2008 MY OBD System Operation Summary for 6.0L Diesel Engine

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Introduction – OBD-I, OBD-II and EMD

OBD-I Systems

OBD-I vehicles use that same PCM, J1850/CAN serial data communication link, J1962 Data Link Connector, and PCM software as the corresponding OBD-II vehicle. The only difference is a different PCM calibration. Starting in the 2006 MY, all Federal vehicles from 8,500 to 14,000 lbs. GVWR will have been phased into OBD-II and OBD-I systems will no longer be utilized in vehicles up to 14,000 lbs GVWR.

OBD-II Systems

California OBD-II applies to all California and "California State" gasoline engine vehicles up to 14,000 lbs. Gross Vehicle Weight Rating (GVWR) starting in the 1996 MY and all diesel engine vehicles up to 14,000 lbs. GVWR starting in the 1997 MY.

"California States" are ones that have adopted California emission regulations, starting in the 1998 MY. At this time, Massachusetts, New York, Vermont and Maine have adopted California's regulations. These States receive California-certified vehicles for passenger cars and light trucks, and medium-duty vehicles, up to 14,000 lbs. GVWR."

Federal OBD-II applies to all gasoline engine vehicles up to 8,500 lbs. GVWR starting in the 1996 MY and all diesel engine vehicles up to 8,500 lbs. GVWR starting in the 1997 MY.

Starting in the 2004 MY, Federal vehicle over 8,500 lbs. are required to phase in OBD-II. Starting in 2004 MY, gasoline-fueled Medium Duty Passenger Vehicles (MDPVs) are required to have OBD-II. By the 2006 MY, all Federal vehicles from 8,500 to 14,000 lbs. GVWR will have been phased into OBD-II.

OBD-II system implementation and operation is described in the remainder of this document.

EMD Systems

Engine Manufacturer Diagnostics (EMD) applies to all 2007 MY and beyond California gasoline-fueled and diesel fueled on-road heavy duty engines used in vehicles over 14,000 lbs Gross Vehicle Weight Rating (GVWR). EMD systems are required to functionally monitor the fuel delivery system, exhaust gas recirculation system, particulate matter trap, as well as emission related ECM inputs for circuit continuity and rationality, and emission-related outputs for circuit continuity and functionality. EMD requirements are very similar to current OBD-I system requirements. As such, OBD-I system philosophy will be employed, the only change being the addition of some comprehensive component monitor (CCM) rationality and functionality checks.

EMD vehicles use the same PCM, CAN serial data communication link, J1962 Data Link Connector, and PCM software as the corresponding OBD-II vehicle. The only difference is a different PCM calibration.

The following list indicates what monitors and functions have been altered from OBD-II for EMD calibrations:

Monitor / Feature	Calibration
Misfire Monitor	Same as OBD-II but does not set the MIL.
EGR Cooler Monitor	Same as OBD-II but does not set the MIL.
Glow Plug Monitor	Same as OBD-II but does not set the MIL.
Comprehensive Component Monitor	All circuit checks for components supporting other EMD monitors, as well as those for some of the other components, are the same as OBD-II.
Communication Protocol and DLC	Utilizes CAN communication, same as OBD-II, all generic and enhanced scan tool modes work the same as OBD-II but reflect the EMD calibration that contains fewer supported monitors. "OBD Supported" PID indicates EMD.
MIL Control	Same as OBD-II

General Description 6.0 DIT V8

The 6.0L is a V8 engine designed to meet customer expectations of high horsepower and torque with exceptional fuel economy and low NVH. It must do this while meeting the tough emissions standards set by the EPA and CARB.

Some of the technologies employed to meet these diverse criteria include EVRT (Electronic Variable Response Turbocharger), digital fuel injection system, four valves per cylinder, and electronically controlled cooled EGR. High-pressure oil is used with an intensifier piston to create the extremely high fuel injection pressures required for efficient combustion.

The airflow schematic on the next page shows the path of the air as it is compressed by the turbocharger, cooled by the air-to-air intercooler, and mixed with the cooled EGR gases. The state of this compressed and heated air is sensed by the MAT (manifold air temperature) and MAP (manifold absolute pressure) sensors just before it enters the cylinders. The exhaust gas pressure is measured by the exhaust backpressure gauge (EP) sensor before it exits through the turbocharger.

The EVRT control valve is electronically controlled and uses oil pressure to position the vanes to determine the effective size of the turbine housing to meet a desired backpressure. This backpressure is used to control manifold boost pressure.

An electronic, proportional valve controls EGR rates with an integral position sensor (EGRP). Flows are determined by valve position and the amount that backpressure exceeds boost pressure.

Fuel injection pressures are determined by the high-pressure oil rail (ICP_MPA) that is controlled by the injection pressure regulating (IPR) valve and fed by a high-pressure positive displacement pump.

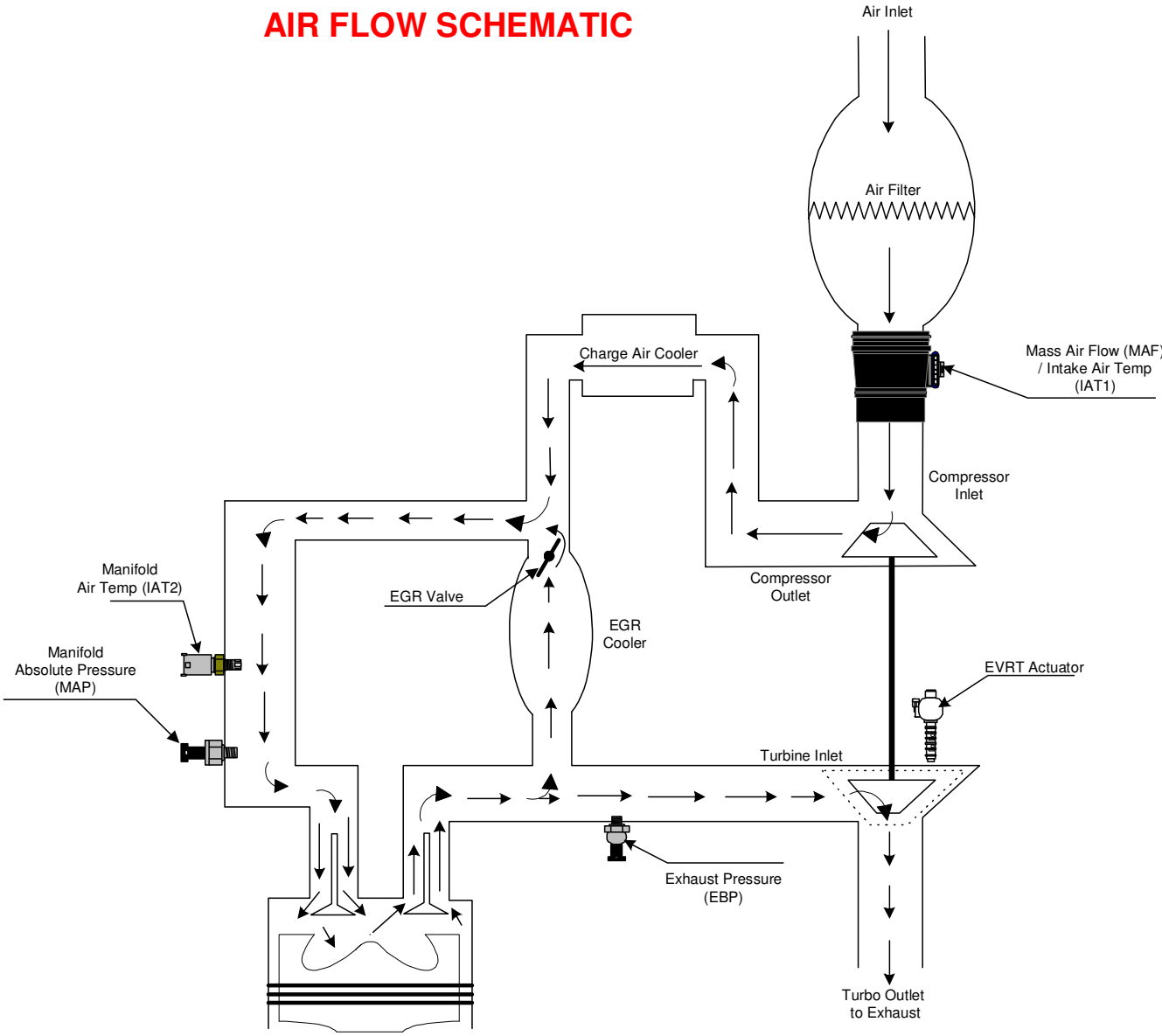
Engine speed (N) and crankshaft position are determined by the crankshaft position sensor (CKP) which reacts to a 60 minus 2 tooth target wheel. Camshaft position (and speed) is determined by the camshaft position sensor (CMP), which reacts to a peg located on the camshaft.

