Fuel Delivery and Air Induction: Description and Operation
Fuel Systems

FUEL SYSTEMS

Overview

The fuel system supplies the Sequential Multiport Fuel Injection **(SFI)** fuel injectors with clean fuel at controlled pressure. The Powertrain Control Module **(PCM)** controls the fuel pump and monitors the fuel pump circuit. The PCM also controls the duration of the on/off cycle providing correct timing of the fuel injectors. If the injectors have been replaced, it is necessary to clear learned values contained in the Keep Alive Random Access Memory **(KAM)** in the PCM. This can be done by disconnecting the battery or the PCM for **five minutes**. (Refer to Section 2, Resetting The Keep Alive Memory (KAM), for more information).

The three types of fuel Systems used are:

^ Returnable Fuel
^ Mechanical Returnless Fuel
^ Electronic Returnless Fuel

Returnable Fuel System

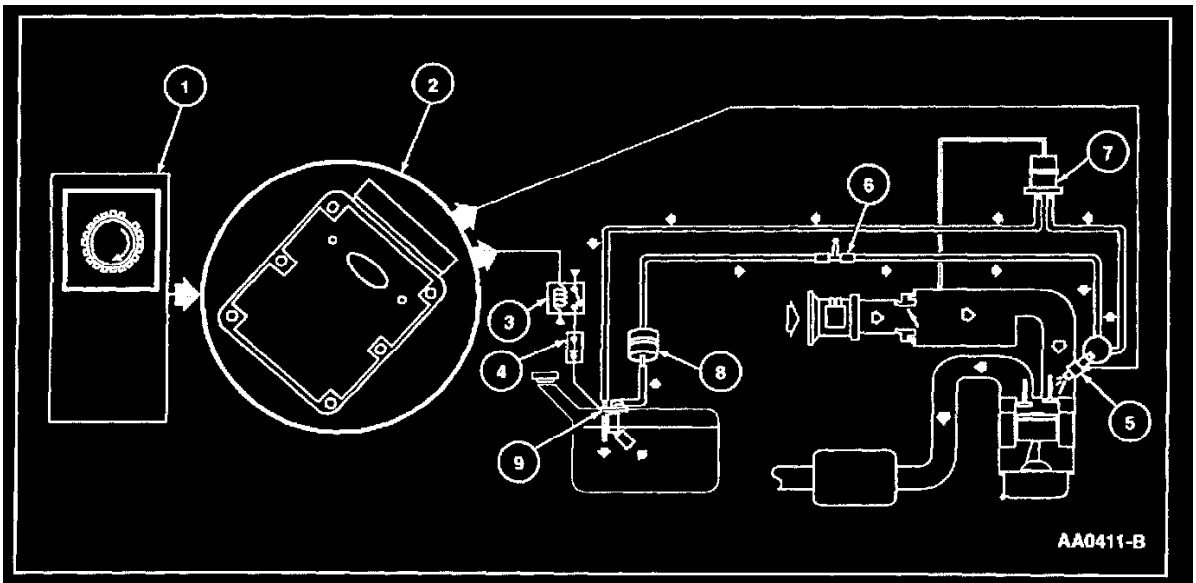


Figure 64: Fuel System - All others

Fuel System

The fuel system consists of a fuel tank with a reservoir, fuel pump module, fuel supply lines, fuel filter(s), schrader/pressure test point, fuel rail, fuel injectors, and fuel pressure regulator. Operation of the system is as follows (refer to (Figure 63) for all others):

1. The fuel delivery system uses the Crankshaft Position **(CKP)** sensor to signal the PCM that the engine is either cranking or running.
2. The fuel pump logic is defined in the Fuel System control strategy and is executed in the PCM. The PCM will ground the fuel pump relay for **one second** during key on and engine off. During crank the fuel pump relay is grounded as long as the PCM receives a CKP signal.
3. The fuel pump relay has a primary and a secondary circuit. The primary side is controlled by the PCM and the secondary side provides B+ to the fuel pump circuit when the relay is energized.
4. The Inertia Fuel Shut-Off **(IFS)** switch is used to de-energize the fuel delivery secondary circuit in the event of a collision. The IFS Switch is a safety device that should only be reset after a thorough inspection of the vehicle (following a collision).
5. The fuel injector is a solenoid-operated valve that meters fuel flow to each combustion cylinder. The fuel injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel is controlled by length of time the fuel injector is held open. The injector is normally closed and is operated by **12 volt** Vehicle Power **(VPWR)** from the power relay. The ground signal is controlled by the PCM.
6. A pressure test point valve (schrader valve) is located on the fuel rail. This is used to measure fuel injector supply pressure for service and diagnostic procedures. ON VEHICLES NOT EQUIPPED WITH A SCHRADER VALVE, USE ROTUNDA FUEL PRESSURE TEST KIT #134-R0087 OR EQUIVALENT.
7. The fuel pressure regulator is attached to the fuel rail downstream of the fuel injectors. It regulates fuel pressure supplied to the fuel injectors. The fuel pressure regulator is a diaphragm-operated relief valve. One side of the diaphragm senses fuel pressure and the other side is connected to the intake manifold vacuum. Fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold vacuum maintains a constant fuel pressure drop across the fuel injectors. Fuel pressure is high when engine vacuum

