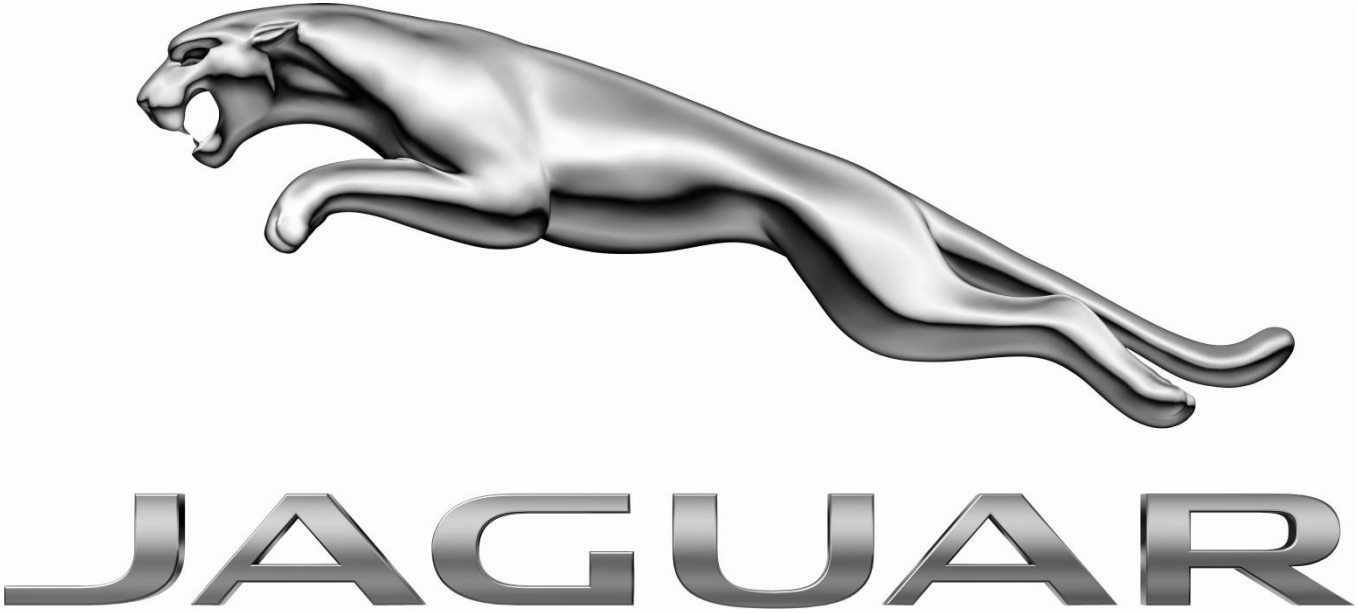


ON-BOARD DIAGNOSTICS
V6 and V8 Engine Management

Vehicle Coverage:

X-Type 2.5L V6 and 3.0L V6 2001 model year onwards
X-Type 2.0L V6 2001 model year onwards
S-Type 3.0L V6, 4.2L V8 (normally aspirated and supercharged) from 2002 model year onwards
XK Range 4.2L V8 (normally aspirated and supercharged) from 2003 model year onwards
New XJ 4.2L V8 2003 model year onwards.
Includes Anti-lock Braking System (ABS) monitors from 2004 model year

1 Contents

2 OBDII Systems

California On-Board Diagnostics II (OBD) applies to all gasoline engine vehicles up to 14,000 lbs. Gross Vehicle Weight Rating (GVWR) starting in the 1996 model year and all diesel engine vehicles up to 14,000 lbs. GVWR starting in the 1997 model year.

"Green States" are states in the Northeast that chose to adopt California emission regulations, starting in the 1998 model year. At this time, Massachusetts, New York, Vermont and Maine are Green States. Green States receive California certified vehicles for passenger cars and light trucks up to 6,000 lbs. GVWR.

The National Low Emissions Vehicle program (NLEV) requires compliance with California OBDII, including 0.020" Evaporative Emissions (EVAP) system monitoring requirements. The NLEV program applies to passenger cars and light trucks up to 6,000 lbs. GVWR nationwide from 2001 model year through 2003 model year.

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

OBDII system implementation and operation is described in the remainder of this document.

2.1 Generic OBD-II Drive Cycle

For each monitoring strategy, the OBD-II drive cycle to be used is stated. The purpose of the drive cycle is to run the onboard diagnostics monitoring strategy under consideration. The number of drive cycles that must be completed in order to illuminate the MIL is given in the Monitoring Operation table for each monitoring strategy. The drive cycle should be performed after any Diagnostic Trouble Codes (DTCs) have been erased from the ECM's memory, or after the battery has been disconnected.

Unless stated otherwise, the following generic drive cycle will apply:

Start engine and bring to normal operating temperature > 82 °C (180 °F).For the duration of the drive cycle, fuel level should remain between 30% and 85%.

Complete the following drive cycle elements in order:

- Steady drive between 65km/h (40mph) and 100km/h (60mph) for > 10mins, avoiding conditions resulting in excessive fuel movement, such as sudden lane changes.

- Two consecutive ‘coast downs’ are required. Drive steady at approximately 3500rpm for 1 minute in 3rd.gear. Release pedal and coast to stop (desired duration for coast down is approximately 30 seconds). Do not touch accelerator pedal for 4 seconds after coming to a stop. On completion of second coast down, idle the vehicle for > 11 minutes.
- In neutral, increase revs to 2500rpm and hold for a further 5 minutes. Drive vehicle ensuring that vehicle speed exceeds 15 km/h (10 mph) and the engine speed exceeds 1500rpm.

A number of monitors require a cold start (e.g., first start of the day for the car) in order to run. Ensure that engine coolant temperature is below 40 °C (104°F) before starting drive cycle.

The above drive cycle does not cover the driving conditions required to run the evaporative system monitor. Refer to Technical Service Bulletin 021210 for a drive cycle specific to the evaporative system monitor.

3 Engine Management System

The Engine Control Module (ECM) controls the engine management system. The system consists of an ECM and a number of sensing and actuating devices. The sensors supply the ECM with input signals, which relate to engine operating conditions and driver requirements. The ECM uses calibrated data-tables and maps to evaluate the sensor information. The ECM then uses the results to command an appropriate response from the actuating devices. The system provides the necessary engine control accuracy and adaptability to:

- Minimize exhaust emissions and fuel consumption.
- Provide optimum driver control under all conditions.
- Minimize evaporative fuel emissions.
- Provide system diagnostics when malfunctions occur.

In addition to these functions the ECM also interfaces with other vehicle systems through the Controller Area Network (CAN) communications network.

The 32-bit ECM is at the center of the system and provides the overall control. Its functions are listed below, each of which are dependent on the engine and vehicle state at any moment of time and driver requirements.

- Starting: Ensures that conditions are safe to crank the engine.
- Engine: Controls the rate of air and fuel flow into the cylinders; adjusts the intake manifold volume; controls the ignition and intake camshaft timing.
- Fuel supply: Controls the operation of the fuel pumps and the EVAP canister purge valve.
- Cooling: Controls the engine cooling fans.
- Battery: Optimizes the battery charging conditions.
- Air Conditioning (A/C) and screen heater: Controls the speed of the engine when these additional loads are added, also disables the A/C when it is beneficial to reduce the load on the engine.
- Speed control: Provides the option to maintain a fixed vehicle speed without driver intervention.
- Robustness: Maintains engine running condition under intermittent or permanent single point failures on any sensors or actuators fitted to the system, and records Diagnostic Trouble Codes (DTCs) of these failures for system diagnosis.
- Diagnosis: Notifies the driver when a system malfunction occurs and records data for system diagnosis.

3.1.1 Fuel Injection

The ECM controls one injector per cylinder in sequential operation. The size of the injector used is so that stoichiometric control is possible at minimum load with allowance for EVAP canister purge valve correction, and at maximum load to provide sufficient fuel flow at all engine speeds. The timing of injector firing, relative to intake valve closing, during normal starting and running conditions is optimized to provide the best compromise between emissions and performance, time to first-ignition and smooth engine operation at start-up, for all engine conditions at all temperatures. The mass of fuel per-injection is derived from a calculation based on a ratiometric match to the metered airflow.