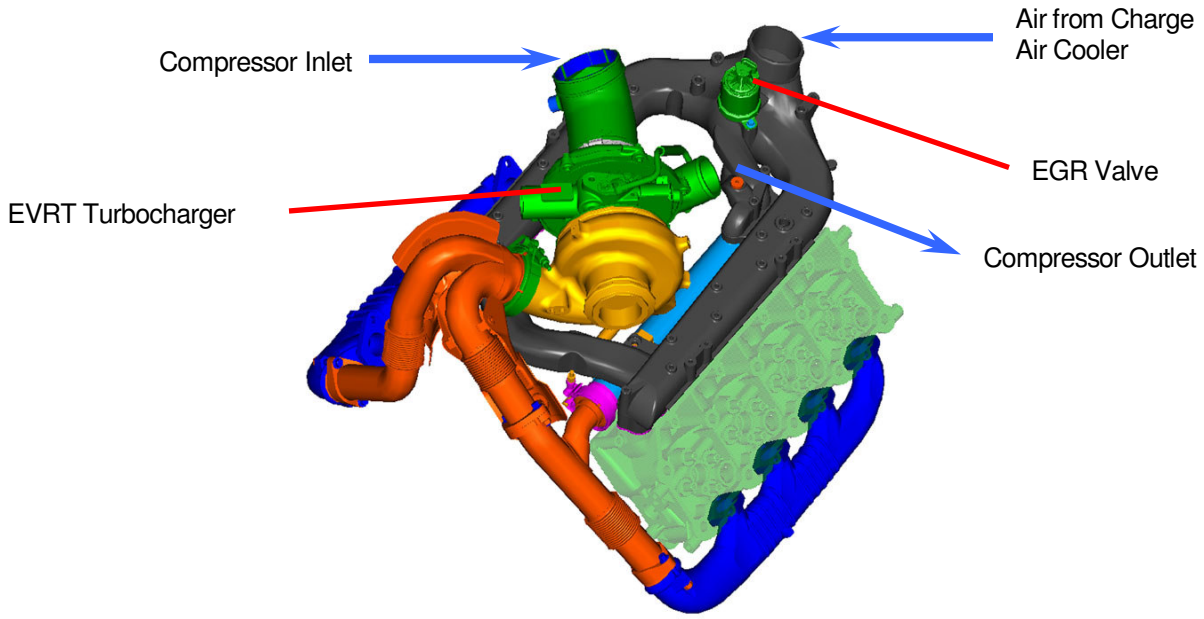
Atmospheric pressure is determined by the barometric pressure (BP) sensor.

During engine operation, the PCM (powertrain control module) calculates engine speed from signals sent by the crankshaft position sensor. The PCM and FICM (fuel injection control module) control engine operation by controlling injector solenoid movement as well as the pressure at which the fuel is injected, thereby controlling fuel quantity (MFDES) and timing (DIT). Simultaneously, airflow is modulated by controlling the turbocharger vane position.

Fuel quantity is controlled by injector “on time” (pulse width) and the oil rail pressure. Required engine speed is determined from the position of the accelerator pedal (PPS).

AIR FLOW SCHEMATIC





Misfire Monitor

Low Data Rate System

The 6.0L Diesel engine utilizes a variable reluctance sensor that processes the edges of a 60-2 tooth stamped target wheel mounted on the crankshaft (CKP). The software gets an edge every 3 degrees and these edges are used for fuel injection timing, fuel quantity control along with the calculation of engine speed. The 6.0L utilizes a second variable reluctance sensor (CMP) that processes a peg mounted on the camshaft for cylinder identification. These two signals are hardware buffered and sent to the Fuel Injector Control Module that performs the injection event.

The LDR Misfire Monitor utilizes the variable reluctance crankshaft (CKP) sensor signal from the 60-2 tooth wheel. There is a missing two-tooth window to provide sync pulses to the CKP sensor along with a CMP peg, which indicates proper camshaft to crankshaft position for correct cylinder timing. The PCM calculates crankshaft rotational velocity for each cylinder from this position signal. The acceleration for each cylinder is then calculated into a percentage delta change decrease in velocity for use by the misfire algorithm. The resulting deviant cylinder acceleration values are used in evaluating misfire.

Misfire is defined as a loss of compression. The amount of compression loss in a cylinder that misfire monitor will detect is referenced as a 3/16" or larger hole in a cylinder or valve train component.

Misfire Algorithm Processing

The acceleration that a piston undergoes during a normal firing event is directly related to the amount of torque that a cylinder produces. For misfire determination the CKP signal is processed at the peak instantaneous inverse velocity angle of 90^{o} after top dead center (ATDC) from the previous cylinder firing event. The calculated inverse velocity of a cylinder under test is compared to the previous cylinder firing event to establish a percentage delta velocity change decrease. A cylinder with a misfire is identified by a large delta velocity value. When the delta value exceeds the calibrated threshold, the misfire algorithm increments the specific cylinders misfire counter.

The number of misfires are counted in a block of 1000 revs. (The misfire counters are not reset if the misfire monitor is temporarily disabled such as an off idle condition, etc.)

To insure accurate misfire calculation and reliable cylinder misfire quantification, misfire data is sampled at engine speeds below 750 RPM. Misfire data becomes unreliable in an operating range outside of the idle region. For this reason other engine operating parameters are monitored to insure misfire operates in a region that yields accurate misfire results. The table below outlines the entry conditions required in order to execute the misfire monitor algorithm.

Misfire Monitor Operation:	
DTCs	P0300 – Random Misfire Detected P0301 – Cylinder 1 Misfire Detected P0302 – Cylinder 2 Misfire Detected P0303 – Cylinder 3 Misfire Detected P0304 – Cylinder 4 Misfire Detected P0305 – Cylinder 5 Misfire Detected P0306 – Cylinder 6 Misfire Detected P0307 –Cylinder 7 Misfire Detected P0308 – Cylinder 8 Misfire Detected
Monitor execution	Continuous every combustion event.
Monitor Sequence	None
Sensors OK	Camshaft Position (CMP) and Crankshaft Position (CKP) No injector faults
Monitoring Duration	Continuous after first 1000 revs.

Typical Misfire Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Fuel desired	None	35 mg/stroke
Engine Oil Temperature	50 ^{o}C	110 ^{o}C
Engine Speed (Low Idle)	600 rpm	750 rpm
Vehicle Speed	0 MPH	1 MPH
Intake Air Temperature	-15 ^{o}C	100 ^{o}C
Exhaust Backpressure Gauge	None	50 kPaG
Injection Control Pressure Duty Cycle	0	50%
PTO off	None	None

Typical Misfire Monitor Malfunction Thresholds:
Greater than 40 occurrences in a block of 1000 revolutions

Exhaust Gas Recirculation Monitor

EGR System and Comprehensive Component Monitors:

The Delta Pressure Exhaust Gas Recirculation (EGR) System is a closed loop EGR Valve Position control system. It utilizes an exhaust manifold pressure sensor, an intake manifold pressure sensor and a speed density estimate of total mass flow and derives a desired EGR Valve position based on a desired EGR flow percentage.

The EGR Monitor is a series of electrical tests and functional tests that monitor various aspects of EGR system operation.

When normal EGR rates are being commanded and when the engine enters into either one of two specified operating ranges, a flow check is performed. The operating ranges are defined to insure an adequate amount of EGR is being requested to allow for an accurate estimate of the EGR flow percentage. At this point EGR flow is estimated based on the difference between the Mass Air Flow (MAF) sensor reading and the total mass flow calculated by the speed density calculation. The estimated EGR flow is then compared to the expected EGR flow to determine if there is insufficient or excessive flow.

