

FUEL SYSTEM

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GENERAL INFORMATION

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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.

PCM REPLACEMENT

USE THE DRB SCAN TOOL TO REPROGRAM THE NEW PCM WITH THE VEHICLES ORIGINAL IDENTIFICATION NUMBER (VIN) AND THE VEHICLES ORIGINAL MILEAGE. IF THIS STEP IS NOT DONE A DIAGNOSTIC TROUBLE CODE (DTC) MAY BE SET.

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.

GENERAL INFORMATION (Continued)

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.

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

DESCRIPTION AND OPERATION

FUEL DELIVERY SYSTEM

The front wheel drive car uses a plastic fuel tank located rear center of the vehicle.

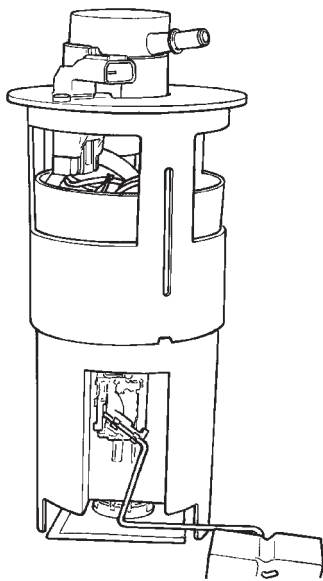
The Fuel Delivery System consists of: the electric fuel pump module, fuel filter, tubes/lines/hoses, fuel rail, and fuel injectors.

The in-tank fuel pump module contains the fuel pump. The pump is serviced as part of the fuel pump module. Refer to Fuel Pump Module.

The fuel filter is replaceable, it is a combination fuel pressure regulator/filter on the fuel pump module. Refer to the Maintenance Schedules in the Introduction section of this manual for recommended fuel filter replacement intervals.

FUEL PUMP MODULE—ALL

The fuel pump module contains the fuel pump, fuel reservoir, level sensor, inlet strainer, and fuel pressure regulator/filter (Fig. 1). The inlet strainer, level sensor and fuel pressure regulator/filter are the only serviceable items. If the fuel pump requires service, replace the fuel pump module.



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Fig. 1 Fuel Pump Module—Typical

ELECTRIC FUEL PUMP

The fuel system uses a positive displacement, gerotor gear, immersible pump with a permanent magnet electric motor. The pump draws fuel through a strainer and pushes it through the motor to the 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. The fuel pump relay provides voltage to operate the fuel pump.

FUEL LEVEL SENSOR

This procedure tests the resistance of the level sensor itself. It does not test the level sensor circuit. Refer to Group 8W - Wiring Diagrams for circuit identification.

The level sensor is a variable resistor. Its resistance changes with the amount of fuel in the tank. The float arm attached to the sensor moves as the fuel level changes.

FUEL TANK

The fuel tanks of all Chrysler Motors built vehicles are equipped with fuel and vapor controls that allow the vehicle to pass a full 360° rollover without fuel leakage.

Front Wheel Drive fuel delivery systems contain a fuel tank rollover valve. The valve is mounted on top of the fuel tank. The valve functions as a tank pressure control valve while the vehicle is upright, but contains a check valve that prevents fuel from escaping from the fuel tank when the vehicle is turned over.

The fuel filler cap acts as a pressure/vacuum relief valve. When air pressure inside the fuel tank gets too high or too low, the fuel filler cap opens to relieve the difference in pressure.

DESCRIPTION AND OPERATION (Continued)

An evaporation control system restricts fuel evaporation into the atmosphere and reduces unburned hydrocarbons. Vapors from the fuel tank are collected in a charcoal filled canister. The vapors are held in the canister until the engine is operating. When the engine is running, the vapors are drawn through the intake manifold into the combustion chambers.

FUEL INJECTORS

The fuel injectors are 12 ohm electrical solenoids (Fig. 2). The injector contains a pintle that closes off an orifice at the nozzle end. When electric current is supplied to the injector, the armature and needle move a short distance against a spring, allowing fuel to flow out the orifice. Because the fuel is under high pressure, a fine spray is developed in the shape of 2 streams. The spraying action atomizes the fuel, adding it to the air entering the combustion chamber. The injectors are positioned in the cylinder heads. Fuel injectors are not interchangeable between engines.

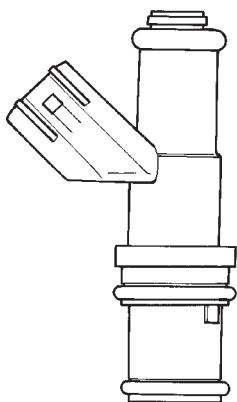


Fig. 2 Fuel Injector

The injectors are positioned in the cylinder heads with the nozzle ends directly above the intake valve port (Fig. 3).

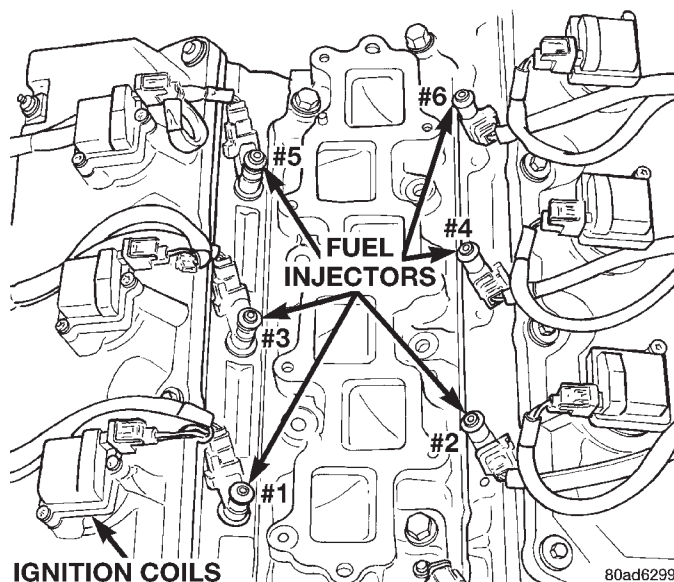


Fig. 3 Fuel Injector Location—Typical

FUEL FILTER/FUEL PRESSURE REGULATOR

A combination fuel filter and fuel pressure regulator is used on all gas powered engines. It is located on the top of the fuel pump module. A separate frame mounted fuel filter is not used.

Fuel Pressure Regulator Operation: The pressure regulator is a mechanical device that is calibrated to maintain fuel system operating pressure of approximately 338 kPa (49 psi) at the fuel injectors.

It contains a diaphragm, calibrated springs and a fuel return valve. The internal fuel filter (Fig. 4) is also part of the assembly.

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

The fuel pump module contains a check valve to maintain some fuel pressure when the engine is not operating. This will help to start the engine.

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

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DESCRIPTION AND OPERATION (Continued)

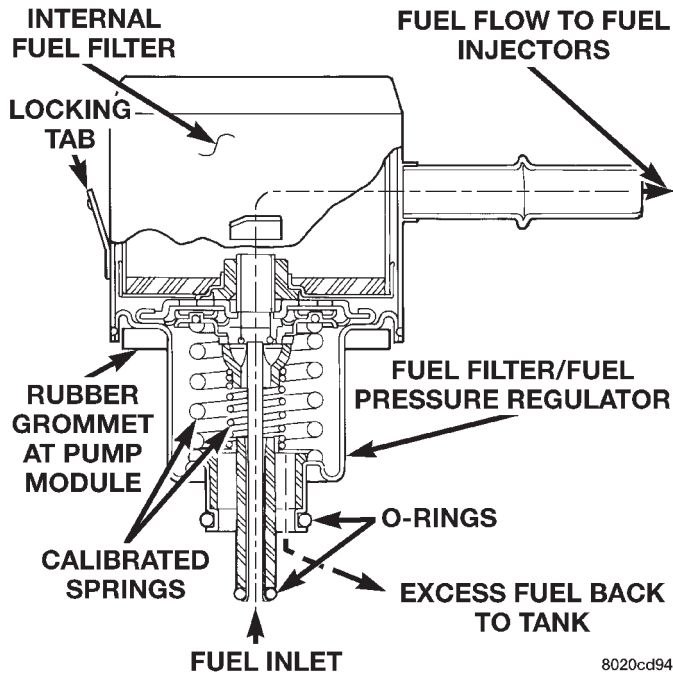


Fig. 4 Side View—Filter/Regulator

PRESSURE-VACUUM FILLER CAP

The fuel filler cap incorporates a two-way relief valve that is closed to atmosphere during normal operating conditions. The relief valve is calibrated to open when a pressure of 10 kPa (1.5 psi) or vacuum of 6 kPa (1.8 in. Hg) occurs in the fuel tank. When the pressure or vacuum is relieved, the valve returns to the normally closed position.

CAUTION: Remove the fuel filler cap to release fuel tank pressure before disconnecting any fuel system component.

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. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

Fuel tubes connect fuel system components with plastic quick-connect fuel fittings. The fitting contains non-serviceable O-ring seals (Fig. 5).

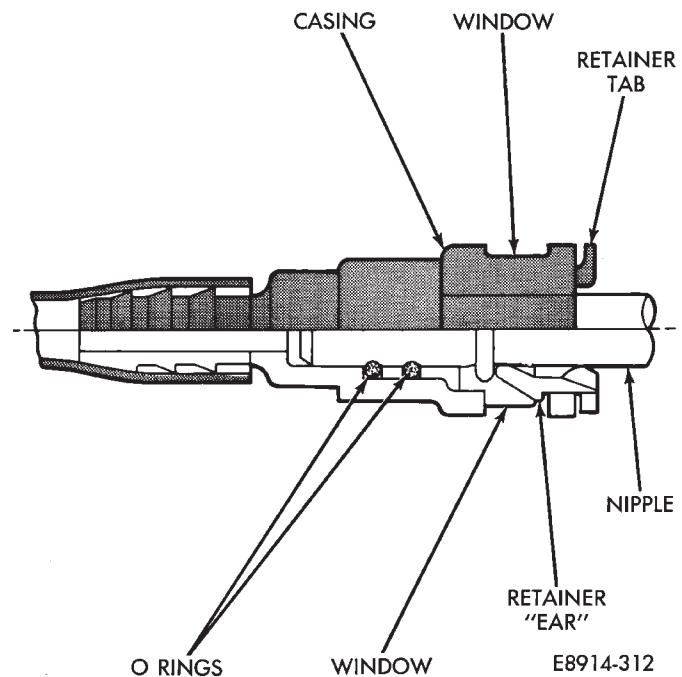


Fig. 5 Plastic Quick-Connect Fittings

CAUTION: Quick-connect fittings are not serviced separately. Do not attempt to repair damaged quick-connect fittings or fuel tubes. Replace the complete fuel tube/quick-connect fitting assembly.

The quick-connect fitting consists of the O-rings, retainer and casing (Fig. 5). When the fuel tube enters the fitting, the retainer locks the shoulder of the nipple in place and the O-rings seal the tube.

ROLLOVER VALVE

The LH fuel tank has fuel and vapor controls that allow the vehicle to pass a full 360° rollover without fuel leakage. Refer to Group 25, Emission Controls System for information.

DIAGNOSIS AND TESTING

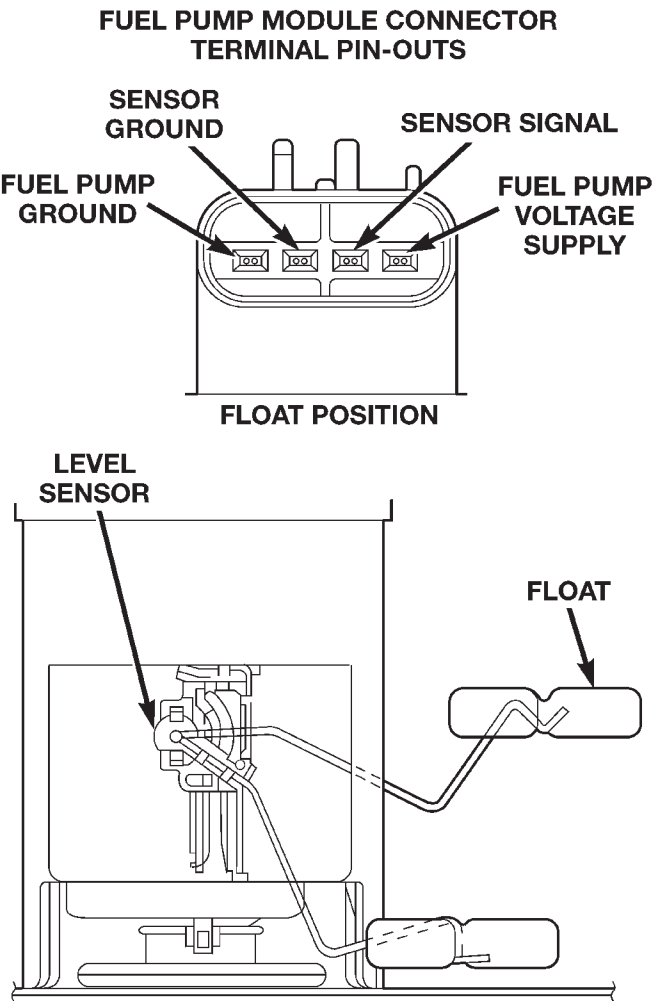
FUEL LEVEL SENSOR

This procedure tests the resistance of the level sensor itself. It does not test the level sensor circuit. Refer to Group 8W - Wiring Diagrams for circuit identification.

The level sensor is a variable resistor. Its resistance changes with the amount of fuel in the tank. The float arm attached to the sensor moves as the fuel level changes. To test the level sensor, connect an ohmmeter across the sensor signal and sensor ground terminals of the fuel pump module connector (Fig. 6). Move the float lever to the positions shown in the resistance chart (Fig. 6). Record the resistance at each point. Replace the level sensor if the resistance is not within specifications.

FUEL INJECTORS

For fuel injector diagnosis, refer to the Fuel Injector Diagnosis charts.



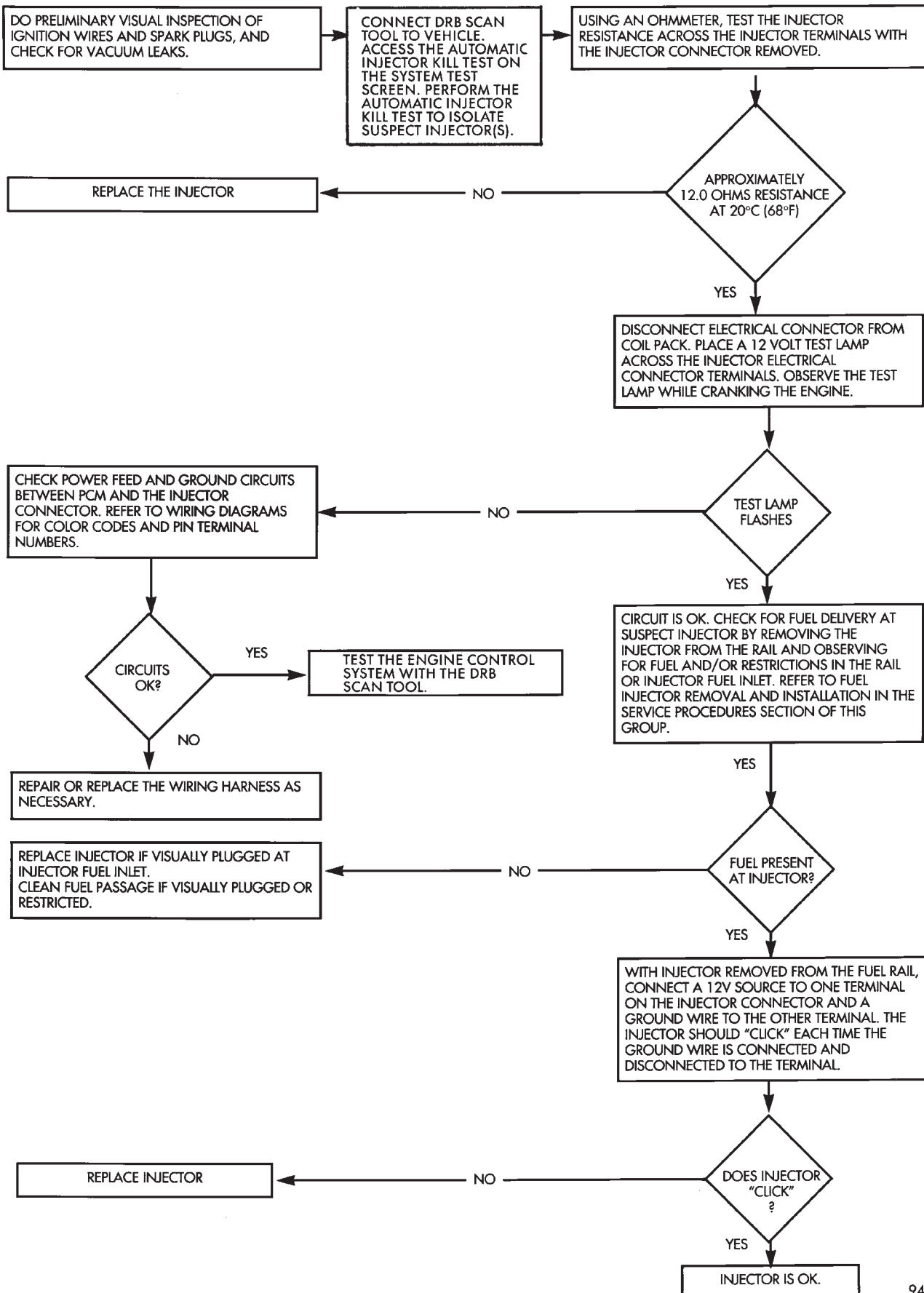
FLOAT POSITION (HEIGHT)	RESISTANCE
151.4 mm (Sensor Full Stop)	60 ± 10 Ohms
141.0 mm (Stop on Gauge)	130 ± 15 Ohms
105.8 mm (3/4 position)	340 ± 30 Ohms
74.5 mm (1/2 position)	550 ± 30 Ohms
43.0 mm (1/4 position)	760 ± 30 Ohms
11.1 mm (Empty on Gauge)	920 ± 30 Ohms
1.4 mm (Sensor Empty Stop)	1050 ± 10 Ohms

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Fig. 6 Level Sensor Diagnosis

DIAGNOSIS AND TESTING (Continued)

FUEL INJECTOR DIAGNOSIS



SERVICE PROCEDURES

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

(1) Remove Fuel Pump relay from Power Distribution Center (PDC). For location of relay, refer to label on underside of 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 fuel rail. Do not attempt to use 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 other end of jumper wire to positive side of battery.

(8) Connect one end of a second jumper wire to remaining injector terminal.

CAUTION: Powering an injector for more than a few seconds will permanently damage the injector.

(9) Momentarily touch other end of jumper wire to negative terminal of battery for no more than a few seconds.

(10) Place a rag or towel below fuel line quick-connect fitting at fuel rail.

(11) Disconnect quick-connect fitting at fuel rail. Refer to Quick-Connect Fittings in this section.

(12) Return fuel pump relay to PDC.

(13) One or more Diagnostic Trouble Codes (DTC's) may have been stored in 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.

DRAINING FUEL TANK

Raise and support vehicle on hoist. Obtain the proper container for **GASOLINE**. Remove drain plug and drain fuel tank (Fig. 7).

HOSES AND CLAMPS

Inspect all hose connections (clamps and quick connect fittings) for completeness and leaks. Replace cracked, scuffed, or swelled hoses. Replace hoses that rub against other vehicle components or show sign of wear.

Fuel injected vehicles use specially constructed hoses. When replacing hoses, only use hoses marked EFM/EFI.

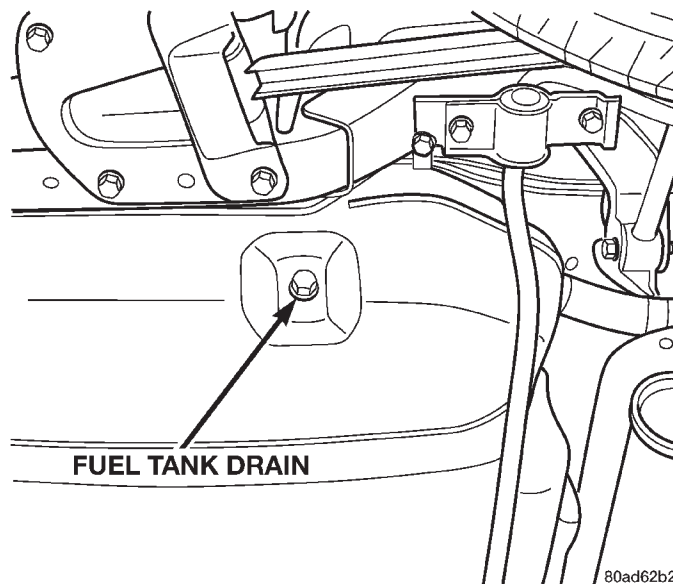


Fig. 7 Fuel Tank Drain Plug

When installing hoses, ensure that they are routed away from contact with other vehicle components that could rub against them and cause failure. Avoid contact with clamps or other components that cause abrasions or scuffing. Ensure that rubber hoses are properly routed and avoid heat sources.

The hose clamps have rolled edges to prevent the clamp from cutting into the hose. Only use clamps that are original equipment or equivalent. Other types of clamps may cut into the hoses and cause high pressure fuel leaks. Tighten hose clamps to 1 N·m (10 in. lbs.) torque.

QUICK-CONNECT FITTINGS

REMOVAL

When disconnecting a quick-connect fitting, the retainer will remain on the fuel tube nipple.

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING A QUICK-CONNECT FITTINGS. REFER TO THE FUEL PRESSURE RELEASE PROCEDURE.

(1) Disconnect negative cable from battery.

(2) Perform Fuel Pressure Release Procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) Squeeze retainer tabs together and pull fuel tube/quick-connect fitting assembly off of fuel tube nipple. The retainer will remain on fuel tube.

SERVICE PROCEDURES (Continued)

INSTALLATION

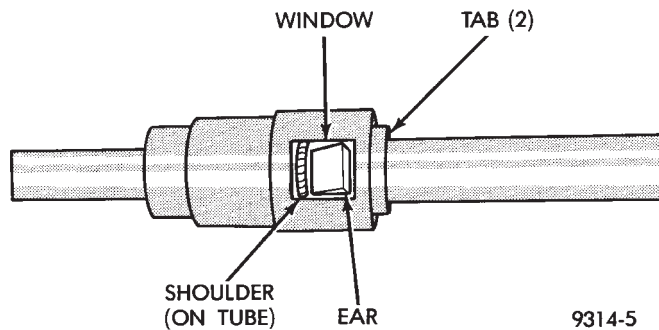
CAUTION: Never install a quick-connect fitting without the retainer being either on the fuel tube or already in the quick-connect fitting. In either case, ensure the retainer locks securely into the quick-connect fitting by firmly pulling on fuel tube and fitting to ensure it is secured.

(1) Using a clean lint free cloth, clean the fuel tube nipple and retainer.

(2) Prior to connecting the fitting to the fuel tube, coat the fuel tube nipple with clean 30 weight engine oil.

(3) Push the quick-connect fitting over the fuel tube until the **retainer seats and a click is heard**.

(4) The plastic quick-connect fitting has windows in the sides of the casing. When the fitting completely attaches to the fuel tube, the retainer locking ears and the fuel tube shoulder are visible in the windows. If they are not visible, the retainer was not properly installed (Fig. 8). **Do not rely upon the audible click to confirm a secure connection.**



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Fig. 8 Plastic Quick-Connect Fitting/Fuel Tube Connection

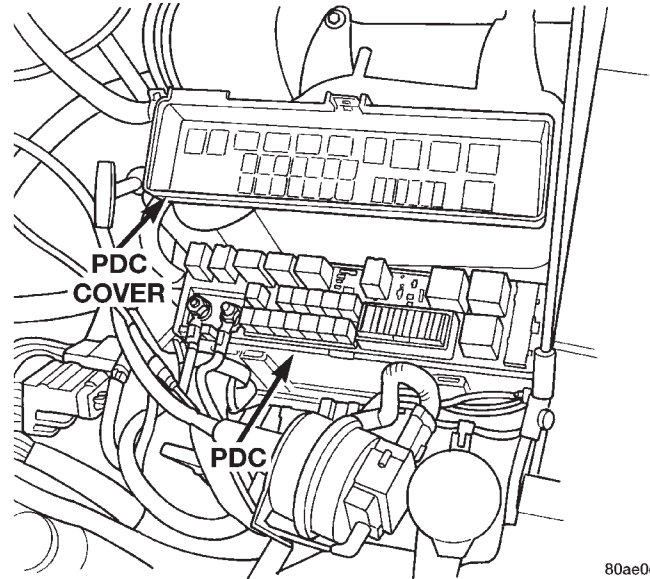
CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(5) Use the DRB scan tool ASD Fuel System Test to pressurize the fuel system. Check for leaks.

REMOVAL AND INSTALLATION

AUTOMATIC SHUTDOWN RELAY

The relay is located in the Power Distribution Center (PDC) (Fig. 9). For the location of the relay within the PDC, refer to the PDC cover for location. Check electrical terminals for corrosion and repair as necessary.



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Fig. 9 Power Distribution Center (PDC)

FUEL PUMP RELAY

The fuel pump relay is located in the PDC. The inside top of the PDC cover has a label showing relay and fuse location.

FUEL PUMP MODULE

REMOVAL

(1) Release fuel pressure, Refer to Fuel System Pressure Release Procedure in Group 14, Fuel Delivery.

(2) Remove Fuel Tank refer to the Fuel Tank Removal/Installation in this group.

WARNING: THE FUEL RESERVOIR OF THE FUEL PUMP MODULE DOES NOT EMPTY OUT WHEN THE TANK IS DRAINED. THE FUEL IN THE RESERVOIR WILL SPILL OUT WHEN THE MODULE IS REMOVED.

(3) Disconnect fuel line from fuel pump module by depressing quick connect retainers with thumb and fore finger.

(4) Slide fuel pump module electrical connector lock to unlock.

(5) Disconnect the electrical connection from the fuel pump module, by pushing down on connector retainer and pulling connector off of module.

