2010 MAXXFORCE® 7 FOR TECHNICIANS

Study Guide

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Study Guide

2010 MAXXFORCE® 7 FOR TECHNICIANS

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Introduction

Welcome to the 2010 MaxxForce® 7 For Technicians, a web-based training course provided by Navistar Education. This course is intended for personnel who maintain, diagnose and repair Navistar heavy duty truck engines.

The course introduces you to the 2010 MaxxForce® 7 engine and covers changes in the following engine systems:

- Lubrication
- Cooling
- Fuel Management
- Air Management
- Aftertreatment
- Electrical and Electronic Systems

Course Modules

The course has six separate parts. First is the Introduction. Next is the Base Engine module.

Base Engine covers the Lubrication System that includes the oil filter, oil filter bypass valve, oil pan, oil pump, oil cooler and oil cooler bypass valve, and the turbo oil feed lines and oil drain lines. The Base Engine module also covers the Cooling System coolant flow through the EGR and Fuel coolers.

Course Objectives

Upon completion of this program, you will be able to:

- **Locate the components on the 2010 engine**
- **Identify the operation for each of the systems**
- **Identify the path for oil, coolant and fuel flow**

The Fuel Management module is next. The Fuel Management module includes the High Pressure Fuel Pump, Wiring, and the Fuel Filter Module.

The Air Management module identifies the Crankcase Breather, Breather Filter, Turbocharger, Boost Control Solenoid, Intake Manifold and the EGR Cooler.

The next module Aftertreatment covers the components and sensors used to monitor and reduce particulate matter and oxides of nitrogen. The engine components include the Inlet Throttle Valve, Inlet Air Heater, and the Exhaust Throttle Valve. The chassis components include the Diesel Particulate Filter, Diesel Oxidation Catalyst, the Exhaust Gas Temperature Sensors and the Exhaust Gas Differential Pressure Sensor.

The final module, Electronics and Electrical Systems, describes the Electronic Control Module and identifies which sensors and actuators are new for 2010 and which are carried-over.

Module 1: Base Engine

Upon completion of the Lubrication System section, you will be able to:

- **Identify the changes to the lubrication system**
- **Identify the positions of the lube system control valves**

Systems Overview

The Base Engine module covers two systems, Lubrication and Cooling.

Lubrication System

Fuel Filter and Oil Pan

The oil filter for the 2010 MaxxForce® 7 engine is located at the bottom of the engine. This makes room for the dual turbocharger in the valley of the crankcase. The pan is cast aluminum. When the filter is removed you can see the oil filter adapter.

Crankcase Oil Ports

The crankcase oil ports are:

- oil from the pickup tube
- pressure to the filter
- return oil from the filter back to the pump
- oil to the cooler

The material for the crankcase is Compacted Graphite Iron. As a result, the crankcase is stronger and lighter weight.

Oil Flow – Oil Pump

Oil from the pickup tube comes into the pump where the rotor set pumps oil into a passage that goes out to the oil filter. After the oil passes through the filter, it returns to the pump housing where it is redirected into a crankcase passage that leads to the oil cooler.

When removing the oil pump, observe the following caution.

⚠ CAUTION

To prevent damage to the engine, cut protruding sealant from the joint of the crankcase and lower crankcase before removing the oil pump and oil pump gasket.

Pulling off the pump and gasket without cutting this sealant can cause the seal between the crankcase and lower crankcase to fail. Complete engine removal and disassembly is required to install new crankcase seals.

Oil Flow – Crankcase

There are two lower crankcase ports: oil to the filter, and filtered oil back to the pump. The oil pan has matching ports.

Oil Pump Mounting

The oil pump mounts directly to the crankcase, not the front cover. The cover no longer extends down to the crankshaft.

There are no dowel pins used to locate the pump to the crankcase. Instead, there are sacrificial nubs on the pump housing. The nubs center the pump around the crankshaft during installation.

Oil Pressure Regulator

The pressure regulator valve has been moved to a more horizontal position and is easier to remove for service.

If debris lodges between the regulator piston and the housing the piston could stick in the bore. This could be the cause of a low oil pressure complaint. To check it, remove the regulator and test for free movement.

