Electrical Components

- Sensors
- Actuators
- ECM
- Glow Plug System

Components Overview

- The ECM uses information from the sensors to decide which commands to send to the actuators, and the glow plug system.

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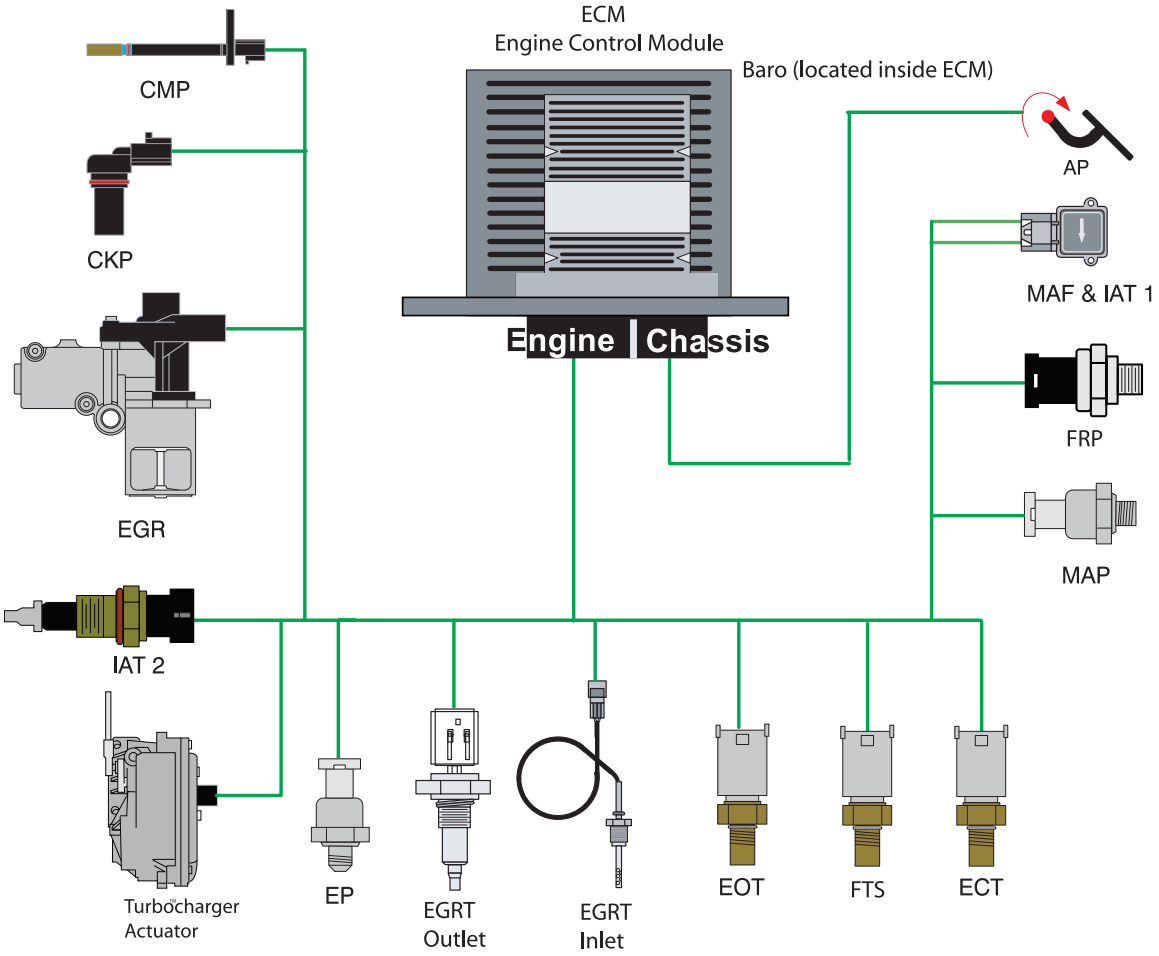
Sensor Overview



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Sensors Overview

- The ECM sends a reference voltage (Vref) of 5.0 volts (external power) to the pressure sensors and 5.0 volts (internal power) to the temperature sensors, except for CMP and CKP which generate voltage through the collapse of a magnetic field.
- The sensor signals are conditioned by the interface circuits within the ECM. The signals are used as inputs to various control strategies.

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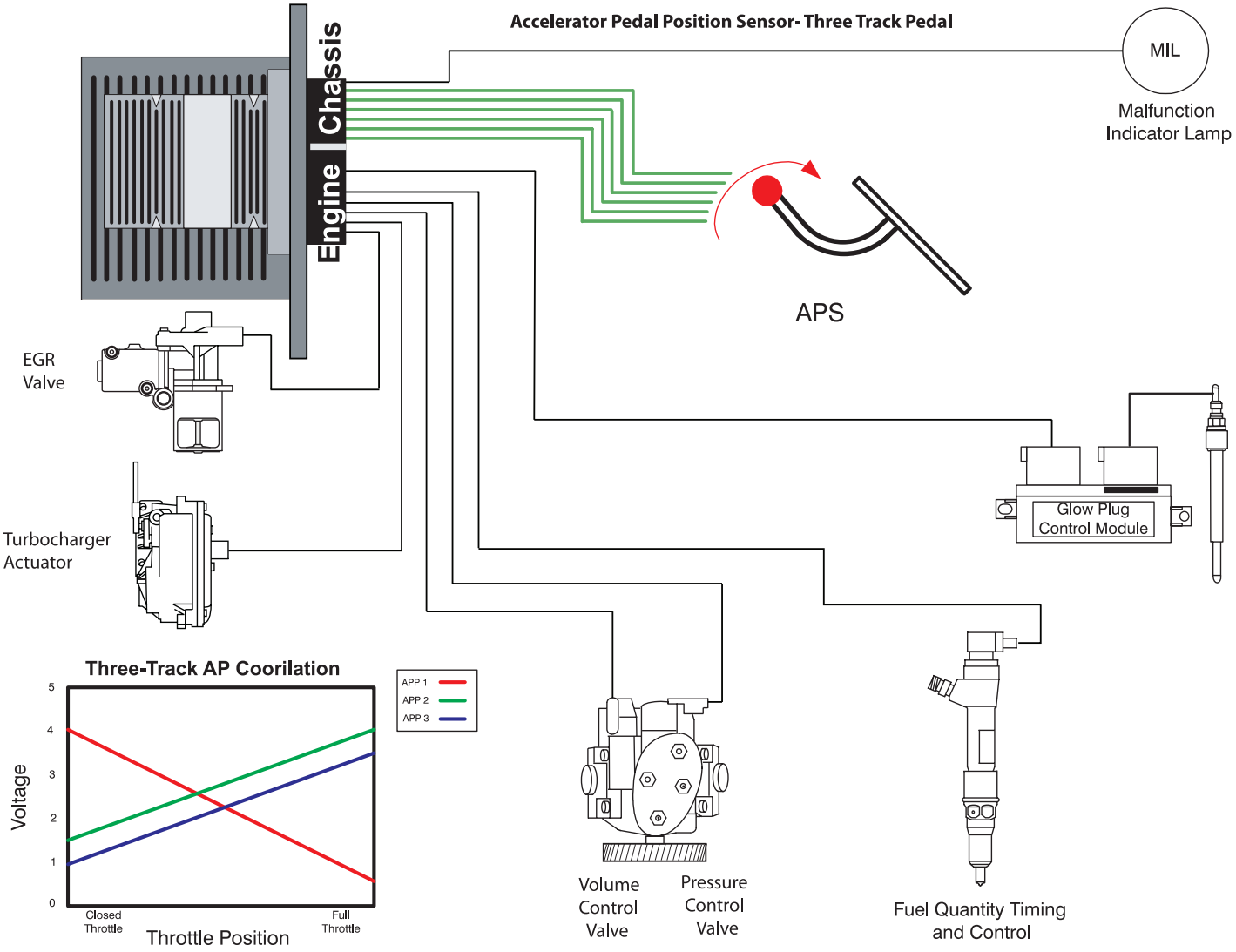
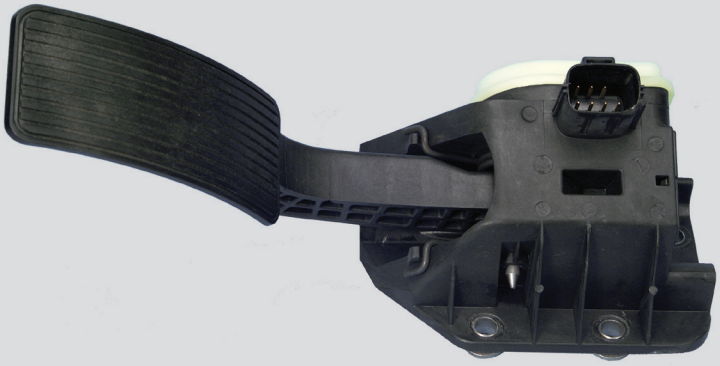
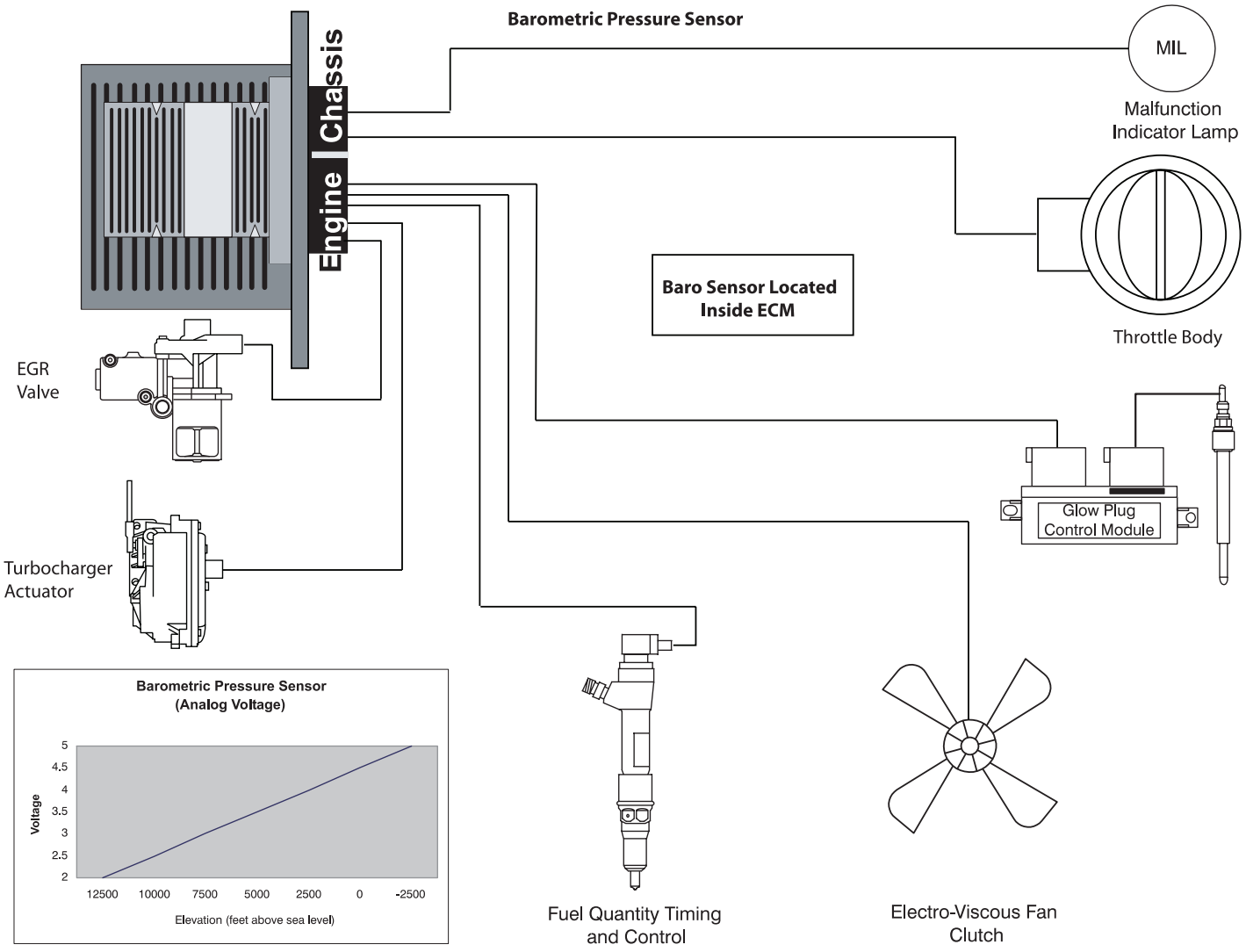