The ECM is capable of adapting to fuel system tolerances and engine internal wear under all operating conditions. The ECM continually monitors the differential pressure between the fuel rail and plenum, and uses this value to calculate the injector pulse width with the required mass of fuel per-injection. The ECM also continually monitors the temperature of the fuel being injected into the engine and provides compensation for the changing flow characteristics of the fuel system at different temperatures. By monitoring the battery supply voltage the ECM can ensure that the fuel supply to the engine is unaffected by voltage fluctuation.

3.1.2 Ignition

The system uses one ignition coil per-cylinder. A base ignition map is provided so that the engine can be optimized for emissions, fuel economy, performance and avoidance of cylinder knock throughout its speed and load range. Ignition timing during starting is used during engine cranking and under speed modes to provide the best compromise between emissions, time to first ignition and smooth engine operation at start up, at all temperatures. Provision is made to compensate for the effect of changing air intake temperature on the combustion detonation limit. The system contains the necessary hardware for the detection of combustion knock within the engine cylinders; the ECM uses this information to gradually adjust the ignition timing until the combustion knock is at a safe and inaudible level.

3.1.3 Variable Valve Timing (Normally Aspirated Engines)

The ECM controls the fully variable phase change system, which acts on the intake camshafts. The target positions of both camshafts are optimized to provide the best compromise between performance, refinement, fuel economy and emissions. During transient operation, the rate of change of the Camshaft Position (CMP) is controlled to optimize drivability. Operation of the Variable Valve Timing (VVT) will be restricted if environmental conditions exist that could affect normal operation of the VVT, for example very low ambient temperatures. Provision is made to ensure that the intake camshafts are restrained in the retard position during engine start. The ECM will also detect a variable valve timing mechanical malfunction, and act to compensate for the malfunction.

3.1.4 Variable Air Intake System (V6 Engines)

The ECM controls two intake manifold tuning valves. Each valve is a two positional device; the switching point of the valve is dependant on engine speed and a definable change in engine performance. The valve switching points are optimized for maximum torque in the wide-open Throttle Position (TP).

3.1.5 Exhaust Gas Recirculation (V8 Engines)

The ECM controls the flow of exhaust gases to reduce oxides of nitrogen in emissions by re-circulating metered amounts of exhaust gas into the intake of the engine. This lowers the combustion temperature, limiting the formation of nitrogen oxides. The Exhaust Gas Recirculation (EGR) flow is optimized for fuel economy, emissions and drivability for all engine-operating conditions.

3.1.6 Electronic Throttle Control

The electronic throttle controls the airflow into the engine under closed loop feedback control of the ECM. The correct throttle disc position is calculated as a function of driver demand and of the engine's momentary operating mode. A fail safe system is incorporated that complies with legislative requirements, including mechanical limp-home operation.

3.1.7 Idle Speed Control

Idle speed is dependent on Engine Coolant Temperature (ECT) and gear selection (neutral or drive). Idle speed is optimized for combustion stability, idle quality, Idle Speed Control (ISC) capability and fuel economy at all operating conditions. Compensations to the idle speed will be made for conditions, such as variable ambient air temperature, to increase idle speed to satisfy charging system requirements.

3.1.8 Vehicle Speed Control

The engine management system incorporates a speed control system. This enables the driver to set a speed, and control and maintain the speed of the vehicle without having to operate the accelerator pedal. The speed control switches are momentary action switches, mounted on the steering wheel. The function of the switches is organized so that a function relating to a switch of higher priority always overrides a function relating to a lower priority switch. The switch priority is:

- 1. Cancel
- 2. Set
- 3. Resume

4 Sensors and Actuators

The following table defines the function of the engine mounted sensors and actuators:

Component	Function
Fuel injectors	Delivers fuel to the engine cylinder intake ports in sequential order. There are 12 fuel injection holes per cylinder, delivering fuel droplets as small as 60 microns in diameter. This size of fuel droplet reduces fuel wetting of the intake port and promotes excellent fuel air mixing. Reducing noxious emissions and improving fuel economy while the engine is warming up.
On-plug ignition coil	The ECM controls one coil per spark plug in sequential order. The ignition coil provides the energy to the spark plug to ignite the air fuel mixture in the engine cylinder. The ignition coil works on the principle of 'mutual induction'. By closing and then opening the ignition coil primary circuit, the primary current increases, and then suddenly decreases to induce the high voltage in the secondary circuit needed to fire the spark plug.
CMP sensor	Signals from the CMP sensors are used to synchronize the ECM to the engine cycle during engine starting. For example, whether the Crankshaft Position (CKP) sensor is indicating an induction or firing stroke. The position of both intake camshafts is monitored to allow the ECM to control the phase of the intake camshafts relative to the position of the crankshaft. On engines with VVT, the CMP sensor provides feedback control on the intake camshaft's position relative to the position of the crankshaft and exhaust camshafts.
Oil control solenoid - VVT (normally aspirated engines)	The oil control solenoid is a hydraulic actuator, which advances and retards the intake camshaft timing, thereby altering the camshaft-to-crankshaft phasing.
Manifold Absolute Pressure (MAP) sensor	The manifold absolute pressure sensor is used for EGR diagnostic testing only.
Knock sensor	The knock sensors produce a voltage signal with respect to the engine's combustion level. The knock sensor detects and reports combustion knock within the engine cylinders. The ECM uses this information to gradually adjust the ignition timing until the combustion knock is at a safe and inaudible level. The knock control system cannot advance the ignition past the mapped values; it retards the ignition timing to reduce combustion knock and then advances to its original value.
Fuel rail pressure sensor	Continuously monitors the fuel pressure between the fuel rail and plenum, this value is used by the ECM as one of its factors to calculate the injector pulse-width required to deliver the correct mass of fuel per injection. The ECM also uses this information to demand a specific fuel flow rate from the fuel pump via the fuel pump module.
Fuel rail temperature sensor	The fuel rail temperature sensor continuously monitors the temperature of fuel being injected into the engine; this value is used by the ECM to provide compensation for the changing flow characteristics of the fuel system with temperature. The ECM therefore ensures that engine performance is unaffected by temperature changes in the fuel supply.
Intake manifold tuning valves (V6 engines)	The intake manifold tuning valves are a two positional 'open or close' device used to create a variable air intake system. The intake manifold tuning valve positions are switched, via signals from the ECM, to optimize torque across the engine speed and load range. The intake manifold tuning valves work in conjunction with the operation of the throttle body sensors.

Component	Function
Throttle body assembly	The throttle body controls the airflow into the engine by use of the throttle motor and Throttle Position (TP) sensor. Throttle-disc position is operated by the throttle motor using signals received from the Accelerator Pedal Position (APP) sensor, via the ECM. The ECM, via the TP sensor, monitors throttle disc angle. The ECM on application of external loads, for example the A/C compressor, makes compensation to the throttle disc angle.
Mass Airflow (MAF) sensor with integrated Intake Air Temperature (IAT) sensor	The MAF sensor informs the ECM of the rate of airflow entering the engine by producing a voltage, which increases as the rate of airflow increases. The MAF sensor also takes into account the density of air entering the engine so it is possible to maintain the required air fuel ratio, and compensate for variations in atmospheric pressure and temperatures. The integral IAT sensor measures the temperature of the air entering the intake system. The ECM uses this information to compensate for higher than normal IAT upon combustion detonation.
CKP sensor	The CKP sensor is an inductive pulse generator, which scans protrusions on a pulse ring, to inform the ECM of the crankshaft's position and engine speed.
Engine Coolant Temperature sensor	The thermistor type sensor provides an input signal to the ECM, which is proportional to the temperature of the engine coolant being circulated around the coolant system.
Engine Oil Temperature (EOT) sensor	The thermistor type sensor provides an input signal to the ECM, which is proportional to the temperature of the oil being circulated around the engine oil passageways.
Heated Oxygen Sensor (HO2S) 1	The HO2S 1 is a linear characteristic type sensor, fitted forward of the exhaust system's catalytic converter. The sensor is used by the ECM as a primary sensor to measure oxygen content within the exhaust system. The sensor is used in conjunction with the ECM to provide closed loop fuelling control.
HO2S 2	The HO2S 2 is a non-linear characteristic type sensor fitted to the exhaust system's catalytic converter, and is used by the ECM as a secondary sensor to measure oxygen content within the exhaust system. Used in conjunction with the ECM and the HO2S 1, the HO2S 2 aids closed loop fuelling control. It is also used to monitor catalyst efficiency.
EGR valve	A defined portion of the engine's exhaust emissions is extracted and returned to the intake mixture via a solenoid valve, as controlled by the ECM.
Air intake control flap solenoid (S/C engine)	The ECM directly controls the solenoid, to open and close the air intake control flap in the air cleaner assembly. The control flap is opened at high engine speed and loads to satisfy engine air charge requirements.
Engine oil pressure switch	This switch is connected to the Instrument Pack (IPK) and is used for a low oil pressure warning. It is not used by the engine management system.