Oil Cooler

The 2010 MaxxForce® 7 has a larger oil cooler. To make it fit, the valley of the crankcase was changed. The oil cooler still mounts in the cavity at the top of the crankcase, but now the valley has only two areas, the high pressure pump opening and the much larger oil cooler opening. This allows for the larger cooler.

Turbo Drain Ports

There are two ports in the crankcase for the drained oil from the turbos. The oil enters ports on the cooler cover and then flows through passages in the crankcase back to the oil pan. The cavity remains dry.

Cooler Bypass Valve

There are two valves required in this system. One is the Oil Cooler Bypass Valve, located at the front of the cooler cover. This valve allows cold thick oil to bypass the cooler.

There are only two valves required in this system. One is the Oil Cooler Bypass Valve.

Filter Bypass Valve

The second valve, is the Filter Bypass, located inside the oil filter.

The second valve, is the Filter Bypass, located inside the oil filter.

Turbo Feed Line

The turbo oil feed line still comes from the oil cooler cover, however the line changed for 2010 because there are two turbos instead of one.

Compressor Oil Supply

If the engine is equipped with a compressor, a tee is mounted between the cooler and the Engine Oil Pressure (EOP) sensor. A hose from the tee feeds oil to a fitting on the rear of the compressor. After lubricating the compressor, the drain oil enters the compressor bracket and flows down a hose to a fitting on the oil pan.

After lubricating the compressor, the drain oil enters the compressor bracket and flows down a hose to a fitting on the oil pan.

Cooling System

EGR Coolant Tubes

There are several changes in the 2010 MaxxForce® 7 engine cooling system. The first is coolant flow through the EGR cooler. Two tubes route coolant from the front cover to the EGR cooler and back. The forward tube is the supply to the cooler, and the rear is the return.

EGR Coolant Flow

The forward tube takes coolant from the water pump, through the front cover to the left bank intake manifold base.

Coolant flows through a cast passage in the base to a port at the rear. When the cooler plugs into that port, coolant can flow through the EGR cooler and then enter the return tube.

Coolant Tube Assemblies

Both the forward and rear tubes have two parts: the tube and 90° elbow. Both tubes have o-rings at each joint.

Fuel Cooler

Coolant flow to the fuel cooler is similar to the '07 model year engine however the cooler is in a new location. The fuel cooler controls the temperature of the fuel because a common rail system requires that fuel be at a reasonable temperature.

Upon completion of the Cooling System section, you will be able to:

- **Identify the changes to the cooling system**
- **Identify the coolant flow through the cooling system**

Fuel Cooler Coolant Flow

The system has a fuel cooler, Low Temperature Radiator (LTR), and the hoses and lines.

During operation, coolant exits the front cover and flows through a hose to the LTR. This allows the coolant to flow from the water pump to the LTR where it is cooled again. This twice-cooled coolant then enters the fuel cooler which is mounted on the back of the fuel filter module. The coolant absorbs the heat, then returns to the back of the front cover.

Fuel Cooler Ports

Coolant from the LTR enters a port on the fuel module. It then flows through the cooler, back into the module, and then returns to the front cover.

For some applications in 2010 the ECM regulates a coolant control valve. This valve controls the flow of coolant through the low temperature radiator. On applications where the valve is not used, the ECM does not regulate coolant flow. Coolant flows constantly through the LTR.

Module 2: Fuel Management System

Upon completion of the Fuel Management System module, you will be able to:

- **identify the components of the Fuel Management System**
- **Locate the components on the engine**
- **Trace the fuel flow through the system**

System Overview

The 2010 MaxxForce® 7 Fuel System can be divided into three areas or sub-systems. They are: low-pressure supply, high-pressure common rail, and low-pressure return.

Low Pressure Supply

In the low pressure supply sub-system, the electric fuel pump within the fuel filter module draws fuel from the fuel tank. Within the module, fuel is filtered twice, water is removed, fuel temperature is controlled, and the pressure is regulated. Fuel pressure at that point is less than 10 psi or 68 kPa. The fuel leaves the module and enters the high pressure pump.

The high pressure pump delivers fuel under pressures as high as 27,500 psi or 1900 bar.

The high-pressure pump delivers fuel under pressures as high as 27,500 psi or 1900 bar.