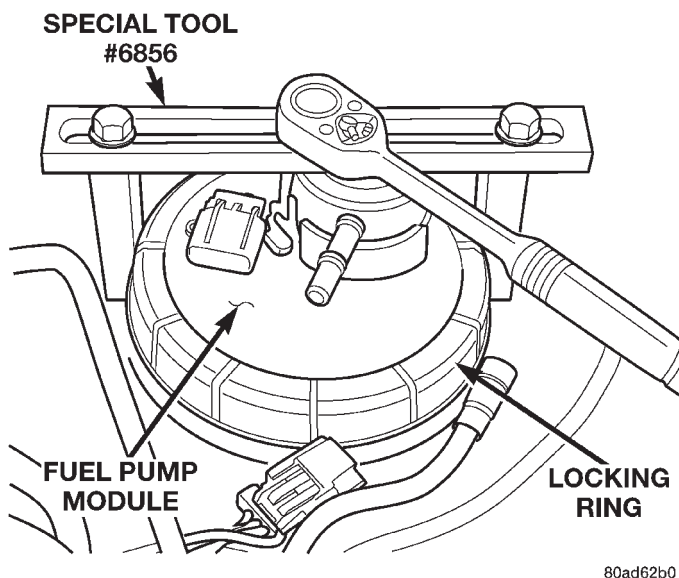
(6) Use Special Tool 6856 to remove fuel pump module locknut (Fig. 10).

(7) Remove fuel pump and O-ring seal from tank. Discard old seal.

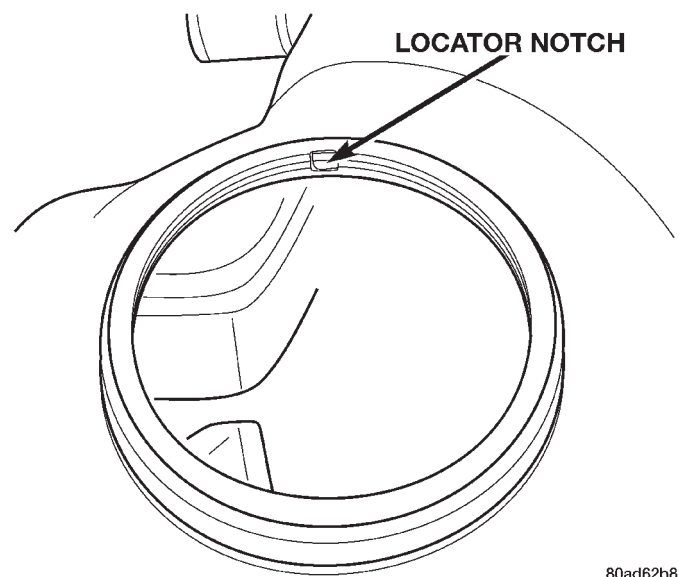
INSTALLATION

(1) Wipe seal area of tank clean and place a new seal in position in the tank opening.

REMOVAL AND INSTALLATION (Continued)

**Fig. 10 Fuel Tank Locknut**

(2) Position fuel pump in the tank. Make sure the alignment tab on the underside of the fuel pump module flange sits in the notch on the fuel tank (Fig. 11).

**Fig. 11 Fuel Tank Locator Notch**

(3) Position the locknut over the fuel pump module.

(4) Tighten the locknut using Special Tool 6856 to 55 N·m (40.5 ft. lbs.).

CAUTION: Over tightening the pump lock ring may result in a leak.

- (5) Raise the fuel tank on the transmission stand.
- (6) Install fuel pump electrical connector into hole in the body.
- (7) Connect the purge and vent lines.

(8) Raise tank into position and install tank straps.

(9) Install the fuel filler tube and tighten the clamp.

(10) Reposition the stabilizer bar and install bolts.

(11) Lower vehicle.

(12) Connect the fuel pump electrical connector that is in the rear seat.

(13) Install the rear seat.

(14) Connect the battery cable.

(15) Fill fuel tank. Use the DRB scan tool to pressurize the fuel system. Check for leaks.

FUEL PRESSURE/REGULATOR**REMOVAL**

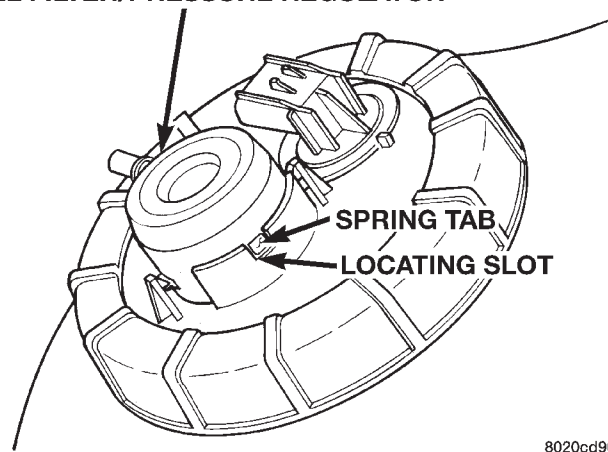
(1) Release fuel pressure, Refer to Fuel System Pressure Release Procedure in Group 14, Fuel Delivery.

(2) Remove Fuel Tank refer to the Fuel Tank Removal/Installation in this group.

(3) Lower fuel tank and remove the purge line and vent line.

(4) Disconnect fuel line from pressure regulator.

(5) Push locking tab in from locking slot. Turn pressure regulator to unlock it (Fig. 12).

FUEL FILTER/PRESSURE REGULATOR**Fig. 12 Fuel Pressure Regulator Locking Tab**

(6) Pull regulator straight up.

INSTALLATION

(1) Push regulator down and into place.

(2) Turn fuel pressure regulator to lock it in place (Fig. 12). Make sure the locking tab is in the locking slot.

(3) Connect fuel line to regulator

(4) Raise the fuel tank on the transmission stand.

(5) Install fuel pump electrical connector into hole in the body.

(6) Connect the purge and vent lines.

REMOVAL AND INSTALLATION (Continued)

- (7) Raise tank into position and install tank straps.
- (8) Install the fuel filler tube and tighten the clamp.
- (9) Reposition the stabilizer bar and install bolts.
- (10) Lower vehicle.
- (11) Connect the fuel pump electrical connector that is in the rear seat.
- (12) Install the rear seat.
- (13) Connect the battery cable.
- (14) Fill fuel tank. Use the DRB scan tool to pressurize the fuel system. Check for leaks.

FUEL PUMP INLET STRAINER

REMOVAL

- (1) Remove fuel pump module. Refer to Fuel Pump Module Removal in this section.
- (2) Using a thin straight blade screwdriver, pry back the locking tabs on fuel pump reservoir and remove the strainer (Fig. 13).
- (3) Remove strainer O-ring from the fuel pump reservoir body.
- (4) Remove any contaminants in the fuel tank by washing the inside of the fuel tank.

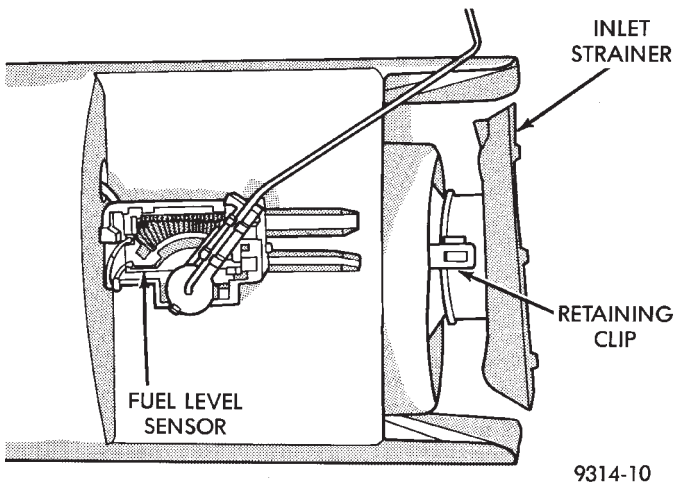


Fig. 13 Inlet Strainer Removal

INSTALLATION

- (1) Lubricate the strainer O-ring with clean engine oil.
- (2) Insert strainer O-ring into outlet of strainer so that it sits evenly on the step inside the outlet.
- (3) Push strainer onto the inlet of the fuel pump reservoir body. Make sure the locking tabs on the reservoir body lock over the locking tangs on the strainer.
- (4) Install fuel pump module. Refer to Fuel Pump Module Installation in this section.

FUEL LEVEL SENSOR

REMOVAL

Remove fuel pump module. Refer to Fuel Pump Module in this section.

- (1) Depress the retaining tab and remove the fuel pump/level sensor connector from the bottom of the fuel pump module electrical connector (Fig. 14).

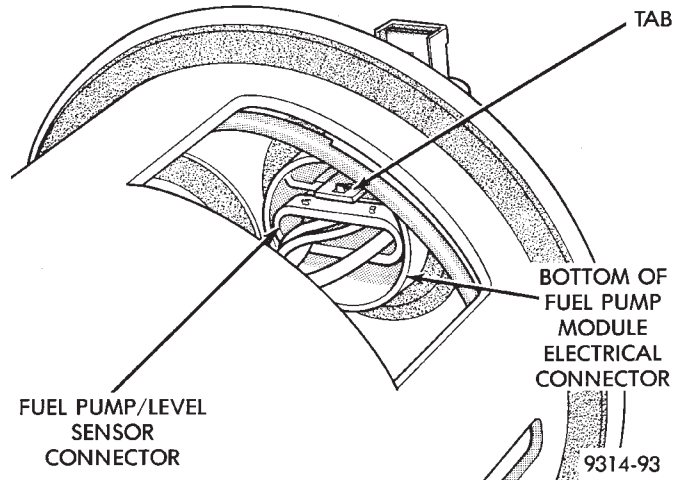


Fig. 14 Fuel Pump/Level Sensor Connector

- (2) Remove wire terminal retaining clip from connector (Fig. 15). Note the location of terminals for the level sensor wires (Fig. 16).

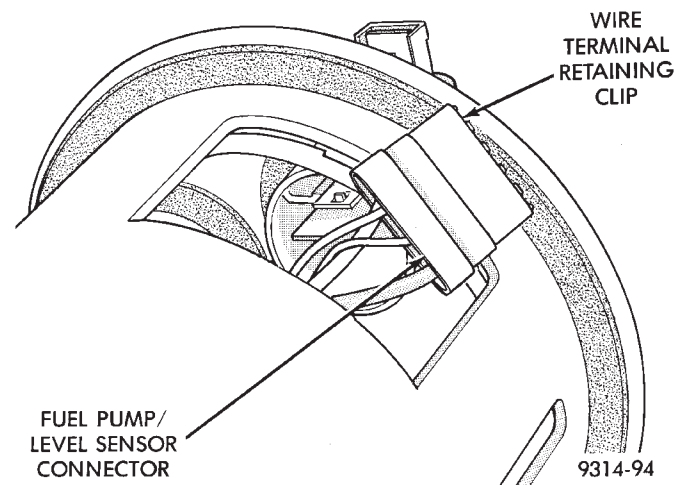
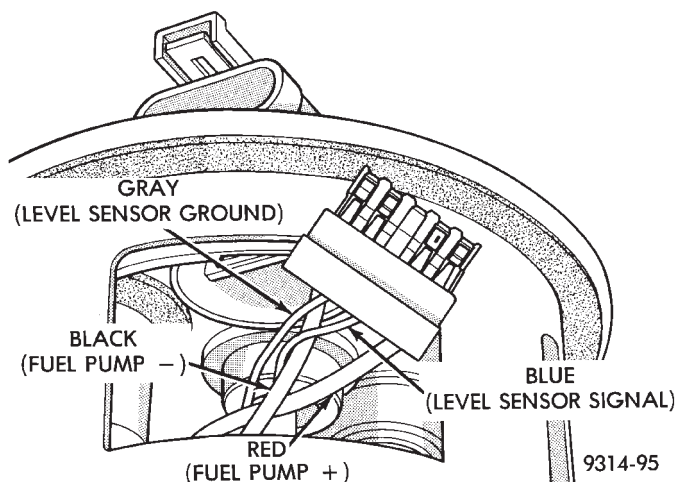
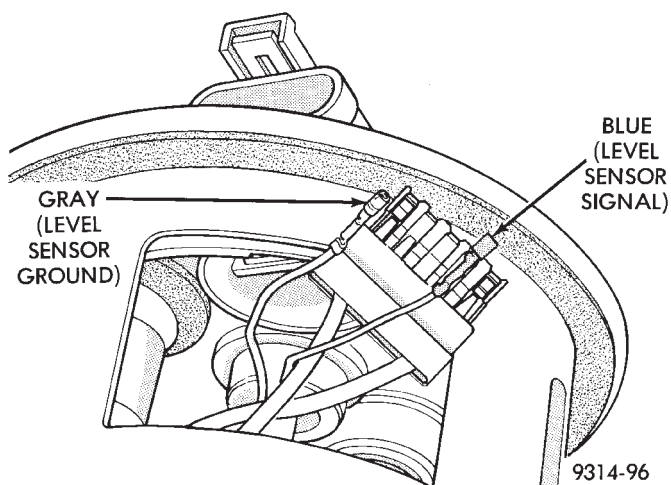


Fig. 15 Wire Terminal Retaining Clip

REMOVAL AND INSTALLATION (Continued)

**Fig. 16 Wire Terminal Identification**

(3) Using special tool 7812 or an equivalent, push level sensor signal and ground terminals out of the connector (Fig. 17).

**Fig. 17 Level Sensor Signal and Ground Wires**

(4) Insert a screwdriver between the fuel pump module and the top of the level sensor housing (Fig. 18). Push level sensor down slightly.

(5) Slide level sensor wires through standpipe inside fuel pump module (Fig. 19).

(6) Slide level sensor out of installation channel (Fig. 18).

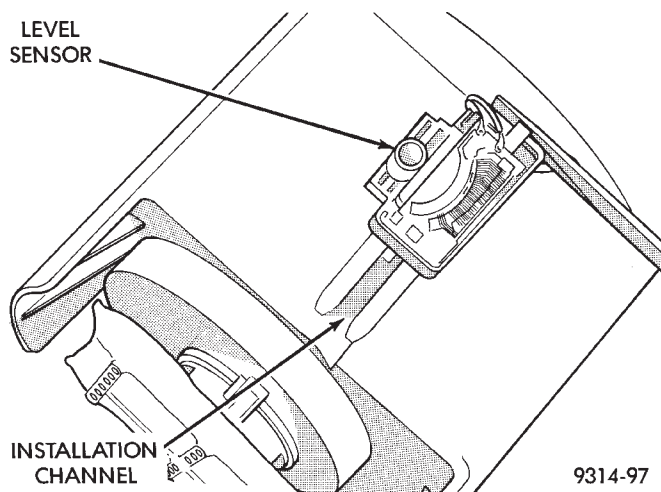
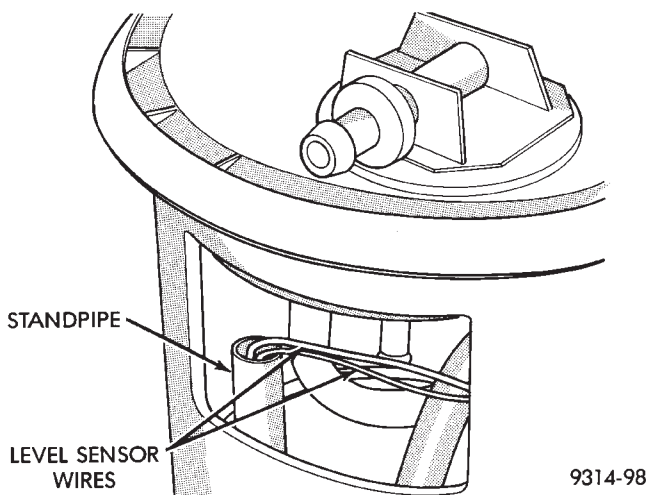
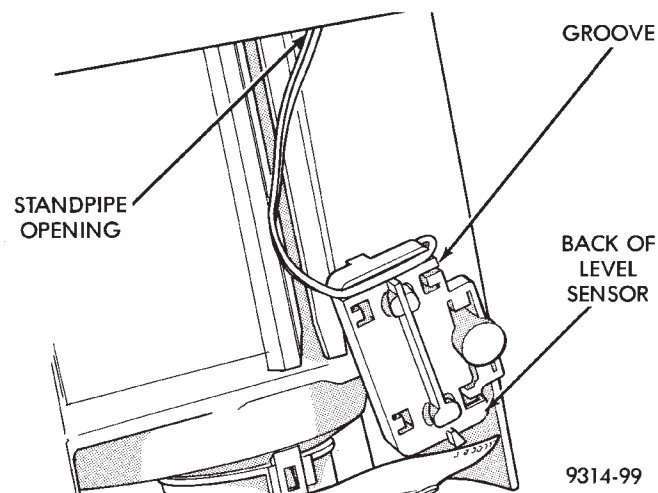
INSTALLATION

(1) Insert level sensor wires in bottom of standpipe.

(2) Wrap wires into groove in back of level sensor (Fig. 20).

(3) While feeding wires into standpipe, slide level sensor up into installation channel until it snaps into place. Ensure tab at bottom of sensor locks in place.

(4) Install level sensor wires in connector. Push the wires up through the connector and then pull

**Fig. 18 Fuel Level Sensor Removal****Fig. 19 Standpipe Inside Module****Fig. 20 Level Sensor Installation**

them down until they lock in place. Ensure signal and ground wires are installed in the correct position (Fig. 16).

(5) Install retaining clip on connector.

REMOVAL AND INSTALLATION (Continued)

(6) Push fuel pump/level sensor connector up into bottom of fuel pump module electrical connector.

(7) Install fuel pump module. Refer to Fuel Pump Module in this section.

FUEL RAIL—2.7L ENGINE

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING FUEL RAIL. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.

REMOVAL

(1) Release fuel system pressure. Refer to Fuel System Pressure Release Procedure in this section.

(2) Disconnect negative battery cable.

(3) Remove intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for intake removal.

(4) Remove intake manifold plenum mounting bolts. Lift Plenum up off of engine. Cover intake manifold to prevent foreign material from entering engine.

(5) Disconnect fuel supply tube quick connect fittings at the rear of intake manifold. Refer to Quick Connect Fittings in the Fuel Delivery Section of this Group.

(6) If the injector connectors are not tagged with their cylinder number, tag them to identify the correct cylinder.

(7) Remove fuel rail mounting bolts.

(8) Lift fuel rail straight up off of cylinder head.

(9) Remove retaining clips from fuel injectors at fuel rail.

(10) Remove fuel injector from fuel rail.

INSTALLATION

(1) Lightly lubricate the fuel injector O-rings with a couple drops of clean engine oil.

(2) Install retaining clips on fuel injectors.

(3) Push injectors into fuel injector rail until clips are in the correct position.

(4) Position fuel rail over cylinder heads, and push rail into place. Tighten fuel rail mounting bolts to 11 N·m (100 in. lbs.) torque.

(5) Install intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for intake installation.

(6) Connect negative cable to battery.

FUEL RAIL—3.2/3.5L ENGINE

REMOVAL

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING FUEL RAIL. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID

IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.

(1) Release fuel system pressure. Refer to Fuel System Pressure Release Procedure in this section.

(2) Disconnect the negative battery cable.

(3) Remove intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for intake removal.

(4) Remove intake manifold plenum mounting bolts. Lift Plenum up off of engine. Cover intake manifold to prevent foreign material from entering engine.

(5) Disconnect fuel supply tube quick connect fitting at the rear of the fuel rail.

(6) If the injector connectors are not tagged with their cylinder number, tag them to identify the correct cylinder (Fig. 21).

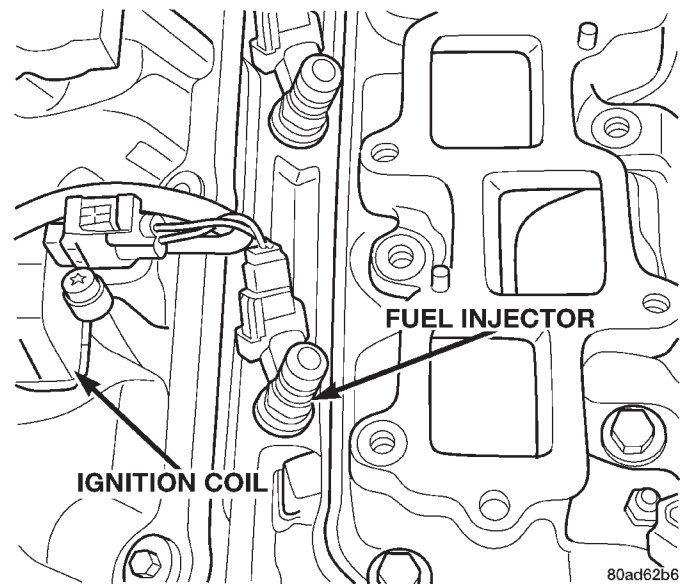


Fig. 21 Injector Electrical Connectors

(7) Remove mounting bolts on both sides of fuel rail.

(8) Lift fuel rail straight up off of cylinder head.

(9) Remove retaining clips from fuel injectors at fuel rail.

(10) Remove fuel injector from fuel rail.

INSTALLATION

(1) Lightly lubricate the fuel injector O-rings with a couple drops of clean engine oil.

(2) Install retaining clips on fuel injectors.

(3) Push injectors into fuel injector rail until clips are in the correct position.

(4) Position fuel rail over cylinder heads, and push rail into place. Tighten fuel rail mounting bolts to 11 N·m (100 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

(5) Install intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for intake installation.

(6) Connect negative cable to battery.

FUEL INJECTORS—2.7L ENGINE

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING FUEL RAIL. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.

REMOVAL

(1) Release fuel system pressure. Refer to Fuel System Pressure Release Procedure in this section.

(2) Disconnect negative cable to battery.

(3) Remove intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for intake removal.

(4) Remove intake manifold plenum mounting bolts. Lift Plenum up off of engine. Cover intake manifold to prevent foreign material from entering engine.

(5) Disconnect fuel supply tube quick connect fittings at the rear of intake manifold. Refer to Quick Connect Fittings in the Fuel Delivery Section of this Group.

(6) If the injector connectors are not tagged with their cylinder number, tag them to identify the correct cylinder.

(7) Remove electrical connectors from the fuel injectors.

(8) Remove fuel rail mounting bolts.

(9) Lift fuel rail straight up off of the cylinder head.

(10) Remove retaining clips from fuel injectors at fuel rail.

(11) Remove fuel injectors.

INSTALLATION

(1) Lightly lubricate the fuel injector O-rings with a couple drops of clean engine oil.

(2) Install fuel injectors.

(3) Install retaining clips on fuel injectors.

(4) Push injectors into fuel injector rail until clips are in the correct position.

(5) Position fuel rail over cylinder head, and push rail into place. Tighten fuel rail mounting bolts to 11 N·m (100 in. lbs.) torque.

(6) Connect fuel supply tube quick connect fittings at the rear of intake manifold. Refer to Quick Connect Fittings in the Fuel Delivery Section of this Group.

(7) Connect electrical connectors to fuel injectors.

(8) Install intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for intake installation.

(9) Connect negative cable to battery.

FUEL INJECTORS—3.2/3.5L ENGINE

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING FUEL RAIL. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.

REMOVAL

(1) Release fuel system pressure. Refer to Fuel System Pressure Release Procedure in this section.

(2) Disconnect the negative battery cable.

(3) Remove intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for intake removal.

(4) Remove intake manifold plenum mounting bolts. Lift Plenum up off of engine. Cover intake manifold to prevent foreign material from entering engine.

(5) Disconnect fuel supply tube quick connect fittings at the rear of intake manifold. Refer to Quick Connect Fittings in the Fuel Delivery Section of this Group.

(6) If the injector connectors are not tagged with their cylinder number, tag them to identify the correct cylinder (Fig. 21).

(7) Remove electrical connectors from the fuel injectors.

(8) Remove mounting bolts on both sides of fuel rail.

(9) Lift fuel rail straight up off of cylinder head.

(10) Remove retaining clips from fuel injectors at fuel rail.

(11) Remove fuel injectors.

INSTALLATION

(1) Lightly lubricate the fuel injector O-rings with a couple drops of clean engine oil.

(2) Install retaining clips on fuel injectors.

(3) Push injectors into fuel injector rail until clips are in the correct position.

(4) Position fuel rail over cylinder head, and push rail into place. Tighten fuel rail mounting bolts to 11 N·m (100 in. lbs.) torque.

(5) Connect fuel supply tube quick connect fittings at the rear of intake manifold. Refer to Quick Connect Fittings in the Fuel Delivery Section of this Group.

(6) Connect electrical connectors to fuel injectors.

REMOVAL AND INSTALLATION (Continued)

(7) Install intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold for intake installation.

(8) Connect the battery cable.

FUEL TANK

REMOVAL

(1) Release fuel pressure. Refer to Fuel System Pressure Release Procedure in Group 14, Fuel Delivery.

(2) Remove rear seat.

(3) Disconnect fuel pump electrical connector (Fig. 22).

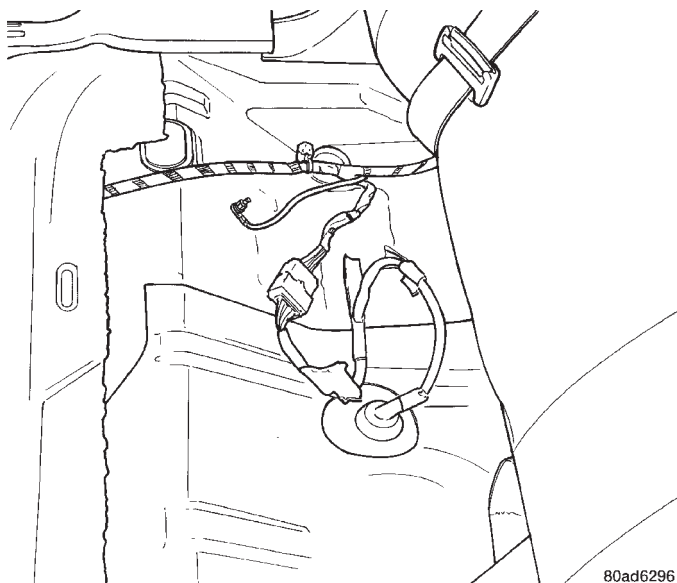


Fig. 22 Electrical Connector

(4) Disconnect battery cable (Fig. 23).

