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FUEL SYSTEM

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FUEL DELIVERY SYSTEM

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DESCRIPTION AND OPERATION

GASOLINE/OXYGENATE BLENDS

DESCRIPTION

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.

DESCRIPTION AND OPERATION (Continued)

DO NOT USE GASOLINE 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 gasoline are specially blended to reduce vehicle emissions and improve air quality.

Chrysler Corporation strongly supports the use of reformulated gasoline 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

OPERATION

The fuel delivery system consists of: the electric fuel pump, fuel filter/fuel pressure regulator, fuel tubes/lines/hoses, fuel rail, fuel injectors, fuel tank, accelerator pedal and throttle cable.

A fuel return system is used on all models (all engines). Fuel is returned through the fuel pump module and back into the fuel tank through the fuel filter/fuel pressure regulator. A separate fuel return line from the engine to the tank is no longer used with any engine.

The fuel tank assembly consists of: the fuel tank, filler tube, fuel gauge sending unit/electric fuel pump module, a rollover valve(s) and a pressure-vacuum filler cap.

Also to be considered part of the fuel system is the evaporation control system or Onboard Refueling Vapor recovery (ORVR). This is designed to reduce the emission of fuel vapors into the atmosphere. The description and function of the Evaporative Control System is found in the Emission Control Systems section.

FUEL PUMP MODULE

DESCRIPTION

The fuel pump module is installed in the fuel tank (Fig. 1).

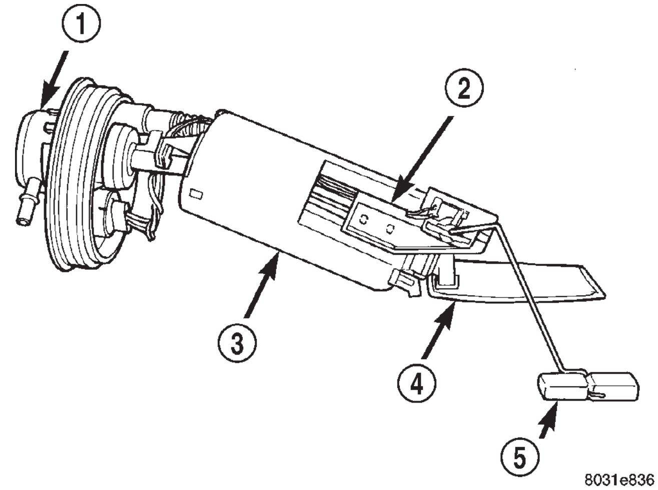


Fig. 1 Fuel Pump Module

1 – FUEL FILTER/PRESSURE REGULATOR
2 – FUEL LEVEL SENSOR
3 – FUEL RESERVOIR
4 – INLET STRAINER
5 – FLOAT

OPERATION

The fuel pump module contains the following:

- Electric fuel pump
- Fuel pump reservoir
- Inlet strainer
- Fuel filter/pressure regulator
- Fuel gauge sending unit
- Fuel supply line connection

The inlet strainer, fuel pressure regulator and fuel level sensor are the only serviceable items. If the fuel pump requires service, replace the fuel pump module.

ELECTRIC FUEL PUMP

DESCRIPTION

The electric fuel pump is located in and is part of the fuel pump module. It is a positive displacement, gerotor type, immersible pump with a permanent magnet electric motor. The fuel pump module is suspended in fuel in the fuel tank.

DESCRIPTION AND OPERATION (Continued)

OPERATION

The pump draws fuel through a strainer and pushes it through the motor to the outlet. The pump contains a check valve. The valve, in the pump outlet, maintains pump pressure during engine off conditions. The fuel pump relay provides voltage to the fuel pump. The fuel pump has a maximum deadheaded pressure output of approximately 880 kPa (130 psi). The regulator adjusts fuel system pressure to approximately 338 kPa (49 psi).

FUEL GAUGE SENDING UNIT

DESCRIPTION

The fuel gauge sending unit (fuel level sensor) is attached to the side of the fuel pump module. The sending unit consists of a float, an arm, and a variable resistor (track). The resistor track is used to send electrical signals to the instrument cluster for fuel gauge operation and are then transmitted to the engine controller for OBDII emission requirements.

OPERATION

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

After this fuel level signal is sent to the instrument cluster, the instrument cluster will transmit the data across the J1850 bus circuits to the PCM.

For OBD II emission requirements: The voltage signal is sent to the instrument cluster to indicate fuel level. The cluster transmits the fuel level to the PCM where it is used to prevent a false setting of misfire and fuel system monitor trouble codes. This occurs if the fuel level in the tank is less than approximately 15 percent of its rated capacity.

FUEL FILTER/FUEL PRESSURE REGULATOR

DESCRIPTION

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.

It contains a diaphragm, calibrated springs and a fuel return valve. The internal fuel filter (Fig. 2) is also part of the assembly.

OPERATION

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.

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.

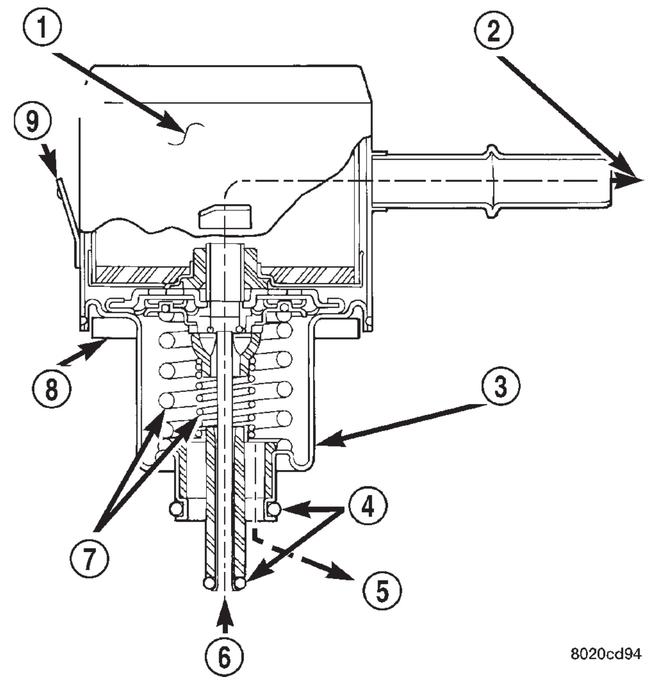


Fig. 2 Side View—Filter/Regulator

1 – INTERNAL FUEL FILTER
2 – FUEL FLOW TO FUEL INJECTORS
3 – FUEL FILTER/FUEL PRESSURE REGULATOR
4 – O-RINGS
5 – EXCESS FUEL BACK TO TANK
6 – FUEL INLET
7 – CALIBRATED SPRINGS
8 – RUBBER GROMMET AT PUMP MODULE
9 – LOCKING TAB

DESCRIPTION AND OPERATION (Continued)

FUEL TANK

DESCRIPTION

The fuel tank is constructed of a plastic material. Its main functions are for fuel storage and for placement of the fuel pump module. The tank is made from High density Polyethylene (HDPE) material.

OPERATION

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

All models are equipped with either one or two rollover valves mounted into the top of the fuel tank (or pump module).

An evaporation control system is connected to the rollover valve(s) to reduce emissions of fuel vapors into the atmosphere. When fuel evaporates from the fuel tank, vapors pass through vent hoses or tubes to a charcoal canister where they are temporarily held. When the engine is running, the vapors are drawn into the intake manifold. Certain models are also equipped with a self-diagnosing system using a Leak Detection Pump (LDP). Refer to the Emission Control System for additional information.

FUEL RAIL

DESCRIPTION

The fuel rail supplies the necessary fuel to each individual fuel injector and is mounted to the intake manifold (Fig. 3).

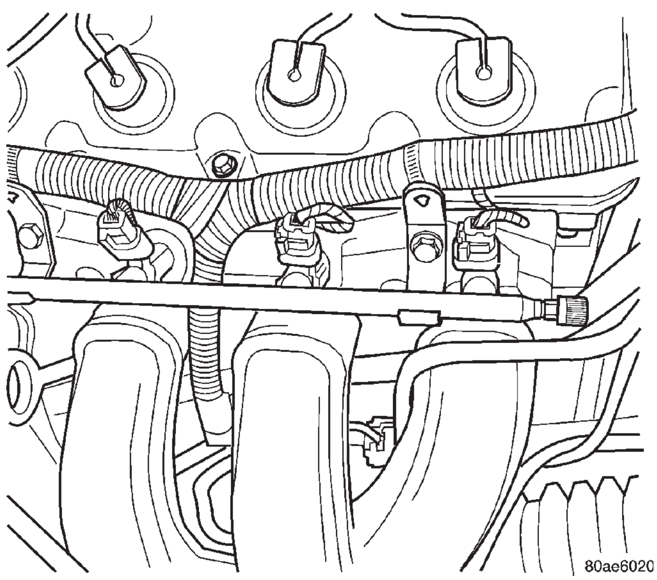


Fig. 3 Fuel Rail

OPERATION

The fuel pressure regulator is no longer mounted to the fuel rail on any engine. It is now located on the fuel tank mounted fuel pump module. Refer to Fuel Filter/Fuel Pressure Regulator in the Fuel Delivery System section of this group for information. The fuel rail is not repairable.

FUEL INJECTORS

DESCRIPTION

The injectors are positioned in the intake manifold with the nozzle ends directly above the intake valve port (Fig. 4).

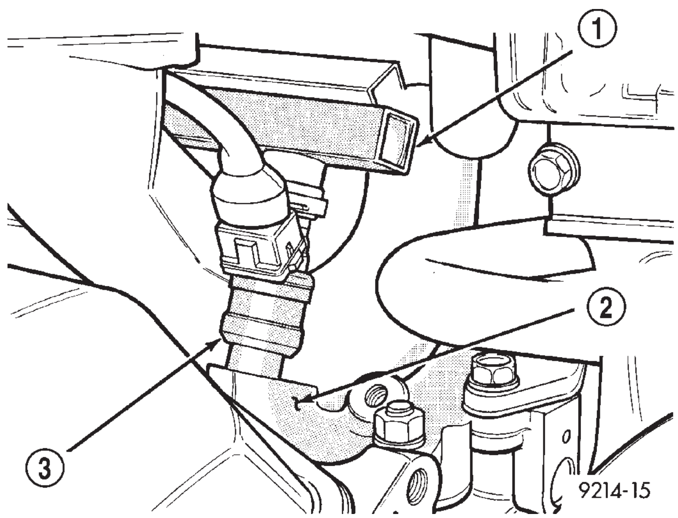


Fig. 4 Fuel Injector Location—Typical

1 – FUEL RAIL
2 – INTAKE MANIFOLD
3 – FUEL INJECTORS

OPERATION

The fuel injectors are electrical solenoids (Fig. 5). 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 a hollow cone. The spraying action atomizes the fuel, adding it to the air entering the combustion chamber. Fuel injectors are not interchangeable between engines.

DESCRIPTION AND OPERATION (Continued)

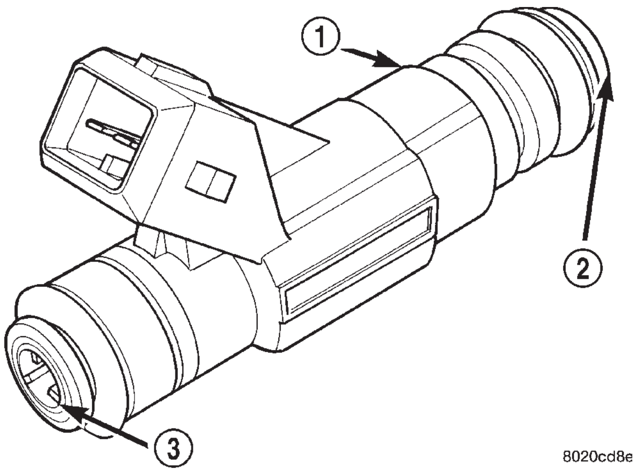


Fig. 5 Fuel Injector

1 – FUEL INJECTOR
2 – NOZZLE
3 – TOP (FUEL ENTRY)

PRESSURE-VACUUM FILLER CAP

DESCRIPTION

The plastic fuel fill cap is threaded/quarter turn onto the end of the fuel filler tube. It's purpose is to retain vapors and fuel in the fuel tank.

OPERATION

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.

ONBOARD REFUELING VAPOR RECOVERY (ORVR)

DESCRIPTION

ORVR System Schematic and components.

OPERATION

The emission control principle used in the ORVR system is that the fuel flowing into the filler tube (appx. 1” I. D.) creates an aspiration effect which draws air into the fill tube (Fig. 6). During refueling, the fuel tank is vented to the vapor canister to capture escaping vapors. With air flowing into the filler tube, there are no fuel vapors escaping to the atmosphere. Once the refueling vapors are captured by the canister, the vehicle's computer controlled purge system draws vapor out of the canister for the engine to burn. The vapors flow is metered by the purge solenoid so that there is no or minimal impact on driveability or tailpipe emissions.

As fuel starts to flow through the fill tube, it opens the normally closed check valve and enters the fuel tank. Vapor or air is expelled from the tank through the control valve to the vapor canister. Vapor is absorbed in the canister until vapor flow in the lines stops, either following shut-off or by having the fuel level in the tank rise high enough to close the control valve. The control valve contains a float that rises to seal the large diameter vent path to the canister. At this point in the fueling of the vehicle, the tank pressure increase, the check valve closes (preventing tank fuel from spiting back at the operator), and fuel then rises up the filler tube to shut-off the dispensing nozzle.

If the engine is shut-off while the On-Board diagnostics test is running, low level tank pressure can be trapped in the fuel tank and fuel can not be added to the tank until the pressure is relieved. This is due to the leak detection pump closing the vapor outlet from the top of the tank and the one-way check valve not allowing the tank to vent through the fill tube to atmosphere. Therefore, when fuel is added, it will back-up in the fill tube and shut off the dispensing nozzle. The pressure can be eliminated in two ways: 1. Vehicle purge must be activated and for a long enough period to eliminate the pressure. 2. Removing the fuel cap and allowing enough time for the system to vent thru the recirulation tube.

DESCRIPTION AND OPERATION (Continued)

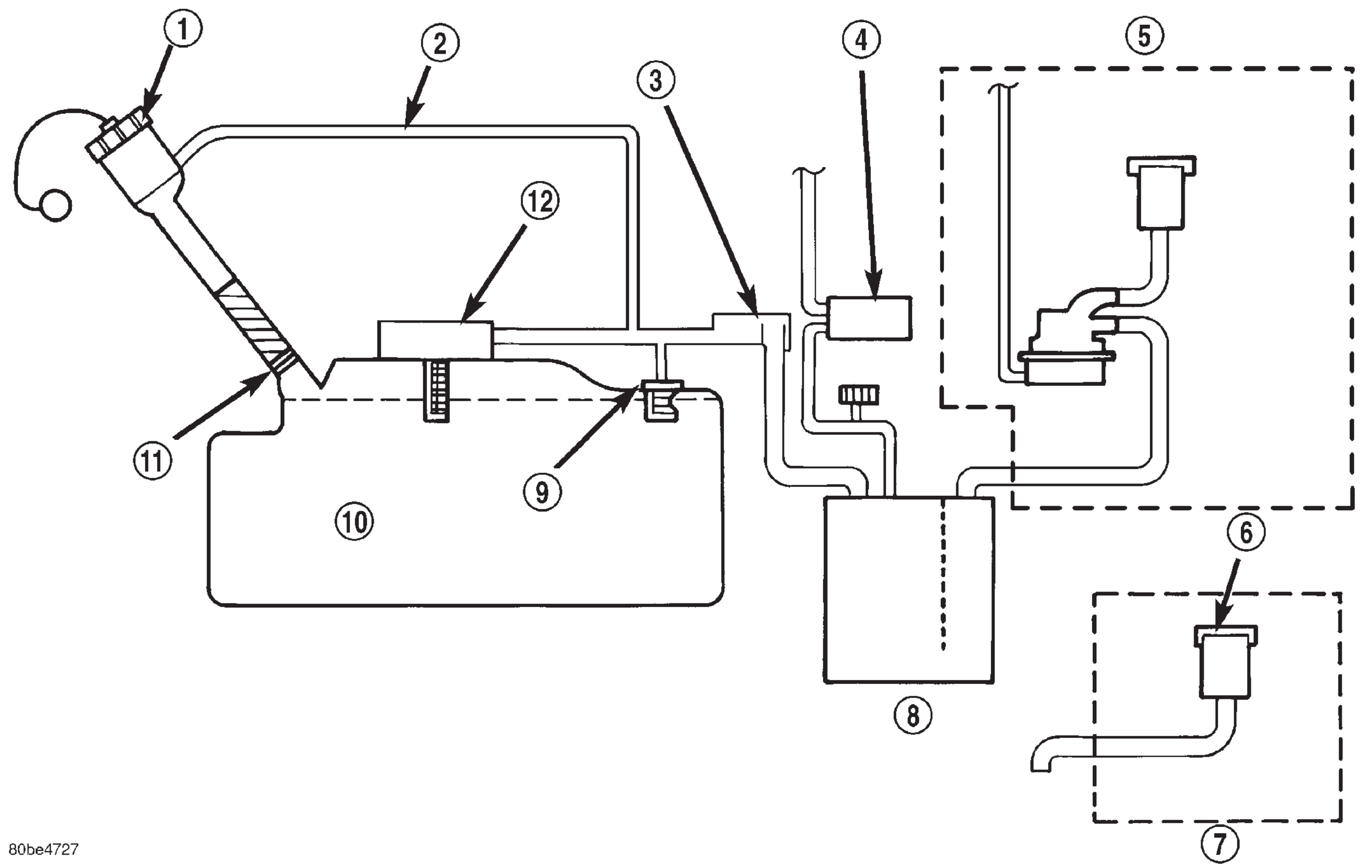


Fig. 6 ORVR System Schematic

1 – FUEL CAP
2 – RECIRCULATION TUBE
3 – LIQUID SEPARATOR
4 – PURGE
5 – W/LDP
6 – BREATHER ELEMENT
7 – W/O LDP
8 – CANISTER
9 – ROLLOVER VALVE
10 – FUEL TANK
11 – CHECK VALVE
12 – CONTROL VALVE

CONTROL VALVE

DESCRIPTION

It is a valve in the top of the fuel tank that controls fuel fill rate and fuel fill level and directs vapors to a storage area.

OPERATION

The valve controls the fuel fill rate and set the fuel level in the fuel tank. It also allows the proper operation of OBDII leak detection monitor. It prevent liquid fuel carry over into the EVAP system.

DESCRIPTION AND OPERATION (Continued)

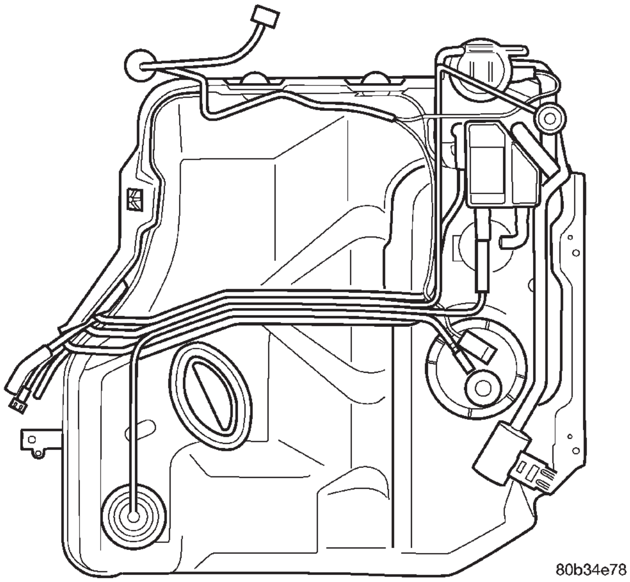


Fig. 7 ORVR System

ROLLOVER VALVES

DESCRIPTION

All vehicles have rollover valve(s) on top of the fuel tank.

OPERATION

The valves prevent fuel flow through the fuel tank vent valve hoses should the vehicle rollover.

The rollover valves on the fuel tank are not serviceable.

FUEL TUBES/LINES/HOSES AND CLAMPS

DESCRIPTION

Also refer to Quick-Connect Fittings.

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

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

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

Use new original equipment type hose clamps.

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

(6) Return fuel pump relay to PDC.

(7) One or more Diagnostic Trouble Codes (DTC's) may have been stored in PCM memory due to fuel pump relay removal. The DRB III® scan tool must be used to erase a DTC.

INJECTOR CONNECTOR

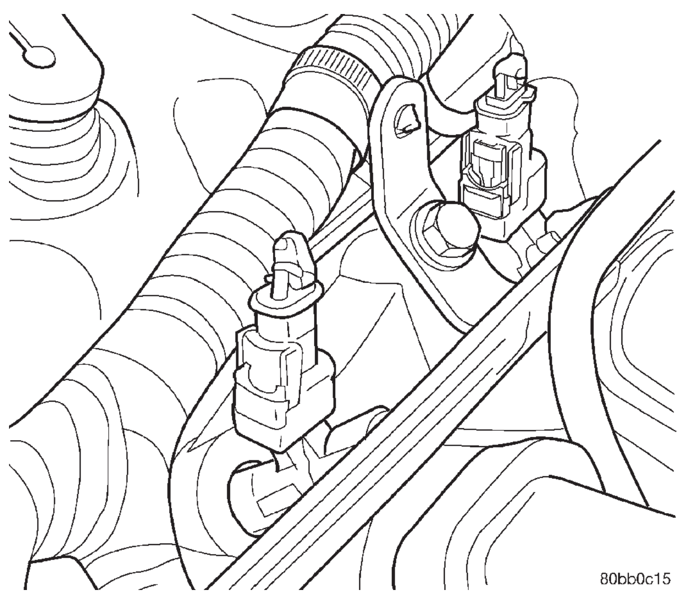


Fig. 8 Fuel Injectors

REMOVAL

(1) Disconnect electrical connectors at the fuel injectors. To remove connector refer to (Fig. 9). Pull

the red colored slider away from injector (1). While pulling the slider, depress tab (2) and remove connector (3) from injector. The factory fuel injection wiring harness is numerically tagged (INJ 1, INJ 2, etc.) for injector position identification. If harness is not tagged, make note of wiring location before removal.

