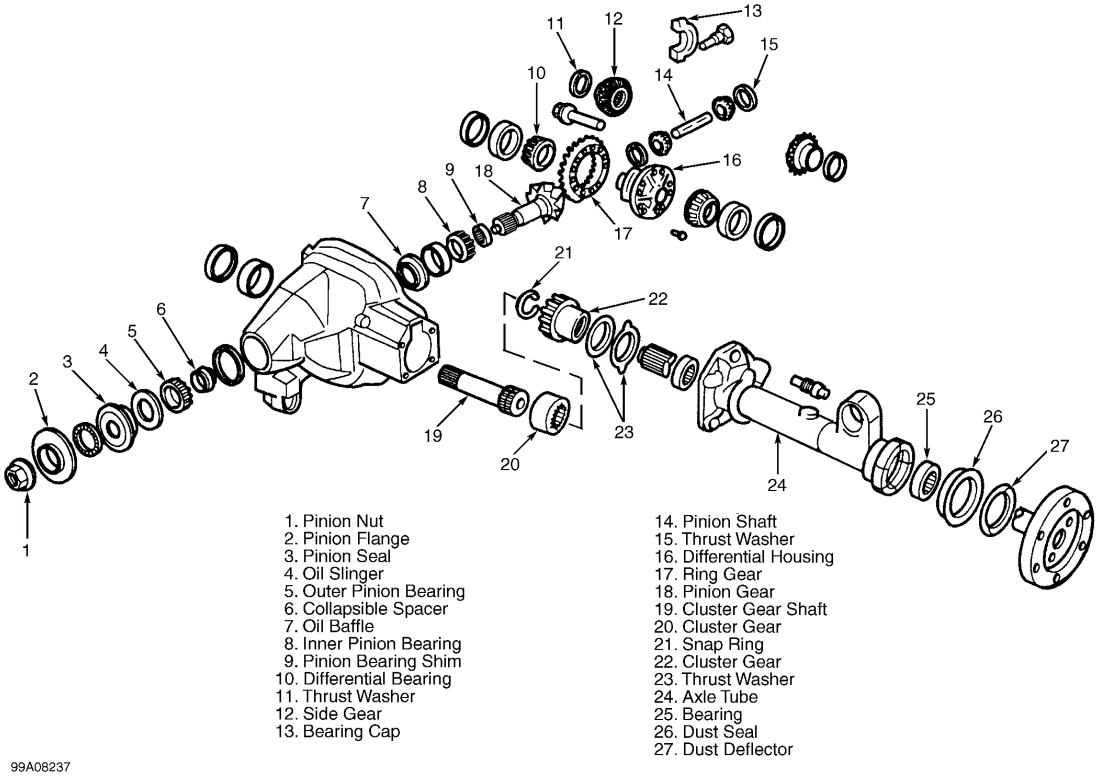


Fig. 2: Exploded View Of Front Axle Housing Assembly (1999 Expedition & Navigator)
Courtesy of FORD MOTOR CO.

AXLE RATIO & IDENTIFICATION

Axle application can be determined through the axle code on the Safety Certification Label on left door pillar. Additionally, a metal identification tag stamped with gear ratio and diameter is secured to axle housing. See **Fig. 3** .

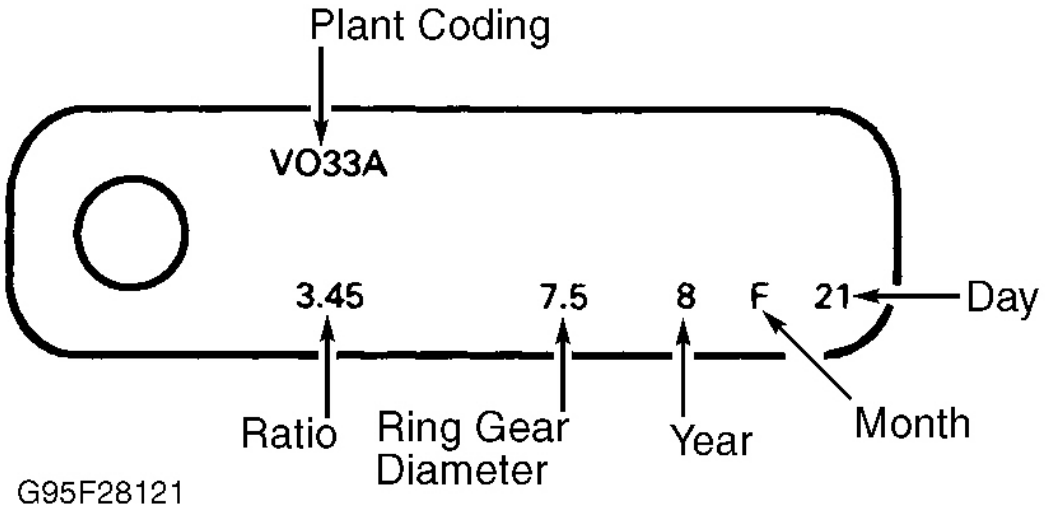


Fig. 3: Identifying Axle Identification Tag
Courtesy of FORD MOTOR CO.

LUBRICATION

Capacity is 3.5-3.7 Pts. (1.8-2.0L) of Motorcraft SAE 75W90 Thermally Stable 4X4 Axle Lubricant (XY-75W90-QL). Capacities listed are approximate. Fill differential until fluid level is about 1/4" below bottom of filler plug hole.

TROUBLE SHOOTING

NOTE: See appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

WARNING: On vehicles with air suspension, power to air suspension must be shut off before hoisting, jacking or towing. Failure to do so can result in unexpected inflation or deflation of air suspension, which can result in shifting of vehicle during servicing.

AXLE HOUSING ASSEMBLY

Removal & Installation

NOTE: DO NOT allow drive shaft to hang unsupported.

1. Raise and support vehicle. Mark pinion yoke and drive shaft alignment for reassembly reference. Disconnect drive shaft from yoke, and wire aside. Remove axle shaft-to-stub axle retaining bolts and wire aside (both sides). Disconnect vent tube. Disconnect front axle actuator motor vacuum line (if equipped).
2. Using a suitable jack, support axle housing assembly and secure axle housing to jack. Remove axle housing support bracket. Remove axle housing retaining bolts. To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** table.

OVERHAUL (EXCEPT 1999 EXPEDITION & NAVIGATOR)

WARNING: On vehicles with air suspension, power to air suspension must be shut off before hoisting, jacking or towing. Failure to do so can result in unexpected inflation or deflation of air suspension, which can result in shifting of vehicle during servicing.

DISASSEMBLY

1. Remove axle housing. See **AXLE HOUSING ASSEMBLY** under REMOVAL & INSTALLATION. Drain differential fluid. Remove housing cover. Mount axle housing in Holding Fixture (T57L-500-B) using Adapters (T90T-4000-A) and Spacer (T80T-4000-B2).
2. Pull back clutch boot and remove snap ring. Remove front axle actuator motor. Remove axle housing retaining bolts and remove assembly. Remove cluster gear thrust washer. Remove front axle cluster gear. Lift front axle shift lever and remove gear selector. Remove shift lever and shift fork by removing roll pin.
3. Remove left stub axle retaining clip (inside differential assembly). Remove left stub axle. Install Housing Spreader Adapter Set (T90T-4000-A) and Differential Housing Spreader (TOOL-4000-E). See **Fig. 4** . Mount dial indicator on axle housing to measure amount of spread.

CAUTION: DO NOT spread axle housing more than .030" (.76 mm); permanent damage to housing could result.

4. Spread axle housing to .030" (.76 mm). Remove dial indicator. Mark bearing cap for installation reference. Remove bearing cap retaining bolts and remove bearing caps. Carefully pry differential assembly out of housing. Remove spreader immediately so housing does not permanently distort. Remove and tag side bearing races to indicate from which side of carrier they were removed.
5. Turn nose of axle housing up. Using an INCH lbs. torque wrench, measure and record pinion bearing preload. Hold pinion flange and remove pinion nut. Scribe index marks on pinion flange and pinion stem for installation reference. Remove pinion flange. Using Converter Seal Remover (T94P-77001-BH) and slide hammer, remove pinion seal.
6. Remove drive pinion by tapping with soft-faced mallet. Remove outer pinion bearing and oil slinger. Using Puller Tool (T77F-1102-A) and Slide Hammer (T50T-100-A), remove inner bearing race. If necessary, remove oil baffle. Remove pinion outer bearing race. Press pinion bearing off pinion. Measure and record inner pinion bearing shim thickness.
7. Place differential case in vise, with rags underneath to protect ring gear. Remove ring gear bolts. Tap ring gear with soft-face mallet to remove ring gear from case. Remove pinion shaft lock bolt. Remove pinion

shaft.

8. Rotate side gears until pinion gears are aligned with case opening. Remove pinion gears and thrust washers. Remove side gears with thrust washers. Remove differential case side bearings.

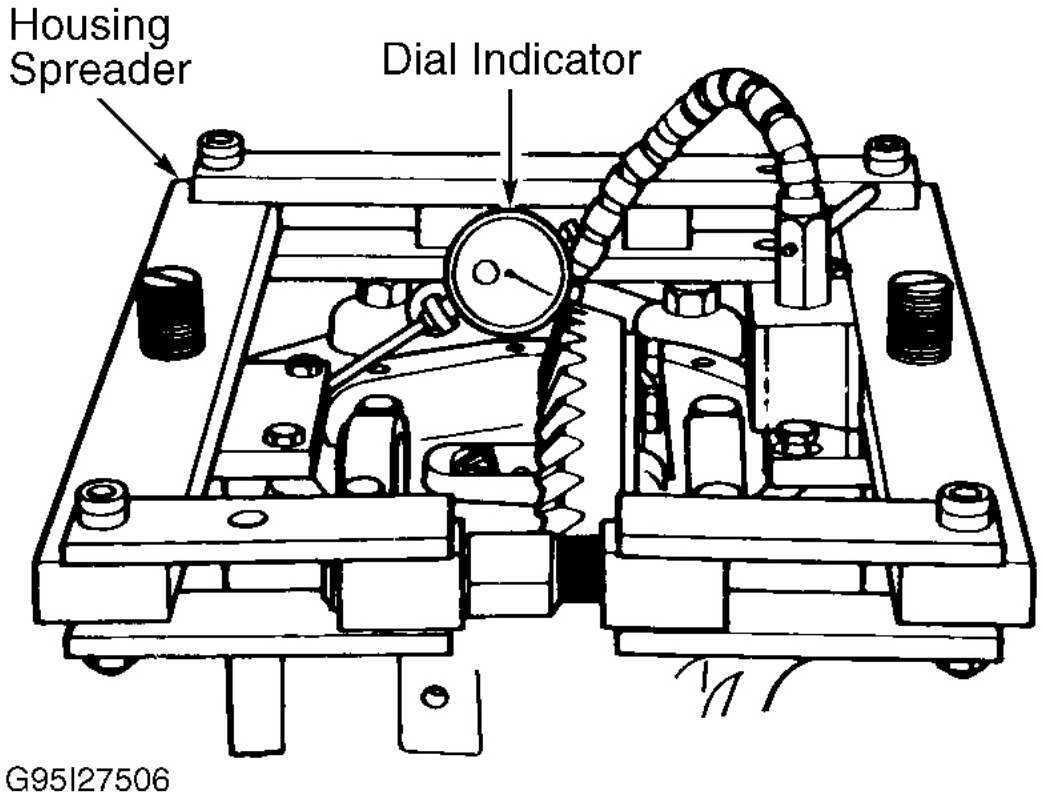


Fig. 4: Spreading Axle Housing
Courtesy of FORD MOTOR CO.

CLEANING & INSPECTION

1. Clean all components in solvent. Allow bearings to air dry. Inspect all machined surfaces for smoothness or raised edges. Inspect all gear teeth for wear or chipping and replace as necessary.
2. Check all bearings and races for nicks, roller end wear, grooves or damage. Replace as needed. Check pinion flange for wear in sealing area and replace as necessary.
3. Check differential pinion shaft, pinion gears, side gears and thrust washers for wear or damage. Replace all defective parts. Replace pinion gear and ring gear as a set.

REASSEMBLY

1. Install thrust washers on differential side gears. Install differential side gears in differential housing.

Install thrust washer and pinion gear in differential case. Install pinion shaft. Install pinion shaft lock bolt.

2. Install oil baffle. Using Pinion Bearing Cup Replacer (T53T-4621-C), install pinion bearing races. Apply a light film of oil on pinion bearings.
3. Assemble Pinion Depth Gauge (T79P-4020-A). Install aligning adapter, gauge disc and screw. Place rear pinion bearing over aligning adapter and in to bearing cup of carrier housing. See **Fig. 5** .
4. Install front pinion bearing into front bearing cup. Place handle onto screw and tighten to 20 INCH lbs. (2.25 N.m). See **Fig. 6** . Ensure pinion depth measuring tool is properly installed and tightened.
5. Rotate gauge block several times to seat bearings. Rotational torque on gauge block assembly should be 20 INCH lbs. (2.25 N.m) with new bearings. Final position of gauge block should be 45 degrees above axle shaft center line. See **Fig. 7** .
6. Clean differential bearing bores thoroughly, and install gauge tube. Tighten differential bearing cap bolts to specification. See **TORQUE SPECIFICATIONS** . Use flat pinion shims as a gauge for shim selection. Hold gauge block in proper position, and measure clearance between gauge block and tube.
7. Correct shim selection is accomplished when a slight drag is felt as shim is drawn between gauge block and tube. Shims are available in various thicknesses. Install correct shim on pinion for reassembly. Pinion bearings must be installed in the same location as during pinion depth measurement. Remove measuring equipment.

NOTE: If oil seal becomes cocked during installation, remove seal and install NEW oil seal.

8. Place pinion shim previously determine on pinion shaft and press on inner pinion bearing. Place NEW collapsible spacer on pinion shaft. Install outer pinion bearing and oil slinger in axle housing. Using Pinion Oil Seal Replacer (T79P-4676-A), install oil seal into axle housing.
9. Position pinion gear in axle housing. Align marks on pinion flange and pinion stem. Apply a small amount of lubricant to pinion flange splines. Install pinion flange and NEW pinion nut. Hold pinion flange, and gradually tighten nut while rotating pinion.

NOTE: If desired preload is exceeded, a NEW collapsible spacer must be installed. Tighten nut to obtain proper preload.

10. Check pinion bearing preload often, until correct preload is obtained. DO NOT back off pinion nut to reduce preload. See **DIFFERENTIAL SPECIFICATIONS** . Install Right Master Bearing (T93P-4222-B) and Left Master Bearing (T93P-4222-A) on differential housing.
11. Insert differential and master bearings into axle housing. Position dial indicator to outside mounting hole. Position indicator tip on machined surface of differential case flange. Adjust dial indicator to measure full travel. Push differential case left and right as far as possible. Measure total end play and record on **Line-A** of differential bearing shim selection procedure work sheet. See **Fig. 9** .
12. Remove differential case from carrier to install ring gear. Ensure ring is free of any nicks or burrs. Press ring gear onto case, and tighten bolts to correct torque. See **TORQUE SPECIFICATIONS** . Install differential case with master bearings into axle housing.
13. With dial indicator in place, push ring gear to mesh with pinion gear. Rock ring gear to allow full mesh with pinion gear. Zero dial indicator. Move ring gear away from pinion gear as much as possible. Record measurement on **Line-B** of differential bearing shim selection procedure work sheet. Remove differential

from housing, and remove master bearing from carrier assembly.

14. Identify and mark right and left bearing for installation reference. Clamp Bearing Preload Tool (T93P-4220-AR) base in a soft-jaw vise. Keep bearing mounting surface above vise jaws. Position bearing assembly on bearing preload tool base, and tighten tool bolt to 20 INCH lbs. (2.3 N.m). See **Fig. 8** .
15. Invert preload tool and clamp bolt head in vise. Position depth micrometer over top of bearing. With depth micrometer positioned on bearing cone, measure height of each individual bearing assembly. Measure distance from bearing cone to bearing preload tool disc. Record both bearing measurements on **Line-D** on differential bearing shim selection procedure work sheet.
16. Select appropriate bearing shims using differential bearing shim selection procedure work sheet. See **Fig. 9** . For correct shim, see **DIFFERENTIAL SHIM SIZE** table.
17. Remove master bearing from carrier, and press appropriate differential bearing on appropriate side of differential case. Tighten housing spreader so dial indicator reads .030" (.76 mm). Install selected shims.
18. Install differential assembly in axle housing. Install and tighten bearing caps to correct torque with housing spreader still installed. See **TORQUE SPECIFICATIONS** . Loosen and remove spreader. Move dial indicator base and mount in line with ring gear.
19. Mount dial indicator, and zero on any ring gear drive tooth. See **Fig. 10** . Turn ring gear without turning pinion gear to measure backlash. Preferred backlash is .008-.013" (.203-.330 mm).
20. If backlash is not to specification, adjust backlash by increasing thickness of one shim and decreasing thickness of other shim by same amount. See **RING GEAR BACKLASH-TO-SHIM THICKNESS CONVERSION** table. See **Fig. 11** .
21. Instal NEW "O" ring on shift lever. Position shift fork in axle housing. Lubricate "O" ring, and install shift lever. Install roll pin until flush with top of shift fork. Lift shift lever and install selector gear. Install front axle cluster gear and cluster gear thrust washer.
22. Using Ford Black Silicone Rubber (F4AZ-19562-B), fill grove groove in axle housing and install front axle tube. Tighten axle tube retaining bolts to specification. See **TORQUE SPECIFICATIONS** .
23. Install left stub axle seal. Install left stub axle and new retaining clip (inside differential assembly). Install front axle actuator motor. Using a vacuum pump, verify front axle actuator motor does not leak down. Also, ensure front axle clutch is engaging completely.
24. To complete assembly, reverse disassembly procedure. Tighten all nuts and bolts to specifications. See **TORQUE SPECIFICATIONS** . Fill differential with proper lubricant until fluid level is about 1/4" below bottom of filler plug hole. See **LUBRICATION** .

DIFFERENTIAL SHIM SIZE

Color	No. Of Stripes	Shim Thickness In. (mm)
Red	1	.2410-.2415 (6.121-6.134)
Red	2	.2430-.2435 (6.172-6.185)
Orange	1	.2450-.2455 (6.223-6.236)
Orange	2	.2470-.2475 (6.274-6.287)
Orange	3	.2490-.2495 (6.325-6.337)
Orange	4	.2510-.2515 (6.375-6.388)
Orange	5	.2530-.2535 (6.426-6.439)
Yellow	1	.2550-.2555 (6.477-6.490)
Yellow	2	.2570-.2575 (6.528-6.541)

Yellow	3	.2590-.2595 (6.579-6.591)
Yellow	4	.2610-.2615 (6.629-6.642)
Yellow	5	.2630-.2635 (6.680-6.693)
White	1	.2650-.2655 (6.731-6.744)
White	2	.2670-.2675 (6.782-6.795)
White	3	.2690-.2695 (6.833-6.845)
White	4	.2710-.2715 (6.883-6.896)
White	5	.2730-.2735 (6.934-6.947)
Green	1	.2750-.2755 (6.985-6.998)
Green	2	.2770-.2775 (7.036-7.049)
Green	3	.2790-.2795 (7.087-7.099)
Green	4	.2810-.2815 (7.137-7.150)
Green	5	.2830-.2835 (7.188-7.201)
Pink	1	.2850-.2855 (7.239-7.252)
Pink	2	.2870-.2875 (7.290-7.303)
Pink	3	.2890-.2895 (7.341-7.353)
Pink	4	.2910-.2915 (7.391-7.404)
Pink	5	.2930-.2935 (7.442-7.455)
Blue	2	.2970-.2975 (7.544-7.557)
Blue	3	.2990-.2995 (7.595-7.607)
Blue	4	.3010-.3015 (7.645-7.658)
Blue	5	.3030-.3035 (7.696-7.709)
Gray	1	.3050-.3055 (7.747-7.760)
Gray	2	.3070-.3075 (7.798-7.811)

RING GEAR BACKLASH-TO-SHIM THICKNESS CONVERSION

Required Change In Backlash - In. (mm)	Required Change In Shim Thickness - In. (mm)
.001 (.03)	.002 (.05)
.002 (.05)	.002 (.05)
.003 (.08)	.004 (.10)
.004 (.10)	.006 (.15)
.005 (.13)	.006 (.15)
.006 (.15)	.008 (.20)
.007 (.18)	.010 (.25)
.008 (.20)	.010 (.25)
.009 (.23)	.012 (.30)
.010 (.25)	.014 (.36)
.011 (.28)	.014 (.36)
.012 (.30)	.016 (.41)
.013 (.33)	.018 (.46)
.014 (.36)	.018 (.46)

.015 (.38)	.020 (.51)

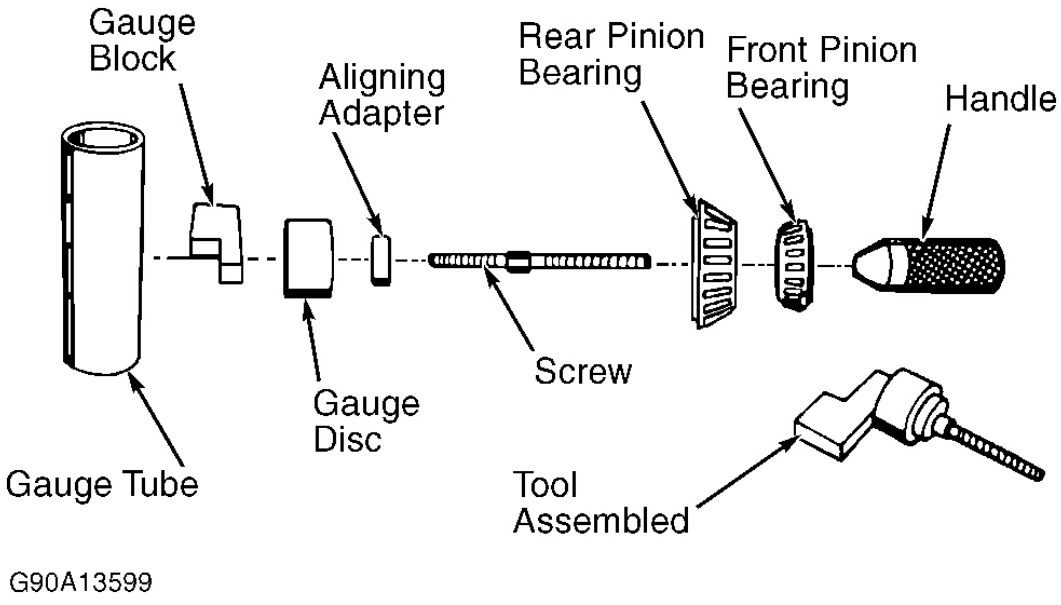


Fig. 5: Assembling Pinion Depth Gauge
Courtesy of FORD MOTOR CO.

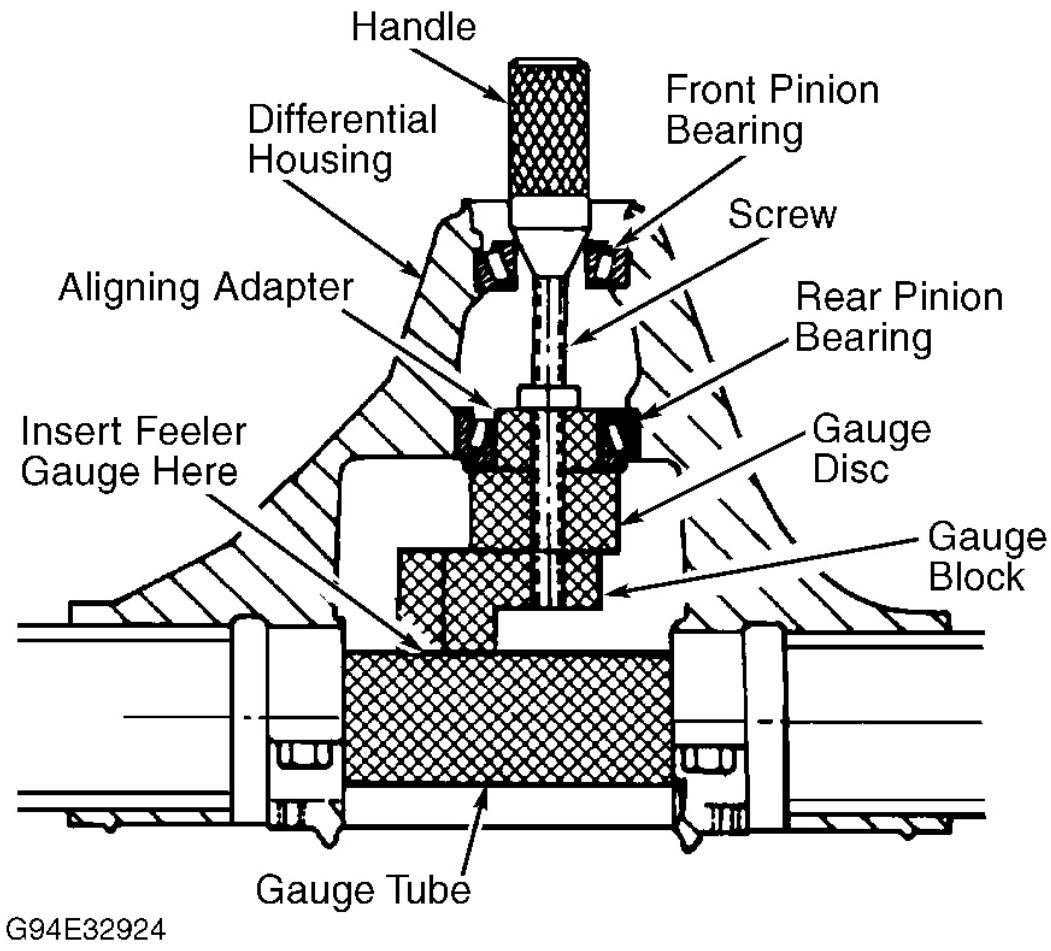


Fig. 6: Installing Pinion Depth Gauge
Courtesy of FORD MOTOR CO.

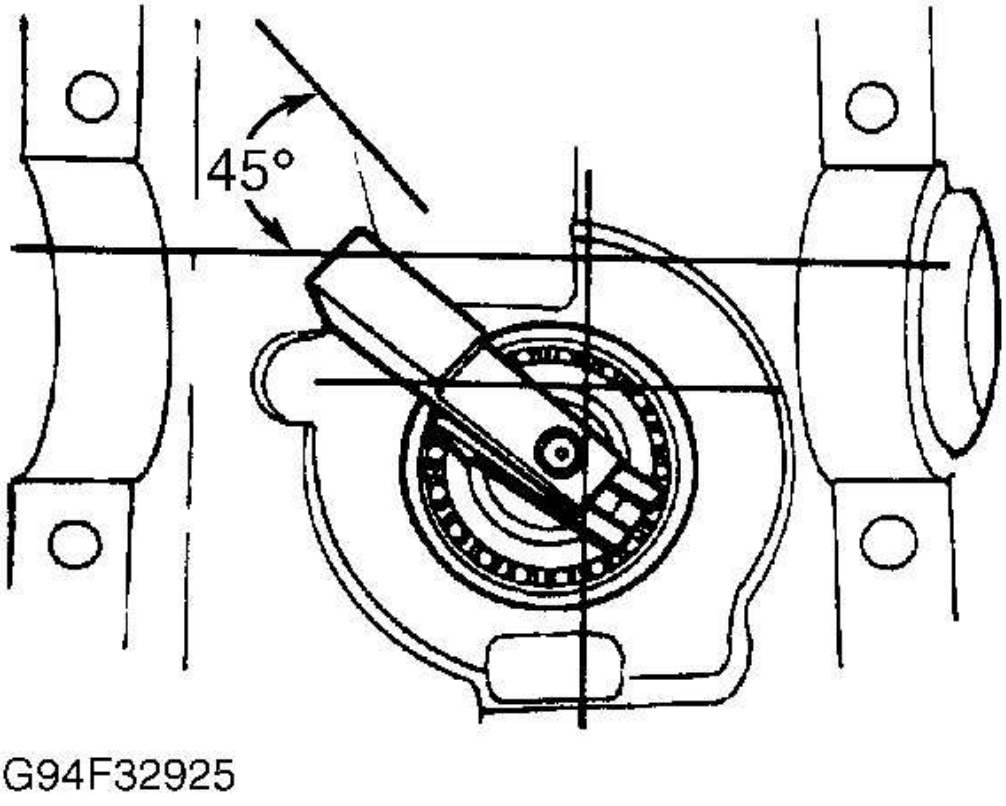


Fig. 7: Final Position Of Pinion Depth Gauge
Courtesy of FORD MOTOR CO.

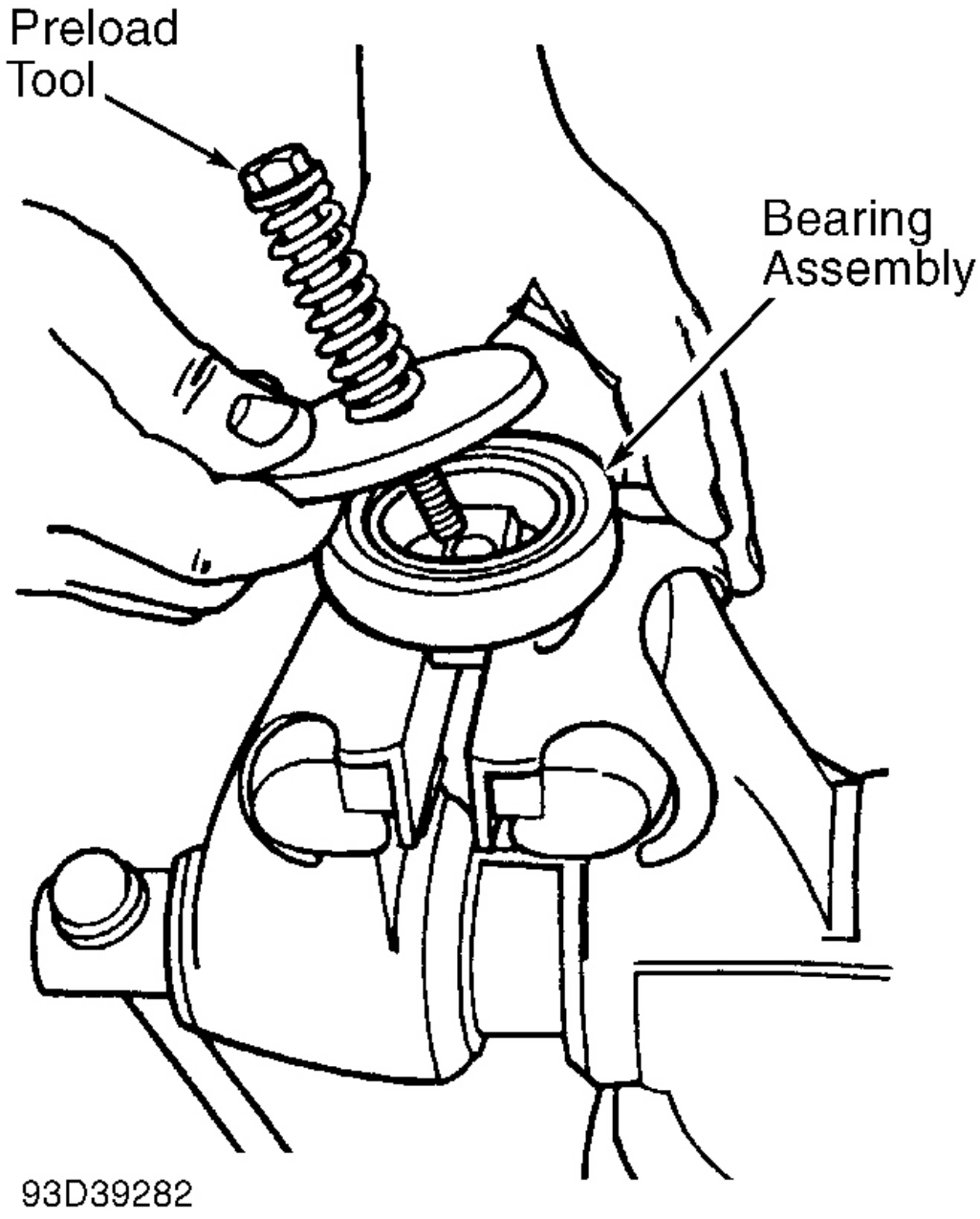


Fig. 8: Positioning Bearing Preload Tool
Courtesy of FORD MOTOR CO.

Dana 35 Axle	Actual	Example
Line-A End play without ring gear		0.498
Line-B End play with ring gear		-0.245
Line-C Subtract Line-B from Line-A, also record on Line-C, below		0.253

Dana 35 Axle	Left Differential Bearing Height		Right Differential Bearing Height	
	Actual	Example	Actual	Example
Master Bearing Height	0.8695	0.8695	0.8695	0.8695
Line-D Actual Bearing Height		-0.8478		-0.8491
Line-E Difference		0.0217		0.0204

Dana 35 Axle	Left Side		Dana 35 Axle	Right Side	
	Actual	Example		Actual	Example
Line-B End Play With Ring Gear Line-E Bearing Height	+	0.2450 +0.0217	Line-C End Play Line-E Bearing Height	+	0.2530 +0.0204
TOTAL Lines B and E Backlash (Subtract)	-0.006	0.2667 -0.0060	TOTAL Lines C and E Backlash/preload (Add)	+0.0200	0.2734 +0.0200
Initial Thickness [a]		0.2607	Initial Thickness	0.2934	
Final Shim Thickness-Left		0.261	Final Shim Thickness-Right		0.293

a Round off initial thickness to the nearest shim thickness as in the example for final shim thickness.

99G08235

Fig. 9: Differential Bearing Shim Selection Procedure Work Sheet
Courtesy of FORD MOTOR CO.

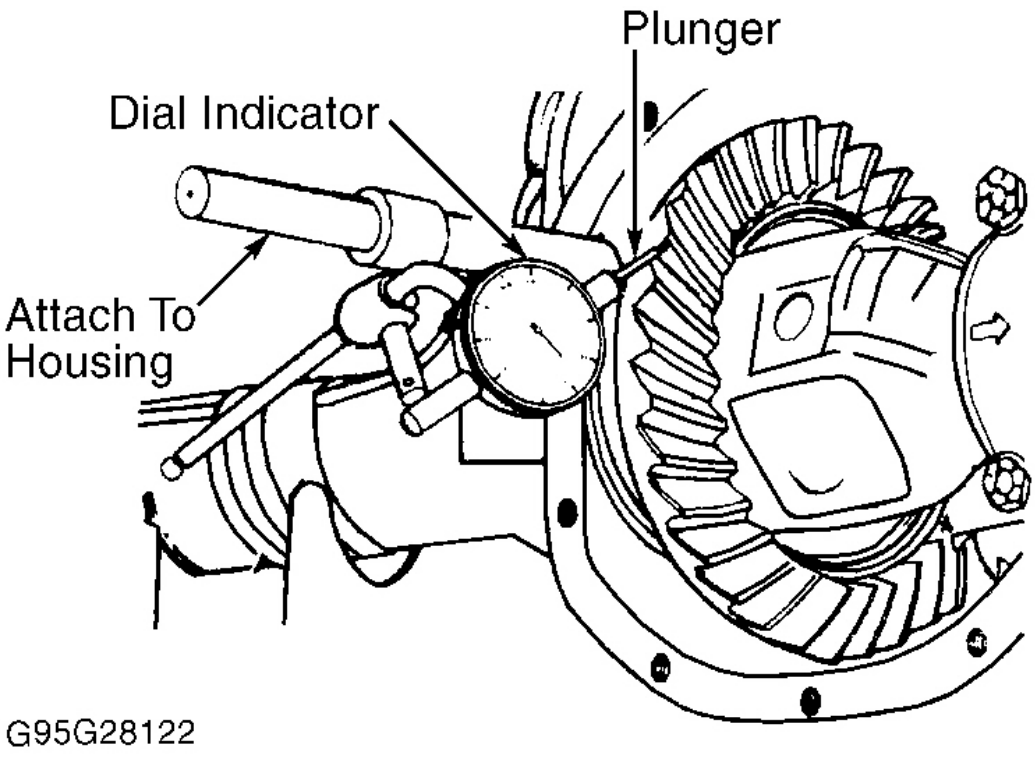


Fig. 10: Checking Ring Gear Backlash
Courtesy of FORD MOTOR CO.

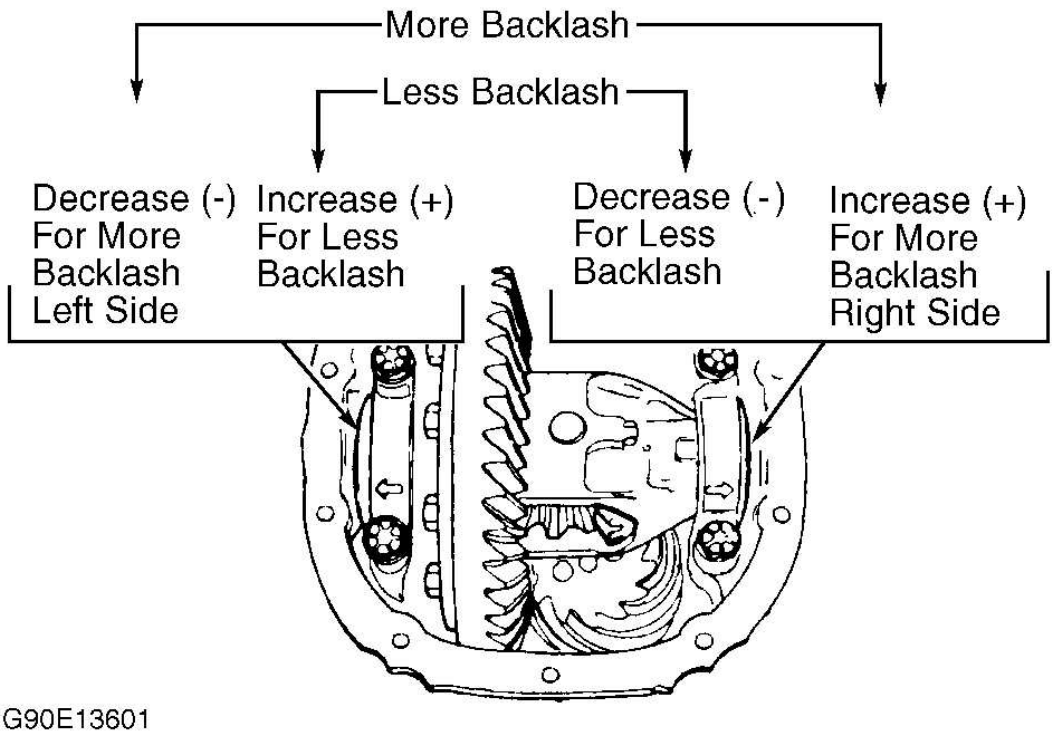


Fig. 11: Adjusting Ring Gear Backlash
Courtesy of FORD MOTOR CO.

OVERHAUL (1999 EXPEDITION & NAVIGATOR)

WARNING: On vehicles with air suspension, power to air suspension must be shut off before hoisting, jacking or towing. Failure to do so can result in unexpected inflation or deflation of air suspension, which can result in shifting of vehicle during servicing.

DISASSEMBLY

1. Remove axle housing. See **AXLE HOUSING ASSEMBLY** under REMOVAL & INSTALLATION. Drain differential fluid. Remove housing cover. Mount axle housing in Holding Fixture (T57L-500-B) using Adapters (T90T-4000-A) and Spacer (T80T-4000-B2).
2. Remove axle housing retaining bolts and remove assembly. Remove coupler shaft selector gear. Remove front axle cluster gear.
3. Remove left stub axle retaining clip (inside differential assembly). Remove left stub axle. Install Housing Spreader Adapter Set (T90T-4000-A) and Differential Housing Spreader (TOOL-4000-E). See **Fig. 4** . Mount dial indicator on axle housing to measure amount of spread.

CAUTION: DO NOT spread axle housing more than .030" (.76 mm); permanent damage to housing could result.

4. Spread axle housing to .030" (.76 mm). Remove dial indicator. Mark bearing cap for installation reference. Remove bearing cap retaining bolts and remove bearing caps. Carefully pry differential assembly out of housing. Remove spreader immediately so housing does not permanently distort. Remove and tag side bearing races to indicate from which side of carrier they were removed.
5. Turn nose of axle housing up. Using an INCH lbs. torque wrench, measure and record pinion bearing preload. Hold pinion flange and remove pinion nut. Scribe index marks on pinion flange and pinion stem for installation reference. Remove pinion flange. Using Converter Seal Remover (T94P-77001-BH) and slide hammer, remove pinion seal.
6. Remove drive pinion by tapping with soft-faced mallet. Remove outer pinion bearing and oil slinger. Using Puller Tool (T77F-1102-A) and Slide Hammer (T50T-100-A), remove inner bearing race. If necessary, remove oil baffle. Remove pinion outer bearing race. Press pinion bearing off pinion. Measure and record inner pinion bearing shim thickness.
7. Place differential case in vise, with rags underneath to protect ring gear. Remove ring gear bolts. Tap ring gear with soft-faced mallet to remove ring gear from case. Remove pinion shaft lock bolt. Remove pinion shaft.
8. Rotate side gears until pinion gears are aligned with case opening. Remove pinion gears and thrust washers. Remove side gears with thrust washers. Remove differential case side bearings.

CLEANING & INSPECTION

1. Clean all components in solvent. Allow bearings to air dry. Inspect all machined surfaces for smoothness or raised edges. Inspect all gear teeth for wear or chipping and replace as necessary.
2. Check all bearings and races for nicks, roller end wear, grooves or damage. Replace as needed. Check pinion flange for wear in sealing area and replace as necessary.
3. Check differential pinion shaft, pinion gears, side gears and thrust washers for wear or damage. Replace all defective parts. Replace pinion gear and ring gear as a set.

REASSEMBLY

1. Install thrust washers on differential side gears. Install differential side gears in differential housing. Install thrust washer and pinion gear in differential case. Install pinion shaft. Install pinion shaft lock bolt.
2. Install oil baffle. Using Pinion Bearing Cup Replacer (T53T-4621-C), install pinion bearing races. Apply a light film of oil on pinion bearings.
3. Assemble Pinion Depth Gauge (T79P-4020-A). Install aligning adapter, gauge disc and screw. Place rear pinion bearing over aligning adapter and into bearing cup of carrier housing. See **Fig. 5** .
4. Install front pinion bearing into front bearing cup. Place handle onto screw and tighten to 20 INCH lbs. (2.25 N.m). See **Fig. 6** . Ensure pinion depth measuring tool is properly installed and tightened.
5. Rotate gauge block several times to seat bearings. Rotational torque on gauge block assembly should be 20 INCH lbs. (2.25 N.m) with new bearings. Final position of gauge block should be 45 degrees above axle shaft center line. See **Fig. 7** .
6. Clean differential bearing bores thoroughly, and install gauge tube. Tighten differential bearing cap bolts

to specification. See **TORQUE SPECIFICATIONS** . Use flat pinion shims as a gauge for shim selection. Hold gauge block in proper position, and measure clearance between gauge block and tube.

7. Correct shim selection is accomplished when a slight drag is felt as shim is drawn between gauge block and tube. Shims are available in various thicknesses. Install correct shim on pinion for reassembly. Pinion bearings must be installed in the same location as during pinion depth measurement. Remove measuring equipment.

NOTE: If oil seal becomes cocked during installation, remove seal and install NEW oil seal.

8. Place pinion shim previously determine on pinion shaft and press on inner pinion bearing. Place NEW collapsible spacer on pinion shaft. Install outer pinion bearing and oil slinger in axle housing. Using Pinion Oil Seal Replacer (T79P-4676-A), install oil seal into axle housing.
9. Position pinion gear in axle housing. Align marks on pinion flange and pinion stem. Apply a small amount of lubricant to pinion flange splines. Install pinion flange and NEW pinion nut. Hold pinion flange, and gradually tighten nut while rotating pinion.

NOTE: If desired preload is exceeded, a NEW collapsible spacer must be installed. Tighten nut to obtain proper preload.

10. Check pinion bearing preload often, until correct preload is obtained. DO NOT back off pinion nut to reduce preload. See **DIFFERENTIAL SPECIFICATIONS** . Install Right Master Bearing (T93P-4222-B) and Left Master Bearing (T93P-4222-A) on differential housing.
11. Insert differential and master bearings into axle housing. Position dial indicator to outside mounting hole. Position indicator tip on machined surface of differential case flange. Adjust dial indicator to measure full travel. Push differential case left and right as far as possible. Measure total end play and record on **Line-A** of differential bearing shim selection procedure work sheet. See **Fig. 9** .
12. Remove differential case from carrier to install ring gear. Ensure ring is free of any nicks or burrs. Press ring gear onto case and tighten bolts to correct torque. See **TORQUE SPECIFICATIONS** . Install differential case with master bearings into axle housing.
13. With dial indicator in place, push ring gear to mesh with pinion gear. Rock ring gear to allow full mesh with pinion gear. Zero dial indicator. Move ring gear away from pinion gear as much as possible. Record measurement on **Line-B** of differential bearing shim selection procedure work sheet. Remove differential from housing, and remove master bearing from carrier assembly.
14. Identify and mark right and left bearing for installation reference. Clamp Bearing Preload Tool (T93P-4220-AR) base in a soft-jaw vise. Keep bearing mounting surface above vise jaws. Position bearing assembly on bearing preload tool base, and tighten tool bolt to 20 INCH lbs. (2.3 N.m). See **Fig. 8** .
15. Invert preload tool and clamp bolt head in vise. Position depth micrometer over top of bearing. With depth micrometer positioned on bearing cone, measure height of each individual bearing assembly. Measure distance from bearing cone to bearing preload tool disc. Record both bearing measurements on **Line-D** on differential bearing shim selection procedure work sheet.
16. Select appropriate bearing shims using differential bearing shim selection procedure work sheet. See **Fig. 9** . For correct shim, see **DIFFERENTIAL SHIM SIZE** table.
17. Remove master bearing from carrier, and press appropriate differential bearing on appropriate side of

differential case. Tighten housing spreader so dial indicator reads .030" (.76 mm). Install selected shims.

18. Install differential assembly in axle housing. Install and tighten bearing caps to correct torque with housing spreader still installed. See **TORQUE SPECIFICATIONS** . Loosen and remove spreader. Move dial indicator base, and mount in line with ring gear.
19. Mount dial indicator, and zero on any ring gear drive tooth. See **Fig. 10** . Turn ring gear without turning pinion gear to measure backlash. Preferred backlash is .012-.015" (.304-.381 mm).
20. If backlash is not to specification, adjust backlash by increasing thickness of one shim and decreasing thickness of other shim by same amount. See **RING GEAR BACKLASH-TO-SHIM THICKNESS CONVERSION** table. See **Fig. 11** .
21. Install front axle cluster gear and coupler shaft selector gear. Using Ford Black Silicone Rubber (F4AZ-19562-B), fill grove groove in axle housing and install front axle tube. Tighten axle tube retaining bolts to specification. See **TORQUE SPECIFICATIONS** .
22. Install left stub axle seal. Install left stub axle and NEW retaining clip (inside differential assembly).
23. To complete assembly, reverse disassembly procedure. Tighten all nuts and bolts to specifications. See **TORQUE SPECIFICATIONS** . Fill differential with proper lubricant until fluid level is about 1/4" below bottom of filler plug hole. See **LUBRICATION** .

DIFFERENTIAL SPECIFICATIONS

AXLE ASSEMBLY SPECIFICATIONS

Application	In. (mm)
Differential Case Runout (Maximum)	.003 (.076)
Ring Gear Runout (Maximum)	.004 (.10)
Ring Gear-To-Pinion Backlash	
1997-98	.008-.013 (.20-.33)
1999	(1) .008-.015 (.20-.38)
	INCH Lbs. (N.m)
Drive Pinion Bearing Preload	
New Bearings	16-29 (1.8-3.3)
Used Bearings	8-14 (.9-1.6)
(1) Preferred backlash is .012-.015 (.30-.38)	

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Axle Housing Mount Bolt	66 (89)
Axle Shaft-To-Stub Axle Bolts	51-67 (69-91)
Axle Tube Bolt	54 (73)
Drain & Filler Plug	18 (24)

1997 Ford Pickup F150

1997-99 DRIVE AXLES Differential - Front - 8.8" Ring Gear - Expedition, "F" Series Light Duty, Mountaineer & Navigator

Drive Shaft Bolts	70-95 (95-129)
Housing Cover Bolt	24 (33)
Pinion Shaft Lock Bolt	22 (30)
Ring Gear Bolt	77 (104)
Side Bearing Cap Bolt	77 (104)

1996-97 SUSPENSION

Front (2WD) - Trucks

DESCRIPTION

NOTE: Unless otherwise specified, references to Pickup include the F350 Super Duty. Unless otherwise specified, references to F350 Super Duty include commercial chassis and motorhome chassis vehicles.

On F150 and F250 Light Duty models, front suspension consists of a coil spring, upper and lower control arms. On F250 Heavy Duty and F350 models (except F350 Super Duty), front suspension consists of a coil spring, twin "I" beam-type front axle assembly. "I" beams are mounted to a frame pivot bracket at one end, and to spindle (with ball joints) and a radius arm at the other. Springs are mounted between frame spring pocket and axle.

F350 Super Duty models use leaf springs attached to a solid "I" beam axle. Spindle is attached to "I" beam with solid pins (kingpins) and bushings. On standard chassis, springs are attached to fixed bracket on the rear and movable shackle on the front. On commercial and motorhome chassis, the movable shackle is on rear of spring and fixed bracket is located at front.

ADJUSTMENTS & INSPECTION

WHEEL ALIGNMENT

NOTE: See SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT.

WHEEL BEARING ADJUSTMENT

1. Turn off air suspension switch at right kick panel (if equipped). Raise and support vehicle. Remove wheel cover and grease cap. Remove cotter pin and retainer. Loosen adjusting nut 3 turns.
2. Obtain running clearance between brake rotor surface and lining by rocking entire wheel assembly several times to push caliper and brake pads away from rotor.
3. An alternate method of obtaining running clearance is to lightly tap on brake caliper housing. DO NOT tap on any area which may damage rotor and lining. DO NOT pry on brake caliper piston.
4. Running clearance must be maintained throughout bearing adjustment procedure. If proper clearance cannot be maintained, caliper must be removed.
5. Tighten adjusting nut to 17-25 ft. lbs. (23-34 N.m) while rotating brake rotor in opposite direction. Back off adjusting nut 120-180 degrees.
6. Tighten adjusting nut to 17-25 INCH lbs. (1.92-2.82 N.m). Bearing end play should be .00025-.00500" (.006-.127 mm). Torque required to turn hub should be 10-25 INCH lbs. (1.13-2.82 N.m).
7. Install retainer and NEW cotter pin without loosening adjusting nut. Bend ends of cotter pin around retainer.

BALL JOINT & SPINDLE PIN CHECKING

NOTE: On models with spindle pin and bushings, the bushing I.D. should be .001-.003" (.03-.08 mm) larger than diameter of spindle pin when new. No further information is available from manufacturer.

NOTE: Upper and lower ball joints on F150 and F250 Light Duty models are not serviceable. If ball joints are found to be worn, upper or lower control arm must be replaced as an assembly.

Turn off air suspension switch at right kick panel (if equipped). Raise and support vehicle. Ensure wheel bearings are properly adjusted. Grasp lower edge of tire and move wheel in and out while watching for spindle movement. Spindle movement must not exceed 1/32" (.794 mm) at upper or lower arms, relative to axle. If movement exceeds limit, replace ball joints.

REMOVAL & INSTALLATION

WARNING: Failure to retighten wheel lug nuts at 500 miles (100 miles and 500 miles on dual-rear wheel vehicles) after installation, may result in wheel coming loose and loss of vehicle control.

FRONT WHEEL BEARINGS

Removal & Installation

1. Turn off air suspension switch at right kick panel (if equipped). Raise front of vehicle, and remove wheels. Remove brake caliper, and wire it to underbody to prevent damage to brake hose.
2. Remove grease cap from hub. Remove cotter pin, retainer, adjusting nut and flat washer from spindle. Remove outer wheel bearing. Pull hub and rotor from spindle. Remove grease seal and inner wheel bearing.
3. Clean bearings, inspect for damage and replace as necessary. Fill inside of hub, flush with inside diameter of bearing outer races, with lithium-based grease. Install bearings and NEW seal.
4. To complete installation, reverse removal procedure. Adjust wheel bearings. See **WHEEL BEARING ADJUSTMENT** under ADJUSTMENTS & INSPECTION.

SHOCK ABSORBER

Removal & Installation (F150 & F250 Light Duty)

Remove shock absorber-to-upper bracket nut. On F150 and F250 Light Duty, remove shock absorber-to-lower control arm nuts and remove shock absorber. On Van, remove shock absorber-to-radius arm nut and remove shock absorber. To install, reverse removal procedure. Tighten nuts to specification. See **TORQUE SPECIFICATIONS** table.

Removal (F250 Heavy Duty & F350)

Hold upper shock retaining nut. Loosen stud by turning hex on exposed lower part of stud. Remove nut and disconnect shock absorber from lower mount. Compress shock absorber and remove shock absorber. Cut or remove bushing from upper shock mount.

Installation

To install, reverse removal procedure. Coat upper spring seat with soap solution and install NEW bushing. Tighten bolts or nuts to specification. See **TORQUE SPECIFICATIONS (F250 HEAVY DUTY & F350)** table.

Removal & Installation (F350 Super Duty)

Remove shock absorber-to-upper bracket nut. Remove shock absorber-to-spring spacer nut and remove shock absorber. To install, reverse removal procedure. Tighten nuts to specification. See **TORQUE SPECIFICATIONS (F350 SUPER DUTY)** table.

SPINDLE

Removal & Installation (F150 & F250 Light Duty)

1. Turn off air suspension switch at right kick panel (if equipped). Raise and support vehicle. Remove wheel assembly. Remove brake caliper, and wire aside. Remove grease cap, cotter pin, retainer, adjusting nut, flat washer and outer wheel bearing.
2. Remove brake rotor and rotor shield. Using a floor jack, support lower control arm. Remove cotter pin and nut from upper ball joint. Using Pitman Arm Puller (T64P-3590-F), separate upper ball joint from wheel spindle. Remove upper shock absorber nut. Remove 2 lower shock absorber nuts and remove shock absorber.
3. Remove cotter pin and nut from tie rod end. Using Pitman Arm Puller (T64P-3590-F), separate tie rod end from wheel spindle. Using Spring Compressor (D78P-5310-A), compress coil spring. Remove cotter pin and nut from lower ball joint. Separate lower ball joint from wheel spindle using pitman arm puller. Remove wheel spindle.
4. To install, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS** table. Adjust wheel bearings. See **WHEEL BEARING ADJUSTMENT** under ADJUSTMENTS & INSPECTION. Check and adjust front end alignment. See SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT.

Removal (F250 Heavy Duty, F350)

1. Raise vehicle and support under front axle. Remove wheel assembly. Remove brake caliper, and wire it to underbody to prevent damage to brake hose. Remove grease cap, cotter pin, retainer, adjusting nut, flat washer and outer wheel bearing.
2. Remove brake rotor and brake dust shield. Remove inner bearing and seal. Remove cotter pin and nut from tie rod end. Using Tie Rod Remover (TOOL-3290-D), remove tie rod end from spindle arm.
3. Remove cotter pin and nut from lower ball joint. Remove nut from axle clamp bolt and remove bolt. Note position of camber adjuster on top of axle. See **Fig. 1** . Remove camber adjuster from upper ball joint.
4. Strike axle to break lower ball joint loose from axle. See **Fig. 1** . Remove spindle assembly.

CAUTION: DO NOT use pickle fork to separate ball joint from spindle, as seal and ball joint socket will be damaged.

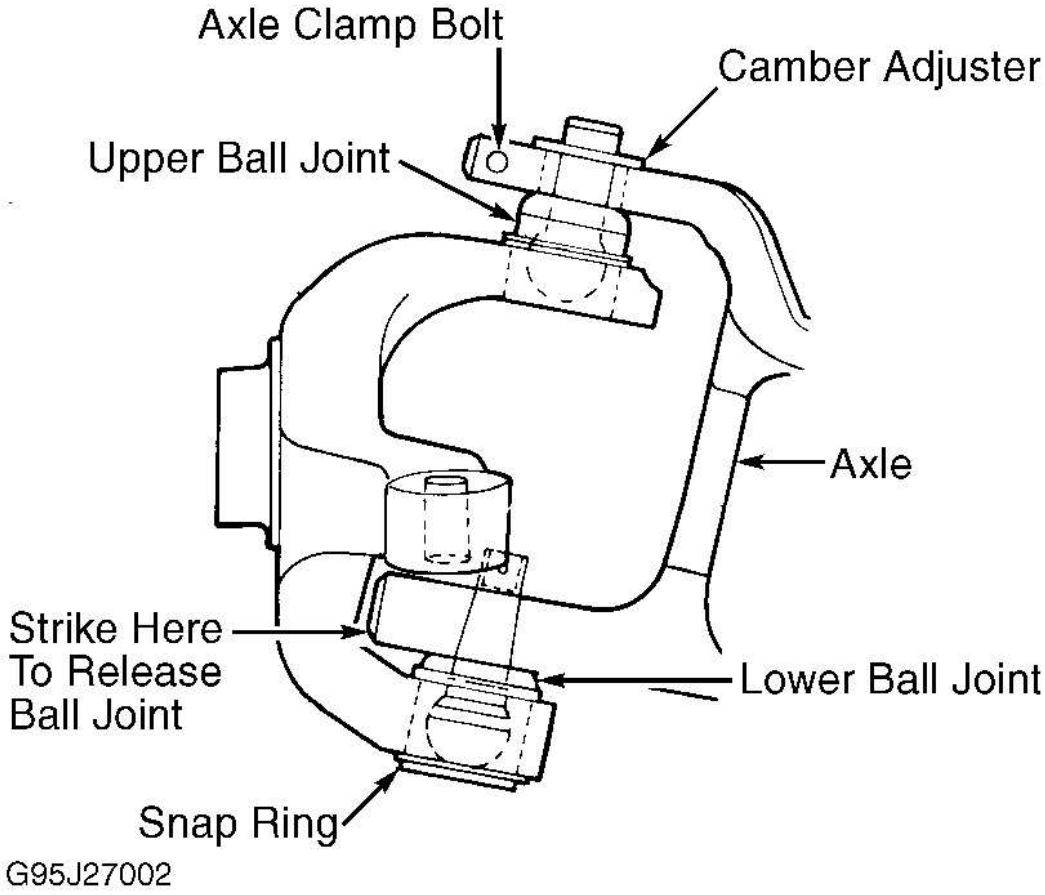


Fig. 1: Removing Spindle (Except F350 Super Duty)
Courtesy of FORD MOTOR CO.

Installation

1. Ensure ball joint seals are in position. Place spindle and ball joints into axle. Install lower ball joint nut and tighten to specification. See **TORQUE SPECIFICATIONS (F250 HEAVY DUTY & F350)** table.
2. Install camber adjuster over upper ball joint stud. Ensure camber adjuster is properly aligned. If camber adjustment is required, special camber adjusters must be installed. Tap camber adjuster into spindle. Tighten upper ball joint nut to specification.
3. Install cotter pin. Install axle clamp bolt and tighten to specification. To complete installation, reverse removal procedure. Adjust wheel bearings. See **WHEEL BEARING ADJUSTMENT** under ADJUSTMENTS & INSPECTION. Check and adjust front end alignment. See SPECIFICATIONS &

PROCEDURES article in WHEEL ALIGNMENT.

Removal (F350 Super Duty)

1. Raise vehicle and support under front axle. Remove wheel assembly. Remove brake caliper, and wire it to underbody to prevent damage to brake hose. Remove grease cap, cotter pin, retainer, adjusting nut, flat washer and outer wheel bearing.
2. Remove brake rotor and brake dust shield. Remove inner wheel bearing and seal. Remove tie rod cotter pin and nut. Use Tie Rod Remover (TOOL-3290-D) to separate tie rod end from spindle arm (standard models) or drag link (commercial chassis and motorhome chassis models).
3. Remove nut and lock washer from spindle pin lock bolt. See **Fig. 2** . Tap out spindle pin lock bolt. Remove upper and lower spindle pin plugs. Drive spindle pin out from top of axle. Remove spindle, thrust bearing, shims and seals.

NOTE: On F350 Super Duty models, a seal is used at top and bottom of spindle pin.

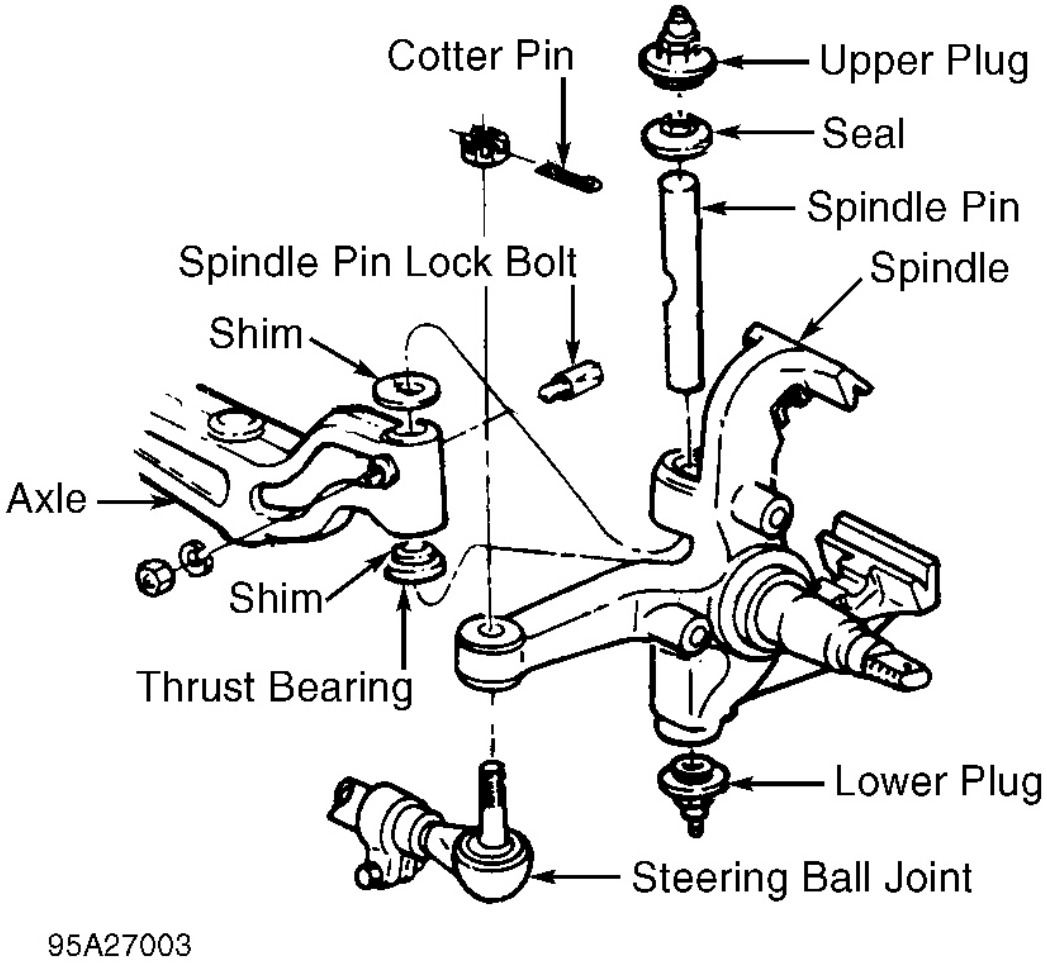


Fig. 2: Exploded View Of Spindle & Pin Assembly (F350 Super Duty)
Courtesy of FORD MOTOR CO.

Installation

1. Ensure spindle pin bore is free of nicks, burrs and corrosion. Lightly coat bore surface with a lithium-based grease. Install spindle pin seal with metal backing facing toward the bushing.
2. Press seal into position. Use care not to bend seal casing. Install NEW thrust bearing with lip flange facing toward lower bushing. Install thrust bearing until firmly seated against spindle surface.
3. Lightly coat bushing surface with lithium-based grease and place spindle in position on axle. Hold spindle and thrust bearing tightly against axle and measure distance between spindle and top of axle. Select proper thickness shim(s) and install.
4. Install spindle pin with "T" marking toward top, and notch in pin aligned with spindle pin lock bolt hole in axle. Drive spindle pin through bushings from top of axle until spindle pin notch aligns with spindle

pin lock bolt hole. Install spindle pin lock bolt with threads pointing forward and groove facing spindle pin notch.

5. Firmly drive spindle pin lock bolt into position, and install lock washer and nut. Tighten nut to specification. Install upper and lower plugs and tighten to specification. See **TORQUE SPECIFICATIONS (F350 SUPER DUTY)** table.
6. Lubricate spindle pin and bushings through grease fittings until grease seeps past upper seal at top and from thrust bearing slip joint at bottom. If grease fails to appear, recheck installation procedure.
7. To complete installation, reverse removal procedure. Adjust wheel bearings. See **WHEEL BEARING ADJUSTMENT** under ADJUSTMENTS & INSPECTION. Check and adjust front end alignment. See SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT.

SPINDLE PIN BUSHINGS

Removal & Installation (F350 Super Duty)

1. Remove spindle. See **Removal (F350 Super Duty)** . Install spindle in a vise.
2. Use Reamer (D88T-3110-BH), Bushing Remover/Installer Driver (D88T-3110-AH) and Driver Handle (T80T-4000-W) for bushing service.
3. Each side of bushing remover/installer driver is marked with "T" or "B". Use "T" side to install top spindle bushing and "B" side for bottom spindle bushing. Remove seal from bottom of upper bushing bore. Top spindle bushing should be removed first. Install driver handle through bottom bore.
4. Position new bushing on "T" side of bushing remover/installer driver so bushing open end grooves will face outward when installed. Position new bushing and remover/installer driver over old bushing. Drive old bushing out, while installing new bushing. Install bushing until remover/installer driver is seated.
5. Bushing must be installed a minimum distance of .080" (2.03 mm) from bottom of upper spindle boss. Using "B" side, repeat procedure and install bottom bushing. Proper minimum depth of bottom bushing is .130" (3.30 mm) from top of lower spindle boss. Using reamer, ream bushings I.D. to .001-.003" (.03-.08 mm) larger than diameter of new spindle pin. Ream top bushing first.
6. Install smaller diameter of reamer through top bore and into bottom bore until cutting blades are positioned in top bushing. Rotate reamer until cutting blades clear top bushing.
7. Ream bottom bushing. Larger diameter portion of reamer acts as a pilot in top bushing to properly ream bottom bushing. Remove all metal shavings and lubricate bushings and spindle pins with grease.
8. Install a new seal on bushing remover/installer driver on side marked with "T" stamping. Using handle and remover/installer driver, install seal in bottom of top bushing bore. To complete installation, reverse removal procedure.

BALL JOINTS

NOTE: Upper and lower ball joints on F150 and F250 Light Duty models are not serviceable. If ball joints are found to be worn, upper or lower control arm must be replaced as an assembly.

Removal (F250 Heavy Duty & F350)

1. Remove spindle. See **SPINDLE** . Install spindle in a vise. Remove snap ring from lower ball joint.
2. Using "C" Frame (T74P-4635-C) and Ball Joint Remover (T94T-3010-AH), rotate forcing screw clockwise until lower ball joint is removed from spindle. Install "C" frame onto upper ball joint with forcing screw going through lower ball joint bore. See **Fig. 3** . Remove upper ball joint.

CAUTION: When replacing ball joint, DO NOT heat ball joint or spindle.

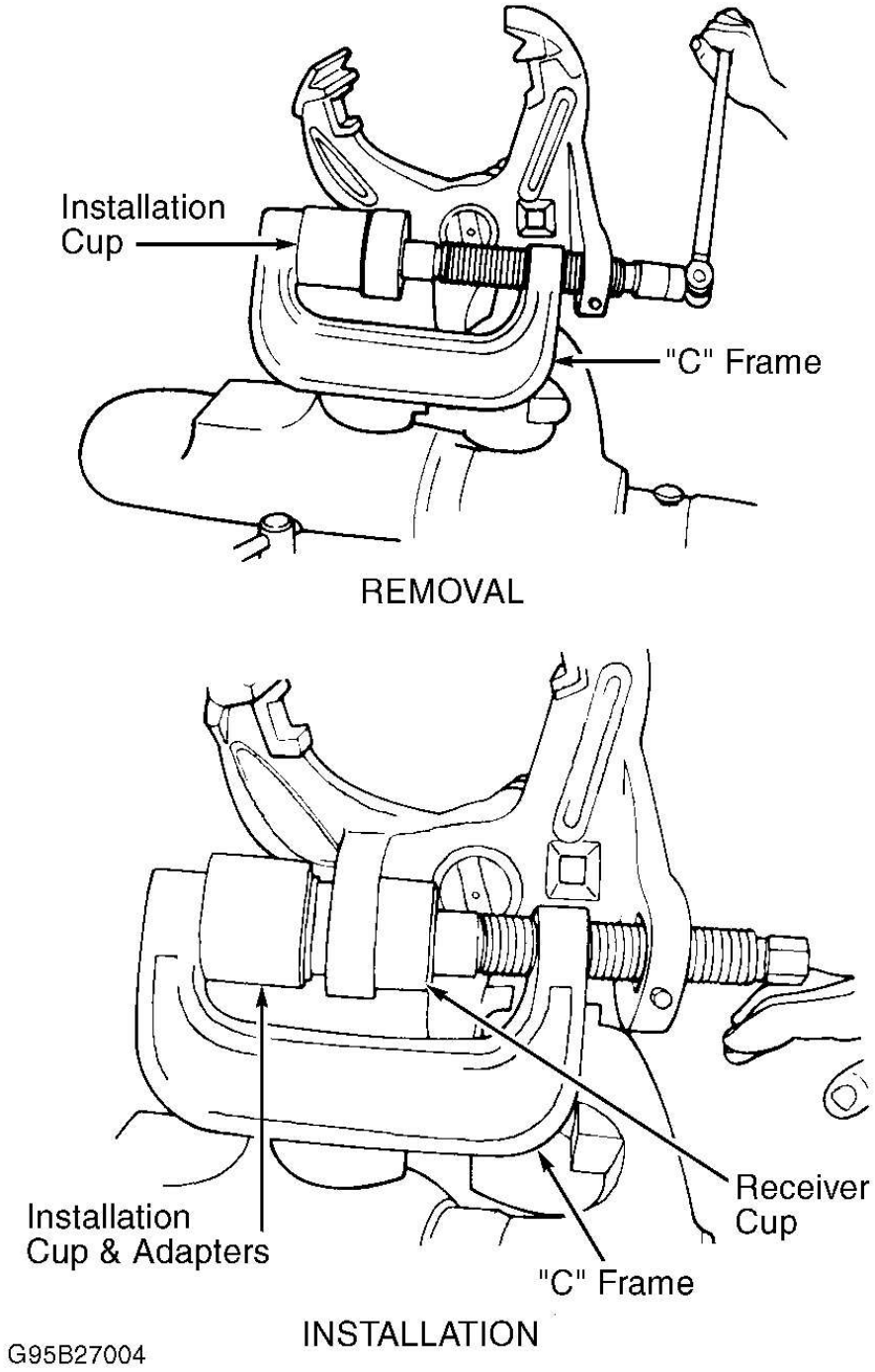


Fig. 3: Removing & Installing Upper Ball Joint (F250 Heavy Duty & F350)
Courtesy of FORD MOTOR CO.

Installation

1. Upper ball joint must be installed first. Install upper ball joint squarely in spindle. Using "C" Frame, Receiver Cup, Installation Cup and Adapters (D81T-3010-A1 and D81T-3010-A3), install ball joint until firmly seated.
2. Repeat procedure for lower ball joint installation. Install snap ring. To complete installation, reverse removal procedure. Tighten bolts and nuts to specifications. See **TORQUE SPECIFICATIONS (F250 HEAVY DUTY & F350)** table.

COIL SPRING

NOTE: Support axle with a floor jack during coil spring removal and installation procedures. If brake hose length does not permit adequate clearance, remove brake caliper.

Removal & Installation (F150 & F250 Light Duty)

1. Turn off air suspension switch at right kick panel (if equipped). Raise and support vehicle. Remove wheel assembly. Remove brake caliper, and wire aside. Remove grease cap, cotter pin, retainer, adjusting nut, flat washer and outer wheel bearing. Remove brake rotor and rotor shield.
2. Remove upper shock absorber nut and washer. Remove lower shock absorber nuts. Remove shock absorber. Remove brake hose bracket from lower control arm. Disconnect stabilizer bar link from lower control arm. Using Coil Spring Compressor (D78P-5310-A), compress coil spring.
3. Remove cotter pin and nut from lower ball joint. Using Pitman Arm Puller (T64P-3590-F), separate lower ball joint from spindle. Position wheel spindle aside, and remove coil spring.
4. To install, reverse removal procedure. Ensure end of spring is positioned properly between 2 holes in lower control arm. See **Fig. 4** . Adjust wheel bearings. See **WHEEL BEARING ADJUSTMENT** under ADJUSTMENTS & INSPECTION. Tighten all bolts and nuts to specification. See **TORQUE SPECIFICATIONS** table.

Removal (F250 Heavy Duty & F350)

Raise front of vehicle and support with jack stands under frame and floor jack under axle. Remove wheel assembly. Disconnect shock absorber from lower bracket. Remove upper spring retainer bolts and remove retainer. Remove lower spring retainer-to-spring seat and axle. Lower floor jack and remove spring.

Installation

Place spring in position and slowly raise front axle. Position spring lower retainer over stud, lower insulator, and lower seat. Position upper retainer over spring coil and against spring upper seat. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS (F250 HEAVY DUTY & F350)** table. To complete installation, reverse removal procedure.

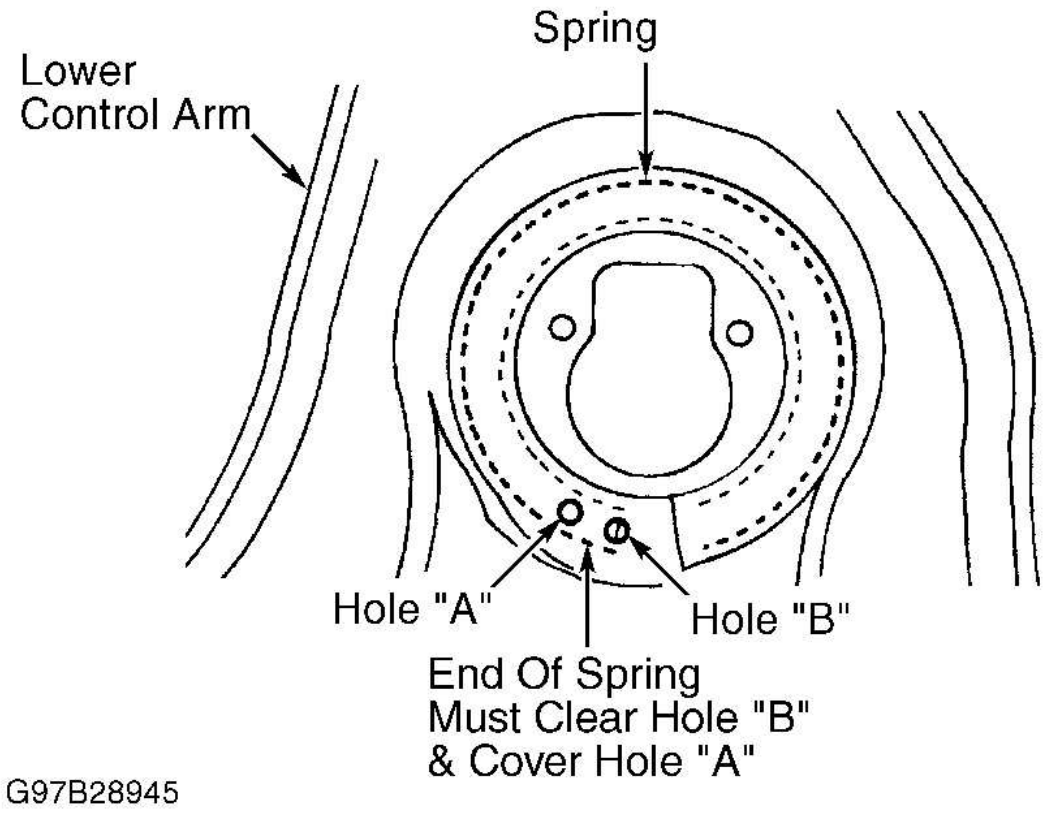


Fig. 4: Positioning Spring In Lower Control Arm (F150 & F250 Light Duty)
Courtesy of FORD MOTOR CO.

LEAF SPRING

Removal (F350 Super Duty)

1. Raise front of vehicle so weight is off front springs and tires are touching the floor. Support axle with jack to release weight from spring "U" bolts.
2. Disconnect shock absorber from spring spacer. Spacer is located below "U" bolts. Remove front and rear spring shackle bolts and stabilizer bar bracket. Remove "U" bolts and leaf spring.

Installation

1. Apply grease to spring bushings prior to shackle bolt installation. Ensure spring is aligned with shackle, bracket and axle.
2. Install attaching bolts and "U" bolts. To complete installation, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS (F350 SUPER DUTY)** table.

LOWER CONTROL ARM

Removal & Installation (F150 & F250 Light Duty)

1. Turn off air suspension switch at right kick panel (if equipped). Raise and support vehicle. Remove wheel assembly. Remove brake caliper, and wire aside. Remove grease cap, cotter pin, retainer, adjusting nut, flat washer and outer wheel bearing. Remove brake rotor and rotor shield.
2. Remove shock absorber upper nut and washer. Remove shock absorber lower nuts and remove shock absorber. Remove brake hose bracket from lower control arm. Disconnect stabilizer bar link from lower control arm. Using Coil Spring Compressor (D78P-5310-A), compress coil spring.
3. Remove cotter pin and nut from lower ball joint. Using Pitman Arm Puller (T64P-3590-F), separate lower ball joint from wheel spindle. Remove 2 lower control arm pivot bolts and nuts. Remove lower control arm and coil spring.
4. To install, reverse removal procedure. Ensure end of spring is positioned properly between 2 holes in lower control arm. See **Fig. 4** . Lower control arm forward pivot bolts must be tightened first with lower control arm at normal ride height. Tighten all bolts and nuts to specification. See **TORQUE SPECIFICATIONS** table. Check and adjust front end alignment. See SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT.

UPPER CONTROL ARM

Removal & Installation (F150 & F250 Light Duty)

1. Turn off air suspension switch at right kick panel (if equipped). Raise and support vehicle. Remove wheel assembly. Support lower control arm with floor jack. Mark position of upper control arm alignment cam.
2. Remove cotter pin and nut from upper ball joint. Using Pitman Arm Puller (T64P-3590-F), separate ball joint from wheel spindle. Remove 2 upper control arm pivot bolts and nuts. Remove upper control arm.
3. To install, reverse removal procedure. Upper control arm forward pivot bolts must be tightened first with upper control arm at normal ride height. Ensure upper control arm alignment cam marks are aligned. Tighten all bolts and nuts to specification. See **TORQUE SPECIFICATIONS** table. Check and adjust front end alignment. See SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT.

FRONT AXLE

Removal (F250 Heavy Duty & F350)

Remove spindle. See **SPINDLE** . Remove coil spring and stabilizer bar (if equipped). Remove lower spring seat from radius arm. Remove radius arm-to-front axle bolt. Remove axle-to-frame pivot bolt and remove axle.

Installation

1. Install axle with frame pivot bolt finger tight. Connect radius arm to front axle. Install lower spring seat, ensuring it aligns over radius arm bolt. Ensure spring seat pin engages with slot in radius arm.
2. Install remaining components. Tighten axle-to-frame pivot bolt to specification with vehicle at normal operating height. See **TORQUE SPECIFICATIONS (F250 HEAVY DUTY & F350)** table.

Removal & Installation (F350 Super Duty)

1. Raise front of vehicle so weight is off front springs and tires are touching the floor. Raise axle slightly and remove both wheels. Remove brake calipers and secure out of the way.
2. On commercial and motorhome chassis, remove shock absorber lower mounting bolt. On all models, temporarily install both wheels. Disconnect stabilizer bar links at stabilizer bar. Disconnect steering linkage from spindle. Disconnect track bar from axle (if equipped).
3. Remove "U" bolts and stabilizer bar bracket. Raise vehicle and roll axle out from under vehicle. To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS (F350 SUPER DUTY)** table.

RADIUS ARM

NOTE: Support axle with a floor jack during coil spring removal and installation procedures. If brake hose length does not permit adequate clearance, remove brake caliper.

Removal (F250 Heavy Duty & F350)

1. Raise and support vehicle with safety stands under frame and jack under axle. Remove front wheels. Disconnect link from stabilizer bar (if equipped).
2. Disconnect shock absorber from lower bracket. Remove coil spring. See **COIL SPRING** . Remove lower spring seat from radius arm.
3. Remove radius arm-to-axle bolt. Remove nut, washer, insulator and spacer from rear radius arm mount. Remove radius arm.

Installation

To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS (F250 HEAVY DUTY & F350)** table.

STABILIZER BAR

Removal & Installation (F150 & F250 Light Duty)

Turn off air suspension switch at right kick panel (if equipped). Raise and support vehicle. Remove wheel assembly. Disconnect stabilizer bar links from lower control arms. Remove stabilizer bar links. Remove retaining bolts and stabilizer bar. To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** table.

Removal & Installation (F250 Heavy Duty & F350)

Disconnect stabilizer bar from link assembly. Remove retaining bolts and stabilizer bar. Remove link assembly from axle brackets. To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS (F250 HEAVY DUTY & F350)** table.

Removal (F350 Super Duty)

Disconnect stabilizer bar from link assembly. Remove retaining bolts and stabilizer bar from front axle. Remove link assembly from frame rail.

Installation

Loosely install stabilizer bar assembly. Ensure stabilizer bar is centered on front axle and insulators are properly positioned. Attach links to brackets and stabilizer bar. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS (F350 SUPER DUTY)** table.

TRACK BAR

Removal & Installation (F350 Super Duty)

Remove track bar-to-crossmember bolt. Remove track bar-to-axle bracket bolt, and remove track bar. To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS (F350 SUPER DUTY)** table.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS (F150 & F250 LIGHT DUTY)

Application	Ft. Lbs. (N.m.)
Brake Hose Bracket Bolt	10-13 (14-18)
Brake Rotor Shield Bolt	(1)
Caliper Bolt	21-26 (28-35)
Lower Ball Joint Nut	83-112 (112-152)
Lower Control Arm Pivot Bolt	121-148 (164-201)
Shock Absorber Lower Mount Nut	22-29 (30-39)
Shock Absorber Upper Mount Nut	35-46 (47-62)
Stabilizer Bar Link Nut	15-21 (20-28)
Stabilizer Bar Retaining Nut	19-26 (26-35)
Tie Rod End Nut	57-76 (77-103)
Upper Ball Joint Nut	57-76 (77-103)
Upper Control Arm Pivot Bolt	84-112 (114-152)
Wheel Lug Nuts	(2) 83-112 (112-152)

(1) Tighten to 90-107 INCH lbs. (10-12 N.m).

(2) Failure to retighten wheel lug nuts at 500 miles after installation, may result in wheel coming loose and loss of vehicle control.

TORQUE SPECIFICATIONS (F250 HEAVY DUTY & F350)

Application	Ft. Lbs. (N.m.)
Axle Clamp Bolt	50-68 (68-92)

Axle-To-Pivot Bracket Bolt	110-148 (149-201)
Axle-To-Radius Arm Bolt	188-254 (255-344)
Coil Spring-To-Lower Retainer Nut	83-112 (112-152)
Coil Spring Upper Retainer-To-Spring Seat Bolt	13-17 (18-23)
Jounce Bumper-To-Frame Bolt	17-23 (23-31)
Lower Ball Joint-To-Spindle Nut	83-112 (112-152)
Radius Arm-To-Rear Bracket Nut	83-112 (112-152)
Shock Absorber Bracket-To-Radius Arm Bolt	23-42 (31-57)
Shock Absorber Lower Mount Bolt/Nut	44-59 (60-80)
Shock Absorber Upper Mount Nut	25-35 (34-47)
Stabilizer Bar Link-To-Spring Seat	52-74 (70-100)
Stabilizer Bar Link-To-Stabilizer Bar	53-80 (72-108)
Stabilizer Bar Retainer-To-Mounting Bracket Nut	25-34 (34-46)
Tie Rod End-To-Spindle Nut	57-75 (77-102)
Upper Ball Joint Clamp Bolt	50-68 (68-92)
Wheel Lug Nuts	(1) 140 (190)

(1) Failure to retighten wheel lug nuts at 500 miles (100 miles and 500 miles on dual-rear wheel vehicles) after installation, may result in wheel coming loose and loss of vehicle control.

TORQUE SPECIFICATIONS (F350 SUPER DUTY)

Application	**Ft. Lbs. (N.m.)**
Axle-To-Spring "U" Bolt Nut	
Commercial & Motorhome Chassis	220-300 (298-407)
Standard Chassis	157-211 (213-286)
Jounce Bumper Bracket "U" Bolt Nut	22-30 (30-41)
Jounce Bumper Mounting Nut	22-30 (30-41)
Shock Absorber Retaining Nut	
Commercial & Motorhome Chassis	220-300 (298-407)
Standard Chassis	39-53 (53-72)
Spindle Lock Pin Nut	37-52 (50-71)
Spindle Upper & Lower Plugs	35-49 (47-66)
Spring Shackle-To-Bracket Nut (Commercial & Motorhome Chassis)	74-111 (100-150)
Spring Shackle-To-Frame Nut (Standard Chassis)	148-207 (201-280)
Spring Shackle-To-Spring Nut	
Commercial & Motorhome Chassis	74-111 (100-150)
Standard Chassis	120-150 (163-203)
Spring-To-Bracket Nut	150-210 (203-285)
Stabilizer Bar Link Bracket Nut	
Commercial & Motorhome Chassis	57-81 (77-110)
Standard Chassis	52-74 (70-100)

Stabilizer Bar Link-To-Stabilizer Bar Nut	15-25 (20-34)
Stabilizer Bar Mounting Bracket	
Bolt (Standard Chassis)	35-46 (47-62)
Nut (Commercial & Motorhome Chassis)	30-47 (41-64)
Steering Linkage-To-Spindle Nut	44-59 (60-80)
Track Bar Bolt	120-150 (163-203)
Track Bar Mounting Bracket Bolt	120-150 (163-203)
Wheel Lug Nuts	(1) 140 (190)

(1) Failure to retighten wheel lug nuts at 500 miles (100 miles and 500 miles on dual-rear wheel vehicles) after installation, may result in wheel coming loose and loss of vehicle control.

1997 SUSPENSION

Front - 4WD Torsion Bar

DESCRIPTION

Front suspension consists of upper and lower control arms, stabilizer bar, shock absorbers, and left and right torsion bars. See **Fig. 1** . Front end of torsion bar is connected to lower control arm. Rear end of torsion bar is mounted to an adjustable arm at crossmember.

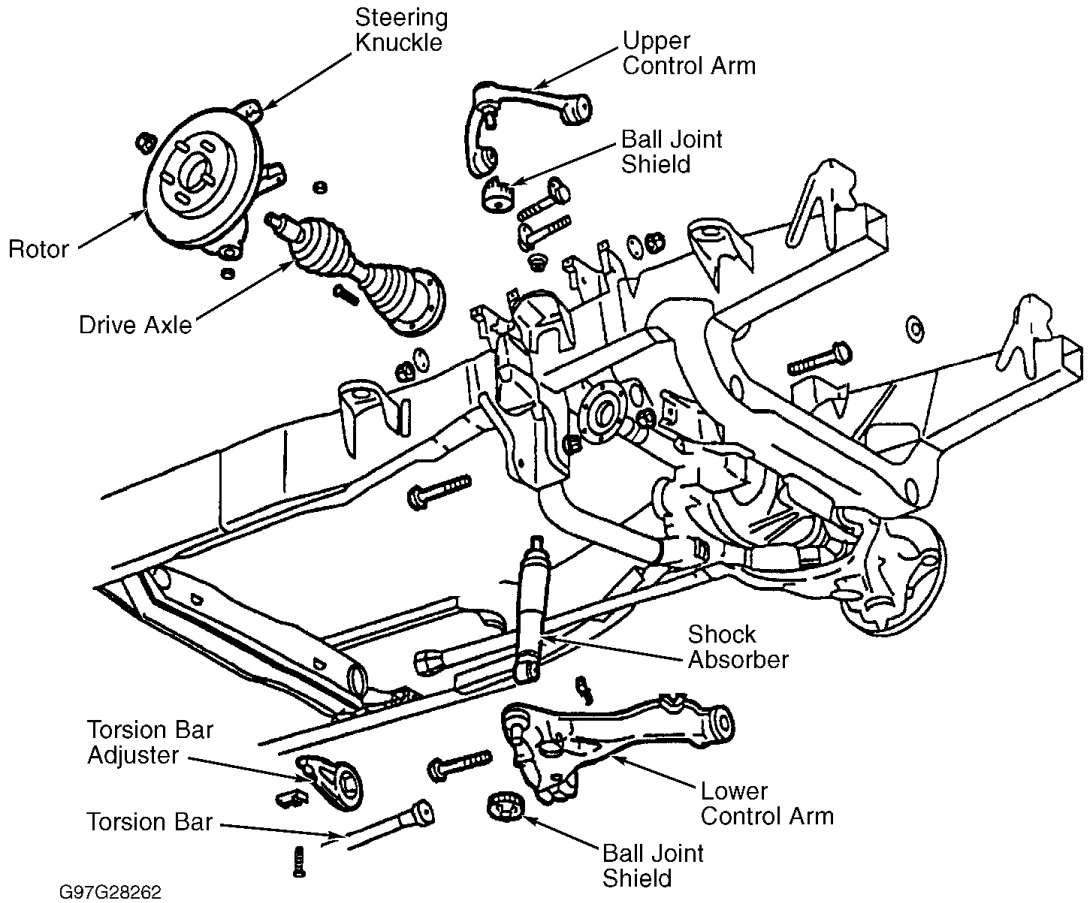


Fig. 1: Exploded View Of Front Suspension
Courtesy of FORD MOTOR CO.

ADJUSTMENTS & INSPECTION

CAUTION: If vehicle is equipped with air suspension system, electrical power supply to system must be turned off prior to hoisting, jacking or towing vehicle. This can be done by disconnecting battery or turning air suspension

switch to OFF position. Switch is located in right kick panel.

WHEEL ALIGNMENT

NOTE: See SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT.

WHEEL BEARING

Front wheel bearings are permanently sealed and do not require lubrication or adjustment. Hub and bearing is replaced as an assembly. Tighten hub retainer nut to 188-254 ft. lbs. (254-344 N.m) with brakes applied.

RIDING HEIGHT

CAUTION: Use hand tools to adjust riding height. DO NOT use power tools.

NOTE: On vehicles with front air suspension system, air shock absorbers must be vented prior to adjusting riding height. Connect New Generation Star (NGS) tester to Data Link Connector (DLC) located under steering column. Using manufacturer's instructions, initiate active command FRNT VENT.

1. Turn off air suspension system, if equipped. Raise vehicle on hoist with frictionless plates to support front wheels. Measure distance between center of lower control arm front bolt and ground (STEP 1). See **Fig. 2** . Measure distance between bottom of steering knuckle and ground (STEP 2). Subtract smaller measurement from larger measurement. This is riding height measurement.
2. Riding height should be 3.03-3.27" (77-83 mm). If riding height is not as specified, tighten or loosen torsion bar adjusting bolt as required.

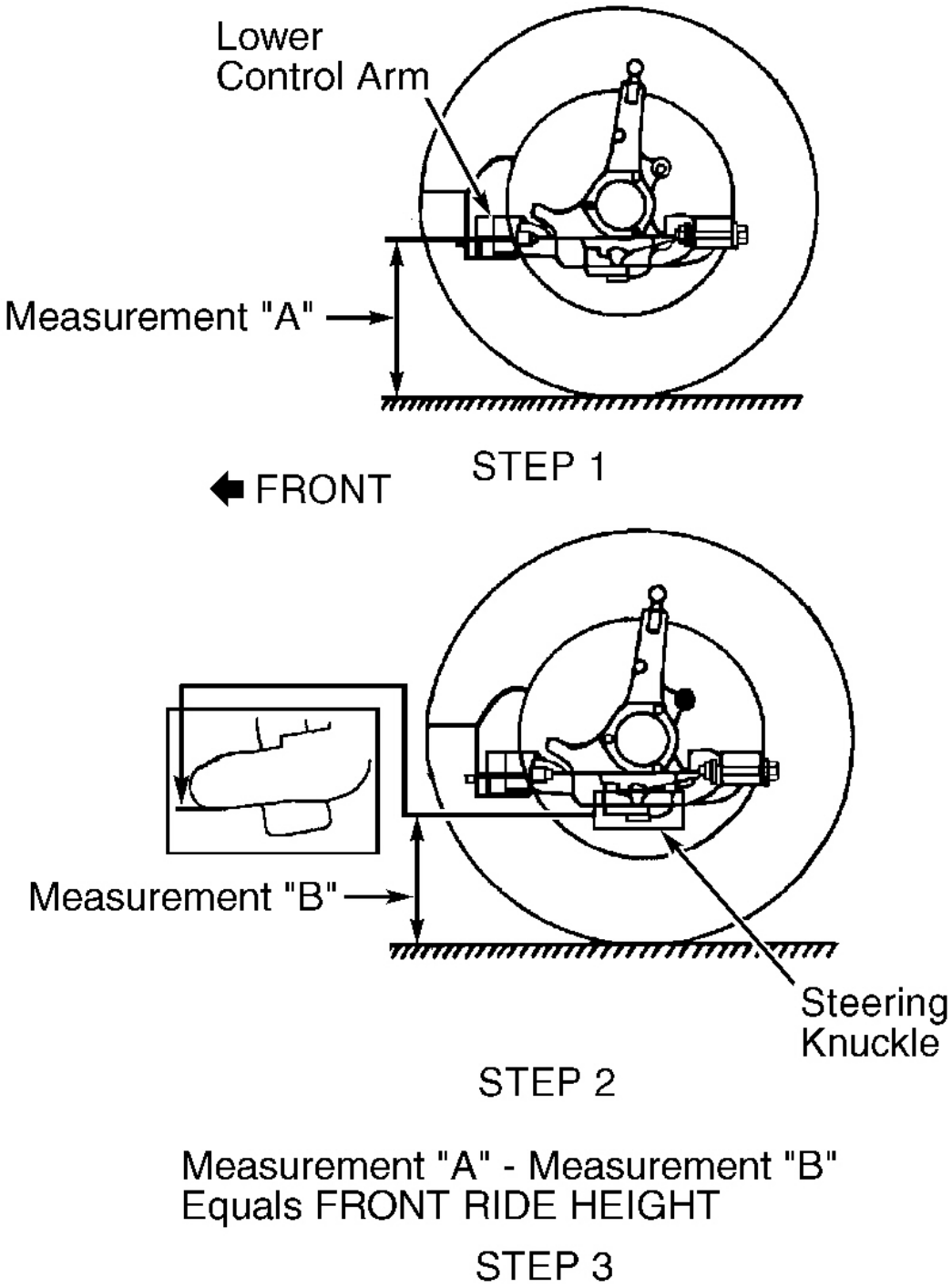


Fig. 2: Adjusting Front Riding Height

Courtesy of FORD MOTOR CO.

BALL JOINT CHECKING

Turn off air suspension system, if equipped. Raise and support front of vehicle under lower control arm. Have assistant grasp tire at upper and lower edge. Move tire in and out in a rocking motion. Replace ball joint(s) if movement exceeds .03" (.79 mm).

REMOVAL & INSTALLATION

CAUTION: If vehicle is equipped with air suspension system, electrical power supply to system must be turned off prior to hoisting, jacking or towing vehicle. This can be done by disconnecting battery or turning air suspension switch to OFF position. Switch is located in right kick panel.

CV AXLE SHAFT

Removal

1. Turn off air suspension system, if equipped. Remove cotter pin, nut lock and spring washer. Loosen hub retainer nut. Raise and support vehicle. Remove wheel, hub nut and hub washer.
2. Remove cotter pin and upper ball joint castellated nut. Using puller, separate upper ball joint from steering knuckle. Remove shock absorber upper mounting nut and washer.
3. Support CV axle shaft and remove CV axle shaft-to-differential housing flange mounting bolts. Separate CV axle shaft from hub and bearing assembly, and remove CV axle shaft from vehicle.

Installation

1. Install CV axle shaft into hub and bearing assembly, carefully guiding CV axle shaft through spline in hub. Install CV axle shaft onto differential housing flange and tighten mounting bolts to 51-67 ft. lbs. (69-91 N.m).
2. Install upper ball joint in steering knuckle. Install shock absorber upper mounting nut and washer. With brakes applied, tighten hub retainer nut to specification. See **TORQUE SPECIFICATIONS** table. Install spring washer, nut lock and NEW cotter pin. DO NOT back off nut to install cotter pin. To complete installation, reverse removal procedure. Tighten nuts and bolts to specification.

HUB & BEARING ASSEMBLY

Removal

1. Turn off air suspension system, if equipped. Remove cotter pin, nut lock and spring washer. Loosen hub retainer nut. Raise and support vehicle. Remove wheel, hub nut and hub washer. Remove brake caliper. Support caliper aside. Mark brake rotor and hub, and remove brake rotor.
2. Remove hub and bearing assembly mounting bolts from rear of steering knuckle. See **Fig. 1** . Slide hub and bearing assembly off CV axle shaft splines. Inspect steering knuckle grease seal and hub and bearing

assembly for excessive wear and damage. Replace components as necessary.

Installation

1. Install hub and bearing assembly onto steering knuckle, guiding CV axle shaft through spline in hub. Tighten hub and bearing assembly-to-steering knuckle mounting bolts to 110-148 ft. lbs. (149-201 N.m).
2. Align marks, and install brake rotor and caliper. With brakes applied, tighten hub retainer nut to specification. See **TORQUE SPECIFICATIONS** table. Install washer, nut lock and NEW cotter pin. DO NOT back off nut to install cotter pin. To complete installation, reverse removal procedure.

LOWER CONTROL ARM & BALL JOINT

Removal & Installation

1. Turn off air suspension system, if equipped. Remove hub and bearing assembly. See **HUB & BEARING ASSEMBLY** . Measure length of adjuster bolt extension from adjuster. Mark torsion bar alignment position. See **Fig. 3** .
2. Remove torsion bar adjuster bolt. Install torsion bar Installer/Remover (T95T-5310-A) and Adapter (T96T-5310-A) on Torsion bar. See **Fig. 4** . Tighten remover/installer until adjuster lifts off adjuster nut. Remove adjuster nut. Remove remover/installer.
3. Remove stabilizer bar link from lower control arm. Remove lower shock absorber bolt and nut. Remove lower ball joint castellated nut. Using puller, separate lower ball joint from steering knuckle. Remove lower control arm mounting bolts and nuts. Remove lower control arm and torsion bar as an assembly. To install, reverse removal procedure. Tighten fasteners to specification. See **TORQUE SPECIFICATIONS** table.

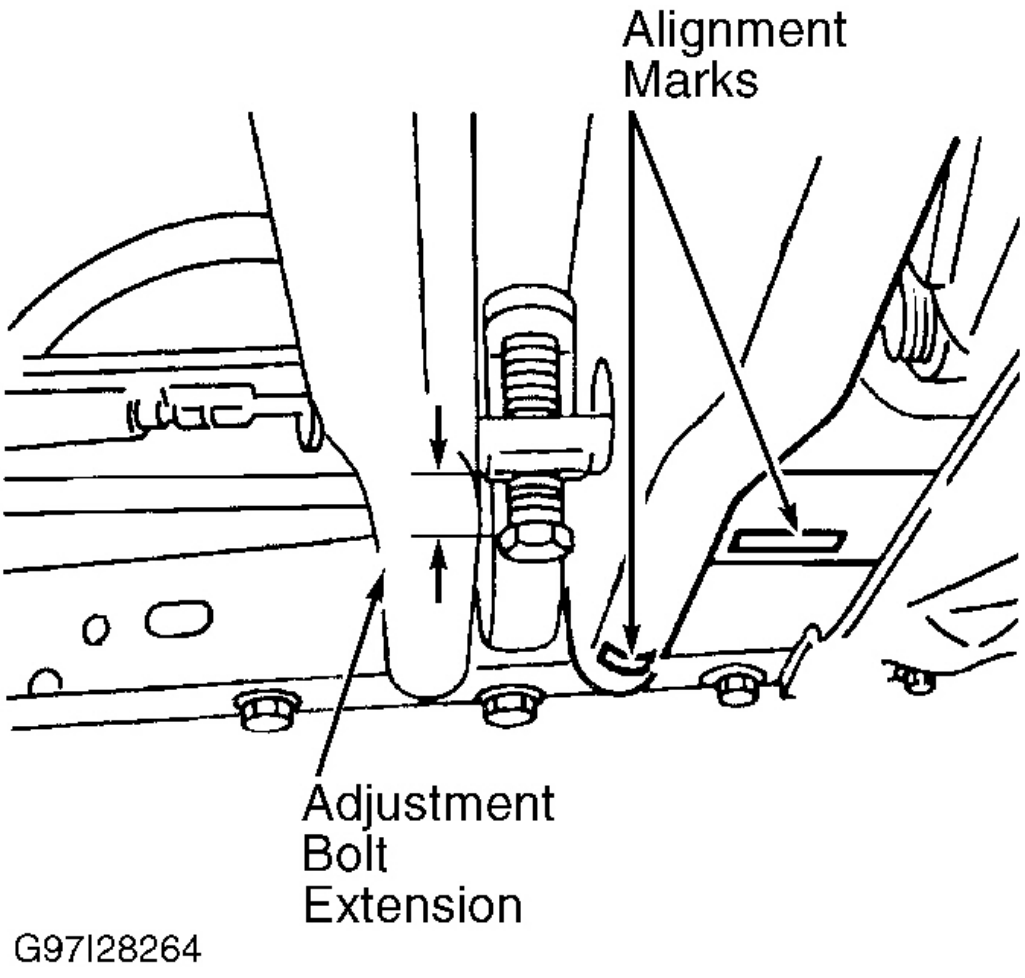


Fig. 3: Making Preliminary Torsion Bar Adjustment References
Courtesy of FORD MOTOR CO.

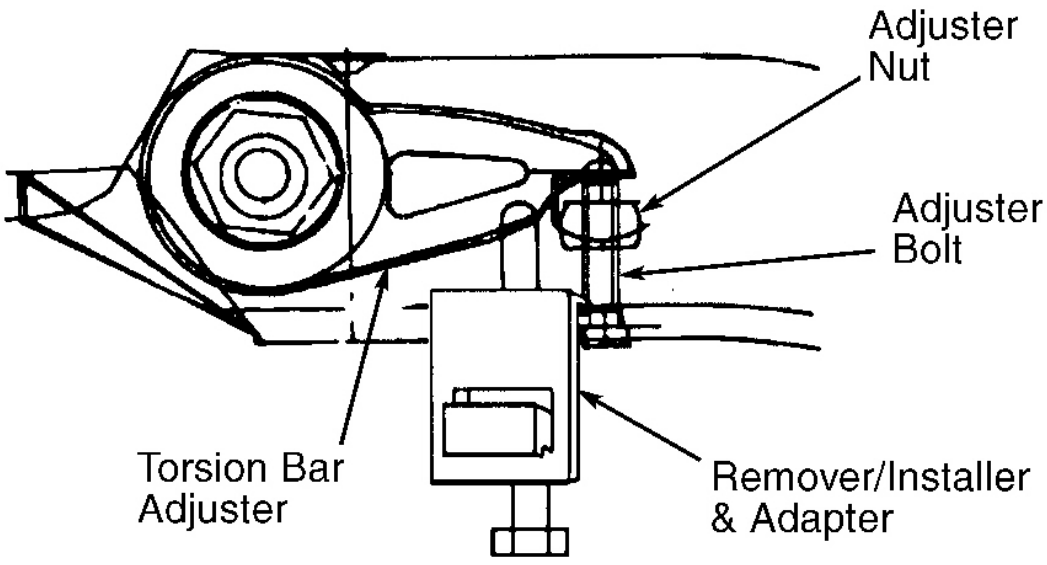


Fig. 4: Relieving Torsion Bar Tension
Courtesy of FORD MOTOR CO.

STABILIZER BAR

Removal & Installation

Raise and support vehicle. Remove link rod retaining nut at each end of stabilizer bar. Remove outer retainers and rubber bushings from link rods. Remove bolts from "U"-shaped support brackets. Remove stabilizer bar from vehicle. To install, reverse removal procedure. Tighten all nuts and bolts to specifications. See **TORQUE SPECIFICATIONS** table.

TORSION BARS

NOTE: Left and right torsion bars are NOT interchangeable. Torsion bars are marked with an "L" or "R" on one end.

Removal & Installation

1. Turn off air suspension system, if equipped. Remove hub and bearing assembly. See **HUB & BEARING ASSEMBLY** . Measure length of adjuster bolt extension from adjuster. Mark torsion bar alignment position. See **Fig. 3** .
2. Remove torsion bar adjuster bolt. Install Torsion Bar Installer/Remover (T95T-5310-A) and Adapter (T96T-5310-A) on torsion bar. See **Fig. 4** . Tighten remover/installer until adjuster lifts off adjuster nut.

Remove adjuster nut. Remove remover/installer. Remove torsion bar adjuster. Repeat procedure on other side.

3. Remove torsion bar crossmember support bolts and nuts. Remove crossmember support. Remove torsion bars. To install, reverse removal procedure. Tighten fasteners to specification. See **TORQUE SPECIFICATIONS** table. Adjust riding height. See **RIDING HEIGHT** under ADJUSTMENTS & INSPECTION.

UPPER CONTROL ARM & BALL JOINT

Removal

1. Turn off air suspension system, if equipped. Remove Wheel and tire assembly. Support front suspension under lower control arm. Mark position of camber adjustment cam. Move ABS sensor wire and position aside.
2. Remove cotter pin and castellated nut from upper control arm ball joint stud. Using puller, separate upper control and ball joint from steering knuckle.
3. Remove upper control arm mounting nuts. Remove upper control pivot bolts. Remove upper control arm. To install, reverse removal procedure. Lubricate ball joint. With vehicle on floor, tighten upper control arm pivot bolts. See **TORQUE SPECIFICATIONS** table.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Ball Joint Nuts	
Lower	83-112 (113-152)
Upper	57-75 (77-102)
Brake Hose Bracket-To-Lower Control Arm Screw	10-13 (14-18)
Control Arm Nut	
Lower	121-148 (164-201)
Upper	83-112 (113-152)
Front Axle Hub Nut (1)	188-254 (255-344)
Hub & Bearing Assembly-To-Knuckle Bolts	110-148 (149-201)
Lower Shock Absorber Mounting Nut & Bolt	57-75 (77-102)
Stabilizer Bar Bolts/Nuts	
Bracket Bolt	19-25 (26-34)
Link End	16-21 (22-28)
Tie Rod End Nut	57-75 (77-102)
Upper Control Arm Pivot Bolt	83-112 (113-152)
Upper Shock Absorber Mounting Bolt	34-46 (46-62)
Wheel Lug Nuts	83-112 (113-152)
	INCH Lbs. (N.m)

ABS Sensor Wire Bracket	62-80 (7-9)

(1) DO NOT back off retainer nut to install NEW cotter pin. After reaching specification, tighten nut only enough to align slot.

1997 ELECTRICAL

Fuses & Circuit Breakers - F150/F250 Light Duty Pickups

IDENTIFICATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

JUNCTION BOX FUSE/RELAY PANEL

NOTE: Junction box fuse/relay panel is located under driver's side of instrument panel. See Fig. 1 .

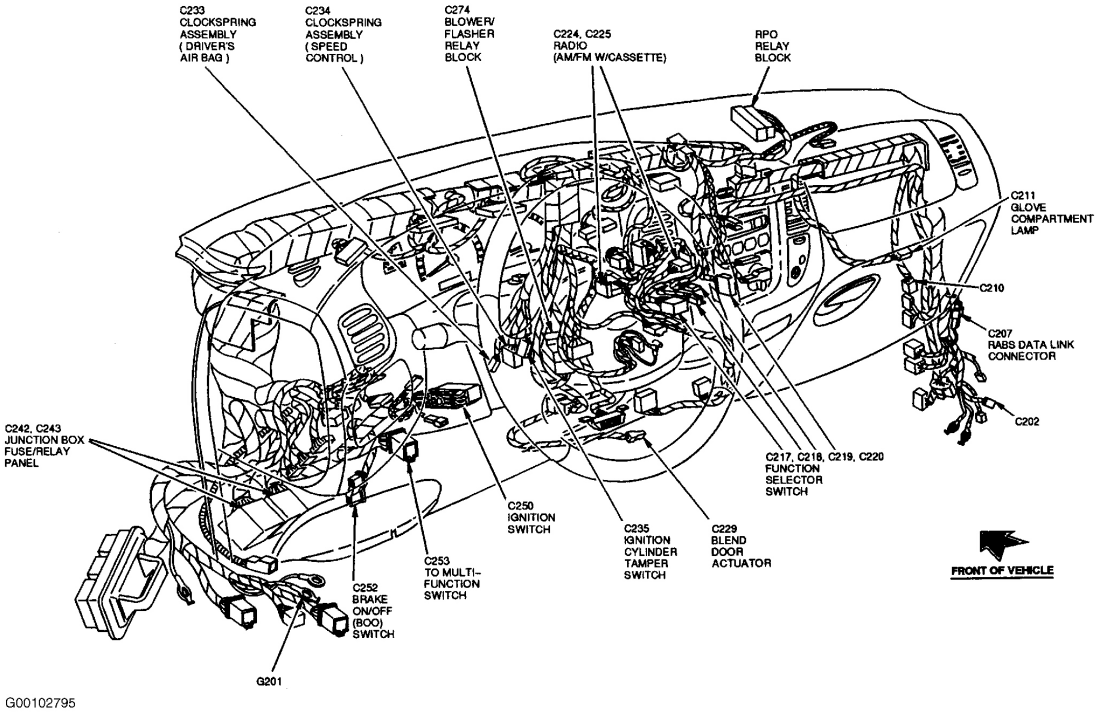


Fig. 1: Locating Instrument Panel Electrical Components
Courtesy of FORD MOTOR CO.

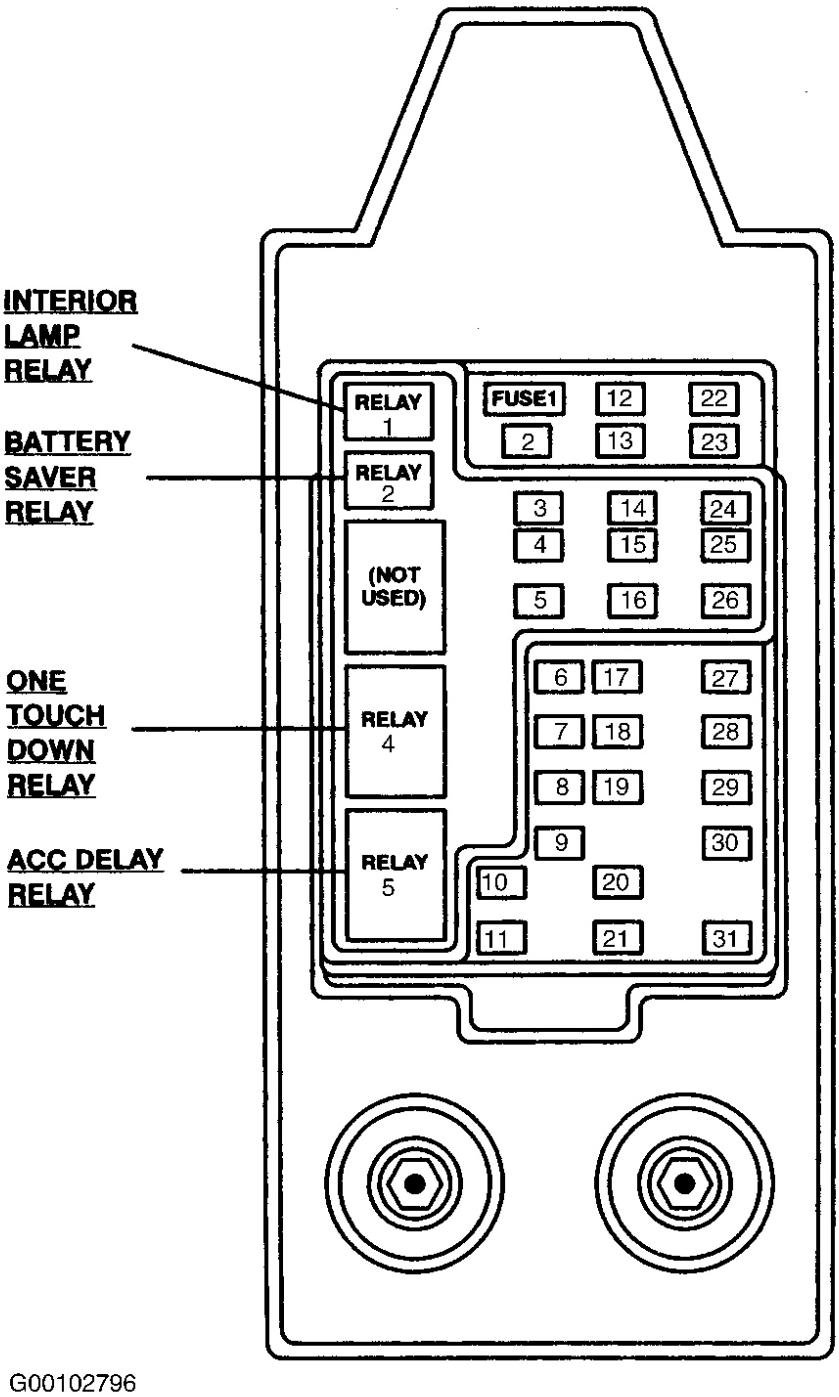


Fig. 2: Identifying Junction Box Fuse/Relay Panel Components
Courtesy of FORD MOTOR CO.

Fuse Position	Amps	Circuits Protected
1	15	Flasher Relay
2	5	Instrument Cluster
3	25	Cigar Lighter
4	5	Park Lamp Relay, Headlamp Relay, Autolamp Module, Remote Anti-Theft Personality (RAP) Module, Power Mirror Switch
5	15	*Transmission Range (TR) Sensor (A/T), **Digital Transmission Range (DTR) Senor (A/T), Backup Lamp Switch (M/T), Daytime Running Lamps (DRL) Module, Speed Control Servo/Amplifier Assembly, Heater-A/C Control Assembly, Blend Door Actuator
6	5	Shift Lock Actuator, Generic Electronic Module (GEM), Rear Air Suspension (RAS) Module
7	–	NOT USED
8	5	Radio, Main Light Switch, Remote Anti-Theft Personality (RAP) Module
9	–	NOT USED
10	–	NOT USED
11	30	Washer Pump Relay, Wiper Run/Park Relay, Wiper Hi/LO Relay, Windshield Wiper Motor
12	5	Data Link Connector (DLC)
13	15	Rear Anti-Lock Brake System (RABS) Module, Brake On/Off (BOO) Switch, Brake Pressure Switch
14	15	Battery Saver Relay, Interior Lamp Relay
15	5	Generic Electronic Module (GEM)
16	20	Instrument Cluster (W/O DRL), Daytime Running Lamps (DRL) Module, Hi–Beam Headlamps (Power supplied through Multi-Function Switch)
17	–	NOT USED
18	5	Park Lamp Relay, Trailer Electronic Brake Controller, Main Light Switch, Trailer Tow Run Relay, Front Park/Turn Lamps, License Lamps, Stop/Park/Turn Lamps, Tail/Side Marker Lamps (Power supplied through Main Light Switch)
19	10	Instrument Cluster, Air Bag Diagnostic Monitor
20	5	Powertrain Control Module (PCM), Generic Electronic Module (GEM)/Central Timer Module (CTM)
21	15	Clutch Pedal Position (CPP) Switch (W/O RAP), Starter Interrupt Relay (W/RAP)
22	10	Air Bag Diagnostic Monitor, Passive De-Activation (PAD) Module
23	10	Trailer Tow Battery Charge Relay, 4X4 Hub Solenoid, 4X2 Hub Solenoid, Flasher Relay, Shift on the Fly Relay
24	10	Blower Relay
25	5	4 Wheel Anti-Lock Brake System (4WABS) Module, 4WABS Relay
26	10	Daytime Running Lamps (DRL) Module, Right Headlamp
27	5	Main Light Switch, Fog Lamp Relay
28	10	Left Headlamp
29	5	Autolamp Module, Instrument Cluster, Transmission Control Switch (TCS), Brake Warning Resistor/Diode Assembly (W/RABS)
30	30	Radio Noise Capacitor, Ignition Coil, PCM Power Diode
31	–	NOT USED

* VEHICLES BUILT BEFORE 6/24/96
** VEHICLES BUILT AFTER 6/24/96

G00102797

Fig. 3: Junction Box Fuse/Relay Panel Legend
Courtesy of FORD MOTOR CO.

POWER DISTRIBUTION BOX

NOTE: Power distribution box is located on driver's side of engine compartment. See

Fig. 4 , Fig. 5 or Fig. 6 .

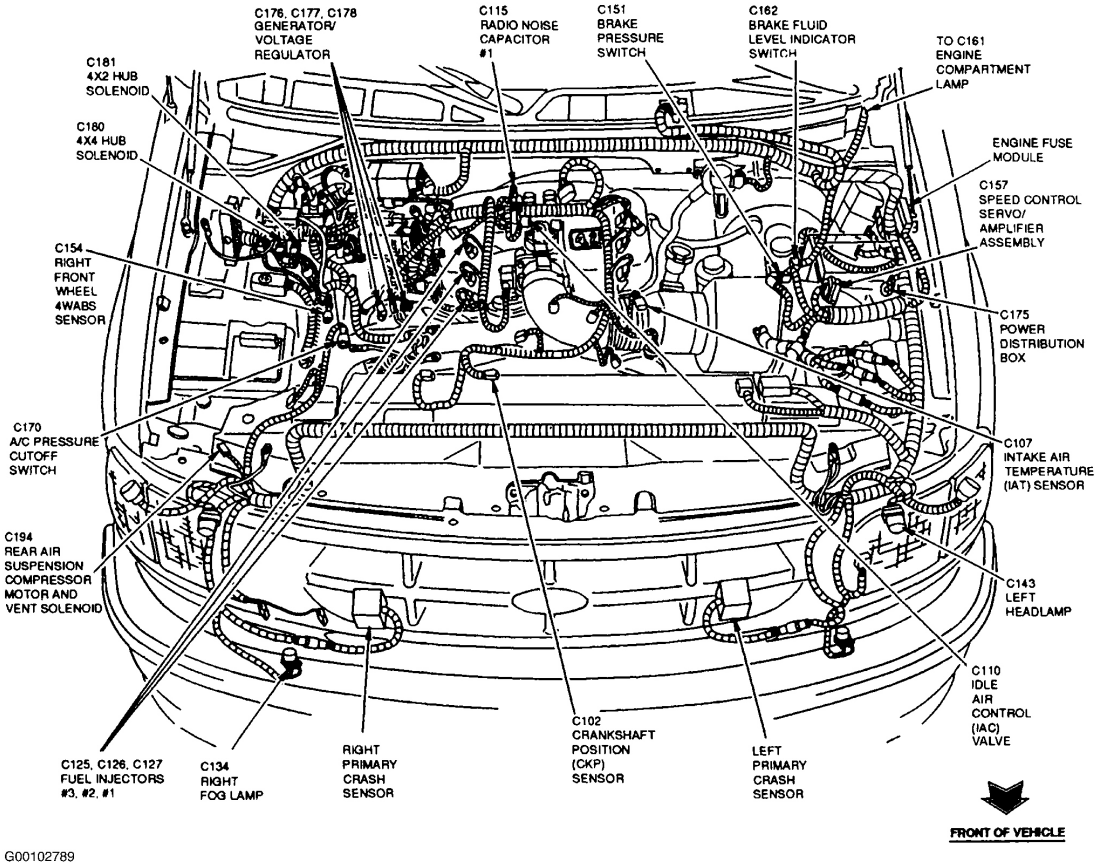


Fig. 4: Locating Engine Compartment Electrical Components (4.2L)
Courtesy of FORD MOTOR CO.

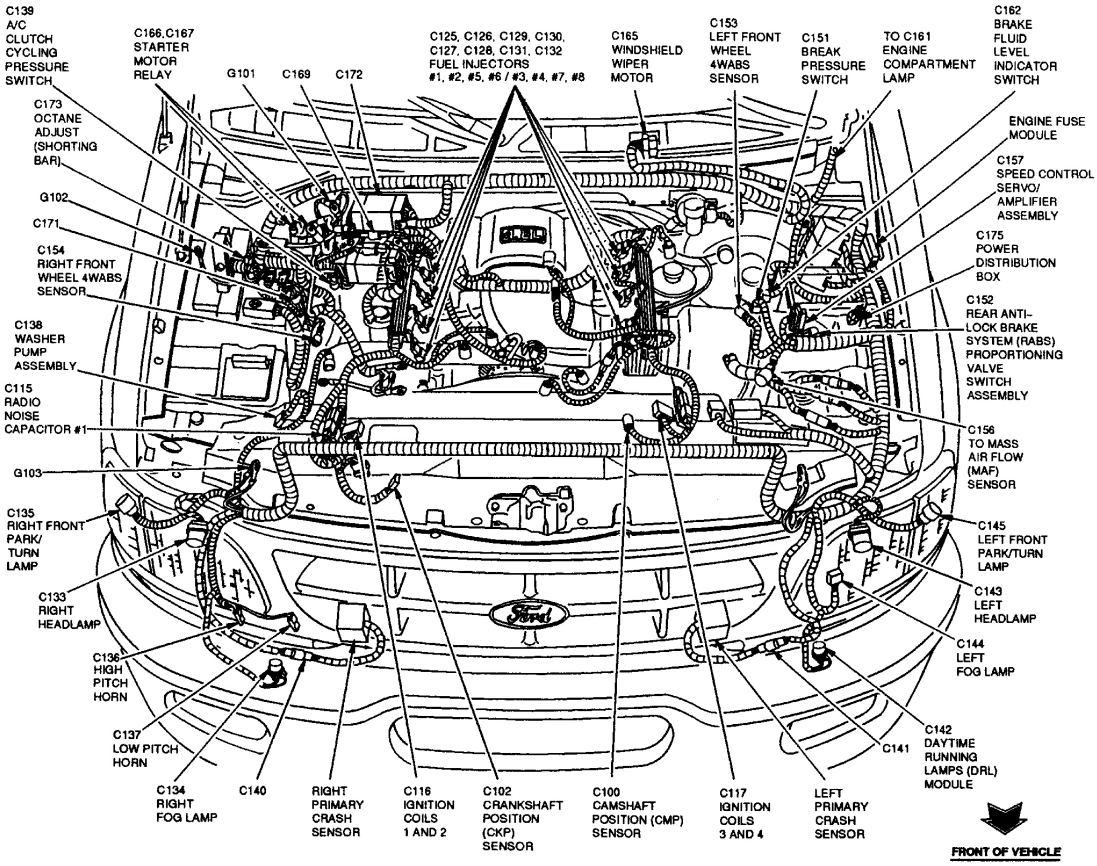


Fig. 5: Locating Engine Compartment Electrical Components (4.6L)
Courtesy of FORD MOTOR CO.

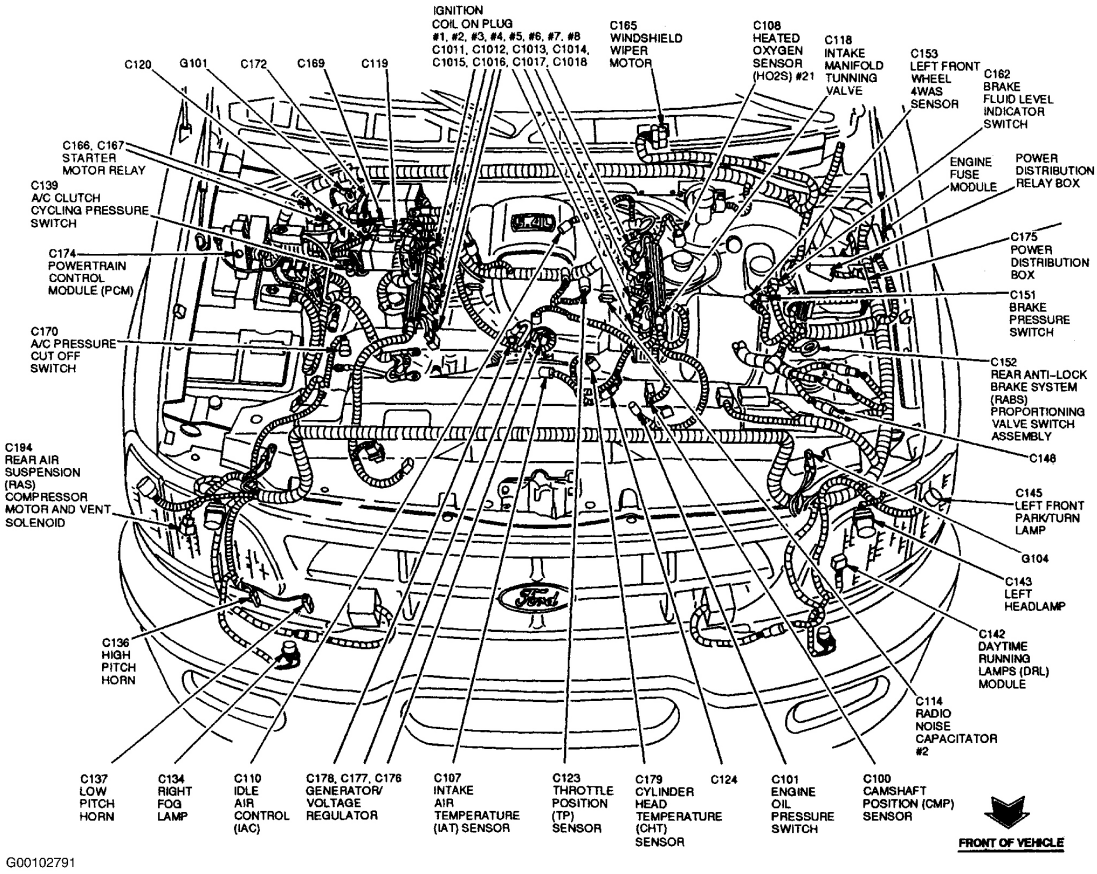


Fig. 6: Locating Engine Compartment Electrical Components (5.4L)
Courtesy of FORD MOTOR CO.

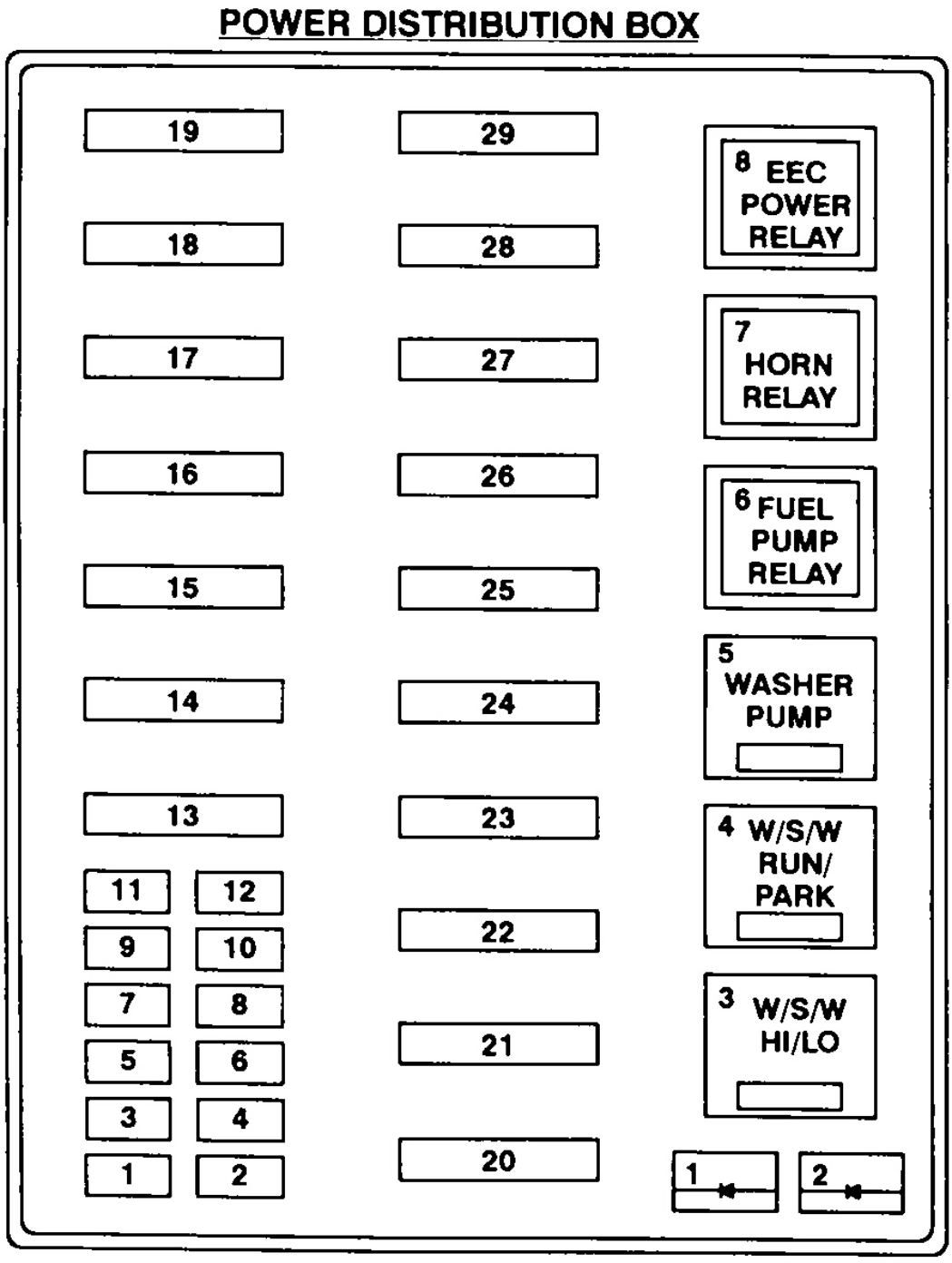


Fig. 7: Identifying Power Distribution Box Components
Courtesy of FORD MOTOR CO.

VEHICLES BUILT BEFORE 6/24/96

Fuse Position	Amps	Circuits Protected
1	20 (MINI)	Trailer Tow Running Lamp Relay, Trailer Tow Backup Lamp Relay
2	10 (MINI)	Airbag Diagnostic Monitor
3	–	NOT USED
4	–	NOT USED
5	20 (MINI)	Horn Relay
6	15 (MINI)	Radio, Premium Sound Amplifier, CD Changer
7	15 (MINI)	Main Light Switch, Park Lamp Relay
8	30 (MINI)	Main Light Switch, Headlamp Relay, Multi–function Switch
9	15 (MINI)	Daytime Running Lamps (DRL) Module, Fog Lamp Relay
10	25 (MINI)	Auxiliary Power Socket
11	–	NOT USED
12	–	NOT USED
13	–	NOT USED
14	60 (MAXI)	4 Wheel Anti–Lock Brake System (4WABS) Module
14	20 (MAXI)	Ignition Switch (W/RABS Only)
15	–	NOT USED
16	40 (MAXI)	Trailer Tow Battery Charge Relay, Engine Fuse Module (Fuse 2)
17	30 (MAXI)	Shift on the Fly Relay, Transfer Case Shift Relay
18	30 (MAXI)	Power Seat Control Switch
19	20 (MAXI)	Fuel Pump Relay
20	50 (MAXI)	Ignition Switch (B4 & B5)
21	50 (MAXI)	Ignition Switch (B1 & B3)
22	50 (MAXI)	Junction Box Fuse/Relay Panel Battery Feed
23	40 (MAXI)	Blower Relay
24	30 (MAXI)	PCM Power Relay, Engine Fuse Module (Fuse 1)
25	30 (MAXI)	Junction Box Fuse/Relay Panel, Acc Delay Relay
26	20 (MAXI)	All Unlock Relay, All Lock Relay, Driver Unlock Relay, Left Power Door Lock Switch, Right Power Door Lock Switch
27	–	NOT USED
28	30 (MAXI)	Trailer Electronic Brake Controller
29	–	NOT USED

G00102794

Fig. 8: Power Distribution Box Legend (1997 Build Date Pre 6/24/96)
Courtesy of FORD MOTOR CO.

VEHICLES BUILT AFTER 6/24/96

Fuse Position	Amps	Circuits Protected
1	20 (MINI)	Trailer Tow Running Lamp Relay, Trailer Tow Backup Lamp Relay
2	10 (MINI)	Airbag Diagnostic Monitor
3	15 (MINI)	All Unlock Relay, All Lock Relay, Driver Unlock Relay, LH Power Door Lock Switch, RH Power Door Lock Switch
4	15 (MINI)	Rear Air Suspension (RAS)
5	20 (MINI)	Horn Relay
6	15 (MINI)	Radio, Premium Sound Amplifier, CD Changer
7	15 (MINI)	Main Light Switch, Park Lamp Relay
8	30 (MINI)	Main Light Switch, Headlamp Relay, Multi-function Switch
9	15 (MINI)	Daytime Running Lamps (DRL) Module, Fog Lamp Relay
10	25 (MINI)	Auxiliary Power Socket
11	–	NOT USED
12	–	NOT USED
13	–	NOT USED
14	60 (MAXI)	4 Wheel Anti-Lock Brake System (4WABS) Module
14	20 (MAXI)	Ignition Switch (W/RABS Only)
15	50 (MAXI)	Rear Air Suspension Compressor
16	40 (MAXI)	Trailer Tow Battery Charge Relay, Engine Fuse Module (Fuse 2)
17	30 (MAXI)	Shift on the Fly Relay, Transfer Case Shift Relay
18	30 (MAXI)	Power Seat Control Switch
19	20 (MAXI)	Fuel Pump Relay
20	50 (MAXI)	Ignition Switch (B4 & B5)
21	50 (MAXI)	Ignition Switch (B1 & B3)
22	50 (MAXI)	Junction Box Fuse/Relay Panel Battery Feed
23	40 (MAXI)	Blower Relay
24	30 (MAXI)	PCM Power Relay, Engine Fuse Module (Fuse 1)
25	30 (MAXI)	Junction Box Fuse/Relay Panel, Acc Delay Relay
26	–	NOT USED
27	–	NOT USED
28	30 (MAXI)	Trailer Electronic Brake Controller
29	–	NOT USED

G00102793

Fig. 9: Power Distribution Box Legend (1997 Build Date Post 6/24/96)
Courtesy of FORD MOTOR CO.

PRIMARY BATTERY FUSES

NOTE: Primary battery fuses are located under "PRIMARY BATTERY FUSE" cover, next to starter relay. See Fig. 10 .

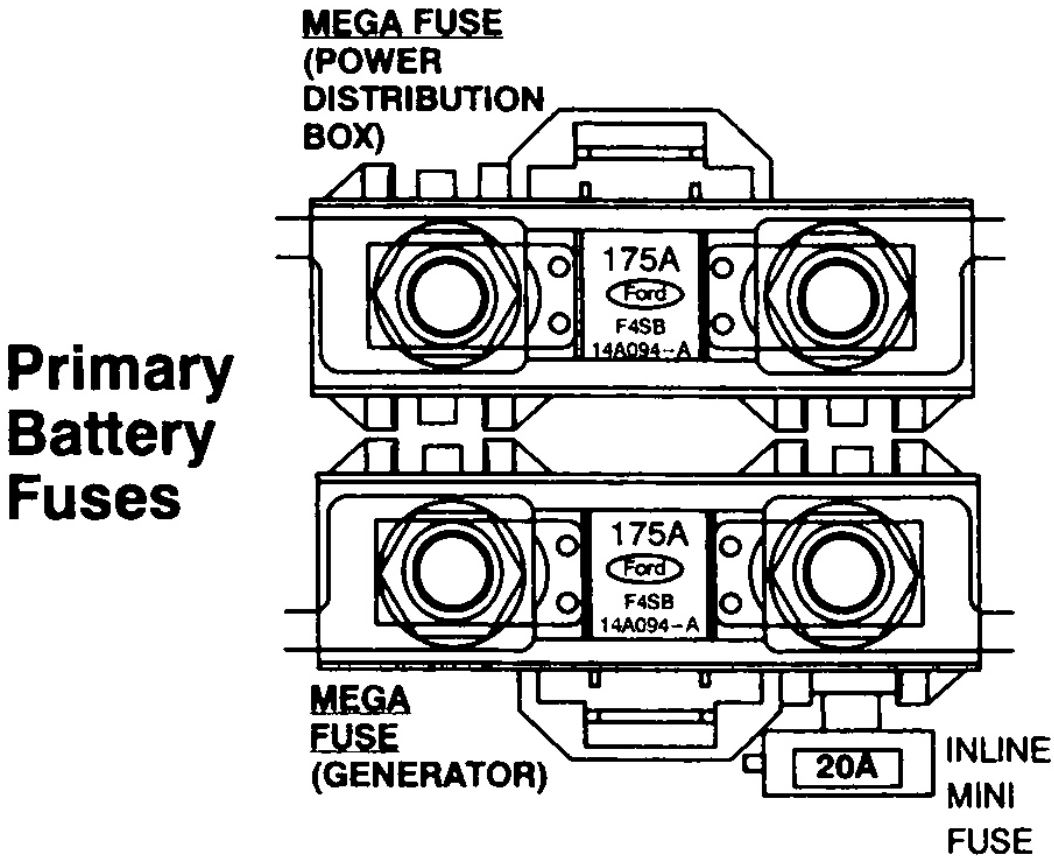


Fig. 10: Identifying Primary Battery Fuses
Courtesy of FORD MOTOR CO.

ENGINE MINI-FUSE BLOCK

NOTE: Engine mini-fuse block is located on left fender behind the power distribution box. See Fig. 11 .

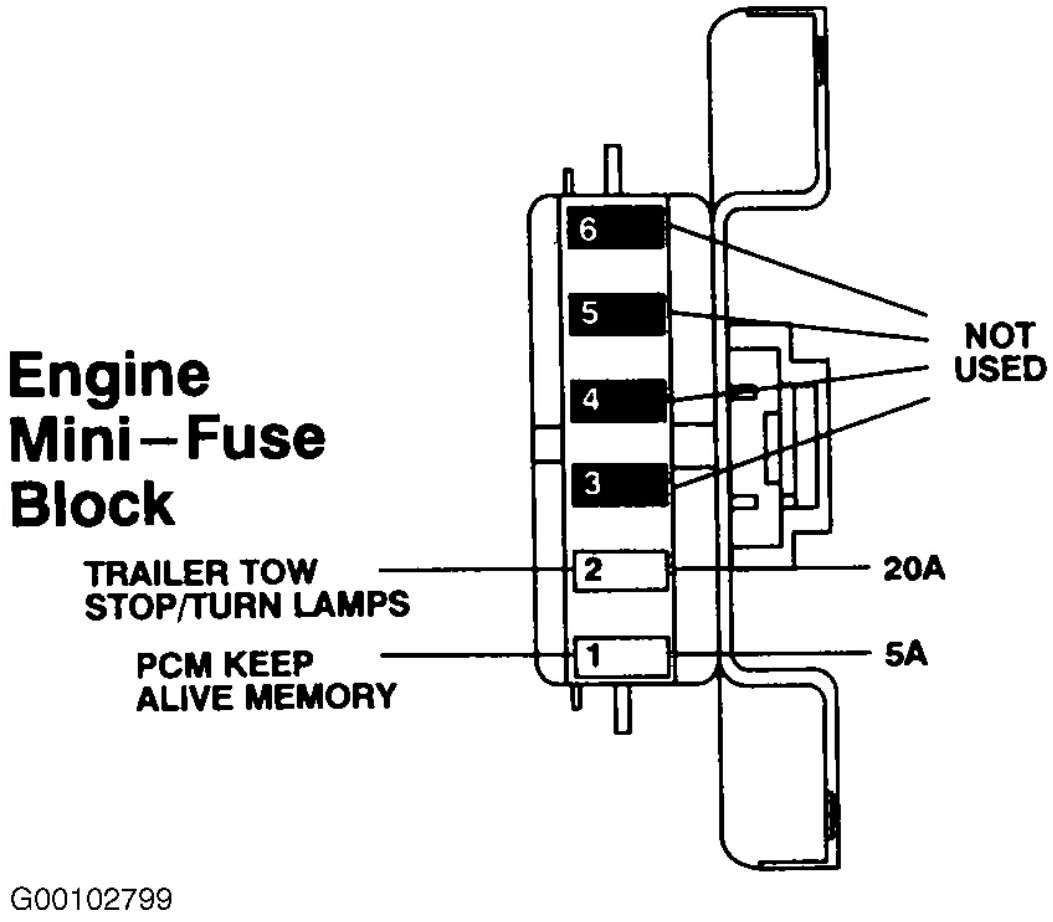


Fig. 11: Identifying Engine Min-Fuse Block Fuses
Courtesy of FORD MOTOR CO.

GENERATOR - MITSUBISHI

1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Generators - Mitsubishi

DESCRIPTION

The Mitsubishi 215-amp generator is an external-fan, brushless unit that is self-current limiting and temperature compensating. The voltage regulator is internal and integral with the rear half of the generator.

ADJUSTMENTS

BELT TENSION

Inspect condition and tension of generator drive belt prior to performing any on-vehicle charging system tests. Replace belt and/or repair tensioner mechanism if necessary.

TROUBLE SHOOTING

NOTE: See TROUBLE SHOOTING - BASIC PROCEDURES article in GENERAL INFORMATION.

ON-VEHICLE TESTING

GENERAL INSPECTION

Ensure battery posts and cables are clean and tight. Check drive belt tension. Ensure connections at alternator, regulator and engine ground are clean and tight. Check fusible links and replace as necessary.

Turn ignition on and ensure charge warning light operates. Check bulb and circuit if necessary. Start engine and verify charge warning light goes out. If warning light goes out, see **AMPERAGE OUTPUT TEST** . If warning light does not go out, see **NO-LOAD TEST** . There are 4 conditions that can cause charge indicator light to come on:

- No Generator Output
- Overcharging
- Generator Output Wire Open
- Voltage Sensing Wire (Terminal "A" circuit) Open

Check 300-amp megafuse in B+ circuit. Check 20-amp "A" circuit fuse, located in power distribution box.

BASE VOLTAGE TEST

NOTE: Prior to performing BASE VOLTAGE TEST, turn on headlights for 10-15 seconds to remove any surface charge from battery.

Ensure battery is in good condition and fully charged. Connect negative voltmeter lead to negative battery post, and positive voltmeter lead to positive battery post. Record battery voltage. This measurement is base voltage.

VOLTAGE OUTPUT TEST

1. Ensure battery is fully charged. Turn ignition switch to RUN position and leave engine off. Battery voltage should be present at terminals "B+" and "A" at alternator connector. Approximately one volt should be present at terminal "I". If voltages are correct, go to next step. If voltages are not correct go to step 3).
2. Start engine and run at 2000 RPM. With alternator connected, check voltage at terminals "B+", "A" and "I". At terminals "B+" and "A", 14.1-14.7 volts should be present. At terminal "I", 13-14 volts should be present (engine running). If voltages are not correct, go to next step. If voltages are correct, go to step 4).
3. Check 300-amp megafuse and 20-amp fuse in in "A" circuit. If fuses are okay, test "B+", "A" and "I" circuits for opens, shorts and excessive resistance. Repair as necessary. If okay, go to next step.
4. Perform voltage drop test on "B+" circuit (between positive battery and terminal "B+" on alternator). If voltage drops .5 volt or more, repair wire between terminal "B+" and positive battery. If voltage is still not correct, repair or replace alternator.

OVERCHARGE TEST

1. Disconnect voltage regulator connector. Measure voltage at wiring harness connector terminal "A". See **Fig. 1** . If battery voltage is present, go to next step. If battery voltage is not present, check for blown fuse or open circuit in "A" circuit wiring. 2) Check ground connections of alternator, engine and battery. If ground connection are okay, repair or replace generator assembly.

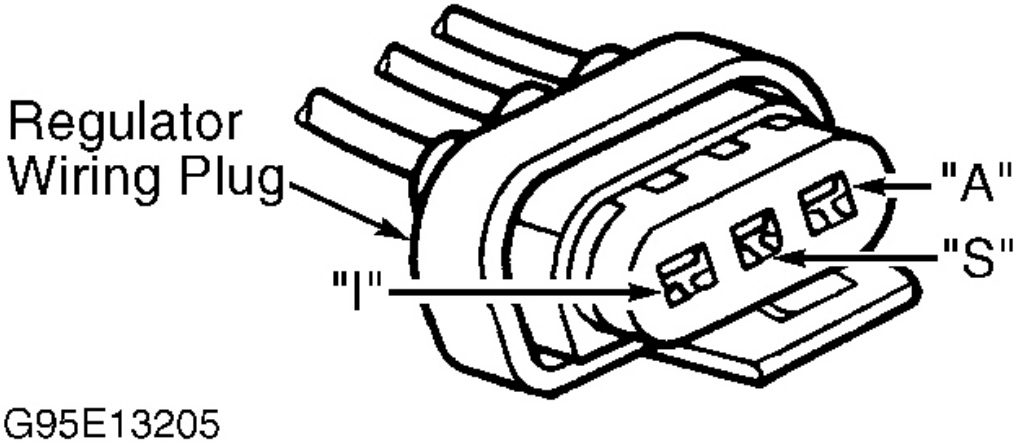


Fig. 1: Identifying Regulator Harness Connector Terminals
Courtesy of FORD MOTOR CO.

AMPERAGE OUTPUT TEST

1. Ensure drive belt is in good condition and properly tightened. Connect charging system load tester in accordance with manufacturer's instructions. Start and run engine at 1500-2000 RPM and apply load until alternator output levels off.
2. Maximum alternator output should be at least 160 amps. If alternator output is within 20 percent of rated output amperage, alternator output is okay. If alternator does not produce rated output, go to NO-LOAD TEST.

NO-LOAD TEST

1. Connect voltmeter positive lead to B+ terminal on generator and negative lead to ground. Start and run engine at 2000 RPM with no electrical load (foot off brake and doors closed). Read voltmeter when voltage stabilizes. This may require waiting a few minutes. Voltage should be 13-15 volts.
2. If voltage increases to proper level, proceed to **AMPERAGE OUTPUT TEST** . If voltage increases beyond proper level, proceed to **OVERCHARGE TEST** . If there is no voltage increase, proceed to **VOLTAGE OUTPUT TEST** .

CHARGING SYSTEM CIRCUIT TEST

1. Turn ignition off. Unplug 3-pin connector from generator. Turn ignition on. Connect jumper wire between Light/Green Red wire at harness connector and ground. If charge indicator light comes on, go to next step. If charge indicator light does not come on, repair Light Green/Red wire, by-pass resistor, or charge indicator bulb.
2. Turn ignition off. Test for battery voltage at Yellow/White wire at 3-pin harness connector. If battery voltage exists, go to next step. If battery voltage does not exist, repair Yellow/White wire between engine compartment fuse panel and generator, or replace defective fuse "K".
3. Test for battery voltage at generator output stud. If battery voltage exists, replace generator. If battery voltage does not exist, repair wire between output stud and battery, or replace defective 300-amp megafuse, located beneath generator.

REMOVAL & INSTALLATION

CAUTION: When batteries are disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

REMOVAL & INSTALLATION

Removal & Installation

Disconnect both negative battery cables. Disconnect wiring from generator. Disengage drive belt. Remove attachment bolts and generator. Reverse removal procedure to install.

BENCH TESTING & OVERHAUL

Manufacturer recommends generator be serviced only as an assembly.

WIRING DIAGRAMS

1997 Ford Pickup F150

GENERATOR - MITSUBISHI 1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Generators - Mitsubishi

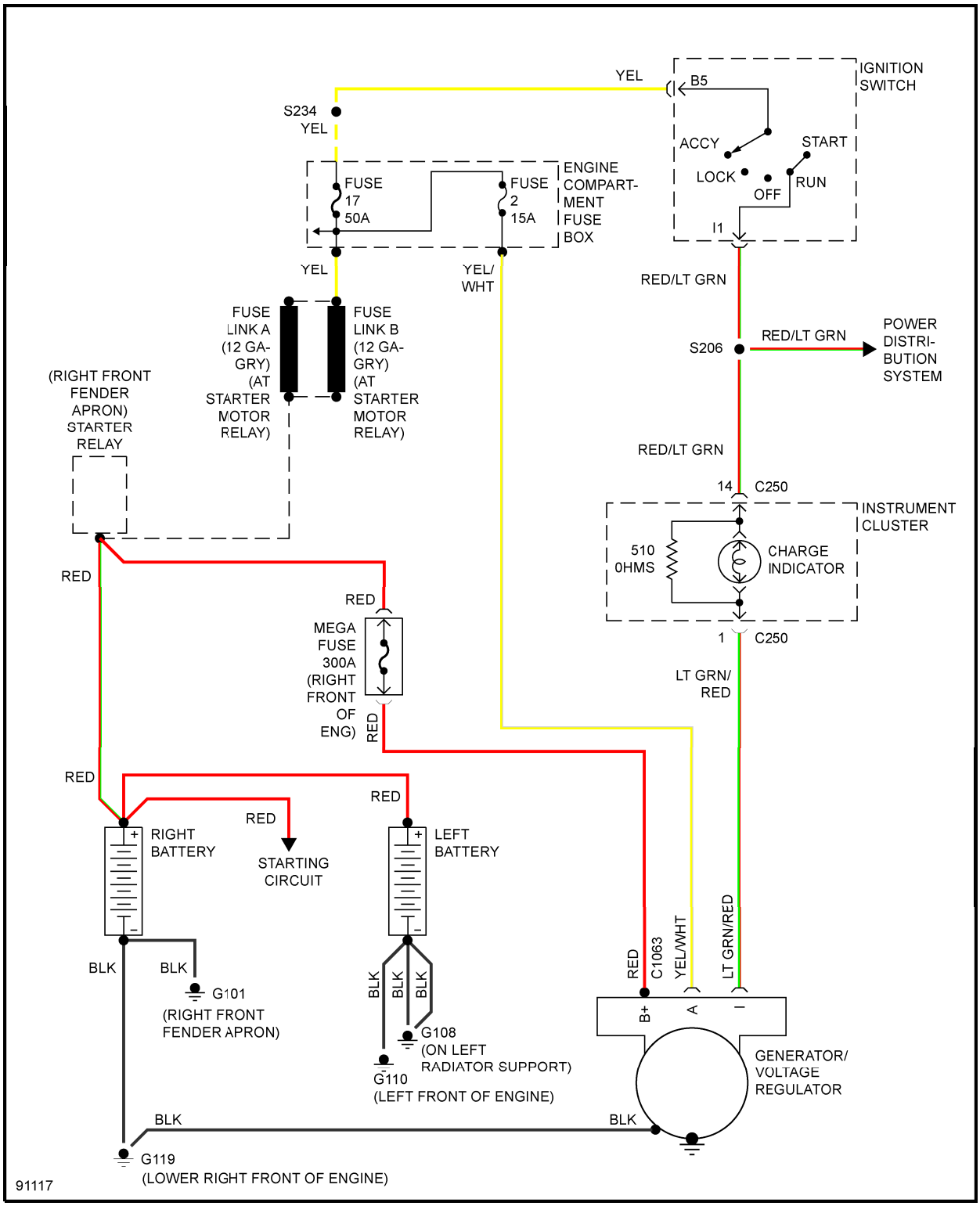


Fig. 2: Charging System Wiring Diagram

GENERATOR - MOTORCRAFT

1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Generators - Motorcraft

DESCRIPTION

Major components of the Motorcraft integral generator-regulator system with internal fan are: end frames, rotor, stator, rectifier assembly and electronic voltage regulator mounted on the rear of the generator. These generators are rated at 75, 95 or 130 amps, depending on application. See **Fig. 1** .

NOTE: The terms generator and alternator are interchangeable. Either may be found within illustrations.

ADJUSTMENTS

BELT TENSION

Inspect condition and tension of generator drive belt prior to performing any on-vehicle charging system tests. Replace belt and/or repair tensioner mechanism if necessary. Belt tension is okay if belt length indicator is within limit marks on tensioner. Replace belt and/or tensioner mechanism if necessary.

TROUBLE SHOOTING

NOTE: See TROUBLE SHOOTING - BASIC PROCEDURES article in GENERAL INFORMATION.

ON-VEHICLE TESTING

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

GENERAL INSPECTION

Ensure battery posts and cables are clean and tight. Check drive belt tension. Ensure connections at generator, regulator and engine ground are clean and tight. Check fuses and fusible links, replace as necessary.

Check condition of battery to see if battery has the ability to accept and hold a charge. If battery capacity meets requirements, charge battery before proceeding with testing to ensure battery is fully charged.

NO-LOAD TEST

1. Connect voltmeter positive lead to B+ terminal on generator and negative lead to ground. Start and run engine at 1500 RPM with no electrical load (foot off brake and doors closed). Read voltmeter when voltage stabilizes. This may require waiting a few minutes. Voltage should be 13-15 volts.
2. If voltage increases to proper level, proceed to **LOAD TEST** . If voltage increases beyond proper level, proceed to **OVERCHARGE CONDITION** . If there is no voltage increase, proceed to **LOW OR NO CHARGE CONDITION** .

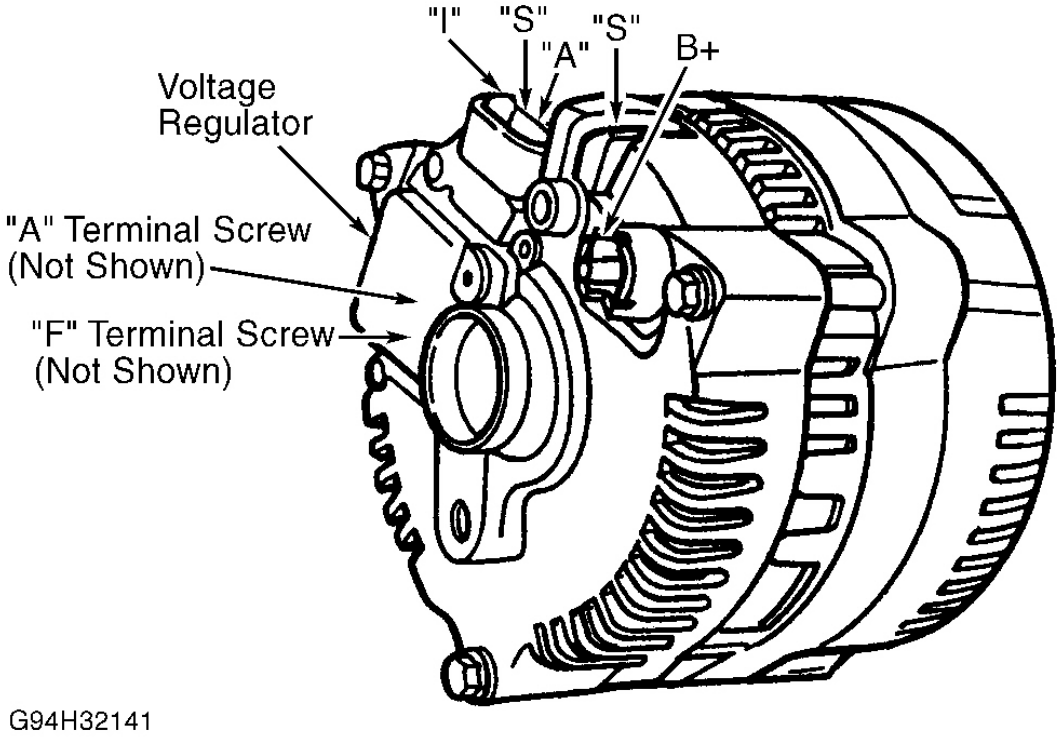


Fig. 1: Identifying Generator-Regulator Terminals
Courtesy of FORD MOTOR COMPANY

LOAD TEST

1. Ensure drive belt is in good condition and properly tightened. Connect charging system load tester in accordance with manufacturer's instructions. Start and run engine at 2000 RPM and apply load until generator output amperage levels off.
2. Record maximum generator amperage output. See GENERATOR OUTPUT SPECIFICATIONS TABLE for output values. If generator output is within 20 percent of rated output amperage and voltage remains 12.5-14.5 volts, generator output is okay. If generator does not produce rated output, proceed with appropriate testing.

GENERATOR OUTPUT SPECIFICATIONS

Application	Amps Rating
Standard	95
Optional	130

OVERCHARGE CONDITION

1. If voltmeter indicates high voltage (more than 15.4 volts), turn ignition switch to ON position. Connect negative voltmeter lead to ground. Connect positive voltmeter lead to generator output connection at starter solenoid. Record voltage.
2. Connect positive voltmeter lead to regulator "A" terminal screw on rear of generator. See **Fig. 1** and **Fig. 3** . If voltage difference between both locations exceeds 0.25 volt, repair high resistance condition in "A" circuit wiring.
3. If excessive voltage still exists, check ground connections for both generator and regulator. Tighten regulator ground screws to 16-24 INCH lbs. (1.8-2.7 N.m.), and recheck output voltage.
4. If excessive voltage still exists, connect voltmeter negative lead to ground. Connect positive voltmeter lead first to regulator "A" terminal screw, then to "F" terminal screw. Record readings. Different voltages at each screw head indicates a short in field circuit or a grounded rotor coil. To correct either condition, replace generator.
5. If same voltage appears at both screw heads, no internal short to ground is indicated. Replace voltage regulator.

LOW OR NO CHARGE CONDITION

1. Unplug harness connector from regulator at rear of generator. Connect ohmmeter between regulator "A" and "F" terminal screws. See **Fig. 1** and **Fig. 3** . If resistance is not greater than 2.4 ohms, a short in field circuit or a grounded rotor coil is indicated. Replace generator. If resistance is greater than 2.4 ohms, go to next step.
2. Reconnect regulator wiring plug. Connect negative voltmeter lead to ground. Contact positive voltmeter lead to regulator "A" terminal screw. If voltmeter does not indicate battery voltage, repair open or high resistance in "A" circuit wiring. Perform load test after repairs.
3. If battery voltage is indicated at "A" terminal screw, ensure ignition switch is in OFF position. Connect positive voltmeter lead to regulator "F" terminal screw. If battery voltage is present, go to step 4). If battery voltage is not present, replace generator.
4. Turn ignition switch to ON position (engine off). With voltmeter negative lead to ground, contact positive lead of voltmeter to regulator "F" terminal screw. If voltmeter indicates 2 volts or less, go to next step. If voltage is greater than 2 volts, check circuit between "I" terminal and ignition switch. Repair if necessary. See **"S" & "I" CIRCUIT TEST** . If "I" circuit is okay, replace regulator. Perform LOAD TEST after repair.
5. Start engine and run at 2000 RPM with headlights on. Measure voltage at "B+" terminal of generator and at generator feed wire at starter relay. If voltage readings differ by more than 0.5 volt, repair high resistance or open in wire between "B+" terminal and junction near starter relay.
6. If generator still does not charge sufficiently, connect a jumper wire to regulator "F" terminal screw and ground it to rear housing. If output voltage increases to 13-15 volts, replace regulator. If output voltage does not increase to at least 13 volts, replace generator.

"S" & "I" CIRCUIT TEST

1. Unplug regulator 3-wire harness connector. Connect jumper wire from harness "A" terminal to regulator "A" terminal. See **Fig. 1** and **Fig. 2** . Connect another jumper wire from regulator "F" terminal screw to generator housing.
2. With engine idling, connect voltmeter negative lead to battery ground terminal. Connect voltmeter positive lead first to "S" terminal and then to "I" terminal of regulator harness connector. See **Fig. 2** . Voltage at "S" terminal should be about 7 volts and about 14 vo lts at "I" terminal. If "S" terminal and "I" voltages are okay, replace voltage regulator. Repeat LOAD TEST. If "S" and "I" circuit voltages are not as specified, go to next step.
3. If voltage is present at "S" terminal, but not 6-8 volts, replace generator. If no voltage is present at "S" terminal, disconnect one-wire connector ("S" terminal) on back of generator. See **Fig. 1** . Check voltage at single "S" terminal. If about 7 volts are present repair "S" circuit wiring. If no voltage is present at single "S" terminal, replace generator.
4. If no voltage is present at "I" terminal, repair indicator light wiring circuit. Restore wiring connections and repeat LOAD TEST.

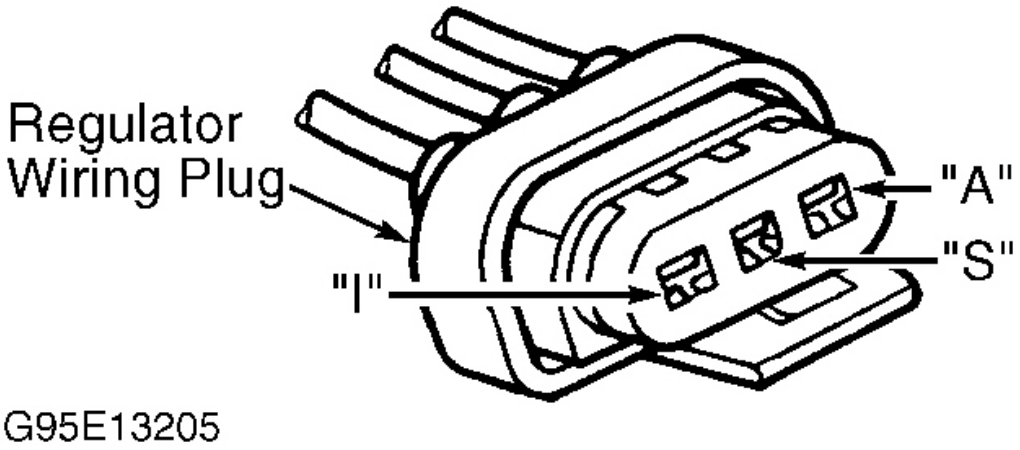


Fig. 2: Identifying Regulator Harness Connector Terminals
Courtesy of FORD MOTOR CO.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

GENERATOR

Removal & Installation

Disconnect negative battery cable. Disengage drive belt from pulley. Disconnect wiring from generator. Remove generator mounting bolts (and mounting bracket if necessary). Remove generator. To install, reverse removal procedure.

REGULATOR & BRUSH HOLDER

Removal & Installation

1. Remove generator. Remove 4 Torx screws from regulator and separate regulator and brush holder from generator.
2. Holding regulator in one hand, pry off the cap covering "A" terminal screw head with a screwdriver. Remove 2 screws attaching regulator to brush holder ("A" and "F" terminal screws). See **Fig. 3** . Separate regulator from brush holder. To install, reverse removal procedure. Tighten screws to 25-35 INCH lbs. (2.8-4.0 N.m).

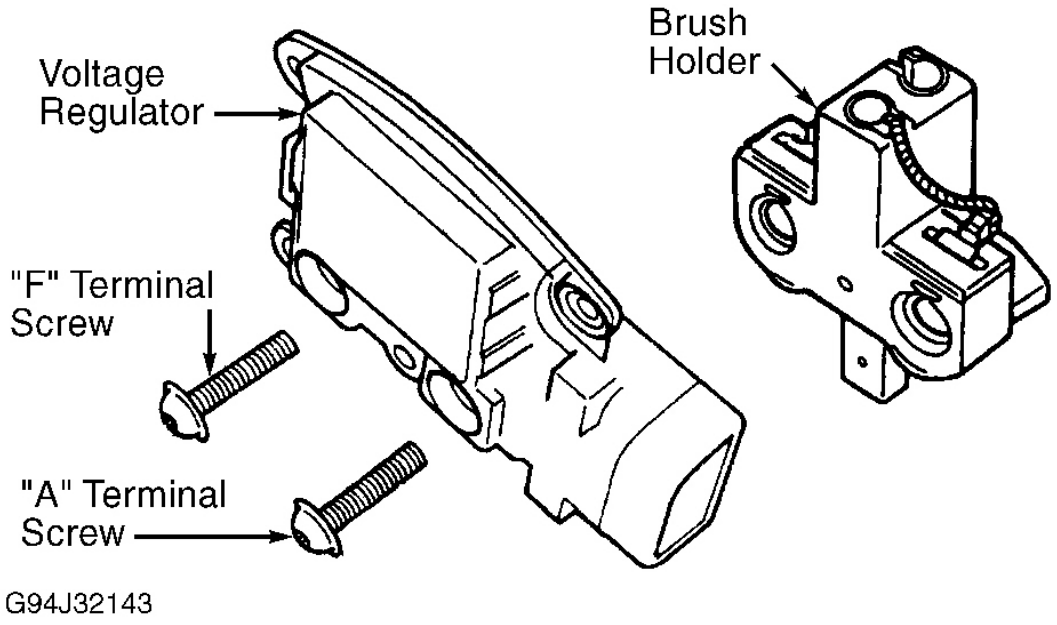


Fig. 3: Exploded View Of Voltage Regulator & Brush Holder
Courtesy of FORD MOTOR CO.

OVERHAUL

Overhaul information is not supplied by manufacturer. The only serviceable parts are the integral voltage

regulator and brush holder. See **Fig. 3** .

WIRING DIAGRAMS

1997 Ford Pickup F150

GENERATOR - MOTORCRAFT 1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Generators - Motorcraft

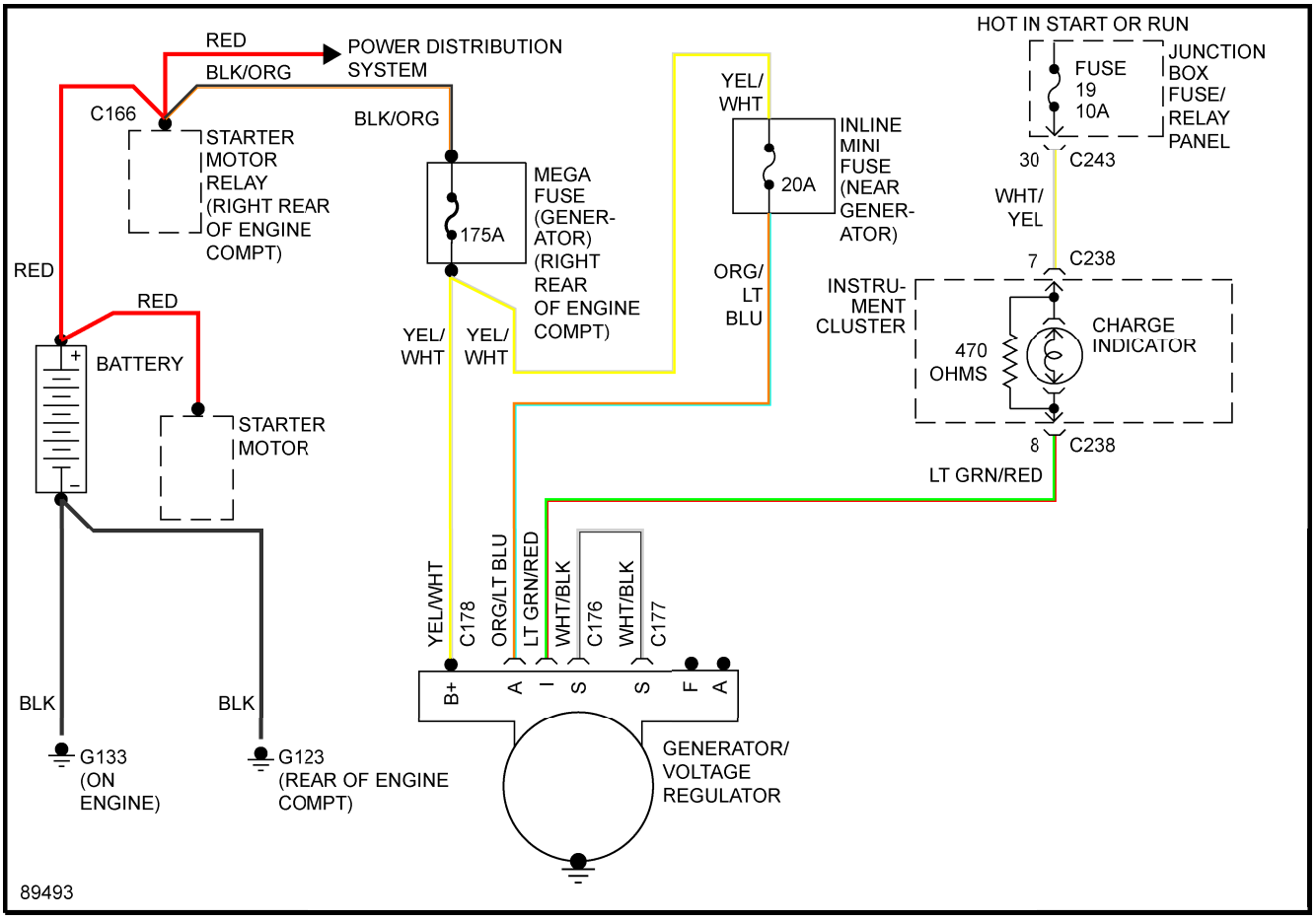


Fig. 4: Charging System Wiring Diagram (F150 & F250 Light Duty)

1997 Ford Pickup F150

GENERATOR - MOTORCRAFT 1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Generators - Motorcraft

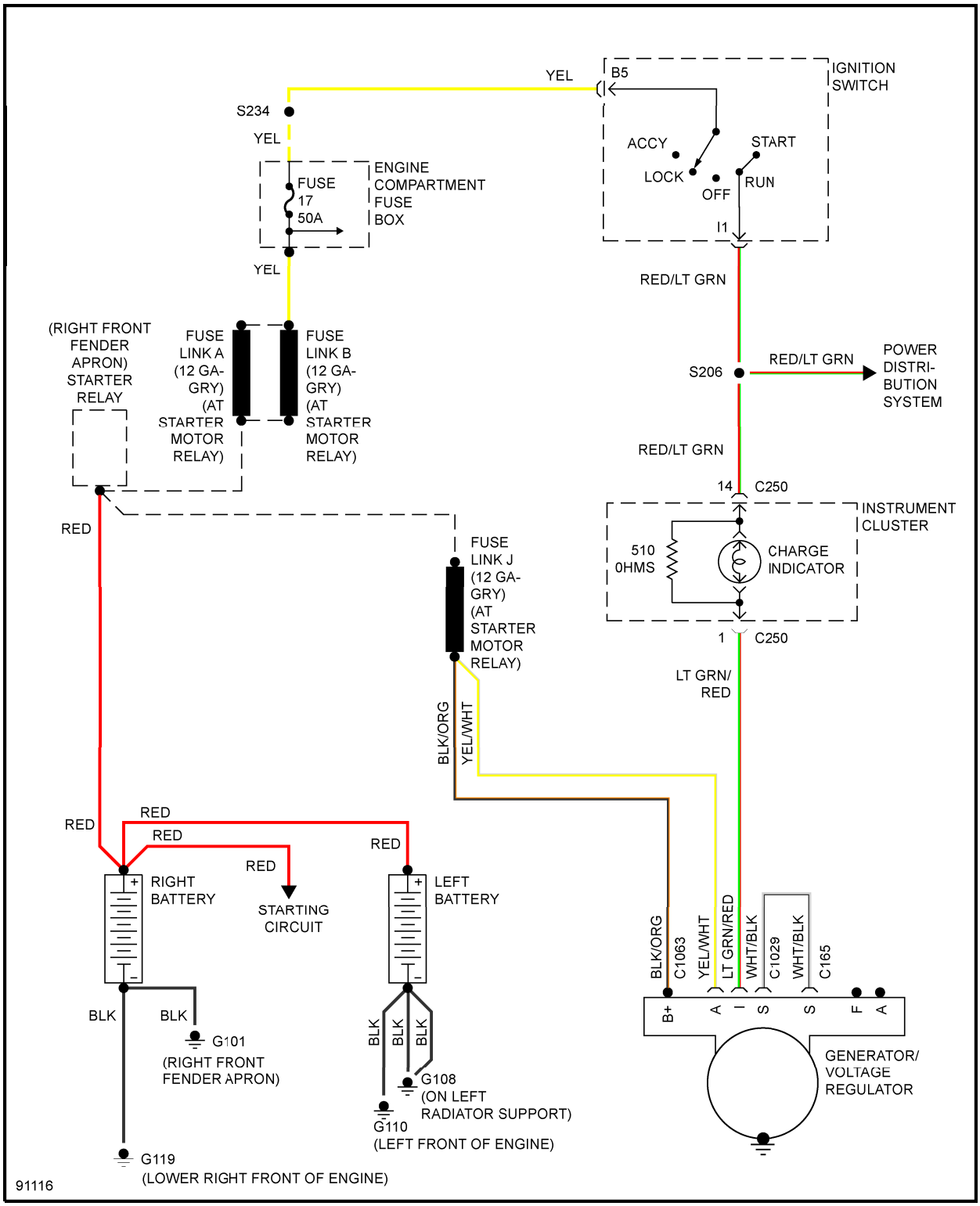


Fig. 5: Charging System Wiring Diagram (F250 Heavy-Duty & F350 - Diesel)

1997 Ford Pickup F150

GENERATOR - MOTORCRAFT 1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Generators - Motorcraft

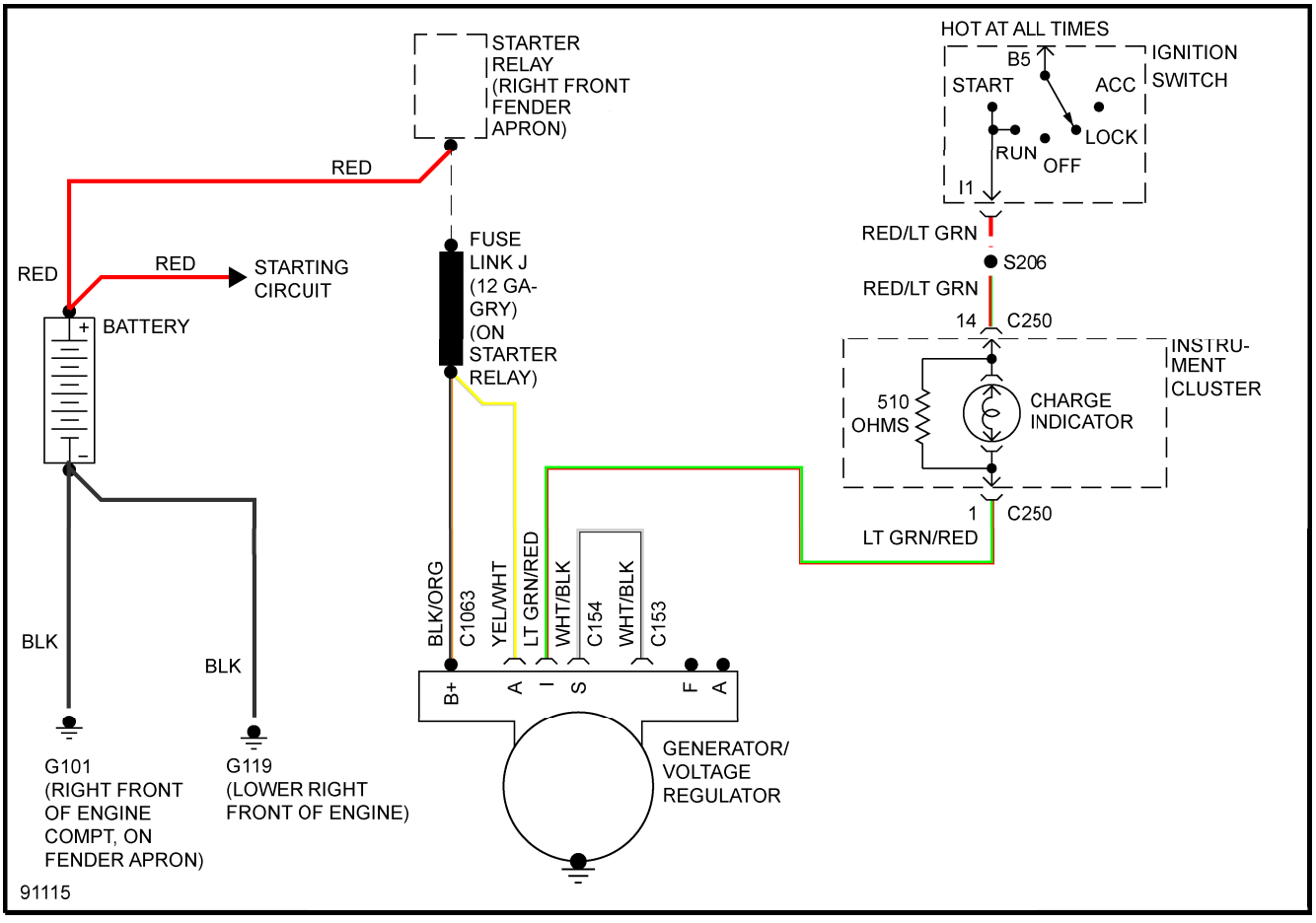


Fig. 6: Charging System Wiring Diagram (F250 Heavy-Duty & F350 - Gasoline)

HEATER SYSTEM

1997 A/C-HEATER SYSTEMS Ford Motor Co. - Heater Systems

DESCRIPTION

WARNING: To avoid injury from accidental air bag deployment, read and follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in the AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

Heater system is a blend-air type, consisting of a control panel, blower motor and plenum assembly. Blower motor is located in plenum assembly, under instrument panel. Plenum assembly contains heater core, floor/defrost door, panel/defrost door and electric motor actuated temperature blend door. See **Fig. 2** or **Fig. 3** .

OPERATION

BLOWER MOTOR SWITCH

Three of 4 operating speeds (low, medium low and medium high) are controlled by a blower motor resistor connected in series with 3 of the operating positions and ground. High speed is obtained by by-passing blower motor resistor. See **Fig. 2** or **Fig. 3** .

MODE SELECTOR KNOB

Mode selector knob can be placed in PANEL, PANEL & FLOOR, OFF, FLOOR, FLR & DEF (floor and defrost) and DEF (defrost) positions. Mode selector knob position determines which mode doors are open, partially open or closed. Mode doors direct airflow to selected outlets. The 3 vacuum motors and doors are outside/recirculation, panel/defrost and floor/defrost. See **Fig. 2** or **Fig. 3** .

MODE SELECTOR MODES

NOTE: The mode selector knob does not affect temperature blend door. Any desired temperature, from full cool to full warm, can be set regardless of which mode control mode is selected. See Fig. 2 or Fig. 3 .

PANEL (Vent)

In PANEL mode, outside air is allowed into system. Vacuum is not applied to outside/recirculation and panel/floor door motors. Vacuum is applied to panel/defrost door motor. Airflow is directed to panel outlets. Blower motor speed and temperature can be adjusted to desired settings.

OFF

In OFF mode, vacuum is applied to outside/recirculation and floor/panel door motors. Vacuum is not applied to panel/defrost door motor. Temperature can be adjusted to desired settings. Blower motor is off.

PANEL & FLOOR

In PANEL & FLOOR mode, outside air is allowed through system. Vacuum is not applied to outside/recirculation door motor and floor/panel door motor Yellow vacuum hose. Recirculated air is blocked off. Vacuum is applied to panel/defrost door motor and floor/panel door motor Blue vacuum hose. Airflow is routed to floor outlets. A small amount of air is directed to windshield defroster outlets. Blower motor speed and temperature can be adjusted to desired settings.

FLOOR

In FLOOR mode, outside air is allowed into system. Vacuum is not applied to outside/recirculation and panel/defrost door motors. Vacuum is applied to Yellow and Blue vacuum hoses of panel/floor door motor, allowing equal outlet airflow. Blower motor speed and temperature can be adjusted to desired settings.

FLR & DEF (Floor & Defrost)

In FLR & DEF mode, outside air is routed through system and out floor and defroster outlets. Vacuum is not applied to outside/recirculation door motor, Yellow vacuum hose of panel/floor door motor and panel/defrost door motor. Blower motor speed and temperature can be adjusted to desired settings.

DEF (Defrost)

In DEF mode, outside air is routed through system and out defroster outlets. Vacuum is not applied to any door motor. Blower motor speed and temperature can be adjusted to desired settings.

TEMPERATURE CONTROL KNOB

Temperature control knob controls a blend door potentiometer which controls an electronic temperature blend door motor. Temperature blend door motor provides a variable number of temperature blend door positions. When temperature control knob is in COOL position, temperature blend door shuts off airflow to heater core. When knob is in WARM position, air is directed through heater core. When knob is in intermediate positions, heated air is blended with cooler incoming air to achieve desired temperature.

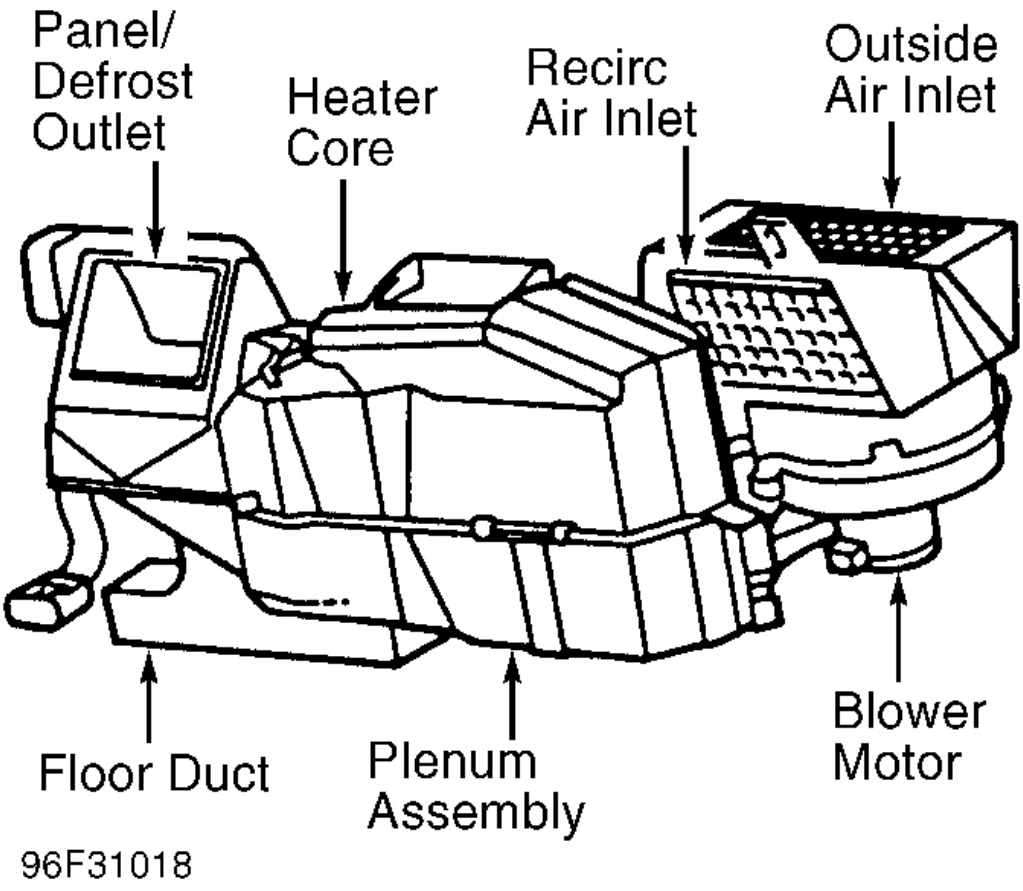


Fig. 1: Identifying Heater System Components
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

BLOWER MOTOR INOPERATIVE

1. **Check Fuse**

   Turn ignition switch to OFF position. Using an ohmmeter, check fuse No. 23 (40-amp). If fuse is not okay, replace fuse and ensure system is operating properly. If fuse blows again, go to next step. If fuse is okay, go to step 4).

2. **Check For Short To Ground In Blue/Light Green Wire**

   Disconnect blower motor relay. Remove fuse No. 23 (40-amp), located in power distribution box. Using

an ohmmeter, measure resistance of Blue/Light Green wire between ground and load side of fuse No. 23. See **WIRING DIAGRAMS** . If resistance is more than 10,000 ohms, go to next step. If resistance is 10,000 ohms or less, repair short to ground in Blue/Light Green wire. Ensure system is operating properly.

3. **Check For Short To Ground In Brown/Yellow Wire**

   Disconnect mode selector switch connector. Using an ohmmeter, measure resistance of Brown/Yellow wire between ground and blower motor relay connector terminal No. 30. If resistance is more than 10,000 ohms, repair Brown/Orange wire between mode selector switch and blower motor. If resistance is 10,000 ohms or less, repair Brown/Yellow wire between blower motor relay and mode selector switch.

4. **Check Voltage To Blower Motor**

   Turn ignition switch to OFF position. Disconnect blower motor. Turn ignition switch to ON position. Using a voltmeter, measure voltage between ground and blower motor connector Brown/Orange wire terminal. Rotate mode selector switch to different positions. If voltage is 10 volts or more in all mode selector switch positions except off, go to next step. If voltage is less than 10 volts in any mode selector switch position, go to step 8).

5. **Check Voltage To Blower Motor Resistor**

   Turn ignition switch to OFF position. Disconnect blower motor resistor. Turn ignition switch to ON position. Turn mode selector switch to FLOOR position and blower motor switch to LO position. Using a voltmeter, measure voltage between ground and blower motor resistor Orange/Black wire terminal. If voltage is less than 10 volts, go to next step. If voltage is 10 volts or more, go to step 7).

6. **Check Orange/Black Wire**

   Turn ignition switch to OFF position. Disconnect blower motor connector. Ensure blower motor switch is in LO position. Using an ohmmeter, measure resistance of Orange/Black wire between blower motor and blower motor resistor, and between ground and blower motor. Resistance should be 5 ohms between blower motor and blower motor resistor, and more than 10,000 ohms between ground and blower motor. If resistance is as specified, replace blower motor. If resistance is not as specified, repair Orange/Black wire. Ensure system is operating properly.

7. **Check Blower Motor Resistor**

   Using an ohmmeter, measure resistance between blower motor resistor terminals No. 2 (Black wire) and No. 4 (Orange/Black wire). See **WIRING DIAGRAMS** . If resistance is 8 ohms or less, repair Black wire. If resistance is more than 8 ohms, replace blower motor resistor. Ensure system is operating properly.

8. **Check Voltage To Blower Motor Relay**

   Turn ignition switch to OFF position. Disconnect blower motor relay. Using a voltmeter, measure voltage between ground and blower motor relay connector Blue/Light Green wire terminal. If voltage is 10 volts

or more, replace blower motor relay and go to next step. If voltage is less than 10 volts, repair Blue/Light Green wire. Ensure system is operating properly.

9. **Check Voltage To Mode Selector Switch**

   Turn ignition switch to OFF position. Disconnect mode selector switch. Turn ignition switch to ON position. Using a voltmeter, measure voltage between ground and mode selector switch connector terminal No. 2 (Brown/Yellow wire). If voltage is less than 10 volts, go to next step. If voltage is 10 volts or more, go to step 11).

10. **Check Brown/Yellow Wire Circuit**

    Turn ignition switch to OFF position. Disconnect blower motor relay. Using an ohmmeter, measure resistance of Brown/Yellow wire between blower motor relay and mode selector switch connector terminal No. 2, and between ground and blower motor relay. Resistance should be 5 ohms between mode selector switch and blower motor relay, and more than 10,000 ohms between ground and blower motor relay. If resistance is as specified, replace blower motor relay. If resistance is not as specified, repair Brown/Yellow wire. Ensure system is operating properly.

11. **Check Mode Selector Switch Continuity**

    Turn ignition switch to OFF position. Disconnect mode selector switch. Using an ohmmeter, measure resistance of mode selector switch between Brown/Yellow wire terminal and Brown/Orange wire terminal. Rotate selector knob through all positions. Resistance should be less than 5 ohms in all positions except OFF. If resistance is as specified, repair Brown/Orange wire. If resistance is not as specified, replace mode selector switch. Ensure system is operating properly.

BLOWER MOTOR DOES NOT OPERATE PROPERLY

1. **Check Blower Motor Operation**

   Turn ignition switch to ON position. Turn mode selector switch to FLOOR position. Turn blower motor to LO position. If blower motor does not operate, go to next step. If blower motor operates, go to step 5).

2. **Check Blower Motor Switch Positions**

   Turn ignition switch to ON position. Turn mode selector switch to FLOOR position. Slowly rotate blower motor switch from LO position to HI position. If blower motor does not operate in any position except HI position, go to next step. If blower motor operates in any position except HI position, go to step 4).

3. **Check Ground Circuit**

   Turn ignition switch to OFF position. Disconnect blower motor resistor connector. Using an ohmmeter, measure resistance between ground and blower motor resistor connector Black wire terminal. If resistance is less than 5 ohms, replace blower motor resistor. If resistance is 5 ohms or more, repair Black wire. Ensure system is operating properly.

4. **Check Orange/Black Wire Circuit Continuity**

   Turn ignition switch to OFF position. Disconnect blower motor resistor and blower motor connectors. Using an ohmmeter, measure resistance of Orange/Black wire between blower motor resistor and blower motor. If resistance is less than 5 ohms, replace blower motor resistor. If resistance is 5 ohms or more, repair Orange/Black wire. Ensure system is operating properly.

5. **Check Blower Motor Switch**

   Ensure ignition switch is in ON position and mode selector switch is in FLOOR position. Slowly rotate blower motor switch from LO position to HI position and back several times. If blower motor does not operate without interruption in all switch positions, go to next step. If blower motor operates without interruption in all switch positions, system is okay.

6. **Check Blower Motor Switch Continuity**

   Turn ignition switch to OFF position. Disconnect blower motor switch. Using an ohmmeter, measure continuity between specified blower motor switch terminals with switch in each position. See **BLOWER MOTOR SWITCH TESTING** table. If switch continuity is as specified, check for opens or shorts in Yellow/Red wire and Light Green/White wire. Repair as necessary. If switch continuity is not as specified, replace blower motor switch. Ensure system is operating properly.

BLOWER MOTOR SWITCH TESTING

Switch Position	Continuity Between Terminals
Low (LO)	None
Medium-Low (MED LO)	2 (ORG/BLK) & 3 (LT GRN/WHT)
Medium-High (MED HI)	2 (ORG/BLK) & 4 (YEL/RED)
High (HI)	1 (BLK) & 2 (ORG/BLK)

NO HIGH SPEED BLOWER OPERATION

1. **Check Blower Motor Operation**

   Turn ignition switch to ON position. Turn mode selector switch to FLOOR position and blower motor switch to medium-high position (next to HI). If blower motor operates, go to next step. If blower motor does not operate, go to step 4).

2. **Check Blower Motor Speed**

   Turn mode selector switch to FLOOR position and blower motor switch to HI position. If blower motor does not operate, go to next step. If blower motor operates, cycle blower motor switch from HI to LO positions several times. If blower motor operates in all positions, system is okay. If blower motor does not operate properly, replace blower motor switch. Ensure system is operating properly.

3. **Check Blower Motor Switch**

Turn ignition switch to OFF position. Disconnect blower motor switch. Using an ohmmeter, measure continuity between specified blower motor switch terminals with switch in each position. See **BLOWER MOTOR SWITCH TESTING** table. If switch continuity is as specified, check for opens or shorts in Black wire. Repair as necessary. If switch continuity is not as specified, replace blower motor switch. Ensure system is operating properly.

4. **Check Blower Motor Speed For High & Low Operation**

   Turn mode selector switch to FLOOR position. Turn blower motor switch to LO position and then to medium low position. If blower motor only operates in LO position, go to next step. If blower motor does not operate in LO position, replace blower motor resistor. If blower motor operates in both positions, check blower motor harness connector for an open, or loose or disconnected terminals. If connector is okay, replace blower motor switch. Ensure system is operating properly.

5. **Check Blower Motor Switch Connector**

   Turn ignition switch to OFF position. Ensure blower motor switch connector is not open, or have loose or disconnected terminals. If connector is okay, replace blower motor switch. If connector is not okay, repair as necessary. Ensure system is operating properly.

AIR FLOWS FROM WRONG OUTLETS

Test vacuum check valve. Check for vacuum leaks and inoperative vacuum motor. Ensure correct vacuum hose routing. See **Fig. 2** or **Fig. 3** .

INSUFFICIENT HEAT

Check for low coolant level. Check for pinched, damaged, collapsed, or improperly routed heater hoses. Ensure engine is not overheating. Check for plugged or partially plugged heater core. Check for loose or misaligned cable to temperature blend door.

IMPROPER OR ERRATIC AIRFLOW FROM OUTLET(S)

1. Check vacuum source at engine manifold and vacuum reservoir tank for leaks or damage. Ensure check valve is installed correctly and not damaged. Check for vacuum leaks at mode selector switch. Ensure all vacuum hoses are correctly routed, connected tightly, and not damaged, kinked or pinched.
2. Check for leaking or collapsed vacuum motors. Check all mode doors for binding and foreign material. Ensure door motor linkage is properly connected. Check blower motor for foreign material and binding.

NO TEMPERATURE CHANGE IN ALL SETTINGS

1. **Check Temperature Blend Door Motor**

   Start engine and bring to normal operating temperature. Turn blower motor switch to LO position. Turn mode selector switch to PANEL position (MAX A/C position, if equipped). Turn temperature control knob to full COOL position and check for cool air discharge. Turn temperature control knob to full WARM position and check for warm air discharge. Rotate temperature control knob from full WARM

position to full COOL position. If air temperature does not change, go to next step. If air temperature changes, system is operating properly.

2. **Check Fuse No. 5 (15-Amp)**

   Turn ignition switch to OFF position. Remove fuse No. 5 (15-amp), located in junction box fuse/relay panel. Using an ohmmeter, check fuse condition. If fuse is okay, go to step 4). If fuse is not okay, replace fuse and ensure system is operating properly. If fuse blows again, go to next step.

3. **Check Light Blue/Pink Wire For Short To Ground**

   Ensure ignition switch is off. Disconnect electronic blend door motor connector. Disconnect temperature control switch (potentiometer) connector. Disconnect junction box fuse/relay panel 34-pin Gray connector located under left side of instrument panel. Using an ohmmeter, measure resistance between ground and junction box fuse/relay connector terminal No. 15 (Light Blue/Pink wire). If resistance is greater than 10,000 ohms, replace junction box fuse/relay panel. If resistance is 10,000 ohms or less, repair Light Blue/Pink wire. Ensure system is operating properly.

4. **Check Voltage To Electronic Blend Door Motor**

   Turn ignition switch to OFF position. Disconnect electronic blend door motor connector. Turn ignition switch to ON position. Using a voltmeter, measure voltage between ground and blend door motor connector terminal No. 6 (Light Blue/Pink wire). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair Light Blue/Pink wire. Ensure system is operating properly.

5. **Check Red/Light Green Wire, Yellow/Light Green Wire &**

   MD11Red/White Wire Turn ignition switch to OFF position. Disconnect electronic blend door motor connector. Using an ohmmeter, measure resistance of the following wires:

   - Red/White wire between temperature control switch connector terminal No. 1 and electronic blend door motor connector terminal No. 6.
   - Yellow/Light Green wire between temperature control switch connector terminal No. 2 and electronic blend door motor connector terminal No. 3.
   - Red/Light Green wire between temperature control switch connector terminal No. 3 and electronic blend door motor connector terminal No. 4.

   If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or more, repair suspect circuit. See **WIRING DIAGRAMS** . Ensure system is operating properly.

6. **Check Temperature Control Switch (Potentiometer)**

   Using an ohmmeter, measure resistance between temperature control switch (potentiometer) terminals No. 2 (Yellow/Light Green wire) and No. 3 (Red/Light Green wire). Temperature control switch resistance should be 15 ohms in full WARM position and 3000 ohms in full COOL position. Resistance should change uninterrupted as temperature control switch knob is turned from COOL to WARM and back. If switch resistance is as specified, replace temperature blend door motor. If temperature control

switch resistance is not as specified, replace temperature control switch. Ensure system is operating properly.

TESTING

WARNING: To avoid injury from accidental air bag deployment, read and follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in the AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

BLOWER MOTOR

Disconnect blower motor harness connector. Using a jumper wire, connect battery voltage to blower motor connector Brown/Orange wire terminal. Connect a second jumper wire from ground to blower motor connector Orange/Black wire terminal. Replace motor if it does not operate at high speed.

BLOWER MOTOR RESISTOR

Disconnect blower motor resistor connector. Using an ohmmeter or a self-powered test light, check for continuity between blower motor resistor terminals. Continuity should exist between all terminals. If continuity does not exist, replace blower motor resistor.

MODE SELECTOR VALVE

Place mode selector knob in specified position. Using a vacuum gauge, check for presence or absence of vacuum. See **Fig. 2** or **Fig. 3** . If test results are not as specified, check for kinked or broken vacuum lines. If vacuum lines are okay, replace mode selector valve.

REMOVAL & INSTALLATION

WARNING: To avoid injury from accidental air bag deployment, read and follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in the AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

BLOWER MOTOR

Removal & Installation

If equipped, remove air filter and mounting bracket. Disconnect christmas-tree retainer from blower motor mounting plate. Disconnect blower motor electrical connector. Remove blower motor cover. Remove blower motor, using car not to damage wheel. To install, reverse removal procedure.

COOLING SYSTEM FILL & BLEED

Some vehicles may exhibit (repeat) heater core leaks. This may be caused by a chemical reaction called electrolysis. Electrolysis involves an ion exchange between the heater core and engine coolant which can result in a breakdown of the heater core material. This is similar to the operation of a battery. To address this issue, or for coolant fill procedure, see TSB 01-15-6, dated 8/6/2001.

CONTROL PANEL

Removal & Installation

1. Disconnect negative battery cable and wait at least one minute to deplete air bag backup power supply. Disconnect 2 passenger side air bag defeat switch connectors.
2. Remove instrument panel relay cover. Pull center finish panel from instrument panel. Disconnect 4WD control switch connector (if equipped). Remove 4 screws attaching control panel to instrument panel.
3. Pull control panel far enough from opening to disconnect electrical connectors and illumination light. Disconnect vacuum harness connector. Remove control panel from instrument panel. Switch knobs will drop off when each switch is removed. To install, reverse removal procedure.

HEATER CORE

Removal & Installation

Disconnect negative battery cable. Drain cooling system. Remove instrument panel. See **INSTRUMENT PANEL** . Disconnect heater hoses at heater core. See **Fig. 1** . Remove A/C plenum demister adapter. Disconnect vacuum line. Remove heater core bracket. Remove 13 plenum assembly top screws and remove plenum top. Remove temperature blend door assembly. Remove heater core from plenum. To install, reverse removal procedure. Fill and bleed cooling system. See **COOLING SYSTEM FILL & BLEED** .

INSTRUMENT PANEL

Removal & Installation

1. Disconnect negative battery cable. Disconnect positive battery cable and wait at least one minute for air bag backup power supply to deplete. Move automatic transmission shift lever to "1" position (if equipped). Carefully pry to release 4 clips and remove steering column opening cover. Remove fuse door. Position hood latch and parking brake release handles aside.
2. Remove instrument panel floor duct panel. Remove lower instrument panel steering column cover. Remove left and right side door scuff plates. Remove left and right side cowl side trim panels. Disconnect brake on/off switch connector. Disconnect radio and Generic Electronic Module (GEM)/Central Timer Module (CTM) ground connections.
3. Disconnect 3 instrument panel main harness connectors. Remove firewall wiring harness from inside left

side of engine compartment. Pull bulkhead electrical connector handle and disconnect harness. Disconnect both air bag diagnostic monitor connectors located behind right side of instrument panel. Disconnect inertia fuel shutoff switch connector located behind right side of instrument panel.

4. Disconnect right side ground connections. Disconnect electronic blend door motor connector and climate control panel vacuum line connector. Remove instrument panel steering column opening cover support. Remove 4 steering column support nuts and lower steering column. Disconnect radio antenna cable and remove radio.

CAUTION: Carry air bag with trim cover facing away from body to reduce injury from an accidental deployment. Place air bag on bench or other surface with trim cover facing upward.

5. Remove instrument panel relay cover. Open glove box and release both door stops. Remove passenger side air bag module. Remove right side assist handle and windshield molding. Remove instrument panel bolt under left side of glove box. Remove 2 instrument panel bolts behind passenger side air bag module opening. Remove 2 upper instrument panel bolts and bolt on relay bracket. Remove lower instrument panel bolt on left side of cigarette lighter.
6. Remove 2 lower instrument panel nuts located on either corner of instrument panel. Remove instrument panel bolt under center of steering column. Remove 2 instrument panel bolts on bottom left and right sides of instrument cluster opening. Disconnect air bag sliding contact connectors and anti-theft sensor connector. Disconnect steering column connectors. Remove instrument panel from right side floor brace. Remove instrument panel. To install, align and position instrument panel with clips in sheet metal. To continue installation, reverse removal procedures. Tighten steering column mounting nuts to 10-13 ft. lbs. (13.5-17.6 N.m).

PLENUM ASSEMBLY

Removal & Installation

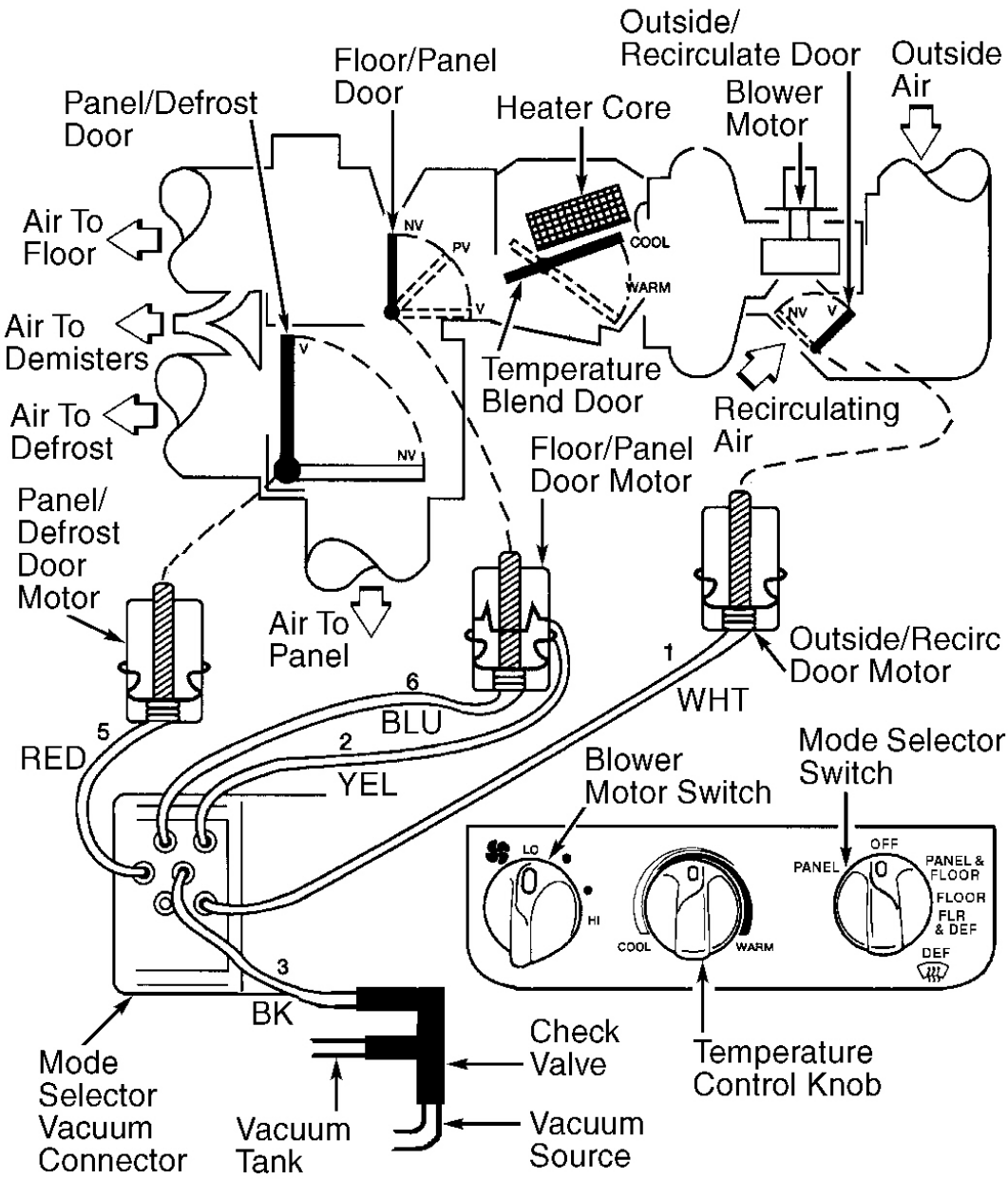
Disconnect negative battery cable. Drain cooling system. Remove instrument panel. See **INSTRUMENT PANEL** . See **Fig. 1** . Disconnect heater hoses from heater core. Remove 2 plenum assembly nuts from engine compartment. Disconnect vacuum hose, which is secured to right heater core cover. Remove 2 plenum assembly nuts from under instrument panel. Lower plenum assembly, and remove assembly from vehicle. To install, reverse removal procedure.

TEMPERATURE BLEND DOOR MOTOR

Removal & Installation

Remove floor duct panel plastic push pins and release expander clip and remove floor duct panel. Remove right side instrument panel brace. Remove left side instrument panel brace lower nut and move brace out of the way. Remove floor duct. Disconnect temperature blend door motor connector. Remove 3 mounting screws. Pull down on blend door motor to release door motor shaft and remove blend door motor. To install, reverse removal procedures.

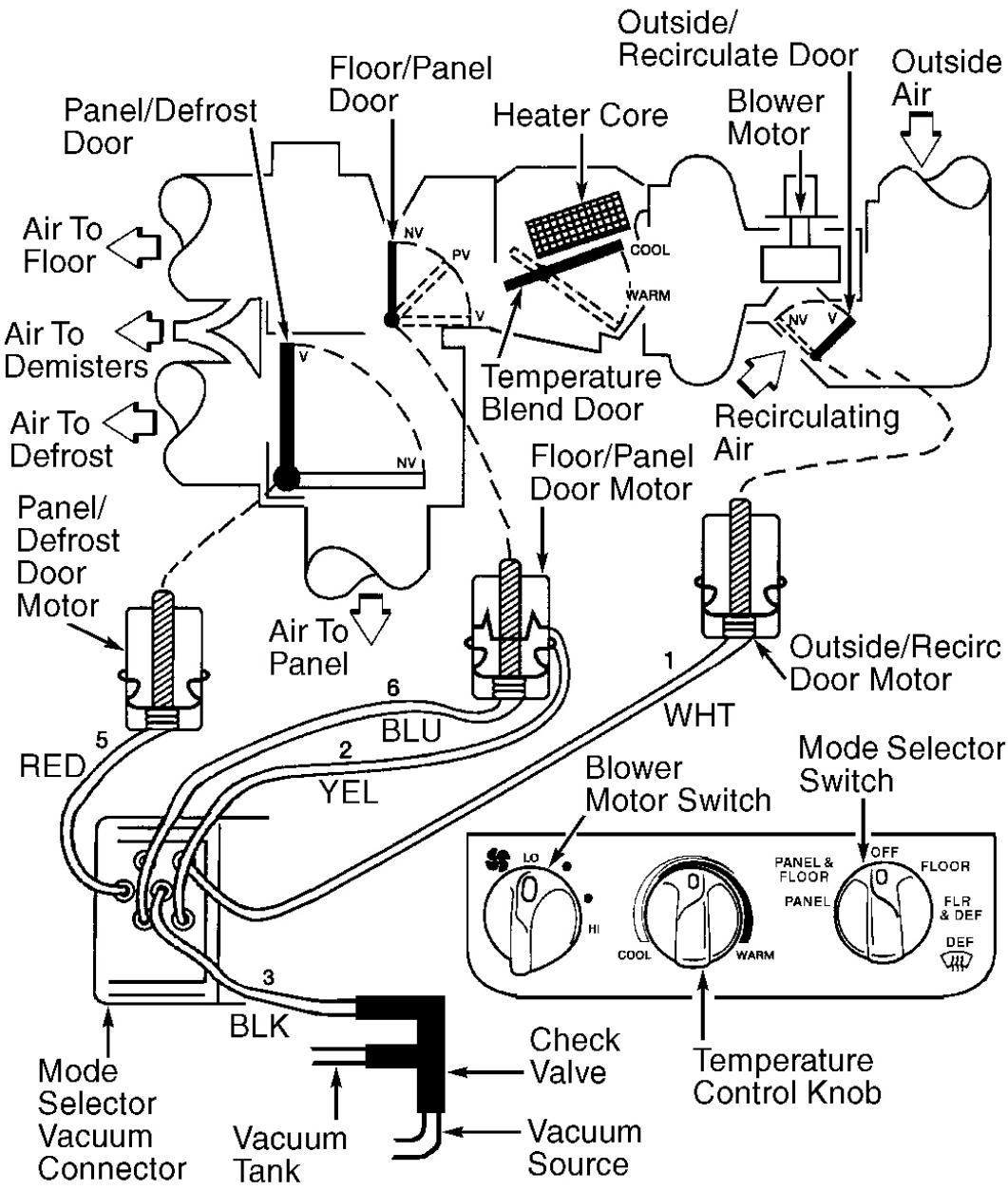
VACUUM DIAGRAMS



VACUUM LOGIC TABLE

	Fresh/Recirc No. 1 (White)	Panel/Floor No. 6 (Blue)	Panel/Floor No. 2 (Yellow)	Panel/Defrost No. 5 (Red)	Source No. 3 (Black)
Panel (Vent)	Atmosphere	Atmosphere	Atmosphere	Vacuum	Vacuum
Off	Vacuum	Vacuum	Vacuum	Atmosphere	Vacuum
Panel/Floor	Atmosphere	Vacuum	Atmosphere	Vacuum	Vacuum
Floor	Atmosphere	Vacuum	Vacuum	Atmosphere	Vacuum
Floor/Defrost	Atmosphere	Vacuum	Atmosphere	Atmosphere	Vacuum
Defrost	Atmosphere	Atmosphere	Atmosphere	Atmosphere	Vacuum

Fig. 2: Heater System Vacuum Diagram (F150 Early Production)
Courtesy of FORD MOTOR CO.



VACUUM LOGIC TABLE

	Fresh/Recirc No. 1 (White)	Panel/Floor No. 6 (Blue)	Panel/Floor No. 2 (Yellow)	Panel/Defrost No. 5 (Red)	Source No. 3 (Black)
Panel (Vent)	Atmosphere	Atmosphere	Atmosphere	Vacuum	Vacuum
Off	Vacuum	Vacuum	Vacuum	Atmosphere	Vacuum
Panel/Floor	Atmosphere	Vacuum	Atmosphere	Vacuum	Vacuum
Floor	Atmosphere	Vacuum	Vacuum	Atmosphere	Vacuum
Floor/Defrost	Atmosphere	Vacuum	Atmosphere	Atmosphere	Vacuum
Defrost	Atmosphere	Atmosphere	Atmosphere	Atmosphere	Vacuum

Fig. 3: Heater System Vacuum Diagram (F150 Late Production & F250LD)
Courtesy of FORD MOTOR CO.

WIRING DIAGRAMS

1997 Ford Pickup F150

HEATER SYSTEM 1997 A/C-HEATER SYSTEMS Ford Motor Co. - Heater Systems

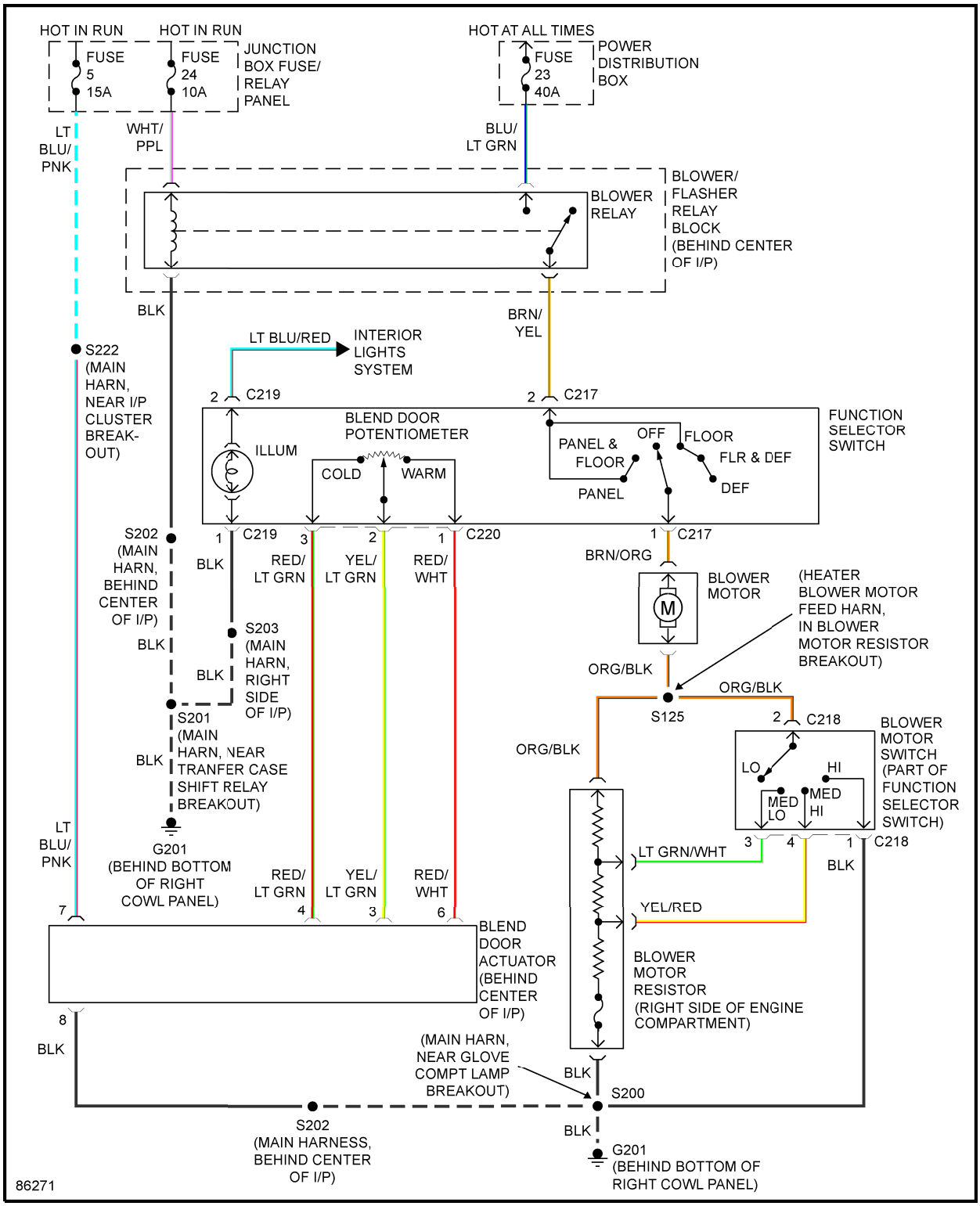


Fig. 4: Heater System Wiring Diagram (F150 Early Production)

1997 Ford Pickup F150

HEATER SYSTEM 1997 A/C-HEATER SYSTEMS Ford Motor Co. - Heater Systems

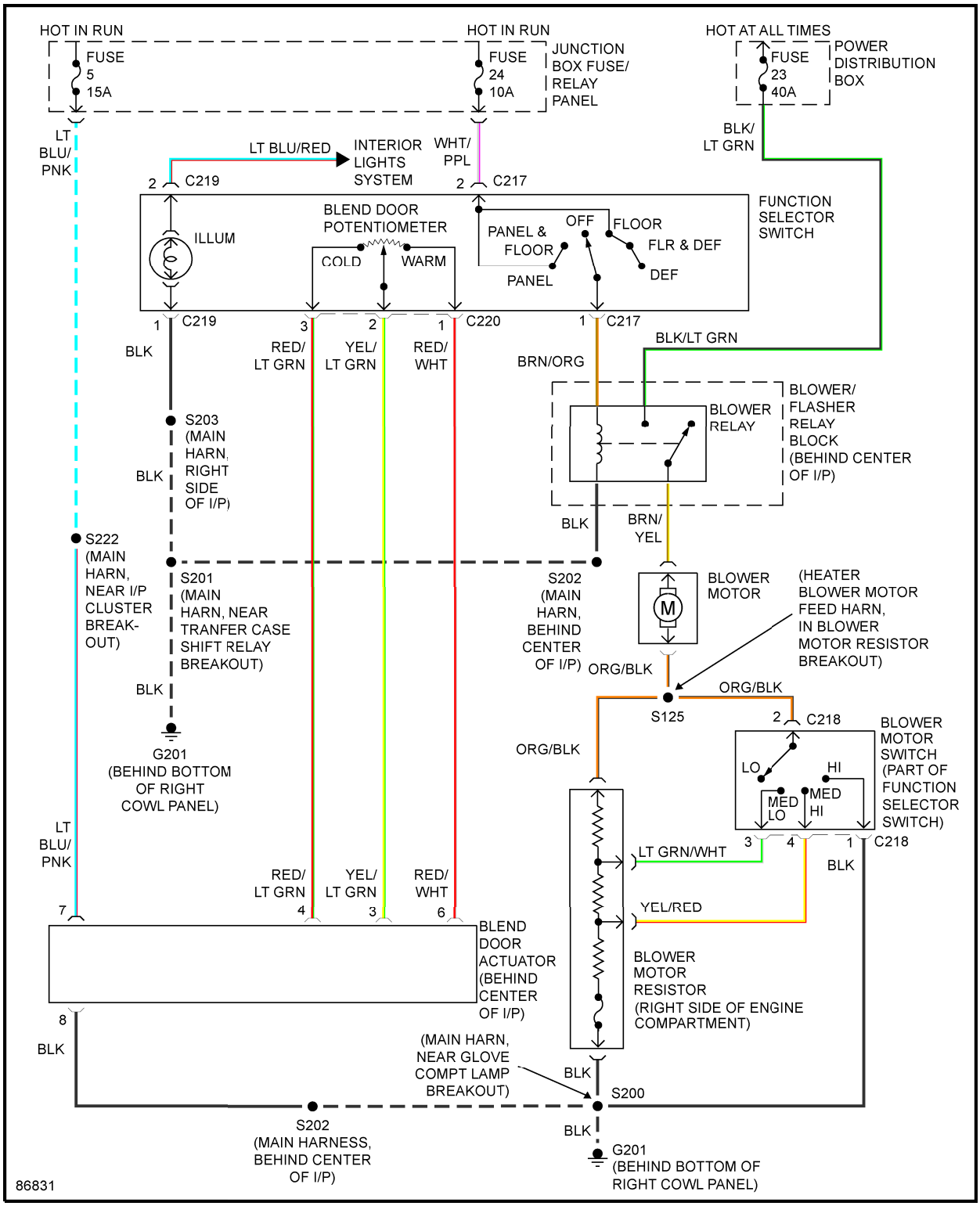


Fig. 5: Heater System Wiring Diagram (F150 Late Production & F-250LD)

1997 AIR CONDITIONING & HEAT

Manual A/C

A/C SYSTEM SPECIFICATIONS

WARNING: To avoid injury from accidental air bag deployment, read and follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

NOTE: Specifications for Late Production models not available at time of publication.

A/C SYSTEM SPECIFICATIONS

Application	Specification
Compressor Type	Ford FS-10 10-Cyl.
Compressor Belt Tension	(1)
System Oil Capacity (2)	7 ozs.
Refrigerant (R-134a) Capacity	38 ozs.
System Operating Pressures (3)	
High Side	128-230 psi (9-16 kg/cm^2)
Low Side	22-45 psi (1.5-3 kg/cm^2)

(1) Belt tension automatically adjusted by belt tensioner. Tension should be within tensioner indicator marks.

(2) Use YN-12b PAG Oil (Part No. F2AZ-19577-A).

(3) Approximate operating pressures with ambient temp. of 80°F (27°C).

EARLY/LATE PRODUCTION IDENTIFICATION

1997 F150 Early Production models end at manufacture date 6/23/96. 1997 F150/250LD Late Production models begin at manufacture date 6/24/96. Manufacture date is located on the Certification Label attached to driver's side door or door lock pillar. Since the Certification Label only indicates month and year of vehicle manufacture, it is necessary to use the Vacuum or Wiring diagrams to distinguish between Early/Late Production vehicles built in 6/96.

NOTE: Information other than Vacuum and Wiring diagrams for Late Production models not available.

DESCRIPTION

A/C-heater system is a blend air type, consisting of a control panel, compressor and clutch, blower motor, evaporator core, condenser core, accumulator-drier and plenum assembly. System is controlled by a clutch cycling pressure switch and a A/C high pressure cut-off switch.

Blower motor is located in plenum assembly, under instrument panel. Plenum assembly contains evaporator core, heater core, floor/defrost door, panel/defrost door and electric motor actuated temperature blend door. See **Fig. 16** or **Fig. 17** .

OPERATION

CONTROL PANEL

Blower Motor Switch

Three of the 4 operating speeds (low, medium-low and medium-high) are controlled by a blower motor resistor connected in series with the 3 operating positions and ground. High speed is obtained by by-passing blower motor resistor. See **Fig. 16** or **Fig. 17** .

Mode Selector Knob

Mode selector knob can be placed in MAX A/C, A/C, PANEL, OFF, PANEL & FLOOR, FLOOR, FLR & DEF (floor and defrost) and DEF (defrost) positions. MAX A/C and A/C positions control A/C compressor operation. PANEL, PANEL & FLOOR, FLOOR, FLR & DEF (floor and defrost) and DEF (defrost) positions direct air-flow to chosen outlets. Defrost positions activates A/C compressor to dehumidify air directed at windshield. Mode selector knob position determines which mode doors are open, partially open or closed. Mode doors direct airflow to selected outlets. See **Fig. 16** or **Fig. 17** .

Temperature Control Knob

Temperature control knob controls a blend door potentiometer which controls an electronic temperature blend door motor. Temperature blend door motor provides a variable number of temperature blend door positions. When temperature control knob is in COOL position, temperature blend door shuts off airflow to heater core. When knob is in WARM position, air is directed through heater core. When knob is in intermediate positions, heated air is blended with cooler incoming air to achieve desired temperature.

BLOWER MOTOR RESISTOR & THERMAL LIMITER

The blower motor resistor assembly contains a thermal limiter, which serves as a temperature protection fuse. Thermal limiter is located a preset distance from resistor coils. If temperature of thermal limiter reaches about 250°F (121°C), limiter contacts will open. This interrupts all blower speed operations except high speed. If thermal limiter opens, resistor assembly must be replaced.

CLUTCH CYCLING PRESSURE SWITCH

Clutch cycling pressure switch is mounted on top of accumulator-drier. A Schrader valve depressor, located in end of switch, presses in on Schrader valve stem as switch is installed. This allows pressure inside accumulator-drier to control switch operation. When replacing clutch cycling switch it is not necessary to discharge A/C

system.

Electrical contacts inside clutch cycling pressure switch are normally open when pressure is 22-24 psi (1.5-1.7 kg/cm^2). Contacts close and energize compressor clutch when low side pressure reaches 40-47 psi (2.8-3.3 kg/cm^2). When working properly, clutch cycling switch keeps evaporator core temperature greater than freezing.

A/C HIGH PRESSURE CUT-OFF SWITCH

A/C high pressure cut-off switch is used to interrupt compressor clutch operation in case of high system discharge pressures. When system discharge pressure increases to approximately 450 psi (31.6 kg/cm^2), compressor clutch will be disengaged. When discharge pressure decreases to 260 psi (18.3 kg/cm^2), compressor clutch will be energized. When replacing A/C high pressure cut-off switch it is necessary to discharge A/C system.

TROUBLE SHOOTING

WARNING: To avoid injury from accidental air bag deployment, read and follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

A/C DOES NOT OPERATE OR DOES NOT OPERATE PROPERLY

NOTE: Ambient temperature should be greater than 50°F (10°C) for compressor operation.

1. **Check A/C Compressor Clutch Operation**

   Start engine and allow to idle. Turn mode selector switch to MAX A/C position. Turn temperature control knob to middle position and blower to medium-high position. Ensure battery voltage is 12 volts or more. If compressor clutch does not engage, go to next step. If compressor clutch engages, compressor clutch circuit is operating properly.

2. **Check Clutch Cycling Switch**

   Turn ignition switch to OFF position. Disconnect clutch cycling switch connector. Connect a jumper wire between clutch cycling switch connector Red/Yellow wire terminal and Black/Yellow wire terminal. Start engine and allow to idle. Turn mode selector switch to A/C position and blower motor control knob to HI position. If compressor clutch engages, connect clutch cycling switch connector and go to next step. If compressor clutch does not engage, go to step 4).

3. **Check Refrigerant System Pressure**

   Turn ignition switch to OFF position. Connect manifold set to service ports. If refrigerant system pressure

is 50-400 psi (3.5-28.1 kg/cm^2), replace clutch cycling switch. Ensure system is operating properly. If refrigerant system pressure is not as specified, check refrigerant system for leaks or low charge. Repair and necessary. Ensure system is operating properly.

4. **Check Voltage At A/C High Pressure Cut-Off Switch**

   Turn ignition switch to OFF position. Disconnect A/C high pressure cut-off switch connector. Turn ignition switch to RUN position. Turn mode selector knob to MAX A/C position. Using a voltmeter, measure voltage between ground and high pressure switch connector Purple wire terminal. If voltage is 10 volts or more, turn ignition switch off and go to next step. If voltage is less than 10 volts, go to step 13).

5. **Check Voltage At Clutch Cycling Switch**

   Connect A/C high pressure cut-off switch connector. Turn ignition switch to RUN switch. Turn mode selector switch to MAX A/C position. Using a voltmeter, measure voltage between ground and clutch cycling switch connector Red/Yellow wire terminal. If voltage is less than 10 volts, go to next step. If voltage is 10 volts or more, go to step 7).

6. **Check A/C Pressure Cut-Off Switch Continuity**

   Turn ignition switch to OFF position. Disconnect pressure cut-off switch. Using an ohmmeter, check continuity between pressure cut-off switch Purple wire terminal and Red/Yellow wire terminal. If continuity exists, repair open in Red/Yellow wire. If continuity does not exist, replace A/C pressure cut-off switch. Ensure system is operating properly.

7. **Check A/C Clutch Cycling Switch Continuity**

   Connect manifold set to service ports. Ensure refrigerant system pressure is 50-400 psi (3.5-28.1 kg/cm^2). Using an ohmmeter, check continuity between clutch cycling switch Red/Yellow wire terminal and Black/Yellow wire terminal. If continuity exists, go to next step. If continuity does not exist, replace A/C clutch cycling switch. Ensure system is operating properly.

8. **Check PCM Input Voltage From Clutch Cycling Switch**

   Turn ignition switch to OFF position. Connect 104-pin break-out box to PCM Gray connector. Turn ignition switch to RUN position. Turn mode selector knob to MAX A/C position. Using a voltmeter, measure voltage between ground and break-out box terminal No. 41 (Black/Yellow wire). If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair Black/Yellow wire. Ensure system is operating properly.

9. **Check Voltage To Compressor Clutch**

   Turn ignition switch to OFF position. Disconnect compressor clutch connector. Turn ignition switch to RUN position. Turn mode selector knob to MAX A/C position. Using a voltmeter, measure voltage between ground and compressor clutch connector Black/Yellow wire. If voltage is 10 volts or more, go to next step. If voltage is less than 10 volts, repair Black/Yellow wire. Ensure system is operating properly.

10. **Check Compressor Clutch Ground**

    Turn ignition switch to OFF position. Using an ohmmeter, measure resistance between ground and compressor clutch connector Black wire terminal. If resistance is one ohm or less, go to next step. If resistance is more than one ohm, repair Black wire. Ensure system is operating properly.

11. **Check Compressor Clutch Coil Resistance**

    Using an ohmmeter, measure resistance across compressor clutch coil terminals. If resistance is less than 6 ohms, go to next step. If resistance is 6 ohms or more, replace compressor clutch. Ensure system is operating properly.

12. **Check Compressor Clutch Field Coil Current Draw**

    Turn ignition switch to OFF position. Connect ammeter between compressor clutch field coil Black wire terminal and compressor clutch field coil connector Black wire terminal. Connect a jumper wire between compressor clutch field coil Black/Yellow wire terminal and compressor clutch field coil connector Black/Yellow wire terminal to complete circuit. Turn ignition switch to RUN position and measure current draw. If current draw is 2.5-4.5 amps, repair compressor clutch air gap. If current draw is not 2.5-4.5 amps, replace compressor clutch. Ensure system is operating properly.

13. **Check Voltage At Mode Selector Switch**

    Turn ignition switch to OFF position. Disconnect mode selector switch connector. Turn ignition switch to RUN position. Using a voltmeter, measure voltage between ground and mode selector switch connector terminal No. 1 (Light Blue/Pink wire). If voltage is less than 10 volts, go to next step. If voltage is 10 volts or more, go to step 16).

14. **Check Voltage At Mode Selector Switch**

    Using a voltmeter, measure voltage between ground and output side of fuse No. 5 (Light Blue/Pink wire), located in junction box fuse/relay panel. If voltage is less than 10 volts, go to next step. If voltage is 10 volts or more, repair Light Blue/Pink wire. Ensure system is operating properly.

15. **Check Light Blue/Pink Wire**

    Turn ignition switch to OFF position. Disconnect mode selector switch connector. Using an ohmmeter, check for continuity between ground and mode selector switch connector terminal No. 1 (Light Blue/Pink wire). If continuity does not exist, connect mode selector switch connector and go to next step. If continuity exists, repair Light Blue/Pink wire. Replace fuse No. 5 (15-amp). Ensure system is operating properly.

16. **Check Mode Selector Switch MAX A/C Position**

    Disconnect A/C high pressure cut-off switch connector. Turn ignition switch to RUN position. Turn mode selector switch to MAX A/C position. Using a voltmeter, measure voltage between ground and mode selector switch connector terminal No. 3 (Purple wire). If voltage is 10 volts or more, go to next

step. If voltage is less than 10 volts, replace mode selector switch. Ensure system is operating properly.

17. **Check Mode Selector Switch A/C Position**

    Turn mode selector switch to A/C position. Using a voltmeter, measure voltage between ground and mode selector switch connector terminal No. 3 (Purple wire). If voltage is 10 volts or more, go to step 5). If voltage is less than 10 volts, replace mode selector switch. Ensure system is operating properly.

TESTING

WARNING: To avoid injury from accidental air bag deployment, read and follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

NOTE: For testing procedures not covered in this article, see the HEATER SYSTEM article.

BLOWER MOTOR VOLTAGE & CURRENT DRAW TEST

1. Turn temperature control knob to full WARM position. Place function selector knob in MAX A/C position. Using a voltmeter, backprobe blower motor connector.
2. Ensure probes contact wire terminals. Measure voltage and current draw across blower motor. With engine running (battery system voltage should be about 14.2 volts), voltage and current readings should be within specified range. See **BLOWER MOTOR CURRENT DRAW SPECIFICATIONS** table.

BLOWER MOTOR CURRENT DRAW SPECIFICATIONS

Switch Position	Amps	Volts
LO	9-11.5	5.0
Medium-Low	11.5-14.0	8.0
Medium-High	14.0-16.5	10.0
HI	16.0-18.5	12.0

ON-VEHICLE SERVICE

A/C SYSTEM FLUSHING

WARNING: Use extreme care and observe all safety and service precautions related to the use of refrigerants.

WARNING: Due to refrigerant hazards, always wear safety goggles and non-penetrable gloves when working on or flushing a/c systems.

CAUTION: A/C Refrigerant Analyzer must be used before the recovery of any vehicle's A/C refrigerant. Failure to do so puts the shop's bulk refrigerant at risk of contamination. If the vehicle's A/C refrigerant is contaminated, refer the customer to the service facility that performed the last A/C service. If the customer wishes to pay the additional cost, use the A/C recovery equipment that is designated for recovering contaminated A/C refrigerant. All contaminated A/C refrigerant must be disposed of as hazardous waste. For all equipment, follow the equipment manufacturer's procedures and instructions.

CAUTION: Suction accumulator/drier, muffler, hoses, thermal expansion valve, and fixed orifice tube should be removed when flushing the A/C system. Internal plumbing of these devices makes it impossible to properly remove any residual-flushing agent. Except for the hoses, these components are typically discarded after A/C system contamination. Hoses can normally be reused unless they are clogged with debris. The 3.78 liters (1 gal) of Ford A/C Flushing Solvent F4AZ-19579-A and FL1-A filter used in A/C Flusher, 219-00002 are intended for use on one vehicle only. They may be used to flush both the A/C condenser core and the A/C evaporator core on an individual vehicle, but under no circumstances should they be used on more than one vehicle.

CAUTION: Only the A/C Flusher Kit, 219-00002 which includes A/C Flusher, A/C Flusher Fitting Kit and the Ford Part number F4AZ-19579-A A/C system Flushing Solvent, is approved for use on Ford vehicles. No other flushing device or solvent is approved for flushing heat exchangers. Use of any other Flusher or solvent may cause damage to the A/C system and the flushing unit. Ford Motor Company has approved a procedure to provide technicians with a non-CFC method of flushing contaminated A/C system heat exchangers, A/C evaporator core, A/C condenser core. The procedure allows the specific components to be cleaned and flushed while installed in their normal in-vehicle location. The types of contamination flushed include particle matter that results from A/C compressor and/or desiccant failure within the suction accumulator/drier and gummy residue that may form when refrigerant oil is overheated during A/C compressor seizure. The flushing process is a two step procedure that involves the use of an A/C Flusher, 219-00002 to: Circulate the flushing solvent through the heat exchanger in the reverse direction of normal refrigerant flow (back-flushing). Particulate matter picked up during flushing is filtered from the returning solvent before the solvent is returned to the reservoir for continued circulation. Remove the flushing solvent from the heat exchanger. In this step of the procedure, pressurized air 621-862 kPa (90-125 psi) is used to push and/or evaporate any remaining flush solvent from the heat exchanger.

NOTE: Prior to using the A/C Flusher, 219-00002 for the first time, review the operating

instructions.

1. Discharge the A/C system. Observe all safety precautions.
2. Disconnect the refrigerant lines from the heat exchanger(s) to be flushed.
3. Connect the A/C Flusher, 219-00002 and A/C System Flusher Fitting Kit to the heat exchanger to be flushed. Do not flush through the A/C evaporator core orifice, mufflers or hoses. Internal plumbing and material make-up of these components make it impossible to properly remove debris and/or residual flushing solvent.
4. Use four liters (one gallon) of Ford A/C Flushing part number F4AZ-195790A to flush the heat exchanger for a minimum of 15 minutes. The flush solvent may be used for one or both heat exchangers in the A/C system. However, the flush solvent is intended for one vehicle only. The filter is used on the flushing unit is also intended for use on one vehicle only.
5. Flush the component for a minimum of 15 minutes.
6. Apply 621-862 kPa (90-125psi) pressurized air to the component for a minimum of 30 minutes. The 30-minute purger time is required to force and/or evaporate all residual solvent from the A/C system component. Failure to successfully remove all residual solvent within the component can result in system damage when reconnected and operated. Dispose of the used flush solvent and filter in accordance with local, state and federal emissions.
7. A/C system filtering as described in this section is optional if system flushing is performed. However, the filter kit use is recommended after flushing if the A/C system contamination is extensive.
8. Replace the A/C evaporator core orifice in any vehicle being serviced for A/C compressor or desiccant failure.
9. Replace the refrigerant hoses if clogged with debris.
10. Reconnect the heat exchanger being serviced.
11. Add additional refrigerant oil as required.
12. Evacuate, leak test and charge the A/C system.
13. Check the system for proper operation.

FILTERING AIR CONDITIONING SYSTEM

CAUTION: Follow all refrigerant system safety precautions.

1. An A/C kit has been released to provide the necessary equipment and information to perform the new, mandatory A/C system filtering procedure.
2. To determine that the A/C compressor has failed and must be replaced, remove the A/C evaporator core orifice and condenser to evaporator tube, if necessary. Look for a dirty A/C evaporator core orifice or a condenser to evaporator tube containing black refrigerant oil and particles.
3. Cap all open refrigerant lines and components to prevent entry of dirt and moisture.
4. Remove the damaged A/C compressor. Drain the oil into a calibrated container.
5. The proper amount of refrigerant oil must be added to the new A/C compressor before it can be installed. A new replacement A/C compressor contains no refrigerant oil. If the amount of oil drained from the

removed A/C compressor is between 85 and 142 ml (3 oz to 5 oz), pour the same amount plus 1 (one) ounce of clean oil into the new A/C compressor. If the amount of oil drained from the old A/C compressor is greater than 142 ml (5 oz), pour only 142 ml (5 oz) of clean refrigerant oil into the new A/C compressor. If the amount of refrigerant oil drained from the old A/C compressor is less than 85 ml (3 oz), pour 85 ml (3 oz) of clean refrigerant oil into the new compressor.

6. It will be necessary to transfer the A/C clutch from the old A/C compressor to the new A/C compressor. Install the new A/C compressor. Be sure the compressor mounting bolts are tightened to the proper specification. Check the tension of the drive belt. Adjust, if necessary.
7. Remove the suction accumulator/drier and drain the oil into a calibrated container.
8. Add clean refrigerant oil to the new suction accumulator/drier in the same amount that was removed from the old unit, plus an additional 60 ml (2 oz) of new refrigerant oil.
9. Install the suction accumulator/drier in the vehicle.
10. Get the proper service kit for the vehicle on which you are working. Filter kit with the SPN suffix A is used on vehicles with a nylon lined evaporator to compressor suction line (19867).
11. Remove a length of evaporator to compressor suction line to accommodate the suction filter and install the filter using the clamps provided with the kit. Be sure the filter is correctly oriented for refrigerant system flow. Check the label on the filter. On the filter for the nylon lined evaporator to compressor suction line, install O-rings (two on each filter tube being sure they are properly seated in the grooves on the tube). Tighten the clamps securely.
12. Install a new A/C evaporator core orifice. If the A/C evaporator core orifice is located in the condenser to evaporator tube between the A/C condenser core and the A/C evaporator core, replace the condenser to evaporator tube.
13. Install a pancake filter in the condenser to evaporator tube between the A/C condenser core and the A/C evaporator core orifice. Be sure the filter inlet is toward the A/C condenser core. Connections can be made using A/C Test Fitting Set and flexible refrigerant hose of 2500 psi burst rating. Individual fittings are also available.
14. Evacuate, charge and leak test the system.
15. Check all refrigerant system hoses, lines and the positioning of the newly installed filters to be sure they do not interfere with other engine compartment components. If necessary, use tie straps to make adjustments.
16. Provide adequate air flow to the front of the vehicle (with a fan, if necessary), and set the selector valve at MAX A/C. Set the blower motor on HIGH and temperature control at full cool. Start the engine and let it idle briefly. Make sure the A/C system is operating properly.
17. Gradually bring the engine up to 1200 RPM by running it at lower RPMs for short periods (first at 800 RPM, then at 1000 RPM). Set the engine at 1200 RPM and run it for an hour with the A/C system operating.
18. Stop the engine.
19. Allow the engine to cool sufficiently to remove the fittings, flexible hoses and pancake filter from the condenser to evaporator tube (It will be necessary to discharge the system first).
20. Discard the pancake filter. It can be used one time only.
21. Reconnect the condenser to evaporator tube back into the system.
22. Evacuate, charge and leak test the system. Make any necessary adjustments.
23. Check the operation of the system in all modes.

REMOVAL & INSTALLATION

WARNING: To avoid injury from accidental air bag deployment, read and follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

NOTE: For removal and installation procedures not covered in this article, see the HEATER SYSTEM article.

ACCUMULATOR-DRIER

Removal

1. Disconnect negative battery cable. Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect electrical connector from cycling pressure switch. Remove cycling pressure switch from accumulator-drier. Disconnect suction hose from accumulator-drier, and plug opening.
2. Using 2 wrenches, loosen fitting that connects accumulator-drier to evaporator core. Remove mounting straps-to-mounting bracket screws. Remove accumulator-drier from evaporator core. Remove straps from accumulator-drier.

Installation

To install, reverse removal procedure. Use new "O" ring lubricated with clean refrigerant oil. Evacuate, recharge and leak test system. Check system for proper operation.

BLOWER MOTOR & FAN

Removal & Installation

If equipped, remove air filter and mounting bracket. Disconnect christmas-tree retainer from blower motor mounting plate. Disconnect blower motor electrical connector. Remove blower motor cover. Remove blower motor, using car not to damage wheel. To install, reverse removal procedure.

A/C COMPRESSOR

CAUTION: If installing a new air conditioning compressor due to an internal failure of the old unit, you must carry out the following procedures to remove contamination from the air conditioning system: If A/C flushing equipment is available, carry out flushing of the air conditioning system prior to installing a new air conditioning compressor. See A/C SYSTEM FLUSHING . If A/C flushing equipment is not available, carry out filtering of the air conditioning system after a new air conditioning compressor has been installed. Install new Evaporator Core Orifice (19D990) as directed by the A/C flushing or filtering procedure. Install a new Suction Accumulator

(19C836) as directed by the A/C flushing or filtering procedure.

NOTE: Installation of new suction accumulator is not required when preparing the air conditioning system except when there is physical evidence of system contamination from a failed A/C compressor or damage to the suction accumulator.

Removal & Installation (4.2L)

1. Disconnect the battery.
2. If flushing of the refrigerant system has not been performed, recover the refrigerant.
3. Remove the drive belt from the A/C compressor pulley.
4. Disconnect the A/C compressor electrical connector.
5. Remove the manifold and tube assembly. See **Fig. 1** .
6. To install, reverse the removal procedure. Install new O-ring seals lubricated in clean PAG oil. To maintain the original total oil charge, it is necessary to compensate for the oil lost by adding oil to the system with the new part. Service A/C compressors are shipped without compressor oil. Rotate the A/C compressor shaft six to eight revolutions while collecting oil in a clean measuring device. See **Fig. 5** .
7. If the amount of oil drained from the old A/C compressor is between 85-142 ml (3-5 ounces), pour the same amount plus 30 ml (1 ounce) of clean PAG compressor oil YN-12-C F7AZ-19589-DA or equivalent meeting Ford specification WSH-M1C231-B into the new A/C compressor.
8. If the amount of oil that was removed from the old A/C compressor is greater than 142 ml (5 ounces), pour the same amount drained of clean PAG compressor oil YN-12-C F7AZ-19589-DA or equivalent meeting Ford specification WSH-M1C231-B into the new A/C compressor.
9. If the amount of oil that was removed from the old A/C compressor is less than 85 ml (3 ounces), pour 85 ml (3 ounces) of clean PAG compressor oil YN-12-C F7AZ-19589-DA or equivalent meeting Ford specification WSH-M1C231-B into the new A/C compressor.
10. If filtering of the refrigerant system is not to be carried out, evacuate, leak-test, and charge the refrigerant system.

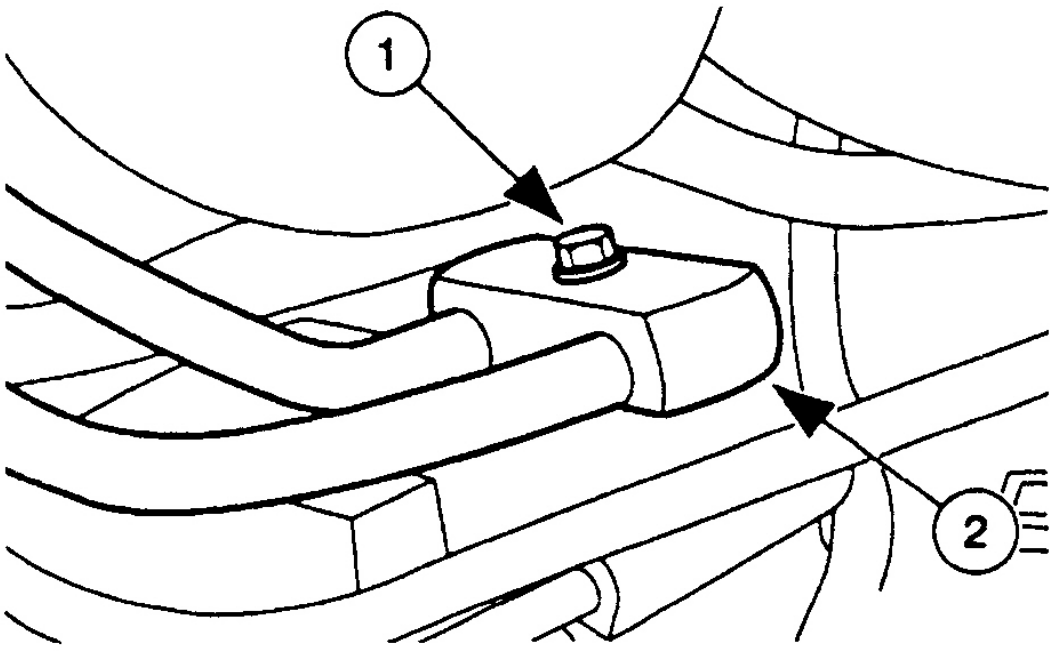
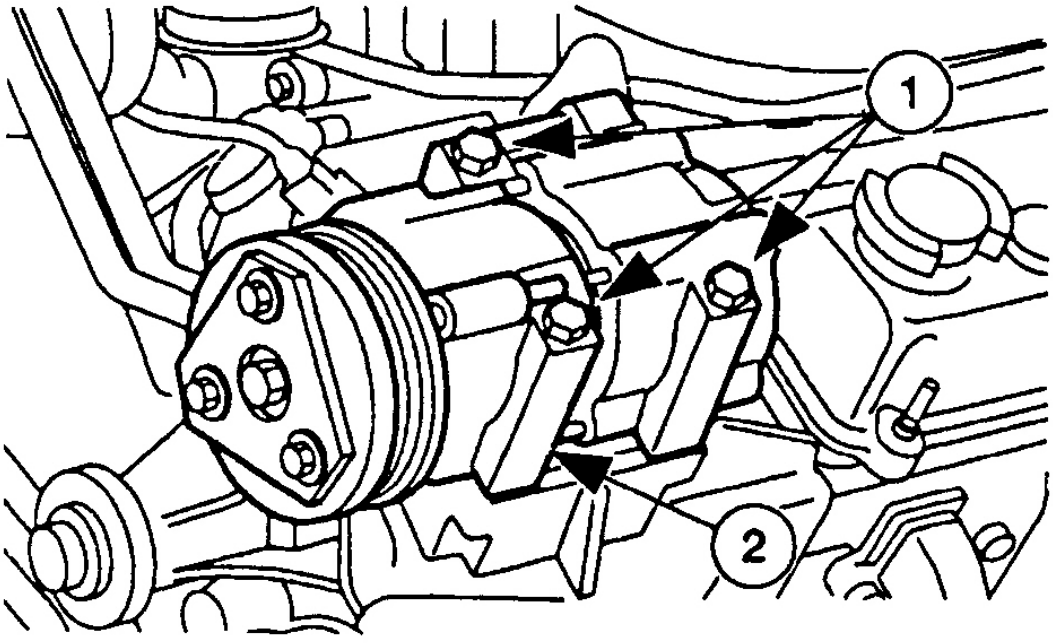


Fig. 1: Removing Manifold & Tube Assembly
Courtesy of FORD MOTOR CO.



G00134517

Fig. 2: Removing A/C Compressor
Courtesy of FORD MOTOR CO.

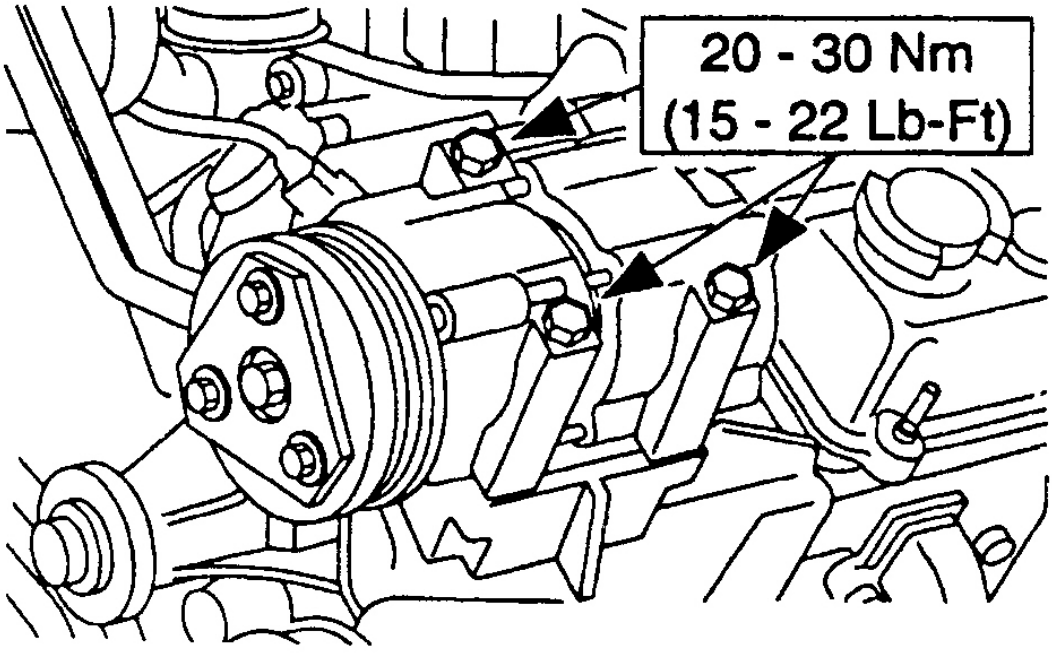


Fig. 3: Installing A/C Compressor
Courtesy of FORD MOTOR CO.

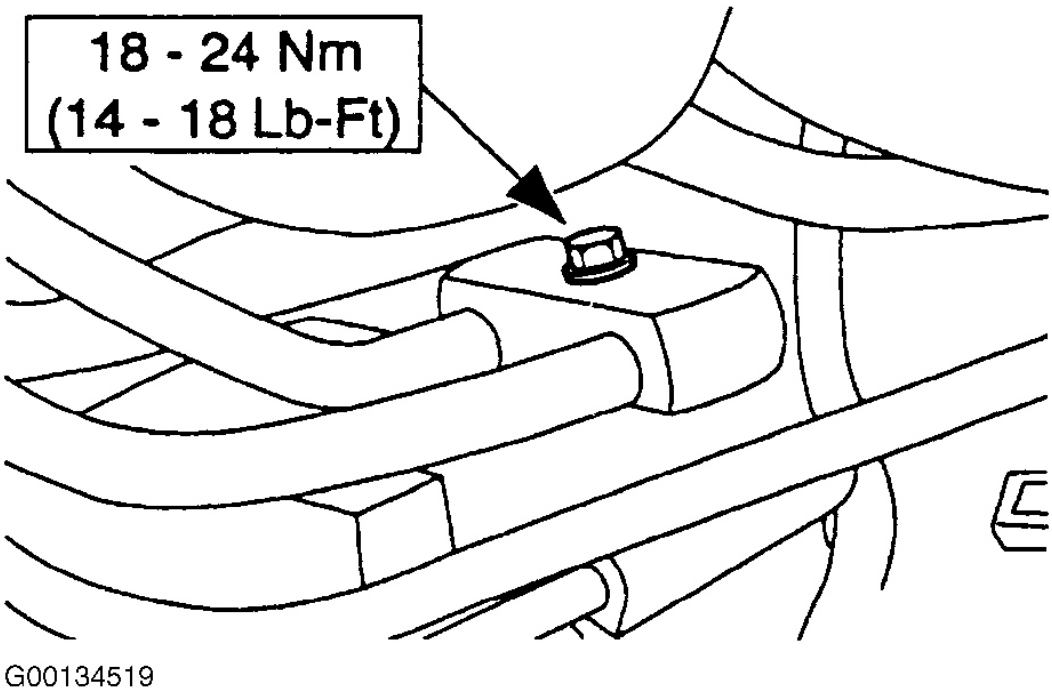


Fig. 4: Installing A/C Manifold & Tube On Compressor
Courtesy of FORD MOTOR CO.

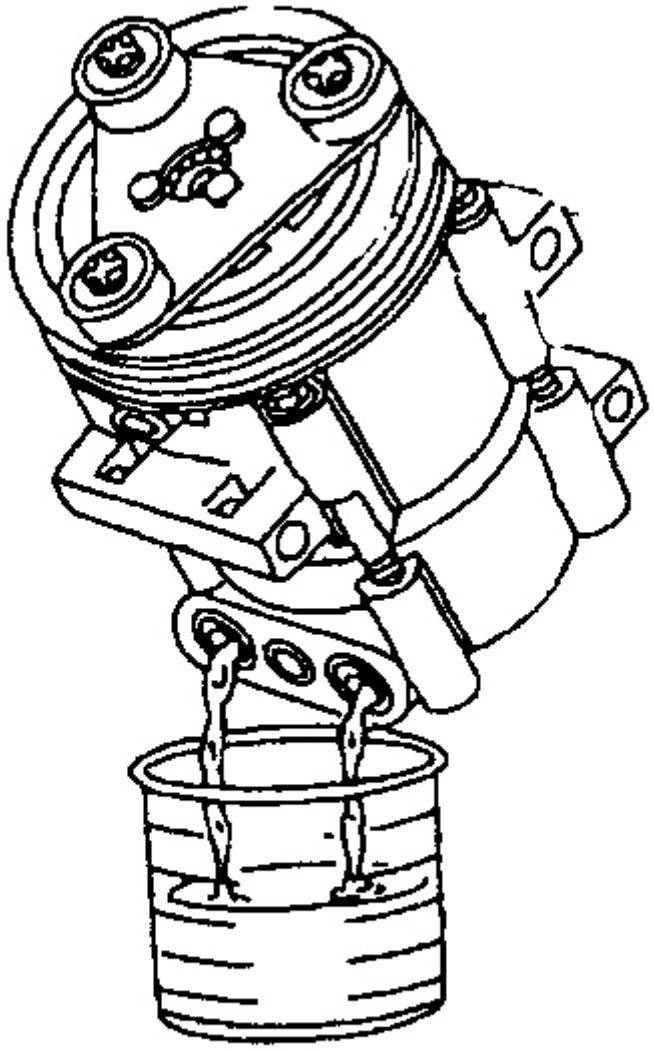


Fig. 5: Removing & Measuring Oil From Old Compressor
Courtesy of FORD MOTOR CO.

Removal & Installation (4.6L & 5.4L)

NOTE: Installation of new suction accumulator is not required when preparing the air conditioning system except when there is physical evidence of system

contamination from a failed A/C compressor or damage to the suction accumulator.

1. If flushing of the refrigerant system has not been performed, recover the refrigerant.
2. Remove the drive belt from the A/C compressor pulley.
3. Raise and support the vehicle.
4. Disconnect the A/C compressor electrical connector.
5. Disconnect the crankshaft position sensor connector.
6. Loosen the A/C compressor mounting bolts and move to gain access to the A/C manifold bolt.
7. Remove the manifold and tube assembly. See **Fig. 1** .
8. Remove the A/C compressor. See **Fig. 2** .
9. When installing the A/C compressor, leave the bolts loose until the A/C manifold bolt is tightened. See **Fig. 3** and **Fig. 4** . To install, reverse the removal procedure. If filtering of the refrigerant system is not to be performed, service the replacement A/C compressor (19703) with the proper amount of PAG Refrigerant Compressor Oil (R-134a Systems) F7AZ-19589-DA (Motorcraft YN-12-C) or equivalent meeting Ford specification WSH-M1C231-B.
10. Lubricate the new A/C manifold O-rings with PAG Refrigerant Compressor Oil (R-134a Systems) F7AZ-19589-DA (Motorcraft YN-12-C) or equivalent meeting Ford specification WSH-M1C231-B.
11. If filtering of the refrigerant system is not to be performed, evacuate, charge and leak test the refrigerant system.

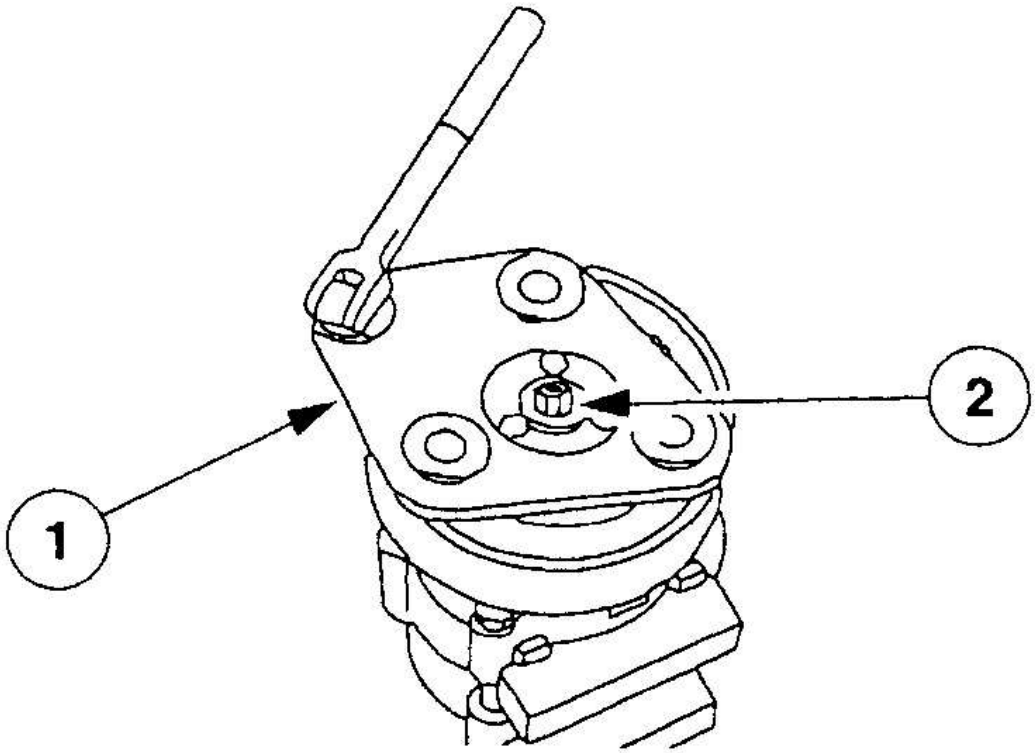
A/C COMPRESSOR CLUTCH & CLUTCH FIELD COIL

Removal & Installation

1. Discharge A/C system, using approved refrigerant recovery/recycling equipment. Remove the A/C compressor. See **A/C COMPRESSOR REMOVAL** .
2. Hold the A/C clutch hub with the Compressor Clutch Holding Tool. See **Fig. 20** and **Fig. 6** .
3. Remove the A/C Clutch (2884) and the A/C clutch hub spacer (19D648), using the following procedure:
   - Thread an 8 x 1.25 mm bolt into the A/C clutch to force it from the compressor shaft.
   - Lift the A/C clutch and the A/C clutch hub spacer from the compressor shaft. See **Fig. 7** .
4. Remove the pulley snap ring. See **Fig. 8** .
5. Remove the A/C clutch pulley (2E884). See **Fig. 9** .
6. Do not use air tools when removing clutch field coil (2987), it can be easily damaged. Remove the A/C clutch field coil, using the following procedure:
   - Note the location of the A/C clutch field coil electrical connector.
   - Install the Field Coil Remover on the nose opening of the A/C compressor.
   - Install the Puller-Differential Side Bearing.
   - Remove the A/C clutch field coil. See **Fig. 10** .

Installation

1. Clean the A/C clutch field coil and pulley bearing mounting surfaces.
2. Install A/C clutch field coil. Do not use air tools, the A/C clutch field coil can be easily damaged. Place the A/C clutch field coil on the A/C compressor with the A/C clutch field coil electrical connector properly positioned use the following procedure:
   - Place the Field Coil Replacer on the A/C clutch field coil.
   - Place the Coil Replacer on the Field Coil Replacer.
   - Use the 2-Jaw Puller to install the A/C clutch field coil until bottomed completely against the A/C compressor. See **Fig. 11** .
3. The A/C clutch pulley is a tight fit on the A/C compressor head; it must be correctly aligned during installation. Install the A/C clutch pulley.
4. Install the pulley snap ring with the bevel side out. See **Fig. 12** .
5. Place one nominal thickness A/C clutch hub spacer inside the clutch hub spline opening. See **Fig. 13** .
6. Install the A/C clutch. Install the hub retaining bolt. Hold the A/C clutch hub with the Compressor Clutch Holding Tool. See **Fig. 14** . Tighten the bolt.
7. Measure and adjust the clutch air gap by removing or adding A/C clutch hub spacers. See **Fig. 15** .



G00134504

Fig. 6: Installing A/C Compressor Clutch Holding Tool
Courtesy of FORD MOTOR CO.

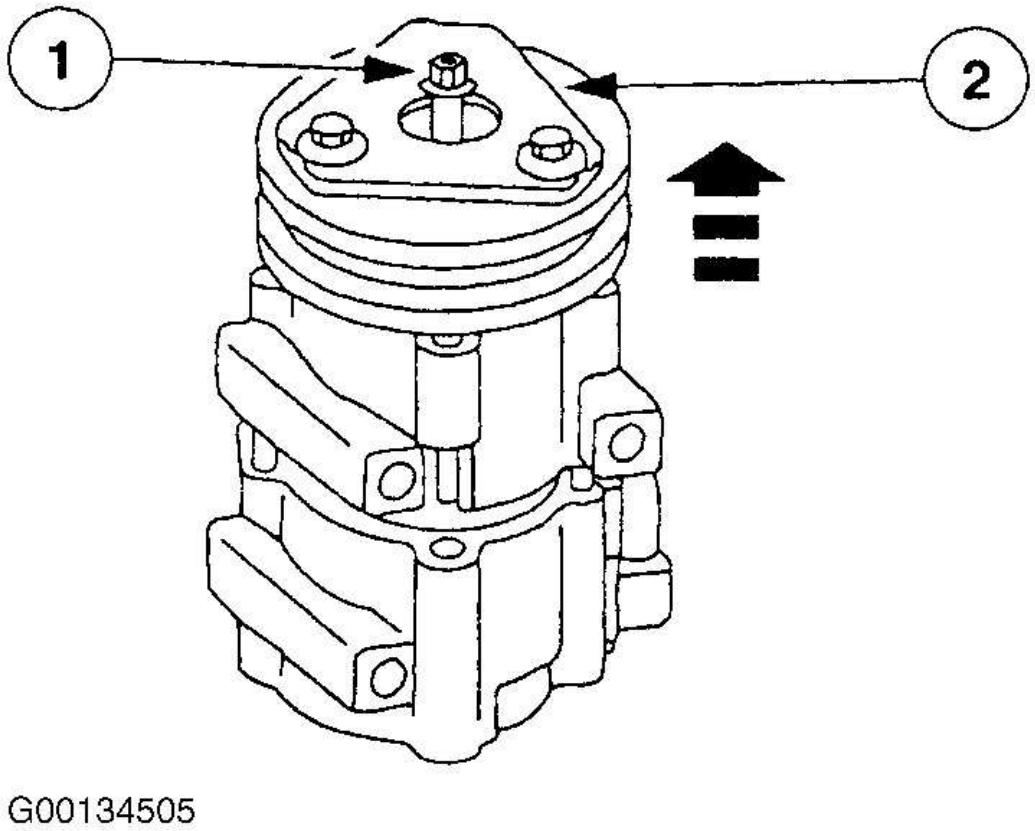
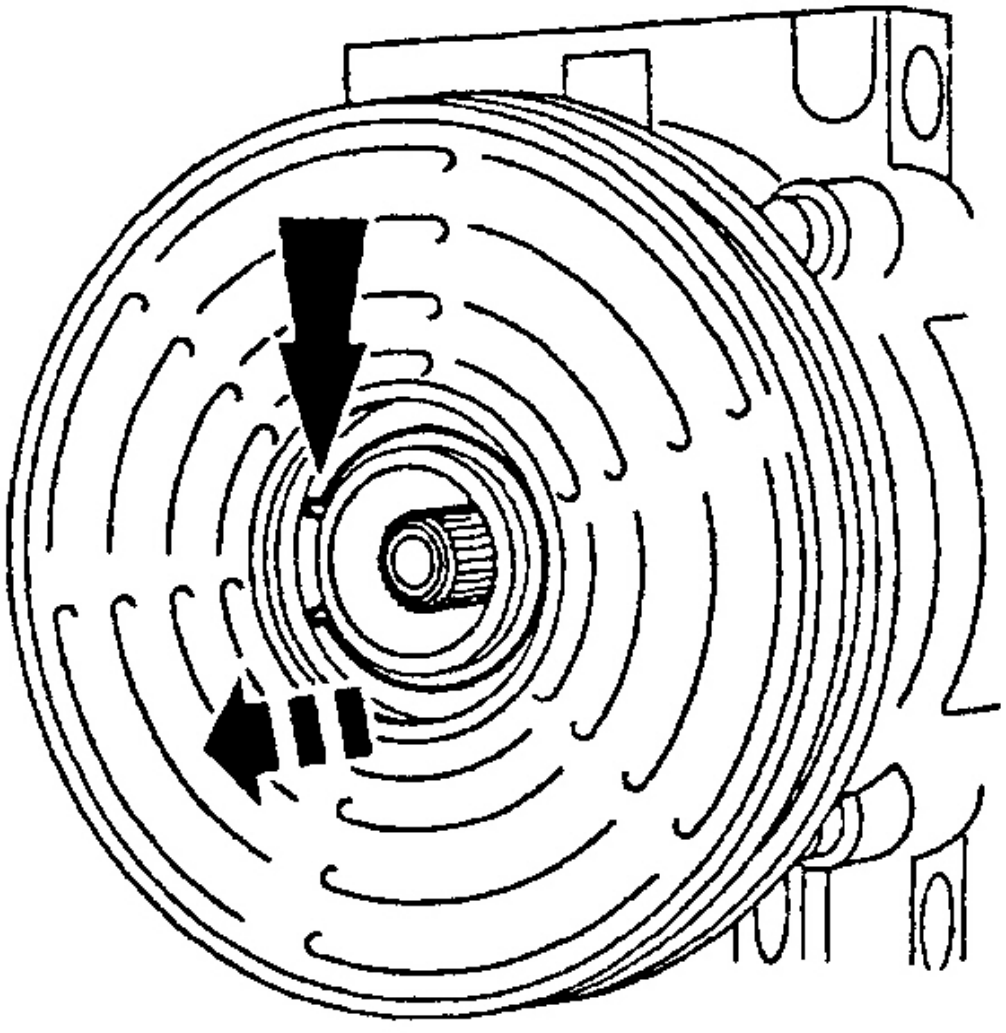
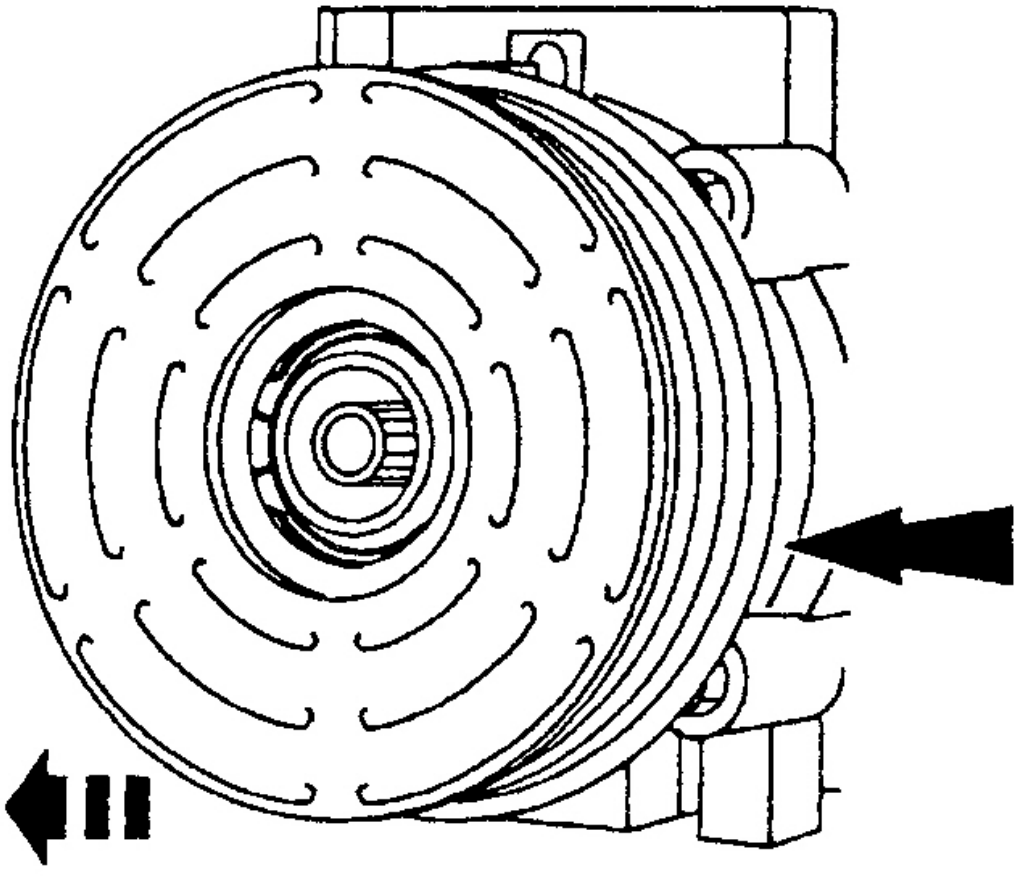


Fig. 7: Removing A/C Clutch Hub Spacer
Courtesy of FORD MOTOR CO.



G00134506

Fig. 8: Identifying Pulley Snap Ring
Courtesy of FORD MOTOR CO.



G00134507

Fig. 9: Removing A/C Clutch Pulley
Courtesy of FORD MOTOR CO.

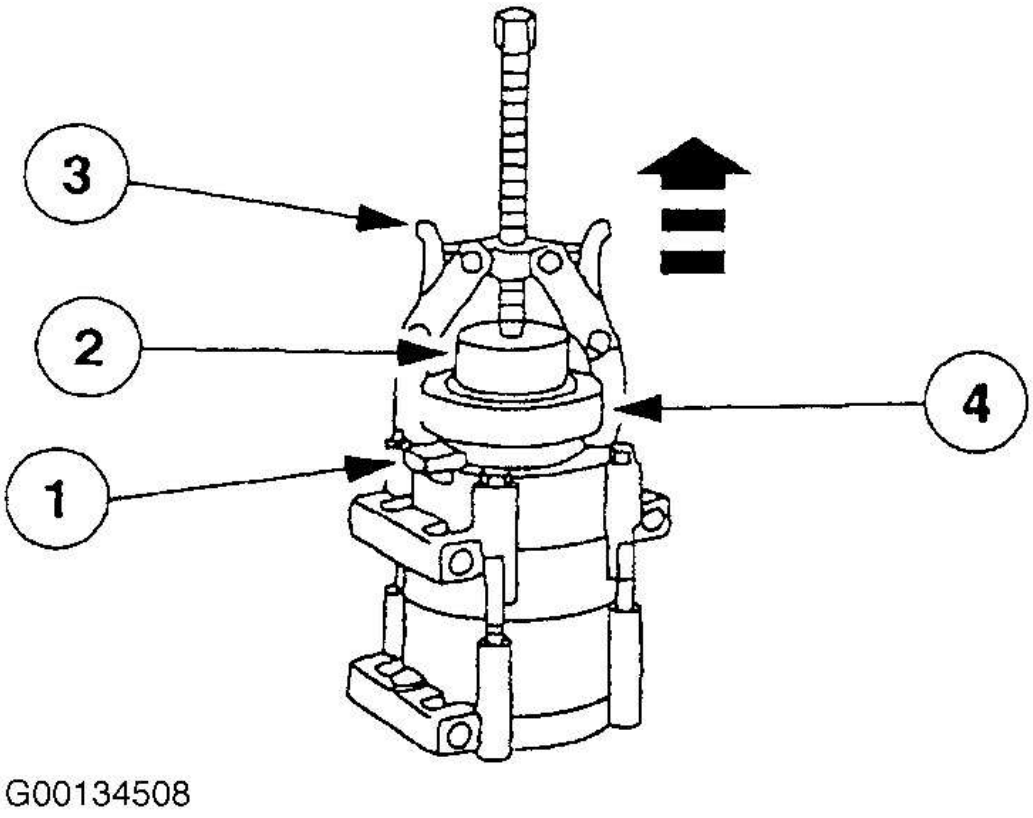


Fig. 10: Removing A/C Clutch Field Coil
Courtesy of FORD MOTOR CO.

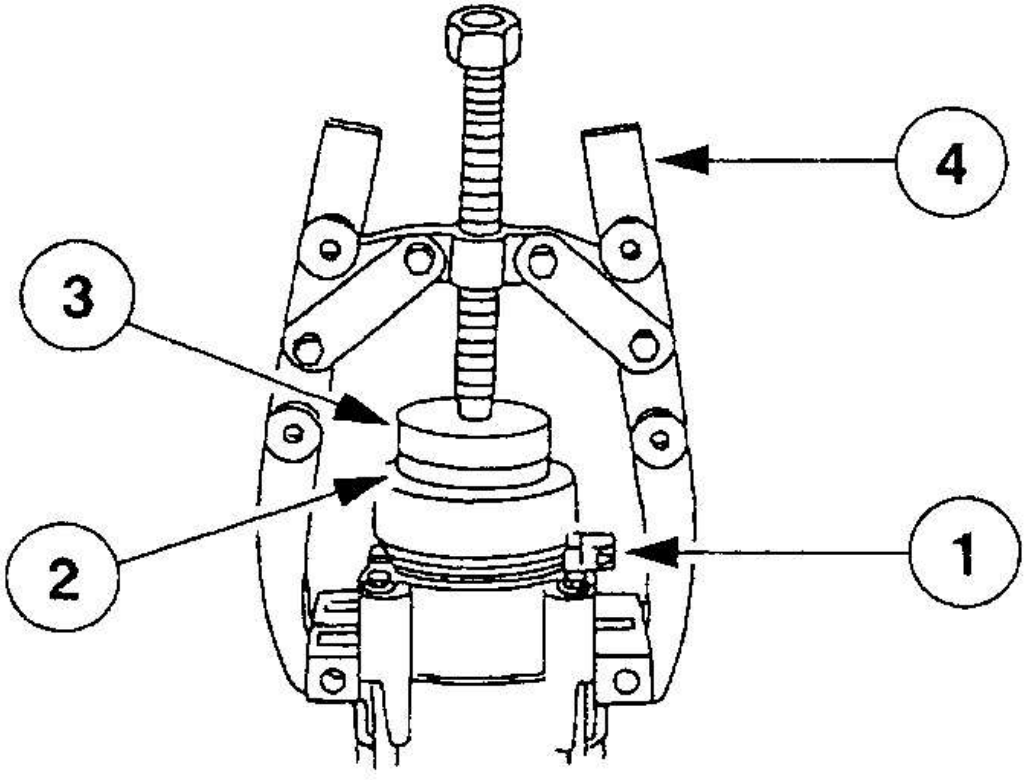
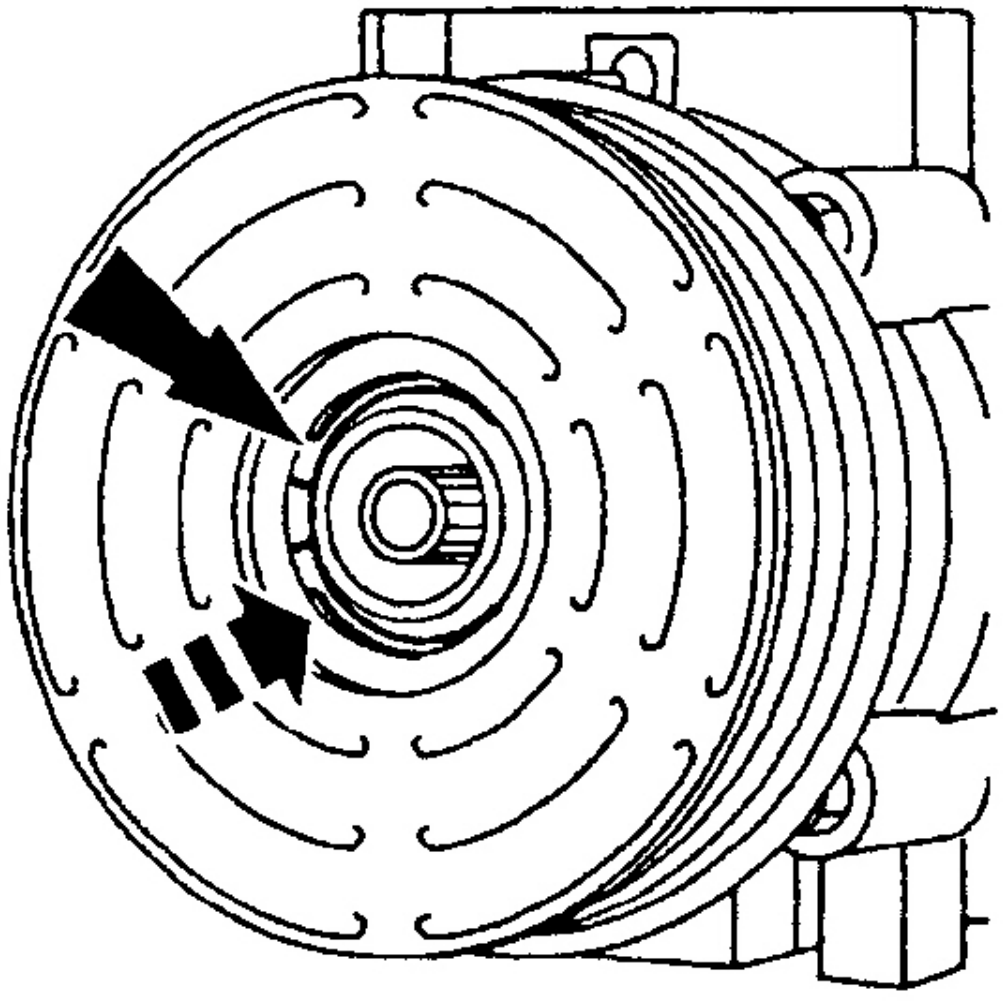
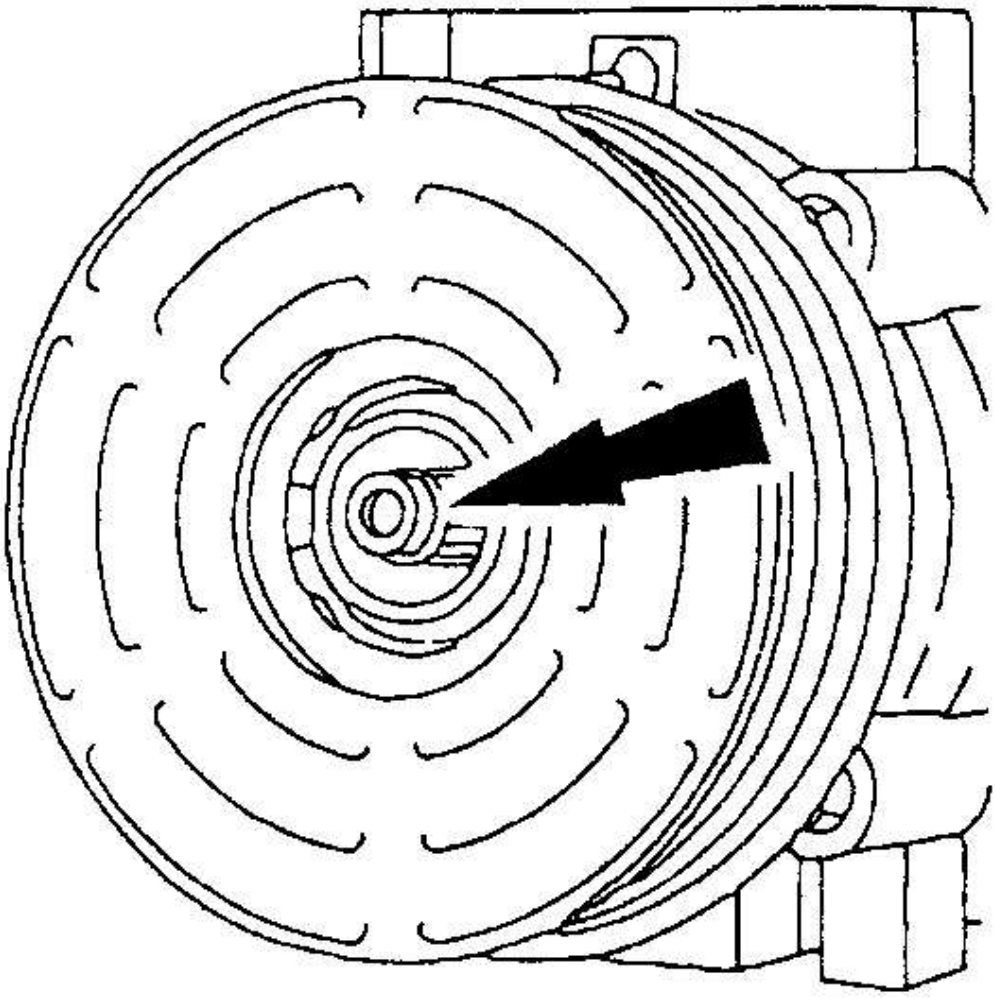


Fig. 11: Installing A/C Clutch Field Coil
Courtesy of FORD MOTOR CO.



G00134511

Fig. 12: Installing Snap Ring
Courtesy of FORD MOTOR CO.



G00134512

Fig. 13: Identifying Clutch Hub Spacer Position
Courtesy of FORD MOTOR CO.

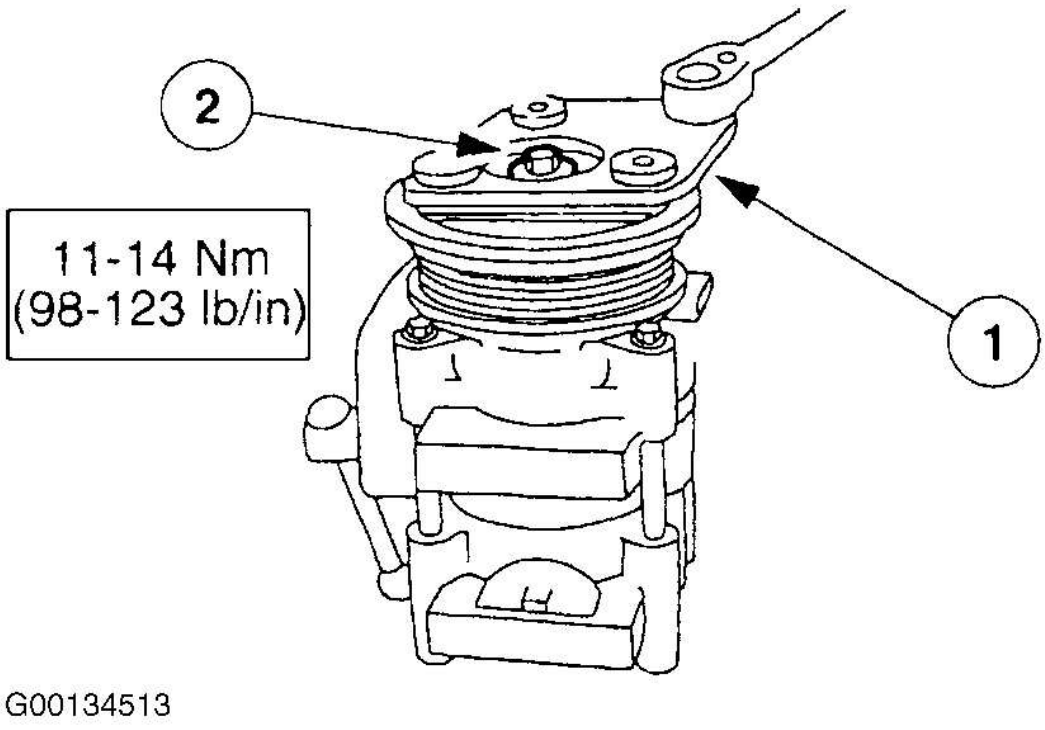


Fig. 14: Installing Clutch Hub With Compressor Clutch Holding Tool
Courtesy of FORD MOTOR CO.

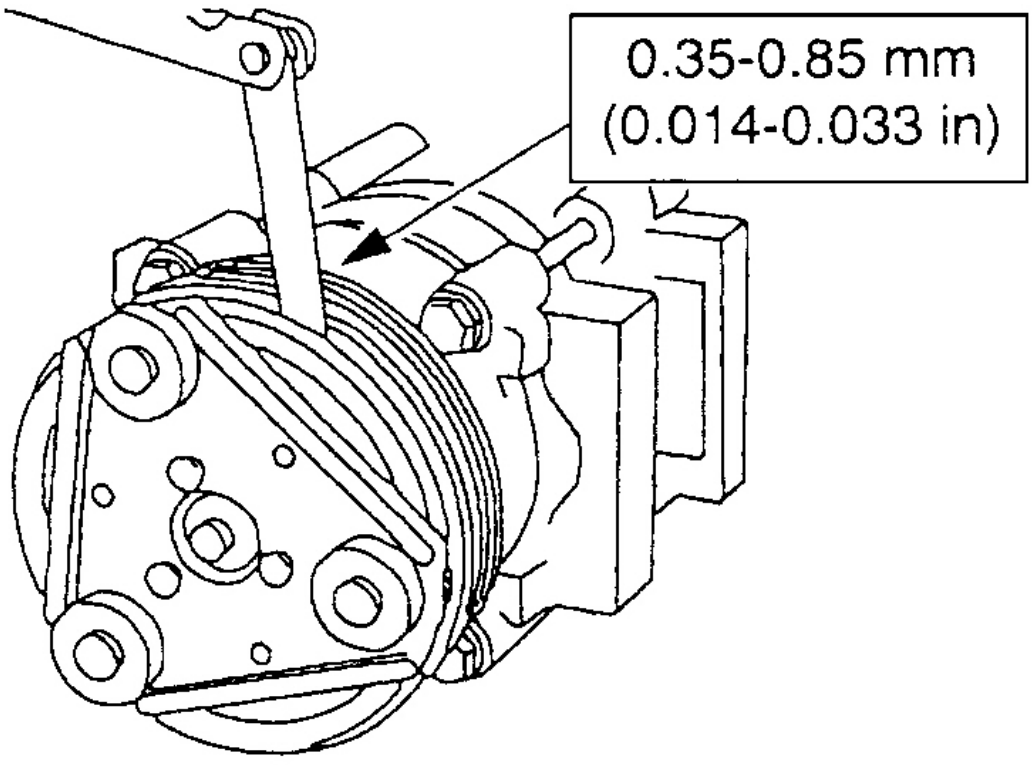


Fig. 15: Measuring & Adjusting Clutch Air Gap
Courtesy of FORD MOTOR CO.

CLUTCH CYCLING PRESSURE SWITCH

Removal & Installation

Disconnect wire connector from pressure switch. Remove pressure switch from accumulator-drier. To install, use new "O" ring lubricated with clean refrigerant oil. Tighten switch to 62-115 INCH lbs. (7-13 N.m). Check for leaks.

CONTROL PANEL

Removal & Installation

1. Disconnect negative battery cable and wait at least one minute to deplete air bag backup power supply. Disconnect 2 passenger side air bag defeat switch connectors.
2. Remove instrument panel relay cover. Pull center finish panel from instrument panel. Disconnect 4WD

control switch connector (if equipped). Remove 4 screws attaching control panel to instrument panel.

3. Pull control panel far enough from opening to disconnect electrical connectors and illumination light. Disconnect vacuum harness connector. Remove control panel from instrument panel. Switch knobs will drop off when each switch is removed. To install, reverse removal procedure.

EVAPORATOR CASE

Removal

Disconnect negative battery cable. Discharge A/C system, using approved refrigerant recovery/recycling equipment. Drain cooling system. Remove instrument panel. See **INSTRUMENT PANEL** under REMOVAL & INSTALLATION. Disconnect heater hoses at heater core. Disconnect refrigerant lines from evaporator case. Remove right side A/C plenum demister adapter. Disconnect vacuum line. Remove heater core bracket. Remove 13 plenum assembly top screws and remove plenum top. Remove evaporator core from plenum.

Installation

To install, reverse removal procedure. Use new "O" rings, lubricated with clean refrigerant oil, at refrigerant lines. Evacuate, recharge and leak test system. Fill and bleed cooling system. Check system for proper operation.

INSTRUMENT PANEL

Removal & Installation

1. Disconnect negative battery cable. Disconnect positive battery cable and wait at least one minute for air bag backup power supply to deplete. Move automatic transmission shift lever to "1" position (if equipped). Carefully pry to release 4 clips and remove steering column opening cover. Remove fuse door. Position hood latch and parking brake release handles aside.
2. Remove instrument panel floor duct panel. Remove lower instrument panel steering column cover. Remove left and right side door scuff plates. Remove left and right side cowl side trim panels. Disconnect brake on/off switch connector. Disconnect radio and Generic Electronic Module (GEM)/Central Timer Module (CTM) ground connections.
3. Disconnect 3 instrument panel main harness connectors. Remove firewall wiring harness from inside left side of engine compartment. Pull bulkhead electrical connector handle and disconnect harness. Disconnect both air bag diagnostic monitor connectors located behind right side of instrument panel. Disconnect inertia fuel shutoff switch connector located behind right side of instrument panel.
4. Disconnect right side ground connections. Disconnect electronic blend door motor connector and climate control panel vacuum line connector. Remove instrument panel steering column opening cover support. Remove 4 steering column support nuts and lower steering column. Disconnect radio antenna cable and remove radio.

CAUTION: Carry air bag with trim cover facing away from body to reduce injury from an accidental deployment. Place air bag on bench or other surface with trim cover facing upward.

5. Remove instrument panel relay cover. Open glove box and release both door stops. Remove passenger side air bag module. Remove right side assist handle and windshield molding. Remove instrument panel bolt under left side of glove box. Remove 2 instrument panel bolts behind passenger side air bag module opening. Remove 2 upper instrument panel bolts and bolt on relay bracket. Remove lower instrument panel bolt on left side of cigarette lighter.
6. Remove 2 lower instrument panel nuts located on either corner of instrument panel. Remove instrument panel bolt under center of steering column. Remove 2 instrument panel bolts on bottom left and right sides of instrument cluster opening. Disconnect air bag sliding contact connectors and anti-theft sensor connector. Disconnect steering column connectors. Remove instrument panel from right side floor brace. Remove instrument panel. To install, align and position instrument panel with clips in sheet metal. To continue installation, reverse removal procedures. Tighten steering column mounting nuts to 10-13 ft. lbs. (13-18 N.m).