AP (Accelerator Pedal Position)

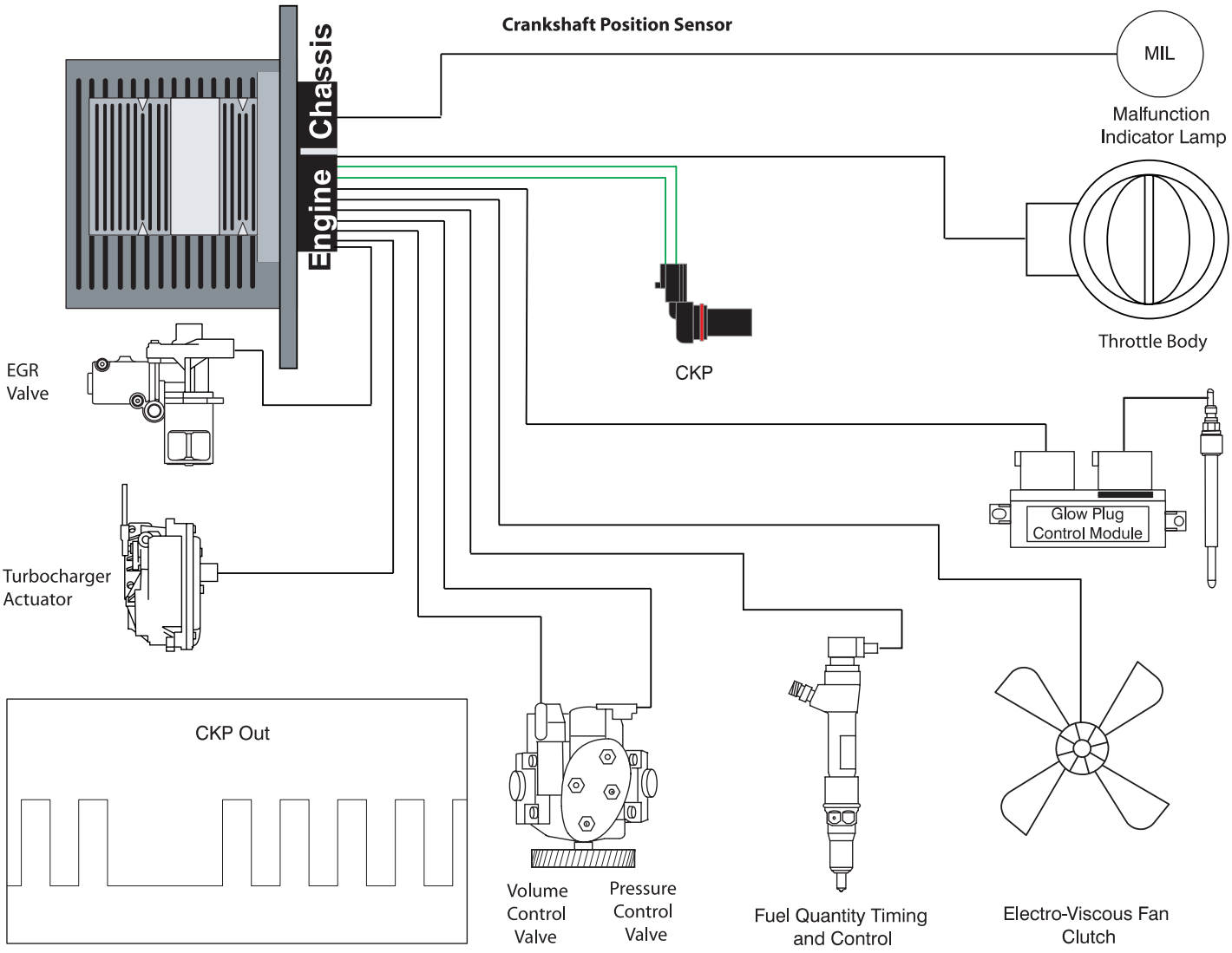
- The AP (Accelerator Pedal) is a three track pedal. The AP incorporates three potentiometers. Throughout the movement of the AP the resistance values of the three potentiometers must agree. During the movement of the AP if any of the three potentiometer readings do not agree, the check engine light will illuminate and the vehicle will continue to perform as normal. If two signals from the AP are lost the ECM will allow the engine to idle only and illuminate the check engine light.
- Having three (3) signals for comparison is an added safety feature.





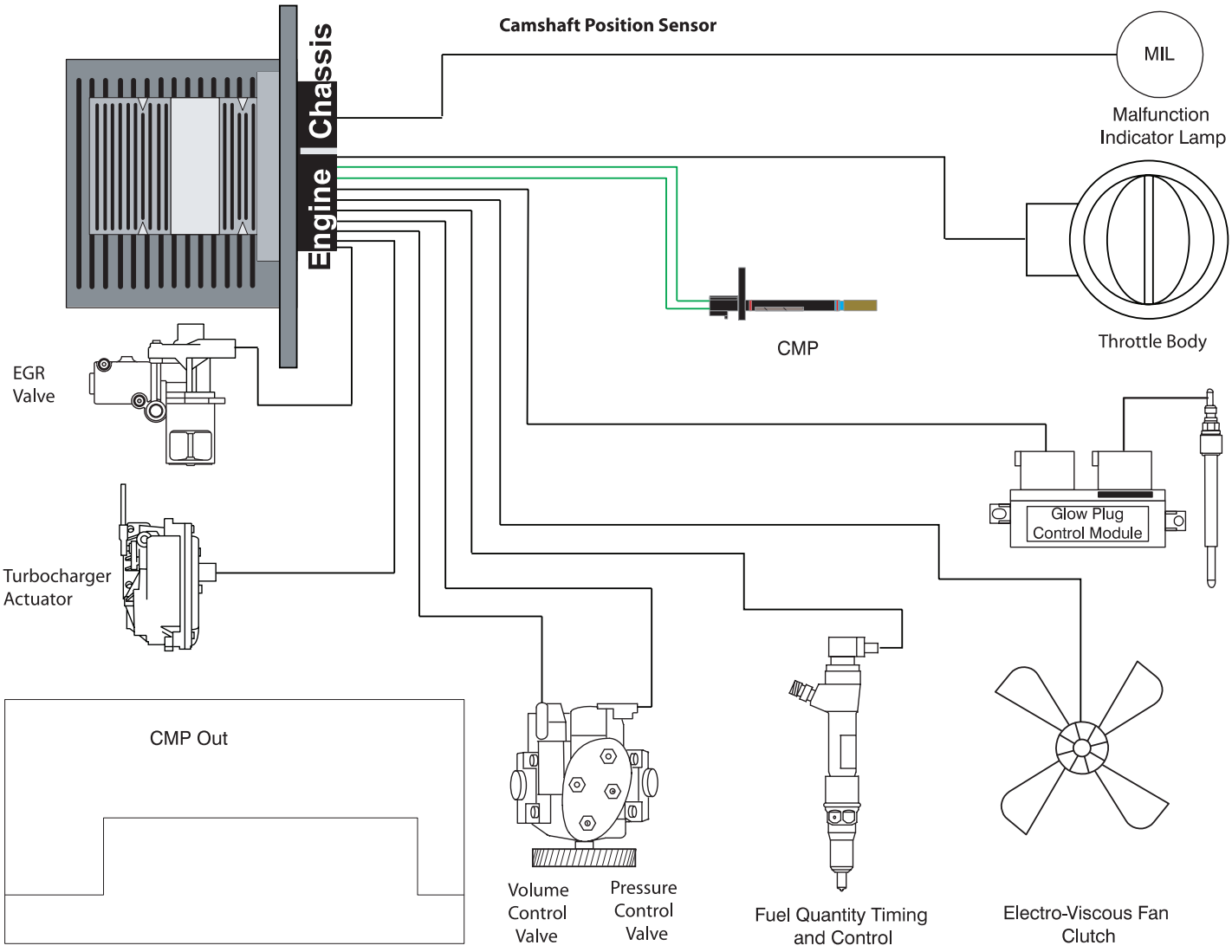
Baro (Barometric Pressure)

- The ECM supplies a 5 volt reference signal which the Baro sensor uses to produce a linear analog voltage signal that indicates pressure.
- The primary function of the Baro sensor is to provide altitude information so that the ECM can adjust timing, fuel quantity, glow plug on time, and turbocharger control.
- The Baro sensor is located inside the ECM. If the sensor fails, the ECM must be replaced.