HP Common Rail and LP Return

The high pressure fuel is routed to the rails and injectors. When the ECM sends a signal to an injector, fuel is sprayed into the cylinder. In addition, a small amount of return fuel leaves the injector and enters a passage in the cylinder head.

Return fuel exits the front of the heads at the banjo bolts, meets the return fuel from the pump, and flows back to the fuel cooler.

This return fuel exits the front of the heads at the banjo bolts, meets the return fuel from the pump, and flows back to the fuel cooler.

Low Pressure Supply

Fuel Module Connections

The filter module has a suction connection to the fuel tank and a fuel return connection. This return connection is where fuel released by the pressure regulator exits the module and returns to the tank.

The low pressure fuel supply connection routes fuel under low pressure to the high pressure pump. The return port on the fuel cooler receives fuel from the high pressure pump and from the injectors. The fuel passes through the cooler before returning to the filters.

Fuel Module Components

The fuel module components are:

- Water Drain
- Water-in-Fuel (WIF) Sensor
- Electric Fuel Pump: seated in the bottom of the module and is sealed with several o-rings.
- Primary Filter that surrounds the pump
- Thermal Bypass Valve
- Fuel Pressure Regulator
- Secondary Filter
- Diagnostic Valve: used to connect a fuel pressure gauge, unless there is an optional fuel pressure sensor. If that is the case, the fuel pressure sensor replaces the diagnostic valve and must be removed to measure the pressure.
- Fuel Temperature Sensor
- Check Valves: one built into the pump, and the other on the secondary filter stand pipe, prevent engine operation when either filter is missing. Without the filter depressing the valves, no fuel will pass. The engine may start, but will not run for long.

The low pressure electric fuel pump is seated in the bottom of the fuel module primary filter housing and is sealed with several o-rings.

Two valves, one built into the pump, and the other on the secondary filter stand pipe, prevent engine operation when either filter is missing.

High Pressure Common Rail

The common rail section of the fuel management system consists of the high-pressure pump, high-pressure lines, two common rails, eight injectors, and one sensor.

High Pressure Pump

The high-pressure pump is gear driven. The driving gear is the camshaft gear.

The wiring from the pump goes through the flywheel housing and connects to the engine wiring harness just below the fuel cooler.

Two valves or actuators control the high-pressure fuel. One controls the volume, the other controls the pressure.

Two valves or actuators control the high-pressure fuel. One controls the volume, the other controls the pressure.

The pump has four fuel connections. One is the low pressure inlet, and one is the low pressure return to the fuel filter module. There are two high pressure fittings. One fitting is for the right bank of cylinders and the other for the left.

A small amount of fuel passes through the pump for internal lubrication and cooling. The fuel flows back to the filter module.

Fuel Flow

When fuel exits the pump under high pressure, it passes through two high pressure steel lines to the right and left Common Rails. Eight individual high pressure lines connect the rails to the eight injectors. The ECM controls the injectors.

When fuel exits the pump under high pressure, it passes through two high pressure steel lines to the right and left Common Rails.

The Fuel Rail Pressure Sensor is located on the right bank high pressure rail. This sensor provides feedback on rail pressure to the ECM so it can constantly adjust the signal to the pump control valves.

During service, any high-pressure line that is removed, or even loosened, must be replaced. Do not ever loosen a high pressure line while the engine is running.

WARNING

To prevent personal injury or death, whenever any fuel line (tubing) in the high pressure fuel system is removed, it must be replaced with new.

There are separate harnesses for each bank that exit the Base Valve Cover area, and connect to the main engine harness.

Low Pressure Return

During operation, excess fuel from each injector travels through a drilled passage to the front of each cylinder head. This excess fuel exits the heads through low pressure fuel hoses attached to the front of the heads with banjo bolts.

Excess fuel from each injector returns to the fuel cooler through drilled passages in the cylinder head, low-pressure lines and a check valve.

The two hoses join at a tee fitting where the combined fuel flows back to a check valve located in the line. This is also where the fuel joins excess fuel from the high pressure fuel pump. The check valve keeps a small amount of pressure in the return line all the way back to the injector.

Fuel Cooler

The return fuel from the High Pressure Pump enters a fitting on the fuel cooler. The fuel passes through the cooler and loses excess heat to the engine coolant. Then the fuel re-enters the module and flows to the recirculation valve.