is low. Excess fuel is bypassed through the fuel pressure regulator and returned through the fuel return line to the fuel tank.

8. There are four filtering or screening devices in the fuel delivery system. The fuel intake sock or screen is a fine, nylon mesh mounted on the intake side of the fuel pump. There is a fuel filter screen located at the fuel rail side of the fuel injector. A fuel filter/screen is located in the inlet side of the fuel pressure regulator. The fuel filter assembly is located between the fuel pump and the pressure test point/schrader valve.
9. The Fuel Pump **(FP)** module is a device that contains both fuel pump and fuel sender assembly. The fuel pump is located inside the reservoir and supplies fuel through the fuel pump module manifold to the engine and the fuel pump module jet pump.

NOTE: Some vehicles have the relay located in the Power Distribution Box.

Mechanical Returnless Fuel System

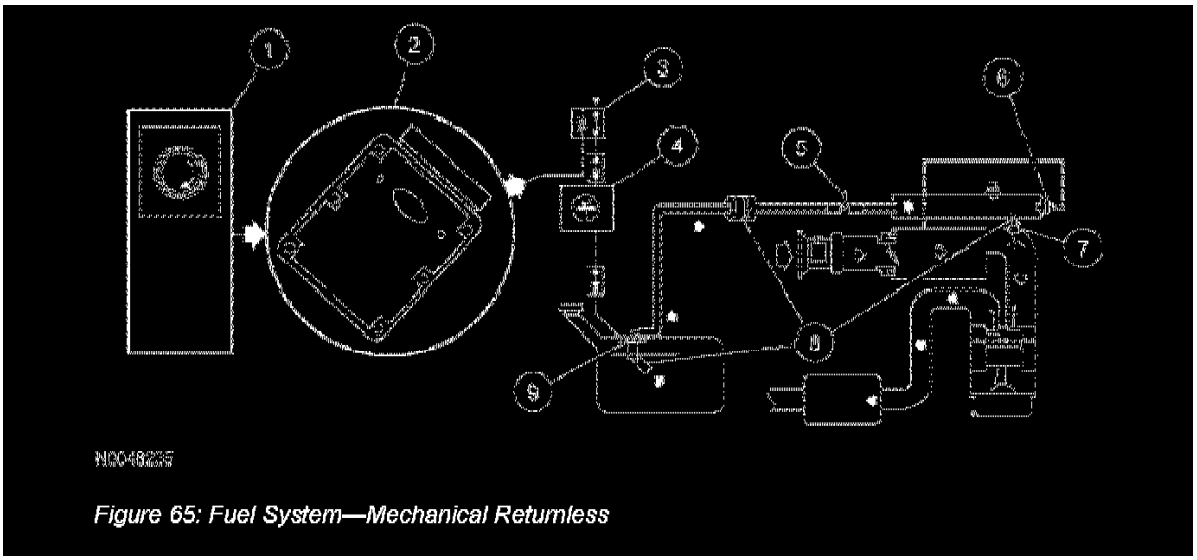


Figure 65: Fuel System—Mechanical Returnless

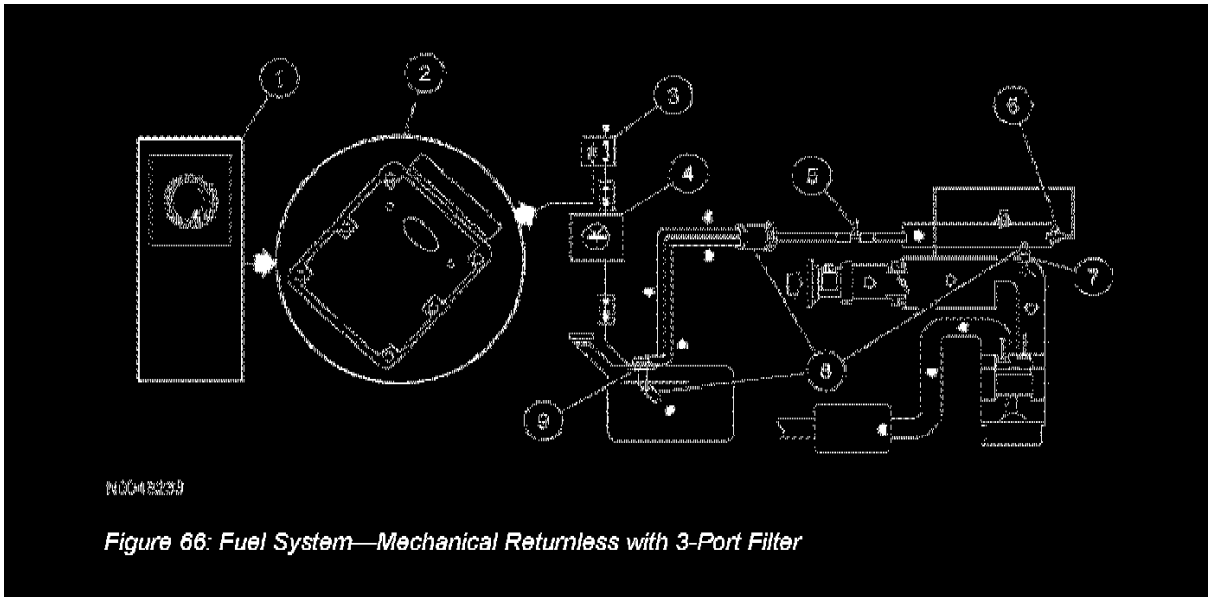


Figure 66: Fuel System—Mechanical Returnless with 3-Port Filter

The fuel system consists of a fuel tank with reservoir, fuel pump, fuel pressure regulator, fuel filter, fuel supply line, fuel rail, fuel rail pulse damper, fuel injectors, and schrader/pressure test point. Operation of the system is as follows (Figure 65) or (Figure 66):

