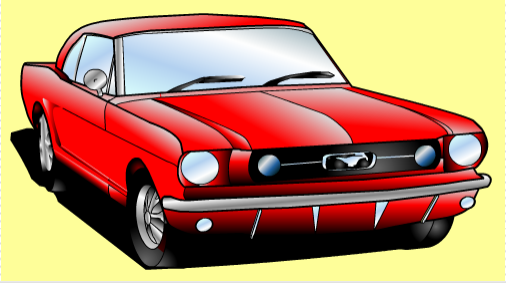
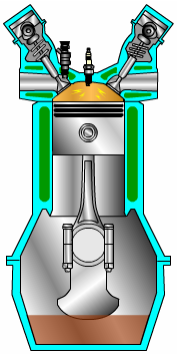
Fuel Systems

Matthew Whitten
Brookhaven College



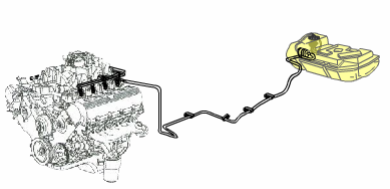
Fuel and Air

- The purpose of the fuel and air system is to achieve the ideal air/fuel mixture within the combustion chamber.
- The air and fuel must mix properly and at the right ratio to balance fuel economy, emissions, and power.



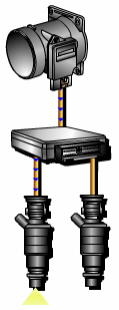
Air and Fuel Paths

- Air and Fuel are not mixed until they reach the intake valve and combustion chamber



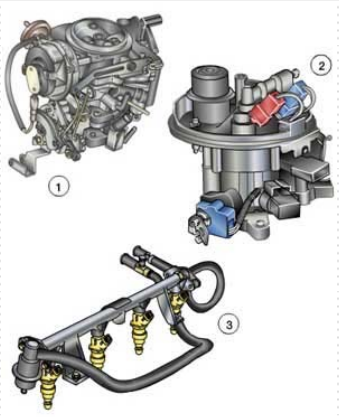
PCM Fuel Control

- Our current method of controlling the air fuel mixture includes numerous sensors and the ability to control outputs with great accuracy.
- Items used to determine A/F ratio:
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____



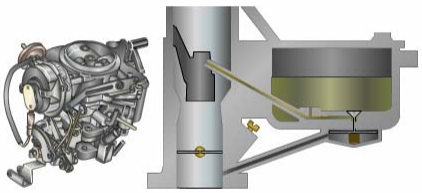
Past and Current Fuel Systems

1. Carburetor
2. CFI
3. PI



Carburetors

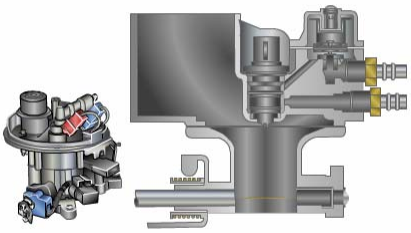
- Carburetors used the venturi effect to create a low pressure inside the intake port. This low pressure allowed the high pressure to push out the fuel from the fuel bowl.
- Pros:
  - Cheap
- Cons:
  - Not automatically adaptable to different conditions.



Return

CFI

- Central Fuel Injection
- Uses one or two centrally located low pressure fuel injectors to meter fuel.
- Pros:
  - Cheap
  - Computer control allowed for better A/F control
- Cons:
  - Air/Fuel charge must travel long distance. The fuel may drop out of the charge.



Return

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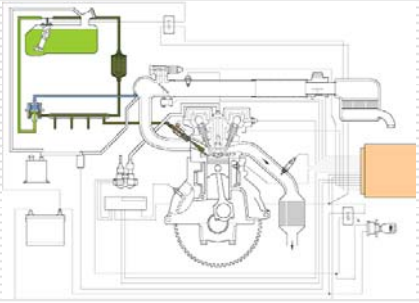
Port Injection

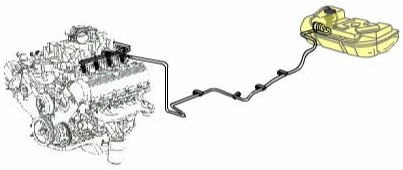
- Uses one or two injectors for each cylinder of the engine.
- Pros:
  - Precise control of Air/Fuel mixture. (can control bank to bank)
  - Better Air/Fuel mixture
- Cons:
  - More components to fail.
  - Costs more.



