

SUPER DUTY



6.4L Power Stroke® Diesel Engine



2008 "F" SERIES SUPER DUTY

-
- Engine Description • Systems Overview • Component Location • Technician Tips •

This publication is intended to provide technicians and service personnel with an overview of technical advancements in the 6.4L POWER STROKE® DIESEL Engine. The information contained in this publication will supplement information contained in available service literature.

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as, the personal safety of the individual performing the work. This manual provides general directions for accomplishing service repair work with tested, effective techniques. Following the directions will assure reliability. There are numerous variations in the procedures; techniques, tools, parts for servicing vehicles and the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that they do not compromise their personal safety or the vehicle integrity by their choice of methods, tools or parts.

The following list contains some general WARNINGS that you should follow when you work on a vehicle.

Always wear safety glasses for eye protection.

Always perform work in a well ventilated area.

Use safety stands whenever a procedure requires you to be under the vehicle.

Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.

Never perform any service to the engine with the air cleaner removed and the engine running unless a turbocharger compressor inlet shield is installed.

Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific service operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific service operation.

Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.

Keep yourself and your clothing away from moving parts when the engine is running, especially the fan, belts, and the turbocharger compressor.

To prevent serious burns, avoid contact with hot metal parts such as the radiator, turbocharger pipes, exhaust manifold, tail pipe, catalytic converter and muffler.

Do not smoke while working on the vehicle.

To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind the head.

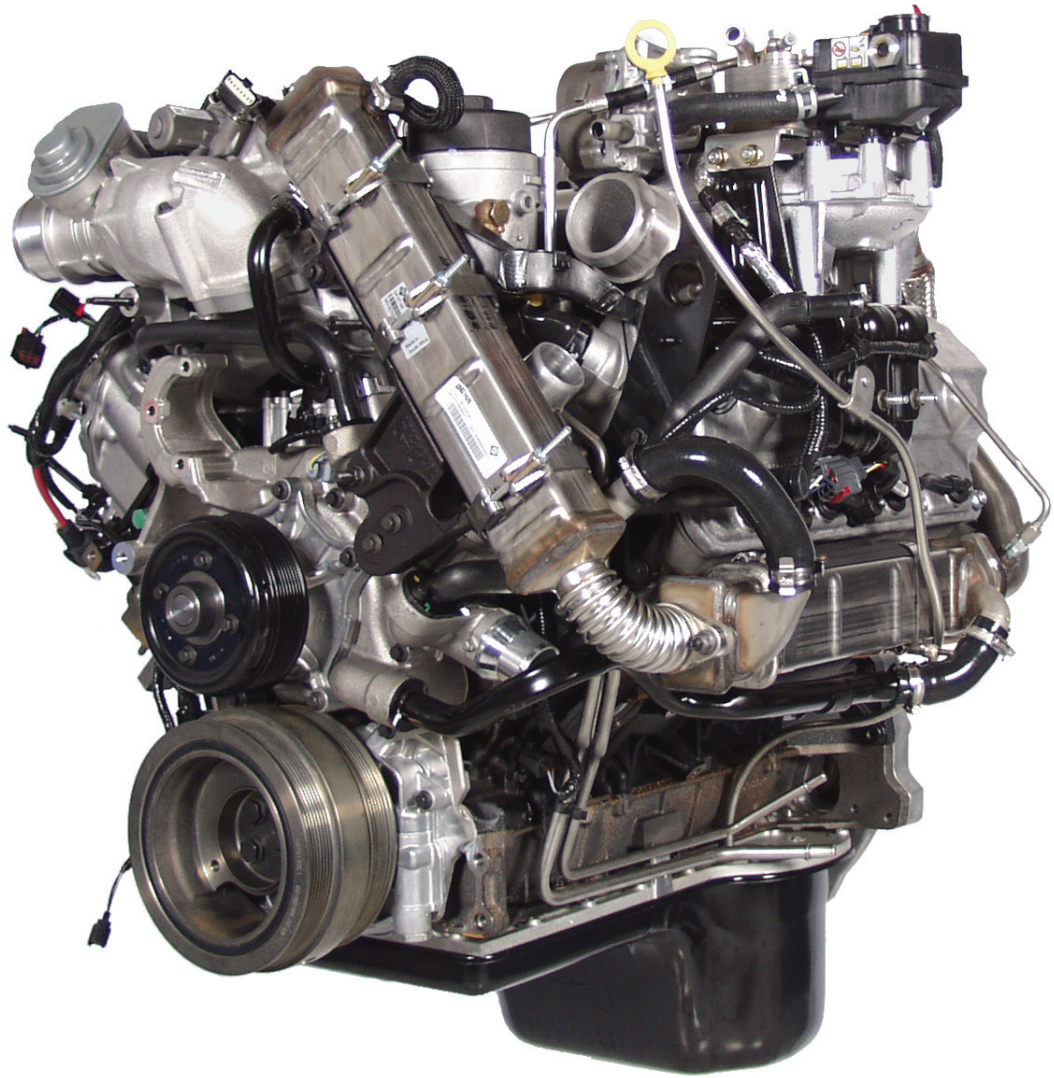
Keep hands and other objects clear of the radiator fan blades.

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6.4L Power Stroke[®] Diesel

**Direct Injection
Turbocharged
Diesel Engine**

6.4L POWER STROKE® DIESEL OVERVIEW

6.4L Power Stroke Diesel Overview

- This publication is not intended to replace the Service Manual but to introduce the 6.4L Power Stroke® Diesel Engine.

6.4L Power Stroke Diesel Direct Injected Turbocharged Diesel Engine Overview

- Engine Features
- Horsepower & Torque
- Engine Specifications
- Physical ID
- Labeling

1

Engine Features

- The 6.4L Power Stroke Diesel has been designed to meet the tougher emissions standards set by the government.
- The 6.4L Power Stroke Diesel has been designed to meet the customers' expectations of high horsepower and torque over a wide RPM range.
- Meeting the more stringent customer and regulated demands are accomplished in part by: High Pressure Common Rail Fuel System, Series Sequential Turbocharger System, 4 valves per cylinder, and a dual timing system.

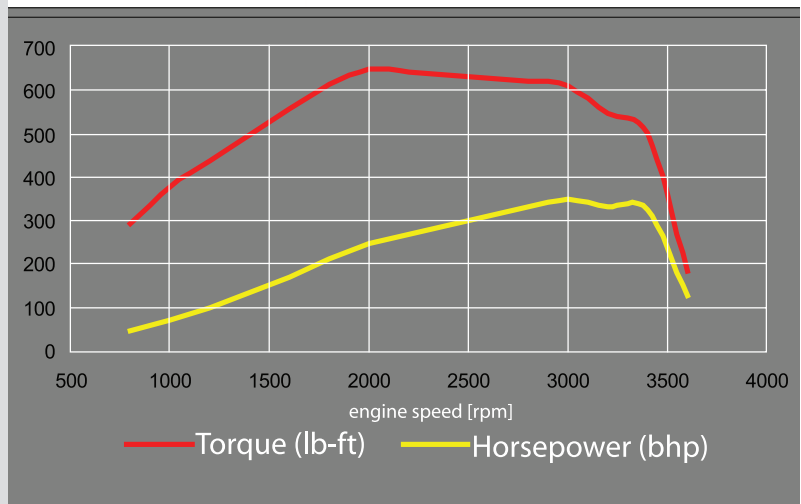
Engine Features

- High Pressure Common Rail Fuel System
- Series Sequential Turbocharger
- 4 Valves per Cylinder
- Rear Gear Train
- Dual Timing System

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Horsepower & Torque

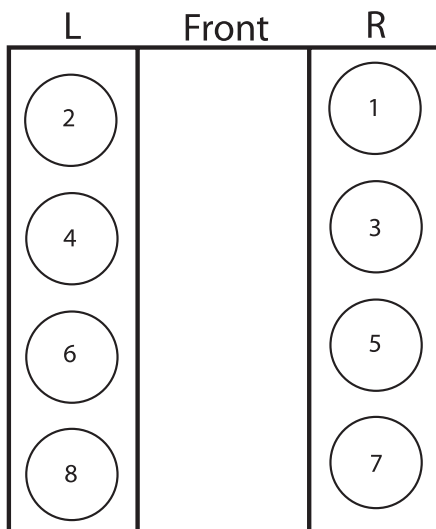
- The 6.4L Power Stroke Diesel creates 350 horsepower at 3000rpm and 650 lb/ft of torque at 2000rpm.



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6.4L Power Stroke Diesel Specifications

Engine Type	Diesel, 4 Cycle
Configuration	4 OHV/1 Cam-in-Crankcase-V8
Displacement	390 cu. in. (6.4L)
Bore & Stroke	3.87 X 4.134 (98.2 X 105 mm)
Compression Ratio	17.5:1
Aspiration	Series Sequential Turbo with CAC
Rated Power @ RPM	350 @ 3000 RPM
Peak Torque @ RPM	650 @ 2000 RPM
Engine Rotation, Facing Flywheel	Counter Clockwise
Combustion System	High Pressure Common Rail Direct Injection
Total Engine Weight (auto with oil)	1130 lb. (498.95 kg)
Coolant Flow (to radiator)	125 gal/min (473 L/min) @ 3000 RPM
Air Flow @ RPM (compressor inlet)	744 CFM (21.1 m3/min) @ 3000 RPM
Exhaust Flow @ RPM (engine outlet)	1962 CFM (55.6 m3/min) @ 3000 RPM
Oil Flow @ RPM	13 gal/min (59 L/min) @ 3000 RPM
Cooling System Capacity (engine only)	25.3 qts (24 L)
Lube System Capacity (including filter)	15 qts. (14.2 L)
Firing Order	1-2-7-3-4-5-6-8



Specifications

- The cylinders of the 6.4L Power Stroke Diesel are numbered from the front on the right side 1,3,5,7 and from the front on the left side 2,4,6,8.

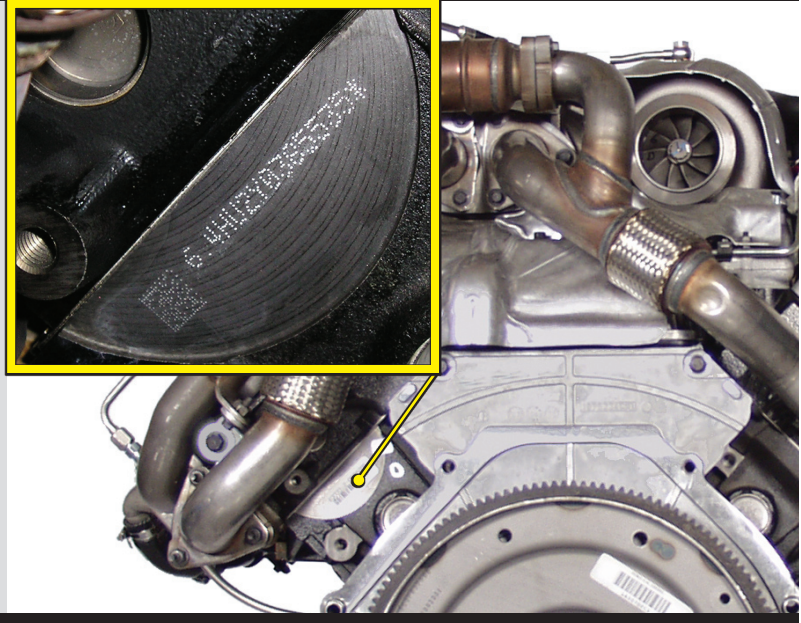
6.4L POWER STROKE® DIESEL OVERVIEW

Engine Serial Number

- The engine serial number is located on the left rear corner of the crank case on a half moon machined surface.
- A white sticker is placed over this number during production, this sticker was removed for illustration purposes.
- 6.4 - is the engine family identifier.
- HU2Y - is a manufacturing designator

Ex: HU2Y or HU2U “Y designates Huntsville, AL and U designates Indianapolis, IN”

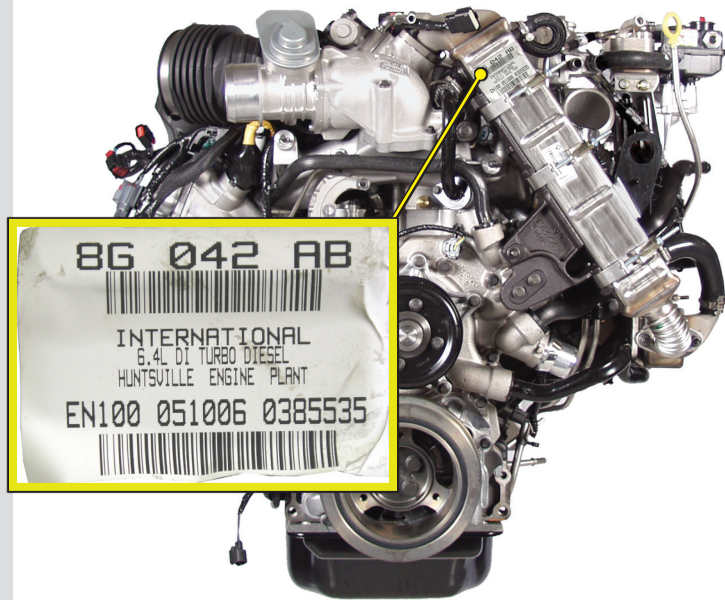
- 0385535 - is a sequential build number



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Serial Number Label

- Located on the top of the vertical EGR cooler.
- States the engine serial number.
- example at right, “0385535”
- States the engine family.
- example at right, “6.4L DI turbo diesel”



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Emissions Label

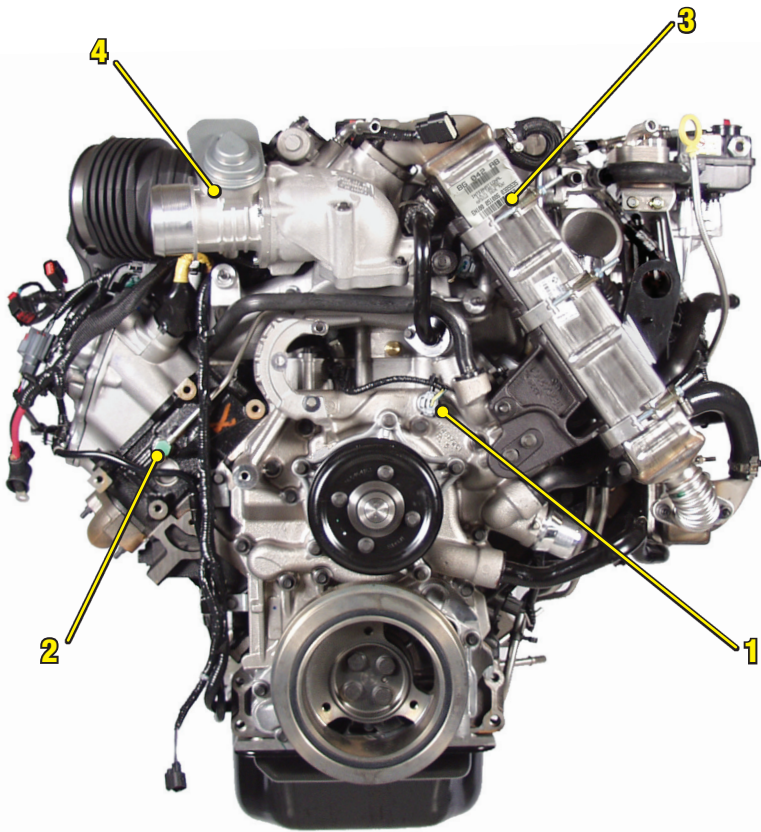
- States the horsepower rating for the engine, programmed in the Engine Control Module (ECM).
- Depicts where the engine meets or exceeds emission standards.
- Shows the engine displacement.
- Is affixed to the right hand valve cover.
- F250/350 labels are red.
- F450/550 labels are blue.

2006 6.4L ENGINE FAMILY 6NVX86 .4AGC EMISSION CONTROL INFORMATION ENGINE MANUFACTURED BY: INTERNATIONAL TRUCK AND ENGINE CORPORATION INTERNATIONAL® 1874332C2	<table border="1"> <thead> <tr> <th>MODEL</th> <th>ADV. BHP @ RPM</th> <th>LB - FT TORQ. @ RPM</th> </tr> </thead> <tbody> <tr> <td>A350</td> <td>350 @ 3000</td> <td>650 @ 2000</td> </tr> </tbody> </table>	MODEL	ADV. BHP @ RPM	LB - FT TORQ. @ RPM	A350	350 @ 3000	650 @ 2000	<table border="1"> <thead> <tr> <th>HC + NOX PART. EMISSION LIMITS</th> <th>PART. EMISSION LIMITS</th> </tr> </thead> <tbody> <tr> <td>1.3</td> <td>1874332C2</td> </tr> </tbody> </table>	HC + NOX PART. EMISSION LIMITS	PART. EMISSION LIMITS	1.3	1874332C2
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HC + NOX PART. EMISSION LIMITS	PART. EMISSION LIMITS											
1.3	1874332C2											
CURB IDLE, FUEL RATE @ ADVERTISED POWER, AND INJECTION TIMING ARE NON-ADJUSTABLE. EMISSION CONTROL SYSTEM: ECM, TC, DI, CAC, EGR, OC, PTOX DISPLACEMENT: 6.4L IMPORTANT ENGINE INFORMATION: THIS ENGINE CONFORMS TO: CALIFORNIA REGULATIONS APPLICABLE TO 2006 MODEL YEAR ULEV MEDIUM-DUTY VEHICLES FOR A COMPLETE VEHICLE 8,501 TO 14,000 POUNDS GVWR AND A MAXIMUM FRONTAL AREA OF 45 SQUARE FEET. THIS ENGINE MEETS OBDII REQUIREMENTS, AND U.S. EPA REGULATIONS AND OBD REGULATIONS, CANADIAN, AND AUSTRALIAN ADR-30 REGULATIONS FOR THE 2006 MODEL YEAR AND IS CERTIFIED TO OPERATE ON DIESEL FUEL. THIS ENGINE IS INTRODUCED EARLY PURSUANT TO 86,007-11(g) (2) AND CERTIFIED TO THE PM STANDARD OF 0.01 g/BHP-HR.												

2006 6.4L ENGINE FAMILY 6NVX86 .4AGA EMISSION CONTROL INFORMATION ENGINE MANUFACTURED BY: INTERNATIONAL TRUCK AND ENGINE CORPORATION INTERNATIONAL® 1874333C2	<table border="1"> <thead> <tr> <th>MODEL</th> <th>ADV. BHP @ RPM</th> <th>LB - FT TORQ. @ RPM</th> </tr> </thead> <tbody> <tr> <td>A325</td> <td>325 @ 3000</td> <td>600 @ 2000</td> </tr> </tbody> </table>	MODEL	ADV. BHP @ RPM	LB - FT TORQ. @ RPM	A325	325 @ 3000	600 @ 2000	<table border="1"> <thead> <tr> <th>HC + NOX PART. EMISSION LIMITS</th> <th>PART. EMISSION LIMITS</th> </tr> </thead> <tbody> <tr> <td>1.3</td> <td>1874333C2</td> </tr> </tbody> </table>	HC + NOX PART. EMISSION LIMITS	PART. EMISSION LIMITS	1.3	1874333C2
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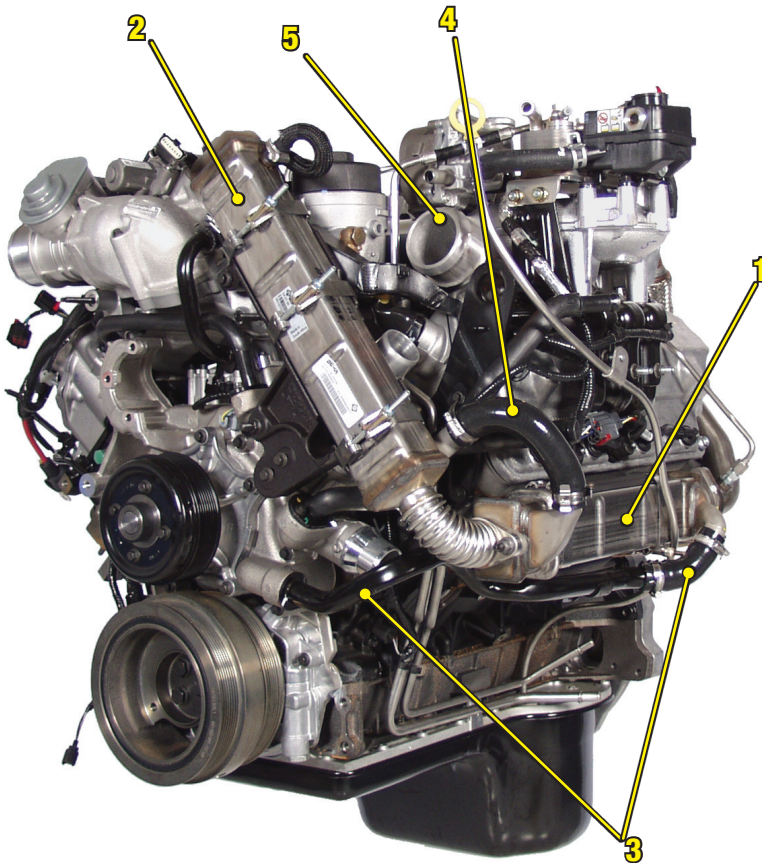
COMPONENT LOCATIONS



Front of Engine

- 1) ECT Sensor
- 2) Fuel Return Line
- 3) EGR Cooler Vertical
- 4) EGR Throttle

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Left Front of Engine

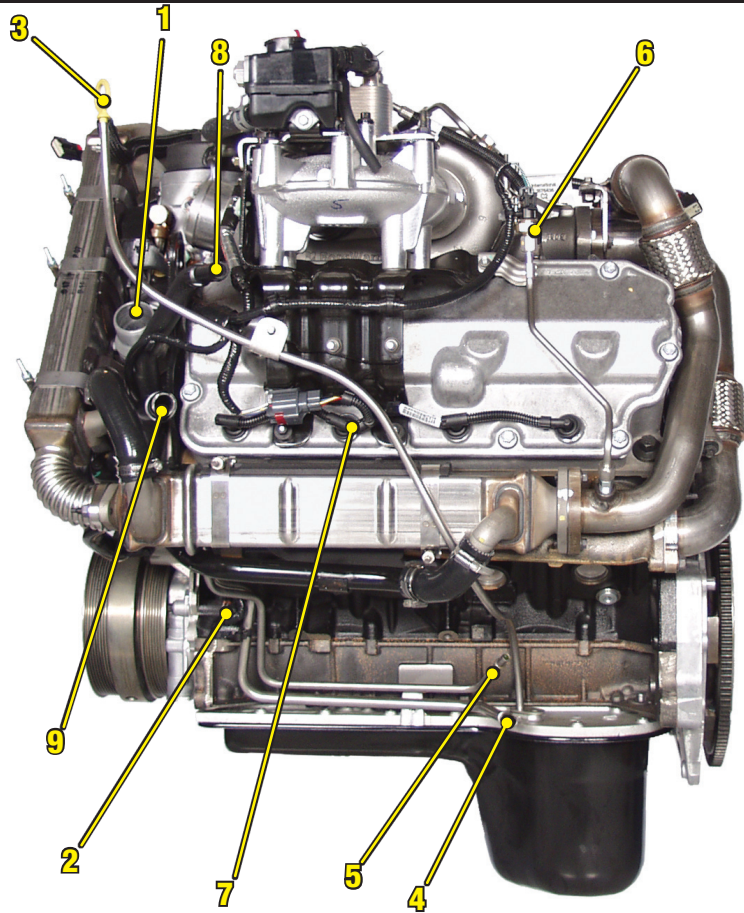
- 1) EGR Cooler Horizontal
- 2) EGR Cooler Vertical
- 3) Coolant Supply for Horizontal Cooler
- 4) Coolant Supply for Vertical Cooler
- 5) Turbocharger Outlet

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COMPONENT LOCATIONS

Left of Engine

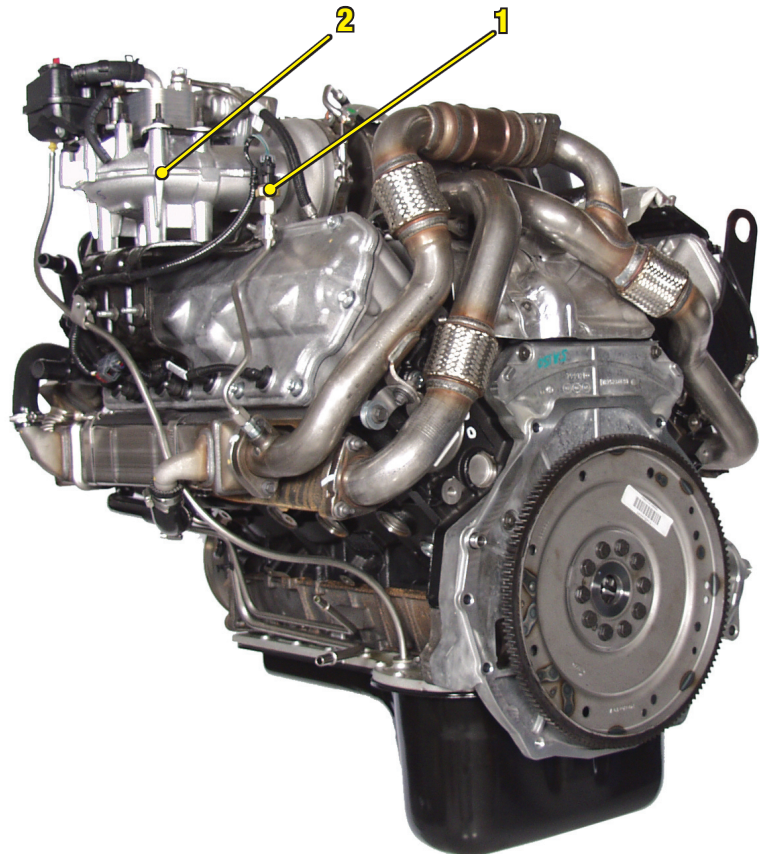
- 1) Thermostat Housing Outlet
- 2) CMP Sensor
- 3) Oil Level Gauge
- 4) Fuel Supply Line
- 5) Fuel Return Line
- 6) EP Sensor
- 7) Glow Plug Harness
- 8) Heater Return Line
- 9) Degas Bottle Return Line



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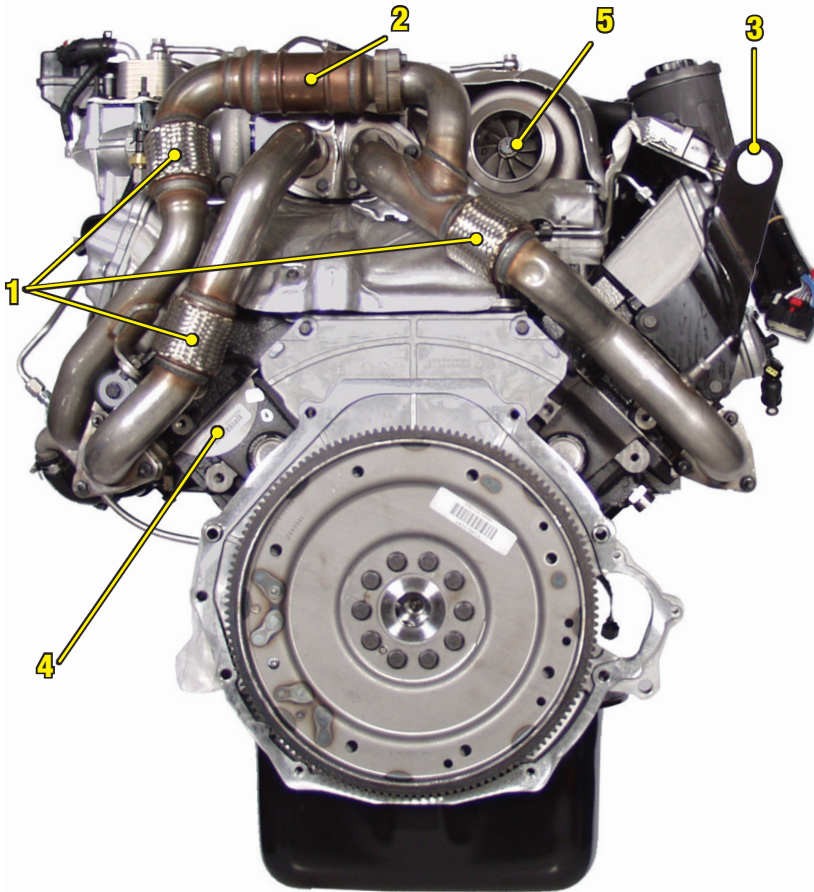
Left Rear of Engine

- 1) EP Sensor
- 2) Turbocharger Crossover Tube



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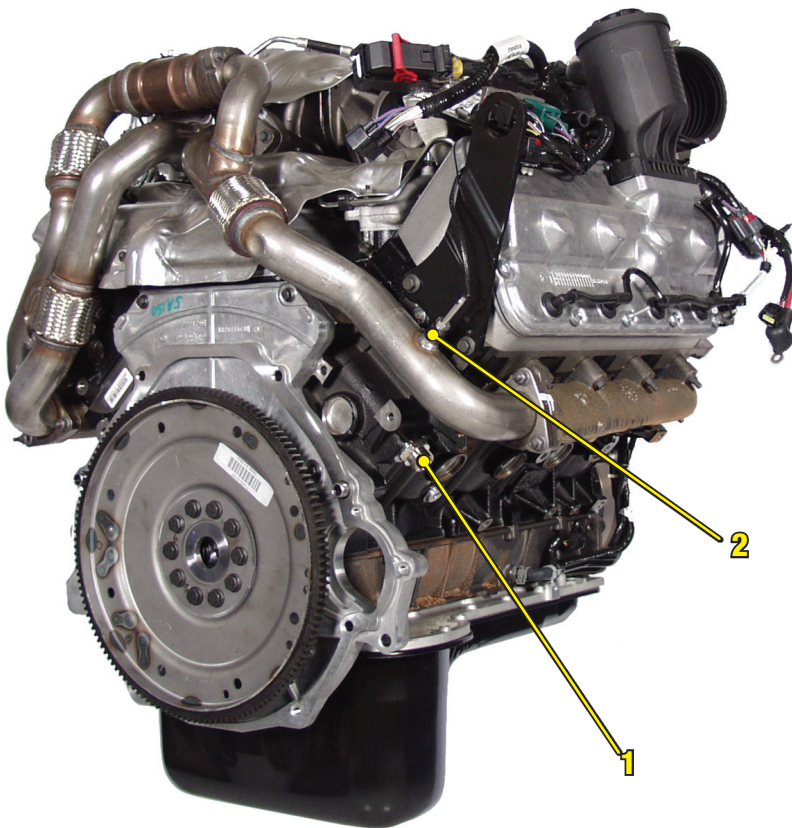
COMPONENT LOCATIONS



Rear of Engine

- 1) Exhaust Expansion Joints
- 2) Catalyast
- 3) Lifting Eye
- 4) Serial Number
- 5) Turbocharger Outlet to Exhaust System

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Right Rear of Engine

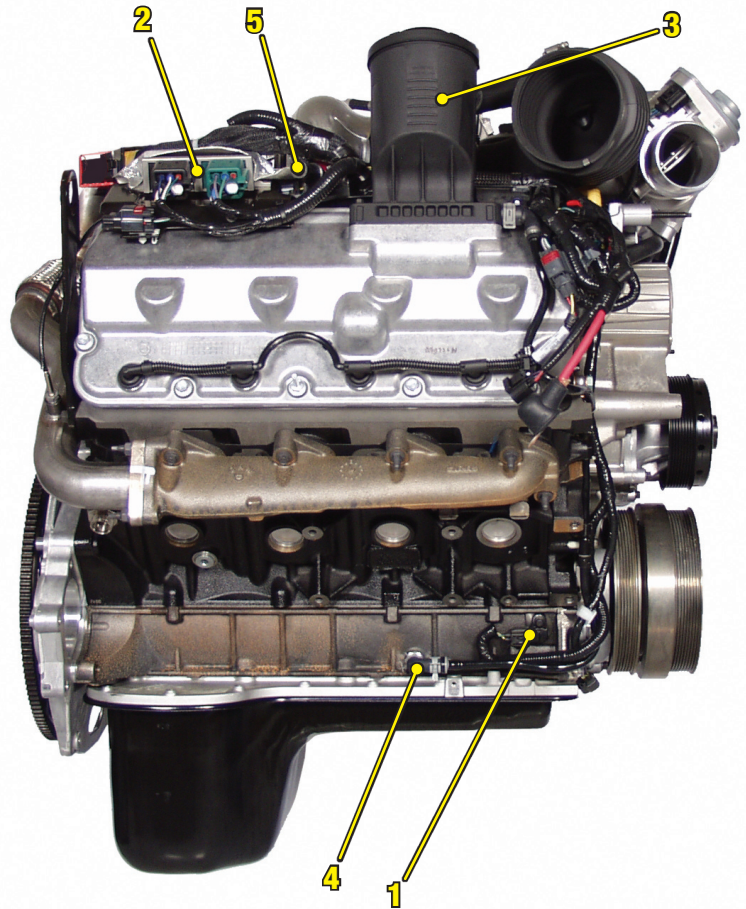
- 1) Block Heater
- 2) EGRT Inlet Sensor

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COMPONENT LOCATIONS

Right Side of Engine

- 1) CKP Sensor
- 2) Glow Plug Control Module
- 3) Crankcase Ventilation/Oil Separator
- 4) Oil Separator Drain Tube
- 5) Heater Supply



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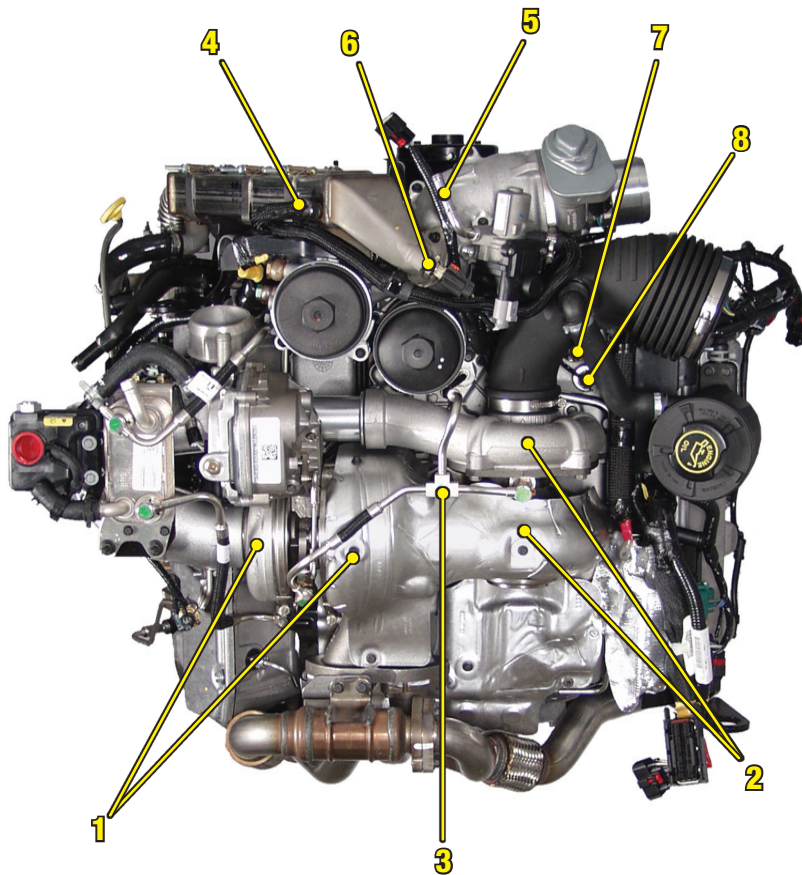
Right Front of Engine

- 1) Injector Electrical Connector
- 2) Throttle Body



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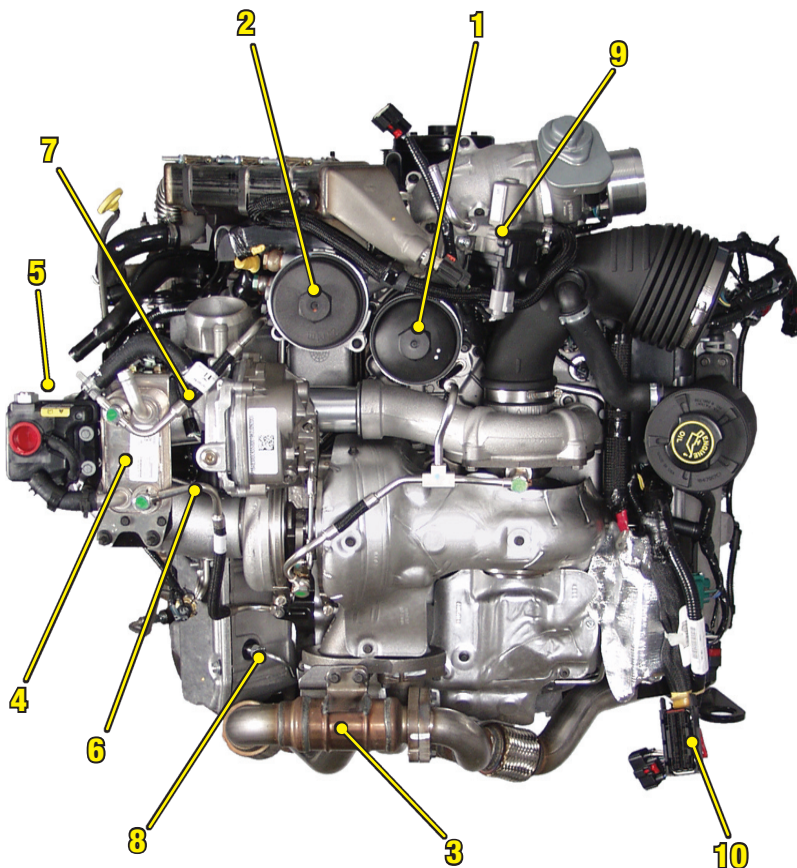
COMPONENT LOCATIONS



Top of Engine

- 1) High Pressure Turbocharger
- 2) Low Pressure Turbocharger
- 3) Turbocharger Oil Supply Line
- 4) EGR Valve Coolant Supply Port
- 5) EGR Valve Coolant Return Port/Deaeration Port
- 6) EGRT Outlet Sensor
- 7) MAP Sensor
- 8) IAT 2 Sensor

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Top of Engine

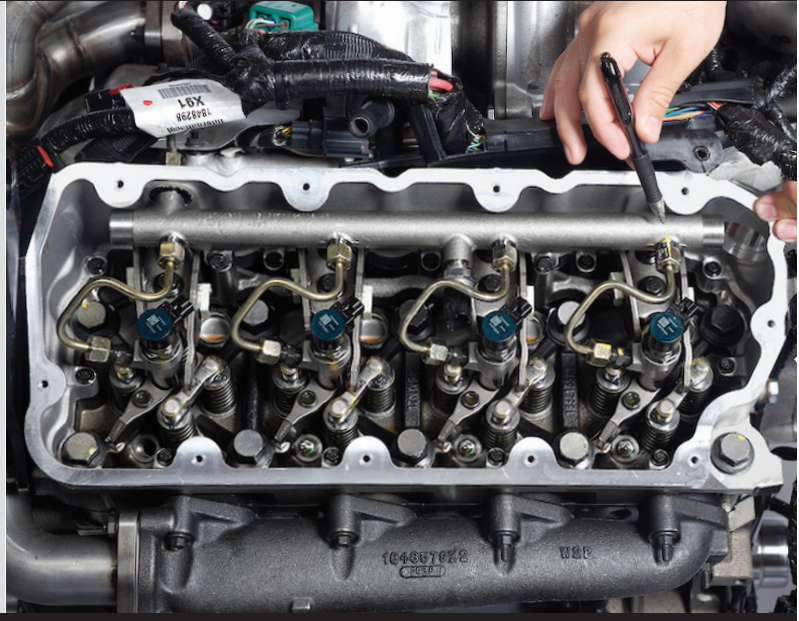
- 1) Oil Filter
- 2) Engine Mounted Fuel Filter
- 3) Catalyst
- 4) Fuel Cooler
- 5) Fuel Cooler Coolant Tank
- 6) Fuel Return Hot (inlet to cooler)
- 7) Fuel Return Cold (outlet from cooler)
- 8) LH High Pressure Fuel Line
- 9) EGR Valve
- 10) ECM Connection

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6.4L POWER STROKE® DIESEL OVERVIEW

High Pressure Common Rail Fuel System

- The 6.4L Power Stroke Diesel engine uses a high pressure fuel injection pump to deliver fuel to each piezo electric fuel injector via a high pressure common fuel rail, one rail per bank.



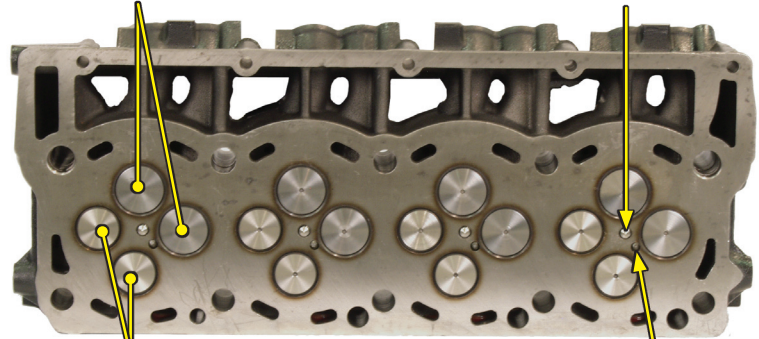
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Cylinder Head & Head Bolts

- The 6.4L Power Stroke Diesel uses a four (4) valve per cylinder head design to optimize airflow and efficiency.
- The 6.4L Power Stroke Diesel engine uses larger head bolts than the 6.0L Power Stroke Diesel engine (M16 vs M14).
- The 6.4L head bolts are also slightly shorter than the 6.0L head bolts. The 6.4L head bolts do not retain the rocker carrier like the 6.0L head bolts do.

Intake Valves

Injector Nozzle

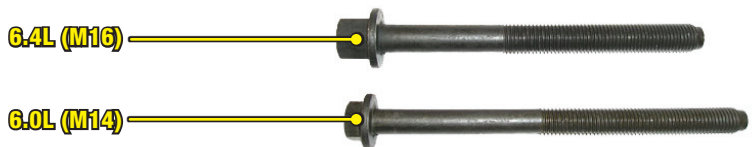


Exhaust Valves

Glow Plug

6.4L (M16)

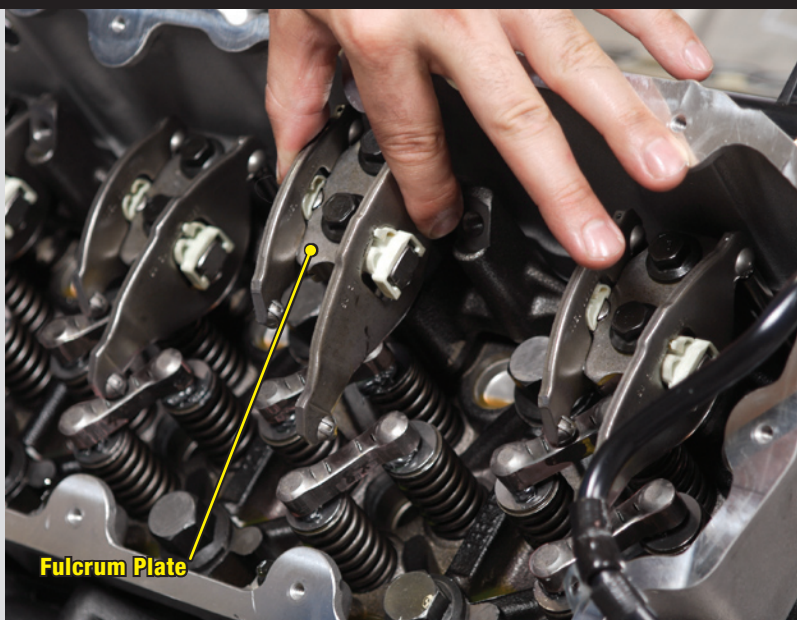
6.0L (M14)



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Fulcrum Plate & Rocker Arms

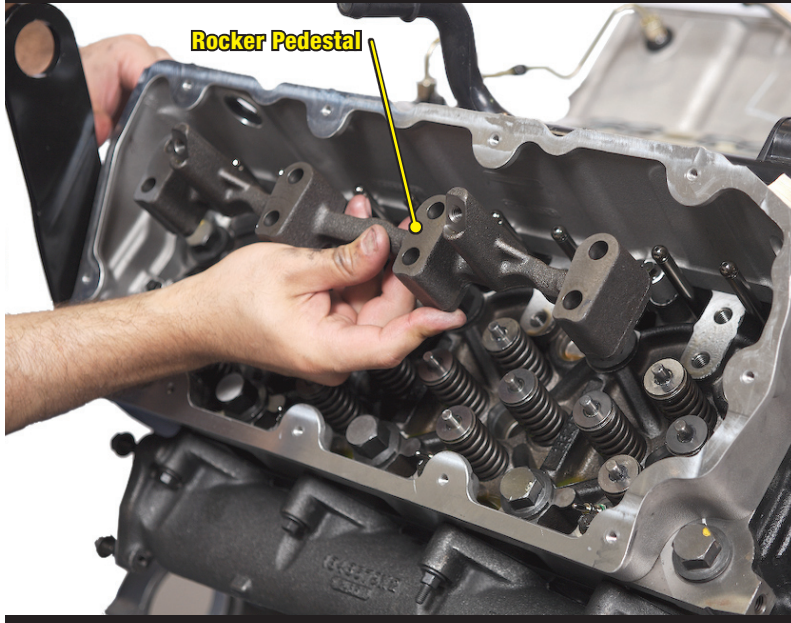
- The fulcrum plate, which holds the rocker arms, is bolted to the rocker pedestal.
- The two (2) bolts that secure the fulcrum plate pass through the fulcrum plate and the rocker pedestal and are then secured into the cylinder head.



Fulcrum Plate

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6.4L POWER STROKE® DIESEL OVERVIEW

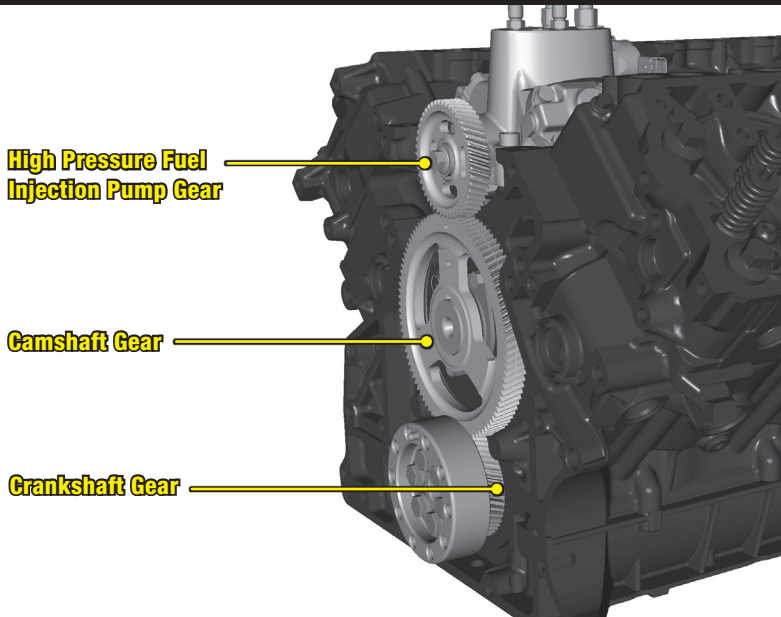


Rocker Pedestal

Rocker Pedestal

- The rocker pedestal is secured independent of the cylinder head bolts, which no longer need to be removed to service the rocker arms.

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High Pressure Fuel Injection Pump Gear

Camshaft Gear

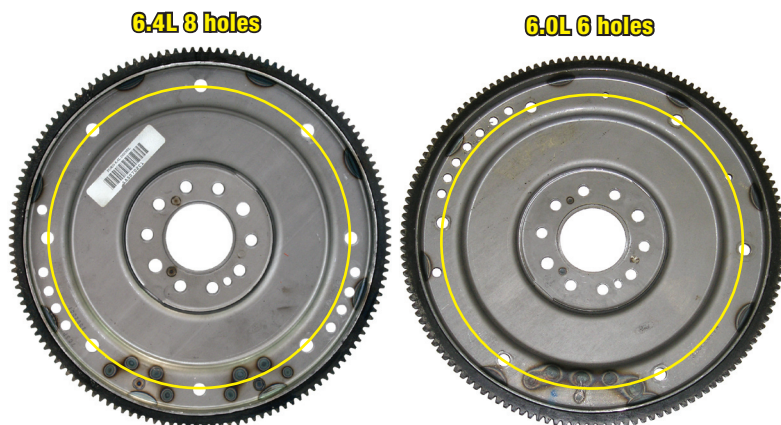
Crankshaft Gear

High Pressure Fuel Injection Pump & Rear Geartrain

- The geartrain for the crankshaft, camshaft, and the high pressure fuel injection pump are located in the rear of the engine under the rear cover.
- This allows for the high pressure fuel pump to be mounted inside the engine and also reduces noise.
- The high pressure fuel injection pump turns at a ratio of 1:1 with crankshaft speed.

NOTE: The helical cut gears used on the 6.4L differ from those used on the 6.0L.

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6.4L 8 holes

6.0L 6 holes

6.4L vs 6.0L Flexplate

- The flexplate for the 6.4L automatic equipped engine uses an 8 bolt torque converter bolt pattern.
- The flexplate for the 6.0L automatic equipped engine uses a 6 bolt torque converter bolt pattern.

NOTE: Yellow circle added for bolt circle reference.