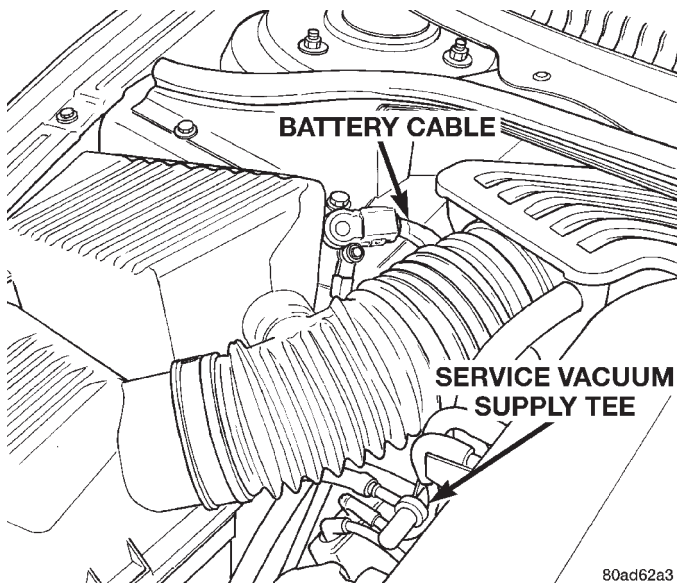


Fig. 23 Battery Cable

(5) Raise vehicle and support.

(6) Drain fuel tank, refer to Draining Fuel Tank in Group 14, Fuel Delivery (Fig. 24).

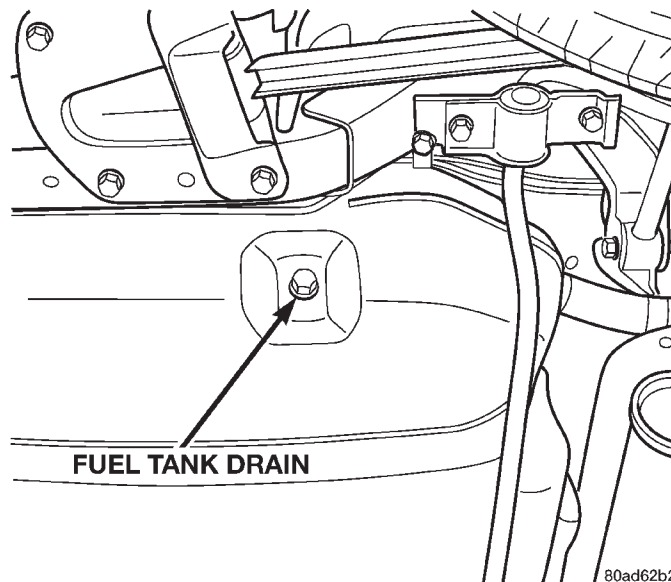


Fig. 24 Fuel Tank Drain

(7) Loosen the rear stabilizer bar brackets from body. Swing stabilizer bar toward rear of vehicle (Fig. 25) and (Fig. 26).

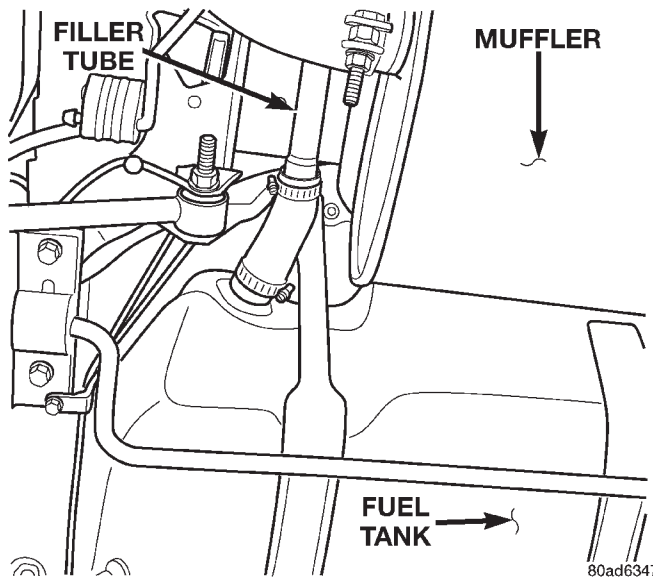


Fig. 25 Stabilizer Bar

(8) Loosen and remove fuel filler tube from fuel tank (Fig. 27).

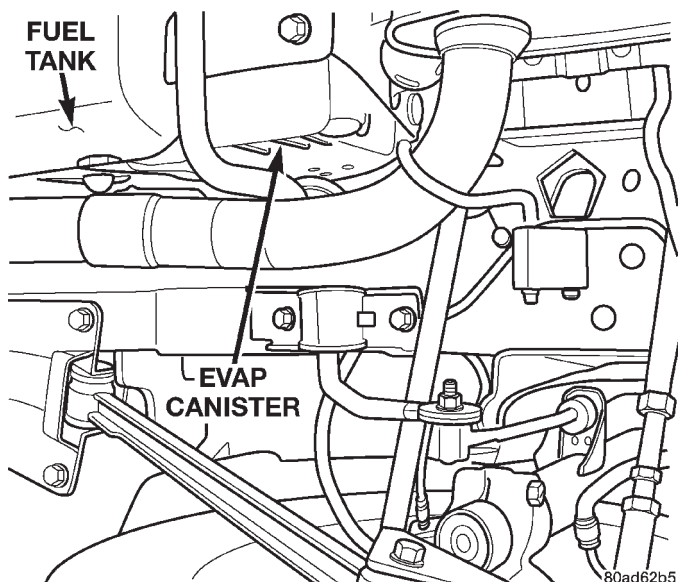
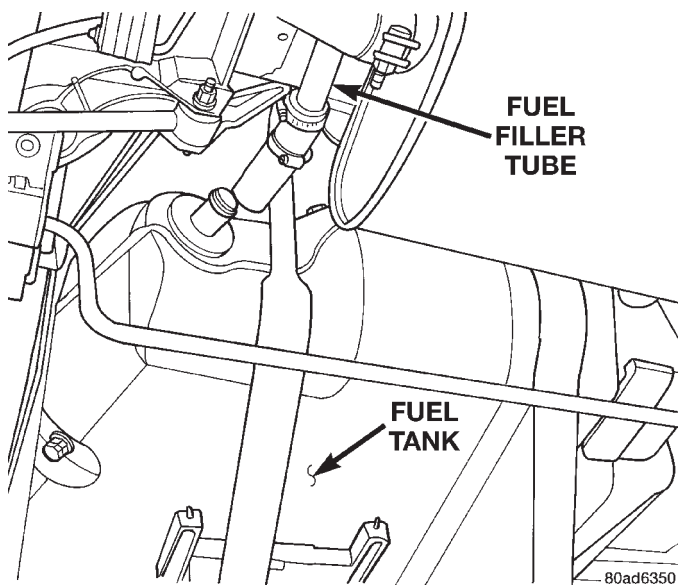
(9) Disconnect fuel and EVAP lines (Fig. 28).

(10) Position transmission jack under fuel tank assembly.

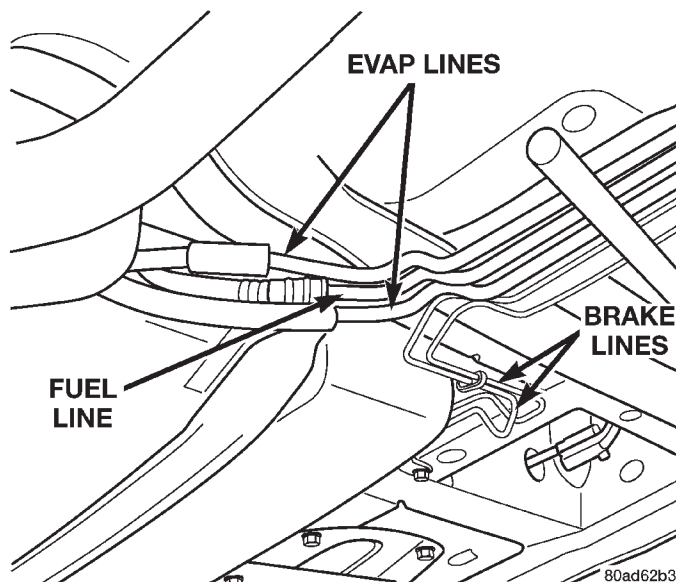
(11) Remove fuel tank straps bolts. Passenger side first.

(12) Lower fuel tank and remove the purge line and vent line.

REMOVAL AND INSTALLATION (Continued)

**Fig. 26 Stabilizer Bar and EVAP Canister****Fig. 27 Fuel Filler Tube****INSTALLATION**

- (1) Raise the fuel tank on the transmission stand.
- (2) Install fuel pump electrical connector into hole in the body.
- (3) Connect the purge and vent lines.
- (4) Raise tank into position and install tank straps.
- (5) Install the fuel filler tube and tighten the clamp.
- (6) Reposition the stabilizer bar and install bolts.
- (7) Lower vehicle.
- (8) Connect the fuel pump electrical connector that is in the rear seat.
- (9) Install the rear seat.
- (10) Connect the battery cable.

**Fig. 28 Fuel and EVAP Lines**

- (11) Fill fuel tank. Use the DRB scan tool to pressurize the fuel system. Check for leaks.

FUEL FILLER NECK**REMOVAL**

- (1) Disconnect negative cable from battery.
- (2) Drain fuel tank.
- (3) Remove 3 screws from filler neck to quarter panel.
- (4) Raise and support vehicle on host.
- (5) Loosen clamps at filler neck.
- (6) Remove filler neck.

INSTALLATION

- (1) Install filler neck to filler hose.
- (2) Tighten clamps.
- (3) Lower vehicle.
- (4) Install 3 screws to filler neck and quarter panel.
- (5) Fill tank and check for leaks.
- (6) Connect negative cable from battery.

FUEL FILLER VENT HOSE**REMOVAL**

- (1) Perform fuel system pressure release.
- (2) Disconnect negative cable from battery.
- (3) Drain fuel tank.
- (4) Raise and support vehicle on host.
- (5) Lower fuel tank, refer to Fuel Tank Removal/Installation in this section.
- (6) Remove vent hose from top of tank.
- (7) Remove vent hose from fuel filler neck.

INSTALLATION

- (1) Install vent hose and tighten clamp.

REMOVAL AND INSTALLATION (Continued)

- (2) Install fuel tank, refer to Fuel Tank Removal/Installation in this section.
- (3) Install vent hose to fuel filler neck and tighten clamp.
- (4) Lower vehicle.
- (5) Fill fuel tank and check for leaks.
- (6) Connect negative cable to battery.

ACCELERATOR PEDAL

REMOVAL

(1) Working from the engine compartment, hold the throttle body throttle lever in the wide open position. Remove the throttle cable from the throttle body cam.

(2) From inside the vehicle, hold up the pedal and remove the cable retainer and throttle cable from the upper end of the pedal shaft (Fig. 29) and (Fig. 30).

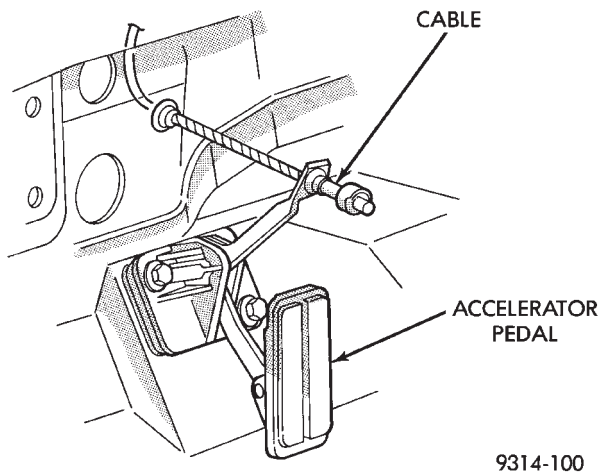


Fig. 29 Accelerator Pedal and Throttle Cable

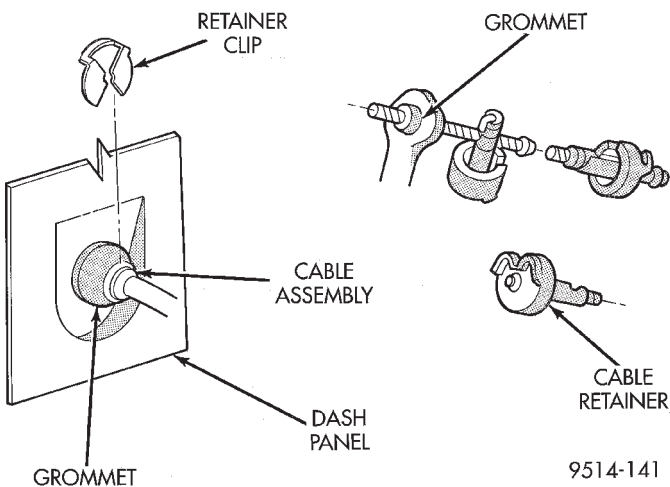


Fig. 30 Throttle Cable Removal/Installation

(3) Working from the passenger compartment, remove nuts from accelerator pedal base (Fig. 31). Remove pedal and base from vehicle.

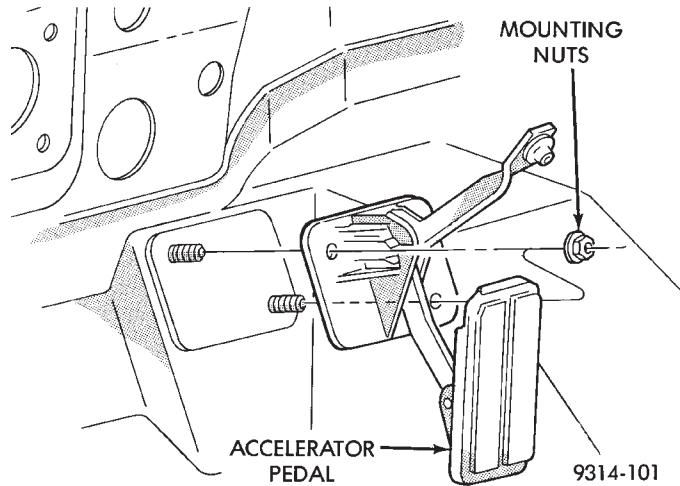


Fig. 31 Accelerator Pedal Removal/Installation

INSTALLATION

(1) Position accelerator pedal assembly over studs onto dash panel. Ensure carpet and insulation are trapped between the lip of the pedal base and the floor pan (Fig. 32). Install mounting nuts and tighten to 12 N·m (105 in. lbs.) torque.

(2) From inside the vehicle, hold up the pedal and install the throttle cable and cable retainer in the upper end of the pedal shaft.

(3) From the engine compartment, hold the throttle body lever in the wide open position and install the throttle cable.

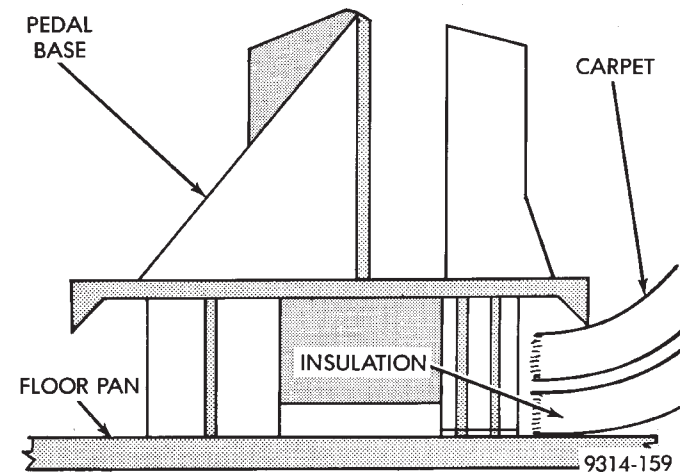


Fig. 32 Carpet and Insulation Placement

THROTTLE CABLE

CAUTION: When servicing the accelerator pedal, throttle cable or speed control cable, do not damage or kink the core wire inside the cable sheathing.

REMOVAL AND INSTALLATION (Continued)

REMOVAL

- (1) Working from the engine compartment, hold the throttle body throttle lever in the wide open position. Pull the cable forward and slide it out of the throttle body cam.
 - (2) From inside the vehicle, hold up the pedal and remove the cable retainer and throttle cable from the upper end of the pedal shaft.
 - (3) Remove retainer clip from throttle cable and grommet at dash panel.
 - (4) From the engine compartment, pull the throttle cable out of the dash panel grommet. The grommet should remain in the dash panel.
 - (5) Remove the throttle cable from throttle bracket by carefully compressing both retaining ears simultaneously. Then gently pull the throttle cable from throttle bracket.
- INSTALLATION
- (1) From the engine compartment, push the housing end fitting into the dash panel grommet.
 - (2) Install the cable housing (throttle body end) into the cable mounting bracket on the engine.
 - (3) From inside the vehicle, hold up the pedal and install throttle cable and cable retainer in the upper end of the pedal shaft.

- (4) At the dash panel, install the cable retainer clip between the end of the throttle cable fitting and grommet.
- (5) From the engine compartment, rotate the throttle lever to wide open and install the throttle cable.

SPECIFICATIONS

TORQUE

DESCRIPTION	TORQUE
Accelerator Pedal to Dash Nuts	12 N·m (105 in. lbs.)
Fuel Pump Module Locknut	55 N·m (40 ft. lbs.)
Fuel Tank strap Bolts	60 N·m (44 ft. lbs.)
Fuel Rail Bolts—2.7L	23 N·m (195 in. lbs.)
Fuel Rail Bolts—3.2L	23 N·m (195 in. lbs.)
Fuel Rail Bolts—3.5L	11 N·m (100 in. lbs.)

FUEL INJECTION SYSTEM

GENERAL INFORMATION

INTRODUCTION

All engines used in this section have a sequential Multi-Port Electronic Fuel Injection system. The MPI system is computer regulated and provides precise air/fuel ratios for all driving conditions. The Powertrain Control Module (PCM) operates the fuel injection system.

The PCM regulates:

- Ignition timing
- Air/fuel ratio
- Emission control devices
- Cooling fan
- Charging system
- Idle speed
- Vehicle speed control

Various sensors provide the inputs necessary for the PCM to correctly operate these systems. In addition to the sensors, various switches also provide inputs to the PCM.

All inputs to the PCM are converted into signals. The PCM can adapt its programming to meet changing operating conditions.

Fuel is injected into the intake port above the intake valve in precise metered amounts through electrically operated injectors. The PCM fires the injectors in a specific sequence. Under most operating conditions, the PCM maintains an air fuel ratio of 14.7 parts air to 1 part fuel by constantly adjusting injector pulse width. Injector pulse width is the length of time the injector is open.

The PCM adjusts injector pulse width by opening and closing the ground path to the injector. Engine RPM (speed) and manifold absolute pressure (air density) are the primary inputs that determine injector pulse width.

MODES OF OPERATION

As input signals to the PCM change, the PCM adjusts its response to output devices. For example, the PCM must calculate a different injector pulse width and ignition timing for idle than it does for Wide Open Throttle (WOT). There are several different modes of operation that determine how the PCM responds to the various input signals.

There are two different areas of operation, OPEN LOOP and CLOSED LOOP.

During OPEN LOOP modes the PCM receives input signals and responds according to preset PCM programming. Inputs from the upstream and downstream heated oxygen sensors are not monitored during OPEN LOOP modes, except for heated oxygen

sensor diagnostics (they are checked for shorted conditions at all times).

During CLOSED LOOP modes the PCM monitors the inputs from the upstream and downstream heated oxygen sensors. The upstream heated oxygen sensor input tells the PCM if the calculated injector pulse width resulted in the ideal air-fuel ratio of 14.7 to one. By monitoring the exhaust oxygen content through the upstream heated oxygen sensor, the PCM can fine tune injector pulse width. Fine tuning injector pulse width allows the PCM to achieve optimum fuel economy combined with low emissions.

For the PCM to enter CLOSED LOOP operation, the following must occur:

- (1) Engine coolant temperature must be over 35°F.
 - If the coolant is over 35° the PCM will wait 44 seconds.
 - If the coolant is over 50°F the PCM will wait 38 seconds.
 - If the coolant is over 167°F the PCM will wait 11 seconds.
- (2) For other temperatures the PCM will interpolate the correct waiting time.
- (3) O2 sensor must read either greater than .745 volts or less than .1 volt.
- (4) The multi-port fuel injection systems has the following modes of operation:
 - Ignition switch ON (Zero RPM)
 - Engine start-up
 - Engine warm-up
 - Cruise
 - Idle
 - Acceleration
 - Deceleration
 - Wide Open Throttle
 - Ignition switch OFF

(5) The engine start-up (crank), engine warm-up, deceleration with fuel shutoff and wide open throttle modes are OPEN LOOP modes. Under most operating conditions, the acceleration, deceleration (with A/C on), idle and cruise modes, **with the engine at operating temperature** are CLOSED LOOP modes.

IGNITION SWITCH ON (ZERO RPM) MODE

When the ignition switch activates the fuel injection system, the following actions occur:

- The PCM monitors the engine coolant temperature sensor and throttle position sensor input. The PCM determines basic fuel injector pulse width from this input.
- The PCM determines atmospheric air pressure from the MAP sensor input to modify injector pulse width.

GENERAL INFORMATION (Continued)

When the key is in the ON position and the engine is not running (zero rpm), the Auto Shutdown (ASD) and fuel pump relays de-energize after approximately 1 second. Therefore, battery voltage is not supplied to the fuel pump, ignition coil, fuel injectors and heated oxygen sensors.

ENGINE START-UP MODE

This is an OPEN LOOP mode. If the vehicle is in park or neutral (automatic transaxles) or the clutch pedal is depressed (manual transaxles) the ignition switch energizes the starter relay. The following actions occur when the starter motor is engaged.

- If the PCM receives the camshaft position sensor and crankshaft position sensor signals, it energizes the Auto Shutdown (ASD) and fuel pump relays. If the PCM does not receive both signals within approximately one second, it will not energize the ASD relay and fuel pump relay. The ASD and fuel pump relays supply battery voltage to the fuel pump, fuel injectors, ignition coil and heated oxygen sensors.

- The PCM energizes the injectors (on the 69° degree falling edge) for a calculated pulse width until it determines crankshaft position from the camshaft position sensor and crankshaft position sensor signals. The PCM determines crankshaft position within 1 engine revolution.

- After determining crankshaft position, the PCM begins energizing the injectors in sequence. It adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

- When the engine idles within ± 64 RPM of its target RPM, the PCM compares current MAP sensor value with the atmospheric pressure value received during the Ignition Switch On (zero RPM) mode. If the PCM does not detect a minimum difference between the two values, it sets a MAP diagnostic trouble code into memory.

Once the ASD and fuel pump relays have been energized, the PCM determines injector pulse width based on the following:

- Battery voltage
- Engine coolant temperature
- Engine RPM
- Intake air temperature (IAT)
- Throttle position
- The number of engine revolutions since cranking was initiated

During Start-up the PCM maintains ignition timing at 9° BTDC.

ENGINE WARM-UP MODE

This is an OPEN LOOP mode. The following inputs are received by the PCM:

- Engine coolant temperature
- Manifold Absolute Pressure (MAP)
- Intake air temperature (IAT)
- Crankshaft position (engine speed)
- Camshaft position
- Knock sensor
- Throttle position
- A/C switch
- Battery voltage
- Power steering pressure switch
- Vehicle speed
- Speed control
- O2 sensors
- All diagnostics

The PCM adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

The PCM adjusts ignition timing and engine idle speed. Engine idle speed is adjusted through the idle air control motor.

CRUISE OR IDLE MODE

When the engine is at operating temperature this is a CLOSED LOOP mode. During cruising or idle the following inputs are received by the PCM:

- Intake air temperature
- Engine coolant temperature
- Manifold absolute pressure
- Crankshaft position (engine speed)
- Camshaft position
- Knock sensor
- Throttle position
- Exhaust gas oxygen content
- A/C control positions
- Power steering pressure switch
- Battery voltage
- Vehicle speed

The PCM adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

The PCM adjusts engine idle speed and ignition timing. The PCM adjusts the air/fuel ratio according to the oxygen content in the exhaust gas (measured by the upstream and downstream heated oxygen sensor).

The PCM monitors for engine misfire. During active misfire and depending on the severity, the PCM either continuously illuminates or flashes the malfunction indicator lamp (Check Engine light on instrument panel). Also, the PCM stores an engine misfire DTC in memory.

GENERAL INFORMATION (Continued)

The PCM performs several diagnostic routines. They include:

- Oxygen sensor monitor
- Downstream heated oxygen sensor diagnostics during open loop operation (except for shorted)
- Fuel system monitor
- EGR monitor
- Purge system monitor
- All inputs monitored for proper voltage range.
- All monitored components (refer to Group 25 for On-Board Diagnostics).

The PCM compares the upstream and downstream heated oxygen sensor inputs to measure catalytic convertor efficiency. If the catalyst efficiency drops below the minimum acceptable percentage, the PCM stores a diagnostic trouble code in memory.

During certain idle conditions, the PCM may enter a variable idle speed strategy. During variable idle speed strategy the PCM adjusts engine speed based on the following inputs.

- A/C sense
- Battery voltage
- Battery temperature
- Engine coolant temperature
- Engine run time
- Power steering pressure switch
- Vehicle mileage

ACCELERATION MODE

This is a CLOSED LOOP mode. The PCM recognizes an abrupt increase in Throttle Position sensor output voltage or MAP sensor output voltage as a demand for increased engine output and vehicle acceleration. The PCM increases injector pulse width in response to increased fuel demand.

DECELERATION MODE

This is a CLOSED LOOP mode. During deceleration the following inputs are received by the PCM:

- A/C pressure transducer
- A/C sense
- Battery voltage
- Intake air temperature
- Engine coolant temperature
- Crankshaft position (engine speed)
- Exhaust gas oxygen content (upstream heated oxygen sensor)
- Knock sensor
- Manifold absolute pressure
- Power steering pressure switch
- Throttle position
- IAC motor control changes in response to MAP sensor feedback

The PCM may receive a closed throttle input from the Throttle Position Sensor (TPS) when it senses an abrupt decrease in manifold pressure. This indicates a hard deceleration. In response, the PCM may momentarily turn off the injectors. This helps improve fuel economy, emissions and engine braking.

If decel fuel shutoff is detected, downstream oxygen sensor diagnostics is performed.

WIDE-OPEN-THROTTLE MODE

This is an OPEN LOOP mode. During wide-open-throttle operation, the following inputs are received by the PCM:

- Intake air temperature
- Engine coolant temperature
- Engine speed
- Knock sensor
- Manifold absolute pressure
- Throttle position

When the PCM senses a wide-open-throttle condition through the Throttle Position Sensor (TPS) it de-energizes the A/C compressor clutch relay. This disables the air conditioning system.