5 Mode $06 Data

SAE J1979 Mode $06 Data			
Test ID	Comp ID	Description	Units
$02	$00	Catalyst system efficiency below threshold 1 - bank (delay time)	msec
$04	$00	Catalyst system efficiency below threshold 2 - bank (delay time)	msec
Conversion for TID $02 and $04: Multiply by 4 to get result in milliseconds.			
$06	$00	EVAP system leak detected (20 thou)	kPa
$07	$00	EVAP system leak detected (gross leak)	kPa
$08	$00	EVAP system leak detected (40 thou)	kPa
Conversion for TID $06 and $08: Multiply by 6.25/1024, then subtract 4.125 to get result in kPa. Conversion for TID $07: Multiply by 6.25/1024 to get result in kPa.			
$09	$00	EGR system flow malfunction (GA changing rate low)	g/sec
$0A	$00	EGR system flow malfunction (GA changing rate high)	g/sec
Conversion for TID $09 and $0A: Multiply by 400/65536, then subtract 200 to get result in g/sec. Result can be positive or negative.			
$0B	$00	EVAP system flow check	None
$0C	$00	EVAP system flow check	None
Conversion for TID $0B and $0C: Multiply by 0.5/65536.			
$0D	$00	EVAP system flow check	None
$0E	$00	EVAP system flow check	None
Conversion for TID $0D and $0E: Multiply by 2/65536.			
$0F	$00	EVAP system flow check	rpm
$10	$00	EVAP system flow check	rpm
$11	$00	EVAP system flow check	rpm
Conversion for TID $0F, $10 and $11: Multiply by 100/256 to get result in RPM.			
$12	$00	EVAP system flow check	g/sec
Conversion for TID $12: Multiply by 1/1024 to get result in g/sec.			
$13	$00	Catalyst system efficiency below threshold 1 - bank (high airflow)	None
$14	$00	Catalyst system efficiency below threshold 2 - bank (high airflow)	None
Conversion for TID $13 and $14: Multiply by 1.25/256			
$1A	$00	Upstream HO2S 11 lean to rich response time counter	msec
$1B	$00	Upstream HO2S 21 lean to rich response time counter	msec
Conversion for TID $1A and $1B: Multiply by 64 to get result in msec.			
$1C	$00	Upstream HO2S 11 minimum sensor current for test cycle	mA
$1D	$00	Upstream HO2S 21 minimum sensor current for test cycle	mA
$1E	$00	Upstream HO2S 11 maximum sensor current for test cycle	mA
$1F	$00	Upstream HO2S 21 maximum sensor current for test cycle	mA
Conversion for TID $1C, $1D, $1E and $1F: Multiply by 1/256, then subtract 128 to get result in mA. Result can be positive or negative.			
$21	$00	EGR system flow malfunction (MAP changing rate low)	kPa
$22	$00	EGR system flow malfunction (MAP changing rate high)	kPa
Conversion for TID $21 and $22: Multiply by 500/65536, then subtract 133.35 to get result in kPa. Result can be positive or negative.			

6 On Board Monitoring

The vehicle drive train is continually monitored throughout its life to maintain its proper function and ensure that emission levels do not exceed accepted limits.

6.1 Catalyst Efficiency Monitor

Catalytic converters oxidize unburned Hydrocarbons (HC) and Carbon Monoxide (CO) by combining them with oxygen to produce water vapor, and reduce nitrogen oxides to nitrogen and oxygen. When the engine air fuel ratio is lean, the oxygen content of the catalytic converter reaches its maximum value. When the air fuel ratio is rich, the oxygen content is depleted. If the air fuel ratio remains rich for an extended period, the converter may fail to convert the harmful gases.

The Catalyst monitor operates once per trip, and is not a continuous monitor.

The monitor waits until all entry conditions are met, including the modeled catalyst temperature reaching its threshold. Once all entry conditions are met, the monitor starts to run. The fuelling is cycled rich and lean (called dither) by approximately 3% to get a reaction at the downstream Oxygen Sensor (O2S). At the start of the monitor, delay counters operate so that the fuelling is stable when the diagnosis takes place. If the entry conditions then drop out, the monitor result and execution timer are held at the values that they were when the entry conditions dropped out. The next time entry conditions are met the monitor carries on from where it stopped previously. This will happen for a maximum of four attempts, after this, the monitor will reset and the diagnosis restarts.

The monitor runs for a calibratable period of time, after which the monitor results are made. The monitor results are decided by accumulating the locus of the downstream O2S signal versus the accumulation of the upstream O2S. The more active the downstream sensor, the less oxygen storage capacity the catalyst has, so the higher the locus value.

With a 100,000-mile catalyst, the downstream O2S is not so active, so lower locus values are obtained.

A judgment is made when the monitor has finished. The judgment made can either be "normal" or "fail". The normal judgment is made if the accumulated count is lower than a calibratable threshold at the judgment point. The failure judgment is made if the accumulated count equals or exceeds the calibratable threshold at the judgment point. If a failure judgment is made, then the relevant DTCs are stored within the engine management system.

6.1.1 Monitoring Structure

Catalyst Monitoring Operation – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Catalyst efficiency Bank A	P0420	Ratio of locus of upstream/ downstream HO2S during mixture dither.	Accumulative locus of downstream sensor	> 17	Engine speed Closed lop fuelling Engine Coolant Temperature	1300 to 3000 RPM Active 75 to 120 °C	30s	2 Drive Cycles
Catalyst efficiency Bank B	P0430				Intake Air Temperature Mass Airflow Atmospheric pressure Airflow change Engine speed change Throttle angle change Idle Sub feedback compensation Air fuel ratio compensation Linear air fuel ratio compensation Fuel level	-20 to 110 °C 14 to 65 g/s > 70.0 kPa < 30 g/s/s < 360 RPM/s < 10 deg/s Inactive 0.9 to 1.1 0.75 to 1.25 0.5 to 1.5 > 11%		2 Drive Cycles
					Disable:	P0101, P0102, P0103, P0104, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0125, P0128, P0222, P0223, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0443, P0444, P0445, P0460, P0603, P1224, P1229, P1251, P1313, P1314, P1316, P1367, P1368, P1609, P1611, P1631, P1633, P1637, P1642, P1215, P1216, P1344, P1234, P1236, P1338, P3029		
					Bank A	P0031, P0032, P0037, P0038, P0137, P0138, P0140, P0171, P0172, P0201, P0203, P0205, P0207, P0351, P0353, P0355, P0357		
					Bank B	P0051, P0052, P0057, P0058, P0157, P0158, P0160, P0174, P0175, P0202, P0204, P0206, P0208, P0352, P0354, P0356, P0358		