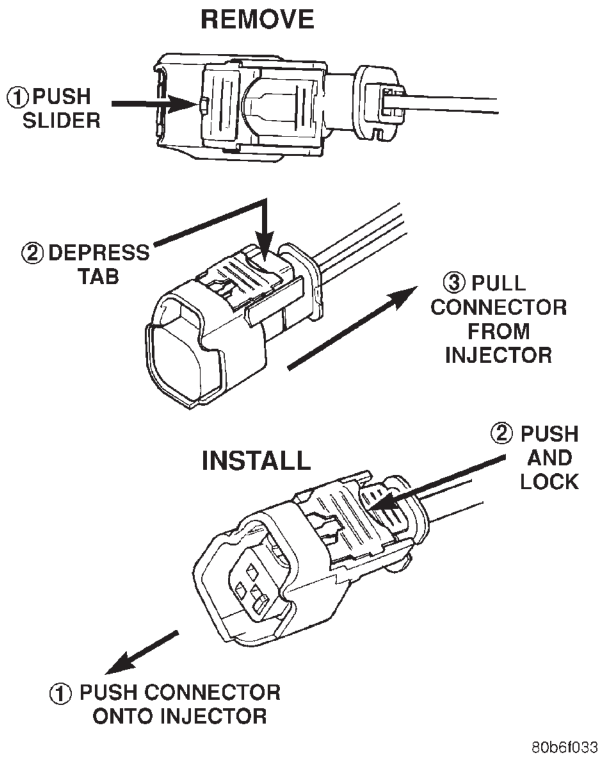


Fig. 9 Remove/Install Injector Connector

INSTALLATION

(1) Connect electrical connectors at all fuel injectors. To install connector, refer to (Fig. 9). Push connector onto injector (1) and then push and lock red colored slider (2). Verify connector is locked to injector by lightly tugging on connector.

DRAINING FUEL TANK

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

(1) Remove fuel filler cap.

(2) Perform the Fuel System Pressure Release procedure.

(3) Disconnect negative cable from battery.

(4) Raise vehicle and support.

(5) Remove quick connect cap from drain port.

(6) Drain fuel tank into holding tank or a properly labeled **Gasoline** safety container.

(7) Replace quick connect cap.

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.

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.

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

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

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

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

(2) Disconnect negative cable from battery or auxiliary jumper terminal.

(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. 10). **Do not rely upon the audible click to confirm a secure connection.**

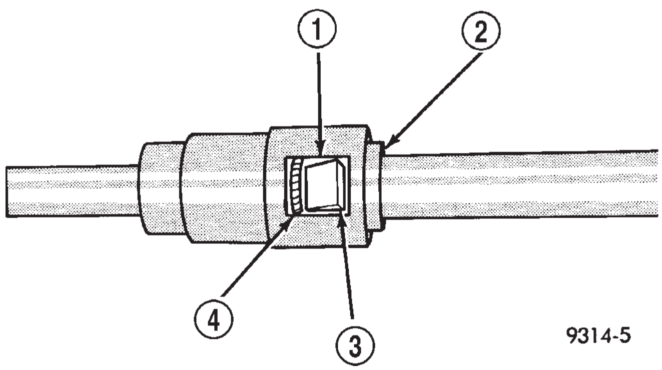


Fig. 10 Plastic Quick-Connect Fitting/Fuel Tube Connection

1 – WINDOW
2 – TAB (2)
3 – EAR
4 – SHOULDER (ON TUBE)

(5) Connect negative cable to battery or auxiliary jumper terminal.

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

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

TWO-TAB TYPE FITTING

This type of fitting is equipped with tabs located on both sides of the fitting (Fig. 11). These tabs are supplied for disconnecting the quick-connect fitting from component being serviced.

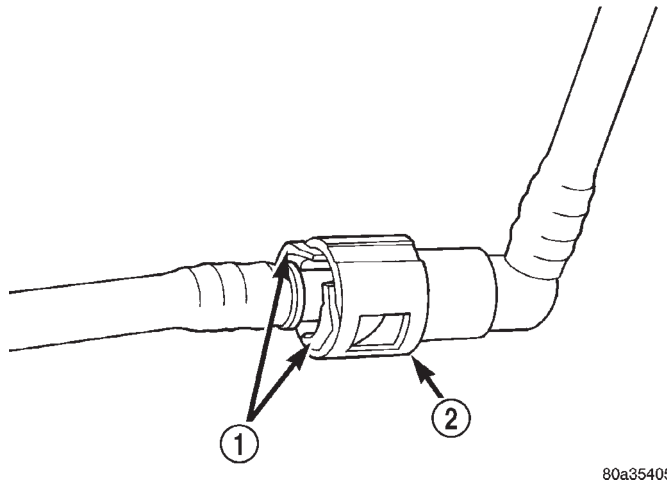


Fig. 11 Typical Two-Tab Type Quick-Connect Fitting

1 – TAB(S)
2 – QUICK-CONNECT FITTING

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

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

DISCONNECTION/CONNECTION

(1) Perform fuel pressure release procedure. Refer to Fuel Pressure Release Procedure in this group.

(2) Disconnect negative battery cable from battery or auxiliary jumper terminal.

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

(4) To disconnect quick-connect fitting, squeeze plastic retainer tabs (Fig. 11) against sides of quick-connect fitting with your fingers. Tool use is not required for removal and may damage plastic retainer. Pull fitting from fuel system component being serviced. The plastic retainer will remain on component being serviced after fitting is discon-

SERVICE PROCEDURES (Continued)

nected. The O-rings and spacer will remain in quick-connect fitting connector body.

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

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

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

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

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

(9) Connect negative cable to battery or auxiliary jumper terminal.

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

PLASTIC RETAINER RING TYPE FITTING

This type of fitting can be identified by the use of a full-round plastic retainer ring (Fig. 12) usually black in color.

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

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

DISCONNECTION/CONNECTION

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

(2) Disconnect negative battery cable from battery or auxiliary jumper terminal.

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

(4) To release fuel system component from quick-connect fitting, firmly push fitting towards component being serviced while firmly pushing plastic retainer ring into fitting (Fig. 12). With plastic ring depressed, pull fitting from component. **The plastic retainer ring must be pressed squarely into fitting body. If this retainer is cocked during removal, it may be difficult to disconnect fitting. Use an open-end wrench on shoulder of plastic retainer ring to aid in disconnection.**

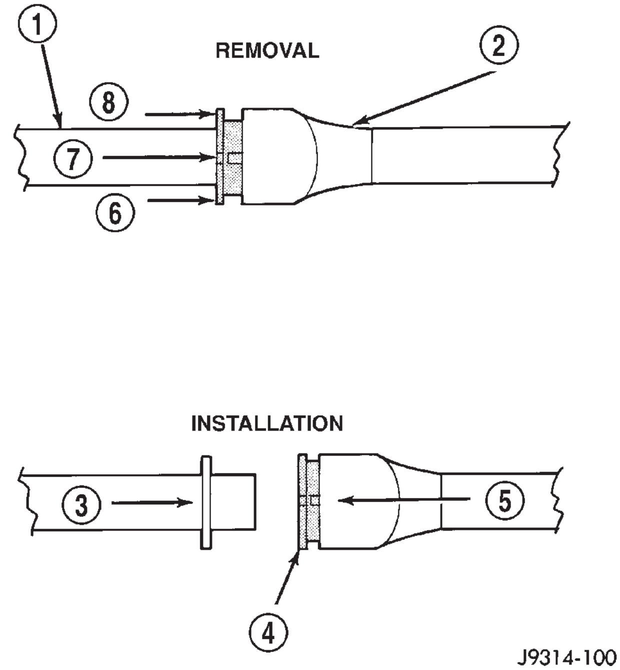


Fig. 12 Plastic Retainer Ring Type Fitting

1 – FUEL TUBE
2 – QUICK CONNECT FITTING
3 – PUSH
4 – PLASTIC RETAINER
5 – PUSH
6 – PUSH
7 – PUSH
8 – PUSH

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

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

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

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

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

(10) Connect negative battery cable to battery or auxiliary jumper terminal.

(11) 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. 13). The PDC is located next to the battery in the engine compartment. 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.

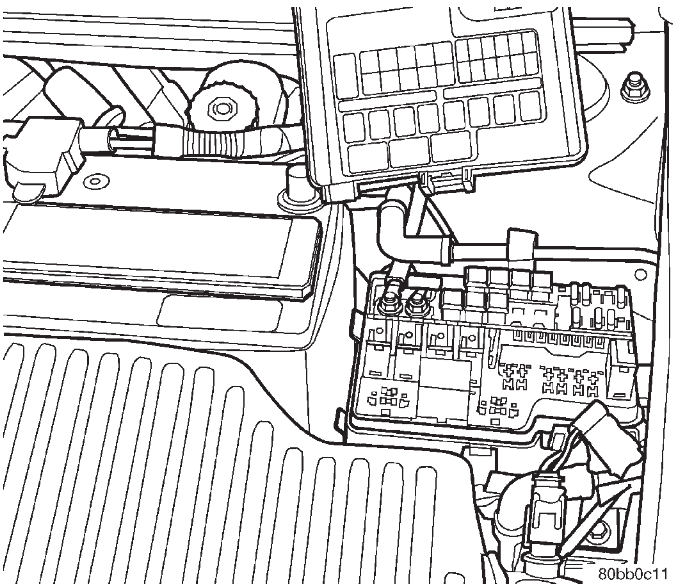


Fig. 13 Power Distribution Center (PDC)

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

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

(1) Drain the fuel. Refer to Draining Fuel Tank in the Fuel Tank section of 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.

(2) Remove fuel tank, refer to the Fuel Tank removal/installation section.

(3) Lower tank.

(4) Use Special Tool 6856 to remove fuel pump module locknut (Fig. 16).

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

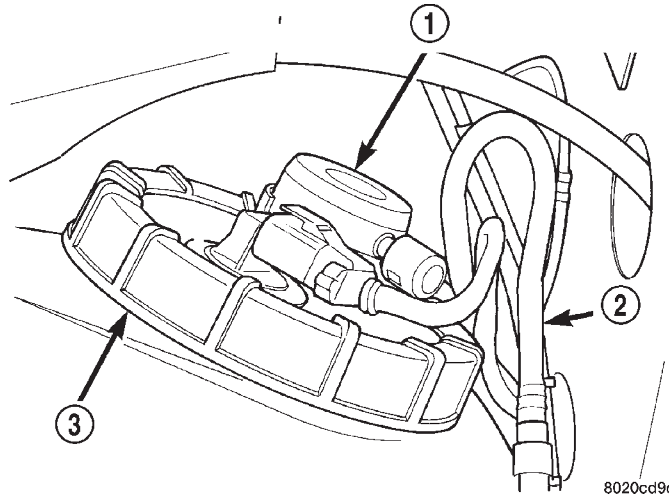


Fig. 14 Fuel Pump Module Removal

1 – FUEL FILTER/PRESSURE REGULATOR
2 – FUEL LINE
3 – LOCKNUT

INSTALLATION

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

(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. 15).

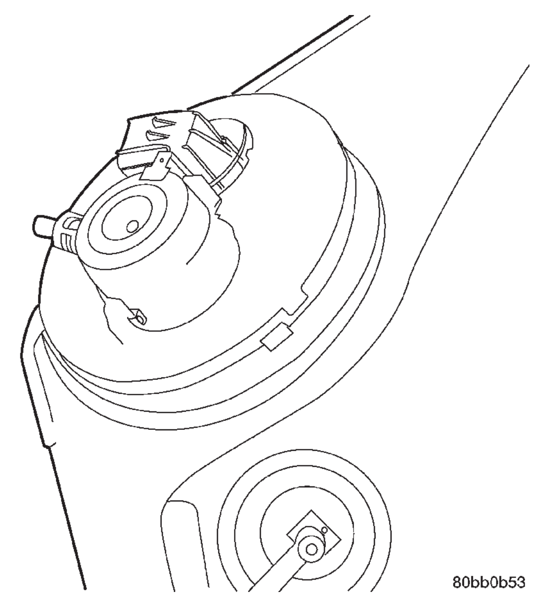


Fig. 15 Alignment Tab

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

REMOVAL AND INSTALLATION (Continued)

(4) Tighten the locknut using Special Tool 6856 to 55 N·m (40.5 ft. lbs.) (Fig. 16).

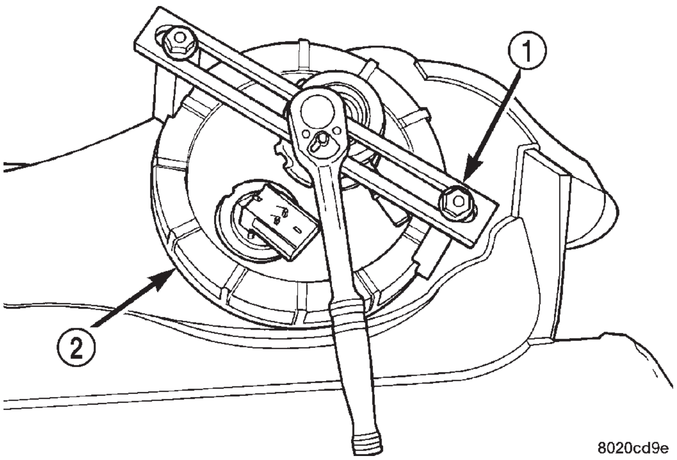


Fig. 16 Fuel Tank Locknut

1 – SPECIAL TOOL 6856
2 – LOCKNUT

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

(5) Install fuel tank, refer to the Fuel Tank removal/installation section.
(6) Lower vehicle.
(7) Fill fuel tank. Check for leaks.

FUEL FILTER / PRESSURE REGULATOR

REMOVAL

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE, EVEN WITH ENGINE OFF. BEFORE SERVICING THE FUEL FILTER/FUEL PRESSURE REGULATOR, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

(1) Refer to Fuel System Pressure Release in the Fuel Delivery System section of this group.

The fuel filter/fuel pressure regulator is located on the top of fuel pump module. Fuel pump module removal is not necessary.

(2) Raise vehicle on hoist.
(3) Disconnect fuel supply line at the Filter/Regulator nipple (refer to Quick Connect Fittings in this section).
(4) Depress locking spring tab on side of Fuel/Regulator (Fig. 17) and rotate 90° counter-clockwise and pull out.

NOTE: Make sure that the upper and lower O-rings are on the Filter/Regulator assembly.

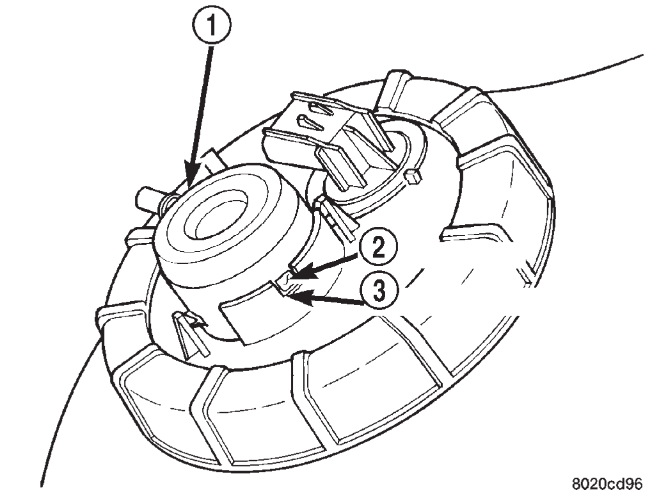


Fig. 17 Locking Spring Tab

1 – FUEL FILTER/PRESSURE REGULATOR
2 – SPRING TAB
3 – LOCATING SLOT

INSTALLATION

Lightly lubricate the O-rings with engine oil.

(1) Insert Filter/Regulator into the opening in the fuel pump module, align the two hold down tabs with the flange.
(2) While applying downward pressure, rotate the Filter/Regulator clockwise until the the spring tab engages the locating slot (Fig. 18).
(3) Connect the fuel line to the Filter/Regulator.
(4) Lower vehicle from hoist.

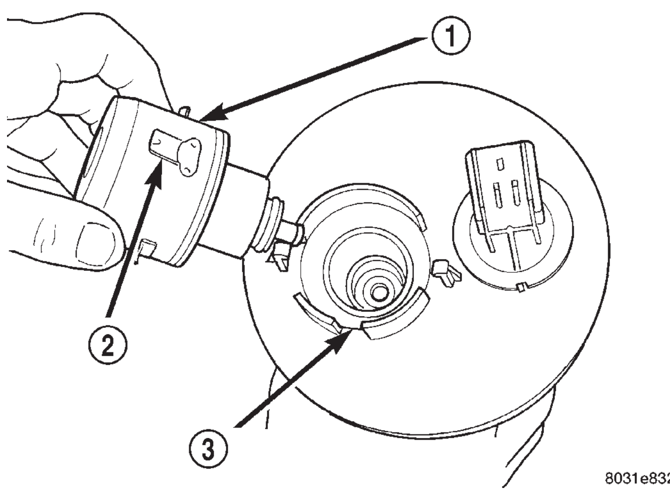


Fig. 18 Spring Tab In Locating Slot

1 – FUEL FILTER/PRESSURE REGULATOR
2 – SPRING TAB
3 – LOCATING SLOT

REMOVAL AND INSTALLATION (Continued)

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. 19).

(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.

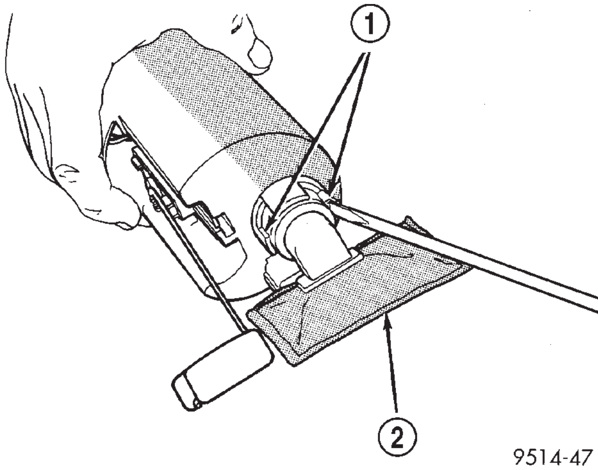


Fig. 19 Inlet Strainer Removal

1 – TABS
2 – INLET STRAINER

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 retaining tab and remove the fuel pump/level sensor connector from the bottom of the fuel pump module electrical connector (Fig. 20).

(2) Pull off blue locking wedge (Fig. 21).

(3) Using a small screwdriver lift locking finger away from terminal and push terminal out of connector (Fig. 22).

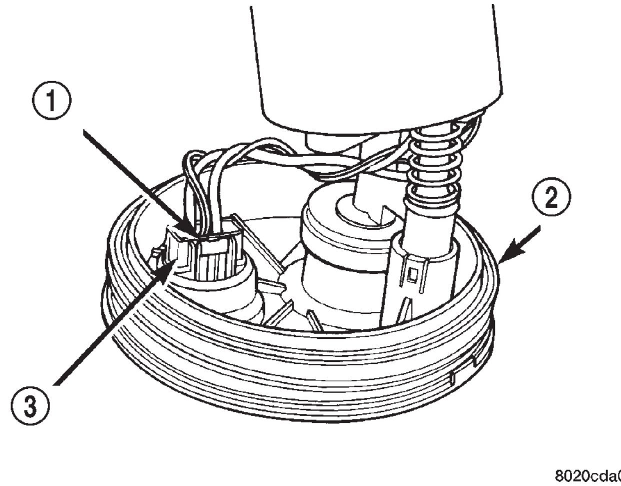


Fig. 20 Fuel Pump/Level Sensor Electrical Connector

1 – RETAINING TAB
2 – TANK SEAL
3 – ELECTRICAL CONNECTOR

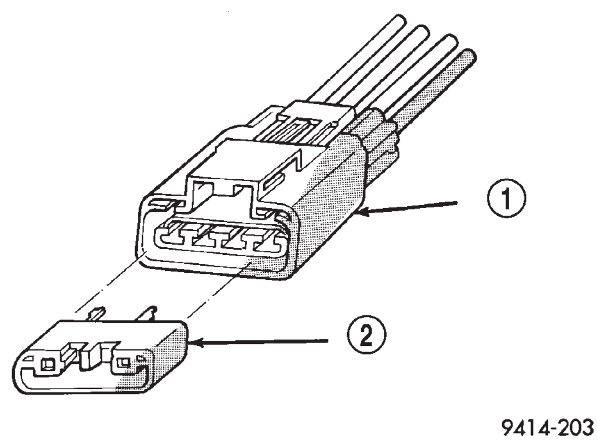


Fig. 21 Wire Terminal Locking Wedge

1 – ELECTRICAL CONNECTOR
2 – BLUE LOCKING WEDGE

(4) Push level sensor signal and ground terminals out of the connector (Fig. 23).

(5) Insert a screwdriver between the fuel pump module and the top of the level sensor housing (Fig. 24). Push level sensor down slightly.

(6) Slide level sensor wires through opening fuel pump module (Fig. 25).

(7) Slide level sensor out of installation channel in module.

INSTALLATION

(1) Insert level sensor wires into bottom of opening in module.

(2) Wrap wires into groove in back of level sensor (Fig. 24).

