FUEL SYSTEM

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GENERAL INFORMATION

INTRODUCTION

Throughout this group, references may be made to a particular vehicle by letter or number designation. A chart showing the breakdown of these designations is included in the Introduction Section at the front of this service manual.

The Evaporation Control System, is also considered part of the fuel system. The system reduces the emission of fuel vapor into the atmosphere.

The description and function of the Evaporation Control System is found in Group 25 of this manual.

FUEL REQUIREMENTS

Your vehicle was designed to meet all emission regulations and provide excellent fuel economy when using high quality unleaded gasoline.

Use unleaded gasolines having a minimum posted octane of 87.

If your vehicle develops occasional light spark knock (ping) at low engine speeds this is not harmful. However; continued heavy knock at high speeds can cause damage and should be reported to your dealer immediately. Engine damage as a result of heavy knock operation may not be covered by the new vehicle warranty.

In addition to using unleaded gasoline with the proper octane rating, those that contain detergents, corrosion and stability additives are recommended. Using gasolines that have these additives will help improve fuel economy, reduce emissions, and maintain vehicle performance.

Poor quality gasoline can cause problems such as hard starting, stalling, and stumble. If you experience these problems, try another brand of gasoline before considering service for the vehicle.

GASOLINE/OXYGENATE BLENDS

Some fuel suppliers blend unleaded gasoline with materials that contain oxygen such as alcohol, MTBE (Methyl Tertiary Butyl Ether) and ETBE (Ethyl Tertiary Butyl Ether). Oxygenates are required in some areas of the country during winter months to reduce carbon monoxide emissions. The type and amount of oxygenate used in the blend is important.

The following are generally used in gasoline blends:

Ethanol - (Ethyl or Grain Alcohol) properly blended, is used as a mixture of 10 percent ethanol and 90 percent gasoline. Gasoline blended with ethanol may be used in your vehicle.

MTBE/ETBE - Gasoline and MTBE (Methyl Tertiary Butyl Ether) blends are a mixture of unleaded gasoline and up to 15 percent MTBE. Gasoline and ETBE (Ethyl Tertiary Butyl Ether) are blends of gasoline and up to 17 percent ETBE. Gasoline blended with MTBE or ETBE may be used in your vehicle.

Methanol - Methanol (Methyl or Wood Alcohol) is used in a variety of concentrations blended with unleaded gasoline. You may encounter fuels containing 3 percent or more methanol along with other alcohols called cosolvents.

DO NOT USE GASOLINES CONTAINING METHANOL.

GENERAL INFORMATION (Continued)

Use of methanol/gasoline blends may result in starting and driveability problems and damage critical fuel system components.

Problems that are the result of using methanol/gasoline blends are not the responsibility of Chrysler Corporation and may not be covered by the vehicle warranty.

Reformulated Gasoline

Many areas of the country are requiring the use of cleaner-burning fuel referred to as **Reformulated Gasoline** . Reformulated gasolines are specially blended to reduce vehicle emissions and improve air quality.

Chrysler Corporation strongly supports the use of reformulated gasolines whenever available. Although your vehicle was designed to provide optimum performance and lowest emissions operating on high quality unleaded gasoline, it will perform equally well and produce even lower emissions when operating on reformulated gasoline.

Materials Added to Fuel

Indiscriminate use of fuel system cleaning agents should be avoided. Many of these materials intended for gum and varnish removal may contain active solvents of similar ingredients that can be harmful to fuel system gasket and diaphragm materials.

FUEL DELIVERY SYSTEM

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DESCRIPTION AND OPERATION

FUEL DELIVERY SYSTEM

The fuel delivery system consists of:

- the fuel pump module containing the electric fuel pump, fuel filter/fuel pressure regulator, fuel gauge sending unit (fuel level sensor) and a separate fuel filter located at bottom of pump module
- fuel tubes/lines/hoses
- quick-connect fittings
- fuel injector rail
- fuel injectors
- fuel tank
- fuel tank filler/vent tube assembly
- fuel tank filler tube cap
- accelerator pedal
- throttle cable

Fuel is returned through the fuel pump module and back into the fuel tank through the fuel filter/fuel pressure regulator. A separate fuel return line from the engine to the tank is not used.

The fuel tank assembly consists of: the fuel tank, fuel pump module assembly, fuel pump module locknut/gasket, and rollover valve (refer to Group 25, Emission Control System for rollover valve information).

A fuel filler/vent tube assembly consisting of a pressure-vacuum filler cap is used.

Also to be considered part of the fuel system is the evaporation control system containing the pressure relief/rollover valve. This is designed to reduce the emission of fuel vapors into the atmosphere. The description and function of the Evaporative Control System is found in Group 25, Emission Control Systems.

Both fuel filters (at bottom of fuel pump module and within fuel pressure regulator) are designed for extended service. They do not require normal scheduled maintenance. Filters should only be replaced if a diagnostic procedure indicates to do so.

DESCRIPTION AND OPERATION (Continued)

FUEL PUMP MODULE

The fuel pump module is installed in the top of the fuel tank (Fig. 1) or (Fig. 2). The fuel pump module contains the following components:

- A combination fuel filter/fuel pressure regulator
- A separate fuel pick-up filter (strainer)
- An electric fuel pump
- A threaded locknut to retain module to tank
- Fuel gauge sending unit (fuel level sensor)
- Fuel supply tube (line) connection

The fuel gauge sending unit, pick-up filter and fuel filter/fuel pressure regulator may be serviced separately. If the electrical fuel pump requires service, the entire fuel pump module must be replaced.

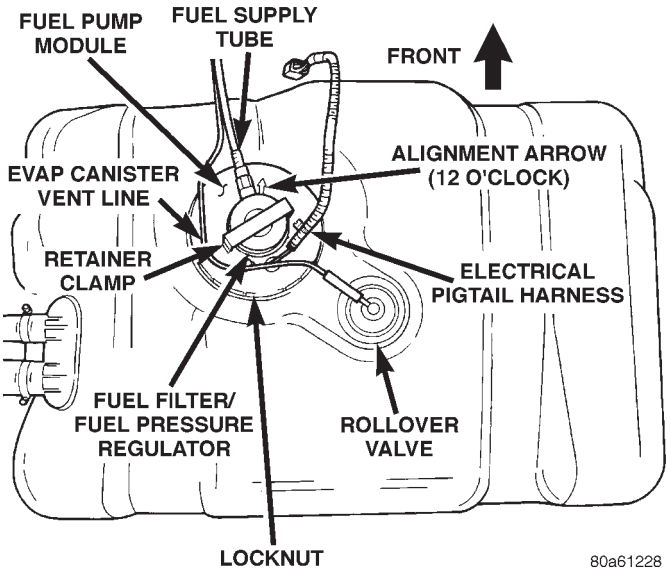


Fig. 1 Fuel Tank/Fuel Pump Module (Top View)

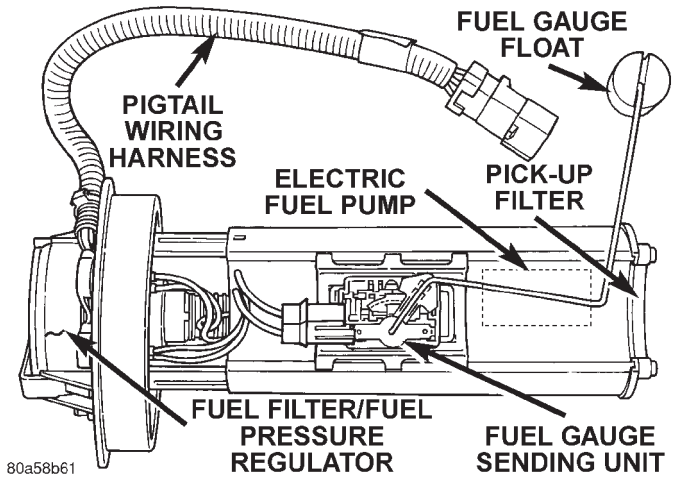


Fig. 2 Fuel Pump Module Components

FUEL PUMP

The fuel pump used in this system has a permanent magnet electric motor. The pump is part of the fuel pump module. Fuel is drawn in through a filter at the bottom of the module and pushed through the electric motor gearset to the pump outlet.

Check Valve Operation: The pump outlet contains a one-way check valve to prevent fuel flow back into the tank and to maintain fuel supply line pressure (engine warm) when pump is not operational. It is also used to keep the fuel supply line full of gasoline when pump is not operational. After the vehicle has cooled down, fuel pressure may drop to 0 psi (cold fluid contracts), but liquid gasoline will remain in fuel supply line between the check valve and fuel injectors. **Fuel pressure that has dropped to 0 psi on a cooled down vehicle (engine off) is a normal condition.** Refer to the Fuel Pressure Leak Down Test in this group for more information.

Voltage to operate the electric pump is supplied through the fuel pump relay.

FUEL GAUGE SENDING UNIT

The fuel gauge sending unit (fuel level sensor) is attached to the side of the fuel pump module (Fig. 2). The sending unit consists of a float, an arm, and a variable resistor (track). The resistor track is used to send electrical signals to the Powertrain Control Module (PCM) for fuel gauge operation and for OBD II emission requirements.

For fuel gauge operation: As fuel level increases, the float and arm move up. This decreases the sending unit resistance, causing the fuel gauge to read full. As fuel level decreases, the float and arm move down. This increases the sending unit resistance causing the fuel gauge to read empty.

After this fuel level signal is sent to the PCM, the PCM will transmit the data across the CCD bus circuits to the instrument panel. Here it is translated into the appropriate fuel gauge level reading.

For OBD II emission requirements: The voltage signal is sent from the resistor track to the PCM to indicate fuel level. The purpose of this feature is to prevent a false setting of misfire and fuel system monitor trouble codes. This is if the fuel level in the tank is less than approximately 15 percent, or more than approximately 85 percent of its rated capacity.

FUEL FILTER/FUEL PRESSURE REGULATOR

A combination fuel filter and fuel pressure regulator is used on all engines. It is located on the top of fuel pump module (Fig. 1). A separate frame mounted fuel filter is not used with any engine.

Fuel Pressure Regulator Operation: The pressure regulator is a mechanical device that is not controlled by engine vacuum or the Powertrain Control Module (PCM).

The regulator is calibrated to maintain fuel system operating pressure of approximately 339 kPa ± 34 kPa (49.2 psi ± 5 psi) at the fuel injectors. It con-

DESCRIPTION AND OPERATION (Continued)

tains a diaphragm, calibrated springs and a fuel return valve. The internal fuel filter is also part of the assembly.

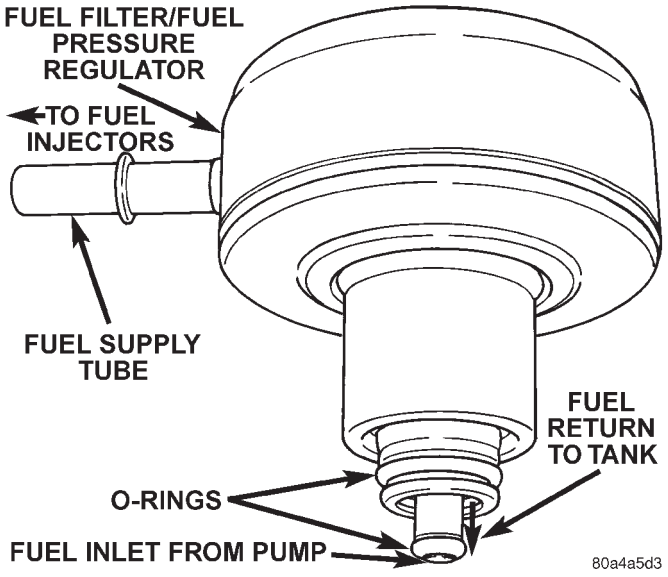


Fig. 3 Fuel Filter/Fuel Pressure Regulator

Fuel is supplied to the filter/regulator by the electric fuel pump through an opening tube at the bottom of filter/regulator (Fig. 3).

The regulator acts as a check valve to maintain some fuel pressure when the engine is not operating. This will help to start the engine. A second check valve is located at the outlet end of the electric fuel pump. **Refer to Fuel Pump—Description and Operation for more information. Also refer to the Fuel Pressure Leak Down Test and the Fuel Pump Pressure Tests.**

If fuel pressure at the pressure regulator exceeds approximately 49 psi, an internal diaphragm closes and excess fuel is routed back into the tank through the pressure regulator. A separate fuel return line is not used.

FUEL TANK

All models pass a full 360 degree rollover test without fuel leakage. To accomplish this, fuel and vapor flow controls are required for all fuel tank connections.

All models have a pressure relief/rollover valve mounted on the top of the fuel tank.

An evaporative control system is used to reduce emissions of fuel vapors into atmosphere by evaporation and to reduce unburned hydrocarbons emitted by vehicle engine. When fuel evaporates from fuel tank, vapors pass through vent hoses or tubes to a charcoal canister. The vapors are temporarily held in the canister. When the engine is running, the vapors are drawn into intake manifold. Refer to Group 25, Emission Control System for additional information.

ROLLOVER VALVE(S)

Refer to Group 25, Emission Control System for information.

FUEL INJECTORS—5.2L/5.9L ENGINES

The fuel injectors are attached to the fuel rail (Fig. 4). 5.2L V-8 engines use eight injectors.

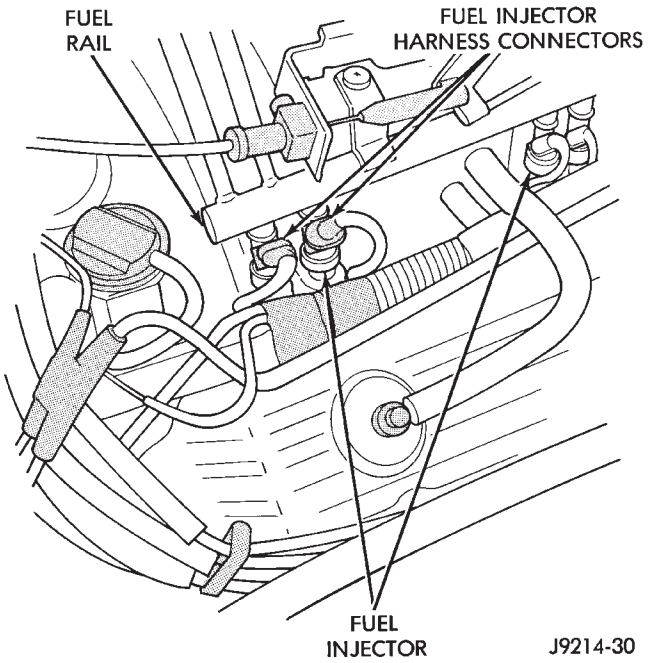


Fig. 4 Fuel Injectors—5.2L5.9LEngines—Typical

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector with its respective cylinder number.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

FUEL INJECTORS—4.0L ENGINE

Six individual fuel injectors are used with the 4.0L 6-cylinder engine. The injectors are attached to the fuel rail (Fig. 5).

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped

DESCRIPTION AND OPERATION (Continued)

with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

During start up, battery voltage is supplied to the injectors through the ASD relay. When the engine is operating, voltage is supplied by the charging system. The PCM determines injector pulse width based on various inputs.

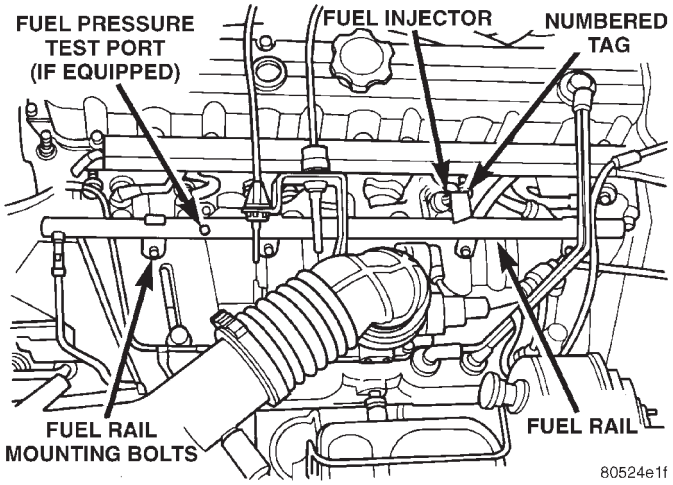


Fig. 5 Fuel Injectors—4.0L Engine

FUEL RAIL

The fuel rail supplies the necessary fuel to each individual fuel injector and is mounted to the intake manifold. The fuel pressure regulator is no longer mounted to the fuel rail on any engine. It is now located on the fuel tank mounted fuel pump module. Refer to Fuel Pressure Regulator in this group for information.

Certain engines are equipped with a fuel pressure test port. **Not all engines are equipped with this test port.**

The fuel rail is not repairable.

CAUTION: 5.2L/5.9L Engines Only: The left and right sections of the fuel rail are connected with a flexible connecting hose. Do not attempt to separate the rail halves at this connecting hose. Due to the design of this connecting hose, it does not use any clamps. Never attempt to install a clamping device of any kind to the hose. When removing the fuel rail assembly for any reason, be careful not to bend or kink the connecting hose.

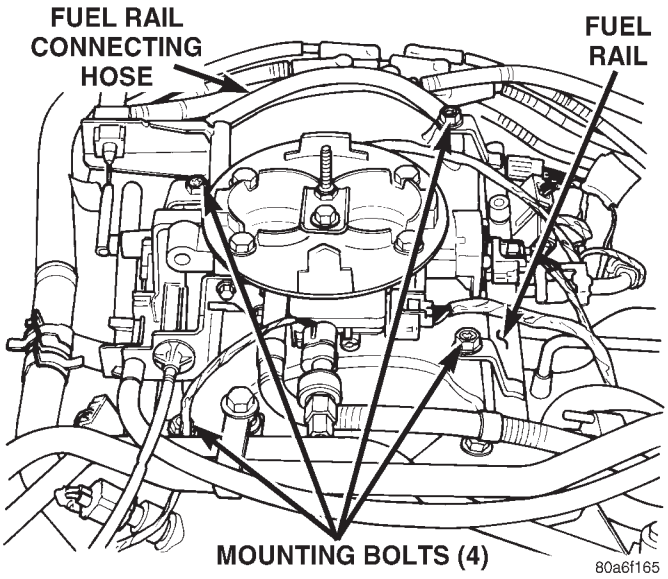


Fig. 6 Fuel Rail—Typical(5.2L/5.9L Engine Shown)

FUEL TANK FILLER TUBE CAP

The loss of any fuel or vapor out of filler neck is prevented by the use of a pressure-vacuum fuel tank filler tube cap. Relief valves inside cap will release only under significant pressure of 6.58 to 8.44 kPa (1.95 to 2.5 psi). The vacuum release for all fuel filler tube caps is between .97 and 5.0 kPa (.14 and .72 psi). This cap must be replaced by a similar unit if replacement is necessary. This is in order for the system to remain effective.

CAUTION: Remove fuel tank filler tube cap before servicing any fuel system component. This is done to help relieve tank pressure.

QUICK-CONNECT FITTINGS

Different types of quick-connect fittings are used to attach various fuel system components. These are: a single-tab type, a two-tab type or a plastic retainer ring type. Some are equipped with safety latch clips. Refer to the Removal/Installation section for more information.

CAUTION: The interior components (o-rings, spacers) of quick-connect fitting are not serviced separately, but new pull tabs are available for some types. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

DIAGNOSIS AND TESTING

FUEL PUMP PRESSURE TEST–4.0L ENGINE

Use this test in conjunction with the Fuel Pump Capacity Test and Fuel Pressure Leak Down Test found elsewhere in this group.

Check Valve Operation: The electric fuel pump outlet contains a one-way check valve to prevent fuel flow back into the tank and to maintain fuel supply line pressure (engine warm) when pump is not operational. It is also used to keep the fuel supply line full of gasoline when pump is not operational. After the vehicle has cooled down, fuel pressure may drop to 0 psi (cold fluid contracts), but liquid gasoline will remain in fuel supply line between the check valve and fuel injectors. **Fuel pressure that has dropped to 0 psi on a cooled down vehicle (engine off) is a normal condition.** When the electric fuel pump is activated, fuel pressure should **immediately** rise to specification.

NOTE: The fuel pressure test port is used on certain engines only. If equipped, the test port will be located on the fuel rail (Fig. 7). A sealing cap is screwed onto the test port.

All fuel systems are equipped with a fuel tank module mounted, combination fuel filter/fuel pressure regulator. The fuel pressure regulator is not controlled by engine vacuum.

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE EVEN WITH THE ENGINE OFF. BEFORE DISCONNECTING FUEL LINE AT FUEL RAIL, THIS PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE.

(1) Remove the protective cap at the fuel rail test port. Connect the 0–414 kPa (0-60 psi) fuel pressure gauge (from gauge set 5069) to the test port pressure fitting on the fuel rail.

(2) Start and warm the engine and note pressure gauge reading. Fuel pressure should be 339 kPa ± 34 kPa (49.2 psi ± 5 psi) at idle.

(3) If engine runs but pressure is below 44.2 psi, check for a kinked fuel supply line somewhere between fuel rail and fuel pump module. If line is not kinked, replace fuel pump module assembly. Refer to Fuel Pump Module Removal/Installation.

(4) If operating pressure is above 54.2 psi, electric fuel pump is OK, but fuel pressure regulator is defective. Replace fuel filter/fuel pressure regulator. Refer to Fuel Filter/Fuel Pressure Regulator Removal/Installation.

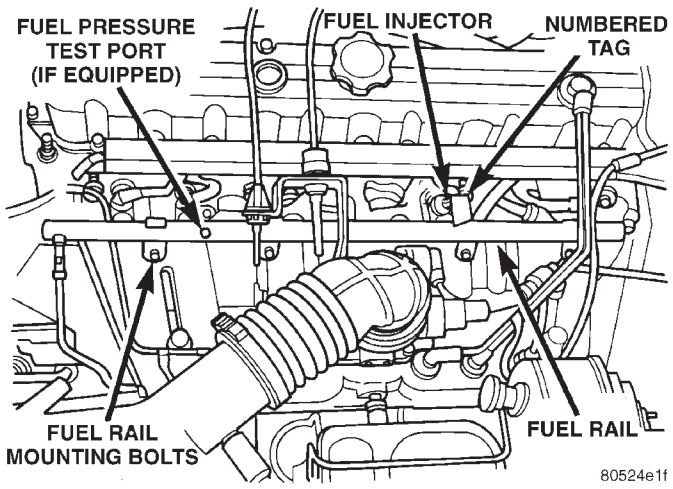


Fig. 7 Fuel Pressure Test Port—4.0LEngine

FUEL PUMP PRESSURE TEST—5.2L/5.9L ENGINES WITH PRESSURE TEST PORT

Use this test in conjunction with the Fuel Pump Capacity Test and Fuel Pressure Leak Down Test found elsewhere in this group.

Check Valve Operation: The electric fuel pump outlet contains a one-way check valve to prevent fuel flow back into the tank and to maintain fuel supply line pressure (engine warm) when pump is not operational. It is also used to keep the fuel supply line full of gasoline when pump is not operational. After the vehicle has cooled down, fuel pressure may drop to 0 psi (cold fluid contracts), but liquid gasoline will remain in fuel supply line between the check valve and fuel injectors. **Fuel pressure that has dropped to 0 psi on a cooled down vehicle (engine off) is a normal condition.** When the electric fuel pump is activated, fuel pressure should **immediately** rise to specification.

NOTE: The fuel pressure test port is used on certain engines only. On 5.2L/5.9L engines, and when equipped, the test port will be located on the fuel rail near the throttle position sensor (Fig. 8). A sealing cap is screwed onto the test port.

All fuel systems are equipped with a fuel tank module mounted, combination fuel filter/fuel pressure regulator. The fuel pressure regulator is not controlled by engine vacuum.

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE EVEN WITH THE ENGINE OFF. BEFORE DISCONNECTING FUEL LINE AT FUEL RAIL, THIS PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE.

DIAGNOSIS AND TESTING (Continued)

(1) Remove the protective cap at the fuel rail test port. Connect the 0–414 kPa (0-60 psi) fuel pressure gauge (from gauge set 5069) to the test port pressure fitting on the fuel rail (Fig. 8).

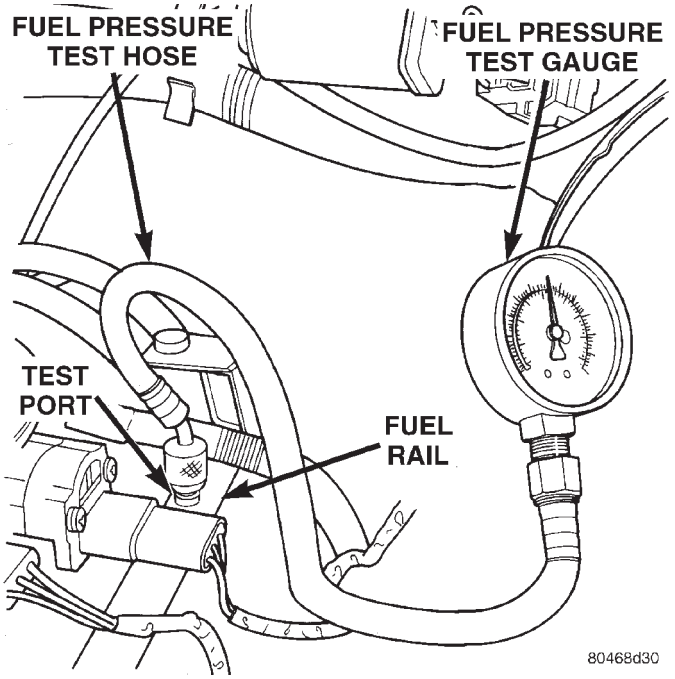


Fig. 8 Fuel Pressure Test Port—5.2L/5.9LEngines—Typical

(2) Start and warm the engine and note pressure gauge reading. Fuel pressure should be 339 kPa ± 34 kPa (49.2 psi ± 5 psi) at idle.

(3) If engine runs but pressure is below 44.2 psi, check for a kinked fuel supply line somewhere between fuel rail and fuel pump module. If line is not kinked, replace fuel pump module assembly. Refer to Fuel Pump Module Removal/Installation.

(4) If operating pressure is above 54.2 psi, electric fuel pump is OK, but fuel pressure regulator is defective. Replace fuel filter/fuel pressure regulator. Refer to Fuel Filter/Fuel Pressure Regulator Removal/Installation.

FUEL PUMP PRESSURE TEST—5.2L/5.9L ENGINES WITHOUT PRESSURE TEST PORT

Use this test in conjunction with the Fuel Pump Capacity Test and Fuel Pressure Leak Down Test found elsewhere in this group.

Check Valve Operation: The electric fuel pump outlet contains a one-way check valve to prevent fuel flow back into the tank and to maintain fuel supply line pressure (engine warm) when pump is not operational. It is also used to keep the fuel supply line full of gasoline when pump is not operational. After the vehicle has cooled down, fuel pressure may drop to 0 psi (cold fluid contracts), but liquid gasoline will remain in fuel supply line between the check valve and fuel injectors. **Fuel pressure that has dropped to 0 psi on a cooled down vehicle (engine off) is a normal condition.** When the electric fuel pump is activated, fuel pressure should **immediately** rise to specification.

NOTE: The fuel pressure test port is used on certain 5.2L/5.9L engines only. If equipped, the test port will be located on the fuel rail near the throttle position sensor. If not equipped, refer to the following procedure:

All fuel systems are equipped with a fuel tank module mounted, combination fuel filter/fuel pressure regulator. The fuel pressure regulator is not controlled by engine vacuum.

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE EVEN WITH THE ENGINE OFF. BEFORE DISCONNECTING FUEL LINE AT FUEL RAIL, THIS PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE.

(1) Release fuel pressure. Refer to the Fuel System Pressure Release Procedure—Without Pressure Test Port.

(2) Disconnect latch clip and fuel line at fuel rail. Refer to Quick-Connect Fittings for procedures. This can be found in this section of the group.

(3) Connect adapter tool number 6923 into the fuel rail (Fig. 9). **Be sure adapter tool is fully seated into fuel rail.**

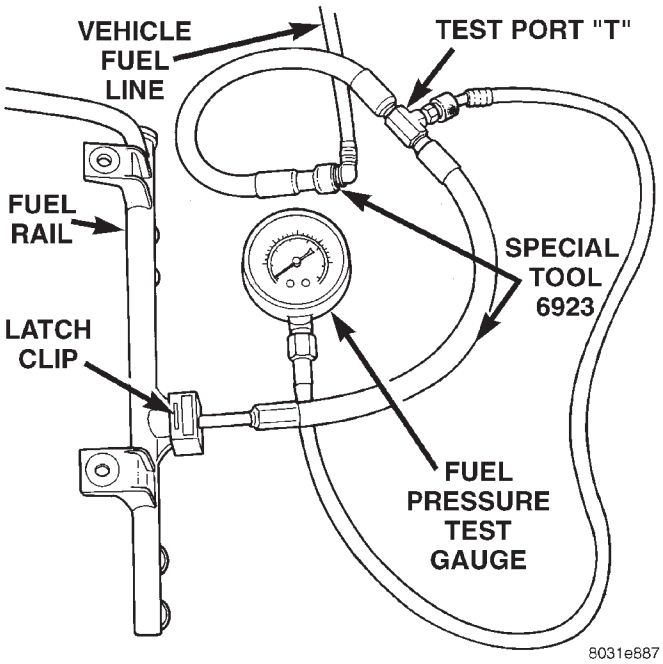


Fig. 9 Installing Adapter Tool and PressureGauge

DIAGNOSIS AND TESTING (Continued)

(4) Install latch clip to fuel rail. If latch clip can not be fully seated into fuel rail, check for adapter tool not fully seated to fuel rail.

(5) Connect vehicle fuel line into adapter tool 6923 (Fig. 9). Be sure fuel line is fully seated into adapter tool 6923.

(6) Remove protective cap at test port "T" on adapter tool number 6923.

(7) Connect the 0–414 kPa (0-60 psi) fuel pressure gauge (from gauge set 5069) to the test port "T" (Fig. 9).

(8) Start and warm the engine and note pressure gauge reading. Fuel pressure should be 339 kPa ± 34 kPa (49.2 psi ± 5 psi) at idle.

(9) If engine runs but pressure is below 44.2 psi, check for a kinked fuel supply line somewhere between fuel rail and fuel pump module. If line is not kinked, replace fuel pump module assembly. Refer to Fuel Pump Module Removal/Installation.

(10) If operating pressure is above 54.2 psi, electric fuel pump is OK, but fuel pressure regulator is defective. Replace fuel filter/fuel pressure regulator. Refer to Fuel Filter/Fuel Pressure Regulator Removal/Installation.

(11) After performing pressure test, install fuel line into fuel rail. Install latch clip into fuel rail. Refer to Quick-Connect Fittings for procedures. This can be found in this section of the group.

FUEL PUMP CAPACITY TEST

Before performing this test, verify fuel pump pressure by performing the Fuel Pump Pressure Test. Use this test in conjunction with the Fuel Pressure Leak Down Test found elsewhere in this group.

(1) Release fuel system pressure. Refer to the Fuel Pressure Release Procedure in this group.

(2) Disconnect fuel supply line at fuel rail. Refer to Quick-Connect Fittings in the Service Procedures section of this group for procedures. Some engines may require air cleaner housing removal before line disconnection.

(3) Connect appropriate Fuel Line Pressure Test Adapter Tool Hose (number 6631, 6923, 6541 or 6539) into disconnected fuel supply line. Insert other end of Adaptor Tool hose into a graduated container.

(4) Remove fuel fill cap.

(5) To activate fuel pump and pressurize system, obtain DRB scan tool and actuate ASD Fuel System Test.

(6) A good fuel pump will deliver at least 1/4 liter of fuel in 7 seconds. Do not operate fuel pump for longer than 7 seconds with fuel line disconnected as fuel pump module reservoir may run empty.

(a) If capacity is lower than specification, but fuel pump can be heard operating through fuel fill cap opening, check for a kinked/damaged fuel supply line somewhere between fuel rail and fuel pump module.

(b) If line is not kinked/damaged, and fuel pressure is OK, but capacity is low, replace fuel filter/fuel pressure regulator. The filter/regulator may be serviced separately on certain applications. Refer to Fuel Filter/Fuel Pressure Regulator Removal/Installation for additional information.

(c) If both fuel pressure and capacity are low, replace fuel pump module assembly. Refer to Fuel Pump Module Removal/Installation.

FUEL PRESSURE LEAK DOWN TEST

Use this test in conjunction with the Fuel Pump Pressure Test and Fuel Pump Capacity Test.

Check Valve Operation: The electric fuel pump outlet contains a one-way check valve to prevent fuel flow back into the tank and to maintain fuel supply line pressure (engine warm) when pump is not operational. It is also used to keep the fuel supply line full of gasoline when pump is not operational. After the vehicle has cooled down, fuel pressure may drop to 0 psi (cold fluid contracts), but liquid gasoline will remain in fuel supply line between the check valve and fuel injectors. **Fuel pressure that has dropped to 0 psi on a cooled down vehicle (engine off) is a normal condition.** When the electric fuel pump is activated, fuel pressure should **immediately** rise to specification.

Abnormally long periods of cranking to restart a **hot** engine that has been shut down for a short period of time may be caused by:

- Fuel pressure bleeding past a fuel injector(s).
- Fuel pressure bleeding past the check valve in the fuel pump module.

(1) Disconnect the fuel inlet line at fuel rail. Refer to Fuel Tubes/Lines/Hoses and Clamps in this section of the group for procedures. On some engines, air cleaner housing removal may be necessary before fuel line disconnection.

(2) Connect the appropriate Fuel Line Pressure Test Adapter Tool (number 6539, 6631, 6541 or 6923) between the disconnected fuel line and fuel rail (Fig. 10) or (Fig. 11).

(3) Connect the 0-414 kPa (0-60 psi) fuel pressure test gauge (from Gauge Set 5069) to the test port on the appropriate Adaptor Tool. **The fittings on both tools must be in good condition and free from any small leaks before performing the proceeding test.**

(4) Start engine and bring to normal operating temperature.

(5) Observe test gauge. Normal operating pressure should be 339 kPa ± 34 kPa (49.2 psi ± 5 psi).

(6) Shut engine off.

DIAGNOSIS AND TESTING (Continued)

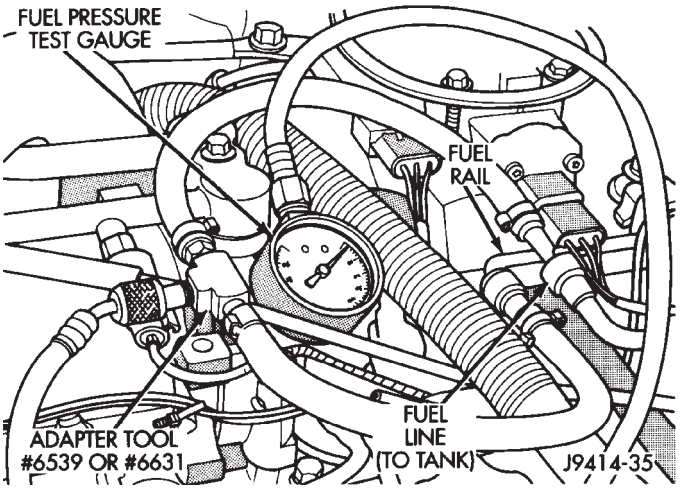


Fig. 10 Connecting Adapter Tool—Typical

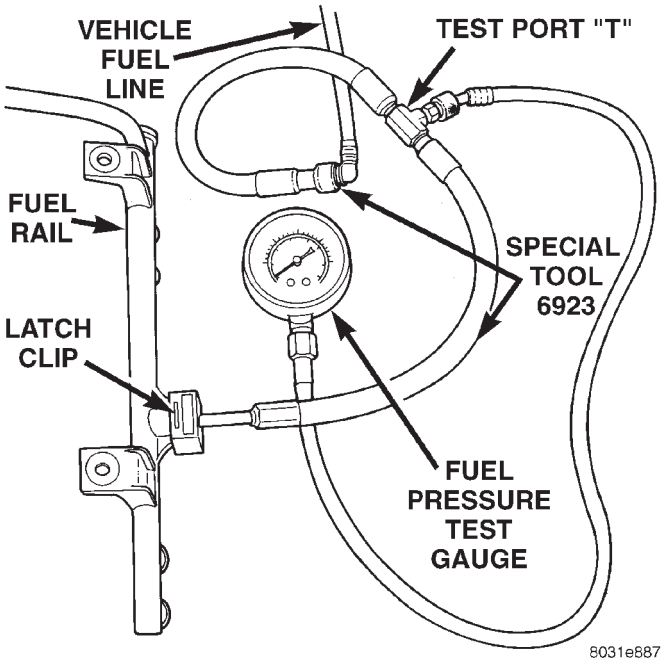


Fig. 11 Connecting Adapter Tool—Typical

(7) Pressure should not fall below **30 psi for five minutes.**

(8) If pressure falls below 30 psi, it must be determined if a fuel injector, the check valve within the fuel pump module, or a fuel tube/line is leaking.

(9) Again, start engine and bring to normal operating temperature.

(10) Shut engine off.

(11) **Testing for fuel injector or fuel rail leakage:** Clamp off the rubber hose portion of Adaptor Tool between the fuel rail and the test port "T" on Adapter Tool. If pressure now holds at or above 30 psi, a fuel injector or the fuel rail is leaking.

(12) **Testing for fuel pump check valve, filter/regulator check valve or fuel tube/line leakage:** Clamp off the rubber hose portion of Adaptor Tool between the vehicle fuel line and test port "T" on Adapter Tool. If pressure now holds at or above 30 psi, a leak may be found at a fuel tube/line. If no leaks are found at fuel tubes or lines, one of the check valves in either the electric fuel pump or filter/regulator may be leaking.

Note: A quick loss of pressure usually indicates a defective check valve in the filter/regulator. A slow loss of pressure usually indicates a defective check valve in the electric fuel pump.

The electric fuel pump is not serviced separately. Replace the fuel pump module assembly. The filter/regulator may be replaced separately on certain applications. Refer to Fuel Filter/Fuel Pressure Regulator Removal/Installation for additional information.

FUEL GAUGE SENDING UNIT

The fuel gauge sending unit contains a variable resistor (track). As the float moves up or down, electrical resistance will change. Refer to Group 8E, Instrument Panel and Gauges for Fuel Gauge testing. To test the gauge sending unit only, it must be removed from vehicle. The unit is part of the fuel pump module. Refer to Fuel Pump Module Removal/Installation for procedures. Measure the resistance across the sending unit terminals. With float in up position, resistance should be 20 ohms. With float in down position, resistance should be 220 ohms.

FUEL INJECTOR TEST

To perform a complete test of the fuel injectors and their circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the injector only, refer to the following:

Disconnect the fuel injector wire harness connector from the injector. Place an ohmmeter across the injector electrical terminals. Resistance reading should be approximately 12 ohms ±1.2 ohms at 20°C (68°F).

SERVICE PROCEDURES

FUEL SYSTEM PRESSURE RELEASE PROCEDURE–WITH PRESSURE TEST PORT

NOTE: The fuel pressure test port is used on certain engines only. If equipped, the test port will be located on the fuel rail near the throttle position sensor. A sealing cap is screwed onto the test port.

The fuel system is under constant fuel pressure (even with the engine off).

SERVICE PROCEDURES (Continued)

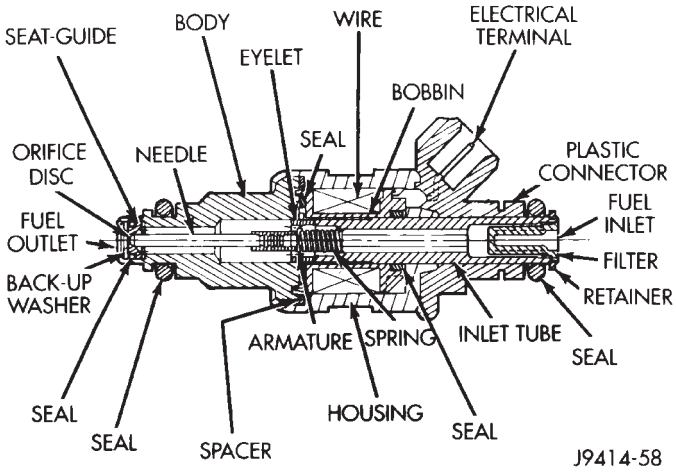


Fig. 12 Fuel Injector Internal Components—Typical

WARNING: BECAUSE THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE, THE PRESSURE MUST BE RELEASED BEFORE SERVICING ANY FUEL SYSTEM COMPONENT. THIS DOES NOT APPLY TO THROTTLE BODY REMOVAL.

(1) Disconnect negative battery cable.
(2) Remove the fuel tank filler tube cap to release fuel tank pressure.
(3) Remove protective cap from pressure test port on the fuel rail. This is located on top of fuel rail near the throttle position sensor.

WARNING: DO NOT ALLOW FUEL TO SPILL ONTO THE ENGINE INTAKE OR EXHAUST MANIFOLDS. PLACE SHOP TOWELS UNDER AND AROUND THE PRESSURE PORT TO ABSORB FUEL WHEN THE PRESSURE IS RELEASED FROM THE FUEL RAIL.

WARNING: WEAR PROPER EYE PROTECTION WHEN RELEASING FUEL SYSTEM PRESSURE.

(4) Obtain the fuel pressure gauge/hose assembly from fuel pressure gauge tool set 5069. Remove the gauge from the hose.
(5) Place one end of hose (gauge end) into an approved gasoline container.
(6) Place a shop towel under the test port.
(7) To release fuel pressure, screw the other end of hose onto the fuel pressure test port.
(8) After fuel pressure has been released, remove the hose from the test port.
(9) Install protective cap to fuel test port.

FUEL SYSTEM PRESSURE RELEASE PROCEDURE—WITHOUT PRESSURE TEST PORT

Use the following procedure if the fuel rail is not equipped with a fuel pressure test port.

(1) Remove the Fuel Pump relay from the Power Distribution Center (PDC). For location of the relay, refer to the label on the underside of the PDC cover.
(2) Start and run engine until it stalls.
(3) Attempt restarting engine until it will no longer run.
(4) Turn ignition key to OFF position.

CAUTION: Steps 1, 2, 3 and 4 must be performed to relieve high pressure fuel from within the fuel rail. Do not attempt to use the following steps to relieve this pressure as excessive fuel will be forced into a cylinder chamber.

(5) Unplug connector from any injector.
(6) Attach one end of a jumper wire with alligator clips (18 gauge or smaller) to either injector terminal.
(7) Connect the other end of the jumper wire to the positive side of the battery.
(8) Connect one end of a second jumper wire to the remaining injector terminal.

CAUTION: Supplying power to an injector for more than 4 seconds will permanently damage the injector. Do not leave the injector connected to power for more than 4 seconds.

(9) Momentarily touch the other end of this jumper wire to the negative terminal of the battery for no more than 4 seconds.
(10) Place a rag or towel below the fuel line at the quick connect to the rail.
(11) Disconnect the quick connect fitting to the rail. Refer to Quick-Connect Fittings in this section.
(12) Return the fuel pump relay to the PDC.
(13) One or more Diagnostic Trouble Codes (DTC's) may have been stored in the PCM memory due to fuel pump relay removal. The DRB scan tool must be used to erase a DTC. Refer to Group 25, Emission Control System. See On-Board Diagnostics.

FUEL TUBES/LINES/HOSES AND CLAMPS

Also refer to the section on Quick-Connect Fittings.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE IN THIS GROUP.

Inspect all hose connections such as clamps, couplings and fittings to make sure they are secure and leaks are not present. The component should be replaced immediately if there is any evidence of degradation that could result in failure.

SERVICE PROCEDURES (Continued)

Never attempt to repair a plastic fuel line/tube. Replace as necessary.

Avoid contact of any fuel tubes/hoses with other vehicle components that could cause abrasions or scuffing. Be sure that the plastic fuel lines/tubes are properly routed to prevent pinching and to avoid heat sources.

The lines/tubes/hoses used on fuel injected vehicles are of a special construction. This is due to the higher fuel pressures and the possibility of contaminated fuel in this system. If it is necessary to replace these lines/tubes/hoses, only those marked EFM/EFI may be used.

The hose clamps used to secure rubber hoses on fuel injected vehicles are of a special rolled edge construction. This construction is used to prevent the edge of the clamp from cutting into the hose. Only these rolled edge type clamps may be used in this system. All other types of clamps may cut into the hoses and cause high-pressure fuel leaks.

Use new original equipment type hose clamps. Tighten hose clamps to 1 N·m (15 in. lbs.) torque.

QUICK-CONNECT FITTINGS

Also refer to the Fuel Tubes/Lines/Hoses and Clamps section.

Different types of quick-connect fittings are used to attach various fuel system components. These are: a single-tab type, a two-tab type, a plastic retainer ring type or a latch clip type. Certain fittings may require the use of a special tool for disconnection.

SINGLE-TAB TYPE

This type of fitting is equipped with a single pull tab (Fig. 13). The tab is removable. After the tab is removed, the quick-connect fitting can be separated from the fuel system component.

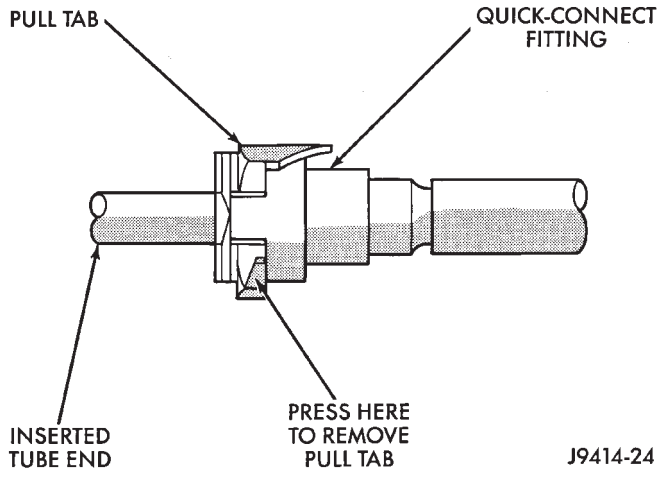


Fig. 13 Single-Tab Type Fitting

CAUTION: The interior components (o-rings, spacers) of this type of quick-connect fitting are not serviced separately, but new pull tabs are available. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE IN THIS GROUP.

DISCONNECTION/CONNECTION

(1) Disconnect negative battery cable from battery.

(2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Clean the fitting of any foreign material before disassembly.

(4) Press the release tab on the side of fitting to release pull tab (Fig. 14).

CAUTION: If this release tab is not pressed prior to releasing the pull tab, the pull tab will be damaged.

(5) While pressing the release tab on the side of the fitting, use a screwdriver to pry up the pull tab (Fig. 14).

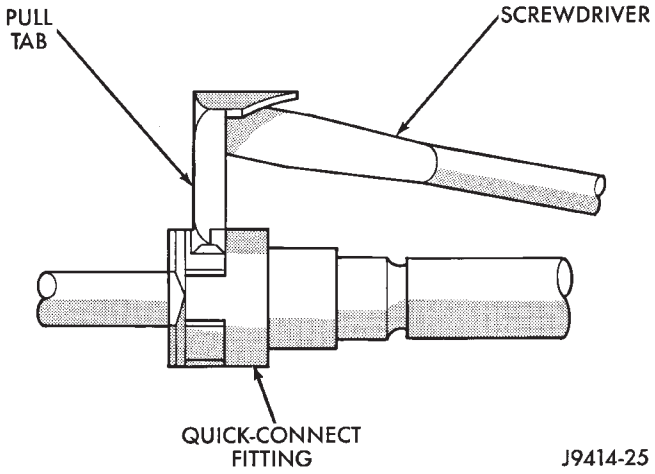


Fig. 14 Disconnecting Single-Tab Type Fitting

(6) Raise the pull tab until it separates from the quick-connect fitting (Fig. 15). Discard the old pull tab.

(7) Disconnect the quick-connect fitting from the fuel system component being serviced.

(8) Inspect the quick-connect fitting body and fuel system component for damage. Replace as necessary.

SERVICE PROCEDURES (Continued)

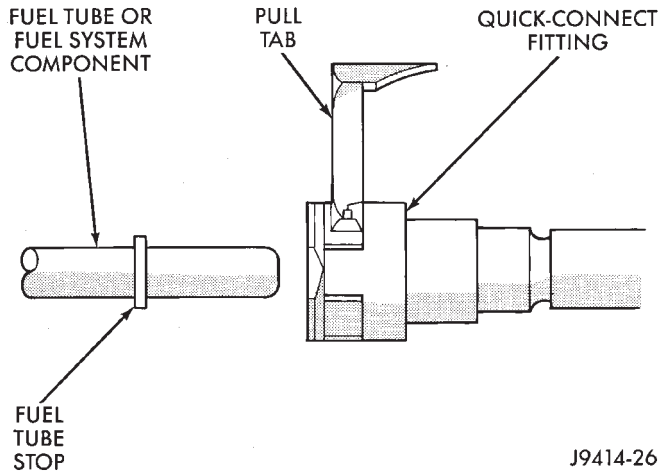


Fig. 15 Removing Pull Tab

(9) Prior to connecting the quick-connect fitting to component being serviced, check condition of fitting and component. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(10) Insert the quick-connect fitting into the fuel tube or fuel system component until the built-on stop on the fuel tube or component rests against back of fitting.

(11) Obtain a new pull tab. Push the new tab down until it locks into place in the quick-connect fitting.

(12) Verify a locked condition by firmly pulling on fuel tube and fitting (15-30 lbs.).

(13) Connect negative cable to battery.

(14) Start engine and check for leaks.

TWO-TAB TYPE FITTING

This type of fitting is equipped with tabs located on both sides of the fitting (Fig. 16). These tabs are supplied for disconnecting the quick-connect fitting from component being serviced.

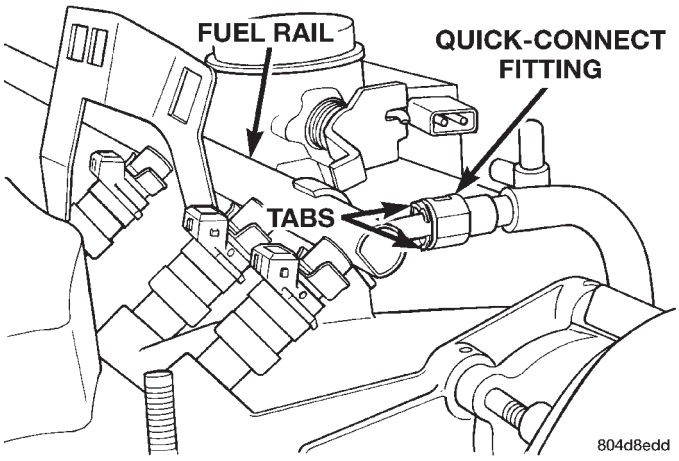


Fig. 16 Typical Two-Tab Type Quick-ConnectFitting

CAUTION: The interior components (o-rings, spacers) of this type of quick-connect fitting are not serviced separately, but new plastic retainers are available. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL PRESSURE RELEASE PROCEDURE IN THIS GROUP.

DISCONNECTION/CONNECTION

(1) Disconnect negative battery cable from the battery.

(2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Clean the fitting of any foreign material before disassembly.

(4) To disconnect the quick-connect fitting, squeeze the plastic retainer tabs (Fig. 16) against the sides of the quick-connect fitting with your fingers. Tool use is not required for removal and may damage plastic retainer. Pull the fitting from the fuel system component being serviced. The plastic retainer will remain on the component being serviced after fitting is disconnected. The o-rings and spacer will remain in the quick- connect fitting connector body.

(5) Inspect the quick-connect fitting body and component for damage. Replace as necessary.

CAUTION: When the quick-connect fitting was disconnected, the plastic retainer will remain on the component being serviced. If this retainer must be removed, very carefully release the retainer from the component with two small screwdrivers. After removal, inspect the retainer for cracks or any damage.

(6) Prior to connecting the quick-connect fitting to component being serviced, check condition of fitting and component. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(7) Insert the quick-connect fitting to the component being serviced and into the plastic retainer. When a connection is made, a click will be heard.

(8) Verify a locked condition by firmly pulling on fuel tube and fitting (15-30 lbs.).

(9) Connect negative cable to battery.

(10) Start engine and check for leaks.

SERVICE PROCEDURES (Continued)

PLASTIC RETAINER RING TYPE FITTING

This type of fitting can be identified by the use of a full-round plastic retainer ring (Fig. 17) usually black in color.

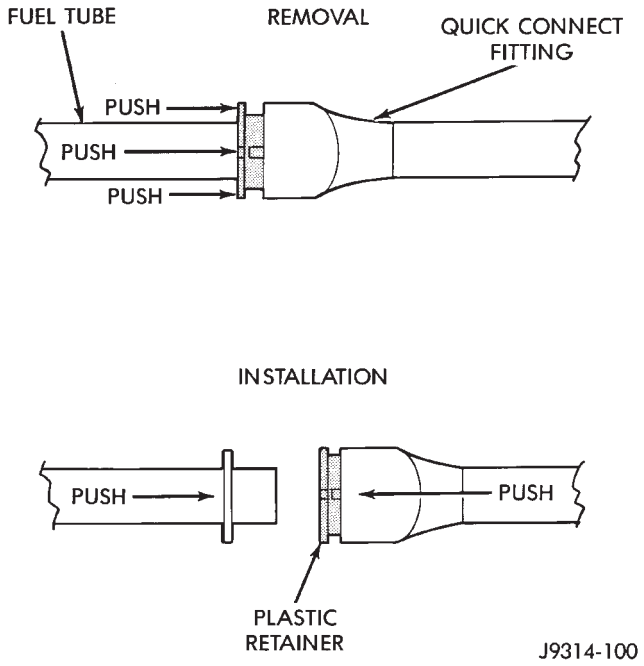


Fig. 17 Plastic Retainer Ring Type Fitting

CAUTION: The interior components (o-rings, spacers, retainers) of this type of quick-connect fitting are not serviced separately. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE IN THIS GROUP.

DISCONNECTION/CONNECTION

(1) Disconnect negative battery cable from the battery.

(2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Clean the fitting of any foreign material before disassembly.

(4) To release the fuel system component from the quick-connect fitting, firmly push the fitting towards the component being serviced while firmly pushing the plastic retainer ring into the fitting (Fig. 17). With the plastic ring depressed, pull the fitting from the component. **The plastic retainer ring must be pressed squarely into the fitting body. If this retainer is cocked during removal, it may be difficult to disconnect fitting. Use an open-end wrench on the shoulder of the plastic retainer ring to aid in disconnection.**

(5) After disconnection, the plastic retainer ring will remain with the quick-connect fitting connector body.

(6) Inspect fitting connector body, plastic retainer ring and fuel system component for damage. Replace as necessary.

(7) Prior to connecting the quick-connect fitting to component being serviced, check condition of fitting and component. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(8) Insert the quick-connect fitting into the component being serviced until a click is felt.

(9) Verify a locked condition by firmly pulling on fuel tube and fitting (15-30 lbs.).

(10) Connect negative battery cable to battery.

(11) Start engine and check for leaks.

FUEL LINE AT FUEL RAIL

Use the following procedure if the fuel rail is equipped with a fuel pressure test port.

A latch clip is used to secure the fuel line to the fuel rail on certain engines (Fig. 18). A special tool will be necessary to separate the fuel line from the fuel rail after the latch clip is removed.

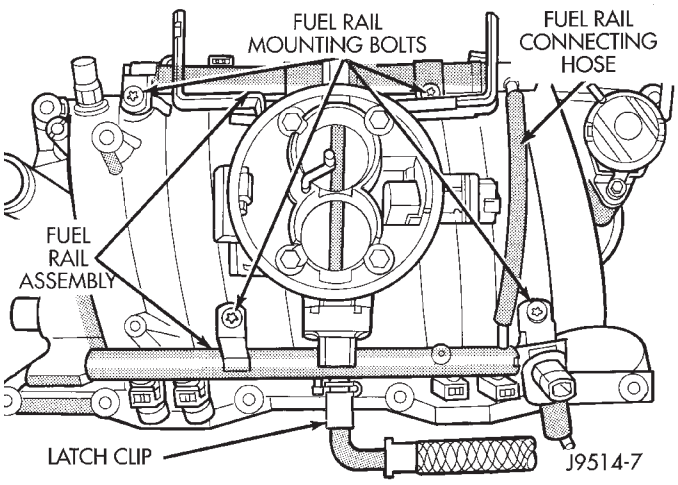


Fig. 18 Latch Clip Location—Typical

DISCONNECTION/CONNECTION AT FUEL RAIL

(1) Disconnect the negative battery cable from battery.

(2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Clean the fitting of any foreign material before disassembly.

SERVICE PROCEDURES (Continued)

(4) Pry up on the latch clip with a screwdriver (Fig. 19).

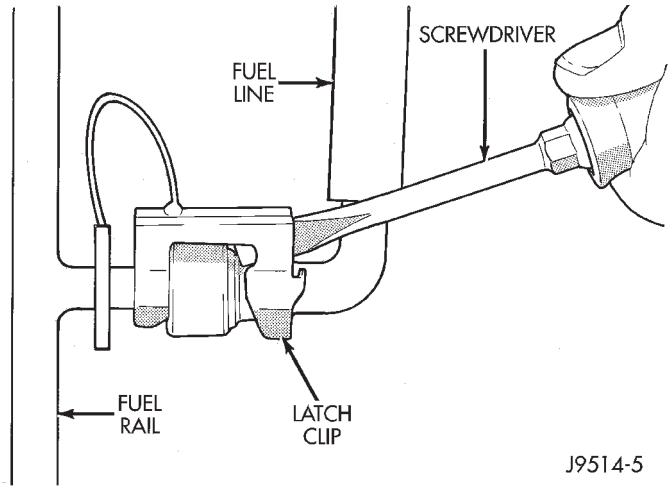


Fig. 19 Latch Clip Removal—Typical

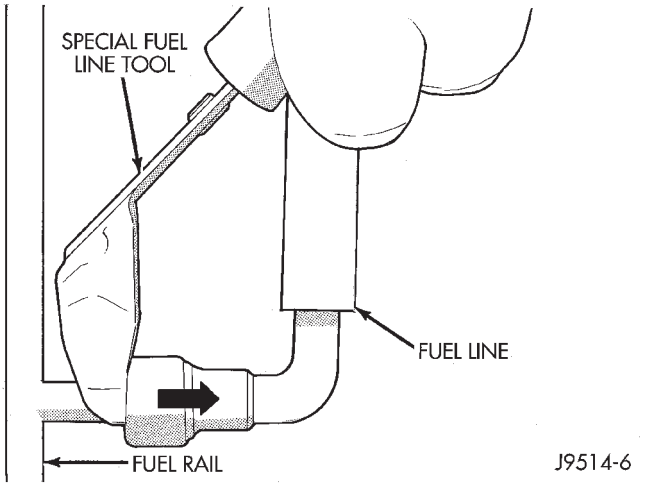


Fig. 20 Fuel Line Disconnection—Typical

(5) Slide the latch clip toward the fuel rail while lifting with the screwdriver.

(6) Insert special fuel line removal tool (Snap-On number FIH 9055- 1 or equivalent) into the fuel line (Fig. 20). Use this tool to release the locking fingers in the end of the line.

(7) With the special tool still inserted, pull the fuel line from the fuel rail.

(8) After disconnection, the locking fingers will remain within the quick-connect fitting at the end of the fuel line.

(9) Inspect fuel line fitting, locking fingers and fuel rail fitting for damage. Replace as necessary.

(10) Prior to connecting the fuel line to the fuel rail, check condition of both fittings. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(11) Insert the fuel line onto the fuel rail until a click is felt.

(12) Verify a locked condition by firmly pulling on fuel line and fitting (15-30 lbs.).

(13) Install latch clip (snaps into position). **If the latch clip will not fit, this indicates the fuel line is not properly installed to the fuel rail. Recheck the fuel line connection.**

(14) Connect negative battery cable to battery.

(15) Start engine and check for leaks.

FUEL LINE AT FUEL RAIL—5.2L ENGINES

Use the following procedure if the fuel rail is not equipped with a fuel pressure test port.

A special latch clip is used to secure the fuel line to the fuel rail on this particular engine (Fig. 21).

DISCONNECTION/CONNECTION AT FUEL RAIL

(1) Disconnect the negative battery cable from battery.

(2) Perform the fuel pressure release procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Clean the fitting of any foreign material before disassembly.

(4) Compress the clip fingers (Fig. 21) and pull clip straight up for removal.

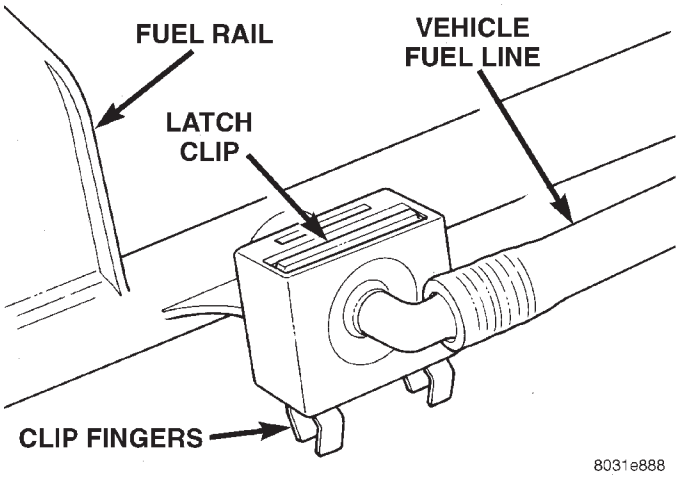


Fig. 21 Latch Clip—5.2L/5.9L EnginesWithout Fuel Test Port

(5) Pull the fuel line from the fuel rail.

(6) After disconnection, the locking fingers will remain within the quick-connect fitting in the fuel rail.

(7) Inspect fuel line fitting, locking fingers and fuel rail fitting for damage. Replace as necessary.

(8) Prior to connecting the fuel line to the fuel rail, check condition of both fittings. Clean the parts with a lint-free cloth. Lubricate them with clean engine oil.

(9) Insert the fuel line into the fuel rail.

(10) Install latch clip with fingers down (snaps into position). The fingers should protrude below the

SERVICE PROCEDURES (Continued)

fuel rail if properly installed (Fig. 21). **If the latch clip will not fit, this indicates the fuel line is not properly installed to the fuel rail. Recheck the fuel line connection.**

(11) Verify a locked condition by firmly pulling on fuel line and fitting (15-30 lbs.).

(12) Connect negative battery cable to battery.

(13) Start engine and check for leaks.

REMOVAL AND INSTALLATION

FUEL FILTER/FUEL PRESSURE REGULATOR

The combination Fuel Filter/Fuel Pressure Regulator is located on the fuel pump module. The fuel pump module is located on top of fuel tank.

The filter/regulator may be removed without removing fuel pump module although fuel tank must be removed.

REMOVAL

(1) Remove fuel tank. Refer to Fuel Tank Removal/Installation.

(2) Clean area around filter/regulator.