TORQUE SPECIFICATIONS

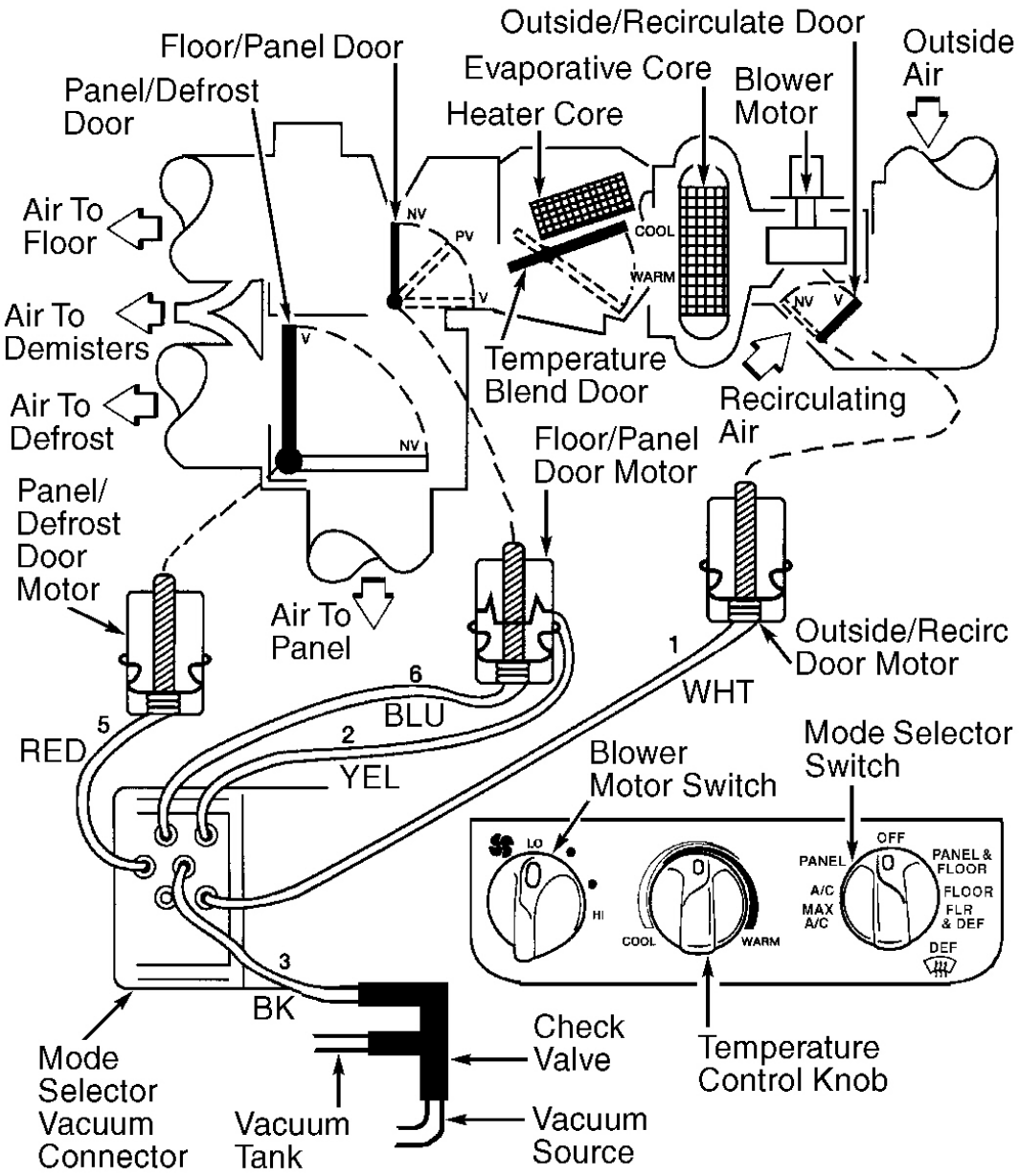
TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Compressor Bolts	15-22 (21-30)
Condenser Mounting Brackets	10-14 (13-18)
Refrigerant Lines-To-Condenser	15-20 (21-27)
Manifold-To-Compressor	14-17 (18-23)
Suction Line-To-Accumulator	19-25 (26-34)
	INCH Lbs. (N.m)
Accumulator Bracket Bolt	80-100 (9-11)
Cycling Pressure Switch	62-115 (7-13)
High Pressure Cut-Off Switch	62-121 (7-14)
Plenum Assembly Nuts	36-53 (4-6)

VACUUM DIAGRAMS

EARLY/LATE PRODUCTION IDENTIFICATION

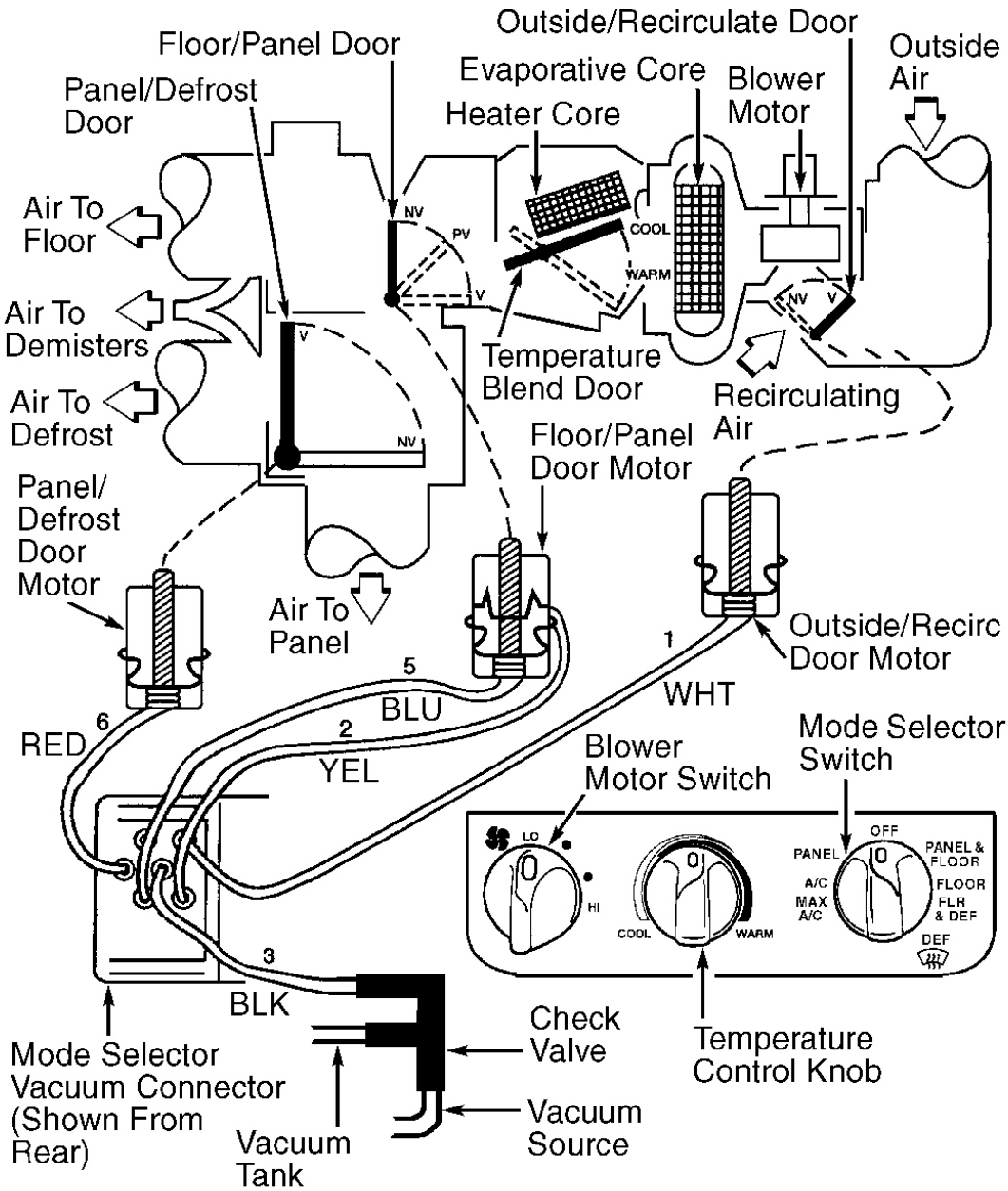
1997 F150 Early Production models end at manufacture date 6/23/96. 1997 F150/250LD Late Production models begin at manufacture date 6/24/96. Manufacture date is located on the Certification Label attached to driver's side door or door lock pillar. Since the Certification Label only indicates month and year of vehicle manufacture, it is necessary to use the Vacuum or Wiring diagrams to distinguish between Early/Late Production vehicles built in 6/96.



VACUUM LOGIC TABLE

	Fresh/Recirc NO. 1 (White)	Panel/Floor NO. 6 (Blue)	Panel/Floor NO. 2 (Yellow)	Panel/Defrost NO. 5 (Red)	Source NO. 3 (Black)
MAX A/C	Vacuum	Atmosphere	Atmosphere	Vacuum	Vacuum
A/C	Atmosphere	Atmosphere	Atmosphere	Vacuum	Vacuum
Panel (Vent)	Atmosphere	Atmosphere	Atmosphere	Vacuum	Vacuum
Off	Vacuum	Vacuum	Vacuum	Atmosphere	Vacuum
Panel/Floor	Atmosphere	Vacuum	Atmosphere	Vacuum	Vacuum
Floor	Atmosphere	Vacuum	Vacuum	Atmosphere	Vacuum
Floor/Defrost	Atmosphere	Vacuum	Atmosphere	Atmosphere	Vacuum
Defrost	Atmosphere	Atmosphere	Atmosphere	Atmosphere	Vacuum

Fig. 16: Vacuum Schematic & Mode Selector Chart (F150 Early Production)
Courtesy of FORD MOTOR CO.



VACUUM LOGIC TABLE

	Fresh/Recirc NO. 1 (White)	Panel/Floor NO. 5 (Red)	Panel/Floor NO. 2 (Yellow)	Panel/Defrost NO. 6 (Blue)	Source NO. 3 (Black)
MAX A/C	Vacuum	Atmosphere	Atmosphere	Vacuum	Vacuum
A/C	Atmosphere	Atmosphere	Atmosphere	Vacuum	Vacuum
Panel (Vent)	Atmosphere	Atmosphere	Atmosphere	Vacuum	Vacuum
Off	Vacuum	Vacuum	Vacuum	Atmosphere	Vacuum
Panel/Floor	Atmosphere	Vacuum	Atmosphere	Vacuum	Vacuum
Floor	Atmosphere	Vacuum	Vacuum	Atmosphere	Vacuum
Floor/Defrost	Atmosphere	Vacuum	Atmosphere	Atmosphere	Vacuum
Defrost	Atmosphere	Atmosphere	Atmosphere	Atmosphere	Vacuum

Fig. 17: Vacuum Schematic & Mode Selector Chart (F150 Late Production & F250LD)
Courtesy of FORD MOTOR CO.

WIRING DIAGRAMS

EARLY/LATE PRODUCTION INDENTIFICATION

1997 F150 Early Production models end at manufacture date 6/23/96. 1997 F150/250LD Late Production models begin at manufacture date 6/24/96. Manufacture date is located on the Certification Label attached to driver's side door or door lock pillar. Since the Certification Label only indicates month and year of vehicle manufacture, it is necessary to use the Vacuum or Wiring diagrams to distinguish between Early/Late Production vehicles built in 6/96.

1997 Ford Pickup F150

1997 AIR CONDITIONING & HEAT Manual A/C

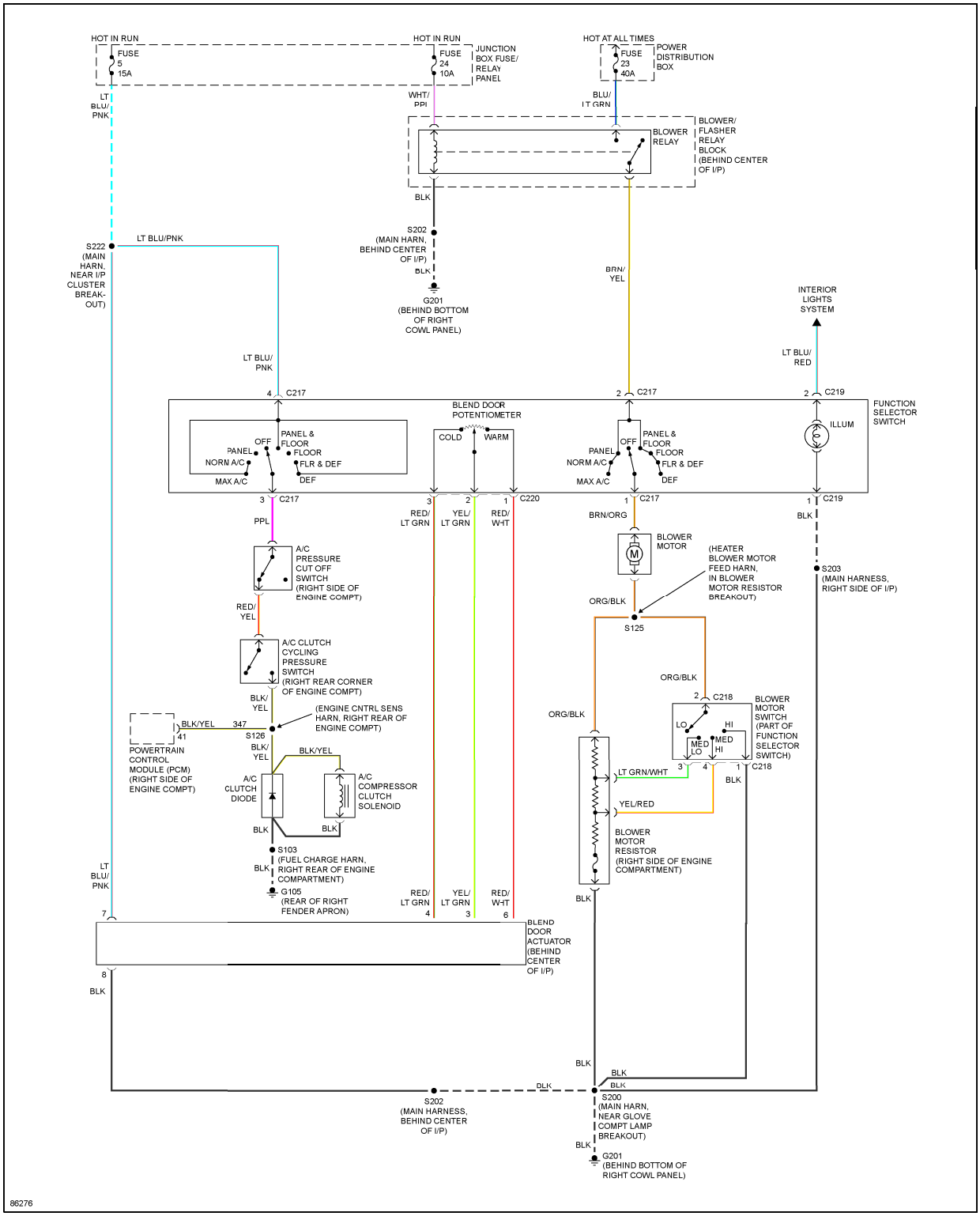


Fig. 18: Manual A/C-Heater System Wiring Diagram (F150 Early Production)

1997 Ford Pickup F150

1997 AIR CONDITIONING & HEAT Manual A/C

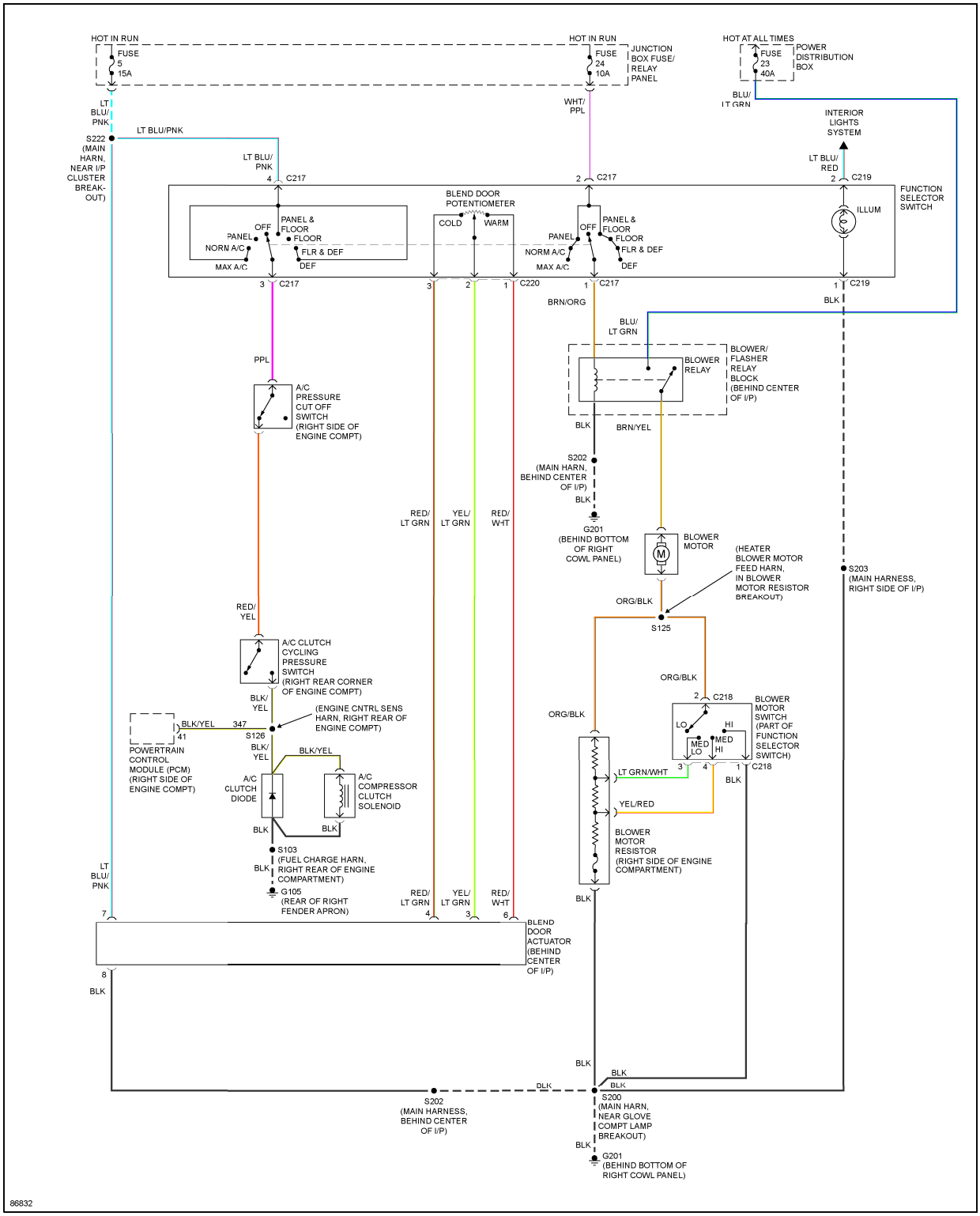


Fig. 19: Manual A/C-Heater System Wiring Diagram (F150 Late Production & F250LD)

SPECIAL TOOLS

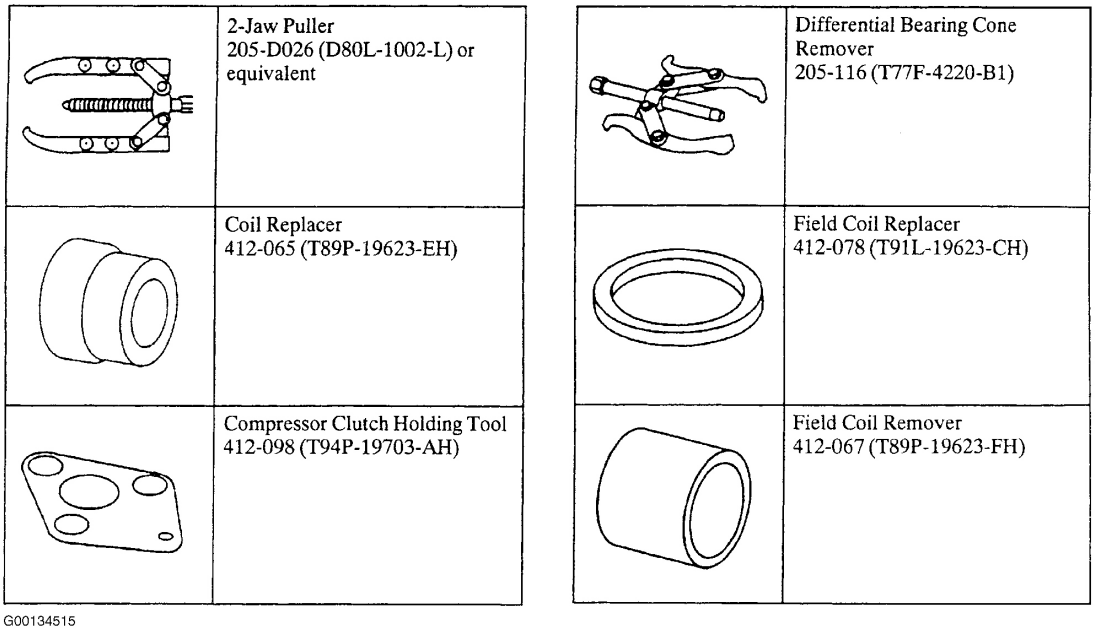


Fig. 20: Identifying A/C Clutch & Clutch Field Coil Tools
Courtesy of FORD MOTOR CO.

INSTRUMENT PANEL - STANDARD

1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Analog Instrument Panels

DESCRIPTION & OPERATION

Analog instrument cluster is equipped with electronic speedometer, fuel, oil pressure, temperature and voltage gauges. Some models are equipped with a tachometer.

ADJUSTMENTS

SPEEDOMETER CALIBRATION

1. Remove VSS. See **VEHICLE SPEED SENSOR & GEAR** under REMOVAL & INSTALLATION.
2. To calculate proper VSS driven gear, use the following formula: Indicated vehicle speed x No. of teeth on original VSS driven gear / actual vehicle speed = new driven gear size.
3. Round of number to nearest gear size (No. of teeth). Reinstall VSS with correct driven gear.

TROUBLE SHOOTING

INSPECTION

1. Verify customer concern by observing indicators and gauges to determine correct operation with ignition switch in RUN position, with engine off, in START before ignition switch is released and in RUN with engine running.
2. Visually inspect mechanical components of instrument cluster.
    - Low Brake Fluid Level
    - Damaged Engine Oil Filter
    - Damaged Vehicle Speed Sensor Gear
    - Damaged Washer Fluid Reservoir
    - Low Washer Fluid
    - Door Adjustment
    - Low Coolant Level
    - Low Engine Oil
    - Stuck Gauge Needle
    - Worn Or Damaged Generator Drive Belt
3. Visually inspect electrical components of instrument cluster.
    - Blown Fuse
    - Damaged Miniature Bulbs
    - Damaged Wiring Harness
    - Loose Or Corroded Connections

- Damaged Harness
- Damaged Switches and Sensors
- Damaged Instrument Cluster.

4. Verify that charging system, safety belt warning chime, turn signals, headlights and cruise control are working properly. Diagnose and repair those systems before performing instrument cluster diagnostics.

SYSTEM TESTING

SPEEDOMETER INOPERATIVE/ODOMETER OKAY

Replace instrument cluster.

TRIP ODOMETER INOPERATIVE/SPEEDOMETER OKAY

Replace instrument cluster.

SINGLE GAUGE DOES NOT RETURN TO ZERO WITH KEY OFF

1. **Check Fuse**

   Turn ignition off. Check fuse No. 2 in junction box fuse relay panel (under instrument panel). If fuse is okay, go to next step. If fuse fails repeatedly, go to step 3).

2. **Check Power To Cluster**

   Disconnect negative battery cable. Disconnect instrument cluster harness connector C237. See **Fig. 1** . Measure voltage between C237 pin No. 3 (Red/White wire) and ground. If battery voltage exists, repair or replace instrument cluster. If battery voltage does not exist, go to next step.

3. **Check Red/White Wire For Short To Ground**

   Measure resistance between C237 pin No. 3 (Red/White wire) and ground. If resistance is less than 10 k/ohms, repair short to ground in Red/White wire. If resistance is greater than 10 k/ohms, check for intermittent short to ground.

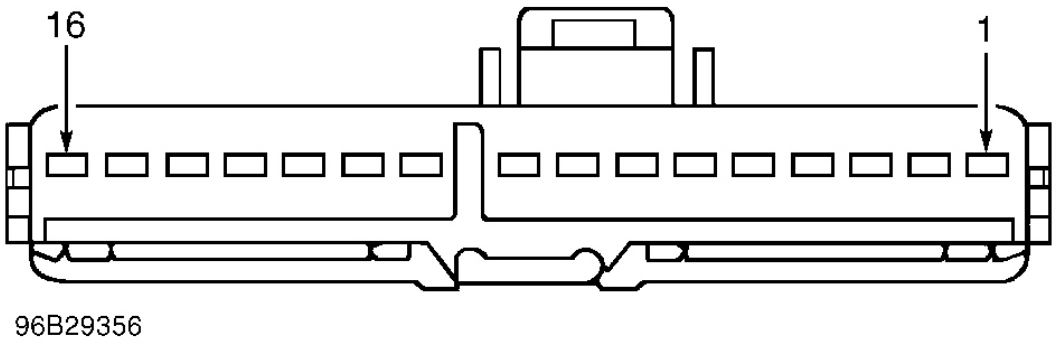


Fig. 1: Identifying Instrument Panel Harness Connector C237
Courtesy of FORD MOTOR CO.

HARNESS CONNECTOR C237 PIN IDENTIFICATION

Pin No. (Wire Color)	Description
1 (Black)	Ground
2 (Light Blue/Red)	Illumination Power
3 (Red/White)	Hot At All Times
4 (Not Used)	Not Used
5 (Pink/Orange)	Ground
6 (White/Red)	Oil Pressure Warning Light
7 (Gray/Black)	Vehicle Speed Sensor Signal
8 (Black/White)	Tachometer Select
9 (Red/White)	Engine Coolant Temperature
10 (Yellow/White)	Fuel Level Signal
11 (Dark Blue/Light Green)	Anti Theft Indicator
12 (White/Pink)	Tachometer Signal
13 (Not Used)	Not Used
14 (White/Light Blue)	Right Turn Indicator
15 (Black)	Ground
16 (Light Green/White)	Left Turn Indicator

FUEL GAUGE INACCURATE

1. Disconnect negative battery cable, wait one minute then reconnect. Check gauge operation. If gauge indication is okay, problem intermittent. If fuel tank is full, go to next step. If fuel tank is empty, go to step 3).
2. Check Resistance Of Fuel tank Sender With Full Tank Ensure fuel tank is full. Disconnect negative battery cable. Disconnect instrument cluster harness connector C237. See **Fig. 1** . Measure resistance between C237, pins No. 5 (Pink/Orange wire) and No. 10 (Yellow/White wire). If resistance is greater

than 140 ohms, repair open Yellow/White wire or Pink/Orange wire or replace fuel tank sender. If resistance is less than 140 ohms, repair/replace instrument cluster and printed circuit. Test system operation.

3. Check Resistance Of Fuel Tank Sender With Empty Tank -Ensure fuel tank is empty. Disconnect negative battery cable. Disconnect instrument cluster harness connector C237. See **Fig. 1** . Measure resistance between C237, pins No. 5 (Pink/Orange wire) and No. 10 (Yellow/White wire). If resistance is greater than 20 ohms, repair open Yellow/White wire or Pink/Orange wire or replace fuel tank sender. If resistance is less than 20 ohms, repair/replace instrument cluster and printed circuit. Test system operation.

LOW FUEL INDICATOR INOPERATIVE

1. **Perform Indicator Prove Out** - If low fuel indicator momentarily illuminates when ignition is initially turned on (bulb prove out), go to next step. If low fuel indicator does not illuminate when ignition is initially turned on, go to step 3).
2. If low fuel indicator passes bulb prove out and will not illuminate when fuel level is less than 1/16 of a tank, and fuel gauge is okay, replace instrument cluster and printed circuit.
3. **Check Power To Low Fuel Indicator** - Turn ignition off. Disconnect instrument cluster harness connector C238. See **Fig. 2** . Measure voltage between C238 pin No. 12 (Red/Yellow wire) and chassis ground. If battery voltage does not exist, replace low fuel warning bulb. If problem still exists, replace printed circuit and instrument cluster.

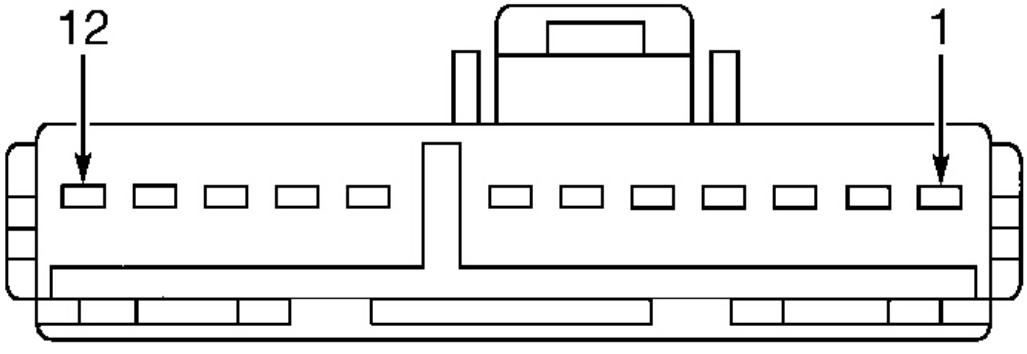


Fig. 2: Identifying Instrument Panel Harness Connector C238
Courtesy of FORD MOTOR CO.

HARNESS CONNECTOR C238 PIN IDENTIFICATION

Pin No. (Wire Color)	Description
1 (Not Used)	Not Used

2 (Not Used)	Not Used
3 (Not Used)	Not Used
4 (Not Used)	Not Used
5 (Not Used)	Not Used
6 (Black/Yellow)	Air Bag Indicator
7 (White/Yellow)	Hot In Start And Run
8 (Light Green/Red)	Charge Indicator
9 (Dark Green/Light Green)	Fasten Belt Indicator
10 (Purple/White)	Brake Warning Indicator
11 (Dark Green/Orange)	Door Ajar Indicator
12 (Red/Yellow)	Hot In Start And Run

VOLTMETER INACCURATE

1. **Check Gauge Operation** - Verify charging system is functioning properly. Repair if necessary. If charging system is okay, and voltmeter indication is low, go to next step.
2. **Check Cluster Harness Connectors** - Check instrument panel harness connectors for proper connection, corrosion, bent pins etc. Correct as necessary. If okay, go to next step.
3. **Check Printed Circuit Connections** - Verify printed circuit connections. Correct as necessary. If circuit connections are okay, go to next step.
4. **Check Fuses** - Check fuse No. 2 (5-amp) and fuse No. 29 in fuse junction panel. If fuses are okay, go to step 7). If fuse(s) is blown, replace fuse(s). If fuse No. 2 blows again, go to next step. If fuse No. 29 blows again, go to step 6).
5. **Check Red/White Wire** - Disconnect instrument cluster harness connector C237. See **Fig. 1** . Ensure fuse No. 2 is removed. Measure resistance between C237 p in No. 3 (Red/White wire) and ground. If resistance is greater than 10 k/ohms, repair/replace instrument cluster. If resistance is less than 10 k/ohms, repair short to ground in Red/White wire.
6. **Check Red/Yellow Wire** - Disconnect instrument cluster harness connector C237. See **Fig. 1** . Ensure fuse No. 29 is removed. Measure resistance between C237 pin No. 11 (Red/Yellow wire) and ground. If resistance is greater than 10 k/ohms, repair/replace instrument cluster. If resistance is less than 10 k/ohms, repair short to ground in Red/Yellow wire.
7. **Check Red/White Wire For Open** - Install new fuse No. 2 (5-amp). Disconnect instrument panel harness connector C237. See **Fig. 1** . Measure voltage between instrument cluster harness connector C237 pin No. 3 (Red/White wire) and ground. If battery voltage exists, go to next step. If battery voltage does not exist, repair open Red/White wire.
8. **Check Red/Yellow Wire For Open** - Install new fuse No. 29 (5-amp). Disconnect instrument panel harness connector C237 and C238. See **Fig. 1** and **Fig. 2** . Measure voltage between instrument cluster harness connector C237 pin No. 11 (Red/Yellow wire) and ground. Also measure voltage between instrument cluster harness connector C238 pin No. 12 (Red/Yellow wire) and ground. If battery voltage exists for both measurements, go to next step. If battery voltage does not exist for both measurements, repair open Red/Yellow wire.

OIL PRESSURE GAUGE INACCURATE

1. **Monitor Gauge With Engine Off** - Turn ignition on, engine off. If oil pressure gauge reads low, go to next step. If oil pressure gauge reads high, repair short to ground in White/Red wire or replace shorted oil pressure switch.
2. **Check Oil Pressure With Engine Running** - Start engine. If oil pressure gauge reads high (normal oil pressure), system is okay at this time. If oil pressure reads low go to nest step.
3. **Check White/Red Wire For Short To Ground** - Turn ignition off. Disconnect instrument cluster harness connector C237. Measure resistance between C237 pin No. 6 (White/Red wire) and ground. If resistance is less than 10 k/ohms, go to next step. If resistance is greater than 10 k/ohms, repair/replace instrument cluster. Check gauge operation.
4. **Check Red/White Wire For Open** - Disconnect oil pressure switch. Measure resistance of Red/White wire between instrument panel harness connector C237 and oil pressure switch. If resistance is less than 5 ohms, replace oil pressure switch. If resistance is greater than 5 ohms, repair open Red/White wire.

TEMPERATURE GAUGE INACCURATE

1. **Disconnect Sensor** - Ensure temperature sensor connector is in good condition. Turn ignition off. Disconnect coolant temperature sensor. Turn ignition off. If temperature gauge indicates cold, go to next step. If temperature gauge does not indicate cold, go to step 3).
2. **Bypass Temperature Sensor** - Connect a jumper wire between the 2 pins of temperature sensor harness connector. If temperature gauge indicates hot, replace coolant temperature sensor. If temperature gauge does not indicate hot, go to next step.
3. **Check Red/White Wire For Short To Ground** - Turn ignition off. Disconnect instrument cluster harness connector C237. Measure resistance between instrument cluster harness connector C237 pin No. 9 (Red/White wire) and ground. If resistance is greater than 10 k/ohms, repair/replace instrument cluster. If resistance is less than 10 k/ohms, repair short to ground in Red/White wire. Check gauge operation.
4. **Check Red/White Wire & Pink/Orange Wire For Open** - Turn ignition off. Disconnect instrument cluster harness connector C237. Measure resistance between C237 pin No. 9 (Red/White wire) and pin No. 5 (Pink/Orange wire). If resistance is less than 5 ohms, repair/replace instrument cluster. If resistance is greater than 5 ohms, repair open Red/White or Pink/Orange wire.

SPEEDOMETER & ODOMETER INOPERATIVE

1. **Verify Cruise Control Operation** - Drive vehicle and check cruise control operation. If cruise control operates properly, go to next step. If cruise control does not operate, see appropriate **CRUISE CONTROL SYSTEM** article. Repair as necessary.
2. **Check VSS PID** - Using New Generation Star (NGS) scan tester, access GEM. Select VSS PID. Monitor VSS PID while driving vehicle. If VSS PID seems to indicate actual vehicle speed, go to next step. If VSS PID does not indicate actual vehicle speed, go to step 4).
3. **Check Gray/Black Wire For Open** - Turn ignition off. Disconnect NGS scan tester. Disconnect instrument cluster harness connector C237 and VSS harness connector. Measure resistance of Gray/Black wire between C237 pin No. 7 and VSS harness connector. If resistance is less than 5 ohms, repair/replace instrument cluster. If resistance is greater than 5 ohms, repair open Gray/Black wire. Check speedometer operation.
4. **Check VSS** - Turn ignition off. Disconnect NGS tester. Disconnect VSS harness connector. Measure resistance between VSS terminals. If resistance is 200-300 ohms, go to next step. If resistance is not 200-

300 ohms, replace VSS. Check speedometer operation.

5. **Check Pink/Orange Wire For Open** - Measure resistance of Pink/Orange wire between VSS harness connector and ground. If resistance is less than 5 ohms, repair open Gray/Black wire. If resistance is greater than 5 ohms, repair open Pink/Orange wire. Check speedometer operation.

SPEEDOMETER FLUCTUATES

1. **Verify Connector Seating** - Check instrument cluster connectors for good clean connection. Repair as necessary. If connections are okay, go to next step.
2. **Check For DTCs** - Using New Generation Star (NGS) scan tester, check PCM for any continuous DTCs. If no DTCs are retrieved, go to next step. If any DTCs are retrieved from PCM, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.
3. **Check Gray/Black Wire For Open** - Turn ignition off. Disconnect NGS scan tester. Disconnect instrument cluster harness connector C237 and VSS harness connector. Measure resistance of Gray/Black wire between C237 pin No. 7 and VSS harness connector. If resistance is less than 5 ohms, repair/replace instrument cluster. If resistance is greater than 5 ohms, repair open Gray/Black wire. Check speedometer operation.
4. **Check VSS** - Turn ignition off. Disconnect NGS tester. Disconnect VSS harness connector. Measure resistance between VSS terminals. If resistance is 200-300 ohms, go to next step. If resistance is not 200-300 ohms, replace VSS. Check speedometer operation.
5. **Check Pink/Orange Wire For Open** - Measure resistance of Pink/Orange wire between VSS harness connector and ground. If resistance is less than 5 ohms, check VSS drive gears. Repair as necessary. If resistance is greater than 5 ohms, repair open Pink/Orange wire. Check speedometer operation.

REMOVAL & INSTALLATION

INSTRUMENT CLUSTER

1. **Removal & Installation** - Disconnect negative battery cable. Remove headlight switch. See **HEADLIGHT SWITCH** . Pry to release four retaining clips and remove steering column opening cover. See **Fig. 3** .
2. Remove seven instrument panel finish panel screws. Remove instrument panel finish panel. See **Fig. 4** . Remove four instrument cluster screws and instrument cluster. To install, reverse removal procedure.

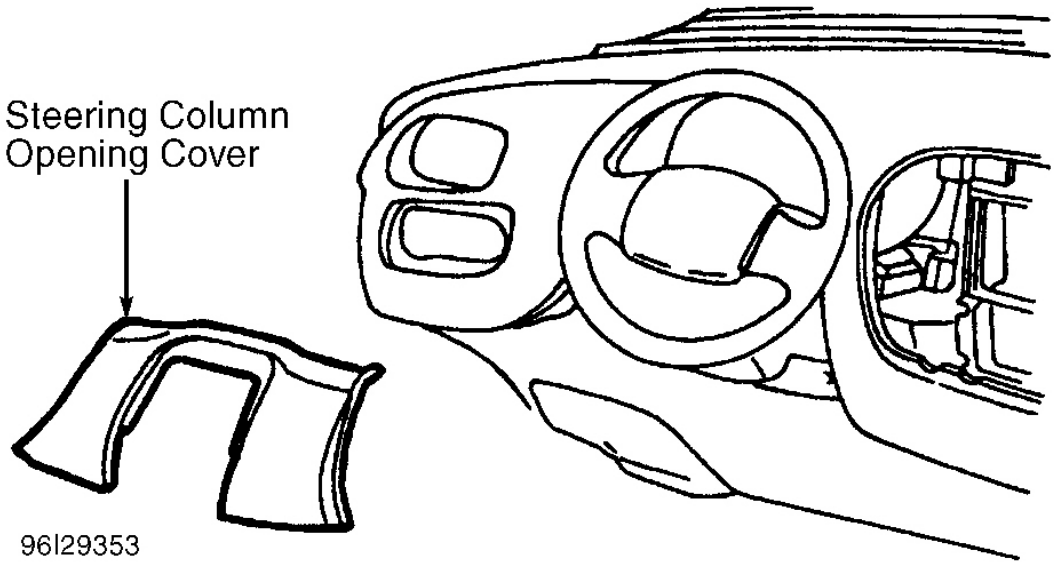


Fig. 3: Removing Steering Column Hole Cover
Courtesy of FORD MOTOR CO.

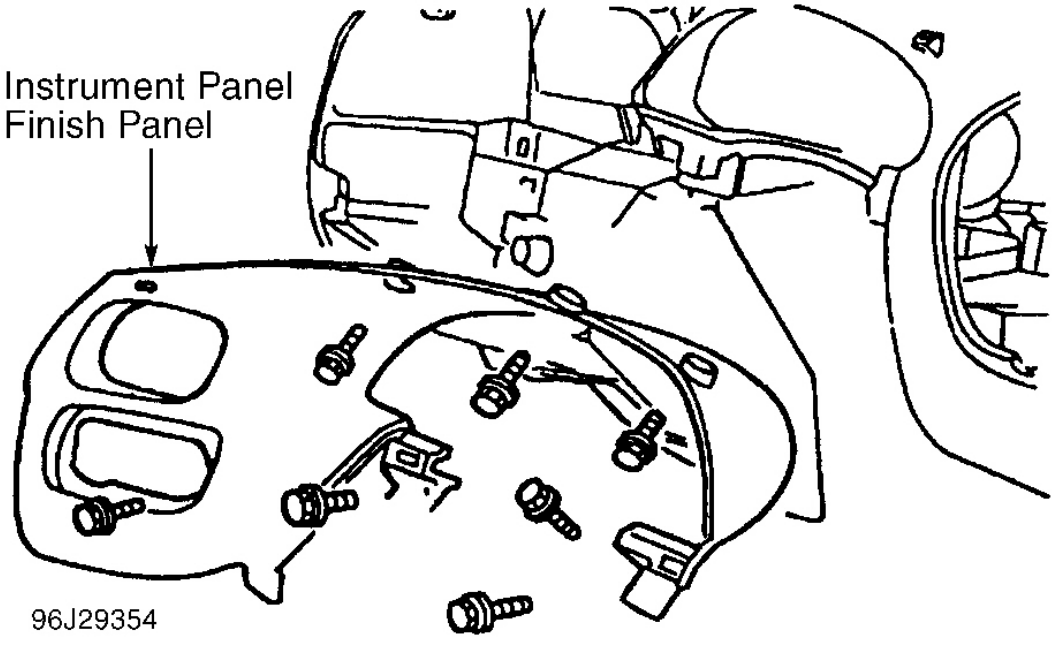


Fig. 4: Removing Instrument Panel Finish Panel

Courtesy of FORD MOTOR CO.

VEHICLE SPEED SENSOR & GEAR

Removal & Installation

Remove Vehicle Speed Sensor (VSS) retaining bolt and VSS. Remove clip and VSS driven gear. To install, reverse removal procedure.

HEADLIGHT SWITCH

Removal & Installation

1. Disconnect negative battery cable. Turn headlight switch to headlights on position. Pull headlight switch knob. Insert a thin tool into back of headlight switch knob to release, remove knob.
2. Reinstall headlight switch knob 180° from original position. Turn knob fully counterclockwise. Turn knob fully clockwise. Remove headlight switch from instrument panel. To install, reverse removal procedure.

WIRING DIAGRAMS

1997 Ford Pickup F150

INSTRUMENT PANEL - STANDARD 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Analog Instrument Panels

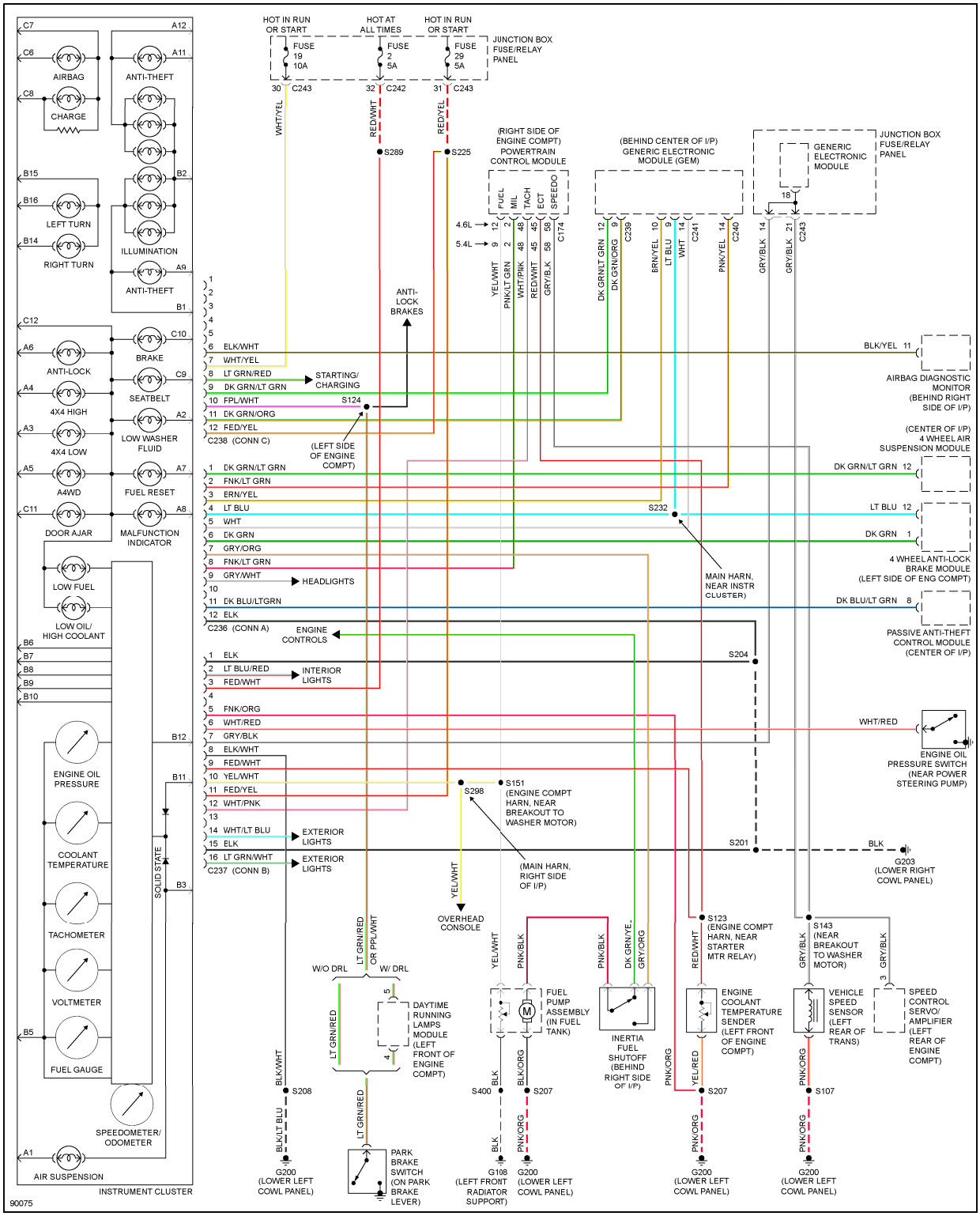


Fig. 5: Analog Instrument Panel Wiring Diagram (Expedition)

1997 Ford Pickup F150

INSTRUMENT PANEL - STANDARD 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Analog Instrument Panels

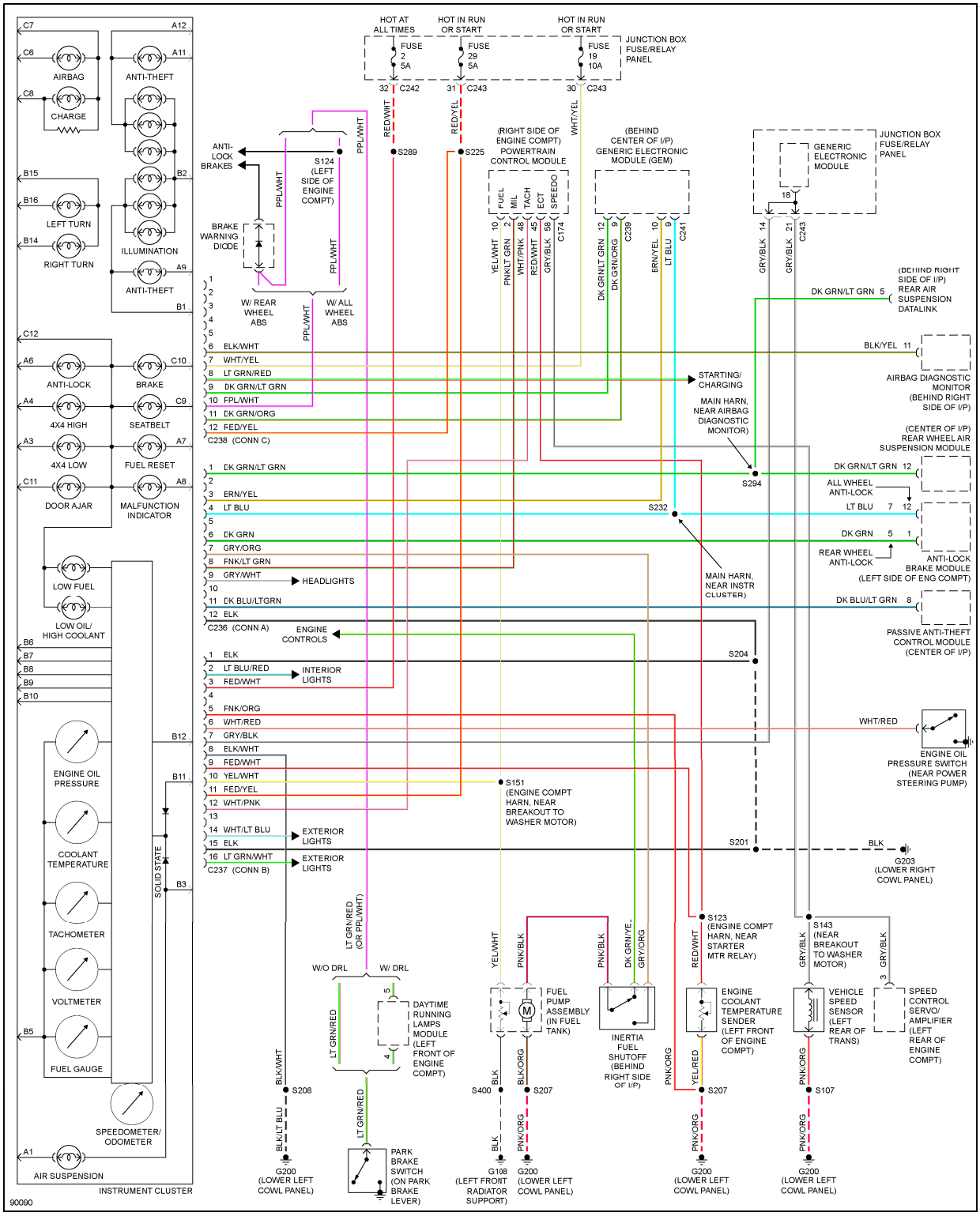


Fig. 6: Analog Instrument Panel Wiring Diagram (F150 & F250 Light Duty)

DRIVE AXLE - LIMITED-SLIP 10.25" RING GEAR

1996-97 Drive Axles - Limited-Slip 10.25" Ring Gear Differential

AXLE RATIO & IDENTIFICATION

Axle can be identified by axle code on Safety Certification Label on left door pillar. Also, a metal identification tag stamped with gear ratio and diameter is secured to housing by rear cover bolt.

DESCRIPTION

NOTE: Limited-slip and conventional rear axle assemblies are identical except for differential case. Most of the information in this article is related to differential case overhaul. For all other information, see DRIVE AXLE - 8.8" & 10.25" RING GEAR DIFFERENTIALS article.

Limited-slip differential case employs 2 sets of multiple disc clutches to control differential action. Side gear mounting distance is controlled by a clutch pack on each side gear. Each clutch pack includes 5 splined plates, 5 stationary plates and one Belleville spring plate.

LUBRICATION

CAPACITY

Capacity is 6.5 pts. (3.0L) with axle assembly installed in vehicle, or 7.5 pts. (3.5L) with axle assembly out of vehicle. In addition to normal lubricant, add 8 ozs. (.23L) of friction modifier.

FLUID TYPE

Use Motorcraft Premium Rear Axle Lubricant (XL-80W90-QL or XL-80W90-KL ;or EST-M2C118-A) and Friction Modifier (C8AZ-19B546-A or EST-M2C118-A).

DRAINING & REFILLING

CAUTION: DO NOT clean internal components of differential case with solvent. Clean components with clean, lint-free shop towel only.

Drive vehicle until lubricant is warm. Remove rear cover to drain lubricant. Remove gasket. Clean all lubricant from gasket surfaces. Install NEW gasket. Apply continuous bead of silicone sealant to housing, ensuring bead is inside of bolt holes. Install rear cover within 15 minutes of silicone application. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Fill housing with specified gear lubricant until fluid level is at bottom of fill hole.

TROUBLE SHOOTING

See **TROUBLE SHOOTING - BASIC PROCEDURES** article in GENERAL INFORMATION.

NOTE: A slight stick-slip noise in differential on tight turns after extended highway driving is considered acceptable and has no detrimental effect.

REMOVAL & INSTALLATION

Because conventional and limited-slip rear axle assemblies are identical except for differential case, removal and installation procedures for both axles are the same. See **DRIVE AXLE - 8.8" & 10.25" RING GEAR DIFFERENTIALS** article.

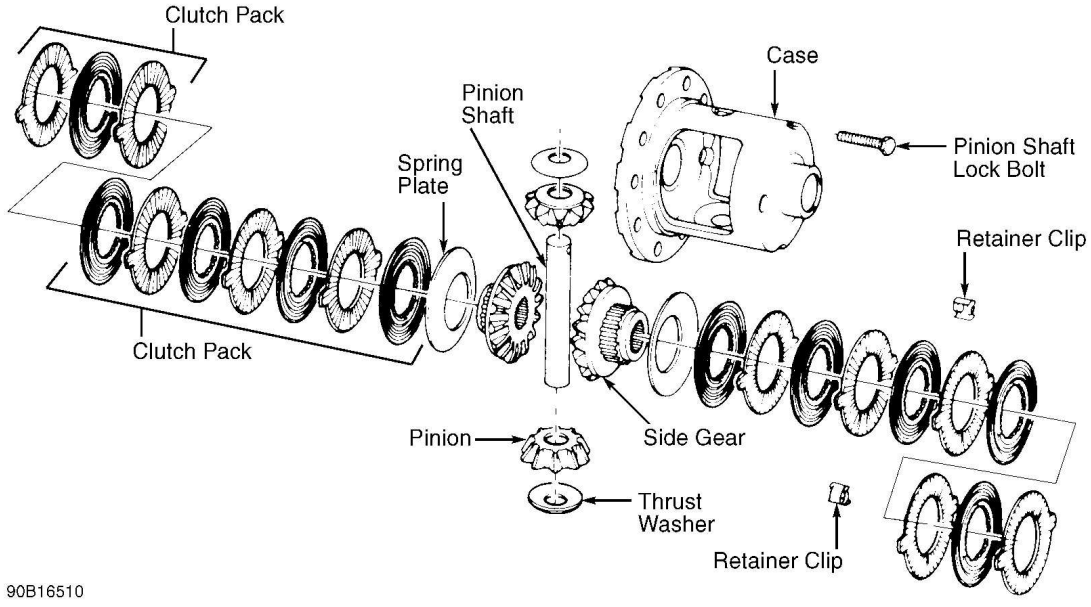


Fig. 1: Exploded View Of 10.25" Ring Gear Limited-Slip Differential Case
Courtesy of FORD MOTOR CO.

OVERHAUL

NOTE: It is not necessary to remove differential bearings to overhaul case.

DISASSEMBLY

1. Remove differential case. Remove ring gear from differential case. Remove pinion shaft lock bolt. Mount Differential Case Holder (D83T-4205-A) in a vise. Mount differential case onto holder with ring gear side of case facing up.
2. Using a drift, drive pinion shaft from differential case. Install Step Plate (D83T-4205-C2) in bore of right side gear (on bottom as mounted in vise). See **Fig. 2** . Apply a small amount of grease to centering hole of step plate. Install Nut (part of D83T-4205-C) in left side gear. Hold nut in position while installing Hex

Head Screw (part of D83T-4205-C). See **Fig. 3** .

3. Install Dowel Bar (part of D83T-4205-C) into hole of nut to keep nut from turning. Tighten hex head screw to force side gears away from pinion mating gears. Using a proper size feeler gauge, push pinion gear thrust washers out from between pinion gears and case.
4. Remove thrust washers. Back off hex head screw until loose (about one turn). Ensure vise is tightened securely. Insert Rotating Handle (T86T-4205-A) into pinion shaft bore. Turn case to "walk" pinion gears out of differential case windows.

CAUTION: When separating clutch plates, note disassembly sequence. Reassemble clutch plates in same sequence. DO NOT clean clutch components with solvent. Dry clutch components with a clean, lint-free shop towel only.

5. Remove hex head screw and step plate. Remove side gears, retainer clips and clutch pack assemblies. See **Fig. 4** . Remove retainer clips from both clutch packs. Separate, clean and inspect clutch plates.

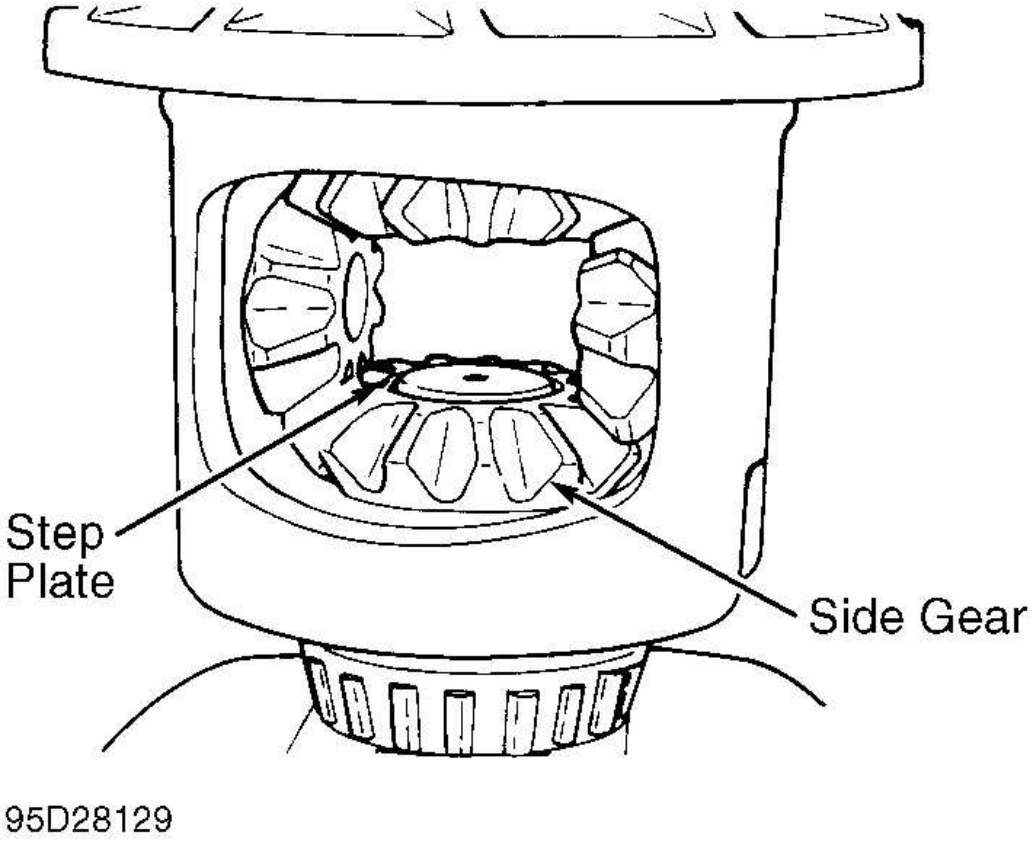


Fig. 2: Installing Step Plate In Side Gear Bore

Courtesy of FORD MOTOR CO.

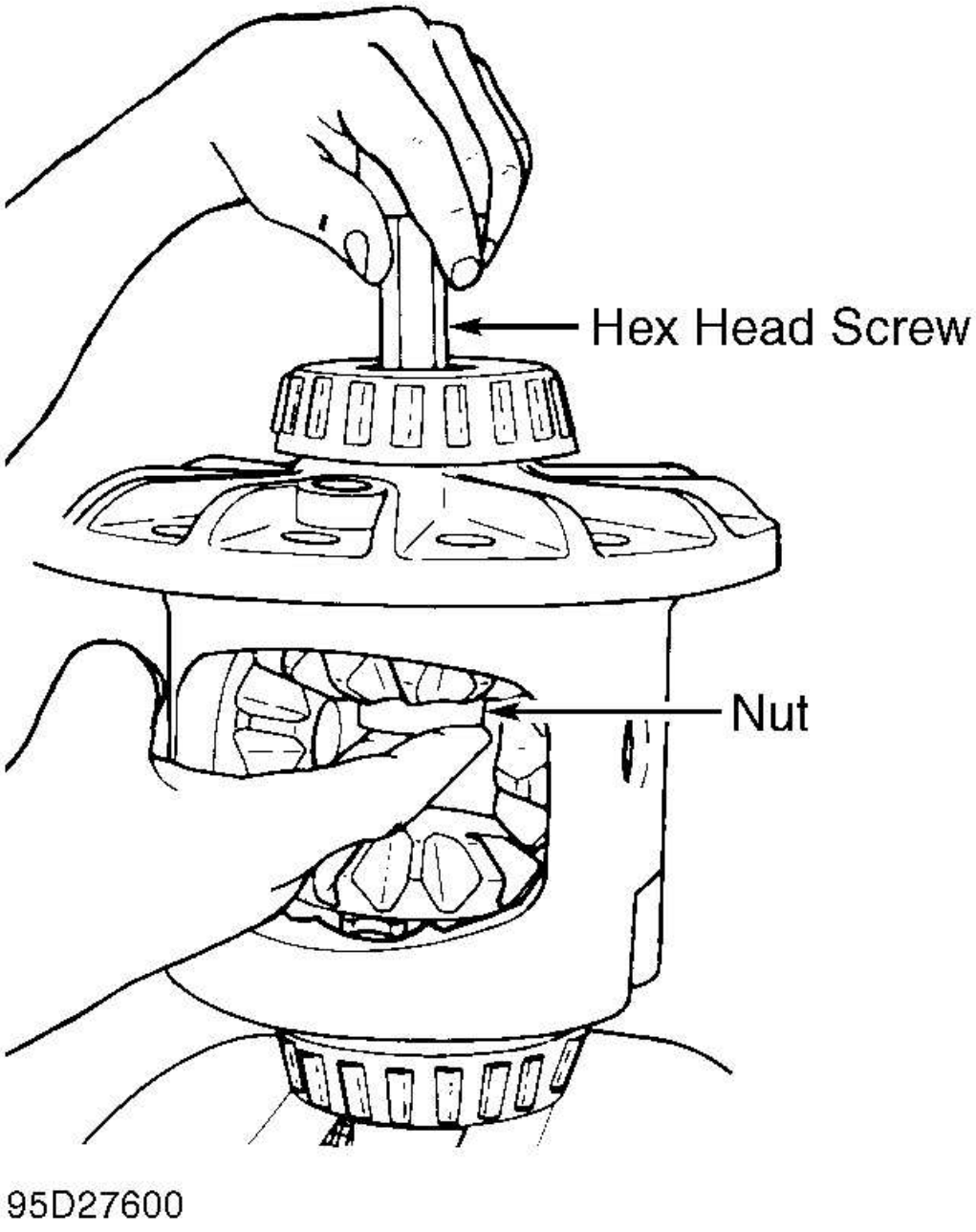


Fig. 3: Positioning Hex Head Screw & Nut
Courtesy of FORD MOTOR CO.

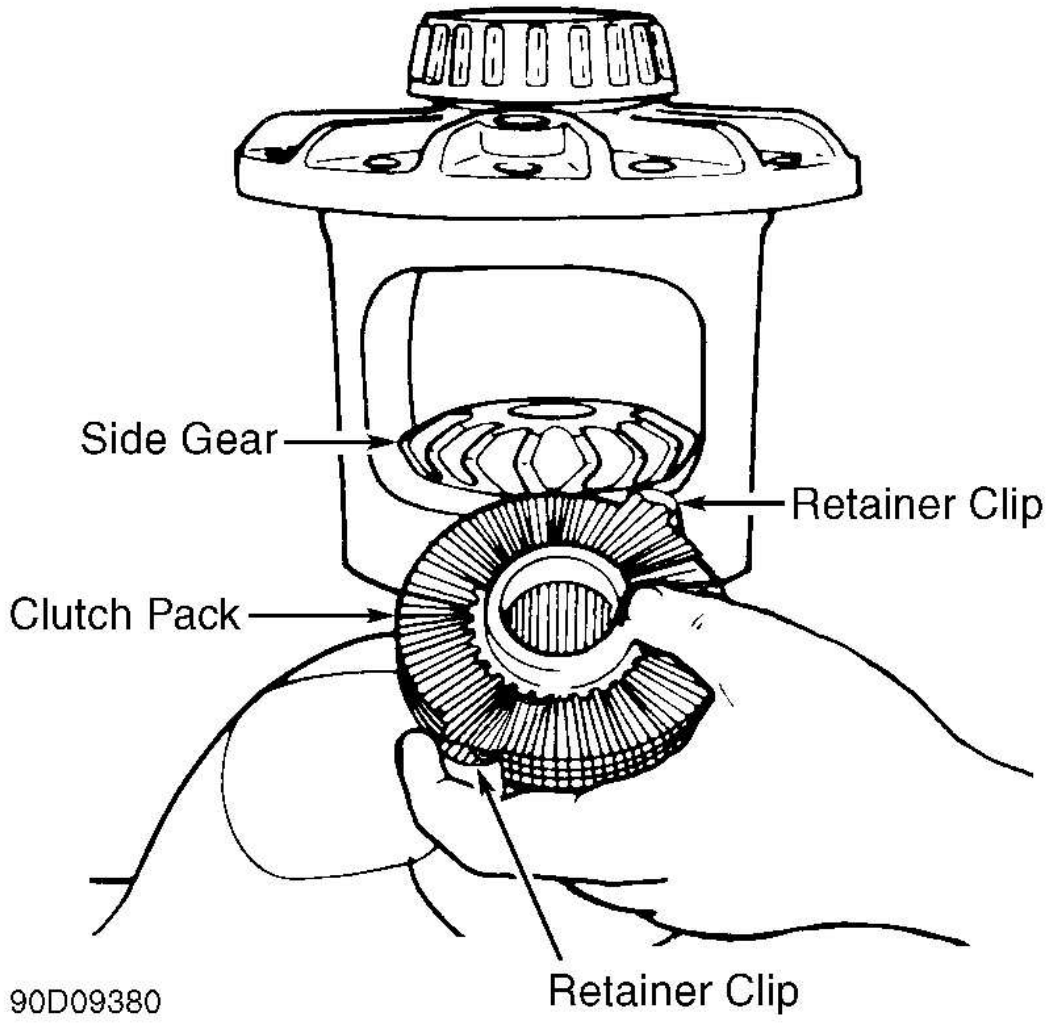


Fig. 4: Removing Side Gear, Retainer Clip & Clutch Pack
Courtesy of FORD MOTOR CO.

INSPECTION

Inspect clutch plates and discs for uneven or extreme wear. Plates must be free from burrs, nicks and scratches. Check discs for condition of material. Replace discs if spline teeth are worn. Replace plates if scored or if thickness is less than .058" (1.5 mm).

REASSEMBLY

1. To reassemble, reverse disassembly procedure. Lubricate clutch plates with Friction Modifier (C8AZ-19B546-A or EST-M2C118-A). Lubricate side gear thrust face and thrust washers with Gear Lubricant

(XL-80W90-QL or XL-80W90-KL ; or WSP-M2C197-A).

2. Ensure thrust washers are installed with concave side facing inward. Ensure clutch plate retainer clips are completely assembled and seated into clutch plate ears. See **Fig. 1** .
3. Apply Loctite Thread Sealer (E0AZ-19554-B) to ring gear bolts and pinion shaft lock bolt. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Differential Case Bearing Cap Bolt	80-95 (108-129)
Filler Plug	15-30 (20-41)
Pinion Nut	160 (217)
Pinion Shaft Lock Bolt	(1) 15-30 (20-41)
Rear Cover Bolt	25-35 (34-47)
Ring Gear Bolt	(1) 100-120 (136-163)
Wheel Lug Nut	140 (190)
(1) Apply Loctite Thread Sealer (E0AZ-19554-B) to bolt threads.	

1996-97 DRIVE AXLES

Locking Hubs - Pickup & Ranger

DESCRIPTION

NOTE: For 1997 Pickup F250 Heavy Duty models, see Front Axle - Dana IFS - Pickup F250 Heavy Duty article for manual locking hub or automatic locking hub removal and installation procedures.

NOTE: References to Pickup include Cab and Chassis.

On Ranger, front driving axle hub locks are automatically actuated. When actuated, hub lock assembly engages, locking wheel hub assembly to front drive axle. Front drive axle is then driven by transfer case. When released, front drive axle is disengaged from hub assembly, and wheel assembly rotates freely.

On Pickup, front hub locks are manually actuated.

OPERATION

AUTOMATIC LOCKING HUBS (RANGER)

Shifting Between 2WD & 4X4 HIGH

Transfer case can be shifted from 2WD to 4X4 HIGH at speeds up to 55 MPH. DO NOT shift into 4X4 HIGH when rear wheels slipping.

Shifting Between High/Low Ranges

Stop vehicle and shift transmission to Neutral. On manual transmission models, disengage clutch before depressing LOW RANGE button. On all models, 4WD LOW light should illuminate. DO NOT attempt to shift from, or to, low range with vehicle in motion.

MANUAL LOCKING HUBS (PICKUP)

Shifting Between 2H & 4H

Rotate hub lock control from FREE to LOCK. Move transfer case lever from 2H to 4H. DO NOT shift into 4H with rear wheels slipping.

Shifting Between High/Low Ranges

Bring vehicle to a complete stop. Press brake pedal. Shift transmission into Neutral (A/T) or depress clutch (M/T). Move transfer case lever to 4L.

ADJUSTMENTS

FRONT WHEEL BEARINGS

Bearing preload is set at factory and is not adjustable. DO NOT remove large nut on hub and bearing.

REMOVAL & INSTALLATION

AUTOMATIC LOCKING HUBS (RANGER)

Removal

CAUTION: DO NOT pry on hub lock. This will crack or break hub lock, causing vacuum leaks.

1. Raise and support vehicle. Remove wheel. Remove brake caliper and caliper bracket. Remove brake rotor. Install Hub Removal Clips (205-404) and Hub Puller (205-405). Use slide hammer to remove hub lock.
2. Remove and discard hub "O" ring. Remove brake rotor shield. Remove axle shaft retainer ring. Disconnect vacuum hose and ABS harness connector (if equipped). Remove tie rod end castle nut. Using Pitman Arm Puller (211-003), disconnect tie rod end from knuckle.

CAUTION: If any dirt, metal shavings, moisture or corrosion exists in hub or hub bore, hub lock vacuum valve must be replaced.

3. Remove 3 hub mounting bolts. Pull hub out of knuckle. Remove "O" ring. Remove thrust washer. Using Bearing Cup Puller (308-047) and Slide Hammer (307-003), remove needle bearing.

Inspection

Inspect bearing nut and bore slots to ensure slots are aligned. If slots are damaged or not aligned, replace hub and bearing. Inspect axle shaft bore for scoring or excessive wear. Inspect needle bearing bore for scoring and excessive wear. Inspect wheel bearing for excessive looseness or binding.

Installation

NOTE: Needle bearings must be installed with part number facing upward.

1. Lubricate needle bearings with high temperature wheel bearing grease. Insert needle bearings into hub. Position Needle Bearing Replacer (205-402) onto needle bearings. Install Driver Handle (205-153) onto needle bearing replacer. Using a hammer, tap driver handle until needle bearing replacer seats against hub and bearing.

CAUTION: To prevent wheel bearing nut from loosening, ensure all 8 locking

tabs are seated into groove in hub and bearing assembly.

2. Ensure needle bearing is recessed .354-.394 in. (9.00-10.00 mm) from face of hub. Coat needle bearings with high temperature wheel bearing grease. Install NEW thrust washer. Apply a thin coat of high temperature wheel bearing grease to bore of knuckle.
3. Using Seal Depth Set (205-400) and Seal Replacer (205-399), install axle shaft seal. Lubricate axle shaft seal with at least .1 oz. (3.00 g) of high temperature wheel bearing grease. Install NEW bearing/knuckle "O" ring. Lubricate "O" ring with high temperature wheel bearing grease.
4. Carefully install axle shaft and hub into knuckle. DO NOT damage "O" ring or axle shaft seal. Install hub mounting bolts and tighten to 85 ft. lbs. (115 N.m). Install tie rod end and castle nut. Tighten nut to 52 ft. lbs. (70 N.m). Install a NEW cotter pin.

NOTE: Install NEW retainer ring with steel band facing outward.

5. Place a NEW retainer ring onto Snap Ring Sleeve (205-403) with steel band facing outward. Place snap ring sleeve onto axle shaft. Position Pusher (211-078) onto snap ring sleeve. Position Seal Remover Guide (211-071) onto snap ring sleeve.

CAUTION: Ensure retainer ring snaps in place. An audible "click" should be heard.

6. While holding axle shaft into knuckle, push seal remover guide until retainer ring snaps in place. Position hub lock onto hub. Using a rubber mallet, install hub lock. Ensure all hub lock arms are fully seated into hub groove.
7. Using a hand vacuum pump, apply 15 in. Hg of vacuum to wheel-end assembly. Ensure vacuum does not drop more than .5 in. Hg in 30 seconds. To complete installation, reverse removal procedure.

MANUAL LOCKING HUBS

Removal

1. Raise and support vehicle. Remove wheel and tire. Remove brake caliper and rotor. Remove hub lock retaining ring. Pull hub lock outward to remove. Remove axle shaft snap ring. Remove 3 thrust washers.
2. On vehicles equipped with ABS, disconnect wheel sensor connector and harness routing clips. On all models, remove 4 hub and bearing assembly lock nuts. Remove hub and bearing assembly.

Installation

1. Install NEW "O" ring on hub and bearing assembly. Apply high temperature wheel bearing grease to "O" ring area of hub and bearing assembly. Position hub and bearing in place and install 4 lock nuts.
2. Tighten lock nuts to 55 ft. lbs. (74 N.m). Install harness routing clips and reconnect harness connector. On all models, install 3 thrust washers and snap ring on axle shaft.
3. Install NEW "O" ring on hub lock. Install hub lock and retaining ring. To complete installation, reverse removal procedure. Tighten anchor plate bolts to 166 ft. lbs. (225 N.m).

GENERAL INFORMATION

Service Reminder Indicators - Ford

CHANGE OIL SOON/OIL CHANGE REQUIRED MESSAGE

NOTE: This article is only to be used for resetting maintenance reminder lights (when applicable). Some models (not all) may be equipped with one or more resettable maintenance reminder lights indicating maintenance is required. Once required maintenance services are performed, resetting of lights may be required. Information is provided to reset these lights where applicable.

NOTE: Most vehicles are equipped with a Malfunction Indicator Light (MIL) or check engine light. If light comes on and remains on while driving, the vehicle requires some type of repair. See appropriate service and repair information. After repairing fault(s) and clearing fault code(s), the Malfunction Indicator Light (MIL) or check engine light should go out. Some models may use a dual-function indicator light, which is also used to indicate emission component service is due. After performing required service, reset indicator light.

1999-2001 EXPLORER

To reset oil life feature, press and hold the OIL CHANGE RESET control for 5 seconds. The message center will count down for 5 seconds. If reset is successful, message center will display OIL LIFE RESET TO 100%.

1999 WINDSTAR

1. The CHANGE OIL SOON message will be displayed on message center when remaining engine oil life is 5% or less. The OIL CHANGE REQUIRED message will be displayed when engine oil life is 0%.
2. To reset display after oil change, press RESET and SETUP buttons at the same time to activate service mode. OIL LIFE % HOLD RESET NEW will be displayed on message center. Press SETUP button to access System Check function. Press RESET button to start System Check. Press and hold RESET button until display changes. Press RESET and SETUP buttons for personalized setting.
3. After a successful reset, the message center will display OIL LIFE RESET TO 100%.

2000-03 WINDSTAR

1. The CHANGE OIL SOON message will be displayed on message center when remaining engine oil life is 5% or less. The OIL CHANGE REQUIRED message will be displayed when engine oil life is 0%.
2. To reset display after oil change, press SETUP button to access System Check function. Press and release the RESET control to display OIL LIFE XX% HOLD RESET NEW on message center. Press and hold RESET control for 2 seconds to display IF NEW OIL HOLD RESET. Press and hold RESET control. If OIL LIFE SET TO 100% displays, oil life is now reset.

2002-04 EXPLORER

1. The CHANGE OIL SOON message will be displayed on message center when remaining engine oil life is 5% or less. The OIL CHANGE REQUIRED message will be displayed when engine oil life is 0%.
2. To reset display after oil change, press SETUP button to access System Check function. Press and release the RESET control to display OIL LIFE % HOLD RESET NEW on message center. Press and hold RESET control for 2 seconds to display IF NEW OIL HOLD RESET. Press and hold RESET control. If OIL LIFE SET TO 100% displays, oil life is now reset.

2003 TAURUS

The oil life minder has 2-level warnings, both cleared by the RESET button. The critical one returns on the display after a period of time (if the condition is still active). Oil life minder warning can overwrite normal mode messages. Pressing RESET button acknowledges the warning.

1. Press the MODE button repeatedly until OIL LIFE XX% is displayed. XX will be between 6-100% when the oil life is okay. CHANGE OIL SOON is displayed if the oil life is 5% or less. CHANGE OIL NOW is displayed if the oil life is 0%.
2. Press and hold the MODE button for 5 seconds until RESET FOR NEW OIL LIFE is displayed. If the RESET button is not pressed, after one minute of inactivity or if the power is interrupted during the reset oil life mode, the message center resets the oil life to the original value. Press and release the RESET button. The oil life value will be reset to 100%.

2004-07 FREESTAR

1. The CHANGE OIL SOON message will be displayed on message center when remaining engine oil life is 5% or less. The OIL CHANGE REQUIRED message will be displayed when engine oil life is 0%.
2. To reset display after oil change, press SETUP button to access System Check function. Press and release the RESET control to display OIL LIFE XX% HOLD RESET NEW on message center. Press and hold RESET control for 2 seconds to display IF NEW OIL HOLD RESET. Press and hold RESET control. If OIL LIFE SET TO 100% displays, oil life is now reset.

2005-08 ESCAPE

1. The ENGINE OIL CHANGE SOON message will be displayed on message center when remaining engine oil life is 5% or less. The ENGINE OIL CHANGE NOW message will be displayed when engine oil life is 0%.
2. To reset the oil monitoring system to 100%, press SET control to access the system check function. Press and release the SET control to display OIL CHNG XXX% HOLD SET NEW.
3. Press and hold the SET control for 2 seconds to display OIL CHANGE SET TO 100%. Oil life is now reset.

2005-08 EXPLORER

1. The CHANGE OIL SOON message will be displayed on message center when remaining engine oil life is 5% or less. The OIL CHANGE REQUIRED message will be displayed when engine oil life is 0%.
2. To reset the oil monitoring system to 100%, select PRESS RESET AT OIL CHANGE from SETUP

control for current display mode. Press and release the RESET control to display HOLD RESET TO CONFIRM.

3. Press and hold the RESET control to display OIL LIFE SET TO 100%. Oil life is now reset.

2005-07 FIVE HUNDRED & FREESTYLE

1. The CHANGE SOON message is displayed when engine oil life remaining is 10 percent and again when the engine oil life remaining is between 5 and 1 percent. When oil life reaches 0 percent, the OIL LIFE 0%, CHANGE OIL message will be displayed.
2. To reset the oil monitoring system to 100 percent after each oil change, select PRESS RESET AT OIL CHANGE function using the SETUP control. Press and release the RESET control to display HOLD RESET TO CONFIRM.
3. Press and hold the RESET control to display OIL LIFE SET TO 100%. Oil life is now reset.

2006-08 CROWN VICTORIA

1. The CHANGE SOON message is displayed when engine oil life remaining is 10 percent and again when the engine oil life remaining is between 5 and 1 percent. When oil life reaches 0 percent, the OIL LIFE 0%, CHANGE OIL message will be displayed.
2. To reset the oil monitoring system to 100 percent after each oil change, select PRESS RESET AT OIL CHANGE function using the SETUP control. Press and release the RESET control to display HOLD RESET TO CONFIRM.
3. Press and hold the RESET control to display OIL LIFE SET TO 100%. Oil life is now reset.

2007-08 EXPEDITION

1. The CHANGE OIL SOON message will be displayed on message center when remaining engine oil life is 5% or less. The OIL CHANGE REQUIRED message will be displayed when engine oil life is 0%.
2. To reset the oil monitoring system to 100%, press and release SETUP control to display "OIL LIFE = XXX% HOLD RESET = NEW".
3. Press and hold the RESET control for 2 seconds and release. Oil life is set to 100% and OIL LIFE SET TO 100% is displayed. Oil life is now reset.

2007-08 EXPLORER

1. The CHANGE OIL SOON message will be displayed on message center when remaining engine oil life is 5% or less. The OIL CHANGE REQUIRED message will be displayed when engine oil life is 0%.
2. To reset the oil monitoring system, select OIL LIFE SET TO XX% from the SETUP MENU for the current display mode.
3. Press the SELECT/RESET control switch for the next SETUP MENU item or wait for more than 4 seconds to return to the INFO MENU.
4. Press and hold the RESET control to display OIL LIFE SET TO 100%. Oil life is now reset.

2007 FREESTYLE

With System Warning Displayed (CHANGE OIL SOON/OIL CHANGE REQUIRED)

1. Select OIL LIFE XX% RESET IF NEW function from the SETUP control for current display mode.
2. Press and release RESET control to display "IF NEW OIL HOLD RESET".
3. Press and HOLD RESET control to display OIL LIFE SET TO 100%. Oil life is now reset.

Without System Warning Displayed

1. Press SETUP to display "PRESS RESET FOR SYS CHECK".
2. Press and hold the RESET until "IF NEW OIL HOLD RESET" is displayed, then release.
3. Press and hold RESET control again until OIL LIFE SET TO 100% is displayed. Oil life is now reset.

2007-08 SPORT TRAC

1. Select OIL LIFE SET TO XX% from the SETUP MENU for the current display mode.
2. Press and hold TRIP/RESET control switch to reset oil change.
3. Press the TRIP/RESET control switch for the next SETUP MENU item or wait more than 4 seconds to return to the INFO MENU. Oil life is now reset.

2008 TAURUS & TAURUS X

1. To reset the oil monitoring system, press the SETUP control to enter SYSTEM CHECK, then press SETUP control again to display "OIL LIFE = XXX% HOLD RESET = NEW".
2. Press and hold RESET control for 2 seconds and release. Oil life is set to "100%" and "OIL LIFE SET TO 100%" is displayed.
3. While "OIL LIFE SET TO 100%" is displayed, if a lower oil life reset is desired, press and release the RESET control to reduce the value. Each press of the RESET control reduces the value by 10 percent.

CHECK ENGINE LIGHT

1993-94 7.0L LPG HEAVY DUTY TRUCKS

The CHECK ENGINE light is a maintenance reminder light connected to an Emission Maintenance Warning (EMW) module, located under the instrument panel and is used to indicate that the 60,000 mile emission system maintenance is required. Emission maintenance should be performed if CHECK ENGINE light stays on continuously. After servicing emission system, reset light.

1. To reset light, turn ignition off. Remove sticker labeled RESET on EMW module. Using a 7/32" drill bit, insert and lightly press and hold down drill bit in reset hole.
2. Still pressing down on drill bit, turn ignition to RUN position. Light should stay on while drill bit is pressed down. Hold drill bit down for approximately 5 seconds.
3. Remove drill bit. Light should go out within 2-5 seconds. If light does not go out, repeat steps 1, 2 and 3.
4. Cycle ignition from OFF to RUN position. CHECK ENGINE light should illuminate for 2-5 seconds. This verifies proper reset of EMW module.

SERVICE INTERVAL REMINDER LIGHT

NOTE: 1980-84 trucks do not use a Service Reminder Indicator (SRI). Non-EEC vehicles for 1988 are the 2.0L Ranger, 2.3L Ranger, 6.1L and 7.0L gasoline trucks.

1985-87 LIGHT DUTY TRUCKS, 1988 NON-EEC LIGHT DUTY TRUCKS & 1989-92 HEAVY-DUTY TRUCKS

A SRI is used to indicate emission system maintenance is required. Control unit (timer) for maintenance light is located under dash, near steering column or behind glove box. Some models use a non-resettable control unit. Replace it with a resettable type. After servicing emission system, reset SRI.

1. To reset SRI, turn ignition off. Remove tape over reset hole in timer. Lightly push a small Phillips screwdriver into hole in timer unit marked RESET. With light pressure on screwdriver, turn ignition switch to RUN position.
2. Light should stay on while screwdriver is pressed down. Hold screwdriver down for approximately 5 seconds. Remove screwdriver. Light should go out within 2-5 seconds. If light does not go out, repeat steps 1 and 2.
3. Cycle ignition from OFF to RUN position. Light should glow for 2-5 seconds. This verifies proper reset of maintenance reminder light.

1985-89 PASSENGER CARS

Every 5000 or 7500 miles, depending upon engine application, a SERVICE interval reminder light on the dash will illuminate (for approximately 30 seconds), or begin flashing, indicating an oil change is due.

To reset reminder light, turn ignition on. Simultaneously depress and hold TRIP (ODO SEL on Taurus and Sable, SYSTEM CHECK or CHECK OUT on Continental) and RESET or TRIP RESET buttons. On Probe models, depress and hold SERVICE RESET button, located on speed alarm keyboard. On all models, 3 beeps will verify that reminder light has been reset.

TIRE PRESSURE MONITOR SYSTEM

2001-06 FREESTAR & WINDSTAR (INDIRECT SYSTEM)

NOTE: After tire rotation, replacement, balancing, alignment or pressure adjustment, TPM system will need to be reset.

Vehicles With Message Center

1. To reset the system, turn ignition switch to ON position.
2. Press and hold the SETUP button and wait for the message center to display "SYSTEM CHECK".
3. Press the RESET button and wait for the message center to display "HOLD RESET TO RELEARN".
4. Continue to hold the RESET button for 3 seconds. The message "HOLD RESET TO RELEARN" and the

low tire warning light will flash 3 times, indicating the reset procedure is complete.

5. If the light illuminates, reset the tire pressure to specification, then repeat procedure from step 1.
6. The system normally requires 15-20 minutes of driving in each of 3 speed ranges to learn how the tires behave after the system has been reset. See **TIRE LEARNING SPEED RANGES** table. However, the system will become functional in each speed range as soon as learning completes in each individual speed range.

TIRE LEARNING SPEED RANGES

Speed Range	MPH (KM/H)
Low	25-42 (40-68)
Medium	42-62 (68-100)
High	Above 62 (100)

Vehicles Without Message Center

1. To reset the system, turn ignition switch to ON position.
2. Press and hold the Trip/odometer reset button, and wait until "TIRE RESET" or "CHECK TIRE AND RESET" is displayed in odometer display window.
3. Continue to press the button for 3 seconds, then release. After 3 seconds, the low tire pressure warning light will flash 3 times, indicating that the low tire warning system reset procedure is complete.

2004-06 EXPLORER & RANGER

NOTE: If tire pressure sensor is replaced, it will need to be trained.

WARNING: In the following procedure, TPM Activation Magnet (204-324) is used. Death or serious injury can occur if magnetically sensitive devices are exposed to the relearn magnet. Magnets can affect pacemakers.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

1. Turn ignition switch to OFF position.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
6. The horn will sound once and the TPMS indicator will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE"). Place TPM Activation Magnet (204-324)

on the valve stem of the left front tire pressure sensor. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the TPMS module. See **Fig. 1** and **Fig. 2** .

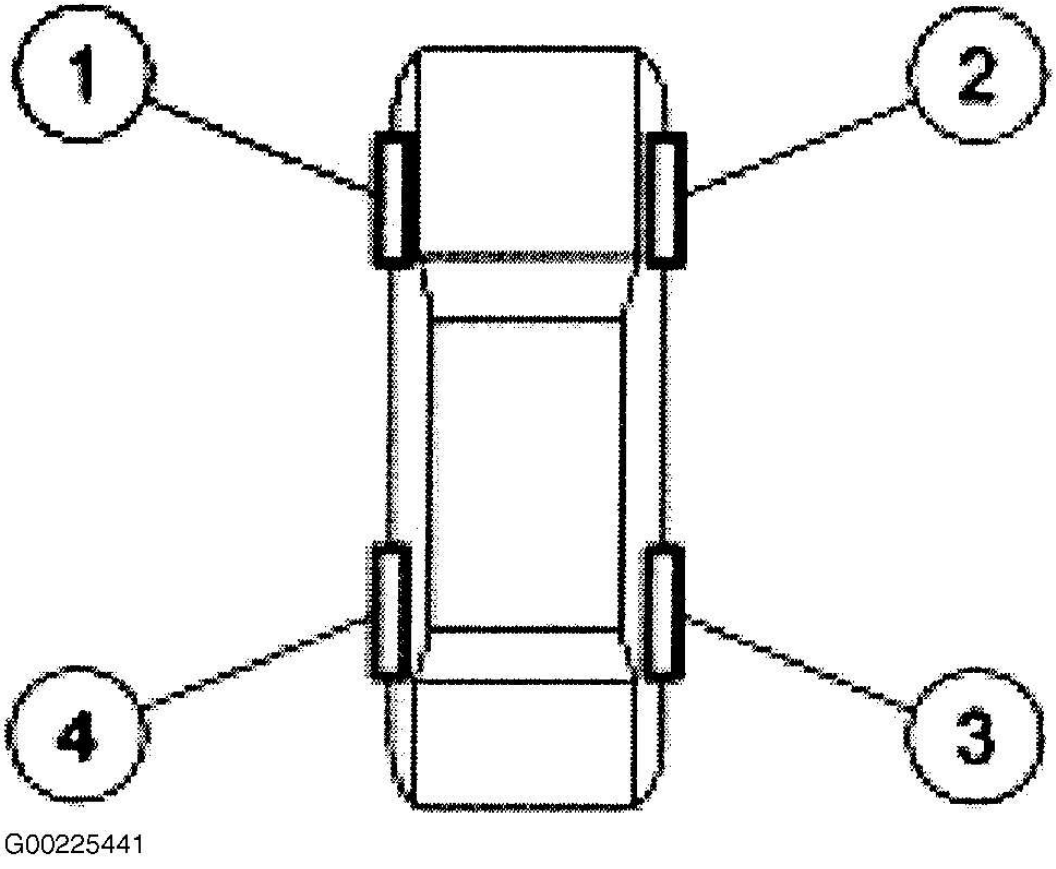


Fig. 1: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

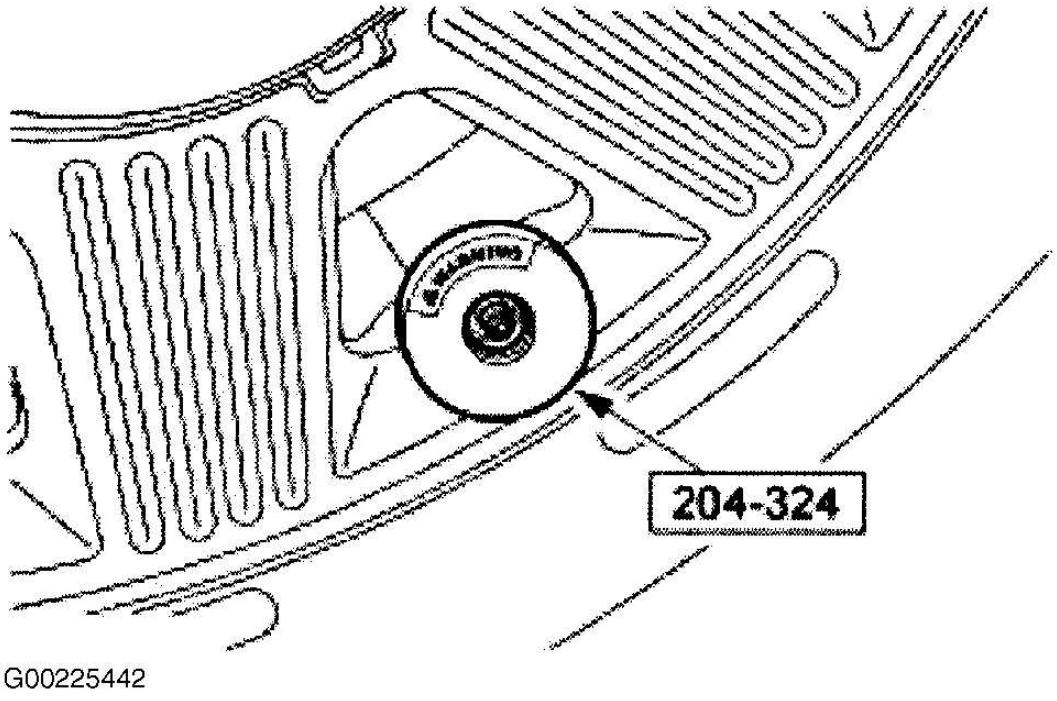


Fig. 2: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

7. Within 2 minutes after the horn sounds, place the magnet on the valve stem of the right front tire pressure sensor. Repeat procedure for right rear and left rear tires.

NOTE: If the VSM (TPMS module is integral to VSM) does not recognize any one of the 4 tire pressure sensors during the tire training procedure, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". If this occurs, procedure must be repeated.

8. When the tire training procedure is complete, the horn will sound once and the message center (if equipped) will display "TIRE TRAINING MODE COMPLETE".

2004-05 FREESTAR (DIRECT SYSTEM)

NOTE: The tire pressure monitoring system is not affected by wheel and tire rotation.

NOTE: If tire pressure sensor is replaced, it will need to be trained. See TIRE PRESSURE SENSOR TRAINING in appropriate manufacturer service information.

2004-06 EXPEDITION

NOTE: If tire pressure sensor is replaced, it will need to be trained.

WARNING: In the following procedure, TPM Activation Magnet (204-324) is used. Death or serious injury can occur if magnetically sensitive devices are exposed to the relearn magnet. Magnets can affect pacemakers.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

1. Turn ignition switch to OFF position.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
6. The horn will sound once and the TPMS indicator will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE"). Place TPM Activation Magnet (204-324) on the valve stem of the left front tire pressure sensor. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the TPMS module. See **Fig. 3** and **Fig. 4** .

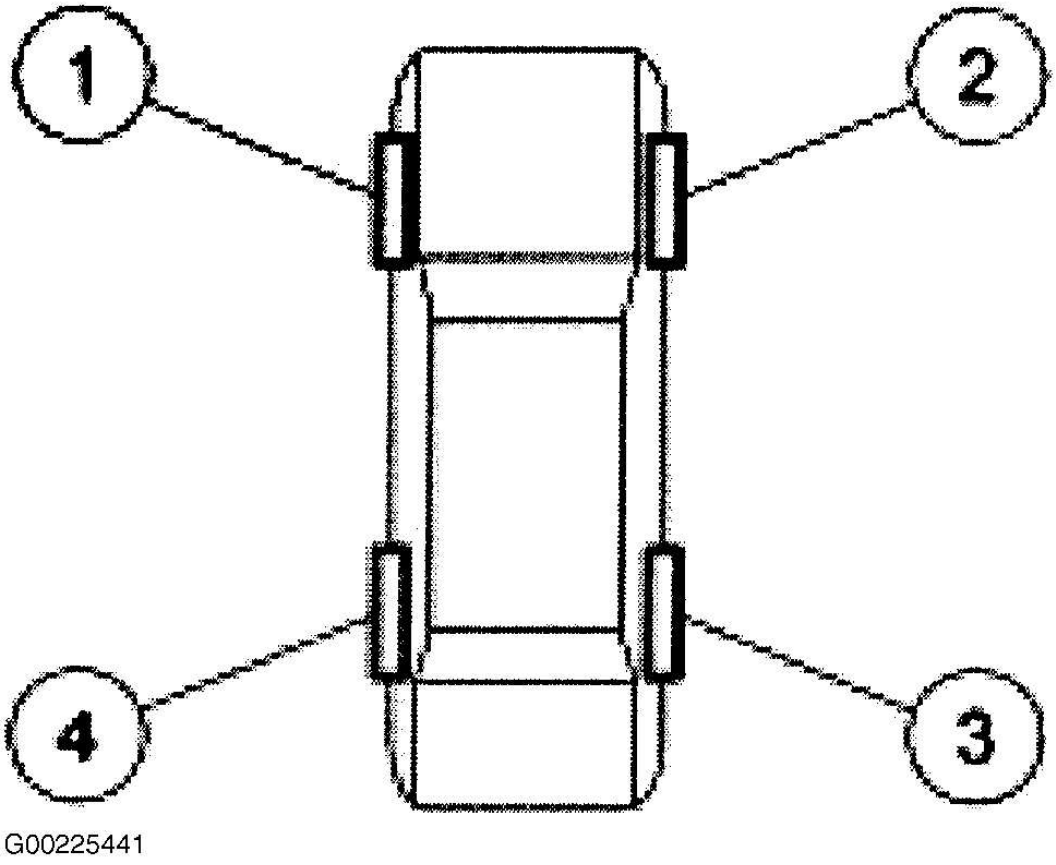


Fig. 3: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

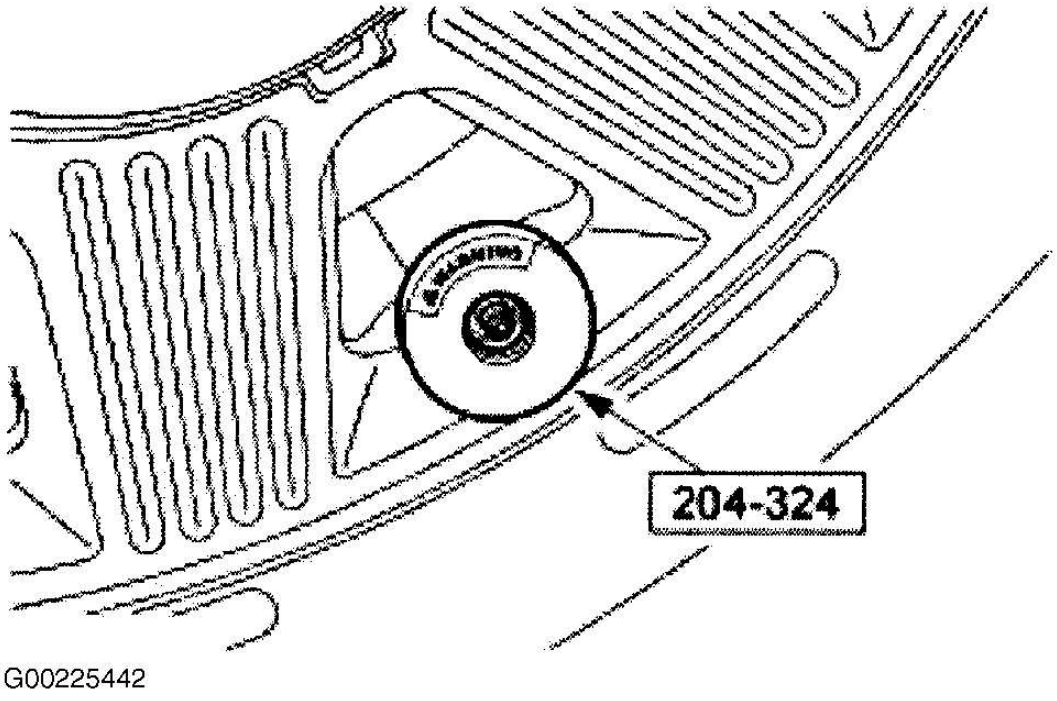


Fig. 4: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

7. Within 2 minutes after the horn sounds, place the magnet on the valve stem of the right front tire pressure sensor. Repeat procedure for right rear and left rear tires.

NOTE: If the VSM (TPMS module is integral to VSM) does not recognize any one of the 4 tire pressure sensors during the tire training procedure, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". If this occurs, procedure must be repeated.

8. When the tire training procedure is complete, the horn will sound once and the message center (if equipped) will display "TIRE TRAINING MODE COMPLETE".

2006-08 ESCAPE, EXPLORER & FREESTAR

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If tire pressure sensor is replaced, it will need to be trained. The TPM system is not affected by wheel and tire rotation.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle,

in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode), and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 5.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the SJB does not recognize any one of the 4 tire pressure sensors during the tire training procedure, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". Repeat training procedure from the beginning.

6. The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE"). Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the SJB.

NOTE: Do not wait more than 2 minutes between training each sensor.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Repeat procedure for right rear and left rear tires. See **Fig. 6**.
8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING MODE COMPLETE". For vehicles not equipped with a message center, successful

completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds when ignition is turned off, the training procedure was not successful.

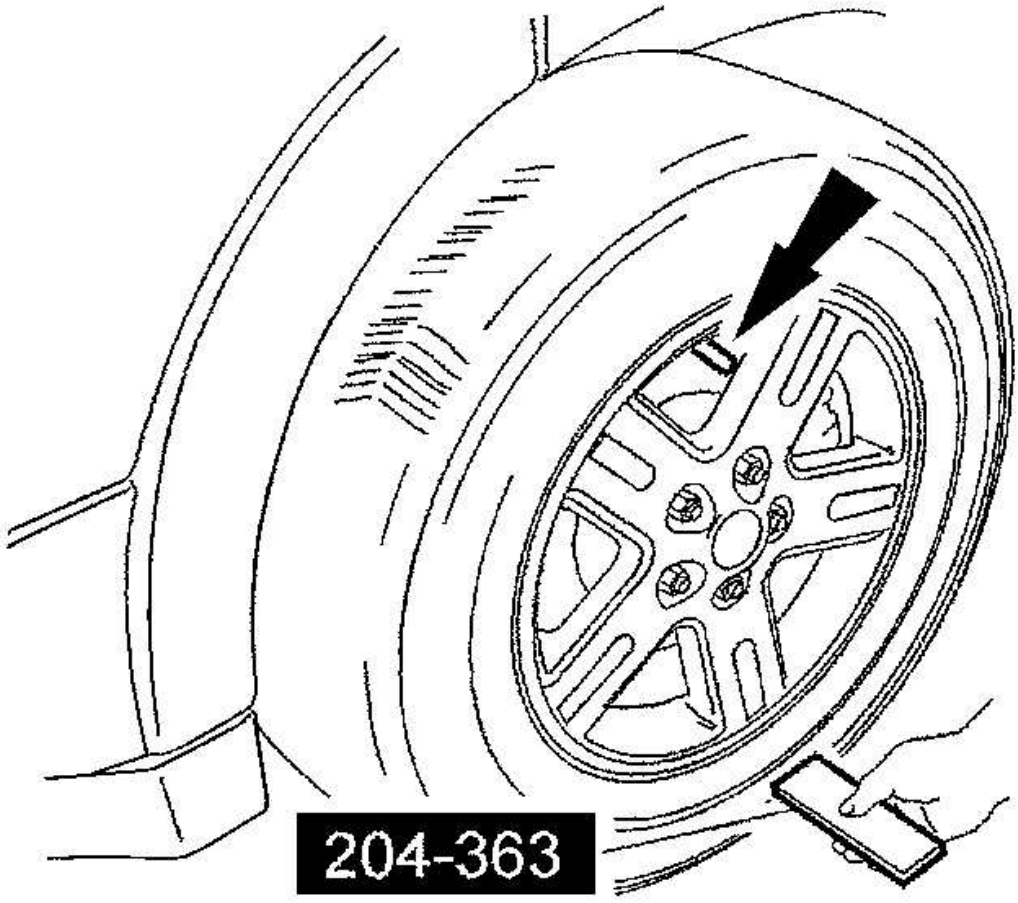


Fig. 5: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

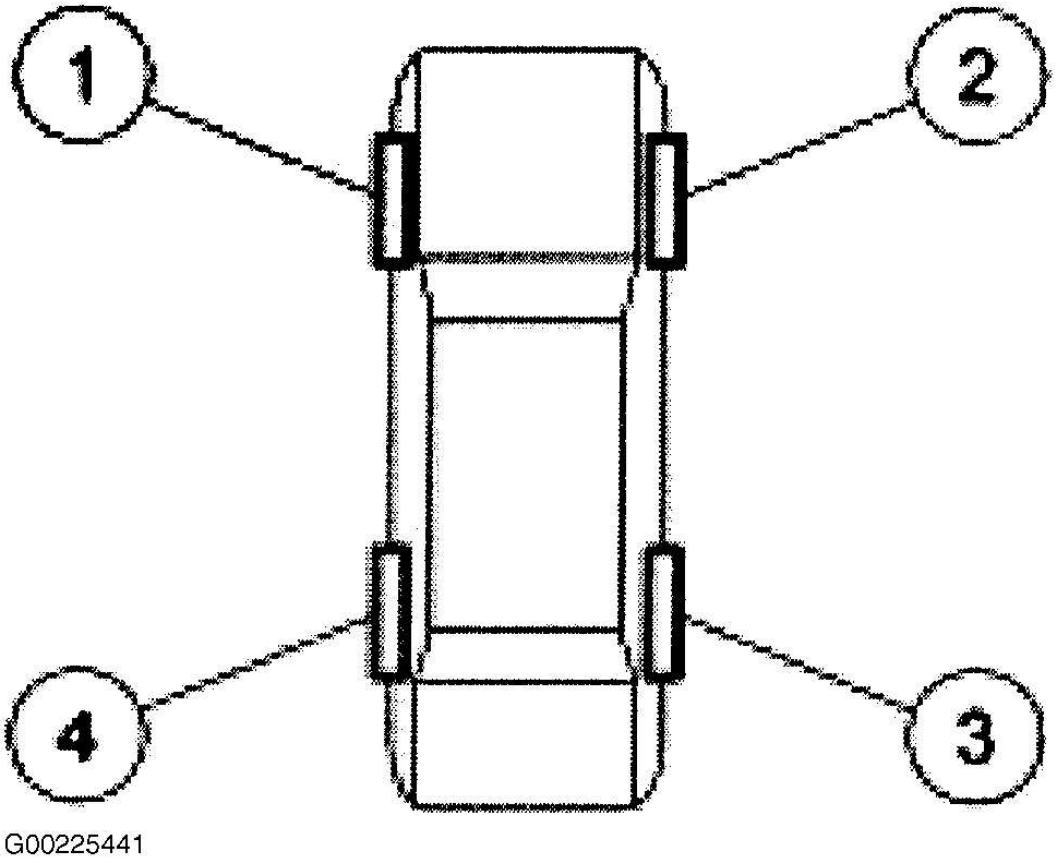


Fig. 6: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

2007-08 EXPEDITION, F150 PICKUP & RANGER

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If tire pressure sensor is replaced, it will need to be trained. The TPM system is not affected by wheel and tire rotation.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode),

and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 7.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the SJB does not recognize any one of the 4 tire pressure sensors during the tire training procedure, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". Repeat training procedure from the beginning.

6. The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE"). Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the SJB.

NOTE: Do not wait more than 2 minutes between training each sensor.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Repeat procedure for right rear and left rear tires. See **Fig. 8**.
8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING MODE COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds when ignition is turned off, the training procedure was not successful.

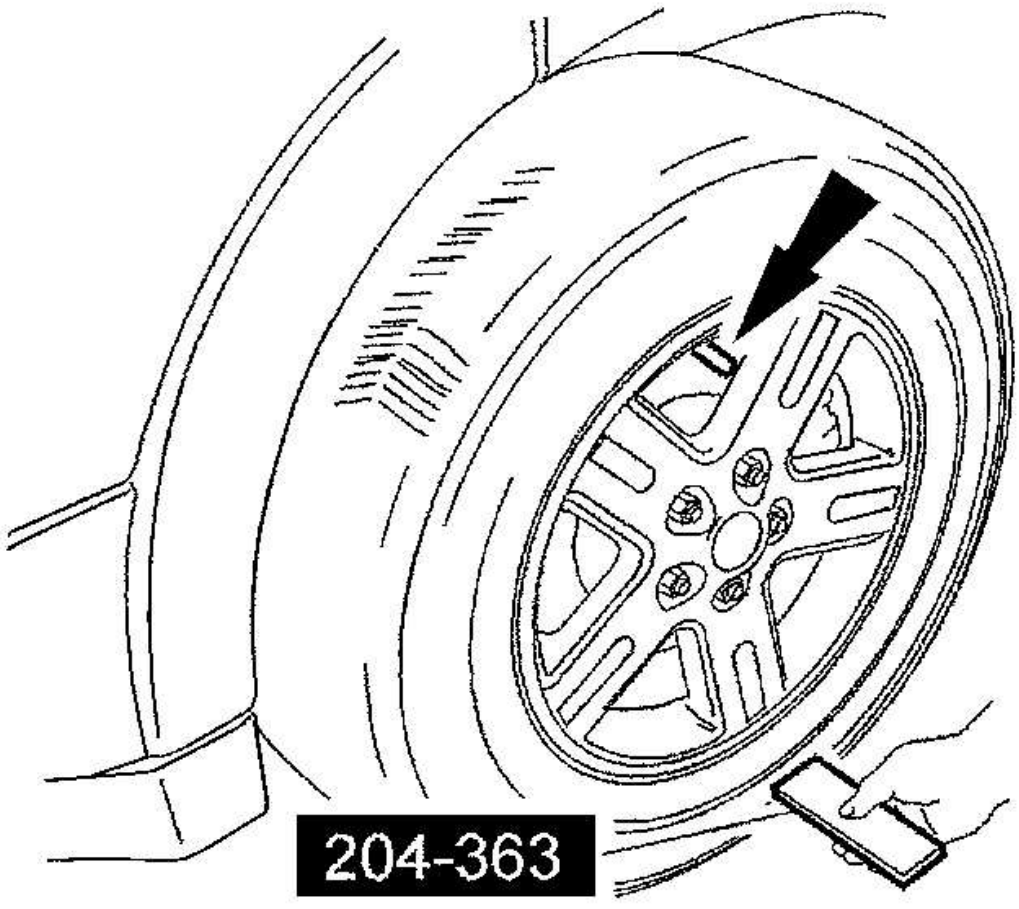


Fig. 7: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

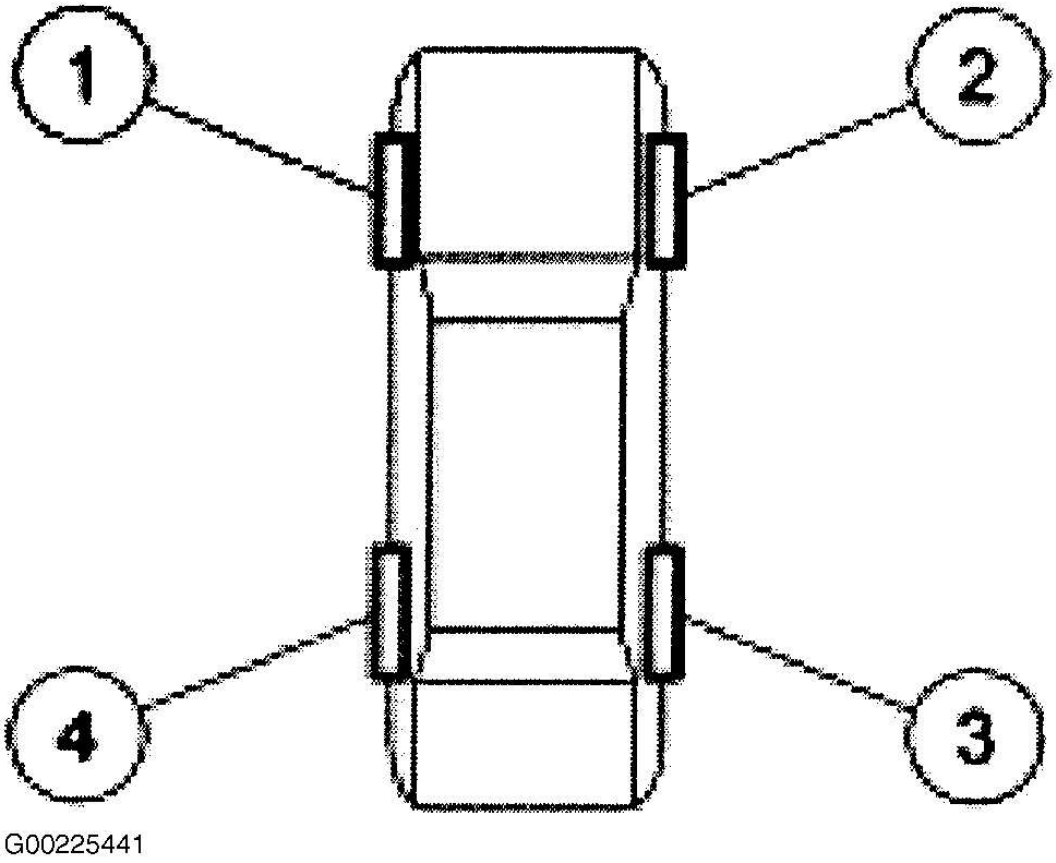


Fig. 8: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

2007-08 MUSTANG

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If tire pressure sensor is replaced, it will need to be trained. The TPM system is not affected by wheel and tire rotation.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode),

and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 9.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the SJB does not recognize any one of the 4 tire pressure sensors during the tire training procedure, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". Repeat training procedure from the beginning.

6. The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE"). Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the SJB.

NOTE: Do not wait more than 2 minutes between training each sensor.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Repeat procedure for right rear and left rear tires. See **Fig. 10**.
8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING MODE COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds when ignition is turned off, the training procedure was not successful.

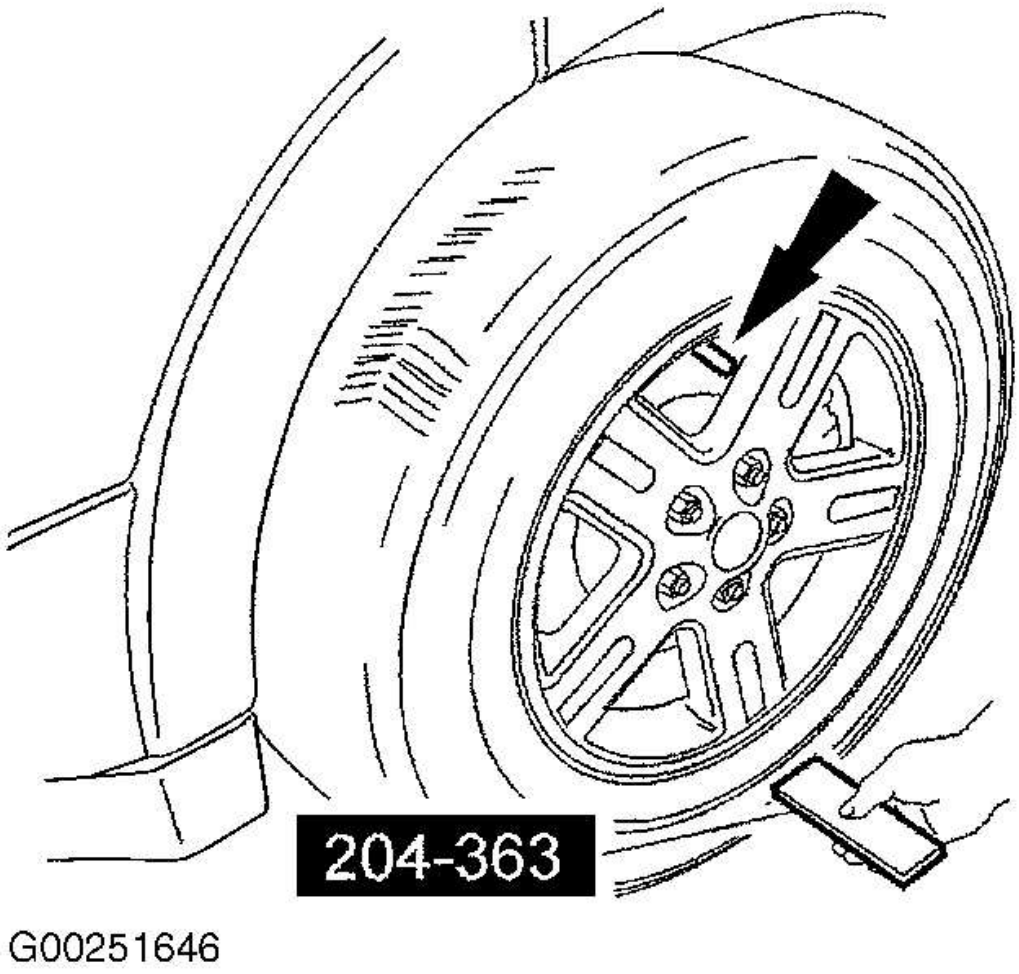


Fig. 9: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

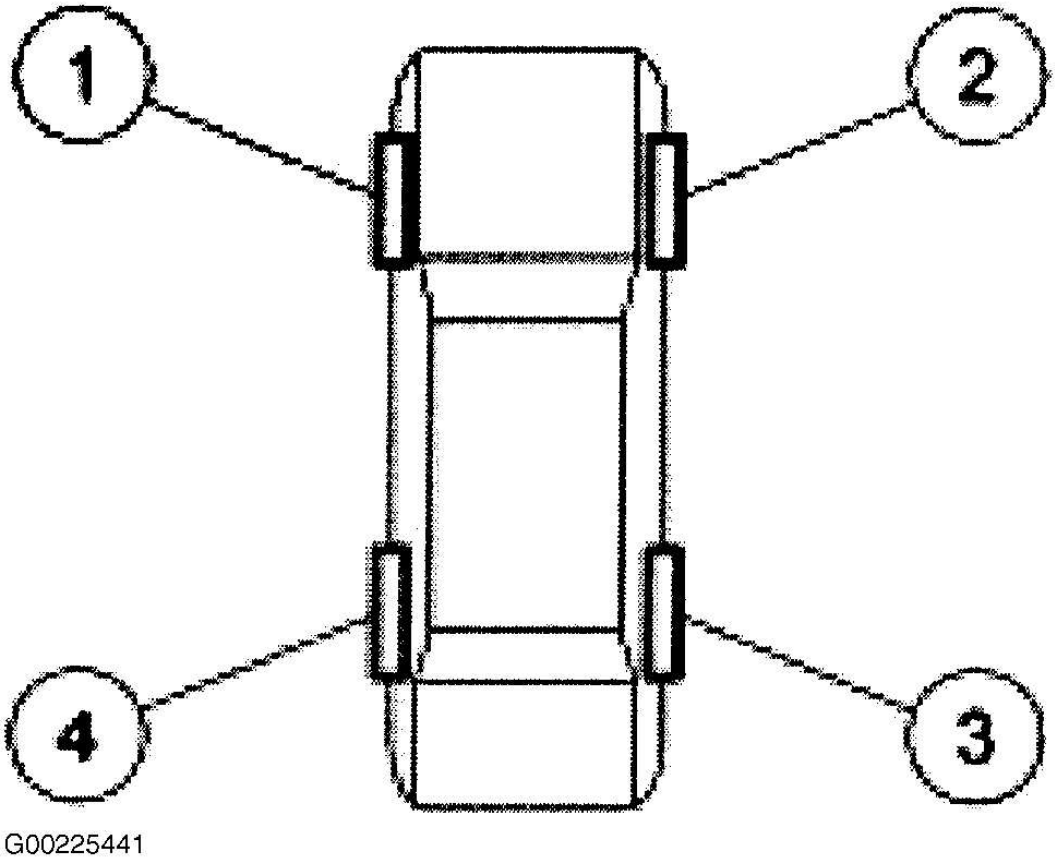


Fig. 10: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

2008 CROWN VICTORIA

Tire Pressure Sensor Training

NOTE: **In the following procedure, TPM Activation Tool (204-363) must be used.**

NOTE: **If tire pressure sensor is replaced, it will need to be trained. The TPM system is not affected by wheel and tire rotation.**

NOTE: **The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.**

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode), and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE").

6. Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the DDM.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 11.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the DDM does not recognize any one of the 4 tire pressure sensors during the 2 minute time limit for each sensor response, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". The training procedure must be repeated from the beginning.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Then press the activation tool test button to train the right front tire pressure sensor. Repeat procedure for right rear and left rear tires. See **Fig. 12**.

NOTE: Do not wait more than 2 minutes between training each sensor. If the wait time is more than 2 minutes the DDM will stop and the training procedure must be repeated from the beginning.

8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds twice when ignition is turned off, the training procedure was not successful.

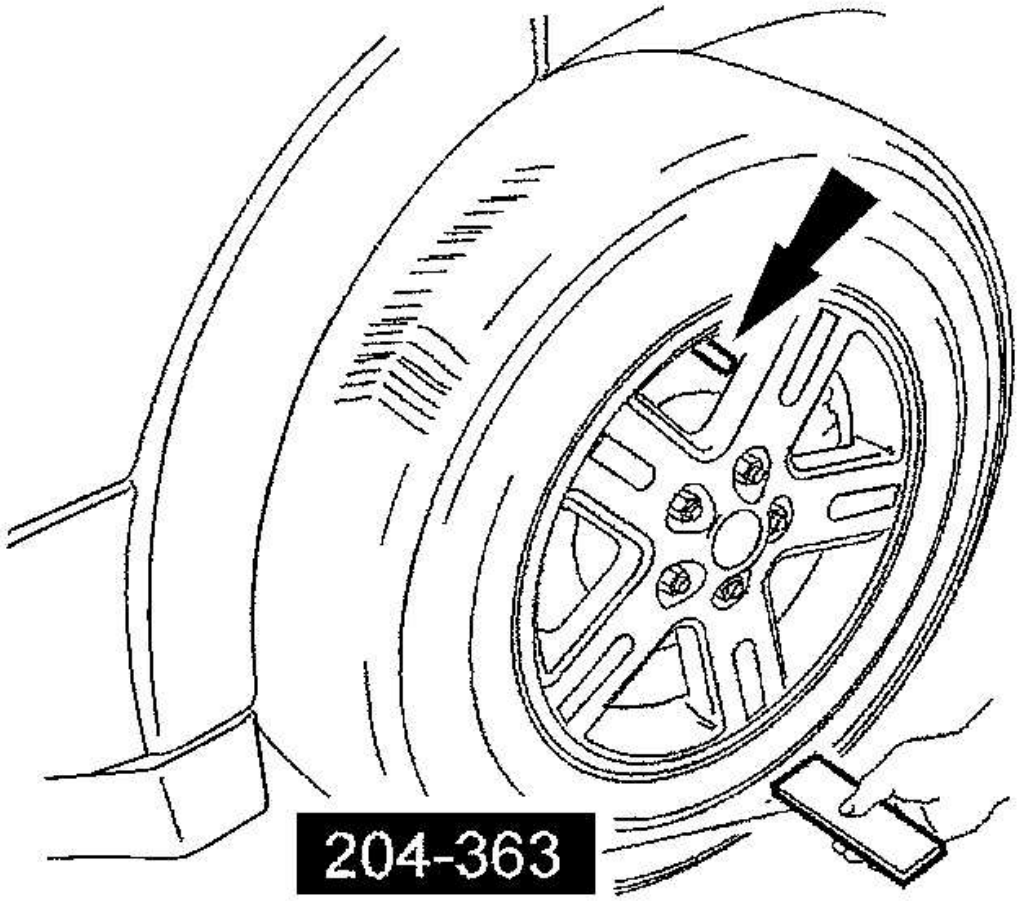


Fig. 11: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

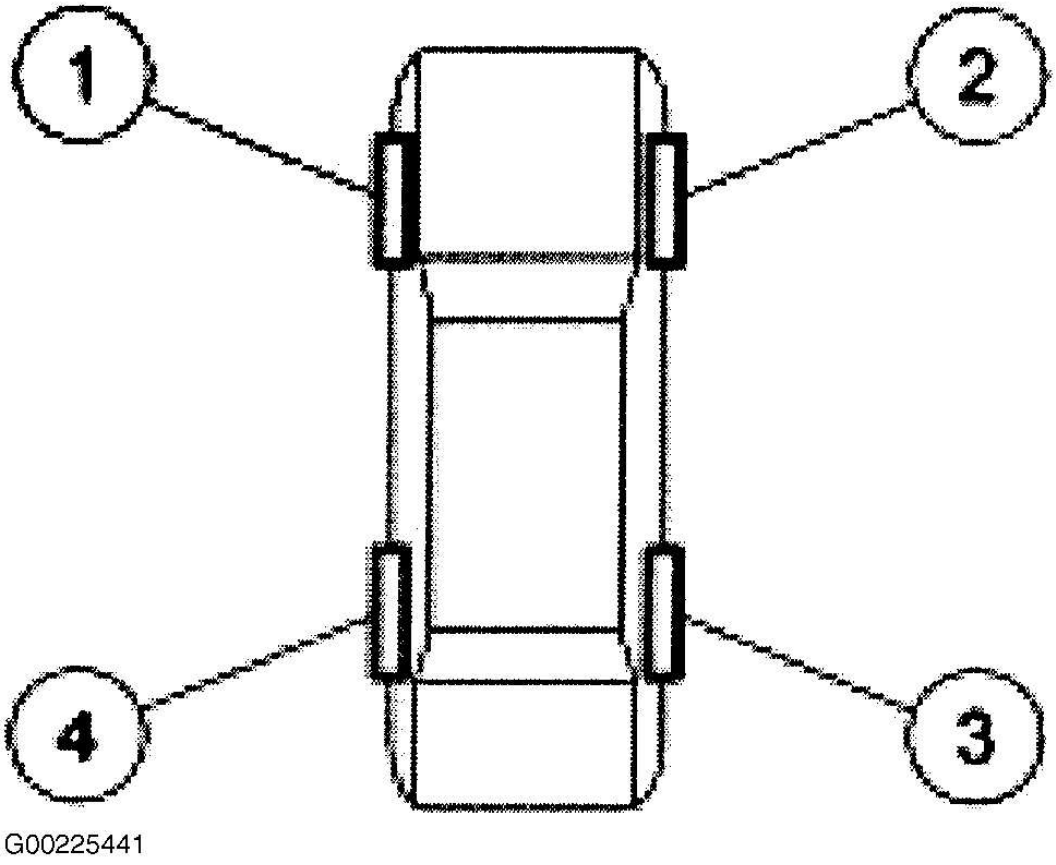


Fig. 12: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

Tire Pressure Sensor Activation

1. Turn ignition switch to ON position.
2. Place the activation tool on the left front tire wall 180 degrees from the valve stem.
3. Press the test button on the Activation Tool to activate the TPM sensor. For best results, activate each sensor twice.

NOTE: A green light will flash and a beep sound on the Activation Tool for each successful TPM sensor response.

4. Preform steps 1-3 for each remaining tire.

NOTE: After adjusting tire pressures and activating sensors, the tire pressure warning light is still illuminated. There is a malfunction in the TPM system.

See appropriate manufacturer service information.

2008 E-SERIES & ECONOLINE

Tire Pressure Sensor Training

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If the vehicle has different front and rear tire pressures, the tire pressure has to be adjusted and the TPM sensors has to be trained. If the vehicle has the same tire pressure on the front and rear tires, the tire pressure monitoring system is not affected by wheel and tire rotation.

NOTE: If tire pressure sensor is replaced, it will need to be trained.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode), and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE").

6. Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem. Press the test button on the Activation Tool. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the VSM.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this

time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 13.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the VSM does not recognize any one of the 4 tire pressure sensors during the 2 minute time limit for each sensor response, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". The training procedure must be repeated from the beginning.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Repeat procedure for right rear and left rear tires. See **Fig. 14**.

NOTE: Do not wait more than 2 minutes between training each sensor. If the wait time is more than 2 minutes the VSM will stop and the training procedure must be repeated from the beginning.

8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds twice when ignition is turned off, the training procedure was not successful.

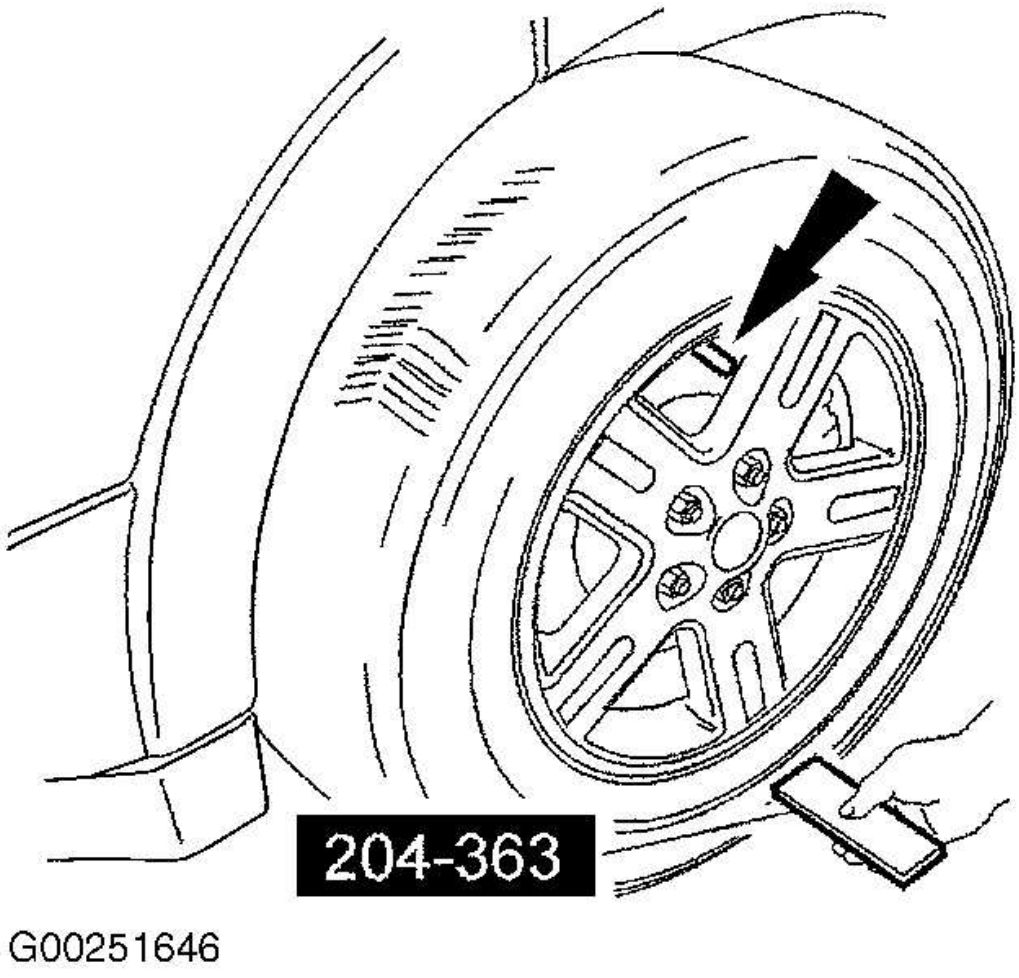


Fig. 13: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

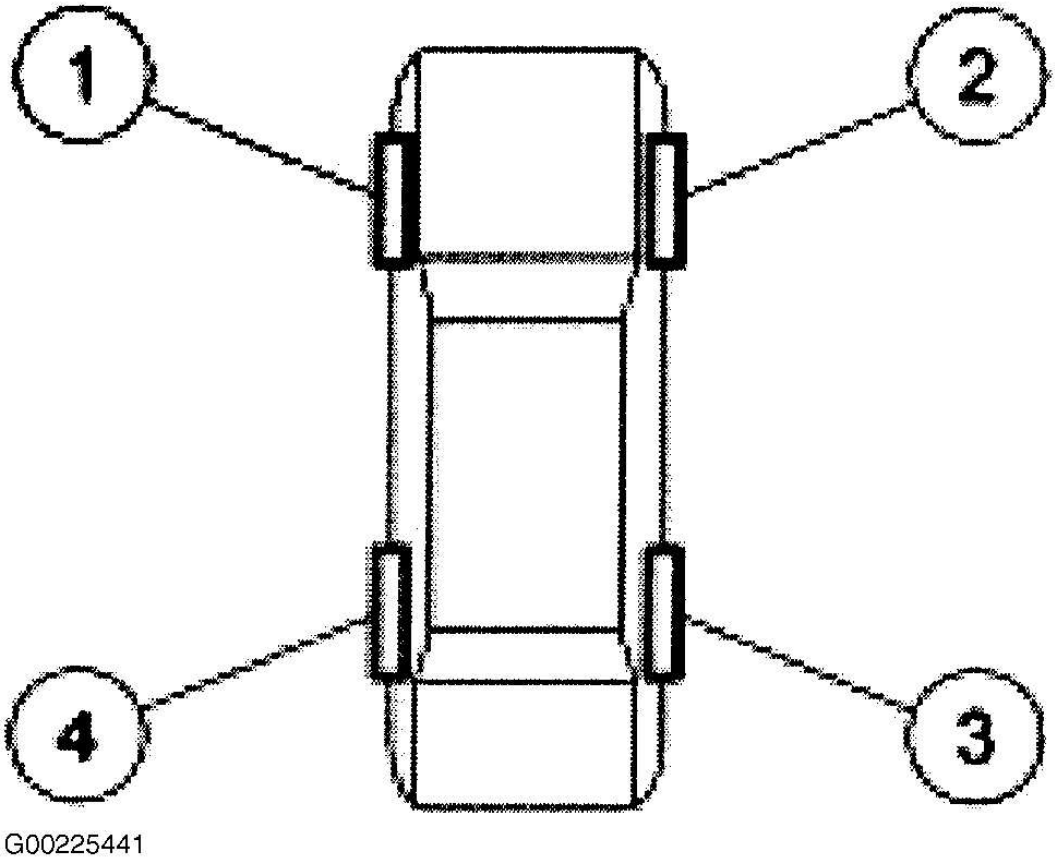


Fig. 14: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

Tire Pressure Sensor Activation

1. Turn ignition switch to ON position.
2. Place the activation tool on the left front tire wall 180 degrees from the valve stem.
3. Press the test button on the Activation Tool to activate the TPM sensor. For best results, activate each sensor twice.

NOTE: A green light will flash and a beep sound on the Activation Tool for each successful TPM sensor response.

4. Preform steps 1-3 for each remaining tire.

NOTE: After adjusting tire pressures and activating sensors, the tire pressure warning light is still illuminated. There is a malfunction in the TPM system.

See appropriate manufacturer service information.

2008 EDGE

Tire Pressure Sensor Training

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If tire pressure sensor is replaced, it will need to be trained. The TPM system is not affected by wheel and tire rotation.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode), and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE").

6. Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem and press the test button on the Activation Tool. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the SJB.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 15.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the

same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the SJB does not recognize any one of the 4 tire pressure sensors during the 2 minute time limit for each sensor response, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". The training procedure must be repeated from the beginning.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Then press the activation tool test button to train the right front tire pressure sensor. Repeat procedure for right rear and left rear tires. See **Fig. 16**.

NOTE: Do not wait more than 2 minutes between training each sensor. If the wait time is more than 2 minutes the SJB will stop and the training procedure must be repeated from the beginning.

8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds twice when ignition is turned off, the training procedure was not successful.

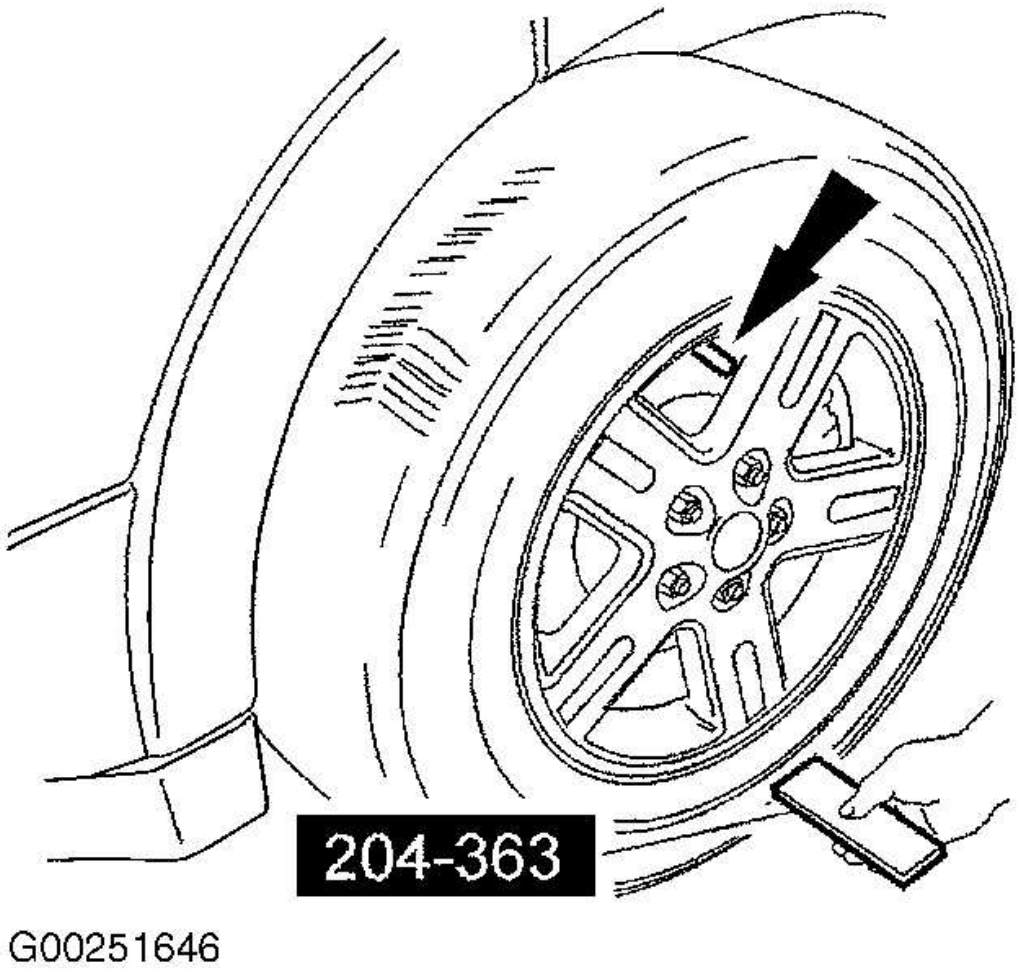


Fig. 15: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

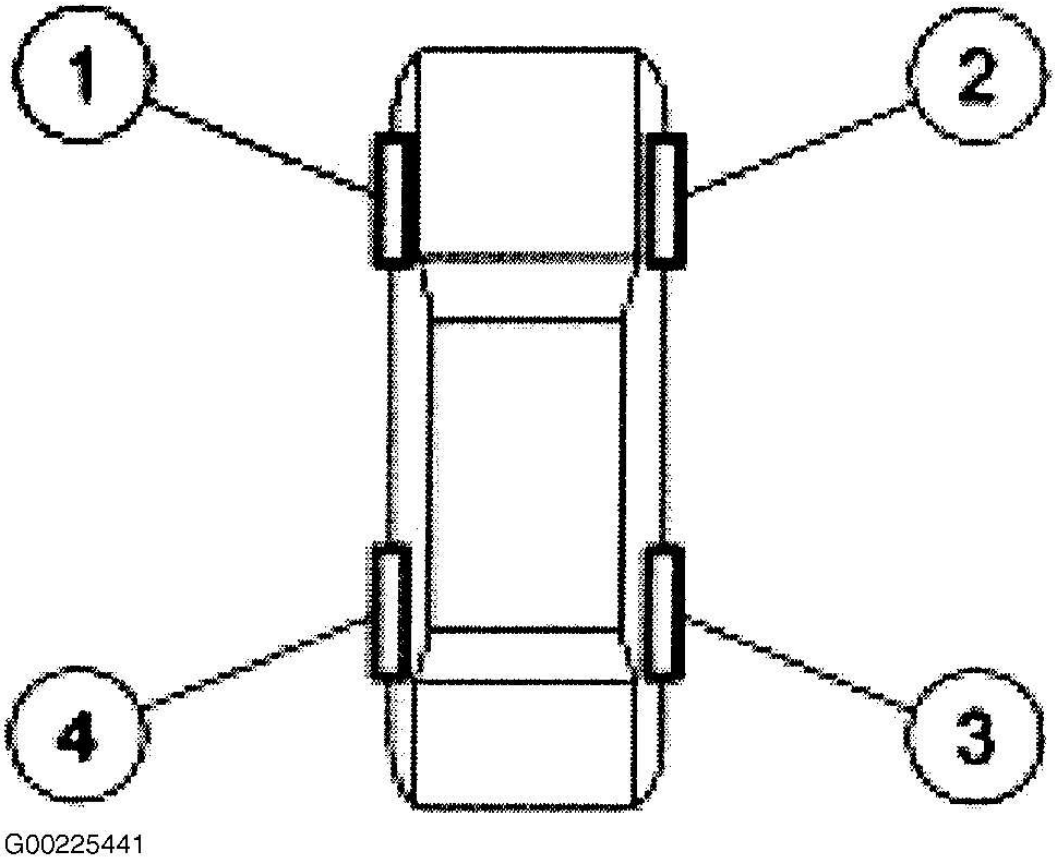


Fig. 16: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

Tire Pressure Sensor Activation

1. Turn ignition switch to ON position.
2. Place the activation tool on the left front tire wall 180 degrees from the valve stem.
3. Press the test button on the Activation Tool to activate the TPM sensor. For best results, activate each sensor twice.

NOTE: A green light will flash and a beep sound on the Activation Tool for each successful TPM sensor response.

4. Repeat steps 1-3 for each remaining tire.

NOTE: After adjusting tire pressures and activating sensors, the tire pressure warning light is still illuminated. There is a malfunction in the TPM system.

See appropriate manufacturer service information.

2008 EXPLORER SPORT TRAC

Tire Pressure Sensor Training

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If tire pressure sensor is replaced, it will need to be trained. The TPM system is not affected by wheel and tire rotation.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode), and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE").

6. Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem and press the test button on the Activation Tool. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the SJB.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 17.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the

same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the SJB does not recognize any one of the 4 tire pressure sensors during the 2 minute time limit for each sensor response, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". The training procedure must be repeated from the beginning.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Then press the activation tool test button to train the right front tire pressure sensor. Repeat procedure for right rear and left rear tires. See **Fig. 18**.

NOTE: Do not wait more than 2 minutes between training each sensor. If the wait time is more than 2 minutes the SJB will stop and the training procedure must be repeated from the beginning.

8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds twice when ignition is turned off, the training procedure was not successful.

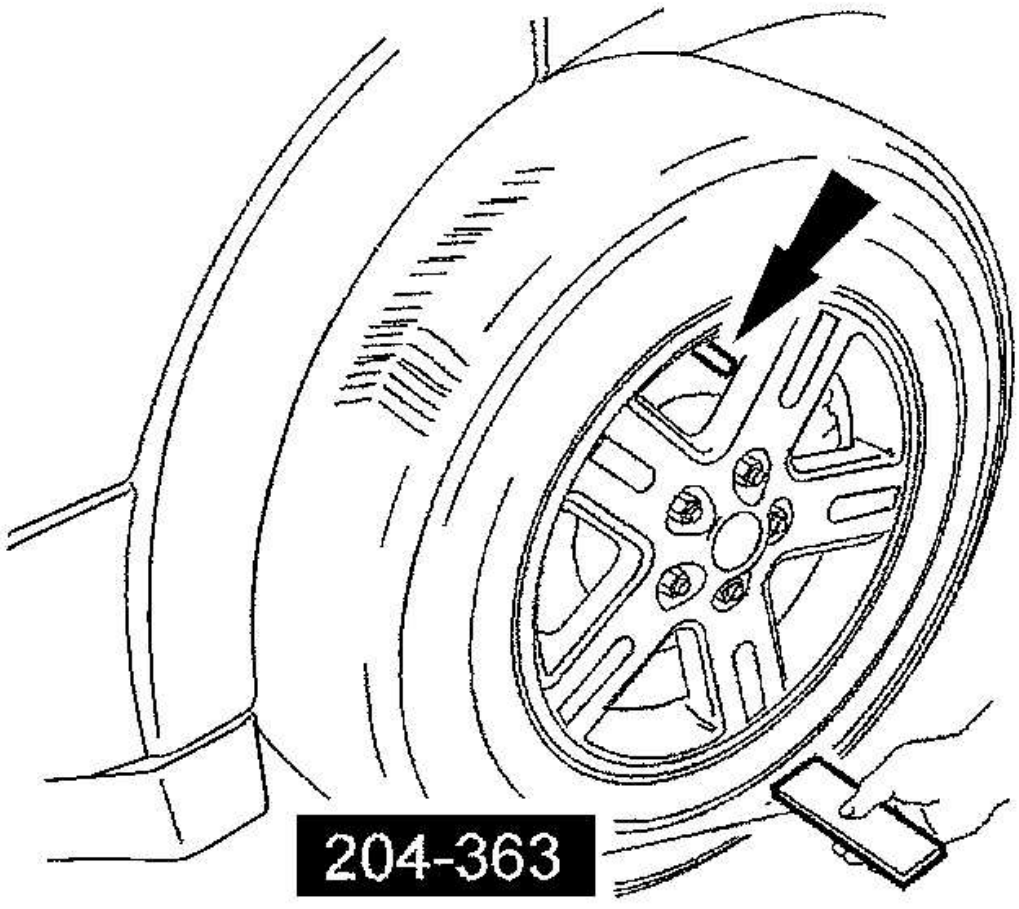


Fig. 17: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

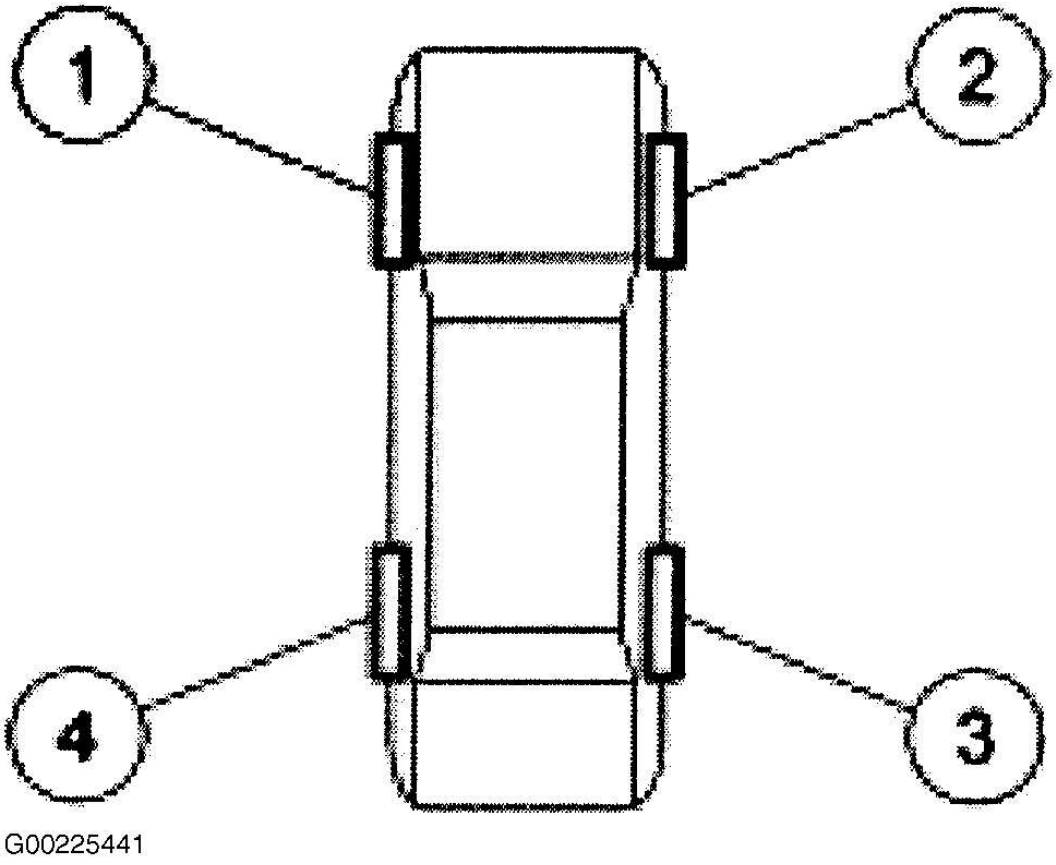


Fig. 18: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

Tire Pressure Sensor Activation

1. Turn ignition switch to ON position.
2. Place the activation tool on the left front tire wall 180 degrees from the valve stem.
3. Press the test button on the Activation Tool to activate the TPM sensor. For best results, activate each sensor twice.

NOTE: A green light will flash and a beep sound on the Activation Tool for each successful TPM sensor response.

4. Preform steps 1-3 for each remaining tire.

NOTE: After adjusting tire pressures and activating sensors, the tire pressure warning light is still illuminated. There is a malfunction in the TPM system.

See appropriate manufacturer service information.

2008 F450 SUPER DUTY & F550 SUPER DUTY

Tire Pressure Sensor Training

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If the vehicle has different front and rear tire pressures, the tire pressure has to be adjusted and the TPM sensors have to be trained. If the vehicle has the same tire pressure on the front and rear tires, the tire pressure monitoring system is not affected by wheel and tire rotation.

NOTE: If tire pressure sensor is replaced, it will need to be trained.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode), and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE").

6. Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem. Press the test button on the Activation Tool. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the SJB.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this

time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 19.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the SJB does not recognize any one of the 4 tire pressure sensors during the 2 minute time limit for each sensor response, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". The training procedure must be repeated from the beginning.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Repeat procedure for right rear and left rear tires. See **Fig. 20**.

NOTE: Do not wait more than 2 minutes between training each sensor. If the wait time is more than 2 minutes the SJB will stop and the training procedure must be repeated from the beginning.

8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds twice when ignition is turned off, the training procedure was not successful.

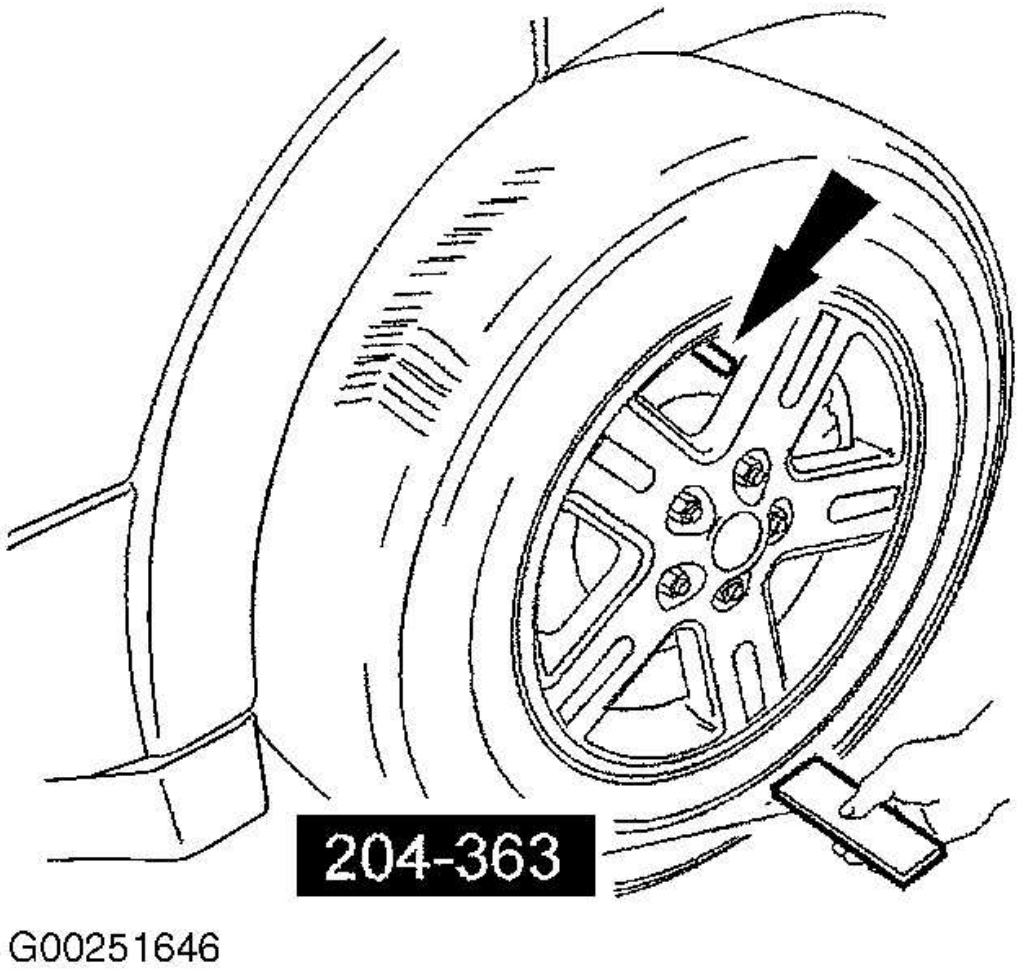


Fig. 19: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

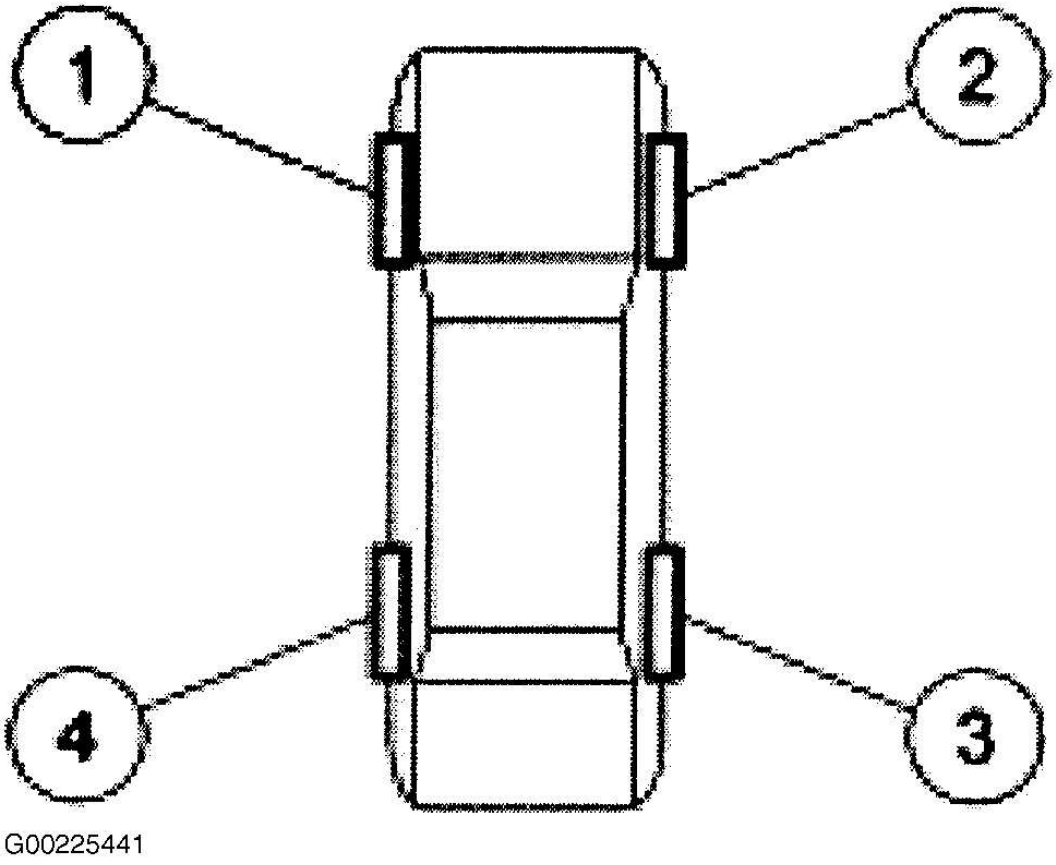


Fig. 20: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

Tire Pressure Sensor Activation

1. Turn ignition switch to ON position.
2. Place the activation tool on the left front tire wall 180 degrees from the valve stem.
3. Press the test button on the Activation Tool to activate the TPM sensor. For best results, activate each sensor twice.

NOTE: A green light will flash and a beep sound on the Activation Tool for each successful TPM sensor response.

4. Repeat steps 1-3 for each remaining tire.

NOTE: After adjusting tire pressures and activating sensors, the tire pressure warning light is still illuminated. There is a malfunction in the TPM system.

See appropriate manufacturer service information.

2008 FOCUS & FUSION

Tire Pressure Sensor Training

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If tire pressure sensor is replaced, it will need to be trained. The TPM system is not affected by wheel and tire rotation.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode), and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE").

6. Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem and press the test button on the Activation Tool. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the SJB.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 21.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the

same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the SJB does not recognize any one of the 4 tire pressure sensors during the 2 minute time limit for each sensor response, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". The training procedure must be repeated from the beginning.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Then press the activation tool test button to train the right front tire pressure sensor. Repeat procedure for right rear and left rear tires. See **Fig. 22**.

NOTE: Do not wait more than 2 minutes between training each sensor. If the wait time is more than 2 minutes the SJB will stop and the training procedure must be repeated from the beginning.

8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds twice when ignition is turned off, the training procedure was not successful.

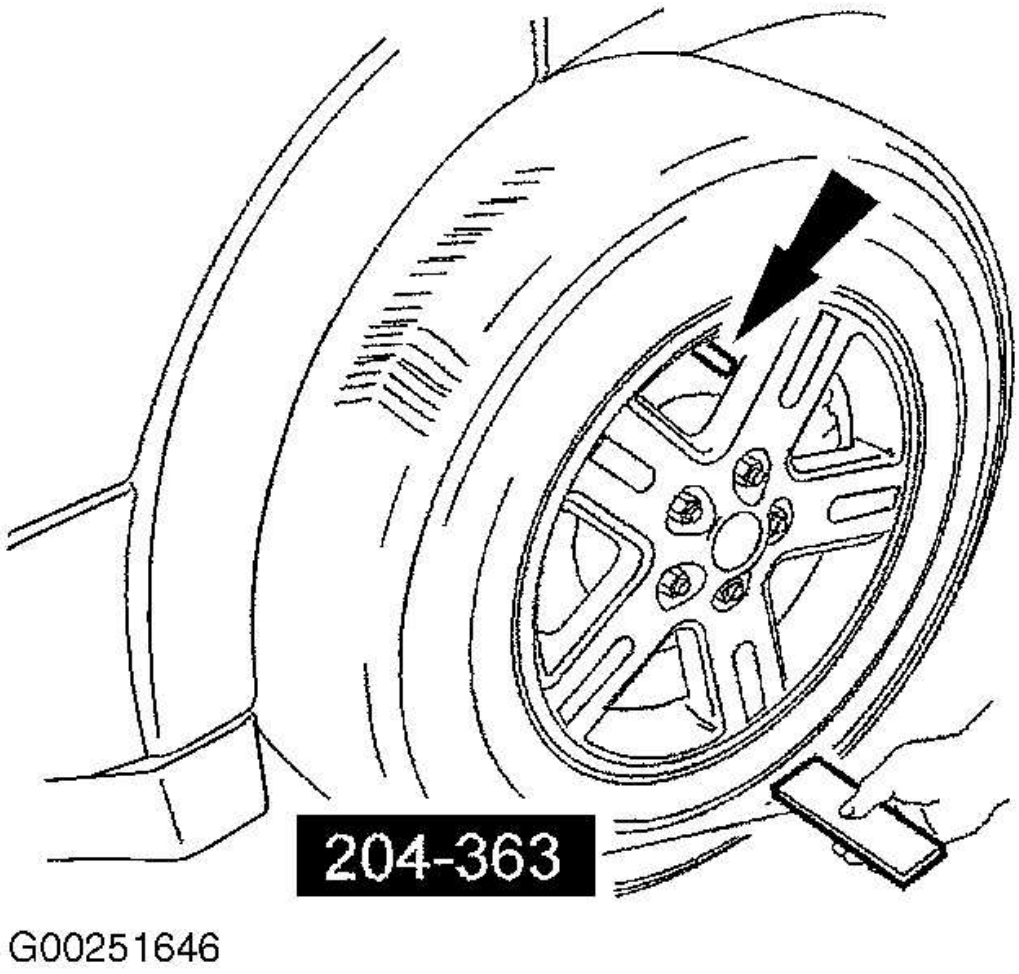


Fig. 21: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

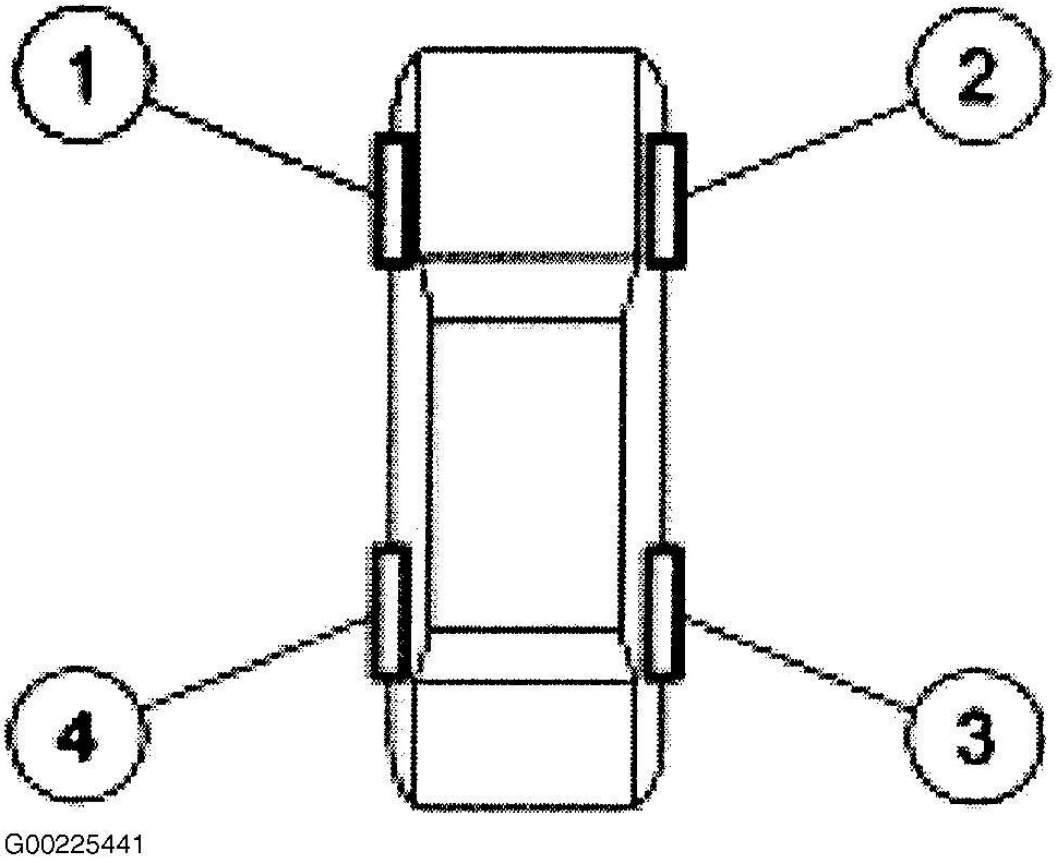


Fig. 22: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

Tire Pressure Sensor Activation

1. Turn ignition switch to ON position.
2. Place the activation tool on the left front tire wall 180 degrees from the valve stem.
3. Press the test button on the Activation Tool to activate the TPM sensor. For best results, activate each sensor twice.

NOTE: A green light will flash and a beep sound on the Activation Tool for each successful TPM sensor response.

4. Repeat steps 1-3 for each remaining tire.

NOTE: After adjusting tire pressures and activating sensors, the tire pressure warning light is still illuminated. There is a malfunction in the TPM system.

See appropriate manufacturer service information.

2008 TAURUS & TAURUS X

Tire Pressure Sensor Training

NOTE: In the following procedure, TPM Activation Tool (204-363) must be used.

NOTE: If tire pressure sensor is replaced, it will need to be trained. The TPM system is not affected by wheel and tire rotation.

NOTE: The tire pressure sensor training procedure must be done on a single vehicle, in an area without Radio Frequency (RF) noise and at least 3 ft. (1 m) away from any other vehicle equipped with TPM system. RF noise is generated by electrical motor and appliance operation, cellular telephones and remote transmitters, power inverters and portable entertainment equipment.

NOTE: A new tire pressure sensor is shipped in an OFF mode (or battery saver mode), and must be turned ON before it can be trained. To turn the sensor on, inflate the tire to the recommended inflation pressure and wait at least 2 minutes, then continue with the sensor training procedure.

1. Turn ignition switch to OFF position, then press and release brake pedal.
2. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.
3. Press and release the brake pedal.
4. Turn ignition switch to OFF position.
5. Turn ignition switch from OFF position to the RUN position 3 times, ending in RUN position. Do not wait more than one minute between each key cycle.

NOTE: The horn will sound once and the tire pressure warning light will flash if train mode has been entered successfully (if equipped, the message center displays "TRAIN LF TIRE").

6. Place TPM Activation Tool (204-363) on the left front tire wall opposite (180 degrees) from the valve stem and press the test button on the Activation Tool. The horn will sound briefly to indicate that the tire pressure sensor has been recognized by the SJB.

NOTE: It may take up to 6 seconds to activate a tire pressure sensor. During this time, the activation tool must remain in place 180 degrees from the valve stem. See Fig. 23.

NOTE: If a sensor does not respond to the activation tool, attempt to activate the

same sensor using activation tool. If the sensor still does not respond, move the vehicle to rotate the wheels at least 1/4 of a turn and attempt to activate the same sensor again.

NOTE: If the SJB does not recognize any one of the 4 tire pressure sensors during the 2 minute time limit for each sensor response, the horn will sound twice and the message center (if equipped) will display "TIRE NOT TRAINED REPEAT". The training procedure must be repeated from the beginning.

7. Within 2 minutes after the horn sounds, place the activation tool on the right front tire wall opposite (180 degrees) from the valve stem. Then press the activation tool test button to train the right front tire pressure sensor. Repeat procedure for right rear and left rear tires. See **Fig. 24**.

NOTE: Do not wait more than 2 minutes between training each sensor. If the wait time is more than 2 minutes the SJB will stop and the training procedure must be repeated from the beginning.

8. When the tire training procedure is complete, the message center (if equipped) will display "TIRE TRAINING COMPLETE". For vehicles not equipped with a message center, successful completion of the training procedure will be verified by turning the ignition switch to the OFF position without the horn sounding. If the horn sounds twice when ignition is turned off, the training procedure was not successful.

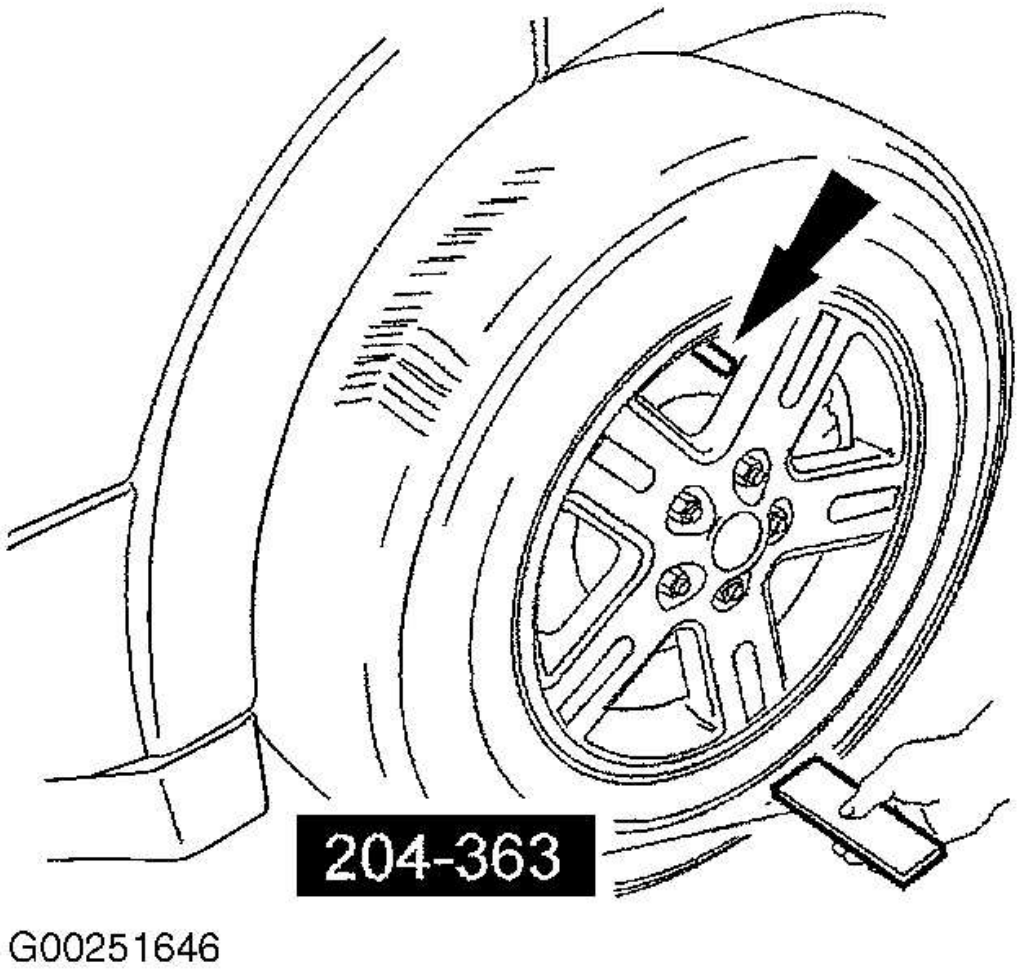


Fig. 23: Training Tire Pressure Sensors (1 Of 2)
Courtesy of FORD MOTOR CO.

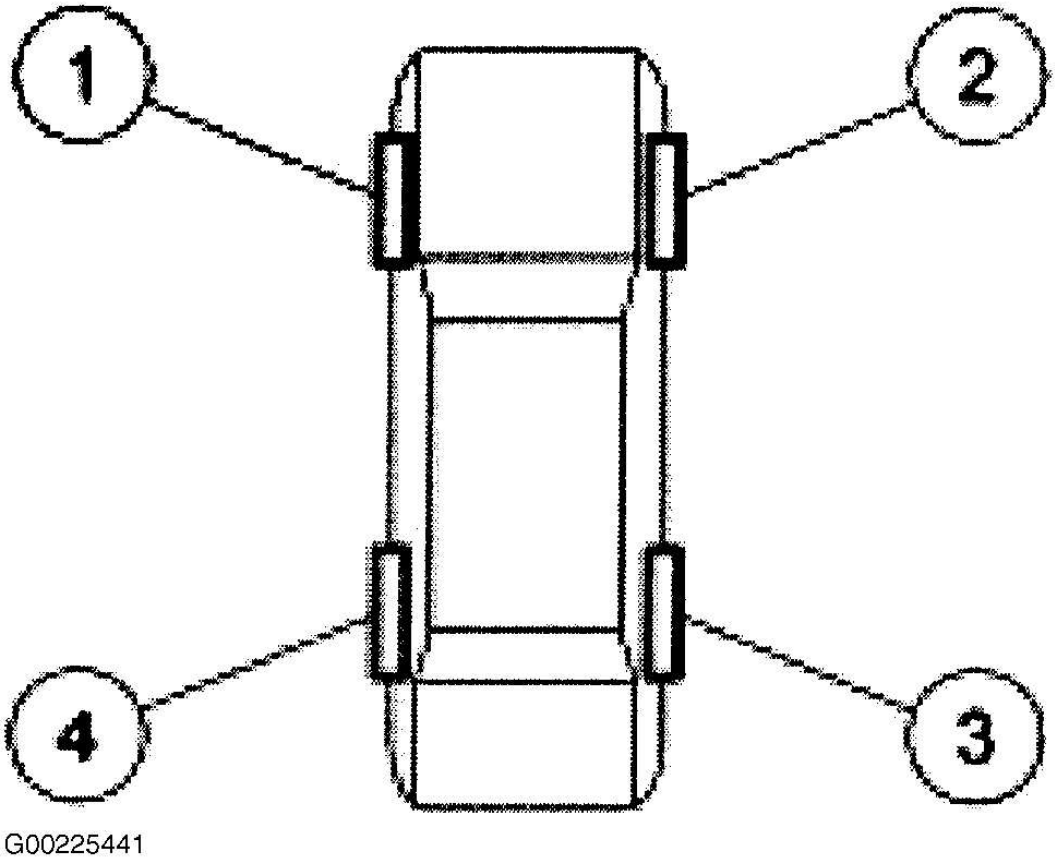


Fig. 24: Training Tire Pressure Sensors (2 Of 2)
Courtesy of FORD MOTOR CO.

Tire Pressure Sensor Activation

1. Turn ignition switch to ON position.
2. Place the activation tool on the left front tire wall 180 degrees from the valve stem.
3. Press the test button on the Activation Tool to activate the TPM sensor. For best results, activate each sensor twice.

NOTE: A green light will flash and a beep sound on the Activation Tool for each successful TPM sensor response.

4. Repeat steps 1-3 for each remaining tire.

NOTE: After adjusting tire pressures and activating sensors, the tire pressure warning light is still illuminated. There is a malfunction in the TPM system.

See appropriate manufacturer service information.

VEHICLE MAINTENANCE MONITOR (VMM)

1989-92 THUNDERBIRD

1. Turn ignition switch to ON position. Within 16 seconds of turning ignition on, insert small diameter shank into reset switch hole, and firmly push in switch. Reset switch hole is located on left side of VMM panel.
2. Keep switch depressed until left side of display stops flashing. If switch is not kept depressed until left side of display stops flashing, VMM will not be reset.

1990-92 PROBE (WITH STANDARD INSTRUMENT CLUSTER)

1. The SERVICE light will come on approximately every 7500 miles, indicating routine service is required. The light will remain on for 3 minutes after vehicle is started.
2. To cancel the message and reset SERVICE light on 1990 models, depress and hold SERVICE RESET button until 3 beeps are sounded. This will verify that reminder light has been reset. SERVICE RESET button is located in VMM unit, in center of overhead console.
3. To cancel the message and reset SERVICE light on 1991-92 models, insert a small diameter shank into hole centered directly above VMM display lights, and press switch once.

1990-92 PROBE (WITH ELECTRONIC INSTRUMENT CLUSTER)

1. SERVICE INTERVAL will be displayed on system scanner every 7500 miles, indicating that routine service is due. At 7500 miles, the message will remain on for 3 minutes after vehicle is started.
2. To cancel message and reset service interval on 1990 models, press and hold ODO SEL and TRIP RESET buttons until 3 beeps are heard. Buttons are located on speed alarm keyboard.
3. To cancel message and reset service interval on 1991-92 models, press and hold SERV button until 3 tones are heard. SERV button is located on speed alarm keyboard.

1997 MANUAL TRANSMISSIONS

Ford (Mazda) M5OD-R2 5-Speed Overhaul

APPLICATION

TRANSMISSION APPLICATION

Application	Transmission Model
F150 Pickup	M5OD-R2
F250 Pickup	M5OD-R2

IDENTIFICATION

The M5OD identification tag is located on left side of transmission main case. Vehicle certification label, located on left side door lock pillar, lists applicable transmission identification codes under TRANS space. M5OD-R2 transmission is identified by an "M" code on label.

DESCRIPTION

This Mazda built transmission is a fully synchronized, 5-speed, top shift transmission. Fifth gear is an overdrive ratio. All gear changes, including reverse are accomplished with synchronizer sleeves. Transmission case is aluminum alloy with steel bearing race inserts.

LUBRICATION & ADJUSTMENTS

See **TRANSMISSION SERVICING** article in MANUAL TRANS SERVICE section.

TROUBLE SHOOTING

See **TROUBLE SHOOTING - BASIC PROCEDURE** article in GENERAL TROUBLE SHOOTING section.

ON-VEHICLE SERVICE

GEARSHIFT LEVER REPLACEMENT

Removal

Shift transmission into Neutral position. Remove transfer case shift lever knob (if equipped). Remove carpet or floor mat to expose transmission shift lever boot screws. Remove transmission shift lever boot screws. Slide boot upward on shift lever to expose transmission shift lever nut and bolt. Remove shift lever nut, bolt and shift lever. Remove inner shift lever boot.

Installation

To install, reverse removal procedure.

EXTENSION HOUSING SEAL

Removal

Remove drive shaft. Using appropriate seal remover, remove extension housing seal.

Installation

Using appropriate seal installer, install NEW seal on extension housing. Lubricate oil seal lip prior to installation. Ensure oil seal drain hole faces downward. Install drive shaft.

EXTENSION HOUSING BUSHING

Extension housing bushing cannot be serviced. If bushing requires service or replacement, extension housing must be replaced as a unit.

REMOVAL & INSTALLATION

See TRANSMISSION REMOVAL & INSTALLATION article MANUAL TRANS SERVICE section.

TRANSMISSION DISASSEMBLY

1. Remove transmission drain plug and drain transmission. Remove top cover assembly and extension housing. Remove speedometer drive gear and steel ball (if equipped). If necessary, remove rear oil passage. Lock transmission into 1st and 3rd gears. Ensure staked areas securing output shaft and countershaft lock nuts are fully released or thread damage will occur. Remove and discard countershaft rear bearing lock nut.
2. Remove rear bearing and thrust washer. Remove and discard output shaft rear bearing lock nut. Remove reverse idler shaft attaching bolt. See **Fig. 1** . Remove reverse idler gear assembly by grasping and pulling rearward. Using remover/replacer tube, forcing screw and bearing puller, remove output shaft rear bearing from output shaft.

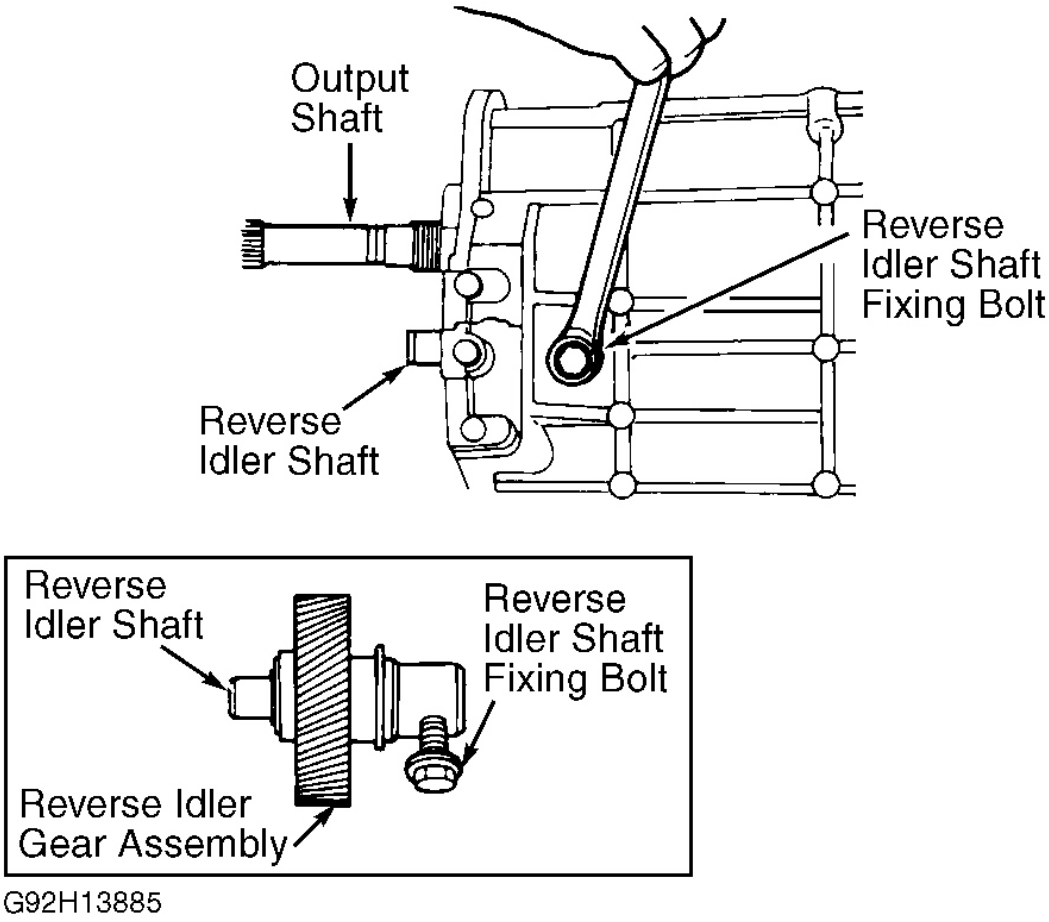
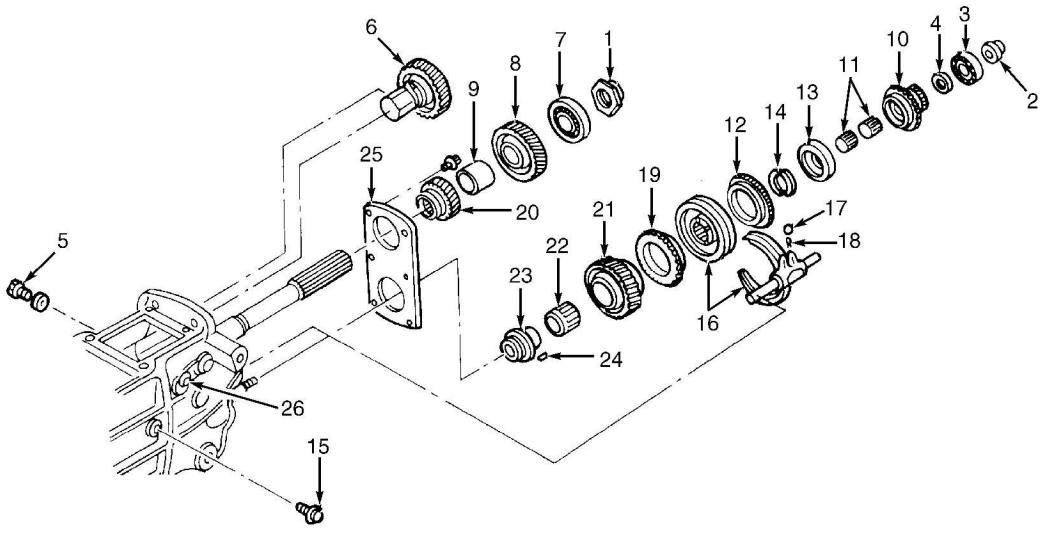


Fig. 1: Removing Reverse Idler Shaft Fixing Bolt
Courtesy of FORD MOTOR CO.

3. Using brass drift and hammer, drive reverse gear from output shaft. Remove output shaft sleeve. See **Fig. 2** . Remove countershaft reverse gear with 2 needle bearings and reverse synchronizer ring.
4. Remove thrust washer and split washer from countershaft. Remove 5th and reverse shift rod attaching bolt. Remove the following parts as an assembly; 5th-reverse synchronizer hub and sleeve assembly (countershaft), 5th-reverse shift fork and rod. DO NOT separate steel ball and spring (removed from shift fork groove) unless necessary.
5. Remove 5th gear synchronizer ring, 5th-reverse counter lever lock plate bolt, inner circlip and counter lever assembly from transmission case. DO NOT remove Torx nut retaining counter lever pin at this time. Remove countershaft 5th gear with needle bearing.
6. Remove output shaft 5th gear using bearing collet (for 3 1/2" bearing), gear removal collet assembly and remover/replacer tube with forcing screw. Remove 5th gear sleeve and Woodruff key or lock ball. Remove center and front bearing cover bolts.
7. To remove front bearing cover, thread 2 bolts into front bearing cover bolt locations at 3 and 9 o'clock

positions. Alternately tighten bolts lifting front bearing cover away from transmission case. DO NOT remove plastic scoop ring from input shaft at this time.

8. Remove oil trough from upper transmission case by removing bolt. See **Fig. 3** . Pull input shaft forward and remove input shaft bearing. Pull output shaft rearward.
9. Pull input shaft forward and separate it from output shaft assembly. Incline output shaft upward and lift from transmission case. Remove input shaft from transmission case.
10. Remove countershaft front and center bearings by moving countershaft forward and rearward. Pull countershaft rearward to permit clearance for bearing puller behind countershaft front bearing. Remove countershaft front bearing. Remove countershaft through top of transmission case.



1. Lock Nut (Output Shaft)
2. Lock Nut (Countershaft)
3. Countershaft Rear Bearing
4. Thrust Washer
5. Fixing Bolt (Reverse Idler Gear)
6. Reverse Idler Gear Assembly
7. Bearing (Rear Output Shaft)
8. Reverse Gear (Output Shaft)
9. Sleeve-Output Shaft
10. Countershaft Reverse Gear
11. Needle Bearing
12. Synchronizer Ring (Reverse)
13. Thrust Washer
14. Split Washer (2)
15. Fixing Bolt (Shift Rod)
16. Shift Rail Fork Hub/Sleeve Assembly
17. Lock Ball (Shift Rail)
18. Spring (Shift Rail)
19. Synchronizing Ring (5th Gear)
20. 5th Gear (Output Shaft)
21. 5th Gear (Countershaft)
22. Needle Bearing (5th Gear)
23. Sleeve (5th Gear)
24. Woodruff Key Or Lock Ball
25. Center Bearing Cover
26. 5th-Reverse Counter Lever Lock Plate Bolt

G92G13884

Fig. 2: Exploded View Of Rear Housing Components
Courtesy of FORD MOTOR CO.

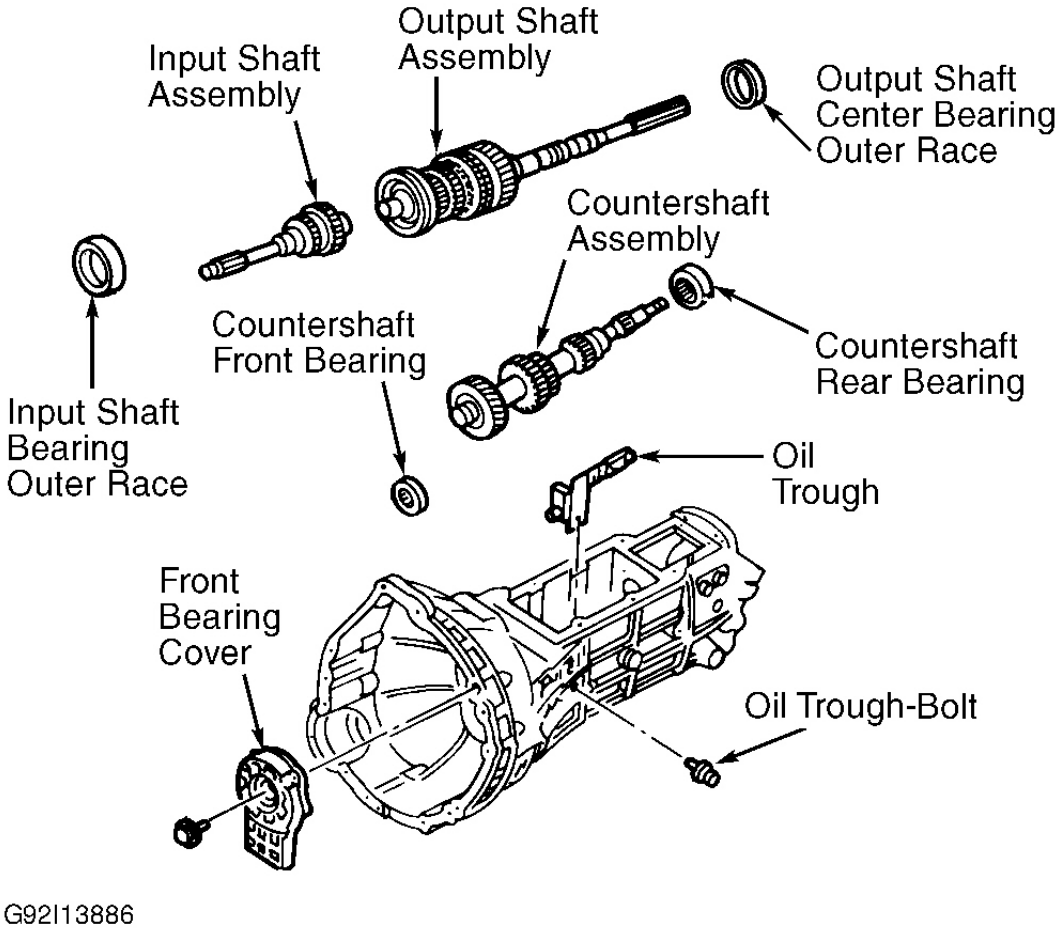


Fig. 3: Exploded View Of Transmission Main Case Components
Courtesy of FORD MOTOR CO.

COMPONENT DISASSEMBLY & REASSEMBLY

INPUT SHAFT

Disassembly

Remove and discard plastic scoop ring. Using bearing cone remover/installer and arbor press, press tapered roller bearing from input shaft. See **Fig. 4** . For cleaning and inspection of components, see **CLEANING & INSPECTION** .

Reassembly

Using a press and bearing cone remover/installer, install input shaft bearing onto input shaft. Install NEW plastic scoop ring onto input shaft. Manually rotate ring clockwise to ensure input shaft holes properly engage

scoop ring. A click should be heard as scoop ring notches align with input shaft holes.

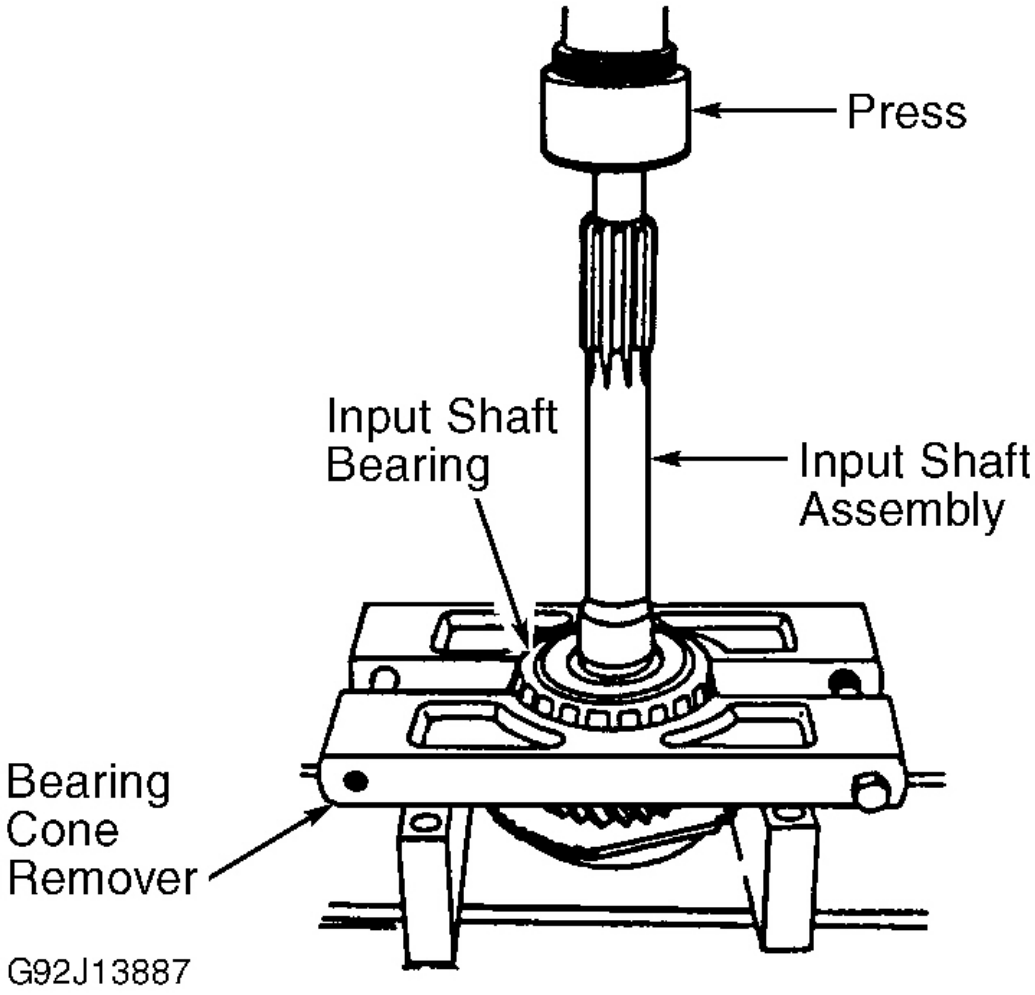


Fig. 4: Removing Input Shaft Bearing
Courtesy of FORD MOTOR CO.

OUTPUT SHAFT

Disassembly

1. Note location of output shaft flange. See **Fig. 5** . Use this flange as reference point and dividing line during assembly procedure. Remove pilot bearing, retaining ring, needle bearing (plain) and spacer from front of output shaft. See **Fig. 6** .
2. Position front (short side) of output shaft so that it faces upward. Lift off the following components as a

unit; clutch hub and sleeve assembly (3rd-4th), 3rd gear synchronizer ring, 3rd gear and needle bearing. See **Fig. 6** .

NOTE: Ensure output shaft flange does not contact or ride upward onto press cradle. Improper positioning of output shaft can cause component damage.

3. Position output shaft with rear end (long side) facing upward. Position output shaft into press with press cradle contacting lower part of 2nd gear. See **Fig. 7** .
4. Press off the following components as a unit; center bearing, 1st gear sleeve, 1st gear and needle bearing, 1st-2nd clutch hub and sleeve assembly, 1st-2nd synchronizer rings, 2nd gear and needle bearing. For cleaning and inspection of components, see **CLEANING & INSPECTION** .

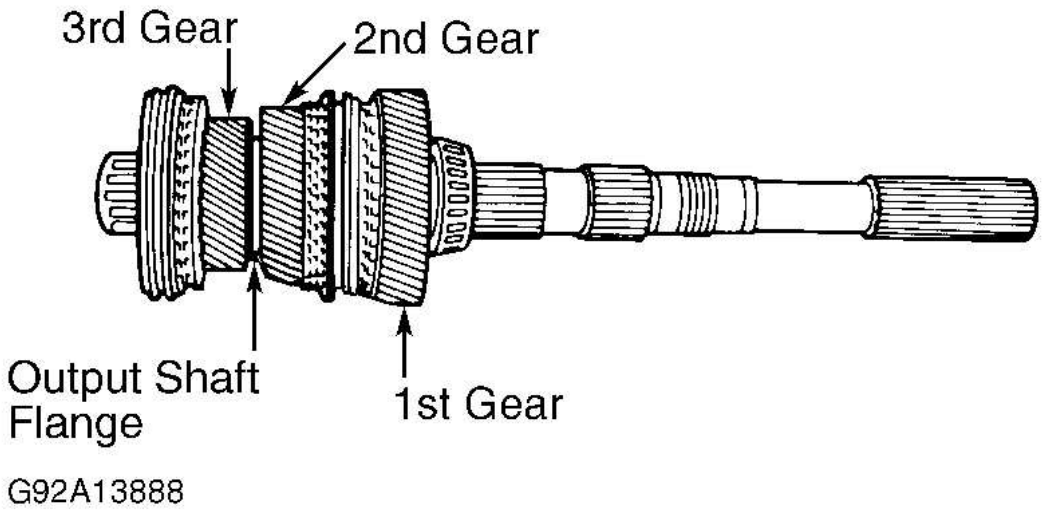


Fig. 5: Locating Flange On Output Shaft Assembly
Courtesy of FORD MOTOR CO.

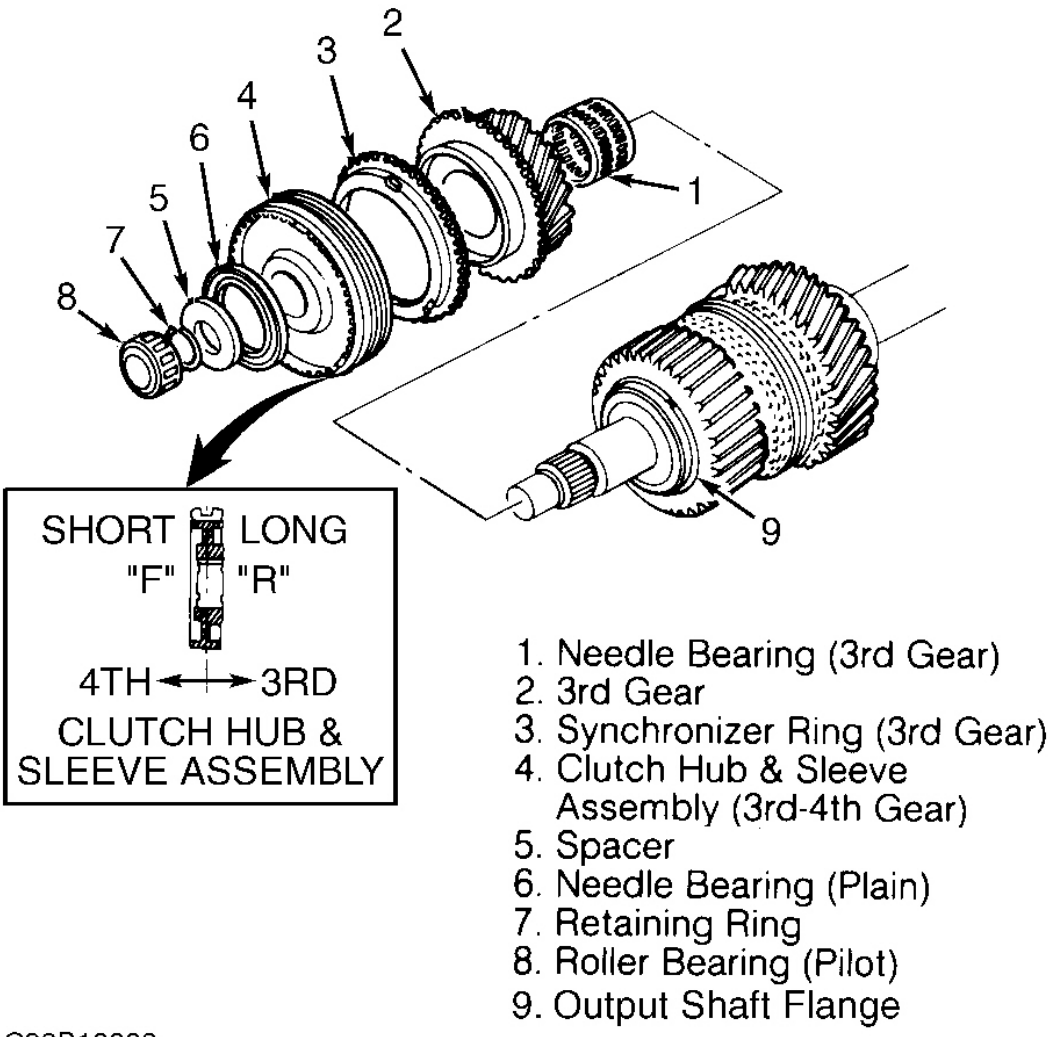
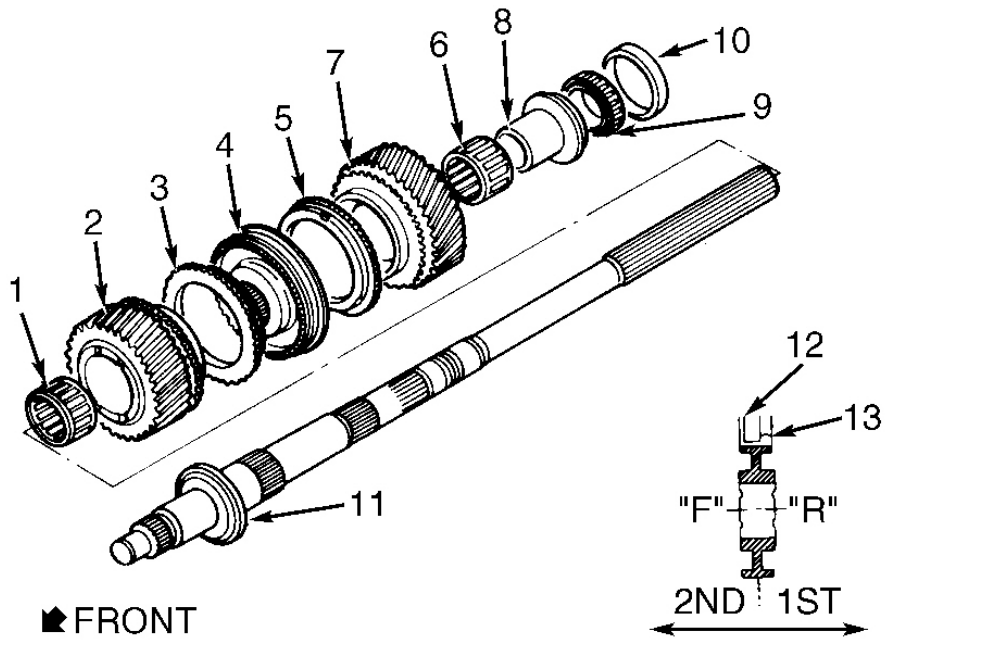


Fig. 6: Exploded View Of Front Of Output Shaft
Courtesy of FORD MOTOR CO.



1. Needle Bearing (2nd Gear)
2. 2nd Gear
3. Synchronizer Ring (2nd Gear)
4. Clutch Hub & Sleeve Assembly (1st & 2nd Gear)
5. Synchronizer Ring (1st Gear)
6. Needle Bearing (1st Gear)
7. 1st Gear
8. Sleeve (1st Gear)
9. Center Bearing
10. Center Bearing Outer Race
11. Output Shaft Flange
12. Narrow
13. Wide

G92E13890

Fig. 7: Exploded View Of Rear Of Output Shaft
Courtesy of FORD MOTOR CO.

Reassembly

1. Ensure center bearing outer race is installed into transmission case. Position output shaft so that rear (long side) faces upward.
2. Install components onto output shaft in following order; 2nd gear needle bearing, 2nd gear, 2nd gear synchronizer ring, 1st-2nd clutch hub and sleeve assembly, 1st gear synchronizer ring, 1st gear needle bearing, 1st gear, 1st gear sleeve and inner center bearing. Ensure narrow width of 1st-2nd synchronizer faces 2nd gear. See **Fig. 7** .
3. Press center bearing onto rear (long side) of output shaft. Position output shaft front (short side) facing upward. Install parts in following order; 3rd gear needle bearing, 3rd gear and 3rd gear synchronizer ring.
4. Mate 3rd-4th clutch hub synchronizer key groove with reference mark on clutch hub sleeve. Install 3rd-4th clutch hub and sleeve with reference mark and long clutch hub flange facing rearward. See **Fig. 6** and

Fig. 11 . Install spacer and retainer on output shaft.

5. Using a feeler gauge, measure clutch hub end play. Adjust 3rd-4th clutch hub end play to .00-.002" (.00-.05 mm) by selecting proper retaining ring. Retaining rings are available in thicknesses of .59-.077" (1.50-1.95 mm) in .002" (.05 mm) increments.

REVERSE IDLER GEAR

Disassembly & Reassembly

1. Remove retaining ring, spacer, idler gear, needle bearing and thrust washer. For cleaning and inspection of components, see **CLEANING & INSPECTION** .
2. To reassemble, reverse disassembly procedure. Ensure tab on thrust washer mates with groove on reverse idler shaft to prevent rotation of thrust washer. See **Fig. 8** .
3. Install original retaining ring onto reverse idler gear shaft. Insert feeler gauge between retaining ring and reverse idler gear to measure reverse idler gear end play. Adjust reverse idler gear end play to .004-.008" (.10-.20 mm). Reverse idler gear retaining rings are available in thicknesses of .059-.075" (1.50-1.90 mm) in .004" (.10 mm) increments.

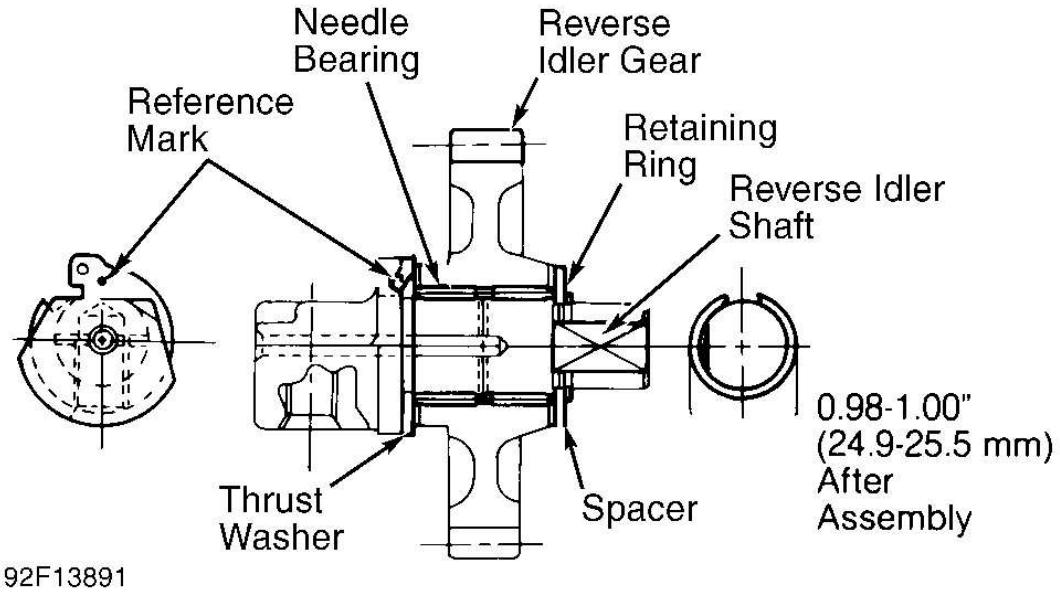


Fig. 8: Assembling Reverse Idler Gear
Courtesy of FORD MOTOR CO.

INPUT SHAFT END PLAY

1. Position transmission with clutch housing facing up. Ensure input shaft bearing is squarely positioned in bore. Using appropriate seal replacer, install front cover oil baffle (if removed). Install countershaft front

bearing by hand.

2. Using depth micrometer, measure height of input shaft bearing above transmission case, record as Dimension "A". Measure depth of input shaft bearing retainer bore, record as Dimension "B". See **Fig. 9** .
3. Calculate input shaft end play as follows; Dimension "B" - (Dimension "A" + shim thickness)=.002-.006" (.05-.15 mm). Select shim to maintain end play within specified limit. See **INPUT SHAFT SHIM SELECTION** table.
4. Measure depth of countershaft bearing below transmission case, record as Dimension "C". Measure depth of countershaft bearing retainer bore, record as Dimension "D". See **Fig. 9** .
5. Calculate countershaft end play as follows; Dimension "C" + (Dimension "D" + shim thickness)=.006-.010" (.15-.25 mm). Select shim to maintain end play within specified limit. See **COUNTERSHAFT SPACER SELECTION** table.

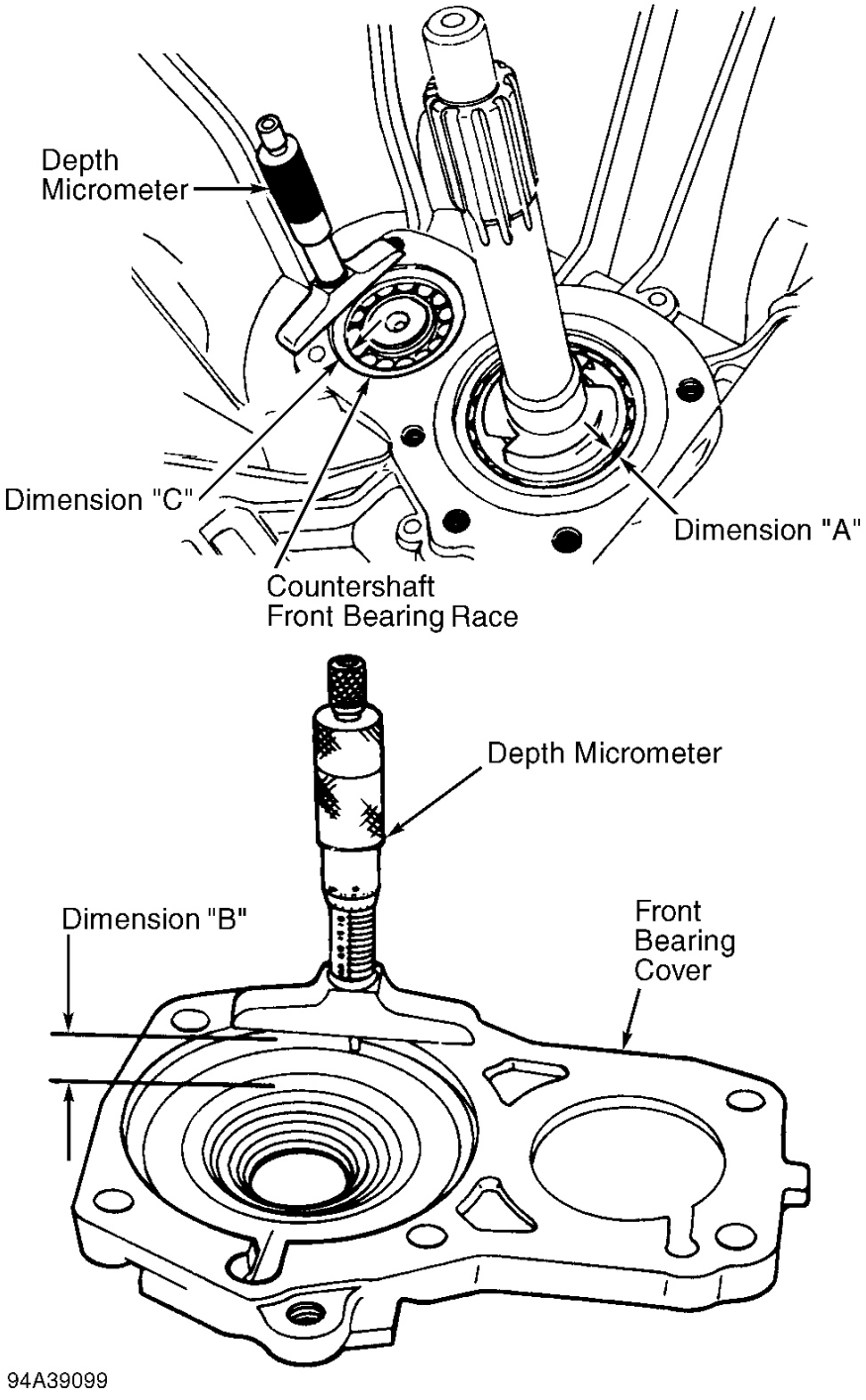


Fig. 9: Determining End Play Shim Thickness
Courtesy of FORD MOTOR CO.

INPUT SHAFT SHIM SELECTION

Part No.	In. (mm)
E8TZ-7029-FA	.0551 (1.4)
E8TZ-7029-GA	.0590 (1.5)
E8TZ-7029-HA	.0629 (1.6)
E8TZ-7029-JA	.0669 (1.7)
E8TZ-7029-S	.0708 (1.8)
E8TZ-7029-T	.0748 (1.9)
E8TZ-7029-U	.0787 (2.0)
E8TZ-7029-V	.0826 (2.1)
E8TZ-7029-W	.0866 (2.2)
E8TZ-7029-X	.0905 (2.3)
E8TZ-7029-Y	.0944 (2.4)
E8TZ-7029-Z	.0984 (2.5)
E8TZ-7029-AA	.1023 (2.6)
E8TZ-7029-BA	.1062 (2.7)
E8TZ-7029-CA	.1102 (2.8)
E8TZ-7029-DA	.1141 (2.9)
E8TZ-7029-EA	.1181 (3.0)

COUNTERSHAFT SPACER SELECTION

Part No.	In. (mm)
E8TZ-7C434-K	.122 (3.1)
E8TZ-7C434-L	.125 (3.2)
E8TZ-7C434-M	.129 (3.3)
E8TZ-7C434-N	.133 (3.4)
E8TZ-7C434-P	.137 (3.5)
E8TZ-7C434-R	.141 (3.6)
E8TZ-7C434-S	.145 (3.7)
E8TZ-7C434-T	.118 (3.0)

CLEANING & INSPECTION

CLEANING

Wash all parts except seals, in cleaning solvent. Dry all parts with compressed air. DO NOT spin bearings with compressed air.

INSPECTION

Bearings

Inspect bearings and replace if broken, worn or rough. Lubricate cleaned bearing. Hold bearing vertically by

inner race and spin outer race by hand. DO NOT spin bearings with compressed air. If roughness or vibration is noticed, bearing should be cleaned and lubricated again and retested. If roughness or vibration is noticed after 3 tests, replace bearing.

Countershaft

Inspect splines and gear teeth for damage or wear. Replace countershaft if bent, damaged or worn.

Input Shaft

Replace input shaft if splines are damaged, needle bearing surfaces are worn or rough, or other bearing surfaces are damaged.

Output Shaft

Mount output shaft in V-blocks. Check runout on shaft at several locations. If runout exceeds .002" (.05 mm), replace output shaft.

Synchronizers

If teeth on synchronizer ring are chipped, broken or worn, replace synchronizer ring. Note that 3rd gear synchronizer is different from others. To check for wear, mount synchronizer to mating gear and measure clearance between gear and synchronizer side faces using a feeler gauge. If clearance is less than .031" (.80 mm), replace synchronizer ring or mating gear.

Check contact surfaces of shift fork and clutch hub sleeve for wear or damage. Using feeler gauge, check shift fork-to-clutch hub sleeve clearance. Clearance should not exceed .031" (.80 mm).

Check operation of clutch hub sleeve installed on hub. Position clutch hub and sleeve horizontally. Lift hub approximately 3/4 of the way off sleeve and release. If hub does not return into sleeve, service as necessary.

TRANSMISSION REASSEMBLY

1. Install countershaft, input shaft and output shaft assemblies into transmission case through top opening. See **Fig. 10** .

   NOTE: Ensure needle roller bearing is installed into input shaft and 4th gear synchronizer ring is installed at this time.

2. Mate input and output shaft assemblies by positioning them at an upward angle and setting them together. Install output shaft bearing using a brass drift. Ensure center bearing outer races are squarely positioned in bores. Install countershaft center bearing.

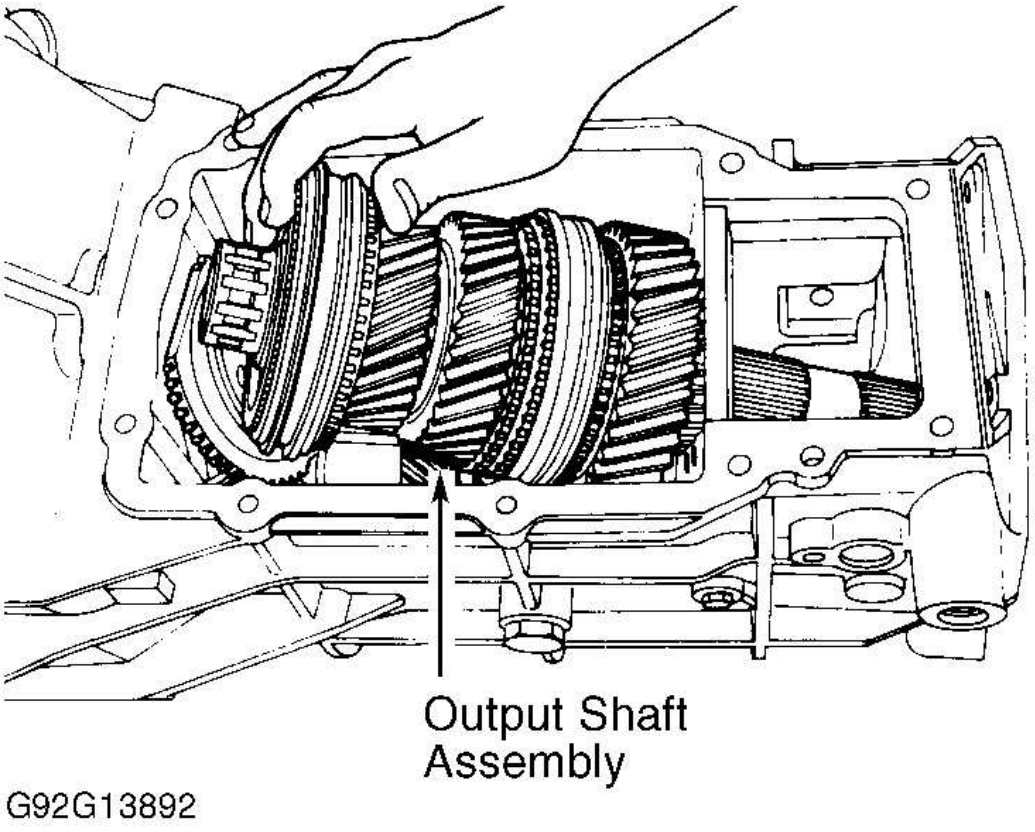


Fig. 10: Installing Output Shaft
Courtesy of FORD MOTOR CO.

3. Position center bearing cover to transmission case with reference arrow pointing upward. Ensure all center bearing cover bolt heads are marked with an "8". Tighten center bearing cover bolts to specification. See **TORQUE SPECIFICATIONS** .

NOTE: If any input shaft, output shaft or countershaft related components are replaced, end play must be readjusted. See INPUT SHAFT END PLAY .

4. Install countershaft front bearing by hand. Apply grease to shim, bearing cover and oil baffle to retain them in position during assembly. Install shim with groove showing. Install spacer to transmission case countershaft front bearing bore.
5. Tape input shaft splines along their entire length to prevent damage to oil seal lip. Apply a thin coat of lubricant to front cover oil seal lip. Apply 1/8" bead of sealant to front cover and retaining bolt threads. Ensure front bearing cover bolt heads are marked with a "6". Install front bearing cover. Tighten bolts to specification.

6. Install Woodruff key or lock ball, 5th gear sleeve and 5th gear needle bearing onto 5th gear countershaft. To install 5th gear assembly on 2WD, use Gear Installing Spacer (T88T-7025-F). When tool bottoms, add Gear Installing Spacer (T88T-7025-G) and press 5th gear assembly all the way into position. Ensure long flange on 5th gear faces forward.

NOTE: On 4WD vehicles, installation of 5th gear is similar except that Remover/Replacer Tube (T85T-7025-A) and TOD Bearing Remover/Replacer Adapter (T84T-7025-A) are used.

7. Position 5th and reverse shift lever to transmission and install thrust washer and retaining ring. Apply sealant to counter lever retaining bolt threads. Tighten bolt to specification. If removed, position 5th-reverse shift fork and shift rail to top cover. See **Fig. 11** . Insert 5th-reverse shift rail through top cover bore and 5th-reverse shift fork. Install spring and detent ball to lower part of rod.

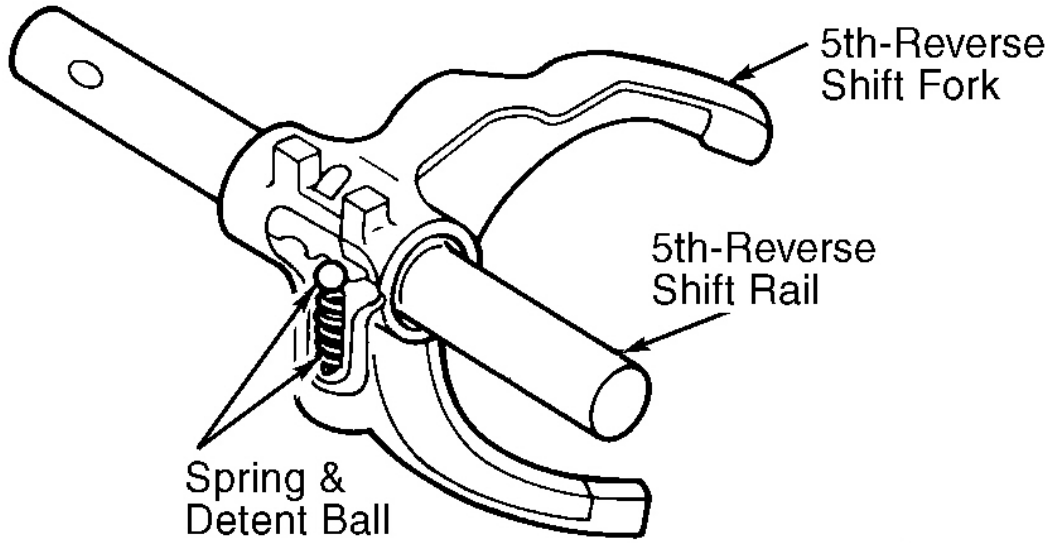


Fig. 11: Installing 5th-Reverse Shift Fork & Rail
Courtesy of FORD MOTOR CO.

8. Assemble 5th-reverse synchronizer hub, sleeve and 5th gear synchronizer ring to 5th-reverse shift fork and rod assembly. Install longer flange, on 5th-reverse hub, sleeve and synchronizer assembly, toward front of transmission. Reference mark on synchronizer sleeve must be installed toward reverse gear. See **Fig. 12** .

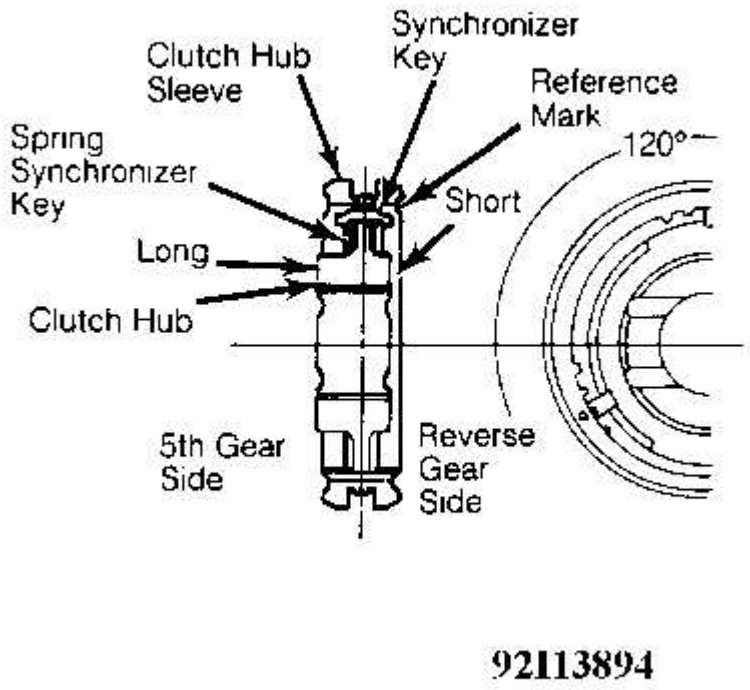


Fig. 12: Installing Synchronizer Assembly
Courtesy of FORD MOTOR CO.

9. Install and mate 5th-reverse shift fork and shift rail assembly to counter lever end. Install assembly in case, aligning threaded fixing bolt bores, in rail and transmission case. Apply sealant to bolt threads and tighten to specification. See **TORQUE SPECIFICATIONS** . Position oil passage to transmission case. Apply sealant to oil passage bolt threads and tighten to specification.
10. If original clutch hub and/or counter reverse gear are being used, install original split washers onto countershaft and go to step 12). If synchronizer hub has been replaced, install original split washers. Using a feeler gauge, measure 5th-reverse synchronizer hub end play between synchronizer hub and split washers.
11. End play should be 0-0.002" (0-.05 mm). Replace split washers to obtain proper end play. Split washers are available in thicknesses of .12-.14" (3.0-3.5 mm) in .004" (.10 mm) increments. Ensure NEW split washers are matched, having identical thickness. Go to next step.
12. Install reverse synchronizer ring and needle bearing into reverse gear. Install counter reverse gear and needle bearings onto counter shaft as an assembly. Install thrust washer and press forward by hand against shoulder on countershaft.
13. Maintain forward pressure and measure end play with feeler gauge between counter reverse gear and thrust washer. Counter reverse gear end play should be .010-.014" (.25-.36 mm). Replace thrust washer to

obtain proper end play. Thrust washers are available in thicknesses of .293-.309" (7.45-7.85 mm) in .004" (.10 mm) increments.

14. Temporarily install a spacer in place of countershaft bearing. Loosely install countershaft lock nut to retain components. Install reverse idler gear assembly. Apply sealant to retaining bolt threads. Install bolt and tighten to specification.
15. Drive sleeve and reverse gear assembly onto output shaft, using Gear Replacing Spacer (T88T-7025-G), Shaft Adapter (T75L-7025-P), Shaft Adapter Screw (T75L-7025-K), Remover/Replacer Tube (T75L-7025-B, 2WD or T85T-7025-A, 4WD), nut and washer. Install reverse gear with longer flange facing forward. Install output shaft rear bearing.
16. Remove temporary spacer from countershaft. Install countershaft rear bearing by hand. Ensure bearing is fully seated to avoid damage to output shaft threads.
17. Lock transmission into 1st and 3rd gear. Install NEW output and countershaft lock nuts by hand. Tighten nuts to specification. See **TORQUE SPECIFICATIONS** . Stake lock nuts to bottom of shaft.
18. Install speedometer drive gear and steel ball (if equipped). Apply 1/8" bead of sealant to case and install transmission extension housing. Place synchronizers in neutral position. DO NOT apply sealant to mating surfaces of top cover or case.
19. If necessary, lightly grease cover gasket to retain in position. Install top cover. Apply sealant to threads of 2 rearmost top cover bolts only. Install remaining bolts without sealant. Tighten bolts to specification. Fill transmission with Mercon automatic transmission fluid.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Center Bearing Cover Bolt	14-19 (19-26)
Countershaft Lock Nut	94-144 (127-195)
Drain Plug	29-43 (39-58)
Extension Housing Bolt	24-34 (33-46)
Filler Plug	29-43 (39-58)
Front Bearing Cover Bolt	12-16 (16-22)
Gear Shift Lever Bolt/Nut	12-18 (16-24)
Output Shaft Lock Nut	160-203 (217-275)
Reverse Idler Shaft Fixing Bolt	58-86 (79-117)
Top Cover Bolt	12-16 (16-22)
5th-Reverse Shift Rail Bolt	16-22 (22-30)
	INCH Lbs. (N.m)
Counter Lever Bolt	72-89 (8-10)
Front Oil Passage Bolt	72-96 (8-11)
Rear Oil Passage Bolt	60-84 (7-9)

TRANSMISSION SERVICING - M/T

1997 MANUAL TRANSMISSION SERVICING Ford Motor Co. - ZF S5-47 (M5HD) & M5OD-R2 5-Speeds

APPLICATION

WARNING: Before removing engine/transmission assembly on compressed natural gas powered vehicles, see safety precautions in the COMPRESSED NATURAL GAS SAFETY PRECAUTIONS article in GENERAL INFORMATION section.

TRANSMISSION IDENTIFICATION

Application	Transmission
F150 & F250 Light Duty	M5OD-R2 5-Speed
F250 HD, F350 & Super Duty	ZF S5-47 (M5HD) 5-Speed

LUBRICATION

SERVICE INTERVALS

Transmission

Under normal driving conditions, replace transmission fluid every 60,000 miles. Under severe driving conditions, replace transmission fluid every 30,000 miles. Change fluid after vehicle operation in water.

Transfer Case

Under normal driving conditions, replace transfer case fluid every 60,000 miles. Under severe 4WD driving conditions, replace transfer case fluid every 30,000 miles.

CHECKING FLUID LEVEL

Transmission

Check fluid level at transmission filler plug hole. It should be level with bottom of filler hole. Add lubricant as needed.

Transfer Case (Without PTO)

Remove filler plug. If fluid drains out or is level with opening, replace filler plug. If not, fill until fluid is level with filler plug opening.

CAUTION: On Borg-Warner 13-56 transfer cases with PTO, additional fluid is required.

Transfer Case (With PTO)

Remove filler plug labeled FOR PTO FILL ONLY on front of case. If fluid drains out or is level with opening, replace filler plug. If not, fill until fluid is level with filler plug opening.

RECOMMENDED FLUID

Transmission

All models except vehicles over 8500 lbs. GVW equipped with a diesel engine, use Mercon ATF (XT-2-DDX or QDX). Vehicles over 8500 lbs. GVW equipped with a diesel engine use Motorcraft Mercon (XT-2-QDX).

Parking Brake Assembly (F350 Super Duty Commercial)

Use Motorcraft Mercon (XT-2-QDX).

Transfer Case

Motorcraft Mercon (XT-2-QDX) should be used in transfer cases.

FLUID CAPACITY

NOTE: Capacities given are approximate. Correct fluid level should be determined by level at filler plug hole, rather than amount added.

TRANSMISSION REFILL CAPACITIES

Application	Pts. (L)
Ford S5-47 ZF (M5HD) 5-Speed	6.8 (3.2)
Mazda M5OD 5-Speed Overdrive	7.6 (3.6)

TRANSFER CASE REFILL CAPACITIES

Application	Pts. (L)
Dana TC-28	4.5 (2.1)
Borg-Warner 13-54	2.5 (1.2)
Borg-Warner 13-56	4.0 (1.9)
Borg-Warner 13-56 With PTO (1)	12.2 (5.8)
Borg-Warner 44-05	2.5 (1.2)
Borg-Warner 44-06	4.0 (1.9)
Borg-Warner 44-07	(2)
Borg-Warner 44-72	(2)

(1) F-350 only.

(2) Refill capacity not available at time of publication. Fill until fluid is level with filler plug opening.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Drain & Fill Plug	
Transmission	
M5OD	30-43 (40-58)
S5-47 ZF (M5HD)	(1)
Transfer Case	
Dana TC-28	10-20 (14-27)
Borg-Warner 13-54	14-22 (19-30)
Borg-Warner 13-56	(1)
Borg-Warner 44-05, 44-06 & 44-07	7-17 (9-23)
Borg-Warner 44-72	18 (25)
(1) Specification not available at time of publication.	

MIRRORS - POWER

1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Mirrors

DESCRIPTION & OPERATION

Power side view mirror system consists of mirror head with integral reversible servomotor assembly and mirror control switch. Some models are equipped with an electric heating element in outside mirror glass.

Automatic dimming is an option on the inside and left side mirrors on some models. The auto-dimming mirror is controlled by 2 light-sensitive photocells. Outside light level is measured by a sensor on backside of mirror housing. A second sensor, located on reflective side of mirror, detects approaching rear lights. The mirror photochromatically dims when glare is detected from rear of vehicle. Mirror switches to normal state whenever transmission gear selector is placed in Reverse.

TESTING

BOTH SIDE MIRRORS INOPERATIVE

1. **Power & Ground Circuit Check** - Remove power mirror control switch and unplug harness connector. Measure voltage between mirror control switch connector Black wire (Pink/Orange wire on Town Car) and appropriate power wire. See POWER WIRE COLOR IDENTIFICATION TABLE. If battery voltage is present, go to step 6). If battery voltage is not present, go to next step.

POWER WIRE COLOR IDENTIFICATION

Application	Wire Color
Pickup	Light Green/Yellow

2. **Ground Circuit Check** - Disconnect mirror switch harness connector. Measure resistance between ground and mirror switch harness connector Black wire. If resistance is 5 ohms or less, go to next step. If resistance is more than 5 ohms, repair open Black wire. Reconnect harness connector and retest system.
3. **Power Supply Check** - Turn ignition on. Measure voltage between ground and appropriate mirror switch harness connector power wire. See POWER WIRE COLOR IDENTIFICATION TABLE. If battery voltage is present, go to step 6). If battery voltage is not present, go to next step.
4. **Short To Ground Check** - Turn ignition off. Remove power mirror system fuse. See **WIRING DIAGRAM** , for fuse identification. Measure resistance between chassis ground and power wire at mirror switch harness connector. If resistance is more than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair short to ground in power wire.
5. **Power Supply Circuit Continuity Check** - Remove power mirror system fuse. See **WIRING DIAGRAM** , for fuse identification. Check continuity of power wire between mirror control switch and fuse cavity. If resistance is 5 ohms or less, replace fuse and to next step. If resistance is more than 5 ohms, repair open in power wire and retest system.
6. **Mirror Function Check** - Unplug mirror control switch. Using fused jumper wires, check mirror operation by applying battery voltage and ground to appropriate wire terminals. See MIRROR FUNCTION TEST TABLE. Mirror should move in one direction. To move mirror in opposite direction

reverse polarity of jumper wires. If mirrors operate in all directions, replace mirror control switch and retest system. If mirrors do not operate in all directions, go to next step.

MIRROR FUNCTION TEST

Mirror Function	Wire Color
Right Mirror	
Up/Down Operation	Purple & Yellow
Left/Right Operation	Dark Green & Yellow
Left Mirror	
Up/Down Operation	Dark Blue & Yellow
Left/Right Operation	Red & Yellow

7. **Mirror Circuit Continuity Check -** Unplug mirror switch. Unplug harness connector at suspect mirror. See **SIDE MIRROR ASSEMBLY** under REMOVAL & INSTALLATION. Using ohmmeter, check continuity of each wire between mirror and mirror switch harness connectors. For wire color identification, see **WIRING DIAGRAMS** . Measure resistance between each wire at mirror harness connector and ground. If ohmmeter indicates any wire open or shorted to ground, repair open shorted wire(s). If all mirror circuits are okay, replace mirror motor.

ONE SIDE MIRROR INOPERATIVE

Check mirror for evidence of damage or foreign object affecting mirror movement. Service as necessary. If mirrors appear okay, perform steps 6) and 7) in BOTH SIDE MIRRORS INOPERATIVE test. Repair as necessary.

REMOVAL & INSTALLATION

WARNING: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

INSIDE MIRROR

Removal & Installation

If equipped with auto-dimming, unplug harness connectors at rear of mirror. Grasp mirror firmly, insert small flat-bladed screwdriver into slot at base of mirror mount and pry mirror off mount. To install, use Mirror Replacer (T91P-17700-AH). Slide mirror onto mounting bracket. Reconnect wiring.

SIDE MIRROR ASSEMBLY

Removal & Installation

Remove door panel. Remove mirror mounting hole cover. See **Fig. 1** . Disconnect mirror wiring harness connector. Remove mirror attac hing nuts. Remove mirror assembly while guiding wiring and connector through hole in door. To install, reverse removal procedure. Tighten nuts to approximately 53 INCH lbs. (6 N.m).

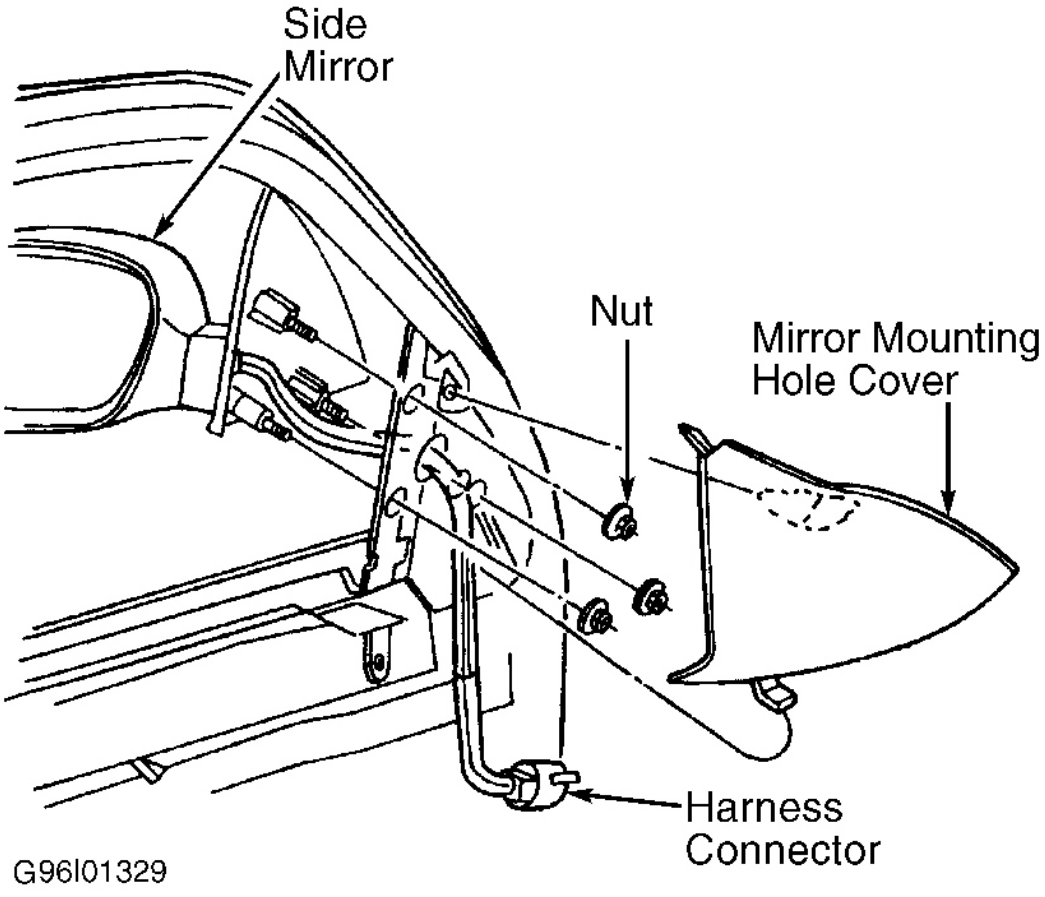


Fig. 1: Removing Side Mirror (Typical)
Courtesy of FORD MOTOR CO.

SIDE MIRROR GLASS & MOTOR

Removal & Installation

Point mirror glass as far inward as possible to allow clearance between glass and mirror housing at outer edge

of mirror. Insert fingers into clearance, and pull mirror glass. If fingers will not fit between glass and housing, use a screwdriver and cloth to pry mirror glass out. Glass will snap out without being damaged. Disconnect heater wires (if equipped). Remove motor attaching screws. Unplug motor connector, and remove motor. To install, reverse removal procedure. Ensure mirror glass locking tabs align before snapping in glass.

WIRING DIAGRAMS

1997 Ford Pickup F150

MIRRORS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Mirrors

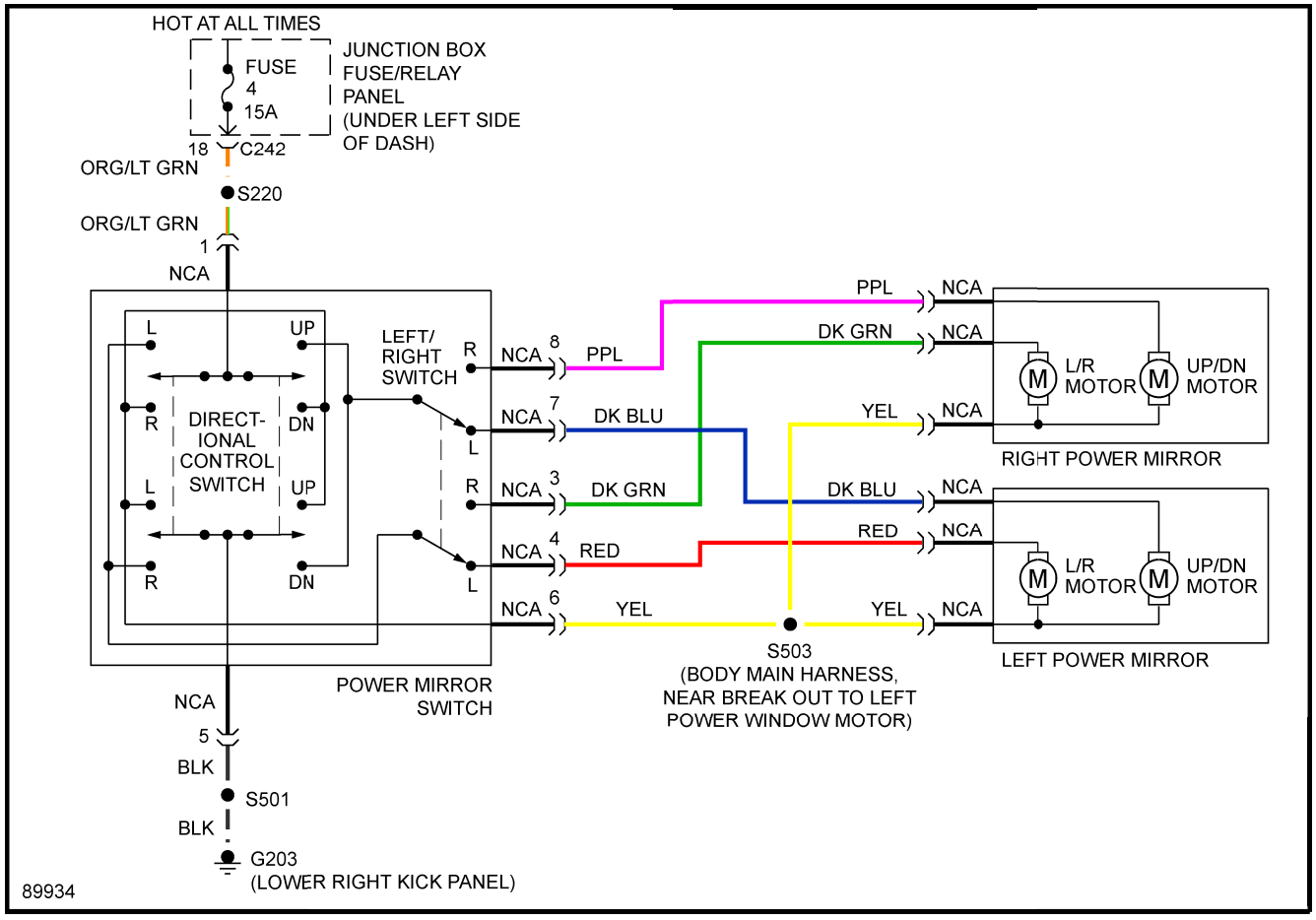


Fig. 2: Power Mirror System Wiring Diagram

SEATS - POWER

1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

DESCRIPTION

NOTE: Aerostar uses only power lumbar support.

The 6-way power seats provide horizontal, vertical and tilt adjustments. System consists of control switch, seat regulator motor, vertical and horizontal screw drives and gear mechanism, housing assembly and necessary wiring. Seat function switches are mounted on side of seat trim panel. Power seat circuits are protected by fuses and/or circuit breakers located in fuse panel and power distribution box.

OPERATION

Horizontal movement is controlled by a transmission, lead screw and motor attached to the movable section of the track. Vertical drive unit is located on left side of the movable track. Vertical operation energizes center and rear armatures and vertical drive units move seat up or down. In tilt operation, armatures move front or rear vertical drive screws to adjust seat. The motor unit is serviced as an assembly.

COMPONENT TESTS

NOTE: Some individual component testing is not available from manufacturer. See SYMPTOM TEST .

MEMORY CONTROL SWITCH (EXPLORER & MOUNTAINEER)

Remove memory control switch and disconnect connector. Check resistance between memory control switch terminals with switch in each position. See MEMORY CONTROL SWITCH RESISTANCE (EXPLORER & MOUNTAINEER) TABLE. See **Fig. 1** . If resistance is not as specified, replace memory control switch.

MEMORY CONTROL SWITCH RESISTANCE

Switch Position	Terminals	Resistance Ohms
OFF (1)	1 & 6	Greater Than 10,000
SET	1 & 6	Less Than 5
MEM 1	1 & 3	Less Than 5
MEM 2	1 & 4	Less Than 5

(1) Between terminals 8 and 9, the resistance should be infinite. When ohmmeter leads are reversed, resistance should be low resistance.

MOTOR ASSEMBLY (EXPLORER & MOUNTAINEER)

Disconnect motor assembly connectors. Apply battery voltage across specified terminals and observe operation. See MOTOR ASSEMBLY OPERATION (EXPLORER & MOUNTAINEER) TABLE. See **Fig. 2** and **Fig. 3** .

If motor does not operate smoothly and in direction specified, replace motor assembly.

MOTOR ASSEMBLY OPERATION

Motor Test	Positive Voltage	Negative Voltage	Motor Direction
Front	2	1	Up
"	1	2	Down
FWD/RWD	5	4	Forward
"	4	5	Rearward
Rear	3	6	Up
"	6	3	Down

SEAT CONTROL SWITCH (EXPLORER & MOUNTAINEER)

Remove seat control switch and disconnect connector. Check resistance between seat control switch terminals. See SEAT CONTROL SWITCH RESISTANCE (EXPLORER & MOUNTAINEER) TABLE. See **Fig. 4** . If resistance is not as specified, replace seat control switch.

SEAT CONTROL SWITCH RESISTANCE

Switch Position	Terminals	Resistance Ohms
Rearward	3 & 5	Less Than 5
"	1 & 2; 4; 6; 7; 8	Less Than 5
Forward	3 & 2	Less Than 5
"	1 & 4; 5; 6; 7; 8	Less Than 5
Front Down	3 & 8	Less Than 5
"	1 & 2; 4; 5; 6; 7	Less Than 5
Front Up	3 & 6	Less Than 5
"	1 & 2; 4; 5; 7; 8	Less Than 5
Rear Down	3 & 7	Less Than 5
"	1 & 2; 4; 5; 6; 8	Less Than 5
Rear Up	3 & 4	Less Than 5
"	1 & 2; 5; 6; 7; 8	Less Than 5
Entire Seat Up	3 & 4; 6	Less Than 5
"	1 & 2; 5; 7; 8	Less Than 5
Entire Seat Down	3 & 7; 8	Less Than 5
"	1 & 2; 4; 5; 6	Less Than 5

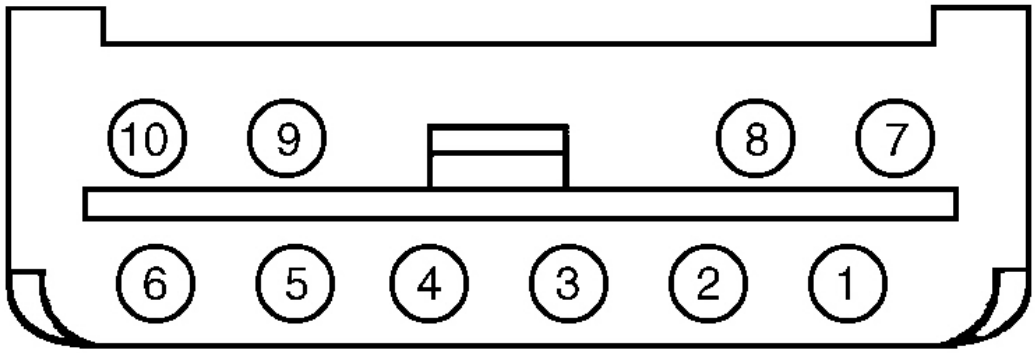
SEAT CONTROL SWITCH (EXPEDITION)

Remove seat control switch and disconnect connector. Check resistance between seat control switch terminals. See SEAT CONTROL SWITCH RESISTANCE (EXPEDITION) TABLE. See **Fig. 5** . If resistance is not as specified, replace seat control switch.

SEAT CONTROL SWITCH RESISTANCE

Switch Position	Terminals	Resistance Ohms
Off (1)	1 & 4	Greater Than 5
Rearward	4 & 7	Less Than 5
Forward	4 & 6	Less Than 5
Front Down	4 & 5	Less Than 5
Front Up	4 & 1	Less Than 5
Rear Down	4 & 2	Less Than 5
Rear Up	4 & 3	Less Than 5
Entire Seat Up	4 & 1; 3	Less Than 5
Entire Seat Down	4 & 2; 5	Less Than 5

(1) Resistance between terminal No. 8 and all other terminals except terminal No. 4 should be less than 5 ohms.



G96J31343

Fig. 1: Identifying Memory Control Switch Terminals (Explorer & Mountaineer)
Courtesy of FORD MOTOR CO.

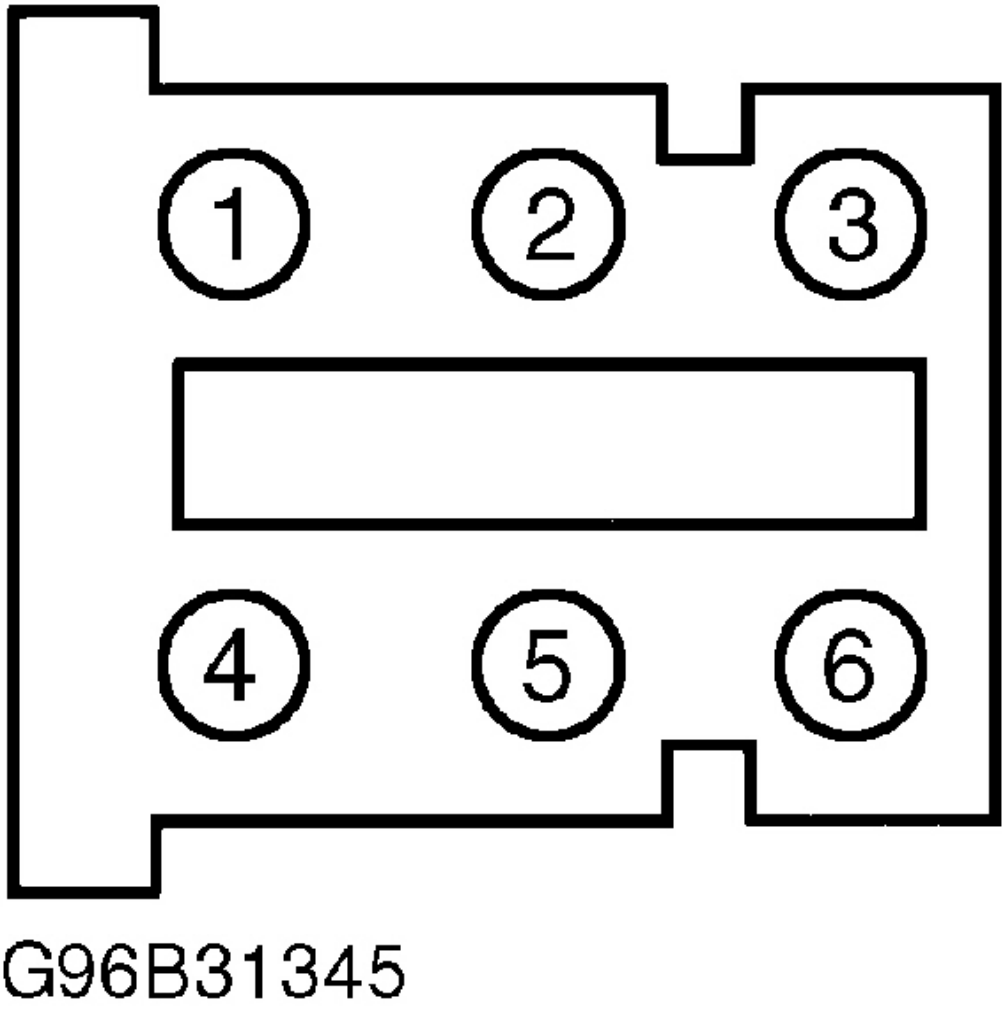


Fig. 2: Motor Connector
Courtesy of FORD MOTOR CO.

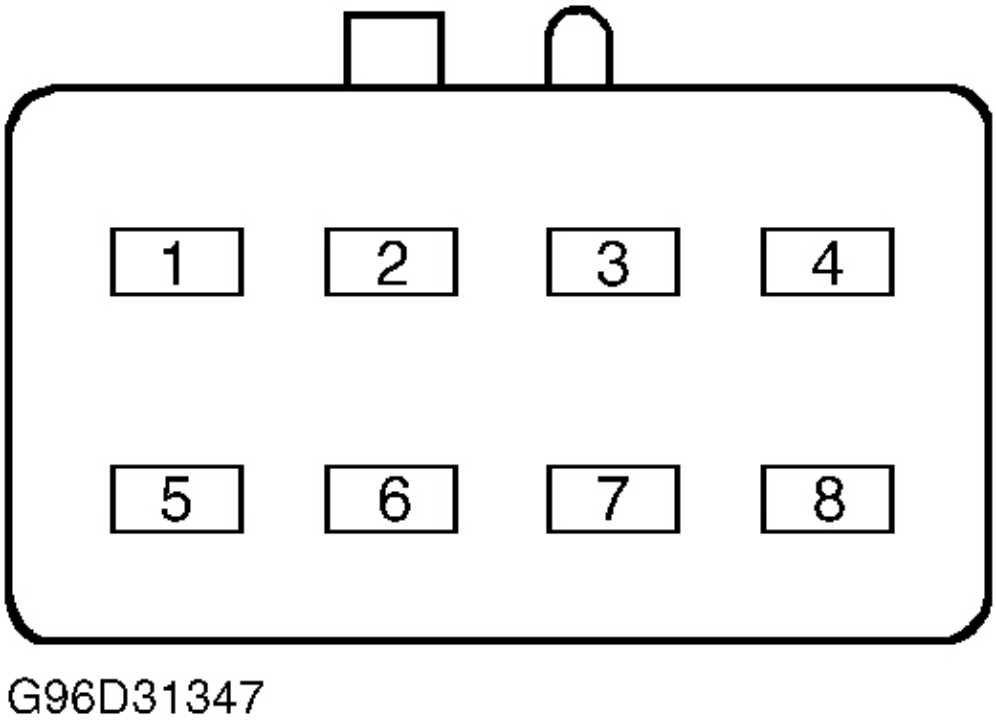


Fig. 3: Identifying Motor Assembly Terminals 96B31345 Sensor Connector
Courtesy of FORD MOTOR CO.

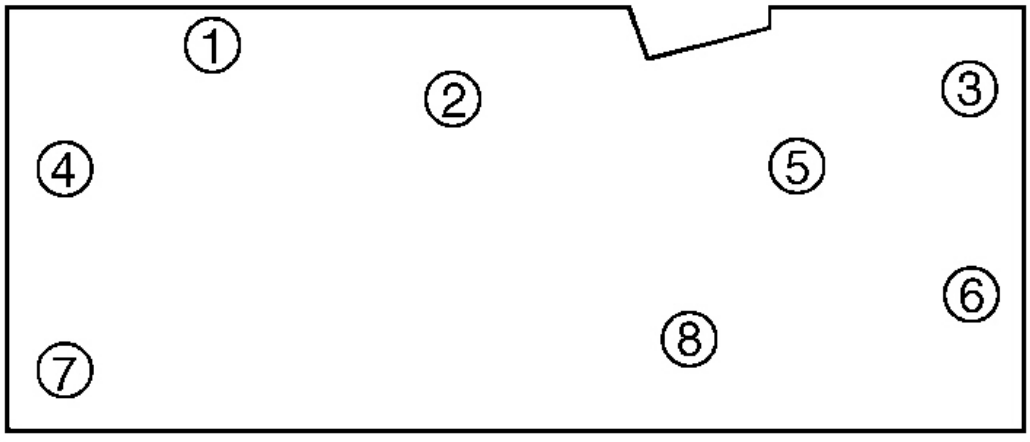


Fig. 4: Identifying Seat Control Switch Terminals (Explorer & Mountaineer)
Courtesy of FORD MOTOR CO.

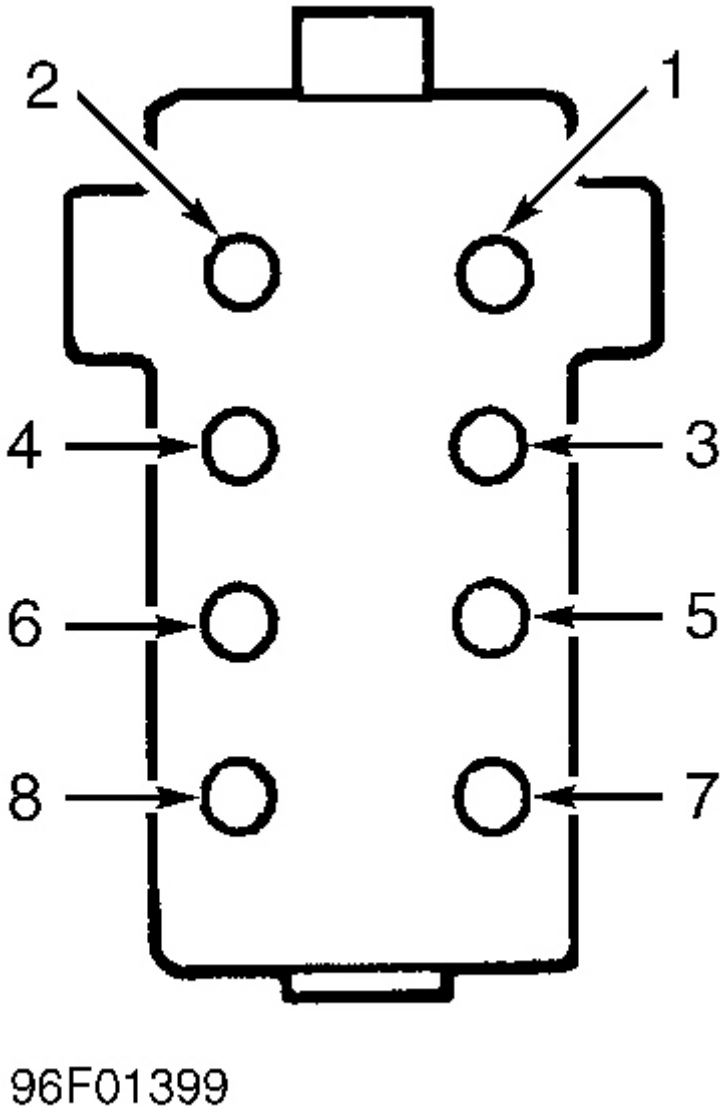


Fig. 5: Identifying Seat Control Switch Terminals (Expedition)
Courtesy of FORD MOTOR CO.

SYMPTOM TESTING

NOTE: **To determine appropriate test, see SYMPTOM CHART TABLE. Unless otherwise directed, perform tests in order listed.**

Verify the customer complaint by operating power seat. Visually inspect for obvious sign of mechanical and electrical damage. If no visual damage is evident, go to SYMPTOM CHART TABLE. A digital volt-ohmmeter is required to test the power seat system. See **WIRING DIAGRAMS** for pin numbers. These connectors are identified in illustration. See **Fig. 1** -9.

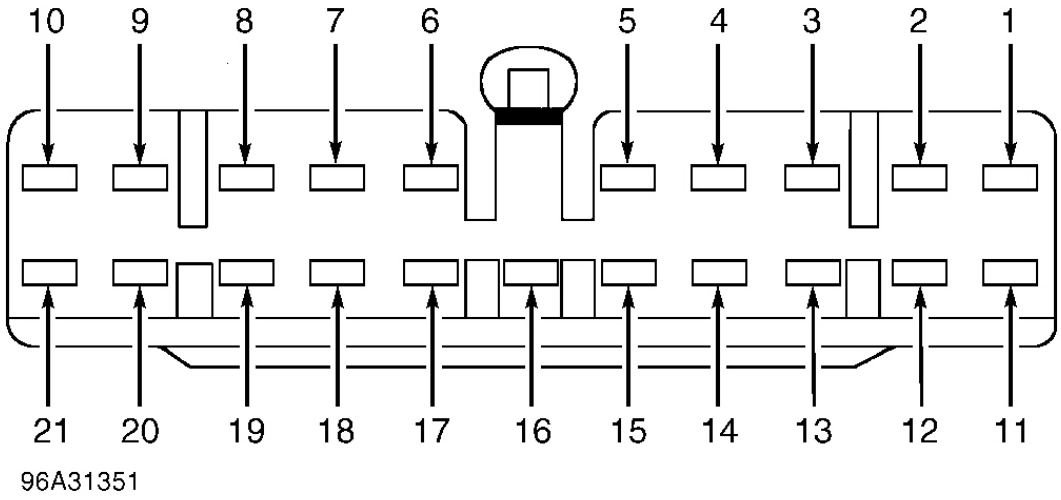


Fig. 6: Identifying Memory Control Module Harness Connectors (Explorer & Mountaineer) Connector C335
Courtesy of FORD MOTOR CO.

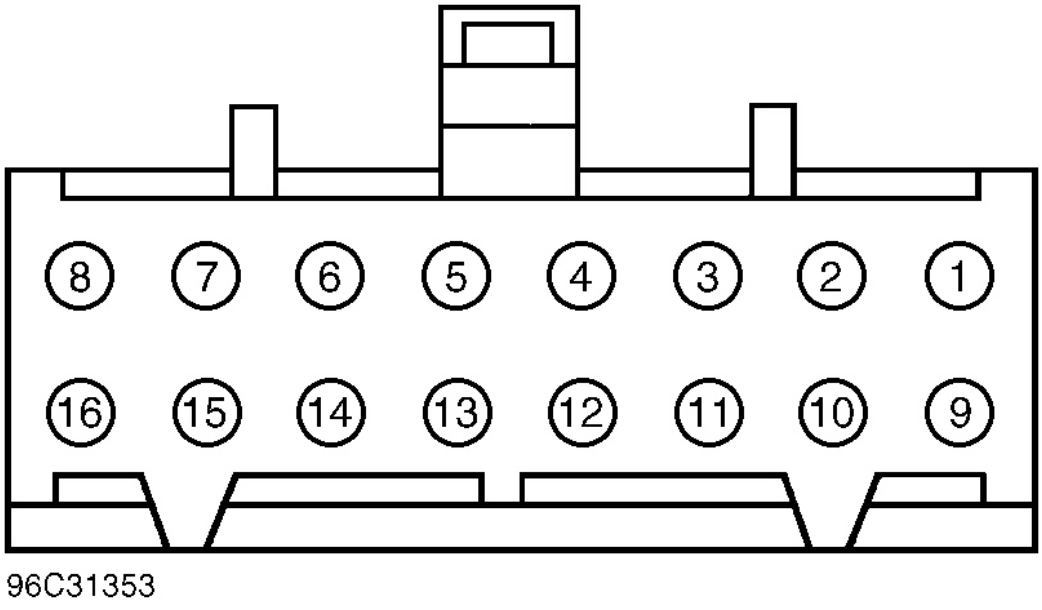


Fig. 7: Identifying Memory Control Module Harness Connectors (Explorer & Mountaineer) Connector C351

Courtesy of FORD MOTOR CO.

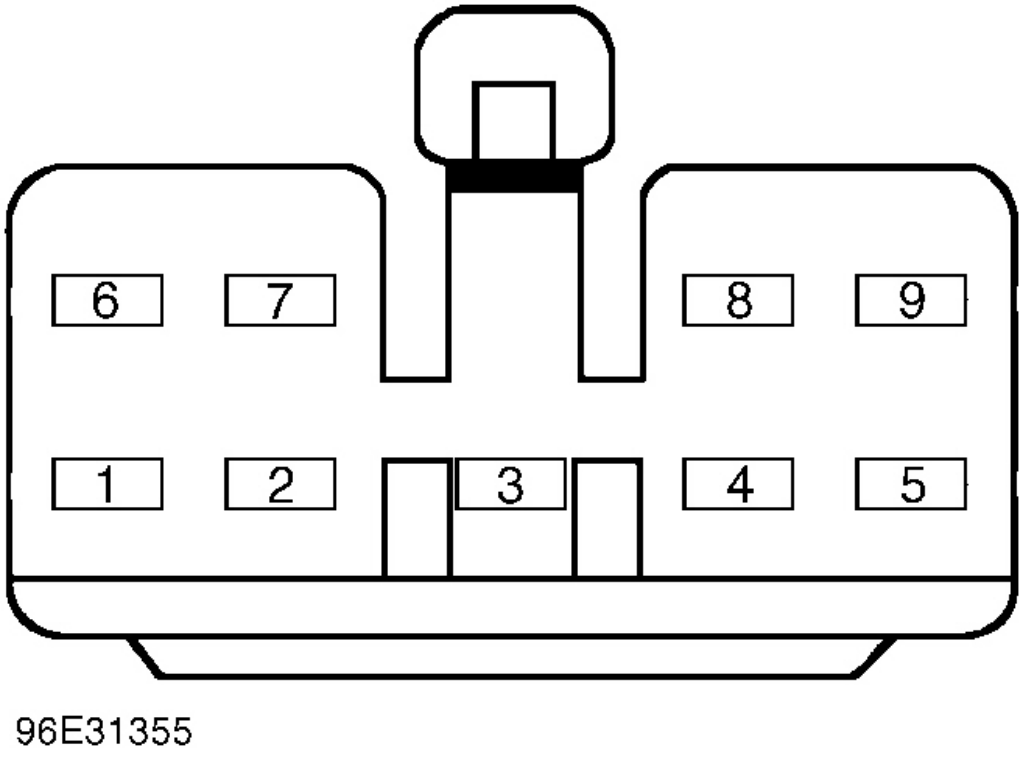


Fig. 8: Identifying Memory Control Module Harness Connectors (Explorer & Mountaineer) Connector C352
Courtesy of FORD MOTOR CO.

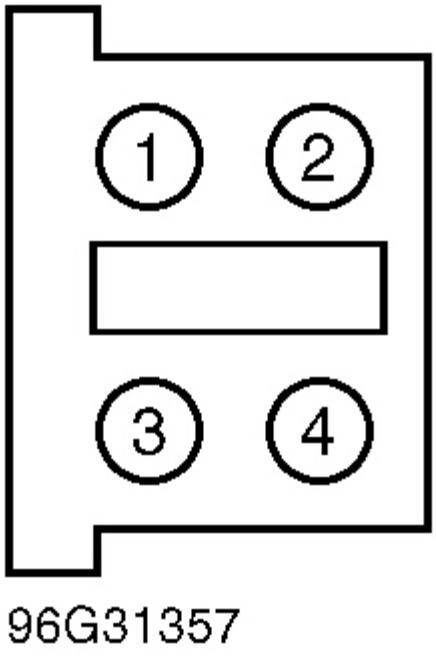


Fig. 9: Identifying Memory Control Module Harness Connectors (Explorer & Mountaineer) Connector C350
Courtesy of FORD MOTOR CO.

SYMPTOM CHART

Symptom	Go To Test
Power Seat Completely Inoperative	(1) A
Power Seat Noisy	B
Power Seat Loose	C
Power Seat Operation Incomplete	D
Power Seat Does Move Horizontally or Vertically	E
Power Lumbar Seat Inoperative	F
Memory Seat Inoperative	G
(1) If equipped with memory seat, perform **TEST G** .	

TEST A: POWER SEAT COMPLETELY INOPERATIVE

NOTE: On Explorer and Mountaineer the 30-amp power seat fuse also supplies voltage

to the following components: driver door lock relay, door lock relay, door unlock relay, accessary delay relay and power lumbar switch.

1. **Test Fuse** - Ensure ignition switch is off. Remove 30-amp (60-amp on Windstar) power seat fuse, located in power distribution box in engine compartment (in-car fuse panel on Van). Check fuse. If fuse is not blown, go to next step. If fuse is blown, repair short in Dark Green wire (Black/White wire on Van, Explorer and Mountaineer). See **WIRING DIAGRAMS** .
2. **Test Power To Seat Switch** - Disconnect seat control switch. Check voltage at Dark Green wire (Black/White wire on Van, Explorer and Mountaineer) of seat control switch harness connector. If battery voltage exists, go to next step. If battery voltage does not exist, repair open in Dark Green wire.
3. **Test Ground At Switch** - Check resistance in Black wire between seat control switch harness connector and ground. If resistance is 5 ohms or less, go to **TEST E** . If resistance is greater than 5 ohms, repair open in Black wire.

TEST B: POWER SEAT NOISY

Check Seat Track Alignment

Ensure ignition switch is off. Check alignment of seat track to floor and seat bottom. If seat track is out of alignment, align seat track. If seat track is not out of alignment, replace seat track.

TEST C: POWER SEAT LOOSE

Check Hardware

Check fastening hardware for proper installation. If hardware is loose, tighten hardware. If hardware is not loose, replace seat track.

TEST D: POWER SEAT OPERATION INCOMPLETE

Check For Obstruction

Ensure ignition switch is off. Remove driver seat. If track has obstructions, remove obstructions and grease track. If track has no obstructions, replace seat track.

TEST E: POWER SEAT DOES NOT MOVE HORIZONTALLY OR VERTICALLY

NOTE: On Explorer, Mountaineer and Van the seat motors are an assembly and has only one connector that operates all motors. All others have three separate motors and connectors and can be serviced separately.

1. **Which Direction Has Failed** - Ensure ignition switch is off. Operate seat in all directions. If seat does not move horizontally, go to next step. If seat moves horizontally, go to step 7).
2. **Test Voltage At Forward/Reverse Motor** - Disconnect forward/reverse motor connector, motor closest to front of seat. Connect voltmeter between Yellow/White and Red/White wires at forward/reverse motor harness connector. Operate forward/reverse switch in both directions, while observing voltmeter. If

voltage does not change from less than -10 volts to greater than 10 volts, go to next step. If voltage changes from less than -10 volts to greater than 10 volts, check seat track for smooth operation. If seat track is okay, replace forward/reverse motor.

3. **Test Yellow/White Wire For Open** - Disconnect seat control switch connector. Check resistance in Yellow/White wire between seat control switch harness connector and forward/reverse motor harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/White wire.
4. **Test Yellow/White Wire For Short** - Check resistance in Yellow/White wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Yellow/White wire.
5. **Test Red/White Wire For Open** - Check resistance in Red/White wire between seat control switch harness connector and forward/reverse motor harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/White wire.
6. **Test Red/White Wire For Short** - Check resistance in Red/White wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, replace seat control switch. If resistance is less than 10,000 ohms, repair short in Red/White wire.
7. **Test For Tilting Function Failure** - Operate tilting functions. If only forward tilting function works, go to next step. If only rear tilting function works, go to step 13). If no tilting functions work, replace seat control switch.
8. **Test Voltage At Rear Tilting Motor** - Disconnect rear tilting motor connector. Connect voltmeter between Red/Light Green and Yellow/Light Green wires at rear tilting motor harness connector. Operate rear tilting switch in both directions, while observing voltmeter. If voltage does not change from less than -10 volts to greater than 10 volts, go to next step. If voltage changes from less than -10 volts to greater than 10 volts, check seat track for smooth operation. If seat track is okay, replace rear tilting motor.
9. **Test Red/Light Green Wire For Open** - Disconnect seat control switch connector. Check resistance in Red/Light Green wire between seat control switch harness connector and rear tilting motor harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/Light Green wire.
10. **Test Red/Light Green Wire For Short** - Check resistance in Red/Light Green wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Red/Light Green wire.
11. **Test Yellow/Light Green Wire For Open** - Check resistance in Yellow/Light Green wire between seat control switch harness connector and rear tilting motor harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/Light Green wire.
12. **Test Yellow/Light Green Wire For Short** - Check resistance in Yellow/Light Green wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, replace seat control switch. If resistance is less than 10,000 ohms, repair short in Yellow/Light Green wire.
13. **Test Voltage At Front Tilting Motor** - Disconnect front tilting motor connector. Connect voltmeter between Red/Light Blue and Yellow/Light Blue wires at front tilting motor harness connector. Operate front tilting switch in both directions, while observing voltmeter. If voltage does not change from less than -10 volts to greater than 10 volts, go to next step. If voltage changes from less than -10 volts to greater than 10 volts, check seat track for smooth operation. If seat track is okay, replace front tilting motor.
14. **Test Red/Light Blue Wire For Open** - Disconnect seat control switch connector. Check resistance in

Red/Light Blue wire between seat control switch harness connector and front tilting motor harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/Light Blue wire.

15. **Test Red/Light Blue Wire For Short** - Check resistance in Red/Light Blue wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Red/Light Blue wire.
16. **Test Yellow/Light Blue Wire For Open** - Check resistance in Yellow/Light Blue wire between seat control switch harness connector and front tilting motor harness connector. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/Light Blue wire.
17. **Test Yellow/Light Blue Wire For Short** - Check resistance in Yellow/Light Blue wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, replace seat control switch. If resistance is less than 10,000 ohms, repair short in Yellow/Light Blue wire.

TEST F: IMPROPER OR NO POWER LUMBAR SUPPORT OPERATION

1. **Switch Circuit Test** - Disconnect lumbar switch. Check voltage at Black/White wire (Dark Green wire on Windstar) at lumbar switch harness connector. If battery voltage does not exist, go to next step. If battery voltage exists, go to step 5).
2. **Test For Short To Ground** - Remove power seat fuse, located in engine compartment fuse box. See **WIRING DIAGRAMS** for fuse number and amperage. Check resistance in Black/White wire (Dark Green wire on Windstar) between lumbar switch harness connector and ground. If resistance is 10,000 ohms or more, go to next step. If resistance is less than 10,000 ohms, repair short in Black/White wire (Dark Green wire on Windstar).
3. **Test Circuit Continuity** - Check resistance of Black/White wire (Dark Green wire on Windstar) between lumbar switch harness connector and output side of power seat fuse terminal. If resistance is 5 ohms or less, install power seat fuse and go to next step. If resistance is more than 5 ohms, repair open in Black/White wire (Dark Green wire on Windstar).
4. **Test Switch Operation** - Connect lumbar switch. Using a voltmeter, backprobe Red wire at lumbar switch connector while activating lumbar switch to inflate position. If battery voltage exists, go to next step. If battery voltage does not exist, replace lumbar switch.
5. **Test Pump/Motor** - Activate lumbar switch to inflate position. If pump/motor does not run, go to next step. If pump/motor runs, go to step 9).
6. **Test Pump/Motor Circuit** - Disconnect connector from pump/motor. Check voltage between Black wire and Red wire at pump/motor harness connector. Activate lumbar switch to inflate position. If battery voltage does not exist, go to next step. If battery voltage exists, replace pump/motor.
7. **Test Power Supply To Pump/Motor** - Check voltage at Red wire of pump/motor harness connector. Activate lumbar switch to inflate position. If battery voltage does not exist, go to next step. If battery voltage exists, repair open in Black wire.
8. **Test For Short** - Check resistance in Red wire between lumbar switch harness connector and ground. If resistance is 5 ohms or less, repair short in Red wire. If resistance is more than 5 ohms, replace lumbar switch.
9. **Test Pump Adjusting System** - Activate lumbar switch to inflate position. Observe seatback pad. If seatback does not inflate, go to next step. If seatback inflates, go to step 13).
10. **Test Lumbar Support Bladder** - Inspect support bladder. If no damage is visible, go to next step. If any

damage is visible, replace support bladder.

11. **Test Airflow At Pump/Motor** - Remove support bladder hose from pump/motor. Activate lumbar switch to inflate position. If air is felt coming from pump/motor, go to next step. If no air is felt coming from pump/motor, replace pump/motor.
12. **Test Airflow At Seat Switch** - Connect support bladder hose to pump/motor. Disconnect hose from lumbar switch. Activate lumbar switch to inflate position. If air is felt at open hose, go to next step. If no air is felt at open hose, replace hose.
13. **Test System For Leaks** - Reconnect support bladder hose to lumbar switch. Connect in-line pressure gauge to hose. Hold lumbar switch in inflate position until pressure is 5 psi (0.35 kg/cm^2). Wait 3 hours. Observe pressure. If pressure does not hold, go to next step. If pressure holds, system is okay.
14. **Test Lumbar Support Bladder For Leaks** - Disconnect hose from lumbar support bladder. Using hand pump, inflate pad to 5 psi (0.35 kg/cm^2). Wait 3 hours. Observe pressure. If pressure does not hold, replace lumbar support bladder. If pressure holds, replace lumbar switch.

TEST G: MEMORY SEAT INOPERATIVE

NOTE: If seat is stuck in most rearward and down position, it may be necessary to unbolt seat from car to gain access to self-test switch.

1. **Execute Self-Test** - Turn ignition switch to RUN position. Press self-test button, located on top of seat module. Observe movement in 4 threaded adjuster and LED light. If nothing was observed, go to next step. If all 4 adjusters moved briefly in both directions and LED flashed 5 times then 2 times, go to step 44). If left-hand front adjust does not operate, go to step 6). If one or more adjusters did not operate, go to step 21).
2. **Test Fuses** - Check fuse No. 5 (30-amp), located in power distribution box in engine compartment. Check fuse No. 9 (10-amp) and fuse No. 28 (7.5-amp), located in in-car fuse panel. If any fuse is blown, go to next step. If all fuses are not blown, go to step 4).
3. **Test For Short** - Disconnect seat control switch and memory control switch connectors. Disconnect accessory delay, driver door lock, door lock and door unlock relays. Disconnect memory control module connectors. Check resistance between memory control module harness connectors and ground at the following wires: circuit No. 171 (Black/White wire), circuit No. 1000 (Red/Black wire) and circuit No. 54 (Light Green/Yellow wire). See **WIRING DIAGRAMS** for appropriate circuit identification. If resistance is 10,000 ohms or less in any wire(s), repair short in appropriate wire(s). If resistance is greater than 10,000 ohms in all wires, replace memory control module if fuse No. 28 or 9 had failed. If fuse No. 5 had failed replace components one at a time until fuse blows, then replace appropriate component.
4. **Test For Power** - Install fuses. Disconnect memory control module connector. Turn ignition switch to RUN position. Check voltage at wires described in previous step. If 10 volts or greater exists, go to next step. If less than 10 volts exists, repair open in appropriate wire(s).
5. **Test Ground At Seat Module** - Check resistance in Black wire and Black/White wire between memory control module harness connector and ground. If resistance is 5 ohms or less, replace memory control module. If resistance is greater than 5 ohms, repair open in appropriate wire(s).
6. **Test Ground At Switch** - Disconnect seat control switch. Check resistance in Black wire between seat control switch harness connector and ground. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Black wire.

7. **Test Power at Switch** - Check voltage at Black/White wire of seat control switch harness connector. If 10 volts or greater exists,go to next step. If less than 10 volts exists, repair open in Black/White wire.
8. **Test Seat Control Switch** - Test seat control switch. See SEAT CONTROL SWITCH (EXPLORER & MOUNTAINEER) under **COMPONENT TESTS** . If resistances are as specified, go to next step. If resistances are not as specified, replace seat control switch.
9. **Test Yellow/Light Blue Wire For Open** - Disconnect memory control module. Check resistance in Yellow/Light Blue wire between memory control module and seat control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/Light Blue wire.
10. **Test Yellow/Light Blue Wire For Short** - Check resistance between Yellow/Light Blue wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Yellow/Light Blue wire.
11. **Test Red/Light Blue Wire For Open** - Check resistance in Red/Light Blue wire between memory control module and seat control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/Light Blue wire.
12. **Test Red/Light Blue Wire For Short** - Check resistance between Red/Light Blue wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Red/Light Blue wire.
13. **Test Yellow/White Wire For Open** - Check resistance in Yellow/White wire between memory control module and seat control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/White wire.
14. **Test Yellow/White Wire For Short** - Check resistance between Yellow/White wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Yellow/White wire.
15. **Test Red/White Wire For Open** - Check resistance in Red/White wire between memory control module and seat control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/White wire.
16. **Test Red/White Wire For Short** - Check resistance between Red/White wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Red/White wire.
17. **Test Yellow/Light Green Wire For Open** - Check resistance in Yellow/Light Green wire between memory control module and seat control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/Light Green wire.
18. **Test Yellow/Light Green Wire For Short** - Check resistance between Yellow/Light Green wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Yellow/Light Green wire.
19. **Test Red/Light Green Wire For Open** - Check resistance in Red/Light Green wire between memory control module and seat control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/Light Green wire.
20. **Test Red/Light Green Wire For Short** - Check resistance between Red/Light Green wire between seat control switch harness connector and ground. If resistance is 10,000 ohms or greater, replace memory control module. If resistance is less than 10,000 ohms, repair short in Red/Light Green wire.
21. **Test Red/Light Blue Wire For Open** - Disconnect memory control module connectors. Disconnect seat

motor connectors. Check resistance in Red/Light Blue wire between memory control module and seat motor harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/Light Blue wire.

22. **Test Red/Light Blue Wire For Short** - Check resistance between Red/Light Blue wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Red/Light Blue wire.
23. **Test Yellow/Light Blue Wire For Open** - Check resistance in Yellow/Light Blue wire between memory control module and seat motor harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/Light Blue wire.
24. **Test Yellow/Light Blue Wire For Short** - Check resistance between Yellow/Light Blue wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Yellow/Light Blue wire.
25. **Test Red/White Wire For Open** - Check resistance in Red/White wire between memory control module and seat motor harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/White wire.
26. **Test Red/White Wire For Short** - Check resistance between Red/White wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Red/White wire.
27. **Test Yellow/White Wire For Open** - Check resistance in Yellow/White wire between memory control module and seat motor harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/White wire.
28. **Test Yellow/White Wire For Short** - Check resistance between Yellow/White wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Yellow/White wire.
29. **Test Red/Light Green Wire For Open** - Check resistance in Red/Light Green wire between memory control module and seat motor harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Red/Light Green wire.
30. **Test Red/Light Green Wire For Short** - Check resistance between Red/Light Green wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Red/Light Green wire.
31. **Test Yellow/Light Green Wire For Open** - Check resistance in Yellow/Light Green wire between memory control module and seat motor harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/Light Green wire.
32. **Test Yellow/Light Green Wire For Short** - Check resistance between Yellow/Light Green wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Yellow/Light Green wire.
33. **Test Orange/Red Wire For Open** - Check resistance in Orange/Red wire between memory control module and seat motor harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Orange/Red wire.
34. **Test Orange/Red Wire For Short** - Check resistance between Orange/Red wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Orange/Red wire.
35. **Test Light Green/Red Wire For Open** - Check resistance in Light Green/Red wire between memory control module and seat motor switch harness connectors. If resistance is 5 ohms or less, go to next step.

If resistance is greater than 5 ohms, repair open in Light Green/Red wire.

36. **Test Light Green/Red Wire For Short** - Check resistance between Light Green/Red wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Light Green/Red wire.
37. **Test Light Green/Orange Wire For Open** - Check resistance in Light Green/Orange wire between memory control module and seat motor harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Light Green/Orange wire.
38. **Test Light Green/Orange Wire For Short** - Check resistance between Light Green/Orange wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Light Green/Orange wire.
39. **Test Orange/White Wire For Open** - Check resistance in Orange/White wire between memory control module and seat motor switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Orange/White wire.
40. **Test Orange/White Wire For Short** - Check resistance between Orange/White wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Orange/White wire.
41. **Test Light Green/Black Wire For Open** - Check resistance in Light Green/Black wire between memory control module and seat motor switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Light Green/Black wire.
42. **Test Light Green/Black Wire For Short** - Check resistance between Light Green/Black wire between memory control module harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Light Green/Black wire.
43. **Test Motor Assembly** - Check motor assembly operation. See MOTOR ASSEMBLY (EXPLORER & MOUNTAINEER) under **COMPONENT TESTS** . If motor assembly operates as specified, go to next step. If motor assembly does not operate as specified, replace motor assembly.
44. **Test Motor Assembly Hall Effect Sensor** - Connect memory control module. Connect motor assembly connectors. Press memory seat recall switch "1". Observe memory seat module LED. If LED flashes 3, 4 or 6 times, replace seat motor assembly and preform self-test. If LED does not flash 3, 4 or 6 times, replace memory seat module and preform self-test.
45. **Test Memory Control Switch** - Disconnect memory control switch. Check memory control switch operation. See MEMORY CONTROL SWITCH (EXPLORER & MOUNTAINEER) under **COMPONENT TESTS** . If switch operation is as specified, go to next step. If switch operation is not as specified, replace memory control switch.
46. **Test Pink/White Wire For Open** - Disconnect memory control module connector. Check resistance in Pink/White wire between memory control module and memory control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Pink/White wire.
47. **Test Pink/White Wire For Short** - Check resistance between Pink/White wire between memory control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Pink/White wire.
48. **Test Brown/Orange Wire For Open** - Check resistance in Brown/Orange wire between memory control module and memory control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Brown/Orange wire.
49. **Test Brown/Orange Wire For Short** - Check resistance between Brown/Orange wire between memory

control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Brown/Orange wire.

50. **Test Light Green/White Wire For Open** - Check resistance in Light Green/White wire between memory control module and memory control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Light Green/White wire.
51. **Test Light Green/White Wire For Short** - Check resistance between Light Green/White wire between memory control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Light Green/White wire.
52. **Test White/Orange Wire For Open** - Check resistance in White/Orange wire between memory control module and memory control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in White/Orange wire.
53. **Test White/Orange Wire For Short** - Check resistance between White/Orange wire between memory control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in White/Orange wire.
54. **Test Brown/Light Green Wire For Open** - Disconnect remote anti-theft personality module. Check resistance in Brown/Light Green wire between memory control module and memory control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Brown/Light Green wire.
55. **Test Brown/Light Green Wire For Short** - Check resistance between Brown/Light Green wire between memory control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Brown/Light Green wire.
56. **Test Black/Orange Wire For Open** - Check resistance in Black/Orange wire between memory control module and memory control switch harness connectors. If resistance is 5 ohms or less, go to next step. If resistance is greater than 5 ohms, repair open in Black/Orange wire.
57. **Test Black/Orange Wire For Short** - Check resistance between Black/Orange wire between memory control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, repair short in Black/Orange wire.
58. **Test Brown/Light Green Wire For Short** - Connect remote anti-theft personality module. Check resistance between Brown/Light Green wire between memory control switch harness connector and ground. If resistance is 10,000 ohms or greater, go to next step. If resistance is less than 10,000 ohms, replace remote anti-theft personality module.
59. **Test Black/Orange Wire For Short** - Check resistance between Black/Orange wire between memory control switch harness connector and ground. If resistance is 10,000 ohms or greater, replace memory control module. If resistance is less than 10,000 ohms, replace remote anti-theft personality module.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

SEAT ASSEMBLY

Removal & Installation (Explorer)

Open locking tabs and remove covers to expose nuts at right rear of front seat track. Position seat track to full forward position. Remove rear nuts and front bolts retaining seat and seat track lower shield. Remove bolt securing slide bar to floorpan. Disconnect electrical connector. Remove seat from vehicle. To install, reverse removal procedure.

Removal & Installation (Van)

Remove seat track lower shield, if equipped. Remove insulators covering mounting nuts and/or bolts. Remove mounting nuts, bolts and washers. Lift seat slightly and disconnect harness connectors. Remove seat assembly. To install, reverse removal procedure.

Removal & Installation (Windstar)

Remove caps from seat retaining nuts. Remove 2 nuts and 2 bolts retaining seat track to floorpan. Disconnect electrical connectors and remove seat from vehicle. To install, reverse removal procedure.

SEAT CUSHION

NOTE: Procedure may vary slightly depending on seat size and power options.

Removal & Installation

1. Remove seat and track assembly. See **SEAT ASSEMBLY** . Remove screws from left side shield. Carefully disconnect and tag air hoses from lumbar/bolster support switches, if equipped. Disconnect switch-to-motor connectors. Remove left side shield. Remove remaining shields.
2. Remove hog rings securing lower portion of seatback cover. Slide seatback cover up enough to remove seatback frame bolts. Remove seatback. Disconnect air line from lumbar and bolster bladders, if equipped. Remove hog rings securing cover rods to seat frame. Remove cover and cushion. To install, reverse removal procedure.

POWER SEAT MOTOR

NOTE: Power seat motors are not serviceable. If power seat motor is defective, entire seat track must be replaced.

LUMBAR SUPPORT BACK PAD ADJUSTER

Removal & Installation

Remove seat and track assembly. See **SEAT ASSEMBLY** . Remove seatback cover. Disconnect seatback adjusting hose. Using a screwdriver, bend adjuster-to-seatback frame retaining tabs inward. Remove adjuster from seatback frame. To install, reverse removal procedure.

SEAT CONTROL SWITCH

Removal & Installation

Disconnect negative battery cable. Remove side shield retaining screws. Remove side shield. Remove 2 switch retaining screws. Remove switch and housing. Disconnect electrical connector. Remove control switch. To install, reverse removal procedure.

SEAT BACK CONTROL SWITCH

Removal & Installation

Disconnect negative battery cable. Remove seat cushion frame and spring assembly. Remove regulator control processor sensor. Remove control switch and housing attaching screws. Disconnect adjusting hose and electrical connector from switch. Remove switch. To install, reverse removal procedure.

MEMORY CONTROL SWITCH (EXPLORER)

Removal & Installation

Using screwdriver, disengage retaining stud at rear edge of bezel from door panel and remove trim panel. Gently snap switch from bezel. Disconnect electrical connector and remove switch. To install, reverse removal procedure.

MEMORY SEAT MODULE (EXPLORER)

Removal & Installation

Remove seat and track assembly. See **SEAT ASSEMBLY** . Place seat upside-down on clean surface. Remove 2 nuts and screw attaching module to seat track. Remove module. To install, reverse removal procedure.