Recirculation Valve

When the fuel reaches the Recirculation Valve it is routed based on the temperature of the fuel.

If the fuel is hot, it returns directly to the secondary filter. Since the pressure regulator is almost always relieving excess pressure, the hot fuel returns to the tank.

If the fuel is cold, the recirculation valve divides the fuel and it passes through both filter areas.

O-rings

The o-ring in the primary filter area is one of the pump o-rings. It can be seen when the pump is out of the housing.

Stand Pipe

When the electric fuel pump is installed in the fuel module, it also serves as a stand pipe.

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Module 3: Air Management System

Upon completion of the Air Management System module, you will be able to:

- **Identify the components within the system**
- **Locate the components on the engine**
- **Identify the system flow**
- **Identify the proper operation of the boost control solenoid**

System Overview

There are four subsystems within the 2010 Air Management System. The first is the Dual Turbocharger Assembly with a smaller, high-pressure turbo, providing boost during low speeds and acceleration; and a larger, low-pressure turbo that provides boost at higher speeds and loads.

The second subsystem is Air Induction, where boost air is cooled and directed through the Manifold Mixer to the Manifold Bases.

The third system is EGR. A portion of the exhaust is directed through the cooler to the EGR Valve mounted on the Manifold Mixer.

The last system is Crankcase Ventilation.

Crankcase Ventilation System

The Crankcase Ventilation System is made up of the Breather Housing, the Boost Line, the Draft Tube, and the Breather Filter inside the Breather Housing.

Crankcase Breather Flow

Blow-by enters the filters through a large opening in the valve cover.

When the engine is running, all the blow-by enters the filters through a large opening in the valve cover. The gases then pass through the filters and enter the Breather Housing.

Filter Assembly

The filters strip out the oil from the blow-by and the oil drips back into a cavity.

Relief Valve

If the filters are plugged, a relief valve opens and allows blow-by to bypass the filter, but then the oil is not stripped out by the filter.

Jet Pump

Oil that collects in the cavity is moved out through a small hole and back under the valve cover by a jet pump.

A tube on the bottom of the filter enters the small hole in the cover. The other end of the tube sits in the pool of oil that collects in the cavity. Boost from a fitting on the inlet air heater housing, enters the hole and creates a venturi effect. It sucks the oil out of the pool and pushes it through the hole. The oil is constantly pumped back under the valve cover. Gases exit out the road draft tube.

While the jet pump may direct some boost into the crankcase, the volume of air is small, only about 10% of the blow-by in the engine is from the jet pump.

Maintenance

The filter is a maintenance item with a service schedule. Check the service literature for the proper intervals.

The filter is a maintenance item with a service schedule. Check the service literature for the proper intervals.

Dual Turbocharger Assembly

There are two turbochargers; a small diameter high-pressure turbo, and a larger diameter low-pressure turbo. Both mount to the oil cooler cover as one assembly, and both turbos are interconnected through both the exhaust and intake air flow.

There are two turbos, a small diameter high–pressure turbo, and a larger diameter low-pressure turbo.

During operation, exhaust enters the high-pressure turbo turbine housing. After driving that turbine, the exhaust enters the low-pressure housing and drives the low-pressure turbine. Then, the exhaust exits the turbo and enters the Aftertreatment system.

Turbocharger Air Flow

On the charge air side, air enters the low-pressure compressor housing and is pushed under pressure to the high-pressure compressor housing. Air is further compressed then flows through the Charge Air Cooler (CAC) before flowing back to the engine to enter the inlet throttle valve.

There are two oil drain tubes, one for each turbo.

There are two oil drain tubes, one for each turbo. The pipe nearest the actuator is the drain tube for the low-pressure turbo. The other drain tube is below the center section of the high pressure turbo.

Wastegate

The wastegate is a valve that can divert some of the exhaust flow past the high-pressure turbo.

The actuator is mechanically connected to the wastegate. The wastegate is a valve that can divert some of the exhaust flow past the high pressure turbo.

With this valve closed, all the exhaust passes through the small high pressure turbo. With it open, a portion of the exhaust bypasses the high pressure turbo and flows directly to the larger low-pressure turbo. When the vehicle is under light load and accelerating, the wastegate is closed. But, under a heavy load, the wastegate is open to reduce back-pressure and protect the turbo from over-speeding.