(3) Remove retainer clamp from top of filter/regulator (Fig. 22). Clamp snaps to tabs on pump module. Discard old clamp.

(4) Pry filter/regulator from top of pump module with 2 screwdrivers. Unit is snapped into module.

(5) Discard gasket below filter/regulator (Fig. 23).

(6) Before discarding filter/regulator assembly, inspect assembly to verify that o-rings (Fig. 24) are intact. If the smallest of the two o-rings can not be found on bottom of filter/regulator, it may be necessary to remove it from the fuel inlet passage in fuel pump module.

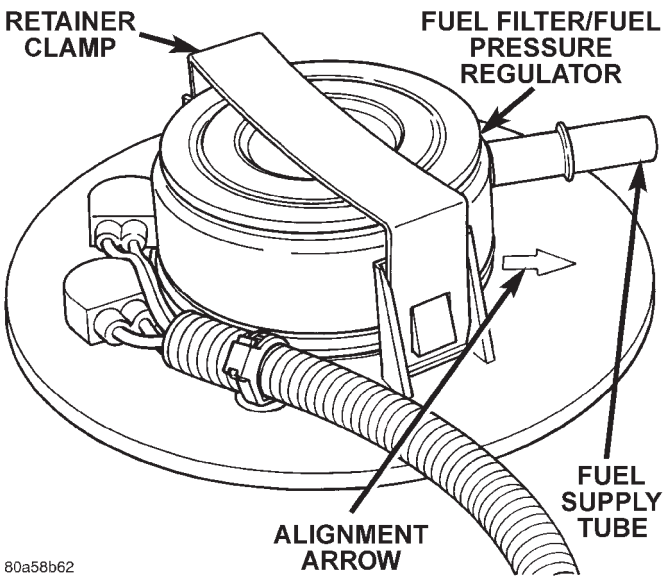


Fig. 22 Fuel Filter/Fuel Pressure Regulator

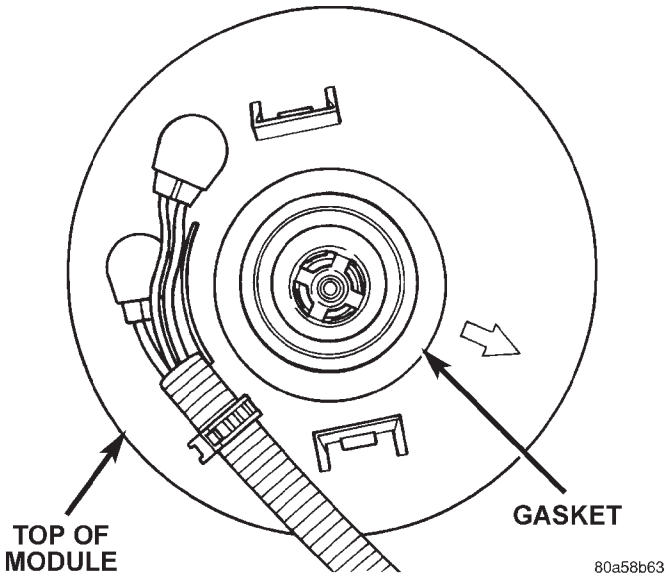


Fig. 23 Fuel Filter/Fuel Pressure RegulatorGasket

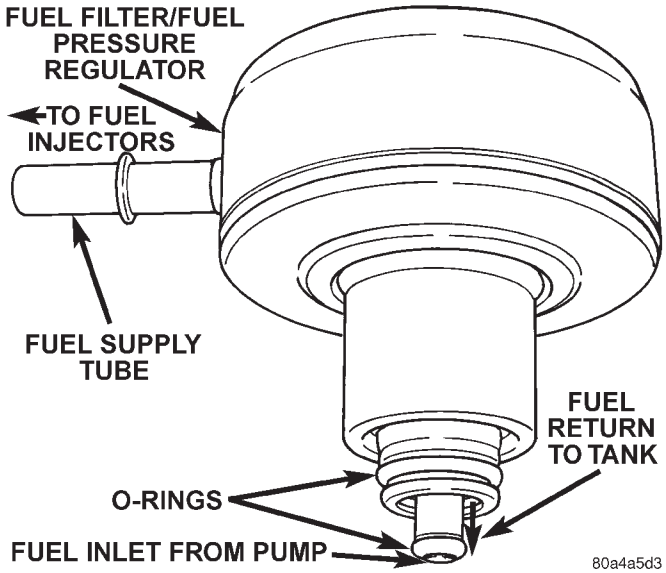


Fig. 24 Fuel Filter/Fuel Pressure RegulatorO-Rings

INSTALLATION

(1) Clean recessed area in pump module where filter/regulator is to be installed.

(2) Obtain new filter/regulator (two new o-rings should already be installed).

(3) Apply a small amount of clean engine oil to o-rings. **Do not install o-rings separately into fuel pump module. They will be damaged when installing filter/regulator.**

(4) Install new gasket to top of fuel pump module.

(5) Press new filter/regulator into top of pump module until it snaps into position (a positive click must be heard or felt).

(6) The arrow (Fig. 22) on top of fuel pump module should be pointed towards front of vehicle (12 o'clock position).

REMOVAL AND INSTALLATION (Continued)

(7) Rotate filter/regulator until fuel supply tube (fitting) is pointed to 11 o'clock position.

(8) Install new retainer clamp (clamp snaps over top of filter/regulator and locks to flanges on pump module).

(9) Install fuel tank. Refer to Fuel Tank Removal/Installation.

FUEL PUMP MODULE

Fuel tank removal will be necessary for fuel pump module removal.

REMOVAL

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING THE FUEL PUMP MODULE, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

(1) Drain fuel tank and remove tank. Refer to the Fuel Tank Removal/Installation section of this group.

(2) Thoroughly wash and clean area around pump module to prevent contaminants from entering tank.

(3) The plastic fuel pump module locknut is threaded onto fuel tank (Fig. 25). Install Special Tool 6856 to fuel pump module locknut and remove locknut (Fig. 26). The fuel pump module will spring up when locknut is removed.

(4) Remove module from fuel tank.

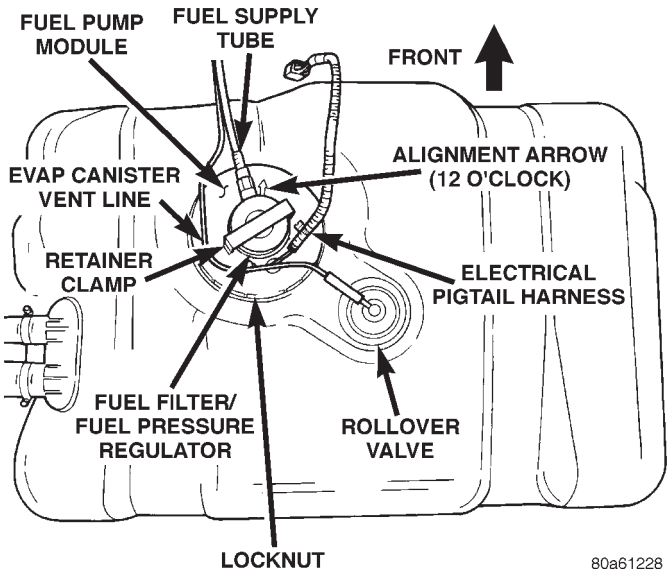


Fig. 25 Top View of Fuel Tank and Fuel PumpModule

INSTALLATION

CAUTION: Whenever the fuel pump module is serviced, the module gasket must be replaced.

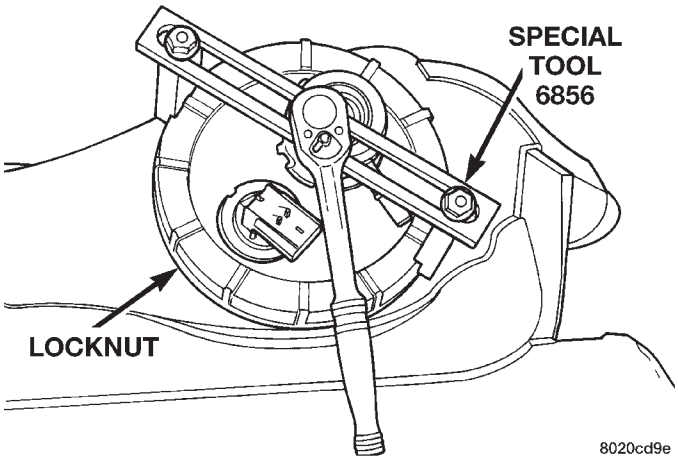


Fig. 26 Locknut Removal/Installation—Typical

(1) Using a new gasket, position fuel pump module into opening in fuel tank.

(2) Position locknut over top of fuel pump module.

(3) Rotate module until arrow (Fig. 22) is pointed toward front of vehicle (12 o'clock position). This step must be done to prevent float/float rod assembly from contacting sides of fuel tank.

(4) Install Special Tool 6856 to locknut.

(5) Tighten locknut to 34 N·m (25 ft. lbs.) torque.

(6) Rotate fuel filter/fuel pressure regulator until its fitting is pointed to 11 o'clock position.

(7) Install fuel tank. Refer to Fuel Tank Installation in this section.

FUEL PUMP INLET FILTER

The fuel pump inlet filter (strainer) is located on the bottom of fuel pump module (Fig. 27). The fuel pump module is located on top of fuel tank.

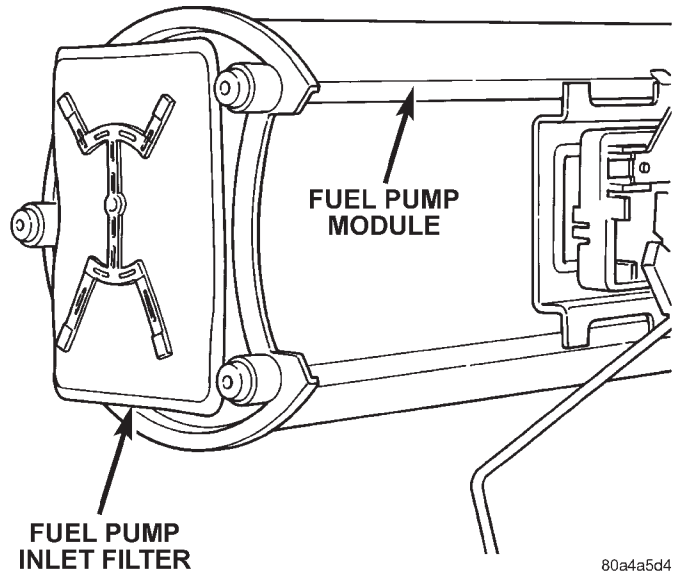


Fig. 27 Fuel Pump Inlet Filter

REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) Remove fuel tank. Refer to Fuel Tank Removal/Installation.

(2) Remove fuel pump module. Refer to Fuel Pump Module Removal/Installation.

(3) Remove filter by prying from bottom of module with 2 screwdrivers. Filter is snapped to module.

(4) Clean bottom of pump module.

INSTALLATION

(1) Snap new filter to bottom of module.

(2) Install fuel pump module. Refer to Fuel Pump Module Removal/Installation.

(3) Install fuel tank. Refer to Fuel Tank Removal/Installation.

FUEL GAUGE SENDING UNIT

The fuel gauge sending unit (fuel level sensor) and float assembly is located on the side of fuel pump module (Fig. 28). The fuel pump module is located on top of fuel tank.

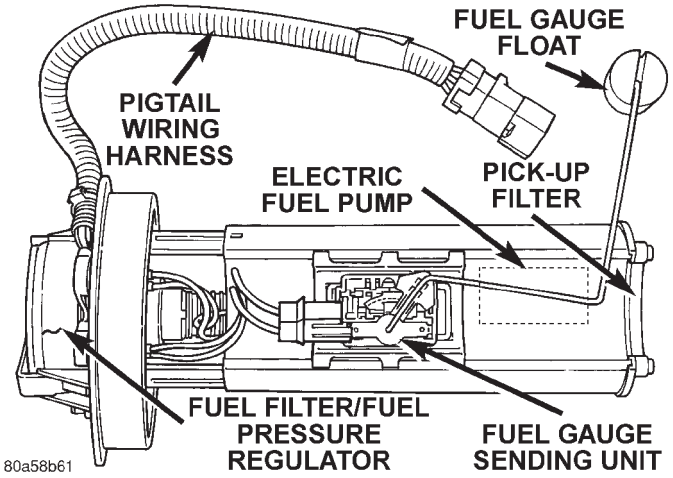


Fig. 28 Fuel Gauge Sending Unit Location

REMOVAL

(1) Remove fuel tank. Refer to Fuel Tank Removal/Installation.

(2) Remove fuel pump module. Refer to Fuel Pump Module Removal/Installation.

(3) Remove electrical wire connector at sending unit terminals.

(4) Press on release tab (Fig. 29) to remove sending unit from pump module.

INSTALLATION

(1) Position sending unit to pump module and snap into place.

(2) Connect electrical connector to terminals.

(3) Install fuel pump module. Refer to Fuel Pump Module Removal/Installation.

(4) Install fuel tank. Refer to Fuel Tank Removal/Installation.

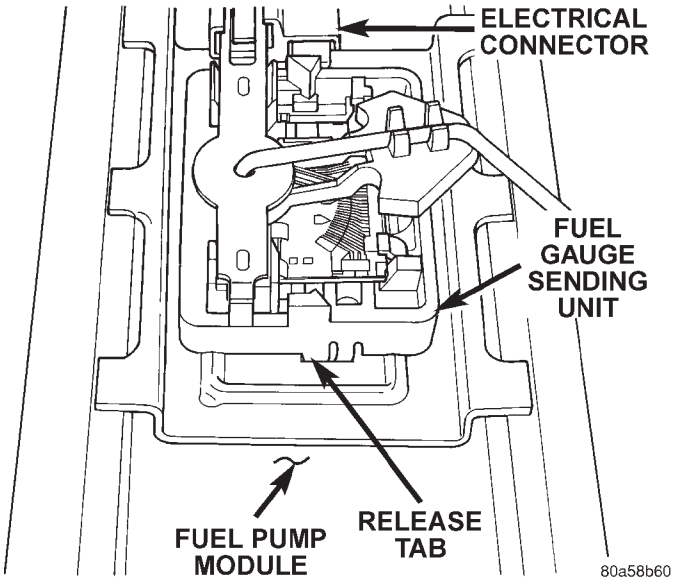


Fig. 29 Fuel Gauge Sending UnitRelease Tab

FUEL INJECTOR RAIL—5.2L/5.9L ENGINES

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE TURNED OFF). BEFORE SERVICING THE FUEL RAIL ASSEMBLY, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

To release fuel pressure, refer to the Fuel System Pressure Release Procedure found in this group.

CAUTION: The left and right fuel rails are replaced as an assembly. Do not attempt to separate the rail halves at the connecting hose (Fig. 30). Due to the design of this connecting hose, it does use any clamps. Never attempt to install a clamping device of any kind to the hose. When removing the fuel rail assembly for any reason, be careful not to bend or kink the connecting hose.

REMOVAL

(1) Remove negative battery cable at battery.

(2) Remove air duct at throttle body.

(3) Perform the fuel pressure release procedure.

(4) Remove throttle body from intake manifold. Refer to Throttle Body removal in this group.

(5) If equipped with air conditioning, remove the A-shaped A/C compressor-to-intake manifold support bracket (three bolts) (Fig. 31).

(6) Disconnect electrical connectors at all fuel injectors (Fig. 32). The factory fuel injection wiring harness is numerically tagged (INJ 1, INJ 2, etc.) for injector position identification.

(7) Disconnect fuel tube (line) at side of fuel rail. Refer to Quick-Connect Fittings for procedures,

REMOVAL AND INSTALLATION (Continued)

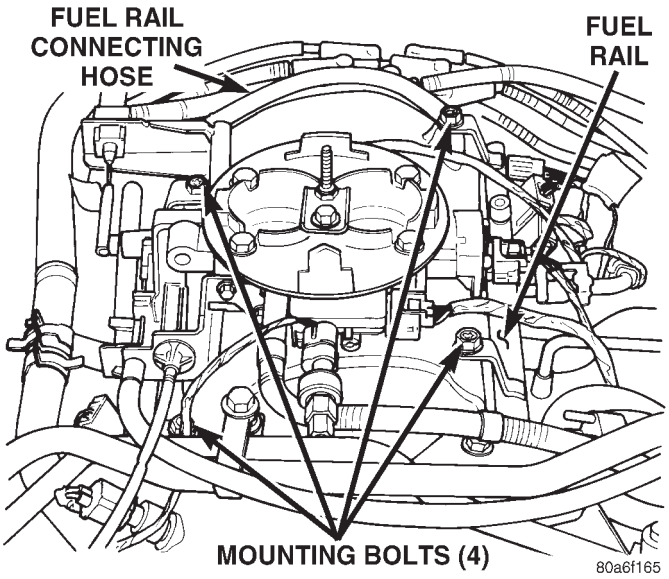


Fig. 30 Fuel Rail Assembly—Typical

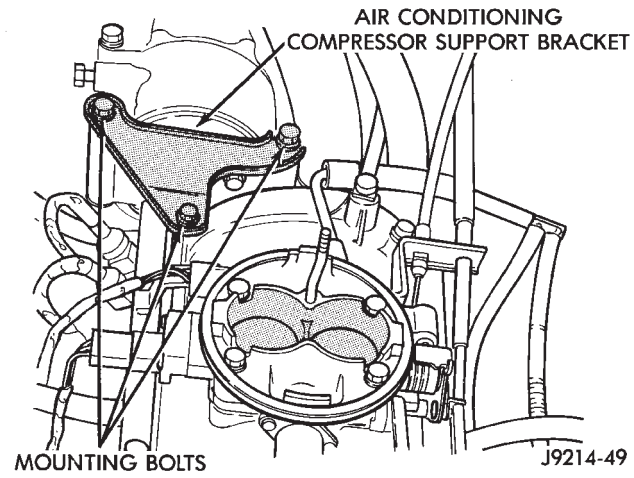


Fig. 31 A/C Compressor Support Bracket—Typical

(8) Remove the remaining fuel rail mounting bolts.

(9) Gently rock and pull the **left** fuel rail until the fuel injectors just start to clear the intake manifold. Gently rock and pull the **right** fuel rail until the fuel injectors just start to clear the intake manifold. Repeat this procedure (left/right) until all fuel injectors have cleared the intake manifold.

(10) Remove fuel rail (with injectors attached) from engine.

(11) Remove the clip(s) retaining the injector(s) to fuel rail (Fig. 33) or (Fig. 34).

INSTALLATION

(1) Apply a small amount of engine oil to each fuel injector o-ring. This will help in fuel rail installation.

(2) Install injector(s) and injector clip(s) to fuel rail.

(3) Position the fuel rail/fuel injector assembly to the injector openings on the intake manifold.

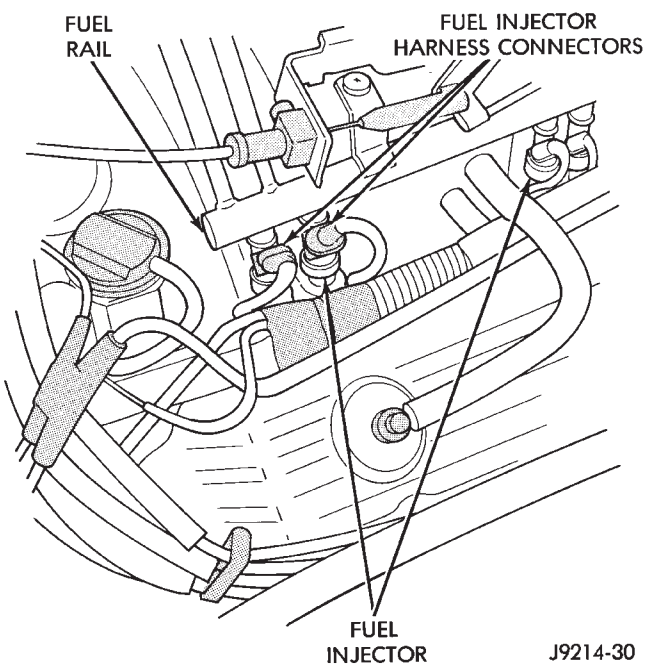


Fig. 32 Fuel Injector Connectors—Typical

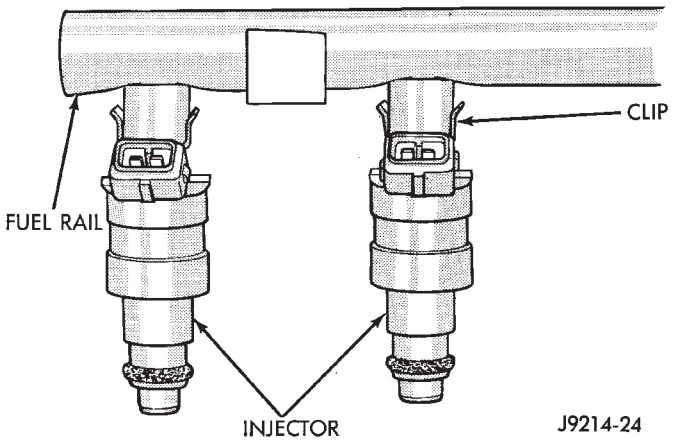


Fig. 33 Fuel Injector Mounting—Typical

(4) Guide each injector into the intake manifold. Be careful not to tear the injector o-ring.

(5) Push the **right** fuel rail down until fuel injectors have bottomed on injector shoulder. Push the **left** fuel rail down until fuel injectors have bottomed on injector shoulder.

(6) Install fuel rail mounting bolts.

(7) Connect electrical connector to intake manifold air temperature sensor.

(8) Connect wiring to all fuel injectors. The injector wiring harness is numerically tagged.

(9) Install the A/C support bracket (if equipped).

(10) Install throttle body to intake manifold. Refer to Throttle Body installation in this section of the group.

(11) Install fuel tube (line) at side of fuel rail. Refer to Quick-Connect Fittings for procedures.

REMOVAL AND INSTALLATION (Continued)

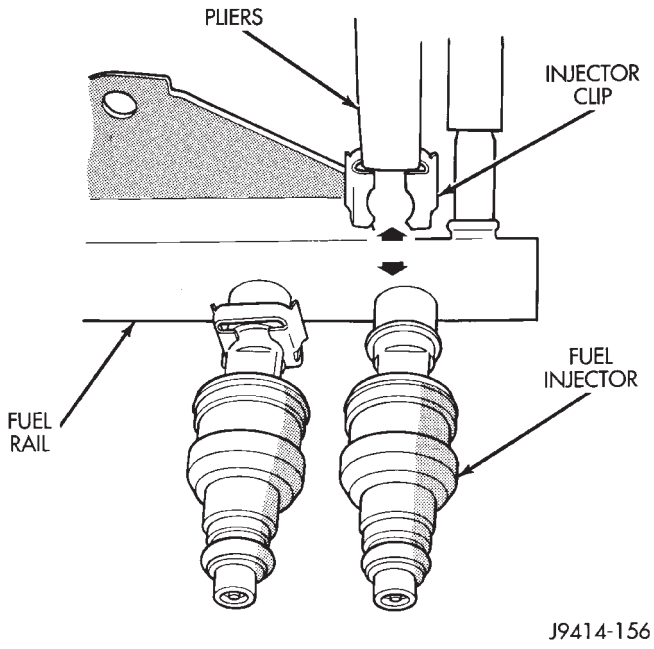


Fig. 34 Injector Retaining Clips—TypicalInjector

(12) Install air duct to throttle body.
(13) Connect battery cable to battery.
(14) Start engine and check for leaks.

FUEL INJECTOR RAIL—4.0L ENGINE

REMOVAL

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE EVEN WITH THE ENGINE OFF. THIS PRESSURE MUST BE RELEASED BEFORE SERVICING THE FUEL RAIL.

(1) Remove fuel tank filler tube cap.
(2) Disconnect the negative battery cable from battery.
(3) Perform the Fuel System Pressure Release Procedure as described in this Group.
(4) Remove and numerically attach a tag (if fuel injector is not already tagged), the injector harness connectors. Do this at each injector (Fig. 35).
(5) Disconnect fuel supply line latch clip and fuel line at fuel rail. Refer to Fuel Tubes/Lines/Hoses and Clamps, or Quick-Connect Fittings. These can both be found in the Fuel Delivery section of this group.
(6) Remove fuel rail mounting bolts (Fig. 35).
(7) Remove cable mounting bracket and cables at intake manifold.
(8) Remove fuel rail by gently rocking until all the fuel injectors are out of the intake manifold.

INSTALLATION

(1) Apply a small amount of clean engine oil to each injector o-ring. This will aid in installation.

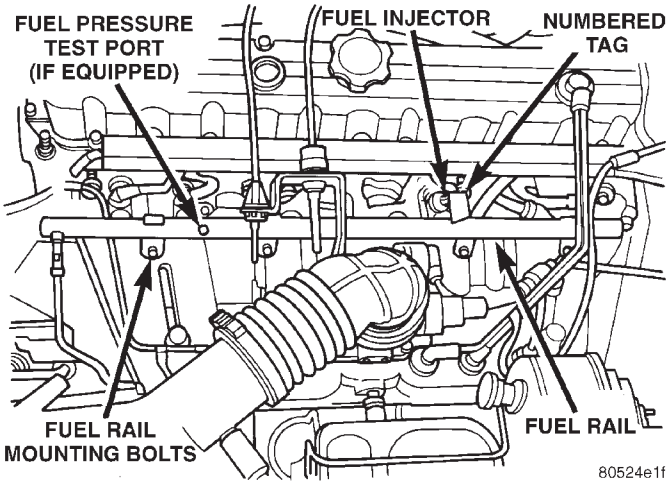


Fig. 35 Fuel Rail Mounting

(2) Position tips of all fuel injectors into the corresponding injector bore in the intake manifold. Seat injectors into manifold.
(3) Tighten fuel rail mounting bolts to 27 N·m (20 ft. lbs.) torque.
(4) Install cable mounting bracket and cables to intake manifold.
(5) Connect injector harness connectors to appropriate (tagged) injector.
(6) Connect fuel line and fuel line latch clip to fuel rail. Refer to this group for procedures.
(7) Install protective cap to pressure test port fitting (if equipped).
(8) Install fuel tank cap.
(9) Connect negative battery cable to battery.
(10) Start engine and check for fuel leaks.

FUEL INJECTOR(S)

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE EVEN WITH THE ENGINE TURNED OFF. BEFORE SERVICING THE FUEL INJECTOR(S), THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

To release fuel pressure, refer to the Fuel System Pressure Release Procedure.

To remove one or more fuel injectors, the fuel rail assembly must be removed from engine.

REMOVAL

(1) Remove air duct at throttle body.
(2) Remove fuel injector rail assembly. Refer to Fuel Injector Rail removal in this section.
(3) Remove the clip(s) retaining the injector(s) to fuel rail (Fig. 33) or (Fig. 34).
(4) Remove injector(s) from fuel rail.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Apply a small amount of engine oil to each fuel injector o-ring. This will help in fuel rail installation.

(2) Install injector(s) and injector clip(s) to fuel rail.

(3) Install fuel rail assembly. Refer to Fuel Injector Rail installation.

(4) Install air duct at throttle body.

(5) Start engine and check for leaks.

FUEL TANK

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE EVEN WITH THE ENGINE OFF. THIS PRESSURE MUST BE RELEASED BEFORE SERVICING FUEL TANK.

The electric fuel pump may be activated allowing fuel tank to be drained. This is done at fuel rail connection using DRB scan tool. Refer to scan tool for fuel pump activation procedures. Before disconnecting fuel line at fuel rail, release fuel pressure. Refer to the Fuel System Pressure Release Procedure in this group for procedures. Attach end of special test hose tool number 6541, 6539, 6631 or 6923 at fuel rail disconnection (tool number will depend on model and/or engine application). Position opposite end of this hose tool to an approved gasoline draining station. Activate fuel pump and drain tank until empty. If electric fuel pump is not operating, tank will have to be lowered for fuel draining. Refer to following procedures.

REMOVAL

(1) Disconnect negative battery cable at battery.

(2) Release fuel system pressure. Refer to the Fuel System Pressure Release Procedure in this group.

(3) Raise and support vehicle.

(4) Remove fuel tank fill hose and vent hose clamps at fuel tank filler tube (Fig. 36). Remove both hoses at fuel filler tube (Fig. 36).

(5) Remove rear tow hooks (if equipped).

(6) Remove fuel tank skid plate mounting nuts/bolts and remove skid plate (Fig. 37) (if equipped).

(7) Remove optional trailer hitch (if equipped).

(8) Remove exhaust tailpipe heat shield mounting bolts and remove shield.

CAUTION: To protect fuel tank from exhaust heat, this shield must reinstalled after tank installation.

(9) Place a hydraulic jack to bottom of fuel tank.

WARNING: PLACE A SHOP TOWEL AROUND FUEL LINES TO CATCH ANY EXCESS FUEL.

(10) Disconnect fuel supply line near front of fuel tank (Fig. 38). Refer to Fuel Tubes/Lines/Hoses and Clamps in this group. Also refer to Quick-Connect Fittings for procedures.

(11) Disconnect EVAP canister vent line near front of tank (Fig. 38).

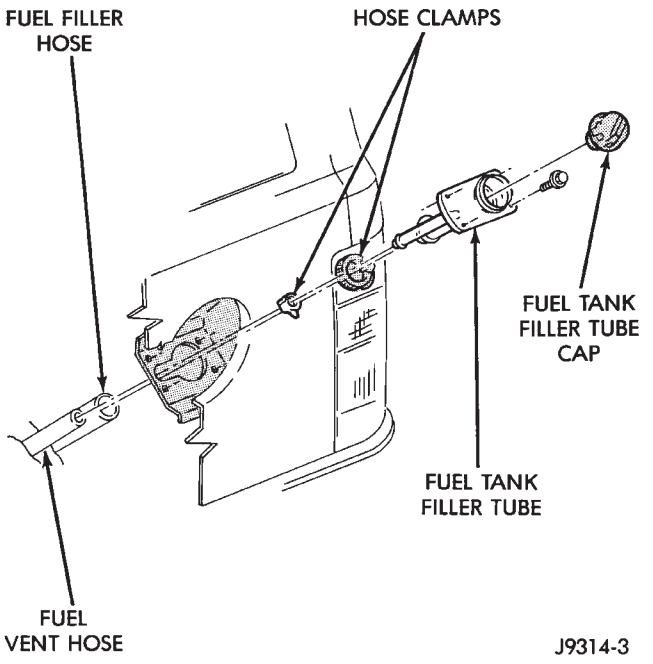


Fig. 36 Fuel Filler Tube and Hoses

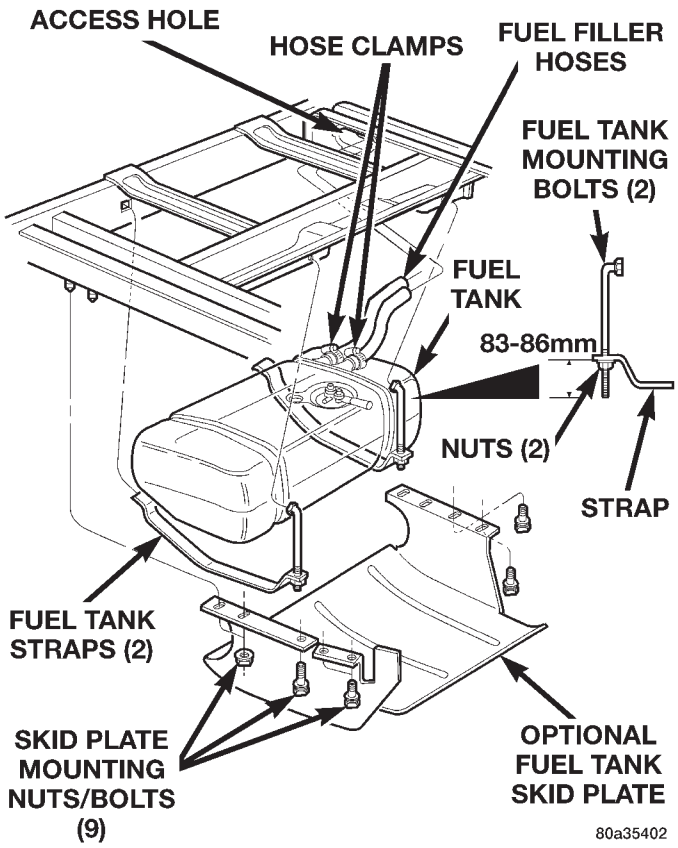


Fig. 37 Fuel Tank Mounting

REMOVAL AND INSTALLATION (Continued)

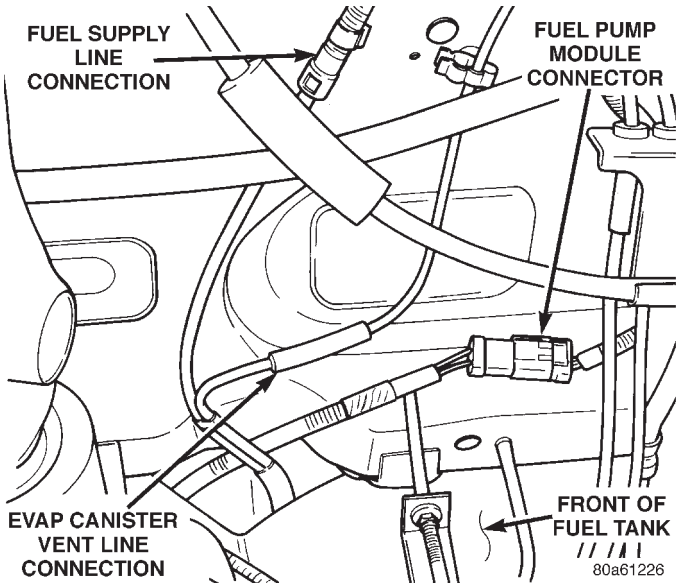


Fig. 38 Fuel Tank Connections at Front ofFuel Tank

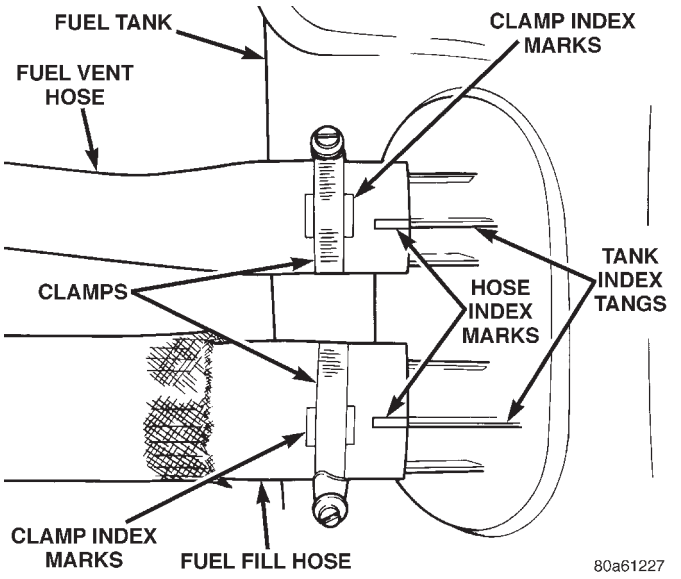


Fig. 39 Fuel Fill/Vent Hose Index Marks

(12) Disconnect fuel pump module electrical connector (pigtail harness) near front of tank (Fig. 38). Harness connector is clipped to body.

(13) Remove two fuel tank strap nuts (Fig. 37). Position both tank support straps away from tank.

(14) Carefully lower right side of tank while feeding both fuel hoses through access hole in body. **Fuel Tank Full And Not Drained Using DRB Scan Tool:** To prevent fuel loss through hoses, keep left side of tank higher than right side while lowering. Do not allow hose openings to drop lower than top of tank.

(15) Continue lowering tank until clear of vehicle. Place tank on floor with left side (hose side) higher than right side.

(16) Drain tank by removing fuel fill hose at tank. Fuel fill hose is largest of 2 hoses (Fig. 39). Insert the drain hose (from an approved gasoline draining station) into hose opening. Drain tank until empty.

(17) If fuel pump module removal is necessary, refer to Fuel Pump Module Removal/Installation in this group for procedures.

INSTALLATION

(1) If fuel pump module is being installed, refer to Fuel Pump Module Removal/Installation in this group for procedures.

(2) Install fuel fill/vent hoses to tank fittings. To prevent hose from kinking, rotate each hose until index mark on hose is aligned to index tang on fuel tank (Fig. 39).

(3) Install hose clamps to hoses. Position clamps between index marks on each hose (Fig. 39).

(4) Position fuel tank to hydraulic jack.

(5) Raise tank into position while guiding fuel fill and vent hoses into and through access hole in body.

(6) Continue raising tank until positioned to body.

(7) Attach two fuel tank mounting straps and mounting nuts.

CAUTION: The two mounting nuts must be tightened until 83–86 mm (3.27 in.—3.39 in.) is attained between end of mounting bolt and bottom of strap. See insert (Fig. 37). Do not over tighten nuts.

(8) Install both fuel hoses to fuel fill tube. Tighten both retaining clamps.

(9) Connect fuel pump module pigtail harness electrical connector near front of tank.

(10) Connect fuel pump module supply line near front of tank. Refer to Fuel Tubes/Lines/Hoses and Clamps in this group. Also refer to Quick-Connect Fittings for procedures.

(11) Connect EVAP hose near front of tank.

(12) Install exhaust tailpipe heat shield.

(13) Install fuel tank skid plate and trailer hitch (if equipped).

(14) Install rear tow hooks (if equipped).

(15) Lower vehicle and connect battery cable to battery.

FUEL TANK FILLER TUBE CAP

If replacement of the fuel tank filler tube cap is necessary, it must be replaced with an identical cap to be sure of correct system operation.

CAUTION: Remove the fuel tank filler tube cap to relieve fuel tank pressure. The cap must be removed prior to disconnecting any fuel system component or before draining the fuel tank.

REMOVAL AND INSTALLATION (Continued)

ACCELERATOR PEDAL

The accelerator pedal is connected to the throttle body linkage by the throttle cable. The cable is protected by a plastic sheathing and is connected to the throttle body linkage by a ball socket. It is connected to the accelerator pedal arm by a plastic retainer (clip) (Fig. 40). This retainer (clip) snaps into the top of the accelerator pedal arm. Retainer tabs (built into the cable sheathing) fasten the cable to the dash panel.

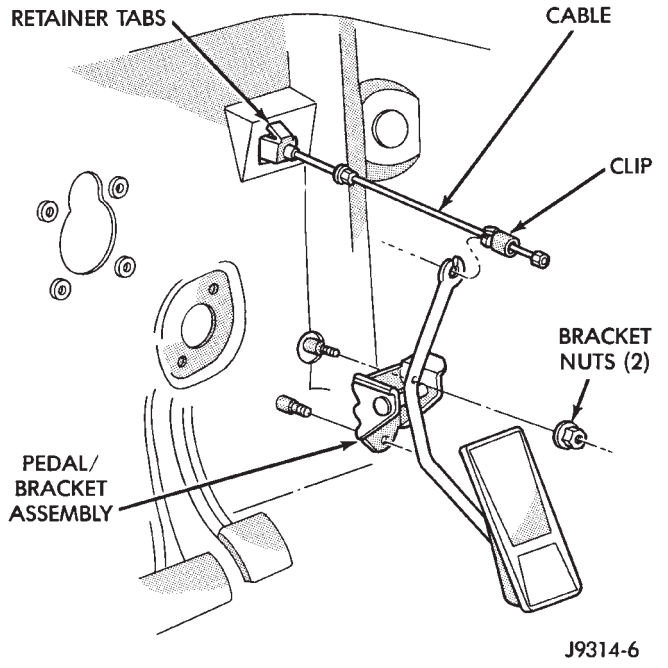


Fig. 40 Accelerator Pedal Mounting

Dual throttle return springs (attached to the throttle shaft) are used to close the throttle.

CAUTION: Never attempt to remove or alter these springs.

REMOVAL

CAUTION: Be careful not to damage or kink the cable core wire (within the cable sheathing) while servicing accelerator pedal or throttle cable.

(1) From inside the vehicle, hold up accelerator pedal. Remove plastic cable retainer (clip) and throttle cable core wire from upper end of pedal arm. Plastic cable retainer (clip) snaps into pedal arm.

(2) Remove accelerator pedal bracket nuts. Remove accelerator pedal assembly.

INSTALLATION

(1) Place accelerator pedal assembly over studs protruding from floor pan. Tighten mounting nuts to 8.5 N·m (75 in. lbs.) torque.

(2) Slide throttle cable into opening in top of pedal arm. Push plastic cable retainer (clip) into pedal arm opening until it snaps into place.

(3) Before starting engine, operate accelerator pedal to check for any binding.

THROTTLE CABLE

REMOVAL

(1) From inside the vehicle, hold up accelerator pedal. Remove plastic cable retainer (clip) and throttle cable core wire from upper end of pedal arm (Fig. 40). Plastic cable retainer (clip) snaps into pedal arm.

(2) Remove the cable core wire at pedal arm.

(3) From inside the vehicle, pinch both sides of the cable housing retainer tabs (Fig. 40). at the dash panel. Remove cable housing from dash panel and pull into the engine compartment.

(4) 4.0L Engine: Remove cable from clip on engine valve cover (Fig. 41).

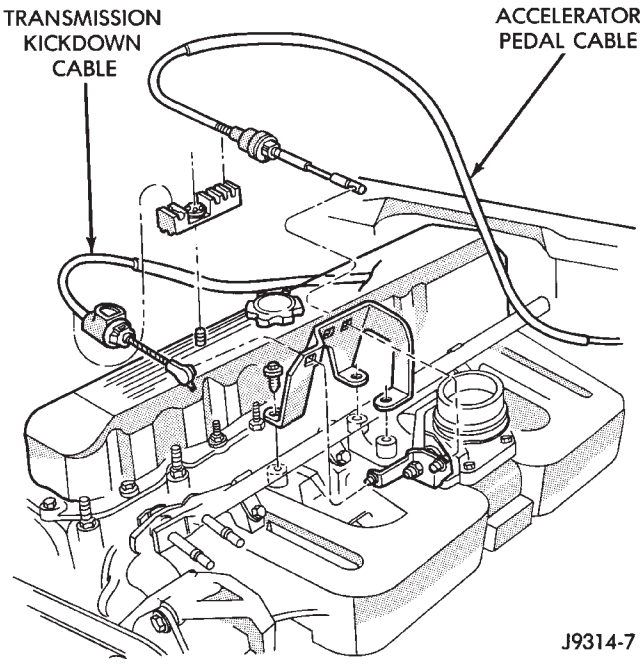


Fig. 41 Throttle Cable Routing—4.0LEngine

(5) Remove the throttle cable ball end socket at throttle body linkage (Fig. 42) or (Fig. 43) (snaps off).

(6) 4.0L Engine: Remove throttle cable from throttle body mounting bracket by compressing retainer tabs and pushing cable through hole in bracket. Remove throttle cable from vehicle.

(7) 5.2L/5.9L Engines: Remove cable housing at throttle body mounting bracket by pressing forward on release tab with a small screwdriver (Fig. 44). **To**

REMOVAL AND INSTALLATION (Continued)

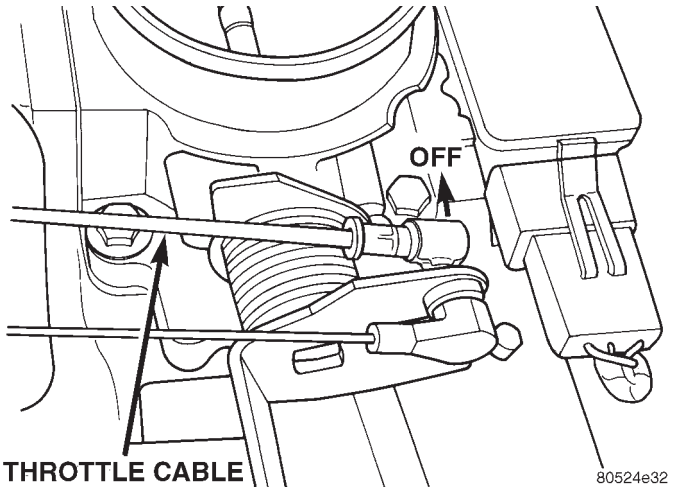


Fig. 42 Throttle Cable at Throttle Body—4.0LEngine

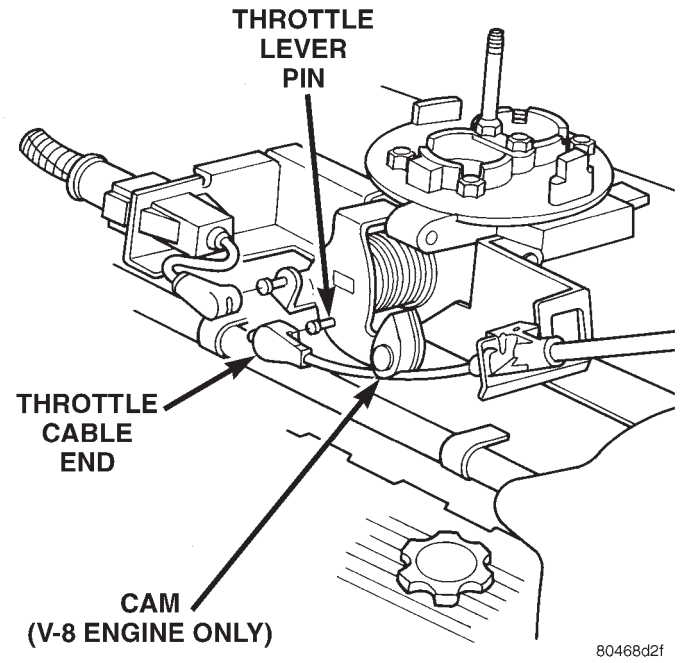


Fig. 43 Throttle Cable at Throttle Body—5.2L/5.9LV-8 Engines

prevent cable housing breakage, press on the tab only enough to release the cable from the bracket. Lift the cable housing straight up from bracket while pressing on release tab. Remove throttle cable from vehicle.

INSTALLATION

(1) 4.0L Engine: Slide throttle cable through hole in throttle body bracket until retainer tabs lock into bracket. Connect cable ball end to throttle body linkage ball (snaps on).

(2) 5.2L/5.9L Engines: Connect cable ball end to throttle body linkage ball (snaps on). Connect cable to throttle body bracket (push down and lock).

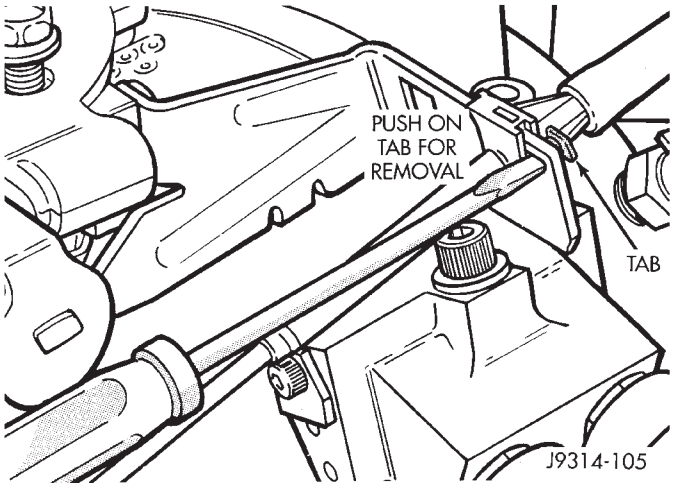


Fig. 44 Cable Release Tab—5.2L/5.9LEngines—Typical

(3) 4.0L Engine: Snap cable into clip on engine valve cover.

(4) Push other end of cable through opening in dash panel until retaining tabs lock into panel.

(5) From inside drivers compartment, slide throttle cable core wire into opening in top of pedal arm. Push cable retainer (clip) into pedal arm opening until it snaps in place.

(6) Before starting engine, operate accelerator pedal to check for any binding.

SPECIFICATIONS

VECI LABEL

If anything differs between the specifications found on the Vehicle Emission Control Information (VECI) label and the following specifications, use specifications on VECI label. The VECI label is located in the engine compartment.

FUEL TANK CAPACITY

Models	Liters	U.S. Gallons
All	87	23
Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerance and refill procedure.		

FUEL SYSTEM PRESSURE

339 kPa ± 34 kPa (49.2 psi ± 5 psi).

SPECIFICATIONS (Continued)

TORQUE CHART

DESCRIPTION	TORQUE
Accelerator Pedal Bracket Mounting Nuts	8.5 N·m (75 in. lbs.)
Fuel Pump Module Locknut	34 N·m (25 ft. lbs.)
Fuel Rail Mounting Bolts— 4.0L Engine	11 N·m (100 in. lbs.)
Fuel Rail Mounting Bolts— 5.2L/5.9L Engines	23 N·m (200 in. lbs.)
Fuel Tank Mounting Nuts	Refer To Manual Text
Fuel Hose Clamps	1 N·m (15 in. lbs.)

FUEL INJECTION SYSTEM

INDEX

GENERAL INFORMATION

INTRODUCTION

All engines are equipped with sequential Multi-Port Fuel Injection (MFI). The MFI system provides precise air/fuel ratios for all driving conditions.

The powertrain control module (PCM) (Fig. 1) operates the fuel system.

MODES OF OPERATION

As input signals to the powertrain control module (PCM) change, the PCM adjusts its response to the output devices. For example, the PCM must calculate different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT).

The PCM will operate in two different modes: **Open Loop and Closed Loop** .

During Open Loop modes, the powertrain control module (PCM) receives input signals and responds only according to preset PCM programming. Input from the oxygen (O2S) sensors is not monitored during Open Loop modes.

During Closed Loop modes, the PCM will monitor the oxygen (O2S) sensors input. This input indicates to the PCM whether or not the calculated injector pulse width results in the ideal air-fuel ratio. This ratio is 14.7 parts air-to-1 part fuel. By monitoring the exhaust oxygen content through the O2S sensor, the PCM can fine tune the injector pulse width. This

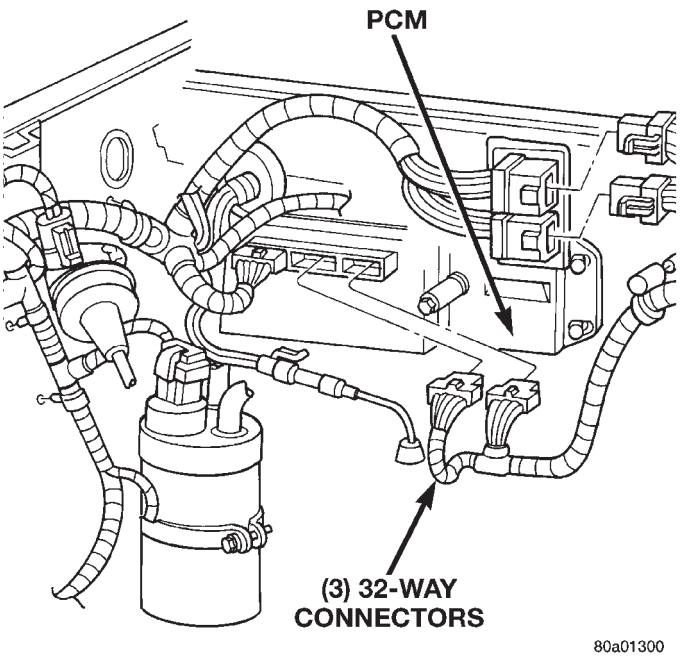


Fig. 1 Powertrain Control Module (PCM)

is done to achieve optimum fuel economy combined with low emission engine performance.

The fuel injection system has the following modes of operation:

- Ignition switch ON
- Engine start-up (crank)
- Engine warm-up
- Idle
- Cruise
- Acceleration
- Deceleration
- Wide open throttle (WOT)
- Ignition switch OFF

The ignition switch On, engine start-up (crank), engine warm-up, acceleration, deceleration and wide open throttle modes are Open Loop modes. The idle and cruise modes, (with the engine at operating temperature) are Closed Loop modes.

IGNITION SWITCH (KEY-ON) MODE

This is an Open Loop mode. When the fuel system is activated by the ignition switch, the following actions occur:

- The powertrain control module (PCM) pre-positions the idle air control (IAC) motor.
- The PCM determines atmospheric air pressure from the MAP sensor input to determine basic fuel strategy.
- The PCM monitors the engine coolant temperature sensor input. The PCM modifies fuel strategy based on this input.
- Intake manifold air temperature sensor input is monitored.
- Throttle position sensor (TPS) is monitored.
- The auto shutdown (ASD) relay is energized by the PCM for approximately three seconds.
- The fuel pump is energized through the fuel pump relay by the PCM. The fuel pump will operate for approximately three seconds unless the engine is operating or the starter motor is engaged.
- The O2S sensor heater element is energized via the ASD relay. The O2S sensor input is not used by the PCM to calibrate air-fuel ratio during this mode of operation.

ENGINE START-UP MODE

This is an Open Loop mode. The following actions occur when the starter motor is engaged.

The powertrain control module (PCM) receives inputs from:

- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Starter motor relay
- Camshaft position sensor signal

The PCM monitors the crankshaft position sensor. If the PCM does not receive a crankshaft position sensor signal within 3 seconds of cranking the engine, it will shut down the fuel injection system.

The fuel pump is activated by the PCM through the fuel pump relay.

Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.

The PCM determines the proper ignition timing according to input received from the crankshaft position sensor.

ENGINE WARM-UP MODE

This is an Open Loop mode. During engine warm-up, the powertrain control module (PCM) receives inputs from:

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/neutral switch (gear indicator signal—auto. trans. only)
- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)

Based on these inputs the following occurs:

GENERAL INFORMATION (Continued)

• Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.
• The PCM adjusts engine idle speed through the idle air control (IAC) motor and adjusts ignition timing.
• The PCM operates the A/C compressor clutch through the clutch relay. This is done if A/C has been selected by the vehicle operator and requested by the A/C thermostat.
• When engine has reached operating temperature, the PCM will begin monitoring O2S sensor input. The system will then leave the warm-up mode and go into closed loop operation.

IDLE MODE

When the engine is at operating temperature, this is a Closed Loop mode. At idle speed, the powertrain control module (PCM) receives inputs from:
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)
• Battery voltage
• Crankshaft position sensor
• Engine coolant temperature sensor
• Intake manifold air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Camshaft position sensor signal (in the distributor)
• Battery voltage
• Park/neutral switch (gear indicator signal—auto. trans. only)
• Oxygen sensors

Based on these inputs, the following occurs:
• Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then control injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.
• The PCM monitors the O2S sensor input and adjusts air-fuel ratio by varying injector pulse width. It also adjusts engine idle speed through the idle air control (IAC) motor.
• The PCM adjusts ignition timing by increasing and decreasing spark advance.
• The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

CRUISE MODE

When the engine is at operating temperature, this is a Closed Loop mode. At cruising speed, the powertrain control module (PCM) receives inputs from:
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)
• Battery voltage
• Engine coolant temperature sensor
• Crankshaft position sensor
• Intake manifold air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Camshaft position sensor signal (in the distributor)
• Park/neutral switch (gear indicator signal—auto. trans. only)
• Oxygen (O2S) sensors

Based on these inputs, the following occurs:
• Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then adjust the injector pulse width by turning the ground circuit to each individual injector on and off.
• The PCM monitors the O2S sensor input and adjusts air-fuel ratio. It also adjusts engine idle speed through the idle air control (IAC) motor.
• The PCM adjusts ignition timing by turning the ground path to the coil on and off.
• The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

ACCELERATION MODE

This is an Open Loop mode. The powertrain control module (PCM) recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The PCM increases injector pulse width in response to increased throttle opening.

DECELERATION MODE

When the engine is at operating temperature, this is an Open Loop mode. During hard deceleration, the powertrain control module (PCM) receives the following inputs.
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)
• Battery voltage
• Engine coolant temperature sensor
• Crankshaft position sensor
• Intake manifold air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Camshaft position sensor signal (in the distributor)
• Park/neutral switch (gear indicator signal—auto. trans. only)
• Vehicle speed sensor

If the vehicle is under hard deceleration with the proper rpm and closed throttle conditions, the PCM will ignore the oxygen sensor input signal. The PCM will enter a fuel cut-off strategy in which it will not

supply a ground to the injectors. If a hard deceleration does not exist, the PCM will determine the proper injector pulse width and continue injection.

Based on the above inputs, the PCM will adjust engine idle speed through the idle air control (IAC) motor.

The PCM adjusts ignition timing by turning the ground path to the coil on and off.

WIDE OPEN THROTTLE MODE

This is an Open Loop mode. During wide open throttle operation, the powertrain control module (PCM) receives the following inputs.

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)

During wide open throttle conditions, the following occurs:

- Voltage is applied to the fuel injectors with the ASD relay via the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off. The PCM ignores the oxygen sensor input signal and provides a predetermined amount of additional fuel. This is done by adjusting injector pulse width.
- The PCM adjusts ignition timing by turning the ground path to the coil on and off.

IGNITION SWITCH OFF MODE

When ignition switch is turned to OFF position, the PCM stops operating the injectors, ignition coil, ASD relay and fuel pump relay.

DESCRIPTION AND OPERATION

SYSTEM DIAGNOSIS

The Powertrain Control Module (PCM) can test many of its own input and output circuits. If the PCM senses a fault in a major system, it stores a Diagnostic Trouble Code (DTC) in its memory.

Technicians can display stored DTC's with different methods. One way is using the DRB scan tool. Another way is using the malfunction indicator (check engine) lamp. On certain models the vehicle odometer can be used to display the numeric DTC.

For DTC information, refer to Group 25, Emission Control Systems. See On-Board Diagnostics.

POWERTRAIN CONTROL MODULE (PCM)

The powertrain control module (PCM) (Fig. 1) operates the fuel system. The PCM was formerly referred to as the SBEC or engine controller. The PCM is a pre-programmed, tripple microprocessor digital computer. It regulates ignition timing, air-fuel ratio, emission control devices, charging system, certain transmission features, speed control, air conditioning compressor clutch engagement and idle speed. The PCM can adapt its programming to meet changing operating conditions.

The PCM receives input signals from various switches and sensors. Based on these inputs, the PCM regulates various engine and vehicle operations through different system components. These components are referred to as Powertrain Control Module (PCM) Outputs. The sensors and switches that provide inputs to the PCM are considered Powertrain Control Module (PCM) Inputs.

The PCM adjusts ignition timing based upon inputs it receives from sensors that react to: engine rpm, manifold absolute pressure, engine coolant temperature, throttle position, transmission gear selection (automatic transmission), vehicle speed and the brake switch.

The PCM adjusts idle speed based on inputs it receives from sensors that react to: throttle position, vehicle speed, transmission gear selection, engine coolant temperature and from inputs it receives from the air conditioning clutch switch and brake switch.

Based on inputs that it receives, the PCM adjusts ignition coil dwell. The PCM also adjusts the generator charge rate through control of the generator field and provides speed control operation.

NOTE: PCM Inputs:

- A/C request (if equipped with factory A/C)
- A/C select (if equipped with factory A/C)
- Auto shutdown (ASD) sense
- Battery temperature
- Battery voltage
- Brake switch
- CCD bus (+) circuits
- CCD bus (-) circuits
- Camshaft position sensor signal
- Crankshaft position sensor
- Data link connection for DRB scan tool
- Engine coolant temperature sensor
- Fuel level
- Generator (battery voltage) output
- Ignition circuit sense (ignition switch in on/off/crank/run position)
- Intake manifold air temperature sensor
- Leak detection pump (switch) sense (if equipped)
- Manifold absolute pressure (MAP) sensor
- Oil pressure

DESCRIPTION AND OPERATION (Continued)

- Output shaft speed sensor
- Overdrive/override switch
- Oxygen sensors
- Park/neutral switch (auto. trans. only)
- Power ground
- Sensor return
- Signal ground
- Speed control multiplexed single wire input
- Throttle position sensor
- Transmission governor pressure sensor
- Transmission temperature sensor
- Vehicle speed sensor

NOTE: PCM Outputs:

- A/C clutch relay
- Auto shutdown (ASD) relay
- CCD bus (+) circuits
- CCD bus (-) circuits
- Data link connection for DRB scan tool
- EGR valve control solenoid (if equipped)
- EVAP canister purge solenoid
- Five volt sensor supply (primary)
- Five volt sensor supply (secondary)
- Fuel injectors
- Fuel pump relay
- Generator field driver (-)
- Generator field driver (+)
- Generator lamp (if equipped)
- Idle air control (IAC) motor
- Ignition coil
- Leak detection pump
- Malfunction indicator lamp (Check engine lamp). Driven through CCD circuits.
- Overdrive indicator lamp (if equipped)
- Speed control vacuum solenoid
- Speed control vent solenoid
- Tachometer (if equipped). Driven through CCD circuits.
- Transmission convertor clutch circuit
- Transmission 3–4 shift solenoid
- Transmission relay
- Transmission temperature lamp (if equipped)
- Transmission variable force solenoid

The powertrain control module (PCM) contains a voltage convertor. This converts battery voltage to a regulated 5.0 volts. It is used to power the crankshaft position sensor, camshaft position sensor and vehicle speed sensor. The PCM also provides a five (5) volt supply for the manifold absolute pressure (MAP) sensor and throttle position sensor (TPS).

AIR CONDITIONING (A/C) CONTROLS—PCM INPUT

The A/C control system information applies to factory installed air conditioning units.

A/C SELECT SIGNAL: When the A/C switch is in the ON position, an input signal is sent to the powertrain control module (PCM). The signal informs the PCM that the A/C has been selected. The PCM adjusts idle speed to a pre-programmed rpm through the idle air control (IAC) motor to compensate for increased engine load.

A/C REQUEST SIGNAL: Once A/C has been selected, the powertrain control module (PCM) receives the A/C request signal from the clutch cycling pressure switch. The input indicates that the evaporator pressure is in the proper range for A/C application. The PCM uses this input to cycle the A/C compressor clutch (through the A/C relay). It will also determine the correct engine idle speed through the idle air control (IAC) motor position.

If the A/C low-pressure switch or high-pressure switch opens (indicating a low or high refrigerant pressure), the PCM will not receive an A/C request signal. The PCM will then remove the ground from the A/C relay. This will deactivate the A/C compressor clutch.

If the switch opens, (indicating that evaporator is not in proper pressure range), the PCM will not receive the A/C request signal. The PCM will then remove the ground from the A/C relay, deactivating the A/C compressor clutch.

AUTOMATIC SHUTDOWN (ASD) RELAY SENSE—PCM INPUT

A 12 volt signal at this input indicates to the PCM that the ASD has been activated. The ASD relay is located in the Power Distribution Center (PDC). The PDC is located in the engine compartment (Fig. 2). Refer to label on PDC cover for relay location. The relay is used to connect the oxygen sensor heater element, ignition coil and fuel injectors to 12 volt + power supply.

This input is used only to sense that the ASD relay is energized. If the powertrain control module (PCM) does not see 12 volts at this input when the ASD should be activated, it will set a diagnostic trouble code (DTC).