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COOLING SYSTEM

Cooling System Features

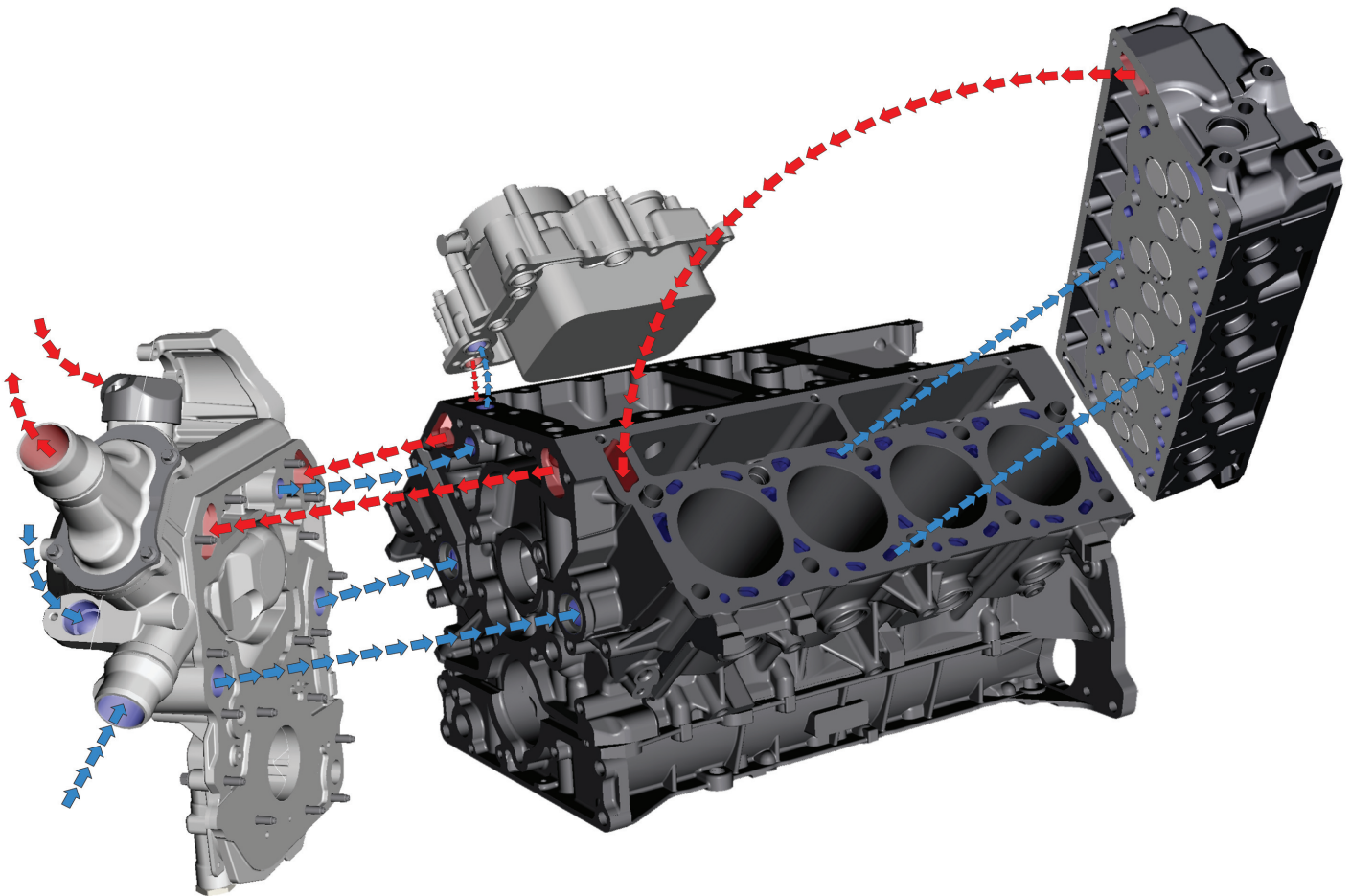
- The coolant pump can be serviced without disconnecting radiator hoses.
- Both the glow plug sleeves and the injector sleeves are stainless steel.

Cooling System Features

- Coolant Pump
- Stainless Steel Injector Sleeves
- Stainless Steel Glow Plug Sleeves

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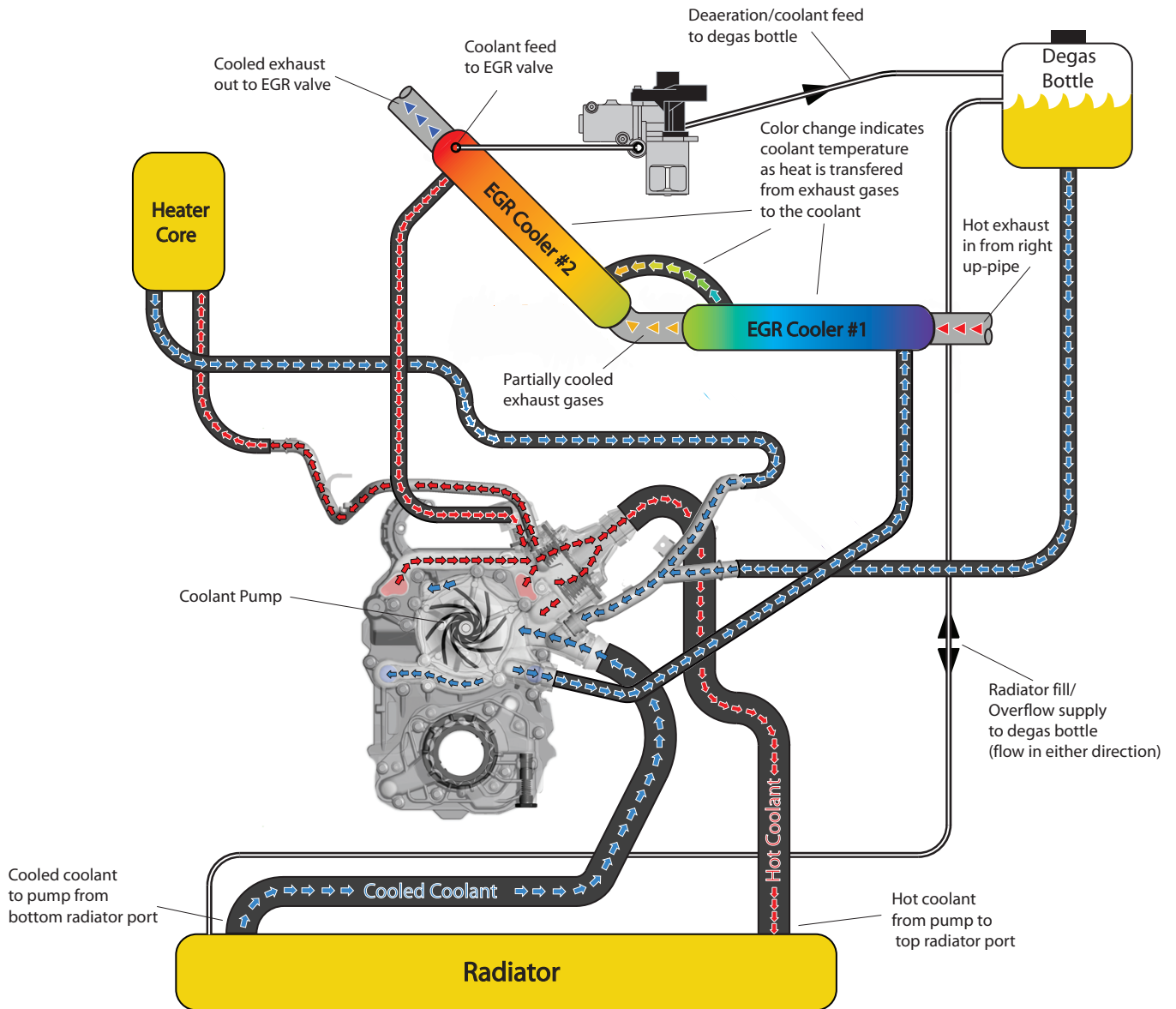
Internal Coolant Flow



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COOLING SYSTEM

External Coolant Flow



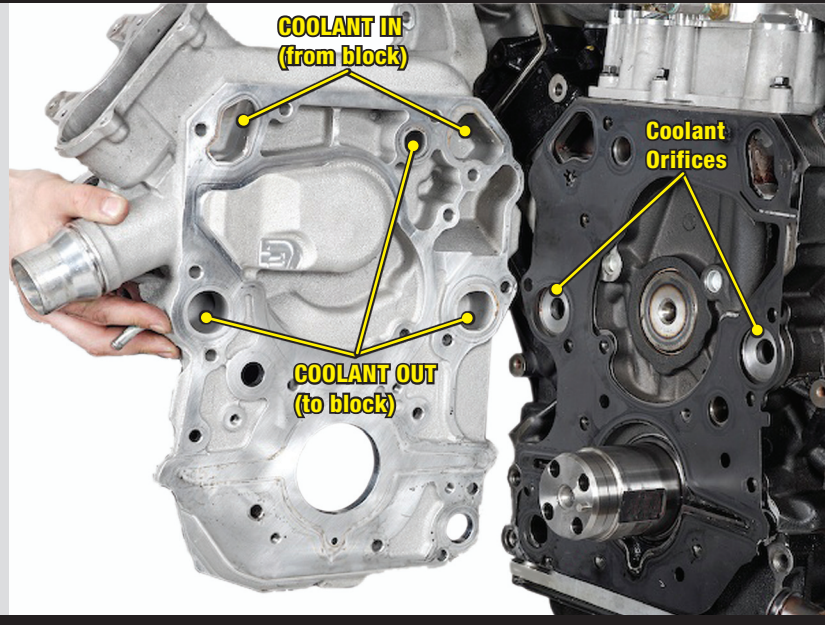
Cooling System Flow: External Flow

- Coolant is drawn into the inlet of the front cover from the bottom radiator port and then flows from the coolant pump through the front cover to the crankcase.
- Coolant is also routed from the front cover into the crankcase to a passage that feeds the oil cooler (shown on next page).
- Coolant is routed from the front cover to the EGR coolers, EGR valve, degas bottle, and the vehicle heater core.
- The horizontal EGR cooler receives coolant first, then the coolant travels to the vertical EGR cooler through a short connection hose. Hot coolant exits the vertical EGR cooler at the top and enters into the front cover.
- A port next to the hot EGR return port in the front cover routes hot coolant to the heater core for vehicle heating. The coolant then travels to a Y-pipe where it meets with degas return coolant before being sent into the front cover, just above the main coolant inlet from the radiator.
- The EGR valve receives its coolant from a passage at the top of the vertical EGR cooler. Once the coolant exits the EGR valve it is sent to the degas bottle (this passage is the highest point in the system and is also the deaeration port).
- The port directly below the EGR valve return/deaeration port on the degas bottle is used as a radiator fill/overflow line connecting with the top of the radiator.
- A dual thermostat system is used to control the flow of return coolant to the radiator. If the thermostats are open, coolant flows to the radiator to be cooled. The bottom thermostat has a bypass circuit that will allow coolant to return to the pump when the thermostats are closed (speeding engine warm up).

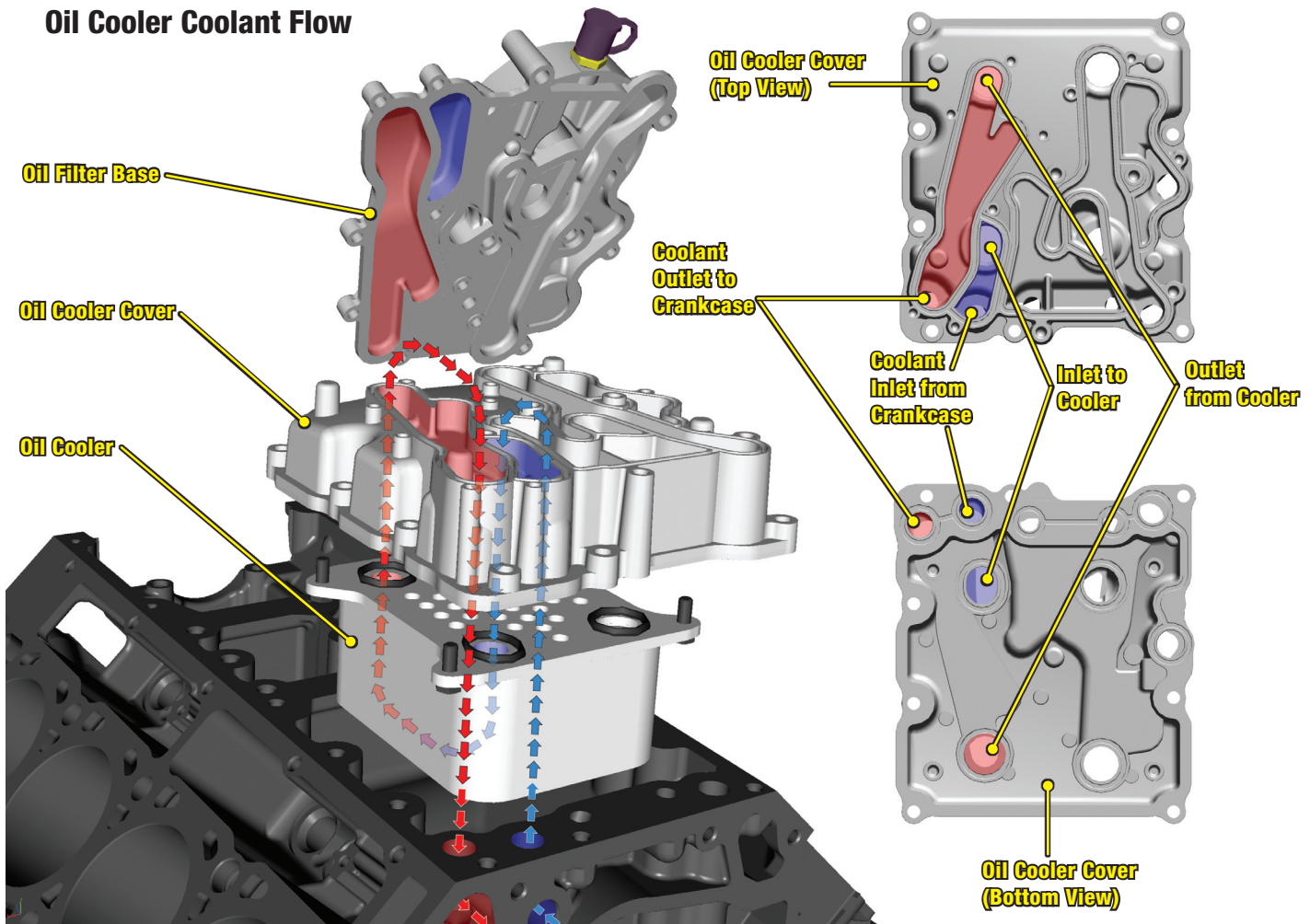
COOLING SYSTEM

Cooling System Flow: Back of Front Cover

- Coolant is sealed via a metal one piece gasket and is directed out of the front cover through three (3) passages.
- Two of the passages route coolant to the crankcase to cool the cylinder walls and cylinder heads (there are different sized orifices pressed into the crankcase in these two passages).
- The third passage routes coolant to the oil cooler via a passage in the crankcase.
- There are two passages for coolant to return from the crankcase into the front cover.



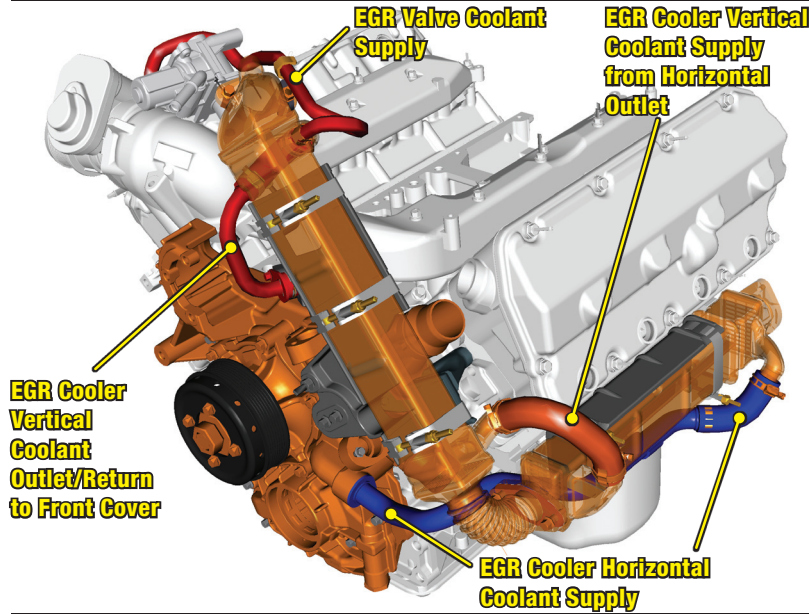
Oil Cooler Coolant Flow



Cooling System Flow: Oil Cooler

- Coolant is directed out of the crankcase and into the oil filter base at the front of the engine.
- The oil filter base routes the coolant down into the front of the oil cooler then toward the rear of the engine.
- Once the coolant has passed through the oil cooler it is routed up to the top of the oil cooler then directed towards the front through a port where it is then routed down, out of the cooler, through a port in the block.

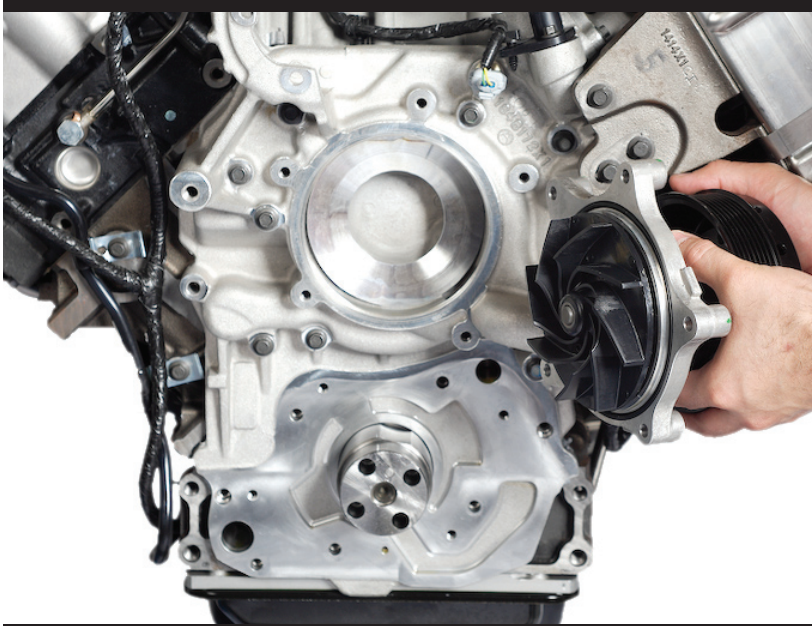
COOLING SYSTEM



Cooling System Flow: EGR Coolers

- Cooled coolant flows out of the supply port of the front cover where it is routed to the horizontal cooler at the left rear side of the engine.
- The coolant then exits the horizontal cooler and is immediately routed into the vertical cooler. The coolant then exits the vertical cooler where it is routed to the return port in the front cover.
- There is a small port at the top of the vertical cooler where coolant is allowed to flow to the EGR valve, cool the valve, then the coolant is routed to the degas bottle. This port is also used as the deaeration port.
- Coolant flows through the EGR coolers and removes heat from the exhaust before the exhaust arrives at the EGR valve.

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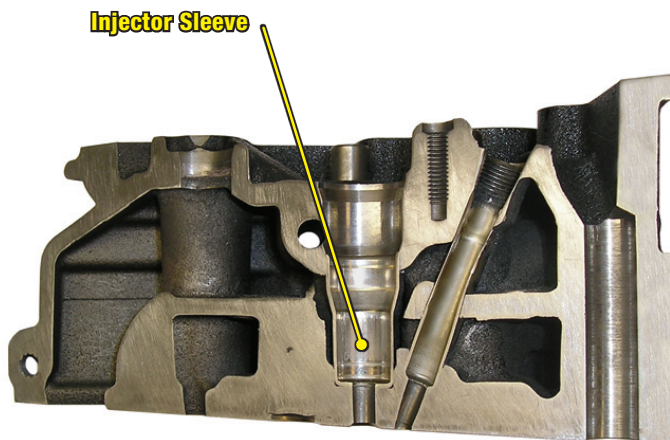


Coolant Pump & Front Cover

- The coolant pump, (hub and impeller) is mounted into the front cover which is the housing for the water pump.
- The coolant pump impeller pulls coolant from the center of the housing and pushes it outward.
- The coolant pump has a built in reservoir to catch small amounts of coolant that during normal operation of the engine may seep past the seal. This coolant will evaporate over time.

Note: The coolant pump impeller may be damaged if dropped or hit by a hard object.

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Injector Sleeve

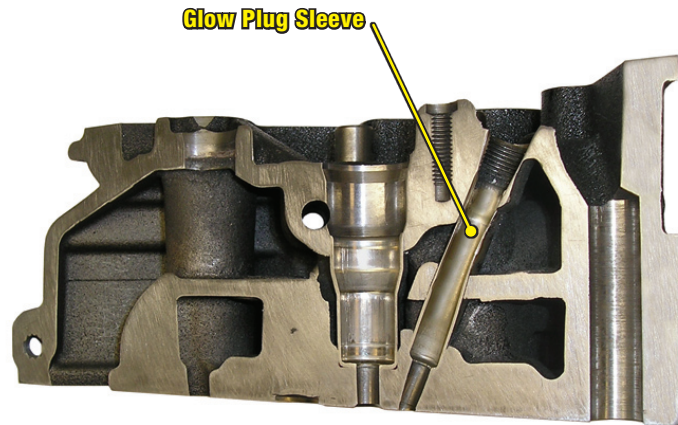
- The 6.4L Power Stroke uses stainless steel injector sleeves to seal coolant from the injector and to transfer heat from the injector to the coolant.
- The injector sleeve is replaceable.

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COOLING SYSTEM

Glow Plug Sleeve

- Glow plug sleeves are used to keep coolant from coming in direct contact with the glow plugs and to seal coolant from the combustion chamber.
- The glow plug sleeve is replaceable. See unique service procedures or the service manual for more details.



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Degas Bottle

- The degas bottle is located on the left side of the engine compartment and is part of the left side battery tray.
- One of the ports on the bottle is attached to the EGR valve coolant line (which is supplied from the top of the vertical EGR cooler). If this port or hose is blocked, damage could occur to the EGR coolers and/or the EGR valve.



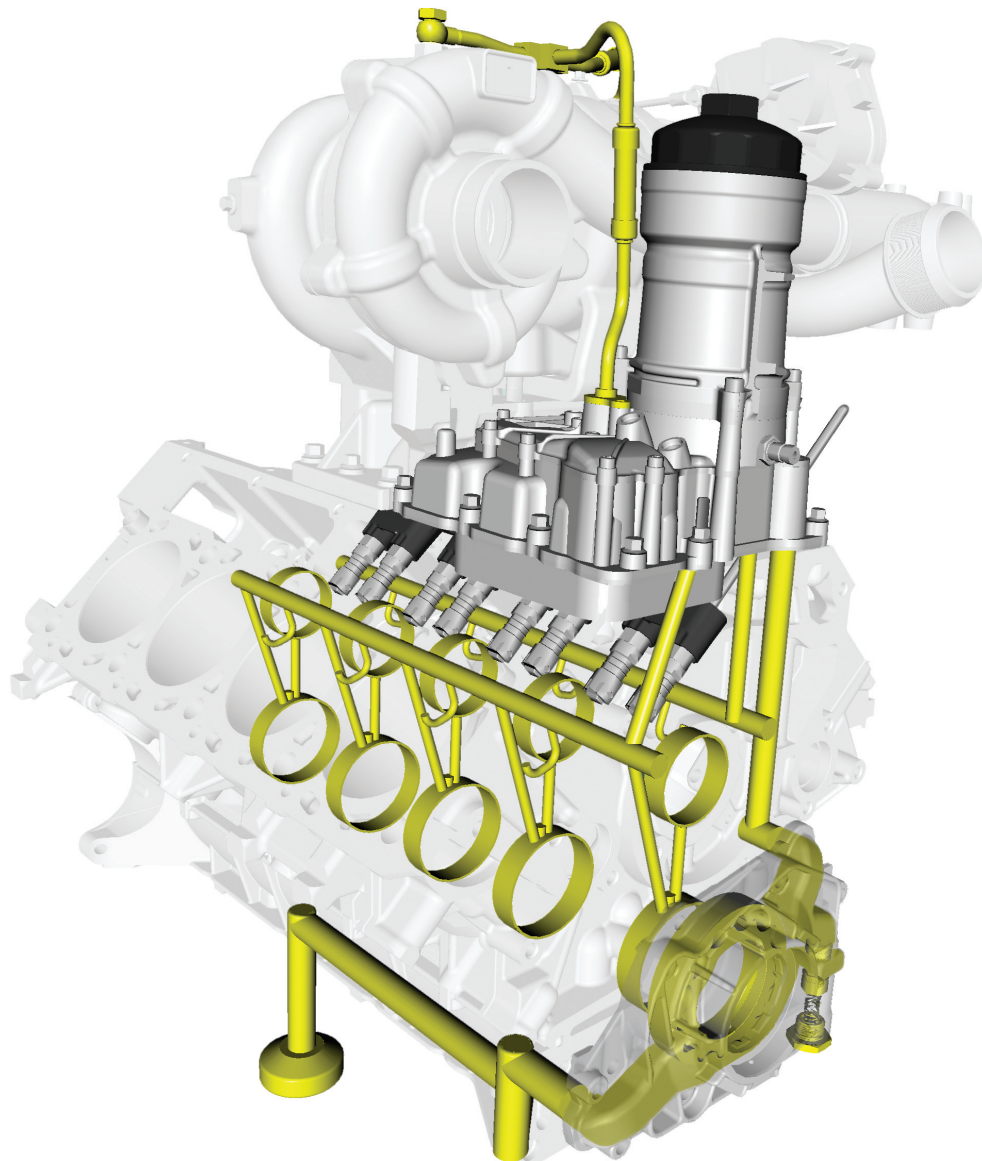
32

Lubrication System Features

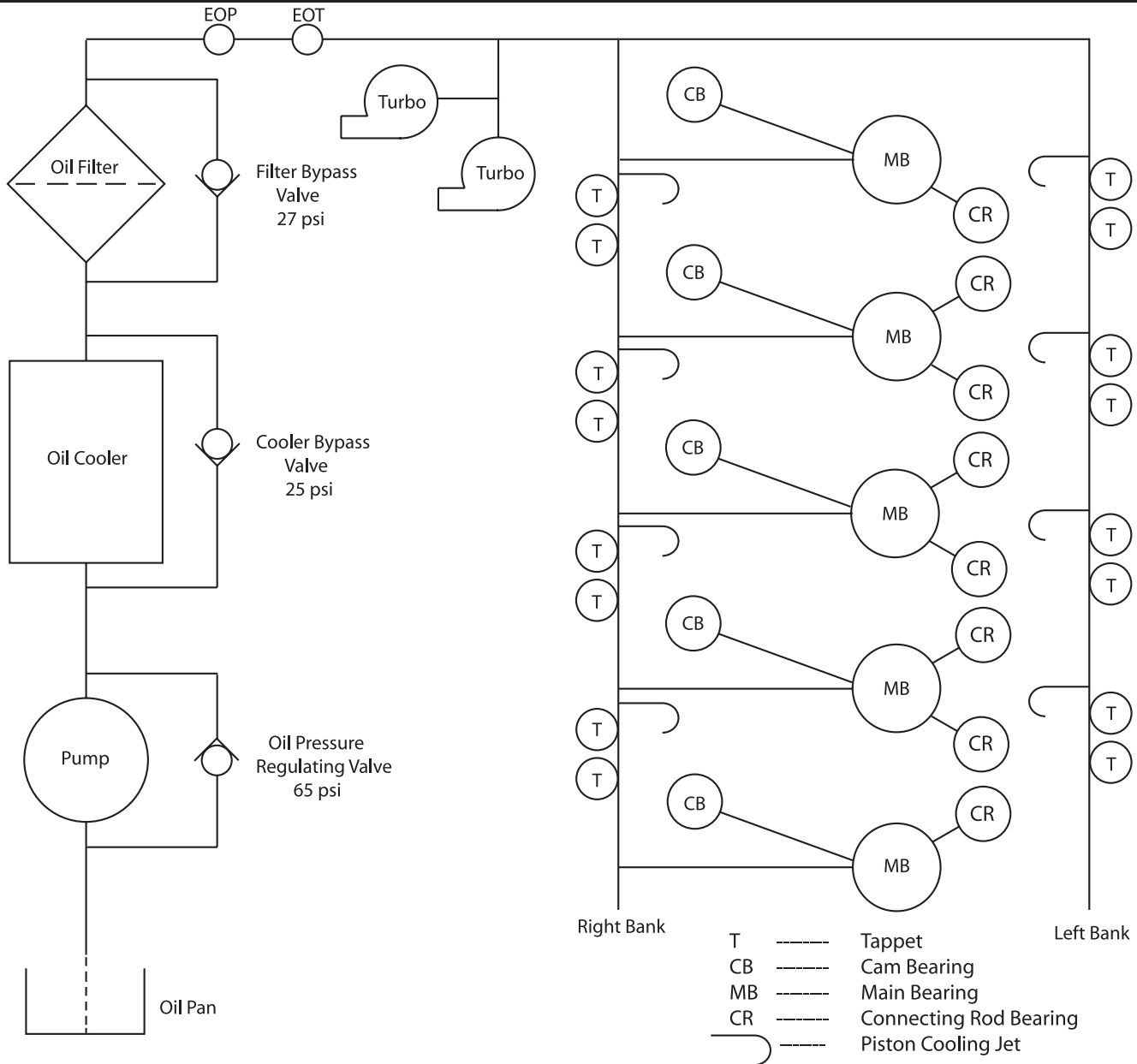
- Integrated Oil Cooler
- No External Oil Passages in Crankcase
- Easy Access Cartridge Style Oil Filter
- External Oil Pressure Regulator

Lubrication System Features

- The 6.4L Power Stroke® Diesel uses an oil cooler that is mounted in the valley of the engine under the oil filter.
- The oil filter is a cartridge style filter mounted on the top of the engine for ease of service. This system also incorporates a valve that drains the oil to the pan when the filter is removed.
- The gerotor oil pump and oil pressure regulator are both located in the front of the engine behind the vibration damper in their own removeable aluminum housing.



LUBRICATION SYSTEM

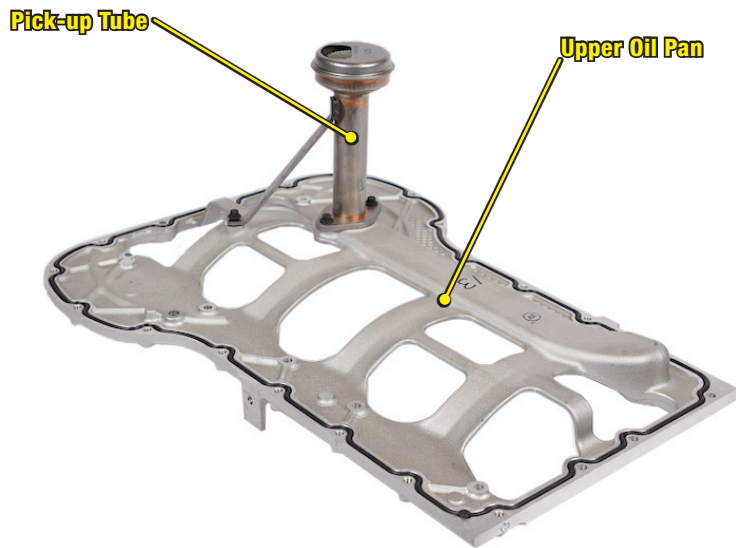


Lubrication System Oil Flow

- Oil is drawn from the oil pan through the pick-up tube. The oil is then routed through a passage cast into the upper oil pan before being routed through a passage in the block, a passage in the front cover, and finally to the oil pump inlet.
- The regulator valve utilizes a force, provided via the regulator spring, to apply a pressure equal to 65 psi. Whenever oil pressure exceeds this force, the regulator valve will move downward and allow the excess pressure to bleed off back through a passage that routes the oil back to the inlet side of the pump.
- From the oil pump, oil is directed to the oil cooler and then to the oil filter.
- From the oil filter the oil is supplied to a chamber incorporating five (5) passages. One (1) is to the turbochargers for lubrication. Two (2) are to the EOT and EOP sensors.

- The two (2) other passages are to the tappet oil supply on the right and left banks. The tappet galleries also provide oil to the piston cooling jets.
- Cross drillings off of the right bank tappet gallery supply oil to the main bearings.
- Another cross drilling vertically up from each main bearing supplies oil to the camshaft bearings.

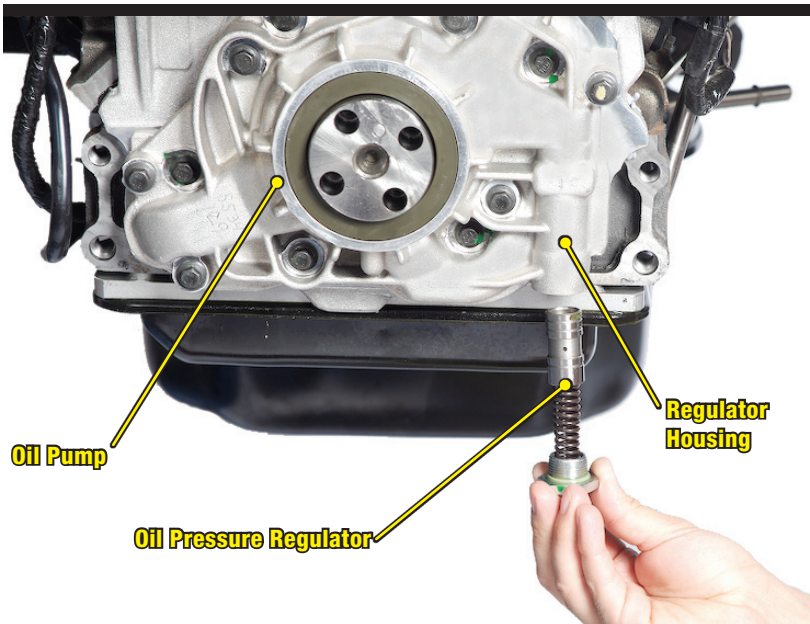
Note: This oil supply routing is different than the 6.0L and uses different bearings which are also placed differently with respect to the oil holes.



Pick-up Tube / Oil Aeration

- The pick-up tube supplies oil from the oil pan to the oil pump.
- The pick-up tube is sealed to the upper oil pan utilizing an o-ring. If the o-ring is damaged or missing, it could cause oil aeration.

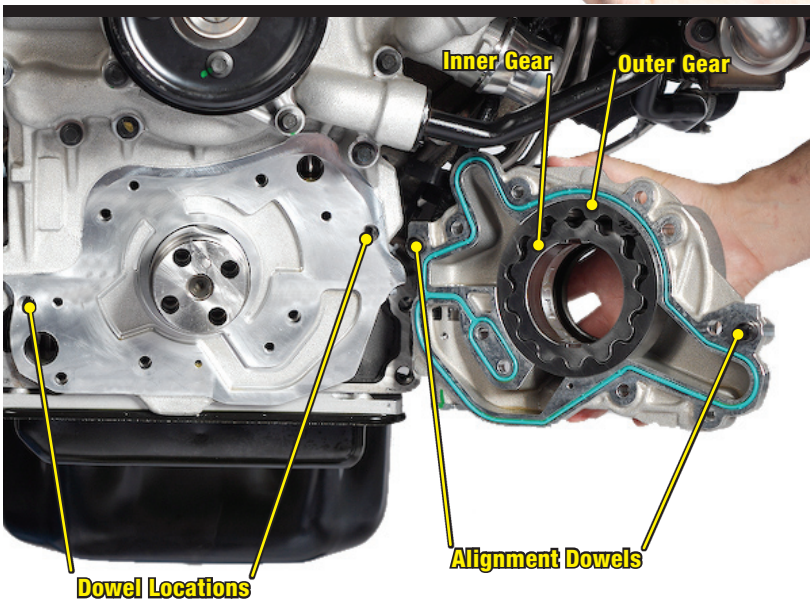
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Oil Pressure Regulator

- The oil pressure regulator is located in the gerotor housing just to the right (when looking at the engine from the front) of the gerotor oil pump.
- The oil pressure regulator is calibrated to open at pressures above 65 psi. It should be closed below that pressure.
- The regulator valve utilizes a force, provided via the regulator spring, to apply a pressure equal to 65 psi. Whenever oil pressure exceeds this force, the regulator valve will move downward and allow the excess pressure to bleed off back through a passage that routes the oil back to the inlet side of the pump.

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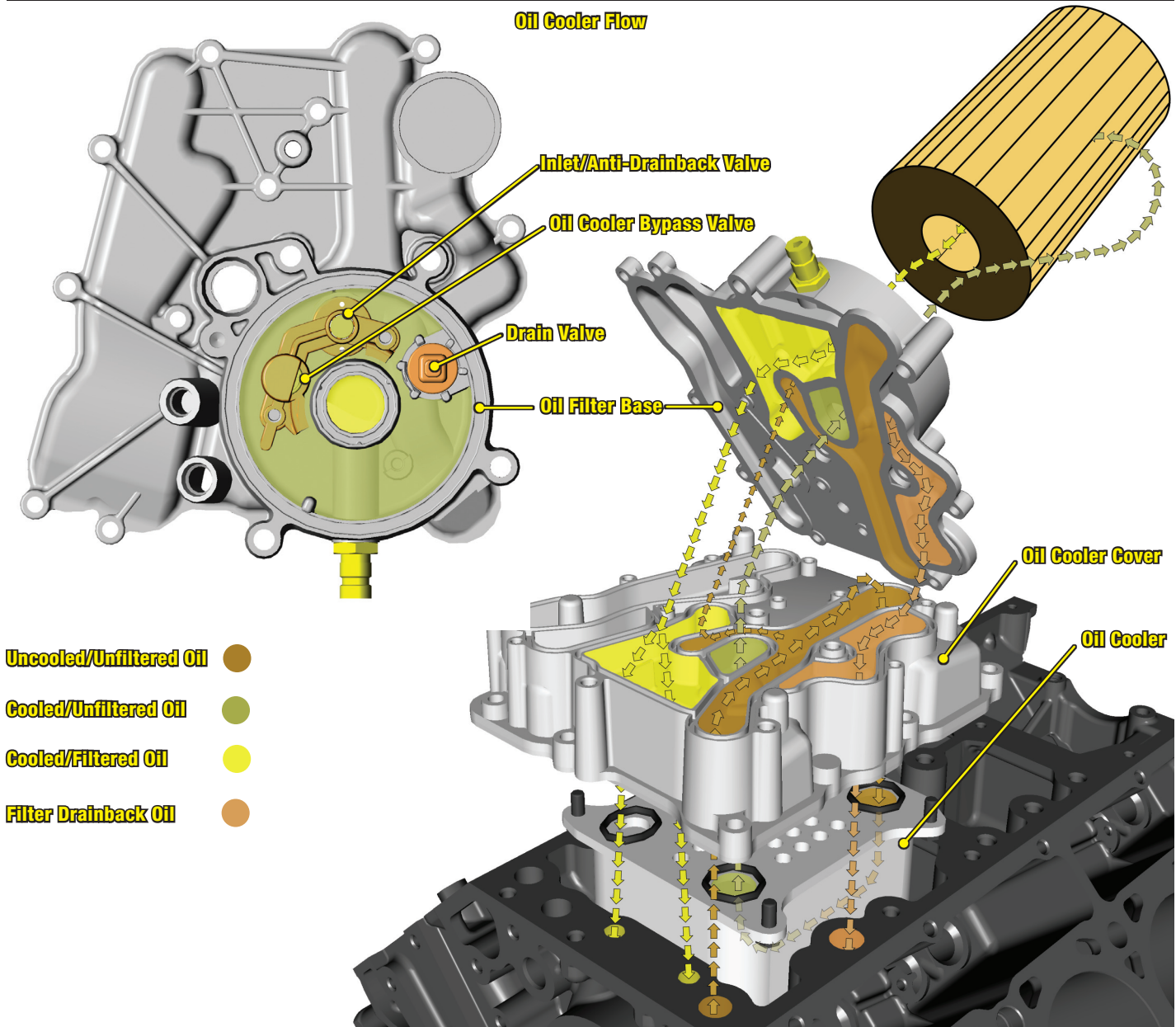
Gerotor Oil Pump

- The gerotor oil pump is driven off of the flats on the nose of the crankshaft.
- The gerotor oil pump and regulator valve are held in their own removeable housing.

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LUBRICATION SYSTEM

Oil Cooler Flow



- Uncooled/Unfiltered Oil ●
- Cooled/Unfiltered Oil ●
- Cooled/Filtered Oil ●
- Filter Drainback Oil ●

Lube System Flow: Oil Cooler

- Uncooled/Unfiltered oil is directed out of the crankcase at the front left corner of the engine via a drilled passage from the oil pump.
- Uncooled/Unfiltered oil is then directed across the oil cooler cover then down into the oil cooler.
- The oil is then cooled via the oil cooler as it passes through the cooler towards the front of the engine.
- The cooled/unfiltered oil is routed up through the oil cooler cover then through the oil filter base where it enters the oil filter housing (there is a small inlet valve in the oil filter base that the oil must pass through to keep the oil from draining out of the filter housing during non-operation). At this point the oil flows through the filter (from the outside of the filter to the center) where it is cleaned.

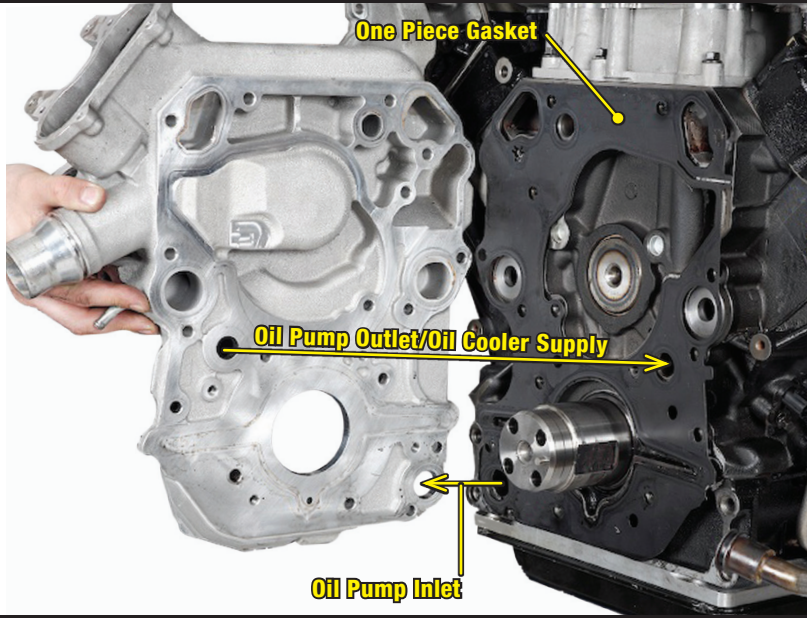
Note: There is an oil filter bypass valve located at the top of the oil filter stand pipe (plastic tube the oil filter slides over) which will open and allow unfiltered oil to enter the system whenever a pressure differential of 27 psi is reached.

- After being cleaned via the oil filter, the oil is routed through the oil filter base and into a cavity that has ports to direct the oil to the following areas: left and right oil galleries, turbocharger oil supply, and the EOT & EOP sensors.

Note: There is a drain valve inside the oil filter base which is held closed by the oil filter whenever the oil filter cap is tight. Whenever this cap is loosened, the valve is allowed to open and oil will then escape through this valve, through the oil cooler cover, and then down through a drilled passage in the crankcase to the oil pan.

Note: There is an oil cooler bypass valve inside the oil filter base which will open and let uncooled oil bypass the oil cooler and enter the oil filter housing whenever a pressure differential of 25 psi is reached.

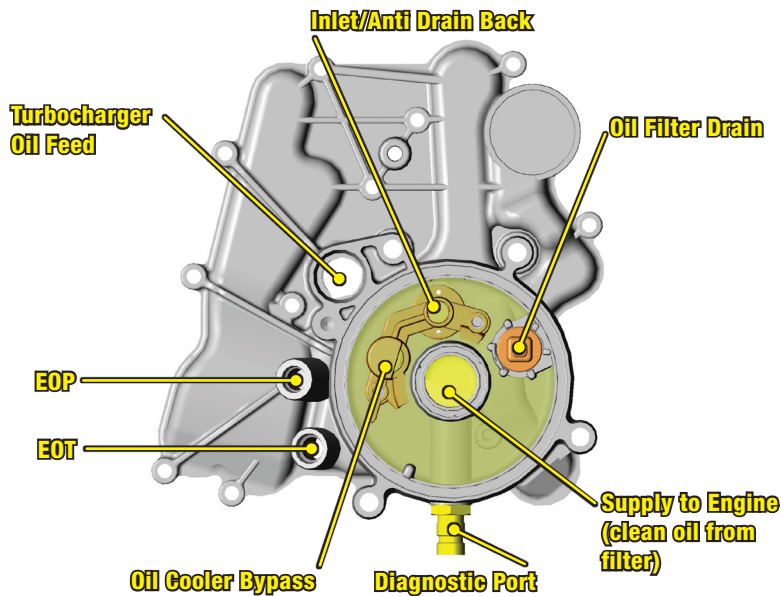
LUBRICATION SYSTEM



Front Cover

- Oil flows from the crankcase to the oil pump via a passage through the upper oil pan, front cover, and oil pump housing.
- When the oil pump is turned by the crankshaft it creates oil flow and pushes oil through two passages. One passage is to the oil cooler and the other is through the oil pressure regulator then to the oil pump inlet (this passage is only used when pressure exceeds 65 psi). When the oil reaches the numerous restrictions throughout the engine, pressure is then created (pressure is the resistance to flow).
- All of the passages from the front cover to the crankcase are sealed with a rubber coated metal, one piece gasket.

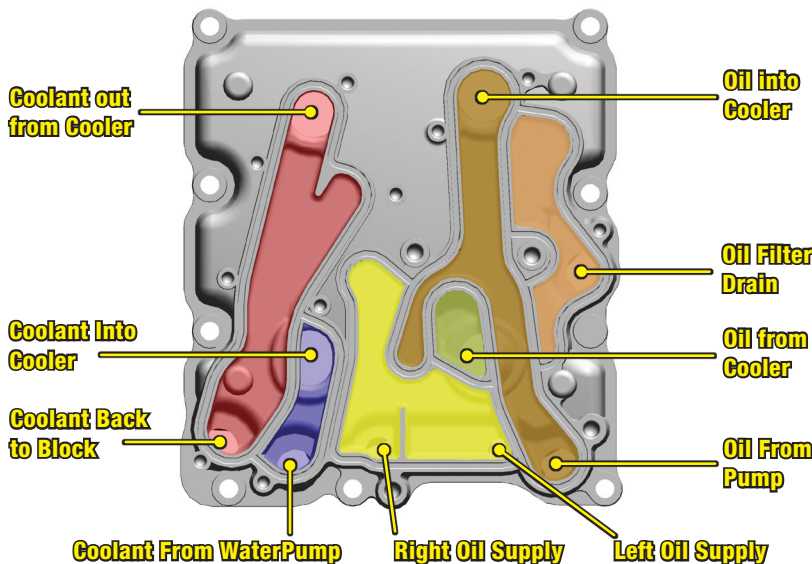
40



Oil Filter Base

- The oil filter base contains the mounting provisions for the oil filter housing and the oil filter stand pipe (which contains the oil filter bypass valve).
- Inside the oil filter housing, there are the following valves: Inlet/Anti drainback valve, oil cooler bypass valve, and the oil filter drain valve.
- The oil filter base also contains the ports for the EOT, EOP, and turbocharger oil supply. These ports are all connected with the cooled/filtered oil passage directly beneath them.

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Oil Cooler Cover

- The oil cooler cover has passages in it to direct the flow of coolant and oil.
- Oil is routed from the front of the crankcase to the rear of the housing where it enters the oil cooler. The oil passes from the rear of the oil cooler to the front of the cooler and is cooled in the process. The oil is then sent to the oil filter through the oil filter base. Filtered oil is sent to the oil passages in the crankcase, the turbocharger supply line, and the EOT/EOP sensors.
- The coolant is directed from the front of the crankcase to the front of the oil cooler. It then passes through the oil cooler and cools the oil. As the coolant exits the front of the cooler it is directed down into the coolant stream where it re-enters the crankcase cooling system.

Note: If the oil cooler is damaged it could cause contamination of the lubrication and cooling systems.

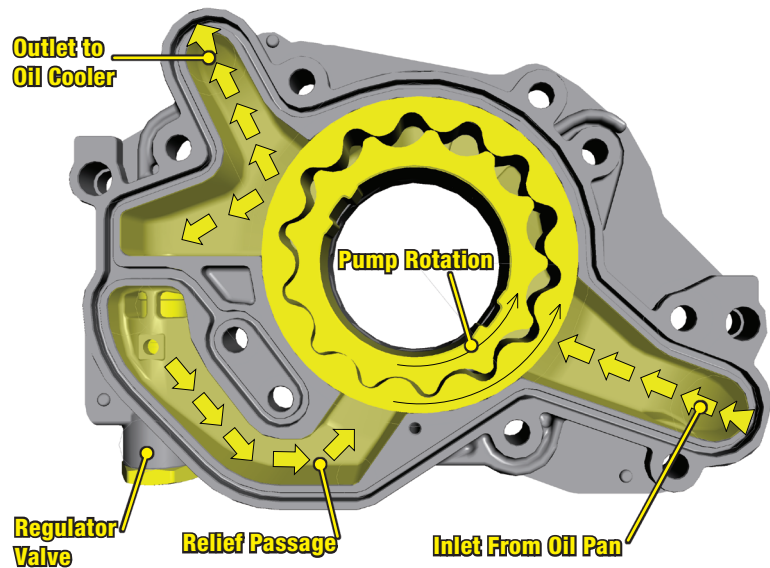
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LUBRICATION SYSTEM

Oil Pump Flow (back side)

- The oil pump is a gerotor style pump driven off of the flats on the front of the engine's crankshaft.
- The 6.4L oil pump is held in its own removeable aluminum housing which also contains the regulator valve.
- Oil is drawn into the pump via the combination of atmospheric pressure (applied to the oil in the pan) and the low pressure area that is created between the gerotor gears on the inlet side of the pump whenever the pump is being driven by the crankshaft.
- Once this happens, the oil will flow into the pump and the pump will create a generous amount of oil flow.
- When the oil reaches various restriction throughout the engine, pressure is created.
- Pressure is limited via a pressure regulator valve located inside the pump housing. Whenever a pressure of 65 psi is reached, the regulator valve will open and allow pressurized oil to flow back through a relief passage to the inlet side of the pump, thus regulating system pressure.