CKP (Crankshaft Position)

- The crankshaft position signal source is a magnetic pickup sensor mounted in the right front side of the engine block.
- The sensor reacts to a trigger wheel positioned on the crankshaft. The trigger wheel is a 60 minus 2 tooth steel disk with 58 evenly spaced teeth and a slot that's width is equivalent to removing 2 teeth (minus 2 slot) that is the SYNC gap.
- The sensor produces sine waves (converted to square waves via the ECM) for each tooth edge that breaks the magnetic field created by the permanent magnet that is in the end of the sensor.
- Crankshaft speed is derived from the frequency of the CKP sensor signal.
- Crankshaft position can be determined by the syncronization of the CMP peg signal to the CKP minus 2 slot signal.
- Diagnostic information on the CKP input signal is obtained by performing accuracy checks on frequency.
- The ECM needs both the CKP and CMP signal to calculate engine position. The CKP creates a signal that relates to crankshaft speed and position relative to TDC (Top Dead Center). The CMP creates a signal relative to which stroke (compression or exhaust)



CMP (Camshaft Position)

- The camshaft position signal source is a magnetic pickup sensor mounted on the left front side of the engine block.
- The sensor reacts to a peg, pressed into the camshaft at the front of the engine.
- The peg will pass the sensor once per camshaft revolution, the sensor will produce a single pulse correspondingly.
- Camshaft speed is derived from the frequency of the CMP sensor signal.
- Diagnostic information on the CMP input signal is obtained by performing accuracy checks on signal levels and frequency.
- The ECM needs both the CKP and CMP signal to calculate engine position. The CMP creates a signal that the ECM uses to indicate a particular bank.
- The CMP contains a permanent magnet which creates a magnetic field, when the magnetic field is broken by the peg on the camshaft a signal in the form of a sine wave is created (converted to a square wave by the ECM).

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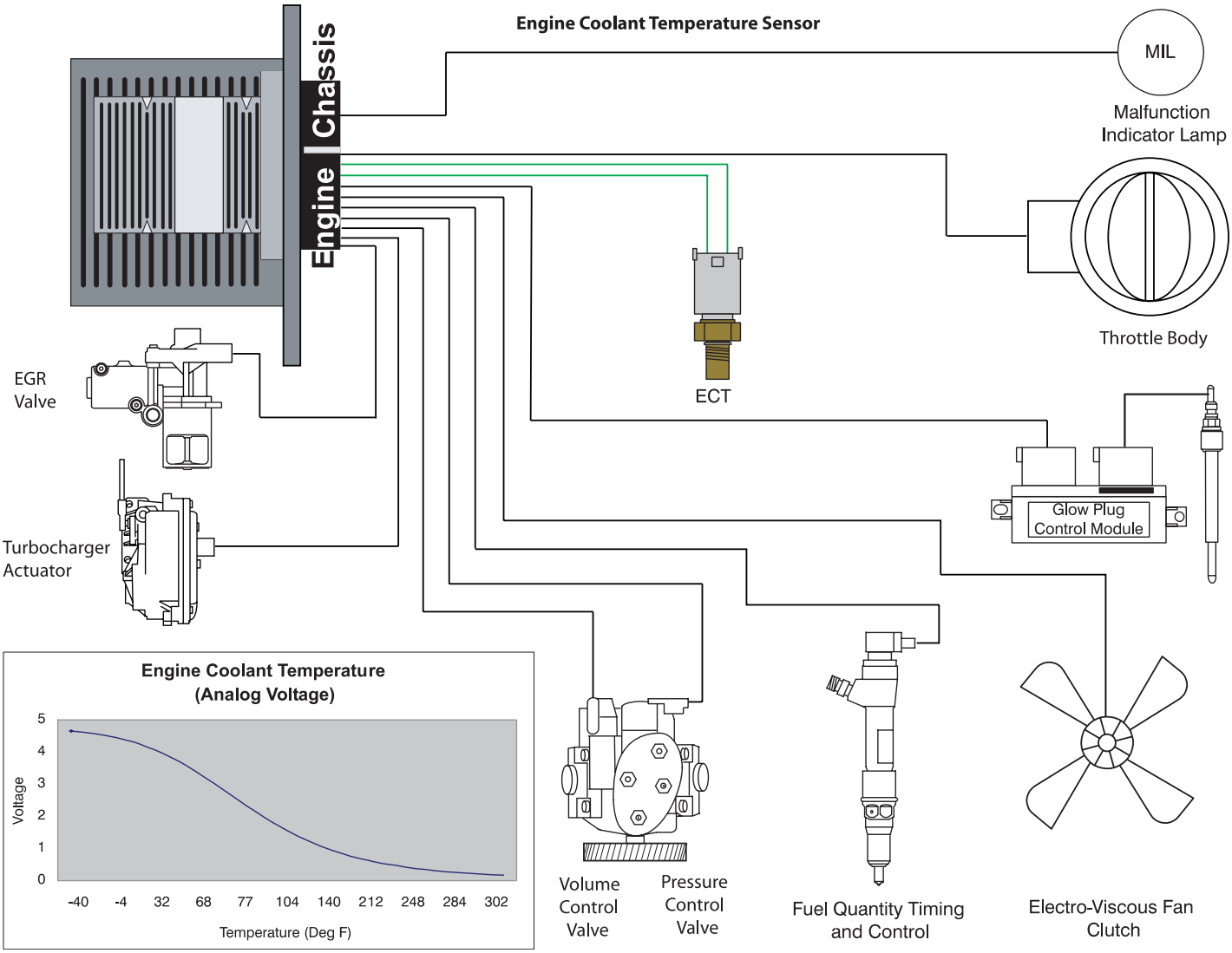
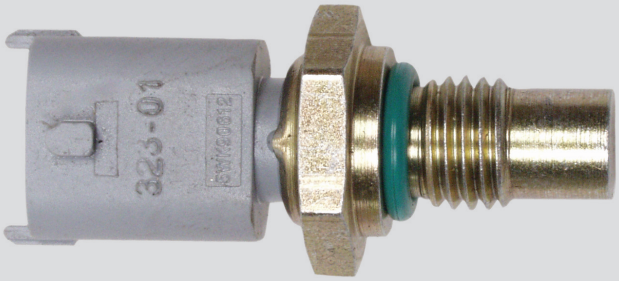
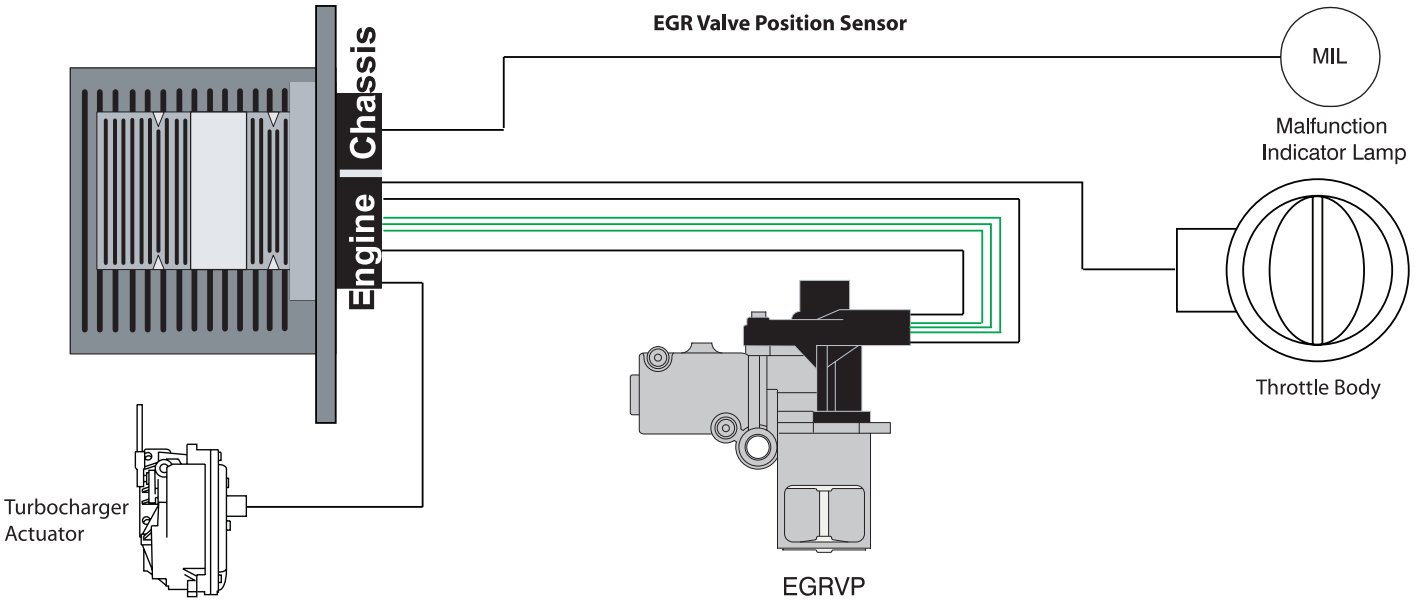
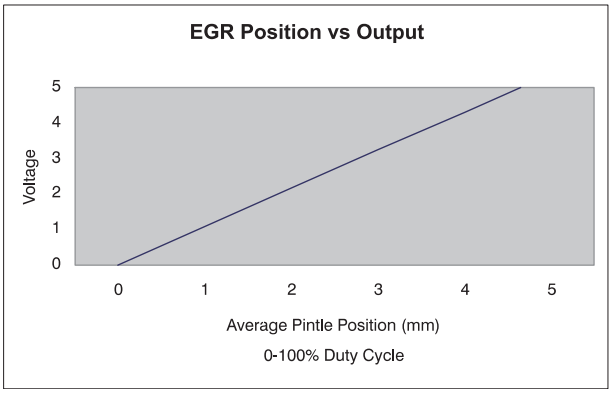


ECT (Engine Coolant Temperature)

- The ECT sensor is a two (2) wire thermistor sensor.
- The ECT sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECT sensor changes resistance when exposed to different temperatures.
- When the temperature of the coolant decreases, the resistance of the thermistor increases and the signal voltage increases.
- When the temperature of the coolant increases, the resistance of the thermistor decreases and the signal voltage decreases.



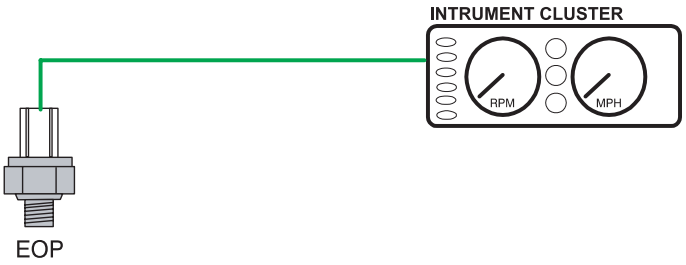


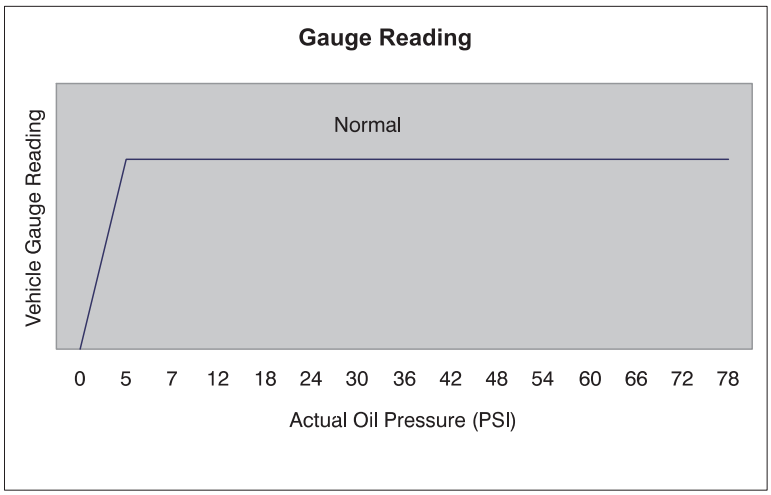


EGRVP (EGR Valve Position)

- The EGRVP sensor is a three (3) wire potentiometer type sensor.
- The ECM supplies a 5 volt reference voltage that the EGRVP uses to produce a linear analog voltage that indicates the amount of movement of the valve.
- The ECM monitors EGRVP as the engine is operating to modulate the EGR valve.
- This is a closed loop function which means that the ECM continuously monitors the EGRVP to ensure proper valve position.