Exhaust Gas Recirculation Position Sensor (EGRP):	
DTCs	P0405 – Exhaust Gas Recirculation Sensor A Circuit Low P0406 – Exhaust Gas Recirculation Sensor A Circuit High
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not Applicable
Typical Monitoring Duration	Less than 1 second

Typical Exhaust Gas Recirculation Position Sensor Entry Conditions:
No entry conditions.

Typical Exhaust Gas Recirculation Position Sensor Check Malfunction Thresholds:
Voltage less than 0.30 volts for P0405 and voltage greater than 4.90 volts for P0406

Exhaust Gas Recirculation Valve Actuator (EGRAM) Monitor Operation:	
DTCs	P0403 – Exhaust Gas Recirculation Control Circuit
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Monitoring Duration	Less than 1 second

Typical Exhaust Gas Recirculation Valve Actuator Monitor Entry Conditions:
No Entry Conditions

Typical Exhaust Gas Recirculation Valve Actuator Monitor Malfunction Thresholds:
Actuator driver status indicates open/short

Exhaust Gas Recirculation (EGR) Valve:	
DTCs	P0404 – Exhaust Gas Recirculation Control Circuit Range/ Performance P1335 – EGR Position Sensor Minimum Stop Performance
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Exhaust Gas Recirculation Position (EGRP)
Typical Monitoring Duration	P0404 – Greater than 15 seconds. P1335 – Greater than 3 seconds.

Typical Exhaust Gas Recirculation (EGR) Valve Entry Conditions:
P0404 – Engine Running (mode = 2) P1335 – PCM Reset.

Typical Exhaust Gas Recirculation (EGR) Valve Thresholds:
P0404 – +/- 0.10, out of a total working range from 0 to 1, error from the commanded position to the actual position. P1335 – Fault sets when the Exhaust Gas Recirculation (EGR) closed position exceeds the maximum, 1.20 V based on 5.0V power supply, limit at initial key on.

Exhaust Gas Recirculation (EGR) Monitor Operation:	
DTCs	P0401 - Exhaust Gas Recirculation Flow Insufficient Detected P0402 – Exhaust Gas Recirculation Flow Excessive Detected
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Intake Air temperature Sensor 2 (IAT2). Mass Air Flow Sensor (MAF) Barometric Pressure Sensor (BARO) Intake Air Temperature Sensor (IAT) Engine Oil Temperature Sensor (EOT) Manifold Air Pressure Sensor (MAP) Exhaust Pressure Sensor (EP) Exhaust Gas Recirculation Position Sensor (EGRP) Exhaust Gas Recirculation Valve Actuator Monitor (EGRAM) Electronic Variable Response Turbocharger Actuator (EVRT)
Monitoring Duration	15 seconds cumulative – conditions 1 and 2 30 seconds cumulative – condition 3

Typical Exhaust Gas Recirculation (EGR) Monitor Entry Conditions:
Exhaust Gas Recirculation (EGR) valve close position has been learned and one of the following conditions exist. Condition 1: Exhaust Gas Recirculation (EGR) flow commanded greater than 20%, engine speed (N) 1000-2250 RPM and fueling desired (MFDES) 12-29 mg/stroke Condition 2: Exhaust Gas Recirculation (EGR) flow commanded greater than 20%, engine speed (N) 2250-3150 RPM and fueling desired (MFDES) 10-29 mg/stroke. Condition 3: No Exhaust Gas Recirculation (EGR) flow commanded, EGRP voltage < 1.2V, 0 deg C < EOT and ECT < 60 deg C, 0 deg C < MAT < 30 deg C, engine speed (N) 600-750 RPM and fueling desired (MFDES) 4-20 mg/stroke.

Typical EGR Monitor Malfunction Thresholds:
Limits based on engine speed and load.

Exhaust Gas Recirculation (EGR) Cooler Efficiency Monitor:	
DTCs	P2457 – Exhaust Gas Recirculation Cooler System Performance
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Intake Air temperature Sensor 2 (IAT2). Mass Air Flow Sensor (MAF) Barometric Pressure Sensor (BARO) Intake Air Temperature Sensor (IAT) Engine Oil Temperature Sensor (EOT) Manifold Air Pressure Sensor (MAP) Exhaust Pressure Sensor (EP) Exhaust Gas Recirculation Position Sensor (EGRP) Exhaust Gas Recirculation Valve Actuator Monitor (EGRAM) Electronic Variable Response Turbocharger Actuator (EVRT)
Monitoring Duration	45 seconds

Typical Exhaust Gas Recirculation (EGR) Cooler Efficiency Monitor Entry Conditions:
Exhaust Gas Recirculation (EGR) valve close position has been learned, engine off timer > 60 minutes, engine speed (N) 600-750 RPM, fueling desired (MFDES) 4-16 mg/stroke and Exhaust Gas Recirculation (EGR) valve position greater than 0.08.

Typical Exhaust Gas Recirculation (EGR) Cooler Efficiency Monitor Thresholds:
P2457 – Fault sets if IAT2 > 85 deg .C (F series), > 95 deg. C (E series)

Glow Plug Monitor

Glow Plug Control, Comprehensive Component Monitors, and Wait to Start Indicator—California

The California glow plug system is composed of solid state Glow Plug Control Module (GPCM), glow plugs, glow plug light, and the associated wiring harness. The glow plug on time is controlled by the Powertrain Control Module (PCM) and is a function of oil temperature, barometric pressure and battery voltage. The PCM enables the GPCM that drives the individual glow plugs. Glow plug on time normally varies between 1 and 120 seconds. In addition to PCM control, the GPCM internally limits the glow plug operation to 180 seconds regardless of PCM commanded on time. The power to the glow plugs is provided through the GPCM solid-state drivers directly from the vehicle battery. The GPCM monitors and detects individual glow plug functionality, and the control and communication links to the PCM. The failures detected by the GPCM are passed to the PCM using a serial communication signal on the glow plug diagnostic line.

Glow Plug Module Control Circuit Check:	
DTCs	P0670 – Glow Plug Module Control Circuit
Monitor execution	Continuous (30ms)
Monitor Sequence	None
Sensors OK	Not Applicable
Typical Monitoring Duration	Less than 1 second.

Typical Glow Plug Module Control Circuit Check Entry Conditions:
Glow plugs disabled

Typical Glow Plug Module Control Circuit Check Malfunction Thresholds:
Actuator driver status indicates open/short

Glow Plug Module Diagnostic Communication Circuit Operation:	
DTCs	P0683 – Glow Plug Control Module to PCM Communication Circuit
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Monitoring Duration	Glow plug on time greater than 8.5 seconds.

Typical Glow Plug Monitor Entry Conditions:
Glow plugs enabled

Typical Glow Plug Monitor Malfunction Thresholds:
The Glow Plug Control Module (GPCM) passes Glow Plug status information across the Glow Plug Diagnostic Line. If no Glow Plug pass/fail message string can be determined the P0683 fault is set.

Glow Plug Monitor Operation:	
DTCs	P0671 – Cylinder 1 Glow Plug Circuit P0672 – Cylinder 2 Glow Plug Circuit P0673 – Cylinder 3 Glow Plug Circuit P0674 – Cylinder 4 Glow Plug Circuit P0675 – Cylinder 5 Glow Plug Circuit P0676 – Cylinder 6 Glow Plug Circuit P0677 – Cylinder 7 Glow Plug Circuit P0678 – Cylinder 8 Glow Plug Circuit
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Monitoring Duration	Greater than 8.5 seconds.

Typical Glow Plug Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Battery Voltage (IVPWR)	10 V	14 V

Typical Glow Plug Monitor Malfunction Thresholds:
An Open is a current level less than 4 Amps and a current level above 60 Amps is a short.

Glow Plug Wait to Start Light Operation:	
DTCs	P0381 – Glow Plug/ Heater Indicator Circuit
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second

Glow Plug Light Wait to Start Light Entry Conditions:
Glow Plugs Enabled

Glow Plug Light Wait to Start Light Malfunction Thresholds:
Status internal to Instrument Panel

Lost Communication with Instrument Cluster:	
DTCs	U0155 – Lost Communication with Instrument Cluster
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	500 ms

Lost Communication with Instrument Cluster Entry Conditions:
Glow Plugs Enabled

Lost Communication with Instrument Cluster Malfunction Thresholds:
The PCM requests lamp status (pass/fail) from the cluster, and the cluster sends the information via Standard Corporate Protocol (SCP) communication. If no message is received the U0155 fault is set.