Back Side of Pump



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Oil Filter

- The 6.4L Power Stroke® Diesel uses a cartridge style oil filter, located on the top of the engine.
- When the oil filter is removed, the oil filter housing drain valve is automatically opened to drain most of the oil from the housing.
- The oil filter element snaps into the oil filter lid.

Note: The oil filter lid should be removed before draining the oil from the oil pan so that the oil can drain from the filter housing into the oil pan.

Oil Filter Element



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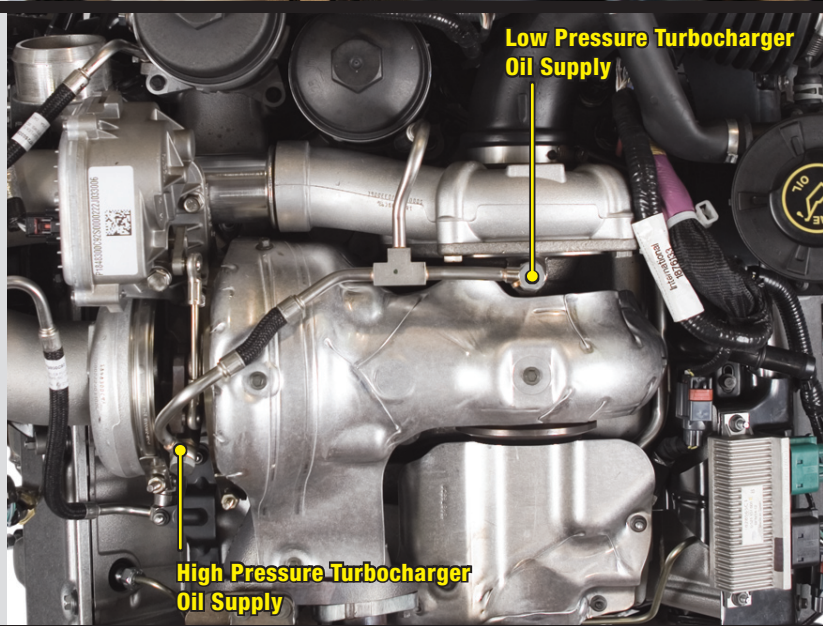
Turbocharger Oil Supply

- Oil is supplied to the turbochargers from the oil filter base via a steel oil line, a steel T fitting, and two separate steel lines to each turbo (the high pressure turbocharger oil supply line has a flexible link in it).
- The oil lines are connected to each turbo via banjo fittings and washer gaskets.

Note: The washer gaskets (which are used as a gasket medium) must be replaced each time the banjo fittings are loosened.

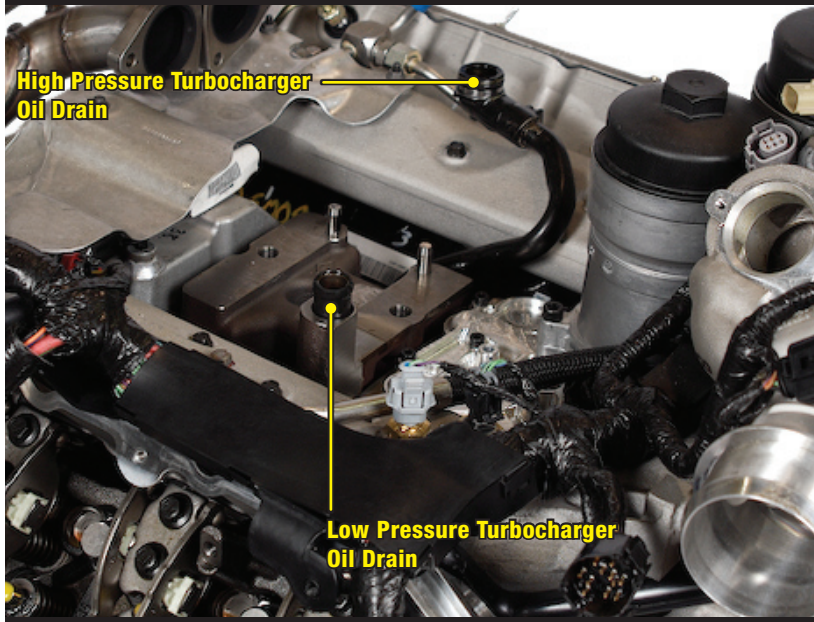
Low Pressure Turbocharger Oil Supply

High Pressure Turbocharger Oil Supply



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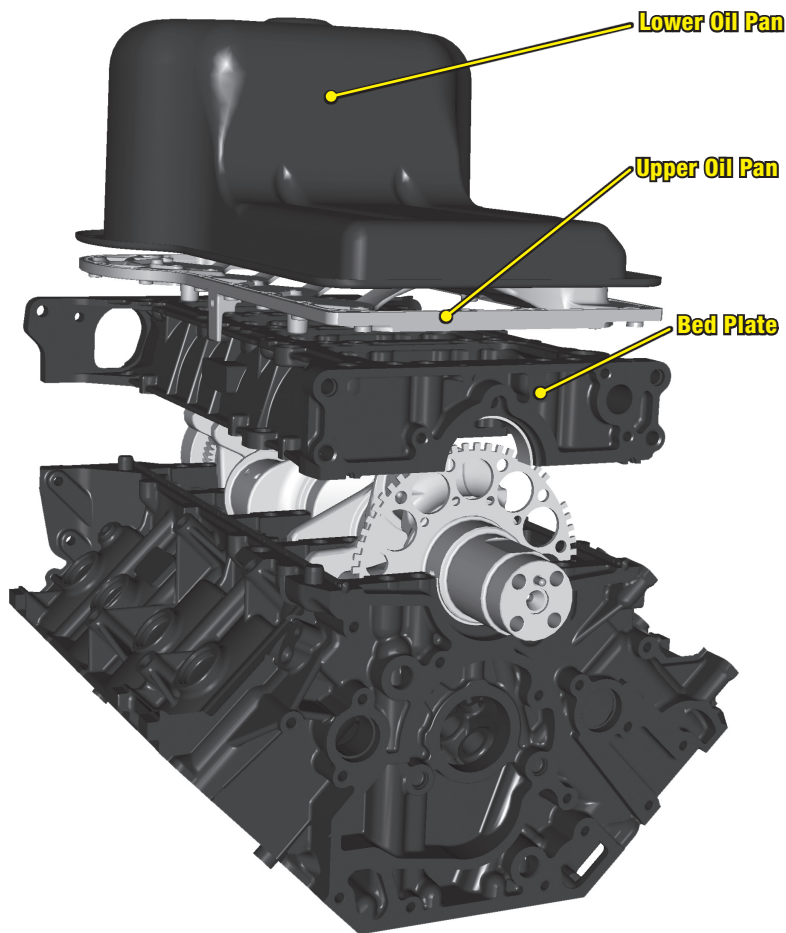
LUBRICATION SYSTEM



Turbocharger Oil Drain Tubes

- Oil is supplied to the turbochargers to lubricate and cool the bearings.
- Each turbocharger has its own drain. The high pressure turbocharger uses a removable tube where as the low pressure turbocharger utilizes a small extension tube off of a machined passage in the turbocharger pedestal.
- The high pressure turbocharger drain tube is sealed via two (2) O-rings, one at each end of the tube.
- The low pressure turbocharger drain extension tube is sealed via a rubber coated metal tube.

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Oil Pan / Bed Plate

- The 6.4L Power Stroke® Diesel uses a two piece oil pan. The lower half is wider than the bottom of the engine to increase the oil capacity of the system. Due to this wider oil pan, an upper oil pan is used to adapt the lower pan to the bed plate. The upper pan also acts as an oil baffle.
- The upper pan is bolted to the bed plate. The bed plate replaces the individual main bearing caps, resulting in a more rigid bearing retaining system.

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FUEL SUPPLY SYSTEM

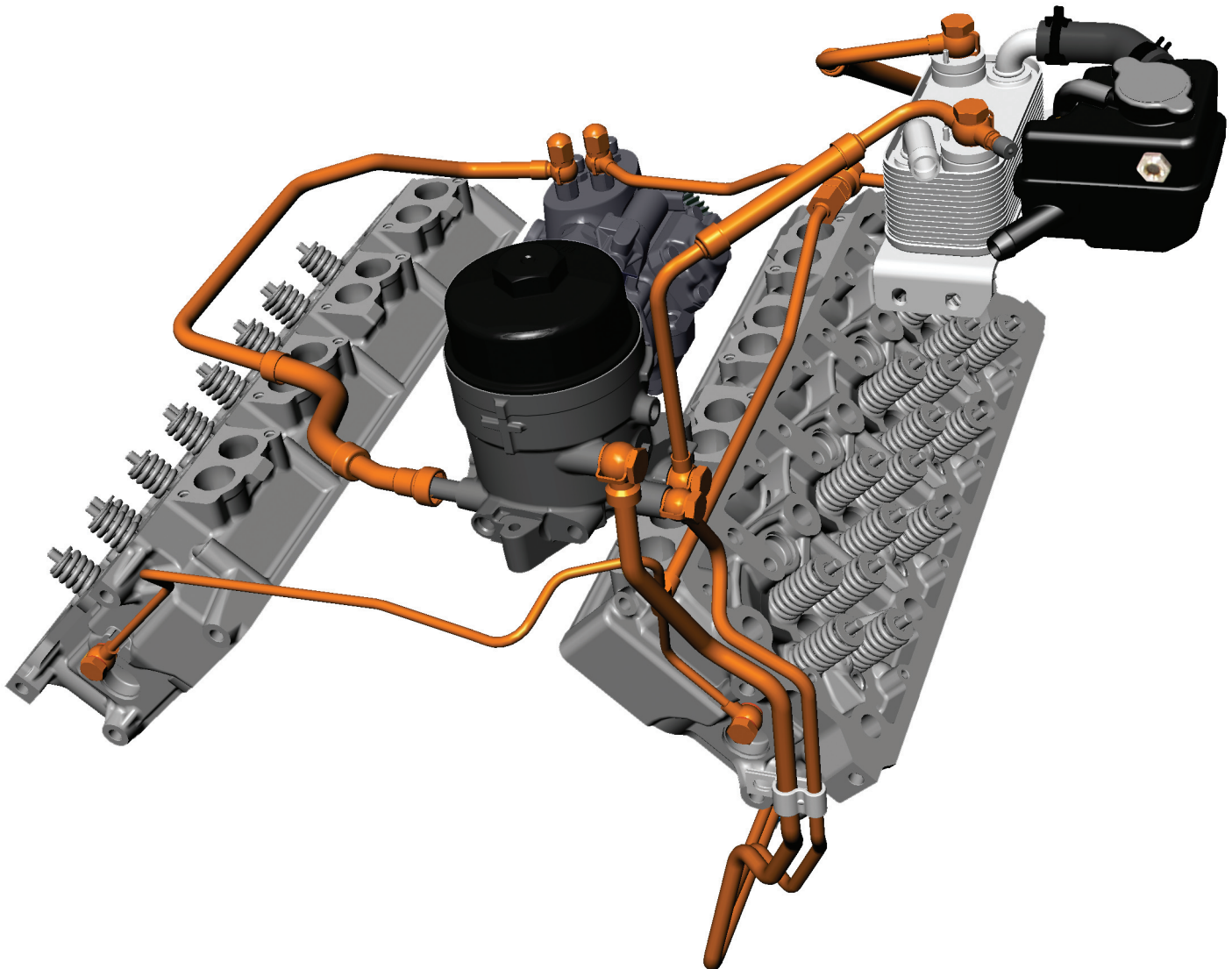
Fuel Supply System Features

- The fuel supply system uses a new Horizontal Fuel Conditioning Module (HFCM). The HFCM filters fuel, separates water, senses water, and recirculates warm fuel through the pump during cool fuel conditions.
- The 6.4L Power Stroke® Diesel also uses 2 fuel filters and a stand alone fuel cooler system.

Fuel Supply System Features

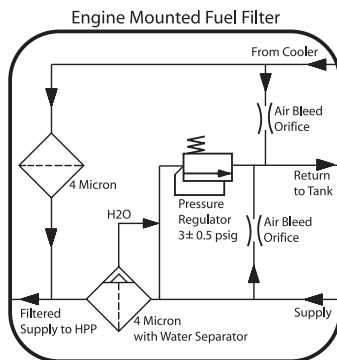
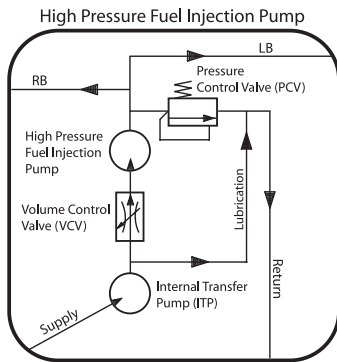
- Horizontal Fuel Conditioning Module (HFCM)
- (1) Chassis Mounted 10 Micron Fuel Filter
- (1) Engine Mounted 4 Micron Fuel Filter
- Water Separator
- Fuel Cooler

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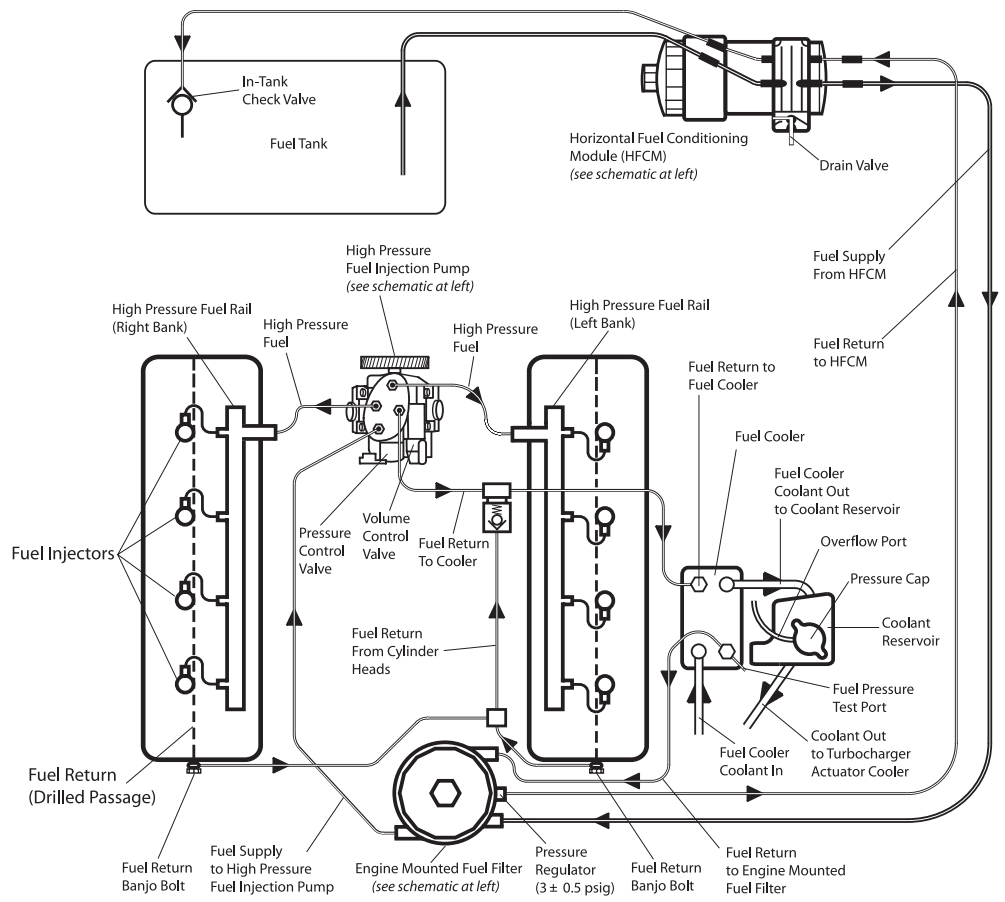
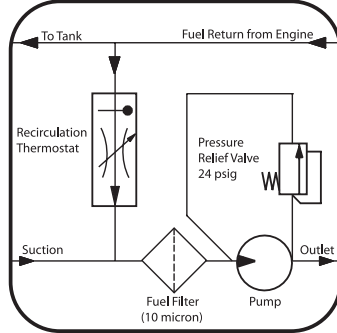


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FUEL FLOW



Horizontal Fuel Conditioning Module (HFCM)



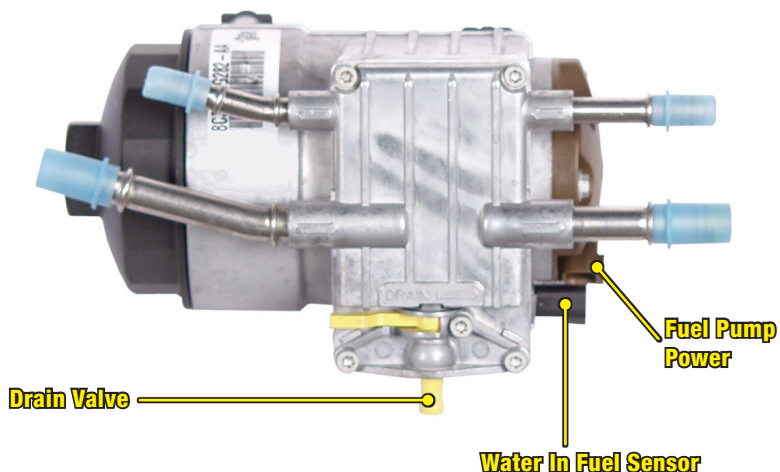
Engine Fuel Flow

- The fuel pump, located in the Horizontal Fuel Conditioning Module (HFCM), draws fuel from the fuel tank and through a 10 micron fuel filter.
- The HFCM contains the fuel pump, filter, water separator, water in fuel switch, fuel drain, and diesel thermo recirculation valve (DTRM).
- The DTRM controls the flow of fuel returned from the engine mounted filter through the HFCM. If the fuel being drawn from the fuel tank is cooler than a specified temperature then return fuel from the engine is recirculated into the inlet of the pump.
- After the fuel is conditioned by the HFCM, the clean pressurized fuel is sent to the engine mounted fuel filter assembly where particles larger than 4 micron are filtered out of the fuel.
- The engine mounted fuel filter assembly also regulates fuel pressure by releasing excess pressure via a return fuel line back to the HFCM. The engine mounted fuel filter also contains air bleed orifices to remove air and return it to the tank.
- After the fuel is filtered it is routed to the Internal Transfer Pump (ITP).
- The ITP is located inside the high pressure fuel injection pump and is used to increase the fuel pressure supplied to the high pressure fuel injection pump's three (3) internal pistons.
- After the fuel is pressurized it is routed to the high pressure fuel rails and to the fuel injectors via high pressure fuel supply tubes.
- A Pressure Control Valve (PCV) located in the outlet side of the high pressure fuel injection pump controls the fuel pressure by dumping excess fuel into the fuel return line.
- A Fuel Rail Pressure (FRP) sensor located in the right side fuel rail monitors the fuel pressure.
- Return fuel from the injectors is routed through a drilled passage from each cylinder head where it is then united with return fuel from the high pressure fuel injection pump before being sent to the fuel cooler and back to the engine mounted fuel filter.

FUEL SUPPLY SYSTEM

HFCM (Horizontal Fuel Conditioning Module)

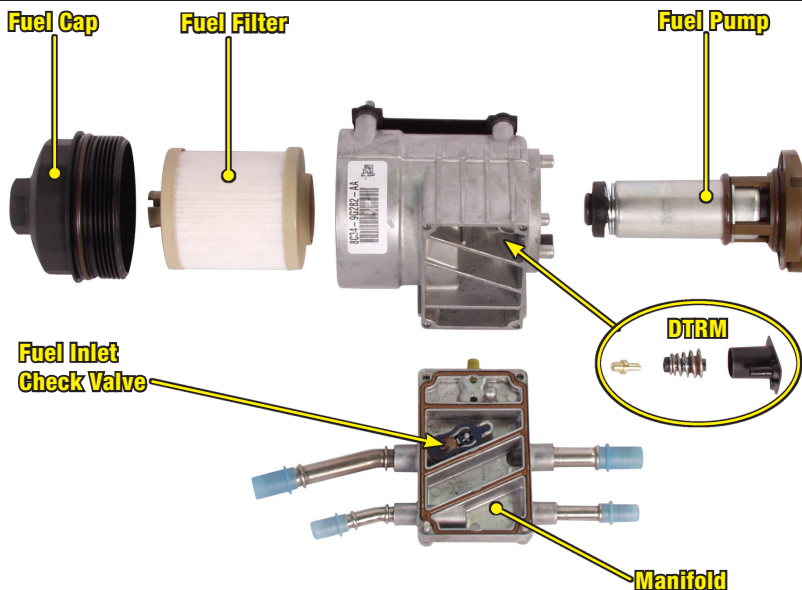
- The HFCM is mounted to the frame rail on the drivers side.
- The HFCM is a single module that performs multiple tasks. It separates water from the fuel, senses when water is present in the fuel, filters particulates from the fuel, and creates the fuel flow needed to supply fuel to the engine mounted fuel filter.
- A DTRM (Diesel Thermo Recirculation Module) is also part of the HFCM. It recirculates fuel that returns from the engine mounted fuel filter back into the fuel filter instead of back to the tank.



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HFCM Components

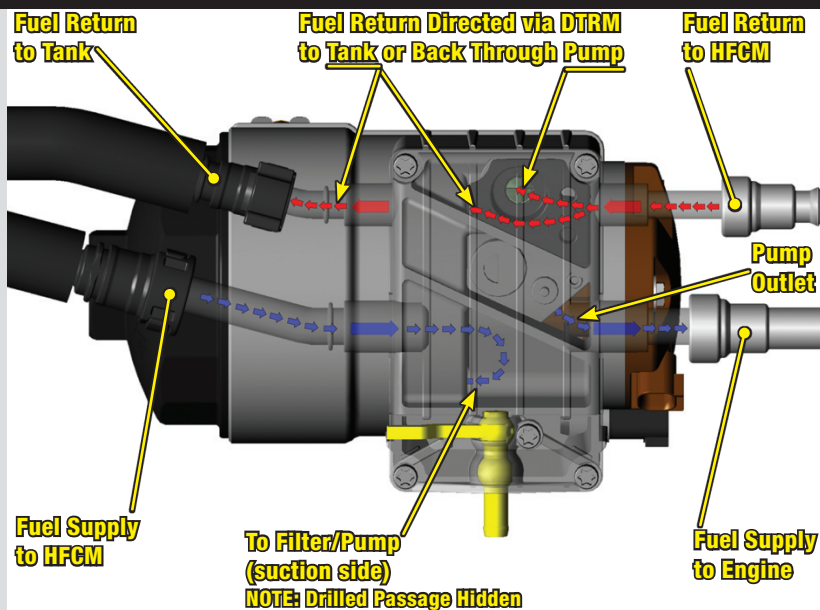
- The HFCM is composed of six (6) main components:
 - Housing
 - Fuel Filter (10 micron)
 - Fuel Cap
 - Electric Fuel Pump
 - Manifold (contains the fuel inlet check valve)
 - Diesel Thermo Recirculation Module (DTRM) is also part of the HFCM. It recirculates fuel that returns from the engine mounted fuel filter back into the fuel filter instead of back to the tank.



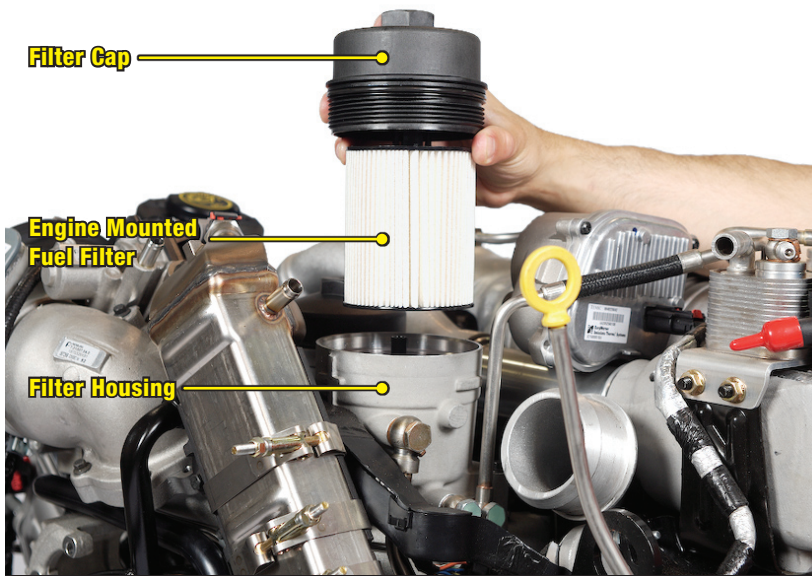
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HFCM Fuel Flow

- Fuel is drawn into the HFCM from the fuel tank via a supply line.
- Fuel enters the filter housing via a one-way check valve.
- Once in the filter housing, water is separated from the fuel. If large amounts of water are found in the fuel, a sensor in the separator warns the operator of this condition by illuminating a light on the dash.
- Fuel is then drawn through the 10 micron fuel filter and into the fuel pump.
- Conditioned pressurized fuel is then supplied to the engine mounted fuel filter via a fuel supply line. The pump has an internal regulator that limits fuel pressure to 24psi.
- Fuel returning from the pressure regulator on the engine mounted fuel filter comes into the HFCM and a DTRM either allows the fuel to return to the tank or returns it to the unfiltered side of the fuel filter in the HFCM. The DTRM starts to open (recirculating fuel back into the pump) at 80°F (27°C) and is fully open at 50°F (10°C).



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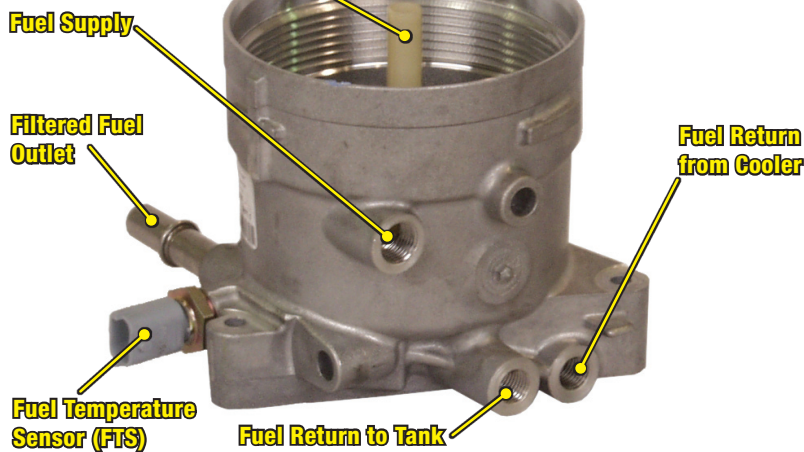
Engine Mounted Fuel Filter

- An engine mounted fuel filter is mounted to the intake manifold.
- The engine mounted fuel filter is a 4 micron cartridge style filter.
- It also incorporates a fuel pressure regulator (in the standpipe) and an air bleed. Fuel from the regulator is returned to the HFCM.

NOTE: Please exercise extreme cleanliness when servicing the fuel filter.

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Fuel Pressure Regulator Located Inside Standpipe Assembly

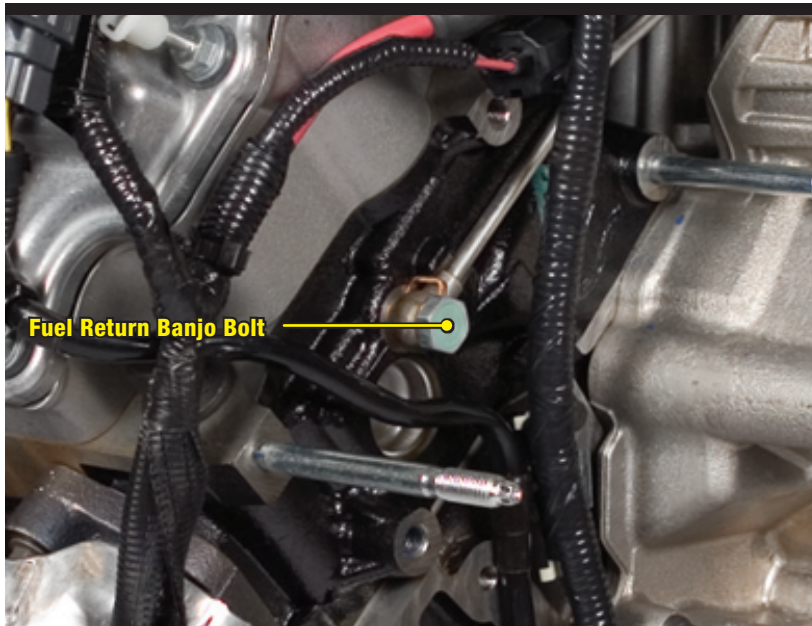


Fuel Pressure Regulator

- The fuel pressure regulator is located inside the engine mounted fuel filter housing in the standpipe.
- It regulates fuel pressure by routing unfiltered fuel from the filter housing to the HFCM via a spring loaded poppet style valve.
- The cracking pressure (pressure at which the valve begins to open) of the valve is 2psi +/- 0.5psi. Actual fuel pressure may be above or below this specification.
- The regulated pressure of the valve is 3psi +/- 0.5psi. Actual fuel pressure may be above or below this specification.

NOTE: The fuel pressure regulator is NOT serviceable separate from the housing! If the regulator needs to be replaced, then the entire housing must be replaced.

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Fuel Return Banjo Fittings

- The fuel return lines (located on the front of each cylinder head) utilize a banjo bolt to route the return fuel back to the fuel system.

NOTE: The 6.0L Power Stroke® Diesel utilized a banjo bolt with a check valve inside. Do not interchange the 6.0L banjo bolt with the 6.4L banjo bolt.

NOTE: The 6.4L Power Stroke Diesel uses an open banjo bolt with no check valve. The check valves are no longer needed since the drilled passages in the cylinder heads are now utilized as fuel return passages.

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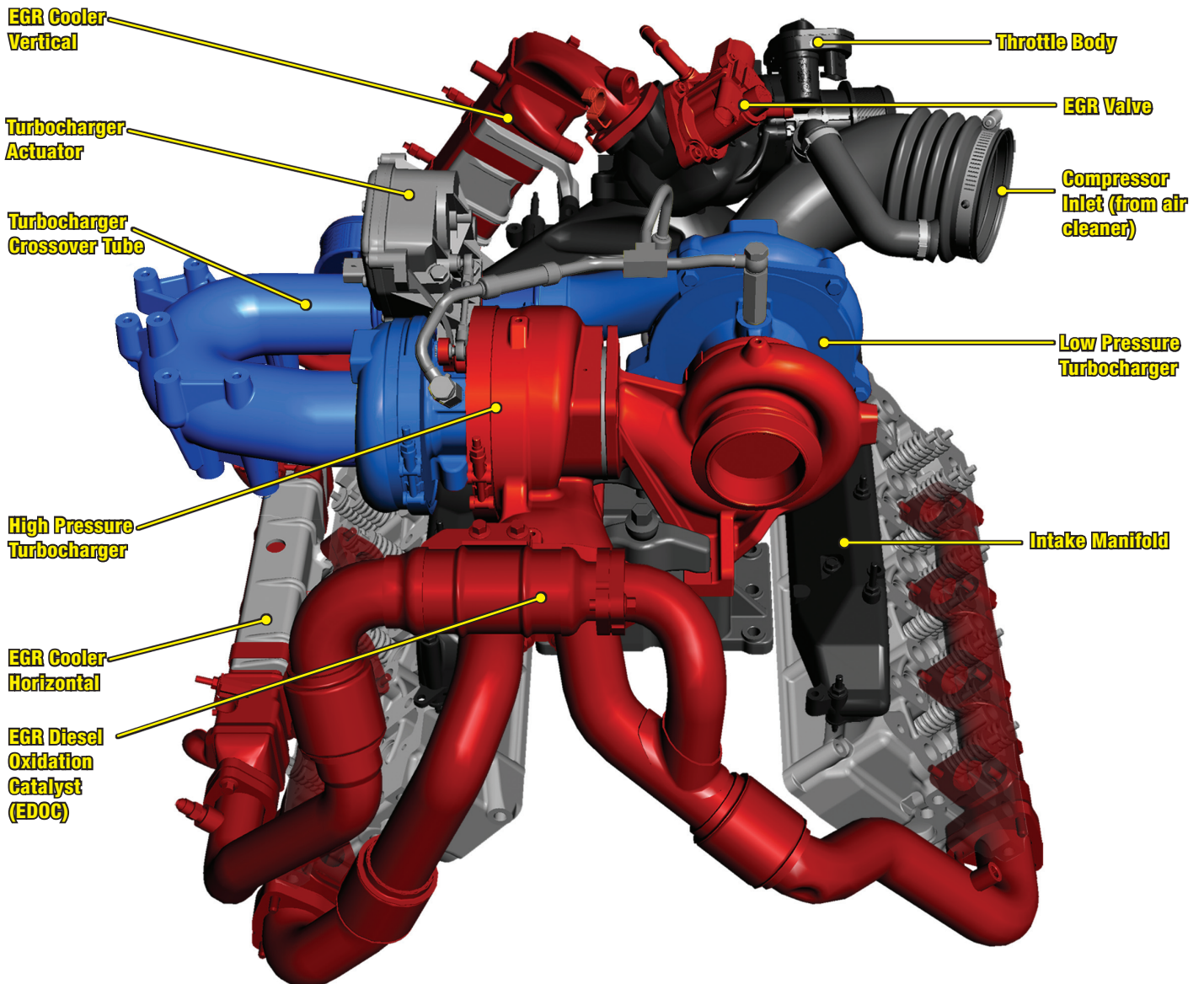
Air Management System Components

- Series Sequential Turbocharger
- Charge Air Cooler
- Intake Manifold
- Air Filter/Filter Minder
- Exhaust Gas Recirculation (EGR) System

Air Management System Features

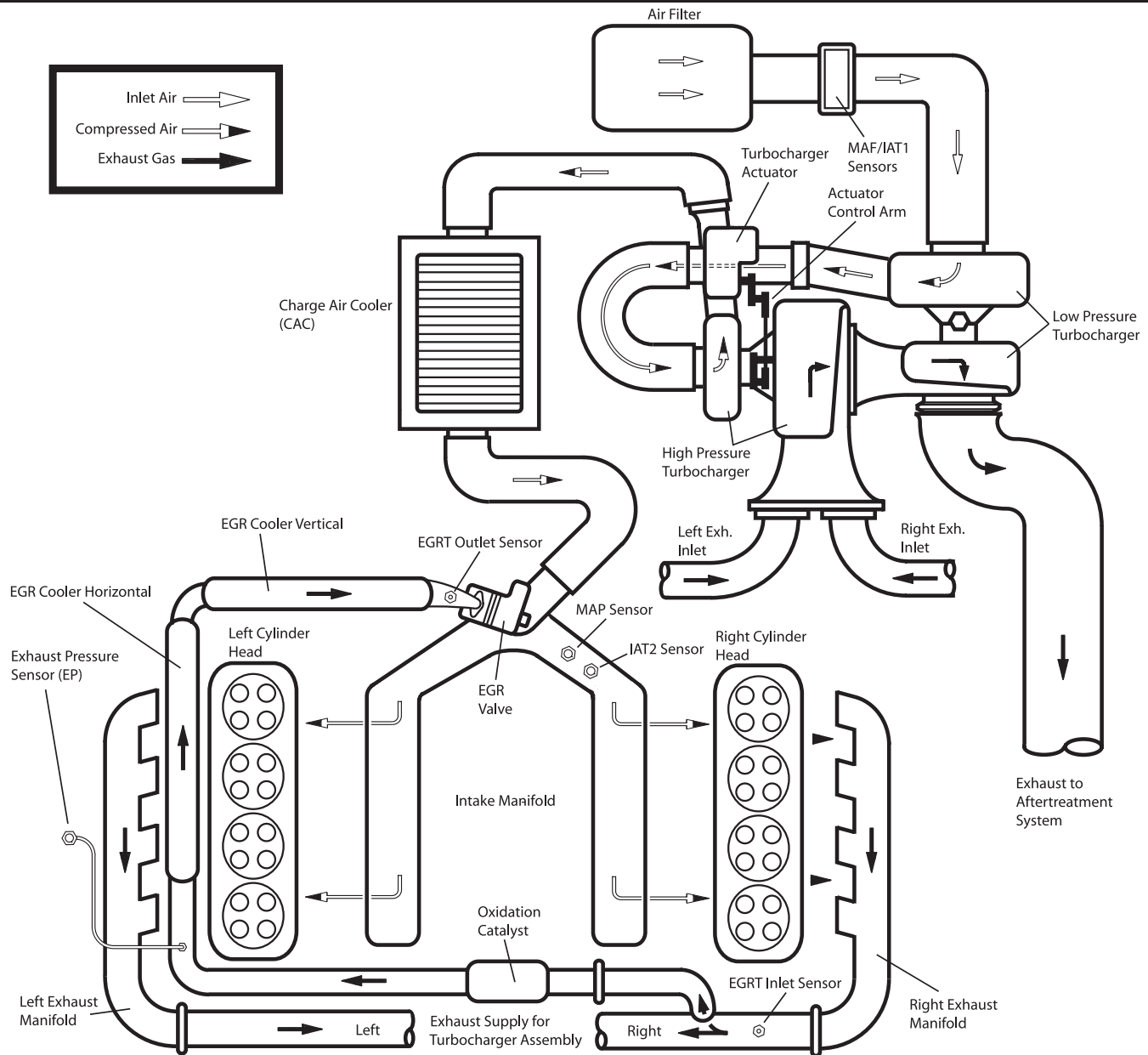
- The series sequential turbocharger is a low pressure/high pressure design working in series with a turbocharger actuator on the high pressure turbine controlling the boost pressures.
- The charge air cooler is utilized to reduce the temperature of the pressurized air therefore inducing a cooler/denser air charge into the intake manifold for maximum efficiency.
- An air filter/filter minder combination is utilized to clean the incoming air and provide a means for monitoring the condition of the air filter via the filter minder.
- The EGR system is designed to reduce exhaust emissions.

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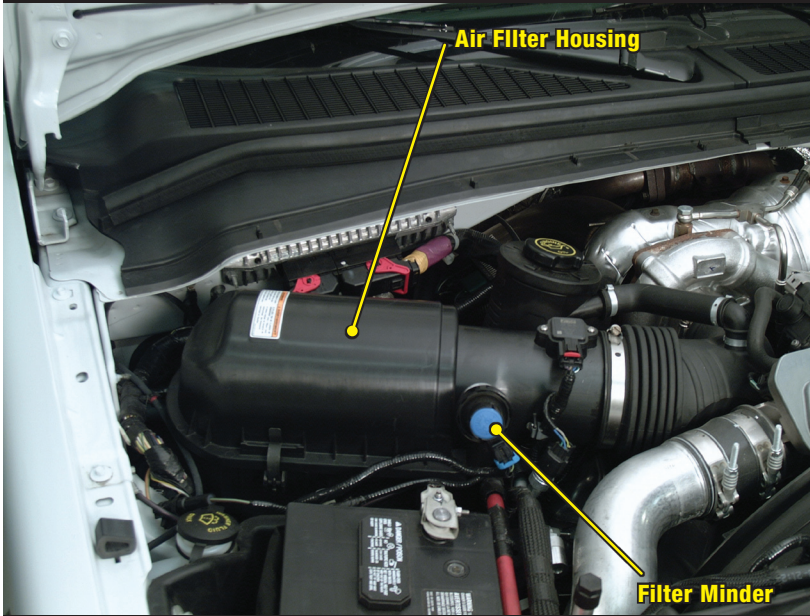
AIR MANAGEMENT SYSTEM



System Flow

- Air enters the system through the air filter where particles are removed from the air. The air filter has a filter minder on it to warn the operator of a restricted air filter.
- After the air is filtered, the mass of the air and temperature are measured by the mass air flow sensor (MAF) and the intake air temperature sensor #1 (IAT1).
- The filtered air is then directed past the crankcase ventilation system where crankcase vapors and fresh air are mixed.
- After mixing with crankcase vapors the fresh air mixture is drawn into the low pressure turbocharger compressor then the compressed air is sent to the high pressure turbocharger where it is further compressed before being sent to the charge air cooler (CAC).
- The (CAC) cools the compressed air via an air-to-air cooler, then the condensed air passes through the EGR throttle, mixes with cooled EGR gases, then enters the intake manifold.
- The intake manifold directs the cooled air to the intake ports of the cylinder heads.
- The burned air fuel mixture is pushed out of the cylinder into the exhaust manifold which collects the exhaust and routes it to the high pressure turbocharger's turbine wheel.
- The exhaust up pipe, connected to the passenger side exhaust manifold has a passage that directs exhaust to the exhaust gas recirculation (EGR) coolers and then to the EGR valve.
- The EGR valve controls the flow of exhaust into the intake system where the gases are mixed with intake air to reduce NO_x (Oxides of Nitrogen) emissions and noise.
- The hot and expanding exhaust gases that are routed to the series sequential turbocharger turbines, spin the turbine wheels through flow and expansion. The spinning turbine wheels then spin the compressor wheels via common shafts.

AIR MANAGEMENT SYSTEM



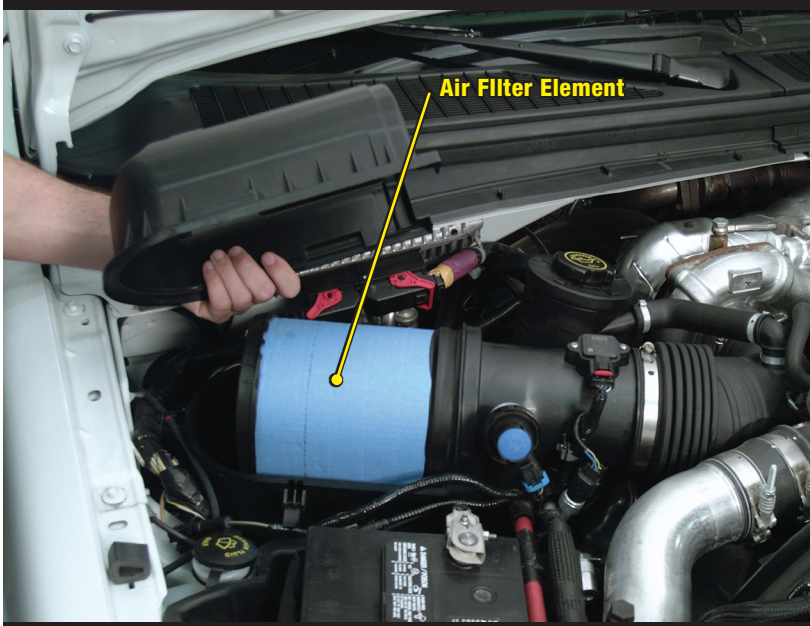
Air Filter Housing

Filter Minder

Air Filter Housing/ Filter Minder

- The air filter is located on the passenger side of the engine compartment between the battery and the cowl.
- A filter minder, device used to measure filter restriction, is located on the outlet side of the air filter housing just before the MAF sensor.
- Fresh air, from the passenger side fender area, is drawn into the air filter and particulates are removed from the air before going to the engine.

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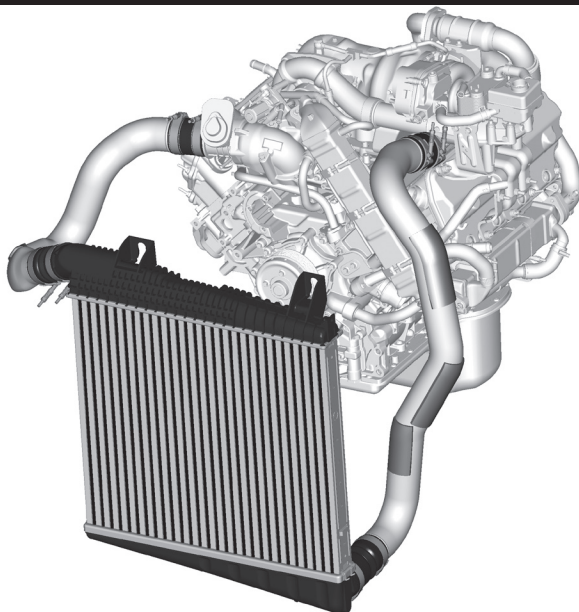


Air Filter Element

Air Filter Element

- The new air filter element is a replaceable cartridge separate from the housing.
- The air filter is capable of holding 750 grams of particulates before needing replacement.
- The filter element is a honeycomb design.

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Charge Air Cooler (CAC)

- The CAC is located in the front of the radiator.
- The CAC is an air to air cooler designed to lower the temperature of the air coming out of the turbocharger outlet before entering the intake manifold.

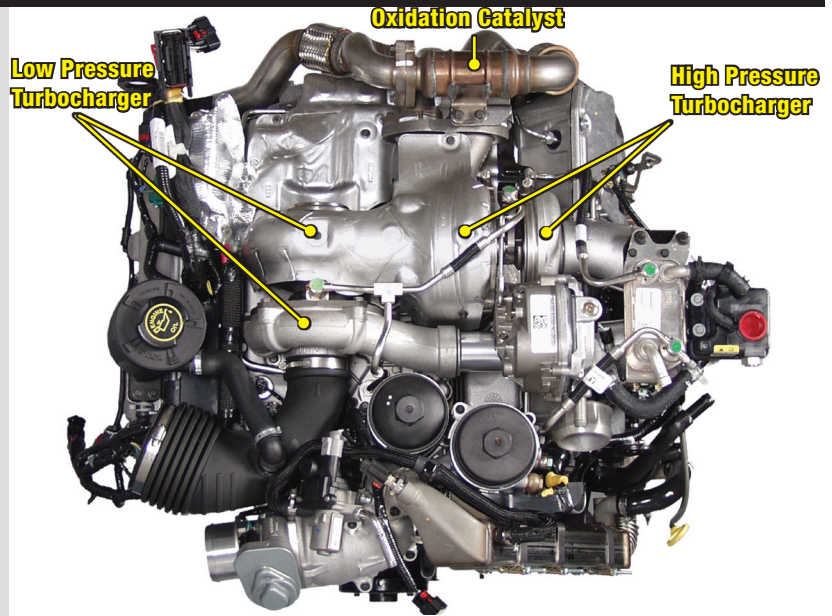
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AIR MANAGEMENT SYSTEM

Series Sequential Turbocharger & Turbocharger Actuator

- The series sequential turbocharger for the 6.4L Power Stroke® Diesel is designed to provide boost control at low and high speeds for improved throttle response.
- The turbocharger actuator is used to control the position of the variable vanes inside the high pressure turbocharger's turbine housing.
- When the vanes of the turbocharger are closed, the engine will have a higher exhaust back pressure and create more heat which will in turn warm the engine faster in cold ambient conditions.

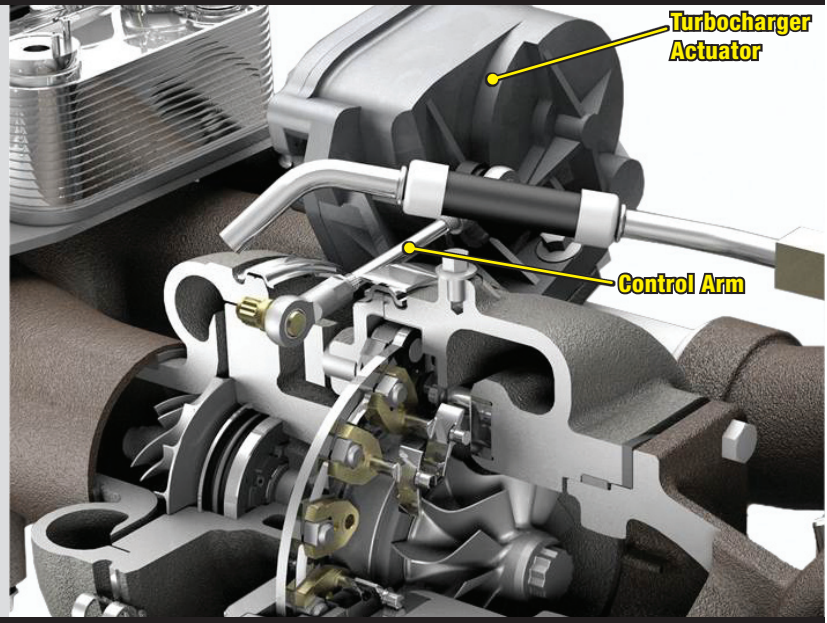
NOTE: There is an oxidation catalyst in the exhaust pipe for the EGR system that is utilized to crack hydrocarbons before they enter the EGR system.



