7.3L DIT Power Stroke - Part 2

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Part 2 of 4 in a series of articles outlining the Features, Description, and Unique Service Procedures of the original 7.3L DIT Power Stroke

7.3 DIT Power Stroke

HEUI Electronic Control System

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- Let's take a closer look at the electronic components that control the HEUI injectors. There are three basic types of components:
- SENSORS
- POWERTRAIN CONTROL MODULE
- ACTUATORS
- These components and their associated harnesses, form a control system that determines optimum injection timing, injection pressure, injection duration, and fuel delivery.

Sensors

- The engine has eight sensors which constantly monitor performance and operating conditions.
- The job of each sensor is to accurately monitor a specific engine condition and generate a signal voltage to send through the vehicle wiring harness to the PCM.
- The sensors provide the information necessary for the PCM to make decisions to control engine performance.

Accelerator Position Sensor (APS)

- The accelerator position sensor (APS) attached to the pedal assembly, provides the PCM with the driver's demand for power.
- The APS signal is used in calculating desired fuel quantity, injector timing and injection control pressure.
- The idle validation switch (IVS) provides the PCM with a redundant signal to verify when the pedal is in the idle position.
- An APS signal that is detected out of range, high or low, by the PCM will cause the engine to ignore the APS signal and will only allow the engine to operate at low idle.
- If a disagreement in the state of IVS and APS is detected by the PCM, the engine will be allowed to operate at low idle only and a fault code will be registered by the on-board diagnostics

Camshaft Position Sensor (CMP)

- The CMP (Camshaft Position) sensor is a hall effect type sensor, located in the front cover. This generates a digital frequency as windows in a target wheel, on the cam gear, pass through its magnetic field.
- The frequency of the windows passing by the sensor, as well as the width of selected windows, allows the PCM to detect engine speed and cylinder/piston position.
- An inactive CMP signal during cranking is detectable by the PCM.
- An inactive CMP signal will cause a no start condition.
- The CMP sensor can be made inactive by a faulty ground.
- A corresponding fault code will be set if a defect is found by the on-board diagnostics.

Injection Control Pressure Sensor (ICP)

- The ICP sensor provides the feedback signal for the closed loop control of the high pressure oil.
- The ICP sensor is a ceramic disk type pressure sensor that converts pressure into a 0 to 5 volt analog signal that the PCM uses to determine injection control pressure.
- The ICP sensor is threaded into the high pressure oil galleries on the left cylinder head.

Manifold Absolute Pressure Sensor (MAP)

- The Manifold Absolute Pressure (MAP) sensor is a variable capacitance (pressure-sensing) disc, mounted on the cowl near the right hood hinge, that sends a frequency to the PCM relative to intake manifold pressure. The sensor frequency increases as pressure decreases.
- The MAP sensor allows the PCM to determine engine load to calculate fuel quantity.
- A MAP signal malfunction detected by the PCM will cause the PCM to ignore the MAP signal and calculate an estimated manifold pressure based on known engine conditions.
- A fault code can be set if the on-board diagnostics detect a defect.

Engine Oil Temperature Sensor (EOT)

- The Engine Oil Temperature (EOT) sensor is a thermister whose resistance decreases as engine oil temperature increases.
- The EOT signal is one of the sensors used by the PCM to calculate fuel quantity, injection timing, glow plug operation, and exhaust back pressure.
- At oil temperatures below 122° F (65° C), low idle is increased to a maximum of 900 RPM to insure faster engine warm-up.
- Fuel quantity and timing is controlled throughout the total operating range to ensure adequate torque and power are available.
- An EOT signal detected out of range, high or low, by the PCM will cause the PCM to ignore the EOT signal and assume an engine oil temperature of 68° F (20° C) for starting purposes and 212° F (100° C) for operating purposes.
- Engine oil temperature is measured in the reservoir.
- A fault code can be set if the on-board diagnostics detects a defect.

Intake Air Temperature Sensor (IAT)

- The Intake Air Temperature Sensor (IAT) sensor is a thermister whose resistance decreases as temperature increases.
- Mounted in the air cleaner, the IAT sensor's function is to provide ambient air temperature information to the PCM.
- The PCM uses IAT output voltage drops to enable exhaust back-pressure control for faster engine warm up.
- An IAT signal detected out of range, high or low, by the PCM will result in the PCM ignoring the signal and assuming an ambient air temperature of 59° F (15° C) while setting a fault code.
- The assumed ambient temperature of 59° F (15° C) will provide sufficient performance to return for service.