Return

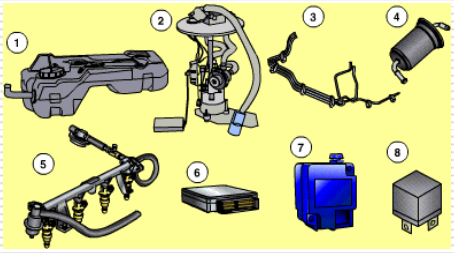
Fuel Delivery Systems

- Basic operation of fuel delivery system:
  - Fuel is delivered under pressure from a storage tank to the fuel metering device.
  - May also include the routing and storing of what other HC based product?



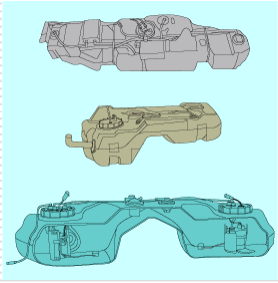
Basic Fuel System Components

1. Fuel Tank
2. Fuel Pump
3. Fuel Lines
4. Fuel Filter
5. Fuel Supply Manifold
6. PCM
7. Inertia Fuel Shutoff (IFS)
8. Fuel Pump Relay



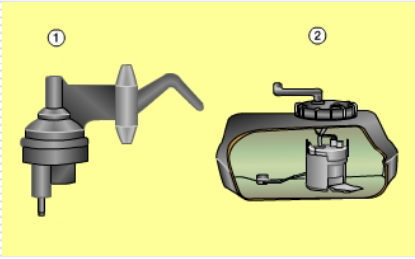
Fuel Tank

- Construction:
  - Plastic
  - Metal
- The Fuel Tank is the storage unit for the liquid and gaseous gasoline in the car.
- May house:
  - Fuel pump
  - Fuel pick up
  - Fuel level sensor
  - Fuel pressure regulator.
  - Check valves
  - Transfer Pump
  - Baffles
- Mountings
- Shapes



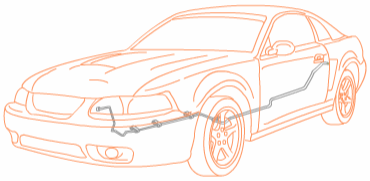
Fuel Pump

- Types:
  1. Mechanical, diaphragm
  2. Electric, vane or gerotor
- Mechanical fuel pumps were driven off the camshaft eccentric, and supplied low pressure fuel to a carburetor.
- Electric fuel pumps are controlled by a module, and may be located on the frame or in the fuel tank. These supply high pressure fuel to the injection system.



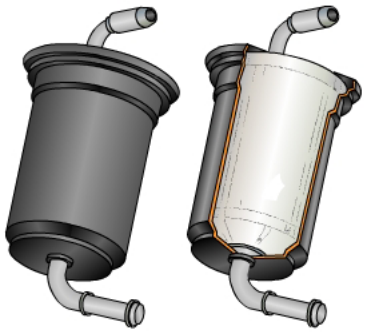
Fuel Lines

- Used to contain pressurized and non-pressurized fuel.
- What materials are fuel lines commonly made of?