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Turbocharger Actuator

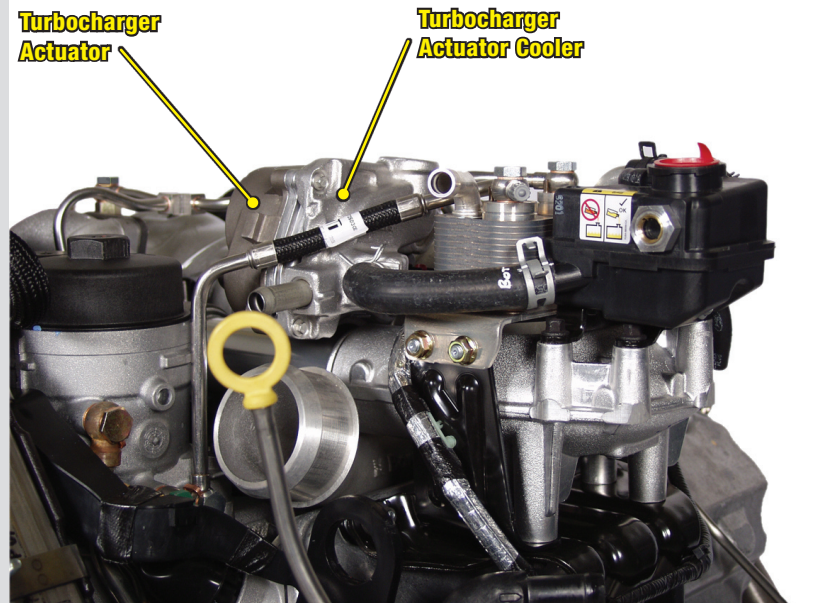
- The variable vanes inside the high pressure turbocharger's turbine housing are now controlled by the turbocharger actuator.
- The high pressure turbocharger's turbine housing contains vanes that control the effective size of the housing. These vanes are controlled by the turbocharger actuator by way of a control arm. The control arm connects the actuator to a pivot shaft which connects to the unison ring that moves the vanes.



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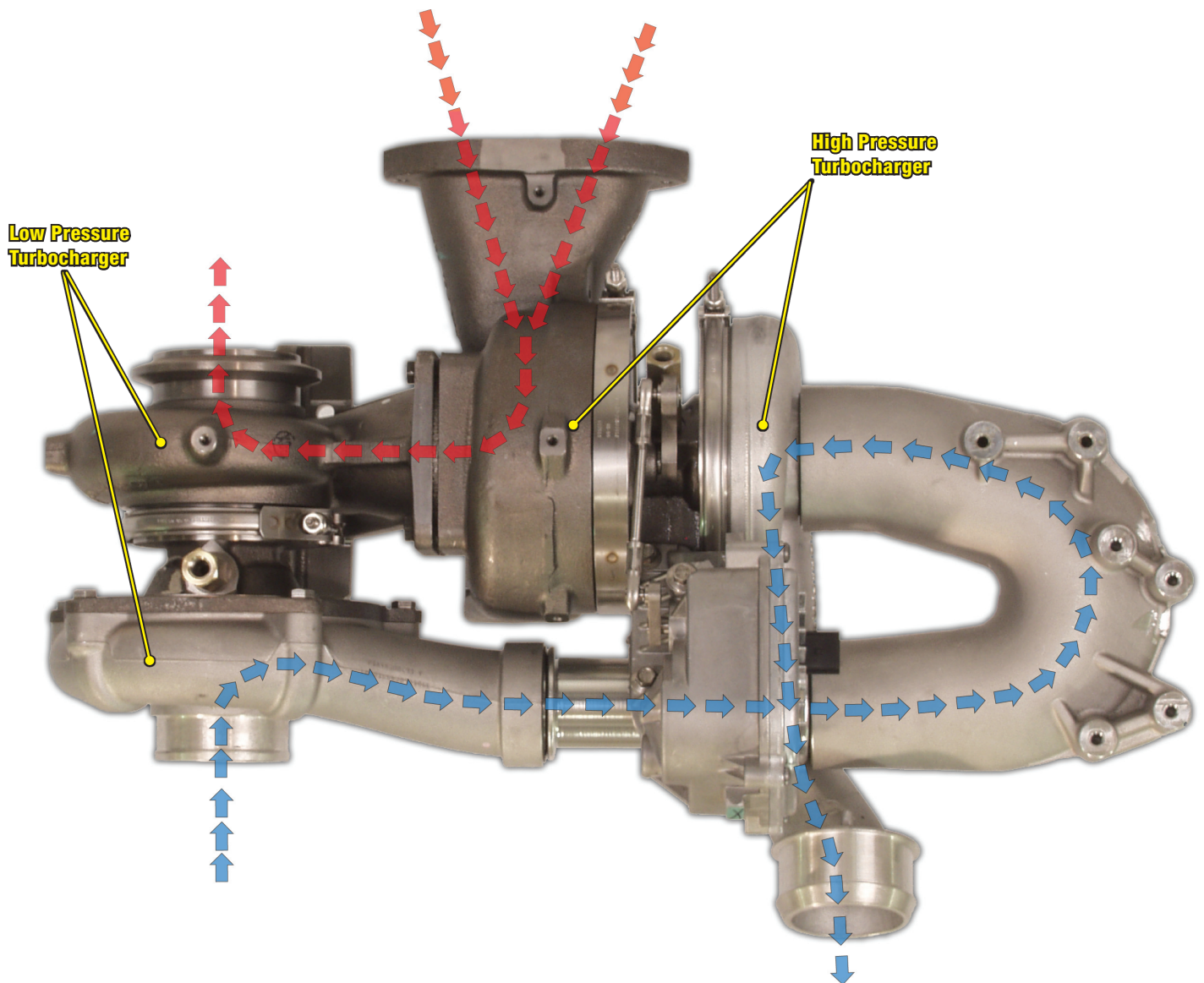
Turbocharger Actuator Cooler

- The turbocharger actuator is fitted with a cooling plate to reduce the temperature of the electronics inside the actuator housing.
- The actuator cooler uses coolant from the fuel system cooler as the heat exchange medium.



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AIR MANAGEMENT SYSTEM



INTAKE AIRFLOW (Blue)

- Air enters the low pressure turbocharger from the air filter.
- The low pressure turbocharger compresses the air and sends the air through the extension tube and the crossover tube prior to entering the high pressure turbocharger.
- The high pressure turbocharger further compresses the air and sends the air to the charge air cooler (CAC) where the air is cooled by an air-to-air cooler prior to entering the intake manifold.

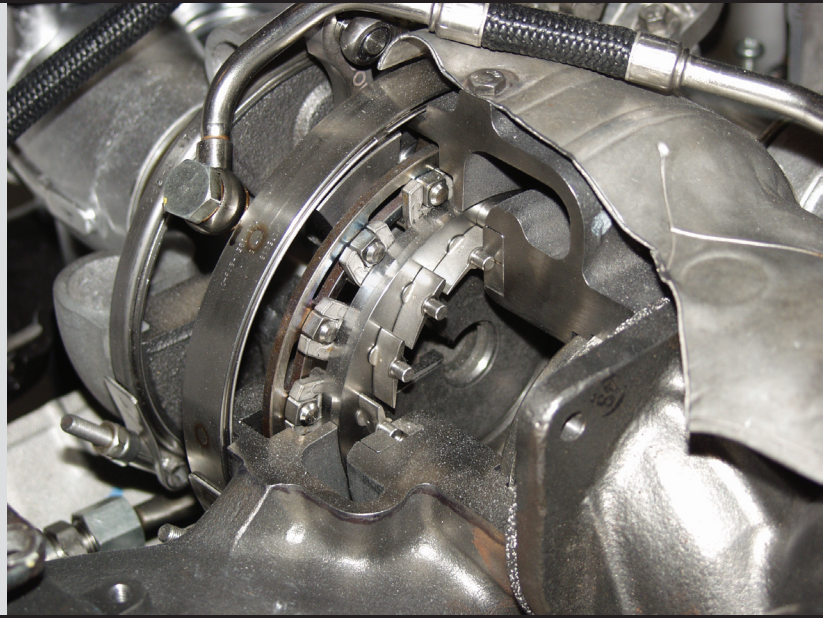
EXHAUST AIRFLOW (Red)

- Exhaust gas enters the high pressure turbocharger turbine housing after being directed through the exhaust up-pipes at the rear of the engine.
- The high pressure turbocharger turbine contains the vanes which are controlled by the turbocharger actuator. These vanes continually change the velocity of the exhaust gas in the high pressure turbocharger turbine.
- After the exhaust gas has passed through the high pressure turbocharger turbine it immediately enters the low pressure turbocharger turbine.
- Once the exhaust gas has powered the low pressure turbocharger turbine the exhaust gas exits through the housing towards the rear of the engine where it is directed to the exhaust aftertreatment system.

AIR MANAGEMENT SYSTEM

Vanes Closed

- During engine operation at low engine speeds and load, little energy is available from the exhaust to generate boost. In order to maximize the use of the energy that is available, the vanes are closed. In doing so, the exhaust gas is accelerated between the vanes and across the turbine wheel. In general, this allows the turbocharger to behave as a small turbocharger, increasing the wheel speed quickly at low speed.
- Closing the vanes also increases the back pressure in the exhaust manifold which is used to drive the exhaust gas through the EGR cooler and valve into the intake manifold.
- The closed vane position is also used for cold ambient warm up.

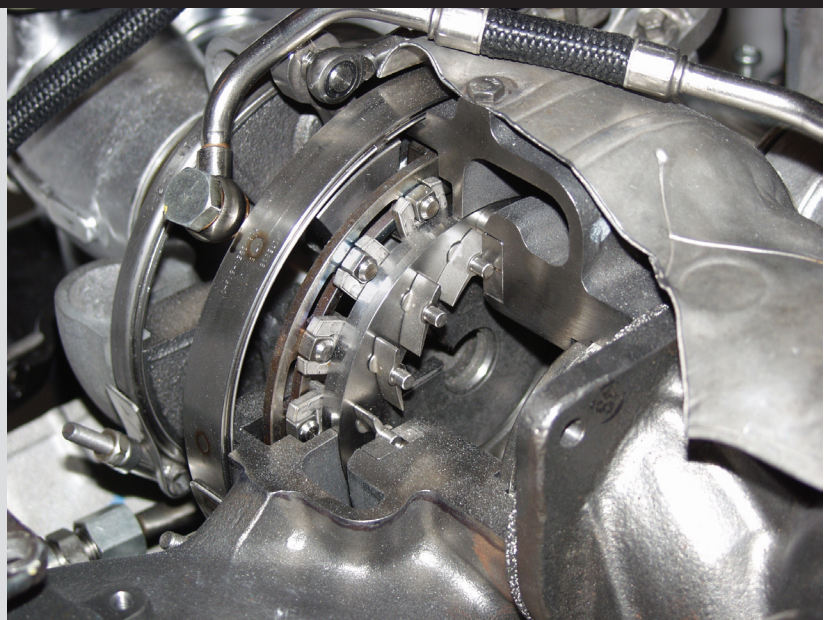


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Vanes Partially Closed

- During Engine operation at moderate engine speeds and load, the vanes are commanded partially open.
- The vanes are set to this intermediate position to supply the correct amount of boost to the engine for optimal combustion as well as providing the necessary back pressure to drive EGR.

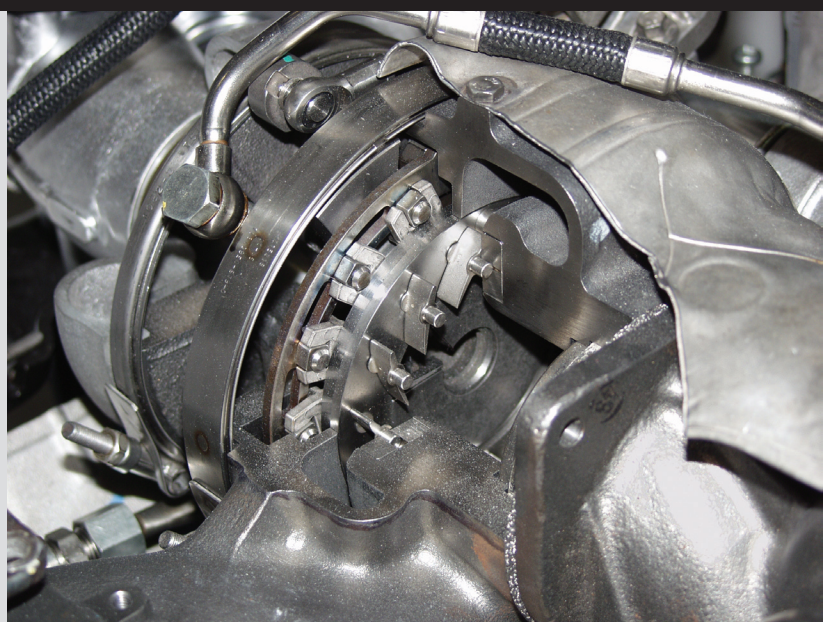
Note: There is actually an infinite number of vane positions between open and closed. The partially closed picture is for illustration purposes only.



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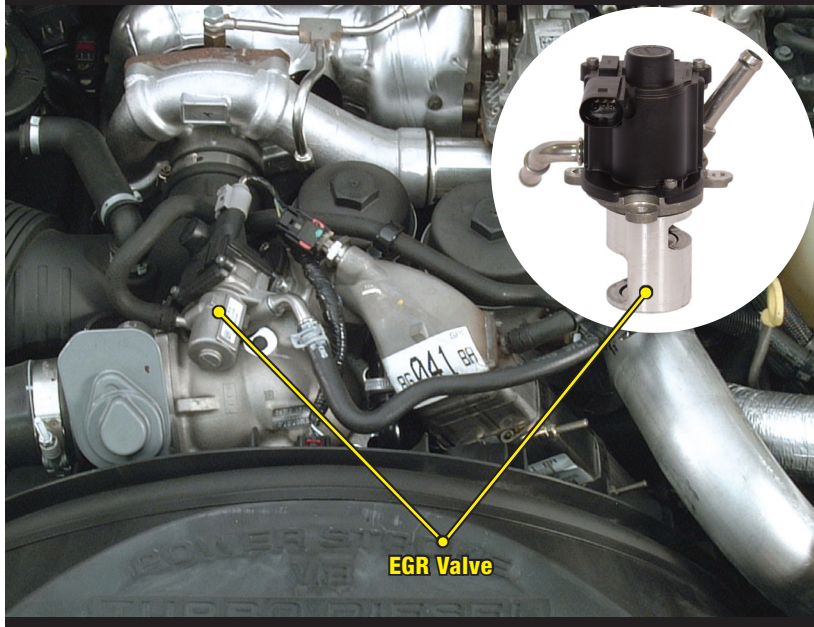
Vanes Open

- During engine operation at high engine speeds and load, there is a great deal of energy available in the exhaust.
- Excessive boost under high speed, high load conditions can negatively affect component durability, therefore the vanes are commanded open preventing turbocharger overspeed.
- Essentially, this allows the turbocharger to act as a large turbocharger with minimal restriction.



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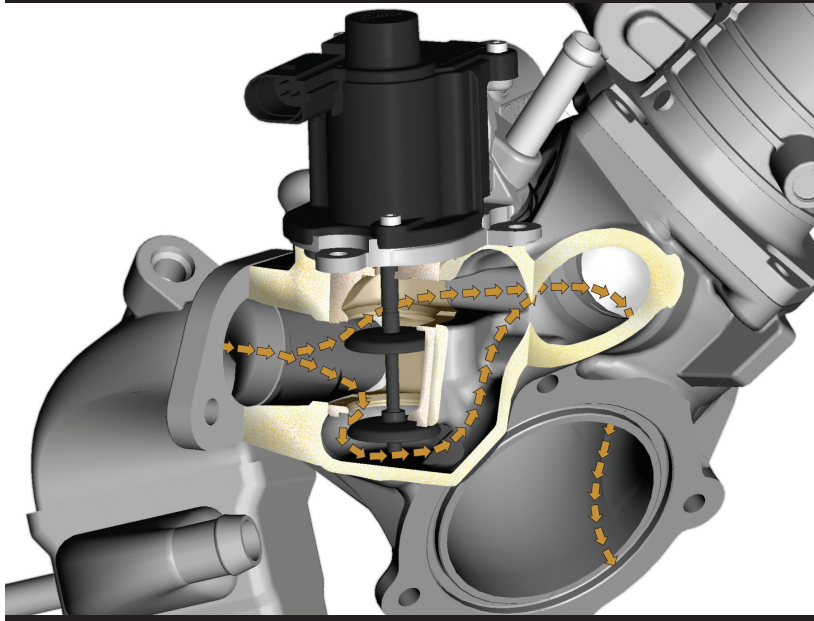
AIR MANAGEMENT SYSTEM



EGR Valve

- The ECM controlled EGR (Exhaust Gas Recirculation) valve adds cooled exhaust gases to the intake manifold to reduce NOx emissions.
- The EGR valve is opened during steady state throttle positions when exhaust back pressures are higher than intake manifold pressures (boost).

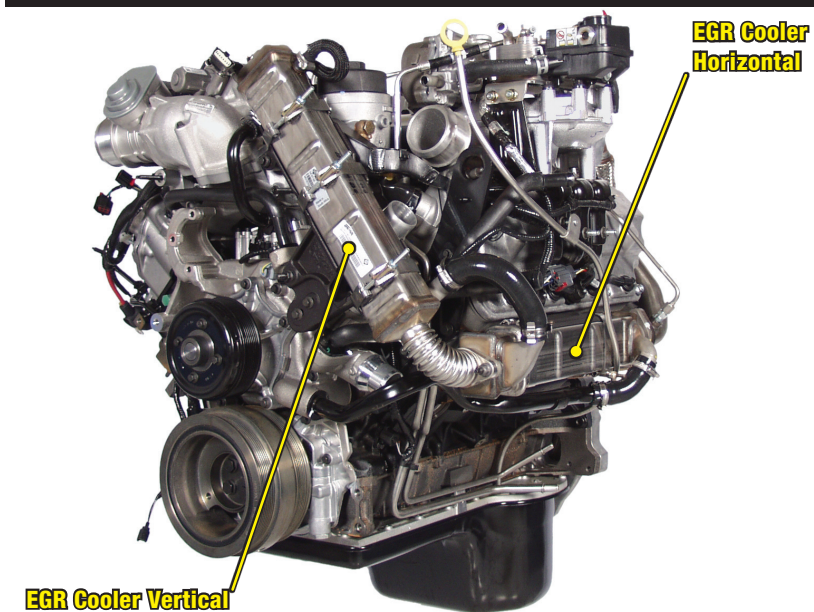
70



EGR Flow

- The EGR valve has two valves connected by a common shaft.
- Cooled exhaust gas enters the lower opening of the EGR valve after leaving the vertical EGR cooler.
- When the valve opens it allows the cooled exhaust gas to flow through two passages, one passage is through the upper opening of the EGR valve (upper valve) and the other is through a passage below the EGR valve (lower valve).
- Both passages merge together prior to being mixed with the filtered incoming air before being sent to the intake manifold.

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Dual EGR Cooling System

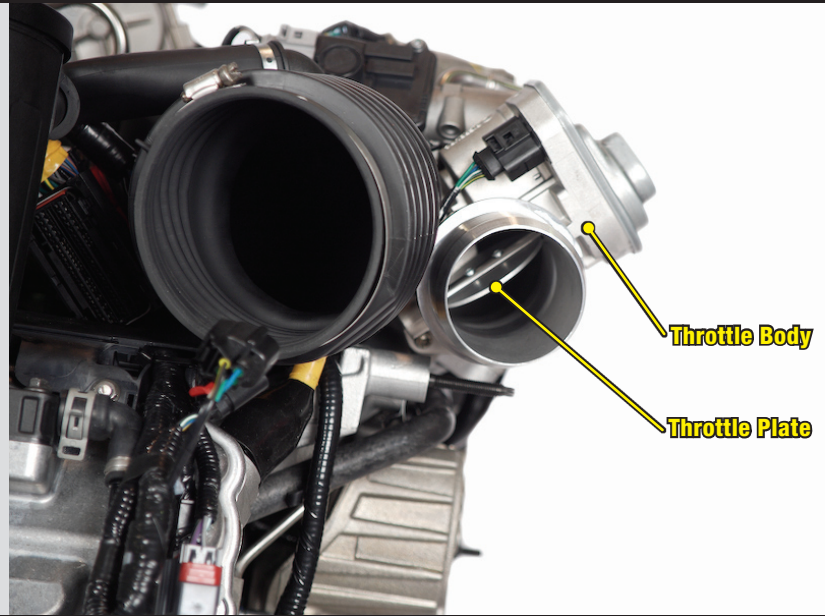
- The EGR cooling system is an air to coolant heat exchanger that is used to cool the exhaust gases before they are sent to the EGR valve.
- The exhaust is routed into the EGR coolers from the exhaust up pipes at the rear of the engine.
- The exhaust is cooled by passing through metal tubes that are surrounded by engine coolant. Depending on conditions, the temperature drop across the coolers could be as much as 850°F.
- The cooled exhaust is then routed to the EGR valve that is mounted to the inlet mixing chamber.

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AIR MANAGEMENT SYSTEM

Throttle Body

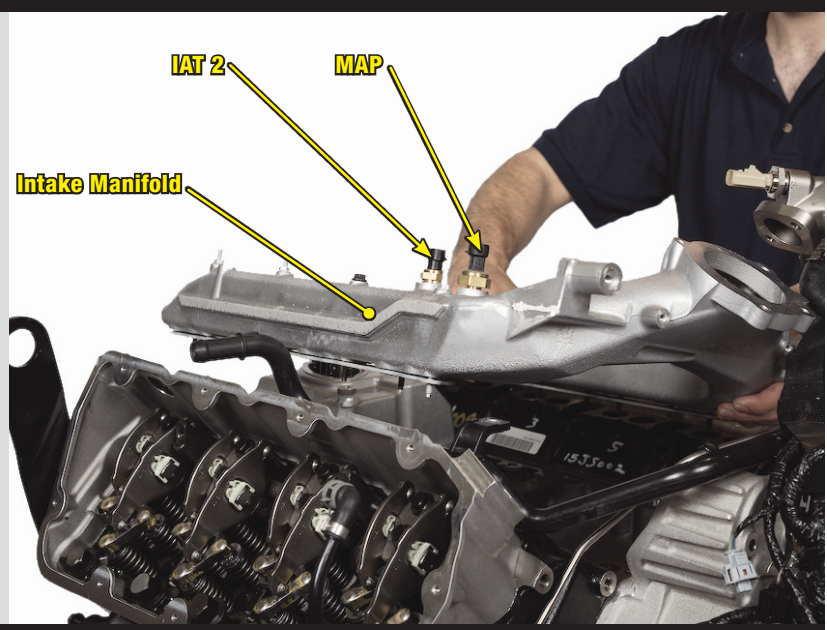
- The throttle body is used to assist with the exhaust aftertreatment system.



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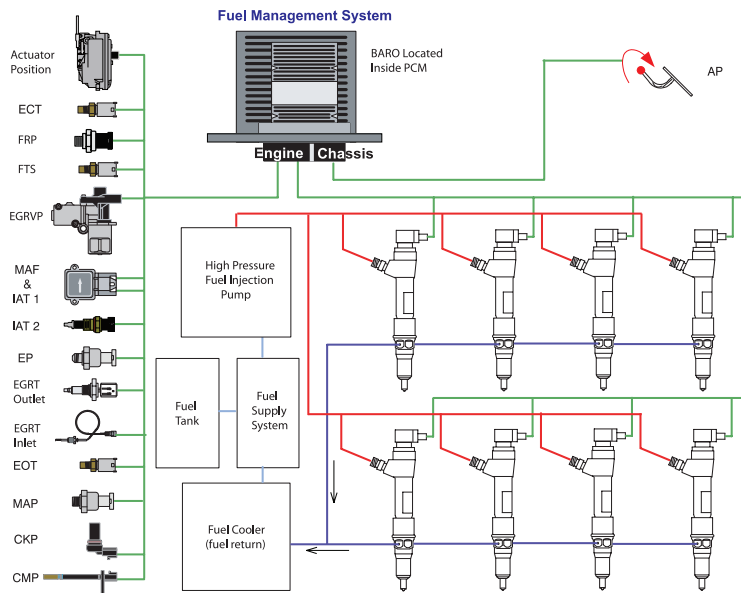
Intake Manifold

- The intake manifold on the 6.4L Power Stroke® Diesel is made of aluminum and directs the flow of air to the intake ports in the cylinder heads.
- The manifold absolute pressure sensor (MAP) and the intake air temperature 2 sensor (IAT2) are both mounted in the intake manifold.



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FUEL MANAGEMENT SYSTEM



High Pressure Common Rail Fuel System

- The high pressure common rail fuel injection system with piezo electric fuel injectors uses pressurized fuel and electronics to actuate and control fuel injection into the cylinders.

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Fuel Management System Major Components

- Fuel Supply System
- High Pressure Fuel Injection Pump
- High Pressure Fuel Tubes
- Sensors
- Injectors
- Electrical Components
- Actuators

High Pressure Common Rail Direct Injection Fuel System Components

- The fuel management system is comprised of several sub systems.
- Each system works together to deliver excellent power and efficiency while meeting the requirements of emissions regulations.

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Fuel Management System Features

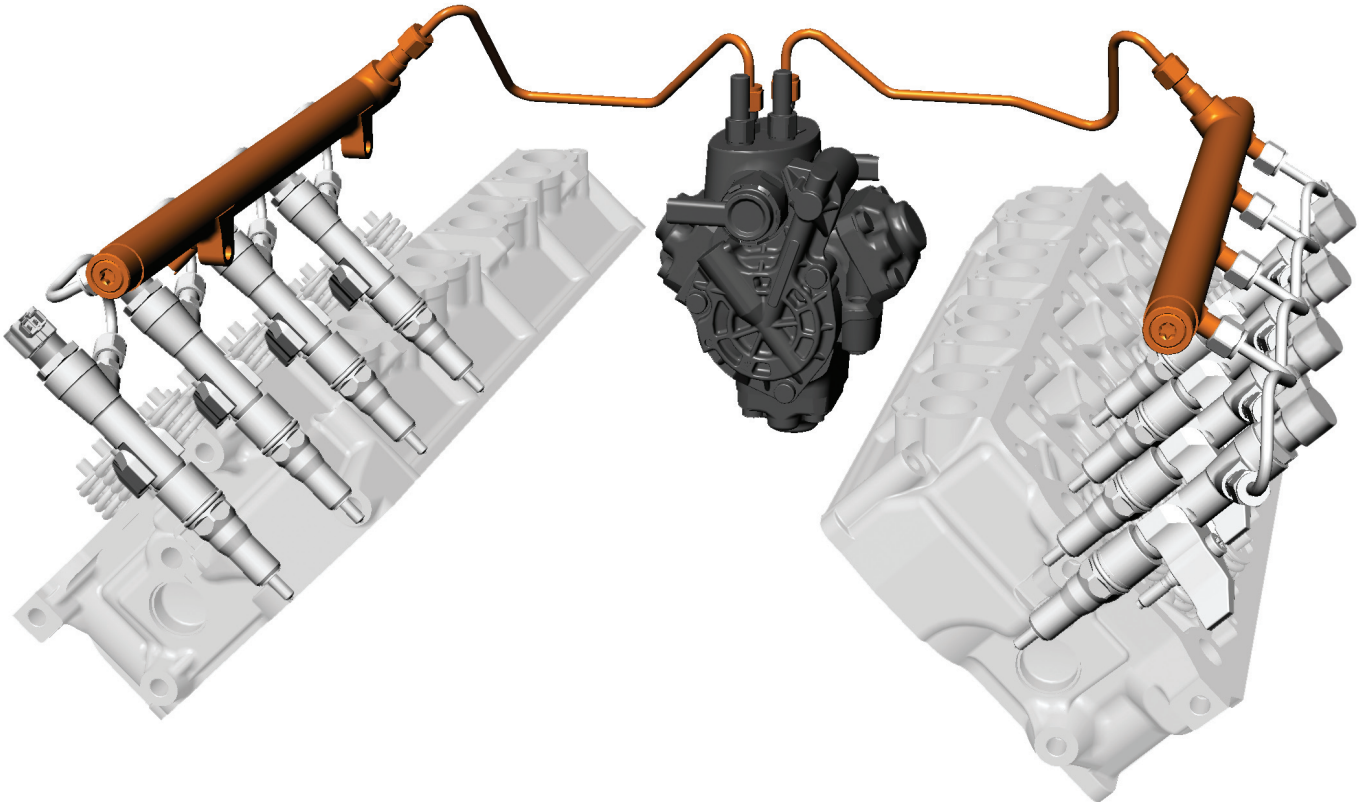
- Emissions
- Noise
- Rate Control
- Timing Control
- PCV (pressure control valve)
- VCV (volume control valve)

High Pressure Common Rail Fuel System Advantages

- Emissions and noise have been reduced through improvements in rate, timing control, and multiple injections.
- The high pressure system's pressure relief function is now controlled by the PCV (Pressure Control Valve), which is mounted to the high pressure fuel injection pump.
- The piezo fuel injectors help reduce noise while delivering optimum performance.

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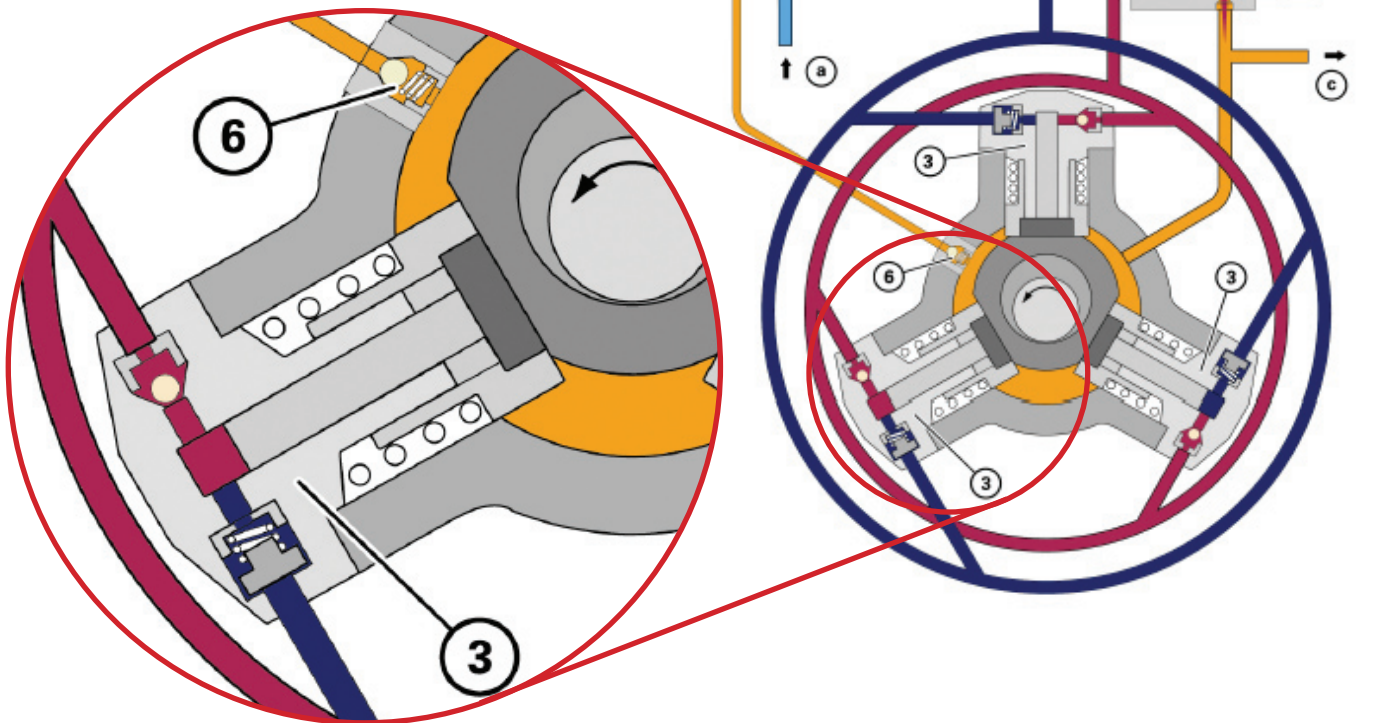
HIGH PRESSURE FUEL SYSTEM



High Pressure Fuel System Flow

- Fuel is supplied to the high pressure fuel injection pump after being filtered by both the HFCM (horizontal fuel conditioning module) and the engine mounted fuel filter.
- The high pressure fuel injection pump is gear driven off of the camshaft gear at the rear of the engine.
- Once the high pressure fuel injection pump pressurizes the fuel it is routed to two (2) high pressure fuel rail supply tubes, one for each bank.
- The high pressure fuel rail supply tubes route the fuel to the high pressure fuel rail located under the valve cover.
- The high pressure fuel rail inlet protrudes through the valve cover spacer at the back of the engine and oil is sealed by a rubber seal.
- The high pressure fuel rail routes fuel to each of the four (4) fuel injectors through four (4) separate fuel injector supply tubes all located under the valve cover.

- 1) ITP (internal transfer pump)
- 2) VCV (volume control valve)
- 3) High-Pressure Fuel Injection Pump Element
- 4) PCV (pressure control valve)
- 5) Inlet Pressure Control Valve
- 6) Lubrication Valve
- 7) Edge Filter
- a) Fuel Inlet
- b) High-Pressure Connection
- c) Fuel Return



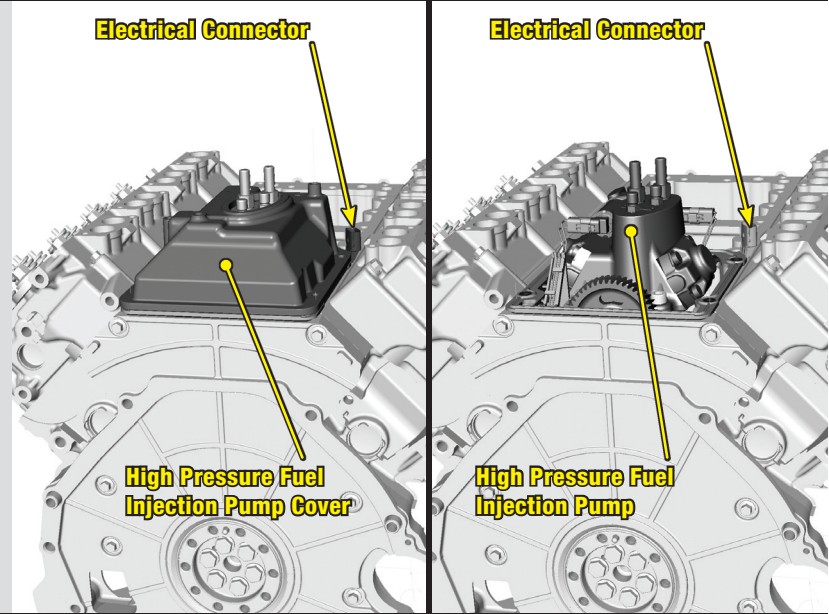
High Pressure Pump Operation

- After being filtered at the engine mounted fuel filter, fuel is directed to the high pressure fuel injection pump.
- Before fuel enters the Volume Control Valve (VCV) the pressure is stepped up by the Internal Transfer Pump (ITP). The ITP is located inside the high pressure fuel injection pump and is driven by its main shaft.
- The VCV controls how much fuel enters the three (3) main pump pistons.
- A portion of the fuel leaving the ITP is sent to a lubrication valve which allows fuel to lubricate and cool the internal mechanical components of the high pressure fuel injection pump.
- The high pressure fuel injection pump main shaft has an offset journal that actuates each of the three (3) pistons as the shaft rotates.
- The offset journal of the main shaft utilizes a free-spinning hub to make contact with the three (3) pistons.
- The pistons start their compression stroke via the offset journal and are returned to rest via spring pressure.
- The pistons receive fuel from the VCV through a one way check valve. Fuel is drawn into the cylinder while the piston is returning to rest.
- The outlet check valve ball is closed while fuel is being drawn in due to the suction (low pressure area) of the piston returning to rest and the pressure exerted by the other two pistons.
- Once the piston starts its compression stroke, the inlet check valve closes via spring and fuel pressure and the outlet check valve opens due to increasing fuel pressure forcing the check valve ball away from its seat.
- The pressure control valve (PCV) controls the pressure in the system by restricting fuel flow to the return line (pressure is the resistance to flow).

FUEL MANAGEMENT SYSTEM

High Pressure Fuel Injection Pump & Cover

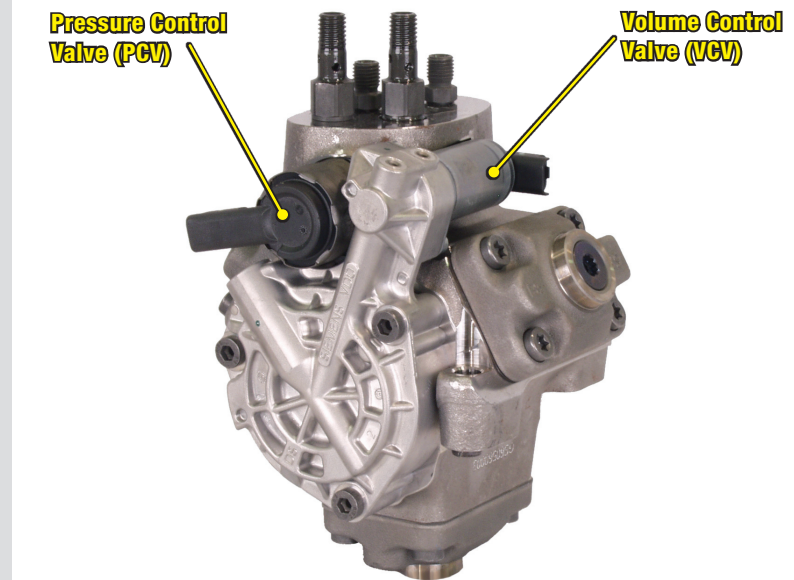
- The high pressure fuel injection pump is installed in the crankcase.
- The pump is a three (3) piston rotary style pump that is driven by the rear gear train.
- Each bank of cylinders has its own pump outlet and high pressure fuel supply tube.



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PCV (Pressure Control Valve) VCV (Volume Control Valve)

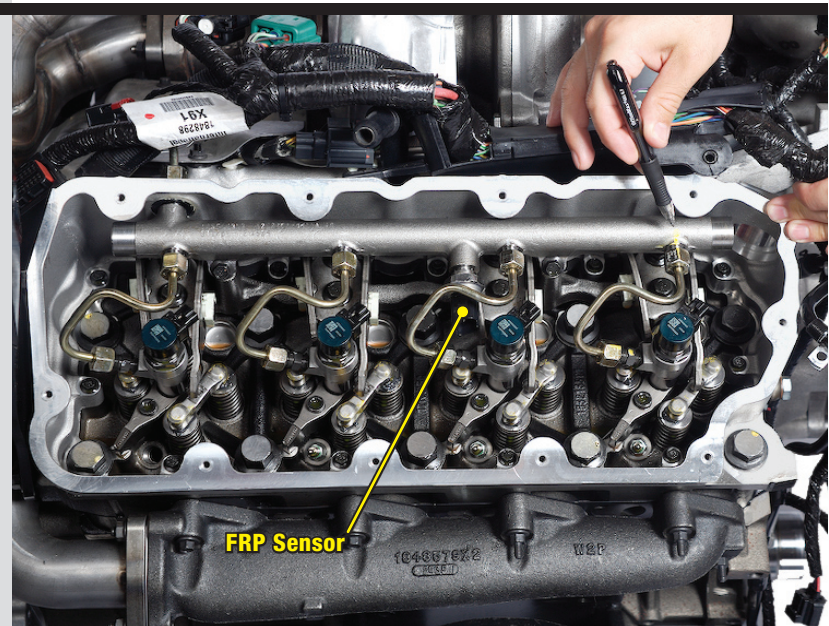
- The PCV and VCV are both installed in the high pressure fuel injection pump.
- The PCV and VCV ARE NOT SERVICEABLE.



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High Pressure Fuel Rail & Fuel Rail Pressure Sensor (FRP)

- Fuel under extremely high pressures is delivered to the fuel injectors from the fuel rail by way of the fuel injector supply tubes.
- The FRP sensor is located on the engine's right side high pressure fuel rail.



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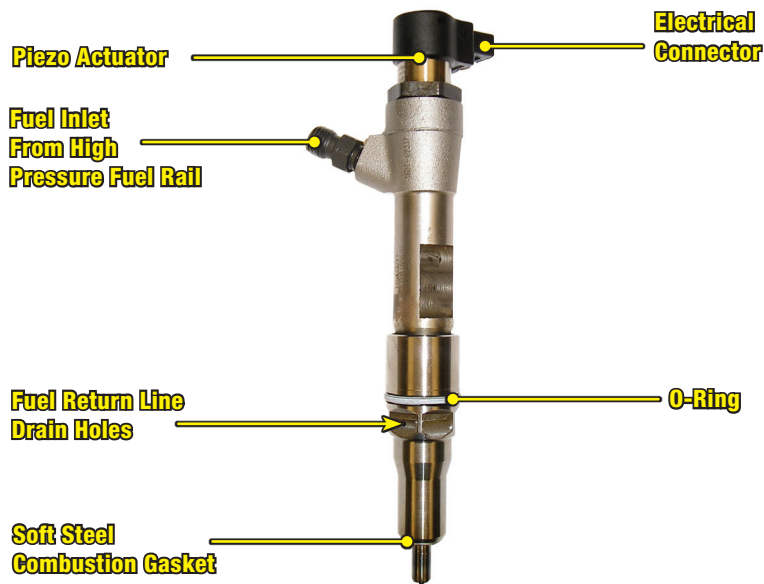
Piezo Electric Fuel Injector

- Piezo Electrically Actuated
- High Electrical Efficiency
- High Voltage Supply
- Up to 5 Injections Per Combustion Event
- Self extracting hold down clamp

Fuel Injector Features

- The injector uses a Piezo Actuator to electrically control the injections with extreme precision.
- The Piezo Actuator is turned on for approximately 0-400 μ s (micro second or millionth of a second) for 2 injections.
- No special tools are needed to remove the injectors from their bore. The injector is slowly removed from its bore by removing the self-extracting hold down clamp bolt.

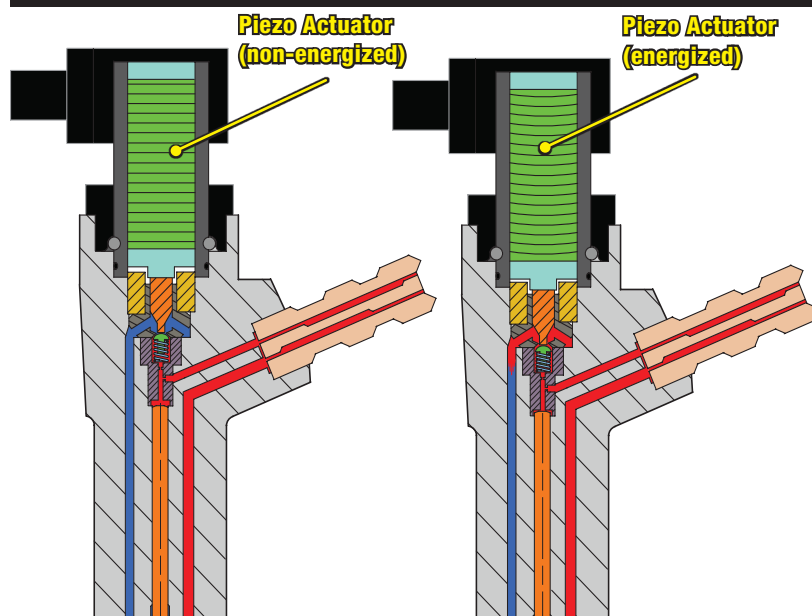
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Injector & O-ring

- The injector has one (1) replaceable o-ring on the outside of the body, and one (1) replaceable soft steel combustion gasket on the tip of the injector.
- The injector's piezo actuator has a single two (2) pin connector that is located under the valve cover.
- The fuel charging harness has a single main connection point at the front of the valve cover spacer.

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Piezo Actuator

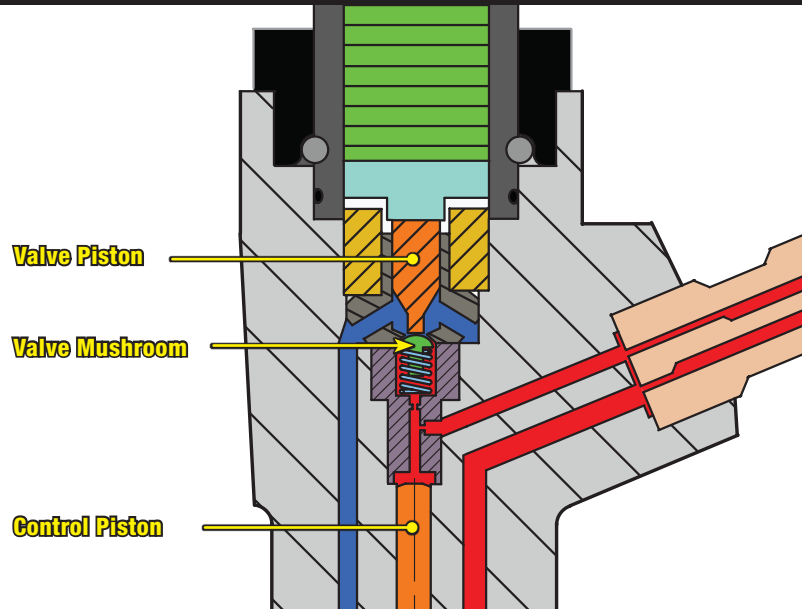
- The piezo actuator is an electrically energized device that acts similar to a solenoid but is much more precise.
- A piezo actuator is a composition of piezo discs, that when electrically energized, cause the discs to deform resulting in an expansion. This expansion results in a longitudinal motion thus controlling the injector.
- When energized, the piezo actuator pushes downward against the valve piston. The piezo actuator is returned to its non energized state via the ECM switching the polarity of the electrical feed to the injector.

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FUEL MANAGEMENT SYSTEM

Valve Piston

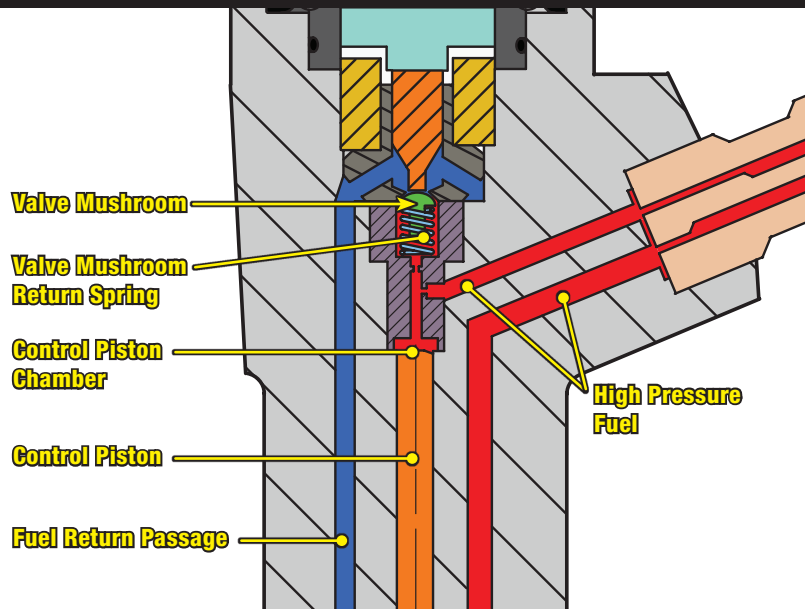
- The valve piston is utilized for one main purpose:
 - 1) It transfers the up and down movement from the Piezo Actuator to the Valve Mushroom.



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Valve Mushroom, Return Spring, and Control Piston

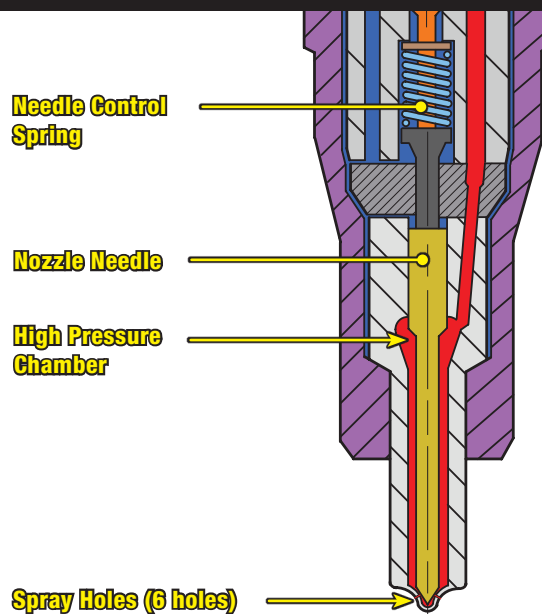
- The valve mushroom is a hydraulic check valve that allows high pressure fuel to bleed off into the fuel return passage directly above it whenever the Piezo Actuator is energized.
- The valve mushroom is held in a closed (sealed) position whenever the Piezo Actuator is not energized via high pressure fuel and spring pressure.
- The control piston utilizes its large surface area for a downward force to overcome the pressure exerted by the smaller surface area of the nozzle needle in the high pressure chamber to keep the nozzle needle in a closed position.



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Nozzle Needle

- The nozzle needle is an inwardly opening type which lifts off its seat every time the pressure in the high pressure chamber exceeds the pressure in the control piston chamber, i.e. when the piezo is actuated.
- The needle control spring is used to hold the nozzle needle in a closed position.
- Fuel is atomized at high pressure through the nozzle tips six spray holes.