Comprehensive Component Monitor - Engine

Engine Inputs (Analog)

Battery Voltage (IVPWR):	
DTCs	P0562 - System Voltage Low
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 3 seconds.

Typical Battery Voltage Entry Conditions:
No entry conditions.

Typical Battery Voltage Malfunction Thresholds:
Voltage less than 6.51 V.

Barometric Pressure (BARO) Sensor Circuit Check:	
DTCs	P0107- Manifold Absolute Pressure / BARO Sensor Low Input P0108 – Manifold Absolute Pressure/ BARO Sensor High Input
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second

Typical Barometric Pressure Sensor Circuit Check Entry Conditions:
No entry conditions.

Typical Barometric Pressure Sensor Circuit Check Malfunction Thresholds:
Voltage less than 0.25 volts for P0107 and voltage greater than 4.90 volts for P0108.

Manifold Absolute Pressure (MAP) / Barometric Pressure (BARO) Rationality Check:	
DTCs	P0069 – MAP/BARO Correlation
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Barometric Pressure (BP) and Manifold Absolute Pressure (MAP)
Typical Monitoring Duration	Greater than 3 sec.

Typical Manifold Absolute Pressure Functional Check Entry Conditions:
Engine Speed (N) <400 rpm or Engine Speed (N) <800 rpm and Fueling Desired (MFDES) < 25 mg/stroke

Typical MAP / BARO Rationality Check malfunction Thresholds:
The difference between Manifold Absolute Pressure (MAP) and Barometric Pressure (BP) is less than 30kPa.

Manifold Absolute Pressure (MAP) Sensor Circuit Check:	
DTCs	P0237 - Turbo/ Super Charger Boost Sensor A Circuit Low P0238 – Turbo/ Super Charger Boost Sensor A Circuit High
Monitor execution	Continuous (8 ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 10 seconds.

Typical Manifold Absolute Pressure Sensor Circuit Check Entry Conditions:
No Entry Conditions

Typical Manifold Absolute Pressure Sensor Circuit Check Malfunction Thresholds:
Voltage less than 0.10 volts for P0237 and voltage greater than 4.90 volts for P0238.

Manifold Absolute Pressure Functional Check Operation:	
DTCs	P0236 - Turbo/ Super Charger Boost Sensor A Circuit Range/ Performance P2263 - Turbo/ Super Charger Boost System Performance P2262 – Turbo/ Super Charger Boost Pressure Not Detected - Mechanical
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	P0236 – Manifold Absolute Pressure (MAP), Barometric Pressure (BARO), Exhaust Gas Recirculation Position (EGRP) P2263 and P2262 – Manifold Absolute Pressure (MAP), Exhaust Gas Recirculation Position (EGRP).
Typical Monitoring Duration	P0236 – Greater than 10 sec. P2263 and P2262 – Greater than 5sec.

Typical Manifold Absolute Pressure Functional Check Entry Conditions:
P0236 – Fuel Requested (MFDES) is less than 14 mg/stroke, Engine speed (N) is less than 850 RPM.
P2263 – Fuel Requested (VFDES) is greater than 35 mm^3/stk, Engine speed (N) is greater than 2800 RPM, and Exhaust Gas Recirculation Position (EGRP) is less than 15% open.
P2262 – Fuel Requested (VFDES) is greater than 20 mm^3/stk, Engine speed (N) is greater than 2800 RPM, and Exhaust Gas Recirculation Position (EGRP) is less than 15% open.

Typical Manifold Absolute Pressure Functional Malfunction Thresholds:
P0236 – Fault sets if MAP signal is higher than the specified pressure. (MAP > 70 kPa and Manifold Gauge Pressure (MGP) > 30kPa)
P2263 – Fault sets if Manifold Absolute Pressure (MAP) does not increase by 15 kPa.
P2262 – Fault sets if Manifold Absolute Pressure (MAP) does not increase by 5 kPa.

Exhaust Pressure (EP) Sensor Circuit Check:	
DTCs	P0472 - Exhaust Pressure Sensor Low Input P0473 – Exhaust Pressure Sensor High Input
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second

Typical Exhaust Pressure Sensor Circuit Check Entry Conditions:
No Entry Conditions

Typical Exhaust Pressure Sensor Circuit Check Malfunction Thresholds:
Voltage less than 0.03 volts for P0472 and voltage greater than 4.90 volts for P0473.

Exhaust Pressure Functional Check Operation:	
DTCs	P0470 – Exhaust Pressure Sensor P0471 – Exhaust Pressure Sensor Range/ Performance P0478 – Exhaust Pressure Control Valve High Input
Monitor execution	Continuous (8ms)
Monitor Sequence	None.
Sensors OK	Exhaust Pressure (EP) and Exhaust Gas Recirculation Position (EGRP) Difference between Manifold absolute pressure (MAP) and barometric pressure (BARO) is less than 30 kPa
Typical Monitoring Duration	P0470 – Greater than 5 seconds. P0471 – Greater than 3 seconds. P0478 – Greater than 30 seconds.

Typical Exhaust Pressure Functional Check Entry Conditions:
P0470 – Engine off (mode = 0) or cranking (mode=1)
P0471 – Engine speed (N) is greater than 2800 RPM and EGR Position sensor (EGRP) is less than 10% open.
P0478 – The engine is running (mode = 2)

Typical Exhaust Pressure Functional Thresholds:
P0470 – 1) Fault sets if the Exhaust Pressure (EP) is greater than a 150kPa absolute 2) Fault sets if difference between Exhaust Pressure (EP) and average of MAP and BP is greater than 18 kPa
P0471 – Checks for a minimum Exhaust Pressure (EP) (10kPaG).
P0478 – Checks the exhaust pressure sensor (EP) by looking for a pressure above a specified value for the sensor (360kPa).

Exhaust Pressure Functional Check Operation:	
DTCs	P0299 – Turbo/Super Charger Underboost
Monitor execution	Continuous (8ms)
Monitor Sequence	None.
Sensors OK	Exhaust Pressure (EP), Exhaust Gas Recirculation Valve Position Sensor (EGRP)
Typical Monitoring Duration	1. Greater than 15 seconds (N < 800 rpm) 2. Greater than 30 seconds (820 rpm < N < 1995 rpm) 3. Greater than 90 seconds (N > 2000 rpm)

Typical Exhaust Pressure Functional Check Entry Conditions:
Engine is running (mode = 2), Engine Oil Temperature greater than 20 deg C

Typical Exhaust Pressure Functional Thresholds:
Checks for the difference in commanded and actual Exhaust Pressure. 1. 14 kPa (N < 800 rpm) 2. 20 kPa (820 rpm < N < 1995 rpm) 3. 80 kPa (N > 2000 rpm)

Engine Off Timer Check Operation:	
DTCs	P0606 – ECM / PCM Processor (Engine off timer)
Monitor execution	At key on
Monitor Sequence	None
Sensors OK	Engine Oil Temperature (EOT)
Typical Monitoring Duration	Initial 5 minutes of engine operation

Typical Engine Off Timer Check Entry Conditions:
No entry conditions.

Typical Engine Off Timer Thresholds:
Upon POWER UP, if the soak timer is less than a calibratable number (5 minutes), then compare EOT at engine start to the EOT stored in KAM. If the two values are close, (within 30°C) then the test is a pass, and no fault should be reported.

Engine Coolant Temperature (ECT) Sensor Circuit Check:	
DTCs	P0117 - Engine Coolant Temperature Sensor Circuit Low Input P0118 – Engine Coolant Temperature Sensor Circuit High Input
Monitor execution	Continuous (30ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second.