The PCM does not monitor the heated oxygen sensor inputs during wide-open-throttle operation except for downstream heated oxygen sensor and both shorted diagnostics. The PCM adjusts injector pulse width to supply a predetermined amount of additional fuel.

IGNITION SWITCH OFF MODE

When the operator turns the ignition switch to the OFF position, the following occurs:

- All outputs are turned off, unless 02 Heater Monitor test is being run. Refer to Group 25, On-Board Diagnostics.
- No inputs are monitored except for the heated oxygen sensors. The PCM monitors the heating elements in the oxygen sensors and then shuts down.

DESCRIPTION AND OPERATION

SYSTEM DIAGNOSIS

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

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

DESCRIPTION AND OPERATION (Continued)

POWER DISTRIBUTION CENTER (PDC)

The Power Distribution Center (PDC) is located in the engine compartment (Fig. 1). The PDC contains the starter relay, radiator fan relay, A/C compressor clutch relay, auto shutdown relay, fuel pump relay and several fuses.

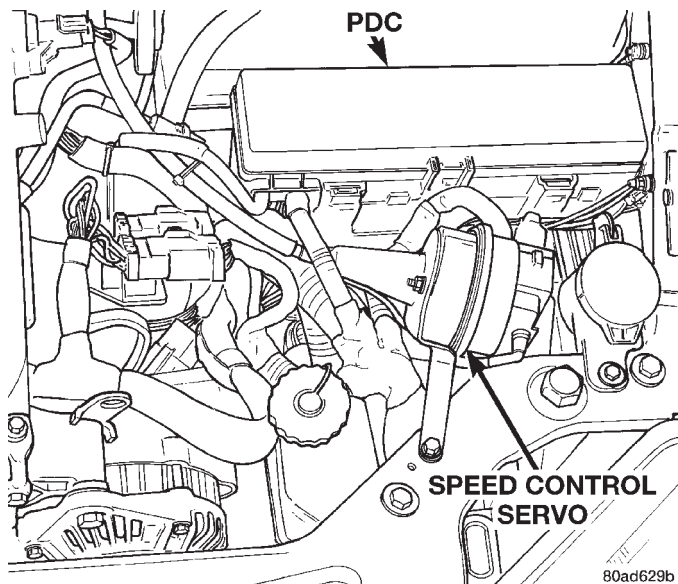


Fig. 1 Power Distribution Center (PDC)

PROGRAMMABLE COMMUNICATIONS INTERFACE (PCI) BUS

Various modules exchange information through a communications port called the PCI Bus. The Powertrain Control Module (PCM) transmits the Malfunction Indicator Lamp (Check Engine) On/Off signal and engine RPM on the PCI Bus. The PCM receives the Air Conditioning select input, transaxle gear position input and speed control engage inputs over the PCI Bus. The PCM also receives the air conditioning evaporator temperature signal from the PCI Bus.

The following components access or send information on the PCI Bus.

- Instrument Panel
- Body Control Module
- Air Bag System Diagnostic Module
- Full ATC Display Head
- ABS Module
- Transmission Control Module
- Powertrain Control Module
- Overhead Travel Module

POWERTRAIN CONTROL MODULE

The Powertrain Control Module (PCM) is a digital computer containing a microprocessor (Fig. 2). The PCM receives input signals from various switches and sensors referred to as Powertrain Control Module Inputs. Based on these inputs, the PCM adjusts

various engine and vehicle operations through devices referred to as Powertrain Control Module Outputs.

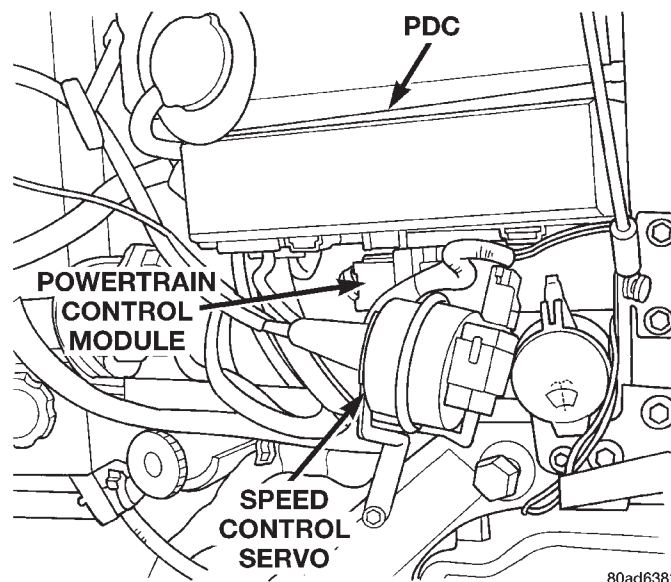


Fig. 2 Powertrain Control Module (PCM)

NOTE: PCM Inputs:

- Air Conditioning Pressure Transducer
- ASD Relay
- Battery Voltage
- Brake Switch
- Camshaft Position Sensor
- Crankshaft Position Sensor
- Distance Sensor (from transmission control module)
- EGR Position Feedback
- Engine Coolant Temperature Sensor
- Heated Oxygen Sensors
- Ignition sense
- Intake Air Temperature Sensor
- Knock Sensor
- Leak Detection Pump Feedback
- Manifold Absolute Pressure (MAP) Sensor
- Park/Neutral (from transmission control module)
- PCI Bus
- Power Steering Pressure Switch
- Proportional Purge Sense
- SCI Receive
- Speed Control
- Throttle Position Sensor
- Torque Management Input (From TCM)
- Transaxle Control Module (TCM)
- Transaxle Gear Engagement (From TCM)
- Vehicle Speed (from transmission control module)

NOTE: PCM Outputs:

- Air Conditioning Clutch Relay
- Automatic Shut Down (ASD) and Fuel Pump Relays

DESCRIPTION AND OPERATION (Continued)

- Data Link Connector (PCI and SCI Transmit)
- Double Start Override
- EGR Solenoid
- Fuel Injectors
- Generator Field
- High Speed Fan Relay
- Idle Air Control Motor
- Ignition Coils
- Leak Detection Pump
- Low Speed Fan Relay
- MTV Actuator
- Proportional Purge Solenoid
- SRV Valve
- Speed Control Relay
- Speed Control Vent Relay
- Speed Control Vacuum Relay
- 8 Volt Output
- 5 Volt Output

Based on inputs it receives, the powertrain control module (PCM) adjusts fuel injector pulse width, idle speed, ignition timing, and canister purge operation. The PCM regulates the cooling fans, air conditioning and speed control systems. The PCM changes generator charge rate by adjusting the generator field.

The PCM adjusts injector pulse width (air-fuel ratio) based on the following inputs.

- Battery Voltage
- Intake Air Temperature Sensor
- Engine Coolant Temperature
- Engine Speed (crankshaft position sensor)
- Exhaust Gas Oxygen Content (heated oxygen sensors)
- Manifold Absolute Pressure
- Throttle Position

The PCM adjusts engine idle speed through the idle air control motor based on the following inputs.

- Brake Switch
- Engine Coolant Temperature
- Engine Speed (crankshaft position sensor)
- Park/Neutral (transmission gear selection)
- Transaxle Gear Engagement
- Throttle Position
- Vehicle Speed (from Transmission Control Module)

The PCM adjusts ignition timing based on the following inputs.

- Intake Air Temperature
- Engine Coolant Temperature
- Engine Speed (crankshaft position sensor)
- Knock Sensor
- Manifold Absolute Pressure
- Park/Neutral (transmission gear selection)
- Transaxle Gear Engagement
- Throttle Position

The automatic shut down (ASD) and fuel pump relays are mounted externally, but turned on and off

by the powertrain control module through the same circuit.

The camshaft and crankshaft signals are sent to the powertrain control module. If the PCM does not receive both signals within approximately one second of engine cranking, it deactivates the ASD and fuel pump relays. When these relays are deactivated, power is shut off to the fuel injectors, ignition coils, fuel pump and the heating element in each oxygen sensor.

The PCM contains a voltage converter that changes battery voltage to a regulated 8.0 volts. The 8.0 volts power the camshaft position sensor, crankshaft position sensor and vehicle speed sensor. The PCM also provides a 5.0 volts supply for the engine coolant temperature sensor, intake air temperature sensor, manifold absolute pressure sensor and throttle position sensor.

The PCM engine control strategy prevents reduced idle speeds until after the engine operates for 320 km (200 miles). If the PCM is replaced after 320 km (200 miles) of usage, update the mileage in new PCM. Use the DRB scan tool to change the mileage in the PCM. Refer to the appropriate Powertrain Diagnostic Manual and the DRB scan tool.

AIR CONDITIONING PRESSURE TRANSDUCER—PCM INPUT

The Powertrain Control Module (PCM) monitors the A/C compressor discharge (high side) pressure through the air conditioning pressure transducer. The transducer supplies an input to the PCM. The PCM engages the A/C compressor clutch if pressure is sufficient for A/C system operation.

AUTOMATIC SHUTDOWN (ASD) SENSE—PCM INPUT

The ASD sense circuit informs the PCM when the ASD relay energizes. A 12 volt signal at this input indicates to the PCM that the ASD has been activated. This input is used only to sense that the ASD relay is energized.

When energized, the ASD relay supplies battery voltage to the fuel injectors, ignition coils and the heating element in each oxygen sensor. If the PCM does not receive 12 volts from this input after grounding the ASD relay, it sets a Diagnostic Trouble Code (DTC).

BATTERY VOLTAGE—PCM INPUT

The PCM monitors the battery voltage input to determine fuel injector pulse width and generator field control.

If battery voltage is low the PCM will increase injector pulse width (period of time that the injector is energized).

DESCRIPTION AND OPERATION (Continued)

BATTERY TEMPERATURE SENSOR—PCM INPUT

The PCM uses the temperature of the battery area to control the charge rate. The signal is used to regulate the system voltage. The system voltage is higher at cold temperatures and is gradually reduced as temperature is increased.

BRAKE SWITCH—PCM INPUT

When the brake switch is activated, the 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 motor. The brake switch is mounted on the brake pedal support bracket.

CAMSHAFT POSITION SENSOR—PCM INPUT

The camshaft position sensor provides cylinder identification to the Powertrain Control Module (PCM) (Fig. 3) or (Fig. 4). The sensor generates pulses as groups of notches on the camshaft sprocket pass underneath it. The PCM keeps track of crankshaft rotation and identifies each cylinder by the pulses generated by the notches on the camshaft sprocket.

When metal aligns with the sensor, voltage goes low (less than 0.3 volts). When a notch aligns with the sensor, voltage spikes high (5.0 volts). As a group of notches pass under the sensor, the voltage switches from low (metal) to high (notch) then back to low. The number of notches determine the amount of pulses. If available, an oscilloscope can display the square wave patterns of each timing events.

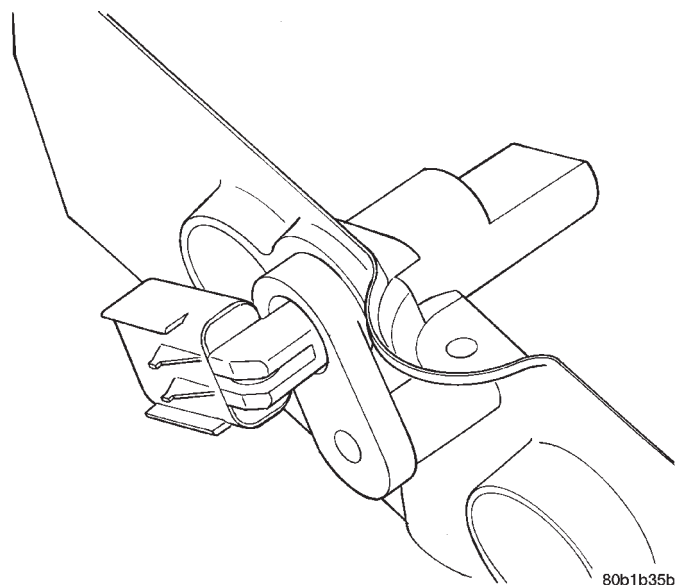
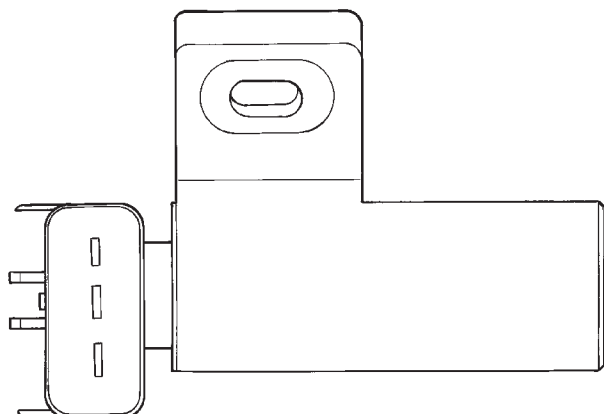


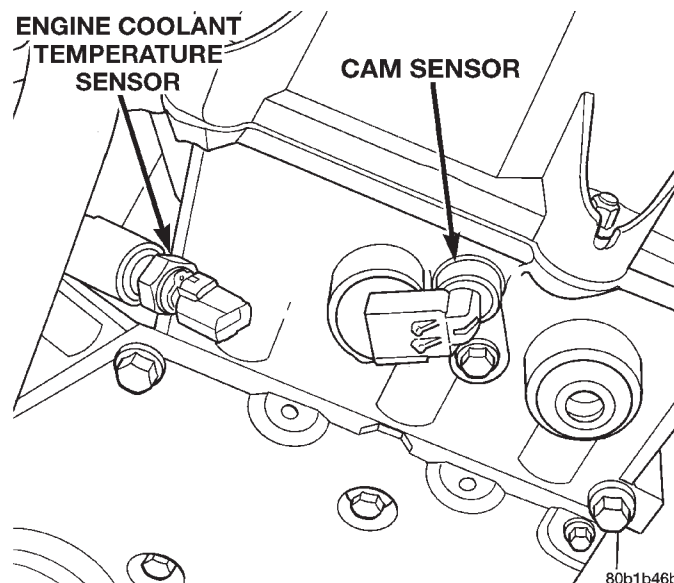
Fig. 3 Camshaft Position Sensor—2.7L Engine



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Fig. 4 Camshaft Position Sensor—3.2/3.5L Engine

The camshaft position sensor is mounted in the front of the timing case cover (Fig. 5) or (Fig. 6).



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Fig. 5 Camshaft Position Sensor Location—2.7L Engine

CRANKSHAFT POSITION SENSOR—PCM INPUT

The crankshaft position sensor detects slots cut into the transmission driveplate extension. There are 3 sets of slots. Each set contains 4 or 5 slots, for a total of 13 slots (Fig. 7). Basic timing is set by the position of the last slot in each group. Once the Powertrain Control Module (PCM) senses the last slot, it determines crankshaft position (which piston will next be at TDC) from the camshaft position sensor input. The 4 pulses generated by the crankshaft position sensor represent the 69°, 49°, 29°, and 9° BTDC

DESCRIPTION AND OPERATION (Continued)

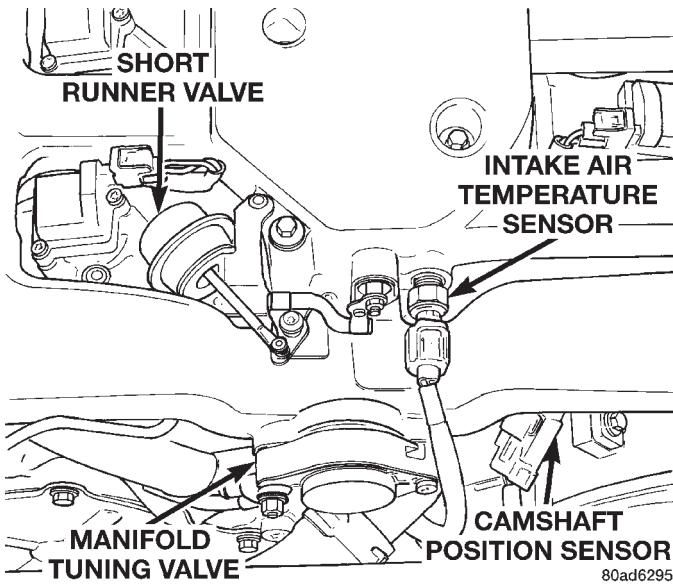


Fig. 6 Camshaft Position Sensor Location—3.2/3.5L Engine

marks. It may take the PCM one engine revolution to determine crankshaft position.

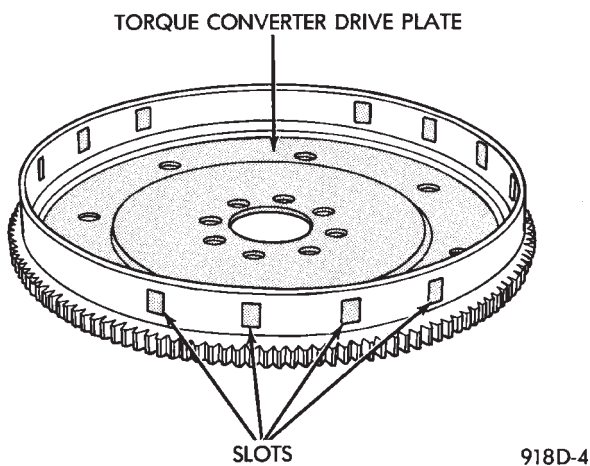


Fig. 7 Timing Slots

The PCM uses crankshaft position reference to determine injector sequence and ignition timing. Once the PCM determines crankshaft position, it begins energizing the injectors in sequence.

The crankshaft sensor is located on the passengers side of the transmission housing, above the differential housing (Fig. 8). The bottom of the sensor is positioned next to the drive plate.

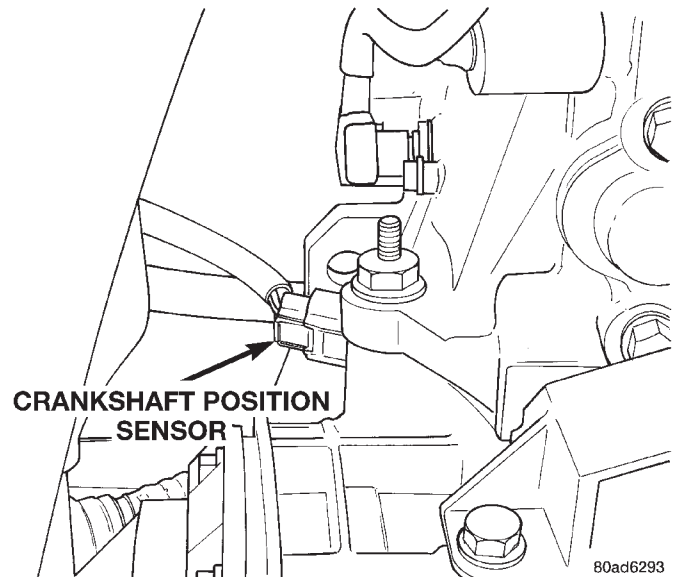


Fig. 8 Crankshaft Position Sensor Location

ENGINE COOLANT TEMPERATURE SENSOR—PCM INPUT

The engine coolant temperature sensor threads into the water jacket near the thermostat housing (Fig. 9) or (Fig. 10). The sensor provides an input to the Powertrain Control Module (PCM). As coolant temperature varies, the sensor resistance changes, resulting in a different input voltage to the PCM.

When the engine is cold, the PCM will demand slightly richer air-fuel mixtures and higher idle speeds until normal operating temperatures are reached.

The engine coolant sensor input also determines operation of the low and high speed cooling fans.

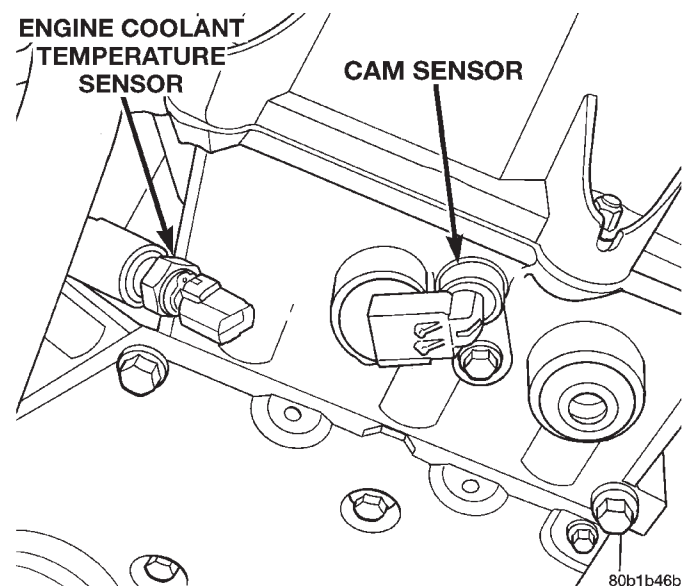


Fig. 9 Engine Coolant Temperature Sensor—2.7L Engine

DESCRIPTION AND OPERATION (Continued)

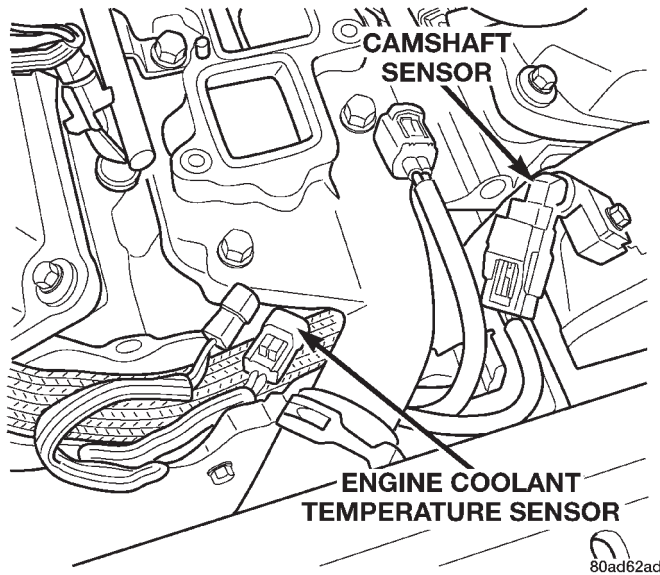


Fig. 10 Engine Coolant Temperature Sensor—3.2/3.5L Engine

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 of its rated capacity. It is also used to send a signal for fuel gauge operation via the PCI bus circuits.

HEATED OXYGEN SENSOR (O₂ SENSOR)—PCM INPUT

As vehicles accumulate mileage, the catalytic converter deteriorates. The deterioration results in a less efficient catalyst. To monitor catalytic converter deterioration, the fuel injection system uses two heated oxygen sensors. One sensor upstream of the catalytic converter, one downstream of the converter. The PCM compares the reading from the sensors to calculate the catalytic converter oxygen storage capacity and converter efficiency. Also, the PCM uses the upstream heated oxygen sensor input when adjusting injector pulse width.

When the catalytic converter efficiency drops below emission standards, the PCM stores a diagnostic trouble code and illuminates the malfunction indicator lamp (MIL).

The O₂S 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.

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.

In Closed Loop operation the PCM monitors the O₂S 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 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 OXYGEN SENSOR

The input from the upstream heated oxygen sensor tells the PCM the oxygen content of the exhaust gas. Based on this input, the PCM fine tunes the air-fuel ratio by adjusting injector pulse width.

The sensor input switches 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 sensor produces voltage as low as 0.1 volt. When there is a lesser amount of oxygen present (rich air-fuel mixture) the sensor produces a voltage as high as 1.0 volt. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

The heating element in the sensor provides heat to the sensor ceramic element. Heating the sensor 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.

In Closed Loop, the PCM adjusts injector pulse width based on the upstream heated oxygen sensor input along with other inputs. In Open Loop, the PCM adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

The upstream oxygen sensor threads into the outlet flange of the exhaust manifold (Fig. 11) or (Fig. 12).

DOWNSTREAM OXYGEN SENSOR

The downstream heated oxygen sensor threads into the outlet pipe at the rear of the catalytic converter (Fig. 13). The downstream heated oxygen sensor input is used to detect catalytic converter deterioration. As the converter deteriorates, the input from

DESCRIPTION AND OPERATION (Continued)

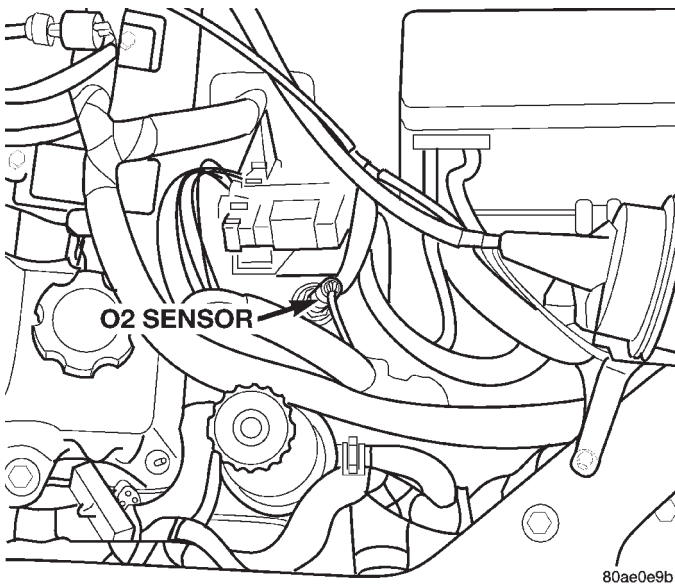


Fig. 11 Upstream Heated Oxygen Sensor

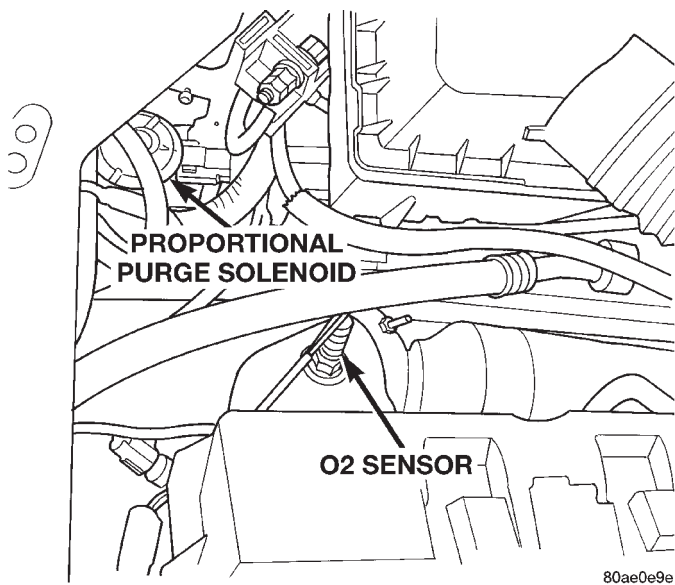


Fig. 12 Upstream Heated Oxygen Sensor

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 converter efficiency.