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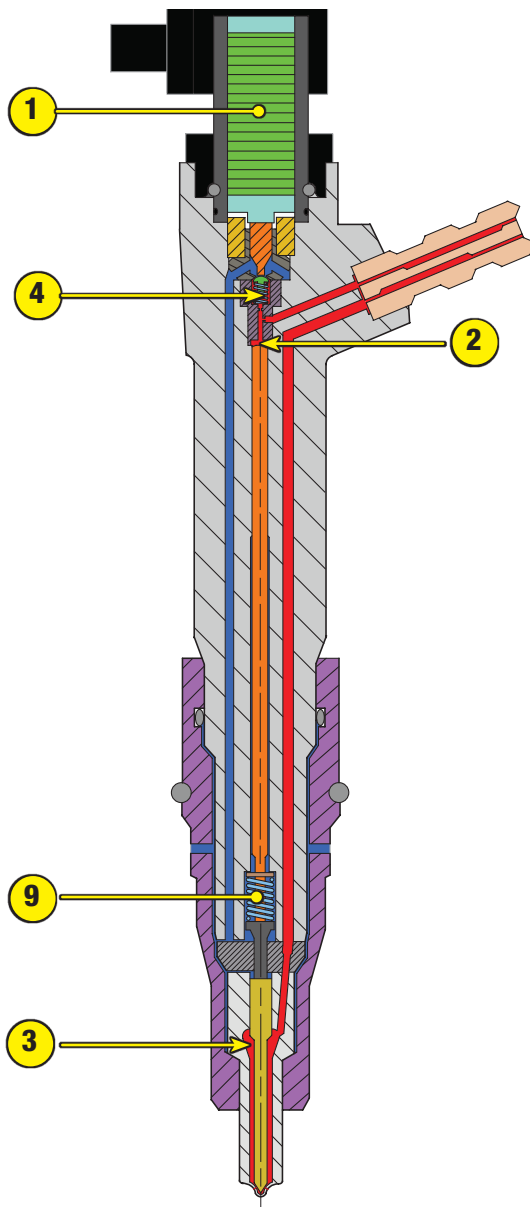
Two Stages of Injection

- Main Injection
- End of Main Injection

Stages of Injection

- The injection cycle has two (2) stages.
- Main injection.
- End of main injection.
- This injection system is capable of performing both steps of the injection cycle up to 5 times per firing cycle.

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Pre-Main Injection

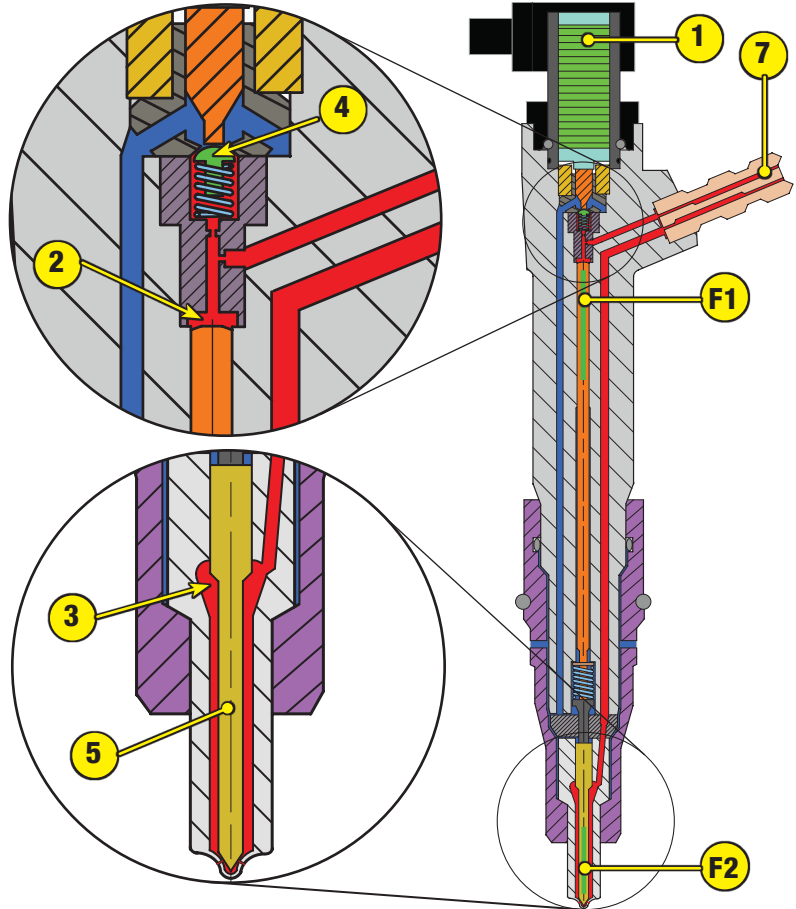
- The piezo electric fuel injector is constantly being filled with fuel via the high pressure fuel injection pump.
- High pressure fuel from the high pressure fuel injection pump enters the following areas:
 - control piston chamber (2).
 - spring side of the valve mushroom (4).
 - high pressure chamber (3).
- The needle control spring (9) holds the needle on its seat so that fuel cannot enter the combustion chamber.
- The piezo actuator (1) is in a non-energized state.

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FUEL MANAGEMENT SYSTEM

Main Injection Step 1

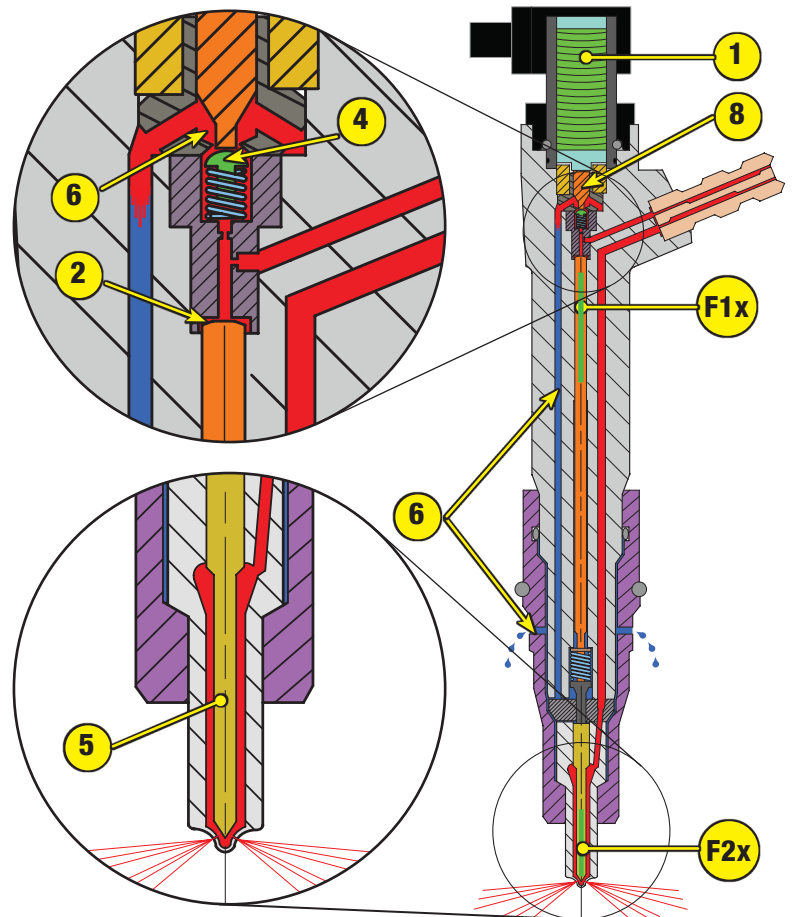
- Fuel under pressure from the rail (7) reaches the control piston chamber (2) and the high pressure chamber (3) of the nozzle needle (5).
- The bore hole to the fuel return line is closed via the valve mushroom (4), which is held closed by a spring and high pressure fuel.
- The surface area of the control piston is much larger than the surface area of the nozzle needle in the high pressure chamber.
- The force (F1) exerted by the control piston due to its larger surface area along with the force of the needle control spring overcomes the force (F2) exerted by the smaller surface area of the nozzle needle in the high pressure chamber which holds the nozzle needle closed.



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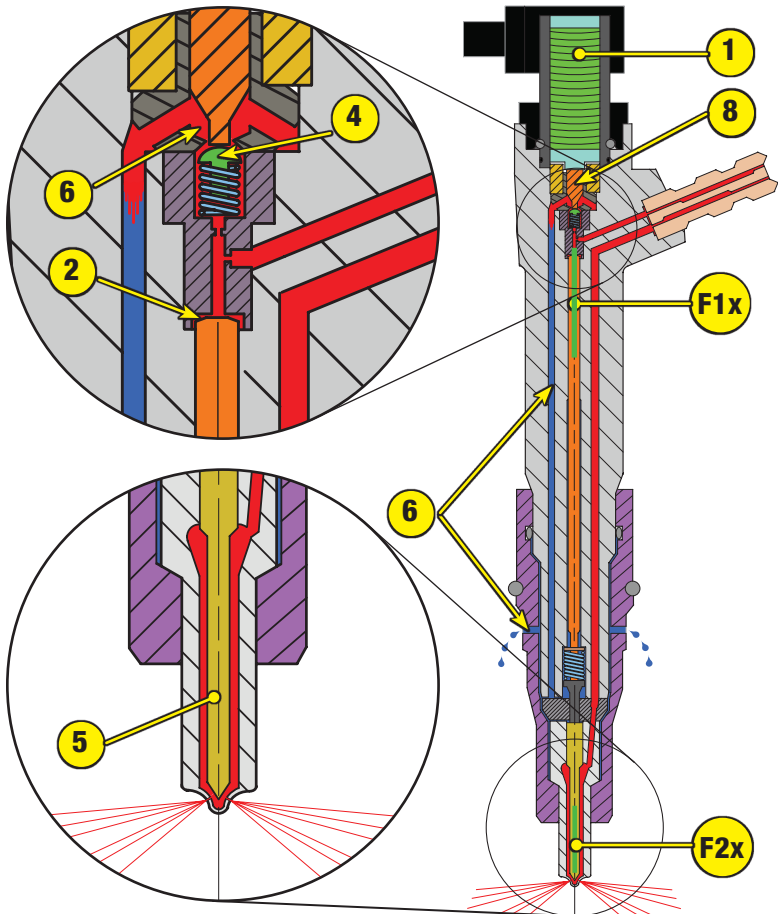
Main Injection Step 2

- When the piezo actuator (1) is commanded on, the actuator is energized (which causes the piezo discs to deform and create a downward force) and pushes the valve piston (8) downward.
- The downward force of the valve piston pushes the valve mushroom (4) and spring down which opens up a bore hole that connects the high pressure fuel to the fuel return line (6).
- When this happens it allows a small amount of high pressure fuel to enter the fuel return line (6) effectively dropping the pressure in the control piston chamber (2).
- This pressure drop is enough for the force (F2x) on the nozzle needle (5) in the high pressure chamber to overcome the force (F1x) in the control piston chamber (2).
- This allows the nozzle needle (5) to move upward uncovering the six spray holes and allowing high pressure fuel to atomize and enter the combustion chamber.



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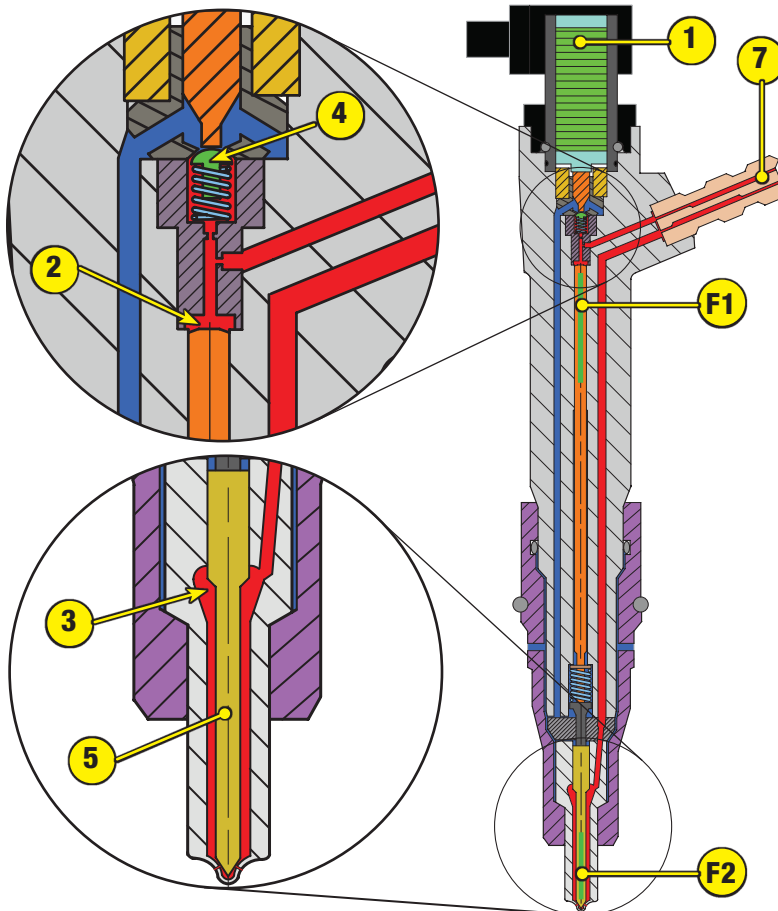
FUEL MANAGEMENT SYSTEM



End of Main Injection Step 1

- The high pressure fuel, that is allowed to escape past the valve mushroom (4) into the fuel return line (6), is routed down a drilled passage to the drain holes in the sides of the injector just below the O-ring seal towards the base of the injector.
- The fuel is then routed through the cylinder head and exits through a banjo fitting on the front side of the cylinder head before being returned to the fuel supply system.

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End of Main Injection Step 2

- When the Engine Control Module (ECM) determines that the correct injector on time has been reached, it switches the polarity of the piezo actuator (1) which causes the piezo discs to return to a non-energized state.
- Switching the polarity of the piezo actuator (1) enables the valve mushroom (4) to seat via spring pressure and completely block the bored passage that connects the high pressure fuel to the fuel return line.
- Seating the valve mushroom (4) allows the pressure to build in the control piston chamber (2) and equal that in the high pressure chamber (3).
- Once these two chambers have equalized in pressure the downward force (F1) of the control valve will overcome the upward force (F2) of the nozzle needle due to the larger surface area of the control valve.
- The control valve then moves downward effectively closing the nozzle needle (5), blocking any fuel from entering the combustion chamber.

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Electrical Components

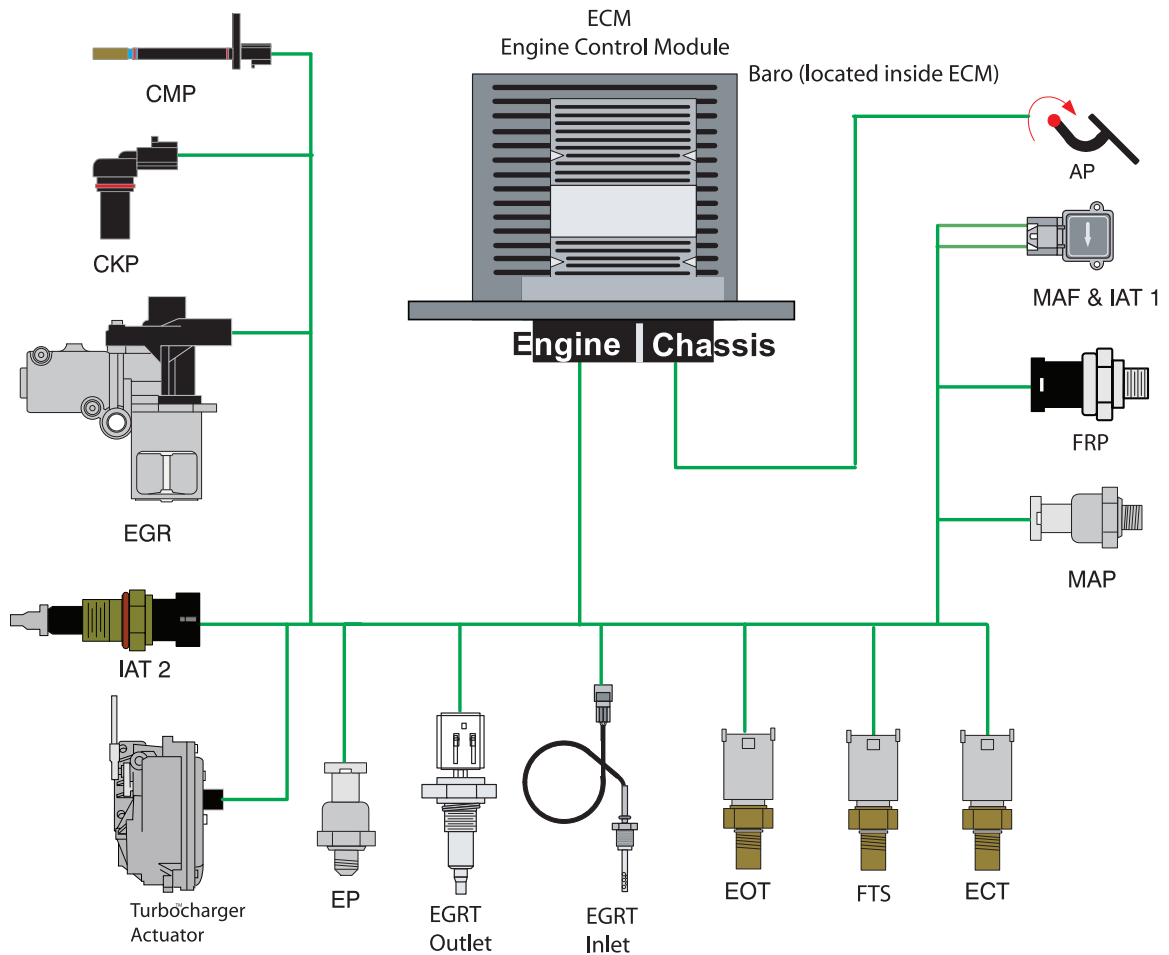
- Sensors
- Actuators
- ECM
- Glow Plug System

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

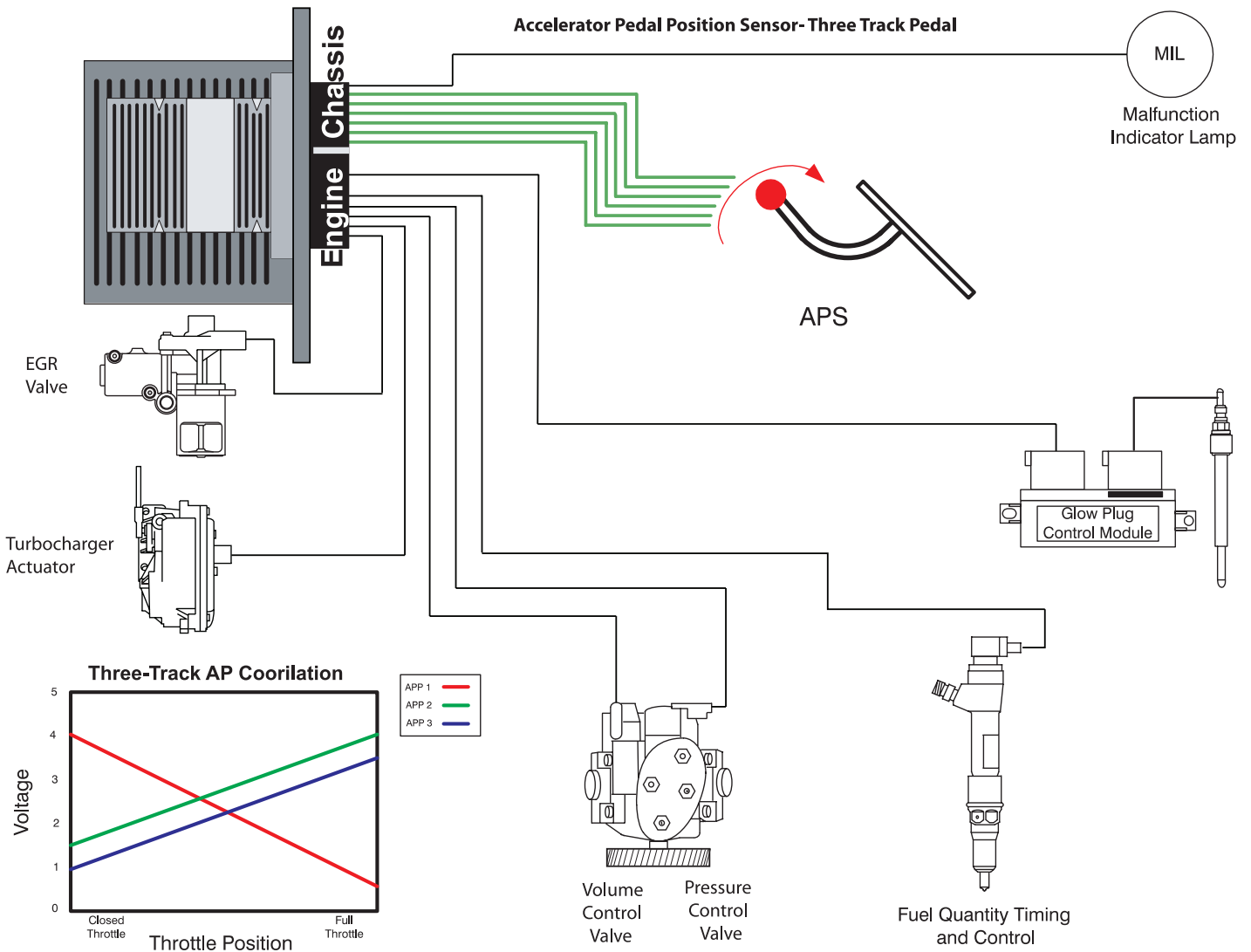


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Sensors Overview

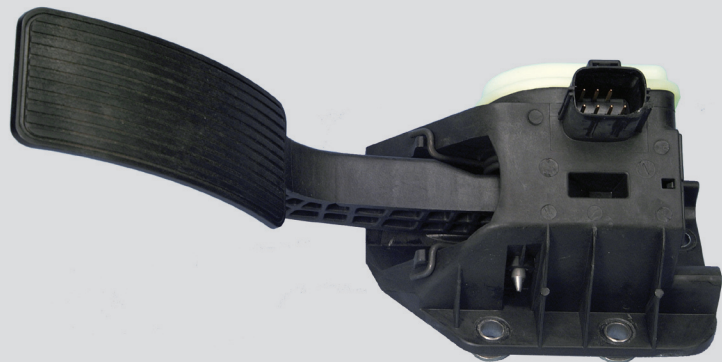
- The ECM sends a reference voltage (V_{ref}) of 5.0 volts (external power) to the pressure sensors and 5.0 volts (internal power) to the temperature sensors, except for CMP and CKP which generate voltage through the collapse of a magnetic field.
- The sensor signals are conditioned by the interface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

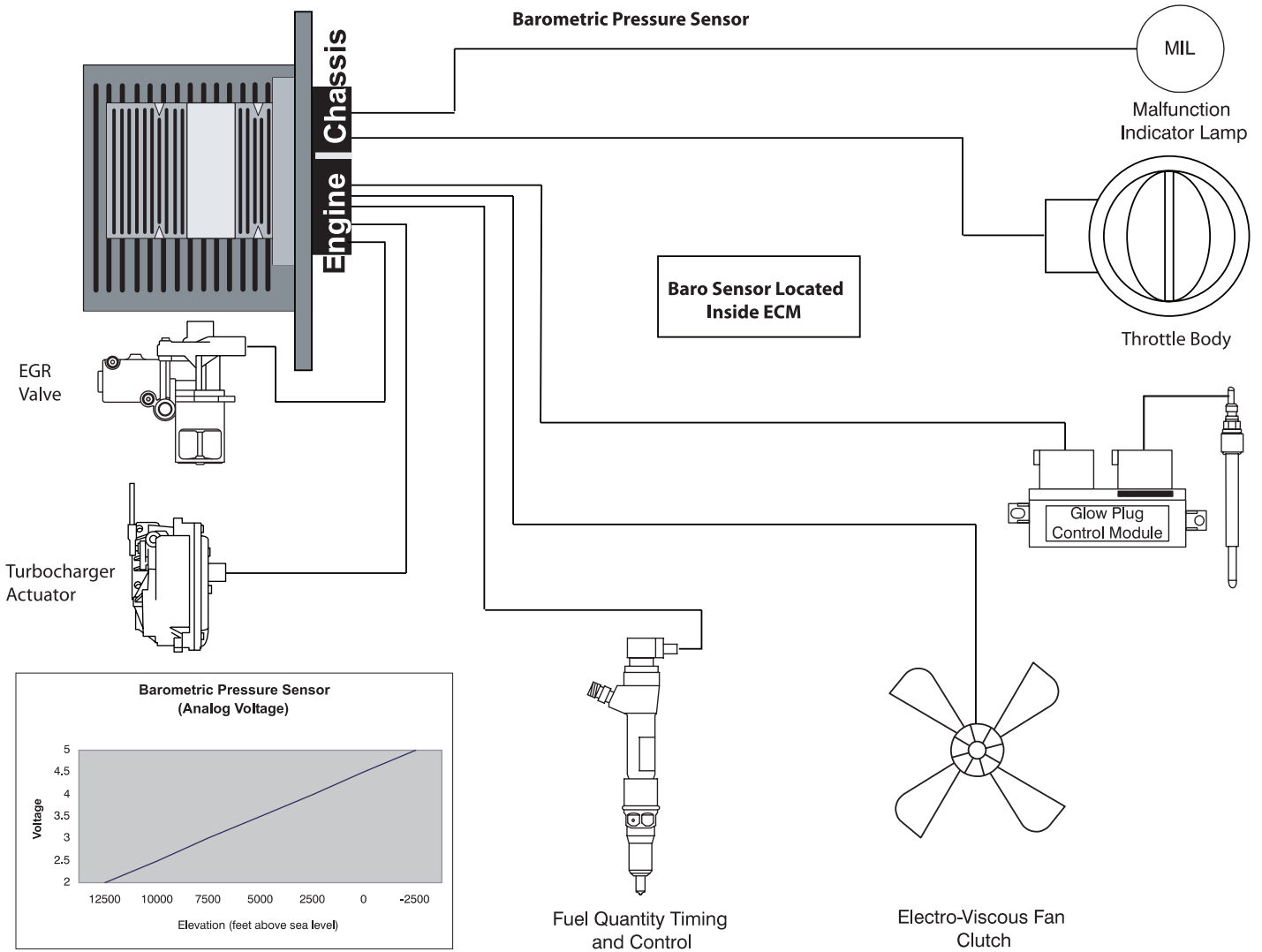
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AP (Accelerator Pedal Position)

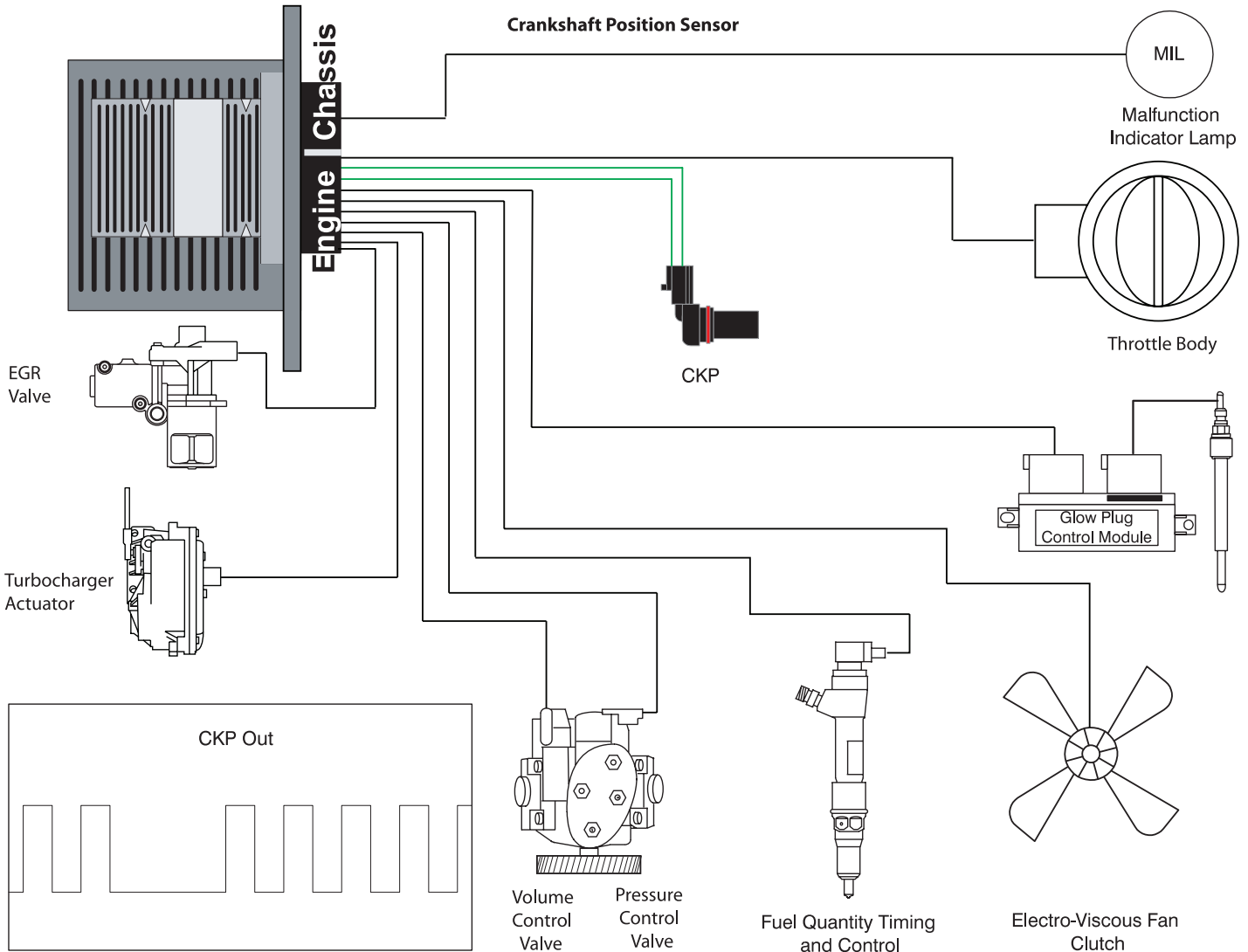
- The AP (Accelerator Pedal) is a three track pedal. The AP incorporates three potentiometers. Throughout the movement of the AP the resistance values of the three potentiometers must agree. During the movement of the AP if any of the three potentiometer readings do not agree, the check engine light 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.



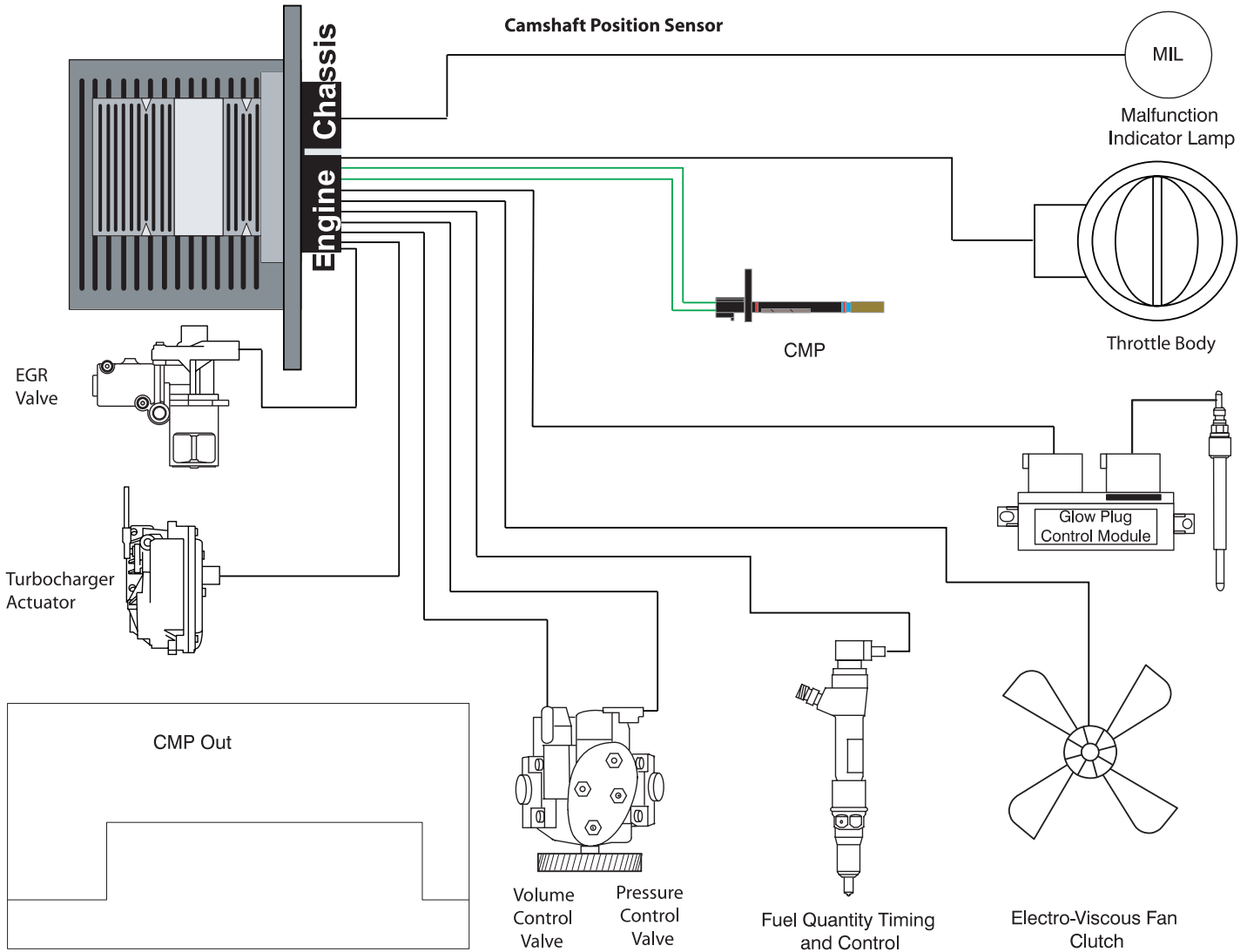
CKP (Crankshaft Position)

- 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 synchronization 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.

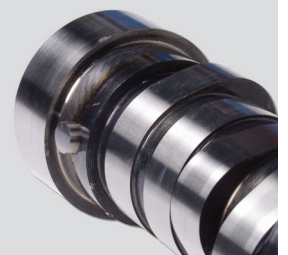
- The ECM needs both the CKP and CMP signal to calculate engine position. The CKP creates a signal that relates to crankshaft speed and position relative to TDC (Top Dead Center). The CMP creates a signal relative to which stroke (compression or exhaust)

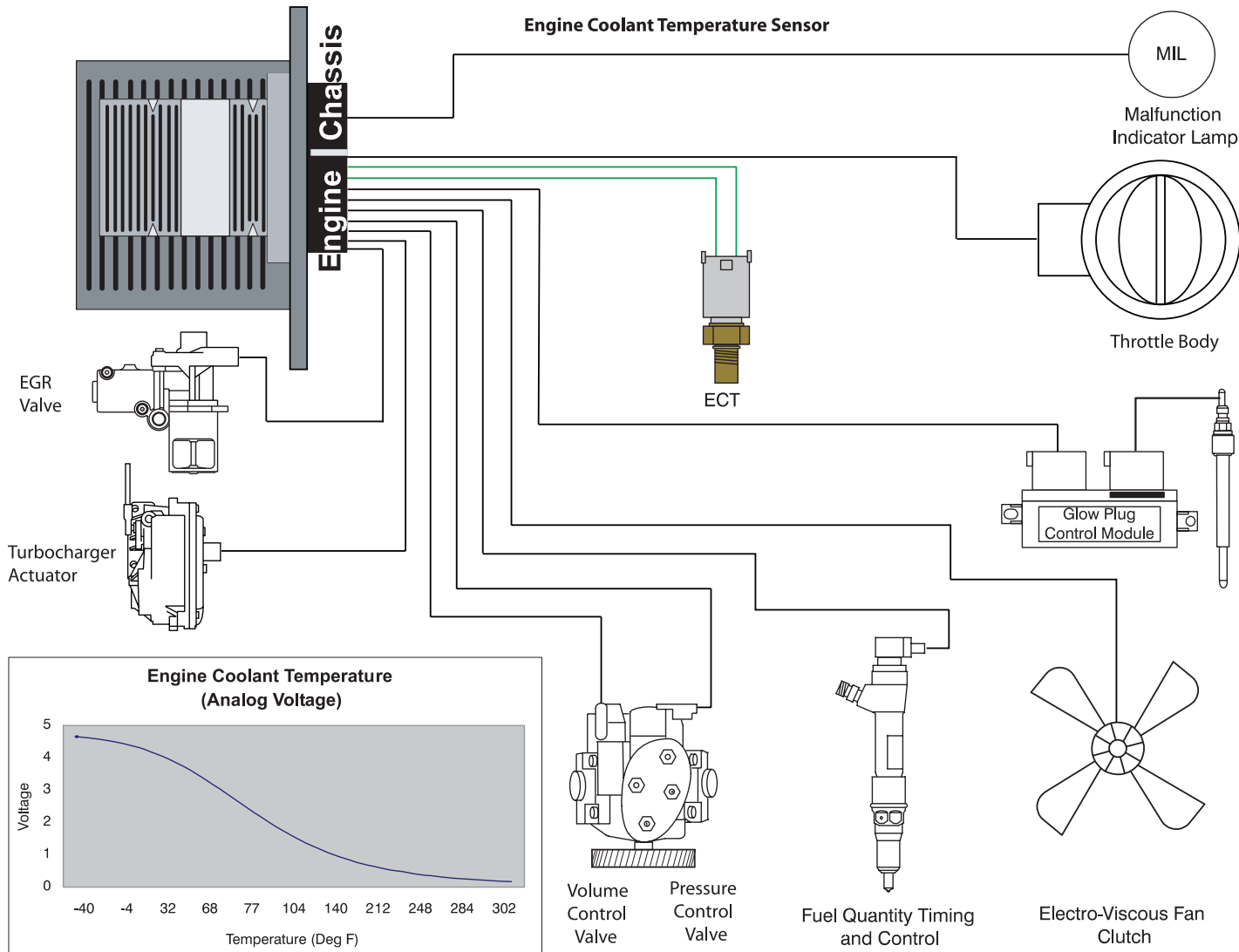




CMP (Camshaft Position)

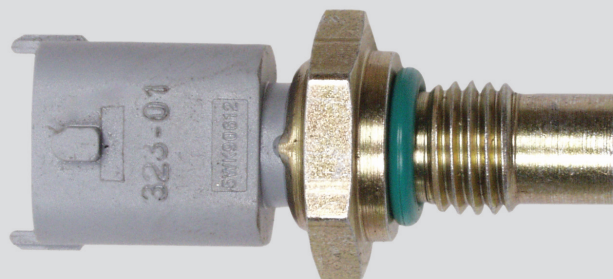
- The camshaft position signal source is a magnetic pickup sensor mounted on the left front side of the engine block.
- The sensor reacts to a peg, pressed into the camshaft at the front of the engine.
- The peg will pass the sensor once per camshaft revolution, the sensor will produce a single pulse 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).

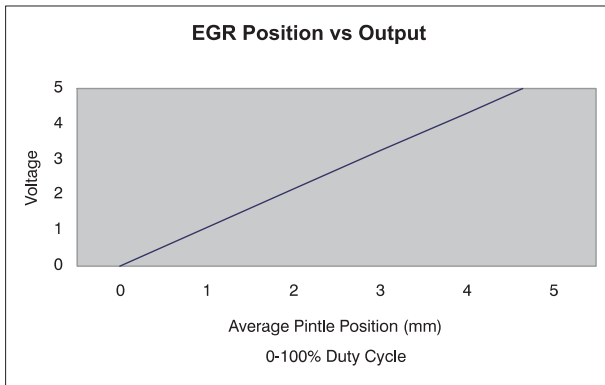
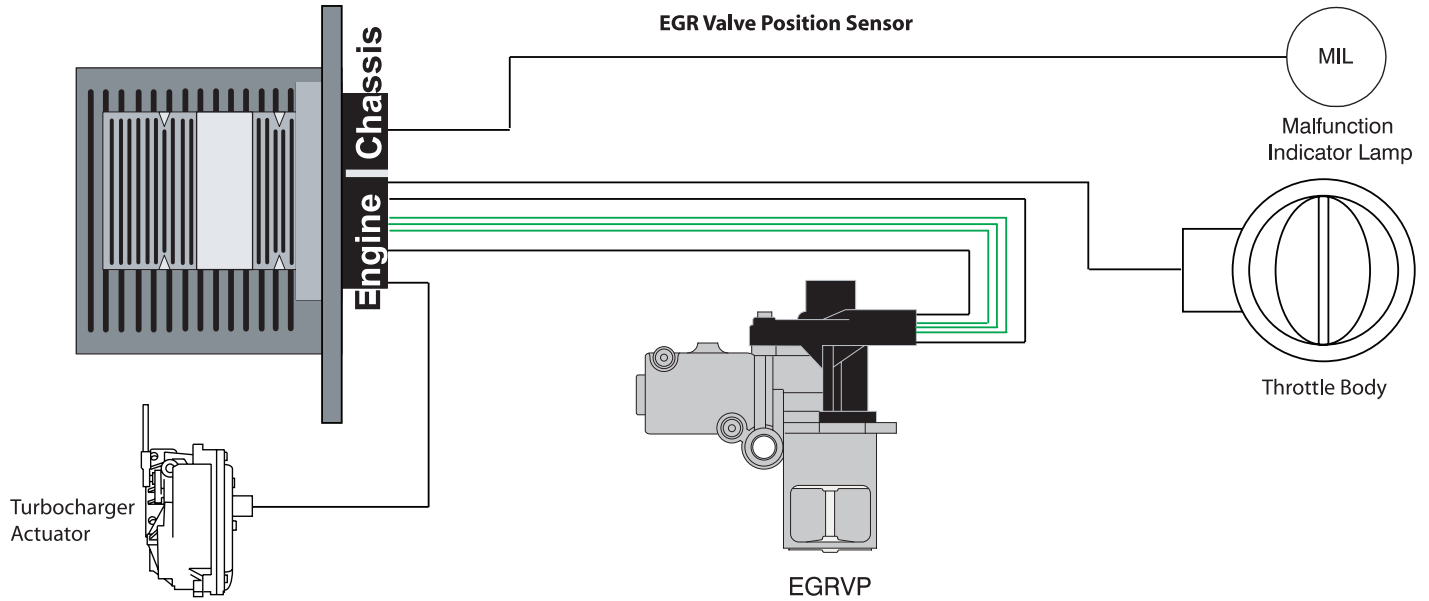




ECT (Engine Coolant Temperature)

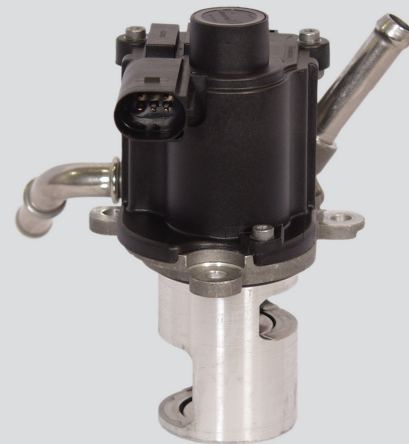
- The ECT sensor is a two (2) wire thermistor sensor.
- The ECT sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECT sensor changes resistance when exposed to different temperatures.
- When the temperature of the coolant decreases, the resistance of the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



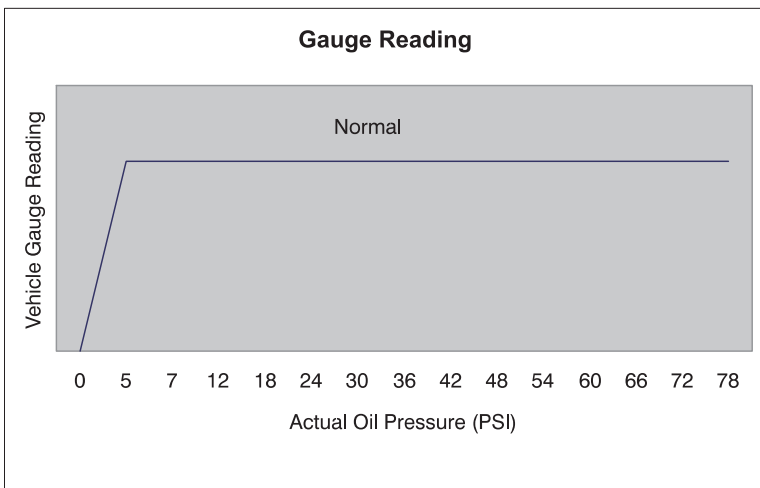
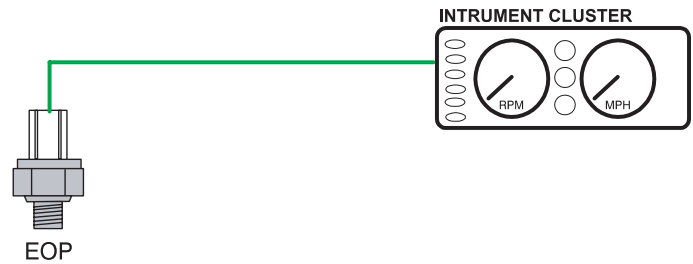


EGRVP (EGR Valve Position)

- 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.

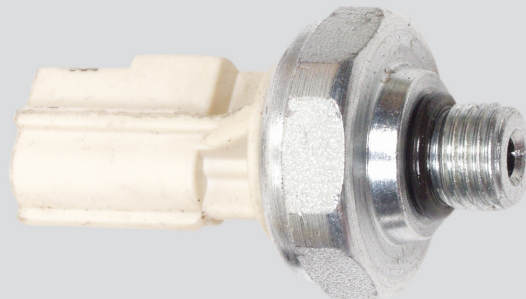


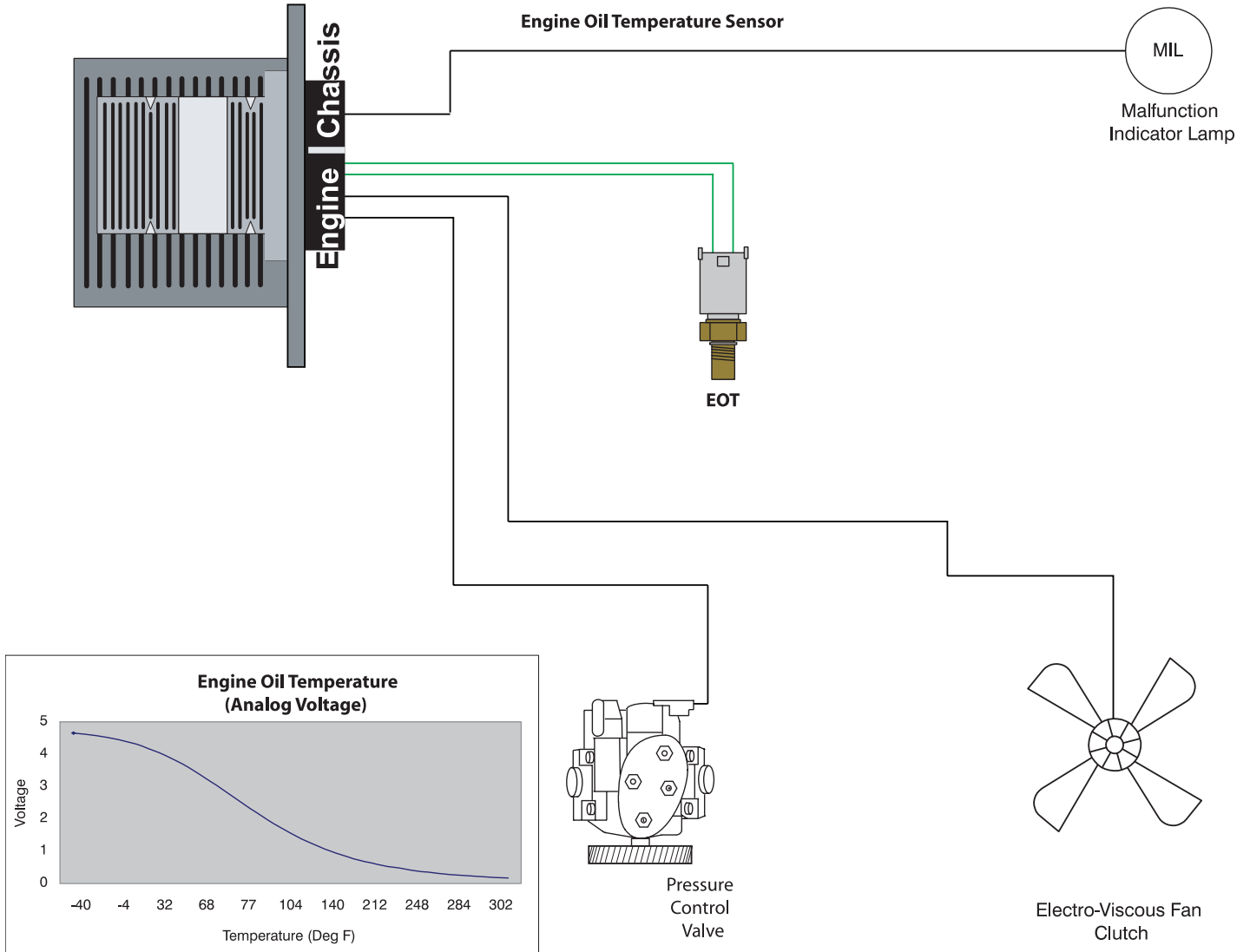
Engine Oil Pressure Switch



EOP (Engine Oil Pressure)

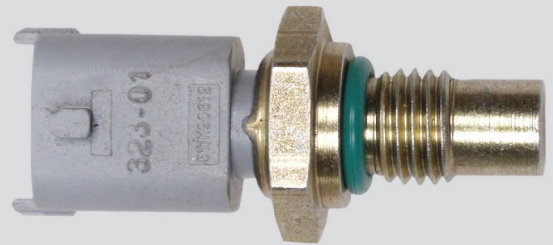
- The EOP (Engine Oil Pressure) is a switch that closes a circuit to ground after engine oil pressure reaches approximately 5-7psi.
- This switch controls the oil pressure gauge on the instrument panel. When pressure is above 7psi the gauge will read normal and if the pressure drops below 5 psi the gauge 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.