BATTERY TEMPERATURE SENSOR—PCM INPUT

Provides a signal to the PCM corresponding to the battery temperature. Refer to Group 8C, Charging System for additional information.

BATTERY VOLTAGE—PCM INPUT

The battery voltage input provides power to the Powertrain Control Module (PCM). It also informs the PCM what voltage level is supplied to the ignition coil and fuel injectors.

If battery voltage is low, the PCM will increase injector pulse width (period of time that the injector is energized). This is done to compensate for the

DESCRIPTION AND OPERATION (Continued)

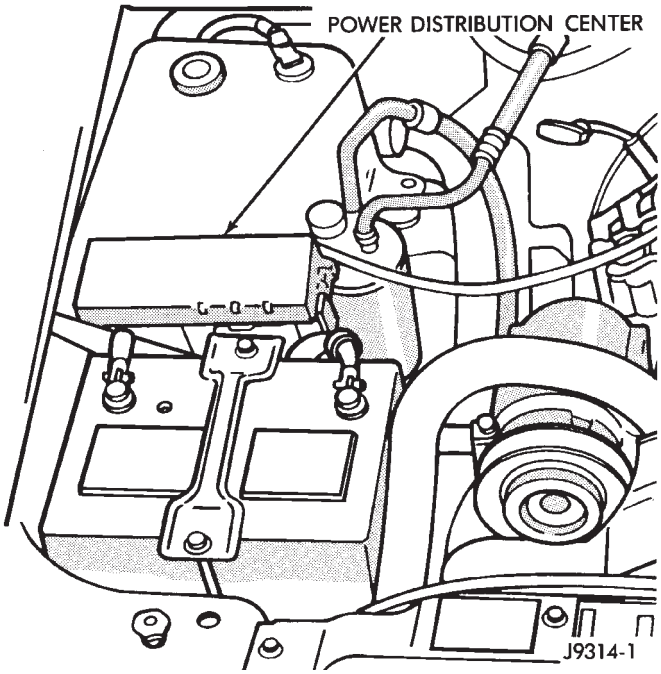


Fig. 2 Power Distribution Center (PDC)

reduced flow through injector caused by the lowered voltage.

BRAKE SWITCH—PCM INPUT

When the brake light switch is activated, the Powertrain Control Module (PCM) receives an input indicating that the brakes are being applied. After receiving this input, the PCM maintains idle speed to a scheduled rpm through control of the Idle Air Control (IAC) motor. The brake switch input is also used to supply/deny power to the speed control servo solenoids.

FIVE VOLT SENSOR SUPPLY—PRIMARY

Supplies the required 5 volt power source to the crankshaft position sensor, camshaft position sensor, MAP sensor and throttle position sensor.

FIVE VOLT SENSOR SUPPLY—SECONDARY

Supplies the required 5 volt power source to the transmission pressure sensor and the vehicle speed sensor.

FUEL LEVEL SENSOR—PCM INPUT

The fuel level sensor (fuel gauge sending unit) sends a signal to the PCM to indicate fuel level. The purpose of this feature is to prevent a false setting of misfire and fuel system monitor trouble codes if the fuel level is less than approximately 15 percent, or more than approximately 85 percent of its rated capacity. It is also used to send a signal for fuel gauge operation via the CCD bus circuits.

CAMSHAFT POSITION SENSOR—PCM INPUT

A sync signal is provide by the camshaft position sensor. The sensor located in the distributor on all 4.0L/5.2L/5.9L engines (Fig. 3). The sync signal from this sensor works in conjunction with the crankshaft position sensor to provide the powertrain control module (PCM) with inputs. This is done to establish and maintain correct injector firing order.

Refer to Camshaft Position Sensor in Group 8D, Ignition System for more information.

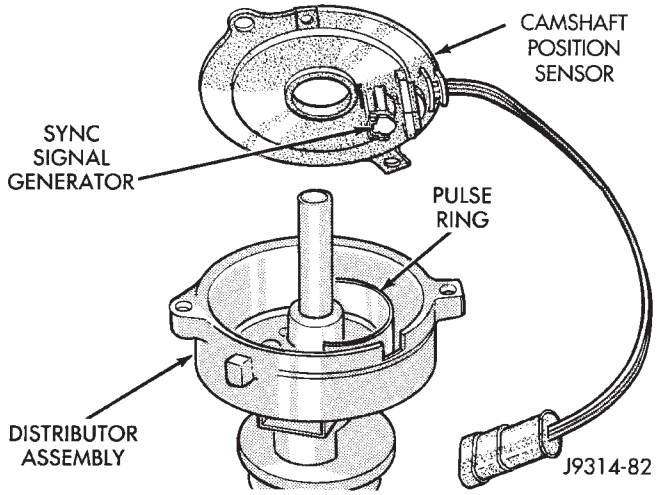


Fig. 3 Camshaft Position Sensor—Typical(5.2L/5.9L Distributor Shown)

CRANKSHAFT POSITION SENSOR—5.2L/5.9L ENGINES—PCM INPUT

This sensor is a hall effect device that detects notches in the flywheel (manual transmission) or flexplate (automatic transmission).

This sensor is used to indicate to the powertrain control module (PCM) that a spark and or fuel injection event is to be required. The output from this sensor, in conjunction with the camshaft position sensor signal, is used to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

The sensor is bolted to the cylinder block near the rear of the right cylinder head (Fig. 4).

Refer to Group 8D, Ignition System for more crankshaft position sensor information.

The engine will not operate if the PCM does not receive a crankshaft position sensor input.

CRANKSHAFT POSITION SENSOR—4.0L ENGINE—PCM INPUT

This sensor is a hall effect device that detects notches in the flywheel (manual transmission) or flexplate (automatic transmission).

This sensor is used to indicate to the powertrain control module (PCM) that a spark and or fuel injec-

DESCRIPTION AND OPERATION (Continued)

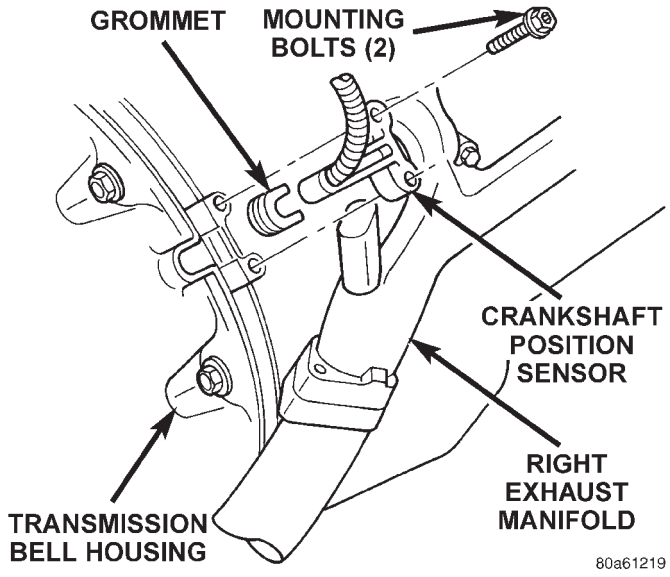


Fig. 4 Crankshaft Position Sensor—5.2L/ 5.9LEngines

tion event is to be required. The output from this sensor, in conjunction with the camshaft position sensor signal, is used to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

The sensor is bolted to the transmission bellhousing (Fig. 5).

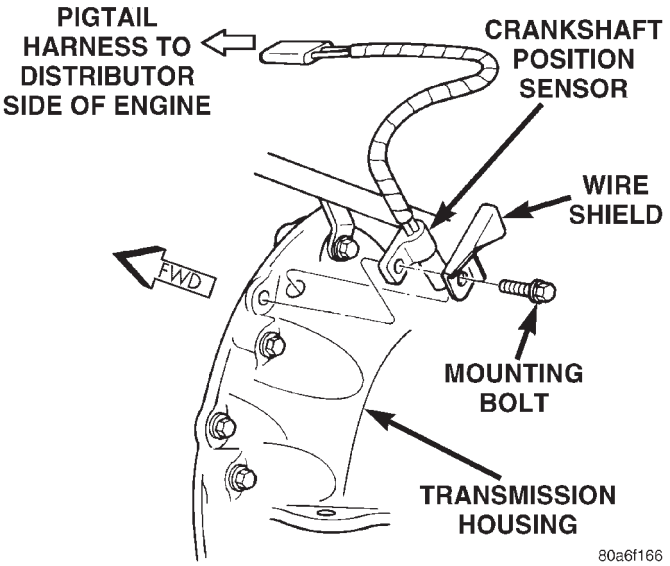


Fig. 5 Crankshaft Position Sensor—4.0LEngine

Refer to Group 8D, Ignition System for more crankshaft position sensor information.

The engine will not operate if the PCM does not receive a crankshaft position sensor input.

ENGINE COOLANT TEMPERATURE SENSOR—5.2L/ 5.9L ENGINES—PCM INPUT

The engine coolant temperature sensor is installed next to the thermostat housing (Fig. 6) and protrudes into the water jacket. The sensor provides an input voltage to the powertrain control module (PCM) relating coolant temperature. The PCM uses this input along with inputs from other sensors to determine injector pulse width and ignition timing. As coolant temperature varies, the coolant temperature sensor resistance will change. This change in resistance results in a different input voltage to the PCM.

When the engine is cold, the PCM will operate in Open Loop cycle. It will demand slightly richer air-fuel mixtures and higher idle speeds. This is done until normal operating temperatures are reached.

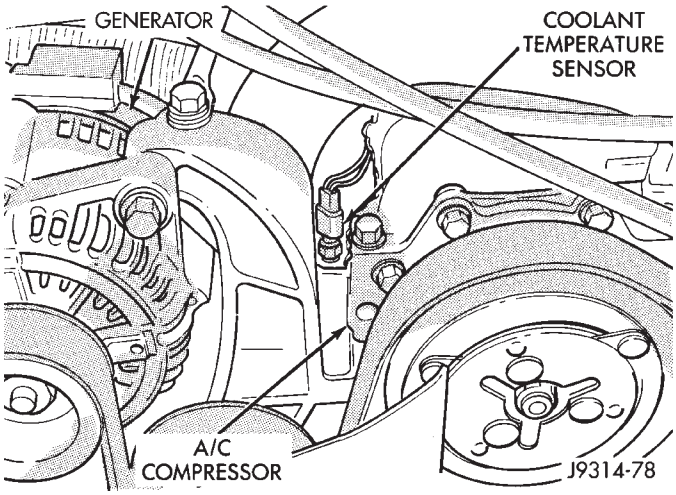


Fig. 6 Engine Coolant Temperature Sensor—5.2L/ 5.9LEngines

ENGINE COOLANT TEMPERATURE SENSOR—4.0L ENGINE—PCM INPUT

The engine coolant temperature sensor is installed in the thermostat housing (Fig. 7) and protrudes into the water jacket. The sensor provides an input voltage to the powertrain control module (PCM) relating coolant temperature. The PCM uses this input along with inputs from other sensors to determine injector pulse width and ignition timing. As coolant temperature varies, the coolant temperature sensor's resistance changes. The change in resistance results in a different input voltage to the PCM.

When the engine is cold, the PCM will operate in Open Loop cycle. It will demand slightly richer air-fuel mixtures and higher idle speeds. This is done until normal operating temperatures are reached.

Refer to Open Loop/Closed Loop Modes of Operation in this section of the group for more information.

DESCRIPTION AND OPERATION (Continued)

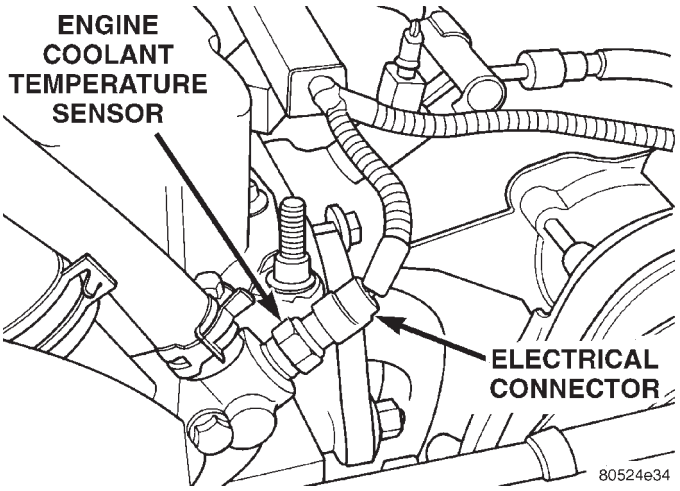


Fig. 7 Engine Coolant Temperature Sensor—4.0LEngine—Typical

GENERATOR OUTPUT—PCM INPUT

Provides a charging system voltage input to the Powertrain Control Module (PCM). It is sensed at the battery input to the PCM.

OXYGEN SENSOR (O2S)—PCM INPUT

Two heated O2S sensors are used. The sensors produce voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air/fuel mixture), the sensors produces a low voltage. When there is a lesser amount present (rich air/fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensors act as a rich-lean switch.

In Closed Loop operation, the PCM monitors the O2S sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation, the PCM ignores the O2 sensor input. The PCM adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

The oxygen sensors are equipped with a heating element that keeps the sensors at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

The Automatic Shutdown (ASD) relay supplies battery voltage to both the upstream and downstream heated oxygen sensors. The oxygen sensors are equipped with a heating element. The heating elements reduce the time required for the sensors to reach operating temperature.

UPSTREAM HEATED OXYGEN SENSOR

The upstream O2S sensor is located near the inlet end of the catalytic converter. It provides an input voltage to the PCM. The input tells the PCM the oxygen content of the exhaust gas. The PCM uses this information to fine tune the air/fuel ratio by adjusting injector pulse width.

DOWNSTREAM HEATED OXYGEN SENSOR

The downstream heated oxygen sensor is located near the outlet end of the catalytic converter. The downstream heated oxygen sensor input is used to detect catalytic convertor deterioration. As the convertor deteriorates, the input from the downstream sensor begins to match the upstream sensor input except for a slight time delay. By comparing the downstream heated oxygen sensor input to the input from the upstream sensor, the PCM calculates catalytic convertor efficiency.

When the catalytic converter efficiency drops below emission standards, the PCM stores a diagnostic trouble code and illuminates the Malfunction Indicator Lamp (MIL). For more information, refer to Group 25, Emission Control Systems.

IGNITION CIRCUIT SENSE—PCM INPUT

The ignition circuit sense input tells the Powertrain Control Module (PCM) the ignition switch has energized the ignition circuit. Refer to the wiring diagrams for circuit information.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—5.2L/5.9L ENGINES—PCM INPUT

The intake manifold air temperature sensor is installed in the intake manifold with the sensor element extending into the air stream (Fig. 8). The sensor provides an input voltage to the powertrain control module (PCM) indicating intake manifold air temperature. The input is used along with inputs from other sensors to determine injector pulse width. As the temperature of the air-fuel stream in the manifold varies, the sensor resistance changes. This results in a different input voltage to the PCM.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—4.0L ENGINE—PCM INPUT

The intake manifold air temperature sensor is installed in the intake manifold with the sensor element extending into the air stream (Fig. 9). The sensor provides an input voltage to the powertrain control module (PCM) indicating intake manifold air temperature. The input is used along with inputs from other sensors to determine injector pulse width. As the temperature of the air-fuel stream in the manifold varies, the sensor resistance changes. This results in a different input voltage to the PCM.

DESCRIPTION AND OPERATION (Continued)

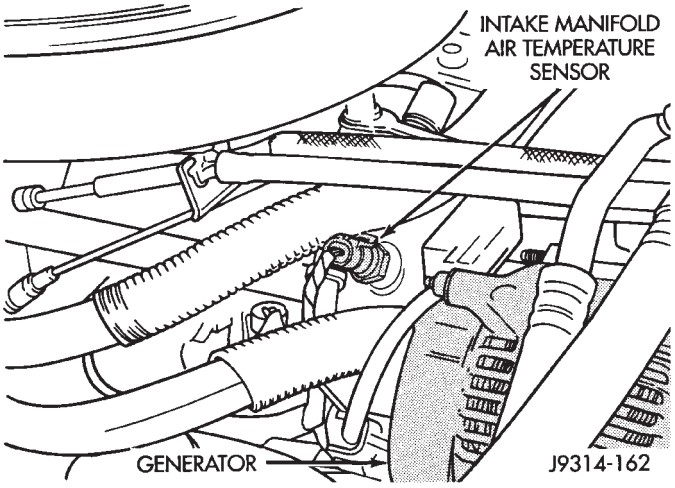


Fig. 8 Intake Manifold Air Temperature Sensor—5.2L/5.9LV-8 Engines—Typical

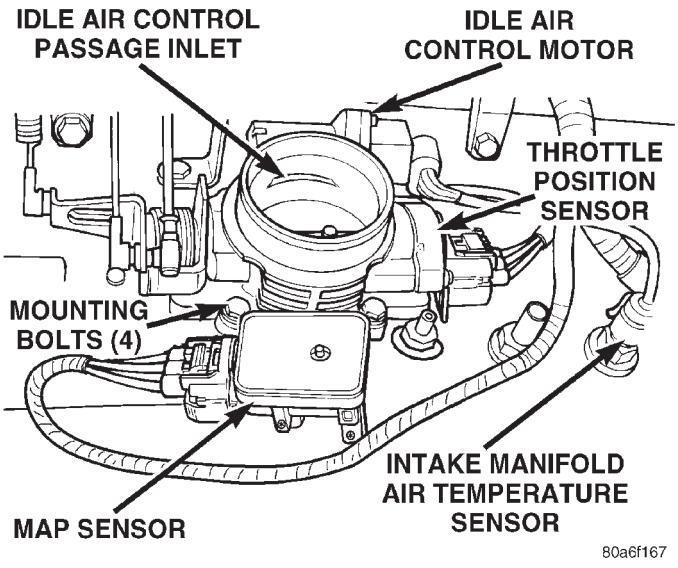


Fig. 9 Throttle Body Sensor Locations—4.0LEngine

LEAK DETECTION PUMP (SWITCH) SENSE—PCM INPUT

Provides an input to the PCM that the leak detection pump (LDP) has been activated. Refer to Group 25, Emission Control System for LDP information.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—5.2L/5.9L ENGINES—PCM INPUT

The MAP sensor reacts to absolute pressure in the intake manifold. It provides an input voltage to the powertrain control module (PCM). As engine load changes, manifold pressure varies. The change in manifold pressure causes MAP sensor voltage to change. The change in MAP sensor voltage results in a different input voltage to the PCM. The input voltage level supplies the PCM with information about ambient barometric pressure during engine start-up (cranking) and engine load while the engine is running. The PCM uses this input along with inputs from other sensors to adjust air-fuel mixture.

The MAP sensor is mounted on the side of the engine throttle body (Fig. 10). The sensor is connected to the throttle body with a rubber L-shaped fitting.

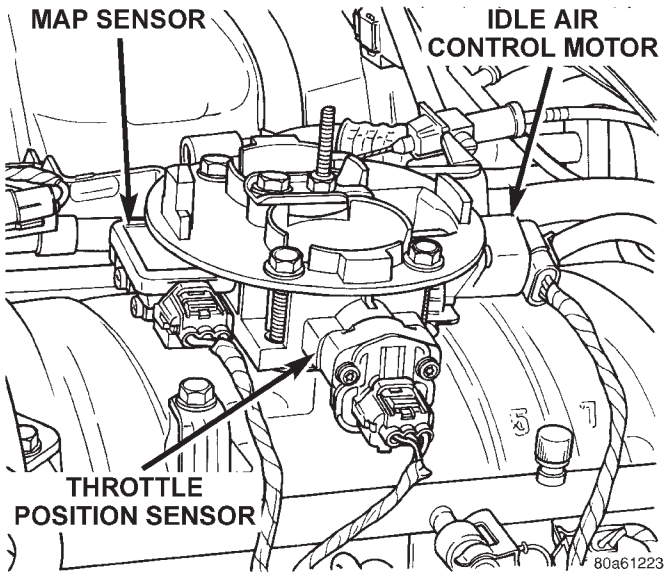


Fig. 10 MAP and Throttle PositionSensor Location—5.2L/5.9L Engines

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—4.0L ENGINE—PCM INPUT

The MAP sensor reacts to absolute pressure in the intake manifold. It provides an input voltage to the powertrain control module (PCM). As engine load changes, manifold pressure varies. The change in manifold pressure causes MAP sensor voltage to change. The change in MAP sensor voltage results in a different input voltage to the PCM. The input voltage level supplies the PCM with information about ambient barometric pressure during engine start-up (cranking) and engine load while the engine is running. The PCM uses this input along with inputs from other sensors to adjust air-fuel mixture.

The MAP sensor is mounted on the side of the engine throttle body (Fig. 9). The sensor is connected to the throttle body with a rubber L-shaped fitting.

OIL PRESSURE SENSOR—PCM INPUT

Sends a signal from the oil pressure sending unit to the Powertrain Control Module (PCM) relating to engine oil pressure.

OUTPUT SHAFT SPEED SENSOR—PCM INPUT

This sensor generates a signal to the PCM relating to the speed of the transmission main drive shaft.

DESCRIPTION AND OPERATION (Continued)

This input is used with 4–speed electronic transmissions only.

OVERDRIVE/OVERRIDE SWITCH-PCM INPUT

On vehicles equipped with an automatic transmission and overdrive, the powertrain control module (PCM) regulates the 3-4 overdrive up-shift and downshift through the overdrive solenoid. This solenoid is located in the transmission. An overdrive/override push-button switch is located on the instrument panel.

The overdrive/override push-button switch is normally open (overdrive allowed) when the lamp is not illuminated. It momentarily closes (overdrive not allowed) when the operator presses the switch and the lamp is illuminated. Overdrive will revert to ON (lamp off) each time the ignition switch in turned on. The transmission downshifts if the operator presses the override switch while in overdrive.

Refer to Group 21 for more transmission information.

SENSOR RETURN—PCM INPUT

Sensor Return provides a low noise ground reference for all system sensors.

SIGNAL GROUND—PCM INPUT

Signal ground provides a low noise ground to the data link connector.

SPEED CONTROL SWITCHES—PCM INPUT

Two separate speed control switch modules are mounted on the steering wheel to the left and right side of the driver's airbag module. Within the two switch modules, five **momentary** contact switches, supporting seven different speed control functions are used. The outputs from these switches are filtered into one input. The Powertrain Control Module (PCM) determines which output has been applied through **resistive multiplexing.** The input circuit voltage is measured by the PCM to determine which switch function has been selected.

A speed control indicator lamp, located on the instrument panel cluster is energized by the PCM via the CCD Bus. This occurs when speed control system power has been turned ON, and the engine is running.

The two switch modules are labeled: ON/OFF, SET, RESUME/ACCEL, CANCEL and COAST. Refer to Group 8H, Speed Control System for more information.

TRANSMISSION PARK/NEUTRAL SWITCH—PCM INPUT

The park/neutral switch is located on the transmission housing and provides an input to the powertrain control module (PCM). This will indicate that the automatic transmission is in Park, Neutral or a drive gear selection. This input is used to determine idle speed (varying with gear selection), fuel injector pulse width, ignition timing advance and vehicle speed control operation. Refer to Group 21, Transmissions, for testing, replacement and adjustment information.

TRANSMISSION GOVERNOR PRESSURE SENSOR—PCM INPUT

Provides a signal proportional to the transmission governor pressure. It provides feedback for control of the governor pressure solenoid, which regulates transmission governor pressure. This input is used with 4–speed electronic transmissions only.

TRANSMISSION TEMPERATURE SENSOR—PCM INPUT

This input is used in the shift operation for 4–speed electronic transmissions only. The temperature data is used for: torque converter clutch operation, overdrive shift, low temperature shift compensation, wide open throttle shift strategy and governor pressure transducer calibration.

THROTTLE POSITION SENSOR (TPS)—5.2L/5.9L ENGINES—PCM INPUT

The throttle position sensor (TPS) is mounted on the throttle body (Fig. 10). The TPS is a variable resistor that provides the powertrain control module (PCM) with an input signal (voltage) that represents throttle blade position. The sensor is connected to the throttle blade shaft. As the position of the throttle blade changes, the resistance of the TPS changes.

The PCM supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the PCM) represents the throttle blade position. The PCM receives an input signal voltage from the TPS. This will vary in an approximate range of from .25 volts at minimum throttle opening (idle), to 4.8 volts at wide open throttle. Along with inputs from other sensors, the PCM uses the TPS input to determine current engine operating conditions. In response to engine operating conditions, the PCM will adjust fuel injector pulse width and ignition timing.

THROTTLE POSITION SENSOR (TPS)—4.0L ENGINE—PCM INPUT

The throttle position sensor (TPS) is mounted on the throttle body (Fig. 9). The TPS is a variable resistor that provides the powertrain control module (PCM) with an input signal (voltage) that represents throttle blade position. The sensor is connected to the throttle blade shaft. As the position of the throttle blade changes, the resistance of the TPS changes.

DESCRIPTION AND OPERATION (Continued)

The PCM supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the PCM) represents the throttle blade position. The PCM receives an input signal voltage from the TPS. This will vary in an approximate range of from .25 volts at minimum throttle opening (idle), to 4.8 volts at wide open throttle. Along with inputs from other sensors, the PCM uses the TPS input to determine current engine operating conditions. In response to engine operating conditions, the PCM will adjust fuel injector pulse width and ignition timing.

VEHICLE SPEED AND DISTANCE SENSOR—PCM INPUT

The vehicle speed sensor is located on the speedometer pinion gear adapter (Fig. 11) or (Fig. 12). The pinion gear adapter is located on the extension housing of the transmission (drivers side—2WD), or on the transfer case (4WD). The sensor input is used by the powertrain control module (PCM) to determine vehicle speed and distance traveled.

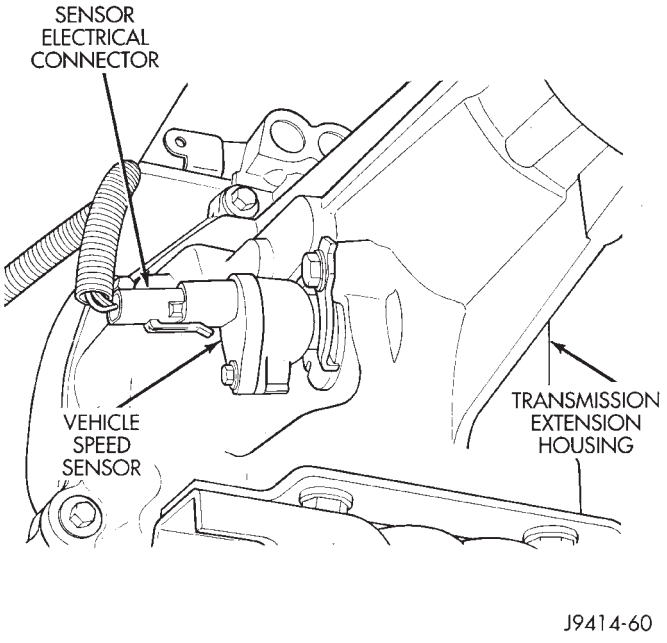


Fig. 11 Vehicle Speed Sensor Location—2WD—Typical

The speed sensor generates 8 pulses per sensor revolution. These signals, in conjunction with a closed throttle signal from the throttle position sensor, indicate a closed throttle deceleration to the PCM. When the vehicle is stopped at idle, a closed throttle signal is received by the PCM (but a speed sensor signal is not received).

Under deceleration conditions, the PCM adjusts the idle air control (IAC) motor to maintain a desired

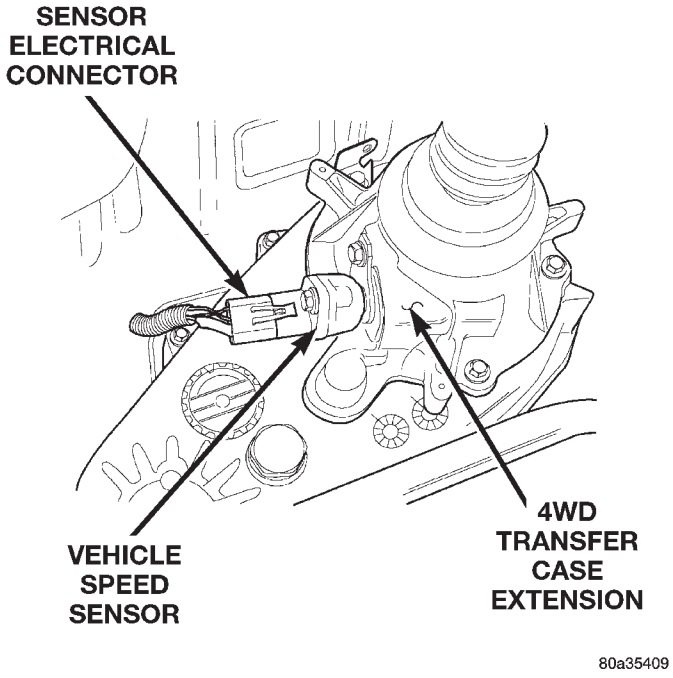


Fig. 12 Vehicle Speed Sensor Location—4WD—Typical

MAP value. Under idle conditions, the PCM adjusts the IAC motor to maintain a desired engine speed.

POWER GROUND

The power ground is used to control ground circuits for the following powertrain control module (PCM) loads:

- Generator field winding
- Fuel injectors
- Ignition coil
- Certain relays/solenoids

AIR CONDITIONING (A/C) CLUTCH RELAY—PCM OUTPUT

The A/C relay is located in the Power Distribution Center (PDC). The PDC is located in the engine compartment (Fig. 13). Refer to label on PDC cover for relay location.

The powertrain control module (PCM) activates the A/C compressor through the A/C clutch relay. The PCM regulates A/C compressor operation by switching the ground circuit for the A/C clutch relay on and off.

When the PCM receives a request for A/C from A/C evaporator switch, it will adjust idle air control (IAC) motor position. This is done to increase idle speed. The PCM will then activate the A/C clutch through the A/C clutch relay. The PCM adjusts idle air control (IAC) stepper motor position to compensate for increased engine load from the A/C compressor.

By switching the ground path for the relay on and off, the PCM is able to cycle the A/C compressor

DESCRIPTION AND OPERATION (Continued)

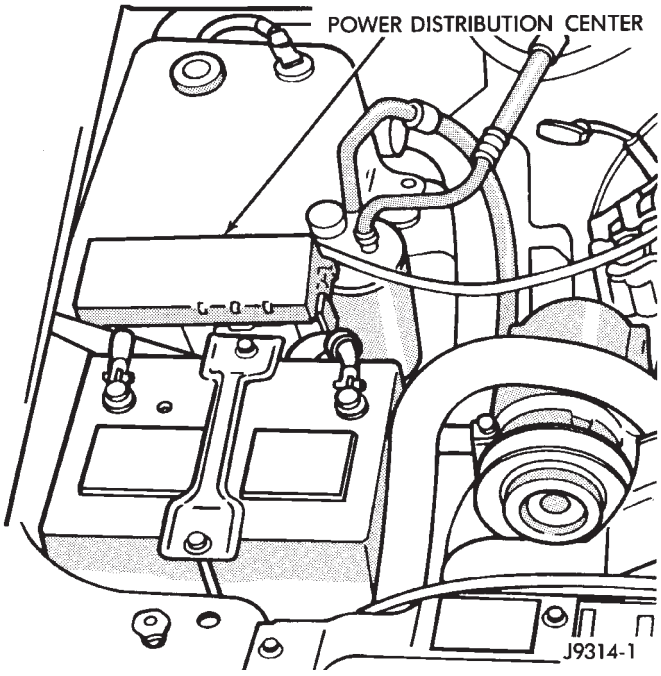


Fig. 13 Power Distribution Center (PDC)

clutch. This is based on changes in engine operating conditions. If, during A/C operation, the PCM senses abnormally low idle speeds it will de-energize the relay. This prevents A/C clutch engagement. The relay will remain de-energized until the idle speed increases. The PCM will also de-energize the relay if coolant temperature exceeds 125°C (257°F) or low or high system pressure exists.

AUTO SHUTDOWN (ASD) RELAY—PCM OUTPUT

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 13).

The ASD supplies battery voltage to the fuel injectors, ignition coil and both oxygen (O2S) sensor heating elements. The ground circuit for the coil in the ASD relay is controlled by the powertrain control module (PCM). The PCM operates the relay by switching the ground circuit on and off.

CCD BUS (+/-) CIRCUITS-PCM OUTPUTS

The Powertrain Control Module (PCM) sends certain output signals through the CCD bus circuits. These signals are used to control certain instrument panel located items and to determine certain identification numbers.

Refer to Group 8E, Instrument Panel and Gauges for additional information.

DATA LINK CONNECTOR—PCM INPUT AND OUTPUT

The 16–way data link connector (diagnostic scan tool connector) links the Diagnostic Readout Box (DRB) scan tool or the Mopar Diagnostic System (MDS) with the powertrain control module (PCM). The data link connector is located under the instrument panel to the left of the steering column (Fig. 14). For operation of the DRB scan tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.

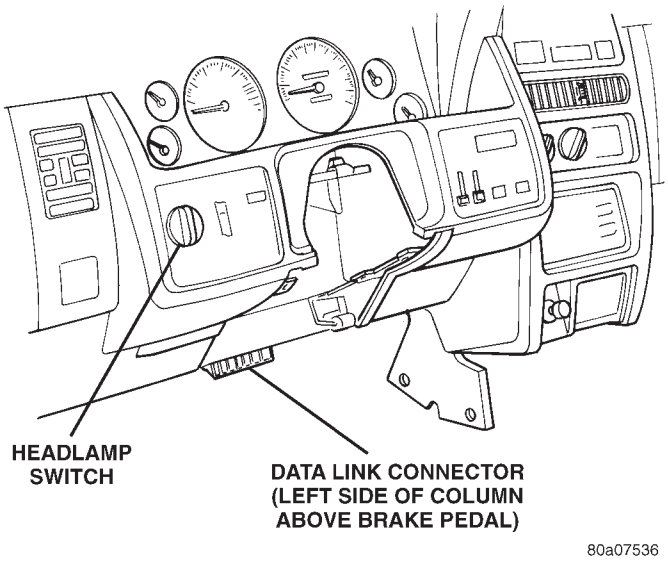


Fig. 14 Data Link Connector Location

DUTY CYCLE EVAP PURGE SOLENOID VALVE-PCM OUTPUT

Refer to Group 25, Emission Control System for information.

FUEL INJECTORS—5.2L/5.9L ENGINES—PCM OUTPUT

The fuel injectors are attached to the fuel rail (Fig. 15). 5.2L/5.9L V-8 engines use eight injectors.

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector with its respective cylinder number.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

During start up, battery voltage is supplied to the injectors through the ASD relay. When the engine is operating, voltage is supplied by the charging system. The PCM determines injector pulse width based on various inputs.

DESCRIPTION AND OPERATION (Continued)

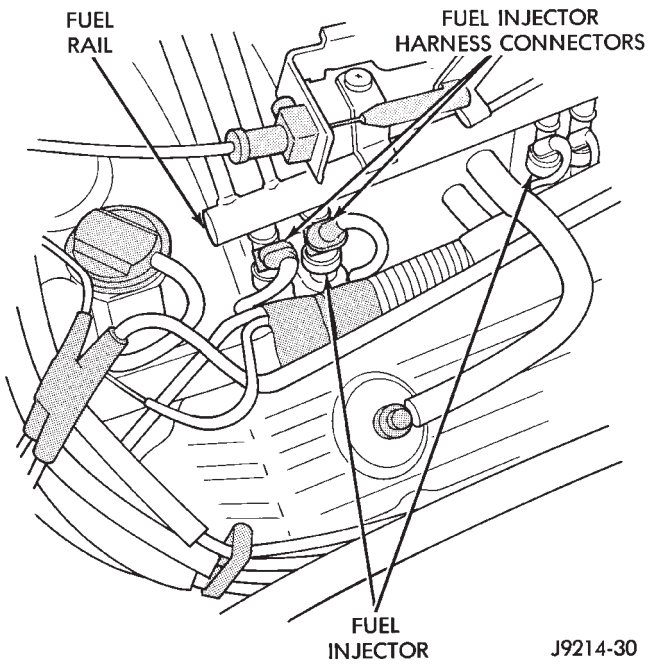


Fig. 15 Fuel Injectors—5.2L/5.9L Engines—Typical

FUEL INJECTORS—4.0L ENGINE—PCM OUTPUT

Six individual fuel injectors are used with the 4.0L 6-cylinder engine. The injectors are attached to the fuel rail (Fig. 16).

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

During start up, battery voltage is supplied to the injectors through the ASD relay. When the engine is operating, voltage is supplied by the charging system. The PCM determines injector pulse width based on various inputs.

FUEL PUMP RELAY-PCM OUTPUT

The PCM energizes the electric fuel pump through the fuel pump relay. Battery voltage is applied to the fuel pump relay when the ignition key is ON. The relay is energized when a ground signal is provided by the PCM.

The fuel pump will operate for approximately one second unless the engine is operating or the starter motor is engaged.

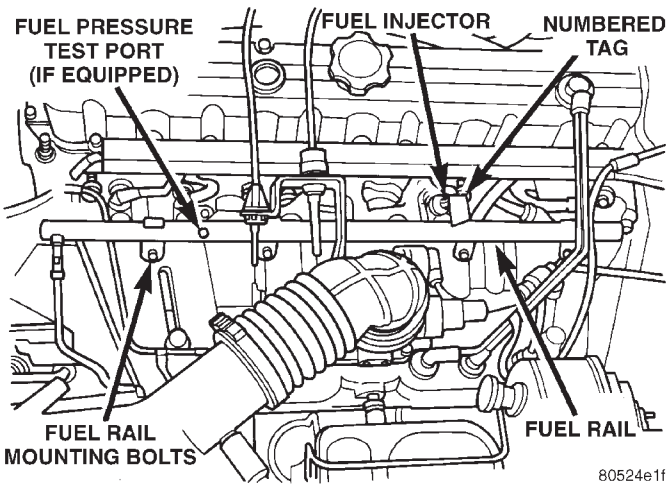


Fig. 16 Fuel Injectors—4.0L Engine

The fuel pump relay is located in the Power Distribution Center (PDC) (Fig. 13).

GENERATOR FIELD SOURCE (+)—PCM OUTPUT

This output from the Powertrain Control Module (PCM) regulates charging system voltage to the generator field source (+) circuit. The voltage range is 12.9 to 15.0 volts. Jeep models of previous years had used the ASD relay to apply the 12 volt + power supply to the generator field source (+) circuit. Refer to Groups 8A and 8C for charging system information.

GENERATOR FIELD DRIVER (-)—PCM OUTPUT

This output from the Powertrain Control Module (PCM) regulates charging system ground control to the generator field driver (-) circuit. Refer to Groups 8A and 8C for charging system information.

GENERATOR LAMP—PCM OUTPUT

If the powertrain control module (PCM) senses a low charging condition in the charging system, it will illuminate the generator lamp (if equipped) on the instrument panel. This is done through the CCD Bus circuits. For example, during low idle with all accessories turned on, the lamp may momentarily go on. Once the PCM corrects idle speed to a higher rpm, the lamp will go out. Refer to Groups 8A and 8C for charging system information.

IDLE AIR CONTROL (IAC) MOTOR—5.2L/5.9L ENGINES—PCM OUTPUT

The IAC motor is mounted to the back of the throttle body (Fig. 10) and is controlled by the powertrain control module (PCM).

The throttle body has an air control passage that provides air for the engine at idle (the throttle plate is closed). The IAC motor pintle protrudes into the air control passage (Fig. 17) and regulates air flow through it. Based on various sensor inputs, the pow-

DESCRIPTION AND OPERATION (Continued)

ertrain control module (PCM) adjusts engine idle speed by moving the IAC motor pintle in and out of the air control passage. The IAC motor is positioned when the ignition key is turned to the On position.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

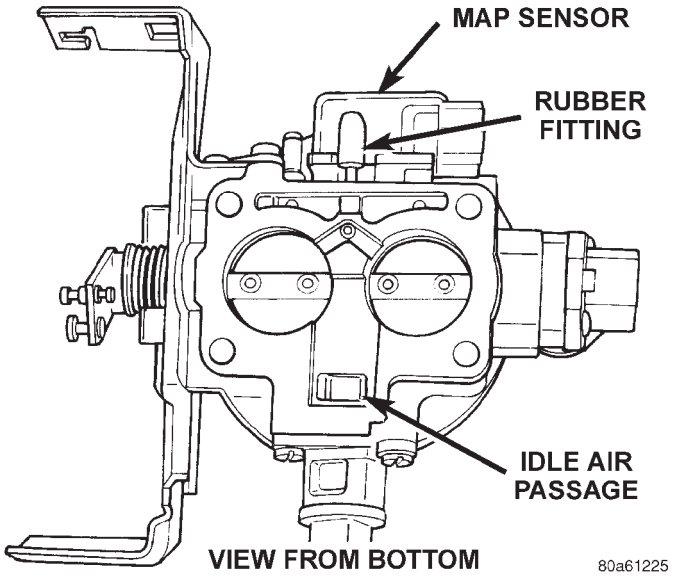


Fig. 17 Throttle Body Air ControlPassage—5.2L/5.9L Engines—Typical

IDLE AIR CONTROL (IAC) MOTOR—4.0L ENGINE—PCM OUTPUT

The IAC motor is mounted on the throttle body (Fig. 9) and is controlled by the powertrain control module (PCM).

The throttle body has an air control passage that provides air for the engine at idle (the throttle plate is closed). The IAC motor pintle protrudes into the air control passage and regulates air flow through it. Based on various sensor inputs, the powertrain control module (PCM) adjusts engine idle speed by moving the IAC motor pintle in and out of the air control passage. The IAC motor is positioned when the ignition key is turned to the On position.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

IGNITION COIL—5.2L/5.9L ENGINES—PCM OUTPUT

System voltage is supplied to the ignition coil positive terminal. The powertrain control module (PCM) operates the ignition coil. **Base (initial) ignition timing is not adjustable.** The PCM adjusts ignition timing to meet changing engine operating conditions.

The ignition coil is located near the front of the right cylinder head (Fig. 18).

Refer to Group 8D, Ignition System for additional information.

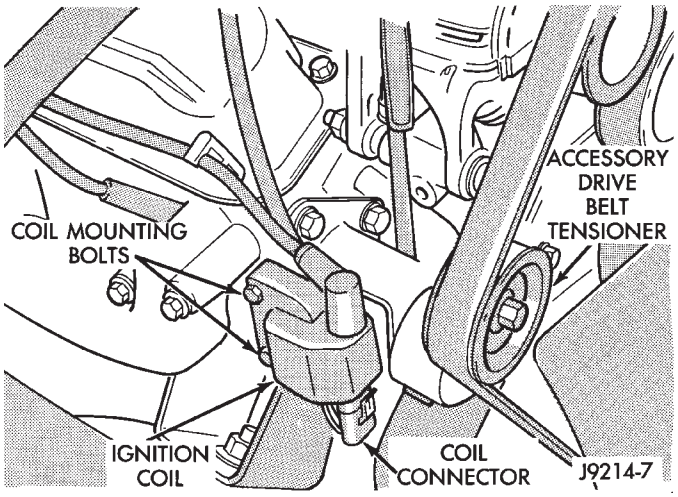


Fig. 18 Ignition Coil—5.2L/5.9L Engines—Typical

IGNITION COIL—4.0L ENGINES—PCM OUTPUT

System voltage is supplied to the ignition coil positive terminal. The powertrain control module (PCM) operates the ignition coil. **Base (initial) ignition timing is not adjustable.** The PCM adjusts ignition timing to meet changing engine operating conditions.

The ignition coil is located near the distributor (Fig. 19).

Refer to Group 8D, Ignition System for additional information.

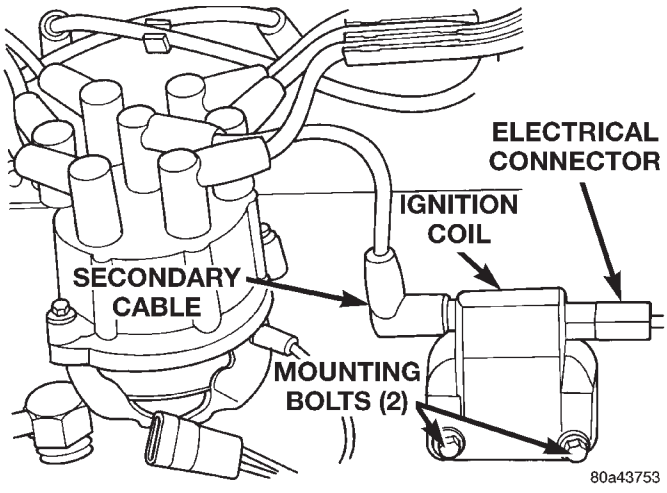


Fig. 19 Ignition Coil—4.0L Engine

LEAK DETECTION PUMP—PCM OUTPUT

Certain California models are equipped with a leak detection pump (LDP). The LDP is activated through

DESCRIPTION AND OPERATION (Continued)

this PCM output. Refer to Group 25, Emission Control System for additional information.

MALFUNCTION INDICATOR (CHECK ENGINE) LAMP—PCM OUTPUT

The malfunction indicator lamp illuminates each time the ignition key is turned on. It will stay on for approximately three seconds as a bulb test. The lamp is displayed on the instrument panel as the CHECK ENGINE lamp.

If the powertrain control module (PCM) receives an incorrect signal, or no signal from certain sensors or emission related systems, the lamp is turned on. This is a warning that the PCM has recorded a system or sensor malfunction. In some cases, when a problem is declared, the PCM will go into a limp-in mode. This is an attempt to keep the system operating. It signals an immediate need for service.

The lamp can also be used to display a Diagnostic Trouble Code (DTC). Cycle the ignition switch On-Off-On-Off-On within three seconds and any codes stored in the PCM memory will be displayed. This is done in a series of flashes representing digits.

The lamp is also used to detect certain engine misfires. Refer to Group 25, Emission Control System for more information.

OVERDRIVE LAMP—PCM OUTPUT

This circuit controls a signal for the operation of the instrument panel mounted push-button overdrive lamp switch. When the lamp is illuminated, the overdrive is disengaged.

SPEED CONTROL SOLENOIDS—PCM OUTPUT

Speed control operation is regulated by the powertrain control module (PCM). The PCM controls the vacuum to the throttle actuator through the speed control vacuum and vent solenoids. Refer to Group 8H for Speed Control Information.

TACHOMETER—PCM OUTPUT

The powertrain control module (PCM) supplies engine rpm values to the instrument cluster tachometer. Refer to Group 8E for tachometer information.

THREE-FOUR SHIFT SOLENOID—PCM OUTPUT

This output is used to control the transmission three-four shift solenoid. It is used on 4–speed electronically controlled automatic transmissions only.

TORQUE CONVERTOR CLUTCH (TCC) SOLENOID—PCM OUTPUT

This circuit controls operation of the transmission mounted torque convertor clutch (TCC) solenoid used for torque convertor engagement.

The powertrain control module (PCM) will determine when to engage and disengage the solenoid by monitoring vehicle miles per hour (mph) versus the output voltage of the throttle position sensor. Also needed are various inputs from:

- Transmission temperature sensor
- Output shaft speed sensor
- Module timer
- Engine rpm
- MAP sensor
- Brake switch

MANUAL TRANSMISSION

If equipped with a manual transmission, this PCM output will control operation of the shift indicator lamp (if equipped with lamp). The lamp is controlled by the powertrain control module (PCM). The lamp illuminates on the instrument panel to indicate when the driver should shift to the next highest gear for best fuel economy. The PCM will turn the lamp OFF after 3 to 5 seconds if the shift of gears is not performed. The lamp will remain off until vehicle stops accelerating and is brought back to range of up-shift lamp operation. This will also happen if vehicle is shifted into fifth gear.

The indicator lamp is normally illuminated when the ignition switch is turned on and it is turned off when the engine is started up. With the engine running, the lamp is turned ON/OFF depending upon engine speed and load.

TRANSMISSION RELAY—PCM OUTPUT

The output to this relay provides battery voltage to the overdrive (OD), torque converter clutch (TCC) and governor pressure solenoids. Once battery voltage is applied to the solenoids, they are individually activated by the PCM through OD, TCC and governor pressure outputs. The relay is located in the Power Distribution Center (PDC). Refer to label on PDC cover for relay location.

GOVERNOR PRESSURE SOLENOID—PCM OUTPUT

This solenoid regulates the transmission fluid line pressure to produce the governor pressure necessary for transmission shift control. It is used on 4–speed electronic transmissions only.

THROTTLE BODY—5.2L/5.9L ENGINES

Filtered air from the air cleaner enters the intake manifold through the throttle body (Fig. 20). Fuel does not enter the intake manifold through the throttle body. Fuel is sprayed into the manifold by the fuel injectors. The throttle body is mounted on the intake manifold. It contains an air control passage (Fig. 21) controlled by an idle air control (IAC) motor. The air control passage is used to supply air for idle condi-

DESCRIPTION AND OPERATION (Continued)

tions. A throttle valve (plate) is used to supply air for above idle conditions.

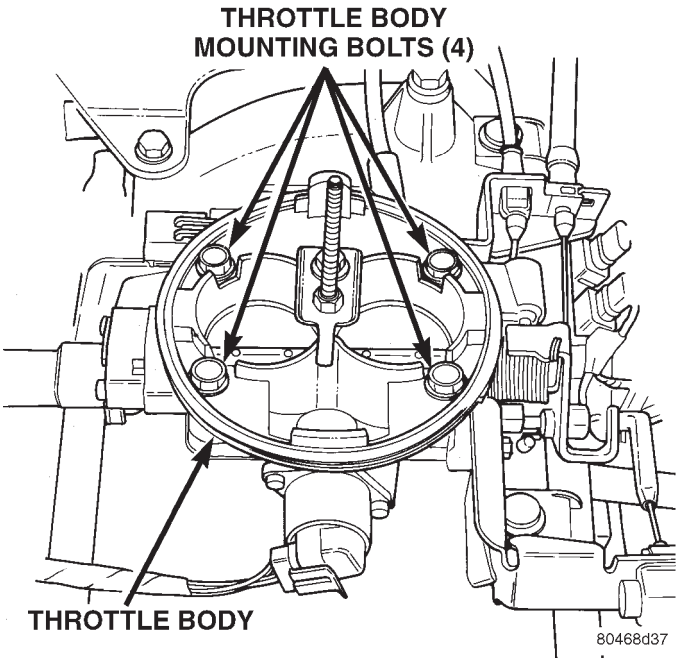


Fig. 20 Throttle Body—5.2L/5.9L Engines—Typical

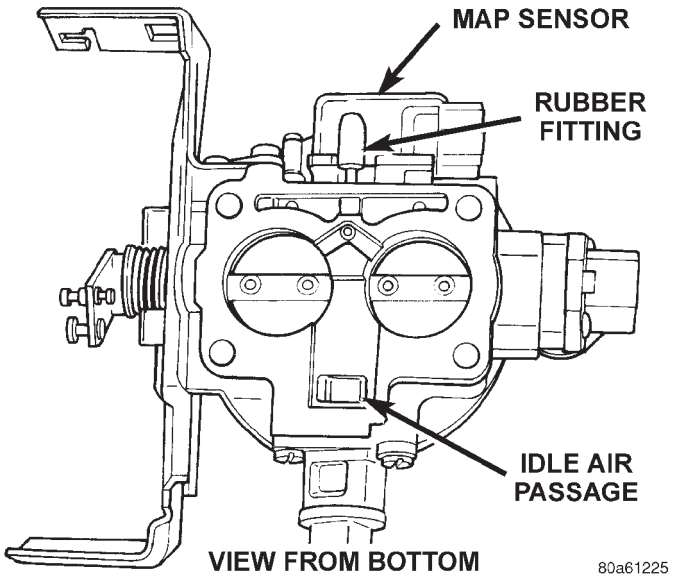


Fig. 21 Air Control Passage—5.2L/5.9LEngines—Typical

The throttle position sensor (TPS), idle air control (IAC) motor and manifold absolute pressure sensor (MAP) are attached to the throttle body. The accelerator pedal cable, speed control cable and transmission control cable (when equipped) are connected to the throttle arm.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

THROTTLE BODY—4.0L ENGINE

Filtered air from the air cleaner enters the intake manifold through the throttle body (Fig. 22). Fuel does not enter the intake manifold through the throttle body. Fuel is sprayed into the manifold by the fuel injectors. The throttle body is mounted on the intake manifold. It contains an air control passage (Fig. 22) controlled by an idle air control (IAC) motor. The air control passage is used to supply air for idle conditions. A throttle valve (plate) is used to supply air for above idle conditions.

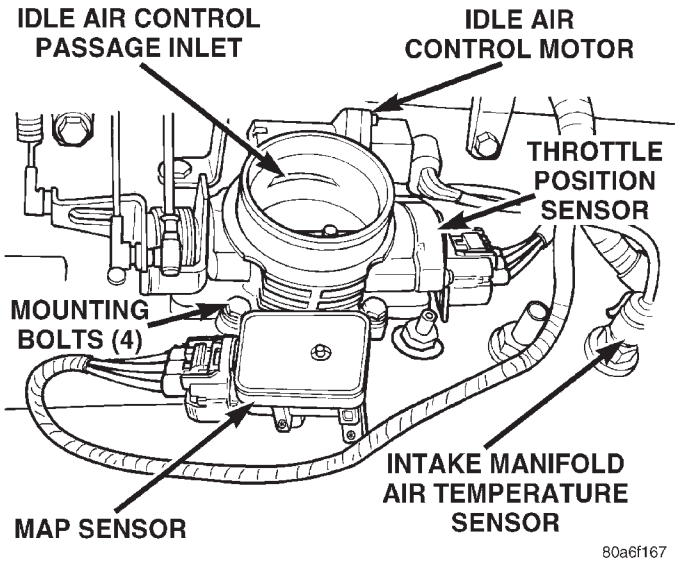


Fig. 22 Throttle Body—4.0LEngine

The throttle position sensor (TPS), idle air control (IAC) motor and manifold absolute pressure sensor (MAP) are attached to the throttle body. The accelerator pedal cable, speed control cable and transmission control cable (when equipped) are connected to the throttle arm.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

DIAGNOSIS AND TESTING

VISUAL INSPECTION—5.2L/5.9L ENGINES

A visual inspection for loose, disconnected or incorrectly routed wires and hoses should be made. This should be done before attempting to diagnose or service the fuel injection system. A visual check will help spot these faults and save unnecessary test and

DIAGNOSIS AND TESTING (Continued)

diagnostic time. A thorough visual inspection will include the following checks:

(1) Verify that the three 32–way electrical connectors are fully inserted into the connector of the powertrain control module (PCM) (Fig. 23).

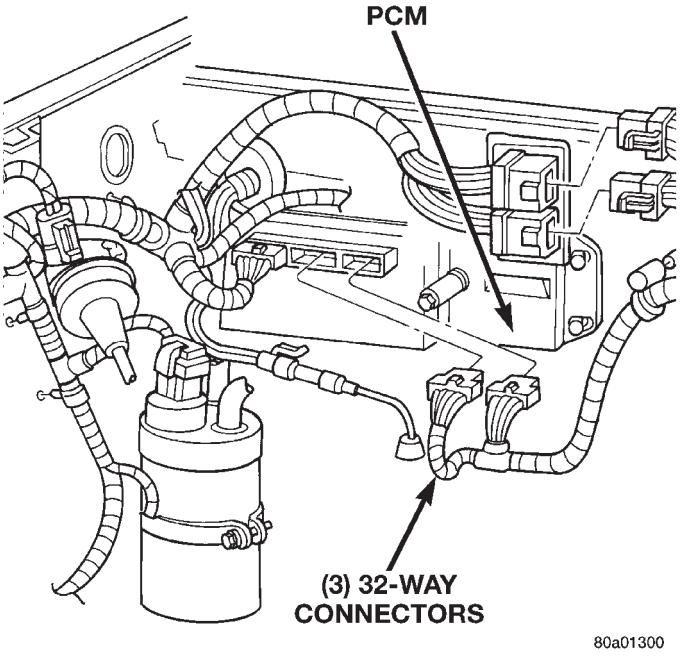


Fig. 23 Powertrain Control Module (PCM)

(2) Inspect the battery cable connections. Be sure that they are clean and tight.

(3) Inspect fuel pump relay and air conditioning compressor clutch relay (if equipped). Inspect the ASD relay connections. Inspect starter motor relay connections. Inspect relays for signs of physical damage and corrosion. The relays are located in the Power Distribution Center (PDC) (Fig. 24). Refer to label on PDC cover for relay location.

(4) Inspect ignition coil connections. Verify that coil secondary cable is firmly connected to coil (Fig. 25).

(5) Verify that distributor cap is correctly attached to distributor. Be sure that spark plug cables are firmly connected to the distributor cap and the spark plugs are in their correct firing order. Be sure that coil cable is firmly connected to distributor cap and coil. Be sure that camshaft position sensor wire connector (at the distributor) is firmly connected to harness connector. Inspect spark plug condition. Refer to Group 8D, Ignition. Connect vehicle to an oscilloscope and inspect spark events for fouled or damaged spark plugs or cables.

(6) Verify that generator output wire, generator connector and ground wire are firmly connected to the generator.

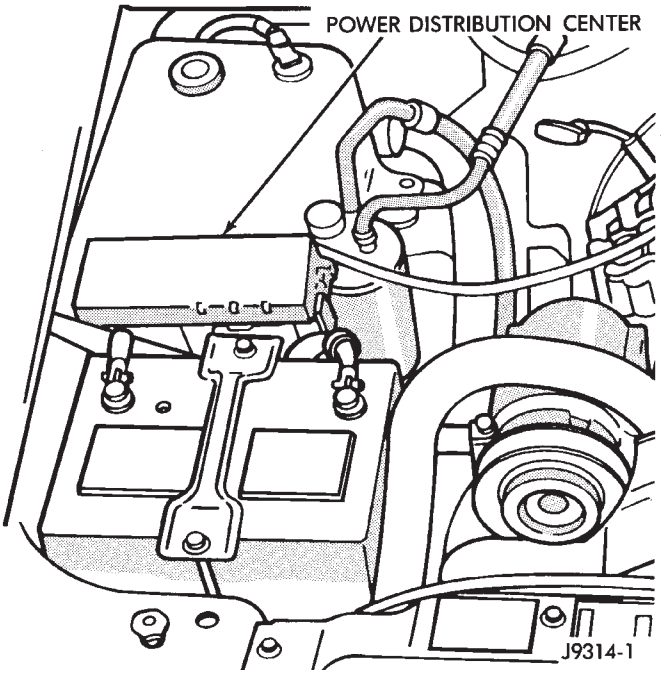


Fig. 24 Power Distribution Center (PDC)

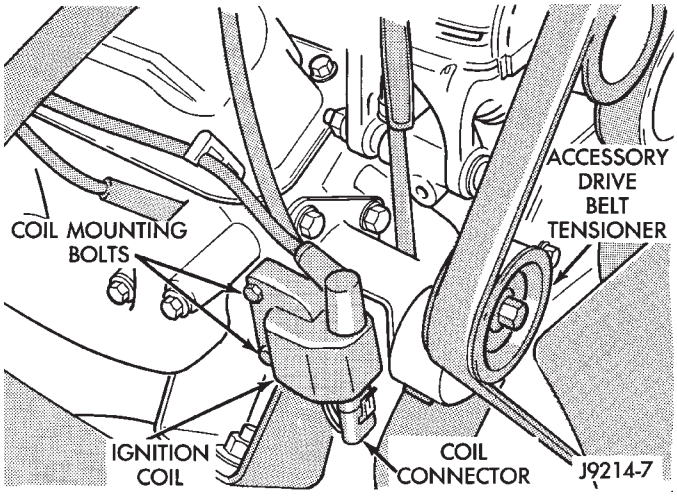


Fig. 25 Ignition Coil—5.2L/5.9L Engines

(7) Inspect the system body grounds for loose or dirty connections. Refer to Group 8, Wiring for ground locations.

(8) Verify positive crankcase ventilation (PCV) valve operation. Refer to Group 25, Emission Control System for additional information. Verify PCV valve hose is firmly connected to PCV valve and manifold (Fig. 26).

(9) Inspect fuel tube quick-connect fitting-to-fuel rail connections.

(10) Verify that hose connections to all ports of vacuum fittings on intake manifold are tight and not leaking.

(11) Inspect accelerator cable, transmission throttle cable (if equipped) and cruise control cable con-

DIAGNOSIS AND TESTING (Continued)

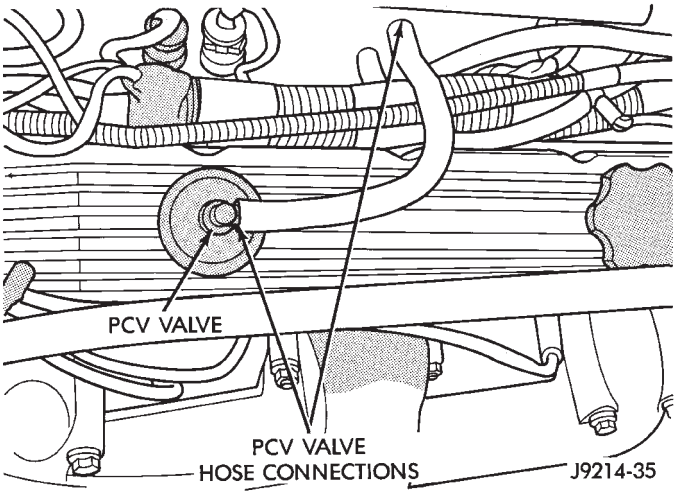


Fig. 26 PCV Valve Hose Connections—5.2L/ 5.9LEngines—Typical

nections (if equipped). Check their connections to the throttle arm of throttle body for any binding or restrictions.

(12) If equipped with vacuum brake booster, verify that vacuum booster hose is firmly connected to fitting on intake manifold. Also check connection to brake vacuum booster.

(13) Inspect the air cleaner inlet and air cleaner element for dirt or restrictions.

(14) Inspect radiator grille area, radiator fins and air conditioning condenser for restrictions.

(15) Verify that the intake manifold air temperature sensor wire connector is firmly connected to harness connector (Fig. 27).

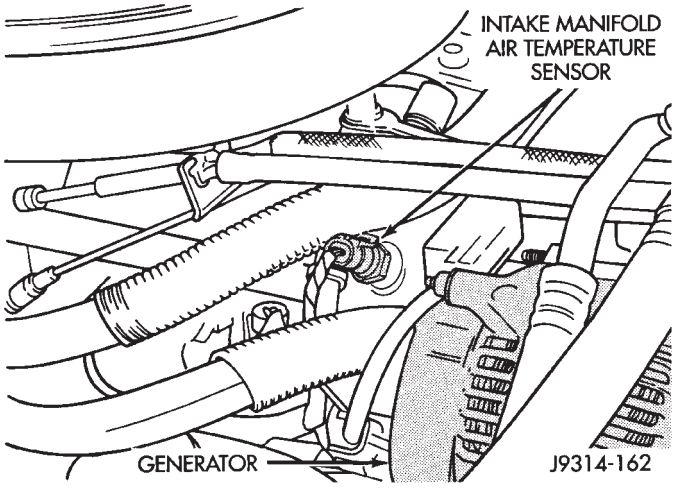


Fig. 27 Air Temperature Sensor—5.2L/5.9LEngines

(16) Verify that MAP sensor electrical connector is firmly connected to MAP sensor (Fig. 28). Also verify that rubber L-shaped fitting from MAP sensor to the throttle body is firmly connected (Fig. 29).