IGNITION SENSE—PCM INPUT

The ignition sense input informs the Powertrain Control Module (PCM) that the ignition switch is in the crank or run position.

KNOCK SENSORS—PCM INPUT

Engine uses a single knock sensor. The sensor monitors both the right and left bank of cylinders. The 3.2/3.5L knock sensors bolts into the top of the cylinder block below the cylinder heads (Fig. 14). The

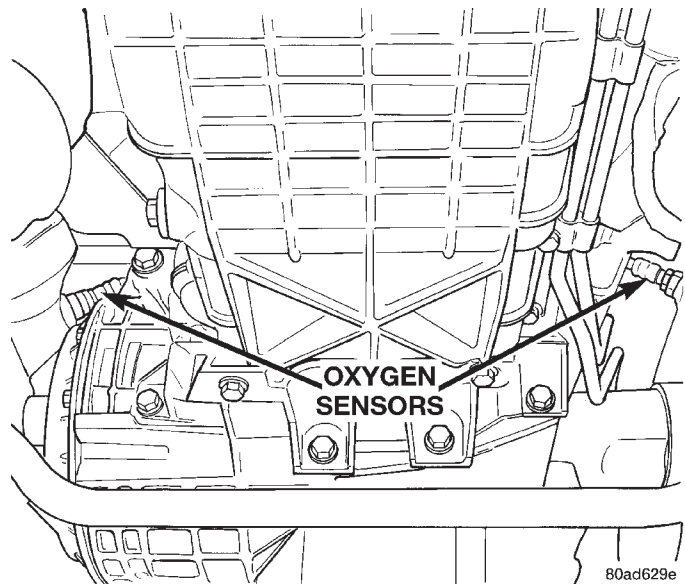


Fig. 13 Downstream Heated Oxygen Sensor

2.7L sensor mounts into the side of the engine block. When the knock sensor detects a knock in one of the cylinders, it sends an input signal to the PCM. In response, the PCM retards ignition timing by a scheduled amount.

Knock sensor contain a crystal which constantly vibrates and sends an input voltage (signal) to the PCM while the engine operates. As the intensity of the crystal's vibration increase, the knock sensor output voltage also increases.

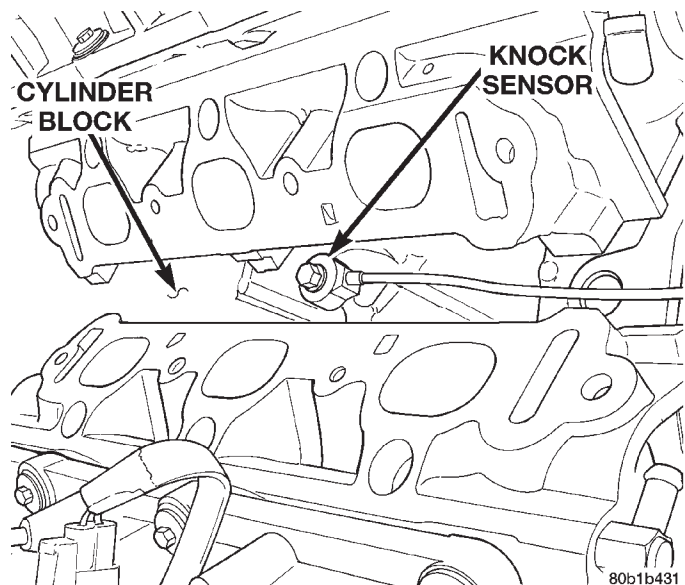


Fig. 14 Knock Sensor Locations—3.2/3.5L

KNOCK SENSOR—PCM INPUT

The knock sensor threads into the side of the cylinder block (Fig. 15). When the knock sensor detects a knock in one of the cylinders, it sends an input sig-

DESCRIPTION AND OPERATION (Continued)

nal to the PCM. In response, the PCM retards ignition timing for all cylinders by a scheduled amount.

Knock sensors contain a piezoelectric material which sends an input voltage (signal) to the PCM. As the intensity of the engine knock vibration increases, the knock sensor output voltage also increases.

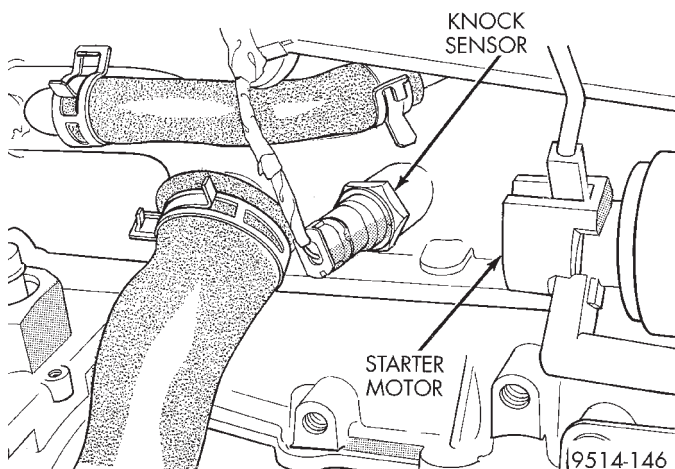


Fig. 15 Knock Sensor—Typical

MANIFOLD ABSOLUTE PRESSURE SENSOR—PCM INPUT

The Powertrain Control Module (PCM) supplies 5 volts to the MAP sensor. The MAP sensor converts intake manifold pressure into voltage. The PCM monitors the MAP sensor output voltage. As vacuum increases, MAP sensor voltage decreases proportionately. Also, as vacuum decreases, MAP sensor voltage increases proportionately.

During cranking, before the engine starts running, the PCM determines atmospheric air pressure from the MAP sensor voltage. While the engine operates, the PCM determines intake manifold pressure from the MAP sensor voltage. Based on MAP sensor voltage and inputs from other sensors, the PCM adjusts spark advance and the air/fuel mixture.

The MAP sensor mounts to the driver side of the intake manifold plenum (Fig. 16) or (Fig. 17).

SENSOR RETURN—PCM INPUT

The sensor return circuit provides a low electrical noise ground reference for all of the systems sensors. The sensor return circuit connects to internal ground circuits within the powertrain control module.

SPEED CONTROL—PCM INPUT

The speed control system provides five separate voltages (inputs) to the Powertrain Control Module (PCM). The voltages correspond to the ON/OFF, SET, RESUME, CANCEL, and DECEL.

The speed control ON voltage informs the PCM that the speed control system has been activated.

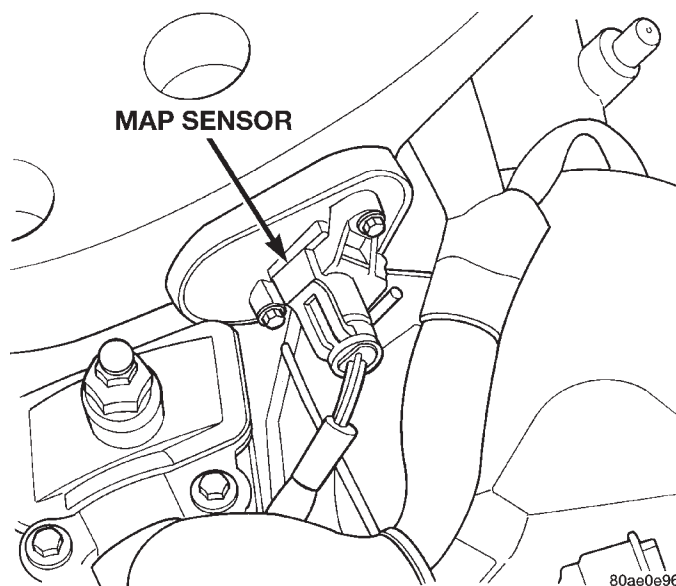


Fig. 16 MAP Sensor—2.7L Engine

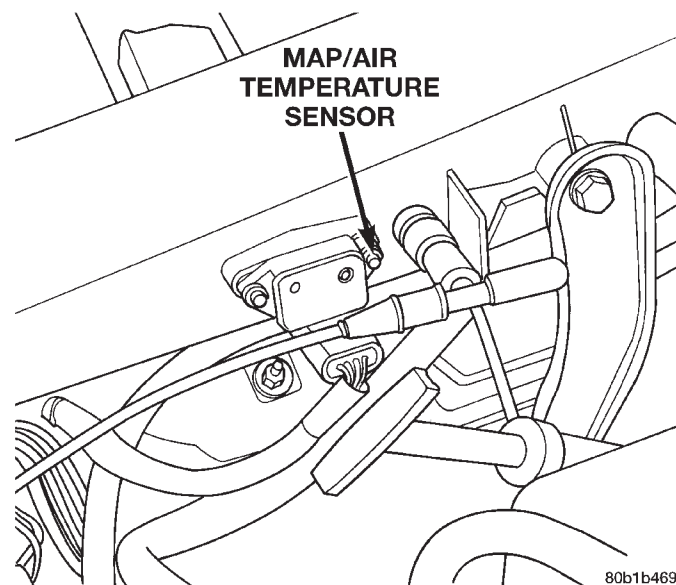


Fig. 17 MAP Sensor—3.2/3.5L Engine

The speed control SET voltage informs the PCM that a fixed vehicle speed has been selected. The speed control RESUME voltage indicates the previous fixed speed is requested. The speed control CANCEL voltage tells the PCM to deactivate but retain set speed in memory (same as depressing the brake pedal). The speed control DECEL voltage informs the PCM to coast down to a new desired speed. The speed control OFF voltage tells the PCM that the speed control system has deactivated. Refer to Group 8H for more speed control information.

DESCRIPTION AND OPERATION (Continued)

SCI RECEIVE—PCM INPUT

SCI Receive is the serial data communication receive circuit for the DRB scan tool. The Powertrain Control Module (PCM) receives data from the DRB through the SCI Receive circuit.

PARK/NEUTRAL SWITCH

The automatic transaxle manual valve lever position sensor supplies the park/neutral input to the powertrain control module. The park/neutral switch input tells the PCM whether the transmission is in Park, Neutral, or a drive gear selection. This input effects idle speed, fuel injector pulse width and ignition timing.

THROTTLE POSITION SENSOR—PCM INPUT

The throttle position sensor mounts to the side of the throttle body (Fig. 18) or (Fig. 19).

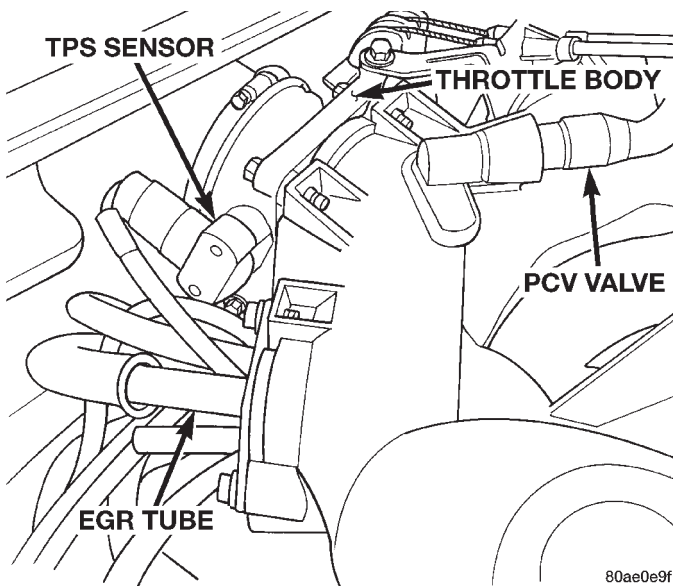


Fig. 18 Throttle Position Sensor—2.7L Engine

The sensor connects to the throttle blade shaft. The TPS is a variable resistor that provides the powertrain control module (PCM) with an input signal (voltage). The signal represents throttle blade position. 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 powertrain control module) represents throttle blade position. The TPS output voltage to the PCM varies from approximately 0.6 volt at minimum throttle opening (idle) to a maximum of 4.5 volts at wide open throttle.

Along with inputs from other sensors, the PCM uses the TPS input to determine current engine operating conditions. The PCM also adjusts fuel injector

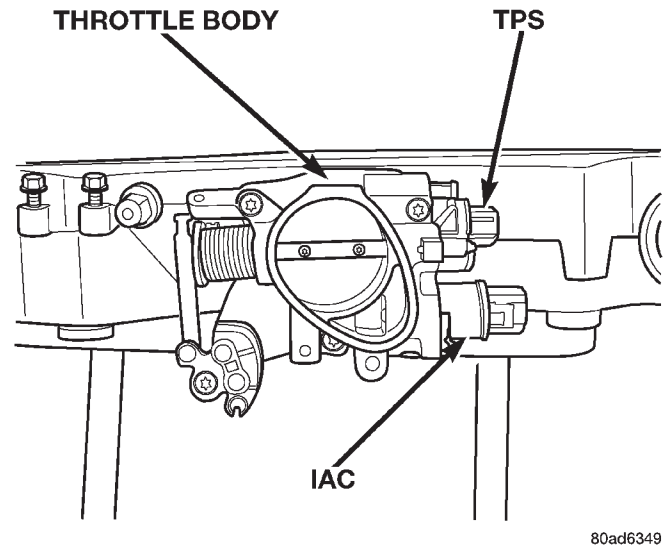


Fig. 19 Throttle Position Sensor—3.2/3.5L Engine

pulse width and ignition timing based on these inputs.

VEHICLE SPEED AND DISTANCE—PCM INPUT

The Transmission Control Module (TCM) supplies the road speed and distance traveled inputs to the PCM. From these inputs and the throttle position sensor input, the PCM determines when a deceleration condition occurs.

AIR CONDITIONING COMPRESSOR CLUTCH RELAY—PCM OUTPUT

The Powertrain Control Module (PCM) operates the air conditioning clutch relay ground circuit. The battery supplies power to the solenoid side of the relay. The PCM grounds the relay when the operator puts the A/C or defrost switch in the ON position and it receives an acceptable input from the A/C pressure transducer. If the A/C pressure transducer input indicates high side pressure is too high or too low, the PCM will not ground the A/C compressor clutch relay.

With the engine operating, the PCM cycles the air conditioning clutch on and off during A/C operation. When the PCM senses low idle speeds or wide open throttle through the throttle position sensor, it de-energizes the A/C compressor clutch relay.

The A/C compressor clutch relay is located in the Power Distribution Center (PDC) (Fig. 20). A decal on the inside of the PDC covers shows the locations of each relay and fuse contained in the PDC.

DESCRIPTION AND OPERATION (Continued)

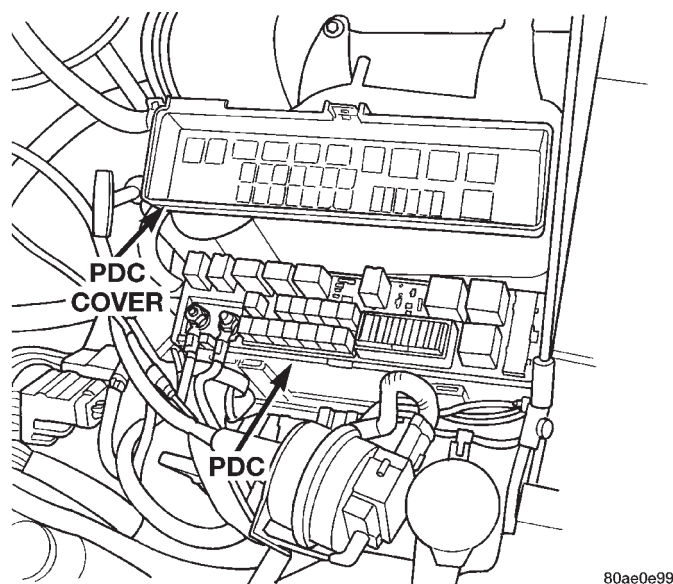


Fig. 20 Power Distribution Center (PDC)

AUTOMATIC SHUT DOWN (ASD) AND FUEL PUMP RELAYS—PCM OUTPUT

The PCM operates the Automatic Shut Down (ASD) relay and fuel pump relay through one ground path. The PCM operates them by switching the ground path for the solenoid side of the relays on and off. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injectors and ignition coil. The fuel pump relay connects battery voltage to the fuel pump.

The PCM turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the PCM monitors the crankshaft position sensor and camshaft position sensor signals to determine engine speed and ignition timing (coil dwell). If the PCM does not receive a crankshaft position sensor signal and camshaft position sensor signal when the ignition switch is in the Run position, it de-energizes both relays. When the relays are de-energized, battery voltage is not supplied to the fuel injectors, ignition coil and fuel pump.

The ASD relay and fuel pump relay are located in the Power Distribution Center (PDC) near the battery. A decal on the inside of the PDC covers shows the locations of each relay and fuse contained in the PDC.

PROPORTIONAL PURGE SOLENOID—PCM OUTPUT

All vehicles use a proportional purge solenoid. The solenoid regulates the rate of vapor flow from the EVAP canister to the throttle body. The PCM operates the solenoid.

During the cold start warm-up period and the hot start time delay, the PCM does not energize the solenoid. When de-energized, no vapors are purged.

The proportional purge solenoid operates at a frequency of 200 hz and is controlled by an engine controller circuit that senses the current being applied to the proportional purge solenoid (Fig. 21) and then adjusts that current to achieve the desired purge flow. The proportional purge solenoid controls the purge rate of fuel vapors from the vapor canister and fuel tank to the engine intake manifold.

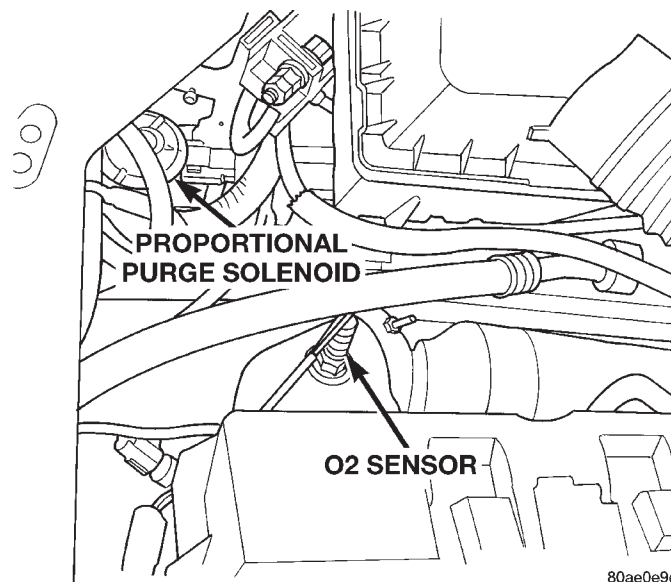


Fig. 21 Proportional Purge Solenoid

EXHAUST GAS RECIRCULATION (LSEGR)

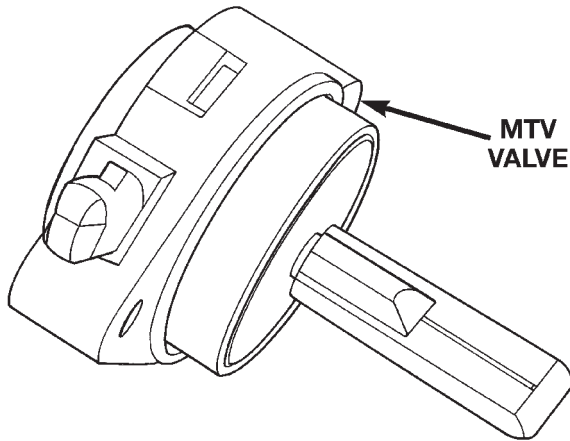
The EGR valve consists of three major components. First there is the pintle, valve seat, and housing which contains and regulates the gas flow. Second there is the armature, return spring, and solenoid coil to provide the operating force to regulate the flow by changing the pintle position. The solenoid coil assembly is in parallel with a diode and connects to the two connectors in the connector assembly. The third major component which senses pintle position and is connected to the three connectors in the electrical connector.

The exhaust gas recirculation flow is determined by the engine controller. For a given set of conditions, the engine controller knows the ideal exhaust gas recirculation flow to optimize NOx and fuel economy as a function of the pintle position. Pintle position is obtained from the position sensor and the engine controller by adjusting the duty cycle of 128 Hz power supplied to the solenoid coil to obtain the correct position.

DESCRIPTION AND OPERATION (Continued)

MANIFOLD TUNING VALVE (MTV)—PCM OUTPUT

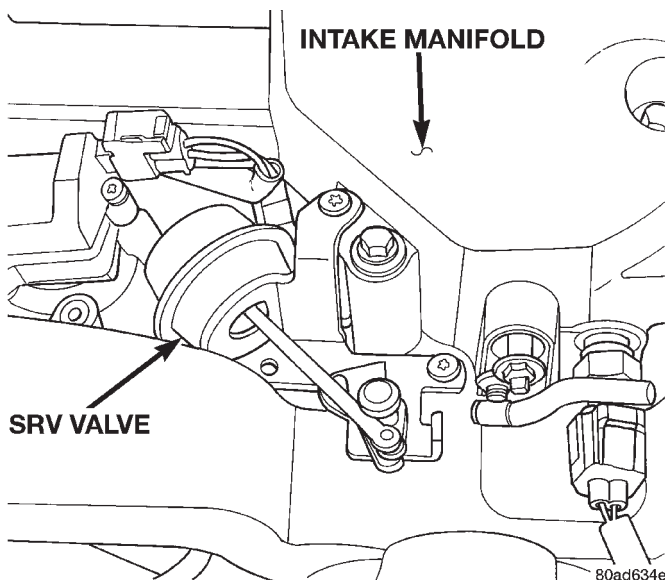
The PCM controls the MTV solenoid. The manifold tuning valve optimizes acoustical tuning of the intake system during wide open throttle operation throughout the RPM range. The valve opens a cross-over passage in that connects both sides of the intake manifold plenum (Fig. 22).



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Fig. 22 Manifold Tuning Valve**SHORT RUNNER VALVE (SRV)**

The SRV system operates under WOT conditions above 5000 rpm to maximize engine performance. When actuated by the PCM, the SRV solenoid energizes, allowing mechanical linkage to redirect the intake air flow to six short runners. The PCM looks for a current spike when actuating the solenoid. If the spike is not present, the PCM sets the DTC.



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Fig. 23 Short Runner Valve (SRV)**GENERATOR FIELD—PCM OUTPUT**

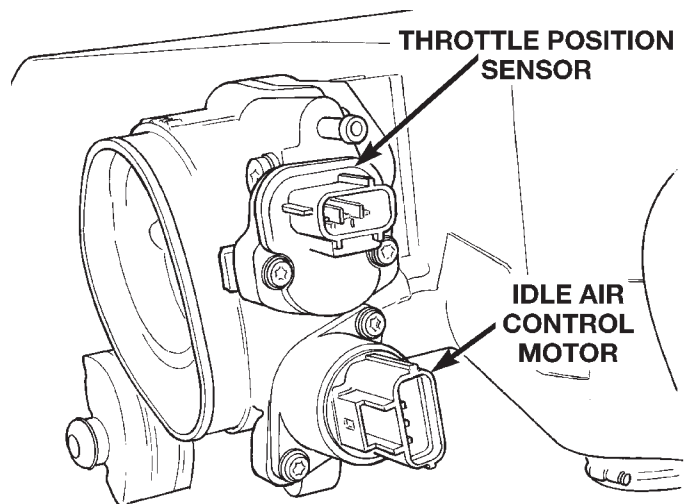
The PCM regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for Battery system information and 8C for charging system information.

IDLE AIR CONTROL MOTOR—PCM OUTPUT

The idle air control motor attaches to the throttle body (Fig. 24). The PCM operates the idle air control motor. The PCM adjusts engine idle speed through the idle air control motor to compensate for engine load or ambient conditions.

The throttle body has an air bypass passage that provides air for the engine at idle (the throttle blade is closed). The idle air control motor pintle protrudes into the air bypass passage and regulates air flow through it.

The PCM adjusts engine idle speed by moving the idle air control motor pintle in and out of the bypass passage. The adjustments are based on inputs the PCM receives. The inputs effecting idle speed include the throttle position sensor, road speed (from Transmission Control Module), coolant temperature sensor, battery voltage and battery temperature. Also various switch operations (brake, park/neutral, air conditioning) effect idle speed. The PCM prevents deceleration die out by increasing air flow when the throttle closes quickly.



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Fig. 24 Idle Air Control Motor

DESCRIPTION AND OPERATION (Continued)

DATA LINK CONNECTOR—PCM OUTPUT

The data link connector (diagnostic connector) links the DRB scan tool with the Powertrain Control Module (PCM). Refer to On-Board Diagnostics in the General Diagnosis section of this group. The data link connector is located inside the vehicle, below instrument panel next to the center column (Fig. 25).

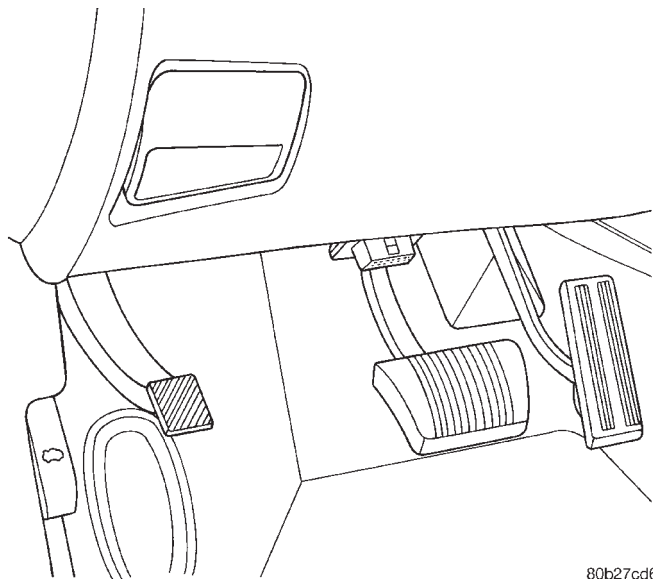


Fig. 25 Data Link Connector

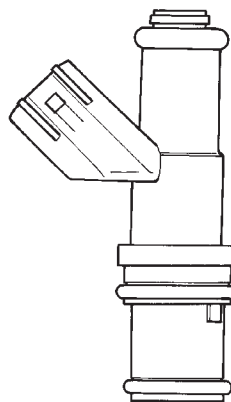
FUEL INJECTORS—PCM OUTPUT

The engine uses top feed injectors (Fig. 26).