WIRING DIAGRAMS

1997 Ford Pickup F150

SEATS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

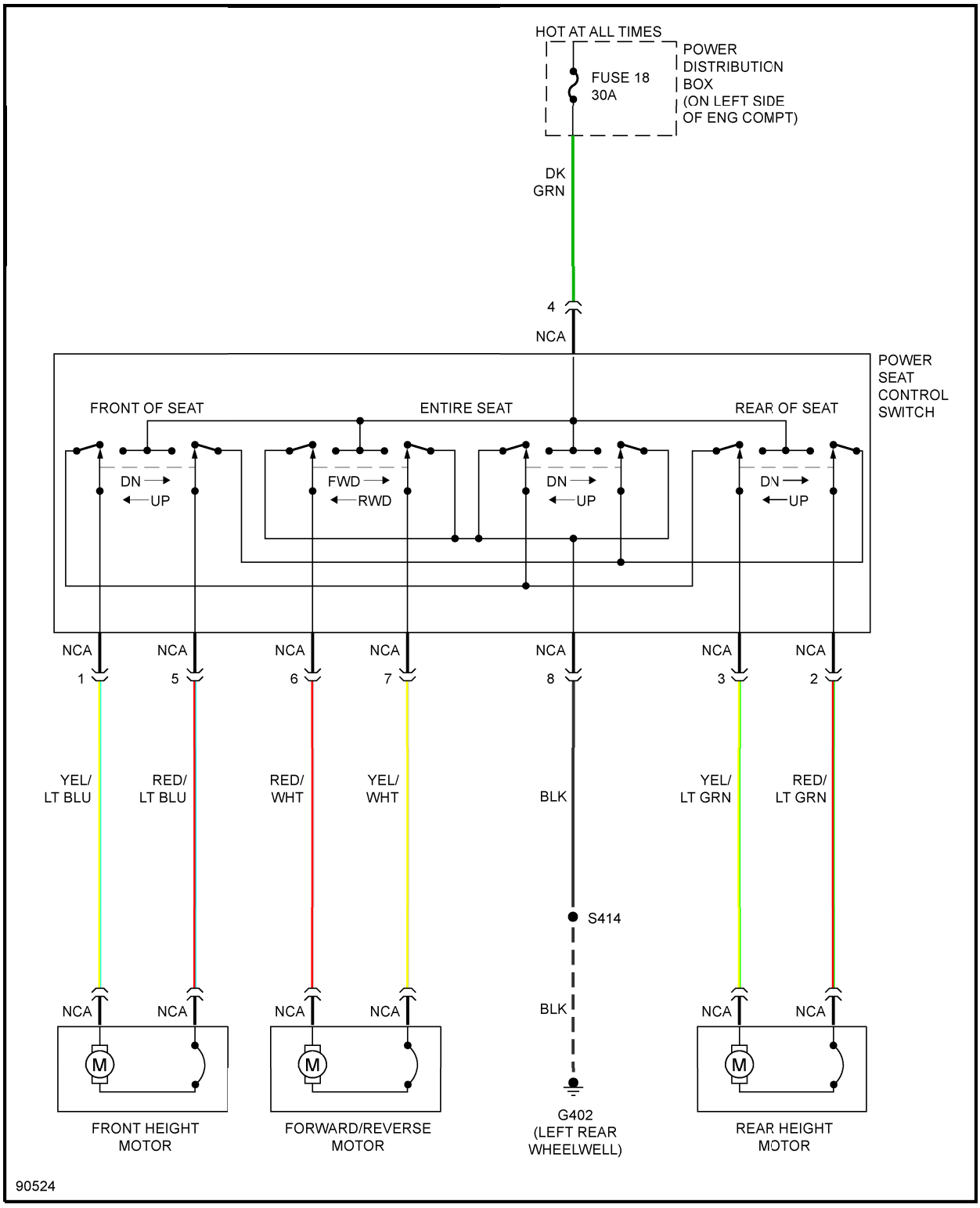


Fig. 10: Power Seats System Wiring Diagram (Expedition)

1997 Ford Pickup F150

SEATS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

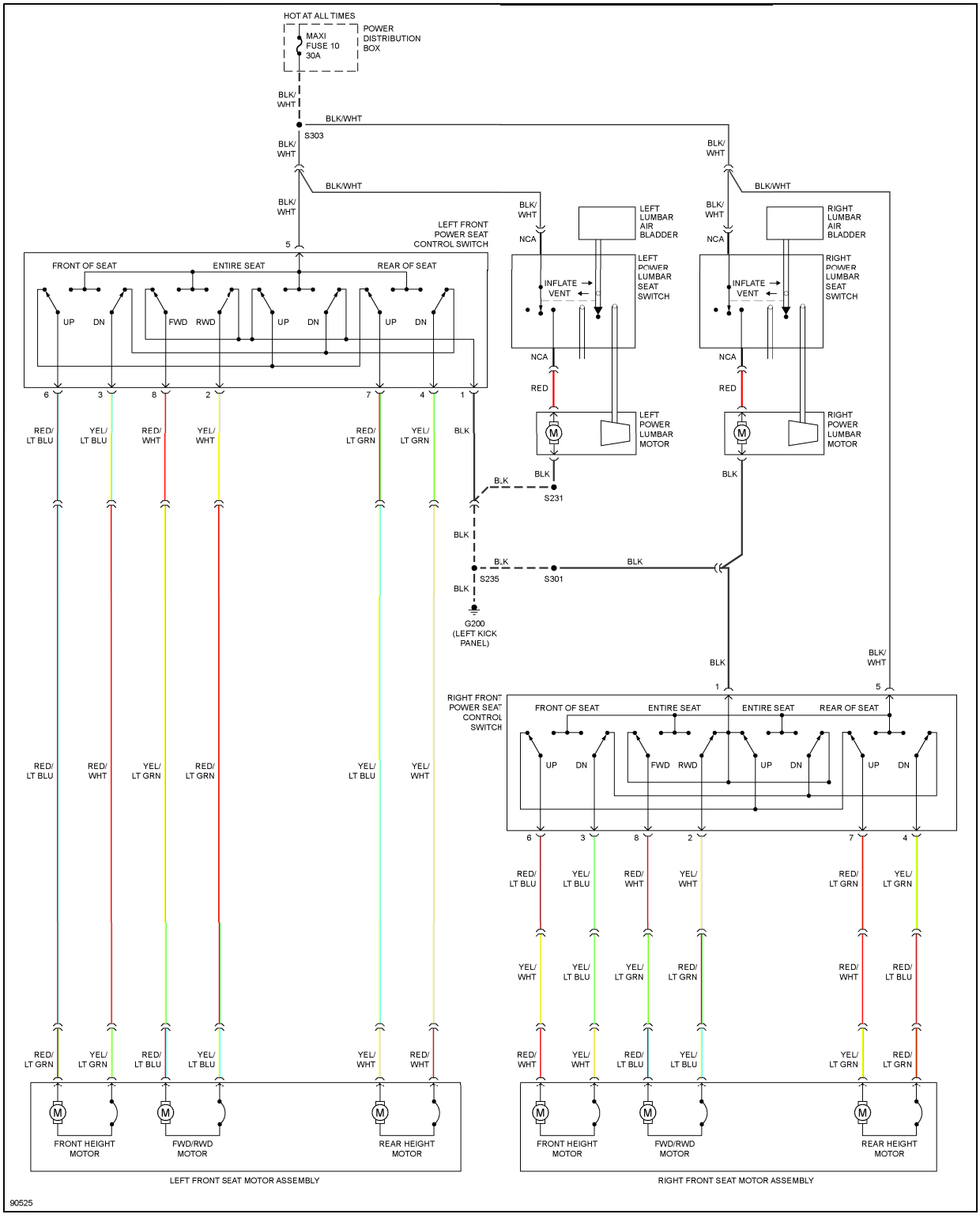


Fig. 11: Power Lumbar & Power Seats System Wiring Diagram (Explorer & Mountaineer)

1997 Ford Pickup F150

SEATS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

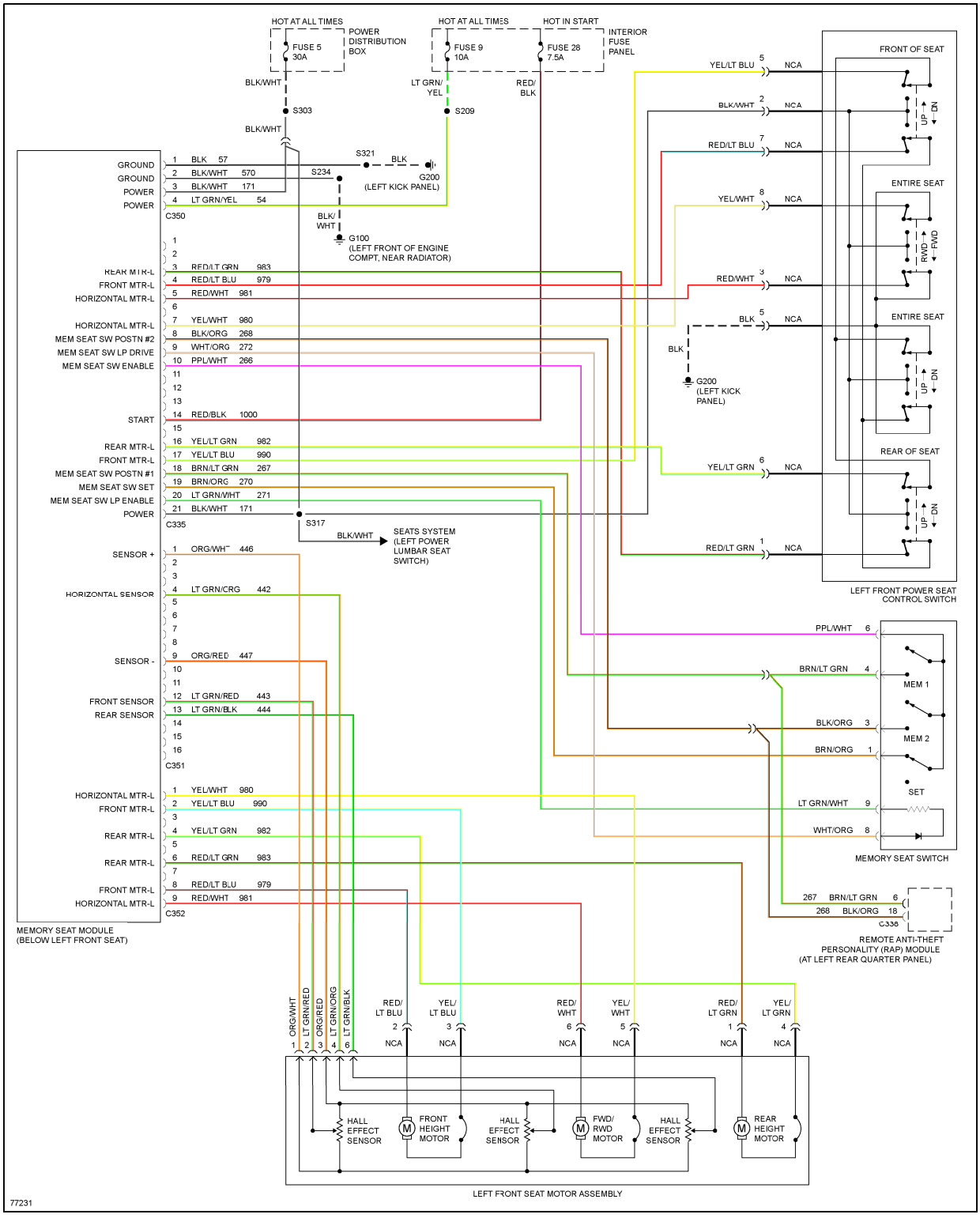


Fig. 12: Power Seats System Wiring Diagram (Explorer & Mountaineer - With Memory Seat)

1997 Ford Pickup F150

SEATS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

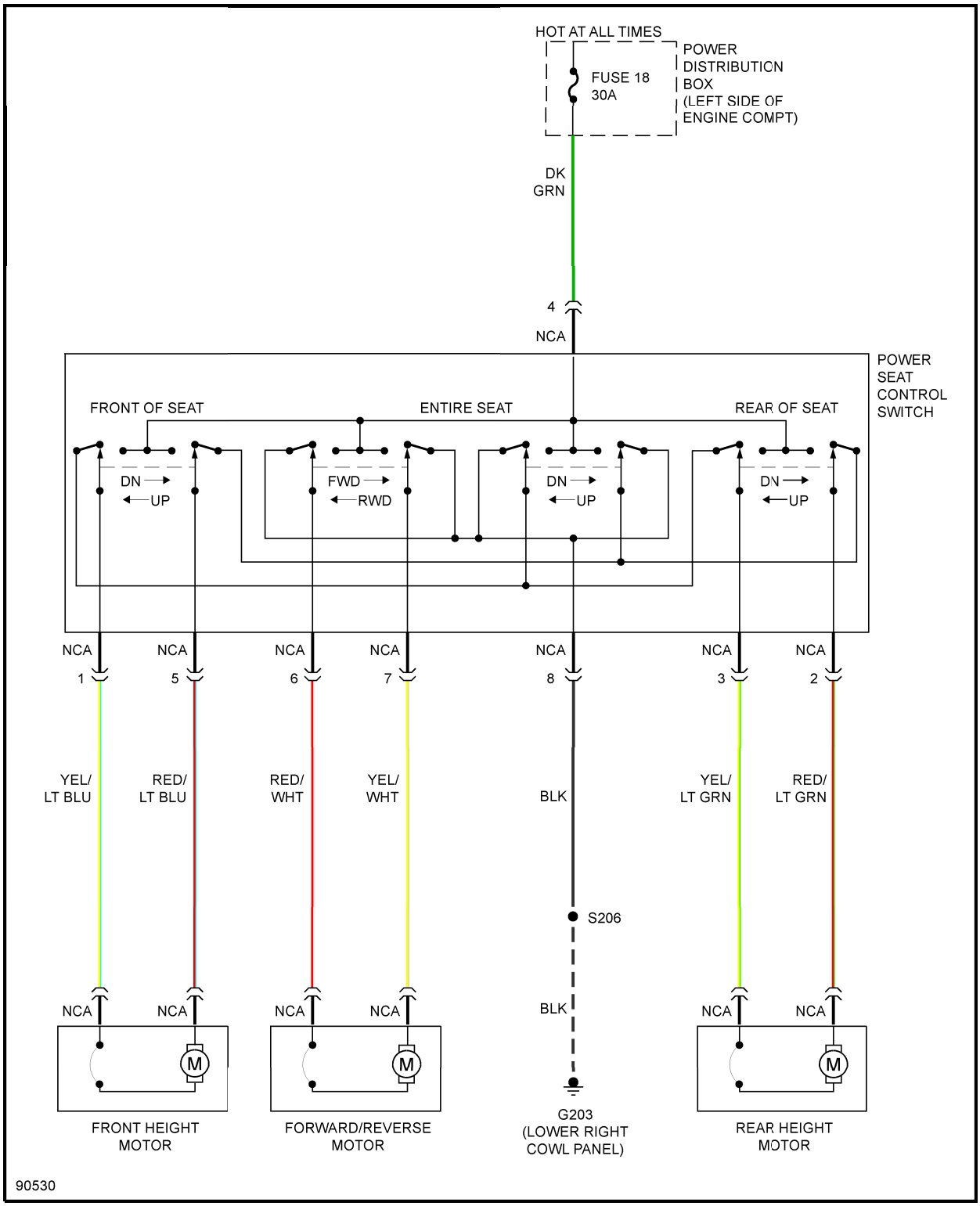


Fig. 13: Power Seats System Wiring Diagram (Pickup - F150 & F250 Light-Duty)

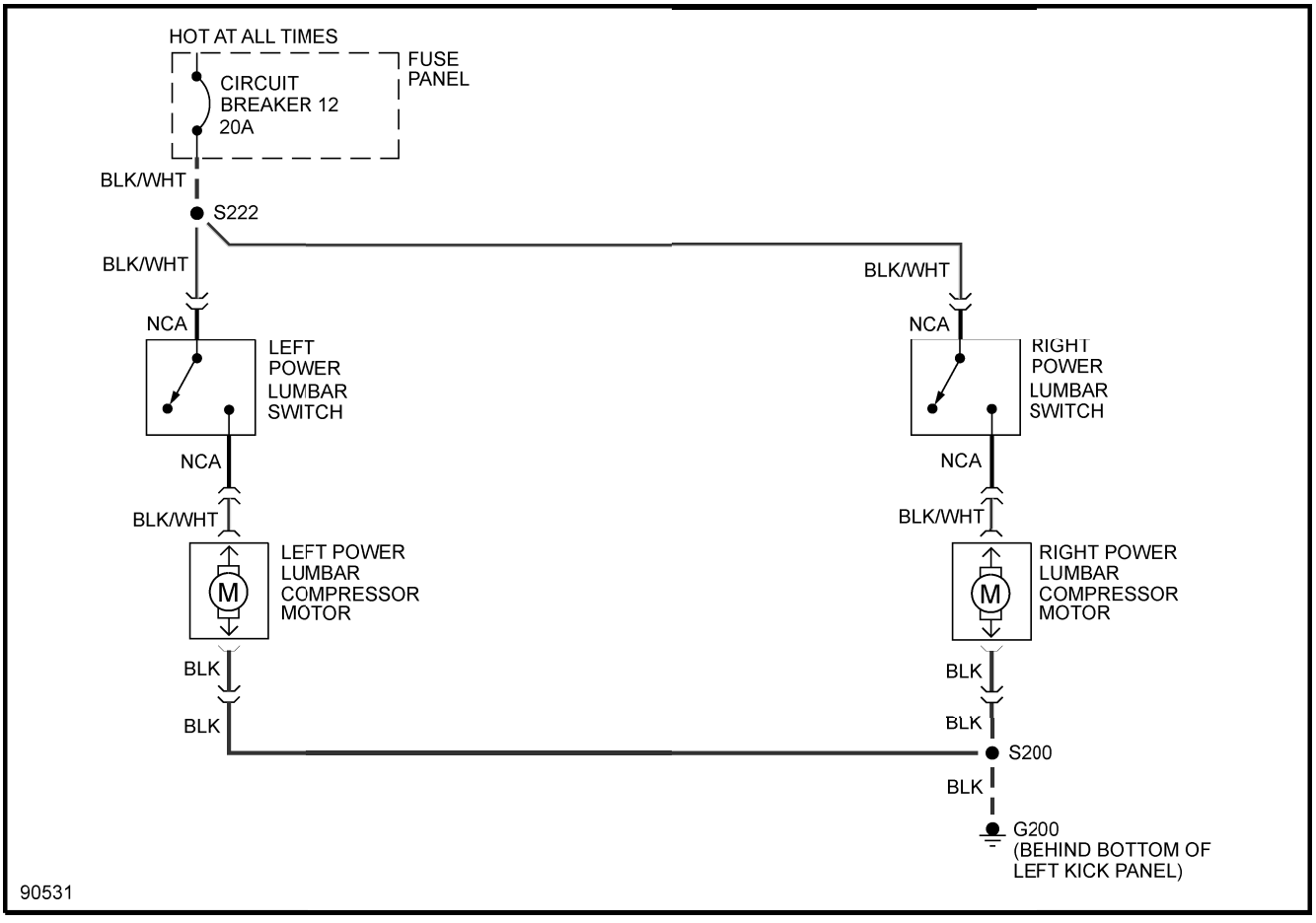

HOT AT ALL TIMES
FUSE PANEL
CIRCUIT BREAKER 12 20A
BLK/WHT
S222
BLK/WHT
BLK/WHT
NCA
NCA
LEFT POWER LUMBAR SWITCH
RIGHT POWER LUMBAR SWITCH
NCA
NCA
BLK/WHT
BLK/WHT
M
M
LEFT POWER LUMBAR COMPRESSOR MOTOR
RIGHT POWER LUMBAR COMPRESSOR MOTOR
BLK
BLK
BLK
BLK
S200
BLK
G200
(BEHIND BOTTOM OF LEFT KICK PANEL)
90531

Fig. 14: Power Lumbar Seats System Wiring Diagram (Pickup - F250 Heavy-Duty & F350 With Captain's Chairs)

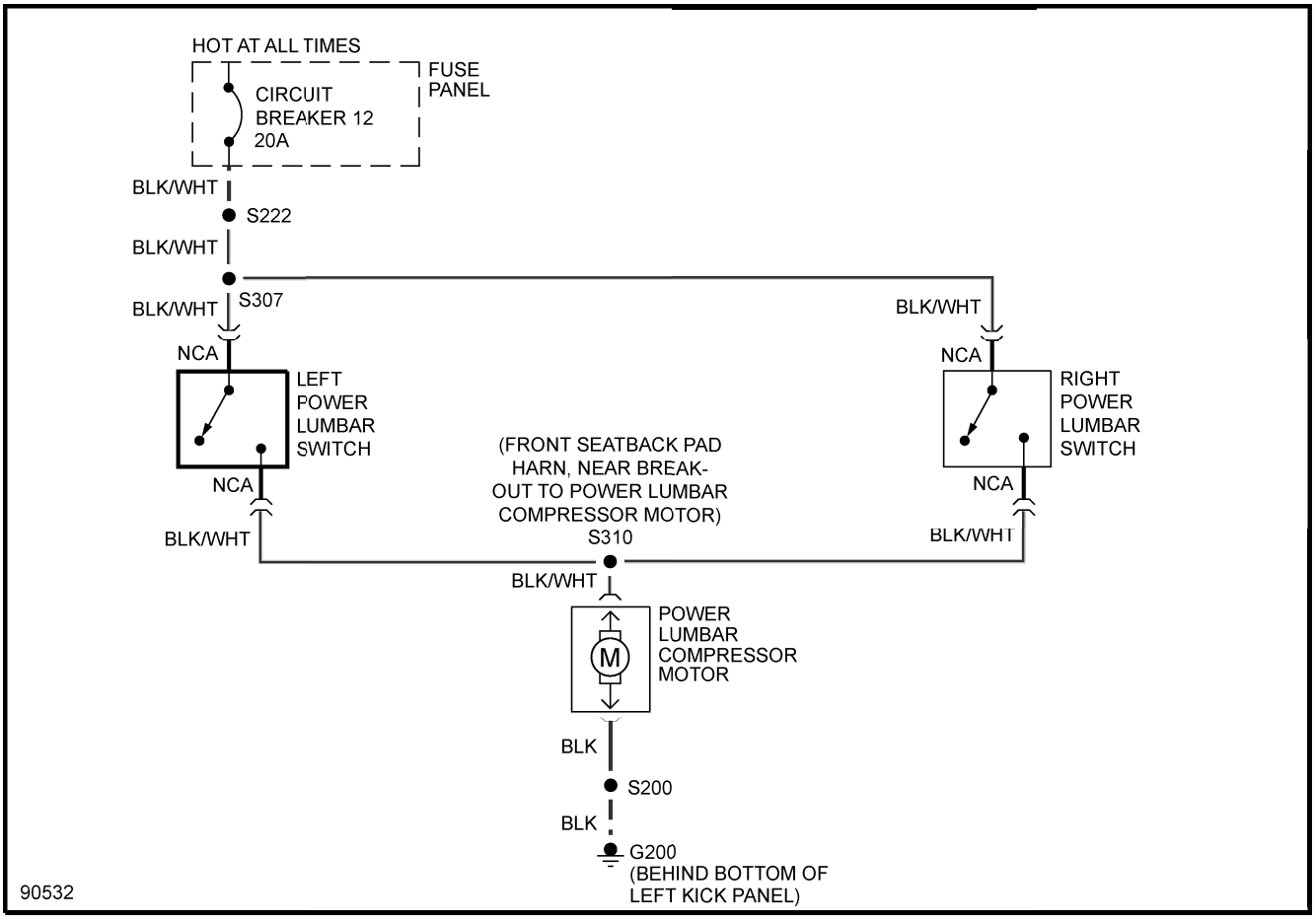

HOT AT ALL TIMES
FUSE PANEL
CIRCUIT BREAKER 12 20A
BLK/WHT
S222
BLK/WHT
BLK/WHT
S307
BLK/WHT
NCA
LEFT POWER LUMBAR SWITCH
NCA
BLK/WHT
(FRONT SEATBACK PAD HARN, NEAR BREAK-OUT TO POWER LUMBAR COMPRESSOR MOTOR)
S310
BLK/WHT
NCA
RIGHT POWER LUMBAR SWITCH
NCA
BLK/WHT
BLK/WHT
M
POWER LUMBAR COMPRESSOR MOTOR
BLK
S200
BLK
G200
(BEHIND BOTTOM OF LEFT KICK PANEL)
90532

Fig. 15: Power Lumbar Seats System Wiring Diagram (Pickup - F250 Heavy-Duty & F350 With Cloth Bench)

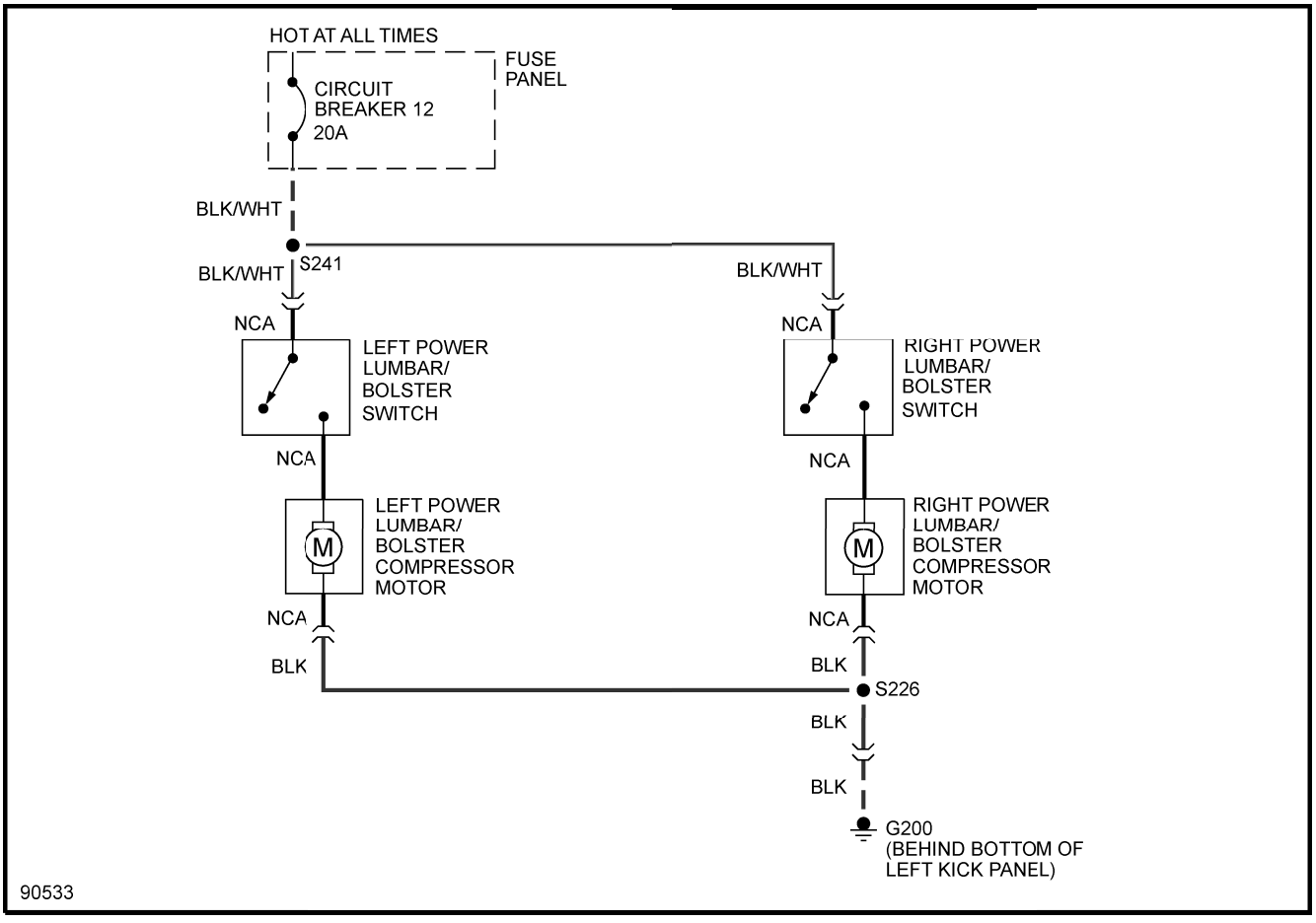

HOT AT ALL TIMES
FUSE PANEL
CIRCUIT BREAKER 12 20A
BLK/WHT
BLK/WHT
S241
BLK/WHT
NCA
NCA
LEFT POWER LUMBAR/ BOLSTER SWITCH
RIGHT POWER LUMBAR/ BOLSTER SWITCH
NCA
NCA
M
M
LEFT POWER LUMBAR/ BOLSTER COMPRESSOR MOTOR
RIGHT POWER LUMBAR/ BOLSTER COMPRESSOR MOTOR
NCA
NCA
BLK
BLK
S226
BLK
BLK
G200
(BEHIND BOTTOM OF LEFT KICK PANEL)
90533

Fig. 16: Power Lumbar/Bolster Seats System Wiring Diagram (Pickup - F250 Heavy-Duty & F350 With Captain's Chairs)

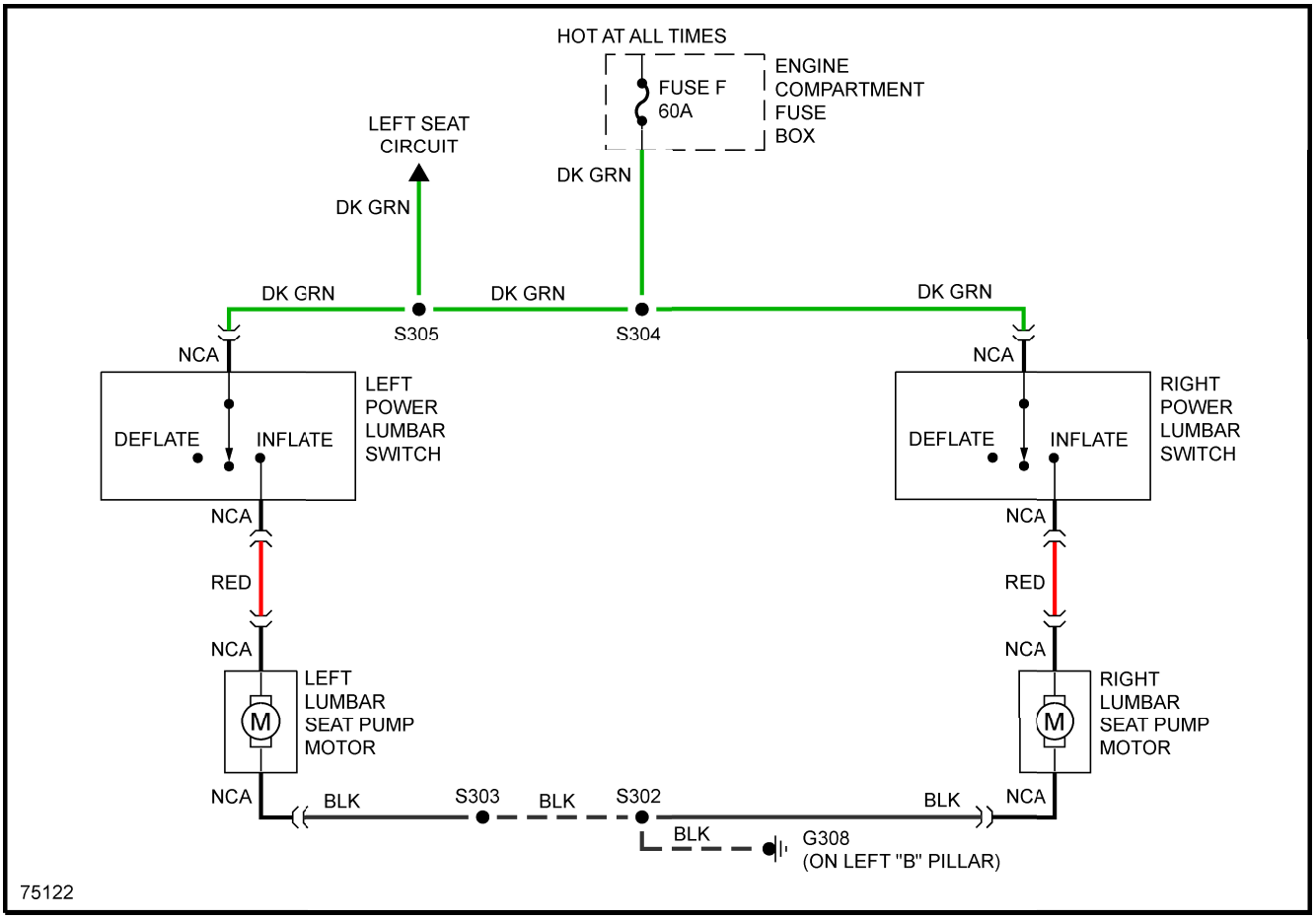

HOT AT ALL TIMES
FUSE F
60A
ENGINE
COMPARTMENT
FUSE
BOX
LEFT SEAT
CIRCUIT
DK GRN
DK GRN
DK GRN
DK GRN
DK GRN
S305
S304
NCA
NCA
LEFT
POWER
LUMBAR
SWITCH
DEFLATE
INFLATE
RIGHT
POWER
LUMBAR
SWITCH
DEFLATE
INFLATE
NCA
NCA
RED
RED
NCA
NCA
LEFT
LUMBAR
SEAT PUMP
MOTOR
M
RIGHT
LUMBAR
SEAT PUMP
MOTOR
M
NCA
BLK
S303
BLK
S302
BLK
NCA
BLK
G308
(ON LEFT "B" PILLAR)
75122

Fig. 17: Power Lumbar Seats System Wiring Diagram (Windstar)

1997 Ford Pickup F150

SEATS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

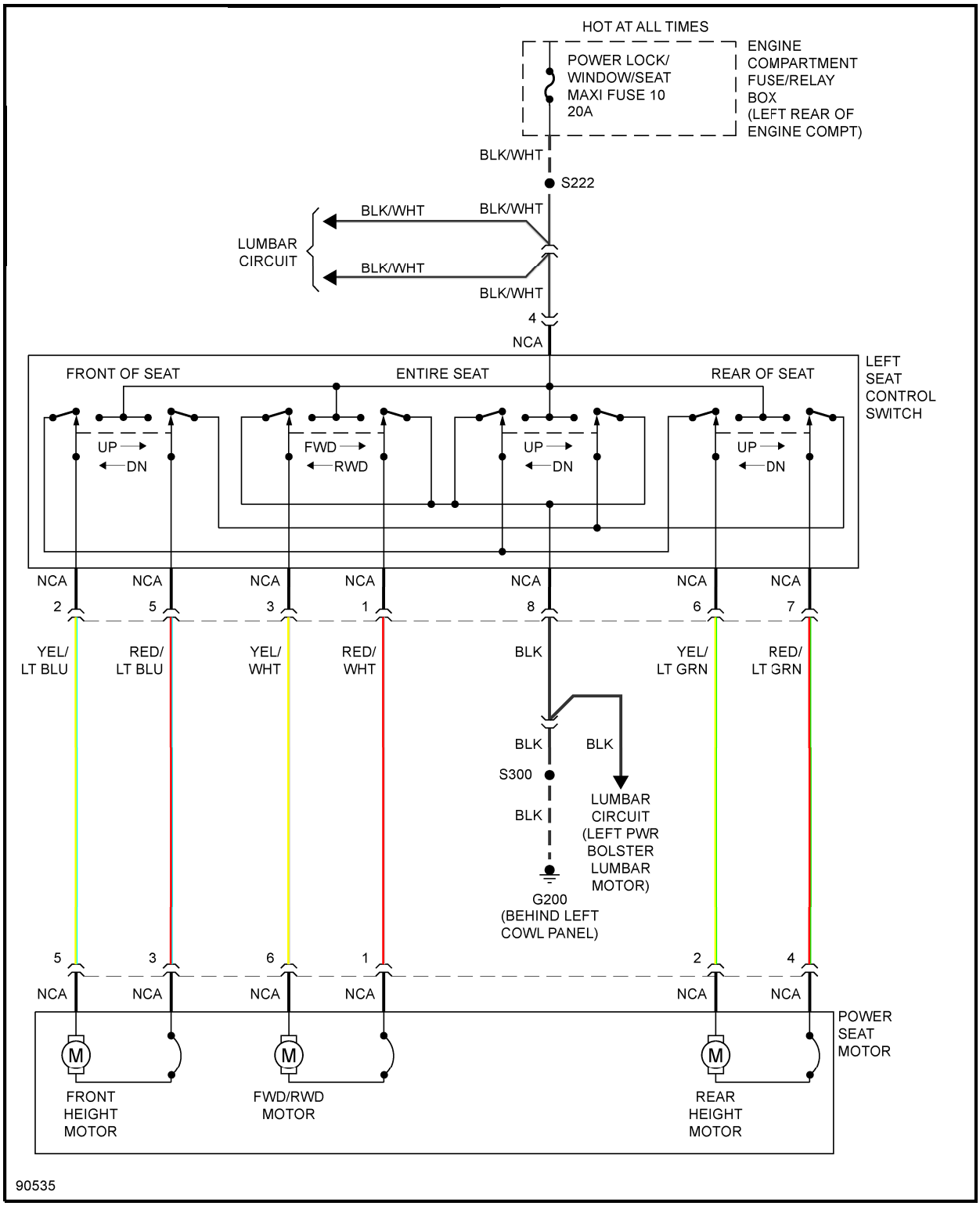


Fig. 18: Power Seats System Wiring Diagram (Ranger)

1997 Ford Pickup F150

SEATS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

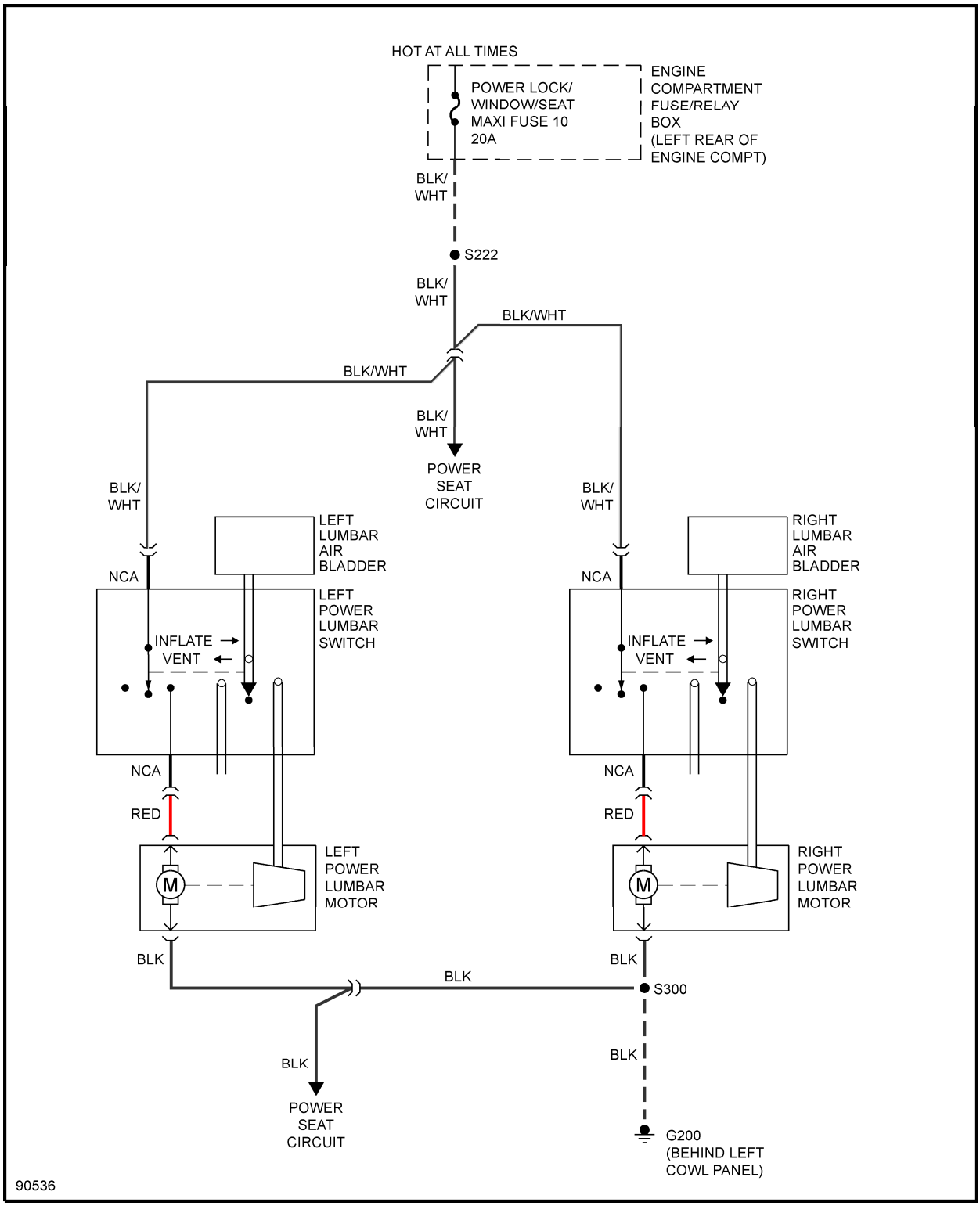


Fig. 19: Power Lumbar Seats System Wiring Diagram (Ranger)

1997 Ford Pickup F150

SEATS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

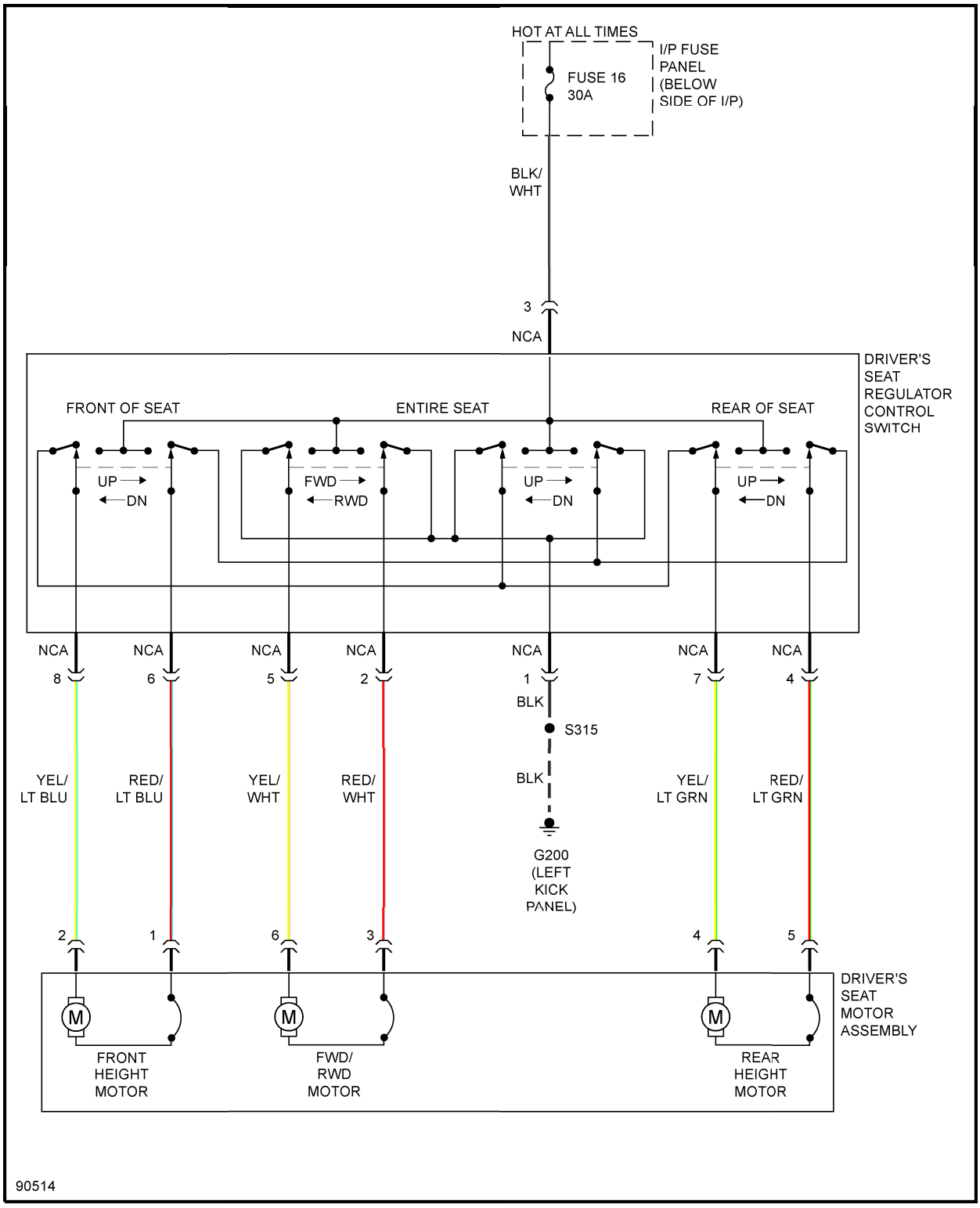


Fig. 20: Power Seats System Wiring Diagram (Van)

1997 Ford Pickup F150

SEATS - POWER 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Seats

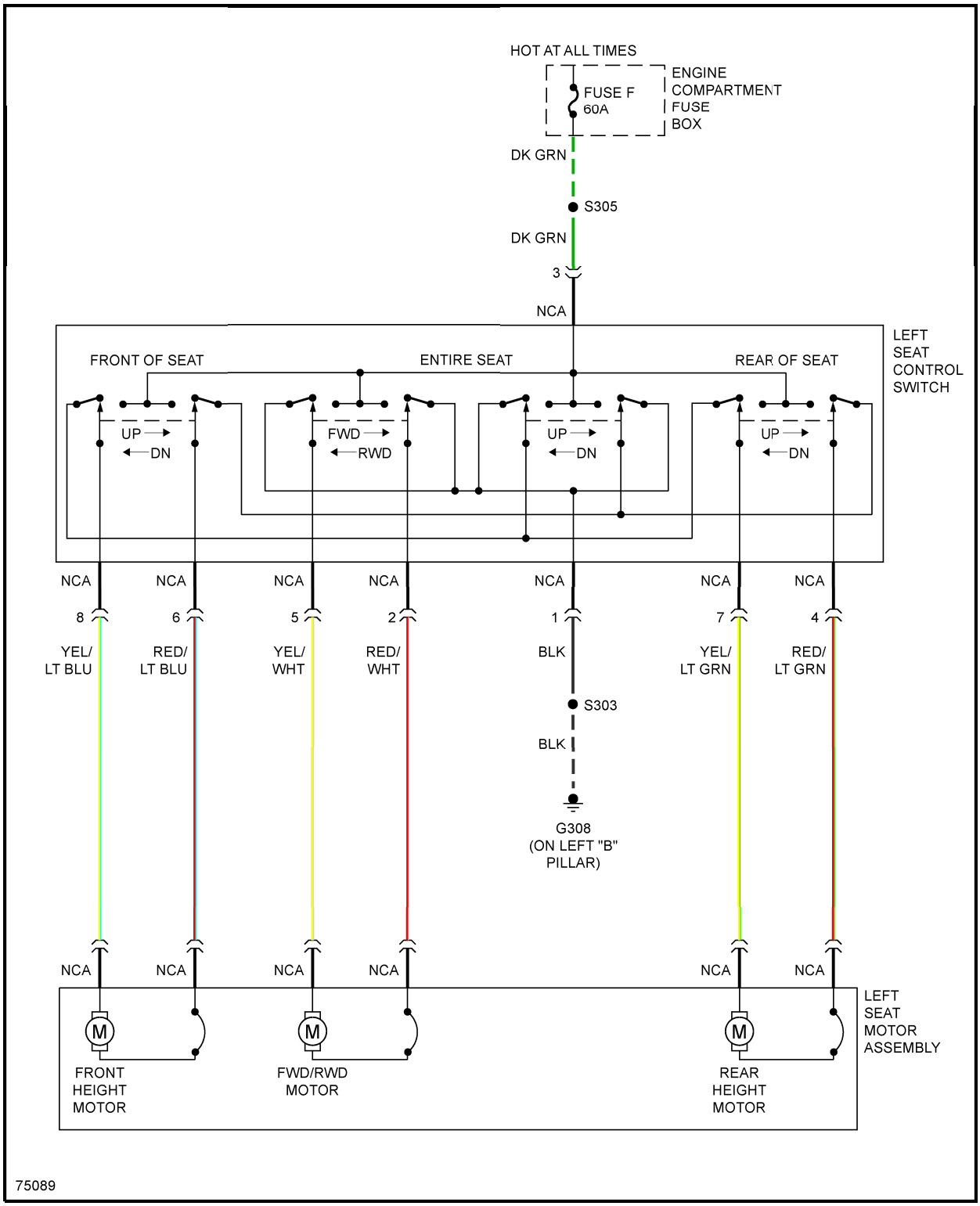
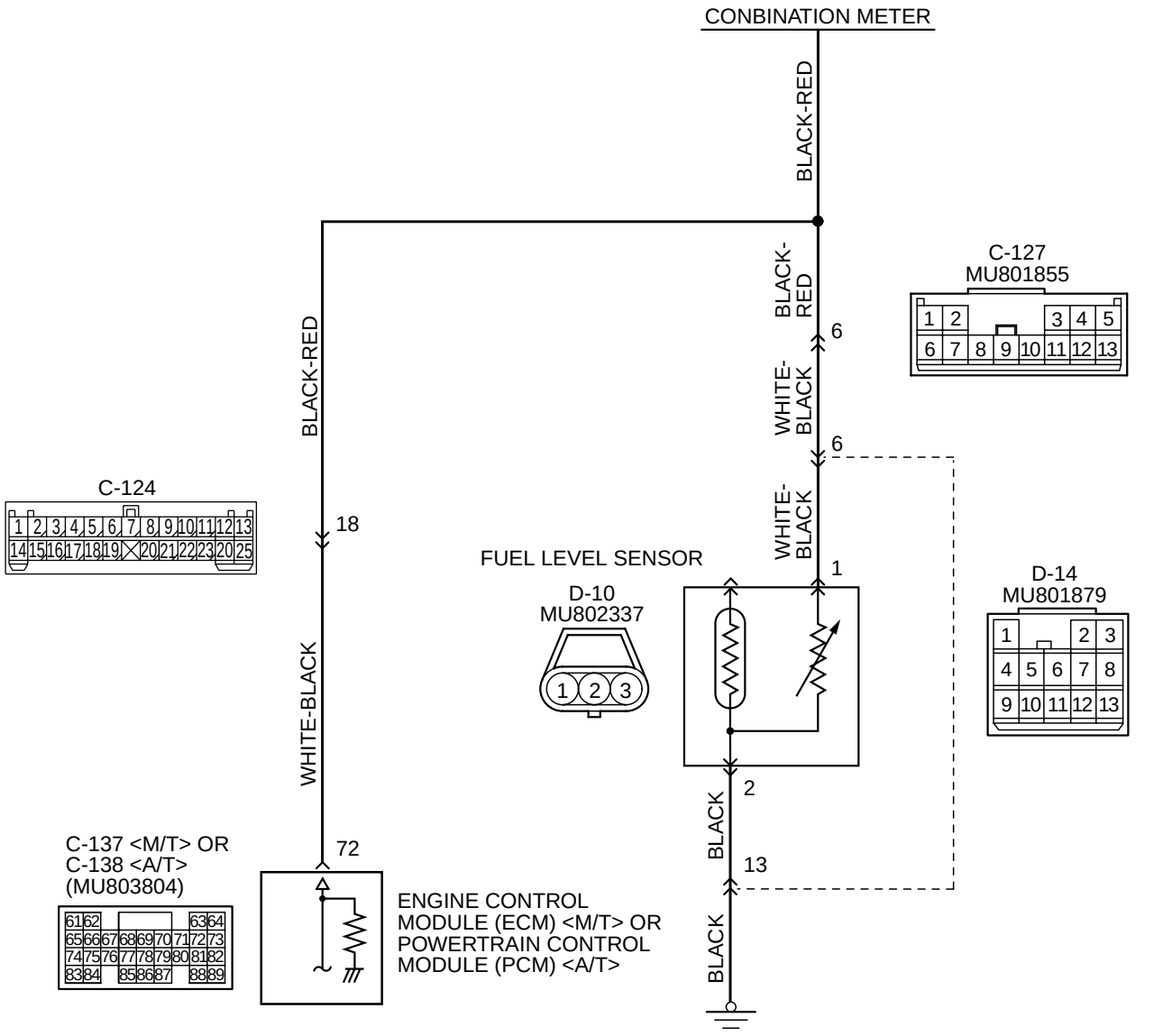


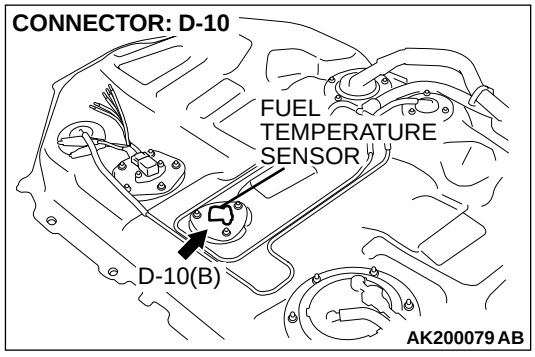
Fig. 21: Power Seats System Wiring Diagram (Windstar)

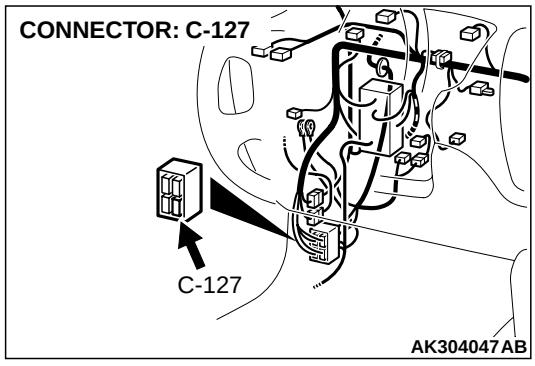
DTC P0461: Fuel Level Sensor Circuit Range/Performance

Fuel Level Sensor Circuit

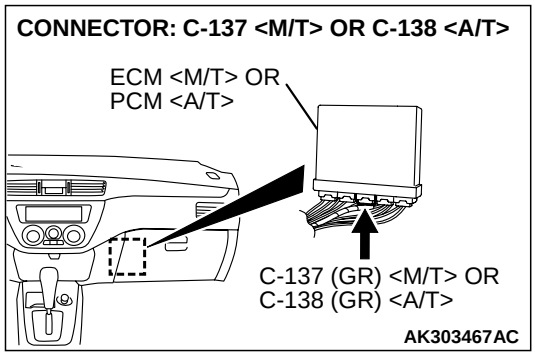


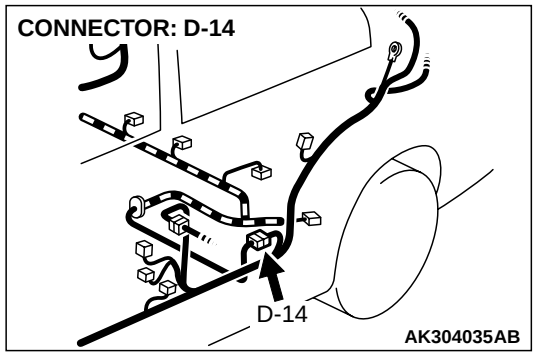
AK303996

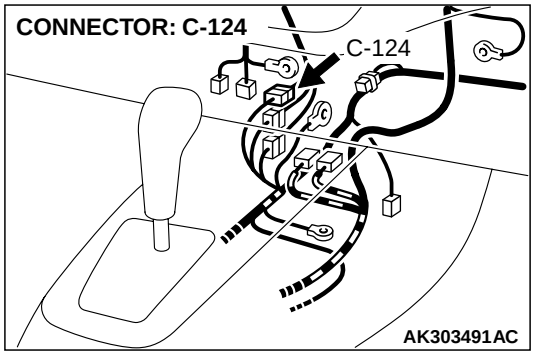




TSB Revision







CIRCUIT OPERATION

- The fuel level sensor drive signal is input in ECM <M/T> or PCM <A/T> (terminal No. 72).

TECHNICAL DESCRIPTION

- Branch the drive signal from the fuel level sensor circuit, and input it into ECM <M/T> or PCM <A/T>.
- The ECM <M/T> or PCM <A/T> detects the amount of fuel left in the fuel tank with this signal, and also controls the fuel level warning light.

DESCRIPTIONS OF MONITOR METHODS

Detect malfunction if change of fuel level sensor output voltage is small when sum of fuel injection is large.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

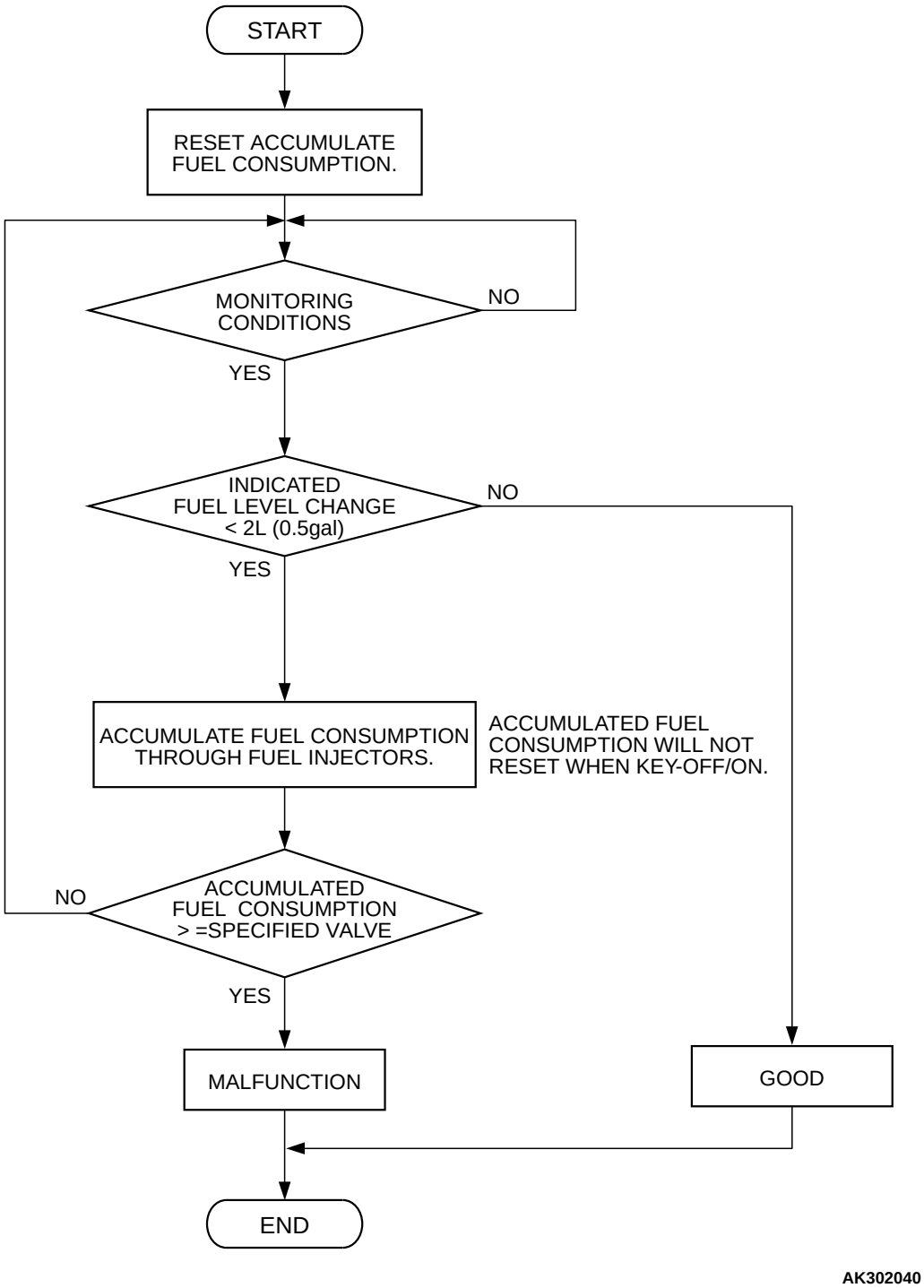
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



Check Conditions, Judgement Criteria

- When the fuel consumption calculated from the operation time of the injector amounts to 20 liters (5.3 gal), the diversity of the amount of fuel in tank calculated from the fuel level sensor is 2 liters (0.5 gal) or less.

TSB Revision

OBD-II DRIVE CYCLE PATTERN

Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Fuel level sensor failed.
- Open or shorted fuel level sensor circuit, harness damage or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

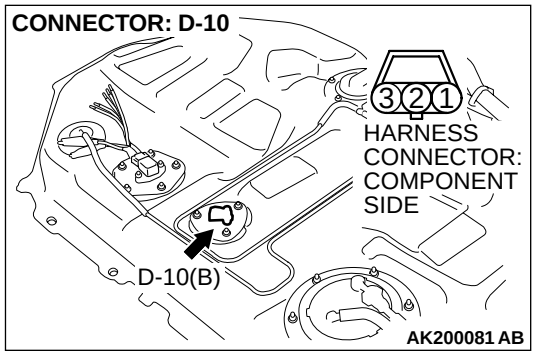
DIAGNOSIS

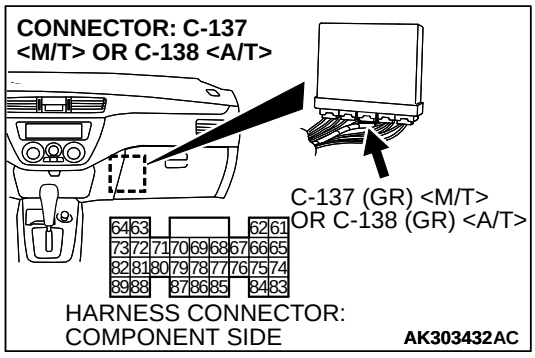
STEP 1. Check fuel gauge.

Q: Is the fuel gauge functioning?

YES : Go to Step 3.
NO : Go to Step 2.

STEP 2. Check for short circuit to ground between fuel level sensor connector D-10 (terminal No. 1) and ECM connector C-137 <M/T> or PCM connector C-138 <A/T> (terminal No. 72).

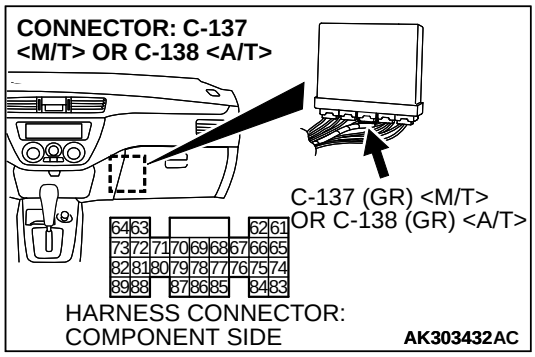




NOTE: Check harness after checking intermediate connectors C-124, C-127 and D-14. If intermediate connectors are damaged, repair or replace them. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 6.

Q: Is the harness wire in good condition?

YES : Refer to GROUP 54A, Chasiss Electrical – Combination Meters Assembly and Vehicle Speed Sensor – Equipment Diagnosis – Symptom Chart P.54A-11.
NO : Repair it. Then go to Step 6.

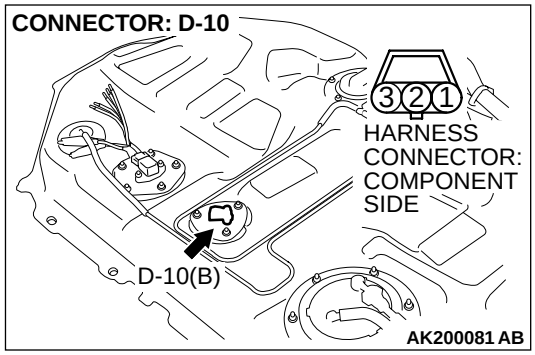


STEP 3. Check harness connector C-137 at ECM <M/T> or C-138 at PCM <A/T> for damage.

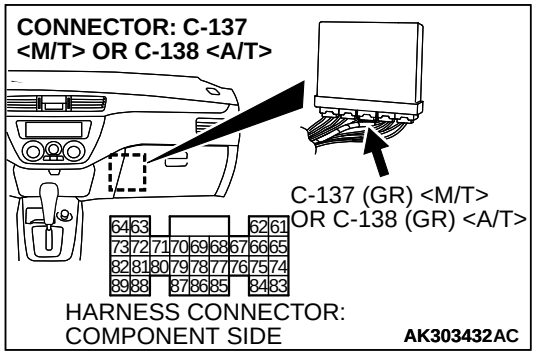
Q: Is the harness connector in good condition?

YES : Go to Step 4.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 6.



STEP 4. Check for open circuit or harness damage between fuel level sensor connector D-10 (terminal No. 1) and ECM connector C-137 <M/T> or PCM connector C-138 <A/T> (terminal No. 72).



NOTE: Check harness after checking intermediate connectors C-124, C-127 and D-14. If intermediate connectors are damaged, repair or replace them. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 6.

Q: Is the harness wire in good condition?

YES : Go to Step 5.

NO : Repair it. Then go to Step 6.

STEP 5. Check the trouble symptoms.

(1) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.
(2) Check the diagnostic trouble code (DTC).

Q: Is DTC P0461 set?

YES : Replace the ECM or PCM. Then go to Step 6.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

STEP 6. Test the OBD-II drive cycle.

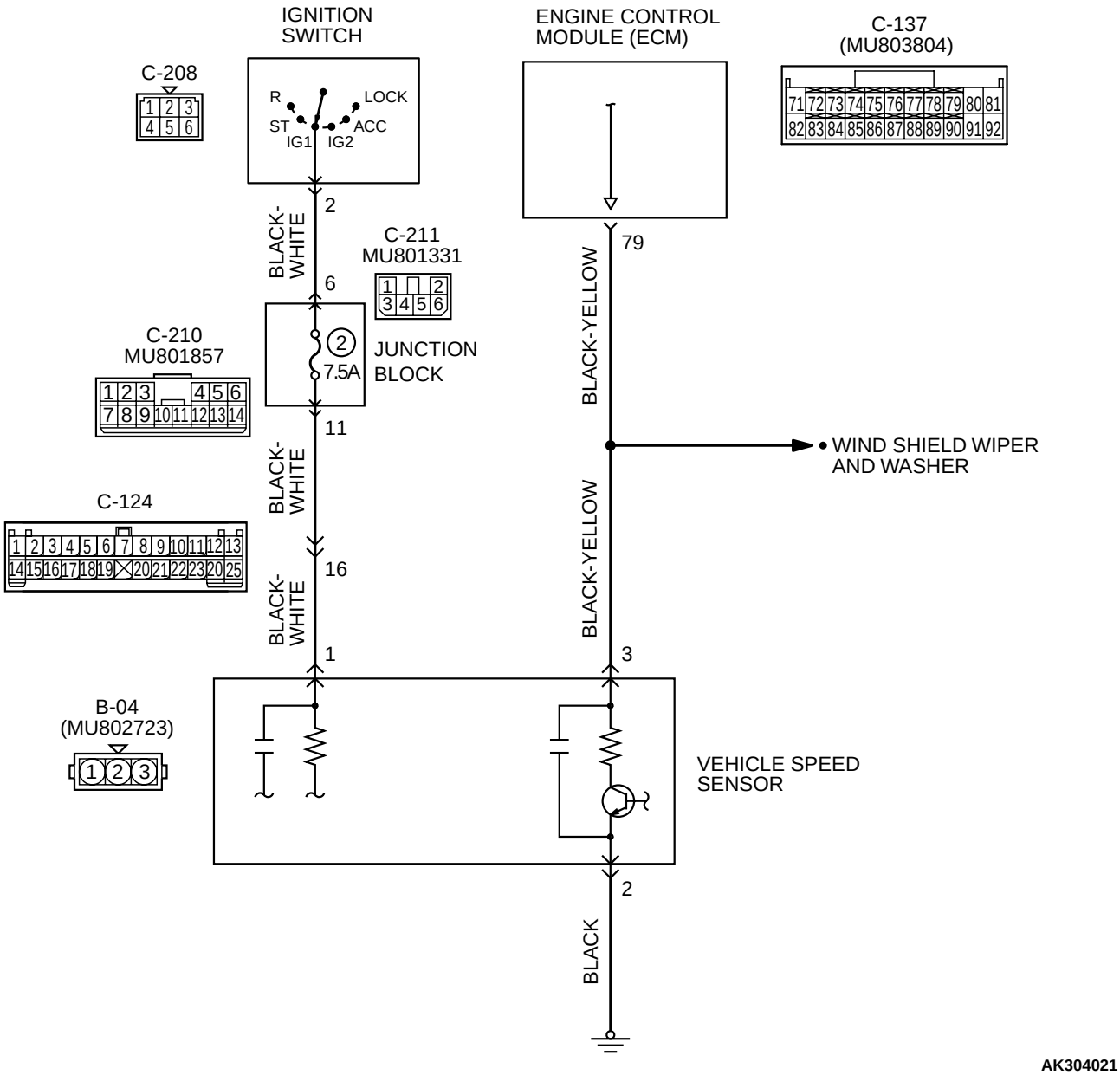
(1) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.
(2) Check the diagnostic trouble code (DTC).

Q: Is DTC P0461 is set?

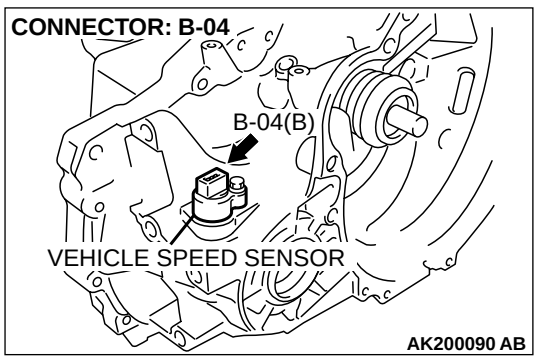
YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P0500: Vehicle Speed Sensor <M/T>

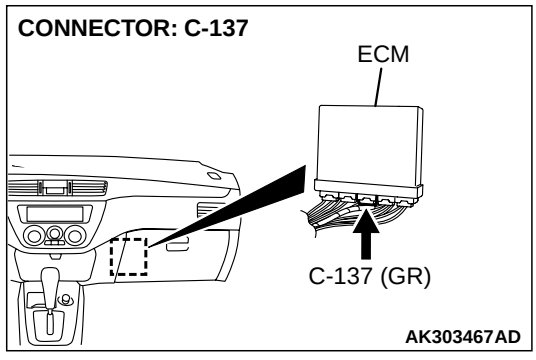
Vehicle Speed Sensor Circuit



AK304021

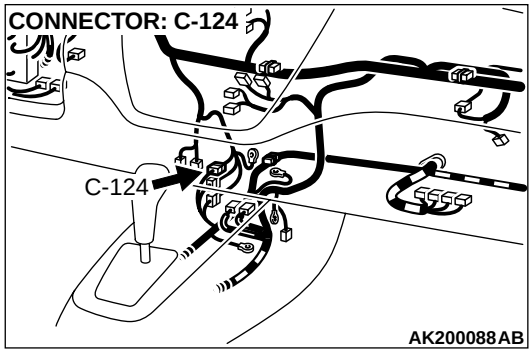


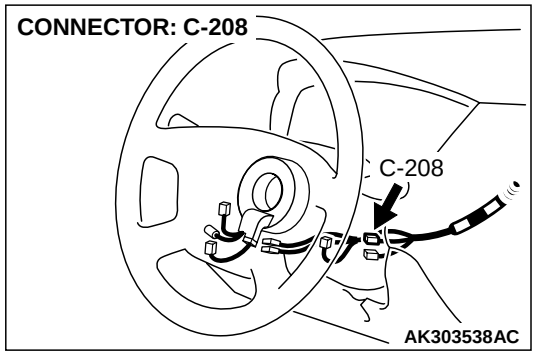
AK200090 AB

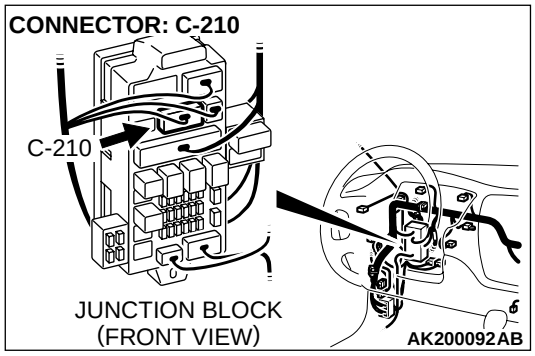


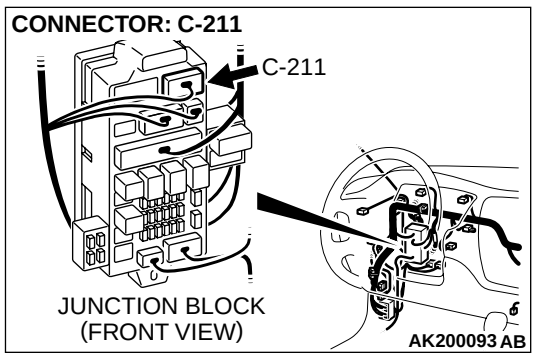
AK303467AD

TSB Revision









CIRCUIT OPERATION

- A 5-volt voltage is applied to the vehicle speed sensor output terminal (terminal No. 3) from the ECM (terminal No. 79). The vehicle speed sensor generates a pulse signal when the output terminal is opened and grounded.

TECHNICAL DESCRIPTION

- The vehicle speed sensor converts the vehicle speed into pulse signals and inputs them to the ECM.
- The vehicle speed sensor outputs a pulse signal while the vehicle is driven.
- The ECM checks whether the pulse signal is output.

DESCRIPTIONS OF MONITOR METHODS

- If the vehicle speed sensor output does not change while the vehicle is being driven in the medium- to high-speed range, a malfunction is determined to have occurred.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

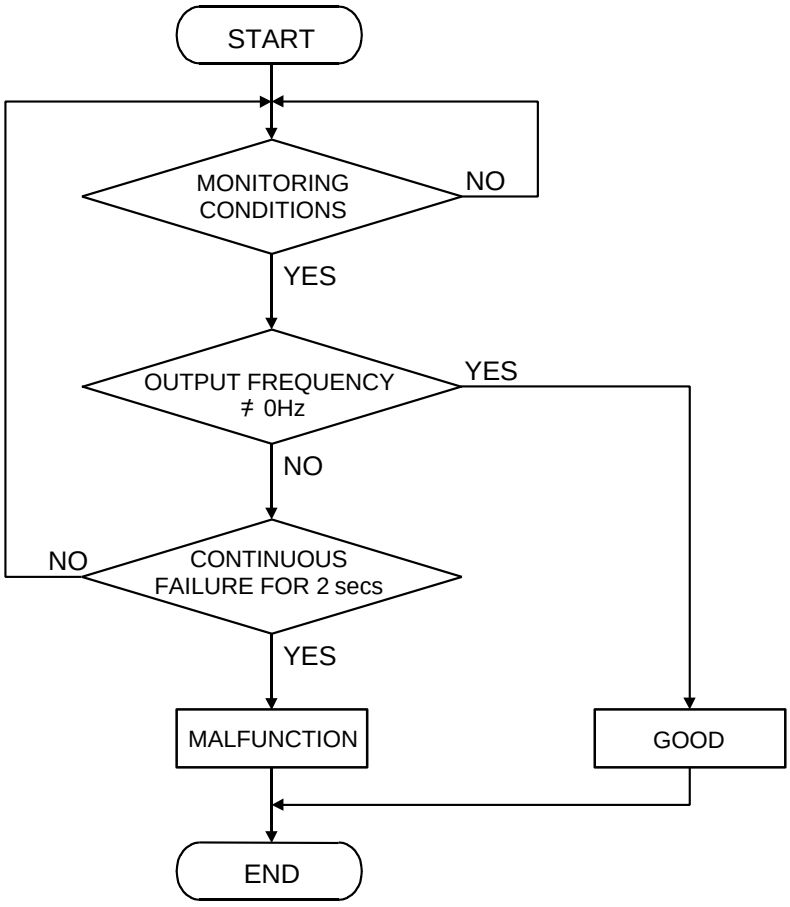
- Not applicable

Sensor (The sensor below is determined to be normal)

- Volume air flow sensor

DTC SET CONDITIONS

Logic Flow Chart



AK200919

Check Conditions

- Two seconds or more have passed the starting sequence was completed.
- Engine speed is at between 2,000 and 4,000 r/min.
- Volumetric efficiency is at between 45 and 100 percent.

Judgement Criteria

- Vehicle speed sensor output voltage has not changed (no pulse signal is input) for 2 seconds.

OBD-II DRIVE CYCLE PATTERN

None

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Vehicle speed sensor failed.
- Open or shorted vehicle speed sensor circuit, or loose connector.
- ECM failed.

TSB Revision

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

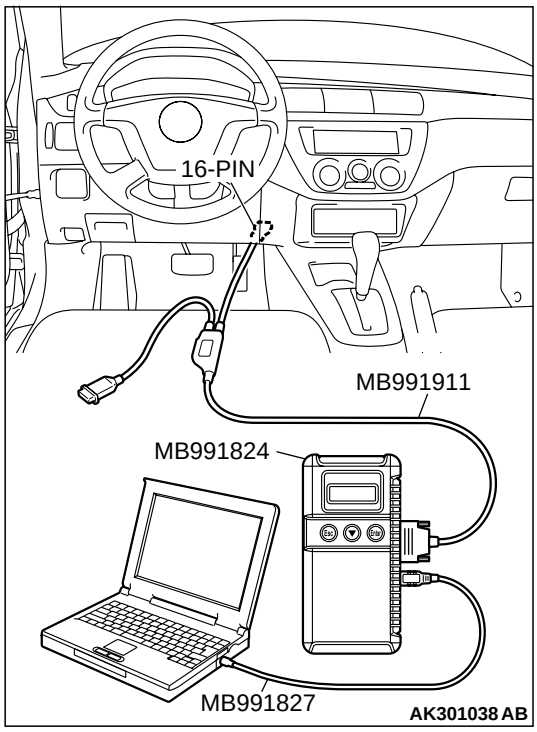
STEP 1. Using scan tool MB991958, check data list item 24: Vehicle Speed Sensor.

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine.
(3) Set scan tool MB991958 to the data reading mode for item 24, Vehicle Speed Sensor.
  - Check that the speedometer and MUT-III display speed match when traveling at a vehicle speed of 40 km/h (25 mph).

(4) Turn the ignition switch to the "LOCK" (OFF) position.



Q: Is the sensor operating properly?

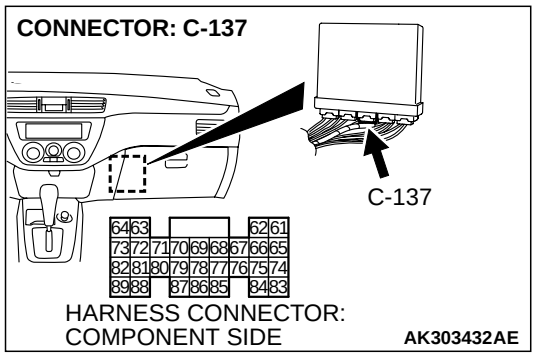
YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.
NO : Go to Step 2.

STEP 2. Check speed meter.

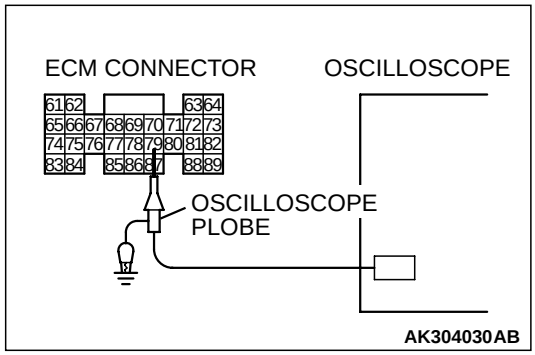
Q: Is the speed meter functioning?

YES : Go to Step 3.
NO : Go to Step 8.

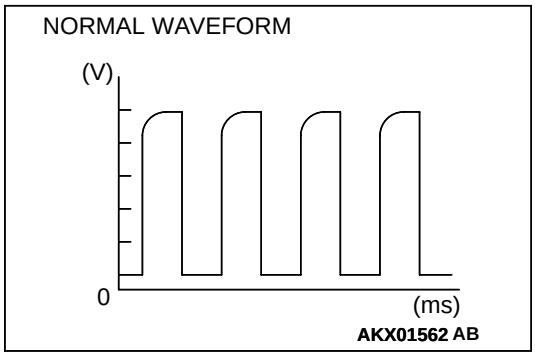
STEP 3. Using the oscilloscope, check the sensor output voltage at ECM connector C-137.



(1) Do not disconnect the ECM connector C-137.
(2) Disconnect the combination meter connector, auto-cruise control-ECU connector and A/C-ECU connector.



(3) Connect the oscilloscope probe to ECM terminal No. 79 by backprobing.
(4) Start the engine.



(5) Check the waveform.
- The waveform should show a pattern similar to the illustration while the vehicle is being moved.

(6) Turn the ignition switch to the "LOCK" (OFF) position.

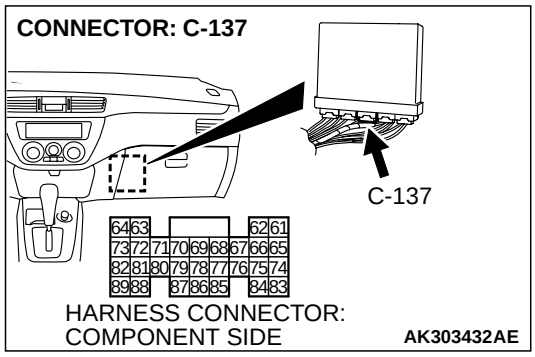
Q: Is the waveform normal?

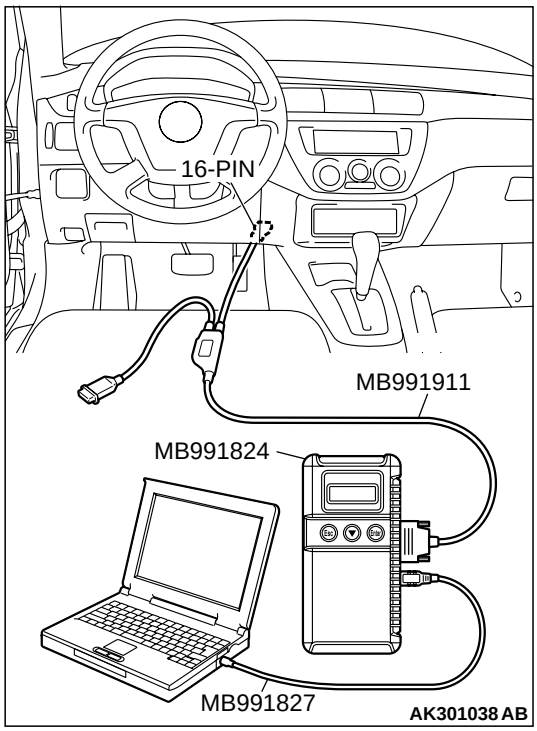
YES : Go to Step 4.
NO : Go to Step 6.

STEP 4. Check connector C-137 at ECM for damage.

Q: Is the connector in good condition?

YES : Go to Step 5.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 17.





STEP 5. Using scan tool MB991958, check data list item 24: Vehicle Speed Sensor.

⚠ CAUTION

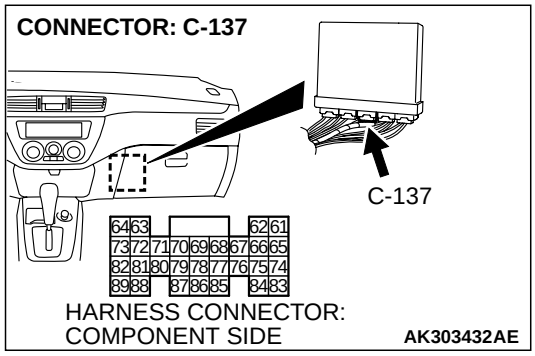
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine.
(3) Set scan tool MB991958 to the data reading mode for item 24, Vehicle Speed Sensor.
- Check that the speedometer and MUT-III display speed match when traveling at a vehicle speed of 40 km/h (25 mph).

(4) Turn the ignition switch to the "LOCK" (OFF) position.

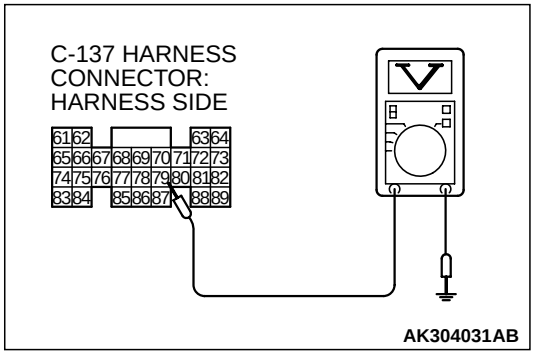
Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.
NO : Replace the ECM. Then go to Step 17.



STEP 6. Measure the sensor supply voltage at ECM connector C-137 by backprobing.

(1) Do not disconnect the ECM connector C-137.
(2) Disconnect the vehicle speed sensor connector B-04.
(3) Turn the ignition switch to the "ON" position.

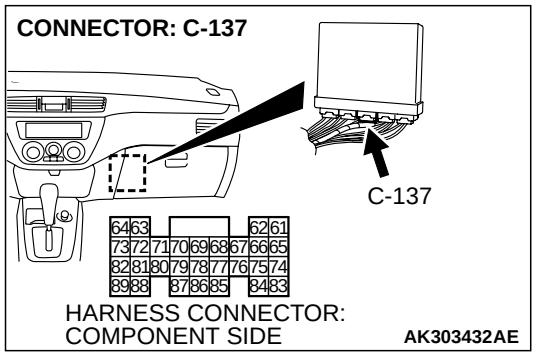


(4) Measure the voltage between terminal No. 79 and ground by backprobing.
- Voltage should measure between 4.8 and 5.2 volts.

(5) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the measured voltage between 4.8 and 5.2 volts?

YES : Go to Step 7.
NO : Replace the ECM. Then go to Step 17.

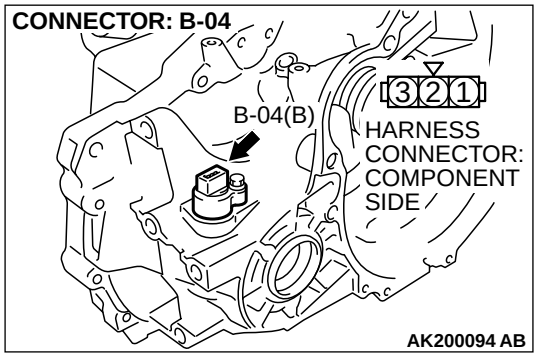


STEP 7. Check connector C-137 at ECM for damage.

Q: Is the connector in good condition?

YES : Repair harness wire between vehicle speed sensor connector B-04 (terminal No. 3) and ECM connector C-137 (terminal No. 79) because of open circuit. Then go to Step 17.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 17.

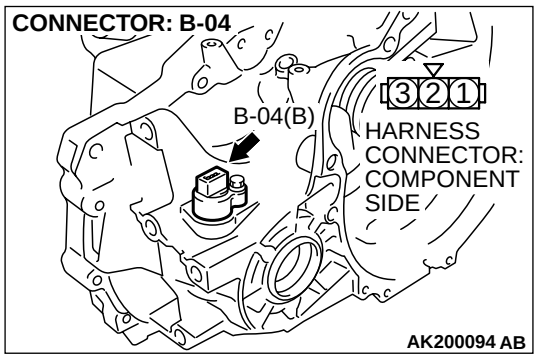


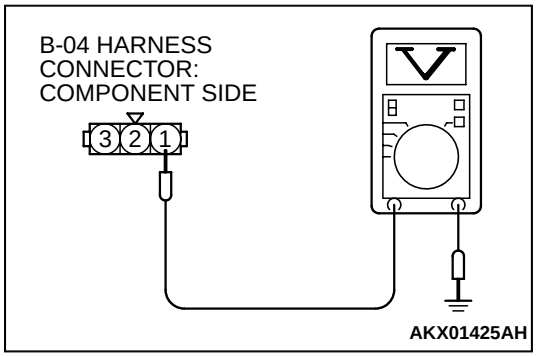
STEP 8. Check connector B-04 at vehicle speed sensor for damage.

Q: Is the connector in good condition?

YES : Go to Step 9.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 17.





STEP 9. Measure the power supply voltage at vehicle speed sensor harness side connector B-04.

(1) Disconnect connector B-04 and measure at the harness side.

(2) Turn the ignition switch to the "ON" position.

(3) Measure the voltage between terminal No. 1 and ground.
- Voltage should measure battery positive voltage.

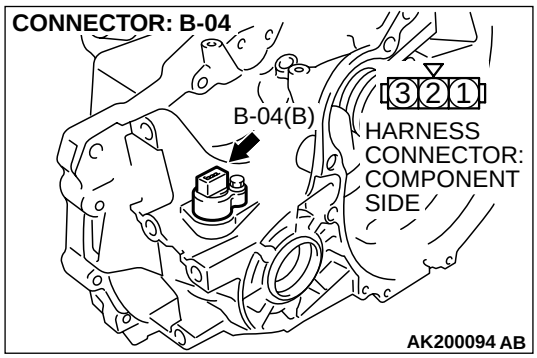
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is battery positive voltage (approximately 12 volts) present?

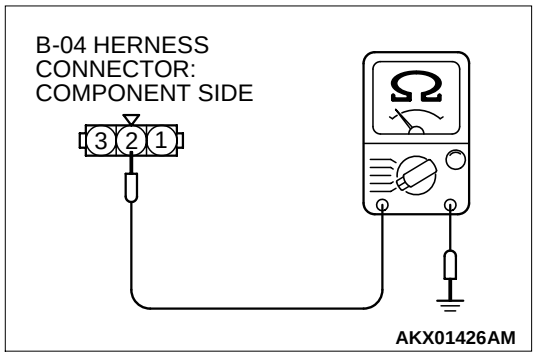
YES : Go to Step 10.

NO : Check connectors C-124, C-210 and C-211 at intermediate connector for damage, and repair or replace as required. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. If intermediate connectors are in good condition, repair harness wire between ignition switch connector C-208 (terminal No. 2) and vehicle speed sensor connector B-04 (terminal No. 1) because of open circuit or short circuit to ground. Then go to Step 17.

STEP 10. Check for continuity at vehicle speed sensor harness side connector B-04.



(1) Disconnect connector B-04 and measure at the harness side.



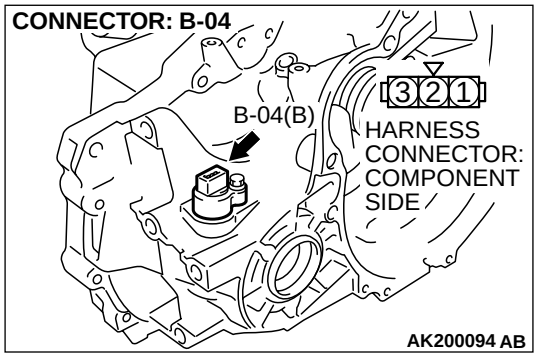
(2) Check for the continuity between terminal No. 2 and ground.
- Should be less than 2 ohms.

Q: Does continuity exist?

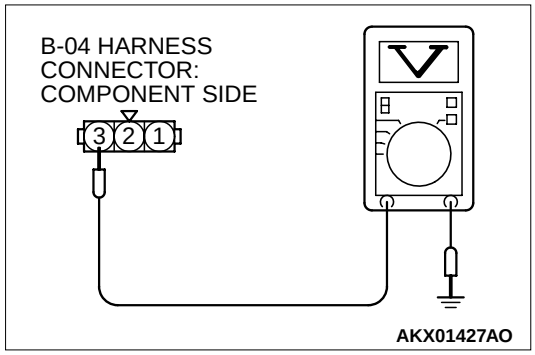
YES : Go to Step 11.

NO : Repair harness wire between vehicle speed sensor connector B-04 (terminal No. 2) and ground because of open circuit or harness damage. Then go to Step 17.

STEP 11. Measure the sensor supply voltage at vehicle speed sensor harness side connector B-04.



(1) Disconnect the vehicle speed sensor connector B-04 and measure at the harness side.
(2) Disconnect the combination meter connector and ETACS-ECU connector.
(3) Turn the ignition switch to the "ON" position.



(4) Measure the voltage between terminal No. 3 and ground.
- Voltage should measure between 4.8 and 5.2 volts.

(5) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the measured voltage between 4.8 and 5.2 volts?

YES : Go to Step 12.

NO : Repair harness wire between vehicle speed sensor connector B-04 (terminal No. 3) and ECM connector C-137 (terminal No. 79) because of short circuit to ground or harness damage. Then go to Step 17.

STEP 12. Check the vehicle speed sensor.

Refer to GROUP 54A, Combination Metre – Inspection – Vehicle Speed Sensor Check P.54A-47.

Q: Is the vehicle speed sensor normal?

YES : Go to Step 13.

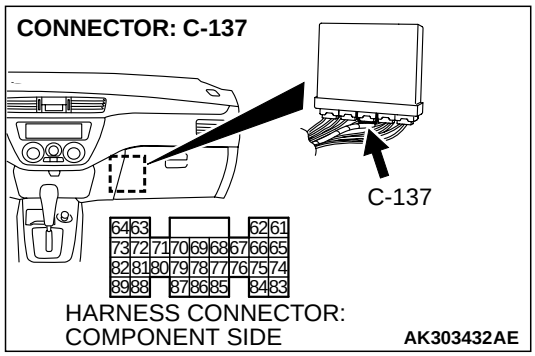
NO : Replace the vehicle speed sensor. Then go to Step 17.

STEP 13. Check connector C-137 at ECM for damage.

Q: Is the connector in good condition?

YES : Go to Step 14.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 17.

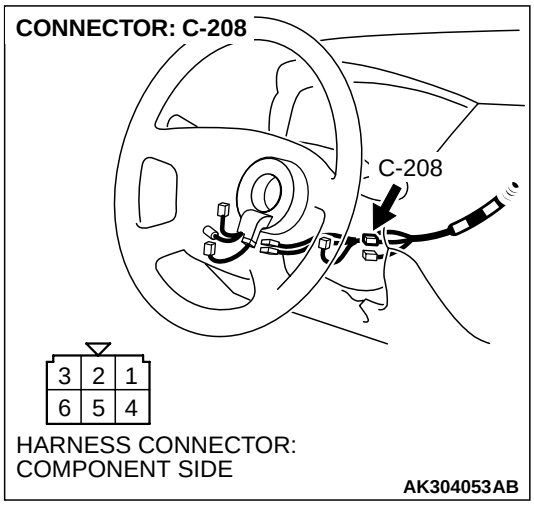


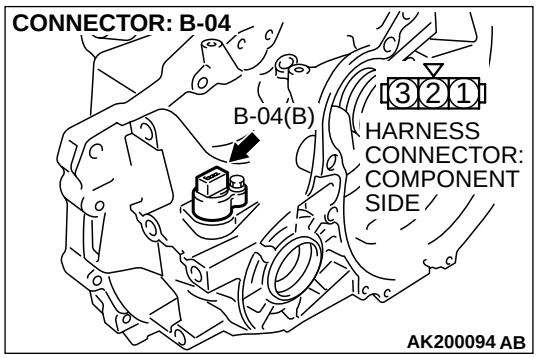
STEP 14. Check for harness damage between ignition switch connector C-208 (terminal No. 2) and vehicle speed sensor connector B-04 (terminal No. 1).

Q: Is the harness wire in good condition?

YES : Go to Step 15.

NO : Repair it. Then go to Step 17.



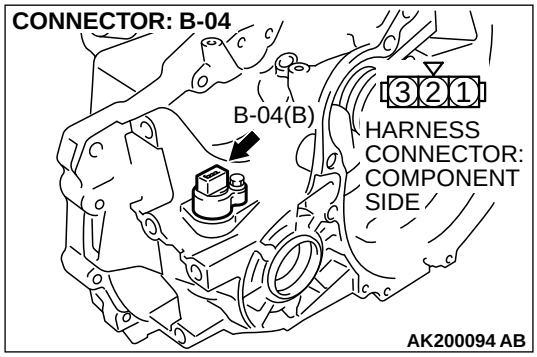


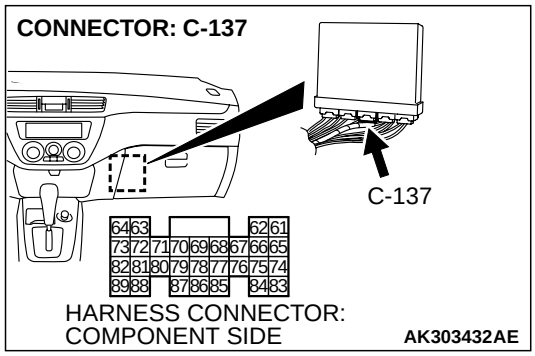
STEP 15. Check for harness damage between vehicle speed sensor connector B-04 (terminal No. 3) and ECM connector C-137 (terminal No. 79).

Q: Is the harness wire in good condition?

YES : Go to Step 16.

NO : Repair it. Then go to Step 17.



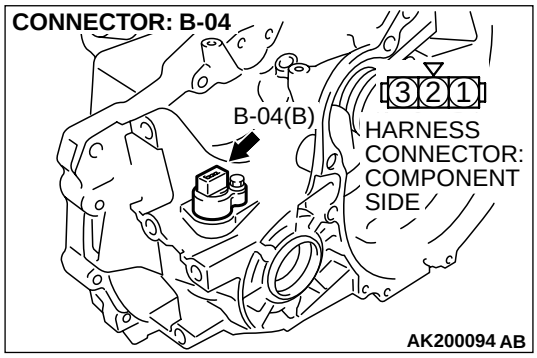


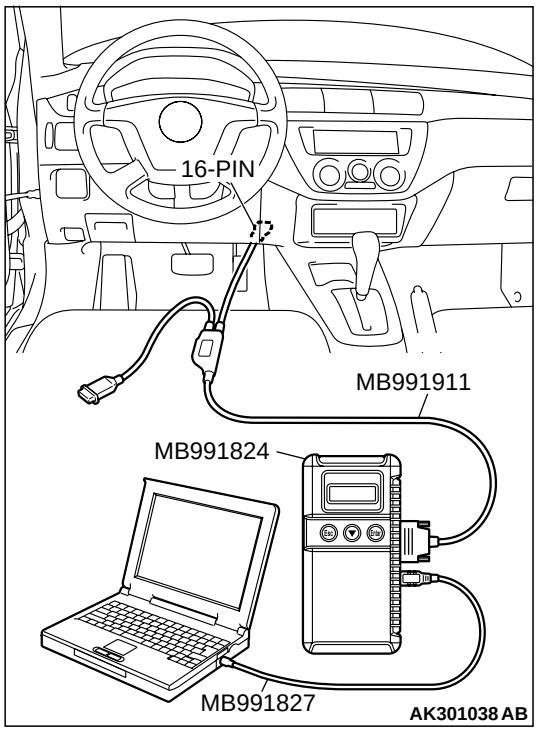
STEP 16. Check for harness damage between vehicle speed sensor connector B-04 (terminal No. 2) and ground.

Q: Is the harness wire in good condition?

YES : Check for harness wire between vehicle speed sensor connector B-04 (terminal No. 3) and other system because of short circuit to ground. Then go to Step 17.

NO : Repair it. Then go to Step 17.





STEP 17. Using scan tool MB991958, check data list item 24: Vehicle Speed Sensor.

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine.
(3) Set scan tool MB991958 to the data reading mode for item 24, Vehicle Speed Sensor.
- Check that the speedometer and MUT-III display speed match when traveling at a vehicle speed of 40 km/h (25 mph).

(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the sensor operating properly?

YES : The procedure is complete.
NO : Repeat the troubleshooting.

DTC P0506: Idle Control Sytem RPM Lower Than Expected

TECHNICAL DESCRIPTION

- The amount of air taken in during idling is regulated by the opening and closing of the throttle valve.
- The ECM <M/T> or PCM <A/T> checks the difference between the actual engine speed and the target engine speed.

DESCRIPTIONS OF MONITOR METHODS

Difference between actual and target idle speed is over the specified value.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

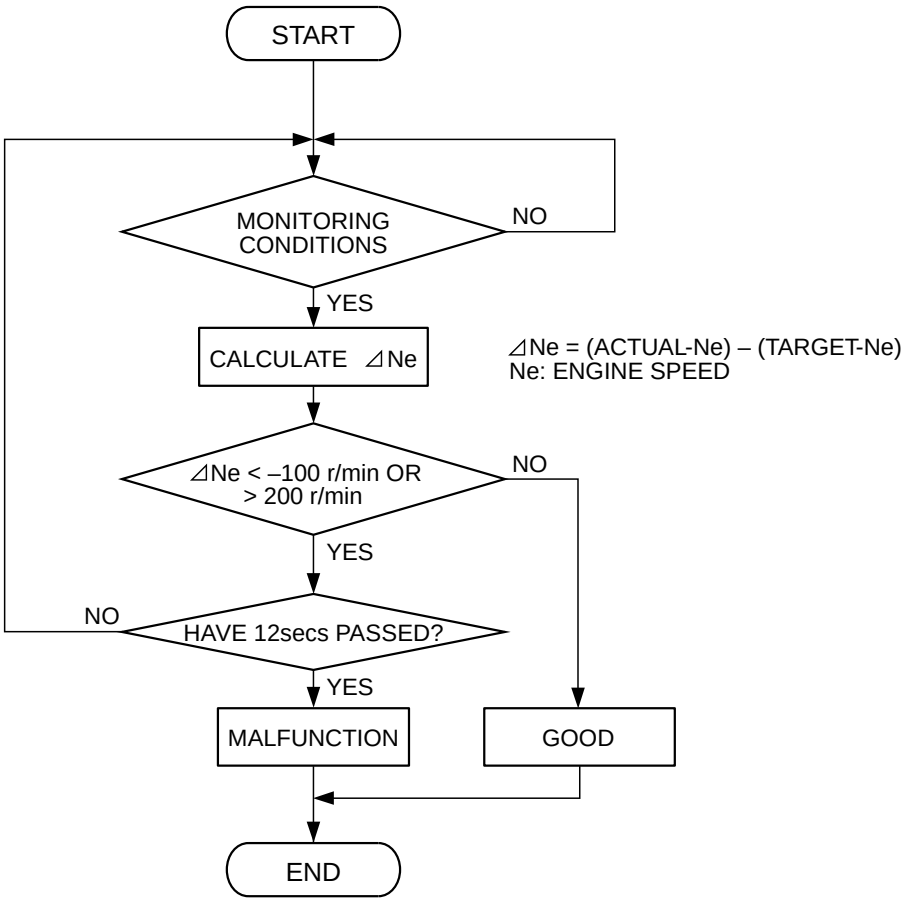
- Misfire monitor
- Exhaust gas recirculation (EGR) system monitor
- Fuel system monitor

Sensor (The sensor below is determined to be normal)

- Mass airflow sensor
- Engine coolant temperature sensor
- Intake air temperature sensor
- Barometric pressure sensor
- Throttle position sensor

DTC SET CONDITIONS

Logic Flow Chart



AK302165

TSB Revision

Check Conditions

- Under the closed loop idle speed control.
- The engine coolant temperature is more than 77°C (171°F).
- Battery positive voltage is higher than 10 volts.
- Power steering pressure switch: OFF
- Volumetric efficiency is lower than 40 percent.
- Barometric pressure is higher than 76 kPa (22.4 in.Hg).
- Intake air temperature is higher than –10°C (14°F).
- 25 seconds have elapsed from the start of the previous monitoring.
- Target throttle actuator control motor position is more than 100 steps.

Judgment Criteria

- The actual idle speed is more than 100 r/min lower than the target idle speed for 12 seconds.

OBD-II DRIVE CYCLE PATTERN

Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Throttole valve area is dirty.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools

- MB991958: Scan tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, read the diagnostic trouble code (DTC).

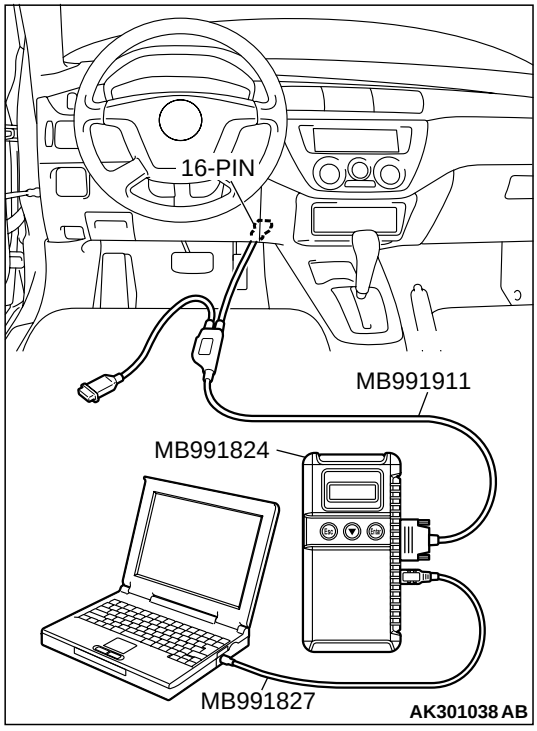
⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958, read the DTC.
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the diagnostic trouble code other than P0506 set?

YES : Refer to Diagnostic Trouble Code Chart P.13B-31.
NO : Go to Step 2.



STEP 2. Check the throttle body. (throttle valve area)

Q: Is the throttle valve area dirty?

YES : Perform cleaning. Refer to Throttle body (throttle valve area) cleaning P.13B-901. Then go to Step 4.
NO : Go to Step 3.

STEP 3. Check the trouble symptoms.

(1) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.
(2) Check the diagnostic trouble code (DTC).

Q: Is DTC P0506 set?

YES : Replace the ECM or PCM. Then go to Step 4.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspectuin Service Points P.00-6.

STEP 4. Test the OBD-II drive cycle.

(1) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.
(2) Check the diagnostic trouble code (DTC).

Q: Is DTC P0506 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P0507: Idle Control Sytem RPM Higher Than Expected

TECHNICAL DESCRIPTION

- The amount of air taken in during idling is regulated by the opening and closing of the throttle valve.
- The ECM <M/T> or PCM <A/T> checks the difference between the actual engine speed and the target engine speed.

DESCRIPTIONS OF MONITOR METHODS

Difference between actual and target idle speed is over the specified value.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

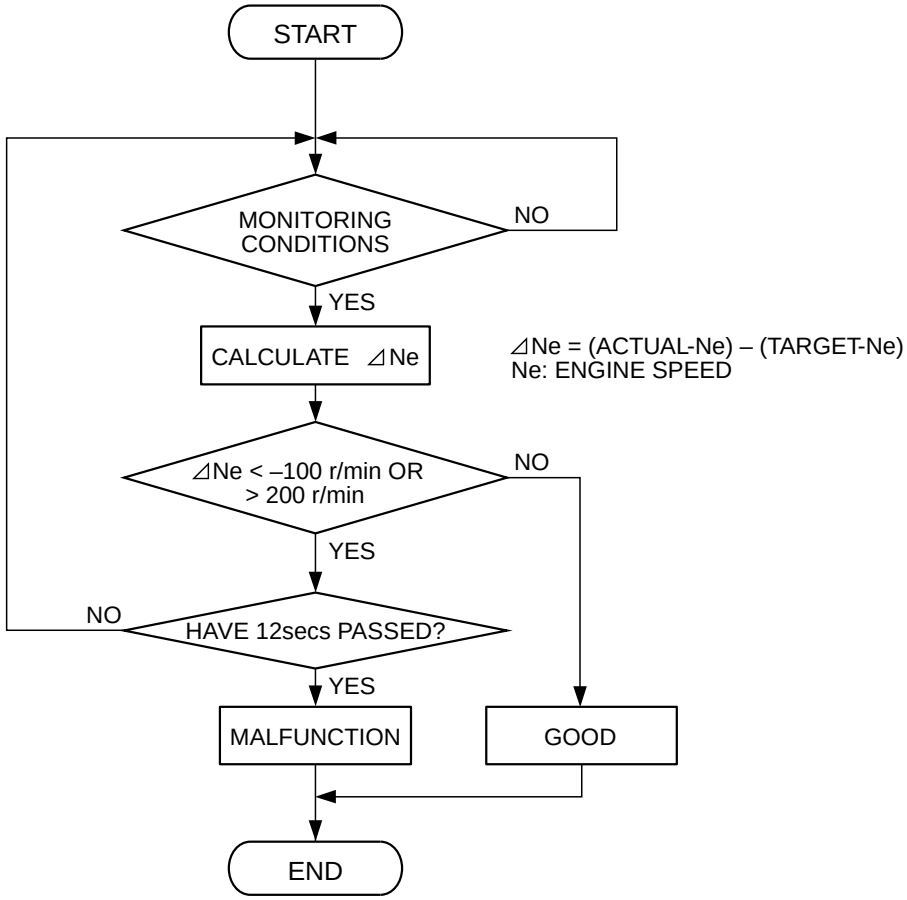
- Misfire monitor
- Exhaust gas recirculation (EGR) system monitor
- Fuel system monitor

Sensor (The sensor below is determined to be normal)

- Mass airflow sensor
- Engine coolant temperature sensor
- Intake air temperature sensor
- Barometric pressure sensor
- Throttle position sensor

DTC SET CONDITIONS

Logic Flow Chart



AK302165

Check Conditions

- Vehicle speed has reached 1.5 km/h (1.0 mph) or more at least once.
- Under the closed loop idle speed control.
- Engine coolant temperature is higher than 77°C (171°F).
- Battery positive voltage is higher than 10 volts.
- Barometric pressure is higher than 76 kPa (22.4 in.Hg).
- Intake air temperature is higher than –10°C (14°F).
- 25 seconds have elapsed from the start of the previous monitoring.
- Target throttle actuator control motor position is 0 step.

Judgment Criteria

- Actual idle speed has continued to be higher than the target idle speed by 200 r/min (300 r/min*) or more for 12 seconds.
  *: Specs in parenthesis is applicable if the maximum air temperature during the previous operation was more than 45°C (113°F).

OBD-II DRIVE CYCLE PATTERN

Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Intake system vacuum leak.
- ECM failed. <M/T>
- PCM failed. <A/T>

TSB Revision

DIAGNOSIS

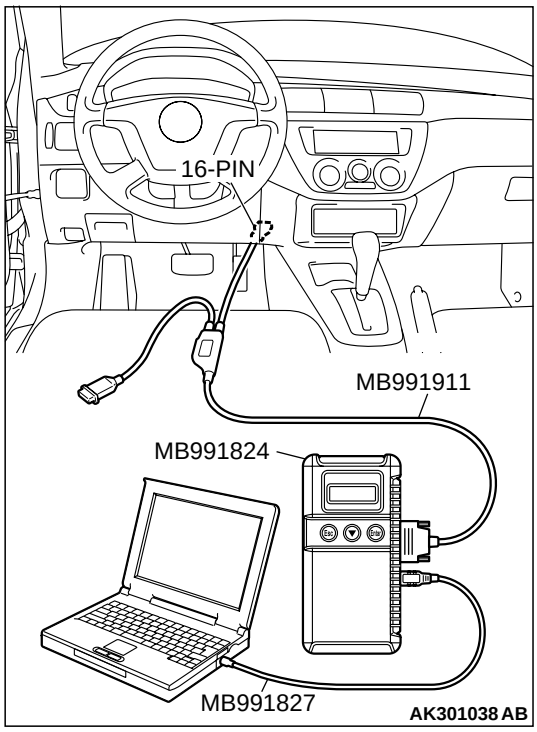
Required Special Tools

- MB991958: Scan tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.



(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958, read the DTC.
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the diagnostic trouble code other than P0507 set?

YES : Refer to Diagnostic Trouble Code Chart P.13B-31.
NO : Go to Step 2.

STEP 2. Check the intake system vacuum leak.

Q: Are there any abnormalities?

YES : Repair or replace it. Then go to Step 4.
NO : Go to Step 3.

STEP 3. Check the trouble symptoms.

(1) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.
(2) Check the diagnostic trouble code (DTC).

Q: Is DTC P0507 set?

YES : Replace the ECM or PCM. Then go to Step 4.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspectuin Service Points P.00-6.

TSB Revision

STEP 4. Test the OBD-II drive cycle.

(1) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.

(2) Check the diagnostic trouble code (DTC).

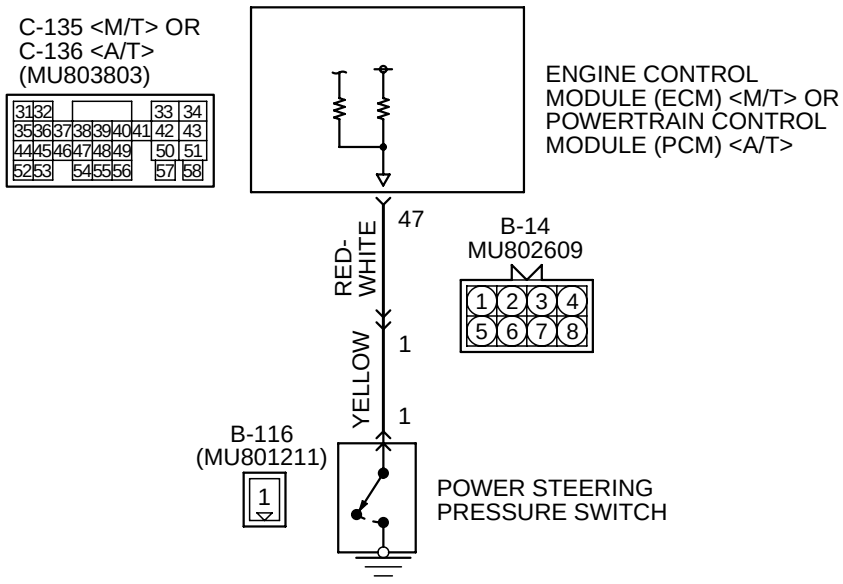
Q: Is DTC P0507 set?

YES : Retry the troubleshooting.

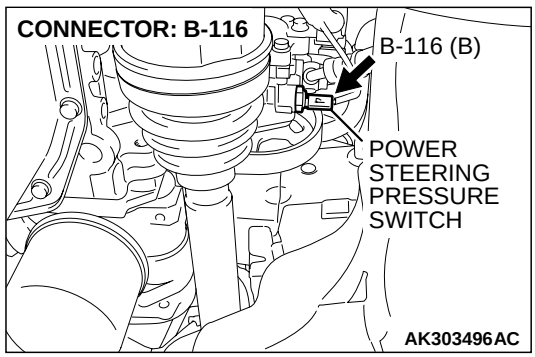
NO : The inspection is complete.

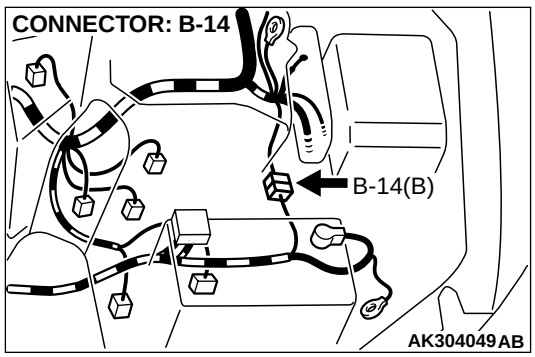
DTC P0551: Power Steering Pressure Switch Circuit Range/Performance

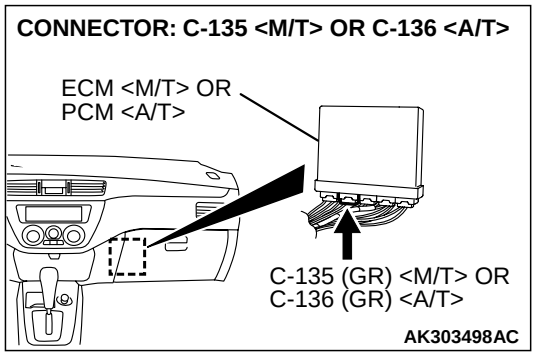
Power Steering Pressure Switch Circuit



AK303997







CIRCUIT OPERATION

- A battery positive voltage is applied to the power steering pressure switch output terminal (terminal No. 1) from the ECM <M/T> or PCM <A/T> (terminal No. 47) via the resistor in the ECM <M/T> or PCM <A/T>.

TECHNICAL DESCRIPTION

- The power steering pressure switch converts the existence of a power steering load into a high/low voltage, and inputs it into the ECM <M/T> or PCM <A/T>.
- When the steering wheel is turned, hydraulic pressure rises. The power steering pressure switch closes, and the applied battery positive voltage will be grounded. With this, the power steering pressure switch output voltage will fluctuate between 12 volts and 0 volt.
- While driving with the steering wheel held straight, the power steering pressure switch turns "OFF".
- The ECM <M/T> or PCM <A/T> checks whether the power steering pressure switch turns "OFF" or "ON" during driving.

DESCRIPTIONS OF MONITOR METHODS

Power steering pressure switch stays on during specified go/stop operations.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

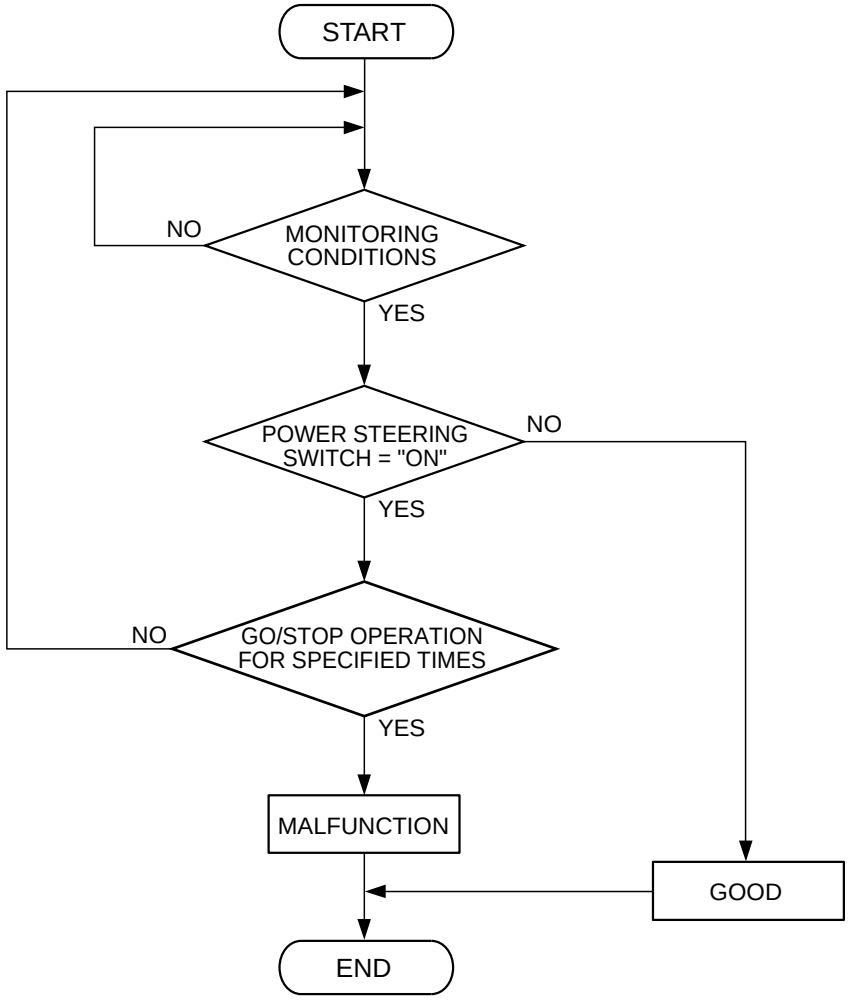
- Not applicable

Sensor (The sensor below is determined to be normal)

- Engine coolant temperature sensor

DTC SET CONDITIONS

Logic Flow Chart



AK302169

Check Conditions
- Engine coolant temperature is higher than 20°C (68°F).
- Drive for 4 seconds or more with the vehicle speed is 50 km/h (31 mph) or more. Stop the vehicle [vehicle speed is 1.5 km/h (0.93 mph) or less]. Repeat 10 times or more.

Judgment Criteria
- Power steering pressure switch continues to be "ON".

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- Power steering pressure switch failed.
- Open or shorted power steering pressure switch circuit, harness damage or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

TSB Revision

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, check data list item 27: Power Steering Pressure Switch.

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

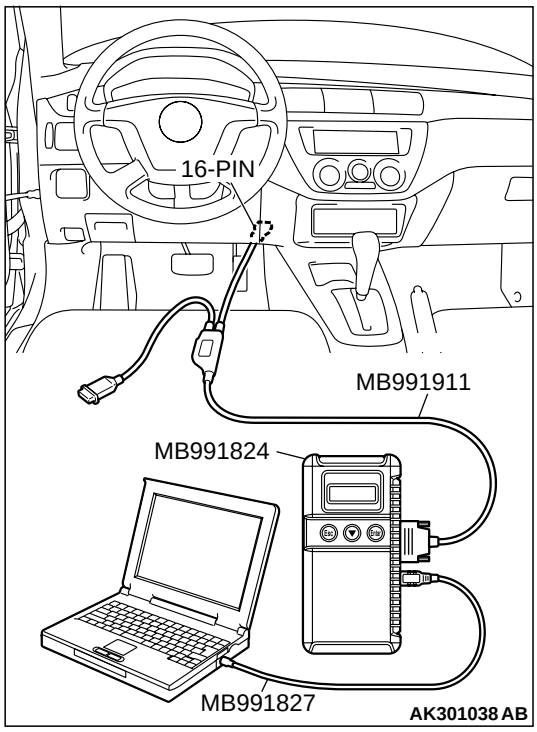
(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine and run at idle.
(3) Set scan tool MB991958 to the data reading mode for item 27, Power Steering Pressure Switch.
  - If the steering wheel is not turned while idling, "OFF" will be displayed.
  - If the steering wheel is turned while idling, "ON" will be displayed.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the sensor operating properly?

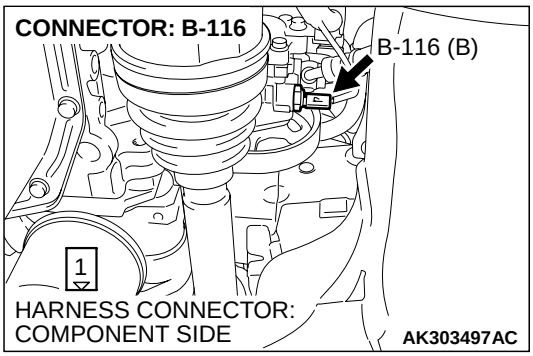
YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

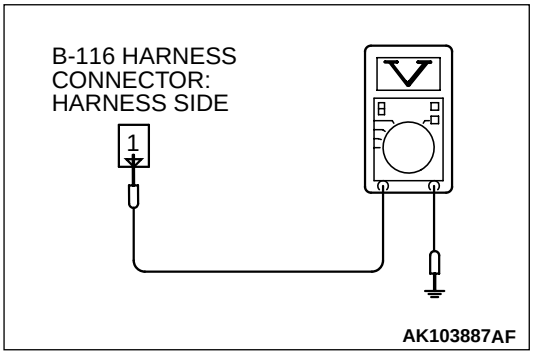
NO : Go to Step 2.



STEP 2. Measure the power supply voltage at power steering pressure switch connector B-116 by backprobing.

(1) Do not disconnect the connector B-116.
(2) Start the engine and run at idle.





(3) Measure the voltage between terminal No. 1 and ground by backprobing.
- When steering wheel is not turned, voltage should measure battery positive voltage.
- When steering wheel is turned, voltage should measure 1 volt or less.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

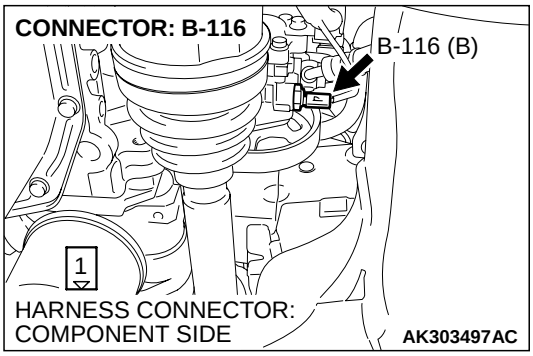
Q: Is the measured voltage within the specified range?

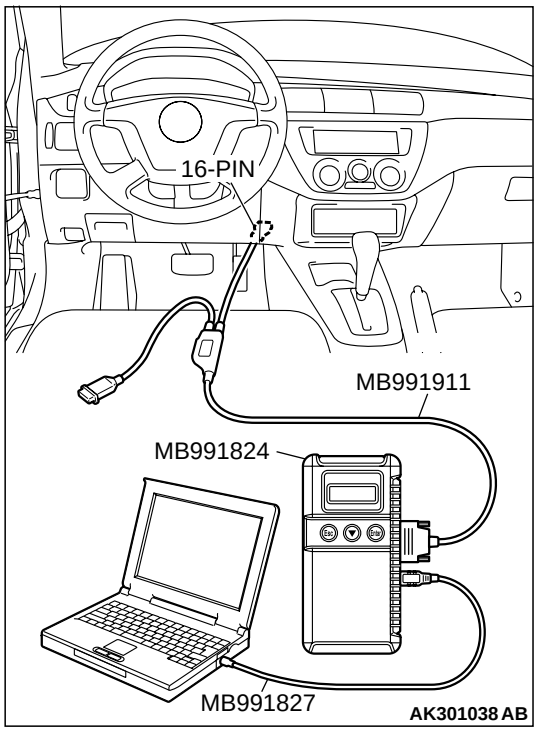
YES : Go to Step 3.
NO : Go to Step 5.

STEP 3. Check harness connector B-116 at power steering pressure switch for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 4.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.





STEP 4. Using scan tool MB991958, check data list item 27: Power Steering Pressure Switch.

⚠ CAUTION

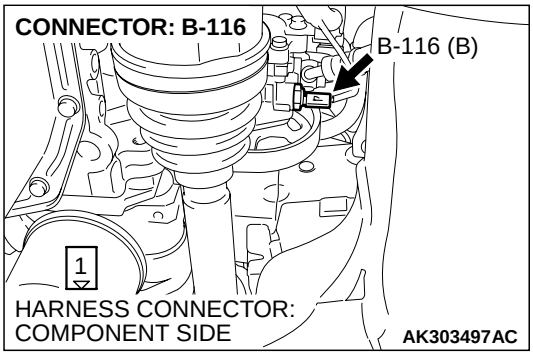
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine and run at idle.
(3) Set scan tool MB991958 to the data reading mode for item 27, Power Steering Pressure Switch.
- If the steering wheel is not turned while idling, "OFF" will be displayed.
- If the steering wheel is turned while idling, "ON" will be displayed.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the sensor operating properly?

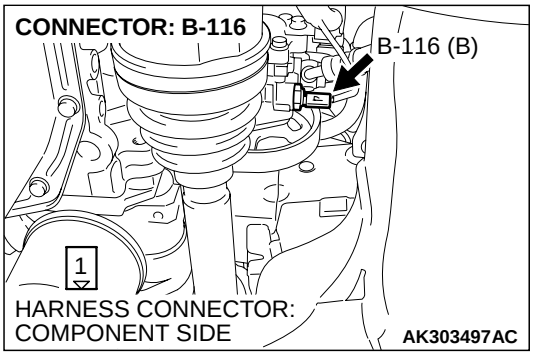
YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.
NO : Replace the ECM or PCM. Then go to Step 14.



STEP 5. Check harness connector B-116 at power steering pressure switch for damage.

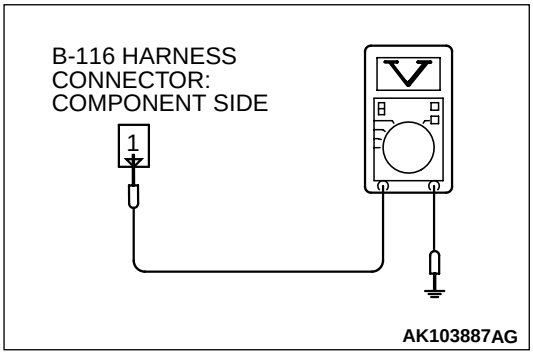
Q: Is the harness connector in good condition?

YES : Go to Step 6.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.



STEP 6. Measure the power supply voltage at power steering pressure switch harness side connector B-116.

(1) Disconnect the connector B-116 and measure at the harness side.
(2) Turn the ignition switch to the "ON" position.



(3) Measure the voltage between terminal No. 1 and ground.
- Voltage should be battery positive voltage.

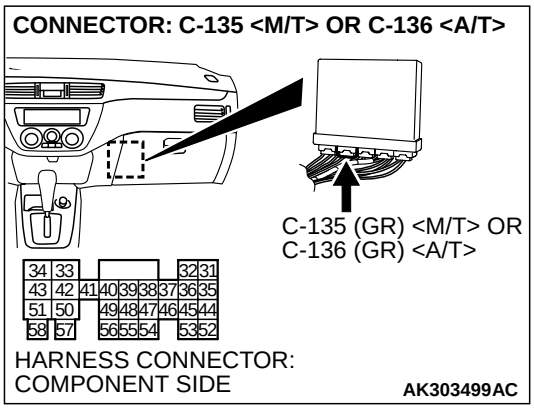
(4) Turn the ignition switch to the "LOCK" (OFF) position.

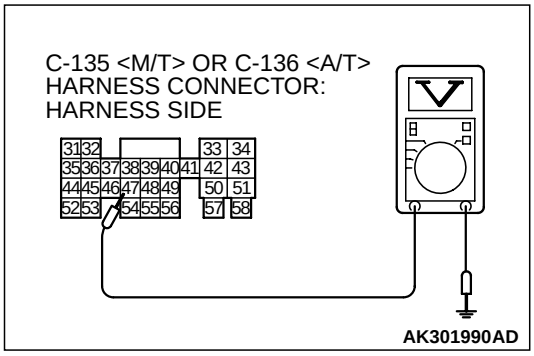
Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 11.
NO : Go to Step 7.

STEP 7. Measure the power supply voltage at ECM connector C-135 <M/T> or PCM connector C-136 <A/T> by backprobing.

(1) Do not disconnect the ECM connector C-135 <M/T> or PCM connector C-136 <A/T>.
(2) Disconnect the power steering pressure switch connector B-116.
(3) Turn the ignition switch to the "ON" position.





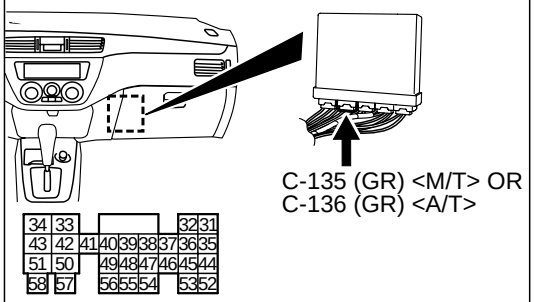
(4) Measure the voltage between terminal No. 47 and ground by backprobing.
- Voltage should be battery positive voltage.

(5) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 8.
NO : Go to Step 9.

CONNECTOR: C-135 <M/T> OR C-136 <A/T>



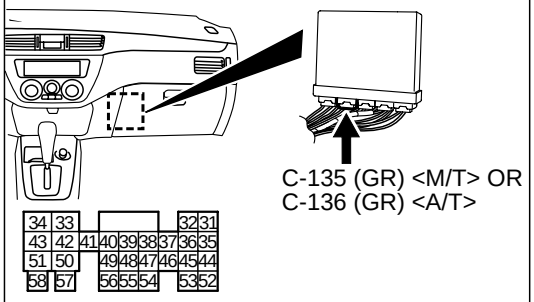
STEP 8. Check harness connector C-135 at ECM <M/T> or C-136 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Check harness connector B-14 at intermediate connector for damage, and repair or replace as required. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. If intermediate connector is in good condition, repair harness wire between power steering pressure switch connector B-116 (terminal No. 1) and ECM connector C-135 <M/T> or PCM connector C-136 <A/T> (terminal No. 47) because of open circuit. Then go to Step 14.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.

CONNECTOR: C-135 <M/T> OR C-136 <A/T>



STEP 9. Check harness connector C-135 at ECM <M/T> or C-136 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 10.

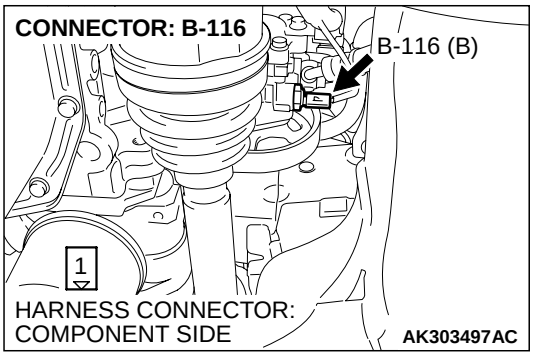
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.

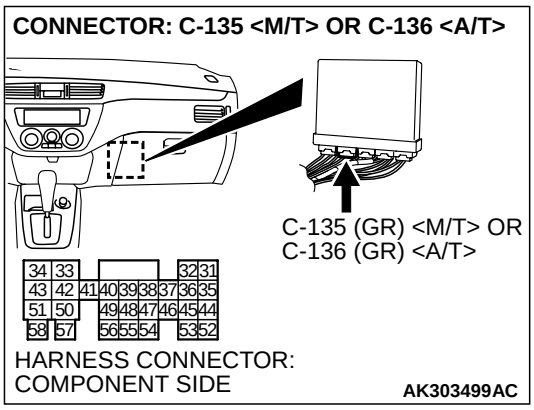
STEP 10. Check for short circuit to ground between power steering pressure switch connector B-116 (terminal No. 1) and ECM connector C-135 <M/T> or PCM connector C-136 <A/T> (terminal No. 47).

Q: Is the harness wire in good condition?

YES : Replace the ECM or PCM. Then go to Step 14.

NO : Repair it. Then go to Step 14.





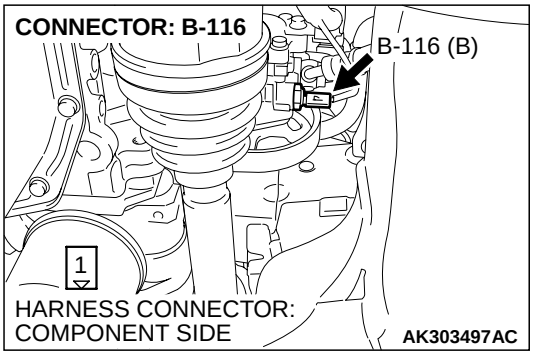
STEP 11. Replace the power steering pressure switch.

(1) Replace the power steering pressure switch.
(2) Retest the system.
(3) Check the diagnostic trouble code (DTC).

Q: Is DTC P0551 set?

YES : Go to Step 12.

NO : Go to Step 14.

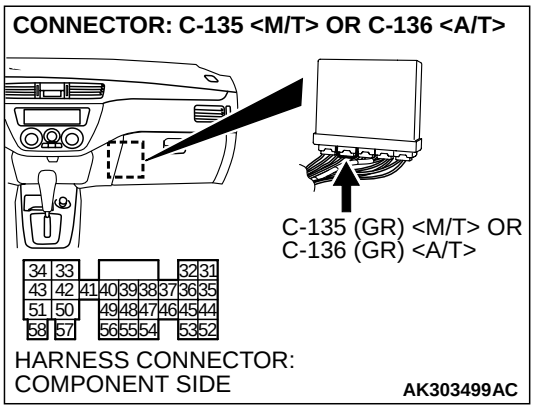


STEP 12. Check connector C-135 at ECM <M/T> or C-136 at PCM <A/T> for damage.

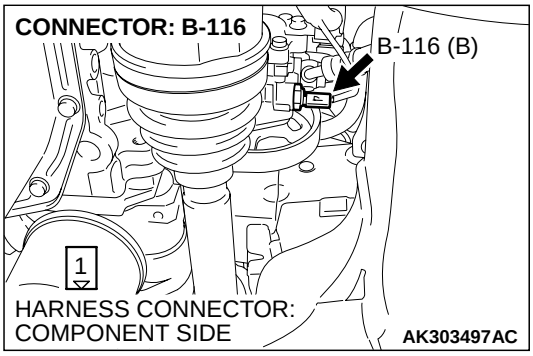
Q: Is the connector in good condition?

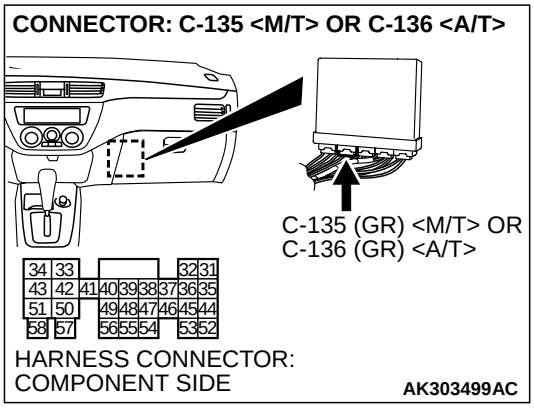
YES : Go to Step 13.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.



STEP 13. Check for harness damage between power steering pressure switch connector B-116 (terminal No. 1) and ECM connector C-135 <M/T> or PCM connector C-136 <A/T> (terminal No. 47).



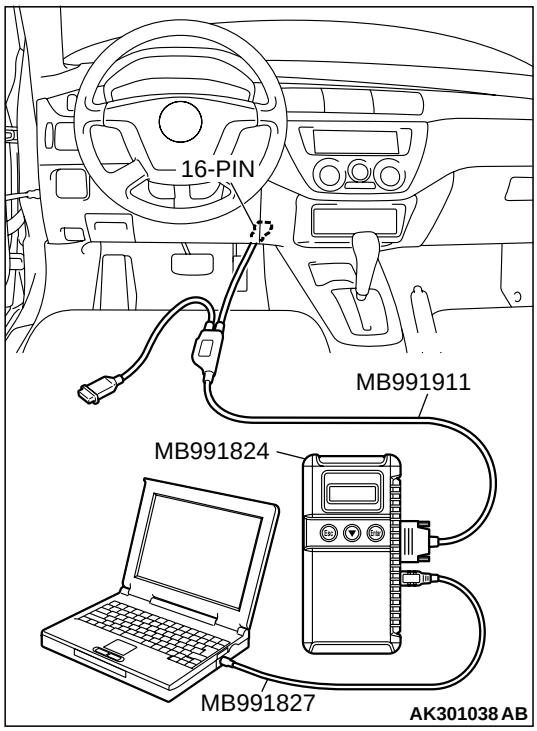


NOTE: Check harness after checking intermediate connector B-14. If intermediate connector is damaged, repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.

Q: Is the harness wire in good condition?

YES : Replace the ECM or PCM. Then go to Step 14.

NO : Repair it. Then go to Step 14.



STEP 14. Using scan tool MB991958, check data list item 27: Power Steering Pressure Switch.

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine and run at idle.
(3) Set scan tool MB991958 to the data reading mode for item 27, Power Steering Pressure Switch.
- If the steering wheel is not turned while idling, "OFF" will be displayed.
- If the steering wheel is turned while idling, "ON" will be displayed.

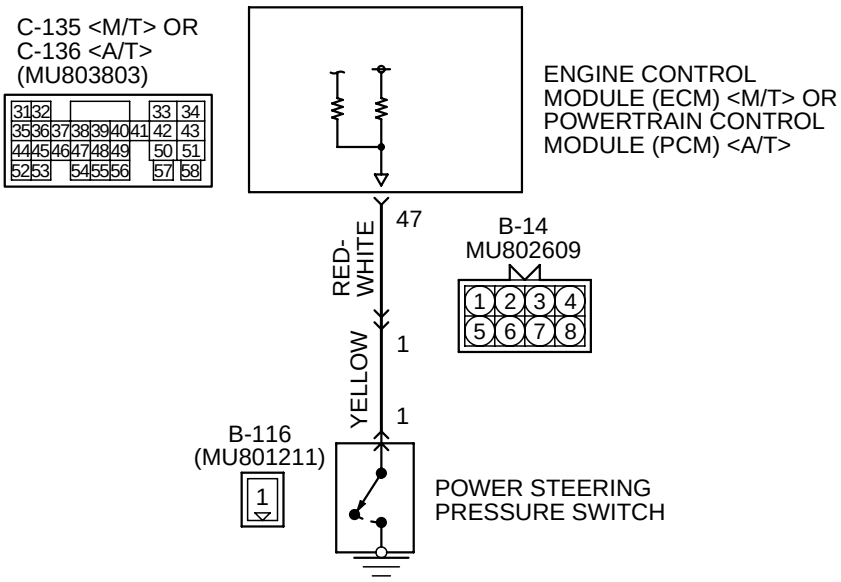
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the switch operating properly?

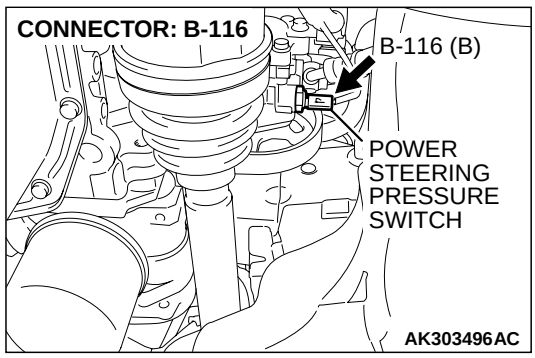
YES : The inspection is complete.
NO : Retry the troubleshooting.

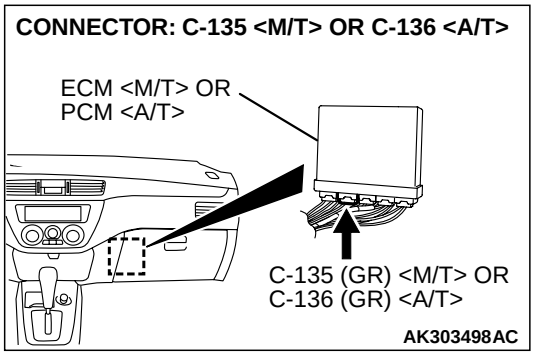
DTC P0554: Power Steering Pressure Switch Circuit Intermittent

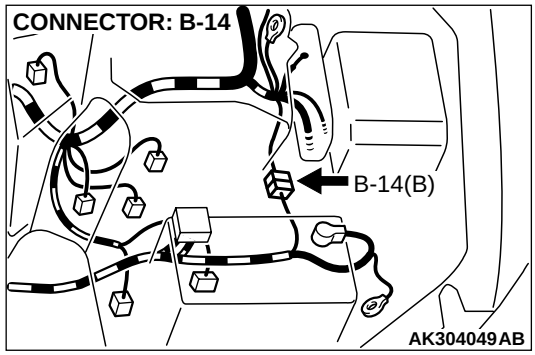
Power Steering Pressure Switch Circuit



AK303997







TSB Revision

CIRCUIT OPERATION

- A battery positive voltage is applied to the power steering pressure switch output terminal (terminal No. 1) from the ECM <M/T> or PCM <A/T> (terminal No. 47) via the resistor in the ECM <M/T> or PCM <A/T>.

TECHNICAL DESCRIPTION

- The power steering pressure switch converts the existence of a power steering load into a high/low voltage, and inputs it into the ECM <M/T> or PCM <A/T>.
- When the steering wheel is turned, hydraulic pressure rises. The power steering pressure switch closes, and the applied battery positive voltage will be grounded. With this, the power steering pressure switch output voltage will fluctuate between 12 volts and 0 volt.
- While driving with the steering wheel held straight, the power steering pressure switch turns "OFF".
- The ECM <M/T> or PCM <A/T> checks whether the power steering pressure switch turns "OFF" or "ON" during driving.

DESCRIPTIONS OF MONITOR METHODS

Power steering pressure switch changes from off to on more than 10 times for 1 second.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

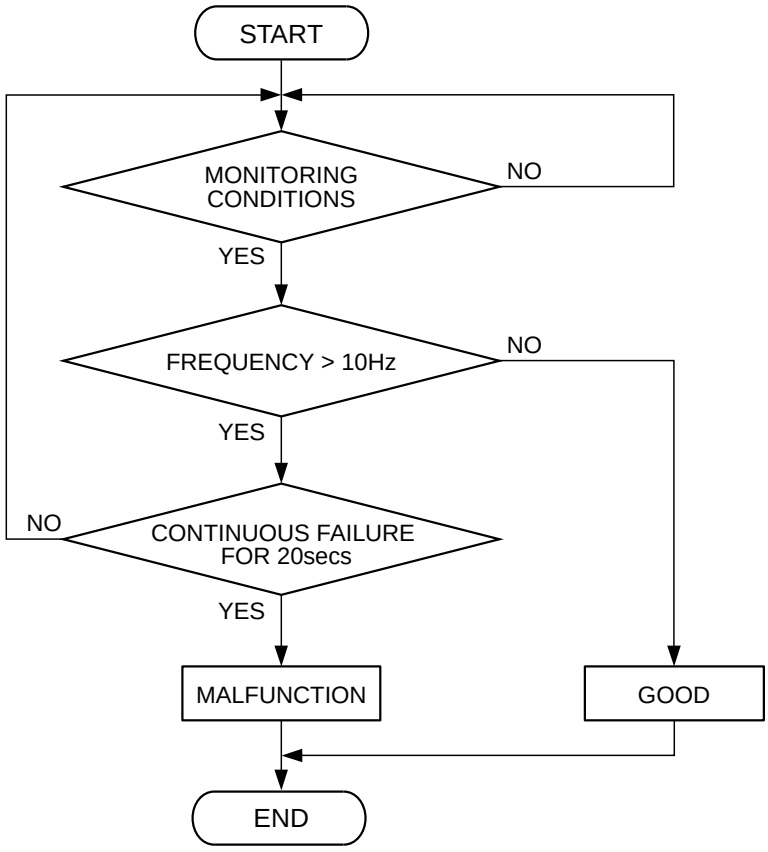
- Not applicable

Sensor (The sensor below is determined to be normal)

- Engine coolant temperature sensor

DTC SET CONDITIONS

Logic Flow Chart



AK302041

Check Conditions

- Engine coolant temperature is higher than 20°C (68°F).
- Vehicle speed is higher than 50 km/h (31 mph).

Judgment Criteria

- The ON/OFF frequency of a power steering pressure switch is 10 Hz or more for 20 seconds.

OBD-II DRIVE CYCLE PATTERN

None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Power steering pressure switch failed.
- Incorrect power steering fluid level.
- Incorrect oil pump pressure.
- Harness damage in power steering pressure switch circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

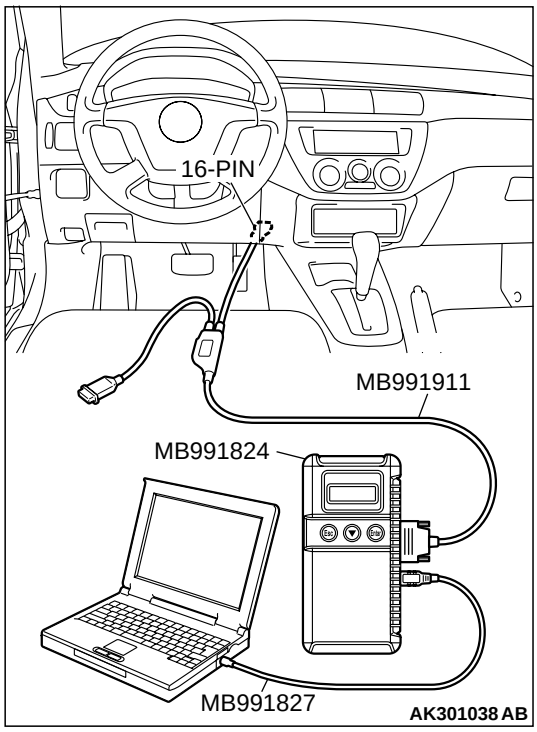
TSB Revision

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, check data list item 27: Power Steering Pressure Switch.



⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine and run at idle.
(3) Set scan tool MB991958 to the data reading mode for item 27, Power Steering Pressure Switch.
  - If the steering wheel is not turned while idling, "OFF" will be displayed.
  - If the steering wheel is turned while idling, "ON" will be displayed.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.
NO : Go to Step 2.

STEP 2. Check the power steering fluid level.

Refer to GROUP 37, On-Vehicle Service – Fluid Level Check P.37A-19.

Q: Are there any abnormalities?

YES : Repair it. Then go to Step 7.
NO : Go to Step 3.

STEP 3. Check the power steering pressure switch.

Refer to GROUP 37, On-Vehicle Service – Power Steering Pressure Switch CheckP.37A-22.

Q: Are there any abnormalities?

YES : Replace the power steering pressure switch. Then go to Step 7.
NO : Go to Step 4.

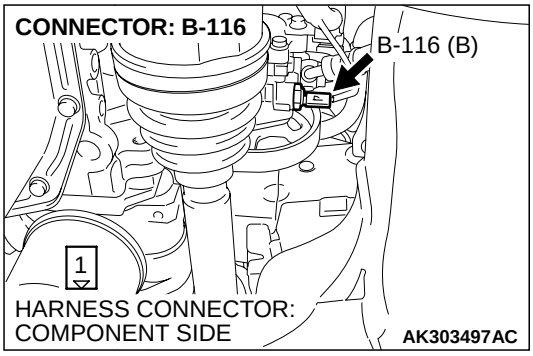
STEP 4. Check the oil pump pressure .
Refer to GROUP 37, On-Vehicle Service – Oil Pump Pressure Test P.37A-4.

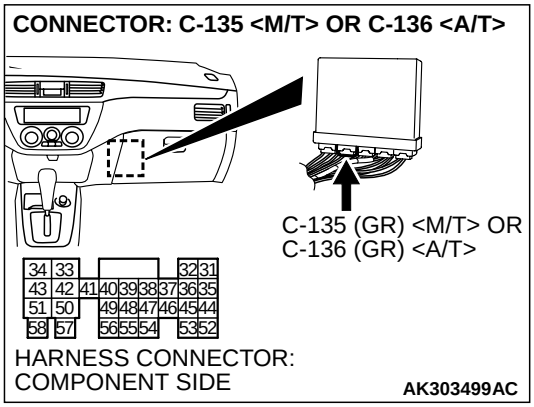
Q: Are there any abnormalities?

YES : Repair it. Then go to Step 7.
NO : Go to Step 5.

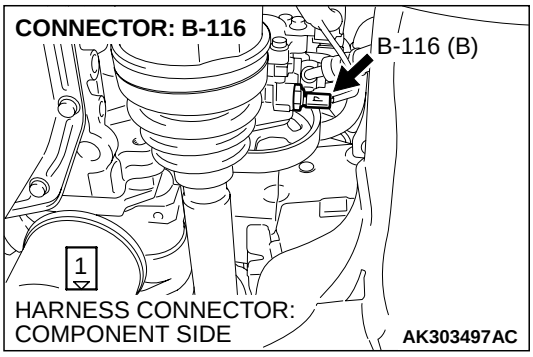
STEP 5. Check harness connector B-116 at the power steering pressure switch and harness connector C-135 at ECM <M/T> or C-136 at PCM <A/T> for damage.
Q: Is the harness connector in good condition?

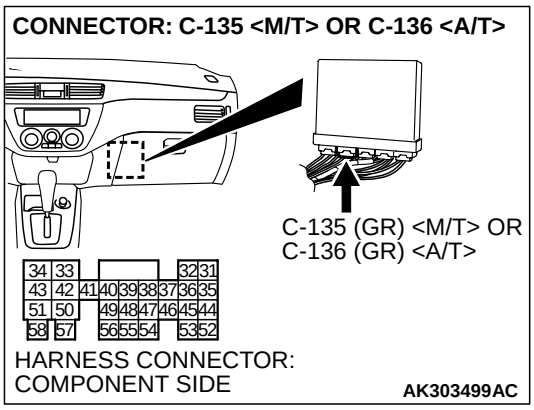
YES : Go to Step 6.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 7.





STEP 6. Check for harness damage between power steering pressure switch connector B-116 (terminal No. 1) and ECM connector C-135 <M/T> or PCM connector C-136 <A/T> (terminal No. 47).

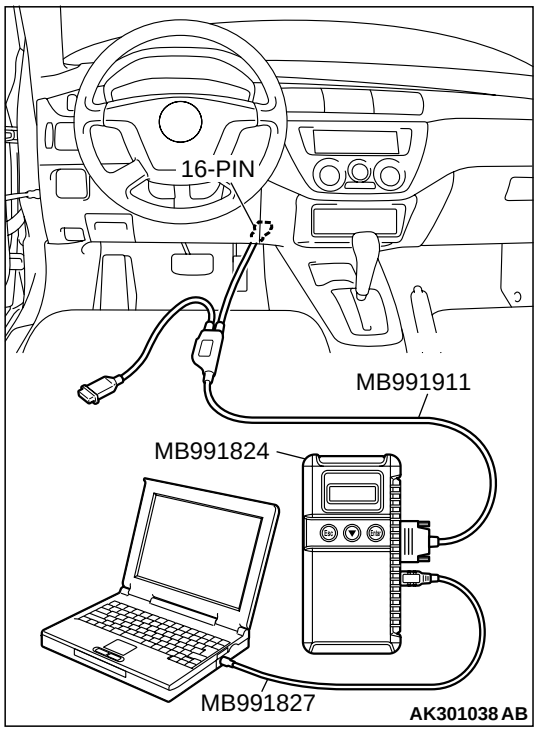




NOTE: Check harness after checking intermediate connector B-14. If intermediate connector is damaged, repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 7.

Q: Is the harness wire in good condition?

YES : Replace the ECM or PCM. Then go to Step 7.
NO : Repair it. Then go to Step 7.



STEP 7. Using scan tool MB991958, check data list item 27: Power Steering Pressure Switch.

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine and run at idle.
(3) Set scan tool MB991958 to the data reading mode for item 27, Power Steering Pressure Switch.
- If the steering wheel is not turned while idling, "OFF" will be displayed.
- If the steering wheel is turned while idling, "ON" will be displayed.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the switch operating properly?

YES : The inspection is complete.
NO : Retry the troubleshooting.

DTC P0606: Engine Control Module or Powertrain Control Module Main Processor Malfunction

TECHNICAL DESCRIPTION
- System LSI checks the ECM <M/T> or PCM <A/T> for abnormal conditions.

DESCRIPTIONS OF MONITOR METHODS
No watch dog pulse is detected.

MONITOR EXECUTION
Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)
- Not applicable

Sensor (The sensor below is determined to be normal)
- Not applicable

DTC SET CONDITIONS

Check Conditions
- Ignition switch is "ON" position.

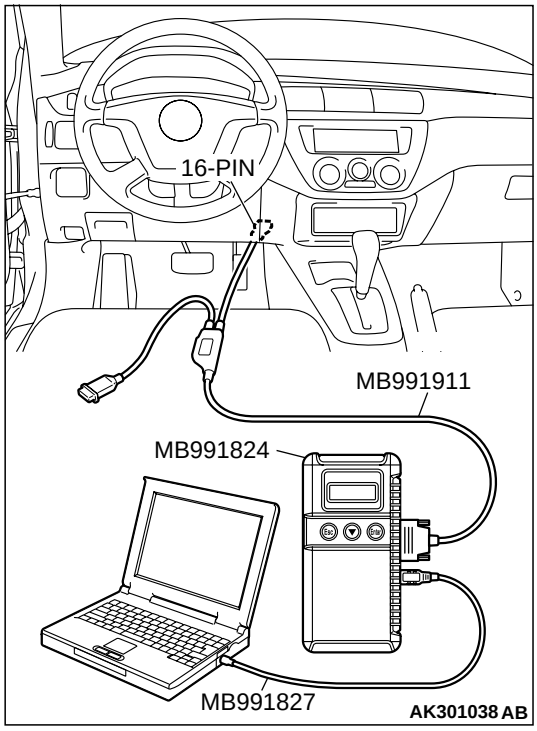
Judgement Criteria
- No surveillance pulse signals should be input for 0.5 second.

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B



STEP 1. Using scan tool MB991958, read the diagnostic trouble code (DTC)

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

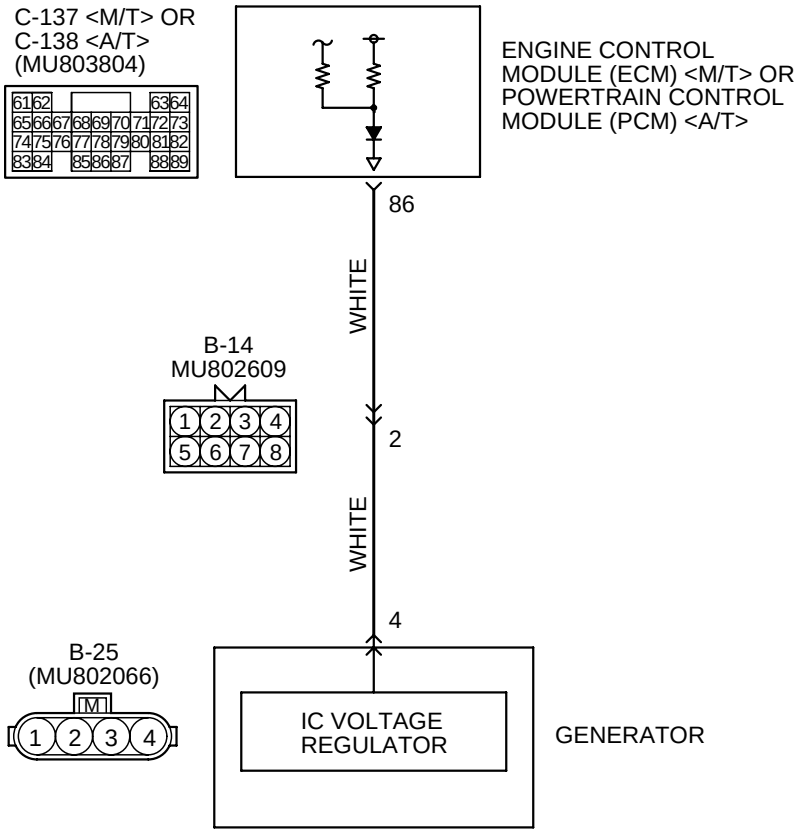
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P0606 set?

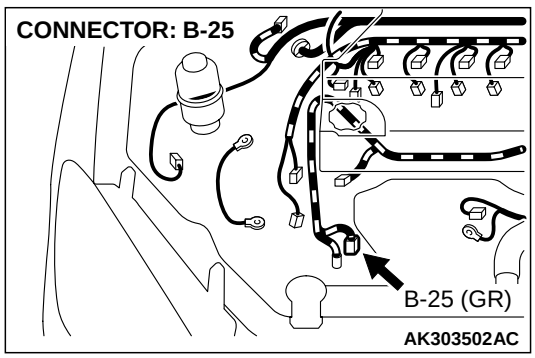
YES : Replace the ECM or PCM.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

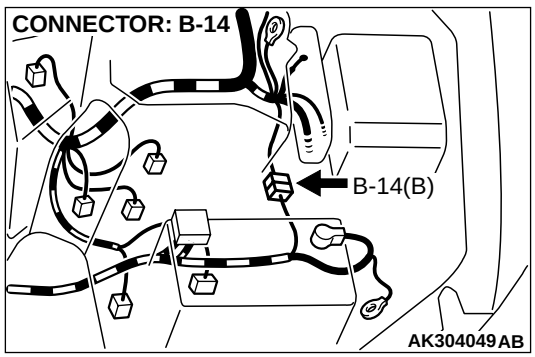
DTC P0622: Generator FR Terminal Circuit Malfunction

Generator Circuit

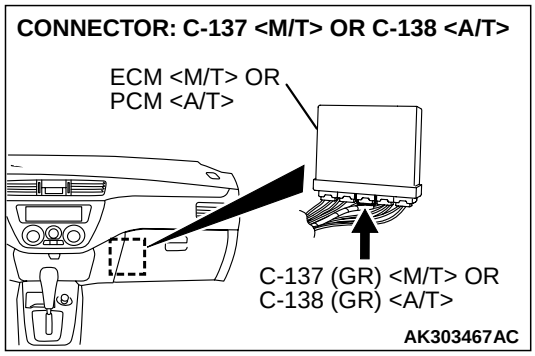


AK303998





TSB Revision



CIRCUIT OPERATION

- The ECM <M/T> or PCM <A/T> (terminal No. 86) apply a battery positive voltage into the generator FR terminal No. 4 via resistance inside the unit.

TECHNICAL DESCRIPTION

- When the generator field coils are controlled, the generator FR terminal inputs signal to the ECM <M/T> or PCM <A/T>.
- The ECM <M/T> or PCM <A/T> detects the generator output with the input signal, and controls the idle air control motor according to the generator output.

DTC SET CONDITIONS

Check Conditions

- Engine speed is higher than 50 r/min.

Judgement Criteria

- Input voltage from the generator FR terminal has continued to be approximately battery positive voltage for 20 seconds.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set area:)

- Generator failed.
- Open or shorted circuit in generator FR terminal circuit, harness damage or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

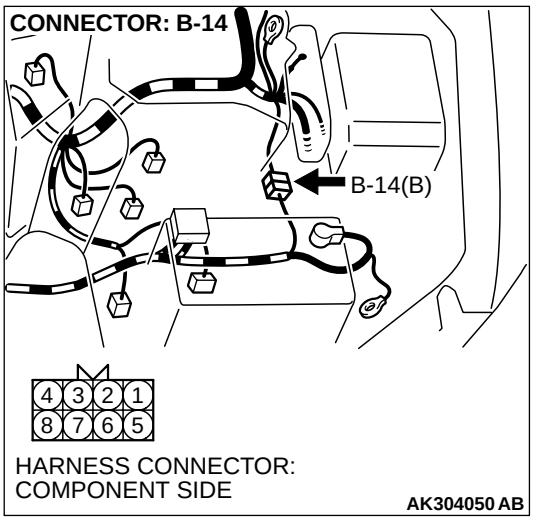
DIAGNOSIS

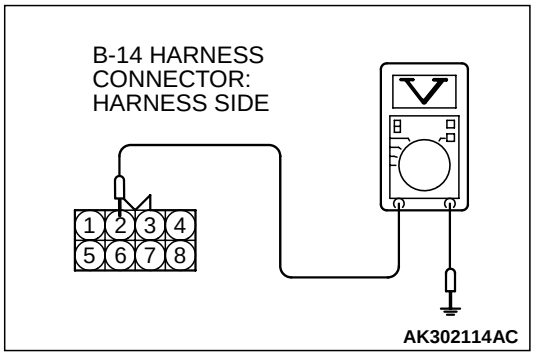
Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Measure the voltage at generator intermediate connector B-14 by backprobing.

(1) Do not disconnect the connector B-14.
(2) Start the engine and run at idle.





(3) Measure the voltage between terminal No. 2 and ground by backprobing.
   a. Engine: warming up
   b. Radiator fan: stopped
   c. Headlight switch: OFF to ON
   d. Rear defogger switch: OFF to ON
   e. Stoplight switch: OFF to ON
   - Voltage should be drops.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

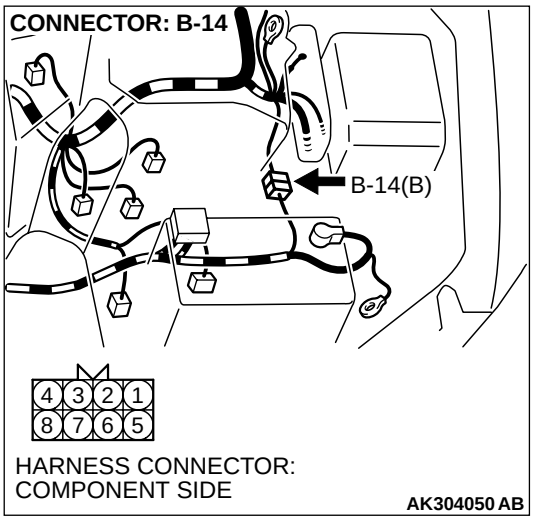
Q: Did the measured voltage drop?

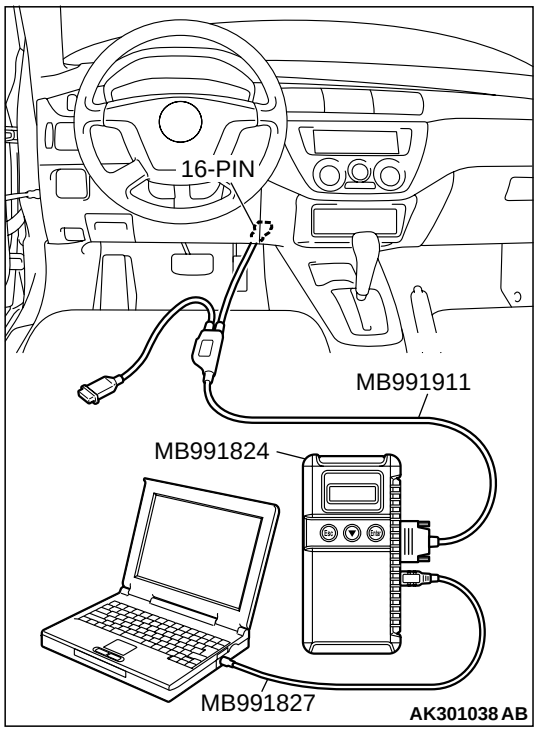
YES : Go to Step 2.
NO : Go to Step 4.

STEP 2. Check harness connector B-14 at generator intermediate connector for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 3.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.





STEP 3. Using scan tool MB991958, read the diagnostic trouble code (DTC).

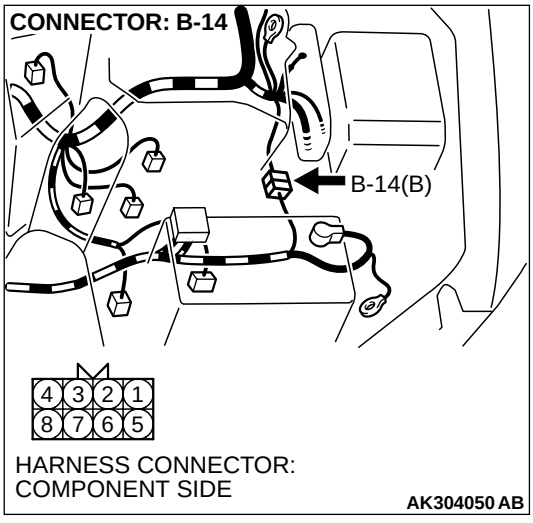
⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine and run at idle.
(3) Read the DTC.
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is DTC P0622 set?

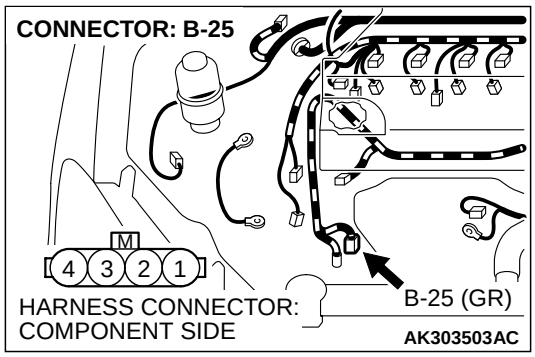
YES : Replace the ECM or PCM. Then go to Step 10.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.



STEP 4. Check harness connector B-14 at generator intermediate connector for damage.

Q: Is the harness connector in good condition?

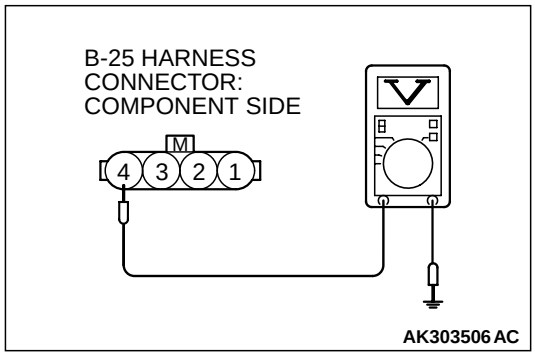
YES : Go to Step 5.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.



STEP 5. Measure the voltage at generator harness side connector B-25.

(1) Disconnect the connector B-25 and measure at the harness side.

(2) Turn the ignition switch to the "ON" position.



(3) Measure the voltage between terminal No. 4 and ground.
- Voltage should be battery positive voltage.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 8.

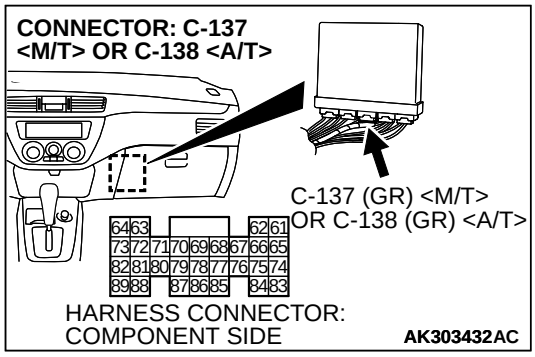
NO : Go to Step 6.

STEP 6. Check harness connector C-137 at ECM <M/T> or C-138 at PCM <A/T> for damage.

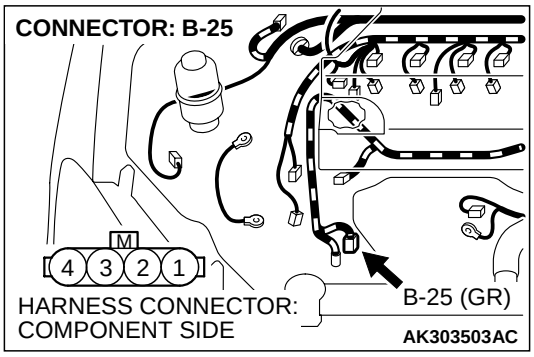
Q: Is the harness connector in good condition?

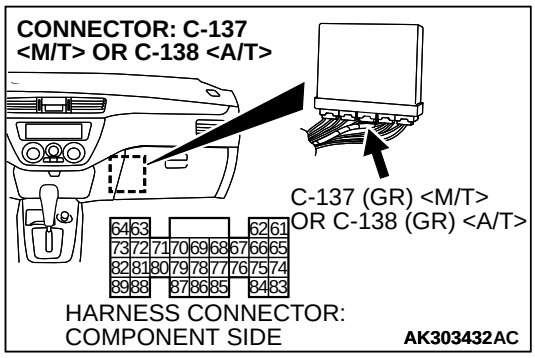
YES : Go to Step 7.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.



STEP 7. Check for open circuit and short circuit to ground between generator connector B-25 (terminal No. 4) and ECM connector C-137 <M/T> or PCM connector C-138 <A/T> (terminal No. 86).





NOTE: Check harness after checking intermediate connector B-14. If intermediate connector is damaged, repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.

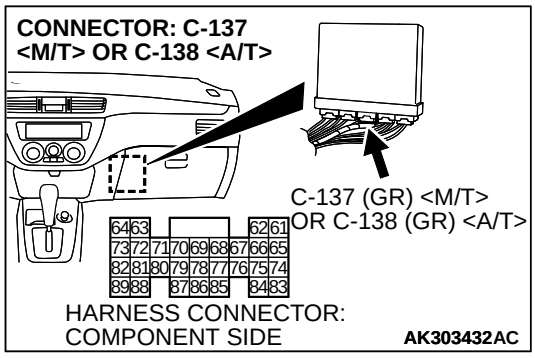
Q: Is the harness wire in good condition?

YES : Replace the ECM or PCM. Then go to Step 10.
NO : Repair it. Then go to Step 10.

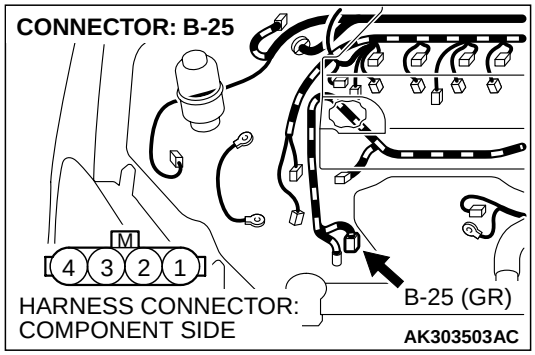
STEP 8. Check harness connector C-137 at ECM <M/T> or C-138 at PCM <A/T> for damage.

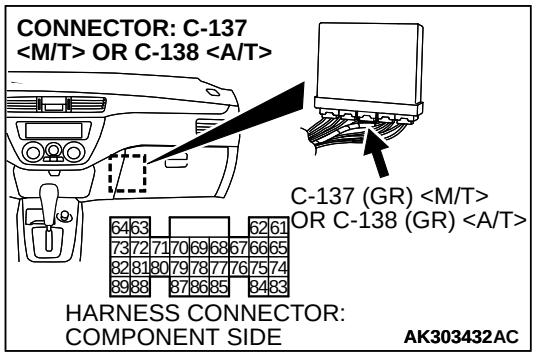
Q: Is the harness connector in good condition?

YES : Go to Step 9.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.



STEP 9. Check for harness damage between generator connector B-25 (terminal No. 4) and ECM connector C-137 <M/T> or PCM connector C-138 <A/T> (terminal No. 86).

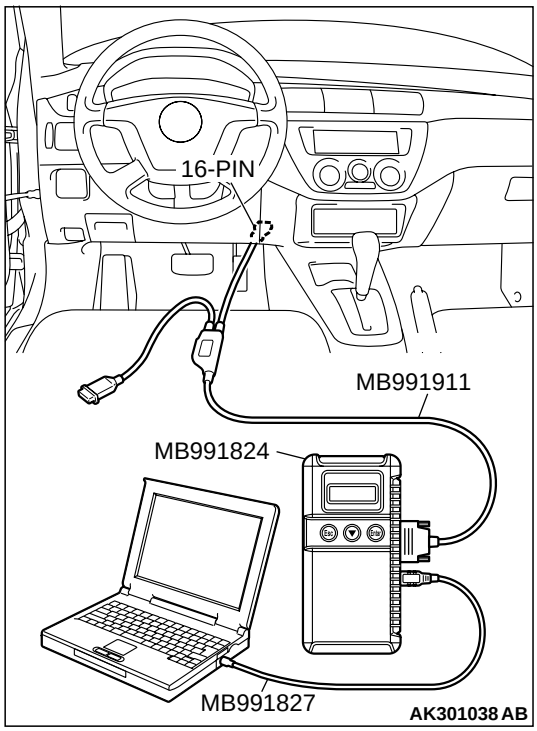




NOTE: Check harness after checking intermediate connector B-14. If intermediate connector is damaged, repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.

Q: Is the harness wire in good condition?

YES : Replace the generator. Then go to Step 10.
NO : Repair it. Then go to Step 10.



STEP 10. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Start the engine and run at idle.
(3) Read the DTC.
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is DTC P0622 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P0638: Throttle Actuator Control Motor Circuit Range/Performance Problem

THROTTLE ACTUATOR CONTROL MOTOR CIRCUIT RANGE/PERFORMANCE PROBLEM CIRCUIT

- Refer to, DTC P2101 – Throttle Actuator Control Motor Circuit P.13B-634.

CIRCUIT OPERATION

- Refer to, DTC P2101 – Throttle Actuator Control Motor Circuit P.13B-634.

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> checks the electronic controlled throttle system for abnormal conditions.

DESCRIPTIONS OF MONITOR METHODS

Difference between throttle position sensor (main) output and target opening is greater than the specified value.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Check Conditions

- Battery positive voltage is higher than 8.3 volts.
- Throttle position sensor (main) output voltage is between 0.35 and 4.8 volts.
- Drop of throttle position sensor (main) output voltage per 100 milliseconds is more than 0.04 volt.

Judgement Criteria

- Throttle position sensor (main) output voltage has continued to be higher than the target throttle position sensor (main) voltage by 0.5 volt or more for 0.5 second.

Check Conditions

- Battery positive voltage is higher than 8.3 volts.
- Throttle position sensor (main) output voltage is between 0.35 and 4.8 volts.

Judgement Criteria

- Difference between throttle position sensor (main) output voltage and target throttle position sensor (main) voltage is 1 volt or higher for 4 seconds.

OBD-II DRIVE CYCLE PATTERN

None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

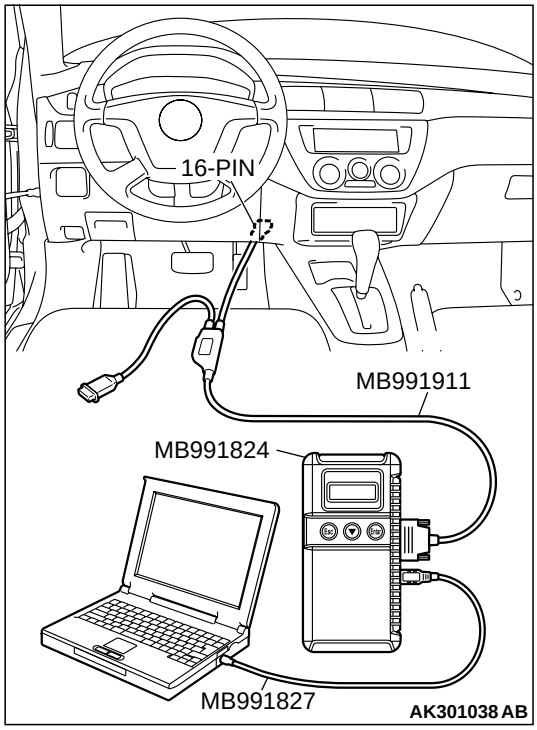
- Throttle valve return spring failed.
- Throttle valve operation failed.
- Throttle actuator control motor failed.
- Harness damage in throttle actuator control motor circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, check data list item 9A: Throttle Position Sensor (main) Mid Opening Learning Value.



⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 9A, Throttle position sensor (main) mid opening learning value.
- Check that it is between 0.6 and 1.2 volts.

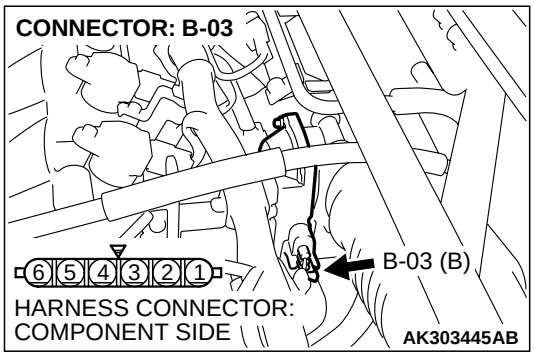
(4) Turn the ignition switch to the "LOCK"(OFF) position.

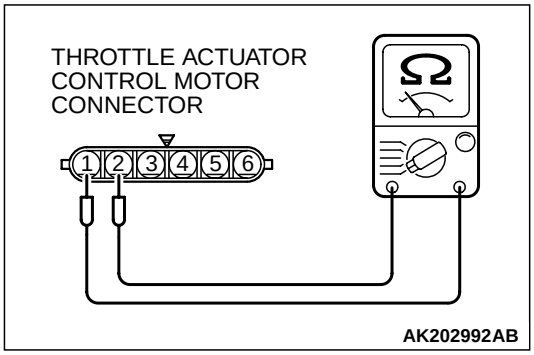
Q: Is voltage between 0.6 and 1.2 volts?

YES : Go to Step 2.
NO : Replace the throttle body assembly. Then go to Step 8.

STEP 2. Check the throttle actuator control motor.

(1) Disconnect the connector B-03.



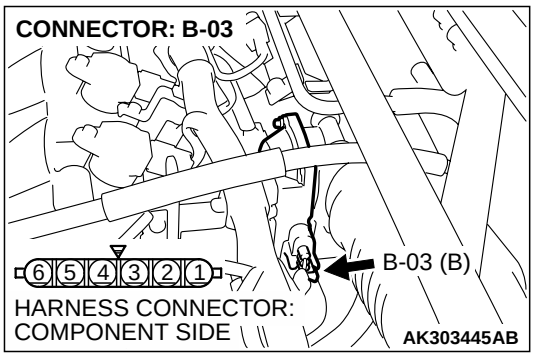


(2) Measure the resistance between throttle actuator control motor side connector terminal No. 1 and No. 2.

Standard value: 0.3 – 80 ohms [at 20°C (68°F)]

Q: Is the measured resistance between 0.3 and 80 ohms [at 20°C (68°F)]?

YES : Go to Step 3.
NO : Replace the throttle body assembly. Then go to Step 8.

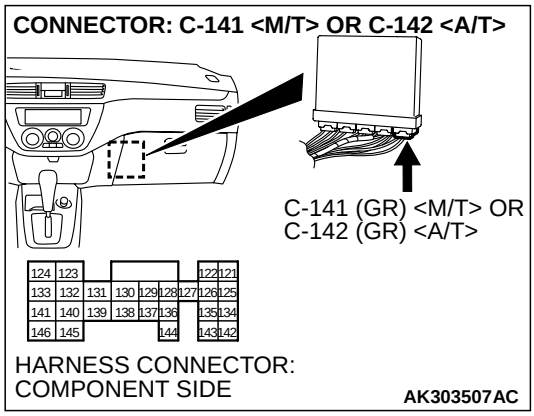


STEP 3. Check harness connector B-03 at throttle actuator control motor for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 4.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 8..

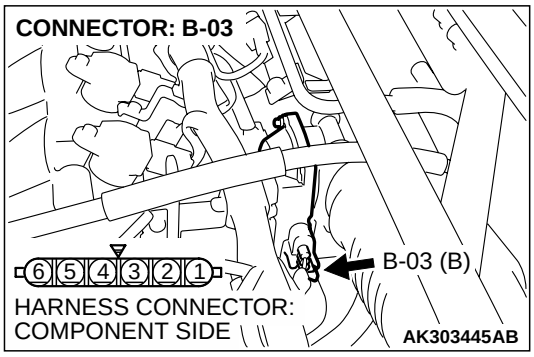


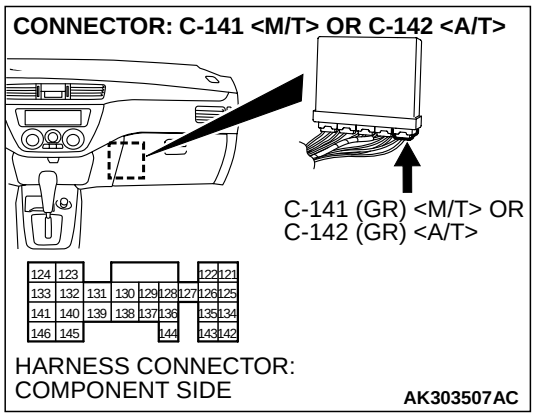
STEP 4. Check harness connector C-141 at ECM <M/T> or C-142 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 5.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 8.





STEP 5. Check for harness damage between throttle actuator control motor connector B-03 (terminal No. 1) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 133).

Q: Is the harness wire in good condition?

YES : Go to Step 6.

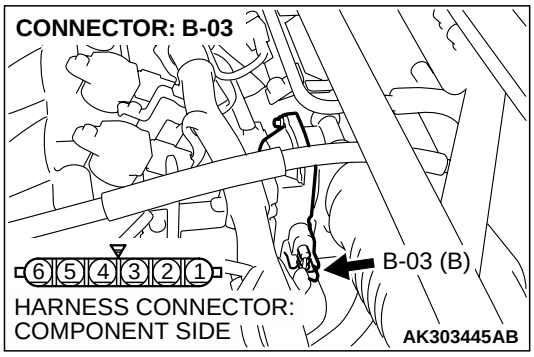
NO : Repair it. Then go to Step 8.

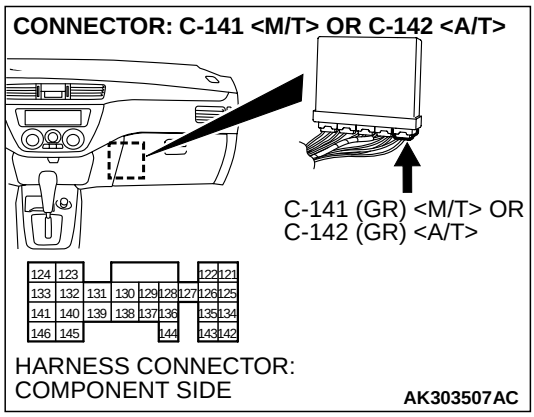
STEP 6. Check for harness damage between throttle actuator control motor connector B-03 (terminal No. 2) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 141).

Q: Is the harness wire in good condition?

YES : Go to Step 7.

NO : Repair it. Then go to Step 8.





STEP 7. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

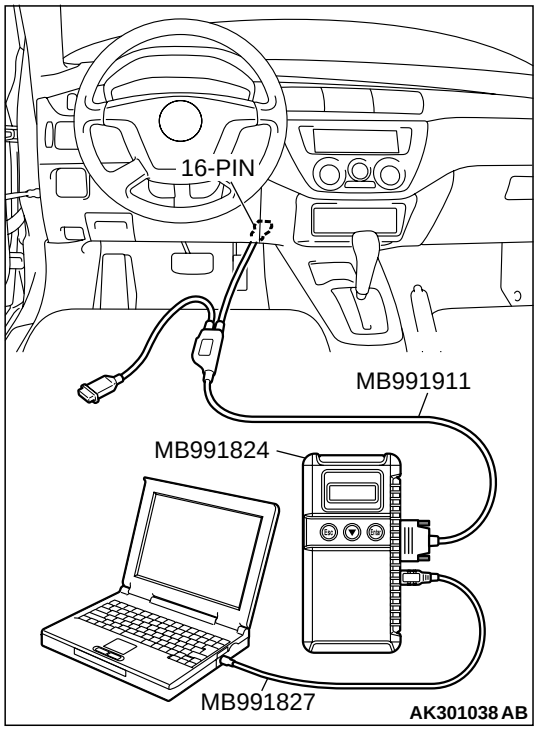
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

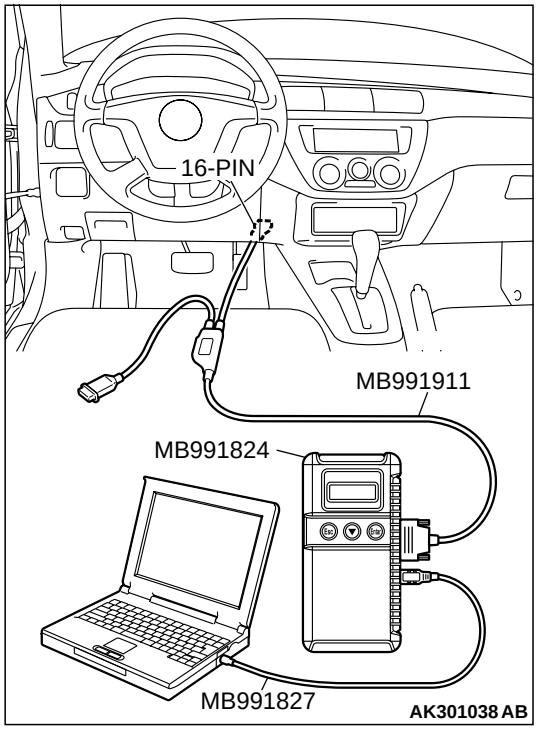
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P0638 set?

YES : Replace the ECM or PCM. Then go to Step 8.

NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.





STEP 8. Using scan tool MB991958, read the diagnostic trouble code (DTC).

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P0638 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P0642: Throttle Position Sensor Power Supply

TECHNICAL DESCRIPTION
- ECM <M/T> or PCM <A/T> checks the throttle position sensor power voltage for abnormal conditions.

DESCRIPTIONS OF MONITOR METHODS
Throttle position sensor source voltage is smaller than the specified value.

MONITOR EXECUTION
Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)
- Not applicable

Sensor (The sensor below is determined to be normal)
- Not applicable

DTC SET CONDITIONS

Check Conditions
- Battery positive voltage is higher than 6.3 volts.

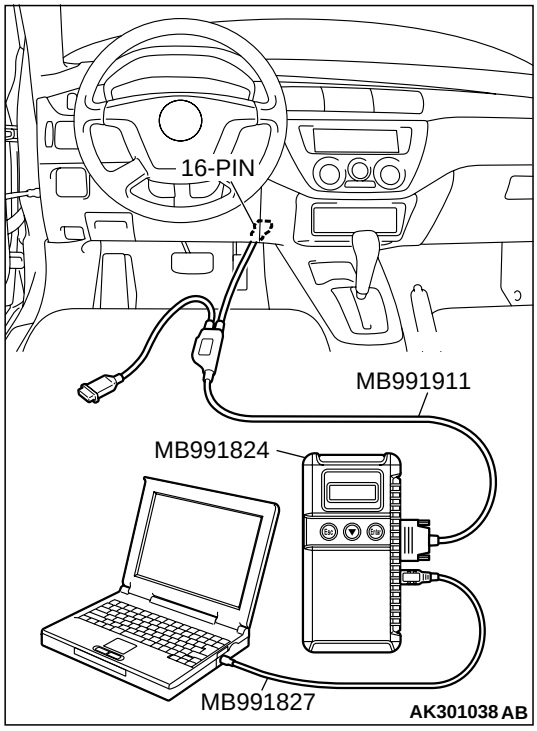
Judgement Criteria
- Throttle position sensor power voltage should be 4.1 volts or less for 0.5 second.

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:
- MB991958: Scan tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B



STEP 1. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

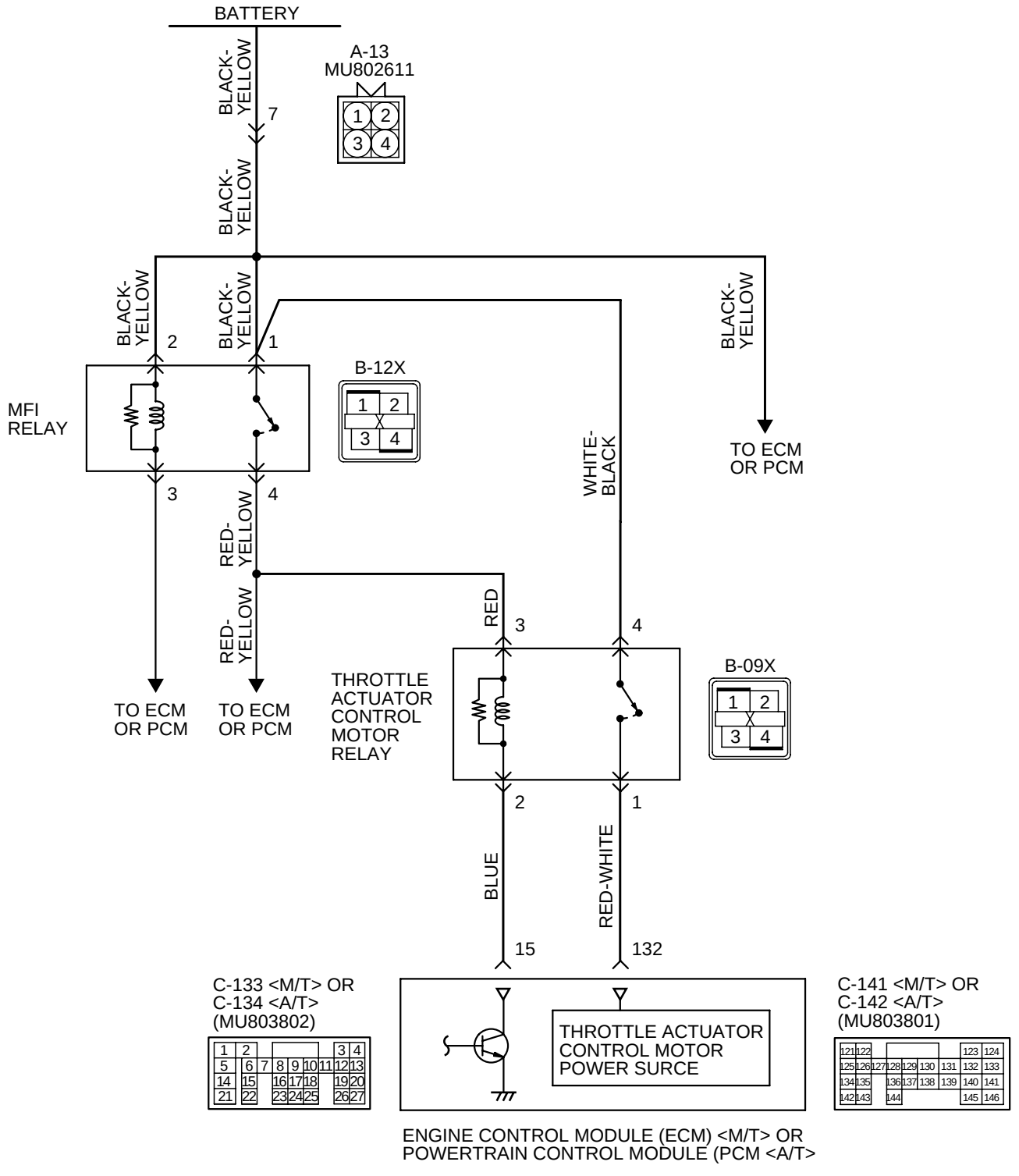
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P0642 set?

YES : Replace the ECM or PCM.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

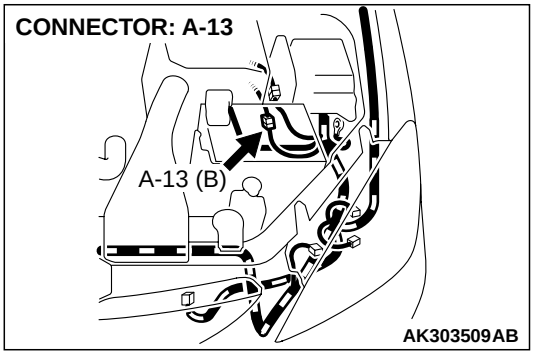
DTC P0657: Throttle Actuator Control Motor Relay Circuit Malfunction

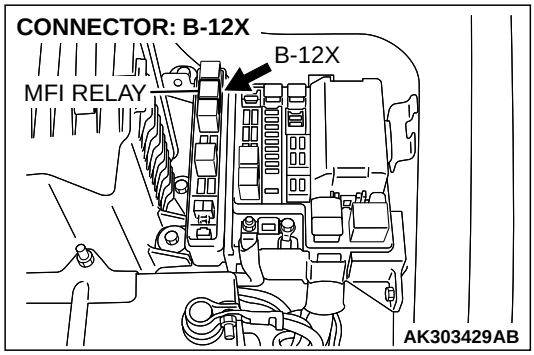
Throttle Actuator Control Motor Relay Circuit

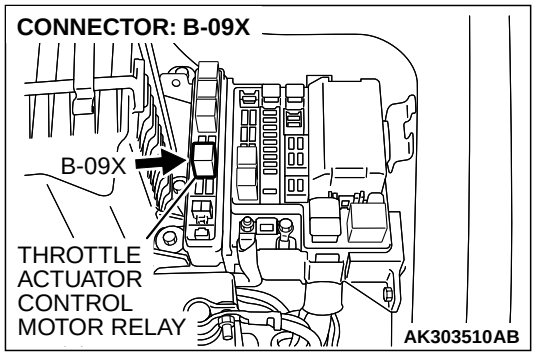


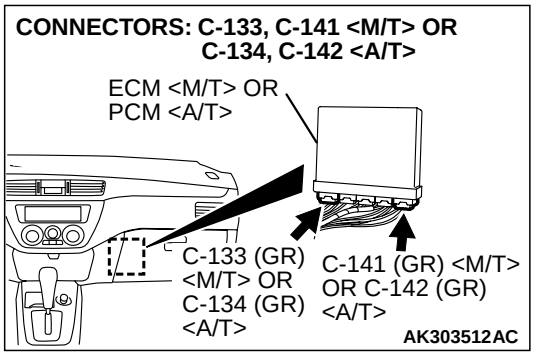
AK303999

TSB Revision









CIRCUIT OPERATION

- Battery positive voltage is applied to the throttle actuator control motor relay terminal (terminal No. 4).
- Battery positive voltage is applied to the throttle actuator control motor relay terminal (terminal No. 3) from the MFI relay (terminal No. 4).
- ECM <M/T> or PCM <A/T> (terminal No. 15) applies current to the throttle actuator control motor relay coil by turning ON the power transistor in the unit in order to turn the relay ON.
- When the throttle actuator control motor relay turns ON, battery positive voltage is supplied by the throttle actuator control motor relay (terminal No. 1) to the ECM <M/T> or PCM <A/T> (terminal No. 132).

TECHNICAL DESCRIPTION

- When the ignition switch ON signal is input into the ECM <M/T> or PCM <A/T>, the ECM <M/T> or PCM <A/T> turns ON the throttle actuator control motor relay.

DESCRIPTIONS OF MONITOR METHODS

Throttle actuator control motor relay circuit voltage is smaller than the specified value.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Check Condition

- Ignition switch is "ON" position.

Judgement Criteria

- The power line voltage of the electronic controlled throttle system should be 4.0 volts or less for 1 second.

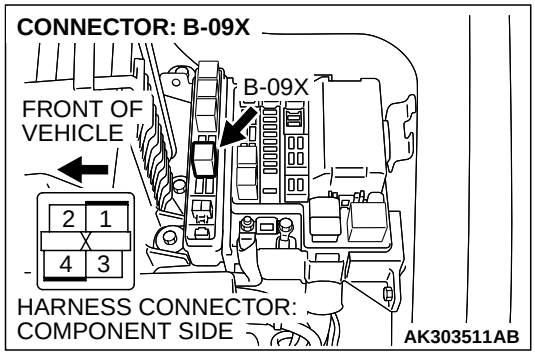
TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Throttle actuator control motor relay failed.
- Open or shorted throttle actuator control motor relay circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

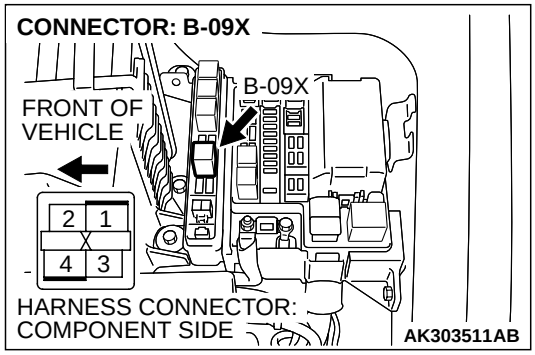


STEP 1. Check connector B-09X at throttle actuator control motor relay for damage.

Q: Is the connector in good condition?

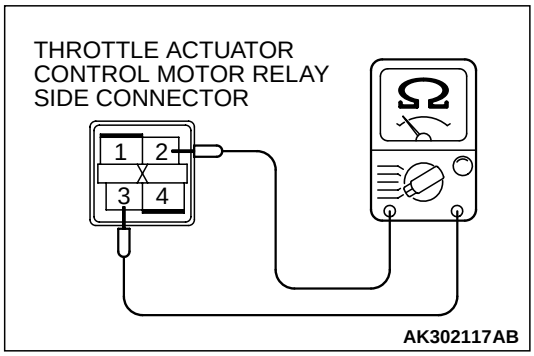
YES : Go to Step 2.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.

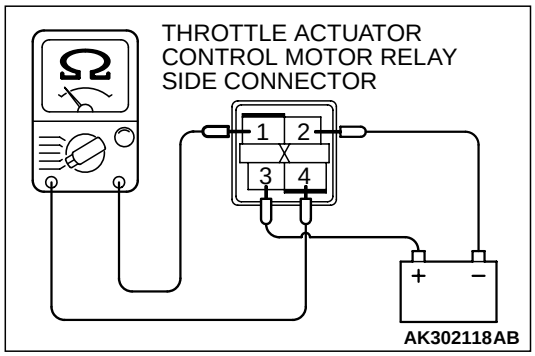


STEP 2. Check the throttle actuator control motor relay.

(1) Remove the throttle actuator control motor relay.



(2) Check for continuity between the throttle actuator control motor relay terminal No. 2 and No. 3.
- There should be continuity (approximately 70 ohms).

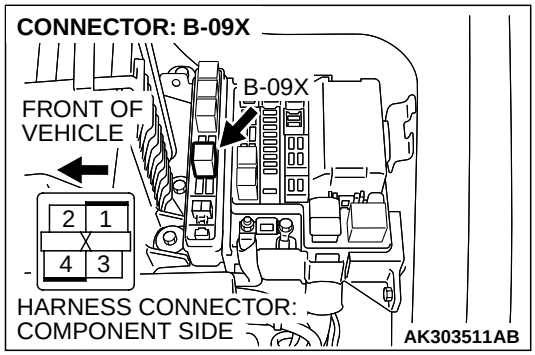


(3) Use jumper wires to connect throttle actuator control motor relay terminal No. 3 to the positive battery terminal and terminal No. 2 to the negative battery terminal.
(4) Check the continuity between the throttle actuator control motor relay terminal No. 1 and No. 4 while connecting and disconnecting the jumper wire at the negative battery terminal.
- Should be less than 2 ohms. (Negative battery terminal connected.)
- Should be open loop. (Negative battery terminal disconnected.)

(5) Install the throttle actuator control motor relay.

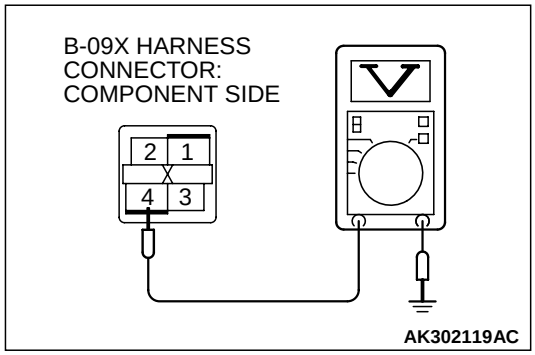
Q: Is the resistance normal?

YES : Go to Step 3.
NO : Replace the throttle actuator control motor relay. Then go to Step 14.



STEP 3. Measure the power supply voltage at throttle actuator control motor relay harness side connector B-09X

(1) Disconnect the connector B-09X and measure at the harness side.



(2) Measure the voltage between terminal No. 4 and ground.
- Voltage should be battery positive voltage.

Q: Is battery positive voltage (approximately 12 volts) present?

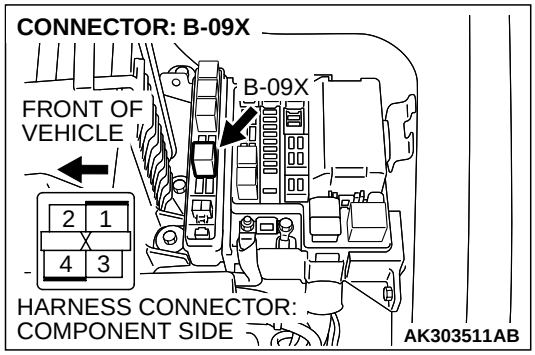
YES : Go to Step 4.

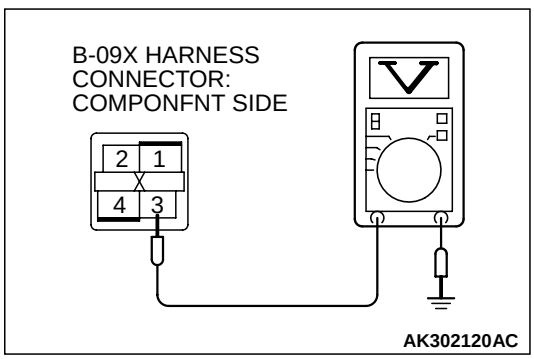
NO : Check harness connector A-13 at intermediate connector for damage, and repair or replace as required. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. If intermediate connector A-13 is in good condition, repair it because of open circuit or short circuit to ground between battery and throttle actuator control motor relay connector B-09X (terminal No. 4). Then go to Step 14.

STEP 4. Measure the power supply voltage at throttle actuator control motor relay harness side connector B-09X.

(1) Disconnect the connector B-09X and measure at the harness side.

(2) Turn the ignition switch to the "ON" position.





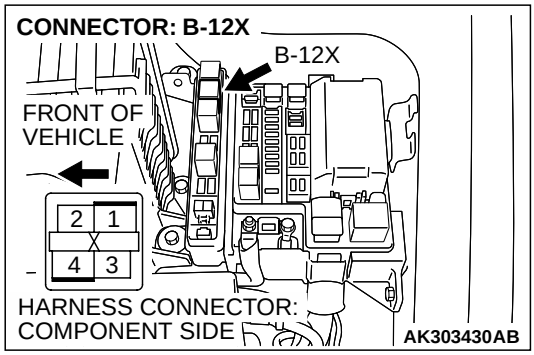
(3) Measure the voltage between terminal No. 3 and ground.
- Voltage should be battery positive voltage.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 6.

NO : Go to Step 5.

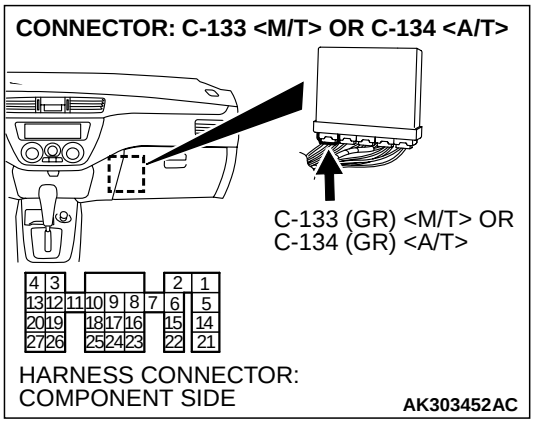


STEP 5. Check connector B-12X at MFI relay for damage.

Q: Is the connector in good condition?

YES : Repair harness wire between MFI relay connector B-12X (terminal No. 4) and throttle actuator control motor relay connector B-09X (terminal No. 3) because of open circuit or short circuit to ground. Then go to Step 14.

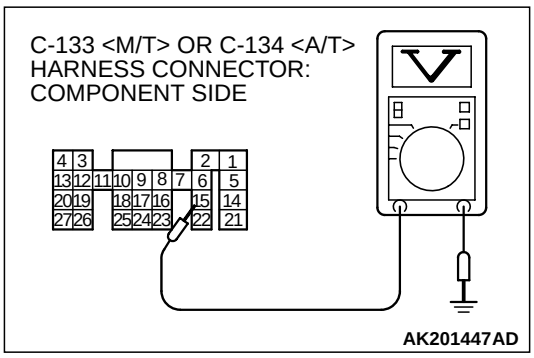
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.



STEP 6. Measure the power supply voltage at ECM harness side connector C-133 <M/T> or PCM harness side connector C-134 <A/T>.

(1) Disconnect the connector C-133 <M/T> or C-134 <A/T> and measure at the harness side.

(2) Turn the ignition switch to the "ON" position.



(3) Measure the voltage between terminal No. 15 and ground.
- Voltage should be battery positive voltage.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

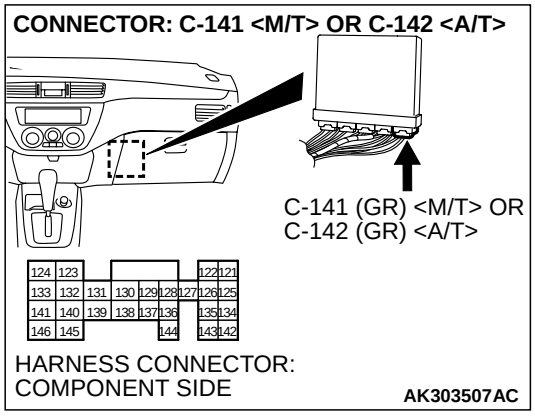
Q: Is battery positive voltage (approximately 12 volts) present?

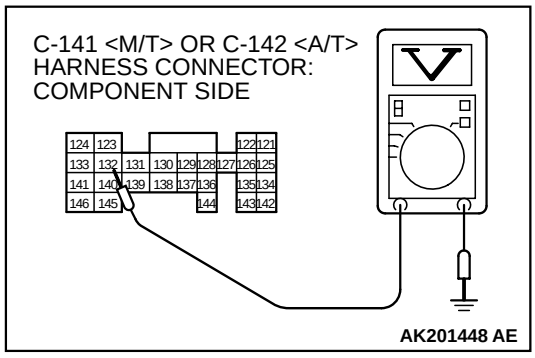
YES : Go to Step 7.

NO : Repair harness wire between throttle actuator control motor relay connector B-09X (terminal No. 2) and ECM connector C-133 <M/T> or PCM connector C-134 <A/T> (terminal No. 15) because of open circuit or short circuit to ground. Then go to Step 14.

STEP 7. Measure the power supply voltage at ECM harness side connector C-141 <M/T> or PCM harness side connector C-142 <A/T>.

(1) Disconnect the connector C-141 <M/T> or C-142 <A/T> and measure at the harness side.
(2) Turn the ignition switch to the "ON" position.





(3) Measure the voltage between terminal No. 132 and ground.
- Voltage should be battery positive voltage.

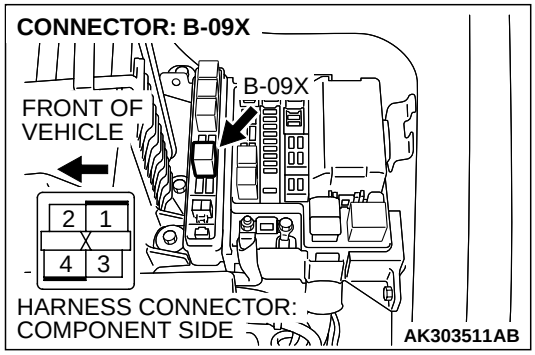
(4) Turn the ignition switch to the "LOCK"(OFF) position.

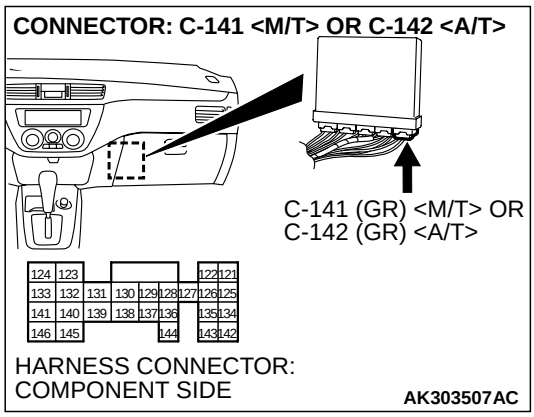
Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 10.
NO : Go to Step 8.

STEP 8. Check for open circuit and short circuit to ground between throttle actuator control motor relay connector B-09X (terminal No. 1) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 132).
Q: Is the harness wire in good condition?

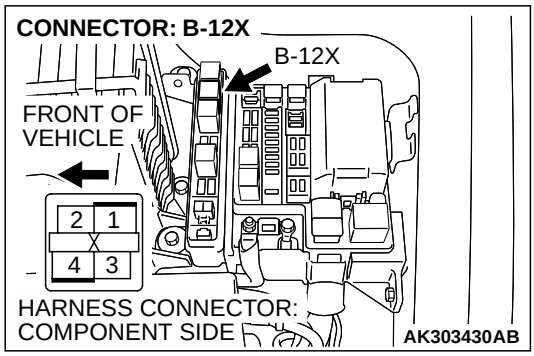
YES : Go to Step 9.
NO : Repair it. Then go to Step 14.

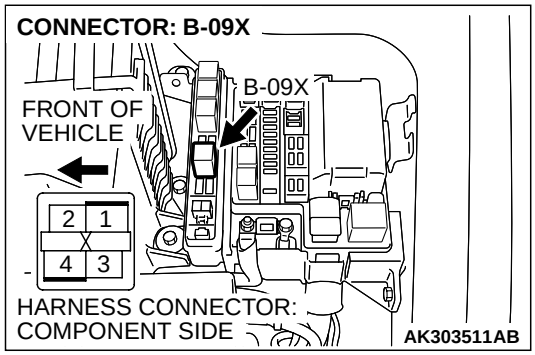




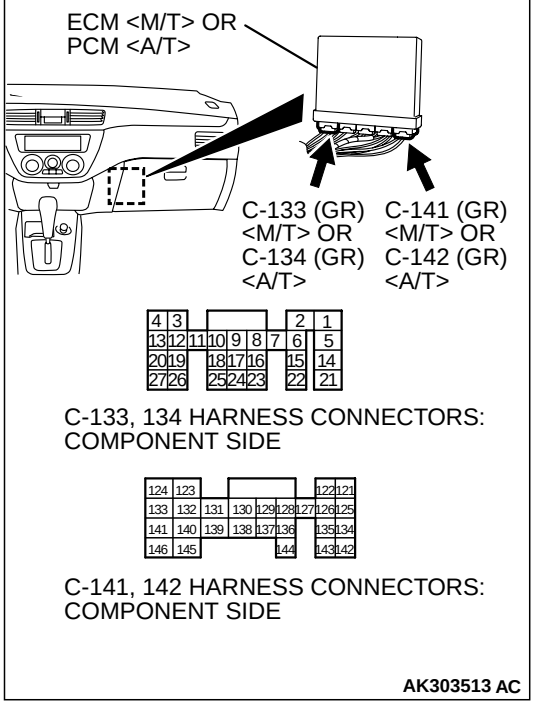
STEP 9. Check for harness damage between MFI relay connector B-12X (terminal No. 4) and throttle actuator control motor relay connector B-09X (terminal No. 3).
Q: Is the harness wire in good condition?

YES : Repair harness wire between throttle actuator control motor relay connector B-09X (terminal No. 2) and ECM connector C-133 <M/T> or PCM connector C-134 <A/T> (terminal No. 15) because of harness damage. Then go to Step 14.
NO : Repair it. Then go to Step 14.





CONNECTORS: C-133, C-141 <M/T> OR C-134, C-142 <A/T>



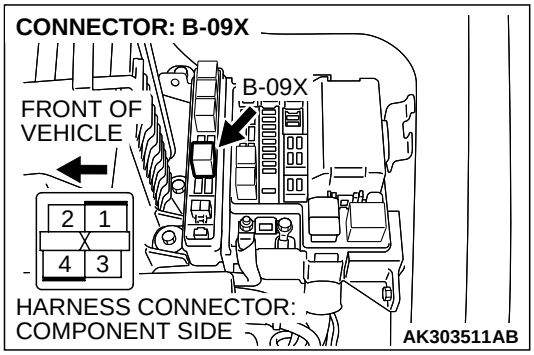
STEP 10. Check harness connector C-133 and C-141 at ECM <M/T> or C-134 and C-142 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 11.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.

CONNECTOR: B-09X



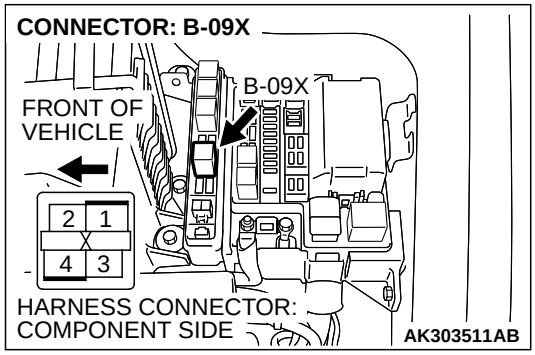
STEP 11. Check for harness damage between battery and throttle actuator control motor relay connector B-09X (terminal No. 4).

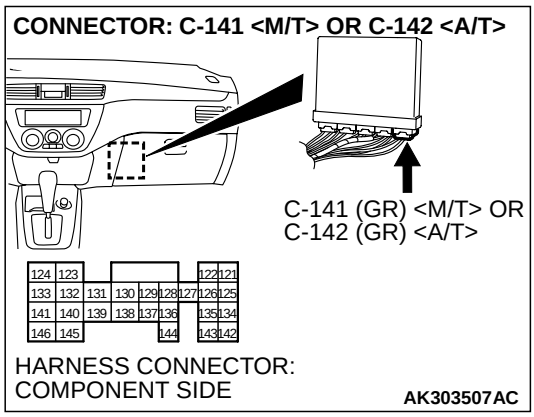
NOTE: Check harness after checking intermediate connector A-13. If intermediate connector is damaged, repair or replace it. refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 14.

Q: Is the harness wire in good condition?

YES : Go to Step 12.

NO : Repair it. Then go to Step 14.



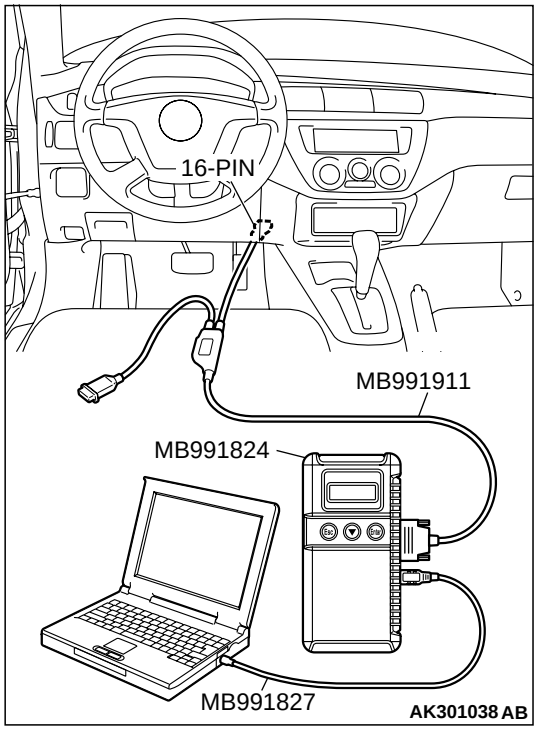


STEP 12. Check for harness damage between throttle actuator control motor relay connector B-09X (terminal No. 1) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 132).

Q: Is the harness wire in good condition?

YES : Go to Step 13.

NO : Repair it. Then go to Step 14.



STEP 13. Using scan tool MB991958, read the diagnostic trouble code (DTC).

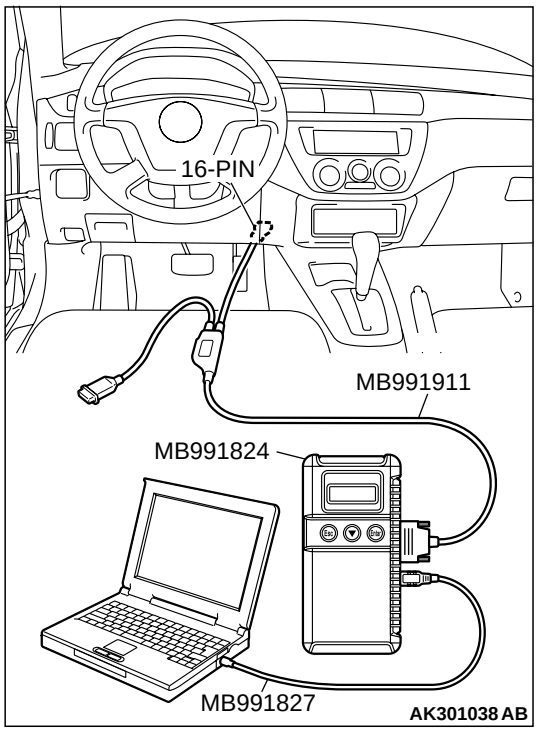
⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P0657 set?

YES : Replace the ECM or PCM. Then go to Step 14.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.



STEP 14. Using scan tool MB991958, read the diagnostic trouble code (DTC).

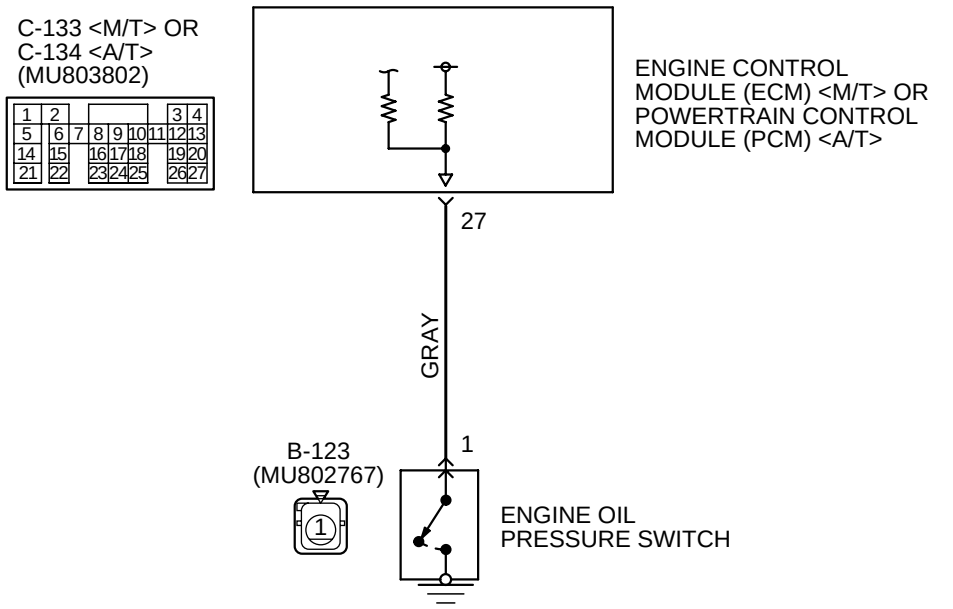
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P0657 set?

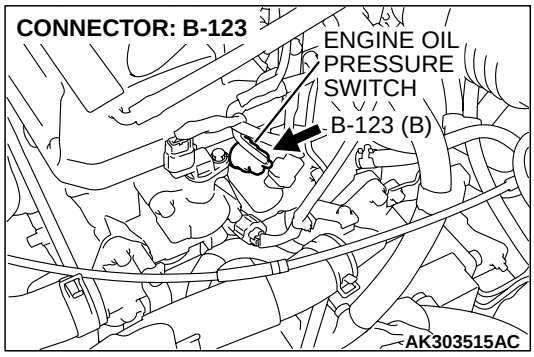
YES : Retry the troubleshooting.
NO : The inspection is complete.

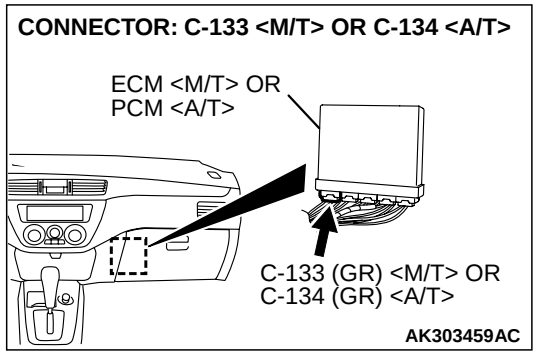
DTC P1020: Mitsubishi Innovative Valve Timing and Lift Electronic Control System (MIVEC) Performance Problem

Engine Oil Pressure Switch Circuit



AK304000





CIRCUIT OPERATION

- A battery positive voltage is applied to the engine oil pressure switch output terminal (terminal No. 1) from the ECM <M/T> or PCM <A/T> (terminal No. 27) via the resistor in the ECM <M/T> or PCM <A/T>.

TECHNICAL DESCRIPTION

- The engine oil pressure switch converts the existence of a engine oil pressure into a high/low voltage, and inputs it into the ECM <M/T> or PCM <A/T>.
- When the engine oil control valve operates, the engine oil pressure in the MIVEC system rises. The engine oil pressure switch opens, thus interrupting the application of the battery positive voltage. As a result, the output voltage of the engine oil pressure switch will fluctuate between 0 and 12 volts.
- The ECM <M/T> or PCM <A/T> checks whether the engine oil pressure switch turns "OFF" or "ON" during driving.

TSB Revision

DTC SET CONDITIONS

Check Conditions

- 30 seconds or more have passed since the engine starting sequence was completed.
- Engine coolant temperature is 77°C (171°F) or higher.
- Battery positive voltage is 10 volts or higher.

Judgment Criteria

- Engine speed is 3,000 r/min or lower and engine oil pressure switch is OFF for 2 seconds.

or

- Engine speed is 4,000 r/min or higher and engine oil pressure switch is ON for 2 seconds.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Engine oil pressure switch failed.
- Engine oil control valve failed.
- Open or shorted engine oil pressure switch circuit, harness damage, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

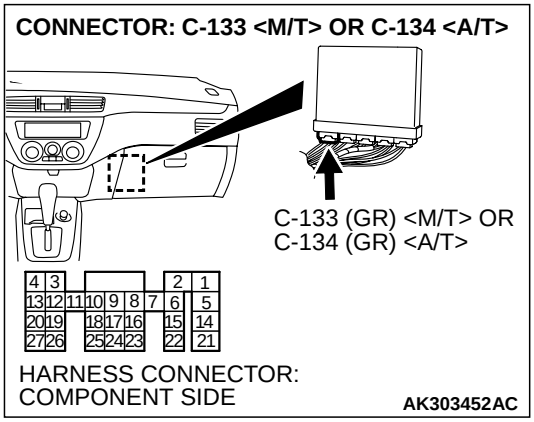
DIAGNOSIS

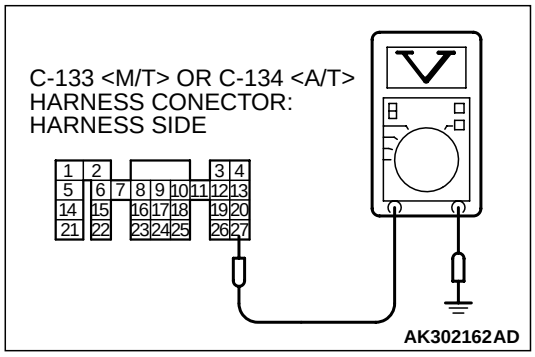
Required Special Tools:

- MB991958: Scan tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Measure the power supply voltage at ECM connector C-133 <M/T> or PCM connector C-134 <A/T> by backprobing.

(1) Do not disconnect the ECM connector C-133 <M/T> or PCM connector C-134 <A/T>.
(2) Start the engine and run at idle.



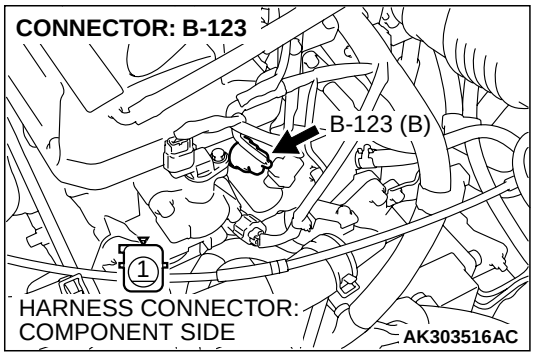


(3) Measure the voltage between terminal No. 27 and ground.
  - Voltage should be 1 volt or less when engine is idling.
  - Voltage should be battery positive voltage when engine speed is higher than 4,000 r/min.
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the measured voltage normal?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

NO : Go to Step 2.

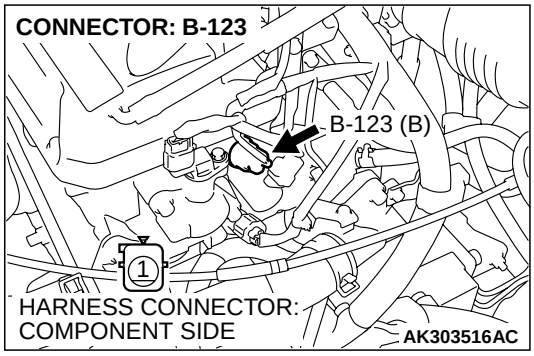


STEP 2. Check harness connector B-123 at engine oil pressure switch for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 3.

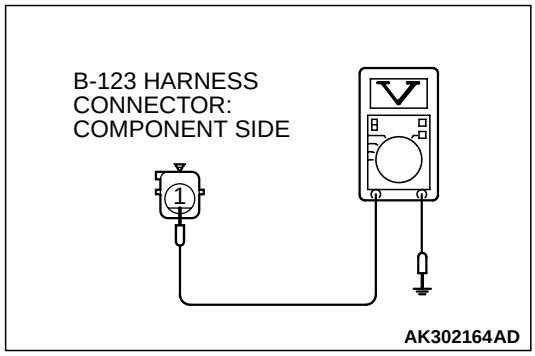
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.



STEP 3. Measure the power supply voltage at engine oil pressure switch connector B-123.

(1) Disconnect the connector B-123 and measure at the harness side.

(2) Turn the ignition switch to the "ON" position.



(3) Measure the voltage between terminal No. 1 and ground.
- Voltage should be battery positive voltage.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the voltage normal?

YES : Go to Step 6.

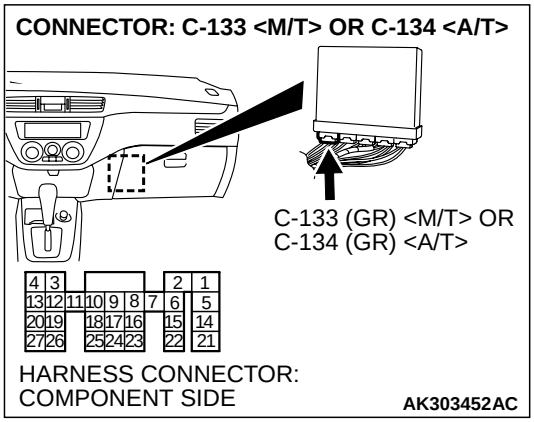
NO : Go to Step 4.

STEP 4. Check harness connector C-133 <M/T> or C-134 <A/T> at PCM for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 5.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.

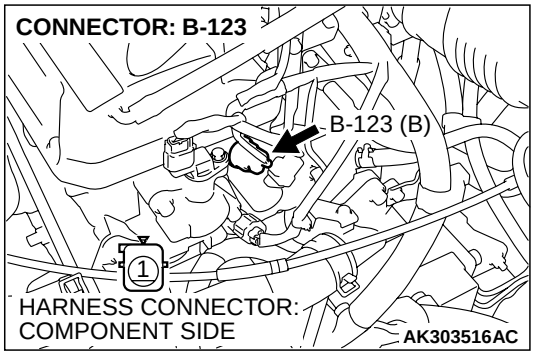


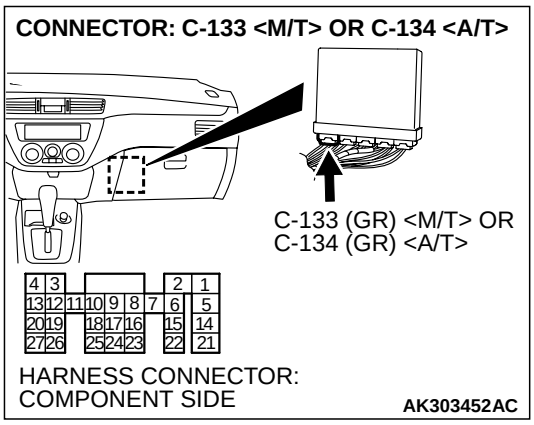
STEP 5. Check for open or shorted circuit to ground between engine oil pressure switch connector B-123 (terminal No. 1) and ECM connector C-133 <M/T> or PCM connector C-134 <A/T> (terminal No. 27).

Q: Is the harness wire in good condition?

YES : Replace the ECM or PCM. Then go to Step 10.

NO : Repair it. Then go to Step 10.



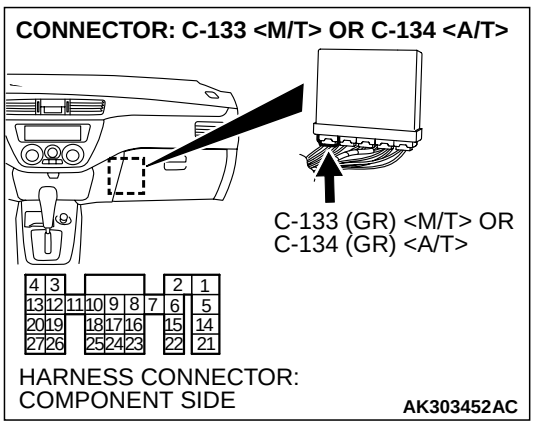


STEP 6. Check harness connector C-133 at ECM <M/T> or C-134 <A/T> at PCM for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 7.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 10.

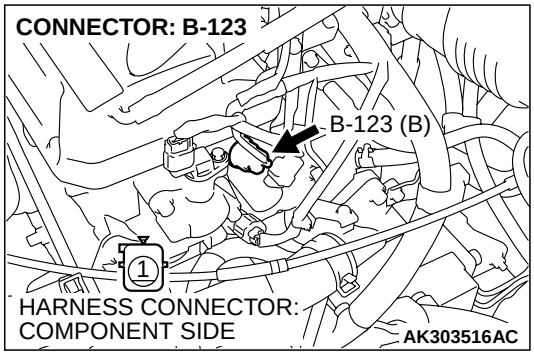


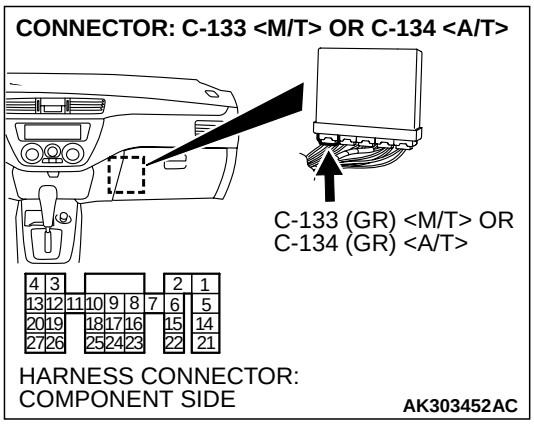
STEP 7. Check for harness damage between engine oil pressure switch connector B-123 (terminal No. 1) and ECM connector C-133 <M/T> or PCM connector C-134 <A/T> (terminal No. 27).

Q: Is the harness wire in good condition?

YES : Go to Step 8.

NO : Repair it. Then go to Step 10.





STEP 8. Using scan tool MB991958, check actuator test item 22: Engine Oil Control Valve.

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

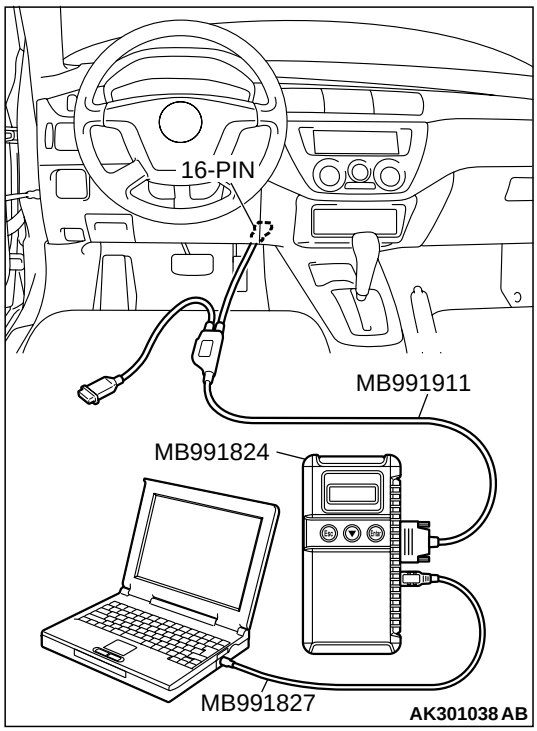
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the actuator test mode for item 22, Engine oil control valve.
- An operation sound should be heard and vibration should be felt when the evaporative emission purge solenoid is operated.

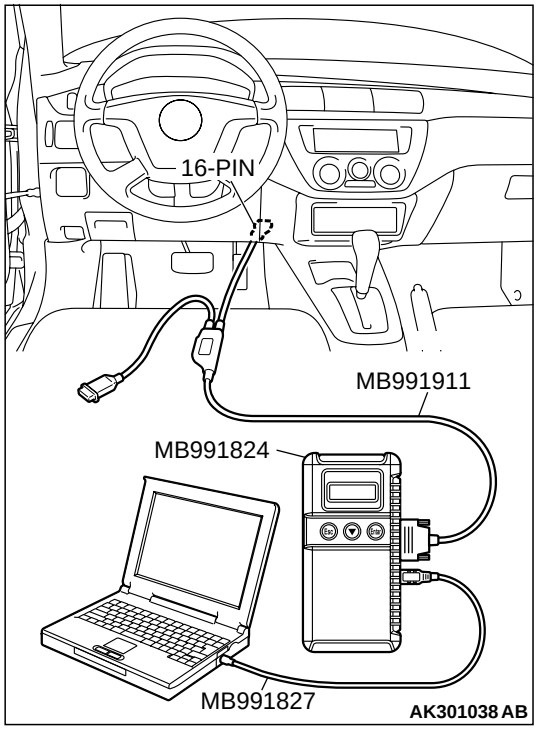
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the engine oil control valve operating properly?

YES : Replace the engine oil pressure switch. Then go to Step 9.

NO : Replace the engine oil control valve. Then go to Step 10.



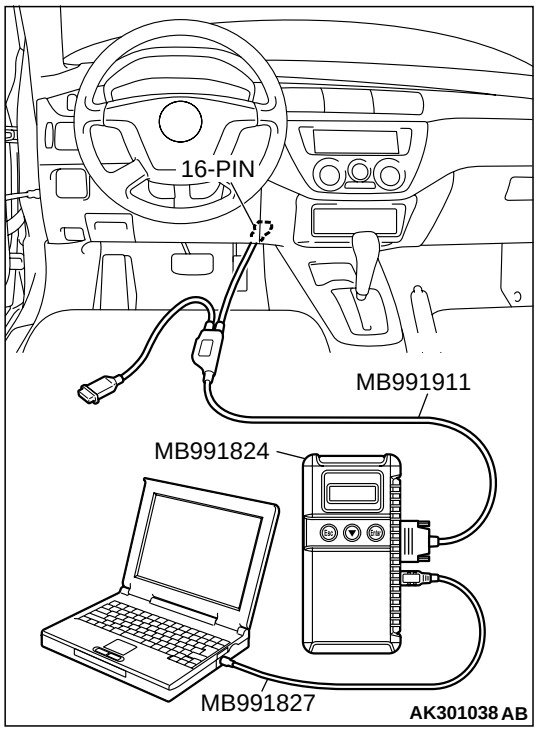


STEP 9. Using scan tool MB991958, read the diagnostic trouble code (DTC).

(1) Turn the ignition switch to the "ON" position.
(2) Erase the DTC.
(3) Warm up the engine until engine coolant temperature reaches 80°C (176°F) or higher.
(4) 30 seconds or more have passed since the engine starting sequence was completed, read the DTC.Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is DTC P1020 set?

YES : Replace the ECM or PCM. Then go to Step 10.
NO : The Inspection is complete.



STEP 10. Using scan tool MB991958, read the diagnostic trouble code (DTC).

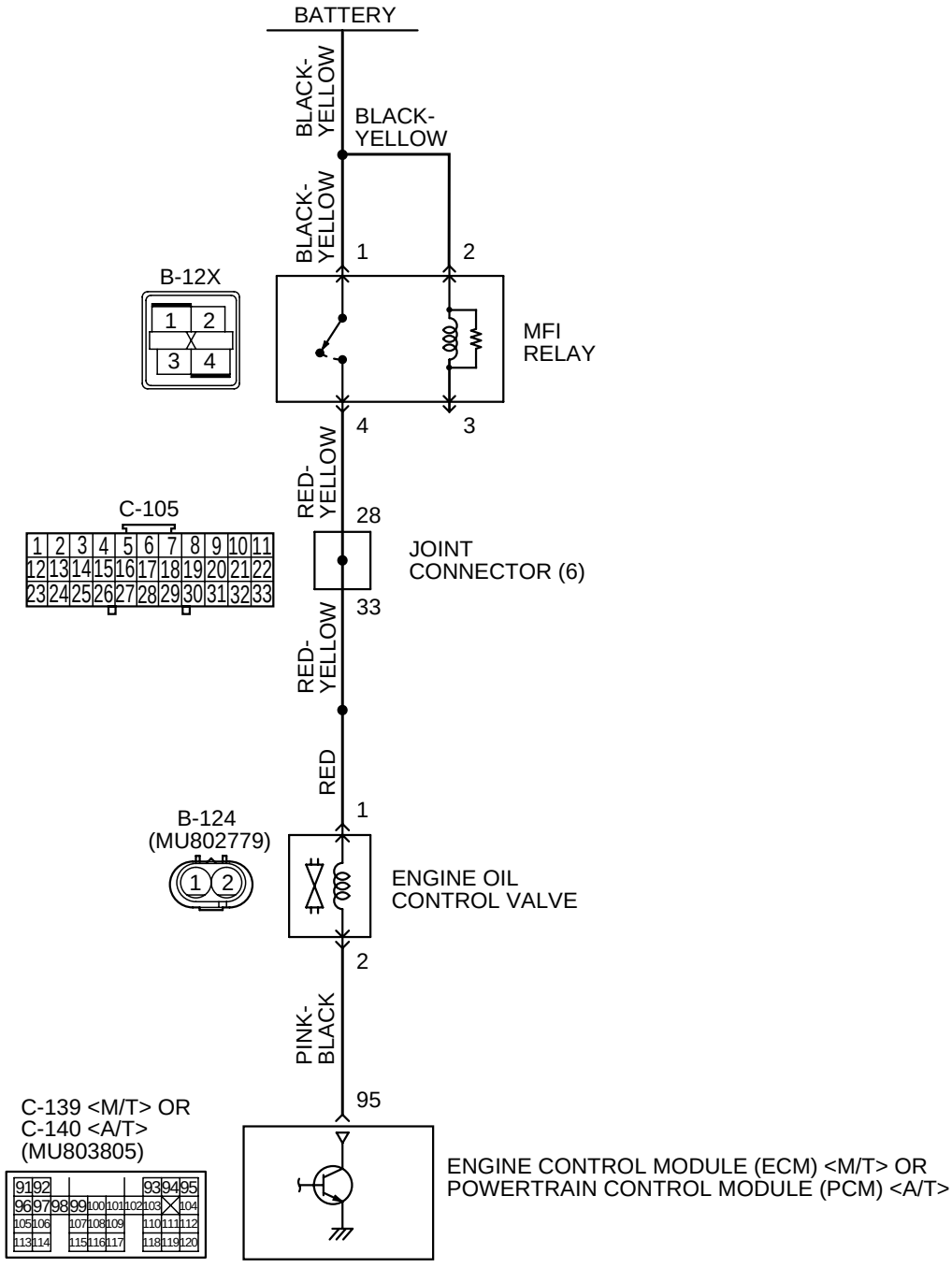
(1) Turn the ignition switch to the "ON" position.
(2) Erase the DTC.
(3) Warm up the engine until engine coolant temperature reaches 80°C (176°F) or higher.
(4) 30 seconds or more have passed since the engine starting sequence was completed, read the DTC.Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is DTC P1020 set?

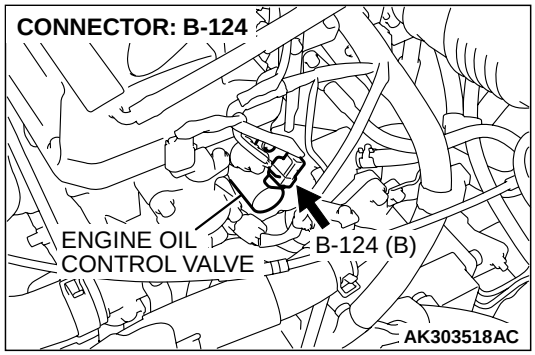
YES : Retry the trouble shooting.
NO : The Inspection is complete.

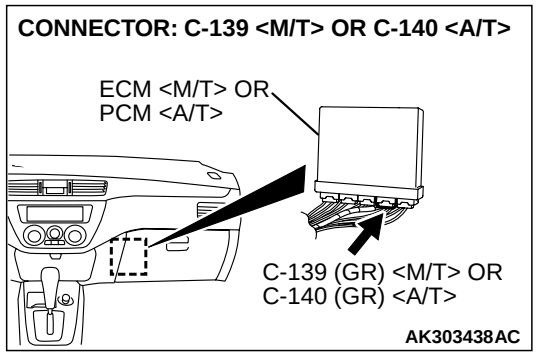
DTC P1021: Engine Oil Control Valve Circuit

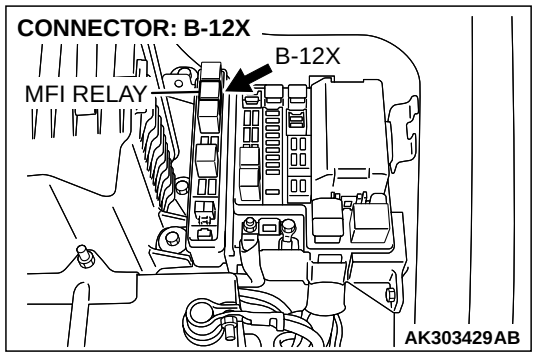
Engine Oil Control Valve Circuit

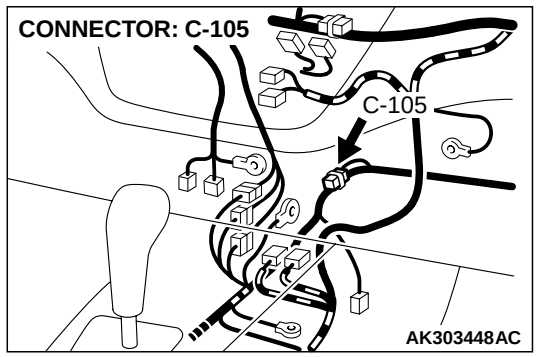


AK304001









CIRCUIT OPERATION

- The engine oil control valve power is supplied from the MFI relay (terminal No. 4).
- The ECM <M/T> or PCM <A/T> controls ground engine oil control valve by turning the power transistor in the ECM <M/T> or PCM <A/T> "ON" and "OFF".

TECHNICAL DESCRIPTION

- The engine oil control valve switches the cams to operate the MIVEC system in the low-speed or high-speed mode in accordance with the signals from the ECM <M/T> or PCM <A/T>.

DTC SET CONDITIONS

Check Conditions

- Ignition switch: ON
- Battery positive voltage is higher than 10 volts.
- MIVEC operating in the low-speed mode.

Judgment Criteria

- The ECM <M/T> or PCM <A/T> terminal voltage of engine control valve circuit is less than 1.5 volts.

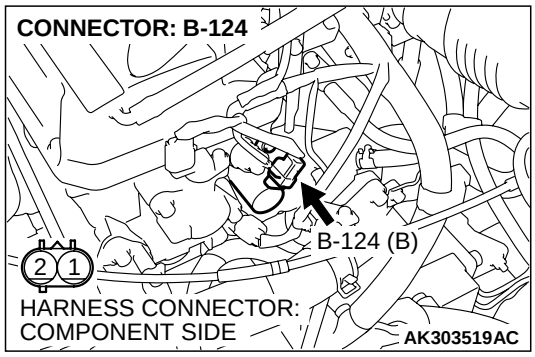
TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Engine oil control valve failed.
- Open or shorted engine oil control valve circuit, or harness damage, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

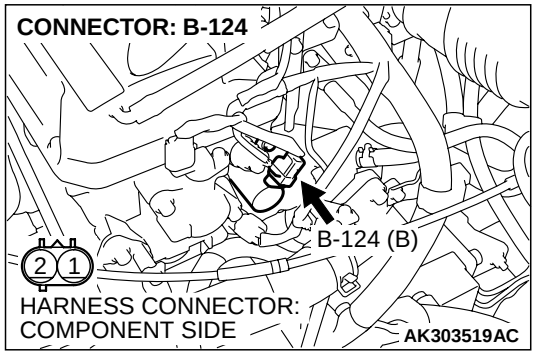


STEP 1. Check harness connector B-124 at the engine oil control valve for damage.

Q: Is the harness connector in good condition?

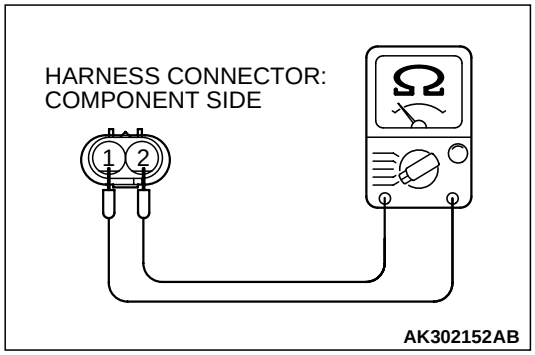
YES : Go to Step 2.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.



STEP 2. Check the engine oil control valve.

(1) Disconnect the engine oil control valve connector B-124.



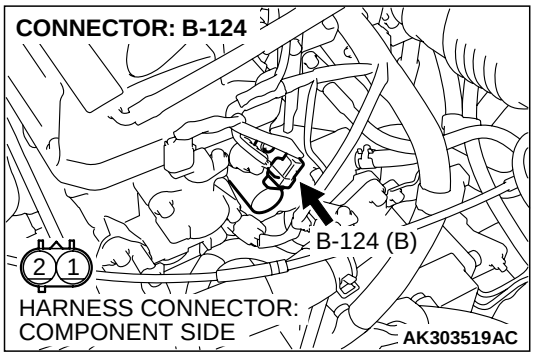
(2) Measure the resistance between engine oil control valve side connector terminal No. 1 and No. 2.

Standard value: 6.9 – 7.9 ohms [at 20°C (68°F)]

Q: Is the measured resistance between 6.9 and 7.9 ohms [at 20°C (68°F)]?

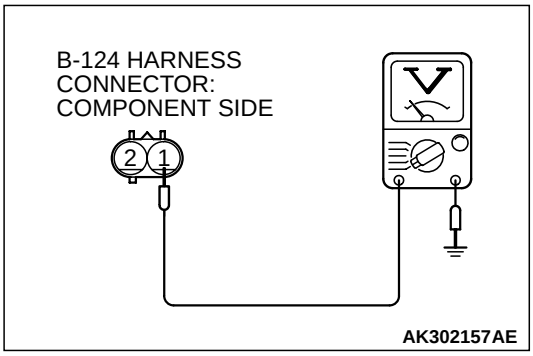
YES : Go to Step 3.

NO : Replace the engine oil control valve. Then go to Step 12.



STEP 3. Measure the power supply voltage at engine oil control valve harness side connector B-124.

(1) Disconnect the connector B-124 and measure at the harness side.
(2) Turn the ignition switch to the "ON" position.

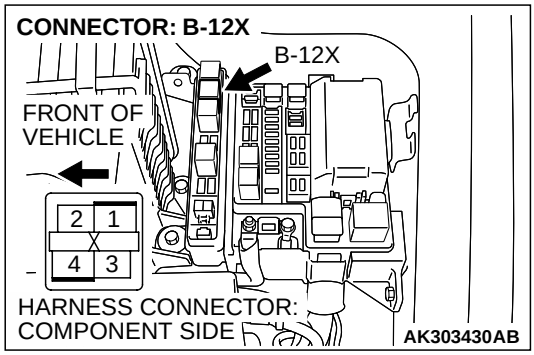


(3) Measure the voltage between terminal No. 1 and ground.
- Voltage should be battery positive voltage.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 5.
NO : Go to Step 4.



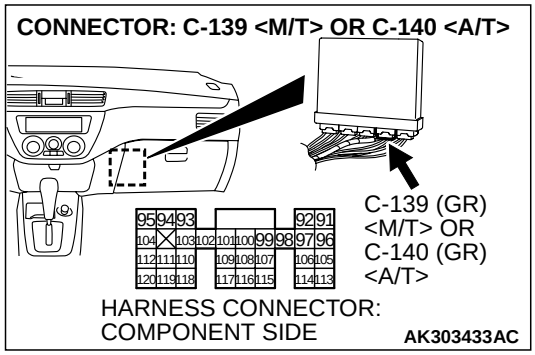
STEP 4. Check harness connector B-12X at MFI relay for damage.

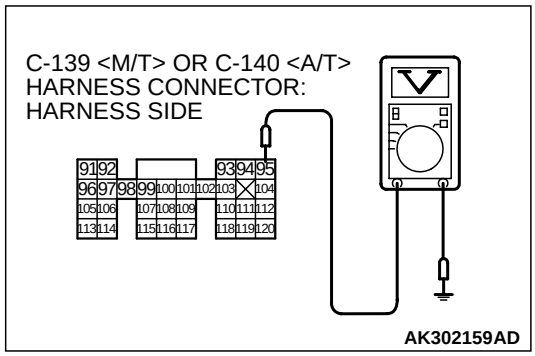
Q: Is the harness connector in good condition?

YES : Check harness connector C-105 at intermediate connector for damage, and repair or replace as required. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. If intermediate connector is in good condition, repair harness wire between MFI relay connector B-12X (terminal No. 4) and engine oil control valve connector B-124 (terminal No. 1) because of open circuit or short circuit to ground. Then go to Step 12.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.

STEP 5. Measure the power supply voltage at ECM connector C-139 <M/T> or PCM connector C-140 <A/T> by backprobing.

(1) Do not disconnect the connector C-139 <M/T> or C-140 <A/T>.
(2) Turn the ignition switch to the "ON" position.





(3) Measure the voltage between terminal No. 95 and ground by backprobing.
- Voltage should be battery positive voltage.

(4) Turn the ignition switch to the "LOCK" (OFF) position.

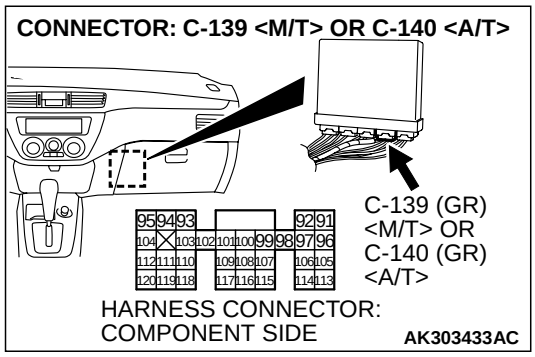
Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 8.
NO : Go to Step 6.

STEP 6. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 7.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.

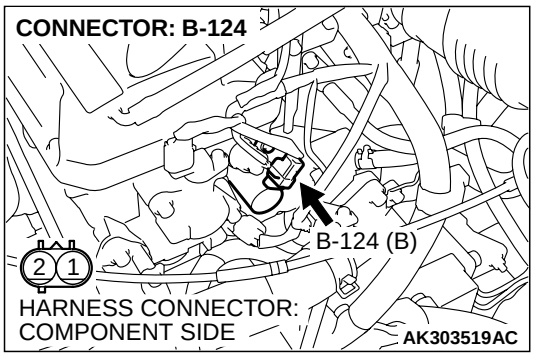


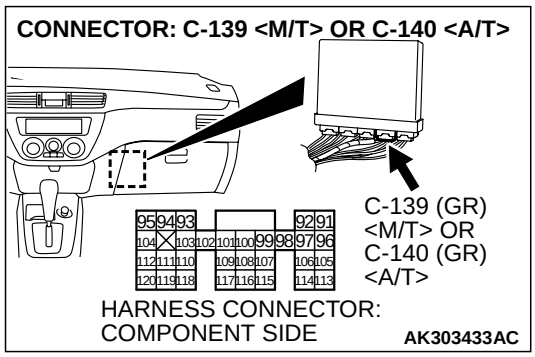
STEP 7. Check for open circuit and short circuit to ground between engine oil control valve connector B-124 (terminal No. 2) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 95).

Q: Is the harness wire in good condition?

YES : Replace the ECM or PCM. Then go to Step 12.

NO : Repair it. Then go to Step 12.



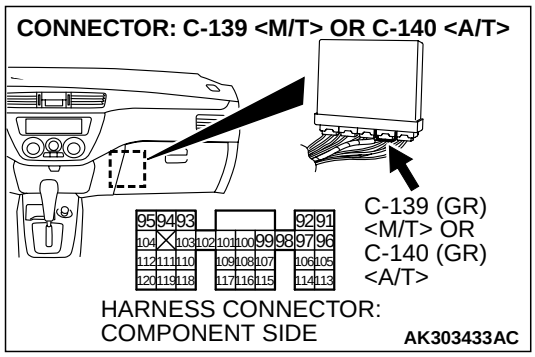


STEP 8. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 9.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.

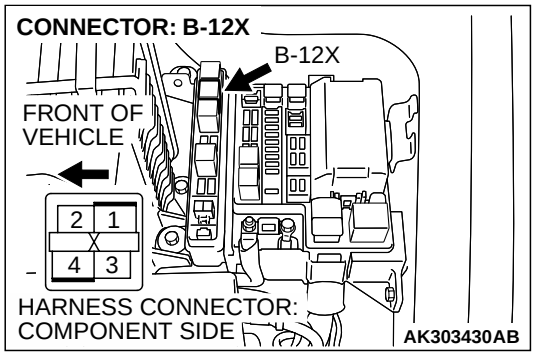


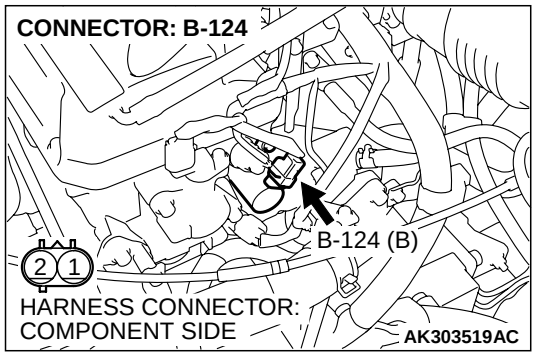
STEP 9. Check for harness damage between MFI relay connector B-12X (terminal No. 4) and engine oil control valve connector B-124 (terminal No. 1).

Q: Is the harness wire in good condition?

YES : Go to Step 10.

NO : Repair it. Then go to Step 12.



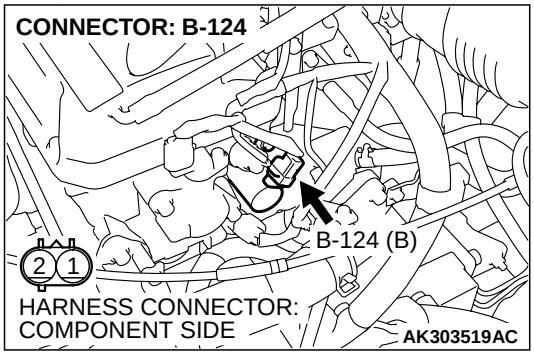


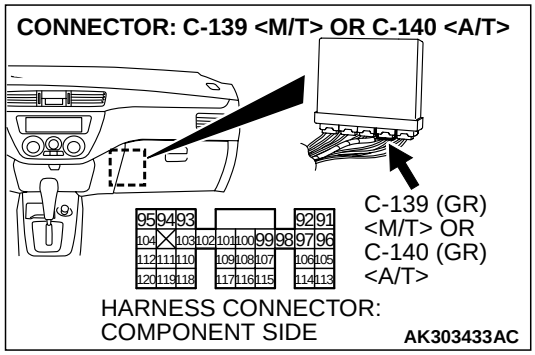
STEP 10. Check for harness damage between engine oil control valve connector B-124 (terminal No. 2) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 95).

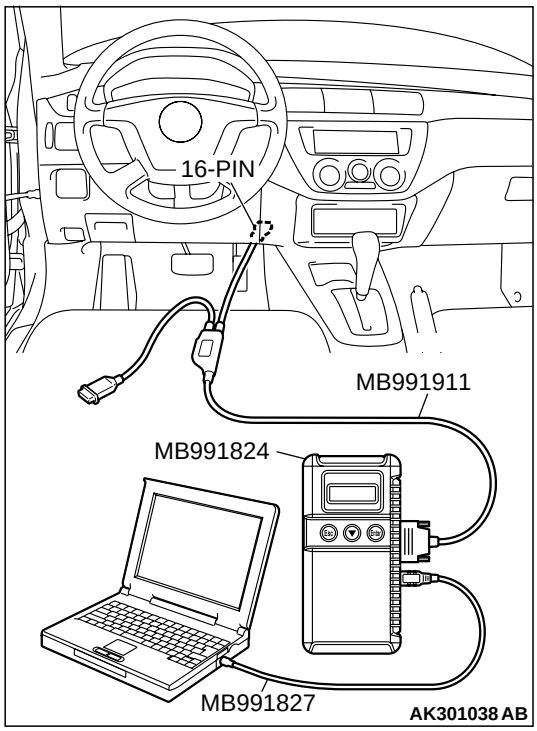
Q: Is the harness wire in good condition?

YES : Go to Step 11.

NO : Repair it. Then go to Step 12.







STEP 11. Using scan tool MB991958, read the diagnostic trouble code (DTC).

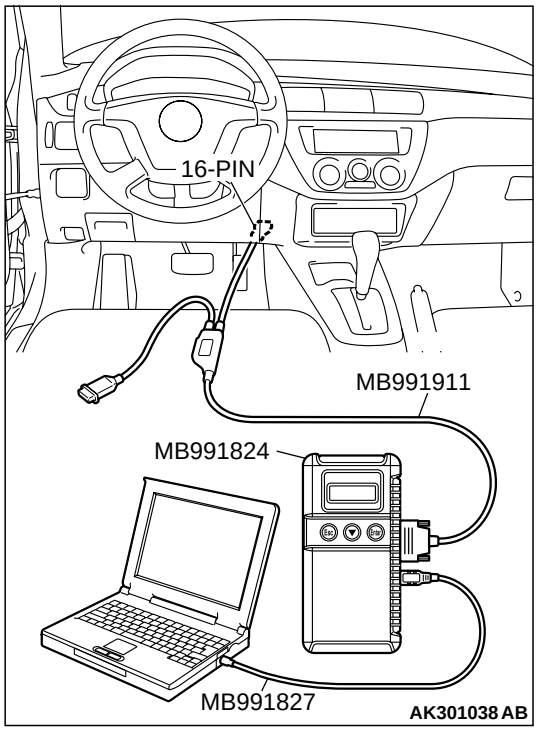
⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P1021 set?

YES : Replace the ECM or PCM. Then go to Step 12.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.



STEP 12. Using scan tool MB991958, read the diagnostic trouble code (DTC).

(1) Turn the ignition switch to the "ON" position.
(2) After the DTC has been deleted, read the DTC again.
(3) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P1021 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P1602: Communication Malfunction (between ECM <M/T> or PCM <A/T> Main Processor and System LSI)

TECHNICAL DESCRIPTION
- ECM <M/T> or PCM <A/T> checks the communication status for abnormal conditions.

DESCRIPTIONS OF MONITOR METHODS
Communication between ECM <M/T> or PCM <A/T> main processor and system LSI is impossible.

MONITOR EXECUTION
Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)
- Not applicable

Sensor (The sensor below is determined to be normal)
- Not applicable

DTC SET CONDITIONS

Check Conditions
- Ignition switch is "ON" position.

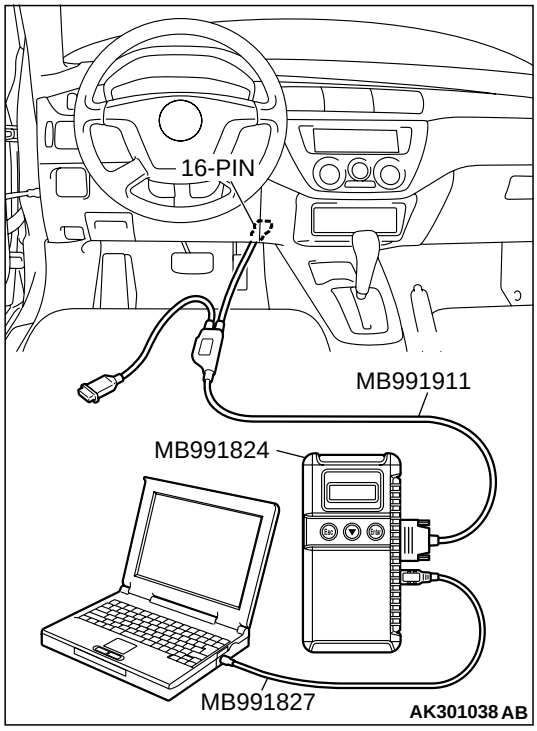
Judgement Criteria
- ECM <M/T> or PCM <A/T> detects an error in communication between ECM <M/T> or PCM <A/T> main processor and system LSI for 0.07 second.

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B



STEP 1. Using scan tool MB991958, read the diagnostic trouble code (DTC)

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

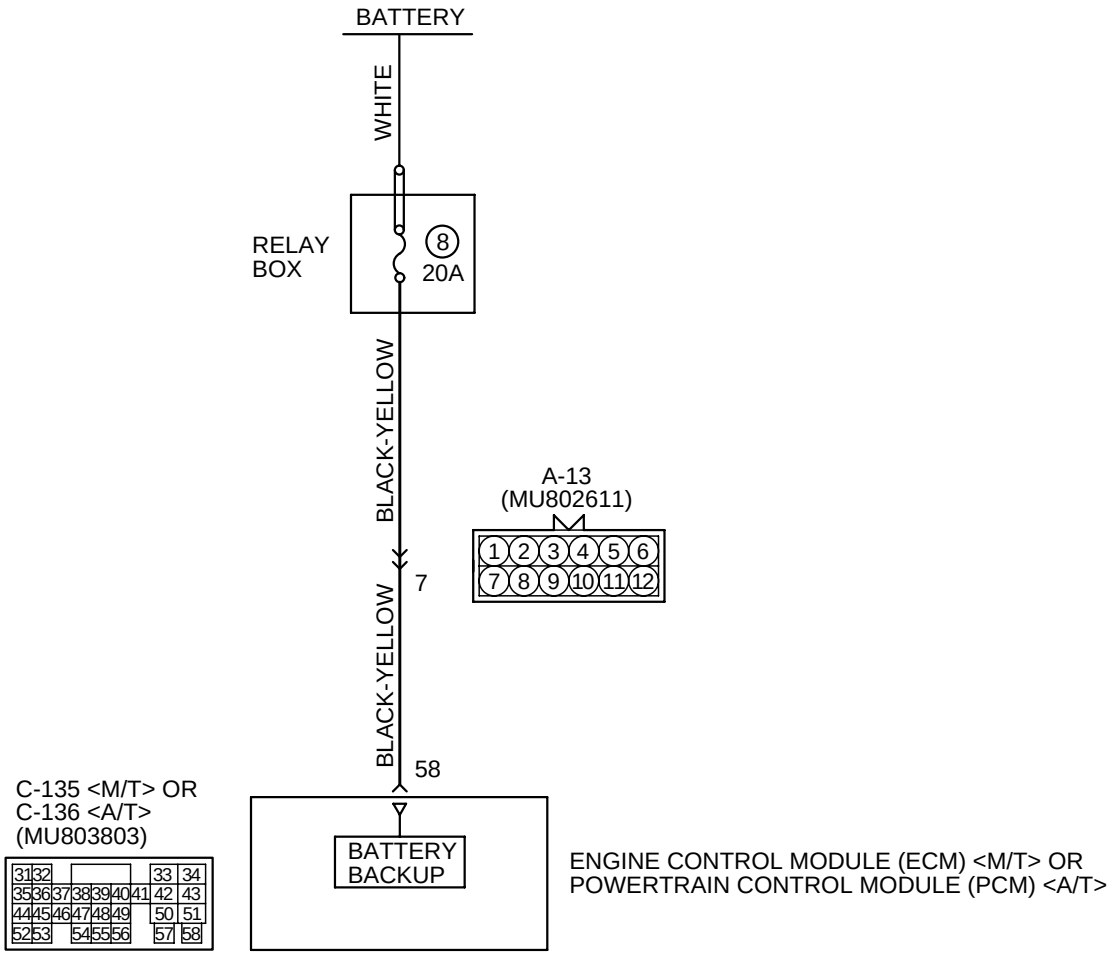
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P01602 set?

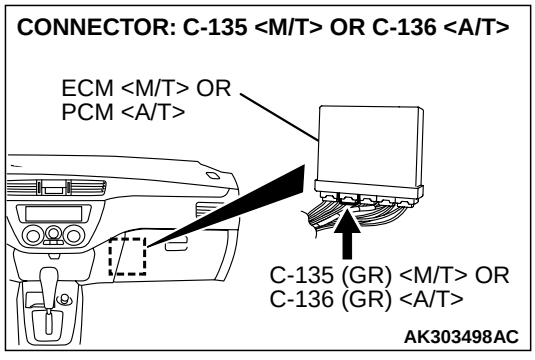
YES : Replace the ECM or PCM.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

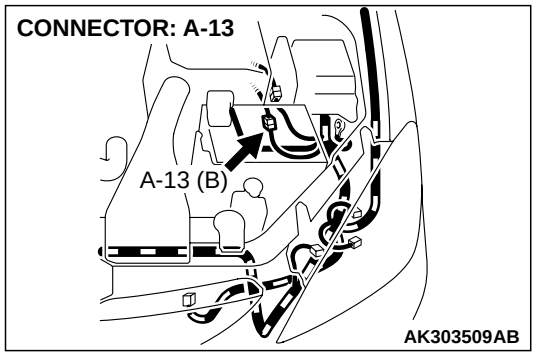
DTC P1603: Battery Backup Line Malfunction

Battery Backup Circuit



AK304002





TECHNICAL DESCRIPTION

- The ECM <M/T> or PCM <A/T> checks the open circuit of battery backup line.

NOTE: When the system detects an open circuit in the battery backup line, it makes 1 failure judgment of other diagnostic trouble codes (DTCs).

TSB Revision

DESCRIPTIONS OF MONITOR METHODS
Battery backup line voltage is under specified value.

MONITOR EXECUTION
Continuous

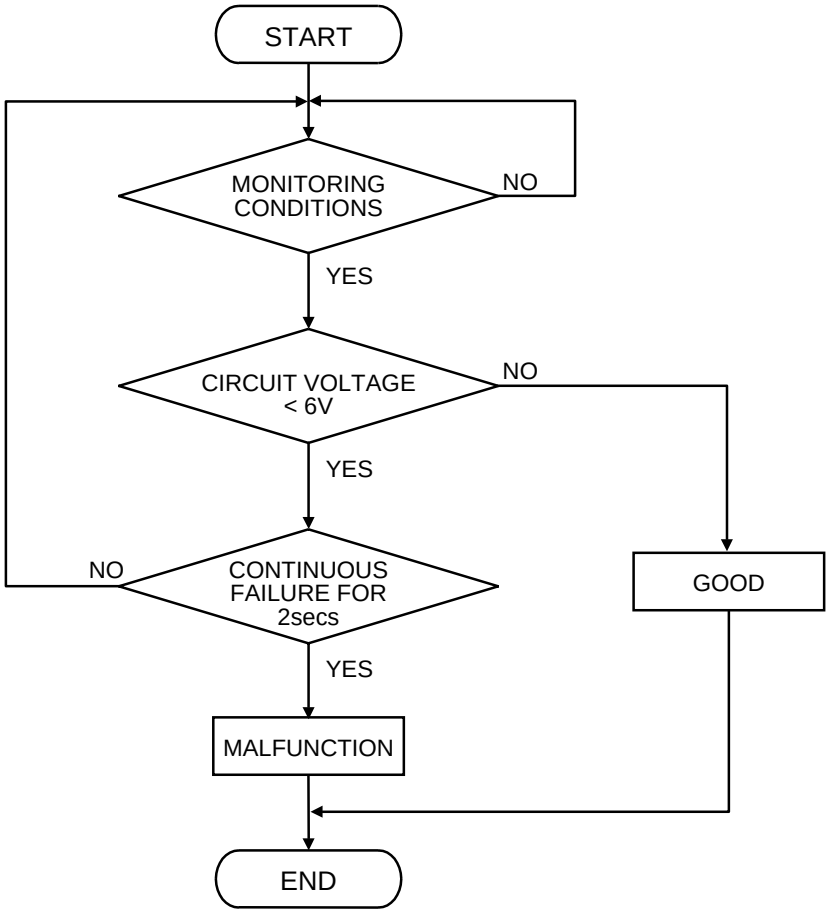
MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)
- Not applicable

Sensor (The sensor below is determined to be normal)
- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302042

Check Conditions
- Engine starting sequence was completed.
- Battery positive voltage is higher than 10 volts.

Judgement Criteria
- Battery backup line voltage is lower than 6 volts for 2 seconds.

OBD-II DRIVE CYCLE PATTERN
None.

TSB Revision

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Open or shorted battery backup line, harness damage or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, read the diagnostic trouble code (DTC).

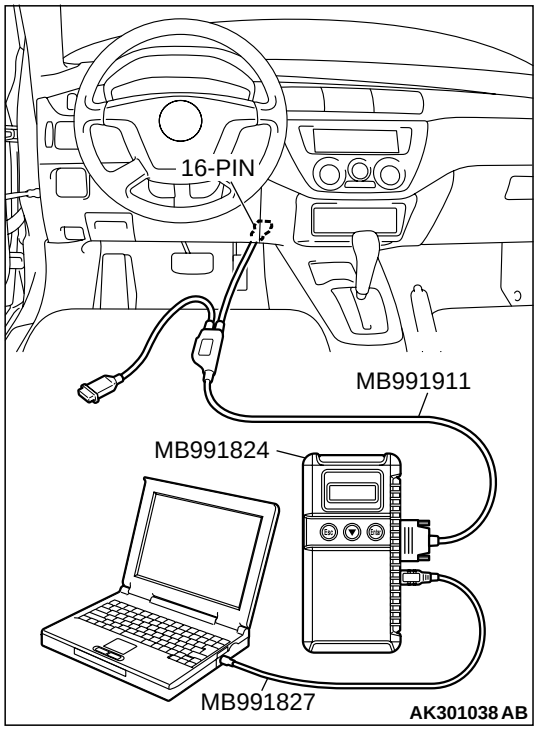
⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Erase the DTC.
(4) Start the engine and run it at idle.
(5) Read the DTC.
(6) Turn the ignition switch to the "LOCK" (OFF) position.

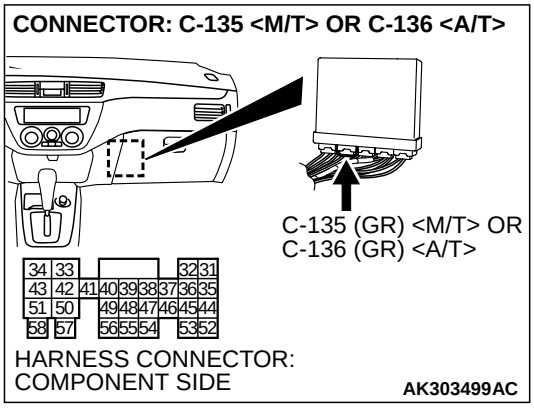
Q: Is DTC P1603 set?

YES : Go to Step 2.
NO : The inspection is complete.

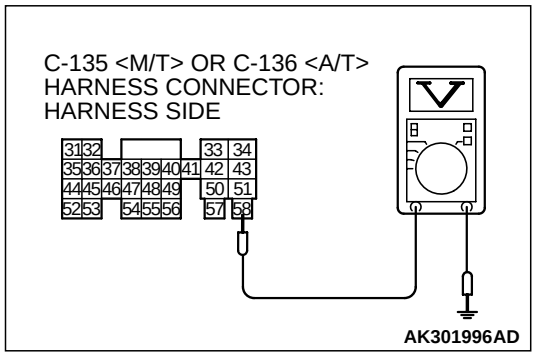


STEP 2. Measure the backup power supply voltage at ECM connector C-135 <M/T> or PCM connector C-136 <A/T> by backprobing.

(1) Do not disconnect the ECM connector C-135 <M/T> or PCM connector C-136 <A/T>.



(2) Measure the voltage between terminal No. 58 and ground by backprobing.
- Voltage should be battery positive voltage.

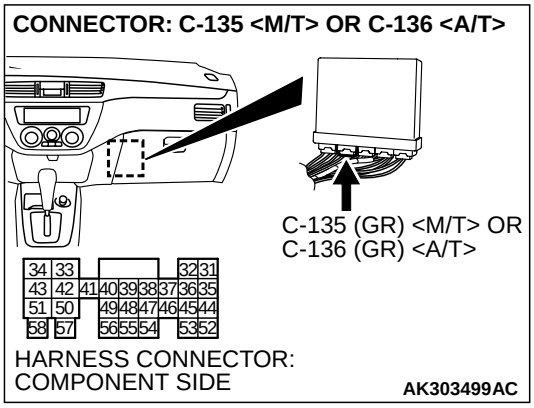


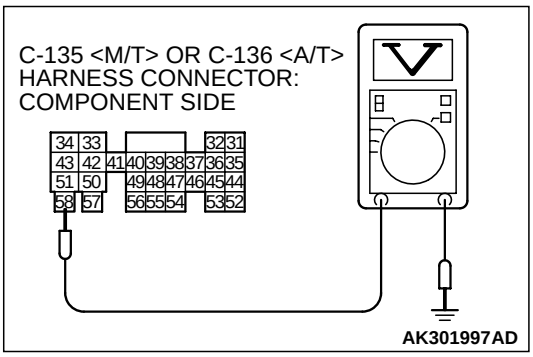
Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 5.
NO : Go to Step 3.

STEP 3. Measure the backup power supply voltage at ECM harness side connector C-135 <M/T> or PCM harness side connector C-136 <A/T>.

(1) Disconnect the ECM connector C-135 <M/T> or PCM connector C-136 <A/T> and measure at the harness side.





(2) Measure the voltage between terminal No. 58 and ground.
- Voltage should be battery positive voltage.

Q: Is battery positive voltage (approximately 12 volts) present?

YES : Go to Step 4.

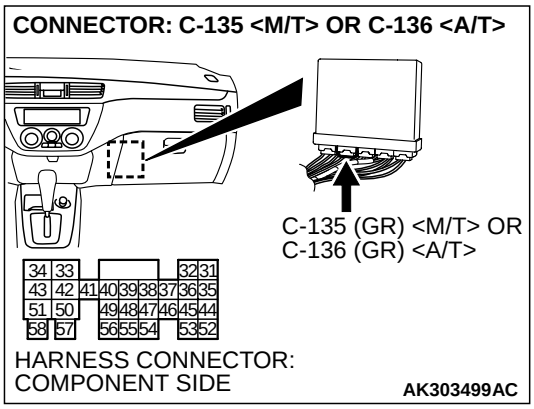
NO : Check connector A-13 at intermediate connector for damage, and repair or replace as required. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. If intermediate connector is in good condition, repair harness wire between battery and ECM connector C-135 <M/T> or PCM connector C-136 <A/T> (terminal No. 58) because of open circuit or short circuit to ground. Then go to Step 6.

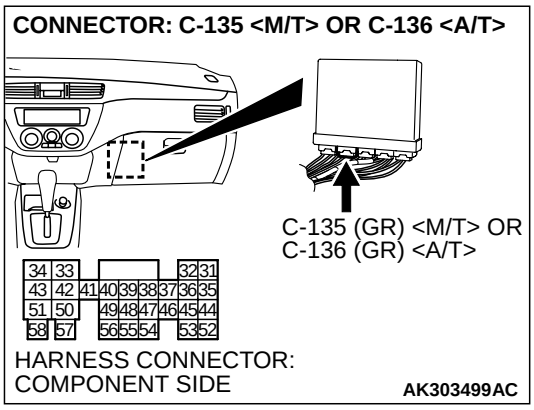
STEP 4. Check harness connector C-135 at ECM <M/T> or C-136 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Check harness connector A-13 at intermediate connector for damage, and repair or replace as required. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. If intermediate connector is in good condition, repair harness wire between battery and ECM connector C-135 <M/T> or PCM connector C-136 <A/T> (terminal No. 58) because of harness damage. Then go to Step 6.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 6.



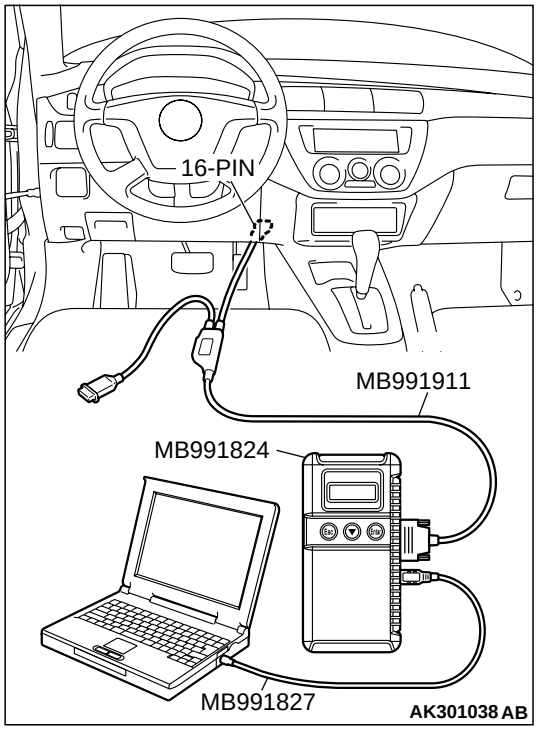


STEP 5. Check harness connector C-135 at ECM <M/T> or C-136 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Replace the ECM or PCM. Then go to Step 6.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 6.



STEP 6. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Read the DTC.
(4) Turn the ignition switch to the "LOCK" (OFF) position.

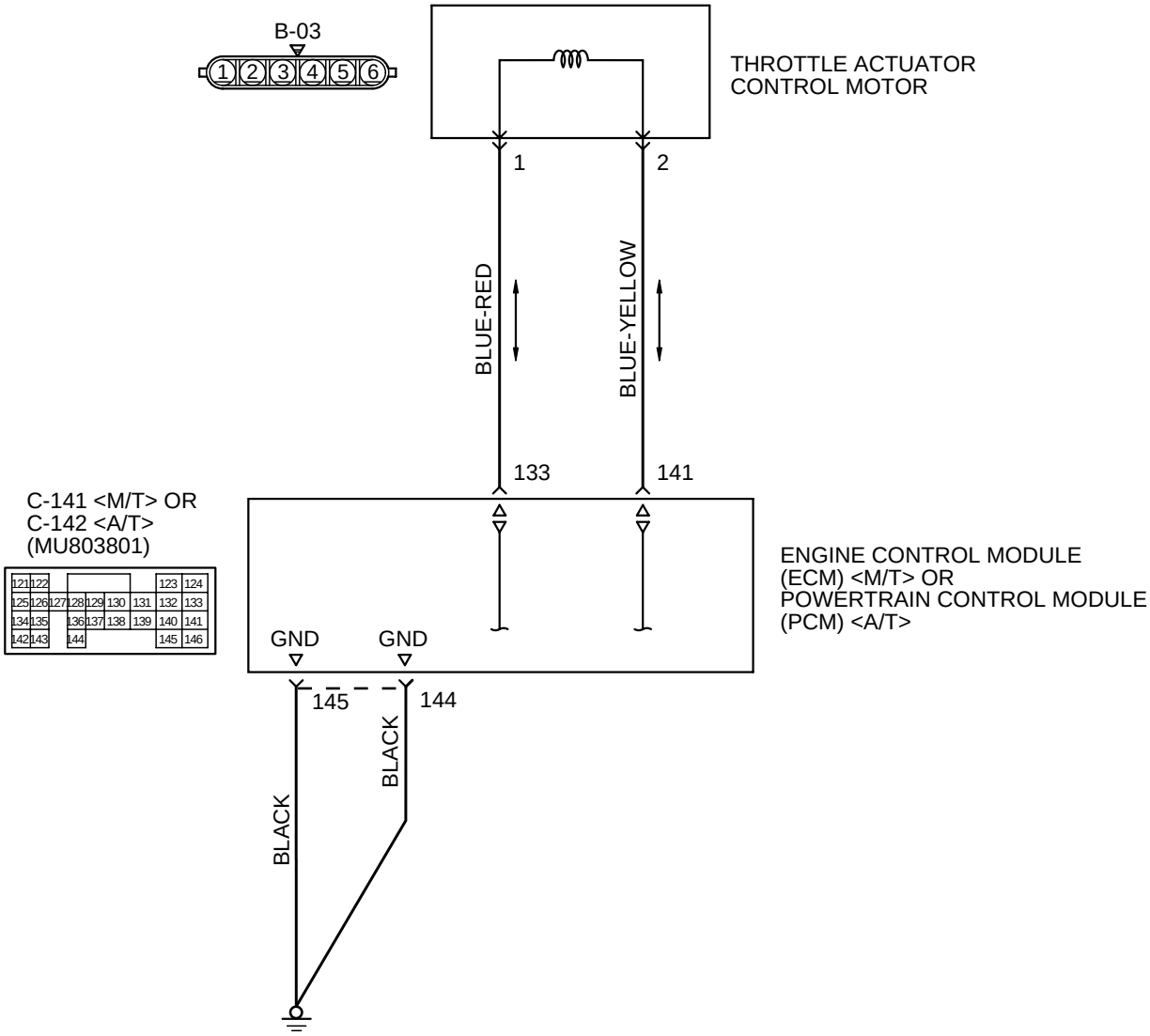
Q: Is DTC P1603 set?

YES : Retry the troubleshooting.

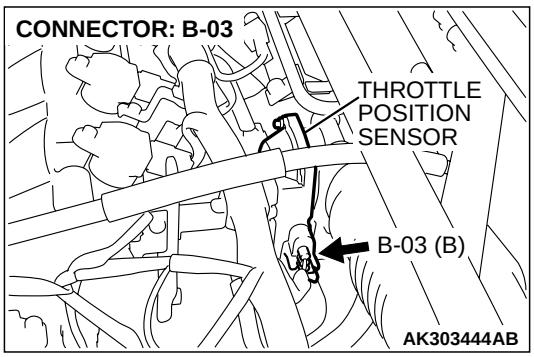
NO : The inspection is complete.

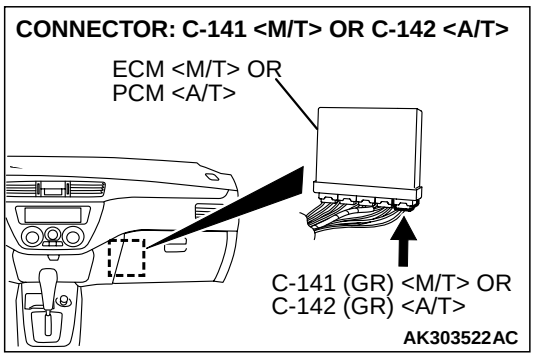
DTC P2100: Throttle Actuator Control Motor Circuit (open)

Throttle Actuator Control Motor Circuit



AK304003





TSB Revision

CIRCUIT OPERATION
- Controls the current that is applied from the ECM <M/T> or PCM <A/T> (terminals No. 141, No. 133) to the throttle actuator control motor (terminals No. 1, No. 2).

TECHNICAL DESCRIPTION
- ECM <M/T> or PCM <A/T> varies the direction and the amperage of the current that is applied to the throttle actuator control motor in order to control the opening of the throttle valve.

DESCRIPTIONS OF MONITOR METHODS
Motor circuit current is smaller than the specified value.

MONITOR EXECUTION
Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)
- Not applicable

Sensor (The sensor below is determined to be normal)
- Not applicable

DTC SET CONDITIONS

Check Condition
- Battery positive voltage is higher than 8.3 volts.

Judgement Criteria
- Throttle actuator control motor current should be 0.1 amperes or less for 0.72 second.

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- Throttle actuator control motor failed.
- Open throttle actuator control motor circuit, or harness damage, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

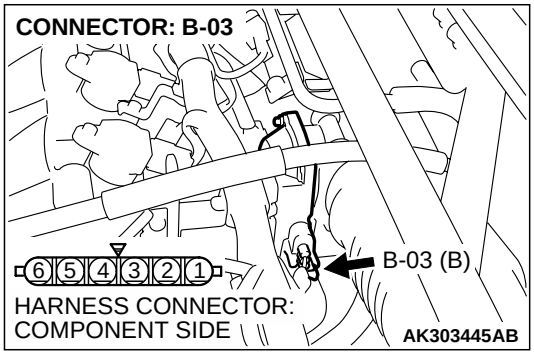
Required Special Tools:
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

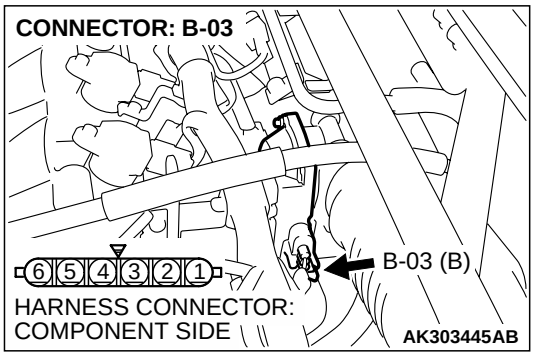
STEP 1. Check harness connector B-03 at throttle actuator control motor for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 2.

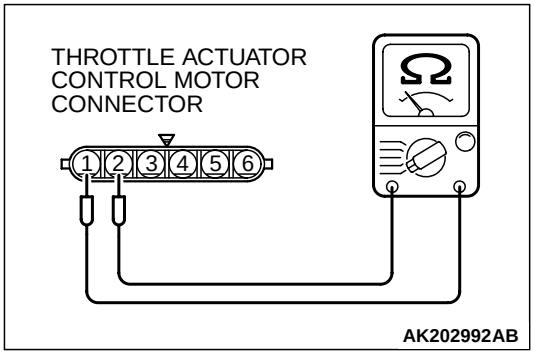
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 8.





STEP 2. Check the throttle actuator control motor.

(1) Disconnect the connector B-03.



(2) Measure the resistance between throttle actuator control motor side connector terminal No. 1 and No. 2.

Standard value: 0.3 – 80 ohms [at 20°C (68°F)]

Q: Is the measured resistance between 0.3 and 80 ohms [at 20°C (68°F)] ?

YES : Go to Step 3.

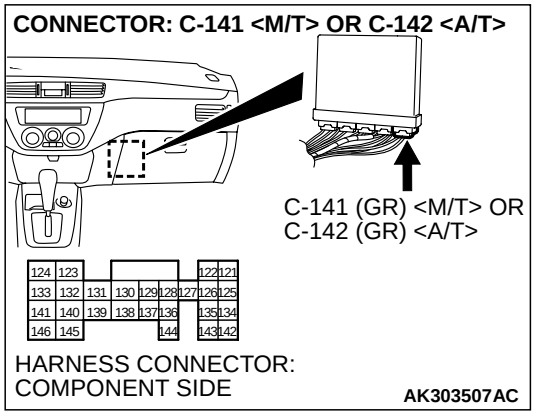
NO : Replace the throttle body assembly. Then go to Step 8.

STEP 3. Check harness connector C-141 at ECM <M/T> or C-142 at PCM <A/T> for damage

Q: Is the harness connector in good condition?

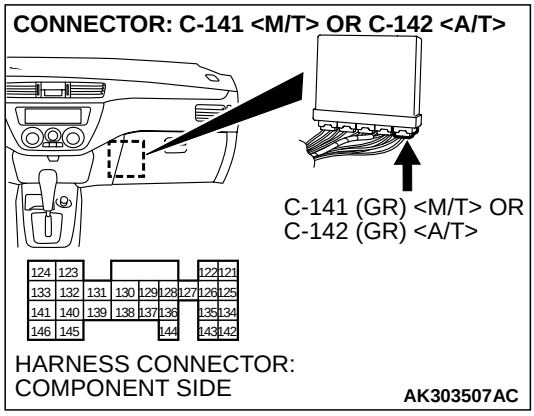
YES : Go to Step 4.

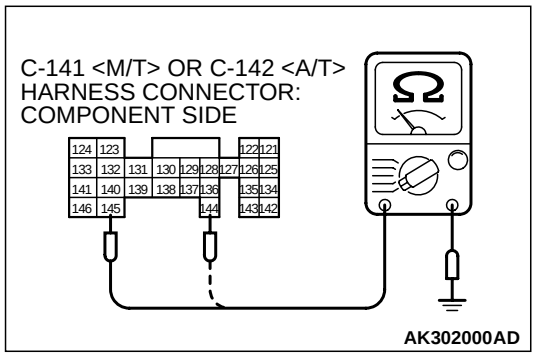
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 8.



STEP 4. Check the continuity at ECM harness side connector C-141 <M/T> or PCM harness side connector C-142 <A/T>.

(1) Disconnect the connector C-141 <M/T> or C-142 <A/T> and measure at the harness side.



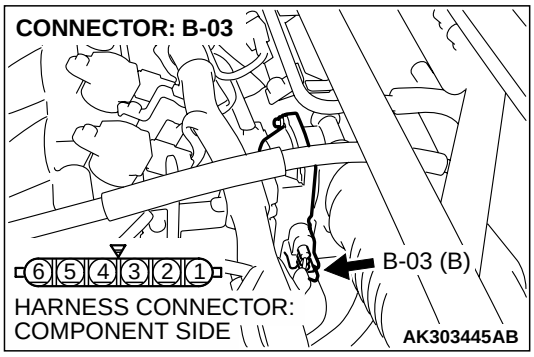


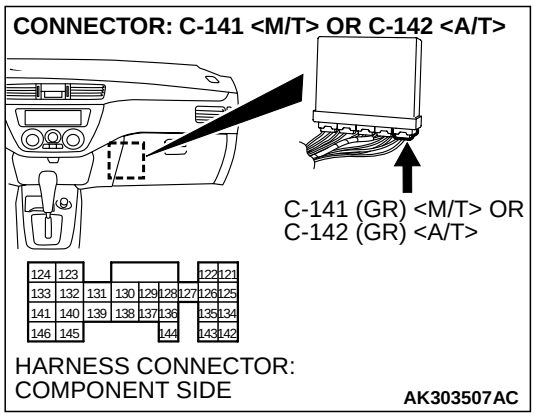
(2) Measure the continuity between terminals No. 144, No. 145 and ground.
- Should be less than 2 ohms.

Q: Does continuity exist?

YES : Go to Step 5.

NO : Repair harness wire between ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminals No. 144, No. 145) and ground because of open circuit or harness damage. Then go to Step 8.





STEP 5. Check for open circuit and harness damage between throttle actuator control motor connector B-03 (terminal No. 1) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 133).

Q: Is the harness wire in good condition?

YES : Go to Step 6.

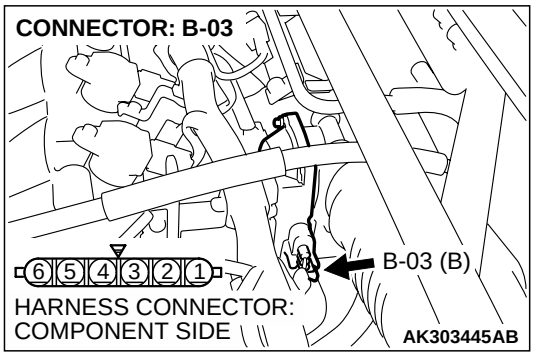
NO : Repair it. Then go to Step 8.

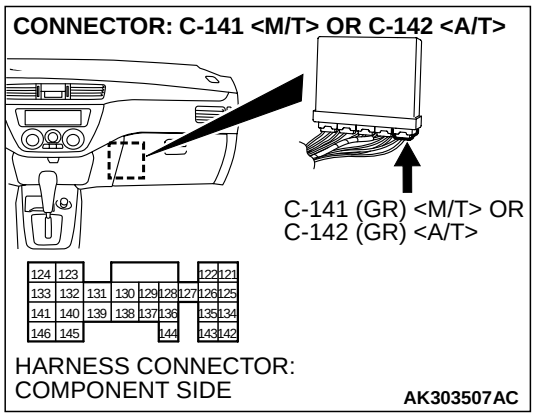
STEP 6. Check for open circuit and harness damage between throttle actuator control motor connector B-03 (terminal No. 2) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 141).

Q: Is the harness wire in good condition?

YES : Go to Step 7.

NO : Repair it. Then go to Step 8.





STEP 7. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

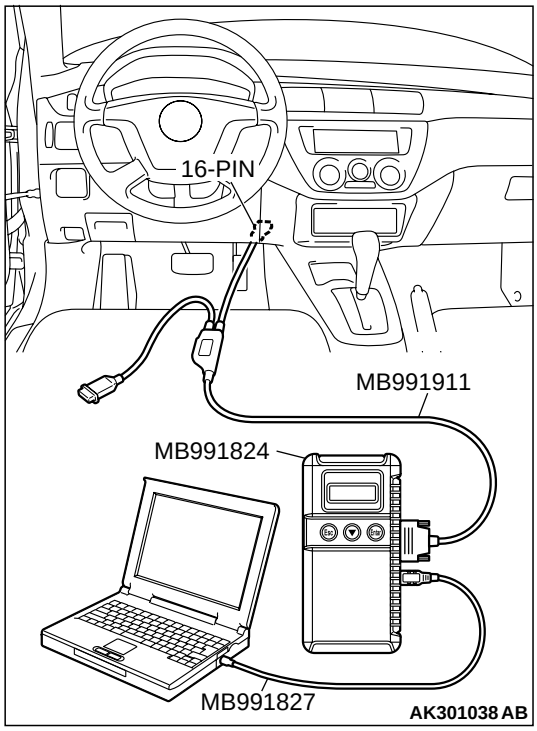
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

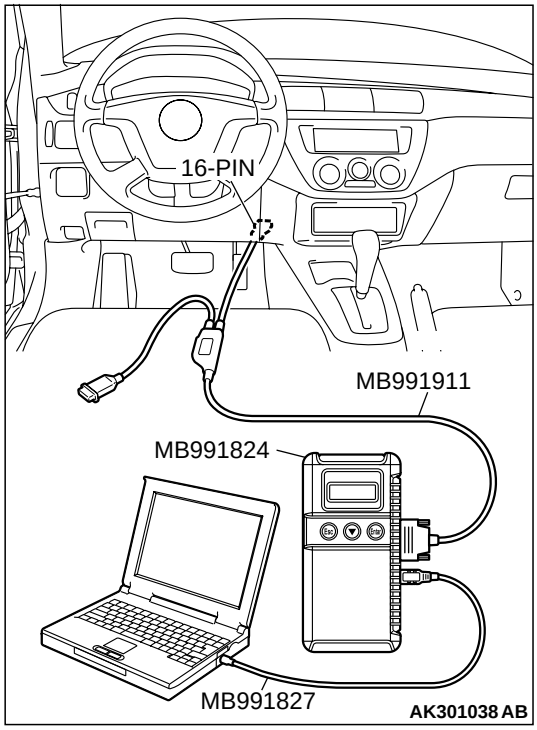
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2100 set?

YES : Replace the ECM or PCM. Then go to Step 8.

NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.





STEP 8. Using scan tool MB991958, read the diagnostic trouble code (DTC).

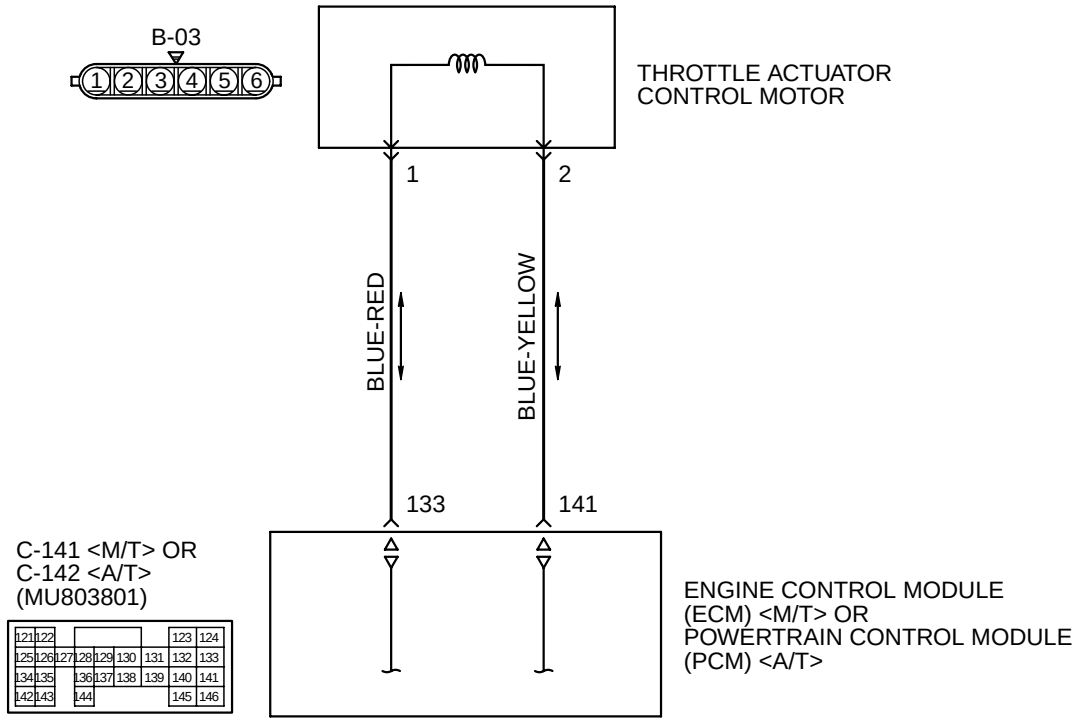
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2100 set?

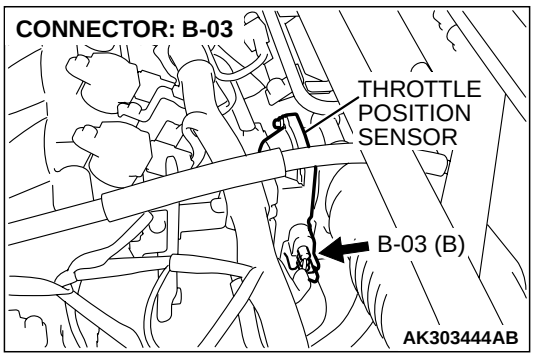
YES : Retry the troubleshooting.
NO : The inspection is complete.

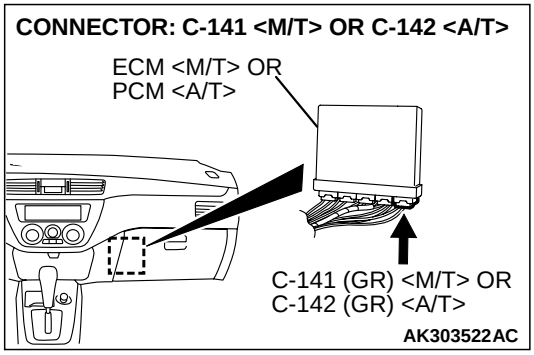
DTC P2101: Throttle Actuator Control Motor Magneto Malfunction

Throttle Actuator Control Motor Circuit



AK304004





CIRCUIT OPERATION

- Controls the current that is applied from the ECM <M/T> or PCM <A/T> (terminals No. 133, No. 141) to the throttle actuator control motor (terminals No. 1, No. 2).