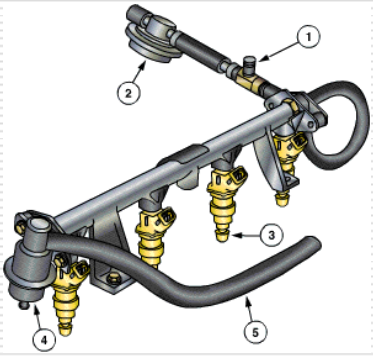
Fuel Filter

- Gasoline engines:
  - Self contained serviceable unit. (except fusion)
  - Inlet port and outlet port.
  - Some Return-less fuel systems utilize three ports. (inlet, outlet, parallel over pressurization)



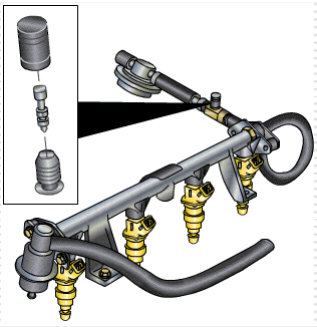
Fuel Supply Manifold

- Components:
  1. Schrader valve
  2. Pulse dampener
  3. Fuel injector
  4. Pressure regulator
  5. Manifold line



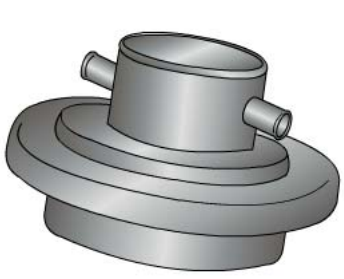
Schrader Valve

- The fuel rail has a pressure test port to help in diagnosis.
- The Schrader valve can be replaced if leaking, but only used fuel compatible valves.
- After using the port always reinstall the cap to keep the port clean and to prevent leaks.



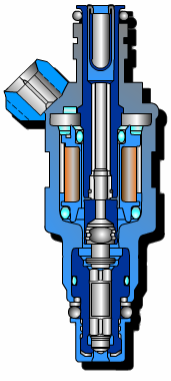
Pulse Dampener

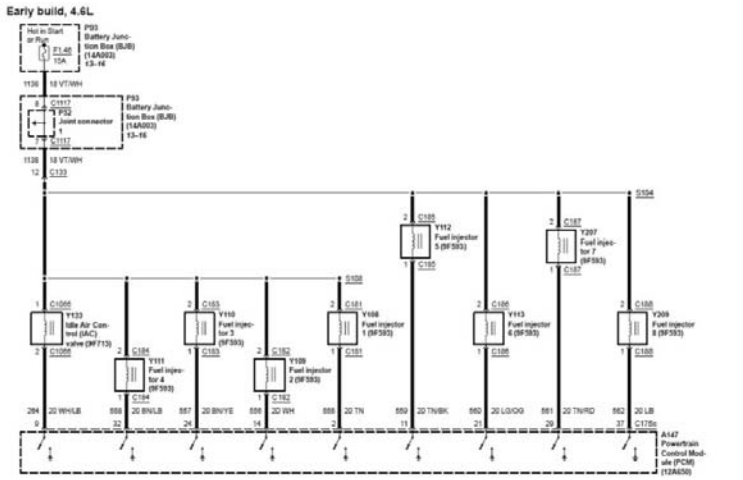
- The pulse dampener is used attenuate the pulses of the injectors opening and closing. If the pulses are not attenuated there is a possibility that the fuel will cavitate. If the fuel cavitates there will not be enough fuel injected.



Fuel Injector

- The fuel injector is a normally closed solenoid.
- The PCM directly/indirectly controls the injector?





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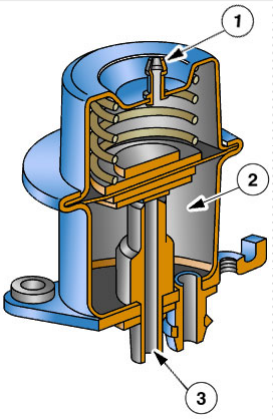
Pressure Regulator

- On a return type fuel system the regulator is mounted to the fuel rail.
- Engine vacuum is used to control fuel pressure.
- As vacuum is applied to the diaphragm it retracts the return pintle, allowing fuel pressure to dump back to the tank. At WOT spring pressure forces the return port closed.
- Components:
  1. Manifold vacuum
  2. Fuel
  3. Return



Inertia Fuel Cutt/off

- In the event of an collision the IFS will interrupt the electrical current controlling the fuel pump