The Automatic Shut Down (ASD) relay supplies battery voltage to the injectors. The PCM controls the ground path for each injector in sequence. By switching the ground paths on and off, the PCM fine-tunes injector pulse width. Injector pulse width refers to the amount of time an injector operates.

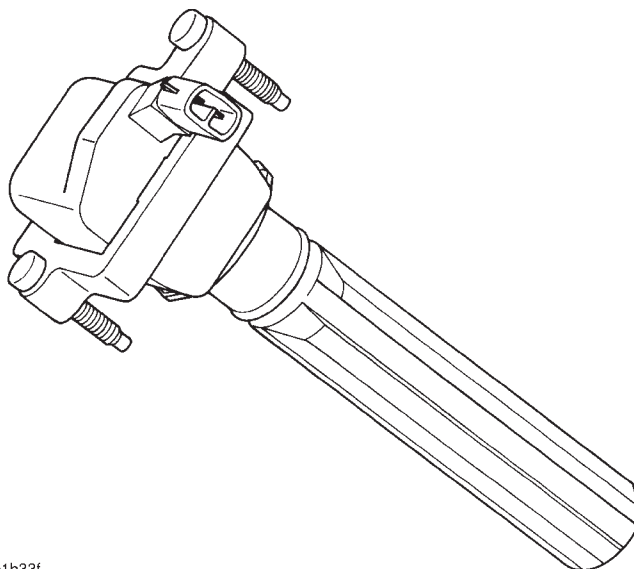
The PCM determines injector synchronization from the camshaft position sensor and crankshaft position sensor inputs. The PCM grounds the ASD and fuel pump relays after receiving the camshaft position sensor and crankshaft position sensor inputs.

The PCM energizes the injectors in a sequential order during all engine operating conditions except start-up. During start-up, when the coolant temperature is below 15° C (60° F), all injectors are energized at the same time. Above 15° C, the PCM energizes the injectors in sequence. Once the PCM determines crankshaft position, it begins energizing the injectors in sequence.



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Fig. 26 Fuel Injector

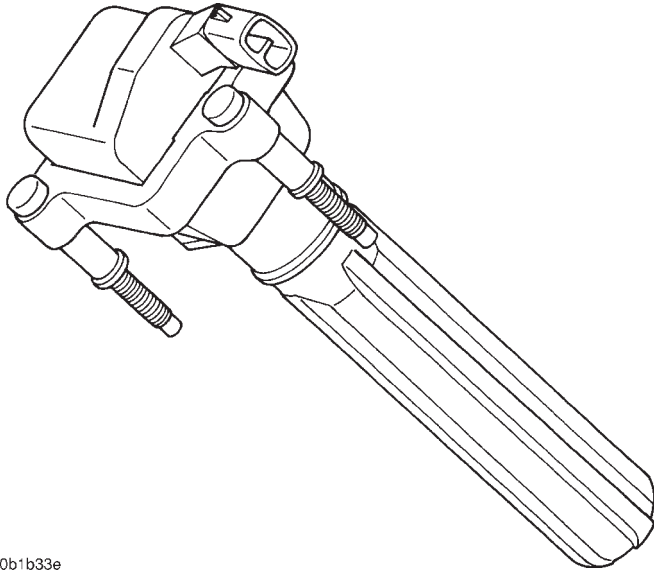
IGNITION COIL—PCM OUTPUT

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Fig. 27 Ignition Coil 2.7L Engine

The PCM determines which of the coils to charge and fire at the correct time. The Automatic Shut Down (ASD) relay provides battery voltage to the ignition coil. The PCM provides a ground contact (circuit) for energizing the coil. When the PCM breaks the contact, the energy in the coil primary transfers to the secondary causing the spark. The PCM will de-energize the ASD relay if it does not receive the crankshaft sensor and camshaft sensor inputs. Refer to Automatic Shut Down (ASD) Relay and Fuel Pump Relay—PCM in this section for relay operation.

DESCRIPTION AND OPERATION (Continued)



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Fig. 28 Ignition Coil 3.2/3.5L Engine**MALFUNCTION INDICATOR (CHECK ENGINE) LAMP—PCM OUTPUT**

The PCM supplies the malfunction indicator (check engine) lamp on/off signal to the instrument panel through the PCI Bus. The PCI Bus is a communications port. Various modules use the PCI Bus to exchange information.

The Check Engine lamp comes on each time the ignition key is turned ON and stays on for 3 seconds as a bulb test.

The Malfunction Indicator Lamp (MIL) stays on continuously, when the PCM has entered a Limp-In mode or identified a failed emission component. During Limp-in Mode, the PCM attempts to keep the system operational. The MIL signals the need for immediate service. In limp-in mode, the PCM compensates for the failure of certain components that send incorrect signals. The PCM substitutes for the incorrect signals with inputs from other sensors.

If the PCM detects active engine misfire severe enough to cause catalyst damage, it flashes the MIL. At the same time the PCM also sets a Diagnostic Trouble Code (DTC).

For signals that can trigger the MIL (Check Engine Lamp) refer to Group 25, On-Board Diagnostics.

RADIATOR FAN RELAYS—PCM OUTPUT

The cooling system uses two fans. Both fans operate at two different speeds, low and high. Depending on engine coolant temperature and A/C system high side pressure, the both fans operate at either low or high. The PCM controls radiator speed by grounding the coil side of either the low speed fan relay or the high speed fan relay. The ignition switch supplies voltage to the coil sides of the relay. When the PCM grounds the coil side of the relay, the contacts close and the battery supplies power to the fans.

The low speed and high speed fan relays are located in the Power Distribution Center (PDC) near the battery. A decal on the inside of the PDC covers shows the locations of each relay and fuse contained in the PDC.

SPEED CONTROL SERVOS—PCM OUTPUT

The PCM controls operation of the vacuum and vent solenoids inside the speed control servo. When the operator presses the on switch, the PCM provides power through the brake switch to the servo. When the speed control system is engaged following a set or resume, the PCM supplies a ground to the vacuum and or vent solenoids inside the servo as needed to maintain the selected vehicle speed. Refer to Group 8H, Speed Control for more information.

TACHOMETER—PCM OUTPUT

The tachometer receives its information across the PCI Bus from the Body Control Module (BCM). Information on engine RPM is transmitted from the Powertrain Control Module (PCM) across the PCI Bus to the BCM. The BCM calculates the position of the tachometer pointer based on the input from the PCM and adjusts the position of the gauge pointer to the necessary position. This signal is sent over the PCI Bus to the instrument cluster.

TORQUE MANAGEMENT

The PCM receives the torque management input from the transmission control module. The PCM receives the input when the transmission shifts gears. In response, the PCM shuts off a number of fuel injectors when the transmission shifts gears.

DESCRIPTION AND OPERATION (Continued)

5 VOLT SUPPLY—PCM OUTPUT

The PCM supplies 5 volts to the following sensors:

- A/C pressure transducer
- Engine coolant temperature sensor
- Manifold absolute pressure sensor
- Throttle position sensor
- Linear EGR solenoid

8-VOLT SUPPLY—PCM OUTPUT

The PCM supplies 8 volts to the crankshaft position sensor, camshaft position sensor.

DIAGNOSIS AND TESTING**VISUAL INSPECTION**

Before diagnosing or servicing the fuel injection system, perform a visual inspection for loose, disconnected, or misrouted wires and hoses. A thorough visual inspection that includes the following checks saves unnecessary test and diagnostic time.

(1) Remove the Power Distribution Center (PDC) cover. Check for blown fuses. Ensure all relays are properly installed (Fig. 29).

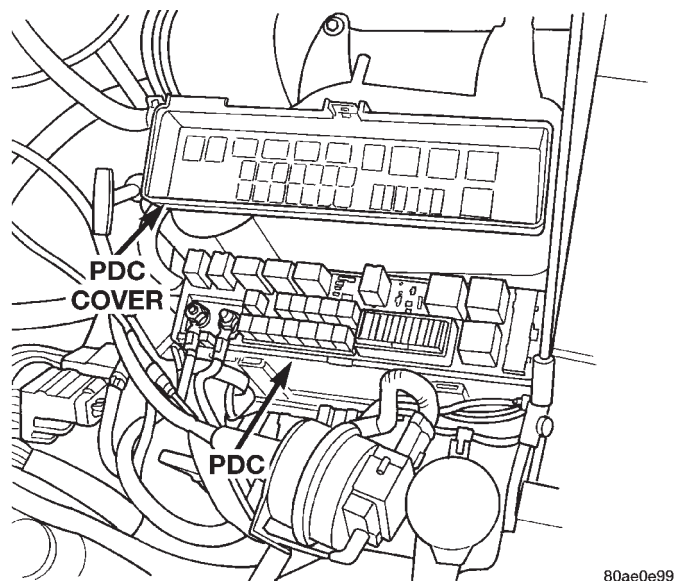


Fig. 29 Power Distribution Center

(2) Check the battery terminal connections for loose cables and corrosion.

(3) Check the MAP sensor electrical connection (Fig. 30) or (Fig. 31).

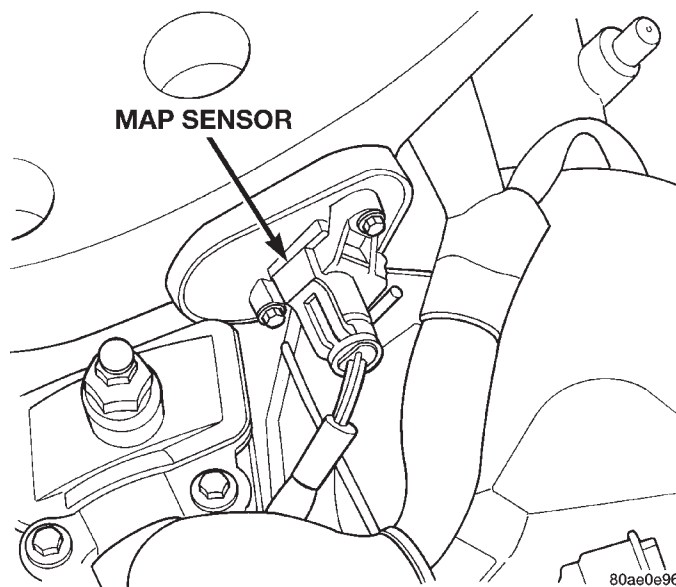


Fig. 30 MAP Sensor—2.7L Engine

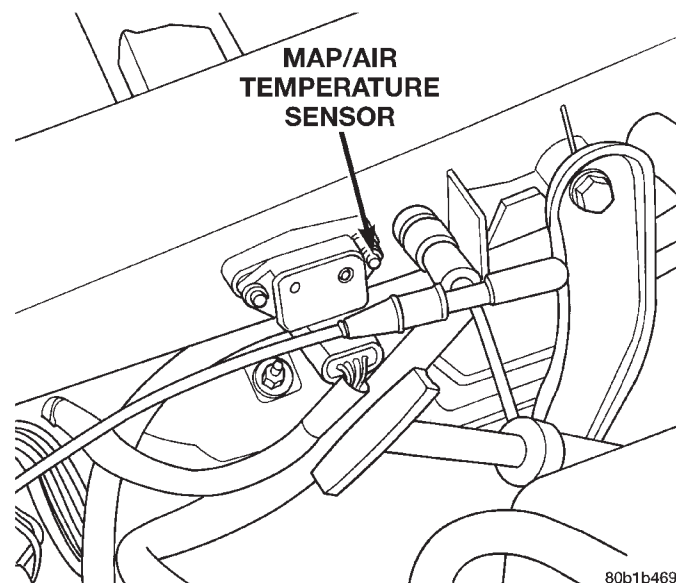
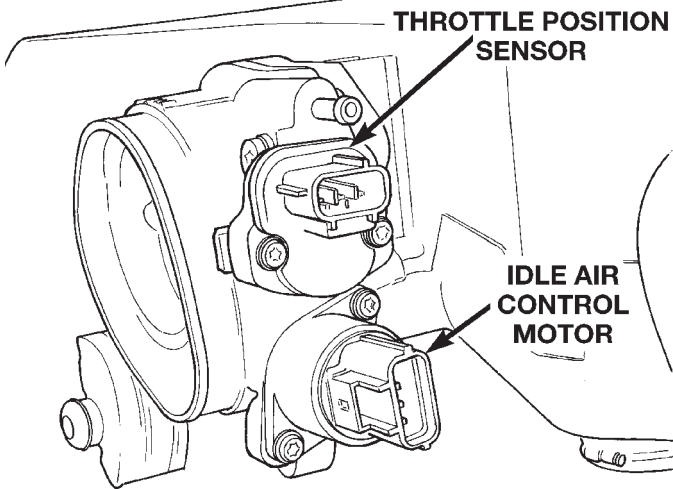


Fig. 31 MAP Sensor—3.2/3.5L Engine

DIAGNOSIS AND TESTING (Continued)

(4) Ensure the electrical connector is completely attached to the idle air control motor (Fig. 32).

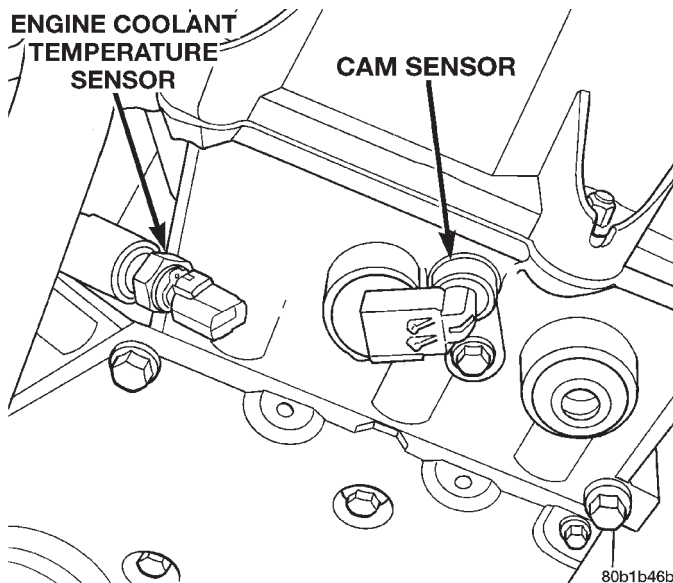


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Fig. 32 Idle Air Control Motor—2.7L Engine

(5) Ensure electrical connector is attached to the throttle position sensor (Fig. 32).

(6) Verify the electrical connector is attached to the engine coolant temperature sensor (Fig. 33) or (Fig. 34).



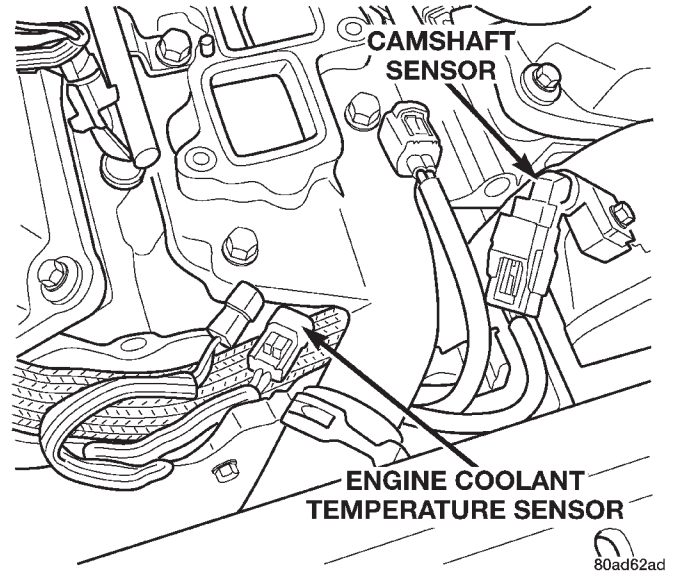
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Fig. 33 Engine Coolant Temperature Sensor—2.7L Engine

(7) Ensure purge hose is connected to throttle body.

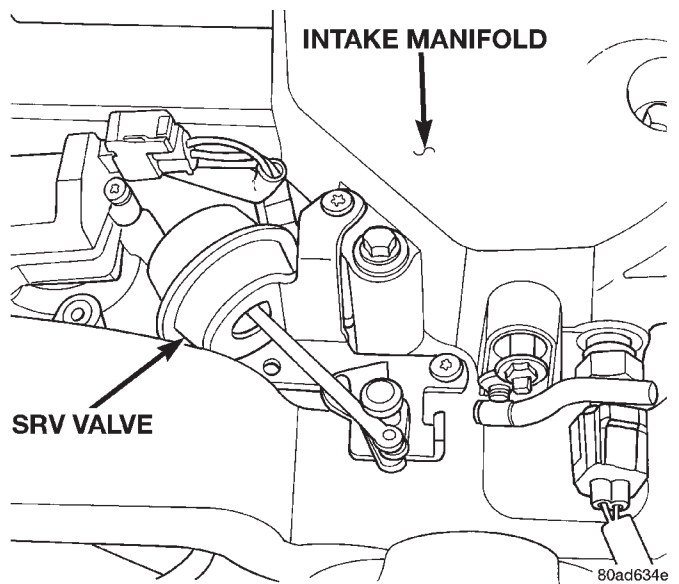
(8) Ensure the vacuum hose is connected to the Short Runner valve and the vacuum harness (Fig. 35).

(9) Ensure the Proportional Purge solenoid (Fig. 36) electrical connectors are attached to the solenoid.



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Fig. 34 Engine Coolant Temperature Sensor—3.2/3.5L Engine



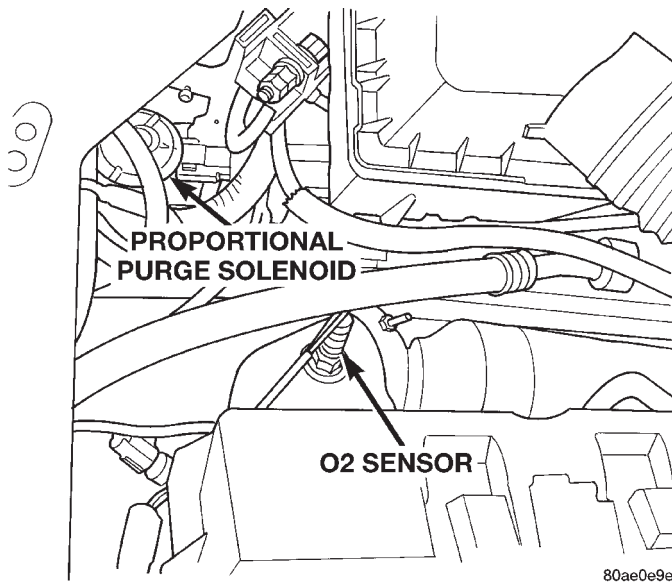
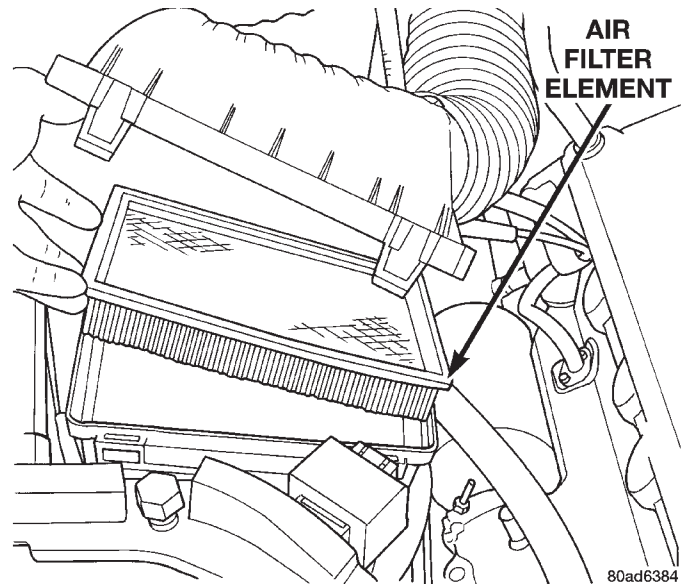
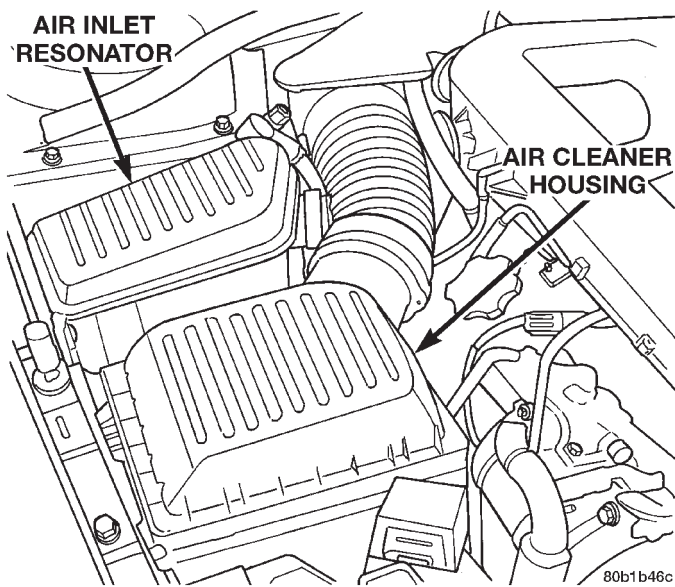
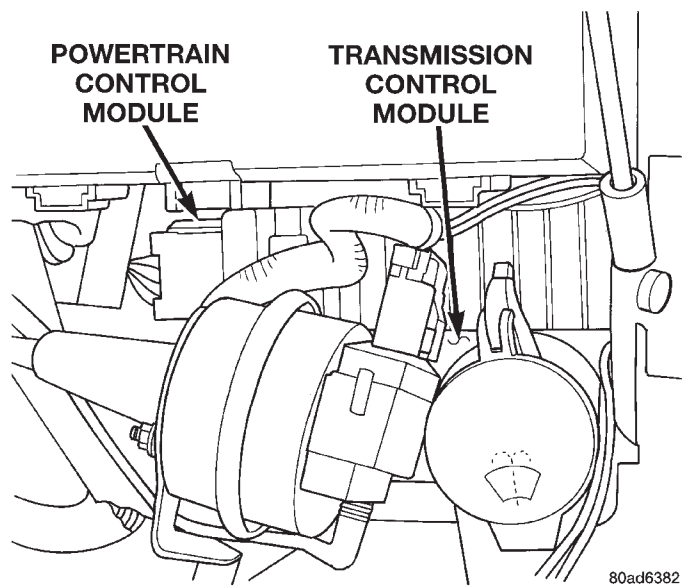
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Fig. 35 Short Runner Valve

(10) Inspect the air cleaner filter element. Replace as necessary.

(11) Verify the 2 40-way connector is fully inserted into the Powertrain Control Module (PCM) (Fig. 39). Ensure the wires are not stretched or pulled out of the socket.

DIAGNOSIS AND TESTING (Continued)

*Fig. 36 Proportional Purge Solenoid**Fig. 38 Air Cleaner Element**Fig. 37 Air Cleaner Housing**Fig. 39 PCM Connectors*

DIAGNOSIS AND TESTING (Continued)

(12) Ensure the accessory drive belt tension is correct.

(13) Check for loose or corroded connections at the generator (Fig. 40).

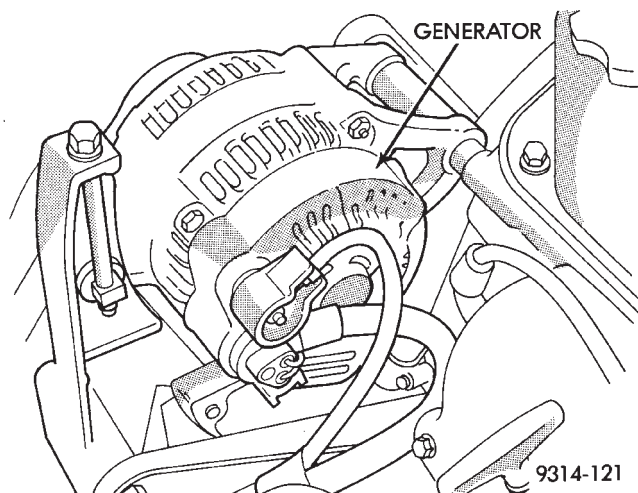


Fig. 40 Generator

(14) Check fuel supply tube connections for leaks.
(15) Verify electrical connector is attached to the crankshaft position sensor (Fig. 41).

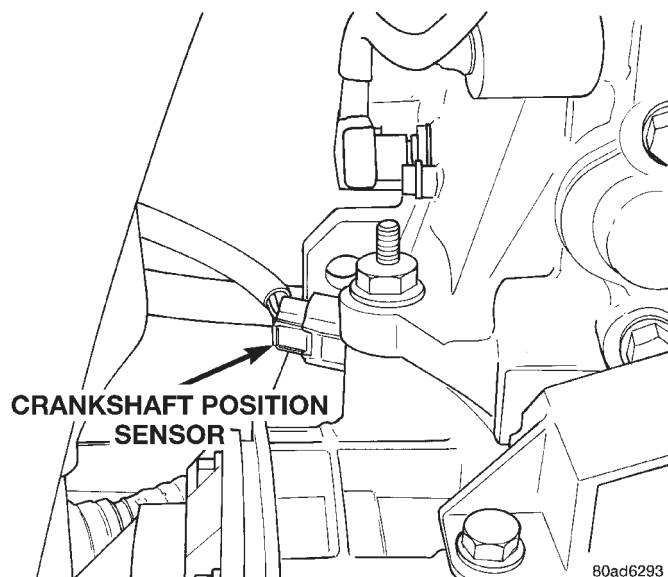


Fig. 41 Crankshaft Position Sensor

(16) Ensure the electrical connectors are attached to the upstream heated oxygen sensors (Fig. 42) or (Fig. 43).