1. The fuel delivery system is enabled during crank or running mode once the PCM receives a crankshaft position (CKP) sensor signal.
2. The fuel pump logic is defined in the fuel system control strategy and is executed by the PCM.
3. The PCM grounds the fuel pump relay, which provides VPWR to the fuel pump.
4. The inertia fuel shut-off (IFS) switch is used to de-energize the fuel delivery secondary circuit in the event of collision. The IFS switch is a safety device that should only be reset after a thorough inspection of the vehicle (following a collision).
5. A pressure test point valve (schrader valve) is located on the fuel rail. This is used to measure fuel injector supply pressure for diagnostic procedures and repairs. ON VEHICLES NOT EQUIPPED WITH A SCHRADER VALVE, USE ROTUNDA FUEL PRESSURE TEST KIT #134-R0087 OR EQUIVALENT.
6. Located on the fuel rail is a pulse damper. The pulse damper reduces fuel system noise caused by the pulsing of the fuel injectors. The vacuum port located on the damper is connected to manifold vacuum to avoid fuel spillage in the event the pulse damper diaphragm were to rupture (the pulse damper should not be confused with a fuel pressure regulator).
7. The fuel injector is a solenoid-operated valve that meters the fuel flow to each combustion cylinder. The fuel injector is opened and closed a