REMOVAL AND INSTALLATION (Continued)

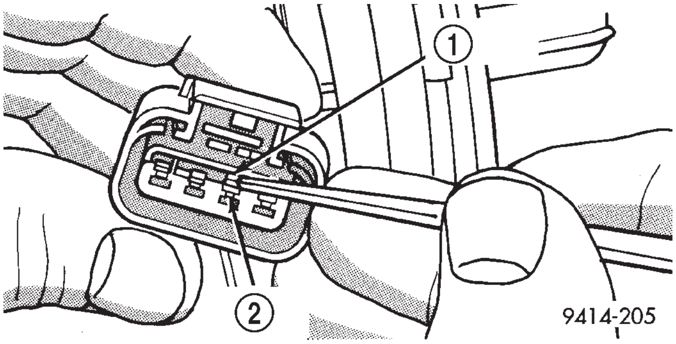


Fig. 22 Wire Terminal Locking Finger

1 – LOCKING FINGER
2 – WIRE TERMINAL

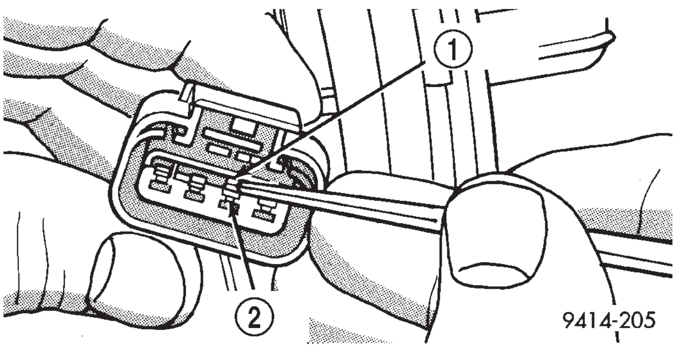


Fig. 23 Removing Wires From Connector

1 – LOCKING FINGER
2 – WIRE TERMINAL

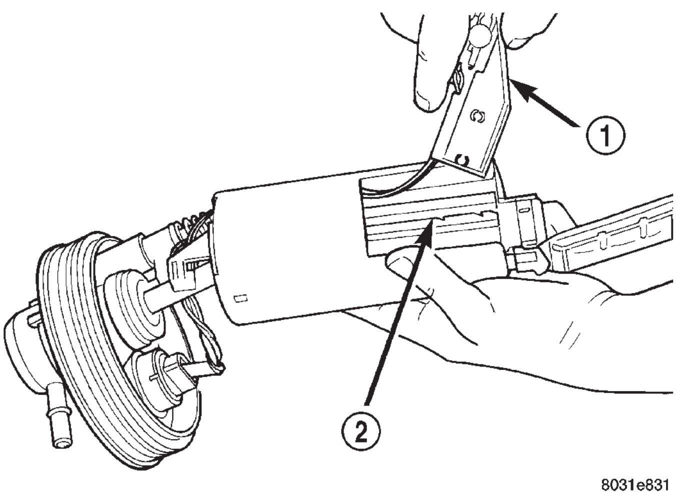


Fig. 24 Loosening Level Sensor

1 – FUEL LEVEL SENSOR
2 – CHANNEL FOR LEVEL SENSOR

(3) While feeding wires into guide grooves, slide level sensor up into channel until it snaps into place (Fig. 25). Ensure tab at bottom of sensor locks in place.

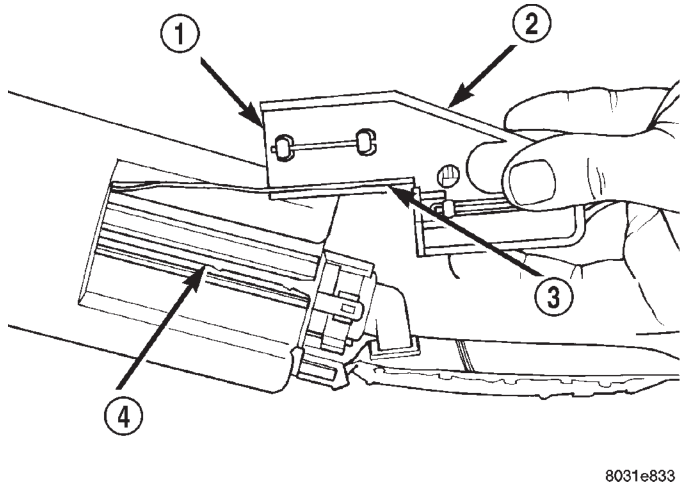


Fig. 25 Level Sensor Removal/Installation

1 – REAR VIEW OF LEVEL SENSOR
2 – LEVEL SENSOR
3 – WRAP WIRES IN GROOVE
4 – CHANNEL FOR LEVEL SENSOR

(4) Install level sensor wires in connector. Push the wires up through the connector and then pull them down until they lock in place. Ensure signal and ground wires are installed in the correct position.

(5) Install locking wedge on connector.

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

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

FUEL INJECTORS

REMOVAL

(1) Disconnect negative cable from battery.

(2) Release fuel system pressure. Refer to Fuel System Pressure Release procedure in this section.

(3) Disconnect fuel supply tube from rail. Refer to Quick-Connect Fittings in the Fuel Delivery section of this group.

(4) Disconnect electrical connectors from fuel injectors (Fig. 26), refer to the fuel injector connector section for electrical connector removal.

(5) Remove fuel rail mounting screws.

(6) Lift rail off of intake manifold. Cover the fuel injector openings in the intake manifold.

(7) Remove fuel injector retainer (Fig. 27).

(8) Pull injector out of fuel rail. Replace fuel injector O-rings (Fig. 28).

INSTALLATION

(1) Apply a light coating of clean engine oil to the upper O-ring.

(2) Install injector in cup on fuel rail.

REMOVAL AND INSTALLATION (Continued)

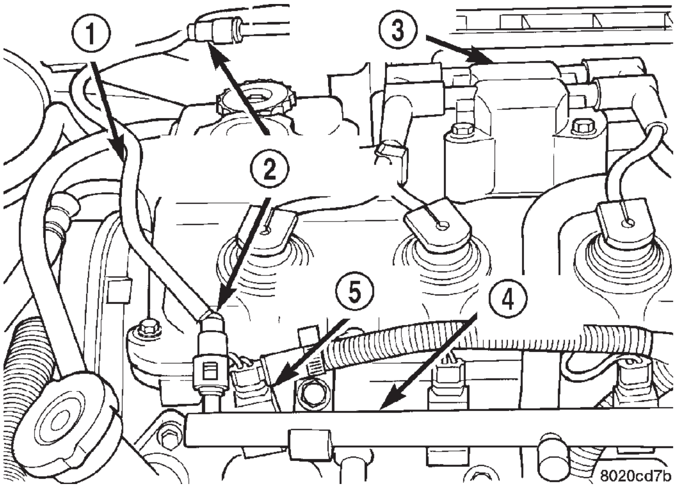


Fig. 26 Fuel Rail and Injectors

1 – FUEL SUPPLY LINE
2 – FUEL LINE QUICK-CONNECTS
3 – IGNITION COIL
4 – FUEL RAIL
5 – FUEL INJECTOR

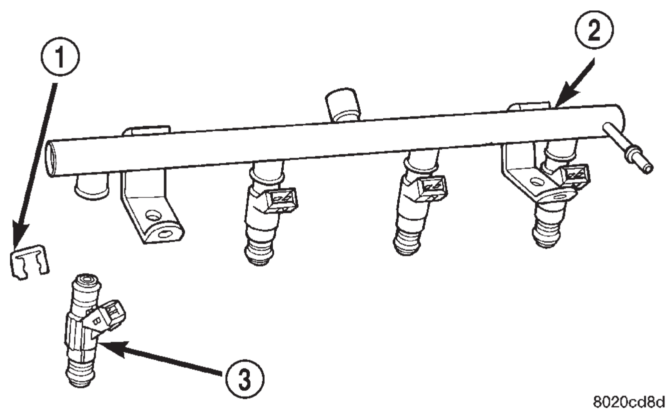


Fig. 27 Fuel Injector Retainer

1 – RETAINER
2 – FUEL RAIL
3 – FUEL INJECTOR

(3) Install retaining clip.

(4) Apply a light coating of clean engine oil to the O-ring on the nozzle end of each injector.

(5) Insert fuel injector nozzles into openings in intake manifold. Seat the injectors in place. Tighten fuel rail mounting screws to 22.5 N·m ± 3 N·m (200±30 in. lbs.).

(6) Attach electrical connectors to fuel injectors, refer to the fuel injector connector section for electrical connector installation.

(7) Connect fuel supply tube to fuel rail. Refer to Quick Connect Fittings in the Fuel Delivery Section of this Group.

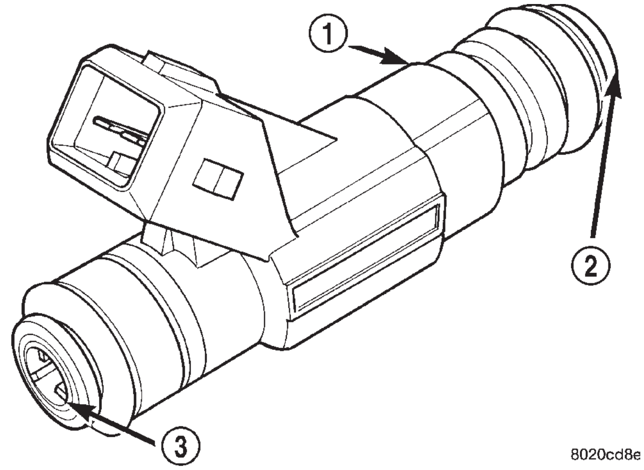


Fig. 28 Fuel Injector O-Rings

1 – FUEL INJECTOR
2 – NOZZLE
3 – TOP (FUEL ENTRY)

FUEL TANK

REMOVAL

(1) Disconnect the negative battery cable (Fig. 29).

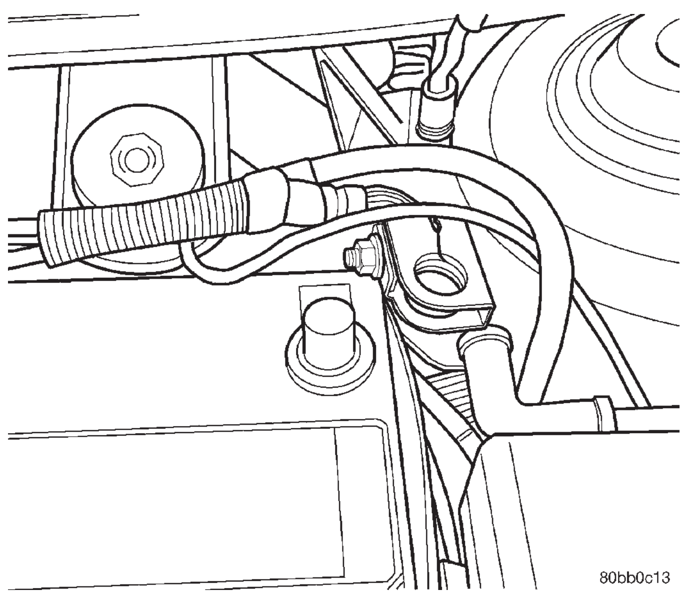


Fig. 29 Battery Cable

(2) Perform fuel system pressure release, refer to the fuel system pressure release procedure in this section.

(3) Raise and support vehicle on hoist.

(4) Disconnect vapor line from EVAP canister tube.

(5) Remove EVAP canister (Fig. 30).

(6) Drain fuel tank. Remove the drain port cap and remove fuel. Drain fuel tank into holding tank or a properly labeled **Gasoline** safety container. Reinstall drain port cap when done draining fuel (Fig. 31).

REMOVAL AND INSTALLATION (Continued)

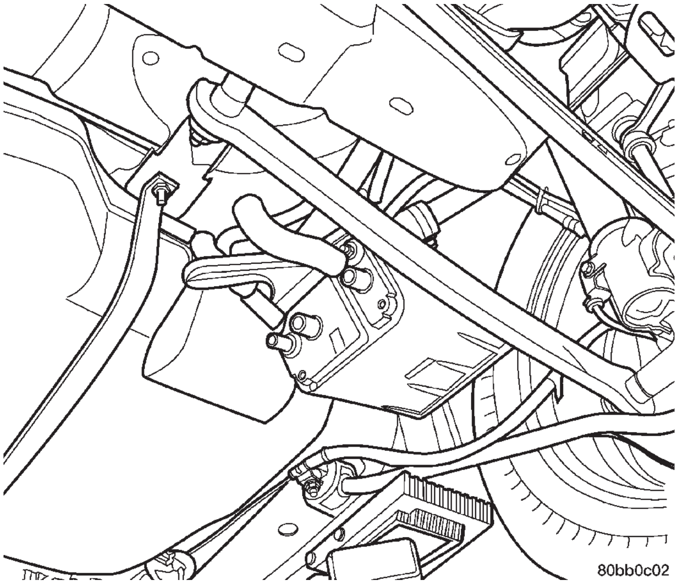


Fig. 30 EVAP Canister

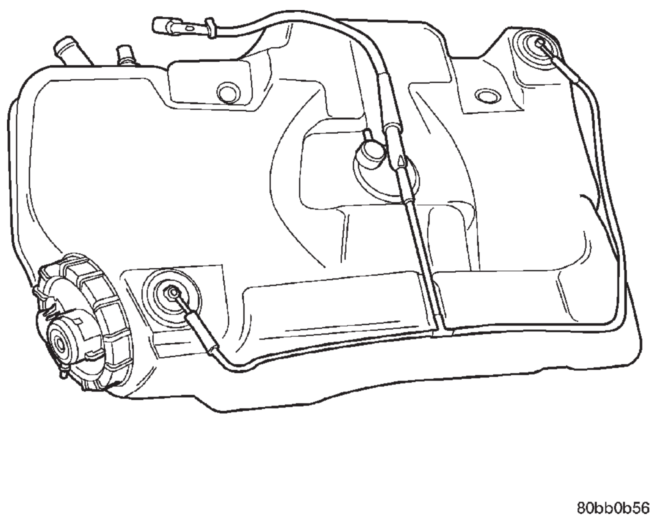


Fig. 31 Fuel Tank

(7) Disconnect fuel pump module electrical connector and ground wire (Fig. 32).

(8) Disconnect the fuel tube from Fuel Filter/Regulator. Refer to Quick Connect Fittings in the Fuel Delivery section of this group.

(9) Disconnect fuel filler tube and filler vent tube from filler hose at fuel tank.

(10) Support tank with transmission jack. Loosen tank mounting straps and lower tank slightly.

(11) Remove tank mounting straps and lower tank.

INSTALLATION

(1) Position fuel tank on transmission jack.

(2) Raise tank into position.

(3) Tighten fuel tank strap nuts to 22.5 N·m (200 in. lbs.) torque. Remove transmission jack. Ensure straps are not twisted or bent.

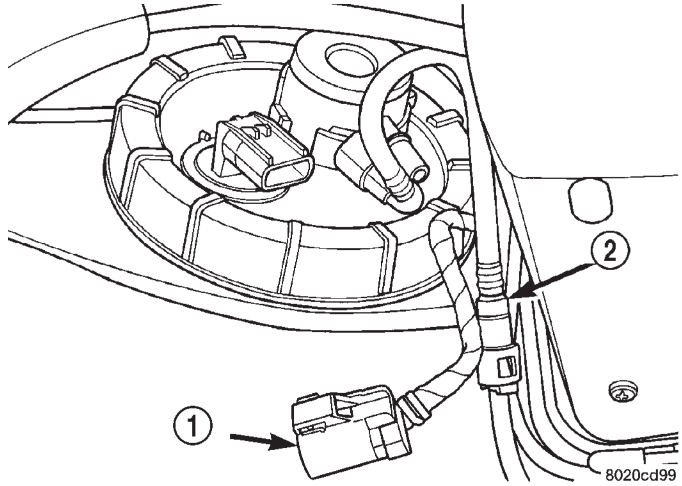


Fig. 32 Pump Module Electrical Connector

1 – ELECTRICAL CONNECTOR
2 – FUEL LINE

(4) Connect fuel filler tube tank inlet nipple. Tighten clamp.

(5) Connect EVAP vent hose.

(6) Attach fuel tubes to pump module and chassis fuel tube. Refer to Quick Connect Fittings in the Fuel Delivery section of this Group.

(7) Attach electrical connector and ground wire to fuel pump module.

(8) Install vapor lines to EVAP canister.

(9) Install EVAP canister.

(10) Lower vehicle.

(11) Fill fuel tank, install filler cap, and connect battery cable.

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.

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

FUEL FILLER NECK

REMOVAL

(1) Loosen fuel filler tube cap.

(2) Remove fuel filler neck screws (Fig. 33).

(3) Raise and support vehicle.

(4) Remove splash shield from wheel well.

(5) Disconnect fuel fill vapor tube.

(6) Disconnect fuel filler tube from fuel tank.

(7) Remove groundstrap from body.

(8) Remove filler neck (Fig. 34).

REMOVAL AND INSTALLATION (Continued)

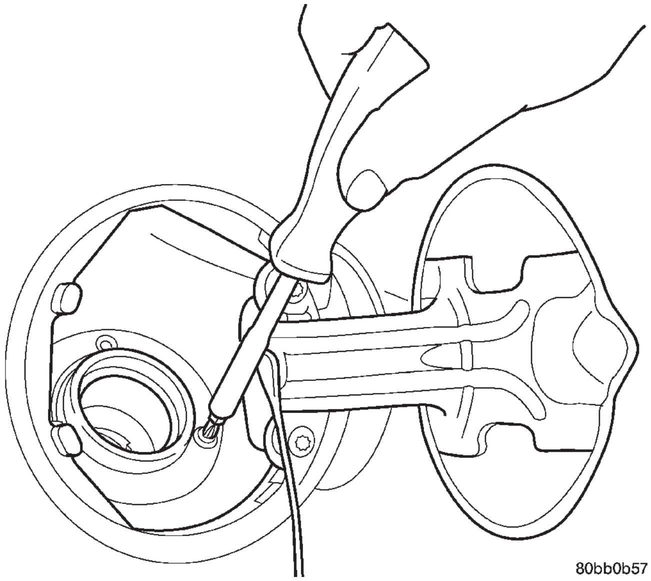


Fig. 33 Fuel Filler Neck

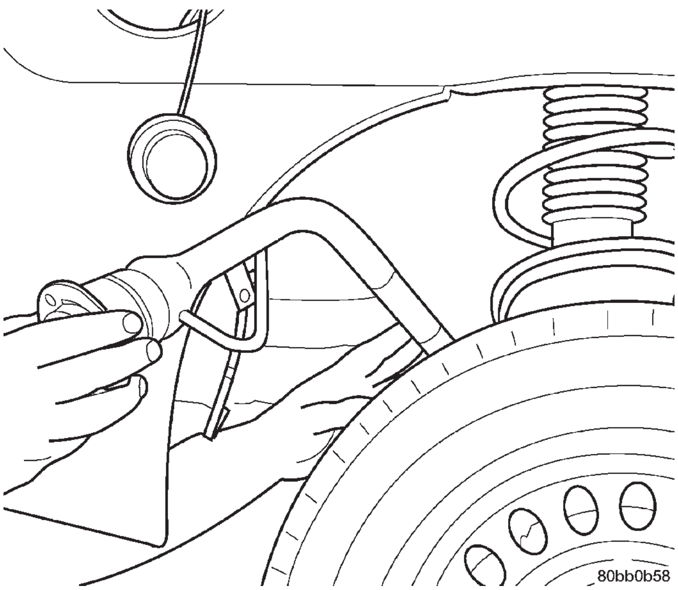


Fig. 34 Remove Filler Neck

INSTALLATION

(1) Install filler tube.

(2) Install fuel filler neck screws and plastic filler cup.

(3) Connect fuel fill vapor tube.

(4) Connect fuel filler tube to fuel tank. Tighten clamp.

(5) Connect ground strap to body.

(6) Lower vehicle.

(7) Install fuel filler tube cap.

ACCELERATOR PEDAL

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

(1) Remove throttle cable cover.

(2) Hold the throttle body throttle lever in the wide open position. Remove the throttle cable from the throttle body cam (Fig. 35).

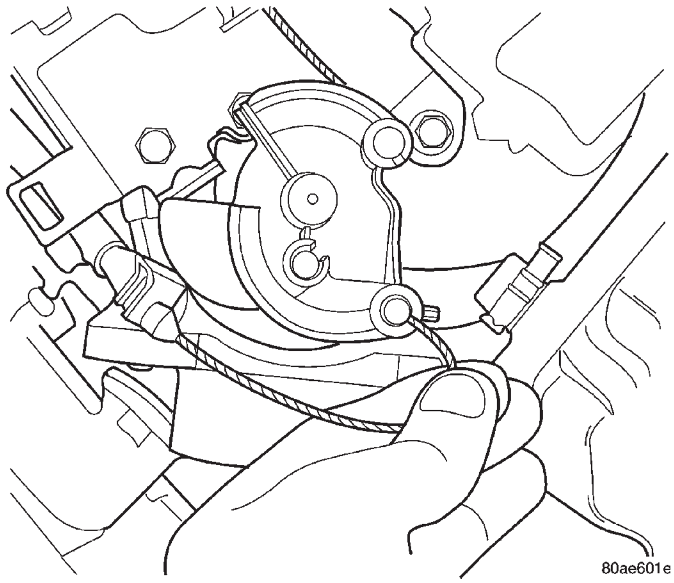


Fig. 35 Throttle Cable

(3) 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. 36).

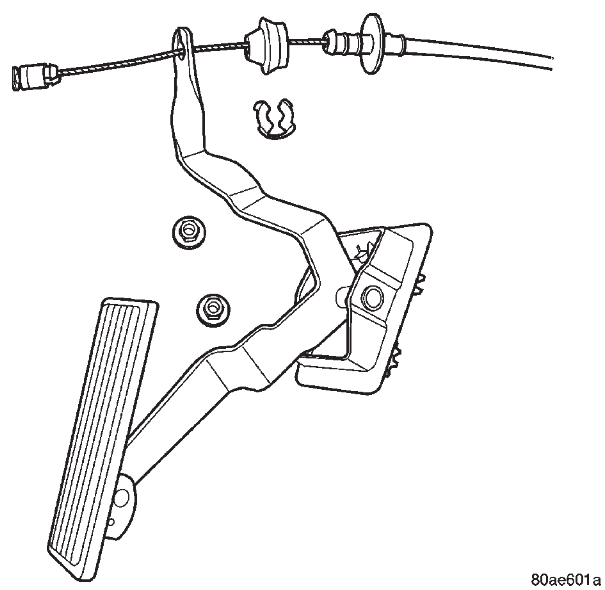


Fig. 36 Accelerator Pedal and Throttle Cable

(4) Pull back the carpet.