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> check whether the throttle actuator control motor magneto has failed.

DESCRIPTIONS OF MONITOR METHODS

Throttle acutuator control motor intelligent power device detects it is overheating.

MONITOR EXECUTION

Continuous

TSB Revision

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)
- Not applicable

Sensor (The sensor below is determined to be normal)
- Not applicable

DTC SET CONDITIONS

Check Condition
- Battery positive voltage is higher than 8.3 volts.

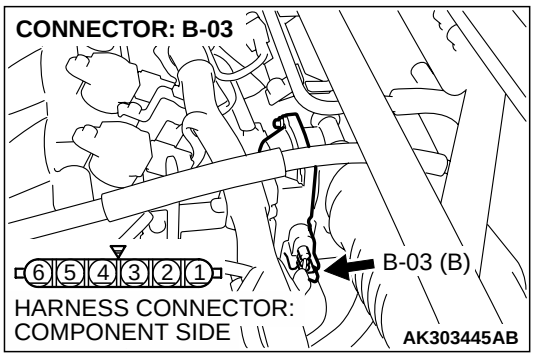
Judgement Criteria
- The coil temperature of the throttle actuator control motor should be 180°C (356°F) or higher for 0.8 second.

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- Throttle actuator control motor failed.
- Shorted throttle actuator control motor circuit, or harness damage, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

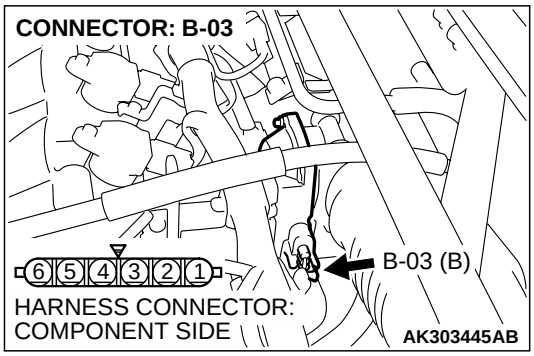
DIAGNOSIS

Required Special Tools:
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B



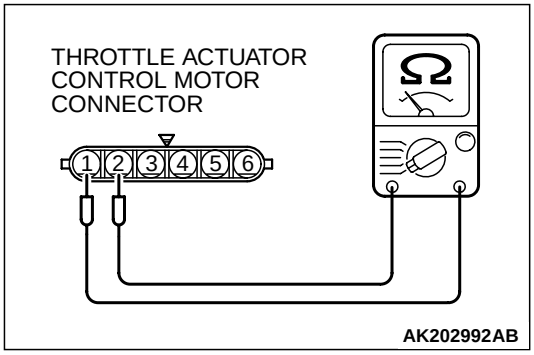
STEP 1. Check harness connector B-03 at throttle actuator control motor for damage.
Q: Is the harness connector in good condition?

YES : Go to Step 2.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 7.



STEP 2. Check the throttle actuator control motor.

(1) Disconnect the connector B-03.



(2) Measure the resistance between throttle actuator control motor side connector terminal No. 1 and No. 2.

Standard value: 0.3 – 80 ohms [at 20°C (68°F)]

Q: Is the measured resistance between 0.3 and 80 ohms [at 20°C (68°F)] ?

YES : Go to Step 3.

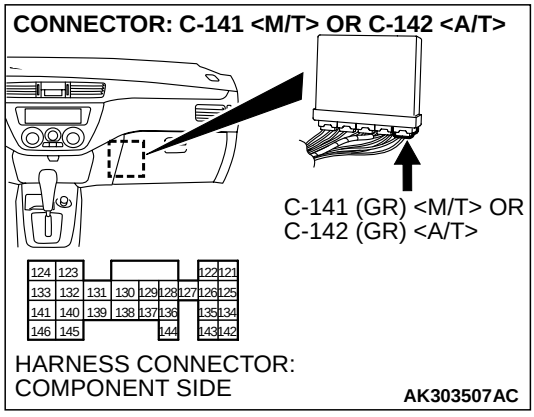
NO : Replace the throttle body assembly. Then go to Step 7.

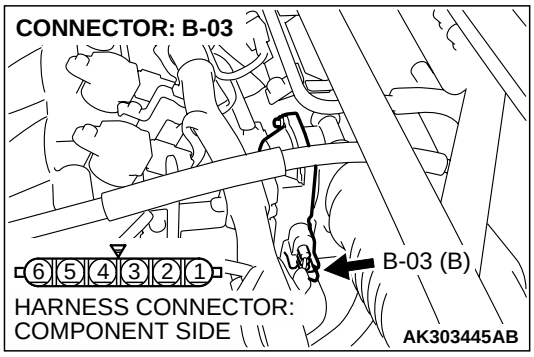
STEP 3. Check harness connector C-141 at ECM <M/T> or C-142 at PCM <A/T> for damage

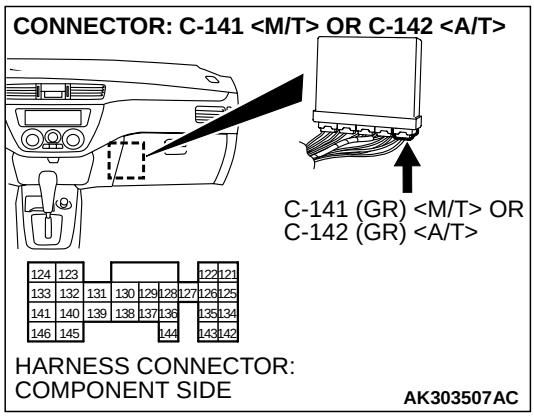
Q: Is the harness connector in good condition?

YES : Go to Step 4.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 7.







STEP 4. Check for short circuit to ground and harness damage between throttle actuator control motor connector B-03 (terminal No. 1) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 133).

Q: Is the harness wire in good condition?

YES : Go to Step 5.

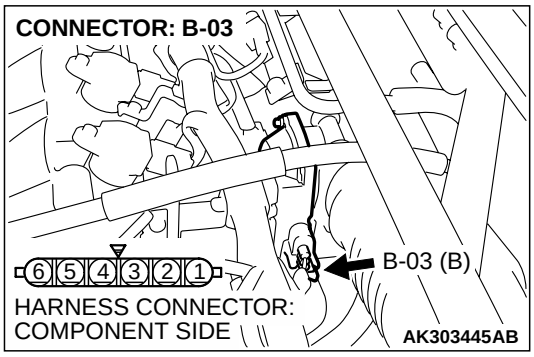
NO : Repair it. Then go to Step 7.

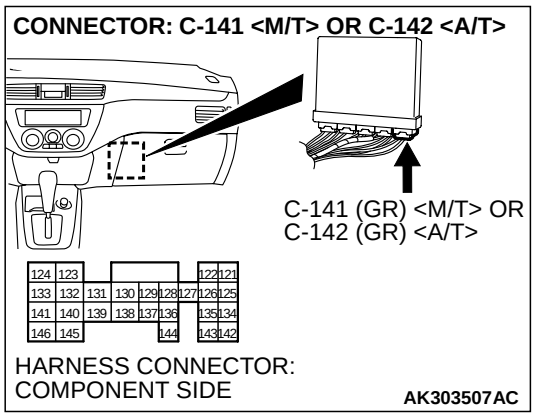
STEP 5. Check for short circuit to ground and harness damage between throttle actuator control motor connector B-03 (terminal No. 2) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 141).

Q: Is the harness wire in good condition?

YES : Go to Step 6.

NO : Repair it. Then go to Step 7.





STEP 6. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

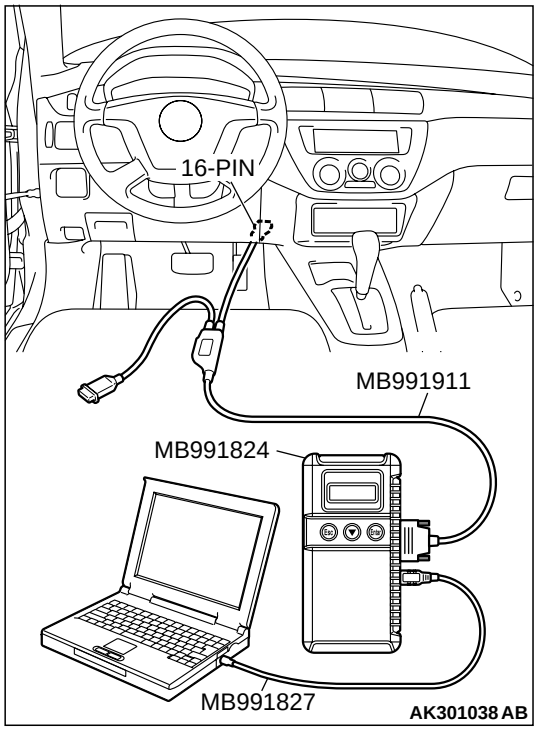
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

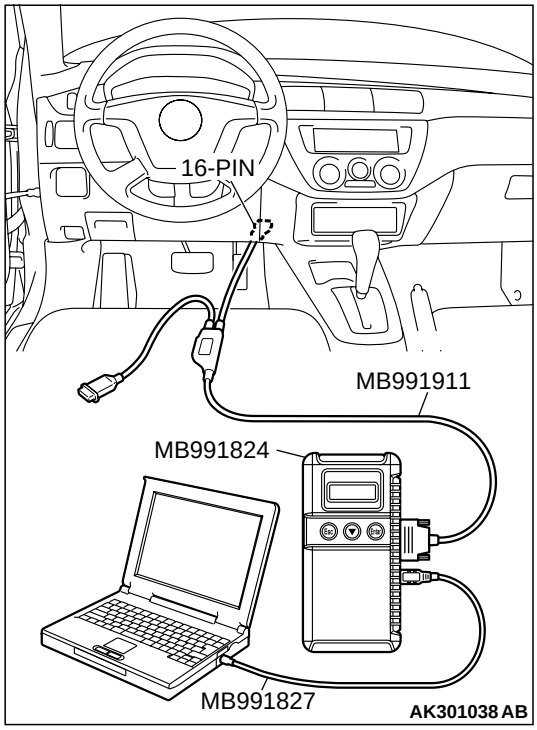
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2101 set?

YES : Replace the ECM or PCM. Then go to Step 7.

NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.





STEP 7. Using scan tool MB991958, read the diagnostic trouble code (DTC).

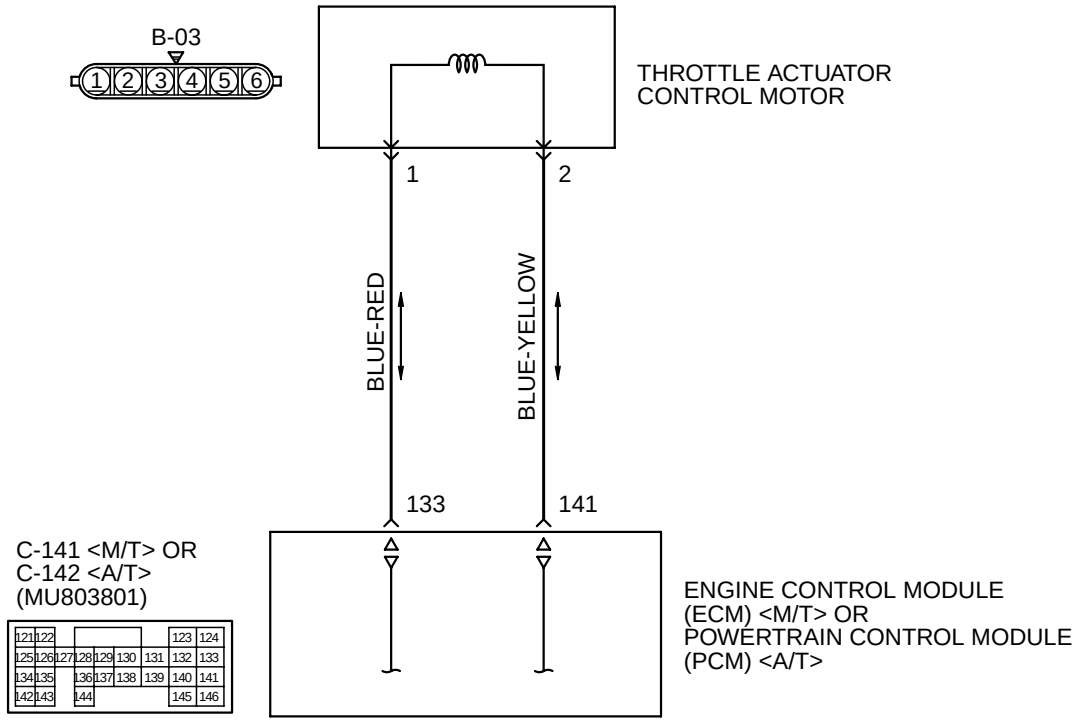
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2101 set?

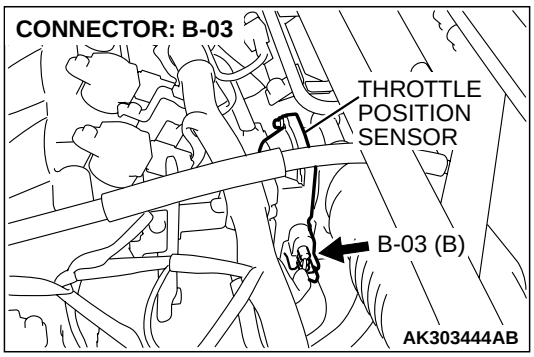
YES : Retry the troubleshooting.
NO : The inspection is complete.

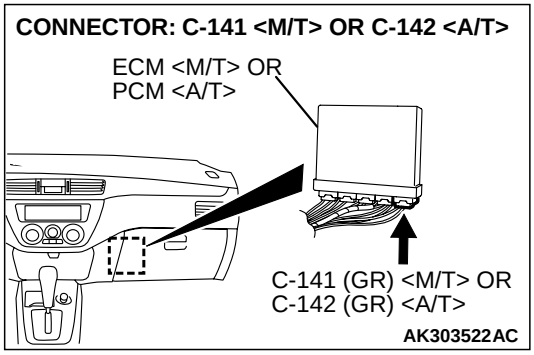
DTC P2102: Throttle Actuator Control Motor Circuit (Shorted Low)

Throttle Actuator Control Motor Circuit



AK304004





CIRCUIT OPERATION

- Controls the current that is applied from the ECM <M/T> or PCM <A/T> (terminals No. 133, No. 141) to the throttle actuator control motor (terminals No. 1, No. 2).

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> varies the direction and the amperage of the current that is applied to the throttle actuator control motor in order to control the opening of the throttle valve.

DESCRIPTIONS OF MONITOR METHODS

Motor intelligent power device detects shorted-low malfunction.

MONITOR EXECUTION

Continuous

TSB Revision

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)
- Not applicable

Sensor (The sensor below is determined to be normal)
- Not applicable

DTC SET CONDITIONS

Check Condition
- Battery positive voltage is higher than 8.3 volts.

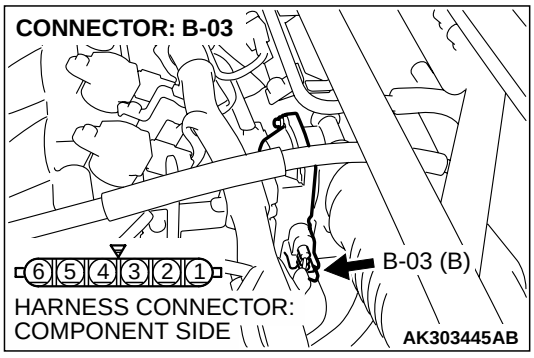
Judgement Criteria
- Throttle actuator control motor current is 12 amperes or higher for 0.8 second.

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- Throttle actuator control motor failed.
- Shorted throttle actuator control motor circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

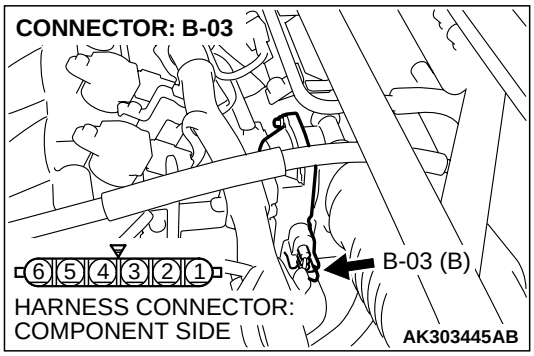
Required Special Tools:
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B



STEP 1. Check harness connector B-03 at throttle actuator control motor for damage.
Q: Is the harness connector in good condition?

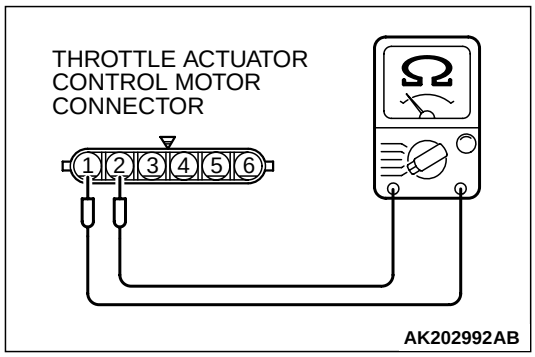
YES : Go to Step 2.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 7.



STEP 2. Check the throttle actuator control motor.

(1) Disconnect the connector B-03.



(2) Measure the resistance between throttle actuator control motor side connector terminals No. 1 and No. 2.

Standard value: 0.3 – 80 ohms [at 20°C (68°F)]

Q: Is the measured resistance between 0.3 and 80 ohms [at 20°C (68°F)] ?

YES : Go to Step 3.

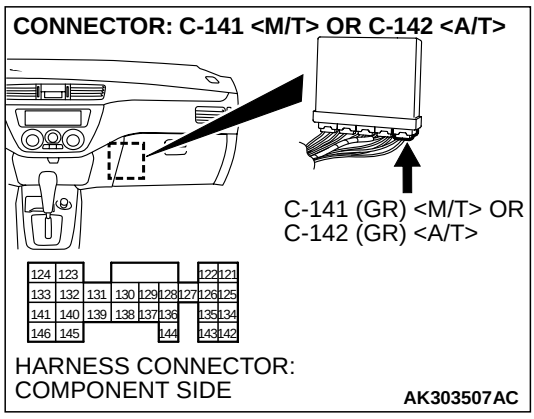
NO : Replace the throttle body assembly. Then go to Step 7.

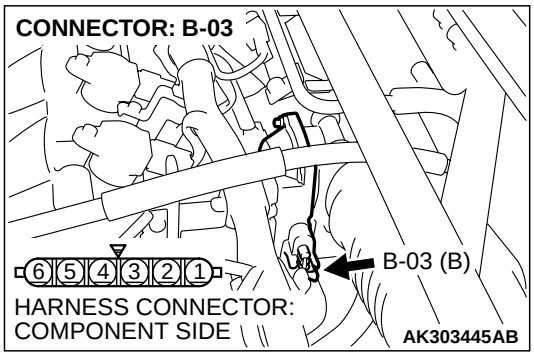
STEP 3. Check harness connector C-141 at ECM <M/T> or C-142 at PCM <A/T>for damage.

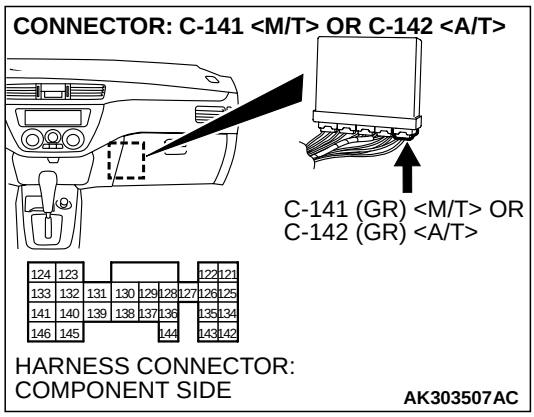
Q: Is the harness connector in good condition?

YES : Go to Step 4.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 7.







STEP 4. Check for short circuit to ground between throttle actuator control motor connector B-03 (terminal No. 1) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 133).

Q: Is the harness wire in good condition?

YES : Go to Step 5.

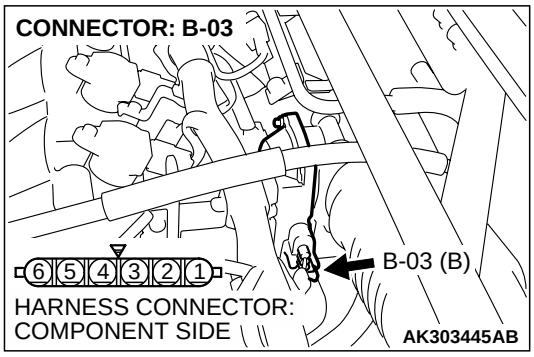
NO : Repair it. Then go to Step 7.

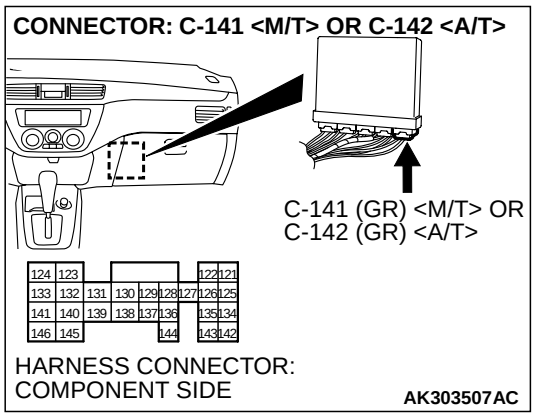
STEP 5. Check for short circuit to ground between throttle actuator control motor connector B-03 (terminal No. 2) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 141).

Q: Is the harness wire in good condition?

YES : Go to Step 6.

NO : Repair it. Then go to Step 7.





STEP 6. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

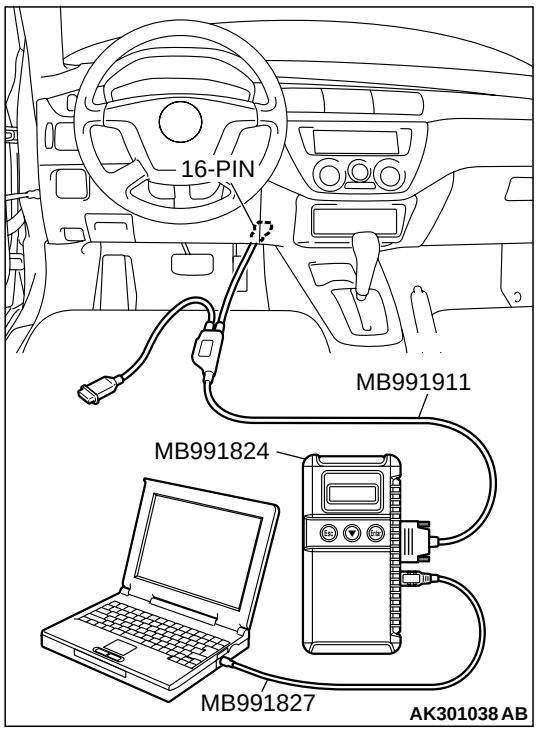
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

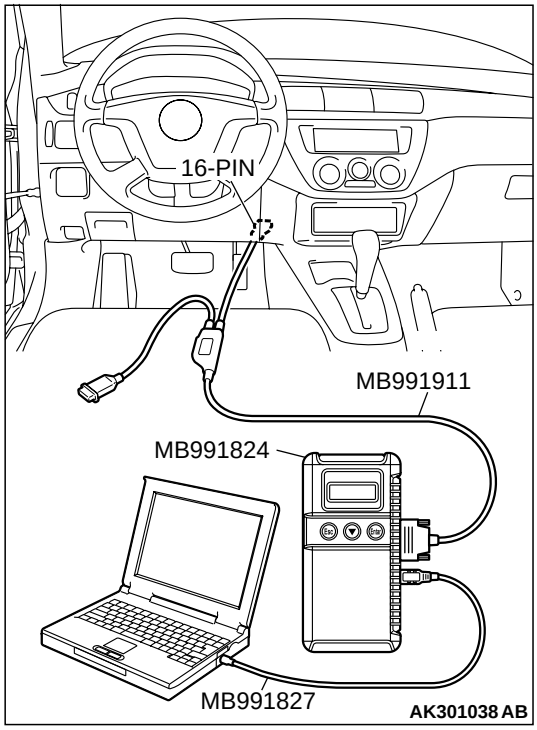
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2102 set?

YES : Replace the ECM or PCM. Then go to Step 7.

NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.





STEP 7. Using scan tool MB991958, read the diagnostic trouble code (DTC).

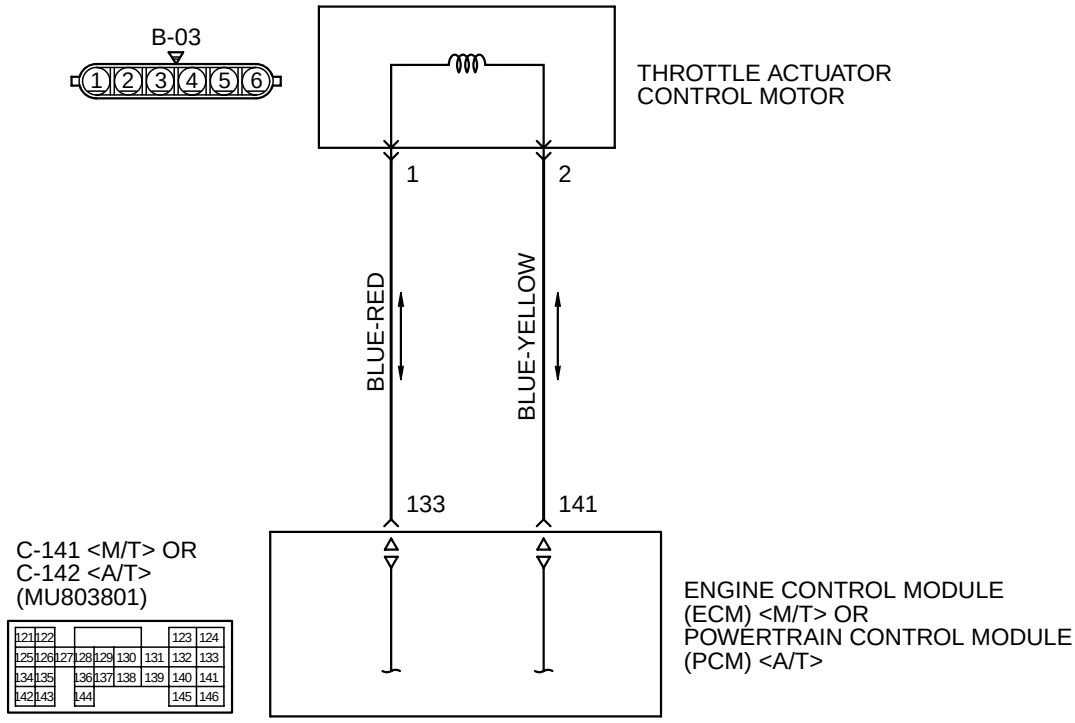
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2102 set?

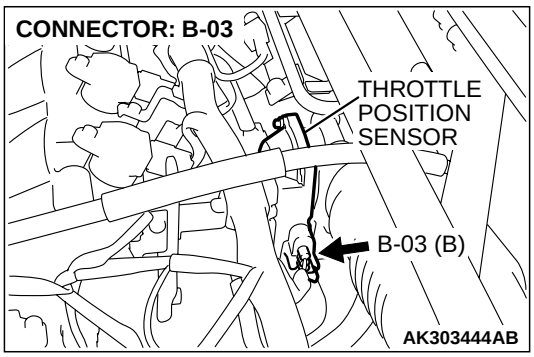
YES : Retry the troubleshooting.
NO : The inspection is complete.

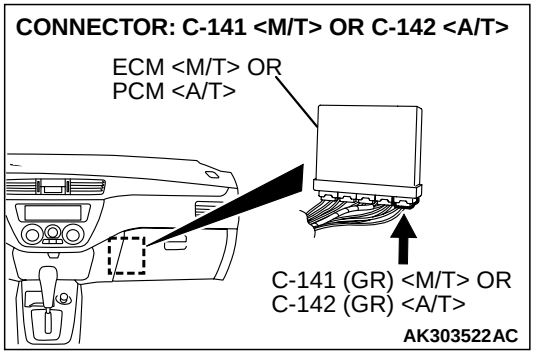
DTC P2103: Throttle Actuator Control Motor Circuit (Shorted High)

Throttle Actuator Control Motor Circuit



AK304004





CIRCUIT OPERATION

- Controls the current that is applied from the ECM <M/T> or PCM <A/T> (terminals No. 133, No. 141) to the throttle actuator control motor (terminals No. 1, No. 2).

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> varies the direction and the amperage of the current that is applied to the throttle actuator control motor in order to control the opening of the throttle valve.

DESCRIPTIONS OF MONITOR METHODS

Motor intelligent power device detects shorted-high malfunction.

MONITOR EXECUTION

Continuous

TSB Revision

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)
- Not applicable

Sensor (The sensor below is determined to be normal)
- Not applicable

DTC SET CONDITIONS

Check Conditions
- Battery positive voltage is higher than 8.3 volts.

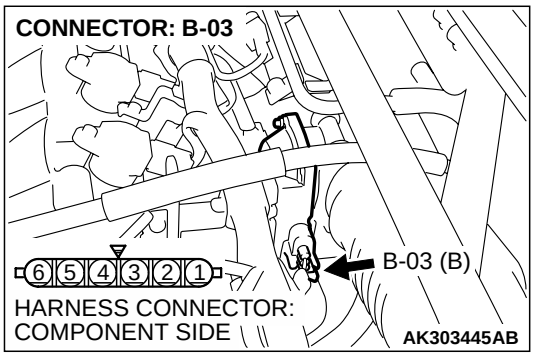
Judgement Criteria
- Throttle actuator control motor current is 8 amperes or higher for 0.8 second.

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- Throttle actuator control motor failed.
- Shorted throttle actuator control motor circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

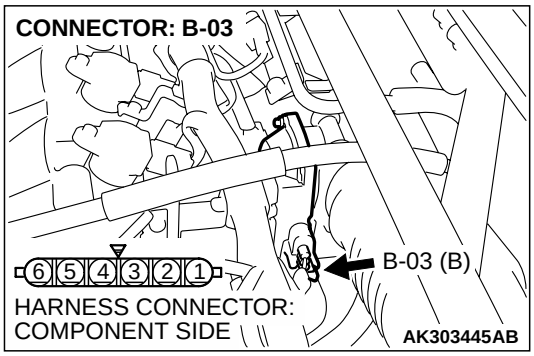
DIAGNOSIS

Required Special Tools:
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B



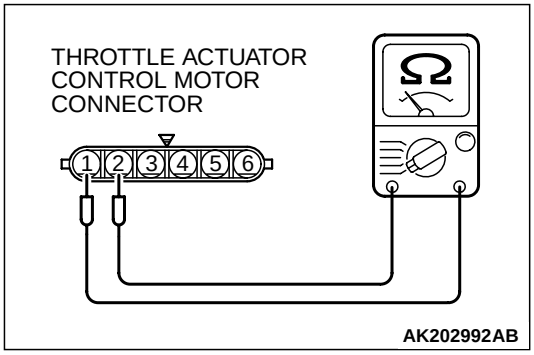
STEP 1. Check harness connector B-03 at throttle actuator control motor for damage.
Q: Is the harness connector in good condition?

YES : Go to Step 2.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 7.



STEP 2. Check the throttle actuator control motor.

(1) Disconnect the connector B-03.



(2) Measure the resistance between throttle actuator control motor side connector terminals No. 1 and No. 2.

Standard value: 0.3 – 80 ohms [at 20°C (68°F)]

Q: Is the measured resistance between 0.3 and 80 ohms [at 20°C (68°F)] ?

YES : Go to Step 3.

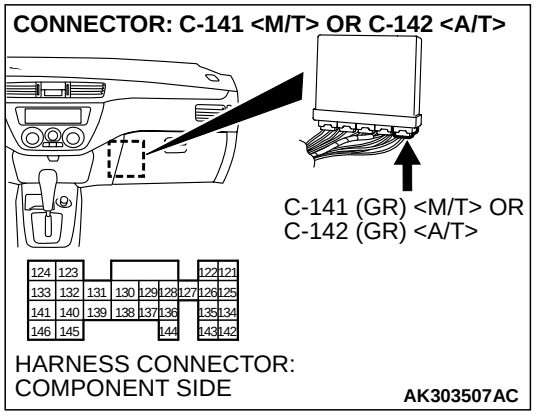
NO : Replace the throttle body assembly. Then go to Step 7.

STEP 3. Check harness connector C-141 at ECM <M/T> or C-142 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 4.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 7.

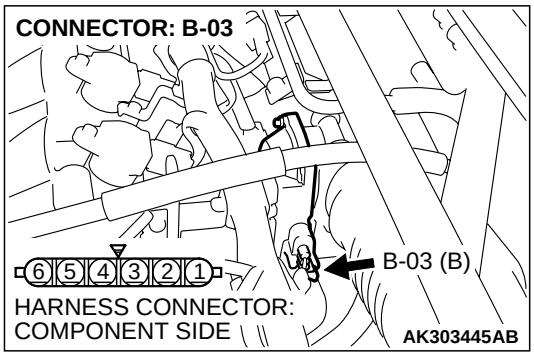


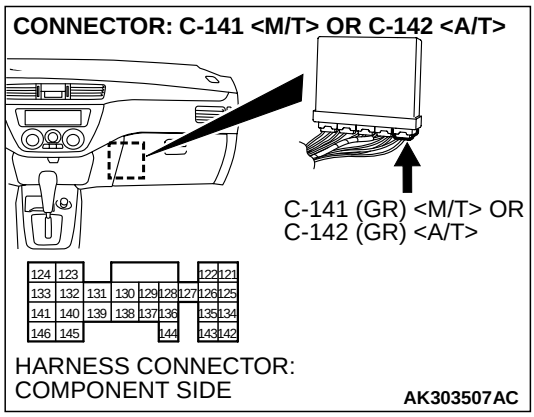
STEP 4. Check for short circuit to ground between throttle actuator control motor connector B-03 (terminal No. 1) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 133).

Q: Is the harness wire in good condition?

YES : Go to Step 5.

NO : Repair it. Then go to Step 7.



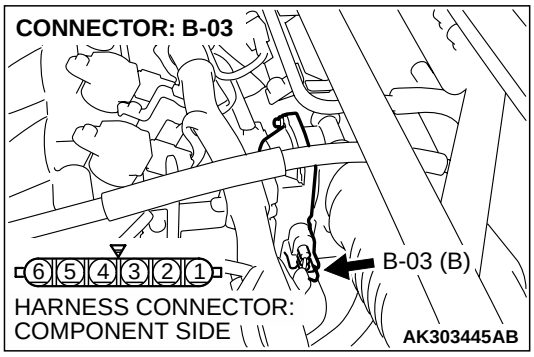


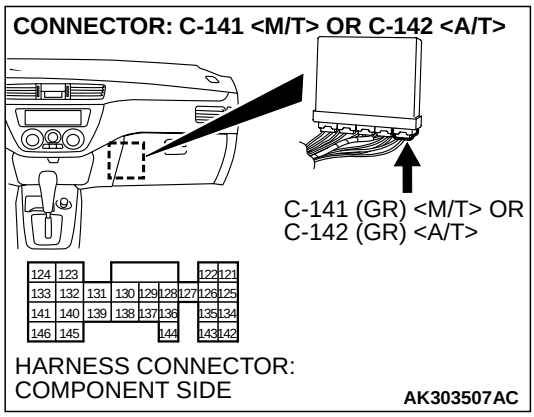
STEP 5. Check for short circuit to ground between throttle actuator control motor connector B-03 (terminal No. 2) and ECM connector C-141 <M/T> or PCM connector C-142 <A/T> (terminal No. 141).

Q: Is the harness wire in good condition?

YES : Go to Step 6.

NO : Repair it. Then go to Step 7.





STEP 6. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

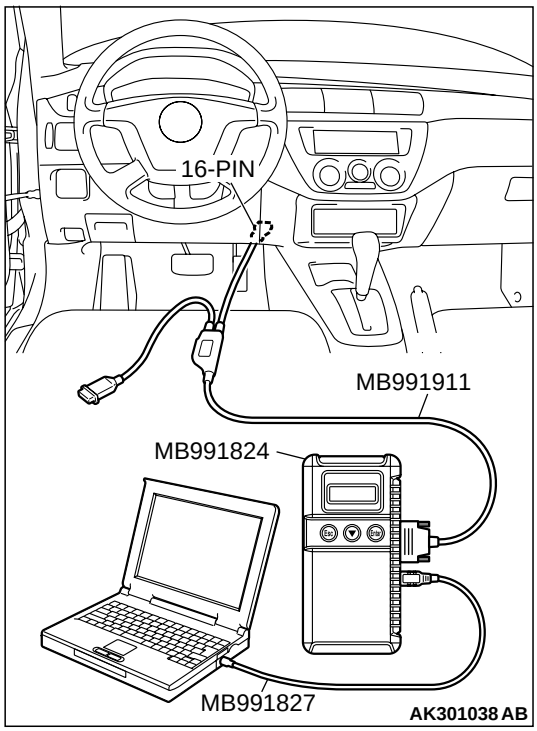
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

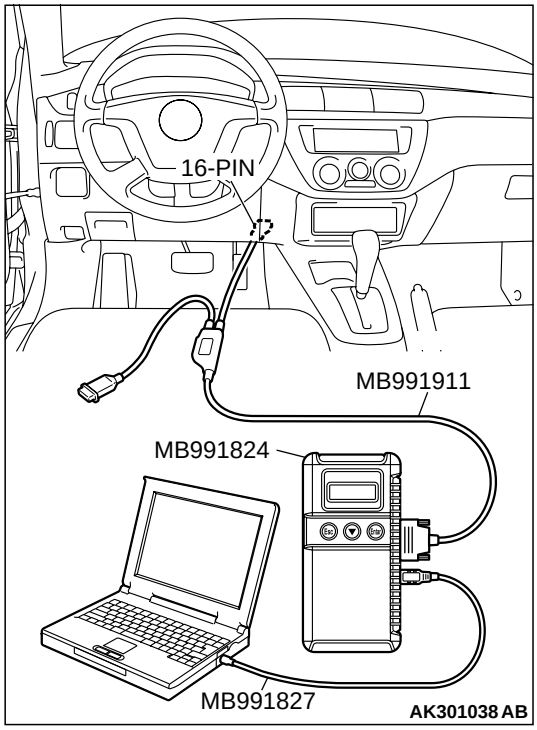
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2103 set?

YES : Replace the ECM or PCM. Then go to Step 7.

NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.





STEP 7. Using scan tool MB991958, read the diagnostic trouble code (DTC).

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2103 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P2121: Accelerator Pedal Position Sensor (main) Circuit Range/Performance Problem

ACCELERATOR PEDAL POSITION SENSOR (MAIN) CIRCUIT RANGE/PERFORMANCE PROBLEM CIRCUIT

- Refer to, DTC P2122 – Accelerator Pedal Position Sensor (main) Circuit P.13B-661.
- Refer to INSPECTION PROCEDURE 35 – Accelerator Pedal Position Switch Circuit P.13B-857.

CIRCUIT OPERATION

- Refer to, DTC P2122 – Accelerator Pedal Position Sensor (main) Circuit P.13B-661.
- Refer to INSPECTION PROCEDURE 35 – Accelerator Pedal Position Switch Circuit P.13B-857.

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> checks the accelerator pedal position sensor (main) output signal characteristics for abnormal conditions.

DESCRIPTIONS OF MONITOR METHODS

- Accelerator pedal position sensor (main) output voltage is greater than that the specified value when the accelerator pedal position switch is on.

MONITOR EXECUTION

- Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

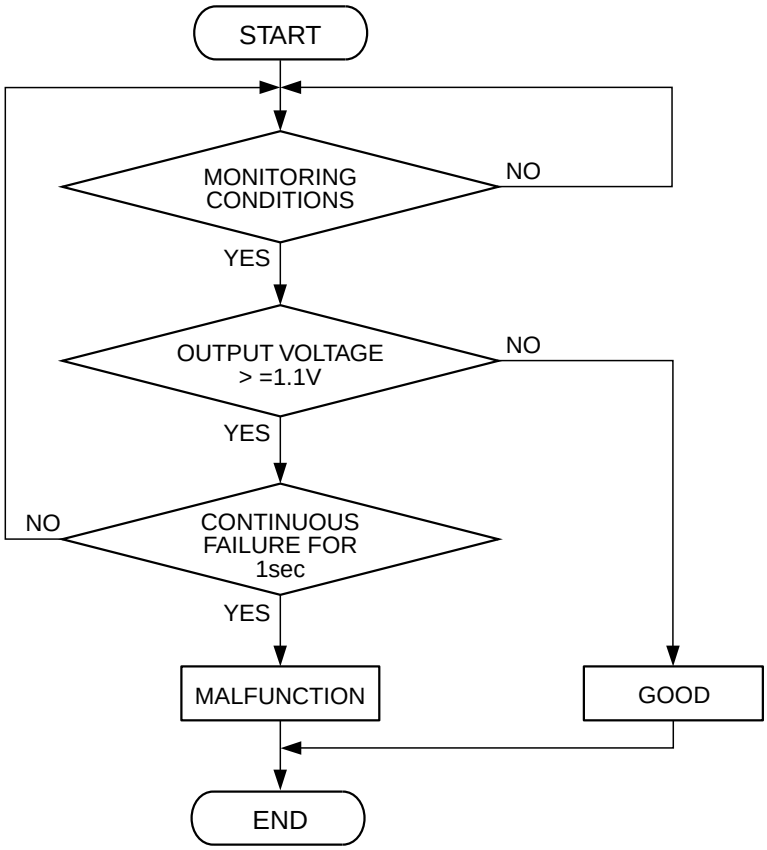
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK304088

Check Conditions
- Ignition switch "ON" position.
- Accelerator pedal position switch: ON
- Accelerator pedal position sensor (sub) output voltage is 1.88 volts or less.

Judgement Criteria
- Accelerator pedal position sensor (main) output voltage is 1.88 volts or higher for 1 second.

OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- Accelerator pedal position sensor failed or maladjusted.
- Open or shorted accelerator pedal position sensor (main) circuit, or loose connector.
- Accelerator pedal position switch failed or maladjusted.
- Open or shorted accelerator pedal position switch circuit, or loose connector.
- ECM failed. <M/T>
- PCM failed. <A/T>

TSB Revision

DIAGNOSIS

Required Special Tools:

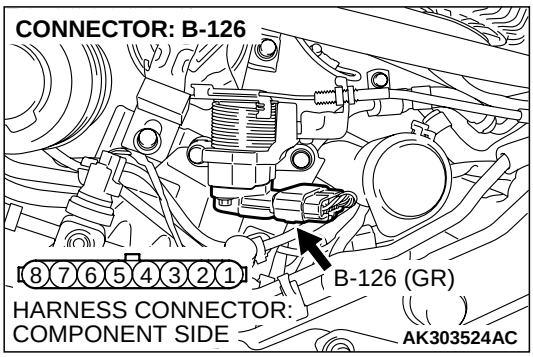
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

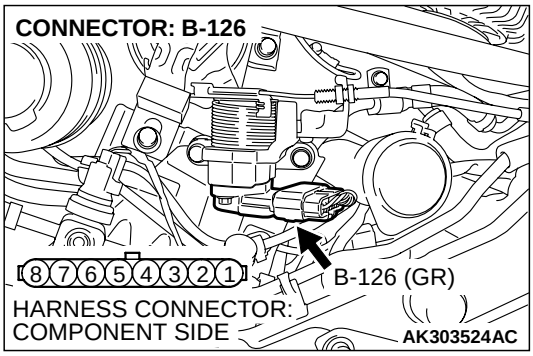
STEP 1. Check harness connector B-126 at accelerator pedal position sensor and accelerator pedal position switch for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 2.

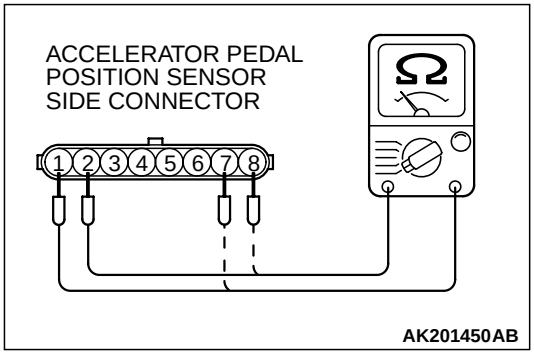
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 11.





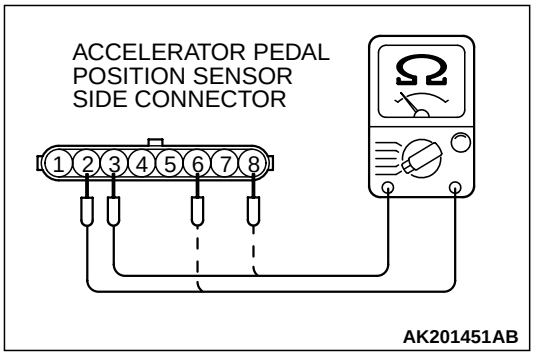
STEP 2. Check the accelerator pedal position sensor.

(1) Disconnect the accelerator pedal position sensor connector B-126.



(2) Measure resistance between terminal No. 1 and No. 2 and between terminal No. 7 and No. 8.

Standard value: 3.5 – 6.5 kΩ



(3) Measure resistance between terminal No. 2 and No. 3 and between terminal No. 6 and No. 8 when the accelerator pedal is gently depressed from idle position to the full open position.

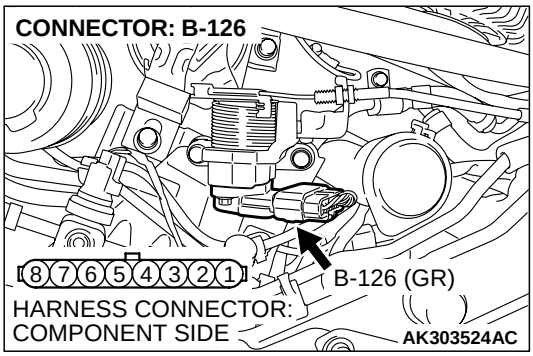
- Resistance value changes in accordance with the accelerator pedal depression smoothly.

Q: Is the resistance normal?

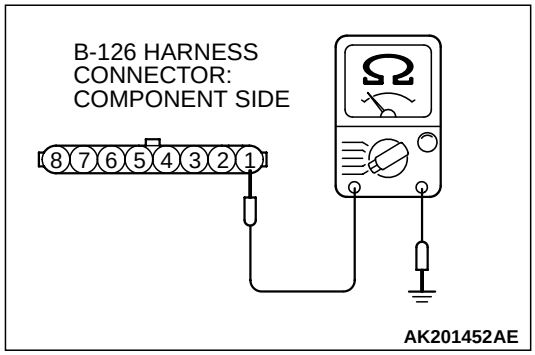
YES : Go to Step 3.

NO : Replace the accelerator pedal position sensor. Then go to Step 11.

STEP 3. Check the continuity at accelerator pedal position sensor harness side connector B-126.



(1) Disconnect the connector B-126 and measure at the harness side.



(2) Measure the continuity between terminal No. 1 and ground.
- Should be less than 2 ohms.

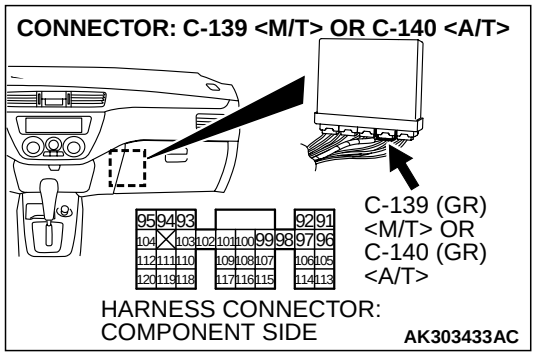
Q: Does continuity exist?

YES : Go to Step 7.
NO : Go to Step 4.

STEP 4. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 5.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 11.

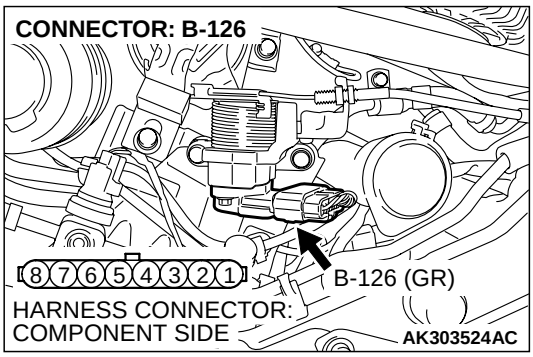


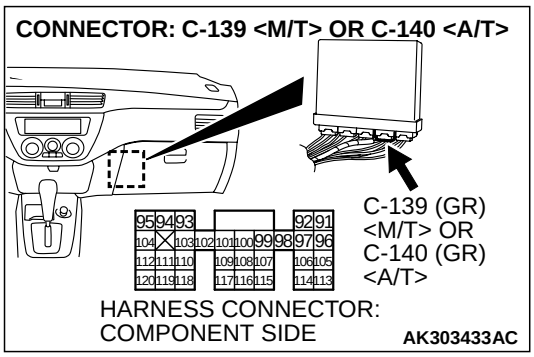
STEP 5. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 1) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 91).

Q: Is the harness wire in good condition?

YES : Go to Step 6.

NO : Repair it. Then go to Step 11.





STEP 6. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

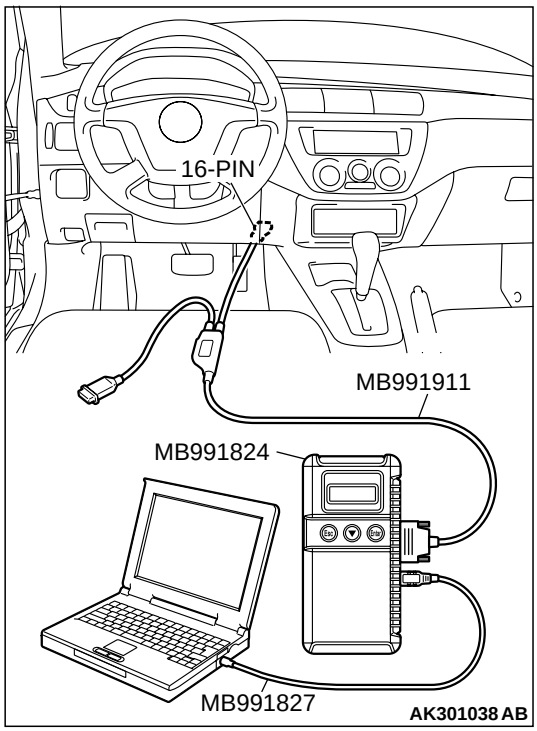
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

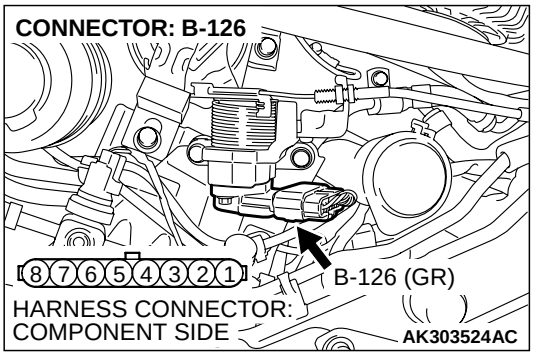
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2121 set?

YES : Replace the ECM or PCM. Then go to Step 11.

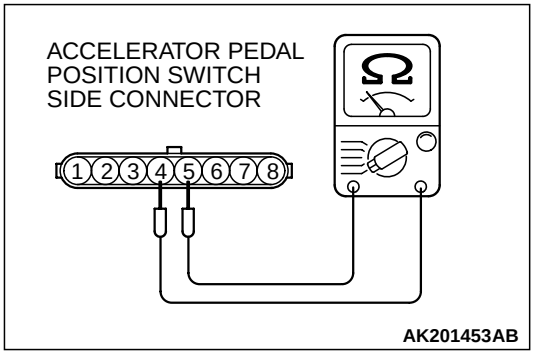
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection. Service Points P.00-6.





STEP 7. Check the accelerator pedal position switch.

(1) Disconnect the accelerator pedal position switch connector B-126.



(2) Check the continuity between accelerator pedal position switch side connector terminal No. 4 and No. 5.

Standard value:
Continuity (foot released from accelerator pedal)
Non-continuity (accelerator pedal depressed)

Q: Is the switch operating properly?

YES : Go to Step 8.

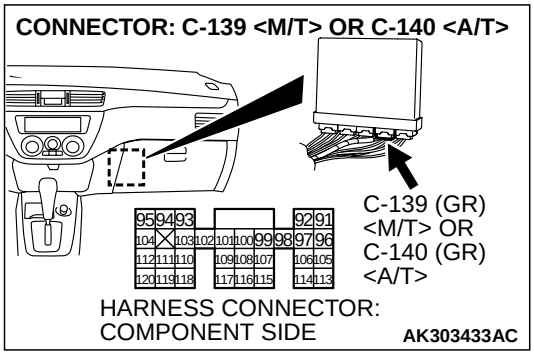
NO : Replace the accelerator pedal position switch. Then go to Step 11.

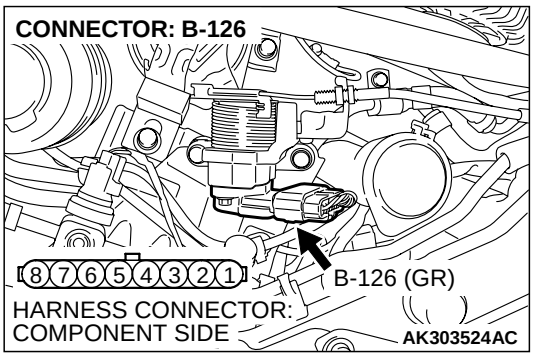
STEP 8. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

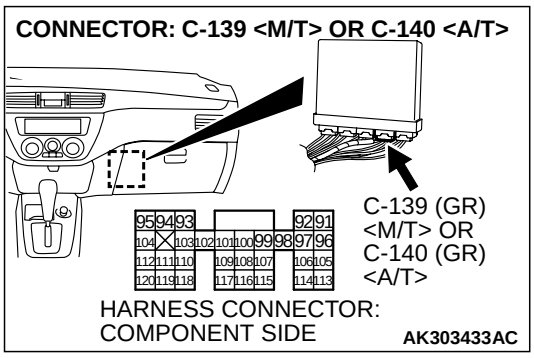
Q: Is the harness connector in good condition?

YES : Go to Step 9.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 11.







STEP 9. Check for short circuit to ground between accelerator pedal position switch connector B-126 (terminal No. 4) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 38).

Q: Is the harness wire in good condition?

YES : Go to Step 10.

NO : Repair it. Then go to Step 11.

STEP 10. Using scan tool MB991958, read the diagnostic trouble code (DTC).

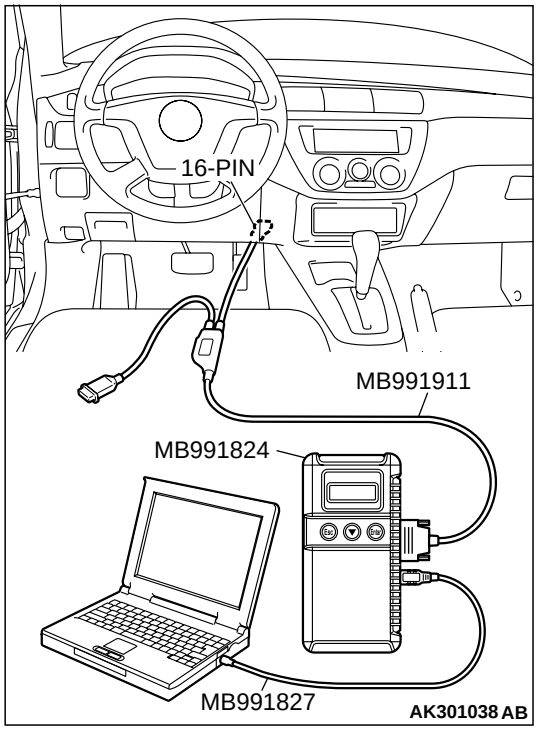
⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2121 set?

YES : Replace the ECM or PCM. Then go to Step 11.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection. Service Points P.00-6.

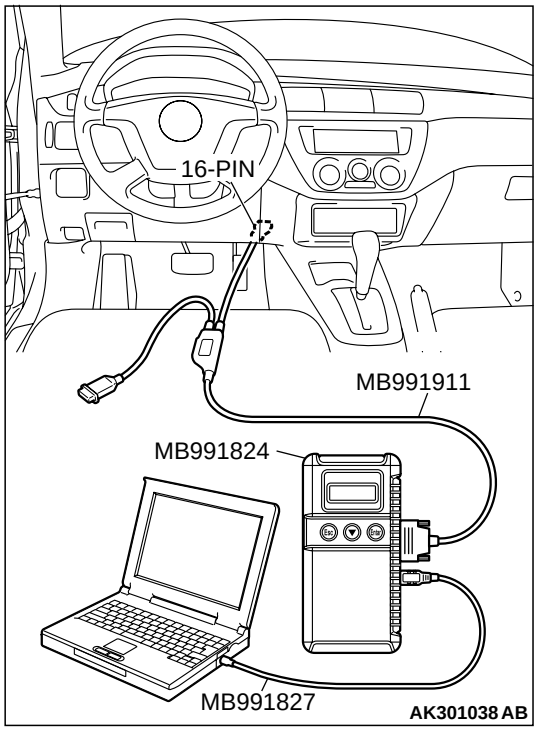


STEP 11. Using scan tool MB991958, read the diagnostic trouble code (DTC).

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

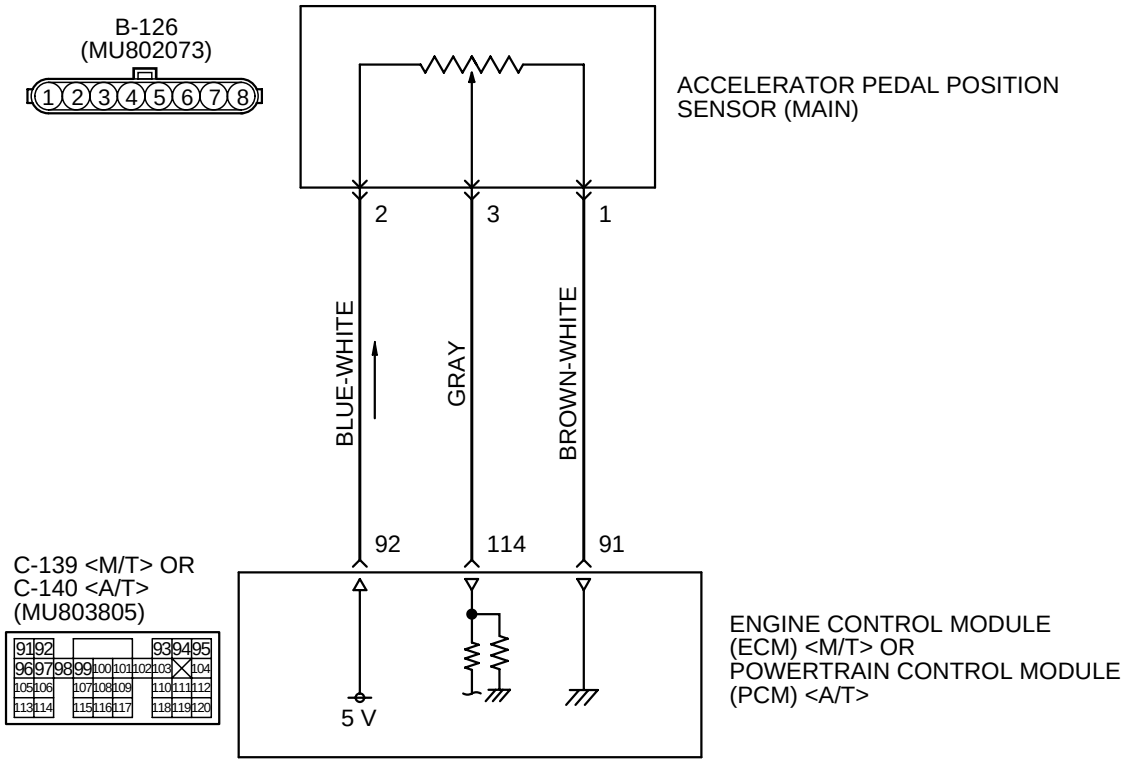
Q: Is DTC P2121 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

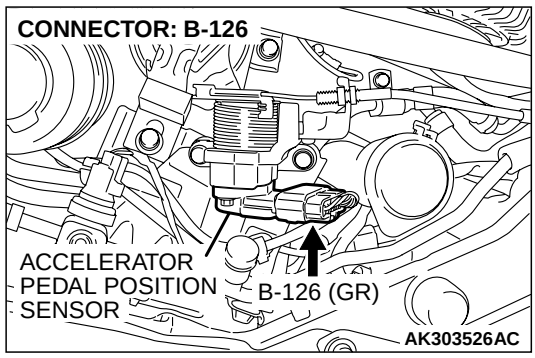


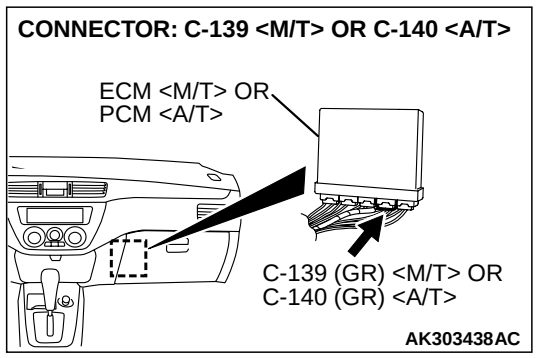
DTC P2122: Accelerator Pedal Position Sensor (main) Circuit Low Input

Accelerator Pedal Position Sensor (main) Circuit



AK304005





CIRCUIT OPERATION

- A 5-volt power supply is applied on the accelerator pedal position sensor (main) power terminal (terminal No. 2) from the ECM <M/T> or PCM <A/T> (terminal No. 92).
  The ground terminal (terminal No. 1) is grounded with ECM <M/T> or PCM <A/T> (terminal No. 91).
- When the accelerator pedal is moved from the idle position to the fully opened position, the resistance between the accelerator pedal position sensor (main) output terminal (terminal No. 3) and ground terminal will increase according to the rotation.

TSB Revision

TECHNICAL DESCRIPTION

- The accelerator pedal position sensor (main) outputs voltage which corresponds to the accelerator pedal depression.
- The ECM <M/T> or PCM <A/T> checks whether the voltage is within a specified range.

DESCRIPTIONS OF MONITOR METHODS

- Accelerator pedal position sensor (main) output voltage is out of specified range.

MONITOR EXECUTION

- Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

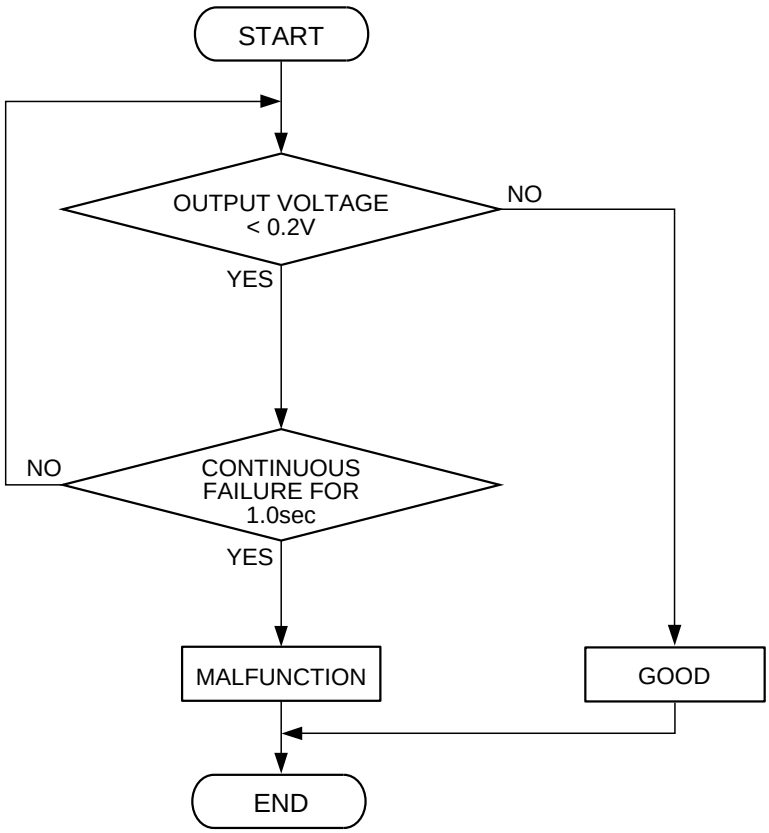
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302044

Check Conditions

- Ignition switch is "ON" position.

Judgement Criteria

- Accelerator pedal position sensor (main) output voltage is 0.2 volt or less for 1 second.

OBD-II DRIVE CYCLE PATTERN

None.

TSB Revision

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Accelerator pedal position sensor failed or maladjusted.
- Open or shorted accelerator pedal position sensor (main) circuit, or loose connector.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

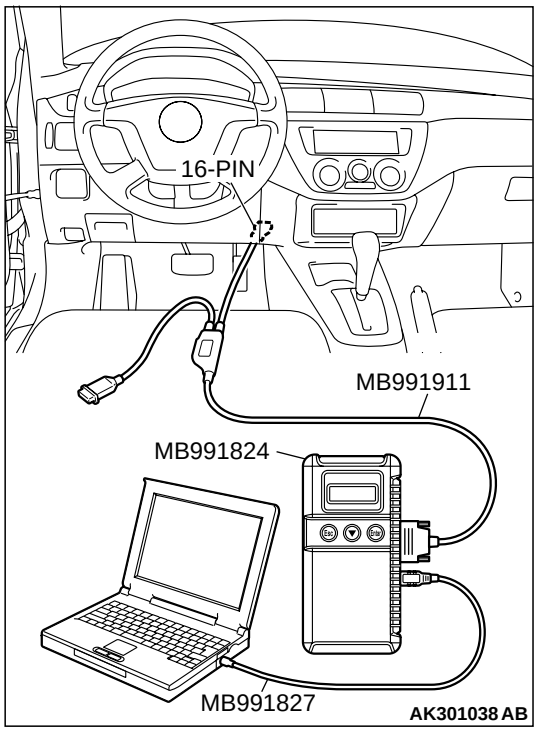
STEP 1. Using scan tool MB991958, check data list item 78: Accelerator Pedal Position Sensor (main).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 78, Accelerator Pedal Position Sensor (main).
  - Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
  - Output voltage is 4.0 volts or higher when accelerator pedal is fully depressed.

(4) Turn the ignition switch to the "LOCK"(OFF) position.



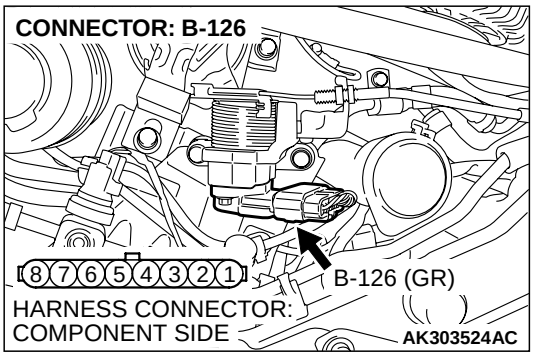
Q: Is the sensor operating properly?

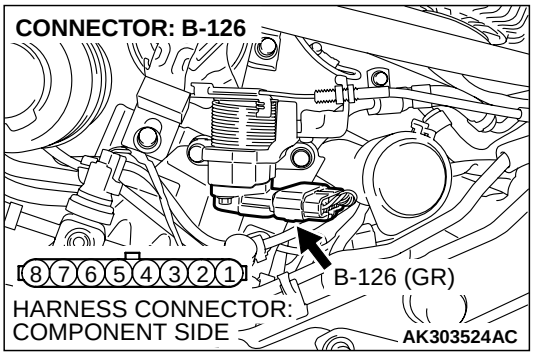
YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection. Service Points P.00-6.
NO : Go to Step 2.

STEP 2. Check harness connector B-126 at accelerator pedal position sensor for damage.

Q: Is the harness connector in good condition?

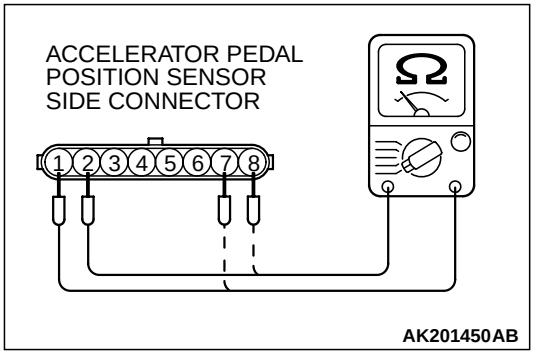
YES : Go to Step 3.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.





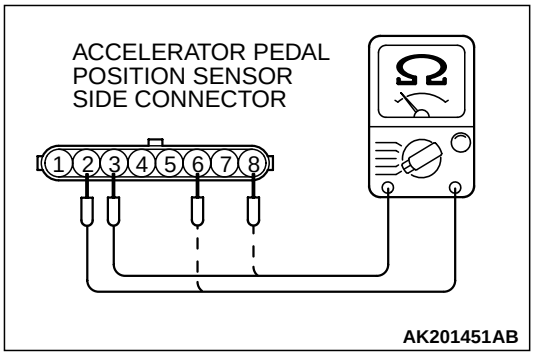
STEP 3. Check the accelerator pedal position sensor.

(1) Disconnect the accelerator pedal position sensor connector B-126.



(2) Measure resistance between terminal No. 1 and No. 2 and between terminal No. 7 and No. 8.

Standard value: 3.5 – 6.5 kΩ



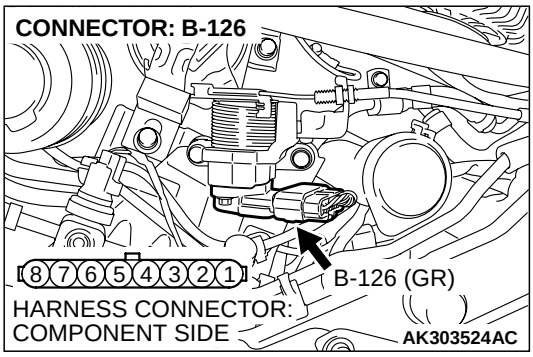
(3) Measure resistance between terminal No. 2 and No. 3 and between terminal No. 6 and No. 8 when the accelerator pedal is gently depressed from idle position to the full open position.

- Resistance value changes in accordance with the accelerator pedal depression smoothly.

Q: Is the resistance normal?

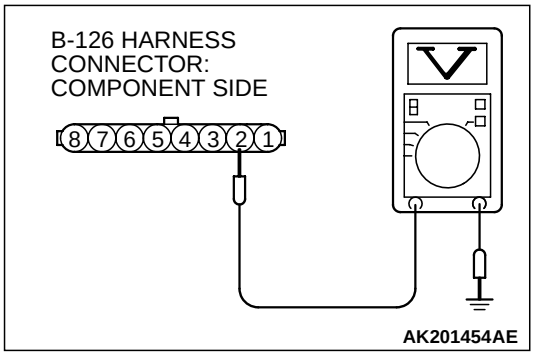
YES : Go to Step 4.

NO : Replace the accelerator pedal position sensor. Then go to Step 12.



STEP 4. Measure the sensor supply voltage at accelerator pedal position sensor harness side connector B-126.

(1) Disconnect the connector B-126 and measure at the harness side.



(2) Turn the ignition switch to the "ON" position.
(3) Measure the voltage between terminal No. 2 and ground.
- Voltage should be between 4.8 and 5.2 volts.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

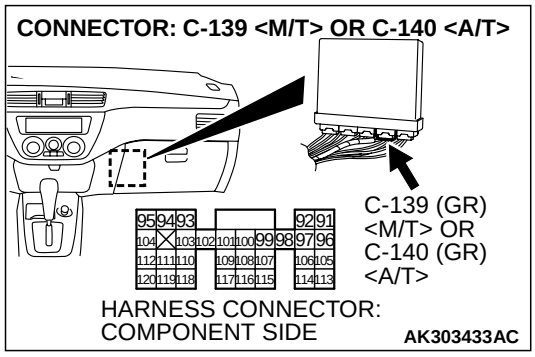
Q: Is the measured voltage between 4.8 and 5.2 volts?

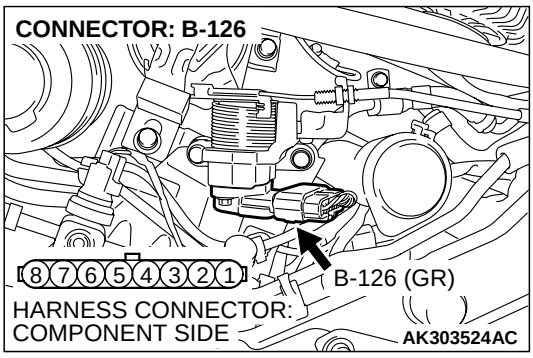
YES : Go to Step 8.
NO : Go to Step 5.

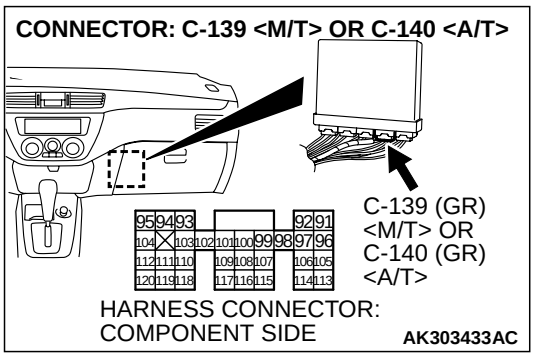
STEP 5. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 6.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.





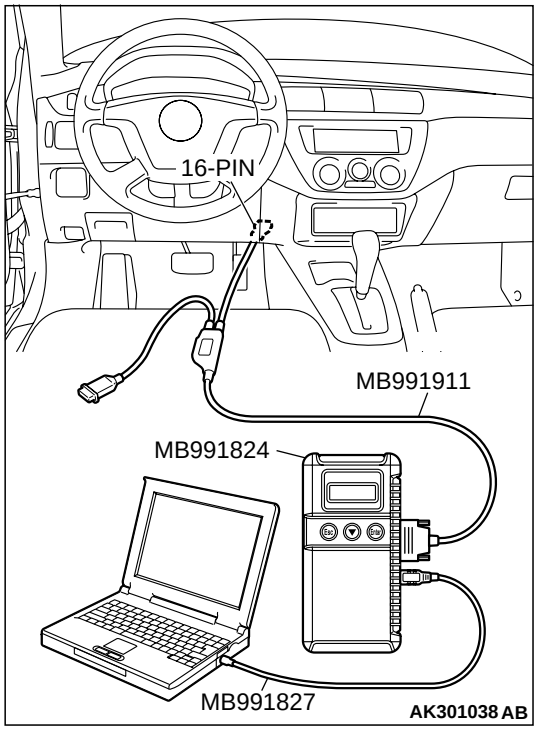


STEP 6. Check for open circuit and short circuit to ground between accelerator pedal position sensor connector B-126 (terminal No. 2) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 92).

Q: Is the harness wire in good condition?

YES : Go to Step 7.

NO : Repair it. Then go to Step 12.



STEP 7. Using scan tool MB991958, check data list item 78: Accelerator Pedal Position Sensor (main).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

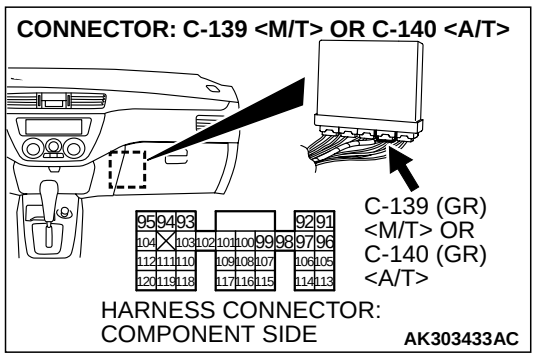
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 78, Accelerator Pedal Position Sensor (main).
- Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
- Output voltage is 4.0 volts or higher when accelerator pedal is fully depressed.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection. Service Points P.00-6.

NO : Replace the ECM or PCM. Then go to Step 12.



STEP 8. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 9.

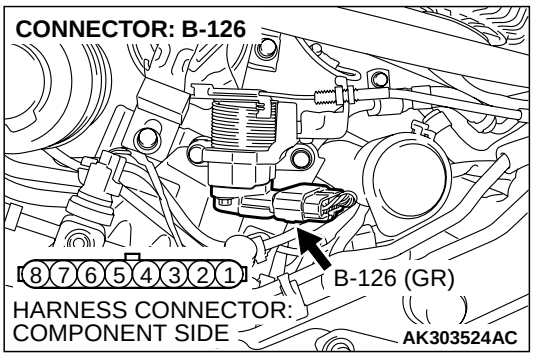
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.

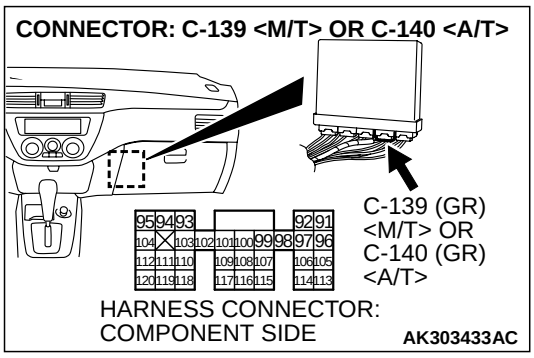
STEP 9. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 2) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 92).

Q: Is the harness wire in good condition?

YES : Go to Step 10.

NO : Repair it. Then go to Step 12.



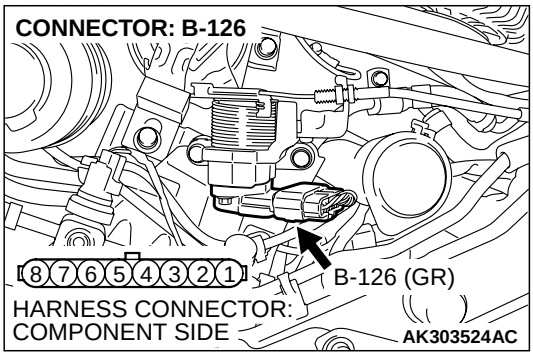


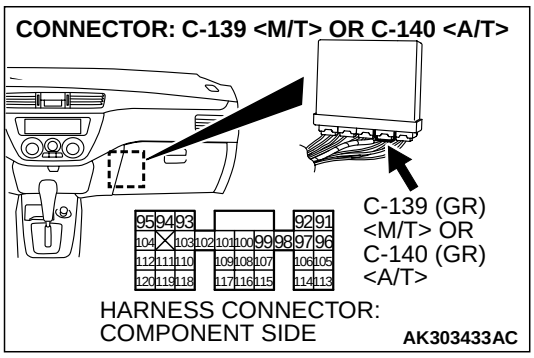
STEP 10. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 3) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 114).

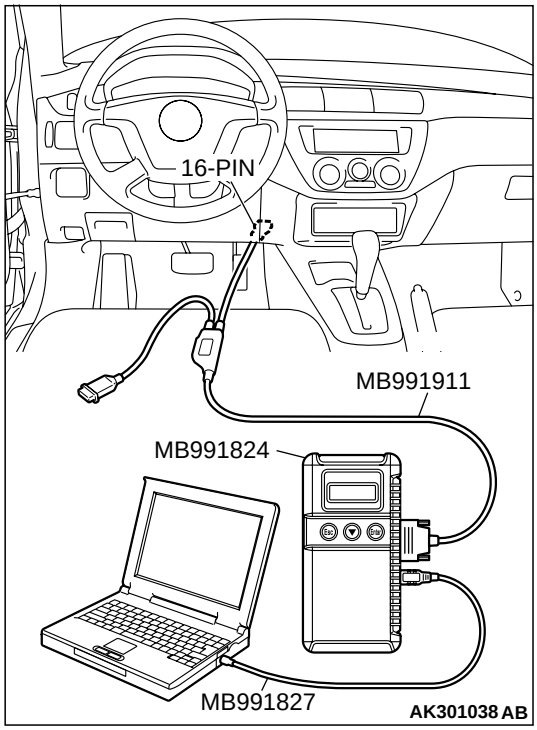
Q: Is the harness wire in good condition?

YES : Go to Step 11.

NO : Repair it. Then go to Step 12.







STEP 11. Using scan tool MB991958, check data list item 78: Accelerator Pedal Position Sensor (main).

⚠ CAUTION

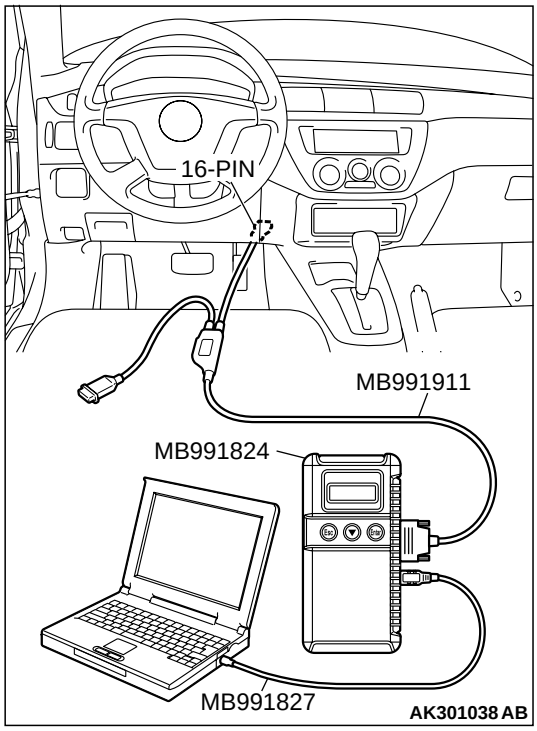
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 78, Accelerator Pedal Position Sensor (main).
- Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
- Output voltage is 4.0 volts or higher when accelerator pedal is fully depressed.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection. Service Points P.00-6.
NO : Replace the ECM or PCM. Then go to Step 12.



STEP 12. Using scan tool MB991958, read the diagnostic trouble code (DTC).

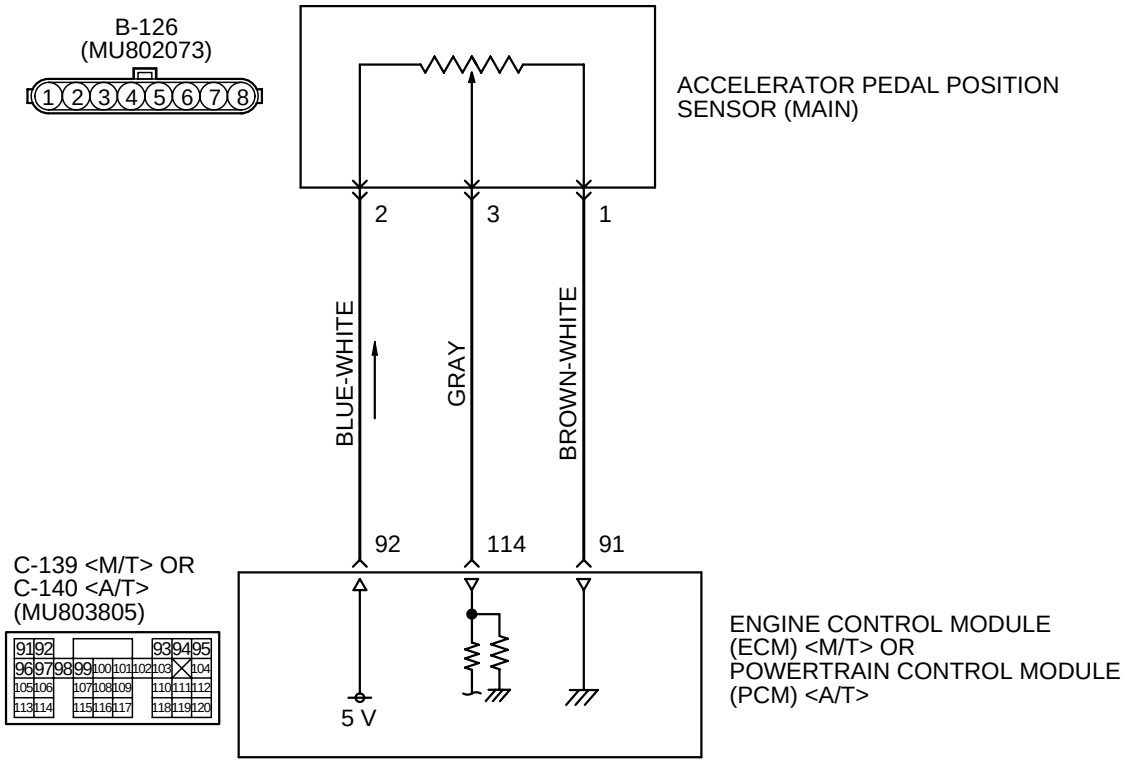
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2122 set?

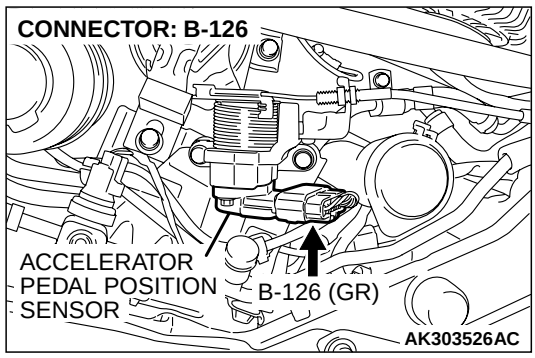
YES : Retry the troubleshooting.
NO : The inspection is complete.

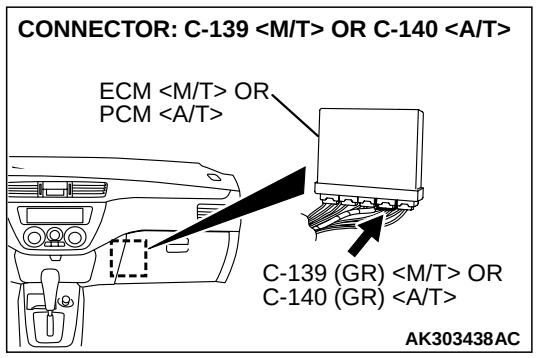
DTC P2123: Accelerator Pedal Position Sensor (main) Circuit High Input

Accelerator Pedal Position Sensor (main) Circuit



AK304005





CIRCUIT OPERATION

- A 5-volt power supply is applied on the accelerator pedal position sensor (main) power terminal (terminal No. 2) from the ECM <M/T> or PCM <A/T> (terminal No. 92).
  The ground terminal (terminal No. 1) is grounded with ECM <M/T> or PCM <A/T> (terminal No. 91).
- When the accelerator pedal is moved from the idle position to the fully opened position, the resistance between the accelerator pedal position sensor (main) output terminal (terminal No. 3) and ground terminal will increase according to the rotation.

TSB Revision

TECHNICAL DESCRIPTION

- The accelerator pedal position sensor (main) outputs voltage which corresponds to the accelerator pedal depression.
- The ECM <M/T> or PCM <A/T> checks whether the voltage is within a specified range.

DESCRIPTIONS OF MONITOR METHODS

- Accelerator pedal position sensor (main) output voltage is out of specified range.

MONITOR EXECUTION

- Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

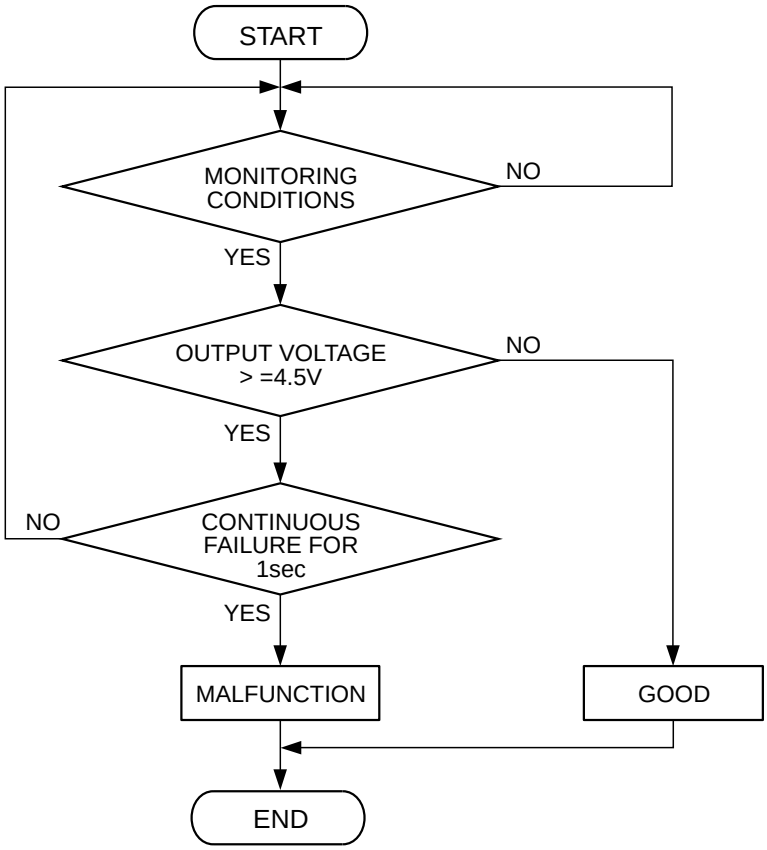
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302045

Check Conditions

- Ignition switch is "ON" position.
- Accelerator pedal position sensor (sub) output voltage is between 0.2 and 2.5 volts.

Judgement Criteria

- Accelerator pedal position sensor (main) output voltage should be 4.5 volts or higher for 1 second.

OBD-II DRIVE CYCLE PATTERN

None.

TSB Revision

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Accelerator pedal position sensor failed or maladjusted.
- Open or shorted accelerator pedal position sensor (main) circuit, or loose connector.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

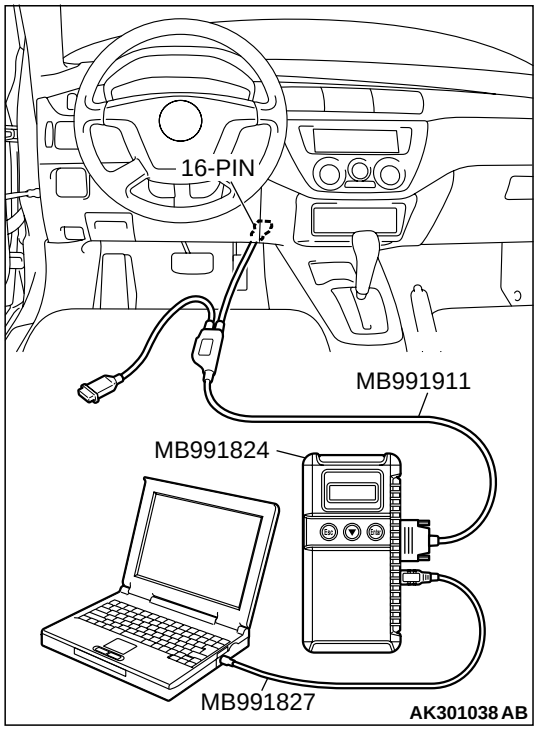
STEP 1. Using scan tool MB991958, check data list item 78: Accelerator Pedal Position Sensor (main).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 78, Accelerator Pedal Position Sensor (main).
  - Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
  - Output voltage is 4.0 volts or higher when accelerator pedal is fully depressed.

(4) Turn the ignition switch to the "LOCK"(OFF) position.



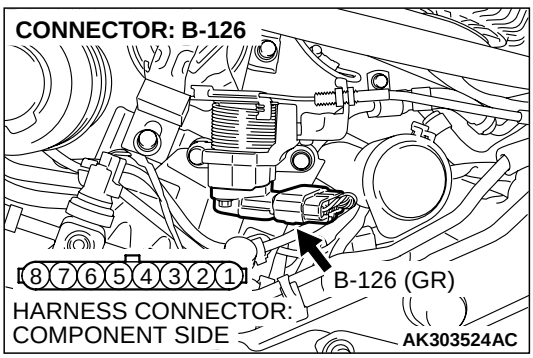
Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection. Service Points P.00-6.
NO : Go to Step 2.

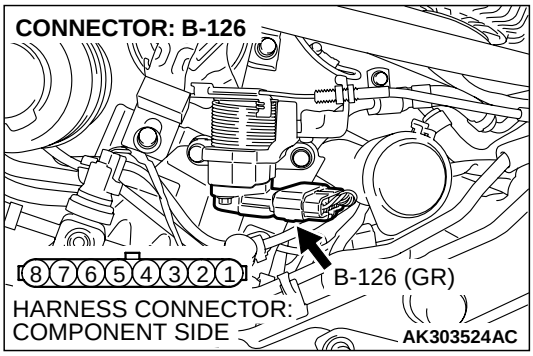
STEP 2. Check harness connector B-126 at accelerator pedal position sensor for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 3.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 8.

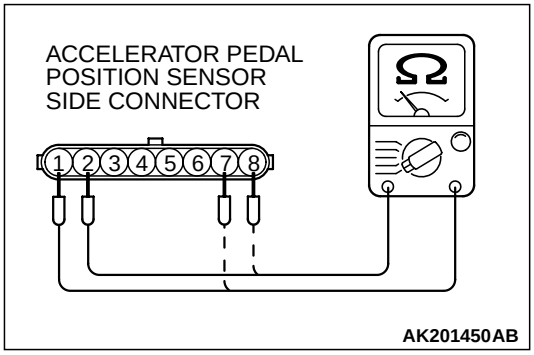


TSB Revision



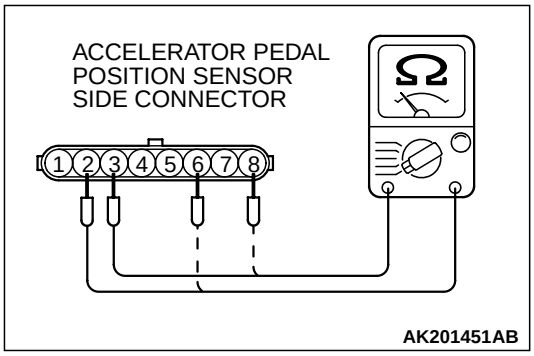
STEP 3. Check the accelerator pedal position sensor.

(1) Disconnect the accelerator pedal position sensor connector B-126.



(2) Measure resistance between terminal No. 1 and No. 2 and between terminal No. 7 and No. 8.

Standard value: 3.5 – 6.5 kΩ



(3) Measure resistance between terminal No. 2 and No. 3 and between terminal No. 6 and No. 8 when the accelerator pedal is gently depressed from idle position to the full open position.

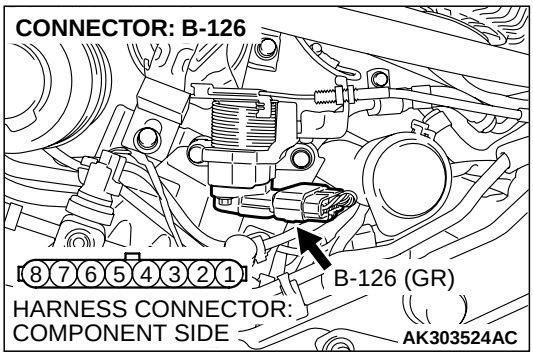
- Resistance value changes in accordance with the accelerator pedal depression smoothly.

Q: Is the resistance normal?

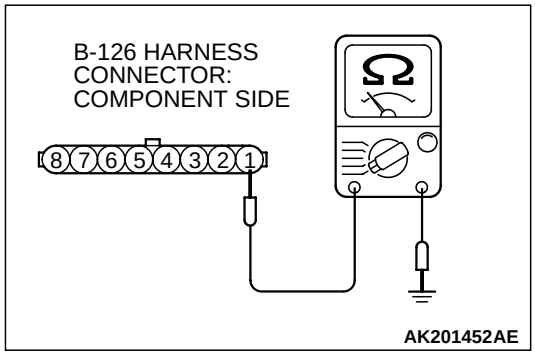
YES : Go to Step 4.

NO : Replace the accelerator pedal position sensor. Then go to Step 8.

STEP 4. Check the continuity at accelerator pedal position sensor harness side connector B-126.



(1) Disconnect the connector B-126 and measure at the harness side.



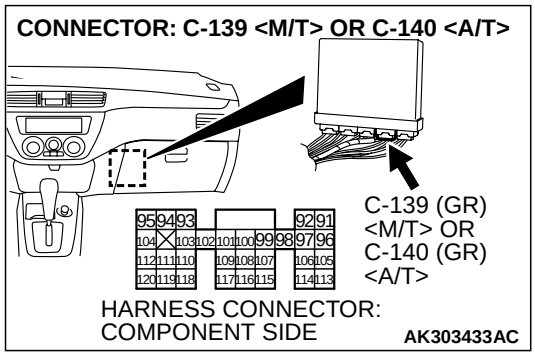
(2) Measure the continuity between terminal No. 1 and ground.
- Should be less than 2 ohms.

Q: Does continuity exist?

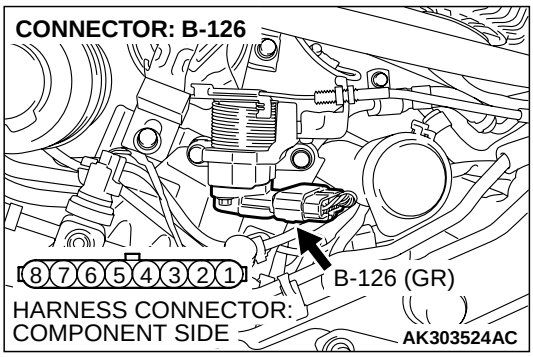
YES : Go to Step 7.
NO : Go to Step 5.

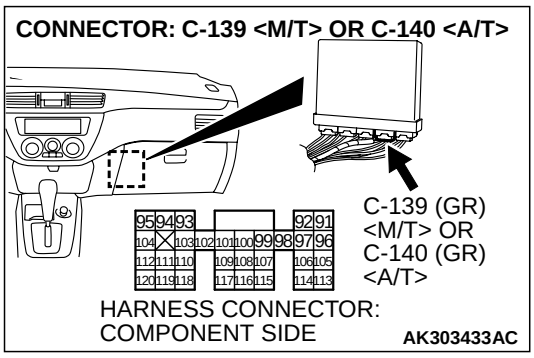
STEP 5. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?



YES : Go to Step 6.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 8.





STEP 6. Check for open circuit and harness damage between accelerator pedal position sensor connector B-126 (terminal No. 1) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 91).

Q: Is the harness wire in good condition?

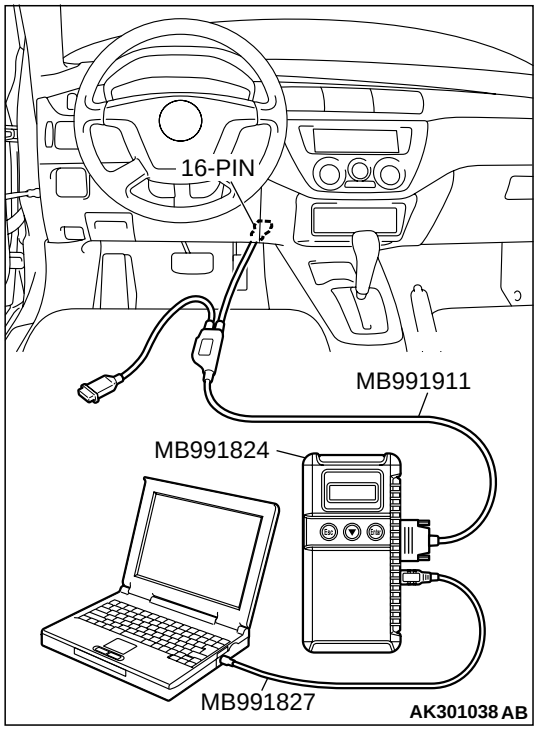
YES : Go to Step 7.

NO : Repair it. Then go to Step 8.

STEP 7. Using scan tool MB991958, check data list item 78: Accelerator Pedal Position Sensor (main).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.



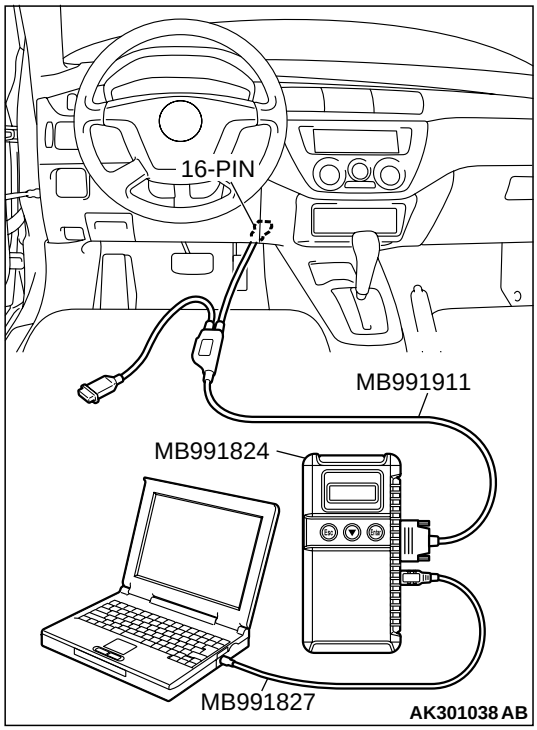
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 78, Accelerator Pedal Position Sensor (main).
- Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
- Output voltage is 4.0 volts or higher when accelerator pedal is fully depressed.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection. Service Points P.00-6.
NO : Replace the ECM or PCM. Then go to Step 8.

STEP 8. Using scan tool MB991958, read the diagnostic trouble code (DTC).



(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2123 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

TSB Revision

DTC P2126: Accelerator Pedal Position Sensor (sub) Circuit Range/Performance Problem

ACCELERATOR PEDAL POSITION SENSOR (SUB) CIRCUIT RANGE/PERFORMANCE PROBLEM CIRCUIT

- Refer to, DTC P2127 – Accelerator Pedal Position Sensor (Sub) Circuit P.13B-686.
- Refer to INSPECTION PROCEDURE 35 – Accelerator Pedal Position Switch Circuit P.13B-857.

CIRCUIT OPERATION

- Refer to, DTC P2127 – Accelerator Pedal Position Sensor (sub) Circuit P.13B-686.
- Refer to INSPECTION PROCEDURE 35 – Accelerator Pedal Position Switch Circuit P.13B-857.

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> checks the accelerator pedal position sensor (sub) output signal characteristics for abnormal conditions.

DESCRIPTIONS OF MONITOR METHODS

- Accelerator pedal position sensor (sub) output voltage is greater than that the specified value when the accelerator pedal position switch is on.

MONITOR EXECUTION

- Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

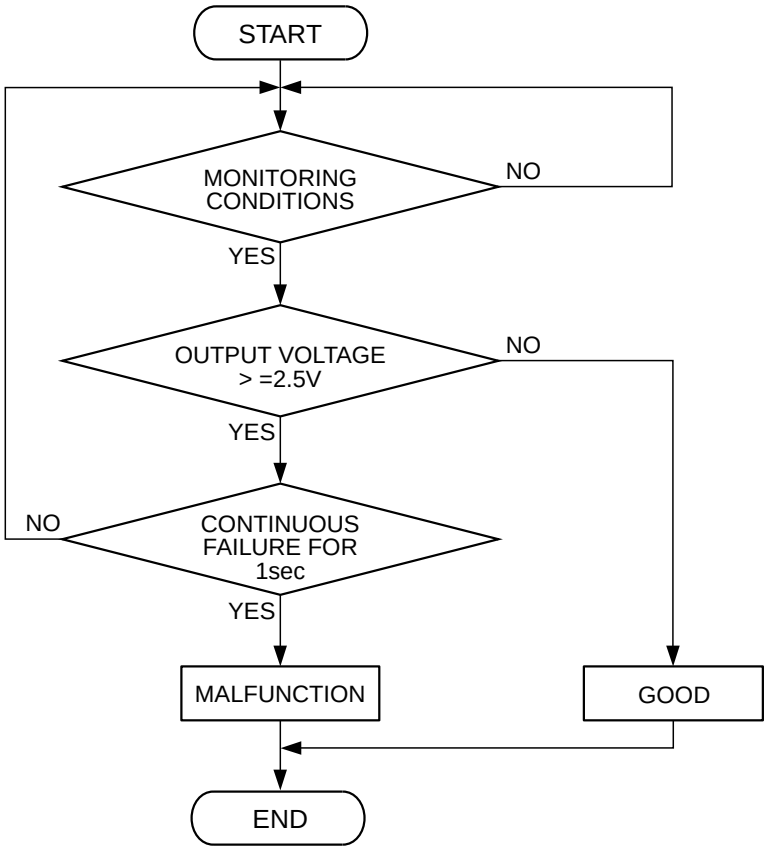
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302046

Check Condition

- Ignition switch is "ON" position.
- Accelerator pedal position switch: ON
- Accelerator pedal position sensor (main) failure detected.

Judgement Criteria

- Accelerator pedal position sensor (sub) output voltage is 2.5 volts or higher for 1 second.

OBD-II DRIVE CYCLE PATTERN

None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Accelerator pedal position sensor failed or maladjusted.
- Open or shorted accelerator pedal position sensor (sub) circuit, or loose connector.
- Accelerator pedal position switch failed or maladjusted.
- Open or shorted accelerator pedal position switch circuit, or loose connector.
- ECM failed. <M/T>
- PCM failed. <A/T>

TSB Revision

DIAGNOSIS

Required Special Tools:

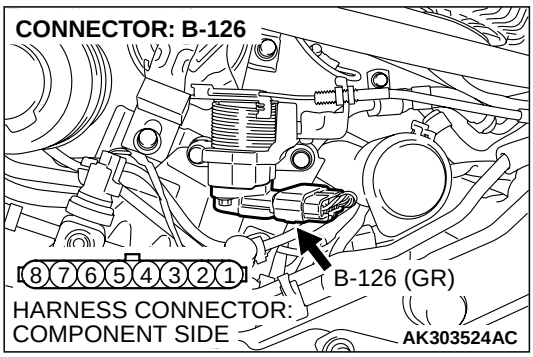
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

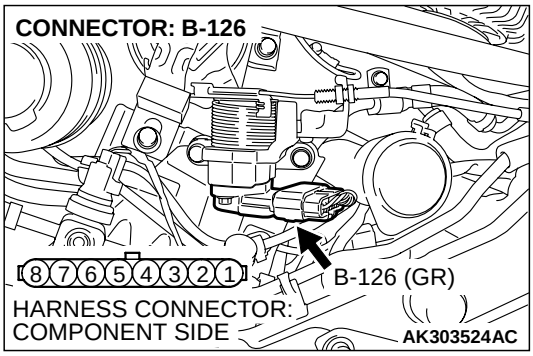
STEP 1. Check harness connector B-126 at accelerator pedal position sensor and accelerator pedal position switch for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 2.

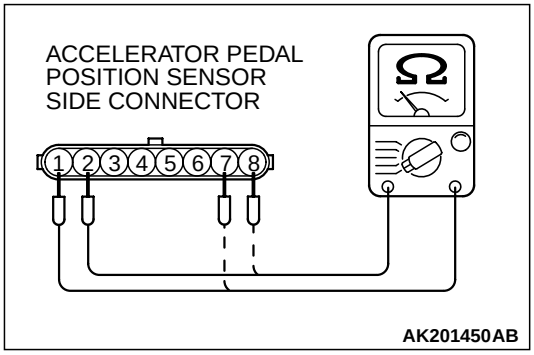
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 11.





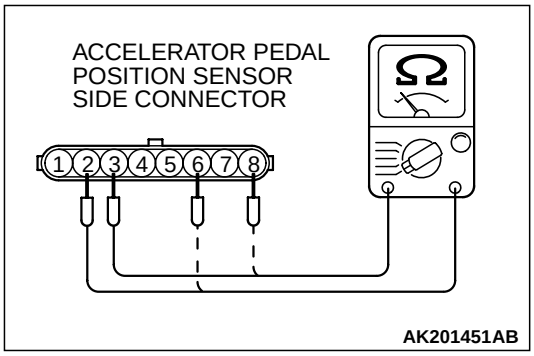
STEP 2. Check the accelerator pedal position sensor.

(1) Disconnect the accelerator pedal position sensor connector B-126.



(2) Measure resistance between terminal No. 1 and No. 2 and between terminal No. 7 and No. 8.

Standard value: 3.5 – 6.5 kΩ



(3) Measure resistance between terminal No. 2 and No. 3 and between terminal No. 6 and No. 8 when the accelerator pedal is gently depressed from idle position to the full open position.

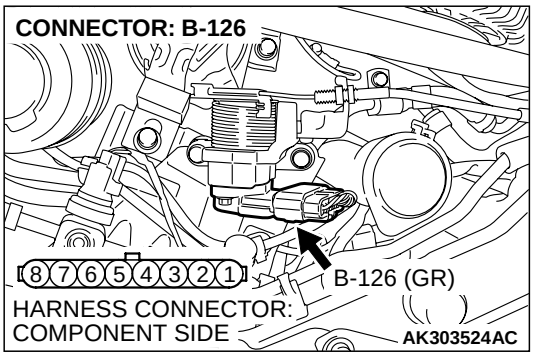
- Resistance value changes in accordance with the accelerator pedal depression smoothly.

Q: Is the resistance normal?

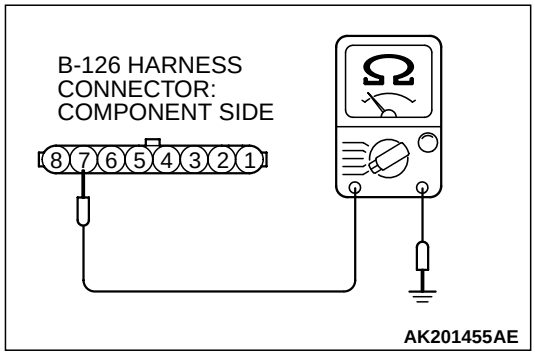
YES : YES: Go to Step 3.

NO : Replace the accelerator pedal position sensor. Then go to Step 11.

STEP 3. Check the continuity at accelerator pedal position sensor harness side connector B-126.



(1) Disconnect the connector B-126 and measure at the harness side.



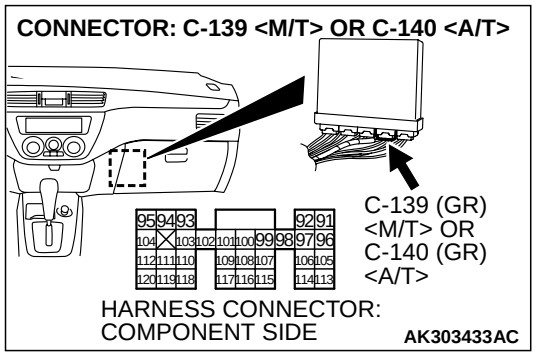
(2) Measure the continuity between terminal No. 7 and ground.
- Should be less than 2 ohms.

Q: Does continuity exist?

YES : Go to Step 7.
NO : Go to Step 4.

STEP 4. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?



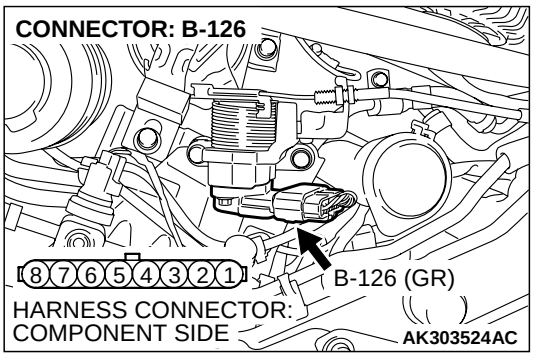
YES : Go to Step 5.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 11.

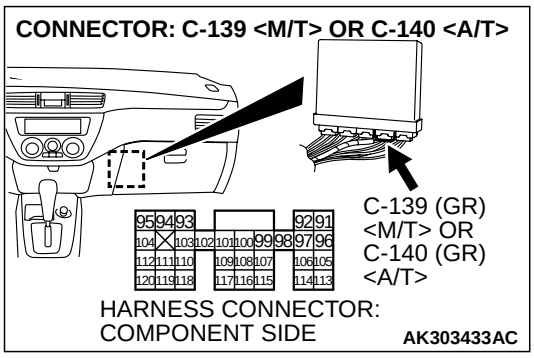
STEP 5. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 7) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 96).

Q: Is the harness wire in good condition?

YES : Go to Step 6.

NO : Repair it. Then go to Step 11.





STEP 6. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

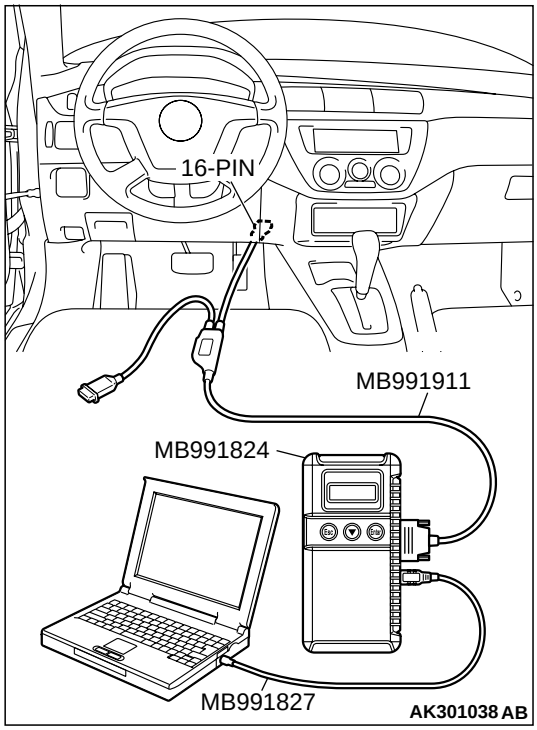
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

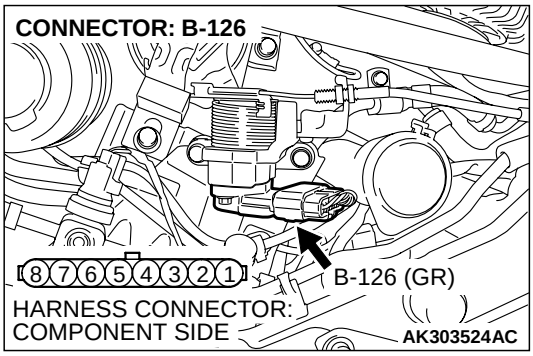
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2126 set?

YES : Replace the ECM or PCM.Then go to Step 11.

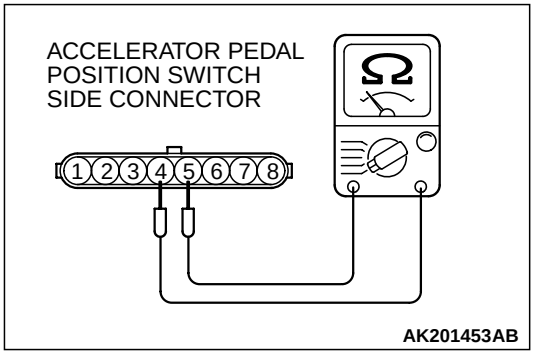
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.





STEP 7. Check the accelerator pedal position switch.

(1) Disconnect the accelerator pedal position switch connector B-126.



(2) Check the continuity between accelerator pedal position switch side connector terminal No. 4 and No. 5.

Standard value:
Continuity (foot released from accelerator pedal)
Non-continuity (accelerator pedal depressed)

Q: Is the switch operating properly?

YES : Go to Step 8.

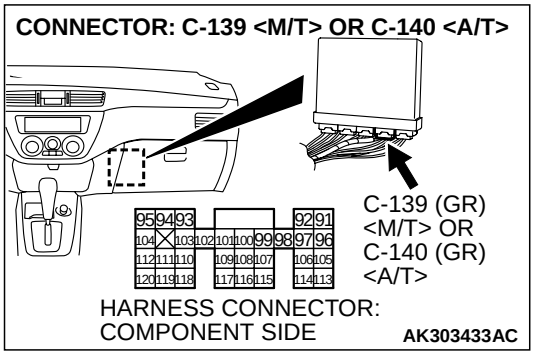
NO : Replace the accelerator pedal position sensor. Then go to Step 11.

STEP 8. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 9.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 11.

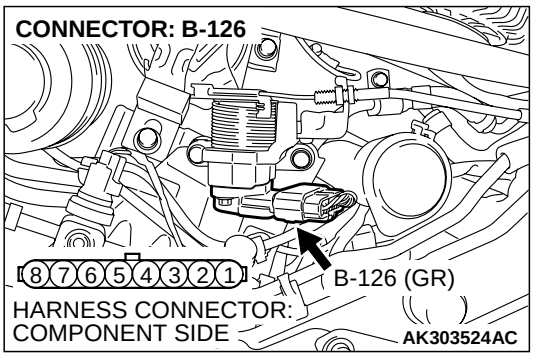


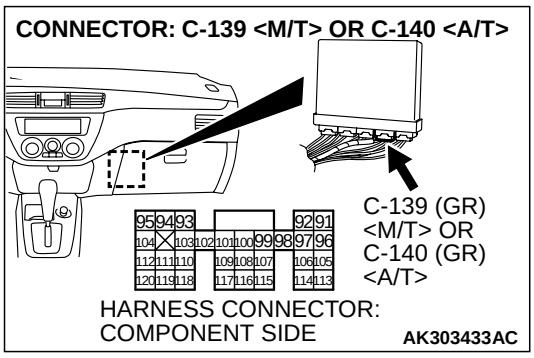
STEP 9. Check for short circuit to ground between accelerator pedal position switch connector B-126 (terminal No. 4) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 38).

Q: Is the harness wire in good condition?

YES : Go to Step 10.

NO : Repair it. Then go to Step 11.





STEP 10. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

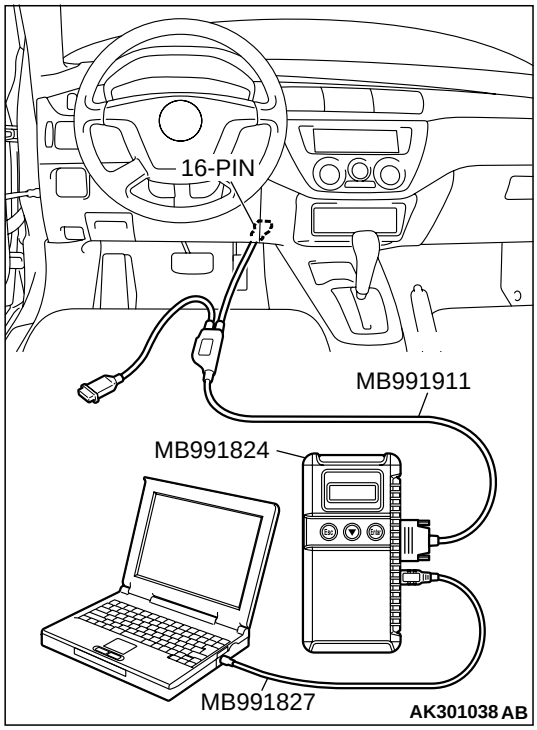
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

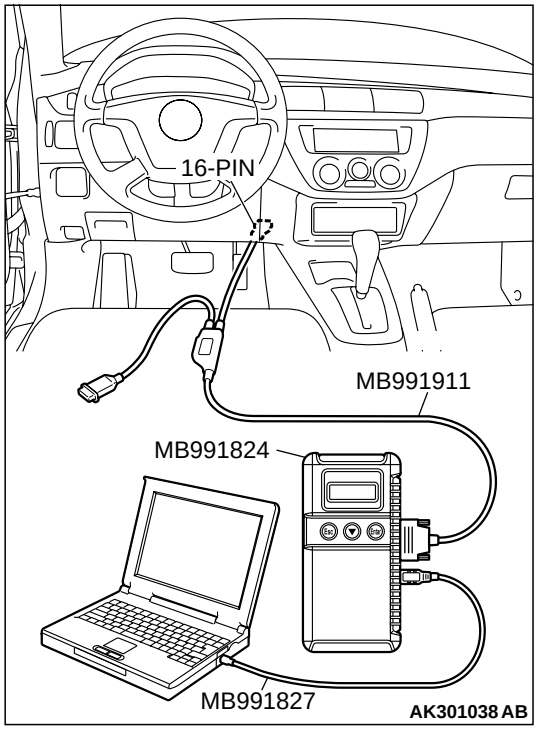
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2126 set?

YES : Replace the ECM or PCM.Then go to Step 11.

NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.





STEP 11. Using scan tool MB991958, read the diagnostic trouble code (DTC).

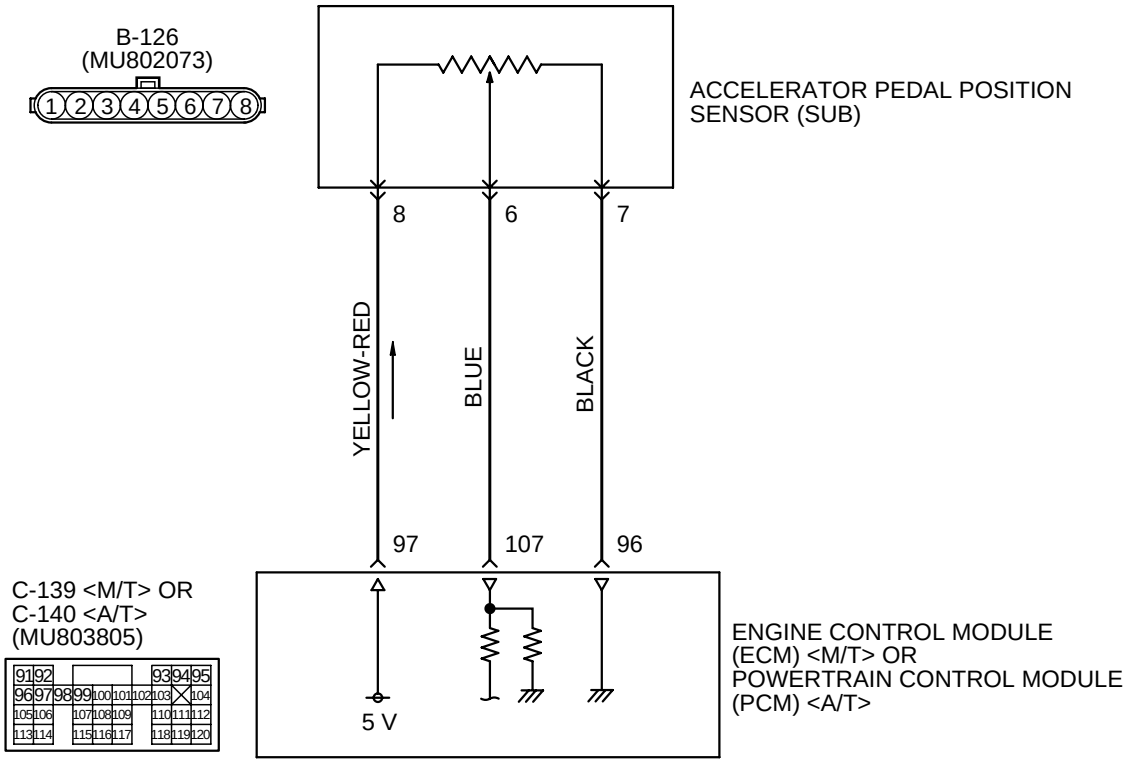
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2126 set?

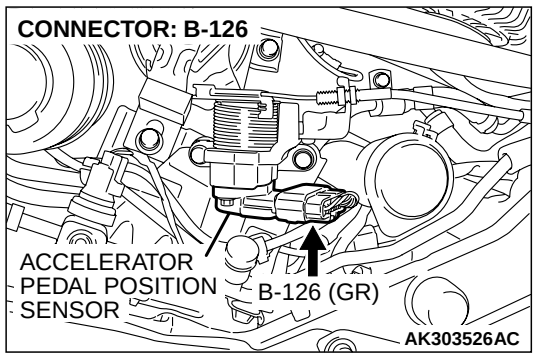
YES : Retry the troubleshooting.
NO : The inspection is complete.

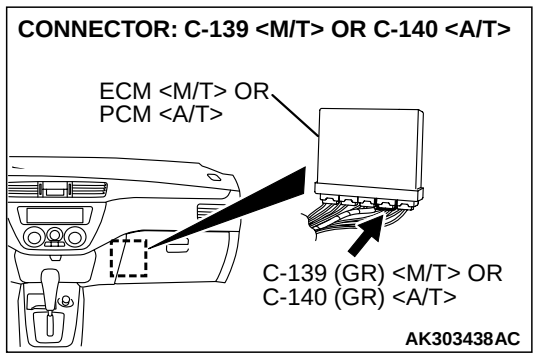
DTC P2127: Accelerator Pedal Position Sensor (sub) Circuit Low Input

Accelerator Pedal Position Sensor (sub) Circuit



AK304006





CIRCUIT OPERATION

- A 5-volt power supply is applied on the accelerator pedal position sensor (sub) power terminal (terminal No. 8) from the ECM <M/T> or PCM <A/T> (terminal No. 97).
  The ground terminal (terminal No. 7) is grounded with ECM <M/T> or PCM <A/T> (terminal No. 96).
- When the accelerator pedal is moved from the idle position to the fully opened position, the resistance between the accelerator pedal position sensor (sub) output terminal (terminal No. 6) and ground terminal will increase according to the rotation.

TSB Revision

TECHNICAL DESCRIPTION

- The accelerator pedal position sensor (sub) outputs voltage which corresponds to the accelerator pedal depression.
- The ECM <M/T> or PCM <A/T> checks whether the voltage is within a specified range.

DESCRIPTIONS OF MONITOR METHODS

- Accelerator pedal position sensor (sub) output voltage is out of specified range.

MONITOR EXECUTION

- Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

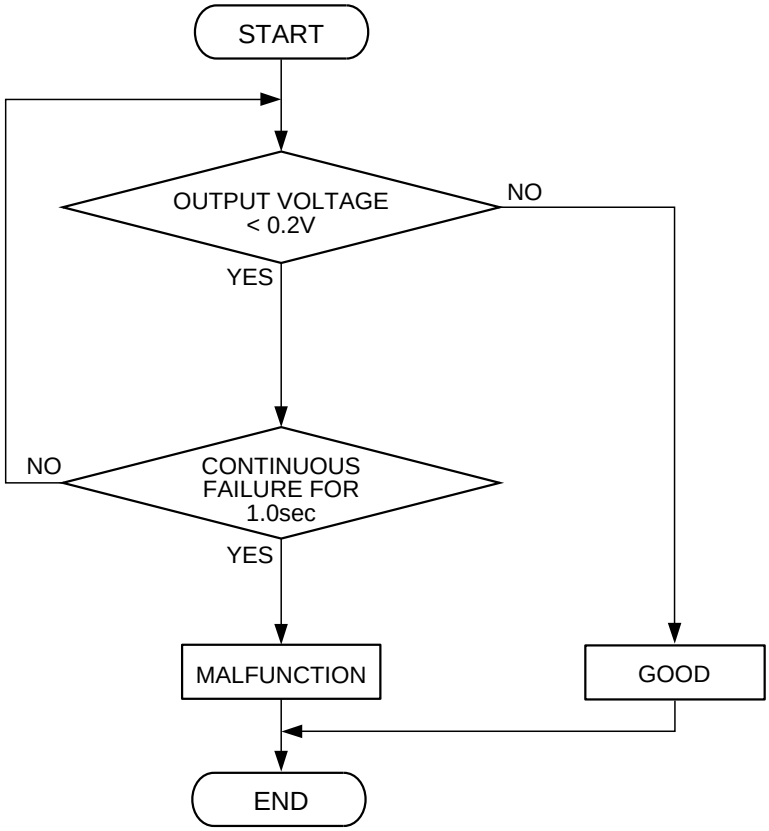
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302044

Check Conditions

- Ignition switch is "ON" position.

Judgement Criteria

- Accelerator pedal position sensor (sub) output voltage is 0.2 volts or less for 1 second.

OBD-II DRIVE CYCLE PATTERN

None.

TSB Revision

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

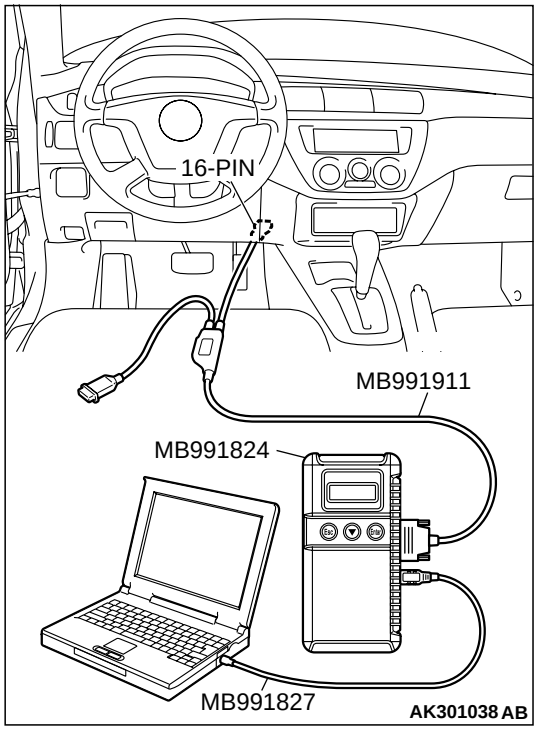
- Accelerator pedal position sensor failed or maladjusted.
- Open or shorted accelerator pedal position sensor (sub) circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, check data list item 77: Accelerator Pedal Position Sensor (sub).



⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

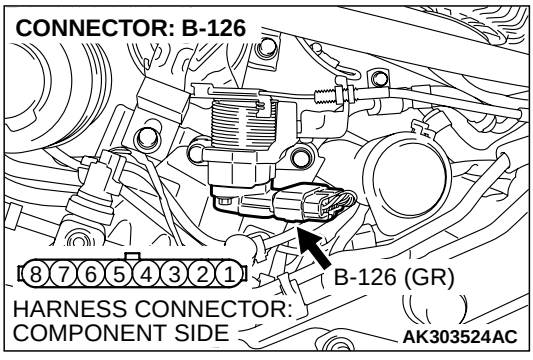
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 77, Accelerator Pedal Position Sensor (sub).
  - Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
  - Output voltage is 3.7 volts or higher when accelerator pedal is fully depressed.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the sensor operating properly?

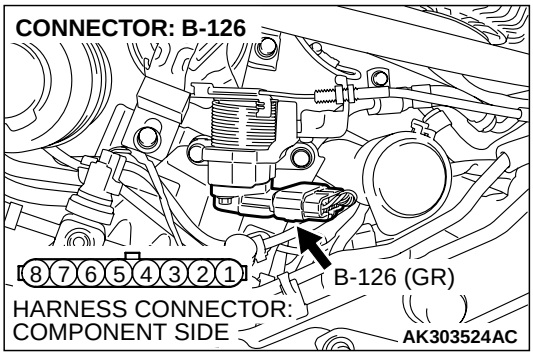
YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.
NO : Go to Step 2.

STEP 2. Check harness connector B-126 at accelerator pedal position sensor for damage.



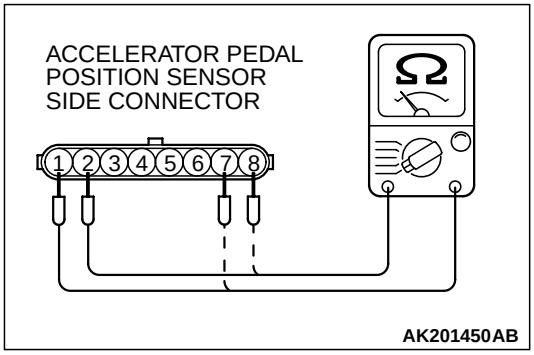
Q: Is the harness connector in good condition?

YES : Go to Step 3.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.



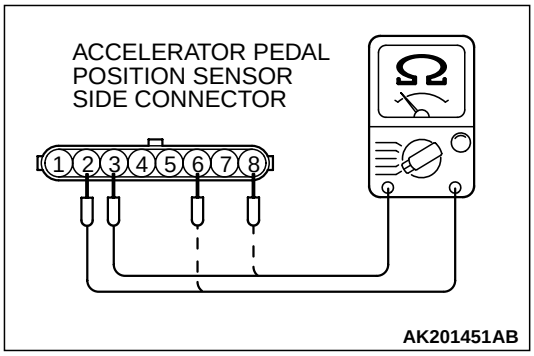
STEP 3. Check the accelerator pedal position sensor.

(1) Disconnect the accelerator pedal position sensor connector B-126.



(2) Measure resistance between terminal No. 1 and No. 2 and between terminal No. 7 and No. 8.

Standard value: 3.5 – 6.5 kΩ



(3) Measure resistance between terminal No. 2 and No. 3 and between terminal No. 6 and No. 8 when the accelerator pedal is gently depressed from idle position to the full open position.

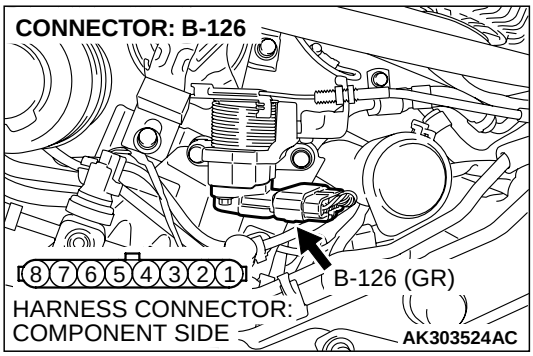
- Resistance value changes in accordance with the accelerator pedal depression smoothly.

Q: Is the resistance normal?

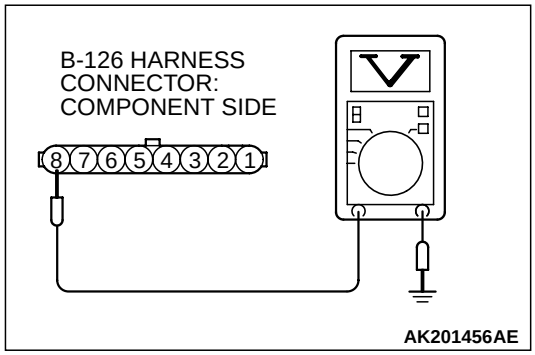
YES : Go to Step 4.

NO : Replace the accelerator pedal position sensor. Then go to Step 12.

STEP 4. Measure the sensor supply voltage at accelerator pedal position sensor harness side connector B-126.



(1) Disconnect the connector B-126 and measure at the harness side.
(2) Turn the ignition switch to the "ON" position.



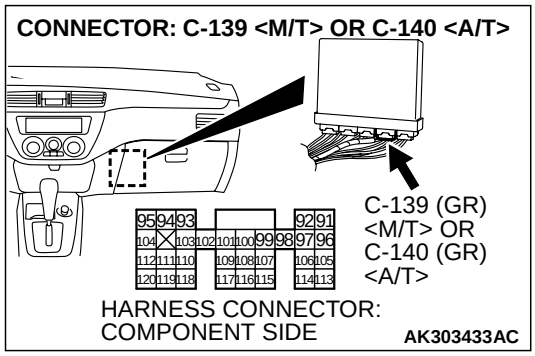
(3) Measure the voltage between terminal No. 8 and ground.
- Voltage should be between 4.8 and 5.2 volts.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the measured voltage between 4.8 and 5.2 volts?

YES : Go to Step 8.
NO : Go to Step 5.

STEP 5. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.



Q: Is the harness connector in good condition?

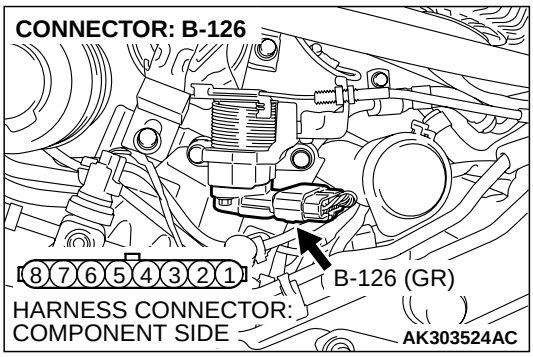
YES : Go to Step 6.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.

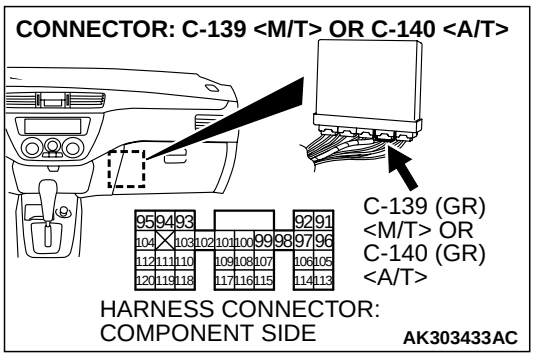
STEP 6. Check for open circuit and short circuit to ground between accelerator pedal position sensor connector B-126 (terminal No. 8) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 97).

Q: Is the harness wire in good condition?

YES : Go to Step 7.

NO : Repair it. Then go to Step 12.





STEP 7. Using scan tool MB991958, check data list item 77: Accelerator Pedal Position Sensor (sub).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

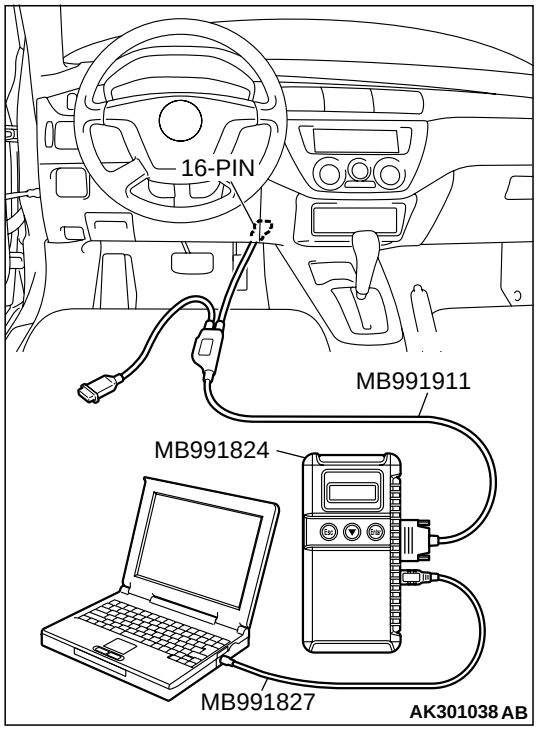
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 77, Accelerator Pedal Position Sensor (sub).
- Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
- Output voltage is 3.7 volts or higher when accelerator pedal is fully depressed.

(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

NO : Replace the ECM or PCM. Then go to Step 12.

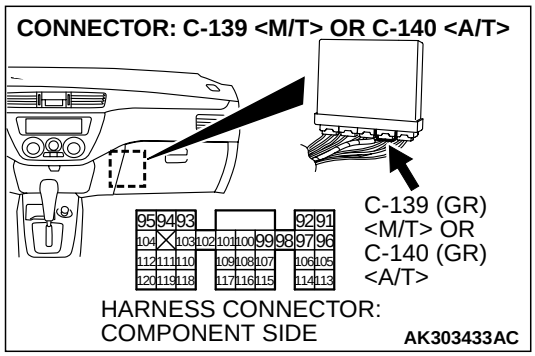


STEP 8. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 9.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 12.

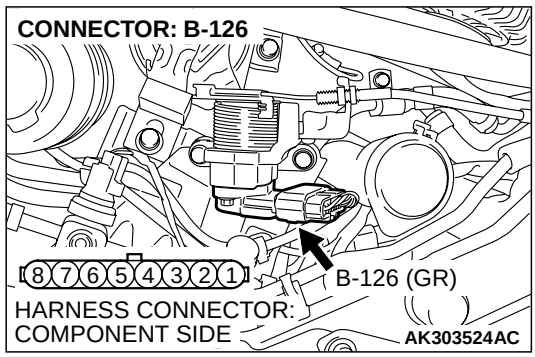


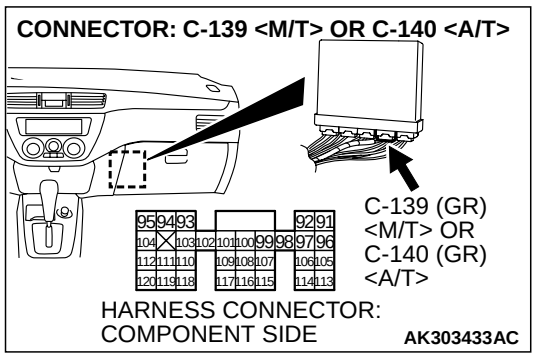
STEP 9. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 8) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 97).

Q: Is the harness wire in good condition?

YES : Go to Step 10.

NO : Repair it. Then go to Step 12.



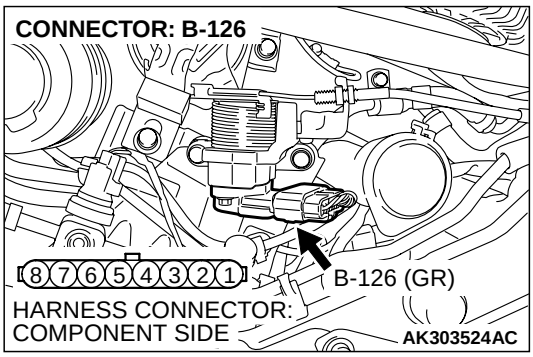


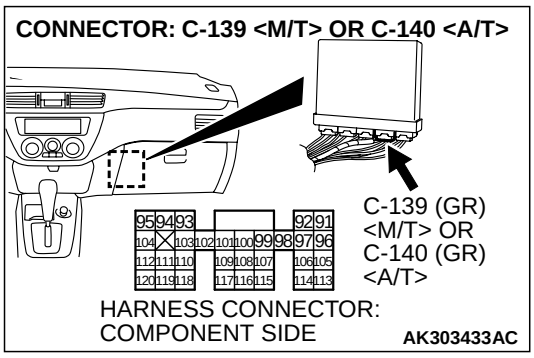
STEP 10. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 6) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 107).

Q: Is the harness wire in good condition?

YES : Go to Step 11.

NO : Repair it. Then go to Step 12.





STEP 11. Using scan tool MB991958, check data list item 77: Accelerator Pedal Position Sensor (sub).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

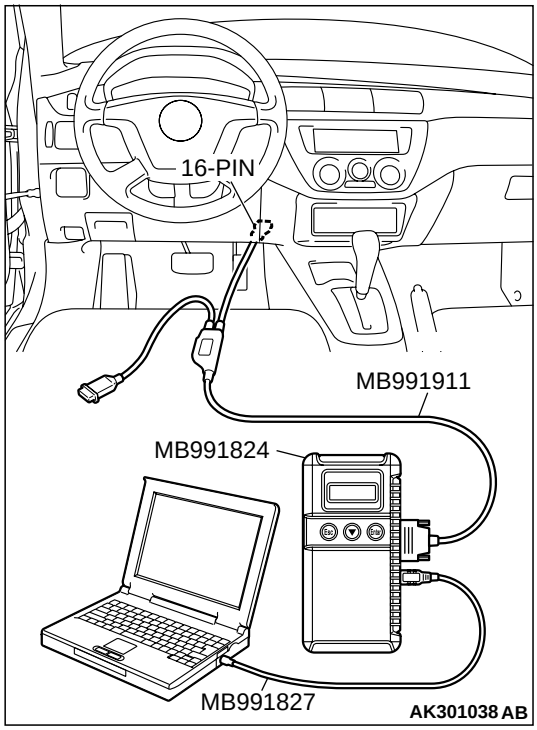
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 77, Accelerator Pedal Position Sensor (sub).
- Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
- Output voltage is 3.7 volts or higher when accelerator pedal is fully depressed.

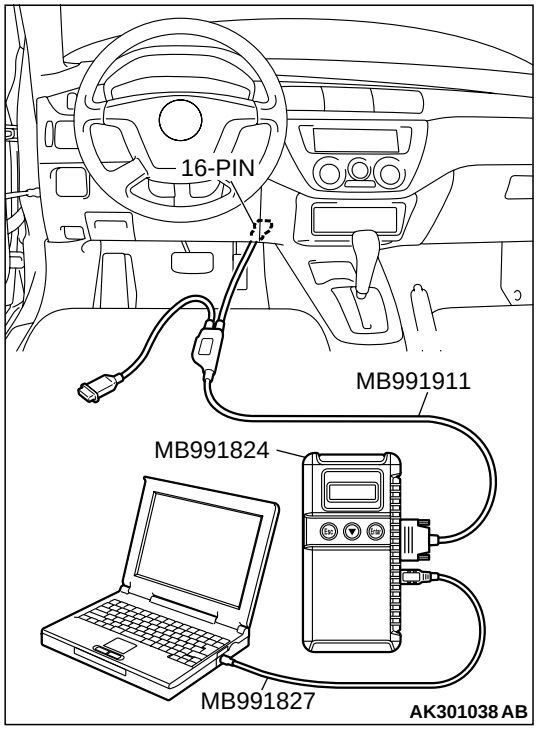
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

NO : Replace the ECM or PCM. Then go to Step 12.





STEP 12. Using scan tool MB991958, read the diagnostic trouble code (DTC).

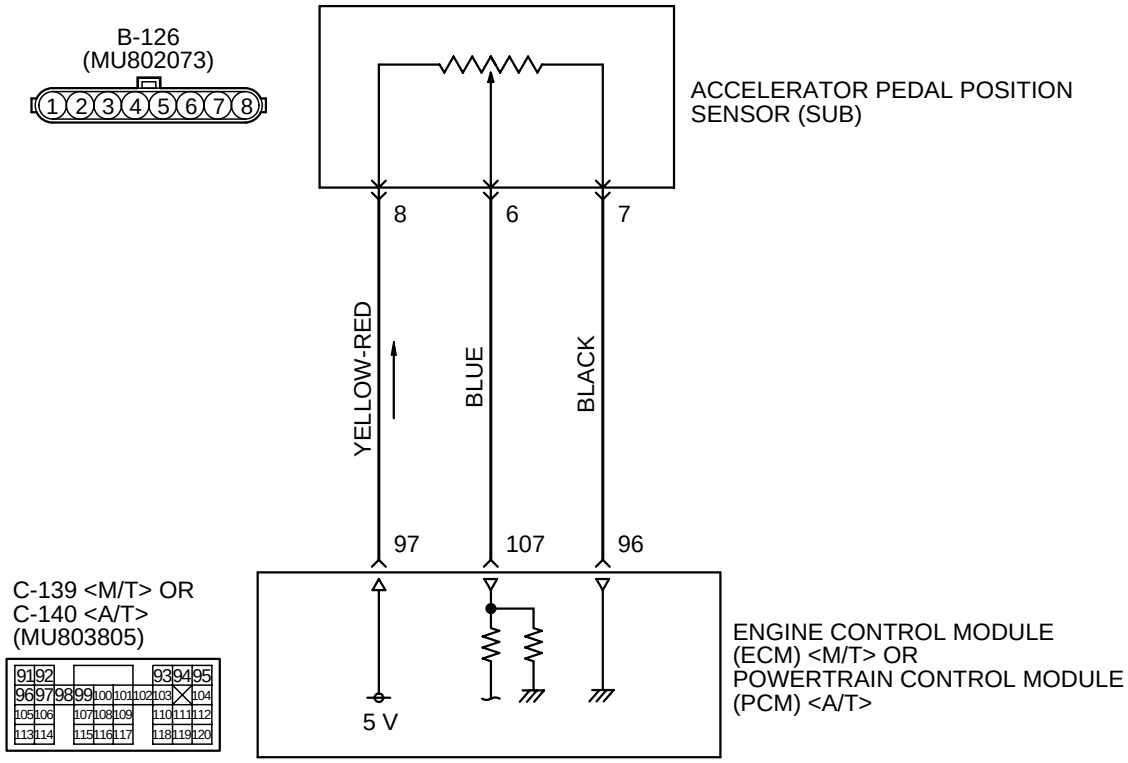
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2127 set?

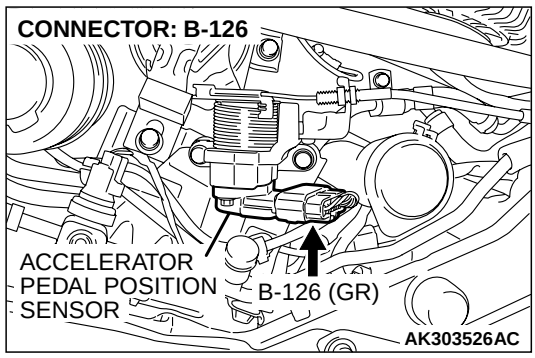
YES : Retry the troubleshooting.
NO : The inspection is complete.

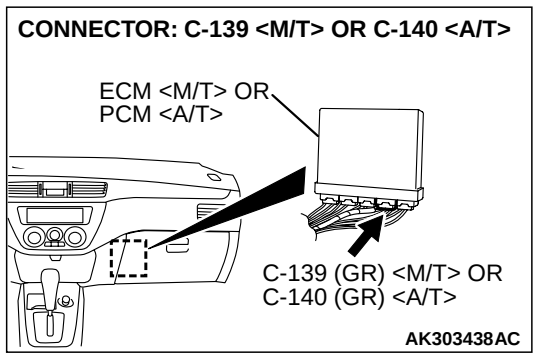
DTC P2128: Accelerator Pedal Position Sensor (sub) Circuit High Input

Accelerator Pedal Position Sensor (sub) Circuit



AK304006





CIRCUIT OPERATION

- A 5-volt power supply is applied on the accelerator pedal position sensor (sub) power terminal (terminal No. 8) from the ECM <M/T> or PCM <A/T> (terminal No. 97).
  The ground terminal (terminal No. 7) is grounded with ECM <M/T> or PCM <A/T> (terminal No. 96).
- When the accelerator pedal is moved from the idle position to the fully opened position, the resistance between the accelerator pedal position sensor (sub) output terminal (terminal No. 6) and ground terminal will increase according to the rotation.

TSB Revision

TECHNICAL DESCRIPTION

- The accelerator pedal position sensor (sub) outputs voltage which corresponds to the accelerator pedal depression.
- The ECM <M/T> or PCM <A/T> checks whether the voltage is within a specified range.

DESCRIPTIONS OF MONITOR METHODS

- Accelerator pedal position sensor (sub) output voltage is out of specified range.

MONITOR EXECUTION

- Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

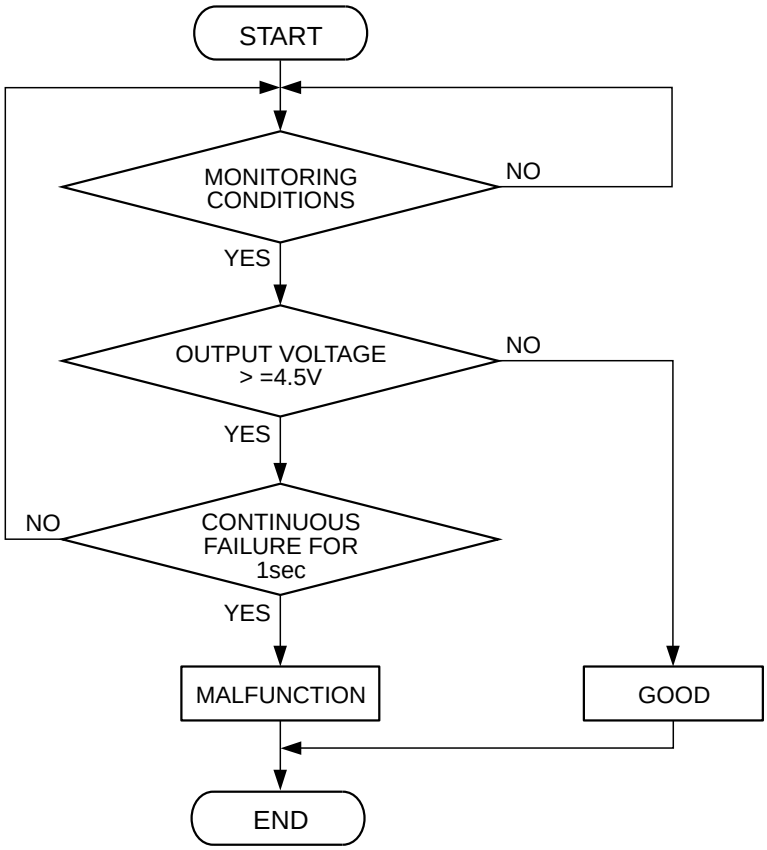
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302045

Check Conditions

- Ignition switch is "ON" position.
- Accelerator pedal position sensor (main) output voltage is between 0.2 and 2.5 volts.

Judgement Criteria

- Accelerator pedal position sensor (sub) output voltage is 4.5 volts or higher for 1 second.

TSB Revision

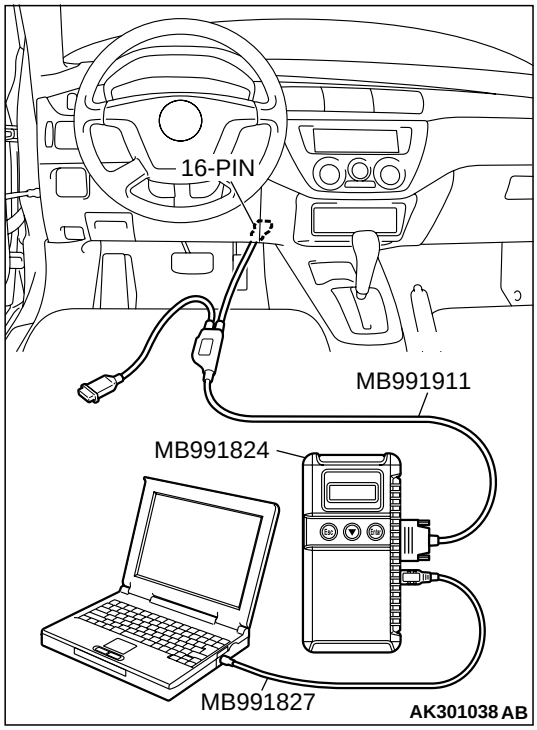
OBD-II DRIVE CYCLE PATTERN
None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)
- Accelerator pedal position sensor failed or maladjusted.
- Open or shorted accelerator pedal position sensor (sub) circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

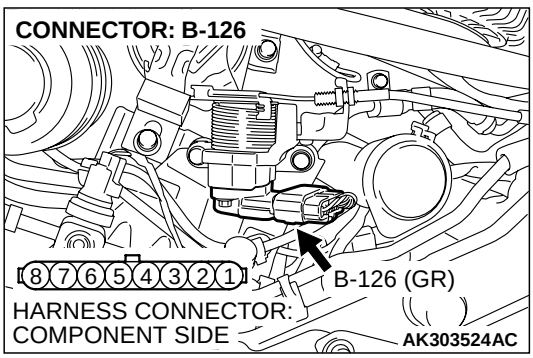
STEP 1. Using scan tool MB991958, check data list item 77: Accelerator Pedal Position Sensor (sub).



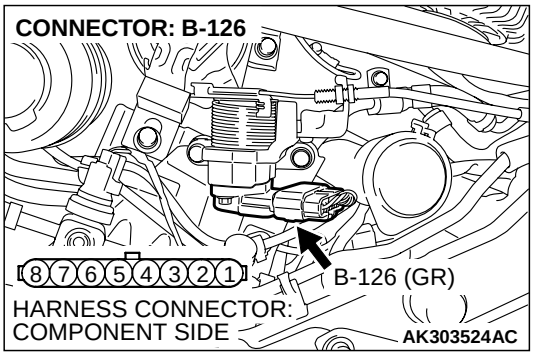
⚠ CAUTION
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 77, Accelerator Pedal Position Sensor (sub).
  - Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
  - Output voltage is 3.7 volts or higher when accelerator pedal is fully depressed.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the sensor operating properly?
YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.
NO : Go to Step 2.

STEP 2. Check harness connector B-126 at accelerator pedal position sensor for damage.

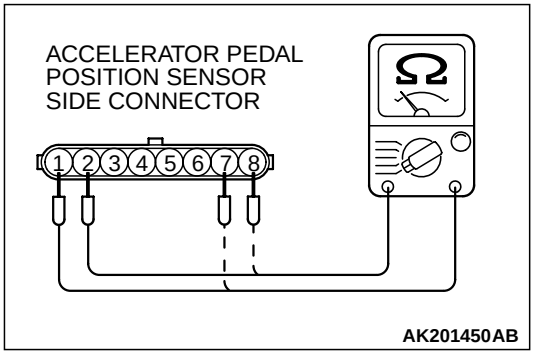


Q: Is the harness connector in good condition?
YES : Go to Step 3.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 8.



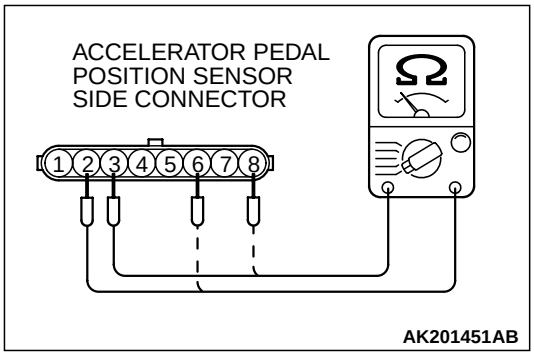
STEP 3. Check the accelerator pedal position sensor.

(1) Disconnect the accelerator pedal position sensor connector B-126.



(2) Measure resistance between terminal No. 1 and No. 2 and between terminal No. 7 and No. 8.

Standard value: 3.5 – 6.5 kΩ



(3) Measure resistance between terminal No. 2 and No. 3 and between terminal No. 6 and No. 8 when the accelerator pedal is gently depressed from idle position to the full open position.

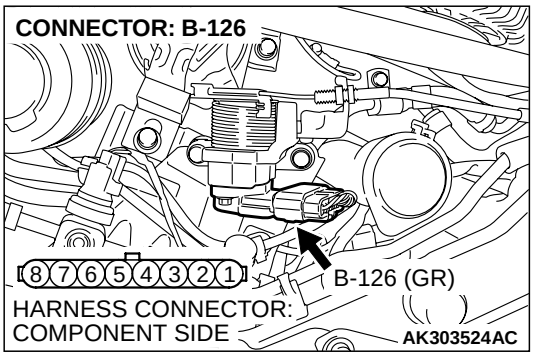
- Resistance value changes in accordance with the accelerator pedal depression smoothly.

Q: Is the resistance normal?

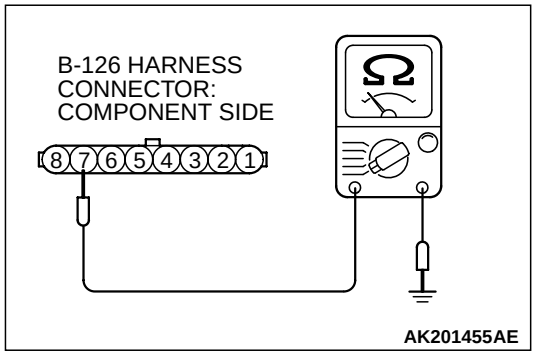
YES : Go to Step 4.

NO : Replace the accelerator pedal position sensor. Then go to Step 8.

STEP 4. Check the continuity at accelerator pedal position sensor harness side connector B-126.



(1) Disconnect the connector B-126 and measure at the harness side.



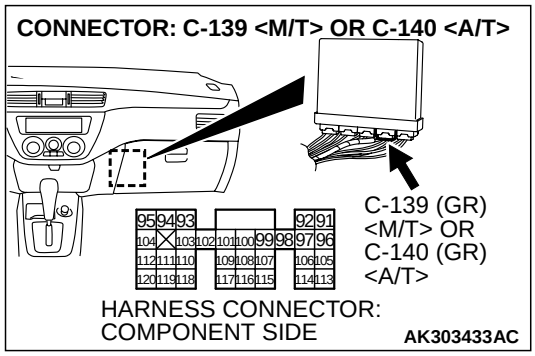
(2) Measure the continuity between terminal No. 7 and ground.
- Should be less than 2 ohms.

Q: Does continuity exist?

YES : Go to Step 7.
NO : Go to Step 5.

STEP 5. Check harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?



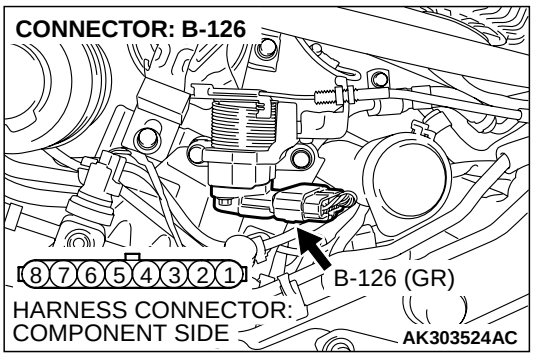
YES : Go to Step 6.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 8.

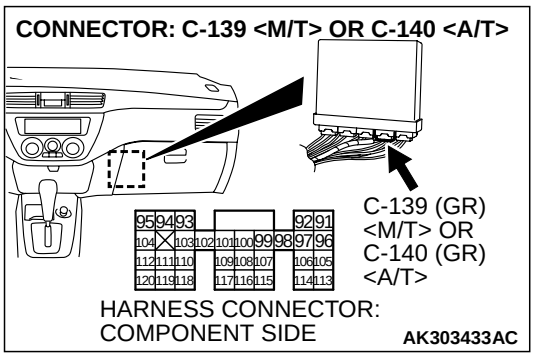
STEP 6. Check for open circuit and harness damage between accelerator pedal position sensor connector B-126 (terminal No. 7) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 96.)

Q: Is the harness wire in good condition?

YES : Go to Step 7.

NO : Repair it. Then go to Step 8.





STEP 7. Using scan tool MB991958, check data list item 77: Accelerator Pedal Position Sensor (sub).

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

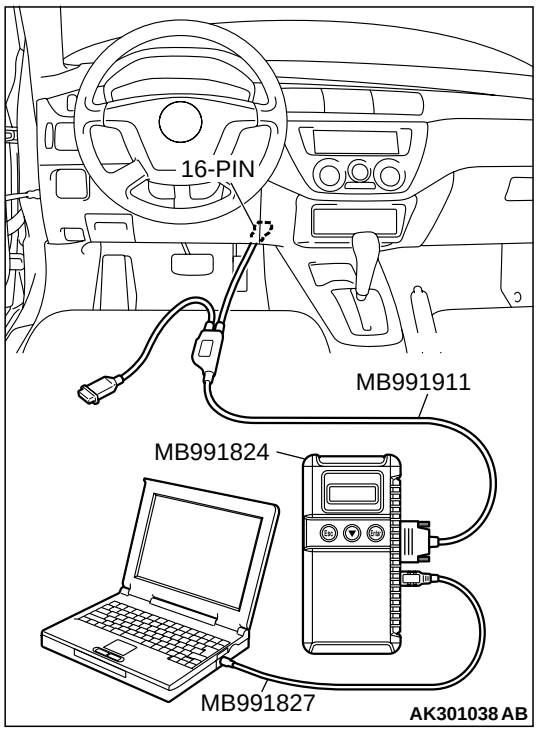
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 77, Accelerator Pedal Position Sensor (sub).
- Output voltage is between 0.335 and 0.935 volts when foot is released from accelerator pedal.
- Output voltage is 3.7 volts or higher when accelerator pedal is fully depressed.

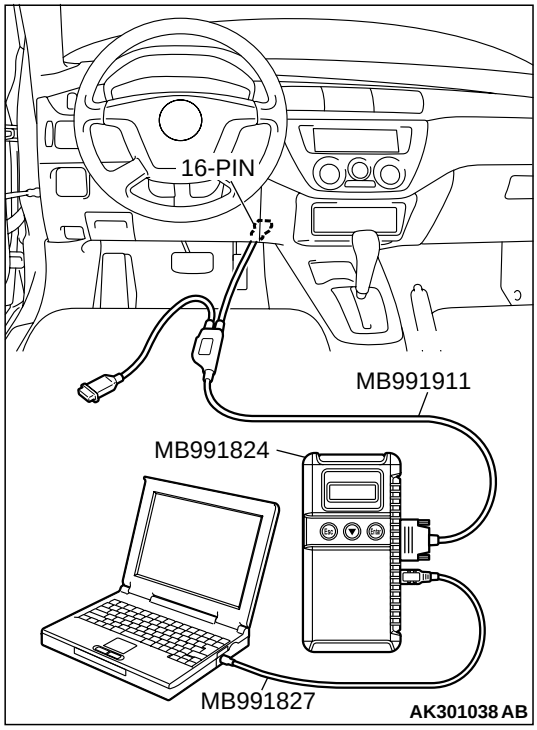
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

NO : Replace the ECM or PCM. Then go to Step 8.





STEP 8. Using scan tool MB991958, read the diagnostic trouble code (DTC).

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2128 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P2135: Throttle Position Sensor (main and sub) Range/Performance Problem

THROTTLE POSITION SENSOR (MAIN AND SUB) RANGE/PERFORMANCE PROBLEM CIRCUIT

- Refer to, DTC P0122 – Throttle Position Sensor (main) Circuit P.13B-136.
- Refer to, DTC P0222 – Throttle Position Sensor (sub) Circuit P.13B-299.

CIRCUIT OPERATION

- Refer to, DTC P0122 – Throttle Position Sensor (main) Circuit P.13B-136.
- Refer to, DTC P0222 – Throttle Position Sensor (sub) Circuit P.13B-299.

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> checks the throttle position sensor output signal characteristics for abnormal conditions.

DESCRIPTIONS OF MONITOR METHODS

Detect malfunction if the relation between throttle position sensor (main) and throttle position sensor (sub) is wrong.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

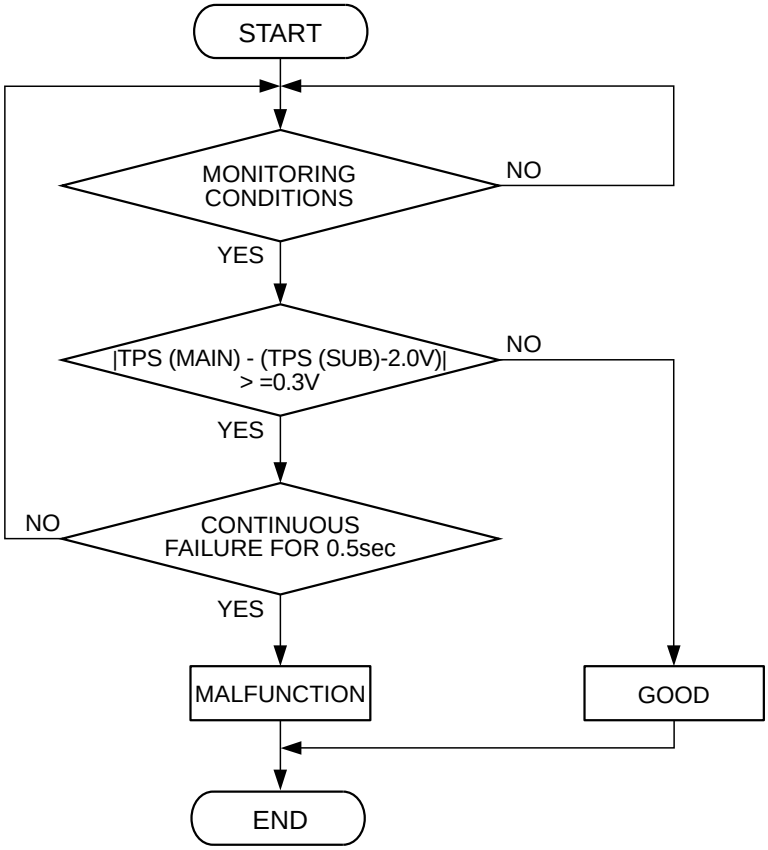
- Not applicable

Sensor (The sensor below is determined to be normal)

- Mass airflow sensor

DTC SET CONDITIONS <Range/Performance problem – relation between main and sub>

Logic Flow Chart



AK302047

Check Conditions

- Ignition switch is "ON" position.
- Throttle position sensor (main) output voltage is between 0.35 and 2.5 volts.
- Throttle position sensor (sub) output voltage is between 2.25 and 4.8 volts.

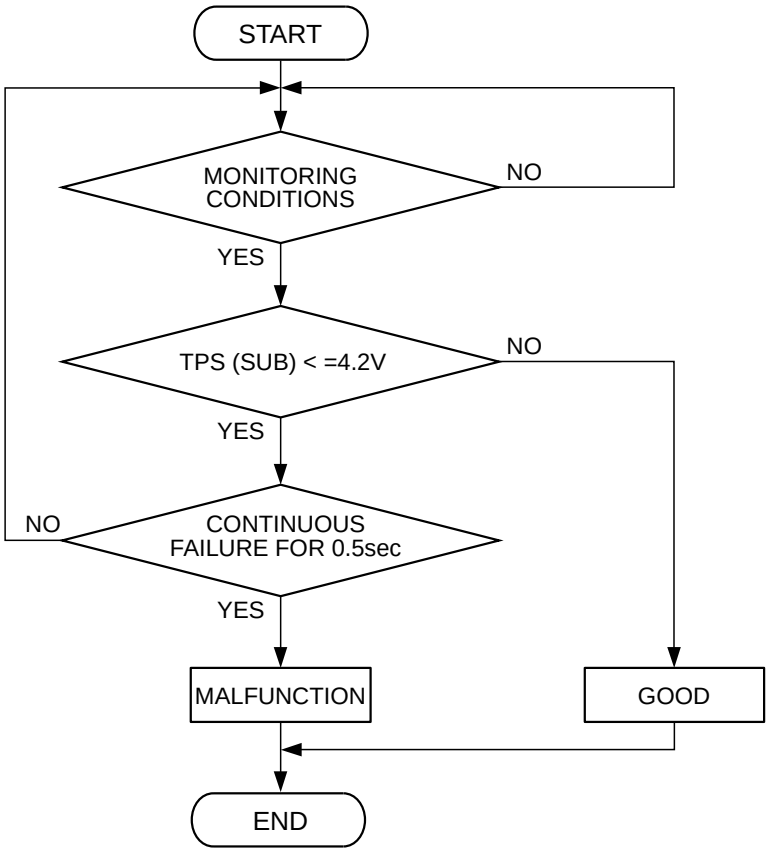
Judgement Criteria

- Voltage obtained with the formula given below is 0.3 volt or higher for 0.5 second: throttle position sensor (main) output voltage – [throttle position sensor (sub) output voltage] – 2 volts

TSB Revision

DTC SET CONDITIONS <Range/Performance problem – relation between main and sub>

Logic Flow Chart



AK302048

Check Conditions

- Ignition switch is "ON" position.
- Throttle position sensor (main) output voltage is between 2.5 and 4.8 volts.
- Throttle position sensor (sub) output voltage is higher than 2.25 volts.

Judgement Criteria

- Throttle position sensor (sub) output voltage is 4.2 volts or lower.

OBD-II DRIVE CYCLE PATTERN

Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Throttle position sensor failed.
- Shorted throttle position sensor circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

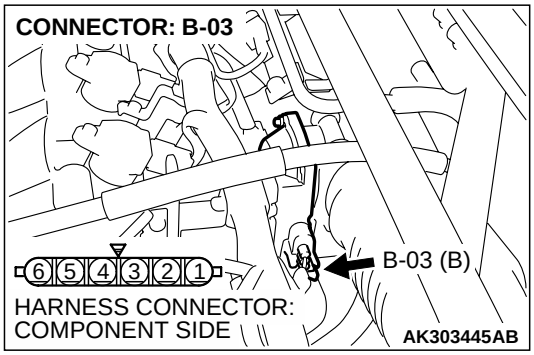
TSB Revision

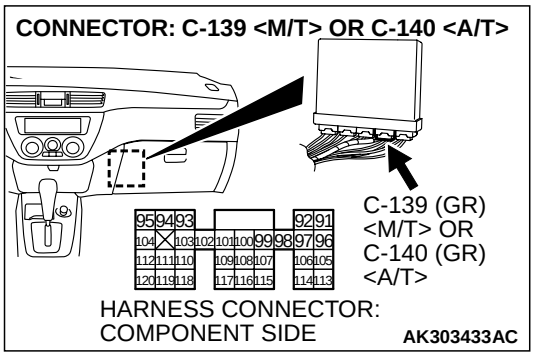
STEP 1. Check harness connector B-03 at throttle position sensor and harness connector C-139 at ECM <M/T> or C-140 at PCM <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 2.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 5.



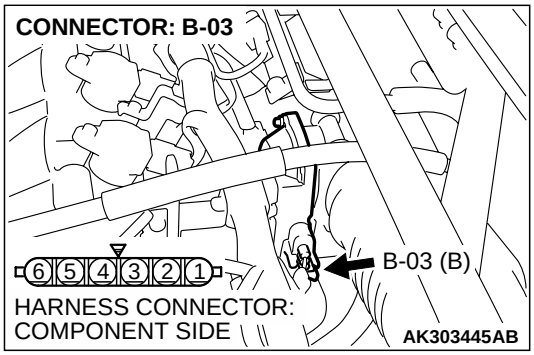


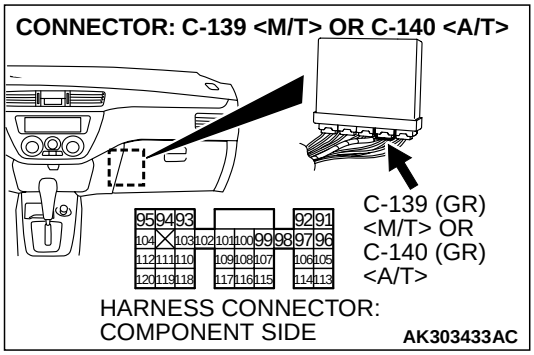
STEP 2. Check for short circuit to ground between throttle position sensor connector B-03 (terminal No. 4) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 115).

Q: Is the harness wire in good condition?

YES : Go to Step 3.

NO : Repair it. Then go to Step 5.



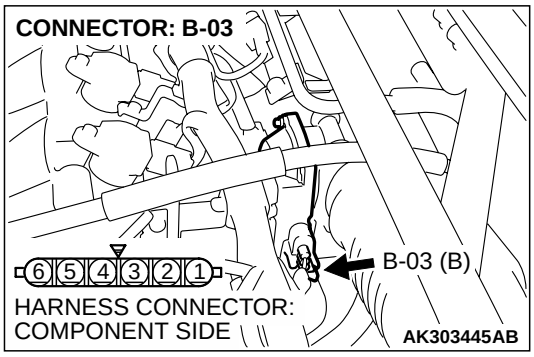


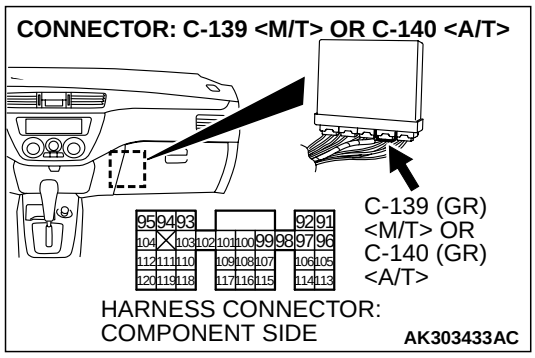
STEP 3. Check for short circuit to ground between throttle position sensor connector B-03 (terminal No. 6) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 113).

Q: Is the harness wire in good condition?

YES : Go to Step 4.

NO : Repair it. Then go to Step 5.





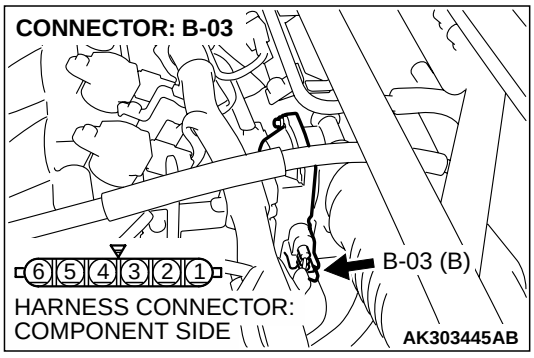
STEP 4. Replace the throttle body assembly.

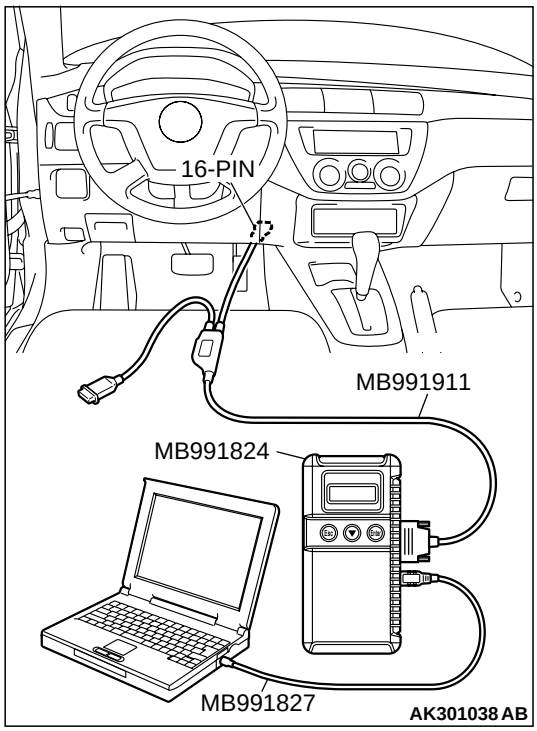
(1) Replace the throttle body assembly.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is DTC P2135 set?

YES : Replace the ECM or PCM. Then go to Step 5.

NO : The procedure is complete.





STEP 5. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2135 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P2138: Accelerator Pedal Position Sensor (main and sub) Circuit Range/Performance Problem

ACCELERATOR PEDAL POSITION SENSOR (MAIN AND SUB) RANGE/PERFORMANCE PROBLEM CIRCUIT

- Refer to, DTC P2122 – Accelerator Pedal Position Sensor (main) Circuit P.13B-661.
- Refer to, DTC P2127 – Accelerator Pedal Position Sensor (sub) Circuit P.13B-686.

CIRCUIT OPERATION

- Refer to, DTC P2122 – Accelerator Pedal Position Sensor (main) Circuit P.13B-661.
- Refer to, DTC P2127 – Accelerator Pedal Position Sensor (sub) Circuit P.13B-686.

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> checks the accelerator pedal position sensor output signal characteristics for abnormal conditions.

DESCRIPTIONS OF MONITOR METHODS

- Detect malfunction if the relation between accelerator pedal position sensor (main) and accelerator pedal position sensor (sub) is wrong.

MONITOR EXECUTION

- Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

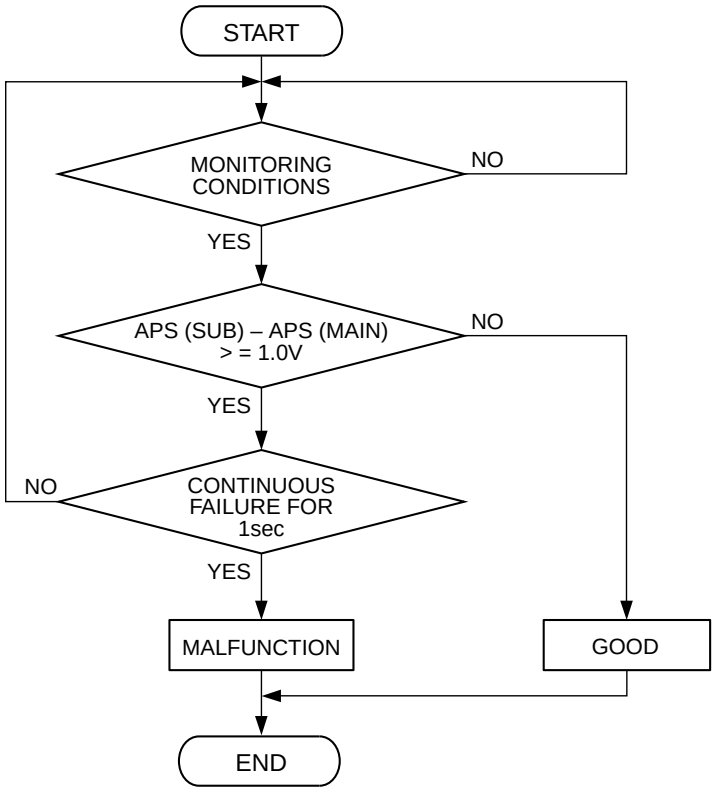
- Not applicable

Sensor (The sensor below is determined to be normal)

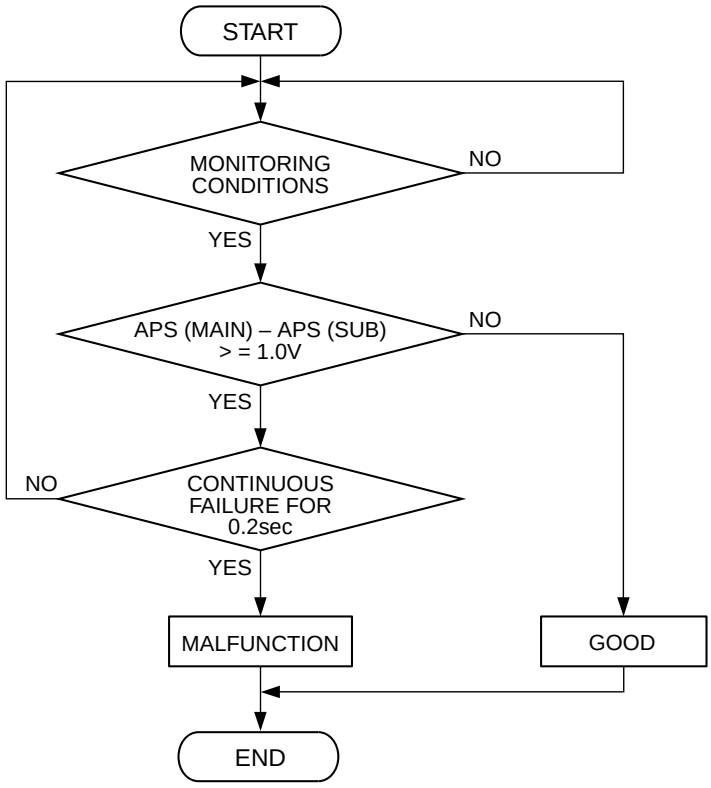
- Not applicable

DTC SET CONDITIONS <Range/Performance problem – relation between main and sub>

Logic Flow Chart



AK302049



AK302050

TSB Revision

Check Condition

- Ignition switch is "ON" position.
- Accelerator pedal position sensor (main) output voltage is between 0.2 and 4.5 volts.
- Accelerator pedal position sensor (sub) output voltage is between 0.2 and 4.5 volts.
- Change of accelerator pedal position sensor (sub) output voltage per 25 milliseconds is lower than 0.1 volt.

Judgement Criteria

- Accelerator pedal position sensor (sub) output voltage minus accelerator pedal position sensor (main) output voltage should be 1 volt or higher for 1 second.
- Accelerator pedal position sensor (main) output voltage minus accelerator pedal position sensor (sub) output voltage should be 1 volt or higher for 0.2 seconds.

OBD-II DRIVE CYCLE PATTERN

None.

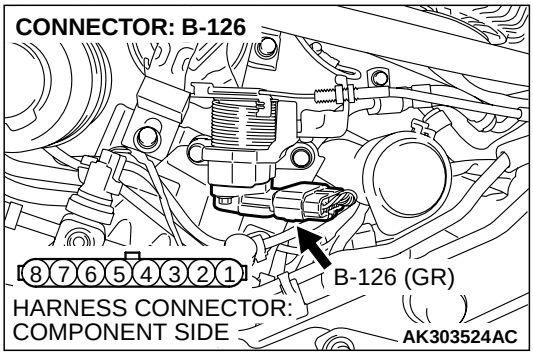
TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Accelerator pedal position sensor failed or maladjusted.
- Open or shorted accelerator pedal position sensor circuit, or connector damage.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

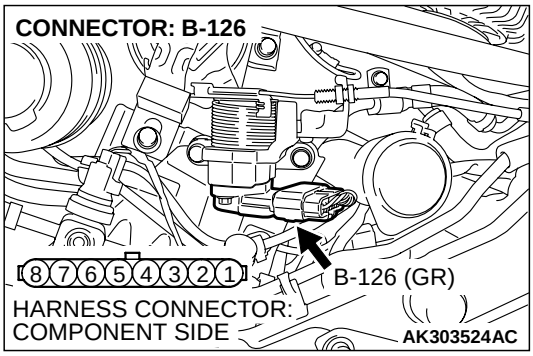


STEP 1. Check harness connector B-126 at accelerator pedal position sensor for damage.

Q: Is the harness connector in good condition?

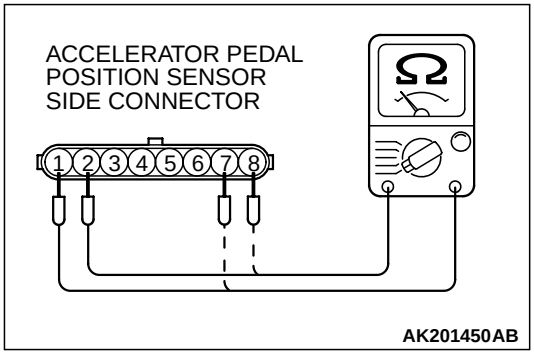
YES : Go to Step 2.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 17.



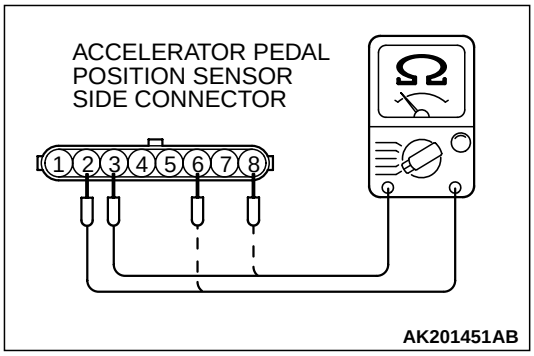
STEP 2. Check the accelerator pedal position sensor.

(1) Disconnect the accelerator pedal position sensor connector B-126.



(2) Measure resistance between terminal No.1 and No. 2 and between terminal No. 7 and No. 8.

Standard value: 3.5 – 6.5 kΩ



(3) Measure resistance between terminal No. 2 and No. 3 and between terminal No. 6 and No. 8 when the accelerator pedal is gently depressed from idle position to the full open position.

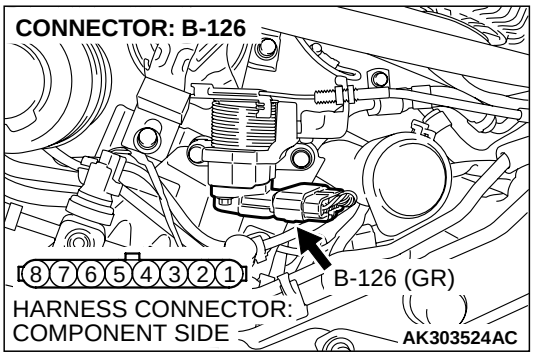
- Resistance value changes in accordance with the accelerator pedal depression smoothly.

Q: Is the resistance normal?

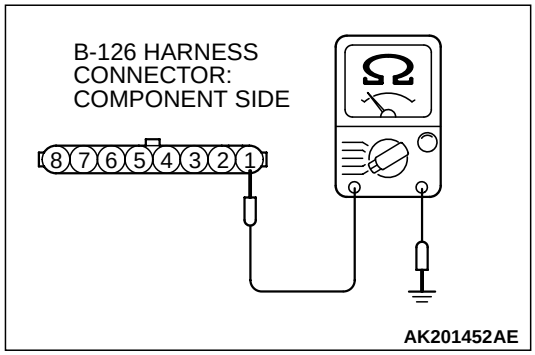
YES : Go to Step 3.

NO : Replace the accelerator pedal position sensor. Then go to Step 17.

STEP 3. Check the continuity at accelerator pedal position sensor harness side connector B-126.



(1) Disconnect the connector B-126 and measure at the harness side.



(2) Measure the continuity between terminal No. 1 and ground.
- Should be less than 2 ohms.

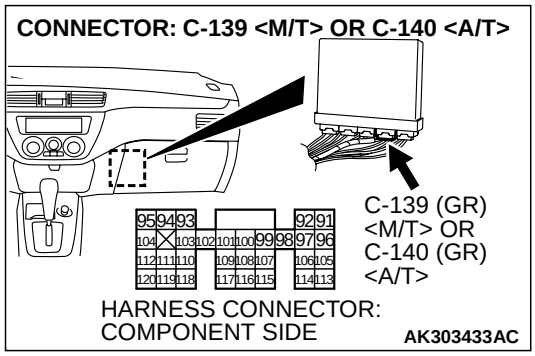
Q: Does continuity exist?

YES : Go to Step 7.
NO : Go to Step 4.

STEP 4. Check harness connector C-139 at ECM <M/T> or C-140 <A/T> at PCM for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 5.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 17.

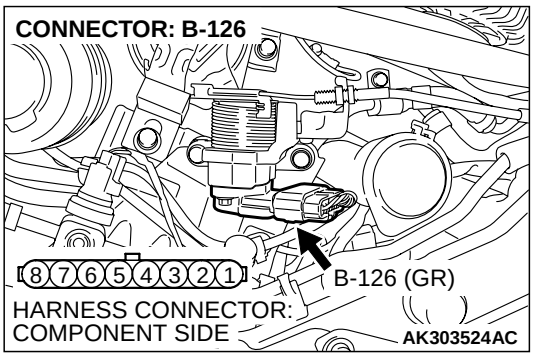


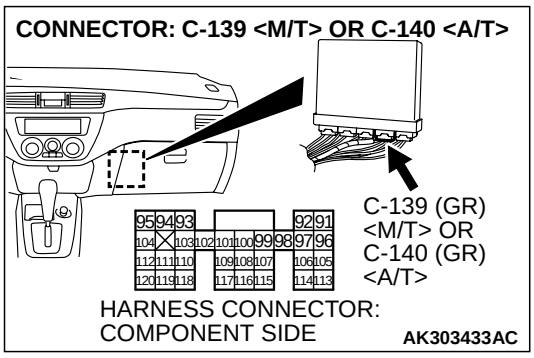
STEP 5. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 1) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 91).

Q: Is the harness wire in good condition?

YES : Go to Step 6.

NO : Repair it. Then go to Step 17.





STEP 6. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

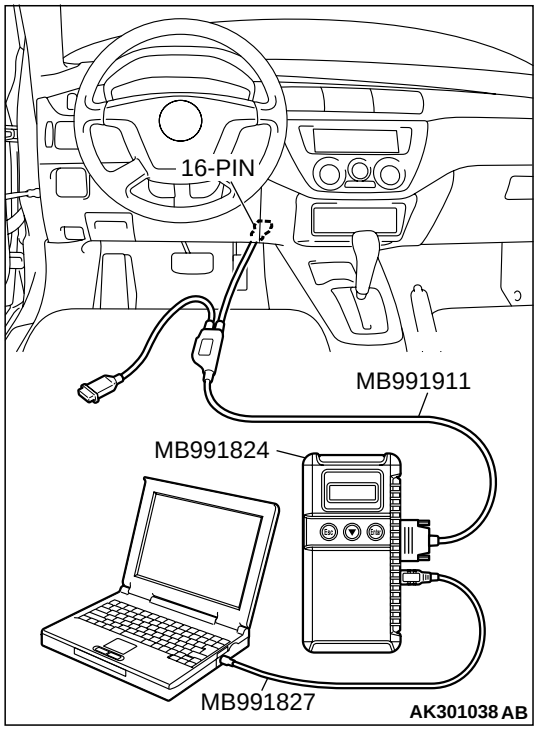
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

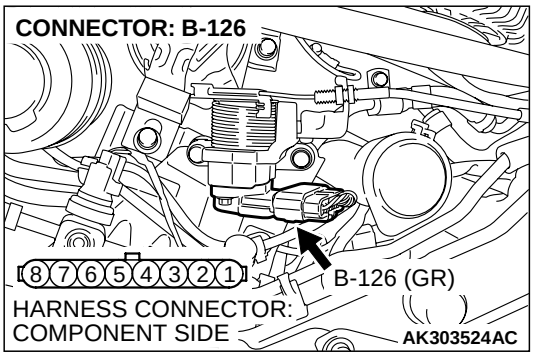
Q: Is DTC P2138 set?

YES : Replace the ECM or PCM. Then go to Step 17.

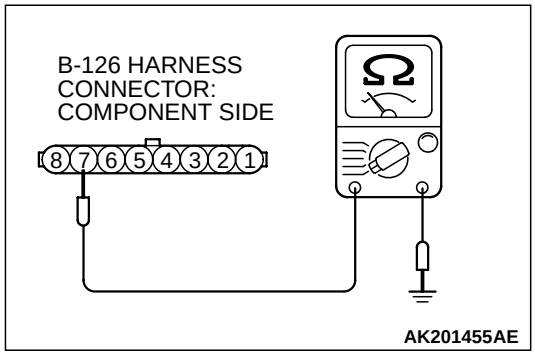
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.



STEP 7. Check the continuity at accelerator pedal position sensor harness side connector B-126.



(1) Disconnect the connector B-126 and measure at the harness side.

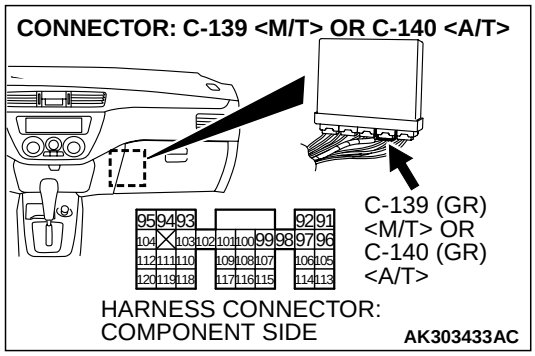


(2) Measure the continuity between terminal No. 7 and ground.
- Should be less than 2 ohms.

Q: Does continuity exist?

YES : Go to Step 11.
NO : Go to Step 8.

STEP 8. Check harness connector C-139 at ECM <M/T> or C-140 <A/T> for damage.



Q: Is the harness connector in good condition?

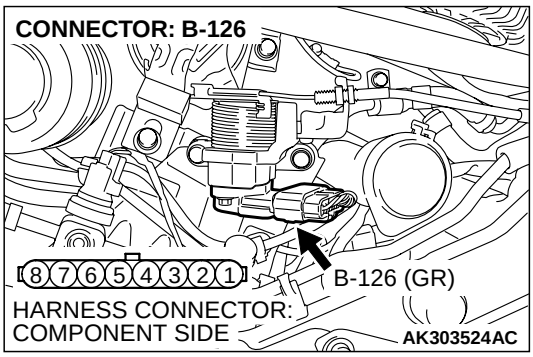
YES : Go to Step 9.
NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 17.

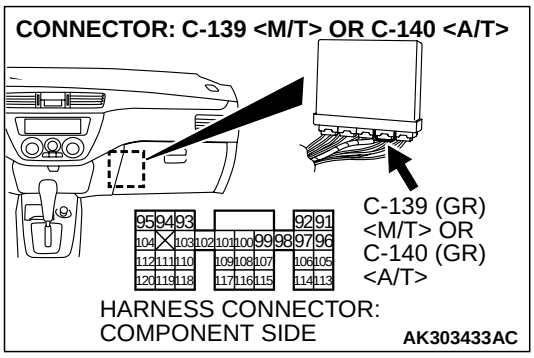
STEP 9. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 7) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 96).

Q: Is the harness wire in good condition?

YES : Go to Step 10.

NO : Repair it. Then go to Step 17.





STEP 10. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

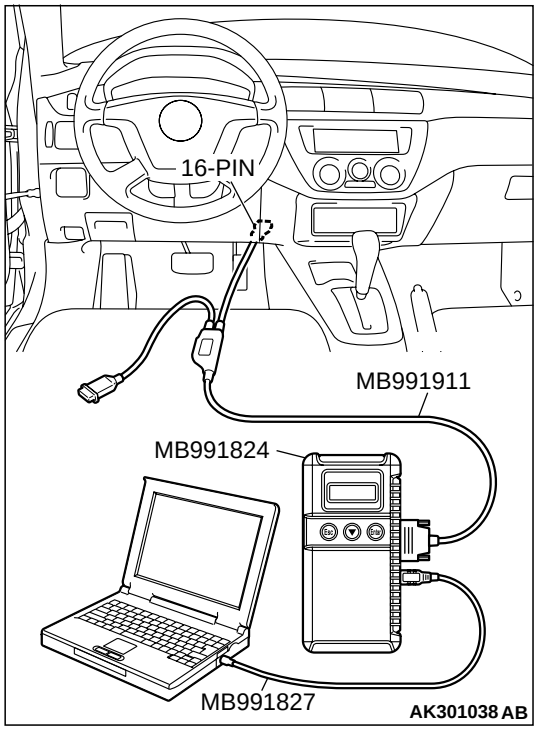
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2138 set?

YES : Replace the ECM or PCM. Then go to Step 17.

NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspectio Service Points P.00-6.

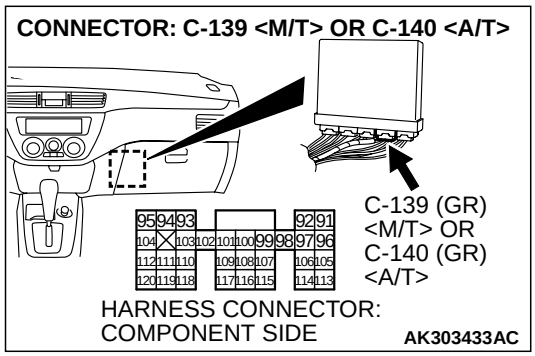


STEP 11. Check harness connector C-139 at ECM <M/T> or C-140 <A/T> for damage.

Q: Is the harness connector in good condition?

YES : Go to Step 12.

NO : Repair or replace it. Refer to GROUP 00E, Harness Connector Inspection P.00E-2. Then go to Step 17.

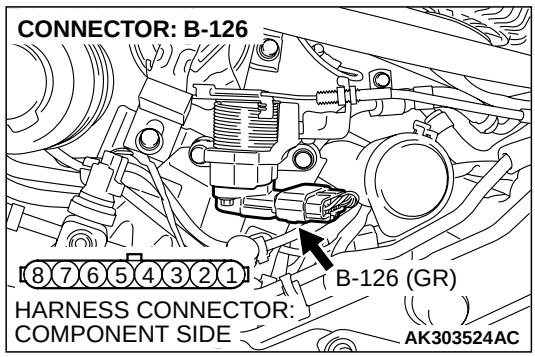


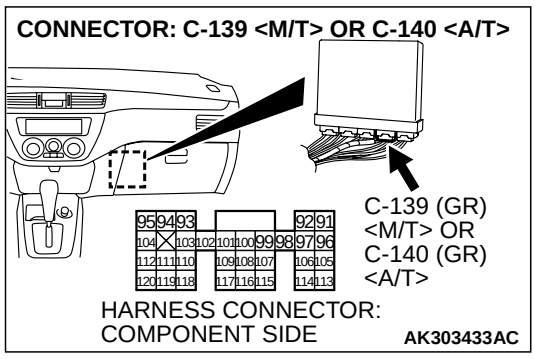
STEP 12. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 2) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 92).

Q: Is the harness wire in good condition?

YES : Go to Step 13.

NO : Repair it. Then go to Step 17.



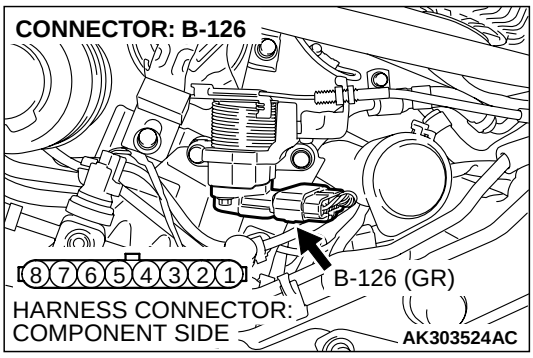


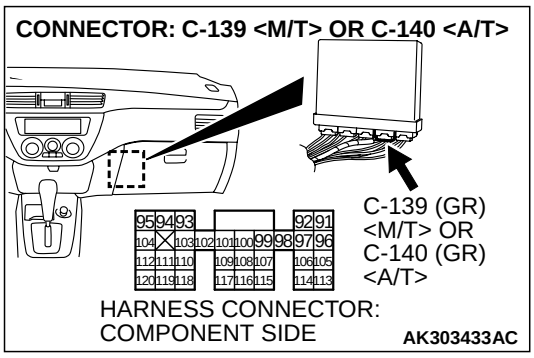
STEP 13. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 8) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 97).

Q: Is the harness wire in good condition?

YES : Go to Step 14.

NO : Repair it. Then go to Step 17.



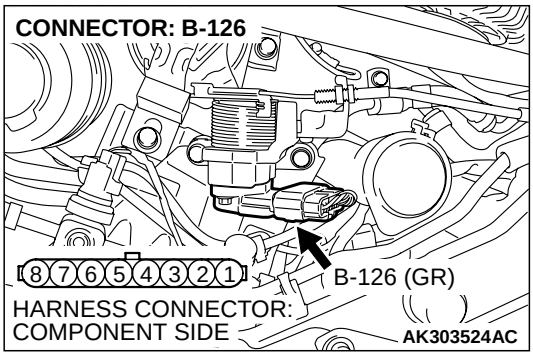


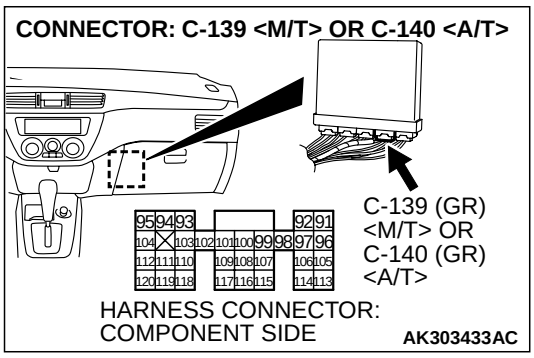
STEP 14. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 3) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 114).

Q: Is the harness wire in good condition?

YES : Go to Step 15.

NO : Repair it. Then go to Step 17.



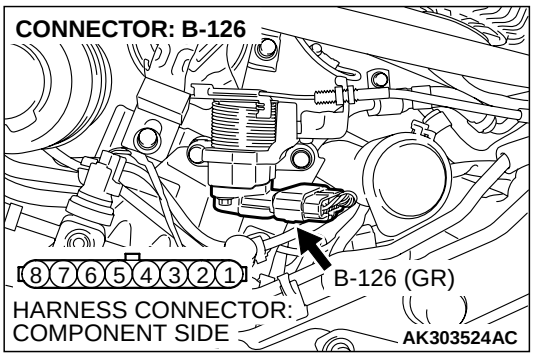


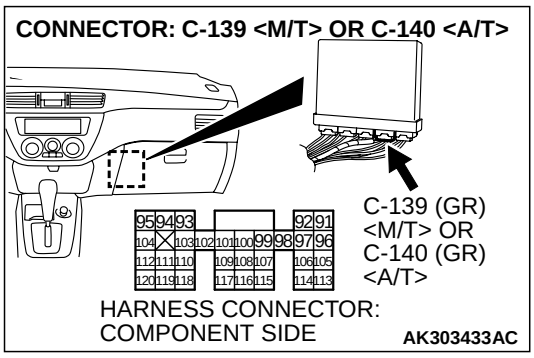
STEP 15. Check for harness damage between accelerator pedal position sensor connector B-126 (terminal No. 6) and ECM connector C-139 <M/T> or PCM connector C-140 <A/T> (terminal No. 107).

Q: Is the harness wire in good condition?

YES : Go to Step 16.

NO : Repair it. Then go to Step 17.





STEP 16. Using scan tool MB991958, read the diagnostic trouble code (DTC).

⚠ CAUTION

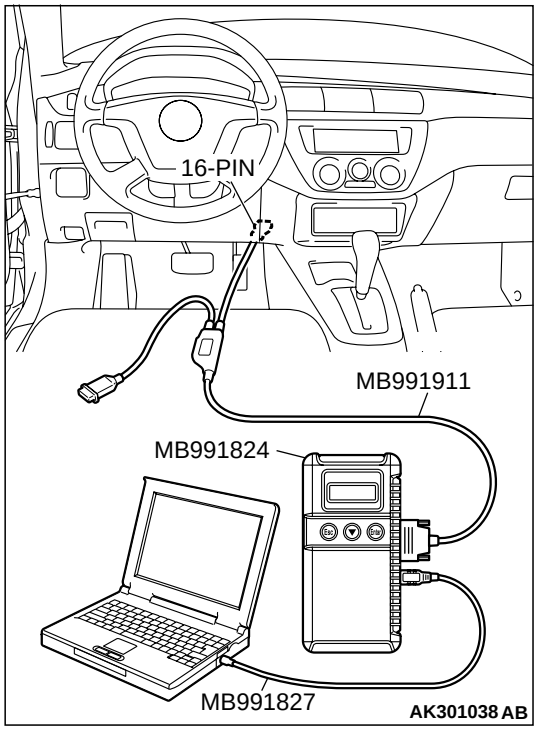
To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

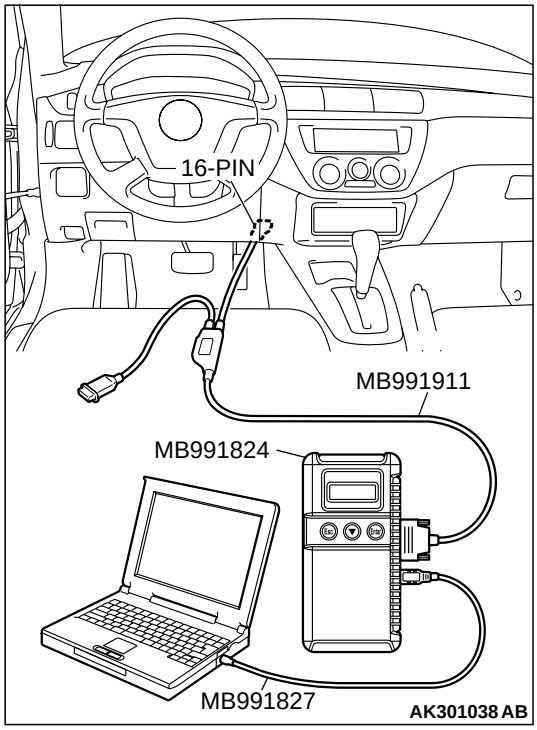
(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2138 set?

YES : Replace the ECM or PCM. Then go to Step 17.

NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.





STEP 17. Using scan tool MB991958, read the diagnostic trouble code (DTC).

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) After the DTC has been deleted, read the DTC again.
(4) Turn the ignition switch to the "LOCK"(OFF) position.

Q: Is DTC P2138 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P2173: Abnormal Intake Air Amount

TECHNICAL DESCRIPTION

- ECM <M/T> or PCM <A/T> decides the allowable intake air amount in accordance with the engine speed and the target opening angle of throttle valve.
- ECM <M/T> or PCM <A/T> checks whether the actual intake air amount is more than the allowable intake air amount.

DESCRIPTIONS OF MONITOR METHODS

The actual intake air amount is more than the allowable intake air amount.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Check Conditions

- Engine is running.

Judgment Criteria

- The actual intake air amount is more than the allowable intake air amount for 1.5 seconds.

OBD-II DRIVE CYCLE PATTERN

None.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- Mass airflow sensor failed.
- Throttle valve faulty operation.
- Throttle position sensor failed.
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools

- MB991958: Scan tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, read the diagnostic trouble code (DTC).

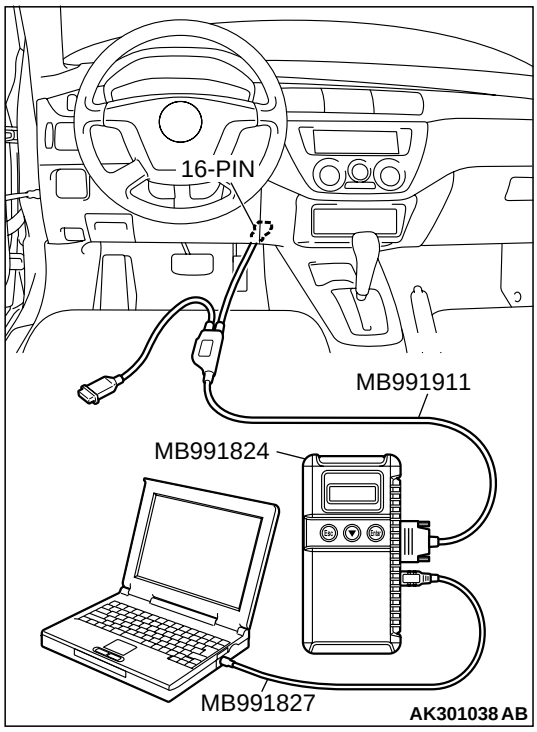
⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958, read the DTC.
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the diagnostic trouble code other than P2173 output?

YES : Refer to, Diagnostic Trouble Code Chart P.13B-31.
NO : Go to Step 2.

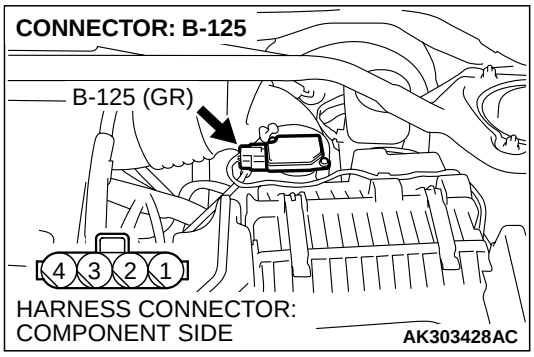


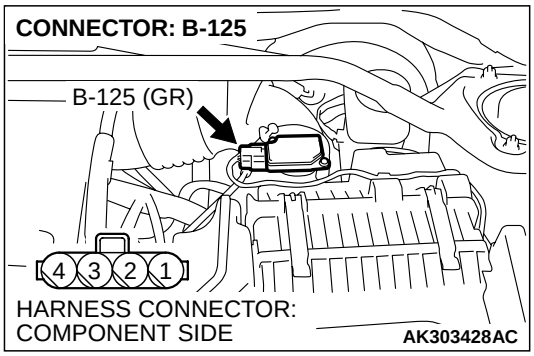
STEP 2. Replace the mass airflow sensor.

(1) Replace the mass airflow sensor.
(2) Turn the ignition switch to the "ON" position.
(3) Erase the DTC.
(4) Start the engine and run at idle for a few seconds.
(5) Read the DTC.
(6) Turn the ignition switch to the "OFF" position.

Q: Is DTC P2173 set?

YES : Go to Step 3.
NO : The inspection is complete.



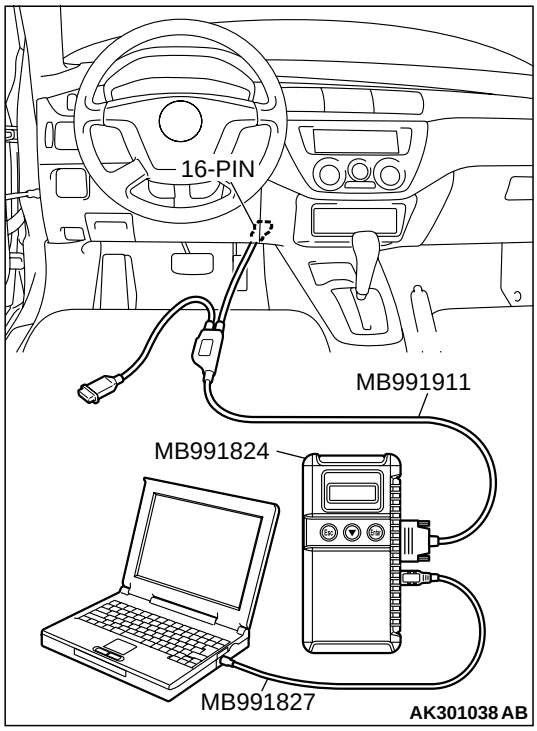


STEP 3. Replace the throttle body assembly.

(1) Replace the throttle body assembly.
(2) Turn the ignition switch to the "ON" position.
(3) Erase the DTC.
(4) Start the engine and run at idle for a few seconds.
(5) Read the DTC.
(6) Turn the ignition switch to the "OFF" position.

Q: Is DTC P2173 set?

YES : Replace the ECM or PCM, then Go to Step 4.
NO : The inspection is complete.



STEP 4. Using scan tool MB991958, read the DTC.

(1) Turn the ignition switch to the "ON" position.
(2) Erase the DTC.
(3) Start the engine and run at idle for a few seconds.
(4) Read the DTC.
(5) Turn the ignition switch to the "OFF" position.

Q: Is DTC P2173 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P2227: Barometric Pressure Circuit Range/Performance Problem

TECHNICAL DESCRIPTION

- The barometric pressure sensor outputs a voltage which corresponds to the barometric pressure.
- The ECM <M/T> or PCM <A/T> checks whether this voltage is within a specified range.

DESCRIPTIONS OF MONITOR METHODS

Barometric pressure sensor output voltage does not change for specified period. (approximately 1 week)

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

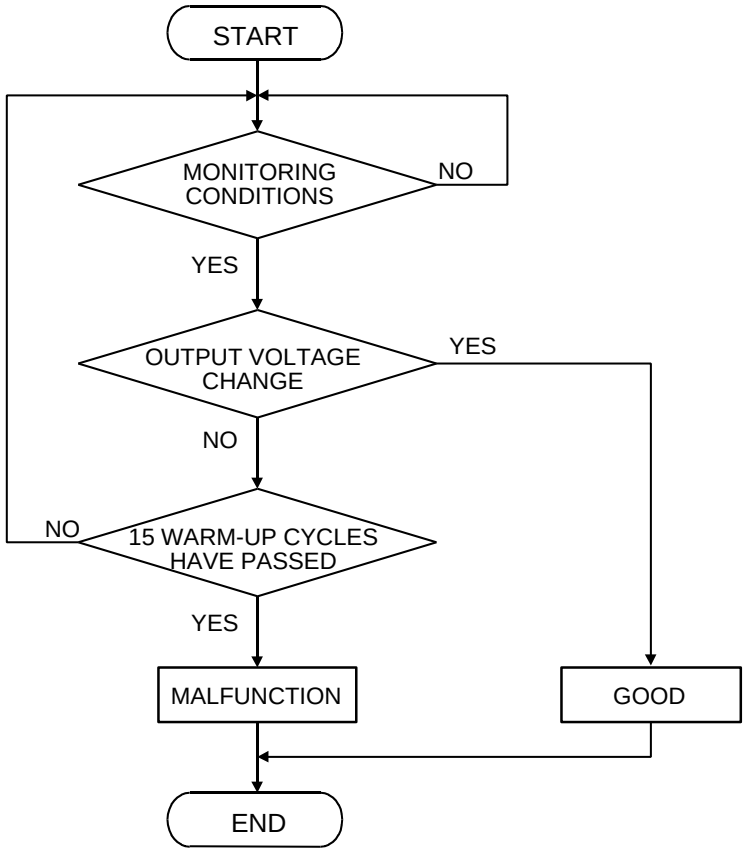
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302051

TSB Revision

Check Conditions

- Barometric pressure is lower than 76 kPa (22.4 in.Hg).

Judgement Criteria

- During 15 times of driving, the changes in the sensor output voltage should be 0.015 volt [equivalent to 0.4 kPa (0.12 in.Hg)] or less.
- Make sure that the engine coolant temperature is 72°C (160°F) or higher during each of the 15 times of driving. Also, during each of the 15 times of driving, make sure that after the engine has been started, the engine coolant temperature has increased to 23°C (40°F) or higher.

OBD-II DRIVE CYCLE PATTERN

Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

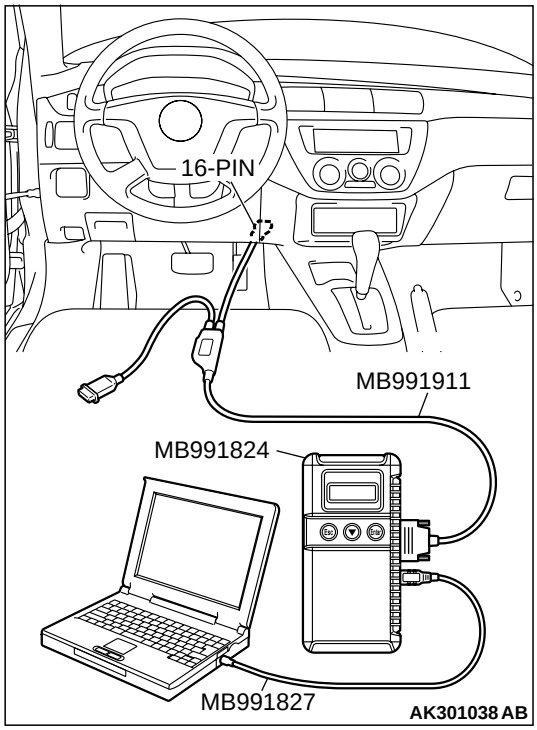
- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, read the diagnostic trouble code (DTC)

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK"(OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Erase the DTC.
(4) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Othe Monitor P.13B-6.
(5) Check the diagnostic trouble code (DTC).



Q: Is DTC P2227 set?

YES : Replace the ECM or PCM.
NO : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.

DTC P2228: Barometric Pressure Circuit Low Input

TECHNICAL DESCRIPTION

- The barometric pressure sensor outputs a voltage which corresponds to the barometric pressure.
- The ECM <M/T> or PCM <A/T> checks whether this voltage is within a specified range.

DESCRIPTIONS OF MONITOR METHODS

Barometric pressure sensor output voltage is out of reasonable barometric pressure range.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

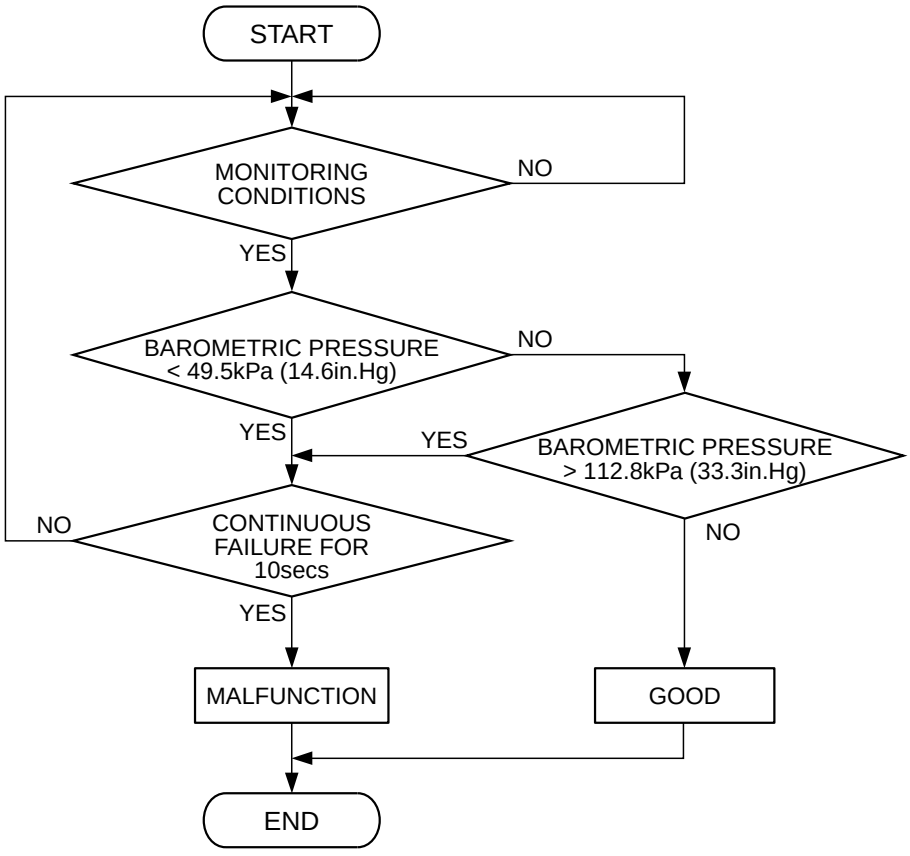
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302052

TSB Revision

Check Conditions

- 2 seconds or more have passed since the engine starting sequence was completed.
- Battery positive voltage is higher than 8 volts.

Judgement Criteria

- Barometric pressure sensor output signal has continued to be 49.5 kPa (14.6 in.Hg) or lower (approximately 15,000 ft above sea level) for 10 seconds.

OBD-II DRIVE CYCLE PATTERN

Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.

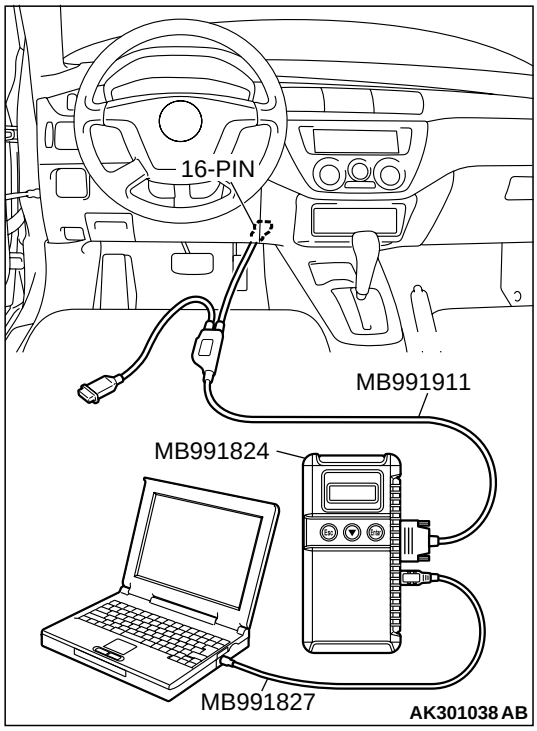
TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B



STEP 1. Using scan tool MB991958, check data list item 25: Barometric Pressure Sensor.

⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 25, Barometric Pressure Sensor.
  - When altitude is 0 m (0 foot), 101 kPa (29.8 In.Hg).
  - When altitude is 600 m (1,969 feet), 95 kPa (28.1 In.Hg).
  - When altitude is 1,200 m (3,937 feet), 88 kPa (26.0 In.Hg).
  - When altitude is 1,800 m (5,906 feet), 81 kPa (23.9 In.Hg).
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.
NO : Replace the ECM or PCM, then go to Step 2.

STEP 2. Test the OBD-II drive cycle.

(1) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.
(2) Check the diagnostic trouble code (DTC).

Q: Is DTC P2228 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

DTC P2229: Barometric Pressure Circuit High Input

TECHNICAL DESCRIPTION

- The barometric pressure sensor outputs a voltage which corresponds to the barometric pressure.
- The ECM <M/T> or PCM <A/T> checks whether this voltage is within a specified range.

DESCRIPTIONS OF MONITOR METHODS

Barometric pressure sensor output voltage is out of reasonable barometric pressure range.

MONITOR EXECUTION

Continuous

MONITOR EXECUTION CONDITIONS (Other monitor and Sensor)

Other Monitor (There is no temporary DTC stored in memory for the item monitored below)

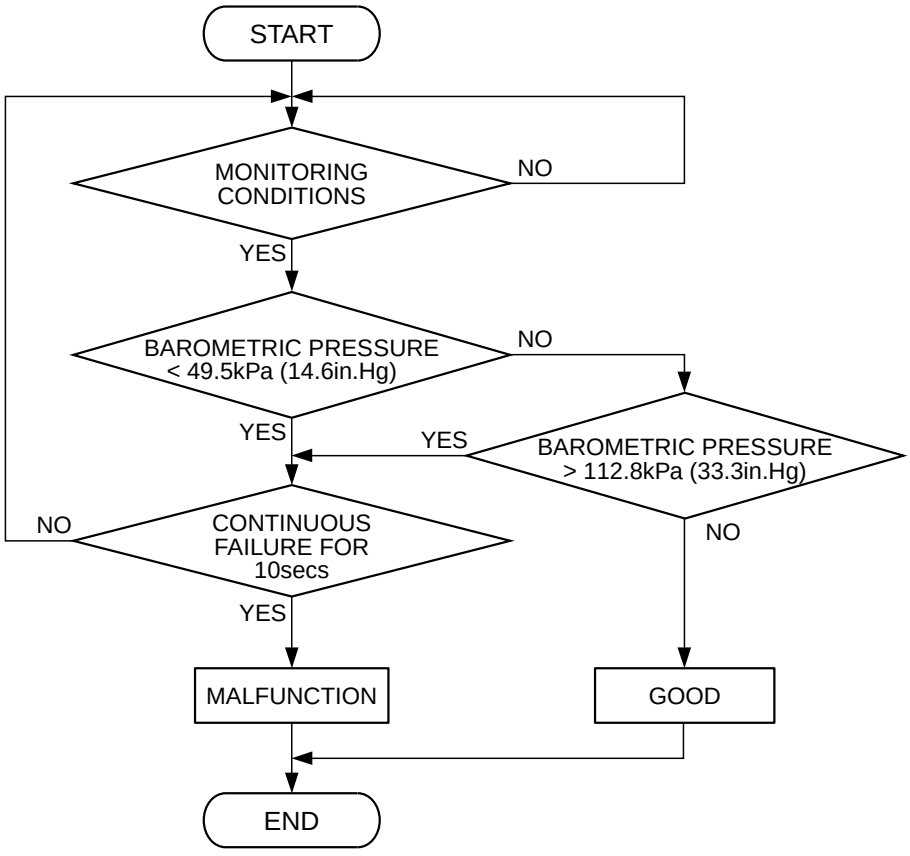
- Not applicable

Sensor (The sensor below is determined to be normal)

- Not applicable

DTC SET CONDITIONS

Logic Flow Chart



AK302052

TSB Revision

Check Conditions

- 2 seconds or more have passed since the engine starting sequence was completed.
- Battery positive voltage is higher than 8 volts.

Judgement Criteria

- Barometric pressure sensor output signal has continued to be 112.8 kPa (33.3 in.Hg) or higher (approximately 4,000 ft below sea level) for 10 seconds.

OBD-II DRIVE CYCLE PATTERN

Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.

TROUBLESHOOTING HINTS (The most likely causes for this code to be set are:)

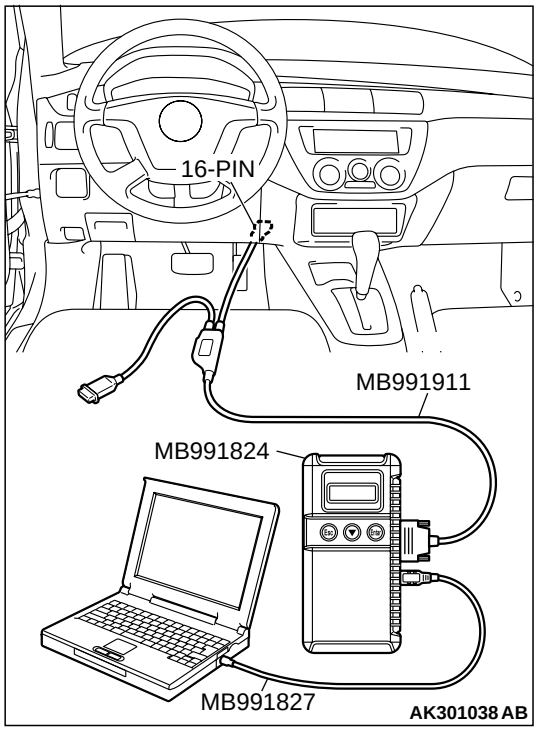
- ECM failed. <M/T>
- PCM failed. <A/T>

DIAGNOSIS

Required Special Tools:

- MB991958: Scan Tool (MUT-III Sub Assembly)
  - MB991824: V.C.I.
  - MB991827: USB Cable
  - MB991911: Main Harness B

STEP 1. Using scan tool MB991958, check data list item 25: Barometric Pressure Sensor.



⚠ CAUTION

To prevent damage to scan tool MB991958, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991958.

(1) Connect scan tool MB991958 to the data link connector.
(2) Turn the ignition switch to the "ON" position.
(3) Set scan tool MB991958 to the data reading mode for item 25, Barometric Pressure Sensor.
  - When altitude is 0 m (0 foot), 101 kPa (29.8 In.Hg).
  - When altitude is 600 m (1,969 feet), 95 kPa (28.1 In.Hg).
  - When altitude is 1,200 m (3,937 feet), 88 kPa (26.0 In.Hg).
  - When altitude is 1,800 m (5,906 feet), 81 kPa (23.9 In.Hg).
(4) Turn the ignition switch to the "LOCK" (OFF) position.

Q: Is the sensor operating properly?

YES : It can be assumed that this malfunction is intermittent. Refer to GROUP 00, How to Use Troubleshooting/Inspection Service Points P.00-6.
NO : Replace the ECM or PCM, then go to Step 2.

STEP 2. Test the OBD-II drive cycle.

(1) Carry out a test drive with the drive cycle pattern. Refer to Diagnostic Function – OBD-II Drive Cycle – Procedure 6 – Other Monitor P.13B-6.
(2) Check the diagnostic trouble code (DTC).

Q: Is DTC P2229 set?

YES : Retry the troubleshooting.
NO : The inspection is complete.

Continue

POWER WINDOWS

1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Windows

DESCRIPTION

Power windows are operated by reversible type motors mounted with each window regulator. Each window has an individual switch for separate control. A master switch is located on the driver's door from which both front and rear (if equipped) windows may be controlled. On Expedition, a lock-out switch is incorporated in master switch. When actuated, it prevents window operation from individual switches.

All models are equipped with a one-touch down feature allowing the driver to lower the left front window fully by momentarily actuating the driver's window down switch at the master power window switch. Holding the switch down longer allows the driver to stop the window as soon as the switch is released. The one-touch down feature is controlled by a Generic Electronic Module (GEM) which incorporates the functions of several different modules into one. The GEM offers diagnostics to locate and repair concerns affecting the subsystem that it controls. The one-touch down feature can only be actuated at the master switch.

TROUBLE SHOOTING

ALL POWER WINDOWS INOPERATIVE

Preliminary Checks

Confirm concern, operate all switches. Ensure battery is fully charged. Ensure windows are properly aligned. Check the following for possible cause of malfunction:

- Faulty fuse(s).
- Open or shorted supply circuit.
- Faulty Generic Electronic Module (GEM).
- Faulty battery saver relay.
- Faulty instrument panel fuse block.
- Faulty delayed accessory relay.
- Faulty master switch.

ONE POWER WINDOW INOPERATIVE

Preliminary Checks

Confirm concern. Ensure battery is fully charged. Ensure window in question is properly aligned. Check the following for possible cause of malfunction:

- Damaged guide or regulator mechanism.
- Malfunctioning window motor. See **POWER WINDOW MOTOR** under COMPONENT TESTING.

- Open or shorted circuit.
- Faulty one-touch down relay.
- Faulty master or passenger switch.
- Faulty battery saver relay.
- Faulty instrument panel fuse block.
- Faulty Generic Electronic Module (GEM).

ONE-TOUCH DOWN FEATURE INOPERATIVE

Preliminary Checks

Confirm concern. Check the following for possible cause of malfunction:

- Open or shorted circuit.
- Faulty one-touch down relay.
- Faulty master switch.
- Faulty Generic Electronic Module (GEM).
- Faulty instrument panel fuse block.

WINDOW STUCK OR BINDING

Preliminary Checks

Confirm concern. Check the following for possible cause of malfunction:

- Damaged window tracks.
- Damaged window regulator.
- Damaged window motor.

TESTING

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

RETRIEVING TROUBLE CODES

Use New Generation Star (NGS) Tester (007-00500) connected to Data Link Connector (DLC), located below instrument panel at right of steering column, to retrieve Diagnostic Trouble Codes (DTCs) and execute self-test diagnostics for Generic Electronic Module (GEM). See MODULE COMMUNICATIONS NETWORK article.

- **MODULE COMMUNICATIONS NETWORK** - Expedition
- **MODULE COMMUNICATIONS NETWORK** - F150 & F250 Light-Duty

If self-test passed and no trouble codes are retrieved, go to appropriate test to continue diagnostics. If DTCs are retrieved, go to appropriate test.

POWER WINDOWS DO NOT OPERATE

NOTE: This test is associated with DTCs B1302, B1304, B1313, B1315 or B1342.

1. Turn ignition switch to OFF position. Measure voltage between ground and output side of fuse No. 14 (15-amp) in instrument panel fuse block. Measure voltage between ground and output side of fuse No. 15 (5-amp) in instrument panel fuse block. If voltages are less than 10 volts, go to next step. If voltages are greater than 10 volts, go to step 4).
2. Ensure ignition switch is off. Check condition of fuse No. 14 (15-amp) and No. 15 (5-amp) in instrument panel fuse block. Check condition of fuse No. 22 (50-amp) and No. 25 (30-amp) in engine compartment power distribution box. If fuses are okay, go to next step. If fuse(s) are blown, replace fuse(s) or repair Tan/Black wire feeding instrument panel fuse block. Clear DTCs and retest system. If fuse(s) fail again, check for short to ground. Repair as necessary.
3. Ensure ignition switch is off. Connect NGS tester to Data Link Connector (DLC). Using NGS tester, read IGN_GEM PID while rotating ignition switch through START, RUN, OFF and ACC positions. If PID values agree with ignition switch positions, go to next step. If PID values do not agree with ignition switch positions, repair suspect open circuit between ignition switch and instrument panel fuse block. See POWER DISTRIBUTION article in WIRING DIAGRAMS. Clear DTCs and retest system.
4. Following manufacturer's instructions, retrieve continuous DTCs from GEM. Using NGS tester, perform ON-DEMAND self-test. If no DTCs are present, go to next step. If DTCs B1302 (continuous and self-test) and B1304 (continuous and self-test) are present, go to step 11). If DTCs B1313 (continuous and self-test) and B1315 (continuous and self-test) are present, go to next step. If DTC B1342 is present, replace GEM. Clear DTCs and retest.
5. Turn ignition switch to RUN position. Using NGS tester, read BATSAV PID. Access ACTIVE COMMAND MODES. Toggle BATTSAVR on and off. If NGS tester indicates OFFO-G, go to next step. If NGS tester indicates ON-B-, go to step 9). If BATSAV PID values agree with command mode, go to step 11).
6. Turn ignition switch to OFF position. Disconnect battery saver relay, from instrument panel fuse/relay block. Measure voltage between ground and terminal No. 2 at battery saver relay socket. See **Fig. 1** . If voltage is greater than 10 volts, go to next step. If voltag e is less than 10 volts, replace fuse/relay block. Clear DTCs and retest.

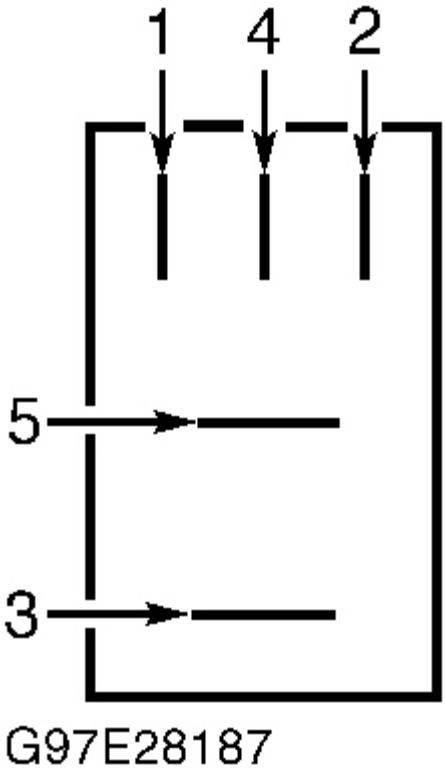
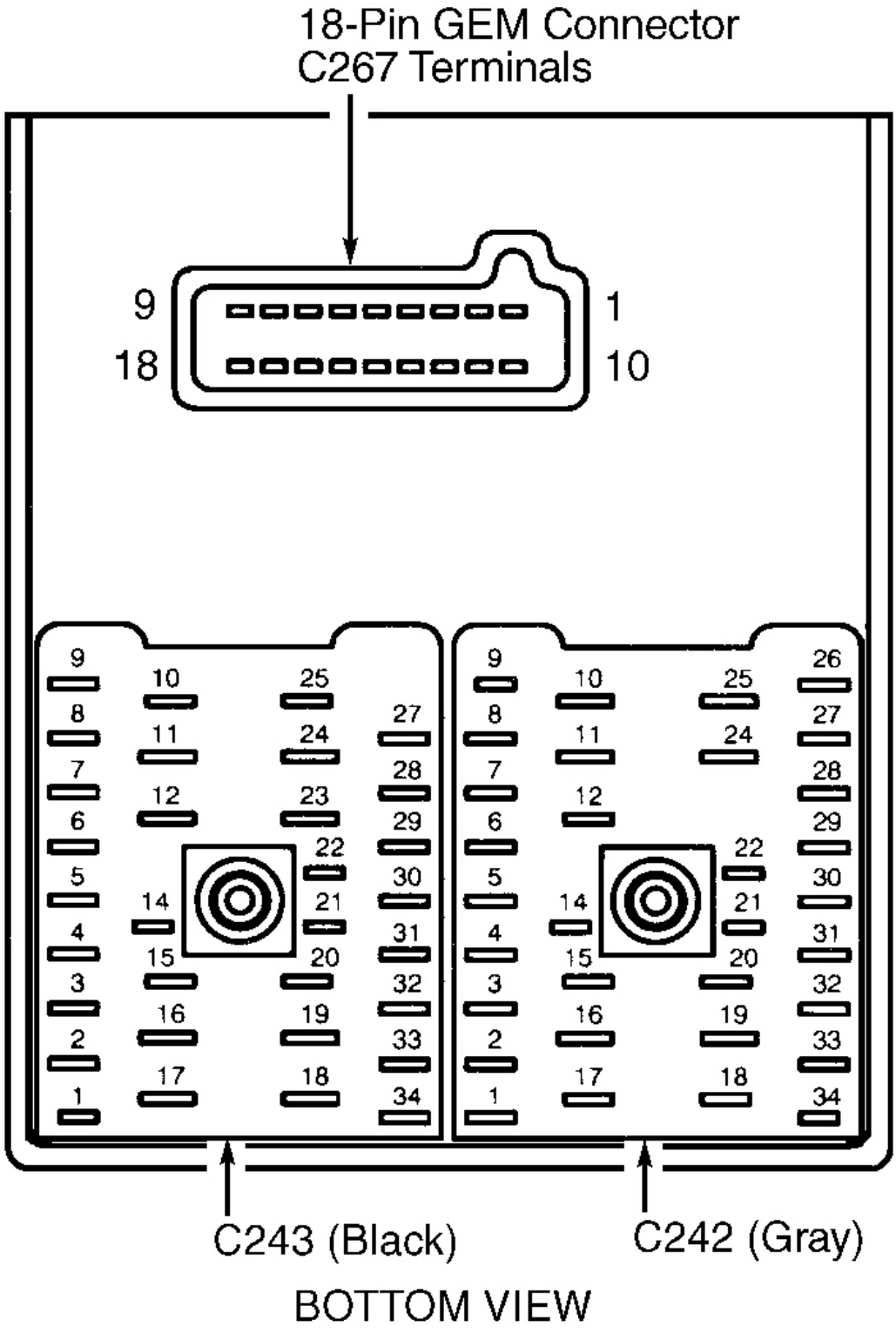


Fig. 1: Identifying Battery Saver Relay Socket
Courtesy of FORD MOTOR CO.

7. Check battery saver relay. See **BATTERY SAVER RELAY** under COMPONENT TESTING. If battery saver relay is okay, go to next step. If battery saver relay does not test as specified, replace battery saver relay. Clear DTCs and retest system.
8. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Measure resistance between instrument panel fuse/relay block GEM connector terminal No. 1 and battery saver relay socket terminal No. 1. See **Fig. 1** and **Fig. 2** . If resistance is less than 5 ohms, replace GEM. If resistance is greater than 5 ohms, replace instrument panel fuse/relay block. Clear DTCs and retest system.


18-Pin GEM Connector
C267 Terminals
9
1
18
10
C243 (Black)
C242 (Gray)
BOTTOM VIEW

G97A28191

Fig. 2: Identifying Instrument Panel Fuse/Relay Block Terminals
Courtesy of FORD MOTOR CO.

9. Check battery saver relay. See **BATTERY SAVER RELAY** under COMPONENT TESTING. If battery saver relay is okay, go to next step. If battery saver relay does not test as specified, replace battery saver relay. Clear DTCs and retest system.
10. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Turn ignition switch to RUN position. Measure voltage between ground and battery saver relay socket terminal No. 1. If voltage is greater than 10 volts, replace instrument panel fuse/relay block. If voltage is less than 10 volts, replace GEM. Clear DTCs and retest system.
11. Using NGS tester, read ACCDLY PID. Access ACTIVE COMMAND MODES. Toggle ACCY RLY on and off. If NGS tester indicates OFFO-G, go to next step. If NGS tester indicates ON-B-, go to step 16). If ACCDLY PID values agree with command mode, go to step 18).
12. Turn ignition switch to OFF position. Remove accessory delay relay from instrument panel fuse/relay block. Measure voltage at accessory delay relay socket terminal No. 86. See **Fig. 3** . If voltage is greater than 10 volts, go to next step. If voltage is less than 10 volts, go to step 15).

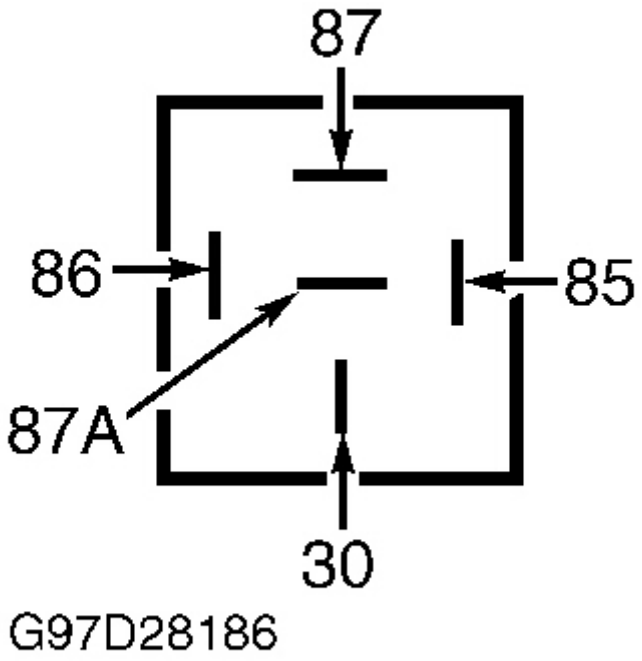


Fig. 3: Identifying Accessory Delay, One-Touch Down Relay, & Vent Window/Moonroof Relay Socket Terminals
Courtesy of FORD MOTOR CO.

13. Check accessory delay relay. See ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS under **COMPONENT TESTING** . If accessory delay relay is okay, go to next step. If accessory delay relay does not test as specified, replace accessory delay relay. Clear DTCs and retest system.
14. Ensure 18-pin GEM connector is still disconnected. Measure resistance between accessory delay relay socket terminal No. 85 and instrument panel fuse/relay block 18-pin connector terminal No. 11. See **Fig. 2** and **Fig. 3** . If resistance is less than 5 ohms, replace GEM. If resistance is greater than 5 ohms, replace instrument panel fuse/relay block. Clear DTCs and retest system.
15. Remove battery saver relay from instrument panel fuse/relay block. Measure resistance between battery saver relay socket terminal No. 5 and accessory delay relay socket terminal No. 86. See **Fig. 1** and **Fig. 3** . If resistance is less than 5 ohms, replace battery saver relay. If resistance is greater than 5 ohms, repalce instrument panel fuse/relay block. Clear DTCs and retest.
16. Turn ignition switch to OFF position. Check accessory delay relay. See ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS under **COMPONENT TESTING** . If accessory delay relay is okay, go to next step. If accessory delay relay does not test as specified, replace accessory delay relay. Clear DTCs and retest system.
17. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Turn ignition switch to RUN position. Measure voltage between ground and accessory delay relay socket terminal No. 85. See **Fig. 3** . If voltage is present, replace instrument panel fuse/relay block. If voltage is not present, replace GEM. Clear DTCs and retest system.
18. Turn ignition switch to OFF position. Remove one-touch down relay from instrument panel fuse/relay block. Turn ignition switch to RUN position. Using NGS tester, access ACTIVE COMMAND MODES. Set active command ACCY RLY on. Measure voltage between ground and one-touch down relay socket terminal No. 85. See **Fig. 3** . If voltage is greater than 10 volts, reconnect one-touch down relay and go to step 22). If voltage is less than 10 volts, go to next step.
19. Remove accessory delay relay from instrument panel fuse/relay block. Measure voltage between ground and accessory delay relay socket terminal No. 30. See **Fig. 3** . If voltage is less than 10 volts, go to next step. If voltage is greater than 10 volts, go to step 21).
20. Turn ignition switch to OFF position. Disconnect instrument panel fuse/relay block Gray connector C242. Measure voltage between ground and instrument panel fuse/relay block Gray connector C242 terminal No. 25. See **Fig. 2** . If voltage is greater than 10 volts, replace instrument panel fuse/relay block. If voltage is less than 10 volts, repair open Red/Light Blue wire. Clear DTCs and retest.
21. Check accessory delay relay. See ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS under **COMPONENT TESTING** . If accessory delay relay is okay, replace instrument panel fuse/relay block. If accessory delay relay does not test as specified, replace accessory delay relay. Clear DTCs and retest system.
22. Turn ignition switch to OFF position. On Expedition, disconnect appropriate master window switch 7-pin connector. On F150/250, disconnect master window switch 4-pin connector. Turn ignition switch to RUN position. Using NGS tester, enter active command mode DELAYED ACCESSORY. Set active command mode to ON. Measure voltage between ground and Light Blue/Black wire terminal at master window switch connector. If voltage is less than 10 volts, go to next step. If voltage is greater than 10 volts, go to step 24).
23. Turn ignition switch to OFF position. Disconnect instrument panel fuse/relay block Gray connector C242. Measure resistance in Light Blue/Black wire between instrument panel fuse/relay block Gray connector C242 terminal No. 10 and master window switch connector. See **Fig. 2** . If resistance is less than 5 ohms,

replace instrument panel fuse/relay block. If resistance is greater than 5 ohms, repair open in Light Blue/Black wire. Clear DTCs and retest system.

24. Turn ignition switch to OFF position. On Expedition, disconnect appropriate master window switch 7-pin connector. On F150/250, disconnect master window switch 5-pin connector. Measure resistance between ground and Black wire at master window switch connector. If resistance is less than 5 ohms, replace master window switch. If resistance is greater than 5 ohms, repair open in Black wire. Clear DTCs and retest system.

DRIVER WINDOW DOES NOT OPERATE (ALL OTHER WINDOWS OPERATE)

NOTE: This test is associated with DTCs B1398, B1400, B1405, B1408, B1410 or B1342.

Expedition

1. Ensure ignition switch is off. Connect NGS tester to Data Link Connector (DLC). Using NGS tester, read IGN_GEM PID while rotating ignition switch through START, RUN, OFF and ACC positions. If PID values agree with ignition switch positions, go to next step. If PID values do not agree with ignition switch positions, repair suspect open circuit between ignition switch and instrument panel fuse block. See POWER DISTRIBUTION article in WIRING DIAGRAMS. Clear DTCs and retest system.
2. Following manufacturer's instructions, retrieve continuous DTCs from GEM. Using NGS tester, perform ON-DEMAND self-test. If no DTCs are present, go to next step. If DTCs B1405 (self-test) and B1408 (self-test) are present, go to step 9). If DTC B1410 (continuous and self-test) are present, go to step 15). If DTCs B1398 (continuous and self-test) and B1400 (continuous and self-test) are present, go to next step. If DTC B1342 is present, replace GEM. Clear DTCs and retest.
3. Turn ignition switch to RUN position. Using NGS tester, access ACTIVE COMMAND MODES. Set active command ACCY RLY on. Read D_PWRLY PID. Toggle active command ONE TOUCH ON and OFF. If D_PWRLY PID value agrees with command mode, go to step 9). If NGS tester indicates OFFO-G, go to next step. If NGS tester indicates ON-B-, go to step 7).
4. Turn ignition switch to OFF position. Check one-touch down relay. See ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS under **COMPONENT TESTING** . If one-touch down relay is okay, go to next step. If one-touch down relay does not test as specified, replace one-touch down relay. Clear DTCs and retest system.
5. Remove accessory delay relay from instrument panel fuse/relay block. Measure resistance between accessory delay relay socket terminal No. 87 and one-touch down relay socket terminal No. 85. See **Fig. 3** . If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, replace instrument panel fuse/relay block.Clear DTCs and retest system.
6. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Measure resistance between one-touch down relay terminal No. 86 and instrument panel fuse/relay block terminal No. 2. See **Fig. 2** and **Fig. 3** . Measure resistance between ground and one-touch down relay terminal No. 86. If resistance is less than 5 ohms between one-touch down relay and instrument panel fuse/relay block 18-pin connector, and greater than 10 k/ohms between one-touch down relay and ground, replace GEM. If resistance is not as specified, replace instrument panel fuse/relay block. Clear DTCs and retest system.
7. Turn ignition switch to OFF position. Check one-touch down relay. See ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS under **COMPONENT TESTING** . If one-touch down relay is okay, go to next step. If one-touch down relay does not test as specified, replace

one-touch down relay. Clear DTCs and retest system.

8. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Turn ignition switch to RUN position. Measure voltage between ground and one-touch down relay socket terminal No. 86. See **Fig. 3** . If voltage is present, replace instrument panel fuse/relay block. If voltage is not present, replace GEM. Clear DTCs and retest system.
9. Using NGS tester, read D_DN_SW PID, D_UP_SW PID, and OTD_SW PID while pressing master window switch in UP, DOWN, and AUTO positions. If PID values do not agree with values specified in master switch input table, go to next step. See MASTER SWITCH INPUT TABLE. If PID values agree with values specified in master switch input table, go to step 15).

MASTER SWITCH INPUT

Switch Position	UP Input	DOWN Input	AUTO Input
OFF	Ground	Ground	Open
UP	12 Volts	Ground	Open
DOWN	Ground	12 Volts	Open
AUTO	Ground	12 Volts	12 Volts

10. Turn ignition switch to OFF position. Remove and disconnect appropriate master window switch 7-pin connector. See POWER WINDOW SWITCH under **REMOVAL & INSTALLATION** . Using NGS tester, read D_DN_SW PID, D_UP_SW PID, and OTD_SW PID. Connect a jumper wire between master switch 7-pin connector Light Blue/Black wire and Gray wire terminals while reading NGS tester. Disconnect jumper wire and reconnect jumper wire between master switch 7-pin connector White/Black wire and Tan/Light Blue wire terminals. If PIDs D_DN_SW and OTD_SW indicate DOWN, and PID D_UP_SW indicates UP with jumpers connected, replace master switch. Clear DTCs and retest system. If PIDs do not indicate DOWN or UP as specified, go to next step. If any PID constantly indicates DOWN, go to step 17).
11. Turn ignition switch to OFF position. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance in Tan/Light Blue wire between master switch 7-pin connector and instrument panel fuse/relay block Black connector C243 terminal No. 10. See **Fig. 2** . Measure resistance between ground and Tan/Light Blue wire at master switch 7-pin connector. If resistance is less than 5 ohms between master switch and fuse/relay block Black connector C243, and greater than 10 k/ohms between ground and master switch 7-pin connector, go to next step. If resistances are not as specified, repair Tan/Light Blue wire. Clear DTCs and retest system.
12. Measure resistance in White/Black wire between master switch 7-pin connector and instrument panel fuse/relay block Black connector C243 terminal No. 9. Measure resistance between ground and White/Black wire at master switch 7-pin connector. If resistance is less than 5 ohms between master switch and fuse/relay block Black connector C243, and greater than 10 k/ohms between ground and master switch 7-pin connector, go to next step. If resistances are not as specified, repair White/Black wire. Clear DTCs and retest system.
13. Measure resistance in Gray wire between master switch 7-pin connector and instrument panel fuse/relay block Black connector C243 terminal No. 28. See **Fig. 2** . Measure resistance between ground and Gray wire at master switch 7-pin connector. If resistances are less than 5 ohms between master switch and fuse/relay block Black connector C243, and greater than 10 k/ohms between ground and master switch 7-pin connector, go to next step. If resistance is greater than 5 ohms, repair open in Gray wire. Clear DTCs and retest system.

14. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance between instrument panel fuse/relay block 18-pin GEM connector terminal No. 8 and instrument panel fuse/relay block Black connector C243 terminal No. 10. See **Fig. 2** . Reconnect instrument panel fuse/relay block Black connector C243. Measure resistance between ground and instrument panel fuse/relay block 18-pin GEM connector terminal No. 8. If resistance is less than 5 ohms between fuse/relay block Black connector C243 terminal No. 10 and fuse/relay block 18-pin GEM connector terminal No. 8, and greater than 10 k/ohms between ground and fuse/relay block 18-pin GEM connector terminal No. 8, go to next step. If resistances are not as specified, replace instrument panel fuse/relay block. Clear DTCs and retest system.
15. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance between instrument panel fuse/relay block 18-pin GEM connector terminal No. 6 and instrument panel fuse/relay block Black connector C243 terminal No. 9. See **Fig. 2** . Reconnect instrument panel fuse/relay block Black connector C243. Measure resistance between ground and instrument panel fuse/relay block 18-pin GEM connector terminal No. 6. If resistance is less than 5 ohms between fuse/relay block Black connector C243 terminal No. 9 and fuse/relay block 18-pin GEM connector terminal No. 6, and greater than 10 k/ohms between ground and fuse/relay block 18-pin GEM connector terminal No. 6, go to next step. If resistances are not as specified, replace instrument panel fuse/relay block. Clear DTCs and retest system.
16. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance between instrument panel fuse/relay block 18-pin GEM connector terminal No. 9 and instrument panel fuse/relay block Black connector C243 terminal No. 28. See **Fig. 2** . Reconnect instrument panel fuse/relay block Black connector C243. Measure resistance between ground and instrument panel fuse/relay block 18-pin GEM connector terminal No. 9. If resistance is less than 5 ohms between fuse/relay block Black connector C243 terminal No. 28 and fuse/relay block 18-pin GEM connector terminal No. 9, and greater than 10 k/ohms between ground and fuse/relay block 18-pin GEM connector terminal No. 9, replace GEM. If resistances are not as specified, replace instrument panel fuse/relay block. Clear DTCs and retest system.
17. Turn ignition switch to OFF position. Disconnect instrument panel fuse/relay block Black connector C243. Turn ignition switch to RUN position. Measure voltage between ground and master switch 7-pin connector Tan/Light Blue wire. Measure voltage between ground and master switch 7-pin connector White/Black wire. Measure voltage between ground and master switch 7-pin connector Gray wire. If voltage is not present, turn ignition switch to OFF position, reconnect instrument panel fuse/relay block Black connector C243 and go to next step. If voltage is present, repair suspect circuit for short to voltage. Clear DTCs and retest system.
18. Turn ignition switch to RUN position. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Measure voltage between ground and instrument panel fuse/relay block 18-pin GEM connector terminal No. 8. Measure voltage between ground and instrument panel fuse/relay block 18-pin GEM connector terminal No. 6. Measure voltage between ground and instrument panel fuse/relay block 18-pin GEM connector terminal No. 9. If voltages are greater than 10 volts, replace GEM. If voltages are less than 10 volts, replace instrument panel fuse/relay block. Clear DTCs and retest system.
19. Turn ignition switch to OFF position. Disconnect left front window motor connector. Using NGS tester, set active command ONE TOUCH ON. Measure voltage between ground and left front window motor connector Orange/White wire. If voltage is less than 10 volts, exit active command mode and go to next step. If voltage is present, go to step 23).
20. Turn ignition switch to OFF position. Disconnect one-touch down relay from instrument panel fuse/relay block. Measure resistance between one-touch down relay socket terminal No. 30 and left front window

motor connector Orange/White wire. See **Fig. 3** . If resistance is greater than 5 ohms, go to next step. If resistance is less than 5 ohms, go to step 22.

21. Disconnect instrument panel fuse/relay block Gray connector C242. Measure resistance in Orange/White wire between instrument panel fuse/relay block Gray connector C242 terminal No. 24 and left front window motor connector. See **Fig. 2** . If resistance is less than 5 ohms, replace instrument panel fuse/relay block. If resistance is greater than 5 ohms, repair open in Orange/White wire. Clear DTCs and retest system.
22. Disconnect accessory delay relay from instrument panel fuse/relay block. Measure resistance between one-touch down relay socket terminal No. 87 and accessory delay relay socket terminal No. 87. See **Fig. 3** . If resistance is less than 5 ohms, replace one-touch down relay. If resistance is greater than 5 ohms, replace instrument panel fuse/relay block. Clear DTCs and retest system.
23. Using NGS tester, set active command ONE TOUCH OFF. Turn ignition switch to OFF position. Measure resistance between ground and left front window motor connector Orange/White wire. If resistance is greater than 5 ohms, go to next step. If resistance is less than 5 ohms, go to step 26).
24. Disconnect one-touch down relay from instrument panel fuse/relay block. Measure resistance between ground and one-touch down relay socket terminal No. 87A. See **Fig. 3** . If resistance is greater than 5 ohms, go to next step. If resistance is less than 5 ohms, replace one-touch down relay. Clear DTCs and retest system.
25. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance between ground and instrument panel fuse/relay block Black connector C243 terminal No. 24 (Black wire). If resistance is less than 5 ohms, replace instrument panel fuse/relay block. If resistance is greater than 5 ohms, repair open in Black wire. Clear DTCs and retest system.
26. Turn ignition switch to RUN position. Measure voltage between ground and left front window motor connector White/Black wire while pressing left front window switch in UP position. If voltage is greater than 10 volts, go to next step. If voltage is less than 10 volts, repair open in White/Black wire. Clear DTCs and retest system.
27. Turn ignition switch to OFF position. Disconnect appropriate master window switch 7-pin connector. Measure resistance between ground and left front window motor connector White/Black wire. If resistance is less than 5 ohms, replace left front window motor. If resistance is greater than 5 ohms, replace master window switch. Clear DTCs and retest system.

F150/F250 Light-Duty

1. Ensure ignition switch is off. Connect NGS tester to Data Link Connector (DLC). Using NGS tester, read IGN_GEM PID while rotating ignition switch through START, RUN, OFF and ACC positions. If PID values agree with ignition switch positions, go to next step. If PID values do not agree with ignition switch positions, repair suspect open circuit between ignition switch and instrument panel fuse block. See POWER DISTRIBUTION article in WIRING DIAGRAMS. Clear DTCs and retest system.
2. Following manufacturer's instructions, retrieve continuous DTCs from GEM. Using NGS tester, perform ON-DEMAND self-test. If no DTCs are present, go to next step. If DTCs B1405 (self-test) and B1408 (self-test) are present, go to step 4). If DTC B1410 (continuous and self-test) is present, go to step 10). If DTCs B1398 (continuous and self-test) and B1400 (continuous and self-test) are present, go to next step. If DTC B1342 is present, replace GEM. Clear DTCs and retest.
3. Turn ignition switch to RUN position. Using NGS tester, set active command DELAYED ACCESSORY ON. Read LFPWRLY PID. Toggle active command ONE TOUCH DOWN ON and OFF. If ACCDLY

PID value agrees with command mode, go to step 9). If NGS tester indicates OFFO-G, go to next step. If NGS tester indicates ON-B-, go to step 7).

4. Turn ignition switch to OFF position. Check one-touch down relay. See ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS under **COMPONENT TESTING** . If one-touch down relay is okay, go to next step. If one-touch down relay does not test as specified, replace one-touch down relay. Clear DTCs and retest system.
5. Remove accessory delay relay from instrument panel fuse/relay block. Measure resistance between accessory delay relay socket terminal No. 87 and one-touch down relay socket terminal No. 85. See **Fig. 3** . If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, replace instrument panel fuse/relay block. Clear DTCs and retest system.
6. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Measure resistance between one-touch down relay terminal No. 86 and instrument panel fuse/relay block 18-pin GEM connector terminal No. 2. See **Fig. 2** and **Fig. 3** . Measure resistance between ground and one-touch down relay terminal No. 86. If resistance is less than 5 ohms between one-touch down relay and instrument panel fuse/relay block 18-pin connector, and greater than 10 k/ohms between one-touch down relay and ground, replace GEM. If resistance is not as specified, replace instrument panel fuse/relay block. Clear DTCs and retest system.
7. Turn ignition switch to OFF position. Check one-touch down relay. See ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS under **COMPONENT TESTING** . If one-touch down relay is okay, go to next step. If one-touch down relay does not test as specified, replace one-touch down relay. Clear DTCs and retest system.
8. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Turn ignition switch to RUN position. Measure voltage between ground and one-touch down relay socket terminal No. 86. See **Fig. 3** . If voltage is present, replace instrument panel fuse/relay block. If voltage is not present, replace GEM. Clear DTCs and retest system.
9. Using NGS tester, read LFD_SW PID, LFU_SW PID, and OTD_SW PID while pressing master window switch in UP, DOWN, and AUTO positions. If PID values do not agree with values specified in master switch input table, go to next step. See MASTER SWITCH INPUT TABLE. If PID values agree with values specified in master switch input table, go to step 16).
10. Turn ignition switch to OFF position. Remove and disconnect master window switch 4-pin connector. See **REMOVAL & INSTALLATION** . Turn ignition switch to RUN position. Using NGS tester, enter active command mode DELAYED ACCESSORY. Set active command mode to ON. Measure voltage between ground and master window switch connector Light Blue/Black wire. If voltage is greater than 10 volts, go to next step. If voltage is less than 10 volts, repair Light Blue/Black wire. Clear DTCs and retest system.
11. Using NGS tester, read LFD_SW PID, LFU_SW PID, and OTD_SW PID. Connect a jumper wire between master switch 4-pin connector Light Blue/Black wire and Gray wire terminals while reading NGS tester. Disconnect jumper wire and reconnect jumper wire between master switch 4-pin connector White/Black wire and Tan/Light Blue wire terminals. If PIDs LFD_SW and OTD_SW indicate DOWN, and PID LFU_SW indicates UP with jumpers connected, replace master switch. Clear DTCs and retest system. If PIDs do not indicate DOWN or UP as specified, go to next step.
12. Turn ignition switch to OFF position. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance in Tan/Light Blue wire between master switch 4-pin connector and instrument panel fuse/relay block Black connector C243 terminal No. 10. See **Fig. 2** . Measure resistance between ground and Tan/Light Blue wire at master switch 4-pin connector. If resistance is less than 5 ohms

between master switch and fuse/relay block Black connector C243, and greater than 10 k/ohms between ground and master switch 4-pin connector, go to next step. If resistances are not as specified, repair Tan/Light Blue wire. Clear DTCs and retest system.

13. Measure resistance in White/Black wire between master switch 4-pin connector and instrument panel fuse/relay block Black connector C243 terminal No. 9. See **Fig. 2** . Measure resistance between ground and White/Black wire at master switch 4-pin connector. If resistance is less than 5 ohms between master switch and fuse/relay block Black connector C243, and greater than 10 k/ohms between ground and master switch 4-pin connector, go to next step. If resistances are not as specified, repair White/Black wire. Clear DTCs and retest system.
14. Measure resistance in Gray wire between master switch 4-pin connector and instrument panel fuse/relay block Black connector C243 terminal No. 28. See **Fig. 2** . Measure resistance between ground and Gray wire at master switch 4-pin connector. If resistances are less than 5 ohms between master switch and fuse/relay block Black connector C243, and greater than 10 k/ohms between ground and master switch 4-pin connector, go to next step. If resistance is greater than 5 ohms, repair open in Gray wire. Clear DTCs and retest system.
15. Turn ignition switch to OFF position. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Measure resistance between instrument panel fuse/relay block 18-pin GEM connector terminal No. 8 and instrument panel fuse/relay block Black connector C243 terminal No. 10. See **Fig. 2** . Measure resistance between instrument panel fuse/relay block 18-pin GEM connector terminal No. 6 and instrument panel fuse/relay block Black connector C243 terminal No. 9. Measure resistance between instrument panel fuse/relay block 18-pin GEM connector terminal No. 9 and instrument panel fuse/relay block Black connector C243 terminal No. 28. If resistances are less than 5 ohms, replace GEM. If resistances are greater than 5 ohms, replace instrument panel fuse/relay block. Clear DTCs and retest system.
16. Turn ignition switch to OFF position. Disconnect left front window motor connector. Turn ignition switch to RUN position. Using NGS tester, set active command ONE TOUCH DOWN ON. Measure voltage between ground and left front window motor connector Orange/White wire. If voltage is less than 10 volts, exit active command mode and go to next step. If voltage is present, go to step 20).
17. Turn ignition switch to OFF position. Disconnect one-touch down relay from instrument panel fuse/relay block. Measure resistance between one-touch down relay socket terminal No. 30 and left front window motor connector Orange/White wire. See **Fig. 3** . If resistance is greater than 5 ohms, go to next step. If resistance is less than 5 ohms, go to step 19.
18. Turn ignition switch to OFF position. Disconnect instrument panel fuse/relay block Gray connector C242. Measure resistance in Orange/White wire between instrument panel fuse/relay block Gray connector C242 terminal No. 24 and left front window motor connector. See **Fig. 2** . If resistance is less than 5 ohms, replace instrument panel fuse/relay block. If resistance is greater than 5 ohms, repair open in Orange/White wire. Clear DTCs and retest system.
19. Disconnect accessory delay relay from instrument panel fuse/relay block. Measure resistance between one-touch down relay socket terminal No. 87 and accessory delay relay socket terminal No. 87. See **Fig. 3** . If resistance is less than 5 ohms, replace one-touch down relay. If resistance is greater than 5 ohms, replace instrument panel fuse/relay block. Clear DTCs and retest system.
20. Using NGS tester, set active command ONE TOUCH DOWN OFF. Turn ignition switch to OFF position. Measure resistance between ground and left front window motor connector Orange/White wire. If resistance is greater than 5 ohms, go to next step. If resistance is less than 5 ohms, go to step 23).
21. Disconnect one-touch down relay from instrument panel fuse/relay block. Measure resistance between

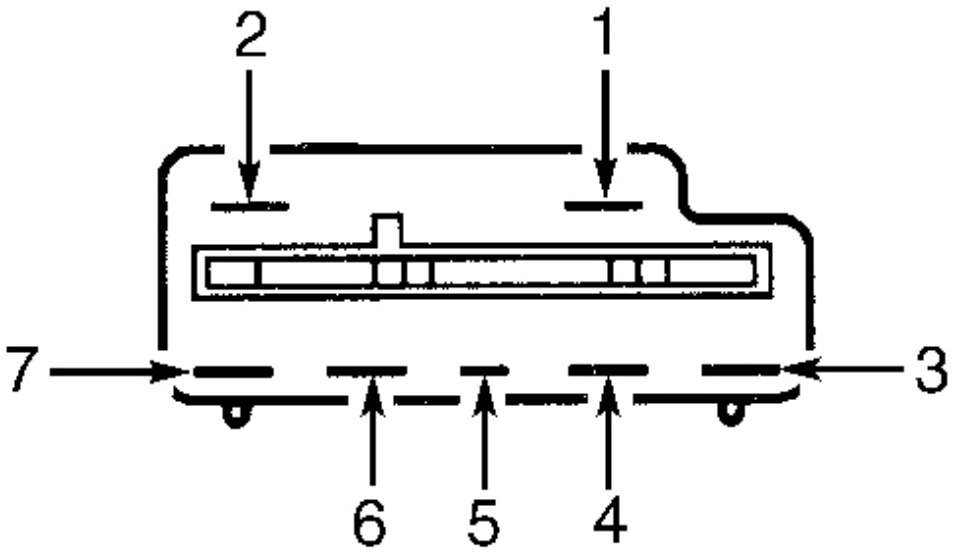
ground and one-touch down relay socket terminal No. 87A. See **Fig. 3** . If resistance is greater than 5 ohms, go to next step. If resistance is less than 5 ohms, replace one-touch down relay. Clear DTCs and retest system.

22. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance between ground and instrument panel fuse/relay block Black connector C243 terminal No. 24 (Black wire). If resistance is less than 5 ohms, replace instrument panel fuse/relay block. If resistance is greater than 5 ohms, repair open in Black wire. Clear DTCs and retest system.
23. Turn ignition switch to RUN position. Measure voltage between ground and left front window motor connector White/Black wire while pressing left front window switch in UP position. If voltage is greater than 10 volts, replace left front window motor. If voltage is less than 10 volts, repair open in White/Black wire. Clear DTCs and retest system.

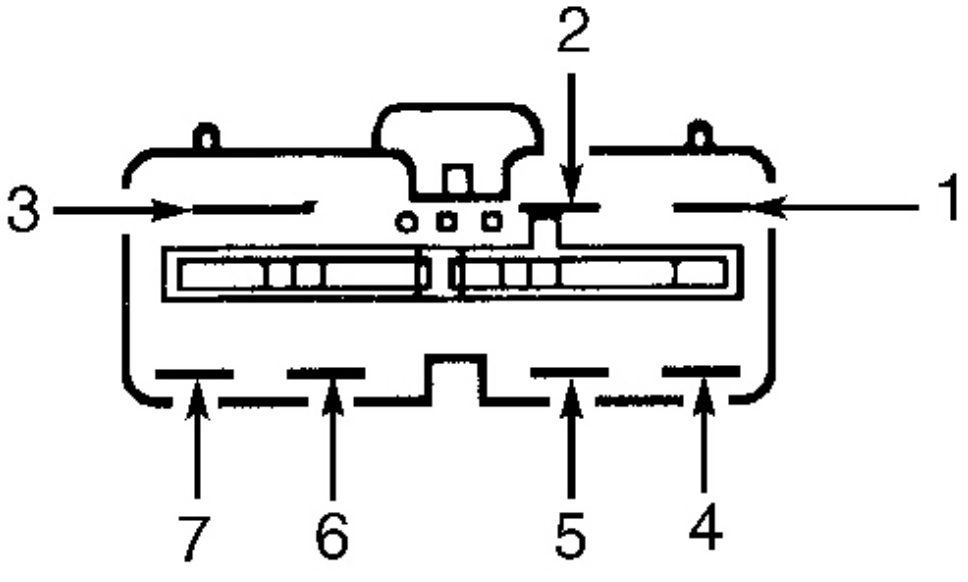
DRIVER'S WINDOW OPERATES, ALL OTHER WINDOWS DO NOT OPERATE

(EXPEDITION)

1. Turn ignition switch to OFF position. Remove and disconnect appropriate power window switch. See **POWER WINDOW SWITCH** under REMOVAL & INSTALLATION. Ensure window lock-out switch on master switch is in OFF position. Turn ignition switch to RUN position. Measure voltage at window switch connector Yellow/Light Green wire terminal. If voltage is greater than 10 volts and right front window is inoperative window, go to next step. If voltage is greater than 10 volts and left rear window is inoperative window, go to step 3). If voltage is greater than 10 volts and right rear window is inoperative window, go to step 4). If voltage is less than 10 volts, go to step 5).
2. Turn ignition switch to OFF position. Measure resistance between ground and right front window switch connector White/Yellow wire terminal. Measure resistance between ground and right front window switch connector Tan/Light Blue wire terminal. If resistances are less than 5 ohms, go to step 7). If resistances are greater than 5 ohms, go to step 6).
3. Turn ignition switch to OFF position. Measure resistance between ground and left rear window switch connector Gray/Orange wire terminal. Measure resistance between ground and left rear window switch connector Yellow/Light Blue wire terminal. If resistances are less than 5 ohms, go to step 7). If resistances are greater than 5 ohms, go to step 6).
4. Turn ignition switch to OFF position. Measure resistance between ground and right rear window switch connector Yellow/Black wire terminal. Measure resistance between ground and right rear window switch connector Red/Black wire terminal. If resistances are less than 5 ohms, go to step 7). If resistances are greater than 5 ohms, go to step 6).
5. Turn ignition switch to OFF position. Remove and disconnect master window switch connectors. See **POWER WINDOW SWITCH** under REMOVAL & INSTALLATION. Ensure window lock-out switch on master switch is in OFF position. Measure resistance between master window switch under C509-2 and C510-3. See **Fig. 4** . If resistance is less than 5 ohms, repair open in Yellow/Light Green wire. If resistance is greater than 5 ohms, replace master switch. Clear DTCs and retest.



C509



C510

G97B28192

Fig. 4: Identifying Power Window Master Switch Terminals (Expedition)
Courtesy of FORD MOTOR CO.

6. Turn ignition switch to OFF position. Remove and disconnect master window switch. See **POWER WINDOW SWITCH** under REMOVAL & INSTALLATION. Measure resistance in appropriate wires between master window switch connectors and inoperative window switch connector as follows:
   - Right Front - Tan/Light Blue & White/Yellow Wires.
   - Left Rear - Gray/Orange & Yellow/Light Blue Wires.
   - Right Rear - Red/Black & Yellow/Black Wires.

If resistance are less than 5 ohms, replace master window switch. If resistances are greater than 5 ohms, repair open in appropriate circuit. Clear DTCs and retest system.

7) Turn ignition switch to OFF position. Ensure window lock-out switch on master switch is in OFF position. Connect jumper wires between inoperative window switch connector appropriate wire terminals as follows:

- Right Front - Tan/Light Blue & Red/Yellow Wires. Yellow/Light Green & Yellow/Red Wires.
- Left Rear - Yellow/Light Blue Wires. Yellow/Light Green & Yellow/Black Wires.
- Right Rear - Red/Black & Brown/Yellow Wires. Yellow/Light Green & Brown Wires.

Turn ignition switch to RUN position. If window does not operate in DOWN direction, go to next step. If window operates in DOWN direction, replace inoperative window switch. Clear DTCs and retest system.

8) Turn ignition switch to OFF position. Ensure window lock-out switch on master switch is in OFF position. Connect jumper wires between inoperative window switch connector appropriate wire terminals as follows:

- Right Front - White/Yellow & Yellow/Red Wires. Yellow/Light Green & Red/Yellow Wires.
- Left Rear - Gray/Orange & Yellow/Black Wires. Yellow/Light Green & Yellow/Light Blue Wires.
- Right Rear - Yellow/Black & Brown Wires. Yellow/Light Green & Brown/Yellow Wires.

Turn ignition switch to RUN position. If window does not operate in UP direction, go to next step. If window operates in UP direction, replace inoperative window switch. Clear DTCs and retest system.

9) Turn ignition switch to OFF position. Disconnect inoperative window motor connector. Measure resistance in circuits between inoperative window switch connector and window motor connector. See **WIRING DIAGRAMS** . If resistances are less than 5 ohms, replace inoperative power window motor. If resistances are greater than 5 ohms, repair open(s) in suspect circuit(s). Clear DTCs and retest sytem.

PASSENGER'S WINDOW DOES NOT OPERATE, DRIVER'S WINDOW OPERATES

(F150/F250 LIGHT-DUTY)

1. Turn ignition switch to OFF position. Remove and disconnect passenger window switch. See **POWER WINDOW SWITCH** under REMOVAL & INSTALLATION. Turn ignition switch to RUN position. Measure voltage between ground and Light Blue/Black wire at passenger window switch connector. If

voltage is greater than 10 volts, go to next step. If voltage is less than 10 volts, repair open in Light Blue/Black wire. Clear DTCs and retest system.

2. Turn ignition switch to OFF position. Measure resistance between ground and White/Yellow wire at passenger window switch connector. Measure resistance between ground and Tan/Light Blue wire at passenger window switch connector. If resistances are greater than 5 ohms, go to next step. If resistances are less than 5 ohms, go to step 4).
3. Turn ignition switch to OFF position. Disconnect master window switch 5-pin connector. Measure resistance in White/Yellow wire between master switch 5-pin connector and passenger window switch connector. Measure resistance in Tan/Light Blue wire between master switch 5-pin connector and passenger window switch connector. If resistances are less than 5 ohms, replace master window switch. If resistances are greater than 5 ohms, repair open in White/Yellow or Tan/Light Blue wires. Clear DTCs and retest system.
4. Turn ignition switch to RUN position. Connect a jumper wire between Tan/Light Blue and Red/Yellow wire terminals at passenger window switch connector. Connect another jumper wire between Light Blue/Black and Yellow/Red wire terminals at passenger window switch connector. If passenger window does not operate in DOWN direction, go to next step. If passenger window operates in DOWN direction, replace inoperative window switch.
5. Connect a jumper wire between White/Yellow and Yellow/Red wire terminals at passenger window switch connector. Connect another jumper wire between Light Blue/Black and Red/Yellow wire terminals at passenger window switch connector. If passenger window does not operate in UP direction, go to next step. If passenger window operates in UP direction, replace inoperative window switch.
6. Turn ignition switch to OFF position. Disconnect passenger's window motor connector. Measure resistance in Yellow/Red wire between passenger window switch connector and passenger's window motor connector. Measure resistance in Red/Yellow wire between passenger window switch connector and passenger's window motor connector. If resistances are less than 5 ohms, replace passenger's power window motor. If resistances are greater than 5 ohms, repair open in Yellow/Red or Red/Yellow wires. Clear DTCs and retest system.

ONE-TOUCH DOWN FEATURE DOES NOT OPERATE (F150/F250

LIGHT-DUTY)

NOTE: This test is associated with DTC B1342.

1. Following manufacturer's instructions, retrieve continuous DTCs from GEM. Using NGS tester, perform ON-DEMAND self-test. If no DTCs are present, go to next step. If DTC B1342 is present, replace GEM. Clear DTCs and retest.
2. Turn ignition switch to OFF position. Using NGS tester, read LFD_SW PID and OTD_SW PID while pressing left window switch in DOWN position. If LFD_SW PID does not indicate OFF and OTD_SW PID does not indicate DOWN, go to next step. If LFD_SW PID indicates OFF, and OTD_SW PID indicates DOWN, replace master window switch. Clear DTCs and retest system.
3. Turn ignition switch to OFF position. Disconnect master window switch 4-pin connector. Using NGS tester, read LFD_SW PID and OTD_SW PID. Connect a jumper wire between Light Blue/Black and Gray wire terminals at master switch 4-pin connector. Connect another jumper wire between Light Blue/Black and Tan/Light Blue wire terminals at master switch 4-pin connector. If LFD_SW PID and

OTD_SW PID does not indicate DOWN, go to next step. If LFD_SW PID and OTD_SW PID indicates DOWN, replace master window switch. Clear DTCs and retest system.

4. Turn ignition switch to OFF position. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance in Gray wire between master window switch 4-pin connector and Black connector C243 terminal No. 28. See **Fig. 2** . If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, repair open in Gray wire. Clear DTCs and retest system.
5. Turn ignition switch to OFF position. Disconnect 18-pin GEM connector from instrument panel fuse/relay block. Disconnect instrument panel fuse/relay block Black connector C243. Measure resistance between instrument panel fuse/relay block 18-pin GEM connector terminal No. 9 and instrument panel fuse/relay block Black connector C243 terminal No. 28. If resistance is less than 5 ohms, replace GEM. If resistance is greater than 5 ohms, replace instrument panel fuse/relay block. Clear DTCs and retest system.

VENT WINDOWS MALFUNCTIONING (EXPEDITION)

1. Verify vent window operation. If left vent window does not operate, go to next step. If left vent window operates, go to step 10). If both vent windows do not operate, go to step 21).
2. Turn ignition switch to OFF position. Disconnect left vent window switch connector. Turn ignition switch to RUN position. Measure voltage between ground and Pink wire at left vent window switch connector. If voltage is greater than 10 volts, go to next step. If voltage is less than 10 volts, repair Pink wire. Retest system.
3. Turn ignition switch to OFF position. Measure resistance between ground and Black wires at left vent window switch connector. If resistances are less than 5 ohms, go to next step. If resistances are greater than 5 ohms, repair open in Black wire(s). Retest system.
4. Measure resistance between left vent window switch terminals No. 3 and 4, and also between terminals No. 1 and 6 while pressing left vent window switch in OPEN position. See **Fig. 5** . If resistances are less than 5 ohms, go to next step. If resistance is greater than 5 ohms, replace left vent window switch. Retest system.

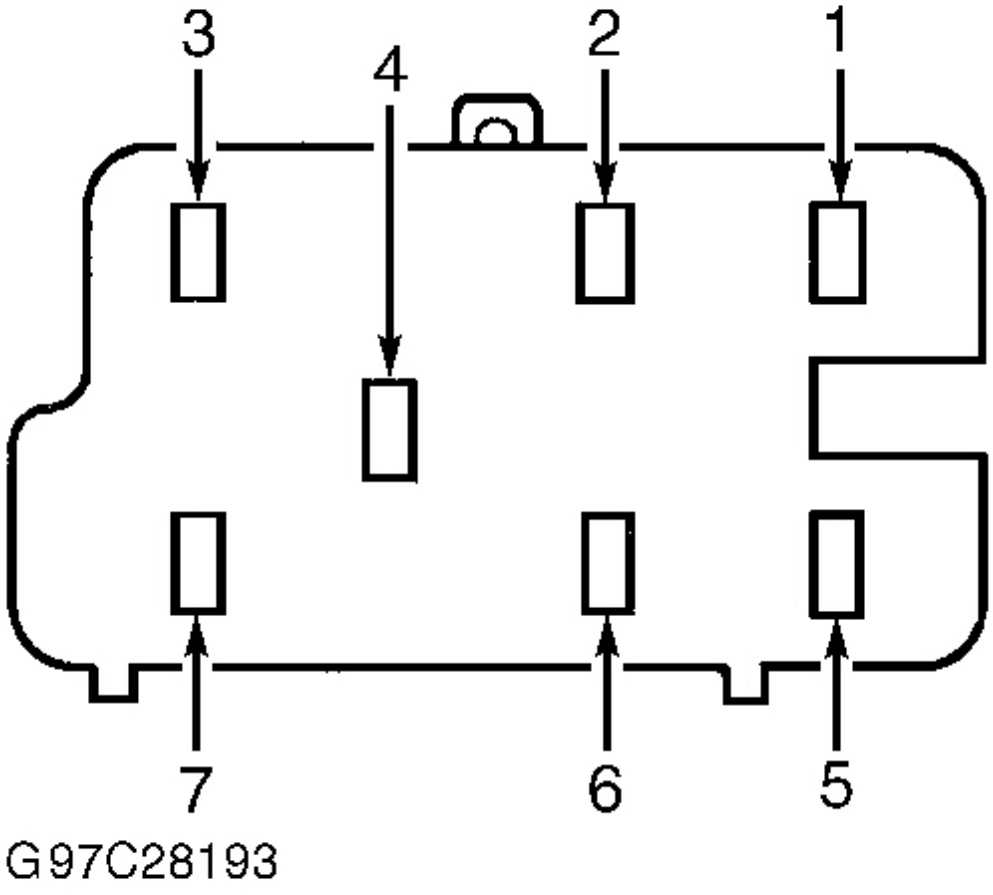


Fig. 5: Identifying Vent Window & Single Switch Terminals
Courtesy of FORD MOTOR CO.

5. Measure resistance between left vent window switch terminals No. 2 and 3, and also between terminals No. 4 and 6 while pressing left vent window switch in CLOSED position. See **Fig. 5** . If resistances are less than 5 ohms, go to next step. If resistance is greater than 5 ohms, replace left vent window switch. Retest system.
6. Disconnect left vent window motor connector. Measure resistance in Yellow/Light Blue wire between left vent window switch connector and left vent window motor connector. If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/Light Blue wire. Retest system.
7. Measure resistance between ground and Yellow/Light Blue wire at left vent window switch connector. If resistance is greater than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair Yellow/Light Blue wire. Retest system.

8. Measure resistance in White/Light Blue wire between left vent window switch connector and left vent window motor connector. If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, repair open in White/Light Blue wire. Retest system.
9. Measure resistance between ground and White/Light Blue wire at left vent window switch connector. If resistance is greater than 10 k/ohms, repair White/Light Blue wire. If resistance is less than 10 k/ohms, replace left vent window motor. Retest system.
10. Turn ignition switch to OFF position. Disconnect right vent window switch connector. Turn ignition switch to RUN position. Measure voltage between ground and Pink wire at right vent window switch connector. If voltage is greater than 10 volts, go to next step. If voltage is less than 10 volts, repair Pink wire. Retest system.
11. Turn ignition switch to OFF position. Measure resistance between ground and Black wires at right vent window switch connector. If resistances are less than 5 ohms, go to next step. If resistances are greater than 5 ohms, repair open in Black wire(s). Retest system.
12. Measure resistance between right vent window switch terminals No. 3 and 4, and also between terminals No. 1 and 6 while pressing right vent window switch in OPEN position. If resistances are less than 5 ohms, go to next step. If resistance is greater than 5 ohms, replace right vent window switch. Retest system.
13. Measure resistance between right vent window switch terminals No. 2 and 3, and also between terminals No. 4 and 6 while pressing right vent window switch in CLOSED position. If resistances are less than 5 ohms, go to next step. If resistance is greater than 5 ohms, replace right vent window switch. Retest system.
14. Disconnect right vent window motor connector. Measure resistance in Yellow/Red wire between right vent window switch connector and right vent window motor connector. If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, repair open in Yellow/Red wire. Retest system.
15. Measure resistance between ground and Yellow/Red wire at right vent window switch connector. If resistance is greater than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair Yellow/Red wire. Retest system.
16. Measure resistance in White/Red wire between right vent window switch connector and right vent window motor connector. If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, repair open in White/Red wire. Retest system.
17. Measure resistance between ground and White/Red wire at right vent window switch connector. If resistance is greater than 10 k/ohms, repair White/Red wire. If resistance is less than 10 k/ohms, replace right vent window motor. Retest system.
18. Check fuse No. 29 (50-amp) in engine compartment fuse block. If fuse is okay, go to next step. If fuse is blown, replace fuse and retest. If fuse blows again, check Red/Black wire between engine compartment fuse block and vent window/moonroof relay. Repair as necessary.
19. Disconnect vent window/moonroof relay from RPO relay block, located behind passenger side of instrument panel. Measure voltage between ground and vent window/moonroof relay socket terminal No. 30. See **Fig. 3** . If voltage is greater than 10 volts, go to next step. If voltage is less than 10 volts, repair Red/Black wire. Retest system.
20. Measure voltage between ground and vent window/moonroof relay socket terminal No. 86. See **Fig. 3** . If voltage is greater than 10 volts, go to next step. If voltage is less than 10 volts, go to **POWER WINDOWS DO NOT OPERATE** . Retest system.
21. Measure resistance between ground and vent window/moonroof relay socket terminal No. 85. See **Fig. 3** .

If resistance is less than 5 ohms, go to next step. If resistance is greater than 5 ohms, repair open in Black wire. Retest system.

22. Check vent window/moonroof relay. See ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS under **COMPONENT TESTING** . If vent window/moonroof relay is okay, repair Pink wire. If vent window/moonroof relay does not test as specified, replace vent window/moonroof relay. Retest system.

COMPONENT TESTING

POWER WINDOW MOTOR

Remove window motor from vehicle, see **POWER WINDOW MOTOR** under REMOVAL & INSTALLATION. Using fused jumper wires, connect a fully charged battery to motor terminals. Observe motor. Motor should operate smoothly. Reverse leads. Motor should operate in reverse direction. Replace window motor if it does not operate as specified.

POWER WINDOW MASTER SWITCH

Remove master switch. See **POWER WINDOW SWITCH** under REMOVAL & INSTALLATION. Check for continuity between terminals as specified while operating switch. See appropriate MASTER SWITCH TESTING TABLE. If continuity does not exist as specified, replace switch. See **Fig. 4** or **Fig. 6** .

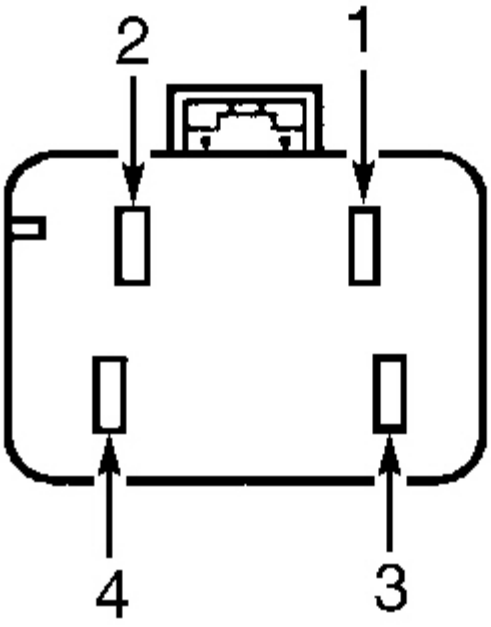
MASTER SWITCH TESTING (EXPEDITION)

Switch Position	Continuity Between Terminal Nos.
Neutral	C510-2 & C510-5; C509-3, C509-4, C509-6, C509-7, C510-4, C510-5, C510-6, C510-7 & C509-1
Left Front	
Up	C509-2 & C509-7; C509-1 & C509-6
Down	C509-2 & C509-6; C509-1 & C509-7
Right Front	
Up	C509-2 & C509-3; C509-1 & C509-4
Down	C509-2 & C509-4; C509-1 & C509-3
Left Rear	
Up	C509-2 & C510-6; C509-1 & C510-7
Down	C509-2 & C510-7; C509-1 & C510-6
Right Rear	
Up	C509-2 & C510-5; C509-1 & C510-4
Down	C509-2 & C510-4; C509-1 & C510-5

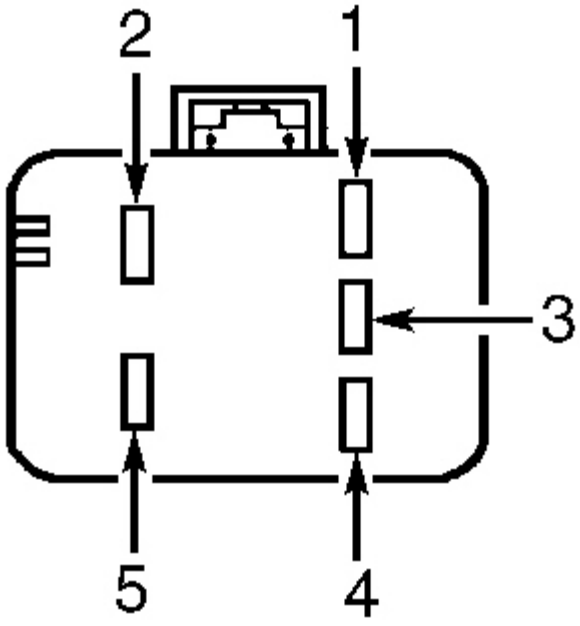
MASTER SWITCH TESTING (F150/F250 LIGHT-DUTY)

Switch Position	Continuity Between Terminal Nos.
Neutral	C510-3 & C510-5; C509-2, C509-3, C510-1, C510-2 & C510-5
Left Front	

Up	C509-4 & C509-2; C509-3 & C510-5
Down	C509-4 & C509-3; C509-2 & C510-5
Right Front	
Up	C509-4 & C510-2; C510-1 & C510-5
Down	C509-4 & C510-1; C510-2 & C510-5



C509



C510

G97D28194

Fig. 6: Identifying Power Window Master Switch Terminals (F150/F250 Light-Duty)
Courtesy of FORD MOTOR CO.

POWER WINDOW SINGLE SWITCH

Remove suspect window switch. See **POWER WINDOW SWITCH** under REMOVAL & INSTALLATION. Check for continuity between terminals as specified while operating switch. See SINGLE SWITCH TESTING TABLE. If continuity does not exist as specified, replace switch. See **Fig. 5** .

SINGLE SWITCH TESTING

Switch Position	Continuity Between Terminal Nos.
Neutral	1 & 5; 2 & 3; 6 & 7
Up	4 & 6; 2 & 3
Down	3 & 4; 6 & 7

POWER VENT WINDOW SWITCH

Remove suspect vent window switch. Check for continuity between terminals as specified while operating switch. See VENT WINDOW SWITCH TESTING TABLE. If continuity does not exist as specified, replace switch. See **Fig. 5** .

VENT WINDOW SWITCH TESTING

Switch Position	Continuity Between Terminal Nos.
Neutral	5 & 7; 1 & 6; 2 & 3
Open	3 & 4; 1 & 6
Close	4 & 6; 2 & 3

ACCESSORY DELAY, ONE-TOUCH DOWN & VENT WINDOW/MOONROOF RELAYS

Remove accessory delay relay or one-touch down relay from instrument panel fuse/relay block. Remove vent window/moonroof relay from RPO relay block, located behind passenger side of instrument panel. Check continuity using an ohmmeter. Continuity should exist between relay terminals 85 and 86, and also between terminals 30 and 87A. See **Fig. 3** . Using fused jumper wires, connect battery terminals to relay terminals 85 and 86. Continuity should now exist between relay terminals 30 and 87. Replace relay if continuity is not as specified.

BATTERY SAVER RELAY

Remove battery saver relay from instrument panel fuse/relay block. Check continuity using an ohmmeter. Continuity should exist between relay terminals No. 1 and 2, and also between terminals No. 3 and 4. See **Fig. 1** . Using fused jumper wires, connect battery terminals to relay terminals No. 1 and 2. Continuity should now exist between relay terminals No. 3 and 5. Replace relay if continuity is not as specified.

REMOVAL & INSTALLATION

POWER WINDOW MOTOR

Removal (Expedition)

1. If glass cannot be raised and is in a partially down position, it must be supported. If not supported, glass will fall into door well during removal. If possible, raise glass to full up position. Disconnect negative battery cable.
2. Remove door trim panel. Disconnect motor wiring connector, and position wiring out of way. Remove 2 regulator retaining bolts. Using a 1/4" drill, remove 4 window regulator motor bracket rivets from door.
3. Remove 3 bolts attaching window regulator and motor. Prior to window regulator and motor removal, ensure regulator arm is in a fixed position to prevent counterbalance spring from unwinding. Disengage motor from regulator.