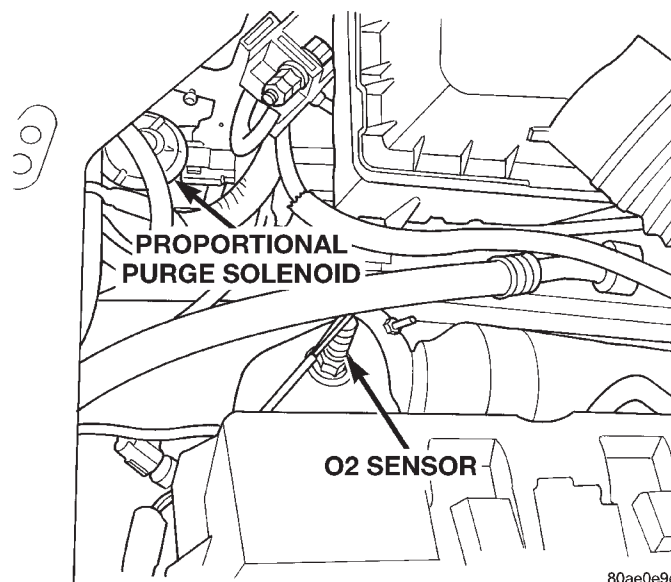


Fig. 42 Upstream Heated Oxygen Sensor

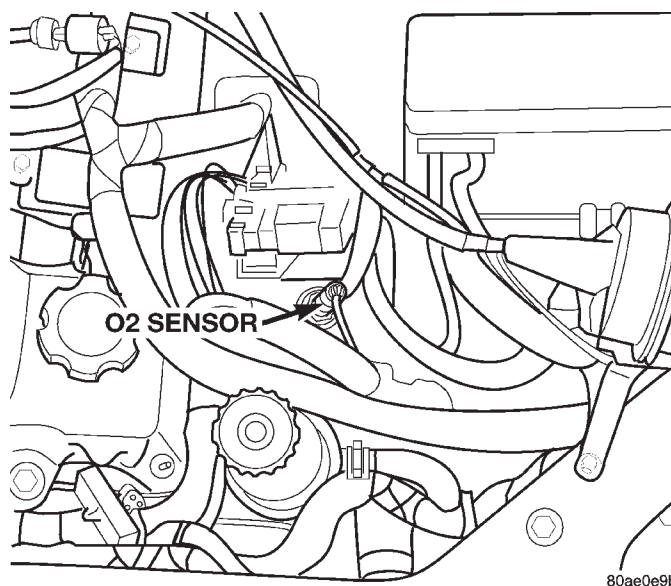


Fig. 43 Upstream Heated Oxygen Sensor

DIAGNOSIS AND TESTING (Continued)

(17) Ensure the electrical connectors are attached to the downstream heated oxygen sensors (Fig. 44).

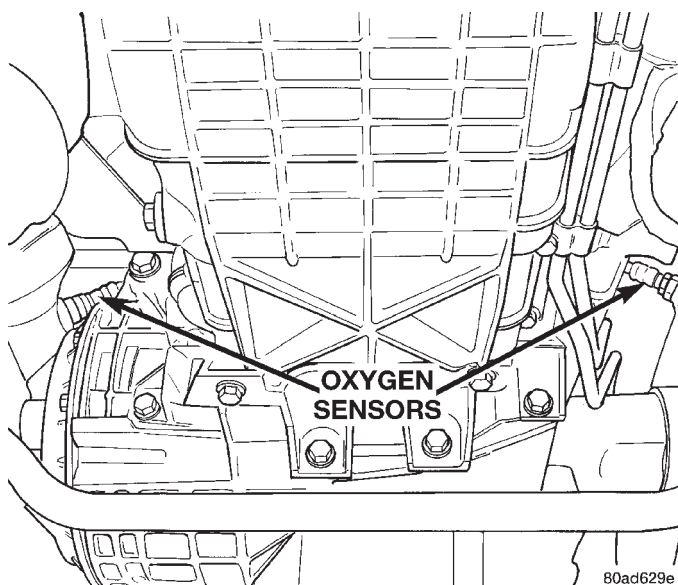


Fig. 44 Downstream Heated Oxygen Sensors

(18) Check for loose or corroded electrical connections at the starter motor (Fig. 45).

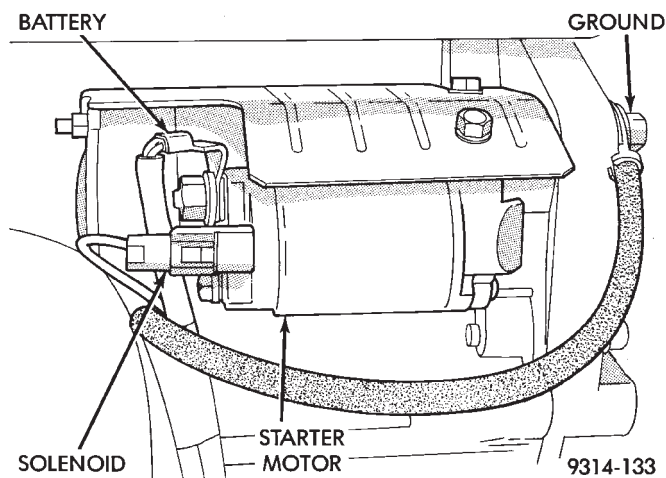


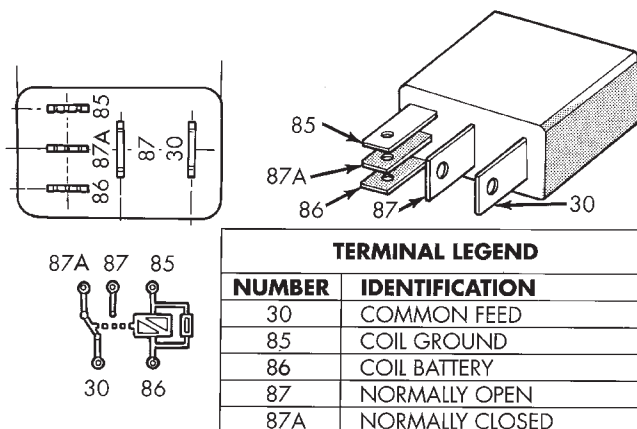
Fig. 45 Starter Motor

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) or (Fig. 47).

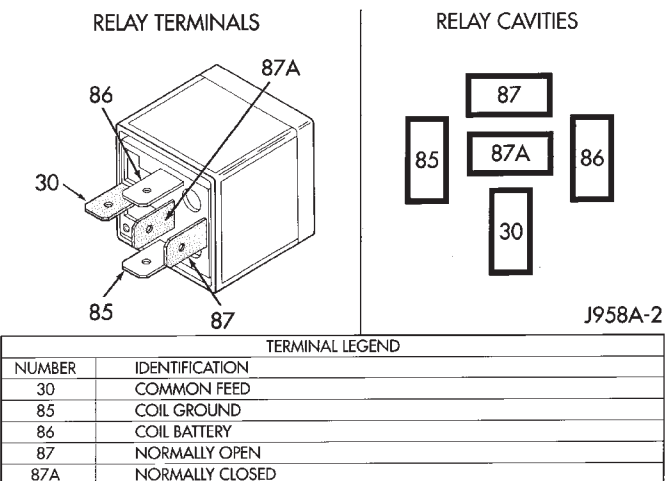
OPERATION

- 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.



9514-16

Fig. 46 ASD and Fuel Pump Relay Terminals



J958A-2

Fig. 47 ASD and Fuel Pump Relay Terminals

- 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.

DIAGNOSIS AND TESTING (Continued)

(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.

CAMSHAFT AND CRANKSHAFT POSITION SENSOR

Refer to Group 8D, Ignition for Diagnosis and Testing of Camshaft and Crankshaft Sensors.

ENGINE COOLANT TEMPERATURE SENSOR

(1) With the key off, disconnect wire harness connector from coolant temperature sensor (Fig. 48) or (Fig. 49).

(2) Connect a high input impedance (digital) volt-ohmmeter to terminals A and B. The ohmmeter should read as follows:

- Engine/Sensor at normal operating temperature around 200°F should read approximately 700 to 1,000 ohms.

- Engine/Sensor at room temperature around 70°F ohmmeter should read approximately 7,000 to 13,000 ohms.

(3) Test the resistance of the wire harness between the PCM 40-way connector terminal 26 and the sensor harness connector. Refer to Group 8W, Wiring diagrams for circuit information. If the resistance is greater than 1 ohm, repair the wire harness as necessary.

HEATED OXYGEN SENSOR

Use an ohmmeter to test the heating element of the oxygen sensors. Disconnect the electrical connec-

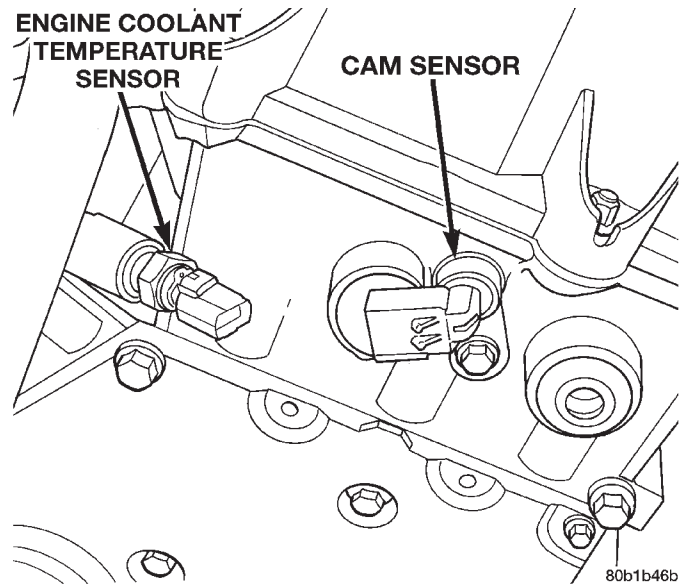


Fig. 48 Engine Coolant Temperature Sensor Location—2.7L

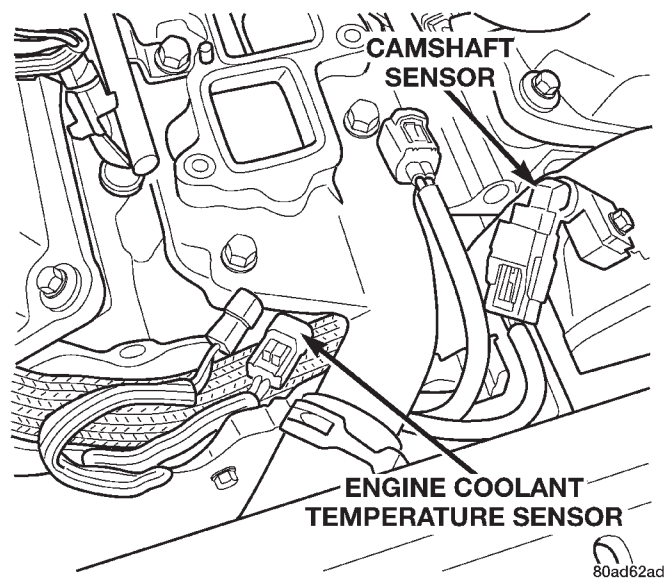


Fig. 49 Engine Coolant Temperature Sensor Location—3.2/3.5L

tor from each oxygen sensor. The white wires in the sensor connector are the power and ground circuits for the heater. Connect the ohmmeter test leads to terminals of the white wires in the heated oxygen sensor connector. Replace the heated oxygen sensor if the resistance is not between 4 and 7 ohms.

IDLE AIR CONTROL (IAC) MOTOR TEST

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

DIAGNOSIS AND TESTING (Continued)

KNOCK SENSOR

The engine knock sensor is affected by a number of factors. A few of these are: ignition timing, cylinder pressure, fuel octane, etc. The knock sensor generates an AC voltage whose amplitude increases with the increase of engine knock. The knock sensor can be tested with a digital voltmeter. The RMS voltage starts at about 20mVac (at about 700 rpm) and increases to approximately 600 mVac (5000 rpm). If the output falls outside of this range a DTC will be set.

THROTTLE POSITION SENSOR

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

The Throttle Position Sensor (TPS) can be tested with a digital voltmeter. The center terminal of the sensor is the output terminal.

With the ignition switch in the ON position, check the output voltage at the center terminal wire of the connector. Check the output voltage at idle and at wide-open-throttle (WOT). At idle, TPS output voltage should be greater than 0.6 volts. At wide open throttle, TPS output voltage should be less than 4.5 volts. The output voltage should gradually increase as the throttle plate moves slowly from idle to WOT.

Check for spread terminals at the sensor and PCM connections before replacing the TPS.

MINIMUM AIR FLOW

(1) Warm engine in Park or Neutral until the cooling fan has cycled on and off at least once.

(2) Ensure that all accessories are off.

(3) Shut off engine.

(4) Disconnect the PCV valve hose from the PCV valve. Cap the PCV valve.

(5) Disconnect purge hose from the nipple on each throttle body.

(6) Use a piece of hose to attach an Air Metering Orifice 6457 (0.125 in. orifice) to the purge nipple on each throttle body.

(7) Connect the DRB scan tool to the data link connector inside the passenger compartment.

(8) Restart the engine. Allow engine to idle for at least one minute.

(9) Using the DRB, access Minimum Airflow Idle Speed.

(10) The following will then occur:

- Idle air control motor will fully close
- Idle spark advance will become fixed
- DRB scan tool displays engine RPM

(11) If idle RPM is within the range shown in the Idle Specification chart, throttle body minimum air-flow is set correctly.

- If idle RPM is below specifications even though the idle air control motor operates normally and the throttle bodies were cleaned of coking and synchronized, replace the throttle bodies.

- If idle RPM is above specifications reset throttle body synchronization. Also, recheck idle air control motor operation using the DRB scan tool. If idle RPM is still above specifications after setting throttle body synchronization, check for leaking intake manifold plenum or gaskets.

(12) Shut off engine.

(13) Remove orifice 6457 from each throttle body. Install purge hoses.

(14) Remove cap from PCV valve. Connect hose to PCV valve.

(15) Remove DRB scan tool.

MINIMUM AIR FLOW IDLE

Engines	Idle RPM
All Engines	350-700 RPM

VEHICLE SPEED SENSOR

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

REMOVAL AND INSTALLATION**THROTTLE BODY—2.7L ENGINE****REMOVAL**

(1) Disconnect negative cable from battery.

(2) Disconnect air plenum from throttle body.

(3) Hold throttle lever in wide open position. Remove throttle cable and speed control cables from throttle arm.

(4) Remove throttle cable bracket.

(5) Remove EGR tube from intake manifold to EGR valve.

(6) Disconnect electrical connectors from throttle body.

(7) Remove 3 throttle body bolts.

(8) Remove purge hose.

(9) Remove throttle body.

(10) Clean mating surfaces.

INSTALLATION

(1) Install throttle body and bolts.

(2) Tighten bolts to 26 N·m (19 ft. lbs.) torque.

(3) Connect purge tube to nipple on throttle body.

(4) Hold throttle lever in wide open throttle position. Install throttle cable and speed control cable.

REMOVAL AND INSTALLATION (Continued)

- (5) Install throttle cable bracket and tighten bolts.
- (6) Install EGR tube from intake manifold to EGR valve. Tighten bolts.
- (7) Install air plenum and tighten clamp.
- (8) Connect negative cable to battery.

THROTTLE BODY—3.2/3.5L ENGINE

REMOVAL

- (1) Disconnect negative cable from battery.
- (2) Remove wiper arms.
- (3) Remove cowl screen.
- (4) Remove cowl plenum.
- (5) Disconnect air plenum from throttle body.
- (6) Remove throttle cable bracket.
- (7) Disconnect electrical connectors.
- (8) Disconnect top vacuum hose.
- (9) Remove 3 throttle body bolts.
- (10) Disconnect purge hose from throttle body.
- (11) Hold throttle lever in wide open position. Remove throttle cable and speed control cables from throttle arm.
- (12) Clean mating surfaces.

INSTALLATION

- (1) Hold throttle lever in wide open throttle position. Install throttle cable and speed control cable.
- (2) Connect purge tube to nipple on throttle body.
- (3) Install throttle body and bolts.
- (4) Tighten bolts to 26 N·m (19 ft. lbs.) torque.
- (5) Install vacuum hose.
- (6) Install throttle cable bracket and tighten bolts.
- (7) Install air plenum and tighten clamp.
- (8) Install cowl plenum.
- (9) Install cowl screen.
- (10) Install wiper arms.
- (11) Connect negative cable to battery.

THROTTLE POSITION SENSOR (TPS)—2.7L ENGINE

REMOVAL

- (1) Disconnect the TPS electrical connector (Fig. 50).
- (2) Remove the TPS mounting screws.
- (3) Remove the TPS.

INSTALLATION

- (1) The throttle shaft end of the throttle body slides into a socket in the TPS. The socket has two tabs inside it. The throttle shaft rests against the tabs. When indexed correctly, the TPS can rotate clockwise a few degrees to line up the mounting screw holes with the screw holes in the throttle body. The TPS has slight tension when rotated into position. If it is difficult to rotate the TPS into position, install the sensor with the throttle shaft on the other

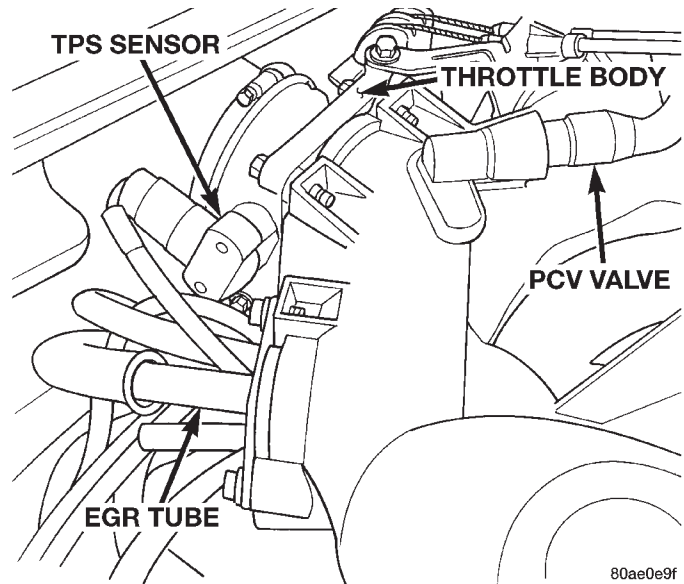


Fig. 50 Throttle Position Sensor—2.7L Engine

side of the tabs in the socket. Tighten mounting screws to 3 N·m (25 in. lbs.) torque.

- (2) After installing the TPS, the throttle plate should be closed. If the throttle plate is open, install the sensor on the other side of the tabs in the socket.
- (3) Attach electrical connector to the TPS.

THROTTLE POSITION SENSOR (TPS)—3.2/3.5L ENGINE

REMOVAL

- (1) Disconnect the negative battery cable.
- (2) Disconnect the air plenum.
- (3) Disconnect the TPS electrical connector (Fig. 50).
- (4) Remove the TPS mounting screws.
- (5) Remove the TPS.

INSTALLATION

- (1) The throttle shaft end of the throttle body slides into a socket in the TPS. The socket has two tabs inside it. The throttle shaft rests against the tabs. When indexed correctly, the TPS can rotate clockwise a few degrees to line up the mounting screw holes with the screw holes in the throttle body. The TPS has slight tension when rotated into position. If it is difficult to rotate the TPS into position, install the sensor with the throttle shaft on the other side of the tabs in the socket. Tighten mounting screws to 3 N·m (25 in. lbs.) torque.

- (2) After installing the TPS, the throttle plate should be closed. If the throttle plate is open, install the sensor on the other side of the tabs in the socket.
- (3) Attach electrical connector to the TPS.
- (4) Install air plenum and tighten the clamp.
- (5) Connect the negative battery cable.

REMOVAL AND INSTALLATION (Continued)

IDLE AIR CONTROL MOTOR—2.7L**REMOVAL**

- (1) Disconnect the negative battery cable.
- (2) Disconnect the TPS electrical connector (Fig. 50).
- (3) Remove the TPS mounting screws.
- (4) Remove the TPS.

INSTALLATION

(1) The throttle shaft end of the throttle body slides into a socket in the TPS. The socket has two tabs inside it. The throttle shaft rests against the tabs. When indexed correctly, the TPS can rotate clockwise a few degrees to line up the mounting screw holes with the screw holes in the throttle body. The TPS has slight tension when rotated into position. If it is difficult to rotate the TPS into position, install the sensor with the throttle shaft on the other side of the tabs in the socket. Tighten mounting screws to 3 N·m (25 in. lbs.) torque.

(2) After installing the TPS, the throttle plate should be closed. If the throttle plate is open, install the sensor on the other side of the tabs in the socket.

- (3) Attach electrical connector to the TPS.
- (4) Connect the negative battery cable.

IDLE AIR CONTROL MOTOR—3.2/3.5L**REMOVAL**

- (1) Disconnect the negative battery cable.
- (2) Disconnect the air plenum.
- (3) Disconnect the TPS electrical connector (Fig. 50).
- (4) Remove the TPS mounting screws.
- (5) Remove the TPS.

INSTALLATION

(1) The throttle shaft end of the throttle body slides into a socket in the TPS. The socket has two tabs inside it. The throttle shaft rests against the tabs. When indexed correctly, the TPS can rotate clockwise a few degrees to line up the mounting screw holes with the screw holes in the throttle body. The TPS has slight tension when rotated into position. If it is difficult to rotate the TPS into position, install the sensor with the throttle shaft on the other side of the tabs in the socket. Tighten mounting screws to 3 N·m (25 in. lbs.) torque.

(2) After installing the TPS, the throttle plate should be closed. If the throttle plate is open, install the sensor on the other side of the tabs in the socket.

- (3) Attach electrical connector to the TPS.
- (4) Install air plenum and tighten the clamp.
- (5) Connect the negative battery cable.

INTAKE AIR TEMPERATURE SENSOR**REMOVAL**

- (1) Disconnect electrical connector from sensor.
- (2) Remove sensor.

INSTALLATION

- (1) Install sensor. Tighten sensor.
- (2) Attach electrical connector to sensor.

PROPORTIONAL PURGE SOLENOID**REMOVAL**

- (1) Remove solenoid from bracket by pulling up on solenoid.
- (2) Disconnect electrical connector from solenoid.
- (3) Disconnect vacuum tubes from solenoid.

INSTALLATION

The top of the solenoid has TOP printed on it. The solenoid will not operate unless it is installed correctly.

- (1) Connect vacuum tube to solenoid.
- (2) Connect electrical connector to solenoid.
- (3) Install solenoid on bracket.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—2.7L

On 2.7L engine, the MAP sensor mounts onto the side of the intake manifold plenum (Fig. 51).

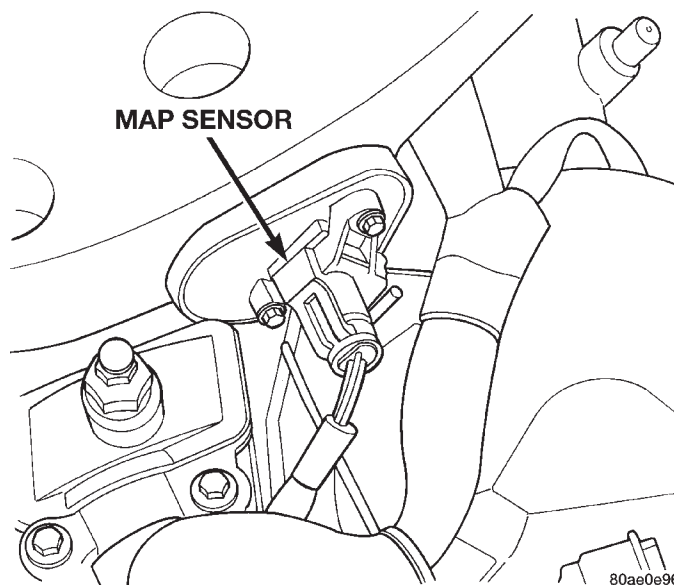


Fig. 51 MAP Sensor—2.7L Engine

REMOVAL

- (1) Disconnect the electrical connector from the MAP sensor.
- (2) Remove sensor.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

- (1) The sensor mounts onto intake manifold plenum. Tighten screws to 2 N·m (20 in. lbs.) torque.
- (2) Attach electrical connector to sensor.

**MANIFOLD ABSOLUTE PRESSURE (MAP)
SENSOR-3.2/3.5L**

The MAP sensor mounts onto the left side of the intake manifold plenum (Fig. 52).

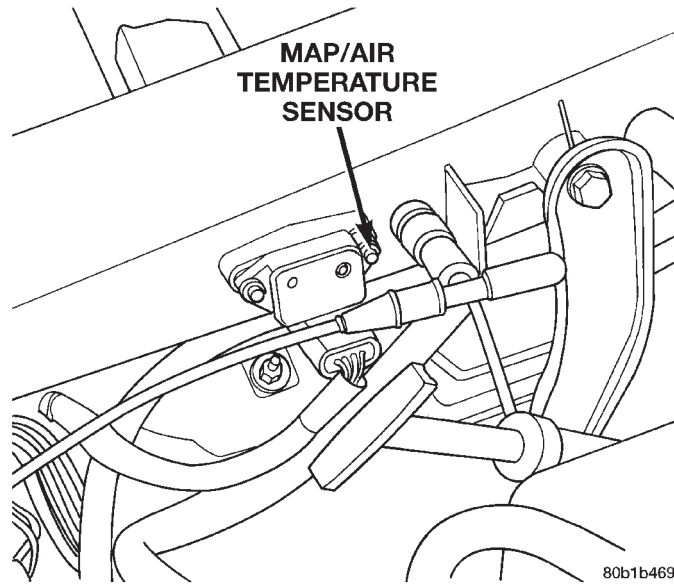


Fig. 52 MAP Sensor—3.5L Engine

REMOVAL

- (1) Disconnect the electrical connector from the MAP sensor.
- (2) Remove bolts from sensor.
- (3) Remove sensor.

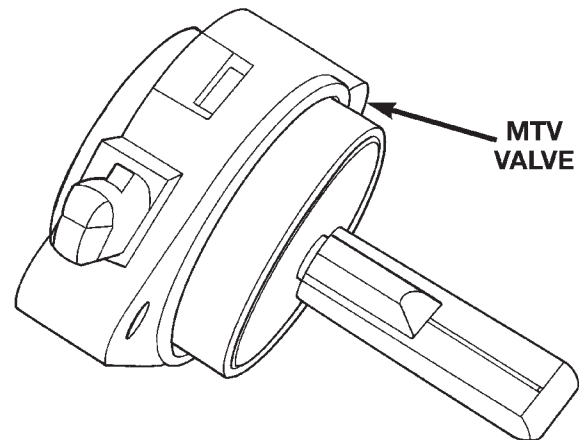
INSTALLATION

- (1) Bolt sensor to intake.
- (2) Attach electrical connector to sensor.