REMOVAL AND INSTALLATION (Continued)

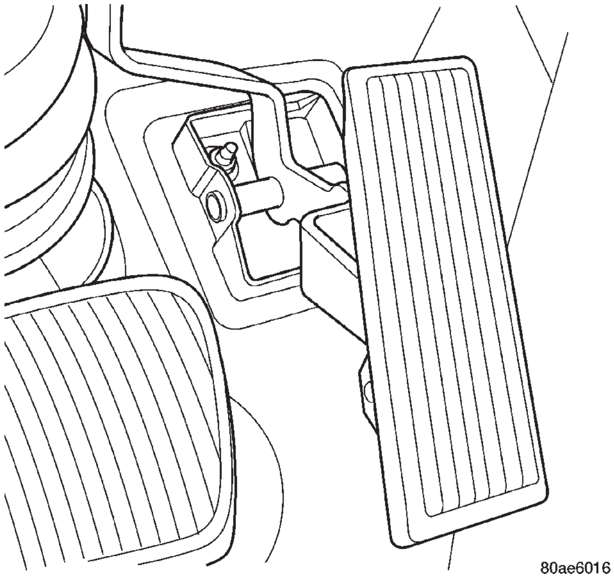


Fig. 37 Accelerator Pedal

(5) Working from inside the vehicle, remove nuts from accelerator pedal attaching studs (Fig. 37). Remove assembly from vehicle.

INSTALLATION

(1) Position accelerator pedal assembly on dash panel. Install retaining nuts. Tighten retaining nuts 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.

(4) Install the throttle cable cover.

THROTTLE CABLE

REMOVAL

(1) Remove throttle cable cover.

(2) Working from the engine compartment, remove throttle cable from throttle body cam (Fig. 38) and (Fig. 39).

(3) Lift the retaining tabs on the cable and slide cable out of bracket.

(4) From inside the vehicle, hold the throttle pedal up and remove the cable retainer and cable from upper end of pedal shaft (Fig. 36).

(5) Remove retainer clip from throttle cable and grommet at the dashpanel (Fig. 40).

(6) From the engine compartment, pull the throttle cable and grommet out of the dash panel.

INSTALLATION

(1) Install grommet into dashpanel.

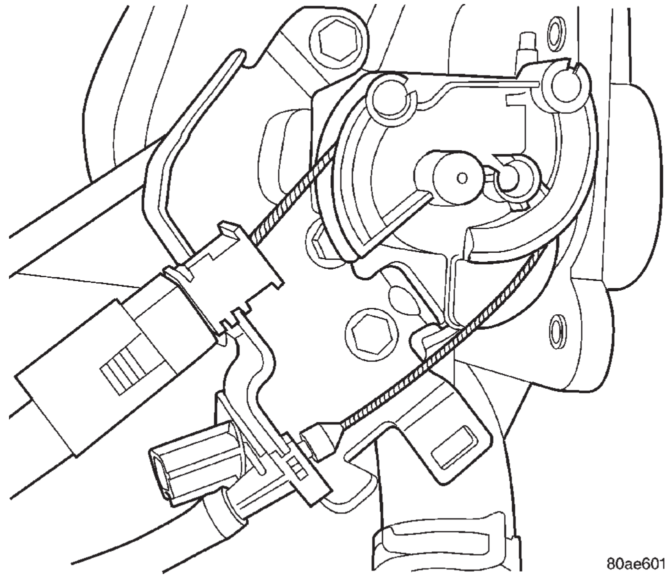


Fig. 38 Throttle Body Cables Attachment to Throttle Body

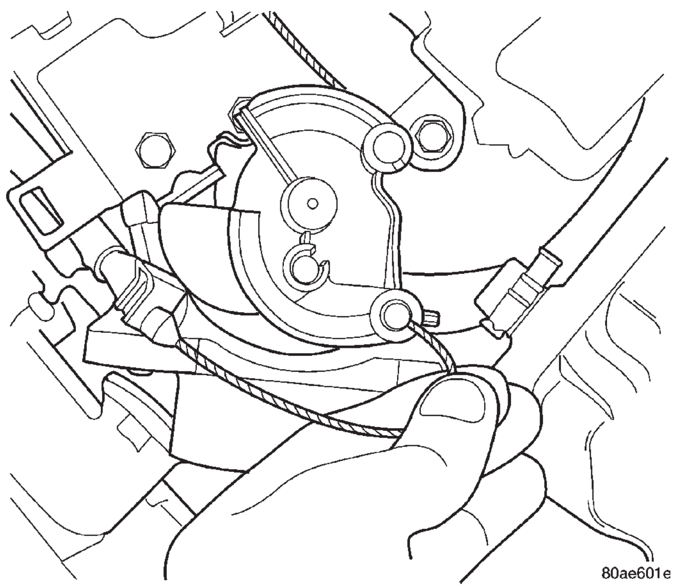


Fig. 39 Disconnecting Throttle Cable

(2) From the engine compartment, push the housing end fitting into the dashpanel grommet.

(3) From the engine compartment, rotate the throttle lever forward to the wide open position and install cable clasp (Fig. 39).

(4) Install cable housing (throttle body end) into the cable mounting bracket on the engine.

(5) Install throttle cable cover.

(6) From inside the vehicle, hold up pedal and feed throttle cable core wire through hole in upper end of the pedal shaft. Install cable retainer (Fig. 40).

(7) Install cable retainer clip (Fig. 40).

CLEANING AND INSPECTION (Continued)

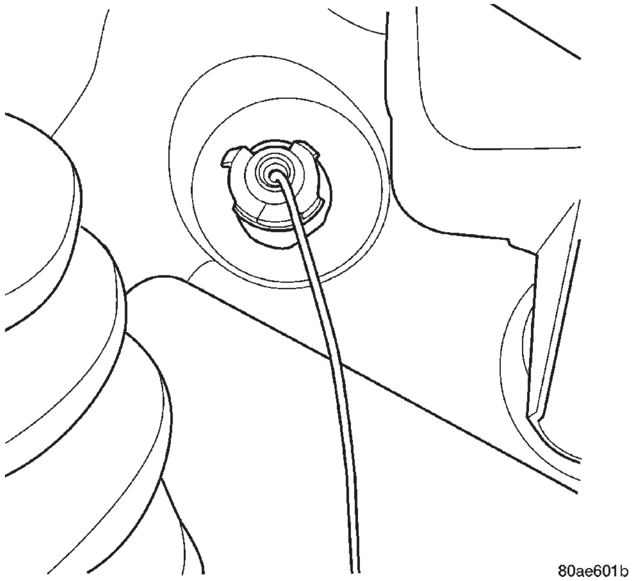


Fig. 40 Retainer Clip

CLEANING AND INSPECTION

FUEL TUBES/LINES/HOSES AND CLAMPS

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

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

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

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	22.5 N·m (200 in. lbs.)
Fuel Rail Bolts	23 N·m (195 in. lbs.)
Ignition Coil Mounting Bolts	11 N·m (95 in. lbs.)

FUEL REQUIREMENTS

Your engine is designed to meet all emissions regulations and provide excellent fuel economy and performance when using high quality unleaded gasoline having an octane rating of 87. The use of premium gasoline is not recommended. The use of premium gasoline will provide no benefit over high quality regular gasoline, and in some circumstances may result in poorer performance.

Light spark knock at low engine speeds is not harmful to your engine. However, continued heavy spark knock at high speeds can cause damage and immediate service is required. Engine damage resulting from operation with a heavy spark knock may not be covered by the new vehicle warranty.

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

Over 40 auto manufacturers world-wide have issued and endorsed consistent gasoline specifications (the Worldwide Fuel Charter, WWFC) to define fuel properties necessary to deliver enhanced emissions, performance and durability for your vehicle. We recommend the use of gasolines that meet the WWFC specifications if they are available.

REFORMULATED GASOLINE

Many areas of the country require the use of cleaner burning gasoline referred to as “reformulated” gasoline. Reformulated gasoline contain oxygenates, and are specifically blended to reduce vehicle emissions and improve air quality.

We strongly supports the use of reformulated gasoline. Properly blended reformulated gasoline will provide excellent performance and durability for the engine and fuel system components.

GASOLINE/OXYGENATE BLENDS

Some fuel suppliers blend unleaded gasoline with oxygenates such as 10% ethanol, MTBE, and ETBE. Oxygenates are required in some areas of the country during the winter months to reduce carbon monoxide emissions. Fuels blended with these oxygenates may be used in your vehicle.

CAUTION: DO NOT use gasoline containing METHANOL. Gasoline containing methanol may damage critical fuel system components.

MMT IN GASOLINE

MMT is a manganese-containing metallic additive that is blended into some gasoline to increase octane. Gasoline blended with MMT provide no performance advantage beyond gasoline of the same octane number without MMT. Gasoline blended with MMT reduce spark plug life and reduce emission system performance in some vehicles. We recommend that gasolines free of MMT be used in your vehicle. The MMT content of gasoline may not be indicated on the gasoline pump; therefore, you should ask your gasoline retailer whether or not his/her gasoline contains MMT.

SPECIFICATIONS (Continued)

It is even more important to look for gasoline without MMT in Canada because MMT can be used at levels higher than allowed in the United States. MMT is prohibited in Federal and California reformulated gasoline.

SULFUR IN GASOLINE

If you live in the northeast United States, your vehicle may have been designed to meet California low emission standards with Cleaner-Burning California reformulated gasoline with low sulfur. If such fuels are not available in states adopting California emission standards, your vehicles will operate satisfactorily on fuels meeting federal specifications, but emission control system performance may be adversely affected. Gasoline sold outside of California is permitted to have higher sulfur levels which may affect the performance of the vehicle's catalytic converter. This may cause the Malfunction Indicator Lamp (MIL), Check Engine or Service Engine Soon light to illuminate. We recommend that you try a different brand of unleaded gasoline having lower sulfur to determine if the problem is fuel related prior to returning your vehicle to an authorized dealer for service.

CAUTION: If the Malfunction Indicator Lamp (MIL), Check Engine or Service Engine Soon light is flashing, immediate service is required; see on-board diagnostics system section.

MATERIALS ADDED TO FUEL

All gasoline sold in the United States and Canada are required to contain effective detergent additives. Use of additional detergents or other additives is not needed under normal conditions.

FUEL SYSTEM CAUTIONS

CAUTION: Follow these guidelines to maintain your vehicle's performance:

- The use of leaded gas is prohibited by Federal law. Using leaded gasoline can impair engine performance, damage the emission control system, and could result in loss of warranty coverage.
- An out-of-tune engine, or certain fuel or ignition malfunctions, can cause the catalytic converter to overheat. If you notice a pungent burning odor or some light smoke, your engine may be out of tune or malfunctioning and may require immediate service. Contact your dealer for service assistance.
- When pulling a heavy load or driving a fully loaded vehicle when the humidity is low and the temperature is high, use a premium unleaded fuel to help prevent spark knock. If spark knock persists, lighten the load, or engine piston damage may result.
- The use of fuel additives which are now being sold as octane enhancers is not recommended. Most of these products contain high concentrations of methanol. Fuel system damage or vehicle performance problems resulting from the use of such fuels or additives is not the responsibility of DaimlerChrysler Corporation and may not be covered under the new vehicle warranty.

NOTE: Intentional tampering with emissions control systems can result in civil penalties being assessed against you.

FUEL INJECTION SYSTEM

TABLE OF CONTENTS

DESCRIPTION AND OPERATION

INJECTION SYSTEM

OPERATION

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.

DESCRIPTION AND OPERATION (Continued)

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.

PCM REPLACEMENT

DESCRIPTION

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.

MODES OF OPERATION

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 0.745 volts or less than 0.1 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.

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) relay and fuel pump relay. If the PCM does not receive both signals within approximately one second, it will not energize the

DESCRIPTION AND OPERATION (Continued)

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
- Inlet/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)
- Inlet/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:

- Inlet/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.

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 the Emission section 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

DESCRIPTION AND OPERATION (Continued)

- Battery temperature
- Engine coolant temperature
- Engine run time
- Inlet/Intake air temperature
- 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 sense
- Battery voltage
- Inlet/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:

- Inlet/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 the Emission section for 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.

SYSTEM DIAGNOSIS

OPERATION

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 see On-Board Diagnostics.

PROGRAMMABLE COMMUNICATIONS INTERFACE (PCI) BUS

DESCRIPTION

The Programmable Communication Interface Multiplex system (PCI Bus) consist of a single wire and is attached to the Data Link Connector (DLC). Modules are wired in parallel to the data bus through its PCI chip set and uses its ground as the bus referance. The wiring is a minimum 20 gage wire.

OPERATION

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 following components access or send information on the PCI Bus.

- Instrument Panel
- Air Bag System Diagnostic Module
- ABS Module
- Powertrain Control Module
- SKIM
- RKE-module

POWERTRAIN CONTROL MODULE

The Powertrain Control Module (PCM) is a digital computer containing a microprocessor (Fig. 1). The PCM receives input signals from various switches and sensors that are referred to as PCM Inputs. Based on these inputs, the PCM adjusts various

DESCRIPTION AND OPERATION (Continued)

engine and vehicle operations through devices that are referred to as PCM Outputs.

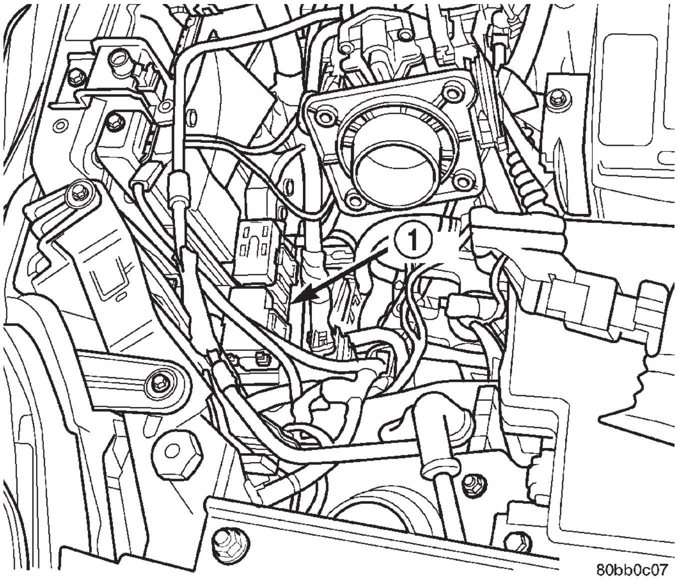


Fig. 1 Powertrain Control Module (PCM)

1 – PCM

PCM Inputs:
- Automatic Shutdown (ASD) Sense
- Air Conditioning Controls
- Battery Voltage
- Inlet Air/Battery Temperature Sensor
- Brake Switch
- Camshaft Position Sensor
- Crankshaft Position Sensor
- Clutch Interlock Switch
- Evaporative Emission Sense
- Engine Coolant Temperature Sensor
- Engine Oil Pressure Switch
- Fuel Level Sensor (PCI Bus)
- Ignition Switch
- Inlet Air/Intake Air Temperature Sensor
- Knock Sensor
- Leak Detection Switch
- Manifold Absolute Pressure (MAP) Sensor
- Oxygen Sensors
- Power Steering Pressure Switch
- Red Brake Warning Indicator
- SCI Receive
- Speed Control Switches
- Throttle Position Sensor
- Transmission Park/Neutral Switch (automatic transmission)
- Vehicle Speed Sensor

PCM Outputs:
- Air Conditioning WOT Relay
- Auto Shutdown (ASD) Relay
- Charging Indicator Lamp (PCI Bus)
- Data Link Connector
- Proportional Purge Solenoid
- Fuel Injectors
- Fuel Pump Relay
- Generator Field
- Idle Air Control Motor
- Ignition Coils
- Malfunction Indicator (Check Engine) Lamp (PCI Bus)
- Oxygen Heater Ground Control
- Radiator Fan Relay
- SCI Transmit
- Speed Control Solenoids
- Starter Relay
- Tachometer (PCI Bus)
- Torque Convertor Clutch Solenoid

Based on inputs it receives, the PCM adjusts fuel injector pulse width, idle speed, ignition spark advance, ignition coil dwell and EVAP canister purge operation. The PCM regulates the cooling fan, air conditioning and speed control systems. The PCM changes generator charge rate by adjusting the generator field. The PCM also performs diagnostics.

The PCM adjusts injector pulse width (air-fuel ratio) based on the following inputs.
- Battery voltage
- Coolant temperature
- Inlet Air/Intake air temperature
- Exhaust gas content (oxygen sensor)
- Engine speed (crankshaft position sensor)
- Manifold absolute pressure
- Throttle position

The PCM adjusts ignition timing based on the following inputs.
- Coolant temperature
- Inlet Air/Intake air temperature
- Engine speed (crankshaft position sensor)
- Knock sensor
- Manifold absolute pressure
- Throttle position
- Transmission gear selection (park/neutral switch)

The PCM also adjusts engine idle speed through the idle air control motor based on the following inputs.
- Air conditioning sense
- Battery voltage
- Battery temperature
- Brake switch
- Coolant temperature
- Engine speed (crankshaft position sensor)
- Engine run time
- Manifold absolute pressure
- Power steering pressure switch
- Throttle position
- Transmission gear selection (park/neutral switch)

DESCRIPTION AND OPERATION (Continued)

- Vehicle distance (speed)

The crankshaft position sensor signal is sent to the PCM. If the PCM does not receive the signal within approximately one second of engine cranking, it deactivates the ASD relay and fuel pump relay. When these relays deactivate, power is shut off from the fuel injectors, ignition coils, heating element in the oxygen sensors and the fuel pump.

The PCM contains a voltage converter that changes battery voltage to a regulated 8 volts direct current to power the camshaft position sensor, crankshaft position sensor and vehicle speed sensor. The PCM also provides a 5 volt direct current supply for the manifold absolute pressure sensor and throttle position sensor.

PCM GROUND

OPERATION

Ground is provided through multiple pins of the PCM connector. Depending on the vehicle there may be as many as three different ground pins. There are power grounds and sensor grounds.

The power grounds are used to control the ground side of any relay, solenoid, ignition coil or injector. The signal ground is used for any input that uses sensor return for ground, and the ground side of any internal processing component.

The SBEC III case is shielded to prevent RFI and EMI. The PCM case is grounded and must be firmly attached to a good, clean body ground.

Internally all grounds are connected together, however there is noise suppression on the sensor ground. For EMI and RFI protection the case is also grounded separately from the ground pins.

FUEL CORRECTION or ADAPTIVE MEMORIES

DESCRIPTION

In Open Loop, the PCM changes pulse width without feedback from the O2 Sensors. Once the engine warms up to approximately 30 to 35° F, the PCM goes into closed loop **Short Term Correction** and utilizes feedback from the O2 Sensors. Closed loop **Long Term Adaptive Memory** is maintained above 170° to 190° F unless the PCM senses wide open throttle. At that time the PCM returns to Open Loop operation.

OPERATION

Short Term

The first fuel correction program that begins functioning is the short term fuel correction. This system corrects fuel delivery in direct proportion to the readings from the Upstream O2 Sensor.

The PCM monitors the air/fuel ratio by using the input voltage from the O2 Sensor. When the voltage reaches its preset high or low limit, the PCM begins to add or remove fuel until the sensor reaches its switch point. The short term corrections then begin.

The PCM makes a series of quick changes in the injector pulse-width until the O2 Sensor reaches its opposite preset limit or switch point. The process then repeats itself in the opposite direction.

Short term fuel correction will keep increasing or decreasing injector pulse-width based upon the upstream O2 Sensor input. The maximum range of authority for short term memory is 25% (+/-) of base pulse-width.

Long Term

The second fuel correction program is the long term adaptive memory. In order to maintain correct emission throughout all operating ranges of the engine, a cell structure based on engine rpm and load (MAP) is used.

There number of cells varies upon the driving conditions. Two cells are used only during idle, based upon TPS and Park/Neutral switch inputs. There may be two other cells used for deceleration, based on TPS, engine rpm, and vehicle speed. The other twelve cells represent a manifold pressure and an rpm range. Six of the cells are high rpm and the other six are low rpm. Each of these cells is a specific MAP voltage range.

As the engine enters one of these cells the PCM looks at the amount of short term correction being used. Because the goal is to keep short term at 0 (O2 Sensor switching at 0.5 volt), long term will update in the same direction as short term correction was moving to bring the short term back to 0. Once short term is back at 0, this long term correction factor is stored in memory.

The values stored in long term adaptive memory are used for all operating conditions, including open loop. However, the updating of the long term memory occurs after the engine has exceeded approximately 17° F, with fuel control in closed loop and two minutes of engine run time. This is done to prevent any transitional temperature or start-up compensations from corrupting long term fuel correction.

Long term adaptive memory can change the pulse-width by as much as 25%, which means it can correct for all of short term. It is possible to have a problem that would drive long term to 25% and short term to another 25% for a total change of 50% away from base pulse-width calculation.

DESCRIPTION AND OPERATION (Continued)

TYPICAL ADAPTIVE MEMORY FUEL CELLS

	Open Throttle	Open Throttle	Open Throttle	Open Throttle	Open Throttle	Open Throttle	Idle	Decel
Vacuum	20	17	13	9	5	0		
Above 1,984 rpm	1	3	5	7	9	11	13 Drive	15
Below 1,984 rpm	0	2	4	6	8	10	12 Neutral	14
MAP volt =	0	1.4	2.0	2.6	3.3	3.9		

Fuel Correction Diagnostics

There are two fuel correction diagnostic routines:

- Fuel System Rich
- Fuel System Lean

A DTC is set and the MIL is illuminated if the PCM detects either of these conditions.

