Fuel Systems

Overview

The fuel system supplies the sequential multiport fuel injection (SFI) fuel injectors with clean fuel at a controlled pressure. The powertrain control module (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 keep alive memory (KAM) in the PCM. Refer to Section 2, Resetting The Keep Alive Memory (KAM).

The 2 types of fuel systems used are:

- electronic returnless fuel
- mechanical returnless fuel

Electronic Returnless Fuel System (ERFS)

The electronic returnless fuel system consists of a fuel tank with reservoir, the fuel pump, the fuel rail pressure (FRP) or fuel rail pressure temperature (FRPT) sensor, the fuel filter, the fuel supply line, the fuel rail, and the fuel injectors. For additional information on the fuel system components, refer to Engine Control Components in this section. Operation of the system is as follows:

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 FPDM modulates the voltage to the fuel pump (FP) required to achieve the correct fuel pressure. Voltage for the fuel pump is supplied by the power relay or FPDM power supply relay. For additional information refer to Fuel Pump Control and Fuel Pump Monitor.

5. The FRP or FRPT 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 FRPT sensor measures the 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 fuel injector is normally closed, and is operated by a 12-volt source from either the electronic engine control (EEC) power relay or the fuel pump relay. The ground signal is controlled by the PCM.

8. There are 3 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 fuel rail.

9. 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.

10. 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.
Fuel Pump Control — ERFS

Note: The Mustang 5.4L uses 2 FPDMs to control fuel for the fuel delivery system. The PCM sends one FP duty cycle on the fuel pump control (FPC) circuit. This circuit is used by both FPDMs.

The FP signal is a duty cycle command sent from the PCM to the FPDM. The FPDM uses the FP command to operate the fuel pump at the speed requested by the PCM or to turn the pump off.

<table>
<thead>
<tr>
<th>FP Duty Cycle Command</th>
<th>PCM Status</th>
<th>FPDM Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5%</td>
<td>PCM does not output this duty cycle.</td>
<td>Invalid FP duty cycle. FPDM sends 25% duty cycle signal on the fuel pump monitor (FPM) circuit. The fuel pump is off.</td>
</tr>
<tr>
<td>5-51%</td>
<td>Normal operation.</td>
<td>FPDM operates the fuel pump at the speed requested. “FP duty cycle” x 2 equals pump speed % of full on. (for example, FP duty cycle equals 42%. 42x2 equals 84. Pump is run at 84% of full on).</td>
</tr>
</tbody>
</table>
For additional information, refer to Powertrain Control Hardware, Fuel Pump Driver Module (FPDM).

Fuel Pump Monitor (FPM) — ERFS

Note: The Mustang 5.4L uses 2 FPDMs to control fuel for the fuel delivery system. The PCM individually monitors both FPDMs through the FPM and FPM2 circuits.

The FPDM communicates diagnostic information to the PCM through the FPM circuit. This information is sent by the FPDM as a duty cycle signal. The 3 duty cycle signals that may be sent are listed in the following table.

FUEL PUMP DRIVER MODULE DUTY CYCLE SIGNALS

<table>
<thead>
<tr>
<th>Duty Cycle</th>
<th>On Time (msec)</th>
<th>Comments</th>
<th>FP_M PID</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>500</td>
<td>All OK output from FPDM. With this input, the PCM can verify that the FPDM is powered and able to communicate on the FPM circuit.</td>
<td>80-125%</td>
</tr>
<tr>
<td>25%</td>
<td>250</td>
<td>FPDM did not receive a fuel pump (FP) duty cycle command from the PCM, or the duty cycle that was received was invalid.</td>
<td>15-60%</td>
</tr>
<tr>
<td>75%</td>
<td>750</td>
<td>The FPDM has detected a concern in the circuits between the fuel pump and FPDM.</td>
<td>250-400%</td>
</tr>
</tbody>
</table>

a If a duty cycle meter and breakout box is used, be aware that these values may be reversed depending on the trigger setting of the specific meter (for example, 25% from FPDM may read as 75% on duty cycle meter depending on trigger setting).

b Some scan tools display the FP_M PID as the duty cycle in column 1. Other scan tools display the FP_M PID as a value shown in the FP_M PID column. This value fluctuates randomly. It is OK for the value to briefly go outside this range, then return.