Catalyst Monitoring Operation – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Catalyst efficiency Bank A	P0420	Ratio of locus of upstream/ downstream HO2S during mixture dither.	Accumulative locus of downstream sensor	>=14 (X-Type) >= 16 (XK8) >= 17 (XJ) >= 18 (V6 S-Type)	Engine speed (RPM) Closed loop fuelling Engine Coolant Temperature	1300 to 2900 (X-Type) 1300 to 3000 (V8) 1300 to 3250 (V6 S-Type) Active 75 to 119 °C	30s 20s (X-Type)	2 Drive Cycles
Catalyst efficiency Bank B	P0430				Intake Air Temperature Mass Airflow Atmospheric pressure Airflow change Engine speed change Throttle angle change Idle Sub feedback control Short term fuel trim Total fuel trim Fuel level	-20 to 101 °C -8.13 to 110 °C (X-Type) 10 to 65 g/s 10 to 40 g/s (X-Type) >= 70.0 kPa >= 75.5 kPa (X-Type <= 30 g/s/0.512s <=20 g/s/0.512s (X-Type) <= 360 RPM/0.512s <= 10 deg/1.024s Inactive 0.9 to 1.1 0.75 to 1.25 0.5 to 1.5 >= 11%		2 Drive Cycles
					Disable:	C1137, C1145, C1155, C1165, C1175, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0125, P0128, P0181, P0182, P0183, P0191, P0192, P0193, P0222, P0223, P0441, P0443, P0444, P0445, P0460, P0603, P1104, P1224, P1229, P1233, P1234, P1236, P1251, P1313, P1314, P1316, P1338, P1339, P1367, P1368, P1609, P1611, P1631, P1633, P1637, P1642		2 Drive Cycles
					Bank A	P0031, P0032, P0037, P0038, P0133, P0137, P0138, P0140, P0171, P0172, P0201, P0203, P0205, P0207, P0351, P0353, P0355, P0357		2 Drive Cycles

Catalyst Monitoring Operation – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
					Bank B	P0051, P0052, P0057, P0058, P0153, P0157, P0158, P0160, P0174, P0175, P0202, P0204, P0206, P0208, P0352, P0354, P0356, P0358	2 Drive Cycles	
					Disable Additions:	P0069, P0607, P0627, P0628, P0629, P2118, P2119, P2135, P2228, P2229, P2632, P2633, P2634, P2635, P2636	2 Drive Cycles	

Catalyst Monitoring Operation – 2008 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Catalyst Monitoring Catalyst efficiency bank A Catalyst efficiency bank B	P0420 P0430	U/s HO2S signal locus compared to d/s HO2S signal locus during A/F dither.	Locus ratio	>= 13	Engine Speed Engine Coolant Temperature Intake Air Temperature Mass Airflow RPM change TP change MAF change Atmospheric pressure Sub F/B trim Total A/F trim (long + short term) short term A/F trim CL A/F control & sub F/B control Idle Fuel level	1300 < N < 3000 rpm >= 78 degC -8 < T < 110 degC 10 < MAF < 45 g/s <= 360 /512ms <= 15.0deg/1024ms <= 30 g/s/512ms >= 75.5 kPa 0.9 < F < 1.1 0.5 < F < 1.5 0.75 < trim < 1.25 Active Inactive >= 11 %	20 s	2 Drive Cycles

Catalyst Monitoring Operation – 2008 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
					Fault Codes that disable P0420	P0300 P0301 P0303 P0305 P0302 P0304 P0306 P1313 P1314 P1316 P0133 P0138 P0137 P0140 P0172 P0171 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0351 P0353 P0355 P1367 P1368 P0201 P0203 P0205 P0031 P0032 P0444 P0445 P0443 P0112 P0113 P0111 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P0054 P0038 P0037 P1637 P1642 P0603 P0460 P1609 P0128 P0193 P0192 P0191 P0181 C0037 C003A P0501 P2119 P2118 P0122 P0123 P0222 P0223 P2135 P1251 P1631 P0607 P1633		
					Fault Codes that disable P0430	P0300 P0301 P0303 P0305 P0302 P0304 P0306 P1313 P1314 P1316 P0153 P0158 P0157 P0160 P0175 P0174 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0352 P0354 P0356 P1367 P1368 P0202 P0204 P0206 P0051 P0052 P0444 P0445 P0443 P0112 P0113 P0111 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P0060 P0058 P0057 P1637 P1642 P0603 P0460 P1609 P0128 P0193 P0192 P0191 P0181 C0037 C003A P0501 P2119 P2118 P0122 P0123 P0222 P0223 P2135 P1251 P1631 P0607 P1633		

6.1.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.2 Misfire Monitor

A misfire is caused by a failure of combustion. When this occurs, unburned HC and excess oxygen are exhausted from the cylinder. Consequently, the catalytic converter may suffer damage through overheating as it tries to convert the excessive HC. Secondly, the O2S will report a lean condition to the ECM, which in turn will increase the injector pulse width and add more raw fuel to the exhaust stream.

The misfire detection monitor is continuous and is designed to detect levels of misfire that can cause thermal damage to the catalyst and/or result in excessive tailpipe emissions. Determination of a misfire is made by analysis of changes in crankshaft speed, a misfire causing a drop in acceleration after an anticipated firing event. This data is analyzed in four ways to ensure all possible combinations of misfire can be detected.

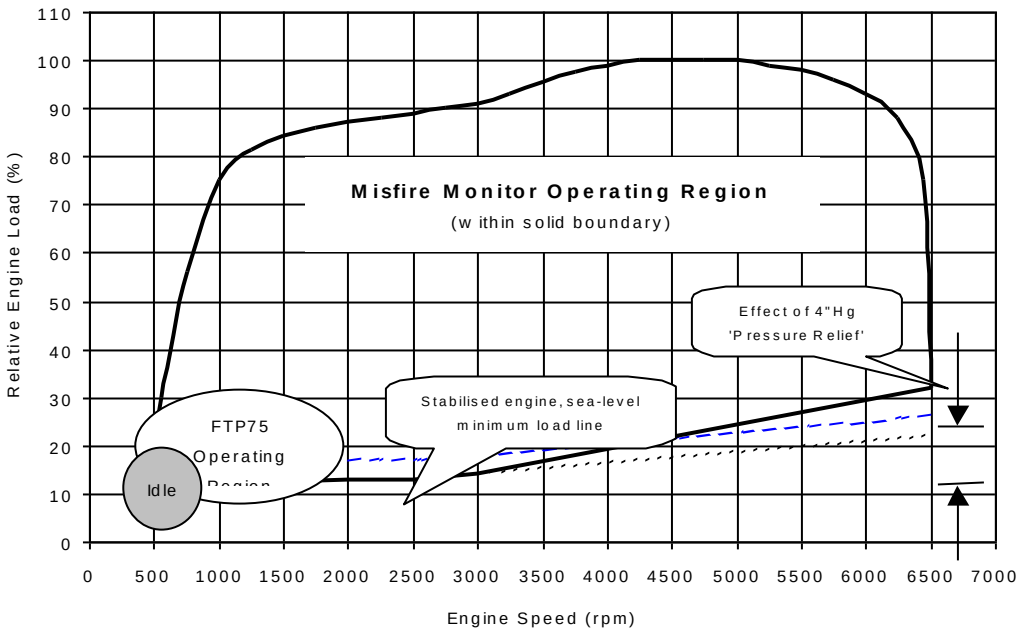
The results of the misfire judgment process on each firing event are used to determine whether two failure levels have been met, 'catalyst damage' misfire and 'excess emissions' misfire. Each fault judgment process has its own failure threshold and calculation period.

Monitor DTCs

P0300	Random/multiple cylinder misfire
P0301	Cylinder 1 (1 Bank A) misfire
P0302	Cylinder 2 (1 Bank B) misfire
P0303	Cylinder 3 (2 Bank A) misfire
P0304	Cylinder 4 (2 Bank B) misfire
P0305	Cylinder 5 (3 Bank A) misfire
P0306	Cylinder 6 (3 Bank B) misfire
P0307	Cylinder 7 (4 Bank A) misfire (V8 engines only)
P0308	Cylinder 8 (4 Bank B) misfire (V8 engines only)
P1313	Catalyst damage misfire, Bank A
P1314	Catalyst damage misfire, Bank B
P1316	Excess emissions misfire

Monitoring Strategy

The misfire monitor operates continuously within the boundaries of the regulated monitor operation window, as shown below:



Region of misfire monitor operation

After engine start, the monitor will enable as soon as the engine speed rises above the minimum operation speed (150 RPM below fully warm stabilized idle speed). Two revolutions of crank angle data, i.e. One sample of data from each cylinder firing, are 'buffered' before any decisions can be made by the monitor. Before engine speed has reached the top of the start flare the monitor will be ready to make misfire judgments, which are then made on every cylinder firing, irrespective of whether the monitor is enabled or not.