Fuel Pump Relay

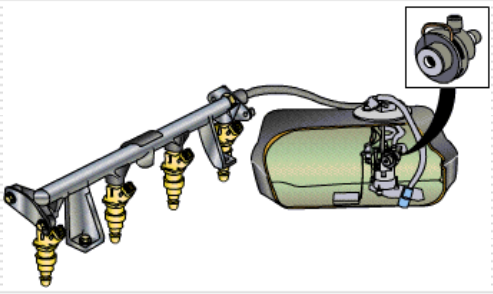
- The fuel pump is a/an _____ output, and the fuel pump relay is a/an _____ output.

Returnless Fuel Systems

- In returnless fuel systems only the needed fuel is sent to the rail.
- This reduces evaporative emissions by lowering the temperature of the liquid and stopping the constant return stream.
- Provides a better resolution of control over the fuel pressure applied to the injectors.
- Types:
  - Mechanical
  - Electronic

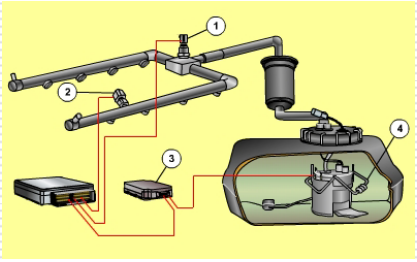
Mechanical Returnless Systems

- This system is very similar to the return systems. The pressure regulator is placed on the FDM and instead of vacuum the pressure is maintained at one pressure by a calibrated spring. Any pressure that is not needed is simply dumped back into the tank directly.



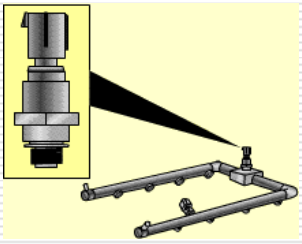
Electronic Returnless

- Fuel pressure is controlled by modulating the current to the fuel pump.
- Modulation is done by a FPDM.
- The FPDM is controlled by the PCM.
- Components:
  1. FPS
  2. FTS
  3. FPDM
  4. PPRV



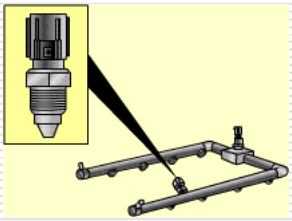
FPS

- Fuel Pressure Sensor
- This sensor is mounted on the fuel rail and samples the pressure within the fuel rail
- The sensor receives VREF from the PCM, and a variable resistance related to pressure drops the voltage.



FTS

- Fuel Temperature Sensor
- This is a thermistor device used to sample the temperature of the fuel in the rail.
- At high temperatures the PCM can command higher pressure to prevent vaporization of the fuel.



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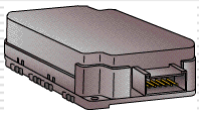
FPDM

- Fuel Pump Driver Module
- This module receives a command from the PCM, this command is then used to control the fuel pump current.



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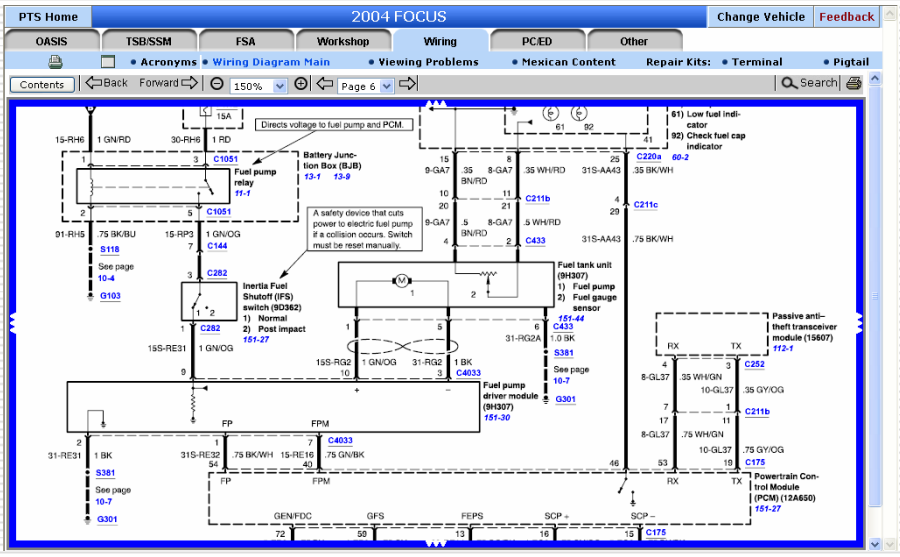