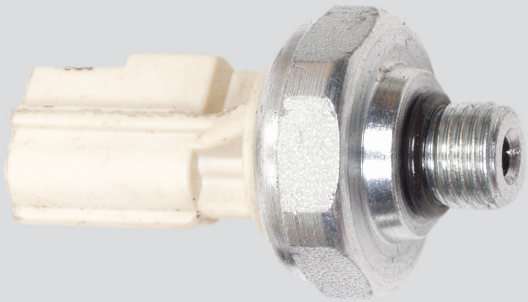
Engine Oil Pressure Switch

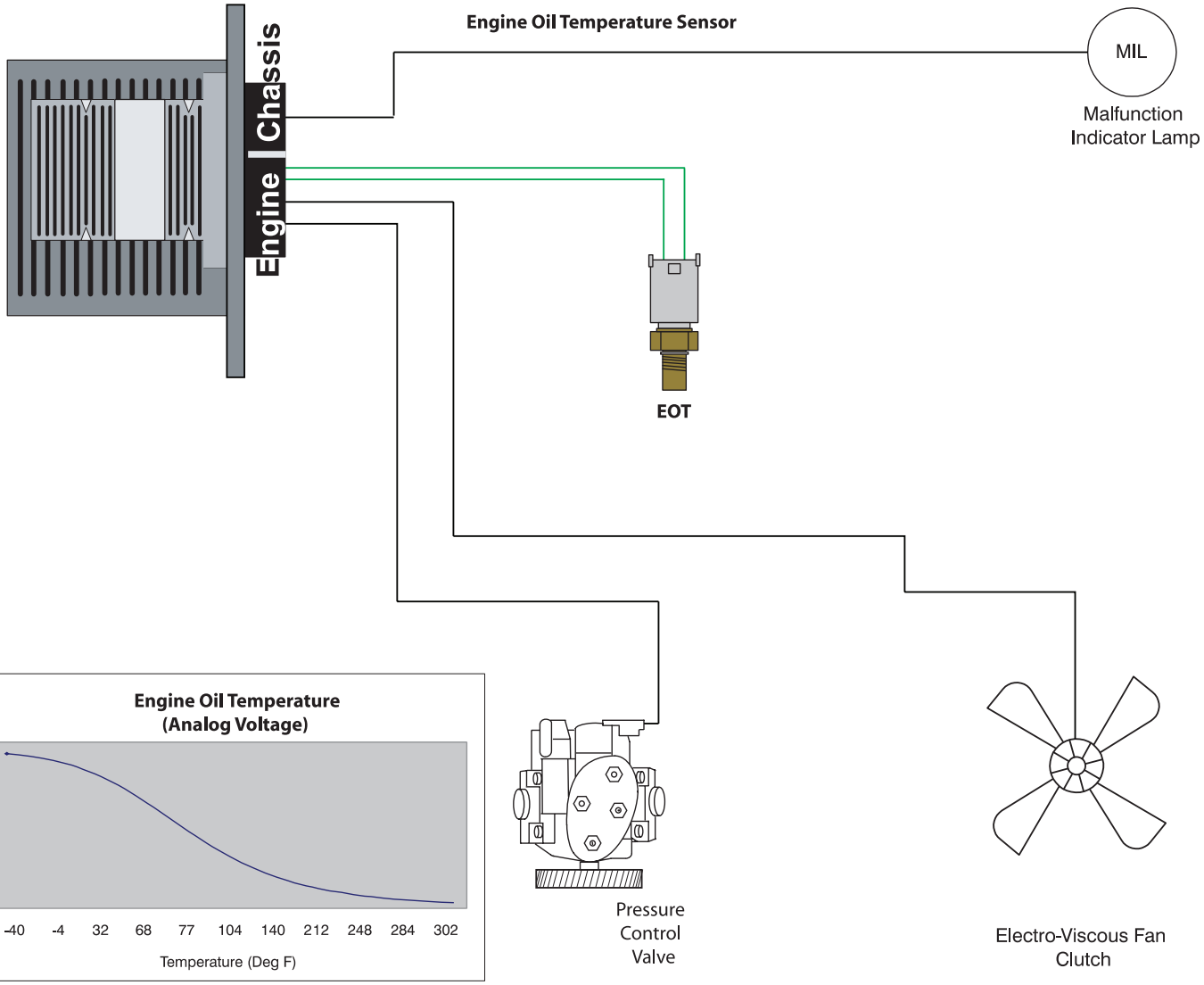




EOP (Engine Oil Pressure)

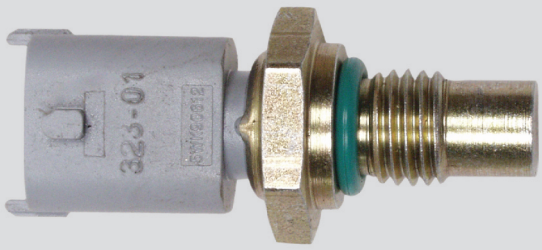
- The EOP (Engine Oil Pressure) is a switch that closes a circuit to ground after engine oil pressure reaches approximately 5-7psi.
- This switch controls the oil pressure gauge on the instrument panel. When pressure is above 7psi the gauge will read normal and if the pressure drops below 5 psi the gauge will show 0.
- The information from the switch is not sent back to the ECM in any way and is to be used as a reference only.

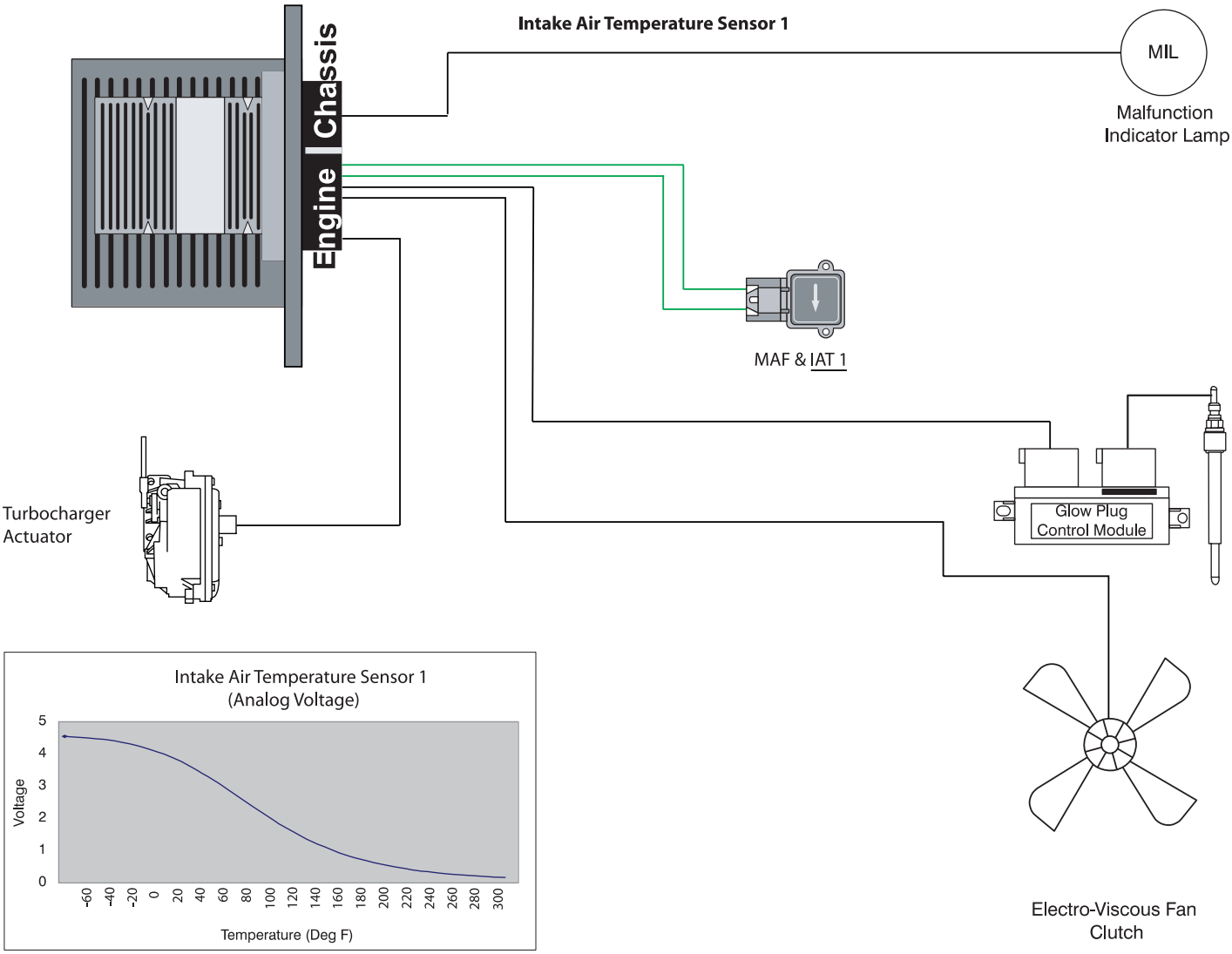




EOT (Engine Oil Temperature)