6.2.1 Monitoring Structure

Misfire Monitor Operation – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Random misfire	P0300	Crank speed fluctuation	Catalyst damage Excessive emissions		Steady state Engine speed (RPM) 4.2L N/A Auto 4.2L S/C Auto 3.0L Manual 3.0L Auto Engine Coolant Temperature Intake Air Temperature Atmospheric pressure Fuel level Load	 450 - 6500 450 – 6200 580 - 7000 530 - 7000 -8 to 120°C -8 to 100°C > 68 kPa > 11% > Value in map MIS2	200 or 1000 revolutions	1+2 Drive Cycles
Misfire cylinder 1	P0301							1+2 Drive Cycles
Misfire cylinder 2	P0302							1+2 Drive Cycles
Misfire cylinder 3	P0303							1+2 Drive Cycles
Misfire cylinder 4	P0304							1+2 Drive Cycles
Misfire cylinder 5	P0305							1+2 Drive Cycles
Misfire cylinder 6	P0306							1+2 Drive Cycles
Misfire cylinder 7 (V8)	P0307							1+2 Drive Cycles
Misfire cylinder 8 (V8)	P0308							1+2 Drive Cycles
Misfire catalyst damage 1	P1313		Catalyst damage %	See table MIS1				No
Misfire catalyst damage 2	P1314		Catalyst damage %					No
Misfire excess emissions	P1316		Emissions failure Normally aspirated Supercharged	 1.3% 1.3%				No
				Disable:	P0101-P0103, P1104, P0111- P0113, P0116- P0118, P0125, P0107, P0108, P0336, P0460, P0603, P0121- P0123, P0137, P0138, P0140, P0157, P0158, P0160, P0171, P0172, P0174, P0175, P0181- P0183, P1233, P1339, P0106, P0831, P0832, P1234, P1236, P1338, P0222, P0223, P1224, P1229, P1230, P1251, P1516, P1609, P1611, P1631, P1633, P1637, P1642. P0128, P0106, C1137, C1165, C1175			

Misfire Monitor Operation – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Random misfire	P0300	Crank speed	Catalyst damage		Steady state		200 or 1000	1+2 Drive Cycles
Misfire cylinder 1	P0301	fluctuation	Excessive emissions		Engine speed (RPM)		revolutions	1+2 Drive Cycles
					4.2L NA Auto (XK8)	450 to 6500		
Misfire cylinder 2	P0302				4.2L S/C Auto (XK8)	450 to 6200		1+2 Drive Cycles
					4.2L NA Auto (XJ)	450 to 6600		
Misfire cylinder 3	P0303				4.2L S/C Auto (XK8)	450 to 6400		1+2 Drive Cycles
					3.0L	530 - 7000		
Misfire cylinder 4	P0304				Engine Coolant Temperature	-8 to 119°C		1+2 Drive Cycles
					Intake Air Temperature	-40 to 119 °C		
Misfire cylinder 5	P0305				Atmospheric pressure	> 68 kPa		1+2 Drive Cycles
						> 75.5 kPa (X-Type)		
Misfire cylinder 6	P0306							1+2 Drive Cycles
					Fuel level	> 11%		
Misfire cylinder 7 (V8)	P0307				Load	> Value in map MIS2		1+2 Drive Cycles
Misfire cylinder 8 (V8)	P0308							1+2 Drive Cycles
Misfire catalyst damage 1	P1313		Catalyst damage %	See table MIS1			200 revolutions	No
Misfire catalyst damage 2	P1314		Catalyst damage %					No
Misfire excess emissions	P1316		Emissions failure				1000 revolutions	No
			4.2L normally aspirated	1.3%				
			4.2L supercharged	1.3%				
			3.0L S-Type	1.3%				
			X-Type manual	4.0%				
			X-Type automatic	2.0%				
			Disable:	C1137, C1145, C1155, C1165, C1175, P0101-P0103, P0106-P0108, P0111-P0113, P0116-P0118, P0121-P0123, P0125, P0128, P0137, P0138, P0140, P0157, P0158, P0160, P0171, P0172, P0174, P0175, P0181-P0183, P0191-P0193, P0222, P0223, P0335, P0336, P0460, P0603, P0831, P0832. P1104, P1224, P1229, P1233, P1234, P1236, P1251, P1338, P1339, P1516, P1609, P1611, P1631, P1633, P1637, P1642.				
		X-Type 2005 model year	Disable additional:	P0069, P0607, P0627-P0629, P0851, P2118, P2119, P2135, P2228, P2229, P2632-P2636				

Misfire Monitor Operation – 2008 Model Year

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Misfire Monitoring							Depends on engine speed, misfire pattern and time after engine start	
		Crank speed fluctuation			Engine speed	530 < N < 7000 rpm		
Random Misfire	P0300				Engine Coolant Temperature	-8 < T < 119 degC		
					Intake Air Temperature	-40 < T < 119 degC		
Misfire cylinder 1	P0301		Misfire at catalyst damage level	See table MIS1	Atmospheric pressure	> 76 kPa		
Misfire cylinder 2	P0302		(200 rev block)		Fuel level	>= 11 %		
Misfire cylinder 3	P0303		or		Engine load	Positive		
Misfire cylinder 4	P0304		Misfire at excess emissions level	> 39 counts	Fuel cut off	Not active for at least 0.26 s		
Misfire cylinder 5	P0305		(1000 rev block)		Fuel cut off Ignition Retard	Not active for at least 0.26 s		
Misfire cylinder 6	P0306				Rough road	Not detected for at least 0.5 s		
					Engine speed delta	< 5078 rpm/s		
					Engine load delta	< 0.20 g/rev/64 ms for at least 20 firing cycles		
					Throttle angle delta	< 250º/s		
Misfire during first 1000 revs	P1316		Misfire during the first 1000 engine revolutions after start					
Catalyst damaging misfire								
Bank 1	P1313		Misfire at catalyst damage or excessive emissions level					
Bank 2	P1314							
					Fault Codes that disable Misfire Detection	P0138 P0137 P0140 P0158 P0157 P0160 P0172 P0171 P0175 P0174 P0335 P0336 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0112 P0113 P0111 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P0851 P1637 P1642 P0603 P0460 P1609 P0128 P0193 P0192 P0191 P0181 C0037 C003A P0501 P2119 P2118 P0122 P0123 P0222 P0223 P2135 P1251 P1631 P0607 P1633		

6.2.1 Misfire Detection

For the purposes of misfire detection, “steady - state“ is defined as:

- At least 1 second since fuel cut-off was last invoked.
- At least 1 second since gear change was last made.
- At least 0.5 seconds since rough road detected (1second for 3.0L).
- At least 1 second since acceleration ignition retard was last invoked.
- At least 1 second since >15% shunt control ignition retard was last invoked (3.0L only).
- At least 1 second since fuel cut-off ignition retard was last invoked.
- At least 1 second since ISC feedback status (off to on only) changed.
- At least 1 second since A/C status (on or off) changed.
- At least 1 second since electrical load status (on or off) changed.
- At least 1 second since traction control ignition retard was last invoked.
- Rate of change of engine speed less than 250 RPM/0.064s.
- Rate of change of engine load has been less than 0.1g/revolution for at least 20 firing cycles.
- Rate of change of throttle angle is less than 1.5 degrees/0.008s.

MIS1 – 2.5L															
Engine load (g/s)	Engine speed (RPM)														
	700	730	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
0.30	148	148	138	116	100	100	100	90	82	74	42	32	32	20	18
0.60	124	124	108	108	90	82	70	64	58	50	42	32	32	20	18
0.80	106	106	106	100	82	74	60	56	50	42	36	30	24	20	18
1.00	100	100	100	82	74	66	50	50	42	32	30	28	32	20	20
1.20	88	88	88	74	62	44	42	40	32	32	28	28	32	30	30
1.40	88	88	88	74	62	60	56	56	48	36	36	32	32	36	36
1.60	88	88	88	74	62	60	56	56	48	36	36	32	32	36	36
2.00	88	88	88	74	62	60	56	56	48	36	36	32	32	36	36

Note: The figures in the map denote the number of misfires in 200 engine revolutions corresponding to catalyst damage misfire failure.