(17) Verify that fuel injector wire harness connectors are firmly connected to injectors in the correct

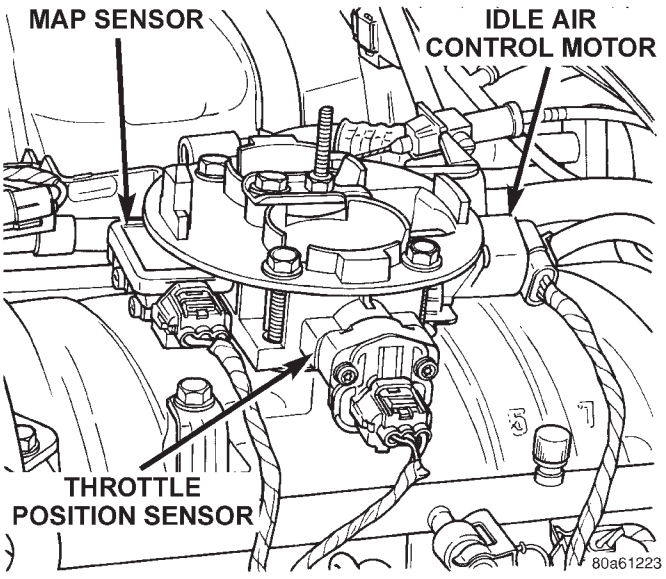


Fig. 28 Sensor and IAC Motor Location—5.2L/ 5.9LEngines

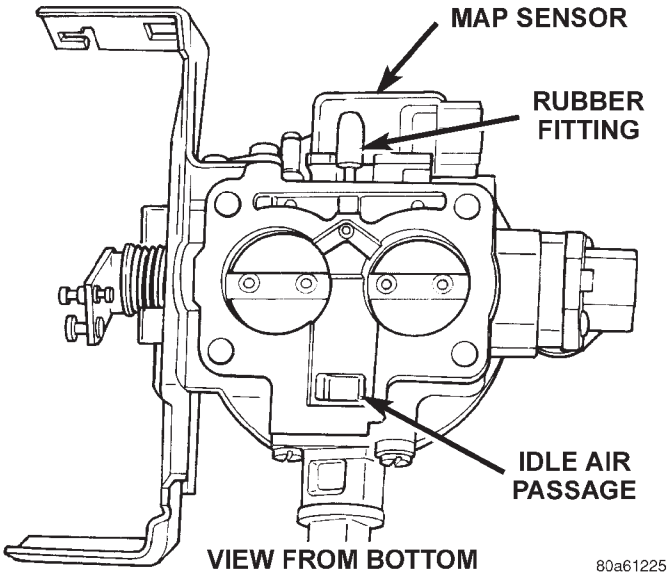


Fig. 29 Rubber L-Shaped Fitting—MAPSensor-to-Throttle Body

order. Each harness connector is numerically tagged with the injector number (INJ 1, INJ 2 etc.) of its corresponding fuel injector and cylinder number.

(18) Verify harness connectors are firmly connected to idle air control (IAC) motor, throttle position sensor (TPS) and manifold absolute pressure (MAP) sensor (Fig. 28).

(19) Verify that wire harness connector is firmly connected to the engine coolant temperature sensor (Fig. 30).

(20) Raise and support the vehicle.

(21) Verify that both the upstream and downstream oxygen sensor wire connectors are firmly con-

DIAGNOSIS AND TESTING (Continued)

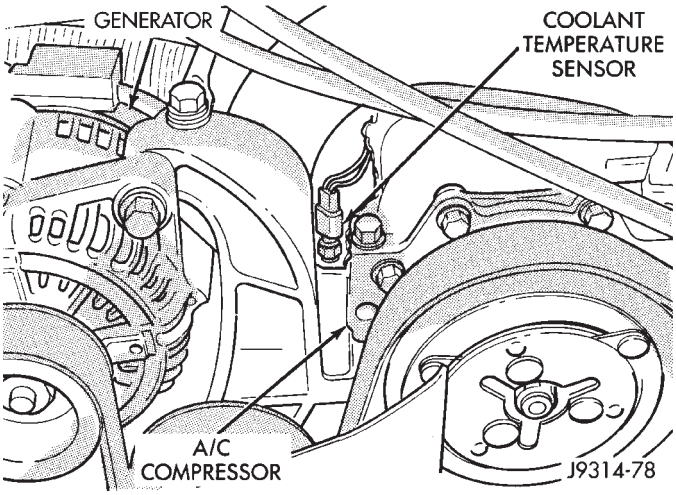


Fig. 30 Engine Coolant Temperature Sensor—5.2L/ 5.9LEngines—Typical

nected to the sensors. Inspect sensors and connectors for damage (Fig. 31) or (Fig. 32).

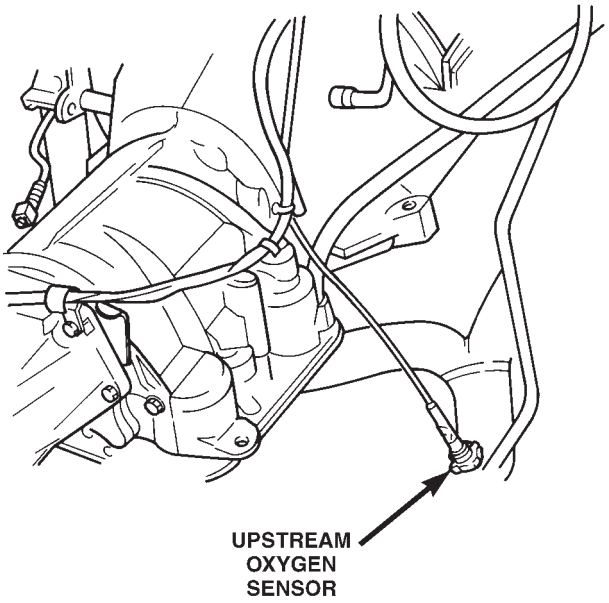


Fig. 31 Upstream Oxygen Sensor—5.2L.5.9LEngines

(22) Inspect for pinched or leaking fuel tubes. Inspect for pinched, cracked or leaking fuel hoses.

(23) Inspect for exhaust system restrictions such as pinched exhaust pipes, collapsed muffler or plugged catalytic convertor.

(24) If equipped with automatic transmission, verify that electrical harness is firmly connected to park/ neutral switch. Refer to Automatic Transmission section of Group 21.

(25) Verify that the electrical harness connector is firmly connected to the vehicle speed sensor (Fig. 33) or (Fig. 34).

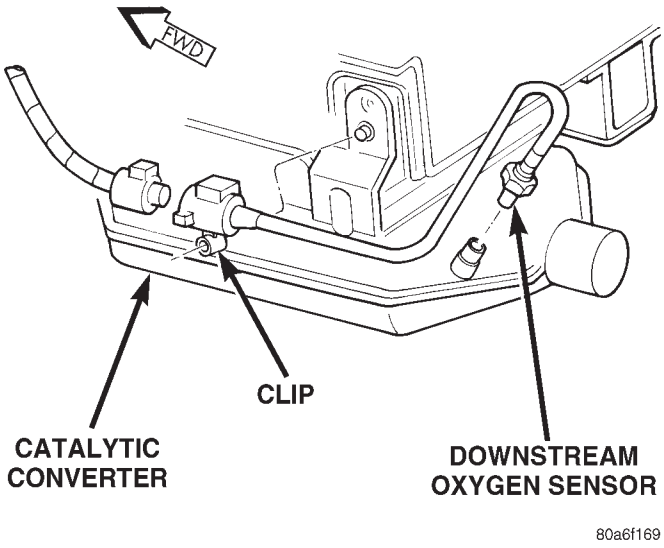


Fig. 32 Downstream Oxygen Sensor—5.2L/ 5.9LEngines

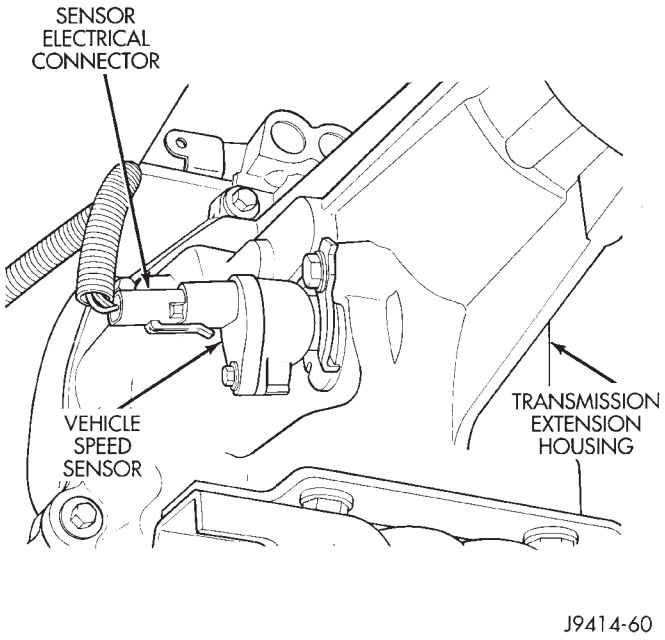


Fig. 33 Vehicle Speed Sensor—2WD—Typical

(26) Verify that fuel pump/gauge sender unit wire connector is firmly connected to harness connector.

(27) Inspect fuel hoses at fuel pump/gauge sender unit for cracks or leaks.

(28) Inspect transmission torque convertor housing (automatic transmission) or clutch housing (manual transmission) for damage to timing ring on drive plate/flywheel.

(29) Verify that battery cable and solenoid feed wire connections to the starter solenoid are tight and clean. Inspect for chaffed wires or wires rubbing up against other components.

DIAGNOSIS AND TESTING (Continued)

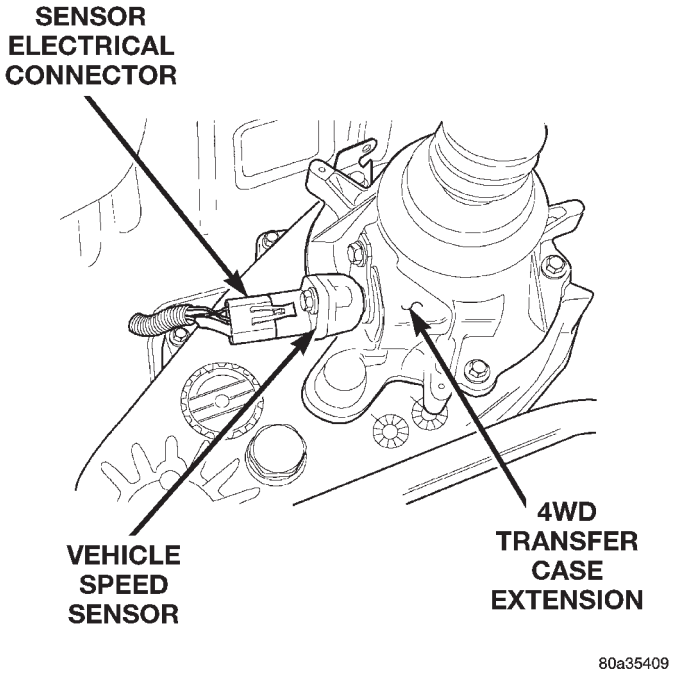


Fig. 34 Vehicle Speed Sensor—4WD—Typical

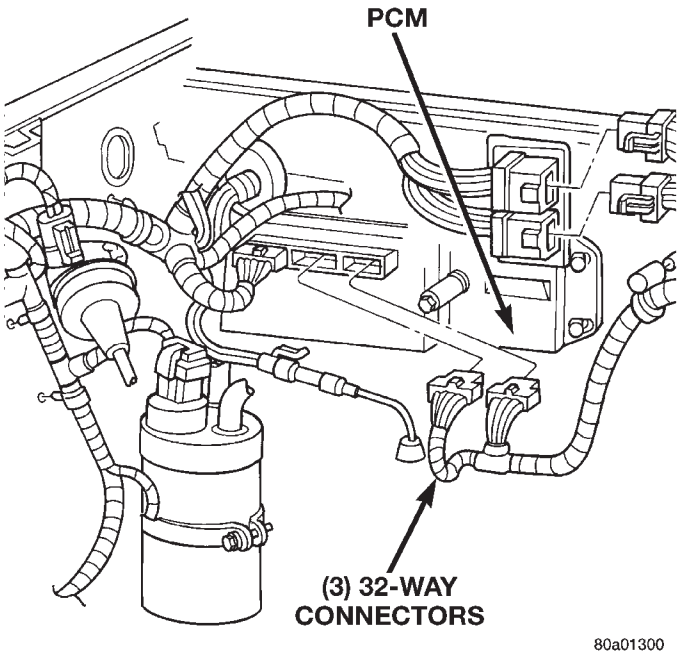


Fig. 35 Powertrain Control Module (PCM)

VISUAL INSPECTION—4.0L ENGINE

A visual inspection for loose, disconnected or incorrectly routed wires and hoses should be made. This should be done before attempting to diagnose or service the fuel injection system. A visual check will help spot these faults and save unnecessary test and diagnostic time. A thorough visual inspection will include the following checks:

(1) Verify that the three 32–way electrical connectors are fully inserted into the connector of the powertrain control module (PCM) (Fig. 35).

(2) Inspect the battery cable connections. Be sure that they are clean and tight.

(3) Inspect fuel pump relay and air conditioning compressor clutch relay (if equipped). Inspect the ASD relay connections. Inspect starter motor relay connections. Inspect relays for signs of physical damage and corrosion. The relays are located in the Power Distribution Center (PDC) (Fig. 36). Refer to label on PDC cover for relay location.

(4) Inspect ignition coil connections. Verify that coil secondary cable is firmly connected to coil (Fig. 37).

(5) Verify that distributor cap is correctly attached to distributor. Be sure that spark plug cables are firmly connected to the distributor cap and the spark plugs are in their correct firing order (Fig. 38). Be sure that coil cable is firmly connected to distributor cap and coil. Be sure that camshaft position sensor wire connector (at the distributor) is firmly connected to harness connector. Inspect spark plug condition. Refer to Group 8D, Ignition. Connect vehicle to an oscilloscope and inspect spark events for fouled or damaged spark plugs or cables.

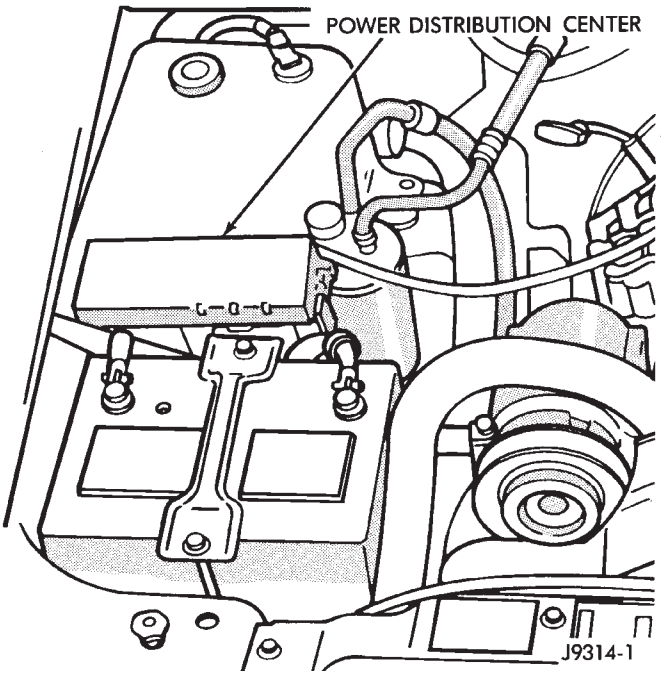


Fig. 36 Power Distribution Center (PDC)

(6) Verify that generator output wire, generator connector and ground wire are firmly connected to the generator.

(7) Inspect the system body grounds for loose or dirty connections. Refer to Group 8, Wiring for ground locations.

DIAGNOSIS AND TESTING (Continued)

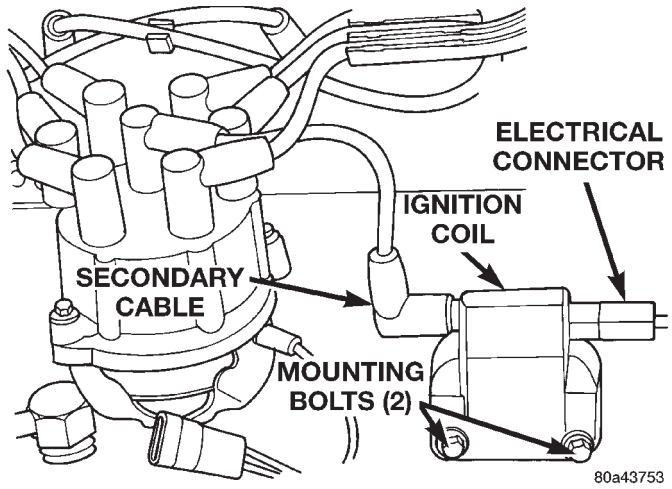


Fig. 37 Ignition Coil—4.0L Engine

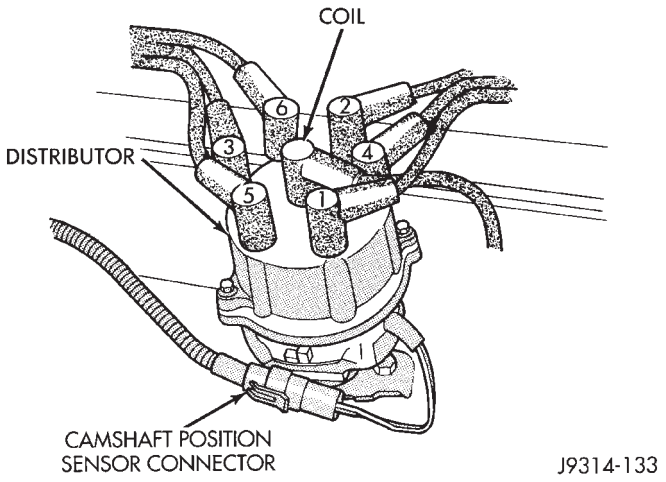


Fig. 38 Distributor and Wiring—4.0LEngine

(8) Verify crankcase ventilation (CCV) operation. Refer to Group 25, Emission Control System for additional information.

(9) Inspect fuel tube quick-connect fitting-to-fuel rail connections.

(10) Verify that hose connections to all ports of vacuum fittings on intake manifold are tight and not leaking.

(11) Inspect accelerator cable, transmission throttle cable (if equipped) and cruise control cable connections (if equipped). Check their connections to the throttle arm of throttle body for any binding or restrictions.

(12) If equipped with vacuum brake booster, verify that vacuum booster hose is firmly connected to fitting on intake manifold. Also check connection to brake vacuum booster.

(13) Inspect the air cleaner inlet and air cleaner element for dirt or restrictions.

(14) Inspect radiator grille area, radiator fins and air conditioning condenser for restrictions.

(15) Verify that the intake manifold air temperature sensor wire connector is firmly connected to harness connector (Fig. 39).

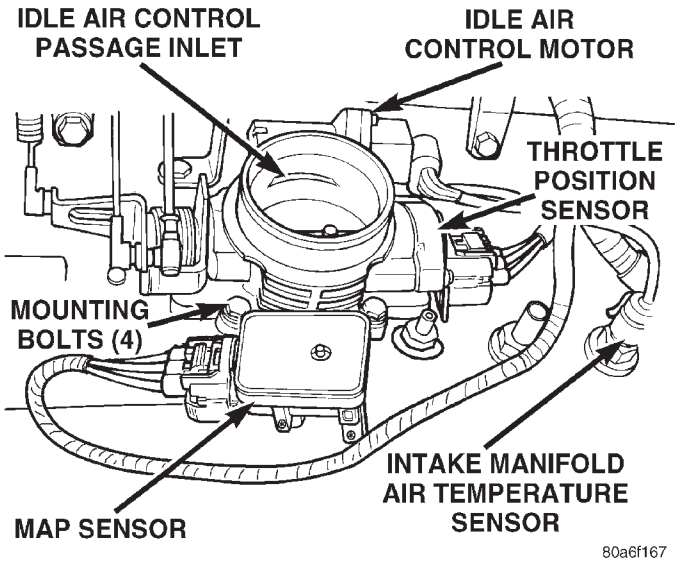


Fig. 39 Sensor Locations—4.0L Engine

(16) Verify that MAP sensor electrical connector is firmly connected to MAP sensor (Fig. 39). Also verify that rubber L-shaped fitting from MAP sensor to the throttle body is firmly connected (Fig. 40).

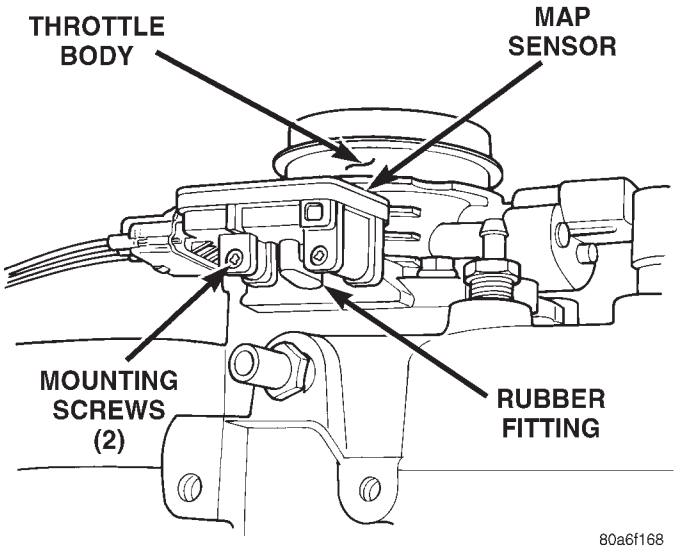


Fig. 40 Rubber L-Shaped Fitting—MAPSensor-to-Throttle Body

(17) Verify that fuel injector wire harness connectors are firmly connected to injectors in the correct order. Each harness connector is numerically tagged with the injector number (INJ 1, INJ 2 etc.) of its corresponding fuel injector and cylinder number.

DIAGNOSIS AND TESTING (Continued)

(18) Verify harness connectors are firmly connected to idle air control (IAC) motor and throttle position sensor (TPS) (Fig. 39).

(19) Verify that wire harness connector is firmly connected to the engine coolant temperature sensor (Fig. 41).

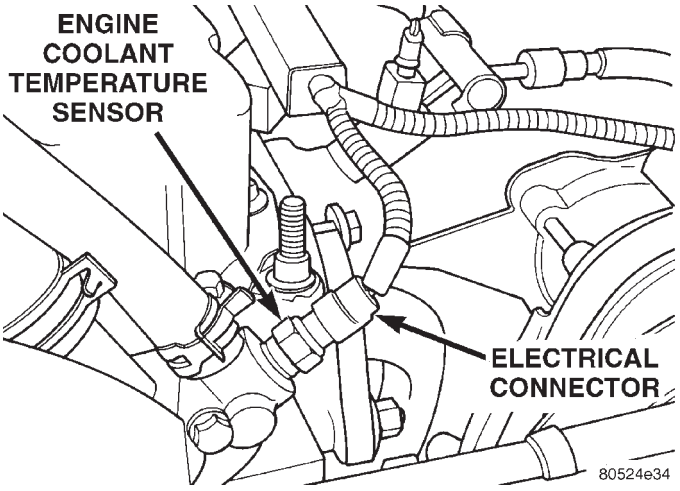


Fig. 41 Engine Coolant Temp. Sensor—4.0LShown

(20) Raise and support the vehicle.

(21) Verify that both of the oxygen sensor wire connectors are firmly connected to the sensors. Inspect sensors and connectors for damage (Fig. 42) or (Fig. 43).

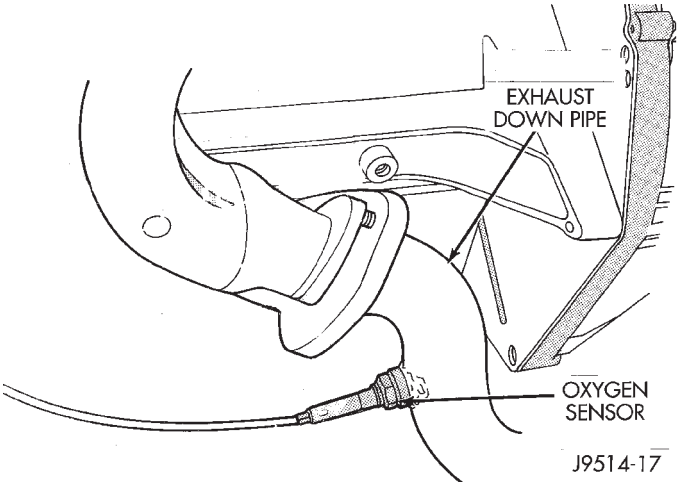


Fig. 42 Upstream Oxygen Sensor—4.0LEngine

(22) Inspect for pinched or leaking fuel tubes. Inspect for pinched, cracked or leaking fuel hoses.

(23) Inspect for exhaust system restrictions such as pinched exhaust pipes, collapsed muffler or plugged catalytic convertor.

(24) If equipped with automatic transmission, verify that electrical harness is firmly connected to park/neutral switch. Refer to Automatic Transmission section of Group 21.

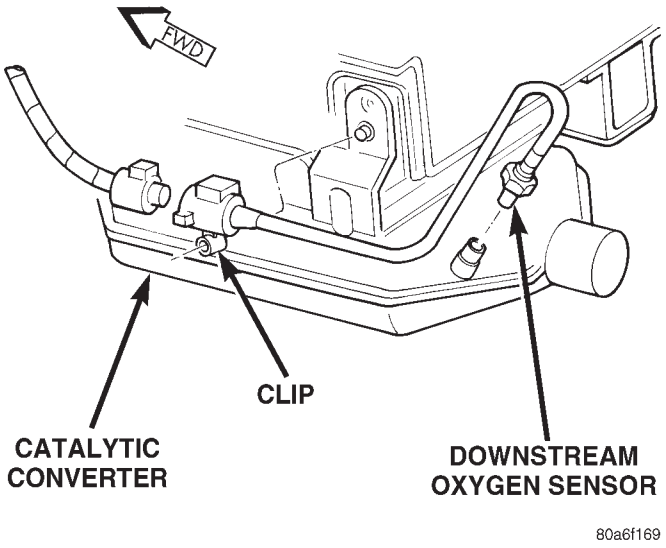


Fig. 43 Downstream Oxygen Sensor—4.0LEngine

(25) Verify that the electrical harness connector is firmly connected to the vehicle speed sensor (Fig. 44) or (Fig. 45).

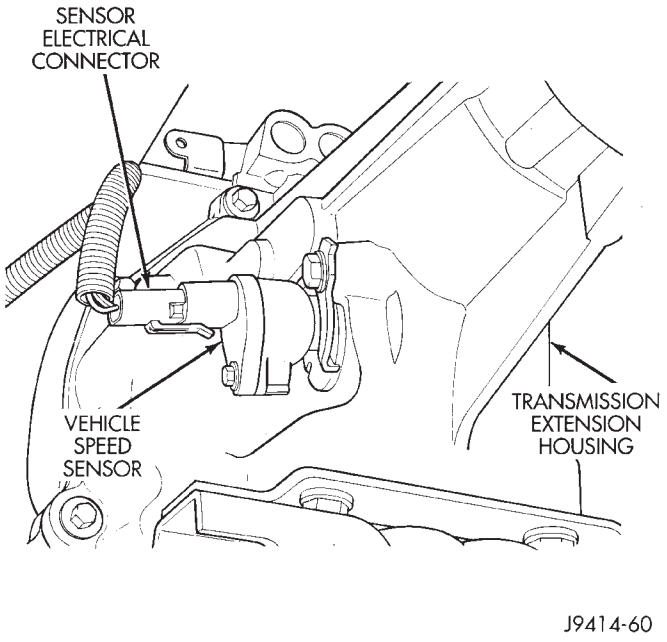


Fig. 44 Vehicle Speed Sensor—2WD—Typical

(26) Verify that fuel pump/gauge sender unit wire connector is firmly connected to harness connector.

(27) Inspect fuel hoses at fuel pump/gauge sender unit for cracks or leaks.

(28) Inspect transmission torque convertor housing (automatic transmission) or clutch housing (manual transmission) for damage to timing ring on drive plate/flywheel.

DIAGNOSIS AND TESTING (Continued)

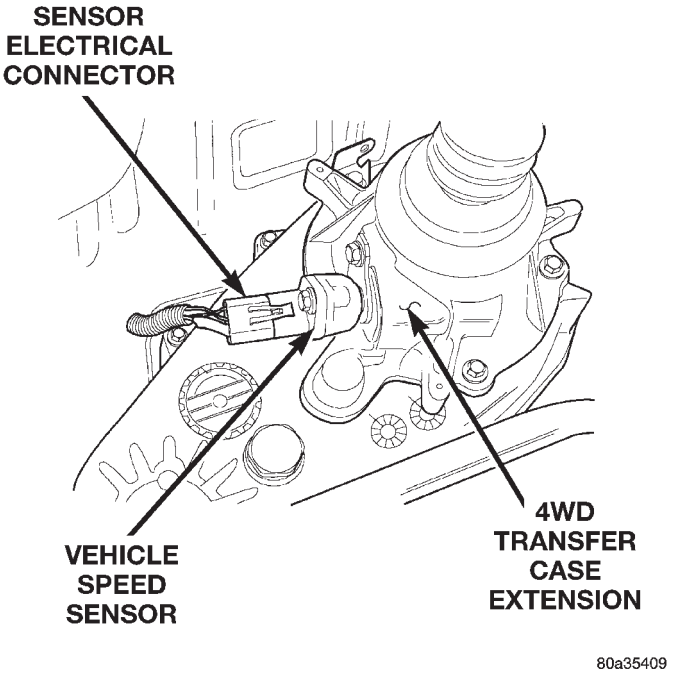
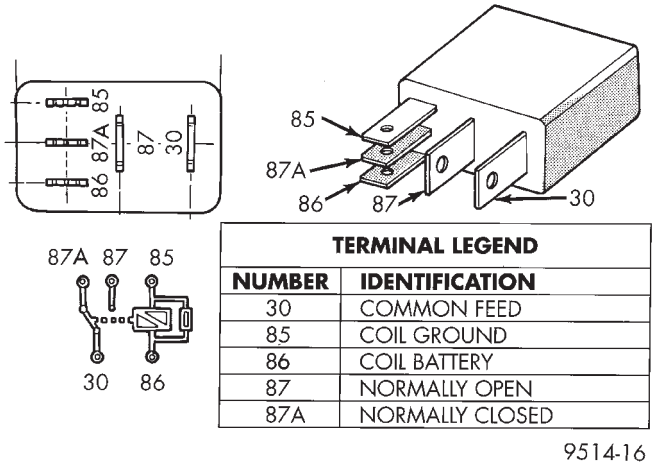


Fig. 45 Vehicle Speed Sensor—4WD—Typical

(29) Verify that battery cable and solenoid feed wire connections to the starter solenoid are tight and clean. Inspect for chaffed wires or wires rubbing up against other components.

ASD AND FUEL PUMP RELAYS

The following description of operation and tests apply only to the Automatic Shutdown (ASD) and fuel pump relays . The terminals on the bottom of each relay are numbered (Fig. 46).



TERMINAL LEGEND	
NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

Fig. 46 ASD and Fuel Pump Relay Terminals

OPERATION

- Terminal number 30 is connected to battery voltage. For both the ASD and fuel pump relays, terminal 30 is connected to battery voltage at all times.
- The PCM grounds the coil side of the relay through terminal number 85.
- Terminal number 86 supplies voltage to the coil side of the relay.
- When the PCM de-energizes the ASD and fuel pump relays, terminal number 87A connects to terminal 30. This is the Off position. In the off position, voltage is not supplied to the rest of the circuit. Terminal 87A is the center terminal on the relay.
- When the PCM energizes the ASD and fuel pump relays, terminal 87 connects to terminal 30. This is the On position. Terminal 87 supplies voltage to the rest of the circuit.

TESTING

The following procedure applies to the ASD and fuel pump relays.

(1) Remove relay from connector before testing.

(2) With the relay removed from the vehicle, use an ohmmeter to check the resistance between terminals 85 and 86. The resistance should be between 75 ±5 ohms.

(3) Connect the ohmmeter between terminals 30 and 87A. The ohmmeter should show continuity between terminals 30 and 87A.

(4) Connect the ohmmeter between terminals 87 and 30. The ohmmeter should not show continuity at this time.

(5) Connect one end of a jumper wire (16 gauge or smaller) to relay terminal 85. Connect the other end of the jumper wire to the ground side of a 12 volt power source.

(6) Connect one end of another jumper wire (16 gauge or smaller) to the power side of the 12 volt power source. **Do not attach the other end of the jumper wire to the relay at this time.**

WARNING: DO NOT ALLOW OHMMETER TO CONTACT TERMINALS 85 OR 86 DURING THIS TEST.

(7) Attach the other end of the jumper wire to relay terminal 86. This activates the relay. The ohmmeter should now show continuity between relay terminals 87 and 30. The ohmmeter should not show continuity between relay terminals 87A and 30.

(8) Disconnect jumper wires.

(9) Replace the relay if it did not pass the continuity and resistance tests. If the relay passed the tests, it operates properly. Check the remainder of the ASD and fuel pump relay circuits. Refer to group 8W, Wiring Diagrams.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST—5.2L.5.9L ENGINES

To perform a complete test of MAP sensor (Fig. 47) and its circuitry, refer to DRB scan tool and appro-

priate Powertrain Diagnostics Procedures manual. To test the MAP sensor only, refer to the following:

(1) Inspect the rubber L-shaped fitting from the MAP sensor to the throttle body (Fig. 48). Repair as necessary.

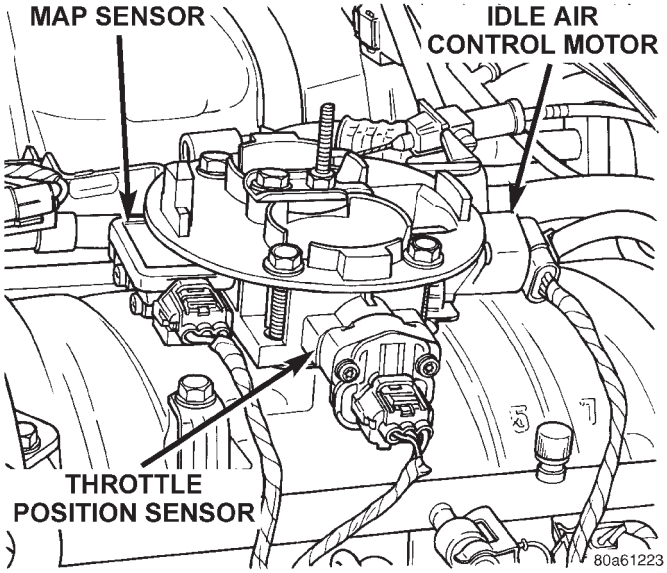


Fig. 47 MAP Sensor—5.2L/5.9L Engines—Typical

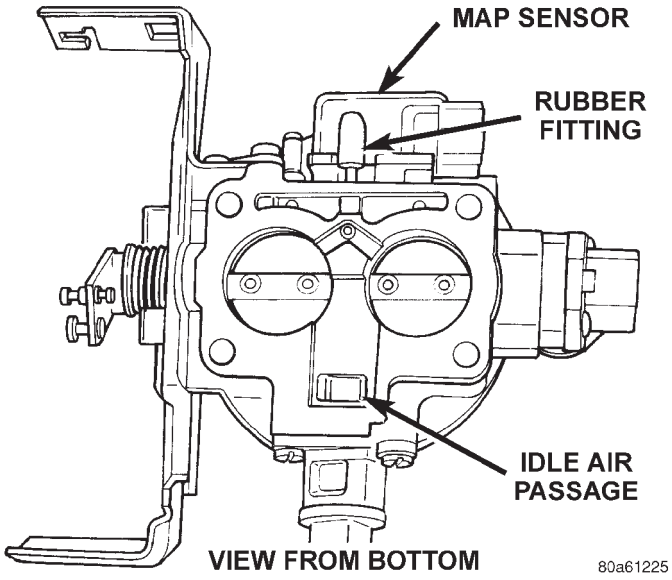


Fig. 48 Rubber L-Shaped Fitting—MAPSensor-to-Throttle Body

CAUTION: When testing the MAP sensor, be sure that the harness wires are not damaged by the test meter probes.

(2) Test the MAP sensor output voltage at the MAP sensor connector between terminals A and B (Fig. 49). With the ignition switch ON and the engine OFF, output voltage should be 4-to-5 volts. The voltage should drop to 1.5-to-2.1 volts with a hot, neutral idle speed condition.

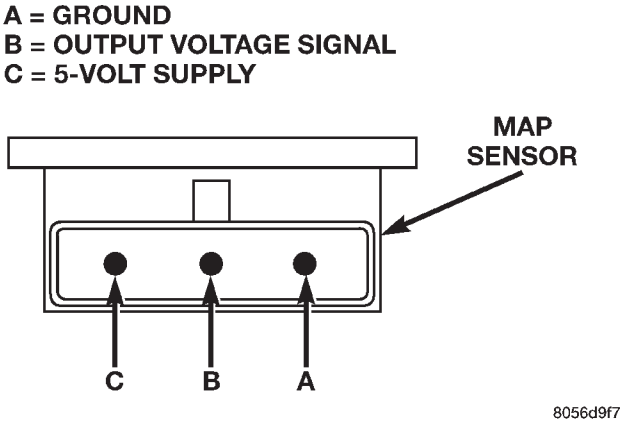


Fig. 49 MAP Sensor Connector Terminals—Typical

(3) Test powertrain control module (PCM) cavity A-27 for the same voltage described above to verify the wire harness condition. Repair as necessary.

(4) Test MAP sensor supply voltage at sensor connector between terminals A and C (Fig. 49) with the ignition ON. The voltage should be approximately 5 volts (±0.5V). Five volts (±0.5V) should also be at cavity A-17 of the PCM wire harness connector. Repair or replace the wire harness as necessary.

(5) Test the MAP sensor ground circuit at sensor connector terminal—A (Fig. 49) and PCM connector A-4. Repair the wire harness if necessary.

Refer to Group 8W, Wiring Diagrams for cavity locations.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST—4.0L ENGINE

To perform a complete test of MAP sensor (Fig. 50) and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the MAP sensor only, refer to the following:

(1) Inspect the rubber L-shaped fitting from the MAP sensor to the throttle body (Fig. 51). Repair as necessary.

CAUTION: When testing the MAP sensor, be sure that the harness wires are not damaged by the test meter probes.

(2) Test the MAP sensor output voltage at the MAP sensor connector between terminals A and B (Fig. 49). With the ignition switch ON and the engine OFF, output voltage should be 4-to-5 volts. The voltage should drop to 1.5-to-2.1 volts with a hot, neutral idle speed condition.

DIAGNOSIS AND TESTING (Continued)

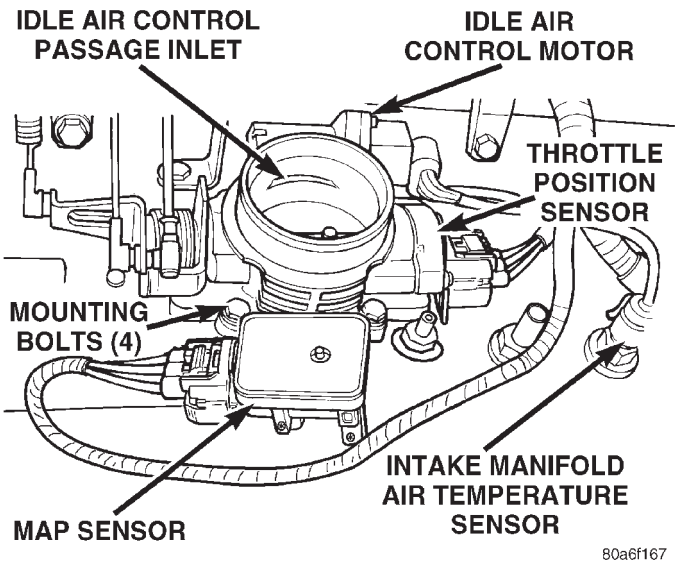


Fig. 50 Sensor Location—4.0L Engine

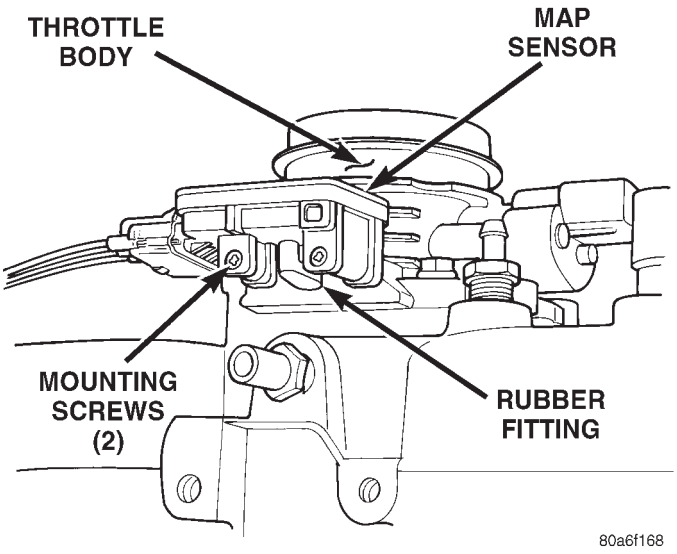


Fig. 51 Rubber L-Shaped Fitting—MAPSensor-to-Throttle Body

(3) Test powertrain control module (PCM) cavity A-27 for the same voltage described above to verify the wire harness condition. Repair as necessary.

(4) Test MAP sensor supply voltage at sensor connector between terminals A and C (Fig. 49) with the ignition ON. The voltage should be approximately 5 volts (±0.5V). Five volts (±0.5V) should also be at cavity A-17 of the PCM wire harness connector. Repair or replace the wire harness as necessary.

(5) Test the MAP sensor ground circuit at sensor connector terminal—A (Fig. 49) and PCM connector A-4. Repair the wire harness if necessary.

Refer to Group 8W, Wiring Diagrams for cavity locations.

OXYGEN (O2S) SENSORS—5.2L/5.9L ENGINES

To perform a complete test of the O2S sensors and their circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the O2S sensors only, refer to the following:

The upstream O2S sensor is located on the exhaust pipe (Fig. 52).

The downstream O2S sensor is located on the outlet end of the catalytic converter (Fig. 53).

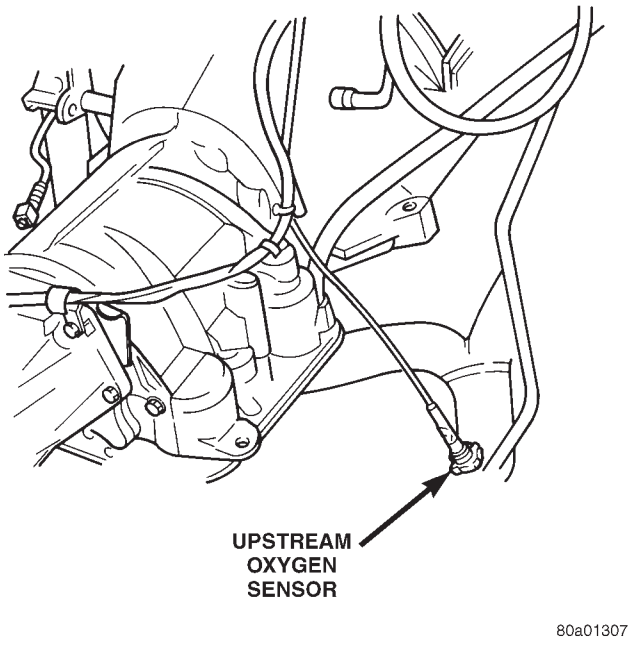


Fig. 52 Upstream Oxygen SensorLocation—5.2L/5.9L Engines

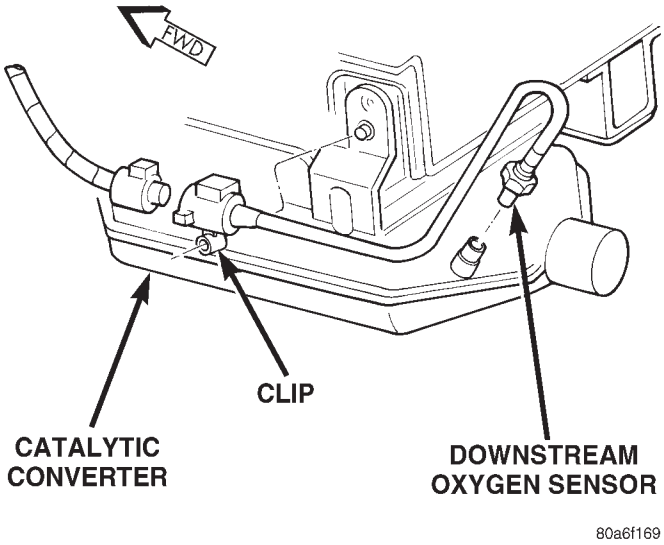


Fig. 53 Downstream Oxygen Sensor Location—AllEngines

DIAGNOSIS AND TESTING (Continued)

Each O2S heating element can be tested with an ohmmeter as follows:

Disconnect the O2S sensor connector. Connect the ohmmeter test leads across the white wire terminals of the sensor connector. Resistance should be between 4.5 ± .5 ohms and 7 ohms. Replace the sensor if the ohmmeter displays an infinity (open) reading.

OXYGEN (O2S) SENSORS—4.0L ENGINE

To perform a complete test of the O2S sensors and their circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the O2S sensors only, refer to the following:

The upstream O2S sensor is located on the exhaust pipe (Fig. 54).

The downstream O2S sensor is located on the outlet end of the catalytic converter (Fig. 53).

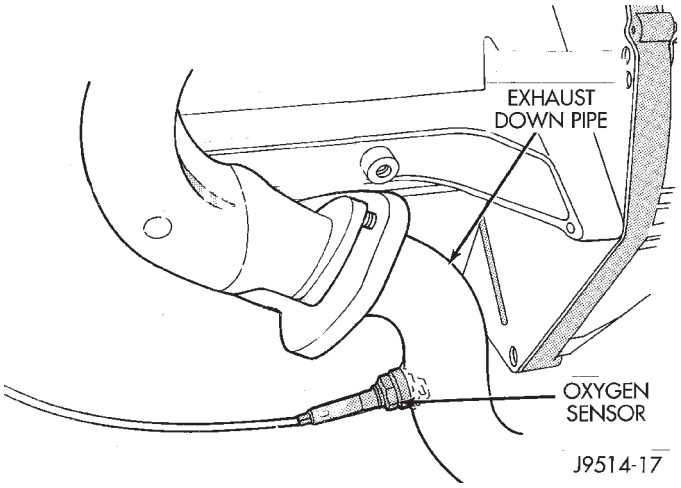


Fig. 54 Upstream Oxygen Sensor Location—4.0LEngine

Each O2S heating element can be tested with an ohmmeter as follows:

Disconnect the O2S sensor connector. Connect the ohmmeter test leads across the white wire terminals of the sensor connector. Resistance should be between 4.5 ± .5 ohms and 7 ohms. Replace the sensor if the ohmmeter displays an infinity (open) reading.

CAMSHAFT AND CRANKSHAFT POSITION SENSORS

Refer to Group 8D, Ignition System for information.

ENGINE COOLANT TEMPERATURE SENSOR—5.2L/5.9L ENGINES

To perform a complete test of the engine coolant temperature sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect wire harness connector from coolant temperature sensor (Fig. 55).

(2) **Engines with air conditioning:** When removing the connector from sensor, do not pull directly on wiring harness. Fabricate an L-shaped hook tool from a coat hanger (approximately eight inches long). Place the hook part of tool under the connector for removal. The connector is snapped onto the sensor. It is not equipped with a lock type tab.

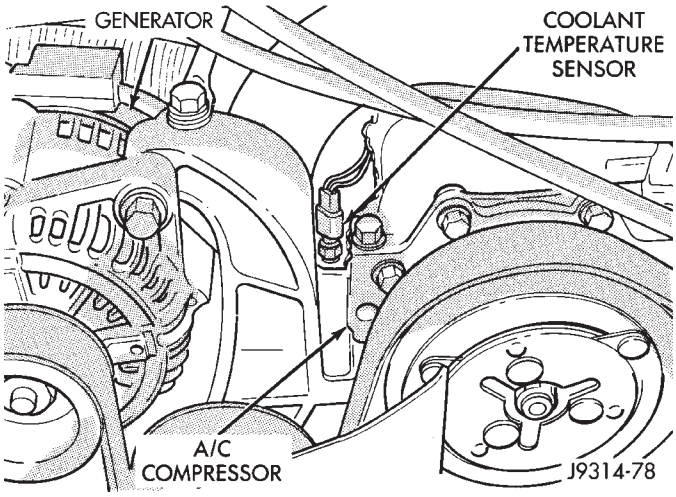


Fig. 55 Engine Coolant Temperature Sensor—5.2L/5.9LEngines

(3) Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be as shown in the Coolant Temperature Sensor/Intake Air Temperature Sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(4) Test continuity of the wire harness between the PCM wire harness connector and the coolant sensor connector terminals. Refer to Group 8, Wiring for terminal/cavity locations. Repair the wire harness if an open circuit is indicated.

(5) After tests are completed, connect electrical connector to sensor. The sensor connector is symmetrical (not indexed). It can be installed to the sensor in either direction.

ENGINE COOLANT TEMPERATURE SENSOR—4.0L ENGINE

To perform a complete test of the engine coolant temperature sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect wire harness connector from coolant temperature sensor (Fig. 56).

DIAGNOSIS AND TESTING (Continued)

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
−40	−40	291,490	381,710
−20	−4	85,850	108,390
−10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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SENSOR RESISTANCE (OHMS)—COOLANT TEMPERATURE SENSOR/INTAKE AIR TEMPERATURE SENSOR

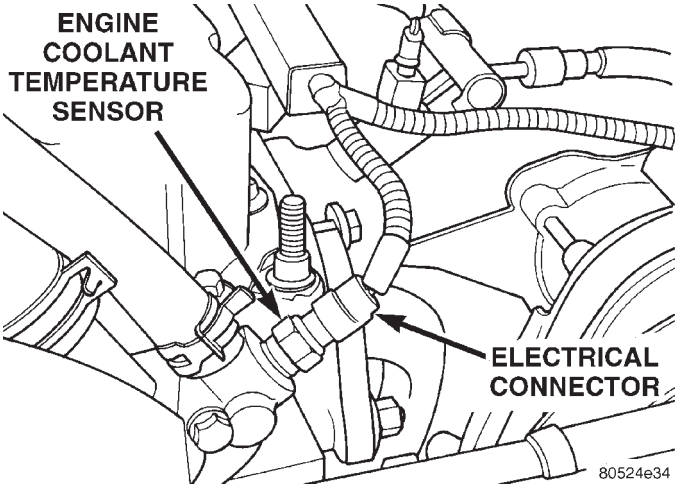


Fig. 56 Engine Coolant Temperature Sensor—4.0LEngine

(2) Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be as shown in the previous Coolant Temperature Sensor/Intake Air Temperature Sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test continuity of the wire harness between the PCM wire harness connector and the coolant sensor connector terminals. Refer to Group 8, Wiring for terminal/cavity locations. Repair the wire harness if an open circuit is indicated.

IDLE AIR CONTROL (IAC) MOTOR—5.2L/5.9L ENGINES

To perform a complete test of the IAC motor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

IDLE AIR CONTROL (IAC) MOTOR—4.0L ENGINE

To perform a complete test of the IAC motor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—5.2L/5.9L ENGINE

To perform a complete test of the intake manifold air temperature sensor and its circuitry, refer to DRB tester and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect the wire harness connector from the intake manifold air temperature sensor (Fig. 57).

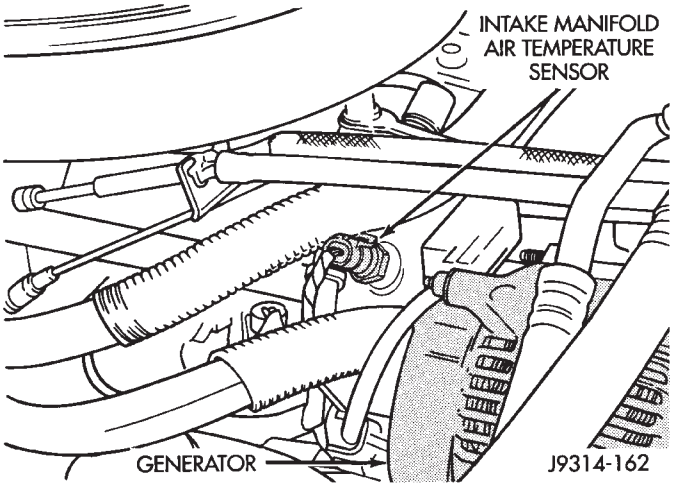


Fig. 57 Air Temperature Sensor—5.2L/5.9LEngines

(2) Test the resistance of the sensor with an input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be as shown in the previous Coolant Temperature sensor/ Intake Air Temperature sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test the resistance of the wire harness. Do this between the PCM wire harness connector A-15 and the sensor connector terminal. Also check between PCM connector A-4 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—4.0L ENGINE

To perform a complete test of the intake manifold air temperature sensor and its circuitry, refer to DRB

DIAGNOSIS AND TESTING (Continued)

tester and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect the wire harness connector from the intake manifold air temperature sensor (Fig. 58).

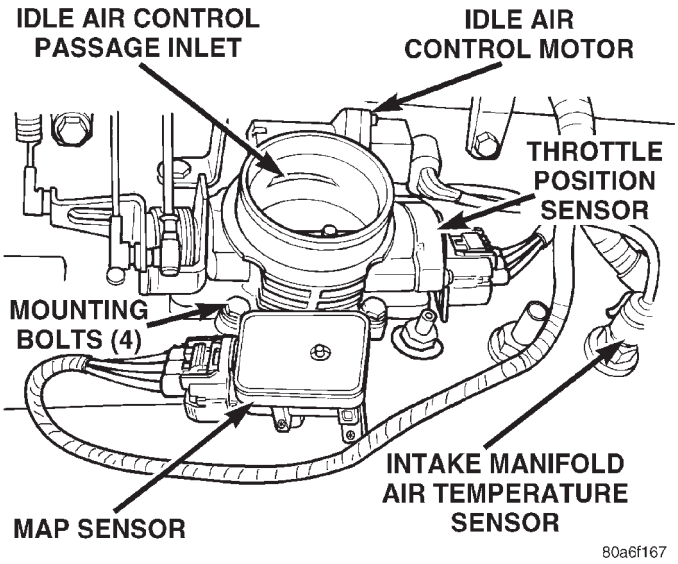


Fig. 58 Intake Manifold Air TemperatureSensor—4.0L Engine

(2) Test the resistance of the sensor with an input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be as shown in the previous Coolant Temperature Sensor/ Intake Air Temperature Sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test the resistance of the wire harness. Do this between the PCM wire harness connector A-15 and the sensor connector terminal. Also check between PCM connector A-4 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

VEHICLE SPEED SENSOR

To perform a complete test of the sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual.

THROTTLE POSITION SENSOR (TPS)—5.2L/5.9L ENGINES

To perform a complete test of the TPS and its circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the TPS only, refer to the following:

The TPS (Fig. 59) can be tested with a digital voltmeter. The center electrical terminal of the TPS is the output terminal.

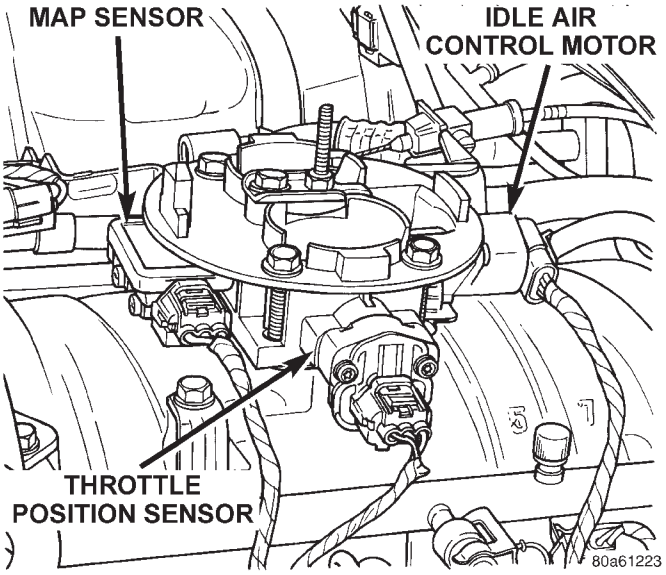


Fig. 59 TPS—5.2L/5.9L Engines

With the ignition key in the ON position, check the TPS output voltage at the center terminal wire of the connector. Check this at idle (throttle plate closed) and at wide open throttle (WOT). At idle, TPS output voltage should be greater than .350 millivolts but less than 900 millivolts. At wide open throttle, TPS output voltage must be less than 4.5 volts. The output voltage should increase gradually as the throttle plate is slowly opened from idle to WOT.

THROTTLE POSITION SENSOR (TPS)—4.0L ENGINE

To perform a complete test of the TPS (Fig. 58) and its circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the TPS only, refer to the following:

The TPS can be tested with a digital voltmeter. The center terminal of the TPS is the output terminal.

With the ignition key in the ON position, check the TPS output voltage at the center terminal wire of the connector. Check this at idle (throttle plate closed) and at wide open throttle (WOT). At idle, TPS output voltage should be greater than .350 millivolts and less than 900 millivolts. At wide open throttle, TPS output voltage must be less than 4.5 volts. The output voltage should increase gradually as the throttle plate is slowly opened from idle to WOT.

THROTTLE BODY MINIMUM AIR FLOW CHECK PROCEDURE

5.2L/5.9L ENGINE

The following test procedure has been developed to check throttle body calibrations for correct idle conditions. The procedure should be used to diagnose the

DIAGNOSIS AND TESTING (Continued)

throttle body for conditions that may cause idle problems. **This procedure should be used only after normal diagnostic procedures have failed to produce results that indicate a throttle body related problem. Be sure to check for proper operation of the idle air control motor before performing this test.**

A special fixed orifice tool (number 6714) (Fig. 60) must be used for the following test.

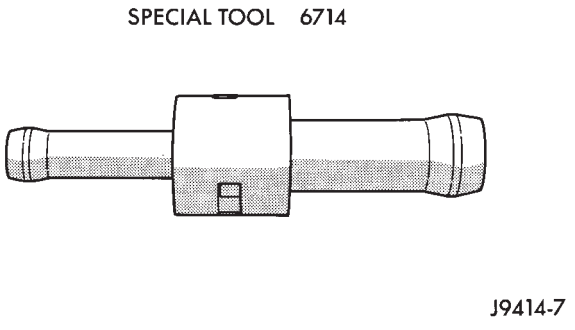


Fig. 60 Fixed Orifice Tool

(1) Start the engine and bring to operating temperature. Be sure all accessories are off before performing this test.

(2) Shut off the engine and remove the air duct at throttle body.

(3) Disconnect the vacuum line at the PCV valve (Fig. 61).

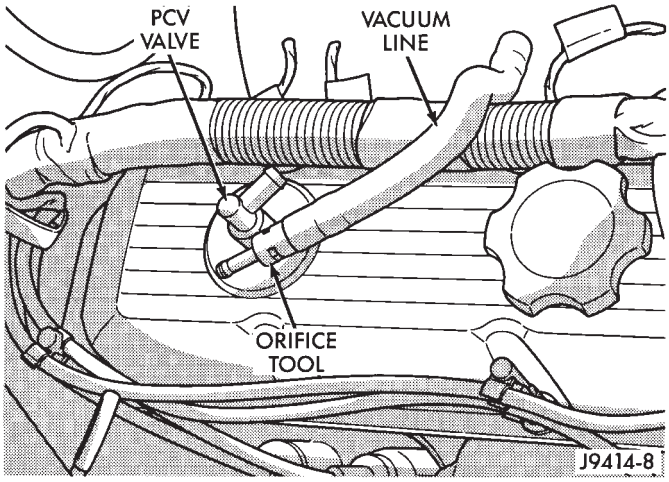


Fig. 61 Install Orifice Tool

(4) Install the 0.185 inch orifice tool (number 6714) into the disconnected vacuum line in place of the PCV valve (Fig. 61).

(5) Disconnect the idle purge vacuum line from fitting at throttle body. This vacuum line is located on the front of throttle body next to the MAP sensor (Fig. 62). Cap the fitting at throttle body after vacuum line has been removed.

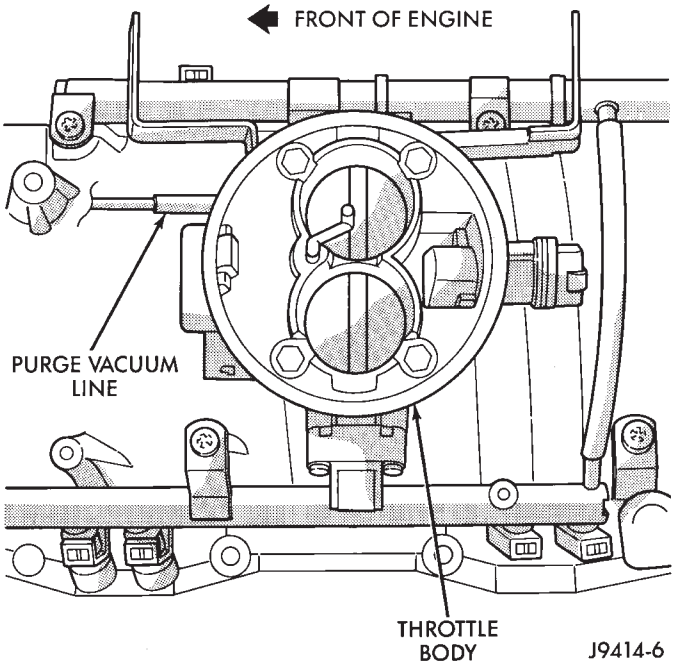


Fig. 62 Idle Purge Line

(6) Connect the DRB scan tool to the 16–way data link connector. This connector is located under the instrument panel to the left of the steering column. Refer to the appropriate Powertrain Diagnostic Procedures service manual for DRB operation.

(7) Start the engine and allow to warm up.

(8) Using the DRB scan tool, scroll through the menus as follows: select—Stand Alone DRB III, select 1994–1997 Diagnostics, select—Engine, select—System Test, select—Minimum Air Flow.

(9) The DRB scan tool will count down to stabilize the idle rpm and display the minimum air flow idle rpm. The idle rpm should be between **500 and 900 rpm.** If the idle speed is outside of these specifications, replace the throttle body. Refer to Throttle Body in the Component Removal/Installation section of this group.