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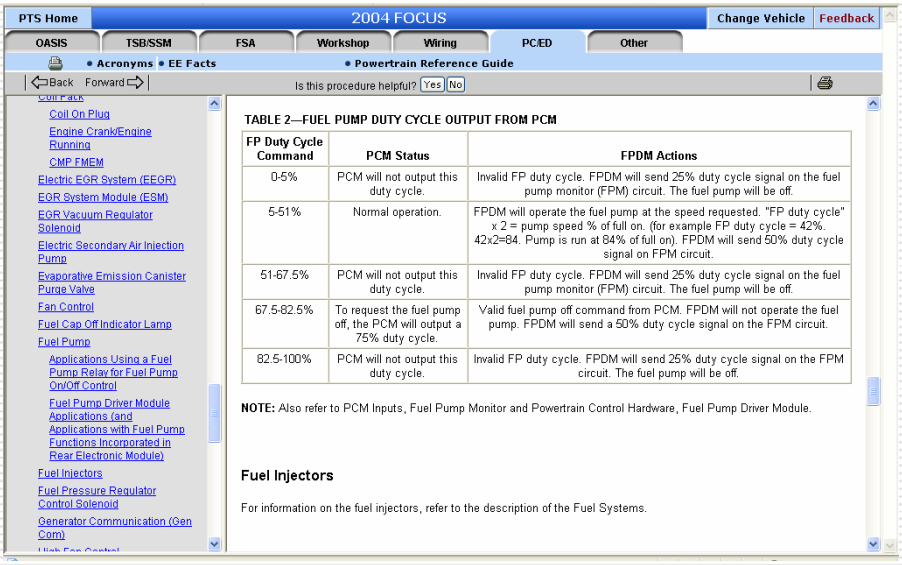


TABLE 2—FUEL PUMP DUTY CYCLE OUTPUT FROM PCM

FP Duty Cycle Command	PCM Status	FPDM Actions
0-5%	PCM will not output this duty cycle.	Invalid FP duty cycle. FPDM will send 25% duty cycle signal on the fuel pump monitor (FPM) circuit. The fuel pump will be off.
5-51%	Normal operation.	FPDM will operate the fuel pump at the speed requested. "FP duty cycle" x 2 = pump speed % of full on. (for example FP duty cycle = 42%. 42x2=84. Pump is run at 84% of full on). FPDM will send 50% duty cycle signal on FPM circuit.
51-67.5%	PCM will not output this duty cycle.	Invalid FP duty cycle. FPDM will send 25% duty cycle signal on the fuel pump monitor (FPM) circuit. The fuel pump will be off.
67.5-82.5%	To request the fuel pump off, the PCM will output a 75% duty cycle.	Valid fuel pump off command from PCM. FPDM will not operate the fuel pump. FPDM will send a 50% duty cycle signal on the FPM circuit.
82.5-100%	PCM will not output this duty cycle.	Invalid FP duty cycle. FPDM will send 25% duty cycle signal on the FPM circuit. The fuel pump will be off.

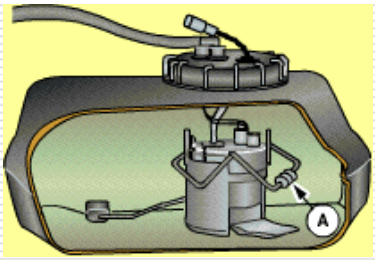
NOTE: Also refer to PCM Inputs, Fuel Pump Monitor and Powertrain Control Hardware, Fuel Pump Driver Module.