MIS1 – 3.0L (S-Type)															
Engine load (g/s)	Engine speed (RPM)														
	680	730	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
0.25	150	150	135	130	125	116	106	99	99	80	76	72	72	68	64
0.3	138	138	125	120	119	110	100	93	93	74	70	66	66	62	58
0.4	126	126	120	110	109	100	90	83	83	64	60	56	56	52	48
0.6	121	121	118	118	102	93	80	69	67	56	55	46	46	43	42
0.9	117	117	111	100	84	72	60	53	52	48	39	31	31	27	26
1.2	93	93	93	76	67	58	56	50	51	38	32	23	23	23	23
1.3	84	84	84	77	64	61	50	41	44	27	27	26	26	25	25
1.6	100	100	100	77	73	68	50	46	57	50	41	36	38	39	38

Note: The figures in the map denote the number of misfires in 200 engine revolutions corresponding to catalyst damage misfire failure.

MIS1 – 3.0L (X-Type)															
Engine load (g/s)	Engine speed (RPM)														
	700	730	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
0.30	148	148	134	116	106	90	70	68	64	56	40	20	26	26	24
0.60	126	126	120	106	90	76	64	58	50	38	32	20	20	20	24
0.80	100	100	100	90	76	64	56	50	40	26	20	18	18	18	24
1.00	84	84	84	80	62	56	42	38	40	26	20	14	14	18	20
1.20	68	68	68	64	50	46	40	34	26	26	30	26	26	26	26
1.40	78	78	78	64	56	46	26	20	26	30	30	30	28	26	34
1.60	78	78	78	64	56	46	50	50	34	30	34	32	34	32	34
2.00	78	78	78	64	56	46	50	50	34	30	34	32	34	32	34

Note: The figures in the map denote the number of misfires in 200 engine revolutions corresponding to catalyst damage misfire failure.

MIS1 – 4.2L Normally Aspirated														
Engine load (g/s)	Engine speed (RPM)													
	600	650	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500
0.3	187	187	179	167	140	122	118	104	94	89	74	60	51	62
0.4	183	183	175	163	137	119	114	100	94	86	70	56	47	58
0.6	173	173	165	153	134	109	109	109	92	83	68	53	44	56
0.8	164	164	156	146	133	120	106	94	83	66	53	41	30	40
1.2	151	151	143	114	96	75	75	63	50	33	20	20	20	20
1.6	122	122	114	94	75	58	50	29	26	20	20	20	20	20
2.2	120	120	112	92	74	58	45	33	26	27	26	31	31	34
2.8	120	120	112	92	74	60	48	36	31	30	26	31	31	34

Note: The figures in the map denote the number of misfires in 200 engine revolutions corresponding to catalyst damage misfire failure.

MIS1 – 4.2L Supercharged														
Engine load (g/s)	Engine speed (RPM)													
	600	650	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6200
0.4	186	186	180	164	150	134	117	101	89	77	64	68	72	74
0.6	186	186	178	160	150	130	110	97	85	73	60	64	68	70
1	183	183	175	159	142	125	108	93	77	63	49	51	52	53
1.6	158	158	150	134	117	104	90	72	54	50	46	52	57	60
2.2	125	125	117	109	100	93	85	66	47	49	52	58	64	68
2.8	122	122	114	88	62	52	42	50	57	56	56	68	80	84
3.4	116	116	108	84	60	55	50	54	58	57	57	69	74	77
3.8	116	116	108	84	60	55	50	53	61	65	70	71	73	77

Note: The figures in the map denote the number of misfires in 200 engine revolutions corresponding to catalyst damage misfire failure.

MIS2 – 2.5L Automatic								
EOT (°C)	Engine speed (RPM)							
	700	730	1000	1500	2000	2500	3000	7000
-10	0.64	0.64	0.64	0.43	0.43	0.43	0.43	0.72
20	0.39	0.39	0.39	0.33	0.33	0.33	0.34	0.63
50	0.27	0.27	0.27	0.25	0.26	0.26	0.27	0.56
80	0.22	0.22	0.22	0.20	0.22	0.22	0.23	0.52

MIS2 – 2.5L Automatic (2005 Model Year X-Type)											
EOT (°C)	Engine speed (RPM)										
	500	650	1000	1150	1380	1800	2300	2550	2760	3000	7000
-8	0.45	0.45	0.45	0.45	0.45	0.46	0.47	0.47	0.47	0.47	0.72
15	0.32	0.32	0.32	0.32	0.33	0.37	0.38	0.38	0.38	0.38	0.63
45	0.26	0.26	0.26	0.26	0.28	0.32	0.32	0.32	0.32	0.32	0.57
80	0.21	0.21	0.23	0.24	0.25	0.26	0.27	0.28	0.28	0.28	0.53

MIS2 – 2.5L Manual								
EOT (°C)	Engine speed (RPM)							
	700	730	1000	1500	2000	2500	3000	7000
-10	0.47	0.47	0.47	0.33	0.33	0.34	0.35	0.64
20	0.32	0.32	0.32	0.26	0.26	0.27	0.28	0.57
50	0.23	0.23	0.23	0.21	0.22	0.23	0.24	0.53
80	0.19	0.19	0.19	0.18	0.19	0.20	0.20	0.49

MIS2 – 2.5L Manual (2005 Model Year X-Type)											
EOT (°C)	Engine speed (RPM)										
	500	650	785	960	1165	1410	1725	2180	2700	3000	7000
-8	0.50	0.50	0.50	0.43	0.37	0.33	0.33	0.33	0.37	0.37	0.66
15	0.36	0.36	0.36	0.31	0.27	0.25	0.27	0.28	0.30	0.30	0.59
45	0.26	0.26	0.26	0.24	0.21	0.22	0.24	0.25	0.25	0.26	0.55
80	0.20	0.20	0.20	0.20	0.18	0.18	0.20	0.20	0.20	0.21	0.50

MIS2 – 3.0L S-Type Automatic								
EOT (°C)	Engine speed (RPM)							
	680	730	1000	1500	2000	2500	3000	7000
-8.1	0.599	0.599	0.599	0.523	0.504	0.504	0.504	0.832
20	0.404	0.404	0.404	0.409	0.399	0.4	0.38	0.709
50	0.34	0.33	0.32	0.32	0.32	0.32	0.35	0.678
80	0.295	0.29	0.27	0.27	0.255	0.26	0.26	0.589

MIS2 – 3.0L S-Type Manual								
EOT (°C)	Engine speed (RPM)							
	680	730	1000	1500	2000	2500	3000	7000
-8.1	0.399	0.399	0.399	0.399	0.409	0.432	0.432	0.841
20	0.32	0.32	0.33	0.335	0.335	0.34	0.361	0.77
50	0.3	0.3	0.314	0.29	0.29	0.3	0.3	0.709
80	0.275	0.275	0.27	0.25	0.245	0.25	0.25	0.659

MIS2 – 3.0L X-Type Automatic								
EOT (°C)	Engine speed (RPM)							
	700	730	1000	1500	2000	2500	3000	7000
-10	0.55	0.55	0.55	0.44	0.44	0.44	0.44	0.79
20	0.41	0.41	0.41	0.35	0.36	0.36	0.36	0.71
50	0.32	0.32	0.32	0.28	0.29	0.29	0.30	0.65
80	0.24	0.24	0.24	0.22	0.22	0.23	0.24	0.59

MIS2 – 3.0L X-Type Manual								
EOT (°C)	Engine speed (RPM)							
	700	730	1000	1500	2000	2500	3000	7000
-10	0.54	0.54	0.54	0.37	0.37	0.38	0.38	0.72
20	0.36	0.36	0.36	0.30	0.30	0.30	0.30	0.64
50	0.25	0.25	0.25	0.24	0.24	0.25	0.25	0.59
80	0.23	0.23	0.23	0.20	0.20	0.20	0.21	0.55

MIS2 – 4.2L Normally Aspirated								
EOT (°C)	Engine speed (RPM)							
	600	650	1000	1500	2000	2500	3000	6500
-8	0.45	0.45	0.45	0.45	0.46	0.46	0.46	0.88
20	0.38	0.38	0.38	0.39	0.4	0.4	0.42	0.83
50	0.31	0.31	0.31	0.32	0.33	0.33	0.34	0.75
80	0.24	0.24	0.24	0.25	0.26	0.25	0.26	0.67

MIS2 – 4.2L Supercharged								
EOT (°C)	Engine speed (RPM)							
	600	650	1000	1500	2000	2500	3000	6500
-8	0.6	0.6	0.6	0.6	0.62	0.64	0.66	1.21
20	0.5	0.5	0.5	0.51	0.51	0.52	0.54	1.09
50	0.37	0.37	0.37	0.38	0.4	0.41	0.44	0.99
80	0.28	0.28	0.28	0.28	0.29	0.31	0.35	0.9

6.2.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.3 Heated Oxygen Sensor Monitor

An O2S comprises of a gas-tight zirconium dioxide ceramic tube covered with thin layer of platinum. One end of the tube is open to atmosphere; the other end is sealed and protrudes into the exhaust. When the tube is filled with oxygen rich atmospheric air, and the outer walls are exposed to the oxygen depleted exhaust gases, a chemical reaction takes place and produces a voltage. The voltage output reflects the differences in oxygen concentrations on either side of the ceramic sensor element. As the oxygen content decreases, the voltage increases. As the oxygen content increases, the voltage decreases.