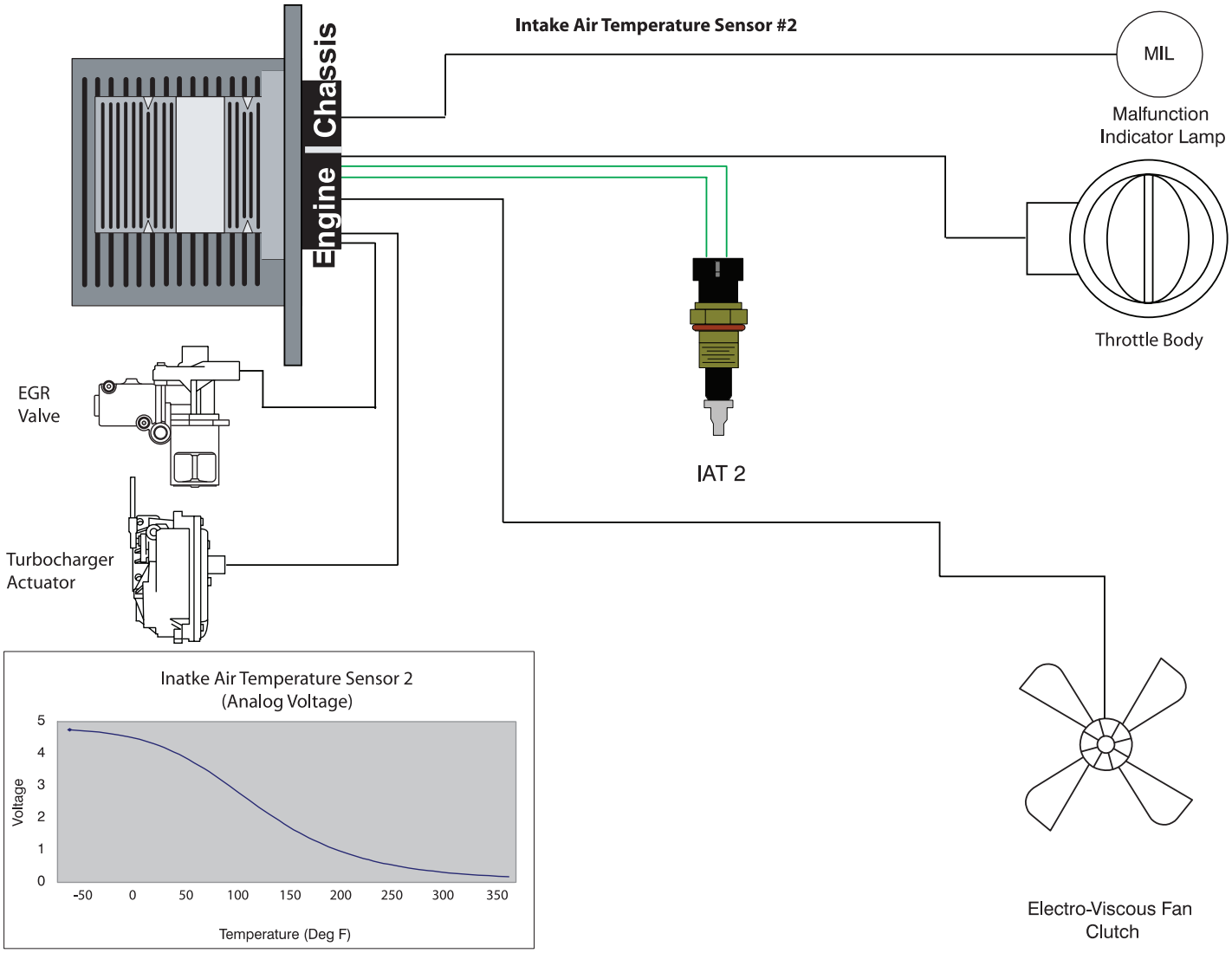
- The EOT sensor is a two (2) wire thermistor type sensor.
- The EOT sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECM monitors engine oil temperature via the EOT sensor signal to aid in controlling fuel rail pressure (FRP) and fan control.
- The EOT signal allows the ECM to compensate for oil viscosity variations due to temperature changes in the operating environment, ensuring adequate power and torque are available for all operating conditions.





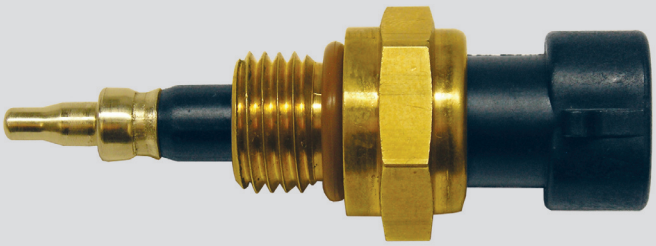
IAT1 (Intake Air Temperature #1)

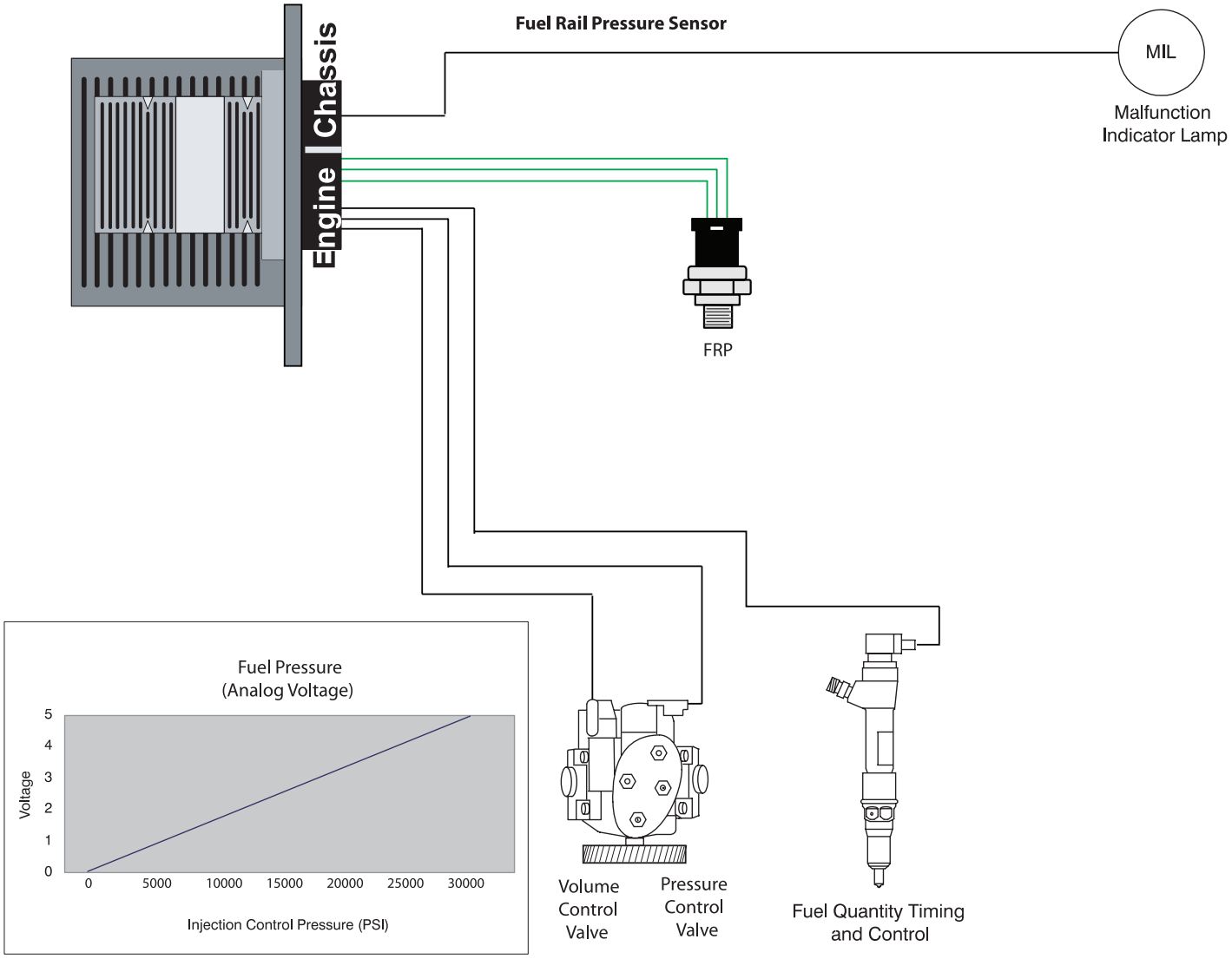
- The Intake Air Temperature1 (IAT1) sensor is a two wire thermistor sensor that is located inside the Mass Air Flow (MAF) sensor.
- The IAT1 sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The IAT1 sensor's primary function is to measure intake air temperature to aid in controlling EVTG and the glow plug system.
- The MAF/IAT1 sensor is mounted in the intake air piping after the air filter.



IAT2 (Intake Air Temperature #2)

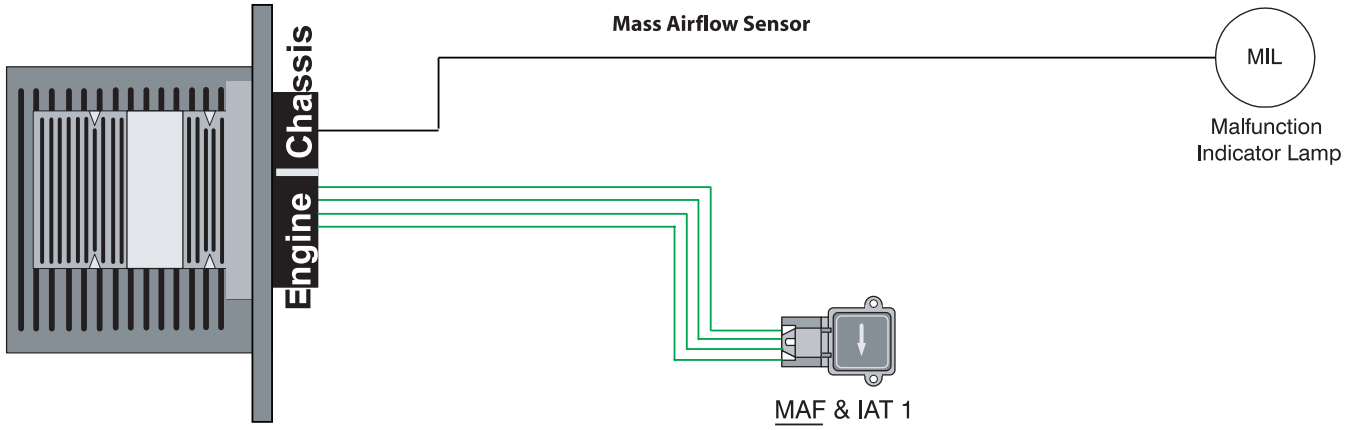
- The IAT2 sensor is a two (2) wire thermistor type sensor.
- The IAT2 sensor changes resistance when exposed to different air temperature.
- The primary function of the IAT2 sensor is to provide a feedback signal to the ECM indicating manifold air temperature.
- The IAT2 sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECM monitors the IAT2 signal to control temperature by adjusting other devices.