Installation

Position motor to regulator and install bolts. Do not tighten. Connect wiring and check glass to ensure gear engagement. After gears engage, tighten 3 attaching bolts to 50-80 INCH lbs. (5.6-9.6 N.m). To complete installation, reverse removal procedure.

Removal (F150/F250 Light-Duty)

1. If glass cannot be raised and is in a partially down position, it must be supported. If not supported, glass will fall into door well during removal. If possible, raise glass to full up position. Disconnect negative battery cable.
2. Remove door trim panel and shield. Disconnect motor wiring connector, and position wiring out of way. Using a 3/4" hole saw with a 1/4" pilot, drill out 2 dimples in door to expose motor mounting screws.
3. Remove 3 bolts attaching window regulator and motor. Prior to window regulator and motor removal, ensure regulator arm is in a fixed position to prevent counterbalance spring from unwinding. Disengage motor from regulator.

Installation

Position motor to regulator and install bolts. Do not tighten. Connect wiring and check glass to ensure gear engagement. After gears engage, tighten 3 attaching bolts to 50-80 INCH lbs. (5.6-9.6 N.m). To complete installation, reverse removal procedure.

POWER WINDOW SWITCH

Removal & Installation

Disconnect negative battery cable. Carefully pry up front and rear of switch plate. Using thin-blade screwdriver, pry connector from switch. Remove window switch by carefully prying up with a flat-bladed tool on switch plate. To install, reverse removal procedure.

WIRING DIAGRAMS

1997 Ford Pickup F150

POWER WINDOWS 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Windows

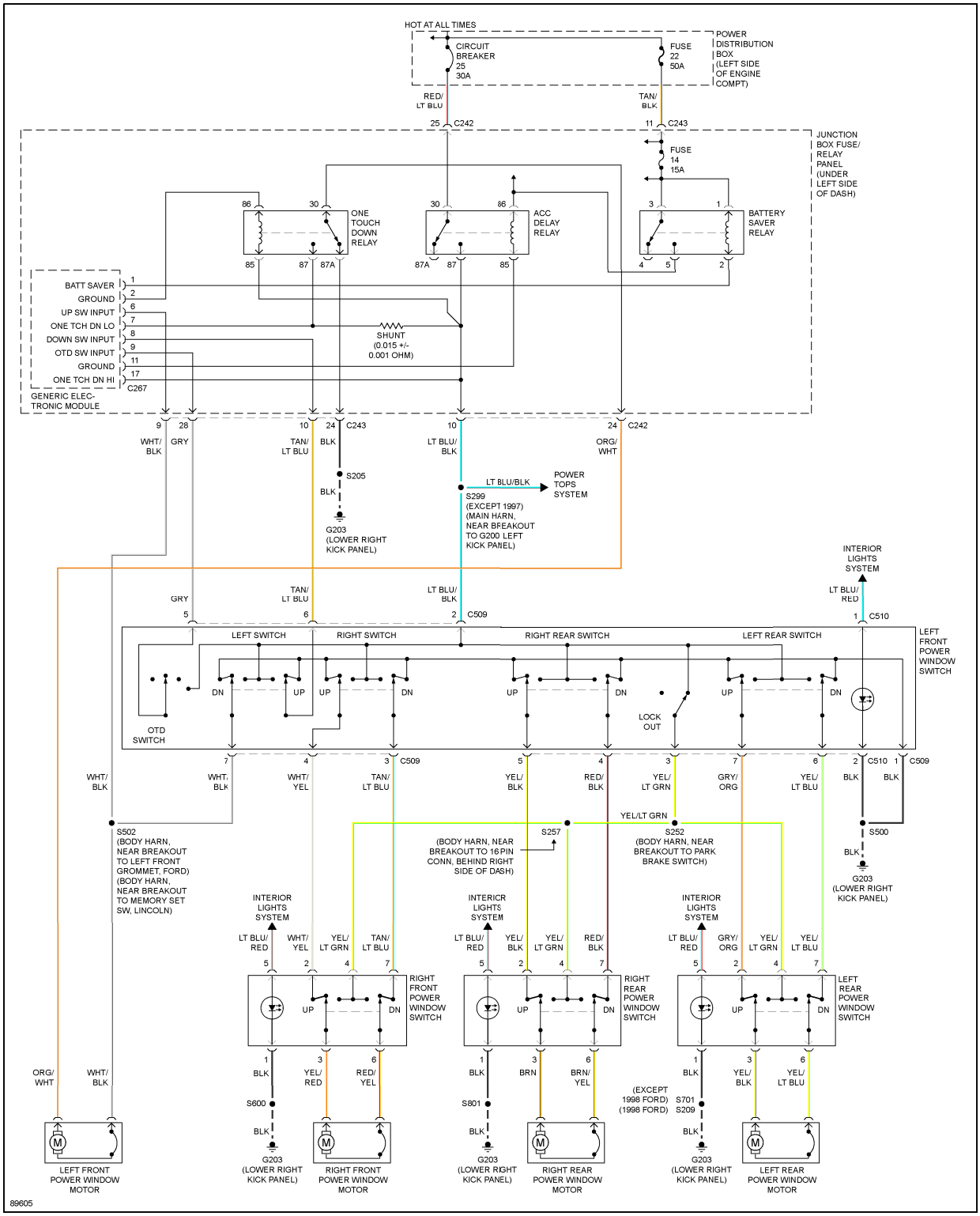


Fig. 7: Power Window System Wiring Diagram (Expedition)

1997 Ford Pickup F150

POWER WINDOWS 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Power Windows

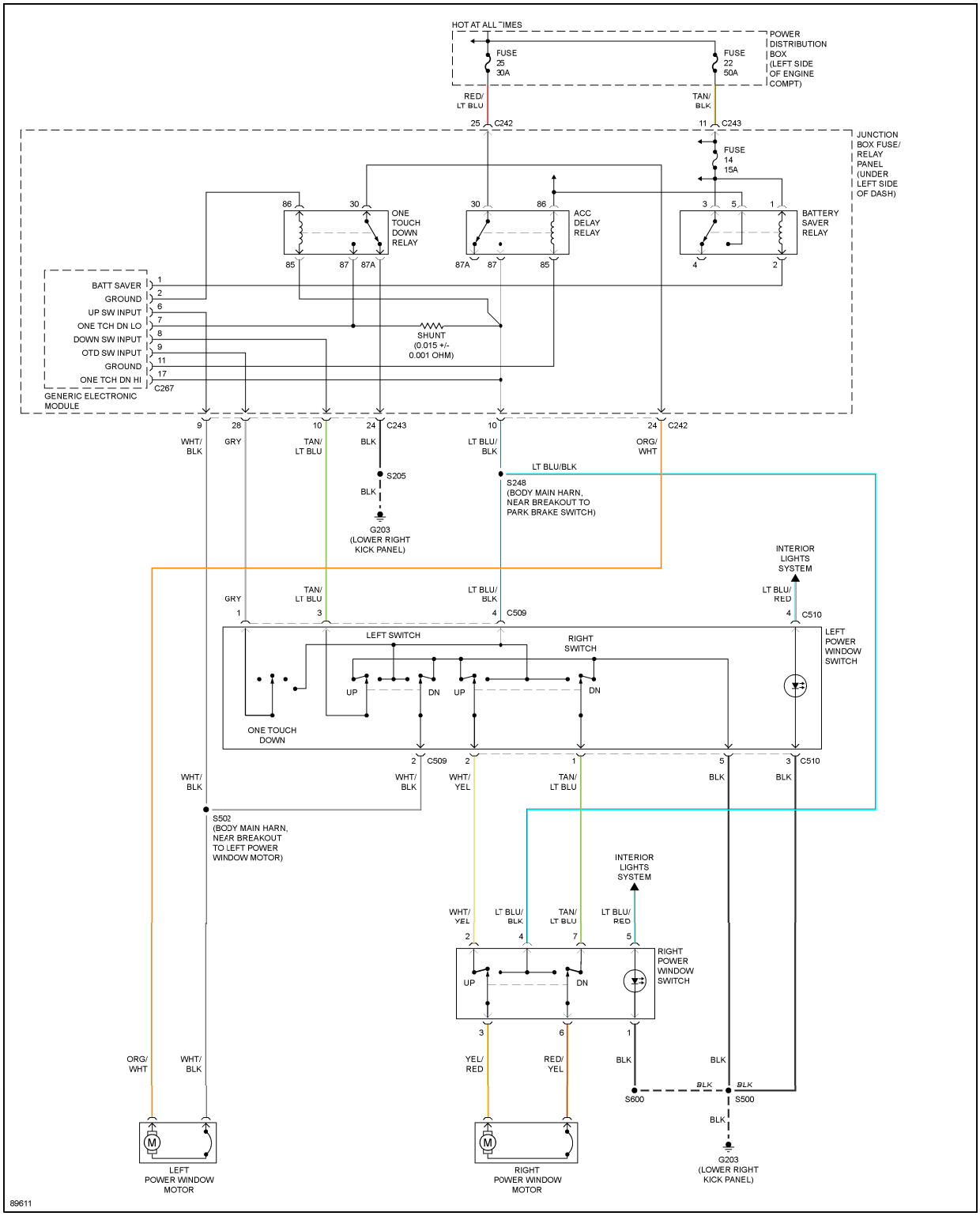


Fig. 8: Power Window System Wiring Diagram (Pickup - F150 & F250 Light-Duty)

1996-97 Drive Axles

Differentials - Rear - 8.8", 9.75" & 10.25" Ring Gear - "F" Series

DESCRIPTION

WARNING: On vehicles equipped with air suspension, power to air suspension must be shut off before hoisting, jacking or towing. Failure to do so can result in unexpected inflation or deflation of air springs, which can result in shifting of vehicle during servicing.

Rear axle is a hypoid-design ring and pinion gear encased in an integral cast iron axle housing. A one-piece differential case contains a conventional 2-pinion differential assembly.

To signal rear anti-lock brake system operation, rear axles use an exciter ring pressed on differential case behind ring gear, and a sensor mounted in axle housing. A space is provided between ring gear and exciter ring for measuring ring gear runout.

AXLE RATIO & IDENTIFICATION

NOTE: If rear axle is a Traction-Lok version, a "L" will be displayed with the ratio. For example, a Traction-Lok axle ratio would be displayed as 3L45.

A metal tag stamped with axle model, date of manufacture, ratio, ring gear diameter and assembly plant is attached to rear cover. Use information on tag to order replacement parts. See **Fig. 1** . Vehicle axle application can also be determined by axle code on Safety Certification Label located on left door pillar.

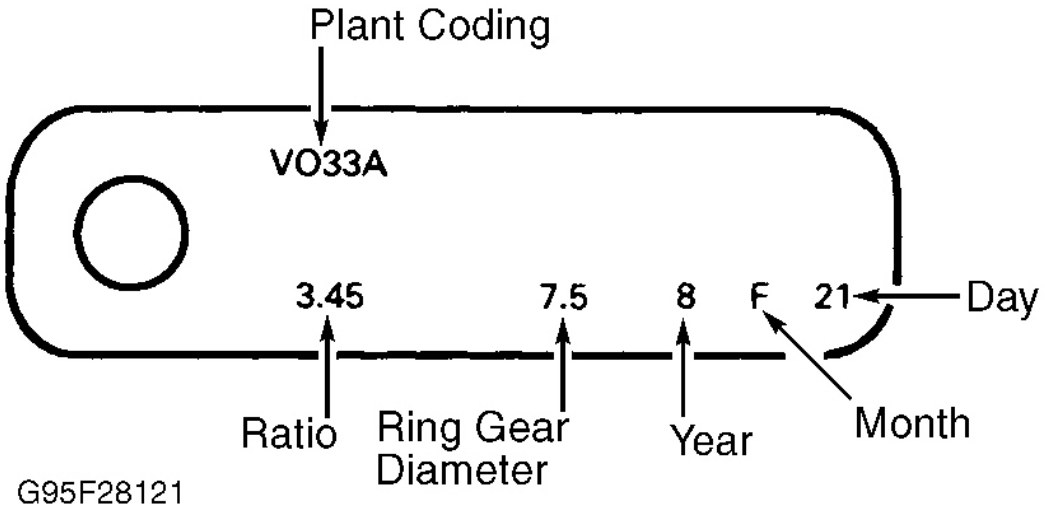


Fig. 1: Identifying Rear Axle Tag
Courtesy of FORD MOTOR CO.

LUBRICATION

F150

CAUTION: On models with Traction-Lok differential, add an additional 4 ozs. of Friction Modifier (C8AZ-19B546-A). Friction modifier must be added to prevent damage to differential.

Capacity is 5.5-5.8 Pts. (2.6-2.7L) of Motorcraft SAE 75W140 High Performance Synthetic Rear Axle Lubricant (F1TZ-19580-B). If vehicle is equipped with Traction-Lok, add an additional 4 ozs. of Friction Modifier (C8AZ-19B546-A). Capacities listed are approximate. Fill differential until fluid level is about 1/4" below bottom of filler plug hole.

F250

CAUTION: On models with Traction-Lok differential, add an additional 8 ozs. of Friction Modifier (C8AZ-19B546-A). Friction modifier must be added to prevent damage to differential.

Capacity is 7.0-7.5 Pts. (3.3-3.5L) of Motorcraft SAE 75W140 High Performance Synthetic Rear Axle Lubricant (F1TZ-19580-B). If vehicle is equipped with Traction-Lok, add an additional 8 ozs. of Friction Modifier (C8AZ-19B546-A). Capacities listed are approximate. Fill differential until fluid level is about 1/4" below bottom of filler plug hole.

TROUBLE SHOOTING

NOTE: See appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

WARNING: On vehicles equipped with air suspension, power to air suspension must be shut off before hoisting, jacking or towing. Failure to do so can result in unexpected inflation or deflation of air springs, which can result in shifting of vehicle during servicing.

AXLE SHAFT & BEARING

CAUTION: DO NOT damage rubber "O" rings in groves on axle shafts, under "C" locks.

Removal (With Rear Disc Brakes)

1. On vehicles with air suspension, turn air suspension switch to OFF position. On all vehicles, raise and support vehicle. Remove wheel assemblies. Remove housing cover, and drain lubricant. Remove rear brake caliper retaining bolts, and wire caliper aside. Remove rear brake rotor.
2. Remove and discard differential pinion shaft lock bolt. Remove pinion shaft. See **Fig. 2** . Push axle shaft inward and remove "C" locks. Remove axle shaft, being careful not to cut axle seal. Using a Axle Wheel Bearing Puller (T83T-1225-A) and Slide Hammer (T50T-100-A), remove bearing and oil seal as a unit.

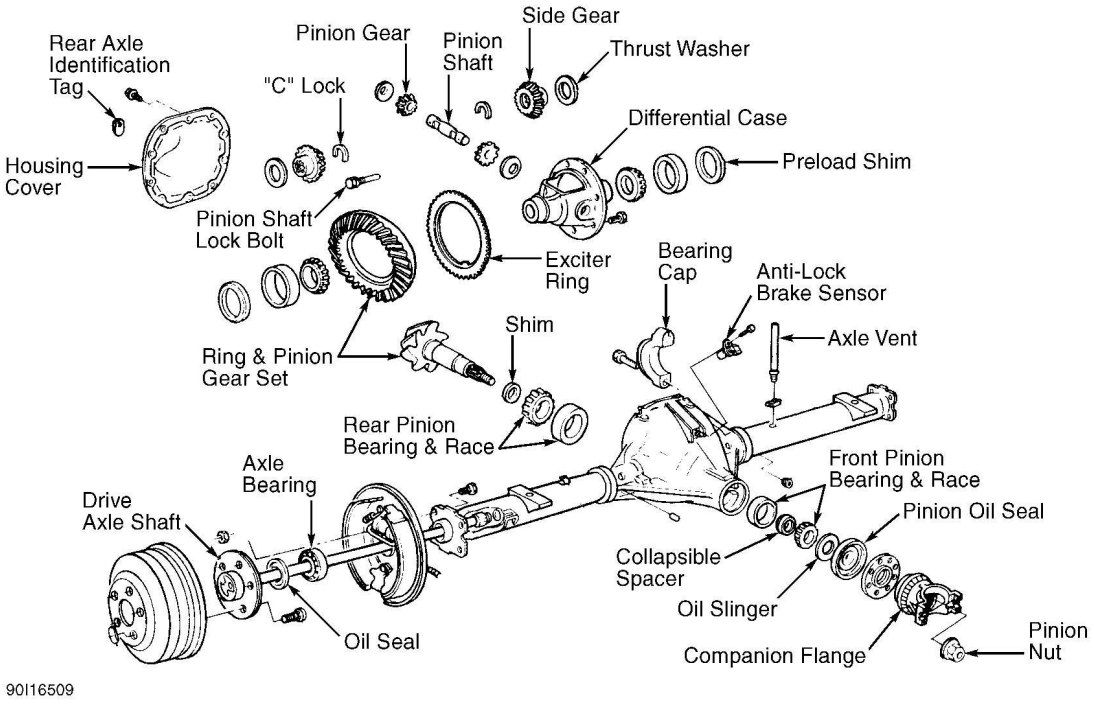


Fig. 2: Exploded View Of Axle Assembly (Typical)
Courtesy of FORD MOTOR CO.

Removal (With Rear Drum Brakes)

1. On vehicles with air suspension, turn air suspension switch to OFF position. On all vehicles, raise and support vehicle. Remove wheel assemblies. Remove housing cover, and drain lubricant. Remove brake drum.
2. Remove and discard differential pinion shaft lock bolt. Remove pinion shaft. See **Fig. 2** . Push axle shaft inward and remove "C" locks. Remove axle shaft, being careful not to cut axle seal. Using a Axle Wheel Bearing Puller (T83T-1225-A) and Slide Hammer (T50T-100-A), remove bearing and oil seal as a unit.

Installation (All Models)

1. Lubricate bearing with rear axle lubricant. Using a driver, install bearing. Lubricate lip of oil seal with Premium Long-Life Grease (XG-1-C). Using Axle Seal Replacer (T97T-1177-B) and Handle (T80T-4000-W), install oil seal. If seal becomes cocked during installation, remove seal and replace with a NEW one.
2. Carefully insert axle in housing to avoid damaging oil seal. Install "C" locks, and push shafts outward to seat locks in counterbore of differential side gears. Install pinion shaft. Apply Loctite to NEW pinion shaft lock bolt, and tighten to specification. See **TORQUE SPECIFICATIONS** .
3. Clean gasket mating surfaces and apply 1/8 - 3/16" wide bead of silicone sealant on axle housing cover. Install housing cover. Tighten cover bolts to specification in a crisscross pattern. See **TORQUE SPECIFICATIONS** .

4. Fill differential with proper lubricant until fluid level is about 1/4" below bottom of filler plug hole. See **LUBRICATION** . To complete installation, reverse removal procedures.

AXLE HOUSING ASSEMBLY

Removal & Installation (With 8.8" & 9.75" Ring Gear)

WARNING: DO NOT remove an air spring or any component holding air spring under any circumstance when air spring is pressurized.

1. Raise and support vehicle. Release parking brake. Scribe alignment marks on companion flange and drive shaft yoke for installation reference. Remove 4 drive shaft bolts, and wire drive shaft aside. Remove axle shafts. See **AXLE SHAFT & BEARING** .
2. Disconnect rear ABS sensor harness connector. Disconnect vent hose. Disconnect rear brake line junction block from axle housing. DO NOT disconnect brake lines from junction block. Disconnect parking brake cable brackets and brake line from axle housing. Remove backing plate bolts, and wire backing plates aside.
3. Position a suitable jack under rear axle housing and strap housing to jack. Remove lower shock bolts. Remove U-bolt assemblies. Remove axle housing from vehicle. To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (With 10.25" Ring Gear)

1. Raise and support vehicle. Release parking brake. Remove rear wheel assemblies. Disconnect parking brake cable from support bracket. Disconnect both parking brake cables from parking brake cable equalizers (both side).
2. Disconnect parking brake cable assembly under vehicle, next to leaf spring. Secure parking brake cables to axle housing. Disconnect rear ABS sensor harness connector. Scribe alignment marks on companion flange and drive shaft yoke for installation reference.
3. Remove 4 drive shaft bolts and wire drive shaft aside. Disconnect rear axle brake line and vent tube at frame. Position a suitable jack under rear axle housing and strap housing to jack. Remove lower shock bolts.
4. Remove U-bolt assemblies. Remove axle housing from vehicle. To install, reverse removal procedure. Bleed brake system. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

PINION FLANGE & OIL SEAL

NOTE: Pinion flange and oil seal replacement affects bearing preload. Preload must be carefully reset during reassembly.

Removal

1. Raise and support vehicle. Scribe alignment marks on pinion flange and drive shaft end yoke for installation reference. Remove drive shaft bolts, and wire drive shaft aside. Using an INCH-lb. torque wrench, measure and record torque required to rotate pinion through several revolutions.

2. Mark pinion flange in relation to pinion shaft for installation reference. Hold pinion flange and remove pinion nut. Using Puller (T77FP-4220-B1), remove pinion flange. Using screwdriver, remove pinion seal.

Installation

NOTE: If oil seal becomes cocked during installation, remove seal and install new oil seal.

1. Ensure pinion shaft splines are free of burrs. Remove burrs with fine crocus cloth if necessary. Lubricate area between oil seal lip, and install oil seal into axle housing using Pinion Oil Seal Replacer (T83T-4676-A).
2. Align marks on pinion flange and pinion. Apply a small amount of lubricant to pinion flange splines. Install pinion flange and NEW pinion nut. Hold pinion flange and gradually tighten nut while rotating pinion.

NOTE: If desired preload is exceeded, a NEW collapsible spacer must be installed. Tighten nut to obtain proper preload.

3. Check pinion bearing preload often, until correct preload is obtained. See **DIFFERENTIAL SPECIFICATIONS** . DO NOT back off pinion nut to reduce preload. Connect rear end of drive shaft to pinion flange, aligning scribed marks.
4. Apply locking compound to drive shaft bolt threads and tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Fill differential with proper lubricant until fluid level is about 1/4" below bottom of filler plug hole. See **LUBRICATION** . To complete installation, reverse removal procedures.

REAR ANTI-LOCK BRAKE SENSOR ASSEMBLY

Removal

Rear anti-lock brake sensor is located on top of axle housing assembly. Clean area around rear anti-lock brake sensor. Disconnect harness connector. Remove retaining bolt, rear anti-lock brake sensor and "O" ring.

Installation

Replace "O" ring if using original rear anti-lock brake sensor. Lubricate "O" ring. Hold rear anti-lock brake sensor on both sides and install. DO NOT push downward on connector area. Install retaining bolt and tighten to specification. See **TORQUE SPECIFICATIONS** . Connect harness connector.

INSPECTION PROCEDURES

WARNING: On vehicles equipped with air suspension, power to air suspension MUST be shut off before hoisting, jacking or towing. Failure to do so can result in unexpected inflation or deflation of air springs, which can result in shifting of vehicle during these operations.

RING GEAR RUNOUT

NOTE: Ring gear runout should be checked before disassembling differential assembly. A space is provided between exciter ring and ring gear for measuring ring gear runout.

1. Assemble dial indicator on axle housing assembly with tip of dial indicator contacting back face of ring gear. Adjust dial indicator to zero. Rotate ring gear and note ring gear runout. Maximum ring gear runout is .004" (.10 mm).
2. If ring gear runout exceeds .004" (.10 mm), check for improper tightening on ring gear bolts or foreign material between ring gear and differential case.
3. If ring gear runout still exceeds .004" (.10 mm), check for warped ring gear, worn differential bearings or warped differential case by checking differential case runout. See **DIFFERENTIAL CASE RUNOUT** .

DIFFERENTIAL CASE RUNOUT

1. Remove differential case from axle housing assembly. Remove retaining bolts and ring gear. Install differential case (with bearing races and preload shims) into axle housing assembly.
2. Install bearing caps and retaining bolts. Tighten bearing cap retaining bolts to specification. See **TORQUE SPECIFICATIONS** . Rotate differential case to ensure bearings are properly seated.
3. Assemble dial indicator on axle housing assembly, with tip of dial indicator contacting ring gear surface of differential case. Adjust dial indicator to zero.
4. Rotate differential case and note differential case runout. If differential case runout is within .003" (.08 mm), install a NEW ring gear and pinion.
5. If differential case runout exceeds .003" (.08 mm), ring gear is okay. The problem area is damaged axle housing assembly or worn bearings on differential case.
6. Visually check for damaged bearings. If bearings are okay, replace both bearings and differential case. Recheck differential case runout using NEW components.
7. If differential case runout is now within .003" (.08 mm), use components for reassembly. If differential case runout exceeds .003" (.08 mm), axle housing assembly is damaged and should be replaced.

OVERHAUL

NOTE: If vehicle is equipped with Traction-Lok, see appropriate TRACTION-LOK article.

DISASSEMBLY

1. Raise and support vehicle. Drain lubricant and remove housing cover. Mount dial indicator and measure and record ring gear runout. See **RING GEAR RUNOUT** under INSPECTION PROCEDURES. Measure and record ring gear backlash. See **Fig. 3** . See **DIFFERENTIAL BEARING PRELOAD & RING GEAR BACKLASH** under REASSEMBLY & ADJUSTMENTS.
2. Remove axle shafts. See **AXLE SHAFT & BEARING** under REMOVAL & INSTALLATION. Place alignment marks on drive shaft, yoke and pinion flange for reassembly reference.

3. Scribe alignment marks on pinion flange and drive shaft yoke for installation reference. Remove 4 drive shaft bolts and wire drive shaft aside. Mark differential bearing caps for reassembly reference and note arrow position. Loosen bearing cap bolts. Pry out differential case, bearing races and shims until loose in bearing caps.

NOTE: Bearing races and caps must be installed in original positions.

4. Remove bearing caps and differential. Remove pinion nut and pinion flange. Drive pinion out of front bearing using soft-faced hammer. Remove pinion from housing. Remove oil seal using slide hammer.

NOTE: DO NOT remove pinion bearing races unless damaged. If races are replaced, bearings must also be replaced.

5. Remove front bearing. Mount bearing puller on pinion shaft, and press shaft out of bearing. Remove, measure, and record thickness of shim located behind bearing. Remove differential side bearings with a puller.

NOTE: Tab on exciter ring must be aligned with slot in differential case.

6. Mark differential case and ring gear for reassembly reference. Remove and discard ring gear mounting bolts. Press or tap off ring gear. Remove exciter ring from differential case (if necessary). If exciter ring is removed from differential case, a NEW exciter ring must be installed. Remove pinion shaft lock bolt and remove shaft. Remove pinion gears, side gears and thrust washers.

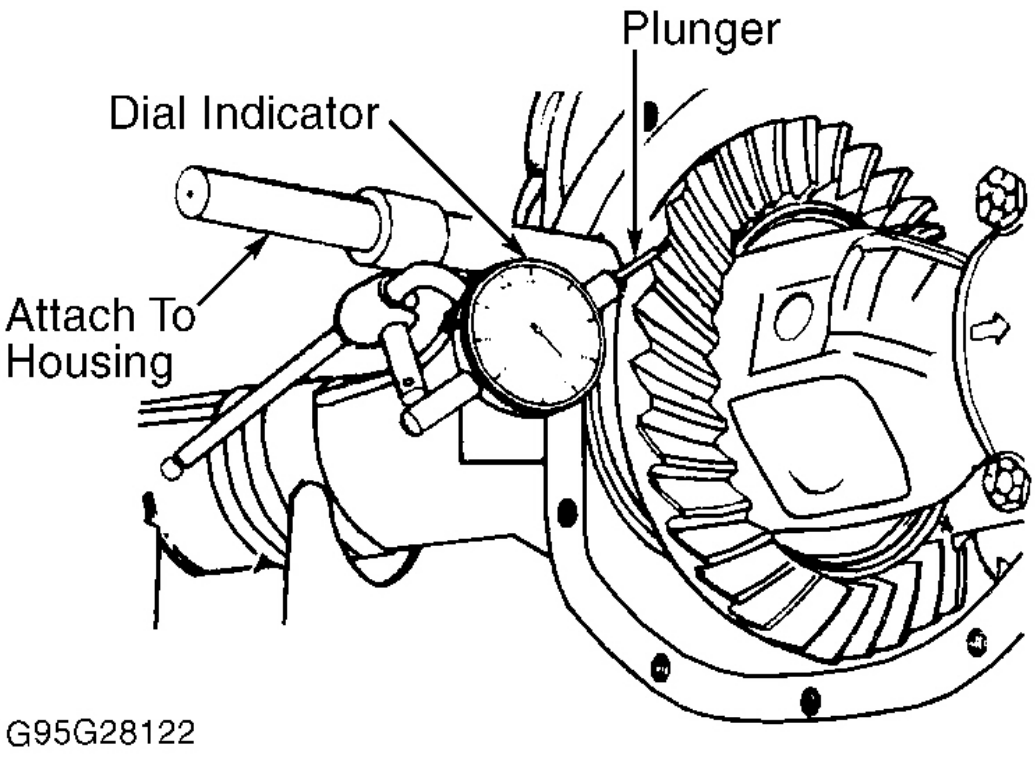


Fig. 3: Measuring Ring Gear Backlash
Courtesy of FORD MOTOR CO.

CLEANING & INSPECTION

Clean all parts thoroughly in solvent. Check pinion and ring gear teeth for scoring, excessive wear, nicks and chipping. Check bearing races for deep scores or galling. Check carrier bearings for wear or damage. Replace components as necessary.

Anti-Lock Brake Sensor

Check sensor pole piece for loose metal particles. Clean if necessary.

Exciter Ring

Ensure exciter ring is properly pressed onto differential case. Examine ring for chips or missing teeth.

Bearing Races

Check bearing races for scoring or galling. If a .0015" (.038 mm) feeler gauge can be inserted between a race and bottom of its bore at any point, race must be reseated.

Bearing & Roller Assemblies

When rotated in races, bearing rollers must turn without roughness. Check roller ends for step wear. If damaged, both parts should be replaced.

Pinion Flange

Ensure flange half-rounds and lugs have not been damaged. End of flange contacting bearing, counterbore and seal surface must be smooth and free of damage.

Gears

Examine pinion and ring gear teeth for scoring, excessive wear, and excessive chipping. Worn or damaged gears CANNOT be rebuilt to correct noisy condition.

Axle Housing

Ensure differential and pinion bearing bores are smooth. Remove any nicks or burrs from mounting surfaces.

Differential Case

Ensure hubs where bearings mount are smooth. Check differential case bearing shoulders for damage. Bearing assemblies will fail if they DO NOT seat firmly against shoulders. Ensure differential side gears rotate freely in counterbores.

REASSEMBLY & ADJUSTMENTS

NOTE: Ring and pinion gears must be replaced in matched sets.

Differential Case

1. Lubricate all parts with axle lubricant. Place side gears and thrust washers into case. Place pinion gears and thrust washers opposite each other in case openings, and in mesh with side gears.
2. Install ring gear with NEW mounting bolts. If bolts are covered with Green coating over 1/2" of threaded area, install and tighten bolts. If NEW bolts do not have Green coating, apply small amount of Loctite to bolt threads then tighten bolts.
3. If bearing races have been replaced, NEW bearing and roller assemblies should be installed. Races must be seated in bores so a .0015" (.038 mm) feeler gauge will not fit between race and bottom of bore.

Pinion Depth

1. Assemble Axle Pinion Depth Gauge Set (T79P-4020-A) and install aligning adapter, gauge disc, gauge block screw and gauge block.
2. Place rear pinion bearing over aligning disc and into bearing race of axle housing. Install front pinion bearing into front bearing race. Place tool handle onto screw and finger tighten. See **Fig. 4** .
3. Ensure pinion depth measuring tools are properly installed and tightened. Apply a light film of oil to

pinion bearings. Rotate gauge block several times to seat bearings.

4. Tighten tool handle to 20 ft. lbs. (27 N.m). Final position of gauge block should be 45 degrees above axle shaft centerline. Clean differential bearing bores thoroughly and install gauge tube. Install bearing caps and bolts. Tighten bearing cap bolts to specification. See **TORQUE SPECIFICATIONS** .
5. Using flat pinion shims as a gauge for shim selection, hold gauge block in proper position and measure clearance between gauge block and tube. Correct shim selection is accomplished when a slight drag is felt as shim is drawn between gauge block and tube.

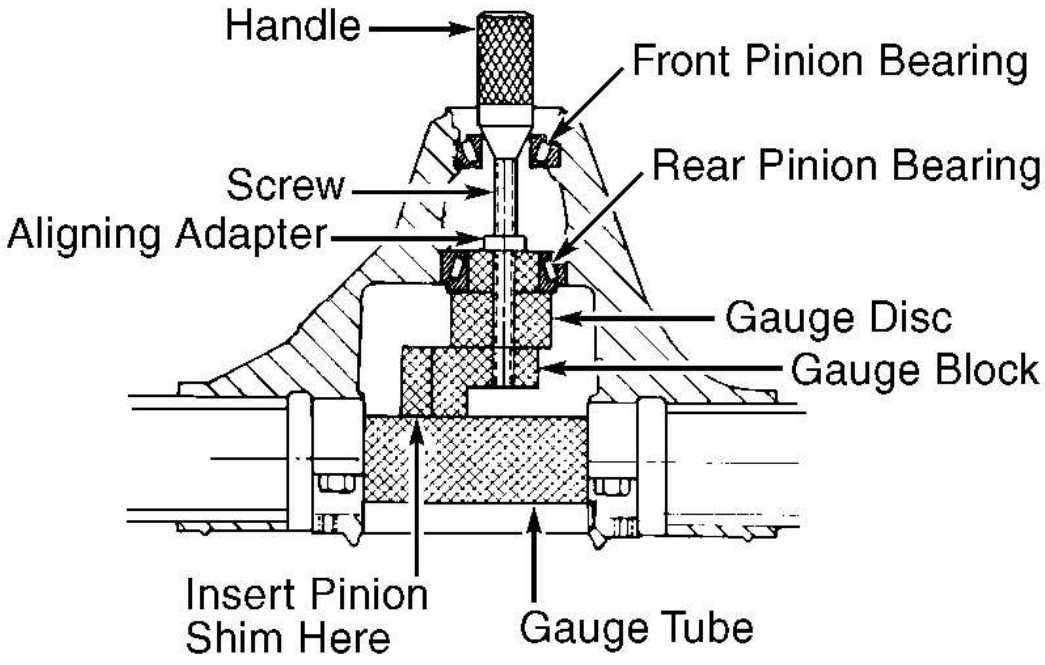


Fig. 4: Installing Pinion Depth Measuring Tools (Tools are included in Axle Pinion Depth Gauge Set) Courtesy of FORD MOTOR CO.

Pinion Bearing Preload

1. Place pre-selected shim on pinion shaft. Press bearing onto shaft until bearing and shim are firmly seated against shoulder of shaft. Install NEW collapsible spacer on pinion shaft
2. Lubricate bearings with axle lubricant. Install front pinion bearing in housing. Install NEW pinion oil seal. Insert pinion flange into oil seal and hold firmly in place.

NOTE: If installing a NEW pinion flange, disregard scribed mark on pinion shaft.

3. From rear of axle housing, insert pinion shaft into flange. Install a NEW pinion nut on pinion shaft and

gradually tighten pinion nut while holding flange.

4. Check bearing preload often. As soon as preload is measured, turn pinion shaft in both directions several times to seat bearings. Hold pinion flange with Pinion Flange Holder (T78P-4851-A) while tightening nut.
5. Tighten pinion nut and continue to measure pinion bearing preload until the specified pinion torque is obtained. See **DIFFERENTIAL SPECIFICATIONS** . If bearing preload is exceeded before torque specification is reached, replace collapsible spacer. Install NEW pinion nut and repeat procedures. DO NOT loosen pinion nut to reduce pinion bearing preload.

Differential Bearing Preload & Ring Gear Backlash

1. With pinion depth set and pinion installed, place differential case and gear assembly (with bearings and races) into axle housing.
2. Install a .265" (6.73 mm) shim on left (ring gear side) side of differential. Install left bearing cap and bolts. Finger tighten bolts. Select and install largest shim that will fit, with a slight drag, on pinion gear side (right side) of differential. Install right bearing cap and bolts and tighten all cap bolts to specification. See **TORQUE SPECIFICATIONS** .
3. Rotate gear assembly to ensure free operation. Check ring and pinion backlash. See **Fig. 3** . If backlash is .008-.015" (.20-.38 mm), proceed to step 6 . If backlash is zero, add .020" (.51 mm) to shim size on right side, and subtract .020" (.51 mm) from shim size on left side.
4. If backlash is less than .008" (.20 mm) or more than .015" (.38 mm), increase or decrease shim size where necessary to correct reading. See **Fig. 5** . See **BACKLASH-TO-SHIM THICKNESS CONVERSION** table.
5. Retighten bearing cap bolts and rotate gear assembly several times. Recheck backlash and correct if necessary. Increase both left and right shim sizes .006" (.15 mm), and reinstall for correct preload.
6. Ensure shims are seated and gear assembly turns freely. Using marking compound, check gear tooth contact pattern. See GEAR TOOTH CONTACT PATTERNS article in GENERAL INFORMATION.

BACKLASH-TO-SHIM THICKNESS CONVERSION

Required Change In Backlash In. (mm)	Change In Shim Thickness In. (mm)
.001 (.03)	.002 (.05)
.002 (.05)	.002 (.05)
.003 (.08)	.004 (.10)
.004 (.10)	.006 (.15)
.005 (.13)	.006 (.15)
.006 (.15)	.008 (.20)
.007 (.18)	.010 (.25)
.008 (.20)	.010 (.25)
.009 (.23)	.012 (.30)
.010 (.25)	.014 (.35)
.011 (.28)	.014 (.35)
.012 (.30)	.016 (.41)
.013 (.33)	.018 (.46)

.014 (.35)	.018 (.46)
.015 (.38)	.020 (.51)

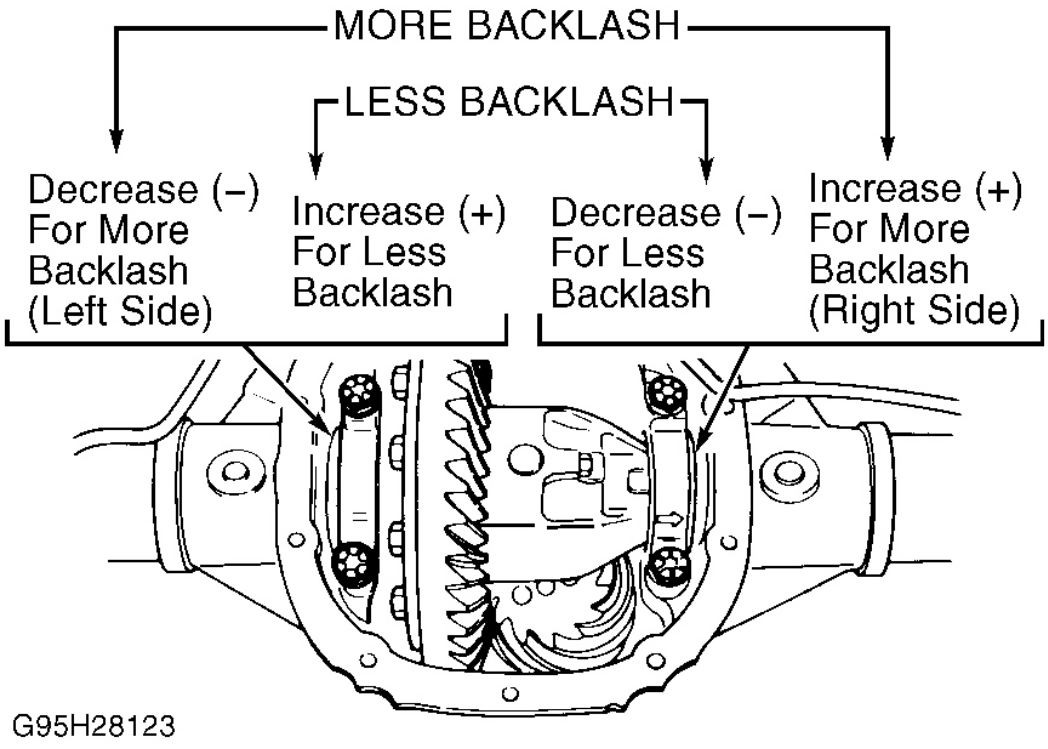


Fig. 5: Adjusting Backlash
Courtesy of FORD MOTOR CO.

Final Assembly

Clean differential housing surface and apply a continuous bead of silicone sealant to housing cover. Install cover and tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Install drive shaft. To complete assembly, reverse disassembly procedure. Fill differential until fluid level is about 1/4" below bottom of filler plug hole. Adjust brakes if required.

DIFFERENTIAL SPECIFICATIONS

DIFFERENTIAL ASSEMBLY SPECIFICATIONS

Application	Specification
ABS Sensor Air Gap	.005-.045" (0.127-1.143 mm)
Axle Shaft End Play (Max.)	.030" (.762 mm)
Differential Case Flange Runout	.003" (.08 mm)

Maximum Backlash Variation Between Teeth	.004" (.10 mm)
Nominal Pinion Shim Thickness	.030" (.76 mm)
Pinion Gear Thrust Washer Thickness	.030-.032" (.76-.81 mm)
Ring Gear Back Face Runout	.004" (.10 mm)
Ring Gear Backlash (1)	.008-.015" (.020-.038 mm)
Side Gear Thrust Washer Thickness	.030-.032" (.76-.81 mm)
	INCH Lbs. (N.m)
Pinion Bearing Preload	
New Bearings	16-29 (1.8-3.2)
Original Bearings (With Oil Seal)	8-14 (.9-1.6)
(1) Preferred setting is .012-.015" (.30-.38 mm).	

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
ABS Sensor Bolt	25-30 (34-41)
Bearing Cap Bolt	
1998	70-85 (95-115)
1999	
8.8" & 9.75" Ring Gear	77 (104)
10.25" Ring Gear	70-85 (95-115)
Driveshaft-To-Pinion Flange Bolt	
1998	70-95 (95-129)
1999	
8.8" Ring Gear	77 (104)
9.75" Ring Gear	83 (113)
10.25" Ring Gear	70-95 (95-129)
Housing Cover Bolt	
1998	28-38 (38-52)
1999	
8.8" & 9.75" Ring Gear	33 (45)
10.25" Ring Gear	28-38 (38-52)
Oil Filler Plug	
1998	15-30 (20-41)
1999	
8.8" & 9.75" Ring Gear	22 (30)
10.25" Ring Gear	15-30 (20-41)
Pinion Shaft Lock Bolt	
1998	15-30 (20-41)

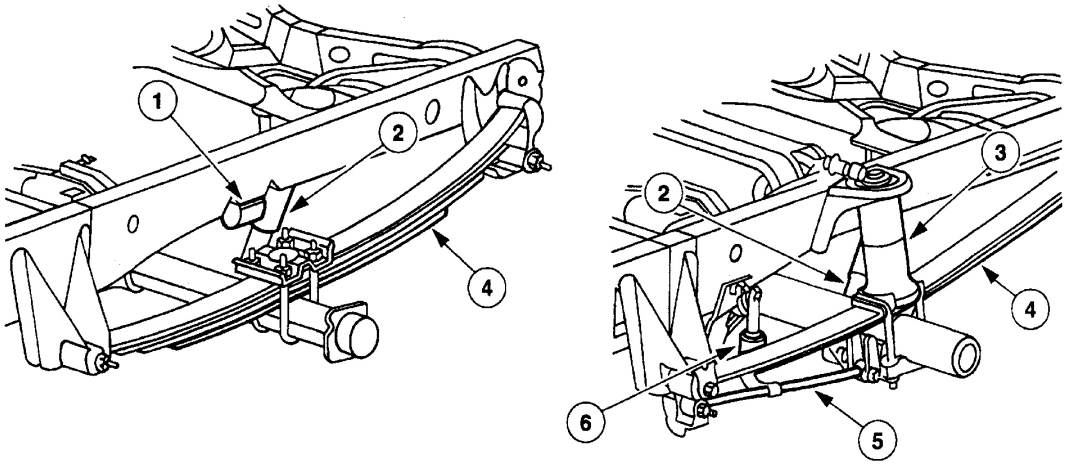
1999	
8.8" & 9.75" Ring Gear	22 (30)
10.25" Ring Gear	15-30 (20-41)
Ring Gear Bolt	
1998	
8.8" Ring Gear	70-85 (95-115)
9.75" & 10.25" Ring Gear	100-120 (136-163)
1999	
8.8" Ring Gear	77 (104)
9.75" Ring Gear	111 (150)
10.25" Ring Gear	100-120 (136-163)
Shock Bolt	
1998	
8.8" & 10.25" Ring Gear	45-59 (61-80)
9.75" Ring Gear	65-85 (88-115)
1999	
8.8" & 9.75" Ring Gear	52 (71)
10.25" Ring Gear	45-59 (61-80)
Wheel Lug Nut	83-112 (113-152)

1997 SUSPENSION

Rear - F150 & F250, Light Duty Pickup

DESCRIPTION & OPERATION

The rear springs and the rear shock absorbers connect the rear axle to the frame. The rear of the spring is shackled to the frame to allow for the axle to have vehicle travel. See **Fig. 1** .



Item	Part Number	Description
1	4730	Rear Axle Bumper
2	—	Shock Absorber
3	—	Air Spring

Item	Part Number	Description
4	—	Rear Spring
5	—	Anti-Wind Bar
6	—	Ride Height Sensor

G00115862

Fig. 1: Exploded View OF Rear Suspension
Courtesy of FORD MOTOR CO.

ANTI-WINDUP BAR

The anti-windup bar compensates for rotational torque placed on the rear axle during acceleration and braking by preventing the rear axle and rear spring from twisting (winding up). The anti-windup bar minimizes noise and vibration issues caused by excessive pinion-to-driveshaft angles during acceleration and braking.

REAR AXLE BUMPERS

The rear axle bumpers are used to prevent metal-to-metal contact between the rear axle and the frame.

REAR SPRING

Semi-elliptic, leaf-type rear springs are used for the rear suspension. Supplemental air springs are available as part of the optional air suspension system.

SHOCK ABSORBERS

The shock absorbers provide the necessary suspension dampening control.

SUSPENSION FASTENERS

These fasteners are important parts that can affect the performance of vital components and systems and result in major vehicle damage. New fasteners must be installed if the old fasteners are loosened or removed. They must be replaced with the same part number or an equivalent part if replacement is necessary. Do not use a replacement part of lesser quality or substitute design. The specified torque value must be used during assembly to ensure proper part retention.

REAR AIR LOAD LEVELING SUSPENSION

WARNING: Before repairing any air suspension components, disconnect power to the system by turning off the air suspension switch located in the right hand kick panel area to prevent vehicle damage or personal injury.

The rear air load leveling suspension available on F250 vehicles as an option, is an air operated, microprocessor controlled, suspension system. This provides low spring rates for improved ride and automatic rear load leveling. The rear air load leveling suspension was designed to keep the rear end of the vehicle level at all times with the vehicle unloaded or fully loaded to provide the best vehicle handling. When the vehicle is loaded in the rear, the suspension along with the rear suspension height sensors are compressed. This sends a signal to the control module. The control module then turns on the air compressor by powering up the air compressor relay. The air compressor then pumps compressed air through the nylon air lines to the rear air springs raising the vehicle.

When the vehicle ignition is turned off the control module stays powered up for 40 minutes. If the weight is removed from the rear of the vehicle, the height sensors will send a rear end high signal to the control module. This will open the vent solenoid and allow compressed air to vent from the air springs through the air spring solenoid valves, air lines, compressor drier and out the solenoid vent valve lowering the vehicle to trim height.

NOTE: For more information on rear load leveling suspension, see ELECTRONIC REAR AIR SUSPENSION -- F150 & F250 .

AIR SUSPENSION SWITCH

If equipped, the air suspension is located behind the right hand kick panel on a mounting bracket. This switch interrupts the height sensor's signal to the control module. Without the control module receiving this signal the load leveling system is inoperative and will not react when the rear of the vehicle is raised or lowered. See **Fig. 16** and **Fig. 17** .

ADJUSTMENTS & INSPECTION

CURB RIDE HEIGHT INSPECTION

For 4x2 curb ride height specification measuring points, see **Fig. 2** .

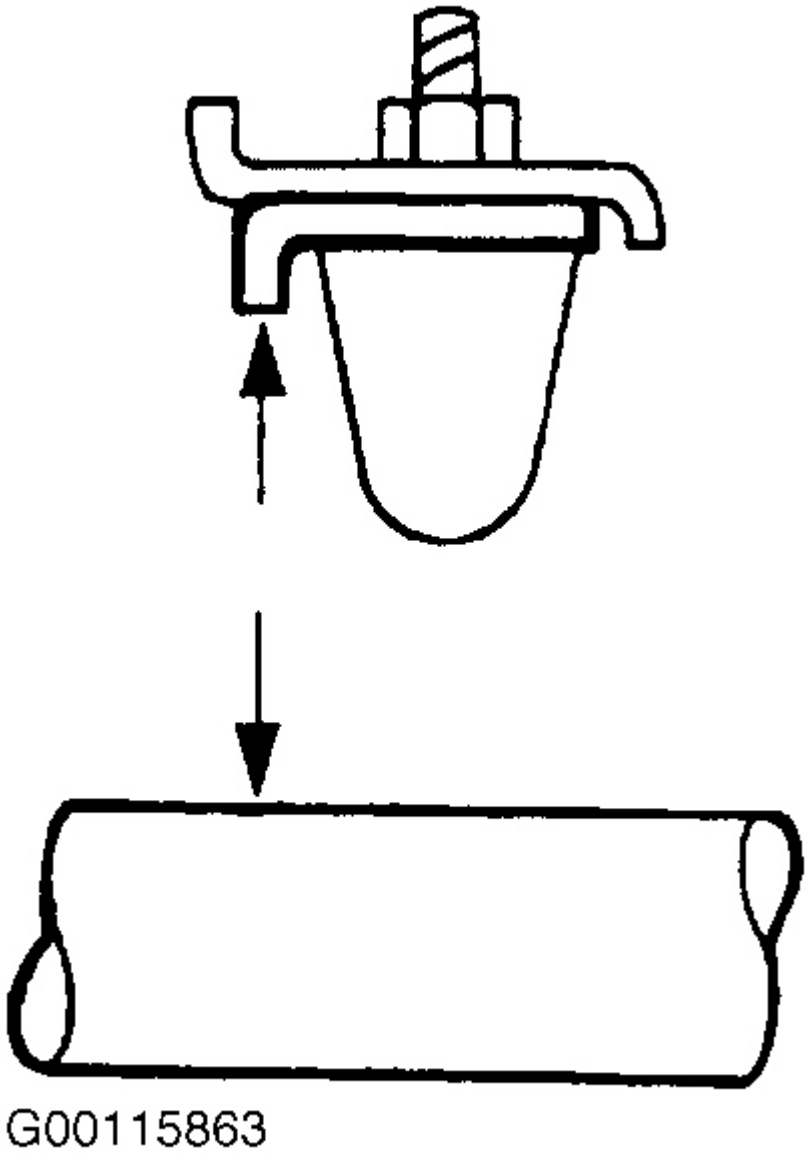


Fig. 2: 4x2 Curb Ride Height Visual Inspection
Courtesy of FORD MOTOR CO.

For 4x4 curb ride height specification measuring points, see **Fig. 3** .

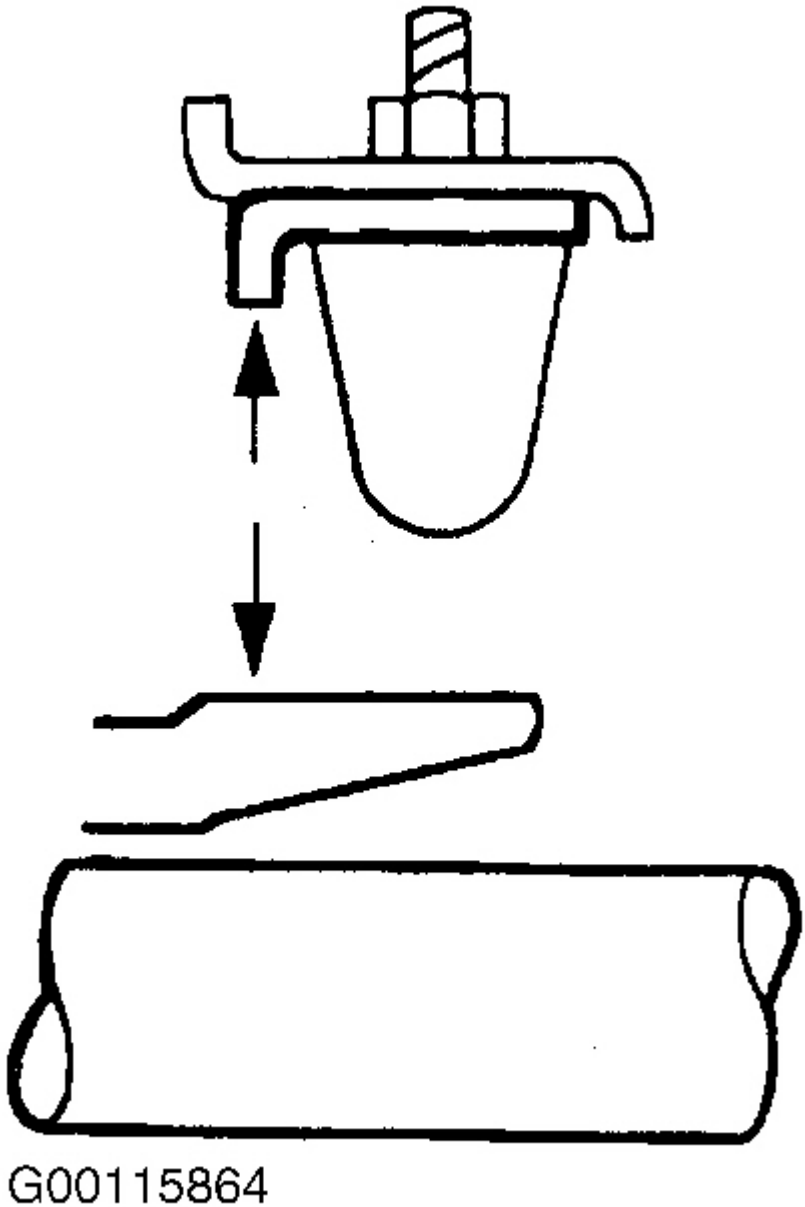


Fig. 3: 4x4 Curb Ride Height Visual Inspection
Courtesy of FORD MOTOR CO.

NOTE: All measurements are to be made with the vehicle in an unloaded condition.

1. On 4x2 vehicles, measure the curb ride height between the jounce bumper bracket and the axle tube.
   - **Without Air Suspension**

     6.0-8.5 In (153-215 mm)
   - **With Air Suspension**

     3.6 In. (41.8 mm)
2. On 4x4 vehicles, measure the curb ride height between the jounce bumper bracket and the axle spacer.
   - **Without Air Suspension**

     5.9-8.1 In (150-205 mm)
   - **With Air Suspension**

     3.4 In (88.0 mm)
3. If not within specifications, check for worn suspension components or weak leaf springs.

SYSTEM TESTING

For diagnosis and testing or rear air load leveling control suspension, see **ELECTRONIC REAR AIR SUSPENSION -- F150 & F250** .

REMOVAL & INSTALLATION

AIR COMPRESSOR

Removal & Installation

WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. this can be accomplished by turning off the air suspension switch located in the right hand kick panel area. failure to do so may result in unexpected inflation or deflation of the air springs which may result in shifting of the vehicle during these operations. See Fig. 16 and Fig. 17 .

WARNING: Do not remove an air spring under any circumstances when there is pressure in the air spring. do not remove any components supporting an air spring without either exhausting the air or providing support for the air spring to prevent vehicle damage or personal injury. Disconnecting an air line that is connected to the air compressor can cause personal injury or damage to components as high pressure air is vented uncontrolled.

1. Access the air suspension diagnostic connector behind the right hand cowl side trim panel. See **Fig. 7** . Using the New Generation Star (NGS) Tester, vent the compressor/drier assembly.
2. Disconnect the battery ground cable.
3. Remove the windshield washer pump and reservoir.
4. Remove the vehicle jack handle.
5. Disconnect the air line tube to the air compressor drier: Depress the red ring. Remove air line. See **Fig. 4** .
6. Disconnect the air compressor electrical connector. See **Fig. 5** .
7. Remove the air compressor bracket bolts and remove the air compressor from vehicle. See **Fig. 6** .
8. To install, reverse the removal procedure.

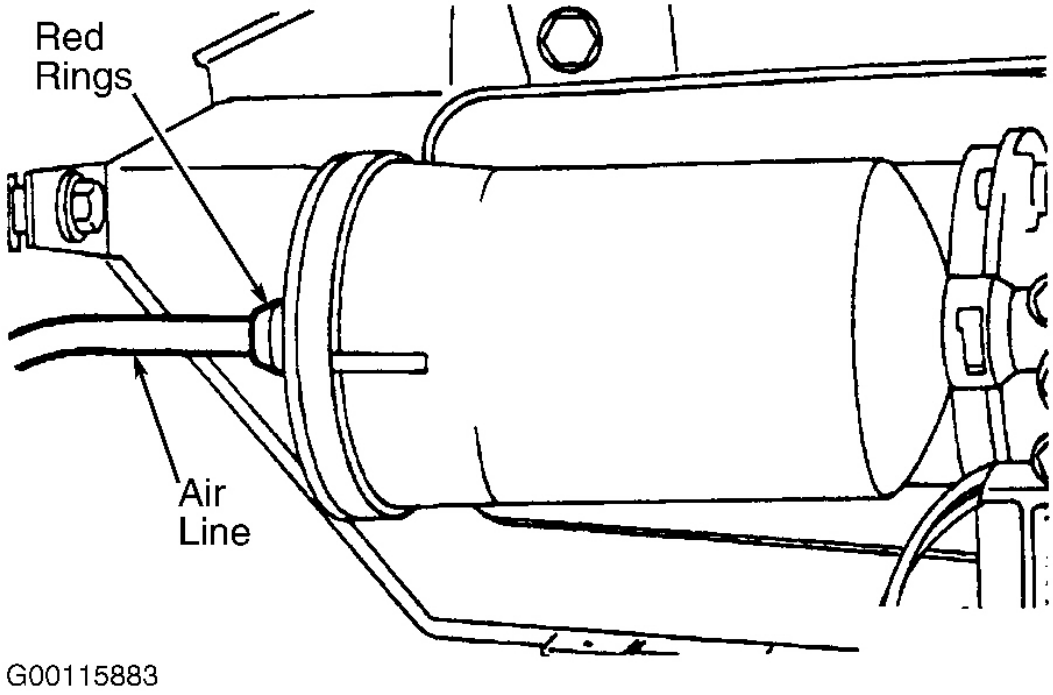


Fig. 4: Locating Compressor Drier Air Line
Courtesy of FORD MOTOR CO.

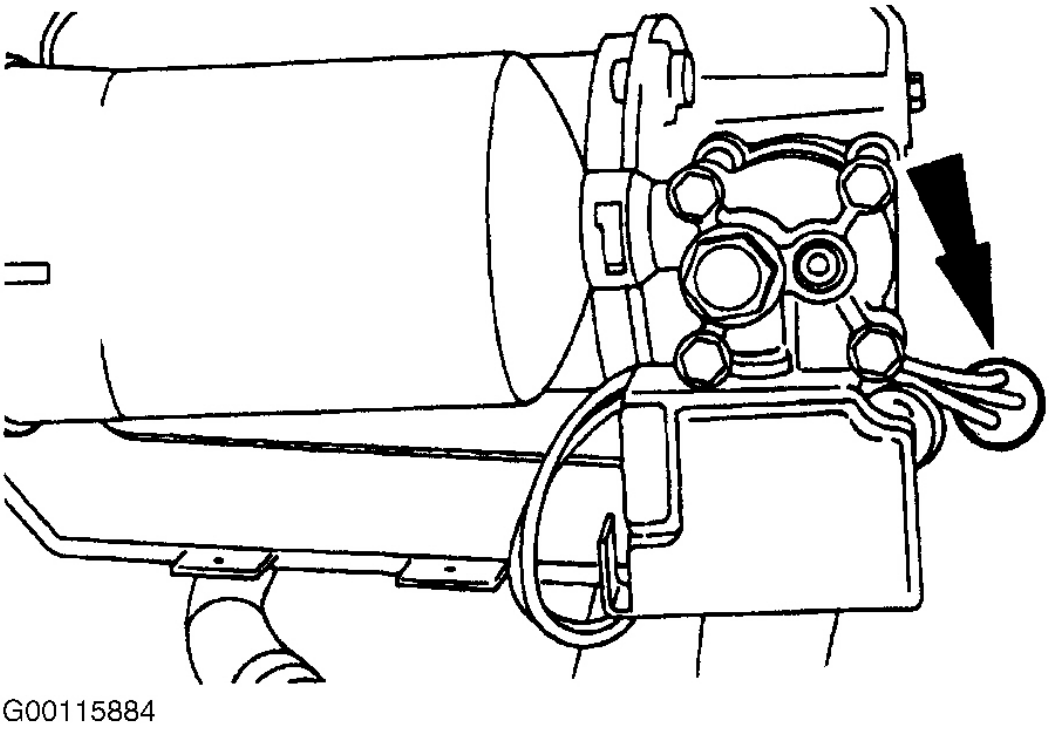


Fig. 5: Disconnecting/Connecting Air Compressor Electrical
Courtesy of FORD MOTOR CO.

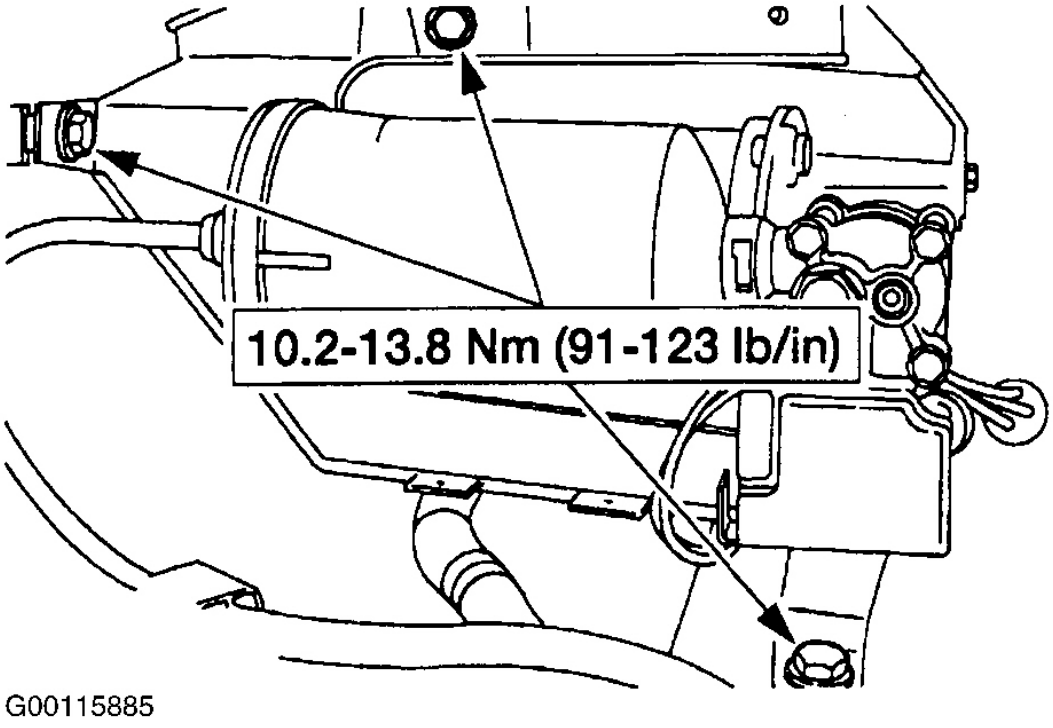


Fig. 6: Replacing Air Compressor
Courtesy of FORD MOTOR CO.

AIR SPRING

WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. this can be accomplished by turning off the air suspension switch located in the right hand kick panel area. failure to do so may result in unexpected inflation or deflation of the air springs which may result in shifting of the vehicle during these operations. See Fig. 16 and Fig. 17 .

WARNING: Do not remove an air spring under any circumstances when there is pressure in the air spring. do not remove any components supporting an air spring without either exhausting the air or providing support for the air spring to prevent vehicle damage or personal injury. Disconnecting an air line that is connected to the air compressor can cause personal injury or damage to components as high pressure air is vented uncontrolled.

Removal

1. Access the air suspension diagnostic connector behind the right hand cowl side trim panel. See **Fig. 7** .

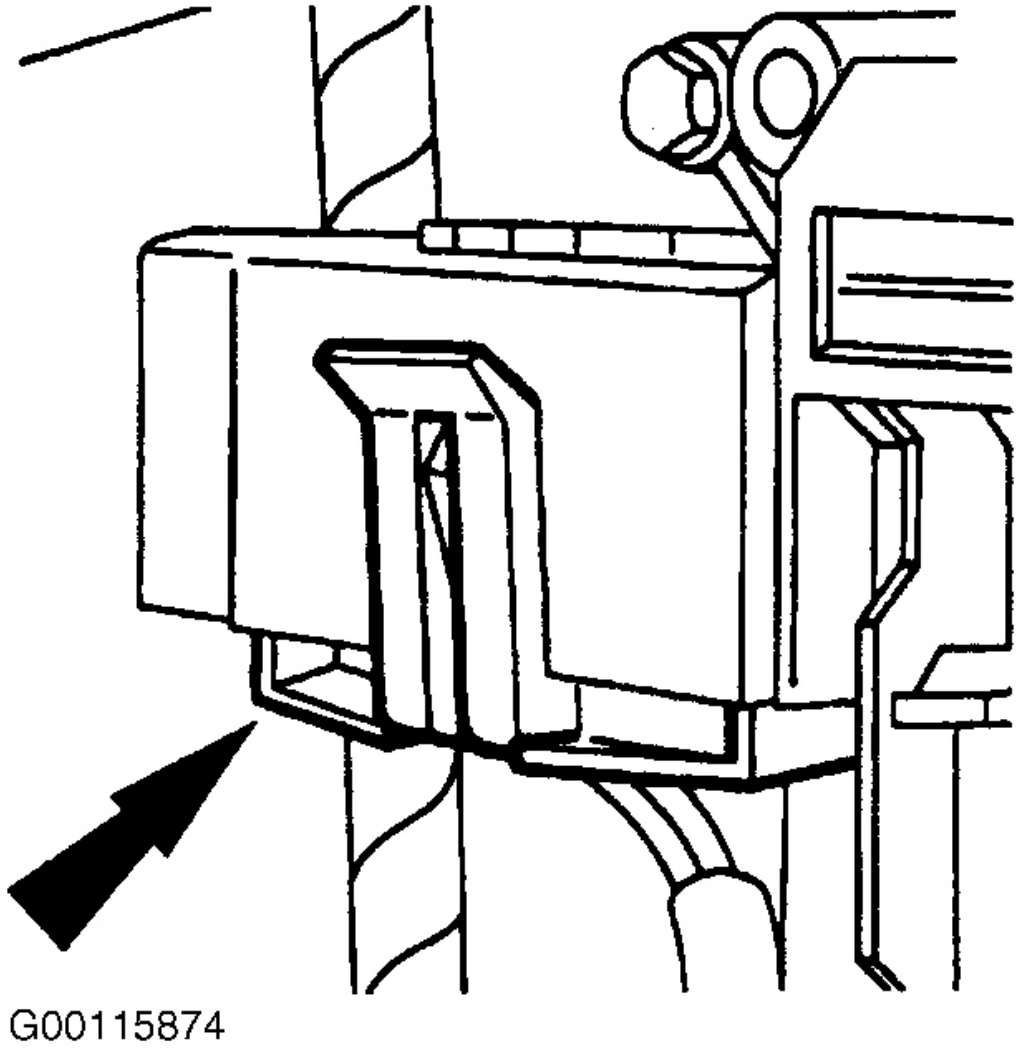


Fig. 7: Air Suspension Diagnostic Connector Location (Right Cowl Side Trim Panel)
Courtesy of FORD MOTOR CO.

2. Turn the air suspension switch to the on position, and the ignition to the key on engine off position. Use Super Star Tester II plugged into the air suspension diagnostic connector to perform the function test. Set Super Star II tester to EEC-IV/MCU mode; also set to FAST mode. Press Star Tester button to TEST position; a DTC 10 will be displayed. Within two minutes a DTC 13 will be displayed. After DTC 13 is displayed, release Star Tester button to Hold position. Wait at least 20 seconds then press Star Tester button to the TEST position. Within 10 seconds the following DTCs will be displayed in order.

REAR AIR SPRING SERVICE DTCs

DTC	Description
23	Vent Right Rear Air Spring
24	Vent Left Rear Air Spring
25	Vent Both Rear Air Springs
26	Compress Right Rear Air Spring
27	Compress Left Rear Air Spring
28	Compress Both Rear Air Springs
31	Cycle Compressor On And Off
32	Cycle Vent Solenoid Valve Open And Close
33	Cycle Spring Solenoid Valves Open And Closed

3. Within four seconds after DTC 23, 24 or 25 is displayed, depending on which air spring is to be deflated, release the Star Tester to the HOLD position. After deflation, turn the ignition to the OFF position.
4. Raise and support the vehicle.
5. Remove the wheel and tire assembly.
6. Remove the air line from the air spring solenoid: Depress the red plastic retaining ring. Pull the air line out of the air spring solenoid. See **Fig. 8** .
7. Disconnect the air spring solenoid electrical connector and position it aside. See **Fig. 9** .
8. Remove the retaining clip from the top of the air spring assembly. See **Fig. 10** .
9. Compress the deflated air spring assembly and remove it from the vehicle. See **Fig. 11** .

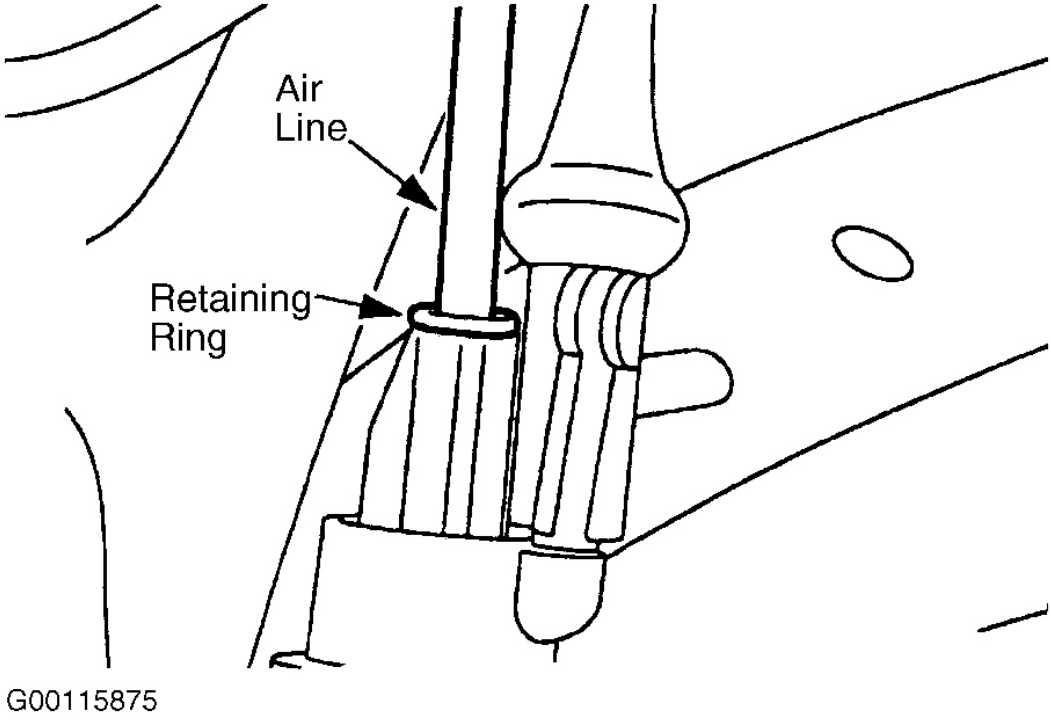


Fig. 8: Air Line From Air Spring Solenoid Replacement
Courtesy of FORD MOTOR CO.

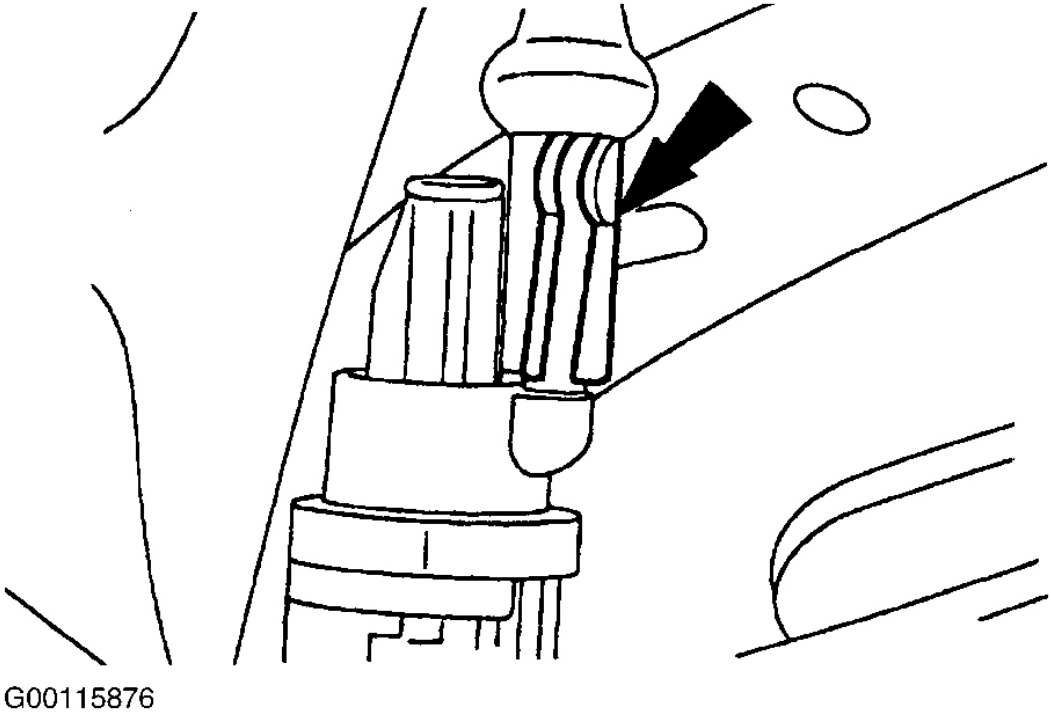


Fig. 9: Disconnect/Reconnect Air Spring Solenoid Electrical Connector
Courtesy of FORD MOTOR CO.

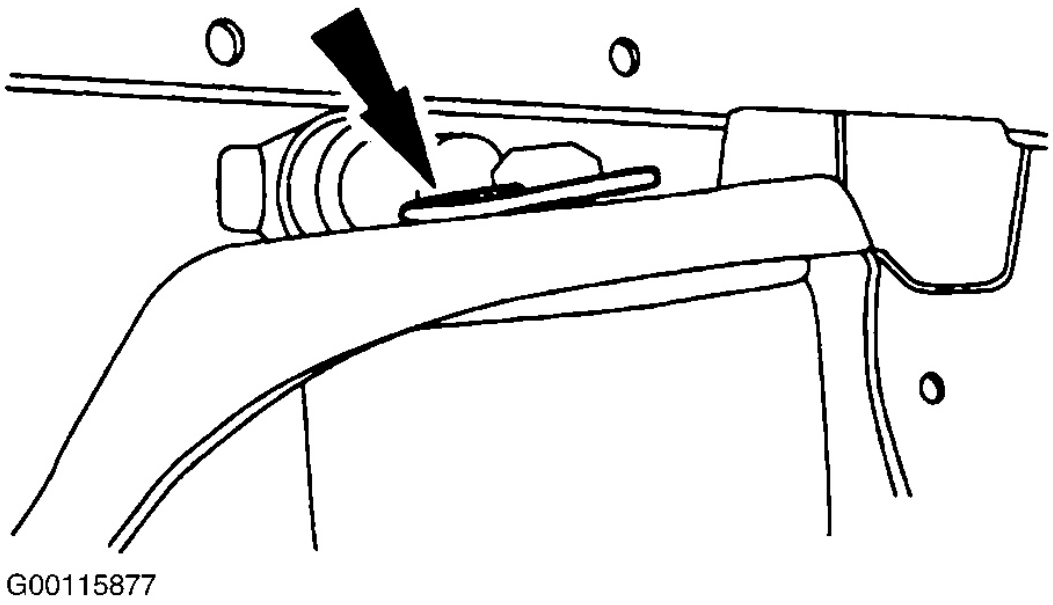
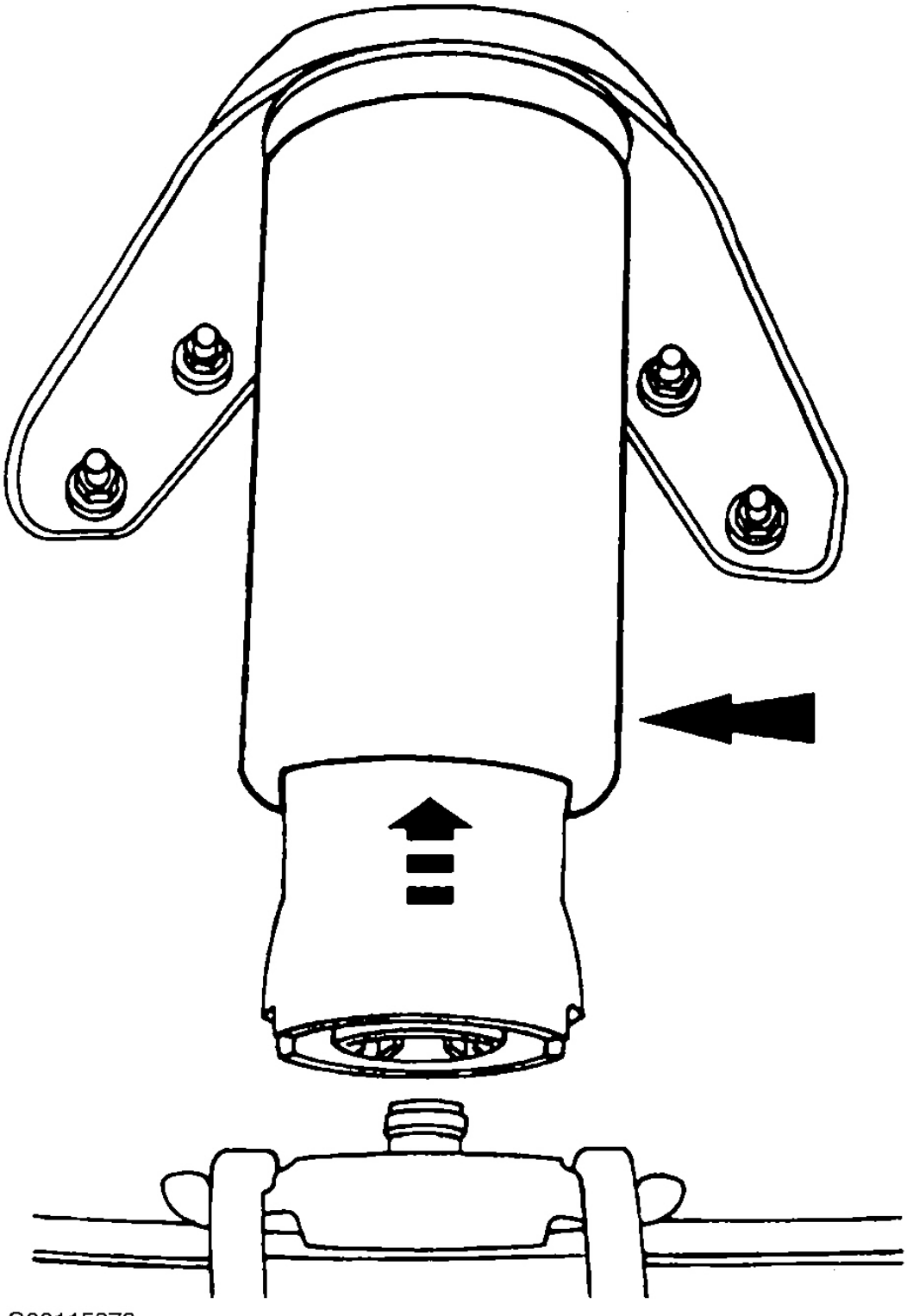


Fig. 10: Replacing Air Spring Assembly Retaining Clip
Courtesy of FORD MOTOR CO.



G00115878

Fig. 11: Removing Spring Assembly
Courtesy of FORD MOTOR CO.

Installation

1. Position the air spring assembly into place and install retaining clip at the top of the air spring assembly. See **Fig. 11** and **Fig. 10** .
2. Connect the air spring solenoid electrical connector. See **Fig. 9** .
3. Connect the air line into air spring solenoid line fitting. See **Fig. 8** .
4. Install the rear wheel and tire assembly. Tighten lug nuts to specification. See **TORQUE SPECIFICATIONS** .
5. Lower the vehicle.
6. Turn the air suspension switch to the on position.

NOTE: Inflation will start after 45 seconds.

7. Turn the ignition to the Key On Engine Off position until the air springs are inflated to trim height.
8. Visually inspect each air spring to ensure correct profile has been obtained. There should be no evidence of buckling or folding of the air bag springs.

AIR SPRING SOLENOID

WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. this can be accomplished by turning off the air suspension switch located in the right hand kick panel area. failure to do so may result in unexpected inflation or deflation of the air springs which may result in shifting of the vehicle during these operations. See Fig. 16 and Fig. 17 .

Removal & Installation

1. Remove the air spring assembly. See **AIR SPRING** .
2. Remove the metal retaining clip from the air spring solenoid. See **Fig. 12** .
3. Twist air spring solenoid and remove. See **Fig. 13** . Inspect the solenoid O-ring and replace as necessary.
4. To install, reverse the removal procedure.

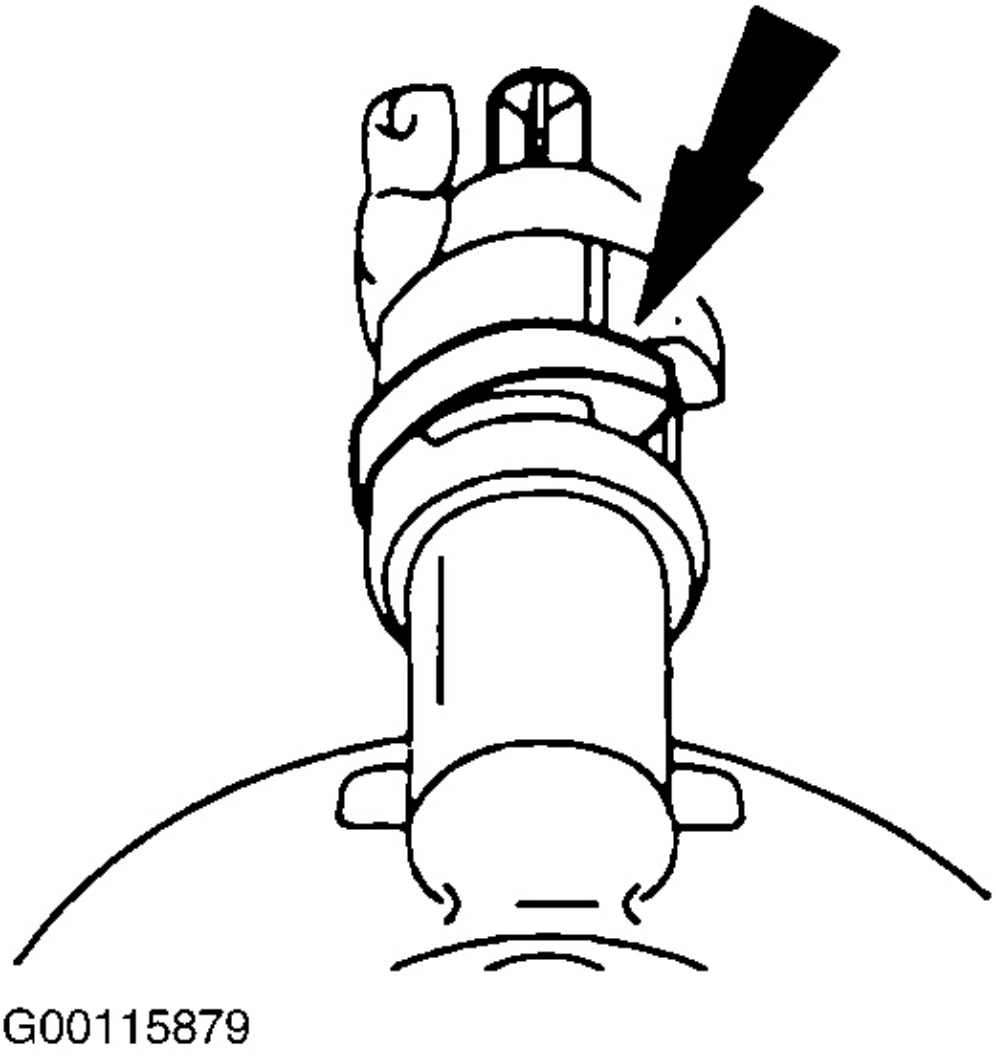


Fig. 12: Locating Air Spring Solenoid Metal Retaining Clip
Courtesy of FORD MOTOR CO.

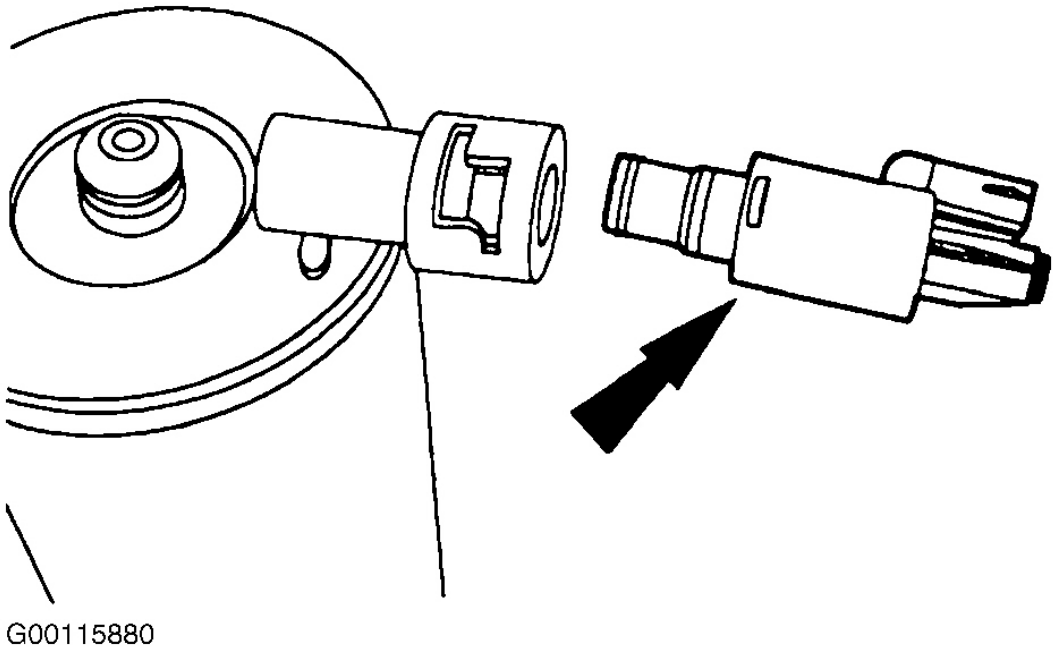


Fig. 13: Removing Air Spring Solenoid
Courtesy of FORD MOTOR CO.

AIR SUSPENSION HEIGHT SENSOR

WARNING: Before repairing any air suspension components, disconnect power to the system by turning off the air suspension switch located in the right hand kick panel area to prevent vehicle damage or personal injury. See Fig. 16 and Fig. 17 .

WARNING: The electrical power supply to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. this can be accomplished by turning off the air suspension switch located in the rh kick panel area. failure to do so may result in unexpected inflation or deflation of the air springs which may result in shifting of the vehicle during these operations.

Removal

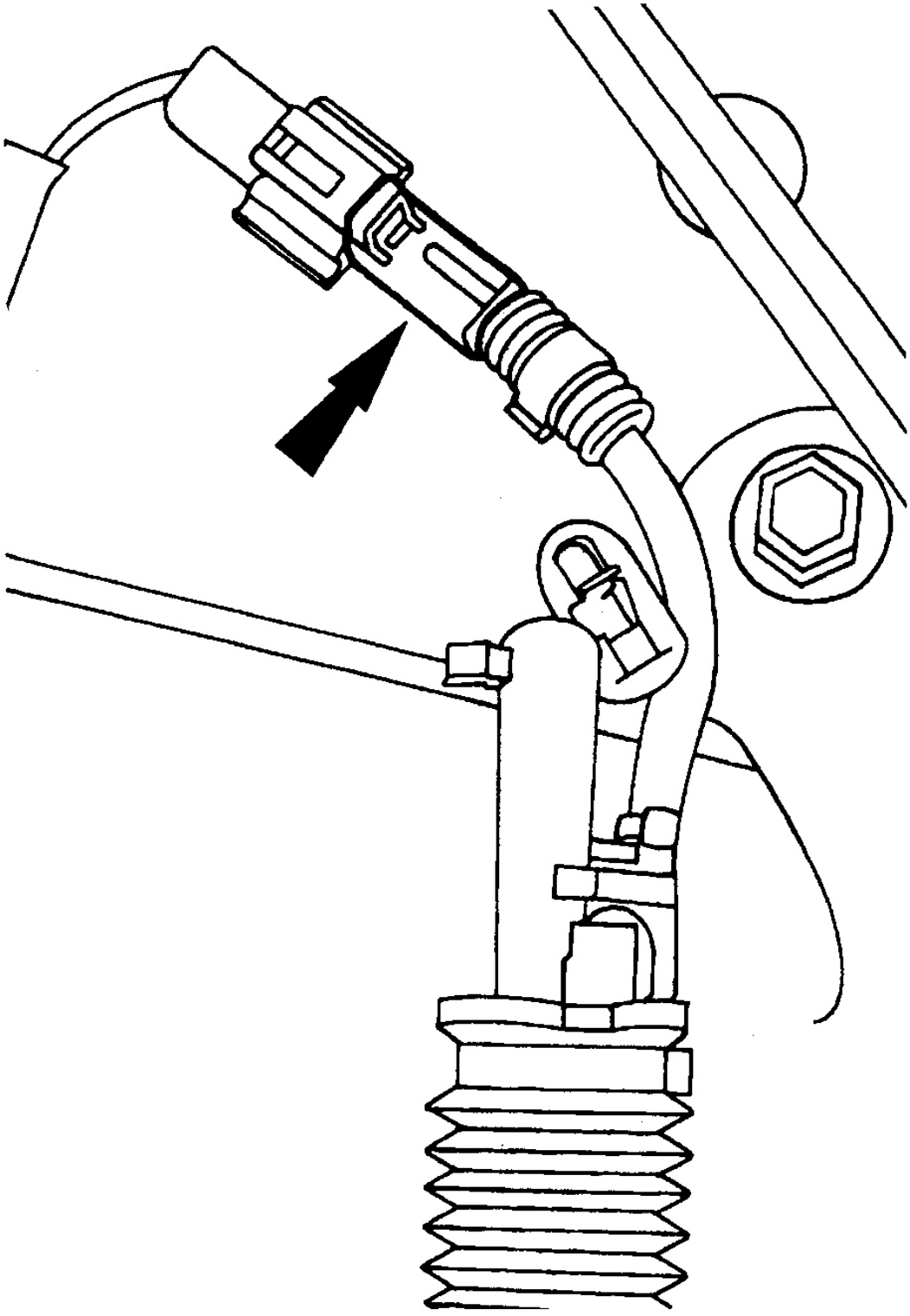
1. Turn the air suspension switch to the off position.
2. Raise and support the vehicle.
3. Disconnect the air suspension height sensor electrical connector. See **Fig. 14** .

NOTE: Before removing the air suspension height sensor from the ball studs. Observe the depth of the ball studs in the air suspension height sensor.

4. Depress the metal retaining tabs and remove the air suspension height sensor. See **Fig. 15** .

Installation

1. Position air suspension height sensor. Press the metal tabs and snap onto ball mounting studs. See **Fig. 15** .
2. Turn the air suspension switch to the ON position.



G00115881

Fig. 14: Locating Air Suspension Height Sensor Electrical Connector
Courtesy of FORD MOTOR CO.

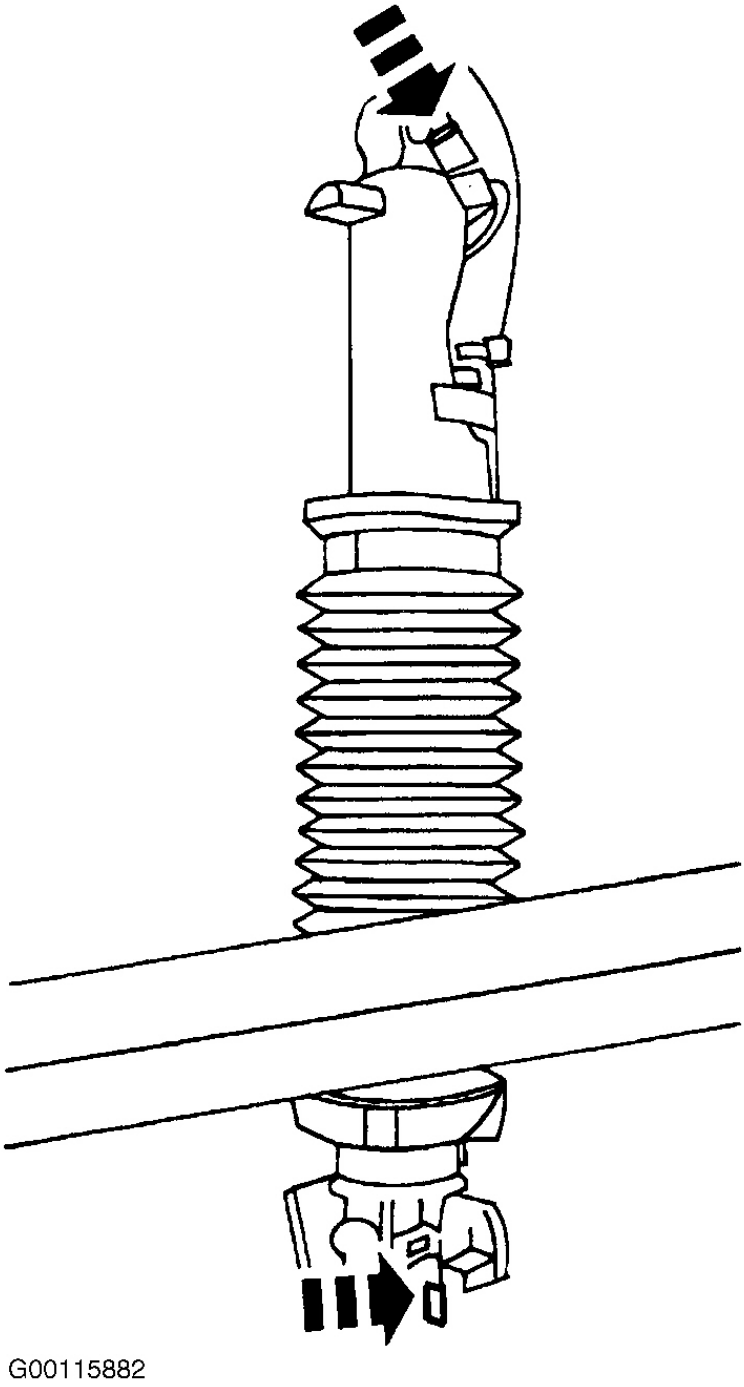


Fig. 15: Replacing Air Suspension Height Sensor

Courtesy of FORD MOTOR CO.

AIR SUSPENSION SWITCH

NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the vehicle relearns its adaptive strategy. The vehicle may need to be driven 10 mi, (16 km) or more to relearn the strategy.

Removal & Installation

1. Disconnect the battery ground cable.
2. Turn the air suspension switch, located behind the right hand cowl side trim panel, to the OFF position. See **Fig. 16** .
3. Disconnect the air suspension switch electrical connector. See **Fig. 17** .
4. Remove the air suspension switch bracket bolt and remove the air suspension switch. See **Fig. 18** .
5. To install, reverse the removal procedure. Tighten the air suspension bracket bolt to specification. See **TORQUE SPECIFICATIONS** .

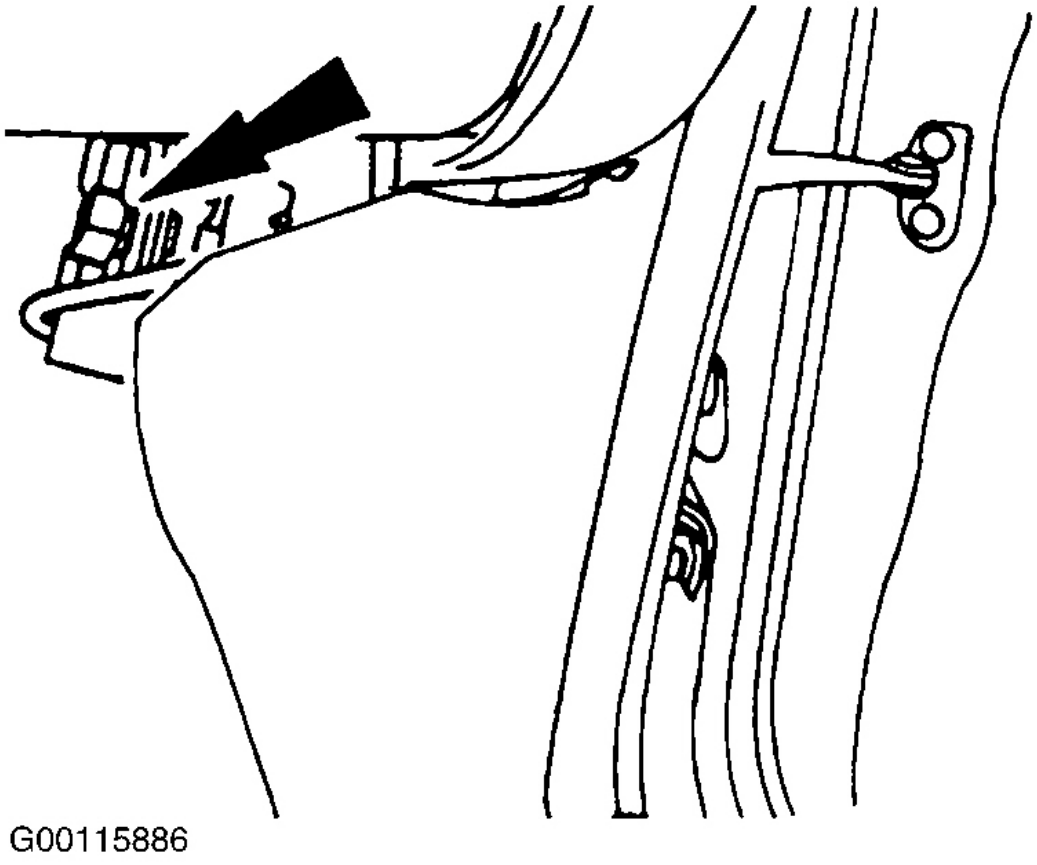


Fig. 16: Locating Air Suspension Switch
Courtesy of FORD MOTOR CO.

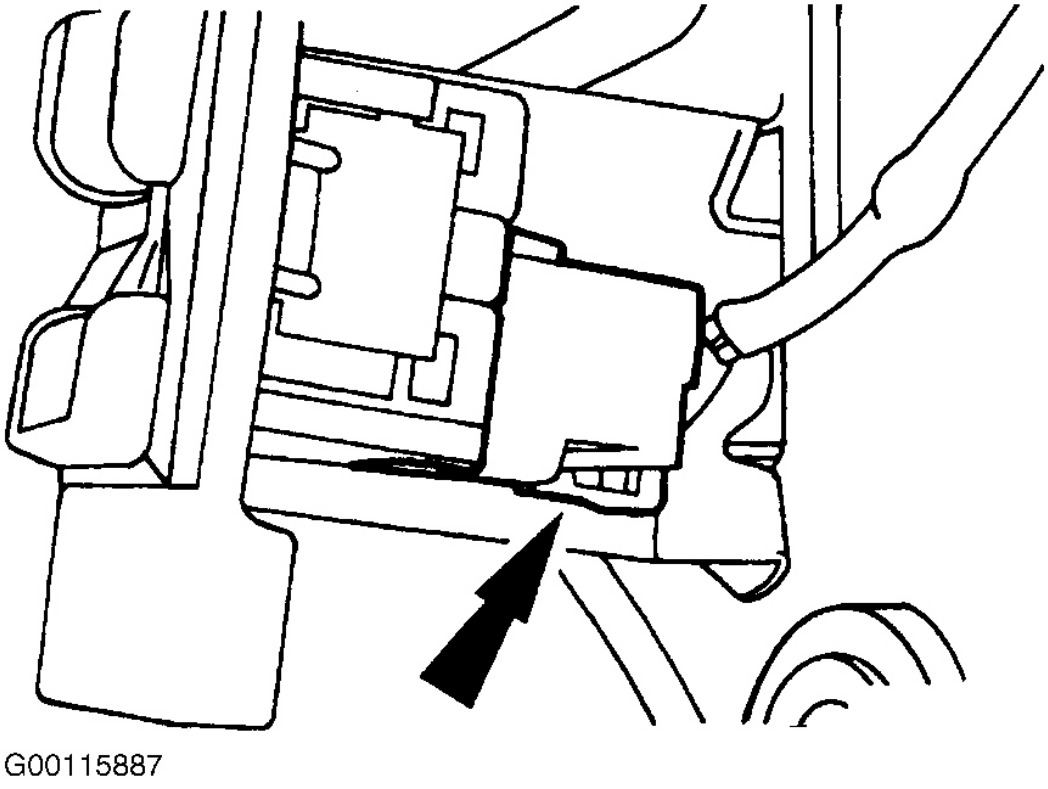


Fig. 17: Locating Air Suspension Switch Connector
Courtesy of FORD MOTOR CO.

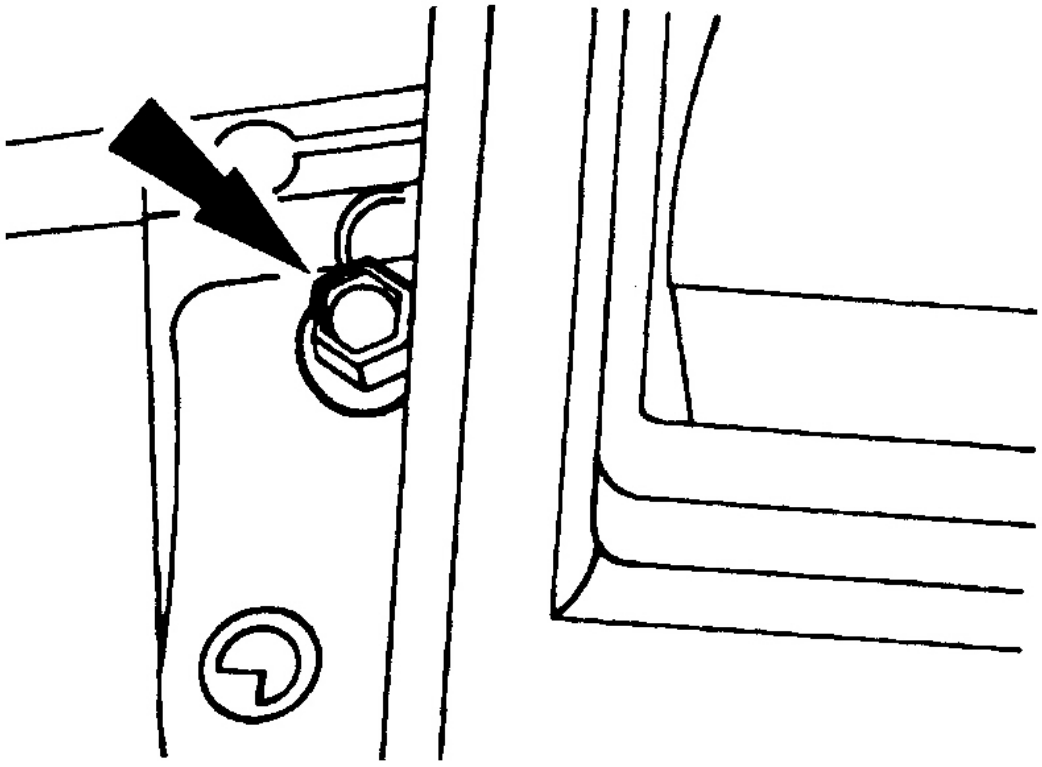


Fig. 18: Replacing Air Suspension Switch
Courtesy of FORD MOTOR CO.

ANTI-WIND BAR

WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. this can be accomplished by turning off the air suspension switch located in the right hand kick panel area. failure to do so may result in unexpected inflation or deflation of the air springs which may result in shifting of the vehicle during these operations. See Fig. 16 and Fig. 17 .

Removal

1. Turn the air suspension switch to the OFF position.
2. Raise and support the vehicle.

NOTE: Before removing the air suspension height sensor from the ball studs,

observe the depth of the ball studs in the air suspension height sensor.

3. Depress the metal retaining tabs and remove the air suspension height sensor. See **Fig. 15** .

NOTE: Be sure to note which position the anti-wind bar connects to the rear axle.

4. Remove the lower bolts, the upper bolts. Remove the anti-wind bars. See **Fig. 19** .

Installation

1. To install, reverse the removal procedure. Tighten the lower and upper anti-wind bar bolts to specification. See **TORQUE SPECIFICATIONS** .
2. Visually inspect each air spring to ensure correct profile has been obtained. There should be no evidence of buckling or folding on the air springs.

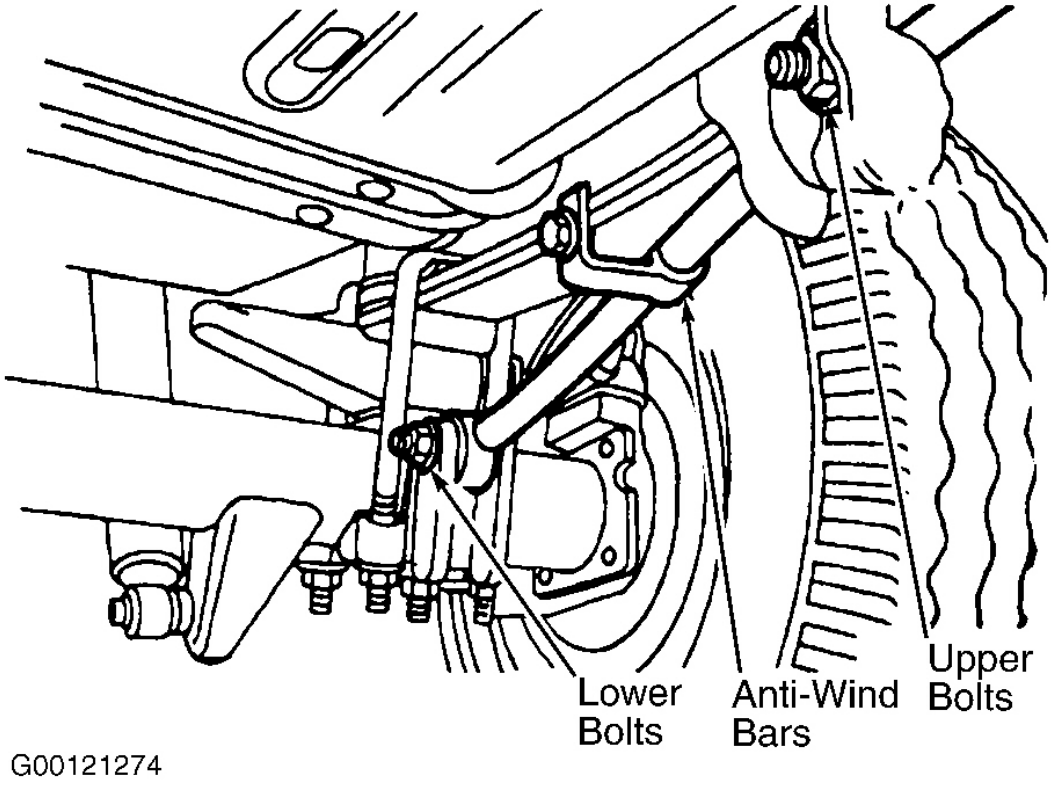


Fig. 19: Identifying Anti-Wind Bar Components
Courtesy of FORD MOTOR CO.

CONTROL MODULE

Removal & Installation

NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the vehicle relearns its adaptive strategy. The vehicle may need to be driven 10 mi (16 km) or more to relearn the strategy.

1. Disconnect the battery ground cable.
2. Remove the center instrument panel finish panel. See **Fig. 20** .

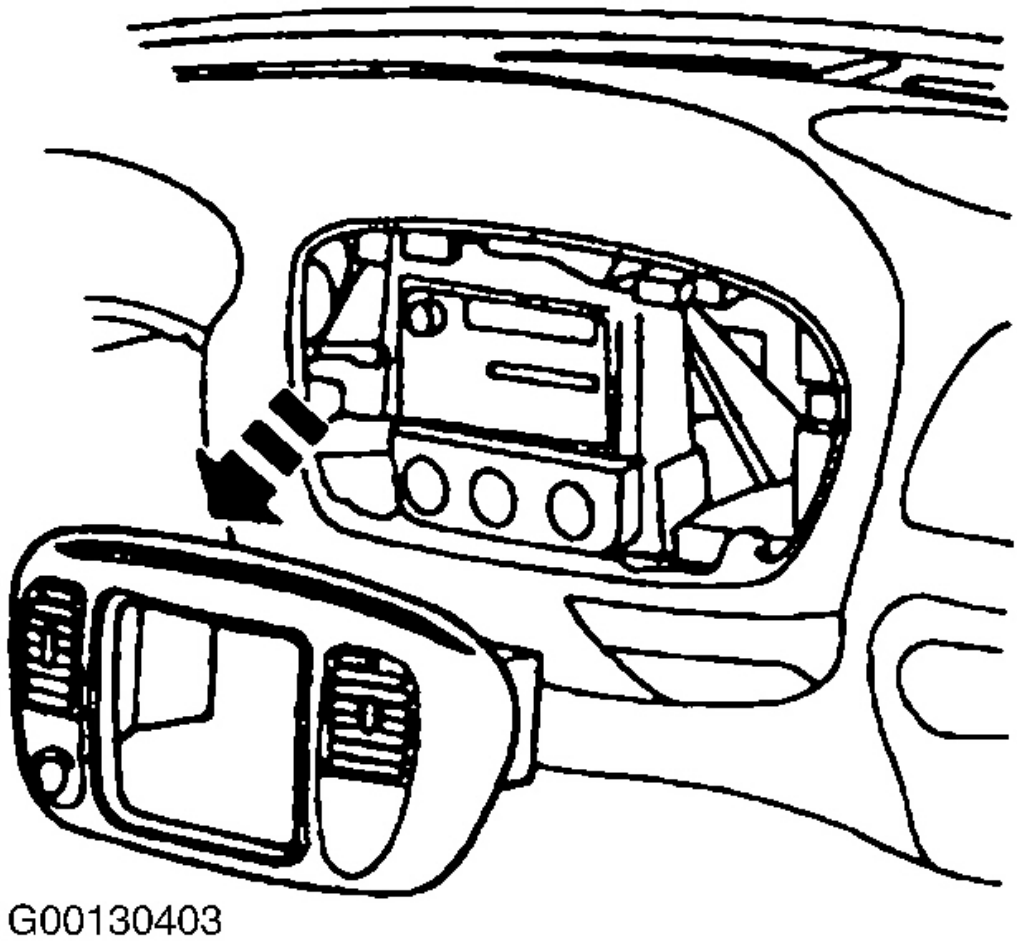
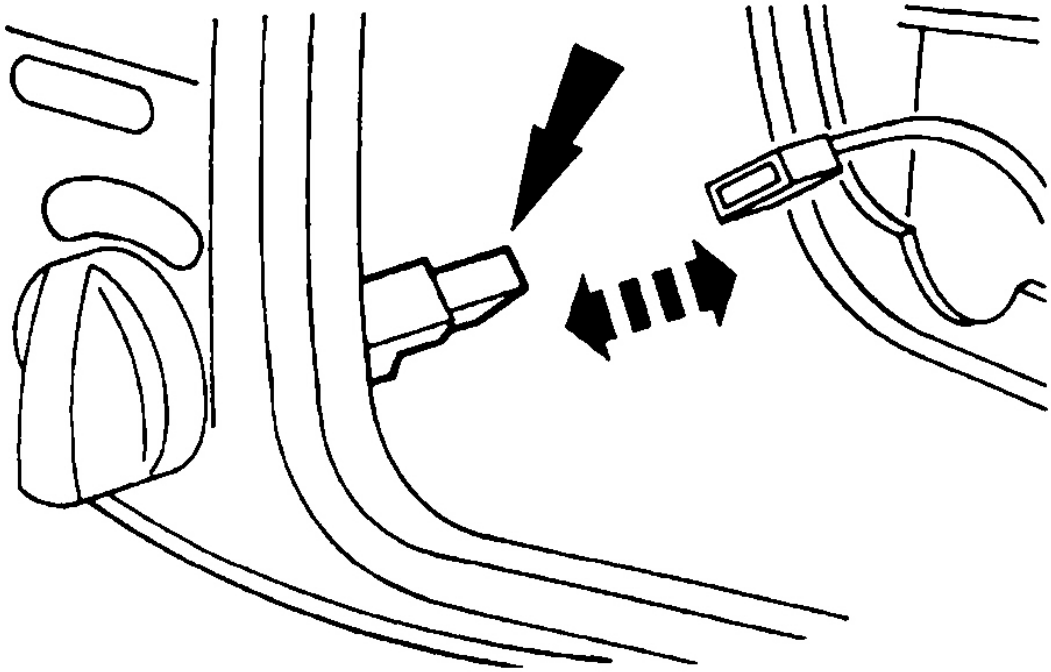


Fig. 20: Removing Center Instrument Panel Finish Panel
Courtesy of FORD MOTOR CO.

3. If equipped, disconnect the transfer case rotary control switch electrical connector. See **Fig. 21** .



G00121268

Fig. 21: Disconnect/Connect Transfer Case Rotary Control Switch Electrical Connector
Courtesy of FORD MOTOR CO.

4. Disconnect the two passenger air bag defeat switch electrical connector. See **Fig. 22** .

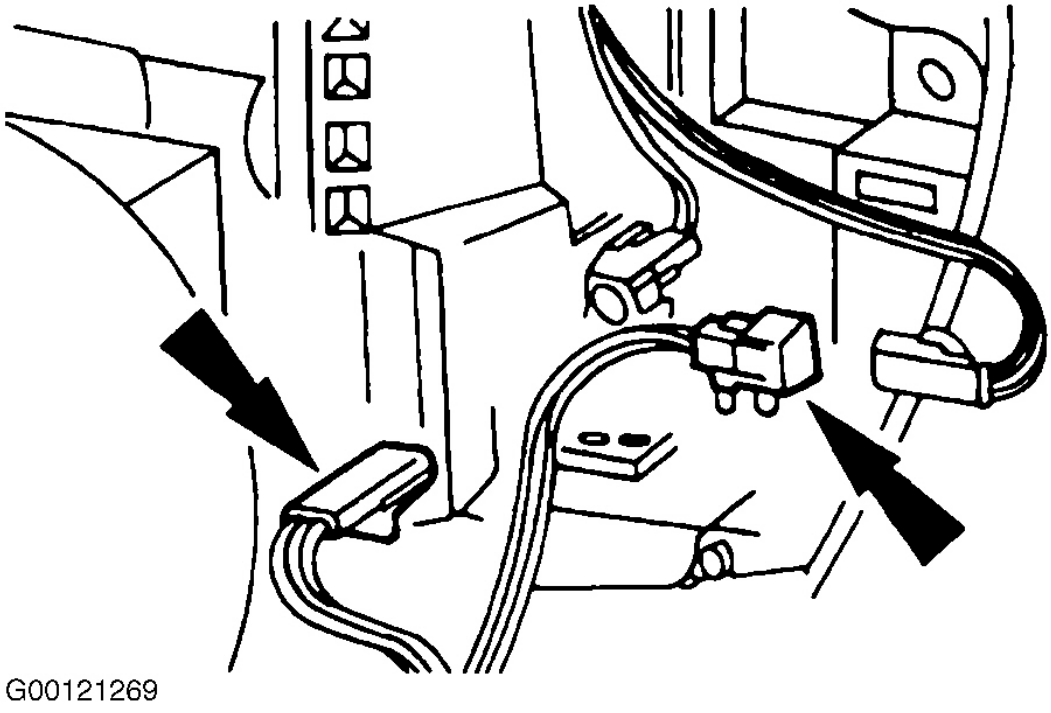


Fig. 22: Disconnect/Connect Two Passenger Air Bag Defeat Switch Electrical Connectors
Courtesy of FORD MOTOR CO.

5. Remove the steering column trim panel.
6. Remove the head lamp switch. See **HEADLAMP SWITCH** .
7. Remove the left hand instrument panel finish panel. See **Fig. 23** . Remove instrument cluster panel. See **Fig. 24** .

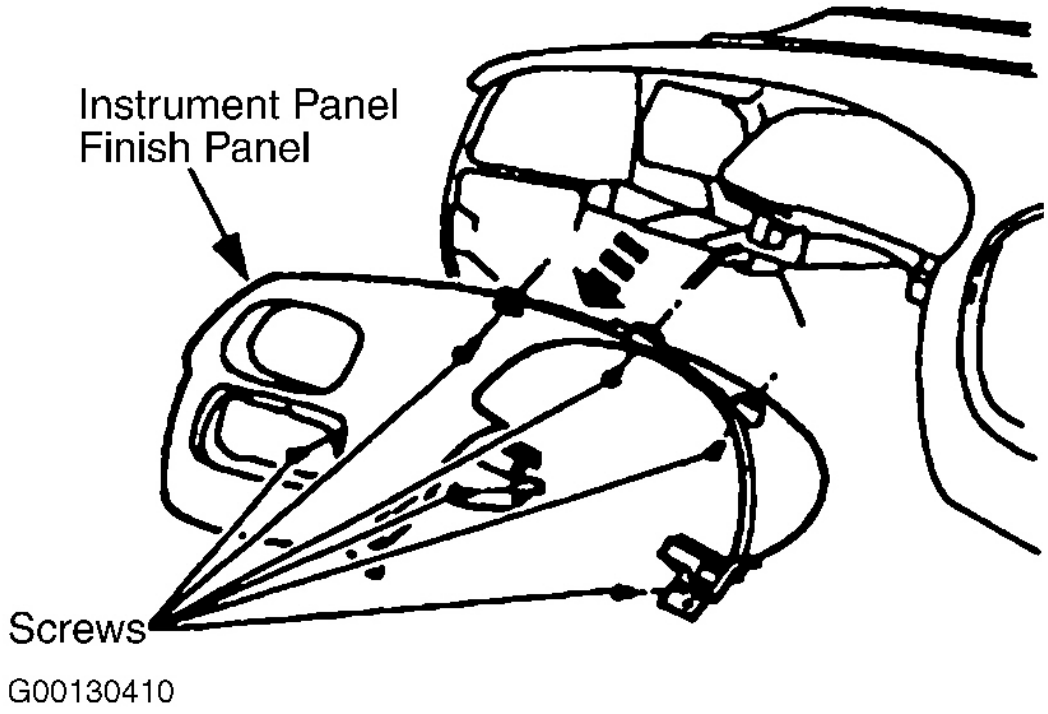


Fig. 23: Removing Instrument Panel Finish Panel
Courtesy of FORD MOTOR CO.

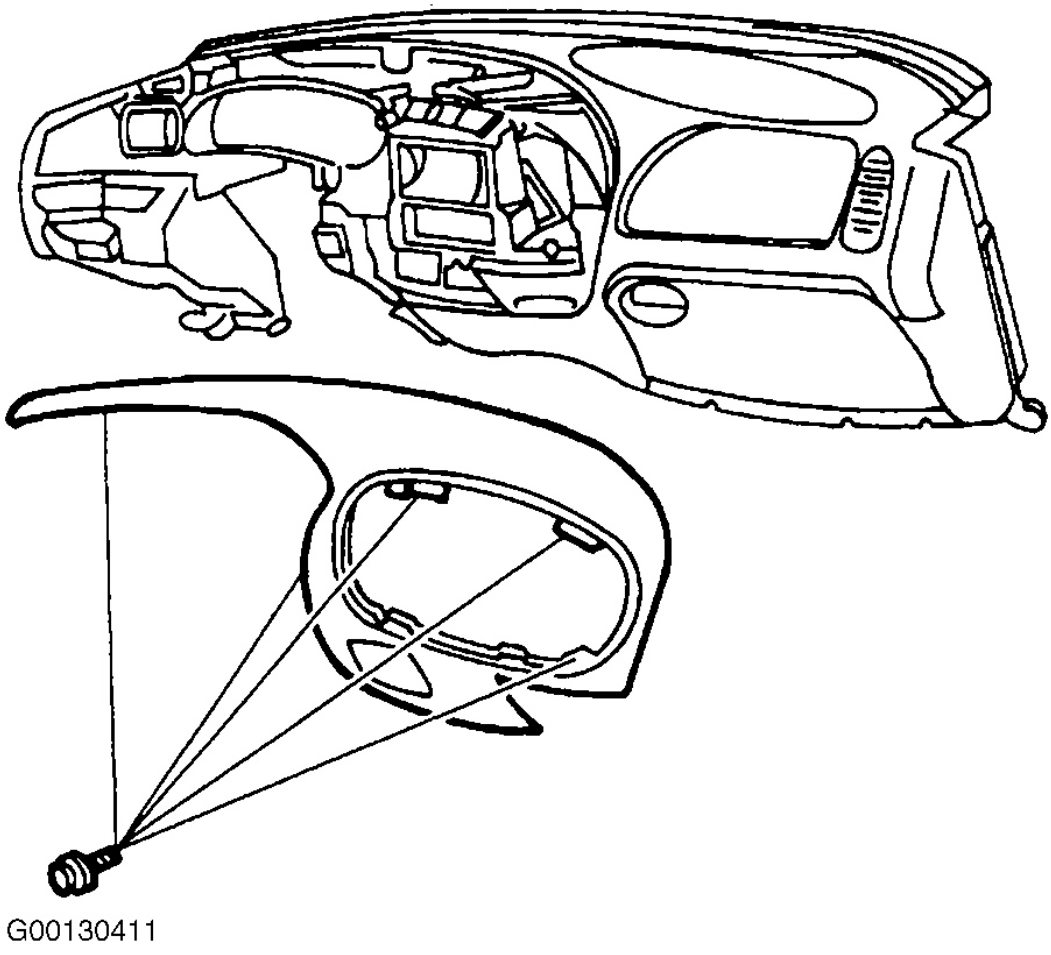


Fig. 24: Removing Instrument Cluster Panel
Courtesy of FORD MOTOR CO.

8. Remove the front control module mounting bracket screws. See **Fig. 25** .

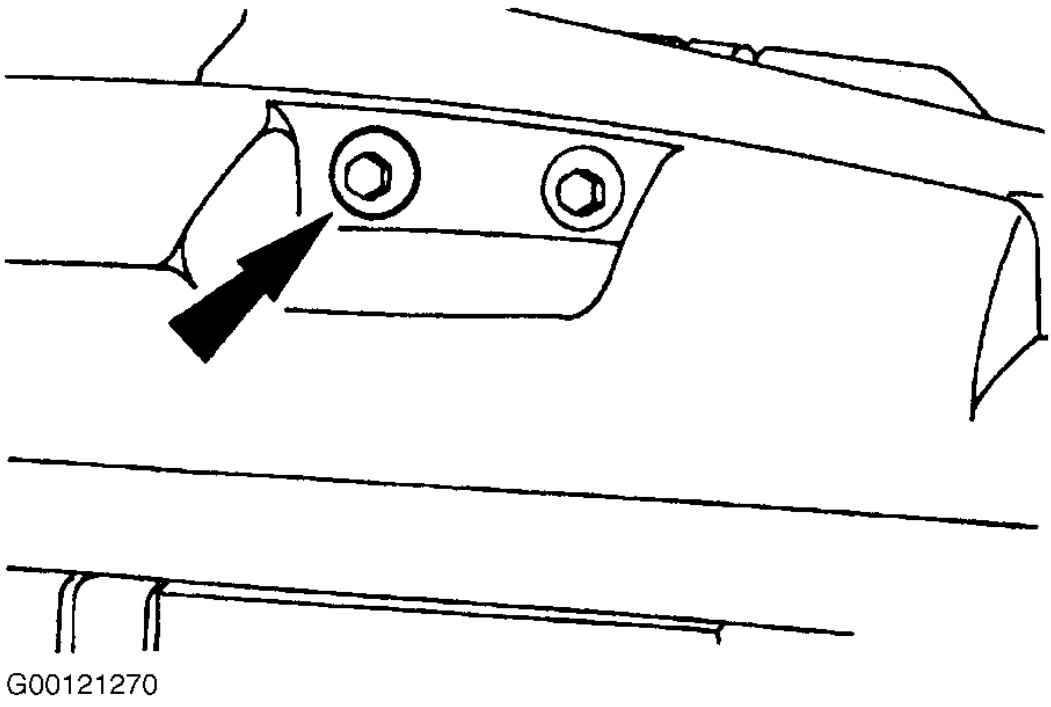


Fig. 25: Replacing Front Control Module Mounting Bracket Screw
Courtesy of FORD MOTOR CO.

9. Remove the rear control mounting bracket screw. See **Fig. 26** .

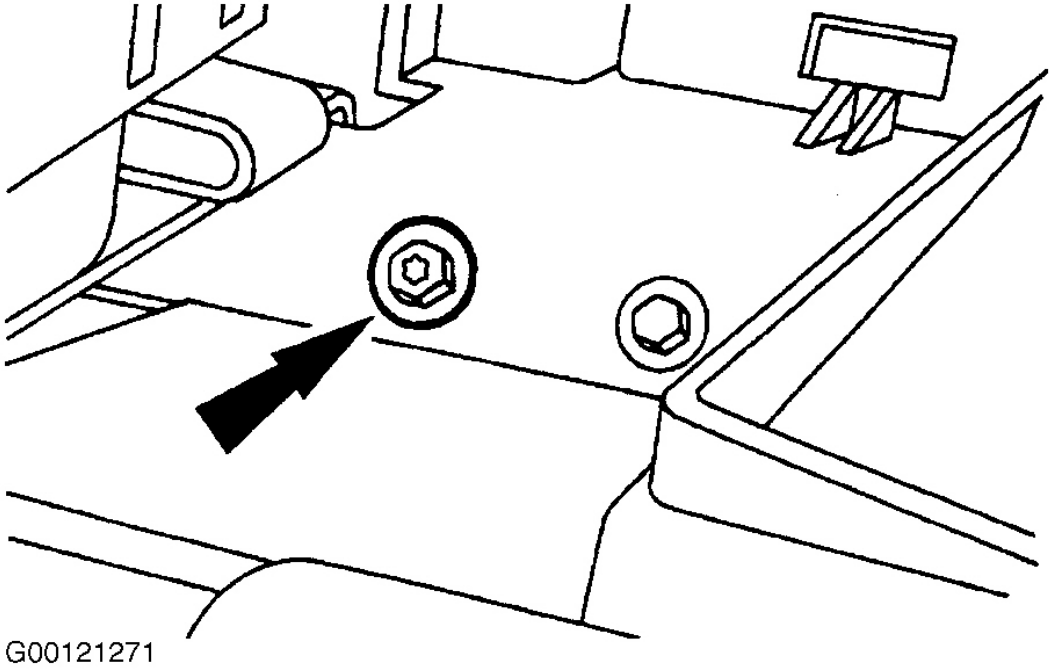


Fig. 26: Replacing Rear Control Mounting Bracket Screw
Courtesy of FORD MOTOR CO.

10. Lift control module and mounting bracket from instrument panel and disconnect the control module electrical connectors. See **Fig. 27** .
11. To install, reverse the removal procedure.

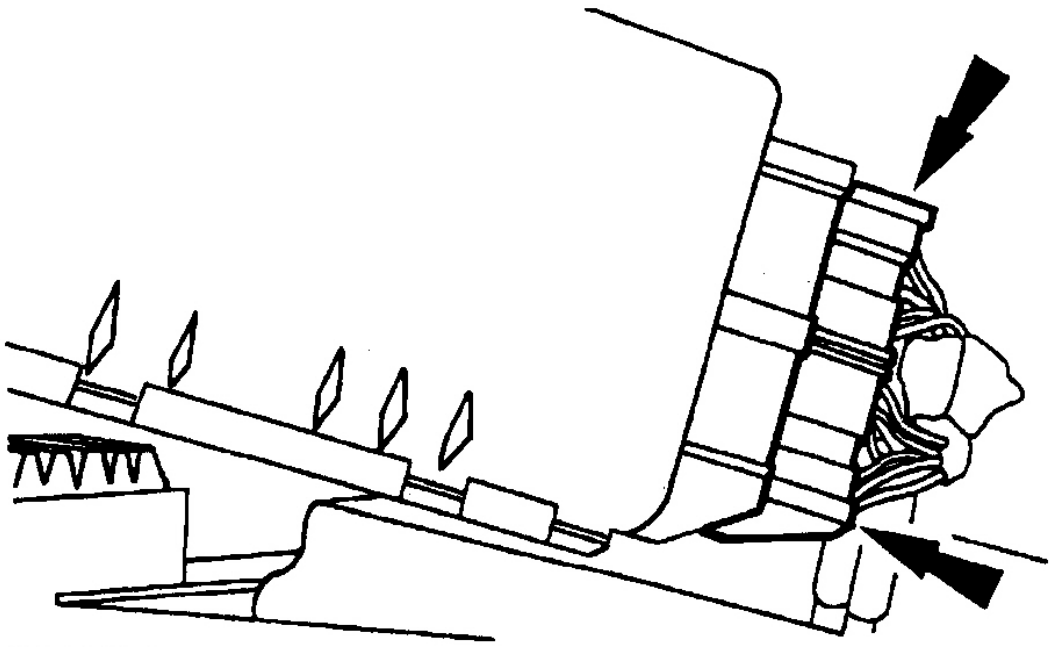


Fig. 27: Identifying Control Module Electrical Connectors
Courtesy of FORD MOTOR CO.

DRIER

WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. this can be accomplished by turning off the air suspension switch located in the right hand kick panel area. failure to do so may result in unexpected inflation or deflation of the air springs which may result in shifting of the vehicle during these operations. See Fig. 16 and Fig. 17 .

WARNING: Do not remove an air spring under any circumstances when there is pressure in the air spring. do not remove any components supporting an air spring without either exhausting the air or providing support for the air spring to prevent vehicle damage or personal injury. Disconnecting an air line that is connected to the air compressor can cause personal injury or damage to components as high pressure air is vented uncontrolled.

Removal & Installation

1. Access the air suspension diagnostic connector behind the right hand cowl side trim panel. See **Fig. 7** .
Using the New Generation Star (NGS) Tester, vent the compressor/drier assembly.

2. Disconnect the battery negative cable.
3. Remove the washer pump and reservoir.
4. Remove the drier hold down screw.

NOTE: Make sure that the O-ring at the drier nose does not fall upon removal.

5. Turn drier clockwise and remove from the air compressor.
6. To install, reverse the removal procedure.

HEADLAMP SWITCH

NOTE: When the battery is disconnected and reconnected, some abnormal drive system may occur while the vehicle relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.

Removal & Installation

1. Disconnect the battery ground cable. Turn the headlamp switch knob to the headlamp position and pull the knob. See **Fig. 28** .

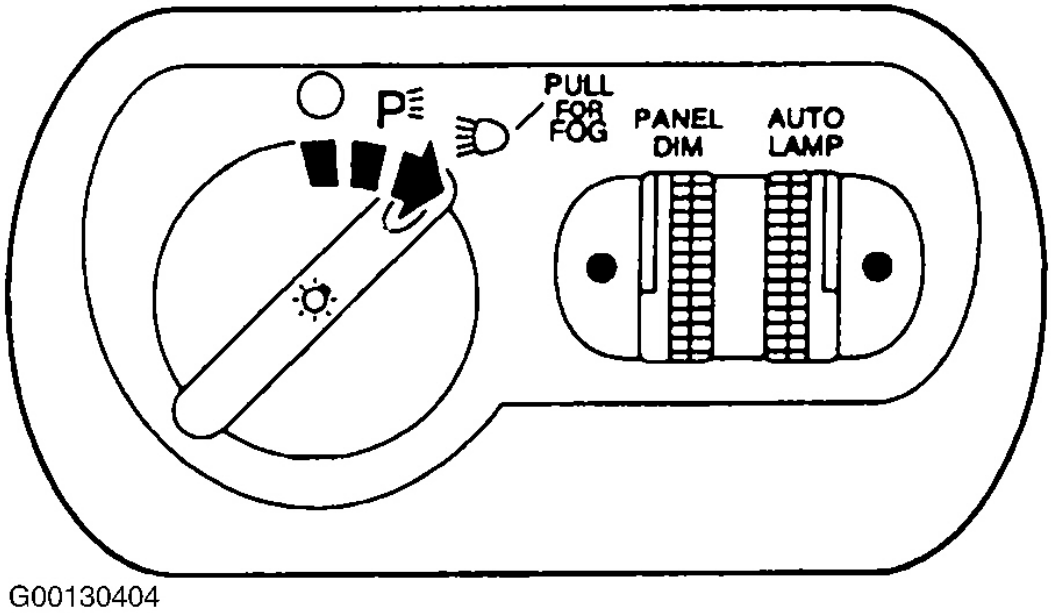


Fig. 28: Turning Headlamp Switch Knob To Right
Courtesy of FORD MOTOR CO.

2. Insert a thin tool to release the headlamp switch knob and remove. See **Fig. 29** .

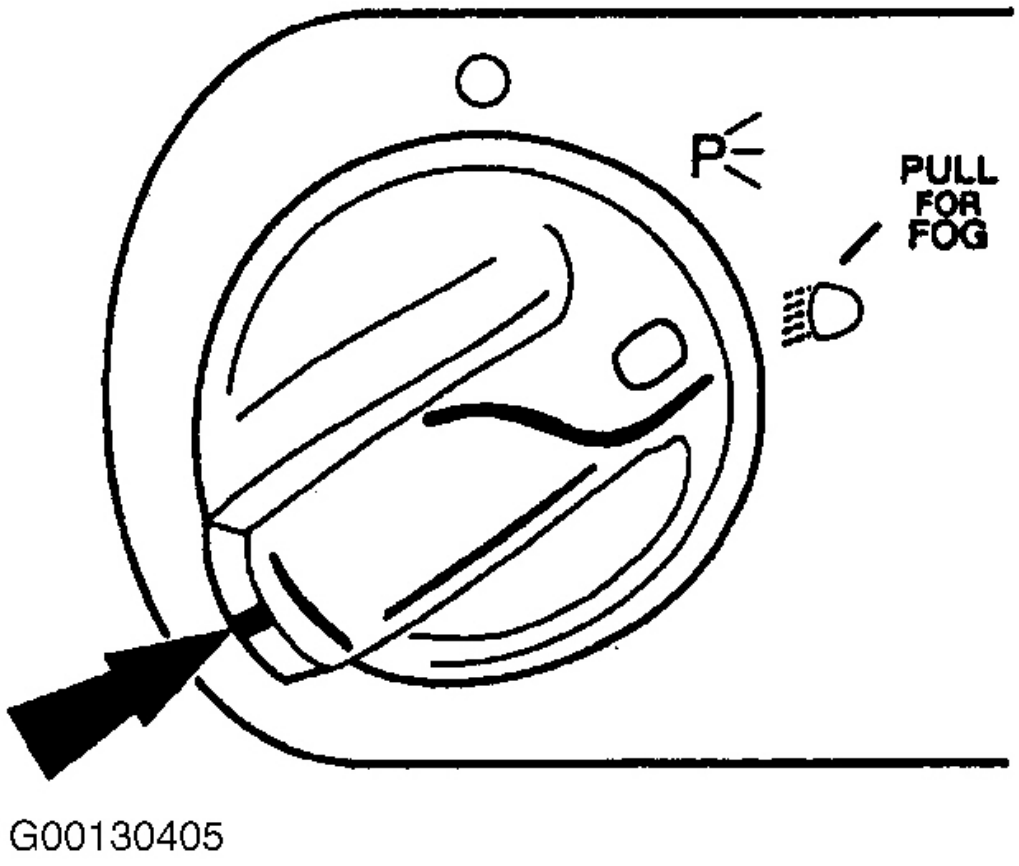


Fig. 29: Locating Headlamp Switch Knob Release Tab
Courtesy of FORD MOTOR CO.

3. Turn the headlamp switch knob 180 degrees and install. See **Fig. 30** .

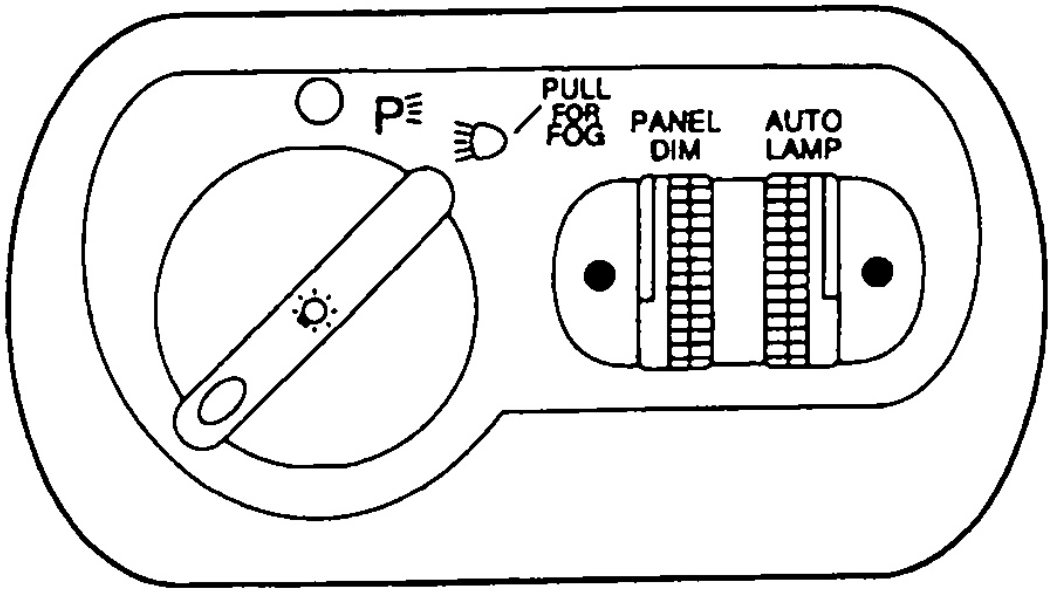


Fig. 30: Installing Headlamp Switch Knob
Courtesy of FORD MOTOR CO.

4. Turn counterclockwise until the back of the headlamp switch knob is in the off position. See **Fig. 31** .

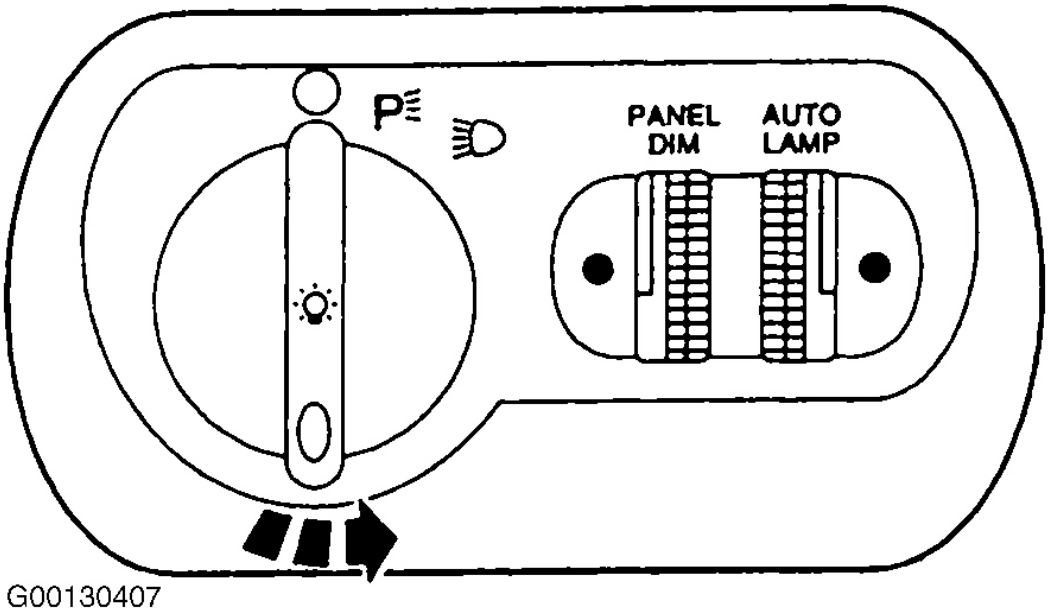


Fig. 31: Locating Headlamp Switch Knob To Off Position
Courtesy of FORD MOTOR CO.

5. Turn the headlamp switch knob clockwise fully. See **Fig. 32** .

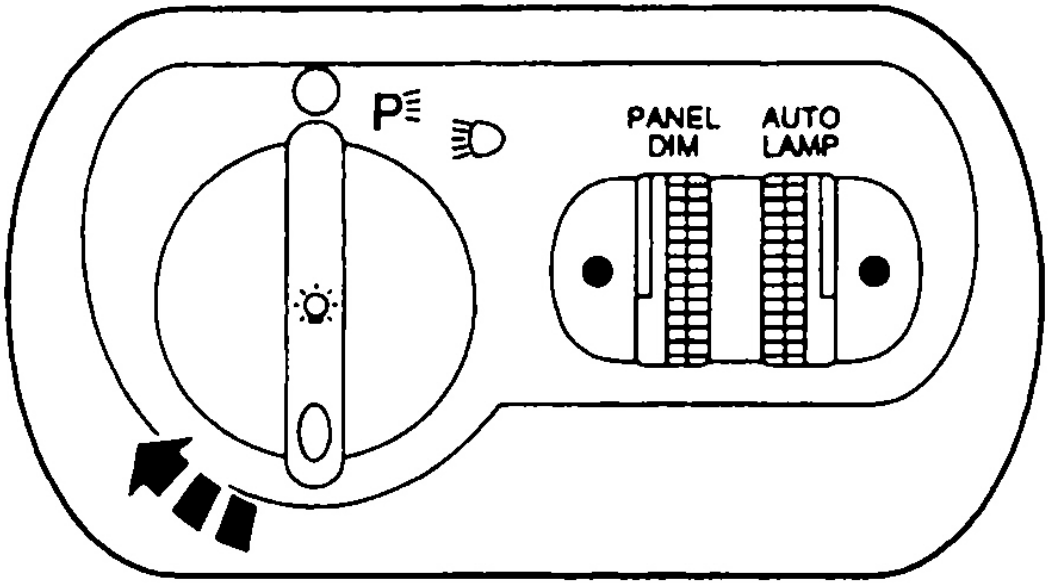


Fig. 32: Turning Headlamp Switch Knob Fully Clockwise
Courtesy of FORD MOTOR CO.

6. Pull headlamp switch from instrument panel. Disconnect the electrical connectors.See **Fig. 33** .

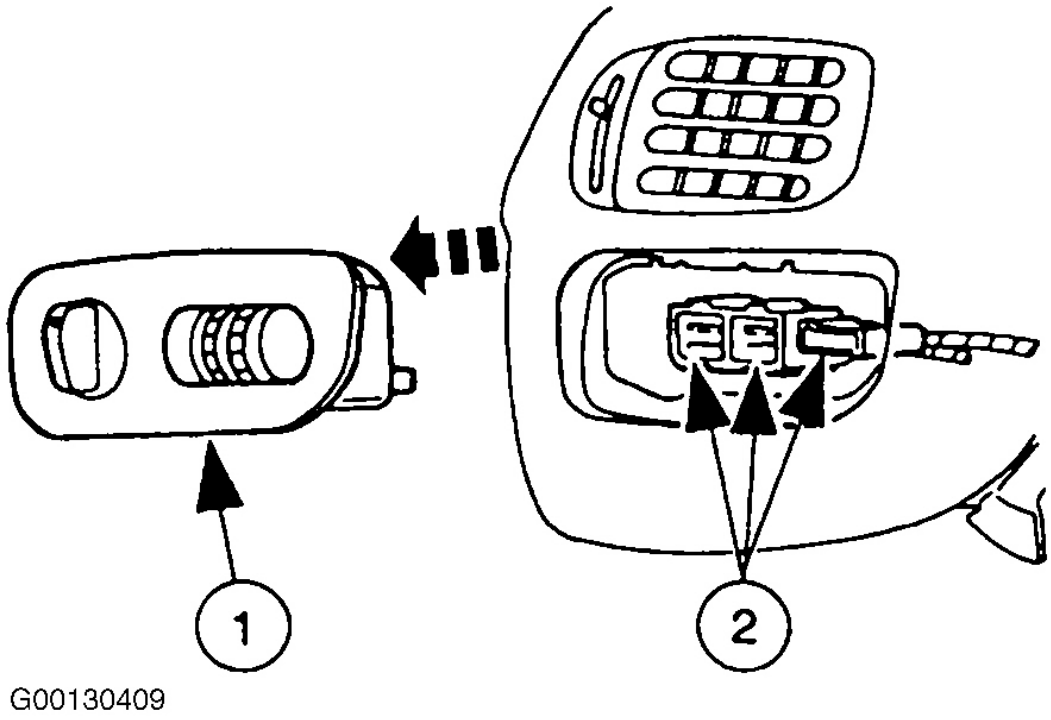


Fig. 33: Removing Headlamp Switch From Instrument Panel
Courtesy of FORD MOTOR CO.

7. To install, reverse the removal procedure.

LEAF SPRING

WARNING: If equipped, the electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. this can be accomplished by turning off the air suspension switch located in the right hand kick panel area. failure to do so may result in unexpected inflation or deflation of the air springs which may result in shifting of the vehicle during these operations. See Fig. 16 and Fig. 17 .

CAUTION: Do not use heat to loosen a seized lug nut. Heat can damage the wheel and the wheel bearings.

Removal

1. Remove the rear wheel center caps. With the weight of the vehicle off the wheels, loosen but do not remove the lug nuts.

2. On vehicle equipped with rear air suspension, deflate the air springs. See **AIR SPRING** .
3. On all vehicles, raise and support the vehicle.
4. Remove the wheel and tire assembly.
5. Use a Hi Lift Jack to support the rear axle. See **Fig. 34** .
6. On models with rear air suspension, separate the air spring from the spring perch. See **Fig. 35** . Disconnect the height sensor. See **Fig. 36** .Disconnect the axle end of the anti-wind bar and position it out of the way. See **Fig. 37** .

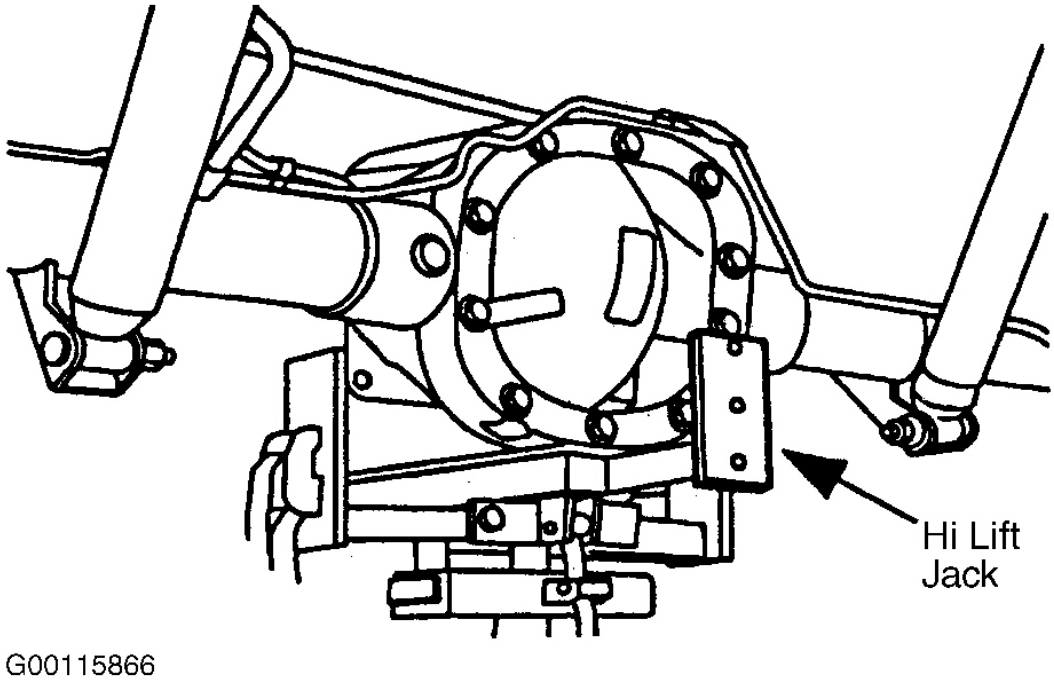


Fig. 34: Location Of Jack For Axle Support
Courtesy of FORD MOTOR CO.

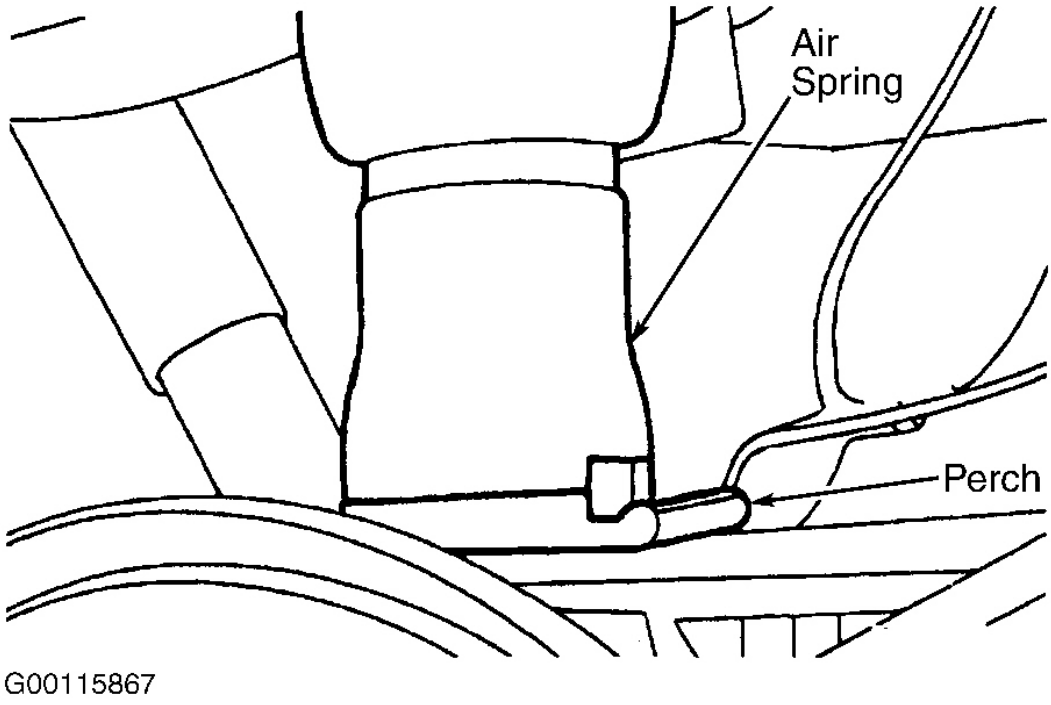


Fig. 35: Separating Air Spring From Perch
Courtesy of FORD MOTOR CO.

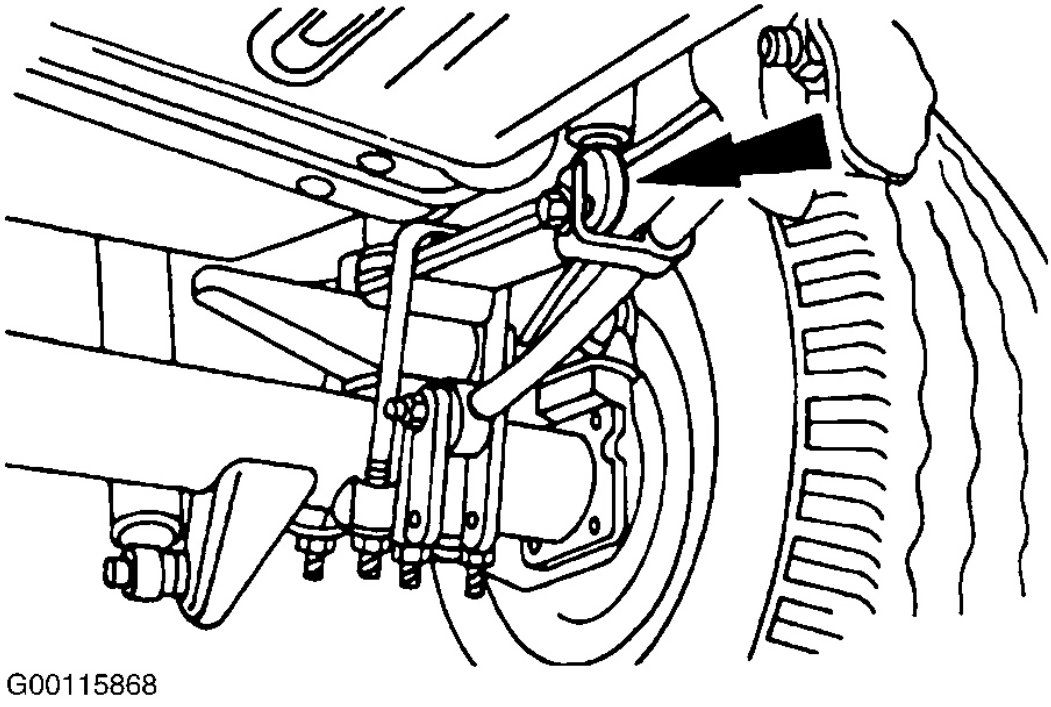


Fig. 36: Identifying Height Sensor
Courtesy of FORD MOTOR CO.

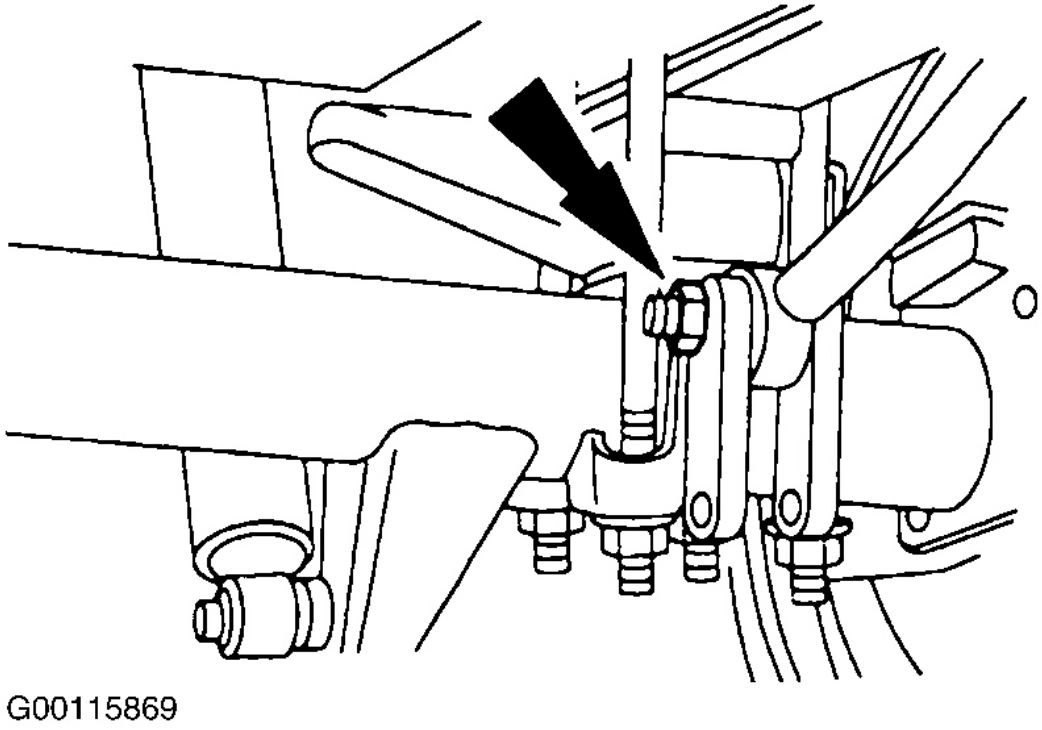


Fig. 37: Disconnecting Axle End Of Anti-Wind Bar
Courtesy of FORD MOTOR CO.

WARNING: Lower the rear axle only enough to gain access to the rear spring.

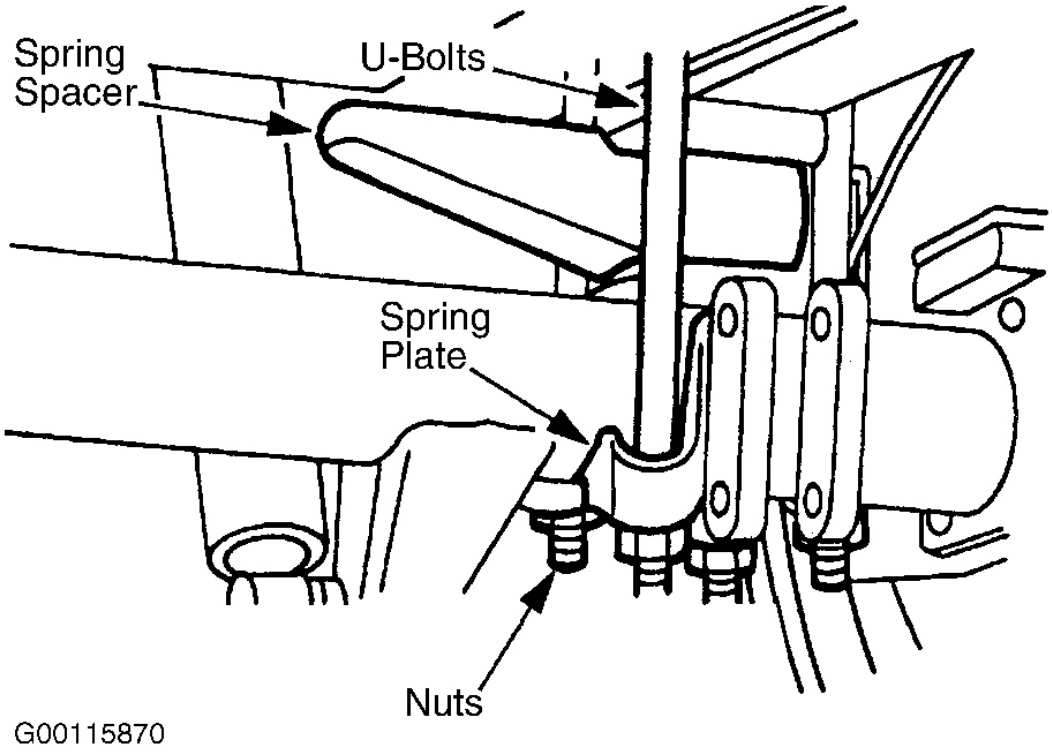


Fig. 38: Positioning Rear Spring Spacer (4x4)
Courtesy of FORD MOTOR CO.

7. On all models, remove the four U-bolt nuts, the U-bolts, and the rear spring plates. Carefully lower the rear axle and separate the rear spring from the rear axle. On 4x4 vehicles, remove the rear spring spacer then the spring from the rear axle. See **Fig. 38** .

> **WARNING: Do not remove an air spring under any circumstances when there is pressure in the air spring. do not remove any components supporting an air spring without either exhausting the air or providing support for the air spring to prevent vehicle damage or personal injury.**

8. Remove the spring to front frame bracket bolt and nut. Remove the spring to shackle upper bolt and nut. Remove the rear spring. See **Fig. 39** .

Installation

1. Position the rear spring. Install the rear nut and bolt. Install the front nut and bolt. See **Fig. 39** . Tighten nuts to specification. See **TORQUE SPECIFICATIONS** .

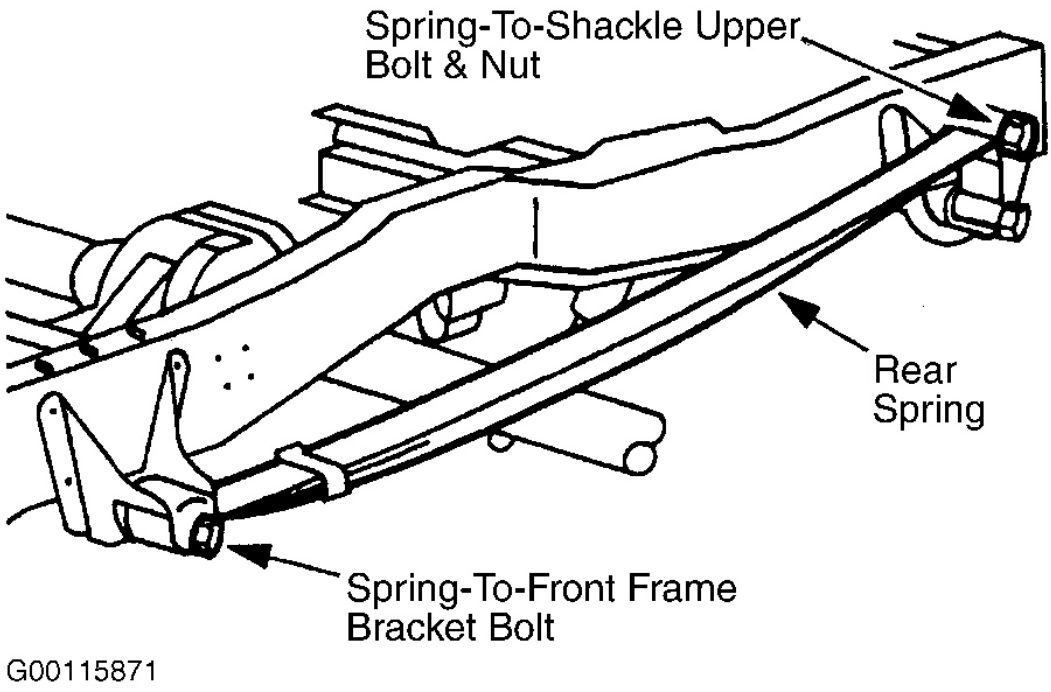


Fig. 39: Locating Leaf Spring Bolts
Courtesy of FORD MOTOR CO.

2. For vehicles with rear air suspension, go to 3 . On vehicles without rear air suspension, go to 4 .
3. On vehicles equipped with rear air suspension, position the spring perch and connect the air spring. See **Fig. 35** . On 4x4 vehicles with air suspensions, position the rear spring spacer. Position the U-bolts. Install the rear spring plate.Install the U-bolt nuts. See **Fig. 38** . Tighten nuts to specification. See **TORQUE SPECIFICATIONS** .
4. On F150 models, position the rear spring spacer (4x4 equipped vehicles). Position the U-bolts. Install the rear spring plate. Install the U-bolt nuts. See **Fig. 40** .Tighten nuts to specification. See **TORQUE SPECIFICATIONS** .

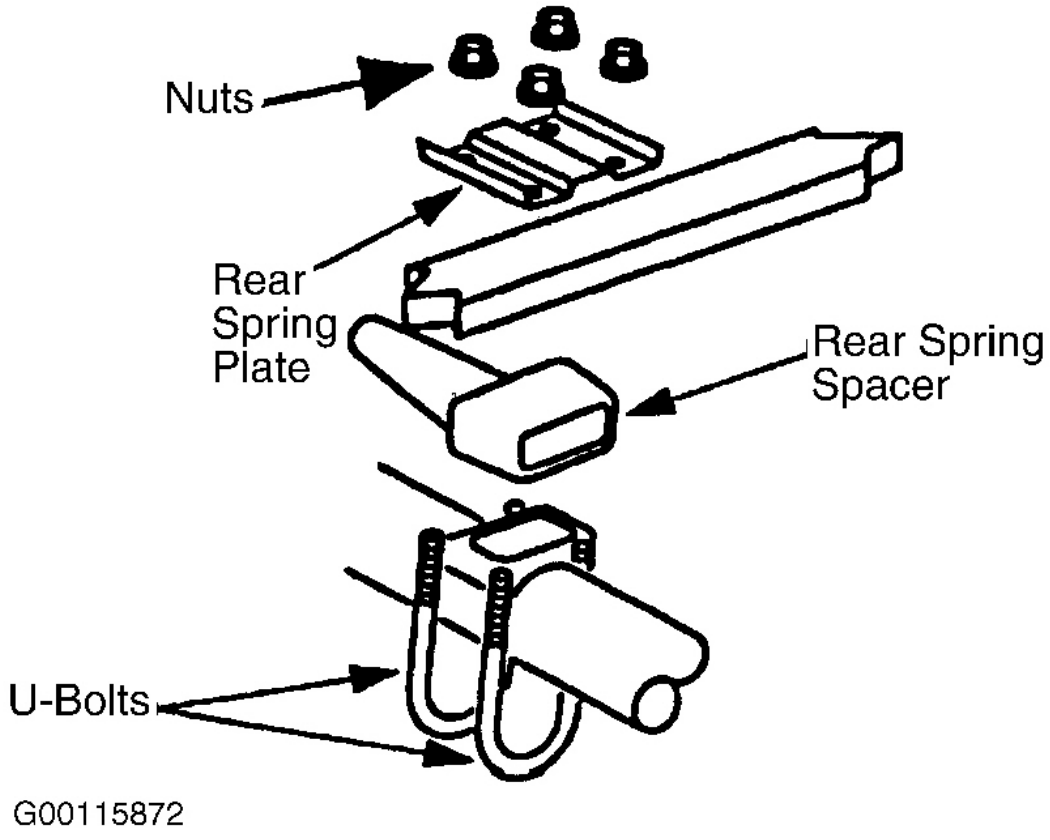


Fig. 40: Installing Rear Spring Plate & Nuts (F150 & F250 Without Rear Air Suspension) Courtesy of FORD MOTOR CO.

5. On F250 models NOT equipped with rear air suspension, position the rear spring spacer (4x4 equipped vehicles). Position the U-bolts. Install the rear spring plate. Install the U-bolt nuts. See **Fig. 40** . Tighten nuts to specification. See **TORQUE SPECIFICATIONS** .

NOTE: When installing the anti-wind bars, be sure to align with the proper spring plate holes; the top is for 4x4 vehicles and the bottom is for 4x2 vehicles.

6. On vehicles equipped with rear air suspension, connect the axle end of the anti-wind bar. See **Fig. 37** . Tighten nut to specification. See **TORQUE SPECIFICATIONS** . Connect the height sensor. See **Fig. 36** .
7. On all models, remove the Hi Lift Jack.

WARNING: When a wheel is installed, always remove any material present on the mounting surfaces of wheel, wheel hub, brake drum or brake rotor that contacts wheel. Installing wheels without proper metal to

metal contact at wheel mounting surfaces can cause lug nuts to loosen and wheel to come off while vehicle is in motion, causing loss of control.

8. Clean the wheel hub mounting surface.
9. On all vehicles, install the wheel and tire assembly. Tighten lug nuts to specification, See **TORQUE SPECIFICATIONS** .

NOTE: On vehicles equipped with rear air suspension, reactivate the system by turning on the air suspension switch.

SHOCK ABSORBER

WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. this can be accomplished by turning off the air suspension switch located in the right hand kick panel area. failure to do so may result in unexpected inflation or deflation of the air springs which may result in shifting of the vehicle during these operations. See Fig. 16 and Fig. 17 .

Removal & Installation

1. Raise and support the vehicle.
2. Use a Hi-Lift Jack to support the rear axle.
3. Remove the lower rear shock absorber bolt and nut. Hold the shock absorber shaft, remove the upper shock absorber nut. Remove the shock absorber. See **Fig. 41** .

NOTE: If equipped with air suspension, reactivate the system by turning on the air suspension switch.

4. To install, reverse the removal procedure. Tighten the lower and upper shock absorber bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

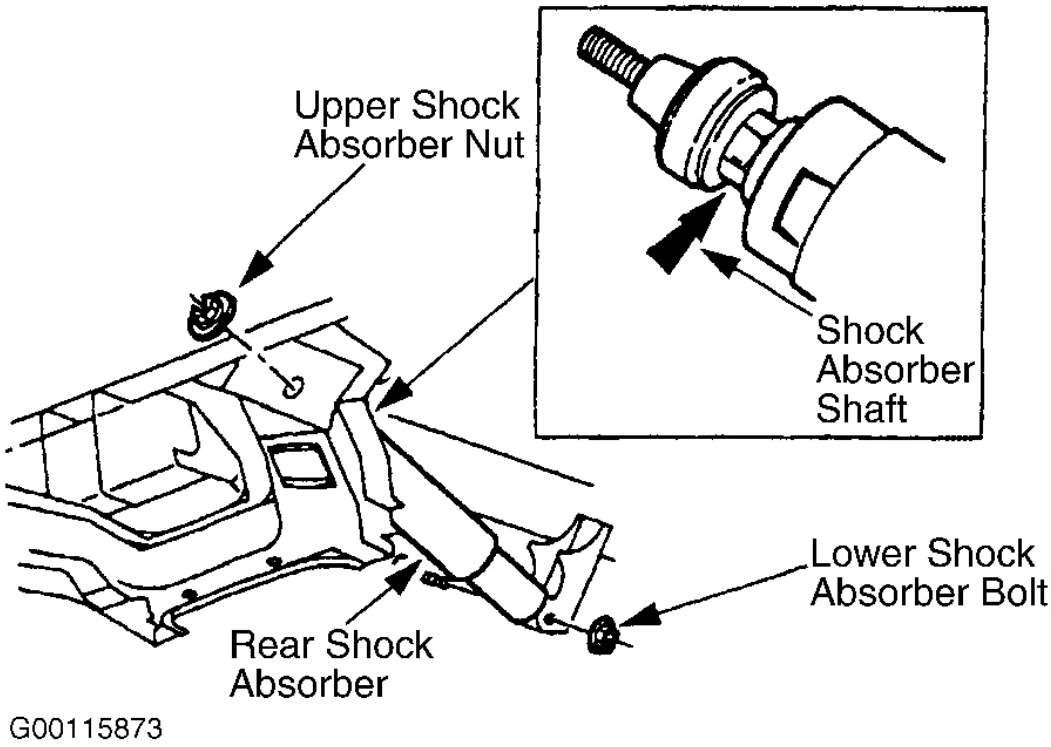


Fig. 41: Replacing Shock Absorber
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Anti-Wind Bar-To-Axle Bolts	83-112 (113-153)
Leaf Spring Bolt (Front & Rear)	72-97 (98-132)
Shock Absorber Nut (Lower)	56-75 (77-103)
Shock Absorber Nut (Upper)	22-29 (30-40)
U-Bolt Nuts (F150)	98 (133)
U-Bolt Nuts (F250)	148 (200)
Wheel Lug Nuts	83-112 (113-153)
	INCH Lbs. (N.m)
Air Compressor Bracket Bolts	91-123 (10.2-13.8)
Air Suspension Switch Bracket Bolt	91-123 (10.2-13.8)
Control Module Mounting Bracket Screws	18-25 (2.1-2.9)
Drier Hold Down Screw	22-30 (2.4-3.4)

Instrument Cluster Panel Screws	18-26 (2-3)
Instrument Panel Finish Panel Screws	18-26 (2-3)

1997-98 AUTOMATIC TRANSMISSIONS

Ford Motor Co. Shift Interlock Systems

DESCRIPTION & OPERATION

LIGHT TRUCKS & VANS

Aerostar & Ranger (1997)

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. An actuator on the ignition switch end of the interlock cable prevents ignition switch from being turned to LOCK position unless shift lever is in "P" position. Shift lever may not be moved from "P" position unless the ignition switch is in the RUN position and the brake pedal is depressed.

An electronic shift lock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

"E" & "F" Series, & Windstar

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. An actuator on the ignition switch end of the interlock cable prevents ignition switch from being turned to LOCK position unless shift lever is in "P" position. Shift lever may not be moved from "P" position unless the ignition switch is in the RUN position and the brake pedal is depressed.

An electronic shift lock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

Villager

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. Shift lever may not be moved from "N" or "P" positions to other gears unless the shift lever button is depressed, the ignition switch is in START or RUN position and the brake pedal is depressed.

A cable system between ignition switch and shift lever prevents ignition key from being removed from switch unless shift lever is in "P" position.

An electronic shift lock actuator, mounted at the base of the shift lever in the steering column, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

PASSENGER CARS

Aspire & Probe

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. Shift lever may not be moved from "N" or "P" positions to other gears unless the shift lever button is depressed, the ignition switch is in START or RUN position and the brake pedal is depressed.

A cable system between ignition switch and shift lever prevents ignition key from being removed from switch unless shift lever is in "P" position.

A electronic shift interlock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

Continental & Town Car

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. An actuator on the ignition switch end of the interlock cable prevents ignition switch from being turned to LOCK position unless shift lever is in "P" position. Shift lever may not be moved from "P" position if the ignition key is in the RUN position unless the brake pedal is depressed.

A electronic shift lock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

Contour & Mystique

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. An actuator on the ignition switch end of the interlock cable prevents ignition switch from being turned to LOCK position unless shift lever is in "P" position. Shift lever may not be moved from "P" position if the ignition key is in the RUN position unless the brake pedal is depressed.

A electronic shift lock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

Crown Victoria, Grand Marquis, Taurus & Sable

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. On models with column shift, a shift interlock actuator is mounted on the steering column. On models with floor-mount shifting, a shift interlock actuator is mounted on the ignition switch end of the interlock cable. This actuator prevents the ignition switch from being turned to LOCK position unless shift lever is in "P" position. Shift lever may not be moved from "P" position if the ignition key is in the RUN position unless the brake pedal is depressed.

A electronic shift lock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

Escort, Escort ZX2 & Tracer

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. Shift lever may not be moved from "N" or "P" positions to other gears unless the shift lever button is depressed, the ignition switch is in START or RUN position and the brake pedal is depressed.

A cable system between ignition switch and shift lever prevents ignition key from being removed from switch unless shift lever is in "P" position.

A electronic shift lock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

Mark VIII

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. An actuator on the ignition switch end of the interlock cable prevents ignition switch from being turned to LOCK position unless shift lever is in "P" position. Shift lever may not be moved from "P" position if the ignition key is in the RUN position unless the brake pedal is depressed.

A electronic shift lock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

Mustang

System is a 2-function electro/mechanical system which prevents free movement of the shift lever. An actuator on the ignition switch end of the interlock cable prevents ignition switch from being turned to LOCK position unless shift lever is in "P" position. Shift lever may not be moved from "P" position if the ignition key is in the RUN position unless the brake pedal is depressed.

A electronic shift lock actuator, mounted at the base of the shift lever, locks shift lever in "P" position until ignition switch is in RUN position and brake pedal is depressed.

TROUBLE SHOOTING

SYSTEM OPERATION CHECK

Turn ignition switch to RUN position. Ensure shift lever is in "P" position. Ensure shift lever may only be moved to "R" position when brake pedal is depressed. Ensure ignition switch can not be turned to LOCK position with shift lever in "R" position. Move shift lever to "P" position and ensure ignition switch may be turned to LOCK position and key removed.

EMERGENCY OVERRIDE FEATURE (IF EQUIPPED)

Ensure shift lever is locked in Park. Use a screwdriver to lift small access cover at upper right corner of shift bezel. Insert a screwdriver vertically into access hole and push downward to release lock lever. Ensure shift lever is released from Park.

DIAGNOSIS & TESTING

AEROSTAR & RANGER (1997)

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment.
- Switches and brackets for damaged. Electrical Components
- Fuses
- Loose Or Damaged Connections
- Brake On/Off (BOO) Switch Connections
- Wiring Harness

Diagnostic Procedure

1. **Check Fuses** - Check appropriate fuses located in the interior fuse junction block. See **WIRING DIAGRAMS** . If fuses are okay, go to step 4 . If fuses are not okay, go to next step.
2. **Check Electrical System** - With ignition off, replace blown fuse(s). Turn ignition on. If fuse does not blow again, go to next step. If fuse blows again, go to step 8 .
3. **Check Supply Voltage To BOO Switch** - Turn ignition off. Locate and disconnect BOO switch connector. Using DVOM, measure and record voltage between Light Green/Red wire at BOO switch connector and ground. If voltage is more than 10 volts, reinstall fuses and go to next step. If voltage is less than 10 volts, repair open in Light Green/Red wire. Reconnect BOO switch connector and retest system.
4. **Check BOO Switch Operation** - Connect DVOM positive lead to Light Green wire of BOO switch connector by backing connector. Connect negative lead to ground. Depress brake pedal. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, replace BOO switch and retest system.
5. **Check Supply Voltage To Shift Lock Actuator** - Disconnect shift lock actuator connector. See **SHIFT INTERLOCK ACTUATOR** under REMOVAL & INSTALLATION. Using DVOM, measure voltage between Gray/Yellow (Aerostar) or Purple/Orange (Ranger) wire at shift lock actuator connector terminal and ground. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open Gray/Yellow or Purple/Orange wire.
6. **Check BOO Switch Signal To Shift Lock Actuator** - Turn ignition off. Using DVOM, measure voltage between Red/Light Green (Aerostar) or Light Green (Ranger) wire at shift lock actuator connector and ground. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair appropriate open wire between BOO switch and shift lock actuator. Retest system.
7. **Check Shift Lock Actuator Ground** - Ensure gearshift lever is in "P" position. Disconnect shift lock actuator connector. Using DVOM, measure resistance between shift lock actuator connector Black wire and ground. If resistance is less than 5 ohms, replace shift lock actuator. If resistance is more than 5 ohms, repair open in Black wire between shift lock actuator and ground. See **WIRING DIAGRAMS** .
8. **Check Supply Voltage For Short To Ground** - Disconnect shift lock actuator connector. See **Fig. 7** . Remove appropriate blown fuse. Using DVOM, measure continuity between fuse holder terminals and ground. If continuity exists, repair short circuit to ground. Replace fuse and retest system. If continuity does not exist, ensure all circuits connected with fuse are okay. See appropriate EXTERIOR LIGHTS article in ACCESSORIES & EQUIPMENT. If other circuits are okay, replace shift lock actuator and retest system.

ASPIRE & PROBE

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment.
- Switches and brackets for damaged. Electrical Components
- Fuses (METER and STOP)
- Loose Or Damaged Connections
- Brake On/Off (BOO) Switch Connections
- Wiring Harness

Diagnostic Procedure

1. **Check Fuses** - Check 15A METER and 15A STOP fuses located in the interior fuse junction block. If fuses are okay, go to step 4 . If fuses are not okay, go to next step.
2. **Check Electrical System** - With ignition off, replace blown fuse(s). Turn ignition on. If the fuse blows again, go to next step. If the fuse does not blow again, go to step 4 .
3. **Check For Short To Ground** - Turn ignition off. Remove METER and STOP fuses. Locate and disconnect shift interlock actuator connectors. See **Fig. 5** . Using DVOM, measure and record resistance between STOP fuse holder terminals and ground. Measure and record resistance between METER fuse holder terminals and ground. If each resistance is more than 10 k/ohms, reinstall fuses and go to next step. If any resistance is less than 10 k/ohms, repair short in appropriate wire. Reconnect all connectors. Install gearshift lever, console and knob.
4. **Check Supply Voltage To Shift Interlock Actuator** - Turn ignition on. Using DVOM, measure voltage between shift interlock actuator 3-pin wiring harness connector Yellow (Aspire) or Yellow/Red (Probe) and Black/Yellow wires and ground. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open in appropriate wire.
5. **Check BOO Switch Signal To Shift Interlock Actuator** - Turn ignition off. Connect DVOM leads between shift interlock actuator 3-pin wiring harness connector Green (Aspire) or White/Green (Probe) wire and ground. While monitoring DVOM, press brake pedal. If voltage is more than 10 volts, go to step 7 . If voltage is less than 10 volts, go to next step.
6. **Check Stoplight Operation** - If stoplights operate when brake pedal is depressed, repair open Green wire between BOO switch and shift lock actuator. If stoplights do not operate when brake pedal is depressed, diagnose problem in stoplight circuit. See appropriate EXTERIOR LIGHTS article in ACCESSORIES & EQUIPMENT.
7. **Check Shift Interlock Actuator Ground** - Ensure gearshift lever is in "P" position. Using DVOM, measure resistance between shift interlock actuator 1-pin connector Black wire and ground. If resistance is less than 5 ohms, replace shift interlock actuator. On Aspire models, if resistance is more than 5 ohms,

repair open in Black wire between shift interlock actuator and ground. See WIRING DIAGRAMS. On Probe models, if resistance is more than 5 ohms, go to next step.

NOTE: Step 8 only applies to Probe models.

8. **Check Park Range Switch** - Remove transmission control selector dial bezel. Press the brake pedal and place transmission selector lever in "1" position. Disconnect park range switch connector. Using DVOM, measure and record resistance between park range switch connector terminals. Depress park range switch and measure resistance between park range switch connector terminals. Resistance should be 5 ohms or less with switch depressed and more than 10 k/ohms with switch released. If either resistance is not as specified, replace park range switch. If both resistance's are as specified, repair Black wire between park range switch and ground. See **WIRING DIAGRAMS** .

CONTINENTAL & TOWN CAR

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment.
- Switches and brackets for damaged. Electrical Components
- Fuses
- Loose Or Damaged Connections
- Brake On/Off (BOO) Or Brake Pedal Position (BPP) Switch Connections
- Wiring harness

Diagnostic Procedure

1. **Check Brakelight Operation** - Depress brake pedal. If brakelights illuminate, go to step 7 . If brakelights do not illuminate, go to next step.
2. **Check Fuse** - Check appropriate fuse (hot at all times circuit) in fuse panel. See WIRING DIAGRAMS. If fuse is okay, go to step 4 . If fuse in blown, go to next step.
3. **Check Wire To BOO/BPP For Short To Ground** - Turn ignition off. Disconnect BOO/BPP switch connector. Using DVOM, measure resistance of wire between fuse (hot at all times circuit) terminal and BOO/BPP switch harness connector terminal. If resistance is more 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair wire between fuse panel and BOO/BPP switch for short to ground. Reconnect all connectors and retest system.
4. **Check Wire To BOO/BPP Switch For Open** - Using DVOM, measure resistance of wire between fuse (hot at all times circuit) terminal and corresponding BOO/BPP switch harness connector terminal. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in wire

between fuse panel and BOO/BPP switch. Reconnect all connectors and retest system.

5. **Check BOO/BPP Switch** - Using DVOM, measure resistance between 2 outer BOO/BPP connector terminals. Apply brakes and recheck resistance. Resistance should be more than 10 k/ohms without brake pedal applied and less than 5 ohms with brake pedal applied. If switch operates as specified, go to next step. If switch does not operate as specified, replace BOO/BPP switch and retest system.
6. **Check Wire To Shift Interlock Actuator For Short To Ground** - Disconnect shift interlock actuator connector. Using DVOM, measure resistance of BOO/BPP switch-to-shift interlock actuator harness connector wire and ground. If resistance is less than 10 k/ohms, go to next step. If resistance is more than 10 k/ohms, repair short in wire between BOO/BPP switch connector and shift interlock actuator connector. Reconnect all connectors and retest system.
7. **Check Wire To Shift Interlock Actuator For Open** - Using DVOM, measure resistance of wire between BOO/BPP switch connector and shift interlock actuator connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in wire between BOO/BPP switch connector and shift interlock actuator connector. Reconnect all connectors and retest system.
8. **Check Voltage To Shift Interlock Actuator** - Turn ignition on. Using DVOM, measure voltage between wire from appropriate fuse (hot in RUN circuit) and ground. If battery voltage is present, go to step 12 . If battery voltage is not present, go to next step.
9. **Check Fuse** - Turn ignition off. Remove and check appropriate fuse (hot in RUN circuit). See **WIRING DIAGRAMS** . If fuse is okay, go to step 11 . If fuse is blown, go to next step.
10. **Check Wire To Shift Interlock Actuator For Short To Ground** - Using DVOM, measure resistance between shift interlock actuator connector terminal (hot in RUN circuit) and ground. If resistance is more than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair open in wire between fuse panel (hot in RUN circuit) and shift interlock actuator connector. Reconnect all connectors and retest system.
11. **Check Wire To Shift Interlock For Open** - Using DVOM, measure resistance of wire between fuse terminal (hot in RUN circuit) and shift interlock actuator connector terminal. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open wire between fuse panel (hot in RUN circuit) and shift interlock actuator connector. Reconnect all connectors and retest system.
12. **Check Shift Interlock Actuator Ground For Open** - Turn ignition on. Using DVOM, measure resistance between shift interlock actuator connector Black wire and ground. If resistance is less than 5 ohms, replace shift interlock actuator. Reconnect all connectors and retest system. If resistance is more than 5 ohms, repair open Black wire between shift interlock actuator connector and ground.

CONTOUR & MYSTIQUE

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly for damage or misadjustment.
- Ignition switch for damage or misadjustment. Electrical Components

- Open Or Shorted Circuits
- Loose Or Damaged Connections
- Brake On/Off (BOO) Or Brake Pedal Position (BPP) Switch Connections
- Fuse(s)
- Faulty Interface Module
- Faulty Key Removal Inhibit Solenoid
- Faulty Bulbs

Diagnostic Procedure

1. **Check Fuse No. 23 (15A)** - Check fuse No. 23 located in the interior fuse panel. If fuse if okay, go to next step. If fuse is not okay, replace fuse and recheck operation. If fuse blows again, check Purple/White wire for short to ground. Repair as necessary.
2. **Check Fuse No. 34 (7.5A)** - Check fuse No. 34 located in the interior fuse panel. If fuse is okay, go to next step. If fuse is not okay, replace fuse and recheck operation. If fuse blows again, check Orange/Yellow wire for short to ground. Repair as necessary.
3. **Check Fuse No. 30 (7.5A)** - Check fuse No. 30 located in the interior fuse panel. If fuse is okay, go to next step. If fuse is not okay, replace fuse and recheck operation. If fuse blows again, check Orange/Black or Purple/Yellow wire between fuse panel and gearshift lever unit for short to ground. Repair as necessary.
4. **Check Voltage To Gearshift Lever Unit** - Remove gearshift lever unit and disconnect electrical connector. Turn ignition on. Using DVOM, measure voltage between gearshift lever unit wiring harness connector Purple/White (terminal No. 1), Orange/Yellow (terminal No. 3) wires and ground. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open wire between fuse panel and gearshift lever unit.
5. **Check Circuit 31S For Open** - Turn ignition off. Disconnect 16-pin instrument interface module connector located below left outer heater duct. Using DVOM, measure resistance of Black/White wire between gearshift lever unit wiring harness connector and instrument interface module connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Black/White wire. Reconnect all connectors and retest system.
6. **Check Circuit 29S For Open** - Using DVOM, measure resistance of Orange/Yellow wire between gearshift lever unit wiring harness connector (terminal No. 4) and instrument interface module connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Orange/Yellow wire. Reconnect all connectors and retest system.
7. **Check Circuit 31S For Short** - Turn ignition on. Using DVOM, measure voltage between gearshift lever unit wiring harness connector Black/White wire and ground. If voltage is less than one volt, go to next step. If voltage is more than one volt, repair short Black/White wire. Reconnect all connectors and retest system.
8. **Check Gearshift Lever Unit Operation** - Ensure ignition is off. Reconnect gearshift lever unit connector. Connect a jumper wire between instrument interface module connector Black/White (terminal No. 8) wire and ground. Turn ignition on. Try to move gearshift lever from Park to Reverse. If gearshift lever moves, go to next step. If gearshift lever will not move, replace gearshift lever unit. Reconnect all connectors and retest system.

9. **Check Instrument Interface Module Ground** - Using DVOM, measure resistance between instrument interface module connector Black/Yellow (terminal No. 15) wire and ground. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Black/Yellow wire. Reconnect all connectors and retest system.
10. **Check Power Supply To Instrument Interface Module** - Turn ignition on. Using DVOM, measure voltage between instrument interface module connector Purple/Black (terminal No. 11) wire and ground. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open Purple/Black wire. Reconnect all connectors and retest system.
11. **Check BOO/BPP Switch Operation** - Turn ignition off. Press down on brake pedal. If stoplights turn on, go to next step. If stoplights do not turn on, diagnose BOO/BPP switch. See appropriate EXTERIOR LIGHTS article in ACCESSORIES & EQUIPMENT.
12. **Check Circuit 29S For Open** - Disconnect PCM. Install breakout box leaving PCM disconnected. Using DVOM, measure resistance between breakout box terminal No. 92 and instrument interface module connector Orange/Black (terminal No. 7) wire. If resistance is less than 5 ohms, replace instrument interface module. Reconnect all connectors and retest system. If resistance is more than 5 ohms, repair open Orange/Black wire. Remove breakout box, reconnect all connectors and retest system.

COUGAR & THUNDERBIRD

NOTE: Information is not available.

CROWN VICTORIA, GRAND MARQUIS, TAURUS & SABLE

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly and cable for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment. Electrical Components
- Open or shorted circuits.
- Loose or damaged connections.
- Brake On/Off (BOO) or Brake Pedal Position (BPP) switch connections.
- Damaged shift lock actuator.
- Fuse(s).
- Faulty PCM.
- Faulty Bulbs.

Diagnostic Procedure

1. **Check No. 5 Fuse** - Check fuse No. 5 located in the interior fuse junction block. If fuse is okay, go to

step 4 . If fuse is not okay, go to next step.

2. **Check For Short To Ground** - Turn ignition off. Remove fuse No. 5. Locate shift interlock actuator on steering column under instrument panel and disconnect electrical connector. Using DVOM, measure and record resistance between fuse holder terminals and ground. If resistance is more than 10 k/ohms, reinstall fuse and go to next step. If resistance is less than 10 k/ohms, repair short Gray/Yellow (Taurus and Sable) or Purple/Orange (Crown Victoria and Grand Marquis) wire. Reconnect all connectors and retest system.
3. **Check Supply Voltage To Shift Lock Actuator** - Turn ignition on. Using DVOM, measure voltage between shift interlock actuator wiring harness connector Gray/Yellow wire and ground. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open Gray/Yellow (Taurus and Sable) or Purple/Orange (Crown Victoria and Grand Marquis) wire.
4. **Check Supply Voltage To BOO/BPP Switch** - Turn ignition off. Disconnect BOO/BPP switch connector. Using DVOM, measure voltage between and ground. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open Light Green/Red wire. Reconnect all connectors and retest system.
5. **Check BOO/BPP Switch Signal To Shift Interlock Actuator** - Disconnect shift lock actuator connector. Depress brake pedal. Using DVOM, measure voltage between shift interlock actuator connector Red/Light Green (Taurus and Sable) or Light Green (Crown Victoria and Grand Marquis) wire and ground. Voltage should be more than 10 volts with brake pedal depressed and less than 1 volt with brake pedal released. If voltage is as specified, go to next step. If voltage is not as specified, repair open Red/Light Green (Taurus and Sable) or Light Green (Crown Victoria and Grand Marquis) wire between BOO/BPP switch and shift interlock actuator.
6. **Check Shift Interlock Actuator Ground** - Ensure gearshift lever is in "P" position. Using DVOM, measure resistance between shift interlock actuator connector Black wire and ground. If resistance is less than 5 ohms, replace shift interlock actuator. If resistance is more than 5 ohms, repair open in Black wire between shift interlock actuator and ground. See **WIRING DIAGRAMS** .

"E" & "F" SERIES, & WINDSTAR

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment.
- Switches and brackets for damaged. Electrical Components
- Fuses
- Loose Or Damaged Connections
- Brake On/Off (BOO) Or Brake Pedal Position (BPP) Switch Connections
- Wiring Harness

Diagnostic Procedure

1. **Check Brakelight Operation** - Depress brake pedal. If brakelights illuminate, go to step 7 . If brakelights do not illuminate, go to next step.
2. **Check Fuse** - Check appropriate fuse (hot at all times circuit) in fuse panel. See **WIRING DIAGRAMS** . If fuse is okay, go to step 4 . If fuse in blown, go to next step.
3. **Check Wire To BOO/BPP For Short To Ground** - Turn ignition off. Disconnect BOO/BPP switch connector. Using DVOM, measure resistance of wire between fuse (hot at all times circuit) terminal and BOO/BPP switch harness connector terminal. If resistance is more 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair wire between fuse panel and BOO/BPP switch for short to ground. Reconnect all connectors and retest system.
4. **Check Wire To BOO/BPP Switch For Open** - Using DVOM, measure resistance of wire between fuse (hot at all times circuit) terminal and corresponding BOO/BPP switch harness connector terminal. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in wire between fuse panel and BOO/BPP switch. Reconnect all connectors and retest system.
5. **Check BOO/BPP Switch** - Using DVOM, measure resistance between 2 outer BOO/BPP connector terminals. Apply brakes and recheck resistance. Resistance should be more than 10 k/ohms without brake pedal applied and less than 5 ohms with brake pedal applied. If switch operates as specified, go to next step. If switch does not operate as specified, replace BOO/BPP switch and retest system.
6. **Check Wire To Shift Interlock Actuator For Short To Ground** - Disconnect shift interlock actuator connector. Using DVOM, measure resistance of BOO/BPP switch-to-shift interlock actuator harness connector wire and ground. If resistance is less than 10 k/ohms, go to next step. If resistance is more than 10 k/ohms, repair short in wire between BOO/BPP switch connector and shift interlock actuator connector. Reconnect all connectors and retest system.
7. **Check Wire To Shift Interlock Actuator For Open** - Using DVOM, measure resistance of wire between BOO/BPP switch connector and shift interlock actuator connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in wire between BOO/BPP switch connector and shift interlock actuator connector. Reconnect all connectors and retest system.
8. **Check Voltage To Shift Interlock Actuator** - Turn ignition on. Using DVOM, measure voltage between wire from appropriate fuse (hot in RUN circuit) and ground. If battery voltage is present, go to step 12 . If battery voltage is not present, go to next step.
9. **Check Fuse** - Turn ignition off. Remove and check appropriate fuse (hot in RUN circuit). See **WIRING DIAGRAMS** . If fuse is okay, go to step 11 . If fuse is blown, go to next step.
10. **Check Wire To Shift Interlock Actuator For Short To Ground** - Using DVOM, measure resistance between shift interlock actuator connector terminal (hot in RUN circuit) and ground. If resistance is more than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair open in wire between fuse panel (hot in RUN circuit) and shift interlock actuator connector. Reconnect all connectors and retest system.
11. **Check Wire To Shift Interlock For Open** - Using DVOM, measure resistance of wire between fuse terminal (hot in RUN circuit) and shift interlock actuator connector terminal. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open wire between fuse panel (hot in RUN circuit) and shift interlock actuator connector. Reconnect all connectors and retest system.
12. **Check Shift Interlock Actuator Ground For Open** - Turn ignition on. Using DVOM, measure resistance between shift interlock actuator connector Black wire and ground. If resistance is less than 5 ohms, replace shift interlock actuator. Reconnect all connectors and retest system. If resistance is more

than 5 ohms, repair open Black wire between shift interlock actuator connector and ground.

ESCORT, ESCORT ZX2 & TRACER

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment.
- Switches and brackets for damaged. Electrical Components
- Fuses (METER, ROOM (Escort and Tracer) Or HORN (Escort ZX2) And STOP)
- Loose Or Damaged Connections
- Brake On/Off (BOO) Or Brake Pedal Position (BPP) Switch Connections
- Faulty Park Sense switch
- Wiring Harness

Diagnostic Procedure

1. **Check Fuses** - Check METER, ROOM or HORN and STOP fuses located in the interior fuse junction block. If fuses are okay, go to step 4 . If fuses are not okay, go to next step.
2. **Check Electrical System** - With ignition off, replace blown fuse(s). Turn ignition on. If the fuse blows again, go to next step. If the fuse does not blow again, go to step 4 .
3. **Check For Short To Ground** - Turn ignition off. Remove METER, ROOM or HORN and STOP fuses. Locate and disconnect shift interlock actuator connector. Using DVOM, measure and record resistance between each METER, ROOM or HORN and STOP fuse holder terminals and ground. If each resistance is more than 10k/ohms, reinstall fuses and go to next step. If any resistance is less than 10 k/ohms, repair short in appropriate wire. See **WIRING DIAGRAMS** . Reconnect all connectors and retest system.
4. **Check Supply Voltage To Shift Lock Actuator** - Turn ignition off. Disconnect shift interlock actuator connector. Turn ignition on. Using DVOM, measure voltage between shift lock actuator wiring harness connector Blue/Red or Green/Yellow wire and ground. See **WIRING DIAGRAMS** for appropriate wire colors. If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open in appropriate wire.
5. **Check BOO Switch Signal To Shift Lock Actuator** - Turn ignition off. Connect DVOM leads between shift lock actuator harness connector Green wire and ground. While monitoring DVOM, press brake pedal. If voltage is less than 10 volts, go to next step. If voltage is more than 10 volts, diagnose problem in stoplight circuit. See appropriate EXTERIOR LIGHTS article in ACCESSORIES & EQUIPMENT.
6. **Check Park Sense Switch Ground For Open** - Disconnect park sense switch connector. Using DVOM, measure resistance between park range switch harness connector Black wire (right side wire with connector tab facing upward) and ground. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Black wire. Reconnect all connectors and retest system.

7. **Check Park Sense Switch** - Using DVOM, measure resistance between park sense switch connector terminals. Resistance should be less than 5 ohms with selector lever release button released and more than 10 k/ohms with selector lever release button pressed or selector lever in any position other than Park. If resistance is not as specified, replace selector lever and park sense switch. If resistance is as specified, replace shift interlock actuator. Reconnect all connectors and retest system.

MARK VIII

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly and cable for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment. Electrical Components
- Open Or Shorted Circuits
- Loose Or Damaged Connections
- Brake On/Off (BOO) Or Brake Pedal Position (BPP) Switch Connections
- Faulty Steering Column/Ignition/Lighting (SCIL) Control Module
- Fuse(s)
- Faulty Bulbs

Diagnostic Procedure

1. **Check Shift Interlock In ACC Position** - Turn ignition to ACC position. With brake pedal released, try and move selector lever to "R" position. If lever moves to "R" position, go to step 3 . If lever does not move to "R" position, go to next step.
2. **Check System Operation** - Turn ignition on. Depress brake pedal and move selector lever to "R" position. If lever does not move to "R" position, go to step 4 . If lever moves to "R" position, system is operating normally. Check wiring harness and connectors for intermittent operation.
3. **Check Steering Column Adjustment** - Actuate steering column adjustment switch to tilt or telescope position. If steering column adjusts, go to next step. If steering column does not adjust, diagnose communication problem with SCIL Module. See appropriate MODULE COMMUNICATION NETWORK article in ACCESSORIES & EQUIPMENT.
4. **Check Stoplight Operation** - Connect NGS scan tool to Datalink connector. Select SCIL PID BOO _ SCI display. While monitoring scan tool display, depress brake pedal. If PID BOO _ SCI changes from off to on, go to next step. If PID BOO _ SCI does not change, diagnose BOO/BPP switch circuit. See appropriate EXTERIOR LIGHTS article in ACCESSORIES & EQUIPMENT.
5. **Check SCIL Module Output To Shift Interlock Solenoid** - Turn ignition off. Locate and disconnect shift interlock solenoid connector. Turn ignition on. Connect DVOM between shift interlock solenoid harness connector Light Blue/Black wire and ground. On NGS scan tool, select SCIL MODULE ACTIVE COMMAND BRAKE SYSTEM. While measuring voltage with DVOM, activate BRK/SHIFT

on NGS scan tool. If battery voltage is present, go to step 8 . If battery voltage is not present, go to next step.

6. **Check Light Blue/Black Wire For Short To Ground** - Turn ignition off. Locate and disconnect SCIL module connector. Using DVOM, measure resistance between SCIL module connector C287 terminal No. 9 and ground. See **Fig. 1** and **Fig. 10** . If resistance is more than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair short Light Blue/Black wire between SCIL module connector and shift interlock solenoid connector.
7. **Check Light Blue/Black Wire For Open** - Using DVOM, measure resistance of Light Blue/Black wire between SCIL module terminal No. 9 and shift interlock solenoid connector. If resistance is less than 5 ohms, replace SCIL module. Reconnect all connectors and retest system. If resistance is more than 5 ohms, repair open in Light Blue/Black wire.
8. **Check Shift Interlock Solenoid Ground For Open** - Using DVOM, measure resistance between shift interlock solenoid connector Black wire and ground. If resistance is less than 5 ohms, replace shift interlock solenoid. Reconnect all connectors and retest system. If resistance is more than 5 ohms, repair open Black wire between shift interlock solenoid connector and ground.
9. **Check Signal To Shift Interlock Solenoid** - Disconnect shift interlock solenoid connector. Using DVOM, measure voltage between shift interlock solenoid connector Light Blue/Black wire terminal and ground. If battery voltage is present, go to next step. If battery voltage is not present, replace shift interlock solenoid. Reconnect all connectors and retest system.
10. **Check SCIL Module For Short To Power** - Disconnect SCIL module connector. Using DVOM, measure voltage between Light Blue/Black wire and ground. If battery voltage is present, repair short in Light Blue/Black wire. Reconnect all connectors and retest system. If battery voltage is not present, replace SCIL module. Reconnect all connectors and retest system.

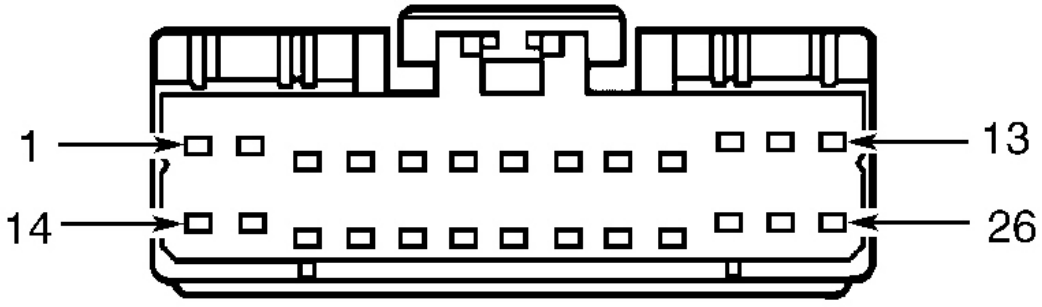


Fig. 1: Identifying SCIL Module Connector C287 Terminals
Courtesy of FORD MOTOR CO.

MUSTANG

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses

and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly and cable for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment. Electrical Components
- Open Or Shorted Circuits
- Loose Or Damaged Connections
- Brake On/Off (BOO) Or Brake Pedal Position (BPP) Switch Connections
- Fuse(s)
- Faulty PCM
- Faulty Bulbs

Diagnostic Procedure

1. **Check Fuse No. 1 (15A)** - Remove and check fuse No. 1 located in the internal fuse panel. If the fuse is okay, go to step 3 . If the fuse is not okay, go to next step.
2. **Check Purple/Orange Wire Resistance** - Ensure fuse No. 1 is removed. Disconnect shift lock actuator connector located near ignition switch. Using DVOM, measure resistance of Purple/Orange wire between shift lock actuator wiring harness connector terminal and ground. If resistance is more than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair short Purple/Orange wire. Reconnect all connectors and retest system.
3. **Check Power Supply To Shift Lock Actuator** - Reinstall fuse No. 1. Disconnect shift lock actuator connector. Using DVOM, measure voltage between Purple/Orange wire terminal and ground. Turn ignition on. If battery voltage is present, go to next step. If battery voltage is not present, repair open Purple/Orange wire. Reconnect all connectors and retest system.
4. **Check Stoplight Operation** - Depress brake pedal. If stoplights turn on, go to next step. If stoplights do not turn on, diagnose BOO/BPP switch. See appropriate EXTERIOR LIGHTS article in ACCESSORIES & EQUIPMENT.
5. **Check Power Supply Between BOO/BPP Switch & Shift Lock Actuator** - With brake pedal depressed, measure voltage of Red/Light Green wire between shift lock actuator connector and ground. If battery voltage is present, go to next step. If battery voltage is not present, repair open Red/Light Green wire. Reconnect all connectors and retest system.
6. **Check Ground Circuit Resistance** - With shift lock actuator connector disconnected, measure resistance between Black wire terminal and ground. If resistance is less than 5 ohms, replace shift lock actuator. If resistance is more than 5 ohms, repair open Black wire. Reconnect all connectors and retest system.

VILLAGER

NOTE: See appropriate wiring diagram to diagnose electrical circuits and identify fuses and circuit numbers. See WIRING DIAGRAMS .

Preliminary Inspection

Verify customer complaint. Visually inspect the following components of the shift interlock system:

- Shift lever assembly for damage or misadjustment.
- Ignition switch/interlock cable for damage or misadjustment.
- Switches and brackets for damaged. Electrical Components
- Fuses (RELAYS)
- Loose Or Damaged Connections
- Brake On/Off (BOO) Switch Connections
- Wiring Harness

Diagnostic Procedure

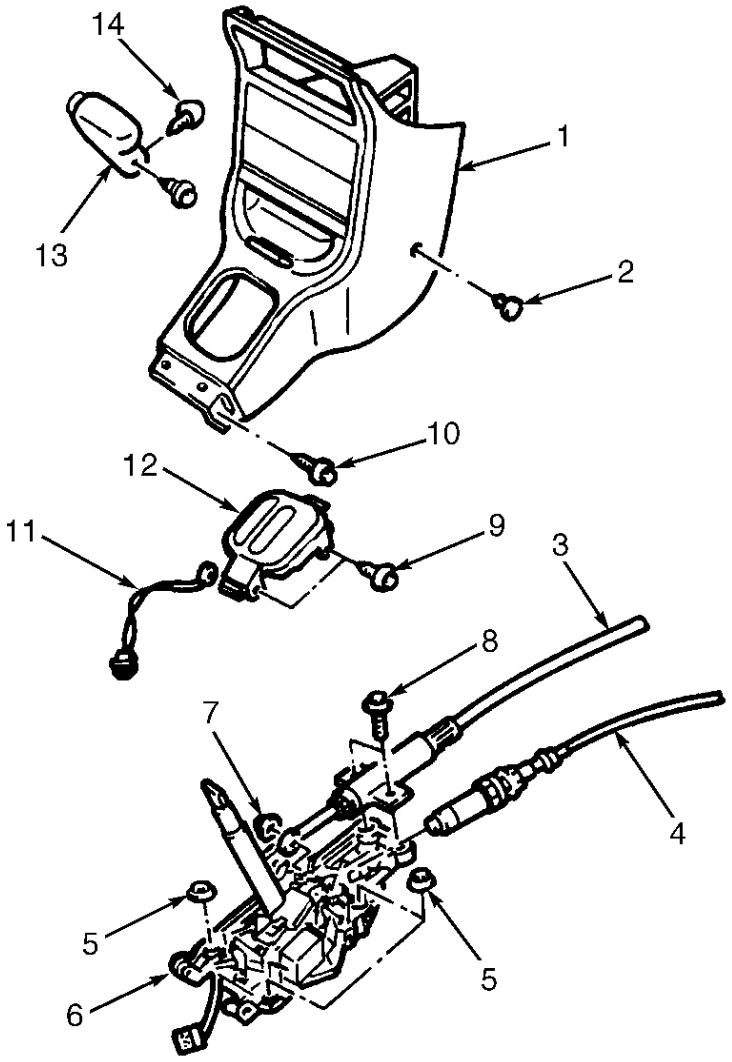
1. **Check Fuse** - Check 10A RELAYS fuse located in the interior fuse junction block. If fuse is okay, go to step 4 . If fuse is not okay, go to next step.
2. **Check Electrical System** - With ignition off, replace blown fuse. Turn ignition on. If the fuse blows again, go to next step. If the fuse does not blow again, go to step 4 .
3. **Check For Short To Ground** - Turn ignition off. Remove RELAYS fuse. Locate and disconnect Speed Control Disengage/BOO switch connector. Using DVOM, measure and record resistance between RELAY fuse holder terminal and ground. If resistance is more than 10 k/ohms, reinstall fuse and go to next step. If resistance is less than 10 k/ohms, repair short in Blue wire between fuse panel Speed Control Disengage/BOO switch. Reconnect all connectors. Install gearshift lever, console and knob.
4. **Check Shift Lock Actuator Ground** - Ensure gearshift lever is in "P" position. Using DVOM, measure resistance between shift lock actuator connector Black wire and ground. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in Black wire between shift lock actuator and ground. See **WIRING DIAGRAMS** .
5. **Check Supply Voltage To Shift Lock Actuator** - Turn ignition on. Using DVOM, measure voltage between shift lock actuator wiring harness connector White wire and ground. If voltage is more than 10 volts, replace shift lock actuator. If voltage is less than 10 volts, repair open in White wire.
6. **Check Speed Control Disengage/BOO Switch** - Turn ignition off. Disconnect BOO switch connector. Using DVOM, measure and record resistance between BOO switch connector terminals. Depress brake pedal and measure resistance of BOO switch terminals again. Resistance should be less than 5 ohms with brake pedal depressed and more than 10 k/ohms with brake pedal released. If resistance is as specified, repair open White wire between BOO switch and shift lock actuator. If resistance is not as specified, replace Speed Control Disengage/BOO switch. Reconnect all connectors and retest system.
7. **Check Stoplight Operation** - If stoplights operate when brake pedal is depressed, repair open Green wire between BOO switch and shift lock actuator. If stoplights do not operate when brake pedal is depressed, diagnose problem in stoplight circuit. See appropriate EXTERIOR LIGHTS article in ACCESSORIES & EQUIPMENT.

REMOVAL & INSTALLATION

GEARSHIFT LEVER ASSEMBLY

Removal & Installation (Aspire)

1. Place gearshift lever in "1" position. Disconnect negative battery cable. Remove console panel storage bin from the parking brake console. Remove parking brake console screw and lift parking brake console. Remove 2 shift console panel screws, console panel pushpins and shift console.
2. Pull the shift console panel forward and disconnect all electrical connectors. Remove 2 gearshift lever knob screws and gearshift lever knob. See **Fig. 2** . Remove 4 transmission control selector dial screws. Lift transmission control selector dial bezel upward and disconnect selector indicator lamp connector.
3. Remove shift cable and bracket locknut. Remove 2 shift cable bracket bolts and remove shift cable. Remove 2 shift lock actuator bracket-to-gearshift lever screws. Disconnect 2 shift lock actuator electrical connectors. Loosen locknut "A" and remove shifter interlock cable. See **Fig. 8** . Remove 4 gearshift lever locknuts and remove gearshift lever.
4. To install, reverse removal procedure. Tighten nuts and bolts to specified torque. See **TORQUE SPECIFICATIONS** .



1. Shift Console Panel
2. Pushpin
3. Transmission Shift Cable
4. Shift Interlock Cable
5. Gearshift Lever Assembly Nut
6. Gearshift Lever Assembly
7. Transmission Shift Cable Nut
8. Bracket Bolt
9. Dial Bezel Screw
10. Console Panel Screw
11. Selector Indicator Bulb
12. Dial Bezel
13. Shift Knob
14. Shift Knob Screw

98D01360

Fig. 2: Exploded View Of Center Console & Gearshift Lever Assembly
Courtesy of FORD MOTOR CO.

Removal & Installation (Continental & Town Car)

1. Disconnect negative battery cable. On vehicles with console shift, go to step 4 . On vehicles with floor shift, remove center console compartment. If equipped, disconnect cellular phone connectors. Remove 4 screws securing CD changer. Disconnect CD changer electrical connector and remove changer.
2. Slide plastic sleeve around shifter knob base downward. Remove 2 screws securing shifter knob to lever and remove knob. Using a flat-tipped screwdriver, remove shift control bezel from center console.
3. Remove panel in front shift lever covering lighter and ashtray. Remove 2 screws securing console to floor bracket. Remove 2 screws securing console to gear shift bracket. Slide floor console rearward and pull up. Disconnect electrical connectors to console. Disconnect shift interlock cable from bracket and shift interlock cam.
4. Disconnect shift cable from selector lever and bracket. Remove 2 bolts securing parking brake release control motor to gearshift lever assembly. Remove 4 bolts securing selector lever to floor.
5. To install reverse removal procedure. Torque all nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Contour & Mystique)

1. Raise and support vehicle. Remove lower heat shield covering access to selector lever mounting bolts. Disconnect selector lever cable adjusting cap and selector lever cable. Remove 4 selector lever mounting nuts.
2. Lower vehicle. Remove selector lever cover. Lift selector lever assembly upwards and disconnect electrical connector. To install, reverse removal procedure. Torque nuts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Cougar, Mustang & Thunderbird)

1. Remove center console. Remove screws securing transmission control selector dial bezel. Remove dial bezel and disconnect shifter interlock cable from transmission range selector lever and interlock cam.
2. Disconnect range indicator light and control switch connector. Place shift lever in "OD" position. Raise and support vehicle. Disconnect shift cable from shift lever and ball stud.
3. Remove shift cable retaining screws from shifter mounted bracket. Lower vehicle. Remove shifter from floorpan retaining bolts. Remove transmission range selector lever assembly.
4. To install, reverse removal procedure. Torque all bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Escort & Tracer)

1. Remove 2 screws securing selector lever knob and remove knob. Move both seats forward. Remove 2 securing parking brake console. Engage parking brake. Lift upward and remove parking brake console.
2. Remove 2 shift console panel screws and 4 forward pushpins. Place selector lever in "L" position. Remove beverage holder from shift console base. Lift upward and remove shift console panel.
3. Remove 4 screws securing selector dial bezel. Disconnect dial bezel indicator light and remove bezel. Disconnect shift interlock actuator and park sense switch connectors. Remove 2 screws securing shift interlock actuator and remove actuator.
4. Remove gearshift lever cable nut and disconnect cable. Remove 2 cable bracket-to-floorpan bracket bolts

and carefully position aside without binding cable. Loosen shift interlock cable nut ensuring not to loosen cable locknut closest to cable end. Disconnect shift interlock cable and position aside without binding cable.

5. Remove 4 gearshift lever assembly nuts and remove assembly. To install, reverse removal procedure. Torque all nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Mark VIII)

1. Disconnect negative battery cable. Pull instrument panel control cover assembly straight out to release lower clip. DO NOT use a pry tool to remove control cover as damage to panel may occur. Disconnect control panel electrical connector.
2. Remove 2 screws securing instrument panel center finish panel surrounding shifter and radio assemblies. Lift up on back of panel and pull panel forward to remove from instrument panel. Disconnect finish panel ground wire.
3. Move gearshift lever to "D" position. Slide plastic sleeve around shifter knob base downward. Remove 2 screws securing shifter knob to lever and remove knob. Disconnect transmission shift cable from range selector lever and selector lever housing.
4. Disconnect shift interlock cable from range selector lever and selector lever bracket. Disconnect selector lever electrical connector. Disconnect shift cable from lever cam. Slide retaining clip from bracket and remove shift cable. Remove 4 bolts securing gearshift lever assembly to floor and remove assembly.
5. To install, reverse removal procedure. Torque all bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Probe)

1. Disconnect negative battery cable. Remove 2 screws securing console armrest base and remove armrest base. Remove 2 screws securing console armrest compartment and remove compartment. Remove console finish panel from the shift console. Engage parking brake. Remove console lower forward kick panel.
2. Disconnect all electrical connectors. Remove 2 gearshift lever knob screws and gearshift lever knob. See **Fig. 3** . Remove 4 transmission control selector dial screws. Lift transmission control selector dial bezel upward and disconnect selector indicator lamp connector.
3. Remove shift cable and bracket locknut. Remove 2 shift cable bracket bolts and remove shift cable. Remove 2 shift lock actuator bracket-to-gearshift lever screws. Disconnect 2 shift lock actuator electrical connectors. Loosen locknuts and remove shifter interlock cable. Remove 3 gearshift lever locknuts and one bolt and remove gearshift lever.
4. To install, reverse removal procedure. Tighten nuts and bolts to specified torque. See **TORQUE SPECIFICATIONS** .

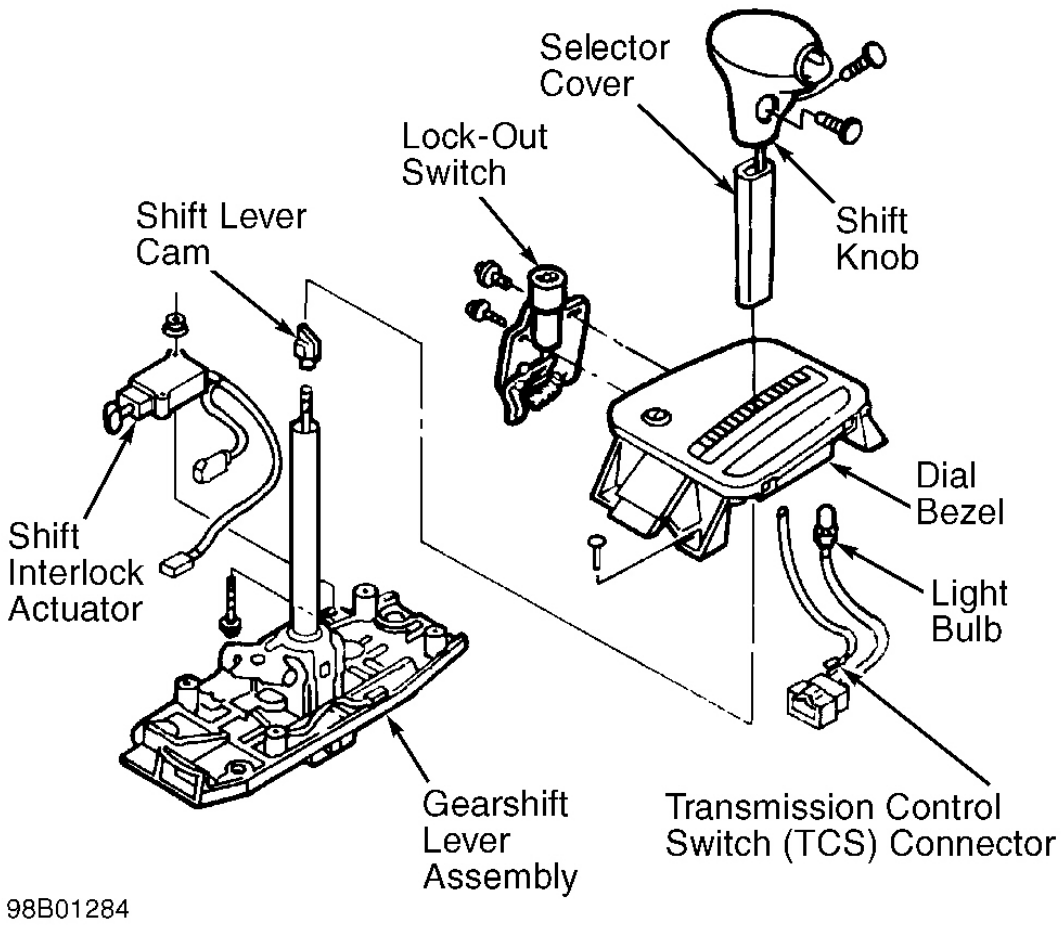


Fig. 3: Exploded View Of Gearshift Lever Assembly (Probe)
Courtesy of FORD MOTOR CO.

Removal & Installation (Sable & Taurus)

1. Using a flat-blade screwdriver, unsnap front portion of beverage holder and remove from console. Move gearshift lever to "1" position. Open ashtray and pull on top finish panel to remove. Disconnect electrical connectors. Remove 2 screws securing console compartment to console and remove compartment.
2. Remove 2 screws securing center console to lower instrument panel. Pull carpet back covering inner kick panels and disconnect panel clips from bracket. Remove 6 bolts retaining center console panel to floor mounting brackets and remove center console.
3. Disconnect transmission shift cable from range selector lever and selector lever housing. Disconnect shift interlock cable from range selector lever and selector lever housing. Remove 4 nuts securing gearshift lever assembly to floor and remove assembly.
4. To install, reverse removal procedure. Torque all bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Light Duty Trucks & Vans)

1. Disconnect negative battery cable. Remove battery-to-starter relay cable and wait one minute for backup power supply to dissipate. Remove screws holding parking brake handle and secure aside.
2. Remove screws for hood release and secure aside. Remove 2 screws for lower instrument panel column cover. Remove 4 screws securing lower instrument panel reinforcement panel. Remove ignition switch electrical connector bolt and disconnect connector. Remove 2 screws securing ignition switch and switch.
3. Remove lower steering column shroud. Insert key in ignition lock and turn ignition on. Using screwdriver, pry upward on ignition cylinder lock and remove ignition lock from upper steering column shroud. Remove upper shroud and rubber shift lever cover.
4. Disconnect shift control lever harness connector. See **Fig. 4** . Remove shift lever pin and discard. Remove shift lever. To install, reverse removal procedure. Replace shift lever pin for reassembly.

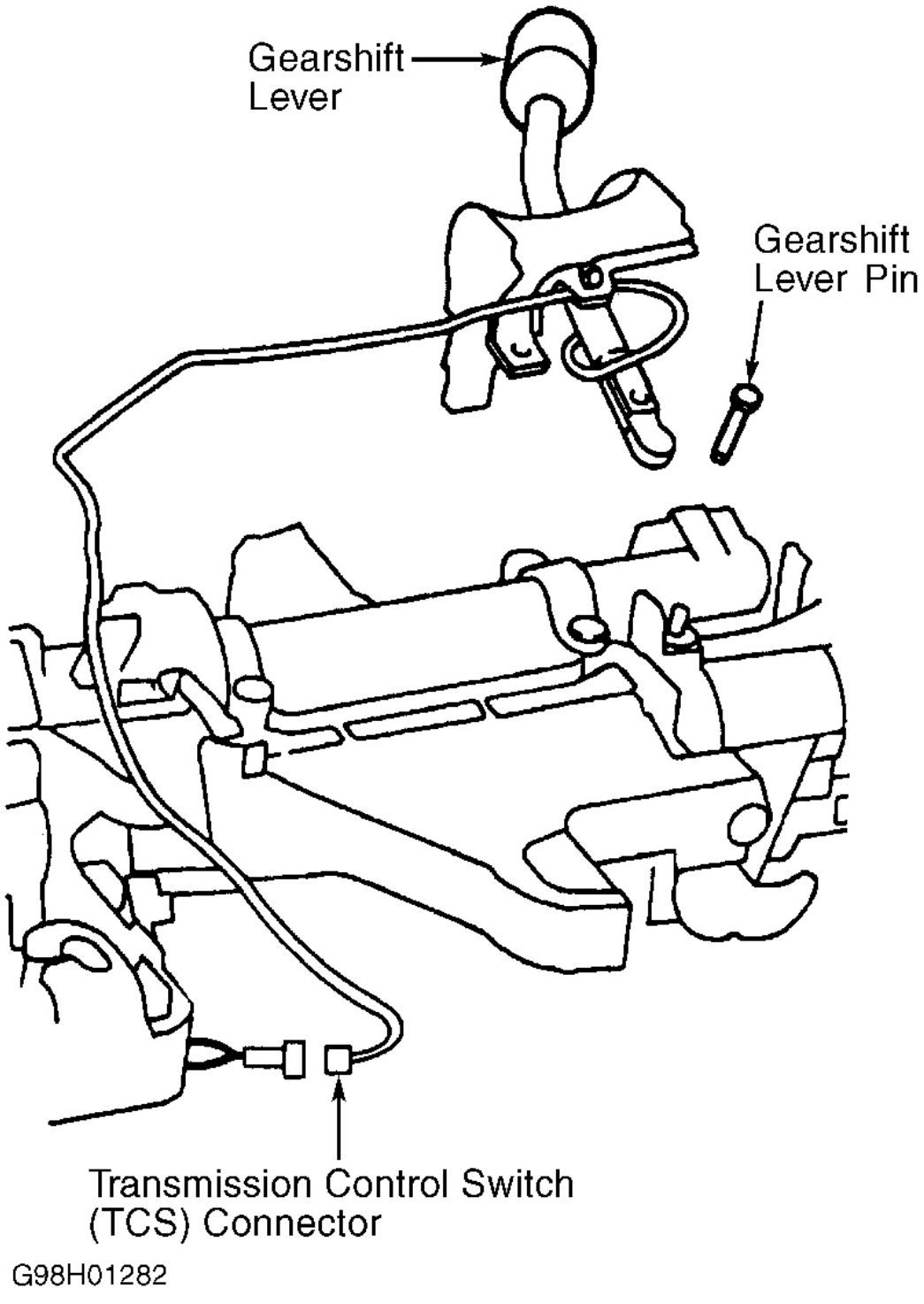


Fig. 4: Removing Gearshift Lever Assembly

Courtesy of FORD MOTOR CO.

SHIFT INTERLOCK ACTUATOR

NOTE: On some models, the shift interlock actuator is part of the shift interlock cable. Refer to SHIFT INTERLOCK CABLE or GEARSHIFT LEVER ASSEMBLY procedures to remove actuator.

Removal & Installation (Aspire & Probe)

1. Remove gearshift lever assembly. See **GEARSHIFT LEVER ASSEMBLY** . Remove 2 shift lock actuator bracket-to-gearshift lever screws. See **Fig. 5** . Disconnect 2 shift lock actuator electrical connectors. Remove shift lock actuator bracket from the actuator.
2. To install, reverse removal procedure. Ensure shift lock actuator arm is engaged with lock lever before installing to gearshift lever assembly.

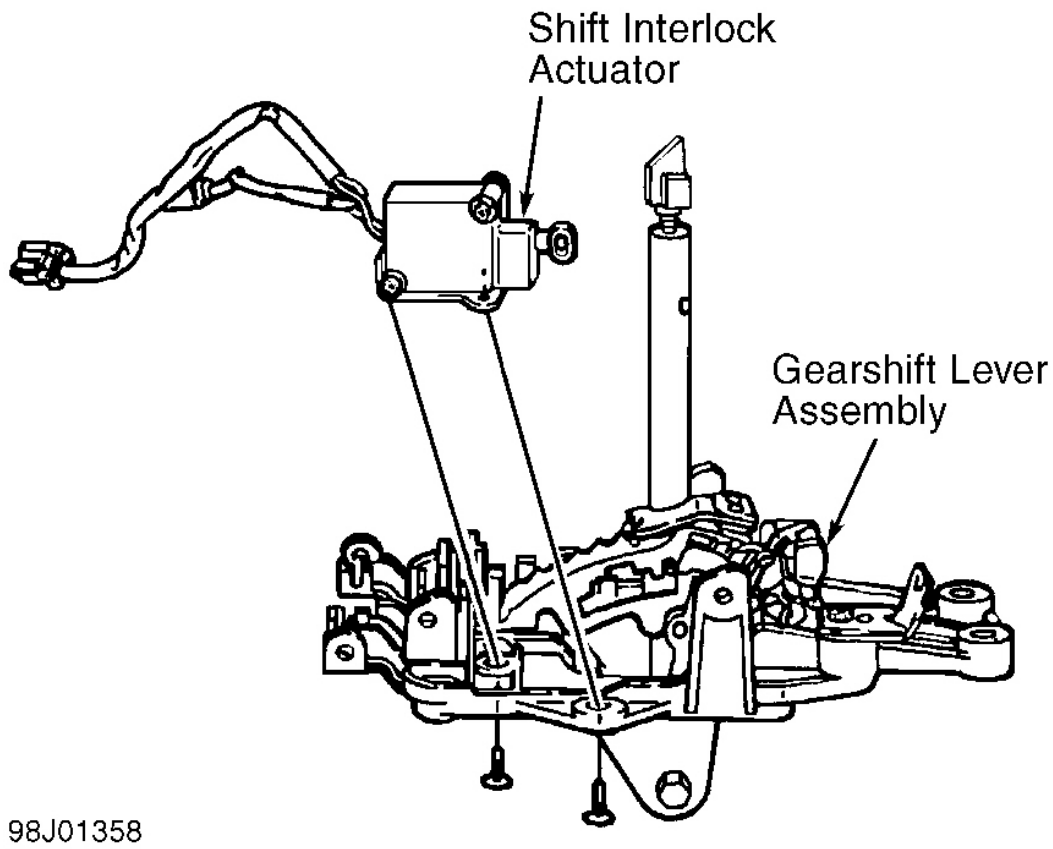


Fig. 5: Removing Shift Lock Actuator (Aspire Shown, Probe Is Similar)
Courtesy of FORD MOTOR CO.

Removal & Installation (Continental & Town Car)

1. Disconnect negative battery cable. On vehicles with console shift, go to step 4 . On vehicles with floor shift, remove center console compartment. If equipped, disconnect cellular phone connectors. Remove 4 screws securing CD changer. Disconnect CD changer electrical connector and remove changer.
2. Slide plastic sleeve around shifter knob base downward. Remove 2 screws securing shifter knob to lever and remove knob. Using a flat-tipped screwdriver, remove shift control bezel from center console.
3. Remove panel in front shift lever covering lighter and ashtray. Remove 2 screws securing console to floor bracket. Remove 2 screws securing console to gear shift bracket. Slide floor console rearward and pull up. Disconnect electrical connectors to console. Disconnect shift interlock cable from bracket and shift interlock cam.
4. Remove driver's side lower instrument panel cover. Remove 4 nuts securing steering column and lower steering column. Disconnect shift interlock actuator connector. On Continental, remove 2 screws securing shift interlock actuator and remove actuator and cable. See **Fig. 6** . On Town Car, remove 3 screws securing shift interlock actuator and remove actuator and cable. See **Fig. 7** .
5. To install, connect shift interlock cable to interlock cam and bracket. To complete installation, reverse removal procedure. Torque all nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

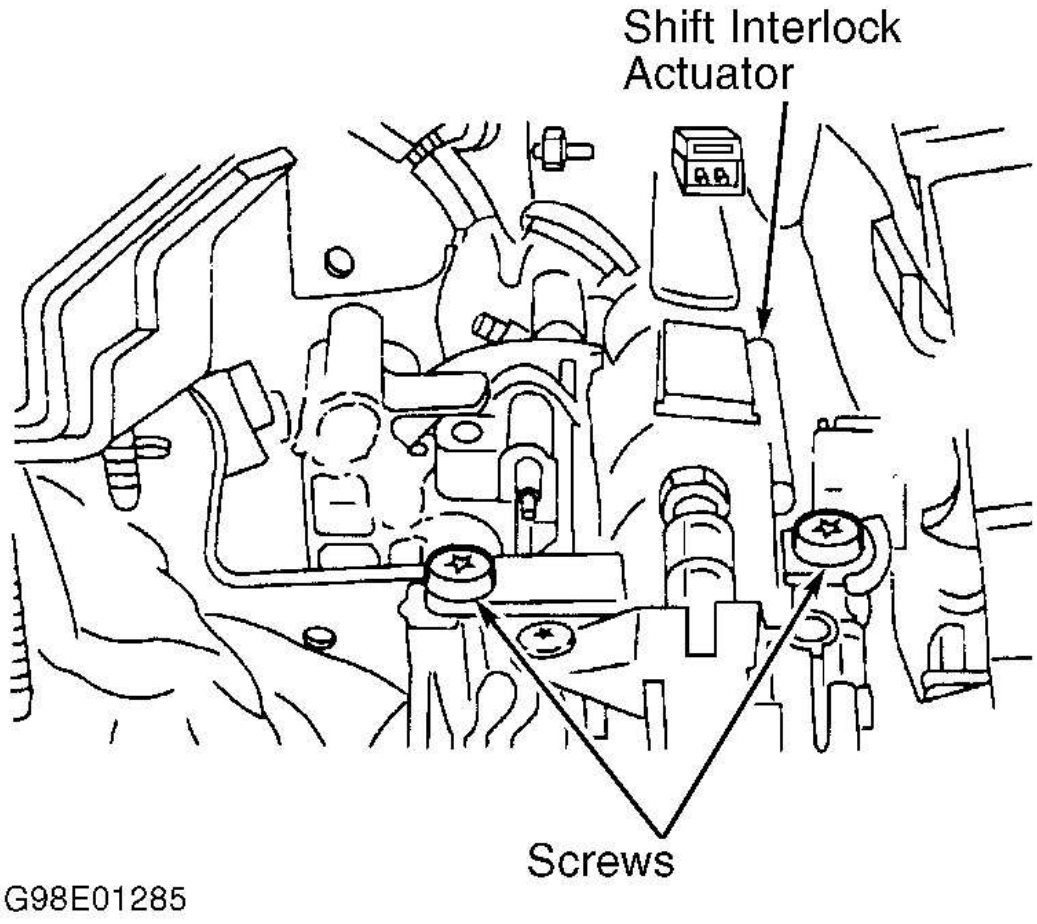


Fig. 6: Removing Shift Interlock Actuator & Cable (Continental)
Courtesy of FORD MOTOR CO.

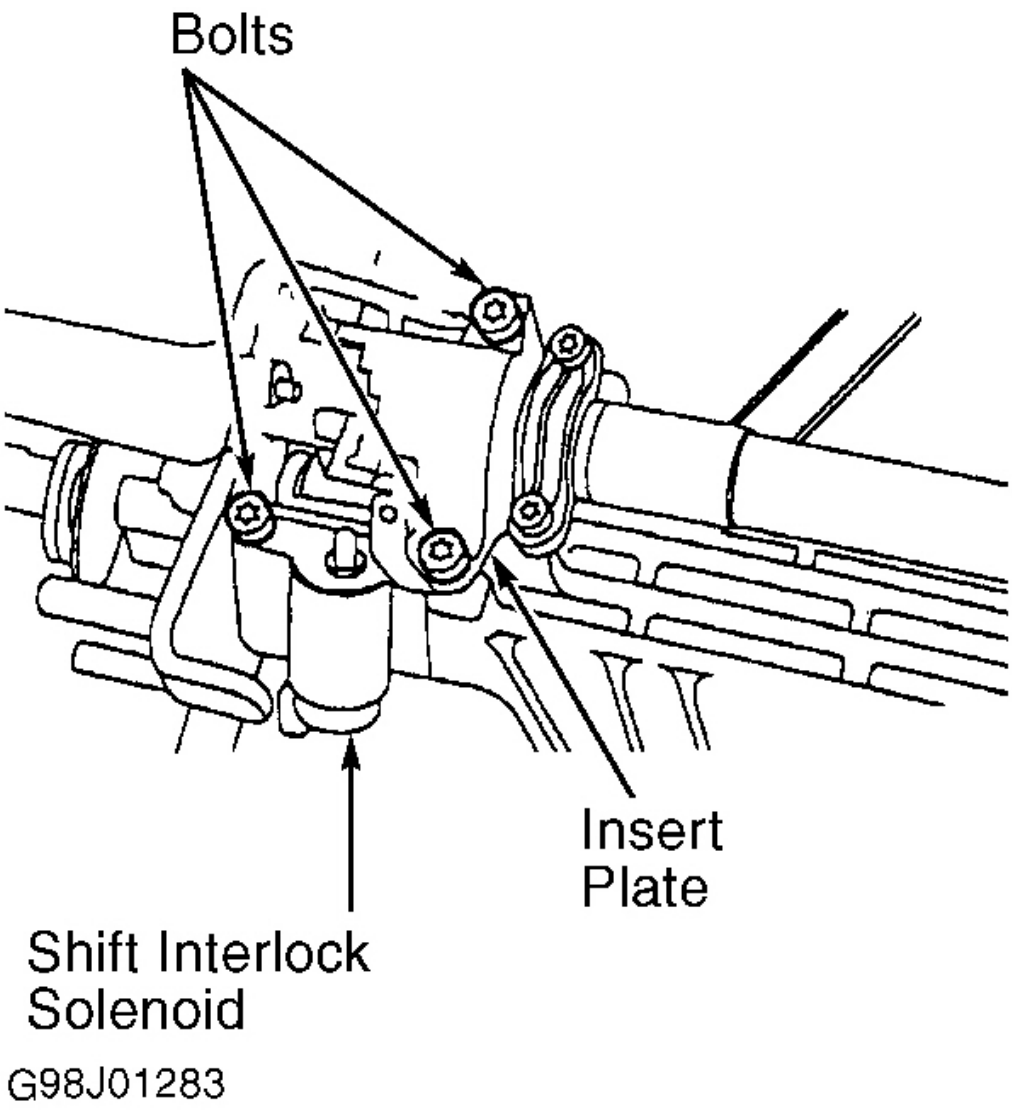


Fig. 7: Removing Shift Interlock Solenoid
Courtesy of FORD MOTOR CO.

Removal & Installation (Crown Victoria, Grand Marquis, Sable & Taurus)

1. On vehicles equipped with floor shift, replace shift interlock actuator with shift interlock cable. Follow shift interlock cable removal and installation procedures for actuator replacement. See **SHIFT INTERLOCK CABLE** . On vehicles equipped with column shift, go to next step.
2. Disconnect negative battery cable. Remove 3 screws securing upper steering column shroud. Insert

scratch awl into access hole on lower steering column shroud and push in the ignition lock cylinder release pin. Insert ignition key into lock, turn ignition on and remove lock cylinder from steering column.

3. Remove lower steering column shroud. Remove 2 screws securing lower instrument panel and remove panel. Completely loosen the shift indicator adjustment wheel and disconnect shift indicator cable from steering column lever.
4. Remove 2 nuts securing steering column absorber. Remove 2 nuts securing lower steering column and remove column. Disconnect electrical connectors to steering column. Remove 2 screws securing shift interlock actuator and remove actuator from column.
5. To install, reverse removal procedures. Torque nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Light Duty Trucks & Vans - Except Villager)

1. Disconnect negative battery cable. Remove battery-to-starter relay cable and wait one minute for backup power supply to dissipate. Ensure front wheels are straight and remove steering wheel. Remove screws holding parking brake handle and secure aside.
2. Remove screws for hood release and secure aside. Remove 2 screws for lower instrument panel column cover. Remove 4 screws securing lower instrument panel reinforcement panel. Remove ignition switch electrical connector bolt and disconnect connector. Disconnect remaining electrical connectors to steering column components.
3. Remove transmission range indicator bolt and disconnect indicator from bracket. Disconnect shift interlock solenoid connector. Remove lower steering column shroud. Insert key in ignition lock and turn ignition on. Using screwdriver, pry upward on ignition cylinder lock and remove ignition lock from upper steering column shroud.
4. Remove air bag sliding contact from steering column. Remove upper intermediate steering shaft-to-column shaft bolt. Remove 2 lower steering column nuts. Remove 2 steering column support bracket nuts, bracket and steering column.
5. Remove 3 bolts securing shift interlock actuator and insert plate. See **Fig. 7** . Remove clip securing insert plate to actuator and discard. This clip is used to aid in initial assembly and is not required during reassembly.
6. To install, reverse removal procedure. Torque all bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Villager)

1. Disconnect negative battery cable. Remove steering wheel and air bag. Remove 4 console pushpins and console panel. Remove one instrument panel steering column screw and 4 instrument panel steering column cover pushpins and remove cover panel.
2. Remove 4 screw securing instrument reinforcement panel and remove. Remove one screw securing lower heater outlet duct and remove duct. Remove upper and lower steering column shrouds. Remove pin securing transmission range selector lever and disconnect electrical connector. Remove selector lever.
3. Disconnect transmission range indicator from lever. Remove transmission control selector indicator bolt and remove range indicator. Disconnect shift interlock actuator connector. Remove transmission shift cable from selector lever arm and support.
4. Remove 2 screws securing multi-function switch and position switch aside. Disconnect "OD" control

switch electrical connector. Remove ignition switch harness bolt and position ignition switch aside. Remove steering column lower yoke clamp bolt.

5. Remove one upper bracket steering column nuts. Remove 2 lower bracket steering column nuts. While supporting steering column, remove remaining upper bracket nut and remove steering column. Remove 2 screws securing shift lock actuator to steering column and remove actuator.
6. To install, reverse removal procedure. Tighten all nuts and bolts to specifications. See **TORQUE SPECIFICATIONS** .

SHIFT INTERLOCK CABLE

NOTE: Procedures for removal and installation of shift interlock cable is given in GEARSHIFT LEVER ASSEMBLY on some models.

Removal & Installation (Aspire)

1. Remove 2 shifter knob securing bolts and knob from gearshift lever. Loosen shift interlock cable locknut "A" and disconnect from gearshift lever bracket. See **Fig. 8** .
2. Attach mechanics wire to cable end to ensure correct installation. Remove 2 cable hold down screws attached to bulkhead under instrument panel. Remove 3 screws securing steering column upper and lower shrouds and remove shrouds. Remove shift interlock cable-to-lock cylinder bolt at lock cylinder housing. See **Fig. 9** . Remove cable and disconnect mechanics wire.

NOTE: DO NOT loosen shifter interlock cable locknut "B" during installation. See Fig. 8 . Locknut is factory preset and incorrect interlock operation may result if changed.

3. To install, attach mechanics wire to new cable and pull wire to feed cable through instrument panel and console. To complete installation, reverse removal procedure. Torque shift locknut to 89-132 INCH lbs. (10-15 N.m).

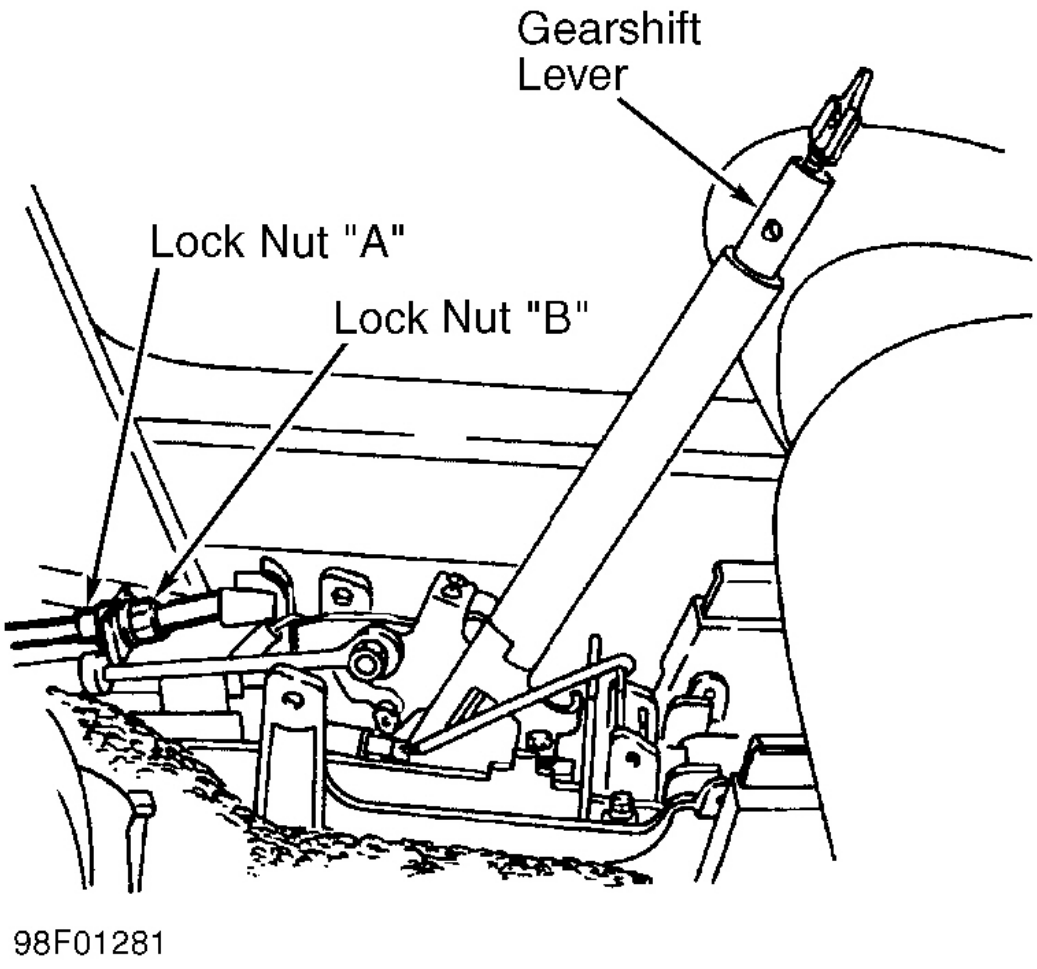


Fig. 8: Removing Shift Interlock Cable
Courtesy of FORD MOTOR CO.

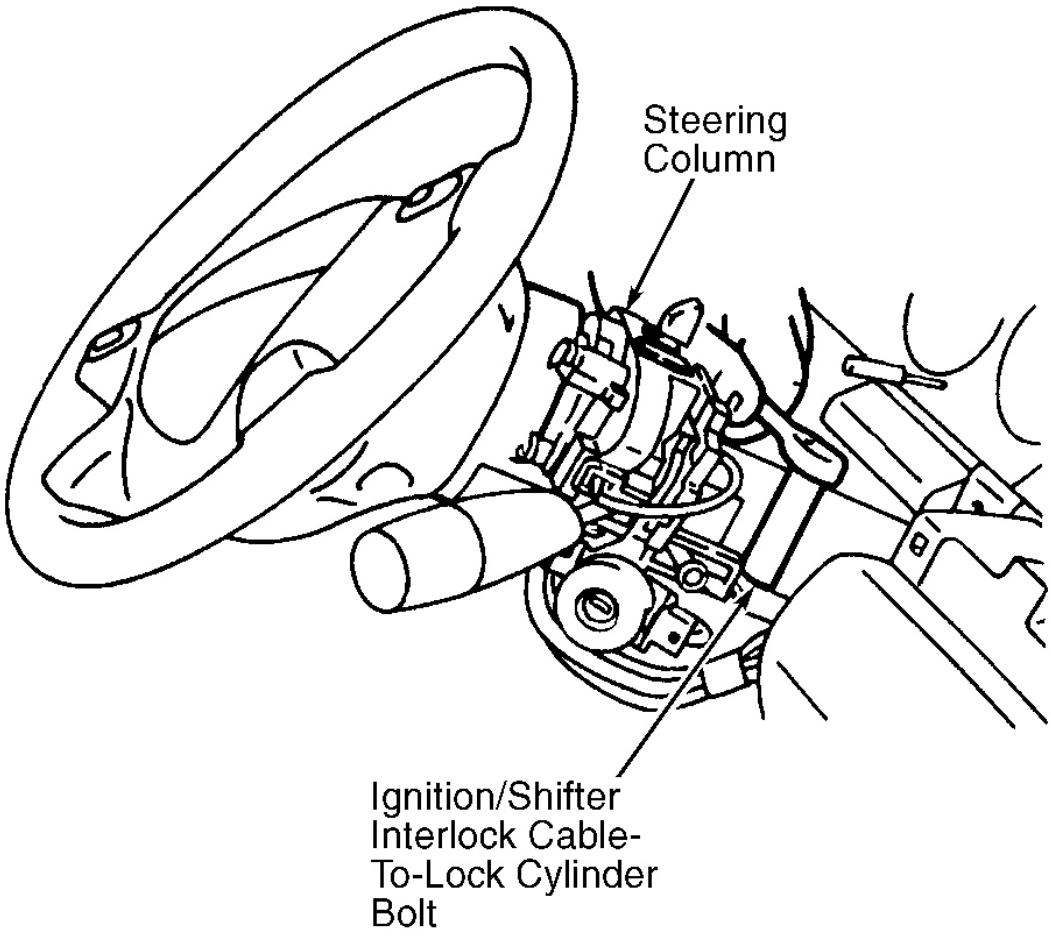


Fig. 9: Locating Shift Interlock Cable-To-Lock Cylinder Bolt
Courtesy of FORD MOTOR CO.

Removal & Installation (Cougar, Mustang & Thunderbird)

1. Disconnect negative battery cable. Carefully pry on retaining clips to remove console finish panel from console. Disconnect electrical connectors and remove console finish panel. Remove 2 screw covers and screws securing center console glove compartment and remove compartment.
2. Remove 4 screws securing center console to floor. Pull parking brake up and move gearshift lever to "1" position. Pull center console upwards and back to remove. Disconnect electrical connectors and remove center console.
3. Remove left-hand lower instrument panel trim and lower steering column shroud. Remove shift interlock cable retaining screw and disconnect from shift interlock cam. Remove steering column nuts and lower steering column to floor.

4. Disconnect shift interlock cable retaining clip. Disconnect actuator electrical connector. Remove screws retaining shift interlock actuator to steering column.
5. Remove shift interlock actuator and cable from console brackets and remove from vehicle. To install, reverse removal procedure. Torque all nuts and bolts to specifications. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Probe)

1. Disconnect negative battery cable. Remove gearshift lever assembly. See GEARSHIFT LEVER ASSEMBLY. Loosen shifter interlock cable locknuts and disconnect from gearshift lever bracket.
2. Remove shift cable clip from brake pedal. Remove console lower forward kick panel. Remove steering column shrouds. Remove control selector cable bracket and screw from the bottom of the steering column and slide the shift interlock cable off the lock cylinder. Slide shift interlock cable out of console.
3. To install, reverse removal procedure. DO NOT kink cable during installation. Torque all bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

Removal & Installation (Sable & Taurus)

1. Disconnect negative battery cable. Unsnap and remove upper center console bezels. Disconnect shift interlock cable conduit from bracket and pull cable from cam on transaxle range selector lever.
2. Remove 3 screws securing upper steering column shroud. Insert scratch awl into access hole on lower steering column shroud and push in the ignition lock cylinder release pin. Insert ignition key into lock, turn ignition on and remove lock cylinder from steering column.
3. Remove lower steering column shroud. Remove 2 screws securing lower instrument panel and remove panel. Completely loosen the shift indicator adjustment wheel and disconnect shift indicator cable from steering column lever.
4. Remove 2 nuts securing steering column absorber. Remove 2 nuts securing lower steering column and remove column. Disconnect electrical connectors to steering column. Remove 2 screws securing shift interlock actuator and remove actuator and cable as an assembly.
5. To install, reverse removal procedures. Torque nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

STEERING COLUMN/IGNITION/LIGHTING CONTROL (SCIL) MODULE

Removal & Installation (Mark VIII Only)

1. SCIL module is located behind passenger's side of instrument panel, to right of glove box. SCIL module contains one 16-pin connector, one 22-pin connector and two 26-pin connectors. See **Fig. 10** .
2. Disconnect negative battery cable. Remove lower cover from passenger's side of instrument panel for access to glove compartment.
3. Remove screws from hinge on glove compartment door. Push inward on each side of glove compartment to release stops from glove compartment and allow glove compartment to rotate downward. Remove glove compartment.
4. Remove retaining screws from SCIL module. Move SCIL module downward from mounting bracket.

Disconnect electrical connectors from SCIL module. Remove SCIL module. To install, reverse removal procedure.