The oxygen content of the exhaust gas stream is directly related to the air fuel mixture supplied to the engine. The voltage output by the O2S is typically 800 to 1000mV for rich mixtures, and around 100mV for lean mixtures.

The ceramic material in the sensor becomes sensitive to the presence of oxygen in the exhaust gas stream at around 315°C. An internal heater is used to bring the sensor quickly up to the operating temperature.

The engine management system runs two tests on the upstream and downstream HO2S, one on the sensor operation and one on the sensor's internal heater.

Note: Only the rear oxygen sensors are used for fuel control.

6.3.1 Downstream Oxygen Sensors High/Low Input Monitor

The downstream O2S are checked for their maximum and minimum output values. The monitor increments an execution timer if the monitor entry conditions are satisfied. A low voltage failure is judged if the output of the sensor does not exceed a calibrated value prior to the monitor execution timer exceeding its calibrated failure threshold. A high voltage failure is judged if the sensor output remains above a calibrated value after the monitor execution timer has exceeded its calibrated failure threshold or after a defined period of over run fuel cut off has been conducted. Additionally, a high voltage failure is invoked if the sensor voltage exceeds battery short threshold for the required time.

Note: Unless specifically included in the tables below, Intake Air Temperature, Engine Coolant Temperature, vehicle speed and time after start up are not critical to enable these monitors.

6.3.2 Monitoring Structure

Heated Oxygen Sensor Monitor Operation – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Downstream HO2S Bank A high voltage	P0138	Sensor voltage stuck high	Sensor voltage	0.9 volts During fuel cut off, duration > 3.8s 2 volts anytime	Air fuel rate feedback compensation: Closed loop compensation: Closed loop compensation Average: Engine Coolant Temperature: Intake Air Temperature: Time after start up	0.75 – 1.25 0.5 – 1.5 0.85 – 1.15 70 – 110 °C -8 – 100 °C 2 seconds	60s	2 Drive Cycles
Downstream HO2S Bank B high voltage	P0158				Disable:	See HO2S downstream no activity check.		2 Drive Cycles

Heated Oxygen Sensor Monitor Operation – From 2004 Model Year (XK8, S-Type and New XJ)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Downstream HO2S Bank A high voltage	P0138	Sensor voltage stuck high	Sensor voltage	>= 0.95 volts or >=2 volts anytime	During fuel cut off, duration	>= 3.8s (XK8) >= 5s (S-Type) >= 3.5s (XJ)	3.8s (XK8) 5s (S-Type) 3.5s (XJ)	2 Drive Cycles
Downstream HO2S Bank B high voltage	P0158						Immediate 0.5s (XJ)	2 Drive Cycles
					Disable:	See HO2S downstream no activity check.		

Heated Oxygen Sensor Monitor Operation – From 2004 Model Year (X -Type)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Downstream HO2S Bank A low input	P0137	Sensor voltage stuck low	Sensor voltage	< 0.30 volts	Heater control HO2S heater power Engine speed Mass Airflow	Active >=180 Watt sec >= 1500 RPM >= 15 g/s	151s	2 Drive Cycles
Downstream HO2S Bank B low input	P0157				Atmospheric pressure Target Lambda Engine Coolant Temperature Intake Air Temperature	>= 74.5 kPa 0.75 to 1 70 to 119 °C -10 to 119°C		2 Drive Cycles
Downstream HO2S Bank A high input	P0138	Sensor voltage stuck high	Sensor voltage or	> 0.80 volts	Time after start Closed loop fuelling Over run fuel cut off time	>= 30s Active >= 30s (high I/P)	151s	2 Drive Cycles
Downstream HO2S Bank B high voltage	P0158		Sensor voltage	> 1.24 volts	Anytime Disable:	 See HO2S downstream no activity check.	0.5s	2 Drive Cycles

Heated Oxygen Sensor Monitor Operation – 2008 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Downstream HO2S Bank A low input Downstream HO2S Bank B low input	P0137 P0157	Sensor voltage stuck low	Maximum sensor voltage	< 0.04 V	Target lambda Closed Loop Fuelling Battery voltage Accumulated Mass Air Flow (This accumulates if: Atmospheric pressure Engine Coolant Temperature Intake Air Temperature Afterstart counter Accumulated Heater Duty (This accumulates if: MAF accumulation conditions Heater control Accumulated HO2S heater energy Engine Speed Target lambda	0.75 <= Lambda <= 1.25 Active < 18 V >= 185 >= 74.5 kPa -10 < T < 120 degC -10 < IAT < 120 degC >= 20 s) >= 1400 True Active >= 180 Watt Seconds >= 500 rpm 0.75 <= Lambda <= 1.00)	5 s	2 Drive Cycles
Downstream HO2S Bank A high input Downstream HO2S Bank B high input	P0138 P0158	Sensor voltage stuck high	Minimum sensor voltage	> 0.15 V	Closed Loop Fuelling Accumulated Mass Air Flow Accumulated Heater Duty An over run fuel cut off has occurred, duration	Active >= 185 >= 1400 >= 3.0 sec (U/s HO2S signal must be >= 0.75 during the fuel cut)		2 Drive Cycles
		or	sensor voltage	> 1.24 V			0.512 s	2 Drive Cycles
					Fault Codes that disable **Bank A** **Bank B**	 See P0140 Monitor See P0160 Monitor		

6.3.3 Downstream Oxygen Sensors Heater Circuit High

Heater resistance checks are performed when the heater is commanded on. If resistance values are outside of the limits when the heater is enabled, then a failure judgment is made.

6.3.4 Monitoring Structure

Heated Oxygen Sensor Monitor Operation								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Heater control circuit Bank A high input	P0038	Heater resistance check when on	Outside limits				0.432s 0.4s (2004 model year) 0.43s (2008 model year)	2 Drive Cycles
Heater control circuit Bank B downstream high input	P0058	Heater resistance when on	Outside limits		Disable:	P1609, P0603	0.432s 0.4s (2004 model year) 0.43s (2008 model year)	2 Drive Cycles

6.3.5 Downstream Oxygen Sensors Heater Circuit Low

Heater resistance checks are performed when the heater is commanded off. If resistance values are outside of the limits, then a failure is flagged.

6.3.6 Monitoring Structure

Heated Oxygen Sensor Monitor Operation								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Heater control circuit Bank A low input	P0037	Heater resistance check when off	Outside limits				0.432s 0.4s (2004 model year) 0.43s (2008 model year)	2 Drive Cycles
Heater control circuit Bank B low input	P0057	Heater resistance check when off	Outside limits		Disable:	P1609, P0603	0.432s 0.4s (2004 model year) 0.43s (2008 model year)	2 Drive Cycles

6.3.7 Downstream Oxygen Sensors No Activity Detected

The monitor is single shot monitor (runs once per trip), which is designed to operate only when the sensor has been lit off (up to operating temperature). The monitor can be sub divided into two sections:

Stuck low

(Output voltage less than calibrated threshold (0.4 volts).

The monitor initially examines the fuelling control to ensure the system is stable, that linear airflow rate closed loop control, and sub feedback execution has been invoked. Once these conditions are satisfied and a calibrated load/airflow has been achieved, a lean stuck timer is incremented. The monitor then checks the output voltage from the sensor and sets a normal end judgment if a calibrated change in sensor output voltage is observed. If the change in sensor voltage is not detected and the lean stuck timer exceeds the failure threshold, and the associated failure conditions are satisfied, then a failure end judgment is made.