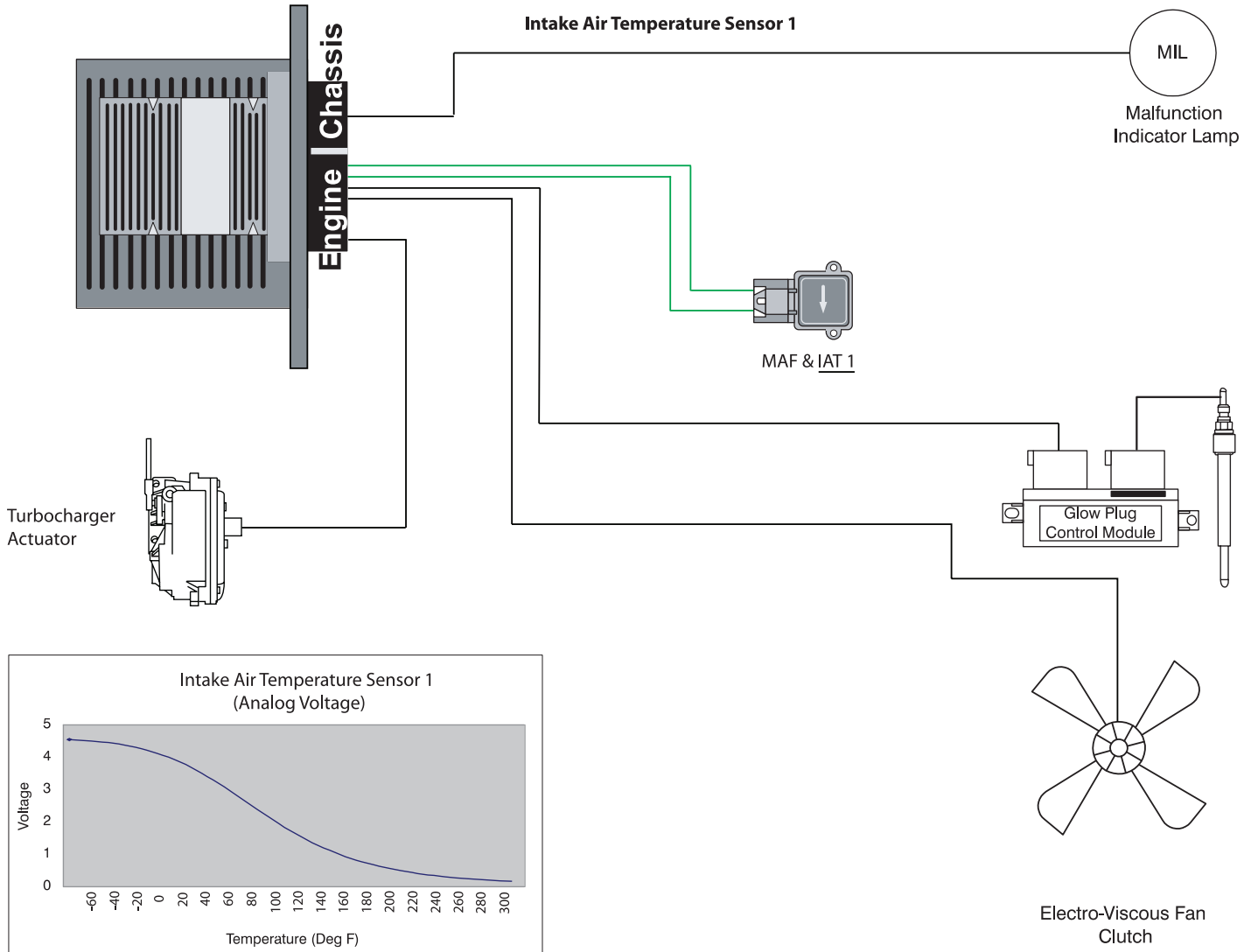




EOT (Engine Oil Temperature)

- 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.

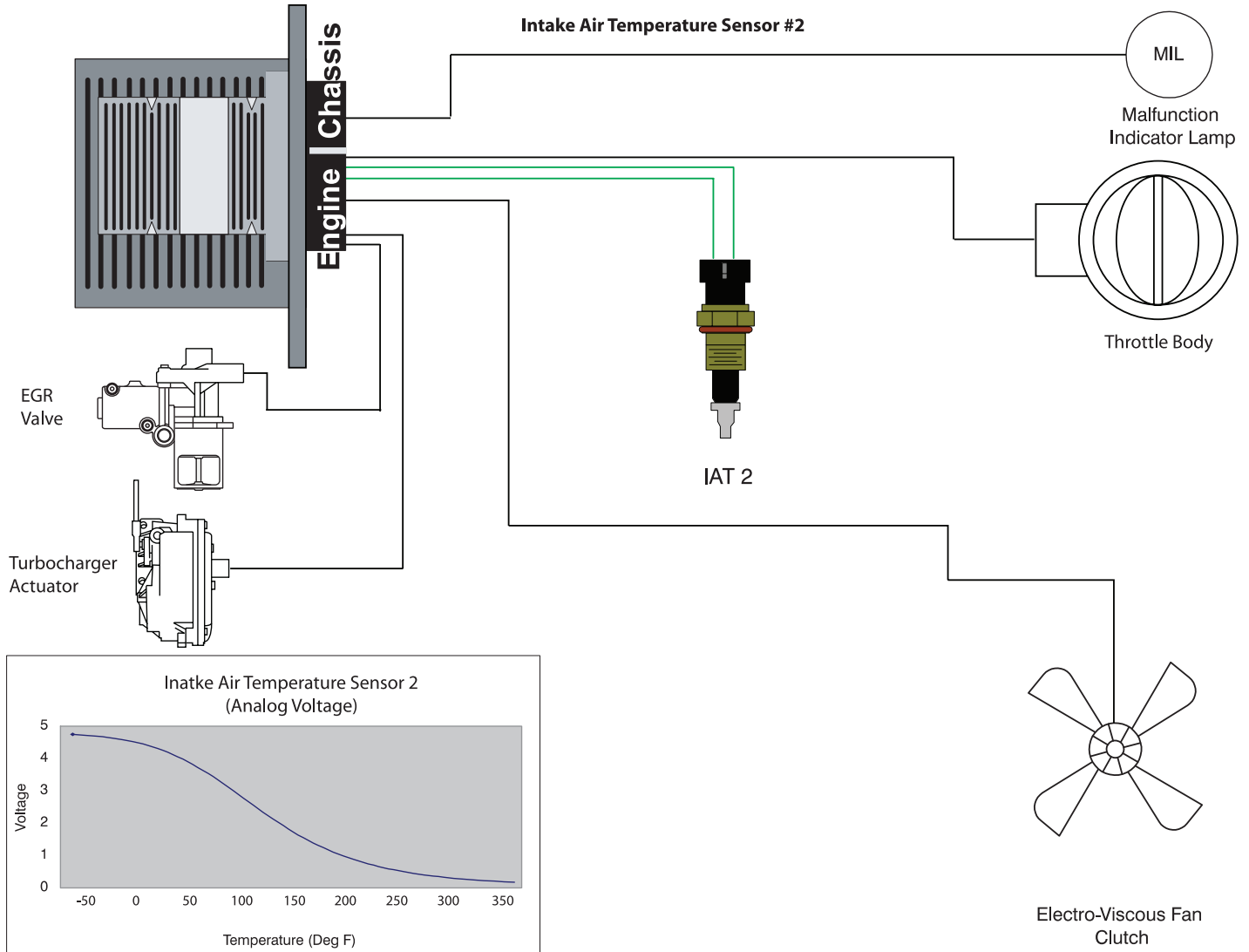




IAT1 (Intake Air Temperature #1)

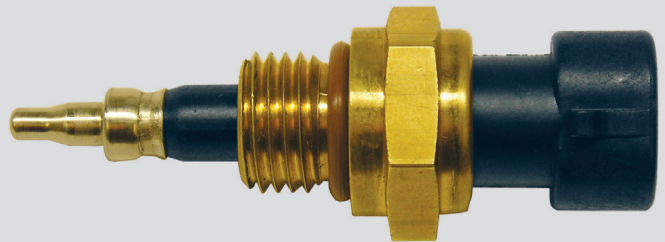
- The Intake Air Temperature1 (IAT1) sensor is a two wire thermistor sensor that is located inside the Mass Air Flow (MAF) sensor.
- The IAT1 sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The IAT1 sensor's primary function is to measure intake air temperature 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.

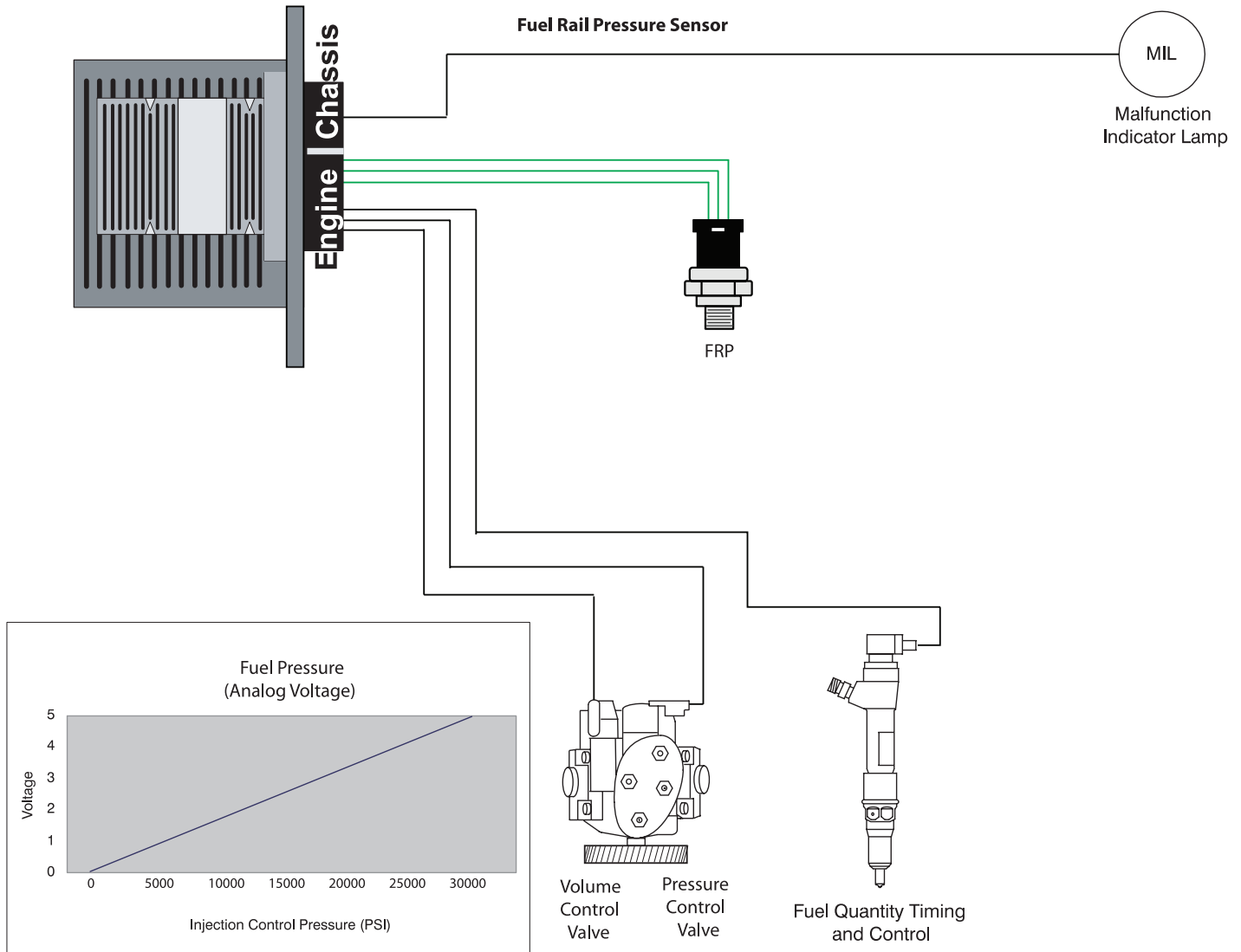




IAT2 (Intake Air Temperature #2)

- 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.

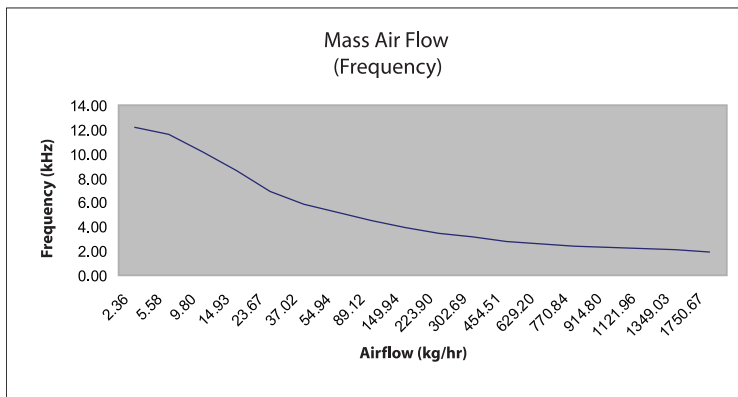
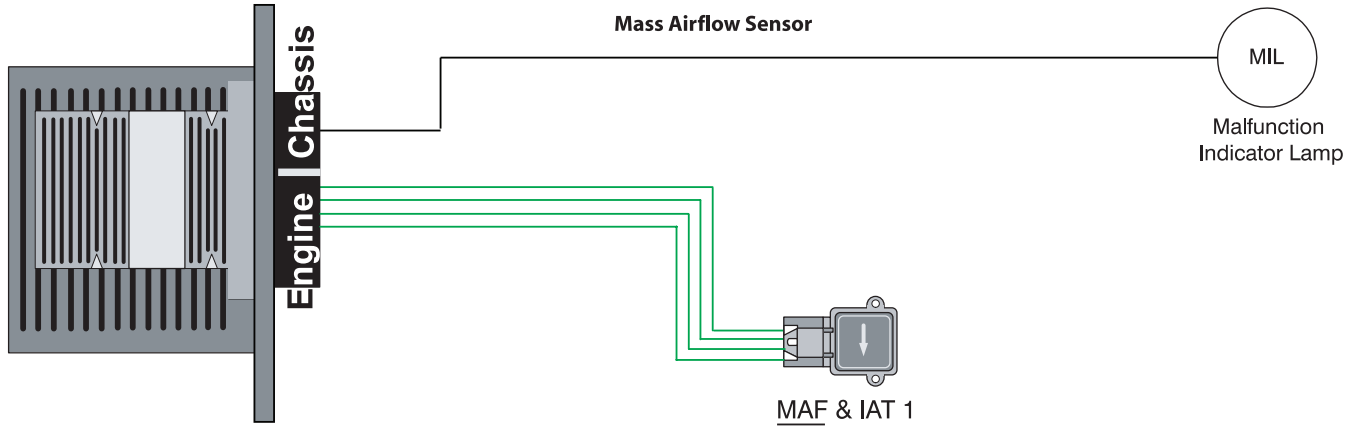




FRP (Fuel Rail Pressure)

- The FRP sensor is a (3) wire variable capacitance sensor.
- The ECM supplies a 5 volt reference signal (V_{ref}) 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.

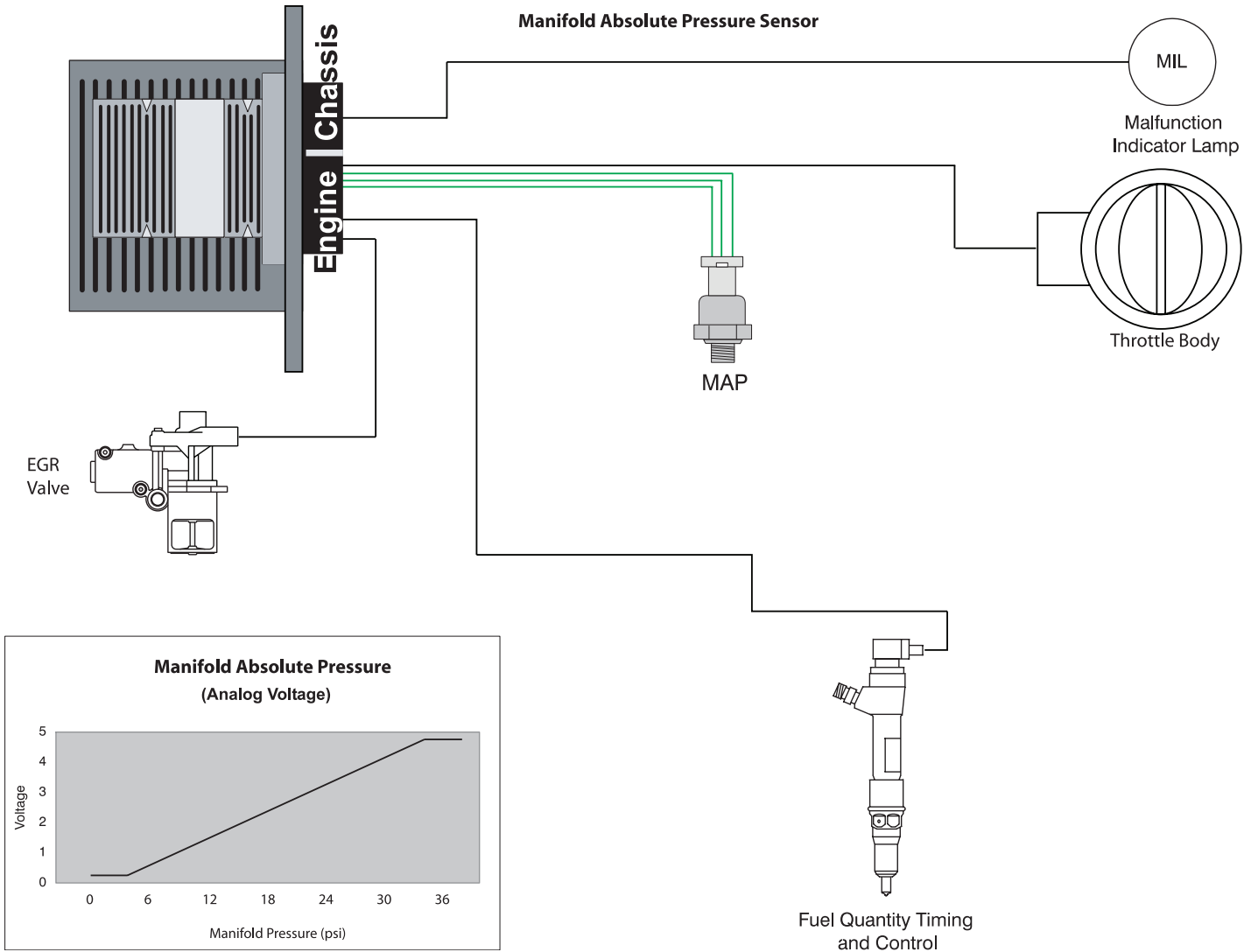




MAF (Mass Air Flow)

- 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.





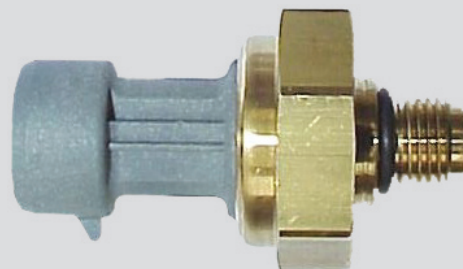
MAP (Manifold Absolute Pressure)

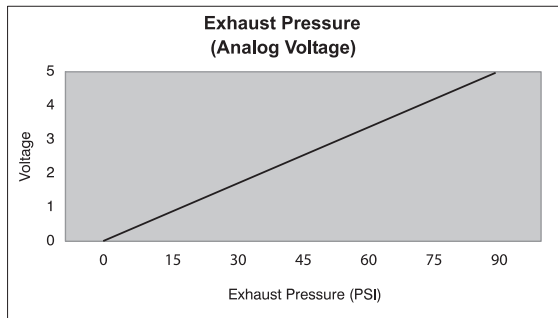
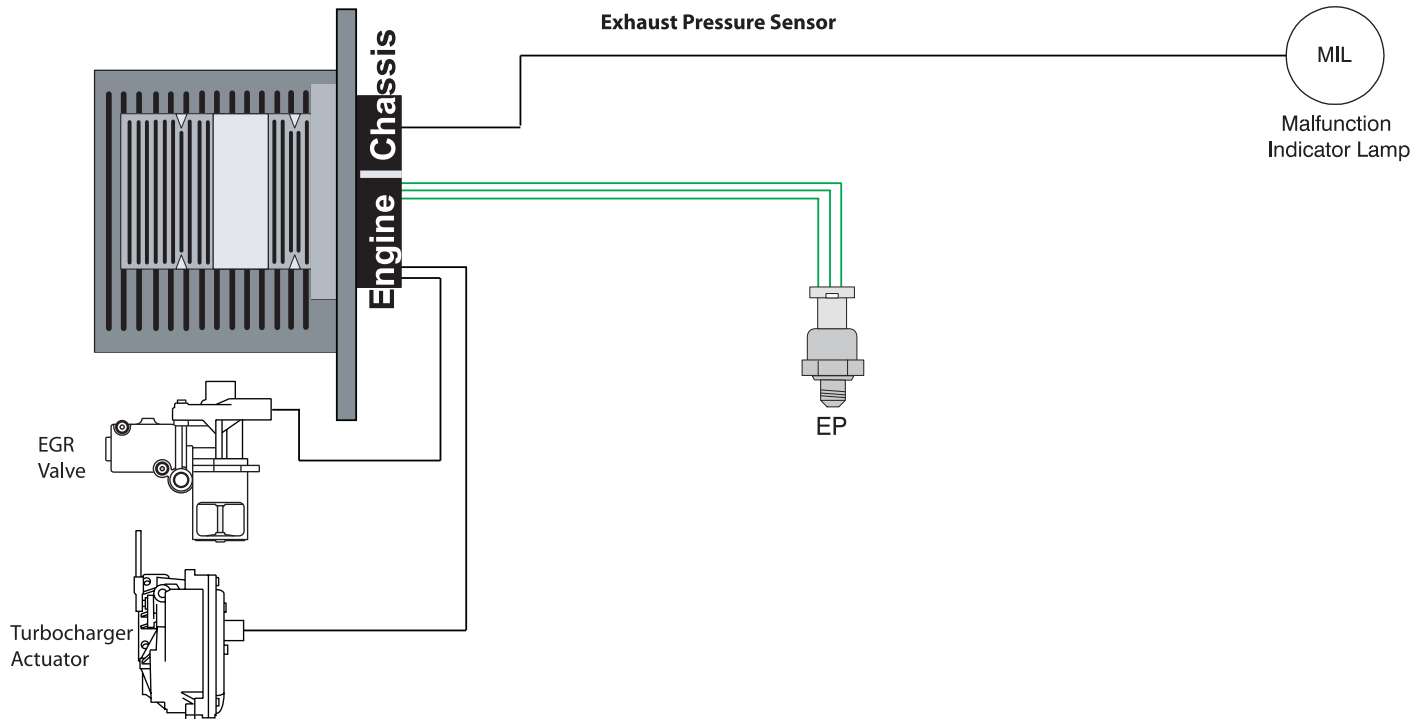
- The MAP sensor is a three (3) wire variable capacitance sensor.
- The ECM uses the MAP sensor signal to assist in the calculation of EGR duty cycle, Fuel Delivery, and Throttle Body Position.
- The ECM measures the MAP signal to determine intake manifold (boost) pressure.

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!





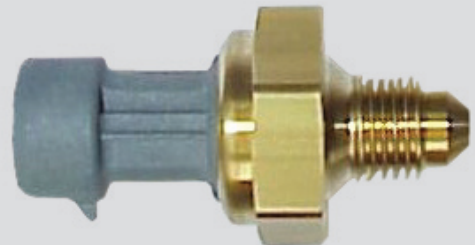
EP (Exhaust Pressure)

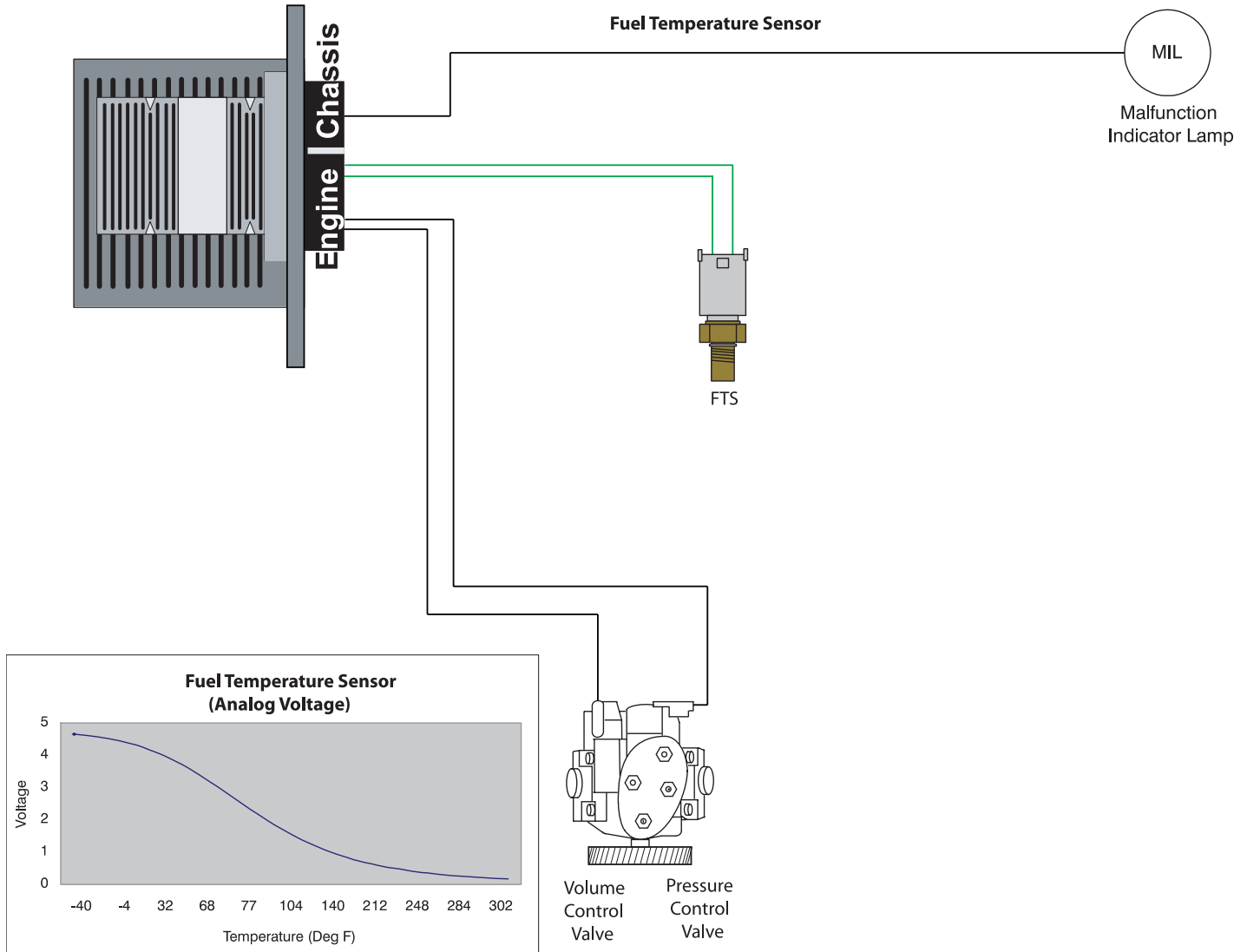
- The EP sensor is a three (3) wire variable capacitance sensor.
- The ECM supplies a 5 volt reference signal which the EP sensor uses to produce a linear analog voltage that indicates pressure.
- The EP measures exhaust back pressure so that the ECM can control the EGR, and the high pressure turbocharger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

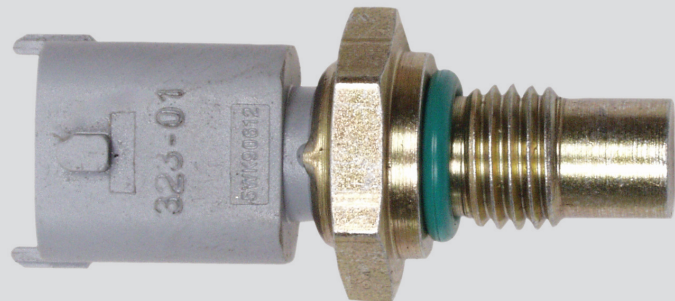
NOTE: Pay special attention to differentiating between the MAP sensor and the EP sensor, do not interchange them!

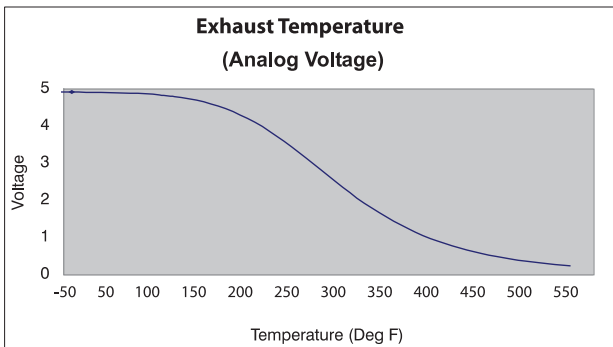
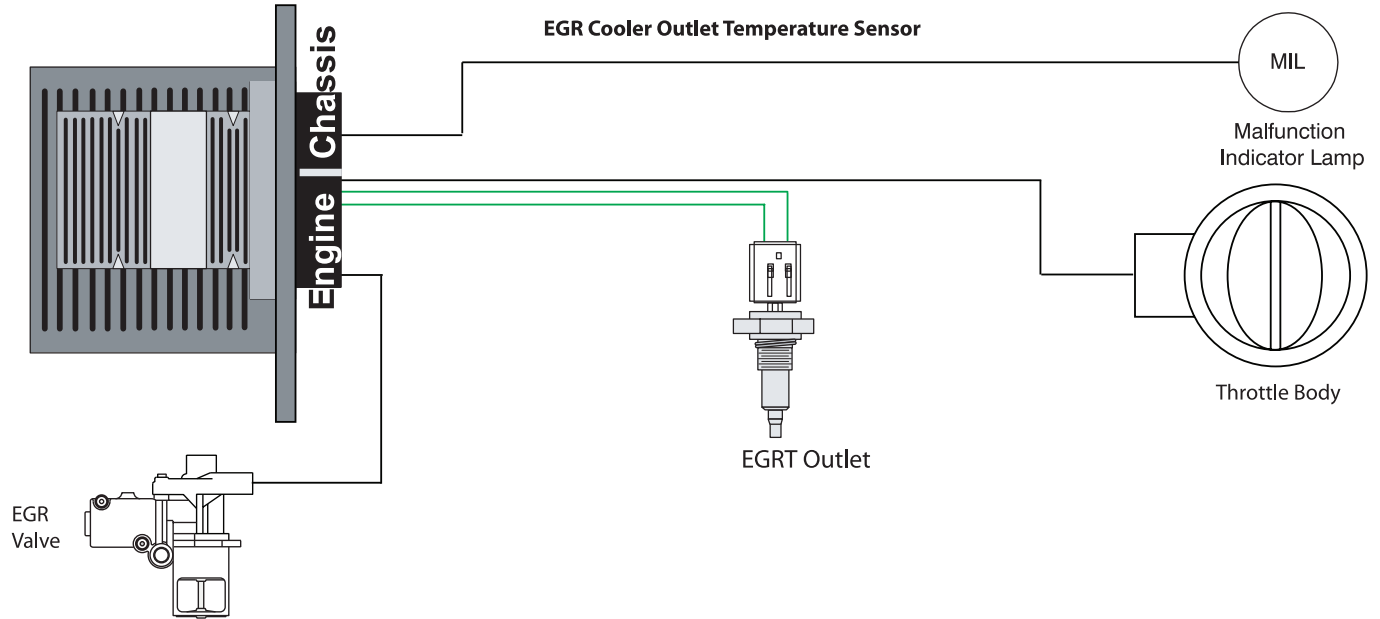




FTS (Fuel Temperature Sensor)

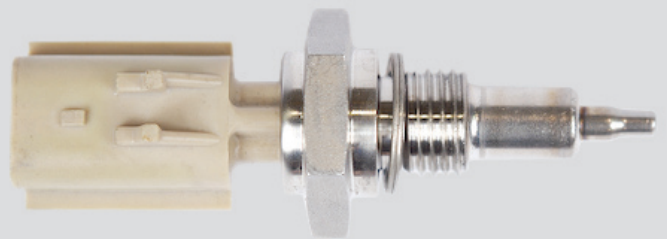
- The FTS sensor is a two (2) wire thermistor sensor.
- The FTS sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The FTS sensor changes resistance when exposed to different temperatures.
- When the temperature of the fuel decreases, the resistance of the thermistor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

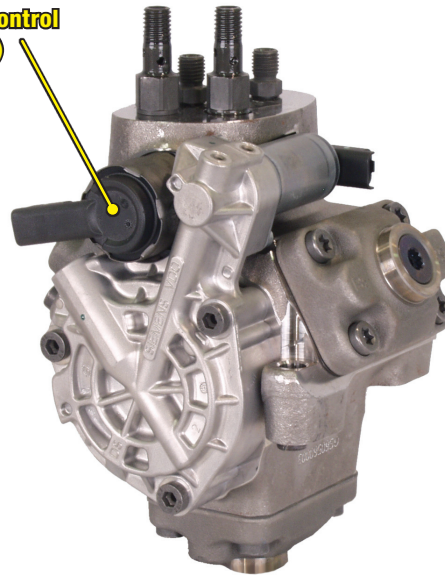
120

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!

Pressure Control Valve (PCV)



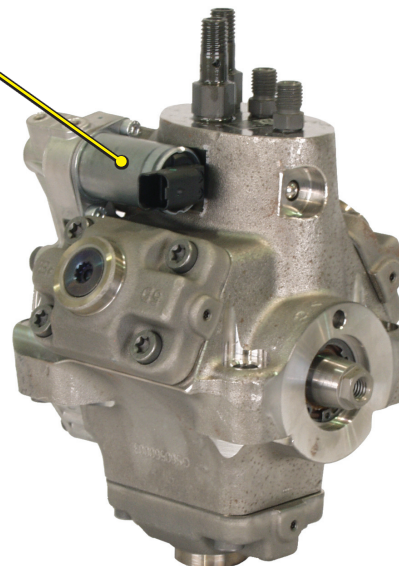
121

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!

Volume Control Valve (VCV)



122

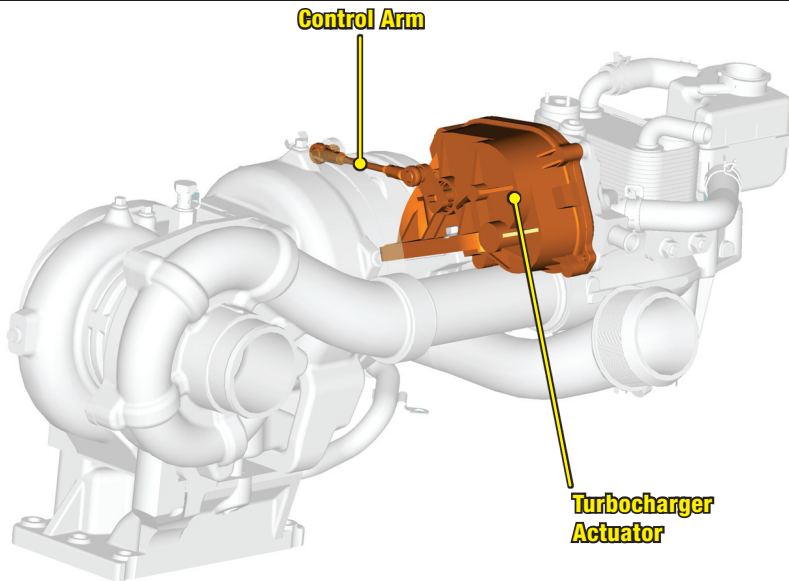
ELECTRICAL COMPONENTS



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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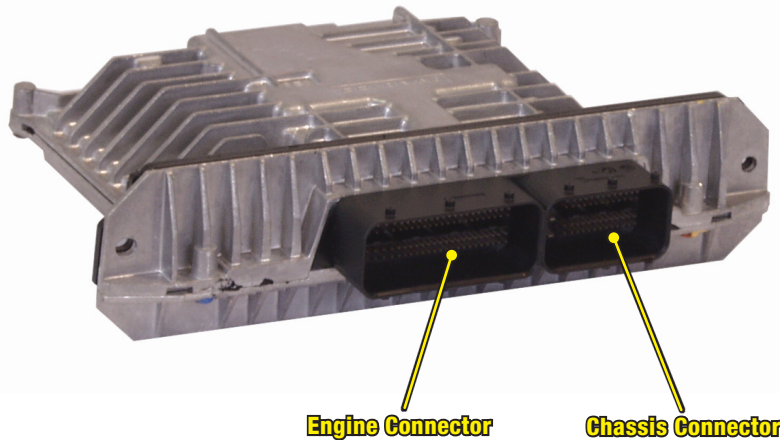
Throttle Body

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

125

ECM (Engine Control Module)

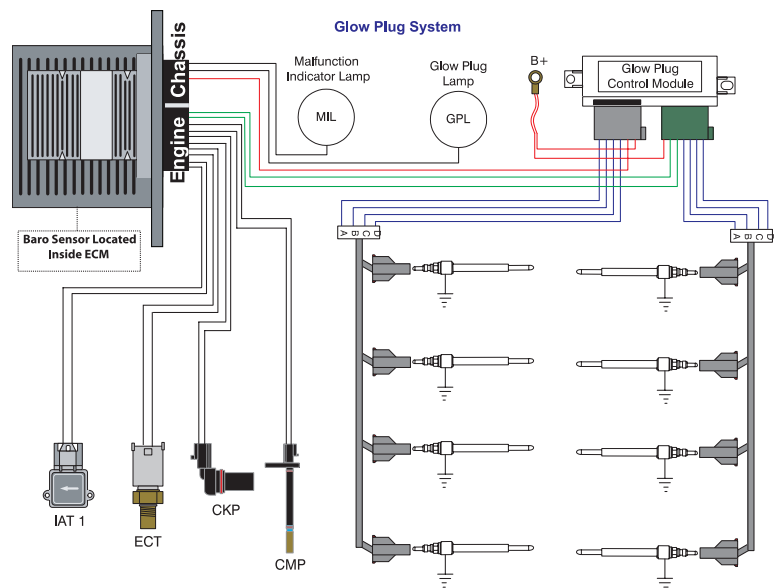
- The ECM, which is mounted behind the engine on the passenger side cowl, uses sensor inputs to control actuators and send fueling commands to the fuel injectors.
- The ECM controls the fuel and air management system on the 6.4L Power Stroke® Diesel.



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Glow Plug System

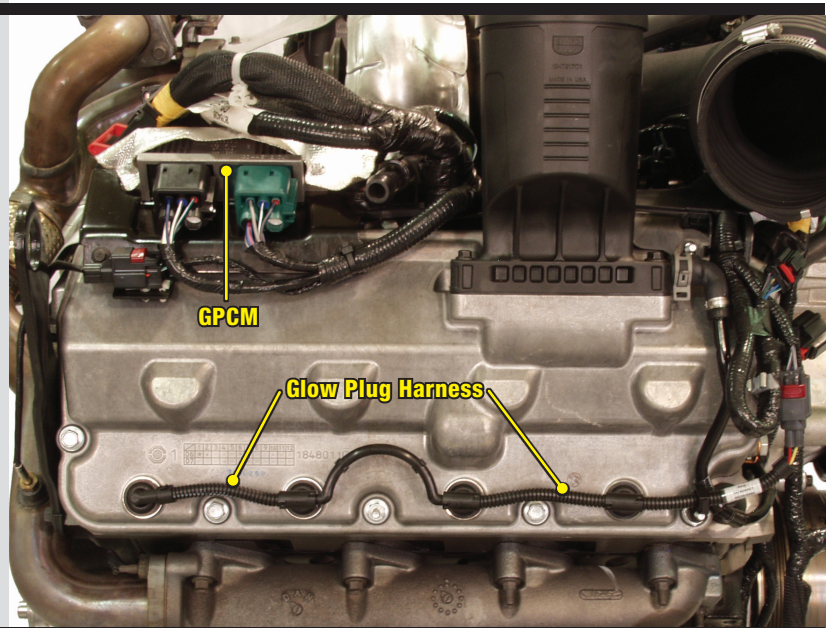
- The glow plug system is used to warm the air in the cylinders to enhance cold weather startability and reduce start up smoke.
- The glow plug system is ECM controlled, and powered by the GPCM.



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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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Piezo Actuator

Fuel Injector

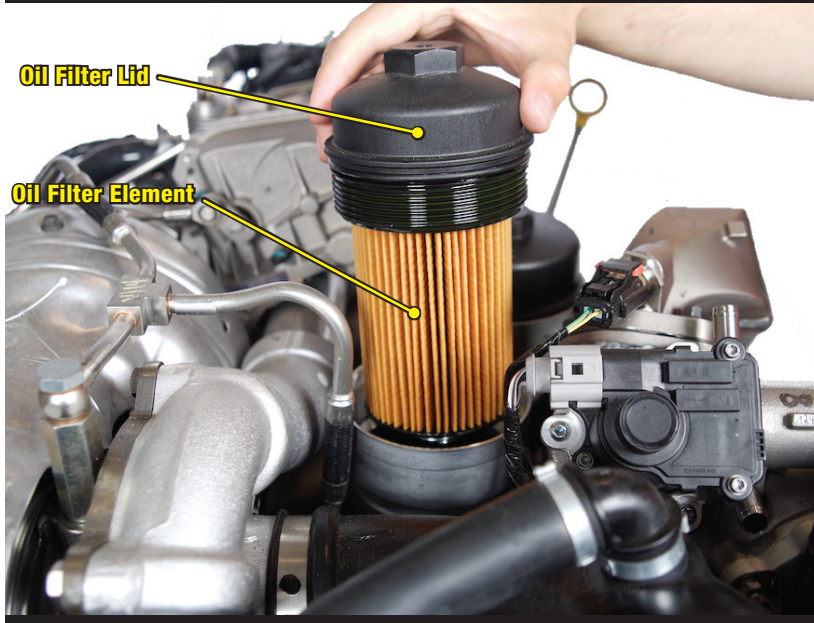
- The fuel injector is controlled by an extremely precise piezo electric actuator that can accomplish multiple injections per combustion event.

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

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UNIQUE SERVICE PROCEDURES

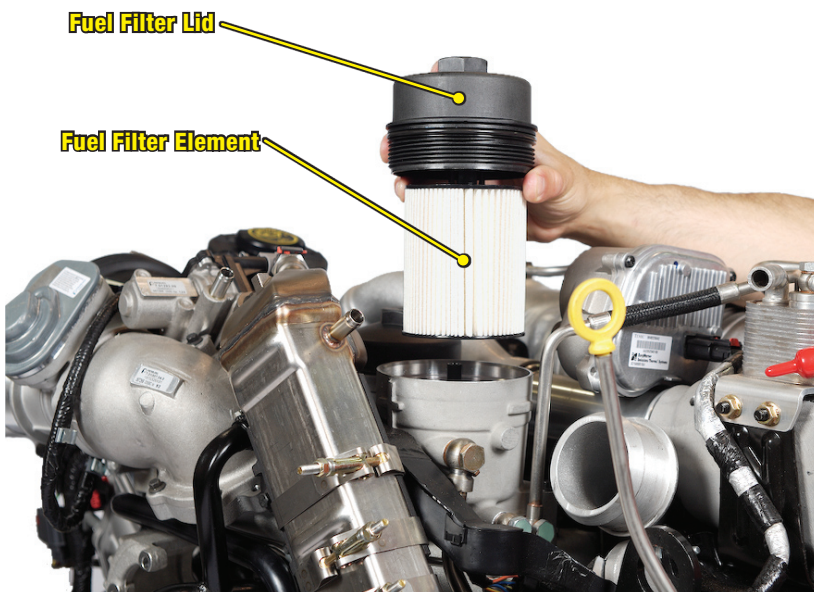


Oil Filter: Replacement

- First loosen the oil filter cap which will open the oil filter drain and allow the oil from the filter housing to drain into the crankcase.
- Drain the oil from the oil pan.
- After all of the oil has drained from the oil pan remove the oil filter and discard it in the appropriate location.
- Install the new oil filter element and tighten the oil filter cap to the recommended torque. This will close the oil filter drain.
- Refill crankcase with the correct volume of recommended oil.

Note: The oil filter snaps into the oil filter lid.

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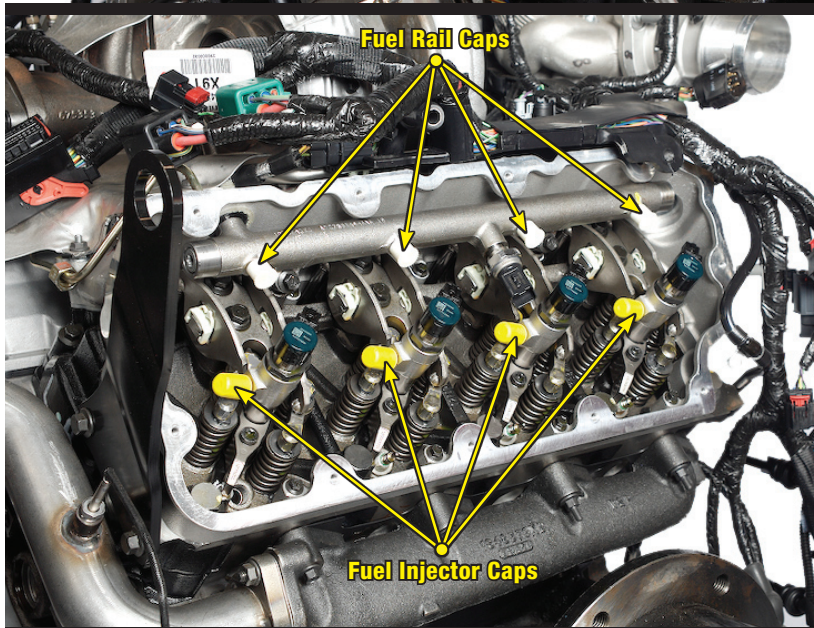
Fuel Filter: Replacement

NOTE: Use proper cleanliness practices while servicing the fuel system, do not let any dirt get into the housing!

- Clean all dirt and debris from the engine mounted fuel filter lid thoroughly. Make sure your hands and any tools involved are clean also!
- Remove the fuel filter lid and lift the filter element out of the housing and discard in the appropriate location.
- To avoid fuel spills, use a suction gun or similar device to remove the remaining fuel from the fuel filter housing.
- Install the new filter and tighten the fuel filter lid to the specified torque.

NOTE: Before starting the vehicle, turn the key to the on position for 30 seconds, then key off. Do this 6 times to ensure the fuel filter housing is full of fuel before starting the vehicle.

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Fuel System Service Cleanliness: Fuel Injectors, Fuel Rail

NOTE: Use proper cleanliness practices while servicing the fuel system!

- Always use fuel system caps when servicing the fuel injectors or replacing fuel lines.
- Do not have the fuel system open to the elements any longer than is necessary to perform the job at hand.
- Tool # 310-158 (fuel caps)

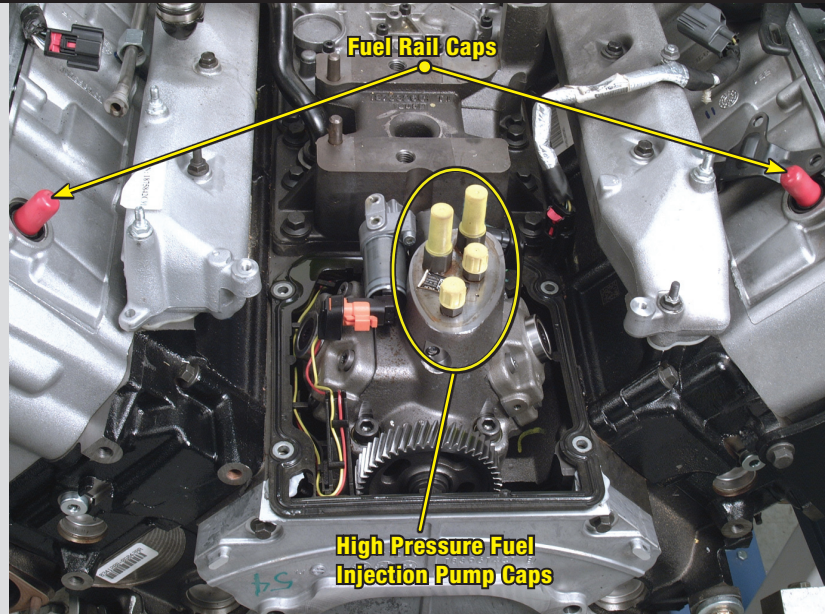
133

UNIQUE SERVICE PROCEDURES

Fuel System Service Cleanliness: High Pressure Fuel Injection Pump

NOTE: Use proper cleanliness practices while servicing the fuel system!