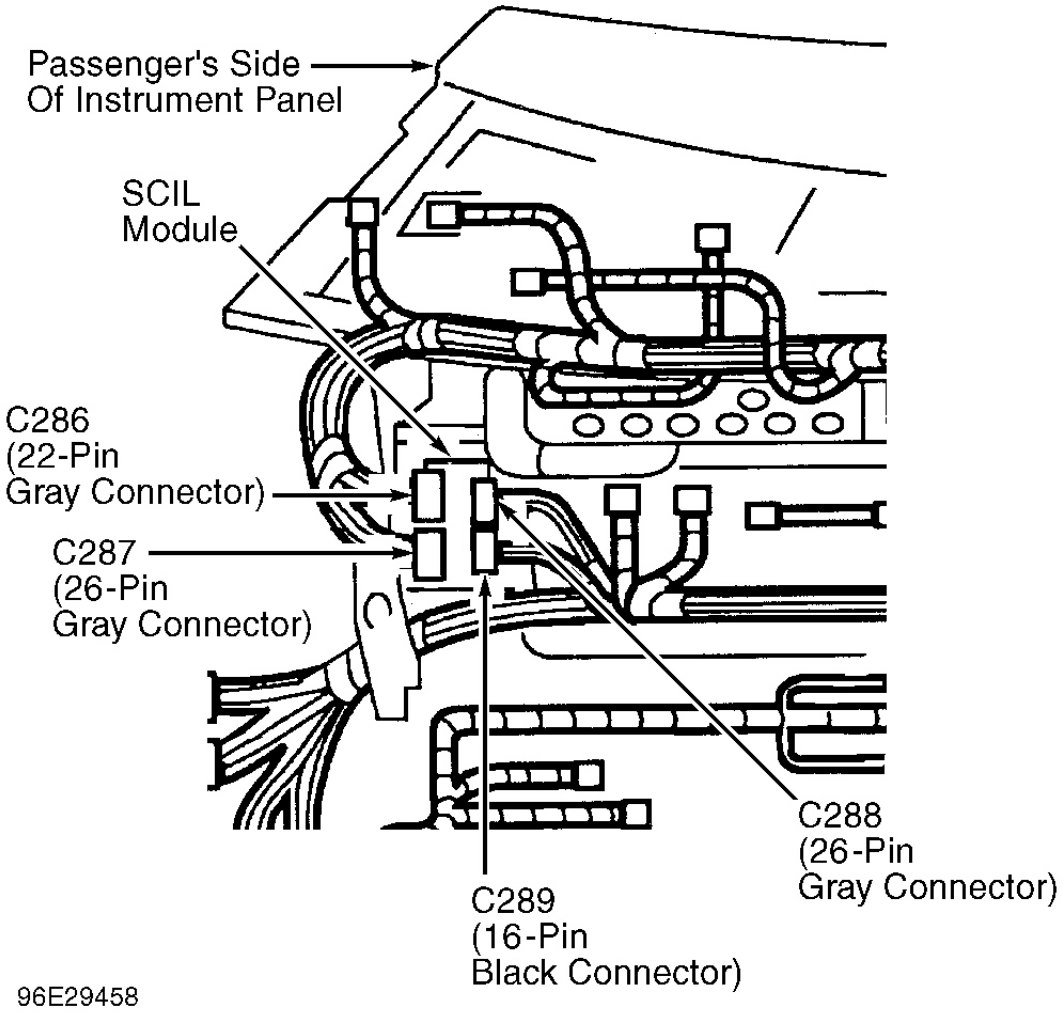


Fig. 10: Locating SCIL Module & Identifying SCIL Module Connectors
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Aerostar, Explorer, Mountaineer & Ranger	
Shift Cable Bracket Bolt	15-21 (21-29)
Steering Column Nut	10-12 (13-17)

Cougar, Mustang & Thunderbird	
Shift Cable Bracket Bolt	18-22 (24-31)
Steering Column Nut	
Cougar & Thunderbird	10-12 (13-17)
Mustang	25-34 (34-46)
Crown Victoria, Grand Marquis, Sable & Taurus	
Shift Cable Bracket Bolt	15-19 (20-26)
Steering Column Absorber Nut	10-12 (13-17)
Steering Column Nut	10-12 (13-17)
Escort & Tracer	
Gearshift Lever Assembly Nut	12-16 (17-22)
Steering Column Nut	10-12 (13-17)
"E" Series, Expedition, "F" Series & Navigator	
Shift Cable Bracket Bolt (4R70W)	
4.2L Engine	17-23 (23-32)
4.6L Engine	20-30 (27-41)
Shift Cable Bracket Bolt (E4OD)	20-30 (27-41)
Shift Cable Bracket Nut	12-15 (17-20)
Steering Column Nut	10-12 (13-17)
Probe	
Steering Column Nut	10-12 (13-17)
Transmission Range Selector Nut	12-16 (17-22)
Town Car	
Shift Cable Bracket Bolt	17-23 (23-32)
Steering Column Nut	10-12 (13-17)
Windstar	
Steering Column Absorber Nut	17-23 (23-32)
Steering Column Nut	10-12 (13-17)
	INCH Lbs. (N.m)
Aerostar, Explorer, Mountaineer & Ranger	
Shift Interlock Actuator Bolt	62-97 (7-11)
Shift Selector Tube Bracket Bolt	62-97 (7-11)
Aspire	
Gearshift Lever Nut	53-71 (6-8)
Shift Cable Bracket Bolt	71-97 (8-11)
Shift Interlock Cable Bracket Locknut	89-132 (10-15)
Continental	
Shifter Interlock Actuator Bolt	71-115 (8-13)
Contour & Mystique	
Selector Lever Assembly Nut	71-97 (8-11)
Cougar, Mustang & Thunderbird	

Range Selector Lever Bolt	54-71 (6-8)
Crown Victoria, Grand Marquis, Sable & Taurus	
Shift Interlock Actuator Bolt	17 (2)
Escort & Tracer	
Cable Floorpan Bracket Bolt	71-97 (8-11)
Dial Bezel Screw	18-26 (2-3)
Selector Lever Cable Nut	71-97 (8-11)
Selector Lever Knob Screw	18-26 (2-3)
Shift Interlock Actuator Screw	12-16 (1.3-1.8)
"E" Series, Expedition, "F" Series & Navigator	
Shift Interlock Actuator Bolt	62-97 (7-11)
Mark VIII	
Gearshift Lever Assembly Bolt	54-71 (6-8)
Shift Knob Bolt	26 (3)
Probe	
Shift Cable Bracket Bolt	71-97 (8-11)
Shift Interlock Cable Bracket Locknut	89-132 (10-15)
Town Car	
Shift Interlock Actuator Bolt	62-97 (7-11)
Villager	
Shift Interlock Actuator Bolt	62-97 (7-11)

WIRING DIAGRAMS

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

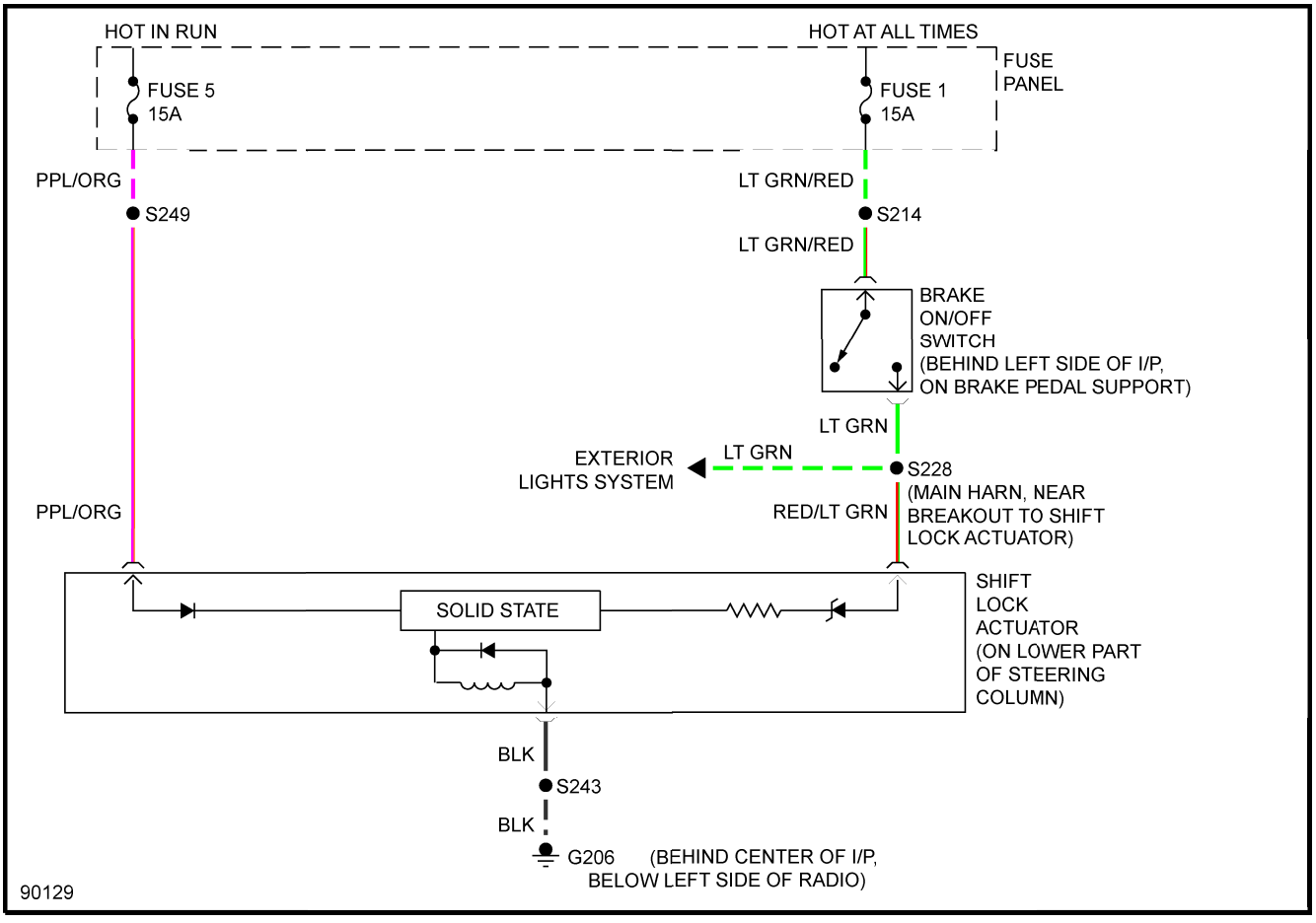


Fig. 11: Shift Interlock System Wiring Diagram (1997 Aerostar)

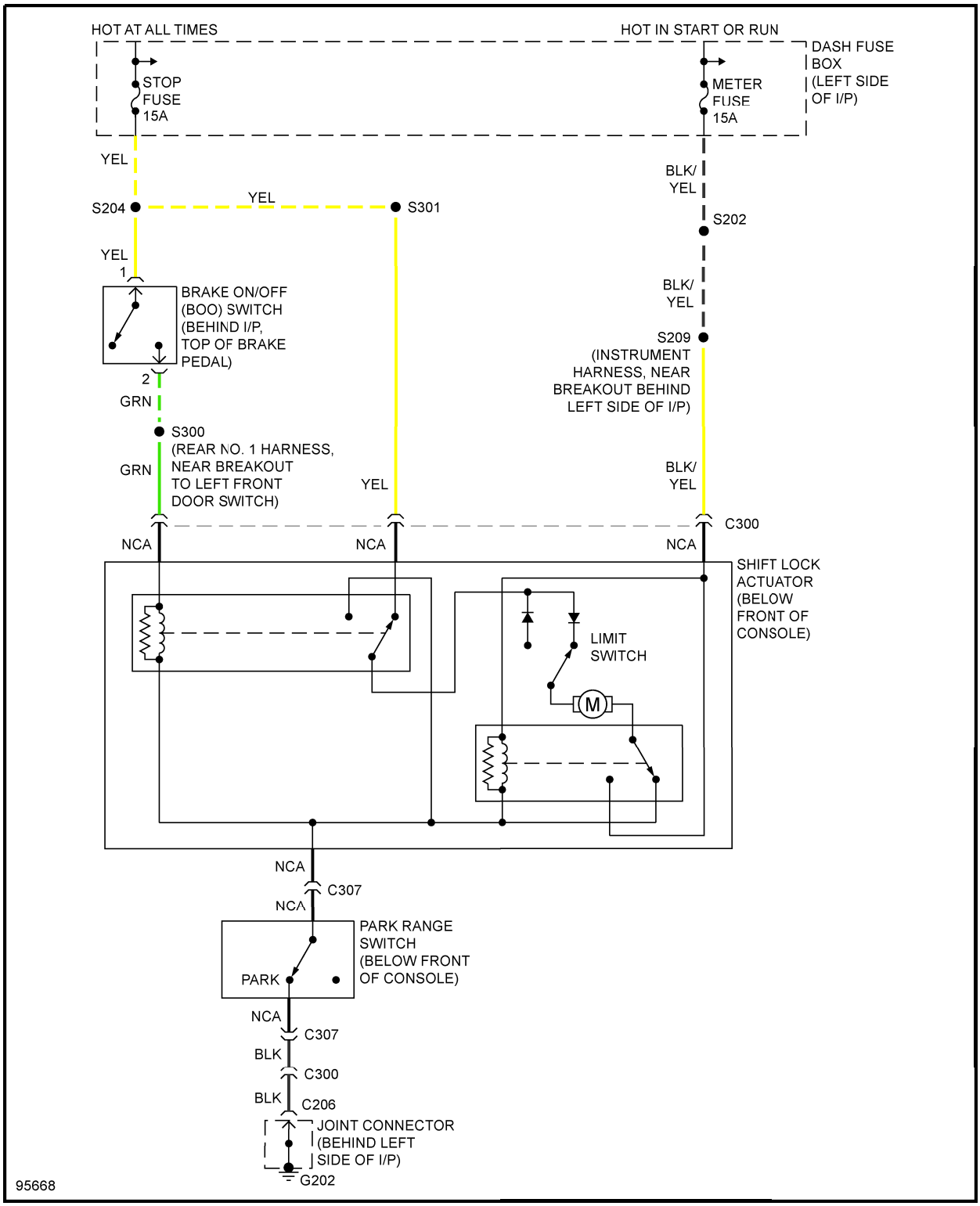

HOT AT ALL TIMES
HOT IN START OR RUN
DASH FUSE BOX (LEFT SIDE OF I/P)
STOP FUSE 15A
METER FUSE 15A
YEL
BLK/ YEL
S204
YEL
S301
S202
YEL 1
BRAKE ON/OFF (BOO) SWITCH (BEHIND I/P, TOP OF BRAKE PEDAL)
BLK/ YEL
S209 (INSTRUMENT HARNESS, NEAR BREAKOUT BEHIND LEFT SIDE OF I/P)
2
GRN
S300 (REAR NO. 1 HARNESS, NEAR BREAKOUT TO LEFT FRONT DOOR SWITCH)
GRN
YEL
BLK/ YEL
C300
NCA
NCA
NCA
SHIFT LOCK ACTUATOR (BELOW FRONT OF CONSOLE)
LIMIT SWITCH
M
NCA
C307
NCA
PARK RANGE SWITCH (BELOW FRONT OF CONSOLE)
PARK
NCA
C307
BLK
C300
BLK
C206
JOINT CONNECTOR (BEHIND LEFT SIDE OF I/P)
G202
95668

Fig. 12: Shift Interlock System Wiring Diagram (1997 Aspire)

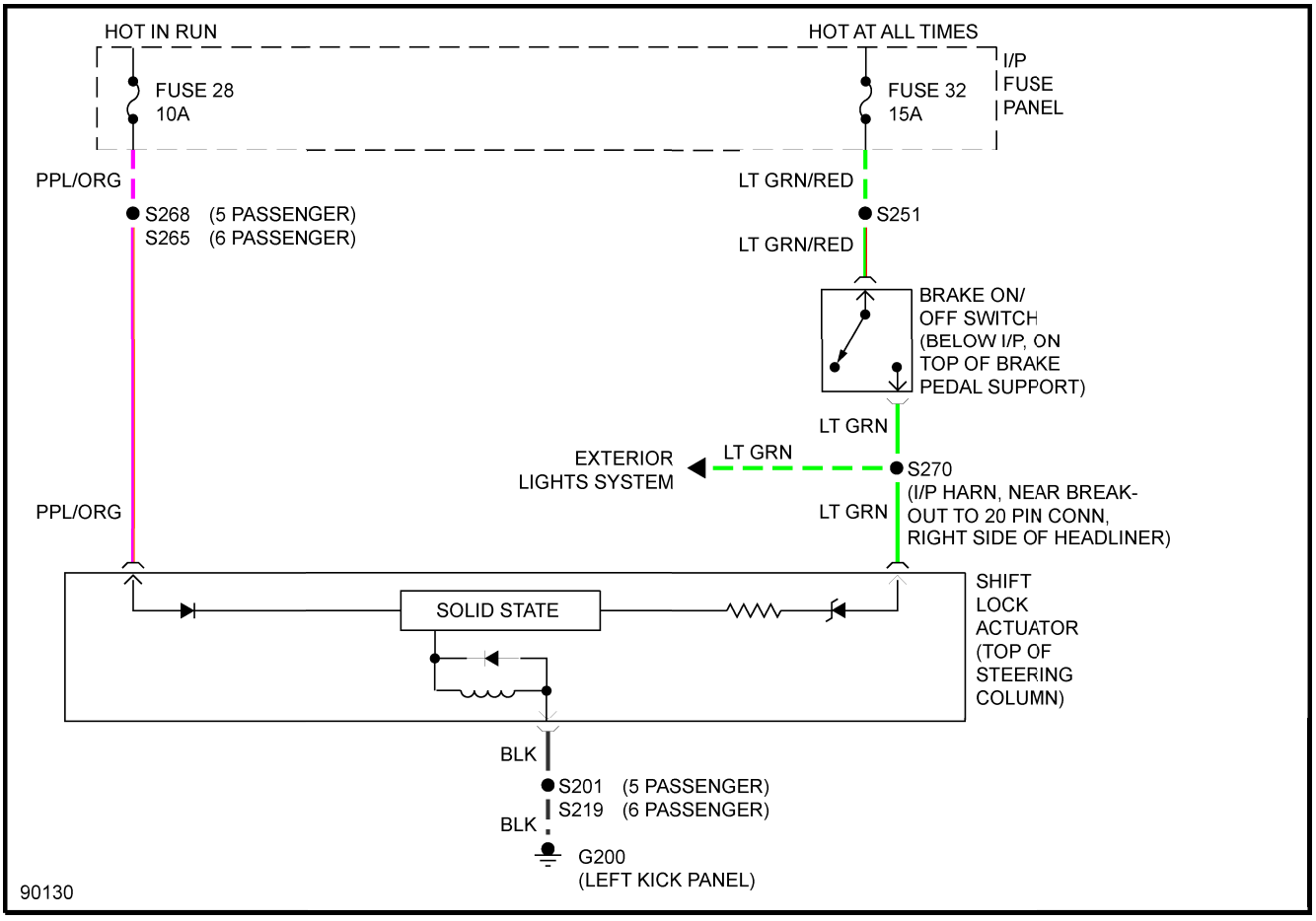

HOT IN RUN
HOT AT ALL TIMES
FUSE 28
10A
FUSE 32
15A
I/P
FUSE
PANEL
PPL/ORG
LT GRN/RED
S268 (5 PASSENGER)
S265 (6 PASSENGER)
S251
LT GRN/RED
BRAKE ON/
OFF SWITCH
(BELOW I/P, ON
TOP OF BRAKE
PEDAL SUPPORT)
LT GRN
EXTERIOR
LIGHTS SYSTEM
LT GRN
S270
(I/P HARN, NEAR BREAK-
OUT TO 20 PIN CONN,
RIGHT SIDE OF HEADLINER)
PPL/ORG
LT GRN
SOLID STATE
SHIFT
LOCK
ACTUATOR
(TOP OF
STEERING
COLUMN)
BLK
S201 (5 PASSENGER)
S219 (6 PASSENGER)
BLK
G200
(LEFT KICK PANEL)
90130

Fig. 13: Shift Interlock System Wiring Diagram (1997 Continental)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

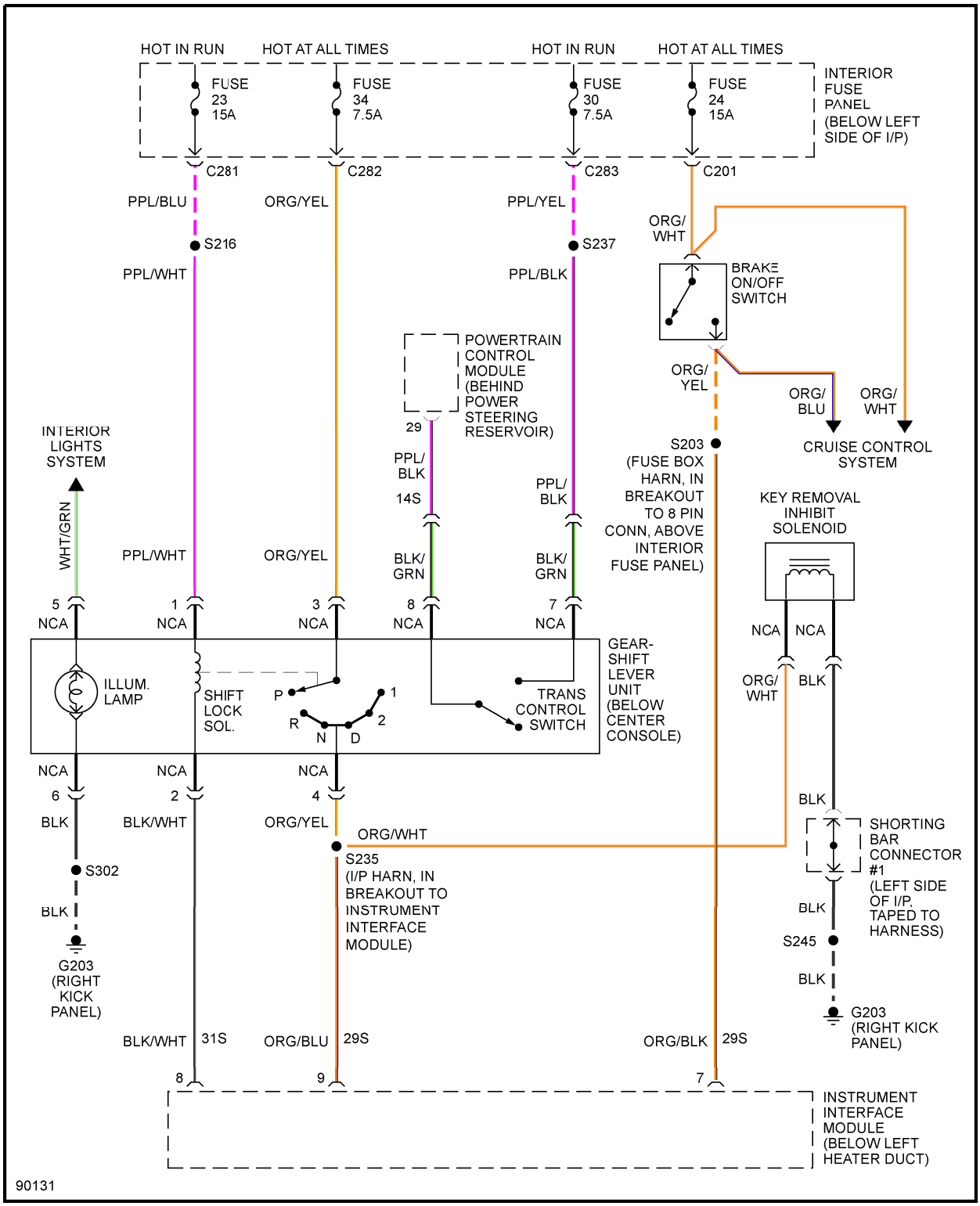


Fig. 14: Shift Interlock System Wiring Diagram (1997 Contour & Mystique)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

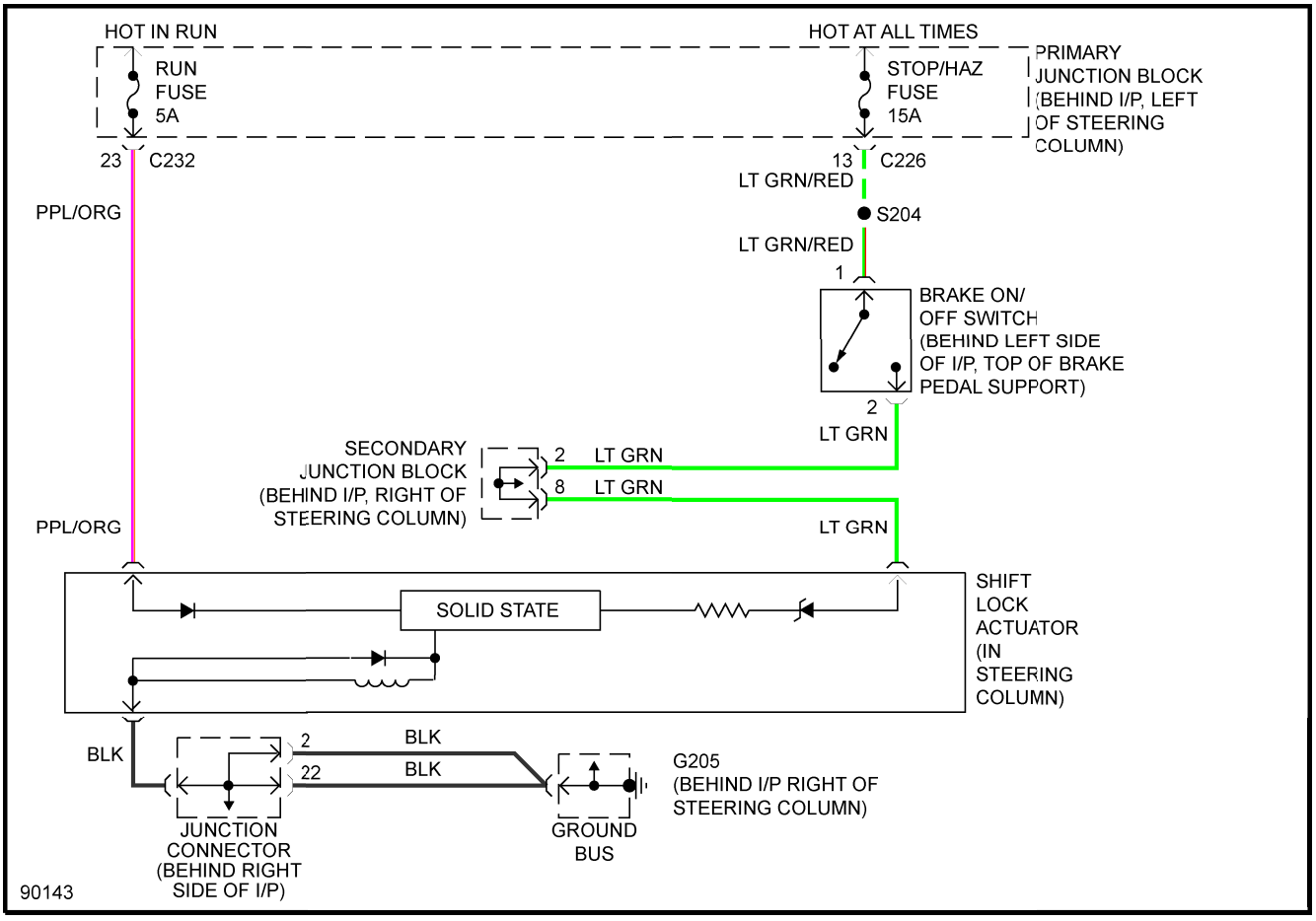


Fig. 15: Shift Interlock System Wiring Diagram (1997 Cougar & Thunderbird)

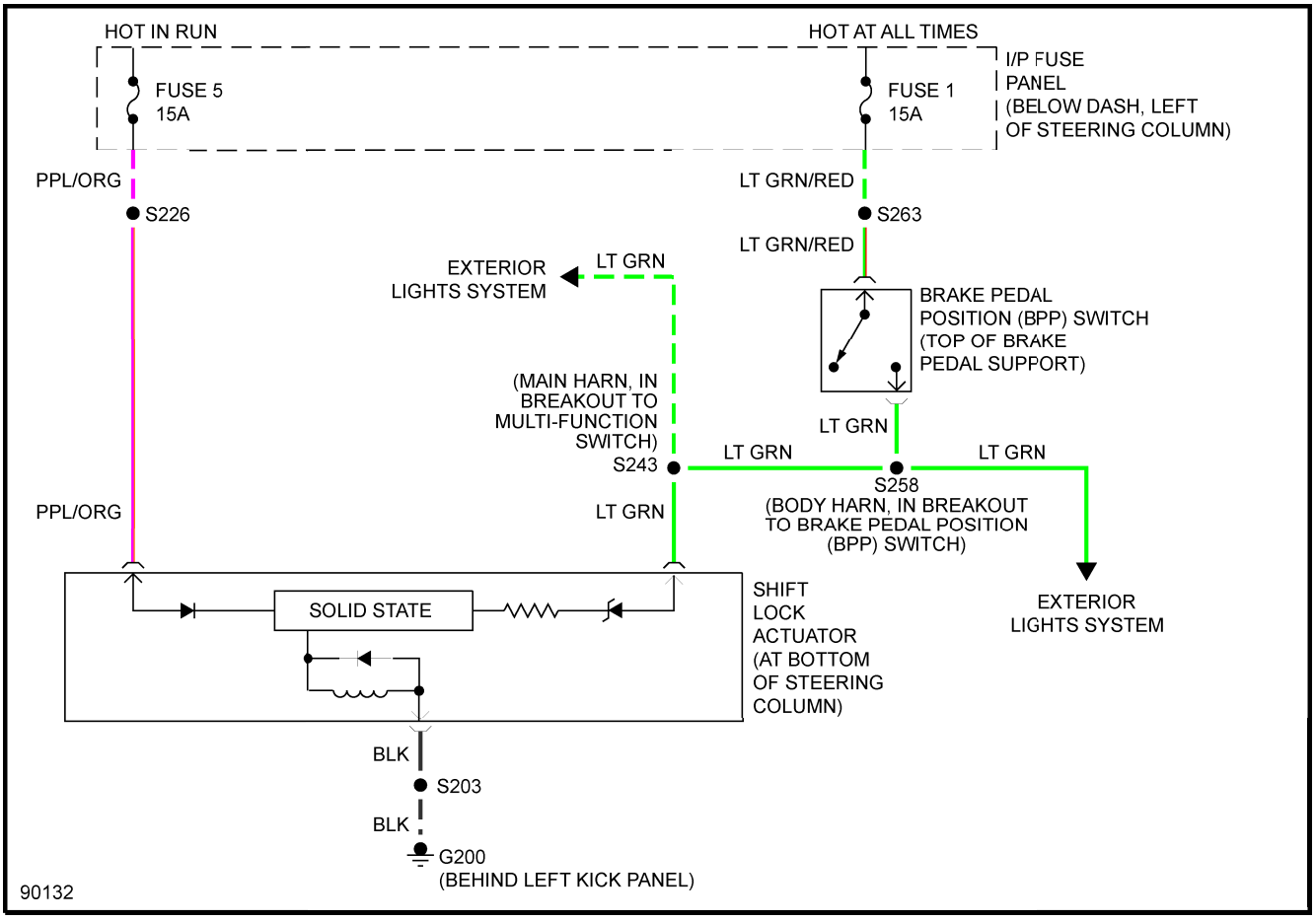

HOT IN RUN
HOT AT ALL TIMES
FUSE 5
15A
FUSE 1
15A
I/P FUSE
PANEL
(BELOW DASH, LEFT
OF STEERING COLUMN)
PPL/ORG
S226
LT GRN/RED
S263
LT GRN/RED
EXTERIOR
LIGHTS SYSTEM
LT GRN
BRAKE PEDAL
POSITION (BPP) SWITCH
(TOP OF BRAKE
PEDAL SUPPORT)
(MAIN HARN, IN
BREAKOUT TO
MULTI-FUNCTION
SWITCH)
S243
LT GRN
LT GRN
LT GRN
S258
(BODY HARN, IN BREAKOUT
TO BRAKE PEDAL POSITION
(BPP) SWITCH)
PPL/ORG
LT GRN
SOLID STATE
SHIFT
LOCK
ACTUATOR
(AT BOTTOM
OF STEERING
COLUMN)
EXTERIOR
LIGHTS SYSTEM
BLK
S203
BLK
G200
(BEHIND LEFT KICK PANEL)
90132

Fig. 16: Shift Interlock System Wiring Diagram (1997-98 Crown Victoria & Grand Marquis)

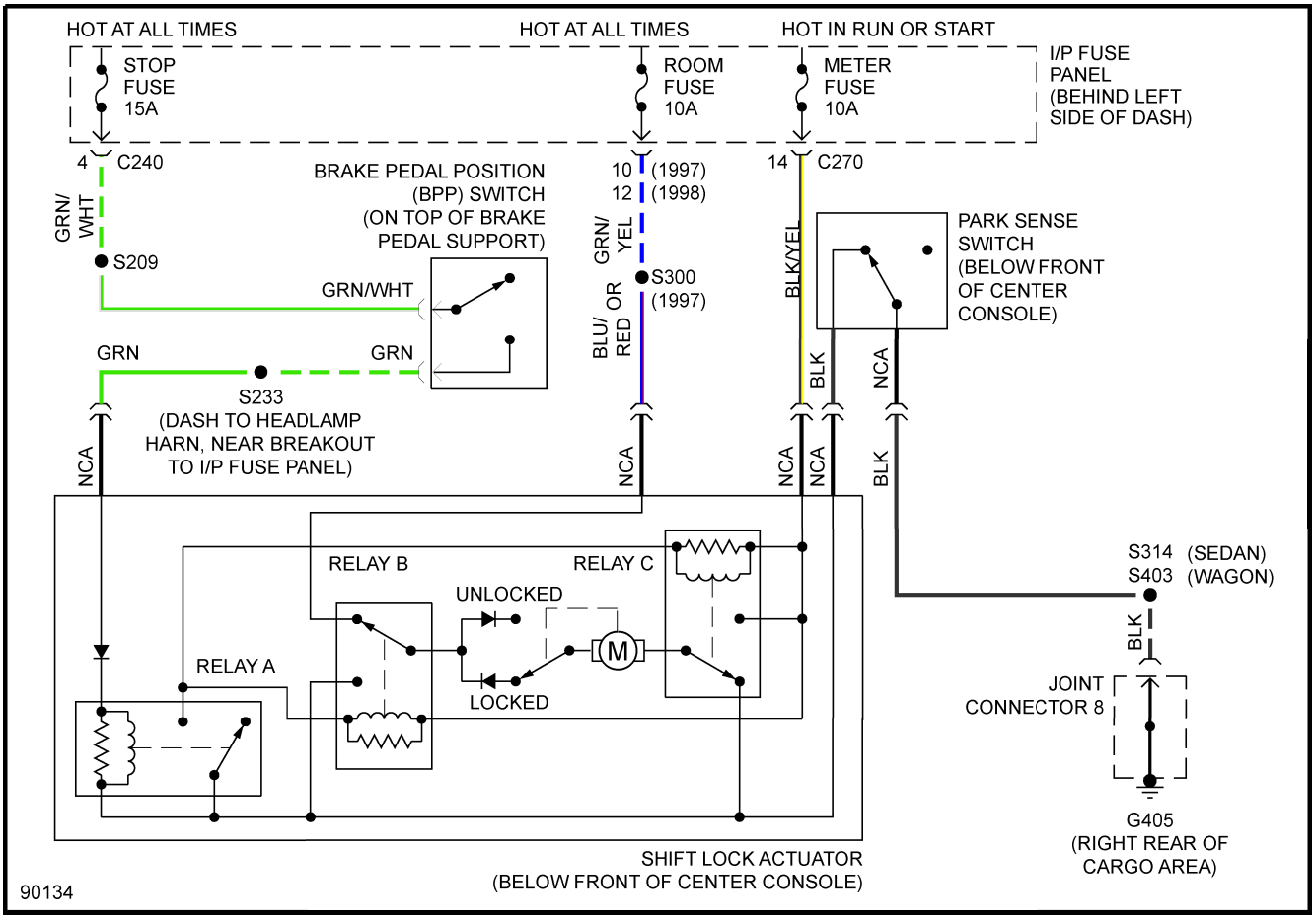

HOT AT ALL TIMES
HOT AT ALL TIMES
HOT IN RUN OR START
STOP FUSE 15A
ROOM FUSE 10A
METER FUSE 10A
I/P FUSE PANEL (BEHIND LEFT SIDE OF DASH)
4
C240
10
(1997)
12
(1998)
14
C270
GRN/ WHT
S209
BRAKE PEDAL POSITION (BPP) SWITCH (ON TOP OF BRAKE PEDAL SUPPORT)
GRN/WHT
GRN/ YEL
S300
(1997)
BLU/ OR RED
BLK/YEL
PARK SENSE SWITCH (BELOW FRONT OF CENTER CONSOLE)
GRN
GRN
S233
(DASH TO HEADLAMP HARN, NEAR BREAKOUT TO I/P FUSE PANEL)
BLK
NCA
NCA
NCA
NCA
NCA
BLK
RELAY B
RELAY C
UNLOCKED
M
RELAY A
LOCKED
S314 (SEDAN)
S403 (WAGON)
BLK
JOINT CONNECTOR 8
G405
(RIGHT REAR OF CARGO AREA)
SHIFT LOCK ACTUATOR
(BELOW FRONT OF CENTER CONSOLE)
90134

Fig. 17: Shift Interlock System Wiring Diagram (1997-98 Escort & Tracer)

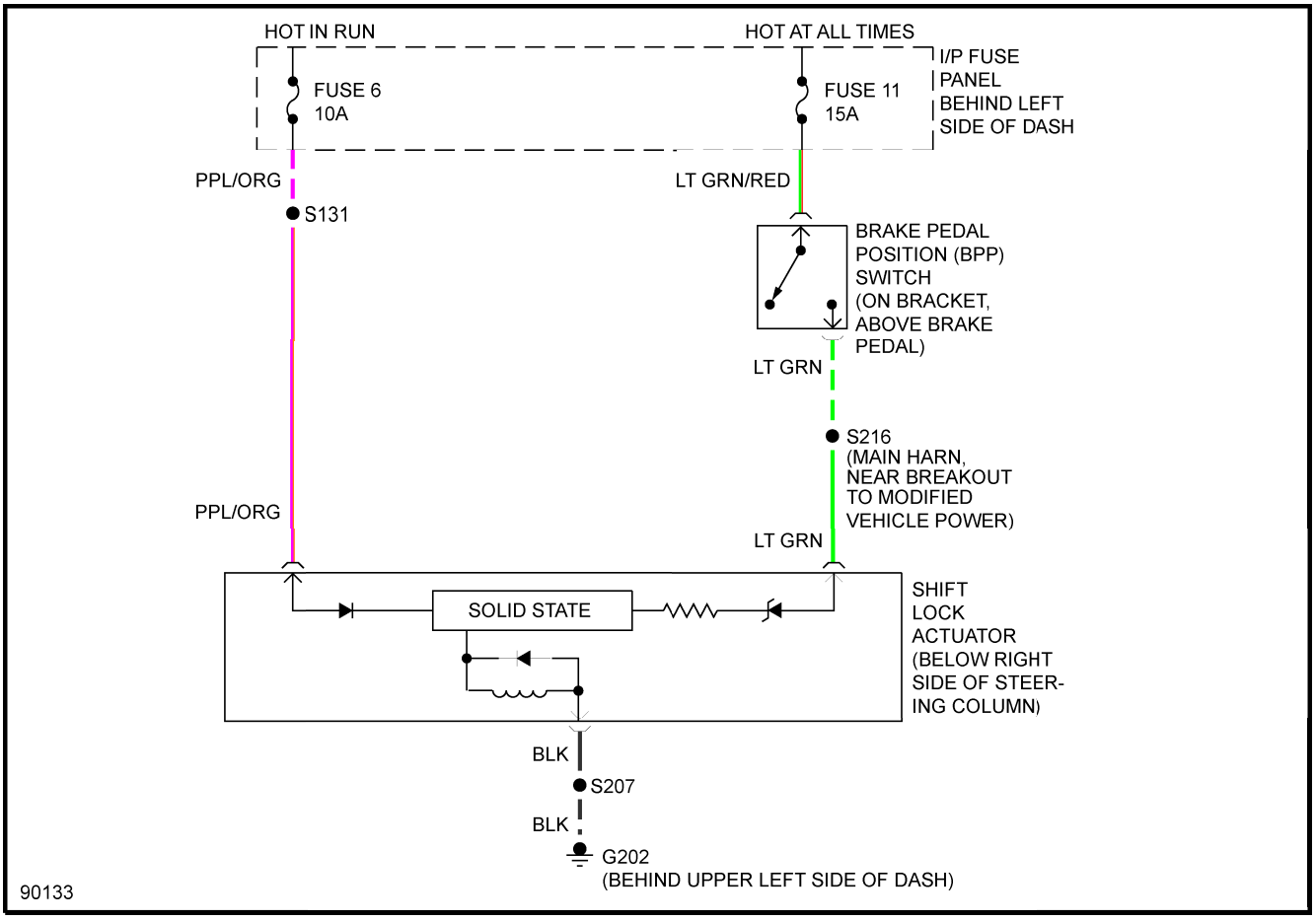

HOT IN RUN
HOT AT ALL TIMES
I/P FUSE PANEL BEHIND LEFT SIDE OF DASH
FUSE 6
10A
FUSE 11
15A
PPL/ORG
LT GRN/RED
S131
BRAKE PEDAL POSITION (BPP) SWITCH (ON BRACKET, ABOVE BRAKE PEDAL)
LT GRN
S216
(MAIN HARN, NEAR BREAKOUT TO MODIFIED VEHICLE POWER)
PPL/ORG
LT GRN
SOLID STATE
SHIFT LOCK ACTUATOR (BELOW RIGHT SIDE OF STEER-ING COLUMN)
BLK
S207
BLK
G202
(BEHIND UPPER LEFT SIDE OF DASH)
90133

Fig. 18: Shift Interlock System Wiring Diagram (1997-98 "E" Series)

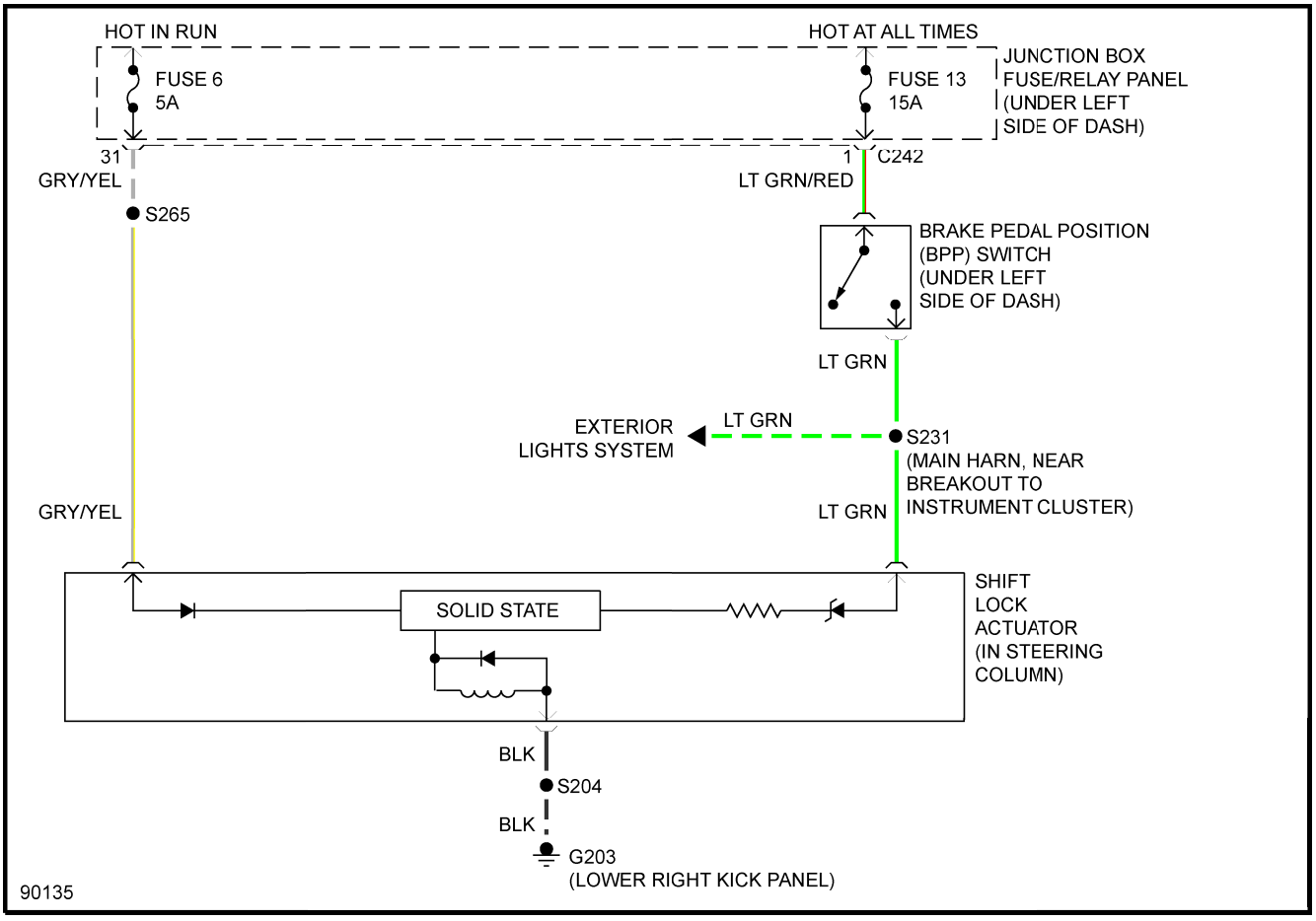

HOT IN RUN
HOT AT ALL TIMES
FUSE 6
5A
FUSE 13
15A
JUNCTION BOX
FUSE/RELAY PANEL
(UNDER LEFT
SIDE OF DASH)
31
1
C242
GRY/YEL
LT GRN/RED
S265
BRAKE PEDAL POSITION
(BPP) SWITCH
(UNDER LEFT
SIDE OF DASH)
LT GRN
EXTERIOR
LIGHTS SYSTEM
LT GRN
S231
(MAIN HARN, NEAR
BREAKOUT TO
INSTRUMENT CLUSTER)
GRY/YEL
LT GRN
SOLID STATE
SHIFT
LOCK
ACTUATOR
(IN STEERING
COLUMN)
BLK
S204
BLK
G203
(LOWER RIGHT KICK PANEL)
90135

Fig. 19: Shift Interlock System Wiring Diagram (1997-98 Expedition & 1998 Navigator)

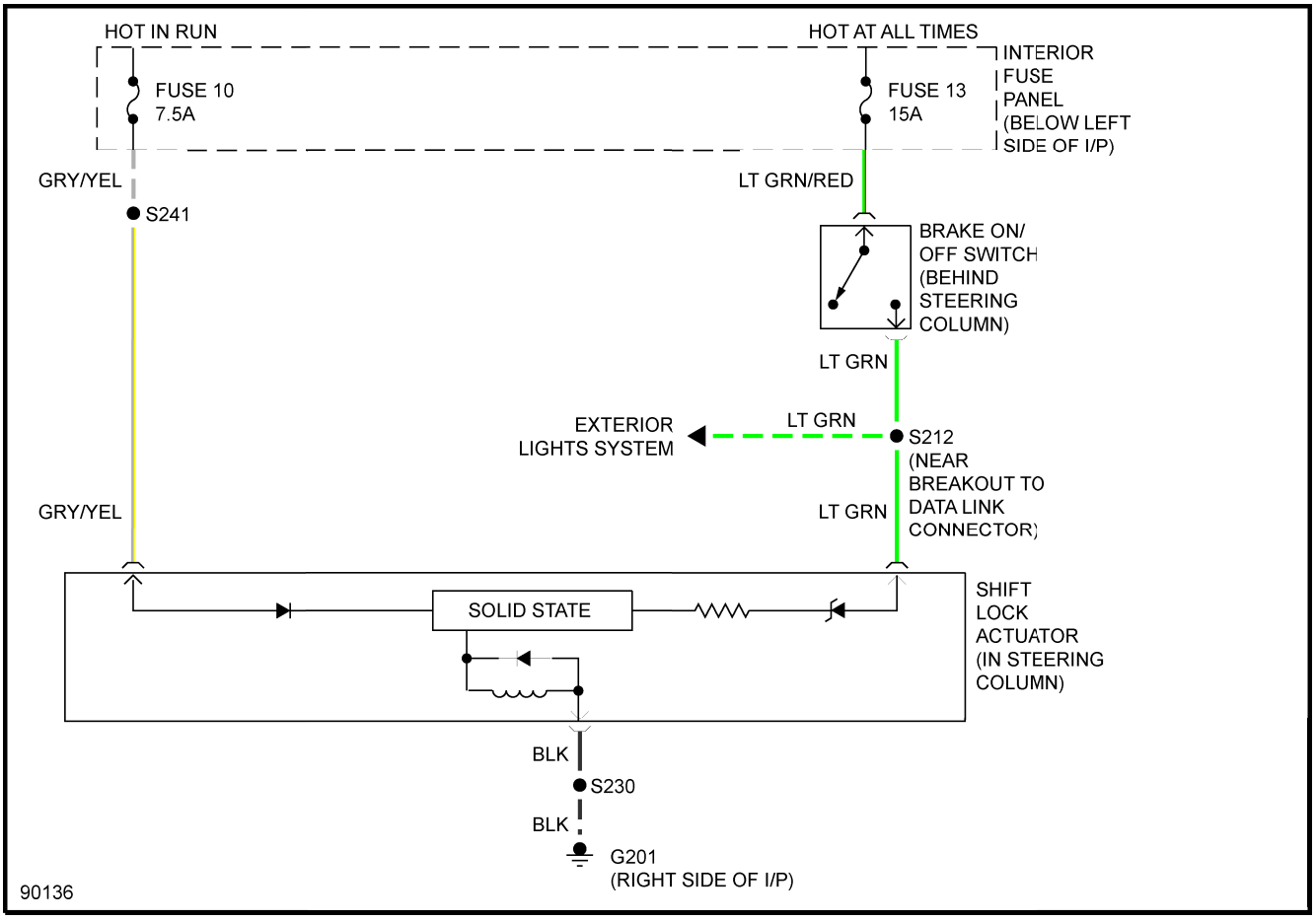

HOT IN RUN
HOT AT ALL TIMES
INTERIOR FUSE PANEL (BELOW LEFT SIDE OF I/P)
FUSE 10 7.5A
FUSE 13 15A
GRY/YEL
LT GRN/RED
S241
BRAKE ON/ OFF SWITCH (BEHIND STEERING COLUMN)
LT GRN
EXTERIOR LIGHTS SYSTEM
LT GRN
S212 (NEAR BREAKOUT TO DATA LINK CONNECTOR)
GRY/YEL
LT GRN
SOLID STATE
SHIFT LOCK ACTUATOR (IN STEERING COLUMN)
BLK
S230
BLK
G201 (RIGHT SIDE OF I/P)
90136

Fig. 20: Shift Interlock System Wiring Diagram (1997 Explorer & Mountaineer)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

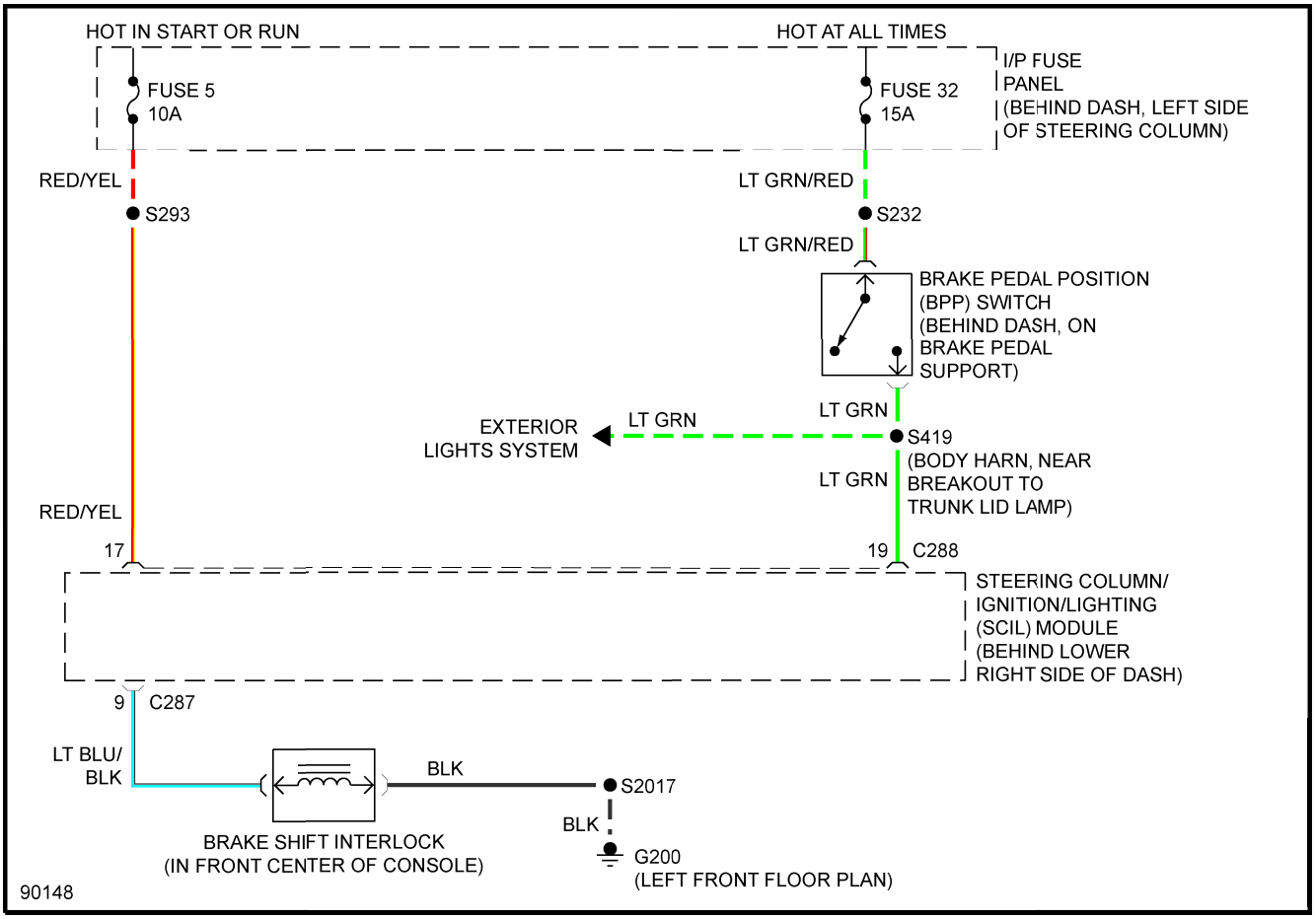


Fig. 21: Shift Interlock System Wiring Diagram (1997-98 Mark VIII)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

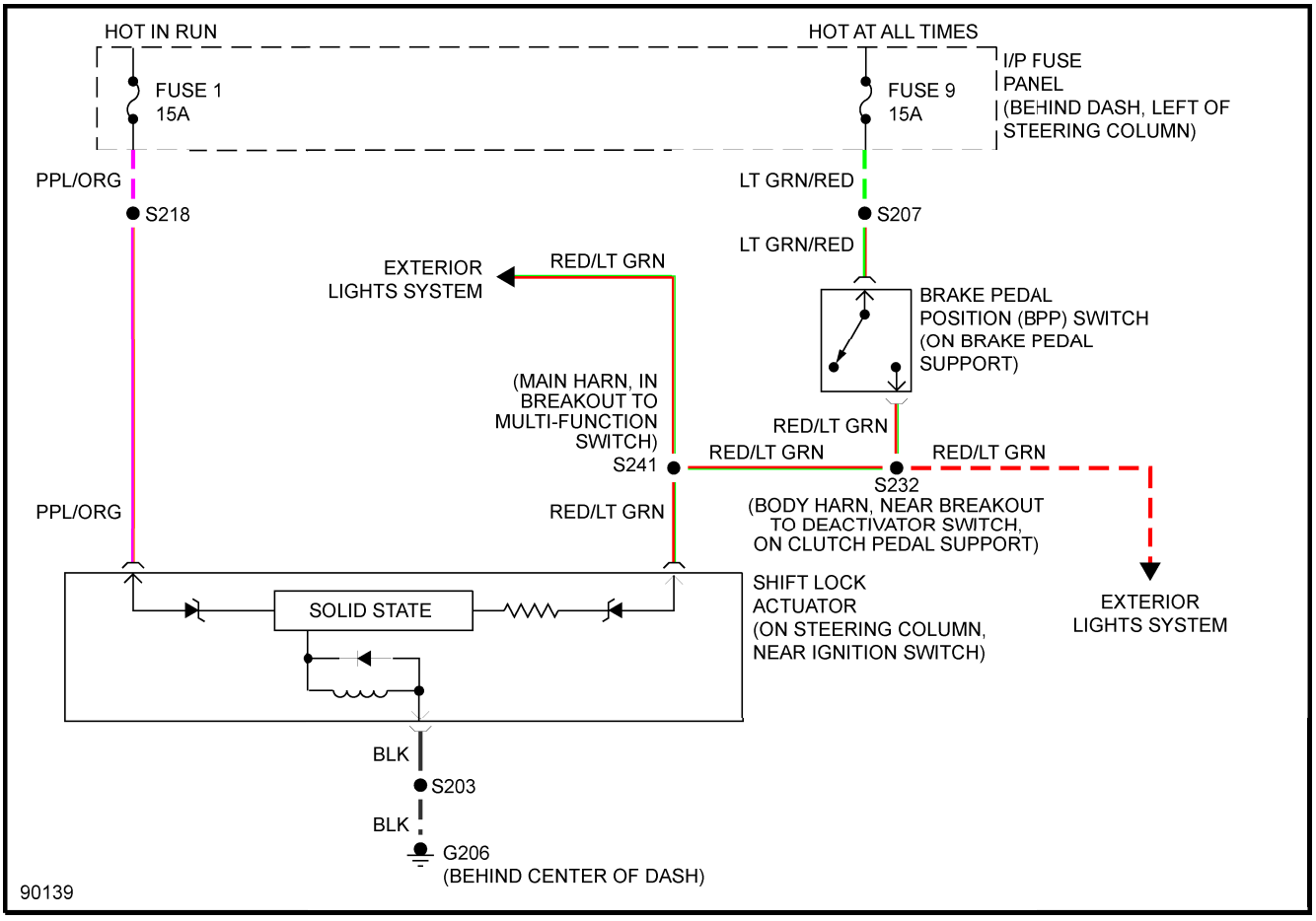


Fig. 22: Shift Interlock System Wiring Diagram (1997-98 Mustang)

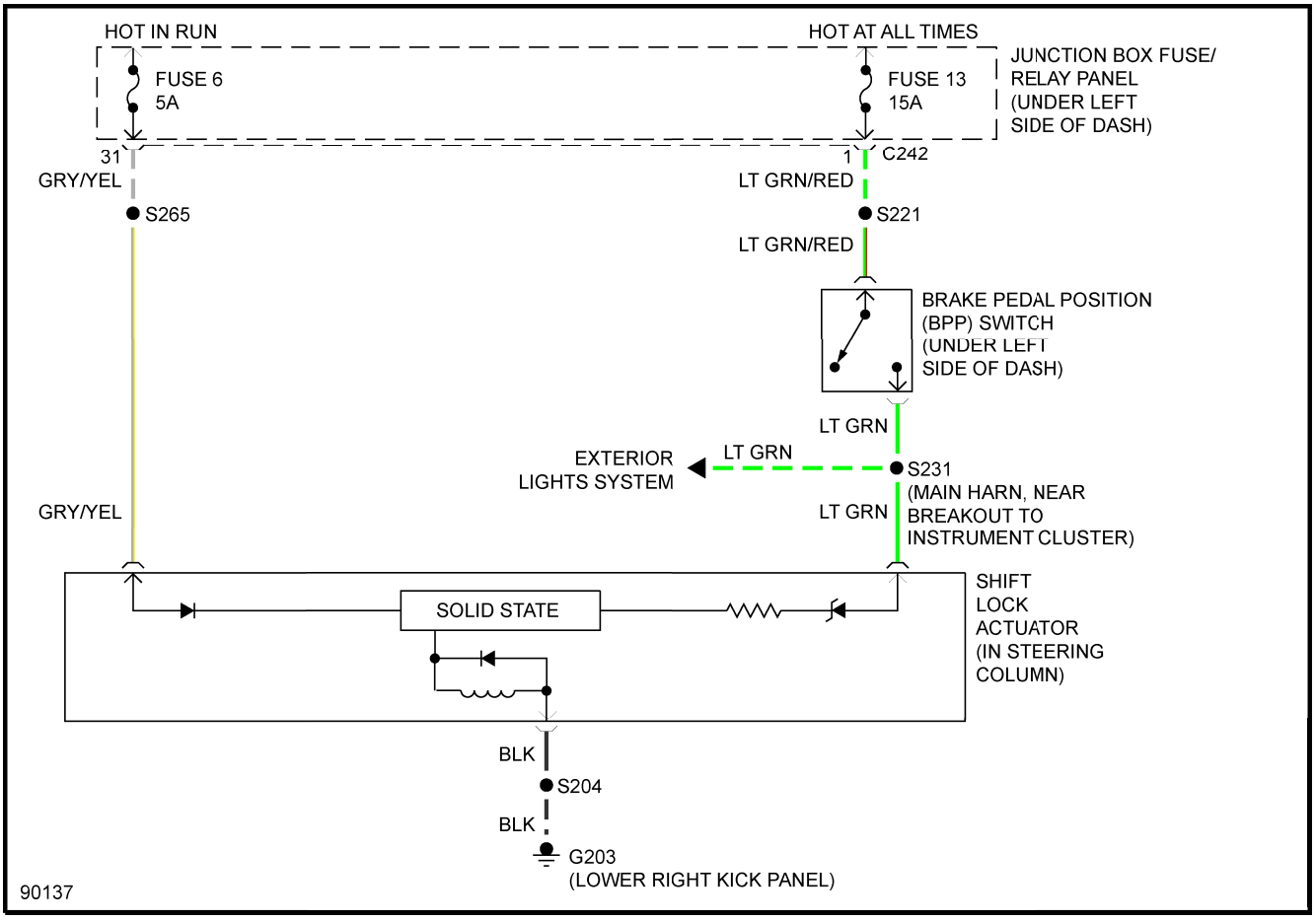

HOT IN RUN
HOT AT ALL TIMES
FUSE 6
5A
FUSE 13
15A
JUNCTION BOX FUSE/
RELAY PANEL
(UNDER LEFT
SIDE OF DASH)
31
1
C242
GRY/YEL
LT GRN/RED
S265
S221
LT GRN/RED
BRAKE PEDAL POSITION
(BPP) SWITCH
(UNDER LEFT
SIDE OF DASH)
LT GRN
EXTERIOR
LIGHTS SYSTEM
LT GRN
S231
(MAIN HARN, NEAR
BREAKOUT TO
INSTRUMENT CLUSTER)
GRY/YEL
LT GRN
SOLID STATE
SHIFT
LOCK
ACTUATOR
(IN STEERING
COLUMN)
BLK
S204
BLK
G203
(LOWER RIGHT KICK PANEL)
90137

Fig. 23: Shift Interlock System Wiring Diagram (1997-98 F150/250 Light Duty)

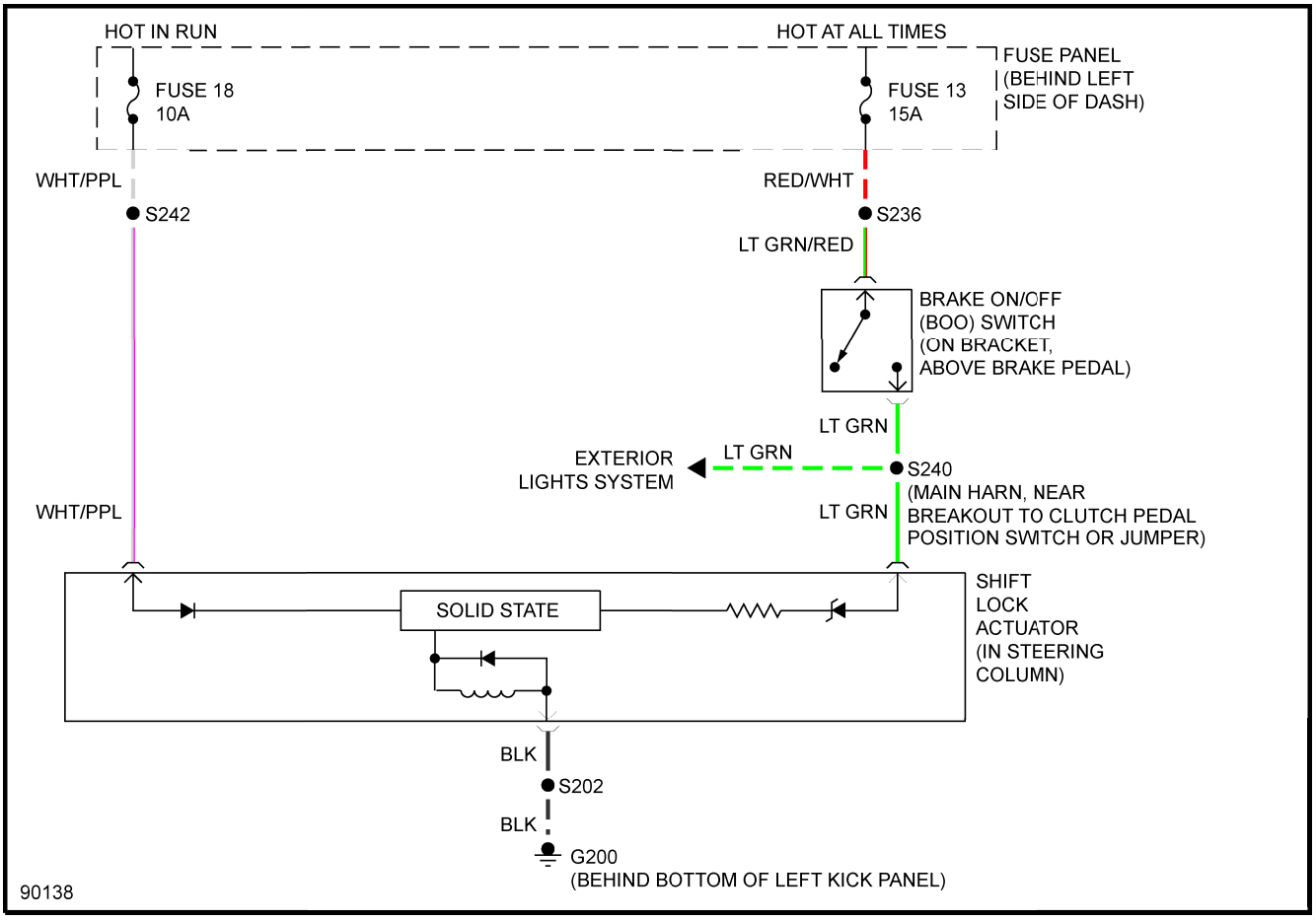

HOT IN RUN
HOT AT ALL TIMES
FUSE PANEL
(BEHIND LEFT
SIDE OF DASH)
FUSE 18
10A
FUSE 13
15A
WHT/PPL
RED/WHT
S242
S236
LT GRN/RED
BRAKE ON/OFF
(BOO) SWITCH
(ON BRACKET,
ABOVE BRAKE PEDAL)
LT GRN
EXTERIOR
LIGHTS SYSTEM
LT GRN
S240
(MAIN HARN, NEAR
BREAKOUT TO CLUTCH PEDAL
POSITION SWITCH OR JUMPER)
WHT/PPL
LT GRN
SOLID STATE
SHIFT
LOCK
ACTUATOR
(IN STEERING
COLUMN)
BLK
S202
BLK
G200
(BEHIND BOTTOM OF LEFT KICK PANEL)
90138

Fig. 24: Shift Interlock System Wiring Diagram (1997-98 F250/350 Heavy/Super Duty)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

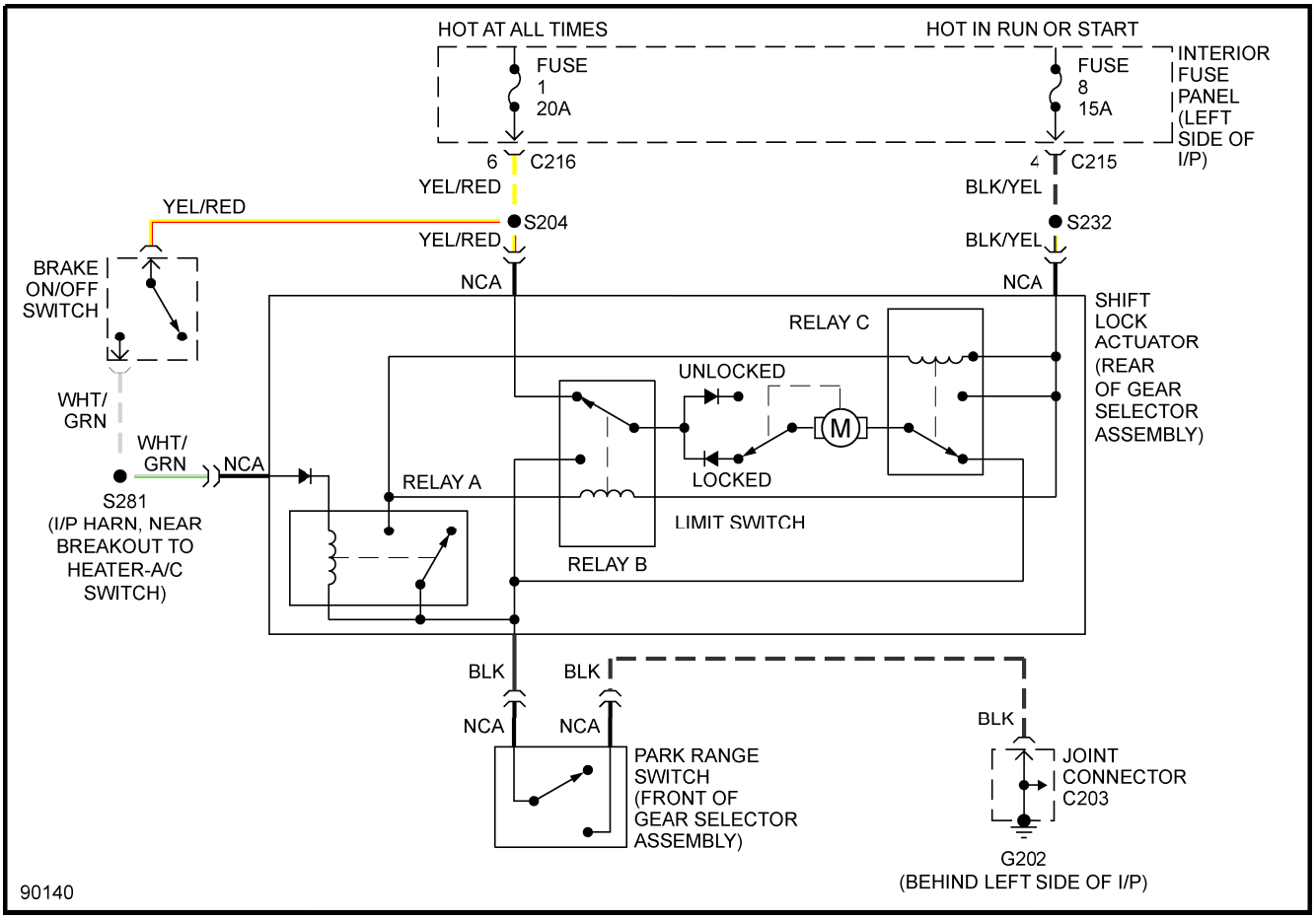


Fig. 25: Shift Interlock System Wiring Diagram (1997 Probe)

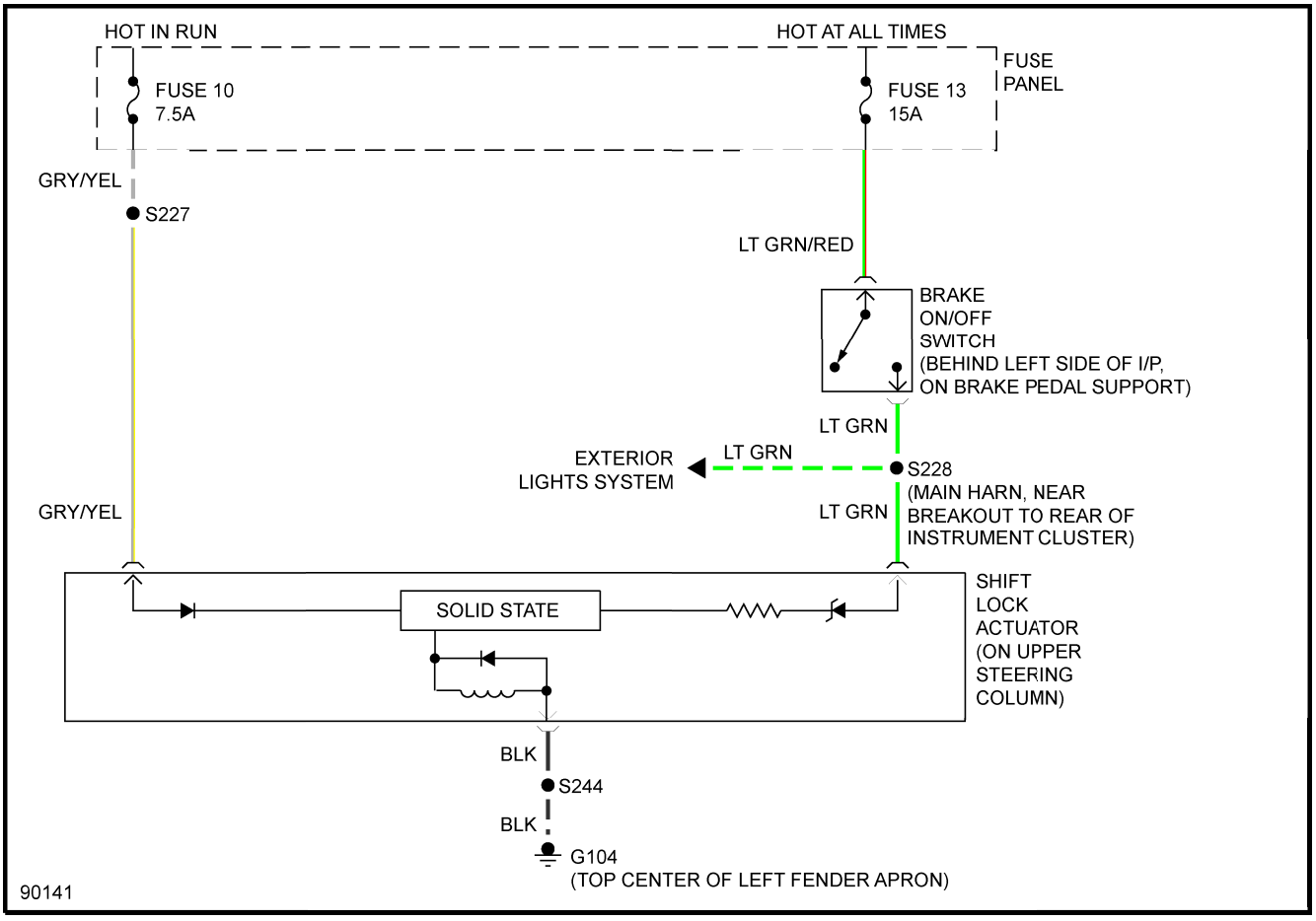

HOT IN RUN
HOT AT ALL TIMES
FUSE 10
7.5A
FUSE 13
15A
FUSE
PANEL
GRY/YEL
S227
LT GRN/RED
BRAKE
ON/OFF
SWITCH
(BEHIND LEFT SIDE OF I/P,
ON BRAKE PEDAL SUPPORT)
LT GRN
EXTERIOR
LIGHTS SYSTEM
LT GRN
S228
(MAIN HARN, NEAR
BREAKOUT TO REAR OF
INSTRUMENT CLUSTER)
GRY/YEL
LT GRN
SOLID STATE
SHIFT
LOCK
ACTUATOR
(ON UPPER
STEERING
COLUMN)
BLK
S244
BLK
G104
(TOP CENTER OF LEFT FENDER APRON)
90141

Fig. 26: Shift Interlock System Wiring Diagram (1997 Ranger)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

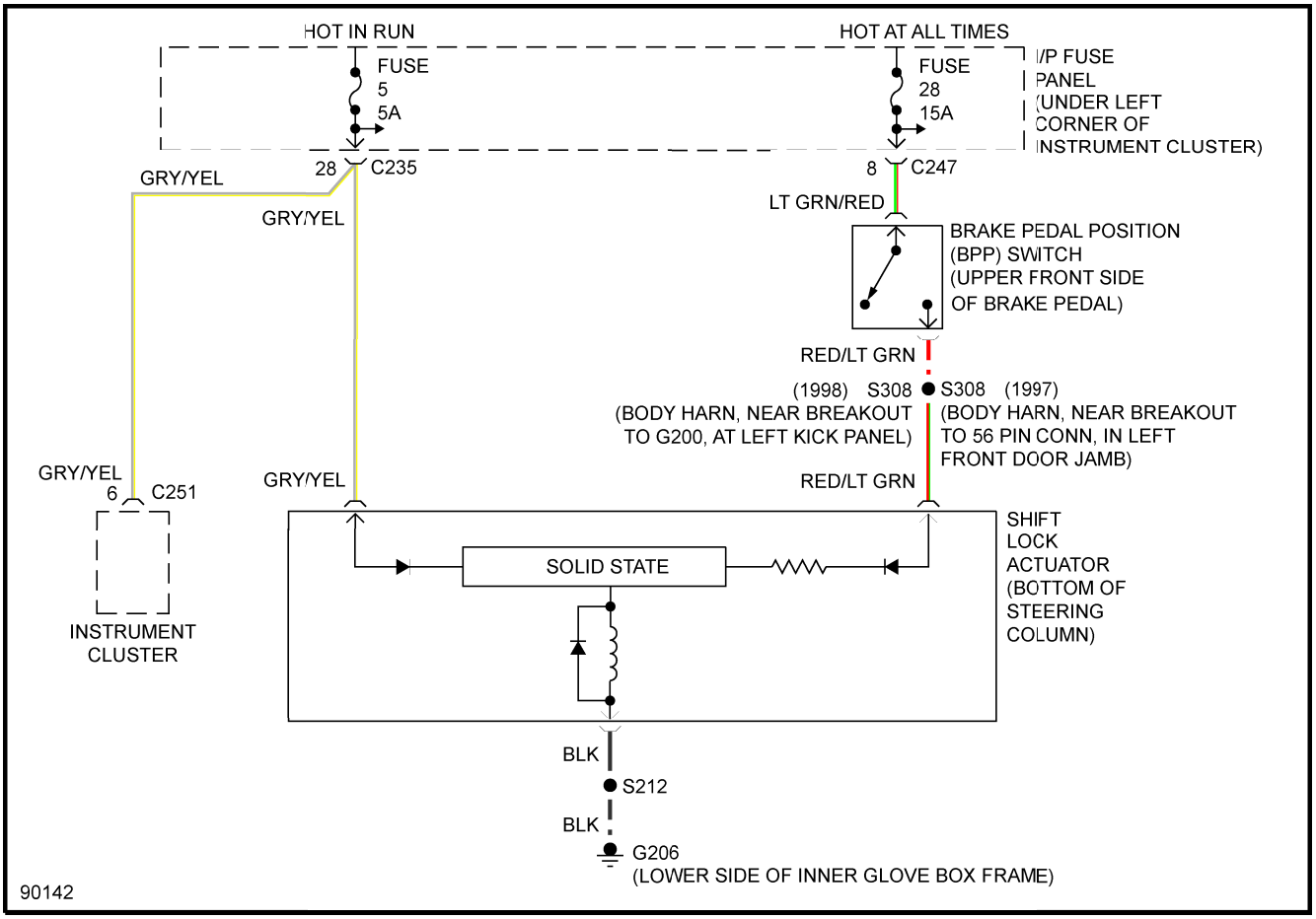


Fig. 27: Shift Interlock System Wiring Diagram (1997-98 Sable & Taurus)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

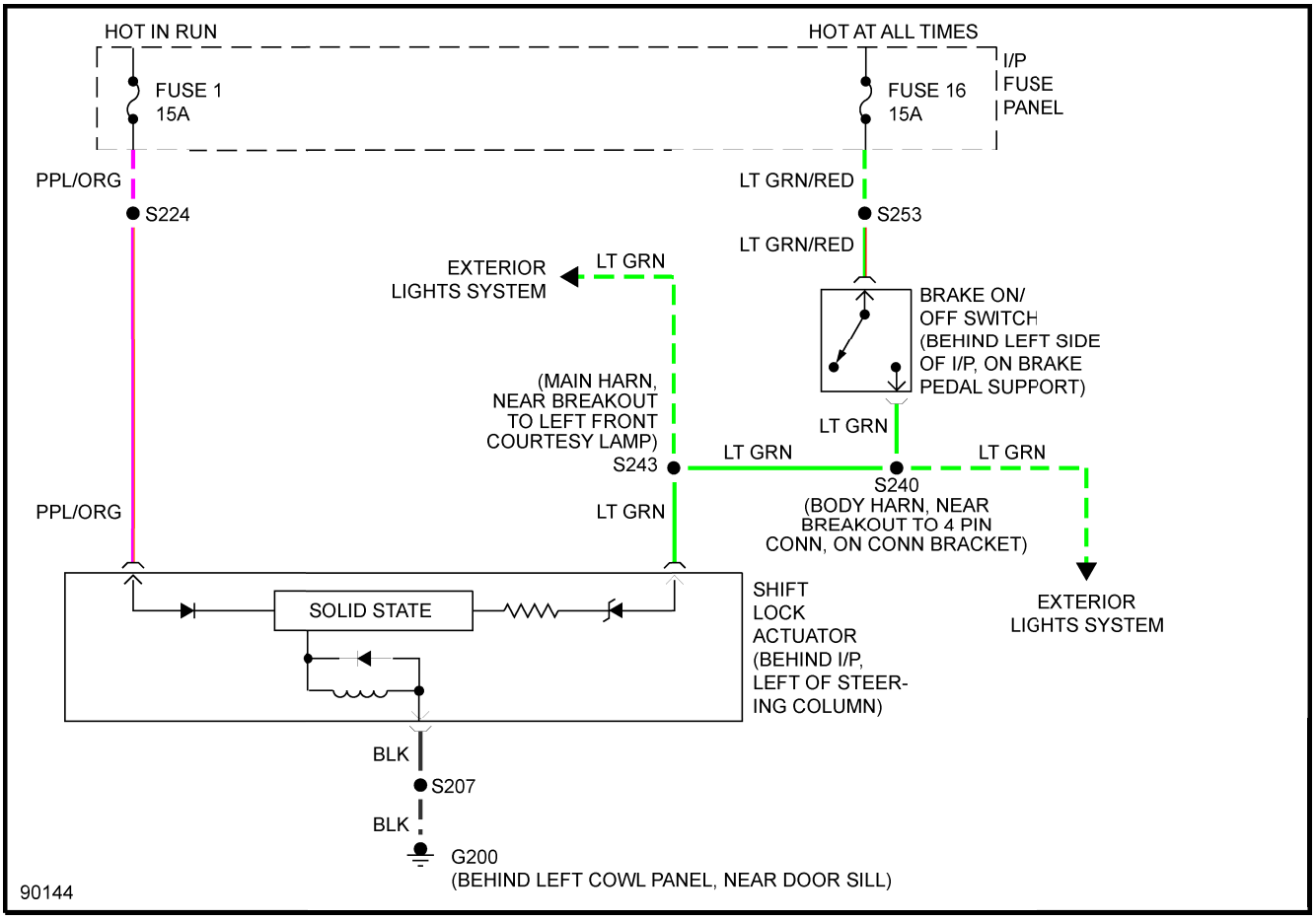


Fig. 28: Shift Interlock System Wiring Diagram (1997 Town Car)

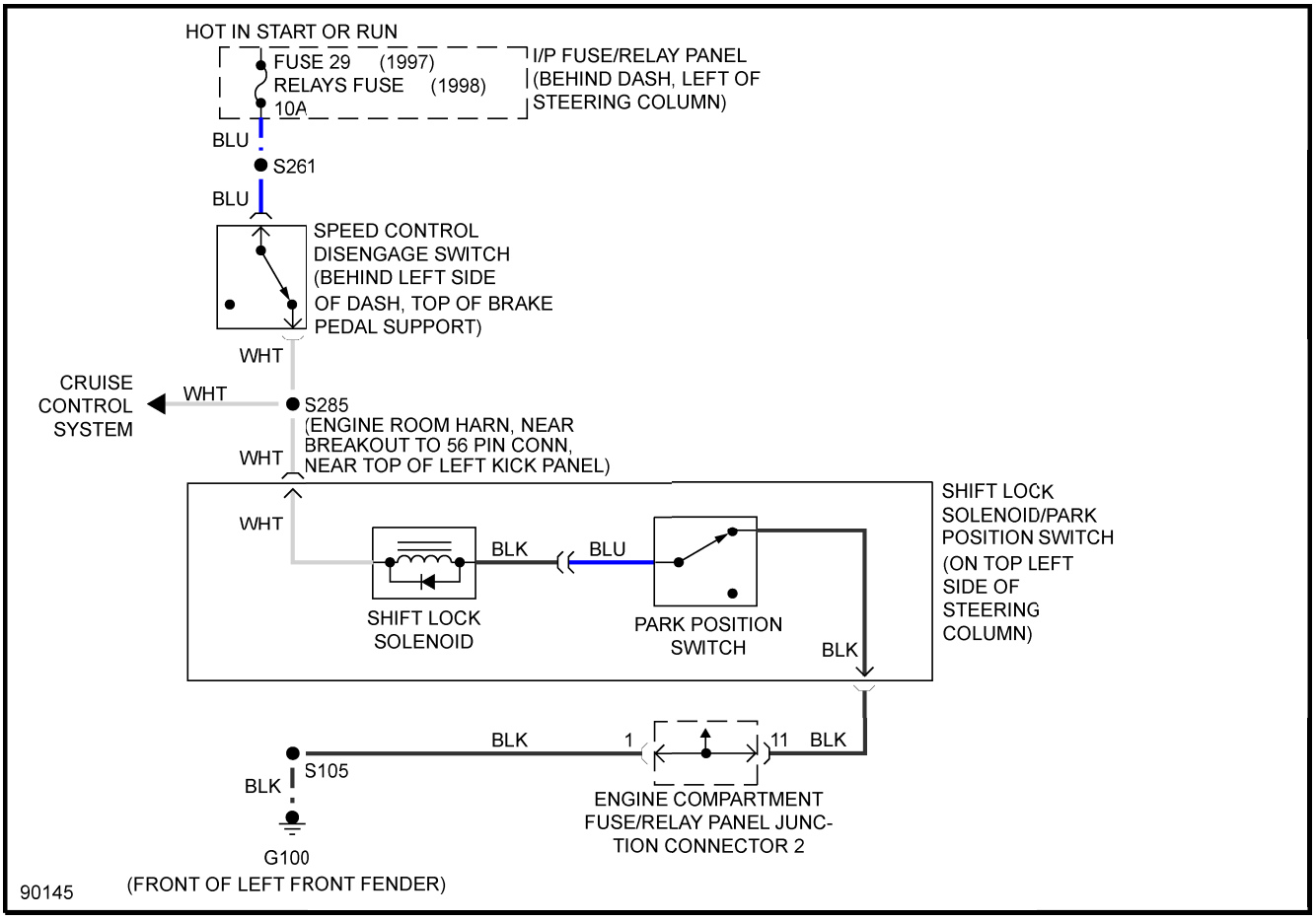

HOT IN START OR RUN
FUSE 29 (1997)
RELAYS FUSE (1998)
10A
I/P FUSE/RELAY PANEL
(BEHIND DASH, LEFT OF
STEERING COLUMN)
BLU
S261
BLU
SPEED CONTROL
DISENGAGE SWITCH
(BEHIND LEFT SIDE
OF DASH, TOP OF BRAKE
PEDAL SUPPORT)
WHT
CRUISE
CONTROL
SYSTEM
WHT
S285
(ENGINE ROOM HARN, NEAR
BREAKOUT TO 56 PIN CONN,
NEAR TOP OF LEFT KICK PANEL)
WHT
WHT
BLK
BLU
SHIFT LOCK
SOLENOID
PARK POSITION
SWITCH
BLK
SHIFT LOCK
SOLENOID/PARK
POSITION SWITCH
(ON TOP LEFT
SIDE OF
STEERING
COLUMN)
BLK
1
11
BLK
BLK
S105
G100
(FRONT OF LEFT FRONT FENDER)
ENGINE COMPARTMENT
FUSE/RELAY PANEL JUNC-
TION CONNECTOR 2
90145

Fig. 29: Shift Interlock System Wiring Diagram (1997-98 Villager)

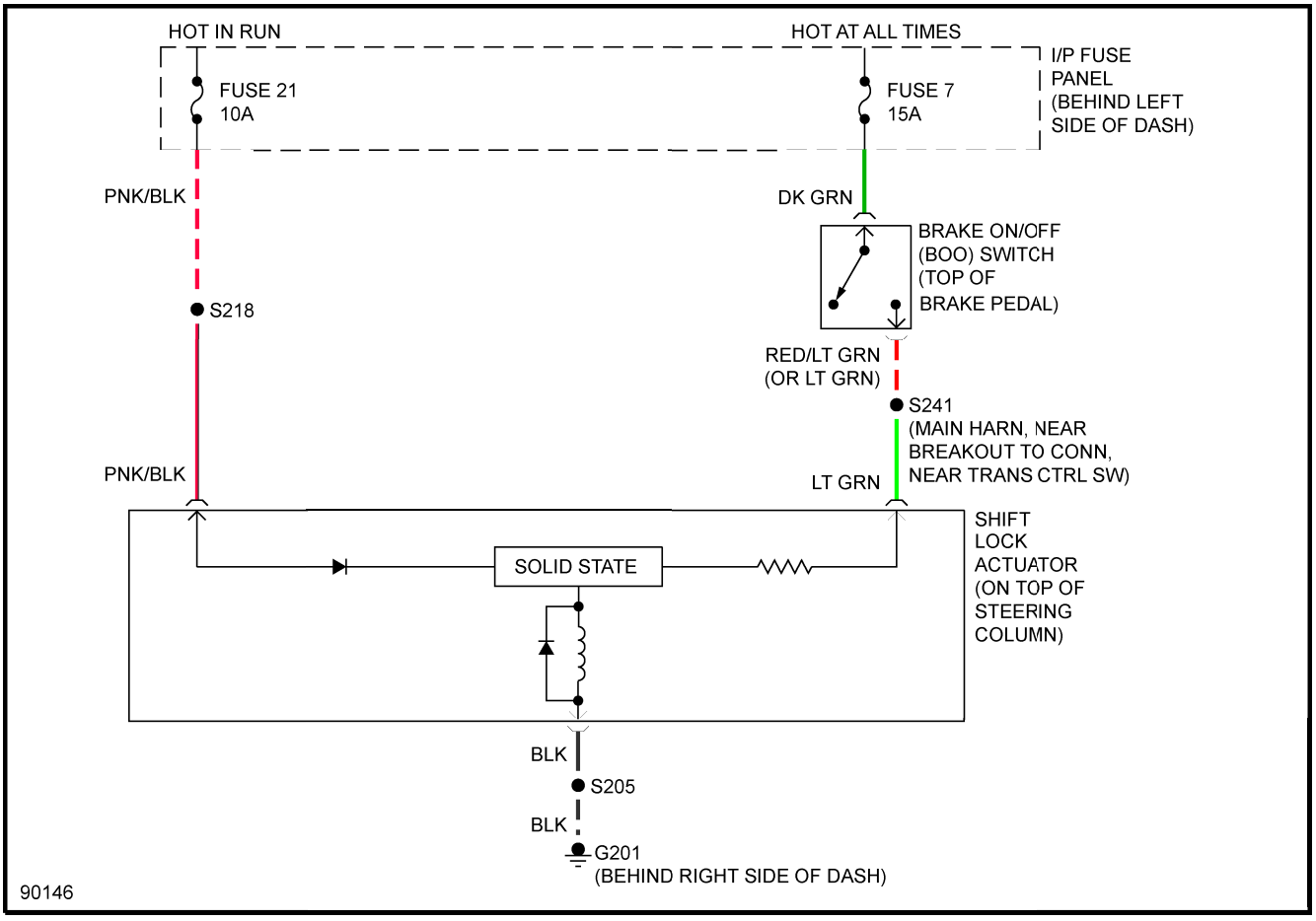

HOT IN RUN
HOT AT ALL TIMES
I/P FUSE PANEL (BEHIND LEFT SIDE OF DASH)
FUSE 21 10A
FUSE 7 15A
PNK/BLK
DK GRN
BRAKE ON/OFF (BOO) SWITCH (TOP OF BRAKE PEDAL)
S218
RED/LT GRN (OR LT GRN)
S241 (MAIN HARN, NEAR BREAKOUT TO CONN, NEAR TRANS CTRL SW)
PNK/BLK
LT GRN
SHIFT LOCK ACTUATOR (ON TOP OF STEERING COLUMN)
SOLID STATE
BLK
S205
BLK
G201 (BEHIND RIGHT SIDE OF DASH)
90146

Fig. 30: Shift Interlock System Wiring Diagram (1997-98 Windstar)

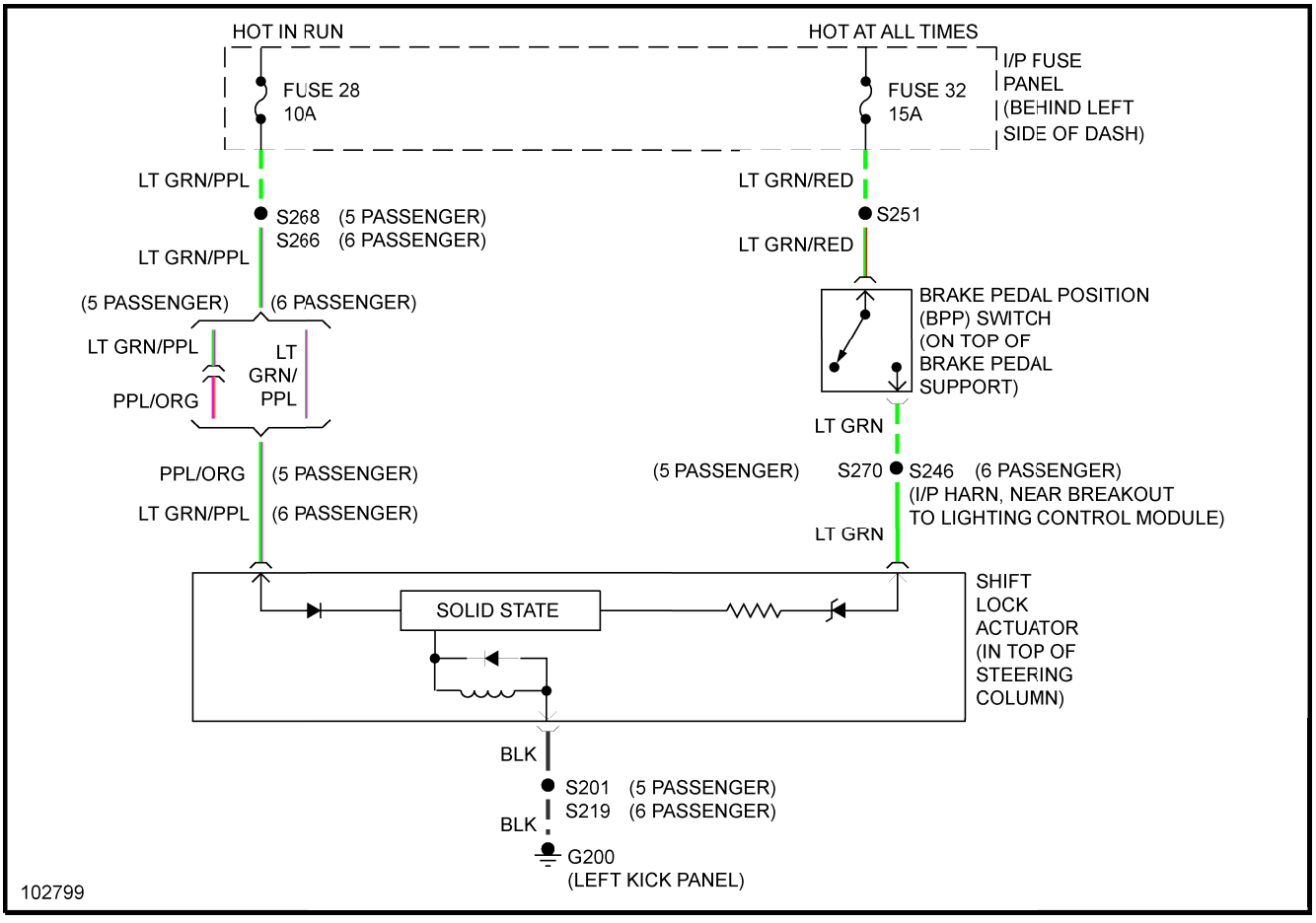

HOT IN RUN
HOT AT ALL TIMES
FUSE 28
10A
FUSE 32
15A
I/P FUSE
PANEL
(BEHIND LEFT
SIDE OF DASH)
LT GRN/PPL
LT GRN/RED
S268 (5 PASSENGER)
S266 (6 PASSENGER)
S251
LT GRN/PPL
LT GRN/RED
(5 PASSENGER)
(6 PASSENGER)
BRAKE PEDAL POSITION
(BPP) SWITCH
(ON TOP OF
BRAKE PEDAL
SUPPORT)
LT GRN/PPL
LT
GRN/
PPL
PPL/ORG
LT GRN
PPL/ORG
(5 PASSENGER)
(5 PASSENGER)
S270
S246 (6 PASSENGER)
(I/P HARN, NEAR BREAKOUT
TO LIGHTING CONTROL MODULE)
LT GRN/PPL
(6 PASSENGER)
LT GRN
SOLID STATE
SHIFT
LOCK
ACTUATOR
(IN TOP OF
STEERING
COLUMN)
BLK
S201 (5 PASSENGER)
S219 (6 PASSENGER)
BLK
G200
(LEFT KICK PANEL)
102799

Fig. 31: Shift Interlock System Wiring Diagram (1998 Continental)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

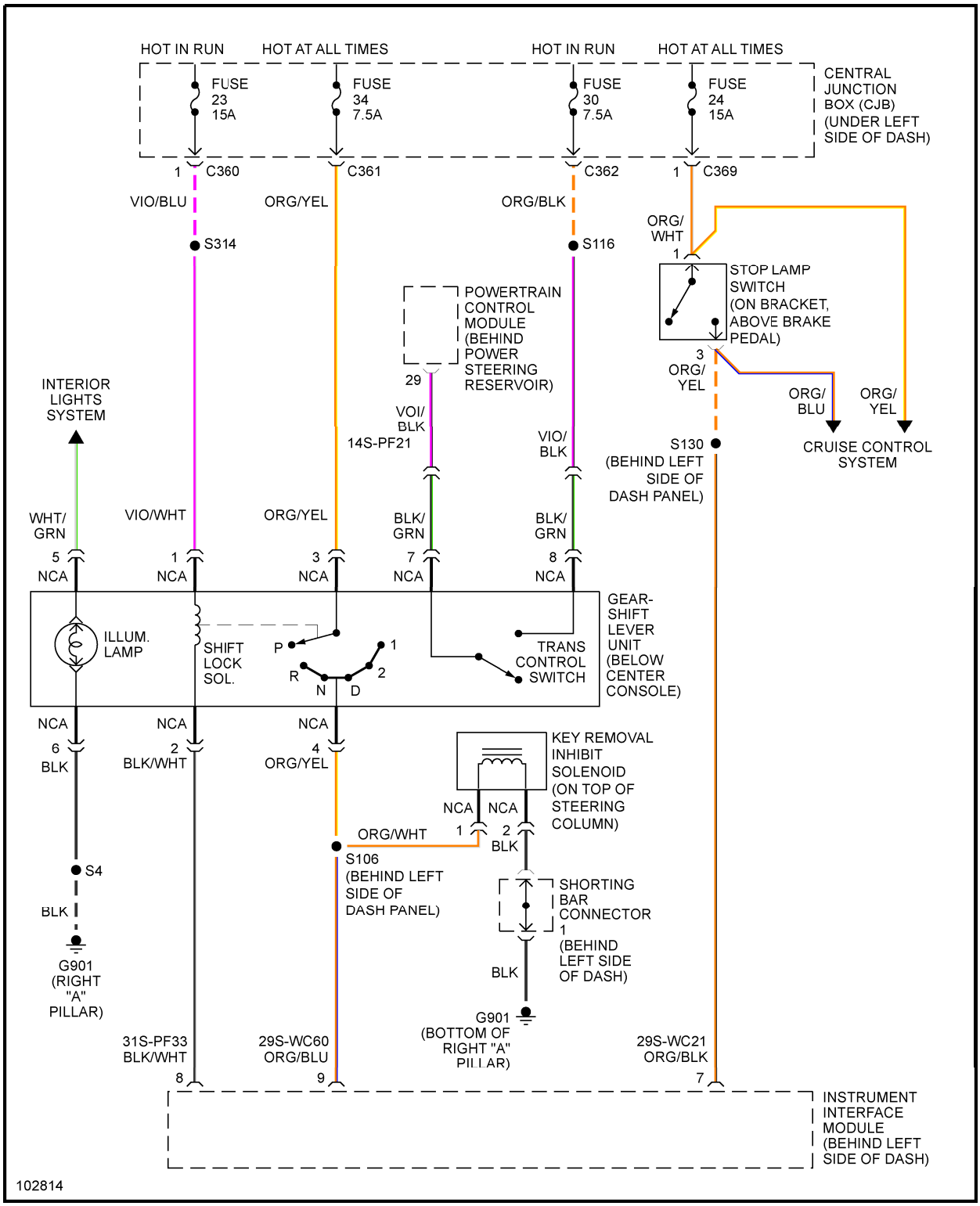


Fig. 32: Shift Interlock System Wiring Diagram (1998 Contour & Mystique)

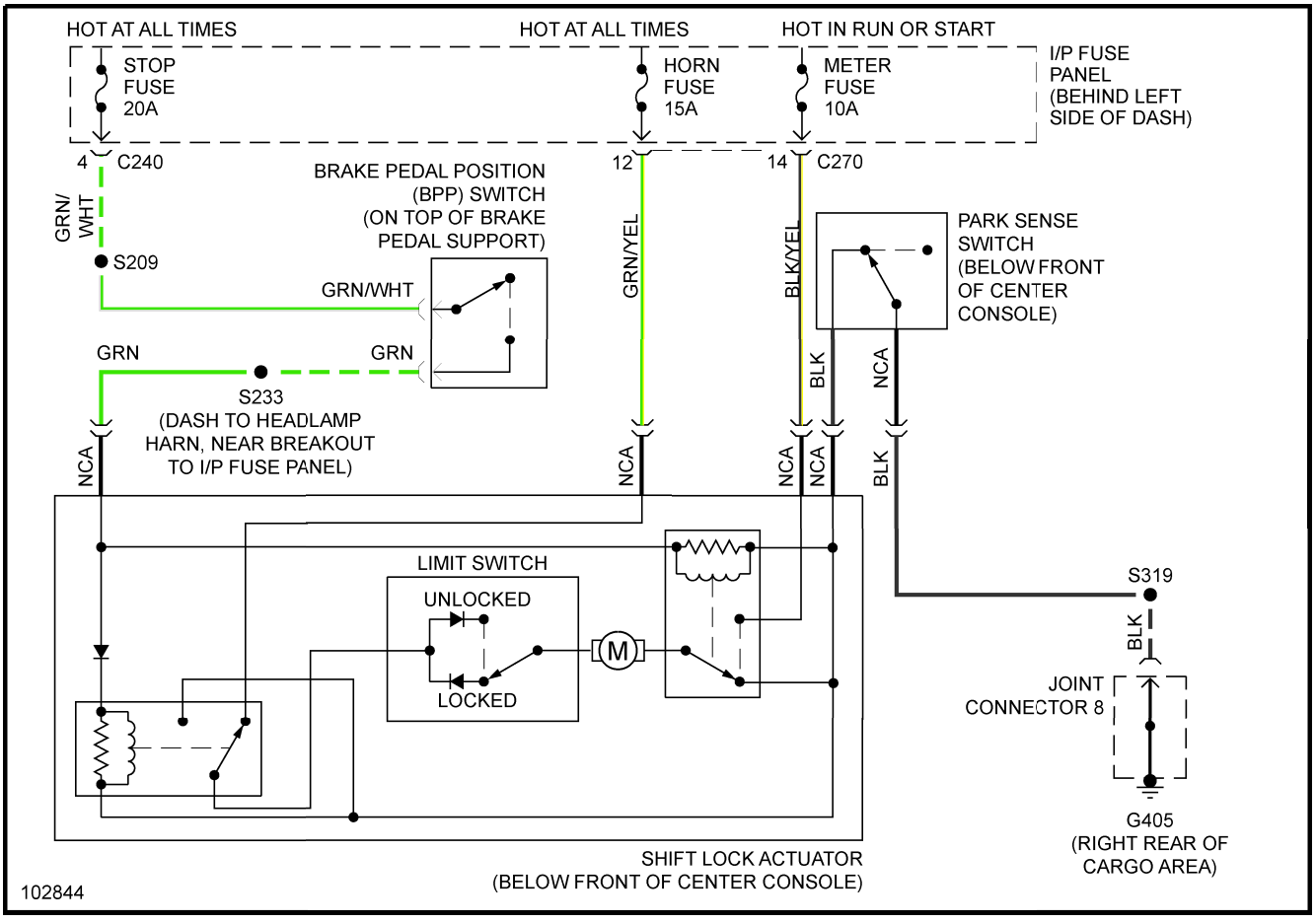

HOT AT ALL TIMES
HOT AT ALL TIMES
HOT IN RUN OR START
STOP FUSE 20A
HORN FUSE 15A
METER FUSE 10A
I/P FUSE PANEL (BEHIND LEFT SIDE OF DASH)
4
C240
12
14
C270
GRN/WHT
S209
BRAKE PEDAL POSITION (BPP) SWITCH (ON TOP OF BRAKE PEDAL SUPPORT)
GRN/WHT
GRN/YEL
BLK/YEL
PARK SENSE SWITCH (BELOW FRONT OF CENTER CONSOLE)
GRN
GRN
S233 (DASH TO HEADLAMP HARN, NEAR BREAKOUT TO I/P FUSE PANEL)
BLK
NCA
NCA
NCA
NCA
NCA
BLK
LIMIT SWITCH
UNLOCKED
LOCKED
M
S319
BLK
JOINT CONNECTOR 8
G405 (RIGHT REAR OF CARGO AREA)
SHIFT LOCK ACTUATOR (BELOW FRONT OF CENTER CONSOLE)
102844

Fig. 33: Shift Interlock System Wiring Diagram (1998 Escort ZX2)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

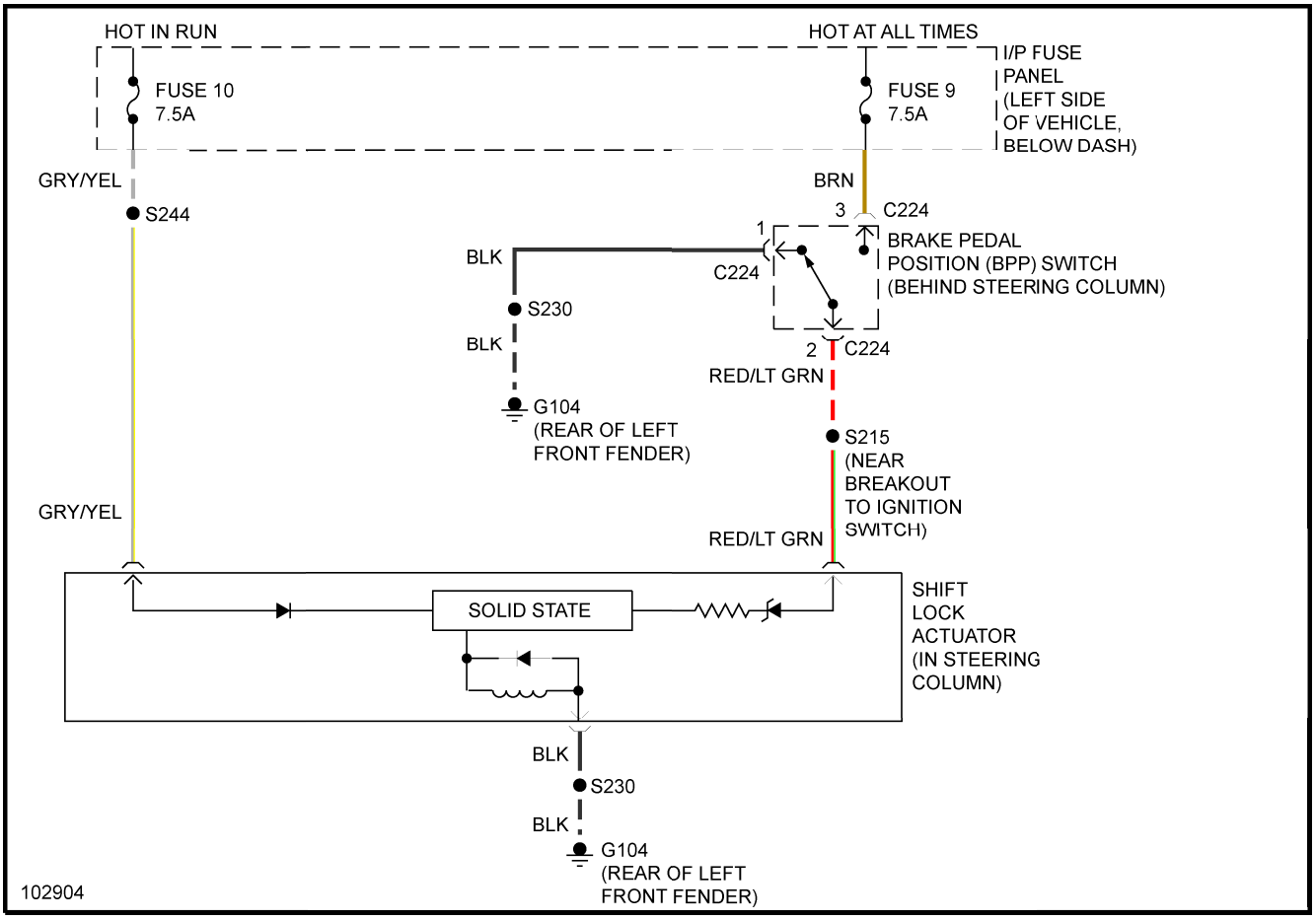


Fig. 34: Shift Interlock System Wiring Diagram (1998 Explorer & Mountaineer)

1997 Ford Pickup F150

1997-98 AUTOMATIC TRANSMISSIONS Ford Motor Co. Shift Interlock Systems

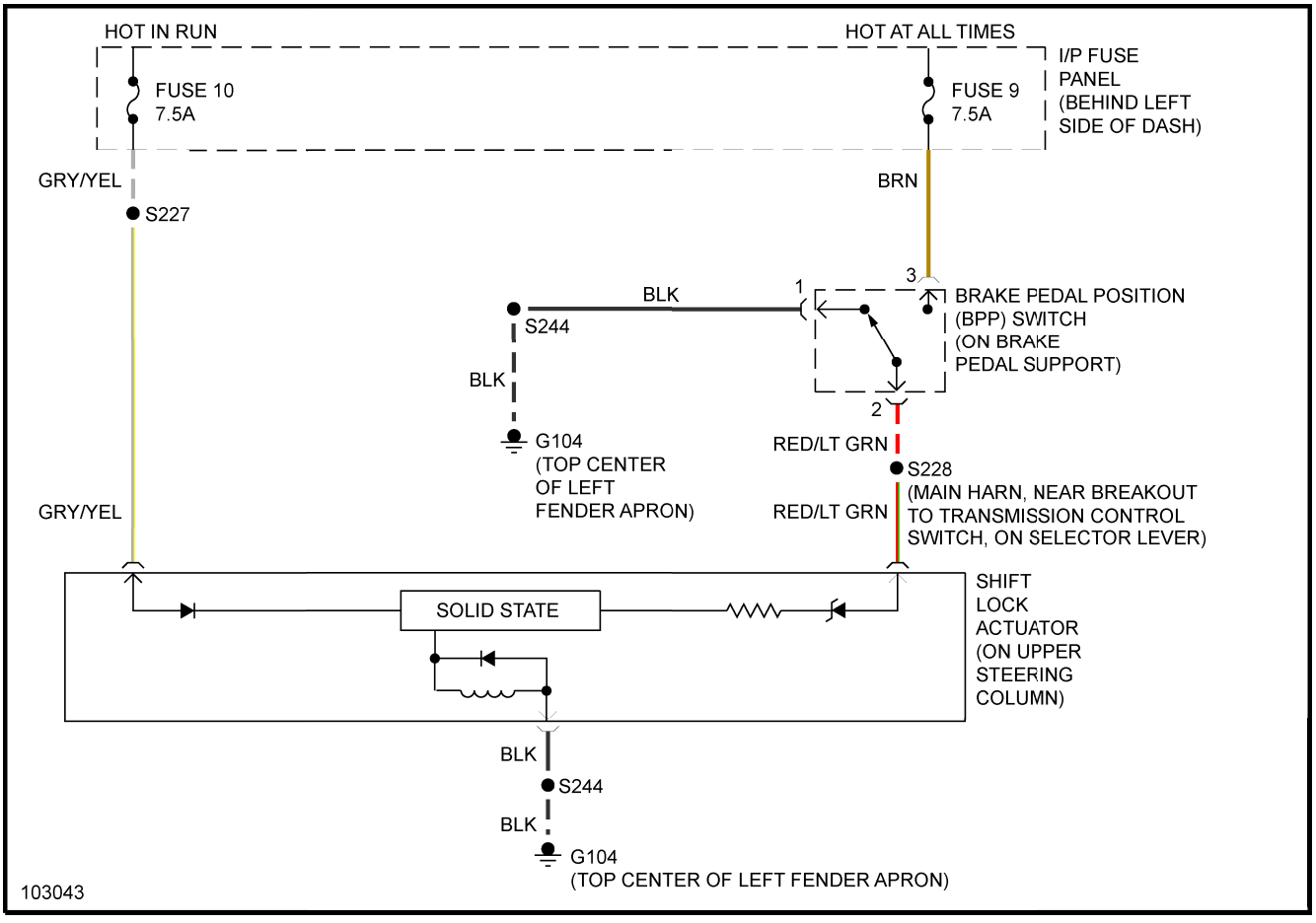


Fig. 35: Shift Interlock System Wiring Diagram (1998 Ranger)

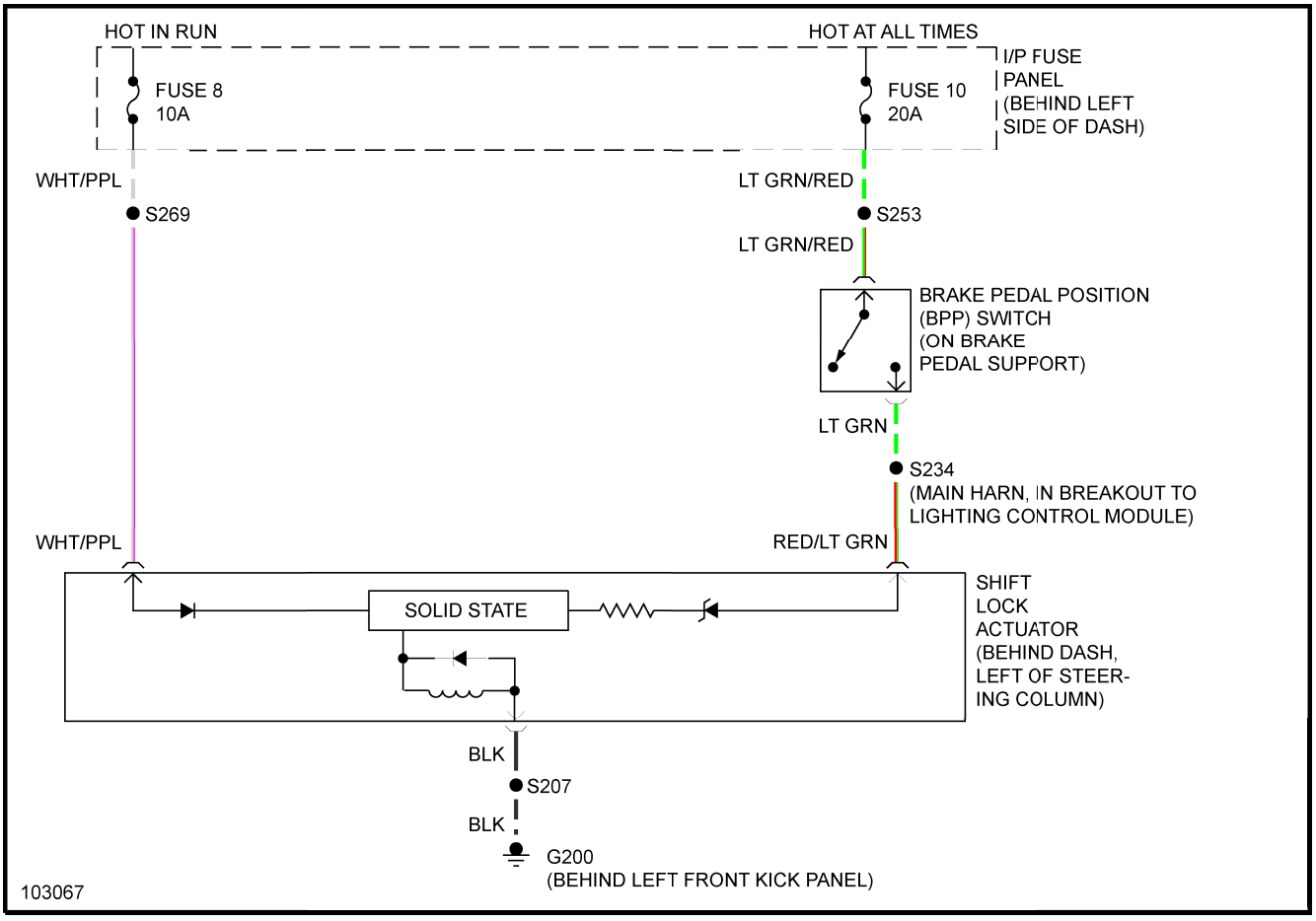

HOT IN RUN
HOT AT ALL TIMES
FUSE 8
10A
FUSE 10
20A
I/P FUSE
PANEL
(BEHIND LEFT
SIDE OF DASH)
WHT/PPL
S269
LT GRN/RED
S253
LT GRN/RED
BRAKE PEDAL POSITION
(BPP) SWITCH
(ON BRAKE
PEDAL SUPPORT)
LT GRN
S234
(MAIN HARN, IN BREAKOUT TO
LIGHTING CONTROL MODULE)
WHT/PPL
RED/LT GRN
SOLID STATE
SHIFT
LOCK
ACTUATOR
(BEHIND DASH,
LEFT OF STEER-
ING COLUMN)
BLK
S207
BLK
G200
(BEHIND LEFT FRONT KICK PANEL)
103067

Fig. 36: Shift Interlock System Wiring Diagram (1998 Town Car)

STARTER - DIESEL

1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Starters - Diesel Engines

DESCRIPTION

The starter used on the 7.3L turbo diesel engine uses internal gear reduction and an externally mounted solenoid. System consists of a starter (ignition) switch, starter relay, batteries, and wiring.

ADJUSTMENTS

PINION GAP

1. Secure starter in vise. Connect a switch in series with starter solenoid and battery. Connect second switch in series with starter field wire. See **Fig. 1** .
2. Turn both switches on. Starter drive should extend and motor should run. Turn switch No. 2 off. Starter should stop running, but drive pinion should remain extended. With the drive pinion extended, measure gap between pinion and stop ring.
3. Pinion gap should be .004-.079" (0.10-2.00 mm). If adjustment is required, insert or remove shims between solenoid and drive end housing. Add shims to decrease gap, or remove shims to increase gap.

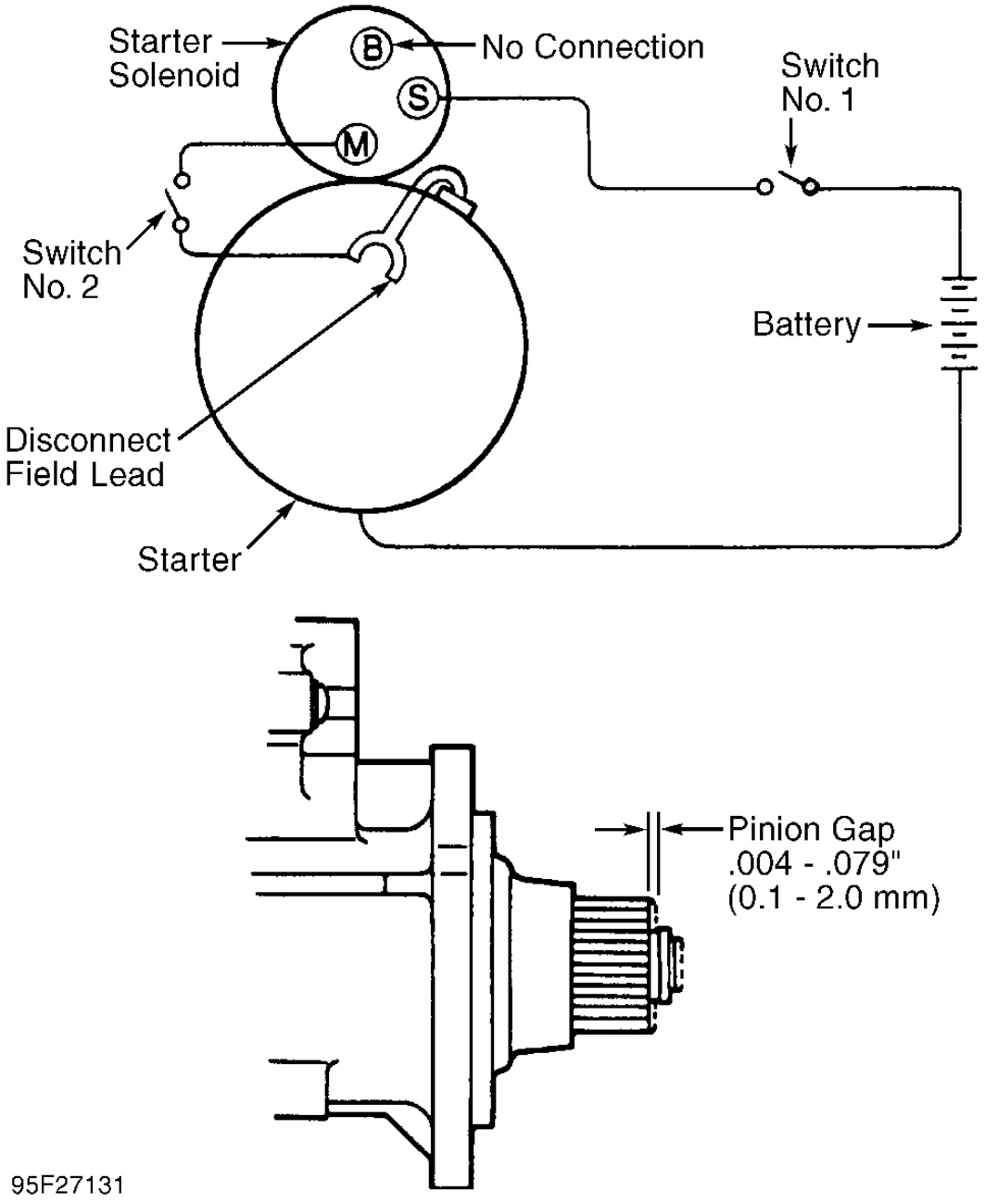


Fig. 1: Measuring Pinion Gap
Courtesy of FORD MOTOR CO.

TROUBLE SHOOTING

NOTE: See TROUBLE SHOOTING - BASIC PROCEDURES article in GENERAL

INFORMATION.

ON-VEHICLE TESTING

CAUTION: Before testing starter, ensure transmission is in Park on A/T models, or in Neutral on M/T models.

STARTER MOTOR TEST

1. Ensure batteries are fully charged and in good condition. Ensure battery cables and connections are in good condition. Measure voltage at starter solenoid battery cable terminal. If voltage is battery voltage, go to next step. If voltage is less than 12 volts, recheck battery cables and connections. Service as necessary.
2. Connect one lead of remote starter switch to battery cable terminal on starter solenoid. Connect remaining lead to "S" terminal on starter solenoid. Operate remote starter switch. If engine does not crank, repair or replace starter. If engine cranks normally, starter is okay; go to STARTER RELAY TEST. If engine cranks sluggishly, inspect batteries, cables, and connections. Repair or replace starter if batteries, cables, and connections are okay.

STARTER RELAY TEST

NOTE: Perform STARTER MOTOR TEST before performing STARTER RELAY TEST.

1. Disconnect wire from terminal "S" of starter relay, located behind right battery. Connect remote starter switch between terminal "S" and positive battery terminal. Ensure transmission is in Park on A/T models, or in Neutral on M/T models.
2. Attempt to crank engine with remote starter switch. If engine cranks, relay is okay. Inspect ignition switch, neutral or clutch switch, and circuitry for open or loose connections. If engine does not crank, replace relay.

SOLENOID TEST

With all solenoid wiring disconnected, test for continuity between terminals. See SOLENOID SPECIFICATIONS TABLE. Inspect contact plate for excessive pitting. Repair or replace as necessary.

SOLENOID SPECIFICATIONS

Terminals	Ohmmeter Reading
"S" & "M"	Continuity
"S" & Ground	Continuity
"B" & "M"	No Continuity

BENCH TESTING

NO-LOAD TEST

1. Secure starter in vise. Verify pinion gap is correct. See **PINION GAP** under ADJUSTMENTS. Connect jumper lead between battery positive post and solenoid terminal "B". Connect remote start switch between battery positive post and solenoid terminal "S". See **Fig. 2** .
2. Starter should rotate at a smooth, consistent speed. If rotation is not smooth, verify shim adjustment for armature-to-starter housing clearance is correct. If shim adjustment is okay, replace starter.

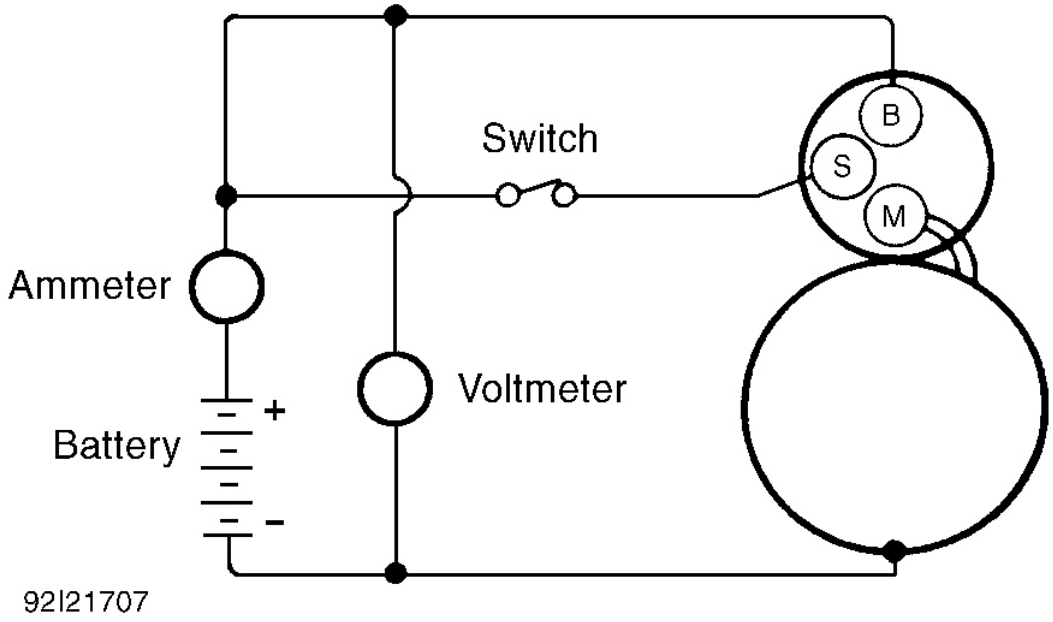


Fig. 2: Testing Starter No-Load Operation
Courtesy of FORD MOTOR CO.

ARMATURE OPEN CIRCUIT TEST

An open armature circuit can often be detected by inspecting the commutator for evidence of burning. If burning exists, replace armature. Inspect for damage to other related components.

ARMATURE GROUNDED CIRCUIT TEST

Connect voltmeter leads to negative battery terminal and starter commutator. Connect jumper cable to positive battery terminal and armature. See **Fig. 3** . If meter indicates any voltage, windings are grounded.

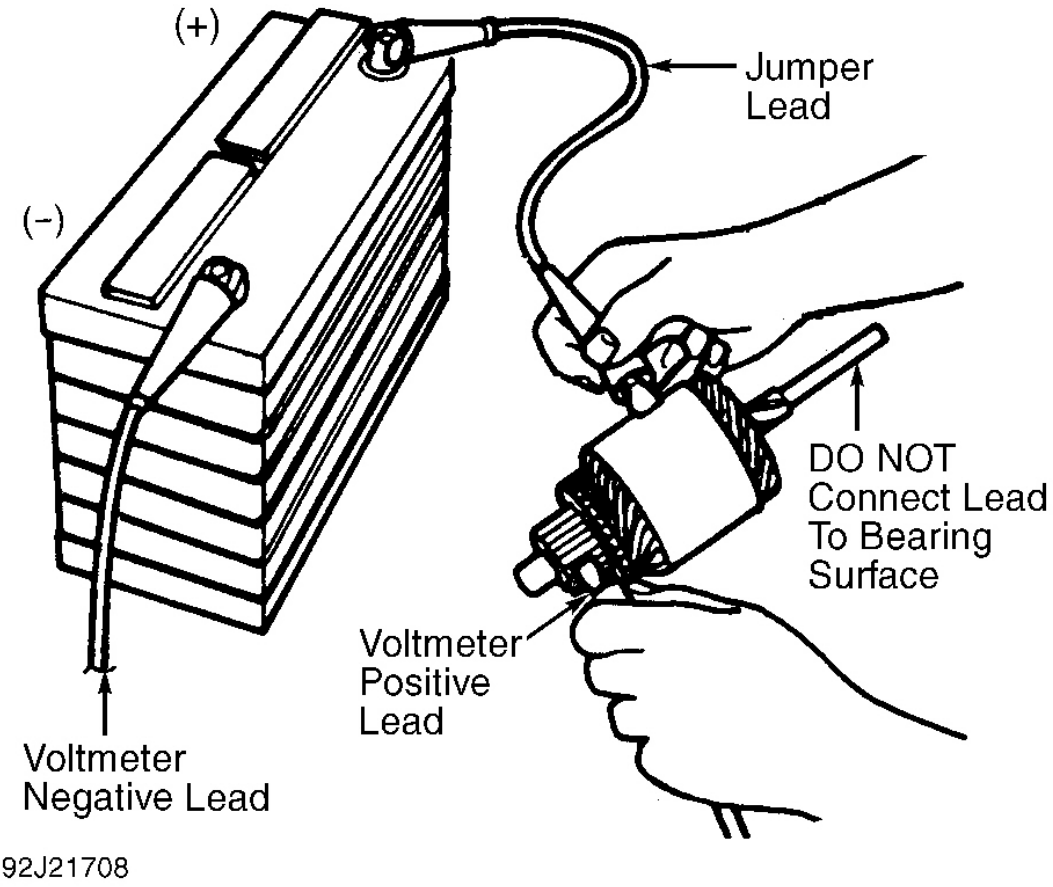


Fig. 3: Testing Armature For Ground
Courtesy of FORD MOTOR CO.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

REMOVAL & INSTALLATION

Removal

Disconnect negative battery cable. Raise vehicle. Disconnect battery cable from starter. Disconnect starter solenoid wiring. Remove starter mounting bolts or nuts. Remove starter from vehicle.

Installation

1. Position starter assembly onto flywheel housing. Start bolts. Hold starter against mounting surface, fully inserted into pilot hole. Tighten bolts or nuts to specification. See **TORQUE SPECIFICATIONS** .
2. Connect battery cable and solenoid wiring to starter. Tighten to specification. Lower vehicle. Connect negative battery cable. Check starter operation.

OVERHAUL

NOTE: Use illustration for exploded view of Motorcraft starter motor assembly. See Fig. 4 .

Adjust pinion gap upon reassembly. See **PINION GAP** under ADJUSTMENTS.

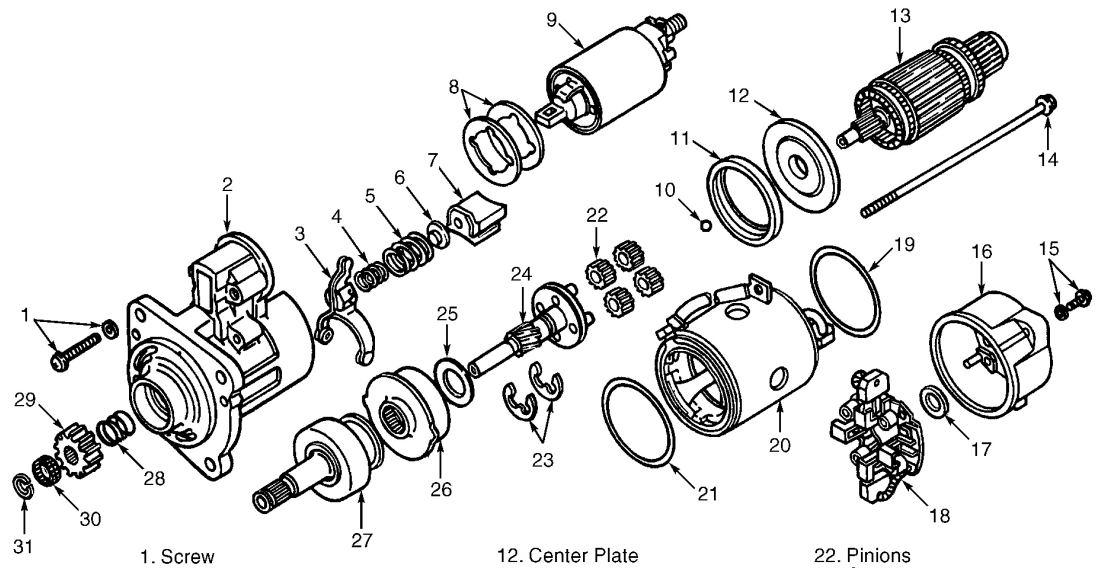


Fig. 4: Exploded View Of Starter
Courtesy of FORD MOTOR CO.

STARTER SPECIFICATIONS

STARTER SPECIFICATIONS

Application	Specification
Brush Length	

3.0" (78 mm) Motor	.66" (16.8 mm)
3.4" (85 mm) Motor	.71" (18 mm)
Brush Spring Tension	
3.0" (78 mm) Motor	64 ozs. (2.3 kg)
3.4" (85 mm) Motor	122 ozs. (3.5 kg)
Commutator Runout	(1) .005" (.12 mm)
Pinion Depth Gap	.004-.079" (0.10-2.00 mm)
Starter Load Test	
Normal Load Current Draw	
3.0" (78 mm) Motor	130-220 Amps
3.4" (85 mm) Motor	230-630 Amps
Maximum Load Current Draw	
3.0" (78 mm) Motor	800 Amps
3.4" (85 mm) Motor	2400 Amps
Starter No-Load Test	
Maximum Current Draw	
3.0" (78 mm) Motor	60-80 Amps
3.4" (85 mm) Motor	170 Amps
(1) Replace armature if runout exceeds specification.	

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Starter Mounting Bolts	15-20 (20-27)
	INCH Lbs. (N.m)
Brush Holder Bolts	18-27 (2-3)
Solenoid Screws	44-62 (5-7)
Solenoid Terminal Nuts	
"M" Terminal	89-106 (10-12)
"B" Terminal	80-124 (9-14)
Through-Bolts	71-89 (8-10)

WIRING DIAGRAMS

1997 Ford Pickup F150

STARTER - DIESEL 1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Starters - Diesel Engines

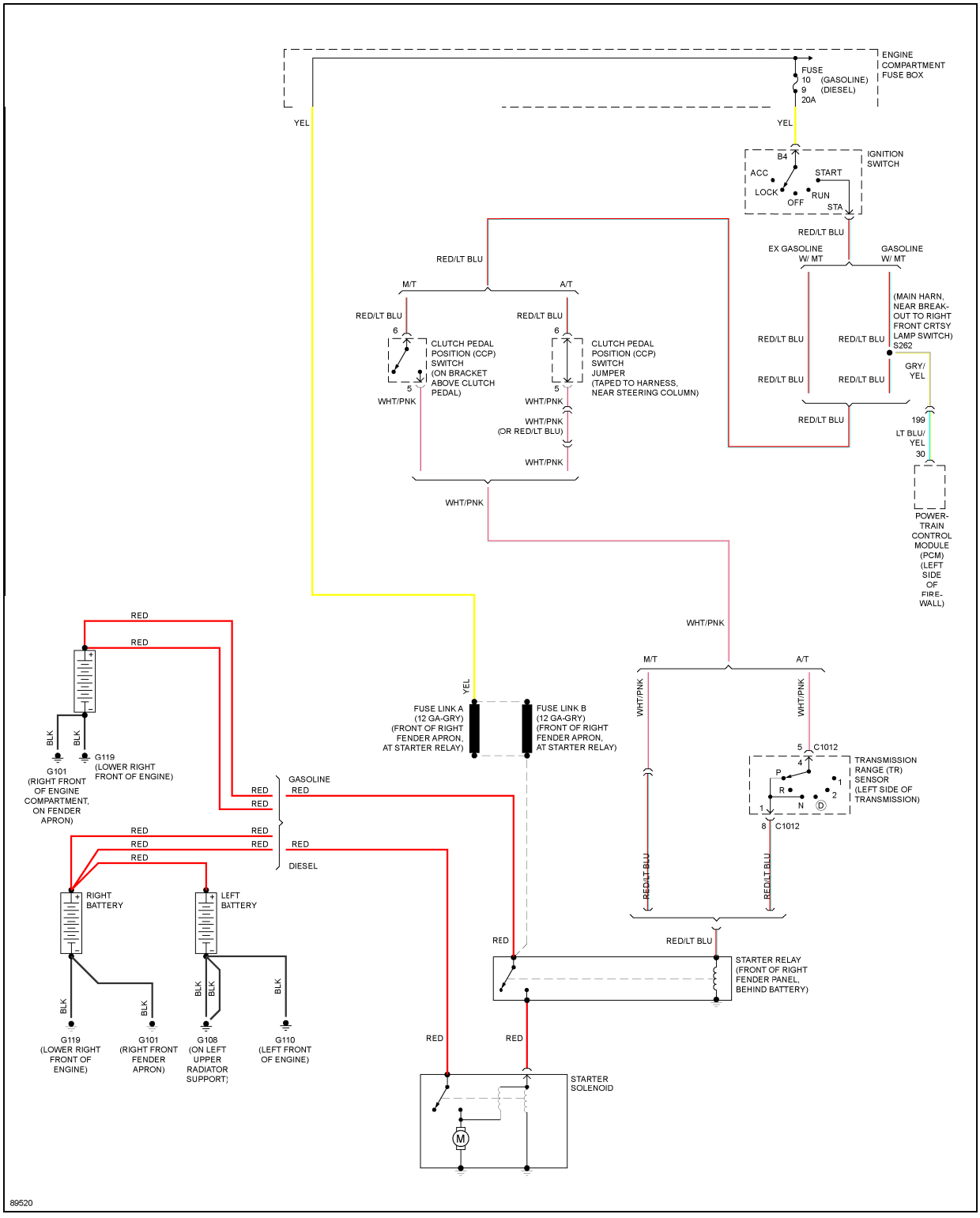


Fig. 5: Starter System Wiring Diagram

STARTER - GASOLINE

1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Starters - Gasoline Engines

DESCRIPTION

A gear reduction starter with permanent magnet fields is used. An internal planetary gear reduction unit provides increased cranking torque. The starting system includes a 6-pole, 4-brush starting motor with solenoid-actuated drive, battery, starter/ignition switch, transmission range switch (A/T), clutch pedal position switch (M/T), starter relay (some models) and associated circuitry.

Power to ignition switch is provided from IGN SW fuse in interior fuse panel.

TROUBLE SHOOTING

NOTE: For "engine not cranking" condition on A/T, determine if condition exists in both Park and Neutral. If condition occurs in one position and not other, manual lever position sensor is probable cause. See appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANS SERVICE section listed below.

- **TRANSMISSION SERVICE - A/T (4R70W)**
- **TRANSMISSION SERVICE - A/T (E40D)**

ON-VEHICLE TESTING

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

STARTER LOAD TEST

1. Connect starter load tester and voltmeter to battery terminals. Ensure no current is flowing through the ammeter and carbon pile of tester. Disconnect terminal "S" of starter relay. See **Fig. 1** .
2. Connect remote starter switch between terminal "S" and positive battery terminal. Ensure transmission is in Park on A/T models, or Neutral on M/T models.
3. Crank engine with ignition off. Note voltmeter indication, then stop cranking engine. Adjust carbon pile to match voltage obtained while cranking. Read ammeter. Replace or repair starter if current exceeds specification. See **STARTER SPECIFICATIONS** .

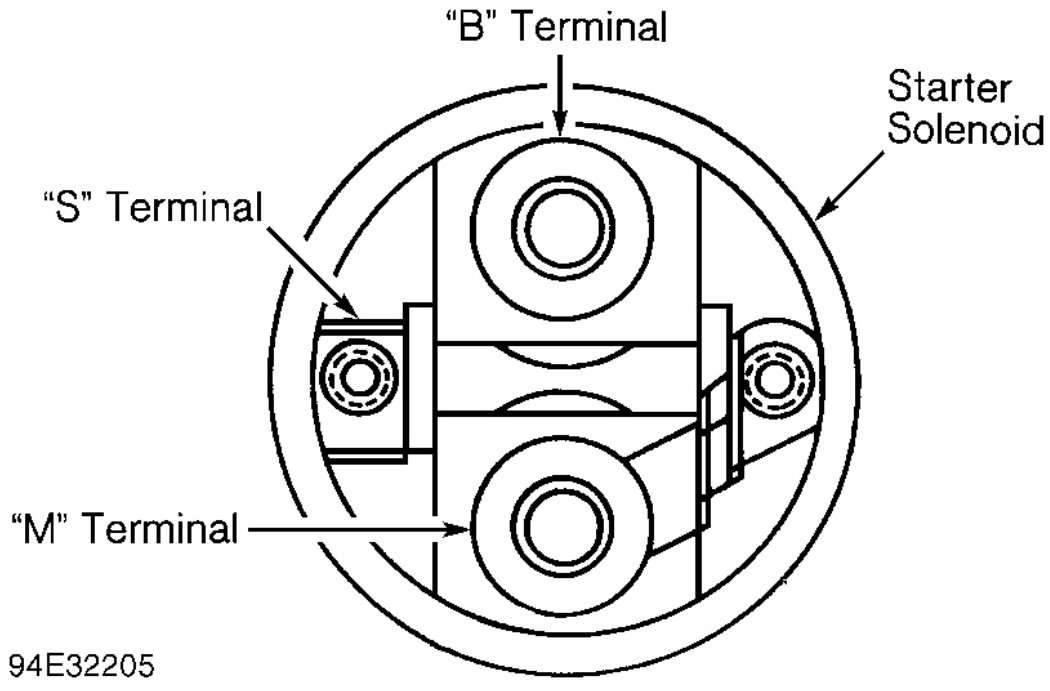


Fig. 1: Identifying Starter Solenoid Terminals
Courtesy of FORD MOTOR CO.

STARTER CIRCUIT VOLTAGE DROP TEST

NOTE: If starter cranks slowly and battery is okay, perform following test.

1. Check engine ground strap and negative battery cable connections and repair as necessary. Prevent engine from starting by disabling ignition system. Ensure transmission is in Park or Neutral. Connect remote control starter switch between starter solenoid "S" terminal and positive battery terminal. See **Fig. 1** .
2. Connect voltmeter positive lead to positive battery terminal. Connect voltmeter negative lead to "M" terminal on starter solenoid. See **Fig. 1** . Crank engine using remote starter switch while observing voltmeter. If voltmeter reads greater than 0.5 volt, go to next step. If voltmeter reading is less than 0.5 volt, starter feed circuit is okay, repair or replace starter.
3. Move voltmeter negative lead to "B" terminal on starter solenoid. Crank engine and record voltmeter reading. If voltmeter reading is still greater than 0.5 volt, excessive resistance is present in positive battery cable or cable connections. If voltmeter reads less than 0.5 volt at "B" terminal, check cable connections at starter solenoid. If okay, replace starter solenoid.

BENCH TESTING

STARTER NO-LOAD TEST

1. Connect starting system test equipment following manufacturer instructions. See **Fig. 2** . Ensure carbon pile rheostat of starter tester is turned off.
2. Connect heavy wire between negative battery terminal and starter frame. Connect another heavy wire between positive battery terminal and "B" terminal of starter solenoid.

CAUTION: Ensure starter is securely mounted in vise while energizing as starter will move or jump.

3. Connect a jumper wire between battery positive terminal and "S" terminal on starter solenoid. See **Fig. 1** . Ensure starter drive ejects completely and starter spins rapidly. Observe ammeter reading.
4. If ammeter is not available, note voltage reading while testing. Using carbon pile load tester, apply load until voltmeter reading is equal to test voltage. Read amperage on carbon pile tester. Replace starter if current draw is more than specified. See **STARTER SPECIFICATIONS** .

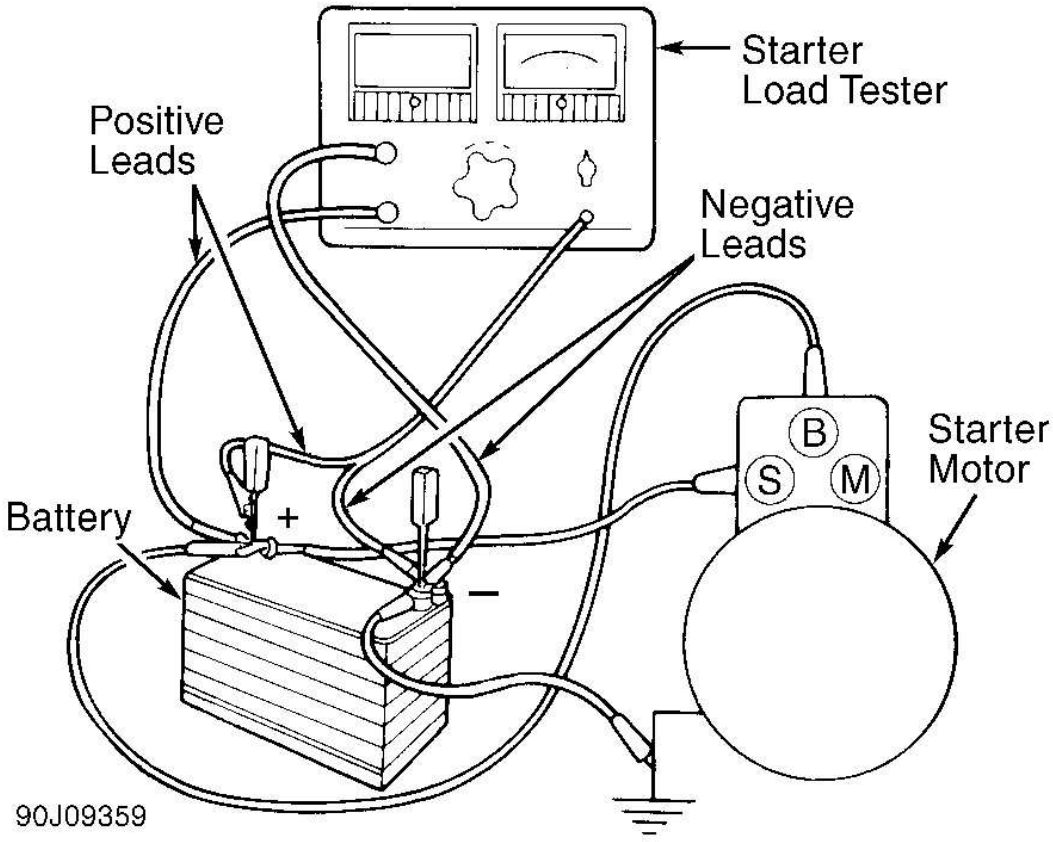


Fig. 2: Identifying Starter No-Load Test Connections (Typical)
Courtesy of FORD MOTOR CO.

ARMATURE OPEN CIRCUIT CHECK

An open armature circuit can be detected by inspecting commutator for burning. If burning is present, replace armature assembly. Check for damage to other related components.

ARMATURE GROUNDED CIRCUIT TEST

Using an ohmmeter, check for continuity between any commutator segment and armature laminations. See **Fig. 3** . If ohmmeter indicates less than infinite resistance, armature is shorted and must be replaced.

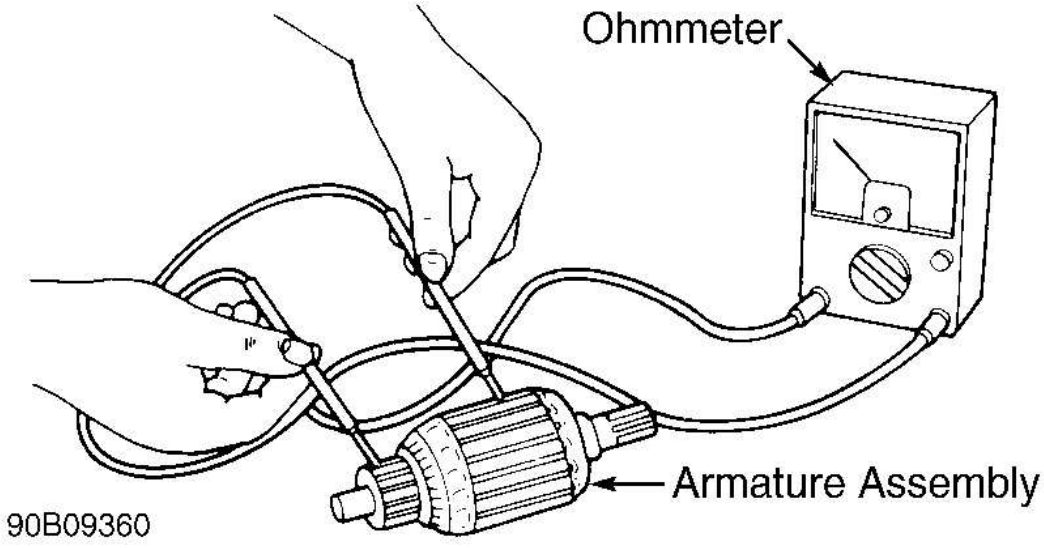


Fig. 3: Testing Armature For Grounded Circuit
Courtesy of FORD MOTOR CO.

OVERHAUL

NOTE: Use illustration for exploded view of Motorcraft starter motor assembly. See Fig. 4 .

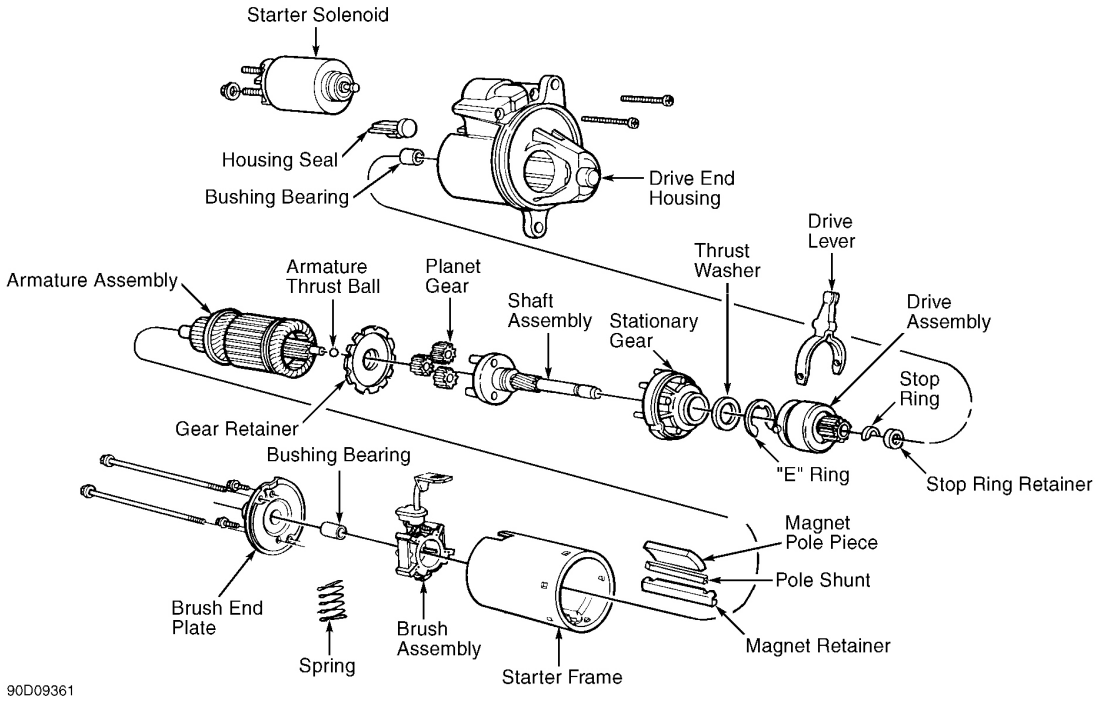


Fig. 4: Exploded View Of Motorcraft Starter Motor Assembly (Typical)
Courtesy of FORD MOTOR CO.

STARTER SPECIFICATIONS

STARTER SPECIFICATIONS

Application	Specification
Brush Length	
New	.55-.66" (14-17 mm)
Service Limit	.25" (6.4 mm)
Brush Spring Tension	64 ozs. (2.3 kg)
Commutator	
Diameter	(1)
Runout	(2) .005" (.13 mm)
Starter Load Test	
Maximum Current Draw	130-220 Amps
Starter No-Load Test	
Maximum Current Draw	60-80 Amps

(1) Not specified by manufacturer.

(2) Replace armature if runout exceeds specification.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Starter-To-Engine Bolts	15-20 (20-27)
	INCH Lbs. (N.m)
Brush End Plate Bolts	55-80 (6-9)
Cable Terminal Nut	70-130 (7.9-14.7)
Solenoid Bolts	45-85 (5-10)
Solenoid Terminal Nuts	80-124 (9-14)
Through-Bolts	55-75 (6.2-8.5)

WIRING DIAGRAMS

1997 Ford Pickup F150

STARTER - GASOLINE 1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Starters - Gasoline Engines

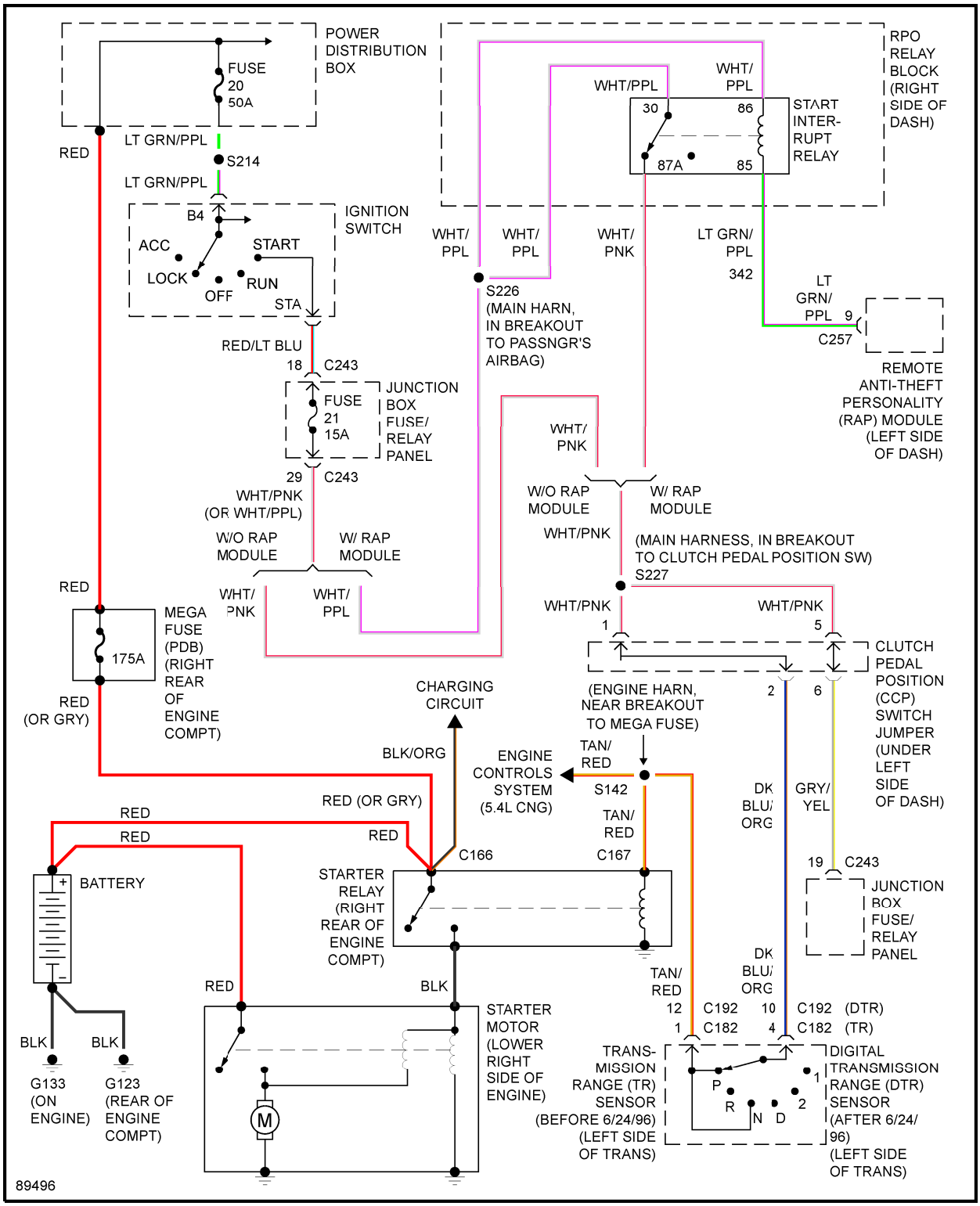


Fig. 5: Starter System Wiring Diagram (Light-Duty - A/T)

1997 Ford Pickup F150

STARTER - GASOLINE 1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Starters - Gasoline Engines

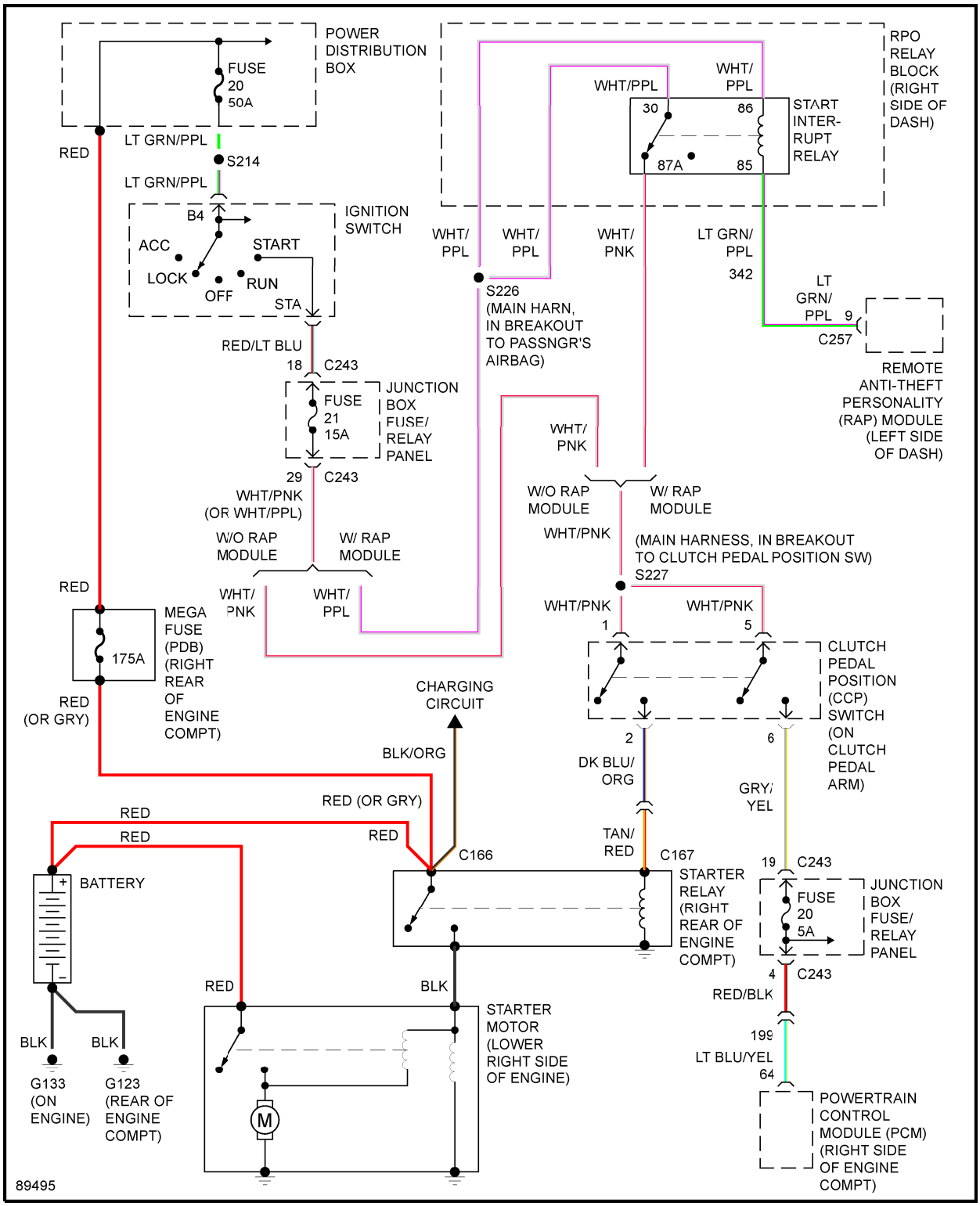


Fig. 6: Starter System Wiring Diagram (Light-Duty - M/T)

1997 Ford Pickup F150

STARTER - GASOLINE 1997 STARTING & CHARGING SYSTEMS Ford Motor Co. - Starters - Gasoline Engines

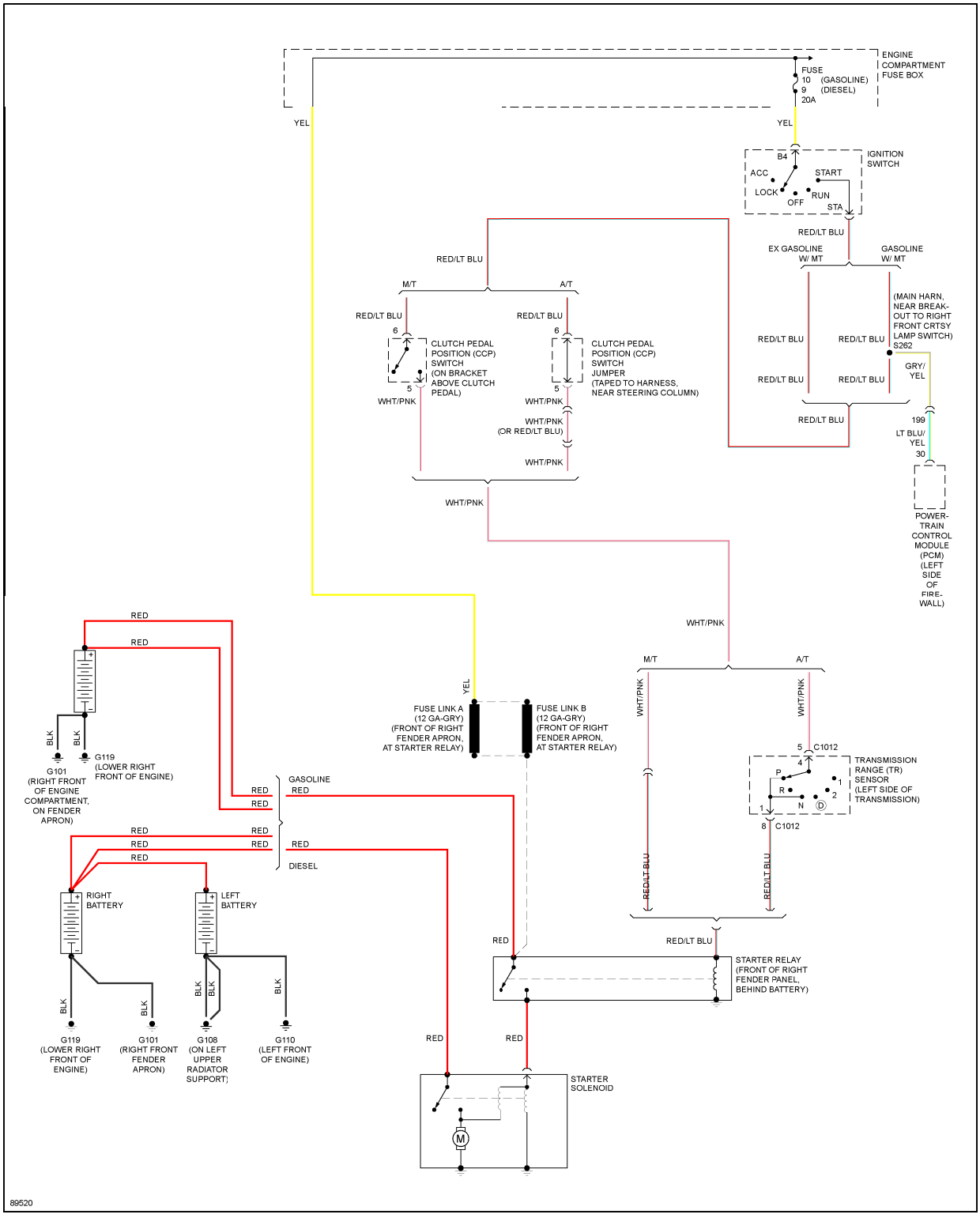


Fig. 7: Starter System Wiring Diagram (F250 Heavy-Duty & F350)

STEERING COLUMN SWITCHES

1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Steering Column Switches

DESCRIPTION & OPERATION

The multifunction switch, located on the steering column, includes headlight dimmer, flash-to-pass and front windshield wiper/washer switches. The ignition switch and lock cylinder are also mounted on the steering column.

WARNING: Deactivate air bag system before performing any service operation involving steering column components. See AIR BAG RESTRAINT SYSTEM article. Do not apply electrical power to any component on steering column without first deactivating air bag system. Air bag may deploy.

ADJUSTMENTS

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

IGNITION SWITCH

Expedition & Pickup

Disconnect negative battery cable. Set ignition switch to RUN position. Align switch pin with slot in lock/column assembly. Position slots in column/lock assembly with index mark on casting.

Ignition switch is properly adjusted if:

- In ACCESSORY, accessory circuit is operative and steering wheel is locked. Automatic shift lever cannot be moved.
- In LOCK, all ignition switch electrical circuits are inoperative and steering wheel is locked. Automatic shift lever cannot be moved.
- In OFF, all ignition switch electrical circuits are inoperative and steering wheel is unlocked. Automatic shift lever can be moved.
- In ON (RUN), all ignition switch circuits or accessory circuits are operative except starter circuit and warning light check circuit. Steering wheel is unlocked and automatic shift lever can be moved.
- In START, only engine ignition, warning light check, and starter circuits are operative. Steering wheel is unlocked and automatic shift lever can be moved.

SYSTEM TESTING

CAUTION: When battery is disconnected, vehicle computer and memory system may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

IGNITION SWITCH INOPERATIVE (EXPEDITION & PICKUP)

1. **Check Fuses**

   Check fuses No. 14 (60-amp), 20 (50-amp) and 21 (50-amp) in power distribution box. If fuses are okay, go to step 4). If any fuse is blown, go to next step.

2. **Check System**

   Replace blown fuse. If fuse repeatedly blows, go to next step. If fuse does not fail again, go to step 4).

3. **Check For Short To Ground**

   Turn ignition off. Remove failing fuse. Disconnect ignition switch harness connector. Measure resistance between load side (right side terminal) of fuse cavity of failing fuse and ground. If resistance is greater than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair shorted wire in question (Yellow, Orange/Yellow or Light Green/Purple wire) between fuse panel and ignition switch. See wiring diagram in POWER DISTRIBUTION article in WIRING DIAGRAMS.

4. **Check Power To Ignition Switch**

   Turn ignition off. Disconnect ignition switch harness connector. Check for battery voltage at ignition switch harness connector terminals B1, B3, B4, and B5. See **Fig. 2** . If battery voltage exists at all terminals specified, replace i nition switch. If battery voltage does not exist, repair suspect wire. See wiring diagram in POWER DISTRIBUTION article in WIRING DIAGRAMS.

IGNITION SWITCH INOPERATIVE (EXPLORER & MOUNTAINEER)

1. **Check Fuse**

   Check fuses No. 14 (60-amp)) in power distribution box. If fuse is okay, go to step 7). If any fuse is blown, replace blown fuse. If fuse repeatedly blows, go to next step. If fuse does not fail again, go to step check system operation.

2. **Check Yellow Wire For Short To Ground**

   Turn ignition off. Remove fuse No. 14 (60-amp). Disconnect ignition switch harness connector. Measure resistance between load side (right side terminal) of fuse cavity No. 14 and ground. If resistance is greater than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair shorted Yellow wire between

power distribution box and ignition switch.

3. **Check Light Green/Purple Wires For Short To Ground**

   Measure resistance between ignition switch harness connector terminals I1, I2 (Light Green/Purple wires) and ground. See **Fig. 3** . If resistance is greater than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair shorted Light Green Purple wire between interior fuse panel and ignition switch.

4. **Check Black/Light Green Wire For Short To Ground**

   Measure resistance between ignition switch harness connector terminal A1 (Black/Light Green wire) and ground. If resistance is greater than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair shorted Black/Light Green wire between interior fuse panel and ignition switch.

5. **Check Red/Light Blue Wire For Short To Ground**

   Measure resistance between ignition switch harness connector terminal ST (Red/Light Green wire) and ground. If resistance is greater than 10 k/ohms, go to next step. If resistance is less than 10 k/ohms, repair shorted Red/Light Blue wire between interior fuse panel and ignition switch.

6. **Check Gray/Yellow Wire For Short To Ground**

   Measure resistance between ignition switch harness connector terminal A2 (Gray/Yellow wire) and ground. If resistance is greater than 10 k/ohms, replace ignition switch and test system operation. If resistance is less than 10 k/ohms, repair shorted Gray/Yellow wire between interior fuse panel and ignition switch.

7. **Check Power To Ignition Switch**

   Turn ignition off. Disconnect ignition switch harness connector. Check for battery voltage at ignition switch harness connector BATT terminals. See **Fig. 3** . If battery voltage exists at both BATT terminals, replace ignition switch. If battery voltage does not exist, repair Yellow between power distribution box and ignition switch.

COMPONENT TESTING

CAUTION: When battery is disconnected, vehicle computer and memory system may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

NOTE: Before performing following tests, ensure all multifunction switch grounds, wiring, and fuses are okay. Also, ensure all circuit connections are clean and tight. For ignition switch circuit identification, see wiring diagram in POWER DISTRIBUTION article in WIRING DIAGRAMS. For multifunction switch circuit identification, see wiring diagram in EXTERIOR LIGHTS article.

DIMMER, FLASH-TO-PASS TURN SIGNAL & HAZARD SWITCH

Remove and disconnect multifunction switch. See MULTIFUNCTION SWITCH under **REMOVAL & INSTALLATION** . Check continuity between specified terminals while operating multifunction switch lever to positions as specified. See **Fig. 1** . See DIMMER & TURN SIGNAL SWITCH TESTING TABLE. If continuity is not as specified, replace multifunction switch.

DIMMER & TURN SIGNAL SWITCH TESTING

Switch Position	Check For Continuity Between Terminals
Neutral Position	"D" & "G"; "D" & "I"
Left Turn Signal On & Hazard Switch Off	"A", "G" & "C"
Right Turn Signal On & Hazard Switch Off	"E", "E" & "C"
Hazard Switch On	"A", "E", "G", "I" & "B"
Flash-To-Pass On (1)	No. 1 & No. 2; No. 3 & No. 4
Headlight Dimmer	
High Beam	No. 1 & No. 3
Low Beam	No. 1 & No. 2

(1) Lever pulled in halfway.

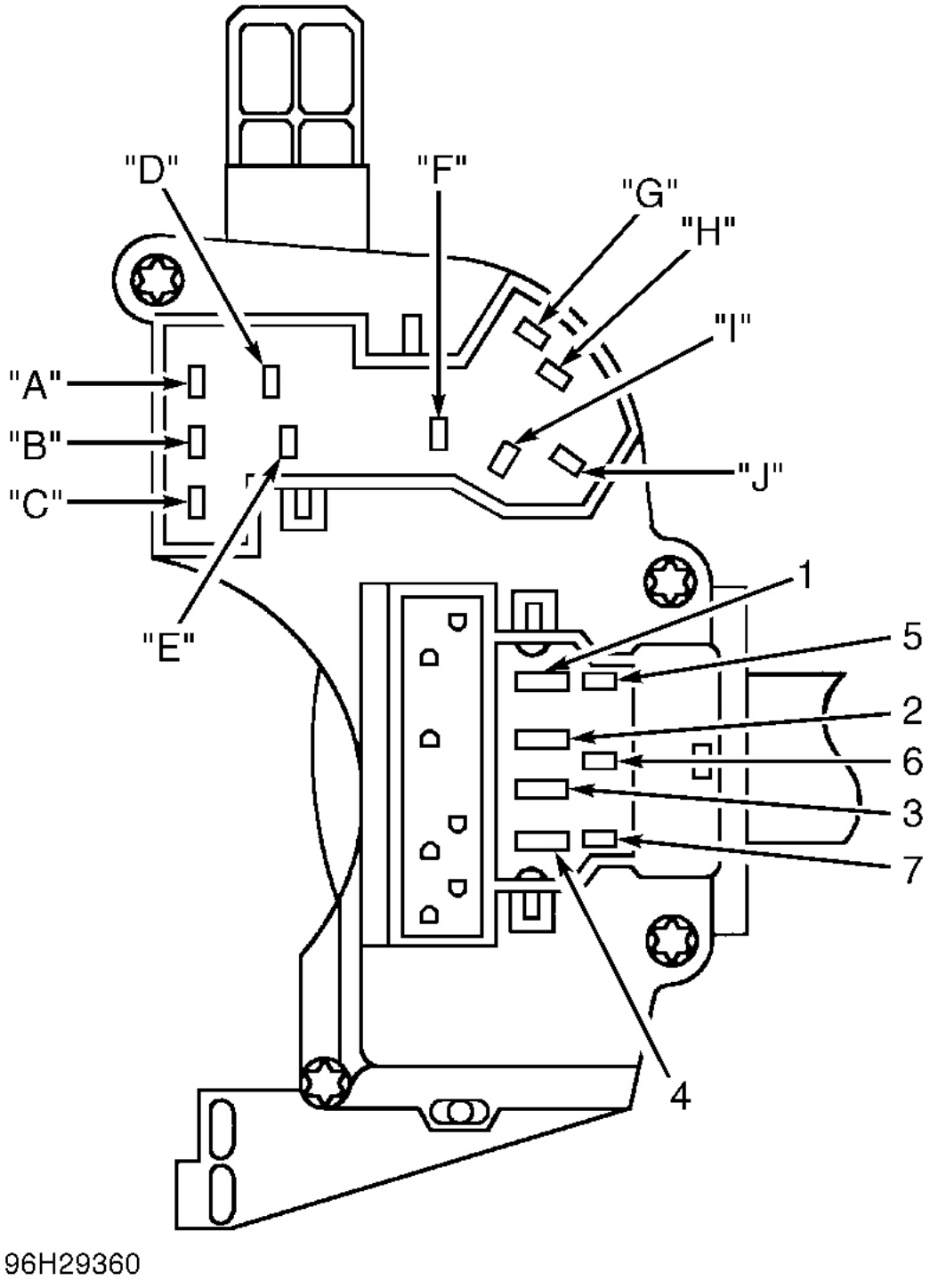


Fig. 1: Identifying Multifunction Switch Terminals
Courtesy of FORD MOTOR CO.

WIPER/WASHER SWITCH

Remove and disconnect multifunction switch. See MULTIFUNCTION SWITCH under **REMOVAL & INSTALLATION** . Measure resistance between specified terminals while operating multifunction switch lever to positions as specified. See **Fig. 1** . See WIPER/WASHER SWITCH TESTING TABLE. If continuity is not as specified, replace multifunction switch.

WIPER/WASHER SWITCH TESTING

Switch Position	Between Terminals	(1) Ohms
Wiper Switch		
Off	No. 5 & No. 6	47,600
Int	No. 5 & No. 6	11,330
Lo	No. 5 & No. 6	4080
Hi	No. 5 & No. 6	0-4
Intermittent Wipers	No. 6 & No. 7	(2)
Washer Switch		
Off	No. 6 & No. 7	103,300
On	No. 6 & No. 7	0-4
Rear Wiper Switch (3)		
Off	H & No. 6	2,900
Int 1	H & No. 6	11,000
Int 2	H & No. 6	330
Rear Washer Switch (3)	H & No. 6	0-4

(1) Specification can vary by as much as 10 percent.

(2) Rotate control from maximum delay to minimum delay. Resistance should gradually decrease from approximately 103 k/ohms to 3.3 k/ohms.

(3) Expedition only.

IGNITION SWITCH

1. To inspect ignition switch for mechanical operation, rotate lock cylinder through all switch positions. Lock cylinder should not bind, and should return from START to RUN position without assistance.
2. If binding or incorrect modes occur, ignition switch should be adjusted. After adjustment, if binding or incorrect modes still exist, lock cylinder should either be disassembled and inspected for damage, or ignition switch should be replaced.
3. To test electrical function of ignition switch, disconnect ignition switch connector. Check continuity between specified switch terminals using a self-powered test light or ohmmeter. See **Fig. 2** or **Fig. 3** . See IGNITION SWITCH CONTINUITY TABLE. If continuity is not as specified, replace ignition switch.

IGNITION SWITCH CONTINUITY

Continuity Between Terminals	Switch Position

STA & B4	Start
GND & P1	Start
B5 & I1	Run
B1 & A1	Run
B5 & A1	ACC
B3 & A3	Run
B2 & A2	Run
B4 & A4	Run

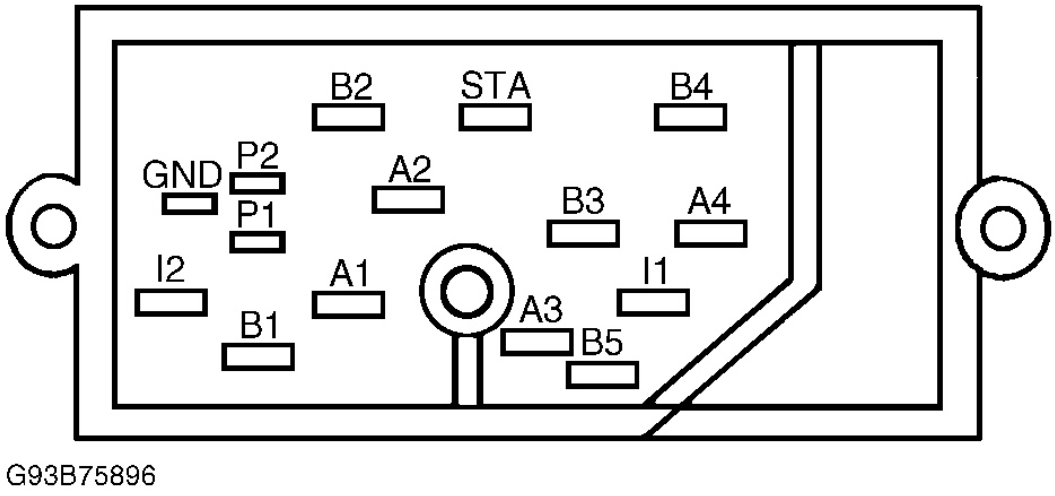


Fig. 2: Identifying Ignition Switch Harness Connector Terminals (Expedition & Pickup)
Courtesy of FORD MOTOR CO.

IGNITION SWITCH CONTINUITY TEST

Continuity Between Terminals	Switch Position
BATT & BATT	All
A2 & A2	All
BATT & ST	Start
BATT & A2 (1)	Run
BATT & I1	Run
BATT & I2	Start
BATT & A1	Accessory
P1, P2 & Switch Case	Start
(1) Terminal located next to P2.	

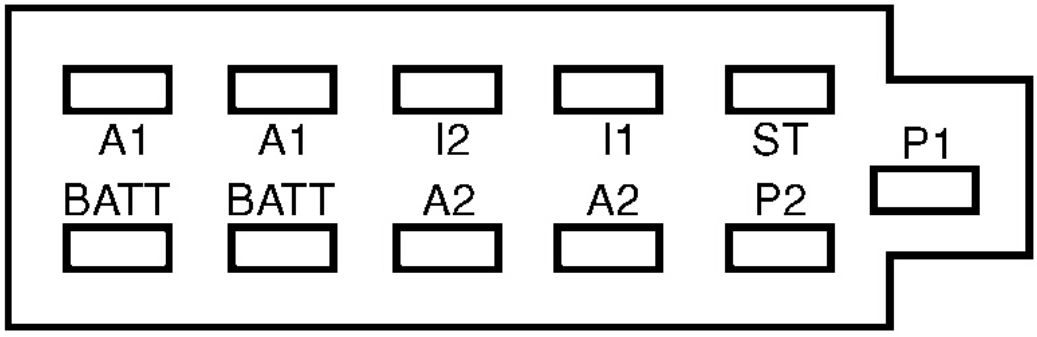


Fig. 3: Identifying Ignition Switch Terminals (Explorer & Mountaineer)
Courtesy of FORD MOTOR CO.

REMOVAL & INSTALLATION

WARNING: Deactivate air bag system before performing any service operation involving steering column components. See AIR BAG RESTRAINT SYSTEM article. Do not apply electrical power to any component on steering column without first deactivating air bag system. Air bag may deploy.

CAUTION: When battery is disconnected, vehicle computer and memory system may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

MULTIFUNCTION SWITCH

Removal & Installation

Disconnect negative battery cable. Remove lock cylinder. See **LOCK CYLINDER** . Remove upper and lower steering column shrouds. Remove retaining screws. Disconnect multifunction switch harness connectors. Remove switch. To install, reverse removal procedure.

IGNITION SWITCH

Removal & Installation

1. Disconnect negative battery cable. Remove steering column opening cover. See **Fig. 4** . Remove hood release handle and position aside.

2. On Explorer and Mountaineer, remove steering column opening cover reinforcement. Disconnect ignition switch harness connector. Remove 2 ignition switch screws and ignition switch. To install, reverse removal procedure.

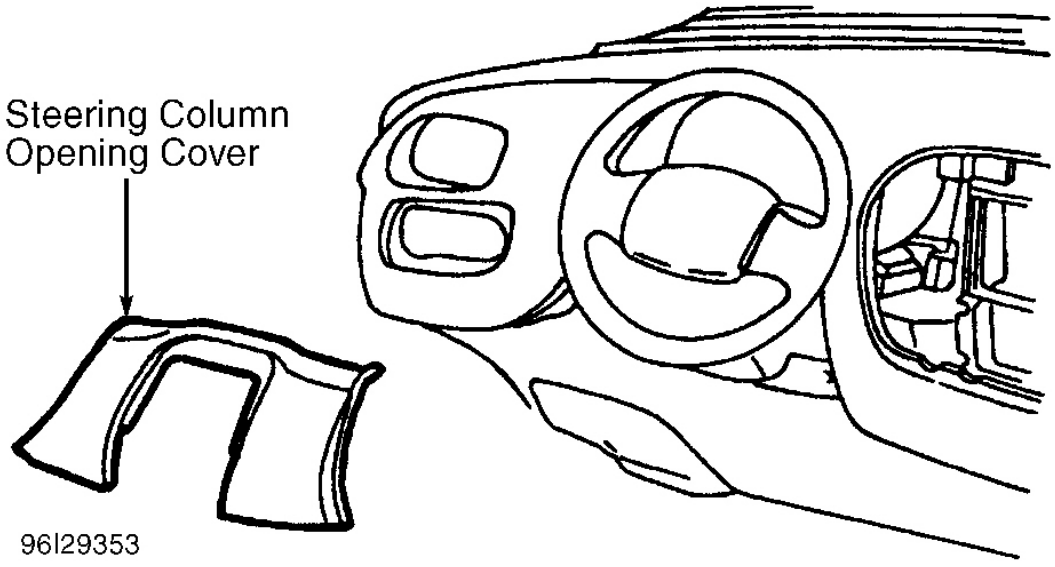


Fig. 4: Identifying Steering Column Opening Cover
Courtesy of FORD MOTOR CO.

LOCK CYLINDER

Removal & Installation (With Key)

Disconnect negative battery cable. Set ignition switch to RUN position. Insert a 1/8" drill bit or wire through access hole in trim steering column trim (below lock cylinder). Press retaining pin inward and pull out lock cylinder. To install, lubricate lock cylinder. Turn lock cylinder to RUN position. Press retaining pin inward and insert lock cylinder into housing. To install remaining components, reverse removal procedure.

Removal (Without Key)

1. Use this procedure to remove ignition lock cylinder if key is missing or cylinder is frozen. Disconnect negative battery cable. Remove steering wheel. Using pliers, twist cap until it separates from ignition switch lock cylinder.
2. Using a 3/8" drill bit, drill down middle of ignition lock key slot about 3/4-1" (19-25 mm) until ignition switch lock cylinder breaks loose from breakaway base of ignition switch lock cylinder. Remove ignition switch lock cylinder and drill shavings from lock cylinder housing.
3. Remove bearing retainer, bearing and gear. Thoroughly clean all metal shavings and other foreign material from housing. Carefully inspect housing for damage. If damage is apparent, replace housing.

Installation

1. Install gear, bearing, and retainer. Lubricate cylinder cavity. Rotate lock cylinder to RUN position. Press retaining pin inward and insert new lock cylinder into lock cylinder housing.
2. Before rotating key to OFF position, ensure cylinder is fully seated and aligned. Use key to rotate cylinder to ensure mechanical operation is okay in all positions.

WIRING DIAGRAMS

1997 Ford Pickup F150

STEERING COLUMN SWITCHES 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Steering Column Switches

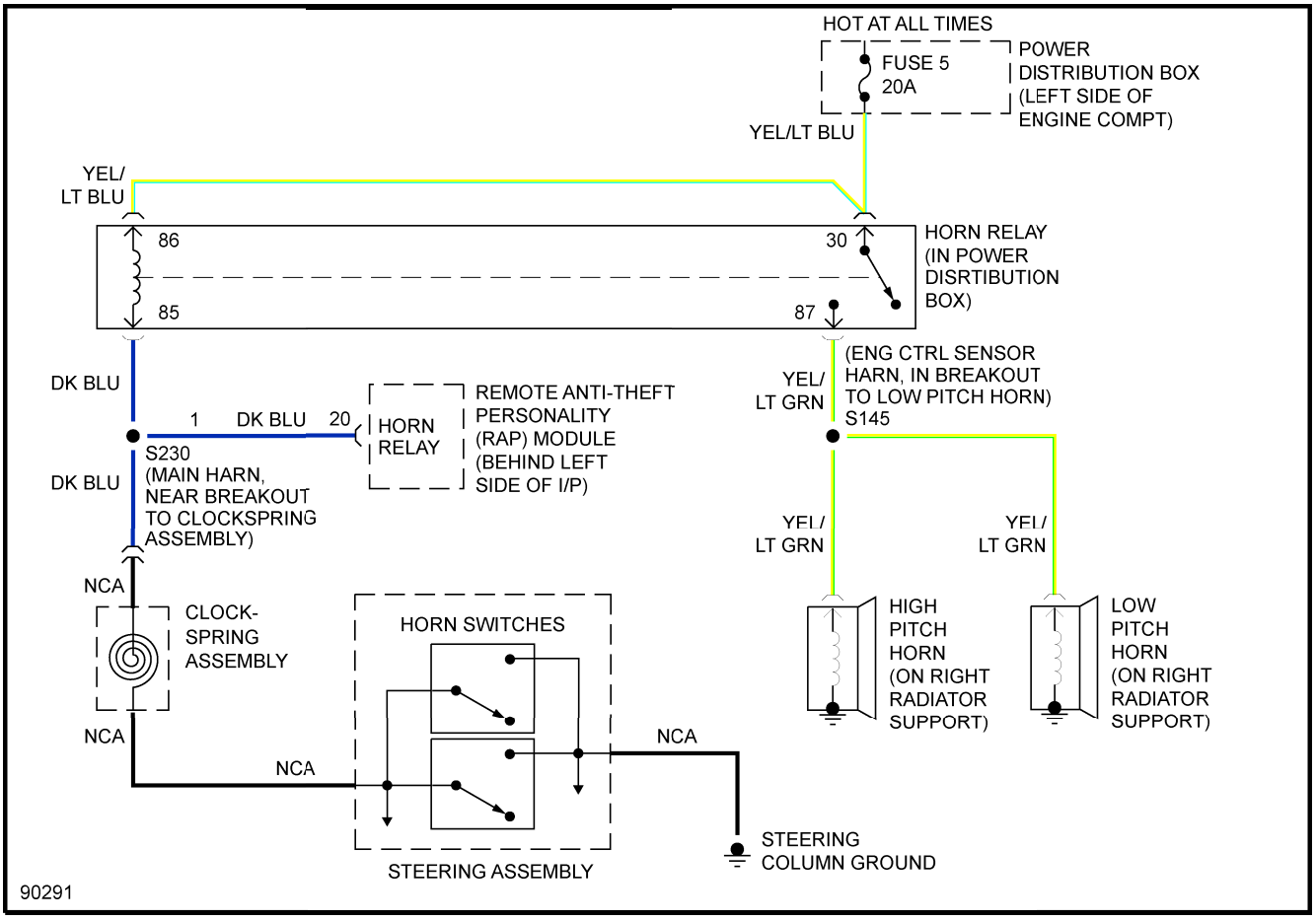


Fig. 5: Horn System Wiring Diagram (Expedition & Pickup - F150 & F250 Light-Duty)

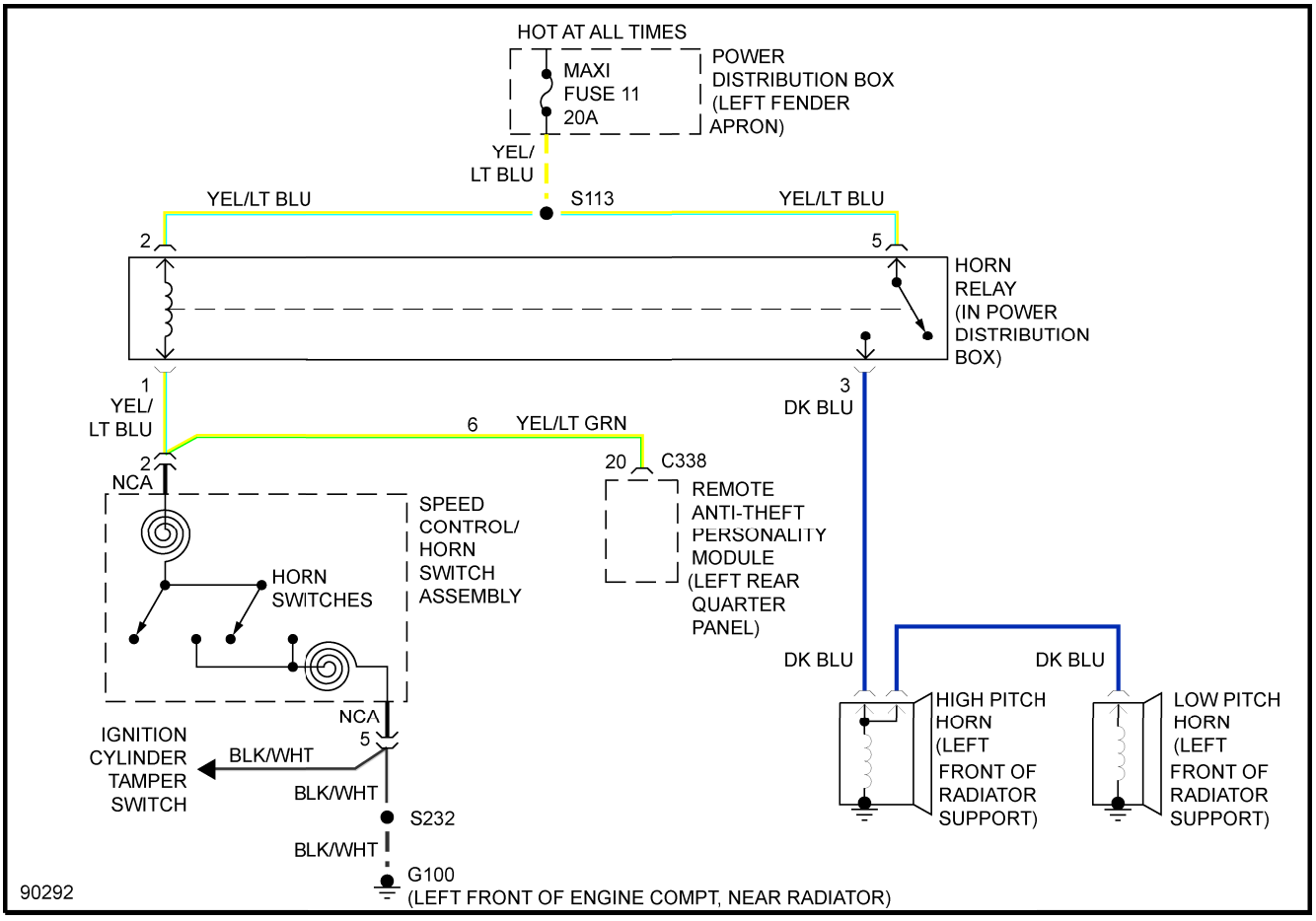

HOT AT ALL TIMES
MAXI FUSE 11 20A
POWER DISTRIBUTION BOX (LEFT FENDER APRON)
YEL/ LT BLU
YEL/LT BLU
S113
YEL/LT BLU
2
5
HORN RELAY (IN POWER DISTRIBUTION BOX)
1 YEL/ LT BLU
3 DK BLU
6 YEL/LT GRN
20 C338
2 NCA
SPEED CONTROL/ HORN SWITCH ASSEMBLY
HORN SWITCHES
REMOTE ANTI-THEFT PERSONALITY MODULE (LEFT REAR QUARTER PANEL)
DK BLU
DK BLU
NCA 5
IGNITION CYLINDER TAMPER SWITCH
BLK/WHT
BLK/WHT
S232
BLK/WHT
G100
(LEFT FRONT OF ENGINE COMPT, NEAR RADIATOR)
HIGH PITCH HORN (LEFT FRONT OF RADIATOR SUPPORT)
LOW PITCH HORN (LEFT FRONT OF RADIATOR SUPPORT)
90292

Fig. 6: Horn System Wiring Diagram (Explorer & Mountaineer)

1997 Ford Pickup F150

STEERING COLUMN SWITCHES 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Steering Column Switches

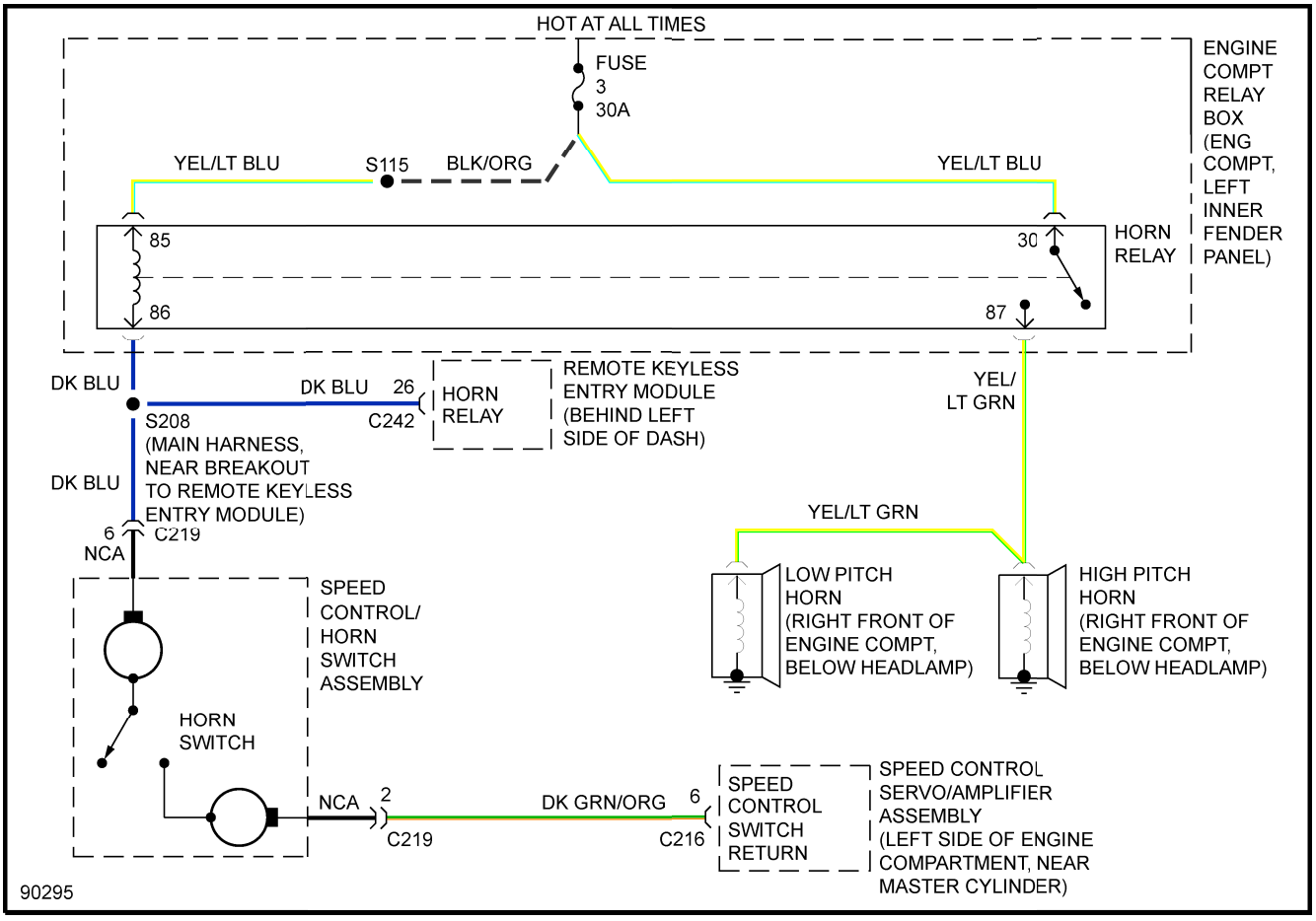


Fig. 7: Horn System Wiring Diagram (Pickup - F250 Heavy-Duty & F350)

STEERING COLUMN

1996-97 STEERING Ford Motor Co. - Steering Column - Except Stripped Chassis

DESCRIPTION

All steering columns are energy-absorbing and collapse upon frontal impact.

Vehicles are equipped with tilt steering wheels and air bags. A multifunction switch operates wiper/washer, turn signal/hazard and horn/dimmer. Multifunction and ignition switches are mounted on steering column.

WARNING: On models with Supplemental Restraint System (SRS), observe following precautions. Before any repairs are performed, disconnect and shield negative battery cable. Disconnect SRS connector at control unit. Use caution when working around steering column (air bag could deploy).

AIR BAG SERVICE PRECAUTIONS

Observe following precautions when working with air bag systems.

- Disable air bag system before servicing any air bag system or steering column components. Failure to do so may result in accidental air bag deployment and cause personal injury. See **DISABLING AIR BAG SYSTEM** .
- Back-up power supply will hold a deployment charge for approximately one minute (10 minutes for Villager) after positive battery cable is disconnected. Servicing SRS before deployment charge is depleted may cause accidental air bag deployment and possible personal injury.
- Because of critical system operating requirements, **DO NOT** service sensors, clockspring, monitor, or air bag module. Corrections are made by replacement only.
- Always wear safety glasses whenever servicing an air bag equipped vehicle or handling an air bag.
- When carrying a live air bag module, ensure air bag module and trim cover are pointed away from your body. This minimizes chance of injury in the event of an accidental deployment.
- When placing a live air bag module on a bench or other surface, always face air bag module and trim cover up, away from surface. This will reduce motion of module if it is accidentally deployed.
- After deployment, air bag surface may contain deposits of sodium hydroxide, which may irritate skin. Sodium hydroxide is a product of gas generant combustion. Always wear gloves and safety glasses when handling a deployed air bag. Wash your hands using mild soap and water. Follow correct disposal procedures.
- If a part is replaced and new part does not correct condition,reinstall original part and perform diagnostic procedure again.
- Never probe connectors on air bag module. Doing so may cause air bag deployment and personal injury.
- The instruction to DISCONNECT always refers to a connector. **DO NOT** disconnect a component from vehicle when instructed to DISCONNECT.
- After repairs, ensure AIR BAG warning light does not indicate any other faults.

DISABLING AIR BAG SYSTEM

WARNING: Back-up power supply will hold a deployment charge for approximately one minute after battery positive cable is disconnected. Servicing SRS before deployment charge is depleted may cause accidental air bag deployment and possible personal injury.

NOTE: Use following disabling procedure for component replacement purposes only. If vehicle was involved in a collision and air bag did not deploy, or SRS is not functioning properly and vehicle needs to be driven, complete system deactivation is required.

Disconnect negative and then positive battery cables. Shield both cables. Air bag system contains a back-up power supply built into the air bag diagnostic monitor. Wait a minimum of one minute before servicing any air bag system components. System is now disabled.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See appropriate COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

- **COMPUTER RELEARN PROCEDURES** - 1996
- **COMPUTER RELEARN PROCEDURES** - 1997

STEERING WHEEL & AIR BAG

Removal & Installation

1. Set front wheels in straight-ahead position. Disconnect and shield negative battery cable then disconnect positive cable. Wait at least one minute to deplete charge in air bag back-up power supply. Remove air bag module-to-steering wheel retaining fasteners. Remove air bag from steering wheel, and disconnect air bag module electrical connector.
2. Disconnect horn switch and speed control (if equipped) electrical connectors. Mark steering wheel-to-steering shaft position for installation reference. Remove bolt and use Steering Wheel Remover (T67L-3600-A) to remove steering wheel.
3. To install, reverse removal procedure. Ensure all wiring is routed properly. Tighten steering wheel retaining bolt and air bag retaining nuts to specification. See **TORQUE SPECIFICATIONS** .

STEERING WHEEL & HORN PAD

Removal & Installation

1. Set front wheels in straight-ahead position. Disconnect negative battery cable. Grasp sides of horn pad and pull upward to unclip retainers. Disconnect horn switch electrical connector, and remove horn pad.
2. Mark steering wheel-to-steering shaft position for installation reference. Remove steering wheel retaining bolt. Using Steering Wheel Remover (T67L-3600-A), remove steering wheel.
3. To install, reverse removal procedure. Tighten steering wheel retaining bolt and horn pad retaining screws (if equipped) to specification. See **TORQUE SPECIFICATIONS** .

MULTIFUNCTION SWITCH

Removal & Installation

Disconnect negative battery cable. Remove upper and lower steering column shrouds. Remove 2 multifunction switch retaining screws. Disconnect multifunction switch electrical connector, and remove multifunction switch from steering column. To install, reverse removal procedure.

LOCK CYLINDER

Removal (With Key)

1. Disconnect negative battery cable. Ensure gear selector is in Park (A/T models). On Pickup, remove steering wheel and steering column shrouds. Disconnect key warning switch electrical connector.
2. Using key, turn lock cylinder to RUN position. Using a 1/8" (3.17 mm) diameter pin or punch, depress retaining pin located in lock cylinder housing, and pull out lock cylinder. See **Fig. 1** .

Installation

1. Turn lock cylinder to RUN position. Depress retaining pin. Insert lock cylinder into housing. Ensure tab on end of lock cylinder aligns with slot in ignition drive gear and lock cylinder is fully engaged in housing.
2. Using key, turn lock cylinder to OFF position. To complete installation, reverse removal procedure. Check lock cylinder and ignition switch functions. Ensure column locks when switch is in LOCK position.

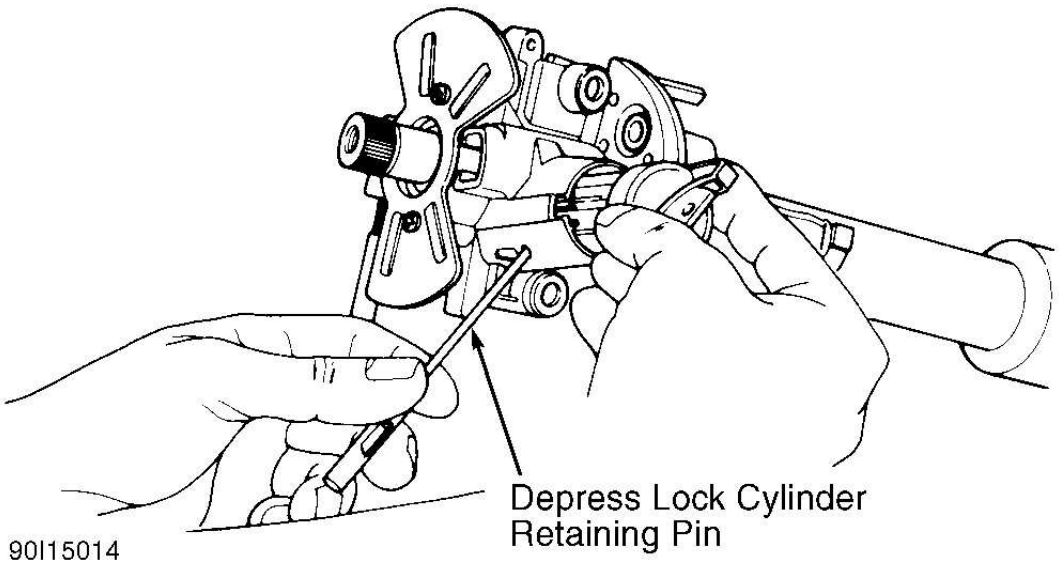


Fig. 1: Removing Ignition Lock Cylinder
Courtesy of FORD MOTOR CO.

Removal (Without Key)

1. Use this procedure to remove ignition lock cylinder if key is missing or cylinder lock is frozen. Disconnect battery negative cable. Remove steering wheel. See **STEERING WHEEL & AIR BAG** under REMOVAL & INSTALLATION or **STEERING WHEEL & HORN PAD** . Remove upper and lower steering column shrouds. Disconnect key warning switch electrical connector. Use a 1/8" (3.17 mm) drill bit to drill out retaining pin. **DO NOT** drill deeper than 1/2" (12.7 mm).
2. Place a chisel at base of lock cylinder cap. Using hammer, strike chisel with sharp blows to break cap away from lock cylinder. On all models, use 3/8" (9.52 mm) drill bit to drill out center of lock cylinder key slot. Drill down approximately 1 3/4" (44 mm) until lock cylinder breaks away from base of lock cylinder.
3. Remove metal shavings from lock cylinder housing. Remove bearing retainer, bearing and ignition drive gear from lock cylinder. Thoroughly clean all metal shavings and other foreign materials from housing. Carefully inspect housing for damage. If damage is apparent, replace housing.

Installation

1. Install ignition drive gear, bearing and bearing retainer. Lubricate cylinder cavity with lock cylinder lubricant. Turn ignition switch to RUN position. Depress retaining pin, and insert NEW lock cylinder into housing.
2. Ensure tab on end of lock cylinder aligns with slot in ignition drive gear. Using key, turn lock cylinder to OFF position to engage cylinder retaining pin into cylinder housing hole. To complete installation, reverse removal procedure. Check lock cylinder functions. Ensure column locks when switch is in LOCK

position.

IGNITION SWITCH

Removal

Disconnect negative battery cable. Using key, turn ignition lock to RUN position. Remove 2 ignition switch retaining screws. Disconnect ignition switch electrical connector, and remove ignition switch from steering column.

Installation

Ensure ignition lock is in RUN position. Slot in actuator housing should be aligned with mark on steering column casting. Align pin on ignition switch with slot in actuator housing. Connect ignition switch electrical connector, and tighten retaining screws to specification. See **TORQUE SPECIFICATIONS** . To complete installation, reverse removal procedure.

STEERING COLUMN

Removal

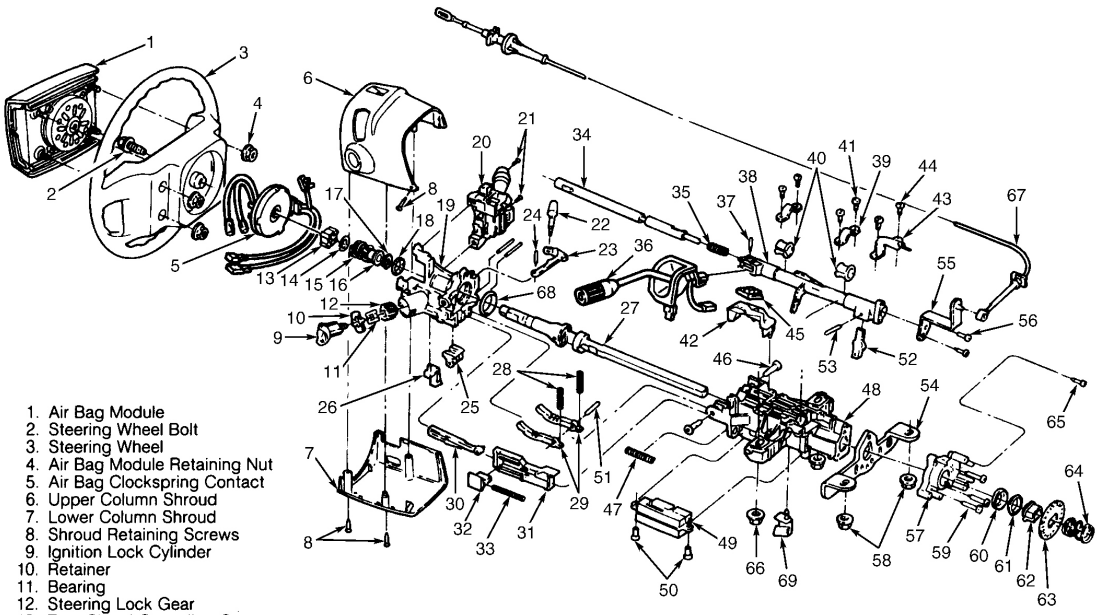
1. Set front wheels in straight-ahead position. Disable air bag (if equipped). See **DISABLING AIR BAG SYSTEM** . Remove steering wheel. See **STEERING WHEEL & AIR BAG** under REMOVAL & INSTALLATION or **STEERING WHEEL & HORN PAD** . Remove right and left instrument panel lower moldings. Remove instrument panel lower trim cover.
2. Remove screws from lower steering column shroud. Remove lower steering column shroud by pulling shroud down and toward rear of vehicle. Disconnect air bag clockspring contact assembly electrical connectors (if equipped). Place tape across contact assembly stator and rotor to prevent accidental rotation (if equipped). Remove upper steering column shroud from column. Remove clockspring contact assembly retaining screws, and remove contact assembly from steering column (if equipped).
3. Unscrew and remove tilt lever from column. Using key, turn lock cylinder to RUN position. Place a 1/8" (3.17 mm) diameter pin in hole located in outer edge of lock cylinder housing. Depress retaining pin, and pull out lock cylinder. Remove 6 instrument panel lower reinforcement brace bolts, and remove reinforcement brace.
4. Remove PRND21 cable retaining screw, and disconnect cable from actuator housing. Disconnect PRND21 cable loop from shift tube hook. Remove 2 screws attaching multifunction switch to steering column. Disconnect multifunction switch electrical connector, and remove switch.
5. Remove pinch bolt from intermediate shaft "U" joint. Disconnect shift cable from selector lever pivot. Push in tab on shift cable, and slide cable off shaft cable bracket. Disconnect ignition switch electrical connector. Support steering column assembly, and remove 4 steering column-to-support bracket retaining nuts. Carefully remove column from vehicle.

Installation

To install, reverse removal procedure. Tighten all nuts and bolts to specifications. See **TORQUE SPECIFICATIONS** .

OVERHAUL

When overhauling steering columns, refer to exploded view illustrations. See **Fig. 2** .



1. Air Bag Module
2. Steering Wheel Bolt
3. Steering Wheel
4. Air Bag Module Retaining Nut
5. Air Bag Clockspring Contact
6. Upper Column Shroud
7. Lower Column Shroud
8. Shroud Retaining Screws
9. Ignition Lock Cylinder
10. Retainer
11. Bearing
12. Steering Lock Gear
13. Turn Signal Canceling Cam
14. Snap Ring
15. Upper Bearing Spring
16. Sleeve
17. Ring
18. Small Upper Bearing
19. Lock Cylinder Housing
20. Multifunction Switch
21. Screws
22. Tilt Release Lever
23. Tilt Actuator Lever
24. Tilt Actuator Lever Pin
25. Steering Column Lock Cam
26. Upper Wiring Clip
27. Steering Shaft
28. Lock Lever Spring
29. Steering Column Lock Lever
30. Upper Lock Actuator
31. Lower Lock Actuator
32. Steering Column Lock Shaft Pawl
33. Steering Column Lock Shaft Spring
34. Transmission Selector Control Plunger
35. Transmission Selector Control Return Spring
36. Shift Lever
37. Shift Lever Pin
38. Transmission Selector Control Tube
39. Transmission Selector Control Tube Clamps
40. Bushings
41. Screws
42. Shield
43. Transmission Selector Control Position Insert
44. Screws
45. Transmission Selector Control Lever Spring Clip
46. Tilt Pivot Screws
47. Steering Column Position Lock Spring
48. Actuator Housing
49. Ignition Switch
50. Screws
51. Pivot Lever Pin
52. Steering Column Lock Shifter Pawl
53. Steering Column Lock Shifter Pin
54. Lower Column Bracket
55. Transmission Selector Control Lower Lever
56. Screws
57. Lower Bearing Housing Retainer
58. Lower Column Mounting Nuts
59. Lower Bearing Housing Retaining Screws
60. Lower Column Bearing Sleeve
61. Lower Column Bearing
62. Lower Tolerance Ring
63. Sensor Ring
64. Spring
65. Shift Cable Bracket Mounting Screws
66. Upper Column Mounting Nuts
67. Shift Cable
68. Large Upper Bearing
69. Lower Wiring Clip

92J22540

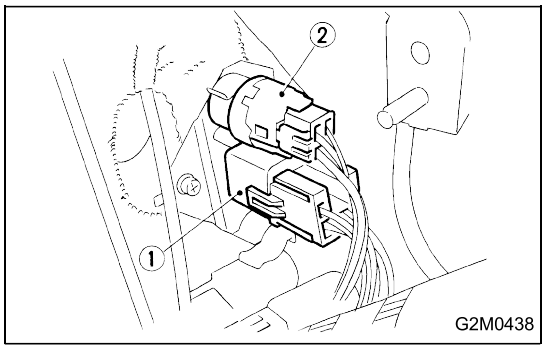
Fig. 2: Exploded View Of Steering Column With Air Bag
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

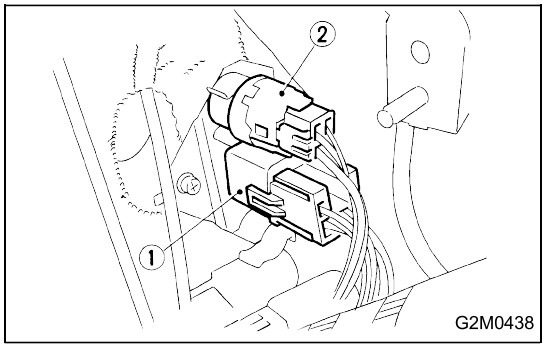
TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Intermediate Shaft-To-Steering Column Shaft Bolt	30-42 (41-57)
Steering Column-To-Support Bracket Nuts	10-14 (14-19)

Steering Wheel Retaining Bolt	23-33 (31-45)
Ignition Switch Retaining Screws	47-64 (5.3-7.2)
Multifunction Switch Screws	18-26 (2-3)
PRND21 Cable Retaining Screw	60-96 (7-11)



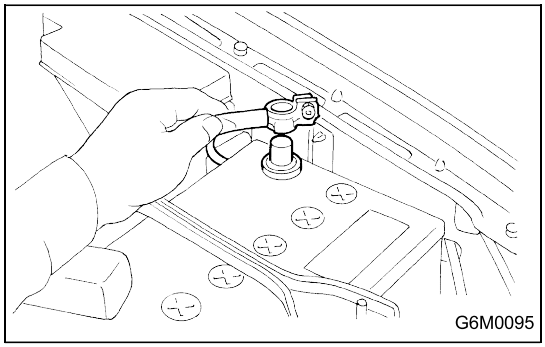
8) Remove screw which retains bracket of main relay ① and fuel pump relay ②.
9) Disconnect connector from main relay.



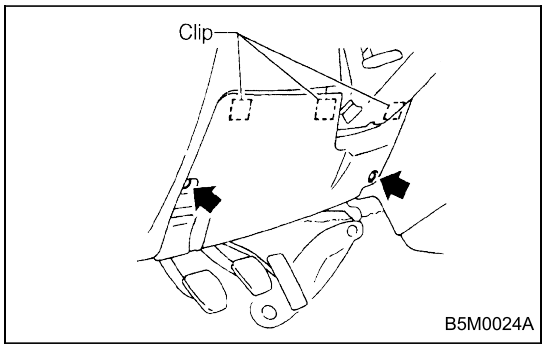
10) Installation is in the reverse order of removal.
① Main relay
② Fuel pump relay

17. Fuel Pump Relay

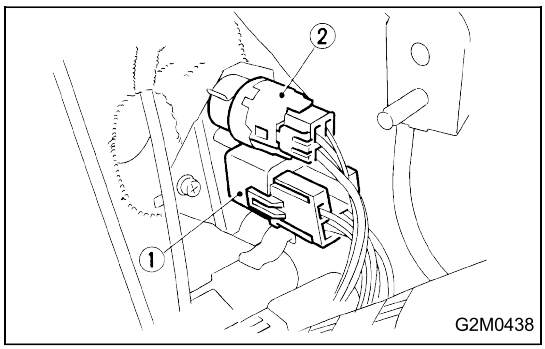
A: REMOVAL AND INSTALLATION



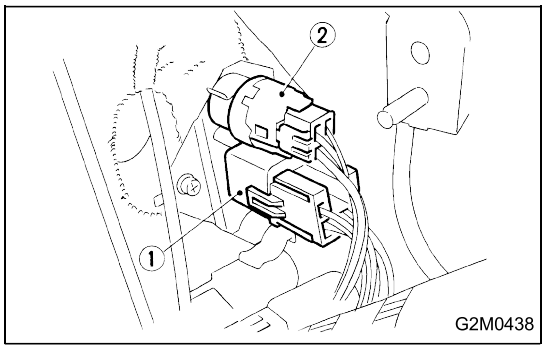
1) Disconnect battery ground cable.



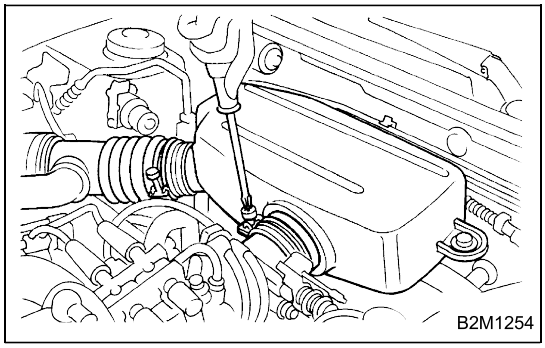
2) Remove lower cover and then disconnect connectors.
3) Lower transmission control module.
4) Remove the front pillar lower trim.
<Ref. to 5-3 [W5A1].>
5) Remove fuse box mounting nuts.
6) Lower fuse box.
7) Remove fuse box mounting bracket.



8) Remove fuel pump relay from main relay and fuel pump relay mounting bracket.
9) Disconnect connector from fuel pump relay.



10) Installation is in the reverse order of removal.
① Main relay
② Fuel pump relay

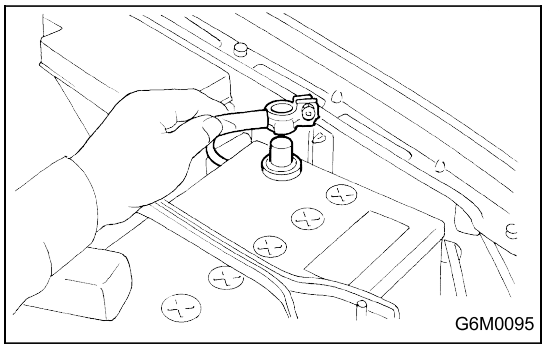


18. Air Intake Chamber

A: REMOVAL AND INSTALLATION

1) Loosen clamps which connect air intake chamber to throttle body and air intake duct.
2) Disconnect air hoses from air intake chamber.
3) Remove bolts which secure air intake chamber to stays.
4) Remove air intake chamber.
5) Installation is in the reverse order of removal.

Tightening torque:
4.9±0.5 N·m (0.5±0.05 kg-m, 3.6±0.4 ft-lb)

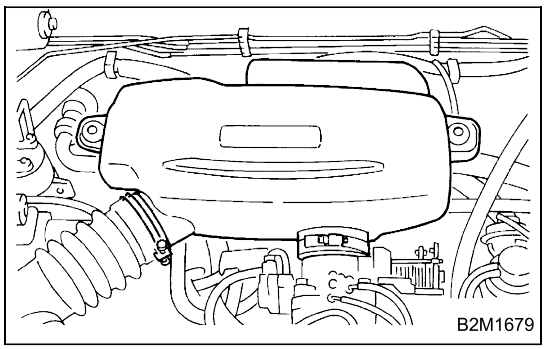


19. Knock Sensor

A: REMOVAL

1. 2200 cc MODEL

1) Disconnect battery ground cable from battery ground terminal.



2) Remove air intake chamber.
<Ref. to 2-7 [W18A0].>

1996-97 DRIVE AXLES

Differentials - Traction-Lok - 7.5", 8.8", 9.75" & 10.25" Ring Gear

DESCRIPTION

NOTE: Differentials are identified by inside diameter of ring gear. Traction-Lok and conventional rear axle assemblies are identical except for differential case. Information in this article is related to Traction-Lok differential case overhaul. To remove differential case from rear axle housing and for all other information, see appropriate rear differential article.

NOTE: The 10.25" differential Traction-Lok unit is also referred to as a Limited Slip Differential on 1998 models.

Traction-Lok differential has limited-slip function. See **Fig. 1** . Two sets of multiple disc clutches control limited slip differential action. On 7.5" ring gear, side gear mounting distance is controlled by 7 plates on each side: 3 steel, 4 friction, and a maximum of 2 steel shims selectively fit to control side gear position. On 8.8" ring gear, side gear mounting distance is controlled by 7 plates on each side: 4 steel, 3 friction, and one steel shim selectively fit to control side gear position. On 9.75" ring gear, side gear mounting distance is controlled by 8 plates on each side: 4 steel, 4 friction, and one or more steel selective shims. Plates are stacked on side gear hubs and housed in differential case. An "S"-shaped preload spring (7.5" and 8.8") or a Belleville spring plate (9.75") between side gears applies pre-load to clutch packs.

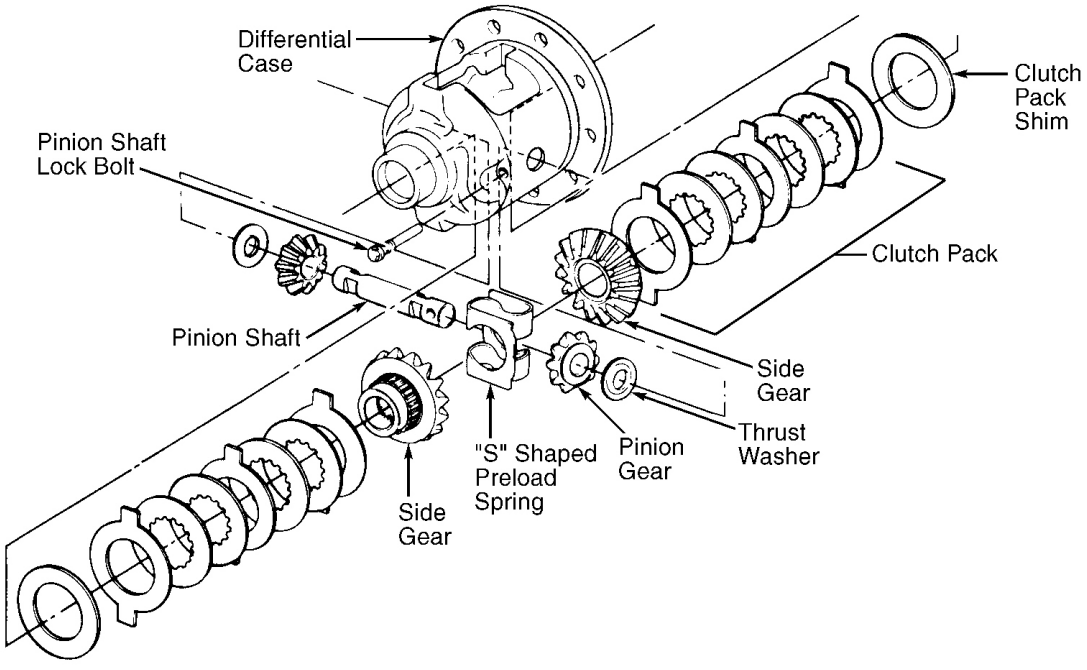


Fig. 1: Exploded View Of Typical Traction-Lok Differential
Courtesy of FORD MOTOR CO.

AXLE RATIO & IDENTIFICATION

Axle can be identified by axle code on Safety Certification Label on left door pillar. A metal identification tag, stamped with gear ratio and ring gear diameter, is attached to rear cover bolt.

DIFFERENTIAL APPLICATION

Vehicle Application	Ring Gear Size
Explorer	8.8" or 9.75"
Expedition	8.8" or 9.75"
E Series	8.8" or 9.75"
F Series	8.8", 9.75" or 10.25"
Mountaineer	8.8" or 9.75"
Navigator	8.8" or 9.75"
Ranger	7.5"

LUBRICATION

CAPACITY

LUBRICANT CAPACITY (1)

Application	Pts. (L)
Expedition	5.5 (2.6)
Explorer	5.5 (2.6)
Mountaineer	5.5 (2.6)
Navigator	5.5 (2.6)
Ranger	5.0 (2.4)
E Series	5.5 (2.6)
F Series	
8.8" & 9.75" Ring Gear	5.5 (2.6)
10.25" Ring Gear	6.5 (3.0)

(1) If refilling, add 4 ounces (.12L) of Ford Friction Modifier (C8AZ-19B546-A) in addition to normal lubricant.

FLUID TYPE

Use Motorcraft Synthetic Axle Lubricant (F1TZ-19580-B or WSP-M2C192-A equivalent) and Friction Modifier (C8AZ-19B546-A or EST-M2C118-A equivalent).

DRAINING & REFILLING

CAUTION: DO NOT clean internal components of differential case with solvent. Clean components with lint-free shop towel only.

Drive vehicle until lubricant is warm. Remove rear cover to drain lubricant. Remove gasket. Clean all lubricant from gasket surfaces. Install NEW gasket. Apply continuous bead of silicone sealant to axle housing, ensuring bead is inside of bolt hole pattern. Install rear cover within 15 minutes of applying silicone. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Fill axle housing with lubricant until level with bottom of fill hole.

TROUBLE SHOOTING

NOTE: See appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

NOTE: A slight "lock-unlock" action and associated sound from the differential on tight turns after extended highway driving is considered normal.

ON-VEHICLE TESTING

NOTE: Torque required to rotate wheel may decrease when wheel is turning.

1. Raise one wheel off ground, leaving opposite wheel firmly on ground. Install Traction-Lok Torque Adapter (T59L-4204-A) on mounting studs of raised wheel. Shift transmission into Neutral. Attach traction-lok torque adapter to torque wrench.
2. Using torque wrench to rotate wheel, note torque required to keep wheel rotating through several revolutions. If break-away torque (torque required to start wheel rotating) is not at least 20 ft. lbs. (27 N.m), and wheel does not turn smoothly without slipping, adjust clutch pack preload. See **CLUTCH PACKS** under OVERHAUL.

REMOVAL & INSTALLATION

NOTE: Because Traction-Lok and conventional rear axle assemblies are identical except for differential case, removal and installation procedures for both differential cases are the same. For removal and installation of components and differential case from axle housing, see appropriate differential article.

OVERHAUL

NOTE: This procedure is with differential case removed from axle housing. It is not necessary to remove differential bearings from differential case to overhaul differential case. Remove ring gear and speed sensor ring from carrier only if necessary. Vehicle speed sensor ring must be replaced if removed. It cannot be reused.

DISASSEMBLY

NOTE: Differential carrier bearings do not need to be removed from differential case during overhaul unless replacement is necessary.

7.5" & 8.8" Differential

WARNING: Preload spring is under pressure; remove carefully.

NOTE: Thrust washers cannot be removed alone. They must be rotated out of case with pinion gears.

1. Remove ring gear. DO NOT remove ABS sensor ring (if equipped). If sensor ring is removed, it must be replaced. Remove pinion shaft lock bolt and pinion shaft. Grasp preload spring with pliers. Pull and tap preload spring until it is removed.
2. Remove both side gear and clutch pack assemblies, marking each assembly for installation reference. Disassemble side gear and clutch pack assemblies; note order of disassembly for reassembly reference.

9.75" & 10.25" Differential

NOTE: Pinion gears are installed with preload. Thrust washers cannot be removed alone. Preload must be released and gears must be rotated out of case with thrust washers.

1. Remove ring gear. DO NOT remove ABS sensor ring (if equipped). If sensor ring is removed, it must be replaced. Remove pinion shaft lock bolt and pinion shaft. Install Traction-Lok Torque Tool (T97T-4205-A) upright in a vise. Position differential case on tool. Install a lubricated Step Plate Adapter (D80L-630-5) or equivalent into bottom gear spline.
2. Install Mandrel (T97T-4946-A) in upper facing side gear with nut positioned against mandrel. Tighten hex-head forcing screw until contact is made with step plate adapter. Use a bar to hold the nut and tighten forcing screw until preload pressure is released. See **Fig. 2** .
3. Insert pinion gear rotating tool into pinion shaft bore and turn differential case to rotate gears and thrust washers into carrier windows. Remove pinion gears ans thrust washers. Remove differential side gears and clutch packs. Mark gears and clutch packs LEFT and RIGHT for reassembly reference.

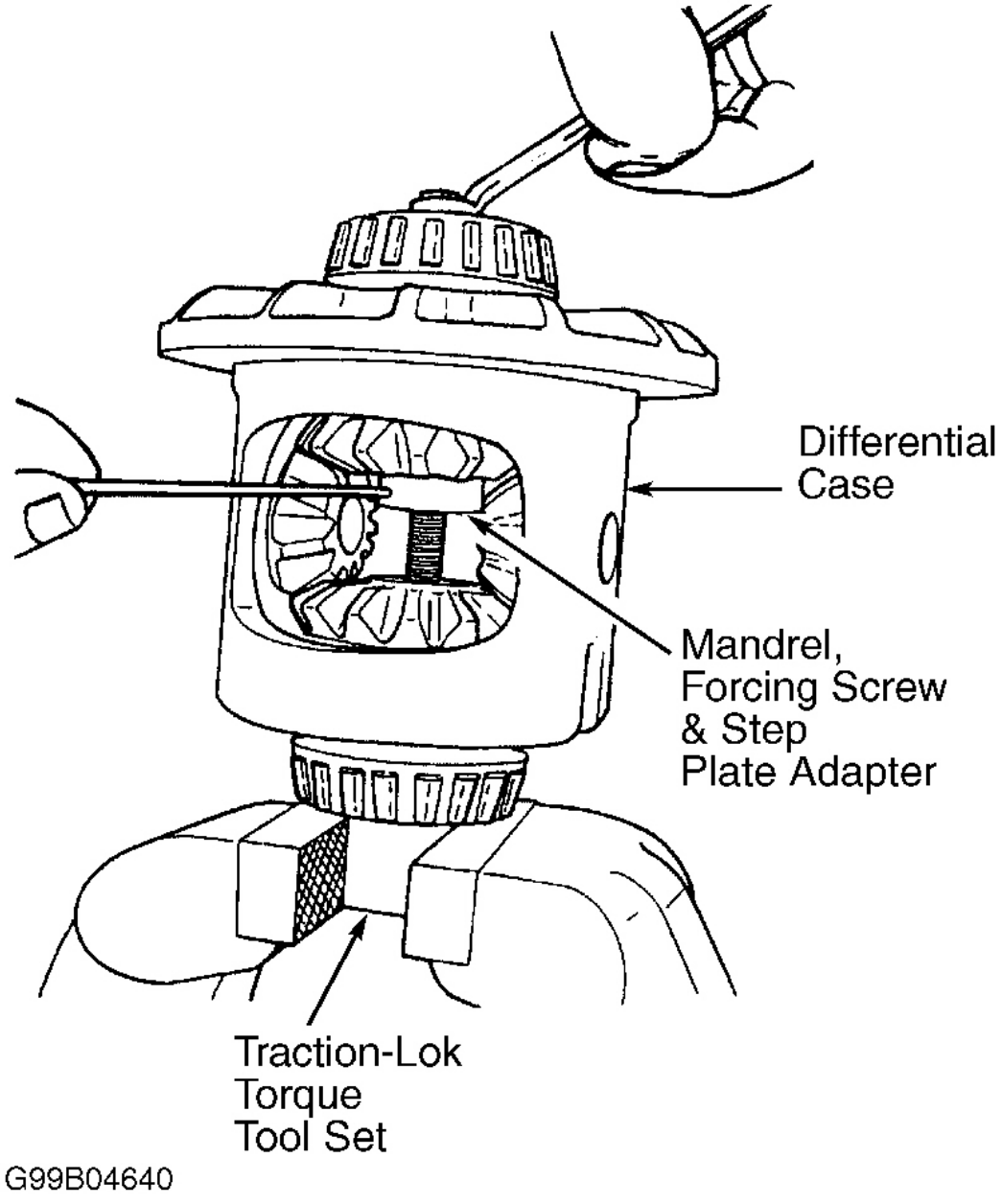


Fig. 2: Using Mandrel & Forcing Screw To Relieve Side Gear Preload (9.75" & 10.25" Differentials)
Courtesy of FORD MOTOR CO.

INSPECTION

CAUTION: DO NOT clean clutch plate friction surfaces with solvent. Wipe with clean shop towel only. DO NOT interchange clutches or shims. Inspect parts for

uneven or extreme wear. Replace if necessary.

CLUTCH PACK ADJUSTMENT

Adjusting Clutch Pack Clearance

1. Disassemble clutch packs, noting order of disassembly for reassembly reference. DO NOT clean clutch plate friction surfaces with solvent. Wipe with clean shop towel only. Inspect clutch plates. Replace plates if they are uneven or extremely worn.
2. Install Differential Clutch Gauge Base (T84P-4946-A for 7.5" ring gear; T97P-4946-A for 8.8" and 9.75" ring gears) in vise. With side gear facing down, slide assembly onto base without shim. Install Differential Clutch Gauge Disc (part of T84P-4946-A for 7.5" ring gear; T80P-4946-A for 8.8", 9.75" and 10.25" ring gears) on top of assembly without shim. See **Fig. 4** .
3. Install nut on threaded end of gauge base. Tighten nut to 60 INCH lbs. (6.7 N.m). Using feeler gauge, select thickest blade that will enter between clutch gauge and clutch pack. This reading will be thickness of new shim for that clutch pack. Shims are available in .005" (.13 mm) increments. See **CLUTCH PACK SHIM SIZES** table. Repeat procedure for opposite clutch pack.
4. Disassemble gauge and clutch packs. Lubricate clutch pack friction plates with Friction Modifier (C8AZ-19B546-A or EST-M2C118-A). Reassemble side gear and clutch pack with appropriate size shim. DO NOT mix plates from side to side.

NOTE: A Differential Clutch Pack Rebuild Kit (F5ZZ4947-B) is available for the 7.5" differential.

CLUTCH PACK SHIM SIZES

Part Number	Shim Thickness - In. (mm)
10.25" Diameter Ring Gear	
F7TW-4A324-CA	.025 (.64)
F7TW-4A324-DA	.030 (.76)
F7TW-4A324-EA	.035 (.89)
F7TW-4A324-FA	.040 (1.02)
F7TW-4A324-GA	.045 (1.14)
F7TW-4A324-HA	.050 (1.27)
F7TW-4A324-JA	.055 (1.39)
F7TW-4A324-KA	.060 (1.52)
9.75" Diameter Ring Gear	
F7TW-4A324-AA	.015 (.38)
F7TW-4A324-BA	.020 (.51)
F7TW-4A324-CA	.025 (.64)
F75Z-4A324-DA	.030 (.76)
F75Z-4A324-EA	.035 (.89)
F75Z-4A324-FA	.040 (1.02)
F75Z-4A324-GA	.045 (1.14)

F75Z-4A324-HA	.050 (1.27)
F75Z-4A324-JA	.055 (1.40)
F75Z-4A324-KA	.060 (1.52)
8.8" Diameter Ring Gear	
EOAZ-4A324-G	.025 (.64)
EOAZ-4A324-H	.030 (.76)
EOAZ-4A324-C	.035 (.89)
EOAZ-4A324-D	.040 (1.02)
EOAZ-4A324-F	.045 (1.14)
7.5" Diameter Ring Gear	
E4DZ-4A324-G	.025 (.64)
E4DZ-4A324-H	.030 (.76)
E4DZ-4A324-C	.035 (.89)
E4DZ-4A324-D	.040 (1.02)
E4DZ-4A324-F	.045 (1.14)

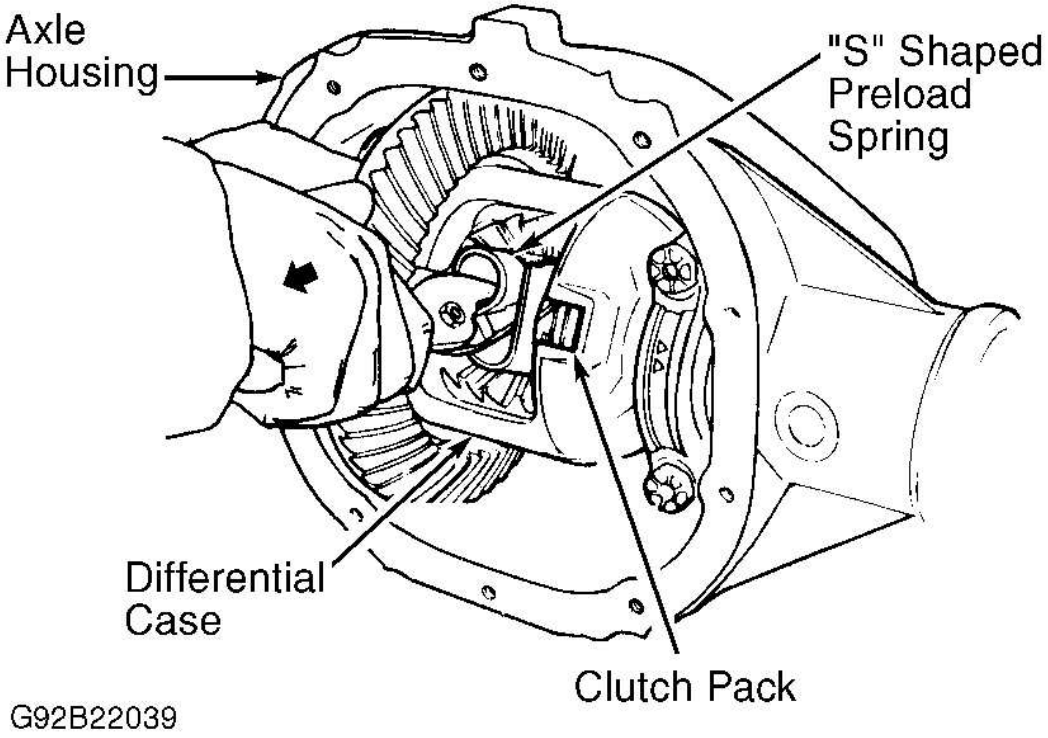


Fig. 3: Removing Clutch Pack Preload Spring
Courtesy of FORD MOTOR CO.

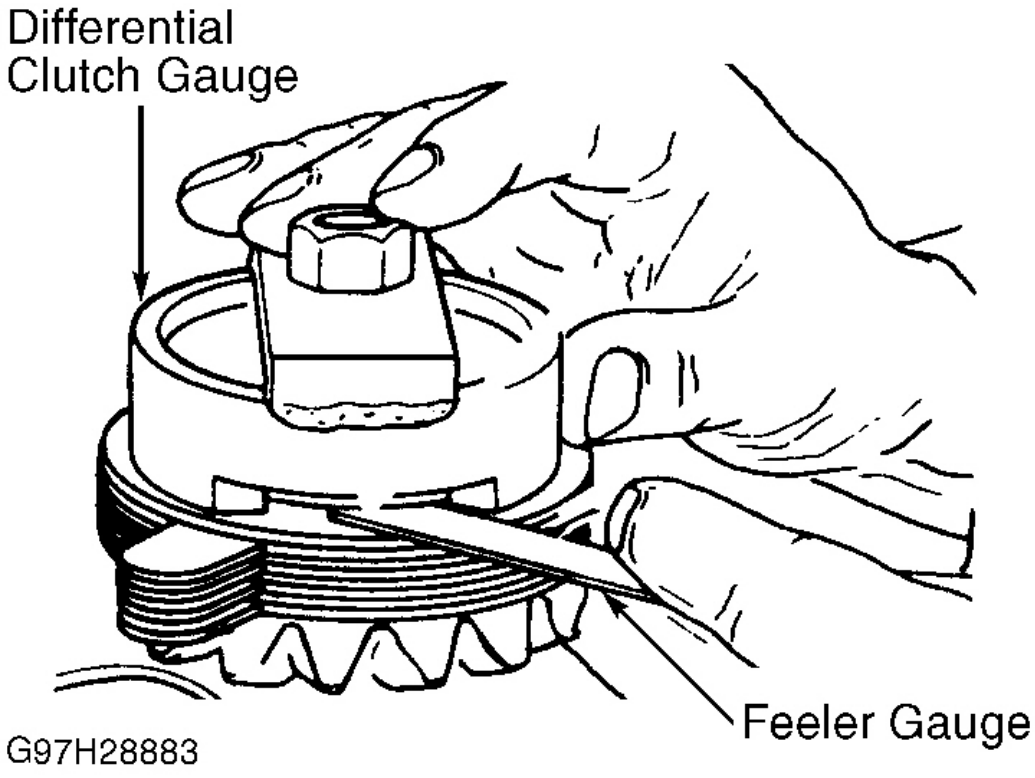


Fig. 4: Measuring Clutch Pack To Determine Shim Size
Courtesy of FORD MOTOR CO.

REASSEMBLY

7.5" & 8.8" Differential

1. Install side gears and thrust washers into differential case. Place pinion gears and thrust washers 180 degrees apart on side gears and rotate into case.
2. Use soft-faced hammer and drive "S"-shaped preload spring into position. Ensure spring is not damaged. Install pinion shaft and NEW pinion shaft lock bolt (use Threadlock (EOAZ-19554-AA) on lock bolt if new bolt is unavailable). Install bolt finger-tight at this time.
3. Place Traction-Lok Torque Tool (205-022/T66L-4204-A) in a vise. Position carrier on Torque Tool and measure rotating torque. Rotating torque should be 20 ft. lbs. (27 N.m). See **Fig. 5** .
4. This checks torque required to rotate one side gear while other is held stationary. If clutch plates are used, break-away torque should be at least 20 ft. lbs. (27 N.m) and rotation should be smooth. If clutch plates are new, break-away torque may vary and be slightly higher than specification.
5. If break-away torque is as specified and rotation is smooth, tighten pinion shaft lock bolt to proper specification. See **TORQUE SPECIFICATIONS** . If sensor ring has been removed, align notch on new

sensor ring with notch on case flange and install new ring. Install side bearings and ring gear, if necessary.

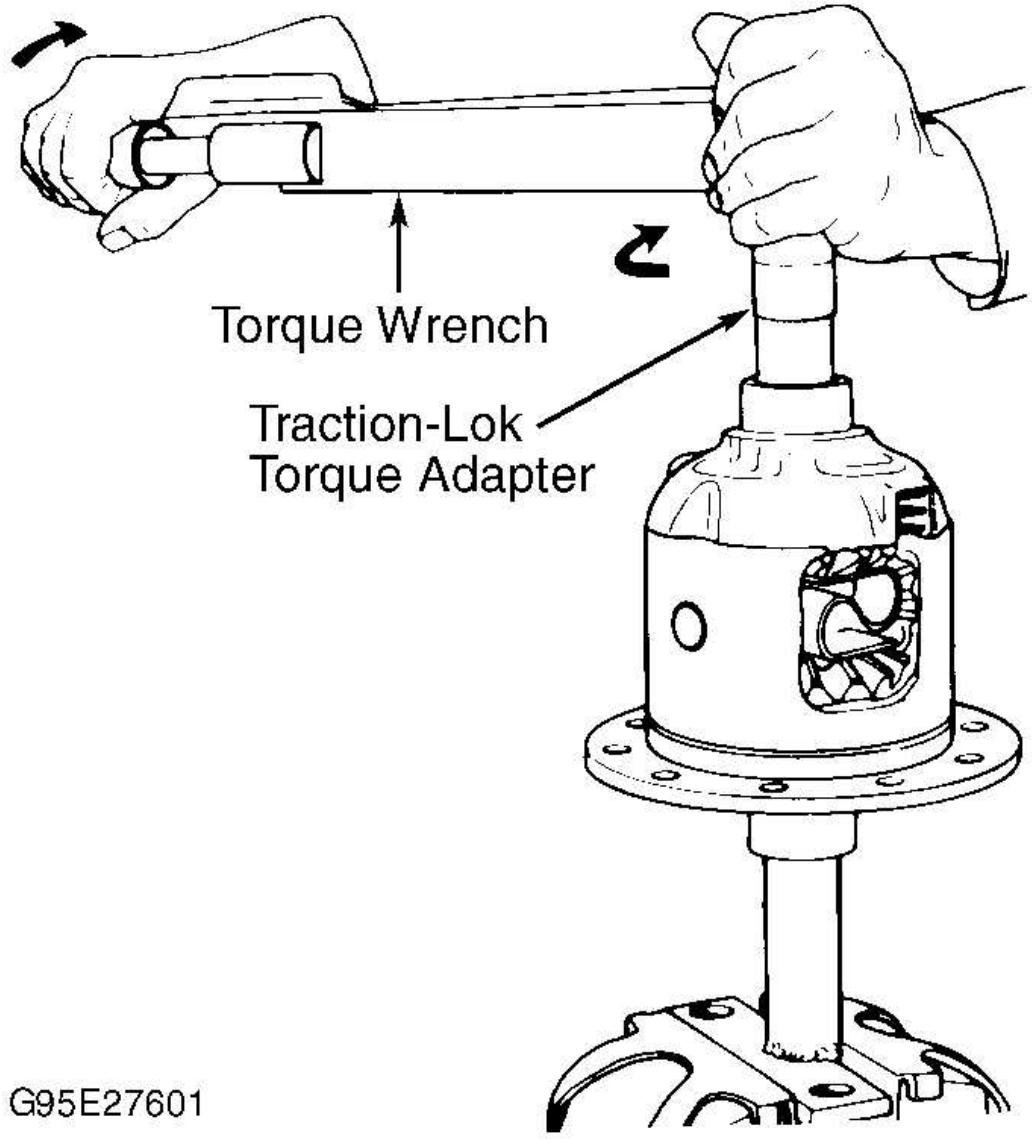


Fig. 5: Bench-Testing Traction-Lok Differential
Courtesy of FORD MOTOR CO.

9.75" & 10.25" Differential

1. Install Traction Lock Torque Tool (T97T-4205-A) in a vise. Install side gears with differential clutch

packs, shims and Belleville spring washers into differential case. Position carrier on Torque Tool. Hold upper side gear in place to keep it from falling out. Apply grease to Step Bore Plate and assemble Mandrel and forcing screw in between side gears. See **Fig. 2** .

2. Lubricate both sides of pinion gear thrust washers with Motorcraft Synthetic Axle Lubricant (F1TZ-19580-B) or equivalent. Place differential pinion gears and thrust washers in carrier windows, 180 degrees apart, on side gears. Install pinion gear rotator handle into pinion gear hole of differential case. Rotate case until pinion gears are aligned with pinion shaft hole. Remove rotator handle from differential case.

WARNING: Keep fingers and hands clear of pinion gears while rotating differential case.

3. Remove forcing screw, Mandrel and Step Bore Plate from differential case. Install pinion shaft and pinion shaft lock bolt. DO NOT tighten pinion shaft lock bolt at this time. Before installing differential case in axle housing, bench-test differential case clutch packs using Traction-Lok Torque Adapter (T59L-4204-A). With differential carrier positioned on Torque Tool in vise, install second Torque Tool in upper side gear. See **Fig. 5** .
4. Measure torque required to turn side gear. This checks torque required to rotate one side gear while other is held stationary. If clutch plates are used, break-away torque should be at least 20 ft. lbs. (27 N.m) and rotation should be smooth. If clutch plates are new, break-away torque may vary and be slightly higher than specification. If break-away torque (torque required to rotate side gear) is not at least 20 ft. lbs. (27 N.m) or rotation is not smooth, different shim must be installed in clutch pack.
5. If break-away torque is as specified and rotation is smooth, tighten pinion shaft lock bolt to proper specification. See **TORQUE SPECIFICATIONS** .

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Filler Plug	22 (30)
Differential Bearing Cap Bolt	77 (105)
Pinion Shaft Lock Bolt	22 (30)
Rear Cover Bolt	33 (45)
Ring Gear Bolt	
7.5" & 8.8" Differential	77 (105)
9.75" Differential	100-120 (136-163)

1997 TRANSFER CASES

Borg-Warner 13-56 Overhaul

DESCRIPTION & OPERATION

The Borg-Warner 13-56 is a manually shifted, part-time 4WD unit equipped with an opening for a Power Takeoff (PTO) unit. Shifting between 2WD high and 4WD high requires vehicle to be stopped and transmission in neutral. Transfer case is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in rear output shaft. Vehicle may be towed with transfer case in Neutral without disconnecting rear drive shaft.

LUBRICATION

RECOMMENDED FLUID

Motorcraft MERCON XT-2-QDX or equivalent should be used in Borg-Warner 13-56 transfer case.

ON-VEHICLE SERVICE

FRONT & REAR OUTPUT SHAFT OIL SEAL

Removal

Raise vehicle. Remove front and/or rear drive shaft from transfer case yoke. Wire drive shafts out of way. Remove yoke lock nut, flat washer, rubber seal and output shaft flange. Using seal remover and slide hammer, remove oil seal.

Installation

Ensure housing face and bore are free from nicks and burrs. Lubricate seals with ATF or multipurpose grease. Using oil seal installer, install NEW oil seal. To complete installation, reverse removal procedure. Tighten to specification. See **TORQUE SPECIFICATIONS** .

REMOVAL & INSTALLATION

TRANSFER CASE

Removal

1. Raise vehicle on hoist. Remove skid plate and damper (if equipped). Remove drain plug and drain transfer case lubricant. Disconnect 4WD indicator switch wire at transfer case (if equipped).
2. Disconnect drive shafts from transfer case. Wire drive shaft out of way. Disconnect speedometer driven gear or cable from case rear cover (if equipped).
3. Disconnect vent hose from transfer case. Disconnect control rod between shift lever and control lever

assembly. Remove heat shield (if equipped).

4. Support transfer case with a transmission jack. Remove transfer case-to-transmission bolts. Slide transfer case rearward off transmission, and lower case from vehicle. Remove gasket from between transfer case and extension housing.

Installation

1. Install new transfer case-to-extension housing gasket. Position transfer case so input shaft splines align with transmission output shaft. Slide case forward onto transmission output shaft and dowel pin.
2. Install transfer case-to-transmission bolts in sequence. See **Fig. 1** . Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Remove jack from transfer case. Install vent assembly so White marking on hose is in position in notch on shifter. To complete installation, reverse removal procedure.

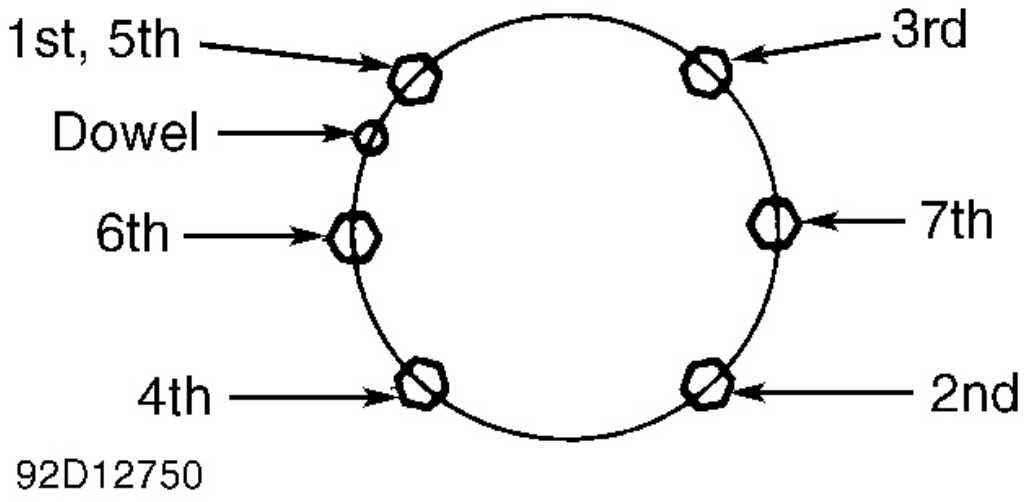


Fig. 1: Transfer Case Mounting Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.

OVERHAUL

TRANSFER CASE DISASSEMBLY

1. Drain and remove transfer case from vehicle. See **REMOVAL & INSTALLATION** . Remove 4WD indicator switch. DO NOT lose aluminum washer from indicator switch. Remove front and rear output shaft yokes. Using seal remover and slide hammer, remove front and rear output shaft seals. Remove rear bearing retainer.
2. Remove rear output shaft yoke seal. Remove 4 No. 50 Torx head bolts and pry rear bearing housing from case. Remove upper rear bearing snap ring. Remove 12 case bolts and separate case halves.

3. Using a slide hammer and bearing puller adapter, remove front output shaft caged needle bearing from cavity in rear half of case. Using a hammer and drift, remove rear output shaft bearing from rear case half.
4. Remove snap ring and shift collar hub from output shaft. Remove shift fork spring from shift rail. Lift shift fork and lock-up collar from output shaft. To disassemble lock-up assembly, remove internal snap ring. See **Fig. 2** .

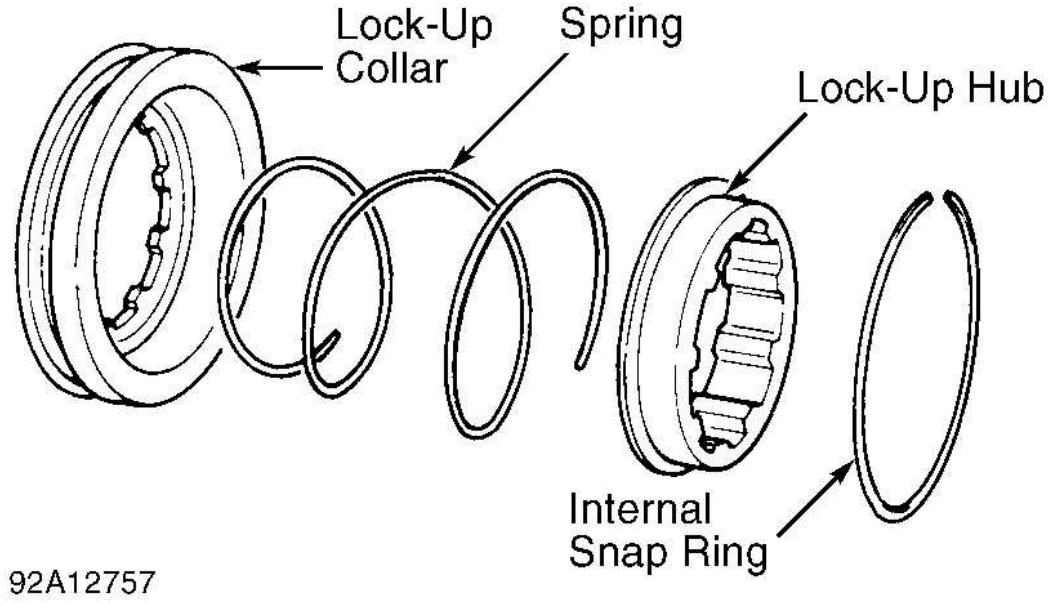


Fig. 2: Exploded View Of 2WD/4WD Lock-Up Assembly
Courtesy of FORD MOTOR CO.

5. Remove snap ring from front output shaft. See **Fig. 3** . Remove both sprockets and chain as an assembly. Remove shift rail from case. Remove magnet from case. Remove output shaft with oil pump.
6. Remove high-low shift hub. Remove front output shaft. Turn case over and remove front oil seal. Reaching through front opening of case, remove snap ring from input shaft and carrier assembly. Input shaft and carrier should only be serviced as an assembly. Needle bearing or bushing may be replaced separately.
7. Remove snap ring securing ring gear. Remove ring gear. Remove power take-off drive gear from input shaft and carrier assembly (if equipped). Remove snap ring and front input shaft bearing. Remove snap ring and front output shaft bearing. See **Fig. 3** .
8. Place transfer case shift lever in neutral. Remove set screw from linkage cam. Slide shift lever out of case. Remove shift shaft seals. Remove shift cam, spring and bushing from case.

TRANSFER CASE REASSEMBLY

1. Lubricate all parts with Mercon ATF. Install input shaft bearing and snap ring. Install front output shaft

bearing and snap ring. Install front output shaft seal. Install front output shaft in front case half. Install front yoke to retain front output shaft. Install rubber seal, flat washer and lock nut. Tighten to specification. See **TORQUE SPECIFICATIONS** .

2. Install needle bearing and Bronze bushing in planetary carrier, if removed. Press power take-off drive gear onto input shaft (if equipped). Position ring gear in case. Install snap ring and ensure ring gear is fully seated. Install input shaft and planetary carrier assembly. Support input shaft and carrier assembly in case. See **Fig. 3** .
3. Install NEW snap ring on front side of input shaft bearing. Ensure snap ring is fully seated. Install upper input shaft oil seal. Install NEW shift shaft seal, bushing, spring and cam. Secure shift cam with retaining clip or set screw as required.
4. To assemble oil pump, place oil pump front cover with TOP facing front of case (when installed). Install 2 pins, with flats facing upward and springs between them, in oil pump bore on output shaft. Place oil pump body and pick-up tube over shaft. Ensure pins are riding against inside of pump body.
5. Place oil pump rear cover, with TOP REAR facing rear of case. Install pump retainer with tabs facing front of case. While rotating output shaft, tighten oil pump bolts to specification. See **TORQUE SPECIFICATIONS** .

NOTE: If binding occurs while tightening oil pump bolts, loosen and retighten.

6. Install reduction hub. Install reduction shift fork by engaging it with shift hub flange and rotating it until roller engages with lower groove of helical cam (electronic) or shift cam (manual). Install shift rail through shift fork bore and case bore.
7. Install output shaft with oil pump assembly into input shaft and carrier assembly. Ensure output shaft external splines and internal splines of shift reduction hub are engaged. Oil pump retainer and oil filter leg should be in case groove and notch.
8. Install magnet in groove in case. Install driven sprocket into chain with REAR on sprocket facing up. Install both sprockets and chain as an assembly. Ensure REAR stamped on driven gear is facing rear of case. Install thrust washer and snap ring on front output shaft sprocket.
9. To assemble lock-up assembly, place tapered spring in lock-up collar, small end first. Place lock-up hub over spring. Compress spring and install snap ring. See **Fig. 2** . Install lock-up assembly in shift fork. Install shift fork over output shaft and align with shift rail. Ensure lockup assembly is facing proper direction. See **Fig. 3** . Install snap ring.
10. Install front output shaft bearing in rear case bore. Install rear output shaft bearing in rear case bore. Install rear output shaft oil seal until fully seated. Apply thin bead of silicone sealant to case half mating surface, (non-acid type). Install case halves and bolts. Ensure output shaft, shift shaft and shift rails are aligned. Tighten to specification. See **TORQUE SPECIFICATIONS** .
11. Install rear bearing snap ring. Ensure snap ring is fully seated. Apply silicone sealant to rear bearing retainer mating surface. Install rear bearing retainer and bolts. Install rear output shaft yoke. Tighten to specification.
12. Install 4WD indicator switch and aluminum washer. Install fill and drain plugs. Install drain plug and refill transfer case with 2 qts. Mercon ATF. Install fill plug.

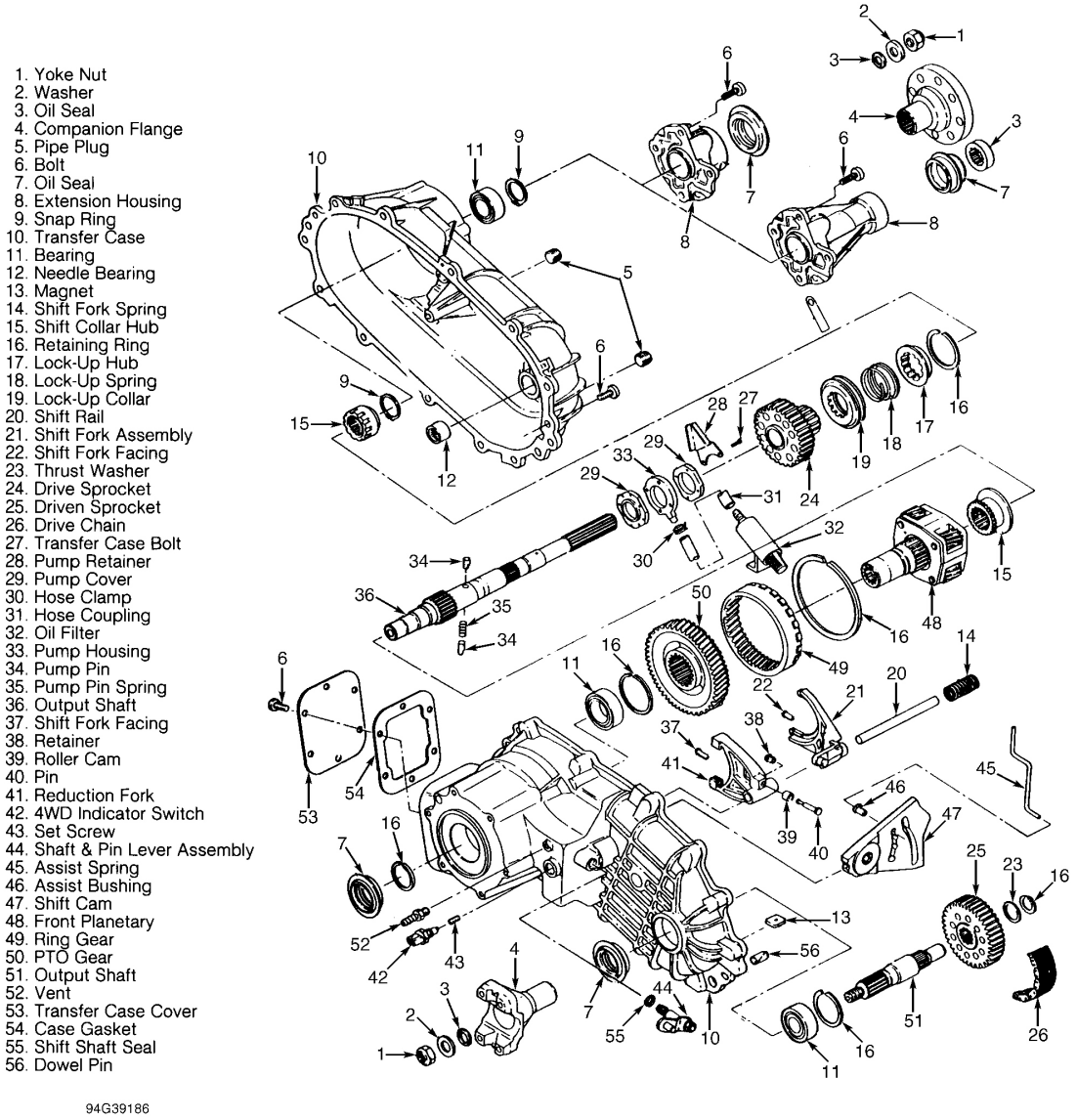


Fig. 3: Exploded View Of Borg-Warner 13-56 Transfer Case
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Case Half Bolts	22-36 (30-49)
4WD Indicator Switch	25-35 (34-47)
Extension Housing Bolt	30-40 (41-54)
Front Output Yoke-To-Transfer Case	150-180 (203-244)
Drain & Fill Plug	7-17 (9-23)

Transfer Case-To-Transmission	30-40 (41-54)
Heat Shield-To-Transfer Case	40-45 (54-61)
Skid Plate-To-Frame Bolt	15-20 (20-27)
Front Drive Shaft-To-Front Output Yoke	8-15 (11-20)
Rear Drive Shaft Nut	8-15 (11-20)
	INCH Lbs. (N.m)
Oil Pump Bolts	36-40 (4-4.5)

1997 TRANSFER CASES

Borg-Warner 44-06 Overhaul

DESCRIPTION

The Borg-Warner 44-06 is available in both Mechanical Shift On the Fly (MSOF) and Electronic Shift On the Fly (ESOF) versions. Both types utilize an internal electromagnetic multi-disc clutch assembly to shift transfer case from 2WD High to 4WD High. Transfer case operation (2H to 4H and 4H to 4L) is conducted either by a manually operated lever or electric motor that move internal shift forks. See **Fig. 1** .

Once the shift lever (MSOF) is moved to 4H position or mode switch is turned (ESOF) to 4H position, the Generic Electronic Module (GEM) energizes internal clutch to lock transfer case. Shifting between 2H and 4H can be done at speeds up to 55 MPH, but vehicle must be stopped with brake pedal applied and transmission in neutral to be shifted between 4H and 4L.

Transfer case is lubricated by a positive displacement fluid pump that channels fluid flow through drilled holes in rear output shaft.

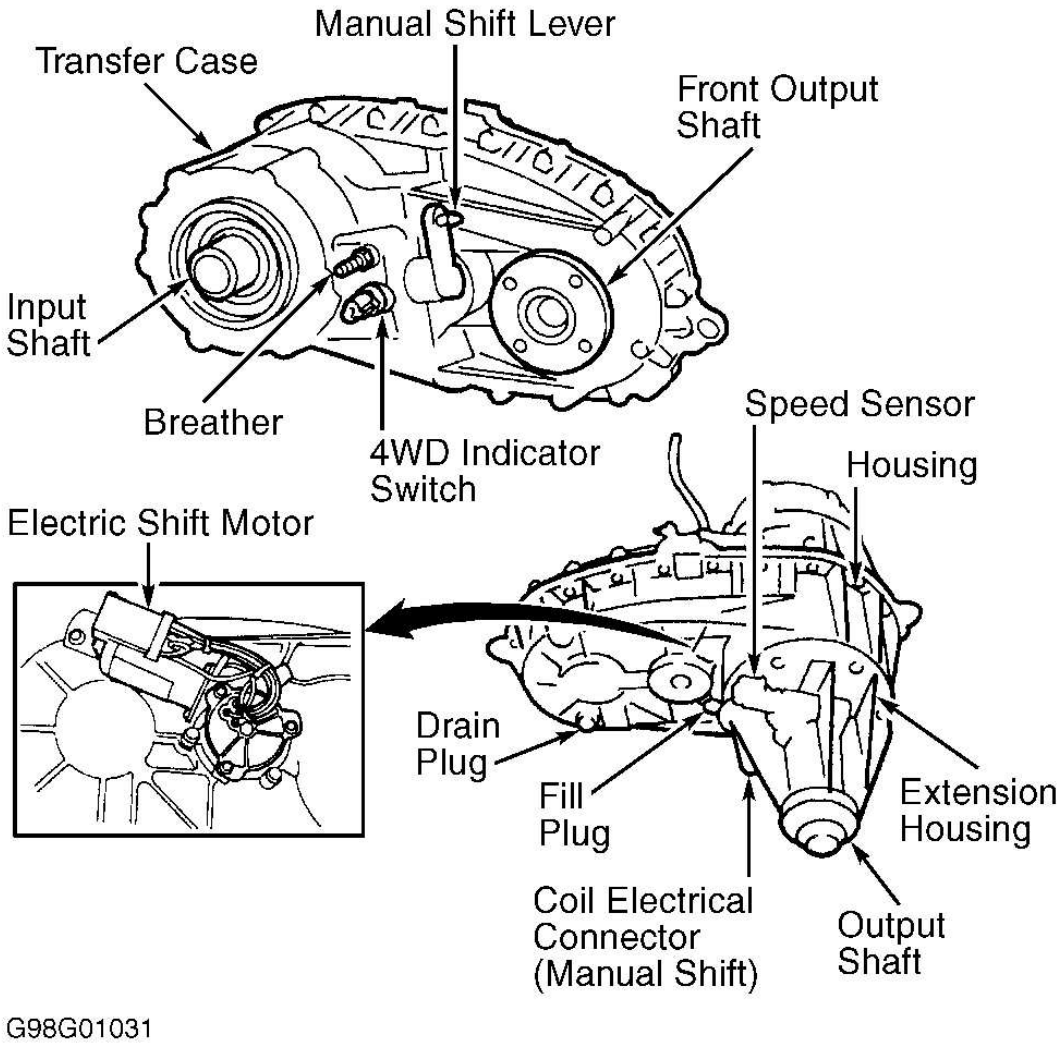


Fig. 1: Identifying Exterior Components Of Transfer Case
Courtesy of FORD MOTOR CO.

LUBRICATION

RECOMMENDED FLUID

Motorcraft MERCON XT-2-DDX or XT-2-QDX or equivalent should be used in Borg-Warner 44-06 transfer case.

ON-VEHICLE SERVICE

REAR OIL SEAL

Removal

If equipped with air suspension, turn air suspension OFF. Raise vehicle on hoist. Index mark rear drive shaft to axle flange for reassembly reference. Remove rear drive shaft from transfer case yoke. Wire drive shaft aside. Using seal remover and slide hammer, remove oil seal.

Installation

Ensure housing face and bore are free from nicks and burrs. Lubricate seals with ATF. Using oil seal installer, install NEW oil seal. To complete installation, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

TESTING

NOTE: For diagnosis & testing, see procedures in TRANSFER CASE DIAGNOSIS BORG-WARNER 44-06 article in the POWERTRAIN section.

REMOVAL & INSTALLATION

MANUAL SHIFT LEVERS

Removal & Installation

Remove shift lever knob, 4 boot attaching screws and boot. Remove 4 lever plate attaching bolts and lever plate. Remove gear shift lever attaching bolt and remove lever. To remove lower transfer case shift lever, install Shift Linkage Insulator (T67P-7341-A) and disconnect shift lever to transfer case rod. Remove 2 shift lever attaching bolts and remove shift lever. To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

4WD MODE SHIFT SWITCH

Removal & Installation

Remove center instrument panel trim plate. Remove shift selector knob. Disconnect mode switch harness connector. Remove 2 selector attaching bolts, and remove shift selector. To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

ELECTRIC SHIFT MOTOR

Removal & Installation

If equipped with air suspension, turn air suspension OFF. Raise and support vehicle. Disconnect shift motor electrical connector on transfer case. Remove coil wire electrical spacer. Using electrical connector pin remover, remove coil wire and pin. Remove 4 shift motor attaching bolts, and remove shift motor. To install, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

TRANSFER CASE

Removal

1. If equipped with air suspension, turn air suspension OFF. Raise and support vehicle. Remove drain plug and drain transfer case lubricant.
2. Index mark front and rear drive shafts for reassembly reference. Remove front drive shaft shield. Disconnect front and rear drive shafts and wire out of way. Remove 2 torsion bars and torsion bar support. Remove skid plate.
3. On MSOF models, remove shift levers. See **MANUAL SHIFT LEVERS** in REMOVAL & INSTALLATION. Disconnect speed sensor electrical connector. Disconnect 4WD indicator and case coil electrical connectors. Remove 4WD indicator switch. On ESOF models, disconnect shift motor electrical connector.
4. On all models, support transfer case with transmission jack. Remove transfer case-to-transmission bolts. Slide transfer case rearward off transmission and lower case from vehicle.

Installation

To install, reverse removal procedure. Align drive shafts with index marks made on removal, before tightening bolts. Fill transfer case with MERCON ATF (XT-2-QDX or XT-2-DDX). Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . When vehicle is lowered, turn air suspension ON.

OVERHAUL

NOTE: Use Fig. Fig. 2 in following procedure for component locations.

TRANSFER CASE DISASSEMBLY

1. Remove transfer case. See **TRANSFER CASE** under REMOVAL & INSTALLATION. On MSOF models, remove 4WD indicator switch. Mount transfer case in bench mounted holding fixture. On ESOF models, remove coil wire spacer and pin. Remove vehicle speed sensor. Remove shift motor from transfer case.
2. On all models, remove 6 extension housing bolts, and remove extension housing. Remove speedometer gear spacer. Push speedometer drive gear toward transfer case. Remove gear detent ball and remove speedometer drive gear. Lift up on rear output shaft and remove shaft snap ring. Remove case half attaching bolts. Use suitable pry tools on case bosses and separate case halves.
3. Remove 3 coil-to-cover nuts and remove coil. Using bearing remover and slide hammer, remove front and rear output shaft bearings. Remove shift collar hub snap ring from rear output shaft. Remove coil housing. Remove shift fork lockup hub. Remove shift fork and spring. Remove lockup hub assembly as an assembly. If lockup hub disassembly is required, remove snap ring and separate collar and spring from hub and armature.
4. Remove drive gear spacer. Remove drive chain and sprocket assembly. Remove case magnet from slot in case. Remove oil pump and output shaft as an assembly. Separate oil pump from output shaft. Remove shift fork shaft.

NOTE: DO NOT attempt to disassemble or service pump. Pump must rotate freely on shaft. If pump binds, it must be replaced.

5. Remove shift fork from case. Remove reduction hub. On ESOF models, remove shift cam assembly. Using seal remover, remove input seal. Hold front planet carrier while removing snap ring, then remove front planet carrier. Remove ring gear snap ring and ring gear. Hold front output shaft while removing snap ring, then remove output shaft.
6. Using bearing remover and slide hammer, remove front yoke-to-flange seal. If necessary, remove bushing and needle bearing from front planet carrier using 1.25"-1.50" collet, actuator pin and slide hammer. A 1.00"-1.25" collet, actuator pin and slide hammer is necessary to remove bearing.
7. Remove front planet carrier bearing snap ring. Using bearing cup replacer and driver handle, remove front planet carrier bearing. Remove front output shaft bearing. On MSOF models, loosen shift lever set screw through 4WD indicator switch opening. From outside of case, remove shift lever, shift cam and spring. Use blind hole collet and slide hammer and remove shift lever seal On ESOF models, use blind hole collet and slide hammer and remove shift motor seal.

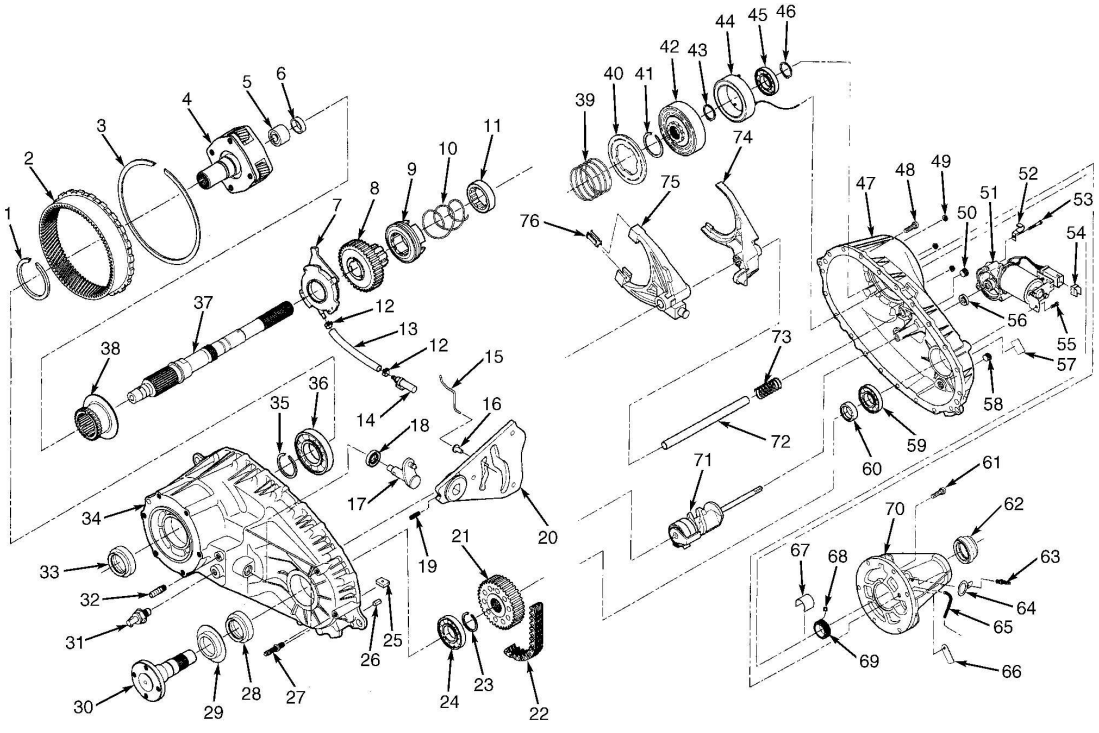


Fig. 2: Exploded View Of Transfer Case
Courtesy of FORD MOTOR CO.

TRANSFER CASE REASSEMBLY

1. On ESOF models, use seal installer and install shift motor seal. On MSOF models, install shift lever seal. From outside of case, install shift lever, shift cam and spring. Tighten shift lever set screw through 4WD indicator switch opening.
2. On all models, drive in front output shaft bearing. Install front planet carrier bearing and snap ring. If removed, install bushing and bearing into front planet carrier. Install front yoke-to-flange seal. Position front output shaft into place and install snap ring. Install ring gear and snap ring.

3. Install front planet carrier and snap ring. Install output shaft seal. On ESOF models, install shift cam assembly. On all models, install shift fork and reduction hub. Install shift fork shaft through shift fork. Install oil pump onto output shaft. Install oil pump and output shaft assembly.
4. Install case magnet into slot in case. Install drive chain and sprocket assembly. Install driven gear spacer. If lockup hub assembly was disassembled, reassemble hub components. See **Fig. 3** .

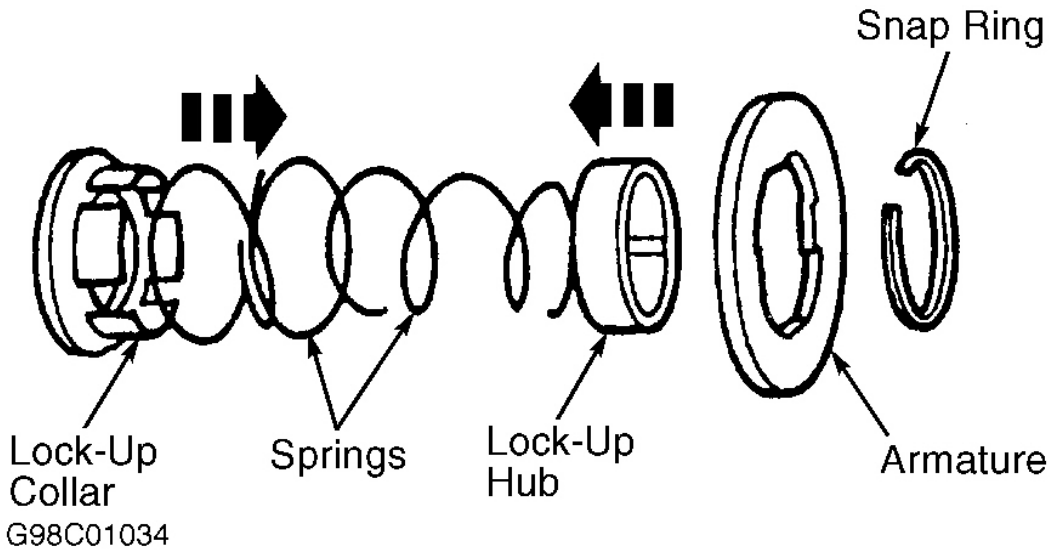


Fig. 3: Exploded View Of Lockup Hub Assembly
Courtesy of FORD MOTOR CO.

5. Install lockup hub assembly, shift fork and spring on output shaft. Install coil housing. Install shift collar hub and snap ring on output shaft. Install front and rear output shaft bearings. Position coil in place and install 3 coil nuts. Tighten nuts to specifications. See **TORQUE SPECIFICATIONS** . Coat mating surfaces of case halves with sealant and position case halves together. Tighten case bolts in crisscross pattern to specification. See **TORQUE SPECIFICATIONS** .
6. Lift up on rear output shaft and install snap ring. Slide speedometer gear onto output shaft until it touches case, then install detent ball. Lift up on speedometer gear and install speedometer gear spacer. Apply thin bead of sealant to extension housing-to-case mating surfaces. Guide coil wire through opening in extension housing, then position extension housing on transfer case. Tighten housing bolts to specification. See **TORQUE SPECIFICATIONS** .
7. Install speed sensor. On ESOF models, install electric motor on transfer case and tighten bolts. See **TORQUE SPECIFICATIONS** . Connect coil wire to motor. Install coil wire spacer. Remove transfer case from holding fixture. On MSOF models, install 4WD indicator switch. Install transfer case in vehicle. See **TRANSFER CASE** under REMOVAL & INSTALLATION. Fill transfer case to top of fill hole with recommended lubricant. See **LUBRICATION** .

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Case Half Bolts	16-20 (22-27)
Control Lever-To-Transmission Case Bolt	72-97 (98-132)
Drain & Fill Plug	7-17 (9-23)
Extension Housing Bolts	16-20 (22-27)
Front Drive Shaft Bolts	65-87 (88-119)
Front Drive Shaft Shield Nuts	11-16 (14-22)
Rear Drive Shaft Bolts	65-87 (88-119)
Transfer Case-To-Transmission	30-40 (41-54)
Skid Plate-To-Frame Bolt	10-13 (13-17)
4WD Indicator Switch	25-35 (34-47)
	INCH Lbs.
Coil Nuts	71-98 (8-11)
Shift Lever Plate Bolts	88-124 (10-14)
Shift Lever Set Screw	71-98 (8-11)
Shift Motor Bolts	71-98 (8-11)
Shift Range Selector Switch	18-26 (2-3)
Vehicle Speed Sensor	26-35 (3-4)

1997 TRANSFER CASES

Borg-Warner 44-07 Overhaul

DESCRIPTION

The Borg-Warner 44-07 is a manually shifted, part-time 4WD unit. Shifting between 2WD high and 4WD high requires vehicle to be stopped and transmission in neutral. Transfer case is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in rear output shaft. Vehicle may be towed with transfer case in Neutral without disconnecting rear drive shaft.

LUBRICATION

RECOMMENDED FLUID

Motorcraft MERCON XT-2-QDX or equivalent should be used in Borg-Warner 44-07 transfer case.

ON-VEHICLE SERVICE

FRONT & REAR OUTPUT SHAFT OIL SEAL

Removal

Raise vehicle on hoist. Remove front and/or rear drive shaft from transfer case yoke. Wire drive shafts out of way. Remove yoke lock nut, flat washer, rubber seal and output shaft flange. Using seal remover and slide hammer, remove oil seal.

Installation

Ensure housing face and bore are free from nicks and burrs. Lubricate seals with ATF or multipurpose grease. Using oil seal installer, install NEW oil seal. To complete installation, reverse removal procedure. Tighten to specification. See **TORQUE SPECIFICATIONS** .

REMOVAL & INSTALLATION

TRANSFER CASE

Removal

1. Raise vehicle on hoist. Remove skid plate and damper (if equipped). Remove drain plug and drain transfer case lubricant.
2. Disconnect drive shafts and wire out of way. Disconnect speedometer driven gear or cable from case rear cover (if equipped).
3. Disconnect vent hose from transfer case. Disconnect control rod between shift lever and control lever assembly. Remove heat shield (if equipped).

4. Support transfer case with transmission jack. Remove transfer case-to-transmission bolts. Slide transfer case rearward off transmission and lower case from vehicle. Remove gasket from between transfer case and extension housing.

Installation

1. Install NEW transfer case-to-extension housing gasket. Position transfer case so input shaft splines align with transmission output shaft. Slide case forward onto transmission output shaft and dowel pin.
2. Install transfer case-to-transmission bolts in sequence. See **Fig. 1** . Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Remove jack from transfer case. Install vent assembly so White marking on hose is in position in notch on shifter. To complete installation, reverse removal procedure.

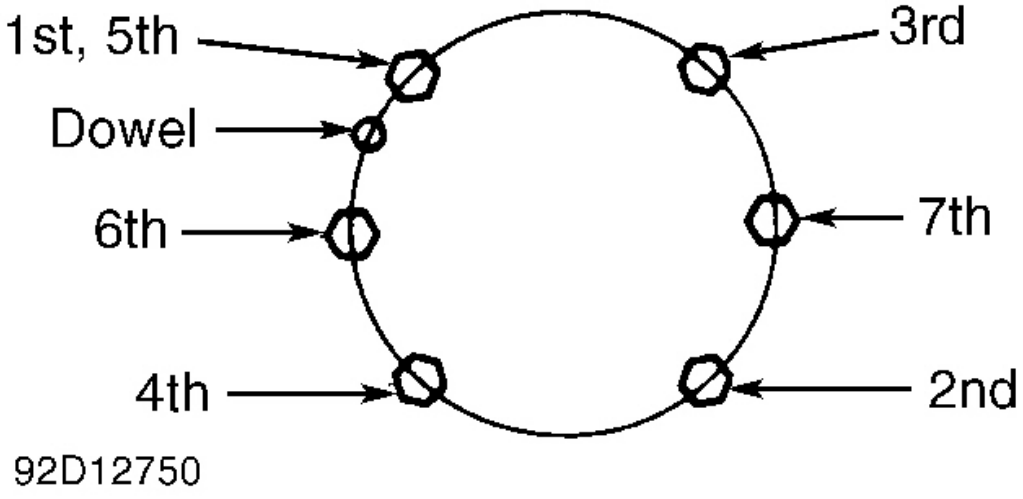
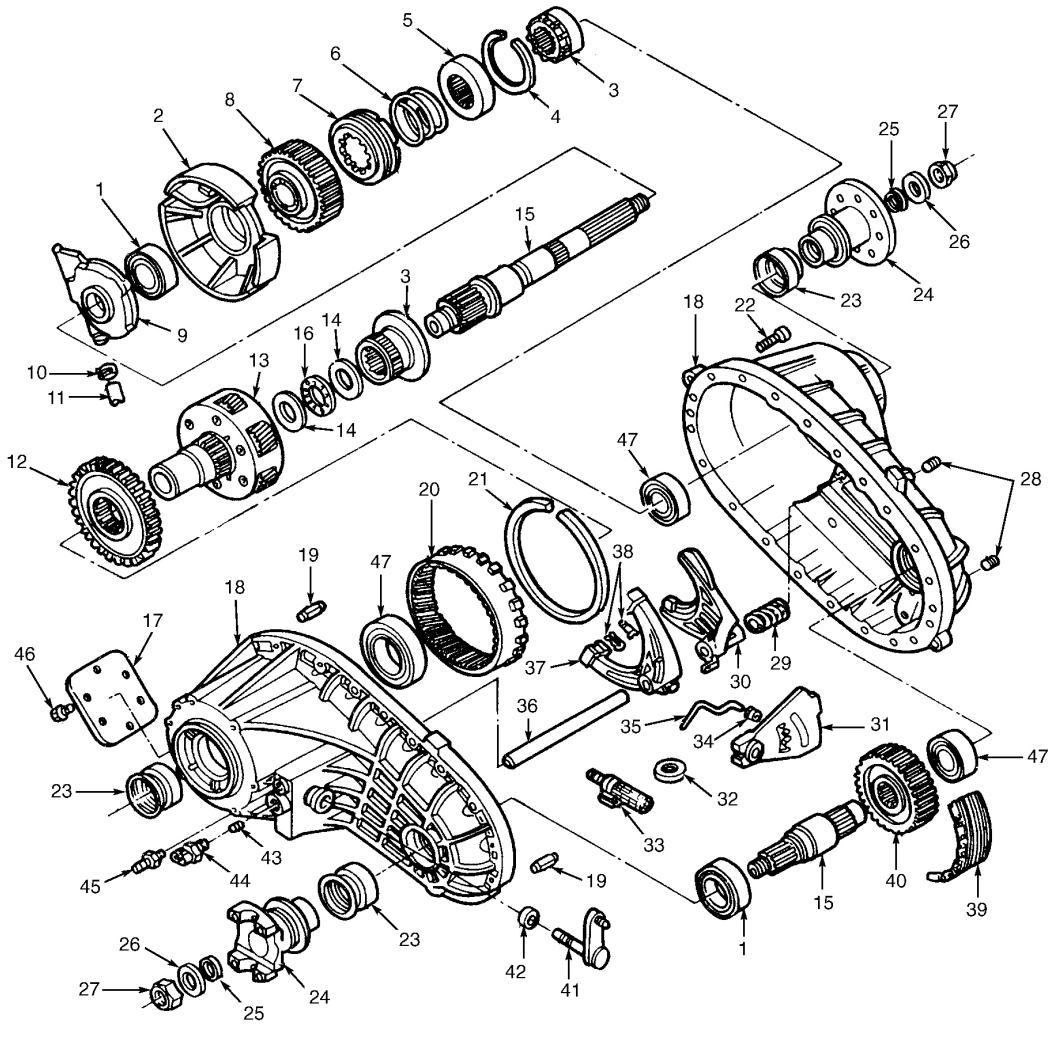


Fig. 1: Transfer Case Mounting Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.



1. Bearing
2. Bearing Retainer
3. Shift Collar Hub
4. Snap Ring
5. Lock-Up Hub
6. Lock-Up Spring
7. Lock-Up Collar
8. Drive Sprocket
9. Oil Pump
10. Hose Clamp
11. Oil Pick-Up Hose
12. PTO Gear (Optional)
13. Planetary Assembly
14. Thrust Washer
15. Output Shaft
16. Thrust Bearing
17. PTO Cover
18. Front Case
19. Dowel
20. Ring Gear
21. Snap Ring
22. Bolt
23. Input/Output Shaft Seal
24. Yoke
25. Oil Seal
26. Washer
27. Shaft Nut
28. Case Plug
29. Shift Fork Spring
30. 2WD/4WD Lock-Up Shift Fork
31. Shift Linkage Cam
32. Magnet
33. Oil Screen
34. Linkage Bushing
35. Detent Spring
36. Shift Rail
37. Reduction Shift Fork
38. Shift Fork Facing
39. Drive Chain
40. Driven Sprocket
41. Shift Lever
42. Shaft Seal
43. Set Screw
44. 4WD Indicator Switch
45. Vent
46. Bolt
47. Bearing

96A04692

Fig. 2: Exploded View Of Borg-Warner Model 44-07 Transfer Case
Courtesy of FORD MOTOR CO.

OVERHAUL

TRANSFER CASE DISASSEMBLY

1. Remove transfer case. See **TRANSFER CASE** under REMOVAL & INSTALLATION. Remove yoke lock nut, washer, oil seal and yoke. Remove 4WD indicator switch.
2. Remove yoke flange seal with a screwdriver. Remove 20 front case-to-rear case bolts. Separate case halves using pry bar. Using bearing remover, remove front output shaft bearing from case. Slide shift collar hub off output shaft. Remove shift fork spring from shift rail and lift mode fork with lock-up collar from rear shaft. See **Fig. 3** .

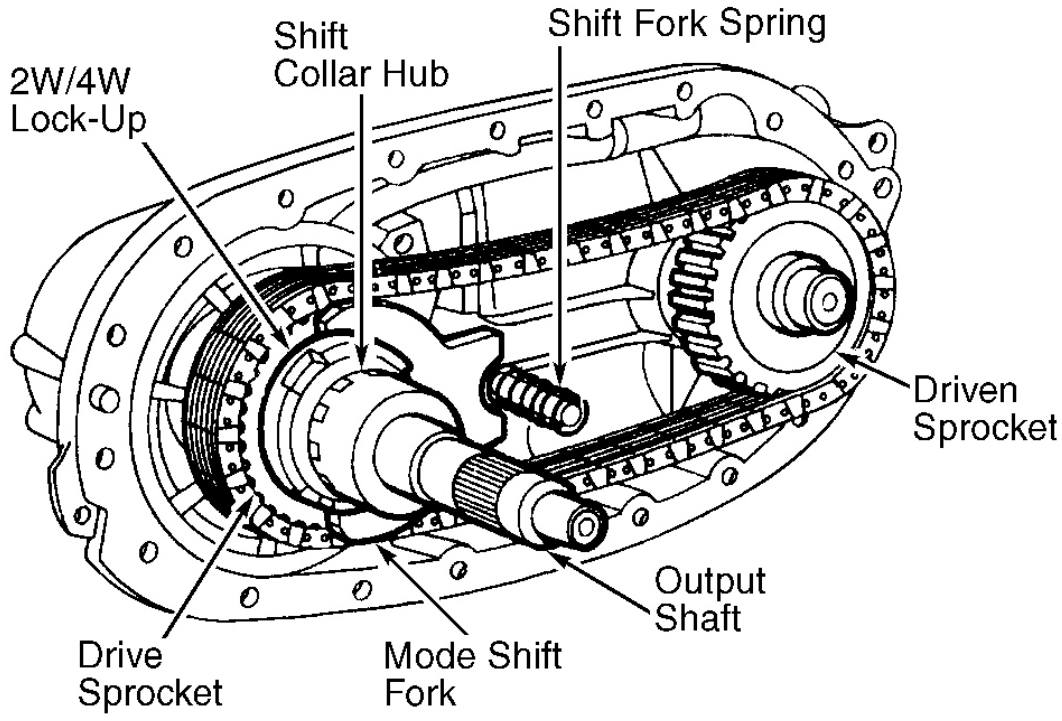


Fig. 3: Drive Sprocket Components
Courtesy of FORD MOTOR CO.

3. Remove 2W/4W lock-up assembly snap ring. Remove hub and spring from collar. Grasp drive and driven sprockets with drive chain and remove them at the same time from output shafts.
4. Remove front output shaft. Remove shift rail by sliding it straight out from shift fork. Remove bearing support and bearing. Using brass drift and mallet, drive bearing out from center, being careful not to damage support. Lift out rotor pump screen and remove output shaft with pump assembled on it.

NOTE: DO NOT attempt to disassemble or service pump. Pump must rotate freely on shaft. If pump binds, it must be replaced.

5. Remove oil pan magnets from slots in case. Remove high-low shift fork by rotating it until roller is free from cam, then sliding out of shift collar hub. Remove shift collar hub. Remove thrust washers and bearing from front planet assembly.

NOTE: Front planet assembly is serviced as an assembly only. Inside diameter of bushing is 1.25" (32 mm). Outside diameter of bushing is 1.50" (38 mm).

6. Remove front planet assembly. Remove PTO gear (if equipped). Pry out ring gear internal snap ring with screwdriver and remove ring gear. Remove input shaft and front output shaft yoke-to-flange seals with a screwdriver. Discard seals.
7. Using brass drift and mallet, drive out input shaft bearing and front and rear output shaft bearings from inside of case. DO NOT damage case. Place shift lever in Neutral position so shift cam setscrew can be seen through opening for 4WD indicator switch. Remove setscrew.
8. Slide shift lever out of case. Remove shift cam, detent spring and bushing. Carefully pry shifter shaft seal out of case.

TRANSFER CASE REASSEMBLY

1. Soak all parts in ATF before reassembly. Using Bearing Installer, install input shaft bearing in case. Drive input and front output yoke-to-flange seals into case until they are fully seated. Install front output shaft through lower bearing. Install front case yoke onto output shaft. Install oil seal, washer and shaft lock nut.
2. Install ring gear into slots in case. Install large snap ring. Install front planet assembly into case through input shaft bearing. Install NEW shifter shaft seal. Position detent spring, bushing and shift cam into recess in case. Slide shift shaft and lever through case and seal until they engage with shift cam. Install setscrew through 4WD indicator switch opening. Install thrust washer and bearing in front planet. See **Fig. 4** .

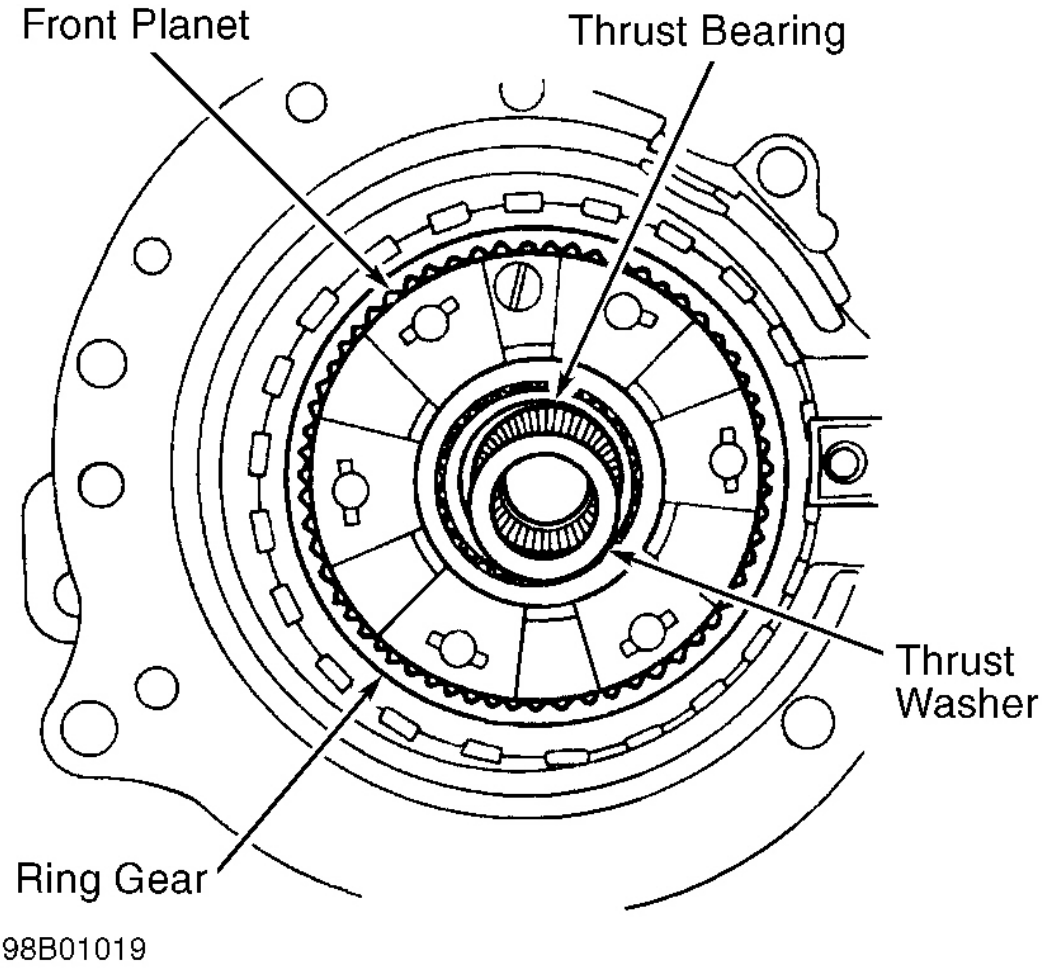


Fig. 4: Front Planet Washer & Bearing Assembly
Courtesy of FORD MOTOR CO.

3. Install shift collar hub. Install high-low shift fork by engaging it with shift hub flange and rotating until roller is engaged with lower groove of cam. Install shift rail through high-low fork bore and into rail bore in case. Ensure external splines of output shaft engage internal splines of shift collar hub. Ensure oil filter leg is in notch in front case.
4. Install output shaft and oil pump in input shaft. Install oil pan magnets in case slots. Using bearing installer and Driver (T80T-4000-W), install center support bearing. Ensure bearing support properly engages with case and pump anti-rotation tab is engaged with bearing support. Install bearing support and bearing in front case.
5. Assemble following components in following order: Assemble drive and driven sprockets in drive chain outside transfer case. External splined boss on drive sprocket and plain extended boss on driven sprocket should face up. Place sprockets and drive chain onto output shafts as an assembly.

6. Position large end of tapered compression lock-up spring in 2WD/4WD lock-up hub. Place lock-up hub over small end of spring and compress spring while installing snap ring. Install lock-up and shift fork over external splines of drive sprocket and shift rail so that cam follower is against shift cam.
7. Install shift fork spring over shift rail. Install lock-up hub over splines of output shaft. Using bearing installer, install front output shaft bearing in rear case, then press rear bearing into case. Install yoke-to-flange seal in rear case. Apply 1/8" bead of sealer on front case mating surface and install case halves. Tighten case bolts to specifications. See **TORQUE SPECIFICATIONS** .
8. Install drain plug and 4WD indicator switch and tighten. Install transfer case. See **TRANSFER CASE** under REMOVAL & INSTALLATION. Fill transfer case with correct amount of lubricant.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Case Half Bolts	22-36 (30-49)
Control Lever-To-Transmission Case Bolt	71-90 (96-122)
Control Lever Retaining Nut	20-28 (27-38)
Drain & Fill Plugs	7-17 (9-23)
Front & Rear Output Yoke Nut	150-180 (203-244)
Transfer Case-To-Transmission	30-40 (41-54)
Skid Plate-To-Frame Bolt	15-20 (20-27)
4WD Indicator Switch	25-35 (34-47)

1997 TRANSFER CASES

Borg-Warner 44-06 Electronic Controls

DESCRIPTION & OPERATION

The Borg-Warner 44-06 is available in both Mechanical Shift On the Fly (MSOF) and Electronic Shift On the Fly (ESOF) versions. Both types utilize an internal electromagnetic multi-disc clutch assembly to shift transfer case from 2WD High to 4WD High. Transfer case operation (2H to 4H and 4H to 4L) is conducted either by a manually operated lever or electric motor that move internal shift forks. See **Fig. 1** .

Once the shift lever (MSOF) is moved to 4H position or mode switch is turned (ESOF) to 4H position, the Generic Electronic Module (GEM) energizes internal clutch to lock transfer case. Shifting between 2H and 4H can be done at speeds up to 55 MPH, but vehicle must be stopped with brake pedal applied and transmission in neutral to be shifted between 4H and 4L.

MODULE LOCATION

Generic Electronic Module (GEM) is mounted on fuse block below left Side of dash panel.

INPUT DEVICES

Brake On/Off (BOO) Switch

The PCM receives a signal from the BOO switch when the brake switch is operated. The GEM and PCM are linked by a communication network. When shifting into or out of LOW range, the GEM requires brake pedal to be depressed.

Clutch Pedal Position (CPP) Switch

The PCM receives a signal from the CPP switch when the clutch pedal is depressed. The GEM and PCM are linked by a communication network. When shifting into or out of LOW range, the GEM requires clutch pedal to be depressed.

4WD Mode Switch

Instrument panel mounted switch sends input signal to GEM pertaining to commanded transfer case range.

Throttle Position (TP) Sensor

The TP sensor is a potentiometer mounted to the engine throttle body. The PCM receives a signal from TP sensor relaying throttle plate position. The GEM and PCM are linked by a communication network. Signal is used by the GEM to control A4WD clutch.

Transmission Range (TR) Switch

The TR sensor is a digital type. The PCM monitors a series of step down resistors in TR sensor that act as a

voltage divider. The voltage signal corresponds with position of transaxle range selector lever. The GEM and PCM are linked by a communication network. The TR sensor also contains neutral/start and backup light circuits. Malfunction of TR sensor or non-confirmation of transmission being in neutral may cause transfer case not to shift. Improper transmission shifting or shift selection and no engine cranking may also result.

Vehicle Speed Sensor (VSS)

The VSS is a magnetic pickup that sends output speed signal to the PCM. The GEM and PCM are linked by a communication network. When shifting into or out of LOW range, the GEM requires vehicle speed to be less than 3 MPH.

OUTPUT DEVICES

Transfer Case Clutch Relay

Pulse width modulated signal operated relay that operates internal electromagnetic clutch.

4WD Shift Motor Relay

Actuates electric shift motor mounted to transfer case. Shift motor drives a rotary cam which moves mode fork and range fork inside transfer case.

4WD/2WD Vacuum Solenoids

Both solenoids are attached to upper RH side of engine compartment dash panel. Solenoids alternately route vacuum to vacuum motor which engages/disengages center axle disconnect collar in front axle assembly. See **Fig. 1** .

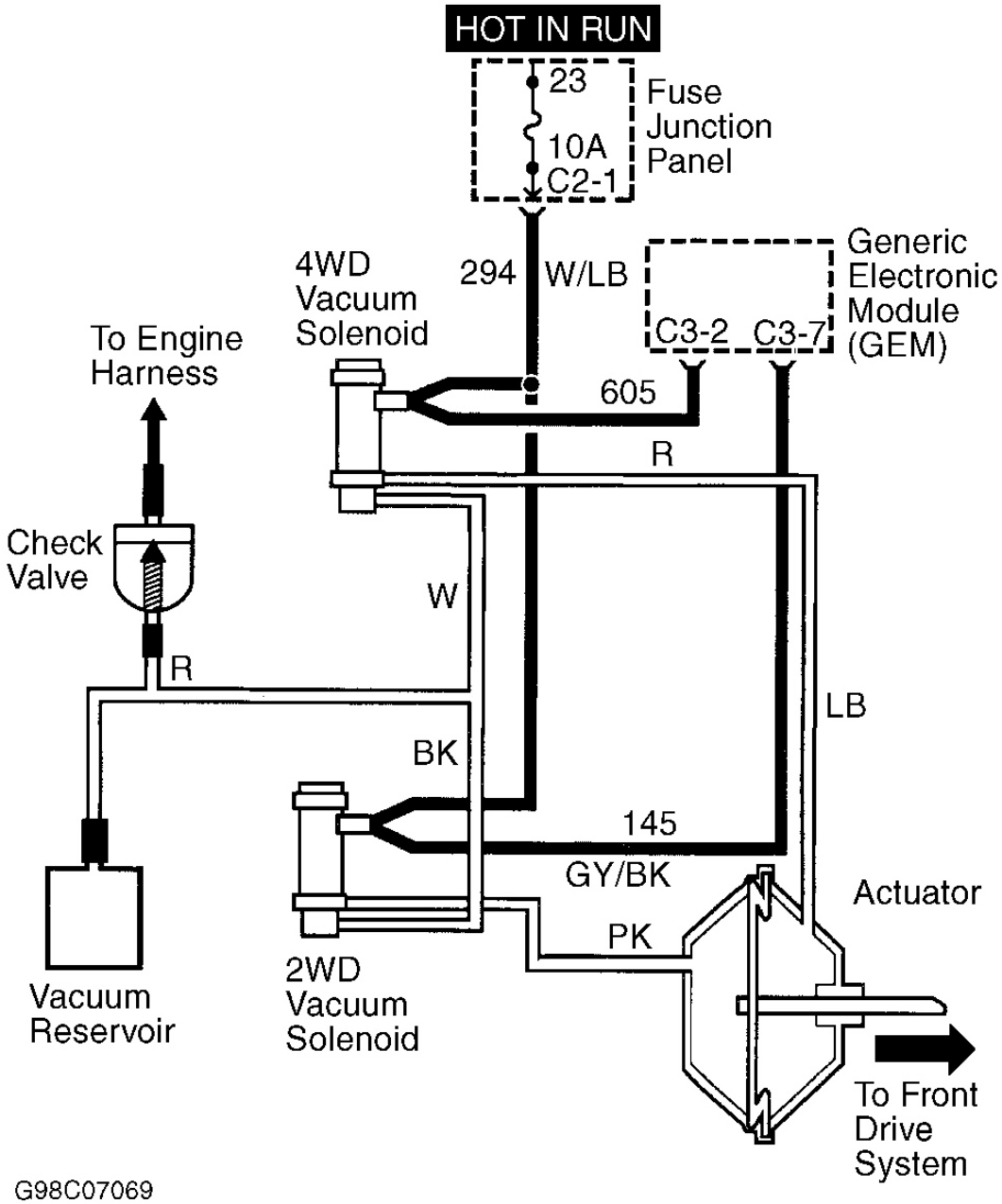


Fig. 1: 4WD Front Axle Vacuum Diagram
Courtesy of FORD MOTOR CO.

SELF-DIAGNOSTIC SYSTEM

PRELIMINARY INSPECTION

NOTE: GEM must be reprogrammed upon replacement. Refer to New Generation Star (NGS) tester screen to program tire size and axle ratio.

1. Verify customer complaint by operating 4WD system. Visually inspect for damage to switches, fuse, wiring harness, wiring connections, vacuum connections, indicator lights, and light circuits.
2. Inspect 16-pin Data Link Connector (DLC) pins for damage. The DLC is located below driver's side of instrument panel, to the right of steering column. If pins are okay, go to next step. If pins are damaged, repair as necessary and proceed to next step.
3. If concern is still present after performing inspection, connect New Generation Star (NGS) tester to DLC. Select vehicle to be tested from NGS tester menu. If NGS tester does not communicate with vehicle, ensure program card is properly installed. Check NGS tester cable connections and ensure ignition is on. If NGS tester still does not communicate with vehicle, see **MODULE COMMUNICATIONS NETWORK** article in the ACCESSORIES & ELECTRICAL section. If NGS tester communicates with vehicle, go to **DIAGNOSTIC PROCEDURE SEQUENCE** .

DIAGNOSTIC PROCEDURE SEQUENCE

1. Ensure transmission is in Park. Ensure all controls and switches are in the OFF position. Connect New Generation Star (NGS) scan tester to DLC.
2. Ensure all doors, hood and trunk are fully closed. Perform proper hook-up procedure and vehicle selection for scan tester. See **EQUIPMENT HOOK-UP** .

NOTE: DO NOT touch any handle or switch that may produce a module input unless instructed to do so by the scan tester.

3. Retrieve continuous Diagnostic Trouble Codes (DTCs) from GEM. See **RETRIEVING DIAGNOSTIC TROUBLE CODES** . Record all continuous DTCs.
4. Clear continuous DTCs from GEM. See **CLEARING DIAGNOSTIC TROUBLE CODES** .
5. Perform On-Demand Self-Test on GEM. See **ON-DEMAND SELF-TEST** . Record all DTCs obtained when performing On-Demand Self-Test. If no DTCs were obtained when retrieving continuous DTCs or performing On-Demand Self-Test, problem is not related to GEM or module communications network. Continue diagnosis by symptom. See **SYMPTOM TESTING** .
6. If DTCs were obtained when retrieving continuous DTCs or performing On-Demand Self-Test, proceed to **DIAGNOSTIC TROUBLE CODE (DTC) DEFINITIONS** table for DTC identification and reference for proper DTC testing procedure.

NOTE: When performing specified test procedures, technician may be instructed to retrieve Parameter Identification (PID) information on a specified component. For information on retrieving PID, see RETRIEVING PARAMETER IDENTIFICATION (PID) INFORMATION.

EQUIPMENT HOOK-UP

NOTE: Manufacturer recommends using New Generation Star (NGS) scan tester for

diagnosis of module communications network.

1. Ensure ignition switch is in OFF position. Select proper program card for scan tester for vehicle application. With scan tester facing away from you, insert program card into slot on scan tester. Ensure program card is properly inserted into scan tester or scan tester will not operate.
2. Connect scan tester to the 16-pin Data Link Connector (DLC). The DLC is located below driver's side of instrument panel, to the right of steering column.
3. Turn ignition switch to ON position. Scan tester automatically performs a initialization test. Initialization test checks the scan tester memory and verifies that vehicle interface module matches program card for scan tester. If an error message is now displayed on scan tester, refer to scan tester operators manual for system messages.
4. The menu item VEHICLE AND ENGINE SELECTION should be highlighted on scan tester. Press trigger to select VEHICLE AND ENGINE SELECTION.
5. Rotate dial on scan tester to menu item SELECT NEW VEHICLE MODEL AND YEAR. Press trigger to select VEHICLE AND ENGINE SELECTION. Select model year, vehicle and engine size by rotating dial to highlight the selection, then press trigger to select. If selected vehicle is not displayed, repeat this step.

RETRIEVING DIAGNOSTIC TROUBLE CODES

NOTE: Procedure may be used for retrieving continuous Diagnostic Trouble Codes (DTCs).

1. Connect New Generation Star (NGS) scan tester to Data Link Connector (DLC) and perform proper hook-up procedure. See **EQUIPMENT HOOK-UP** .

   NOTE: If instructed to retrieve Diagnostic Trouble Codes (DTCs) from a specified test procedure, ensure ignition switch is in proper position as listed in test procedure. GEM requires ignition switch to be in ON position or test will fail.

2. Turn ignition switch to ON position unless otherwise instructed by specified test procedure. Rotate dial on scan tester to DIAGNOSTIC DATA LINK menu and press trigger.
3. Rotate dial on scan tester to highlight the desired module you wish to access. Ensure DIAGNOSTIC TEST MODES is highlighted and press trigger.
4. Rotate dial on scan tester to highlight RETRIEVE/CLEAR CONTINUOUS DTC and press trigger. Press button No. 3 to start.
5. Record all Diagnostic Trouble Codes (DTCs) that are displayed for GEM. Proceed to **DIAGNOSTIC TROUBLE CODE (DTC) DEFINITIONS** table for DTC identification and reference for proper DTC testing procedure.

ON-DEMAND SELF-TEST

NOTE: On-Demand Self-Test may be used to verify operation of a selected module.

1. Connect New Generation Star (NGS) scan tester on Data Link Connector (DLC) and perform proper hook-up procedure. See **EQUIPMENT HOOK-UP** .

NOTE: If instructed to perform On-Demand Self-Test from a specified test procedure, ensure ignition switch is in proper position as listed in test procedure. GEM requires ignition switch to be in ON position or the test will fail.

2. Turn ignition switch to ON position unless otherwise instructed by specified test procedure. Rotate dial on scan tester to DIAGNOSTIC DATA LINK menu and press trigger.
3. Rotate dial on scan tester to highlight the desired module to be tested and press trigger. Ensure DIAGNOSTIC TEST MODES is highlighted and press trigger.
4. Rotate dial on scan tester to highlight ON-DEMAND SELF-TEST and press trigger. Press button No. 3 to start the test. Prepare vehicle for entry condition as specified for each module. Press trigger. Record any Diagnostic Trouble Codes (DTCs) that are displayed.

DIAGNOSTIC TROUBLE CODE (DTC) DEFINITIONS

DIAGNOSTIC TROUBLE CODE INDEX (ESOF MODELS)

DTC	Description	(1) Test
B1342	GEM/CTM Defective	(2)
P0500	VSS Signal Circuit	B
P1804	4WD High Indicator Open/Short To GND	C
P1806	4WD High Indicator Short To Power	C
P1808	4WD Low Indicator Open/Short To GND	C
P1810	4WD Low Indicator Short To Power	C
P1812	4WD Mode Select Switch Open/Short To GND	A
P1815	4WD Mode Select Switch Short To Power	A
P1819	Neutral Safety Switch Short To GND	B
P1820	T/C LO To HI Shift Relay Open/Short To GND	A
P1822	T/C LO To HI Shift Relay Coil Short To Power	A
P1824	4WD Clutch Relay Open/Short To GND	E
P1826	4WD Clutch Relay Short To	E

	Power	
P1828	T/C HI To LO Shift Relay Open/Short To GND	A
P1830	T/C HI To LO Shift Relay Coil Short To Power	A
P1832	T/C 4WD Solenoid Short To Ground	C
P1834	T/C 4WD Solenoid Short To Voltage	C
P1838	T/C Shift Motor Circuit Failure	N/A
P1846	T/C Contact Plate "A" Open Circuit	A
P1850	T/C Contact Plate "B" Open Circuit	A
P1854	T/C Contact Plate "C" Open Circuit	A
P1858	T/C Contact Plate "D" Open Circuit	A
P1866	T/C System Concern	A
P1867	T/C Contact Plate General Circuit Failure	A
P1876	T/C 2WD Solenoid Short To Ground	C
P1877	T/C 2WD Solenoid Short To Voltage	C
P1891	T/C Contact Plate Ground Return Open Circuit	A

(1) See test listed in appropriate **TESTING** section.

(2) Clear codes and retest system. If DTC B1342 is still present, replace GEM.

DIAGNOSTIC TROUBLE CODE INDEX (MSOF MODELS)

DTC	Description	(1) Test
B1342	GEM/CTM Defective	(2)
P1804	4WD High Indicator Open/Short To GND	J
P1806	4WD High Indicator Short To Power	J
P1808	4WD Low Indicator Open/Short To GND	C
P1810	4WD Low Indicator Short To Power	C
P1819	Neutral Safety Switch Short To	B

	GND	
P1820	T/C LO To HI Shift Relay Open/Short To GND	A
P1822	T/C LO To HI Shift Relay Coil Short To Power	A
P1824	4WD Clutch Relay Open/Short To GND	G
P1826	4WD Clutch Relay Short To Power	G
P1828	T/C HI To LO Shift Relay Open/Short To GND	A
P1830	T/C HI To LO Shift Relay Coil Short To Power	A
P1832	T/C 4WD Solenoid Short To Ground	H
P1834	T/C 4WD Solenoid Short To Voltage	H
P1838	T/C Shift Motor Circuit Failure	N/A
P1866	T/C System Concern	A
P1876	T/C 2WD Solenoid Short To Ground	H
P1877	T/C 2WD Solenoid Short To Voltage	H

(1) See test listed in appropriate **TESTING** section.

(2) Clear codes and retest system. If DTC B1342 is still present, replace GEM.

CLEARING DIAGNOSTIC TROUBLE CODES

1. Connect New Generation Star (NGS) scan tester on Data Link Connector (DLC) and perform proper hook-up procedure. See **EQUIPMENT HOOK-UP** .
2. Turn ignition switch to ON position unless otherwise instructed by specified test procedure. Rotate dial on scan tester to DIAGNOSTIC DATA LINK menu and press trigger.
3. Rotate dial on scan tester to highlight the desired module you wish to access. Ensure DIAGNOSTIC TEST MODES is highlighted and press trigger.
4. Rotate dial on scan tester to highlight RETRIEVE/CLEAR CONTINUOUS DTC and press trigger. Press button No. 3 to start.
5. To clear an individual DTC from a selected module, rotate dial on scan tool to highlight the DTC to be cleared. Press button No. 8. This will clear only that DTC from that module.
6. To clear all DTCs from a selected module, press button No. 7. This clears all DTCs from that module. After DTCs are cleared from ABS control module, turn ignition switch to OFF position and then back to the RUN position.

RETRIEVING PARAMETER IDENTIFICATION (PID) INFORMATION

NOTE: This procedure may be used to verify operation of inputs and outputs for a selected module.

1. Connect New Generation Star (NGS) scan tester on Data Link Connector (DLC) and perform proper hook-up procedure. See **EQUIPMENT HOOK-UP** .

   NOTE: If instructed to retrieve PID from a specified test procedure, ensure ignition switch is in proper position as listed in test procedure. GEM requires ignition switch to be in ON position or the test will fail.

2. Turn ignition switch to ON position unless otherwise instructed by specified test procedure. Rotate dial on scan tester to DIAGNOSTIC DATA LINK menu and press trigger.
3. Rotate dial on scan tester to highlight the desired module you wish to access and press trigger. Rotate dial on scan tester to PID/DATA MONITOR AND RECORD and press trigger.
4. Rotate dial on scan tester to highlight the PID acronyms you wish to view and press trigger. Repeat this procedure until all desired PIDs are selected. When all PID acronyms have been selected, press 7 button to view all selected PIDs.

TESTING

TEST A: VEHICLE DOES NOT SHIFT BETWEEN 2WD & 4WD HIGH MODES PROPERLY

NOTE: For GEM connector number identification, see GEM CONNECTOR IDENTIFICATION table. Also see appropriate wiring diagram in WIRING DIAGRAMS .

GEM CONNECTOR IDENTIFICATION

Connector No.	Description
C239	26-Pin
C240	16-Pin
C241	22-Pin
C267	18-Pin

NOTE: Steps 1-3 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

1. **Check Voltage At Fuse No. 15 (5-Amp) -** Turn ignition off. Using voltmeter, measure voltage at terminal No. 1 on fuse junction panel fuse No. 15. If voltage is 10 volts or less, go to next step. If voltage is greater than 10 volts, go to step 4).
2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -**

Inspect fuse junction panel fuse No. 15 (5-amp) and power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to next step. If either fuse is blown, replace fuse. Clear DTCs and retest system. If fuse blows again, inspect circuit for short to ground.

3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.

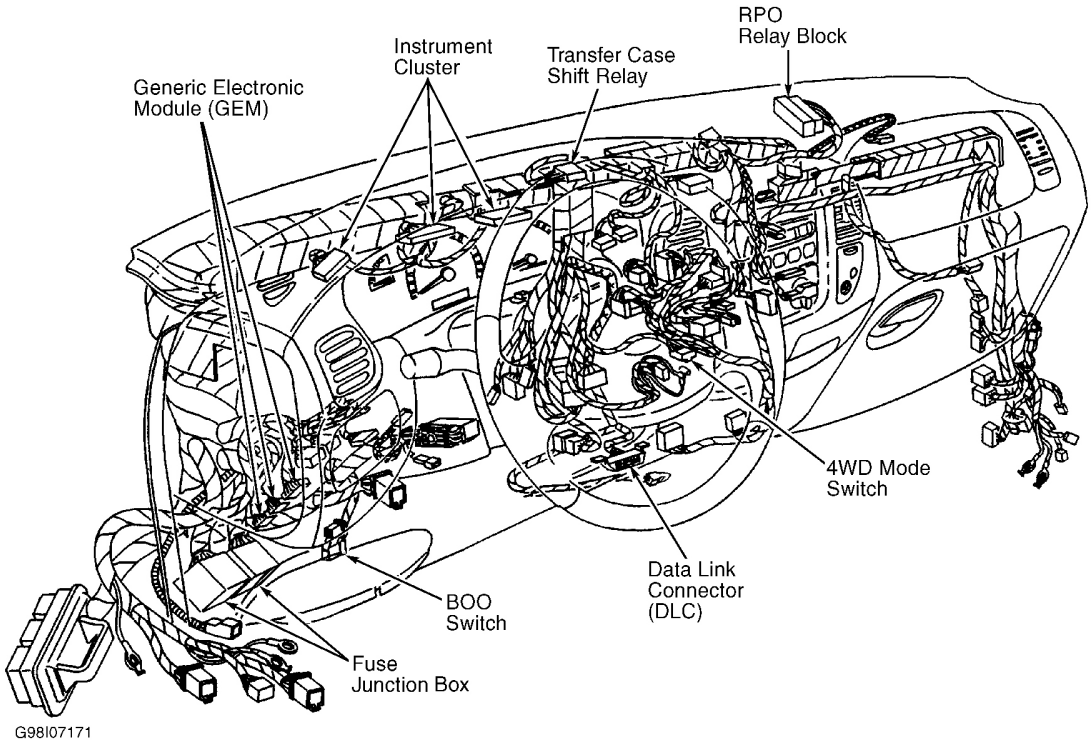


Fig. 2: Locating Fuse Junction Panel, GEM & Relays
Courtesy of FORD MOTOR CO.

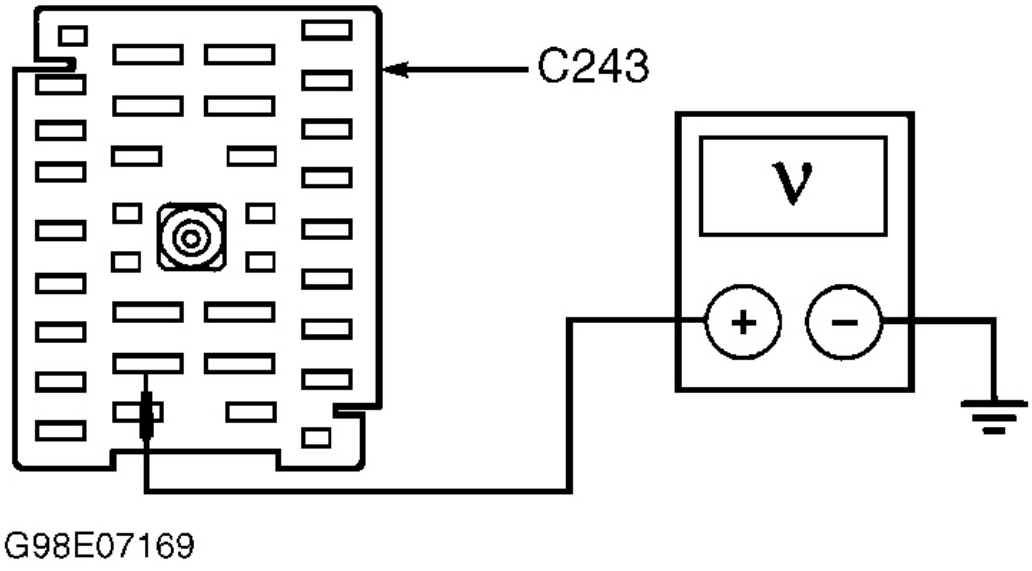


Fig. 3: Checking Circuit 1052 For Voltage
Courtesy of FORD MOTOR CO.

4. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Connect NGS tester. Depress clutch pedal (if applicable). Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF and ACC positions. If values agree, go to next step. If values do not agree, see **STEERING COLUMN SWITCHES** article in the ACCESSORIES/SAFETY EQUIPMENT section.

   NOTE: In next step, if DTC B1342 is retrieved, replace GEM. Clear DTCs and retest system.

5. **Retrieve DTCs -** Retrieve and document continuous DTCs. Clear continuous DTCs. Retrieve on-demand DTCs. If DTCs are recorded, go to appropriate step(s). See **DTC/TEST OR STEP (ESOF MODELS)** table. If no DTCs are retrieved, go to next step.

DTC/TEST OR STEP (ESOF MODELS)

DTC	Go To TEST/STEP
P1804	D
P1806	D
P1808	D
P1810	D
P1812	A/8
P1815	A/8

P1820	A/24
P1822	A/24
P1824	E
P1826	E
P1828	A/24
P1830	A/24
P1832	C
P1834	C
P1846	A/41
P1850	A/41
P1854	A/41
P1858	A/41
P1866	A/41
P1867	A/41
P1876	C
P1877	C
P1891	A/41

6. **Check 4H Indicator Light -** Using scan tool, toggle active command HIGH LAMP on, then off. If indicator light operates correctly, go to next step. If indicator light does not operate correctly, go to **TEST D** .
7. **Check 4L Indicator Light -** Using scan tool, toggle active command LOW LAMP on, then off. If indicator light operates correctly, go to next step. If indicator light does not operate correctly, go to **TEST D** .
8. **Monitor Mode Switch PID 4WDSGEM (2L) -** Turn ignition to RUN position. Rotate 4WD mode switch to 2L position while monitoring PID 4WDSGEM. If scan tool display matches mode switch position, go to next step. If scan tool display does not match mode switch position, go to step 11).
9. **Monitor Mode Switch PID 4WDSGEM (4H) -** Rotate 4WD mode switch to 4H position while monitoring PID 4WDSGEM. If scan tool display matches mode switch position, go to next step. If scan tool display does not match mode switch position, go to step 11).
10. **Monitor Mode Switch PID 4WDSGEM (4L) -** Rotate 4WD mode switch to 4L position while monitoring PID 4WDSGEM. If scan tool display matches mode switch position, go to step 18). If scan tool display does not match mode switch position, go to next step.
11. **Check Mode Switch -** Turn ignition off. Disconnect 4WD mode switch connector. Using external ohmmeter, measure and record resistance between terminals No. 2 and 3 (center terminals) on mode switch connector while moving mode switch through each position. See **MODE SWITCH RESISTANCE SPECIFICATIONS** table. If resistance is within specification, go to next step. If resistance is not as specified, replace mode switch. Clear DTCs and retest system.

MODE SWITCH RESISTANCE SPECIFICATIONS

Switch Position	Ohms
2H	3705-4095

4H	1050-1150
4L	340-380

12. **Check Circuit 780 (Dark Blue Wire) For Open -** Turn ignition off. Disconnect 4WD mode switch connector. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure resistance of Dark Blue wire between terminal No. 3 on mode switch harness connector and terminal No. 8 on GEM 22-pin harness connector. See **Fig. 4** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open in Dark Blue wire. Clear DTCs and retest system.

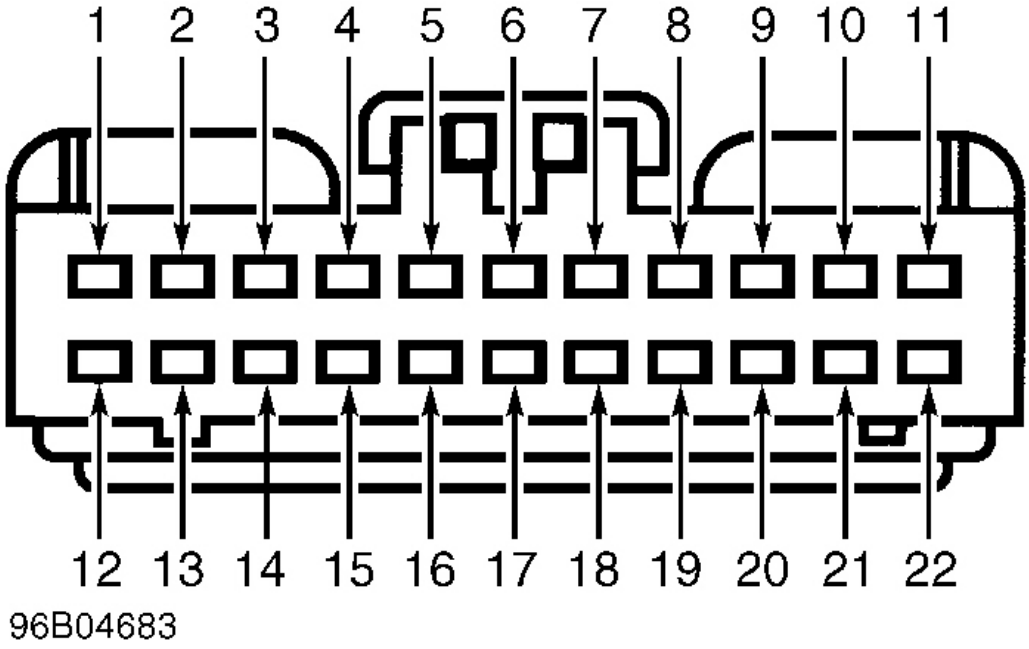


Fig. 4: Identifying GEM 22-Pin Harness Connector Terminals
Courtesy of FORD MOTOR CO.

13. **Check Circuit 780 (Dark Blue Wire) For Short To Ground -** Using ohmmeter, measure resistance between ground and terminal No. 8 (Dark Blue wire) on 22-pin GEM harness connector. See **Fig. 4** . If resistance is more than 10 k/ohms, go to next step. If resistance is 10 k/ohms or less, repair Dark Blue wire for short to ground. Clear DTCs and retest system.
14. **Check Circuit 780 (Dark Blue Wire) For Short To Power -** Turn ignition to RUN position (engine off). Using DVOM, measure voltage between ground and terminal No. 8 (Dark Blue wire) on 22-pin GEM harness connector. See **Fig. 4** . If any voltage is indicated, repair short in Dark Blue wire. Clear DTCs and retest system. If no voltage is present, go to next step.
15. **Check Circuit 682 (Dark Blue Wire) For Open -** Turn ignition off. Disconnect 4WD mode switch connector. Disconnect GEM 26-pin connector. See **Fig. 2** . Measure resistance of Dark Blue wire

between terminal No. 2 on mode switch harness connector and terminal No. 21 on GEM 26-pin harness connector. See **Fig. 5** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open in Dark Blue wire. Clear DTCs and retest system.

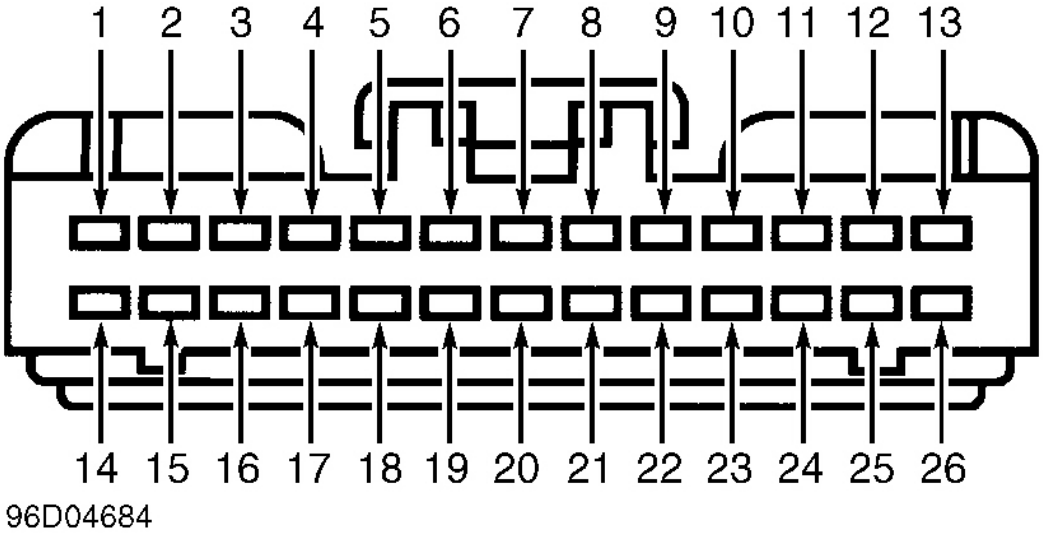


Fig. 5: Identifying GEM 26-Pin Connector Terminals
Courtesy of FORD MOTOR CO.