Typical Engine Coolant Temperature Sensor Circuit Check Entry Conditions:
No entry conditions

Typical Engine Coolant Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.04 volts or voltage > 4.74 volts

Engine Coolant Temperature Functional Check Operation:	
DTCs	P0116 - Engine Coolant Temperature Sensor Circuit Range/ Performance P0126 – Engine Coolant Over temperature Condition
Monitor execution	Continuous (30ms)
Monitor Sequence	None.
Sensors OK	Engine Coolant Temperature (ECT), Intake Air Temperature (IAT)
Typical Monitoring Duration	Engine Coolant Temperature (ECT) dependant

Typical Engine Coolant Temperature Functional Check Entry Conditions:
P0116 – 1. Engine speed (N) is greater than 1500 RPM, desired fuel quantity (MFDES) is greater than 30 mg/stroke, and initial Engine Coolant Temperature (ECT) is less than 70 deg C. **2.** Engine speed (N) is greater than 1250 RPM, desired fuel quantity (MFDES) is greater than 12 mg/stroke, and Engine Coolant Temperature is less than 2 deg C different from stored Engine Coolant Temperature. **3. Engine off for 360 minutes.** P0126 - Engine speed (N) is less than 1000 RPM, desired fuel quantity (MFDES) is less than 20 mg/stroke, and initial Engine Coolant Temperature (ECT) is greater than 110 deg C.

Typical Engine Coolant Temperature Functional Thresholds:
P0116 – 1. Low rationality fault sets if Engine Coolant Temperature (ECT) cannot reach a coolant temperature greater than 70 deg C in a given period of time. 2. If the Engine Coolant Temperature (ECT) does not move 2 deg C within 20 minutes, the P0116 fault will be set. P0126 - high rationality fault sets if Engine Coolant Temperature (ECT) cannot reach a coolant temperature less than 110 deg C in a given period of time.

Engine Oil Temperature (EOT) Sensor Circuit Check:	
DTCs	P0197 - Engine Oil Temperature Sensor Circuit Low Input P0198 – Engine Oil Temperature Sensor Circuit High Input
Monitor execution	Continuous (30ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second.

Typical Engine Oil Temperature Sensor Circuit Check Entry Conditions:
No Entry Conditions

Typical Engine Oil Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage less than 0.04 for P0197 and voltage greater than 4.95 for P0198.

Engine Oil Temperature Functional Check Operation:	
DTCs	P0196 - Engine Oil Temperature Sensor Circuit Range/ Performance P0298 – Engine Oil Over temperature Condition
Monitor execution	Continuous (30ms)
Monitor Sequence	None.
Sensors OK	Engine Oil Temperature (EOT), Intake Air Temperature (IAT)
Typical Monitoring Duration	Engine Oil Temperature (EOT) dependant

Typical Engine Oil Temperature Functional Check Entry Conditions:
P0196 – 1. Engine speed (N) is greater than 1250 RPM, desired fuel quantity (MFDES) is greater than 15mg/stroke, and initial Engine Oil Temperature (EOT) is less than 50 deg C. 2. Engine speed (N) is greater than 1250 RPM, desired fuel quantity (MFDES) is greater than 12mg/stroke, and Engine Oil Temperature is less than 2 deg C different from stored Engine Oil Temperature. **3. Engine off for 360 minutes** P0298 - Engine speed (N) is less than 1000 RPM, desired fuel quantity (MFDES) is less than 20mg/stroke, and initial Engine Oil Temperature (EOT) is greater than 110 deg C.

Typical Engine Oil Temperature Functional Thresholds:
P0196 – 1. Low rationality fault sets if Engine Oil Temperature (EOT) cannot reach an oil temperature greater than 50 deg C in a given period of time. 2. If the Engine Oil Temperature (EOT) does not move 2 deg C within 20 minutes, the P0196 fault will be set. P0298 - high rationality fault sets if Engine Oil Temperature (EOT) cannot reach an oil temperature less than

110 deg C in a given period of time.

Intake Air Temperature (IAT) Sensor Circuit Check:	
DTCs	P0112 - Intake Air Temperature Sensor 1 Circuit Low Input P0113 – Intake Air Temperature Sensor 1 Circuit High Input
Monitor execution	Continuous (30ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second

Typical Intake Air Temperature Entry Conditions:
No Entry Conditions.

Typical Intake Air Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage less than 0.15 volts for P0112 and voltage greater than 4.90 volts for P0113.

Intake Air Temperature 2 (IAT2) Sensor Circuit Check:	
DTCs	P0097 - Intake Air Temperature Sensor 2 Circuit Low Input P0098 – Intake Air Temperature Sensor 2 Circuit High Input
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second

Typical Intake Air Temperature 2 Sensor Circuit Check Entry Conditions:
No Entry Conditions.

Typical Intake Air Temperature 2 Sensor Circuit Check Malfunction Thresholds:
Voltage less than 0.15 for P0097 and voltage greater than 4.8 for P0098.

Intake Air Temperature 2 Rationality Check:	
DTCs	P0096 - Intake Air Temperature Sensor 2 Circuit Range/ Performance
Monitor execution	Continuous (8ms)
Monitor Sequence	None.
Sensors OK	P0096 – Intake Air Temperature 2 (IAT2)
Typical Monitoring Duration	P0096 - 10 drive cycles (A drive cycle is defined as an initial Engine Oil Temperature (EOT) that is less than 40 deg C and rises above 80 deg C)

Typical Intake Air Temperature 2 Rationality Check Entry Conditions:
P0096 - Initial Oil Temperature (EOT) is less than 40 deg C.

Typical Intake Air Temperature 2 Rationality Check Malfunctions Thresholds:
P0096 - When the change in Intake Air Temperature 2 (IAT2) is less than specified (5 deg C), the drive cycle increment counter advances.

Intake Air Temperature 1/2 Rationality Check #1	
DTCs	P2199 – Intake Air Temperature 1/2 Correlation
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Intake Air Temperature (IAT), Intake Air Temperature 2 (IAT2)
Typical Monitoring Duration	Greater than 3 seconds and less than 8 seconds.

Typical Intake Air Temperature Functional Entry Conditions:
Key Off Engine Off for greater than 600 minutes.

Typical Intake Air Temperature Functional Thresholds:
When the difference between Intake Air Temperature 2 (IAT2) and Intake Air Temperature (IAT) is greater than the specified value (40 deg C).

Intake Air Temperature 1/2 Rationality Check #2	
DTCs	P2199 – Intake Air Temperature 1/2 Correlation
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Intake Air Temperature (IAT), Intake Air Temperature 2 (IAT2), Engine Oil Temperature (EOT), Engine Coolant Temperature (ECT)
Typical Monitoring Duration	Greater than 8 minutes

Typical Intake Air Temperature Functional Entry Conditions:
Engine speed (N) between 600 and 800 RPM, desired fuel quantity (MFDES) between 4 and 16 mg/stroke, Engine Oil Temperature (EOT) is greater than 85 deg C, and Exhaust Gas Recirculation Valve Position (EGRP) greater than 0.08.

Typical Intake Air Temperature Functional Thresholds:
The Intake Air Temperature 2 (IAT2) is more than 5 deg. C less than the Intake Air Temperature (IAT).

Injection Control Pressure (ICP) Sensor Circuit Check:	
DTCs	P2285 – Injection Control Pressure Sensor Circuit Low P2286 – Injection Control Pressure Sensor Circuit High
Monitor execution	Continuous (8 ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 sec.

Typical Injection Control Pressure Sensor Circuit Check Entry Conditions:
No Entry Conditions

Typical Injection Control Pressure Sensor Circuit Check Malfunction Thresholds:
Voltage less than 0.03 volts for P2285 and voltage greater than 4.9 volts for P2286.

Injection Control Pressure Functional Check Operation:	
DTCs	P2284 - Injector Control Pressure Sensor Circuit Range/ Performance P2290 - Injector Control Pressure Too Low P2288 - Injector Control Pressure Too High P2289 – Injector Control Pressure Too High – Engine Off
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Injection Control Pressure (ICP)
Typical Monitoring Duration	P2284 –greater than 30 seconds (4-5 ICP commanded), greater than 7 seconds (6-27 MPa ICP commanded) P2290 – greater than 30 seconds (4-5 ICP commanded), greater than 7 seconds (6-27 MPa ICP commanded) P2288 – Greater than 3 seconds. P2289 – Greater than 12 seconds.

Typical Injection Control Pressure Functional Check Entry Conditions:
For P2284, P2290, and P2288 the engine must be running (mode =2). For P2289 the engine must be off (mode = 0).