- Always use fuel system caps when servicing the high pressure fuel injection pump.
- Do not have the fuel system open to the elements any longer than is necessary to perform the job at hand.
- Tool # 310-158 (fuel caps)



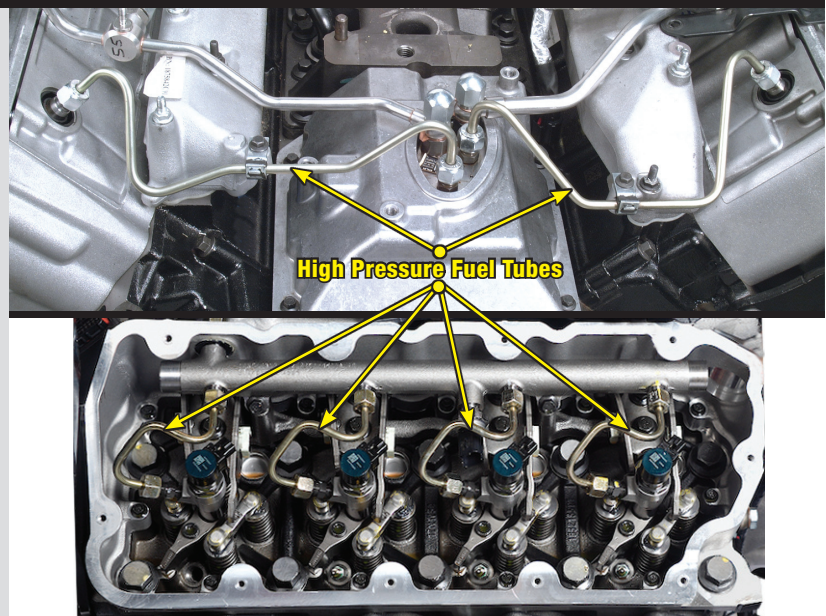
134

Fuel System Service: High Pressure Fuel Tubes

NOTE: Use proper cleanliness practices while servicing the fuel system!

- High pressure fuel supply tubes must always be replaced once loosened. Never re-use a high pressure tube once it has been loosened under any circumstances!

NOTE: Always use the fuel injector connector disconnect tool (tool # 310-157) whenever disconnecting the fuel injector electrical connector. Failure to use this tool can damage the connector.



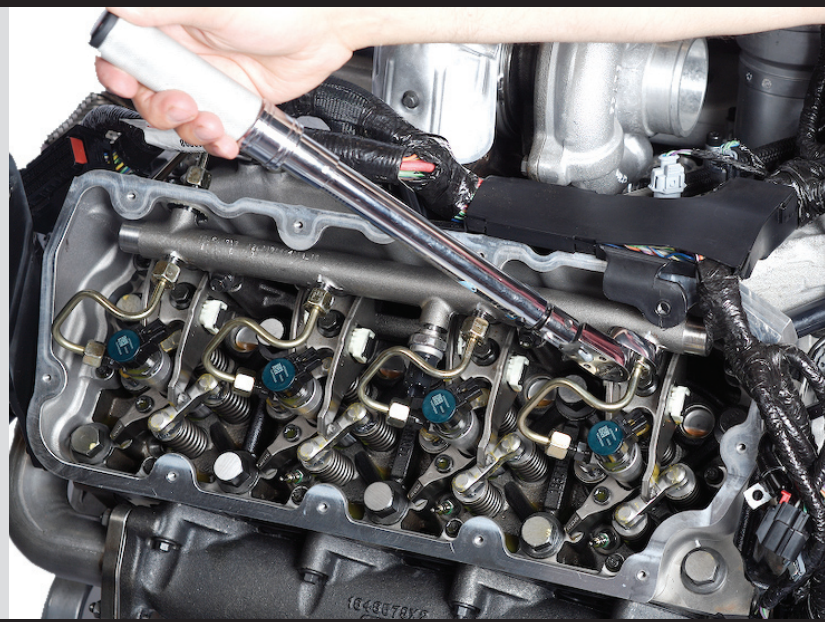
135

Fuel System Service: High Pressure Fuel Tube Service

NOTE: Use proper cleanliness practices while servicing the fuel system!

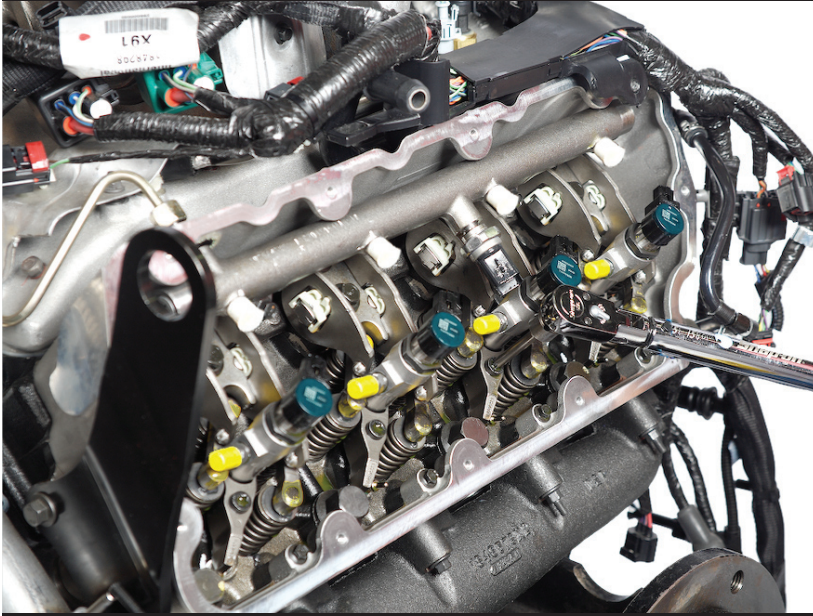
NOTE: Follow the proper service procedures while servicing the fuel system and always use the correct torque!

- Proper torque is crucial with the 6.4L Power Stroke® Diesel's high pressure fuel system.
- When replacing high pressure fuel tubes, always follow the correct procedure for installation and torque.



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UNIQUE SERVICE PROCEDURES



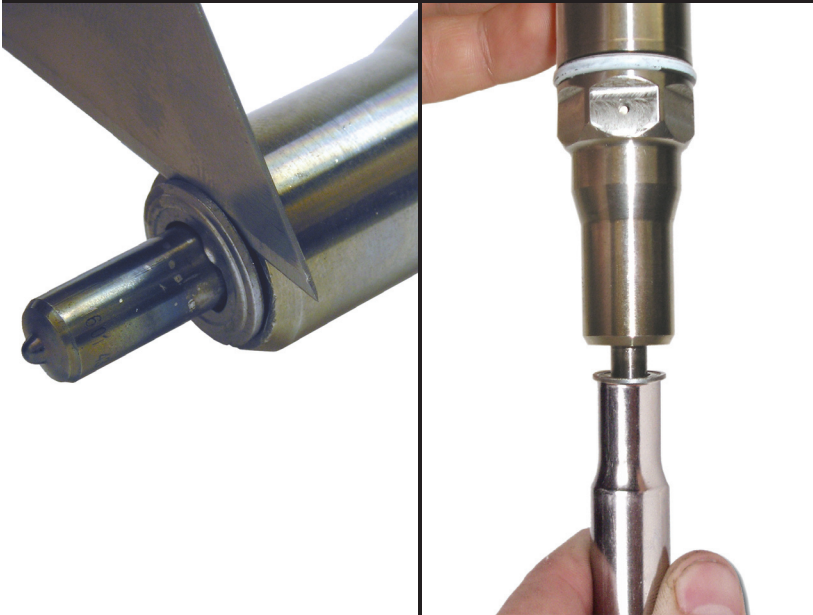
Fuel System Service: Fuel Injector Service

NOTE: Use proper cleanliness practices while servicing the fuel system!

NOTE: Follow the proper service procedures while servicing the fuel system and always use the correct torque!

- Proper torque is crucial with the 6.4L Power Stroke® Diesel's high pressure fuel system.
- When replacing fuel injectors, always follow the correct procedure for installation and torque.
- Always use proper protective fuel system caps whenever a tube is removed.
- Avoid cleaning parts near fuel system components.
- Tool # 310-158 (fuel caps)

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Fuel System Service: Removing and Installing Injector Gasket

NOTE: Use proper cleanliness practices while servicing the fuel system!

- To remove the gasket, use a razor blade to get between the gasket and injector body, then slowly work the gasket off.
- To install the new gasket, use a 9mm 12 point deep well socket and press the gasket on by hand making sure it is fully seated.
- Make sure the gasket is installed correctly. The raised portion of the gasket should be facing away from the injector body.

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Fuel System Service: Fuel Injector Lubrication

NOTE: Use proper cleanliness practices while servicing the fuel system!

- Always replace the O-ring and the steel gasket at the tip of the injector when reinstalling an injector. New injectors come with these items already installed.
- Always lightly lubricate the new O-ring with clean engine oil prior to assembly.

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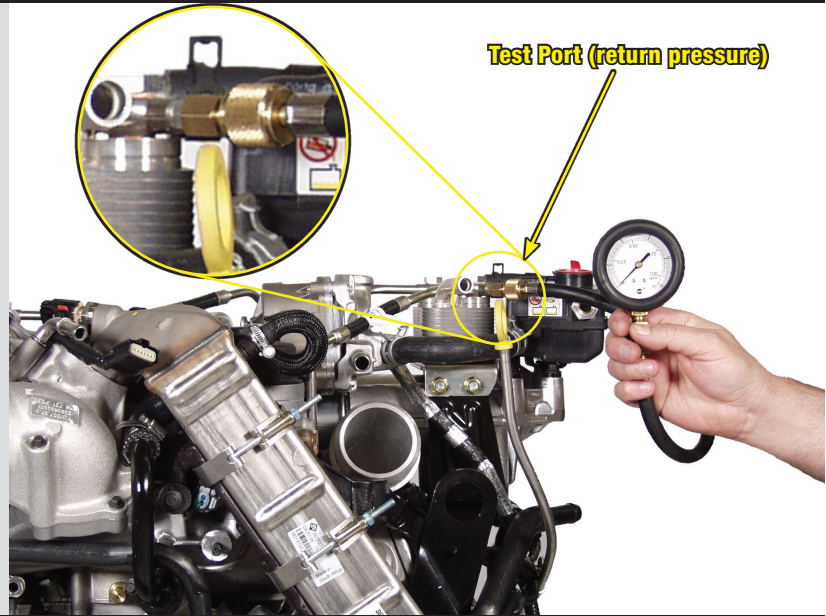
UNIQUE SERVICE PROCEDURES

Checking Fuel Pressure

NOTE: Use proper cleanliness practices while servicing the fuel system!

- There is a fuel return pressure test valve (schraeder) located on the front of the fuel cooler on the left side of the engine.
- Proper fuel pressure is very important. Too much or too little pressure could be detrimental.
- Follow the proper procedure for checking fuel pressure and make sure the correct specification for supply pressure is achieved.

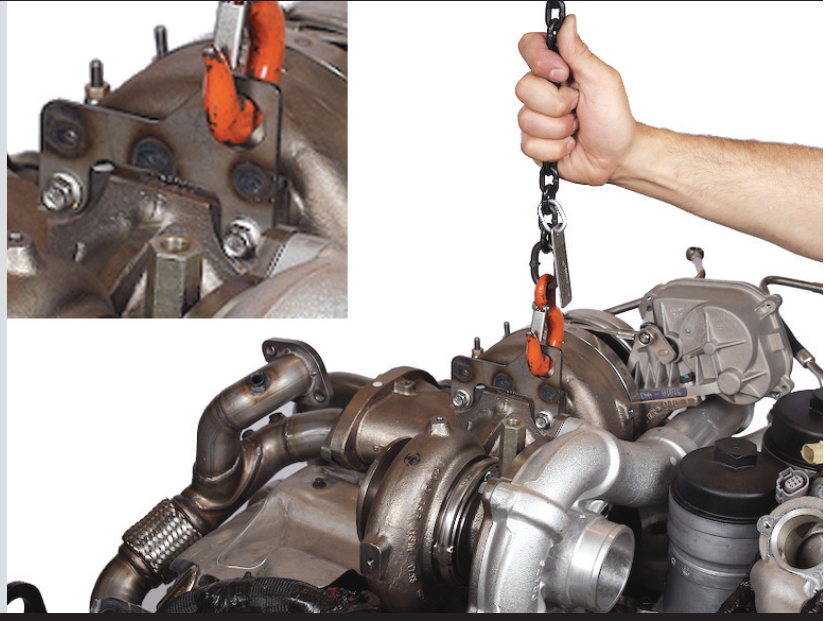
NOTE: Supply pressure needs to be checked at the horizontal fuel conditioning module (HFCM) outlet.



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Turbocharger Lifting Bracket

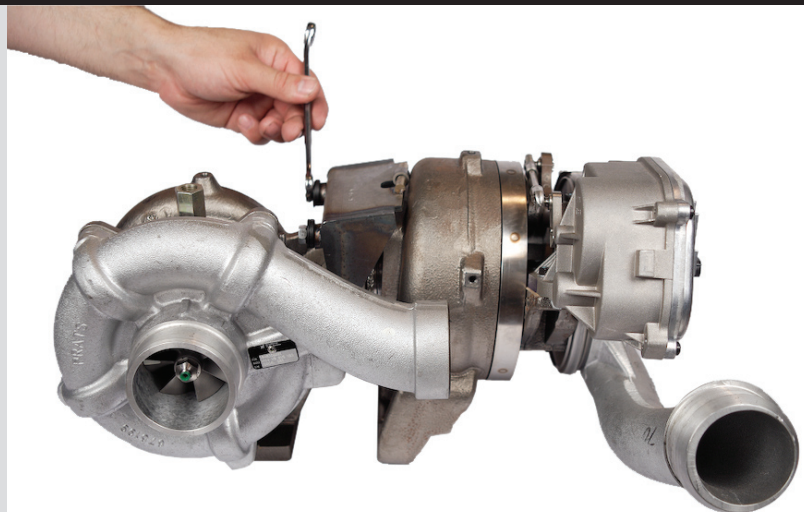
- Anytime removal or installation of the turbocharger is performed, always use the turbocharger lifting bracket to ensure proper engagement and disengagement of the turbocharger drain tubes.
- The tool is designed to balance the turbochargers and hold the two turbine housings in alignment.
- Tool # 303-1266



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Turbocharger Assembly Tool

- The series sequential turbocharger is comprised of two turbochargers, low pressure turbocharger and high pressure turbocharger. When assembling these two turbochargers together, always use the turbocharger assembly tool shown at right.
- Tool # 303-1269
- Follow the proper assembly procedure.
- The turbocharger assembly tool is necessary to ensure that proper alignment/engagement of the two turbochargers is achieved.



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UNIQUE SERVICE PROCEDURES

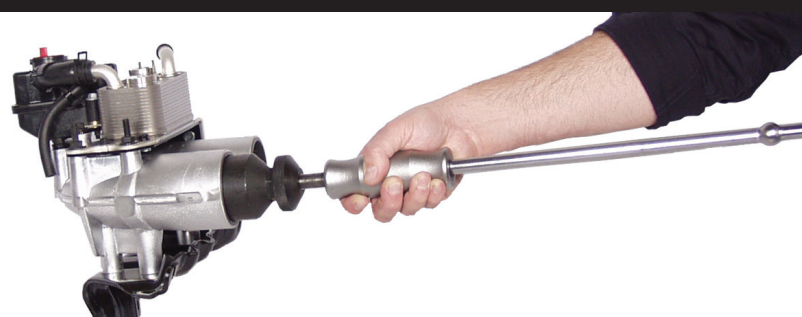


EGR Valve Removal

- Removing the EGR valve must be performed using the proper EGR valve removal tool.
- This tool is comprised of numerous pieces that must be put together around the EGR valve.
- Once the removal tool is assembled on the valve, the valve can be slowly pulled from its housing.
- Tool # 303-1267

NOTE: Pay close attention that the removal tool is installed and used correctly while removing the valve or damage can occur to the EGR valve and/or tool.

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Crossover Tube Seal Removal

- Crossover tube seal removal requires the use of special service tools; slide hammer, seal removal tools.
- There is a different size removal tool for each opening of the crossover tube.
- Tool # 303-1264

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Crossover Tube Seal Installation

- When installing new seals into the turbocharger crossover tube, always use the appropriate installation tools.
- The seals for each passage are two (2) different sizes. Make sure you use the correct sized seal installation tool for each sized seal.

NOTE: Make sure you have the crossover tube mounted securely to assure proper seal installation.

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UNIQUE SERVICE PROCEDURES

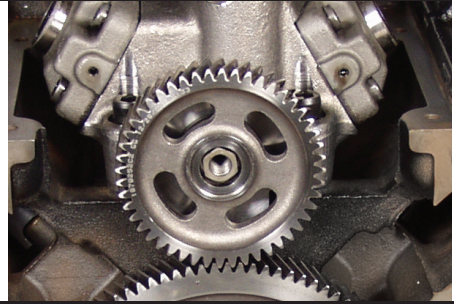
High Pressure Fuel Injection Pump: Gear Service

NOTE: Use proper cleanliness practices while servicing the fuel system!

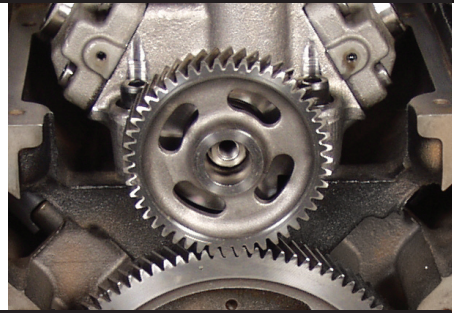
NOTE: Severe engine damage can occur if installed incorrectly!

- It is possible to tighten the gear on the high pressure fuel injection pump with the gear backwards. The gear and shaft both have a taper that needs to match.
- If you tighten the gear with it backwards the tapers will not be aligned but the bolt will start providing a means of tightening.
- Please pay special attention to insure that the gear is installed correctly with the tapers on both the gear and the high pressure fuel injection pump shaft aligned.

Correct



Incorrect



146

Cutting T-Joints: Rear Cover

- The T joint is where the bedplate gasket is bonded to the rear cover. This bond must be cut prior to removing the rear cover.
- After you loosen all of the bolts you can slide a cutting tool between the block/bedplate and the rear cover to sever the bonding compound.

NOTE: Failure to cut the T joint will stretch the bedplate gasket and result in an oil leak!



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Cutting T-Joints: Front Cover

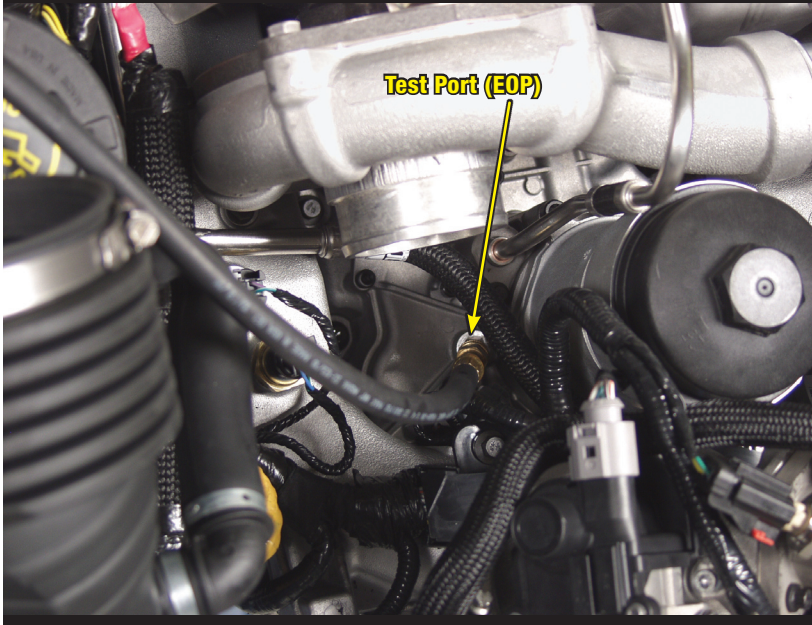
- The T joint is where the bedplate gasket is bonded to the front cover. This bond must be cut prior to removing the front cover.
- After you loosen all of the bolts you can slide a cutting tool between the block/bedplate and the front cover to sever the bonding compound.

NOTE: Failure to cut the T joint will stretch the bedplate gasket and result in an oil leak!



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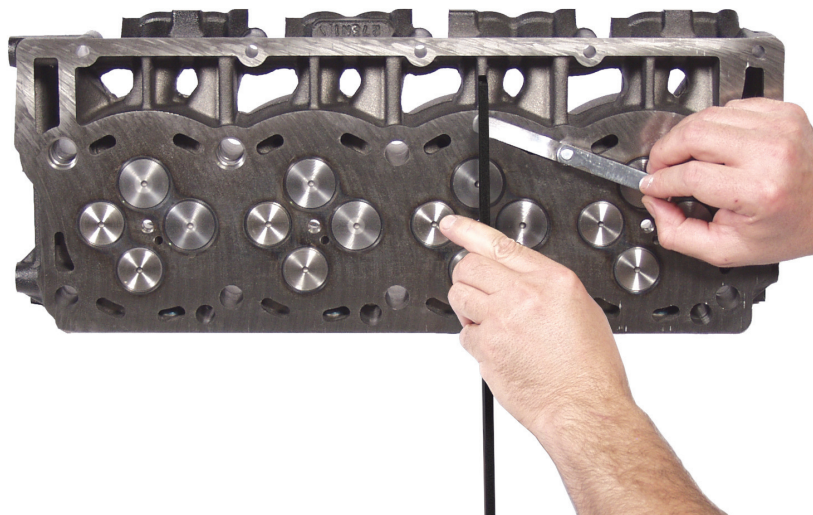
UNIQUE SERVICE PROCEDURES



Checking Oil Pressure

- Remove the engine oil pressure sensor (EOP) from the oil cooler.
- Install an adapter fitting into the port where the EOP was and install an approved oil pressure gauge.
- Follow the proper service procedures for checking oil pressure.
- The thread size for the opening is 7/16 - 20.

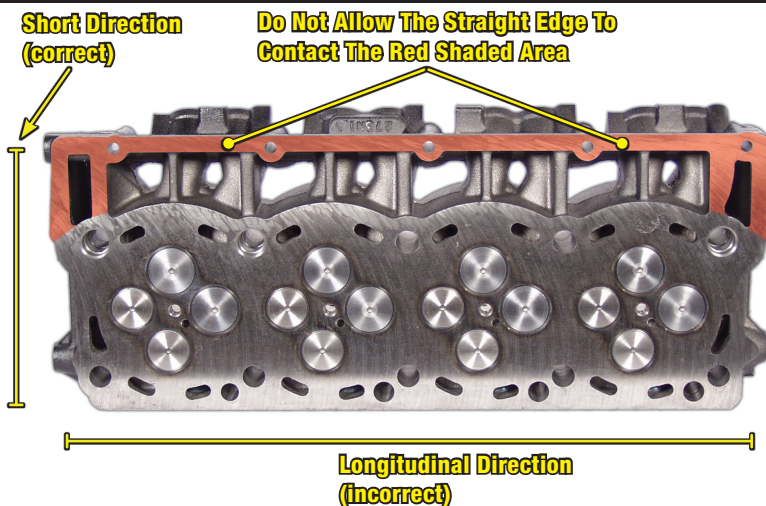
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Checking Cylinder Head Flatness

- Checking cylinder head flatness for the 6.4L engine is carryover from the late 6.0L procedure.
- Check flatness across the short direction (perpendicular to the longitudinal) of the head.
- Use a straight edge that is calibrated by the manufacturer to be flat within 0.0002 in. per running foot length.
- Set the 0.002" feeler gauge on each measurement point (refer to the service procedure graphic in the Ford workshop manual) with the straight edge perpendicular to the longitudinal and not across the area that contains the smaller head bolt holes. Set the straight edge on top of the feeler gauge.
- Use a firm steady force to properly hold the straight edge on top of the feeler gauge. Pull lightly on the feeler gauge.
- The head is locally out of flat, and needs replaced if the 0.002" feeler gauge is loose and easily slides out from under the straight edge.

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Checking Cylinder Head Flatness: Straight Edge Placement

- Never lay the straight edge across the area shaded in red.
- Do not check flatness in the longitudinal direction. Check flatness in the short (perpendicular to longitudinal) direction only.

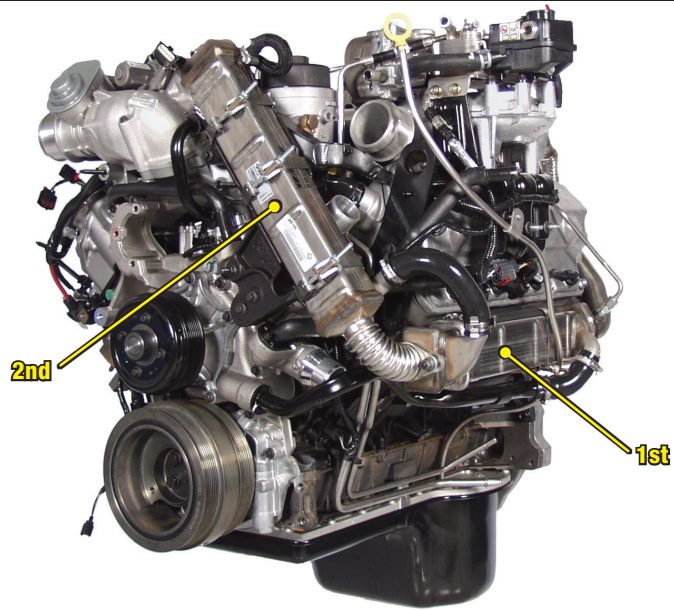
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UNIQUE SERVICE PROCEDURES

EGR Cooler Service

- Servicing the EGR coolers must be performed in the proper order.
- The coolers must first be installed loosely in the order shown, then torqued in the proper sequence as shown in the Ford workshop manual.
- Proper assembly is crucial due to the extreme temperature changes within the EGR coolers. Temperature changes of 800 deg F are possible.

NOTE: All bolts, nuts, clamps, and cooler brackets must be replaced if the coolers are removed

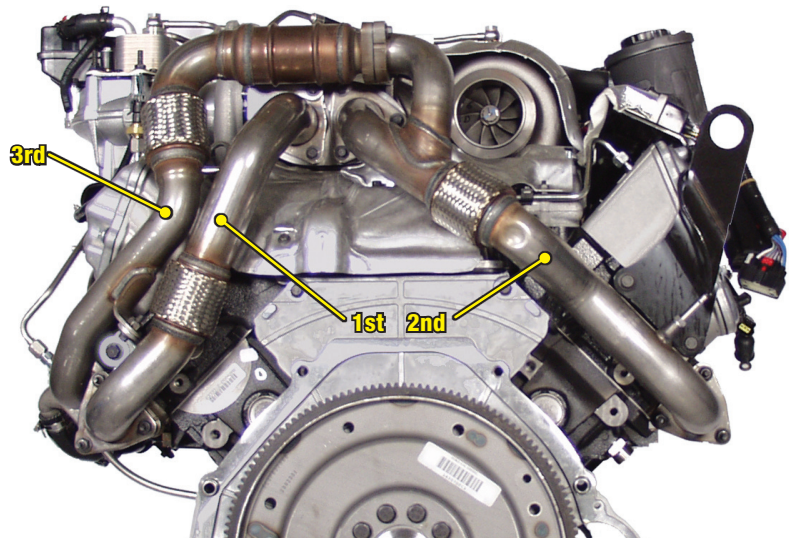


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Exhaust Up-Pipe Service

- Assembly of the exhaust up-pipes and EGR cooler supply pipe must be performed in the proper order.
- The pipes must first be installed loosely in the order shown, then torqued in the proper sequence as shows in the Ford workshop manual.

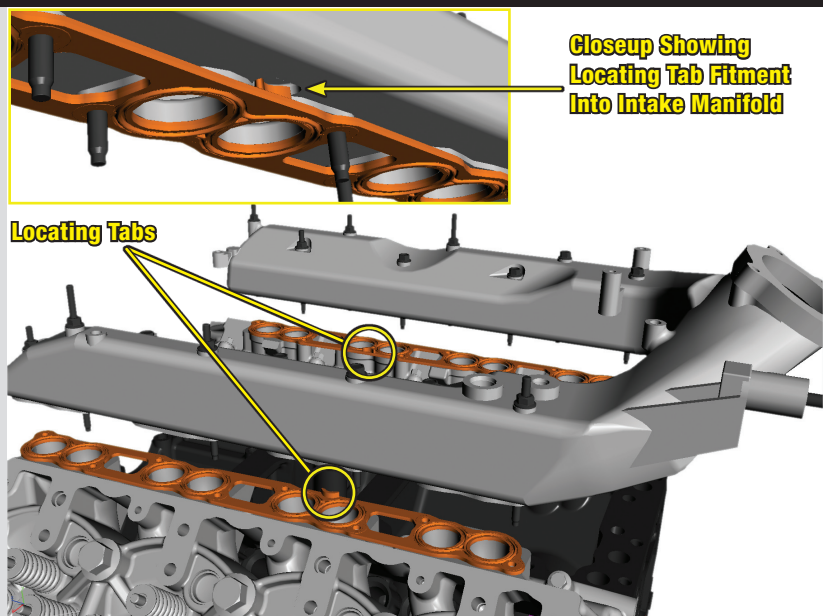
NOTE: Failure to follow the assembly steps can result in exhaust leaks.



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Intake Manifold And Gaskets

- When reinstalling the intake manifold, the locating tabs on the intake manifold gasket should face up and toward the center of the engine.



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SPECIAL TORQUE CHART (REFERENCE ONLY)

Note: All torque specs are $\pm 10\%$ unless stated otherwise.

COMPONENT	STANDARD	METRIC
Bedplate mounting bolts (crankcase bolts)	Figure C	Figure C
Camshaft follower guide bolt/washer	114 lbf/in	13 Nm
Camshaft position (CMP) sensor	114 lbf/in	13 Nm
Camshaft thrust plate mounting bolts	23 lbf/ft	31 Nm
Connecting rod bolt (Initial)	33 lbf/ft	45 Nm
Connecting rod bolt (Final)	50 lbf/ft	68 Nm
Coolant (block) heater	30 lbf/ft	41 Nm
Coolant pump mounting bolts	23 lbf/ft	31 Nm
Coolant pump pulley mounting bolts	23 lbf/ft	31 Nm
Crankcase breather to valve cover	114 lbf/in	13 Nm
Crankcase breather drain fitting to crankcase	18 lbf/ft	25 Nm
Crankcase breather tube clip bolt	23 lbf/ft	31 Nm
Crankcase coolant drain plug (M16)	180 lbf/in	20 Nm
Crankshaft position (CKP) sensor	114 lbf/in	13 Nm
Cylinder head bolts (only use new bolts, note 3)	Figure A	Figure A
EGR cooler inlet temperature sensor (EGRT Inlet)	32 lbf/ft	44 Nm
EGR coolant system hose clamps	31 lbf/in	3.5 Nm
EGR cooler outlet temperature sensor (EGRT Outlet)	28 lbf/ft	38 Nm
EGR DOC tube to RB up-tube bolts & nuts	23 lbf/ft	31 Nm
EGR DOC tube to EGR cooler horizontal bolts	23 lbf/ft	31 Nm
EGR cooler band clamps	Figure K	Figure K
EGR cooler vertical to EGR valve housing bolts	23 lbf/ft	31 Nm
EGR cooler vertical bracket mounting bolts	23 lbf/ft	31 Nm
EGR cooler horizontal to EGR cooler vertical flange	23 lbf/ft	31 Nm
EGR throttle body to EGR valve housing	88 lbf/in	10 Nm
EGR valve housing to intake manifold	88 lbf/in	10 Nm
EGR valve to EGR valve housing	88 lbf/in	10 Nm
Engine coolant temperature sensor (ECT)	159 lbf/in	18 Nm
Engine oil pressure switch (EOP)	124 lbf/in	14 Nm
Engine oil temperature sensor (EOT)	159 lbf/in	18 Nm
Exhaust backpressure (EP) connector to DOC tube	20 lbf/ft	27 Nm
Exhaust backpressure (EP) tube bracket nut	80 lbf/in	9 Nm
Exhaust backpressure (EP) tube nut to EP sensor	180 lbf/in	20 Nm
Exhaust backpressure (EP) tube nut to exhaust connector	180 lbf/in	20 Nm
Exhaust manifold flange studs	159 lbf/in	18 Nm
Exhaust manifold heat shield mounting bolts & nut	88 lbf/in	10 Nm
Exhaust manifold heat shield spacers to stud bolts	88 lbf/in	10 Nm
Exhaust manifold mounting bolts and stud bolts (note 4)	Figure F	Figure F
Exhaust up-tube to exhaust manifold nuts	23 lbf/ft	31 Nm
Exhaust up-tube to turbo bolts	18 lbf/ft	24 Nm
Flywheel/flexplate bolts (only use new bolts, note 3)	Figure B	Figure B
Front cover mounting bolts	23 lbf/ft	31 Nm
Fuel cooler reservoir mounting bolts	114 lbf/in	13 Nm
Fuel filter cap	20 lbf/ft	27 Nm
Fuel fitting banjo bolt with copper washer (M12)	28 lbf/ft	38 Nm
Fuel fitting banjo bolt with steel washer w/viton insert (M12)	18 lbf/ft	25 Nm
Fuel fitting banjo bolt (M14)	35 lbf/ft	47 Nm
Fuel injector hold down clamp bolts	28 lbf/ft	38 Nm
Fuel injector return tube nut to check valve	28 lbf/ft	38 Nm
Fuel return passage plug (rear of cylinder head)	20 lbf/ft	27 Nm
Fuel rail pressure sensor (FRP)	Figure L	Figure L
Fuel supply and return tube clamp to upper oil pan	23 lbf/ft	31 Nm

SPECIAL TORQUE CHART (REFERENCE ONLY)

COMPONENT	STANDARD	METRIC
Glow plug	124 lbf/in	14 Nm
Glow plug control module bolts and nuts (GPCM)	114 lbf/in	13 Nm
High pressure common rail (HPCR) mounting bolts	23 lbf/ft	31 Nm
High pressure common rail (HPCR) to fuel injector tubes	Figure G, I	Figure G, I
High pressure fuel injection pump & pump-to-rail tube installation	Figure H	Figure H
High pressure fuel injection pump cover mounting bolts	114 lbf/in	13 Nm
High pressure fuel injection pump drive gear bolt	57 lbf/ft	78 Nm
High pressure fuel injection pump mounting bolts	45 lbf/ft	62 Nm
High pressure fuel tube nuts (all)	144 lbf/in	30 Nm
Intake manifold pressure sensor (MAP)	106 lbf/in	12 Nm
Intake air temperature 2 (IAT2) sensor	124 lbf/in	14 Nm
Intake manifold bolts and stud bolts	Figure D	Figure D
Lifting eye bolts	45 lbf/ft	62 Nm
Oil cooler to crankcase mounting bolts (M8)	23 lbf/ft	31 Nm
Oil filter base to cooler cover screws (M6 thread forming)	89 lbf/in	10 Nm
Oil filter cap	18 lbf/ft	25 Nm
Oil filter housing to filter base bolts	16 lbf/ft	22 Nm
Oil filter stand pipe bolt (M5 thread forming) W/new oil cooler	61 lbf/in	7 Nm
Oil filter stand pipe bolt (M5 thread forming) reusing existing oil cooler	30 lbf/in	3 Nm
Oil pan bolt - lower pan	114 lbf/in	13 Nm
Oil pan bolt - upper pan	114 lbf/in	13 Nm
Oil pan drain plug (see note 1)	32 lbf/ft	44 Nm
Oil pickup tube bolts	114 lbf/in	13 Nm
Oil pump housing bolts	16 lbf/ft	22 Nm
Oil pressure regulator plug	26 lbf/ft	35 Nm
Piston cooling jet mounting bolts (see note 2)	114 lbf/in	13 Nm
Rocker arm assembly bolts	Figure J	Figure J
Rear cover M10 (manual only)	45 lbf/ft	62 Nm
Rear cover M8 (man & auto)	23 lbf/ft	31 Nm
Thermostat housing hold down plate bolts	114 lbf/in	13 Nm
Turbocharger actuator mounting bolt	168 lbf/in	19 Nm
Turbocharger air inlet duct clamp	44lbf/in	5 Nm
Turbocharger pedestal bolts	45 lbf/ft	62 Nm
Turbocharger to pedestal bolts	148 lbf/ft	201 Nm
Turbocharger crossover tube support mounting	79 lbf/in	9 Nm
Turbocharger heat shield bolts	96 lbf/in	11 Nm
Turbocharger oil supply banjo bolts (M12)	28 lbf/ft	38 Nm
Turbocharger oil supply standoff fittings to center housings	35 lbf/ft	47 Nm
Turbocharger oil supply tube retaining bolt to oil cooler	114 lbf/in	13 Nm
Valve cover base bolts	114 lbf/in	13 Nm
Valve cover bolts and studs	80 lbf/in	9 Nm
Vibration damper bolts (note 3) (only use new bolts)	Figure E	Figure E

STANDARD TORQUE CHART

Hex Flange Head

Thread	Torque	Torque	Wrench
Diameter		Nm	Size (mm)
M6 x 1	114 lbf/in	13	8
M8 x 1.25	23 lbf/ft	31	10
M10 x 1.5	45 lbf/ft	62	13
M12 x 1.75	79 lbf/ft	107	15
M14 x 2	127 lbf/ft	172	
M15 x 2	159 lbf/ft	216	
M16 x 2	196 lbf/ft	266	21

Torque Chart Notes

- 1) Lightly coat o-ring with clean engine prior to install.
- 2) Apply threadlock 262 to bolt threads prior to install.
- 3) Do not reuse. These bolts are one time stretch to yield.
- 4) Do not reuse exhaust manifold bolts and studbolts.

SPECIAL TORQUE CHART (REFERENCE ONLY)

FIGURE A: Cylinder Head Bolts

- Step 1: Lightly lubricate M16 head bolt threads and washer faces with clean engine oil prior to assembly.
- Step 2: Torque M16 head bolts (labeled 1-10) to 70 lb/ft (95 Nm) in numerical sequence shown.
- Step 3: Back out M16 head bolts and retorquing to 115 lb/ft (156 Nm) one at a time in numerical sequence shown.
- Step 4: Tighten M16 head bolts and additional 90 degrees in numerical sequence shown.
- Step 5: Tighten M16 head bolts an additional 90 degrees (2nd time) in numerical sequence shown.
- Step 6: Torque M8 head bolts (labeled 11-15) to 18 lb/ft (24 Nm) in numerical sequence shown.
- Step 7: Torque M8 head bolts to 23 lb/ft (31 Nm) in numerical sequence shown.

Note: Head bolts may not be reused once torqued.

Note: If bolt chatter occurs during step 4, repeat step 3 and continue.

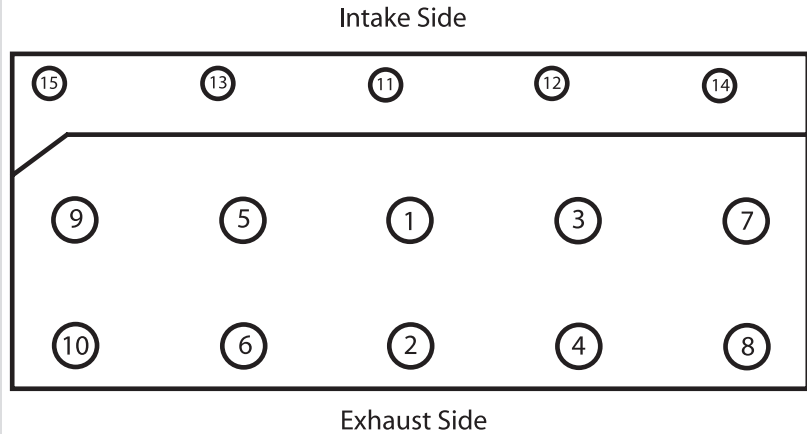


FIGURE B: Flywheel Bolts

- Step 1: Torque the bolts to 44 lbf/in (5 Nm) in the numerical sequence shown.
- Step 2: Torque the bolts to 69 lbf/ft (94 Nm) in the numerical sequence shown above.

Note: Flywheel bolts may not be reused once torqued.

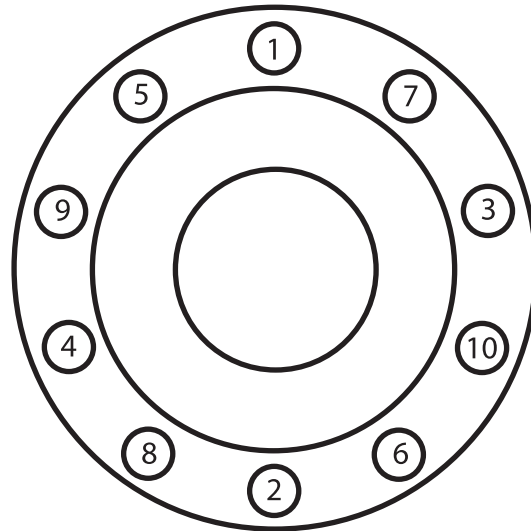
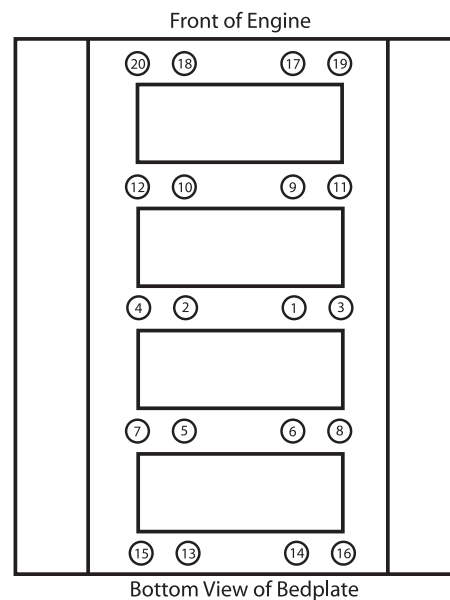


FIGURE C: Bedplate Bolts (main bearing bolts)

- Step 1: Torque the bolts to 110 lbf/ft (149 Nm) in the numerical sequence shown.
- Step 2: Torque the bolts to 130 lbf/ft (176 Nm) in the numerical sequence shown.
- Step 3: Torque the bolts to 170 lbf/ft (231 Nm) in the numerical sequence shown.



SPECIAL TORQUE CHART (REFERENCE ONLY)

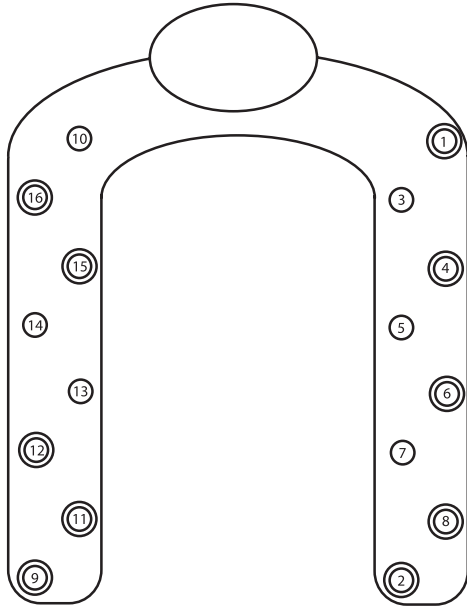


FIGURE D: Intake Manifold Bolts

Step 1: Loosely install all bolts in the numerical sequence shown.

Step 2: Torque bolts to 100 lb/in (11Nm) in the numerical sequence shown.

Note: Bolt locations with double circles represent stud bolts.

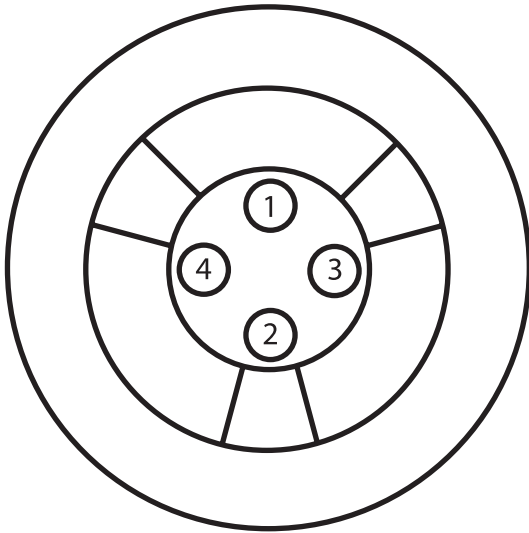


FIGURE E: Vibration Damper Bolts

Step 1: Torque each bolt to 50 lb/ft (68 Nm) in the numerical sequence shown.

Step 2: Tighten each bolt 90 degrees clockwise in the numerical sequence shown.

Note: Damper bolts may not be reused once torqued.

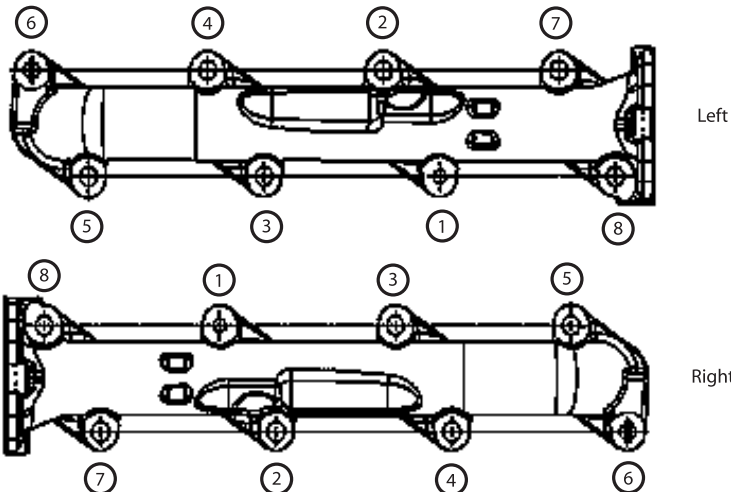


FIGURE F: Exhaust Manifold Bolts

Step 1: Torque bolts to 18 lb/ft (25Nm) in the numerical sequence shown.

Step 2: Repeat the sequence using the same torque.

Note: Exhaust manifold bolts and studbolts may not be reused once torqued.

SPECIAL TORQUE CHART (REFERENCE ONLY)

FIGURE G: HPCR Fuel Components Assembly Procedure

Hand start and hand snug tube nuts.

Step 1: Install injectors, clamps and bolts and hand start the clamp bolts.

Step 2: Rundown the injector clamp bolts to a torque of 1.5 lb/ft (2 Nm). Injectors will seat while torquing the bolts.

Note: The injectors must be fully seated and snugged, but moveable for high pressure connector and HP tube alignment.

Step 3: Install the HP rail and hand start two rail mounting bolts.

Note: Rail must be moveable, but not loose.

Step 4: Remove the four plastic caps from the rail high pressure connectors (HPC's) and four plastic caps from the injector HPC's.

Step 5: Obtain four "rail to injector" jumper tubes from the packaging.

Step 6: Position the four (one at a time) between the rail and injectors and fully hand start and seat the tube nuts onto the mating rail and injector HPC's. Snug the rail and injector tube nuts using the inside-out step sequence (i.e. two inside nuts then two outside nuts) with a tube nut click wrench set to 1.5 lb/ft (2 Nm).

Step 7: Final torque the injector clamp bolts to 28 lb/ft (38 Nm).

Step 8: Final torque the two M8 rail bolts to 23 lb/ft (31 Nm).

Step 9: Torque the rail and injector tube nuts to 106 lb/in (12 Nm +2 / -0).

Step 10: Place a visible mark with a permanent marker on the tube nut and the high pressure fuel rail and fuel injector threaded connection. Turn the tube nuts one flat of the nut which is equal to 60 degrees.

FIGURE H: High Pressure Pump and Pump-to-Rail HP Tubes Installation Procedure

Step 1: Install and final torque the high pressure fuel injection pump to 45 lb/ft (61 Nm).

Step 2: Install the pump cover gasket and make electrical connections between the pump and gasket. Install the pump cover and fasten the bolts.

Step 3: Remove the four plastic caps covering the supply, return, and high pressure rail connectors.

Step 4: Obtain left and right "pump-to-rail" high pressure tubes from the packaging.

Step 5: Position the high pressure tubes between the pump and the rails and fully hand start and seat the tube nuts onto the mating pump and rails high pressure connections.

Note: Support the tubes while hand snugging the nuts to assure proper assembly of the joints.

Step 6: Snug the tube nuts to 1.5 lb/ft (2 Nm).

Step 7: Torque the pump and rail tube nuts to 106 lb/in (12 Nm +2 / -0).

Step 8: Place a visible mark with a permanent marker on the tube nut and the high pressure fuel rail and the high pressure fuel injection pump threaded connection. Turn the tube nuts one flat of the nut which is equal to 60 degrees.

FIGURE I: Injector-Pipe-Rail Sub-Assembly Process

Step 1: Place the fuel injectors w/clamps in the head and snug the bolts.

Step 2: Place and snug the fuel rail (leave one thread loose).

Step 3: Place four fuel jumper tubes to injector/fuel rail and start 1-2 threads.

Step 4: Snug injector side tube nuts to 1.5 lb/ft (2 Nm). (Special torque sequence is used, see note below).

Step 5: Snug fuel rail side tube nuts to 1.5 lb/ft (2 Nm). (Special torque sequence is used, see note below).

Step 6: Final torque the fuel rail mounting bolts.

Step 7: Final torque the injector bolts. (Special torque sequence is used, see note below).

Step 8: Final torque the injector side tube nuts to 106 lb/in (12 Nm +2 / -0). (Special torque sequence is used, see note below).

Step 9: Final torque the fuel rail side tube nuts to 106 lb/in (12 Nm +2 / -0). (Special torque sequence is used, see note below).

Step 10: Place a visible mark with a permanent marker on the tube nut and the fuel injector threaded connection. Turn the tube nuts one flat of the nut which is equal to 60 degrees. (Special torque sequence is used, see note below).

Step 11: Place a visible mark with a permanent marker on the tube nut and the high pressure fuel rail threaded connection. Turn the tube nuts one flat of the nut which is equal to 60 degrees. (Special torque sequence is used, see note below).

NOTE: Torque the components in the center two cylinders first, then torque the components in the outer two cylinders last.