Boost pressure operates the actuator.

Boost Control Solenoid

The Boost Control Solenoid or BCS has three ports and hoses. The three ports are: boost, connected to a boost port on the inlet air heater; vent, connected to the Turbo Inlet Duct; and the actuator, which is connected to the actuator canister.

The actuator is either connected to the boost source, or the inlet duct. Those are the two internal positions of the valve. If the actuator is connected to the boost source, and there is enough boost, the actuator opens the wastegate. If the actuator is connected to the vent, pressure in the canister vents to the turbo inlet and the wastegate closes.

Air Induction

The traditional intake manifold used on previous V8 engines has been replaced with a manifold that is integrated into each valve cover.

The traditional intake manifold used on previous V8 engines is gone. Instead, a manifold is integrated into each valve cover.

Air Induction components include:
the right and left bank Intake Manifold Bases, the Balance Duct, the Manifold Mixer, and the Distribution Duct.

Refer to the latest service literature for the proper procedure when removing the balance duct.

Balance Duct

The Balance Duct is equipped with a tube that ensures the amount of air flow into each manifold base is the same. The tube has two parts. The short tube slides over the longer tube to allow for removal and installation.

Removal may require a special tool and procedure. Refer to the latest service literature for the proper procedure when removing the balance duct.

Manifold Base

The Right-Bank Cylinder Head and Manifold Base has a pass-through for the wiring harness and a larger opening where air from the Manifold Mixer and Distribution Duct enters the Manifold Base.

Air enters a separate area on the side of the casting. The intake ports are directly below it.

Manifold Mixer

EGR Mixer Bushings mounted to the Maniffold Mixer blend the EGR gases into the fresh charge air.

The Inlet throttle valve is used to increase or decrease the flow of exhaust gases into the intake air stream. The Inlet Air Heater is the starting aid that replaces the glow plugs.

There are two ports on the Air Inlet Heater. One for the Boost Control Solenoid, the other is for the Boost Pump in the Crankcase Ventilation Filter.

Exhaust Gas Recirculation (EGR) Flow

Exhaust flow through the EGR system is simple; exhaust enters the cooler and exits through a hose to the EGR Valve mounted on the Manifold Mixer. The mixer combines exhaust gases with charge air before the air enters the distribution duct.

A special tool is required to remove the EGR Valve. Refer to the latest service information.

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Module 4: Aftertreatment System

Upon completion of the Aftertreatment System module, you will be able to:

- **Locate the Aftertreatment components**
- **Identify the functions of the Aftertreatment components**
- **Define the types of Aftertreatment Regeneration**

System Overview

The Aftertreatment System is designed to reduce both particulate matter and oxides of nitrogen (NOx). This system has components located on the chassis and the engine.

Chassis Components

There are several Aftertreatment System components located on the chassis. There are sensors, and exhaust system parts such as the Diesel Particulate Filter (DPF) and the Diesel Oxidation Catalyst (DOC).

The DPF filters particulate matter, or soot, from the engine exhaust. The soot is then burned to ash within the DPF if the temperature of the DPF rises high enough.

The DPF filters particulate matter, or soot, from the engine exhaust. The DOC reduces unburned hydrocarbons.

The other exhaust component is the DOC. The DOC reduces unburned hydrocarbons (raw fuel). If raw fuel enters the DOC when it is up to operating temperature it ignites and burns.

The system has three Exhaust Gas Temperature Sensors that sense the temperature before the DOC, after the DOC, and after the DPF.

The chassis mounted Exhaust Gas Differential Pressure Sensor (EGPD) Sensor allows the ECM to monitor restriction across the DPF. Since restriction is related to the amount of soot stored, it tells the ECM when the DPF is getting full.

All of these sensor signals are used to regulate the Aftertreatment functions.

Engine Components

The engine has three items related to the Aftertreatment. First is the Inlet Throttle Valve which is mounted on the Manifold Mixer with the Inlet Air Heater. The Inlet Throttle Valve is used to control the amount of oxygen in the exhaust for proper Aftertreatment operation.

The injectors are used to add extra fuel into the exhaust stream, which creates extra heat as the exhaust passes through the DOC.