(10) Disconnect the DRB scan tool from the vehicle.

(11) Remove cap from idle purge fitting at throttle body and install vacuum line.

(12) Remove orifice tool and connect vacuum line to PCV valve.

(13) Install air duct to throttle body.

REMOVAL AND INSTALLATION

AUTOMATIC SHUTDOWN (ASD) RELAY

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 63). Refer to label on PDC cover for relay location.

REMOVAL AND INSTALLATION (Continued)

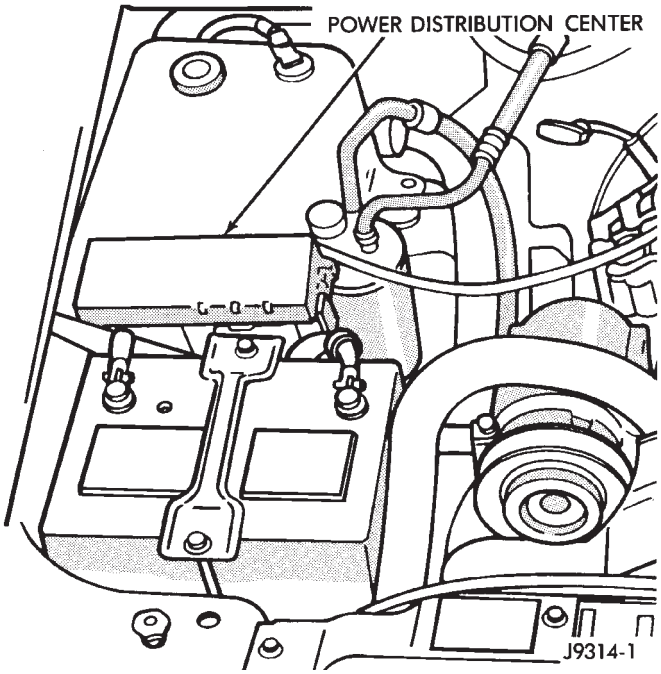


Fig. 63 Power Distribution Center (PDC) Location

REMOVAL

(1) Remove PDC cover.
(2) Remove relay from PDC.
(3) Check condition of relay terminals and PDC connector terminals for damage or corrosion. Repair if necessary before installing relay.
(4) Check for pin height (pin height should be the same for all terminals within the PDC connector). Repair if necessary before installing relay.

INSTALLATION

(1) Install relay to PDC.
(2) Install cover to PDC.

FUEL PUMP RELAY

The fuel pump relay is located in the Power Distribution Center (PDC) (Fig. 63). Refer to label on PDC cover for relay location.

REMOVAL

(1) Remove PDC cover.
(2) Remove relay from PDC.
(3) Check condition of relay terminals and PDC connector terminals for damage or corrosion. Repair if necessary before installing relay.
(4) Check for pin height (pin height should be the same for all terminals within the PDC connector). Repair if necessary before installing relay.

INSTALLATION

(1) Install relay to PDC.
(2) Install cover to PDC.

THROTTLE BODY—5.2L/5.9L ENGINES

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the powertrain control module (PCM).

REMOVAL

(1) Remove the air duct at throttle body.
(2) Disconnect throttle body electrical connectors at MAP sensor, IAC motor and TPS (Fig. 64).

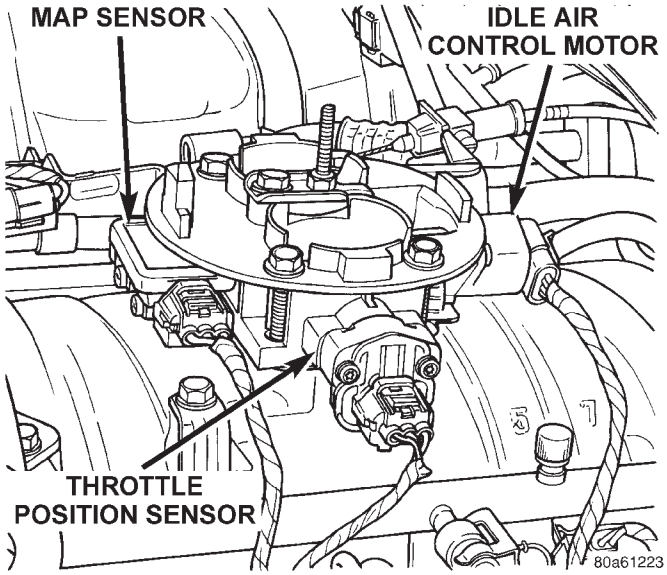


Fig. 64 Sensor Electrical Connectors—5.2L/ 5.9LEngines—Typical

(3) Remove vacuum line at throttle body.
(4) Remove all control cables from throttle body (lever) arm. Refer to the Accelerator Pedal and Throttle Cable section of this group for additional information.
(5) Remove four throttle body mounting bolts (Fig. 65).
(6) Remove throttle body from intake manifold.
(7) Discard old throttle body-to-intake manifold gasket.

INSTALLATION

(1) Clean the mating surfaces of the throttle body and the intake manifold.
(2) Install new throttle body-to-intake manifold gasket.
(3) Install throttle body to intake manifold.
(4) Install four mounting bolts. Tighten bolts to 23 N·m (200 in. lbs.) torque.
(5) Install control cables.
(6) Install vacuum line to throttle body.
(7) Install electrical connectors.
(8) Install air duct at throttle body.

REMOVAL AND INSTALLATION (Continued)

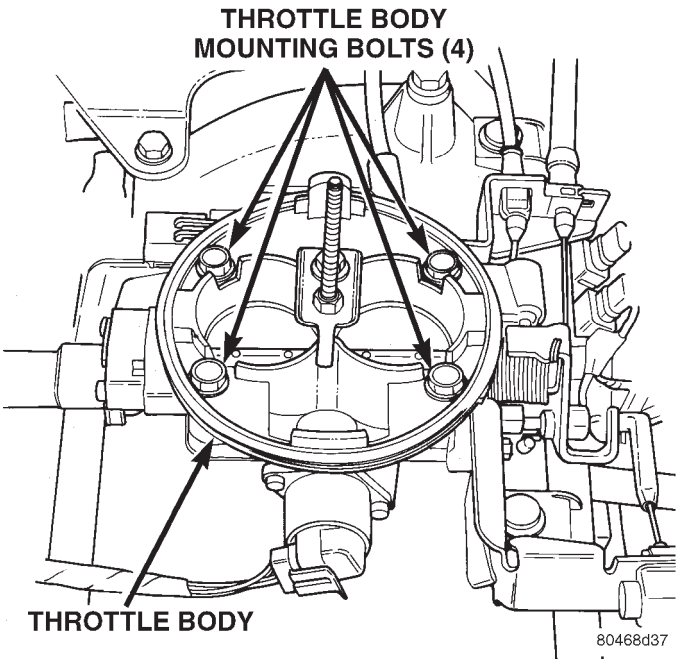


Fig. 65 Throttle Body Mounting Bolts—5.2L/ 5.9LEngines—Typical

THROTTLE BODY—4.0L ENGINE

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the powertrain control module (PCM).

REMOVAL

(1) Remove the air cleaner duct at throttle body.

(2) Disconnect throttle body electrical connectors at MAP sensor, IAC motor and TPS (Fig. 66).

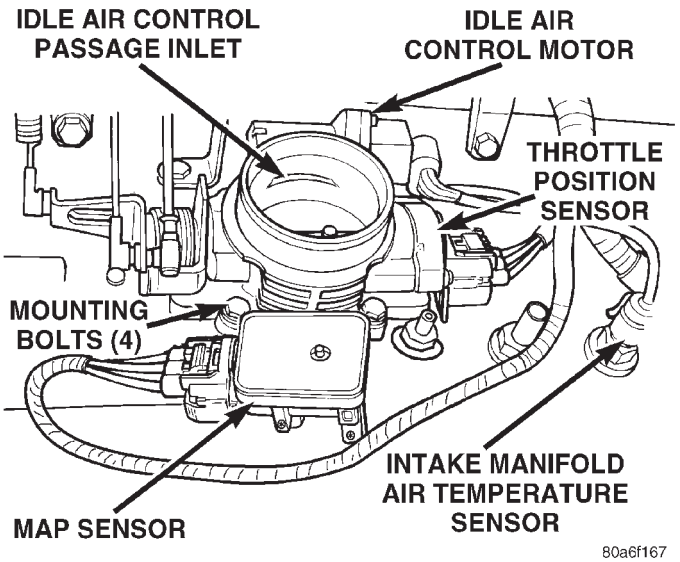


Fig. 66 Throttle Body and Sensor Locations— 4.0LEngine

(3) Remove all control cables from throttle body (lever) arm. Refer to the Accelerator Pedal and Throttle Cable section of this group for additional information.

(4) Remove four throttle body mounting bolts.

(5) Remove throttle body from intake manifold.

(6) Discard old throttle body-to-intake manifold gasket.

INSTALLATION

(1) Clean the mating surfaces of the throttle body and the intake manifold.

(2) Install new throttle body-to-intake manifold gasket.

(3) Install throttle body to intake manifold.

(4) Install four mounting bolts. Tighten bolts to 11 N·m (100 in. lbs.) torque.

(5) Install control cables.

(6) Install electrical connectors.

(7) Install air duct at throttle body.

THROTTLE POSITION SENSOR (TPS)—5.2L/5.9L ENGINES

REMOVAL

The TPS is located on the side of the throttle body.

(1) Remove air duct at throttle body.

(2) Disconnect TPS electrical connector.

(3) Remove two TPS mounting bolts (Fig. 67).

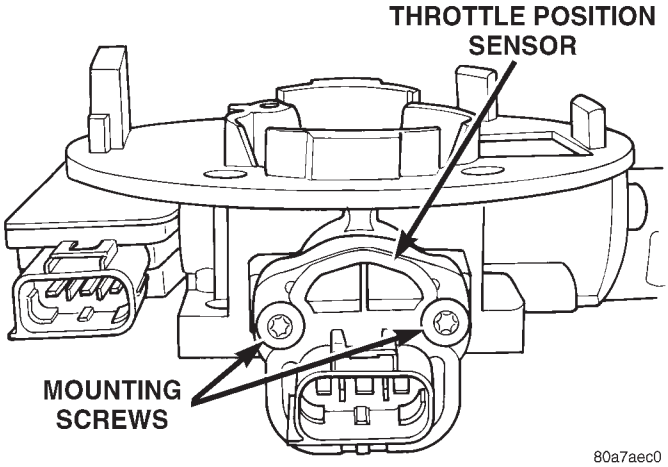


Fig. 67 TPS Mounting Bolts—5.2L/5.9LEngines— Typical

(4) Remove TPS from throttle body.

INSTALLATION

The throttle shaft end of the throttle body slides into a socket in the TPS (Fig. 68). The TPS must be installed so that it can be rotated a few degrees. If the sensor will not rotate, install the sensor with the throttle shaft on the other side of the socket tangs. The TPS will be under slight tension when rotated.

REMOVAL AND INSTALLATION (Continued)

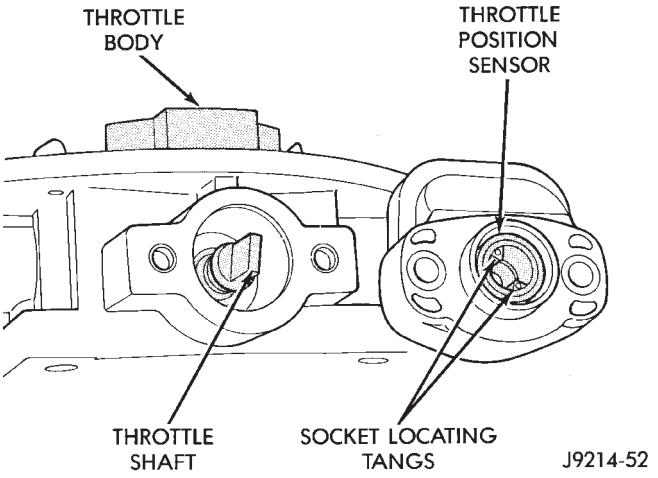


Fig. 68 Installation—5.2L/5.9L Engines—Typical

(1) Install the TPS and two retaining bolts.
(2) Tighten bolts to 7 N·m (60 in. lbs.) torque.
(3) Manually operate the throttle control lever by hand to check for any binding of the TPS.
(4) Connect TPS electrical connector to TPS.
(5) Install air duct at throttle body.

THROTTLE POSITION SENSOR (TPS)—4.0L ENGINE

The TPS is mounted to the throttle body.

REMOVAL

(1) Disconnect TPS electrical connector.
(2) Remove TPS mounting screws (Fig. 69).
(3) Remove TPS.

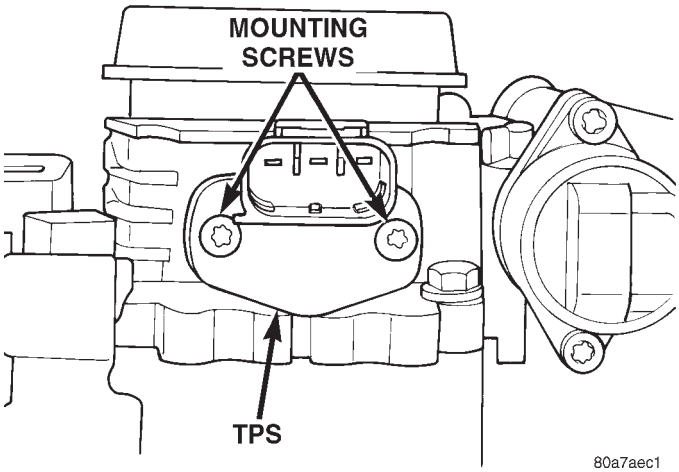


Fig. 69 TPS Mounting Screws—4.0L Engine

INSTALLATION

The throttle shaft end of the throttle body slides into a socket in the TPS (Fig. 70). The TPS must be installed so that it can be rotated a few degrees. (If the sensor will not rotate, install the sensor with the throttle shaft on the other side of the socket tangs). The TPS will be under slight tension when rotated.

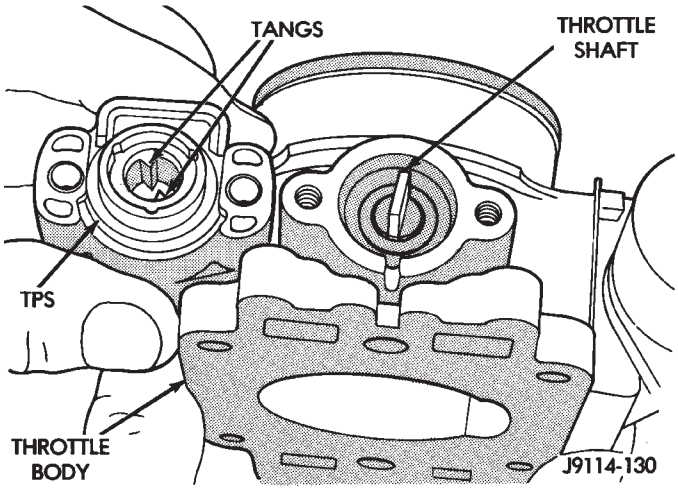


Fig. 70 Throttle Position Sensor Installation—4.0LEngine

(1) Install the TPS and retaining screws.
(2) Tighten screws to 7 N·m (60 in. lbs.) torque.
(3) Connect TPS electrical connector to TPS.
(4) Manually operate the throttle (by hand) to check for any TPS binding before starting the engine.

IDLE AIR CONTROL (IAC) MOTOR—5.2L/5.9L ENGINES

The IAC motor is located on the back of the throttle body.

REMOVAL

(1) Remove air duct at throttle body.
(2) Disconnect electrical connector from IAC motor.
(3) Remove two mounting bolts (screws) (Fig. 71).

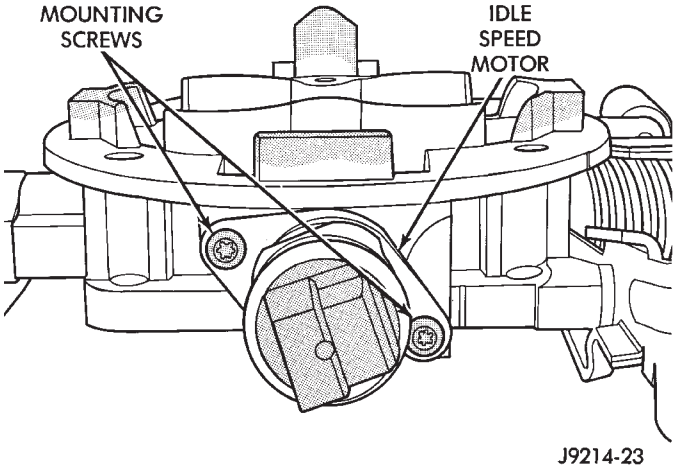


Fig. 71 Mounting Bolts (Screws)—IACMotor—5.2L/5.9L Engines—Typical

(4) Remove IAC motor from throttle body.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Install IAC motor to throttle body.
(2) Install and tighten two mounting bolts (screws) to 7 N·m (60 in. lbs.) torque.
(3) Install electrical connector.
(4) Install air duct at throttle body.

IDLE AIR CONTROL (IAC) MOTOR—4.0L ENGINE

The IAC motor is located on the side of the throttle body.

REMOVAL

(1) Remove air cleaner tube at throttle body.
(2) Disconnect electrical connector from IAC motor.
(3) Remove two mounting bolts (screws) (Fig. 72).
(4) Remove IAC motor from throttle body.

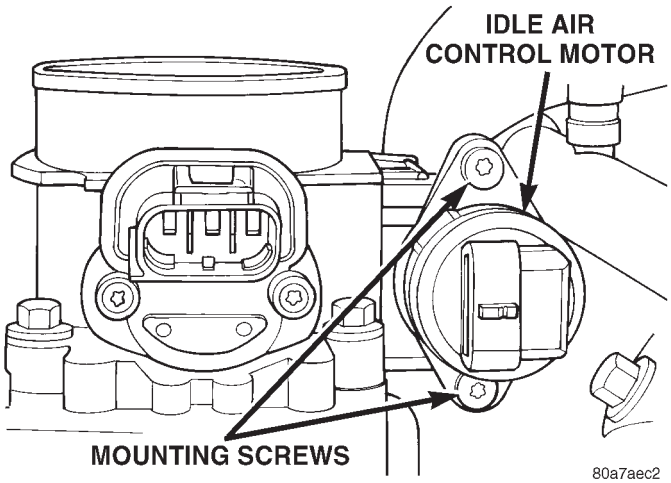


Fig. 72 Mounting Bolts (Screws)—IACMotor—4.0L Engine

INSTALLATION

(1) Install IAC motor to throttle body.
(2) Install and tighten two mounting bolts (screws) to 7 N·m (60 in. lbs.) torque.
(3) Install electrical connector.
(4) Install air cleaner tube to throttle body.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—5.2L/5.9L ENGINES

The MAP sensor is located on the front of the throttle body (Fig. 73). An L-shaped rubber fitting is used to connect the MAP sensor to throttle body (Fig. 74).

REMOVAL

(1) Remove air duct at throttle body.
(2) Disconnect electrical connector at sensor.
(3) Remove two MAP sensor mounting bolts (screws) (Fig. 74).
(4) While removing MAP sensor, slide the vacuum rubber L-shaped fitting (Fig. 74) from the throttle body.

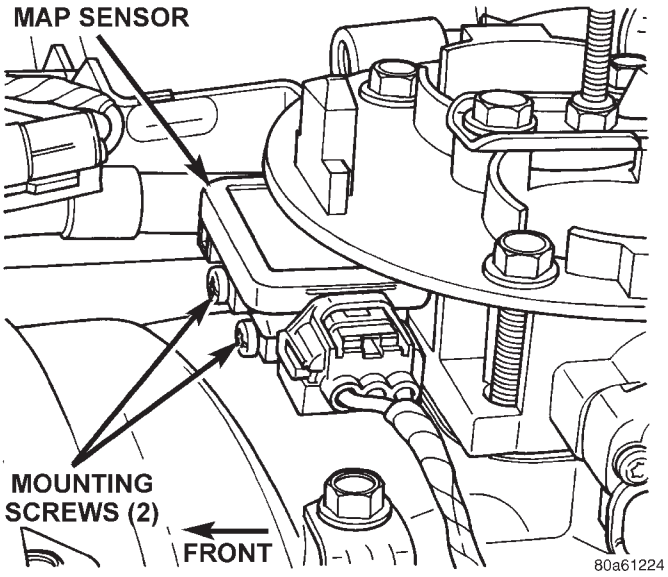


Fig. 73 MAP Sensor Mounting Screws—5.2L/ 5.9LEngines

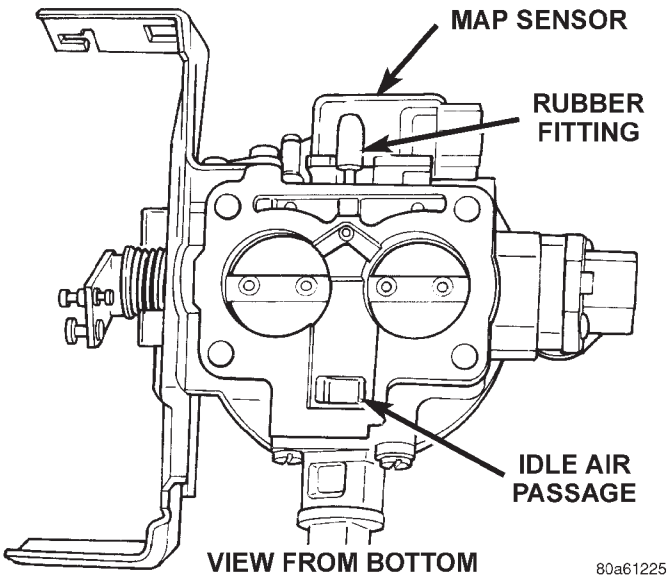


Fig. 74 MAP Sensor L-Shaped Rubber Fitting—5.2L/ 5.9LEngines

(5) Remove rubber L-shaped fitting from MAP sensor.

INSTALLATION

(1) Install rubber L-shaped fitting to MAP sensor.
(2) Position sensor to throttle body while guiding rubber fitting over throttle body vacuum nipple.
(3) Install MAP sensor mounting bolts (screws). Tighten screws to 3 N·m (25 in. lbs.) torque.
(4) Connect electrical connector.
(5) Install air duct at throttle body.

REMOVAL AND INSTALLATION (Continued)

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—4.0L ENGINE

The MAP sensor is mounted to the side of the throttle body (Fig. 75). An L-shaped rubber fitting is used to connect the MAP sensor to throttle body (Fig. 76).

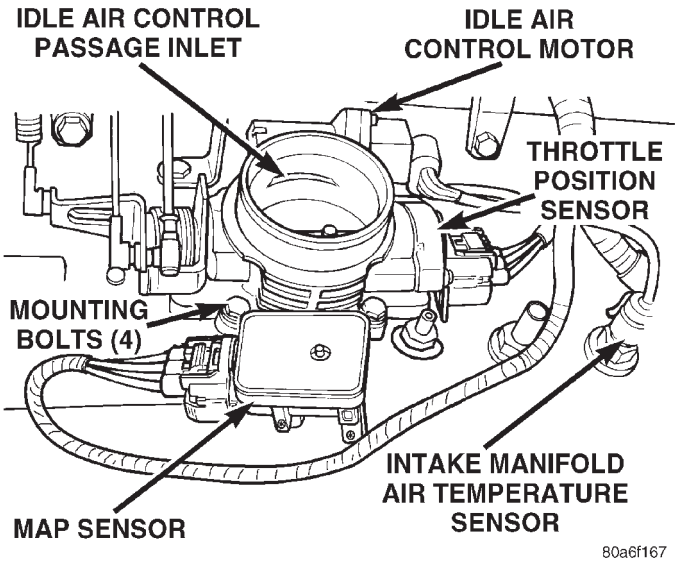


Fig. 75 MAP Sensor Location—4.0L Engine

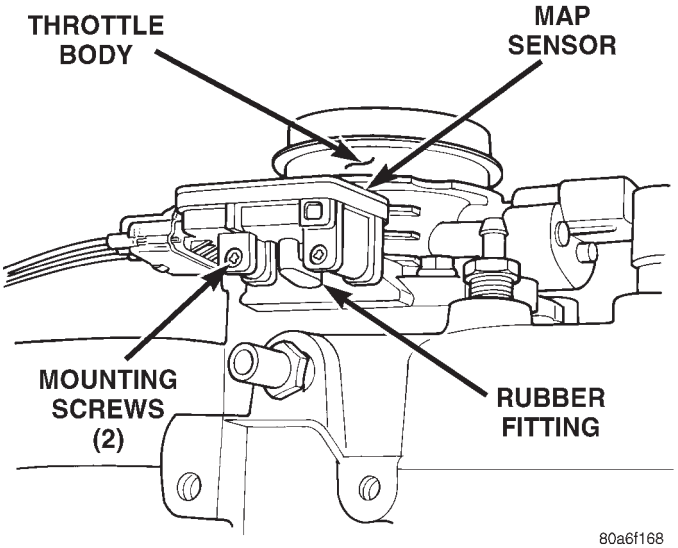


Fig. 76 Rubber L-Shaped Fitting—MAPSensor-to-Throttle Body—4.0L Engine

REMOVAL

(1) Remove air cleaner intake tube at throttle body.

(2) Remove two MAP sensor mounting bolts (screws) (Fig. 76).

(3) While removing MAP sensor, slide the rubber L-shaped fitting (Fig. 76) from the throttle body.

(4) Remove rubber L-shaped fitting from MAP sensor.

INSTALLATION

(1) Install rubber L-shaped fitting to MAP sensor.

(2) Position sensor to throttle body while guiding rubber fitting over throttle body vacuum nipple.

(3) Install MAP sensor mounting bolts (screws). Tighten screws to 3 N·m (25 in. lbs.) torque.

(4) Install air cleaner intake tube.

DUTY CYCLE EVAP CANISTER PURGE SOLENOID

Refer to Group 25, Emission Control System for removal/installation procedures.

POWERTRAIN CONTROL MODULE (PCM)

The PCM is located on the cowl panel in the right/rear side of the engine compartment (Fig. 77).

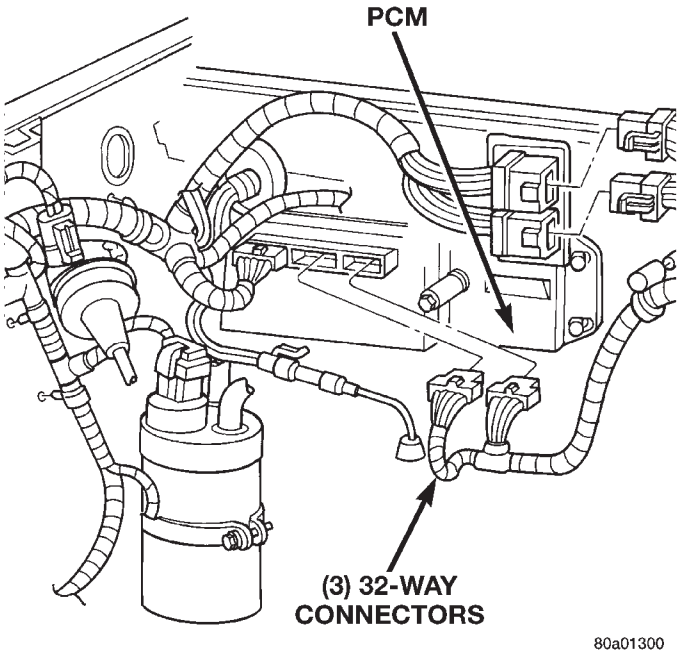


Fig. 77 Powertrain Control Module (PCM) Location

REMOVAL

(1) Disconnect the negative battery cable at battery.

(2) Remove cover over electrical connectors. Cover snaps onto PCM.

(3) Remove the coolant reserve/overflow tank (one bolt and two nuts) (Fig. 78).

(4) Carefully unplug the three 32–way connectors at PCM.

(5) Remove the three PCM mounting bolts (Fig. 79).

(6) Remove PCM.

REMOVAL AND INSTALLATION (Continued)

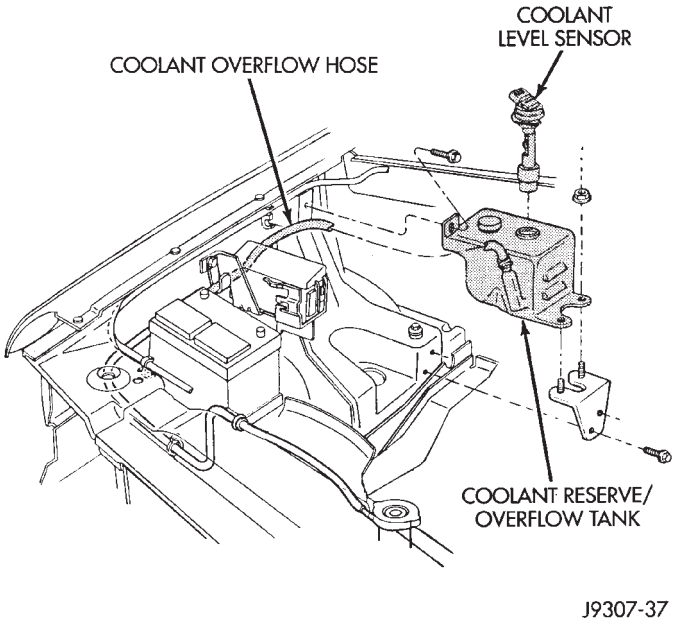


Fig. 78 Coolant Reserve/Overflow Tank Mounting

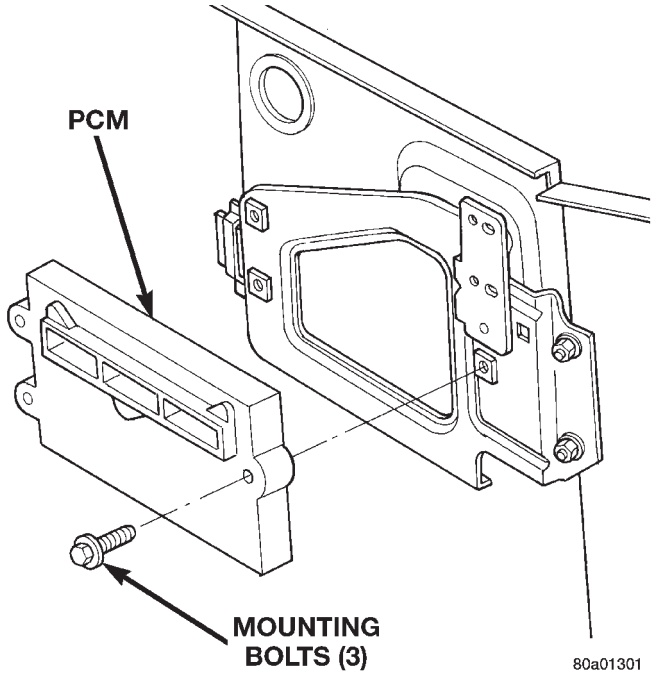


Fig. 79 Powertrain Control Module (PCM) Mounting

INSTALLATION

(1) Check the pins in the three 32–way electrical connectors for damage. Repair as necessary.

(2) Install PCM. Tighten three mounting bolts to 1 N·m (9 in. lbs.) torque.

(3) Install three 32–way connectors.

(4) Install cover over electrical connectors. Cover snaps onto PCM.

(5) Install coolant reserve/overflow tank.

(6) Connect negative cable to battery.

CRANKSHAFT POSITION SENSOR

Refer to Group 8D, Ignition System for removal/installation procedures.

CAMSHAFT POSITION SENSOR

For removal/installation procedures, refer to Group 8D, Ignition System. See Camshaft Position Sensor.

OXYGEN SENSOR—5.2L/5.9L ENGINES

The upstream O2S sensor is located in the exhaust downpipe. The downstream sensor is located near outlet end of catalytic converter. Refer to (Fig. 80) or (Fig. 81).

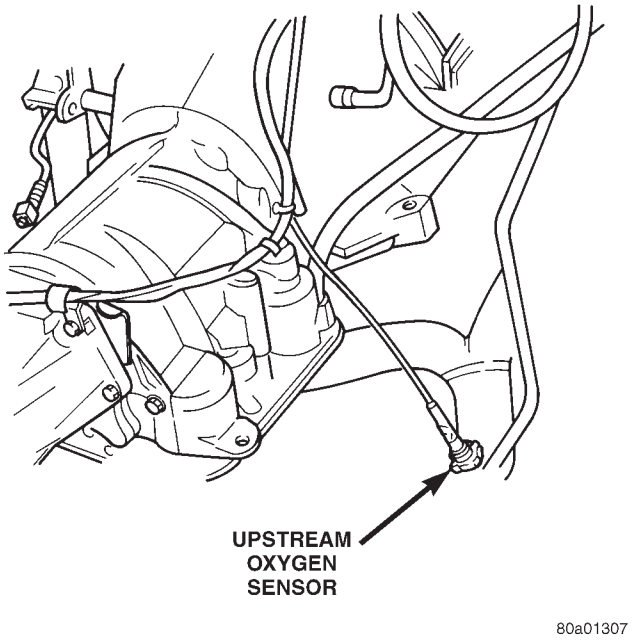


Fig. 80 Upstream Oxygen Sensor Location—5.2L/ 5.9LEngines

REMOVAL

WARNING: THE EXHAUST MANIFOLD, EXHAUST PIPES AND CATALYTIC CONVERTER BECOME VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENSOR.

(1) Raise and support vehicle.

(2) Downstream Sensor Only: Disconnect O2S wiring connector clip (Fig. 81) at body. Remove clip from O2S electrical connector and discard.

(3) Disconnect O2S pigtail harness wire connector from main connector.

CAUTION: When disconnecting the sensor electrical connector, do not pull directly on wire going into sensor.

REMOVAL AND INSTALLATION (Continued)

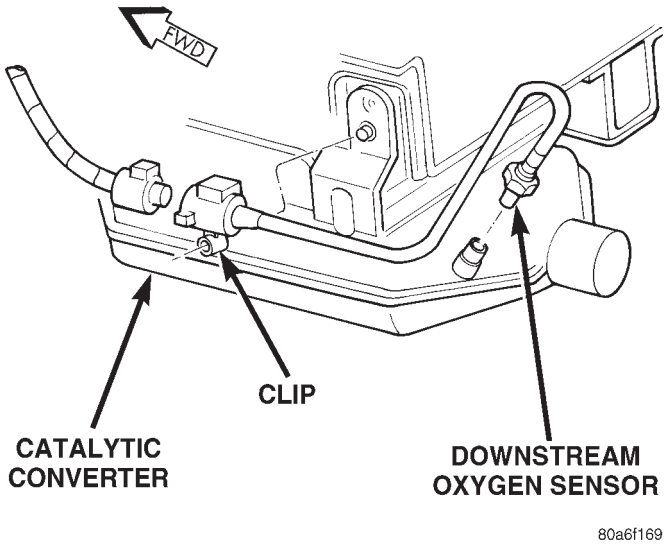


Fig. 81 Downstream Oxygen Sensor Location—AllEngines

(4) Remove O2S sensor. Snap-On oxygen sensor wrench (number YA 8875) may be used for removal and installation.

INSTALLATION

Threads of new oxygen sensors are factory coated with anti-seize compound to aid in removal. **DO NOT add any additional anti-seize compound to threads of a new oxygen sensor.**

(1) Install O2S sensor. Tighten to 30 N·m (22 ft. lbs.) torque.

(2) Connect O2S sensor wire connector to main wiring harness.

(3) Downstream Sensor Only: Install new wiring connector clip into O2S electrical connector. Snap this clip to body. The O2S pigtail harness must be clipped to body to prevent mechanical damage from propshaft.

(4) Lower the vehicle.

OXYGEN SENSOR—4.0L ENGINE

The upstream O2S sensor is located in the exhaust downpipe. The downstream sensor is located near outlet end of catalytic converter. Refer to (Fig. 82) or (Fig. 81).

REMOVAL

WARNING: THE EXHAUST MANIFOLD, EXHAUST PIPES AND CATALYTIC CONVERTER BECOME VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENSOR.

(1) Raise and support vehicle.

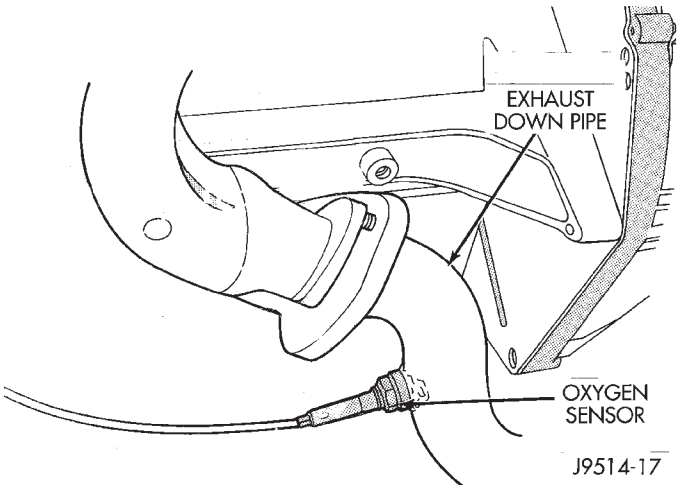


Fig. 82 Upstream Oxygen Sensor Location—4.0LEngine

(2) Downstream Sensor Only: Disconnect O2S wiring connector clip (Fig. 81) at body. Remove clip from O2S electrical connector and discard.

(3) Disconnect O2S pigtail harness wire connector from main connector.

CAUTION: When disconnecting the sensor electrical connector, do not pull directly on wire going into sensor.

(4) Remove O2S sensor. Snap-On oxygen sensor wrench (number YA 8875) may be used for removal and installation.

INSTALLATION

Threads of new oxygen sensors are factory coated with anti-seize compound to aid in removal. **DO NOT add any additional anti-seize compound to the threads of a new oxygen sensor.**

(1) Install the O2S sensor. Tighten to 30 N·m (22 ft. lbs.) torque.

(2) Connect O2S sensor wire connector to main wiring harness.

(3) Downstream Sensor Only: Install new wiring connector clip into O2S electrical connector. Snap this clip to body. The O2S pigtail harness must be clipped to body to prevent mechanical damage from propshaft.

(4) Lower the vehicle.

AIR CLEANER HOUSING

REMOVAL

(1) Unlock clean air hose clamp (Fig. 83) at air cleaner cover. To unlock the clamp, attach adjustable pliers to clamp and rotate pliers as shown in (Fig. 84). Remove clean air hose at cover.

(2) Remove crankcase breather/filter hose at air cleaner cover.

REMOVAL AND INSTALLATION (Continued)

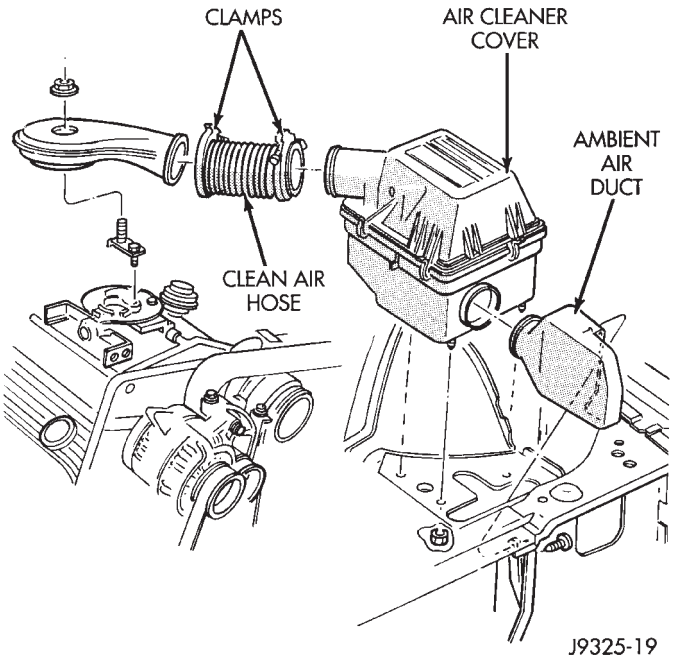


Fig. 83 Air Cleaner—5.2L V-8 EngineShown

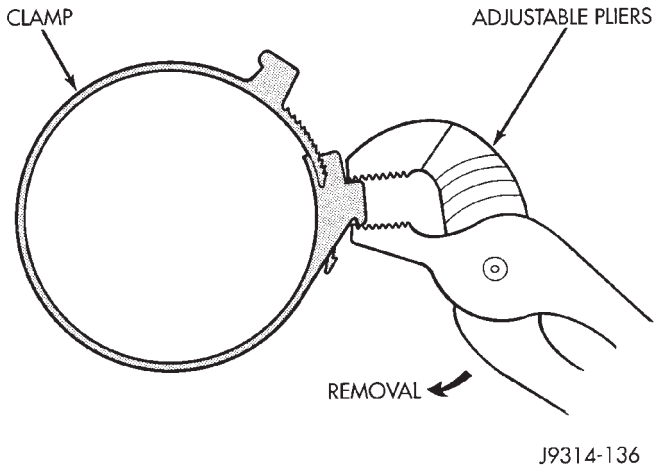


Fig. 84 Clamp Removal

(3) From under vehicle, remove three housing nuts (Fig. 83).

(4) Release the air cleaner housing from the ambient air duct and remove housing from vehicle.

INSTALLATION

(1) Position air cleaner housing to body and ambient air duct (Fig. 83).

(2) Install three nuts and tighten to 10 N·m (93 in. lbs.) torque.

(3) Install crankcase breather/filter hose to cover.

(4) Install clamp to cover. Compress the clamp snugly with adjustable pliers as shown in (Fig. 85).

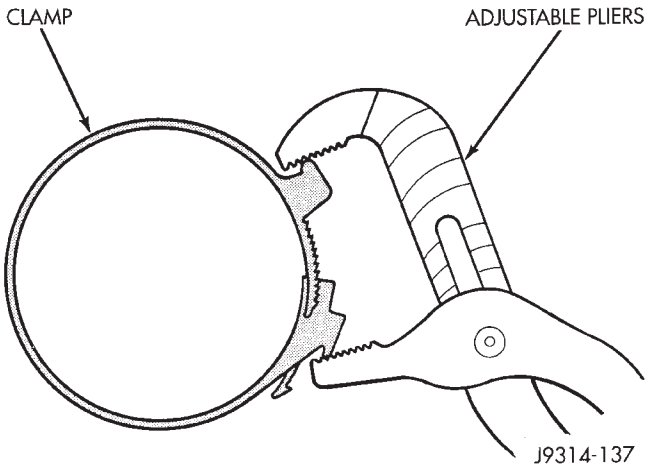


Fig. 85 Clamp Installation

AIR CLEANER ELEMENT (FILTER)

REMOVAL/INSTALLATION

(1) Pry back the six clips retaining the air cleaner cover to the air cleaner housing (Fig. 86).

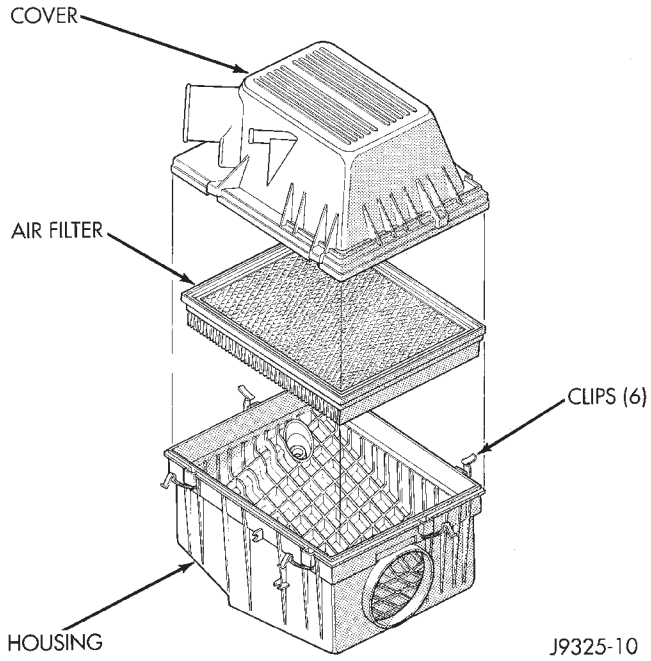


Fig. 86 Air Cleaner Element Removal/Installation

(2) Lift the cover up and position to the side.

(3) Remove air cleaner element.

(4) Clean the inside of air cleaner housing before installing new element.

(5) Reverse the preceding operation for installation. Be sure the air cleaner cover is properly seated to air cleaner housing.

REMOVAL AND INSTALLATION (Continued)

ENGINE COOLANT TEMPERATURE SENSOR—5.2L/ 5.9L ENGINES

REMOVAL

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING. COOLING SYSTEM MUST BE PARTIALLY DRAINED BEFORE REMOVING THE COOLANT TEMPERATURE SENSOR. REFER TO GROUP 7, COOLING.

(1) Partially drain cooling system. Refer to Group 7, Cooling.

(2) Disconnect electrical connector from sensor (Fig. 87).

(3) **Engines with air conditioning:** When removing the connector from sensor, do not pull directly on wiring harness. Fabricate an L-shaped hook tool from a coat hanger (approximately eight inches long). Place the hook part of tool under the connector for removal. The connector is snapped onto the sensor. It is not equipped with a lock type tab.

(4) Remove sensor from intake manifold.

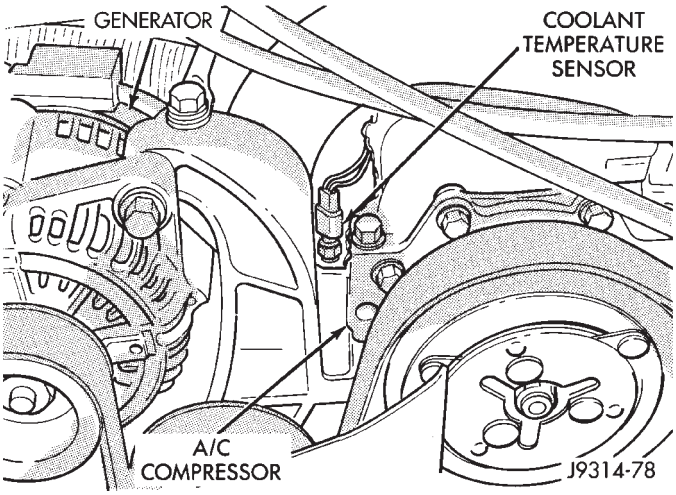


Fig. 87 Engine Coolant Temperature Sensor—5.2L/ 5.9LEngines

INSTALLATION

(1) Install sensor.

(2) Tighten to 11 N·m (8 ft. lbs.) torque.

(3) Connect electrical connector to sensor. The sensor connector is symmetrical (not indexed). It can be installed to the sensor in either direction.

(4) Replace any lost engine coolant. Refer to Group 7, Cooling System.

ENGINE COOLANT TEMPERATURE SENSOR—4.0L ENGINE

The coolant temperature sensor is installed in the thermostat housing (Fig. 88).

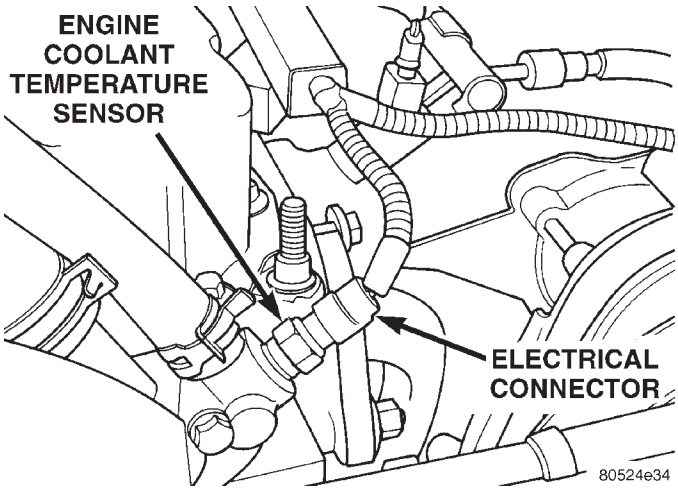


Fig. 88 Engine Coolant Temperature Sensor— 4.0LEngine

REMOVAL

(1) Partially drain cooling system until the coolant level is below the cylinder head. Observe the **WARNINGS** in Group 7, Cooling.

(2) Disconnect the coolant temperature sensor wire connector.

(3) Remove the sensor from the thermostat housing.

INSTALLATION

(1) Apply sealant to sensor threads.

(2) Install coolant temperature sensor into the thermostat housing. Tighten to 11 N·m (8 ft. lbs.) torque.

(3) Connect the wire connector.

(4) Fill the cooling system. Refer to Group 7, Cooling System.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR— 5.2L/5.9L ENGINES

The intake manifold air temperature sensor is located in the front/side of the intake manifold (Fig. 89).

REMOVAL

(1) Disconnect electrical connector at sensor (Fig. 89).

(2) Remove sensor from intake manifold.

INSTALLATION

(1) Install sensor to intake manifold. Tighten to 28 N·m (20 ft. lbs.) torque.

(2) Install electrical connector.

REMOVAL AND INSTALLATION (Continued)

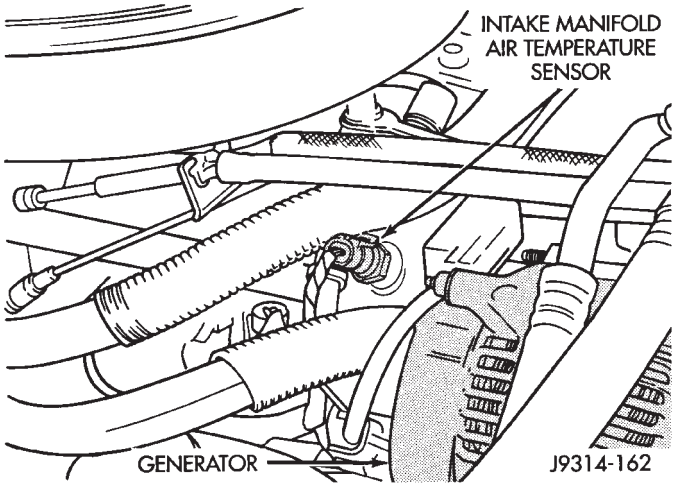


Fig. 89 Air Temperature Sensor—5.2L/5.9LEngines—Typical

INTAKE MANIFOLD AIR TEMPERATURE SENSOR—4.0L ENGINE

The intake manifold air temperature sensor is installed into the intake manifold plenum near the throttle body (Fig. 90).

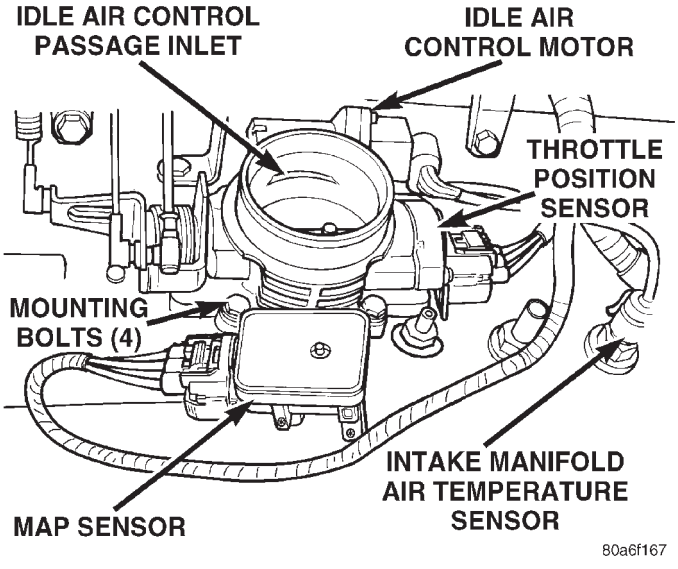


Fig. 90 Intake Air Sensor Location—4.0LEngine

REMOVAL

(1) Disconnect the electrical connector from the sensor.

(2) Remove the sensor from the intake manifold.

INSTALLATION

(1) Install the sensor into the intake manifold. Tighten the sensor to 28 N·m (20 ft. lbs.) torque.

(2) Connect the electrical connector to the sensor.

VEHICLE SPEED SENSOR

The vehicle speed sensor is located on the speedometer pinion gear adapter (Fig. 91) or (Fig. 92). The pinion gear adapter is located on the extension housing of the transmission (drivers side).

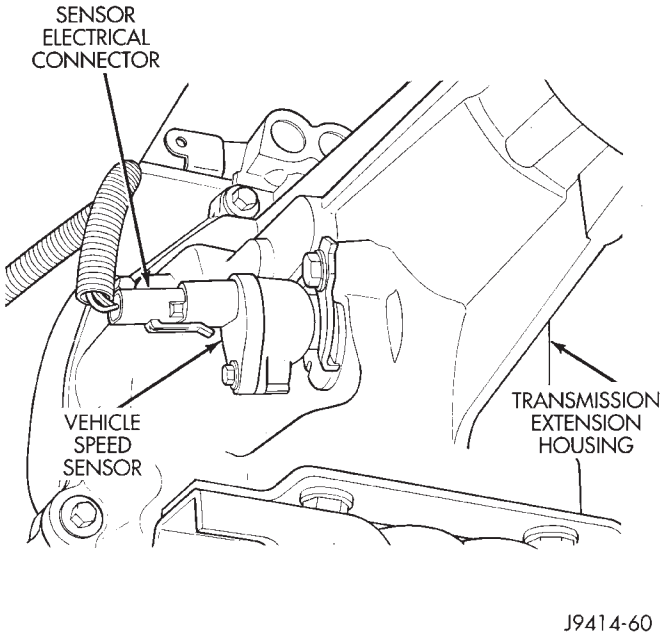


Fig. 91 Vehicle Speed Sensor Location—2WD—Typical

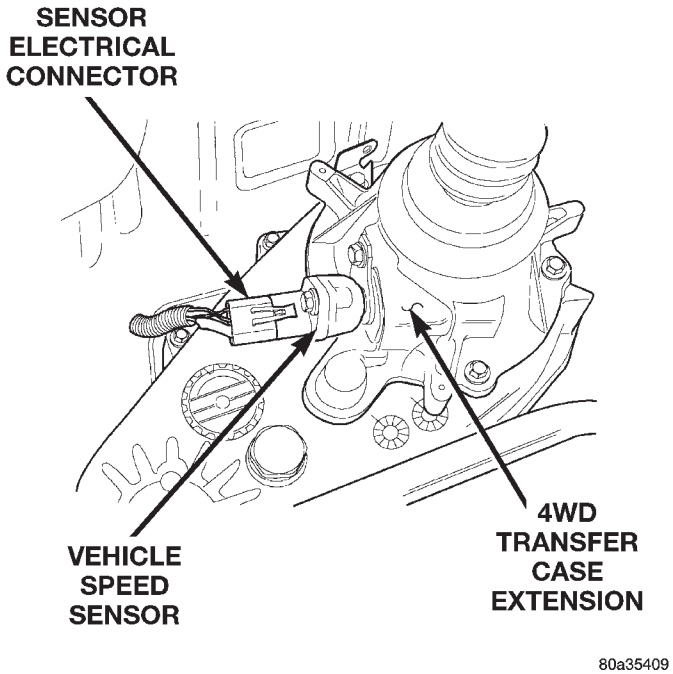


Fig. 92 Vehicle Speed Sensor Location—4WD—Typical

REMOVAL

(1) Raise and support vehicle.

REMOVAL AND INSTALLATION (Continued)

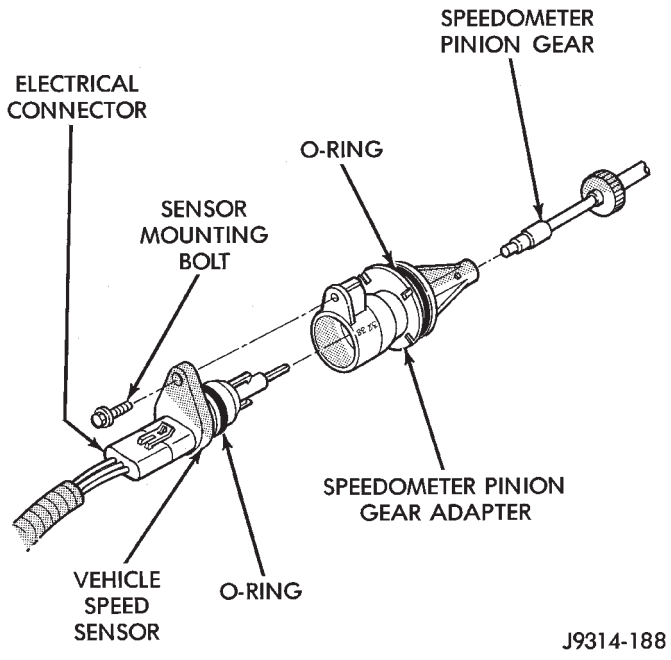


Fig. 93 Sensor Removal/Installation

(2) Disconnect the electrical connector from the sensor.

(3) Remove the sensor mounting bolt (Fig. 93).

(4) Remove the sensor (pull straight out) from the speedometer pinion gear adapter (Fig. 93). Do not remove the gear adapter from the transmission.

INSTALLATION

(1) Clean the inside of speedometer pinion gear adapter before installing speed sensor.

(2) Install sensor into speedometer gear adapter and install mounting bolt. **Before tightening bolt, verify speed sensor is fully seated (mounted flush) to speedometer pinion gear adapter.**

(3) Tighten sensor mounting bolt to 2.2 N·m (20 in. lbs.) torque.

(4) Connect electrical connector to sensor.

SPECIFICATIONS

VECI LABEL

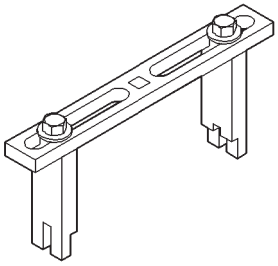
If anything differs between the specifications found on the Vehicle Emission Control Information (VECI) label and the following specifications, use specifications on VECI label. The VECI label is located in the engine compartment.

TORQUE CHART

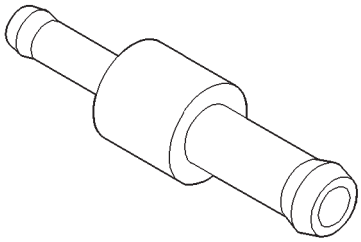
DESCRIPTION	TORQUE
Air Cleaner Housing Mount. Nuts	10 N·m (93 in. lbs.)
Engine Coolant Temperature Sensor—All Engines	11 N·m (96 in. lbs.)
Fuel Hose Clamps	1 N·m (10 in. lbs.)
IAC Motor-To-Throttle Body Bolts	7 N·m (60 in. lbs.)
Intake Manifold Air Temp. ensor—All Engines	28 N·m (20 ft. lbs.)
MAP Sensor Mounting Screws—All Engines	3 N·m (25 in. lbs.)
Oxygen Sensor—All Engines	30 N·m (22 ft. lbs.)
Powertrain Control Module Mounting Screws	1 N·m (9 in. lbs.)
Throttle Body Mounting Bolts— 5.2L/5.9L Engine	23 N·m (200 in. lbs.)
Throttle Body Mounting Bolts— 4.0L Engine	11 N·m (100 in. lbs.)
Throttle Position Sensor Mounting Screws—All Engines	7 N·m (60 in. lbs.)
Vehicle Speed Sensor Mounting Bolt	2.2 N·m (20 in. lbs.)

SPECIAL TOOLS

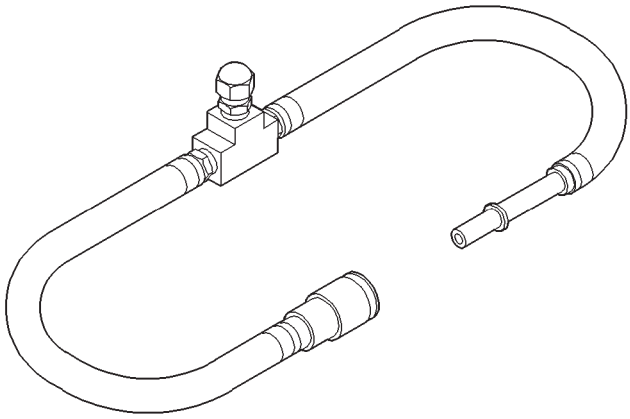
FUEL SYSTEM



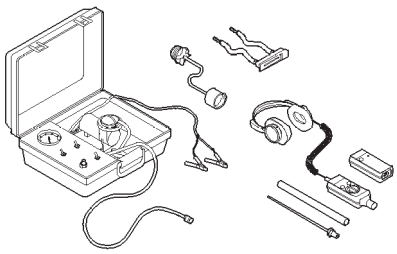
Spanner Wrench—6856



Fitting, Air Metering—6714

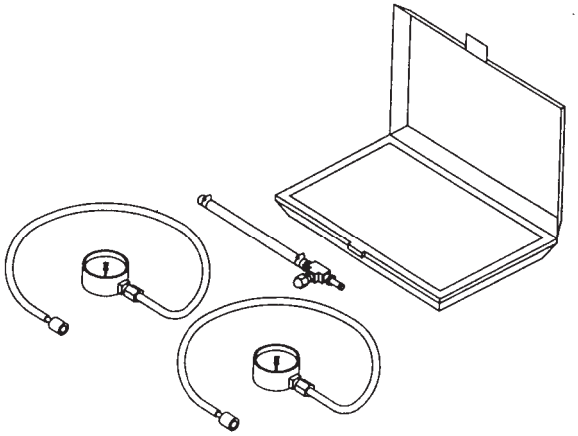


Adapters, Fuel Pressure Test—6541,6539, 6631 or 6923

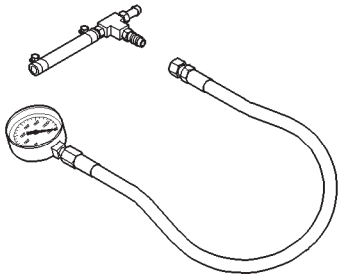


Pump, IM240 EVAP Service Pressure—6917

O2S (Oxygen Sensor) Remover/Installer—C-4907



Test Kit, Fuel Pressure—5069



Test Kit, Fuel Pressure—C-4799-B

Fuel Line Removal Tool—6782

FUEL SYSTEM—2.5L DIESEL ENGINE

CONTENTS

GENERAL INFORMATION

INDEX

GENERAL INFORMATION

INTRODUCTION—2.5L DIESEL

Certain sensors that are part of the 2.5L diesel engine fuel system are monitored by the Bosch engine controller (MSA). Based on inputs recieved from these sensors, the MSA controls the amount of fuel and the timing of when it is delivered to the engine. The MSA controller is located under the left side rear seat. The Powertrain Control Module (PCM) is mounted to a bracket located in the right rear side of the engine compartment behind the coolant tank. It interfaces with the MSA electronically to control other components.

The **Fuel System** consists of: the fuel tank, fuel injection pump (engine mounted), fuel filter/water separator, fuel tank module, electrical fuel gauge sending unit, glow plugs, glow plug relay, PCM, and all the electrical components that control the fuel system. It also consists of fuel tubes/lines/hoses and fittings, vacuum hoses, and fuel injector(s).