Typical Injection Control Pressure Functional Malfunction Thresholds:
P2284 - Fault sets when actual pressure exceeds the commanded by a specified value. Greater than 2 MPa (4-5 ICP commanded), greater than 3 MPa error (6-27 MPa ICP commanded)
P2290 - Fault sets when actual pressure is less than the commanded by a specified value. Greater than 1 MPa (4-5 ICP commanded), greater than 3 MPa error (6-27 MPa ICP commanded)
P2288 - When the actual pressure is greater than a specified maximum pressure (29.5 MPa)
P2289 - When the actual pressure is greater than a specified maximum pressure (10 MPa)

Keep Alive Memory Monitor (KAM) Operation:	
DTC	P1633 – Keep Alive Memory Circuit
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second.

Typical KAM Monitor Entry Conditions:
Engine is running (mode = 2)

Typical KAM Monitor Malfunction Thresholds:
Internal hardware status indicates open circuit on Keep Alive Memory

Mass Air Flow (MAF) Sensor Circuit Check:	
DTCs	P1102 – Mass or Volume Air Flow Circuit Low Input P0103 – Mass or Volume Air Flow Circuit High Input
Monitor execution	Continuous (8 ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	10 seconds

Typical Mass Air Flow Sensor Circuit Check Entry Conditions:
For P1102 - Engine speed (N) must be greater than 600 rpm.
For P0103 - No entry conditions.

Typical Mass Air Flow Sensor Circuit Check Malfunction Thresholds:
Voltage greater than 4.95 volts for P0103, voltage less than limits for P1102 based engine speed (N) and intake manifold boost pressure (MGP).

Mass Air Flow Functional Check Operation:	
DTCs	P0101 – Mass or Volume Air Flow Circuit Range/ Performance
Monitor execution	Continuous (8ms)
Monitor Sequence	None.
Sensors OK	Mass Air Flow (MAF)
Typical Monitoring Duration	10 seconds

Typical Mass Air Flow Functional Check Entry Conditions:
No entry conditions.

Typical Mass Air Flow Functional Thresholds:
Voltage greater than limits based on engine speed (N) and intake manifold boost pressure (MGP).

Pedal Position Sensor Circuit Check:	
DTCs	P2122 – Throttle/Pedal Position Sensor/Switch D Circuit Low Input P2123 - Throttle/Pedal Position Sensor/Switch D Circuit High Input P2127 - Throttle/Pedal Position Sensor/Switch E Circuit Low Input P2128 - Throttle/Pedal Position Sensor/Switch E Circuit High Input P2132 - Throttle/Pedal Position Sensor/Switch F Circuit Low Input P2133 – Throttle/Pedal Position Sensor/Switch F Circuit High Input
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second

Typical Pedal Sensor Circuit Check Entry Conditions:
No entry conditions

Typical Pedal Sensor Circuit Check Malfunction Thresholds:
P2122 – Less than 0.25 V.
P2123 – Greater than 4.75 V.
P2127 – Less than 0.25 V.
P2128 – Greater than 4.75 V.
P2132 – Less than 0.25 V.
P2133 – Greater than 4.75 V.

Note: Pedal position sensor faults do not illuminate the MIL. If one pedal position sensor fails, there is no drivability impact to the customer. If two or more pedal position sensors fail, the vehicle cannot be driven because the engine remains at idle. Engine emissions are not affected for any of these failures.

Engine Inputs (Digital)

Camshaft Position Sensor (CMP) Check Operation:	
DTCs	P0341 –Camshaft Position Sensor A Circuit Range/ Performance P2614 – Camshaft Position Output Circuit/ Open
Monitor execution	Continuous (8ms)
Monitor Sequence	None.
Sensors OK	Not applicable
Typical Monitoring Duration	Continuous

Typical Camshaft Position Sensor Malfunction Entry Conditions:
P0341- 500 rpm < Engine Speed (N) < 4500rpm P2614- 90 rpm < Engine Speed (N)

Typical Camshaft Position Sensor Malfunction Thresholds:
P0341- Powertrain Control Module (PCM) monitors Camshaft Position Sensor (CMP) signal for a unique valid pattern used to indicate piston position. Checks for the absence of the CMP signal. (10 errors). P2614- Counter increments in Fuel Injector Control Module when the input Camshaft Position Signal (CMP) is absent or when engine is out of sync with respect to the Crankshaft Position Signal (CKP). (10 errors).

Crankshaft Position Sensor (CKP) Monitor Operation:	
DTCs	P0336 - Crankshaft Position Sensor A Circuit Range/ Performance P2617 – Crankshaft Position Output Circuit/ Open
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Continuous

Crankshaft Position Sensor Malfunction Entry Conditions:
P0336 – 500 rpm< Engine Speed (N) < 4500 rpm P2617 – 90 rpm < Engine Speed (N)

Crankshaft Position Sensor Malfunction Thresholds:
P0336 – Powertrain Control Module monitors the Crankshaft Position Sensor (CKP) signal for a unique valid pattern used to indicate piston position. Checks for the absence of the CKP signal. (10 errors). P2617 - Counter increments in Fuel Injector Control Module when the input CKP is absent and increments when engine is out of sync with the Camshaft Position Signal (CMP). (10 errors).

Engine Outputs

Dual Alternator Control Check Operation:	
DTCs	P1149 – Gen 2 Monitor Circuit High
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second.

Typical Dual Alternator Control Entry Conditions:
No entry conditions

Typical Dual Alternator Control Malfunction Thresholds:
Actuator driver status indicates open/short

Electronic Variable Response Turbocharger (EVRT) Check Operation:	
DTCs	P0046 – Turbo/Super Charger Boost Control Solenoid Circuit Range/ Performance
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second.

Typical Electronic Variable Response Turbocharger (EVRT) Check Entry Conditions:
No entry conditions

Typical Electronic Variable Response Turbocharger (EVRT) Check Malfunction thresholds:
Actuator driver status indicates open/short

Injection Control Pressure Regulator Actuator Monitor (IPRAM) Operation:	
DTCs	P2623 – Injection Control Pressure Regulator Open
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 1 second.

Typical IPRAM Entry Conditions:
Engine is off (mode = 0) or running (mode = 2)

Typical IPRAM Malfunction Thresholds:
Actuator driver status indicates open/short

Injection Coil Circuits Monitor Operation:	
DTCs	P0261 - Cylinder 1 Injector Circuit Low P0262 - Cylinder 1 Injector Circuit High P0264 - Cylinder 2 Injector Circuit Low P0265 - Cylinder 2 Injector Circuit High P0267 - Cylinder 3 Injector Circuit Low P0268 - Cylinder 3 Injector Circuit High P0270 - Cylinder 4 Injector Circuit Low P0271 - Cylinder 4 Injector Circuit High P0273 - Cylinder 5 Injector Circuit Low P0274 - Cylinder 5 Injector Circuit High P0276 - Cylinder 6 Injector Circuit Low P0277 - Cylinder 6 Injector Circuit High P0279 - Cylinder 7 Injector Circuit Low P0280 - Cylinder 7 Injector Circuit High P0282 - Cylinder 8 Injector Circuit Low P0283 – Cylinder 8 Injector Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Less than 2 seconds.

Typical Injection Coil Circuits Entry Conditions:
Engine is running (mode = 2)

Typical Injection Coil Circuits Malfunction Thresholds:
Open and shorts are detected by the Fuel Injector Control Module

Fuel Pump Monitor Operation:	
DTCs	P0231 – Fuel Pump Secondary Circuit Low
Monitor execution	Continuous (8ms)
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	Greater than 5 sec.

Fuel Pump Monitor Malfunction Entry Conditions:
Fuel Pump commanded "on", engine not cranking, Battery Voltage (IVPWR) above 11V

Fuel Pump Monitor Malfunction Thresholds:
When the fuel pump monitor sees a voltage other than expected for a specified time after the fuel pump is commanded "on", the fault is set.

Comprehensive Component Monitor - Transmission

General

The MIL is illuminated for all emissions related electrical component malfunctions. For malfunctions attributable to a mechanical component (such as a clutch, gear, band, valve, etc.), some transmissions are capable of not commanding the mechanically failed component and providing the remaining maximum functionality (functionality is reassessed on each power up)- in such case a non-MIL Diagnostic Trouble Code (DTC) will be stored and, if so equipped, a Transmission Control Indicator Light (TCIL) will flash.