AUTOMATIC SHUTDOWN (ASD) SENSE—PCM INPUT

DESCRIPTION

It is an input to the Powertrain Control Module from the rely in the Power Distribution Center, refer to the cover for relay location.

OPERATION

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).

When energized, the ASD relay provides power to operate the injectors, ignition coil, generator field, O2 sensor heaters (both upstream and downstream), and also provides a sense circuit to the PCM for diagnostic purposes. The PCM energizes the ASD any time there is a Crankshaft Position sensor signal that exceeds a predetermined value. The ASD relay can also be energized after the engine has been turned off to perform an O2 sensor heater test, if vehicle is equipped with OBD II diagnostics.

With SBEC III, the ASD relay's electromagnet is fed battery voltage, not ignition voltage. The PCM still provides the ground. As mentioned earlier, the PCM energizes the ASD relay during an O2 sensor heater test. This test is performed only after the engine has been shut off. The PCM still operates internally to perform several checks, including monitoring the O2 sensor heaters. This and other DTC tests are explained in detail in the On-Board Diagnostic Student Reference Book.

BATTERY VOLTAGE—PCM INPUT

DESCRIPTION

The direct battery feed to the PCM is used as a reference point to sense battery voltage.

OPERATION

In order for the PCM to operate, it must be supplied with battery voltage and ground. The PCM monitors the direct battery feed input to determine battery charging rate and to control the injector initial opening point. It also has back-up RAM memory used to store Diagnostic Trouble Codes (supply working DTCs). Direct battery feed is also used to perform key-OFF diagnostics and to supply working voltage to the controller for OBDII.

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

Effect on Fuel Injectors

Fuel injectors are rated for operation at a specific voltage. If the voltage increases, the plunger will open faster and further (more efficient) and conversely, if voltage is low the injector will be slow to open and will not open as far. Therefore, if sensed battery voltage drops, the PCM increases injector pulse-width to maintain the same volume of fuel through the injector.

Charging

The PCM uses sensed battery voltage to verify that target charging voltage (determined by Battery Temperature Sensor) is being reached. To maintain the target charging voltage, the PCM will full field the generator to 0.5 volt above target then turn OFF to 0.5 volt below target. This will continue to occur up to a 100 Hz frequency, 100 times per second.

DESCRIPTION AND OPERATION (Continued)

CLUTCH INTERLOCK/UPSTOP SWITCH

DESCRIPTION

The clutch interlock/upstop switch is an assembly consisting of two switches: an engine starter inhibit switch (interlock) and a clutch pedal upstop switch (Fig. 2). The switch assembly is located in the clutch/brake pedal bracket assembly (Fig. 3), each switch being fastened by four plastic wing tabs.

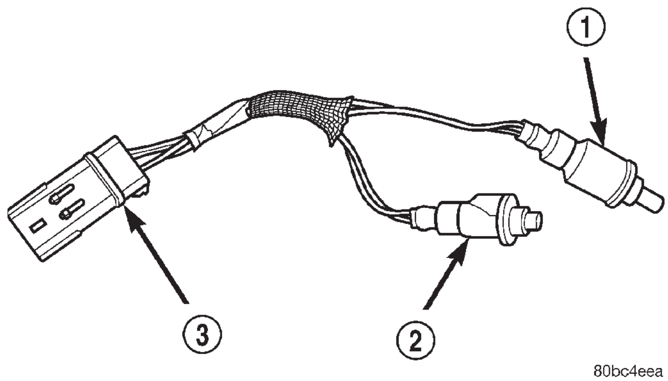


Fig. 2 Clutch Interlock/Upstop Switch

1 – UPSTOP SWITCH
2 – INTERLOCK SWITCH
3 – CONNECTOR

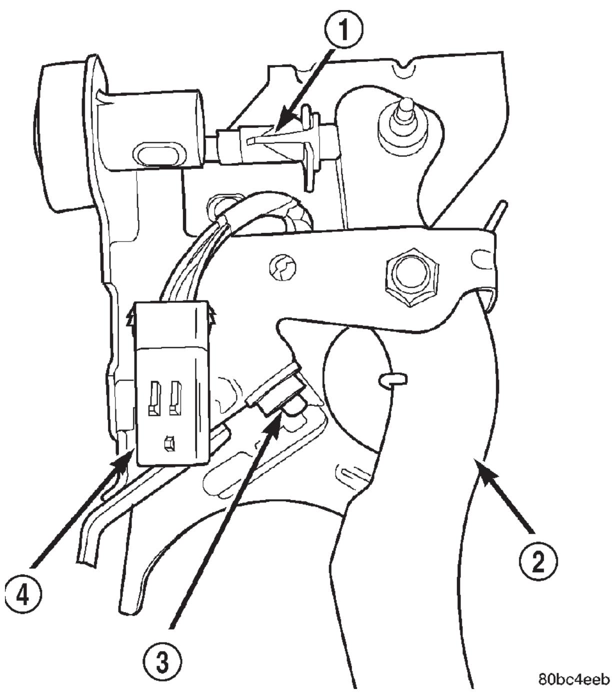


Fig. 3 Clutch/Brake Pedal Bracket Assembly

1 – UPSTOP SWITCH
2 – CLUTCH PEDAL
3 – INTERLOCK SWITCH
4 – CONNECTOR

OPERATION

Clutch Interlock Switch

The clutch interlock switch prevents engine starter operation and inadvertent vehicle movement with the clutch engaged and the transaxle in gear.

The switch is open while the clutch pedal is at rest. When the clutch pedal is fully depressed, the pedal blade contacts and closes the switch, sending a signal to the PCM, allowing engine starter operation. The interlock switch is not adjustable.

Clutch Pedal Upstop Switch

With the clutch pedal at rest, the clutch pedal upstop switch is closed, allowing speed control operation. When the clutch pedal is depressed, the upstop switch opens and signals the PCM to cancel speed control operation, and enter a modified engine calibration schedule to improve driveability during gear-to-gear shifts. The upstop switch is not adjustable.

ENGINE COOLANT TEMPERATURE SENSOR—PCM INPUT

DESCRIPTION

The coolant sensor threads into the rear of the cylinder head, next to the camshaft position sensor (Fig. 4). New sensors have sealant applied to the threads.

The ECT Sensor is a Negative Thermal Coefficient (NTC), dual range Sensor. The resistance of the ECT Sensor changes as coolant temperature changes. This results in different input voltages to the PCM. The PCM also uses the ECT Sensor input to operate the low and high speed radiator cooling fans.

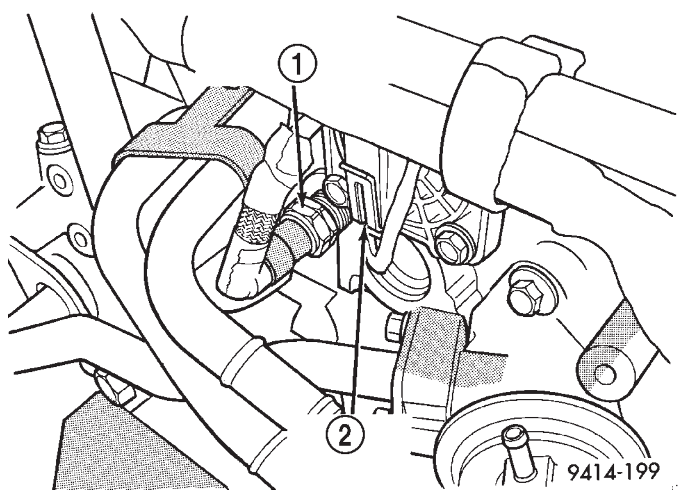


Fig. 4 Engine Coolant Temperature Sensor—SOHC

1 – ENGINE COOLANT TEMPERATURE SENSOR
2 – CAMSHAFT POSITION SENSOR

DESCRIPTION AND OPERATION (Continued)

OPERATION

The combination coolant temperature sensor has two elements. One element supplies coolant temperature signal to the PCM. The other element supplies coolant temperature signal to the instrument panel gauge cluster. The PCM determines engine coolant temperature from the coolant temperature sensor.

As coolant temperature varies the coolant temperature sensors resistance changes resulting in a different input voltage to the PCM and the instrument panel gauge cluster.

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

The PCM has a dual temperature range program for better sensor accuracy at cold temperatures. At key-ON the PCM sends a regulated five volt signal through a 10,000 ohm resistor to the sensor. When the sensed voltage reaches approximately 1.25 volts the PCM turns on the transistor. The transistor connects a 1,000 ohm resistor in parallel with the 10,000 ohm resistor. With this drop in resistance the PCM recognizes an increase in voltage on the input circuit.

HEATED OXYGEN SENSOR (O2 SENSOR)—PCM INPUT

DESCRIPTION

The upstream oxygen sensor threads into the outlet flange of the exhaust manifold (Fig. 5).

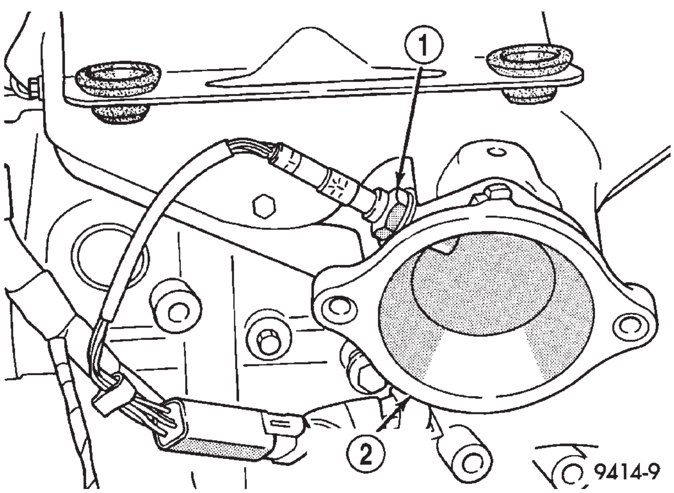


Fig. 5 Upstream Heated Oxygen Sensor 1/1

1 – OXYGEN SENSORS
2 – EXHAUST MANIFOLD

The downstream heated oxygen sensor threads into the system depending on emission package (Fig. 6). Federal package the O2s is mounted after the catalytic convertor, LEV package the O2s is mounted mid catalytic convertor, ULEV package is mounted between the catalytic convertor (Fig. 7).

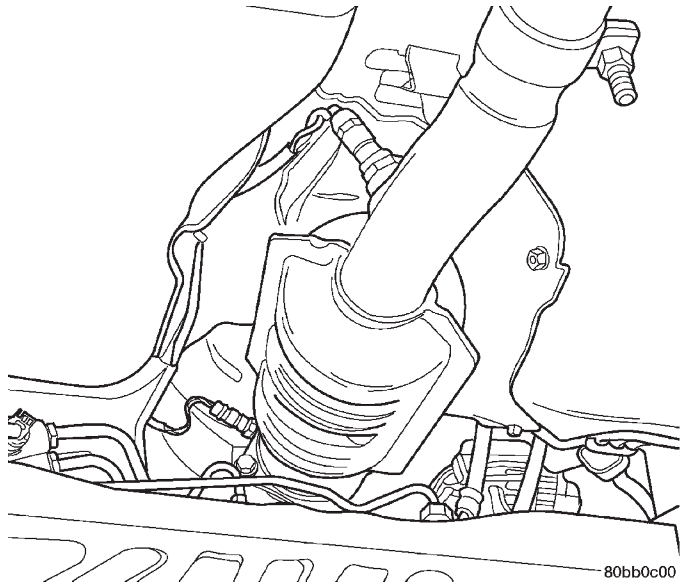


Fig. 6 Downstream Heated Oxygen Sensor 1/2

OPERATION

The O2 sensors produce voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas in the exhaust manifold (Fig. 8). When a large amount of oxygen is present (caused by a lean air/fuel mixture), the sensors produce a voltage below 450 mv. When there is a lesser amount present (rich air/fuel mixture) it produces a voltage above 450 mv. 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 O2 sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation the PCM ignores the O2 sensor input. The PCM adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

The 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.

DESCRIPTION AND OPERATION (Continued)

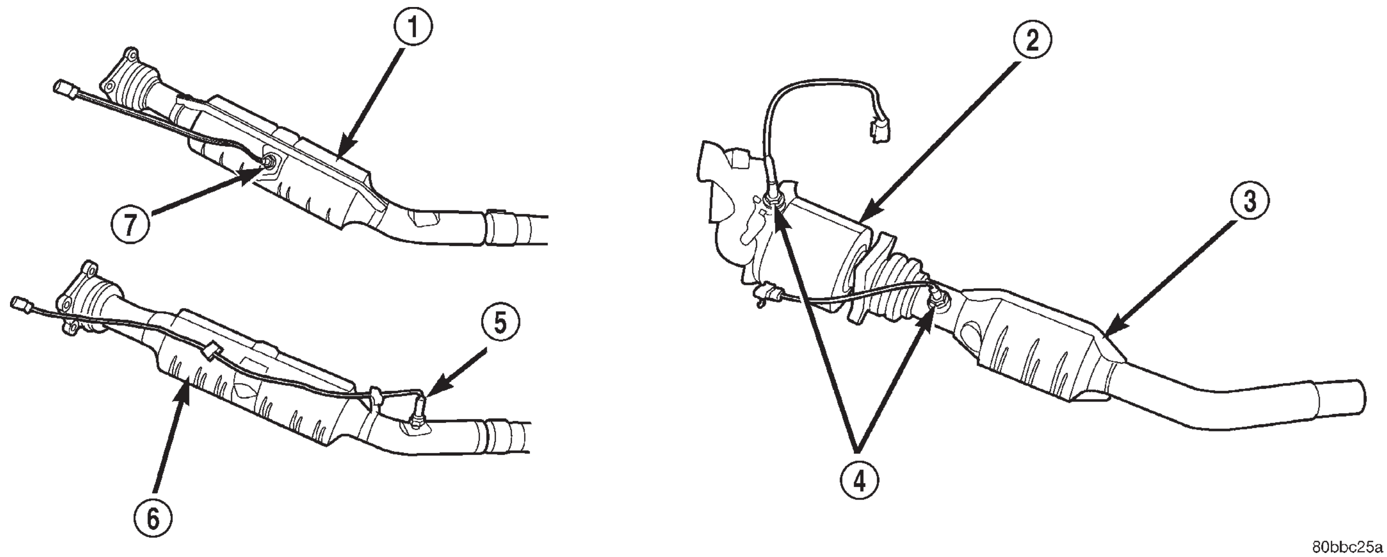


Fig. 7 Heated Oxygen Sensor Systems

1 – CATALYTIC CONVERTER (LEV EMISSION)
2 – CLOSE-COUPLED CATALYTIC CONVERTER (ULEV EMISSION)
3 – UNDER-FLOOR CATALYTIC CONVERTER (ULEV EMISSION)
4 – OXYGEN SENSORS
5 – OXYGEN SENSOR
6 – CATALYTIC CONVERTER (FEDERAL EMISSION)
7 – OXYGEN SENSOR

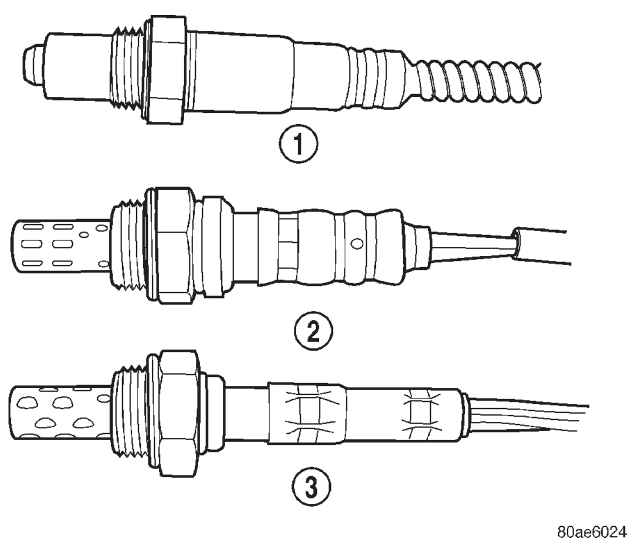


Fig. 8 Types Of O2 Sensors

1 – BOSCH
2 – NEW NTK
3 – NTK

UPSTREAM OXYGEN SENSOR 1/1

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.

DOWNSTREAM OXYGEN SENSOR 1/2

The Downstream O2 Sensor has two functions. One function is measuring catalyst efficiency. This is an OBD II requirement. The oxygen content of the exhaust gasses has significantly less fluctuation than at the inlet if the converter is working properly. The PCM compares upstream and Downstream O2 Sensor switch rates under specific operating conditions to determine if the catalyst is functioning properly.

The other function is a downstream fuel control which was introduced in 1996. The upstream O2 goal varies within the window of operation of the O2 Sen-

DESCRIPTION AND OPERATION (Continued)

sor. In the past the goal was a preprogrammed fixed value based upon where it believed the catalyst operated most efficiently.

While the Upstream O2 Sensor input is used to maintain the 14.7:1 air/fuel ratio, variations in engines, exhaust systems and catalytic converters may cause this ratio to not be the most ideal for a particular catalyst and engine. To help maintain the catalyst operating at maximum efficiency, the PCM will fine tune the air/fuel ratio entering the catalyst based upon the oxygen content leaving the catalyst. This is accomplished by modifying the Upstream O2 Sensor voltage goal.

If the exhaust leaving the catalyst has too much oxygen (lean) the PCM increases the upstream O2 goal which increases fuel in the mixture causing less oxygen to be left over. Conversely, if the oxygen content leaving the catalyst has is too little oxygen (rich) the PCM decreases the upstream O2 goal down which removes fuel from the mixture causing more oxygen to be left over. This function only occurs during downstream closed loop mode operation.

IGNITION CIRCUIT SENSE—PCM INPUT

DESCRIPTION

This circuit ties the ignition switch to the Powertrain Control Module (PCM).

OPERATION

The ignition circuit sense input tells the PCM the ignition switch has energized the ignition circuit.

Battery voltage is also supplied to the PCM through the ignition switch when the ignition is in the RUN or START position. This is referred to as the "ignition sense" circuit and is used to "wake up" the PCM. Voltage on the ignition input can be as low as 6 volts and the PCM will still function. Voltage is supplied to this circuit to power the PCM's 8-volt regulator and to allow the PCM to perform fuel, ignition and emissions control functions. The battery voltage on this line is supplied to the 8-volt regulator which then passes on a power-up supply to the 5-volt regulator.

INLET/INTAKE AIR TEMPERATURE SENSOR—PCM INPUT

DESCRIPTION

The IAT sensor attaches to the intake air duct (Fig. 9).

The IAT Sensor is a Negative Temperature Coefficient (NTC) Sensor that provides information to the PCM regarding the temperature of the air entering the intake manifold.

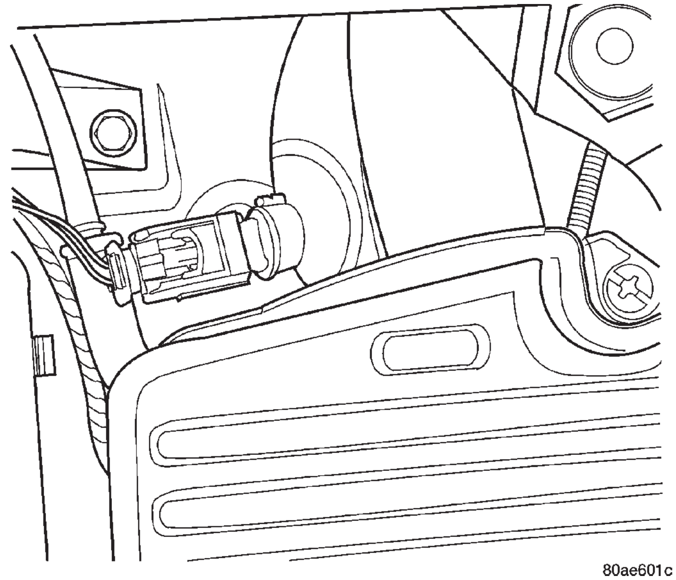


Fig. 9 Inlet Air Temperature Sensor

OPERATION

Inlet/Intake Air Temperature

The inlet air temperature sensor replaces the intake air temperature sensor and the battery temperature sensor. The PCM uses the information from the inlet air temperature sensor to determine values to use as an intake air temperature sensor and a battery temperature sensor.

The Intake Air Temperature (IAT) sensor value is used by the PCM to determine air density.

The PCM uses this information to calculate:

- Injector pulse width
- Adjustment of ignition timing (to prevent spark knock at high intake air temperatures)

Battery Temperature

The inlet air temperature sensor replaces the intake air temperature sensor and the battery temperature sensor. The PCM uses the information from the inlet air temperature sensor to determine values for the PCM to use as an intake air temperature sensor and a battery temperature sensor.

The battery temperature information along with data from monitored line voltage (B+), is used by the PCM to vary the battery charging rate. System voltage will be higher at colder temperatures and is gradually reduced at warmer temperatures.

The battery temperature information is also used for OBD II diagnostics. Certain faults and OBD II monitors are either enabled or disabled depending upon the battery temperature sensor input (example: disable purge, enable LDP). Most OBD II monitors are disabled below 20°F.

DESCRIPTION AND OPERATION (Continued)

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—PCM INPUT

DESCRIPTION

The MAP sensor mounts to the intake manifold (Fig. 10).

The MAP sensor signal is provided from a single piezoresistive element located in the center of a diaphragm. The element and diaphragm are both made of silicone. As the pressures changes the diaphragm moves causing the element to deflect which stresses the silicone. When silicone is exposed to stress its resistance changes. As manifold vacuum increases, the MAP sensor input voltage decreases proportionally. The sensor also contains electronics that condition the signal and provide temperature compensation.