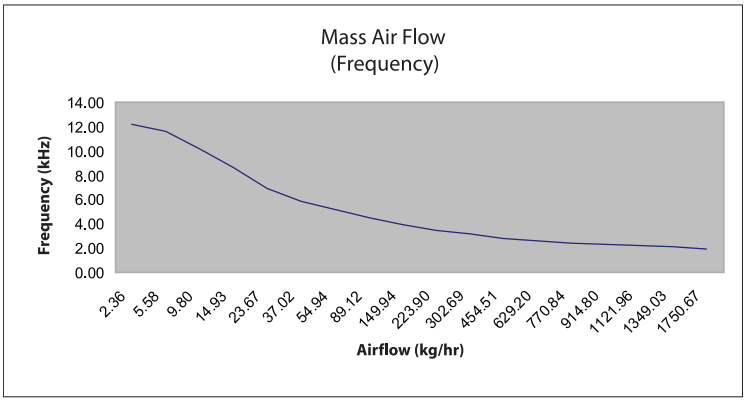




FRP (Fuel Rail Pressure)

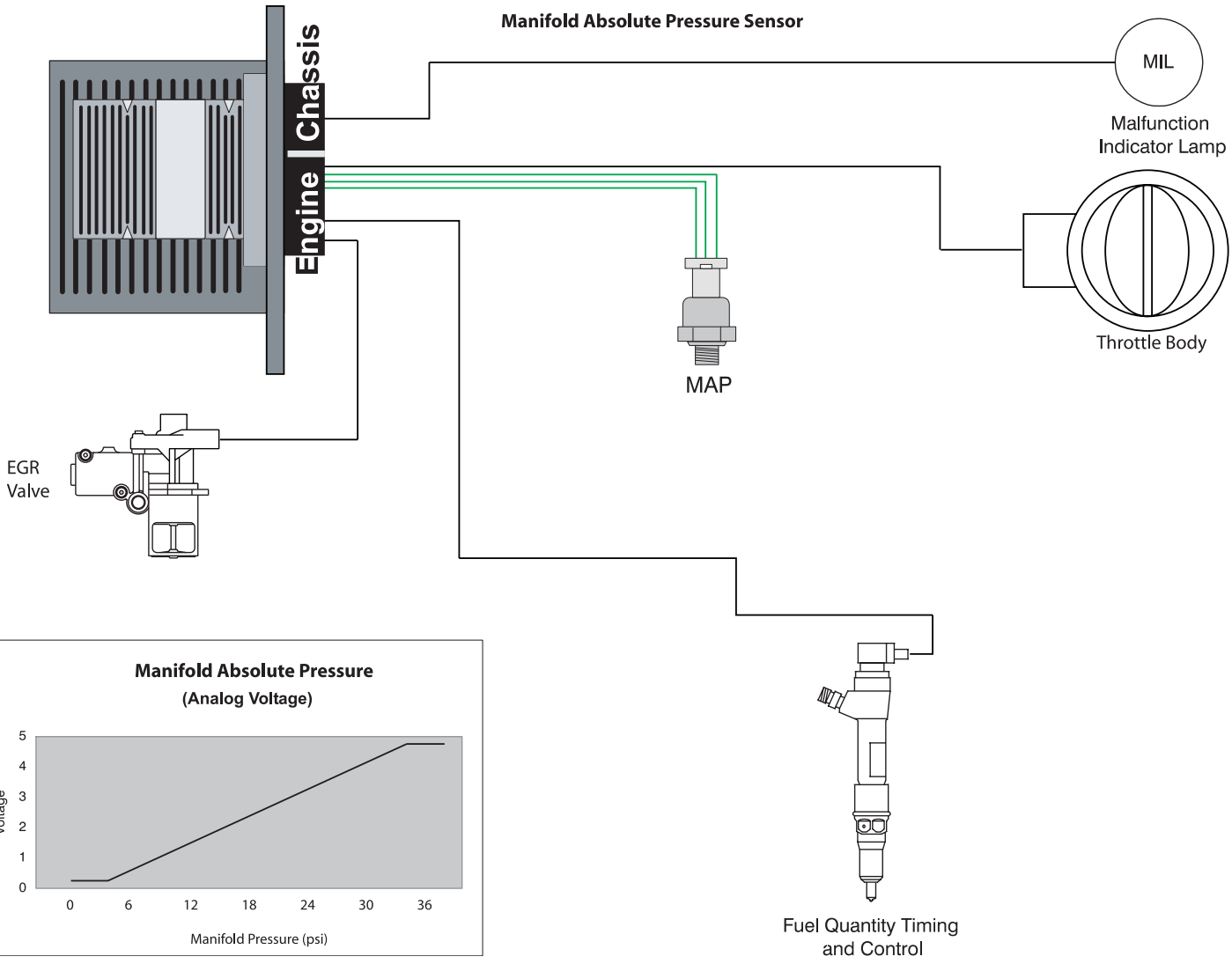
- The FRP sensor is a (3) wire variable capacitance sensor.
- The ECM supplies a 5 volt reference signal (Vref) which the FRP sensor uses to produce a linear analog voltage that indicates pressure.
- The primary function of the FRP sensor is to provide a feedback signal to the ECM indicating the pressure of the fuel in the fuel rail.
- The ECM monitors FRP as the engine is operating to modulate the PCV. This is a closed loop function which means the ECM continuously monitors and adjusts for ideal FRP determined by conditions such as load, speed, and temperature.
- The ECM monitors the FRP signal to determine if the performance of the fuel system is satisfactory.
- During engine operation, if the ECM recognizes that the FRP signal is lower or higher than the value the PCV is trying to achieve the ECM will set a Diagnostic Trouble Code (DTC) and illuminate the amber malfunction indicator lamp on the dash.
- The FRP signal to the ECM is one of the signals used to command the correct injection timing.
- This sensor is replaceable.





MAF (Mass Air Flow)

- The Mass Air Flow (MAF) sensor uses a hot wire sensing element to measure the amount of air entering the engine. Air passing over the hot wire causes it to cool. This hot wire is maintained at 200°C (392°F) above ambient temperature as measured by a constant cold wire.
- The current required to maintain the temperature of the hot wire is proportional to the mass air flow.
- The MAF sensor then outputs a frequency signal to the ECM proportional to the air mass.



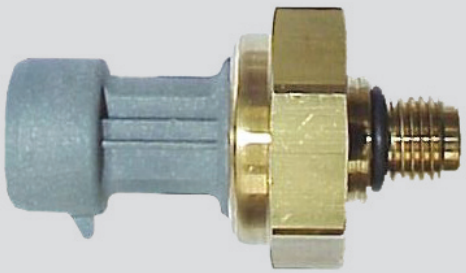
MAP (Manifold Absolute Pressure)

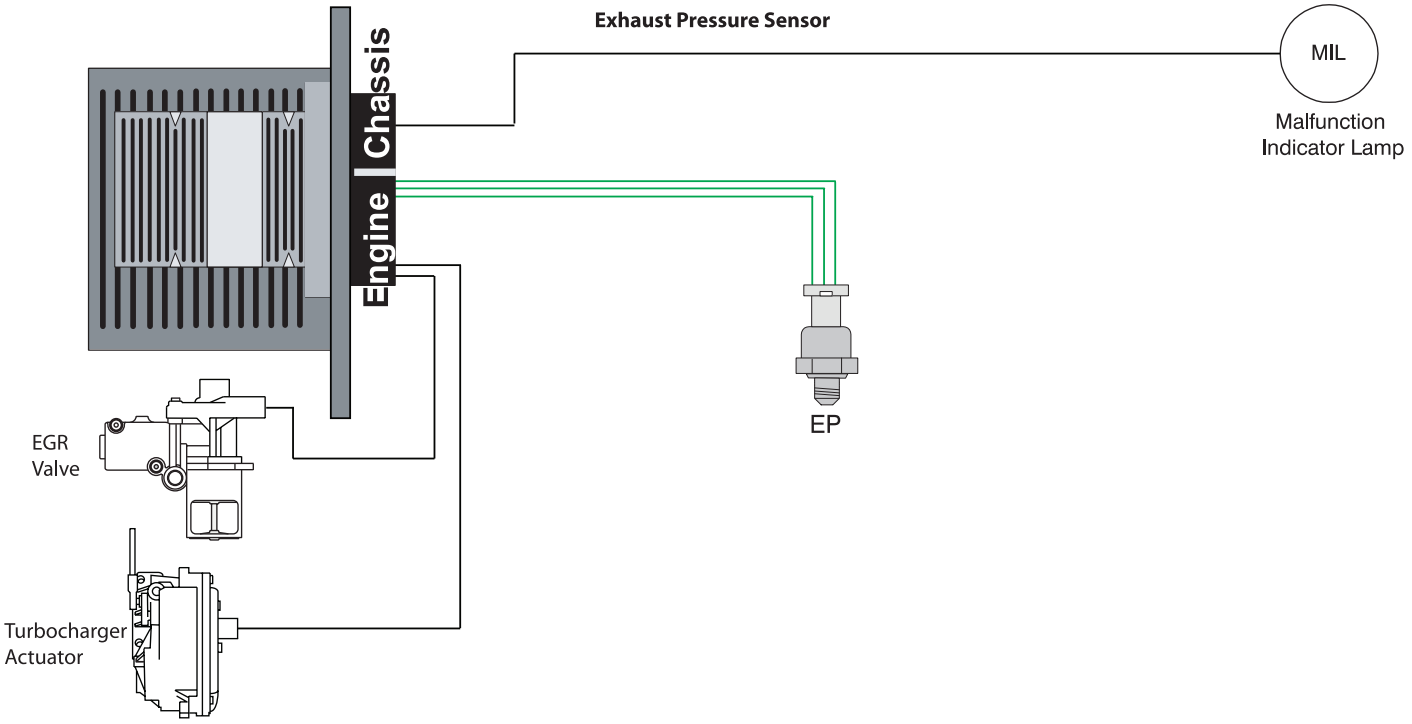
- The MAP sensor is a three (3) wire variable capacitance sensor.
- The ECM uses the MAP sensor signal to assist in the calculation of EGR duty cycle, Fuel Delivery, and Throttle Body Position.
- The ECM measures the MAP signal to determine intake manifold (boost) pressure.

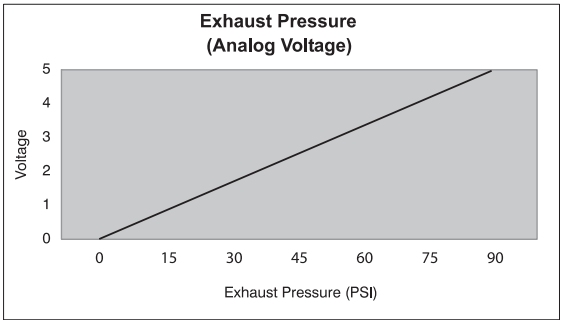
NOTE: Washing a hot engine can have negative effects on this sensor!

NOTE: The 6.0L engine used a remote mounted MAP sensor.