5R110W does not have the ability to isolate a shift solenoid fault from the rest of the mechanical/hydraulic system – all detected ratio errors result in MIL illumination except those attributed to the Over Drive and Simpson On-Way Clutches (which cause Neutral condition failures which cannot be caused by an electrical component).

Transmission Inputs

Transmission Range Sensor Check Operation:	
DTCs	P0706 (Out of range signal frequency for PWM TRS) P0707, P0708 (Low /High duty cycle for PWM TRS)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical TRS check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Faults can be detected independent of lever position	none

Typical TRS malfunction thresholds:
For Pulse Width Modulated (PWM) sensor: Frequency > 160 Hz or < 100 Hz, Duty Cycle > 90% or < 10% If an error is present for 5 seconds a fault code will be stored

On some applications vehicle speed is calculated in the PCM by using the transmission output shaft speed sensor signal and applying a conversion factor for axle ratio and tire programmed into the Vehicle ID block. A Vehicle Speed Output pin on the PCM provides the rest of the vehicle with the standard 8,000 pulses/mile signal.

On all other applications vehicle speed is provided by the Anti-lock Brake System (ABS) or a vehicle speed sensor. In either case the vehicle speed input is tested as a "VSS", using fault code P0500.

Note: If the Vehicle ID block has not been programmed a P1639 DTC will be stored and the MIL will be illuminated. If the Vehicle ID block has been programmed with an out-of-range (uncertified) tire size, axle ratio, or NOV, a P1635 DTC will be stored and the MIL will be illuminated.

Output Shaft Speed Sensor Functional Check Operation:	
DTCs	P0720
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical OSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Any forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	800 rpm	
Intermediate shaft rpm	800 rpm	
Vehicle speed (if available)	10 mph	

Typical OSS functional check malfunction thresholds:
Vehicle is inferred to be moving with positive driving torque and OSS < 100 to 200 rpm for 5 seconds

Intermediate Shaft Speed Sensor Functional Check Operation:	
DTCs	P0791
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical ISS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Any forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	800 rpm	
Output shaft rpm	500 rpm	
Vehicle speed (if available)	10 mph	

Typical ISS functional check malfunction thresholds:
Vehicle is inferred to be moving with positive driving torque and ISS < 250 rpm for 5 seconds

Turbine Shaft Speed Sensor Functional Check Operation:	
DTCs	P0715
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical TSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Any forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Intermediate shaft rpm OR	800 rpm	
Output shaft rpm	500 rpm	
Vehicle speed (if available)	10 mph	
Torque converter lock-up (some applications)	N/A	

Typical TSS functional check malfunction thresholds:
vehicle is inferred to be moving with positive driving torque and TSS < 200 rpm for 5 seconds

Vehicle Speed Sensor Functional Check Operation:	
DTCs	P0500*
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical VSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Any forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	1000 rpm	
Intermediate shaft rpm	1000 rpm	
Output shaft rpm	500 rpm	

Typical VSS functional check malfunction thresholds:
Vehicle is inferred to be moving with positive driving torque and OSS > 500 rpm for 30 seconds

NOTE: on stand alone systems (engine controlled by a ECM, transmission by a TCM) the VSS input (usually provide by the ABS system) is diagnosed by the Engine Control Module.
* The P0500 is used on 6.0L Diesel Heavy Duty applications including F-series and Excursion. P0500 is not used on 6.0L Econoline. Econoline does not use VSS sensor as an input to the PCM.

Transmission Fluid Temperature Sensor Functional Check Operation:	
DTCs (all MIL)	P0712, P0713 (open/short) P0711 (range/performance)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	(ECT substituted if TFT has malfunction if not in cold mode or conditions to exit cold mode have been met, see note below)
Monitoring Duration	5 seconds for electrical, 500 seconds for functional check

Typical TFT functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Engine Coolant Temp (hot or cold, not midrange)	> 100 ^{o}F	< 20 ^{o}F
Time in run mode	500 sec	
Time in gear, vehicle moving, positive torque	150 sec	
Time with engine off (soak time)	420 min	
Vehicle Speed	15 mph	

Typical TFT malfunction thresholds:
Electrical check: TFT voltage <0.05 or > 4.6 volts for 5 seconds
TFT functional check (TFT stuck at high temperature or stuck at low temperature): < 6 ^{o}F rise or fall in TFT after startup
NOTES: 5R110W has a feature called "Cold Mode". If TFT is below 0 deg F, the transmission will limit operation to 1st, 2nd, 3rd, and 4th gears (5th and 6th gears are disabled). Cold mode remains in effect until TFT rises above 0 deg F or vehicle operation (based on shift times or heat generated by driving) indicates that TFT should not be in the cold mode range, at which point normal operation is enabled.
Direct clutch apply times cold have forced the addition of this cold mode because the direct clutch takes an unacceptable amount of time to apply below –10 deg F).
TFT failure management – if TFT is failed at start up, the transmission will be placed in cold mode and remain there until TFT is no longer failed and above 0 deg F or the vehicle operating conditions listed above trigger an exit from cold mode. Once out of cold mode, a TFT failure will not trigger cold mode (transmission will only go into cold mode once per power-up)

Transmission Outputs

The 5R110W shift solenoids are functionally tested by monitoring ratio and shift events for proper execution. Clutch system fault codes (since the solenoid cannot be isolated from the rest of the system using ratio alone) are set if the clutch is in the incorrect state for 3 commanded cycles of the clutch.

NOTE: For the Intermediate Clutch, Direct Clutch, and Over Drive Clutch, once the 1st "bad" event is detected, a special test mode is triggered that will cycle a suspected clutch on/off and retest – the clutch system test modes described below typically complete within 30 seconds drive time (vehicle speed > 5mph) after the 1st event.

For the Coast Clutch and Low Reverse Clutch, the test must wait until the customer goes to closed pedal so the diagnostics can test for engine braking. Once the customer tips out, the tests quickly complete; but test mode duration depends on how long until the customer tips out.

Shift Solenoid Check Operation:	
DTCs	SS A - P0750 (SSA open circuit,) P0973 (SSA short to ground) P0974 (SSA short to power) SS B - P0755 (SSB open circuit) P0976 (SSB short to ground) P0977 (SSB short to power) SS C - P0760 (SSC open circuit) P0979 (SSC short to ground) P0980 (SSC short to power) SS D - P0765 (SSD open circuit) P0982 (SSD short to ground) P0983 (SSD short to power) SS E - P0770 (SSE open circuit) P0985 (SSE short to ground) P0986 (SSE short to power)
Monitor execution	electrical - continuous, functional - during off-to-on solenoid transitions
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds

Typical Shift Solenoid electrical check entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	11.0 Volts	15.99 Volts

Typical Shift Solenoid mechanical functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Turbine, intermediate, and output shaft speed	200 rpm	
Gear	In a forward range (for CC and LRC off faults a manual gear must be selected)	
Monitor execution	Both shifting and non-shifting	

Coast Clutch System (functional test of SSA):	
DTCs	P2700 Coast Clutch Failed On or Off P0751 Coast Clutch Failed Off P0752 Coast Clutch Failed On
Monitor execution	CC failed off – detected in 1M, 3M, or 5M CC failed on – detected during 1-2 or 5-6 shifts, then tested in 1A, 3A, or 5A
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	TSS, ISS
Monitoring Duration	3 bad events

Over Drive Clutch System (functional test of SSB):	
DTCs	P2701 Overdrive Clutch Failed On or Off P0756 Overdrive Clutch Failed Off P0757 Overdrive Clutch Failed On
Monitor execution	ODC failed off – detected in 2nd or 6th gear or during 1-2 or 5-6 shifts ODC failed on – detected in 1st, 3rd, or 5th gear or during shifts into 1M, 3M, or 5M
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	TSS, ISS
Monitoring Duration	3 bad events