SPECIAL TORQUE CHART (REFERENCE ONLY)

FIGURE J: Fulcrum Plate / Rocker Arm Support Assembly

- Step 1: Position crankshaft at approximate #1 & #4 cylinder TDC by observing damper dowel pin and clocking it to the 10:30 position (as viewed from the front of the engine)
- Step 2: Determine which cylinder is actually in the firing position by installing pushrods, and observing #3 intake and #8 intake.
- Step 3: If #3 intake pushrod shows cam lift, this is the #1 firing position. Torque only fulcrum plates #1,2,7,8 per steps 4-6.
If #8 intake pushrod shows cam lift, this is the #4 firing position. Torque only fulcrum plates #3,4,5,6 per steps 4-6.
- Step 4: Partially run down both M10 bolts until they just contact the fulcrum plate.
- Step 5: Fully run down and torque inboard (upper) bolt to 45 lb/ft (62 Nm).
- Step 6: Fully run down and torque outboard (lower) bolt to 45 lb/ft (62 Nm).
- Step 7: Rotate crankshaft 360 degrees to position it at the alternate cylinder TDC (dowel pin at 10:30 position).
- Step 8: Identify remaining group of fulcrum plates per step 3, and torque per steps 4-6.

FIGURE K: EGR Cooler Mounting Clamps

Horizontal Cooler

- Step 1: Pre-torque EGR clamps to 88lb/in (10 Nm).
- Step 2: Loosen clamp nuts two full turns.
- Step 3: Final torque to 69 lb/in (8 Nm)

Vertical Cooler

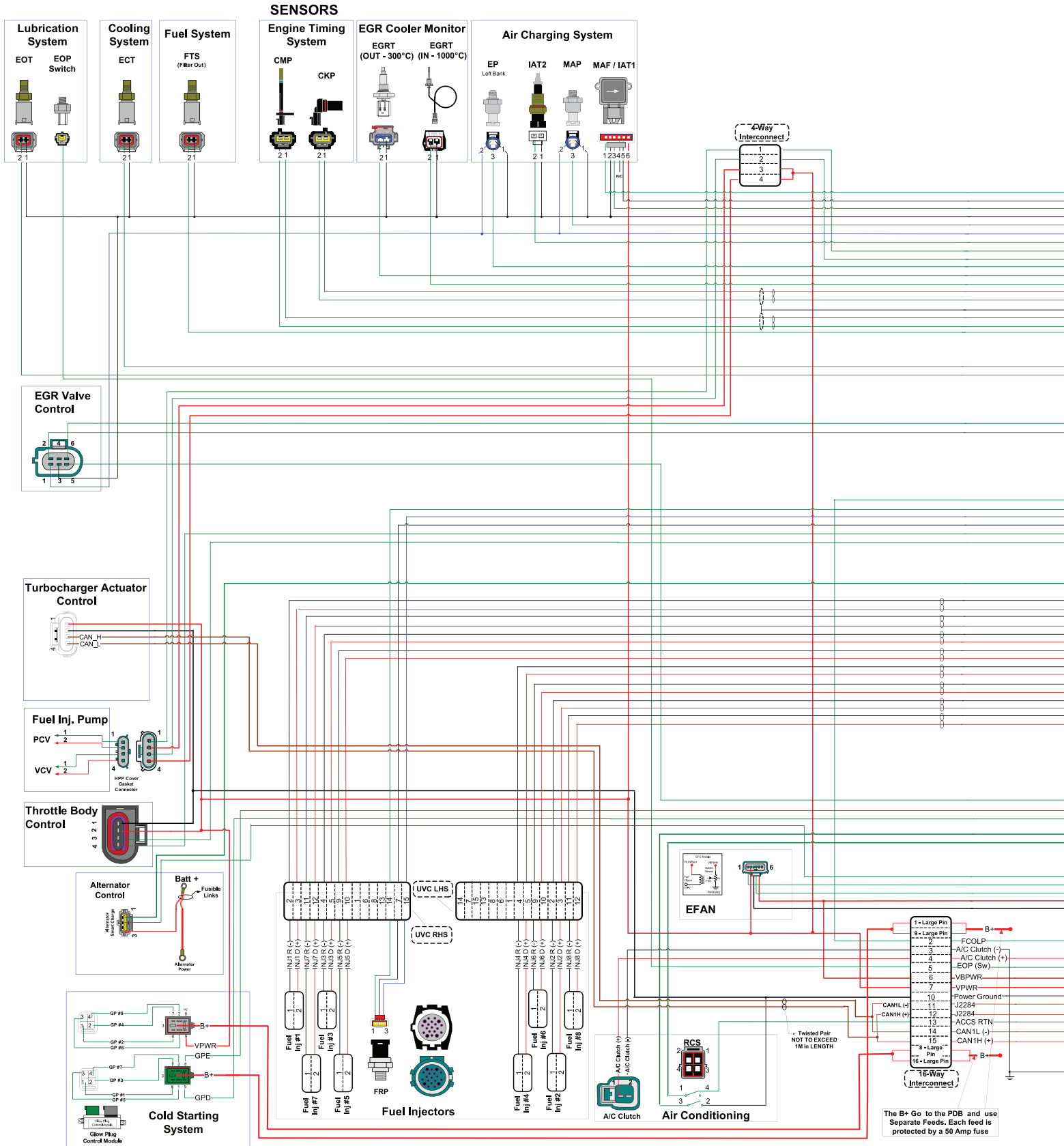
- Step 1: Pre-torque EGR clamps to 75 lb/in (8.5 Nm).
- Step 2: Loosen clamp nuts two full turns.
- Step 3: Final torque to 57 lb/in (6.5 Nm).

FIGURE L: Fuel Rail Pressure Sensor (FRP)

- Step 1: Snug the sensor hand tight to 1.5 lb/ft (2 Nm)
- Step 2: Place a visible mark with a permanent marker on the sensor and the high pressure fuel rail connection.
Turn the sensor one flat of the sensor base which is equal to 60 degrees.

WIRING DIAGRAM (SINGLE ALT.) REFERENCE ONLY

Refer to Ford Wiring Diagrams for Wiring



DIAGNOSTIC CODES

- O** - Self Test - Key On Engine Off
- R** - Key On Engine Running
- C** - Continuous Operation
- REGEN** - Test Follows a REGEN CYCLE
- SHUT DOWN** - Test Follows Key Off
- KO** - Test Operates at Key On
- 1PC** - Once Per Cycle

DATA Color Code	MIL For Both F250/F350 and F450/F550
	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P1111	X	X	X	System Pass			PCM, connection to service tool
P000E		X	X	Fuel Volume Regulator Control Adaptive Learning at Limit	This error is set when the Pulse Width Modulated (PWM) signal for the Volume Control Valve (VCV) is either too low or too high for current operating modes.	+/- 8% error in VCV control	Low pressure fuel system, injector leakage
POA09	X	X	X	DC/DC Converter Fault Circuit Low	The purpose is to diagnose the analog output voltage from the DCDC converter (voltage converter for injectors inside PCM). If the voltage from the converter is lower than a threshold, the fault is set.	Low: < 42 V High: >96 V	PCM
POA10	X	X	X	DC/DC Converter Fault Circuit High	The purpose is to diagnose the analog output voltage from the DCDC converter (voltage converter for injectors inside PCM). If the voltage from the converter is higher than a threshold, the fault is set.	Low: < 42 V High: >96 V	PCM
P0001		X	X	Fuel Volume Regulator Control Circuit / Open	This error is recorded when an open circuit causes the Pulse Width Modulated (PWM) signal of the Volume Control Valve (VCV) to be abnormally high for an extended period of time.	For open load: Resistance > 500 Ohm	Wiring, VCV electrical system
P0003	X	X	X	Fuel Volume Regulator Control Circuit Low	During KOEO diagnostics, this error is set when the measured current through the system is greater than intended. During the KOER or Continuous Monitor modes, this code is a result of a short to ground, which causes the measured current in the system to be lower than expected.	Short to ground: 0 V > 3A	Wiring, VCV electrical system
P0004		X	X	Fuel Volume Regulator Control Circuit High	This error is set if there is short to ground, short to power, or an open load detected in the volume control circuit.	Short to plus: 12 V"	Wiring, VCV electrical system
P0069			X	MAP - Barometric Pressure Correlation	This error is set when the difference between Manifold Absolute Pressure (MAP) and Barometric Pressure (BP) is greater than the specified value for a predetermined period of time.	300 hPa < 2.5 sec	Wiring, MAP sensor, BP sensor (integral part of PCM)
P006B	X		KO	MAP/EBP Correlation	This error is set when the difference between Manifold Absolute Pressure (MAP) and Exhaust Pressure (EP) is greater than the threshold for a predetermined period of time.	Engine off time > 5.0s. 300 hPa > 5.0 sec	Wiring, EP tube plugged, EP Sensor, MAP sensor, PCM
P008C			X	Fuel Cooler Pump Control Circuit / Open	This diagnostic will detect if the relay for the fuel cooling pump has an open load error.		
P008D			X	Fuel Cooler Pump Control Circuit Low	This diagnostic will detect if the relay for the fuel cooling pump has grounded.		
P008E			X	Fuel Cooler Pump Control Circuit High	This diagnostic will detect if the relay for the fuel cooling pump has shorted to positive voltage.		
P008F	X	X	X KO	Engine Coolant Temperature / Fuel Temperature Correlation	This error is set when the difference between Engine Coolant Temperature (ECT) and Fuel Temperature (FTS) is either greater than or less than a specified value depending on current operating modes.	Engine off time > 3600 sec no block heater detected 20 deg C or -20deg < 1 sec	Wiring, ECT or TFU sensor, unknown type block heating device, PCM
P0087		X	X	Fuel Rail/System Pressure - Too Low	This error will be set if the fuel pressure in the rail is too low and the controller cannot regulate it to the setpoint.	20 % "overposition" of the PCV or VCV [% PWM] 5% deviation of the fuel rail pressure to the fuel rail pressure setpoint.	Low pressure system, wiring to VCV and PCV, FUP sensor, pump
P0088		X	X	Fuel Rail/System Pressure - Too High	This error will be set if the fuel pressure in the rail is too high and the controller cannot regulate it to the setpoint.	20 % "overposition" of the PCV [% PWM] 3% deviation of the fuel rail pressure to the fuel rail pressure setpoint	Low pressure system, wiring to VCV and PCV, FUP sensor, pump
P0090	X	X	X	Fuel Pressure Regulator Control Circuit	This error occurs if a short to power is found in the fuel pressure regulator (PCV) circuit.	For open load: Resistance > 500 Ohm	Wiring to PCV, PCV electrical system
P0091	X	X	X	Fuel Pressure Regulator Control Circuit Low	This error occurs if a short to ground or, during the KOEO self test, a current that is excessively high is found in the fuel pressure regulator (PCV) circuit.	Short to ground: 0 V > 3A	Wiring to PCV, PCV electrical system
P0092	X	X	X	Fuel Pressure Regulator Control Circuit High	This error occurs if an open circuit is found in the fuel pressure regulator (PCV) circuit.	Short to plus: 12 V	Wiring to PCV, PCV electrical system

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0096	X	X	X	Intake Air Temperature Sensor 2 Circuit Range/Performance	This error is set when the change in IAT2 is 5°C less than specified over a predetermined period of time.	5 deg C ECT has to change from 40 deg C to 80 deg C to equal 1 drive cycle. 10 drive cycles required	Wiring, IAT2 sensor, PCM
P0097	X	X	X	Intake Air Temperature Sensor 2 Circuit Low Input	This error is set when the IAT2 sensor temperature output provides a value higher than a maximum probable temperature (lower voltage reading) for a predetermined period of time, which indicates a short to ground.	0.17v > 5sec.	Wiring, IAT2 sensor, PCM
P0098	X	X	X	Intake Air Temperature Sensor 2 Circuit High Input	This error is set when the IAT2 sensor temperature output provides a value lower than a minimum probable temperature (higher voltage reading) for a predetermined period of time, which indicates an open circuit or a short to power.	4.81v > 5sec.	Wiring, IAT2 sensor, PCM
P0101			X	Mass Air Flow A Circuit Range/Performance	This error occurs when the PCM detects a MAF sensor that is sending no signal.		Wiring, MAF assembly, PCM
P0102			X	Mass or Volume Air Flow A Circuit Low Input	This error occurs when the value of the mean period time per ms of the mass air flow sensor is less than a calibrateable value.		
P0103			X	Mass or Volume Air Flow A Circuit High Input	This error occurs when the value of the mean period time per ms of the mass air flow sensor is greater than a calibrateable value.		
P0104			X	Mass or Volume Air Flow A Circuit Intermittent/Erratic	This error occurs when the MAF sensor change is too great over a predetermined period of time.		
P0106			X	Manifold Absolute Pressure/BARO Sensor Range/Performance	This diagnostic compares MAP and BP pressures at idle conditions, when they should be within a specified range. This error is set if the MAP sensor reading is above or below the thresholds for a predetermined period of time.	N > function of (ECT) Vehicle speed =0 ECT > 70 deg C 10% < EGRT command < 100% no DPF regen requested for > 10 seconds 300hPa or -300hPa > 5sec	Wiring, MAP sensor, BP sensor (integral part of PCM)
P0107			X	Manifold Absolute Pressure/BARO Sensor Low Input	This diagnostic checks for a minimum intake manifold pressure, indicating an open circuit or a short to ground. This error occurs when the MAP signal voltage is lower than a specified value for a predetermined period of time.	0.15v > 5sec.	Wiring, MAP sensor, PCM
P0108			X	Manifold Absolute Pressure/BARO Sensor High Input	This diagnostic checks for a maximum possible intake manifold pressure, indicating a short to power. This error sets when the MAP signal voltage is higher than a specified value for a predetermined amount of time.	4.90v > 5 sec.	Wiring, MAP sensor, PCM
P0112			X	Intake Air Temperature Sensor 1 Circuit Low Input	This error occurs if the input signal from the intake air temperature sensor falls below a minimum calibrateable threshold for a predetermined period of time.	0.15v > 5sec	
P0113			X	Intake Air Temperature Sensor 1 Circuit High Input	This error occurs if the input signal from the intake air temperature sensor rises above a maximum calibrateable threshold for a predetermined period of time.	4.6v > 5 sec	
P0114			X	Intake Air Temperature Sensor 1 Intermittent/Erratic	This error sets if the gradient of measured intake air temperature sensor outputs is outside of a threshold.		
P0117	X	X	X	Engine Coolant Temperature Sensor 1 Circuit Low Input	This error is set when the ECT sensor signal is lower than the minimum threshold for a predetermined period of time.	0.04v > 1sec.	Wiring, ECT sensor, PCM
P0118	X	X	X	Engine Coolant Temperature Sensor 1 Circuit High Input	This error sets when the ECT sensor signal is higher than a maximum threshold for a predetermined period of time.	4.67v > 1 sec.	Wiring, ECT sensor, PCM
P0128			X	Coolant Thermostat (Coolant Temp Below Thermostat Regulating Temperature)	This error occurs when the ECT sensor signal indicates a coolant temperature lower than the operating temperature of the thermostat for an extended period of time.		
P0148	X	X	X	Fuel Delivery Error	This error sets when injections are detected although they are not commanded.	N/A	PCM, check injectors
P0149		X		Fuel Timing Error			PCM
P0168		X	X	Engine Fuel Temperature Too High	This error occurs when fuel temperature exceeds a predetermined temperature.		
P0181	X		X	Fuel Temperature Sensor A Circuit Range/Performance	This error occurs when the difference of the minimum and maximum fuel temperature exceeds a threshold.		
P0182	X	X	X	Fuel Temperature Sensor A Circuit Low Input	This error occurs when the FTS temperature output is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.	0.07v > 5sec.	Wiring, MAP sensor, PCM

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DATA Color Code	MIL For Both F250/F350 and F450/F550
	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0183	X	X	X	Fuel Temperature Sensor A Circuit High Input	This error occurs when the FTS temperature output is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.	4.76v > 5 sec.	Wiring, MAP sensor, PCM
P0191	X	X	X	Fuel Rail Pressure Sensor A Circuit Range/Performance	This error occurs if the voltage signal of rail pressure sensor is not updated during a calibrated period of time.	checktime is 0.4 s maximum sensor voltage signal minus minimum voltage signal must be greater than 0.01 V	FUP sensor, HP system
P0192			X	Fuel Rail Pressure Sensor A Circuit Low Input	This error occurs if the voltage of the fuel pressure sensor falls below a calibratable threshold.	Low: < 0.20 V	Wiring to FUP sensor, FUP sensor
P0193	X			Fuel Rail Pressure Sensor A Circuit High Input	This error occurs if the voltage of the fuel pressure sensor exceeds a calibratable threshold.	High: >4.80 V	Wiring to FUP sensor, FUP sensor
P0194	X	X	X	Fuel Rail Pressure Sensor A Circuit Intermittent/Erratic	This error occurs if the rate of change of the measured fuel pressure exceeds a calibratable threshold.	max gradient: 40Mpa/10ms	Wiring to FUP sensor (especially for bad connections), FUP sensor, possibly HP system
P0196			X	Engine Oil Temperature Sensor Circuit Range/Performance	This error occurs if time required for EOT to warm up to 50° C is greater than the specified value or the EOT does not change by at least 2 degrees from the value stored in KAM, followed with the engine running off low idle.	EOT dependant 20minutes of engine running and EOT has not changed more than 5 deg C	Wiring, ECT sensor, PCM
P0197	X	X	X	Engine Oil Temperature Sensor Circuit Low Input	This error occurs if the EOT sensor output value is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.	0.04v < 5sec.	Wiring, ECT sensor, PCM
P0198	X	X	X	Engine Oil Temperature Sensor Circuit High Input	This error occurs if the EOT sensor temperature output value is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.	4.76v < 5 sec.	Wiring, ECT sensor, PCM
P02CC		X	X	Cylinder 1 Minimum Fuel Mass Adaptive Learning at Min Limit	This error sets if the fuel mass estimated by the adaptation feature falls outside of a calibrated threshold.		Injector
P02CD		X	X	Cylinder 1 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of the fuel pressure dependent calibration threshold.		
P02CE		X	X	Cylinder 2 Minimum Fuel Mass Adaptive Learning at Min Limit	This error occurs when the fuel mass estimated by the adaptation feature falls outside of a calibration threshold.		Injector
P02CF		X	X	Cylinder 2 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of a fuel pressure dependent calibration threshold.		
P02D0		X	X	Cylinder 3 Minimum Fuel Mass Adaptive Learning at Min Limit	This error sets if the fuel mass estimated by the adaptation feature falls outside of a calibrated threshold.		Injector
P02D1		X	X	Cylinder 3 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of the fuel pressure dependent calibration threshold.		
P02D2		X	X	Cylinder 4 Minimum Fuel Mass Adaptive Learning at Min Limit	This error occurs when the fuel mass estimated by the adaptation feature falls outside of a calibration threshold.		Injector
P02D3		X	X	Cylinder 4 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of a fuel pressure dependent calibration threshold.		
P02D4		X	X	Cylinder 5 Minimum Fuel Mass Adaptive Learning at Min Limit	This error sets if the fuel mass estimated by the adaptation feature falls outside of a calibrated threshold.		Injector
P02D5		X	X	Cylinder 5 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of the fuel pressure dependent calibration threshold.		
P02D6		X	X	Cylinder 6 Minimum Fuel Mass Adaptive Learning at Min Limit	This error occurs when the fuel mass estimated by the adaptation feature falls outside of a calibration threshold.		Injector
P02D7		X	X	Cylinder 6 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of a fuel pressure dependent calibration threshold.		

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P02D8		X	X	Cylinder 7 Minimum Fuel Mass Adaptive Learning at Min Limit	This error sets if the fuel mass estimated by the adaptation feature falls outside of a calibrated threshold.		Injector
P02D9		X	X	Cylinder 7 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of the fuel pressure dependent calibration threshold.		
P02DA		X	X	Cylinder 8 Minimum Fuel Mass Adaptive Learning at Min Limit	This error occurs when the fuel mass estimated by the adaptation feature falls outside of a calibration threshold.		Injector
P02DB		X	X	Cylinder 8 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of a fuel pressure dependent calibration threshold.		
P0201			X	Injector Circuit / Open - Cylinder 1	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0202			X	Injector Circuit / Open - Cylinder 2	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0203			X	Injector Circuit / Open - Cylinder 3	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0204			X	Injector Circuit / Open - Cylinder 4	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0205			X	Injector Circuit / Open - Cylinder 5	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0206			X	Injector Circuit / Open - Cylinder 6	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0207			X	Injector Circuit / Open - Cylinder 7	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0208			X	Injector Circuit / Open - Cylinder 8	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0216		X		Injector/Injection Timing Control Circuit	This error occurs if a post injection cycle is recognized without a main injection cycle.		PCM
P0219			X	Engine Overspeed Condition	This failure occurs when actual engine speed exceeds governed engine speed for a predetermined amount of time.	4000 rpm	
P0231			X	Fuel Pump Secondary Circuit Low			
P0232			X	Fuel Pump Secondary Circuit High			
P0234			X	Turbocharger/Supercharger Overboost Condition	This error occurs when the MAP sensor reading is above the threshold for a predetermined period of time.	4050hPa > 5 sec	System error, causes of overboost.
P0263		X	X	Cylinder 1 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.	Between 0.3 & 1.8	Injector, cylinder (compression)
P0266		X	X	Cylinder 2 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0269		X	X	Cylinder 3 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0272		X	X	Cylinder 4 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0275		X	X	Cylinder 5 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0278		X	X	Cylinder 6 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0281		X	X	Cylinder 7 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0284		X	X	Cylinder 8 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0297			X	Vehicle Overspeed Condition	This error occurs when the vehicle speed exceeds the vehicle speed limiting.		
P0298			X	Engine Oil Overtemperature Condition	This error occurs when the time required for EOT to cool down to 110 deg. C is greater than the specified value.	time dependant on initial EOT temp could be >15minutes	System error, causes of EOT overtemperatue, sensor, PCM
P0300			X	Random Misfire Detected	This error occurs when cylinder deceleration is excessively large and persists long enough on more than one cylinder to set the code. Misfire monitor is calibrated to detect a complete loss of combustion in the cylinder; therefore, cylinder balance codes can be expected.		

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	MIL For Only F250/F350
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DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0301			X	Cylinder 1 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0302			X	Cylinder 2 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0303			X	Cylinder 3 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0304			X	Cylinder 4 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0305			X	Cylinder 5 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0306			X	Cylinder 6 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0307			X	Cylinder 7 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0308			X	Cylinder 8 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0336	X	X	X	Crankshaft Position Sensor A Circuit Range/Performance	This error occurs if the tooth count of the crankshaft trigger wheel reaches a threshold and the system is still not detecting sync between CKP and CMP circuits while a valid CMP sensor signal has been detected (intermittent CKP signal), when the number of missing or extra teeth exceed the threshold, or if spikes are detected in the CKP signal.	3 CAM edges <1sec	Wiring, CMP sensor, CKP sensor, PCM
P0337	X	X	X	Crankshaft Position Sensor A Circuit Low Input	This error occurs when a short or open fault in the CKP circuit is present causing the amplitude of the AC voltage to be excessive.	0.5v < 1sec	Wiring, CKP sensor, PCM
P0341	X	X	X	Camshaft Position Sensor A Circuit Range/Performance	This error occurs when either the number of CMP signals is too great to filter or the CMP signal is not properly aligned with the CKP signal.	Internal to the engine control module Once at key on < 1 sec	Wiring, CMP sensor, PCM
P0342	X	X	X	Camshaft Position Sensor A Circuit Low Input	This error occurs when the CMP signal is missing entirely.	Internal to the engine control module Once at key on < 1 sec	Wiring, CMP sensor, PCM
P0381			X	Glow Plug/Heater Indicator Circuit	The instrument cluster performs the diagnostic of the wait-to-start indicator once per driving cycle and transmits the result to the PCM. The PCM analyzes the message to check if the glow plug lamp circuit is operational.		
P040B	X	X	X	Exhaust Gas Recirculation Temperature Sensor A Circuit Range/Performance	This error occurs when the change in the EGR cooler inlet temperature is less than 40 deg C for a predetermined period of time.	Initial ECT < 30 deg C. ECT increase to > 80 deg C during drive cycle ECM on time > 3 seconds TEGR_IN has not changed more than 6 deg. C in 2 drive cycles	Wiring, Tegr_IN sensor, PCM
P040C	X	X	X	Exhaust Gas Recirculation Temperature Sensor A Circuit Low	This error occurs when the EGR cooler inlet sensor temperature output value is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.	0.07v > 5sec.	Wiring, Tegr_IN sensor, PCM
P040D	X	X	X	Exhaust Gas Recirculation Temperature Sensor A Circuit High	This error occurs when the EGR cooler inlet sensor temperature output value is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or short to power.	N > 650 rpm torque setpoint >53 N-m ECT > 60 deg C 4.65v >5sec	Wiring, Tegr_IN sensor, PCM
P0401			X	Exhaust Gas Recirculation Flow Insufficient Detected	This error is set when the estimated EGR percent is less than the minimum limit for the operating condition.	DPF regeneration not requested PTO not active Pressure ratio across EGR valve < 1 rate of change of engine speed < 0.05 rate of change of indicated torque setpoint < 0.05 600 rpm <engine speed< 800 rpm 45Nm <tq_sp< 174Nm 12 sec to run test 2 low flow failures required to set fault (test runs 5 times per trip) 60 sec wait time between tests	EGR system error

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0402			X	Exhaust Gas Recirculation Flow Excessive Detected	This error occurs when the estimated EGR percent is greater than the maximum limit for the operating condition.	DPF regeneration not requested PTO not active Pressure ratio across EGR valve < 1 rate of change of engine speed < 0.05 rate of change of indicated torque setpoint < 0.05 600 rpm < engine speed < 800 rpm 45Nm < tqi_sp < 174Nm 12 sec to run test 2 low flow failures required to set fault (test runs 5 times per trip) 60 sec wait time between tests	EGR system error
P0403			X	Exhaust Gas Recirculation Control Circuit	This error occurs when the current through the EGR control circuit is outside of a predetermined range.	Internal to the engine control module	Wiring, EGR valve assembly, PCM
P0404			X	Exhaust Gas Recirculation Control Circuit Range/Performance	This error is set when the deviation in EGR position is outside the threshold.	10 percent of full range error >5 sec	System error, EGR valve, PCM
P0405	X	X	X	Exhaust Gas Recirculation Sensor A Circuit Low	This error occurs when the EGR position voltage is below the specified voltage for a predetermined amount of time. This error can indicate either a short to ground or an open circuit.	0.24v <3 sec	Wiring, EGR valve assembly, PCM
P0406	X	X	X	Exhaust Gas Recirculation Sensor A Circuit High	This error occurs when the EGR position voltage is above the specified voltage, for maximum position given the current operation, for a predetermined amount of time. This error can indicate a short to power.	4.84v <3 sec	Wiring, EGR valve assembly, PCM
P041B	X	X	X	Exhaust Gas Recirculation Temperature Sensor B Circuit Range/Performance	This error occurs when the change in the EGR cooler outlet temperature is less than the threshold for a predetermined period of time.	Initial ECT < 30 deg C ECT increase to > 80 deg C during drive cycle ECM on time > 3 seconds TEGR_IN has not changed more than 6 deg. C in 2 drive cycles	Wiring, Tegr_OUT sensor, PCM
P041C	X	X	X	Exhaust Gas Recirculation Temperature Sensor B Circuit Low	This error occurs when the EGR cooler outlet sensor temperature output value is lower than a minimum probable temperature for a predetermined amount of time, indicating an open circuit or short to power.	0.15v > 5sec.	Wiring, Tegr_OUT sensor, PCM
P041D	X	X	X	Exhaust Gas Recirculation Temperature Sensor B Circuit High	This error occurs when the EGR cooler outlet sensor temperature output value is higher than a maximum probable temperature for a predetermined period of time, indicating a short to ground.	N > 650 rpm torque setpoint >53 N-m ECT > 60 deg C 4.95v > 5 sec	Wiring, Tegr_OUT sensor, PCM
P0420		REGEN		Catalyst System Efficiency Below Threshold	This error occurs if the observed exothermic reaction (a reaction that produces heat) during a regeneration event falls below a threshold for a predetermined period of time.		
P042E	X	X	X	EGR Control Stuck Open	This error occurs when the EGR set point is less than a specified threshold, the actual EGR position is greater than a specified threshold, and the EGR control limit is less than a specified limit.	EGR Position > 30 % EGR Position desired < 15% > 4 sec	System error, EGR valve, PCM
P042F	X	X	X	EGR Control Stuck Closed	This error occurs when the EGR set point is greater than a specified threshold, the actual EGR position is less than a specified threshold, and the EGR control limit is greater than a specified limit.	EGR Position < 15 % EGR Position desired > 30% > 4 sec	System error, EGR valve, PCM
P0472			X	Exhaust Pressure Sensor A Circuit Low	This error occurs when the EP signal voltage is lower than a specified value for a predetermined period of time.	0.15v < 3 sec	Wiring, EP sensor, PCM
P0473			X	Exhaust Pressure Sensor A Circuit High	This error occurs when the EP signal voltage is higher than a specified value for a predetermined amount of time.	4.90v < 3 sec	Wiring, EP sensor, PCM
P0480			X	Fan 1 Control Circuit			
P0488			X	EGR Throttle Position Control Range/Performance	This error occurs when there is an error in throttle position vs. desired position, high temperature condition and throttle not returned to open position when commanded, faulty input signal detected, or broken return spring detected.	THR_STATE is low > 3 sec	Wiring, EGRT, PCM
P0494		X		Fan Speed Low			
P0495		X		Fan Speed High			
P0500			X	Vehicle Speed Sensor A	This error occurs when either a faulty signal or a missing signal occurs from the vehicle speed sensor circuit.		
P0503			X	Vehicle Speed Sensor A Intermittent/Erratic/High	This error occurs when an intermittent error is detected in the vehicle speed sensor circuit.		

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DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0528			X	Fan Speed Sensor Circuit No Signal			
P0529			X	Fan Speed Sensor Circuit Intermittent			
P0544			1 P C	Exhaust Gas Temperature Sensor Circuit Bank 1 Sensor 1	This error occurs if the EGT1 temperature signal of the exhaust system does not rise sufficiently immediately after a cold-start following an 8-hour soak.		
P0545			X	Exhaust Gas Temperature Sensor Circuit Low - Bank 1 Sensor 1	This error occurs when the EGT1 sensor temperature signal is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.		
P0546			X	Exhaust Gas Temperature Sensor Circuit High - Bank 1 Sensor 1	This error occurs when the EGT1 sensor temperature signal is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.		
P0560		X		System Voltage	This error occurs when battery voltage falls below a predetermined threshold.		
P0563			X	System Voltage High	This error occurs if the battery voltage increases above a predetermined threshold.		
P0565		X	X	Cruise Control ON Signal	This error occurs is the cruise control on switch is not pressed during the KOER or the cruise control on switch is stuck on during continuous operation.		
P0566		X	X	Cruise Control OFF Signal	This error occurs when the cruise control off switch is not depressed during the KOER self test or when the switch is stuck during continuous operation.		
P0567		X	X	Cruise Control RESUME Signal	This error occurs when the cruise control resume switch is not depressed during the KOER self test or is stuck during continuous operation.		
P0568		X	X	Cruise Control SET Signal	This error occurs when the cruise control set switch is not depressed during the KOER self test or is stuck during continuous operation.		
P0569		X	X	Cruise Control COAST Signal	This error occurs when the cruise control coast switch is not depressed during the KOER self test or is stuck during continuous operation.		
P0571		X		Brake Switch A Circuit	This error occurs when the brake switch is not depressed during the KOER self test.		
P0578			X	Cruise Control Multi-Function Input A Circuit Stuck	This error occurs if the voltage received by the PCM for the cruise control circuit is above the calibrated threshold.		
P0579			X	Cruise Control Multi-Function Input A Circuit Range/Performance	This error occurs when all cruise control circuit voltages are equal to zero.		
P060B	X	X	X	Internal Control Module A/D Processing Performance	This error occurs is the voltages for main controller and monitoring controller within the PCM are outside of a predetermined range.		ECU
P060C			X	Internal Control Module Monitoring Processor Performance	This error occurs if a fault occurs to the monitoring processor within the PCM.		Verify reprogramming files, reflash module, change ECU
P060D			X	Internal Control Module Accelerator Pedal Position Performance			Pedal, wiring to pedal, PCM
P0600	X			Serial Communication Link			PCM
P0602			1 P C	Powertrain Control Module Program Error			VID Block program, PCM
P0603	X		1 P C	Powertrain Control Module Keep Alive Memory (KAM) Error	This error occurs if a fault is detected in the keep alive memory circuit.	engine not longer running than 600 sec	PCM

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0604	X	X	X	Internal Control Module Read Only Memory (RAM) Error	This error occurs if a fault is detected in the read only memory circuit.		PCM
P0605	X	X	X	Internal Control Module Read Only Memory (ROM) Error	The checksum of the calibration ROM area is checked and compared against an expected value (calibration value) at startup.		Verify programming files, PCM
P061B	X	X	X	Internal Control Module Torque Calculation Performance	This error occurs if a fault is detected when monitoring the status of the injection of all cylinders compared to the current engine speed.		PCM
P061C	X	X	X	Internal Control Module Engine RPM Performance	This error occurs when the engine RPM signal, derived from the CKP circuit, differs significantly from the expected engine RPM, developed by the PCM, for a predetermined amount of time		PCM, CRK sensor, CRK wiring
P062D	X	X		Fuel Injector Driver Circuit Performance Bank 1	This error occurs when the sum of the voltage signals for the main injection of all injectors on bank 1 or if the fuel injector driver circuit for bank 1 fails to initialize properly.	max = 229 V min = 93 V	Wiring to injectors, PCM
P062E	X	X		Fuel Injector Driver Circuit Performance Bank 2	This error occurs when the sum of the voltage signals for the main injection of all injectors on bank 2 or if the fuel injector driver circuit for bank 2 fails to initialize properly.	max = 229 V min = 93 V	Wiring to injectors, PCM
P0620			X	Generator Control Circuit			
P0625			X	Generator Field Terminal Circuit Low			
P0626			X	Generator Field Terminal Circuit High			
P0627			X	Fuel Pump A Control Circuit / Open	This error occurs if electrical errors from the fuel pump module result in an open circuit.		
P0628			X	Fuel Pump A Control Circuit Low	This error occurs if electrical errors from the fuel pump module result in a short to ground.		
P0629			X	Fuel Pump A Control Circuit High	This error occurs if electrical errors from the fuel pump module result in a short to power.		
P0642	X	X	X	Sensor Reference Voltage A Circuit Low	This error occurs when the sensor reference voltage falls below the minimum threshold.	Low: < 4.75V	Wiring, PCM
P0643	X	X	X	Sensor Reference Voltage A Circuit High	This error occurs when the sensor reference voltage falls above a maximum threshold.	High: >5.25 V	Wiring, PCM
P065B			X	Generator Control Circuit Range/Performance			
P0652	X	X	X	Sensor Reference Voltage B Circuit Low	This error occurs when the sensor reference voltage falls below a minimum threshold.	Low: < 4.75V	Wiring to sensors, PCM
P0653	X	X	X	Sensor Reference Voltage B Circuit High	This error occurs when the sensor reference voltage is above a maximum threshold.	High: >5.25 V	Wiring to sensors, PCM
P0670	X	X	X	Glow Plug Control Module Control Circuit / Open	This error occurs if the glow plug enable circuit detects an open circuit, short to ground, or short to power.	Internal to Glow Plug Control Module (GPCM) > 5 sec	Wiring, GPCM, PCM
P0671	X	X	X	Cylinder 1 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0672	X	X	X	Cylinder 2 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0673	X	X	X	Cylinder 3 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0674	X	X	X	Cylinder 4 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0675	X	X	X	Cylinder 5 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM

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	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0676	X	X	X	Cylinder 6 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0677	X	X	X	Cylinder 7 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0678	X	X	X	Cylinder 8 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0684	X	X	X	Glow Plug Control Module to PCM Communication Circuit Range/Performance	This error occurs when the pass/fail status information signal, sent by the GPCM to the PCM, is consistently high, consistently low, or the period of the signal is out of range.	GP active >5 sec	Wiring, GPCM, PCM
P0691			X	Fan 1 Control Circuit Low			
P0692			X	Fan 1 Control Circuit High			
P0703		X		Brake Switch B Input Circuit	This error occurs when the brake switch is not activated during the KOER self test.		
P1000	RESET			OBD Systems Readiness Test Not Complete	This error occurs when all other DTC's have been erased from the system. This error will subside when all OBD monitors have been completed.		
P1102			X	Mass Air Flow Sensor In Range But Lower Than Expected	This error occurs when the measured value of mass air flow is lower than a threshold value for a predetermined period of time.	0% < EGR Position < 50% Engine speed >700 rpm < 2400 rpm based on a table > 30sec	Wiring, MAF assembly, PCM
P1103			X	Mass Air Flow Sensor In Range But Higher Than Expected	This error occurs when the measured value of mass air flow is higher than a threshold value for a predetermined period of time.	0% < EGR Position < 50% Engine speed >700 rpm < 2400 rpm based on a table > 30sec	Wiring, MAF assembly, PCM
P115A			X	Low Fuel Level - Forced Limited Power	This error occurs when the PCM receives a signal indicating that the vehicle is critically low on fuel.		
P117B			X	Exhaust Gas Temperature Sensor Correlation	This error occurs when the three exhaust temperature sensor readings are not within a specified temperature range when compared to one another.		
P117F		X	X	Fuel Pressure Regulator Excessive Variation	This error occurs when any of the fuel pressure corrections either become less than a minimum threshold or more than a maximum threshold.		Low pressure fuel system, injector leakage
P1184		X		Engine Oil Temperature Sensor Out Of Self Test Range	This error occurs when the KOER self test is attempted but the engine has not reached an operating temperature of 60° C.	EOT < 60 >205deg C	NA
P120F			X	Fuel Pressure Regulator Excessive Variation	This error occurs when the difference between actual rail pressure and the PCM's calculated setpoint is large, and the actual fuel pressure crosses the setpoint too frequently.		Wiring to FUP sensor, FUP sensor, low pressure fuel system
P127A	X	X	X	Aborted KOER - Fuel Pressure Failure	This error occurs when fuel pressure does not rise sufficiently during the KOER self test.	Cannot achieve or return to 53 FUP_SP. Cannot achieve 139MPa	NA
P132A	X	X	X	Turbocharger Boost Control A Electrical	This error occurs if the turbocharger cannot perform a sweep/learn of the min/max position.		
P132B	X	X	X	Turbocharger/Supercharger Boost Control A Performance	This error occurs if a fault is detected within the turbocharger actuator.	Internal to the turbocharger control module	Wiring, SRA module, PCM
P132C	X	X	X	Turbocharger/Supercharger Boost Control A Voltage	This error occurs when the voltage to the turbocharger actuator is below the threshold for a predetermined period of time.	Internal to the turbocharger control module	Wiring, SRA module, PCM
P1335	X	X	X	EGR Position Sensor Minimum/Maximum Stop Performance	This error occurs when voltage of the EGR valve falls below the minimum threshold.	1.3v >2.5sec	Wiring, EGR valve assembly, PCM
P1336	X	X	X	Crankshaft/Camshaft Sensor Range/Performance	This error occurs when the reference gap of the crankshaft trigger wheel is not detected at the correct position.	Internal to the engine control module	System error, electrical noise, ...

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P138D	X	X	X	Turbocharger Boost Control A Temperature Too High	This error occurs when the internal operating temperature of the actuator exceeds the threshold for a predetermined period of time.	150 deg C	
P1397		X		System Voltage Out Of Self Test Range	This error occurs if the KOER self test is attempted but the vehicle battery voltage is too low.	< 9.0v prior to KOER start	NA
P1408		X		Exhaust Gas Recirculation Flow Out Of Self Test Range	This error occurs if the EGR valve position is not within test limits when the EGR valve is commanded open during the KOER self test.	> 1500hPa and <1500hPa (note numbers are valid only until D00 is released where these need to be in gauge pressure)	NA
P1501		X		Vehicle Speed Sensor Out Of Self Test Range	This error occurs if the KOER self test is attempted while vehicle is moving.	>5MPH (This entry condition is primarily used for the Manual Transmission applications that do not have a "in gear" message.)	NA
P1531		X		Invalid Test - Accelerator Pedal Movement	This error occurs when the accelerator pedal moves during the KOER self test.	>10%	NA
P1536		X		Parking Brake Switch Circuit	This error occurs if the parking brake switch is not active during the KOER self test.		
P1551	X	X		Injector Circuit Range/ Performance - Cylinder 1	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1552	X	X		Injector Circuit Range/ Performance - Cylinder 2	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1553	X	X		Injector Circuit Range/ Performance - Cylinder 3	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1554	X	X		Injector Circuit Range/ Performance - Cylinder 4	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1555	X	X		Injector Circuit Range/ Performance - Cylinder 5	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1556	X	X		Injector Circuit Range/ Performance - Cylinder 6	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1557	X	X		Injector Circuit Range/ Performance - Cylinder 7	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1558	X	X		Injector Circuit Range/ Performance - Cylinder 8	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1586	X	X	X	Electronic Throttle to PCM Communication Error	This error occurs when the digital feedback communication line of the EGR throttle plate is either unreadable by the PCM or missing.		
P1639		X	X	Vehicle ID Block Corrupted, Not Programmed	This error occurs when the VID block data are not programmed or programmed incorrectly.		
P1703		X		Brake Switch Out Of Self Test Range	This error occurs during the KOER self test if the brake pedal switch is stuck in the closed position or the brake pedal is depressed twice.		
P1725	X	X	X	Insufficient Engine Speed Increase During Self Test	This error occurs if the engine RPM drops below a minimum threshold during the KOER self test.	< 500RPM	NA
P1726		X		Insufficient Engine Speed Decrease During Self Test	This error occurs if the engine RPM increases above a maximum threshold during the KOER self test.	>1600 RPM	NA
P179A	X	X	X	CAN ECM/Turbocharger Boost Control & Actuator Circuit Malfunction	This error occurs if the CAN data communication is interrupted between the PCM and the turbocharger actuator.		
P2002		REGEN		Particulate Trap Efficiency Below Threshold	This error occurs if an expected pressure drop through the DPF is lower than the specified value following a regeneration cycle (based on the concept of normalized pressure differential).		
P2031			1 P T	Exhaust Gas Temperature Sensor Circuit Bank 1 Sensor 2	This error occurs if the EGT2 temperature signal of the exhaust system does not rise sufficiently immediately after a cold-start following an 8-hour soak.		
P2032			X	Exhaust Gas Temperature Sensor Circuit Low Bank 1 Sensor 2	This error occurs when the EGT2 sensor temperature signal is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.		
P2033			X	Exhaust Gas Temperature Sensor Circuit High Bank 1 Sensor 2	This error occurs when the EGT2 sensor temperature signal is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.		

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	O	R	C				
P2080			1 P C	Exhaust Gas Temperature Sensor Circuit Range/ Performance Bank 1 Sensor 1	This error occurs if the EGT1 temperature sensor signal in the exhaust at key on, following an 8-hour soak, is significantly different than ambient temperature.		
P2081			X	Exhaust Gas Temperature Sensor Circuit Intermittent Bank 1 Sensor 1	This error occurs if the temperature in the exhaust at key on, following an 8-hour soak, is significantly different than ambient temperature.		
P2084			X	Exhaust Gas Temperature Sensor Circuit Range/ Performance Bank 1 Sensor 2	This error occurs if the EGT2 temperature sensor signal in the exhaust at key on, following an 8-hour soak, is significantly different than ambient temperature.		
P2085			X	Exhaust Gas Temperature Sensor Circuit Intermittent Bank 1 Sensor 2	This error occurs if an intermittent signal from the exhaust gas temperature sensor is detected.		
P2122			X	Throttle/Pedal Position Sensor/ Switch D Circuit Low Input			
P2123			X	Throttle/Pedal Position Sensor/ Switch D Circuit High Input			
P2127			X	Throttle/Pedal Position Sensor/ Switch E Circuit Low Input			
P2128			X	Throttle/Pedal Position Sensor/ Switch E Circuit High Input			
P2138			X	Throttle/Pedal Position Sensor/ Switch D / E Voltage Correlation			
P2199	X	X	X	Intake Air Temperature 1/2 Correlation	This error occurs when the difference between IAT2 and IAT1 is greater than a specified value for a predetermined period of time.	>20 deg C 8 minutes	Wiring, IAT or IAT2 sensor, PCM
P2228	X			Barometric Pressure Circuit Low Input	This error occurs when the voltage signal from the barometric pressure circuit falls below a minimum threshold.	Low: < 2.22 V	PCM
P2229	X			Barometric Pressure Circuit High Input	This error occurs when the voltage signal from the barometric pressure circuit rises above a maximum threshold.	High: >4.36 V	PCM
P2230	X			Barometric Pressure Circuit Intermittent			PCM
P2262			X	Turbocharger/Supercharger Boost Pressure Not Detected - Mechanical	This error occurs if the MAP sensor readings are below a calibrated value for a predetermined amount of time.	engine speed and torque based table >30 sec	System error, CAC hose, MAP sensor plugged,...
P2263			X	Turbocharger/Supercharger Boost System Performance	This error occurs when the difference between the gage exhaust pressure and the set point is less than the minimum threshold or greater than the maximum threshold for a predetermined period of time.	Engine speed > 550 rpm Torque set point > 50 N-m, ECT > 81 deg C IAT > -50 deg C No DPF regeneration request EP setpoint is stable Based on a table on N and TQI >5sec	System error
P2269			X	Water in Fuel Condition	This error occurs when water is detected in the HFCM.		
P2289		SHUTDOWN		Injector Control Pressure Too High - Engine Off	This error occurs if excessive fuel pressure is present after a predetermined period of time following key off.	0.4 sec after engine switch-off fuel rail pressure (FUP) must be lower than 10MPa.	FUP sensor, wiring to FUP sensor, HP fuel system
P2291		X	X	Injector Control Pressure Too Low - Engine Cranking	This error occurs when enough injection control pressure to start the vehicle cannot be achieved during cranking.		Low pressure fuel system, HP fuel system, FUP sensor and wiring to sensor, battery voltage (crank speed)
P242A			1PC	Exhaust Gas Temperature Sensor Circuit Bank 1 Sensor 3	This error occurs if the EGT3 temperature signal of the exhaust system does not rise sufficiently immediately after a cold-start following an 8-hour soak.		
P242B			1PC	Exhaust Gas Temperature Sensor Circuit Range/ Performance Bank 1 Sensor 3	This error occurs if the EGT3 temperature sensor signal in the exhaust at key on, following an 8-hour soak, is significantly different than ambient temperature.		

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P242C			X	Exhaust Gas Temperature Sensor Circuit Low Bank 1 Sensor 3	This error occurs when the EGT3 sensor temperature signal is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.		
P242D			X	Exhaust Gas Temperature Sensor Circuit High Bank 1 Sensor 3	This error occurs when the EGT3 sensor temperature signal is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.		
P242E			X	Exhaust Gas Temperature Sensor Circuit Intermittent Bank 1 Sensor 3	This error occurs if an intermittent signal from the exhaust gas temperature sensor is detected.		
P242F		REGEN		Diesel Particulate Filter Restriction - Ash Accumulation	This error occurs if excessively high exhaust pressures are detected after a regen cycle.		
P244A		REGEN		Diesel Particulate Filter Differential Pressure Too Low	This error occurs if an expected pressure drop through the DPF is lower than the specified value following a regeneration cycle (based on the concept of observed pressure differential).		
P244C	X	X	X	Exhaust Temperature too low for Particulate Filter Regeneration	This error occurs if the exhaust temperature is too low to perform a regen cycle of the diesel particulate filter.		
P244D		REGEN		Exhaust Temperature too high for Particulate Filter Regeneration	This error occurs if exhaust temperatures are too high to perform a regen cycle of the diesel particulate filter.		
P2453	X		X KO	Diesel Particulate Filter Differential Pressure Sensor Circuit Range/Performance	This error occurs if the differential pressure of the diesel particulate filter reads a constant value while the engine is running.		
P2454			X	Diesel Particulate Filter Differential Pressure Sensor Circuit Low	This error occurs if a short to ground is detected in the diesel particulate filter differential pressure sensor circuit.		
P2455			X	Diesel Particulate Filter Differential Pressure Sensor Circuit High	This error occurs if a short to power occurs in the diesel particulate filter differential pressure sensor circuit.		
P2456			X	Diesel Particulate Filter Differential Pressure Sensor Circuit Intermittent/Erratic	This error occurs if the signal from the diesel particulate filter differential pressure sensor to the PCM is unreadable.		
P2457		X	X	Exhaust Gas Recirculation Cooler System Performance	This error occurs if the EGR cooler temperature sensor reading is above a maximum threshold for a predetermined period of time.	EGR Position >= 0 600 rpm < Engine speed < 1300 rpm 50 N-m < Torque set point < 400 N-m >165 deg C >20sec	System error, TEGR_OUT sensor,...
P2458			X	Diesel Particulate Filter Regeneration Duration			
P2459			X	Diesel Particulate Filter Regeneration Frequency			
P2545		X		Torque Management Request Input Signal A Range/Performance			CAN wiring, change ECU
P2563	X	X	X	Turbocharger Boost Control Position Sensor A Circuit Range/Performance	This error occurs when the difference between the turbocharger actuator commanded duty cycle and the feed forward commanded duty cycle is less than the threshold value for the given engine speed and engine load for a predetermined period of time.	600 rpm < Engine speed < 1000 rpm Torque set point > 50 N-m ECT > 70 deg C IAT > -50 deg C No DPF regeneration request EP setpoint is stable -60 % of desired 7.5 sec	System error
P2610			X	ECM/PCM Internal Engine Off Timer Performance	This error occurs when the engine off timer does not correlate to the PCM's internal timer (compared while the engine is running), if the engine off time does not correspond with the measured ECT temperature variation between the last engine stop and the next engine start, or when the engine off timer is defective.		
U0073	X	X	X	Control Module Communication Bus A Off	This error occurs if a fault in the CAN communication is detected.		
U0101	X	X	X	Lost Communication with TCM	This error occurs if the CAN data communication is interrupted between the PCM and the TCM.		



6.4L Power Stroke® Diesel Engine