16. **Check Circuit 682 (Dark Blue Wire) For Short To Ground -** Using ohmmeter, measure resistance between ground and terminal No. 2 (Dark Blue wire) on mode switch harness connector. If resistance is more than 10 k/ohms, go to next step. If resistance is 10 k/ohms or less, repair Dark Blue wire for short to ground. Clear DTCs and retest system.
17. **Check Circuit 682 (Dark Blue Wire) For Short To Power -** Turn ignition to RUN position (engine off). Using DVOM, measure voltage between ground and terminal No. 2 on mode switch harness connector. If any voltage is indicated, repair short in Dark Blue wire. Clear DTCs and retest system. If no voltage is present, replace GEM. Clear DTCs and retest system.
18. **Check Front Axle Engagement -** Start vehicle. Using scan tool, set active commands AXLE ENGG to ON and AXLE DSCN to OFF. Drive vehicle short distance. Raise and support vehicle with engine running. Spin one front tire. Opposite tire should spin in reverse direction. If axle is working correctly, exit active command mode and go to next step. If axle is not working correctly, lower vehicle and go to **TEST C** .
19. **Check Front Drive Shaft Engagement -** Place 4WD mode switch in 4H position. Verify front and rear drive shafts are spinning. If front and rear drive shafts are locked together, go to next step. If front and rear drive shafts are not locked together, go to step 22).

NOTE: When 4WD is disengaged, front drive shaft may spin due to viscous drag in transfer case, especially if cold.

20. **Check Front Drive Shaft Disengagement -** Place 4WD mode switch in 2H position. If rear drive shaft is only being driven, go to next step. If front drive shaft is also being driven, go to step 22).
21. **Check Front Axle Disengagement -** Using scan tool, set active commands AXLE ENGG to OFF and AXLE DSCN to ON. Spin one front tire. Opposite front tire should not spin. If front axle is disengaged, the 4WD system is functioning correctly. If front axle is engaged, go to **TEST C** .
22. **Monitor PIDS MTR_CCW & MTR_CW -** Monitor GEM PIDs MTR_CCW and MTR_CW. Toggle active command CW/CCW on. If PIDs MTR_CCW and MTR_CW indicate ON, go to next step. If PIDs MTR_CCW and MTR_CW indicate ON-B-, go to step 28).
23. **Monitor PIDS MTR_CCW & MTR_CW -** Monitor GEM PIDs MTR_CCW and MTR_CW. Toggle active command CW/CCW off. If PIDs MTR_CCW and MTR_CW indicate OFF, go to step 31). If PIDs MTR_CCW and MTR_CW indicate OFFO-G, go to next step.
24. **Check Voltage At Transfer Case Shift Relay Coil Circuit 704 (Dark Green/Light Green Wire) -** Turn ignition off. Disconnect transfer case shift relay connector. See **Fig. 2** . On ESOF models, measure voltage between ground and terminal No. 5 on shift relay harness connector. See **Fig. 6** . On MSOF models, measure voltage between ground and terminal No. 3 on shift relay harness connector. If voltage is 10 volts or less on all models, repair open Dark Green/Light Green wire. Clear DTCs and retest system. If voltage is greater than 10 volts on ESOF models, go to next step. If voltage is greater than 10 volts on MSOF models, remove electric clutch relay. See **Fig. 2** . Test relay. See **ELECTRIC CLUTCH RELAY TEST** table. Replace as needed. If relay is okay, replace electric clutch in transfer case.

ELECTRIC CLUTCH RELAY TEST

Terminals No. (1)	**Continuity**
No Voltage Applied	
1 & 2	Yes
3 & 4	Yes
3 & 5	No
Voltage Applied (2)	
3 & 5	Yes

(1) See **Fig. 16** .

(2) Apply battery voltage to terminals No. 1 and 2.

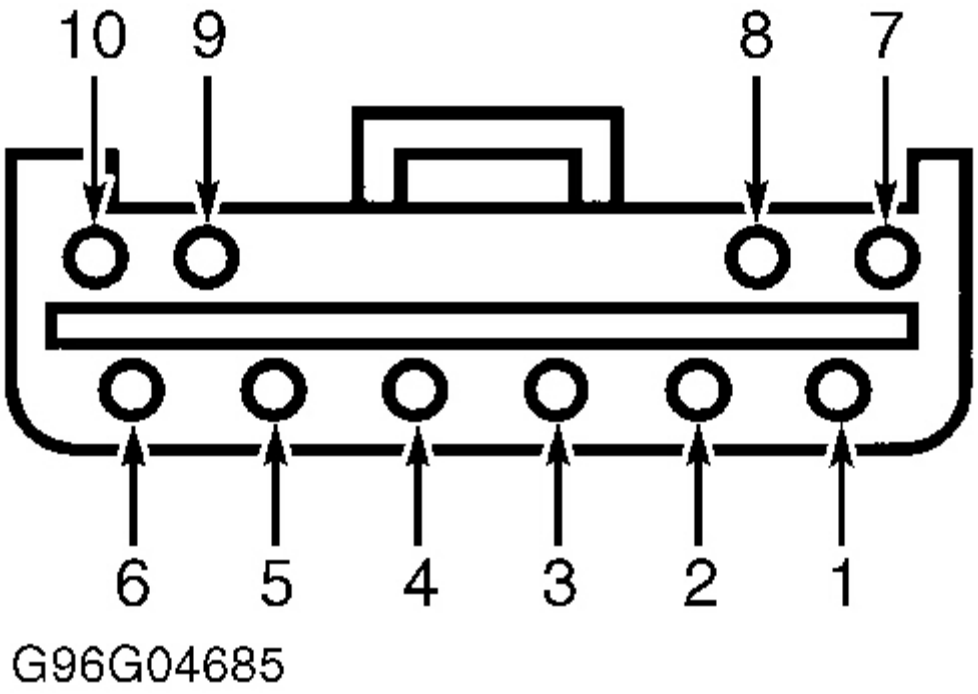


Fig. 6: Transfer Case Shift Relay Harness Connector Terminals
Courtesy of FORD MOTOR CO.

25. **Check Circuit 781 (Orange/Light Blue Wire) For Open -** Disconnect GEM 22-Pin connector. See **Fig. 2** . Using ohmmeter, measure resistance of Orange/Light Blue wire between terminal No. 9 on shift relay harness connector and terminal No. 17 on GEM harness connector. See **Fig. 3** and **Fig. 5** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Orange/Light Blue wire. Clear DTCs and retest system.
26. **Check Circuit 782 (Brown/White Wire) For Open -** Measure resistance of Brown/White wire between terminal No. 8 on shift relay harness connector and terminal No. 16 on GEM harness connector. See **Fig. 3** and **Fig. 5** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Brown/White wire. Clear DTCs and retest system.
27. **Check Circuits 781 (Orange/Light Blue Wire) & 782 Brown/White Wire) For Short To Ground -** Measure resistance between ground and terminals No. 8 and 9 on shift relay harness connector. See **Fig. 6** . If resistance is greater than 10 k/ohms for both circuits, go to next step. If resistance is 10 k/ohms or less for either circuit, repair Orange/Light Blue wire or Brown/White wire for short to ground. Clear DTCs and retest system.
28. **Check Circuit 782 (Brown/White Wire) For Short To Power -** Ensure ignition is off. Disconnect GEM 22-Pin connector and transfer case shift relay connector. See **Fig. 2** . Turn ignition to RUN

position. Measure voltage between ground and terminal No. 8 on shift relay harness connector. See **Fig. 6** . If voltage is not present, go to next step. If voltage is present, repair Brown/White wire for short to voltage. Clear DTCs and retest system.

29. **Check Circuit 781 (Orange/Light Blue Wire) For Short To Power -** Measure voltage between ground and terminal No. 9 on shift relay harness connector. See **Fig. 6** . If voltage is not present, go to next step. If voltage is present, repair Orange/Light Blue wire for short to voltage. Clear DTCs and retest system.
30. **Check Transfer Case Shift Relay Coils -** Turn ignition off. Using ohmmeter, measure resistance between terminal No. 5 and terminals No. 8 and 9 on transfer case shift relay connector. If resistance measured for both circuits is 60-160 ohms, replace GEM. Clear DTCs and retest system. If resistance measured for both circuits is not 60-160 ohms, replace transfer case shift motor relay. Clear DTCs and retest system.
31. **Check Voltage To Transfer Case Shift Motor -** Turn ignition off. Disconnect transfer case 16-pin connector. Turn ignition to RUN position. Using scan tool, set active command CW/CCW to ON. Using DVOM, measure voltage between ground and terminals No. 14 and 15 on 16-pin harness connector. See **Fig. 7** . If voltage is more than 10 volts, go to step 33). If voltage is 10 volts or less, go to next step.

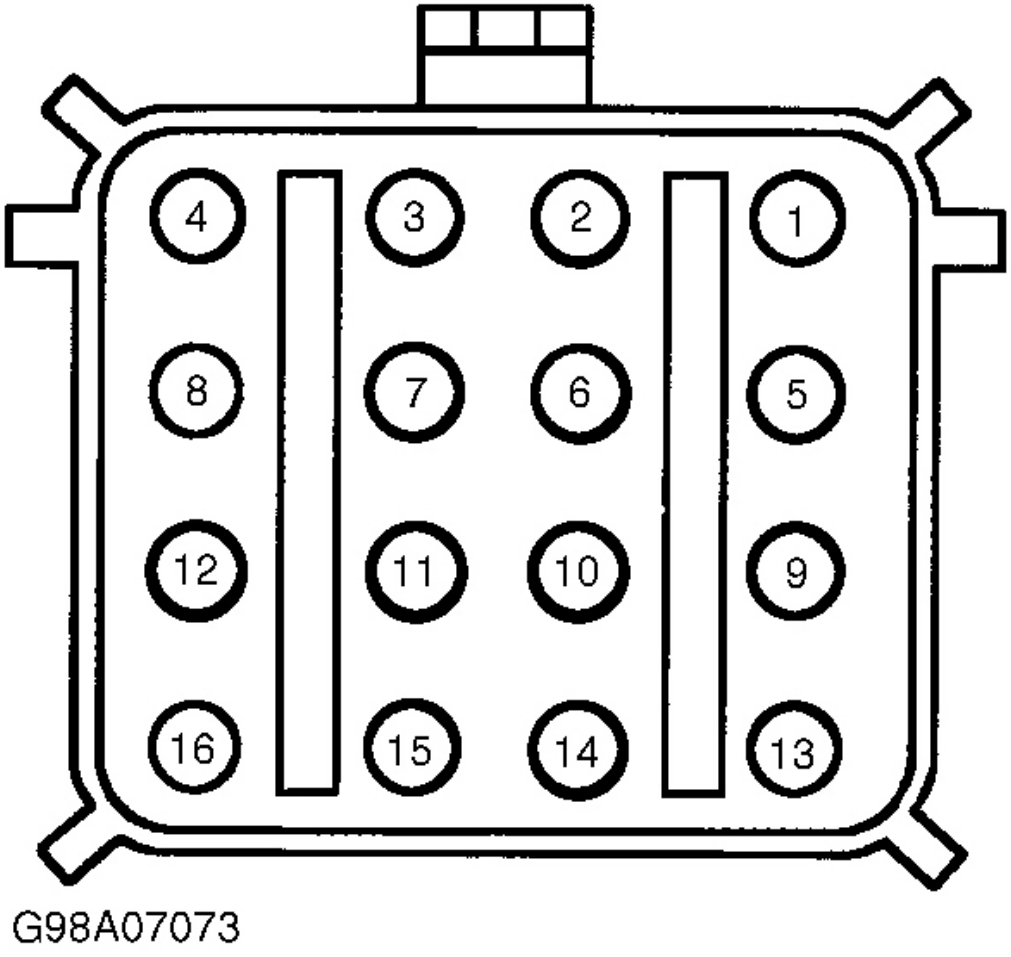


Fig. 7: Identifying Transfer Case 16-Pin Harness Connector Terminals
Courtesy of FORD MOTOR CO.

32. **Check Voltage To Transfer Case Shift Relay Circuit 704 Switch Side -** Turn ignition off. Disconnect transfer case shift relay. See **Fig. 2** . Measure voltage between ground and terminal No. 3 (Dark Green/Light Green wire) on shift relay harness connector. See **Fig. 6** . If voltage is more than 10 volts, go to step 35). If voltage is 10 volts or less, repair open Dark Green/Light Green wire. Clear DTCs and retest system.
33. **Check Voltage To Transfer Case Shift Motor -** Turn ignition to RUN position. Using scan tool, set active command CW/CCW to OFF. Using DVOM, measure voltage between ground and terminals No. 14 and 15 on transfer case 16-pin harness connector. See **Fig. 7** . If voltages are 10 volts or less, go to step 35). If voltages are more than 10 volts, go to next step.
34. **Check Circuits 777 (Yellow Wire) & 778 (Orange Wire) For Short To Power -** Turn ignition off.

Disconnect transfer case 16-pin connector transfer case shift relay. Turn ignition to RUN position. Measure voltage between ground and terminal No. 14 and 15 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present on either circuit, repair Yellow or Orange wire for short to voltage. Clear DTCs and retest system. If voltage is not present on both circuits, go to next step.

35. **Check Circuits 777 (Yellow Wire) & 778 (Orange Wire) For Open Through Transfer Case Relay -** Set active command CW/CCW to OFF. Using ohmmeter, measure resistance between ground and terminals No. 14 and 15 on transfer case 16-pin harness connector. See **Fig. 7** . If resistance for both circuits is less than 5 ohms, connect 16-pin connector and go to step 39). If resistance is 5 ohms or greater for either circuit, go to step 38).
36. **Check Circuit 777 (Yellow Wire) For Open -** Measure resistance between terminal No. 15 on transfer case 16-pin harness connector and terminal No. 7 on shift relay harness connector. See **Fig. 5** and **Fig. 6** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Yellow wire. Clear DTCs and retest system.
37. **Check Circuit 778 (Orange Wire) For Open -** Ensure ignition is off. Measure resistance between terminal No. 14 on transfer case 16-pin harness connector and terminal No. 10 on shift relay harness connector. See **Fig. 5** and **Fig. 6** . If resistance is less than 5 ohms, replace transfer case shift relay. Clear DTCs and retest system. If resistance is 5 ohms or greater, repair open Orange wire. Clear DTCs and retest system.
38. **Check Ground To Transfer Case Shift Relay -** Ensure ignition is off. Disconnect transfer case shift relay. See **Fig. 2** . Measure resistance between ground and terminal No. 1 (Black wire) on shift relay harness connector. If resistance is 5 ohms or greater, repair open Black wire (circuit 57). Clear DTCs and retest system. If resistance is less than 5 ohms, replace transfer case shift relay. Clear DTCs and retest system.
39. **Check Contact Plate Switches -** Clear DTCs. Turn ignition off. Turn ignition to RUN position. Monitor GEM PIDs PLATE_A, PLATE_B, PLATE_C, PLATE_D. Place 4WD mode switch in 2H position. Record PIDs. Place shift lever in "N" position. Depress brake pedal. Move mode switch to 4H position. Record PIDs. See **4WD MODE SWITCH PID OUTPUT** table. If PIDs recorded match table, transfer case may have internal problem. Repair as needed. Clear DTCs and retest system. If PIDs recorded do not match table, go to next step.

4WD MODE SWITCH PID OUTPUT

CONTACT PLATE	2H	4H
PLATE_A	CLOSED	OPEN
PLATE_B	OPEN	CLOSED
PLATE_C	CLOSED	CLOSED
PLATE_D	CLOSED	OPEN

40. **Monitor PID PLATE_A For Open -** Turn ignition off. Disconnect transfer case 16-pin connector. Turn ignition to RUN position. Monitor GEM PID PLATE_A. If scan tool displays OPEN, go to next step. If scan tool does not display OPEN, go to step 42).
41. **Check Contact Plate Switch "A" Circuit 771 (Purple/Yellow Wire) -** Connect jumper wire across terminals No. 5 and 10 on transfer case 16-pin harness connector. PID should display CLOSED. If PLATE_A PID is as specified, go to step 47). If PLATE_A PID is not as specified, go to step 43).
42. **Check Circuit 771 (Purple/Yellow Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 4** . Measure resistance between ground and terminal No. 5 on transfer

case 16-pin harness connector. See **Fig. 7** . If resistance is greater than 10 k/ohms, replace GEM. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair Pink/Yellow wire for short to ground. Clear DTCs and retest system.

43. **Check Circuit 771 (Purple/Yellow Wire) For Open -** Measure resistance of Pink/Yellow wire between terminal No. 21 on GEM connector and terminal No. 5 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Pink/Yellow wire. Clear DTCs and retest system.
44. **Check Circuit 771 (Purple/Yellow Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 5 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present, repair Pink/Yellow wire for short to voltage. If voltage is not present, go to next step.
45. **Check Circuit 762 (Yellow/White Wire) For Short To Power -** Turn ignition off. Disconnect transfer case 16-pin connector. Turn ignition to RUN position. Using DVOM, measure voltage between ground and terminal No. 12 on GEM harness connector. See **Fig. 5** . If voltage is present, repair Yellow/White wire for short to voltage. If voltage is not present, go to next step.
46. **Check Circuit 762 (Yellow/White Wire) For Open -** Turn ignition off. Measure resistance of Yellow/White wire between terminal No. 12 on GEM connector and terminal No. 10 on transfer case 16-pin harness connector. See **Fig. 3** and **Fig. 6** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Yellow/White wire. Clear DTCs and retest system.
47. **Check Contact Plate Switch "B" Circuit 770 (White Wire) -** Turn ignition to RUN position. Monitor GEM PID PLATE_B. PID should be OPEN. Connect jumper wire across terminals No. 1 and 10. PID should change to CLOSED. If PLATE_B PIDs are as specified, remove jumper wire and go to step 51). If PLATE_B PIDs are not as specified, go to next step.
48. **Check Circuit 770 (White Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Measure resistance between ground and terminal No. 1 on transfer case 16-pin harness connector. If resistance is greater than 10 k/ohms, replace GEM. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair White wire for short to ground. Clear DTCs and retest system.
49. **Check Circuit 770 (White Wire) For Open -** Measure resistance of White wire between terminal No. 20 on GEM connector and terminal No. 1 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open White wire. Clear DTCs and retest system.
50. **Check Circuit 770 (White Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 1 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present, repair White wire for short to voltage. Clear DTCs and retest system. If voltage is not present, replace GEM. Clear DTCs and retest system.
51. **Check Contact Plate Switch "C" Circuit 764 (Brown/White Wire) -** Turn ignition to RUN position. Monitor GEM PID PLATE_C. PID should be OPEN. Connect jumper wire across terminals No. 9 and 10. PID should change to CLOSED. If PLATE_C PIDs are as specified, go to step 55). If PLATE_C PIDs are not as specified, go to next step.
52. **Check Circuit 764 (Brown/White Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Measure resistance between ground and terminal No. 9 on transfer case 16-pin harness connector. If resistance is greater than 10 k/ohms, replace GEM. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair Brown/White wire for short to ground. Clear DTCs

and retest system.

53. **Check Circuit 764 (Brown/White Wire) For Open -** Measure resistance of Brown/White wire between terminal No. 19 on GEM connector and terminal No. 9 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Brown/White wire. Clear DTCs and retest system.
54. **Check Circuit 764 (Brown/White Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 9 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present, repair Brown/White wire for short to voltage. Clear DTCs and retest system. If voltage is not present, replace GEM. Clear DTCs and retest system.
55. **Check Contact Plate Switch "D" Circuit 763 (Orange/White Wire) -** Turn ignition to RUN position. Monitor GEM PID PLATE_D. PID should be OPEN. Connect jumper wire across terminals No. 10 and 13. PID should change to CLOSED. If PLATE_D PIDs are as specified, replace transfer case shift motor. See **TRANSFER CASE - BORG/WARNER 44-06** article in the POWERTRAIN section. If PLATE_D PIDs are not as specified, go to next step.
56. **Check Circuit 763 (Orange/White Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Measure resistance between ground and terminal No. 13 on transfer case 16-pin harness connector. If resistance is greater than 10 k/ohms, replace GEM. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair Orange/White wire for short to ground. Clear DTCs and retest system.
57. **Check Circuit 763 (Orange/White Wire) For Open -** Measure resistance of Orange/White wire between terminal No. 18 on GEM connector and terminal No. 13 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Orange/White wire. Clear DTCs and retest system.
58. **Check Circuit 763 (Orange/White Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 13 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present, repair Orange/White wire for short to voltage. Clear DTCs and retest system. If voltage is not present, replace GEM. Clear DTCs and retest system.

TEST B: VEHICLE DOES NOT SHIFT BETWEEN 4WD HIGH TO 4WD LOW PROPERLY, SHIFTS PROPERLY BETWEEN 2WD TO 4WD HIGH, 4WD HIGH TO 2WD

NOTE: For GEM connector number identification, see GEM CONNECTOR IDENTIFICATION table. Also see appropriate wiring diagram in WIRING DIAGRAMS .

GEM CONNECTOR IDENTIFICATION

Connector No.	Description
C239	26-Pin
C240	16-Pin
C241	22-Pin
C267	18-Pin

NOTE: Steps 1-3 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

1. **Check Voltage At Fuse No. 15 (5-Amp) -** Turn ignition off. Using voltmeter, measure voltage at terminal No. 1 on fuse junction panel fuse No. 15. If voltage is 10 volts or less, go to next step. If voltage is greater than 10 volts, go to step 4).
2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -** Inspect fuse junction panel fuse No. 15 (5-amp) and power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to next step. If either fuse is blown, replace fuse. Clear DTCs and retest system. If fuse blows again, inspect circuit for short to ground.
3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.
4. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Connect NGS tester. Depress clutch pedal (if applicable). Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF and ACC positions. If values agree, go to next step. If values do not agree, see appropriate **STEERING COLUMN SWITCHES** article in the ACCESSORIES/SAFETY EQUIPMENT section.

   NOTE: In next step, if DTC B1342 is retrieved, replace GEM. Clear DTCs and retest system.

5. **Retrieve DTCs**

   Retrieve and document continuous DTCs. Clear continuous DTCs. Retrieve on-demand DTCs. If DTCs are recorded, go to appropriate step(s). See **DTC/TEST OR STEP** table. If no DTCs are retrieved, go to next step.

DTC/TEST OR STEP

DTC	Go To TEST/STEP
P0500	B/27
P1483	B/20
P1485	B/20
P1804	D
P1806	D
P1808	D
P1810	D
P1812	B/8
P1815	B/8
P1820	B/24
P1822	B/24

P1824	E
P1826	E
P1828	A
P1830	A
P1832	C
P1834	C
P1846	B/31
P1850	A/31
P1854	A/31
P1858	A/31
P1866	A
P1867	A
P1876	C
P1877	C
P1891	B/41

6. **Check 4H Indicator Light -** Using scan tool, toggle active command HIGH LAMP on, then off. If indicator light operates correctly, go to next step. If indicator light does not operate correctly, go to **TEST D** .
7. **Check 4L Indicator Light -** Using scan tool, toggle active command LOW LAMP on, then off. If indicator light operates correctly, go to next step. If indicator light does not operate correctly, go to **TEST D** .
8. **Monitor Mode Switch PID 4WDSGEM (2L) -** Turn ignition to RUN position. Rotate 4WD mode switch to 2L position while monitoring PID 4WDSGEM. If scan tool display matches mode switch position, go to next step. If scan tool display does not match mode switch position, go to step 11).
9. **Monitor Mode Switch PID 4WDSGEM (4H) -** Rotate 4WD mode switch to 4H position while monitoring PID 4WDSGEM. If scan tool display matches mode switch position, go to next step. If scan tool display does not match mode switch position, go to step 11).
10. **Monitor Mode Switch PID 4WDSGEM (4L) -** Rotate 4WD mode switch to 4L position while monitoring PID 4WDSGEM. If scan tool display matches mode switch position, go to step 18). If scan tool display does not match mode switch position, go to next step.
11. **Check Mode Switch -** Turn ignition off. Disconnect 4WD mode switch connector. Using external ohmmeter, measure and record resistance between terminals No. 2 and 3 (center terminals) on mode switch connector while moving mode switch through each position. See **MODE SWITCH RESISTANCE SPECIFICATIONS** table. If resistance is within specification, go to next step. If resistance is not as specified, replace mode switch. Clear DTCs and retest system.

MODE SWITCH RESISTANCE SPECIFICATIONS

Switch Position	Ohms
2H	3705-4095
4H	1050-1150
4L	340-380

12. **Check Circuit 780 (Dark Blue Wire) For Open -** Turn ignition off. Disconnect 4WD mode switch connector. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure resistance of Dark Blue wire between terminal No. 3 on mode switch harness connector and terminal No. 8 on GEM 22-pin harness connector. See **Fig. 4** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open in Dark Blue wire. Clear DTCs and retest system.
13. **Check Circuit 780 (Dark Blue Wire) For Short To Ground -** Using ohmmeter, measure resistance between ground and terminal No. 8 (Dark Blue wire) on 22-pin GEM harness connector. See **Fig. 4** . If resistance is more than 10 k/ohms, go to next step. If resistance is 10 k/ohms or less, repair Dark Blue wire for short to ground. Clear DTCs and retest system.
14. **Check Circuit 780 (Dark Blue Wire) For Short To Power -** Turn ignition to RUN position (engine off). Using DVOM, measure voltage between ground and terminal No. 8 (Dark Blue wire) on 22-pin GEM harness connector. See **Fig. 4** . If any voltage is indicated, repair short in Dark Blue wire. Clear DTCs and retest system. If no voltage is present, go to next step.
15. **Check Circuit 682 (Dark Blue Wire) For Open -** Turn ignition off. Disconnect 4WD mode switch connector. Disconnect GEM 26-pin connector. See **Fig. 2** . Measure resistance of Dark Blue wire between terminal No. 2 on mode switch harness connector and terminal No. 21 on GEM 26-pin harness connector. See **Fig. 5** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open in Dark Blue wire. Clear DTCs and retest system.
16. **Check Circuit 682 (Dark Blue Wire) For Short To Ground -** Using ohmmeter, measure resistance between ground and terminal No. 2 (Dark Blue wire) on mode switch harness connector. If resistance is more than 10 k/ohms, go to next step. If resistance is 10 k/ohms or less, repair Dark Blue wire for short to ground. Clear DTCs and retest system.
17. **Check Circuit 682 (Dark Blue Wire) For Short To Power -** Turn ignition to RUN position (engine off). Using DVOM, measure voltage between ground and terminal No. 2 on mode switch harness connector. If any voltage is indicated, repair short in Dark Blue wire. Clear DTCs and retest system. If no voltage is present, replace GEM. Clear DTCs and retest system.
18. **Check Brake Pedal Position (BPP) Switch -** While monitoring PID BOO_GEM, depress brake pedal. If PID displayed is ON, go to step 21). If PID is not displayed ON, go to next step.
19. **Check Voltage To Brake Pedal Position (BPP) Switch -** Disconnect BPP switch connector. Using DVOM, measure voltage between ground and Light Green/Red wire terminal on BPP switch harness connector. If voltage is 10 volts or less, repair open Light Green/Red wire. Clear DTCs and retest system. If voltage is more than 10 volts, go to next step.
20. **Check Brake Pedal Position (BPP) Switch -** While monitoring PID BOO_GEM, connect jumper wire across specified BPP harness connector terminals. If PID displayed is ON, replace BPP switch. Clear DTCs and retest system. If PID is not displayed ON, repair open Light Green wire. Clear DTCs and retest system. If problem remains, replace GEM. Clear DTCs and retest system.
21. **Check Clutch Interlock -** Turn ignition to RUN position. Monitor GEM PIN CLTCHSW. On A/T equipped vehicles, place shift lever in park, then neutral. On M/T equipped vehicles, depress clutch pedal. Scan tool should display ACTIVE. Place shift lever in any other position, or release clutch pedal. Scan tool should display NOT_ACT. If scan tool display is as specified, go to next step. If scan tool display is not as specified, inspect Transmission Range (TR) sensor and applicable circuits. See AUTO TRANS DIAGNOSIS article in the AUTOMATIC TRANS DIAGNOSIS section. Repair as needed. If TR sensor and applicable circuits are okay, replace GEM. Clear DTCs and retest system.
22. **Check TR Sensor -** While monitoring PID NTRL_SW, place shift lever in neutral. Scan tool should display, NTRL. Move shift lever to any other position. Scan tool should not display NTRL. If scan tool

display is not as specified, go to next step. If scan tool display is as specified, go to step 26).

23. **Check Digital TR Sensor Ground -** Ensure ignition is off. Disconnect digital TR sensor connector. Using ohmmeter, measure resistance between ground and terminal No. 7 (Black wire) on TR sensor harness connector. See **Fig. 8** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Black wire. Clear DTCs and retest system.

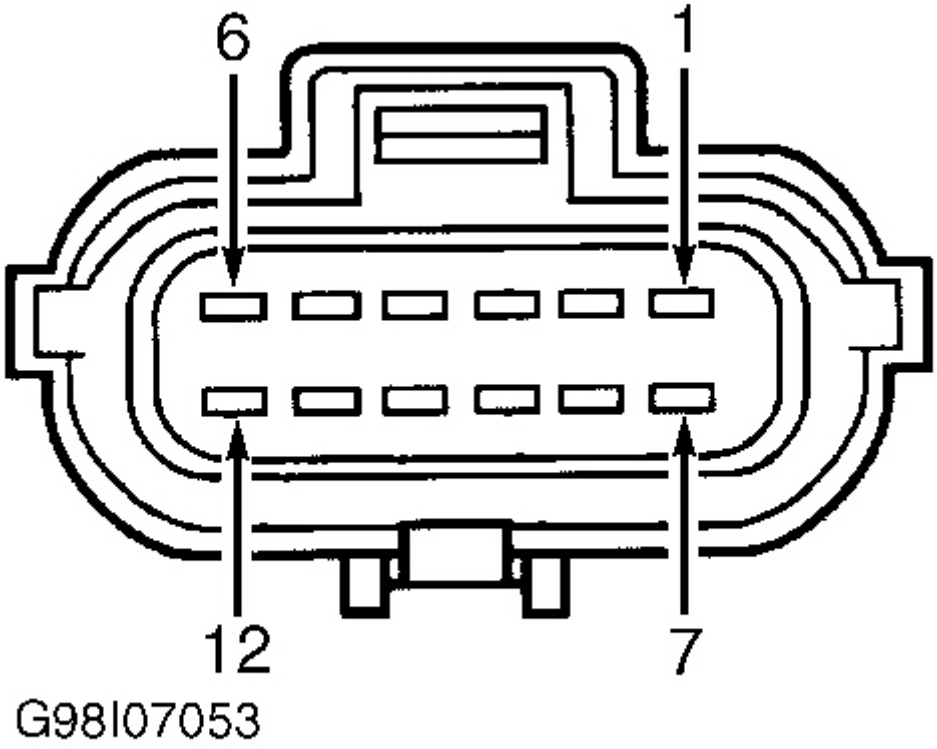


Fig. 8: Identifying Digital TR Sensor Harness Connector Terminals
Courtesy of FORD MOTOR CO.

24. **Check Digital TR Sensor -** While monitoring GEM PID NTRL_SW, connect jumper wire between terminals No. 7 (Black wire) and No. 8 (Red/White wire) on TR sensor harness connector. See **Fig. 8** . Turn ignition to RUN position. Scan tool should display NTRL. Remove jumper wire. Scan tool should not display NTRL. If scan tool display is not as specified, repair open Red/White wire (circuit 463). Clear DTCs and retest system. If problem is still present, replace GEM. Clear DTCs and retest system. If scan tool display is as specified, replace digital TR sensor. Clear DTCs and retest system.
25. **Check Vehicle Speed Signal -** Monitor GEM PID VSS_GEM while driving vehicle 0-55 MPH. If PID values matches speedometer reading, go to step 28). If PID values do not match speedometer reading, go to next step.

26. **Check Circuit 676 (Pink/Orange Wire) For Open -** Turn ignition off. Disconnect VSS connector and fuse junction panel connector C242. Using ohmmeter, measure resistance of Pink/Orange wire between VSS harness connector and terminal No. 9 on fuse junction panel harness connector. See **Fig. 9** and **Fig. 10** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Pink/Orange wire. Clear DTCs and retest system.

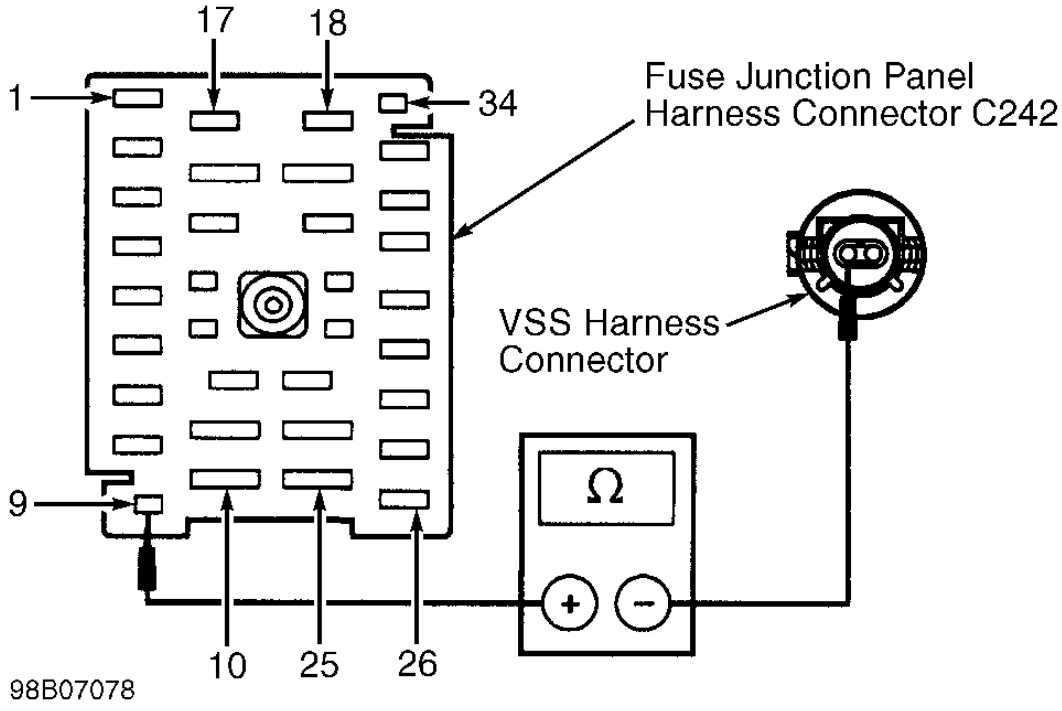


Fig. 9: Checking Continuity Of VSS Circuit 676
Courtesy of FORD MOTOR CO.

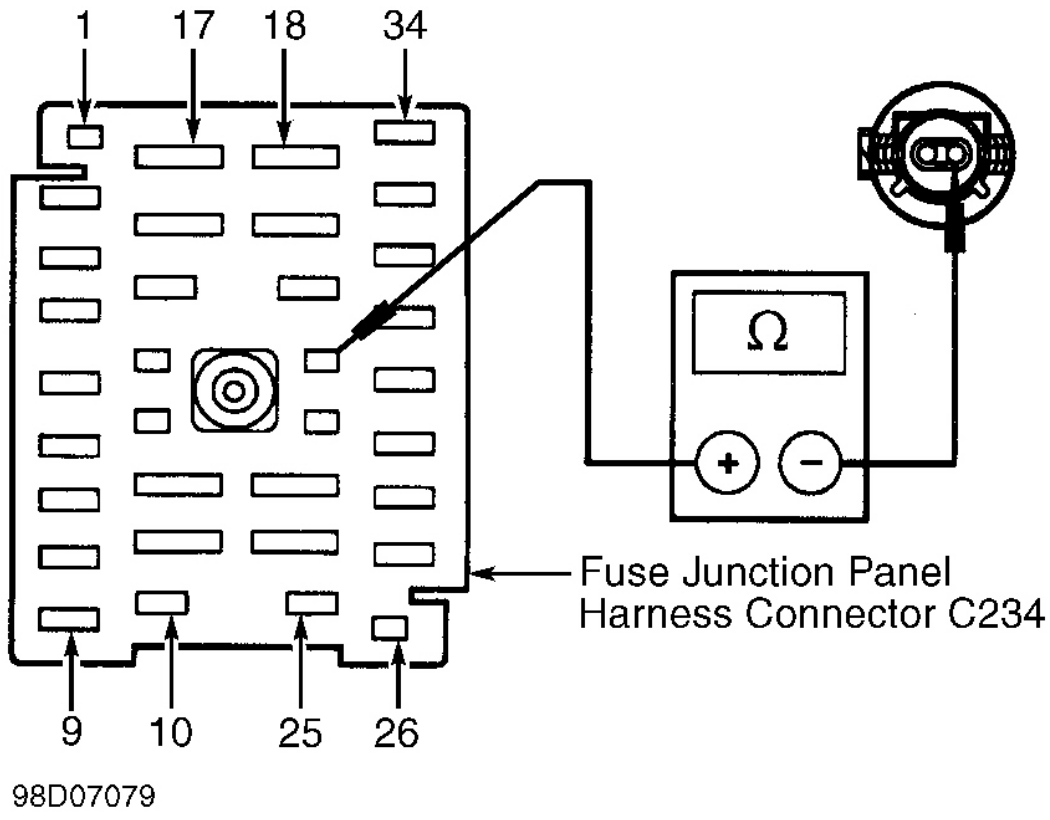


Fig. 10: Checking Continuity Of VSS Circuit 679
Courtesy of FORD MOTOR CO.

27. **Check Circuit 679 (Gray/Black Wire) For Open -** Turn ignition off. Disconnect VSS connector and fuse junction panel connector C243. Using ohmmeter, measure resistance of Gray/Black wire between VSS harness connector and terminal No. 21 on fuse junction panel harness connector. See **Fig. 9** and **Fig. 10** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Gray/Black wire. Clear DTCs and retest system.
28. **Check Continuity Of Internal Fuse Junction Panel Circuit 676 -** Ensure ignition is off. Disconnect GEM from fuse junction panel 18-pin connector. See **Fig. 11** . Measure resistance between terminal No. 9 on fuse junction panel harness connector C242 and terminal No. 10 on GEM harness connector. See **Fig. 11** thru **Fig. 13** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, replace fuse junction panel. Clear DTCs and retest system.

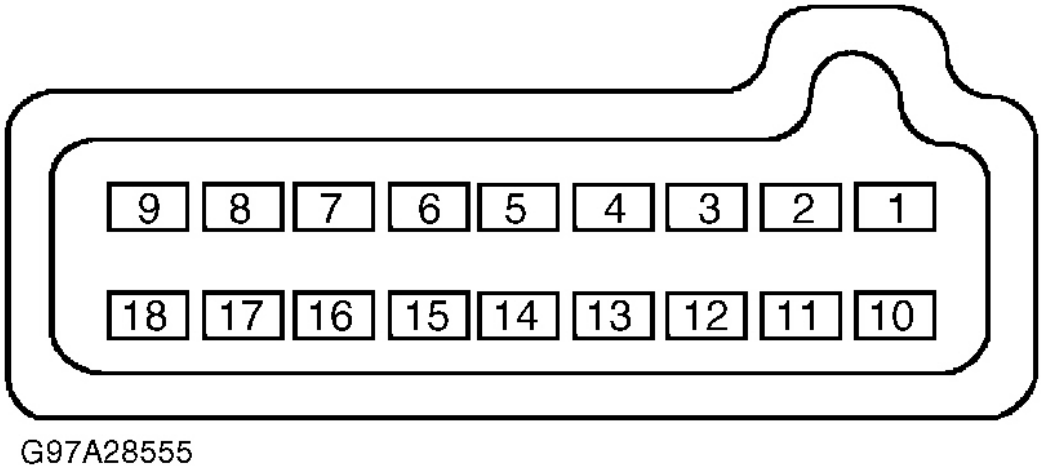


Fig. 11: Identifying GEM 18-Pin Harness Connector Terminals
Courtesy of FORD MOTOR CO.

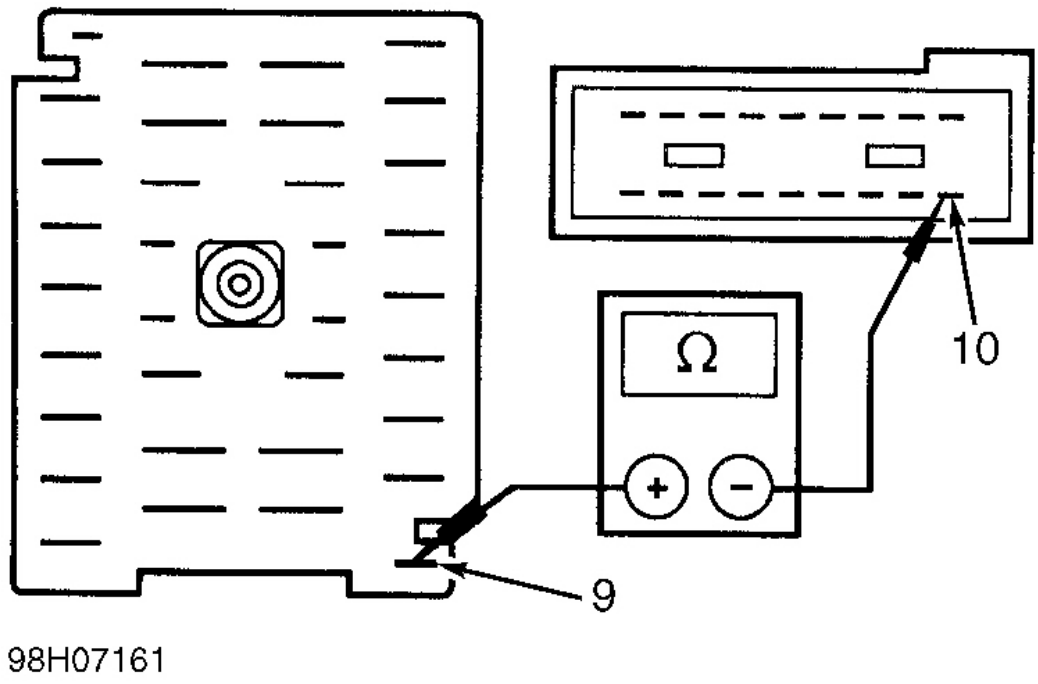


Fig. 12: Checking Continuity Of Fuse Junction Panel Internal Circuit 676

Courtesy of FORD MOTOR CO.

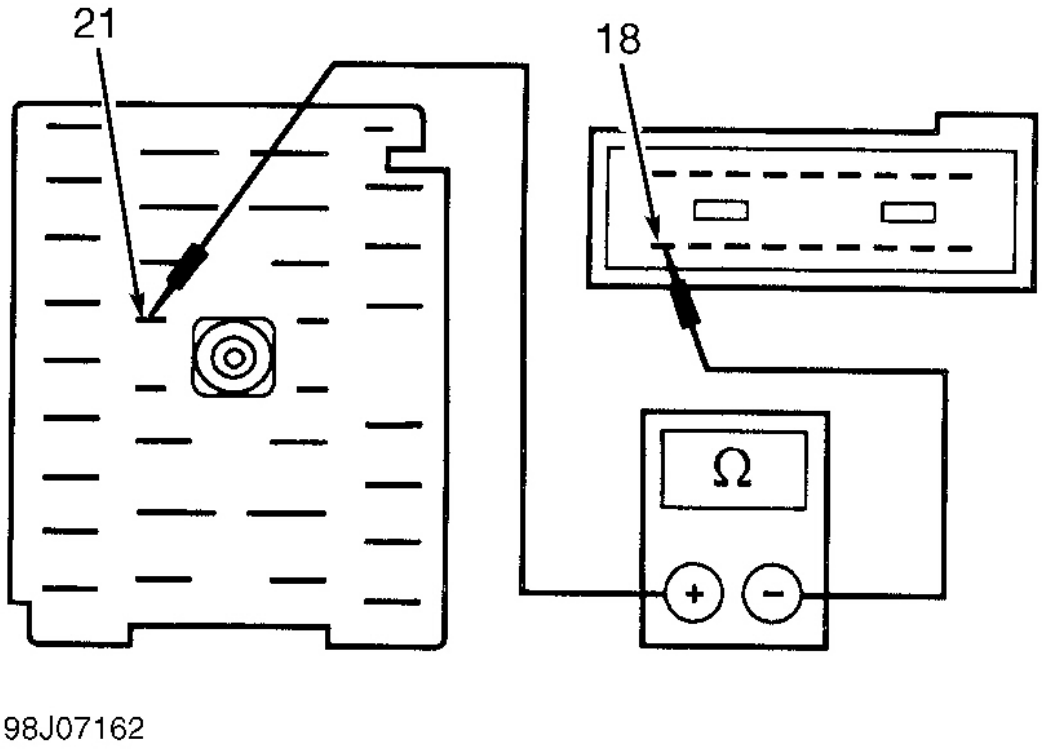


Fig. 13: Checking Continuity Of Fuse Junction Panel Internal Circuit 679
Courtesy of FORD MOTOR CO.

29. **Check Continuity Of Internal Fuse Junction Panel Circuit 676 -** Measure resistance between terminal No. 21 on fuse junction panel harness connector C242 and terminal No. 18 on GEM harness connector. See **Fig. 11** thru **Fig. 13** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, replace fuse junction panel. Clear DTCs and retest system.
30. **Check Contact Plate Switches -** Using scan tool, clear DTCs. Turn ignition off. Turn ignition to RUN position. Monitor GEM PIDs PLATE_A, PLATE_B, PLATE_C, PLATE_D. Place 4WD mode switch in 4H position. Record PIDs. Move mode switch to 4L position. Records PIDs. See **4WD MODE SWITCH PID OUTPUT** table. If PIDs recorded match table, transfer case may have internal problem. Repair as needed. Clear DTCs and retest system. If PIDs recorded do not match table, go to next step.

4WD MODE SWITCH PID OUTPUT

Contact Plate	Auto/4WD High	4WD Low
PLATE_A	CLOSED	OPEN
PLATE_B	OPEN	CLOSED
PLATE_C	CLOSED	OPEN

PLATE_D	CLOSED	CLOSED

31. **Monitor PID PLATE_A For Open -** Turn ignition off. Disconnect transfer case 16-pin connector. Turn ignition to RUN position. Monitor GEM PID PLATE_A. If scan tool displays OPEN, go to next step. If scan tool does not display OPEN, go to step 33).
32. **Check Contact Plate Switch "A" Circuit 771 (Pink/Yellow Wire) -** Connect jumper wire across terminals No. 5 and 10 on transfer case 16-pin harness connector. PID should display CLOSED. If PLATE_A PID is as specified, go to step 38). If PLATE_A PID is not as specified, go to step 34).
33. **Check Circuit 771 (Pink/Yellow Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Measure resistance between ground and terminal No. 21 on GEM harness connector. See **Fig. 4** . If resistance is greater than 10 k/ohms, replace GEM. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair Pink/Yellow wire for short to ground. Clear DTCs and retest system.
34. **Check Circuit 771 (Pink/Yellow Wire) For Open -** Measure resistance of Pink/Yellow wire between terminal No. 21 on GEM connector and terminal No. 5 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Pink/Yellow wire. Clear DTCs and retest system.
35. **Check Circuit 771 (Pink/Yellow Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 5 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present, repair Pink/Yellow wire for short to voltage. If voltage is not present, go to next step.
36. **Check Circuit 762 (Yellow/White Wire) For Short To Power -** Turn ignition off. Disconnect transfer case 16-pin connector. Turn ignition to RUN position. Using DVOM, measure voltage between ground and terminal No. 12 on GEM 22-pin harness connector. See **Fig. 4** . If voltage is present, repair Yellow/White wire for short to voltage. If voltage is not present, go to next step.
37. **Check Circuit 762 (Yellow/White Wire) For Open -** Turn ignition off. Measure resistance of Yellow/White wire between terminal No. 12 on GEM 22-pin connector and terminal No. 10 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Yellow/White wire. Clear DTCs and retest system.
38. **Check Contact Plate Switch "B" Circuit 770 (White Wire) -** Turn ignition to RUN position. Monitor GEM PID PLATE_B. PID should be OPEN. Connect jumper wire across terminals No. 1 and 10. PID should change to CLOSED. If PLATE_B PIDs are as specified, go to step 43). If PLATE_B PIDs are not as specified, go to step 41).
39. **Check Circuit 770 (White Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Measure resistance between ground and terminal No. 20 on GEM harness connector. If resistance is greater than 10 k/ohms, replace GEM. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair White wire for short to ground. Clear DTCs and retest system.
40. **Check Circuit 770 (White Wire) For Open -** Measure resistance of White wire between terminal No. 20 on GEM connector and terminal No. 1 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open White wire. Clear DTCs and retest system.
41. **Check Circuit 770 (White Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 1 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present, repair White

wire for short to voltage. Clear DTCs and retest system. If voltage is not present, replace GEM. Clear DTCs and retest system.

42. **Check Contact Plate Switch "C" Circuit 764 (Brown/White Wire) -** Turn ignition to RUN position. Monitor GEM PID PLATE_C. PID should be OPEN. Connect jumper wire across terminals No. 9 and 10. PID should change to CLOSED. If PLATE_C PIDs are as specified, go to step 46). If PLATE_C PIDs are not as specified, go to step 45).
43. **Check Circuit 764 (Brown/White Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Measure resistance between ground and terminal No. 19 on GEM 22-pin harness connector. If resistance is greater than 10 k/ohms, replace GEM. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair Brown/White wire for short to ground. Clear DTCs and retest system.
44. **Check Circuit 764 (Brown/White Wire) For Open -** Measure resistance of Brown/White wire between terminal No. 19 on GEM connector and terminal No. 9 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Brown/White wire. Clear DTCs and retest system.
45. **Check Circuit 764 (Brown/White Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 9 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present, repair Brown/White wire for short to voltage. Clear DTCs and retest system. If voltage is not present, replace GEM. Clear DTCs and retest system.
46. **Check Contact Plate Switch "D" Circuit 763 (Orange/White Wire) -** Turn ignition to RUN position. Monitor GEM PID PLATE_D. PID should be OPEN. Connect jumper wire across terminals No. 10 and 13. PID should change to CLOSED. If PLATE_D PIDs are as specified, replace transfer case shift motor. See Borg-Warner 44-06 overhaul article. If PLATE_D PIDs are not as specified, go to step 48).
47. **Check Circuit 763 (Orange/White Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Measure resistance between ground and terminal No. 18 on GEM harness connector. See **Fig. 4** . If resistance is greater than 10 k/ohms, replace GEM. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair Orange/White wire for short to ground. Clear DTCs and retest system.
48. **Check Circuit 763 (Orange/White Wire) For Open -** Measure resistance of Orange/White wire between terminal No. 18 on GEM connector and terminal No. 13 on transfer case 16-pin harness connector. See **Fig. 4** and **Fig. 7** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Orange/White wire. Clear DTCs and retest system.
49. **Check Circuit 763 (Orange/White Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin harness connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 13 on transfer case 16-pin harness connector. See **Fig. 7** . If voltage is present, repair Orange/White wire for short to voltage. Clear DTCs and retest system. If voltage is not present, replace GEM. Clear DTCs and retest system.

TEST C: FRONT AXLE NOT ENGAGING OR DISENGAGING PROPERLY

NOTE: Steps 1-3 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

1. **Check Voltage At Fuse No. 15 (5-Amp) -** Turn ignition off. Using voltmeter, measure voltage at terminal No. 1 on fuse junction panel fuse No. 15. If voltage is 10 volts or less, go to next step. If voltage is greater than 10 volts, go to step 4).
2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -** Inspect fuse junction panel fuse No. 15 (5-amp) and power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to next step. If either fuse is blown, replace fuse. Clear DTCs and retest system. If fuse blows again, inspect circuit for short to ground.
3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.
4. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Depress clutch if applicable. Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF, ACC positions. If values agree go to next step. If values do not agree, see **STEERING COLUMN SWITCHES** article in the ACCESSORIES/SAFETY EQUIPMENT section.

NOTE: In next step, if DTC B1342 is retrieved, replace GEM. Clear DTCs and retest system.

5. **Retrieve DTCs -** Retrieve and document continuous DTCs. Clear continuous DTCs. Retrieve on-demand DTCs. If DTCs are recorded, go to appropriate step(s). See **DTC/TEST OR STEP** table. If no DTCs are retrieved, go to next step.

DTC/TEST OR STEP

DTC	Go To TEST/STEP
P1804	D
P1806	D
P1808	D
P1810	D
P1812	A
P1815	A
P1820	A
P1822	A
P1824	E
P1826	E
P1828	A
P1830	A
P1832	C/12
P1834	C/12
P1838	A
P1846	A Or B
P1850	A Or B

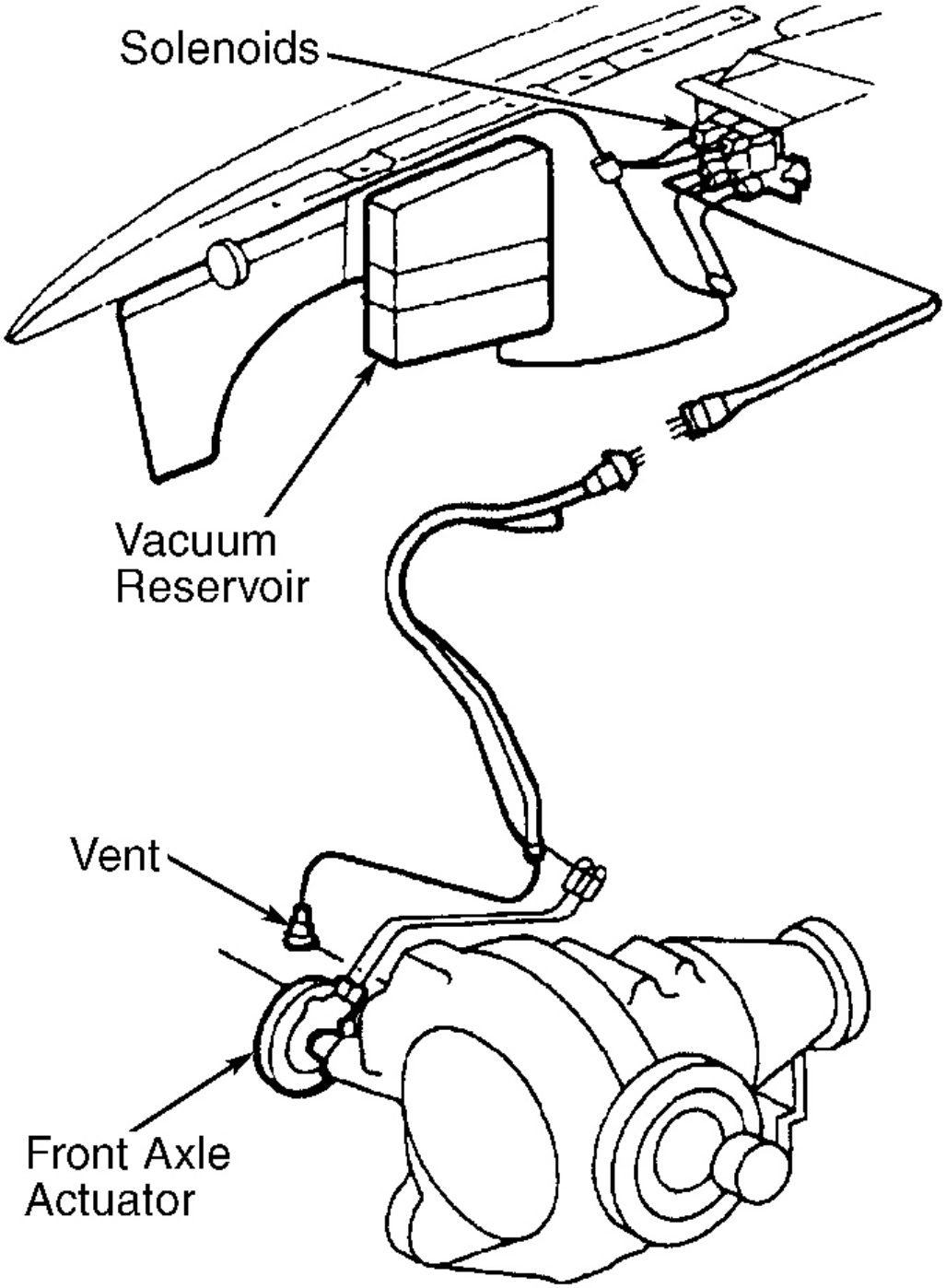
P1854	A Or B
P1858	A Or B
P1866	A
P1867	A
P1876	C/12
P1877	C/12
P1891	A Or B

6. **Check 4H Indicator Light -** Using scan tool, toggle active command HIGH LAMP on, then off. If indicator light operates correctly, go to next step. If indicator light does not operate correctly, go to **TEST D** .
7. **Check 4L Indicator Light -** Using scan tool, toggle active command LOW LAMP on, then off. If indicator light operates correctly, go to next step. If indicator light does not operate correctly, go to **TEST D** .
8. **Check Front Axle Engagement -** Start engine. Using scan tool, toggle active command AXLE ENGG to on and AXLE DSCN to off. Raise and support vehicle with engine running. Spin one front tire. Opposite front tire should spin in reverse direction. If axle disconnect is operating correctly, exit active command mode. Go to next step. If axle disconnect is not operating correctly, go to step 12).
9. **Check Front Drive Shaft Engagement -** Place mode switch in 4H position and drive short distance. Raise and support vehicle. If front and rear drive shafts spin, go to next step. If front and rear drive shafts do not spin, go to **TEST A** .

NOTE: When 4WD is disengaged, front drive shaft may spin due to viscous drag in transfer case, especially if cold.

10. **Check Front Drive Shaft Disengagement -** Place 4WD mode switch in 2H position. If rear drive shaft is only being driven, go to next step. If front drive shaft is also being driven, go to **TEST A** .
11. **Check Front Axle Disengagement -** Using scan tool, set active commands AXLE ENGG to OFF and AXLE DSCN to ON. Active commands AXLE ENGG and AXLE DSCN are located in 4-Wheel Electronic Shift active command menu. Spin one front tire. Opposite front tire should not spin. If front axle is disengaged, the 4WD system is functioning correctly. If front axle is engaged, go to next step.
12. **Check 4WD & 2WD Vacuum Solenoid Circuits -** Using scan tool, monitor PIDs 4WDSOL and 2WDSOL. Set active command AXLE ENGG and AXLE DSCN to ON. If PIDs 4WDSOL and 2WDSOL indicates ON, go to next step. If PIDs indicate ON-B-, go to step 14).
13. **Check 4WD & 2WD Vacuum Solenoids -** Using scan tool, monitor PIDs 4WDSOL and 2WDSOL. Set active command AXLE ENGG and AXLE DSCN to OFF. If PIDs 4WDSOL and 2WDSOL indicate OFF, go to step 23). If PIDs indicate OFFO-G, go to step 16).
14. **Check Circuits 145 (Gray/Black Wire) & 605 (Red Wire) For Short To Power -** Turn ignition off. Disconnect 2WD and 4WD vacuum solenoid harness connectors. Solenoids are mounted to right inner fender. See **Fig. 14** . Disconnect GEM 22-pin connector. See **Fig. 2** . Turn ignition to RUN position. Using DVOM, measure and record voltage between ground and terminal No. 1 (Red wire) on 4WD vacuum solenoid harness connector. Measure and record voltage between ground and terminal No. 1 (Gray/Black wire) on 2WD vacuum solenoid harness connector. If voltage is not present on both circuits, reconnect all harness connectors and go to next step. If voltage is present on either circuit, repair suspect

circuit for short to voltage. Clear DTCs and retest system.



G98F07080

Fig. 14: Locating 4WD & 2WD Vacuum Solenoids
Courtesy of FORD MOTOR CO.

15. **Check 4WD & 2WD Vacuum Solenoid PIDs -** Using scan tool, monitor PIDs 4WDSOL and 2WDSOL. Set active command AXLE ENGG and AXLE DSCN to ON. If PIDs 4WDSOL and 2WDSOL indicate ON-B-, replace GEM. Clear DTCs and retest system. If PID 4WDSOL and/or 2WDSOL do not indicate ON-B-, replace suspect solenoid. Clear DTCs and retest system.
16. **Check Circuit 294 (White/Light Blue Wire) For Voltage -** Turn ignition off. Disconnect 2WD and 4WD vacuum solenoid harness connectors. Solenoids are mounted to right inner fender. See **Fig. 14** . Turn ignition to RUN position. Using DVOM, measure and record voltage between ground and terminal No. 2 (White/Light Blue wire) on 4WD vacuum solenoid harness connector. Measure and record voltage between ground and terminal No. 2 (White/Light Blue wire) on 2WD vacuum solenoid harness connector. If voltage is greater than 10 volts on both circuits, go to next step. If voltage is 10 volts or less on either circuit, repair open circuit. Clear DTCs and retest system.
17. **Check 2WD & 4WD Vacuum Solenoids -** Using ohmmeter, measure resistance between terminals No. 1 and 2 on each vacuum solenoid. If resistance measured is 50-100 ohms for each solenoid, go to next step. If resistance is not 50-100 ohms for either solenoid, replace suspect solenoid. Clear DTCs and retest system.
18. **Check Circuit 145 (Gray/Black Wire) For Open -** Turn ignition off. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure resistance of Gray/Black wire between terminal No. 2 on GEM harness connector and terminal No. 1 on 2WD vacuum solenoid harness connector. See **Fig. 4** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Gray/Black wire. Clear DTCs and retest system.
19. **Check Circuit 605 (Red Wire) For Open -** Turn ignition off. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure resistance of Red wire between terminal No. 7 on GEM harness connector and terminal No. 1 on 4WD vacuum solenoid harness connector. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Red wire. Clear DTCs and retest system.
20. **Check Circuit 145 (Gray/Black Wire) For Short To Ground -** Measure resistance between ground and terminal No. 2 on GEM 22-pin harness connector. If resistance is 10 k/ohms or less, repair Gray/Black wire. Clear DTCs and retest system. If resistance is greater than 10 k/ohms, go to next step.
21. **Check Circuit 605 (Red Wire) For Short To Ground -** Measure resistance between ground and terminal No. 7 on GEM 22-pin harness connector. If resistance is 10 k/ohms or less, repair Red wire. Clear DTCs and retest system. If resistance is greater than 10 k/ohms, go to next step.
22. **Check Vacuum Signal At Solenoids -** Start and run engine at idle. Using vacuum gauge, measure vacuum at solenoid feed line. If vacuum is approximately 20 In. Hg, go to next step. If vacuum is less than 20 In. Hg, repair suspect vacuum feed line. Clear DTCs and retest system.
23. **Check 4WD & 2WD Vacuum Solenoids Closed Condition -** Turn ignition off. Disconnect solenoid vacuum lines. Connect vacuum pump to feed line connection on each solenoid. See **Fig. 15** . Turn ignition to RUN position. Monitor PIDs 2WDSOL and 4WDSOL. Toggle active command AXLE ENGG and AXLE DSCN to OFF. Apply vacuum and verify vacuum solenoids are closed. If solenoids hold vacuum, release vacuum and go to next step. If solenoids do not hold vacuum, replace suspect vacuum solenoid. Clear DTCs and retest system.

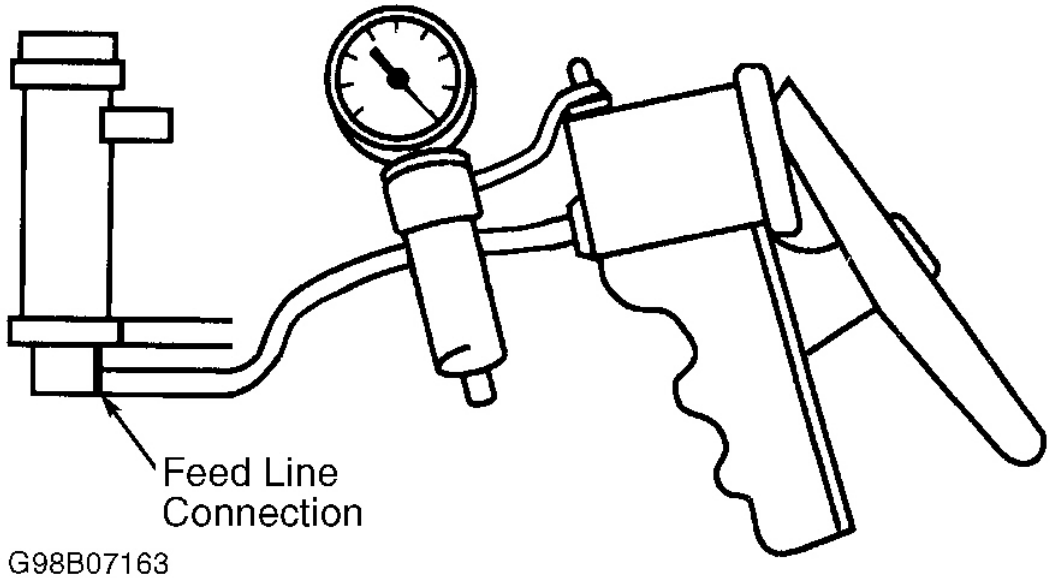


Fig. 15: Applying Vacuum To Vacuum Solenoid
Courtesy of FORD MOTOR CO.

24. **Check 4WD & 2WD Vacuum Solenoids Open Condition -** Turn ignition off. Disconnect solenoid vacuum lines. Connect vacuum pump to feed line connection on each solenoid. Turn ignition to RUN position. Monitor PIDs 2WDSOL and 4WDSOL. Toggle active command AXLE ENGG and AXLE DSCN to ON. Apply vacuum and verify vacuum solenoids are open. If solenoids hold vacuum, replace suspect vacuum solenoid. Clear DTCs and retest system. If solenoids do not hold vacuum, go to next step.
25. **Check Vacuum Lines To Front Axle Actuator -** Inspect vacuum lines to front axle actuator. See **Fig. 14** . If vacuum hoses are okay, go to next step. If vacuum lines are damaged or disconnected, repair as needed. Clear DTCs and retest system.
26. **Check Front Axle Vacuum Actuator -** Disconnect linkage from vacuum actuator. Reconnect all harness connectors and vacuum lines. Start and idle engine. Toggle active command AXLE ENGG to ON and AXLE DSCN to OFF. If vacuum actuator moves to engaged position, go to next step. If vacuum actuator does not move to engaged position, replace vacuum actuator. Clear DTCs and retest system. Clear DTCs and retest system.
27. **Check Front Axle Vacuum Actuator -** Toggle active command AXLE ENGG to OFF and AXLE DSCN to ON. If vacuum actuator move to disengaged position, inspect and repair front axle locking mechanism. If vacuum actuator does not move to disengaged position, replace vacuum actuator. Clear DTCs and retest system. Clear DTCs and retest system.

TEST D: 4WD LO &/OR 4WD HI INDICATOR LIGHT NOT OPERATING PROPERLY

NOTE: Steps 1-3 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the

WIRING DIAGRAMS section.

1. **Check Voltage At Fuse No. 15 (5-Amp) -** Turn ignition off. Using voltmeter, measure voltage at terminal No. 1 on fuse junction panel fuse No. 15. If voltage is 10 volts or less, go to next step. If voltage is greater than 10 volts, go to step 4).
2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -** Inspect fuse junction panel fuse No. 15 (5-amp) and power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to next step. If either fuse is blown, replace fuse. Clear DTCs and retest system. If fuse blows again, inspect circuit for short to ground.
3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.
4. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Connect NGS tester. Depress clutch pedal (if applicable). Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF and ACC positions. If values agree, go to next step. If values do not agree, see **STEERING COLUMN SWITCHES** article in the ACCESSORIES/SAFETY EQUIPMENT section.

NOTE: In next step, if DTC B1342 is retrieved, replace GEM. Clear DTCs and retest system.

5. **Retrieve DTCs -** Retrieve and document continuous DTCs. Clear continuous DTCs. Retrieve on-demand DTCs. If DTCs are recorded, go to appropriate step(s). See **DTC/TEST OR STEP** table. If no DTCs are retrieved, go to next step.

DTC/TEST OR STEP

DTC	Go To TEST/STEP
P1804	D/6
P1806	D/6
P1808	D/6
P1810	D/6
P1812	A
P1815	A
P1820	A
P1822	A
P1824	E
P1826	E
P1828	A
P1830	A
P1832	C
P1834	C
P1838	A

P1846	A Or B
P1850	A Or B
P1854	A Or B
P1858	A Or B
P1866	A
P1867	A
P1876	C
P1877	C
P1891	A Or B

6. **Check 4WD System Indicator Lights -** Using scan tool, monitor PIDs 4WDHIGH and 4WDLOW. Set active command HIGH LAMP and LOW LAMP to ON, then OFF. If scan tool displays ON-B-, go to step 9). If scan tool displays OFFO-G and indicator light is continually illuminated, go to next step. If scan tool displays OFFO-G and indicator light is not illuminated, see appropriate **INSTRUMENT PANELS** article in the ACCESSORIES/SAFETY EQUIPMENT section.
7. **Check GEM For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin connector. See **Fig. 2** . Turn ignition switch to RUN position. If indicator lights are illuminated, go to next step. If indicator lights are not illuminated, replace GEM. Clear DTCs and retest system.
8. **Check Circuits 210 (Light Blue Wire) and 975 (Brown/Yellow Wire) For Short To Ground -** Turn ignition off. Disconnect instrument cluster harness connectors. Measure resistance between ground and terminals No. 9 and 10 on GEM 22-pin harness connector. See **Fig. 4** . If resistance is 10 k/ohms or less, repair Light Blue wire and/or Brown/Yellow wire for short to ground. Clear DTCs and retest system. If resistance is greater than 10 k/ohms, replace or repair instrument cluster. Clear DTCs and retest system.
9. **Check Circuits 210 (Light Blue Wire) and 975 (Brown/Yellow Wire) For Short To Voltage -** Turn ignition off. Disconnect instrument cluster harness connectors. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure voltage between ground and terminals No. 9 and 10 on GEM 22-pin harness connector. See **Fig. 4** . If voltage is present, repair Light Blue wire and/or Brown/Yellow wire for short to voltage. Clear DTCs and retest system. If voltage is not present, go to next step.
10. **Check 4WD System Indicator Lights -** Using scan tool, monitor PIDs 4WDHIGH and 4WDLOW. Set active command HIGH LAMP and LOW LAMP to ON. If scan tool displays ON-B-, replace GEM. Clear DTCs and retest system. If scan tool does not display ON-B-, repair or replace instrument panel, see appropriate **INSTRUMENT PANELS** article in the ACCESSORIES/SAFETY EQUIPMENT section.

TEST E: 4WD HIGH DOES NOT ENGAGE AT SPEED PROPERLY (DRIVELINE DOES NOT SYNCHRONIZE PROPERLY) BUT DOES ENGAGE AT REST

1. **Retrieve DTCs -** Retrieve and document continuous DTCs. Clear continuous DTCs. Retrieve on-demand DTCs. If DTCs are recorded, go to appropriate step(s). See **DTC/TEST OR STEP** table. If no DTCs are retrieved, go to next step.

DTC/TEST OR STEP

DTC	Go To TEST/STEP
P1804	D
P1806	D

P1808	D
P1810	D
P1812	A
P1815	A
P1820	A
P1822	A
P1824	E/4
P1826	E/4
P1828	A
P1830	A
P1832	C
P1834	C
P1838	A
P1846	A Or B
P1850	A Or B
P1854	A Or B
P1858	A Or B
P1866	A
P1867	A
P1876	C
P1877	C
P1891	A Or B

2. **Check Front Axle Engagement -** Start engine. Using scan tool, toggle active command AXLE ENGG to ON and AXLE DSCN to OFF. Raise and support vehicle with engine running. Spin one front tire. Opposite front tire should spin in reverse direction. If axle disconnect is operating correctly, exit active command mode. Go to next step. If axle disconnect is not operating correctly, go to **TEST C** .
3. **Check Front Axle Disengagement -** Using scan tool, set active commands AXLE ENGG to OFF and AXLE DSCN to ON. Active commands AXLE ENGG and AXLE DSCN are located in 4-Wheel Electronic Shift active command menu. Spin one front tire. Opposite front tire should not spin. If front axle is disengaged, the 4WD system is functioning correctly. If front axle is engaged, go to **TEST C** .
4. **Check Electric Clutch Relay Coil Circuit Energized -** Turn ignition switch to RUN position. Using scan tool, monitor GEM PID 4WDELCL. Trigger active command SHFT CLCH to ON. If GEM PID 4WDELCL indicates ON---, go to step 7). If GEM PID 4WDELCL indicates ON-B-, go to next step.
5. **Check Electric Clutch Relay -** Turn ignition off. Disconnect electric clutch relay. Relay is located in RPO relay block. See **Fig. 2** . Test relay. See **ELECTRIC CLUTCH RELAY TEST** table. If relay is okay, go to next step. If relay is not okay, replace relay. Clear DTCs and retest system.

ELECTRIC CLUTCH RELAY TEST

Terminals No. (1)	**Continuity**
No Voltage Applied	

1 & 2	Yes
3 & 4	Yes
3 & 5	No
Voltage Applied (2)	
3 & 5	Yes

(1) See **Fig. 16** .

(2) Apply battery voltage to terminals No. 1 and 2.

6. **Check Circuit 976 (Orange Wire) For Short To Power -** Disconnect GEM 22-pin connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 2 on relay connector. See **Fig. 16** . If voltage is present, repair circuit 976 for short to voltage. If no voltage is present, replace GEM. Clear DTCs and retest system.

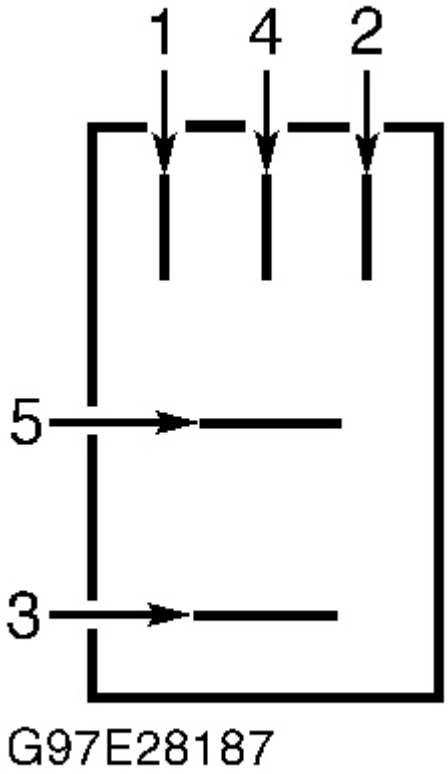


Fig. 16: Identifying Electric Clutch Relay Terminals

Courtesy of FORD MOTOR CO.

7. **Check Electric Clutch Relay Coil Circuit De-Energized** - Using scan tool, monitor GEM PID 4WDDELCL. Trigger active command SHFT CLCH to OFF. If GEM PID 4WDDELCL indicates OFF---, go to step 12). If GEM PID 4WDDELCL indicates OFFO-G, go to next step.
8. **Check Voltage To Electric Clutch Relay Coil Circuit 294 White/Light Blue Wire) -** Turn ignition off. Disconnect electric clutch relay. Relay is located in RPO relay block. See **Fig. 2** . Turn ignition switch to RUN position. Measure voltage between ground and terminal No. 1 on relay connector. See **Fig. 16** . If voltage is 10 volts or less, check fuse No. 23 in fuse junction panel. Replace as needed. If fuse is okay, repair open circuit 294. Clear DTCs and retest system. If voltage is more than 10 volts, go to next step.
9. **Check Electric Clutch Relay -** Turn ignition off. Disconnect electric clutch relay. Relay is located in RPO relay block. See **Fig. 2** . Test relay. See **ELECTRIC CLUTCH RELAY TEST** table. If relay is okay, go to next step. If relay is not okay, replace relay. Clear DTCs and retest system.
10. **Check Circuit 976 (Orange Wire) For Short To Ground -** Disconnect GEM 22-pin connector. See **Fig. 2** . Measure resistance between ground and terminal No. 2 on relay connector. See **Fig. 16** . If resistance is 10 k/ohms or less, repair circuit 976 for short to ground. If resistance is greater than 10 k/ohms, go to next step.
11. **Check Circuit 976 (Orange Wire) For Open -** Measure resistance between terminal No. 14 on GEM 22-pin harness connector and terminal No. 2 on electric clutch relay connector. See **Fig. 4** and **Fig. 16** . If resistance is less than 5 ohms, replace GEM. Clear DTCs and retest system. If resistance is 5 ohms or greater, repair open Orange wire. Clear DTCs and retest system.
12. **Check Circuit 779 (Brown Wire) For Voltage Energized -** Turn ignition off. Disconnect transfer case 16-pin connector. Turn ignition switch to RUN position. Using scan tool, set active command SHFT CLCH to ON. Using DVOM, measure voltage between ground and terminal No. 16 on transfer case 16-pin harness connector. See **Fig. 6** . If voltage is 10 volts or less, go to step 15). If voltage is more than 10 volts, go to next step.
13. **Check Circuit 779 (Brown Wire) For Voltage De-Energized -** Set active command SHFT CLCH to OFF. Measure voltage between ground and terminal No. 16 on transfer case 16-pin harness connector. See **Fig. 6** . If voltage is zero volts, go to step 17). If voltage is not zero volts, go to next step.
14. **Check Circuit 779 (Brown Wire) For Short To Voltage -** Turn ignition off. Disconnect electric clutch relay and T/C shift relay. See **Fig. 2** . Turn ignition switch to RUN position. Measure voltage between ground and terminal No. 5 on relay connector. See **Fig. 16** . If voltage is present, repair circuit 779 for short to voltage. Clear DTCs and retest system. If voltage is not present, replace electric clutch relay. Clear DTCs and retest system.
15. **Check Circuit 704 (Dark Green/Light Green Wire) For Voltage -** Turn ignition off. Disconnect electric clutch relay and T/C shift relay. See **Fig. 2** . Turn ignition switch to RUN position. Measure voltage between ground and terminal No. 3 on relay connector. See **Fig. 16** . If voltage is 10 volts or less, check fuse No. 17 in power distribution box. Replace as needed. If fuse is okay, repair open circuit 704. Clear DTCs and retest system. If voltage is more than 10 volts, go to next step.
16. **Check Circuit 779 (Brown Wire) For Open -** Measure resistance between terminal No. 16 on transfer case 16-pin harness connector and terminal No. 5 on electric clutch relay connector. See **Fig. 6** and **Fig. 16** . If resistance is less than 5 ohms, replace relay. Clear DTCs and retest system. If resistance is 5 ohms or greater, repair open Brown wire. Clear DTCs and retest system.
17. **Check Transfer Case Synchronization -** Raise and support vehicle. Remove front drive shaft. Place 4WD mode switch in 2H position. Start and idle engine. Place shift lever in "D" position. Rotate rear tires

at 20-25 MPH. Place 4WD mode switch in 4H position. If transfer case front output shaft rotates, verify complaint. See **SYMPTOM TESTING** . If transfer case front output shaft does not rotate, inspect transfer case for internal problem. See **TRANSFER CASE - BORG/WARNER 44-06** article in the POWERTRAIN section. Repair as needed. Clear DTCs and retest system.

TEST F: NO COMMUNICATION WITH GEM

1. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Connect NGS tester. Depress clutch pedal (if applicable). Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF and ACC positions. If values agree, go to next step. If values do not agree, see appropriate **STEERING COLUMN SWITCHES** article in the ACCESSORIES/SAFETY EQUIPMENT section.

NOTE: Steps 2, 3, 5 and 6 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -** Inspect fuse junction panel fuse No. 15 (5-amp) and power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to next step. If either fuse is blown, go to step 5).
3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.
4. **Check Fuse Junction Panel For Voltage -** Ensure ignition is off. Disconnect GEM from fuse junction panel. Connect fuse junction panel connector C243. Measure voltage between ground and terminals No. 4 and 16 on GEM 18-pin junction block connector. See **Fig. 11** . If voltage is more than 10 volts for both circuits, go to step 8). If voltage is 10 volts or less for either circuit, replace fuse junction panel. Clear DTCs and retest system.
5. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) GEM Disconnected -** Turn ignition off. Disconnect GEM from fuse junction panel. Inspect fuse junction panel fuse No. 15 (5-amp) and power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to step 7). If fuse No. 22 is blown, go to step 6). If fuse No. 15 is blown, go to step 10).
6. **Check Circuit 1052 (Tan/Black Wire) For Short To Ground -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure resistance between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If resistance is 10 k/ohms or less, repair Tan/Black wire for short to ground. Clear DTCs and retest system. If voltage is greater than 10 k/ohms, replace fuse junction panel. Clear DTCs and retest system.
7. **Check Fuse Junction Panel For Voltage -** Ensure ignition is off. Disconnect GEM from fuse junction panel. Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between terminal No. 11 on fuse junction panel connector C243 and terminals No. 4 and 16 on GEM 18-pin junction block connector. See **Fig. 11** . If resistance is less than 5 ohms for both circuits, go to step 8). If resistance is 5 ohms or greater for either circuit, replace fuse junction panel. Clear DTCs and retest system.
8. **Check Circuit 875 (Black/Light Blue Wire) For Continuity To Ground -** Ensure ignition is off. Disconnect GEM 26-pin connector. See **Fig. 2** . Measure resistance between ground and terminal No. 26

on GEM harness connector. See **Fig. 5** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Black/Light Blue wire. Clear DTCs and retest system.

9. **Check Circuit 875 (Black/Light Blue Wire) For Open -** Measure resistance between ground and terminal No. 14 on GEM harness connector. If resistance is less than 5 ohms, see appropriate **MODULE COMMUNICATIONS NETWORK** article in the ACCESSORIES/SAFETY EQUIPMENT section. If resistance is 5 ohms or greater, repair open Black/Light Blue wire. Clear DTCs and retest system.
10. **Check Fuse Junction Panel For Short To Ground -** Ensure ignition is off. Disconnect GEM from fuse junction panel. Measure resistance between ground and terminals No. 4 on GEM 18-pin junction block connector. See **Fig. 11** . If resistance is 10 k/ohms or less, see appropriate **MODULE COMMUNICATIONS NETWORK** article in the ACCESSORIES/SAFETY EQUIPMENT section. If resistance is greater than 10 k/ohms, replace fuse junction panel. Clear DTCs and retest system.

TEST G: 4WD HIGH DOES NOT ENGAGE AT SPEED PROPERLY (DRIVELINE DOES NOT SYNCHRONIZE PROPERLY) BUT DOES ENGAGE AT REST

NOTE: For GEM connector number identification, see GEM CONNECTOR IDENTIFICATION table. Also see appropriate wiring diagram in WIRING DIAGRAMS .

GEM CONNECTOR IDENTIFICATION

Connector No.	Description
C239	26-Pin
C240	16-Pin
C241	22-Pin
C267	18-Pin

NOTE: Steps 1-3 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

1. **Check Voltage At Fuse No. 15 (5-Amp) -** Turn ignition off. Using voltmeter, measure voltage at terminal No. 1 on fuse junction panel fuse No. 15. If voltage is 10 volts or less, go to next step. If voltage is greater than 10 volts, go to step 4).
2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -** Inspect fuse junction panel fuse No. 15 (5-amp) & power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to next step. If either fuse is blown, replace fuse. Clear DTCs and retest system. If fuse blows again, inspect circuit for short to ground.
3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.
4. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Connect NGS tester. Depress clutch pedal (if applicable). Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF and

ACC positions. If values agree, go to next step. If values do not agree, see appropriate **STEERING COLUMN SWITCHES** article in the ACCESSORIES/ SAFETY EQUIPMENT section.

NOTE: In next step, if DTC B1342 is retrieved, replace GEM. Clear DTCs and retest system.

5. **Retrieve DTCs -** Retrieve and document continuous DTCs. Clear continuous DTCs. Retrieve on-demand DTCs. If DTCs are recorded, go to appropriate step(s). See **DTC/TEST OR STEP (ESOF MODELS)** table. If no DTCs are retrieved, go to next step.

DTC/TEST OR STEP (ESOF MODELS)

DTC	Go To TEST/STEP
P1804	J
P1806	J
P1824	G/11
P1826	G/11
P1832	H
P1834	H
P1876	H
P1877	H

6. **Check 4WD Indicator Lights -** Turn ignition switch to RUN position. Place 4WD shift lever in 2H position. Both indicator lights should be off. Place 4WD shift lever in 4H position. 4WD indicator light should be illuminated. Place 4WD shift lever in 4L position. 4WD indicator light should remain illuminated and low range indicator light should illuminate. If indicator lights operate as specified, go to step 8). If 4H indicator light does not operate as specified, go to next step. If 4L light does not operate as specified, go to **TEST J** .
7. **Check 4WD Indicator Light Initial Operation -** Turn ignition off. Start and idle engine. If 4WD indicator light illuminates for 2 seconds after starting vehicle, go to step 25). If 4WD indicator light does not illuminate for 2 seconds after starting vehicle, go to **TEST J** .
8. **Check Front Axle Engagement -** Start vehicle. Using scan tool, set active commands AXLE ENGG to ON and AXLE DSCN to OFF. Drive vehicle short distance. Raise and support vehicle with engine running. Spin one front tire. Opposite tire should spin in reverse direction. If axle is working correctly, exit active command mode and go to next step. If axle is not working correctly, lower vehicle and go to **TEST H** .
9. **Check Front Drive Shaft Engagement -** Place 4WD shift lever in 4H position. Verify front and rear drive shafts are spinning. If front and rear drive shafts are locked together, go to next step. If front and rear drive shafts are not locked together, inspect transfer case for mechanical malfunction.

NOTE: When 4WD is disengaged, front drive shaft may spin due to viscous drag in transfer case, especially if cold.

10. **Check Front Drive Shaft Disengagement -** Place transmission shift lever in "P" position. Place 4WD shift lever in 2H position. Shift transmission into "D". If rear drive shaft is only being driven, go to next

step. If front drive shaft is also being driven, inspect transfer case for mechanical malfunction.

11. **Check Front Axle Disengagement -** Using scan tool, set active commands AXLE ENGG to OFF and AXLE DSCN to ON. Ensure transmission is in neutral. Spin one front tire. Opposite front tire should not spin. If front axle is disengaged, go to next step. If front axle is engaged, go to **TEST H** .
12. **Check Electric Clutch Relay Coil Circuit Energized -** Turn ignition switch to RUN position. Using scan tool, monitor GEM PID 4WDELCL. Trigger active command SHFT CLCH to ON. If GEM PID 4WDELCL indicates ON---, go to next step. If GEM PID 4WDELCL indicates ON-B-, go to next step 18).
13. **Check Electric Clutch Relay Coil Circuit De-Energized -** Using scan tool, monitor GEM PID 4WDELCL. Trigger active command SHFT CLCH to OFF. If GEM PID 4WDELCL indicates OFF---, go to step 20). If GEM PID 4WDELCL indicates OFFO-G, go to next step.
14. **Check Voltage To Electric Clutch Relay Coil Circuit 294 White/Light Blue Wire) -** Turn ignition off. Disconnect electric clutch relay. Relay is located in RPO relay block. See **Fig. 2** . Turn ignition switch to RUN position. Measure voltage between ground and terminal No. 1 on relay connector. See **Fig. 16** . If voltage is 10 volts or less, repair open circuit 294. Clear DTCs and retest system. If voltage is more than 10 volts, go to next step.
15. **Check Electric Clutch Relay -** Turn ignition off. Disconnect electric clutch relay. Relay is located in RPO relay block. See **Fig. 2** . Test relay. See **ELECTRIC CLUTCH RELAY TEST** table. If relay is okay, go to next step. If relay is not okay, replace relay. Clear DTCs and retest system.

ELECTRIC CLUTCH RELAY TEST

Terminals No. (1)	Continuity
No Voltage Applied	
1 & 2	Yes
3 & 4	Yes
3 & 5	No
Voltage Applied (2)	
3 & 5	Yes

(1) See **Fig. 16** .

(2) Apply battery voltage to terminals No. 1 and 2.

16. **Check Circuit 976 (Orange Wire) For Short To Ground -** Disconnect GEM 22-pin connector. See **Fig. 2** . Measure resistance between ground and terminal No. 2 on relay connector. See **Fig. 16** . If resistance is 10 k/ohms or less, repair circuit 976 for short to ground. If resistance is greater than 10 k/ohms, go to next step.
17. **Check Circuit 976 (Orange Wire) For Open -** Measure resistance between terminal No. 14 on GEM 22-pin harness connector and terminal No. 2 on electric clutch relay connector. See **Fig. 4** and **Fig. 16** . If resistance is less than 5 ohms, replace GEM. Clear DTCs and retest system. If resistance is 5 ohms or greater, repair open Orange wire. Clear DTCs and retest system.
18. **Check Electric Clutch Relay -** Turn ignition off. Disconnect electric clutch relay. Relay is located in RPO relay block. See **Fig. 2** . Test relay. See **ELECTRIC CLUTCH RELAY TEST** table. If relay is

okay, go to next step. If relay is not okay, replace relay. Clear DTCs and retest system.

19. **Check Circuit 976 (Orange Wire) For Short To Power -** Disconnect GEM 22-pin connector. See **Fig. 2** . Turn ignition to RUN position. Measure voltage between ground and terminal No. 14 on GEM harness connector. See **Fig. 4** . If voltage is present, repair circuit Orange wire for short to voltage. If no voltage is present, replace GEM. Clear DTCs and retest system.
20. **Check Circuit 779 (Brown Wire) For Voltage Energized -** Turn ignition off. Disconnect transfer case 4-pin connector. Turn ignition switch to RUN position. Using scan tool, set active command SHFT CLCH to ON. Using DVOM, measure voltage between ground and terminal No. 1 on transfer case 4-pin harness connector. See **Fig. 17** . If voltage is 10 volts or less, go to step 23). If voltage is more than 10 volts, go to next step.

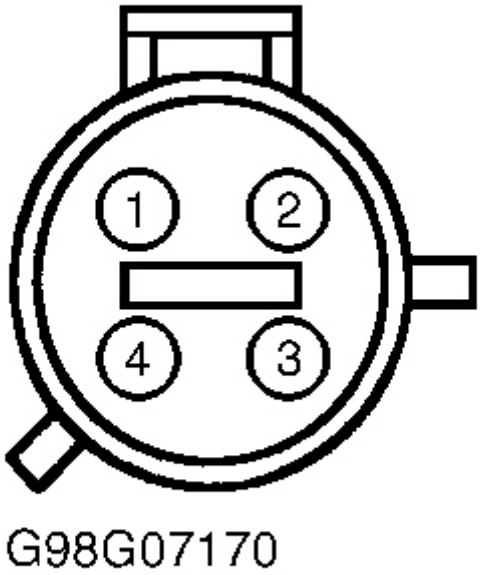


Fig. 17: Identifying MSOF Transfer Case 4-Pin Harness Connector
Courtesy of FORD MOTOR CO.

21. **Check Circuit 779 (Brown Wire) For Voltage De-Energized -** Set active command SHFT CLCH to OFF. Measure voltage between ground and terminal No. 1 on transfer case 4-pin harness connector. See **Fig. 17** . If voltage is zero volts, go to step 29). If voltage is not zero volts, go to next step.
22. **Check Circuit 779 (Brown Wire) For Short To Voltage -** Turn ignition off. Disconnect electric clutch relay. See **Fig. 2** . Disconnect transfer case 4-pin connector. Turn ignition switch to RUN position. Measure voltage between ground and terminal No. 1 on 4-pin harness connector. See **Fig. 17** . If voltage is present, repair Brown wire for short to voltage. Clear DTCs and retest system. If voltage is not present, replace electric clutch relay. Clear DTCs and retest system.

23. **Check Circuit 704 (Dark Green/Light Green Wire) For Voltage -** Turn ignition off. Disconnect electric clutch relay. See **Fig. 2** . Measure voltage between ground and terminal No. 3 on relay connector. See **Fig. 16** . If voltage is 10 volts or less, check fuse No. 17 in power distribution box. Replace as needed. If fuse is okay, repair open circuit 704. Clear DTCs and retest system. If voltage is more than 10 volts, go to next step.
24. **Check Circuit 779 (Brown Wire) For Open -** Measure resistance between terminal No. 1 on transfer case 4-pin harness connector and terminal No. 5 on electric clutch relay connector. See **Fig. 16** and **Fig. 17** . If resistance is less than 5 ohms, replace relay. Clear DTCs and retest system. If resistance is 5 ohms or greater, repair open Brown wire. Clear DTCs and retest system.
25. **Check Circuit 783 (Gray Wire) For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin connector. See **Fig. 2** . Place transfer case shift lever in 2H position. Measure resistance between ground and terminal No. 3 on GEM harness connector. If resistance is greater than 10 k/ohms, go to step 27). If resistance is 10 k/ohms or less, go to next step.
26. **Check HI/LO Indicator Switch (Circuit 783) For Short To Ground -** Turn ignition off. Disconnect indicator switch connector on front of transfer case. Measure resistance between ground and terminal No. 3 on GEM 22-pin harness connector. If resistance is greater than 10 k/ohms, replace indicator switch. Clear DTCs and retest system. If resistance is 10 k/ohms or less, repair Gray wire for short to ground. Clear DTCs and retest system.
27. **Check Circuit 783 (Gray Wire) For Open -** Measure resistance between ground and terminal No. 3 on GEM 22-pin harness connector. If resistance is less than 5 ohms, replace GEM. Clear DTCs and retest system. If resistance is 5 ohms or greater, go to next step.
28. **Check Circuit 783 (Gray Wire) For Open HI/LO Indicator Switch Disconnected -** Turn ignition off. Disconnect indicator switch connector on front of transfer case. Measure resistance of Gray wire between terminal No. 2 on indicator switch harness connector and terminal No. 3 on GEM 22-pin harness connector. If resistance is less than 5 ohms, replace indicator switch. Clear DTCs and retest system. If resistance is 5 ohms or greater, repair open Gray wire. Clear DTCs and retest system.
29. **Check Transfer Case Synchronization -** Raise and support vehicle. Remove front drive shaft. Place shift lever in 2H position. Start and idle engine. Place shift lever in "D" position. Rotate rear tires at 20-25 MPH. Place shift lever in 4H position. If transfer case front output shaft rotates, verify complaint. See **SYMPTOM TESTING** . If transfer case front output shaft does not rotate, inspect transfer case for internal problem. See Borg-Warner 44-06 overhaul article. Repair as needed. Clear DTCs and retest system.

TEST H: FRONT AXLE IS NOT ENGAGING PROPERLY (TRANSFER CASE MOTOR MOVEMENT OKAY)

NOTE: Steps 1-3 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

1. **Check Voltage At Fuse No. 15 (5-Amp) -** Turn ignition off. Using voltmeter, measure voltage at terminal No. 1 on fuse junction panel fuse No. 15. If voltage is 10 volts or less, go to next step. If voltage is greater than 10 volts, go to step 4).
2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -** Inspect fuse junction panel fuse No. 15 (5-amp) & power distribution box fuse No. 22 (50-amp). If both

fuses are okay, go to next step. If either fuse is blown, replace fuse. Clear DTCs and retest system. If fuse blows again, inspect circuit for short to ground.

3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.
4. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Connect NGS tester. Depress clutch pedal (if applicable). Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF and ACC positions. If values agree, go to next step. If values do not agree, see appropriate **STEERING COLUMN SWITCHES** article in the ACCESSORIES/SAFETY EQUIPMENT section.

NOTE: In next step, if DTC B1342 is retrieved, replace GEM. Clear DTCs and retest system.

5. **Retrieve DTCs -** Retrieve and document continuous DTCs. Clear continuous DTCs. Retrieve on-demand DTCs. If DTCs are recorded, go to appropriate step(s). See **DTC/TEST & STEP** table. If no DTCs are retrieved, go to next step.

DTC/TEST & STEP

DTC	Go To TEST/STEP
P1804	J
P1806	J
P1824	J
P1826	J
P1832	H/11
P1834	H/11
P1876	H/11
P1877	H/11

6. **Check 4WD Indicator Lights -** Turn ignition switch to RUN position. Place 4WD shift lever in 2H position. Both indicator lights should be off. Place 4WD shift lever in 4H position. 4WD indicator light should be illuminated. Place 4WD shift lever in 4L position. 4WD indicator light should remain illuminated and low range indicator light should illuminate. If indicator lights operate as specified, go to step 8). If 4L or 4H indicator light does not operate as specified, go to next step.
7. **Check 4WD Indicator Light Initial Operation -** Turn ignition off. Start and idle engine. If 4WD indicator light illuminates for 2 seconds after starting vehicle, go to step 25). If 4WD indicator light does not illuminate for 2 seconds after starting vehicle, go to **TEST J** .
8. **Check Front Axle Engagement -** Start engine. Using scan tool, toggle active command AXLE ENGG to on and AXLE DSCN to off. Raise and support vehicle with engine running. Spin one front tire. Opposite front tire should spin in reverse direction. If axle disconnect is operating correctly, exit active command mode. Go to next step. If axle disconnect is not operating correctly, go to step 12).
9. **Check Front Drive Shaft Engagement -** Place mode switch in 4H position and drive short distance. Raise and support vehicle. If front and rear drive shafts spin, go to next step. If front and rear drive shafts

do not spin, inspect transfer case for internal malfunction. See Borg-Warner 44-06 overhaul article.

NOTE: When 4WD is disengaged, front drive shaft may spin due to viscous drag in transfer case, especially if cold.

10. **Check Front Drive Shaft Disengagement -** Place 4WD mode switch in 2H position. If rear drive shaft is only being driven, go to next step. If front drive shaft is also being driven, inspect transfer case for internal malfunction. See **TRANSFER CASE - BORG/WARNER 44-06** article in the POWERTRAIN section.
11. **Check Front Axle Disengagement -** Using scan tool, set active commands AXLE ENGG to OFF and AXLE DSCN to ON. Active commands AXLE ENGG and AXLE DSCN are located in 4-Wheel Electronic Shift active command menu. Spin one front tire. Opposite front tire should not spin. If front axle is disengaged, the 4WD system is functioning correctly. If front axle is engaged, go to next step.
12. **Check 4WD & 2WD Vacuum Solenoid Circuits -** Using scan tool, monitor PIDs 4WDSOL and 2WDSOL. Set active command AXLE ENGG and AXLE DSCN to ON. If PIDs 4WDSOL and 2WDSOL indicates ON, go to next step. If PIDs indicate ON-B-, go to step 14).
13. **Check 4WD & 2WD Vacuum Solenoids -** Using scan tool, monitor PIDs 4WDSOL and 2WDSOL. Set active command AXLE ENGG and AXLE DSCN to OFF. If PIDs 4WDSOL and 2WDSOL indicate OFF, go to step 23). If PIDs indicate OFFO-G, go to step 16).
14. **Check Circuits 145 (Gray/Black Wire) & 605 (Red Wire) For Short To Power -** Turn ignition off. Disconnect 2WD and 4WD vacuum solenoid harness connectors. Solenoids are mounted to right inner fender. See **Fig. 14** . Disconnect GEM 22-pin connector. See **Fig. 2** . Turn ignition to RUN position. Using DVOM, measure and record voltage between ground and terminal No. 1 (Red wire) on 4WD vacuum solenoid harness connector. Measure and record voltage between ground and terminal No. 1 (Gray/Black wire) on 2WD vacuum solenoid harness connector. If voltage is not present on both circuits, reconnect all harness connectors and go to next step. If voltage is present on either circuit, repair suspect circuit for short to voltage. Clear DTCs and retest system.
15. **Check 4WD & 2WD Vacuum Solenoid PIDs -** Using scan tool, monitor PIDs 4WDSOL and 2WDSOL. Set active command AXLE ENGG and AXLE DSCN to ON. If PIDs 4WDSOL and 2WDSOL indicate ON-B-, replace GEM. Clear DTCs and retest system. If PID 4WDSOL and/or 2WDSOL do not indicate ON-B-, replace suspect solenoid. Clear DTCs and retest system.
16. **Check Circuit 294 (White/Light Blue Wire) For Voltage -** Turn ignition off. Disconnect 2WD and 4WD vacuum solenoid harness connectors. Solenoids are mounted to right inner fender. See **Fig. 14** . Turn ignition to RUN position. Using DVOM, measure and record voltage between ground and terminal No. 2 (White/Light Blue wire) on 4WD vacuum solenoid harness connector. Measure and record voltage between ground and terminal No. 2 (White/Light Blue wire) on 2WD vacuum solenoid harness connector. If voltage is greater than 10 volts on both circuits, go to next step. If voltage is 10 volts or less on either circuit, repair open circuit. Clear DTCs and retest system.
17. **Check 2WD & 4WD Vacuum Solenoids -** Using ohmmeter, measure resistance between terminals No. 1 and 2 on each vacuum solenoid. If resistance measured is 50-100 ohms for each solenoid, go to next step. If resistance is not 50-100 ohms for either solenoid, replace suspect solenoid. Clear DTCs and retest system.
18. **Check Circuit 145 (Gray/Black Wire) For Open -** Turn ignition off. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure resistance of Gray/Black wire between terminal No. 2 on GEM harness connector and terminal No. 1 on 2WD vacuum solenoid harness connector. See **Fig. 4** . If resistance is

less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Gray/Black wire. Clear DTCs and retest system.

19. **Check Circuit 605 (Red Wire) For Open -** Turn ignition off. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure resistance of Red wire between terminal No. 7 on GEM harness connector and terminal No. 1 on 4WD vacuum solenoid harness connector. See **Fig. 4** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Red wire. Clear DTCs and retest system.
20. **Check Circuit 145 (Gray/Black Wire) For Short To Ground -** Measure resistance between ground and terminal No. 2 on GEM 22-pin harness connector. If resistance is 10 k/ohms or less, repair Gray/Black wire. Clear DTCs and retest system. If resistance is greater than 10 k/ohms, go to next step.
21. **Check Circuit 605 (Red Wire) For Short To Ground -** Measure resistance between ground and terminal No. 7 on GEM 22-pin harness connector. See **Fig. 4** . If resistance is 10 k/ohms or less, repair Red wire. Clear DTCs and retest system. If resistance is greater than 10 k/ohms, go to next step.
22. **Check Vacuum Signal At Solenoids -** Start and run engine at idle. Using vacuum gauge, measure vacuum at solenoid feed line. If vacuum is approximately 20 In. Hg, go to next step. If vacuum is less than 20 In. Hg, repair suspect vacuum feed line. Clear DTCs and retest system.
23. **Check 4WD & 2WD Vacuum Solenoids Closed Condition** - Turn ignition off. Disconnect solenoid vacuum lines. Connect vacuum pump to feed line connection on each solenoid. See **Fig. 15** . Turn ignition to RUN position. Monitor PIDs 2WDSOL and 4WDSOL. Toggle active command AXLE ENGG and AXLE DSCN to OFF. Apply vacuum and verify vacuum solenoids are closed. If solenoids hold vacuum, release vacuum and go to next step. If solenoids do not hold vacuum, replace suspect vacuum solenoid. Clear DTCs and retest system.
24. **Check 4WD & 2WD Vacuum Solenoids Open Condition -** Turn ignition off. Disconnect solenoid vacuum lines. Connect vacuum pump to feed line connection on each solenoid. Turn ignition to RUN position. Monitor PIDs 2WDSOL and 4WDSOL. Toggle active command AXLE ENGG and AXLE DSCN to ON. Apply vacuum and verify vacuum solenoids are open. If solenoids hold vacuum, replace suspect vacuum solenoid. Clear DTCs and retest system. If solenoids do not hold vacuum, go to next step.
25. **Check Vacuum Lines To Front Axle Actuator -** Inspect vacuum lines to front axle actuator. See **Fig. 14** . If vacuum hoses are okay, go to next step. If vacuum lines are damaged or disconnected, repair as needed. Clear DTCs and retest system.
26. **Check Front Axle Vacuum Actuator -** Disconnect linkage from vacuum actuator. Reconnect all harness connectors and vacuum lines. Start and idle engine. Toggle active command AXLE ENGG to ON and AXLE DSCN to OFF. If vacuum actuator moves to engaged position, inspect front axle for mechanical malfunction. See **DRIVE AXLE** article in the POWERTRAIN section. If vacuum actuator does not move to engaged position, replace vacuum actuator. Clear DTCs and retest system.Clear DTCs and retest system.
27. **Check Front Axle Vacuum Actuator -** Toggle active command AXLE ENGG to OFF and AXLE DSCN to ON. If vacuum actuator move to disengaged position, inspect and repair front axle locking mechanism. If vacuum actuator does not move to disengaged position, replace vacuum actuator. Clear DTCs and retest system. Clear DTCs and retest system.

TEST J: 4WD LO INDICATOR LIGHT NOT OPERATING PROPERLY

NOTE: Steps 1-3 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

1. **Check Voltage At Fuse No. 15 (5-Amp) -** Turn ignition off. Using voltmeter, measure voltage at terminal No. 1 on fuse junction panel fuse No. 15. If voltage is 10 volts or less, go to next step. If voltage is greater than 10 volts, go to step 4).
2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -** Inspect fuse junction panel fuse No. 15 (5-amp) & power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to next step. If either fuse is blown, replace fuse. Clear DTCs and retest system. If fuse blows again, inspect circuit for short to ground.
3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.
4. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Connect NGS tester. Depress clutch pedal (if applicable). Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF and ACC positions. If values agree, go to next step. If values do not agree, see appropriate **STEERING COLUMN SWITCHES** article in the ACCESSORIES/ SAFETY EQUIPMENT section.

   NOTE: In next step, if DTC B1342 is retrieved, replace GEM. Clear DTCs and retest system.

5. **Retrieve DTCs -** Retrieve and document continuous DTCs. Clear continuous DTCs. Retrieve on-demand DTCs. If DTCs are recorded, go to appropriate step(s). See **DTC/TEST & STEP** table. If no DTCs are retrieved, go to next step.

   DTC/TEST & STEP

DTC	Go To TEST/STEP
P1804	J/6
P1806	J/6
P1824	G
P1826	G
P1828	A
P1832	H
P1834	H
P1876	H
P1877	H

6. **Check 4WD Indicator Lights -** Turn ignition switch to RUN position. Place 4WD shift lever in 2H position. Both indicator lights should be off. Place 4WD shift lever in 4H position. 4WD indicator light should be illuminated. Place 4WD shift lever in 4L position. 4WD indicator light should remain illuminated and low range indicator light should illuminate. If indicator lights operate as specified, indicator lights are operating correctly. If 4L indicator light does not operate as specified, go to step 12). If 4H indicator light does not operate as specified, go to next step.
7. **Check 4WD System Indicator Lights -** Using scan tool, monitor PID 4WDHIGH. Set active command HIGH LAMP to ON, then OFF. If scan tool displays ON-B-, go to step 10). If scan tool displays OFFO-G

and indicator light is continually illuminated, go to next step. If scan tool displays OFFO-G and indicator light is not illuminated, see **INSTRUMENT PANELS** article in the ACCESSORIES/SAFETY EQUIPMENT section.

8. **Check GEM For Short To Ground -** Turn ignition off. Disconnect GEM 22-pin connector. See **Fig. 2** . Turn ignition switch to ON position. If 4H indicator light is illuminated, go to next step. If 4H indicator light is not illuminated, replace GEM. Clear DTCs and retest system.
9. **Check Circuit 210 (Light Blue Wire) For Short To Ground -** Turn ignition off. Disconnect instrument cluster harness connectors. Measure resistance between ground and terminal No. 9 on GEM 22-pin harness connector. See **Fig. 4** . If resistance is 10 k/ohms or less, repair Light Blue wire for short to ground. Clear DTCs and retest system. If resistance is greater than 10 k/ohms, replace or repair instrument cluster. Clear DTCs and retest system.
10. **Check Circuit 210 (Light Blue Wire) For Short To Voltage -** Turn ignition off. Disconnect instrument cluster harness connectors. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure voltage between ground and terminals No. 9 on GEM 22-pin harness connector. See **Fig. 4** . If voltage is present, repair Light Blue wire for short to voltage. Clear DTCs and retest system. If voltage is not present, go to next step.
11. **Check 4WD System Indicator Lights -** Using scan tool, monitor PID 4WDHIGH. Set active command HIGH LAMP to ON. If scan tool displays ON-B-, replace GEM. Clear DTCs and retest system. If scan tool does not display ON-B-, repair or replace instrument panel, see **INSTRUMENT PANELS** article in the ACCESSORIES/SAFETY EQUIPMENT section. Clear DTCs and retest system.
12. **Check 4WD Indicator Switch -** Turn ignition off. Disconnect 4WD indicator switch connector on front of transfer case. Measure resistance between left terminal on switch connector and ground. Move shift lever through all positions. Resistance should be greater than 10 k/ohms in 2H and 4H positions, and less than 5 ohms in 4L position. If resistances are as specified, go to next step. If resistance is not as specified, replace switch. Clear DTCs and retest system.
13. **Check Instrument Cluster 4WD LOW INDICATOR LIGHT -** Disconnect GEM 22-pin connector. See **Fig. 2** . Connect jumper wire between ground and terminal No. 10 (Black/Yellow wire) on GEM harness connector. Turn ignition to RUN position. If 4WD low indicator light illuminated, go to next step. If 4WD low indicator light is not illuminated, see **INSTRUMENT PANELS** article in the ACCESSORIES/SAFETY EQUIPMENT section. Clear DTCs and retest system.
14. **Check Circuit 975 (Brown/Yellow Wire) For Short To Ground -** Turn ignition off. Disconnect instrument cluster harness connectors. Measure resistance between ground and terminal No. 10 on GEM 22-pin harness connector. See **Fig. 4** . If resistance is 10 k/ohms or less, repair Brown/Yellow wire for short to ground. Clear DTCs and retest system. If resistance is greater than 10 k/ohms, replace or repair instrument cluster. Clear DTCs and retest system.
15. **Check Circuit 975 (Brown/Yellow Wire) For Short To Voltage -** Turn ignition off. Disconnect GEM 22-pin connector. See **Fig. 2** . Measure voltage between ground and terminal No. 10 on GEM 22-pin harness connector. See **Fig. 4** . If voltage is present, repair Brown/Yellow wire for short to voltage. Clear DTCs and retest system. If voltage is not present, go to next step.
16. **Check Circuit 784 (Light Blue/Black Wire) For Open -** Turn ignition off. Disconnect GEM 26-pin connector. See **Fig. 2** . Measure resistance of Light Blue/Black wire between terminal No. 2 on 4WD indicator switch harness connector and terminal No. 16 on GEM harness connector. See **Fig. 5** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Light Blue/Black wire. Clear DTCs and retest system.
17. **Check Circuit 784 (Light Blue/Black Wire) For Short To Power -** Turn ignition to RUN position.

Measure voltage between ground and terminal No. 16 (Light Blue/Black wire) on GEM harness connector. See **Fig. 5** . If voltage is present, repair Light Blue/Black wire for short to voltage. Clear DTCs and retest system. If voltage is not present, replace GEM. Clear DTCs and retest system.

TEST K: NO COMMUNICATION WITH GEM

1. **Check Ignition States; Monitor GEM PID IGN_GEM -** Turn ignition off. Connect NGS tester. Depress clutch pedal (if applicable). Monitor Generic Electronic Module (GEM) Parameter Identification (PID) Ignition Switch Status (IGN_GEM) while turning ignition switch through START, RUN, OFF and ACC positions. If values agree, go to next step. If values do not agree, see appropriate **STEERING COLUMN SWITCHES** article in the ACCESSORIES/SAFETY EQUIPMENT section.

NOTE: Steps 2-3 pertain to power supply circuits. For applicable wiring diagrams, see POWER DISTRIBUTION section in SYSTEM WIRING DIAGRAMS article in the WIRING DIAGRAMS section.

2. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) -** Inspect fuse junction panel fuse No. 15 (5-amp) and power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to next step. If either fuse is blown, replace fuse. Clear DTCs and retest system. If fuse blows again, inspect circuit for short to ground.
3. **Check Circuit 1052 (Tan/Black Wire) For Voltage -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If voltage is 10 volts or less, repair open Tan/Black wire. Clear DTCs and retest system. If voltage is greater than 10 volts, replace fuse junction panel. Clear DTCs and retest system.
4. **Check Fuse Junction Panel For Voltage -** Ensure ignition is off. Disconnect GEM from fuse junction panel. Connect fuse junction panel connector C243. Measure voltage between ground and terminals No. 4 and 16 on GEM 18-pin junction block connector. See **Fig. 11** . If voltage is more than 10 volts for both circuits, go to step 8). If voltage is 10 volts or less for either circuit, replace fuse junction panel. Clear DTCs and retest system.
5. **Check Fuse Junction Panel Fuse No. 15 (5-Amp) & Power Distribution Box Fuse No. 22 (50-Amp) GEM Disconnected -** Turn ignition off. Disconnect GEM from fuse junction panel. Inspect fuse junction panel fuse No. 15 (5-amp) & power distribution box fuse No. 22 (50-amp). If both fuses are okay, go to step 7). If fuse No. 22 is blown, go to step 6). If fuse No. 15 is blown, go to step 10).
6. **Check Circuit 1052 (Tan/Black Wire) For Short To Ground -** Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure resistance between ground and terminal No. 11 on fuse junction panel harness connector. See **Fig. 3** . If resistance is 10 k/ohms or less, repair Tan/Black wire for short to ground. Clear DTCs and retest system. If voltage is greater than 10 k/ohms, replace fuse junction panel. Clear DTCs and retest system.
7. **Check Fuse Junction Panel For Voltage -** Ensure ignition is off. Disconnect GEM from fuse junction panel. Disconnect fuse junction panel connector C243. See **Fig. 2** . Measure voltage between terminal No. 11 on fuse junction panel connector C243 and terminals No. 4 and 16 on GEM 18-pin junction block connector. See **Fig. 11** . If resistance is less than 5 ohms for both circuits, go to next step. If resistance is 5 ohms or greater for either circuit, replace fuse junction panel. Clear DTCs and retest system.
8. **Check Circuit 875 (Black/Light Blue Wire) For Continuity To Ground -** Ensure ignition is off. Disconnect GEM 26-pin connector. See **Fig. 2** . Measure resistance between ground and terminal No. 26

on GEM harness connector. See **Fig. 5** . If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open Black/Light Blue wire. Clear DTCs and retest system.

9. **Check Circuit 875 (Black/Light Blue Wire) For Open -** Measure resistance between ground and terminal No. 14 on GEM harness connector. If resistance is less than 5 ohms, see appropriate **MODULE COMMUNICATIONS NETWORK** article in the ACCESSORIES/SAFETY EQUIPMENT section. If resistance is 5 ohms or greater, repair open Black/Light Blue wire. Clear DTCs and retest system.
10. **Check Fuse Junction Panel For Short To Ground -** Ensure ignition is off. Disconnect GEM from fuse junction panel. Measure resistance between ground and terminals No. 4 on GEM 18-pin junction block connector. See **Fig. 11** . If resistance is 10 k/ohms or less, see **MODULE COMMUNICATIONS NETWORK** article in the ACCESSORIES/SAFETY EQUIPMENT section. If resistance is greater than 10 k/ohms, replace fuse junction panel. Clear DTCs and retest system.

SYMPTOM TESTING

ESOF MODELS

Vehicle Does Not Shift Between 2WD & 4WD High Modes Properly

Possible causes: 4WD mode switch, 4WD clutch relay, contact plate sensors, T/C shift motor, transfer case and/or GEM. Go to **TEST A** under TESTING.

Vehicle Does Not Shift Between 4WD High To 4WD Low Properly,

Shifts Properly Between 2WD To 4WD High, 4WD High To 2WD

Possible causes: 4WD mode switch, vehicle speed sensor, BOO switch, transfer case, TR sensor and/or GEM. Go to **TEST B** under TESTING.

Front Axle Not Engaging Or Disengaging Properly

Possible causes: 4WD solenoid, 2WD solenoid, vacuum motor, vacuum lines, front differential and/or GEM. Go to **TEST C** under TESTING.

4WD LO &/Or 4WD HI Indicator Light Not Operating Properly

Possible causes: light bulb, TR sensor and/or GEM. Go to **TEST D** under TESTING.

4WD HI Does Not Engage At Speed Properly (Driveline Does Not

Synchronize Properly) But Does Engage At Rest

Possible causes: ESOF clutch relay, internal clutch, hub release spring and/or wiring harness. Go to **TEST E** under TESTING.

No Communication With GEM

Possible causes: Fuses, harness and/or GEM. Go to **TEST F** under TESTING.

MSOF MODELS

4WD High Does Not Engage At Speed Properly (Driveline Does

Not Synchronize Properly) But Does Engage At Rest

Possible causes: MSOF switch, MSOF clutch relay, internal clutch, harness and/or GEM. Go to **TEST G** under TESTING.

Front Axle Is Not Engaging Properly

Possible causes: 2WD and/or 4WD solenoids, GEM and/or harness. Go to **TEST H** under TESTING.

4WD Low Indicator Light Not Operating Properly

Possible causes: Fuses, harness, MSOF switch, TR sensor and/or GEM. Go to **TEST J** under TESTING.

No Communication With GEM

Possible causes: Fuses, harness and/or GEM. Go to **TEST K** under TESTING.

WIRING DIAGRAMS

1997 Ford Pickup F150

1997 TRANSFER CASES Borg-Warner 44-06 Electronic Controls

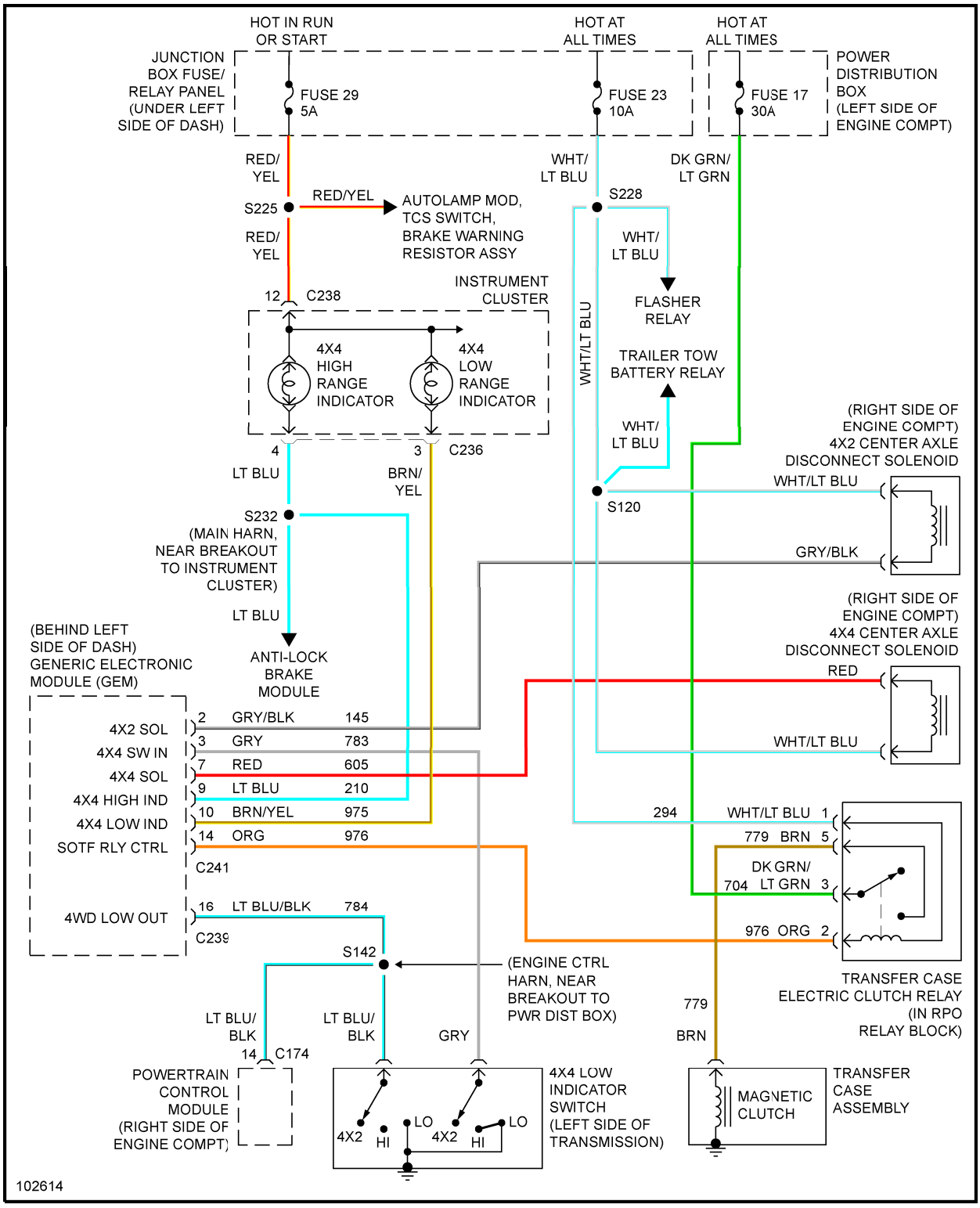


Fig. 18: MSOF Wiring Diagram

1997 Ford Pickup F150

1997 TRANSFER CASES Borg-Warner 44-06 Electronic Controls

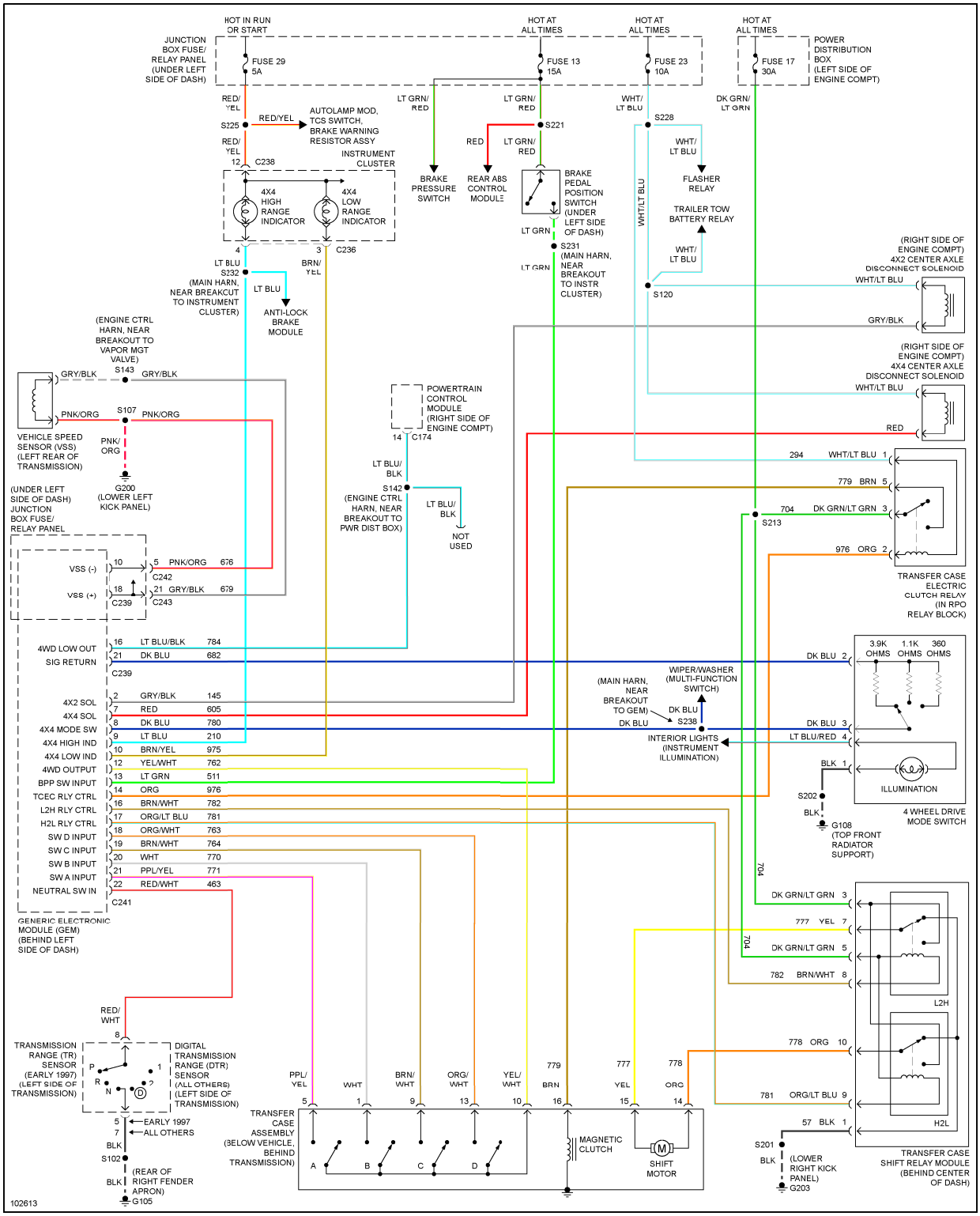


Fig. 19: ESOF Wiring Diagram

ENGINE PERFORMANCE

Vacuum Diagrams - Trucks

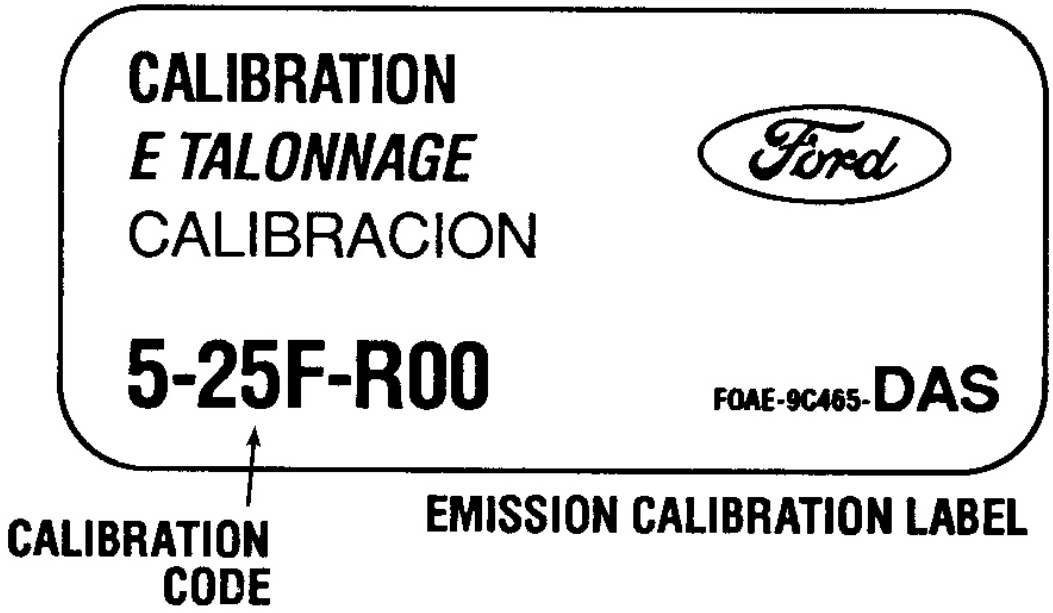
INTRODUCTION

This article contains underhood schematics of vacuum hose routing. Use these vacuum diagrams during the visual inspection in appropriate BASIC DIAGNOSTIC PROCEDURES article. This will assist in identifying improperly routed vacuum hoses, which may cause driveability and/or computer-indicated malfunctions.

VEHICLE CALIBRATION

Vacuum diagrams are identified by calibration code. Use the Emission Calibration Label to identify calibration. Calibration label is attached to left door or left door pillar. See **Fig. 1** . Use calibration code to select vacuum diagram.

NOTE: Vacuum diagrams for calibrations not shown are not available from manufacturer.



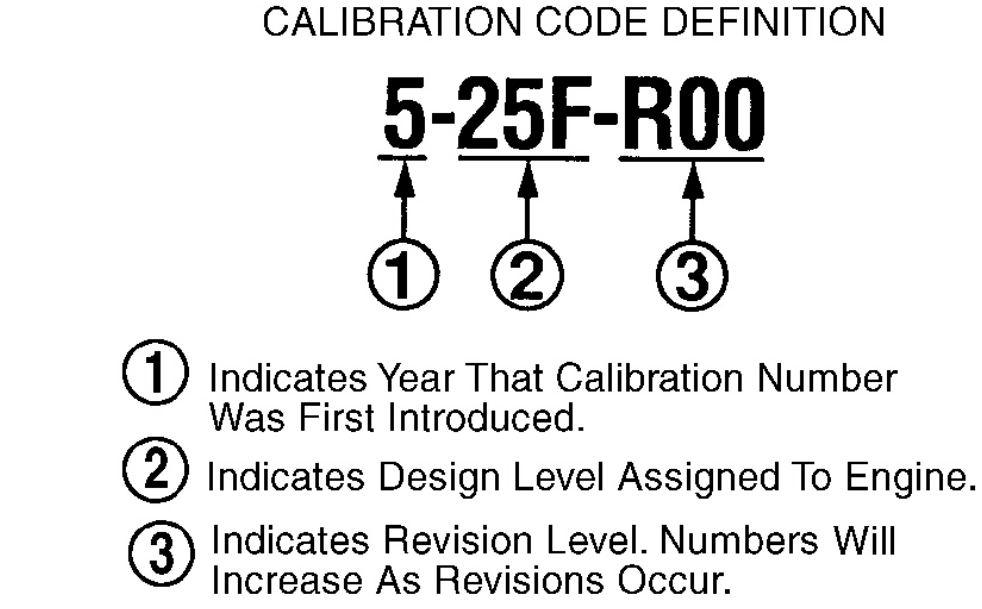


Fig. 1: Identifying Emission Calibration Label
Courtesy of FORD MOTOR CO.

VACUUM DIAGRAM APPLICATIONS

Application & Calibration Codes	See Fig.
Aerostar	

3.0L	
7-56J-R05, 7-56J-R10, 7-56T-R05, 7-56T-R10	**Fig. 2**
4.0L	
7-58J-R05, 7-58J-R10, 7-58K-R05, 7-58K-R10, 7-58N-R05, 7-58N-R10, 7-58Q-R05, 7-58Q-R10	**Fig. 3**
Expedition	
4.6L	
7-48J-R05, 7-48J-R10, 7-48U-R05, 7-48U-R10	**Fig. 4**
5.4L	
7-46F-R07, 7-46F-R10, 7-46U-R07, 7-46U-R10	**Fig. 5**
Explorer	
4.0L - Except SOHC	
7-57B-R05, 7-57B-R10, 7-57R-R05, 7-57R-R10, 7-58B-R05, 7-58B-R10, 7-58R-R05	**Fig. 6**
4.0L SOHC	
7-58C-R06, 7-58C-R10, 7-58C-R11, 7-58V-R06, 7-58V-R10, 7-58V-R11	**Fig. 7**
5.0L	
6-54G-R12, 7-54G-R10, 7-54G-R11, 7-54G-R12	**Fig. 8**
F-150	
4.2L	
6-43E-R07, 6-43E-R10, 6-43F-R07, 6-43F-R10, 6-43R-R07, 6-43R-R10, 6-43S-R07, 6-43S-R10, 6-44E-R07, 6-44E-R10, 6-44F-R07, 6-44F-R10, 6-44R-R07, 6-44R-R10, 6-44S-R07, 6-44S-R10, 7-43E-R10, 7-43E-R11, 7-43F-R10, 7-43F-R11, 7-43R-10, 7-43R-R11, 7-43S-R10, 7-43S-R11, 7-44E-R10, 7-44E-R11, 7-44F-R10, 7-44F-R11, 7-44R-R10, 7-44R-R11, 7-44S-R10, 7-44S-R11	**Fig. 9**
4.6L	
6-48E-R08, 6-48S-R08, 7-47Q-R11, 7-47R-R11, 7-48C-R11, 7-48D-R11, 7-48E-R11, 7-48Q-R11, 7-48R-R11, 7-48S-R11	**Fig. 10**
5.4L	
7-46D-R07, 7-46R-R07	**Fig. 11**
F-250	
4.6L	
7-47F-R05, 7-47G-R05, 7-47S-R05, 7-47T-R05, 7-48G-R05, 7-48P-R05, 7-48T-R05	**Fig. 10**
5.4L	
7-46E-R07, 7-46T-R07	**Fig. 11**
5.8L	
Over 8500 GVWR	
California	
6-76T-R11	**Fig. 12**

Canada & 49-States	
6-75A-R05, 7-76A-R00	**Fig. 13**
7.3L Turbo Diesel	
Information Not Available	**Fig. 14**
7.5L	
Medium-Duty	
California	
6-97Q-R06, 6-98Q-R10	**Fig. 15**
Heavy-Duty	
California	
7-97P-R00, 7-98P-R00	**Fig. 16**
Canada & 49-States	
6-97A-R00, 6-98A-R00	**Fig. 17**
F-350	
5.8L	
California	
6-76S-R11, 6-76T-R11	**Fig. 12**
Canada & 49-States	
6-75A-R05, 7-76A-R00	**Fig. 13**
7.3L Turbo Diesel	
Information Not Available	**Fig. 14**
7.5L	
Medium-Duty	
California	
6-97Q-R06, 6-98Q-R10	**Fig. 15**
Heavy-Duty	
California	
7-97P-R00, 7-98P-R00	**Fig. 16**
Canada & 49-States	
6-97A-R00, 6-98A-R00	**Fig. 17**
Mountaineer	
5.0L	
6-54G-R11, 6-54G-R12, 7-54G-R10, 7-54G-R11, 7-54G-R12	**Fig. 8**
Ranger	
2.3L	
7-49A-R06, 7-49T-R06, 7-50A-R06, 7-50T-R06	**Fig. 18**
3.0L	
7-55F-R05, 7-55F-R10, 7-55H-R05, 7-55H-R10, 7-55R-R05, 7-55R-R10, 7-55S-R05, 7-55S-R10, 7-56F-R05, 7-56F-R10	**Fig. 2**
4.0L	
7-57F-R05, 7-57F-R10, 7-57H-R05, 7-57H-R10, 7-57S-R05, 7-57S-R10,	**Fig. 19**

7-57T-R05, 7-57T-R10, 7-58F-R05, 7-58F-R10, 7-58H-R05, 7-58H-R10, 7-58S-R05, 7-58S-R10, 7-58T-R05, 7-58T-R10	
Super Duty	
Pickup	
7.5L	
6-97B-R00 - Codes SGJ, SKL, STT & SZB	**Fig. 20**
6-97B-R00 - Codes SPD, SPS, SUA & SYC & 6-98B-R00	**Fig. 21**
Van	
6.8L	
7-96J-R06	**Fig. 22**
Van	
4.2L	
7-44J-R06, 7-44J-R10, 7-44K-R06, 7-44K-R10, 7-44L-R06, 7-44L-R10, 7-44M-R06, 7-44M-R10, 7-44T-R06, 7-44T-R10, 7-44U-R06, 7-44U-R10	**Fig. 23**
4.6L	
7-48M-R05, 7-48M-R10, 7-48W-R05, 7-48W-R10, 7-48W-R11	**Fig. 24**
5.4L	
7-46K-R06, 7-46K-R10, 7-46Q-R06, 7-46Q-R10, 7-74C-R07, 7-74S-R07, 7-74U-R06, 7-74U-R10, 7-74V-R06, 7-74V-R10	**Fig. 25**
7-74T-R07 - Code SFS	**Fig. 26**
7-74T-R07 - Code SJF	**Fig. 27**
6.8L	
7-96E-R06, 7-96W-R06	**Fig. 28**
7-96T-R06, 7-96T-R10	**Fig. 29**
7-96X-R06	**Fig. 22**
Windstar	
3.8L	
6-62J-R11, 6-62S-R11	**Fig. 30**

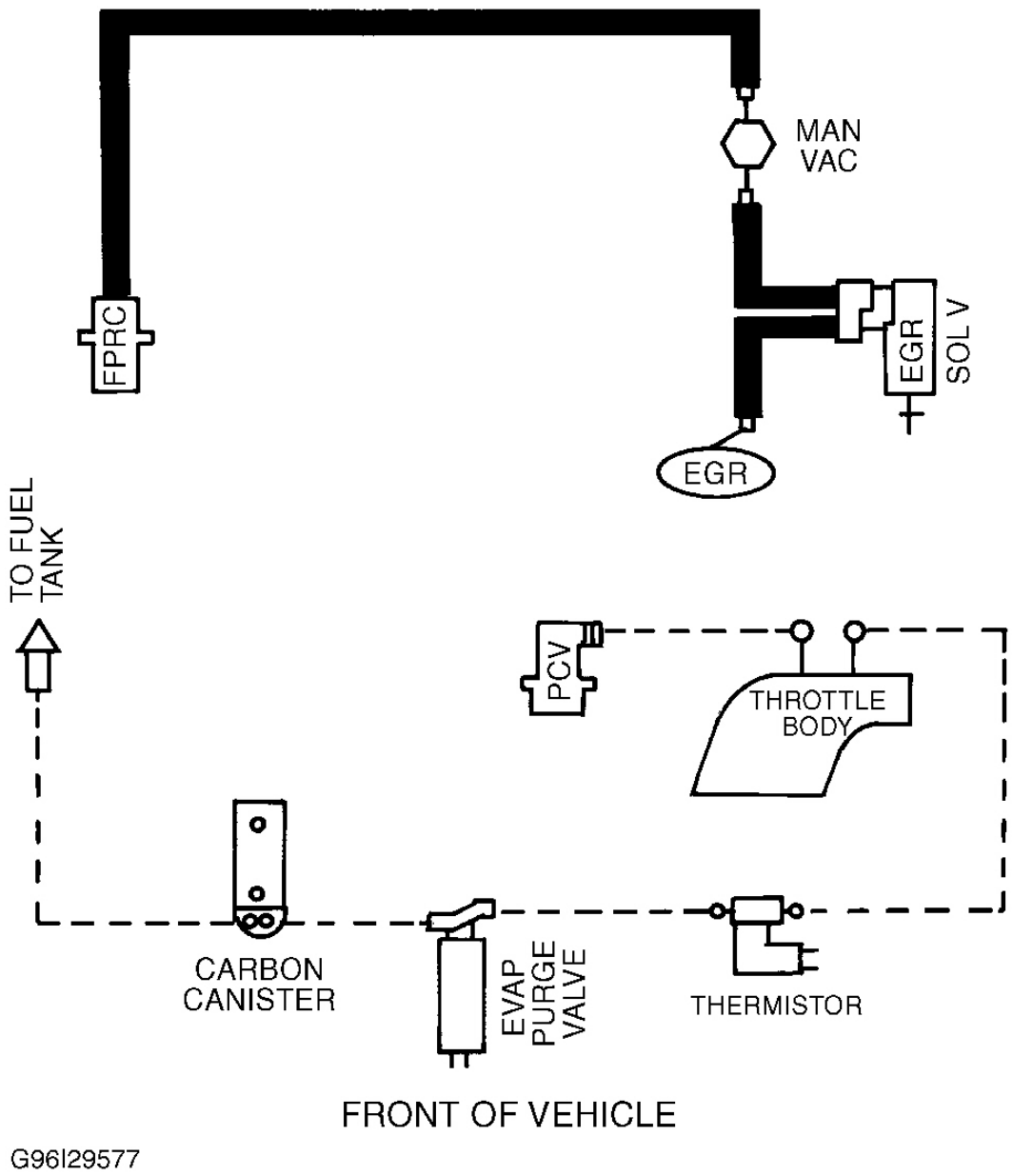


Fig. 2: Vacuum Diagram (Aerostar & Ranger - 3.0L)
Courtesy of FORD MOTOR CO.

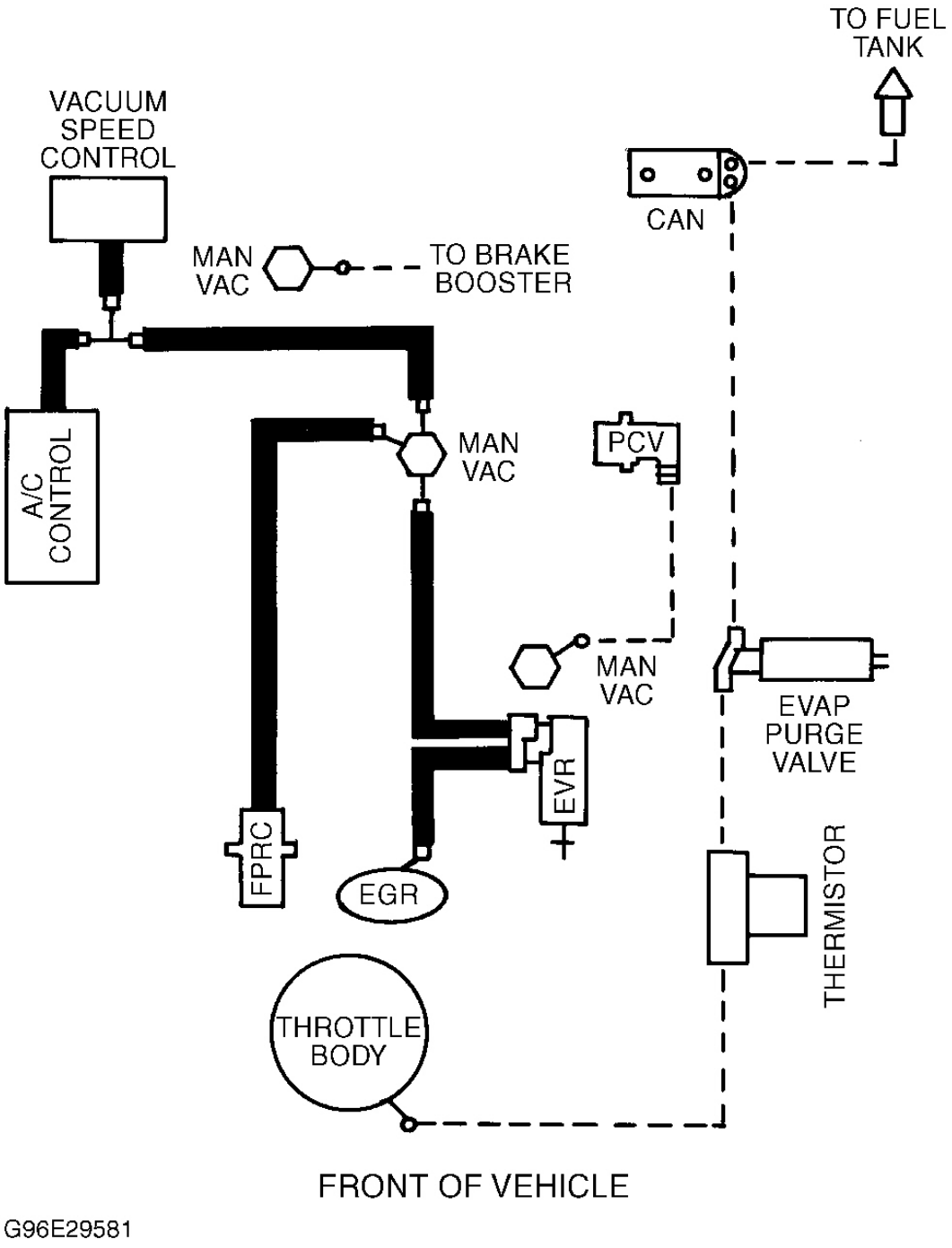


Fig. 3: Vacuum Diagram (Aerostar - 4.0L)
Courtesy of FORD MOTOR CO.

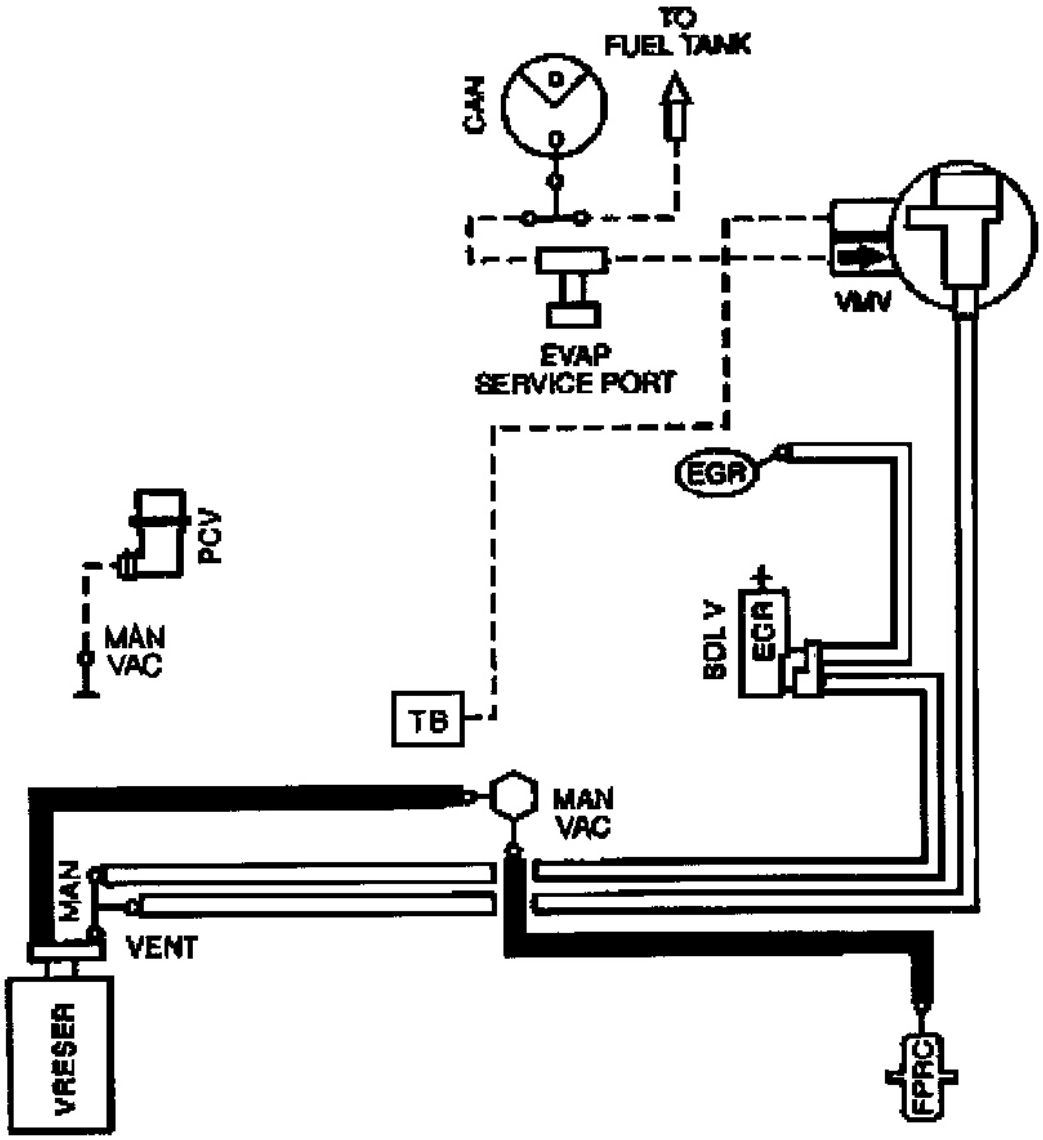


Fig. 4: Vacuum Diagram (Expedition - 4.6L)
Courtesy of FORD MOTOR CO.

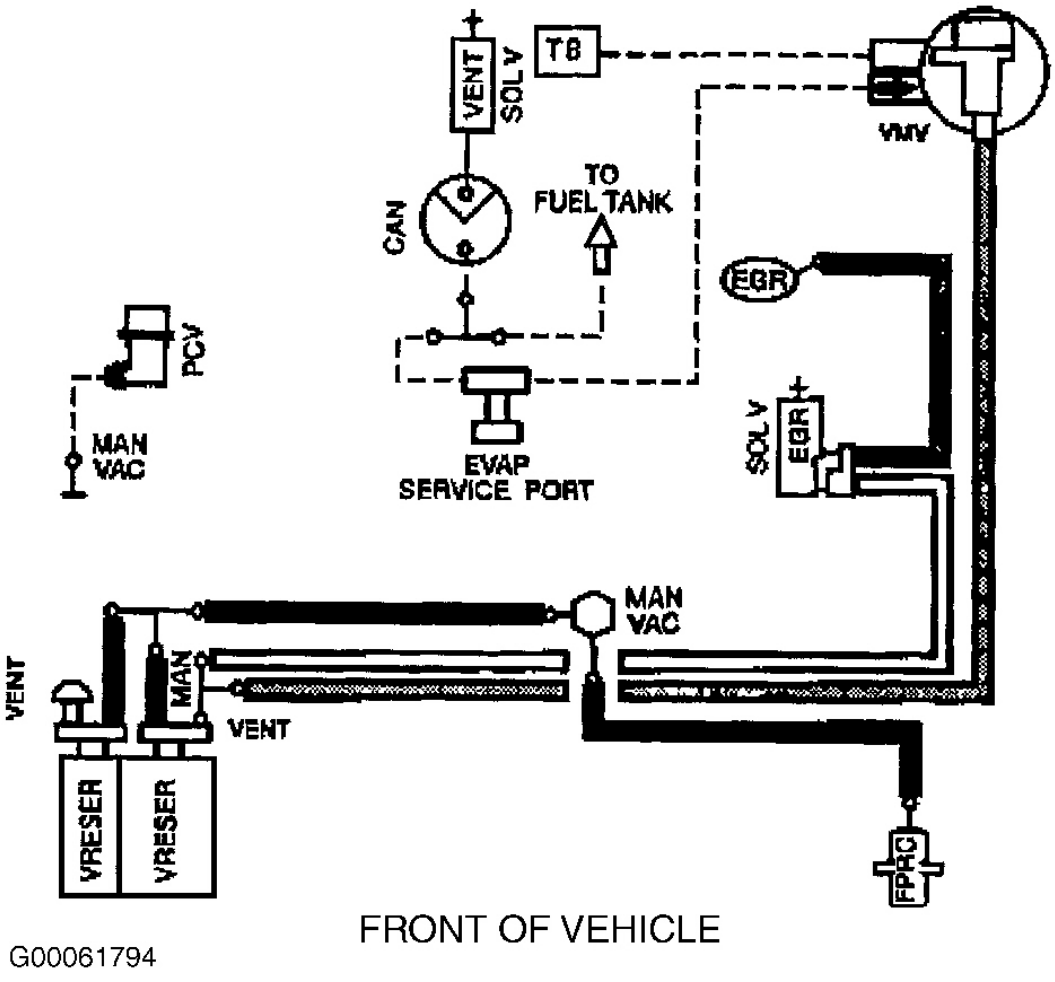


Fig. 5: Vacuum Diagram (Expedition - 5.4L)
Courtesy of FORD MOTOR CO.

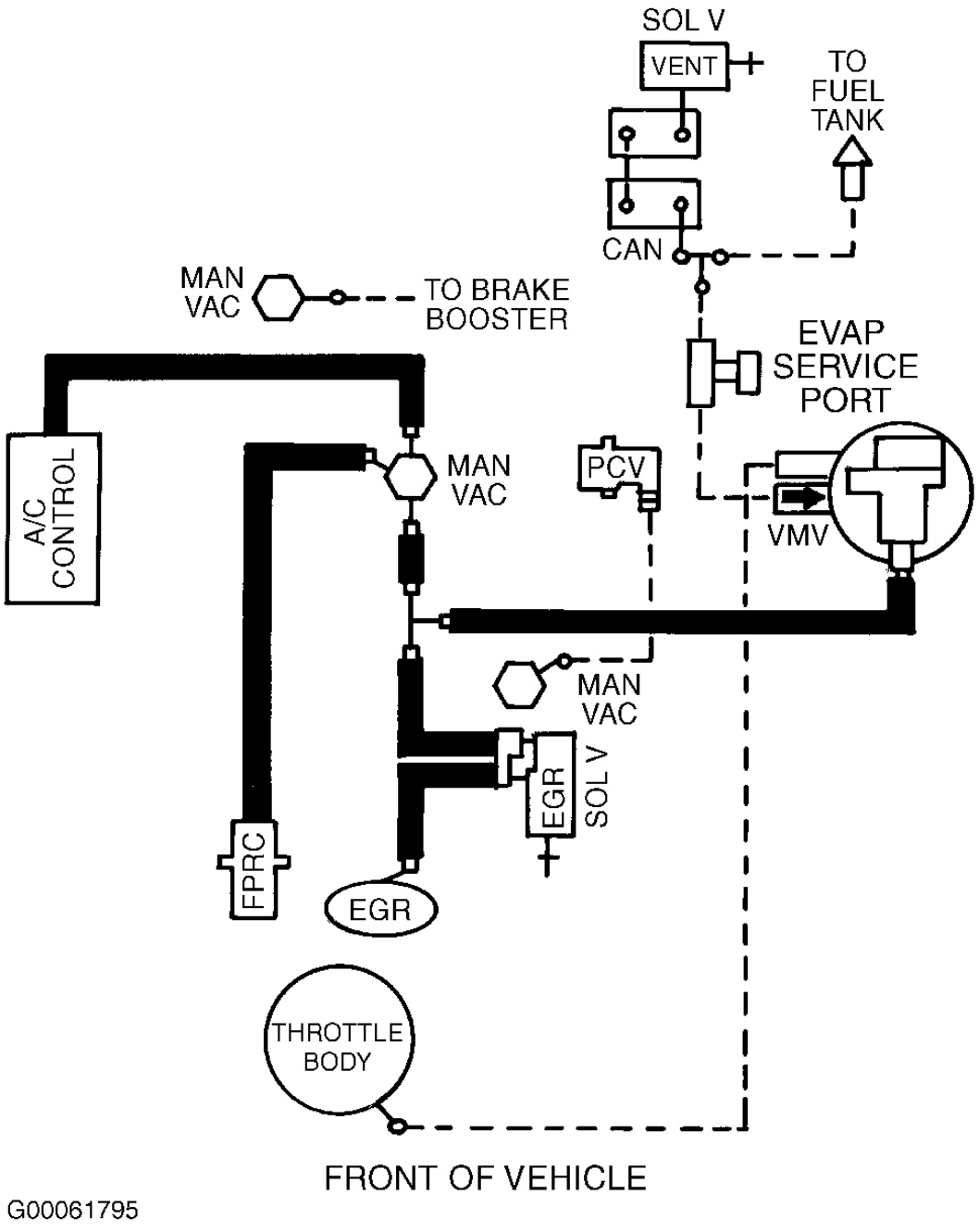


Fig. 6: Vacuum Diagram (Explorer - 4.0L - Except 4.0L SOHC)
Courtesy of FORD MOTOR CO.

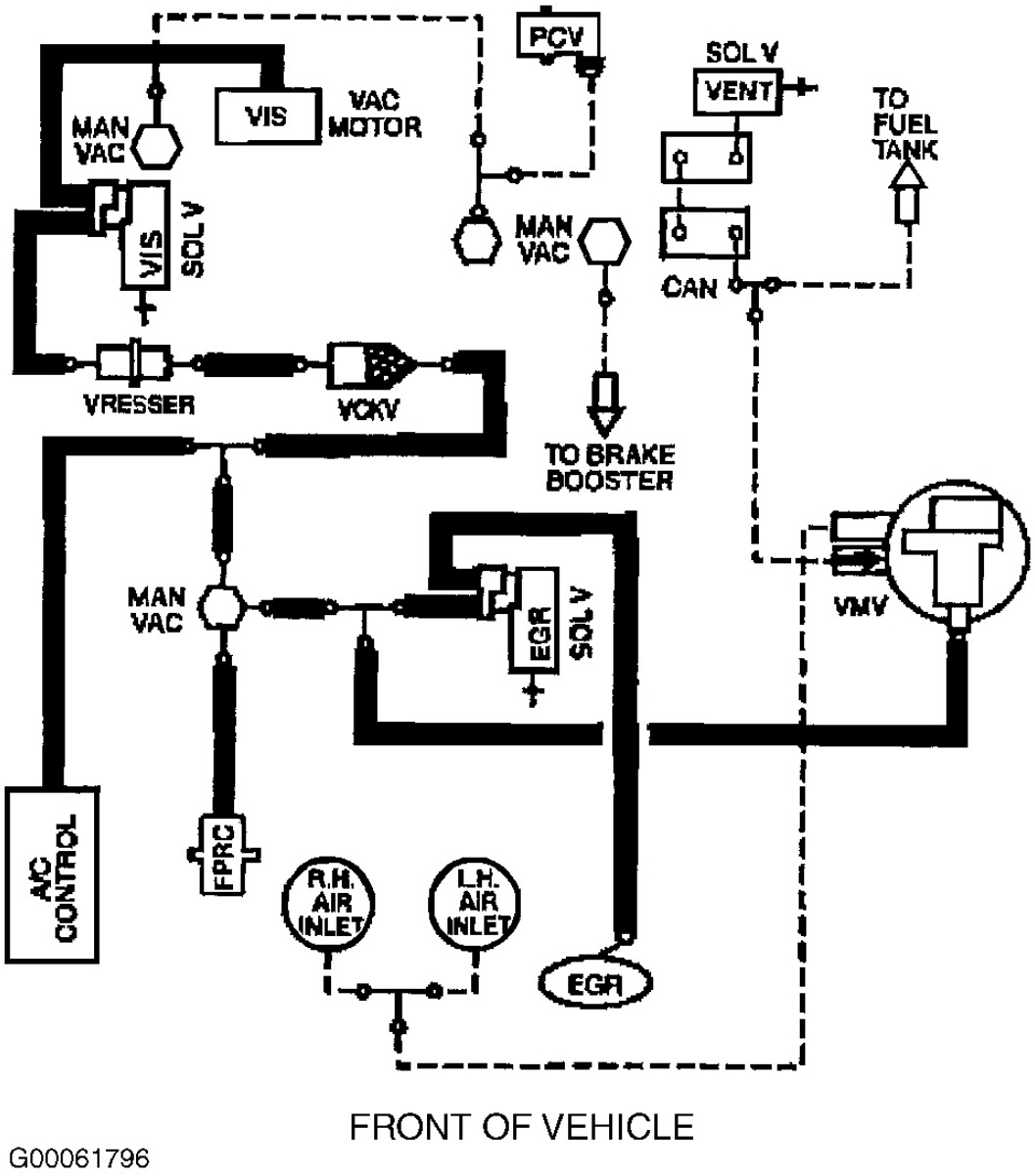


Fig. 7: Vacuum Diagram (Explorer - 4.0L SOHC)
Courtesy of FORD MOTOR CO.

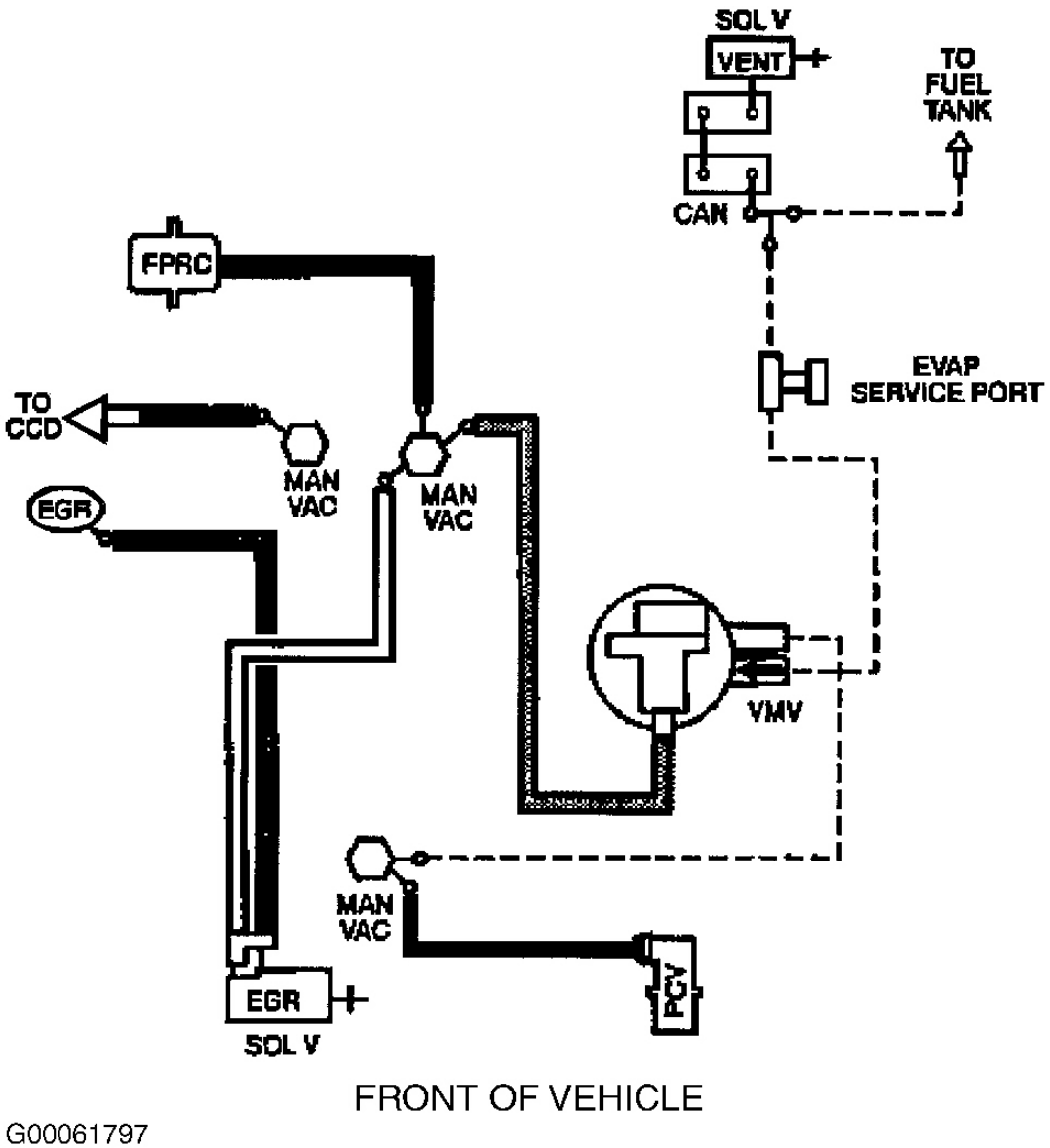


Fig. 8: Vacuum Diagram (Explorer & Mountaineer - 5.0L)
Courtesy of FORD MOTOR CO.

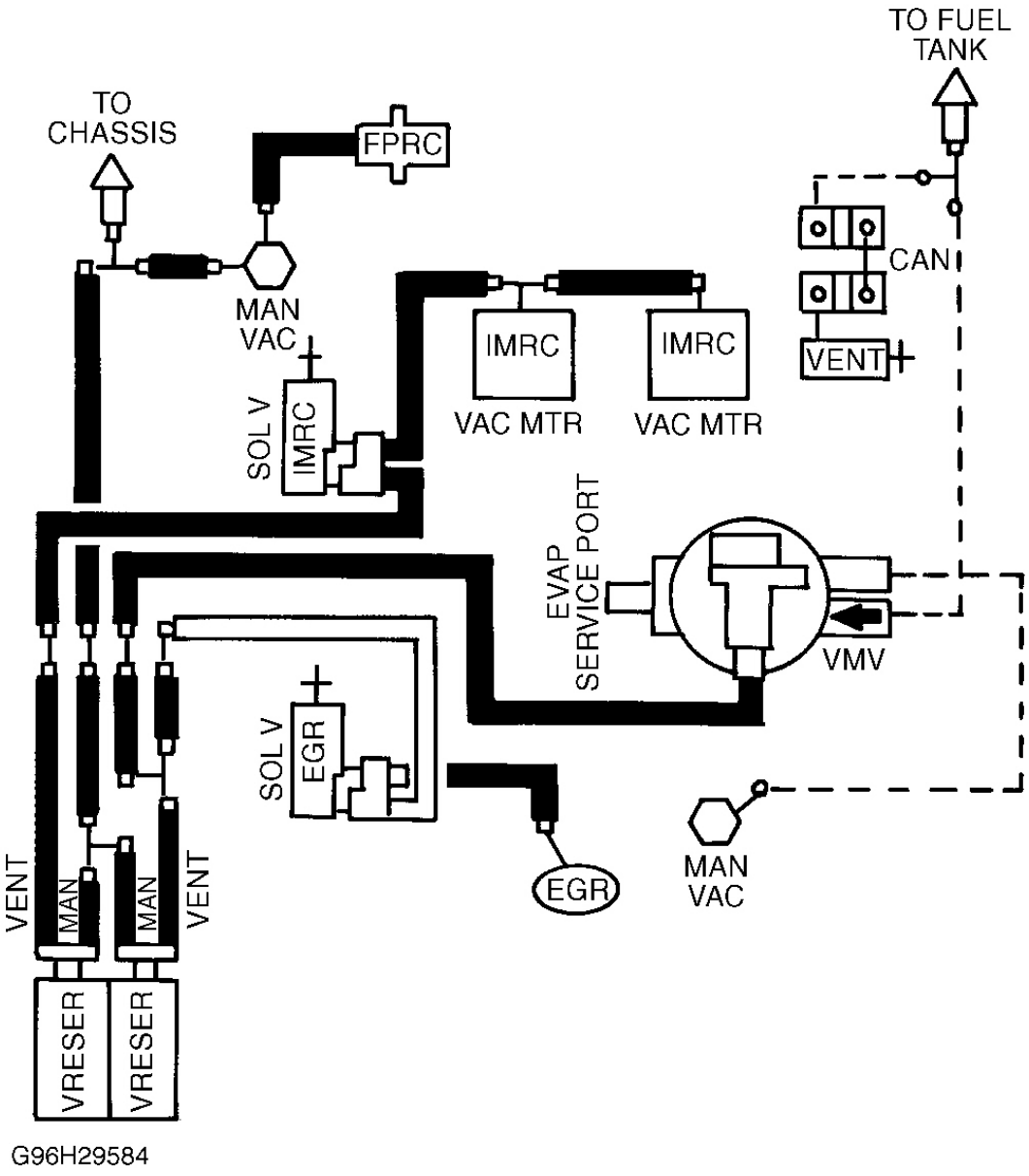


Fig. 9: Vacuum Diagram (F-150 - 4.2L)
Courtesy of FORD MOTOR CO.

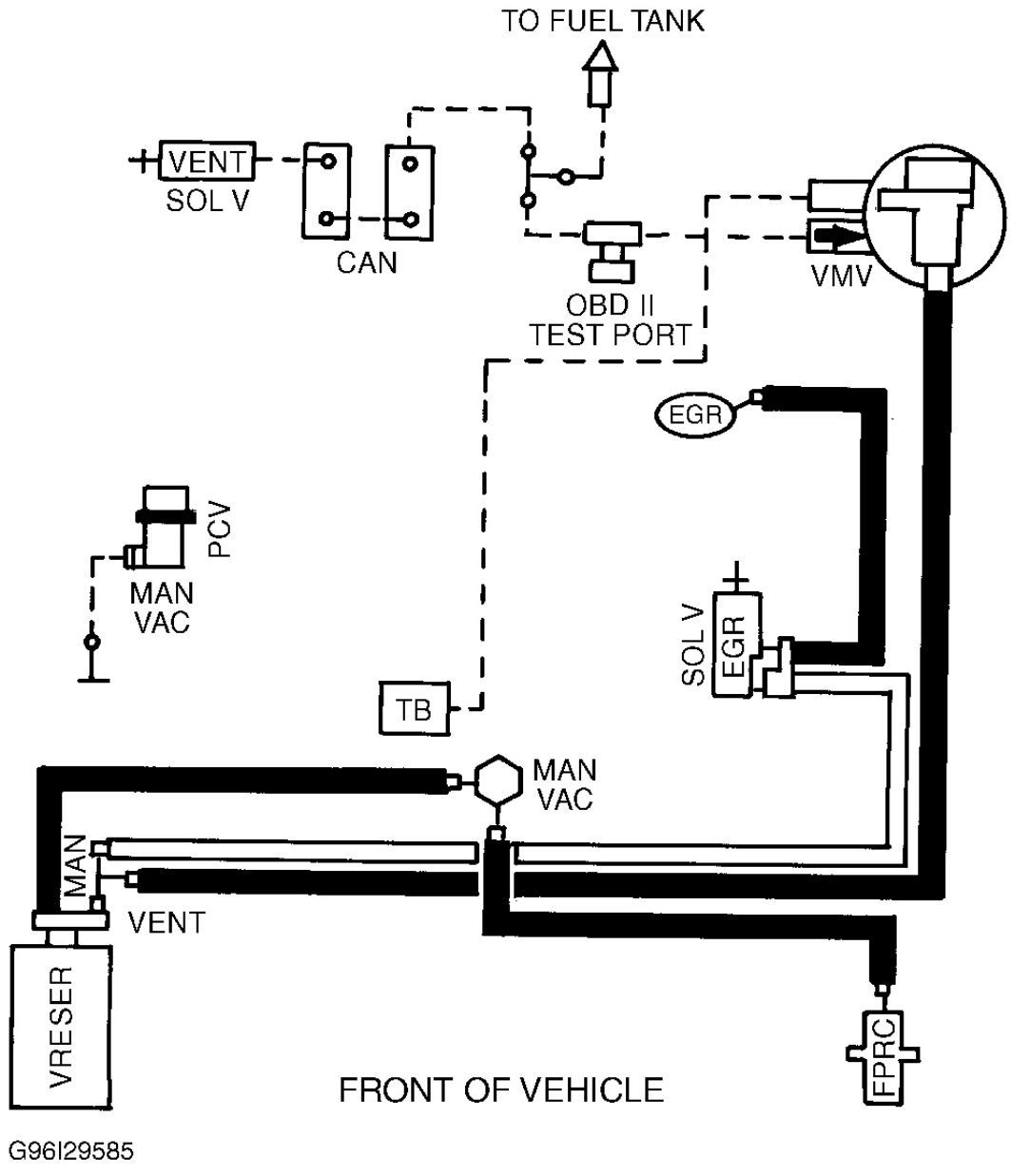


Fig. 10: Vacuum Diagram (F-150 & F-250 - 4.6L)
Courtesy of FORD MOTOR CO.

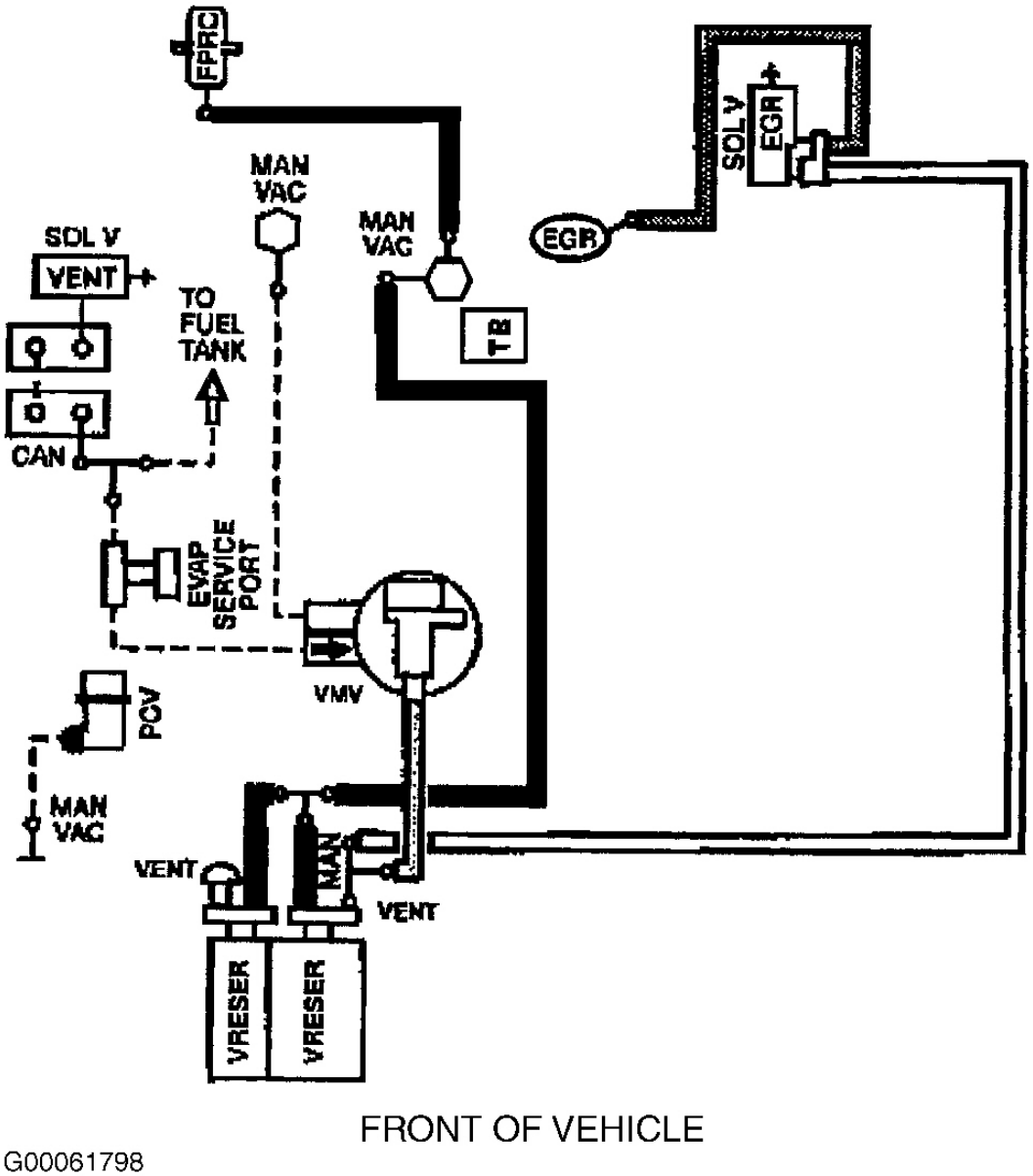


Fig. 11: Vacuum Diagram (F-150 & F-250 - 5.4L)
Courtesy of FORD MOTOR CO.

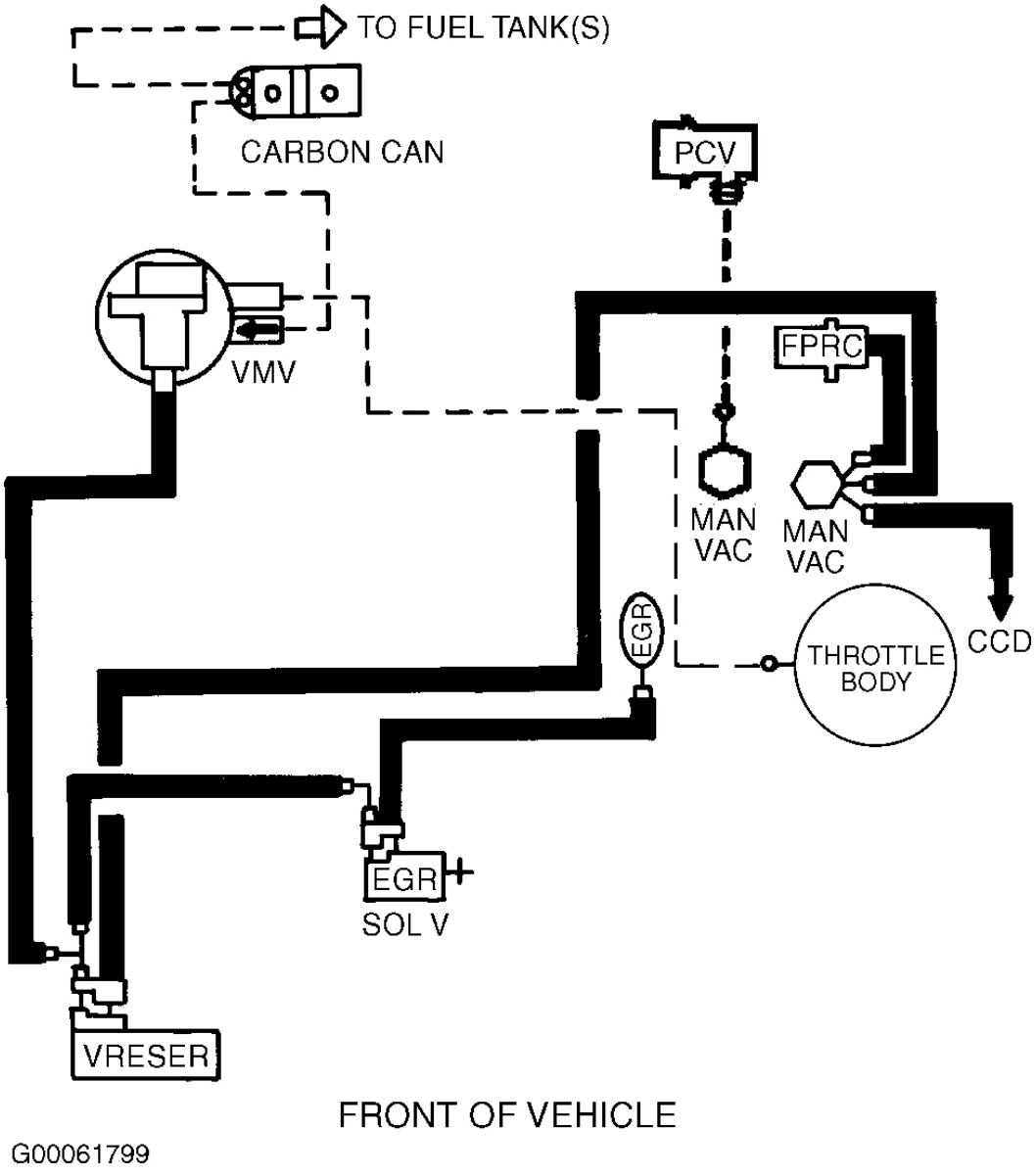


Fig. 12: Vacuum Diagram (F-250 Over 8500 GVWR & F-350 - 5.8L - California)
Courtesy of FORD MOTOR CO.

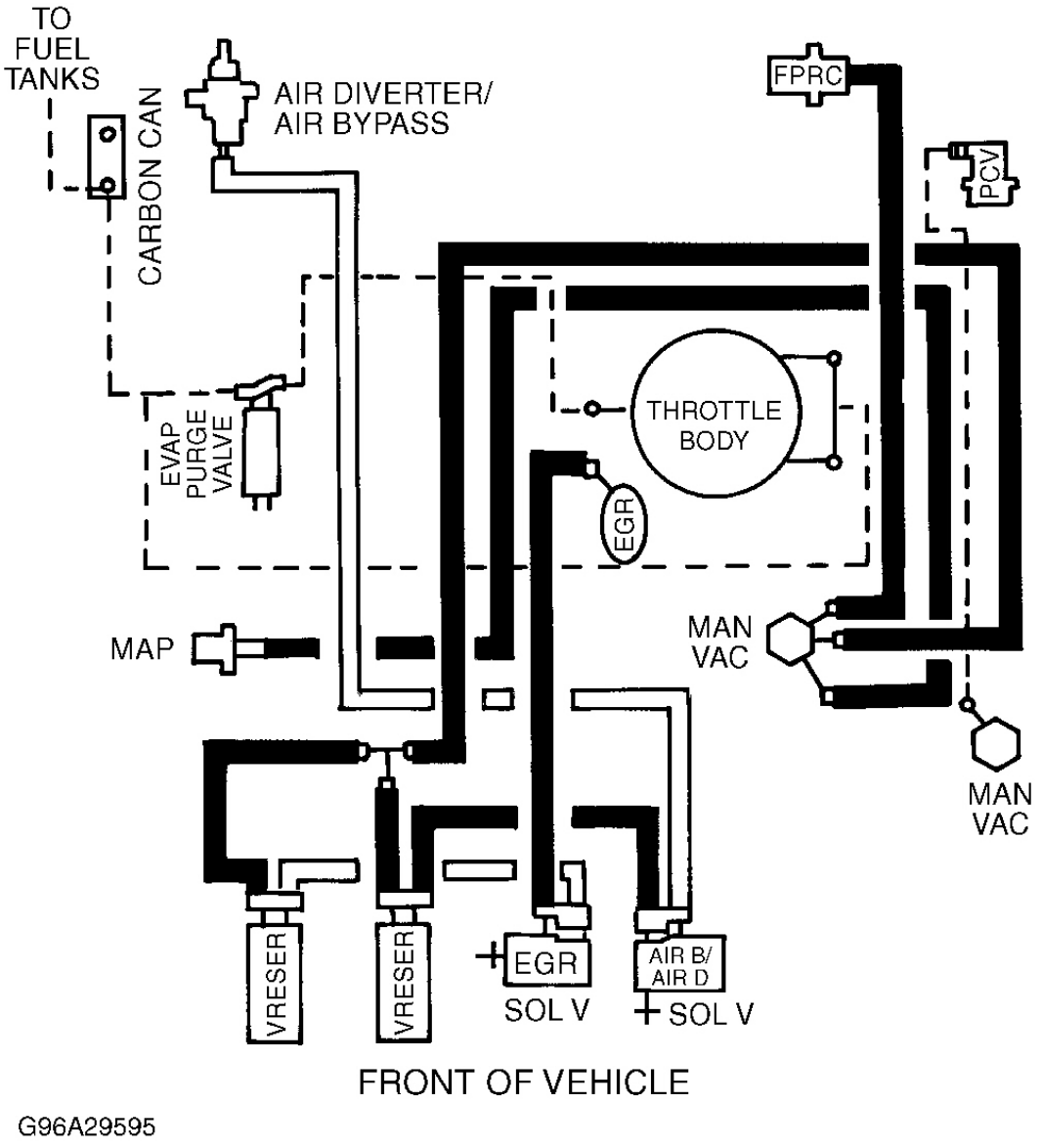


Fig. 13: Vacuum Diagram (F-250 Over 8500 GVWR & F-350 - 5.8L - Canada & 49-States)
Courtesy of FORD MOTOR CO.

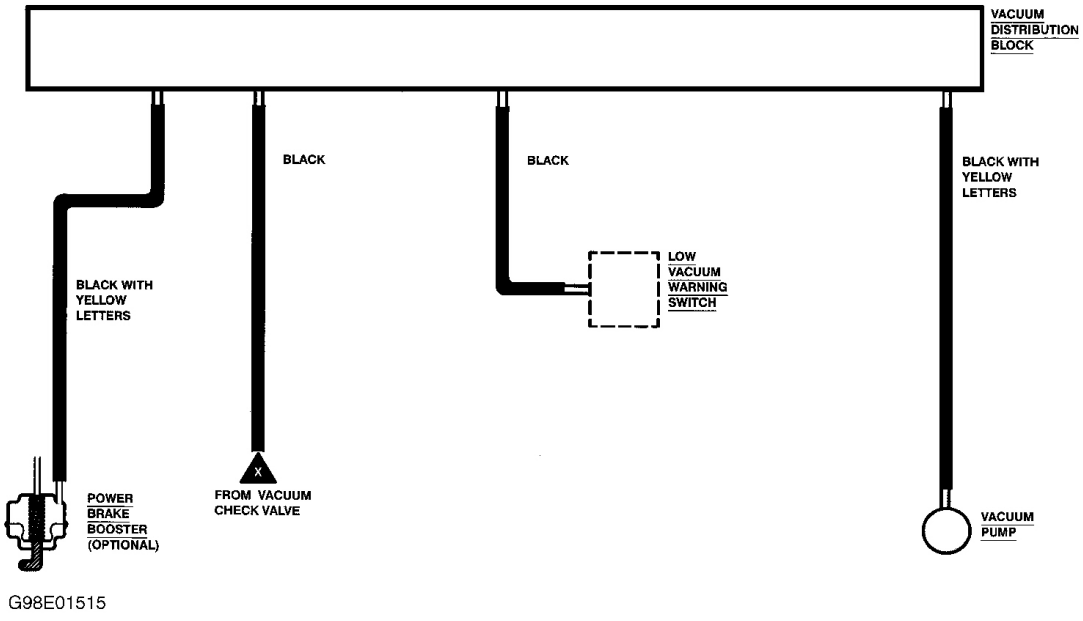


Fig. 14: Vacuum Diagram (F-250, F-350 & Van - 7.3L Turbo Diesel)
Courtesy of FORD MOTOR CO.

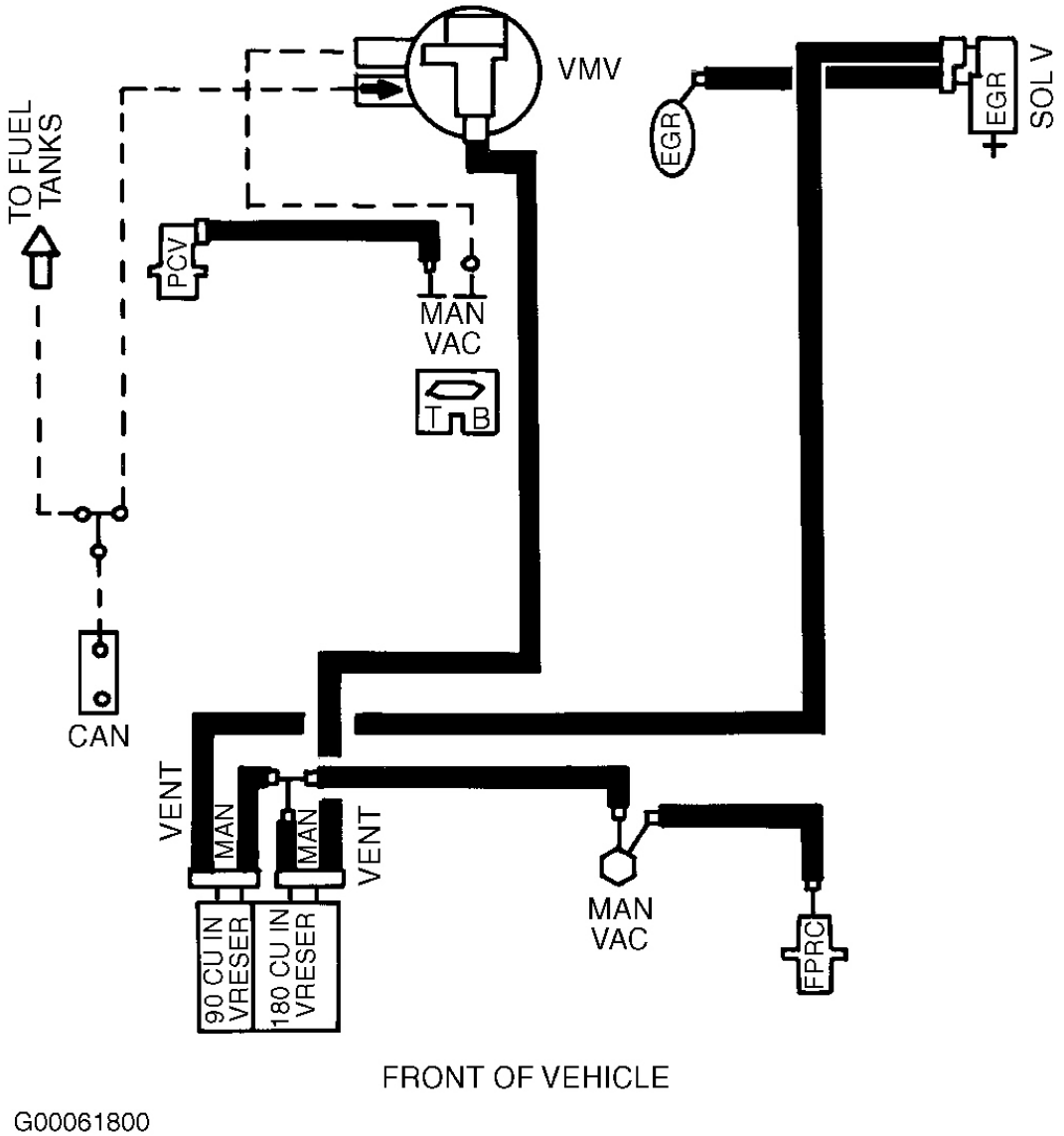


Fig. 15: Vacuum Diagram (F-250 Over 8500 GVWR & F-350 - 7.5L Medium Duty - California)
Courtesy of FORD MOTOR CO.

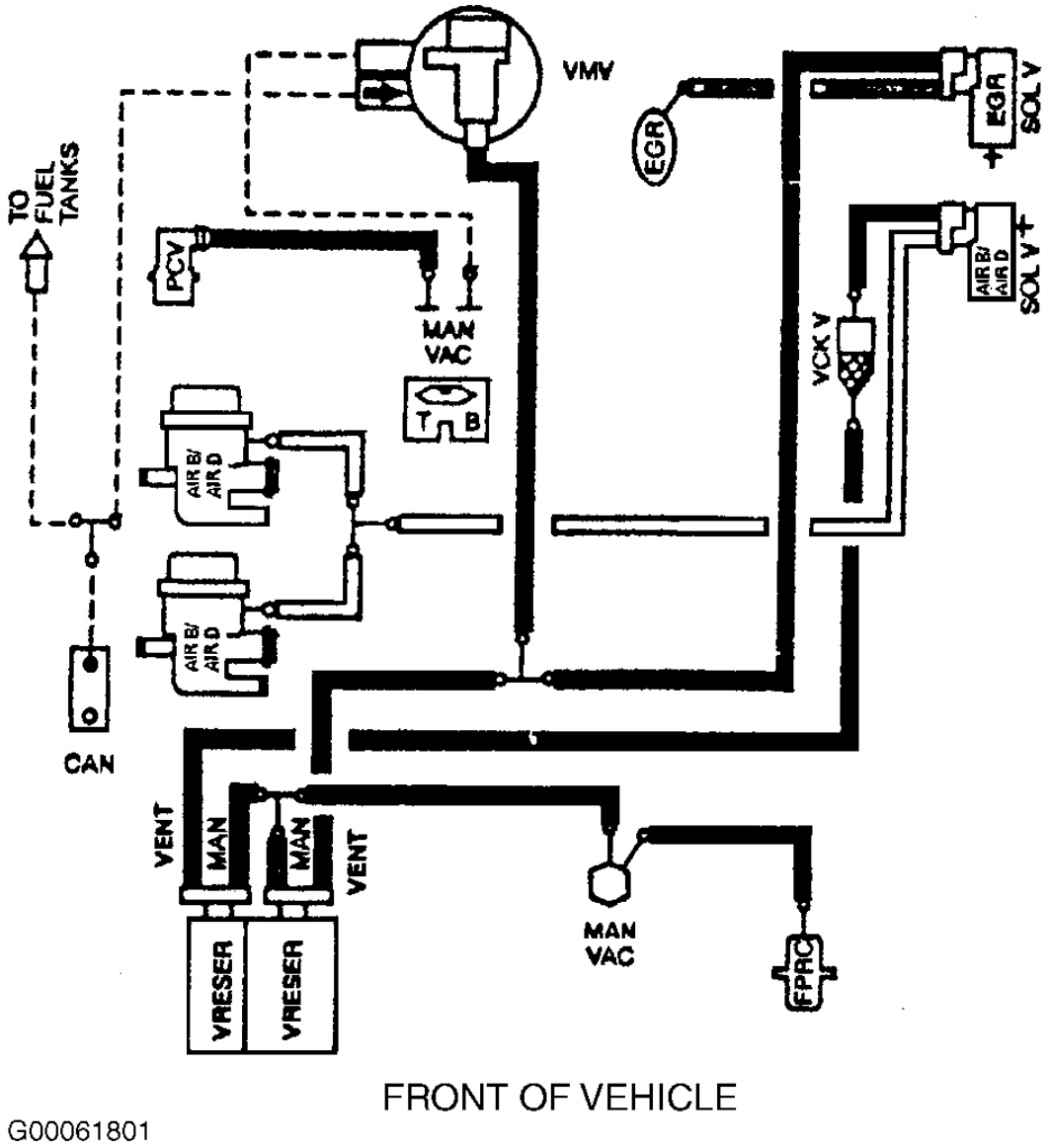


Fig. 16: Vacuum Diagram (F-250 Over 8500 GVWR & F-350 - 7.5L Heavy Duty - California)
Courtesy of FORD MOTOR CO.

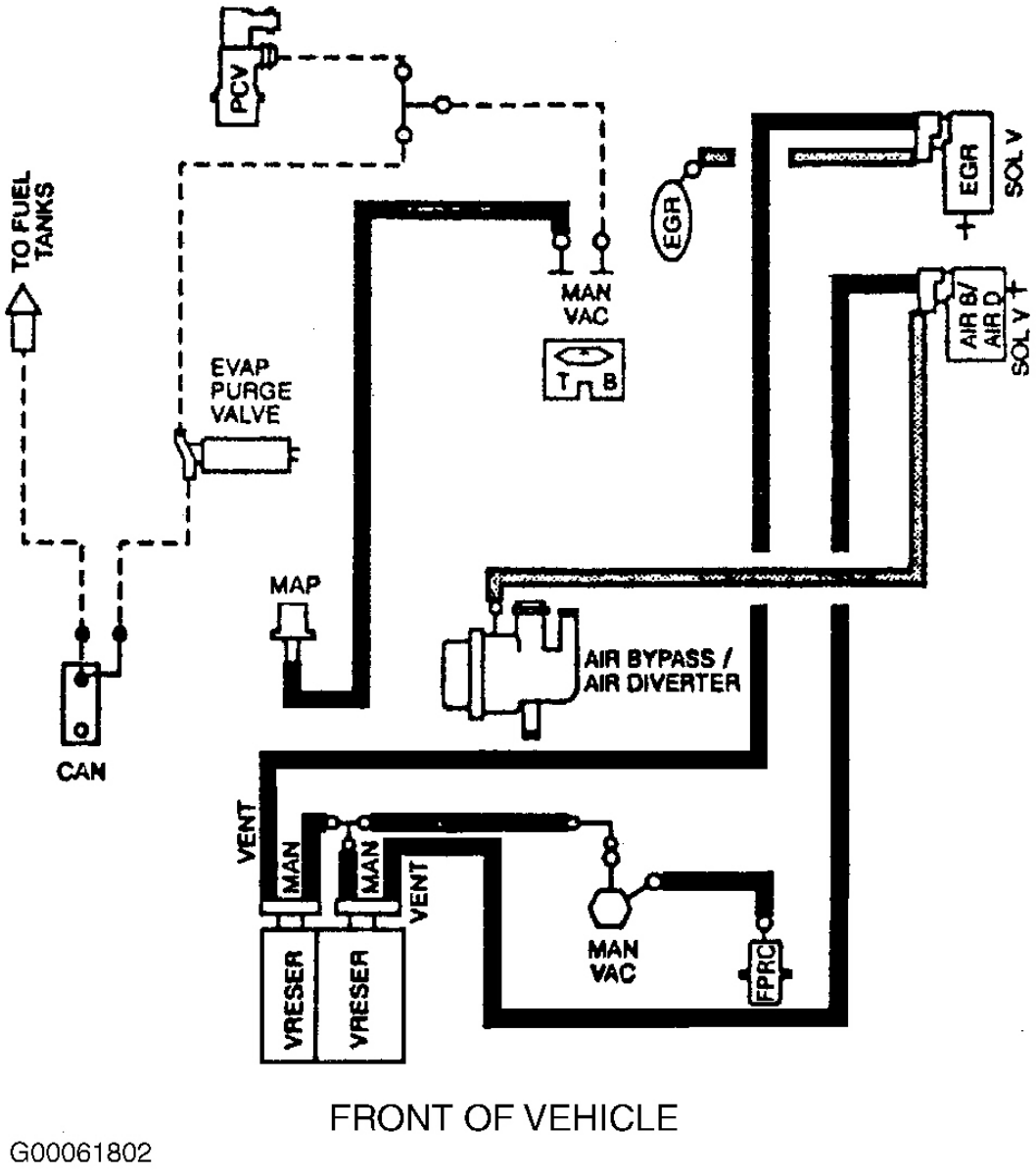


Fig. 17: Vacuum Diagram (F-250 Over 8500 GVWR & F-350 - 7.5L Heavy Duty - Canada & 49-States)
Courtesy of FORD MOTOR CO.

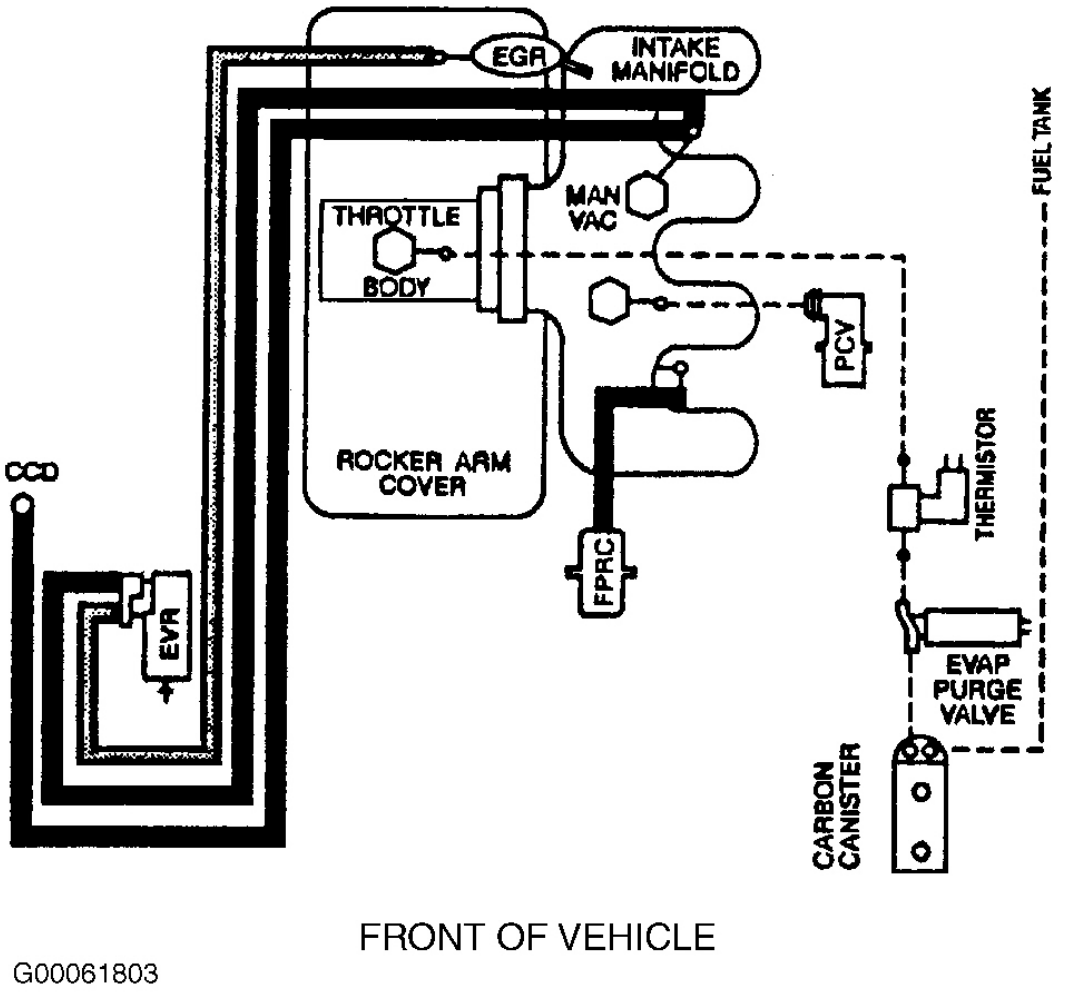


Fig. 18: Vacuum Diagram (Ranger - 2.3L)
Courtesy of FORD MOTOR CO.

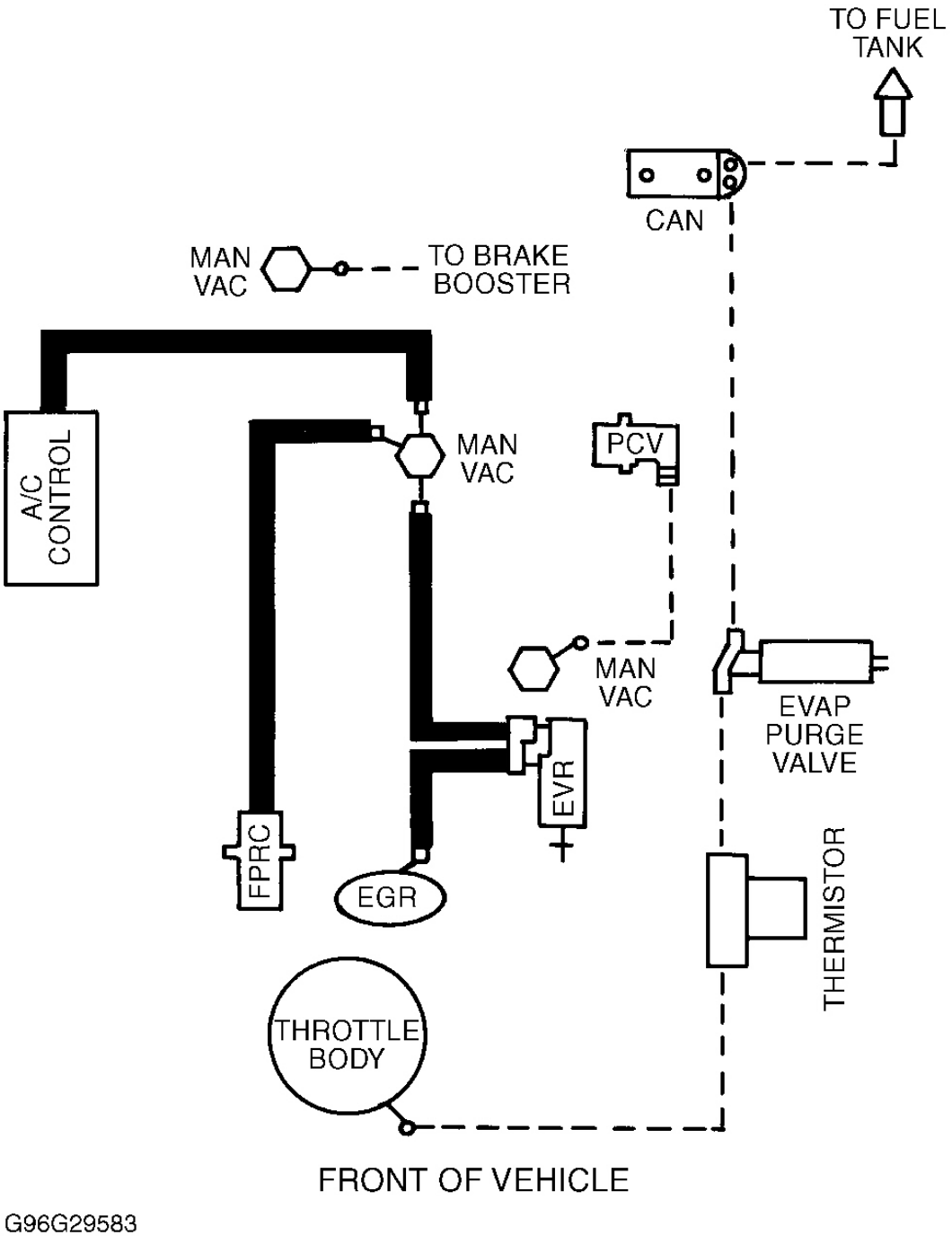


Fig. 19: Vacuum Diagram (Ranger - 4.0L)

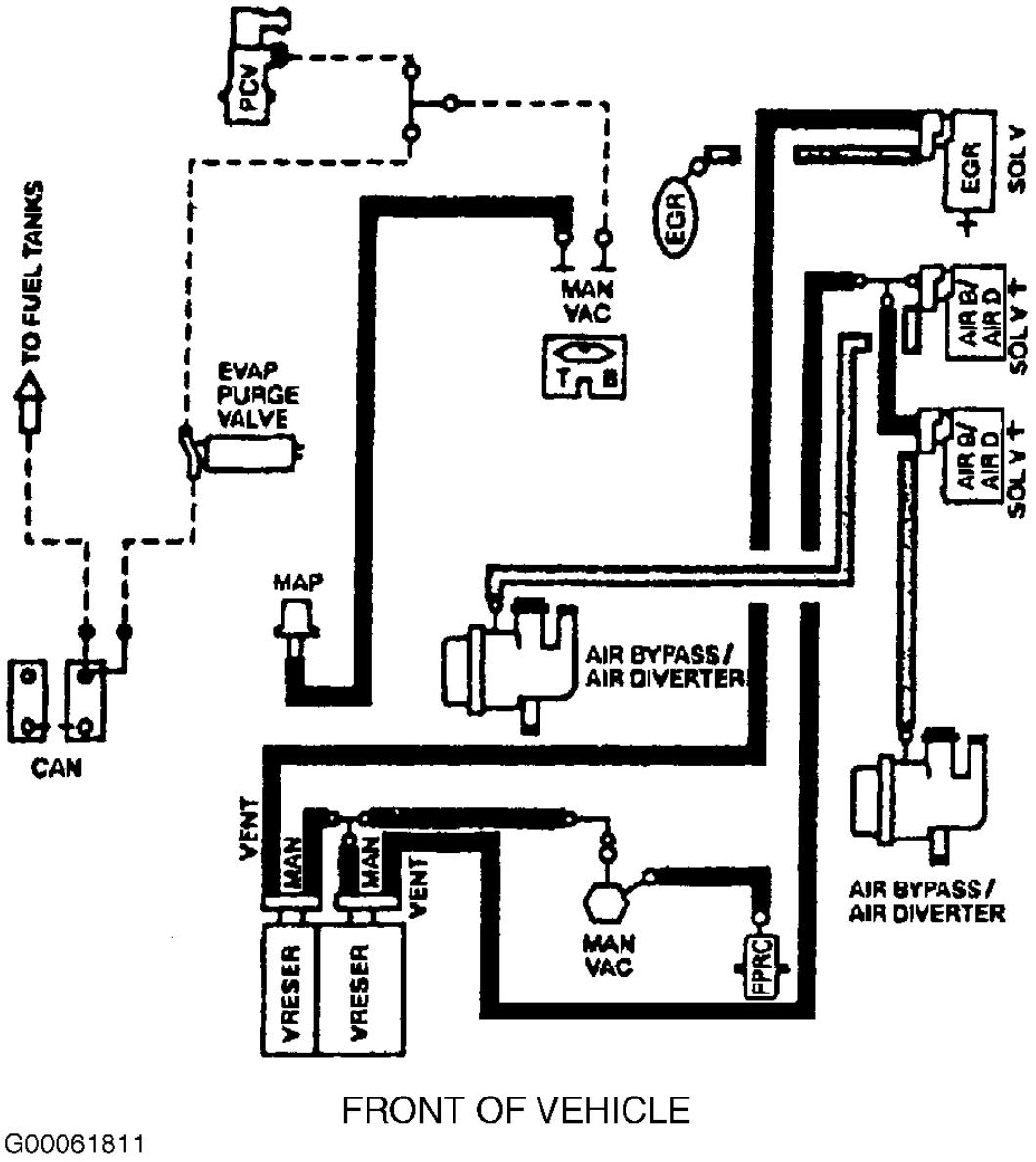


Fig. 20: Vacuum Diagram (Super Duty - Pickup - 7.5L - Calibration No. 6-97B-R00 - Codes SGJ, SKL, STT & SZB)
Courtesy of FORD MOTOR CO.

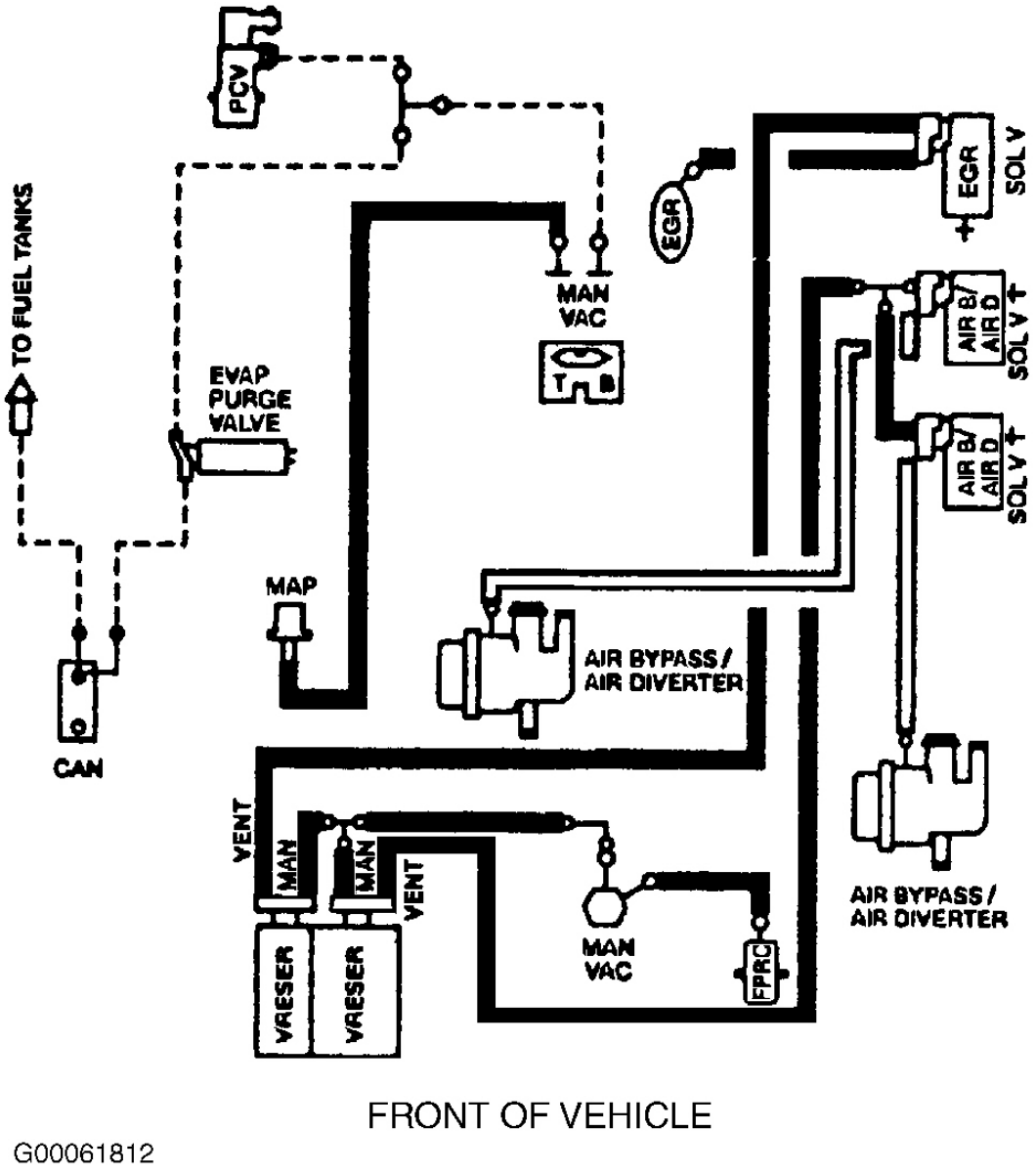


Fig. 21: Vacuum Diagram (Super Duty - Pickup - 7.5L - Calibration No. 6-97B-R00 - Codes SPD, SPS, SUA & SYC & Calibration No. 6-98B-R00)
Courtesy of FORD MOTOR CO.

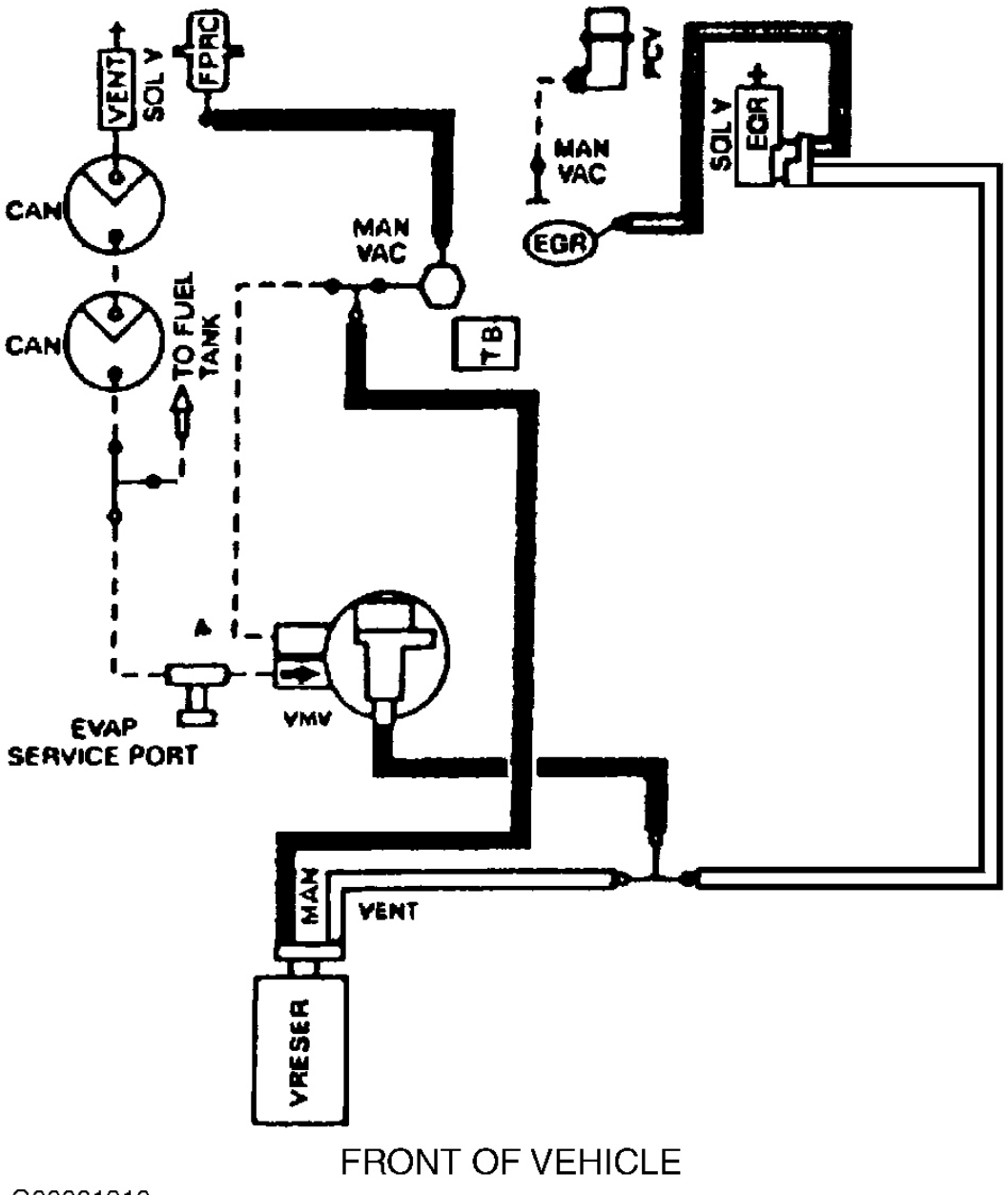


Fig. 22: Vacuum Diagram (Super Duty - Van - 6.8L - Calibration No. 7-96J-R06 & Van - 6.8L - Calibration No. 7-96X-R06)
Courtesy of FORD MOTOR CO.

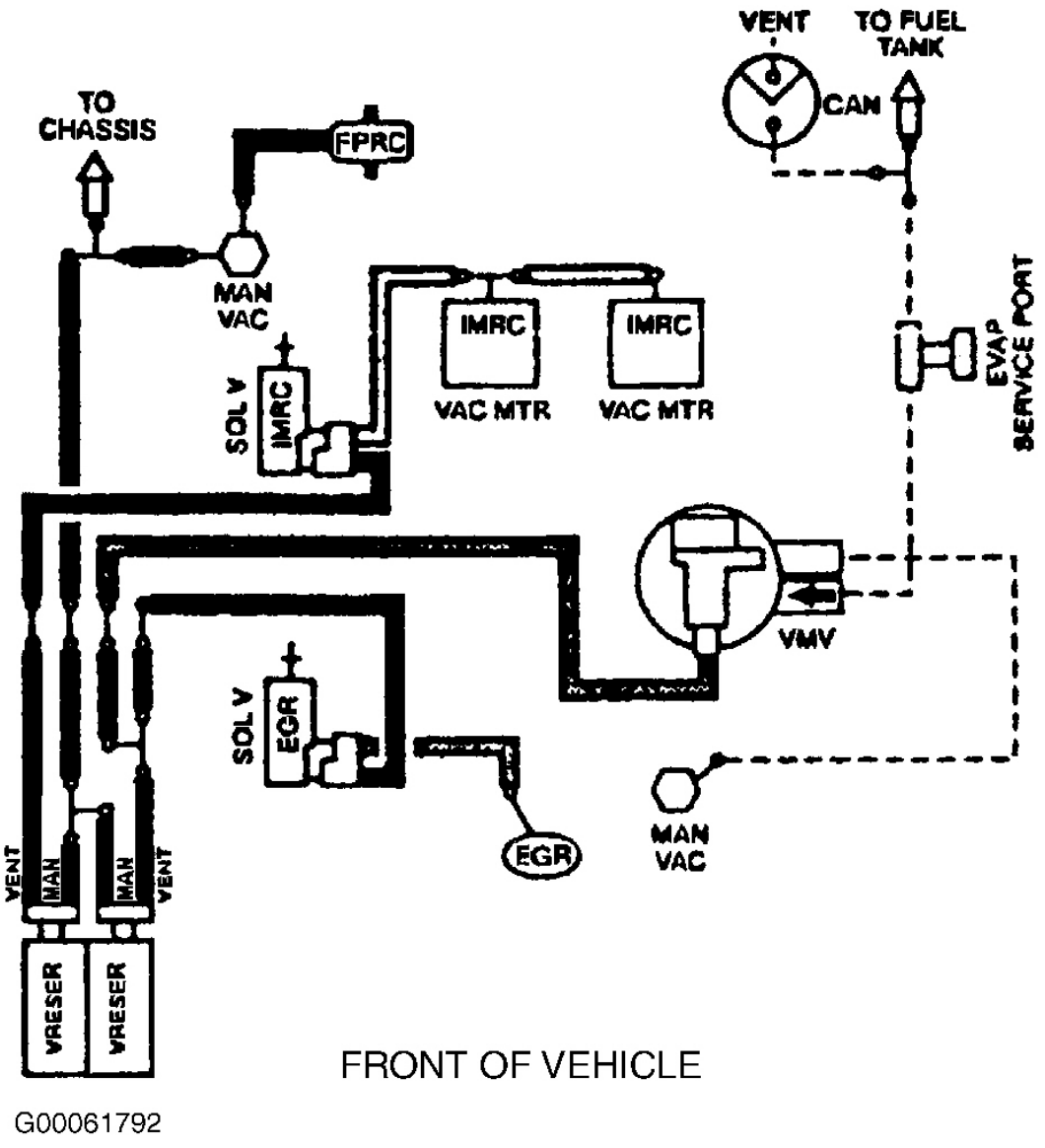


Fig. 23: Vacuum Diagram (Van - 4.2L)
Courtesy of FORD MOTOR CO.

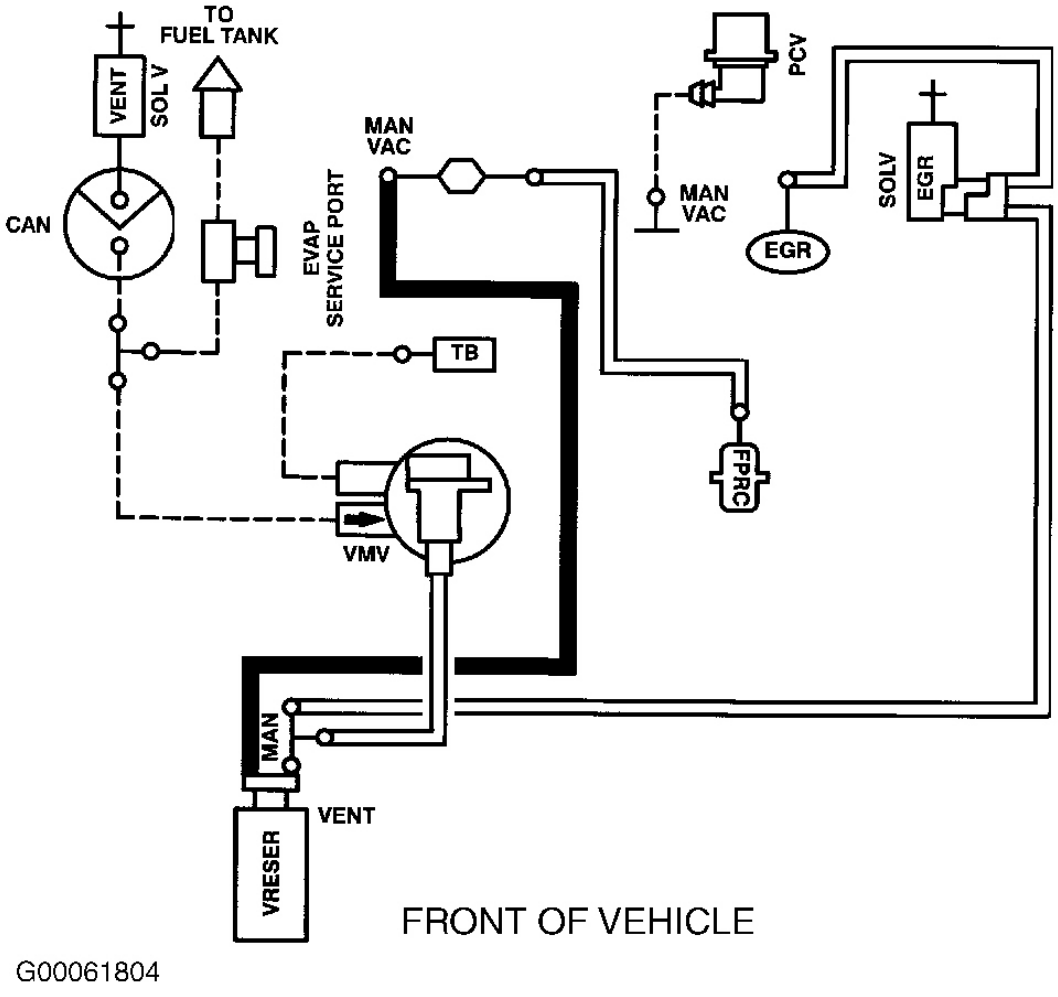


Fig. 24: Vacuum Diagram (Van - 4.6L)
Courtesy of FORD MOTOR CO.

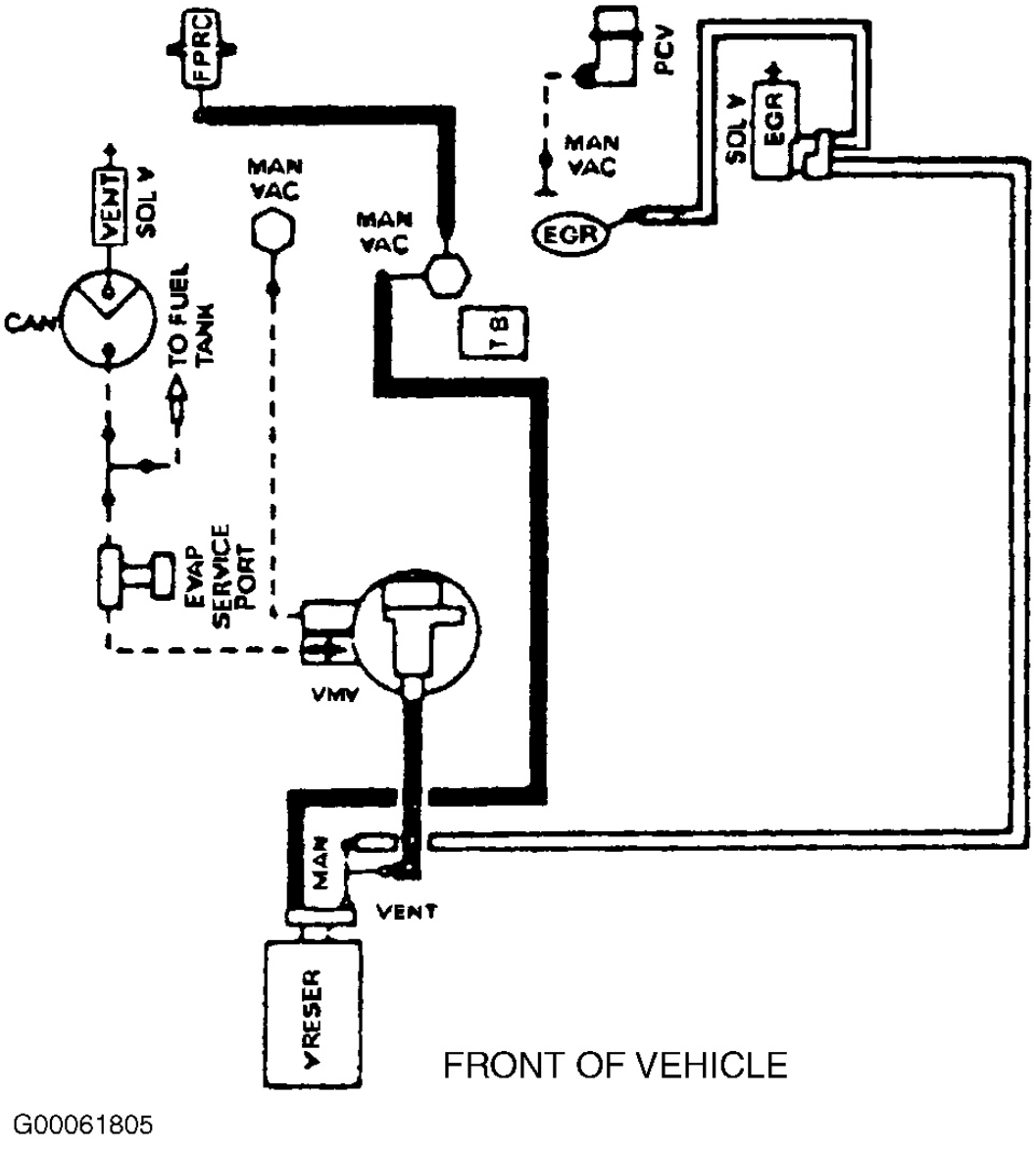


Fig. 25: Vacuum Diagram (Van - 5.4L - Except Calibration No. 7-74T-R07)
Courtesy of FORD MOTOR CO.

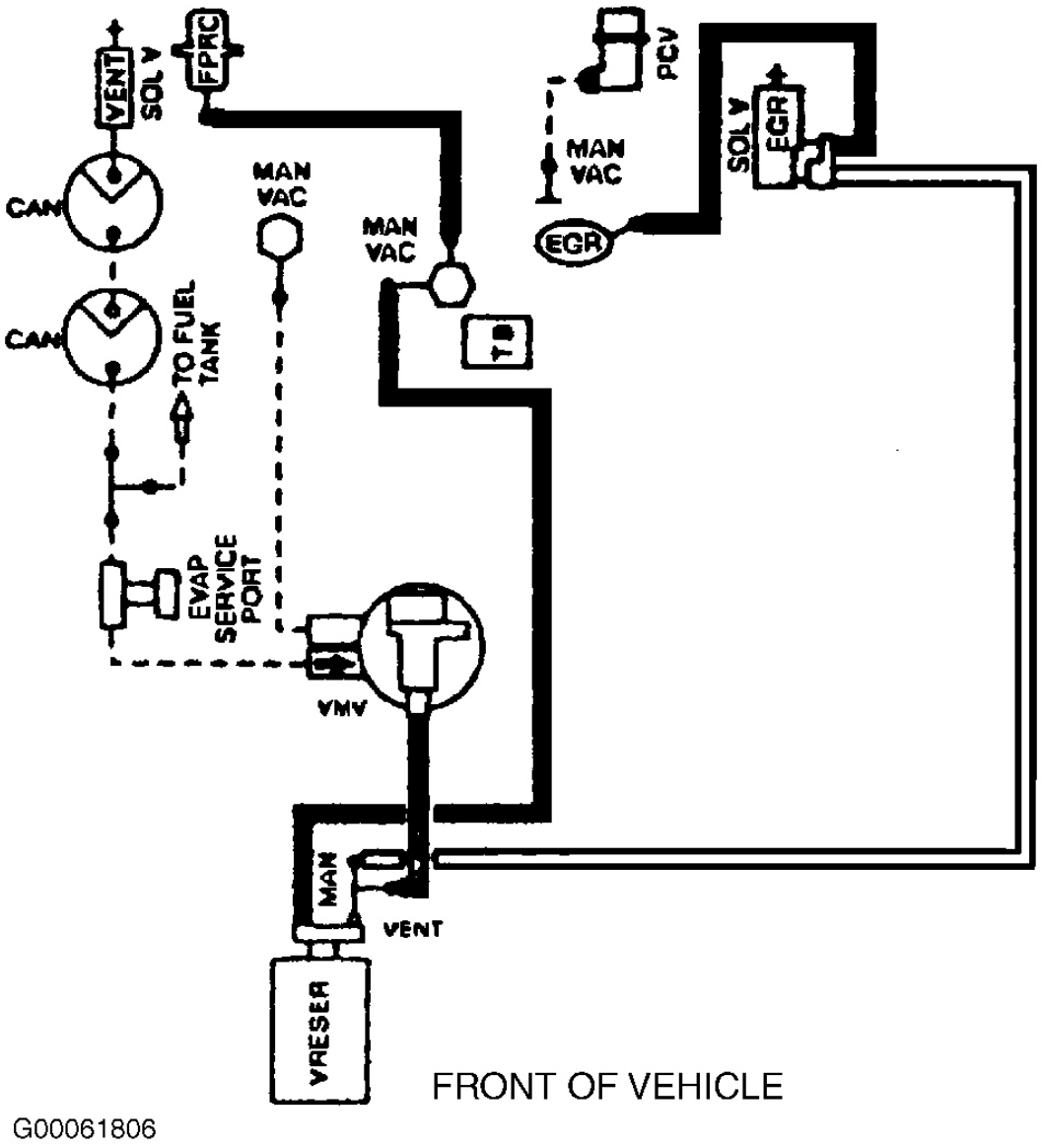


Fig. 26: Vacuum Diagram (Van - 5.4L - Calibration No. 7-74T-R07 - Code SFS)
Courtesy of FORD MOTOR CO.

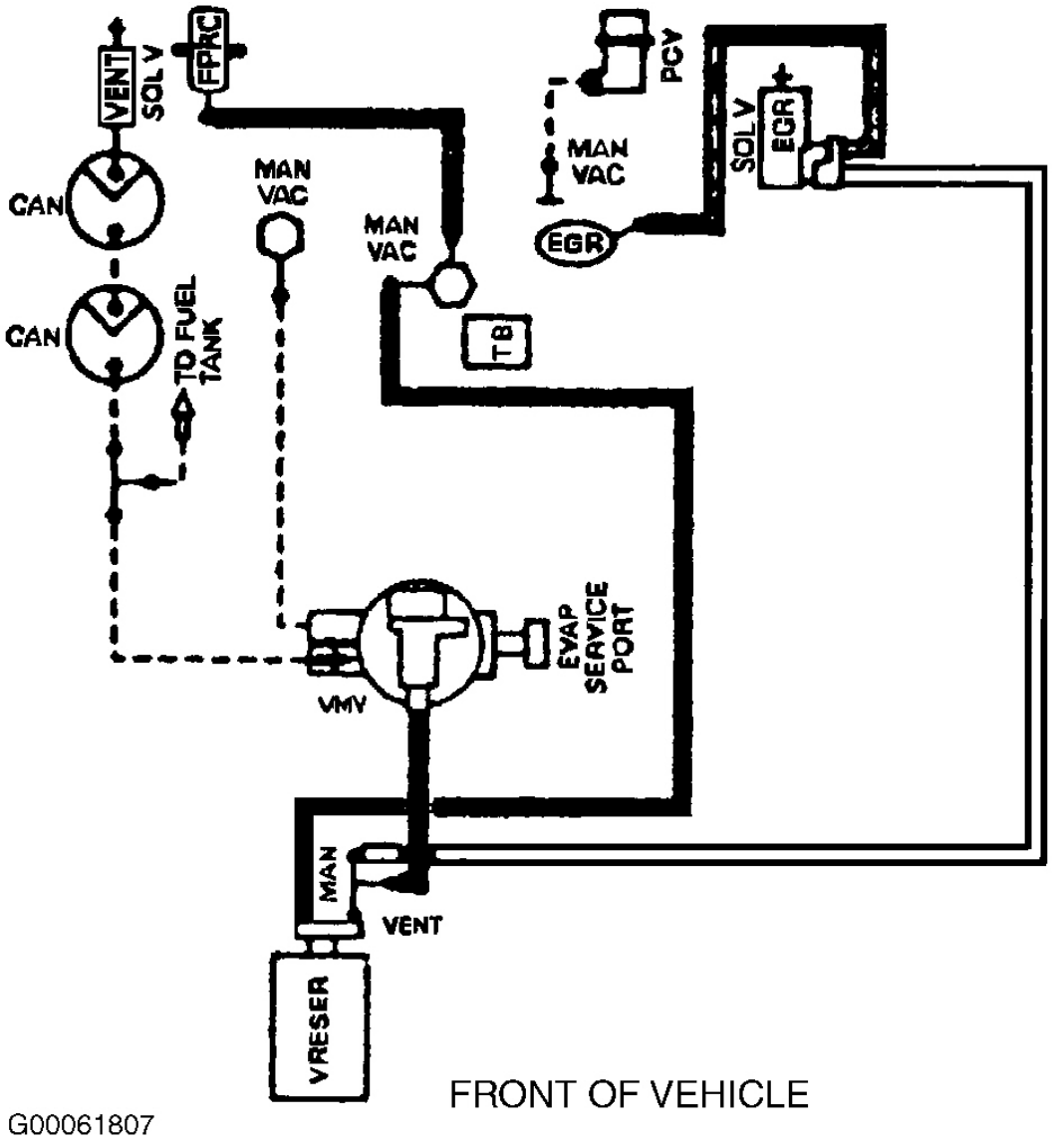


Fig. 27: Vacuum Diagram (Van - 5.4L - Calibration No. 7-74T-R07 - Code SJF)
Courtesy of FORD MOTOR CO.

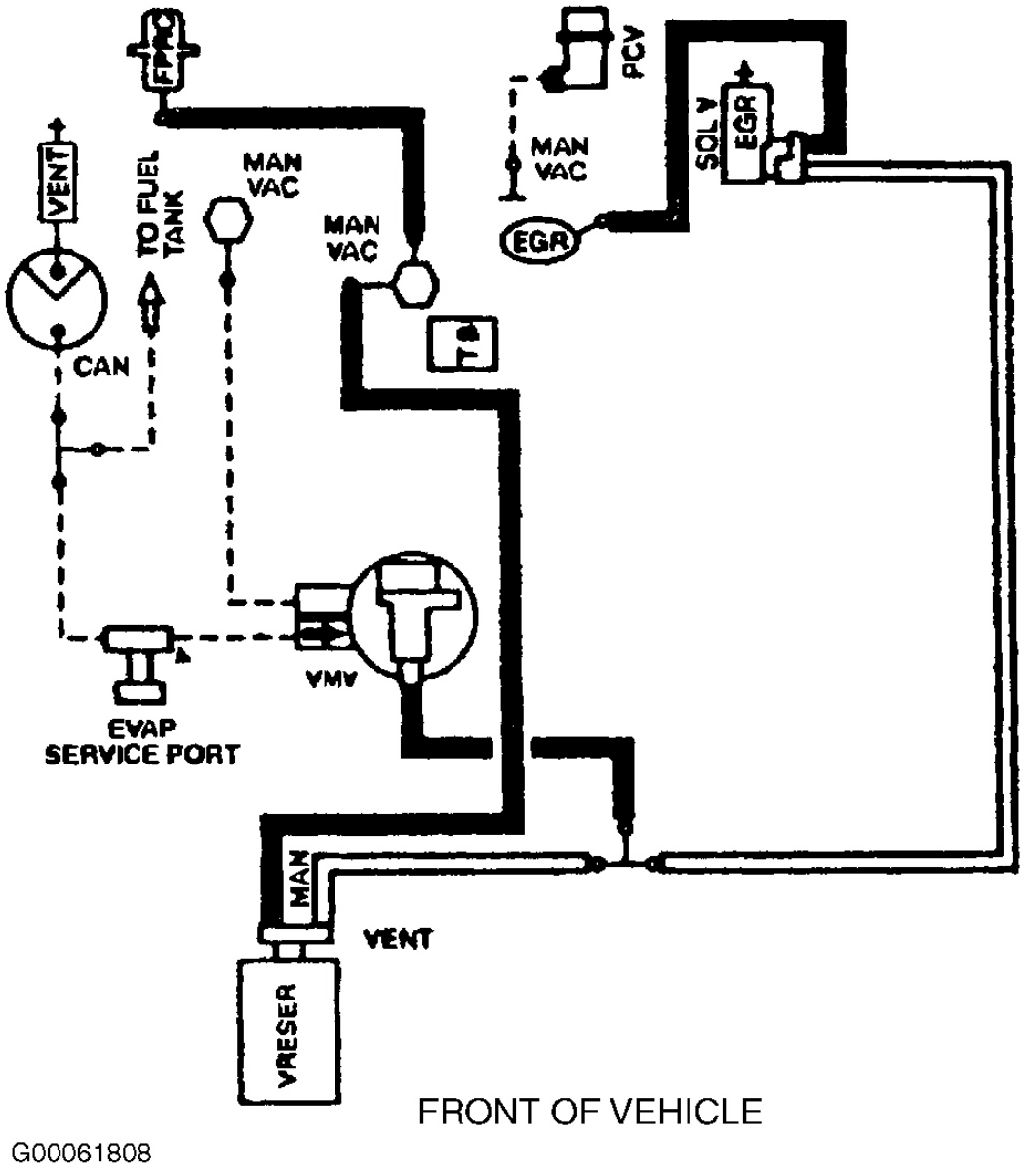


Fig. 28: Vacuum Diagram (Van - 6.8L - Calibration Nos. 7-96E-R06 & 7-96W-R06)
Courtesy of FORD MOTOR CO.

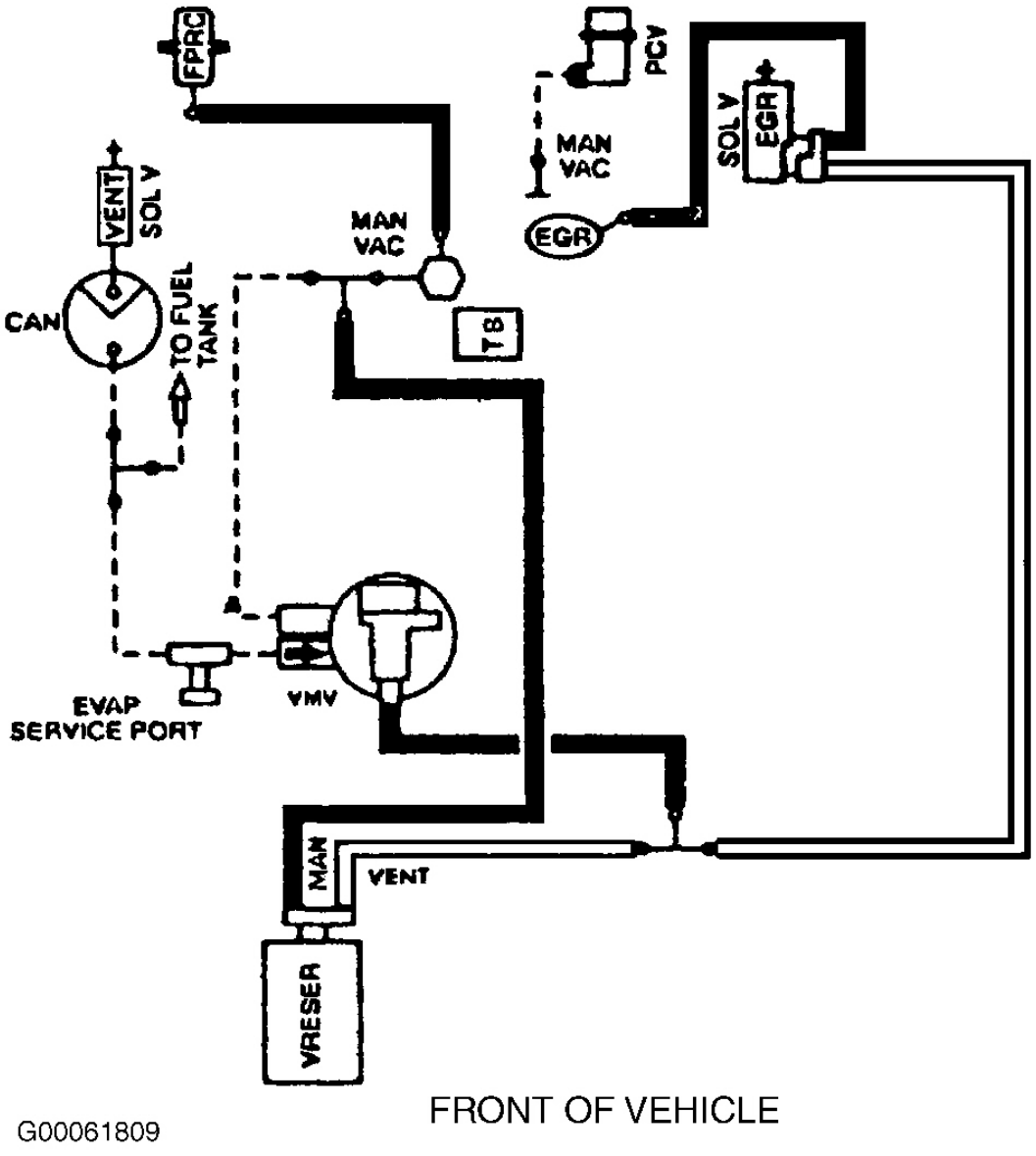


Fig. 29: Vacuum Diagram (Van - 6.8L - Calibration Nos. 7-96T-R06 & 7-96T-R10)
Courtesy of FORD MOTOR CO.

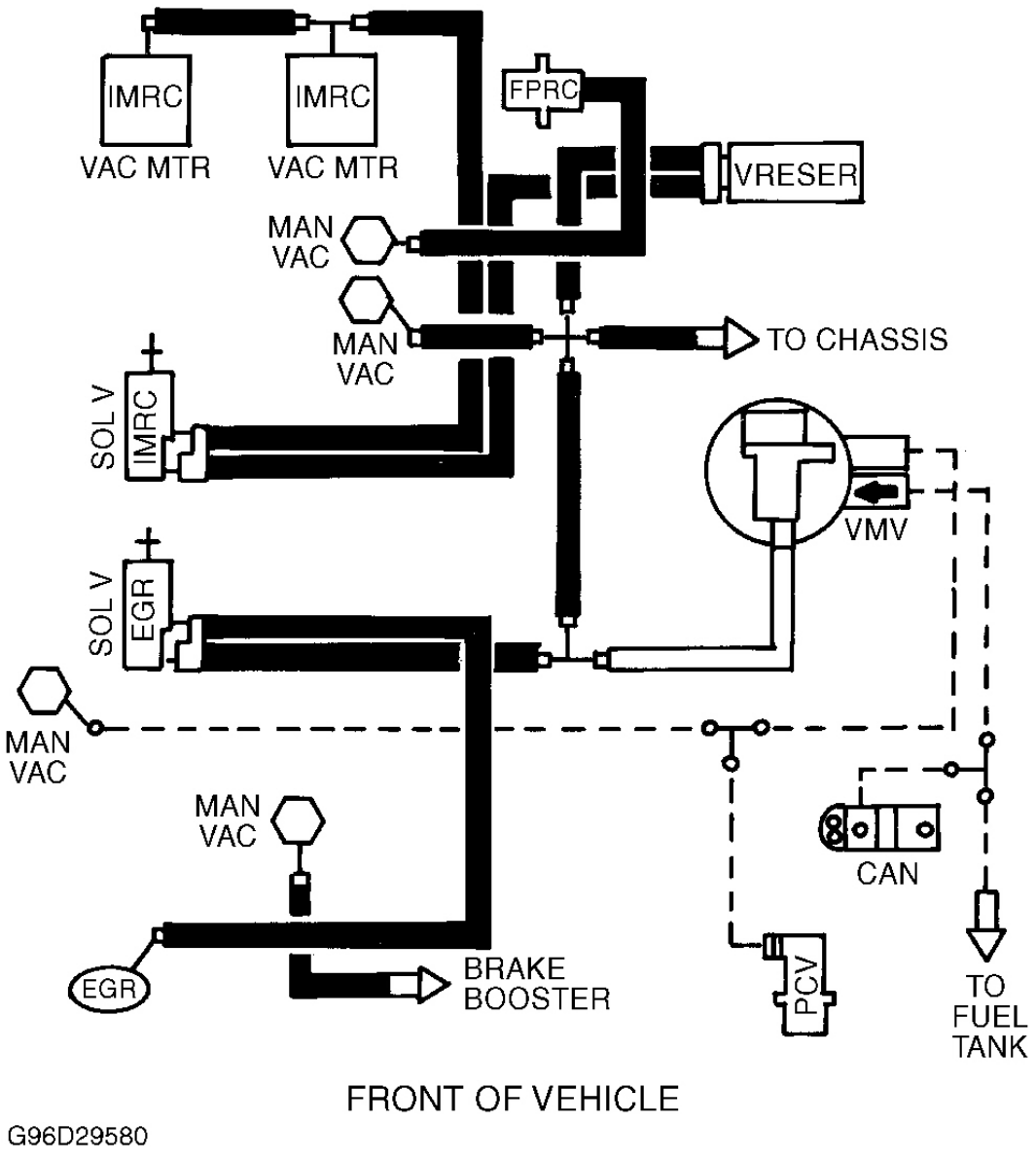


Fig. 30: Vacuum Diagram (Windstar - 3.8L)

WIPER/WASHER SYSTEM

1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Wiper/Washer System

DESCRIPTION & OPERATION

Windshield wipers are operated by a permanent magnet motor. When wiper control switch is in interval (INT) position, wipers make single sweeps, separated by adjustable-length pauses. All wiper functions on vehicles produced through 6/23/96 are controlled by a Central Timer Module (CTM). All wiper functions on vehicles produced 6/24/96 or later are controlled by Generic Electronic Module (GEM). CTM and GEM are located behind left side kick panel.

ADJUSTMENTS

WIPER ARM & BLADE ASSEMBLY

1. Remove wiper arms from pivot shafts. Turn on wipers to allow motor to operate 3 or 4 cycles, then turn wipers off. Wiper pivot shafts will be in park position.
2. Install arm and blade assemblies onto pivot shafts. Adjust clearance between wiper blade and cowl top. Clearance should be 1.7-3.0" (45-75 mm) for driver's side, and 2.6-3.7" (65-93 mm) for passenger's side.

COMPONENT TESTS

WIPER MOTOR TEST

1. Disconnect negative battery cable. Disengage linkage from motor. Disconnect wiper connector. Connect Green lead from Starting and Charging System Tester (078-00005) to negative battery terminal.
2. Connect Red tester lead to wiper motor terminal No. 3 (Black wire on mating connector). Connect a jumper wire between motor positive battery terminal and wiper motor terminal No. 4 (White wire on mating connector). If current draw is 3.5 amps or less, remove jumper wire and go to next step. If current draw is more than 3.5 amps, replace wiper motor.
3. Connect a jumper wire between positive battery terminal and wiper motor terminal No. 5 (Dark Blue/Orange wire on mating connector). If current draw is more than 5.5 amps, replace wiper motor. If current draw is 5.5 amps or less, wiper motor is okay.

RELAYS

NOTE: Same test procedure may be used for all wiper/washer system relays.

1. Remove relay. Measure resistance between terminal No. 85 and all other terminals. See **Fig. 1** . If resistance is 5 ohms or less between terminal No. 85 and any other terminal, replace relay. If all resistances are greater than 5 ohms, go to next step.
2. Using 2 jumper wires, connect terminals No. 30 and 86 to battery positive terminal. See **Fig. 1** . Connect voltmeter negative lead to battery negative terminal. With remaining voltmeter lead, check for voltage at terminal No. 87A. If battery voltage exists, go to next step. If battery voltage does not exist, replace relay.

3. Connect another jumper wire between relay terminal No. 85 and battery negative terminal. See **Fig. 1** . Check for battery voltage at relay terminal No. 87. If battery voltage does not exist, replace relay. If battery voltage exists, relay is good.

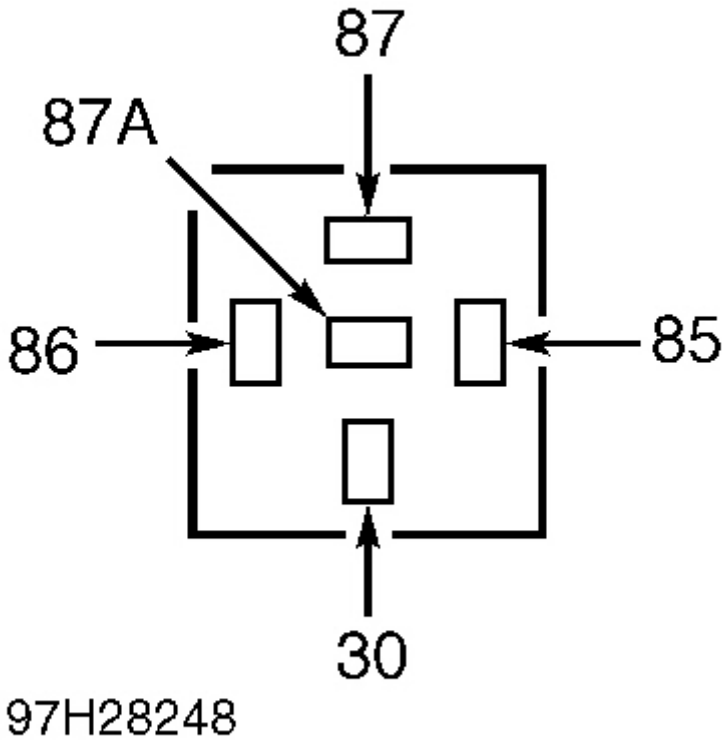


Fig. 1: Identifying Relay Terminals
Courtesy of FORD MOTOR CO.

WIPER SWITCH

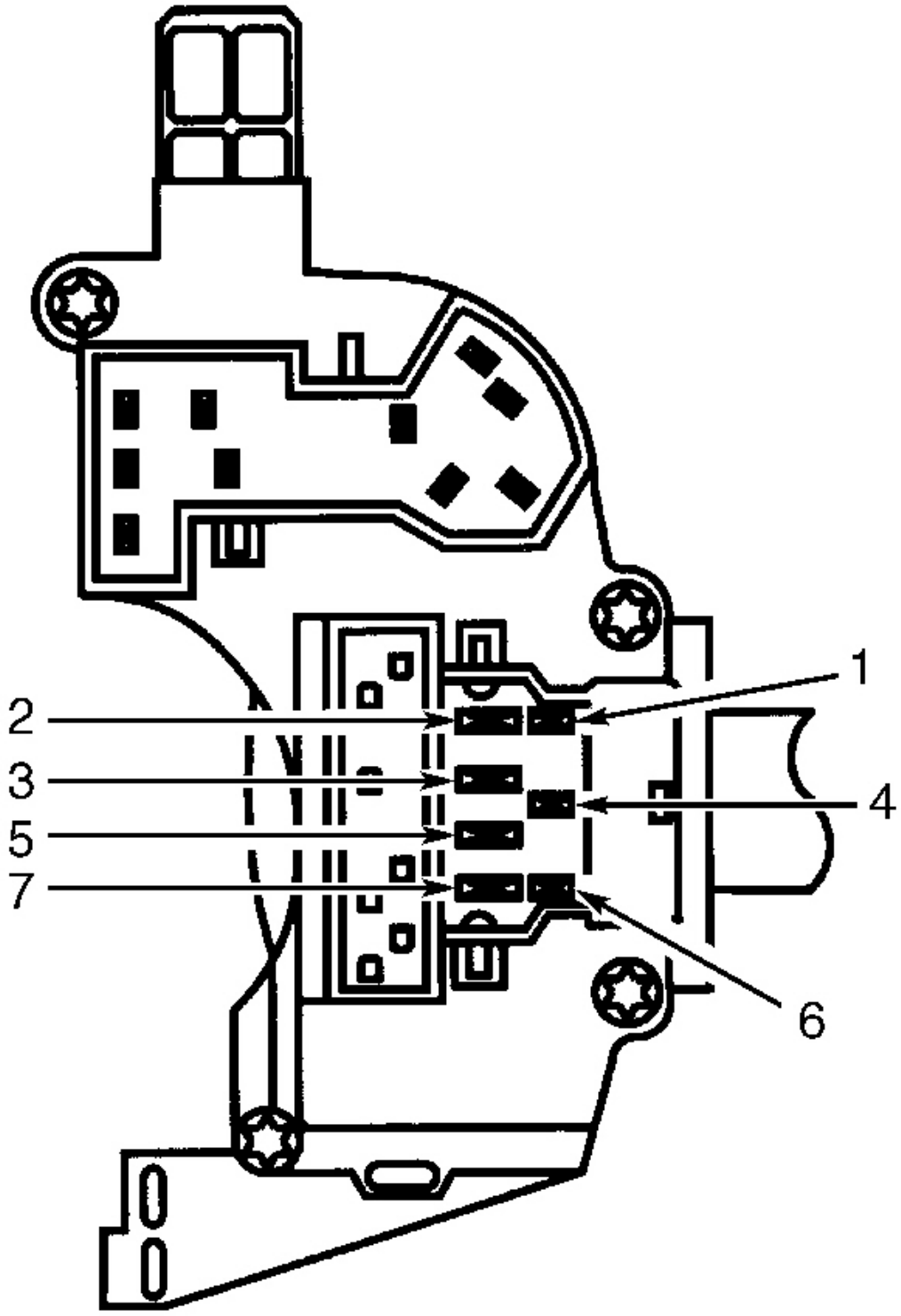
Wiper switch is incorporated into multifunction switch on steering column and is not serviced separately. Replace wiper switch if resistance is not as specified. See WIPER SWITCH RESISTANCE TEST TABLE. See **Fig. 2** .

WIPER SWITCH RESISTANCE TEST

Switch Position	Switch Terminals No.	Resistance in K/ohms
OFF	4 & 6	103.3
OFF	1 & 4	47.6

LOW	1 & 4	4.08
LOW	4 & 6	3.3
HIGH	1 & 4	0
HIGH	4 & 6	3.3
WASH	4 & 6	0
INT	1 & 4	11.3
INT (1)		
MIN	4 & 6	3.3
MAX	1 & 4	11.33
MAX	4 & 6	103.3

(1) Rotate (INT) interval knob from minimum to maximum. Resistance should gradually increase from 3.3 k/ohms (MIN) to 103.3 k/ohms (MAX).



95E27312

Fig. 2: Identifying Wiper Switch Terminals
Courtesy of FORD MOTOR CO.

SYSTEM TESTS

WARNING: Deactivate air bag system before performing any service operation involving steering column components. See AIR BAG RESTRAINT SYSTEM article. Do not apply electrical power to any component on steering column without first deactivating air bag system. Air bag may deploy.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

TROUBLE SHOOTING

Before performing any system tests on wiper/washer system, check the following items to eliminate common problems:

- Wiper/washer related fuses.
- Damaged/stripped wiper motor shaft.
- Damaged/stripped wiper pivot arm shaft.
- Damaged washer pump.
- Loose or corroded connections.
- Damaged wiring harness.
- Binding windshield wiper pivot arm.
- Inoperative multifunction switch.

Identify wiper/washer symptom and perform **PINPOINT TEST** . See PINPOINT TEST INDEX TABLE. For individual component testing, see **COMPONENT TESTS** .

SELF-DIAGNOSTICS

NOTE: A New Generation Star (NGS) Tester (007-00500) is required for testing the wiper/washer system controlled by Generic Electronic Module (GEM). Follow manufacturer's instructions.

NOTE: For further information on Self-Diagnostic System, see MODULE COMMUNICATIONS NETWORK article.

GEM Controlled System

Retrieve Diagnostic Trouble Codes (DTCs) before beginning any testing. Connect NGS tester to Data Link Connector (DLC). DLC is located at instrument panel, below steering column. Following manufacturer's instructions, retrieve any existing codes from Generic Electronic Module (GEM). Perform appropriate DTC test. If symptoms remain or if no DTCs exist, see **PINPOINT TEST INDEX** . NGS tester must be used to clear DTCs. Follow manufacturer's instructions to clear individual DTC or all DTCs stored in GEM.

CTM Controlled System

To retrieve DTC(s) stored in CTM, ignition key must be removed. Using jumper wire, connect terminals of CTM test connector located behind left kick panel. CTM test mode is now active. To exit test mode, remove jumper wire.

Two-digit DTC is evidenced by sounding of CTM indicator chime. Groupings of chime tones are separated by one second pause. For example, 2 tones followed by a pause and then 2 more tones indicate DTC 22. DTCs are cleared when power is removed from CTM. DTCs may also be cleared by moving the ignition switch to START position at any time during diagnostic test procedure.

SYMPTOM DIAGNOSIS

PINPOINT TEST INDEX

Symptom	Pinpoint Test
GEM Controlled System	
Wipers Inoperative	A
Wipers Stay On Continuously	B
Wipers Operate At Interval Setting But Inoperative At High & Low Speed	C
Wipers Inoperative At Interval Setting But Operate At High & Low Speed	D
Washer Pump & Wipers Do Not Function Properly	E
Speed Dependent Interval Mode Inoperative	F
CTM Controlled System	
Wipers Inoperative	G
Wipers Continue To Run When Switch Is Off	H
Wipers Operate At Interval Setting But Inoperative At High & Low Speed	J
Wipers Inoperative At Interval Setting But Operate At High & Low Speed	K
Washer Pump does Not Function Properly	L

PINPOINT TESTS

NOTE: Pinpoint Tests A-F apply to Generic Electronic Module (GEM) controlled wiper/washer systems. PINPOINT TESTS G-L apply to Central Timer Module (CTM) controlled wiper/washer systems.

PINPOINT TEST A - WIPERS INOPERATIVE

1. Measure voltage at output side of fuses No. 11 (30-amp) and No. 15 (5-amp) at junction fuse/relay panel. If reading is 10 volts or more at both fuses, go to step 4) If reading is less than 10 volts at either fuse, go to next step.
2. Check fuses No. 11 (30-amp) and No. 15 (5-amp) at junction fuse/relay panel. If fuses are good, go to next step. If fuse(s) are blown, replace fuse(s), clear any Diagnostic Trouble Codes (DTCs) and test system for proper operation.
3. Measure voltage at junction fuse/relay panel connector C242 terminal No. 16 (Black/Light Green wire). See **Fig. 3** . If reading is 10 volts or greater, replace junction fuse/relay panel, clear DTC(s) and retest system. If reading is less than 10 volts, repair open in Black/Light Green wire, Tan/black wire and/or Yellow wire between junction fuse/relay panel, ignition switch and/or power distribution center. See **WIRING DIAGRAM** .

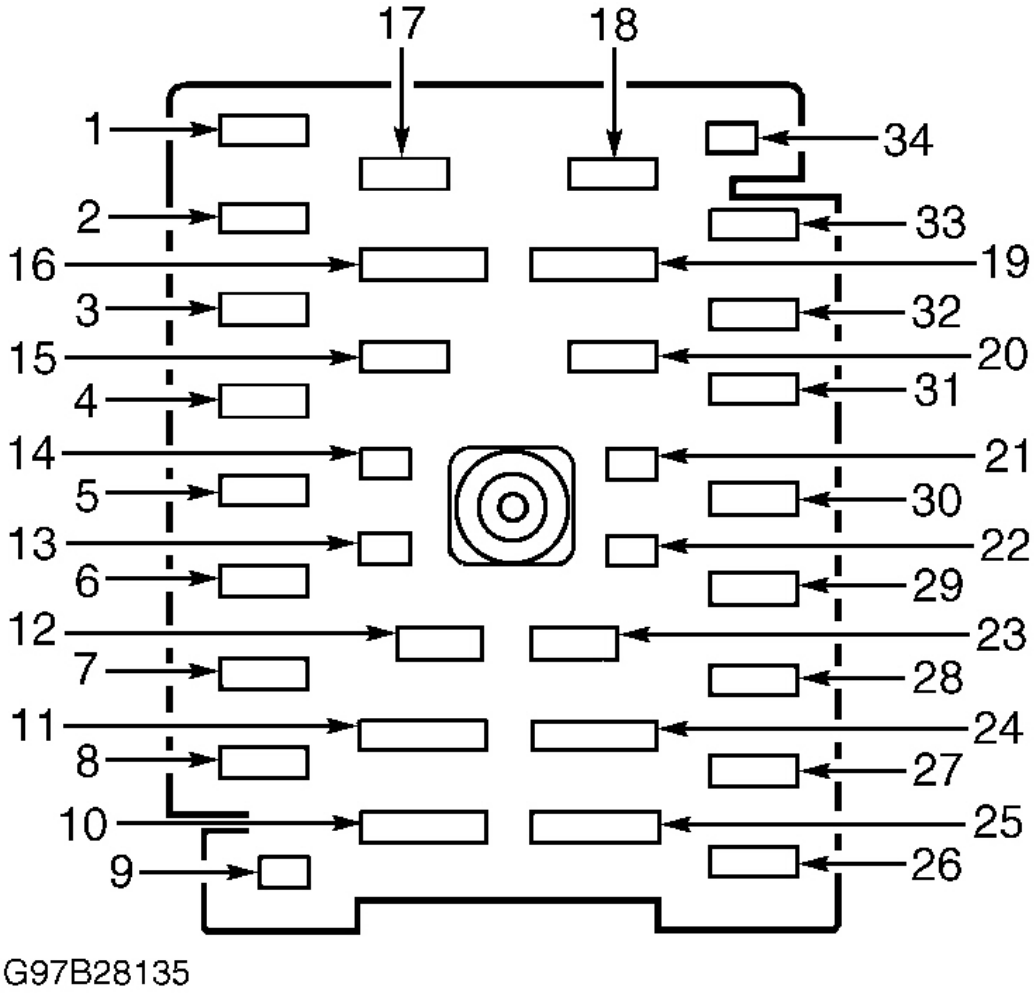


Fig. 3: Identifying Fuse Junction Panel Connector C242 (Gray) & Connector C243 (Black)

Terminals
Courtesy of FORD MOTOR CO.

4. Connect New Generation Star (NGS) tester (007-00500) to Data Link Connector (DLC). DLC is located at instrument panel, below steering column. Monitor PID IGN_GEM while turning the ignition switch through all its positions. If PID values agree with switch position, go to next step. If PID values do not agree with switch position, repair appropriate ignition switch circuit(s) and retest system. See **WIRING DIAGRAM** .
5. Retrieve continuous DTC(s) stored in GEM. Clear continuous DTC(s). Following NGS tester manufacturer's instructions, perform on-demand self-test and note all DTC(s). If DTC(s) exist, service DTC(s) in numerical order. See PINPOINT TEST A DTC INDEX TABLE. If no DTC(s) exist, go to step 7).

PINPOINT TEST A DTC INDEX

DTC	Go To Step
B1342	(1)
B1431	10
B1432	10
B1438	7
B1441	7
B1450	7
B1453	7
B1473	10
B1476	10
B1840	6
(1) Replace GEM, clear DTC(s) and retest system.	

6. Turn ignition off. Remove washer pump relay, high/low relay and run/park relay. Turn ignition on. Check for voltage at all White/Black wire terminals at relay connectors. If 10 or more volts exist at all terminals, go to next step. If reading is less than 10 volts at any terminal(s), repair White/Black wire(s) as necessary, clear DTC(s) and retest system.
7. Turn ignition on. Using NGS tester, monitor PID WPMODE while turning wiper switch through all positions. If PID values agree with switch position, go to step 10). If PID values do not agree with switch position, go to next step.
8. Turn ignition off. Disconnect multifunction switch 7-pin connector. Check wiper switch portion of multifunction switch. See **WIPER SWITCH** . If switch is good, go to next step. If switch is faulty, replace switch and retest system.
9. Disconnect GEM 26-pin connector. Measure resistance of Light Blue/Orange wire, Dark Blue wire and Pink/Yellow wire between GEM 26-pin connector and multifunction switch 7-pin connector. If resistance of all circuits is less than 5 ohms, replace GEM, clear DTC(s). If resistance is 5 ohms or greater, repair wire(s) as necessary. Retest system after repair.
10. Turn ignition on. Using NGS tester, monitor PID WPRUN while toggling active command mode WIPER RLY. If WPRUN PID agrees with command mode and displays ON, go to step 16). If WPRUN PID does

not agree with command mode and displays OFF O-G, go to next step. If WPRUN PID does not agree with command mode and displays ON-B-, go to step 14).

11. Turn ignition off. Remove run/park relay. Turn ignition on. Measure voltage at relay connector terminal No. 86 (White/Black wire). See **Fig. 1** . If 10 volts or greater exist, go to next step. If less than 10 volts exist, Repair White/Black wire, clear DTC(s), and retest system.
12. Turn ignition off. Check run/park relay. See **RELAYS** in COMPONENT TESTING. If relay is good, go to next step. If relay is faulty, replace relay, clear DTC(s), and retest system.
13. Disconnect 26-pin GEM connector. Measure resistance of Yellow/White wire between run/park relay and 26-pin GEM connector. If resistance is less than 5 ohms, replace GEM. If resistance is 5 ohms or greater, repair Yellow/White wire. After repair, clear DTC(s) and retest system.
14. Turn ignition off. Ensure 26-pin GEM connector is disconnected. Disconnect run/park relay. Turn ignition on. Measure voltage at relay connector terminal No. 85 (Yellow/White wire). See **Fig. 1** . If reading is less than 10 volts, go to next step. If reading i s 10 volts or greater, repair Yellow/White wire, clear DTC(s) and retest system.
15. Turn ignition off. Check run/park relay. See **RELAYS** under COMPONENT TESTS. If faulty, replace relay. If relay is good, replace GEM. After repair, clear DTC(s) and retest system.
16. Turn ignition off. Disconnect high/low relay. Turn ignition on. Measure voltage at relay connector terminal No. 30 (Red wire). See **Fig. 1** . If reading is less than 10 volts, go to next step. If reading is 10 volts or greater, go to step 19).
17. Turn ignition off. Disconnect run/park relay. Measure resistance on Red wire between run/park relay and high/low relay. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair Red wire, clear DTC(s) and retest system.
18. Turn ignition on. Measure voltage at run/park relay connector terminal No. 87 (White/Black wire). See **Fig. 1** . If reading is 10 volts or greater, replace run/park relay. If reading is less than 10 volts, repair White/Black wire. After repair, clear DTC(s) and retest system.
19. Connect a jumper wire between high/low relay connector terminal No. 30 (Red wire) and terminal No. 87 (Dark Blue/Orange wire) or terminal No. 87A (White wire). See **Fig. 1** . If wipers do not operate, go to next step. If wipers operate, replace high/low relay, clear DTC(s) and retest system.
20. Turn ignition off. Disconnect wiper motor harness connector. Measure resistance of Black wire between wiper motor harness connector and ground. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair Black wire, clear DTC(s) and retest system.
21. Turn ignition off. Disconnect high/low relay. Measure resistance of Dark Blue/Orange wire between wiper motor harness connector and high/low relay connector. Measure resistance of White wire between wiper motor harness connector and high/low relay connector. If resistance of both wires is less than 5 ohms, go to next step. If resistance in either or both wire(s) is greater than 5 ohms, repair wire(s, clear DTC(s) and retest system. Reconnect all connectors.
22. Turn ignition off. Remove wiper linkage from wiper motor. Check wiper linkage for free operation. If linkage is free of binding and operational resistance, check wiper motor. See **WIPER MOTOR TEST** under COMPONENT TESTS. If linkage does not operate freely, repair as necessary. Reconnect linkage, clear DTC(s) and retest system.

PINPOINT TEST B - WIPERS STAY ON CONTINUOUSLY

1. Turn ignition off. Connect New Generation Star (NGS) tester (007-00500) to Data Link Connector

(DLC). DLC is located at instrument panel, below steering column. Monitor PID IGN_GEM while turning the ignition switch through all its positions. If PID values agree with switch position, go to next step. If PID values do not agree with switch position, repair appropriate ignition switch circuit(s) and retest system. See **WIRING DIAGRAM** .

2. Retrieve continuous DTCs stored in GEM. Clear continuous DTCs. Perform on-demand self-test and note all DTCs. If DTC(s) exist, service DTCs in numerical order. See PINPOINT TEST B DTC INDEX TABLE. If no DTCs exist, go to step 3).

PINPOINT TEST B DTC INDEX

DTC	Go To Step
B1342	(1)
B1431	6
B1441	3
B1446	9
B1453	3
B1473	9
B1476	9
(1) Replace GEM, clear DTC(s) and retest system.	

3. Turn ignition on. Using NGS tester, monitor PID WPMODE while turning wiper switch through all positions. If PID values agree with switch position, go to step 6). If PID values do not agree with switch position, go to next step.
4. Turn ignition off. Disconnect multifunction switch 7-pin connector. Check wiper switch portion of multifunction switch. See **WIPER SWITCH** . If switch is good, go to next step. If switch is faulty, replace switch and retest system.
5. Disconnect GEM 26-pin connector. Measure resistance of Light Blue/Orange wire between multifunction switch 7-pin connector and ground. Measure resistance of Pink/Yellow wire between multifunction switch 7-pin connector and ground. If resistance in both wires is less than 5 ohms, repair short(s) to ground as necessary. If resistance in both wires is 5 ohms or greater, replace GEM. After repair, clear DTC(s) and retest system.
6. Turn ignition on. Using NGS tester, monitor PID WPRUN while toggling active command mode WIPER RLY. If WPRUN PID agrees with command mode and displays ON--- and OFF---, go to step 9). If WPRUN PID does not agree with command mode and displays OFF O-G, go to next step.
7. Turn ignition off. Remove run/park relay. Check run/park relay. See **RELAYS** in COMPONENT TESTS. If relay is good, go to next step. If relay is faulty, replace relay, clear DTC(s), and retest system.
8. Disconnect GEM 26-pin connector. Measure resistance of Yellow/White wire between run/park relay connector terminal No. 85 and ground. See **Fig. 1** . If resistance is greater than 10 k/ohms, replace GEM. If resistance is 10 k/ohms or less, repair Yellow/White wire as necessary. After repair, clear DTC(s) and retest system.
9. Turn ignition on. Turn wiper switch on. Remove run/park relay. If wipers stop operating, replay run/park relay. If wipers continue to operate, reconnect relay and go to next step.
10. Turn ignition off. Disconnect wiper motor harness connector and high/low relay. Turn ignition on. Measure voltage between high/low relay connector terminals No. 87 and 87A. See **Fig. 1** . If reading is

less than 10 volts, replace wiper motor. If reading is 10 volts or greater, repair Dark Blue/Orange and White wire(s). After repair, clear DTC(s) and retest system.

PINPOINT TEST C - WIPERS OPERATE AT INTERVAL SETTING BUT

INOPERATIVE AT HIGH & LOW SPEED

1. Connect New Generation Star (NGS) tester (007-00500) to Data Link Connector (DLC). DLC is located at instrument panel, below steering column. 6Retrieve DTCs stored in GEM. Clear DTC(s). Perform on-demand self-test and note all DTCs. If DTC(s) exist, service DTCs in numerical order. See PINPOINT TEST C DTC INDEX TABLE. If no DTCs exist, go to next step.

PINPOINT TEST C DTC INDEX

DTC	Go To Step
B1342	(1)
B1434	6
B1436	6
B1438	2
B1450	2
6B1466	2
(1) Replace GEM, clear DTC(s) and retest system.	

2. Turn ignition off. Connect New Generation Star (NGS) tester (007-00500) to Data Link Connector (DLC). DLC is located at instrument panel, below steering column. Monitor PID WPMODE while turning the wiper switch through all its positions. If PID values agree with switch position, go to step 6). If PID values do not agree with switch position, go to next step.
3. Turn ignition off. Disconnect multifunction switch 7-pin connector. Check wiper switch. See **WIPER SWITCH** under COMPONENT TESTS. If switch is good, go to next step. If switch is faulty, replace switch. Clear DTC(s) and retest system.
4. Disconnect GEM 26-pin connector. Turn ignition on. Check Light Blue/Orange wire for voltage at multifunction switch harness connector. If reading is less than 10 volts, go to next step. If reading is more than 10 volts, repair Light Blue/Orange wire and/or Pink/Yellow wire. After repair, clear DTC(s) and retest system.
5. Measure resistance of Pink/Yellow wire between GEM 26-pin connector and multifunction switch 7-pin connector. If resistance is less than 5 ohms, replace GEM. If resistance is 5 ohms or greater, repair Pink/Yellow wire and/or Light Blue/Orange wire. After repair, clear DTC(s) and retest system.
6. Turn ignition on. Using NGS tester, monitor PID WPHISP while toggling active command mode SPEED RELAY. If WPHISP PID agree with command mode and displays ON--- and OFF---, go to step 11). If WPHISP does not agree with command mode and displays OFF O-G, go to step 9). If WPHISP does not agree with command mode and displays ON-B, go to next step.
7. Turn ignition off. Disconnect GEM 26-pin connector and high/low relay. Turn ignition on. Measure voltage at high/low relay connector terminal No. 85 (Gray/Light Blue wire). See **Fig. 1** . If reading is less than 10 volts, go to next step. If reading is 10 volts or greater, repair short to power in Gray/Light Blue wire, clear DTC(s) and retest system.

8. Turn ignition off. Remove HI/lo relay. Check high/low relay. See **RELAYS** under COMPONENT TESTS. If relay is good, go to next step. If faulty, replace high/low relay, clear DTC(s) and retest system.
9. Disconnect GEM 26-pin connector. Measure resistance between high/low relay connector terminal No. 85 (Gray/Light Blue wire) and ground. See **Fig. 1** . If resistance is greater than 10 k/ohms, go to next step. If resistance is 10 k/ohms or less, repair short to ground in Gray/Light Blue wire. Clear DTC(s) and retest system.
10. Disconnect GEM 26-pin connector. Measure resistance of Gray/Light Blue wire between GEM 26-pin connector and high/low relay connector. If resistance is less than 5 ohms, replace GEM. If resistance is 5 ohms or greater, repair open in Gray/Light Blue wire. After repair, clear DTC(s) and retest system.
11. Turn ignition off. Disconnect high/low relay. Turn ignition on. Set wiper switch for high speed operation. Connect a jumper wire between high/low relay connector terminal No. 30 (Red wire) and terminal No. 87 (Dark Blue/Orange wire). See **Fig. 1** . Turn wiper switch to low speed operation. Move jumper wire from relay connector terminal No. 87 to terminal No. 87A (White wire). If wipers do not operate at correct speeds, go to next step. If wipers operate at correct speeds, replace high/low relay. Clear DTC(s) and retest system.
12. Turn ignition off. Disconnect wiper motor harness connector. Measure resistance of Dark Blue/Orange wire between high/low relay connector terminal No. 87 and wiper motor harness connector. See **Fig. 1** . Measure resistance of White wire between high/low relay connector terminal No. 87A and wiper motor harness connector. If resistance of both circuits is less than 5 ohms, check wiper switch. See **WIPER SWITCH** under COMPONENT TESTS. If resistance of either or both circuits is 5 ohms or greater, repair wire(s) as necessary. Clear DTC(s) and retest system.

PINPOINT TEST D - WIPERS INOPERATIVE AT INTERVAL SETTING BUT

OPERATE AT HIGH & LOW SPEED

1. Connect New Generation Star (NGS) Tester (007-00500) to Data Link Connector (DLC). DLC is located at instrument panel, below steering column. Retrieve DTCs stored in GEM. Clear DTC(s). Perform on-demand self-test and note all DTCs. If DTC(s) exist, service DTCs in numerical order. See PINPOINT TEST D DTC INDEX TABLE. If no DTCs exist, go to next step.

PINPOINT TEST D DTC INDEX

DTC	Go To Step
B1342	(1)
B1438	2
B1441	2
B1446	6
B1450	2
B1453	2
(1) Replace GEM, clear DTC(s) and retest system.	

2. Turn ignition off. Connect NGS tester to Data Link Connector (DLC). DLC is located at instrument panel, below steering column. Monitor PID WPMODE while turning the wiper switch through all positions. If PID values agree with switch position, go to step 6). If PID values do not agree with switch

position, go to next step.

3. Turn ignition off. Disconnect multifunction switch 7-pin connector. Check wiper switch. See **WIPER SWITCH** under COMPONENT TESTS. If switch is good, go to next step. If switch is faulty, replace switch. Clear DTC(s) and retest system.
4. Disconnect GEM 26-pin connector. Turn ignition on. Check Light Blue/Orange and Pink/Yellow wires for voltage at multifunction switch harness connector. If reading is less than 10 volts, go to next step. If reading is more than 10 volts, repair Light Blue/Orange wire and/or Pink/Yellow wire. After repair, clear DTC(s) and retest system.
5. Measure resistance of Pink/Yellow and Light Blue/Orange wires between GEM 26-pin connector and multifunction switch 7-pin connector. If resistance of both wires is less than 5 ohms, replace GEM. If resistance is 5 ohms or greater, repair Pink/Yellow wire and/or Light Blue/Orange wire. After repair, clear DTC(s) and retest system.
6. Turn ignition on. Using NGS tester, monitor and record PID WPPRKSW while wipers are operating. Using NGS view recorder function, view WPPRKSW graph. If WPPRKSW PID indicates PARK when wipers are in park position and does not indicate PARK when wipers are in any other position, replace GEM, clear DTC(s) and retest system. If WPPRKSW PID does not agree with wiper position, go to next step.
7. Turn ignition off. Disconnect wiper motor harness connector. Measure resistance of Black wire between wiper motor harness connector and ground. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair open in Black wire. Clear DTC(s) and retest system.
8. Turn ignition off. Disconnect wiper motor harness connector. Measure voltage of White/Black wire at wiper motor harness connector. If reading is 10 volts or greater, go to next step. If reading is less than 10 volts, repair White/Black wire. Clear DTC(s) and retest system.
9. Turn ignition off. Disconnect GEM 26-pin connector and wiper motor harness connector. Measure resistance of Black wire between GEM 26-pin connector and wiper motor harness connector. If resistance is less than 5 ohms, reconnect GEM 26-pin connector and go to next step. If resistance is 5 ohms or greater, repair Black wire as necessary. After repair, clear DTC(s) and retest system.
10. Turn ignition on. Monitor PID WPPRKSW. Using a jumper wire, ground Black wire at wiper motor harness connector. Remove jumper wire. Apply battery voltage to Black wire at wiper motor harness connector. If PID indicates PRK when Black wire is grounded and not PRK when battery voltage is applied, replace wiper motor. If PID does not display as indicate, replace GEM. After component replacement, clear DTC(s) and retest system.

PINPOINT TEST E - WASHER PUMP & WIPERS DO NOT FUNCTION

PROPERLY

1. Connect New Generation Star (NGS) Tester (007-00500) to Data Link Connector (DLC). DLC is located at instrument panel, below steering column. Retrieve continuous DTCs stored in GEM. Clear continuous DTCs. Perform on-demand self-test and note all DTCs. If DTC(s) exist, service DTCs in numerical order. See PINPOINT TEST E DTC INDEX TABLE. If no DTCs exist, go to next step.

PINPOINT TEST E DTC INDEX

DTC	Go To Step
B1342	

	(1)
B1450	2
B1453	2
B1458	6
B1460	6
(1) Replace GEM, clear DTC(s) and retest system.	

2. Turn ignition on. Disconnect multifunction switch 7-pin connector. Using NGS tester, monitor PID WPMODE while turning wiper switch through all positions. If PID values agree with switch position, go to step 5). If PID values do not agree with switch position, go to next step.
3. Turn ignition off. Disconnect multifunction switch 7-pin connector. Measure resistance between Dark Blue and Pink/Yellow wires at multifunction switch 7-pin connector while depressing and releasing washer switch. If resistance is less than 5 ohms with switch depressed and greater than 10 k/ohms with switch released, go to next step. If resistance is not as specified, replace multifunction switch. Clear DTC (s) and retest system.
4. Turn ignition off. Disconnect multifunction switch 7-pin connector and GEM 26-pin connector. Measure voltage of Light Blue/Orange wire at multifunction switch 7-pin connector. If reading is 10 volts or greater, clear DTC(s) and retest system. If reading is less than 10 volts, go to next step.
5. Turn ignition off. Disconnect multifunction switch 7-pin connector and GEM 26-pin connector. Measure resistance of Light Blue/Orange wire between multifunction switch 7-pin connector and GEM 26-pin connector. If resistance is less than 5 ohms, Replace GEM. If resistance is 5 ohms or greater, repair open in Light Blue/Orange wire. After repair, retest system.
6. Turn ignition on. Using NGS tester, monitor PID WASHRLY while toggling active command mode. If WASHRLY PID agrees with command mode and displays ON--- and OFF---, go to step 10). If WASHRLY does not agree with command mode and displays ON-B-, go to step 9).
7. Turn ignition off. Disconnect washer pump relay. Check relay. See **RELAYS** under COMPONENT TESTS. If relay is good, go to next step. If faulty, replace relay, clear DTC(s) and retest system.
8. Disconnect GEM 26-pin connector. Measure resistance of Tan/Red wire between GEM 26-pin connector and washer pump relay terminal No. 85. See **Fig. 1** . If resistance is less than 5 ohms, replace GEM. If resistance is 5 ohms or greater, repair open in Tan/Red wire. After repair, clear DTC(s) and retest system.
9. Turn ignition off. Disconnect multifunction switch 7-pin connector and GEM 26-pin connector. Turn ignition on. Measure voltage of Tan/Red wire at washer pump relay connector terminal No. 85. See **Fig. 1** . If reading is 10 volts or greater, repair short to power in Tan /Red wire. If reading is less than 10 volts, replace GEM. After repair, clear DTC(s) and retest system.
10. Turn ignition off. Disconnect washer pump relay connector. Turn ignition on. Connect a jumper wire between washer pump relay terminals No. 30 (White/Black wire) and No. 87 (Black/White wire). See **Fig. 1** . If washer pump does not operate, remove jumper wire and go to next step. If washer pump operates, replace washer pump relay. After repair, clear DTC(s) and retest system.
11. Turn ignition off. Disconnect washer pump harness connector. Measure resistance of Black/White wire between washer pump harness connector and washer pump relay terminal No. 87. See **Fig. 1** . If resistance is less than 5 ohms, reconnect washer pump harness connector and go to next step. If resistance is 5 ohms or greater, repair open in Black/White wire, clear DTC(s) and retest system.
12. Measure resistance of Black wire between washer pump harness connector and ground. If resistance is

less than 5 ohms, replace washer pump. If resistance is 5 ohms or greater, repair Black wire and ground connection as necessary. After repair, clear DTC(s) and retest system.

PINPOINT TEST F - SPEED DEPENDENT INTERVAL MODE INOPERATIVE

1. Connect New Generation Star (NGS) Tester (007-00500) to Data Link Connector (DLC). DLC is located at instrument panel, below steering column. Retrieve continuous DTCs stored in GEM. Clear continuous DTCs. Perform on-demand self-test and note all DTCs. If DTC P0500 exists, go to step 3). If DTC B1342 exists, go to next step.
2. Turn ignition on. Using NGS tester, follow manufacturer's instruction to verify SPEED DEPENDENT WIPER is set to enabled. If SPEED DEPENDENT WIPER is set to enabled, go to next step. If SPEED DEPENDENT WIPER is not set to enabled, ENABLE the active command SPEED DEPENDENT WIPER.
3. Turn ignition on. Using NGS tester, monitor PID VSS_GEM while driving vehicle from 0 to 55 MPH. If PID VSS_GEM values do not agree with speedometer, go to next step. If PID VSS_GEM values agree with speedometer, replace GEM, clear DTC(s) and retest system.
4. Turn ignition off. Disconnect Vehicle Speed Sensor (VSS) and fuse junction panel connector C242 (Gray) Measure resistance of Pink/Orange wire between junction fuse/relay panel connector C242 terminal No. 9 and VSS. See **Fig. 3** . If resistance is less than 5 ohms, reconnect connector C242 and go to next step. If resistance is 5 ohms or greater, repair open in Pink/Orange wire, clear DTC(s) and retest system.
5. Disconnect junction fuse/relay panel connector C243 (Black). Measure resistance of Gray/Black wire between junction fuse/relay panel connector C243 terminal No. 21 and VSS. See **Fig. 3** . If resistance is less than 5 ohms, replace VSS. If resistance is 5 ohms or greater, repair open in Gray/Black wire. After repair, clear DTC(s) and retest system.

PINPOINT TEST G - WIPERS INOPERATIVE

NOTE: Pinpoint Tests G-L apply to Central Timer Module (CTM) controlled wiper/washer systems.

1. Measure voltage at output side of fuses No. 11 (30-amp) and No. 15 (5-amp) at junction fuse/relay panel. If reading is 10 volts or more at both fuses, go to step 4) If reading is less than 10 volts at either fuse, go to next step.
2. Check fuses No. 11 (30-amp) and No. 15 (5-amp) at junction fuse/relay panel. Check fuse No. 22 (50-amp) in power distribution box. If fuses are good, go to next step. If fuse(s) are blown, replace fuse(s), clear any Diagnostic Trouble Codes (DTCs) and test system for proper operation.
3. Turn ignition on. Disconnect fuse junction panel connectors C242 (Gray) and C243 (Black). Measure voltage at fuse junction panel connector C243 terminal No. 11 (Tan/Black wire). Measure voltage at fuse junction panel connector C242 terminal No. 16 (Black/Light Green wire). See **Fig. 3** . If reading is 10 volts or greater, replace fuse junction panel, clear DTC(s) and retest system. If reading is less than 10 volts, repair open in Black/Light Green wire, Tan/black wire and/or Yellow wire between fuse junction panel, ignition switch and/or power distribution center. See **WIRING DIAGRAM** .
4. Measure voltage at output side of fuses No. 6 and 8 (both 5-amp) at fuse junction panel. If vehicle is equipped with manual transmission, depress clutch pedal fully. Turn ignition to start and measure voltage

at input side of fuse No. 20 (5-amp) at fuse junction panel. If reading is 10 volts or greater at each location, go to next step. If reading is less than 10 volts at any location, go to step 5).

5. Recheck fuses No. 6, 8 and 20 at fuse junction panel. If fuses are good, go to next step. If any fuse is faulty, replace fuse(s), clear DTCs and retest system.
6. Turn ignition off. Disconnect fuse junction panel connectors C242 (Gray) and C243 (Black). Turn ignition on. Measure voltage at fuse junction panel connector C242, terminals No. 16 (Black/Light Green wire) and No. 19 (Red/Light Blue wire). See **Fig. 3** . If vehicle is equipped with manual transmission, depress clutch pedal fully. Measure voltage at fuse junction panel connector C243 terminal No. 19 (Gray/Yellow wire). If reading at each location is 10 volts or greater, replace fuse junction panel, clear DTCs and retest system. If reading at any location is less than 10 volts, repair suspect wire(s). Clear DTCs and retest system.
7. Remove key from ignition switch. Connect jumper wire between CTM test connector terminals. Retrieve DTCs stored in CTM. If DTCs exist, service DTCs in numerical order. See PINPOINT TEST G DTC INDEX TABLE. If no DTCs exist, go to step 7).

PINPOINT TEST G DTC INDEX

DTC	Go To Step
12	8
13	8
14	(1)
15	(1)
21	(2)
22	11

(1) Replace CTM, clear DTC(s) and retest system.

(2) Go to PINPOINT TEST J - WIPERS OPERATE AT INTERVAL SETTING BUT INOPERATIVE AT HIGH & LOW SPEED.

8. Turn ignition on. To enter CTM input test mode, connect jumper wire between CTM test connector terminals. Monitor door ajar indicator light and CTM tone while turning wiper switch through all switch positions. If door ajar indicator light and CTM tone activate, exit CTM test mode and go to step 11). If door ajar indicator light and/or CTM tone do not activate, exit CTM test mode and go to next step.
9. Turn ignition off. Disconnect multifunction switch 7-pin connector. Check wiper switch. See **WIPER SWITCH** under COMPONENT TESTS. If switch is good, go to next step. If faulty, replace switch, clear DTC(s) and retest system.
10. Turn ignition off. Disconnect CTM 26-pin connector and multifunction switch 7-pin connector. Measure resistance of Light Blue/Orange wire, Dark Blue wire and Pink/Yellow wire between CTM 26-pin connector and multifunction switch 7-pin connector. If resistance of each wire is less than 5 ohms, replace CTM. If resistance of any wire(s) is 5 ohms or greater, repair wire(s) as necessary. After repair, clear DTC(s) and retest system.
11. Turn ignition off. Remove wiper RUN/PARK relay. Turn ignition on. Measure voltage at relay connector terminals No. 86 and 87 (both White/Black wires). See **Fig. 1** . If 10 volts or greater exist, go to next step. If less than 10 volts exist, repair White/Black wire, clear DTC(s), and retest system.
12. Turn ignition off. Check wiper RUN/PARK relay. See **RELAYS** in COMPONENT TESTING. If relay is

good, go to next step. If relay is faulty, replace relay, clear DTCs, and retest system.

13. Turn ignition on. Set wiper switch for low speed operation. Measure resistance between RUN/PARK relay connector terminal No. 85 (Yellow/White wire) and ground. See **Fig. 1** . If resistance is 5 ohms or greater, go to next step. If resistance is less than 5 ohms, reconnect relay connector and go to step 16).
14. Turn ignition off. Ensure 26-pin CTM connector is disconnected. Disconnect RUN/PARK relay. Turn ignition on. Measure voltage at relay connector terminal No. 85 (Yellow/White wire). See **Fig. 1** . If reading is less than 10 volts, go to next step. If reading i s 10 volts or greater, repair Yellow/White wire, clear DTC(s) and retest system.
15. Disconnect 26-pin CTM connector. Measure resistance of Yellow/White wire between RUN/PARK relay connector terminal No. 85 and 26-pin CTM connector terminal No. 19. See **Fig. 1** . If resistance is less than 5 ohms, replace CTM. If resistance is 5 ohms or greater, repair open in Yellow/White wire. After repair, clear DTC(s) and retest system.
16. Turn ignition off. Disconnect high/low relay. Turn ignition on. Set wiper switch for low speed operation. Measure voltage at relay connector terminal No. 30 (Red wire). See **Fig. 1** . If reading is 10 volts or greater, go to step 18). If reading is less than 10 volts, go to next step.
17. Turn ignition off. Disconnect RUN/PARK relay. Measure resistance on Red wire between RUN/PARK relay connector terminal No. 30 and high/low relay connector terminal No. 30. See **Fig. 1** . If resistance is less than 5 ohms, replace RUN/PARK relay. If resistance is 5 ohms or greater, repair Red wire. After repair, clear DTC(s) and retest system.
18. Turn ignition on. Connect a jumper wire between high/low relay connector terminal No. 30 (Red wire) and terminal No. 87 (Dark Blue/Orange wire) or terminal No. 87A (White wire). See **Fig. 1** . If wipers do not operate, go to next step. If wipers operate, replace high/low relay, clear DTC(s) and retest system.
19. Turn ignition off. Disconnect wiper motor harness connector. Measure resistance of Black wire between wiper motor harness connector and ground. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, repair Black wire, clear DTC(s) and retest system.
20. Measure resistance of Dark Blue/Orange wire between wiper motor harness connector and high/low relay connector. Measure resistance of White wire between wiper motor harness connector and high/low relay connector. If resistance of both wires is less than 5 ohms, go to next step. If resistance in either or both wires is greater than 5 ohms, repair wire(s), clear DTC(s) and retest system. Reconnect all connectors.
21. Turn ignition off. Remove wiper linkage from wiper motor. Check wiper linkage for free operation. If linkage is free of binding and operational resistance, check wiper motor. See **WIPER MOTOR TEST** under COMPONENT TESTS. If linkage does not operate freely, repair as necessary. Reconnect linkage, clear DTC(s) and retest system.

PINPOINT TEST H - WIPERS STAY ON CONTINUOUSLY

1. Remove key from ignition switch. Connect jumper wire between CTM test connector terminals. Retrieve DTCs stored in CTM. If DTC(s) exist, service DTCs in numerical order. See PINPOINT TEST H DTC INDEX TABLE. If no DTCs exist, go to step 7).

PINPOINT TEST H DTC INDEX

DTC	Go To Step
12	2
13	2

14	(1)
15	(1)
21	(2)
22	5

(1) Replace CTM, clear DTC(s) and retest system.

(2) Go to PINPOINT TEST J - WIPERS OPERATE AT INTERVAL SETTING BUT INOPERATIVE AT HIGH & LOW SPEED.

2. Turn ignition on. To enter CTM input test mode, connect jumper wire between CTM test connector terminals. Monitor door ajar indicator light and CTM tone while turning wiper switch through all positions. If door ajar indicator light and CTM tone activate, exit CTM test mode and go to step 5). If door ajar indicator light and/or CTM tone do not activate, exit CTM test mode and go to next step.
3. Turn ignition off. Disconnect multifunction switch 7-pin connector. Check wiper switch. See **WIPER SWITCH** under COMPONENT TESTS. If switch is good, go to next step. If faulty, replace switch, clear DTC(s) and retest system.
4. Turn ignition off. Disconnect CTM 26-pin connector and multifunction switch 7-pin connector. Measure resistance of Light/Blue/Orange wire and Pink/Yellow wire between multifunction switch 7-pin connector and ground. If resistance of each wire is less than 5 ohms, repair short to ground in wire(s). If resistance of any wire(s) is 5 ohms or greater, replace CTM. After repair, clear DTC(s) and retest system.
5. Turn ignition off. Disconnect RUN/PARK relay. Turn ignition on. If wipers stop operating, go to next step. If wipers continue to operate, reconnect RUN/PARK relay and go to step 8).
6. Ensure ignition switch and wiper switch are off. Measure resistance of Yellow/White wire between RUN/PARK relay connector terminal No. 85 and ground. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, replace RUN/PARK relay, clear DTC(s) and retest system.
7. Turn ignition off. Disconnect CTM 26-pin connector. Measure resistance between RUN/PARK relay connector terminal No. 85 (Yellow/White wire) and ground. If resistance is 10 k/ohms or greater, replace CTM. If resistance is less than 10 k/ohms, repair short to ground in Yellow/White wire. After repair, clear DTC(s) and retest system.
8. Turn ignition off. Disconnect high/low relay. Turn ignition on. If wipers do not stop operating, go to next step. If wipers stop operating, repair Red wire as necessary, clear DTC(s) and retest system.
9. Turn ignition off. Disconnect wiper motor harness connector. Turn ignition on. Measure voltage at high/low relay connector terminals No. 87 and 87A. See **Fig. 1** . If reading is less than 10 volts, replace wiper motor. If reading is 10 volts or greater, repair Dark Blue/Orange and White wire(s). After repair, clear DTC(s) and retest system.