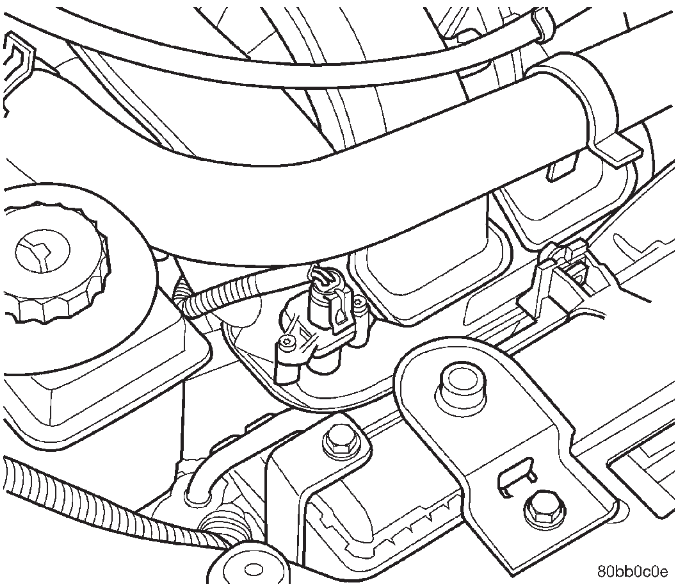


Fig. 10 Manifold Absolute Pressure Sensor

OPERATION

The MAP serves as a PCM input, using a silicon based sensing unit, to provide data on the manifold vacuum that draws the air/fuel mixture into the combustion chamber. The PCM requires this information to determine injector pulse width and spark advance. When MAP equals Barometric pressure, the pulse width will be at maximum.

Also like the cam and crank sensors, a 5 volt reference is supplied from the PCM and returns a voltage signal to the PCM that reflects manifold pressure. The zero pressure reading is 0.5V and full scale is 4.5V. For a pressure swing of 0 — 15 psi the voltage changes 4.0V. The sensor is supplied a regulated 4.8 to 5.1 volts to operate the sensor. Like the cam and crank sensors ground is provided through the sensor return circuit.

The MAP sensor input is the number one contributor to pulse width. The most important function of the MAP sensor is to determine barometric pressure. The PCM needs to know if the vehicle is at sea level or is it in Denver at 5000 feet above sea level, because the air density changes with altitude. It will also help to correct for varying weather conditions. If a hurricane was coming through the pressure would be very, very low or there could be a real fair weather, high pressure area. This is important because as air pressure changes the barometric pressure changes. Barometric pressure and altitude have a direct inverse correlation, as altitude goes up barometric goes down. The first thing that happens as the key is rolled on, before reaching the crank position, the PCM powers up, comes around and looks at the MAP voltage, and based upon the voltage it sees, it knows the current barometric pressure relative to altitude. Once the engine starts, the PCM looks at the voltage again, continuously every 12 milliseconds, and compares the current voltage to what it was at key on. The difference between current and what it was at key on is manifold vacuum.

During key On (engine not running) the sensor reads (updates) barometric pressure. A normal range can be obtained by monitoring known good sensor in you work area.

As the altitude increases the air becomes thinner (less oxygen). If a vehicle is started and driven to a very different altitude than where it was at key On the barometric pressure needs to be updated. Any time the PCM sees Wide Open throttle, based upon TPS angle and RPM it will update barometric pressure in the MAP memory cell. With periodic updates, the PCM can make its calculations more effectively.

The PCM uses the MAP sensor to aid in calculating the following:

- Barometric pressure
- Engine load
- Manifold pressure
- Injector pulse-width
- Spark-advance programs
- Shift-point strategies (F4AC1 transmissions only, via the PCI bus)
- Idle speed
- Decel fuel shutoff

The PCM recognizes a decrease in manifold pressure by monitoring a decrease in voltage from the reading stored in the barometric pressure memory cell. The MAP sensor is a linear sensor; as pressure changes, voltage changes proportionately. The range of voltage output from the sensor is usually between 4.6 volts at sea level to as low as 0.3 volts at 26 in. of Hg. Barometric pressure is the pressure exerted by the atmosphere upon an object. At sea level on a standard day, no storm, barometric pressure is 29.92

DESCRIPTION AND OPERATION (Continued)

in Hg. For every 100 feet of altitude barometric pressure drops.10 in. Hg. If a storm goes through it can either add, high pressure, or decrease, low pressure, from what should be present for that altitude. You should make a habit of knowing what the average pressure and corresponding barometric pressure is for your area.

POWER STEERING PRESSURE SWITCH—PCM INPUT

DESCRIPTION

A pressure sensing switch is located on the power steering gear.

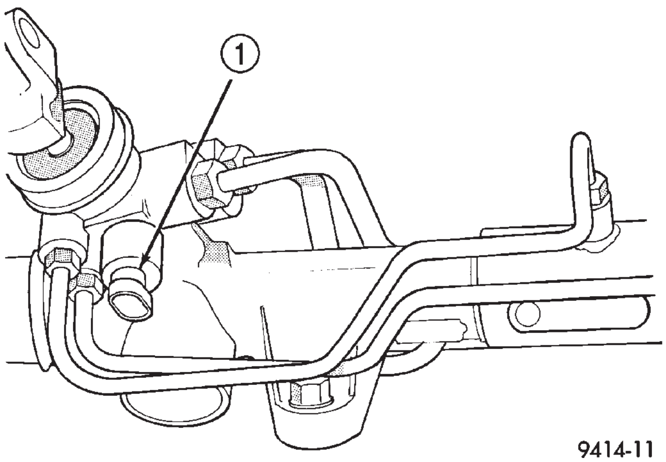


Fig. 11 Power Steering Pressure Switch

1 – POWER STEERING PRESSURE SWITCH

OPERATION

The switch (Fig. 11) provides an input to the PCM during periods of high pump load and low engine RPM; such as during parking maneuvers.

When power steering pump pressure exceeds 2758 kPa (400 psi), the switch is open. The PCM increases idle air flow through the IAC motor to prevent engine stalling. The PCM sends 12 volts through a resister to the sensor circuit to ground. When pump pressure is low, the switch is closed.

SENSOR RETURN—PCM INPUT

OPERATION

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 (PCM).

SCI RECEIVE—PCM INPUT

OPERATION

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 POSITION SWITCH—PCM INPUT

DESCRIPTION

The park/neutral position switch is located on the automatic transaxle housing (Fig. 12).

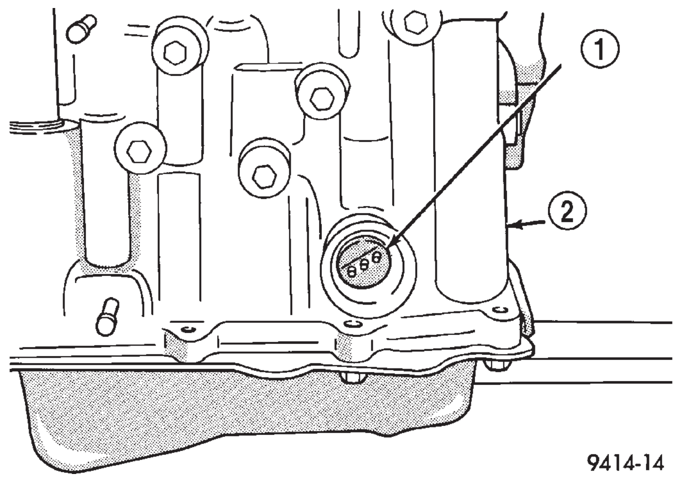


Fig. 12 Park/Neutral Switch

1 – PARK/NEUTRAL SWITCH
2 – TRANSAXLE HOUSING

OPERATION

Manual transaxles do not use park/neutral switches. The switch provides an input to the PCM to indicate whether the automatic transaxle is in Park/Neutral, or a drive gear selection. This input is used to determine idle speed (varying with gear selection) and ignition timing advance. The park/neutral input is also used to cancel vehicle speed control. The park/neutral switch is sometimes referred to as the neutral safety switch.

The PCM delivers 8.5 volts to the center terminal of the Park/Neutral switch. When the gear shift lever is moved to either the Park or the Neutral position, the PCM receives a ground signal from the Park/Neutral switch. With the shift lever positioned in Drive or Reverse, the Park/Neutral switch contacts open, causing the signal to the PCM to go high.

DESCRIPTION AND OPERATION (Continued)

THROTTLE POSITION SENSOR—PCM INPUT

DESCRIPTION

The throttle position sensor mounts to the side of the throttle body (Fig. 13).

The Throttle Position Sensor (TPS) connects to the throttle blade shaft. The TPS is a variable resistor that provides the 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.

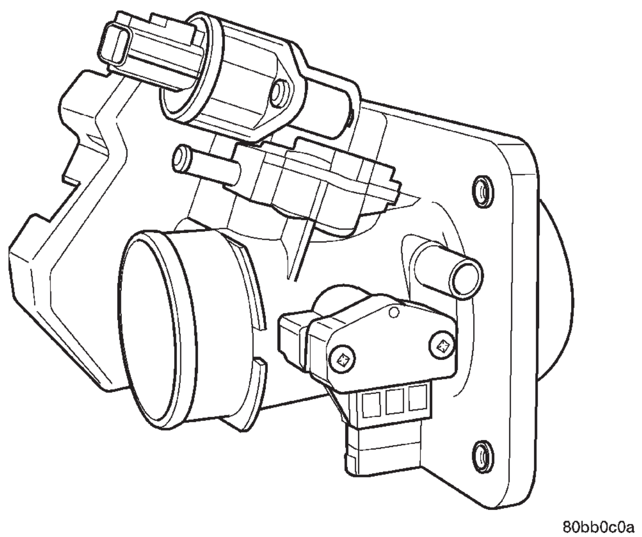


Fig. 13 Throttle Position Sensor and Idle Air Control Motor

OPERATION

The PCM supplies approximately 5 volts DC 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 0.35 to 1.03 volts at minimum throttle opening (idle) to a maximum of 3.1 to 4.0 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 pulse width and ignition timing based on these inputs.

When the TPS indicates a voltage that is too high, too low or not believable, the PCM sets a DTC. When the DTC is set, the MIL is illuminated and the PCM moves into limp-in mode. Limp-in for the TPS is divided into three categories:

- Idle
- Part-throttle
- Wide open throttle (WOT)

VEHICLE SPEED SIGNAL (VSS)—PCM INPUT

DESCRIPTION

The PCM requires the VSS to be able to control the following programs:

- Speed Control
- IAC motor (during deceleration)
- Injection pulse width (during deceleration)
- OBD II diagnostics
- PCM mileage EEPROM
- Road speed shutdown
- Speedometer/Odometer (bused message)

NOTE: Road Speed Shutdown is the PCM shutting off fuel injectors above a preset vehicle speed.

The vehicle speed sensor is located in the transmission extension housing (Fig. 14) and (Fig. 15).

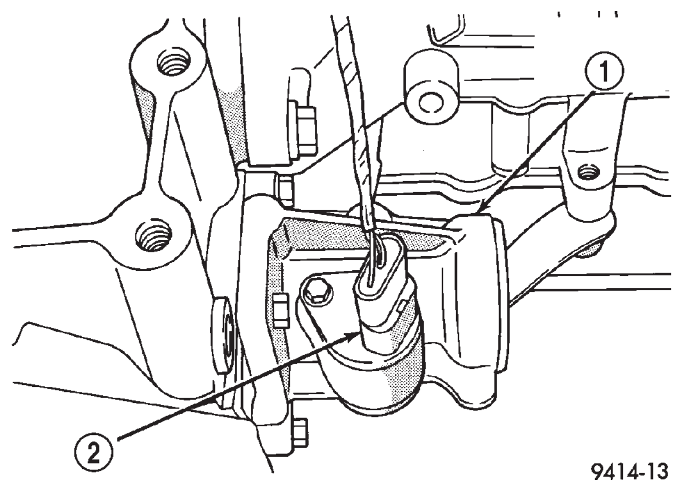


Fig. 14 Vehicle Speed Sensor—Automatic Transmission

1 – TRANSAXLE EXTENSION HOUSING
2 – VEHICLE SPEED SENSOR

OPERATION

The vehicle speed sensor on 3 speed automatic and manual transaxle vehicles is a Hall-effect sensor. This sensor is mechanically driven by a pinion gear that is in mesh with the right axle drive shaft. The hall-effect sensor switches a 5 volt signal sent from the PCM from a ground to an open circuit.

Like all Hall-effect sensors, the electronics of the sensor needs a power source. This power source is provided by the PCM. It is the same 8 volt power supply that is used by the CKP and CMP sensors.

The vehicle speed sensor generates 8 pulses per sensor revolution. This signal, in conjunction with a closed throttle signal from the throttle position sensor, indicates a closed throttle deceleration to the PCM. Under deceleration conditions, the PCM

DESCRIPTION AND OPERATION (Continued)

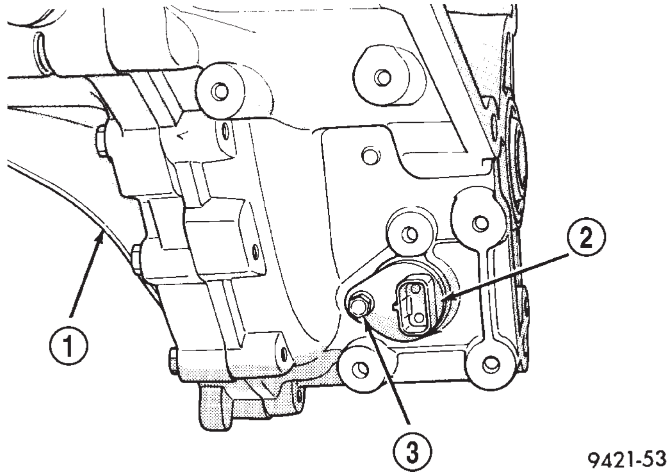


Fig. 15 Vehicle Speed Sensor—Manual Transmission

1 – TRANSAXLE
2 – SPEED SENSOR
3 – SPEED SENSOR RETAINING BOLT

adjusts the Idle Air Control (IAC) motor to maintain a desired MAP value.

When the vehicle is stopped at idle, a closed throttle signal is received by the PCM (but a speed sensor signal is not received). Under idle conditions, the PCM adjusts the IAC motor to maintain a desired engine speed.

AUTOMATIC SHUTDOWN RELAY—PCM OUTPUT

DESCRIPTION

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

OPERATION

The automatic shutdown (ASD) relay supplies battery voltage to the fuel injectors, electronic ignition coil and the heating elements in the oxygen sensors generator field and PCM sense circuit.

A buss bar in the power distribution center (PDC) supplies voltage to the solenoid side and contact side of the relay. The ASD relay power circuit contains a fuse between the buss bar in the PDC and the relay. The fuse also protects the power circuit for the fuel pump relay and pump. The fuse is located in the PDC. Refer to the Wiring Diagrams for circuit information.

The PCM controls the relay by switching the ground path for the solenoid side of the relay on and off. The PCM turns the ground path off when the ignition switch is in the Off position unless the 02 Heater Monitor test is being run. 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 the crankshaft position sensor and camshaft position sensor signals when the ignition switch is in the Run position, it will de-energize the ASD relay.

FUEL PUMP RELAY—PCM OUTPUT

DESCRIPTION

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

OPERATION

The fuel pump relay supplies battery voltage to the fuel pump. A buss bar in the Power Distribution Center (PDC) supplies voltage to the solenoid side and contact side of the relay. The fuel pump relay power circuit contains a fuse between the buss bar in the PDC and the relay. The fuse also protects the power circuit for the Automatic Shutdown (ASD) relay. The fuse is located in the PDC. Refer to the Wiring Diagrams for circuit information.

The PCM controls the fuel pump relay by switching the ground path for the solenoid side of the relay on and off. The PCM turns the ground path off when the ignition switch is in the Off position. When the ignition switch is in the On position, the PCM energizes the fuel pump. If the crankshaft position sensor does not detect engine rotation, the PCM de-energizes the relay after approximately one second.

PROPORTIONAL PURGE SOLENOID—PCM OUTPUT

DESCRIPTION

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.

OPERATION

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. 16) 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.

DESCRIPTION AND OPERATION (Continued)

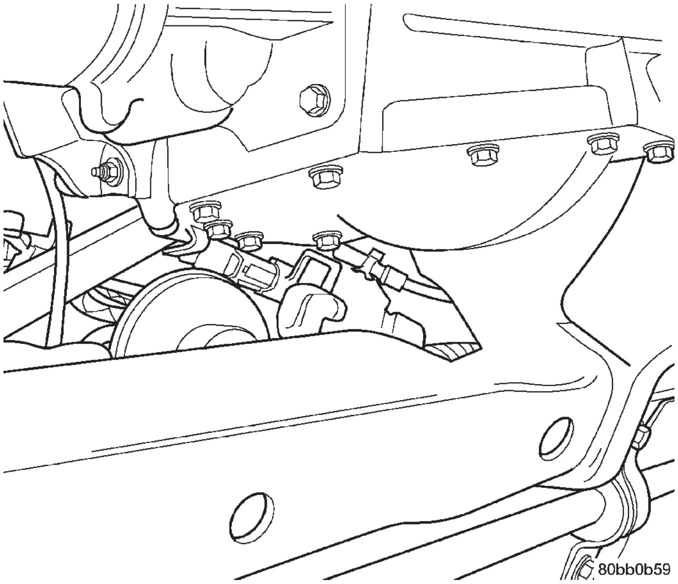


Fig. 16 Proportional Purge Solenoid

IDLE AIR CONTROL MOTOR—PCM OUTPUT

DESCRIPTION

The Idle Air Control (IAC) motor is mounted on the throttle body. The PCM operates the idle air control motor (Fig. 17). It is an electric stepper motor.

OPERATION

The PCM adjusts engine idle speed through the idle air control motor to compensate for engine load, coolant temperature or barometric pressure changes.

The throttle body has an air bypass passage that provides air for the engine during closed throttle idle. 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 IAC motor pintle in and out of the bypass passage. The adjustments are based on inputs the PCM receives. The inputs are from the throttle position sensor, crankshaft position sensor, coolant temperature sensor, MAP sensor, vehicle speed sensor and various switch operations (brake, park/neutral, air conditioning).

When engine rpm is above idle speed, the IAC is used for the following functions:

- Off-idle dashpot
- Deceleration air flow control
- A/C compressor load control (also opens the passage slightly before the compressor is engaged so that the engine rpm does not dip down when the compressor engages)

Target Idle

Target idle is determined by the following inputs:

- Gear position
- ECT Sensor
- Battery voltage
- Ambient/Battery Temperature Sensor
- VSS
- TPS
- MAP Sensor

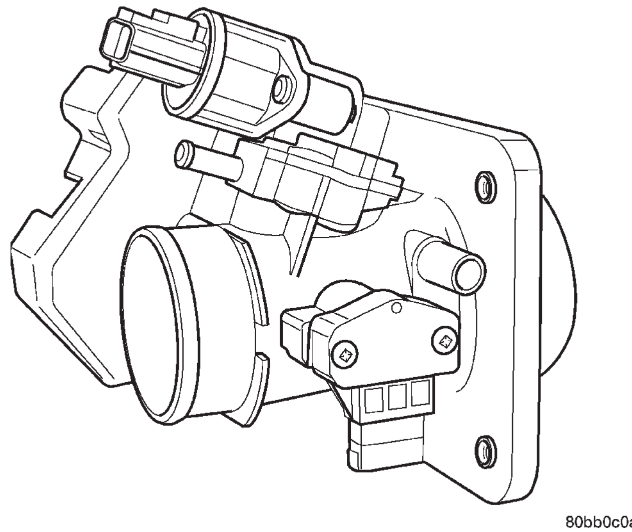


Fig. 17 Idle Air Control Motor—Typical

DATA LINK CONNECTOR

DESCRIPTION

The data link connector is located inside the vehicle, under the instrument panel, left of the steering column (Fig. 18).

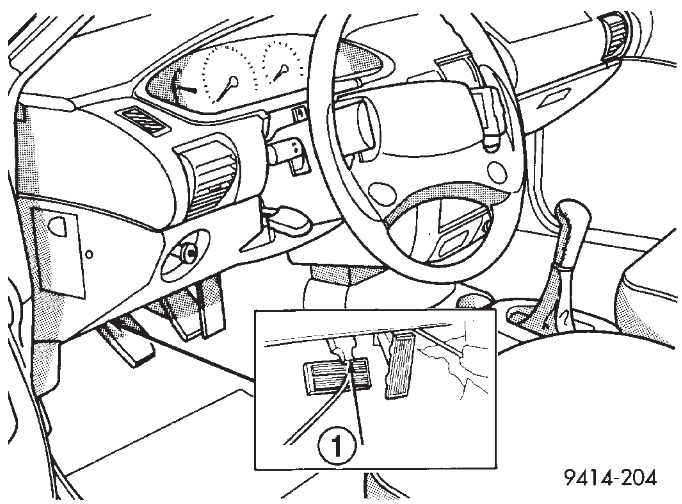


Fig. 18 Data Link Connector

1 – DATA LINK CONNECTOR

DESCRIPTION AND OPERATION (Continued)

OPERATION

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.

MALFUNCTION INDICATOR (CHECK ENGINE) LAMP—PCM OUTPUT

DESCRIPTION

Refer to the Instrument Panel Systems for more information.

OPERATION

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 the On-Board Diagnostics section.

SCI TRANSMIT—PCM INPUT

OPERATION

SCI Transmit is the serial data communication transmit circuit to the DRB scan tool. The Powertrain Control Module (PCM) transmit data to the DRB through the SCI transmit circuit.

TACHOMETER—PCM OUTPUT

DESCRIPTION

Refer to the Instrument panel System for more information.

OPERATION

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.