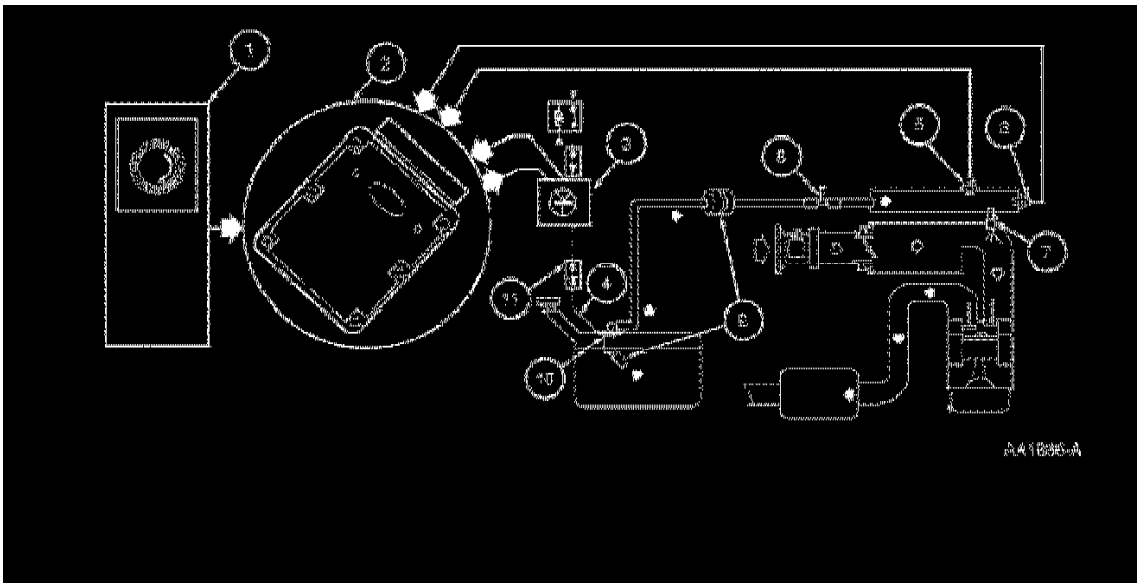
constant number of times per crankshaft revolution. The amount of fuel is controlled by the length of time the fuel injector is held open. The injector is normally closed and is operated by **12 volt** VPWR from the power relay. The ground signal is controlled by the PCM.

8. There are three filtering or screening devices in the fuel delivery system. The intake sock is a fine, nylon mesh screen mounted on the intake side of the fuel pump. There is a fuel filter screen located at the fuel rail side of the fuel injector. The fuel filter assembly is located between the fuel pump and the pressure test point/schrader valve.
9. The fuel pump (FP) module contains the fuel pump, fuel pressure regulator and the fuel sender assembly. The fuel pressure regulator is attached to the fuel pump in the fuel pump module located in the fuel tank. It regulates fuel pressure supplied to the fuel injectors. The fuel pressure regulator is a diaphragm-operated relief valve. Fuel pressure is established by a spring preload applied to the diaphragm. Excess fuel is bypassed through the regulator and returned to the fuel tank.

Electronic Returnless Fuel System

The fuel system consists of a fuel tank with reservoir, fuel pump, fuel rail pressure sensor, fuel filter, fuel supply line, engine fuel temperature sensor, fuel rail, fuel injectors, and schrader/pressure test point. Operation of the system is as follows (Figure 65) and (Figure 66):

1. The fuel delivery system is enabled during crank or running mode once the PCM receives a crankshaft position (CKP) sensor signal.
2. The fuel pump logic is defined in the fuel system control strategy and is executed by the PCM.
3. The PCM commands a duty cycle to the Fuel Pump Driver Module **(FPDM)**.
4. The fuel pump driver module modulates the voltage to the fuel pump (FP) to achieve the proper fuel pressure. Voltage for the fuel pump is supplied by the power relay or FPDM power supply relay. (For additional information on FPDM operation, refer to PCM Outputs-Fuel Pump and PCM Inputs-FPM.)
5. The Fuel Rail Pressure **(FRP)** sensor provides the PCM with the current fuel rail pressure. The PCM uses this information to vary the duty cycle output to the FPDM to compensate for varying loads.
6. The Engine Fuel Temperature **(EFT)** sensor measures current fuel temperatures in the fuel rail. This information is used to vary the fuel pressure and avoid fuel system vaporization.
7. The fuel injector is a solenoid-operated valve that meters the fuel flow to each combustion cylinder. The fuel injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel is controlled by the length of time the fuel injector is held open. The injector is normally closed and is operated by **12 volt** VPWR from the power relay. The ground signal is controlled by the PCM.
8. A pressure test point valve (schrader valve) is located on the fuel rail. This is used to measure fuel injector supply pressure for diagnostic procedures and repairs. ON VEHICLES NOT EQUIPPED WITH A SCHRADER VALVE, USE ROTUNDA FUEL PRESSURE TEST KIT #134-R0087 OR EQUIVALENT.
9. There are three filtering or screening devices in the fuel delivery system. The intake sock is a fine, nylon mesh screen mounted on the intake side of the fuel pump. There is a fuel filter screen located at the fuel rail side of the fuel injector. The fuel filter assembly is located between the fuel pump and the pressure test point/schrader valve.
10. The fuel pump (FP) module is a device that contains the fuel pump and the fuel sender assembly. The fuel pump is located inside the reservoir and supplies fuel through the fuel pump module manifold to the engine and the fuel pump module jet pump.
11. The inertia fuel shut-off (IFS) switch is used to de-energize the fuel delivery secondary circuit in the event of a collision. The IFS switch is a safety device that should only be reset after a thorough inspection of the vehicle (following a collision).