For additional information, refer to Powertrain Control Hardware, Fuel Pump Driver Module (FPDM).
Mechanical Returnless Fuel System (MRFS)

The MRFS consists of a fuel tank with reservoir, the fuel pump, the fuel pressure regulator, the fuel filter, the fuel supply line, the fuel rail, the fuel rail pulse damper (if equipped), fuel injectors, and a Schrader valve/pressure test point. For additional information on the fuel system components, refer to Engine Control Components in this section. Operation of the system is as follows:

1. The fuel delivery system is enabled during crank or running mode once the PCM receives a 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 power to the fuel pump.

4. The 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 and is used to measure the fuel injector supply pressure for diagnostic procedures and repairs. On vehicles not equipped with a Schrader valve, use the Rotunda Fuel Pressure Test Kit 134-R0087 or equivalent.

6. A pulse damper is located on the fuel rail (if equipped). The pulse damper reduces the 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 if the pulse damper diaphragm ruptures. 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 fuel injector is normally closed, and is operated by a 12-volt source from either the EEC power relay or the fuel pump relay. The ground signal is controlled by the PCM.

8. There are 3 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 FP module contains the fuel pump, the 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 the 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.
**Fuel Pump Control — MRFS**

The output signal from the PCM, FP, is used to control the electric fuel pump. With the EEC power relay contacts closed, vehicle power (VPWR) is sent to the coil of the fuel pump relay. For electric fuel pump operation, the PCM grounds the FP circuit, which is connected to the coil of the fuel pump relay. This energizes the coil and closes the contacts of the relay, sending B+ through the FP PWR circuit to the electric fuel pump. When the key is turned on, the electric fuel pump runs for about 1 second and is turned off by the PCM if engine rotation is not detected.

**Fuel Pump Monitor (FPM) — MRFS**

The FPM circuit is spliced into the fuel pump power (FP PWR) circuit and is used by the PCM for diagnostic purposes. The PCM sources a low current voltage down the FPM circuit. With the fuel pump off, this voltage is pulled low by the path to ground through the fuel pump. With the fuel pump off and the FPM circuit low, the PCM can verify that the FPM circuit and the FP PWR circuit are complete from the FPM splice through the fuel pump to ground. This also confirms that the FP PWR or FPM circuits are not short to power. With the fuel pump on, voltage is now being supplied from the fuel pump relay to the FP PWR and FPM circuits. With the fuel pump on and the FPM circuit high, the PCM can verify that the FP PWR circuit from the fuel pump relay to the FPM splice is complete. It can also verify that the fuel pump relay contacts are closed and there is a B+ supply to the fuel pump relay.

**Fuel Filters**
The system contains 4 filtering or screening devices. Refer to the individual component illustrations for locations.

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 repaired separately.

2. The filter/screen at the fuel rail port of the injectors is part of the fuel injector assembly and cannot be repaired separately.

3. The filter/screen at fuel inlet side of the fuel pressure regulator is part of the regulator assembly and cannot be repaired separately.

4. The fuel filter assembly is located between the fuel pump (tank) and the pressure test point (Schrader valve) or injectors. A new filter may be installed.

**Pressure Test Point**

On some applications there is a pressure test point with a Schrader fitting in the fuel rail that relieves the fuel pressure and measures the fuel injector supply pressure for repair and diagnostic procedures. Before repairing or diagnosing the fuel system, read any WARNING, CAUTION, and HANDLING information. On vehicles not equipped with a Schrader valve, use the Rotunda Fuel Pressure Test Kit 134-R0087 or equivalent.