NOTE: Pay special attention to differentiating between the MAP sensor and the EP sensor, do not interchange them!







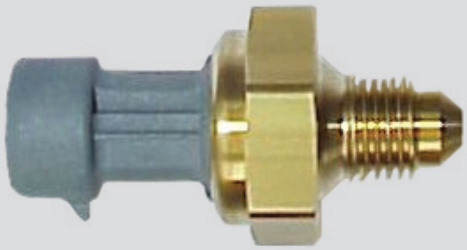
EP (Exhaust Pressure)

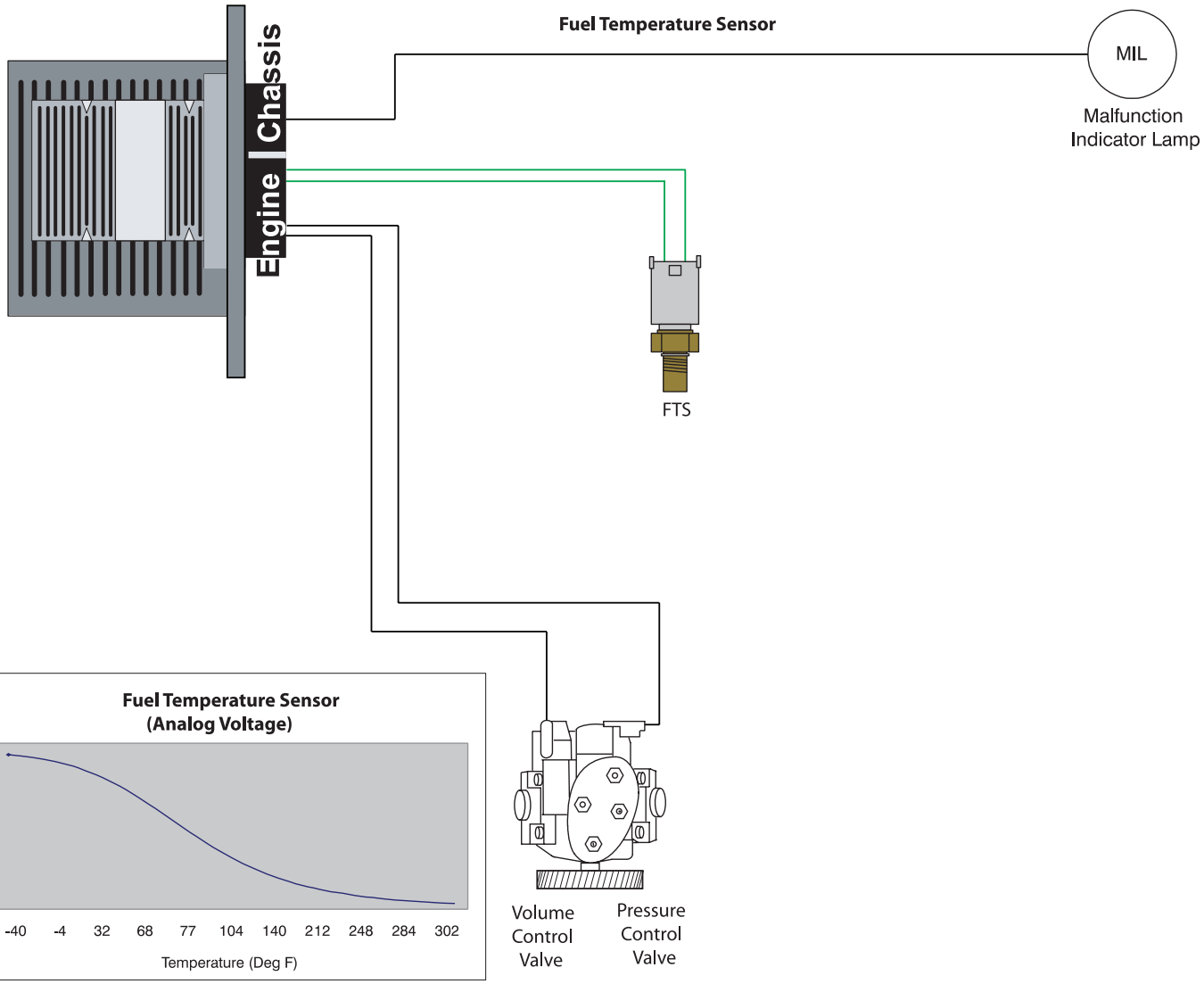
- The EP sensor is a three (3) wire variable capacitance sensor.
- The ECM supples a 5 volt reference signal which the EP sensor uses to produce a linear analog voltage that indicates pressure.
- The EP measures exhuast back pressure so that the ECM can control the EGR, and the high pressure turbocharger via the turbocharger actuator.

NOTE: Washing a hot engine can have negative effects on this sensor!

NOTE: This sensor is gray in color for the 6.4L and black in color for the 6.0L. Some early 6.4L engines may be equipped with black sensors. Do not interchange 6.0L EP sensors with 6.4L EP sensors, these sensors are different.

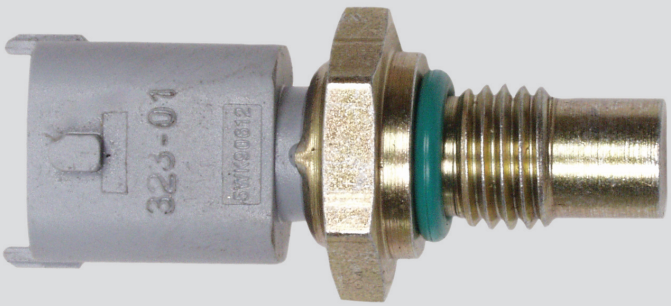
NOTE: Pay special attention to differentiating between the MAP sensor and the EP sensor, do not interchange them!

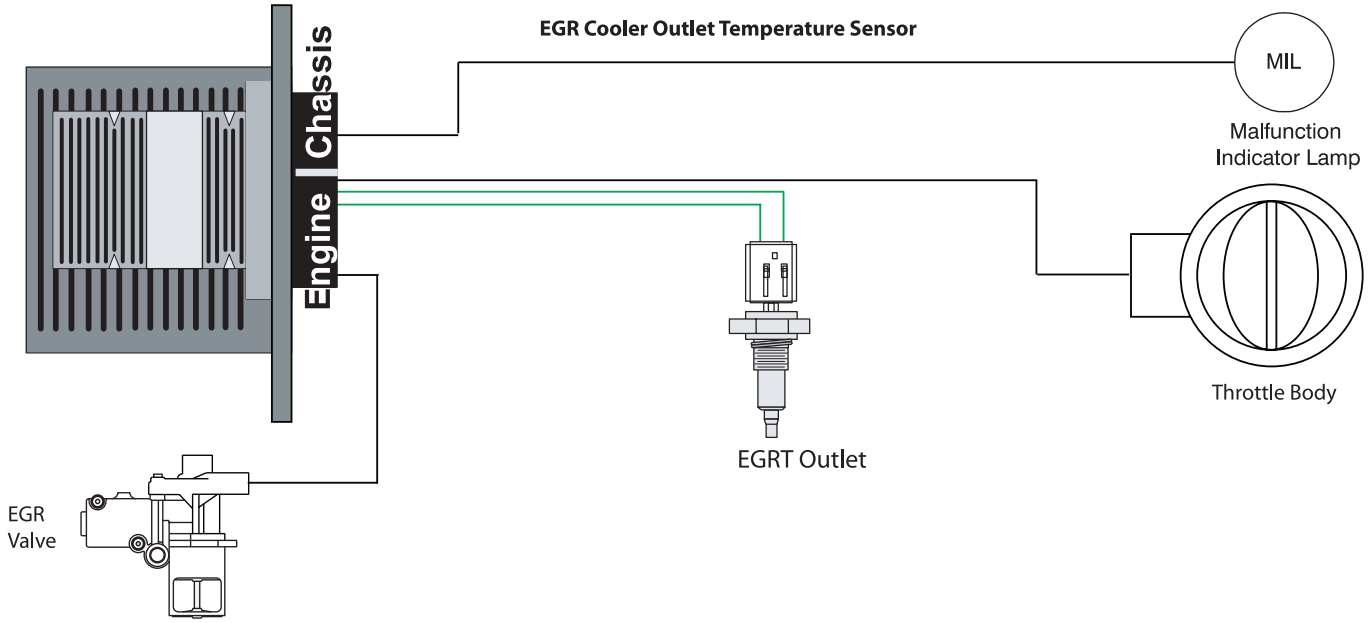


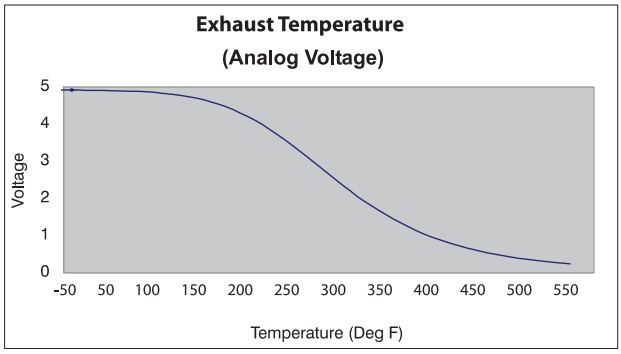


FTS (Fuel Temperature Sensor)

- The FTS sensor is a two (2) wire thermistor sensor.
- The FTS sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The FTS sensor changes resistance when exposed to different temperatures.
- When the temperature of the fuel decreases, the resistance of the thermistor increases and the signal voltage increases.
- When the temperature of the fuel increases, the resistance of the thermistor decreases and the signal voltage decreases.

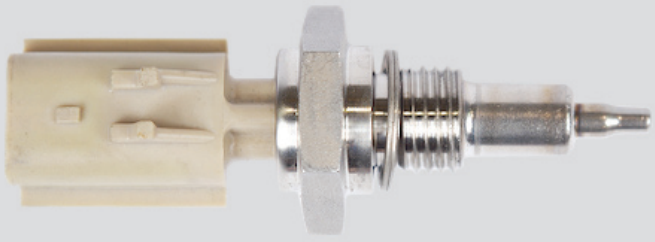






EGRT Outlet (EGR Cooler Outlet Temperature)

- The EGRT Outlet sensor is a two (2) wire thermistor type sensor.
- The EGRT outlet sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECM monitors exhaust temperature from the EGRT outlet sensor signal to aid in controlling the EGR valve position and throttle position.



Control Devices

- The 6.4L Power Stroke® Diesel uses eight (8) control devices: Pressure Control Valve, Volume Control Valve, EGR Valve, Turbocharger Actuator, Glow Plug Control Module, Glow Plugs, Fuel Injectors, and the Throttle Body.