Intermediate Clutch System (functional test of SSC):	
DTCs	P2702 Intermediate Clutch Failed On or Off P0761 Intermediate Clutch Failed Off P0762 Intermediate Clutch Failed On
Monitor execution	IC failed off – detected in 3rd gear or during shifts into 3rd gear. IC failed on – detected in 1st or 2nd gear or during shifts into 5th or 6th
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	ISS, OSS
Monitoring Duration	3 bad events

Direct Clutch System (functional test of SSD):	
DTCs	P2703 Direct Clutch Failed On or Off P0766 Direct Clutch Failed Off P0767 Direct Clutch Failed On
Monitor execution	DC failed off – detected in 5th or 6th gear or during shifts into 5th or 6th gear. DC failed on – detected in 1st or 2nd gear or during shifts into 3rd gear.
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	ISS, OSS
Monitoring Duration	3 bad events

Low/Reverse Clutch System (functional test of SSE):	
DTCs	P2704 Low Reverse Clutch Failed On or Off P0771 Low Reverse Clutch Failed Off P0772 Low Reverse Clutch Failed On
Monitor execution	LRC failed off – detected in 1M or 2M. LRC failed on – detected during upshifts from 1st or 2nd to any higher gear, tested in 1st or 2nd after a bad shift event.
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	ISS, OSS
Monitoring Duration	3 bad events

Torque Converter Clutch Check Operation:	
DTCs	P0740 TCC solenoid open circuit P0742 TCC solenoid short to ground P0744 TCC solenoid short to power P0741 TCC mechanical functional
Monitor execution	electrical - continuous, mechanical - during lockup
Monitor Sequence	none
Sensors OK	TSS
Monitoring Duration	5 lock-up events

Typical Torque Converter Clutch electrical check entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	11.0 Volts	15.99 Volts

Typical Torque Converter Clutch mechanical functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Throttle Position	steady	
Engine Torque	positive drive torque	
Transmission Fluid Temp	None (test runs any time TCC applied)	275 ^{o}F
Commanded TCC current (0 rpm slip)	None (tested whenever the TCC is commanded on)	None
Not shifting		

Typical TCC malfunction thresholds:
Electrical check: Output driver feedback circuit does not match commanded driver state for 5 seconds (> 1.0 volt if commanded on, < 2.0 volts if commanded off.) Mechanical check: Slip across torque converter > 100 rpm or (on some applications) speed ratio < 0.93

The Electronic Pressure Control solenoid controls line pressure. If EPC fails low, all gears will be failed (loss of all movement). If EPC fails high, engagements will be harsh; but all gears available (no impact on steady state ratio). Therefore, EPC is not functionally monitored on it's own; but is tested as each clutch system is tested (since loss of line pressure will cause result in detection of clutch faults if pressure is lower than required to keep the currently applied clutches from slipping).

Electronic Pressure Control Check Operation:	
DTCs	P0960 – open circuit P0962 – short to ground P0963 – short to power
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	
Monitoring Duration	Electrical: 5 seconds

Typical Electronic Pressure Control mechanical functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	11.0 Volts	15.99 Volts

Typical EPC malfunction thresholds:
Electrical check: Current feedback circuit is less than commanded current for > 5 seconds

5R110W has a single high side switch that provides power to all 7 Variable Force Solenoids (5 shift solenoids, TCC, and EPC). The high side switch has circuit diagnostics, and if failed open a fault code will be stored.

High Side Switch:	
DTCs	P0657 Actuator Supply Voltage A Circuit / Open
Monitor execution	Continuous
Monitor Sequence	none
Monitoring Duration	Electrical: 5 seconds

5R110W (RWD) Transmission

Transmission Inputs

Transmission Range Sensor

The Non-contacting Pulse Width Modulated Transmission Range Sensor (TRS) provides a duty cycle signal for each position. This signal is transmitted at a frequency of 125 Hz. The PCM decodes the duty cycle to determine the driver-selected gear position (Park, Rev, Neutral, OD, 3, 2, 1). This input device is checked for out of range frequency, low duty cycle and high duty cycle input signals. (P0706, P0707, P0708)

Speed Sensors

The Turbine Shaft Speed (TSS) sensor, Intermediate Shaft Speed (ISS) sensor and Output Shaft Speed (OSS) sensor, if equipped, are hall effect inputs that are checked for rationality. The vehicle speed signal is provided from the ABS system to the PCM. If the engine rpm is above the torque converter stall speed and engine load is high, it can be inferred that the vehicle must be moving. If there is insufficient output from the VSS sensor, a malfunction is indicated (P0500). If there is insufficient output from the TSS sensor, a malfunction is indicated (P0715). If there is insufficient output from the ISS sensor, a malfunction is indicated (P0791). If there is insufficient output from the OSS sensor, a malfunction is indicated (P0720).

Transmission Fluid Temperature

5R110W has a feature called "Cold mode". If TFT is below 0 deg F, the transmission will limit operation to 1st, 2nd, 3rd, and 4th gears (5th and 6th gears are disabled). Cold mode remains in effect until TFT rises above 0 deg F or vehicle operation (based on shift times or heat generated by driving) indicates that TFT should not be in the cold mode range, at which point normal operation is enabled.

Direct clutch apply times cold have forced the addition of this cold mode (DC takes excessive times to apply below –10 deg F), and require revisions to TFT failure management – if TFT is failed at start up the transmission will be placed in cold mode and remain there until TFT is no longer failed and above 0 deg F or the vehicle operating conditions listed above trigger an exit from cold mode.

Once out of cold mode a TFT failure will not trigger cold mode (can only go into cold mode once/power-up); but this mode is new to 5R110W.

TFT is monitored for circuit faults (P0712, P0713) and in-range failures (P0711)

For this reason all TFT diagnostics illuminate the MIL on 5R110W.

Transmission Outputs

Shift Solenoids

The Shift Solenoid (SSA, SSB, SSC, SSD, and SSE) output circuits are checked for opens and shorts by the PCM by monitoring the status of a feedback circuit from the output driver (SSA P0750, P0973, P0974; SSB P0755, P0976, P0977; SSC P0760, P0979, P0980; SSD P0765, P0982, P0983; SSE P0770, P0985, P0986).

The shift solenoids will be tested for function. This is determined by vehicle inputs such as gear command, and gear. Shift solenoid malfunction codes actually cover the entire clutch system (using ratio there is no way to isolate the solenoid from the rest of the clutch system. Diagnostics will isolate the fault into clutch functionally (non-electrical) failed off (SSA: P0751, SSB: P0756, SSC: P0761, SSD: P0766, SSE: P0771) and clutch functionally failed on (SSA: P0752, SSB: P0757, SSC: P0762, SSD: P0767, SSE: P0772). These fault codes replace the P2700 level clutch fault codes previously used since the additional information of the failed state of the clutch adds value for service.

Torque Converter Clutch

The Torque Converter Clutch (TCC) output circuit is a duty-cycled output that is checked electrically for opens and shorts internally in the PCM by monitoring the status of a feedback circuit from the output driver (P0740, P0742, P0744).

The TCC solenoid is checked functionally by evaluating torque converter slip under steady state conditions when the torque converter is fully applied. If the slip exceeds the malfunction thresholds when the TCC is commanded on, a TCC malfunction is indicated (P0741).

Electronic Pressure Control

The EPC solenoid is a variable force solenoid that controls line pressure in the transmission. The EPC solenoid has a feedback circuit in the PCM that monitors EPC current. If the current indicates a short to ground (low pressure), a high side switch will be opened. This switch removes power from all 7 VFS's, providing Park, Reverse, Neutral, and 5M (in all forward ranges) with maximum line pressure based on manual lever position. This solenoid is tested for open (P0960), short to ground (P0962), and short to power (P0963) malfunctions.

High Side Switch

5R110W has a high side switch that can be used to remove power from all 7 VFS's simultaneously. If the high side switch is opened, all 7 solenoids will be electrically off, providing Park, Reverse, Neutral, and 5M (in all forward ranges) with maximum line pressure based on manual lever position. The switch is tested for open faults (switch failed closed will provide normal control). If the switch fails, a P0657 fault code will be stored.

CAN Communications error

The TCM receives critical information from the ECM via CAN. If the CAN link fails, the TCM no longer has torque or engine speed information available – the high side switch will be opened. The TCM will store a U0100 fault code if unable to communicate with the TCM.