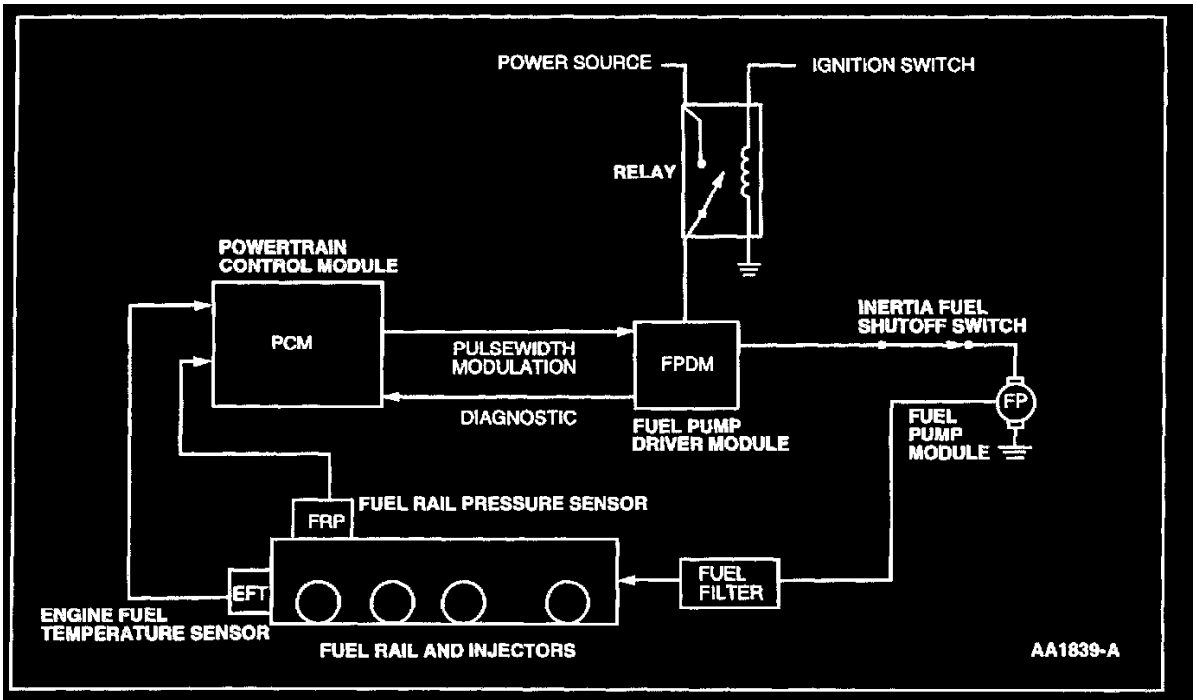


Figure 68: Typical Electronic Returnless Fuel System Schematic (NOTE: See wiring diagram for proper power source and relay usage.)

Electronic Returnless Fuel System Schematic

Fuel Pump and Reservoir

The fuel pump module is mounted inside the fuel tank in a reservoir. The pump has a discharge check valve that maintains system pressure after the ignition key has been turned off to minimize starting concerns. The reservoir prevents fuel flow interruptions during extreme vehicle maneuvers with low tank fill levels.