Barometric Pressure Sensor (BARO)

- The Barometric Pressure (BARO) sensor is an analog device, located under the dash above the accelerator pedal, which senses atmospheric pressure which allows the PCM to compensate for altitude.
- The PCM uses this information to calculate injection timing and control glow plug "on" time.
- An open in the BARO sensor circuit will result in an out of range low signal to the PCM.
- Any other wiring faults will result in an out of range condition. The PCM will assume a default value of 14.5 psi (100 kpa).
- The assumed value of 14.5 psi will allow sufficient performance to return for service.

Exhaust Back-Pressure Sensor (EBP)

- The Exhaust Back-Pressure (EBP) sensor measures pressure in the right exhaust manifold and is located next to the oil reservoir.
- This sensor is used in conjunction with the exhaust back-pressure regulator to form a closed loop exhaust back pressure control system. The EBP sensor is also used for diagnosis of the turbocharger.
- Exhaust back-pressure is controlled to provide more heat to the coolant for cab heating when ambient air temperature is below 45° F (7° C) and engine oil temperature is below 167° F (75° C) during low load, low speed operating conditions.
- An open or short in the EBP sensor wiring will result in a low out of range voltage at the PCM.

Powertrain Control Module (PCM)

- The control module (formerly called EEC) receives the input voltages from the various sensors. These input voltages are known as input signals.
- The input signals are used by the control module to make decisions on how to control the engine.
- These decisions are translated into output signals which are sent to the actuators to change performance.
- Sensors Monitored Include:
- Accelerator Position Sensor (APS)
- Camshaft Position Sensor (CMP)

- Injection Control Pressure Sensor (ICP)
- Manifold Absolute Pressure Sensor (MAP)
- Engine Oil Temperature Sensor (EOT)
- Intake Air Temperature Sensor (IAT)
- Barometric Pressure Sensor (BARO)
- Exhaust Back-Pressure Sensor (EBP)

Actuators

- Actuators convert electrical output signals from the powertrain control module to hydraulic or electrical work to control engine performance.

  ACTUATORS INCLUDE:

- Injection Pressure Regulator
- Exhaust Back-Pressure Regulator

IPR Valve Operations

Injection Pressure Regulator (Actuator)

- The IPR is an electronically-controlled, pilot-operated (small flow that controls a larger flow), pressure control valve.
- The IPR controls pump outlet pressure in a range between 450 and 3,000 psi. An electrical signal to the solenoid creates a magnetic field which applies a variable force on the poppet to control pressure.

Operation - Engine Off

- With the engine off, the valve spool is held to the right by the return spring and the drain ports are closed.

Exhaust Back Pressure Regulator

- The Exhaust Back Pressure Regulator performs similar to the IPR, directing oil flow.
- Turbocharger lube oil is directed into a hydraulic chamber which activates the Exhaust Back Pressure device when the PCM commands exhaust back-pressure.

Operation - Engine Cranking

- Approximately 1,500 psi of oil pressure is required to start an engine with oil temperature greater than 75°F.
- If the engine is cold, 2,750 psi of oil pressure is commanded by the PCM.
- Oil flow through the IPR is as follows:
- Pump outlet pressure enters the end of the body and a small amount of oil flows into the spool chamber through the pilot stage edge filter and control orifice in the end of the spool.

- The electronic signal causes the solenoid to generate a magnetic field which pushes the armature to the right.
- The armature exerts a force on the push pin and poppet holding the poppet closed, allowing spool chamber pressure to build.
- The combination of spool spring force and spool chamber pressure hold the spool to the right, closing the drain ports.
- All oil is directed to the pressure gallery in each cylinder head until the desired pressure is reached.

Operation - Engine Running

- Once the engine starts, the PCM sends a signal to the IPR to give the gallery pressure desired. The injection control pressure sensor monitors actual gallery pressure.
- The PCM compares the actual gallery pressure to the desired gallery pressure and adjusts the signal to the IPR accordingly.
- The actual oil flow through the IPR during engine operation is as follows:
- Pump outlet pressure enters the end of the body and a small amount of oil flows into the spool chamber through the pilot stage filter and the control orifice in the spool.
- The pressure in the spool chamber is controlled by adjusting the position on the poppet and allowing it to bleed off some of the oil in the spool chamber.
- The position of the poppet is controlled by the strength of the magnetic field produced from the electrical signal from the PCM.
- The spool responds to pressure changes in the spool chamber (left side of the spool) by changing positions to maintain a force balance between the right and left side of the spool. The spool position determines how much area of the drain ports is open.

The process of responding to pressure changes on either side of the spool occurs so rapidly the spool is held in a partially open position and pump outlet pressure is closely controlled. The IPR allows infinitely variable control of pump outlet pressure between 450 psi and 3,000 psi.