Actuators & Control Modules

- Pressure Control Valve (PCV)
- Volume Control Valve (VCV)
- Exhaust Gas Recirculation Valve (EGR)
- Turbocharger Actuator
- Glow Plug Control Module (GPCM)
- Glow Plugs
- Piezo Electric Fuel Injectors
- Throttle Body

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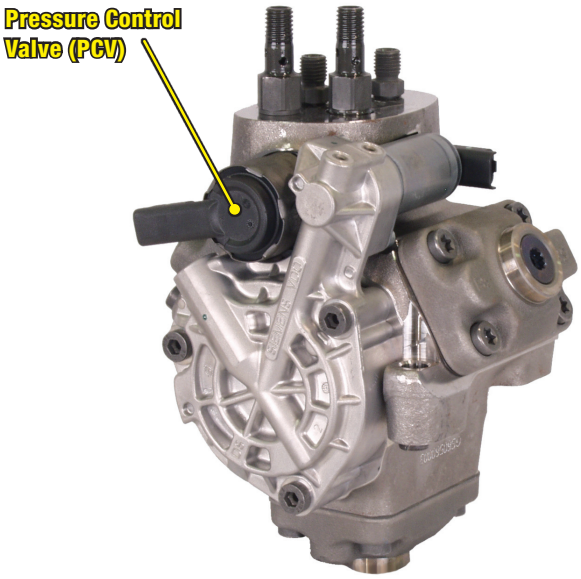
PCV (Pressure Control Valve)

- The PCV governs the fuel pressure that is delivered to the fuel injectors via the high pressure fuel rails and fuel supply tubes.
- The PCV also acts as a dampening device for the fluctuations in pressure that occur during fuel delivery through the pump and the injection process.
- The PCV is controlled by the ECM to maintain optimal fuel pressure throughout all engine operating conditions.
- The PCV is permanently mounted to the high pressure pump and is not to be removed. Removal of the PCV will result in replacement of the high pressure fuel injection pump.

NOTE: Fuel caps have been left off for visualization purposes. Always use fuel caps when servicing the high pressure fuel system!



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VCV (Volume Control Valve)

- The VCV regulates the delivery of fuel from the internal transfer pump (ITP) to the high pressure pumping elements.
- The VCV adjusts the low pressure side of the system to match the needs of the engine thus increasing efficiency.
- The VCV is permanently mounted to the high pressure pump and is not to be removed. Removal of the VCV will result in replacement of the high pressure fuel injection pump.

NOTE: Fuel caps have been left off for visualization purposes. Always use fuel caps when servicing the high pressure fuel system!

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Exhaust Gas Recirculation Valve (EGR Valve)

- The EGR valve is used to mix cooled exhaust gases with intake air to lower emissions and noise.
- The EGR valve is stepper motor controlled
- The valve is powered in both the open and close directions.

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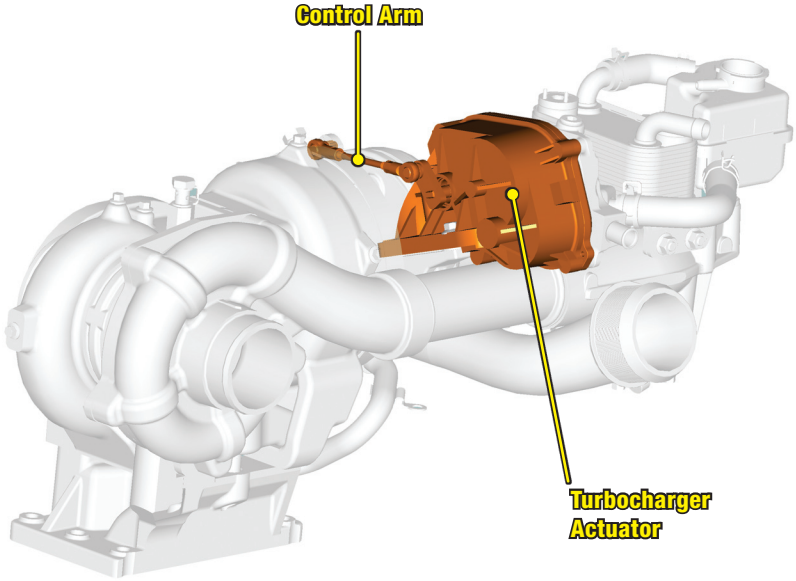

Turbocharger Actuator

- The turbocharger actuator is an electronic motor that controls the position of the vanes inside of the high pressure turbocharger's turbine housing.
- The turbocharger actuator is mounted directly to the high pressure turbo and is connected to the vanes inside the turbine housing by a control arm.

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Throttle Body

- The throttle body is operated by a stepper motor controlled by the ECM and assists with the exhaust aftertreatment system.

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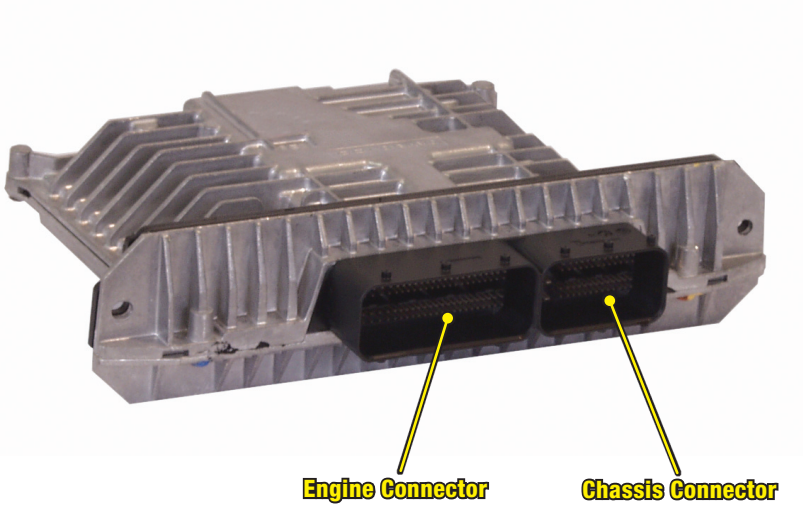
ECM (Engine Control Module)

- The ECM, which is mounted behind the engine on the passenger side cowl, uses sensor inputs to control actuators and send fueling commands to the fuel inectors.
- The ECM controls the fuel and air management system on the 6.4L Power Stroke® Diesel.



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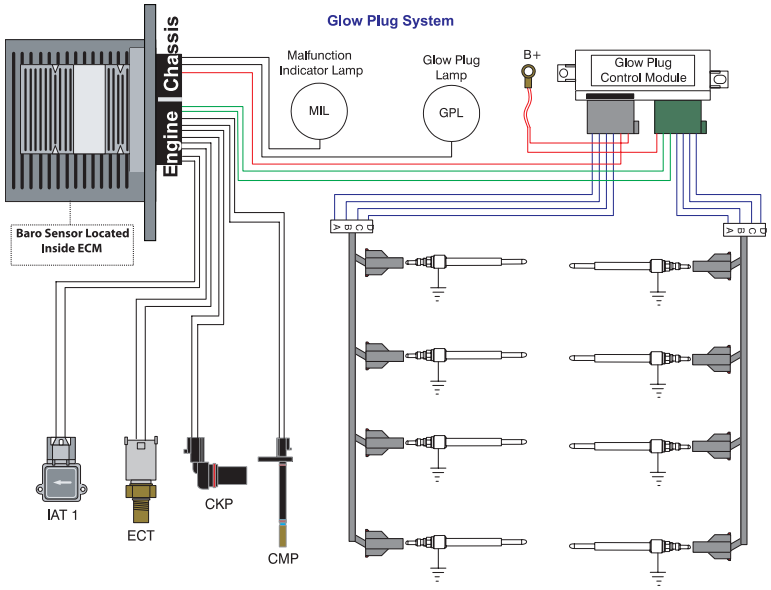
Glow Plug System

- The glow plug system is used to warm the air in the cylinders to enhance cold weather startability and reduce start up smoke.
- The glow plug system is ECM controlled, and powered by the GPCM.



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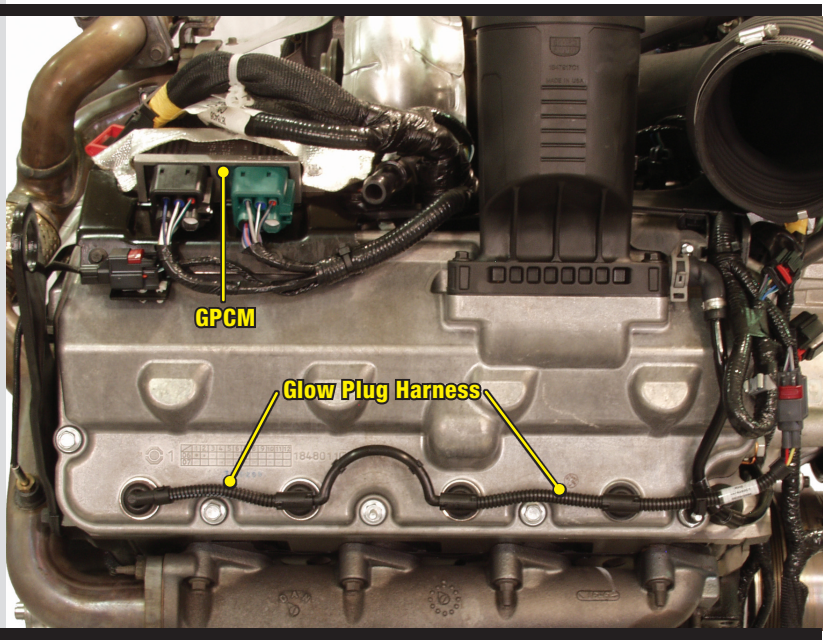
Glow Plug Control Module(GPCM) & Glow Plug Harness

- The GPCM is a unit that controls the glow plugs in order to warm the air in the cylinders.
- The GPCM uses a glow plug enable signal to turn the glow plugs on for a time controlled by the ECM.
- The GPCM is capable of diagnosing a problem with one glow plug and then sending a diagnostic signal to the ECM.
- It also has the ability to turn off one glow plug if a short is detected in that circuit.
- Each bank of glow plugs is connected to the engine wiring harness via a glow plug harness, either left bank or right bank.
- The glow plug harness has four connectors that supply power to the glow plugs and seal oil from escaping through the glow plug access holes.



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Glow Plug

- The glow plug is used to heat the air in the cylinder.
- The glow plug utilizes a system of sending voltage through a resistance coil to create heat.

NOTE: The 6.4L glow plug is very similar to the glow plug used on the 6.0L Power Stroke® Diesel, but they are different. The glow plugs must not be interchanged!

NOTE: The 6.4L glow plug uses a green isolator.

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Fuel Injector

- The fuel injector is controlled by an extremely precise piezo electric actuator that can accomplish multiple injections per combustion event.

NOTE: Never unplug a fuel injector while the engine is running, serious engine damage could occur!

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