5 VOLT SUPPLY—PCM OUTPUT

OPERATION

The PCM supplies 5 volts to the following sensors:

- Manifold absolute pressure sensor
- Throttle position sensor

8-VOLT SUPPLY—PCM OUTPUT

OPERATION

The PCM supplies 8 volts to the crankshaft position sensor, camshaft position sensor and the Vehicle Speed Sensor.

REMOVAL AND INSTALLATION

THROTTLE BODY

REMOVAL

(1) Disconnect the negative battery cable (Fig. 19).

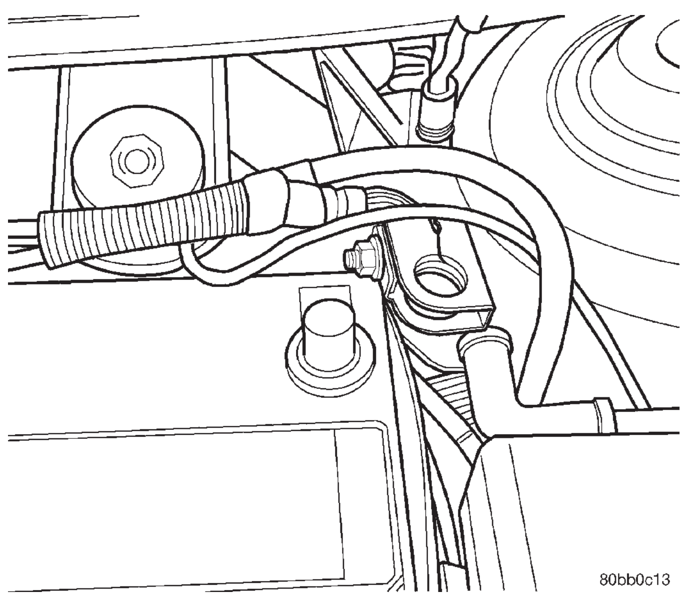


Fig. 19 Battery Negative Cable

(2) Remove the air cleaner box cover.

(3) Remove the air cleaner element (Fig. 20). Pull up on element, past the lip in the box, to remove it from the air cleaner box.

(4) Disconnect the electrical connection at the throttle body.

(5) Loosen the clamp on throttle body outlet hose.

REMOVAL AND INSTALLATION (Continued)

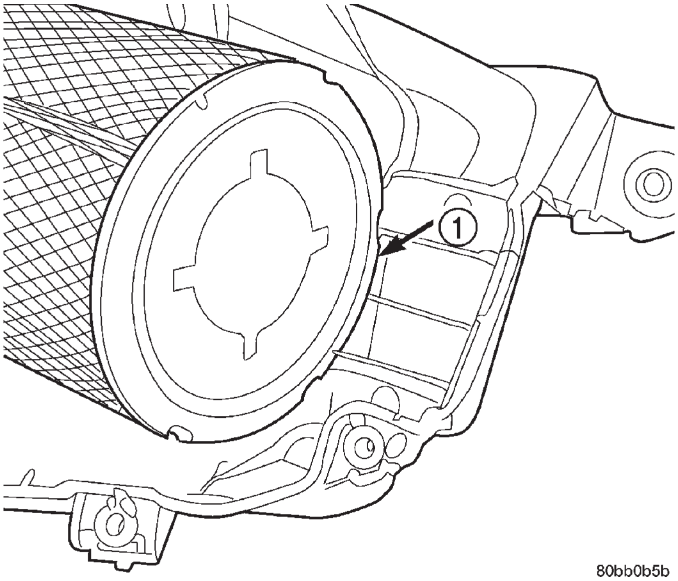


Fig. 20 Air Cleaner Element

1 – LIP

(6) Remove the bolts holding the throttle body to the air cleaner box (Fig. 21).

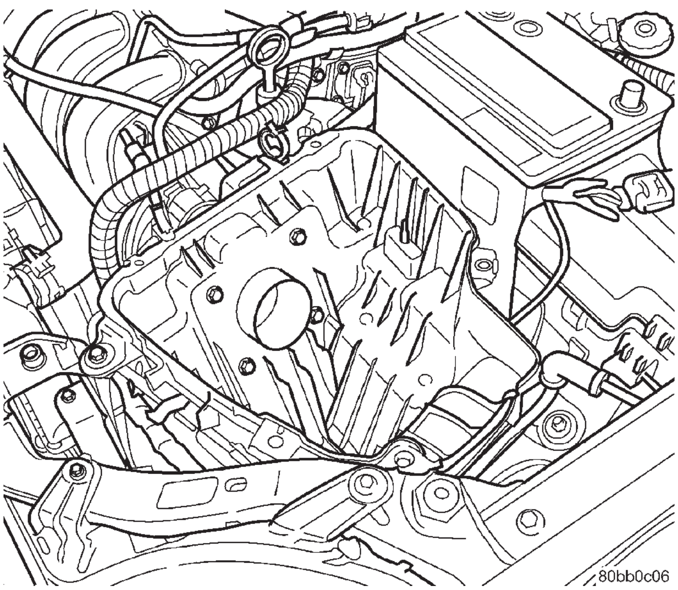


Fig. 21 Throttle body bolts

(7) Remove cable's from throttle body cam (Fig. 22).

INSTALLATION

(1) Install cable's into throttle cam and clip cable's into throttle cable bracket.

(2) Install throttle body onto air cleaner box. Tighten mounting bolts.

(3) Install and tighten the clamp on throttle body outlet hose.

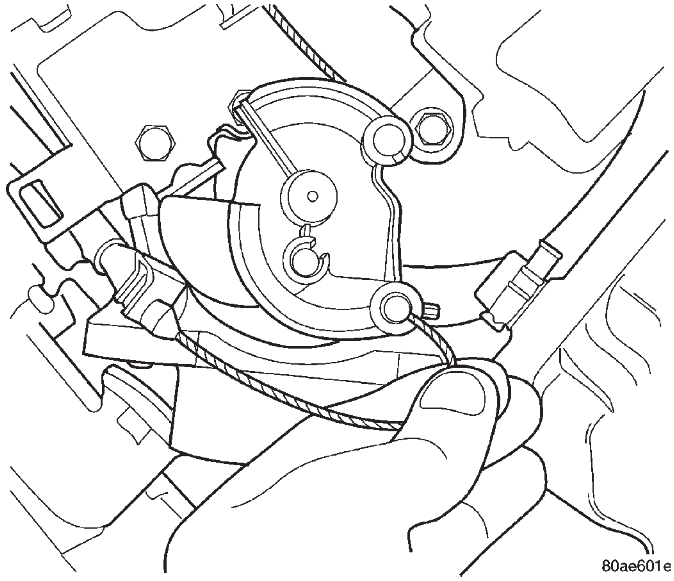


Fig. 22 Disconnecting Throttle Cable

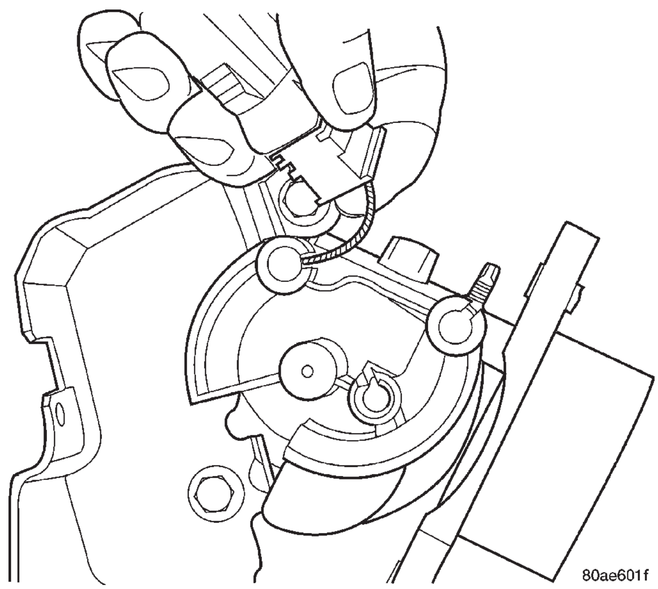


Fig. 23 Transmission Kickdown Cable Connector

(4) Connect the electrical connectors to the throttle body.

(5) Install the air cleaner element, make sure that the element is past the lip on the air cleaner box.

(6) Install the air cleaner box cover and tighten the screws.

(7) Connect the negative battery cable.

THROTTLE POSITION SENSOR

REMOVAL

(1) Disconnect the negative battery cable.

(2) Loosen the clamp for the air duct at the throttle body.

(3) Remove the mounting bolt and nut for the air cleaner box.

REMOVAL AND INSTALLATION (Continued)

(4) Pull the air cleaner box and throttle body up to access the throttle position sensor.

(5) Remove the throttle position sensor.

INSTALLATION

(1) Install the throttle position sensor.

(2) Locate the air cleaner box and throttle body and tighten the mounting bolt and nut.

(3) Install the air duct hose and tighten the clamp.

(4) Connect the negative battery cable.

IDLE AIR CONTROL MOTOR

When servicing throttle body components, always reassemble components with new O-rings and seals where applicable. Never use lubricants on O-rings or seals, damage may result. If assembly of component is difficult, use water to aid assembly. Use care when removing hoses to prevent damage to hose or hose nipple.

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove electrical connector from idle air control motor.

(3) Remove idle air control motor mounting screws (Fig. 24).

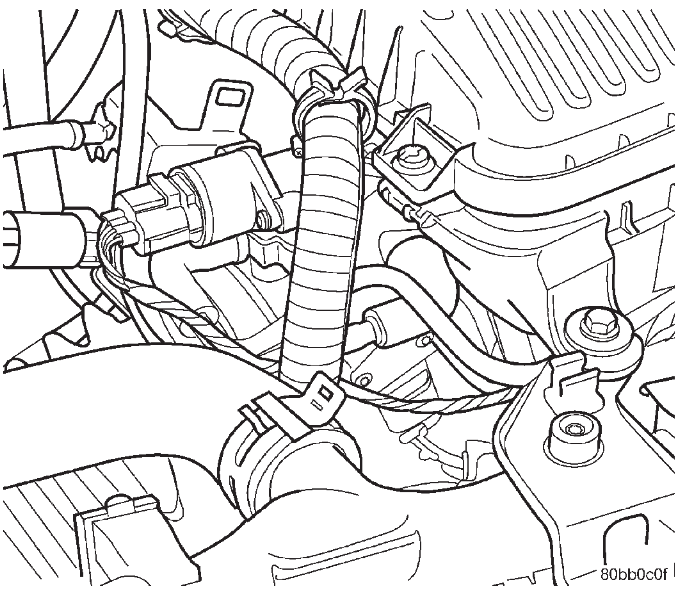


Fig. 24 Servicing Idle Air Control Motor

(4) Remove motor from throttle body. Ensure the O-ring is removed with the motor.

INSTALLATION

(1) The new idle air control motor has a new O-ring installed on it. If pintle measures more than 1 inch (25 mm) it must be retracted. Use the DRB Idle Air Control Motor Open/Close Test to retract the pintle (battery must be connected.)

(2) Carefully place idle air control motor into throttle body.

(3) Install mounting screws. Tighten screws to 4.5 N·m (40 in. lbs.) torque.

(4) Connect electrical connector to idle air control motor

(5) Connect negative cable to battery.

MAP SENSOR

The MAP sensor attaches to the intake manifold plenum (Fig. 25).

REMOVAL

(1) Disconnect the electrical connector from the MAP sensor.

(2) Remove sensor mounting screws.

(3) Remove sensor.

INSTALLATION

(1) Insert sensor into intake manifold while making sure not to damage O-ring seal.

(2) Tighten mounting screws to 4.5 N·m (40 in. lbs.) torque for plastic manifold.

(3) Attach electrical connector to sensor.

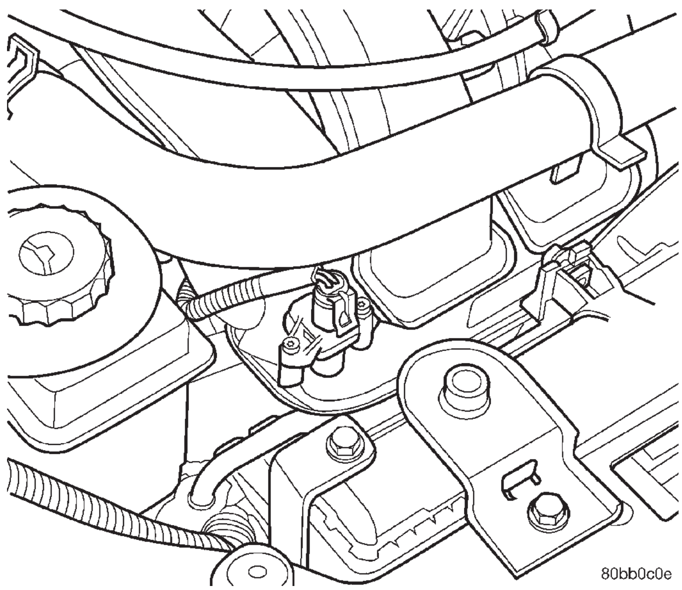


Fig. 25 MAP Sensor

POWERTRAIN CONTROL MODULE (PCM)

REMOVAL

(1) Disconnect the negative battery cable (Fig. 26).

(2) Remove the air cleaner box, refer to the air cleaner box section.

(3) Remove the gray and black connector from the PCM (Fig. 27).

(4) Remove the harness clip bracket from PCM bracket (Fig. 28).

(5) Remove the nut from the upper bracket mount.

REMOVAL AND INSTALLATION (Continued)

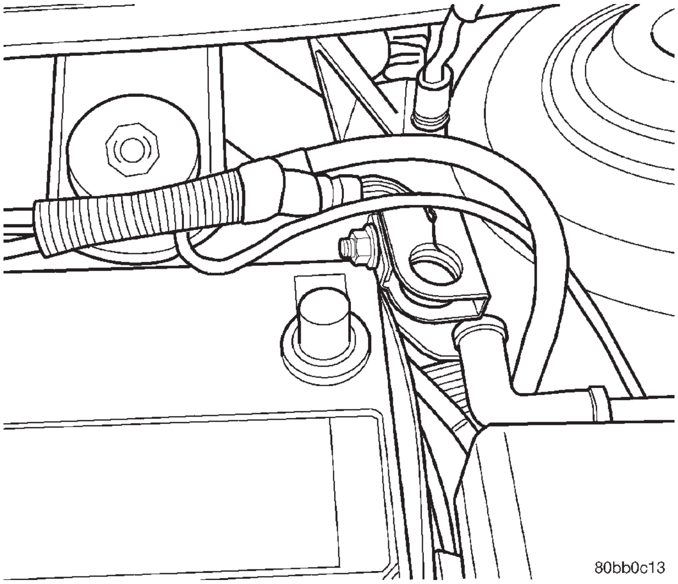


Fig. 26 Battery Cable

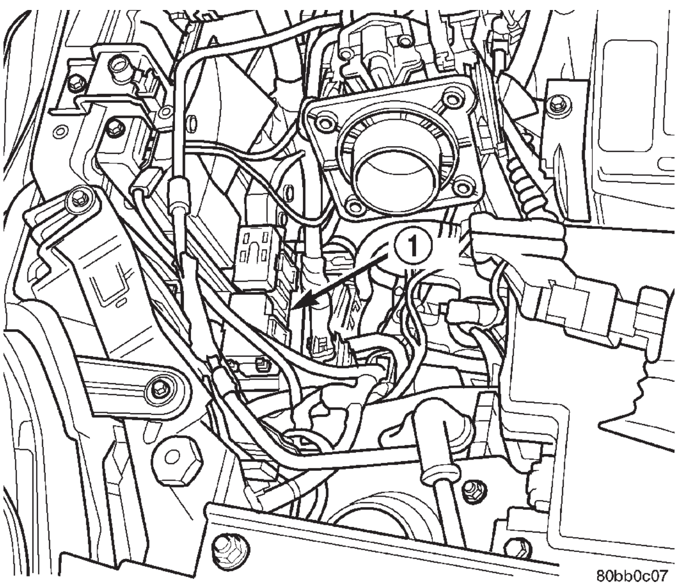


Fig. 27 Powertrain Control Module (PCM)

1 – PCM

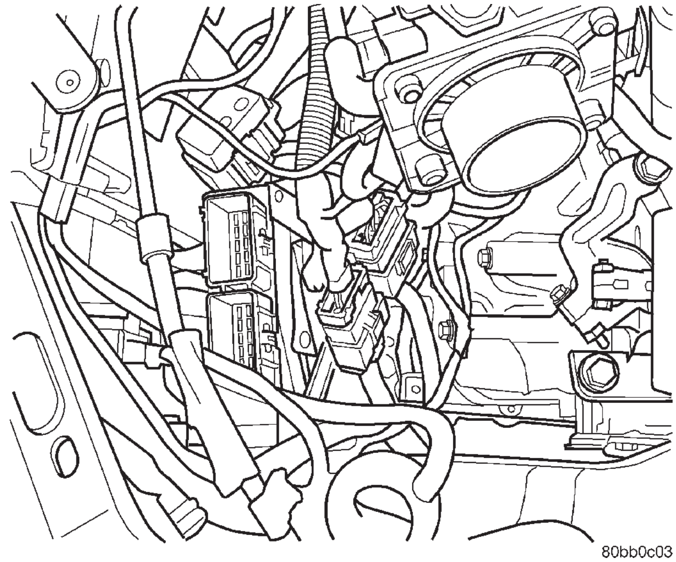


Fig. 28 PCM Wiring Bracket

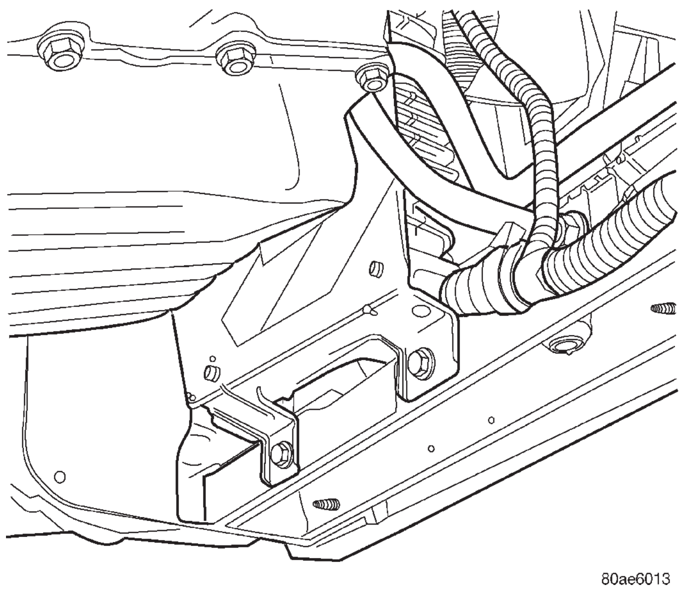


Fig. 29 Lower Mounting Bolts

(6) Raise vehicle and support on hoist.
(7) Remove 2 lower bracket bolts (Fig. 29).
(8) Remove 4 screws from bracket and remove bracket from PCM (Fig. 30).

INSTALLATION

(1) Install bracket to PCM and tighten screws.
(2) Install PCM and bracket to body and tighten the 2 lower bolts.
(3) Lower vehicle.
(4) Install upper bracket nut and tighten.
(5) Clip in wiring harness bracket.
(6) Install gray and black connectors to the PCM.
(7) Install the air cleaner box, refer to the air cleaner box section.
(8) Connect the negative battery cable.

REMOVAL AND INSTALLATION (Continued)

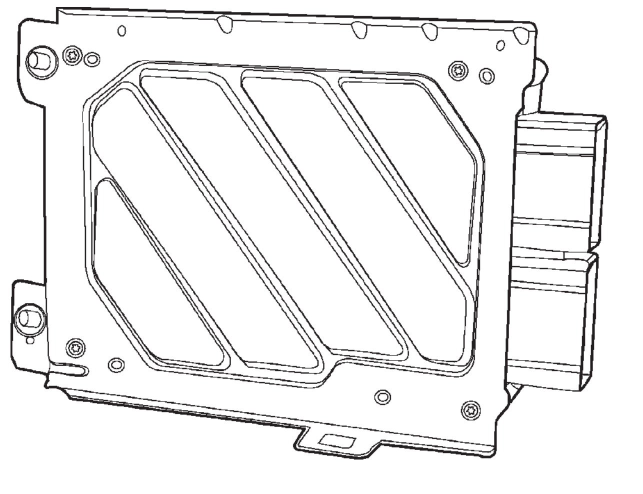


Fig. 30 PCM Bracket Screws

UPSTREAM HEATED OXYGEN SENSOR

REMOVAL

(1) Raise and support vehicle.

(2) Unplug sensor connector.

(3) Remove sensor using an oxygen sensor crow foot wrench such as Snap-On tool YA8875 or equivalent (Fig. 31).

(4) 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.

INSTALLATION

New sensors have compound on the threads and do not require an additional coating.

(1) Install sensor using an oxygen sensor crow foot wrench such as Snap-On tool YA8875 or equivalent (Fig. 31). Tighten the sensor to 28 N·m (20 ft. lbs.) torque.

(2) Plug sensor connector.

(3) Lower vehicle.

DOWNSTREAM HEATED OXYGEN SENSOR 1/2

The downstream heated oxygen sensor threads into the exhaust outlet pipe behind the catalytic convertor (Fig. 32).