Fuel Pump Module

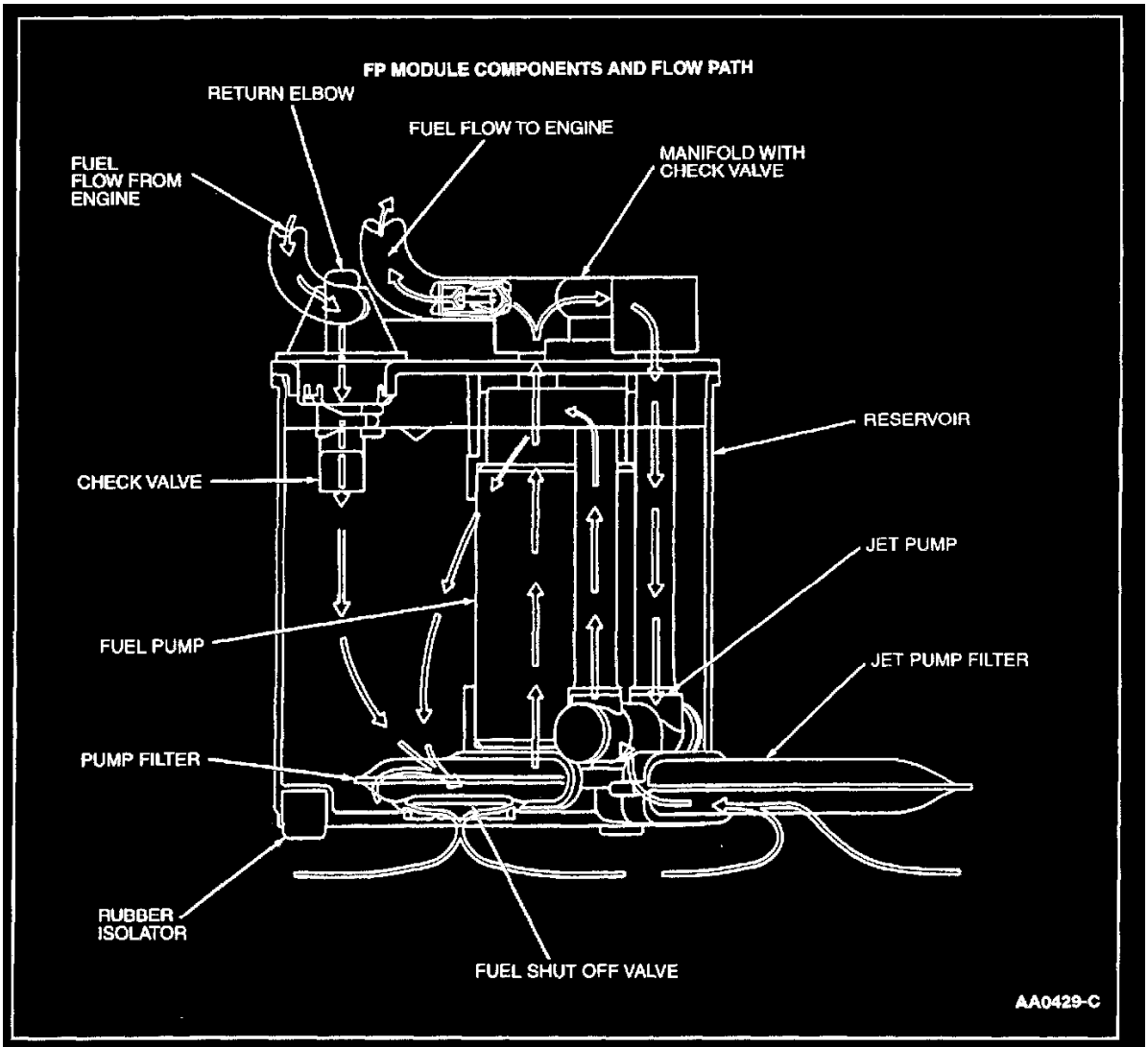
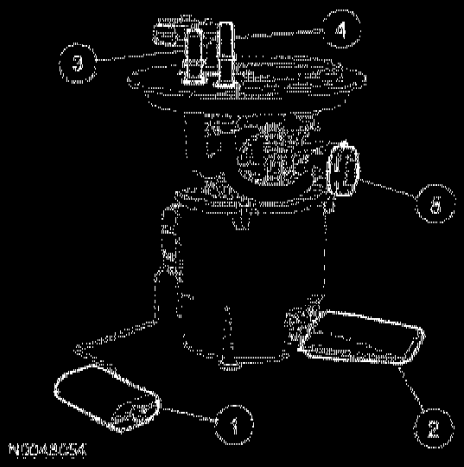


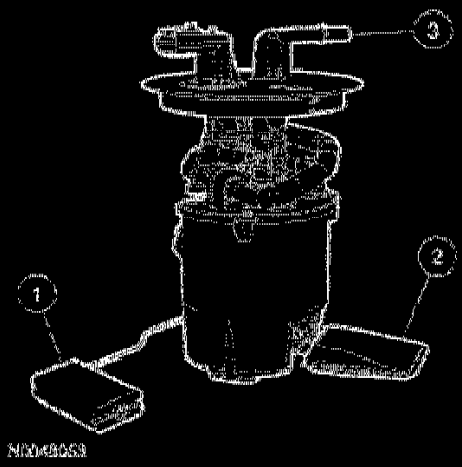
Figure 69: Fuel Pump Module (For Returnable Fuel Systems)

Fuel Pump Module



Item	Number	Description
1	—	Fuel Level Float
2	—	Fuel Intake Filter
3	—	Fuel Supply
4	—	Fuel Return from Fuel Filter
5	—	Fuel Pressure Regulator

Figure 70.