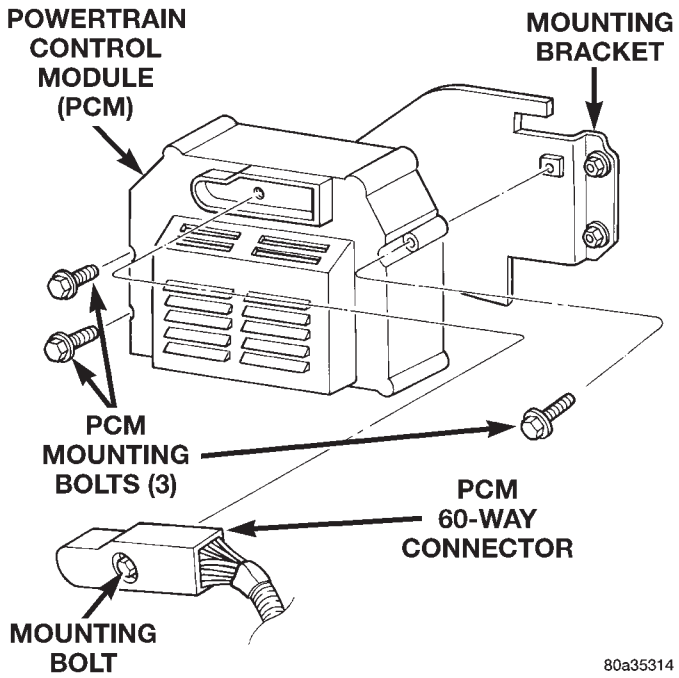


Fig. 1 PCM Location

GENERAL INFORMATION (Continued)

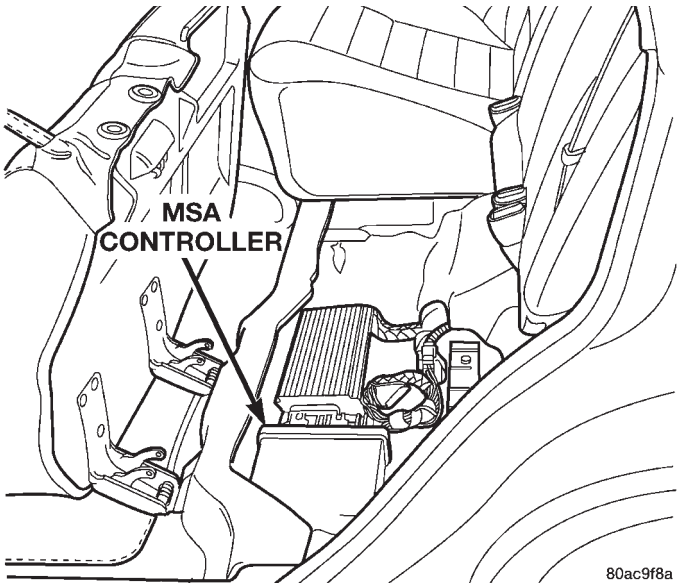


Fig. 2 MSA Controller Location

A **Fuel Return System.** A separate fuel return system is used. This will route excess fuel: from the fuel injectors; through individual injector drain tubes; through the fuel injection pump overflow valve; and back to the fuel tank through a separate fuel line.

The **Fuel Tank Assembly** consists of: the fuel tank, two pressure relief/rollover valves, fuel filler tube, fuel tank module containing a fuel gauge sending unit, and a pressure-vacuum filler cap.

FUEL REQUIREMENTS—2.5L DIESEL

Refer to the Lubrication and Maintenance section of this manual for information. Also refer to the Owner Manual.

FUEL DELIVERY SYSTEM—2.5L DIESEL ENGINE

INDEX

DESCRIPTION AND OPERATION

INTRODUCTION

This Fuel Delivery section will cover components not controlled by the PCM. For components controlled by the PCM, refer to the Fuel Injection System—2.5L Diesel Engine section of this group.

The fuel heater relay, fuel heater and fuel gauge are not operated by the PCM. These components are controlled by the ignition (key) switch. All other fuel system electrical components necessary to operate the engine are controlled or regulated by the PCM.

FUEL SYSTEM PRESSURE WARNING

WARNING: HIGH–PRESSURE FUEL LINES DELIVER DIESEL FUEL UNDER EXTREME PRESSURE FROM THE INJECTION PUMP TO THE FUEL INJECTORS. THIS MAY BE AS HIGH AS 45,000 KPA (6526 PSI). USE EXTREME CAUTION WHEN INSPECTING FOR HIGH–PRESSURE FUEL LEAKS. INSPECT FOR HIGH–PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD (Fig. 1). HIGH FUEL INJECTION PRESSURE CAN CAUSE PERSONAL INJURY IF CONTACT IS MADE WITH THE SKIN.

DESCRIPTION AND OPERATION (Continued)

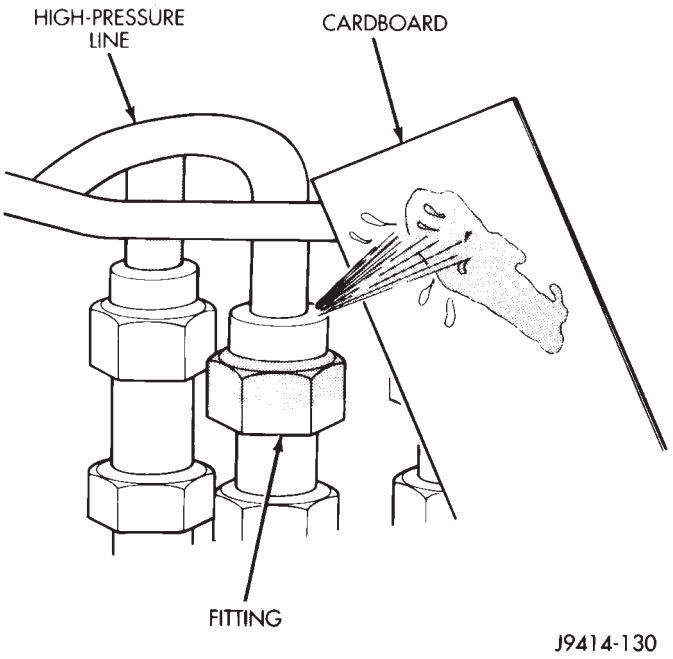


Fig. 1 Typical Fuel Pressure Test at Injector

FUEL TANK

The fuel tank and tank mounting used with the diesel powered engine is the same as used with gasoline powered models, although the fuel tank module is different.

The fuel tank contains the fuel tank module and two rollover valves. Two fuel lines are routed to the fuel tank module. One line is used for fuel supply to the fuel filter/water separator. The other is used to return excess fuel back to the fuel tank.

The fuel tank module contains the fuel gauge electrical sending unit. **An electrical fuel pump is not used with the diesel engine.**

FUEL TANK MODULE

An electric fuel pump is not attached to the fuel tank module for diesel powered engines. Fuel is supplied by the fuel injection pump.

The fuel tank module is installed in the top of the fuel tank (Fig. 2). The fuel tank module contains the following components:

- Fuel reservoir
- A separate in-tank fuel filter
- Electric fuel gauge sending unit
- Fuel supply line connection
- Fuel return line connection

FUEL GAUGE SENDING UNIT

The fuel gauge sending unit is attached to the side of the fuel pump module. The sending unit consists of a float, an arm, and a variable resistor (track). The track is used to send an electrical signal used for fuel gauge operation.

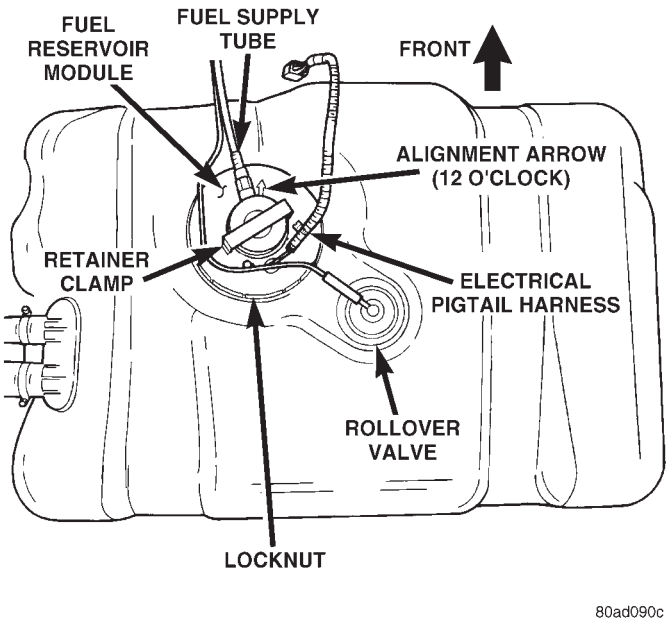


Fig. 2 Fuel Tank

As the fuel level increases, the float and arm move up. This decreases the sending unit resistance, causing the PCM to send a signal to the fuel gauge on the instrument panel to read full. As the fuel level decreases, the float and arm move down. This increases the sending unit resistance, causing the PCM to send a signal to the fuel gauge on the instrument panel to read empty.

FUEL FILTER/WATER SEPARATOR

The fuel filter/water separator assembly is located in the engine compartment near the strut tower (Fig. 3).

The combination fuel filter/water separator protects the fuel injection pump by helping to remove water and contaminants from the fuel. Moisture collects at the bottom of the filter/separator in a plastic bowl.

The fuel filter/water separator assembly contains the fuel filter, fuel heater element, and fuel drain valve.

For information on the fuel heater, refer to Fuel Heater in this group.

Refer to the maintenance schedules in Group 0 in this manual for the recommended fuel filter replacement intervals.

For periodic draining of water from the bowl, refer to Fuel Filter/Water Separator Removal/Installation in this group.

FUEL SHUTDOWN SOLENOID

The fuel shutdown solenoid is controlled and operated by the MSA.

DESCRIPTION AND OPERATION (Continued)

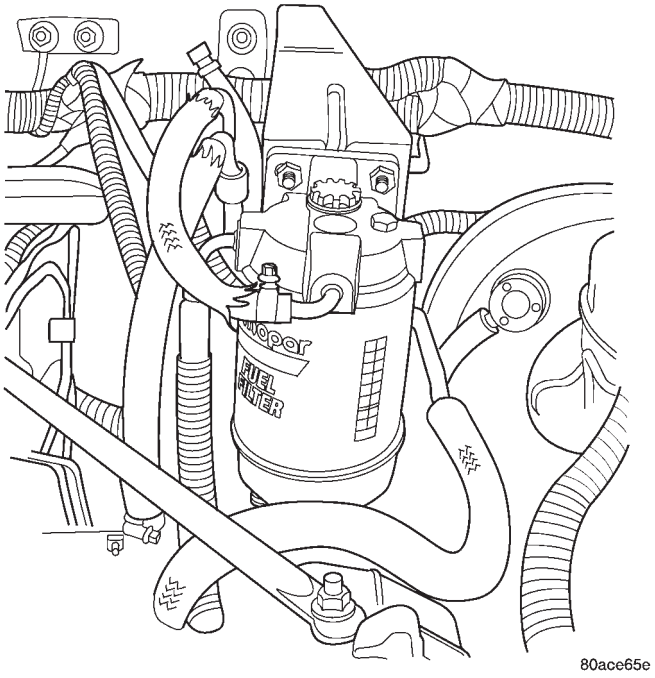


Fig. 3 Fuel Filter/Water Separator Location

The fuel shutdown (shut-off) solenoid is used to electrically shut off the diesel fuel supply to the high-pressure fuel injection pump. The solenoid is mounted to the rear of the injection pump (Fig. 4).

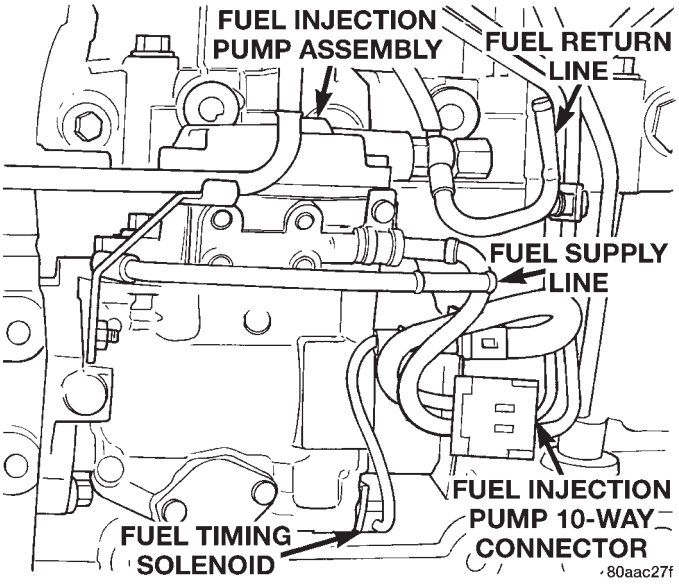


Fig. 4 Fuel Shutdown Solenoid and Overflow Valve Location

The solenoid controls starting and stopping of the engine regardless of the position of the accelerator pedal. When the ignition (key) switch is OFF, the solenoid is shut off and fuel flow is not allowed to the fuel injection pump. When the key is placed in the ON or START positions, fuel supply is allowed at the injection pump.

FUEL INJECTION PUMP

The fuel injection pump is a mechanical distributor–type, Bosch VP36 series (Fig. 5). A gear on the end of the injection pump shaft meshes with the drive chain at the front of engine. The pump is mechanically timed to the engine. The MSA can make adjustments to the timing of the injection pump.

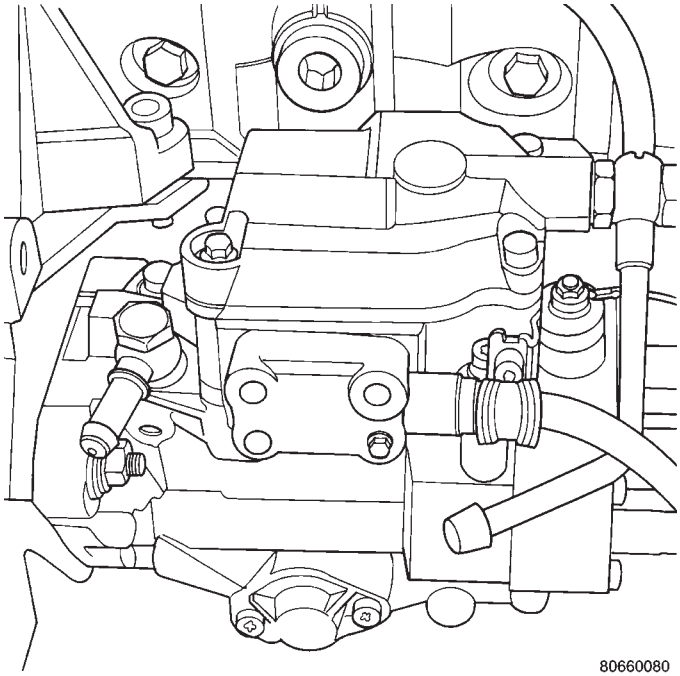


Fig. 5 Fuel Injection Pump

The injection pump contains the fuel shutdown solenoid, fuel temperature sensor, control sleeve sensor, fuel quantity actuator and the fuel timing solenoid (Fig. 5).

In the electronically controlled injection pump, the pump plunger works the same as the pump plunger in a mechanically controlled injection pump, but the amount of fuel and the time the fuel is injected is controlled by the vehicle's MSA, instead of by a mechanical governor assembly. A solenoid controlled by the MSA is used in place of the mechanical governor assembly, and it moves a control sleeve inside the pump that regulates the amount of fuel being injected. There is no mechanical connection between the accelerator pedal and the electronically controlled injection pump. Instead, a sensor connected to the accelerator pedal sends a signal to the MSA that represents the actual position of the accelerator pedal. The MSA uses this input, along with input from other sensors to move the control sleeve to deliver the appropriate amount of fuel. This system is known as "Drive-By-Wire"

The actual time that the fuel is delivered is very important to the diesel combustion process. The MSA

DESCRIPTION AND OPERATION (Continued)

monitors outputs from the engine speed sensor (flywheel position in degrees), and the fuel injector sensor (mechanical movement within the #1 cylinder fuel injector). Outputs from the Accelerator Pedal Position sensor, engine speed sensor (engine rpm) and engine coolant temperature sensor are also used. The MSA will then compare its set values to these outputs to electrically adjust the amount of fuel timing (amount of advance) within the injection pump. This is referred to as "Closed Loop" operation. The MSA monitors fuel timing by comparing its set value to when the injector #1 opens. If the value is greater than a preset value a fault will be set.

Actual electric fuel timing (amount of advance) is accomplished by the fuel timing solenoid mounted to the bottom of the injection pump (Fig. 5). Fuel timing will be adjusted by the MSA, which controls the fuel timing solenoid.

An overflow valve is attached into the fuel return line at the rear of the fuel injection pump (Fig. 4). This valve serves two purposes. One is to ensure that a certain amount of residual pressure is maintained within the pump when the engine is switched off. This will prevent the fuel timing mechanism within the injection pump from returning to its zero position. The other purpose is to allow excess fuel to be returned to the fuel tank through the fuel return line. The pressure values within this valve are preset and can not be adjusted.

The fuel injection pump supplies high–pressure fuel of approximately 45,000 kPa (6526 psi) to each injector in precise metered amounts at the correct time.

For mechanical injection pump timing, refer to Fuel Injection Pump Timing in the Service Procedures section of this group.

FUEL INJECTORS

Fuel drain tubes (Fig. 6) are used to route excess fuel back to the overflow valve (Fig. 4) at the rear of the injection pump. This excess fuel is then returned to the fuel tank through the fuel return line.

The injectors are connected to the fuel injection pump by the high– pressure fuel lines. A separate injector is used for each of the four cylinders. An injector containing a sensor (Fig. 7) is used on the cylinder number one injector. This injector is called instrumented injector #1 or needle movement sensor. It is used to tell the MSA when the #1 injector's internal spring-loaded valve seat has been forced open by pressurized fuel being delivered to the cylinder, which is at the end of its compression stroke. When the instrumented injector's valve seat is force open, it sends a small voltage spike pulse to the MSA. This tells the MSA that the engine is at TDC

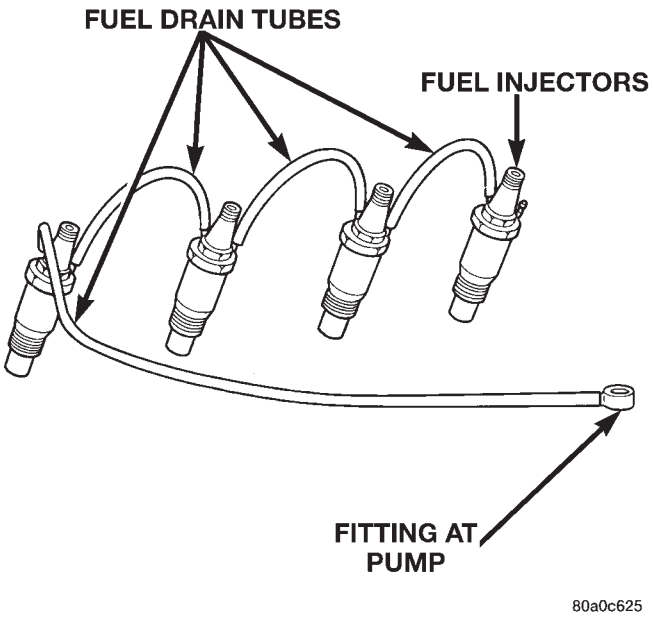


Fig. 6 Fuel Injectors and Drain Tubes

on the number one cylinder. It is not used with the other three injectors.

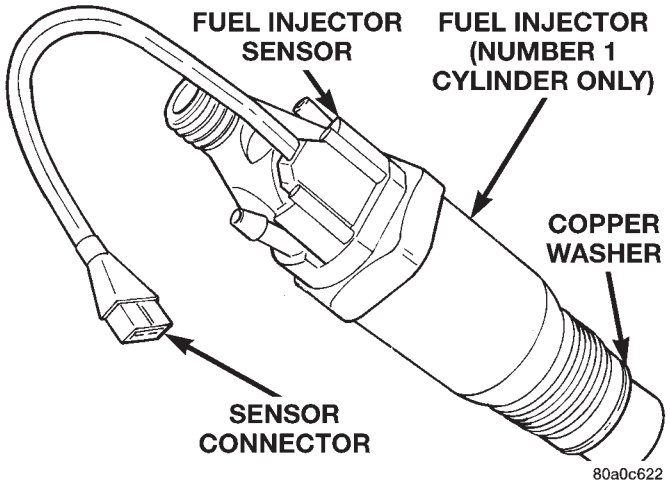


Fig. 7 Fuel Injector Sensor

Fuel enters the injector at the fuel inlet (top of injector) and is routed to the needle valve bore. When fuel pressure rises to approximately 15,000–15,800 kPa (2175–2291 psi), the needle valve spring tension is overcome. The needle valve rises and fuel flows through the spray holes in the nozzle tip into the combustion chamber. The pressure required to lift the needle valve is the injector opening pressure setting. This is referred to as the "pop-off" pressure setting.

Fuel pressure in the injector circuit decreases after injection. The injector needle valve is immediately closed by the needle valve spring and fuel flow into

DESCRIPTION AND OPERATION (Continued)

the combustion chamber is stopped. Exhaust gases are prevented from entering the injector nozzle by the needle valve.

A copper washer (gasket) is used at the base of each injector (Fig. 7) to prevent combustion gases from escaping.

Fuel injector firing sequence is 1–3–4–2.

FUEL TUBES/LINES/HOSES AND CLAMPS—LOW-PRESSURE TYPE

Also refer to the proceeding section on Quick–Connect Fittings.

Inspect all hose connections such as clamps, couplings and fittings to make sure they are secure and leaks are not present. The component should be replaced immediately if there is any evidence of degradation that could result in failure.

Never attempt to repair a plastic fuel line/tube or a quick–connect fitting. Replace complete line/tube as necessary.

Avoid contact of any fuel tubes/hoses with other vehicle components that could cause abrasions or scuffing. Be sure that the fuel lines/tubes are properly routed to prevent pinching and to avoid heat sources.

The lines/tubes/hoses are of a special construction. If it is necessary to replace these lines/tubes/hoses, use only original equipment type.

The hose clamps used to secure the rubber hoses are of a special rolled edge construction. This construction is used to prevent the edge of the clamp from cutting into the hose. Only these rolled edge type clamps may be used in this system. All other types of clamps may cut into the hoses and cause fuel leaks.

Where a rubber hose is joined to a metal tube (staked), do not attempt to repair. Replace entire line/tube assembly.

Use new original equipment type hose clamps. Tighten hose clamps to 2 N·m (20 in. lbs.) torque.

QUICK-CONNECT FITTINGS—LOW PRESSURE TYPE

Different types of quick-connect fittings are used to attach various fuel system components. These are: a single-tab type, a two-tab type or a plastic retainer ring type (Fig. 8). Refer to Quick-Connect Fittings in the Removal/Installation section for more information.

CAUTION: The interior components (o-rings, spacers) of quick-connect fitting are not serviced separately, but new pull tabs are available for some types. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

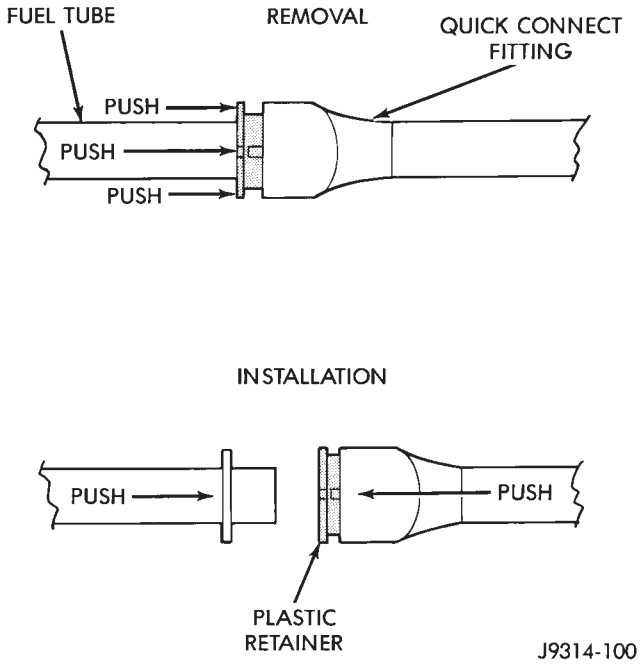


Fig. 8 Plastic Retainer Ring-Type Fitting

HIGH-PRESSURE FUEL LINES

CAUTION: The high–pressure fuel lines must be held securely in place in their holders. The lines cannot contact each other or other components. Do not attempt to weld high–pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high–pressure fuel line is necessary.

High–pressure fuel lines deliver fuel under pressure of up to approximately 45,000 kPa (6526 PSI) from the injection pump to the fuel injectors. The lines expand and contract from the high–pressure fuel pulses generated during the injection process. All high–pressure fuel lines are of the same length and inside diameter. Correct high–pressure fuel line usage and installation is critical to smooth engine operation.

WARNING: USE EXTREME CAUTION WHEN INSPECTING FOR HIGH–PRESSURE FUEL LEAKS. INSPECT FOR HIGH–PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. HIGH FUEL INJECTION PRESSURE CAN CAUSE PERSONAL INJURY IF CONTACT IS MADE WITH THE SKIN.

FUEL DRAIN TUBES

These rubber tubes are low–pressure type.

Some excess fuel is continually vented from the fuel injection pump. During injection, a small amount of fuel flows past the injector nozzle and is not injected into the combustion chamber. This fuel drains into the fuel drain tubes (Fig. 9) and back to the tee banjo fitting, which is connected to the same

DESCRIPTION AND OPERATION (Continued)

line as the overflow valve, which allows a variable quantity to return to the fuel tank. The overflow valve is calibrated to open at a preset pressure. Excess fuel not required by the pump to maintain the minimum pump cavity pressure is then returned through the overflow valve and on to the fuel tank through the fuel return line.

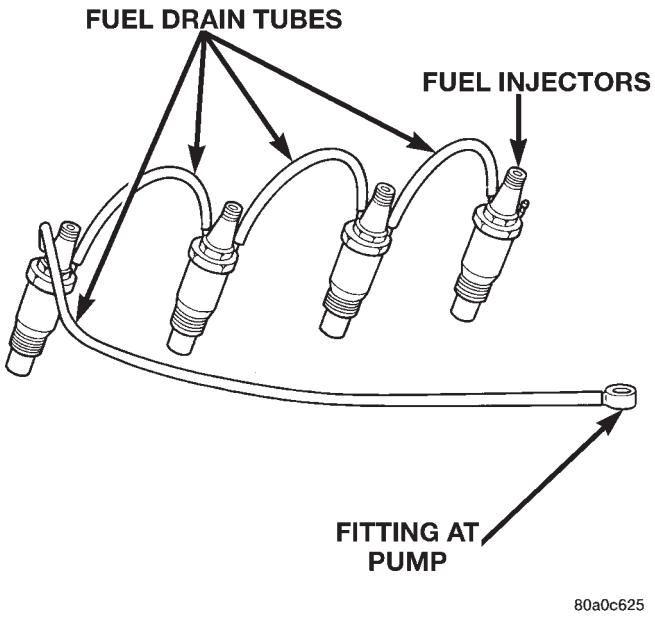


Fig. 9 Fuel Drain Tubes

FUEL HEATER

The fuel heater is used to prevent diesel fuel from waxing during cold weather operation. The fuel heater is located in the bottom plastic bowl of the fuel filter/water separator (Fig. 10).

The element inside the heater assembly is made of a Positive Temperature Coefficient (PTC) material, and has power applied to it by the fuel heater relay anytime the ignition key is in the “on” position. PTC material has a high resistance to current flow when its temperature temperature is high, which means that it will not generate heat when the temperature is above a certain value. When the temperature is below 7°C (45° F), the resistance of the PTC element is lowered, and allows current to flow through the fuel heater element warming the fuel. When the temperature is above 29°C (85° F), the PTC element’s resistance rises, and current flow through the heater element stops.

Voltage to operate the fuel heater is supplied from the ignition (key) switch and through the fuel heater relay. Refer to the following Fuel Heater Relay for additional information. **The fuel heater and fuel heater relay are not controlled by the Powertrain Control Module (PCM).**

Current draw for the heater element is 150 watts at 14 volts (DC).

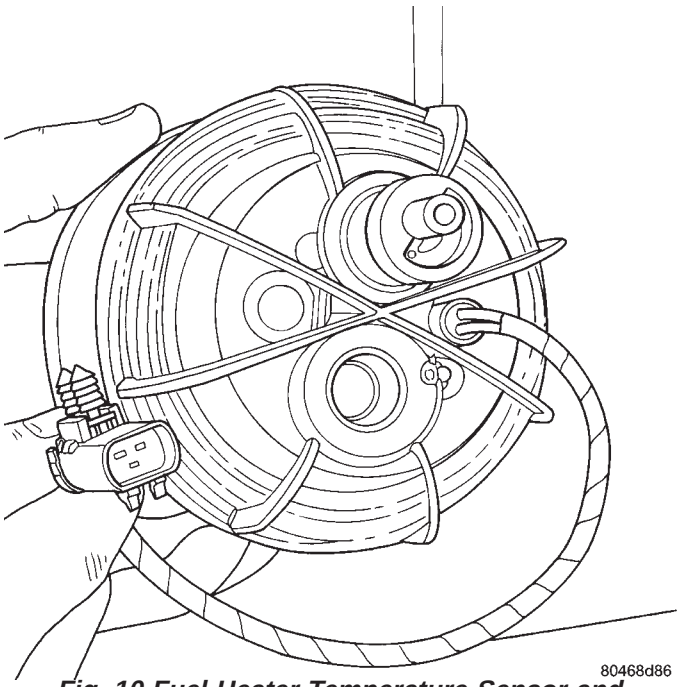


Fig. 10 Fuel Heater Temperature Sensor and Element Location

FUEL HEATER RELAY

Voltage to operate the fuel heater is supplied from the ignition (key) switch through the fuel heater relay. **The PCM or MSA is not used to control this relay.**

The fuel heater relay is located in the PDC. The PDC is located next to the battery in the engine compartment (Fig. 11). For the location of the relay within the PDC, refer to label on PDC cover.

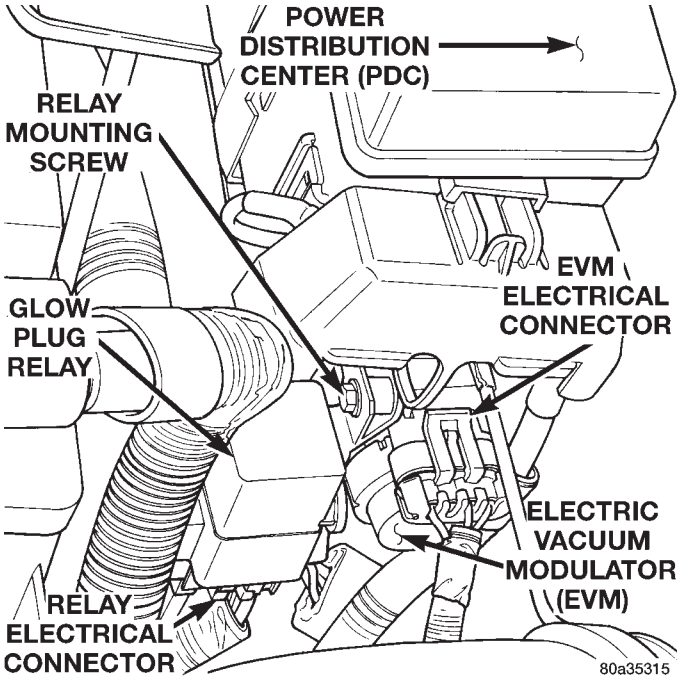


Fig. 11 Relay Location

DESCRIPTION AND OPERATION (Continued)

WASTEGATE (TURBOCHARGER)

Refer to Group 11, Exhaust System and Intake Manifold for information.

DIAGNOSIS AND TESTING

GENERAL INFORMATION

This section of the group will cover a general diagnosis of diesel engine fuel system components.

Diagnostic Trouble Codes: Refer to On-Board Diagnostics in Group 25, Emission Control System for a list of Diagnostic Trouble Codes (DTC's) for certain fuel system components.

The PCM and MSA must be tested with the DRBIII scan tool. The DRBIII should be the first step in any diagnosis of engine performance complaints. Refer to the 1997 ZJ/ZG 2.5L Diesel Powertrain Diagnostic Procedures manual for diagnosis and testing of the diesel engine control system.

VISUAL INSPECTION

A visual inspection for loose, disconnected, or incorrectly routed wires and hoses should be made before attempting to diagnose or service the diesel fuel injection system. A visual check will help find these conditions. It also saves unnecessary test and diagnostic time. A thorough visual inspection of the fuel injection system includes the following checks:

(1) Be sure that the battery connections are tight and not corroded.

(2) Be sure that the 60 way connector is fully engaged with the PCM (Fig. 12).

(3) Be sure that the 68 way connector is fully engaged with the MSA (Fig. 13)

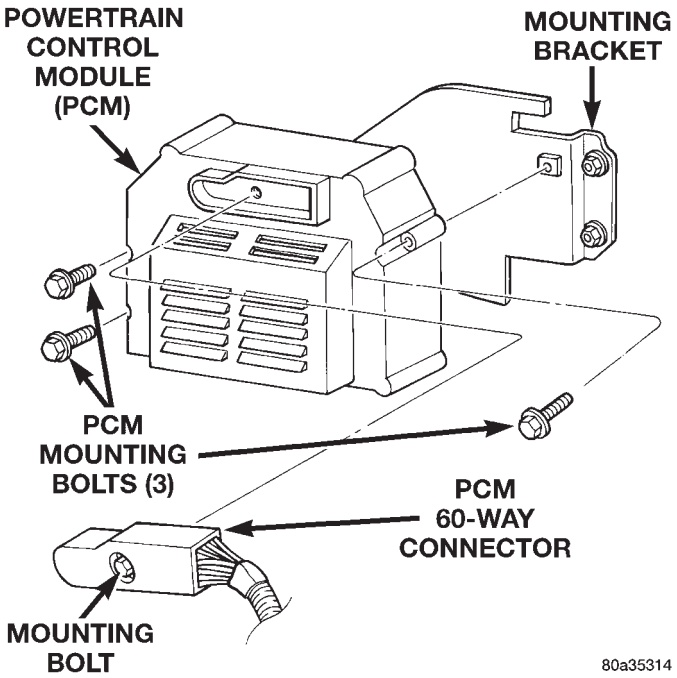


Fig. 12 PCM Location—Typical

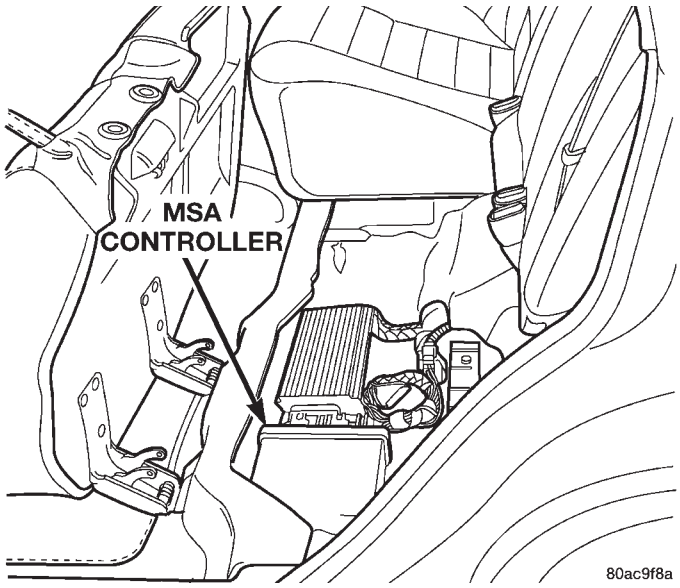


Fig. 13 MSA Location—Typical

(4) Verify that the electrical connections for the ASD relay are clean and free of corrosion. This relay is located in the PDC. For the location of the relay within the PDC, refer to label on PDC cover.

(5) Verify that the electrical connections for the fuel heater relay are clean and free of corrosion. This relay is located in the PDC. For the location of the relay within the PDC, refer to label on PDC cover.

(6) Be sure the electrical connectors at the ends of the glow plugs (Fig. 14) are tight and free of corrosion.

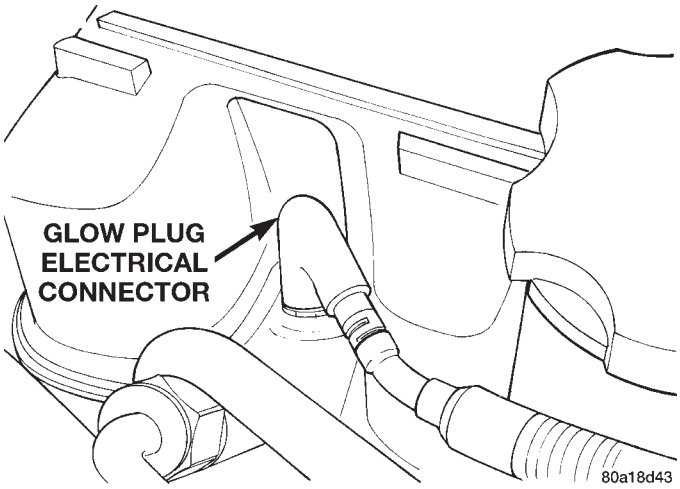


Fig. 14 Glow Plug Connector

DIAGNOSIS AND TESTING (Continued)

(7) Be sure that the electrical connections at the glow plug relay are tight and not corroded. The glow plug relay is located in the engine compartment on the left–inner fender (Fig. 15).

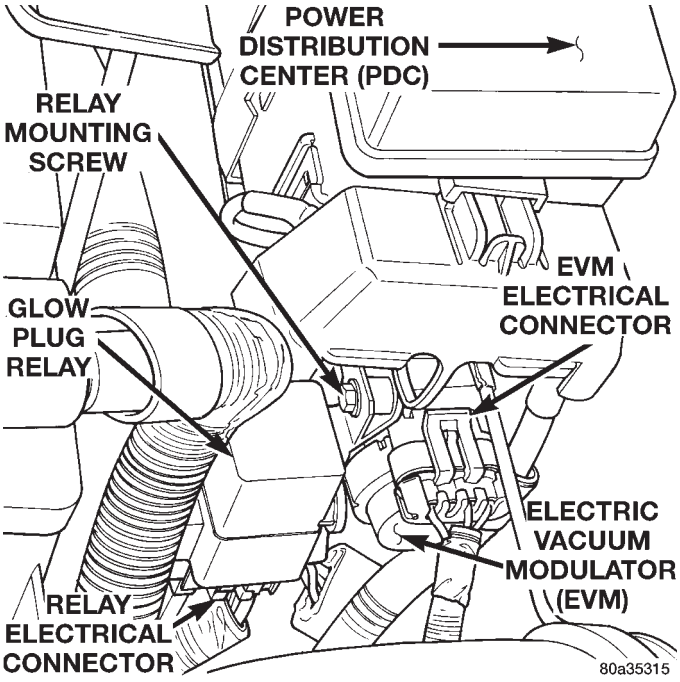


Fig. 15 Glow Plug Relay Location

(8) Inspect the starter motor and starter solenoid connections for tightness and corrosion.

(9) Verify that the Fuel Injection Pump electrical connector is firmly connected. Inspect the connector for corrosion or damaged wires. The solenoid is mounted to the rear of the injection pump (Fig. 16).

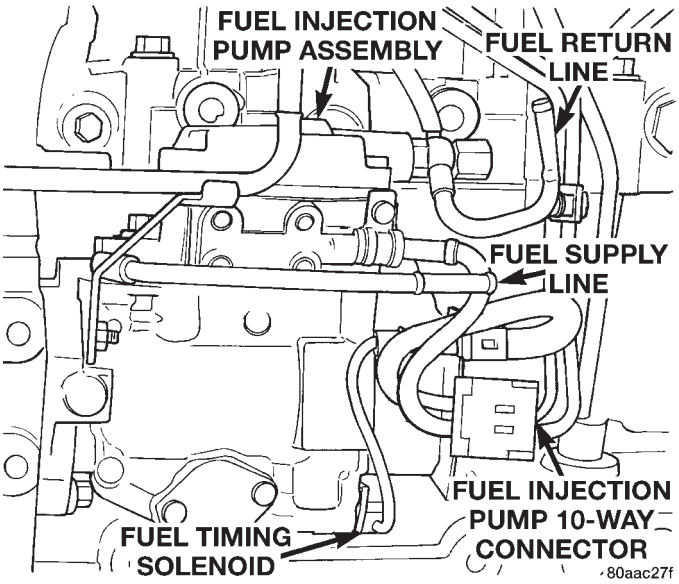


Fig. 16 Fuel Shutdown Solenoid Location

(10) Verify that the fuel heater electrical connector is firmly attached to the filter bowl at the bottom of the fuel filter/water separator. Inspect the connector for corrosion or damaged wires.

(11) Verify that the electrical pigtail connector (sensor connector) (Fig. 17) for the fuel injector sensor is firmly connected to the engine wiring harness. Inspect the connector for corrosion or damaged wires. This sensor is used on the #1 cylinder injector only.

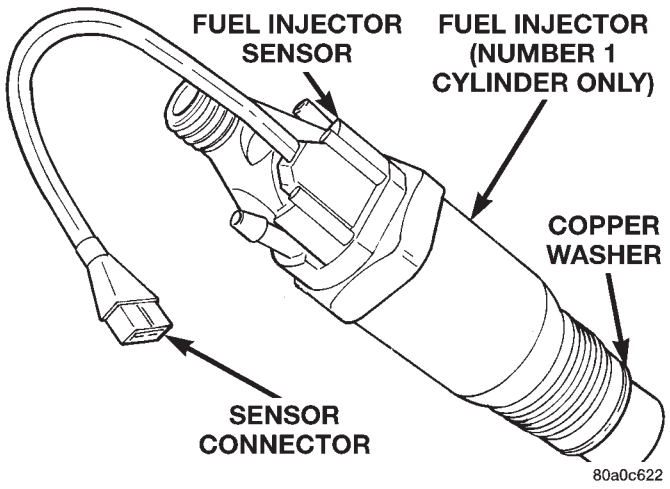


Fig. 17 Fuel Injector Sensor

(12) Inspect for exhaust system restrictions such as pinched exhaust pipes or a collapsed or plugged muffler.

(13) Verify that the harness connector is firmly connected to the vehicle speed sensor (Fig. 18) or (Fig. 19).

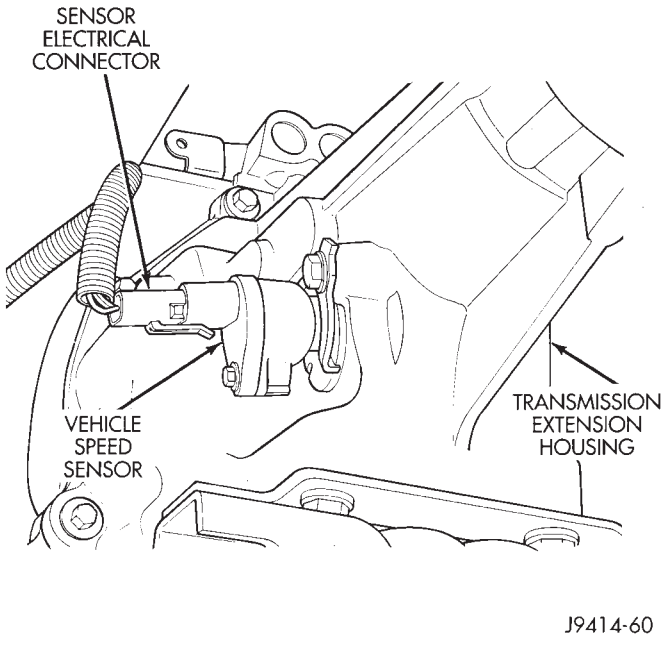


Fig. 18 Vehicle Speed Sensor—2 Wheel Drive

DIAGNOSIS AND TESTING (Continued)

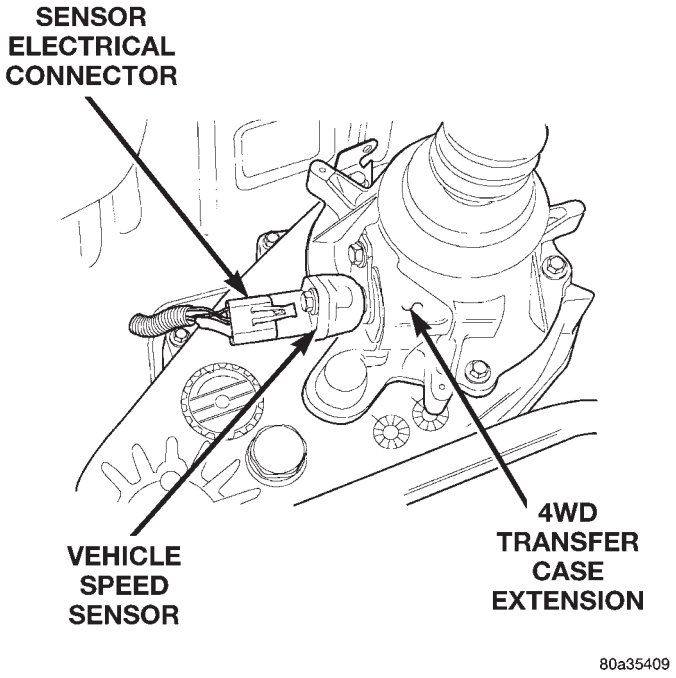


Fig. 19 Vehicle Speed Sensor—4 Wheel Drive

(14) Verify turbocharger wastegate operation. Refer to Group 11, Exhaust System and Intake Manifold Group for information.

(15) Verify that the harness connector is firmly connected to the engine coolant temperature sensor. The sensor is located on the side of cylinder head near the rear of fuel injection pump (Fig. 20).

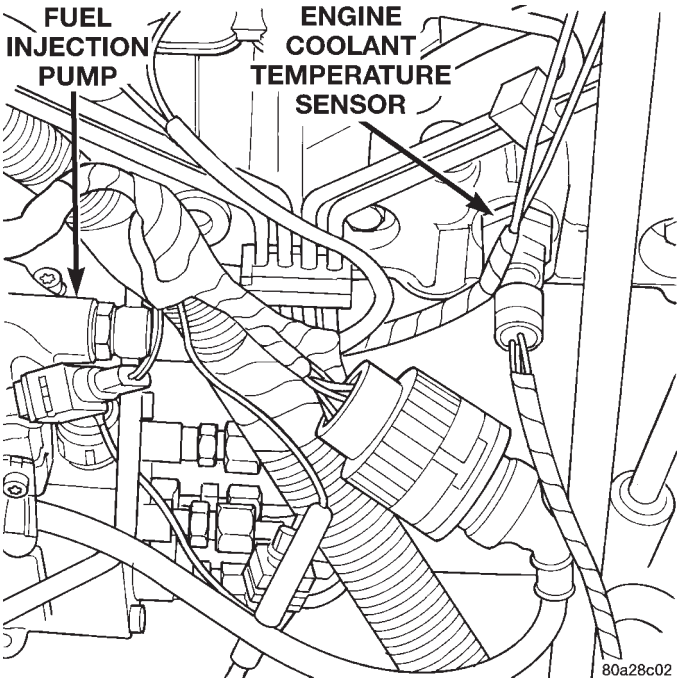


Fig. 20 Engine Coolant Temperature Sensor Location

(16) Check for air in the fuel system. Refer to the Air Bleed Procedure.

(17) Inspect all fuel supply and return lines for signs of leakage.

(18) Be sure that the ground connections are tight and free of corrosion. Refer to Group 8, Wiring for locations of ground connections.

(19) Inspect the air cleaner element (filter) for restrictions.

(20) Be sure that the turbocharger output hose is properly connected to the charge air cooler (intercooler) inlet tube. Verify that the charge air cooler output hose is properly connected to the cooler and the intake manifold. Refer to Group 11, Exhaust System and Intake Manifold for information.

(21) Be sure that the vacuum hoses to the vacuum pump are connected and not leaking. There are two pumps. One is located on the front of engine (internal) and is driven from the crankshaft gear (Fig. 22). The other is mounted to the front of the generator (Fig. 21). Disconnect the hose and check for minimum vacuum from the pump. Refer to Group 5, Brake System for specifications and procedures.

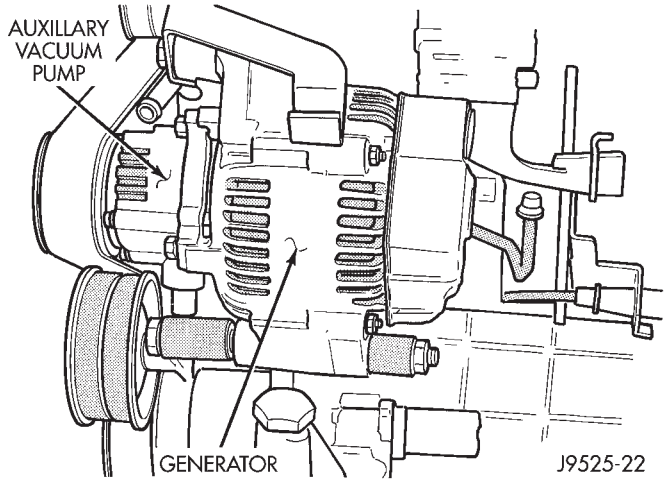


Fig. 21 Vacuum Pump at Generator

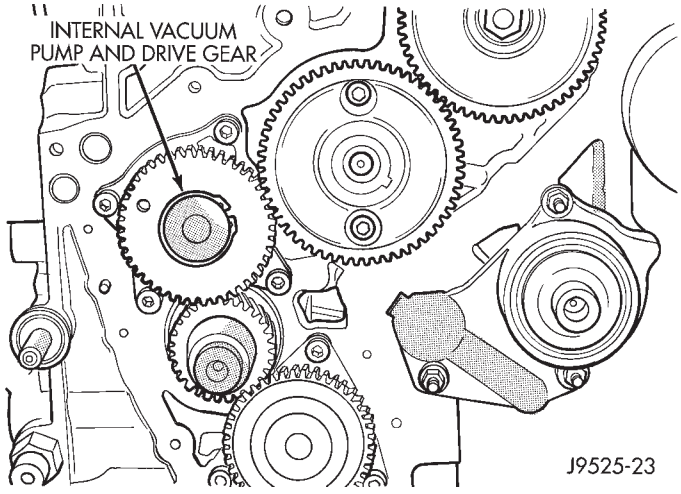


Fig. 22 Vaccum Pump at Front of Engine

(22) Be sure that the accessory drive belt is not damaged or slipping.

DIAGNOSIS AND TESTING (Continued)

(23) Verify there is a good connection at the engine speed sensor. Refer to the Fuel Injection System in this section for location of the engine speed sensor location.

(24) Verify there is a good connection at the Mass Air Flow Sensor, which is a part of the air intake assembly.

AIR IN FUEL SYSTEM

Air will enter the fuel system whenever the fuel supply lines, fuel filter/water separator, fuel filter bowl, injection pump, high–pressure lines or injectors are removed or disconnected. Air will also enter the fuel system whenever the fuel tank has been run empty.

Air trapped in the fuel system can result in hard starting, a rough running engine, engine misfire, low power, excessive smoke and fuel knock. After service is performed, air must be bled from the system before starting the engine.

Inspect the fuel system from the fuel tank to the injectors for loose connections. Leaking fuel is an indicator of loose connections or defective seals. Air can also enter the fuel system between the fuel tank and the injection pump. Inspect the fuel tank and fuel lines for damage that might allow air into the system.

For air bleeding, refer to Air Bleed Procedure in the Service Procedures section of this group.

FUEL HEATER RELAY TEST

The fuel heater relay is located in the Power Distribution Center (PDC). Refer to Relays—Operation/ Testing in Fuel Ingection System section of this group for test procedures.

FUEL INJECTOR TEST

The fuel injection nozzels, located on the engine cylinder head, spray fuel under high pressure into the individual combustion chambers. Pressurized fuel, delivered by the fuel injection pump, unseats a spring-loaded needle valve inside the injector, and the fuel is atomized as it escapes through the injector opening into the engine's combustion chamber. If the fuel injector does not operate properly, the engine may misfire, or cause other driveability problems.

A leak in the injection pump–to–injector high–pressure fuel line can cause many of the same symptoms as a malfunctioning injector. Inspect for a leak in the high–pressure lines before checking for a malfunctioning fuel injector.

WARNING: THE INJECTION PUMP SUPPLIES HIGH–PRESSURE FUEL OF UP TO APPROXIMATELY 45,000 KPA (6526 PSI) TO EACH INDIVIDUAL INJECTOR THROUGH THE HIGH–PRESSURE LINES. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE THE SKIN AND CAUSE PERSONAL INJURY. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING. AVOID CONTACT WITH FUEL SPRAY WHEN BLEEDING HIGH–PRESSURE FUEL LINES.

WARNING: DO NOT BLEED AIR FROM THE FUEL SYSTEM OF A HOT ENGINE. DO NOT ALLOW FUEL TO SPRAY ONTO THE EXHAUST MANIFOLD WHEN BLEEDING AIR FROM THE FUEL SYSTEM.

To determine which fuel injector is malfunctioning, run the engine and loosen the high–pressure fuel line nut at the injector (Fig. 23). Listen for a change in engine speed. If engine speed drops, the injector was operating normally. If engine speed remains the same, the injector may be malfunctioning. After testing, tighten the line nut to 30 N·m (22 ft. lbs.) torque. Test all injectors in the same manner one at a time.

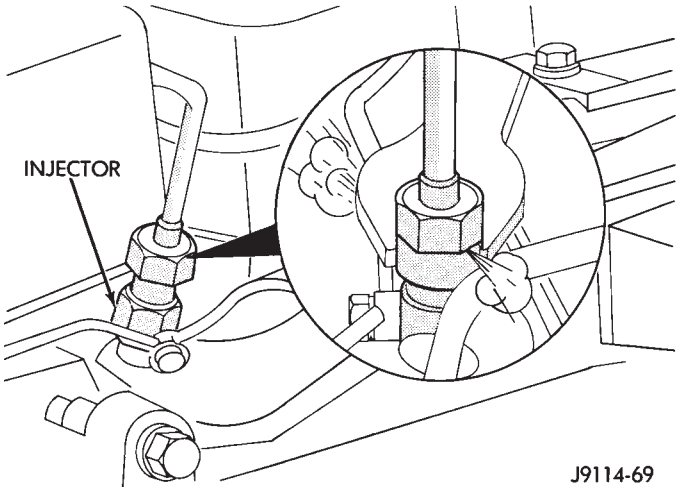


Fig. 23 Typical Inspection of Fuel Injector

Once an injector has been found to be malfunctioning, remove it from the engine and test it. Refer to the Removal/Installation section of this group for procedures.

After the injector has been removed, install it to a bench–mount injector tester. Refer to operating instructions supplied with tester for procedures.

The opening pressure or “pop” pressure should be 15,000–15,800 kPa (2175–2291 psi). If the fuel injector needle valve is opening (“popping”) to early or to late, replace the injector.

DIAGNOSIS AND TESTING (Continued)

FUEL INJECTOR SENSOR TEST

The fuel injector sensor is used only on the fuel injector for the number–1 cylinder (Fig. 24). It is not used on the injectors for cylinders number 2, 3, or 4.

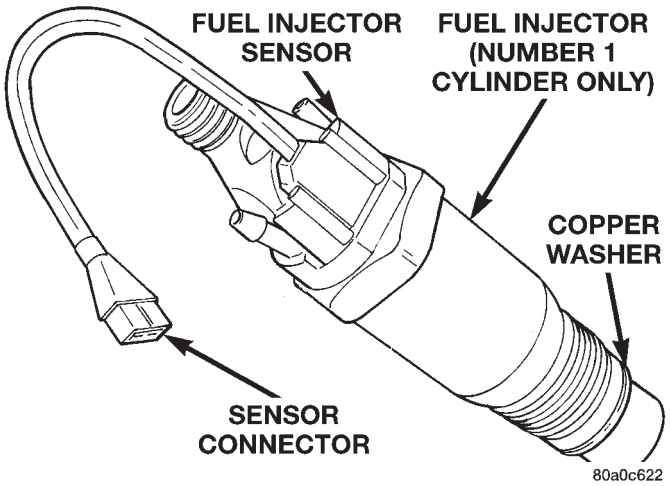


Fig. 24 Fuel Injector Sensor Location

To test the sensor, unplug the sensor connector (Fig. 24) from the engine wiring harness. Check resistance across terminals. Resistance should be 110 ohms ± 10 ohms at 20°C (68°F). Replace sensor if specification cannot be met.

FUEL INJECTION PUMP TEST

The injection pump is not to be serviced or the warranty may be voided. If the injection pump requires service, the complete assembly must be replaced.

Incorrect injection pump timing (mechanical or electrical) can cause poor performance, excessive smoke and emissions and poor fuel economy.

A defective fuel injection pump, defective fuel timing solenoid or misadjusted mechanical pump timing can cause starting problems or prevent the engine from revving up. It can also cause:

- Engine surge at idle
- Rough idle (warm engine)
- Low power
- Excessive fuel consumption
- Poor performance
- Low power
- Black smoke from the exhaust
- Blue or white fog like exhaust
- Incorrect idle or maximum speed

The electronically controlled fuel pump has no mechanical governor like older mechanically controlled fuel pumps. Do not remove the top cover of the fuel pump, or the screws fastening the wiring pigtail to the side of the pump. **The warranty of the injection pump and the engine may be void if those seals have been removed or tampered with.**

FUEL SUPPLY RESTRICTIONS

LOW–PRESSURE LINES

Restricted or Plugged supply lines or fuel filter can cause a timing fault that will cause the PCM to operate the engine in a “Limp Home” mode. See the introduction of the Fuel Injection System in this group for more information on the Limp Home mode. Fuel supply line restrictions can cause starting problems and prevent the engine from revving up. The starting problems include; low power and blue or white fog like exhaust. Test all fuel supply lines for restrictions or blockage. Flush or replace as necessary. Bleed the fuel system of air once a fuel supply line has been replaced. Refer to the Air Bleed Procedure section of this group for procedures.

HIGH–PRESSURE LINES

Restricted (kinked or bent) high–pressure lines can cause starting problems, poor engine performance and black smoke from exhaust.

Examine all high–pressure lines for any damage. Each radius on each high–pressure line must be smooth and free of any bends or kinks.

Replace damaged, restricted or leaking high–pressure fuel lines with the correct replacement line.

CAUTION: The high–pressure fuel lines must be clamped securely in place in the holders. The lines cannot contact each other or other components. Do not attempt to weld high–pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high–pressure fuel line is necessary.

FUEL SHUTDOWN SOLENOID TEST

Refer to 1997 ZJ/ZG 2.5L Diesel Powertrain Diagnostic Manual for the Fuel Shutdown Solenoid test.

HIGH-PRESSURE FUEL LINE LEAK TEST

High–pressure fuel line leaks can cause starting problems and poor engine performance.

WARNING: DUE TO EXTREME FUEL PRESSURES OF UP TO 45,000 KPA (6526 PSI), USE EXTREME CAUTION WHEN INSPECTING FOR HIGH–PRESSURE FUEL LEAKS. DO NOT GET YOUR HAND, OR ANY PART OF YOUR BODY NEAR A SUSPECTED LEAK. INSPECT FOR HIGH–PRESSURE FUEL LEAKS WITH A SHEET OF CARDBOARD. HIGH FUEL INJECTION PRESSURE CAN CAUSE PERSONAL INJURY IF CONTACT IS MADE WITH THE SKIN.

DIAGNOSIS AND TESTING (Continued)

Start the engine. Move the cardboard over the high–pressure fuel lines and check for fuel spray onto the cardboard (Fig. 25). If a high–pressure line connection is leaking, bleed the system and tighten the connection. Refer to the Air Bleed Procedure in this group for procedures. Replace damaged, restricted or leaking high–pressure fuel lines with the correct replacement line.

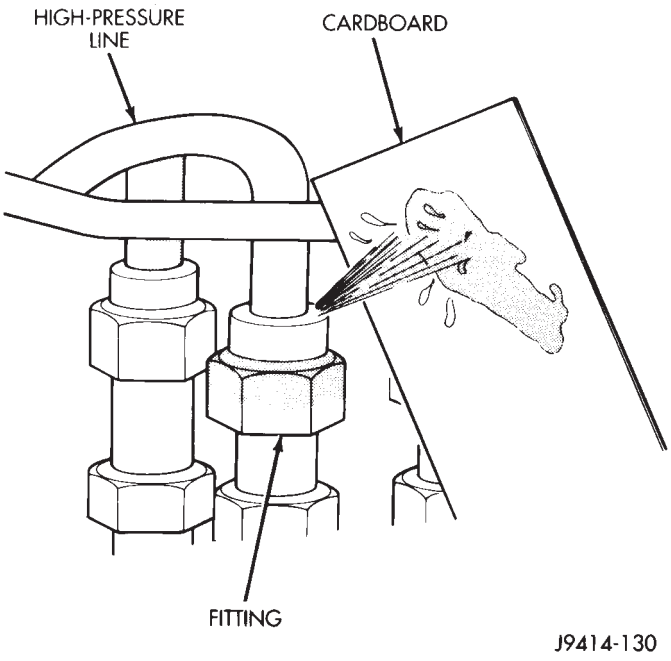


Fig. 25 Typical Test for Leaks with Cardboard

CAUTION: The high–pressure fuel lines must be clamped securely in place in the holders. The lines cannot contact each other or other components. Do not attempt to weld high–pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high–pressure fuel line is necessary.

WASTEGATE (TURBOCHARGER)

Refer to Group 11, Exhaust System and Intake Manifold for information.

SERVICE PROCEDURES

AIR BLEED PROCEDURES

AIR BLEEDING AT FUEL FILTER

A certain amount of air may become trapped in the fuel system when fuel system components are serviced or replaced. Bleed the system as needed after fuel system service according to the following procedures.

WARNING: DO NOT BLEED AIR FROM THE FUEL SYSTEM OF A HOT ENGINE. DO NOT ALLOW FUEL TO SPRAY ONTO THE EXHAUST MANIFOLD WHEN BLEEDING AIR FROM THE FUEL SYSTEM.

Some air enters the fuel system when the fuel filter or injection pump supply line is changed. This small amount of air is vented automatically from the injection pump through the fuel drain manifold tubes if the filter was changed according to instructions. Ensure the bowl of the fuel filter/water separator is full of fuel

It may be necessary to manually bleed the system if:

- The bowl of the fuel filter/water separator is not partially filled before installation of a new filter
- The injection pump is replaced
- High–pressure fuel line connections are loosened or lines replaced
- Initial engine start–up or start–up after an extended period of no engine operation
- Running fuel tank empty

FUEL INJECTION PUMP BLEEDING

(1) If the fuel injection pump has been replaced, air should be bled at the overflow valve before attempting to start engine.