Fuel Injectors

For information on the fuel injectors, refer to the description of the Fuel Systems.

PPRV

- Parallel Pressure Relief Valve
- Due to the closed system any heat build up after the engine is off will directly influence the fuel.
- What will happen as the fuel system is convection heated?
  - Leaking injectors
  - Ruptured lines
  - Over fueling on start-up



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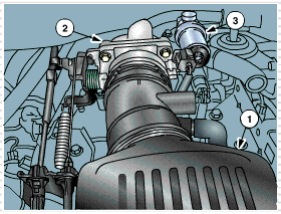
AUMT 2334 Fuel Systems

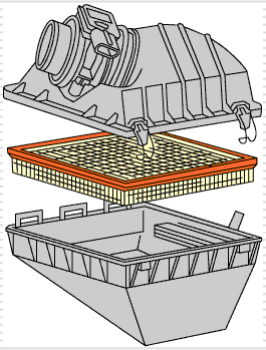
Air Inlet Systems

- The air inlet system consists of:
  - Air filter #1
  - Air filter housing
  - Air inlet tube
  - MAF sensor
  - Throttle Body #2
  - IAC #3



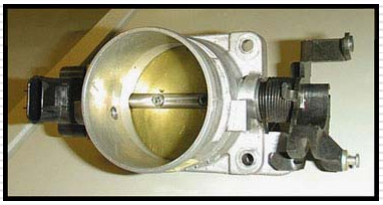
Air Filter and Housing

- The filter element is used to keep all incoming air to the engine free of particle contamination.
- The air filter is also a fire suppression device. (04S11)



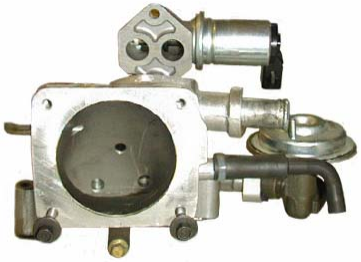
Throttle Body

- The throttle body is the main control valve for air entering the engine. The Throttle body may either be controlled by the driver, directly or indirectly.
- Throttle bodies are not to be adjusted in the field. If the throttle body is out of adjustment or damaged replace it.



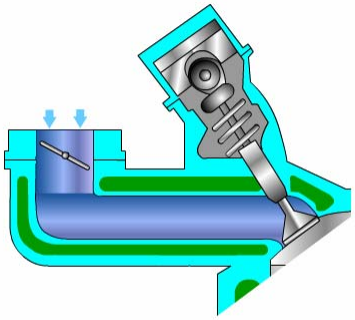
IAC

- Idle Air Control valve.
- The IAC is a normally closed solenoid.
- Its purpose is to provide an alternative path for air when the throttle plate is close. The solenoid is controlled by the PCM for idle, WOT, transmission and dashpot control.
- The old Ford term:
  - Air bypass valve



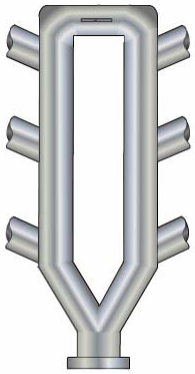
Resonance

- The air that is entering the engine is abruptly stopped by the closing intake valve. This causes a bouncing of the intake air.
- There are some systems used to utilize the resonance to increase efficiency of the engine.
  - IMTV
  - IMRC
  - SCV



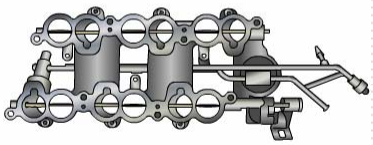
IMTV

- The separation of the two banks of the intake allows for different resonance frequencies.



IMRC

- The Intake Manifold Runner Control assembly provides two different intake paths, and allows one to be closed off.
- At low rpm on side is closed.
- At high rpm both sides are open.



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SCV

- Swirl Control Valve
- The SCV controls the velocity of the incoming air.

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