Item	Number	Description
1	—	Fuel Level Float
2	—	Fuel Intake Filter
3	—	Fuel Supply

Figure 71.

The fuel pump (FP) module is a device that contains the fuel pump and sender assembly. The fuel pump is located inside the FP module reservoir and supplies fuel through the FP module manifold to the engine and FP module jet pump. The jet pump continuously refills the reservoir with fuel, and a check valve located in the manifold outlet maintains system pressure when the fuel pump is not energized. A flapper valve located in the bottom of the reservoir allows fuel to enter the reservoir and prime the fuel pump during the initial fill.

Fuel Filters

The system contains four filtering or screening devices. Refer to the individual component pictorial for location.

1. The fuel intake sock or screen is a fine nylon mesh sock mounted on the intake side of the fuel pump. It is part of the assembly and cannot be serviced separately.
2. The filter/screen at the fuel rail port of the Injectors is part of the fuel injector assembly and cannot be serviced separately.
3. The filter/screen at fuel inlet side of the fuel pressure regulator is part of the regulator assembly and cannot be serviced separately.
4. The fuel filter assembly is located between the fuel pump (tank) and the pressure test point (schrader valve) or Injectors. This filter may be serviced.

Pressure Test Point

There is a pressure test point with a schrader fitting in the fuel rail that relieves fuel pressure and measures the fuel injector supply pressure for service and diagnostic procedures. Before servicing or testing the fuel system, read any CAUTION, WARNING, and HANDLING information. ON VEHICLES NOT EQUIPPED WITH A SCHRADER VALVE, USE ROTUNDA FUEL PRESSURE TEST KIT #134-R0087 OR EQUIVALENT.