Finally, there is the Exhaust Throttle Valve which is a housing with a throttle plate, and a motor to control the position of the plate.

Normally, the ECM keeps the throttle plate wide open. This allows the engine exhaust to flow freely through the housing and into the rest of the exhaust system. But when the ECM wants to raise the exhaust temperature, one of the strategies is to partially close the throttle.

The ECM controls the throttle over the Controller Area Network, or CAN line. The CAN signals are received at the valve and the valve onboard circuits interpret where the ECM wants the throttle plate to be positioned.

There are pipe connections on the valve assembly because the valve is water cooled to control its temperature.

The Exhaust Throttle Valve may not appear at the start of production. However, all versions of the engine will eventually have this throttle.

The Exhaust Throttle Valve may not appear on all versions of the engine at the start of production.

System Operation

The engine creates soot and the soot is trapped in the DPF. Eventually the DPF gets full. The EGDP sensor measures the pressure difference across the DPF, which tells the ECM if the soot is building up. Then the temperature sensors check to verify temperatures are high enough to burn off the soot.

Passive Regeneration

If the current operating conditions are burning off the soot, it is called Passive Regeneration, or just Passive Re-Gen.

Active Regeneration

If the operating conditions are not right, the DPF begins to fill with soot. In this case the ECM uses one of several strategies that employ the intake throttle valve, exhaust throttle valve, and the injectors to create extra heat in the exhaust, which is called Active Re-Gen.

Stationary (Parked) Regeneration

If conditions are not right for the Passive Re-Gen, a warning lamp signals the operator that a Stationary (Parked) Re-Gen, must be used.

In a Stationary (Parked) Re-Gen, the engine must be at idle with no load and no inputs such as accelerator, brake switch etc. Then, the operator pushes the Parked Re-Gen Switch and the ECM takes over engine operation.

Operator Status Indicators

The instrument panel provides the operator with indications of the status of the Aftertreatment System. A series of lamps and/or audio sounds will alert the operator to the current condition of the Aftertreatment System. These indicators will vary from application to application. Check with ISIS or the Operators Manual for a specific application.

The instrument panel provides the operator with indications of the status of the Aftertreatment System.

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Module 5: Electrical and Electronics

Upon completion of the Electrical and Electronics module, you will be able to:

- **Identify the components within the Electrical system**
- **Locate the electrical components on the engine**

Electronic Control Module (ECM)

The engine electrical systems start at the ECM. The 2010 MaxxForce® 7 ECM has two connectors, the 98-pin Engine Harness Connector and the 98-pin Chassis Harness Connector.

Any connections between the chassis and engine other than the two ECM connectors, go through the 24-pin Engine to Chassis Interface Connector. Connections made through this connector are actuator power and ground, optional Fuel-Heater power and ground, and the Water-In-Fuel Sensor signal.

Most of the engine sensors and actuators are carry-overs from the 2007-09 model year, but some are new for 2010.

Base Engine Components

The ECM needs to know the location and speed of both the crankshaft and camshaft. The Crankshaft Position Sensor (CKP) is in the right front edge of the lower crankcase. The Camshaft Position Sensor (CMP) is located on the opposite side of the engine in the lower left front portion of the upper crankcase. Both sensors are two-wire magnetic pick-up style sensors, the same as 2007-09 model year.

The ECM needs to know the location and speed of both the crankshaft and camshaft.

The base engine has two, 2-wire temperature sensors; the Engine Coolant Temperature Sensor located on the front cover, and Engine Oil Temperature Sensor, located on the oil cooler.

The 3-wire Engine Oil Pressure Sensor, is located on the oil cooler housing."

Air Management System Components

There are two temperature sensors for the EGR system; a 2-wire EGR Cooler Inlet Temperature sensor, located at the pipe leading to the turbo, and the EGR Cooler Outlet Temperature sensor, located on the Manifold Mixer. These sensors tell the ECM the temperature of the exhaust going into and out of, the EGR cooler.

The EGR valve, which is controlled by the ECM, also contains a sensor. This sensor reports EGR valve position to the ECM.

The 2-wire Manifold Air Temperature (MAT) sensor is located on the right bank manifold base. Also in the manifold base, adjacent to the MAT sensor, is the 3-wire Manifold Absolute Pressure (MAP) sensor.