(a) Loosen the overflow valve (Fig. 26) at the rear of the injection pump.

(b) Place a towel below the valve.

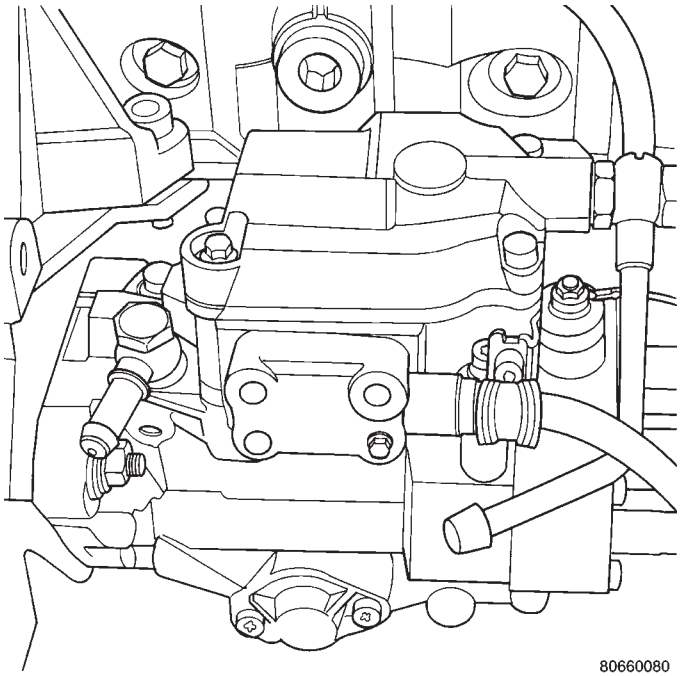


Fig. 26 Overflow Valve

SERVICE PROCEDURES (Continued)

WARNING: WHEN CRANKING THE ENGINE TO BLEED AIR FROM THE INJECTION PUMP, THE ENGINE MAY START. PLACE THE TRANSMISSION IN NEUTRAL OR PARK AND SET PARKING BRAKE BEFORE ENGAGING THE STARTER MOTOR.

CAUTION: Do not engage the starter motor for more than 30 seconds at a time. Allow 2 minutes between cranking intervals.

(2) Crank the engine for 30 seconds at a time to allow air trapped in the injection pump to vent out the fuel injector drain tubes. Continue this procedure until the engine starts. Observe the previous WARNING and CAUTION.

(3) Tighten overflow valve.

HIGH–PRESSURE FUEL LINE BLEEDING

WARNING: THE INJECTION PUMP SUPPLIES HIGH–PRESSURE FUEL OF APPROXIMATELY 59,000 KPA (8,557 PSI) TO EACH INDIVIDUAL INJECTOR THROUGH THE HIGH–PRESSURE LINES. FUEL UNDER THIS AMOUNT OF PRESSURE CAN PENETRATE THE SKIN AND CAUSE PERSONAL INJURY. WEAR SAFETY GOGGLES AND ADEQUATE PROTECTIVE CLOTHING AND AVOID CONTACT WITH FUEL SPRAY WHEN BLEEDING HIGH–PRESSURE FUEL LINES.

WARNING: DO NOT BLEED AIR FROM THE FUEL SYSTEM OF A HOT ENGINE. DO NOT ALLOW FUEL TO SPRAY ONTO THE EXHAUST MANIFOLD WHEN BLEEDING AIR FROM THE FUEL SYSTEM.

Bleed air from one injector at time.

(1) Loosen the high–pressure fuel line fitting at the injector (Fig. 27).

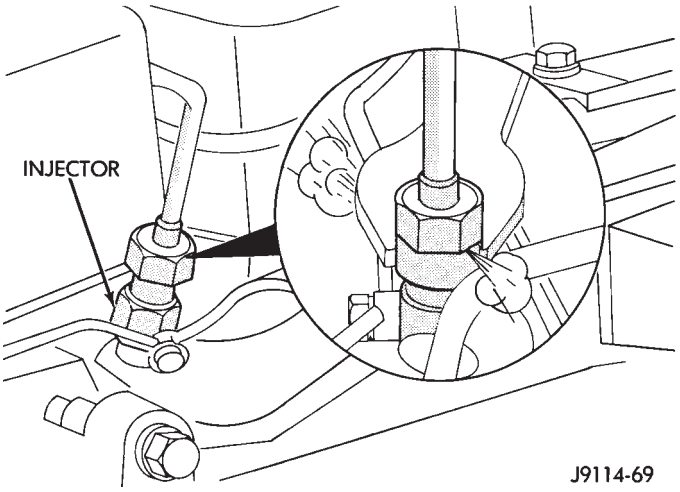


Fig. 27 Bleeding High–Pressure Fuel Line—Typical

(2) Crank the engine until all air has been bled from the line. **Do not operate the starter motor for longer than 30 seconds. Wait 2 minutes between cranking intervals.**

(3) Start the engine and bleed one injector at a time until the engine runs smoothly.

FUEL INJECTION PUMP TIMING

Refer to Removal/Installation and Adjusting Fuel Pump Timing in this Group.

REMOVAL AND INSTALLATION

ACCELERATOR PEDAL

CAUTION: Be careful not to damage or kink the cable core wire (within the cable sheathing) while servicing the accelerator pedal or throttle cable.

REMOVAL

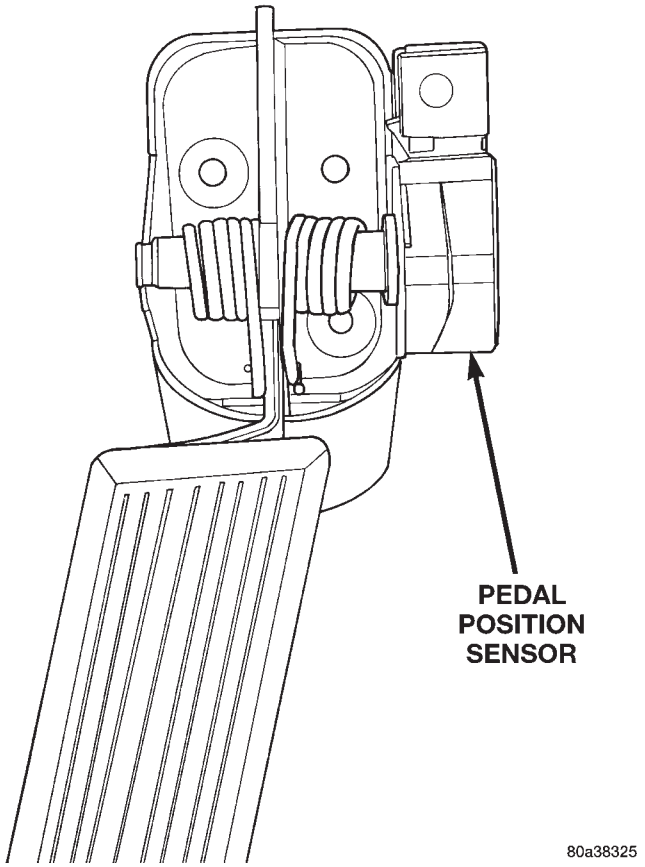


Fig. 28 Accelerator Pedal Mounting-Typical

(1) Disconnect electrical connector.

(2) Remove accelerator pedal mounting bracket nuts. Remove accelerator pedal assembly.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Place accelerator pedal assembly over studs protruding from floor pan. Tighten mounting nuts to 5 N·m (46 in. lbs.) torque.

(2) Connect electrical connector.

(3) Before starting the engine, operate the accelerator pedal to check for any binding.

AIR CLEANER ELEMENT

REMOVAL

(1) Remove hose clamp at Mass Air Flow Sensor.

(2) Remove hose from Mass Air Flow Sensor.

(3) Loosen 2 clamps holding air cleaner housing halves together.

(4) Remove left side of air cleaner housing.

(5) Remove element from air cleaner housing.

INSTALLATION

(1) Install a new element in housing.

(2) Position left side of housing.

(3) Snap clamps into place.

(4) Install hoses and clamps.

FUEL DRAIN TUBES

The fuel drain tubes (Fig. 29) are low–pressure type.

Pull each tube from the injector for removal. Push on for installation. Clamps are not required for these tubes.

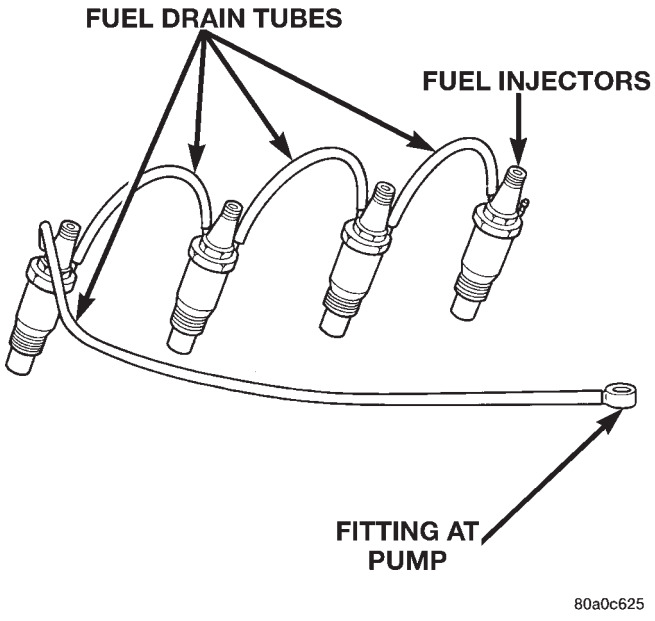


Fig. 29 Fuel Drain Tubes

FUEL FILTER/WATER SEPARATOR

The fuel filter/water separator is located in the engine compartment on the right side near the shock tower. (Fig. 30).

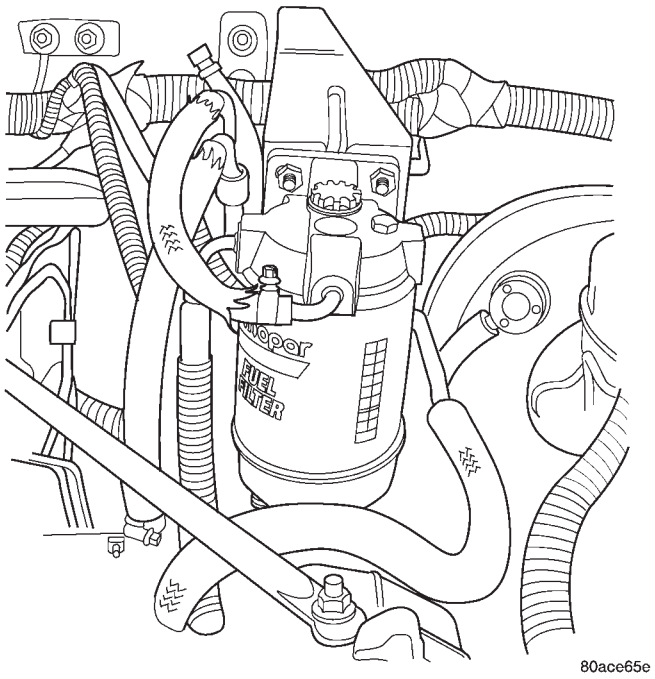


Fig. 30 Fuel Filter/Water Separator Location

The fuel filter/water separator assembly contains the fuel filter, fuel heater element, and fuel drain valve (Fig. 30).

DRAINING WATER FROM FILTER BOWL

Moisture (water) collects at the bottom of the filter/separator in a plastic bowl. Water entering the fuel injection pump can cause serious damage to the pump. **Note that the bulb will be illuminated for approximately 2 seconds each time the key is initially placed in the ON position. This is done for a bulb check.**

WARNING: DO NOT ATTEMPT TO DRAIN WATER FROM THE FILTER/SEPARATOR WITH THE ENGINE HOT.

(1) The bottom of the filter/separator bowl is equipped with a drain valve (Fig. 30). The drain valve is equipped with a fitting. Attach a piece of rubber hose to this fitting. This hose is to be used as a drain hose.

(2) Place a drain pan under the drain hose.

(3) With the engine not running, open the drain valve (unscrew—drain valve has right hand threads) from the filter/separator bowl. To gain access to this fitting, the two filter–to–mounting bracket nuts (Fig. 30) may have to be loosened a few turns.

REMOVAL AND INSTALLATION (Continued)

(4) Hold the drain open until clean fuel exits the drain.
(5) After draining, close drain valve.
(6) Remove rubber drain hose.
(7) Dispose of mixture in drain pan according to applicable local or federal regulations.

FUEL FILTER REMOVAL

(1) Drain all fuel and/or water from fuel filter/water separator assembly. Refer to the previous Draining Water From Filter Bowl.
(2) Unplug the electrical connectors at bottom of plastic bowl.
(3) Remove plastic bowl from bottom of fuel filter (unscrews).
(4) Remove fuel filter from bottom of filter base (unscrews).

FUEL FILTER INSTALLATION

(1) Clean bottom of fuel filter base.
(2) Apply clean diesel fuel to new fuel filter gasket.
(3) Install and tighten filter to filter base. The beveled part of the rubber gasket should be facing up towards the filter base.
(4) Clean the inside of bowl with a soap and water mixture before installation. Carefully clean any residue between the two metal probes at the top of the water–in–fuel sensor. Do not use chemical cleaners as damage to the plastic bowl may result.
(5) Pour diesel fuel into the plastic bowl before installing bowl to bottom of fuel filter. Do this to help prevent air from entering fuel injection pump while attempting to starting engine.
(6) Install filter bowl to bottom of filter.
(7) Install the electrical connectors at bottom of bowl.
(8) Tighten the filter–to–mounting bracket nuts (Fig. 30) to 28 N·m (250 in. lbs.) torque.

FUEL HEATER

If the fuel heater element needs replacement, the plastic filter bowl assembly must be replaced. Refer to Fuel Filter/Water Separator for information.

FUEL HEATER RELAY

The fuel heater relay is located in the PDC. For the location of the relay within the PDC (Fig. 31), refer to label on PDC cover.

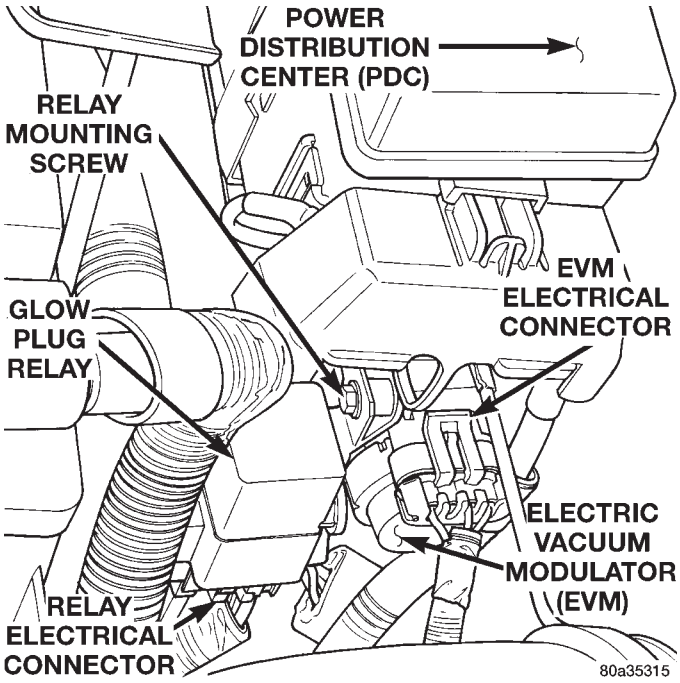


Fig. 31 Power Distribution Center (PDC) Location

FUEL LEVEL SENSOR

The fuel level sensor is located on the side of the fuel pump module. (Fig. 32)

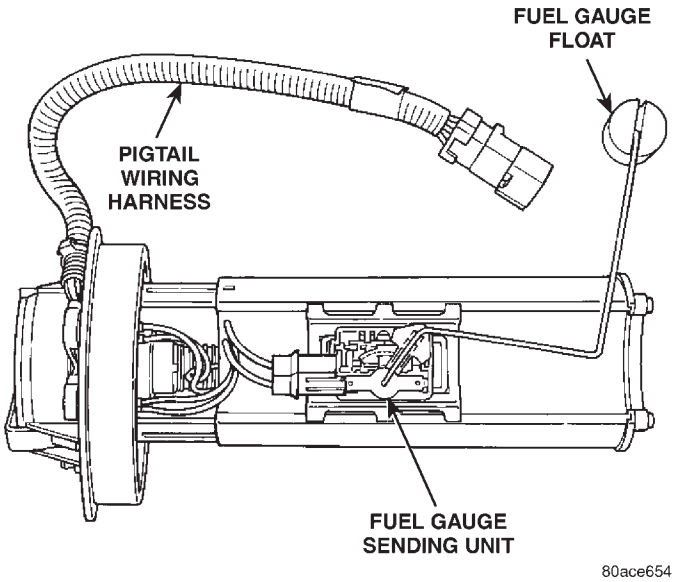


Fig. 32 Fuel Level Sensor

REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) Remove fuel tank. Refer to Fuel Tank Removal/ Installation.

(2) Remove fuel pump module. Refer to Fuel Pump Module Removal/Installation

(3) Remove electrical wire connector at sending unit terminals.

(4) Press on release tab (Fig. 33) to remove sending unit from pump module.

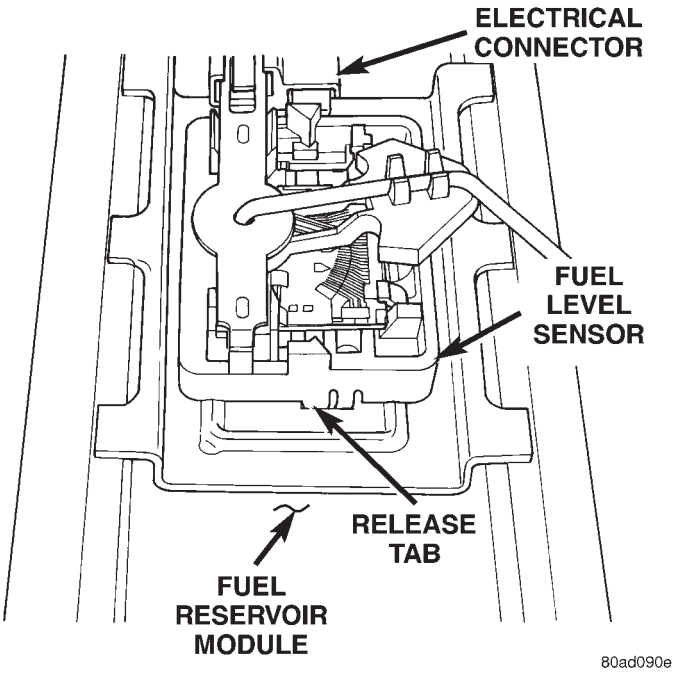


Fig. 33 Fuel Level Sensor Release Tab

FUEL INJECTION PUMP

REMOVAL

(1) Disconnect negative battery cable at battery.

(2) Thoroughly clean the area around the injection pump and fuel lines of all dirt, grease and other contaminants. **Due to the close internal tolerances of the injection pump, this step must be performed before removing pump.**

(3) Remove the engine accessory drive belt. Refer to Group 7, Cooling System for procedures.

(4) Remove the generator assembly.

(5) Remove the rubber fuel return and supply hoses from metal lines at pump (Fig. 34).

(6) Remove the electrical connector at engine coolant temperature sensor (Fig. 35).

(7) Disconnect the Fuel Injection Pump electrical connector at fuel pump. (Fig. 34).

(8) Disconnect the main engine wiring harness from the glow plugs.

(9) Disconnect the four high–pressure fuel lines from the fuel injection pump. Also disconnect fuel lines at the fuel injectors. For procedures, refer to

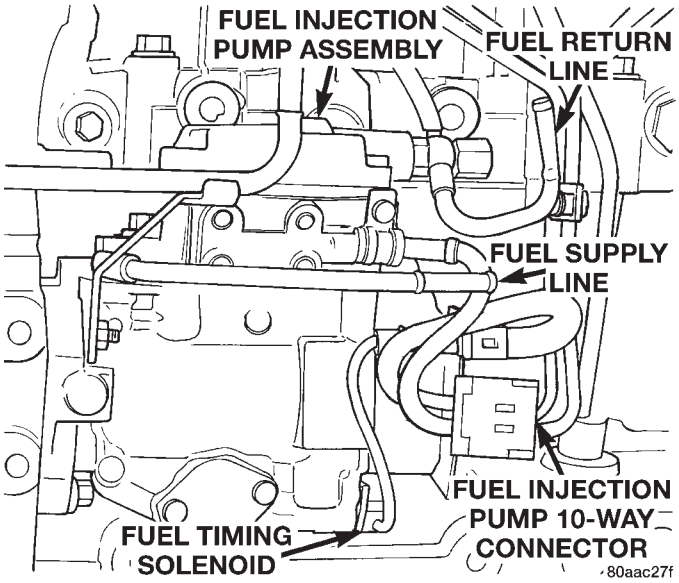


Fig. 34 Overflow Valve and Fuel Shutdown Solenoid

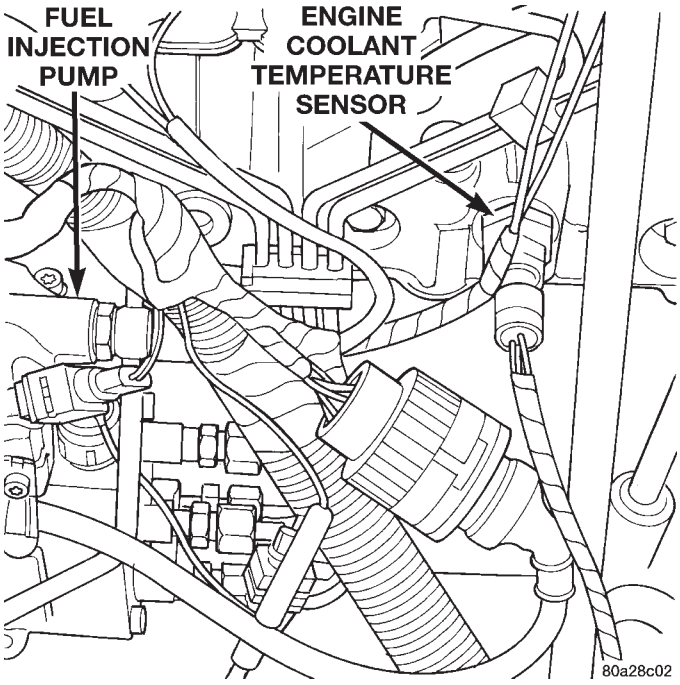


Fig. 35 Engine Coolant Temperature Sensor

High–Pressure Fuel Lines in this group. Place a rag beneath the fittings to catch excess fuel.

(10) Remove plug from timing gear cover.

(11) The “Top Dead Center” (TDC) compression firing stroke must be determined as follows:

(a) Remove the valve cover, refer to Group 9, Valve Cover Removal/Installation.

(b) Remove the right front tire and splash shield. Using a socket attached to the end of crankshaft, rotate the engine (counter—clockwise as viewed from front).

(c) Rotate the engine until cylinder #4 rockers are in between movement.

REMOVAL AND INSTALLATION (Continued)

(d) Remove rocker arm assembly.

(e) Remove valve spring and keepers. **CAUTION: When the piston is at TDC there is only 2 mm (.080 thousand) clearance between the valve and piston.**

(f) Let the valve set on top of piston. Install a dial indicator to the top of the valve stem.

(g) Rotate engine back and forth to find the TDC position with the indicator on the valve stem. Mark the damper and timing cover for TDC.

NOTE: On later model 1997 engines, a hole in the bottom of the clutch housing can be lined up with a hole in the flywheel, allowing the engine to be held at TDC with a special alignment tool, part # VM1035.

(12) Remove injection pump drive gear nut (Fig. 36) and washer. **CAUTION: Be very careful not to drop the washer into the timing gear cover.**

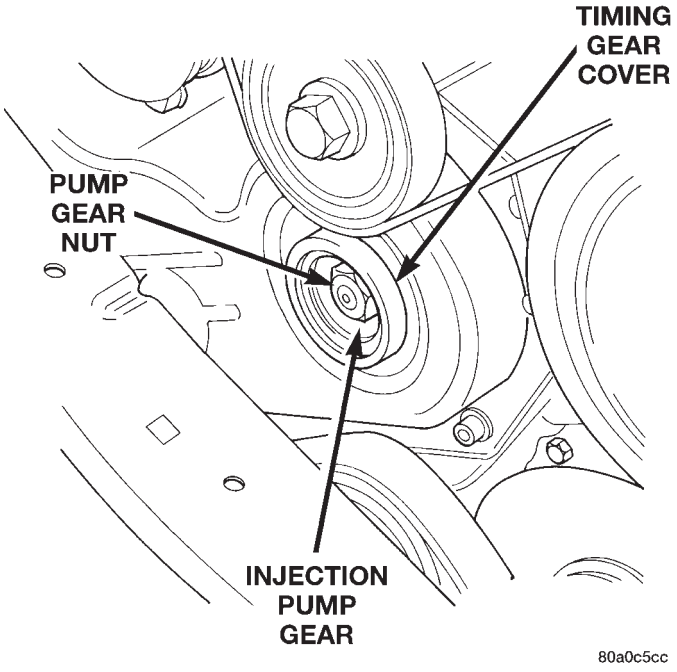


Fig. 36 Removing Pump Drive Gear Nut

(13) A special 3–piece gear removal tool set VM.1003 (Fig. 37) must be used to remove the injection pump drive gear from the pump shaft.

(a) Thread the adapter (Fig. 38) into the timing cover.

(b) Thread the gear puller into the injection pump drive gear (Fig. 38). This tool is also used to hold the gear in synchronization during pump removal.

(c) Remove the three injection pump–to–gear cover mounting nuts (Fig. 39). **CAUTION: This step must be done to prevent breakage of the three injection pump mounting flanges while gear is being removed.**

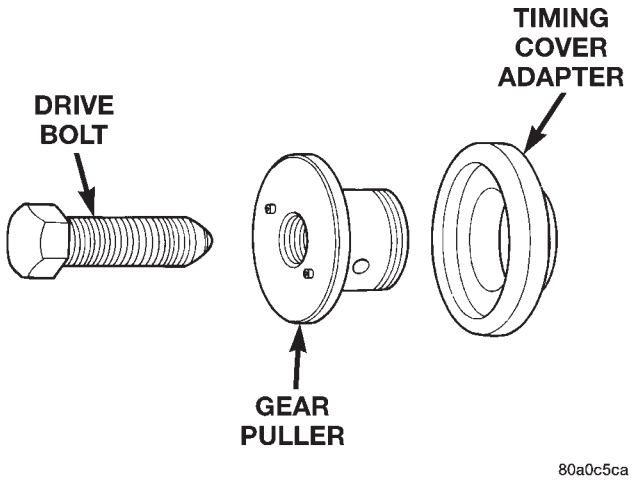


Fig. 37 Pump Gear Tools

(d) Install the drive bolt into the gear puller (Fig. 38). Tighten the drive bolt to press (remove) the drive gear from injection pump shaft while driving injection pump rearward from timing gear cover mounting studs.

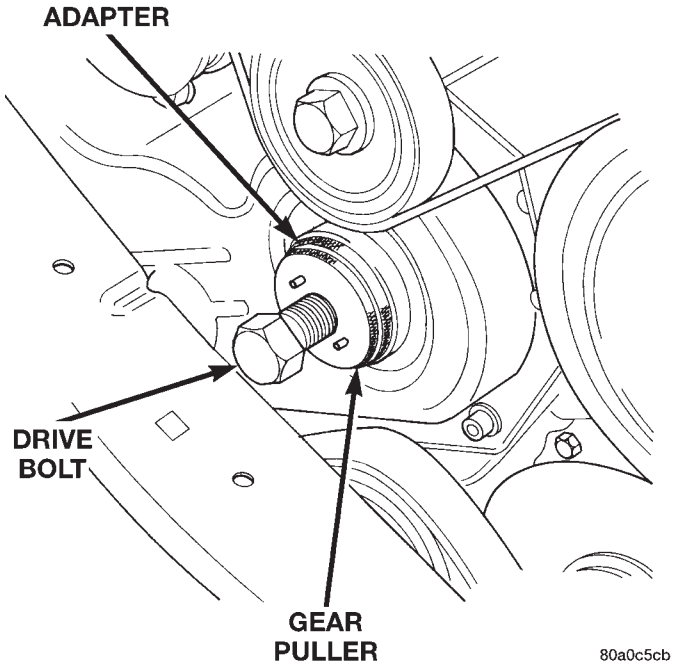


Fig. 38 Installing Pump Drive Gear Removal Tools

(14) Remove pump from engine. **Do not rotate engine while gear puller is installed. Engine damage will occur.**

INSTALLATION/ADJUSTING PUMP TIMING

(1) Clean the mating surfaces of injection pump and timing gear cover.

(2) Install a new injection pump–to–timing gear cover gasket.

REMOVAL AND INSTALLATION (Continued)

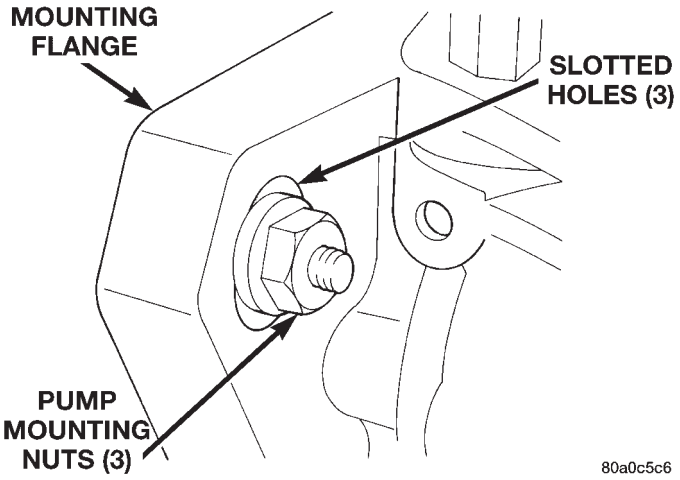


Fig. 39 Injection Pump Mounting Nuts

(3) Remove the gear removing bolt (drive bolt) from gear puller. **CAUTION: Do not remove the special gear puller or timing cover adapter tools from timing cover at this time. Gear misalignment will result.**

(4) Place the key way on the pump shaft to the 11 o'clock position as viewed from the front of pump. Install the pump into the rear of timing gear cover while aligning key way on pump shaft into pump gear.

(5) Install and snug the 3 injection pump mounting nuts. This is not the final tightening sequence.

(6) Remove the special gear puller and adapter tools from timing gear cover.

(7) Install the injection pump drive gear nut and washer. Tighten nut to 88 N·m (65 ft. lbs.) torque.

(8) Remove access plug and plug washer at rear of pump (Fig. 40). Thread special dial indicator adapter tool VM.1011 (Fig. 41) into this opening. Hand tighten only.

(9) Attach special dial indicator tool VM.1013 into the adapter tool (Fig. 41).

(10) Using a socket attached to the end of crankshaft, rotate the engine (counter—clockwise as viewed from front) until thedial indicator stops moving. This rotation is about 20° to 30°.

(11) Set the dial indicator to 0 mm. Be sure the tip of dial indicator is touching the tip inside the adapter tool.

(12) Very slowly rotate the crankshaft clockwise until movement on dial indicator needle has stopped. **Do not rotate crankshaft after needle movement has stopped. Engine should be at TDC at this point**

(13) Check the TDC dial indicator for TDC.

(14) Gauge reading should be at 0.60 mm. If not, the pump must be rotated for adjustment:

(a) Loosen the three injection pump mounting nuts at the mounting flanges. These flanges are equipped with slotted holes. The slotted holes are used to rotate and position the injection pump for fuel timing. Loosen the three nuts just enough to rotate the pump.

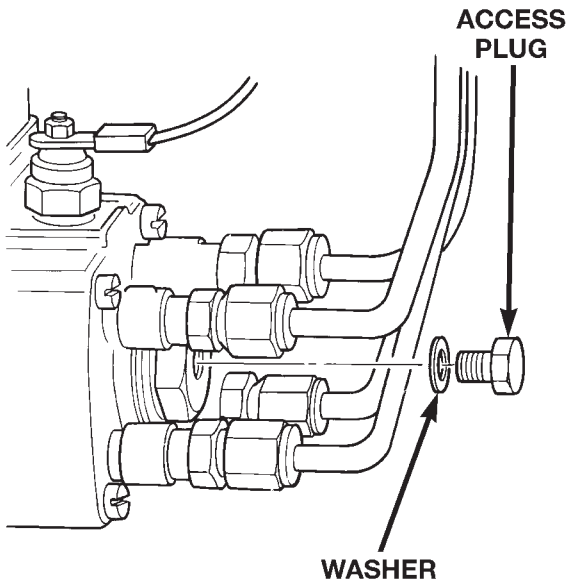


Fig. 40 Access Plug at Rear of Pump

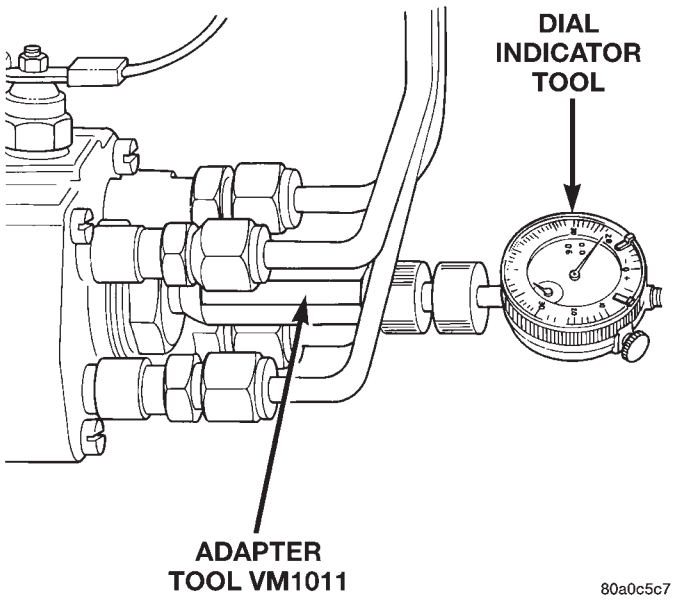


Fig. 41 Installing Dial Indicator and Special Adapter Tools

(b) Rotate the pump **clockwise** (as viewed from front) until .60 mm is indicated on the dial indicator gauge.

(c) Tighten the three pump mounting nuts to 30 N·m (22 ft. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

(d) Recheck the dial indicator after tightening the pump mounting nuts. Gauge should still be reading 0.60 mm. Loosen pump mounting nuts and readjust if necessary.

(15) Remove dial indicator and adapter tools.

(16) Install access plug and washer to rear of injection pump.

(17) Install plug at timing gear cover.

(18) Remove dial indicator from valve stem.

(19) Install valve spring and keepers.

(20) Install rocker arm assembly and tighten nuts.

(21) Install and connect the four high–pressure fuel lines to the fuel injection pump. Also connect fuel lines at the fuel injectors. For procedures, refer to High–Pressure Fuel Lines in this group.

(22) Install electrical connector at engine coolant temperature sensor.

(23) Connect electrical connector at fuel shutdown solenoid.

(24) Connect the main engine wiring harness to the glow plugs.

(25) Connect the fuel timing solenoid pigtail harness to the engine wiring harness.

(26) Connect the overflow valve/banjo fitting (fuel return line assembly). Replace copper gaskets before installing.

(27) Connect the rubber fuel return and supply hoses to metal lines at pump. Tighten hose clamps to 2 N·m (20 in. lbs.) torque.

(28) Install generator assembly.

(29) Install engine accessory drive belt. Refer to Group 7, Cooling System for procedures.

(30) Install negative battery cable to battery.

(31) Start the engine and bring to normal operating temperature.

(32) Check for fuel leaks.

FUEL INJECTORS

Four fuel injectors are used on each engine. Of these four, two different types are used. The fuel injector used on cylinder number one is equipped with a fuel injector sensor (Fig. 42). The other three fuel injectors are identical. **Do not place the fuel injector equipped with the fuel injector sensor into any other location except the cylinder number one position.**

REMOVAL

(1) Disconnect negative battery cable at battery.

(2) Thoroughly clean the area around the injector with compressed air.

(3) Remove the fuel drain hoses (tubes) at each injector (Fig. 43) being serviced. Each of these hoses is slip–fit to the fitting on injector.

(4) Remove the high–pressure fuel line at injector being removed. Refer to High–Pressure Fuel Lines in this group for procedures.

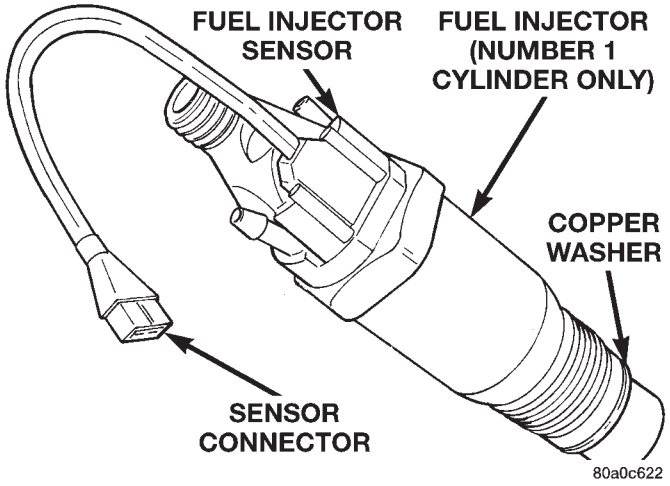


Fig. 42 Fuel Injector Sensor—Number–1 Cylinder

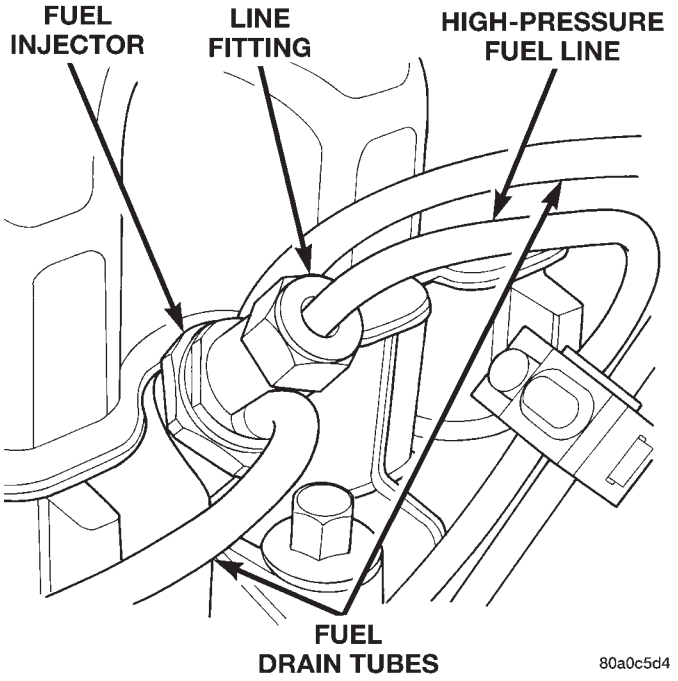


Fig. 43 Fuel Injector—Typical

(5) Remove the injector using special socket tool number VM.1012A. When removing cylinder number one injector, thread the wiring harness through the access hole on the special socket (Fig. 44).

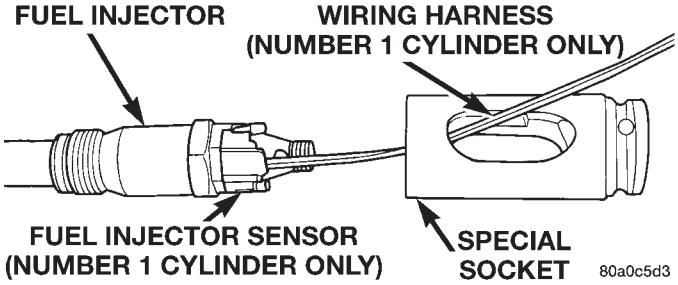


Fig. 44 Wiring Harness Through Socket

REMOVAL AND INSTALLATION (Continued)

(6) Remove and discard the copper washer (seal) at bottom of injector (Fig. 42).

INSTALLATION

(1) Clean the injector threads in cylinder head.

(2) Install new copper washer (seal) to injector.

(3) Install injector to engine. Tighten to 70 N·m (52 ft. lbs.) torque.

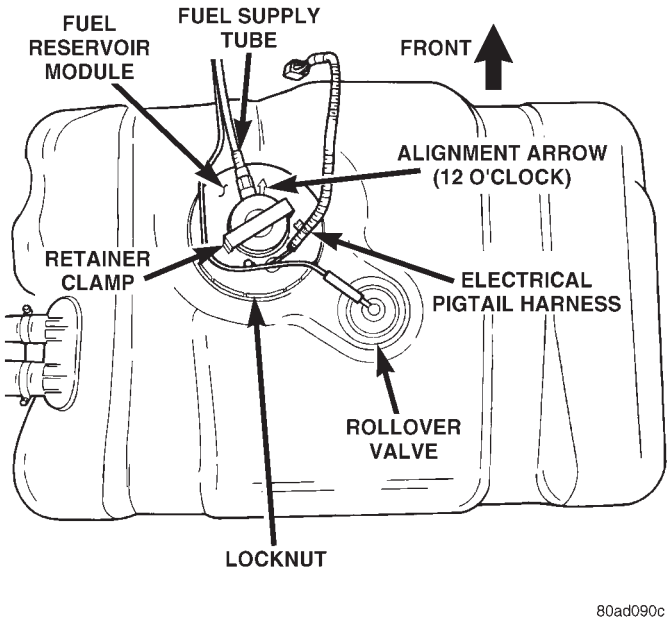
(4) Install high–pressure fuel lines. Refer to High–Pressure Fuel Lines in this group for procedures.

(5) Install fuel drain hoses (tubes) to each injector. Do not use clamps at fuel drain hoses.

(6) Connect negative battery cable to battery.

(7) Bleed the air from the high–pressure lines. Refer to the Air Bleed Procedure section of this group.

FUEL TANK



Fuel Tank

REMOVAL

(1) Disconnect negative cable from battery.

(2) Insert fuel siphon hose into fuel filler neck and push it into the tank.

(3) Drain fuel tank dry into holding tank or a properly labeled **diesel** safety container.

(4) Raise vehicle on hoist.

(5) Disconnect both the fuel fill and fuel vent rubber hoses at the fuel tank.

(6) Disconnect fuel supply and return lines from the steel supply line (Fig. 45).

The fuel reservoir module electrical connector has a retainer that locks it in place .

(7) Slide electrical connector lock to unlock.

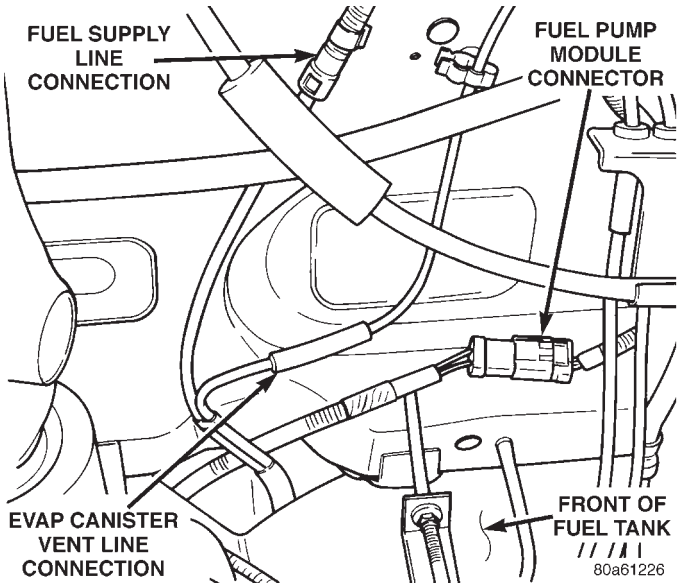


Fig. 45 Fuel Tank Connections at Front of Tank

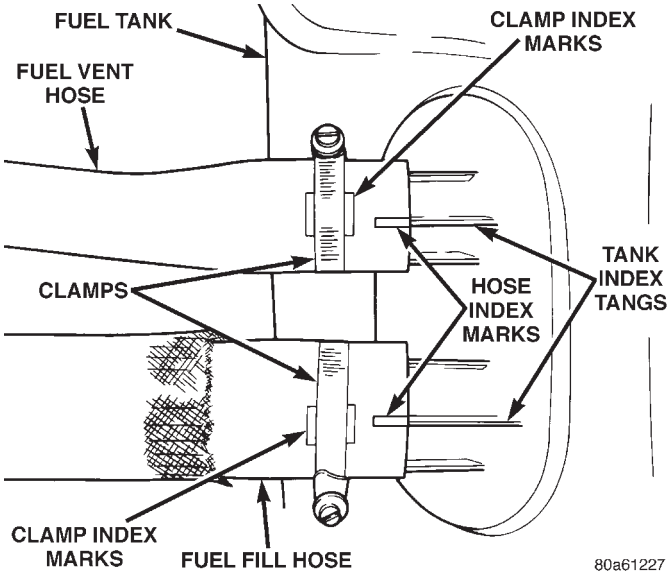


Fig. 46 Fuel Fill/Vent Hose Index Marks

(8) Push down on connector retainer (Fig. 47) and pull connector off module.

(9) Use a transmission jack to support fuel tank. Remove bolts from fuel tank straps.

(10) Lower tank slightly. Carefully remove filler hose from tank.

(11) Lower the fuel tank. Remove clamp and remove fuel filler tube vent hose. Remove fuel tank from vehicle.

INSTALLATION

(1) Position fuel tank on transmission jack. Connect fuel filler tube vent hose and replace clamp.

(2) Raise tank into position and carefully work filler tube into tank. A light coating of clean engine oil on the tube end may be used to aid assembly.

REMOVAL AND INSTALLATION (Continued)

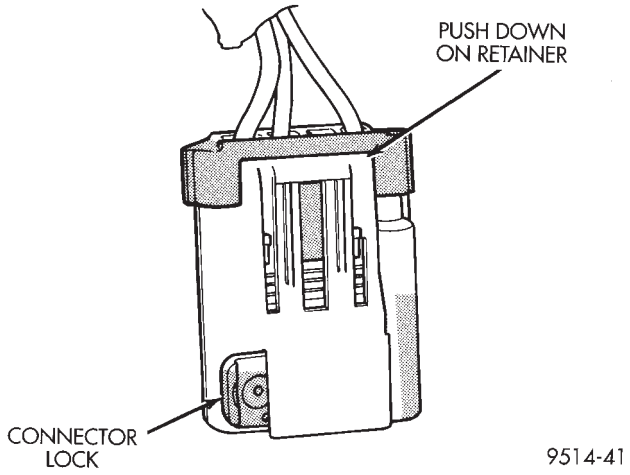


Fig. 47 Module Connector Retainer and Lock

(3) Feed filler vent line thru frame rail. Careful not to cross lines.

(4) Tighten strap bolts to 54 N·m (40 ft. lbs.) torque. Remove transmission jack.

CAUTION: Ensure straps are not twisted or bent before or after tightening strap nuts.

(5) Connect module electrical connector. Place retainer in locked position.

(6) Lubricate the fuel supply and return lines with clean 30 weight engine oil, install the quick connect fuel fitting. Refer to Tube/Fitting Assembly in the Fuel Delivery section of this Group.

(7) Attach filler line to filler tube. Pull on connector to make sure of connection.

(8) Fill fuel tank, replace cap, and connect battery negative cable.

FUEL RESERVOIR MODULE

REMOVAL

WARNING: THE FUEL RESERVOIR OF THE FUEL MODULE DOES NOT EMPTY OUT WHEN THE TANK IS DRAINED. THE FUEL IN THE RESERVOIR WILL SPILL OUT WHEN THE MODULE IS REMOVED.

(1) Disconnect negative cable from battery.

(2) Drain fuel tank dry into holding tank or a properly labeled **diesel** safety container.

(3) Raise vehicle on hoist.

(4) Use a transmission jack to support the fuel tank. Remove bolts from fuel tank straps. Lower tank slightly.

(5) Clean area around fuel reservoir module and tank to keep dirt and foreign material out of tank.

(6) Disconnect fuel lines from fuel module by depressing quick connect retainers with thumb and fore finger.

(7) Slide module electrical connector lock to unlock.

(8) Push down on connector retainer (Fig. 48) and pull connector off module.

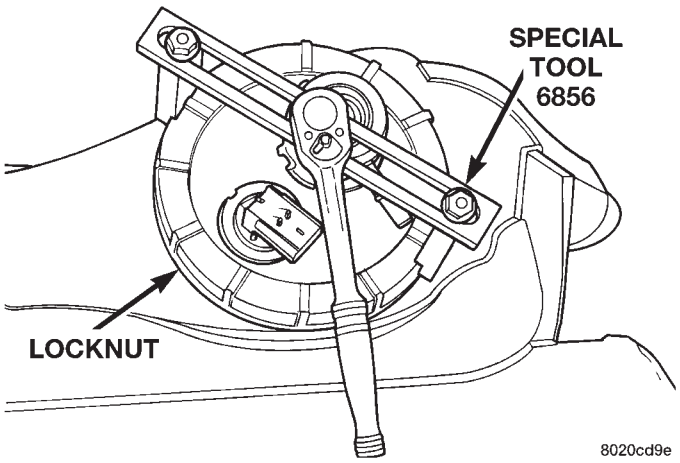


Fig. 48 Module Connector Retainer and Lock

(9) Using Special Tool 6856, remove plastic locknut counterclockwise to release pump module (Fig. 49).

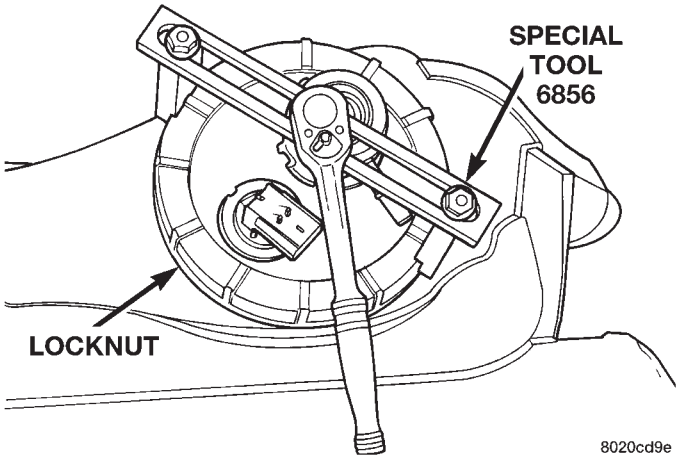


Fig. 49 Fuel Reservoir Module Lock Nut Removal

(10) Carefully remove module and O-ring from tank.

(11) Discard old O-ring.

INSTALLATION

(1) Wipe seal area of tank clean and place a new O-ring seal in position on pump.

(2) Position fuel reservoir module in tank with locknut.

(3) Tighten locknut to 58 N·m (43 ft. lbs.).

(4) Connect fuel lines.

(5) Plug in electrical connector. Slide connector lock into position.

(6) Raise fuel tank, install bolts into fuel tank straps and tighten.

REMOVAL AND INSTALLATION (Continued)

(7) Lower vehicle on hoist.
(8) Connect negative cable from battery.
(9) Fill fuel tank. Check for leaks.
(10) Install fuel filler cap.

HIGH-PRESSURE LINES

All high–pressure fuel lines are of the same length and inside diameter. Correct high–pressure fuel line usage and installation is critical to smooth engine operation.

CAUTION: The high–pressure fuel lines must be clamped securely in place in the holders. The lines cannot contact each other or other components. Do not attempt to weld high–pressure fuel lines or to repair lines that are damaged. Only use the recommended lines when replacement of high–pressure fuel line is necessary.

REMOVAL

(1) Disconnect negative battery cable from battery.
(2) Remove the necessary clamps (Fig. 50) holding the lines to the engine.

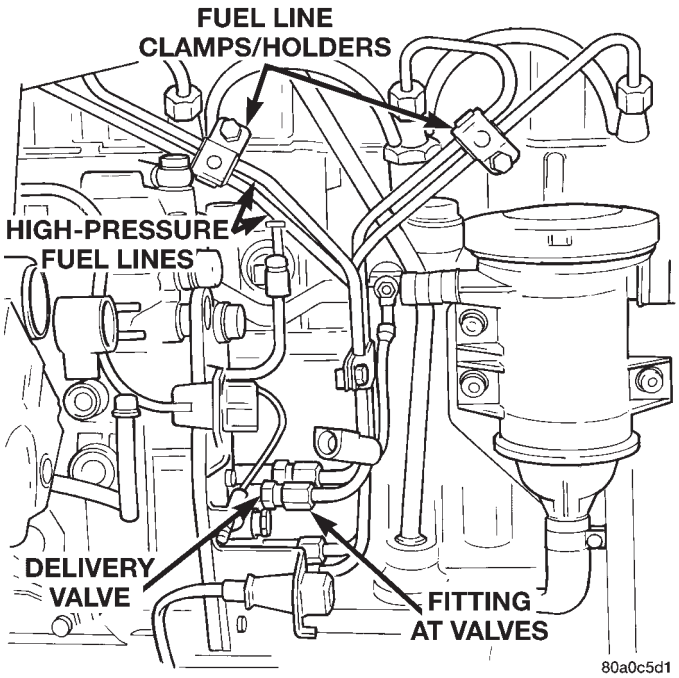


Fig. 50 Fuel Lines and Clamps/Holders

(3) Clean the area around each fuel line connection. Disconnect each line at the top of each fuel injector (Fig. 51).
(4) Disconnect each high–pressure line fitting at each fuel injection pump delivery valve.
(5) Very carefully remove each line from the engine. Note the position (firing order) of each line while removing. **Do not bend the line while removing.**

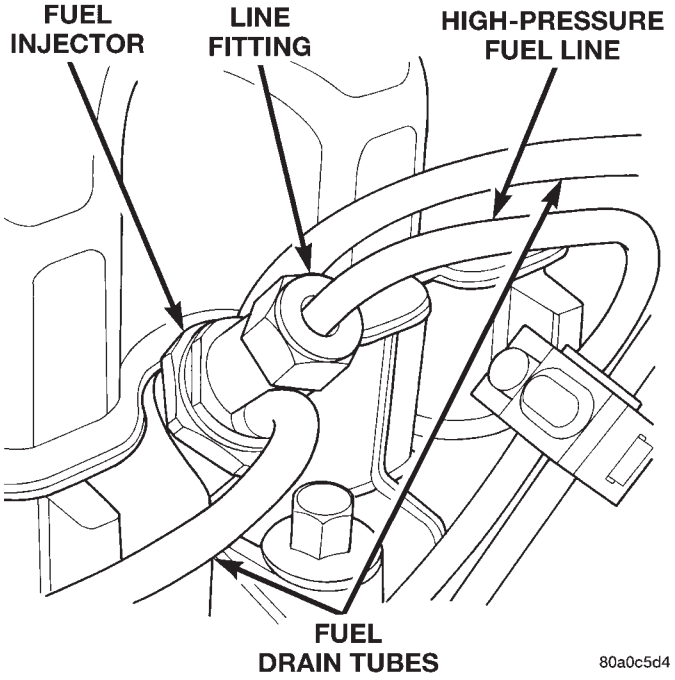


Fig. 51 Fuel Lines at Fuel Injectors

CAUTION: Be sure that the high–pressure fuel lines are installed in the same order that they were removed. Prevent the injection pump delivery valve holders (Fig. 50) from turning when removing or installing high–pressure lines from injection pump.

INSTALLATION

(1) Carefully position each high–pressure fuel line to the fuel injector and fuel injection pump delivery valve holder in the correct firing order. Also position each line in the correct line holder.
(2) Loosely install the line clamp/holder bolts.
(3) Tighten each line at the delivery valve to 30 N·m (22 ft. lbs.) torque.
(4) Tighten each line at the fuel injector to 30 N·m (22 ft. lbs.) torque.

Be sure the lines are not contacting each other or any other component.

(5) Tighten the clamp bracket bolts to 24 N·m (18 ft. lbs.) torque.
(6) Bleed air from the fuel system. Refer to the Air Bleed Procedure section of this group.

SPECIFICATIONS

FUEL TANK CAPACITY

75 Liters (20.0 Gals.)

Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerances, ambient temperatures and refill procedures.

SPECIFICATIONS (Continued)

IDLE SPEED

900 rpm ±25 rpm with engine at normal operating temperature.

FUEL INJECTOR FIRING SEQUENCE

1–3–4–2

FUEL SYSTEM PRESSURE

Peak Injection Pressure/Fuel Injection Pump Operating Pressure: 40,000–45,000 kPa (5801–6526 psi).

Opening Pressure of Fuel Injector: 15,000–15,800 kPa (2175–2291 psi).

FUEL INJECTION SYSTEM—2.5L DIESEL ENGINE

INDEX

GENERAL INFORMATION

INTRODUCTION

This section will cover components either regulated or controlled by the MSA controller and the Powertrain Control Module (PCM). The fuel heater relay and fuel heater are not operated by the MSA controller or the PCM. These components are controlled by the ignition (key) switch. All other fuel system electrical components necessary to operate the engine are controlled or regulated by the MSA controller, which interfaces with the PCM. Refer to the following description for more information.

Certain fuel system component failures may cause a no start, or prevent the engine from running. It is important to know that the MSA has a feature where, if possible, it will ignore the failed sensor, set a code related to the sensor, and operate the engine in a “Limp Home” mode. When the MSA is operating in a “Limp Home” mode, the Check Engine Lamp on the instrument panel may be constantly illuminated, and the engine will most likely have a noticeable loss of performance. An example of this would be an Accelerator Pedal Position Sensor failure, and in that situation, the engine would run at a constant 1100 RPM, regardless of the actual position of the pedal. This is the most extreme of the three “Limp Home” modes.

When the Check Engine Lamp is illuminated constantly with the key on and the engine running, it

GENERAL INFORMATION (Continued)

usually indicates a problem has been detected somewhere within the fuel system. The DRBIII scan tool is the best method for communicating with the MSA and PCM to diagnose faults within the system.

DESCRIPTION AND OPERATION

POWERTRAIN CONTROL MODULE (PCM)

The MSA controller is mounted under the left side rear seat (Fig. 1). The Powertrain Control Module (PCM) is mounted in the engine compartment. (Fig. 2).

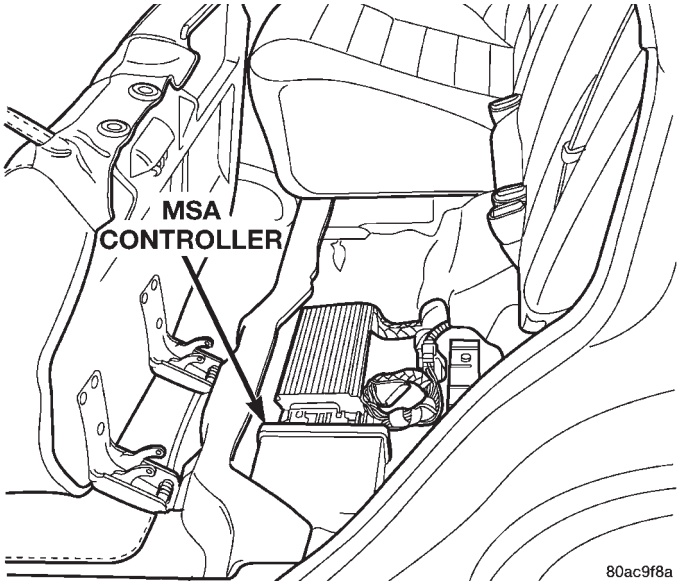


Fig. 1 MSA Controller Location

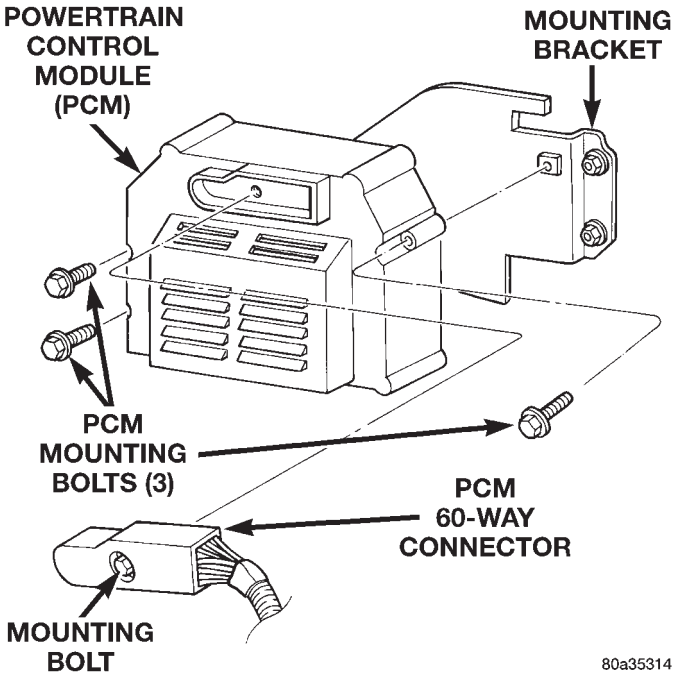


Fig. 2 PCM Location

The MSA Controller is a pre–programmed, digital computer. It will either directly operate or partially regulate the:

- Speed Control
- Speed Control lamp
- Fuel Timing Solenoid
- Check Engine Light
- Glow Plug Relay
- Glow Plugs
- Glow Plug Lamp
- ASD Relay
- Air Conditioning
- Tachometer
- Electric Vacuum Modulator (EVM)

The MSA can adapt its programming to meet changing operating conditions.