Fuel Injector

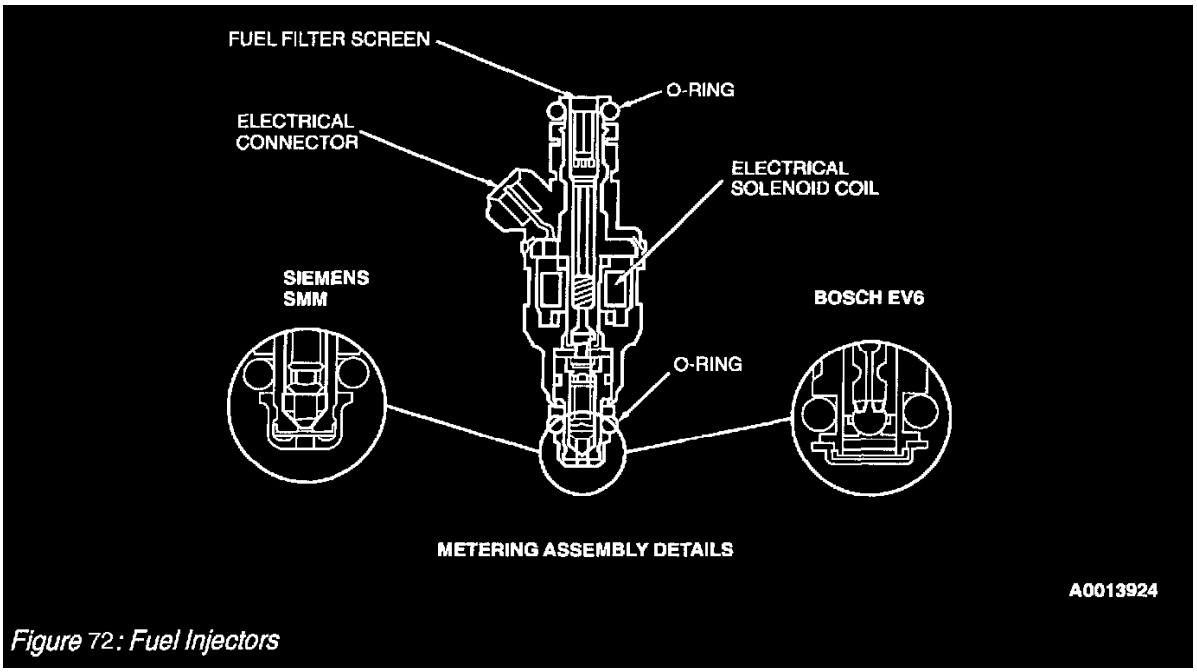


Figure 72: Fuel Injectors

Fuel Injectors

The fuel injector (Figure 70) is a solenoid-operated valve that meters fuel flow to the engine. The fuel injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel is controlled by the length of time the fuel injector is held open.

The fuel injector is normally closed and is operated by **12 volt** VPWR from the electronic engine control power relay. The ground signal is controlled by the PCM.

CAUTION: Do not apply battery positive voltage (B+) directly to the fuel injector electrical connector terminals. The solenoids may be damaged internally in a matter of seconds.

The injector is the Deposit Resistant Injection **(DRI)** type and does not have to be cleaned. However, it can be flow checked and, if found outside of specification, the fuel injector should be replaced.

Fuel Pressure Regulator

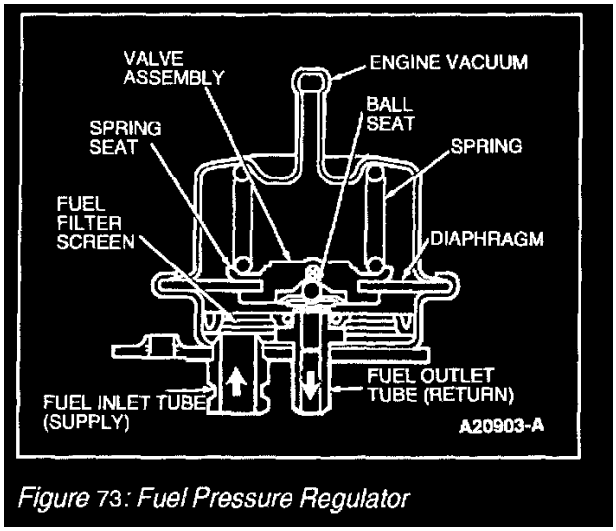


Figure 73: Fuel Pressure Regulator

Fuel Pressure Regulator

The fuel pressure regulator (Figure 71) is attached to the fuel rail downstream of the fuel injectors. It regulates fuel pressure supplied to the fuel injectors. The regulator is a diaphragm-operated relief valve. One side of the diaphragm senses fuel pressure and the other side is connected to the intake manifold vacuum. Fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold vacuum maintains a constant fuel pressure drop across the fuel injectors. Fuel pressure is high when engine vacuum is low. Excess fuel is bypassed through the fuel pressure regulator and returned through the fuel return line to the fuel tank.

Fuel Rail Pulse Damper

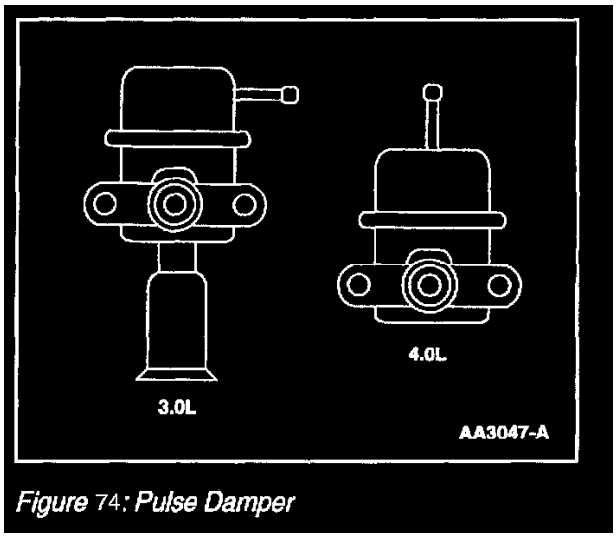


Figure 74: Pulse Damper

Pulse Damper

The fuel rail pulse damper (Figure 72) located on the fuel rail reduces fuel system noise caused by the pulsing of the fuel injectors. The vacuum port located on the damper is connected to manifold vacuum to avoid fuel spillage in the event the pulse damper diaphragm were to rupture. (The pulse damper should not be confused with a fuel pressure regulator, it does not regulate fuel rail pressure.)