The Inlet Air Heater Relay powers the Inlet Air Heater. This is the starting aid for 2010 instead of glow plugs. The inlet air heater raises the temperature of the intake charge during cold starts and takes the place of the glow plugs.

The Inlet Air Heater Relay powers the Inlet Air Heater. This is the starting aid for 2010 instead of glow plugs.

The actuator for the turbo is the Boost Control Solenoid (BCS). The BCS is powered off battery voltage from the 24-way Engine-to-Chassis Interface Connector, then the ECM controls the ground side. No ground is supplied if the ECM wants boost pressure to enter the turbo actuator. A ground is supplied if the ECM wants pressure in the actuator to vent to the turbo inlet duct.

Mass Air Flow Sensor

The last Air Management System sensor is the combined Mass Air Flow and Intake Air Temperature sensor or MAF/IAT.

The Mass Air Flow sensor, often called a MAF sensor, is combined with the Intake Air Temperature sensor (IAT) to create one sensor. The Mass Air Flow/Intake Air Temperature sensor is located in the air filter housing. The MAF sensor is used to help control the EGR system.

During engine operation, the ECM calculates how much exhaust gas to add to the intake mixture, then signals are sent to the EGR valve to position it.

The ECM calculates how much exhaust gas to add to the intake mixture, then signals are sent to the EGR valve to position it.

Information from the MAF sensor is used by the ECM to determine if the flow is correct. The sensor does not check the position of the valve, rather it checks the flow through the system.

With the EGR valve closed, the ECM expects a certain mass air flow through the air filter. With the valve open, exhaust displaces a portion of the fresh air that enters the cylinder, and the ECM expects a lower mass air flow.

Fuel System Components

The rear-most actuator on the high pressure pump is the Fuel Volume Control Valve, and the front actuator is the Fuel Pressure Control Valve. Both valves receive battery voltage from the 24-way connector. The ECM controls the ground side of the circuit.

The filter module has a Water-In-Fuel (WIF) sensor, Engine Fuel Temperature (EFT) sensor, and the location for the optional Engine Fuel Pressure (EFP) sensor.

The optional Fuel Heater takes the place of the Block-off Plate. The Electric Fuel Pump connector is located below the primary filter housing.

Power and ground for the electric pump comes directly off the engine side connector of the ECM. There is no relay.

The Fuel Rail Pressure (FRP) sensor is located on the right bank fuel rail. The FRP sensor is used by the ECM to verify signals to the high pressure pump actuators, which causes the pump to output the desired pressure.

Aftertreatment

Engine Components

The Aftertreatment system has electronic components mounted on the engine and on the chassis. The engine mounted components are discussed here. The Exhaust Throttle is CAN controlled by the ECM and receives both power and ground through the 24-way engine-to-chassis interface connector.

The other engine-mounted component is the Intake Throttle Valve (ITV). The ITV receives its position power and ground signals from the ECM. The sensor within the actuator connects to the same VREF and sensor ground circuits that feed the other engine mounted sensors.

Chassis Components

The chassis-mounted sensors are the three 2-wire temperature sensors: EGT1, EGT2, EGT3, and the 3-wire Exhaust Gas Differential Pressure (EGDP) sensor on the DPF.

All of these sensor inputs go into the ECM through the 98-way chassis-side connector.

Accelerator Position Sensor

In 2010 the Accelerator Position Sensor (APS) has two independent and electrically isolated potentiometers.

In 2010 the Accelerator Position Sensor (APS) has two independent and electrically isolated potentiometers.

Both potentiometers have their own VREF, signal, and ground circuits. The potentiometers produce a signal value depending on pedal position. The signal output of pot number two is always 50% of pot number one.

During operation, the ECM continuously compares the two values to verify that the signals are valid.

It is important that the ECM be able to verify that the APS signal is what the operator really wants. In the past, comparing the Idle Validation Sensor to the APS sensor verified this. But now, comparing two separate APS signals are used.

For maximum safety, separate power and ground circuits are provided for each potentiometer.

For maximum safety, separate power and ground circuits are provided for each potentiometer.

The APS connector has six pins: two VREF circuits, two ground circuits, and two signal circuits The input voltage is 5 +/-1/2 volt to both pots. The signal voltage of pot number two is always one-half of pot number one.

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