PINPOINT TEST J - WIPERS OPERATE AT INTERVAL SETTING BUT

INOPERATIVE AT HIGH & LOW SPEED

1. Remove key from ignition switch. Connect jumper wire between CTM test connector terminals. Retrieve DTCs stored in CTM. If DTC(s) exist, service DTCs in numerical order. See PINPOINT TEST J DTC INDEX TABLE. If no DTCs exist, go to next step.

PINPOINT TEST J DTC INDEX

DTC	Go To Step
12	2
13	2
14	(1)
15	(1)
21	6
22	(2)

(1) Replace CTM, clear DTC(s) and retest system.

(2) Go to PINPOINT TEST G - WIPERS INOPERATIVE.

2. Turn ignition on. To enter CTM input test mode, connect jumper wire between CTM test connector terminals. Monitor door ajar indicator light and CTM tone while turning wiper switch through all positions. If door ajar indicator lights and CTM tone activate, exit CTM test mode and go to step 6). If door ajar indicator light and/or CTM tone do not activate, exit CTM test mode and go to next step.
3. Turn ignition off. Disconnect multifunction switch 7-pin connector. Check wiper switch. See **WIPER SWITCH** under COMPONENT TESTS. If switch is good, go to next step. If faulty, replace switch, clear DTC(s) and retest system.
4. Disconnect CTM 26-pin connector. Turn ignition on. Measure voltage of Light Blue/Orange wire and Pink/Yellow wire at 26-pin CTM connector. If readings of both wires are 10 volts or greater, repair short to power in suspect wire(s). Clear DTC(s) and retest system. If readings are less than 10 volts, go to next step.
5. Turn ignition off. Disconnect CTM 26-pin connector and multifunction switch 7-pin connector. Measure resistance of Light Blue/Orange wire and Pink/Yellow wire between CTM 26-pin connector and multifunction switch 7-pin connector. If resistances are less than 5 ohms, replace CTM. If resistances are 5 ohms or greater, repair open in Light Blue/Orange wire and/or Pink/Yellow wire. After repair, clear DTC(s) and retest system.
6. Turn ignition off. Disconnect high/low relay. Turn ignition on. Measure voltage at high/low relay terminal No. 86 (White/Black wire). See **Fig. 1** . If reading is 10 volts or greater, go to next step. If reading is less than 10 volts, repair White/Black wire as necessary, clear DTC(s) and retest system.
7. Set wiper switch for low speed operation. Measure resistance between high/low relay terminal No. 85 (Gray/Light Blue wire) and ground. See **Fig. 1** . Set wiper switch for high speed operation. Measure resistance as previously directed. If resistance is less than 5 ohms at high speed and greater than 10 k/ohms at low speed, go to step 10). If resistance is not as specified, go to next step.
8. Turn ignition off. Disconnect CTM 26-pin connector. Measure voltage at high/low relay connector terminal No. 85 (Gray/Light Blue wire). See **Fig. 1** . If reading is less than 10 volts, go to next step. If reading is 10 volts or greater, repair short to power in Gray/Light Blue wire. Clear DTC(s) and retest system.
9. Turn ignition off. Disconnect CTM 26-pin connector. Measure resistance of Gray/Light Blue wire between high/low relay and CTM 26-pin connector. If resistance is less than 5 ohms, replace CTM. If resistance is 5 ohms or greater, repair open in Gray/Light Blue wire. After repair, clear DTC(s) and retest system.

10. Turn ignition off. Check high/low relay. See **RELAYS** under COMPONENT TESTS. If relay is good, go to next step. If faulty, replace high/low relay, clear DTC(s) and retest system.
11. Connect a jumper wire between high/low relay terminals No. 30 (Red wire) and No. 87 (Dark Blue/Orange wire). See **Fig. 1** . Wipers should operate at high speed. Leave jumper wire connected to terminal No. 30. Move jumper wire from high/low relay terminal No. 87 (Dark Blue/Orange wire) to terminal No. 87A (White wire). Wipers should operate at low speed. If wipers do not operate as specified, go to next step. If wipers operate as specified, replace high/low relay, clear DTC(s) and retest system.
12. Turn ignition off. Disconnect wiper motor harness connector. Measure resistance of Dark Blue/Orange and White wires between high/low relay and wiper motor harness connector. If resistance is 5 ohms or greater, repair open in White and/or Dark Blue/Orange wire(s). If resistance is less than 5 ohms, check wiper motor. See **WIPER MOTOR TEST** under COMPONENT TESTS. After repair, clear DTC(s) and retest system.

PINPOINT TEST K - WIPERS INOPERATIVE AT INTERVAL SETTING BUT

OPERATE AT HIGH & LOW SPEED

1. Remove key from ignition switch. Connect jumper wire between CTM test connector terminals. Retrieve DTCs stored in CTM. If DTC(s) exist, service DTCs in numerical order. See PINPOINT TEST K DTC INDEX TABLE. If no DTCs exist, go to next step.

PINPOINT TEST K DTC INDEX

DTC	Go To Step
12	2
13	2
14	(1)
15	(1)
(1) Replace CTM, clear DTC(s) and retest system.	

2. Turn ignition on. To enter CTM input test mode, connect jumper wire between CTM test connector terminals. Monitor door ajar indicator light and CTM tone while turning wiper switch through all positions. If door ajar indicator lights and CTM tone activate, exit CTM test mode and go to step 6). If door ajar indicator light and/or CTM tone do not activate, exit CTM test mode and go to next step.
3. Turn ignition off. Disconnect multifunction switch 7-pin connector. Check wiper switch. See **WIPER SWITCH** under COMPONENT TESTS. If switch is good, go to next step. If faulty, replace switch, clear DTC(s) and retest system.
4. Disconnect CTM 26-pin connector. Turn ignition on. Measure voltage of Light Blue/Orange wire and Pink/Yellow wire at multifunction switch 7-pin connector. If readings of both wires are 10 volts or greater, repair short to power in suspect wire(s). Clear DTC(s) and retest system. If readings are less than 10 volts, go to next step.
5. Turn ignition off. Disconnect CTM 26-pin connector and multifunction switch 7-pin connector. Measure resistance of Light Blue/Orange wire and Pink/Yellow wire between CTM 26-pin connector and multifunction switch 7-pin connector. If resistances are less than 5 ohms, replace CTM. If resistances are

5 ohms or greater, repair open in Light Blue/Orange wire and/or Pink/Yellow wire. After repair, clear DTC(s) and retest system.

6. Set wiper switch for slowest intermittent speed operation. Ensure wiper motor harness connector is connected. Using a voltmeter, backprobe Black wire terminal of wiper motor harness connector. If reading is zero volts when wipers are in parked position and greater than 10 volts when wipers are operating, go to next step. If readings are not as specified, go to step 8).
7. Turn ignition off. Disconnect CTM 26-pin connector. Measure resistance of Black wire between CTM 26-pin connector and wiper motor harness connector. If resistance is less than 5 ohms, replace CTM. If resistance is 5 ohms or greater, repair open in Black wire. After repair, clear DTC(s) and retest system.
8. Measure voltage of White/Black wire at wiper motor harness connector. If reading is less than 10 volts, repair open in White/Black wire. If reading is 10 volts or greater, check wiper motor. See **WIPER MOTOR TEST** under COMPONENT TESTS. If faulty, replace wiper motor. After repair, clear DTC(s) and retest system.

PINPOINT TEST L - WASHER PUMP DOES NOT FUNCTION PROPERLY

1. Remove key from ignition switch. Connect jumper wire between CTM test connector terminals. Retrieve DTCs stored in CTM. If DTC(s) exist, service DTCs in numerical order. See PINPOINT TEST L DTC INDEX TABLE. If no DTCs exist, go to next step.

PINPOINT TEST L DTC INDEX

DTC	Go To Step
12	2
13	2
14	(1)
15	(1)
31	6
(1) Replace CTM, clear DTC(s) and retest system.	

2. Turn ignition on. To enter CTM input test mode, connect jumper wire between CTM test connector terminals. Monitor door ajar indicator light and CTM tone while turning wiper switch through all positions. If door ajar indicator light and CTM tone activate, exit CTM test mode and go to step 6). If door ajar indicator light and/or CTM tone do not activate, exit CTM test mode and go to next step.
3. Turn ignition off. Disconnect multifunction switch 7-pin connector. While depressing and releasing washer switch, measure resistance between wiper switch terminals No. 4 (Dark Blue wire) and No. 6 (Light Blue/Orange wire). If resistance is less than 5 ohms when switch is depressed and greater than 10 k/ohms when switch is released, go to next step.
4. Turn ignition off. Disconnect CTM 26-pin connector and multifunction switch 7-pin connector. Turn ignition on. Measure voltage of Light Blue/Orange wire at multifunction switch 7-pin connector. If reading is less than 10 volts, go to next step. If reading is 10 volts or greater, repair short to power in Light Blue/Orange wire, clear DTC(s) and retest system.
5. Turn ignition off. Disconnect CTM 26-pin connector and multifunction switch 7-pin connector. Measure resistance of Light Blue/Orange wire between CTM 26-pin connector and multifunction switch 7-pin

connector. If resistance is less than 5 ohms, replace CTM. If resistance is 5 ohms or greater, repair open in Light Blue/Orange wire. After repair, clear DTC(s) and retest system.

6. Turn ignition off. Disconnect washer pump relay. Turn ignition on. Measure voltage at washer pump relay connector terminal No. 86 (White/Black wire). See **Fig. 1** . If reading is 10 volts or greater, go to next step. If reading is less than 10 volts, repair White/Black wire as necessary, clear DTC(s) and retest system.
7. While depressing washer switch, measure resistance between washer pump relay terminal No. 85 (Yellow/Red wire) and ground. If resistance is less than 5 ohms, go to next step. If resistance is 5 ohms or greater, go to step 9).
8. Check washer pump relay. See **RELAYS** under COMPONENT TESTS. If relay is good, go to next step. If faulty, replace washer pump relay, clear DTC(s) and retest system.
9. Turn ignition off. Disconnect CTM 26-pin connector. Measure resistance of Tan/Red wire CTM 26-pin connector and washer pump relay connector terminal No. 85. See **Fig. 1** . If resistance is less than 5 ohms, replace CTM. If resistance is 5 ohms or greater, repair open in Tan/White wire. After repair, clear DTC(s) and retest system.
10. Turn ignition off. Disconnect washer pump relay. Turn ignition on. Connect jumper wire between washer pump relay connector terminals No. 30 (White/Black wire) and No. 87 (Black/White wire). See **Fig. 1** . If washer pump does not operate, go to next step. If washer pump operates, replace washer pump relay, clear DTC(s) and retest system.
11. Turn ignition off. Disconnect washer pump harness connector. Measure resistance of Black/White wire between washer pump harness connector and washer pump relay connector. If resistance is less than 5 ohms, reconnect washer pump relay and go to next step. If resistance is 5 ohms or greater, repair open in Black/White wire, clear DTC(s) and retest system.
12. Turn ignition off. Disconnect washer pump harness connector. Measure resistance of Black wire between washer pump harness connector and ground. If resistance is less than 5 ohms, replace washer pump. If resistance is 5 ohms or greater, repair Black wire as necessary. After repair, clear DTC(s) and retest system.

REMOVAL & INSTALLATION

WARNING: Deactivate air bag system before performing any service operation involving steering column components. See AIR BAG RESTRAINT SYSTEM article. Do not apply electrical power to any component on steering column without first deactivating air bag system. Air bag may deploy.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

REMOVAL & INSTALLATION

WIPER MOTOR

Removal

1. Remove wiper arms. Remove lower window molding. Remove 5 retaining screws through access holes in cowl vent panel. Disconnect negative battery cable. Remove cowl top vent panel.
2. Partially close hood. Gently lift cowl top vent panel to provide working room. Disconnect antenna lead. Disconnect washer hose. Remove cowl top vent panel. Remove motor shield.
3. Remove wiper linkage clips from motor output arm. Disconnect motor wiring. Remove motor mounting bolts and motor.

Installation

Before installation, connect wiring and run motor until it is in park position. To complete installation, reverse removal procedure. Tighten mounting bolts to 60-85 INCH lbs. (6.8-9.6 N.m).

MULTIFUNCTION SWITCH

Removal & Installation

Disconnect negative battery cable. Remove steering column shroud. Remove retaining screws and multifunction switch. Disconnect electrical connector. Remove switch. To install, reverse removal procedure.

WASHER PUMP & RESERVOIR

Removal & Installation

Using a small screwdriver, release connector. Remove hose. Drain reservoir. Remove pump retaining screws. Remove reservoir retaining screws. To install, reverse removal procedure. Fill reservoir before making electrical connections.

CENTRAL TIMER MODULE (CTM) & GENERIC ELECTRONIC MODULE (GEM)

Removal & Installation

Turn ignition off. Disconnect negative battery cable. Remove left kick panel. Disconnect connector. Remove module from bracket. To install, reverse removal procedure.

WIRING DIAGRAM

1997 Ford Pickup F150

WIPER/WASHER SYSTEM 1997 ACCESSORIES & EQUIPMENT Ford Motor Co. - Wiper/Washer System

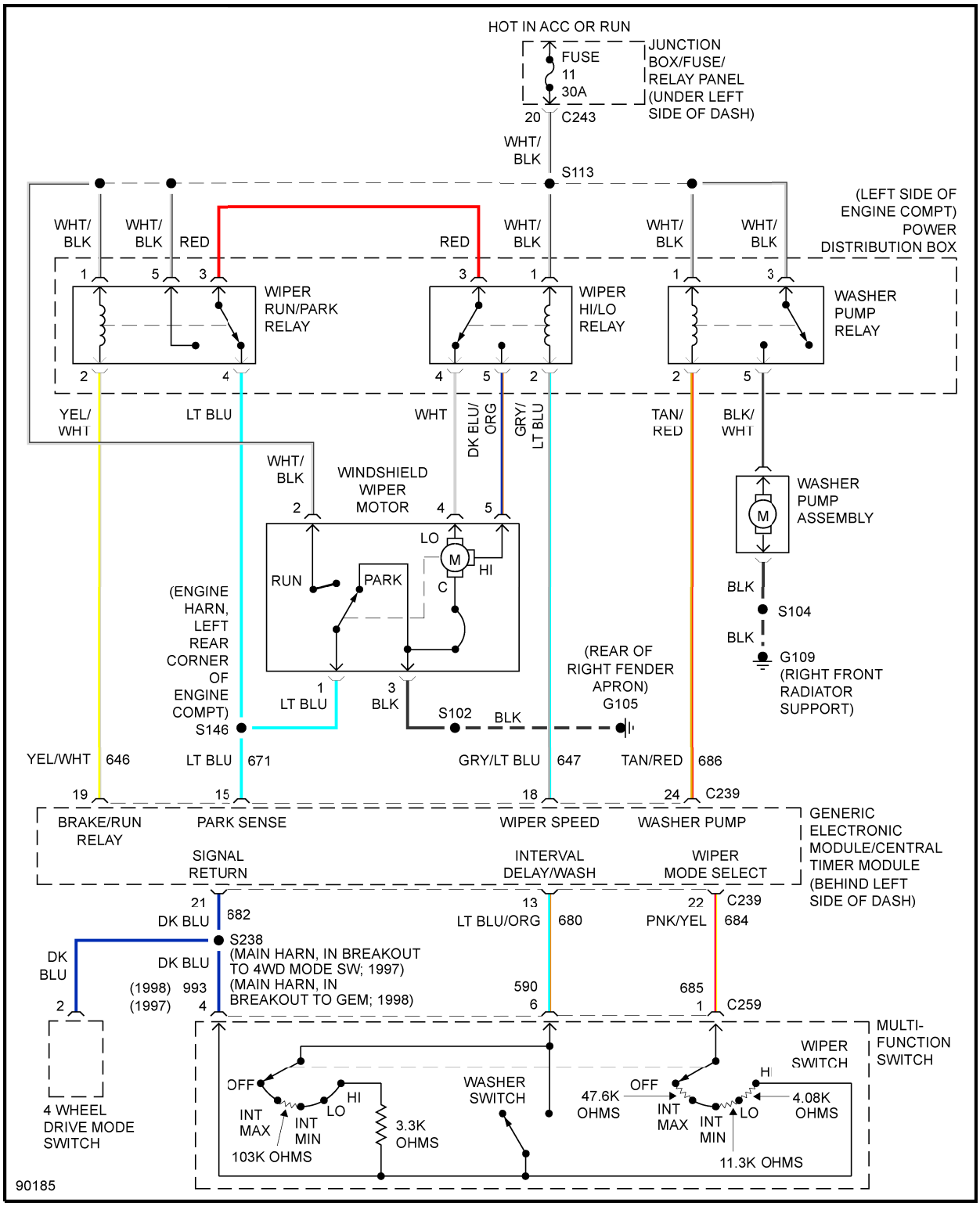


Fig. 4: Wiper/Washer System Wiring Diagram

1997 System Wiring Diagrams

Ford - Pickup F150

AIR CONDITIONING

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

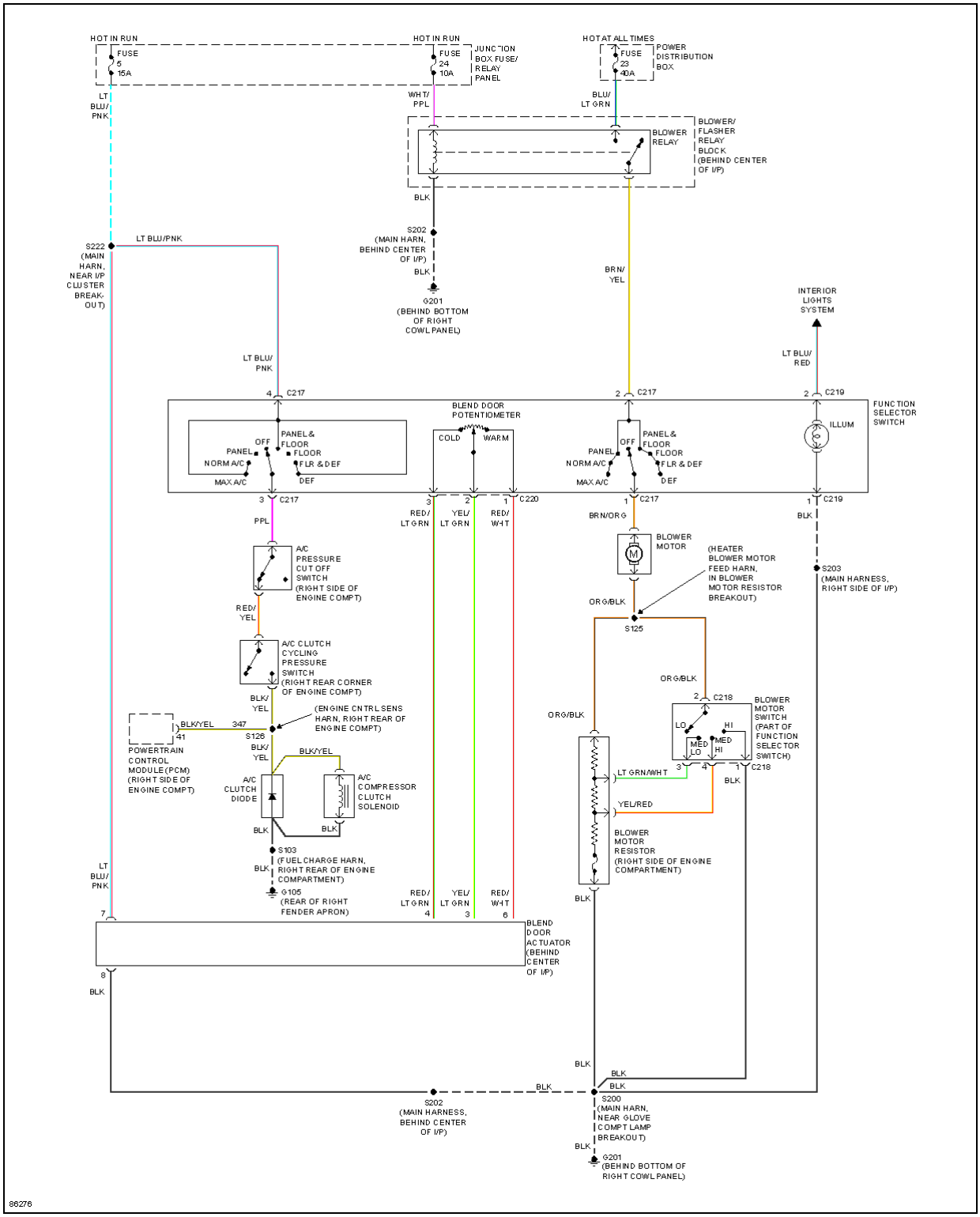


Fig. 1: A/C Circuit, Vehicles Built Before 6/24/96

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

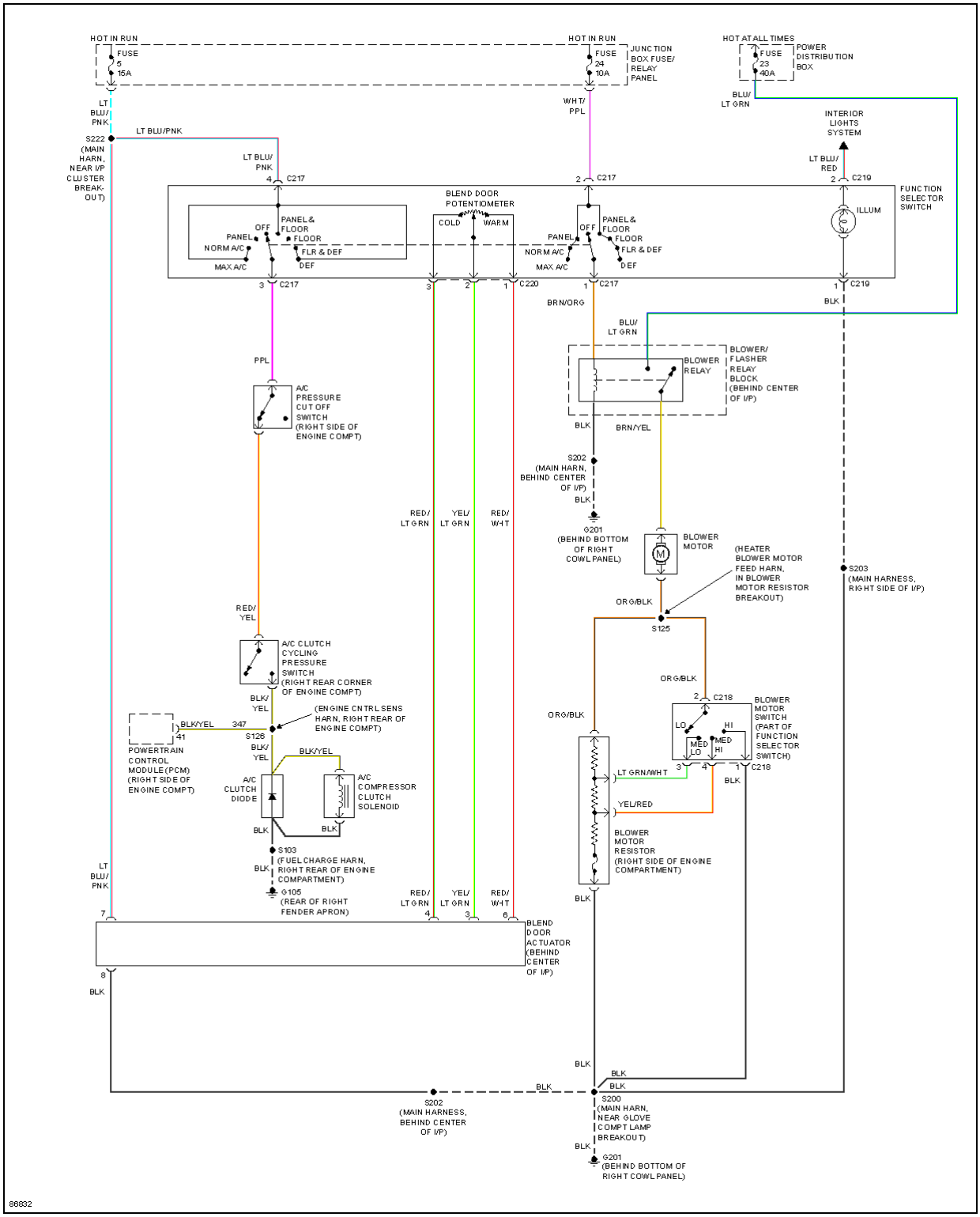


Fig. 2: A/C Circuit, Vehicles Built On or After 6/24/96

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

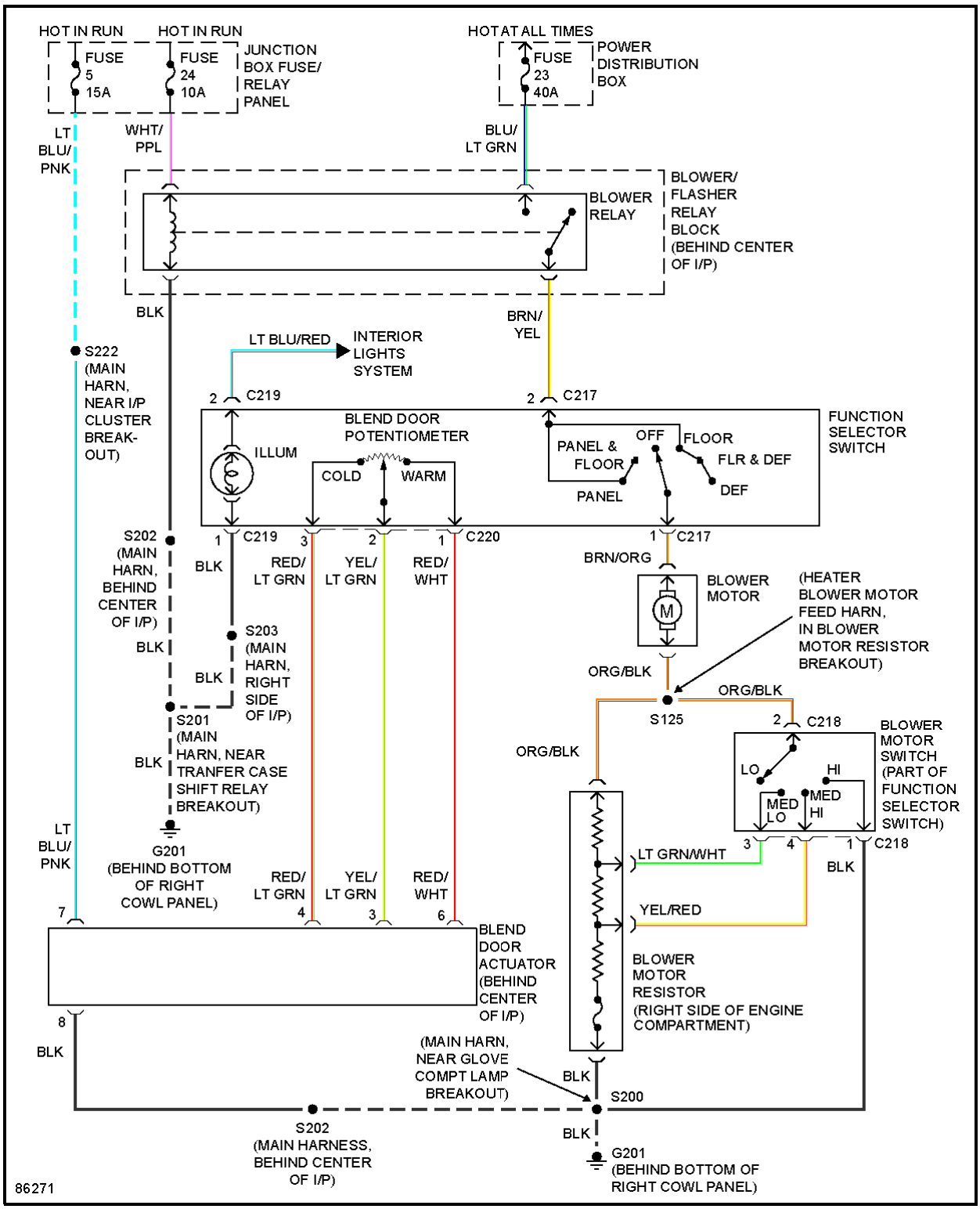


Fig. 3: Heater Circuit, Vehicles Built Before 6/24/96

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

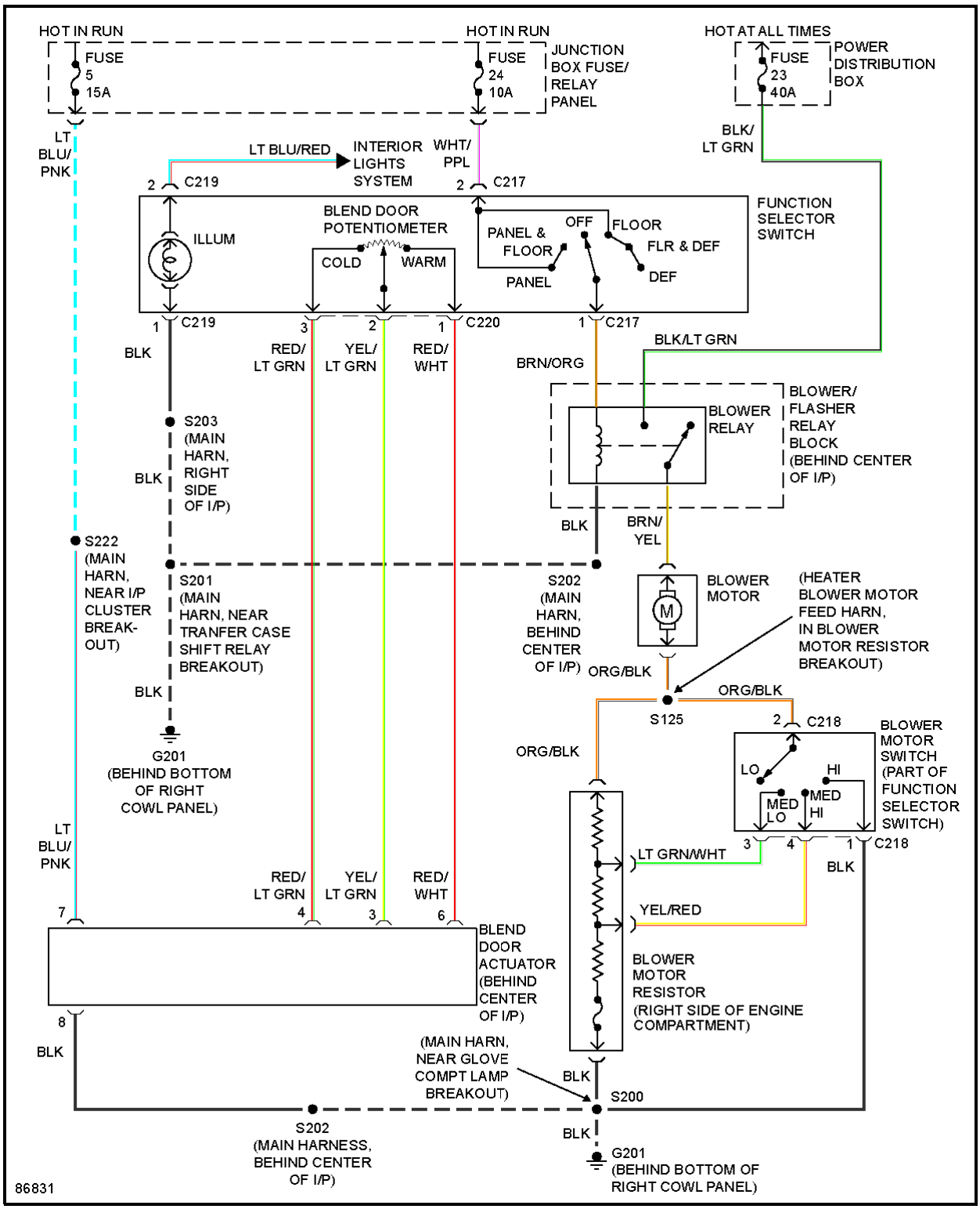


Fig. 4: Heater Circuit, Vehicles Built On or After 6/24/96

ANTI-LOCK BRAKES

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

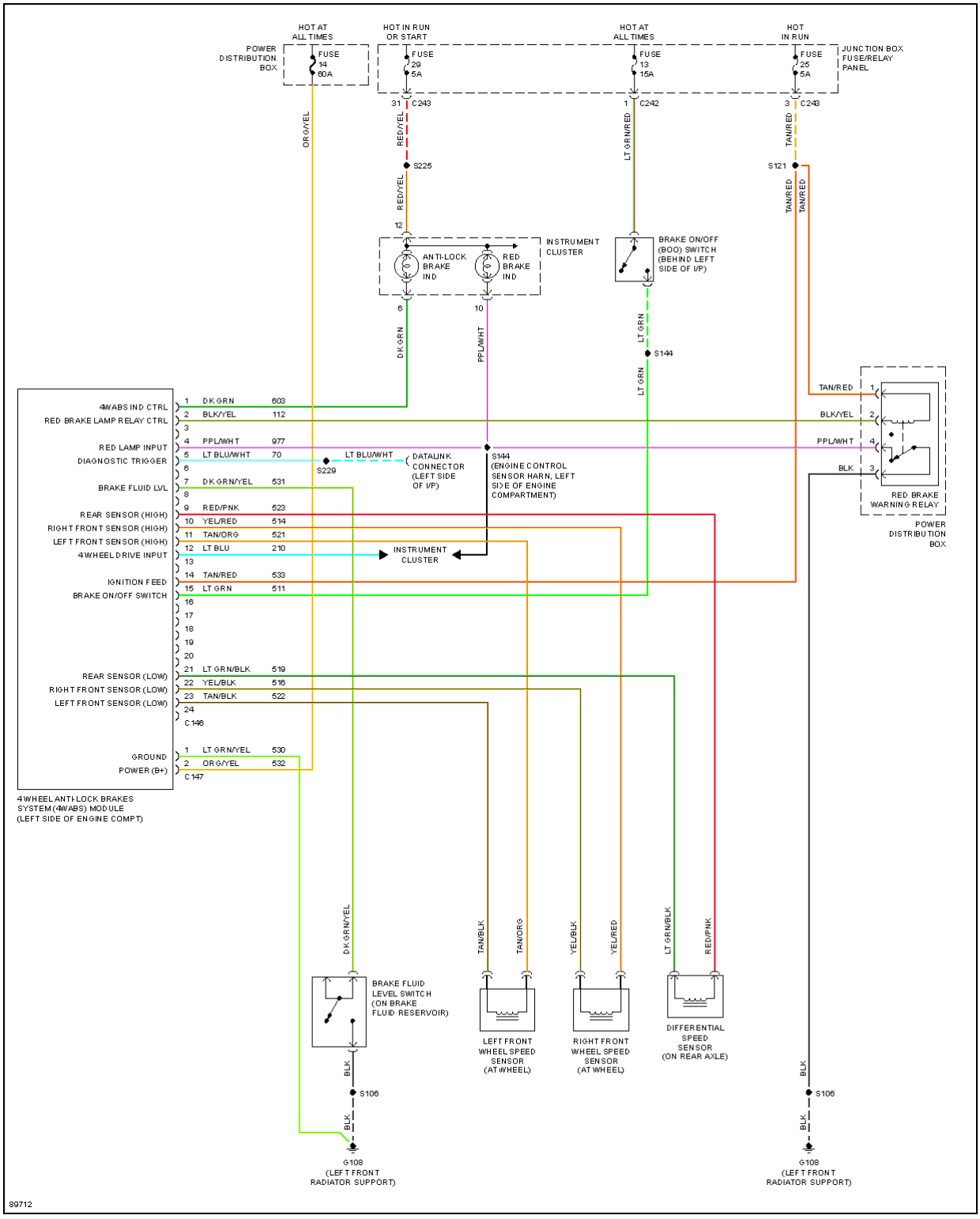


Fig. 5: All-Wheel ABS Circuit

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

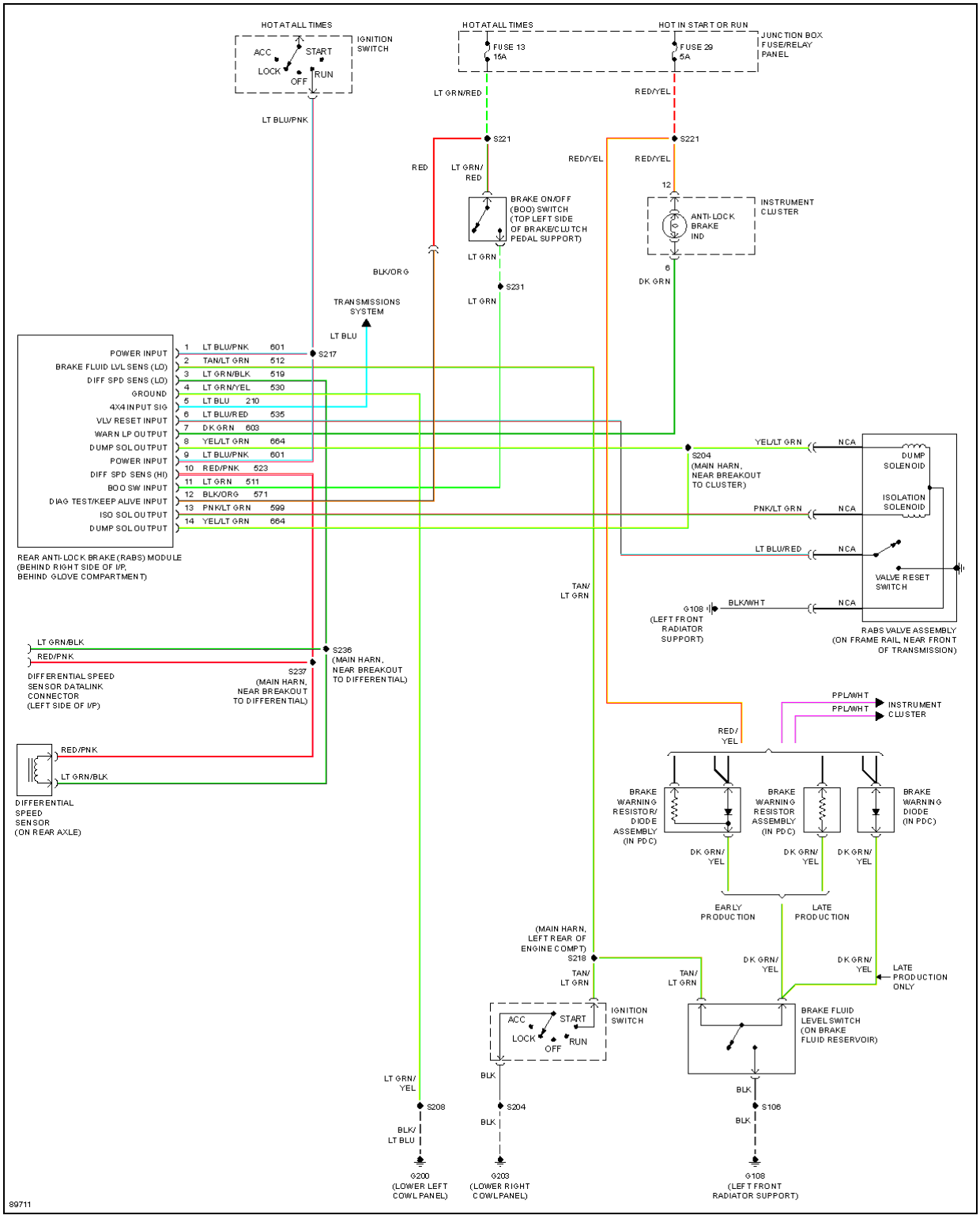


Fig. 6: Rear Wheel ABS Circuit

ANTI-THEFT

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

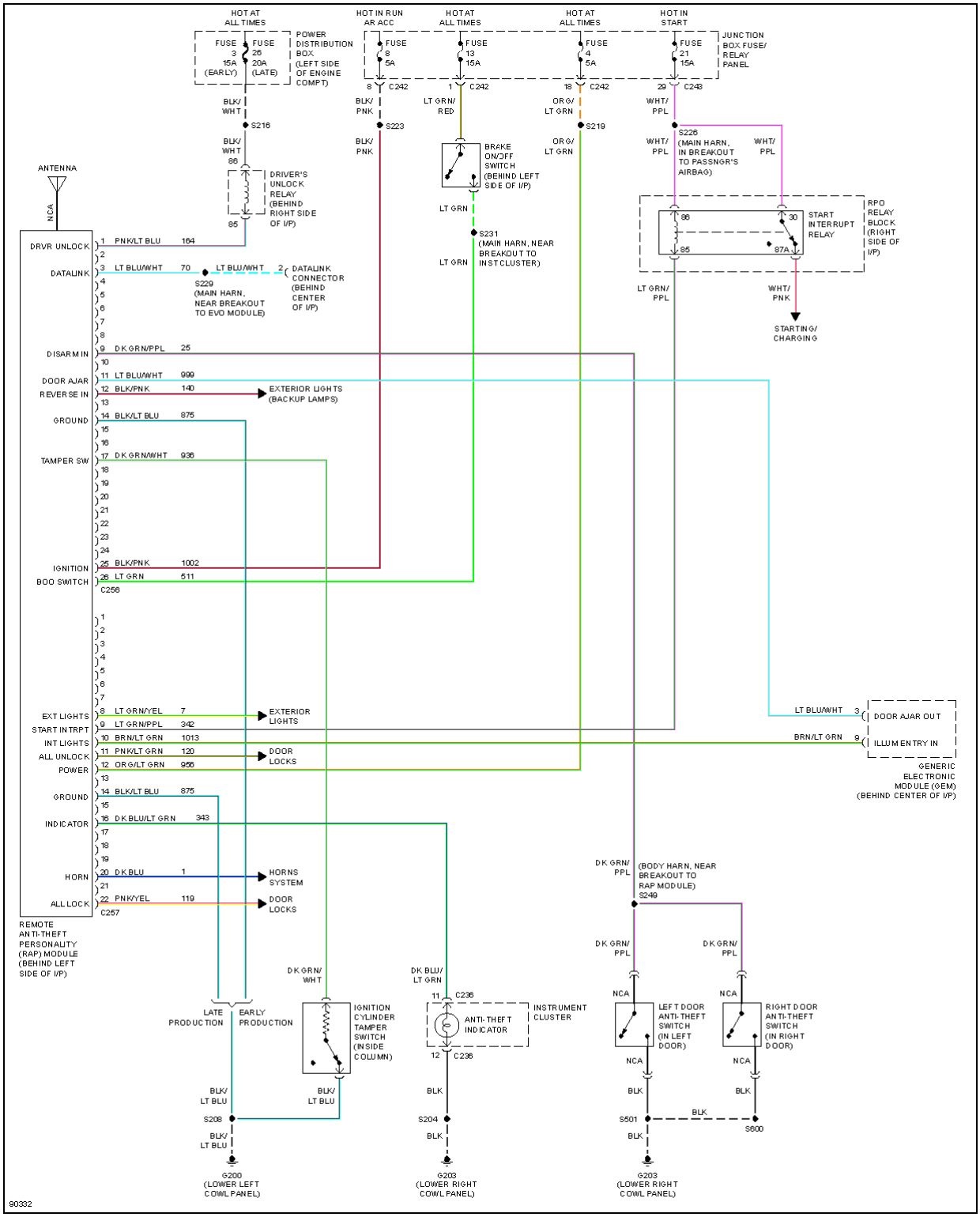


Fig. 7: Anti-theft Circuit

BODY COMPUTER

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

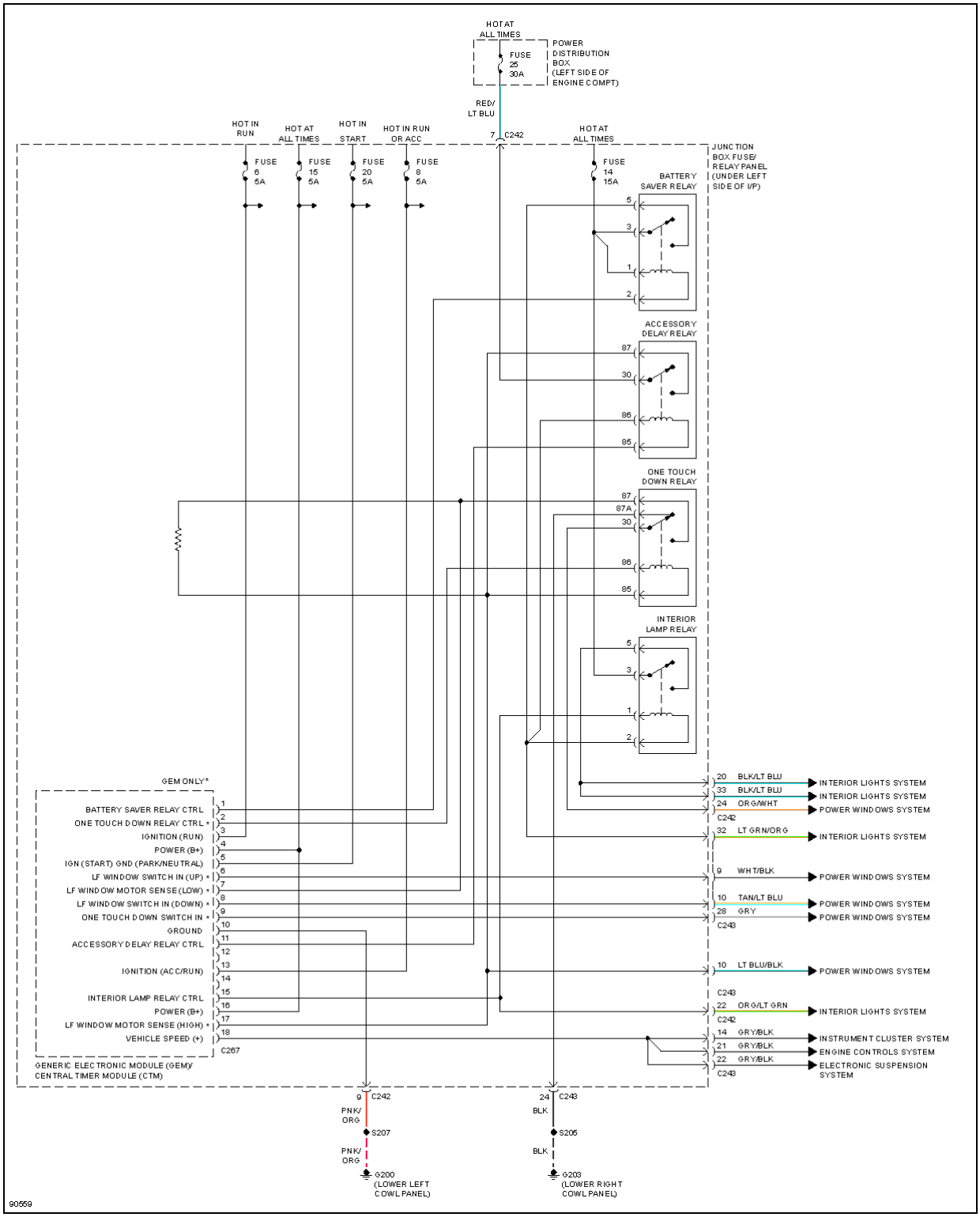


Fig. 8: Body Computer Circuits (1 of 2)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

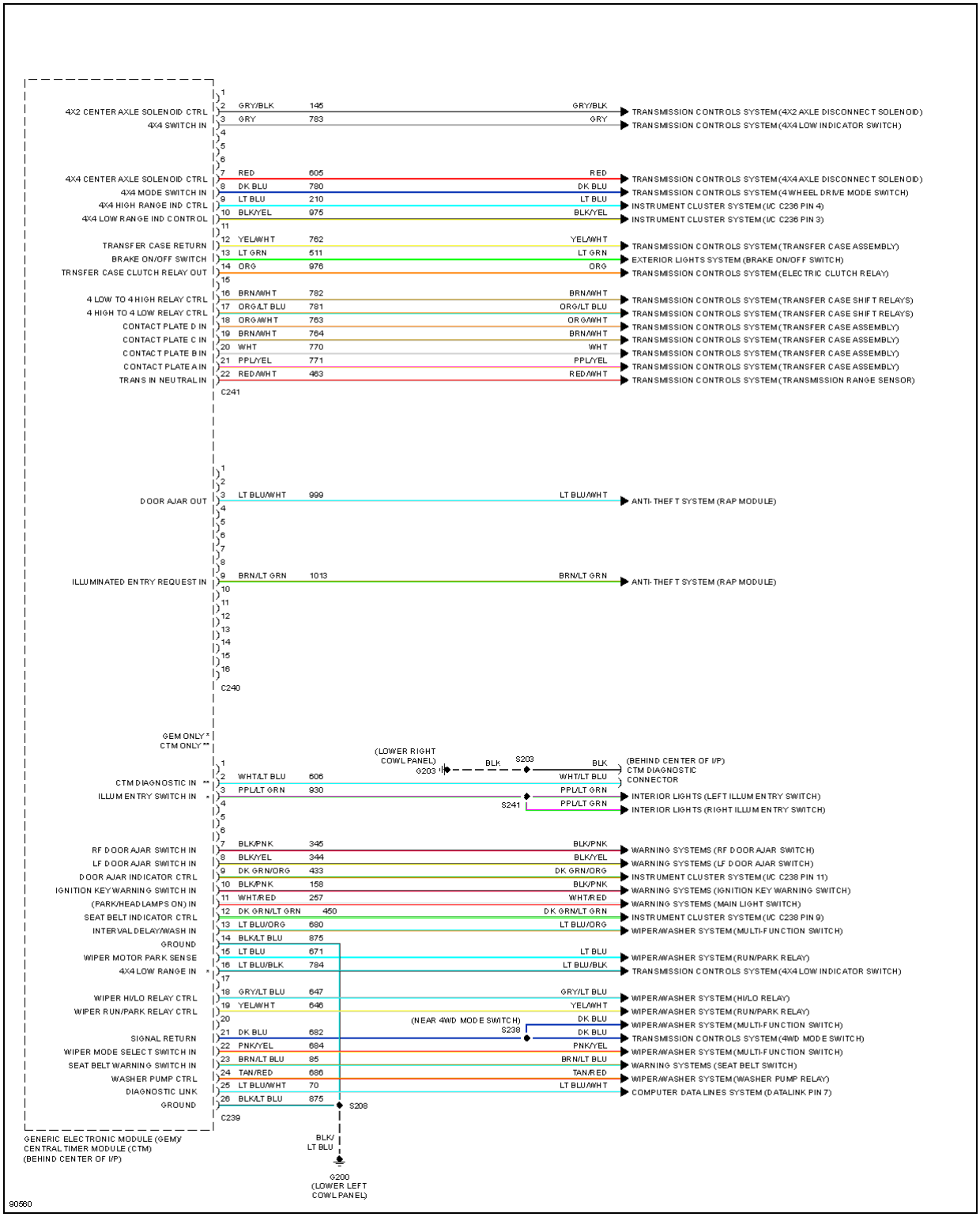


Fig. 9: Body Computer Circuits (2 of 2)

COMPUTER DATA LINES

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

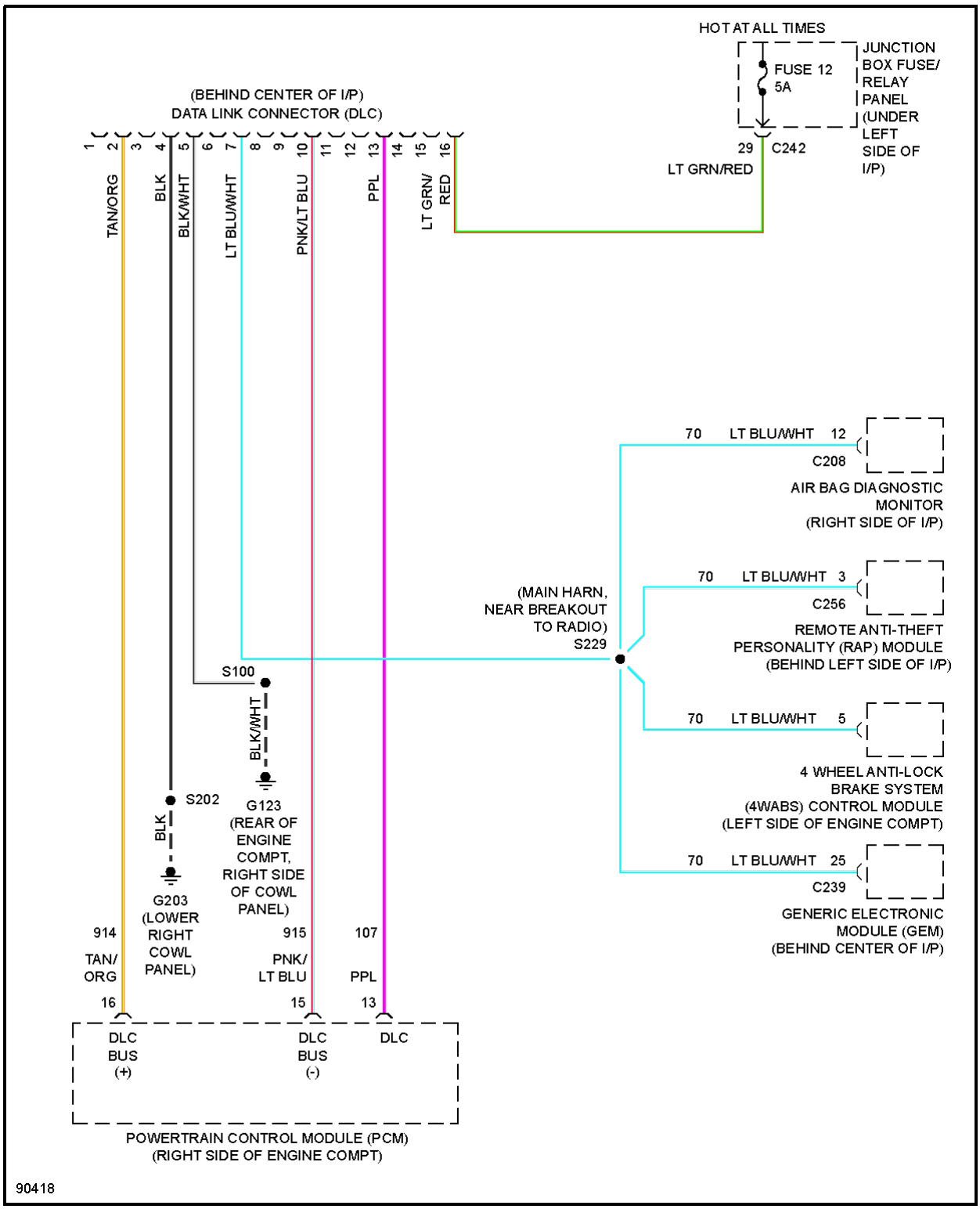


Fig. 10: Computer Data Lines

CRUISE CONTROL

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

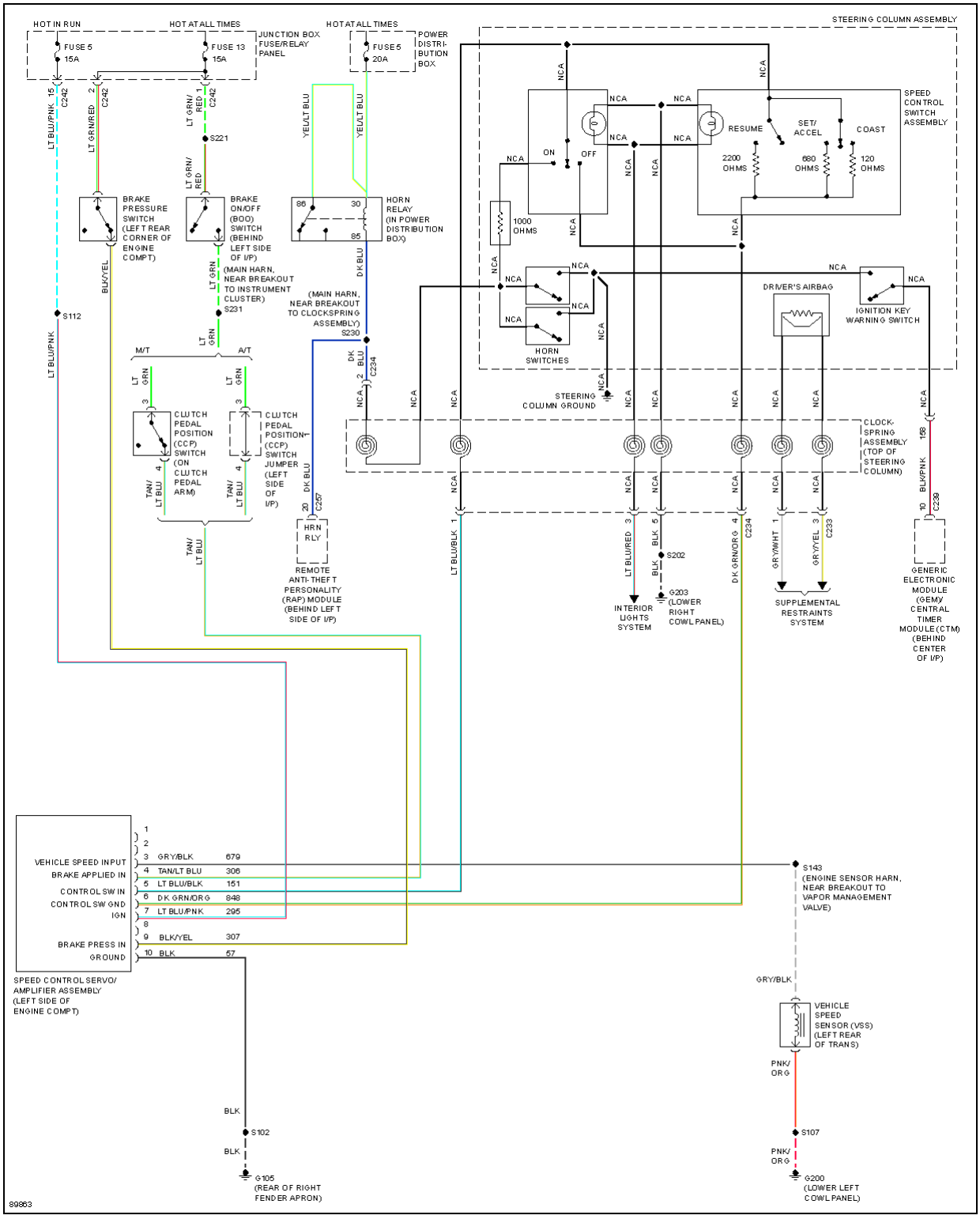


Fig. 11: Cruise Control Circuit

ELECTRONIC SUSPENSION

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

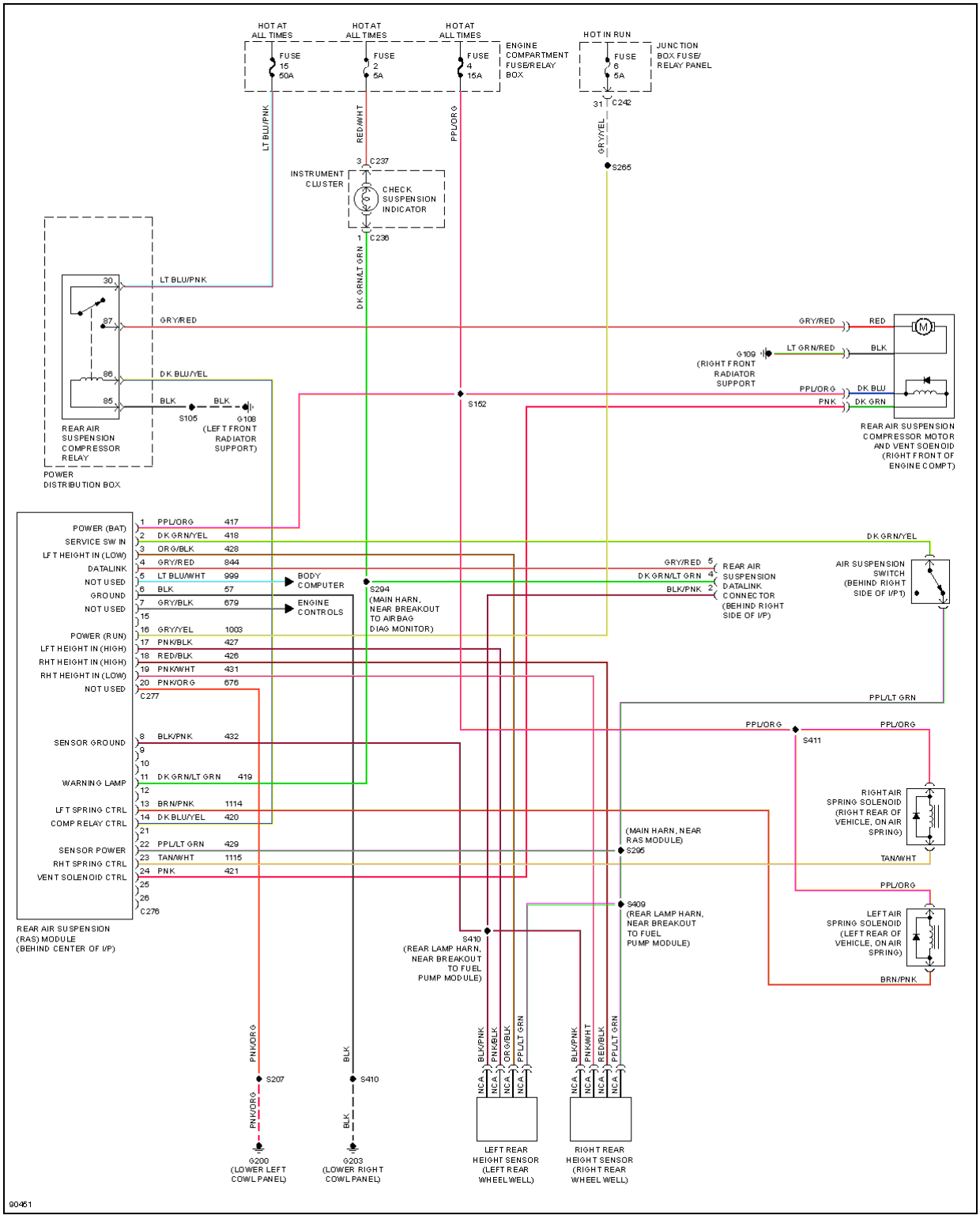


Fig. 12: Electronic Suspension Circuit

ENGINE PERFORMANCE

4.2L

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

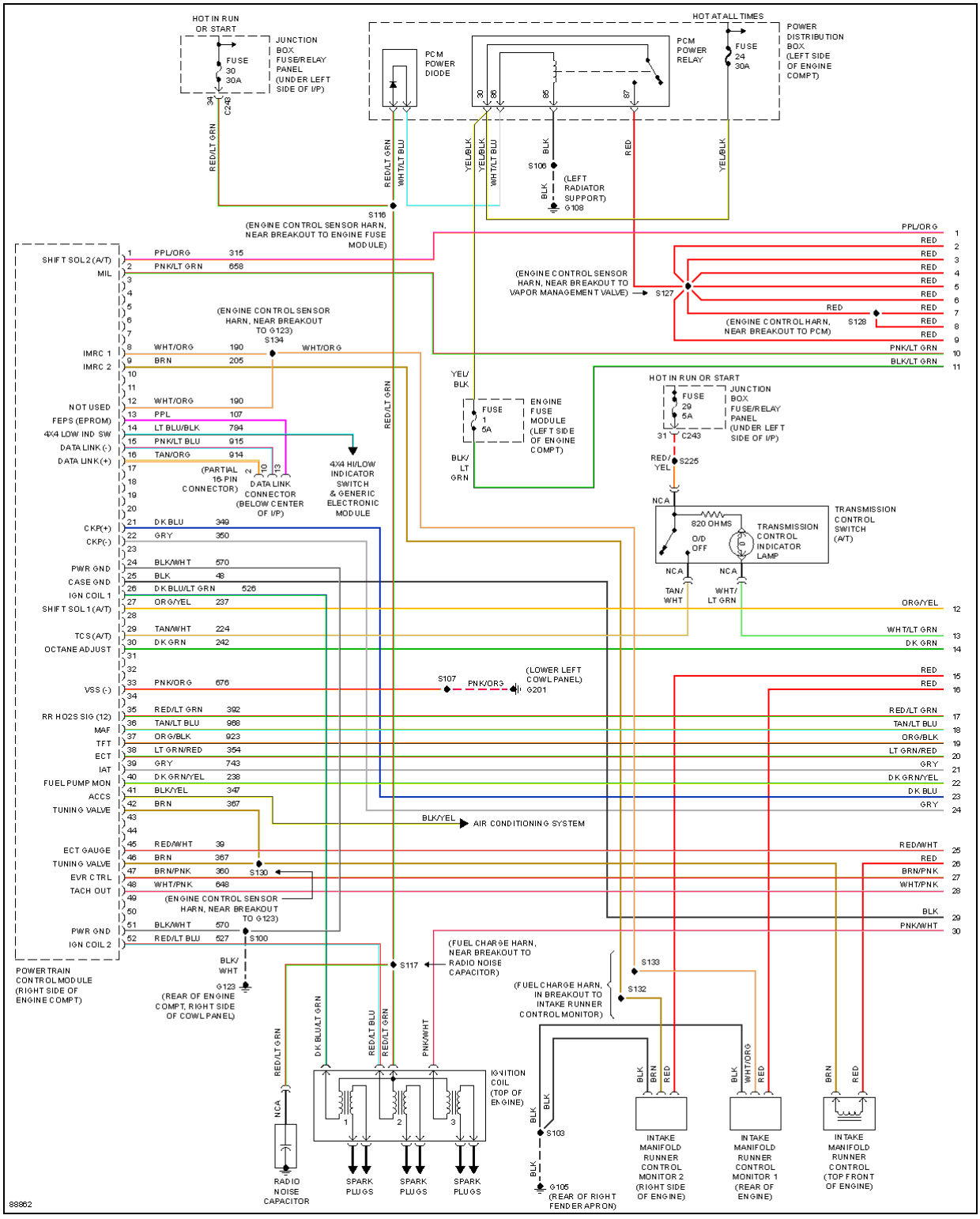


Fig. 13: 4.2L, Engine Performance Circuits, Early Production (1 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

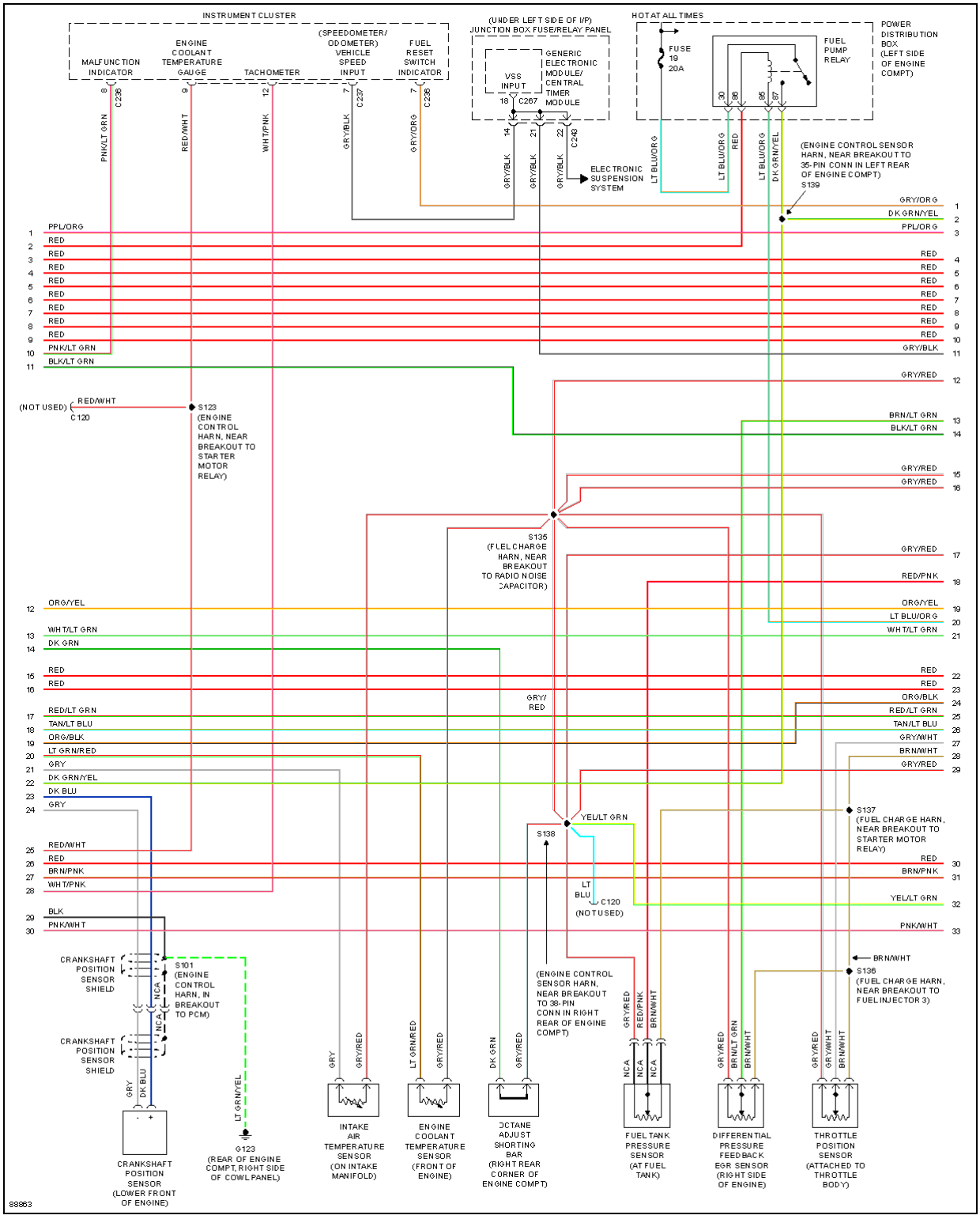


Fig. 14: 4.2L, Engine Performance Circuits, Early Production (2 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

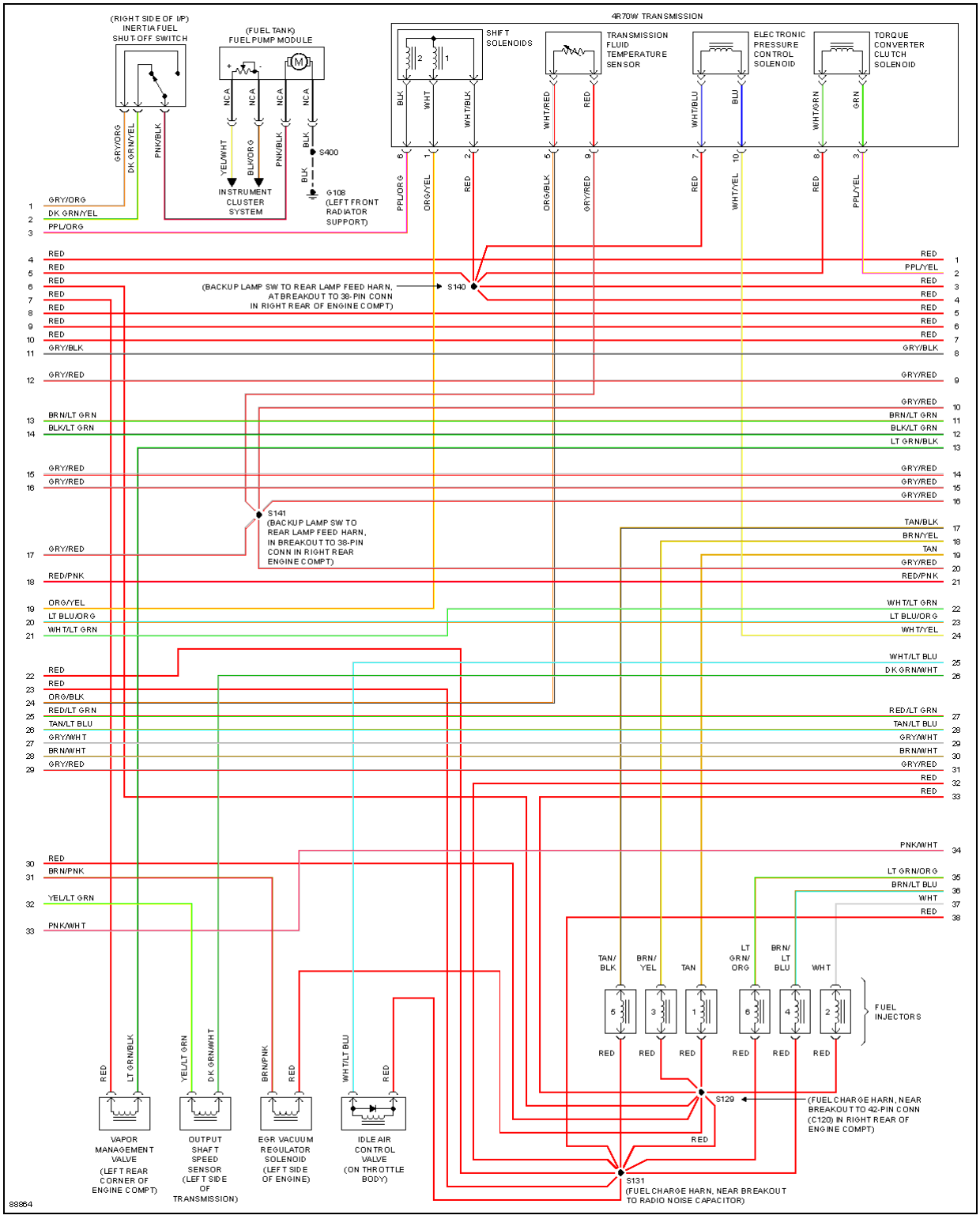


Fig. 15: 4.2L, Engine Performance Circuits, Early Production (3 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

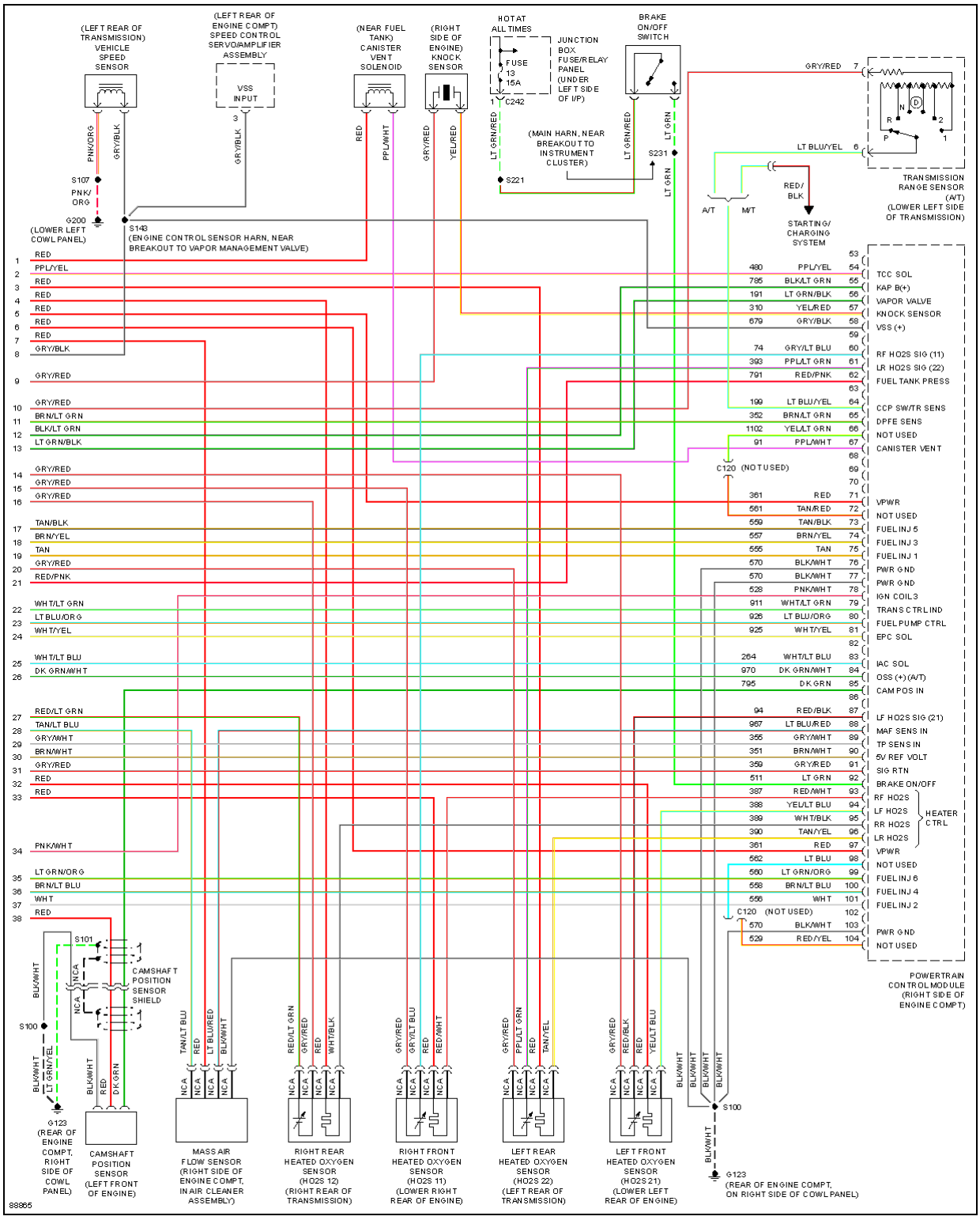


Fig. 16: 4.2L, Engine Performance Circuits, Early Production (4 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

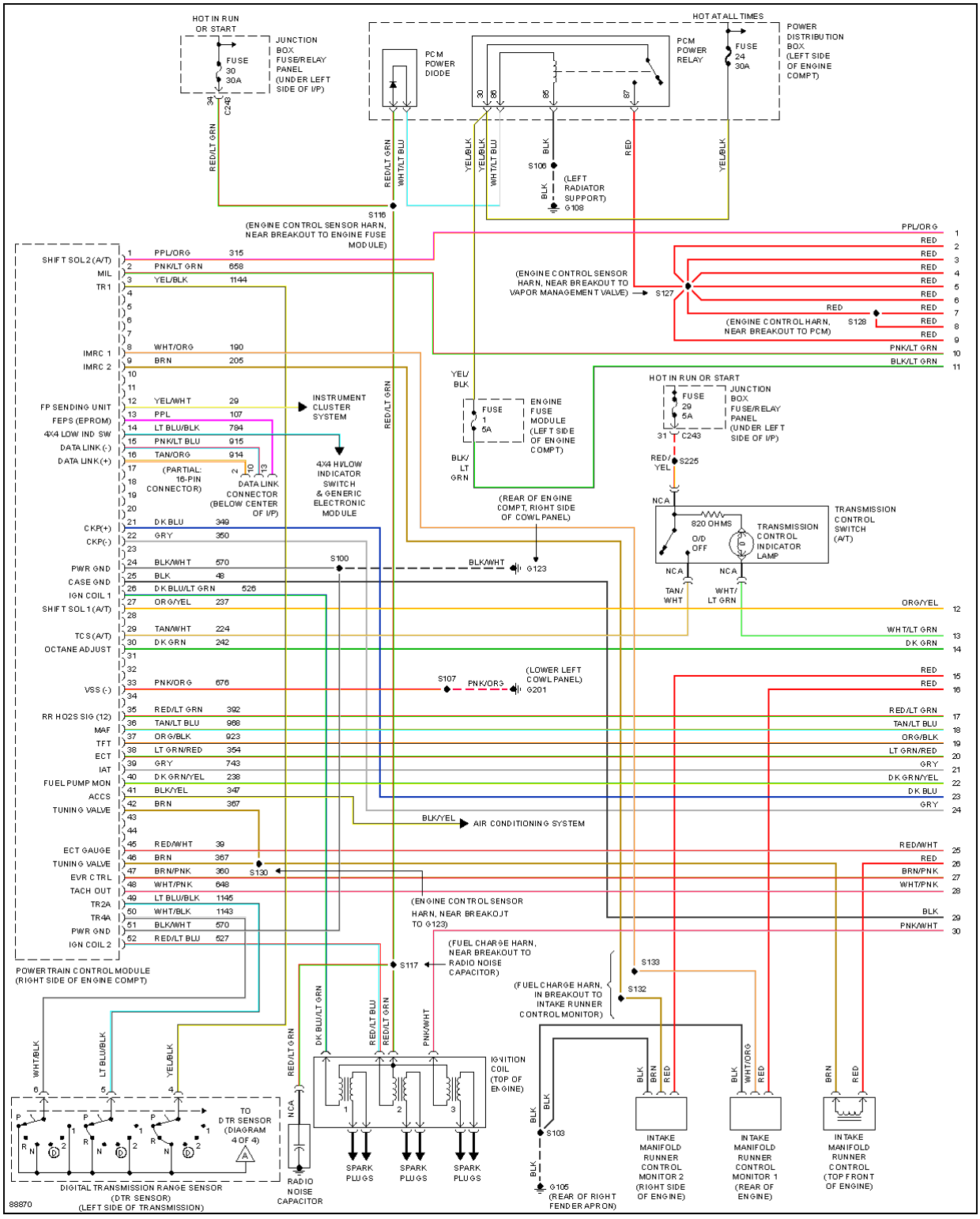


Fig. 17: 4.2L, Engine Performance Circuits, Late Production (1 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

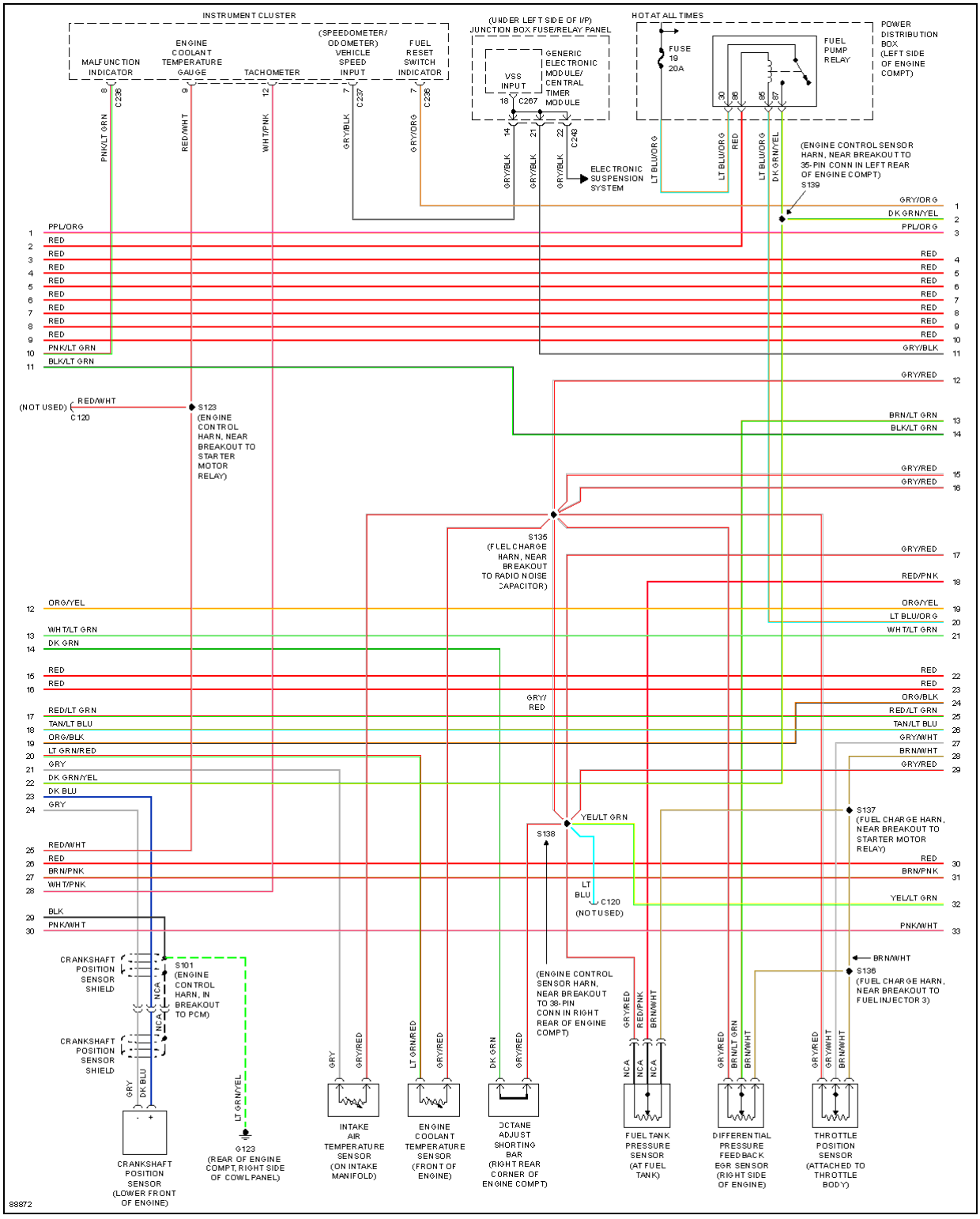


Fig. 18: 4.2L, Engine Performance Circuits, Late Production (2 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

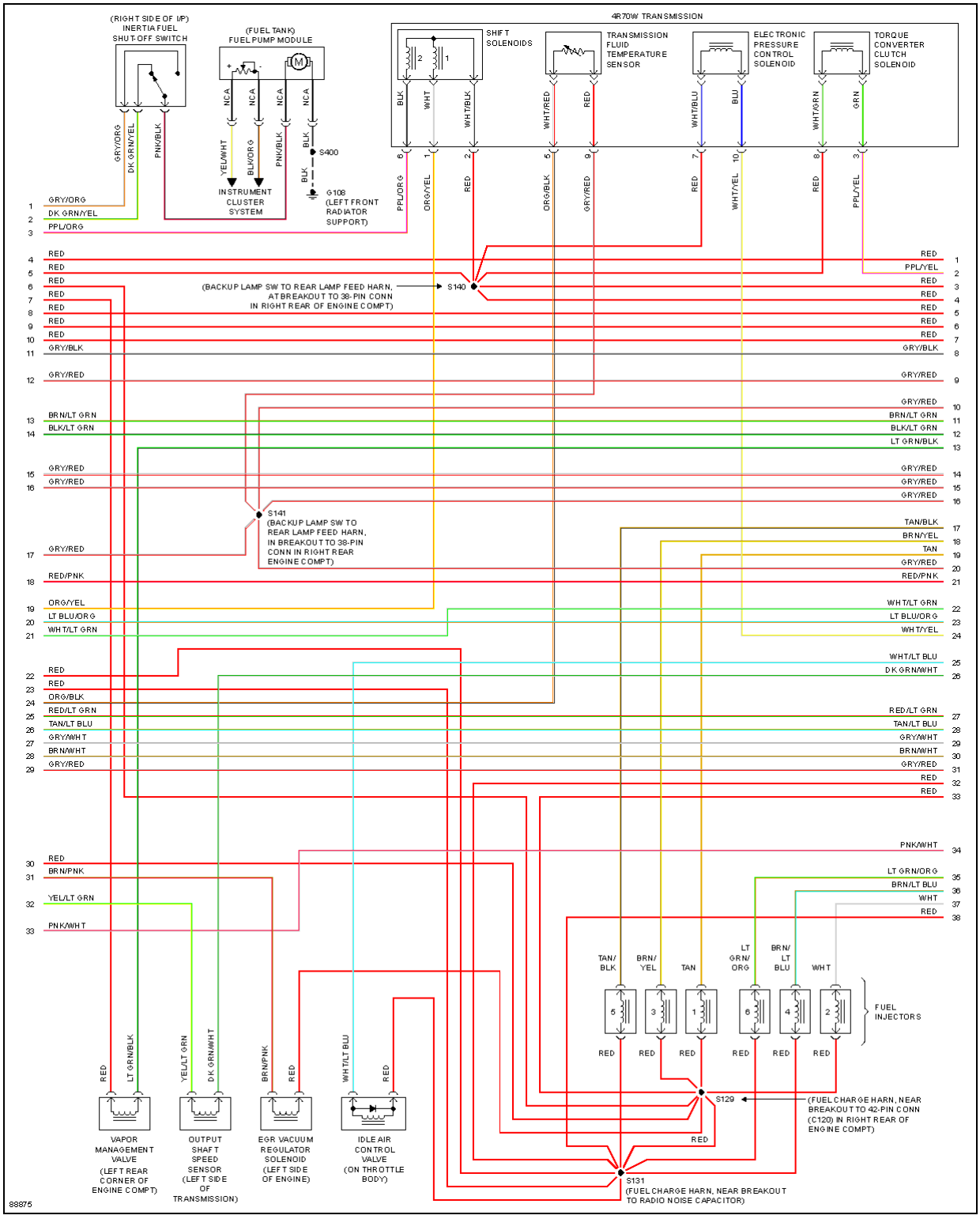


Fig. 19: 4.2L, Engine Performance Circuits, Late Production (3 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

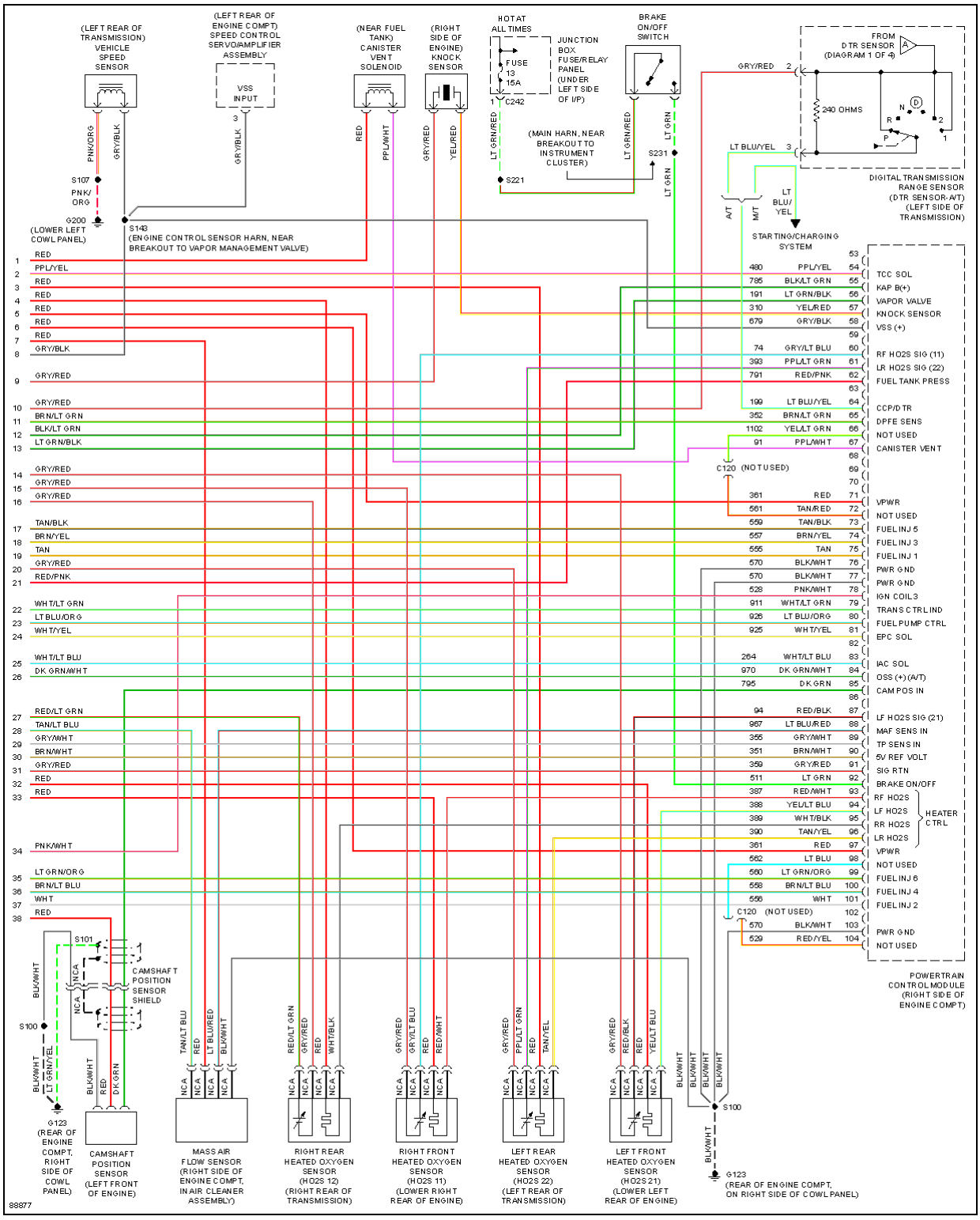


Fig. 20: 4.2L, Engine Performance Circuits, Late Production (4 of 4)

4.6L

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

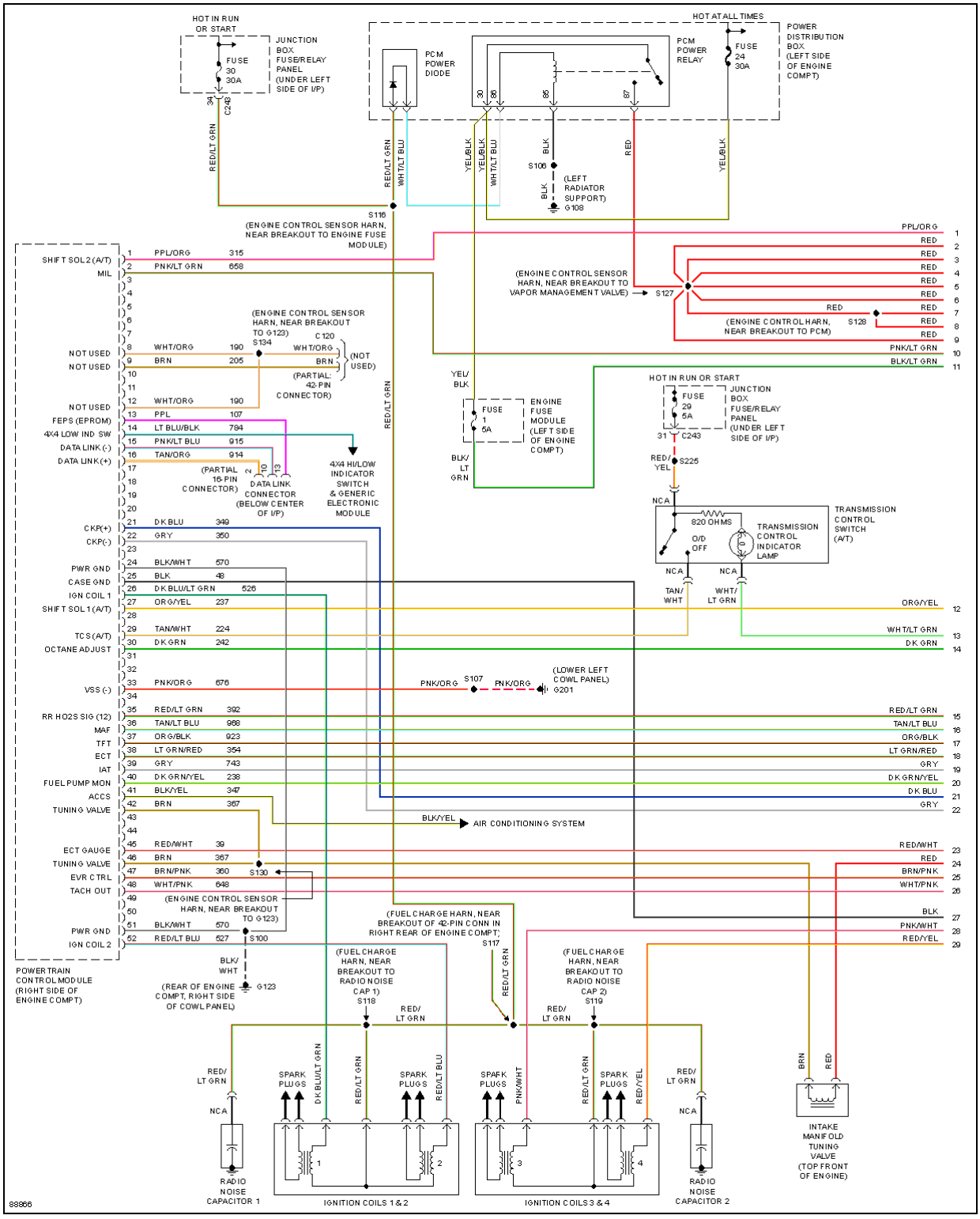


Fig. 21: 4.6L, Engine Performance Circuits, Early Production (1 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

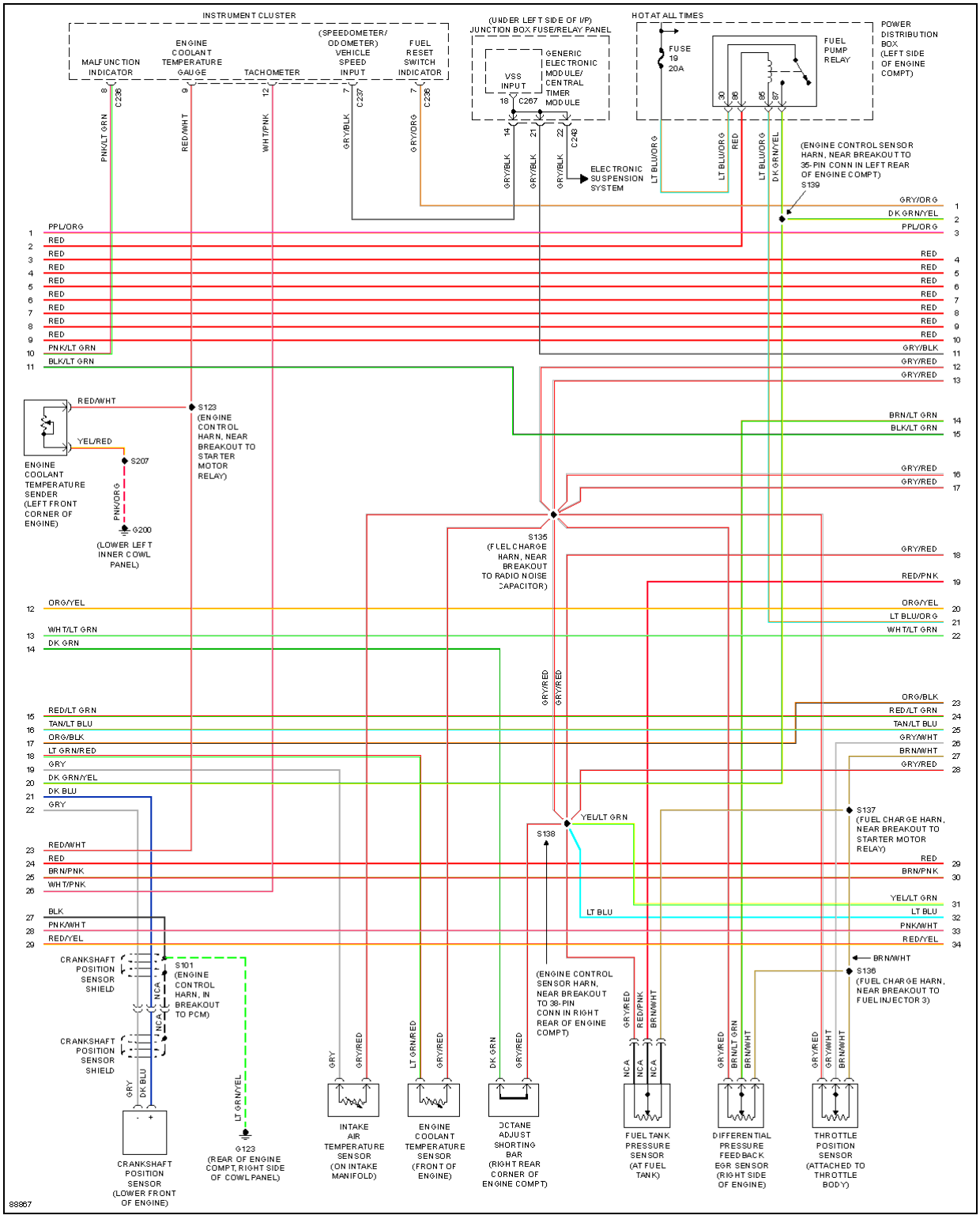


Fig. 22: 4.6L, Engine Performance Circuits, Early Production (2 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

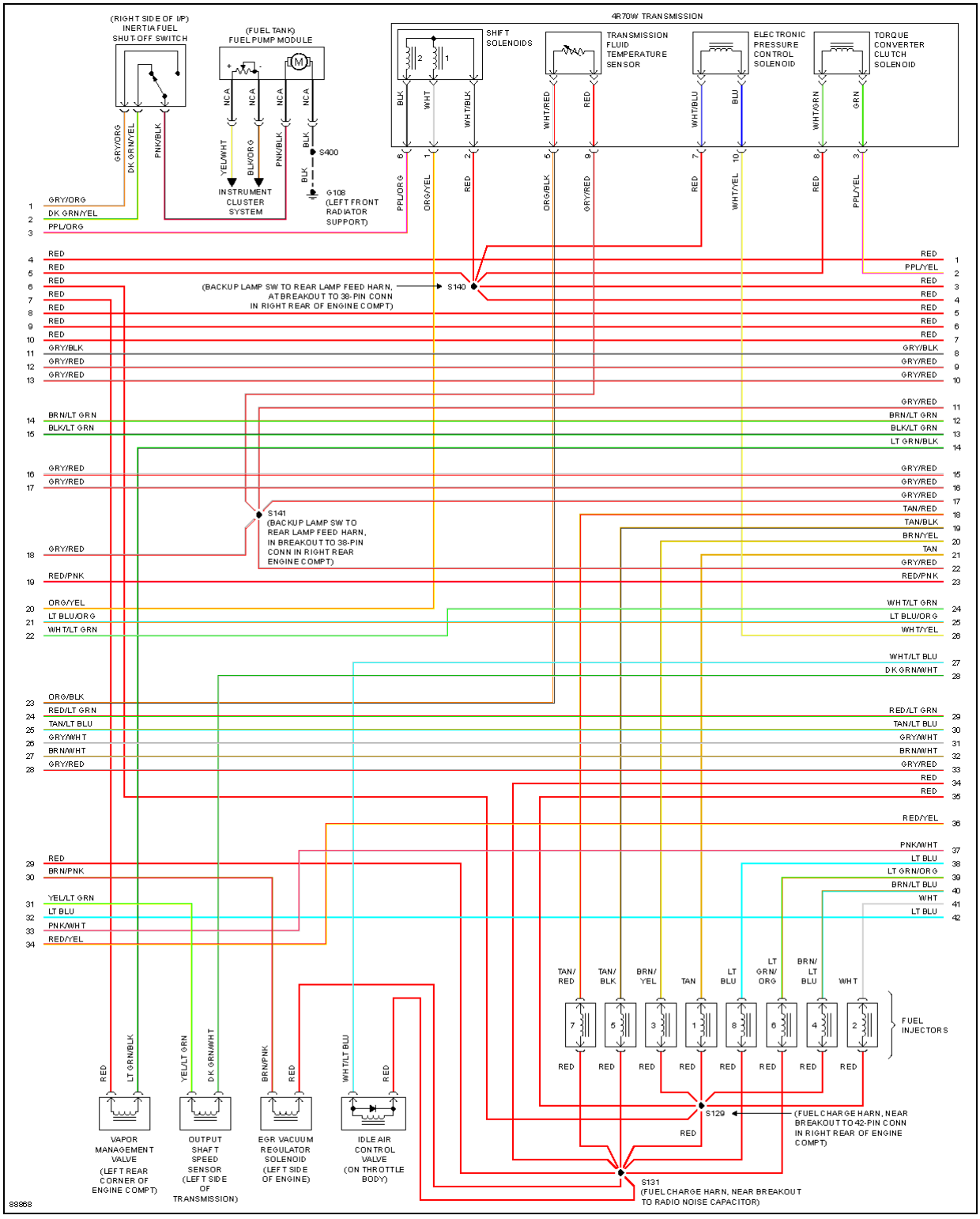


Fig. 23: 4.6L, Engine Performance Circuits, Early Production (3 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

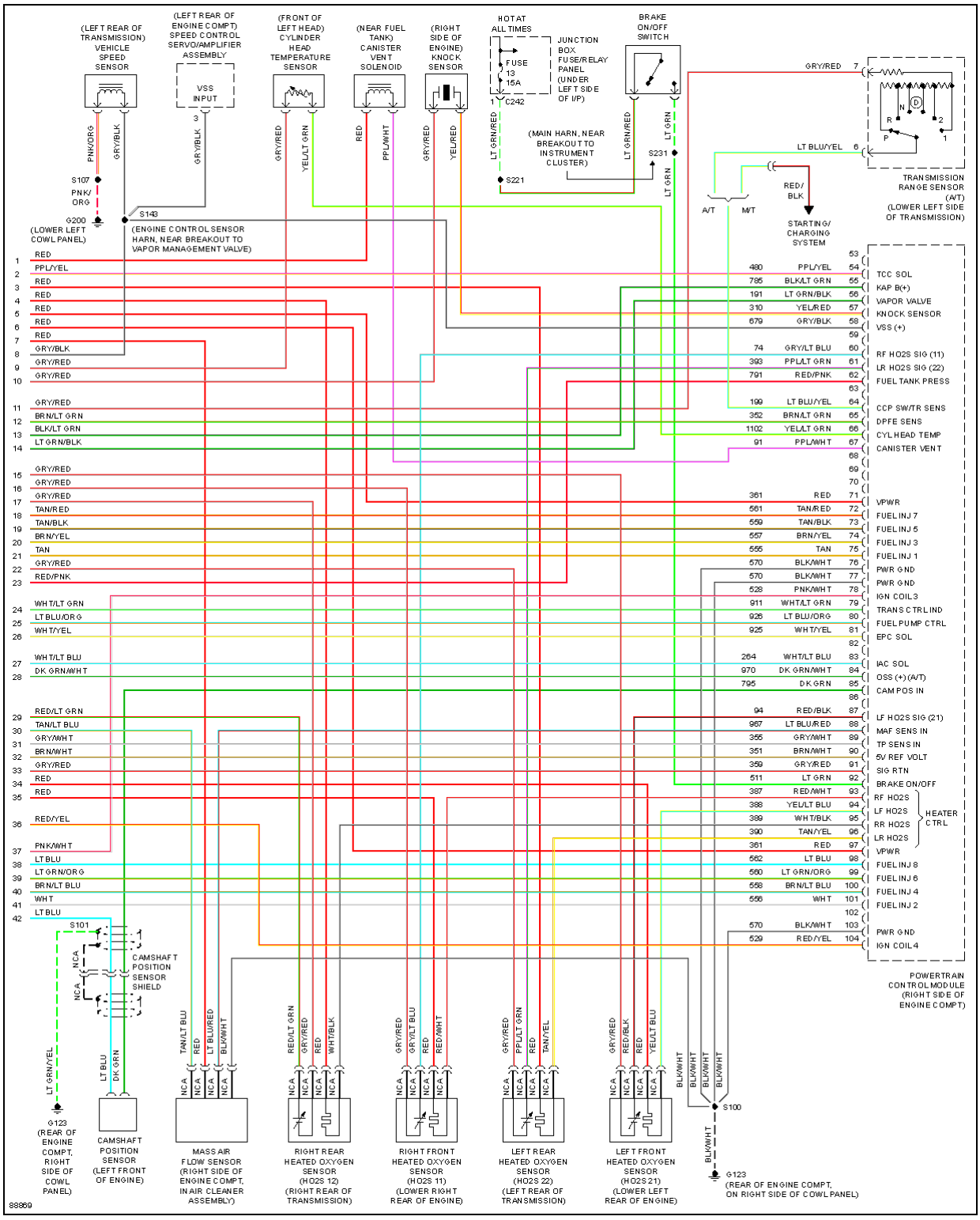


Fig. 24: 4.6L, Engine Performance Circuits, Early Production (4 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

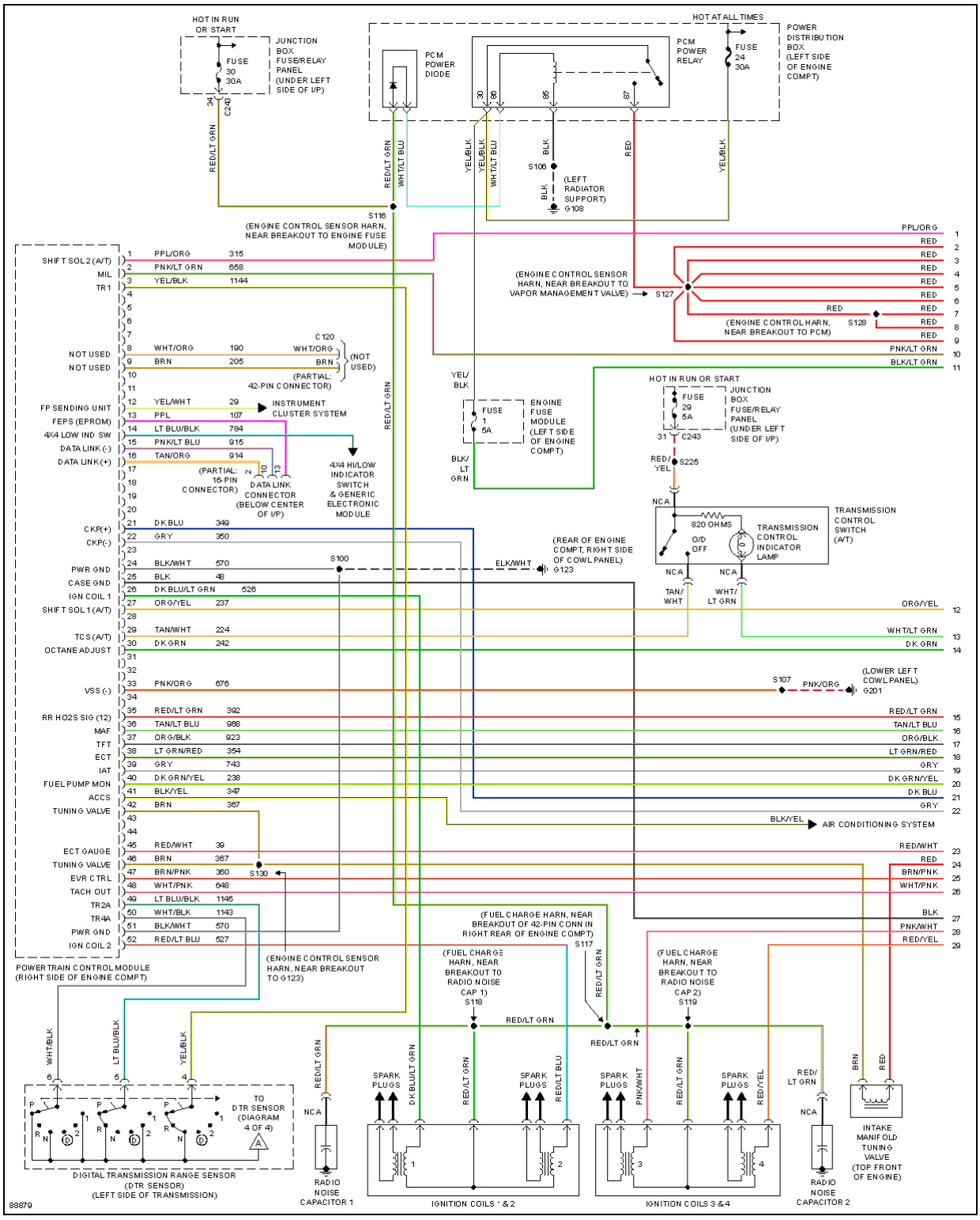


Fig. 25: 4.6L, Engine Performance Circuits, Late Production (1 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

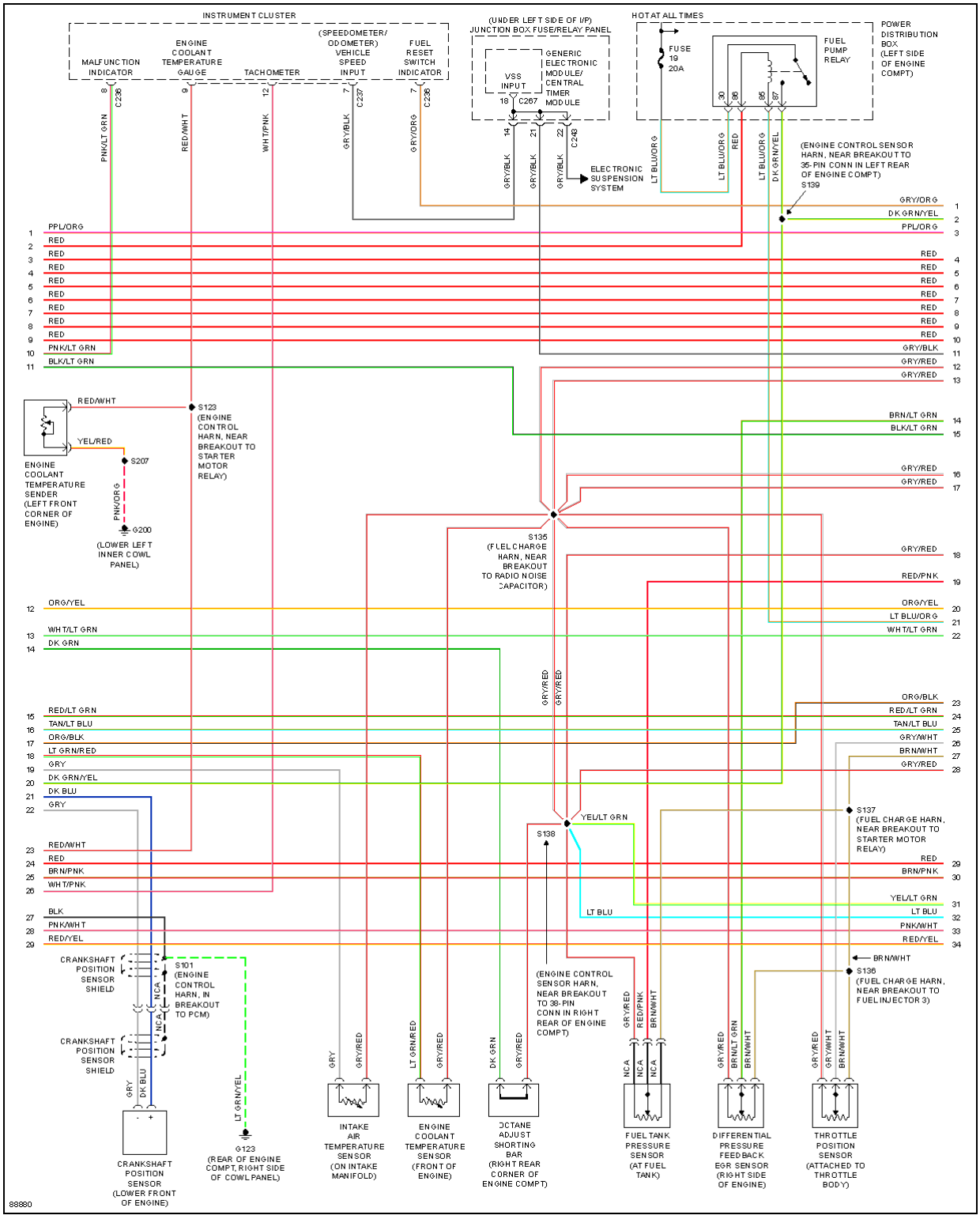


Fig. 26: 4.6L, Engine Performance Circuits, Late Production (2 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

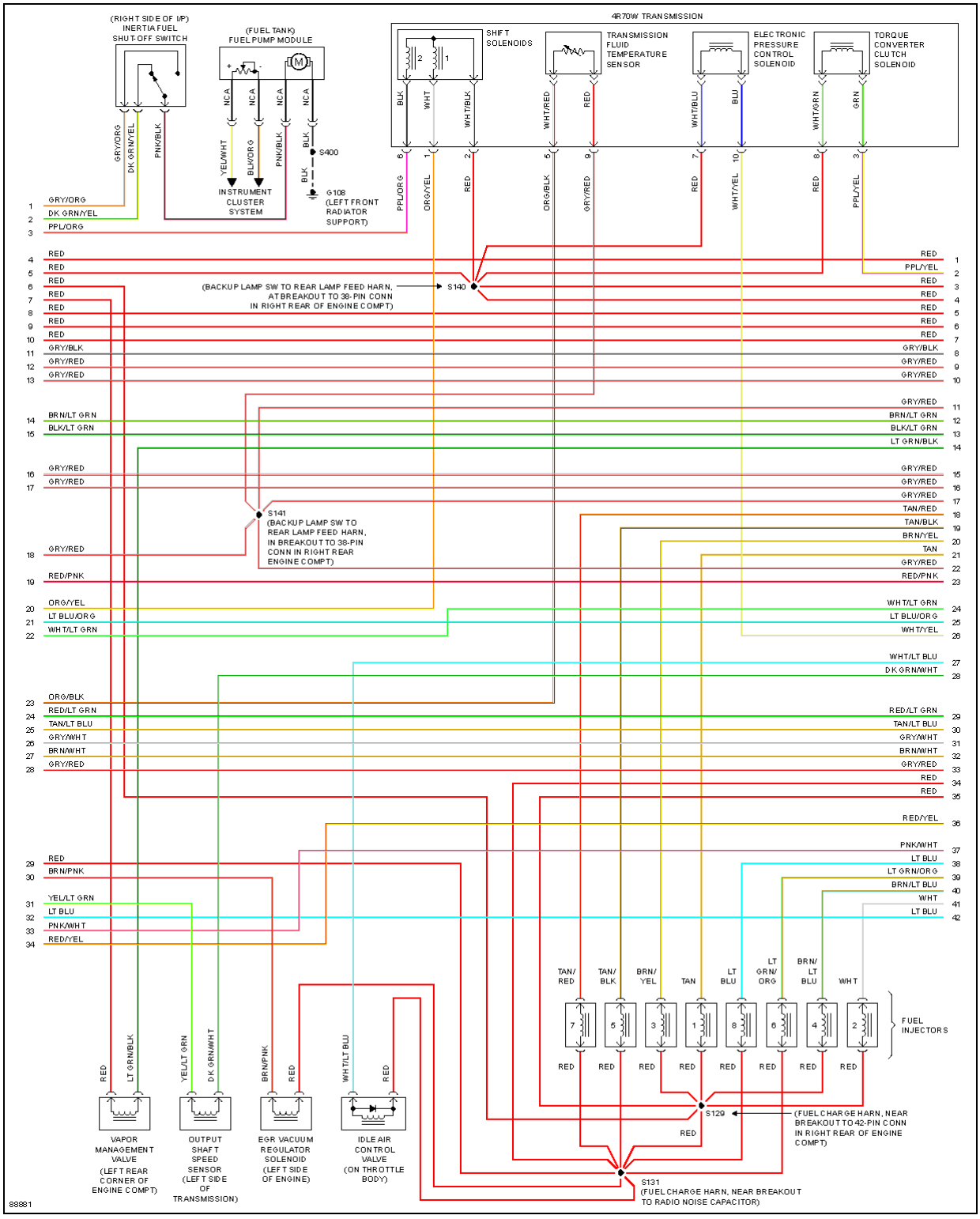


Fig. 27: 4.6L, Engine Performance Circuits, Late Production (3 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

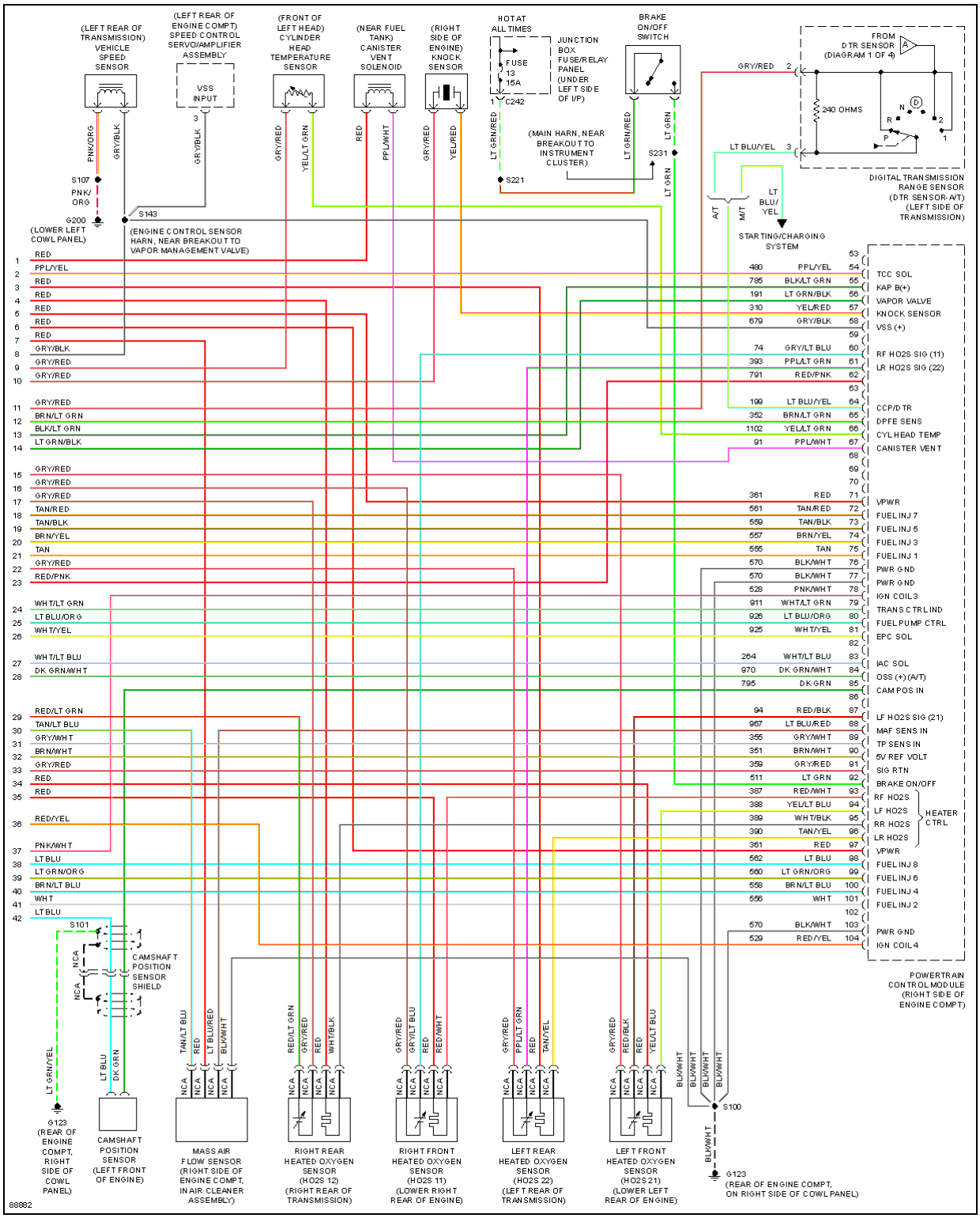


Fig. 28: 4.6L, Engine Performance Circuits, Late Production (4 of 4)

5.4L

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

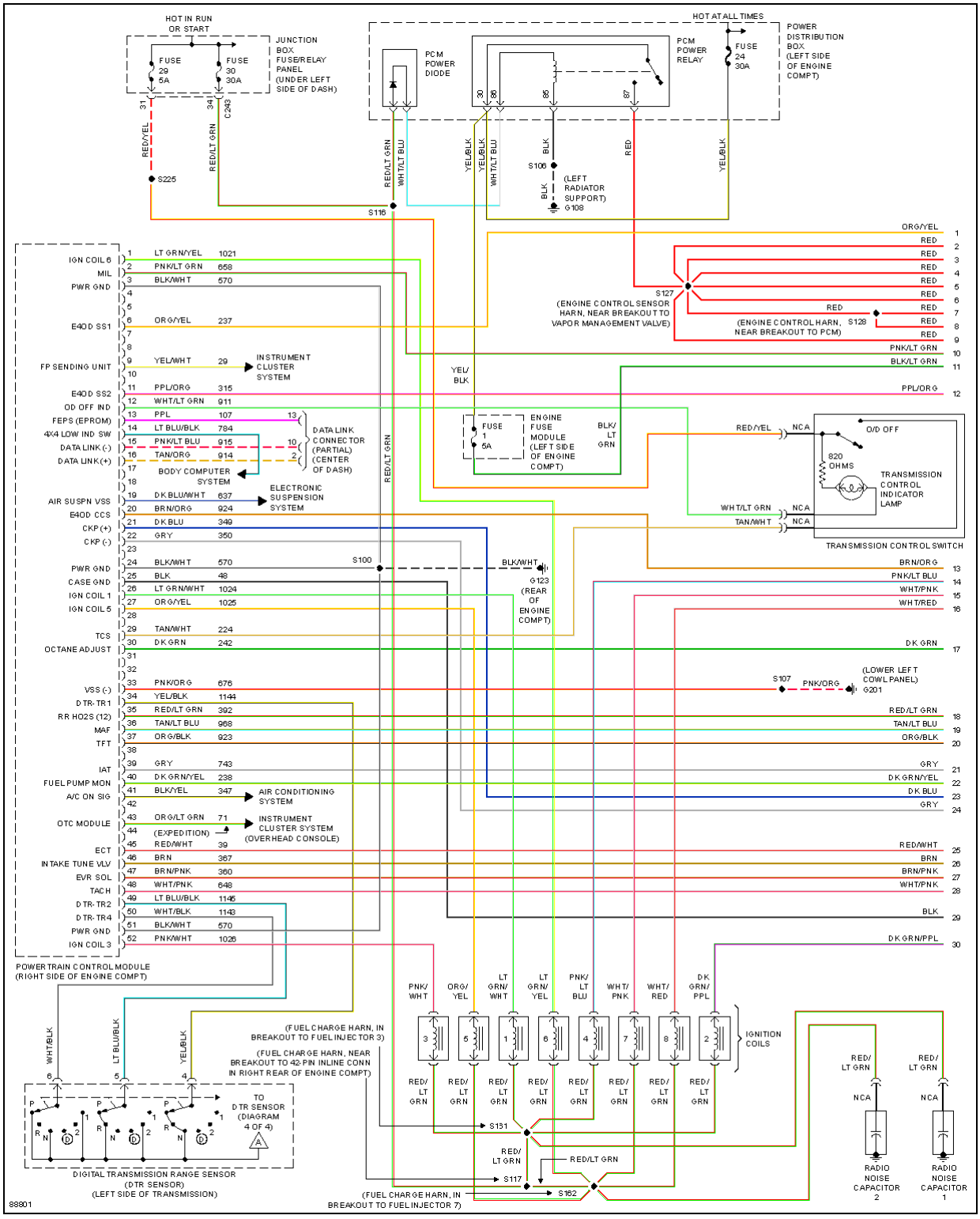


Fig. 29: 5.4L, Engine Performance Circuits (1 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

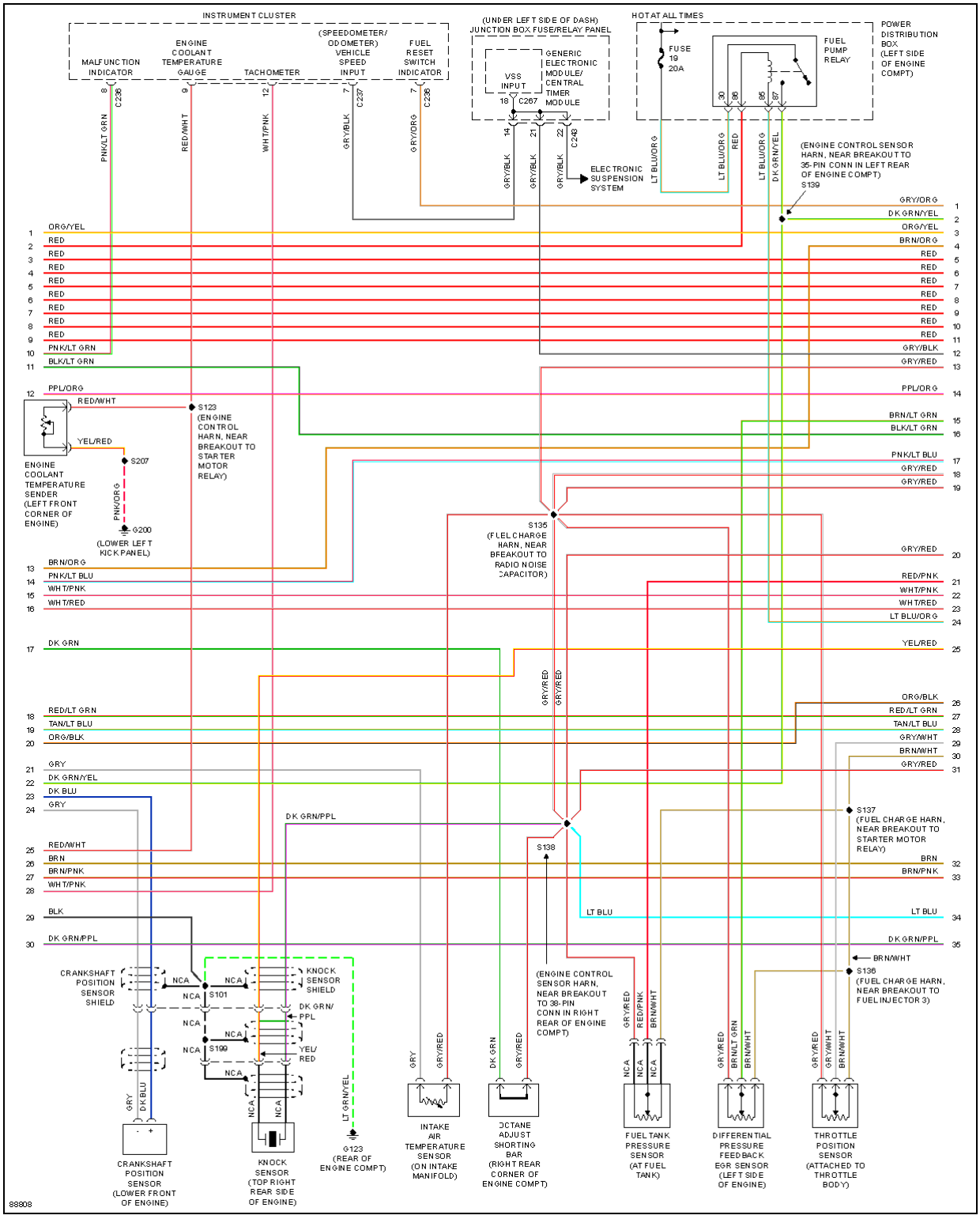


Fig. 30: 5.4L, Engine Performance Circuits (2 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

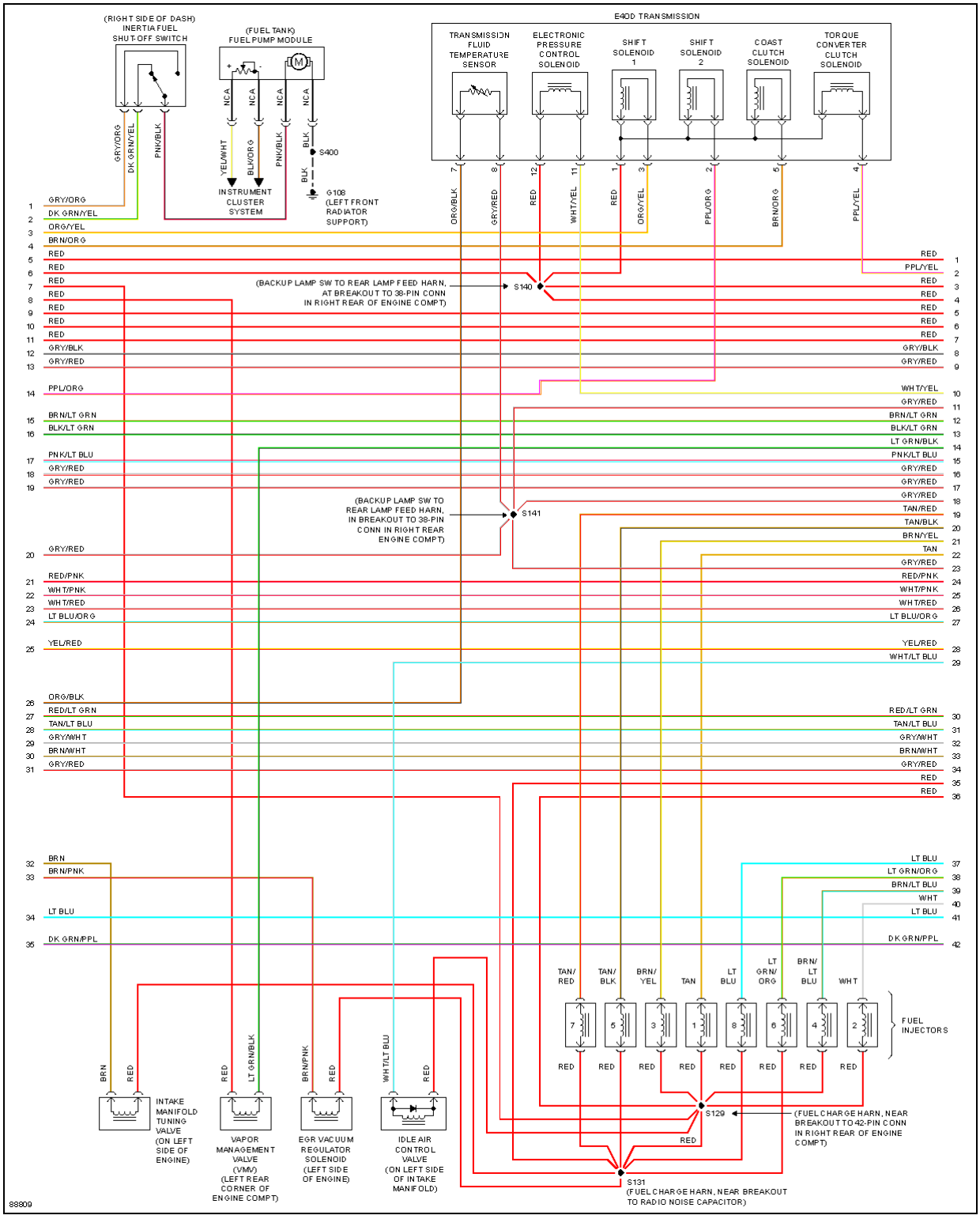


Fig. 31: 5.4L, Engine Performance Circuits (3 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

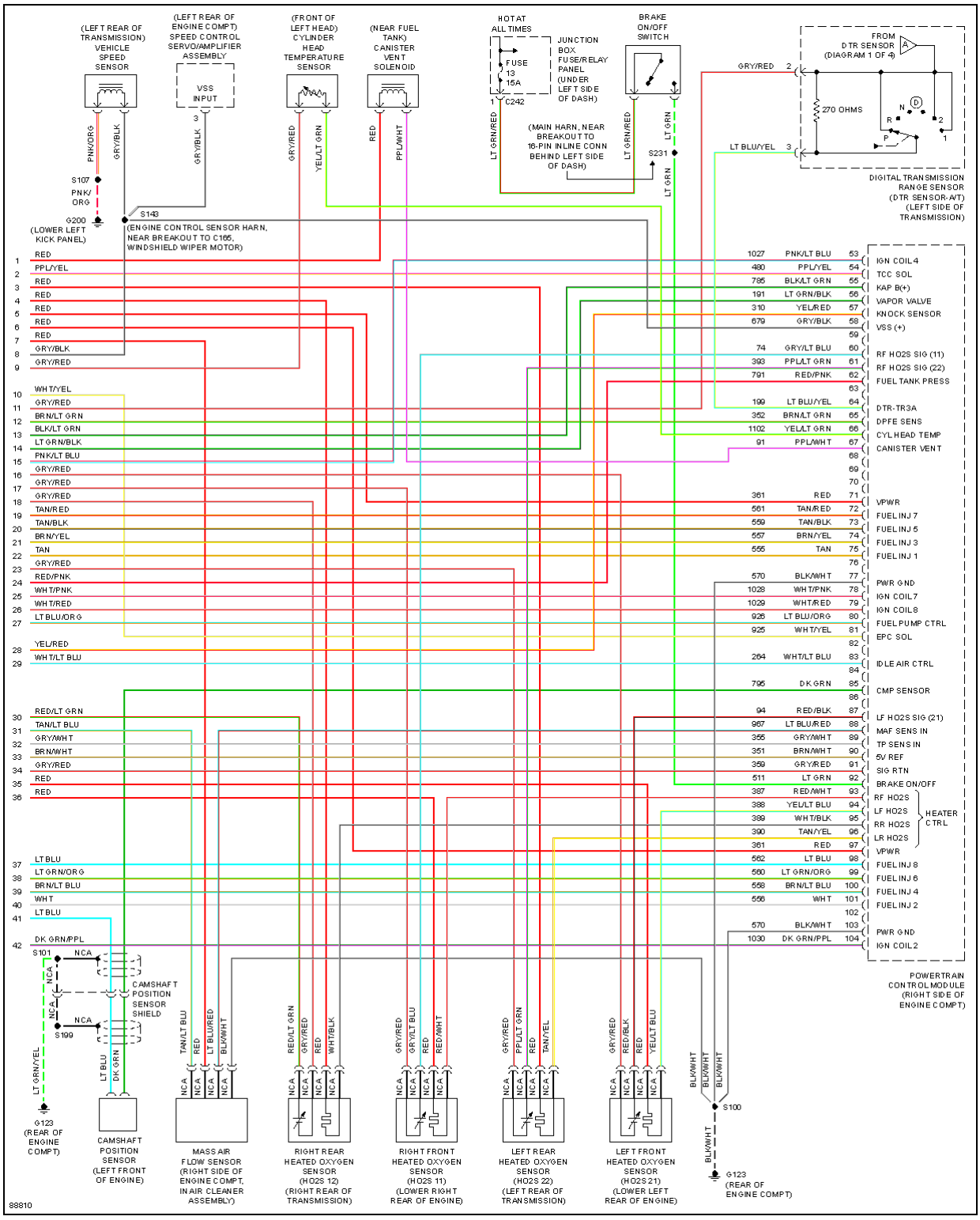


Fig. 32: 5.4L, Engine Performance Circuits (4 of 4)

EXTERIOR LIGHTS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

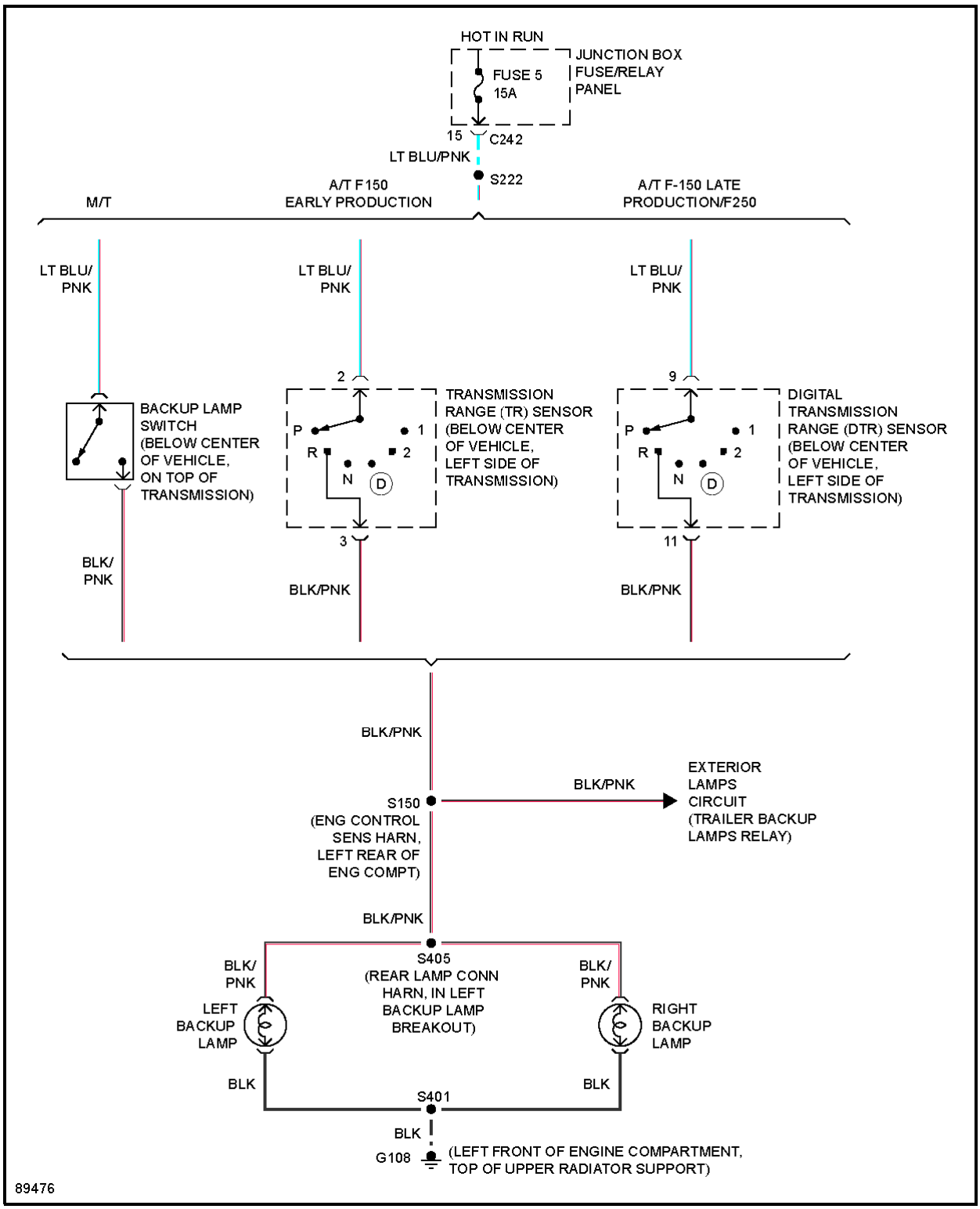


Fig. 33: Back-up Lamps Circuit

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

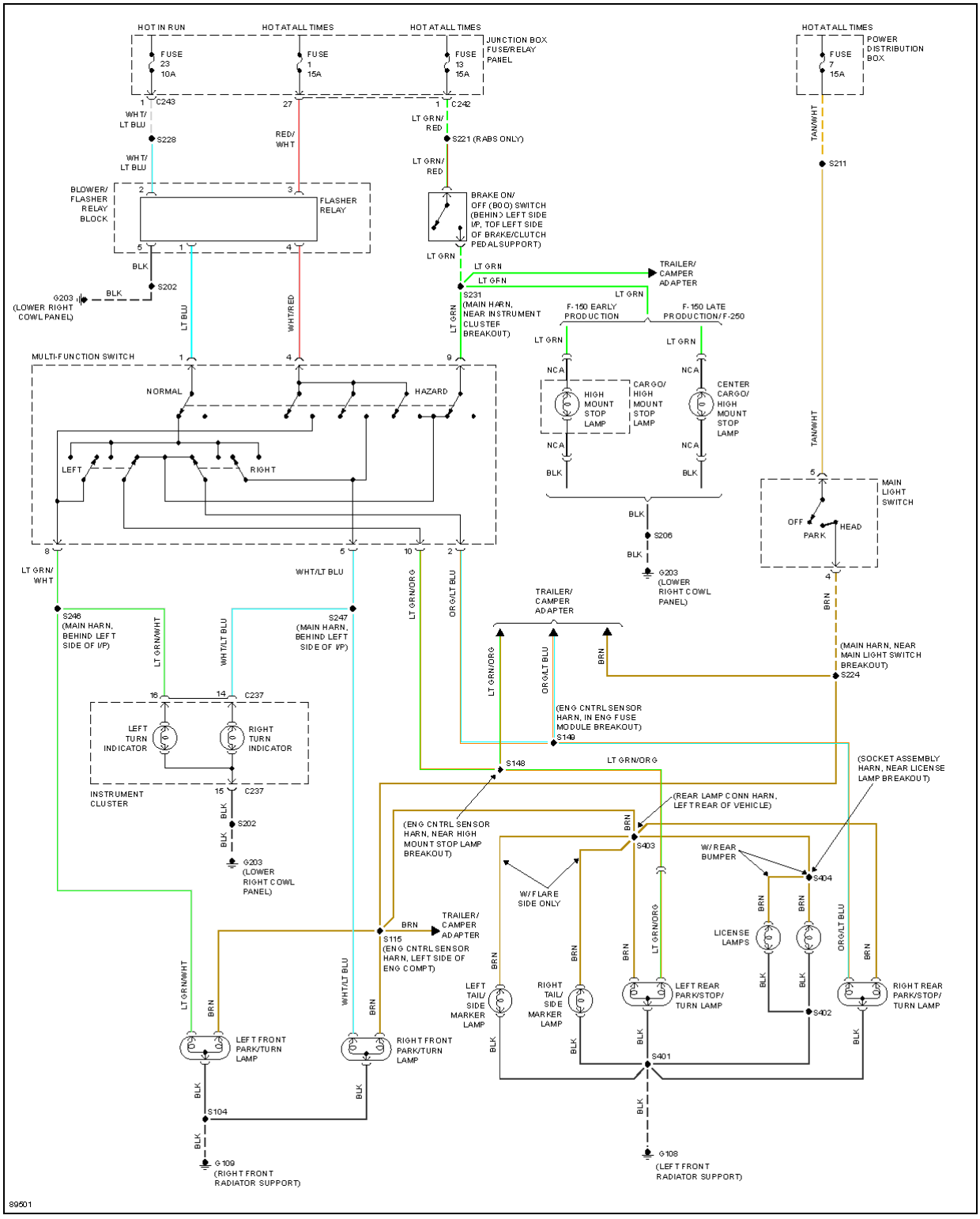


Fig. 34: Exterior Lamps Circuit

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

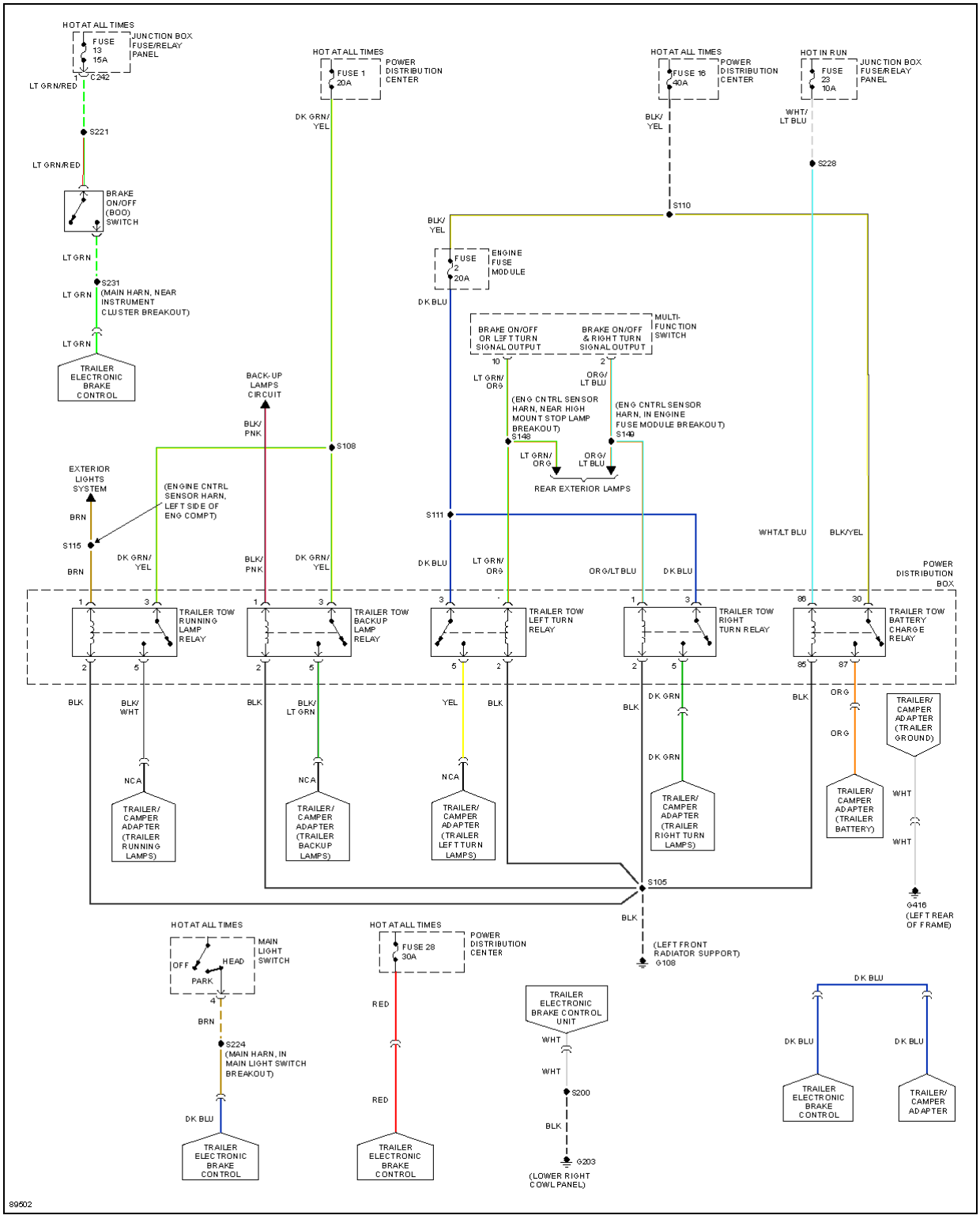


Fig. 35: Trailer/Camper Adapter Circuit

GROUND DISTRIBUTION

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

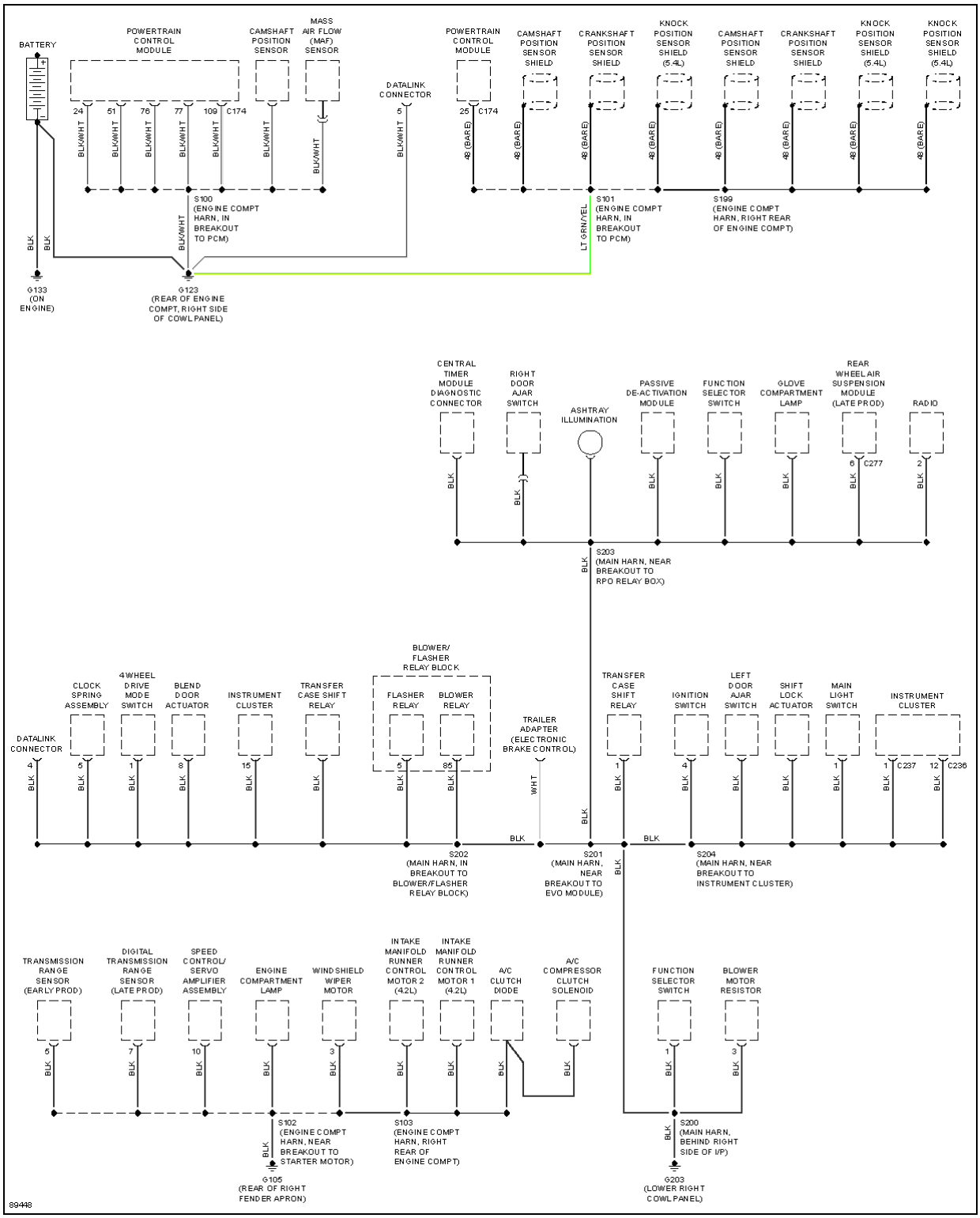


Fig. 36: Ground Distribution Circuit (1 of 3)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

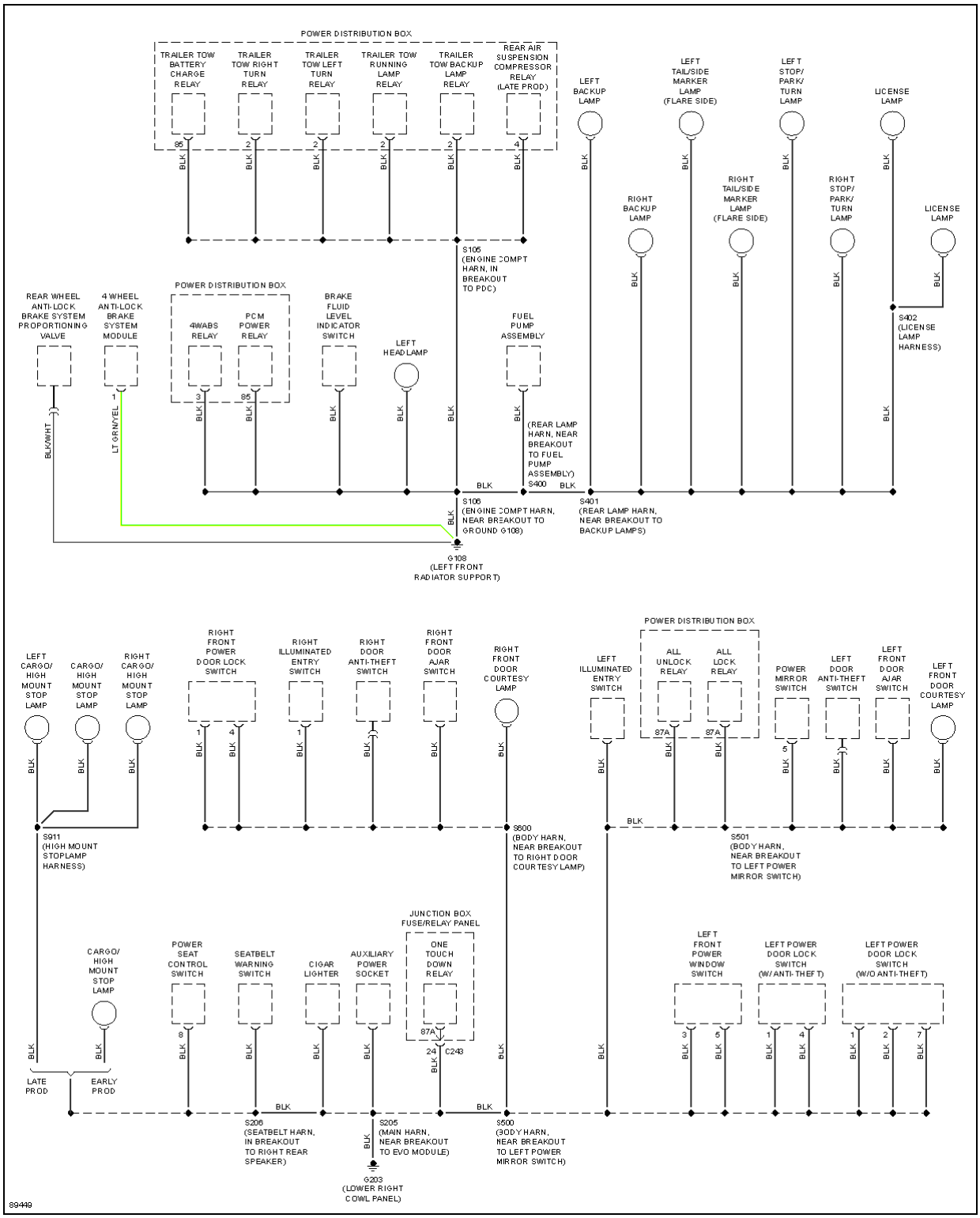


Fig. 37: Ground Distribution Circuit (2 of 3)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

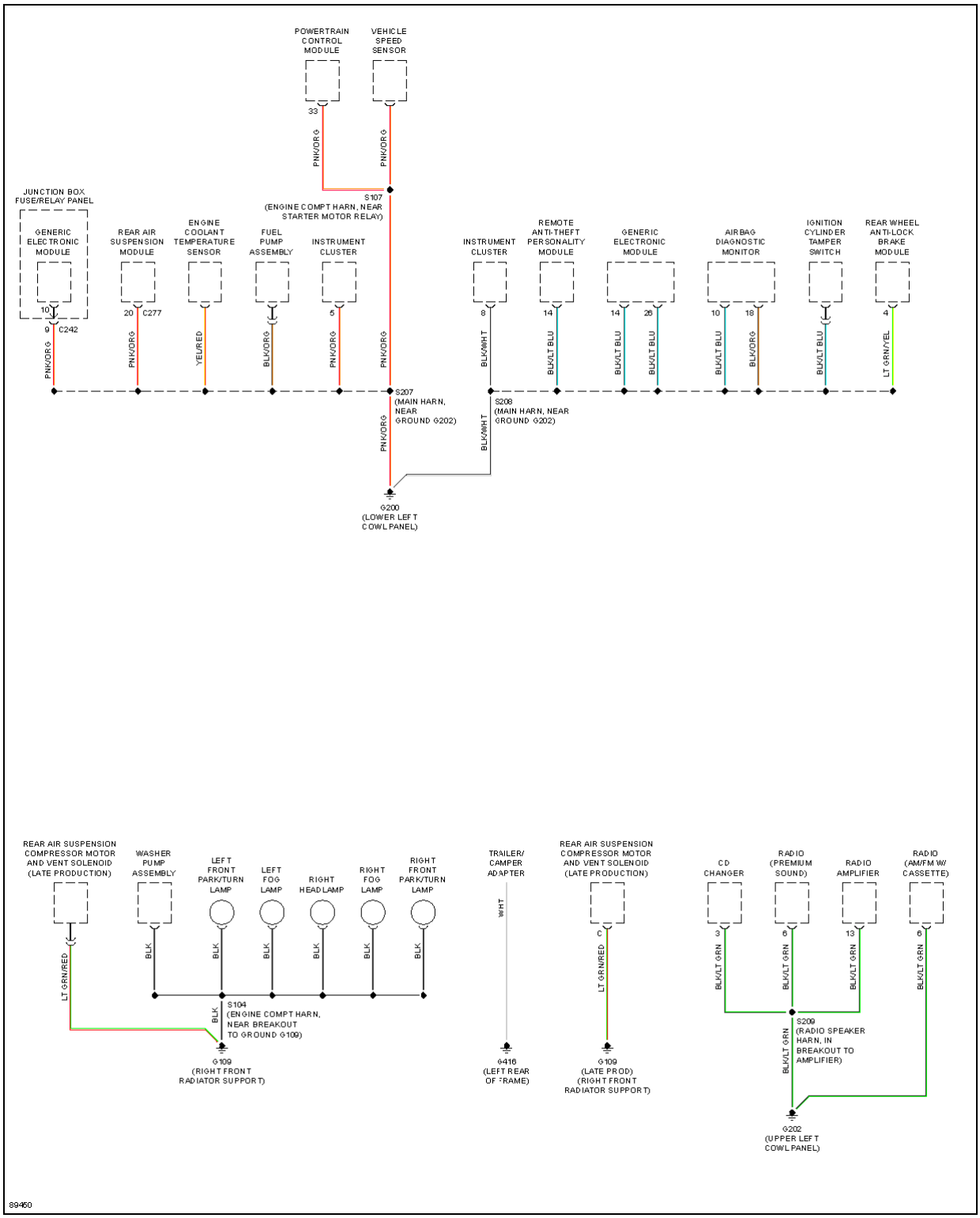


Fig. 38: Ground Distribution Circuit (3 of 3)

HEADLIGHTS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

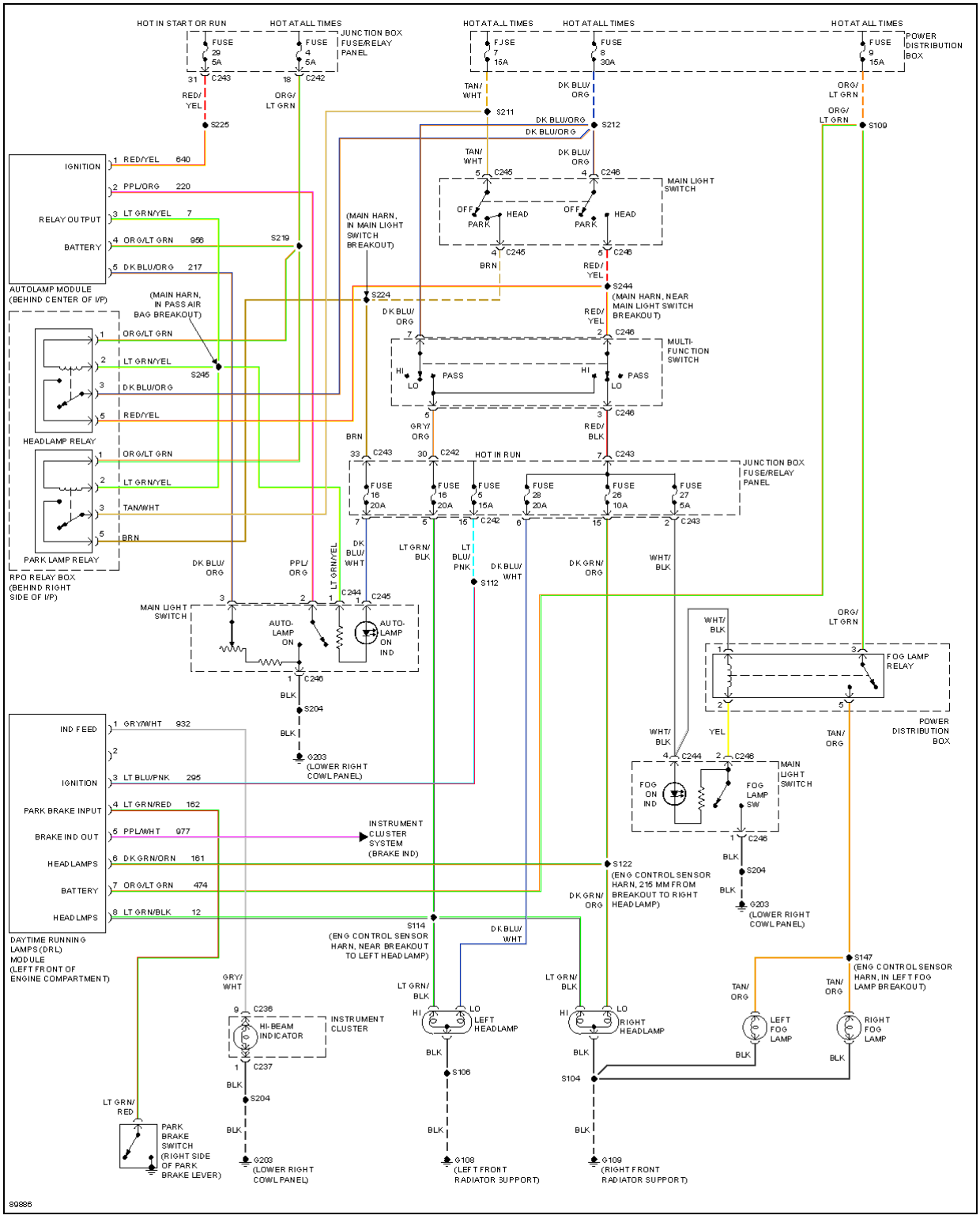


Fig. 39: Autolamps Circuit, W/ DRL

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

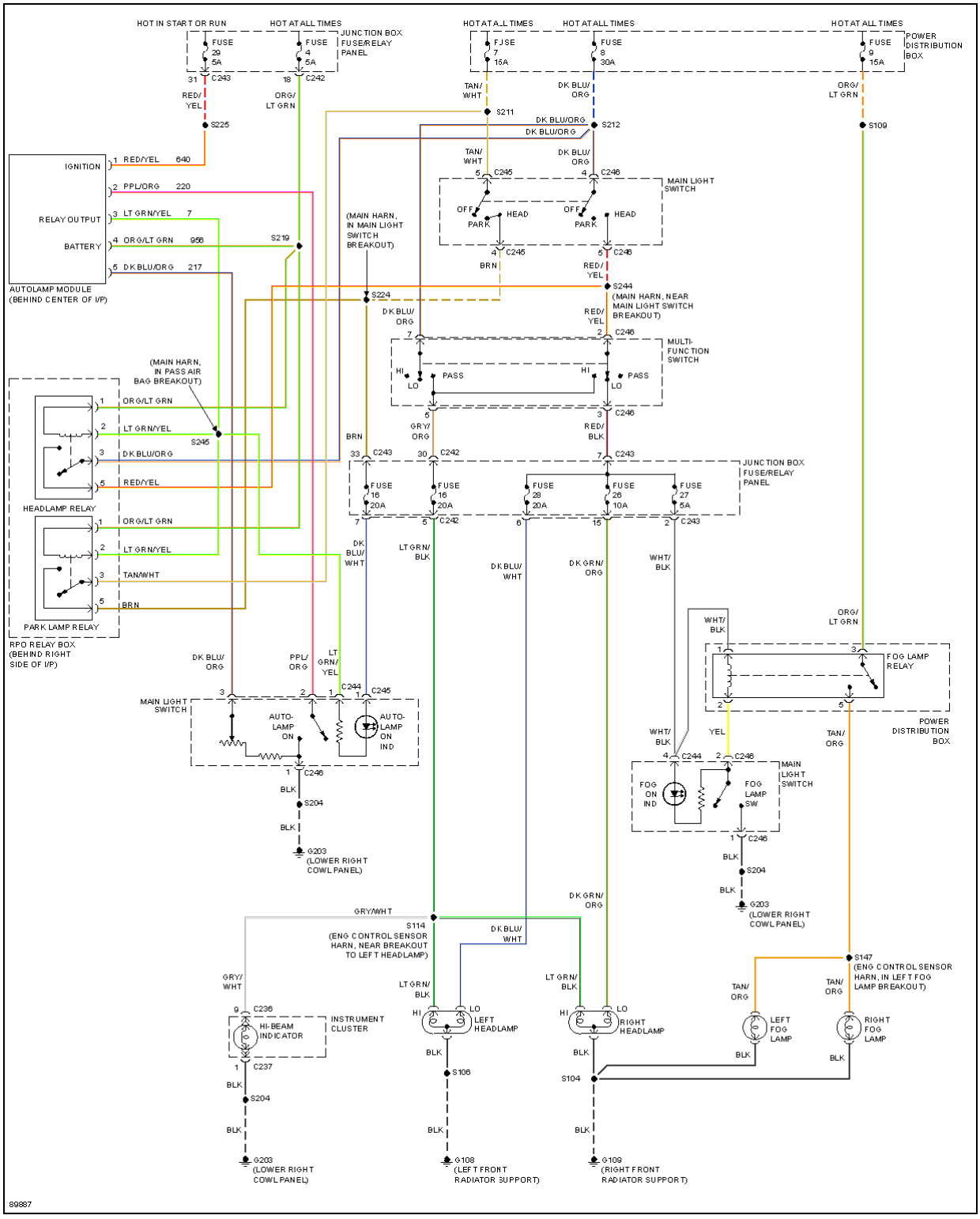


Fig. 40: Autolamps Circuit, W/O DRL

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

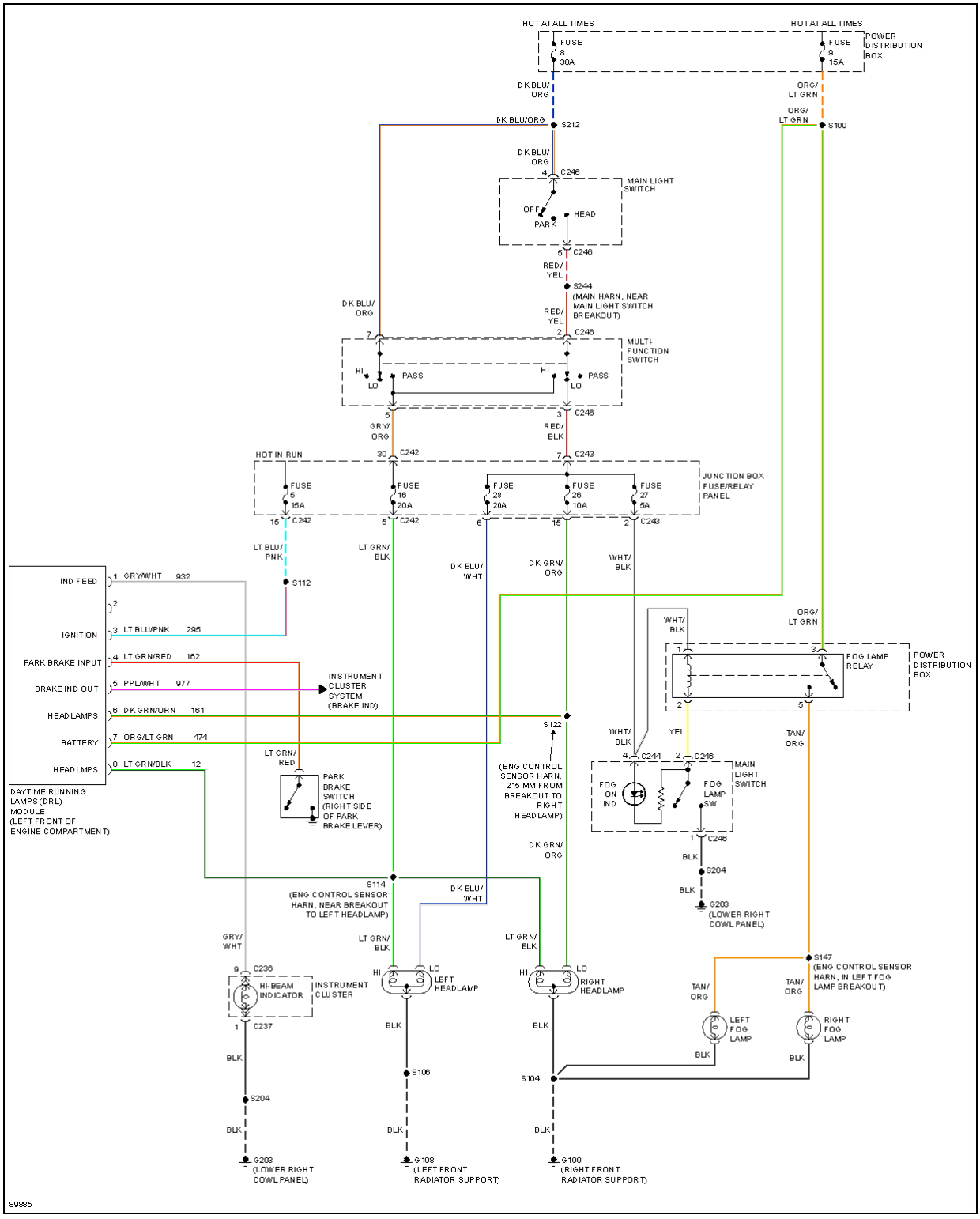


Fig. 41: Headlamps Circuit, W/ DRL

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

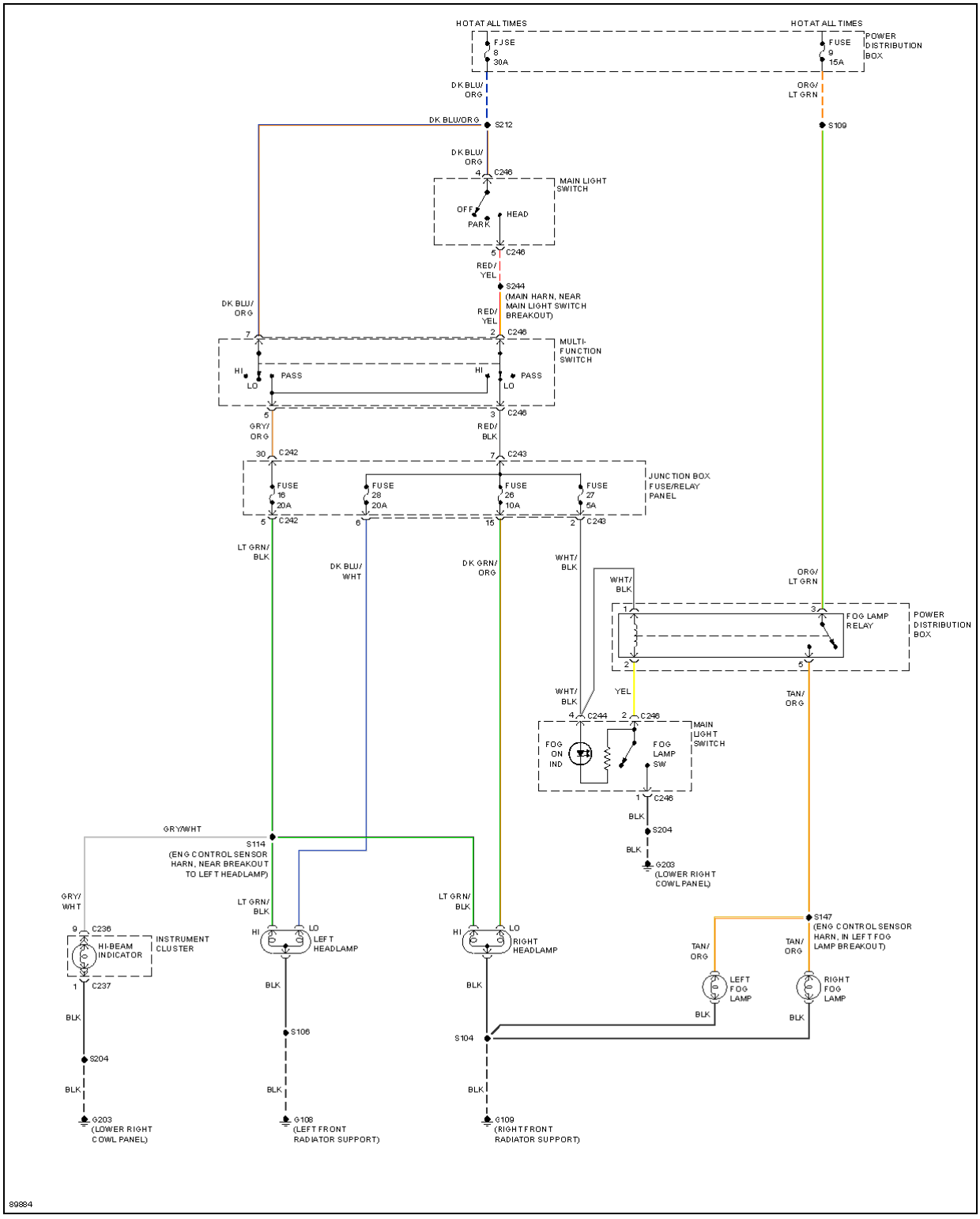


Fig. 42: Headlamps Circuit, W/O DRL

HORN

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

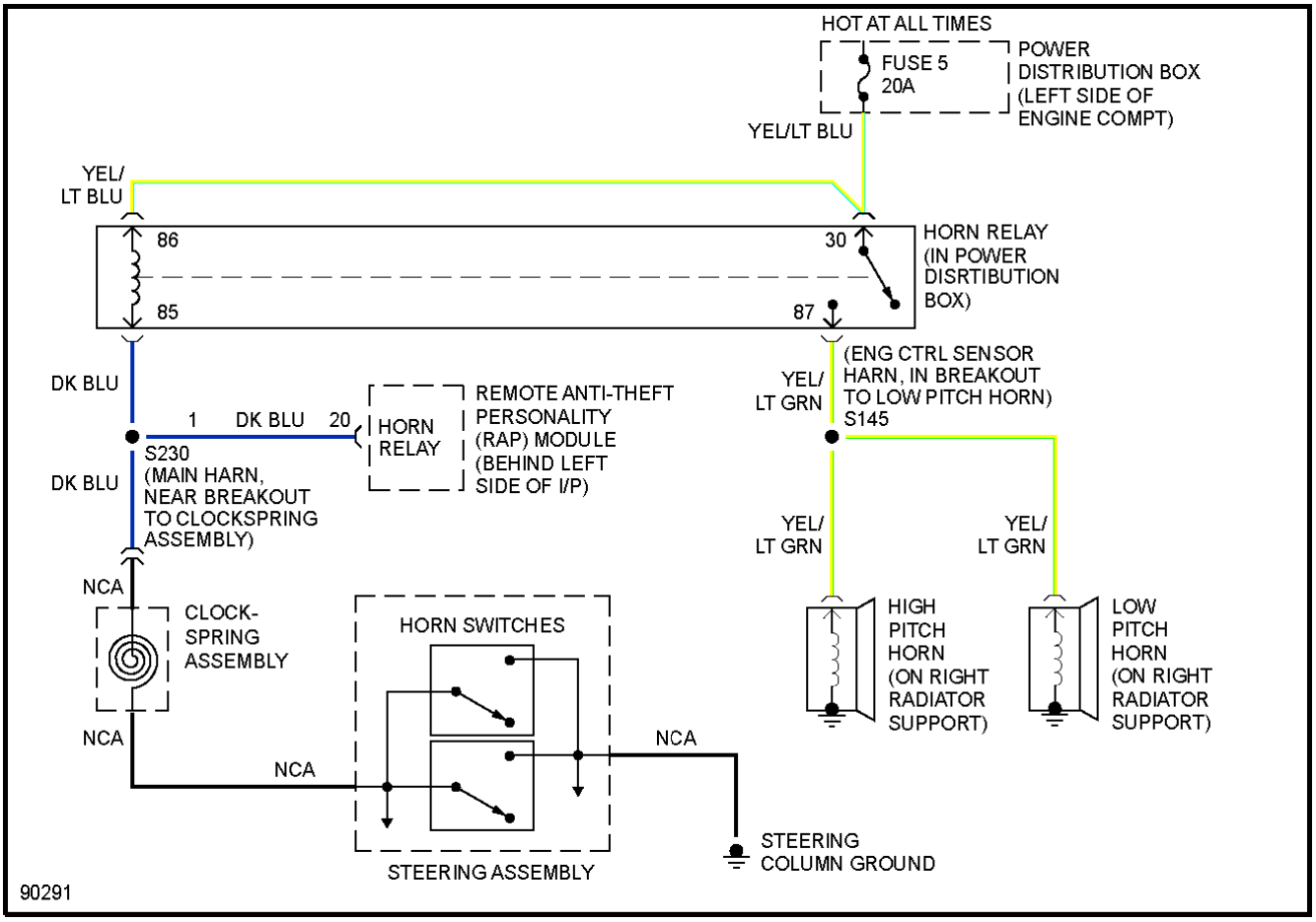


Fig. 43: Horn Circuit

INSTRUMENT CLUSTER

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

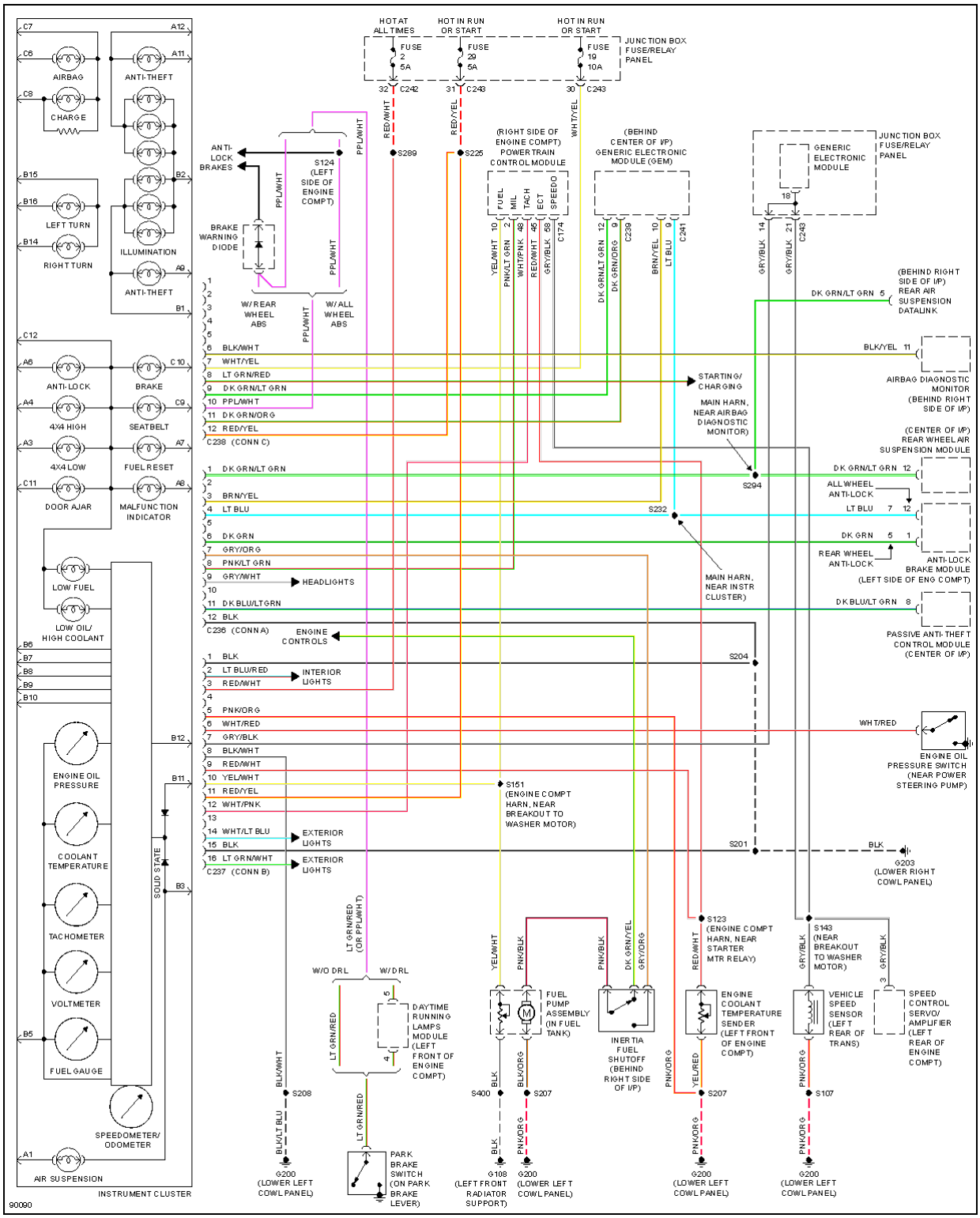


Fig. 44: Instrument Cluster Circuit

INTERIOR LIGHTS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

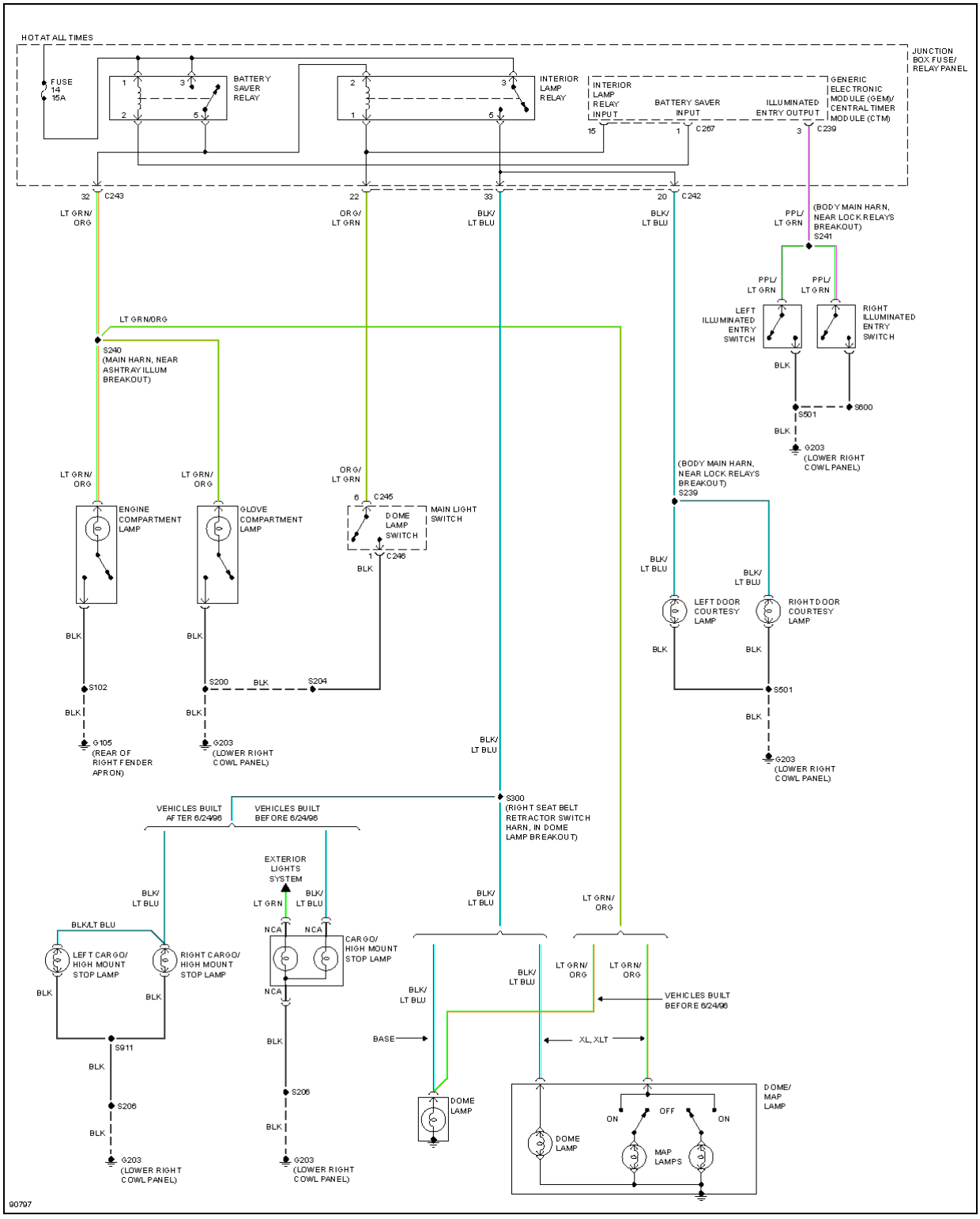


Fig. 45: Courtesy Lamp Circuit

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

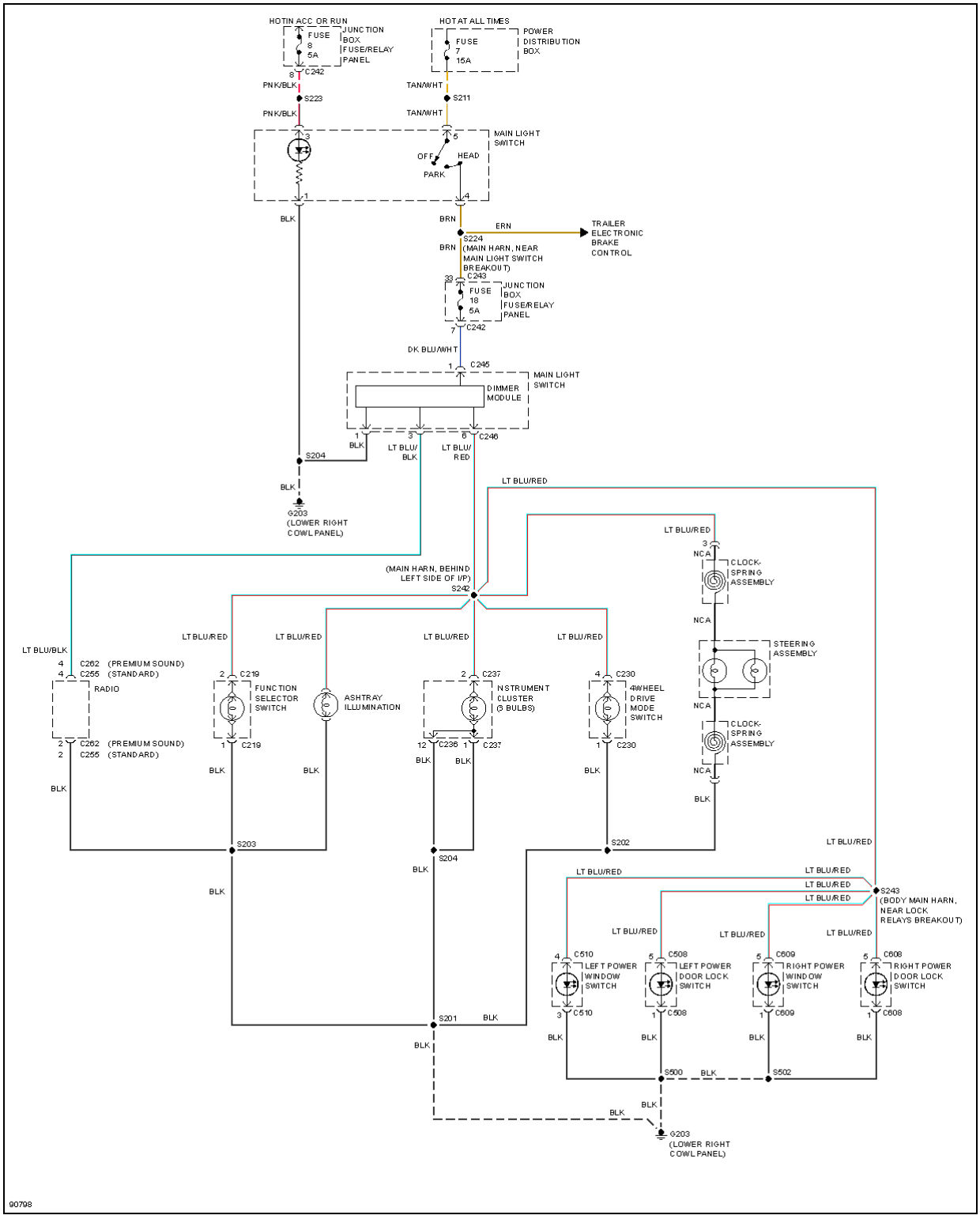


Fig. 46: Instrument Illumination Circuit

POWER DISTRIBUTION

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

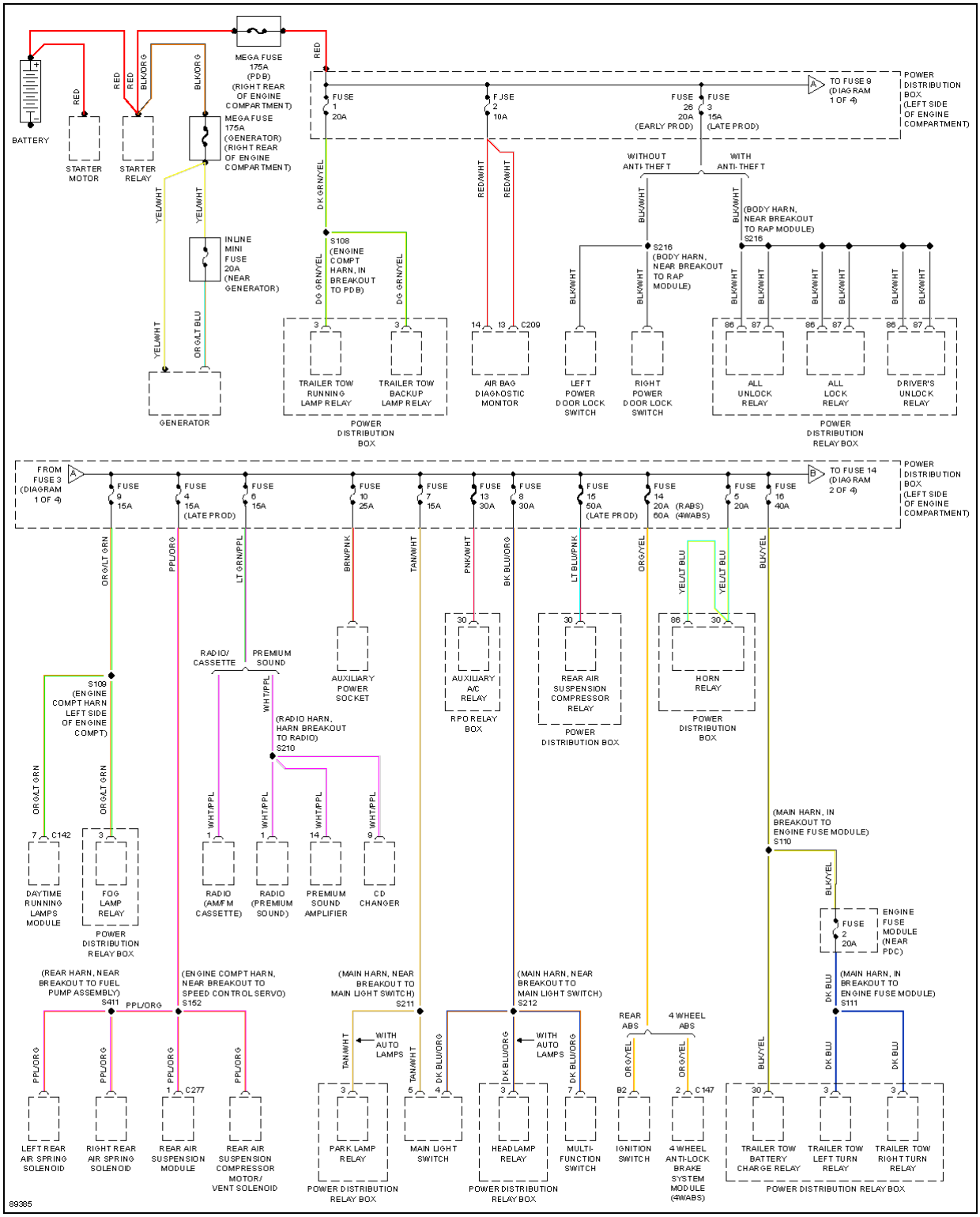


Fig. 47: Power Distribution Circuit (1 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

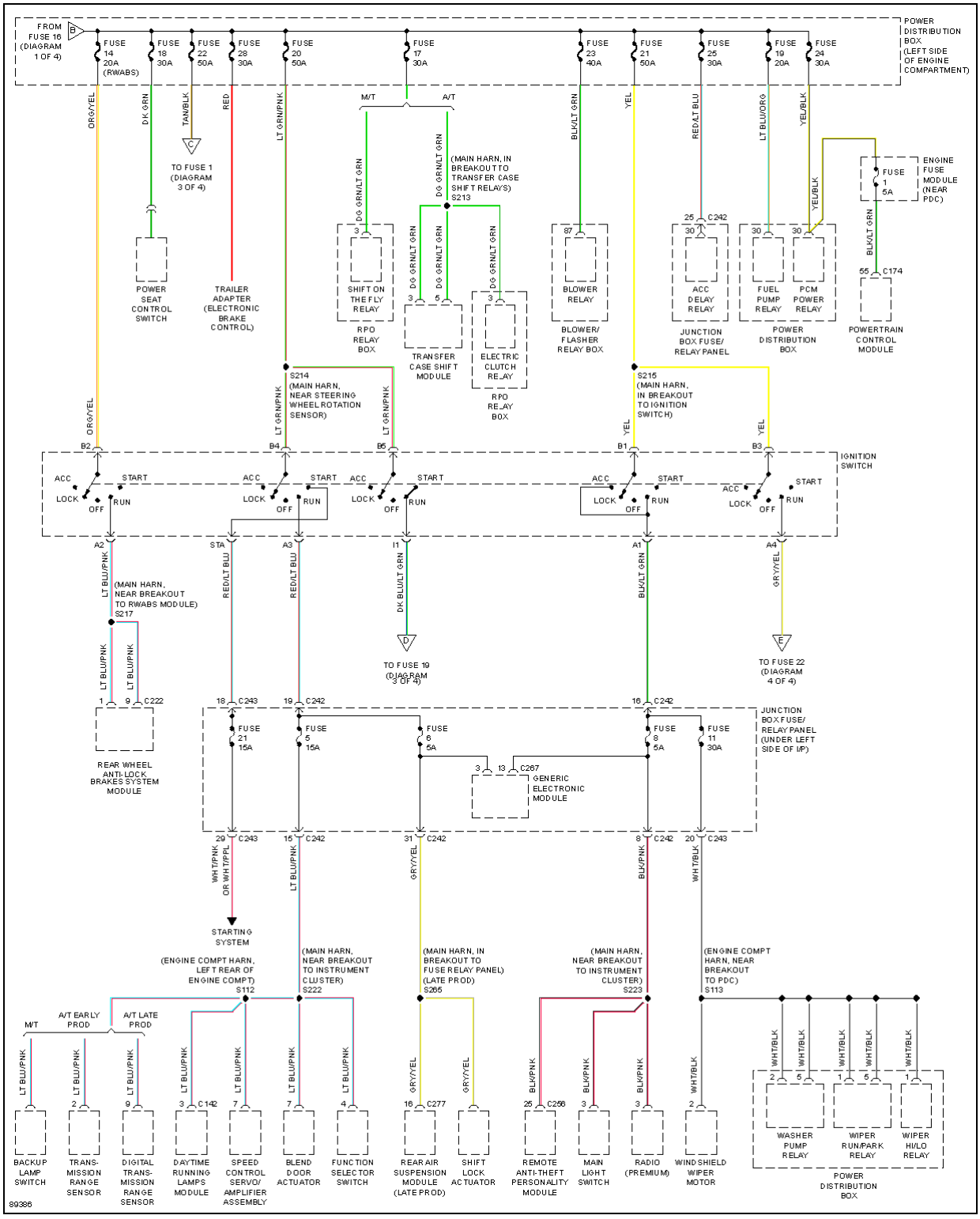


Fig. 48: Power Distribution Circuit (2 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

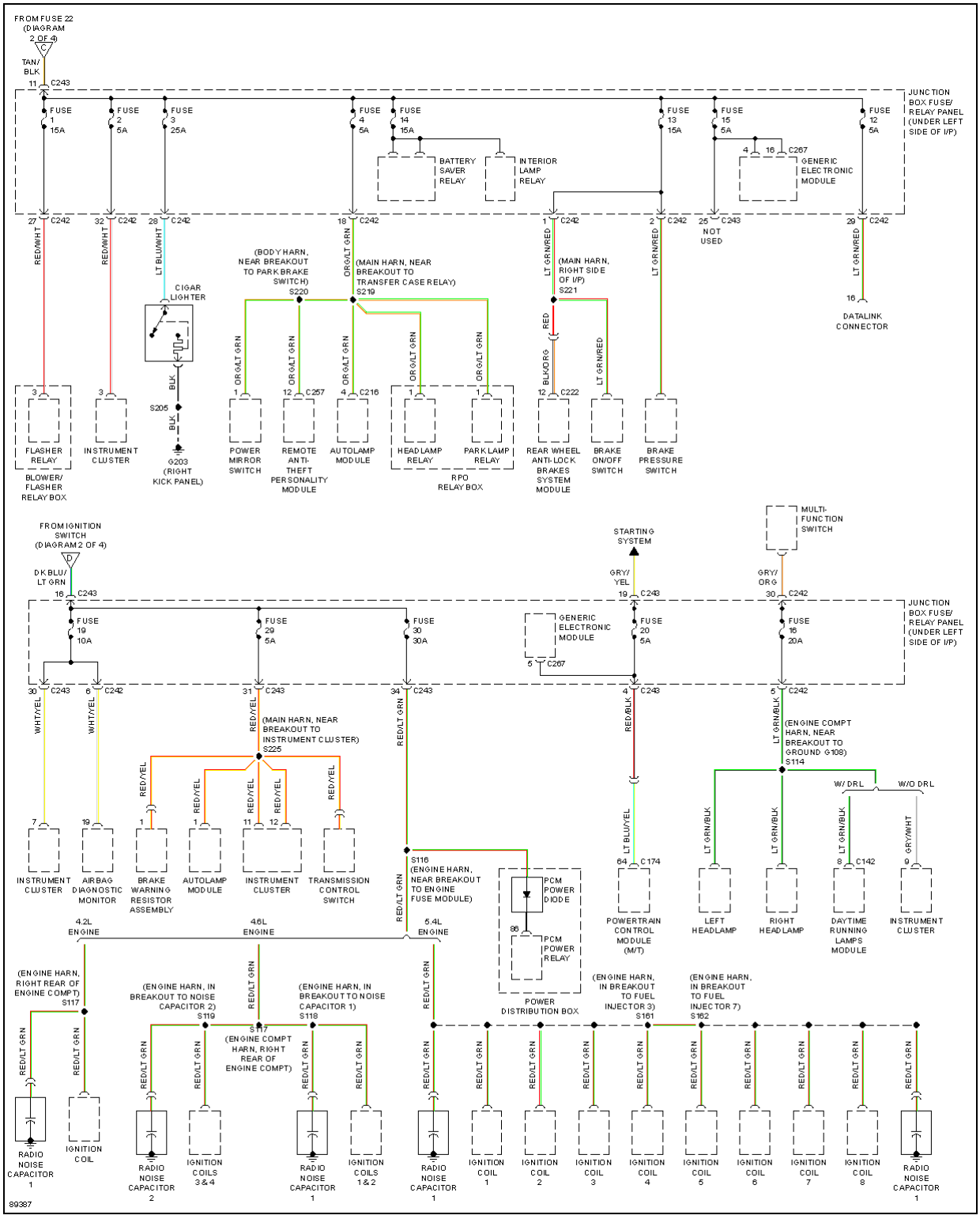


Fig. 49: Power Distribution Circuit (3 of 4)

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

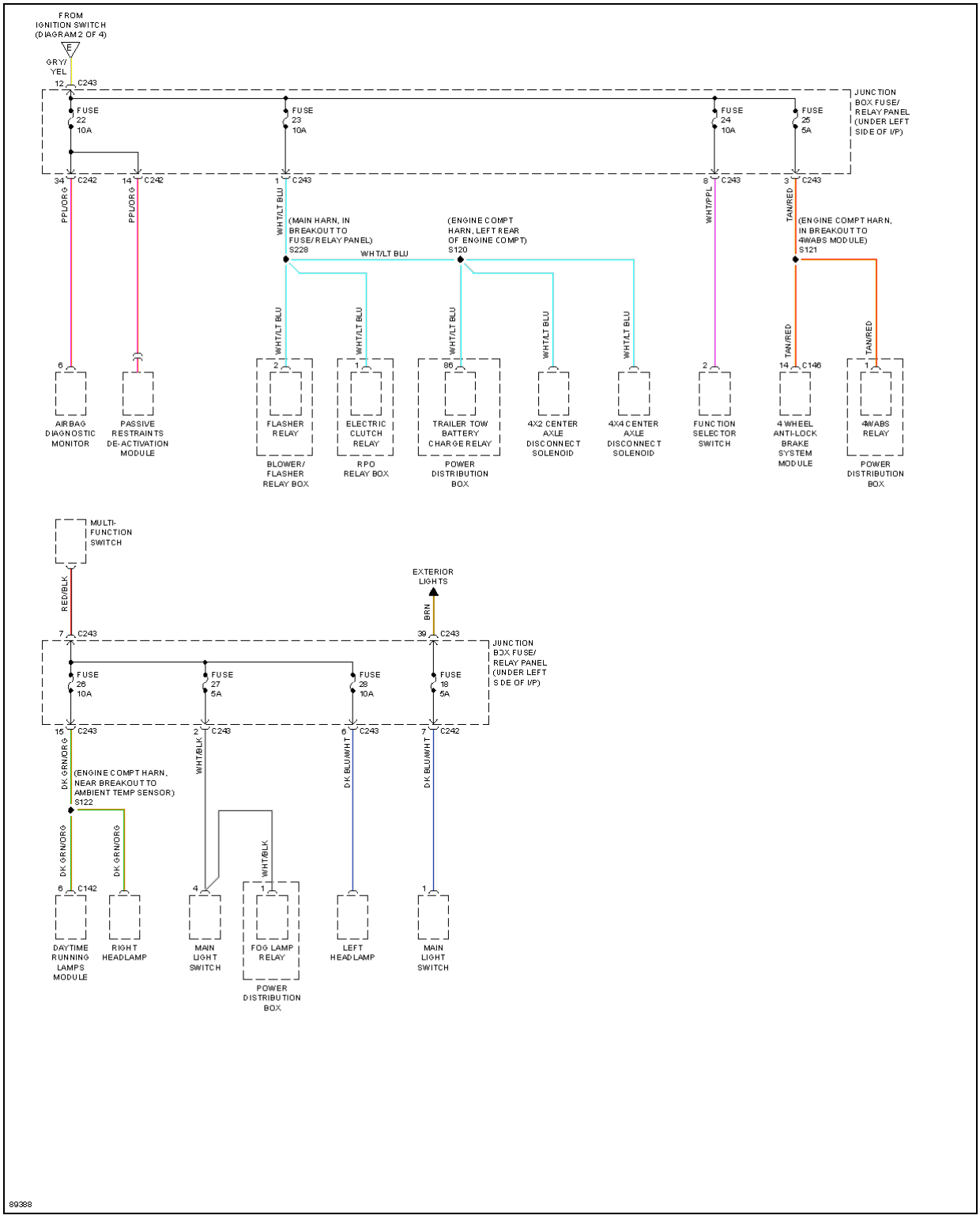


Fig. 50: Power Distribution Circuit (4 of 4)

POWER DOOR LOCKS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

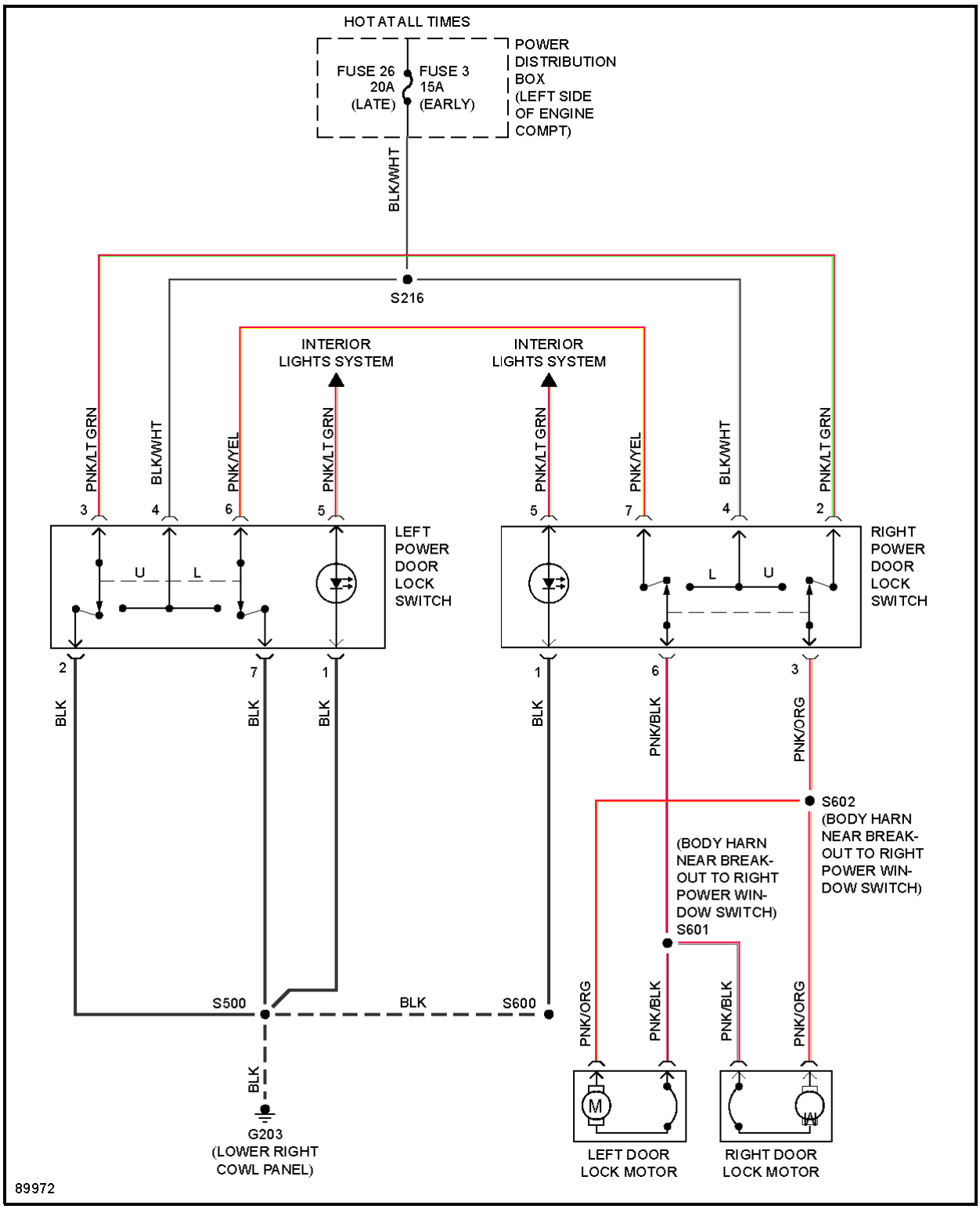


Fig. 51: Door Lock Circuit

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

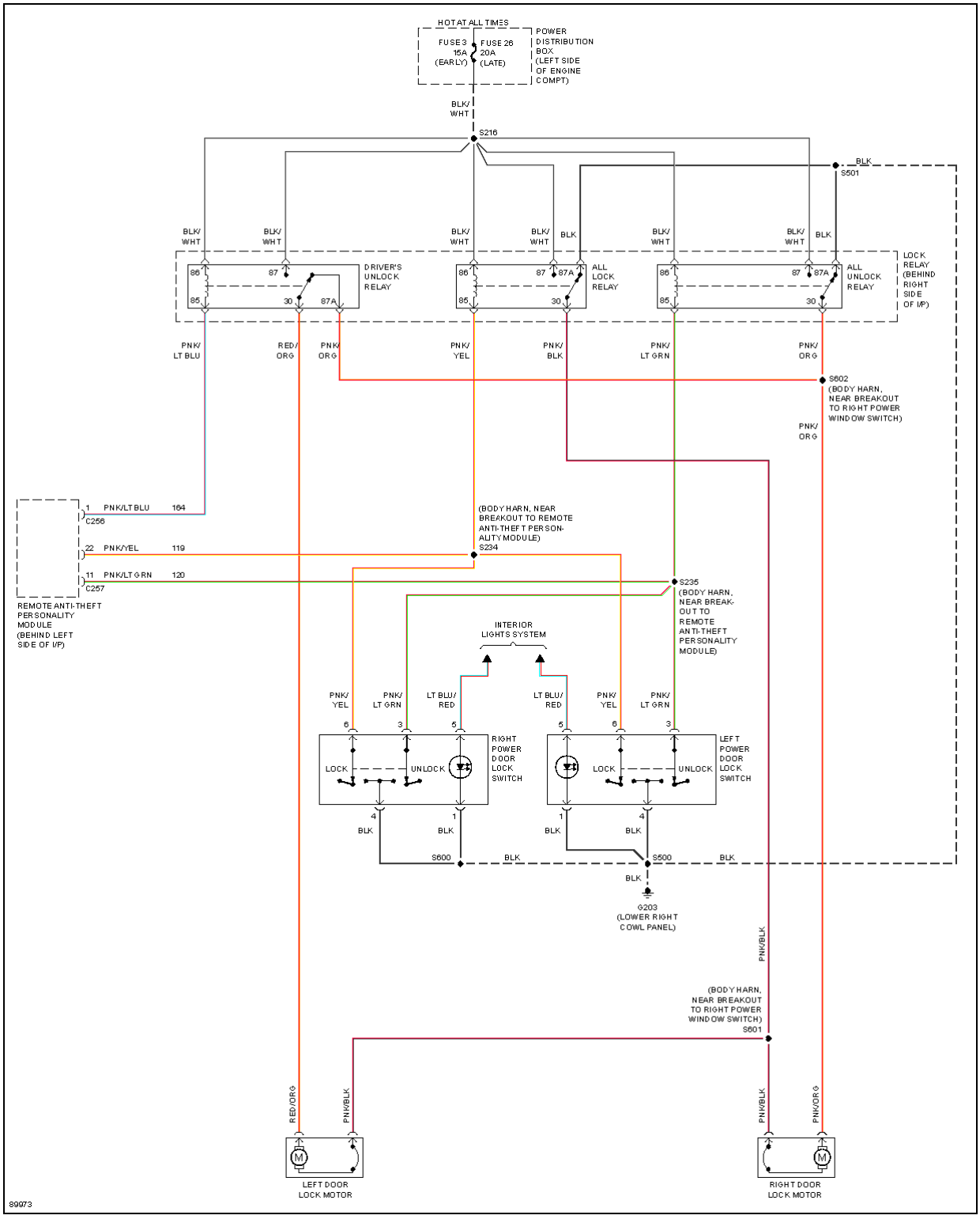


Fig. 52: Keyless Entry Circuit

POWER MIRRORS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

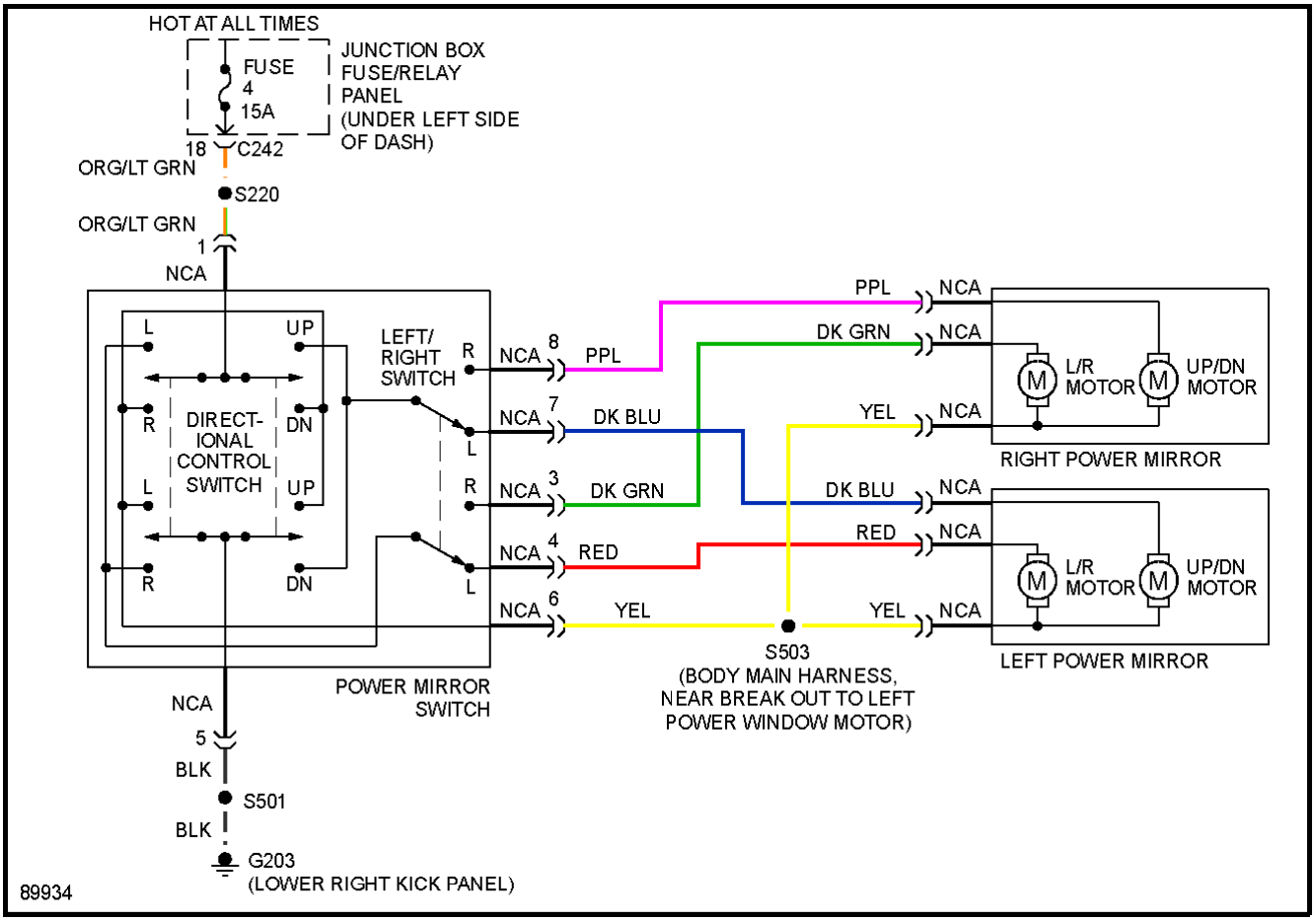


Fig. 53: Power Mirror Circuit

POWER SEATS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

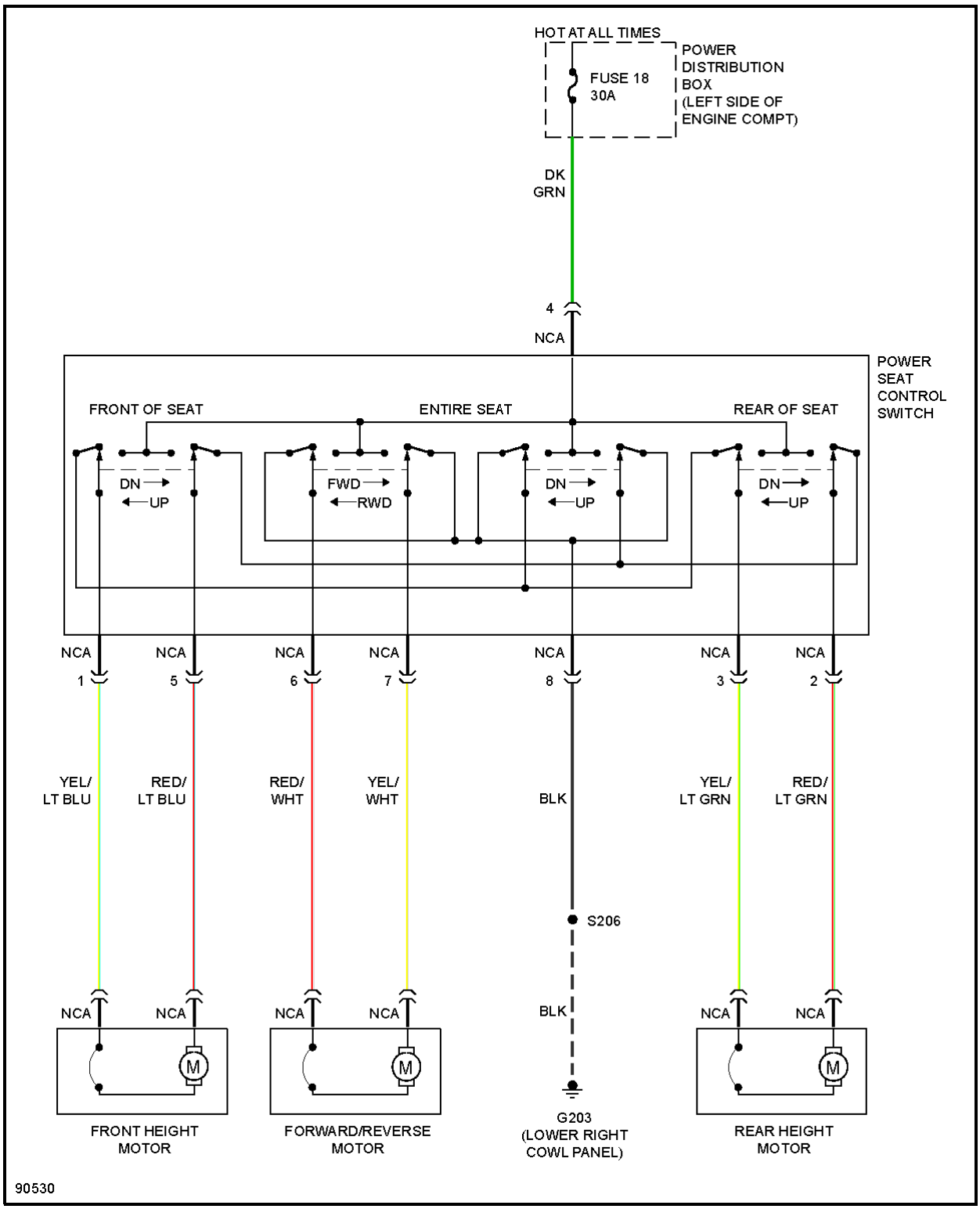


Fig. 54: Power Seat Circuit

POWER WINDOWS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

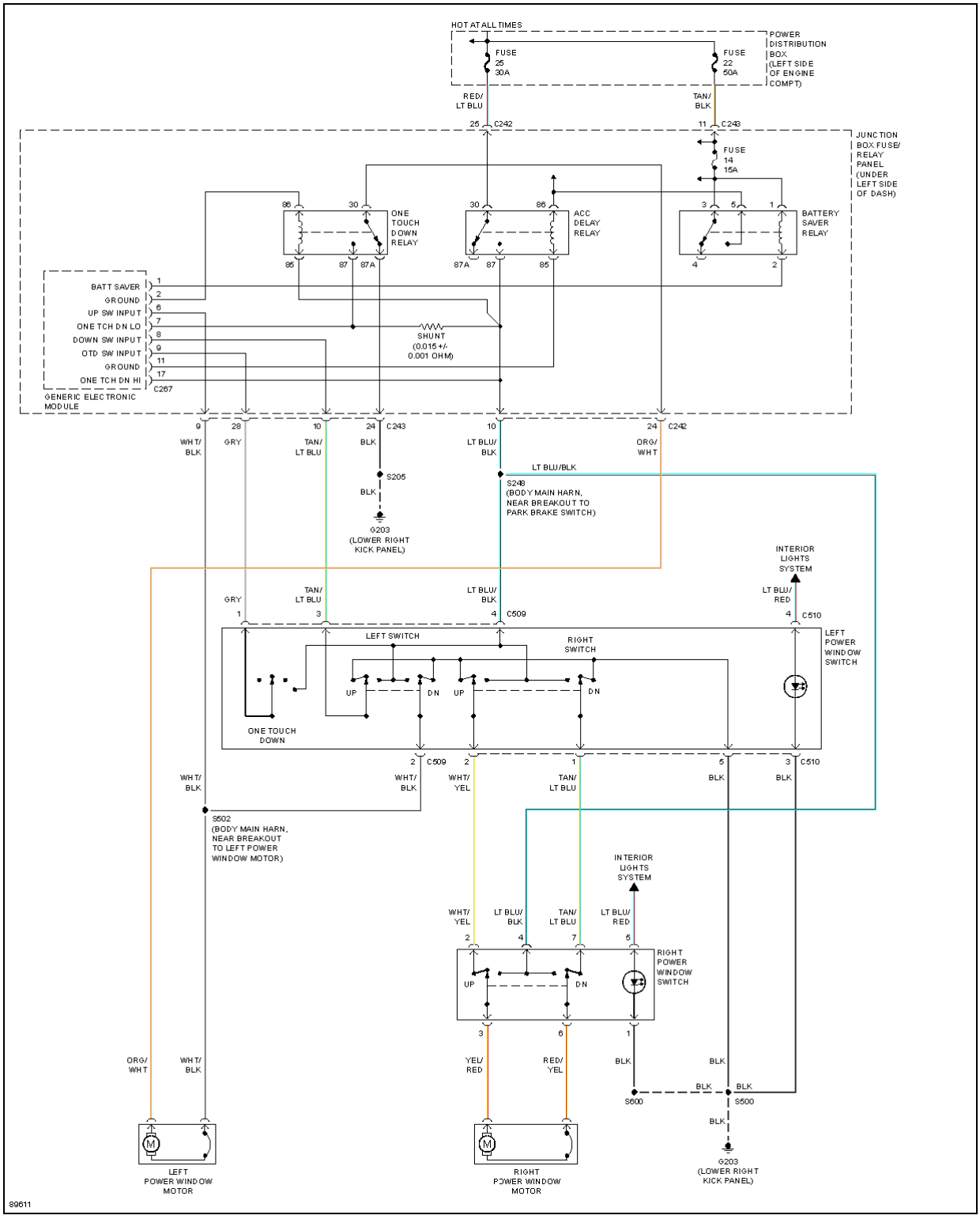


Fig. 55: Power Window Circuit

RADIO

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

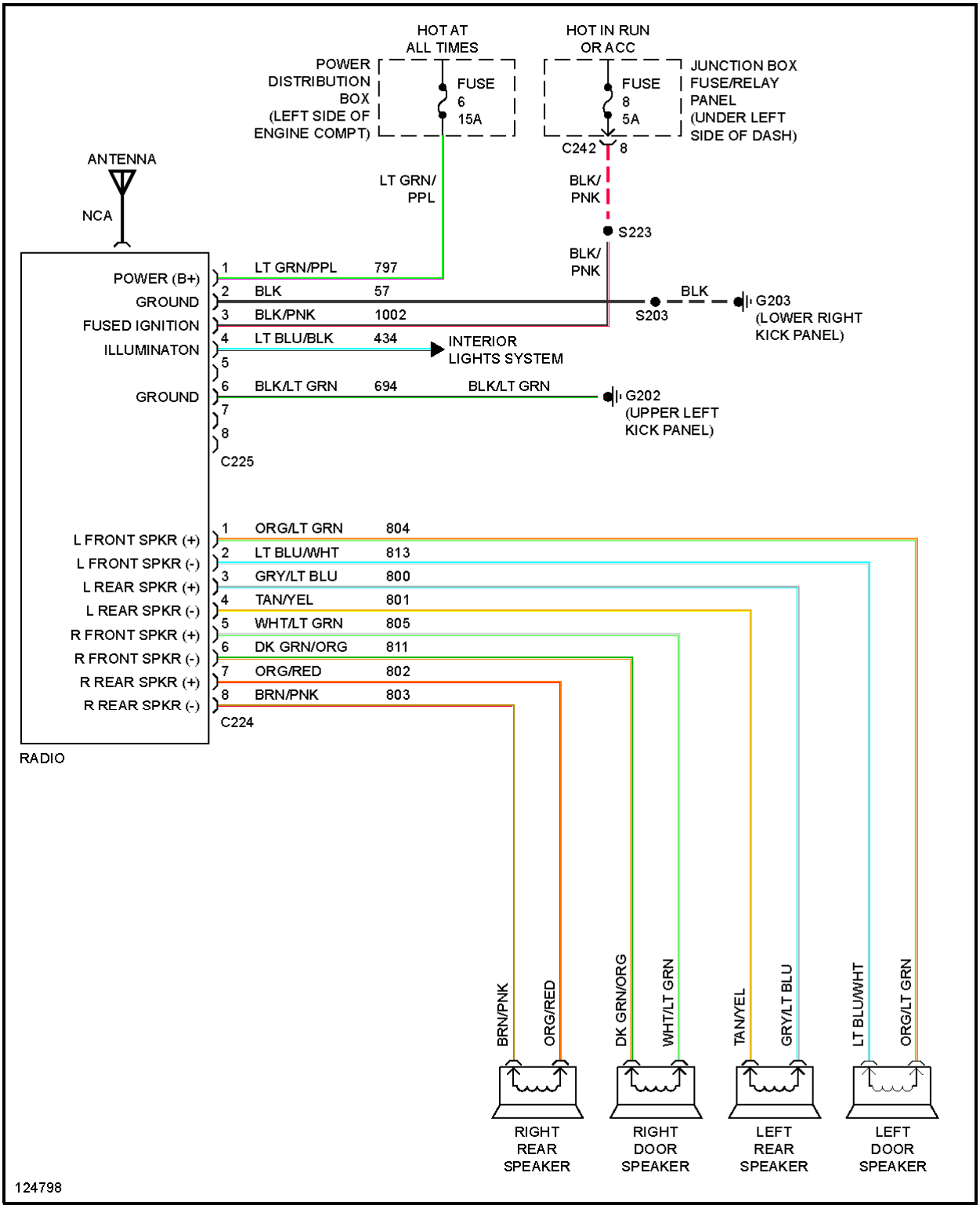


Fig. 56: Base Radio

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

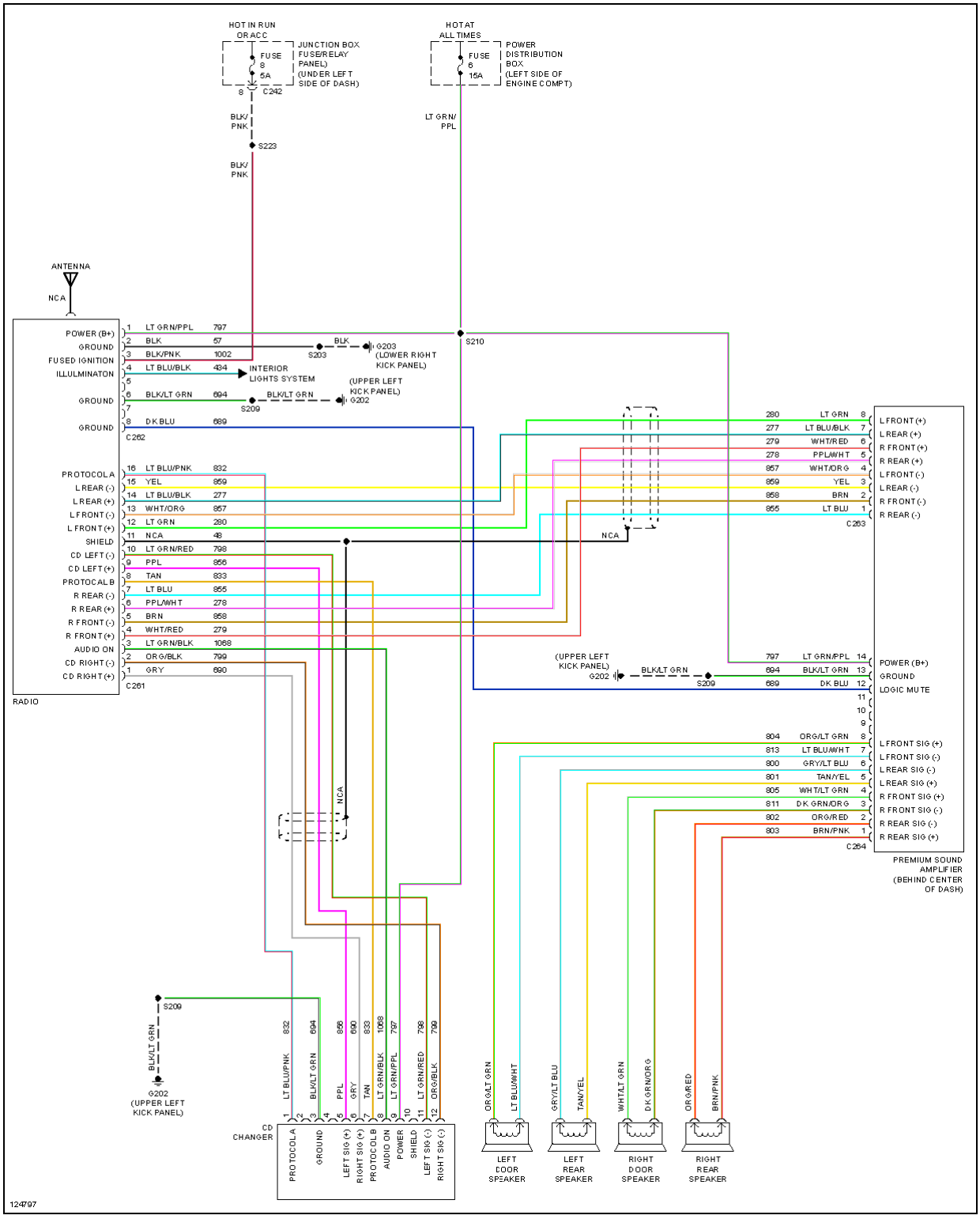


Fig. 57: Premium Sound Radio Circuit

SHIFT INTERLOCKS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

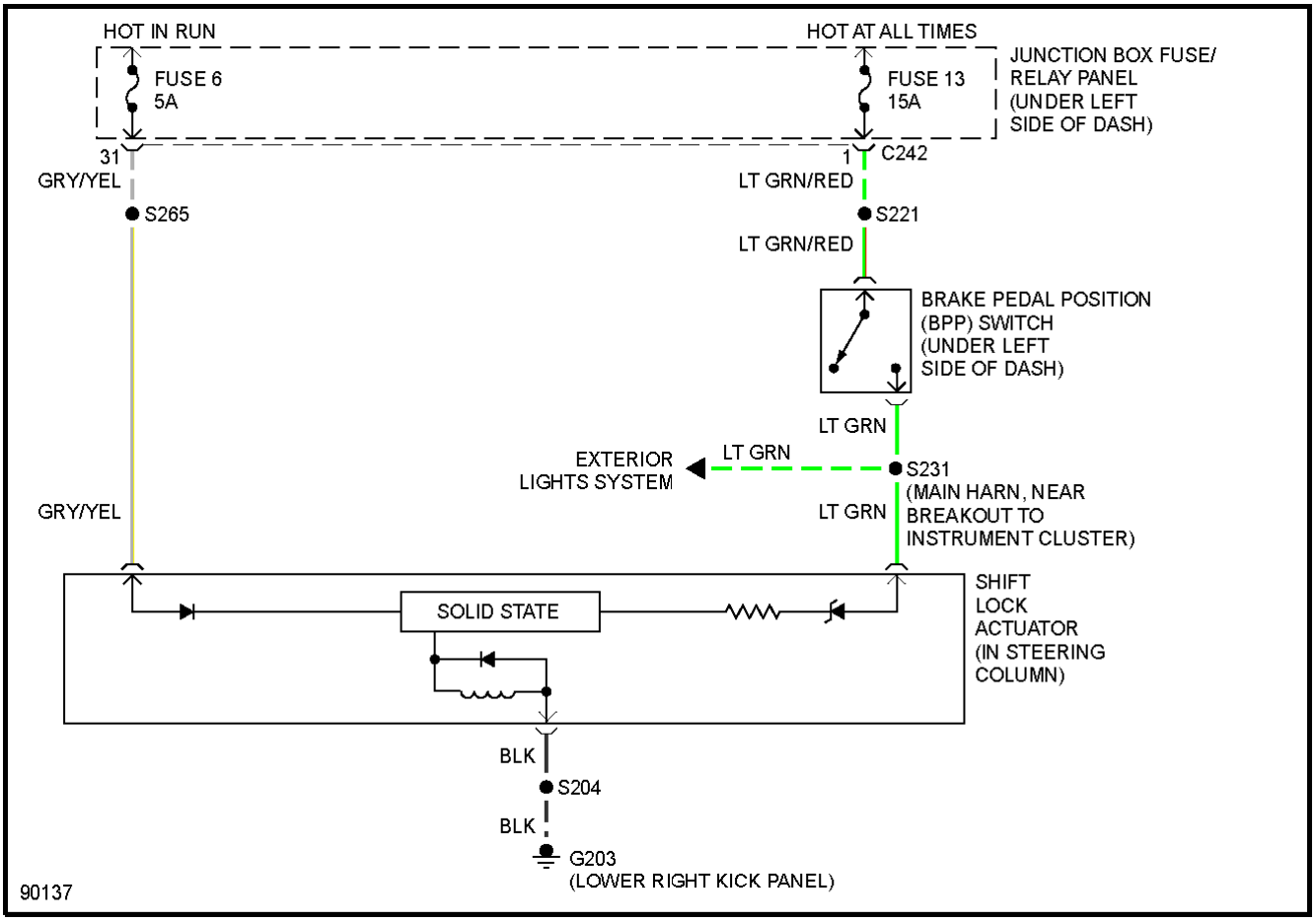


Fig. 58: Shift Interlock Circuit

STARTING/CHARGING

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

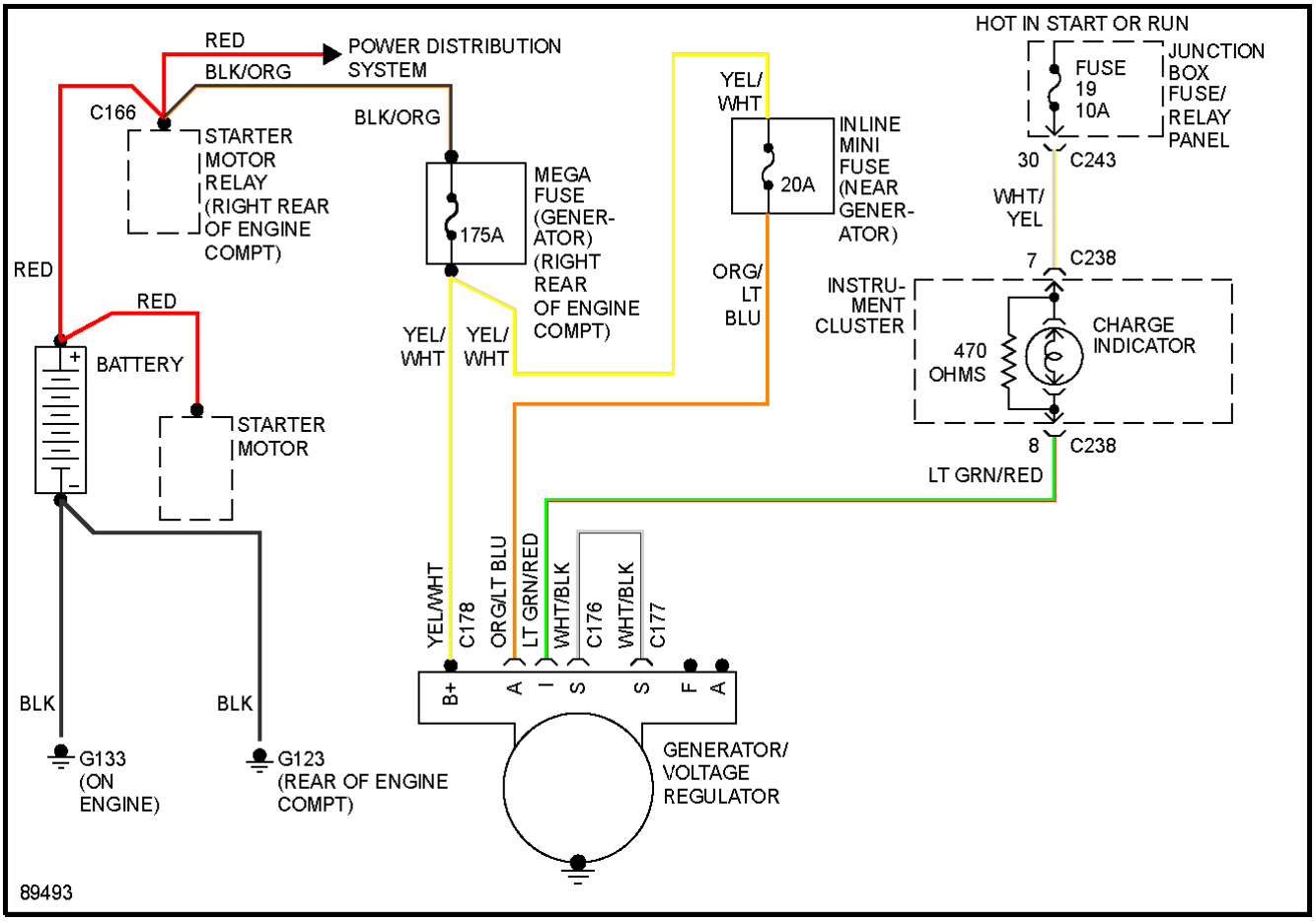


Fig. 59: Charging Circuit

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

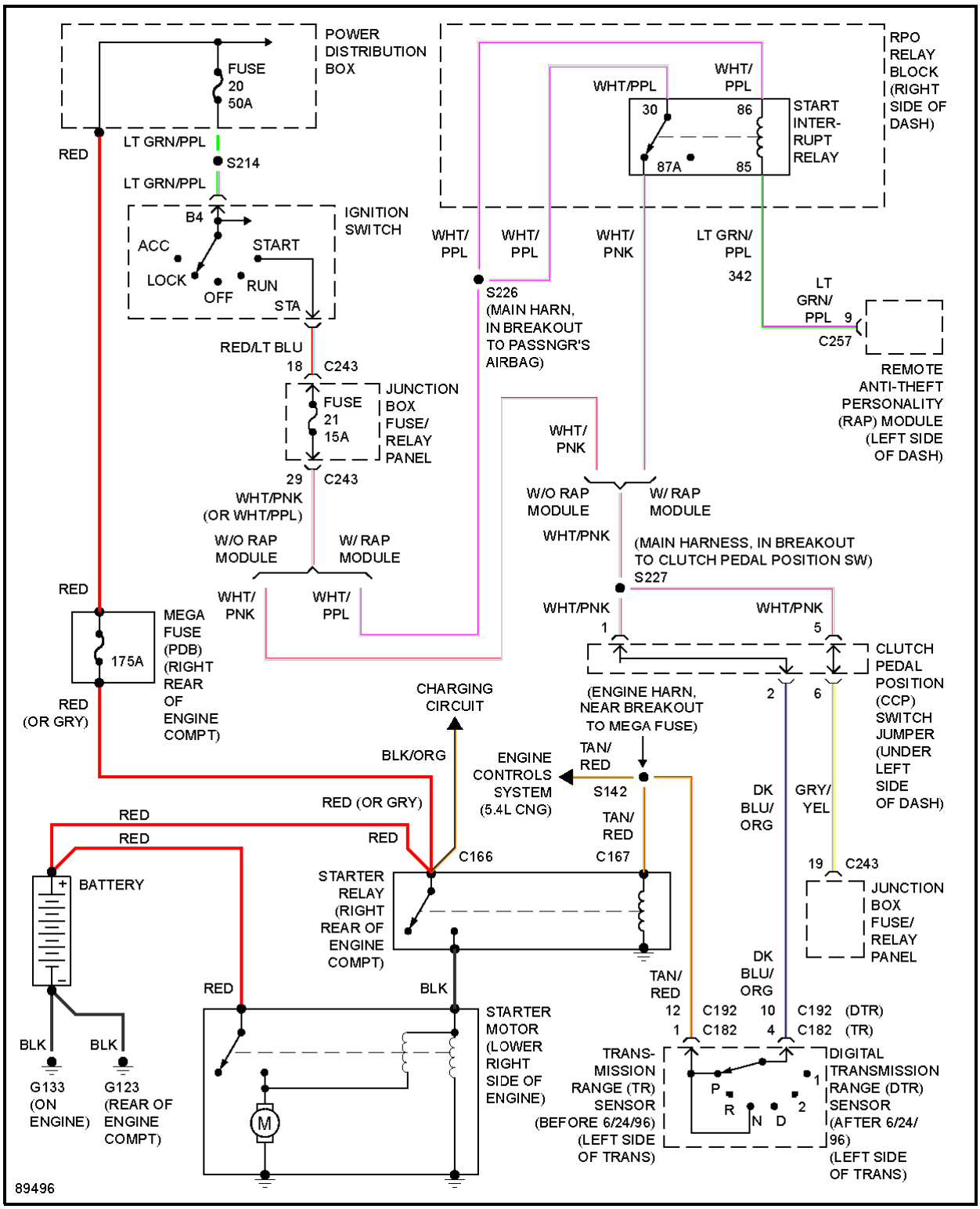


Fig. 60: Starting Circuit, A/T

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

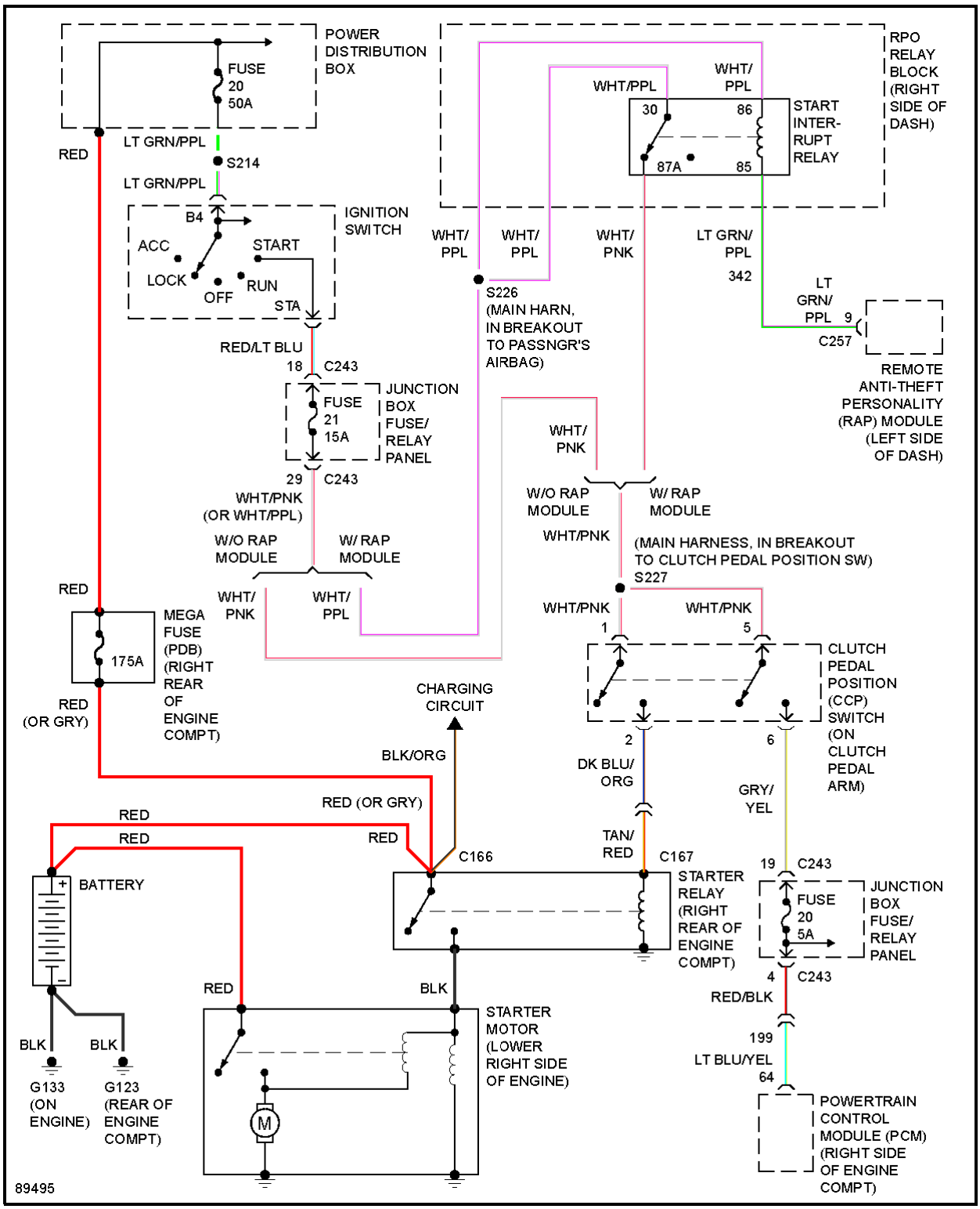


Fig. 61: Starting Circuit, M/T

SUPPLEMENTAL RESTRAINTS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

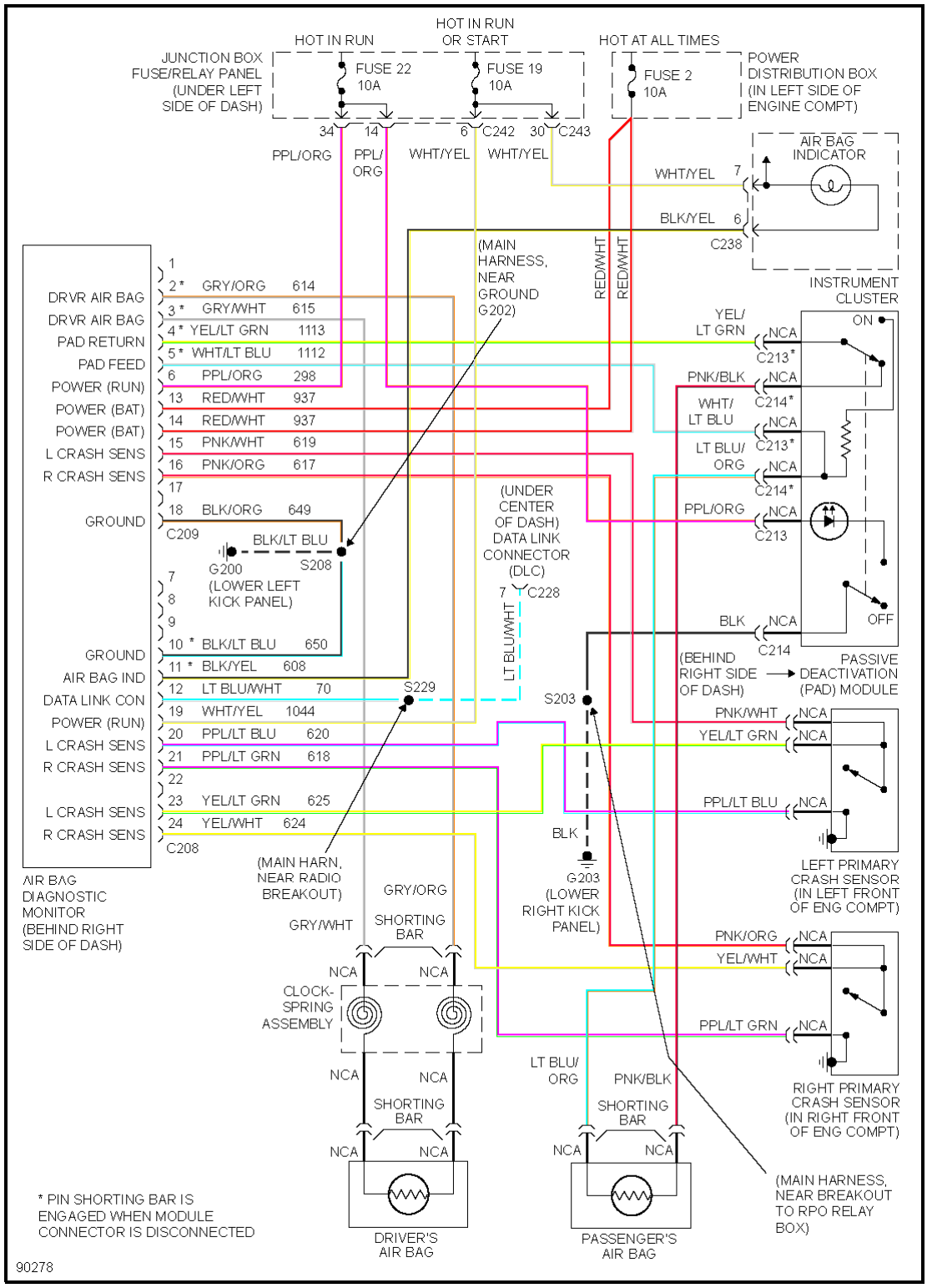


Fig. 62: Supplemental Restraint Circuit

TRANSMISSION

4.2L

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

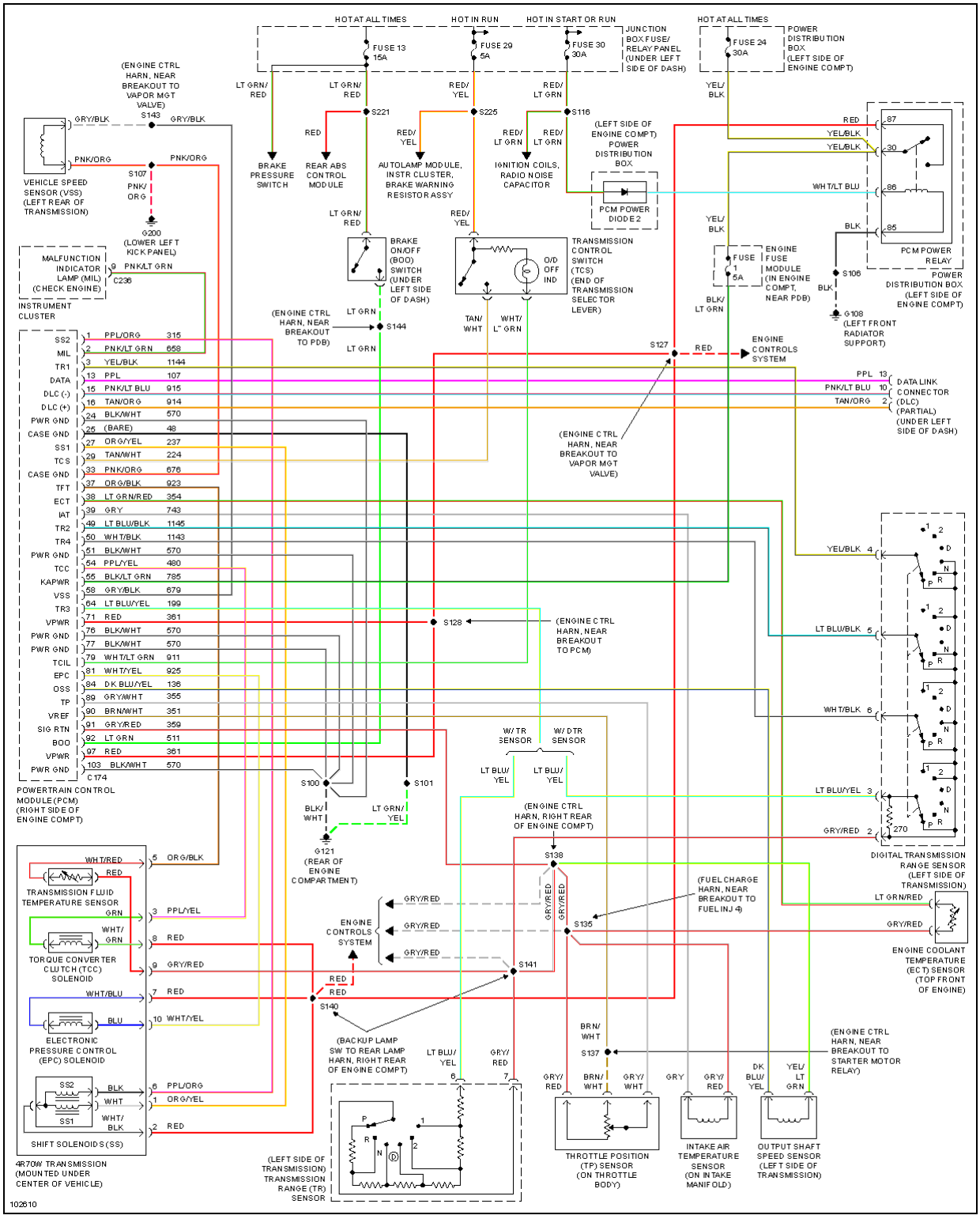


Fig. 63: 4.2L, Transmission Circuit, 4R70W

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

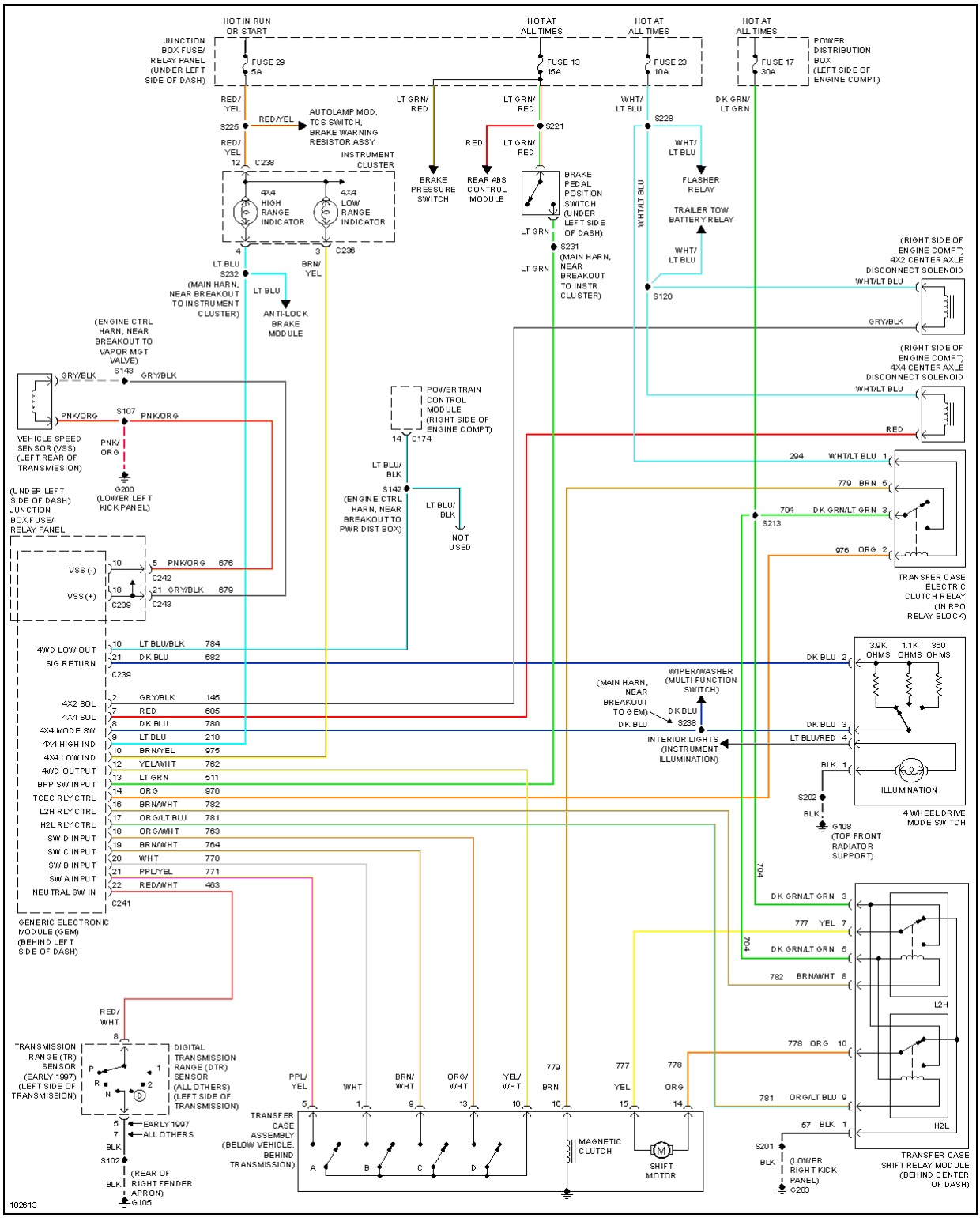


Fig. 64: Transfer Case Circuit, Electronic

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

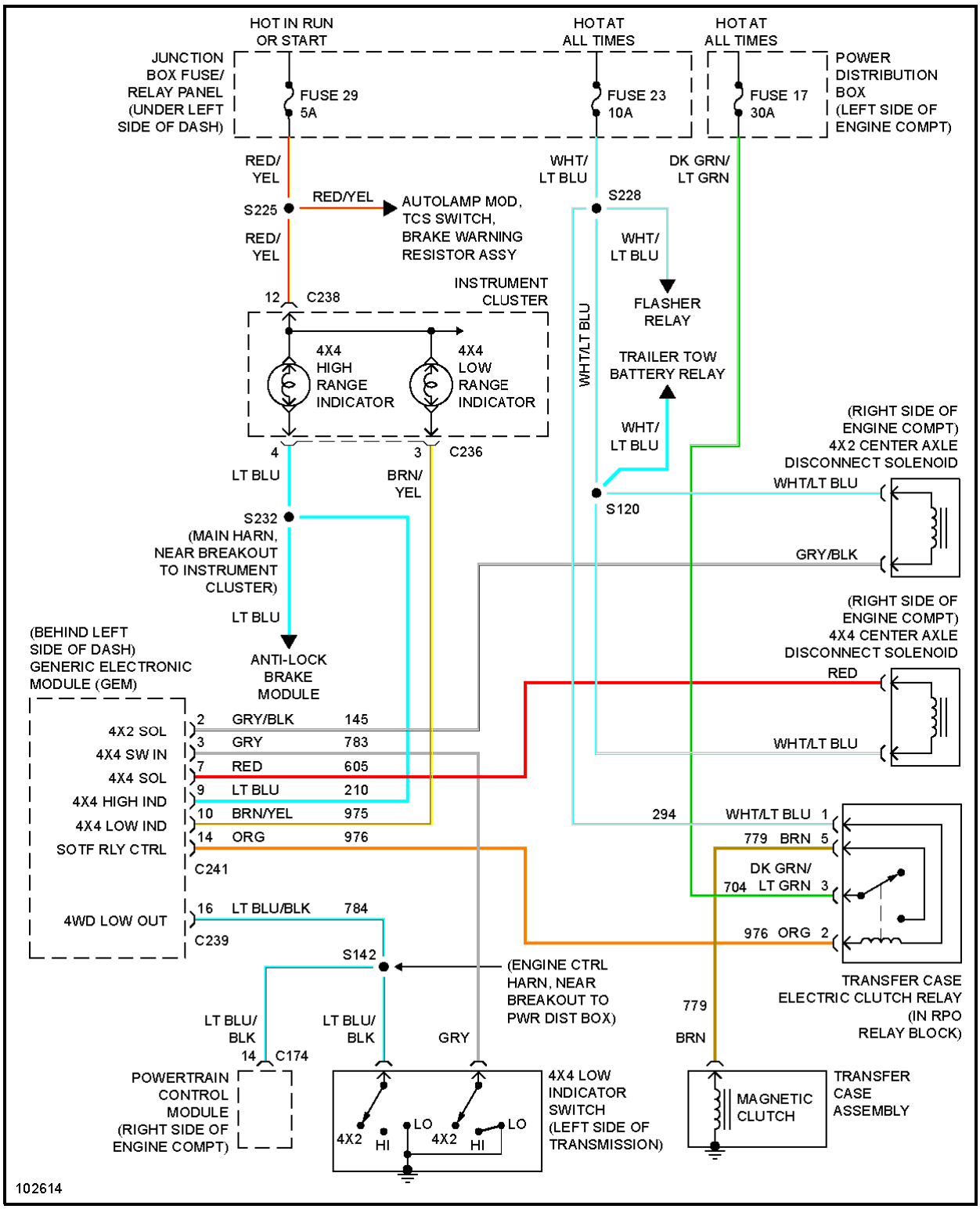


Fig. 65: Transfer Case Circuit, Mechanical

4.6L

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

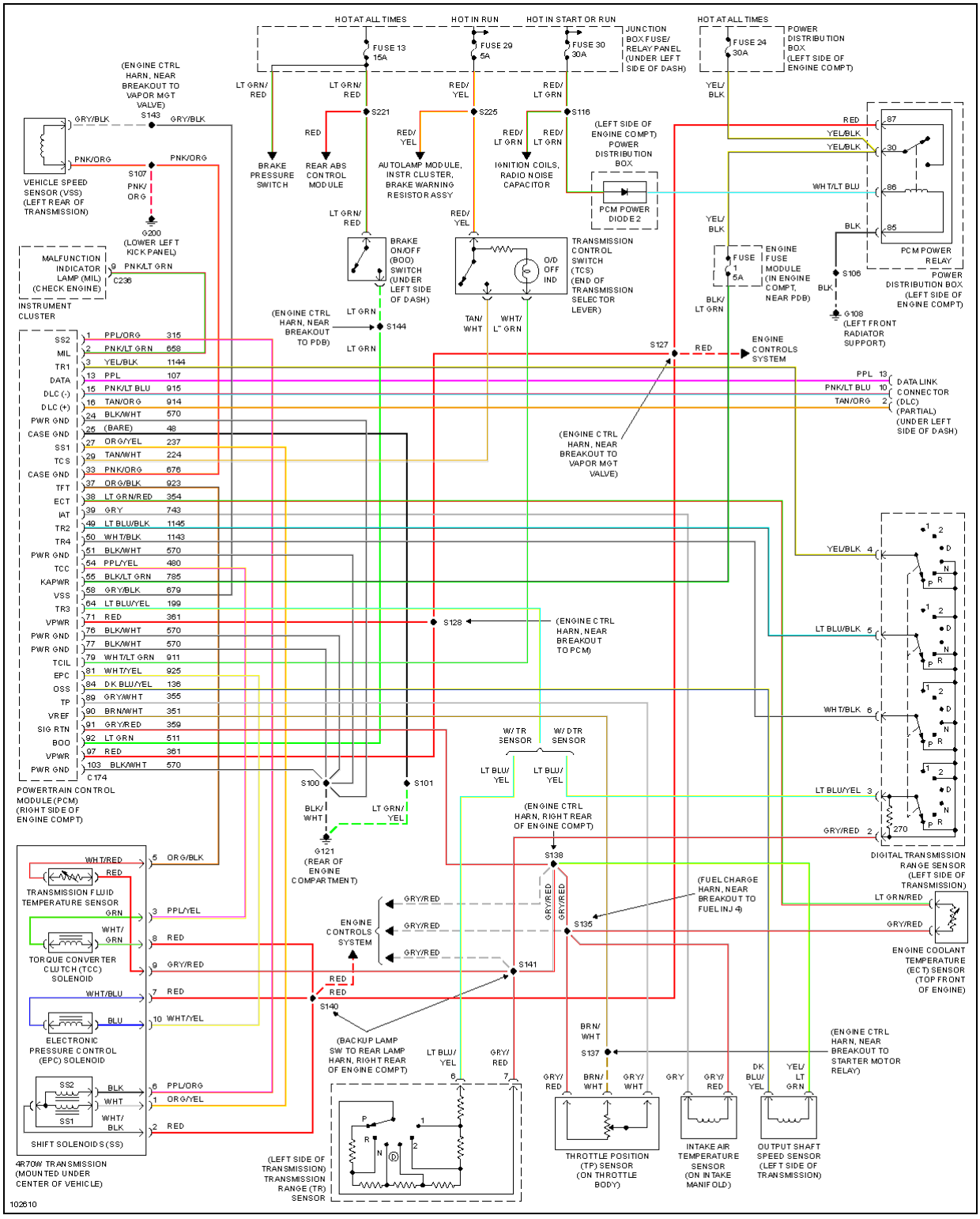


Fig. 66: 4.6L, Transmission Circuit, 4R70W

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

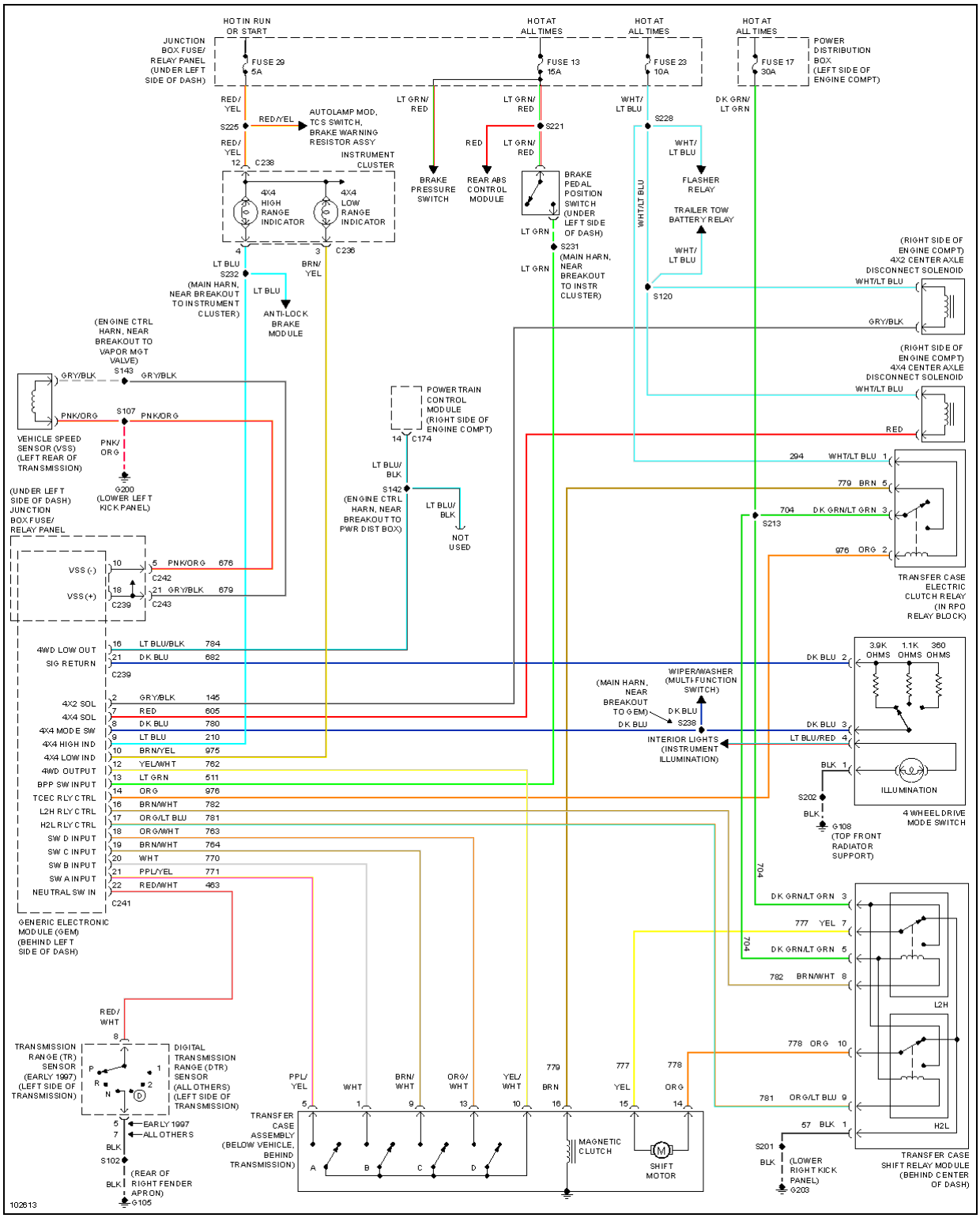


Fig. 67: Transfer Case Circuit, Electronic

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

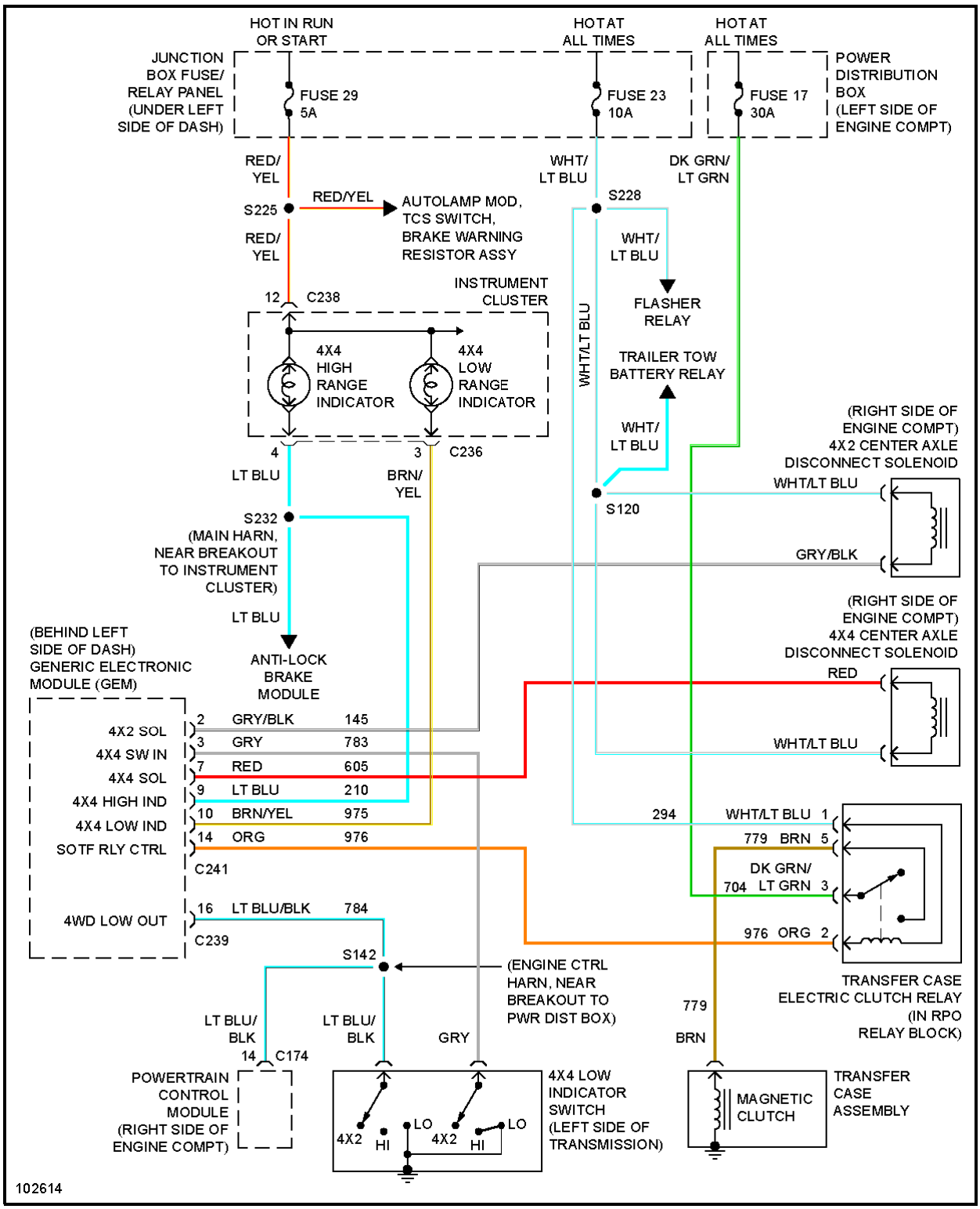


Fig. 68: Transfer Case Circuit, Mechanical

5.4L

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

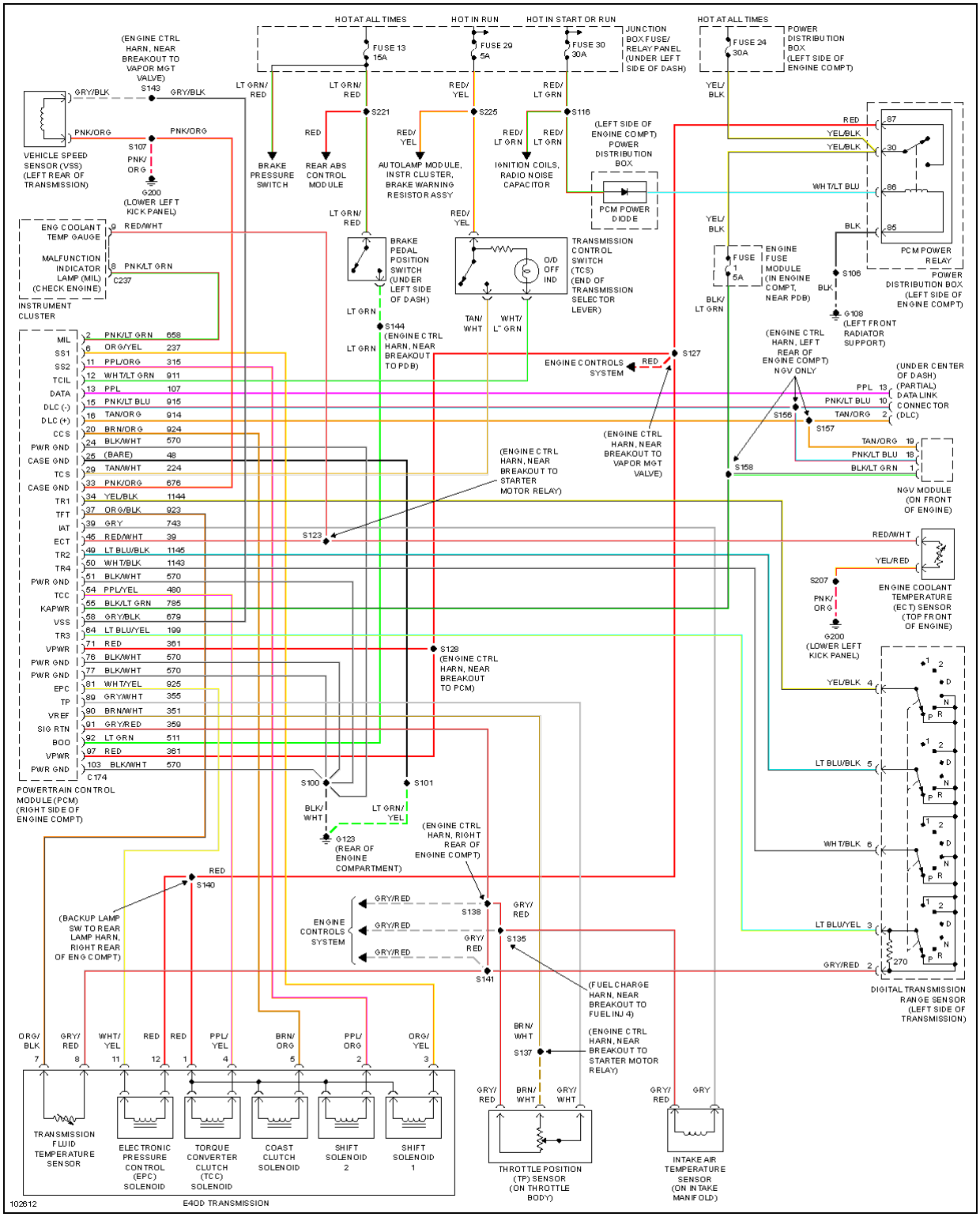


Fig. 69: 5.4L, Transmission Circuit, E4OD

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

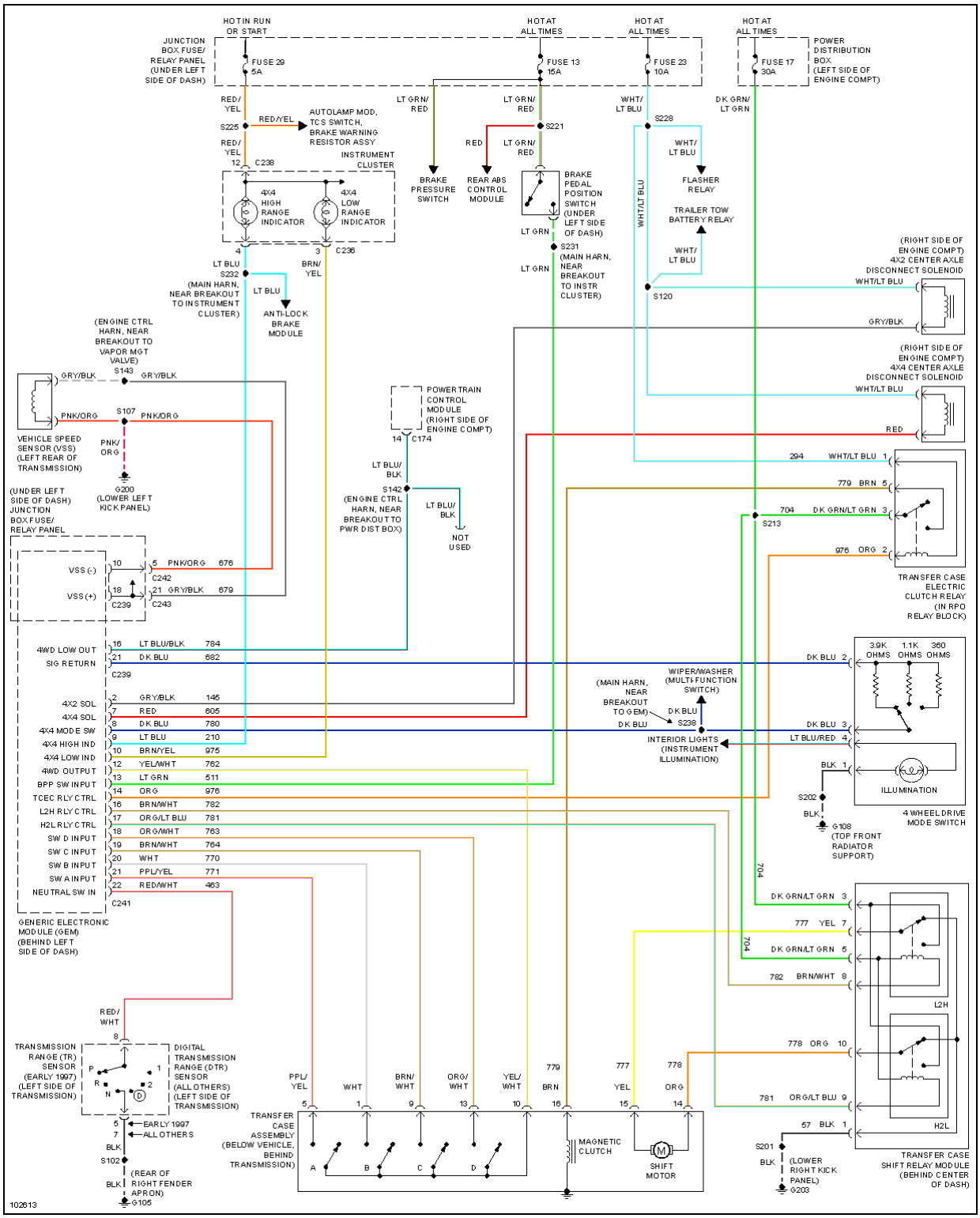


Fig. 70: Transfer Case Circuit, Electronic

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

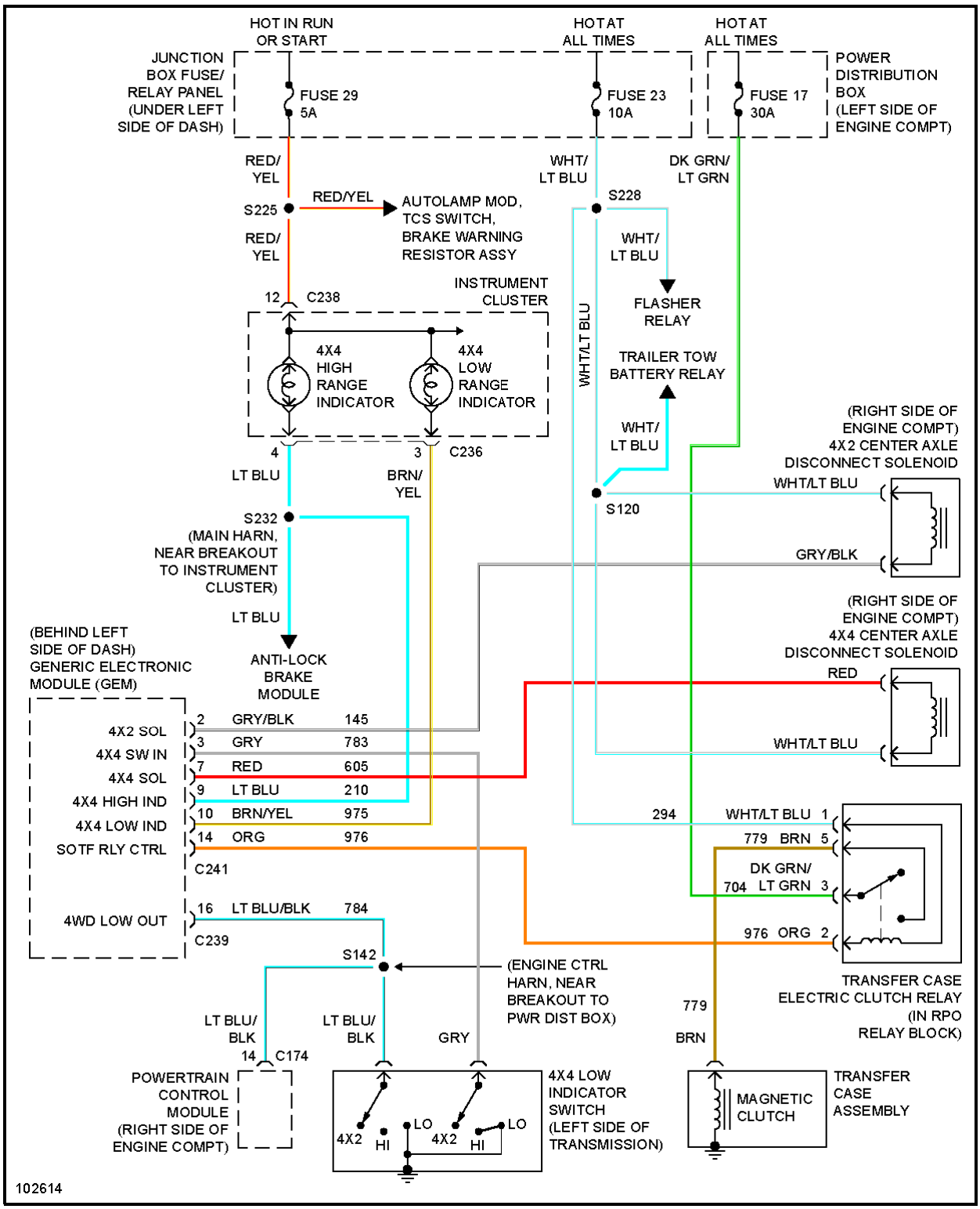


Fig. 71: Transfer Case Circuit, Mechanical

WARNING SYSTEMS

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

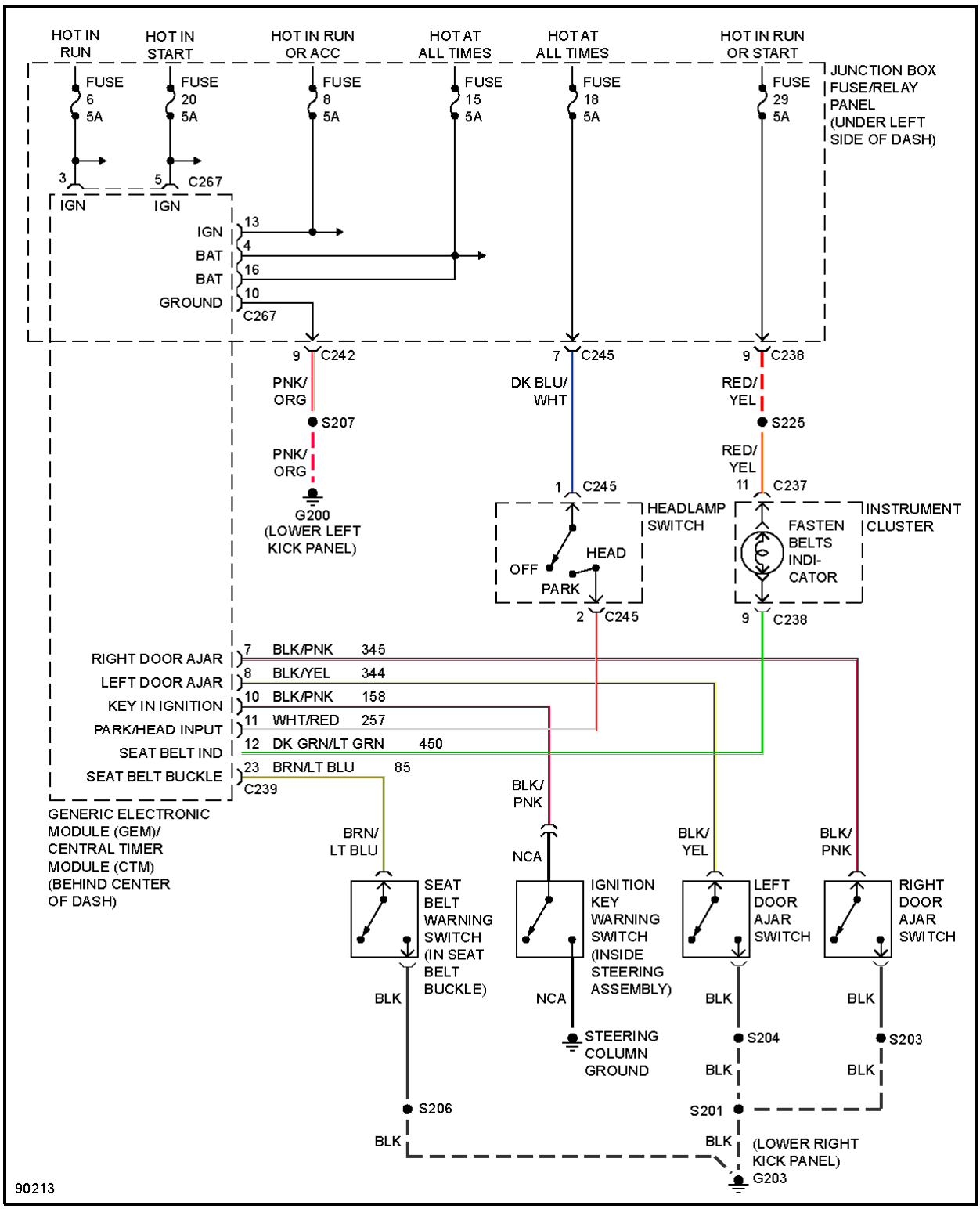


Fig. 72: Warning System Circuits

WIPER/WASHER

1997 Ford Pickup F150

1997 System Wiring Diagrams Ford - Pickup F150

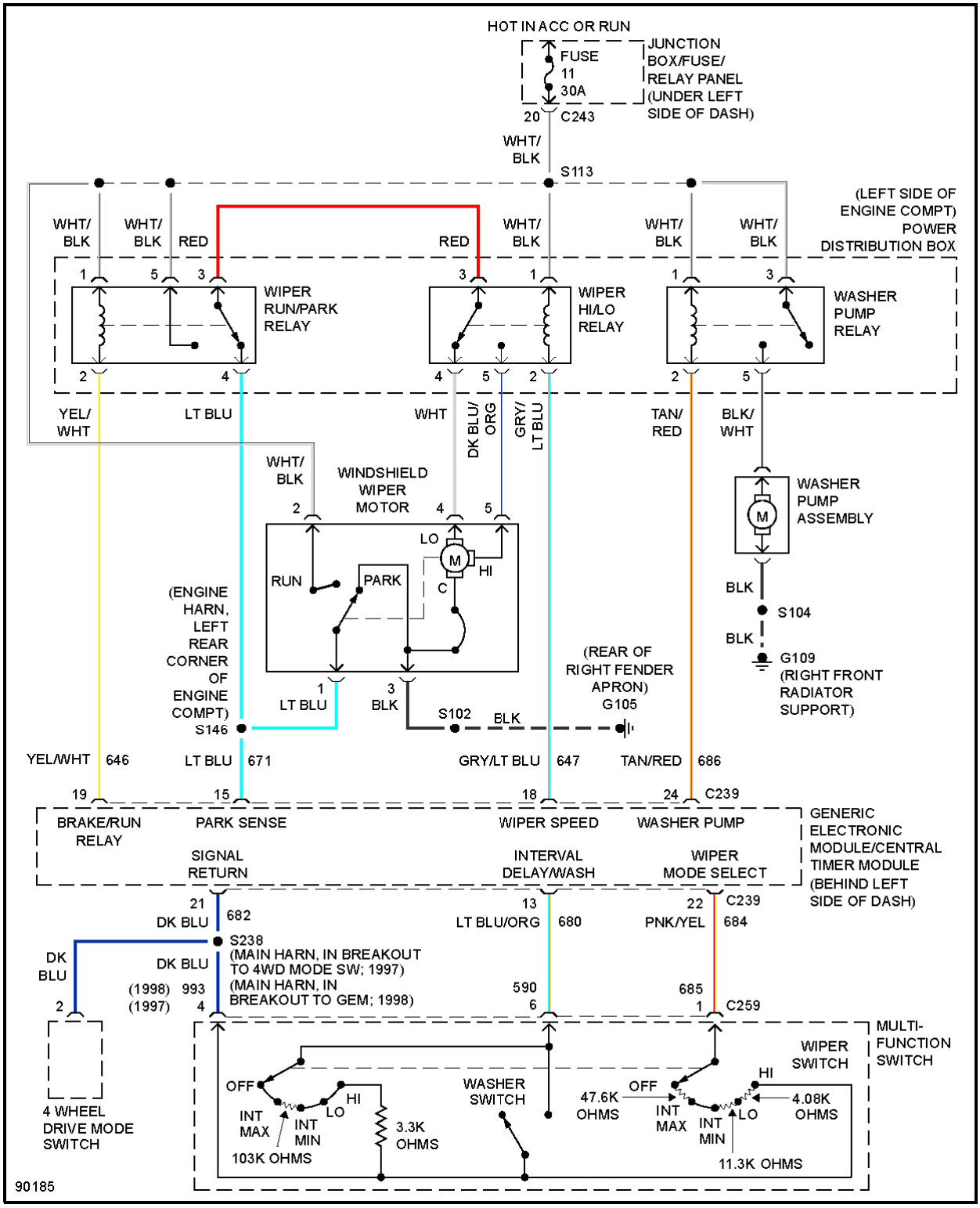


Fig. 73: Wiper/Washer Circuit