The MSA receives input signals from various switches and sensors. Based on these inputs, the MSA regulates various engine and vehicle operations through different system components. These components are referred to as **MSA Outputs.** The sensors and switches that provide inputs to the MSA are considered **MSA Inputs.**

MSA Inputs are:

- Air Conditioning Selection
- Theft Alarm
- ASD Relay
- Control Sleeve Position Sensor
- Fuel Temperature Sensor
- Mass Air Flow Sensor
- Accelerator Pedal Position Sensor
- Engine Coolant Temperature Sensor
- Low Idle Position Switch
- 5 Volt Supply
- Vehicle Speed Sensor
- Engine Speed/Crank Position Sensor (rpm)
- Needle Movement Sensor
- Starter Signal
- Brake Switch
- Speed Control Switch
- Power Ground
- Ignition (key) Switch Sense

MSA Outputs:

After inputs are received by the MSA and PCM, certain sensors, switches and components are controlled or regulated by the MSA and PCM. These are considered **MSA Outputs.** These outputs are for:

- A/C Clutch Relay (for A/C clutch operation)
- Speed Control Lamp
- ASD Relay
- 5 Volts Supply
- Fuel Quantity Actuator
- Fuel Timing Solenoid
- Fuel Shutdown Solenoid
- Glow Plug Lamp
- Check Engine Lamp (“On/Off” signal)

DESCRIPTION AND OPERATION (Continued)

- Electric Vacuum Modulator (EVM)
- Glow Plug Relay
- Tachometer

The PCM sends and recieves signals to and from the MSA controller. **PCM inputs are:**

- Power Gound
- 5 Volts Supply
- Vehicle Speed Sensor
- Water-In-Fuel Sensor
- Coolant Temperature Sensor
- Low Coolant Sensor
- Sensor Return
- Fuel Level Sensor
- Oil Pressure Sensor
- Tachometer Signal
- Glow Plug Lamp
- Check Engine Lamp (“On/Off” signal)
- Brake On/Off Switch
- Battery Voltage
- ASD Relay

PCM Outputs:

- A/C On Signal
- Vehicle Theft Alarm “Ok to Run” signal
- Body Control Module CCD Bus (+)
- Body Control Module CCD Bus (–)
- Scan Tool Data Link Recieve
- Scan Tool Data Link Transmit
- Low Coolant Lamp
- Generator Control

MASS AIR FLOW SENSOR

The Mass Air Flow Sensor is a gauge that measures air density. In the Mass Air Flow Sensor (MAF) there is a ceramic element that changes its resistance based on temperature. The ceramic element is part of an electronic circuit connected to the MSA, and has a voltage applied to it. The MAF sensor is connected in line with the engine's air intake tube, and when the engine is at idle, there is a relatively low amount of air flowing across the ceramic element. This air has a cooling effect on the ceramic element, and its resistance changes, and a voltage signal is sent to the MSA. As a general rule, when the engine is running at a high RPM, the voltage signal sent by the MAF sensor is high. When the engine is running at a low RPM, the voltage signal sent by the MAF is low. The MSA can calculate the mass (actual weight) of the air flowing through the MAF sensor based on the value of the voltage signal.

VEHICLE THEFT ALARM

The PCM can learn if the vehicle has a Vehicle Theft Alarm (VTA) system. Once it detects the vehicle having VTA, **the controller can ONLY BE USED ON VEHICLES WITH VTA.**

If the PCM is put it on a vehicle without VTA the Glow Plug Lamp will start to blink and the vehicle will not start.

The PCM cannot be flashed to remove the VTA.

BATTERY VOLTAGE—PCM INPUT

The battery voltage input provides power to the PCM. It also informs the PCM what voltage level is being supplied by the generator once the vehicle is running.

The battery input also provides the voltage that is needed to keep the PCM memory alive. The memory stores Diagnostic Trouble Code (DTC) messages. Trouble codes will still be stored even if the battary voltage is lost.

SENSOR RETURN—MSA/PCM INPUT (ANALOG GROUND)

Sensor Return provides a low noise Analog ground reference for all system sensors.

IGNITION CIRCUIT SENSE—MSA/PCM INPUT

The ignition circuit sense input signals the MSA and PCM that the ignition (key) switch has been turned to the ON position. This signal initiates the glow plug control routine to begin the “pre–heat” cycle.

IGNITION CIRCUIT SENSE—PCM INPUT

The ignition circuit sense input signals the PCM that the ignition (key) switch has been turned to the ON position. This signal initiates the glow plug control routine to begin the “pre–heat” cycle.

POWER GROUND

Provides a common ground for power devices (solenoid and relay devices).

NEEDLE MOVEMENT OR INTRUMENTED FIRST INJECTOR—MSA INPUT

This input from the MSA supplies a constant 30 mA electrical current source for the first injector sensor. It will vary the voltage to this sensor when it senses a mechanical movement within the injector needle (pintle) of the number–1 cylinder fuel injector. When this voltage has been determined by the MSA, it will then control an output to the fuel timing solenoid (the fuel timing solenoid is located on the fuel injection pump). Also refer to Fuel Injection Pump for additional information.

The first injector sensor is a magnetic (inductive) type.

The first injector sensor is used only on the fuel injector for the number–1 cylinder (Fig. 3). It is not used on the injectors for cylinders number 2, 3, or 4.

DESCRIPTION AND OPERATION (Continued)

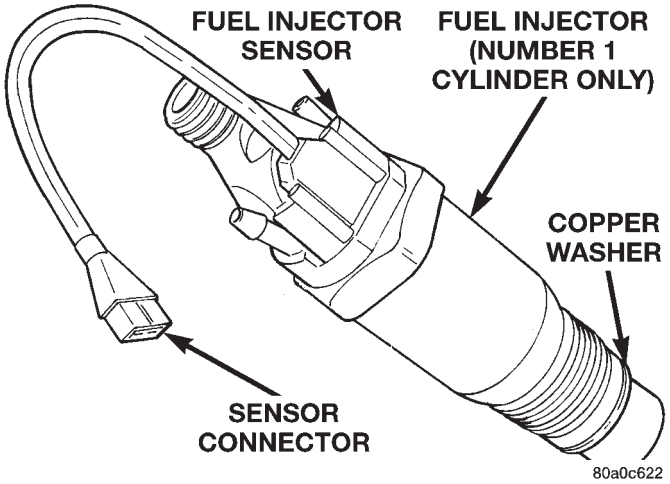


Fig. 3 Fuel Injector Sensor

FUEL INJECTOR SENSOR—GROUND

Provides a low noise ground for the fuel injector sensor only.

ENGINE COOLANT TEMPERATURE SENSOR—MSA/ PCM INPUT

The 0–5 volt input from this sensor tells the MSA and PCM the temperature of the engine coolant. Based on the voltage received at the MSA, it will then determine operation of the fuel timing solenoid, glow plug relay, electrical vacuum modulator (emission component) and generator (charging system).

The sensor is located on the side of the #3 cylinder head near the rear of fuel injection pump (Fig. 4).

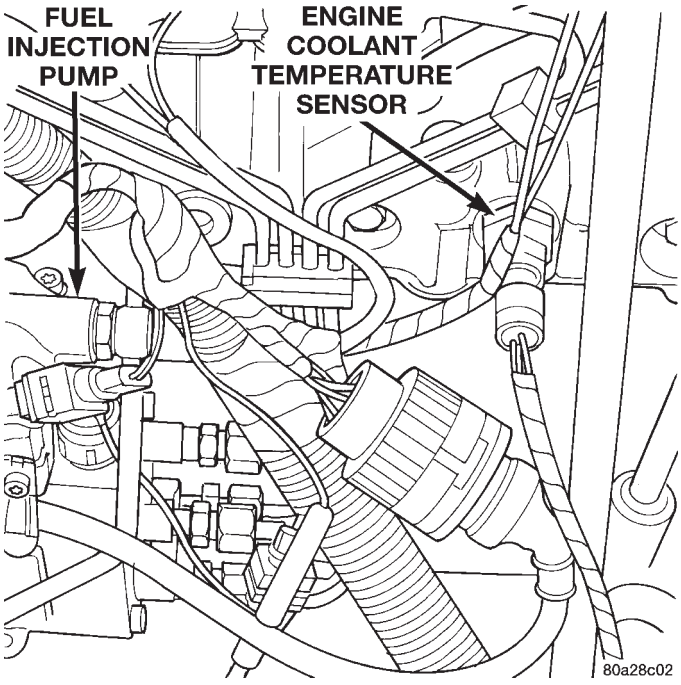


Fig. 4 Engine Coolant Temperature Sensor Location

ENGINE SPEED/CRANK POSITION SENSOR—MSA INPUT

The engine speed sensor is mounted to the transmission bellhousing at the left/rear side of the engine block (Fig. 5).

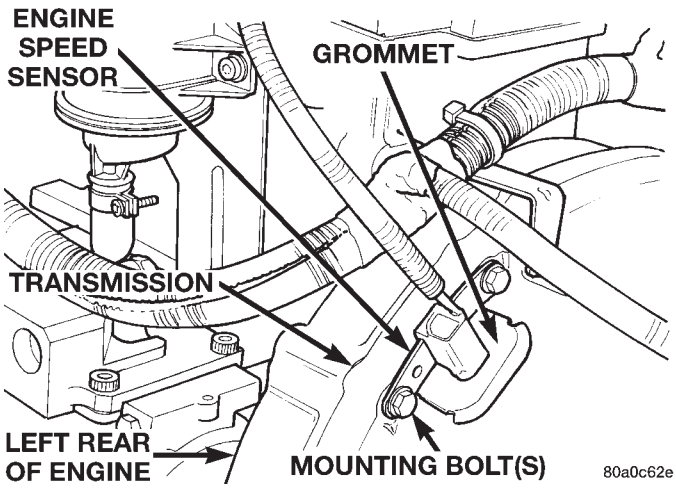


Fig. 5 Engine Speed Sensor Location

The engine speed sensor produces its own output signal. If this signal is not received, the MSA will not allow the engine to start.

The engine speed sensor input is used in conjunction with the first injector sensor to establish fuel injection pump timing.

The flywheel has four notches at its outer edge (Fig. 6). Each notch is spaced equally every 90°. The notches cause a pulse to be generated when they pass under the speed sensor (Fig. 6). These pulses are the input to the MSA. The input from this sensor determines crankshaft position (in degrees) by monitoring the notches.

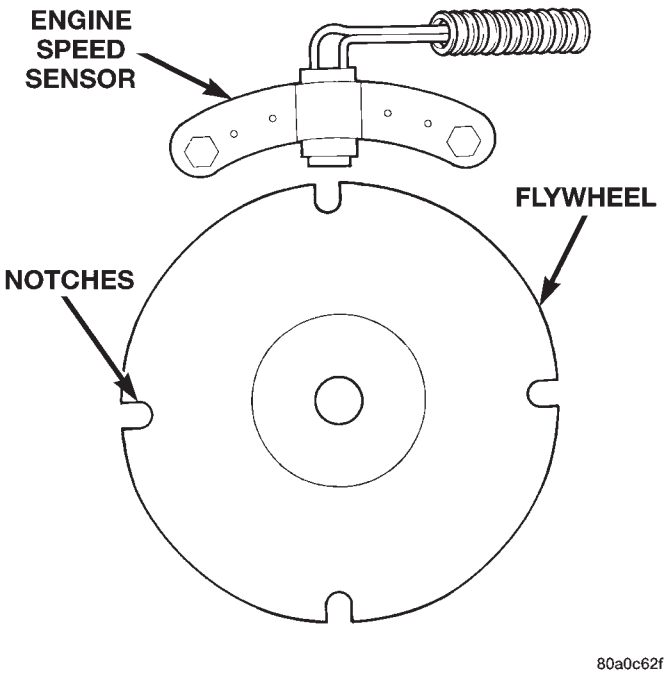


Fig. 6 Speed Sensor Operation

DESCRIPTION AND OPERATION (Continued)

The sensor also generates an rpm signal to the MSA. This signal is used as an input for the control of the generator field, vehicle speed control, and instrument panel mounted tachometer.

If the engine speed sensor should fail, the system is unable to compensate for the problem and the car will stop.

AIR CONDITIONING (A/C) CONTROLS—MSA INPUTS

The A/C control system information applies to factory installed air conditioning units.

A/C REQUEST SIGNAL: When either the A/C or Defrost mode has been selected and the A/C low and high–pressure switches are closed, an input signal is sent to the MSA. The MSA uses this input to cycle the A/C compressor through the A/C relay.

If the A/C low or high–pressure switch opens, the MSA will not receive an A/C request signal. The PCM will then remove the ground from the A/C relay. This will deactivate the A/C compressor clutch. Also, if the engine coolant reaches a temperature outside normal of its normal range, or it overheats, the MSA will deactivate the A/C clutch.

BRAKE SWITCH—MSA INPUT

When the brake light switch is activated, the MSA receives an input indicating that the brakes are being applied. After receiving this input, the MSA is used to control the speed control system. There is a Primary and a Secondary brake switch. The Secondary brake switch is closed until the brake pedal is pressed.

DATA LINK CONNECTOR—PCM AND MSA INPUT AND OUTPUT

The 16–way data link connector (diagnostic scan tool connector) links the Diagnostic Readout Box (DRB) scan tool with the PCM and MSA. The data link connector is located under the instrument panel near the bottom of steering column. (Fig. 7).

VEHICLE SPEED SENSOR—MSA INPUT

The vehicle speed sensor is located in the extension housing of the transmission (2WD) (Fig. 8) or on the transfer case extension housing. The sensor input is used by the MSA to determine vehicle speed and distance traveled.

The speed sensor generates 8 pulses per sensor revolution. These signals, in conjunction with a closed throttle signal from the accelerator pedal position sensor, indicate an idle deceleration to the MSA. When the vehicle is stopped at idle, a released pedal signal is received by the MSA (but a speed sensor signal is not received).

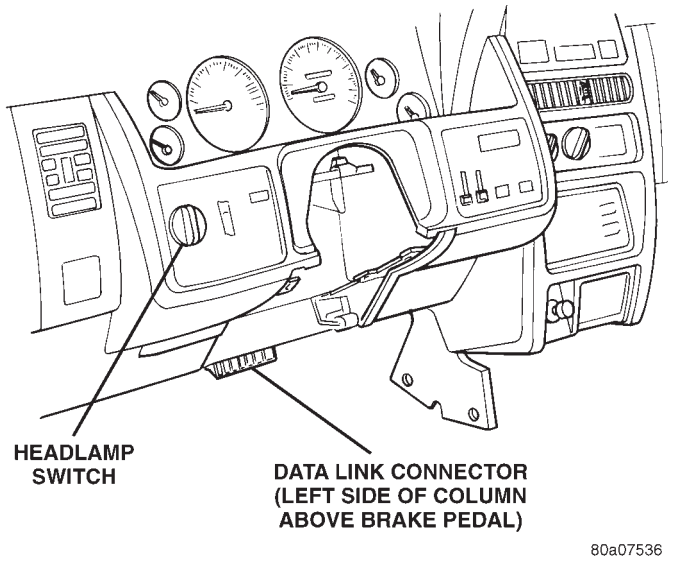


Fig. 7 Data Link Connector Location

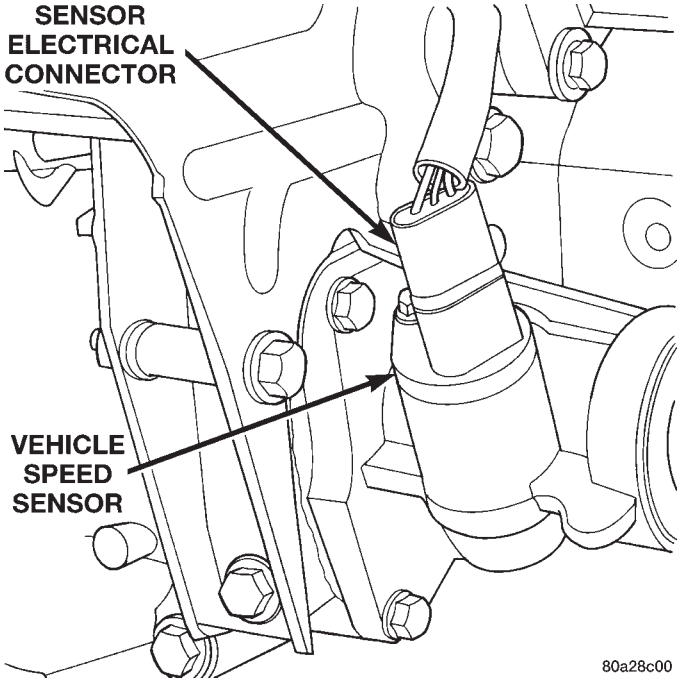


Fig. 8 Vehicle Speed Sensor—Typical

In addition to determining distance and vehicle speed, the output from the sensor is used to control speed control operation.

SPEED CONTROL—MSA INPUT

The speed control system provides five separate inputs to the MSA: On/Off, Set, Resume/Accel, Cancel, and Decel.. The On/Off input informs the MSA that the speed control system has been activated. The Set input informs the MSA that a fixed vehicle speed has been selected. The Resume input indicates

DESCRIPTION AND OPERATION (Continued)

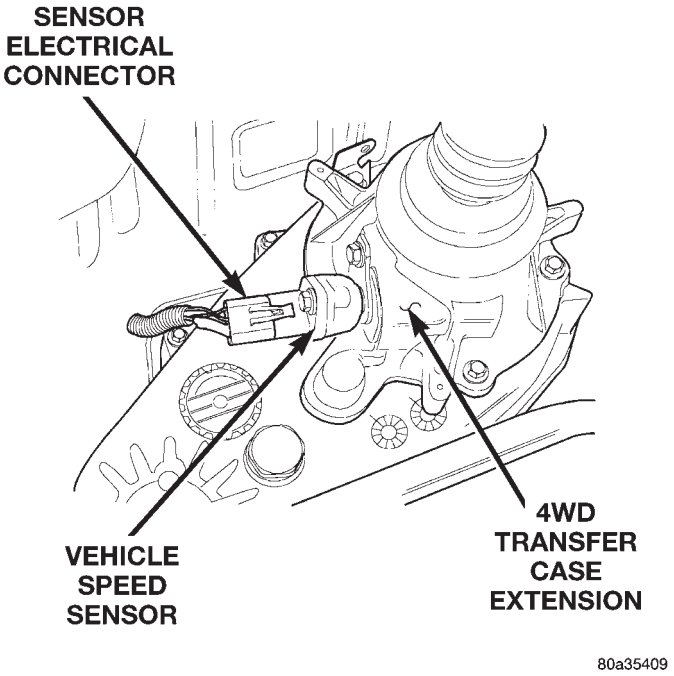


Fig. 9 Vehicle Speed Sensor—4 Wheel Drive

to the MSA that the previous fixed speed is requested.

Speed control operation will start at 50 km/h–142 km/h (35–85 mph). The upper range of operation is not restricted by vehicle speed. Inputs that effect speed control operation are vehicle speed sensor and accelerator pedal position sensor.

Refer to Group 8H for further speed control information.

ASD RELAY—MSA INPUT

A 12 volt signal at this input indicates to the MSA that the ASD relay has been activated. The ASD relay is located in the PDC. The PDC is located next to the battery in the engine compartment. For the location of the relay within the PDC, refer to label on PDC cover.

This input is used only to sense that the ASD relay is energized. If the MSA does not see 12 volts (+) at this input when the ASD relay should be activated, it will set a Diagnostic Trouble Code (DTC).

FIVE VOLT POWER—MSA/PCM OUTPUT

This circuit supplies approximately 5 volts to power the Accelerator Pedal Postion Sensor, and Mass Air Flow Sensor.

ENGINE COOLANT GAUGE—PCM OUTPUT

Refer to the Instrument Panel and Gauges group for additional information.

ENGINE OIL PRESSURE GAUGE—PCM OUTPUT

Refer to the Instrument Panel and Gauges group for additional information.

GLOW PLUG LAMP—PCM OUTPUT

The Glow Plug lamp (malfunction indicator lamp) illuminates on the message center each time the ignition (key) switch is turned on. It will stay on for about two seconds as a bulb test.

If the PCM receives an incorrect signal, or no signal from certain sensors or components, the lamp BLINKS. This is a warning that the PCM has recorded a system or sensor malfunction. It signals an immediate need for service. There are only 5 HARD faults that can turn on this lamp to make it blink.

Fig. 10 Glow Plug Lamp Symbol

SPEED CONTROL—PCM OUTPUTS

These two circuits control the fuel quantity actuator to regulate vehicle speed. Refer to Group 8H for Speed Control information.

AIR CONDITIONING RELAY—MSA OUTPUT

This circuit controls a ground signal for operation of the A/C clutch relay. Also refer to Air Conditioning (A/C) Controls—MSA Input for additional information.

The A/C relay is located in the Power Distribution Center (PDC). The PDC is located next to the battery in the engine compartment. For the location of the relay within the PDC, refer to label on PDC cover.

FUEL TIMING SOLENOID—MSA OUTPUT

The fuel timing solenoid is located on the bottom of the fuel injection pump (Fig. 11).

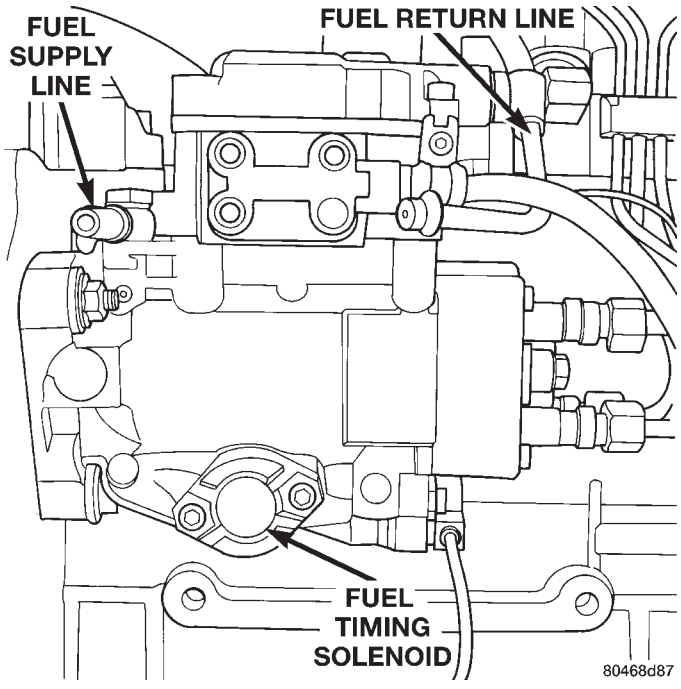


Fig. 11 Fuel Timing Solenoid

DESCRIPTION AND OPERATION (Continued)

This 12(+) volt, pulse width modulated (duty–cycle) output controls the amount of fuel timing (advance) in the fuel injection pump. The higher the duty–cycle, the lower the advance. The lower the duty–cycle, the more advanced the fuel timing.

The duty–cycle is determined by the MSA from inputs it receives from the fuel injector sensor and engine speed sensor.

TACHOMETER—PCM OUTPUT

The PCM recieves engine rpm values from the MSA controller, and then supplies engine rpm values to the Body Controller that then supplies the instrument cluster mounted tachometer (if equipped). Refer to Group 8E for tachometer information.

GLOW PLUG RELAY—MSA OUTPUT

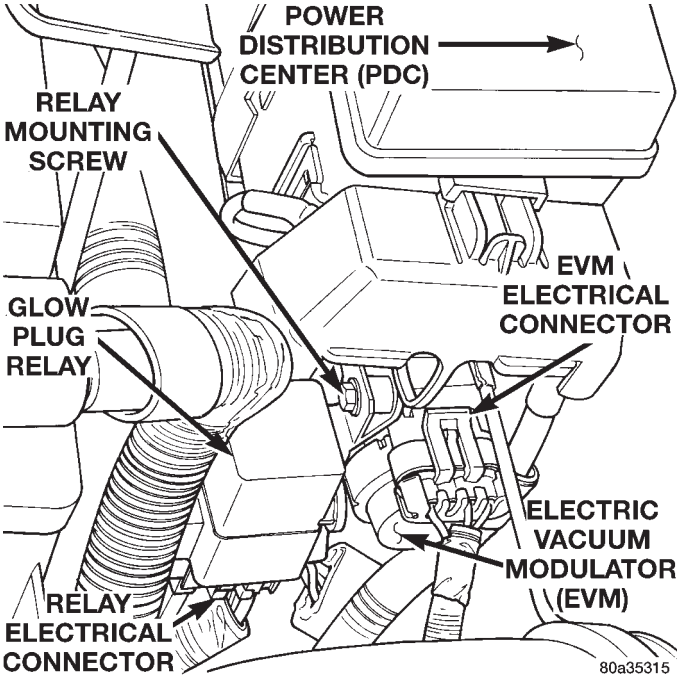


Fig. 12 Glow Plug Relay Location

When the ignition (key) switch is placed in the ON position, a signal is sent to the MSA relating current engine coolant temperature. This signal is sent from the engine coolant temperature sensor.

After receiving this signal, the MSA will determine if, when and for how long a period the glow plug relay should be activated. This is done before, during and after the engine is started. Whenever the glow plug relay is activated, it will control the 12V+ 100 amp circuit for the operation of the four glow plugs.

With a cold engine, the glow plug relay and glow plugs may be activated for a maximum time of 200 seconds. Refer to the following Glow Plug Control chart for a temperature/time comparison of glow plug relay operation.

In this chart, Pre–Heat and Post–Heat times are mentioned. Pre–heat is the amount of time the glow plug relay circuit is activated when the ignition (key) switch is ON, but the engine has yet to be started. Post–heat is the amount of time the glow plug relay circuit is activated after the engine is operating. The Glow Plug lamp will not be illuminated during the post–heat cycle.

GLOW PLUG CONTROL

ENGINE COOLANT TEMPERATURE KEY ON	WAIT-TO-START LAMP ON (SECONDS)	PRE-HEAT CYCLE (GLOW PLUGS ON) (SECONDS)	POST-HEAT CYCLE (SECONDS)
-30 C	15 SEC.	45 SEC.	200 SEC.
-10 C	8 SEC.	35 SEC.	180 SEC.
+10 C	6 SEC.	25 SEC.	118 SEC.
+30 C	5 SEC.	20 SEC.	70 SEC.
+40 C	4 SEC.	16 SEC.	60 SEC.
+70 C	3 SEC.	16 SEC.	20 SEC.

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GLOW PLUGS

Glow plugs are used to help start a cold or cool engine. The plug will heat up and glow to heat the combustion chamber of each cylinder. An individual plug is used for each cylinder. Each plug is threaded into the cylinder head above the fuel injector (Fig. 13).

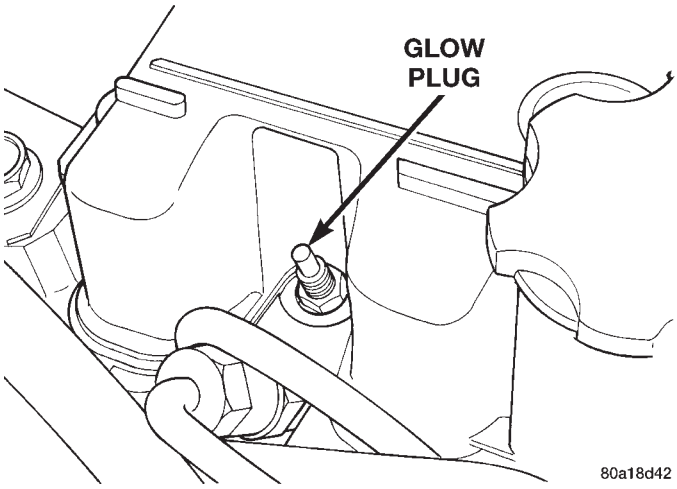

Fig. 13 Glow Plug

Each plug will momentarily draw approximately 25 amps of electrical current during the initial key–on cycle. This is on a cold or cool engine. After heating,

DESCRIPTION AND OPERATION (Continued)

the current draw will drop to approximately 9–12 amps per plug.

Total momentary current draw for all four plugs is approximately 100 amps on a cold engine dropping to a total of approximately 40 amps after the plugs are heated.

Electrical operation of the glow plugs are controlled by the glow plug relay. Refer to the previous Glow Plug Relay—MSA Output for additional information.

ELECTRIC VACUUM MODULATOR (EVM)—MSA OUTPUT

This circuit controls operation of the Electric Vacuum Modulator (EVM). The EVM (Fig. 12) controls operation of the EGR valve.

Refer to Group 25, Emission Control System for information. See Electric Vacuum Modulator.

DIAGNOSIS AND TESTING

DIESEL DIAGONSTICS

The MSA controllers perform engine off diagonstic tests, which may be heard for about 60 seconds after turning the key off.

ASD RELAY TEST

To perform a test of the relay and its related circuitry, refer to the DRB scan tool. To test the relay only, refer to Relays—Operation/Testing in this section of the group.

Diagnostic Trouble Codes: Refer to On-Board Diagnostics in Group 25, Emission Control System for a list of Diagnostic Trouble Codes (DTC's) for certain fuel system components.

ENGINE SPEED SENSOR TEST

To perform a test of the engine speed sensor and its related circuitry, refer to the DRB scan tool.

Diagnostic Trouble Codes: Refer to On-Board Diagnostics in Group 25, Emission Control System for a list of Diagnostic Trouble Codes (DTC's) for certain fuel system components.

ENGINE COOLANT TEMPERATURE SENSOR TEST

The sensor is located on the side of cylinder head near the rear of fuel injection pump (Fig. 14).

For a list of Diagnostic Trouble Codes (DTC's) for certain fuel system components, refer to On-Board Diagnostics in Group 25, Emission Control System. To test the sensor only, refer to the following:

(1) Disconnect wire harness connector from coolant temperature sensor.

(2) Test the resistance of the sensor with a high input impedance (digital) volt–ohmmeter. The resistance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the following Sensor Resistance (OHMS) chart. Replace the sensor if it is not within the range of resistance specified in the chart.

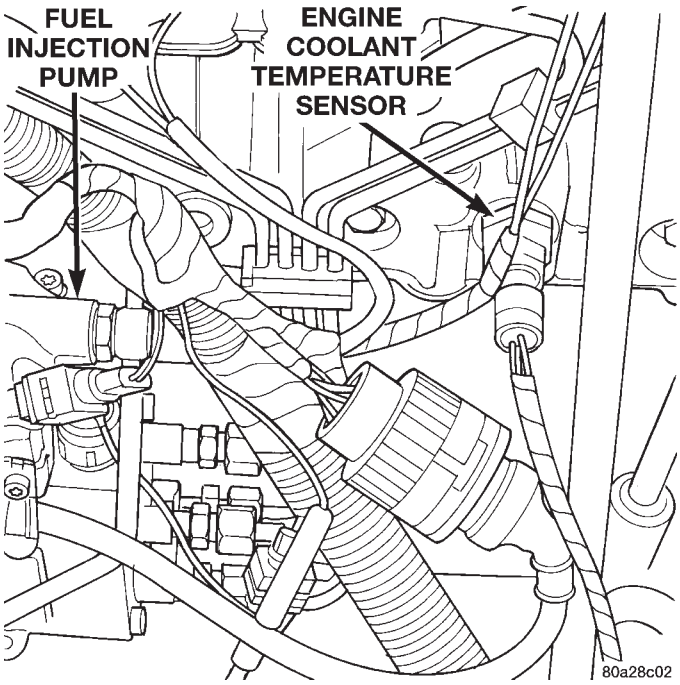

Fig. 14 Engine Coolant Temperature Sensor Location

SENSOR RESISTANCE (OHMS)

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
–40	–40	291,490	381,710
–20	–4	85,850	108,390
–10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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(3) Test continuity of the wire harness. Do this between the MSA wire harness connector and the sensor connector terminal. Also test continuity of wire harness to the sensor connector terminal. Refer

DIAGNOSIS AND TESTING (Continued)

to Group 8W for wiring connector and circuitry information. Repair the wire harness if an open circuit is indicated.

(4) After tests are completed, connect electrical connector to sensor.

GLOW PLUG TEST

Hard starting or a rough idle after starting may be caused by one or more defective glow plugs. Before testing the glow plugs, a test of the glow plug relay should be performed. This will ensure that 12V+ is available at the plugs when starting the engine. Refer to the Glow Plug Relay Test for information.

For accurate test results, the glow plugs should be removed from the engine. The plugs must be checked when cold. **Do not check the plugs if the engine has recently been operated. If plugs are checked when warm, incorrect amp gauge readings will result.**

Use Churchill Glow Plug Tester DX.900 or an equivalent (Fig. 15) for the following tests. This tester is equipped with 4 timer lamps.

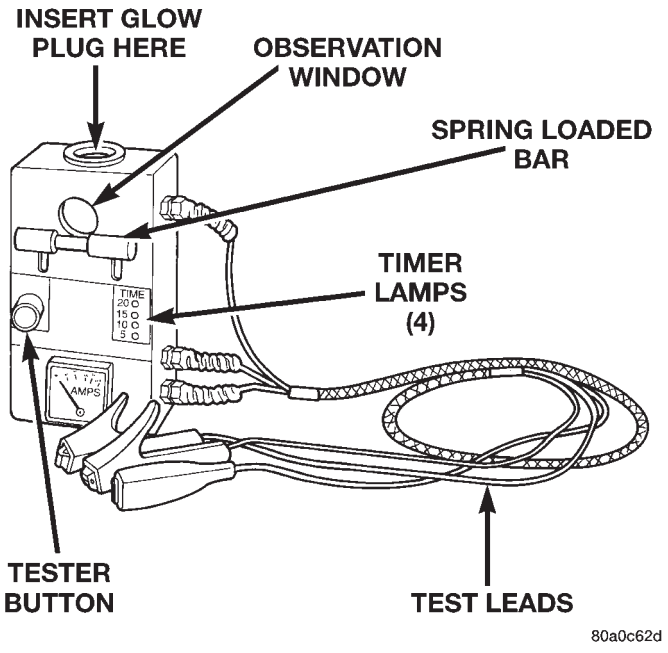

Fig. 15 Typical Glow Plug Tester

(1) Remove the glow plugs from the engine. Refer to Glow Plug Removal/Installation.

(2) Attach the red lead of the tester to the 12V+ (positive) side of the battery.

(3) Attach the black lead of the tester to the 12V– (negative) side of the battery.

(4) Fit the glow plug into the top of the tester and secure it with the spring loaded bar (Fig. 15).

(5) Attach the third lead wire of the tester to the electrical terminal at the end of the glow plug.

(6) When performing the test, the tester button (Fig. 15) should be held continuously without release for 20 seconds as indicated by the 4 timer lamps. Each illuminated lamp represents a 5 second time lapse.

(a) Press and hold the tester button (Fig. 15) and note the amp gauge reading. The gauge reading should indicate a momentary, initial current draw (surge) of approximately 25 amps. After the initial surge, the amp gauge reading should begin to fall off. The glow plug tip should start to glow an orange color after 5 seconds. If the tip did not glow after 5 seconds, replace the glow plug. Before discarding the glow plug, check the position of the circuit breaker on the bottom of the plug tester. It may have to be reset. Reset if necessary.

(b) Continue to hold the tester button while observing the amp gauge and the 4 timer lamps. When all 4 lamps are illuminated, indicating a 20 second time lapse, the amp gauge reading should indicate a 9–12 amp current draw. If not, replace the glow plug. Refer to Glow Plug Removal/Installation.

(7) Check each glow plug in this manner using one 20 second cycle. If the glow plug is to be retested, it must first be allowed to cool to room temperature.

WARNING: THE GLOW PLUG WILL BECOME EXTREMELY HOT (GLOWING) DURING THESE TESTS. BURNS COULD RESULT IF IMPROPERLY HANDLED. ALLOW THE GLOW PLUG TO COOL BEFORE REMOVING FROM TESTER.

(8) Remove the glow plug from the tester.

GLOW PLUG RELAY TEST

The glow plug relay is located in the engine compartment on the left–inner fender (Fig. 16).

When the ignition (key) switch is placed in the ON position, a signal is sent to the MSA relating current engine coolant temperature. This signal is sent from the engine coolant temperature sensor.

After receiving this signal, the MSA will determine if, when and for how long a period the glow plug relay should be activated. This is done before, during and after the engine is started. Whenever the glow plug relay is activated, it will control the 12V+ 100 amp circuit for the operation of the four glow plugs.

The Glow Plug lamp is tied to this circuit. Lamp operation is also controlled by the MSA.

With a cold engine, the glow plug relay and glow plugs may be activated for a maximum time of 200 seconds. Refer to the Glow Plug Control chart for a temperature/time comparison of glow plug relay operation.

In this chart, Pre–Heat and Post–Heat times are mentioned. Pre–heat is the amount of time the glow

DIAGNOSIS AND TESTING (Continued)

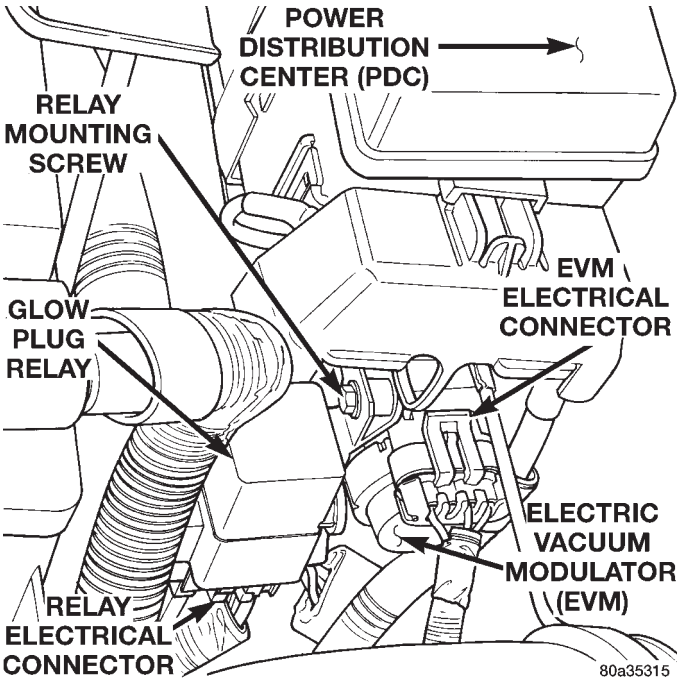

Fig. 16 Glow Plug Relay Location

plug relay circuit is activated when the ignition (key) switch is ON, but the engine has yet to be started. Post–heat is the amount of time the glow plug relay circuit is activated after the engine is operating. The Glow Plug lamp will not be illuminated during the post–heat cycle.

TESTING:

Disconnect and isolate the electrical connectors (Fig. 17) at all four glow plugs. With the engine cool or cold, and the key in the ON position, check for 10–12 volts + at each electrical connector. 10–12 volts + should be at each connector whenever the MSA is operating in the pre–heat or post–heat cycles (refer to the following Glow Plug Control chart). **Be very careful not to allow any of the four disconnected glow plug electrical connectors to contact a metal surface. When the key is turned to the ON position, approximately 100 amps at 12 volts is supplied to these connectors.** If 10–12 volts + is not available at each connector, check continuity of wiring harness directly to the relay. If continuity is good directly to the relay, the fault is either with the relay or the relay input from the MSA. To test the relay only, refer to Relays—Operation/Testing in this section of the group. If the relay test is good, refer to the DRB scan tool.

Diagnostic Trouble Codes: Refer to On-Board Diagnostics in Group 25, Emission Control System for a list of Diagnostic Trouble Codes (DTC's) for certain fuel system components.

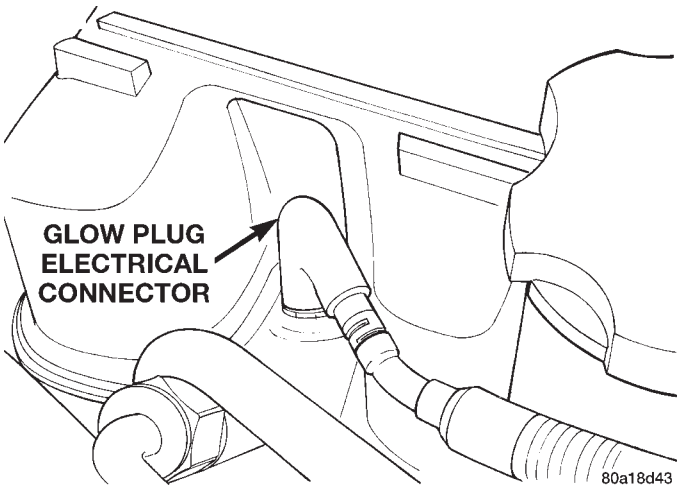

Fig. 17 Wiring Connection at Glow Plug

GLOW PLUG CONTROL

ENGINE COOLANT TEMPERATURE KEY ON	WAIT-TO-START LAMP ON (SECONDS)	PRE-HEAT CYCLE (GLOW PLUGS ON) (SECONDS)	POST-HEAT CYCLE (SECONDS)
-30 C	15 SEC.	45 SEC.	200 SEC.
-10 C	8 SEC.	35 SEC.	180 SEC.
+10 C	6 SEC.	25 SEC.	118 SEC.
+30 C	5 SEC.	20 SEC.	70 SEC.
+40 C	4 SEC.	16 SEC.	60 SEC.
+70 C	3 SEC.	16 SEC.	20 SEC.

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RELAYS—OPERATION/TESTING

The following description of operation and tests apply only to the ASD and other relays . The terminals on the bottom of each relay are numbered (Fig. 18).

OPERATION

- Terminal number 30 is connected to battery voltage. For both the ASD and other relays, terminal 30 is connected to battery voltage at all times.
- The MSA grounds the coil side of the relay through terminal number 85.
- Terminal number 86 supplies voltage to the coil side of the relay.
- When the PCM de-energizes the ASD and other relays, terminal number 87A connects to terminal 30. This is the Off position. In the off position, voltage is not supplied to the rest of the circuit. Terminal 87A is the center terminal on the relay.

DIAGNOSIS AND TESTING (Continued)

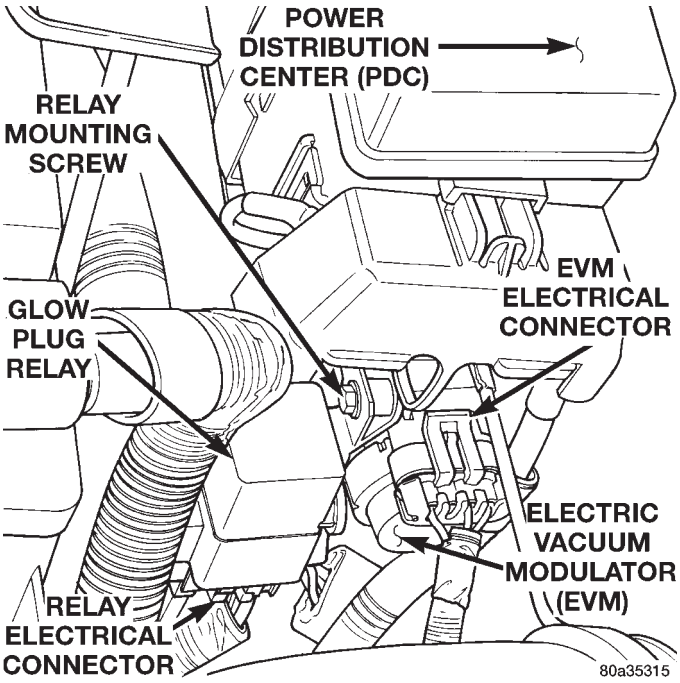

Fig. 18 ASD and Other Relay Terminals

• When the MSA energizes the ASD and other relays, terminal 87 connects to terminal 30. This is the On position. Terminal 87 supplies voltage to the rest of the circuit.

TESTING

The following procedure applies to the ASD and other relays.

(1) Remove relay from connector before testing.

(2) With the relay removed from the vehicle, use an ohmmeter to check the resistance between terminals 85 and 86. The resistance should be between 75 ±5 ohms.

(3) Connect the ohmmeter between terminals 30 and 87A. The ohmmeter should show continuity between terminals 30 and 87A.

(4) Connect the ohmmeter between terminals 87 and 30. The ohmmeter should not show continuity at this time.

(5) Connect one end of a jumper wire (16 gauge or smaller) to relay terminal 85. Connect the other end of the jumper wire to the ground side of a 12 volt power source.

(6) Connect one end of another jumper wire (16 gauge or smaller) to the power side of the 12 volt power source. **Do not attach the other end of the jumper wire to the relay at this time.**

WARNING: DO NOT ALLOW OHMMETER TO CONTACT TERMINALS 85 OR 86 DURING THIS TEST.

(7) Attach the other end of the jumper wire to relay terminal 86. This activates the relay. The ohmmeter should now show continuity between relay terminals 87 and 30. The ohmmeter should not show continuity between relay terminals 87A and 30.

(8) Disconnect jumper wires.

(9) Replace the relay if it did not pass the continuity and resistance tests. If the relay passed the tests, it operates properly. Check the remainder of the ASD and other relay circuits. Refer to group 8W, Wiring Diagrams.

MASS AIR FLOW SENSOR

The Mass Air Flow (MAF) sensor can only be tested by checking for a fault code stored in the MSA. If the mass air flow sensor stops functioning, you will experience a loss of power, as if you had no turbocharger operation. The MSA may indicate no turbo operation if there is no signal from the MAF sensor. If the sensor sets a fault and no loss of power then check to see if there is a clogged air filter.

VEHICLE SPEED SENSOR TEST

To perform a test of the sensor and its related circuitry, refer to DRB scan tool.

Diagnostic Trouble Codes: Refer to On-Board Diagnostics in Group 25, Emission Control System for a list of Diagnostic Trouble Codes (DTC's) for certain fuel system components.

DIAGNOSTIC TROUBLE CODES

For a list of Diagnostic Trouble Codes (DTC's), refer to Group 25, Emission Control System for information. See On-Board Diagnostics.

REMOVAL AND INSTALLATION

ASD RELAY

The ASD relay is located in the PDC. For the location of the relay within the PDC, refer to label on PDC cover.

A/C CLUTCH RELAY

The A/C clutch relay is located in the PDC. For the location of the relay within the PDC, refer to label on PDC cover.

REMOVAL AND INSTALLATION (Continued)

ENGINE SPEED SENSOR

The engine speed sensor is mounted to the transmission bellhousing at the rear of the engine block (Fig. 19).

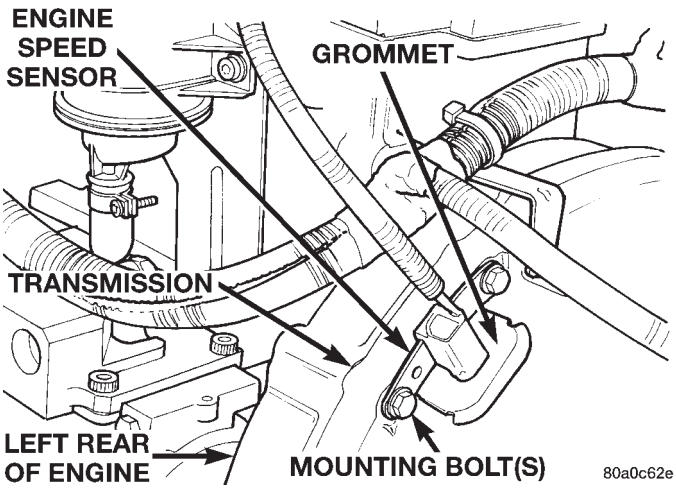

Fig. 19 Engine Speed Sensor

REMOVAL

(1) Disconnect the harness (on the sensor) from the main electrical harness.
(2) Remove the sensor mounting bolts.
(3) Remove the sensor.

INSTALLATION

(1) Install the sensor flush against the opening in the transmission housing.
(2) Install and tighten the sensor mounting bolt to 19 N·m (14 ft. lbs.) torque.
(3) Connect the electrical connector to the sensor.

ENGINE COOLANT TEMPERATURE SENSOR

The sensor is located on the side of cylinder head near the rear of fuel injection pump (Fig. 20).

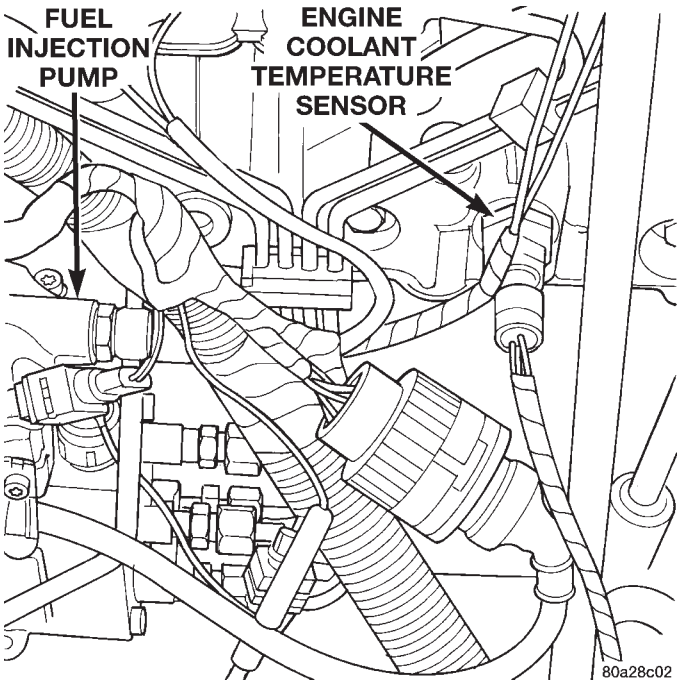

Fig. 20 Engine Coolant Temperature Sensor Location

REMOVAL

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING. COOLING SYSTEM MUST BE PARTIALLY DRAINED BEFORE REMOVING THE COOLANT TEMPERATURE SENSOR. REFER TO GROUP 7, COOLING.

(1) Partially drain cooling system. Refer to Group 7, Cooling.
(2) Disconnect electrical connector from sensor.
(3) Remove sensor from cylinder head.

INSTALLATION

(1) Install a new copper gasket to sensor.
(2) Install sensor to cylinder head.
(3) Tighten sensor to 18 N·m (13 ft. lbs.) torque.
(4) Connect electrical connector to sensor.
(5) Replace any lost engine coolant. Refer to Group 7, Cooling System.

REMOVAL AND INSTALLATION (Continued)

GLOW PLUGS

The glow plugs are located above each fuel injector (Fig. 21). Four individual plugs are used.

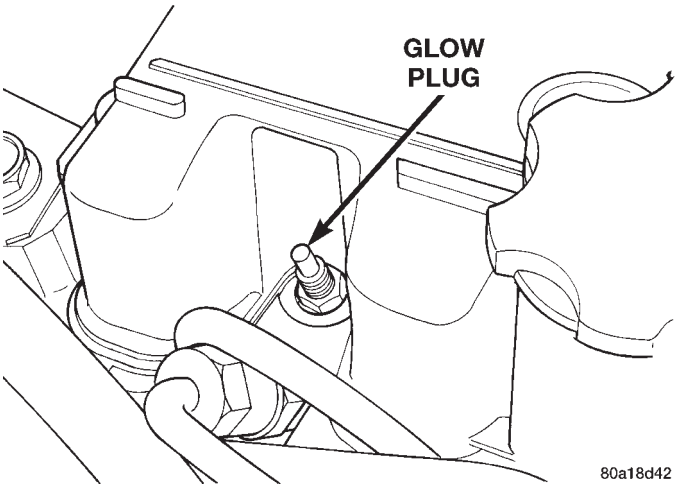

Fig. 21 Glow Plug

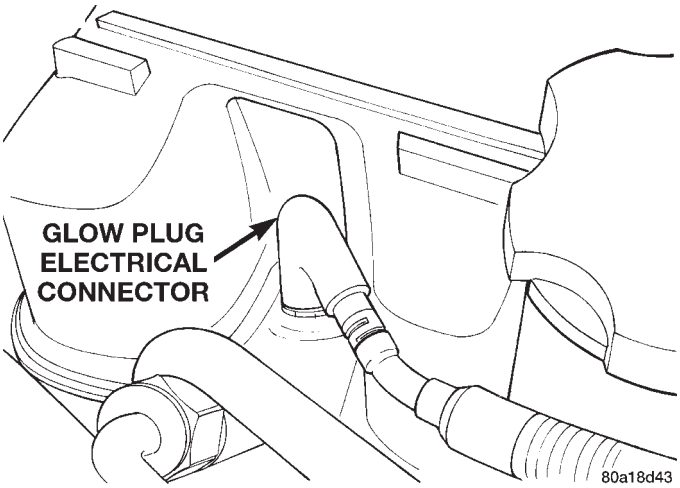

Fig. 22 Glow Plug Electrical Connector

REMOVAL

(1) Disconnect the negative battery cable at the battery.

(2) Clean the area around the glow plug with compressed air before removal.

(3) Disconnect electrical connector (Fig. 22) at glow plug.

(4) Remove the glow plug (Fig. 21) from cylinder head.

INSTALLATION

(1) Apply high–temperature anti–seize compound to glow plug threads before installation

(2) Install the glow plug into the cylinder head. Tighten to 23 N·m (203 in. lbs.) torque.

(3) Connect battery cable to battery.

GLOW PLUG RELAY

The glow plug relay is located in the engine compartment on the left–inner fender (Fig. 23).

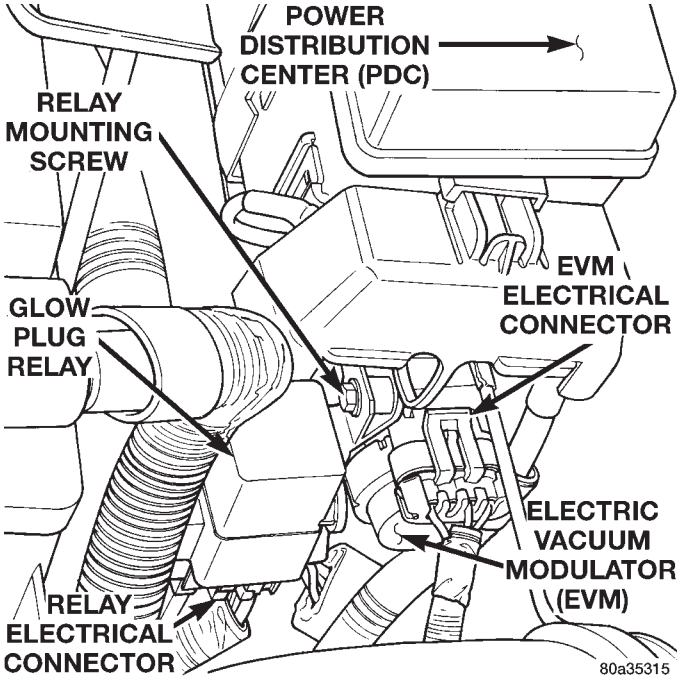

Fig. 23 Glow Plug Relay Location

REMOVAL

(1) Disconnect the negative battery cable at the battery.

(2) Remove relay mounting bolt.

(3) Disconnect electrical connector at relay and remove relay.

INSTALLATION

(1) Check condition of electrical connector for damage or corrosion. Repair as necessary.

(2) Install electrical connector to relay.

(3) Install relay to inner fender.

(4) Connect battery cable to battery.

POWERTRAIN CONTROL MODULE (PCM)

The PCM is mounted to a bracket located in the center console in front of the air bag module (Fig. 24).

REMOVAL

(1) Disconnect the negative battery cable at the battery.

(2) Loosen the 60–Way connector (Fig. 24). The electrical connector has a sliding bar which moves inward to lock or outward to unlock.

(3) Remove the electrical connector by pulling straight out.

(4) Remove PCM.

REMOVAL AND INSTALLATION (Continued)

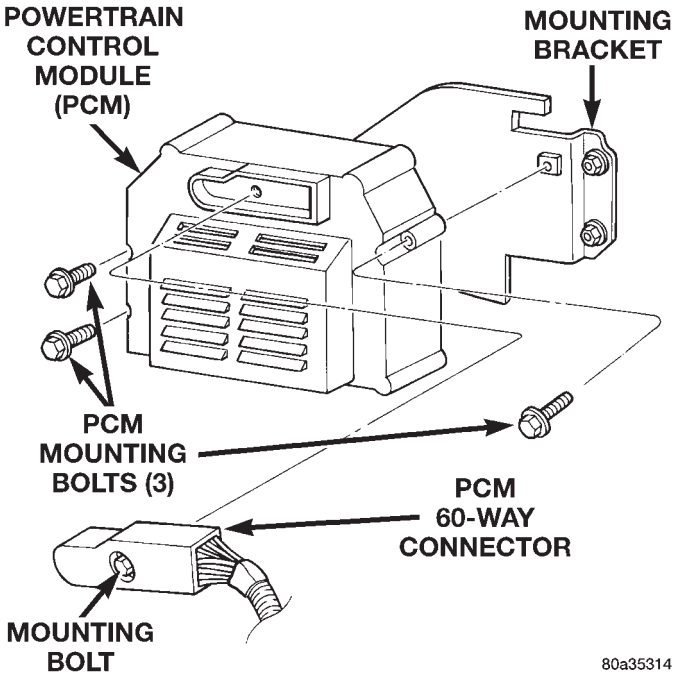

Fig. 24 PCM Location

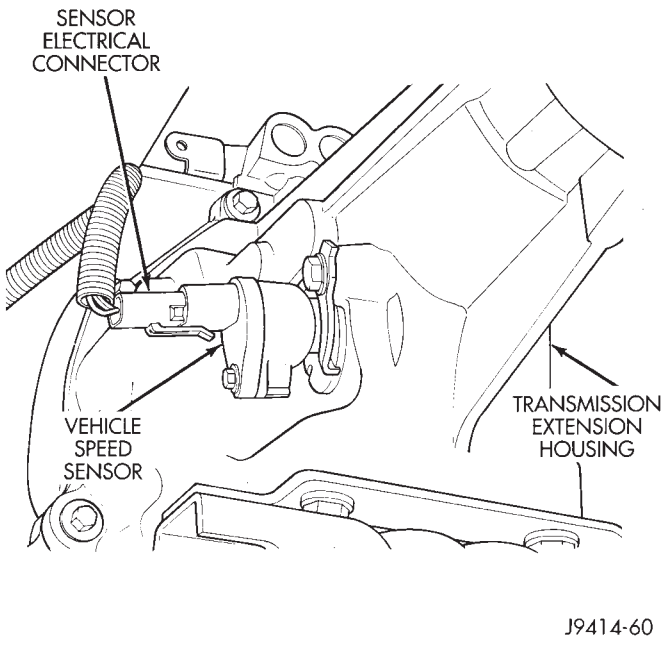

Fig. 25 Vehicle Speed Sensor Location—2 Wheel Drive

INSTALLATION

(1) After the PCM electrical connector has been separated from the PCM, inspect the pins for corrosion, being spread apart, bent or misaligned. Also inspect the pin heights in the connector. If the pin heights are different, this would indicate a pin has separated from the connector. Repair as necessary.

(2) Engage 60–way connector into PCM. Move slide bar to lock connector.

(3) Connect negative cable to battery.

VEHICLE SPEED SENSOR

The vehicle speed sensor (Fig. 25) is located on the extension housing of the transmission for 2 wheel drive vehicle, or on the transfer case housing for 4 wheel drive vehicles (Fig. 26).

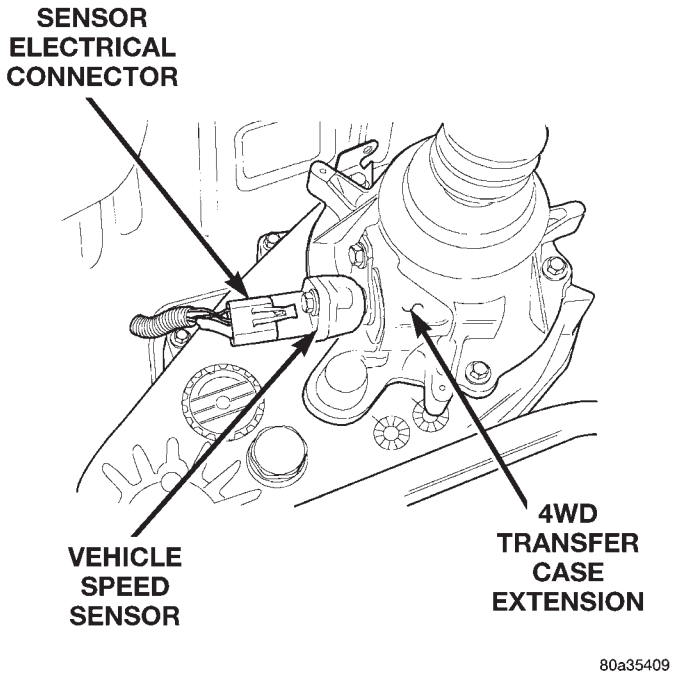

Fig. 26 Vehicle Speed Sensor Location—4WD

REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) Raise and support vehicle.

(2) Clean the area around the sensor before removal.

(3) Disconnect the electrical connector from the sensor (Fig. 27).

(4) Remove the sensor mounting bolt (Fig. 27).

(5) Pull the sensor from the speedometer pinion gear adapter for removal.

INSTALLATION

(1) Install new sensor into speedometer gear adapter.

(2) Tighten sensor mounting bolt. To prevent damage to sensor or speedometer adapter, be sure the sensor is mounted flush to the adapter before tightening.

(3) Connect electrical connector to sensor.

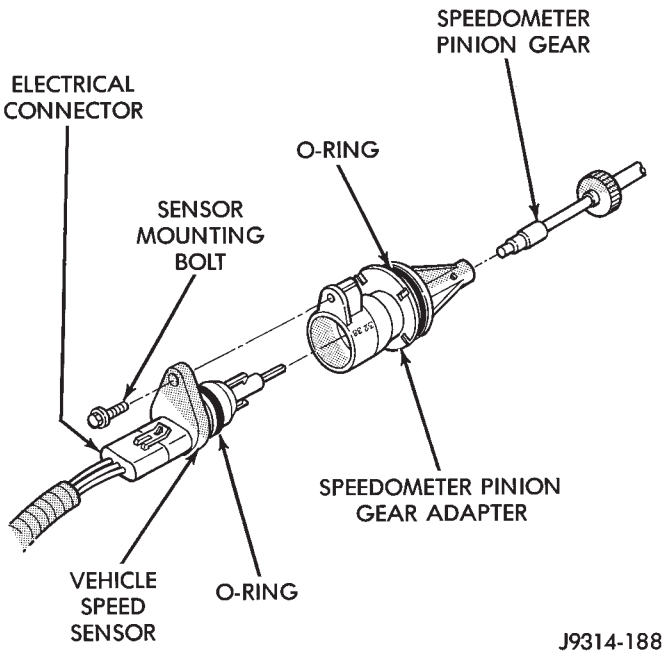

Fig. 27 Sensor Removal/Installation—Typical

SPECIFICATIONS

GLOW PLUG CURRENT DRAW

Initial Current Draw: Approximately 22–25 amps per plug.

After 20 seconds of operation: Approximately 9–12 amps per plug.

TORQUE CHART—2.5L DIESEL

DESCRIPTION	TORQUE
Accelerator Pedal Bracket Mounting Nuts	5 N•m (46 in. lbs.)
Banjo-Type Fittings	19 N•m (14 ft. lbs.)
Engine Coolant Temperature Sensor	18 N•m (13 ft. lbs.)
Engine Speed Sensor Bolts	19 N•m (14 ft. lbs.)
Fuel Hose (Tube) Clamps For Rubber Hose	2 N•m (20 in. lbs.)
Fuel Injector	70 N•m (52 ft. lbs.)
Fuel Injector Line At Injector	30 N•m (22 ft. lbs.)
Fuel Injector Line At Injector Pump	30 N•m (22 ft. lbs.)

DESCRIPTION	TORQUE
Fuel Injection Pump Mounting Nuts	30 N•m (22 ft. lbs.)
Fuel Injection Pump Drive Gear	88 N•m (65 ft. lbs.)
Fuel Line Clamp Bracket Bolts	24 N•m (18 ft. lbs.)
Fuel Tank Nuts	11 N•m (100 in. lbs.)
Glow Plugs	23 N•m (203 in. lbs.)
Powertrain Control Module Mounting Bolts	1 N•m (9 in. lbs.)
Throttle Position Sensor Mounting Bolts	7 N•m (60 in. lbs.)
Vehicle Speed Sensor Mounting Bolt	3 N•m (26 in. lbs.)

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