MANIFOLD TUNING VALVE—3.2/3.5L ENGINE

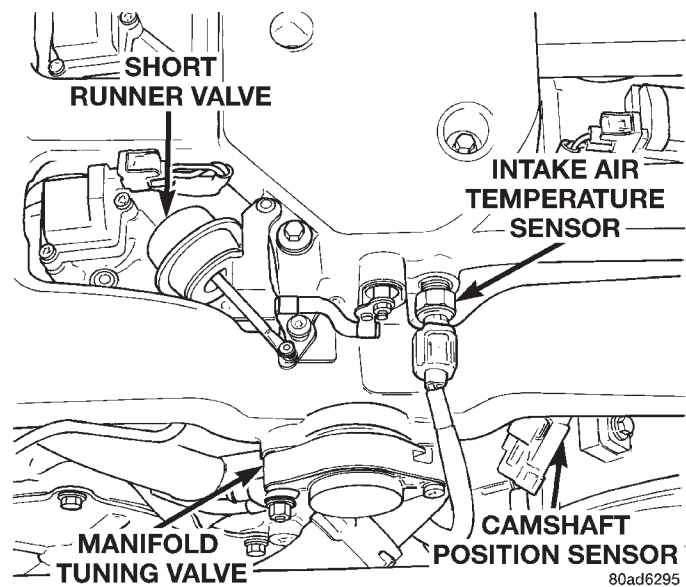
REMOVAL

- (1) Disconnect negative battery cable.
- (2) Disconnect electrical connector (Fig. 53).
- (3) Remove manifold tuning valve mounting screws. Remove tuning valve.



80ad634d

Fig. 53 Manifold Tuning Valve



80ad6295

Fig. 54 Retaining Clip

INSTALLATION

- (1) Install tuning valve. Tighten mounting screws to 11 N·m (8 ft. lbs.) torque.
- (2) Install electrical connector.
- (3) Connect negative battery cable.

REMOVAL AND INSTALLATION (Continued)

SHORT RUNNER VALVE

REMOVAL

- (1) Remove link.
- (2) Remove 2 bolts.
- (3) Remove vacuum hose.
- (4) Remove valve.

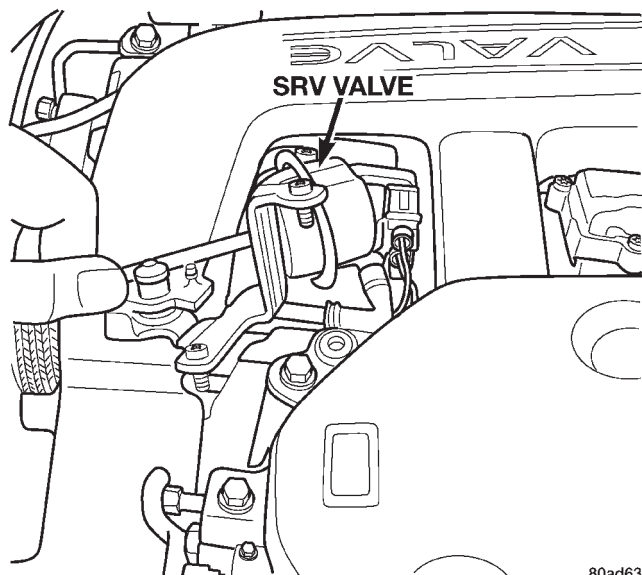


Fig. 55 Short Runner Valve

INSTALLATION

- (1) Install vacuum hose.
- (2) Install 2 bolts.
- (3) Install link.

VACUUM RESERVOIR SRV—3.2/3.5L

REMOVAL

- (1) Disconnect the negative battery cable.
- (2) Remove air inlet hose and resonator box and air cleaner top.
- (3) Remove the 3 fasteners from vacuum reservoir (Fig. 56).
- (4) Remove electrical connector.
- (5) Remove vacuum hoses.
- (6) Remove vacuum reservoir.

INSTALLATION

- (1) Install vacuum hoses to reservoir.
- (2) Install electrical connector.
- (3) Install 3 fasteners and tighten.
- (4) Install air inlet hose and resonator box and air cleaner top.
- (5) Connect the negative battery cable.

POWERTRAIN CONTROL MODULE (PCM)

The PCM engine control strategy prevents reduced idle speeds until after the engine operates for 320 km (200 miles). If the PCM is replaced after 320 km (200

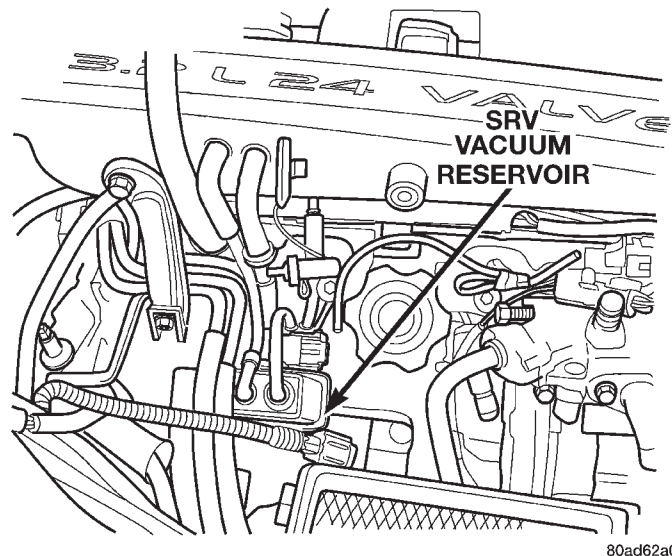


Fig. 56 Vacuum Reservoir

miles) of usage, update the mileage and vehicle identification number (VIN) in the new PCM. Use the DRB scan tool to change the millage and VIN in the PCM. If this step is not done a diagnostic trouble code (DTC) may be set. Refer to the appropriate Powertrain Diagnostic Manual and the DRB scan tool.

REMOVAL

To avoid possible voltage spike damage to PCM, ignition key must be off, and the negative battery cable must be disconnected before unplugging the PCM connectors. Note radio programs.

- (1) Remove speed control servo and bracket and reposition out of the way (Fig. 57).

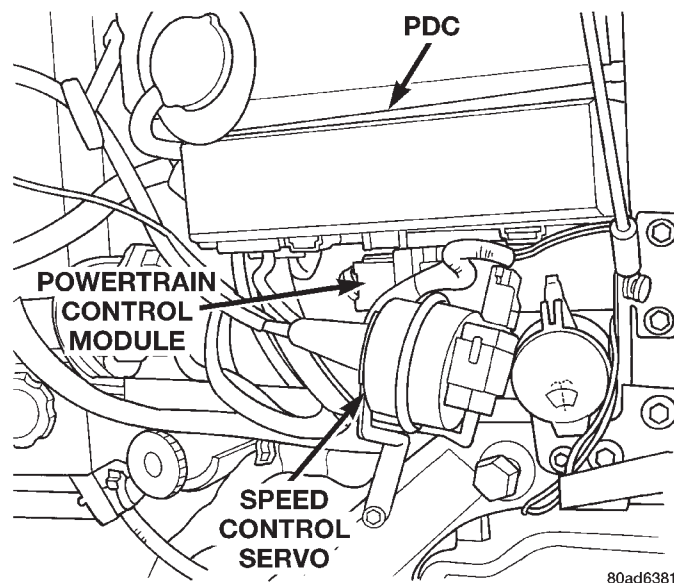


Fig. 57 PCM Location

- (2) Reposition wiring harness out of the way.

REMOVAL AND INSTALLATION (Continued)

- (3) Remove washer bottle filler neck.
- (4) Remove Transmission Control Module (TCM) reposition out of the way (Fig. 58).

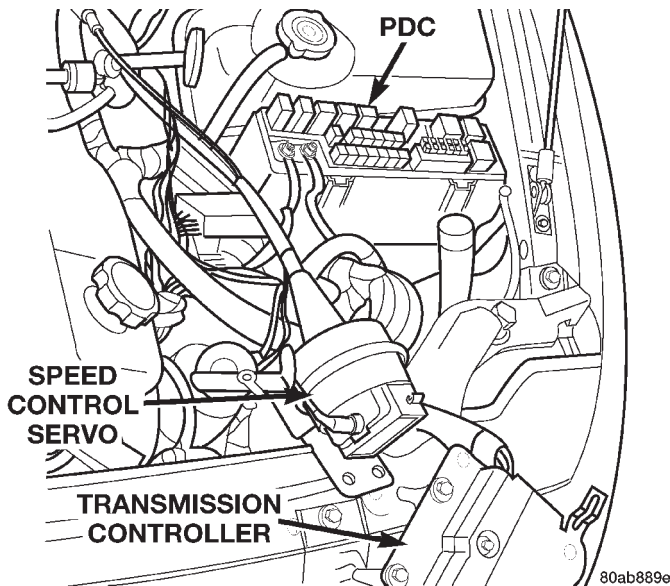


Fig. 58 TCM Location

- (5) Remove PCM.
- (6) Disconnect PCM 2 40-way connector.

INSTALLATION

- (1) Attach 2 40-way connector to PCM.
- (2) Install PCM. Tighten bolt to 4 N·m (35 in. lbs.) torque.
- (3) Install TCM.
- (4) Install washer bottle filler neck.
- (5) Reposition wiring harness.
- (6) Install speed control servo and bracket and tighten fasteners.
- (7) Connect negative battery cable and reprogram radio and clock.
- (8) Using DRB scan tool, program mileage and vehicle identification number (VIN) into PCM. Refer to the DRB scan tool and the appropriate Powertrain Diagnostic Manual.

CRANKSHAFT POSITION SENSOR

For removal/installation procedures refer to group 8D - Ignition System, Service Procedures.

CAMSHAFT POSITION SENSOR

For removal/installation procedures refer to group 8D - Ignition System, Service Procedures.

UPSTREAM HEATED OXYGEN SENSORS

The engine uses two heated oxygen sensors, one in each exhaust manifold.

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

REMOVAL

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

- (1) Disconnect the heated oxygen sensor electrical connector.
- (2) Use a socket such as Snap-On YA8875 or a crow foot wrench to remove oxygen sensor (Fig. 59).

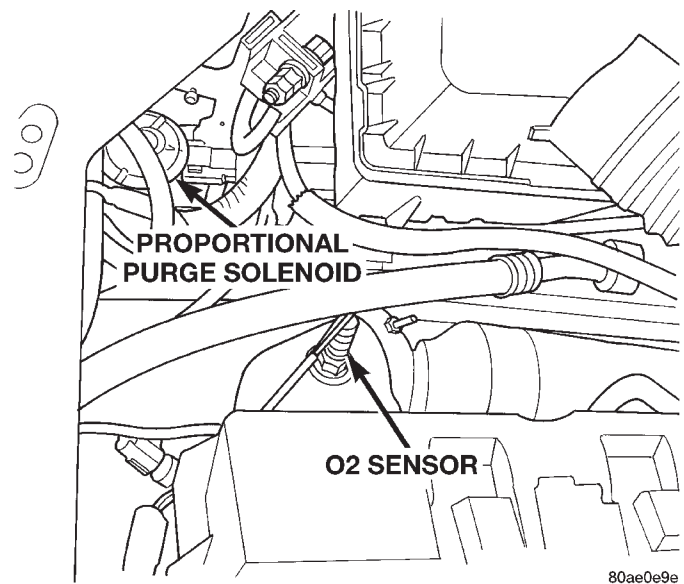


Fig. 59 Heated Oxygen Sensor Removal/Installation

INSTALLATION

- (1) After removing the sensor, the exhaust manifold threads must be cleaned with an 18 mm X 1.5 + 6E tap. If reusing the original sensor, coat the sensor threads with an anti-seize compound such as Loctite 771- 64 or equivalent. New sensors have compound on the threads and do not require an additional coating. Tighten the sensor to 28 N·m (20 ft. lbs.) torque.
- (2) Connect the heated oxygen sensor electrical connector.

REMOVAL AND INSTALLATION (Continued)

DOWNSTREAM HEATED OXYGEN SENSOR

The O2S are located at the outlet ends of the catalytic converter (Fig. 60).

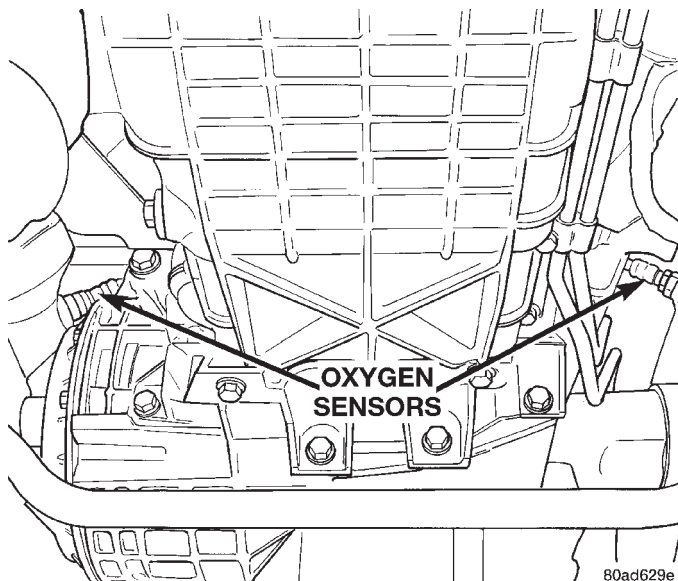


Fig. 60 Downstream Heated Oxygen Sensor

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 the vehicle.
- (2) Disconnect the wire connector from the O2S.

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

(3) Remove the O2S. 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. Tighten to 30 N·m (22 ft. lbs.) torque.
- (2) Connect the O2S wire connector.
- (3) Lower the vehicle.

AIR CLEANER

LH vehicles do not use a heated air inlet system. The Powertrain Control Module (PCM) adjusts fuel injector pulse width and ignition timing to compensate for different ambient temperatures.

The air cleaner attaches to the a bracket on right inner fender panel (Fig. 61). An opening in the body panel connects the inlet duct to ambient air.

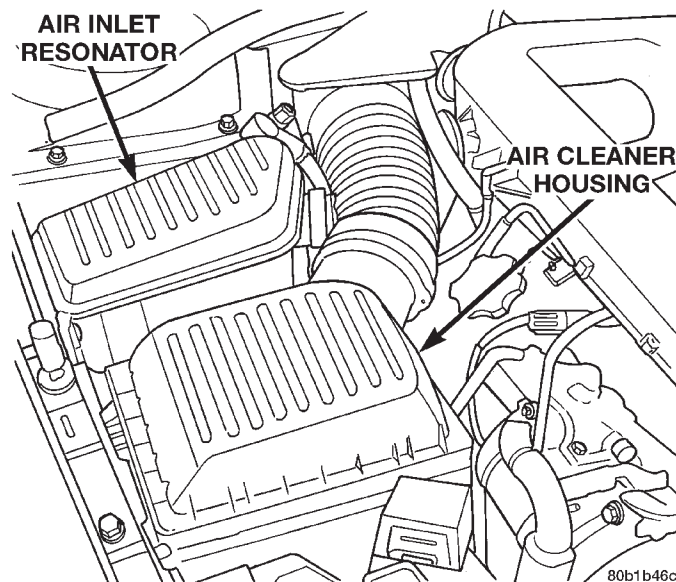


Fig. 61 Air Cleaner and Mounting Bracket

The air induction system uses a resonator between the air cleaner and throttle body (Fig. 61).

FILTER ELEMENT REPLACEMENT

- (1) Remove air cleaner lid. Lift lid off of air cleaner housing.
- (2) Remove filter element (Fig. 62).
- (3) If necessary, clean the inside of the air cleaner housing.
- (4) Install new filter element.
- (5) Place lid over air cleaner housing.

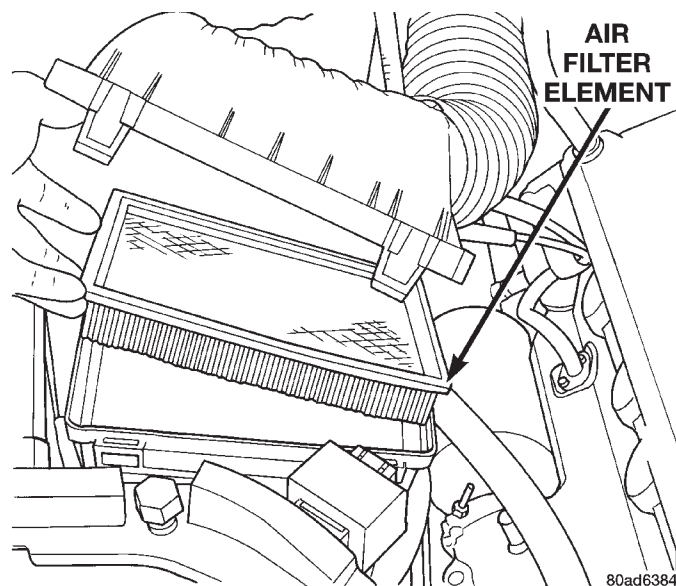


Fig. 62 Air Cleaner Housing and Element

REMOVAL AND INSTALLATION (Continued)

ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant temperature sensor is located next to the thermostat housing (Fig. 63) or (Fig. 64).

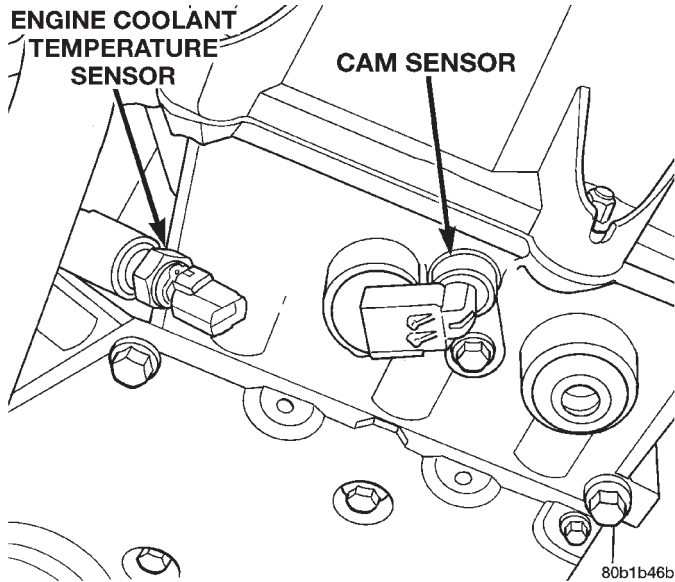


Fig. 63 Engine Coolant Temperature Sensor—2.7L Engine

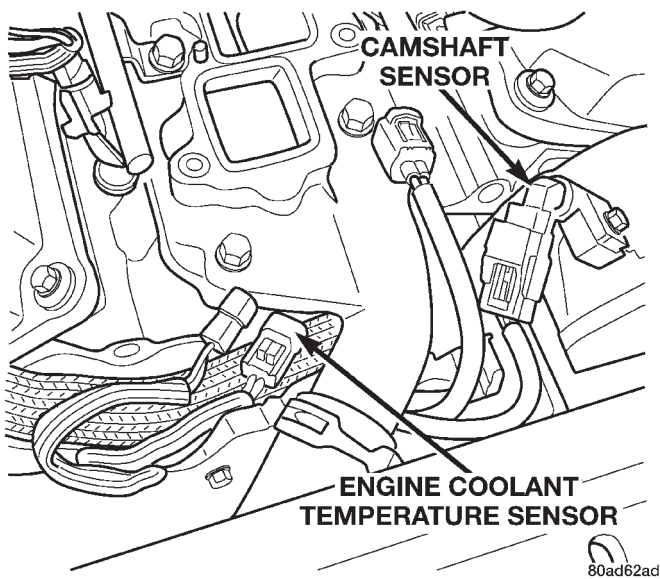
REMOVAL

Fig. 64 Engine Coolant Temperature Sensor—3.2/3.5L Engine

- (1) With the engine cold, disconnect coolant sensor electrical connector.
- (2) Remove sensor.

INSTALLATION

- (1) Install engine coolant temperature sensor. Tighten sensor to 28 N·m (20 ft. lbs.) torque.
- (2) Attach electrical connector to sensor.

VEHICLE SPEED SENSOR

For Removal/Installation of speed sensors refer to Group 21, Transaxle.

KNOCK SENSOR—3.2/3.5L

The engine uses one knock sensor. The sensor bolts into the cylinder block, directly below the intake manifold.

REMOVAL

- (1) Remove intake manifold plenum refer to Group 11, Exhaust System and Intake Manifold.
- (2) Disconnect electrical connector from knock sensor (Fig. 65).

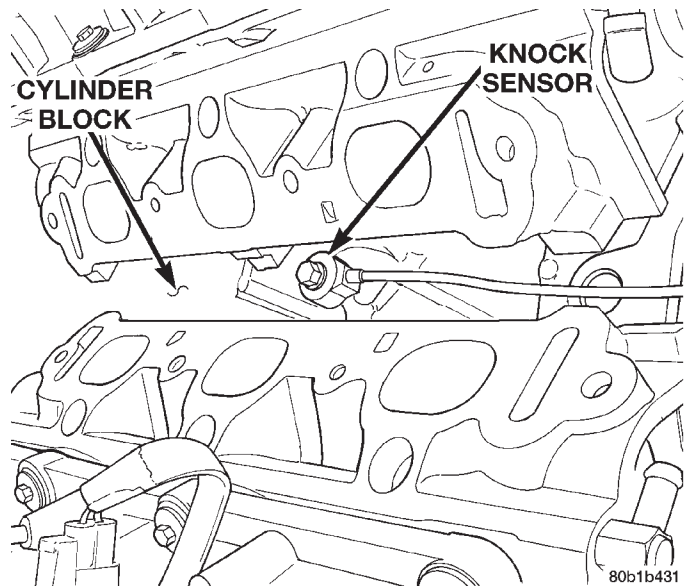


Fig. 65 Knock Sensor Location

- (3) Use a crows foot socket to remove the knock sensors.

INSTALLATION

- (1) Install knock sensor. Tighten knock sensor bolt to 10 N·m (7 ft. lbs) torque. **Over or under tightening effects knock sensor performance resulting in possible improper spark control.**
- (2) Attach electrical connector to knock sensor.
- (3) Install intake manifold plenum. Refer to Group 11, Exhaust System and Intake Manifold.

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.

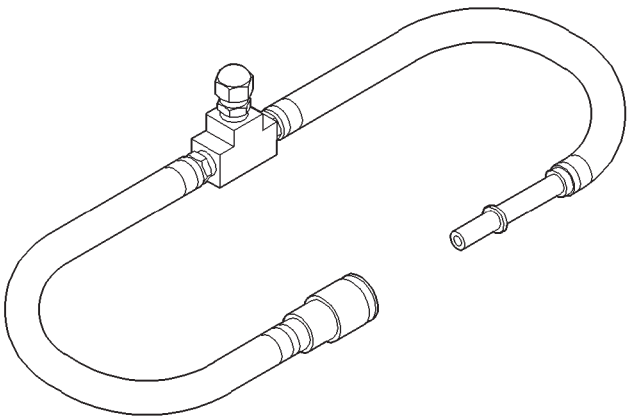
SPECIFICATIONS (Continued)

TORQUE

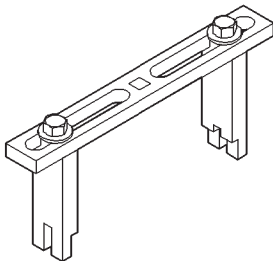
DESCRIPTION	TORQUE
Camshaft Position Semsor	12 N·m (105 in. lbs.)
Crankshaft Position Sensor	
Mounting Bolts.	12 N·m (105 in. lbs.)
Engine Coolant Temperature Sensor	28 N·m
	(20 ft. lbs.)
Idle Air Control Motor	3 N·m (25 in. lbs.)
Air Temperature Sensor—3.2/3.5L	28 N·m
	(20 ft. lbs.)
Knock Sensor bolt—3.2/3.5L	10 N·m (7 ft. lbs.)
Knock Sensor—2.7L	10 N·m (7 ft. lbs.)
Manifold Tuning Valve—3.2/3.5L	11 N·m
	(8 ft. lbs.)
MAP Sensor	3 N·m (25 in. lbs.)
Oxygen Sensor	28 N·m (20 ft. lbs.)
Powertrain Control Module	4 N·m (35 in. lbs.)
Throttle Body Mounting	26 N·m (19 ft. lbs.)
Throttle Position Sensor	3 N·m (25 in. lbs.)
Short Runner Valve	6.7 N·m (60 in. lbs.)

SPECIAL TOOLS

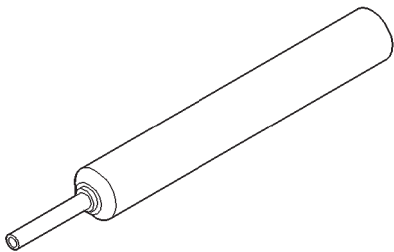
FUEL



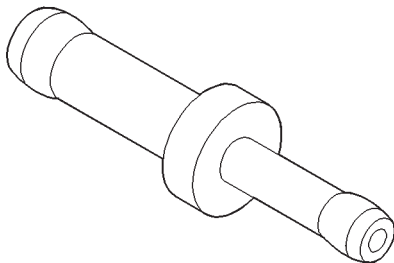
Fuel Pressure Test Adapter 6539



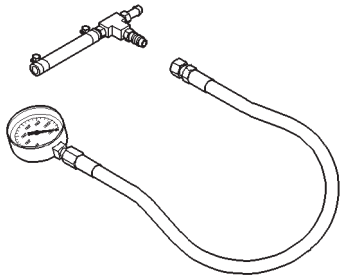
Spanner Wrench 6856



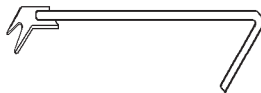
Extractor C-4334



Metering Orifice

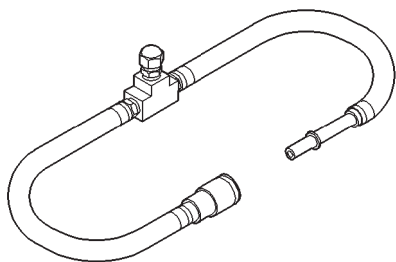
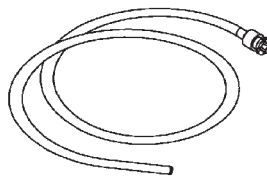


Pressure Gauge Assembly C-4799-B



Fuel Line Tool

SPECIAL TOOLS (Continued)

***Fuel Line Adapter******Fuel Line Adapter 1/4******O2S (Oxygen Sensor) Remover/Installer—C-4907***