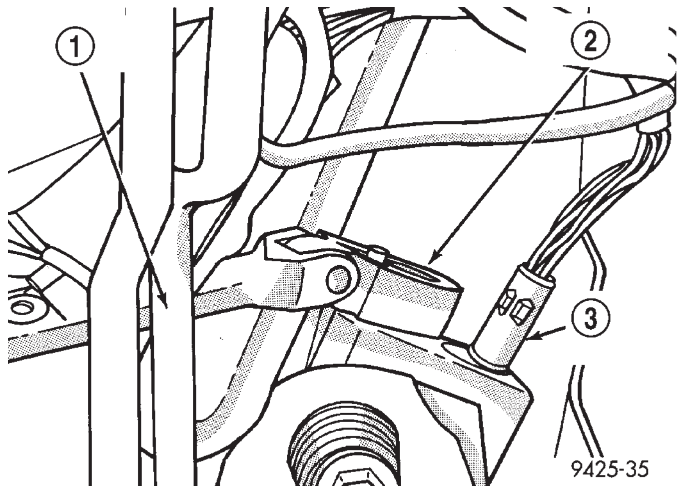


Fig. 31 Upstream Heated Oxygen Sensor Removal/ Installation

1 – EXHAUST PIPE FLANGE
2 – CROW FOOT WRENCH
3 – UPSTREAM OXYGEN SENSOR

REMOVAL

(1) Raise vehicle.

(2) Disconnect electrical connector from harness.

(3) Disconnect sensor electrical harness from clips along body.

(4) Remove sensor using an oxygen sensor crow foot wrench such as Snap-On tool YA8875 or equivalent (Fig. 33).

(5) 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.

INSTALLATION

New sensors have compound on the threads and do not require an additional coating.

(1) Install sensor using an oxygen sensor crow foot wrench such as Snap-On tool YA8875 or equivalent (Fig. 33). Tighten the sensor to 28 N·m (20 ft. lbs.) torque.

(2) Connect sensor electrical harness from clips along body.

(3) Connect electrical connector to harness.

(4) Lower vehicle.

REMOVAL AND INSTALLATION (Continued)

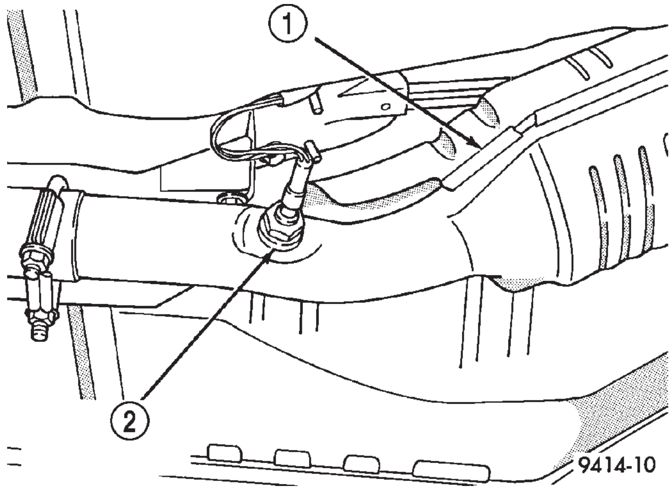


Fig. 32 Downstream Heated Oxygen Sensor

1 – CATALYTIC CONVERTOR
2 – DOWNSTREAM OXYGEN SENSOR

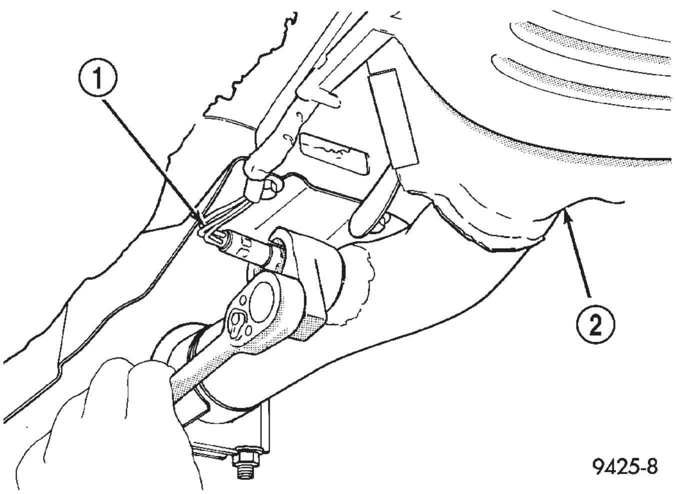


Fig. 33 Downstream Heated Oxygen Sensor Removal/Installation

1 – DOWNSTREAM HEATED OXYGEN SENSOR
2 – CATALYTIC CONVERTOR

AIR CLEANER BOX

REMOVAL

(1) Remove 5 screws from air cleaner element box lid.

(2) Remove lid from air cleaner box.

(3) Pull air cleaner up and out of air cleaner box (Fig. 34).

(4) Move air duct out of the way.

(5) Remove the bolt and nut from the air cleaner box.

(6) Remove wiring harness from the clips on the air cleaner box.

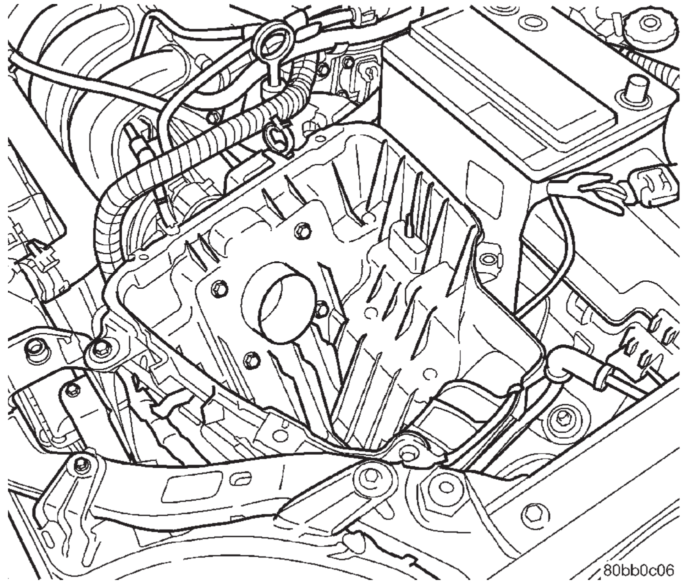


Fig. 34 Air Cleaner Box

(7) Remove the wiring clip from the front of the air cleaner box.

(8) Remove the 4 bolts from the air cleaner box to throttle body.

(9) Pull air cleaner box up and off of stud and battery tray and remove from vehicle.

INSTALLATION

(1) Install air cleaner box. Make sure that it is on the battery tray tab in the back and on the stud on the side.

(2) Install the bolts to the throttle body and tighten.

(3) Install the nut and bolt for air cleaner box and tighten.

(4) Install the wiring clip in the front of the air cleaner box.

(5) Install the wiring harness into the clips on the side of the air cleaner box.

(6) Install air cleaner element on to throttle body and push towards the throttle body and past lip in air cleaner box bottom (Fig. 35).

(7) Install air duct.

(8) Install lid and tighten screws.

REMOVAL AND INSTALLATION (Continued)

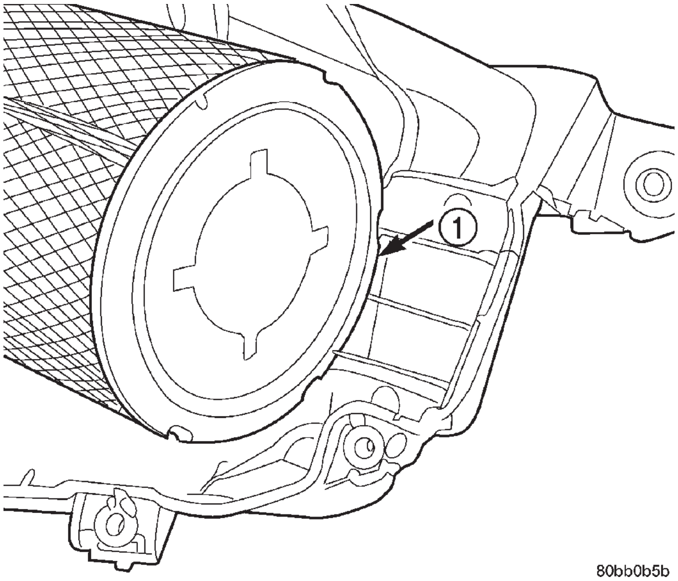


Fig. 35 Air Cleaner Box Lip

1 – LIP

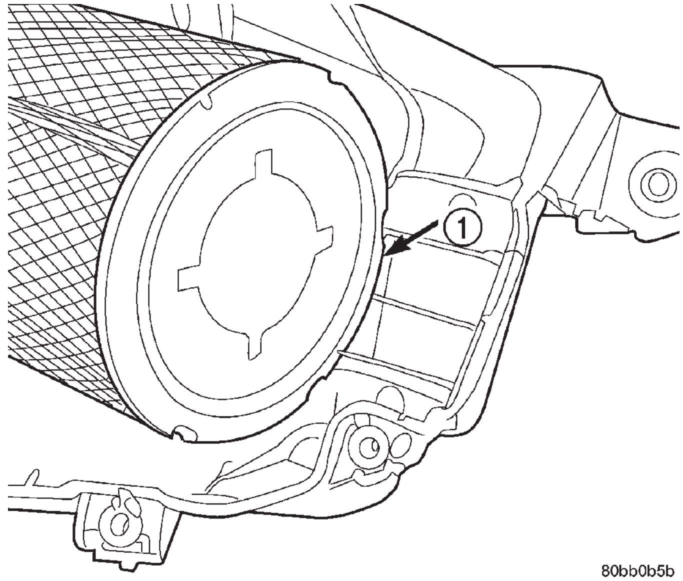


Fig. 36 Air Cleaner Element

1 – LIP

AIR CLEANER ELEMENT

REMOVAL

(1) Remove 5 screws from air cleaner element box lid.

(2) Remove lid from air cleaner box.

(3) Pull air cleaner up and out of air cleaner box.

INSTALLATION

(1) Install air cleaner element on to throttle body and push towards the throttle body and past lip in air cleaner box bottom (Fig. 36).

(2) Install lid and tighten screws.

ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant temperature sensor threads into the rear of the cylinder head (Fig. 37).

REMOVAL

(1) With the engine cold, drain coolant until level drops below cylinder head. Refer to the Cooling System section.

(2) Disconnect coolant sensor electrical connector.

(3) Remove coolant sensor.

INSTALLATION

(1) Install coolant sensor. Tighten sensor to 18 N·m (165 in. lbs.) torque.

(2) Attach electrical connector to sensor.

(3) Fill cooling system. Refer to the Cooling System section.

VEHICLE SPEED SENSOR

The vehicle speed sensor is located in the transmission extension housing (Fig. 38) or (Fig. 39).

REMOVAL

(1) Remove the negative battery cable.

(2) Raise and support vehicle.

(3) Disconnect electrical connector from sensor.

(4) Remove the sensor mounting bolt.

(5) Lift the sensor out of the transaxle extension housing. Ensure the O-ring was removed with the sensor.

INSTALLATION

The speed sensor gear meshes with a gear on the output shaft.

REMOVAL AND INSTALLATION (Continued)

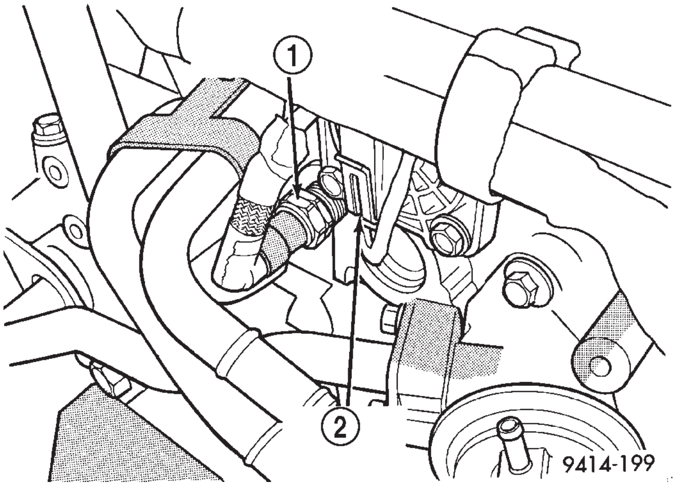


Fig. 37 Engine Coolant Temperature Sensor

1 – ENGINE COOLANT TEMPERATURE SENSOR
2 – CAMSHAFT POSITION SENSOR

(1) With O-ring in place, install sensor.

(2) Install mounting bolt and tighten to 7 N·m (60 in.lbs.).

(3) Connect electrical connector to sensor.

(4) Lower vehicle.

(5) Install the negative battery cable.

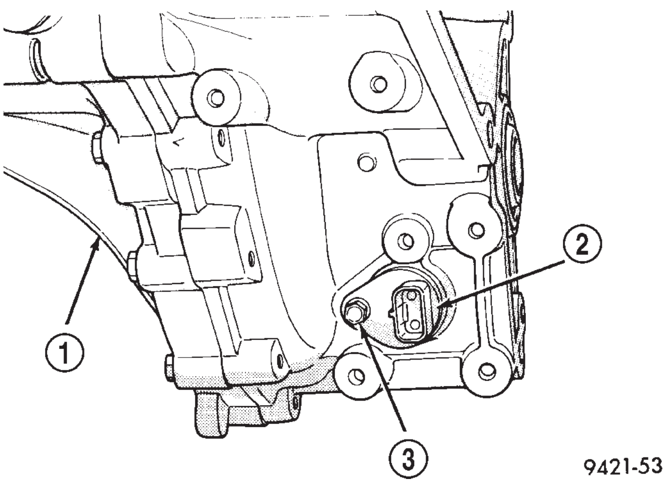


Fig. 38 Vehicle Speed Sensor Manual

1 – TRANSAXLE
2 – SPEED SENSOR
3 – SPEED SENSOR RETAINING BOLT

KNOCK SENSOR

The sensors screws into the cylinder block.

REMOVAL

(1) Raise vehicle on hoist and support.

(2) Disconnect electrical connector from knock sensor (Fig. 40).

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

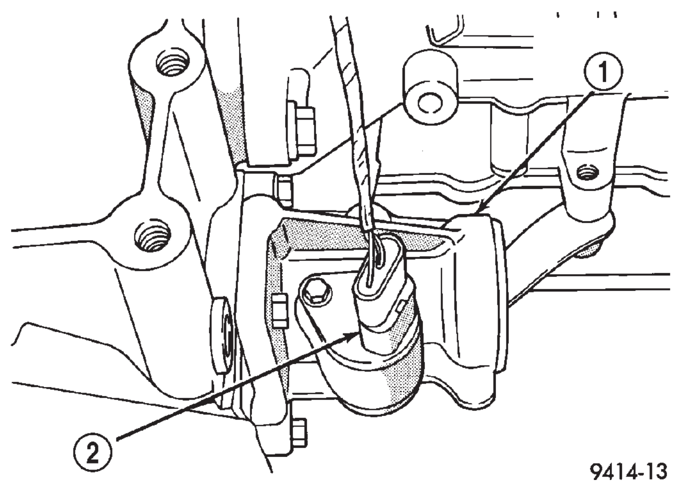


Fig. 39 Vehicle Speed Sensor Automatic

1 – TRANSAXLE EXTENSION HOUSING
2 – VEHICLE SPEED SENSOR

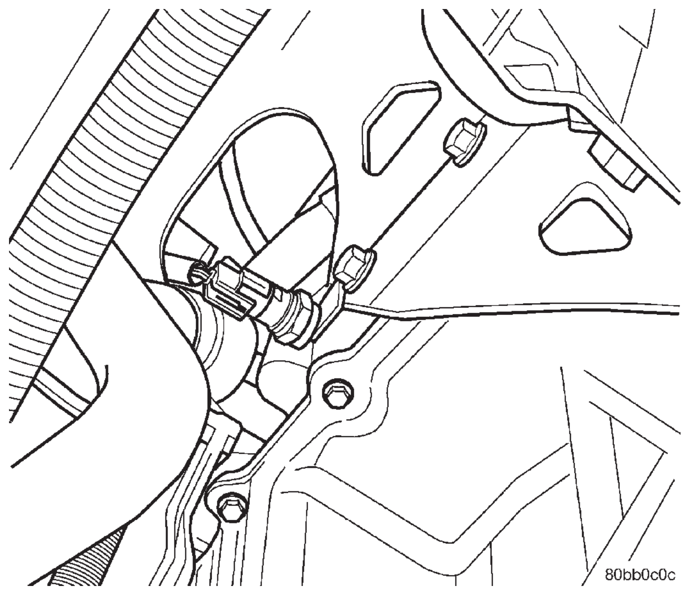


Fig. 40 Knock Sensor Location

INSTALLATION

(1) Install knock sensor. Tighten knock sensor 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) Lower vehicle.

INLET AIR TEMPERATURE SENSOR

The sensors screws into the air inlet tube.

REMOVAL

(1) Disconnect the negative battery cable.

(2) Disconnect electrical connector from the sensor (Fig. 41).

(3) Remove the sensors.

REMOVAL AND INSTALLATION (Continued)

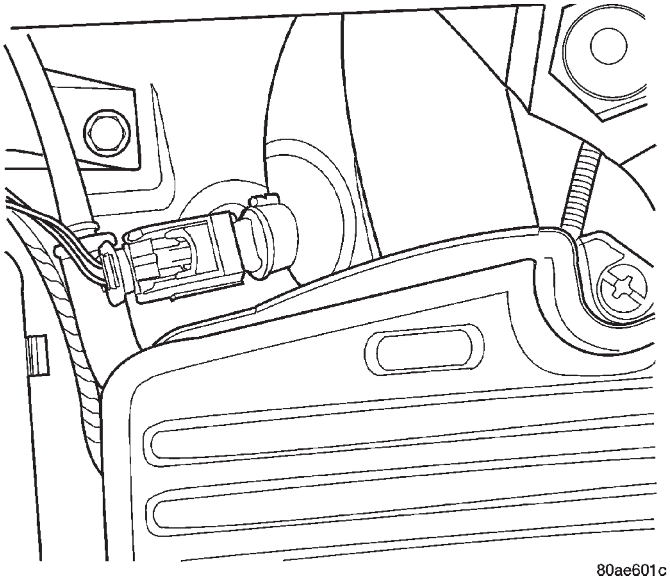


Fig. 41 Inlet Air Temperature Sensor

INSTALLATION

(1) Install sensor.
(2) Attach electrical connector to sensor.
(3) Connect the negative battery cable.

RADIATOR FAN RELAY

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

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.

AUTOMATIC SHUTDOWN (ASD) RELAY

The Automatic Shutdown relay (ASD) relay is located in the PDC. The inside top of the PDC cover has a label showing relay and fuse location.

SPECIFICATIONS

VECI LABEL

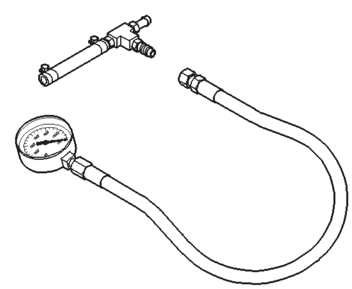
Always use the information found on the Vehicle Emission Control Information (VECI) label. The VECI label is located in the engine compartment.

TORQUE

DESCRIPTION	TORQUE
Air Cleaner Lid Screws	3.9 N·m (35 in. lbs.)
Crankshaft Position Sensor Mounting Bolts	8 N·m (70 in. lbs.)
Engine Coolant Temperature Sensor	18 N·m (165 in. lbs.)
IAC Motor-To-Throttle Body Bolts	4.5 N·m (40 in. lbs.)
MAP Sensor	4.5 N·m (40 in. lbs.)
Oxygen Sensor	28 N·m (20 ft. lbs.)
Powertrain Control Module (PCM) Mounting Screws	4 N·m (35 in. lbs.)
Throttle Body Mounting Bolts	23 N·m (200 in. lbs.)
Throttle Position Sensor Mounting Screws	2 N·m (20 in. lbs.)
Vehicle Speed Sensor Mounting Bolt	2.2 N·m (20 in. lbs.)

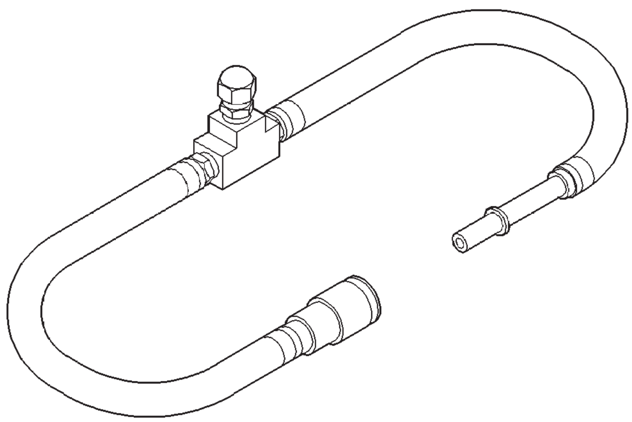
SPECIAL TOOLS

FUEL

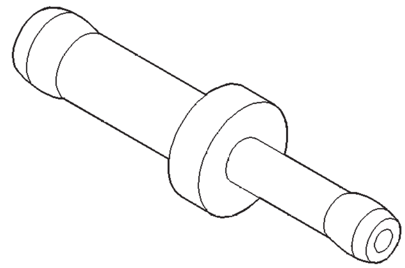


Pressure Gauge Assembly C–4799–B

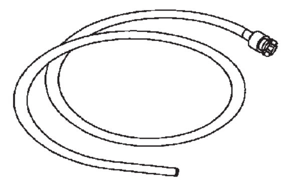
SPECIAL TOOLS (Continued)



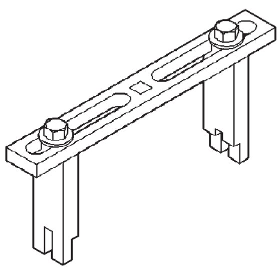
Fuel Pressure Test Adapter 6539



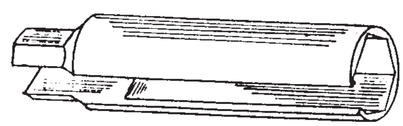
Metering Orifice



Fuel Line Adapter 1/4



Spanner Wrench 6856



O2S (Oxygen Sensor) Remover/Installer—C-4907

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