

Fuel Tank and Lines - System Operation and Component Description

System Operation

Fuel Systems

The fuel system supplies the fuel injectors with clean fuel at a controlled pressure. The PCM controls the fuel pump and monitors the fuel pump circuit. The PCM controls the fuel injector ON/OFF cycle duration and determines the correct timing and amount of fuel delivered. When a new fuel injector is installed it is necessary to reset the learned values contained in the KAM in the PCM.

The mechanical returnless fuel system (MRFS) can be configured with a dual or variable speed fuel pump. The MRFS incorporates a fuel pump control module which is used to control the speed of the fuel pump. The MRFS uses a fuel tank with reservoir, the fuel pump, the fuel pump control module, the fuel pressure regulator, the fuel filter, the fuel supply line, the fuel rail, and fuel injectors.

A pressure accumulator is incorporated into the fuel line to prevent fuel vapor formation after several hours of cold soak and reduce crank time.

- The fuel delivery system is enabled during ignition ON, engine OFF for 1 second and during crank or running mode once the PCM receives a CKP sensor signal. The high pressure fuel system may be under vacuum after several hours of cold soak. Fuel vapor may collect at the fuel injection pump, causing a long start condition. To prevent this, the fuel pump relay is energized, depending on application, when the PCM receives a calibrated signal. This causes the fuel pump control module and the fuel pump to cycle and purge any trapped air or fuel vapor from the high pressure fuel system.
- The fuel pump logic is defined in the fuel system control strategy and executed by the PCM.
- The fuel pump control module relay is located inside the battery junction box. The fuel pump control module relay provides voltage to the fuel pump control module.
- The PCM commands a duty cycle to the fuel pump control module. The fuel pump control module reports diagnostic information to the PCM. The fuel pump control module controls the voltage to the FP based on the duty cycle request from the PCM. Voltage for the fuel pump is supplied by the fuel pump control module relay.
- For vehicles with gasoline direct fuel injection, a fuel pressure sensor monitors the low pressure fuel system.
- For vehicles with gasoline direct fuel injection, the fuel injection pump raises fuel system pressure to as high as 15 MPa (2175 psi), and delivers it to the fuel rail.
- 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 fuel injector is normally closed and is operated by the PCM.
- There are 3 to 5 filtering or screening devices in the fuel delivery system.
- The FP assembly contains the fuel pump, the fuel pressure regulator, lifetime fuel filter and the fuel sender assembly. The fuel pressure regulator is attached to the FP assembly and regulates the pressure of the fuel supplied to the fuel injectors. The fuel pressure regulator controls the pressure of the clean fuel as the fuel returns from the fuel filter. The fuel pressure regulator is a diaphragm operated relief valve. Fuel pressure is established by a spring preload applied to the diaphragm. The FP assembly is located in the fuel tank.

Fuel Pump Control

The FP signal is a duty cycle command sent from the PCM to the fuel pump control module. The fuel pump control module uses the FP command to operate the fuel pump at the speed requested by the PCM or to turn the fuel pump OFF. A valid duty cycle to command the fuel pump ON, is in the range of 15-47%. The fuel pump control module doubles the received duty cycle and provides this voltage to the fuel pump as a percent of the battery voltage. When the ignition is turned ON, the fuel pump runs for about 1 second and is requested OFF by the PCM if engine rotation is not detected.

Fuel Pump Duty Cycle Output From PCM

FP Duty Cycle Command	PCM Status	Fuel Pump Control Module Actions
0-5%	Invalid OFF duty cycle.	The fuel pump control module sends a 20% duty cycle signal on the FPM circuit. The fuel pump is OFF.
5-47%	Normal operation.	The fuel pump control module operates the fuel pump at the speed requested. FP duty cycle times 1.43 minus 14.29 equals pump speed % of full ON. For example, FP duty cycle equals 42%. 42 times 1.43 minus 14.29 equals 46 (rounded). Pump is run at 46% of full ON. The fuel pump control module sends a 60% duty cycle signal on the FPM circuit.
47-51%	Normal operation - full ON.	The fuel pump control module operates the fuel pump at full ON. The fuel pump control module sends a 60% duty cycle signal on the FPM circuit.
51-67%	Invalid OFF duty cycle.	The fuel pump control module sends a 20% duty cycle signal on the FPM circuit. The fuel pump is OFF.
67-83%	Valid OFF duty cycle.	The fuel pump control module sends a 60% duty cycle signal on the FPM circuit. The fuel pump is OFF.
83-100%	Invalid ON duty cycle.	The fuel pump control module sends a 20% duty cycle signal on the FPM circuit. The fuel pump is OFF.

Fuel Pump Monitor (FPM)

The fuel pump control module communicates diagnostic information to the PCM through the FPM circuit. This information is sent by the fuel pump control module as a duty cycle signal. The duty cycle signals that may be sent are listed in the following table.

Fuel Pump Control Module Duty Cycle Signals

Duty Cycle	Comments
20%	This duty cycle indicates the fuel pump control module is receiving an invalid duty cycle from the <u>PCM</u> .
60%	This duty cycle indicates the fuel pump control module is functioning normally.
80%	This duty cycle indicates the fuel pump control module is detecting a concern with the secondary circuits.

Fuel Filters

The system contains 3 to 5 filtering or screening devices.

- The fuel intake filter or screen is a fine nylon mesh filter mounted on the intake side of the fuel pump. It is part of the assembly and cannot be repaired separately.
- The filter/screen at the fuel rail port of the injectors is part of the fuel injector assembly and cannot be repaired separately
- The filter/screen at fuel inlet side of the fuel pressure regulator is part of the regulator assembly and cannot be repaired separately.
- The fuel filter assembly is located between the fuel pump and injectors. This filter may be a lifetime fuel filter located in the fuel pump assembly or an external 3 port inline filter that allows clean fuel to return to the fuel tank. A new filter may be installed for the external filter.
- The fuel filter sock is located on the fuel pump assembly between the reservoir and the fuel tank. The fuel filter sock is located on the fuel pump assembly between the reservoir and the fuel tank.

Component Description

Fuel Pump (FP) Assembly

The FP assembly contains the fuel pump and sender assembly. The fuel pump is located inside the FP assembly reservoir and supplies fuel through the FP assembly manifold to the engine and FP assembly 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 Pump Control Module

The fuel pump control module receives a duty cycle signal from the PCM and controls the fuel pump operation in relation to this duty cycle. The PCM requests low or high speed fuel pump operation depending on engine fuel demand. The fuel pump control module controls the fuel pump by switching the fuel pump power circuit ON and OFF at the required duty cycle. The fuel pump control module sends diagnostic information to the PCM on the FPM circuit.

The high pressure fuel system may be under vacuum after several hours of cold soak. Fuel vapor may collect at the fuel injection pump, causing a long start condition. To prevent this, the fuel pump relay is energized, depending on application, when the PCM receives a calibrated signal. This causes the fuel pump control module and the fuel pump to cycle and purge any trapped air or fuel vapor from the high pressure fuel system.