Stuck high

(Output voltage greater than calibrated threshold (0.4 volts).

Again, the monitor strategy checks for stable air fuel ratio control prior to commencing the examination of the sensors output voltage. The monitor then utilizes the lean switching characteristics of the sensor during an over run fuel cut off (where the sensors output voltage tends towards 0 volts), to determine its correct operation. Finally, if the duration of the fuel cut off exceeds a calibrated period and the output voltage of the sensor is greater than calibrated threshold, then a failure judgment is set.

6.3.8 Monitoring Structure

Heated Oxygen Sensor Monitor Operation – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
D/s HO2S Bank A no activity D/s HO2S Bank B no activity	P0140 P0160	D/s HO2S voltage	Sensor voltage	< 0.4 volts for 600s > 0.4 volts during fuel cut off	Heater energy Airflow Engine speed Engine Coolant Temperature Intake Air Temperature Short term fuel trim Total fuel trim Sub feedback control Linear air fuel control Atmospheric pressure Fuel level	> 524 Joules > 10 g/s > 1500 RPM > 40 °C -10 °C 0.75 – 1.25 0.5 – 1.5 Executing Executing >= 70 kPa >= 0 kPa (2004 model year V6 S-Type) > 11%	600s 3.8s	2 Drive Cycles 2 Drive Cycles
					Disable:	P1313, P1314, P1316, P0106 – P0108, P0116 – P0118, P0125, P1367, P1368, P0444, P0445, P0111 – P0113, P1234, P1236, P1338, P0101 – P0103, P1104, P1637, P1642, P0603, P0460, P1609, P0128, P1229, P1224, P0121 – P0123, P1251, P1631, P1611, P1633, P0441, P0443, P0222, P0223, P0191- P0193, P0181- P0183 C1165, C1175, C1137		
					Bank A Bank B	P0131 – P0133, P0171, P0172, P0351, P0353, P0355, P0357, P0201, P0203, P0205, P0207 P0031, P0032, P0037, P0038 P0151 – P0153, P0174, P0175, P0352, P0354, P0356, P0358 P0202, P0204, P0206, P0208 P0051, P0052, P0057, P0058.		

Heated Oxygen Sensor Monitor Operation – From 2004 Model Year (XK8, S-Type and new XJ)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
D/s HO2S Bank A no activity D/s HO2S Bank B no activity	P0140 P0160	D/s HO2S voltage	Sensor voltage		Heater energy Airflow Engine speed Engine Coolant Temperature Intake Air Temperature Atmospheric pressure Fuel level	>= 524 Joules >= 10 g/s >= 1500 RPM >= 40 °C >= -10 °C >= 70 kPa > 11%		2 Drive Cycles 2 Drive Cycles
			Sensor voltage stuck during normal closed loop control or	<= 0.4 volts with movement of < 0.2 volts	Short term fuel trim Total fuel trim Sub feedback control	0.75 – 1.25 0.5 – 1.5 Executing	600s	
			Sensor voltage stuck during over run fuel cut off	> 0.4 volts with movement of < 0.2 volts	Over run fuel cut off duration	>= 3.8s (XK8) >= 3.5s (XJ) >= 5s (S-Type)	3.8s (XK8) 3.5s (XJ) 5s (S-Type)	
				Disable:	C1137, C1145, C1155, C1165, C1175, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0125, P0128, P0181, P0182, P0183, P0191, P0192, P0193, P0222, P0223, P0441, P0443, P0444, P0445, P0460, P0603, P1104, P1224, P1229, P1233, P1234, P1236, P1251, P1313, P1314, P1316, P1338, P1339, P1367, P1368, P1609, P1611, P1631, P1633, P1637, P1642			
				Bank A	P0031, P0032, P0037, P0038, P0131, P0132, P0133, P0171, P0172, P0201, P0203, P0205, P0207, P0351, P0353, P0355, P0357			
				Bank B	P0051, P0052, P0057, P0058, P0151, P0152, P0153, P0174, P0175, P0202, P0204< P0206, P0208, P0352, P0354, P0356, P0358			

Heated Oxygen Sensor Monitor Operation – From 2004 Model Year (X-Type)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
D/s HO2S Bank A no activity D/s HO2S Bank B no activity	P0140 P0160	D/s HO2S voltage	Sensor voltage	< 0.5 v	Heater control Heater energy Mass Airflow Engine speed Engine Coolant Temperature Intake Air Temperature Atmospheric pressure After start time Target Lambda Closed loop fuelling Over run fuel cut off duration	Active >= 180 watts sec >=15 g/s >= 1500 RPM 70 to 119 °C -10 to 119 °C >= 74.5 kPa 30s 0.75 to 1 Active >= 3.0s	151s	2 Drive Cycles 2 Drive Cycles
				Disable:	C1137, C1145, C1155, C1165, C1175, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0125, P0128, P0181, P0182, P0183, P0191, P0192, P0193, P0222, P0223, P0441, P0443, P0444, P0445, P0460, P0603, P1104, P1224, P1229, P1233, P1234, P1236, P1251, P1313, P1314, P1316, P1338, P1339, P1367, P1368, P1609, P1611, P1631, P1633, P1637, P1642			
			Disable Additions (2005 model year):		P0069, P0335, P0336, P0607,P0627, P0628, P0629, P2118, P2119, P2135, P2228, P2229, P2632, P2633, P2634, P2635, P2636			
				Bank A	P0031, P0032, P0037, P0038, P0131, P0132, P0133, P0171, P0172, P0201, P0203, P0205, P0207, P0351, P0353, P0355, P0357			
				Bank B	P0051, P0052, P0057, P0058, P0151, P0152, P0153, P0174, P0175, P0202, P0204< P0206, P0208, P0352, P0354, P0356, P0358			

Heated Oxygen Sensor Monitor Operation – 2008 Model Yea r (X-Type)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Oxygen Sensors Downstream (HO2S) D/s HO2S A bank no activity D/s HO2S B bank no activity	P0140 P0160	D/s HO2S sensor voltage behaviour	D/s HO2S voltage max - min	< 0.35 V	Closed Loop Fuelling Fuel tank level D/s HO2S Voltage check (P0137/57 & P0138/58 diagnostic) Battery voltage Accumulated Mass Air Flow (This accumulates if: Atmospheric pressure Engine Coolant Temperature Intake Air Temperature Afterstart counter Accumulated Heater Duty (This accumulates if: MAF accumulation conditions Heater control Accumulated HO2S heater energy Engine Speed Target lambda An over run fuel cut off has occurred, duration	Active > 11 % Complete < 18 V >= 185 >= 74.5 kPa -10 < T < 120 degC -10 < IAT < 120 degC >= 20 s) >= 1400 True Active >= 180 Watt Seconds >= 500 rpm 0.75 <= Lambda <= 1.00) >= 3.0 sec (U/s HO2S signal must be >= 0.75 during the fuel cut)		2 Drive Cycles

Heated Oxygen Sensor Monitor Operation – 2008 Model Yea r (X-Type)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Oxygen Sensors Downstream (HO2S)								
D/s HO2S A bank no activity	P0140	D/s HO2S sensor voltage behaviour	D/s HO2S voltage max - min	< 0.35 V	Closed Loop Fuelling	Active		2 Drive Cycles
					Fuel tank level	> 11 %		
D/s HO2S B bank no activity	P0160				D/s HO2S Voltage check (P0137/57 & P0138/58 diagnostic)	Complete		
					Battery voltage	< 18 V		
					Accumulated Mass Air Flow (This accumulates if:	>= 185		
					Atmospheric pressure	>= 74.5 kPa		
					Engine Coolant Temperature	-10 < T < 120 degC		
					Intake Air Temperature	-10 < IAT < 120 degC		
					Afterstart counter	>= 20 s)		
					Accumulated Heater Duty (This accumulates if:	>= 1400		
					MAF accumulation conditions	True		
					Heater control	Active		
					Accumulated HO2S heater energy	>= 180 Watt Seconds		
					Engine Speed	>= 500 rpm		
					Target lambda	0.75 <= Lambda <= 1.00)		
					An over run fuel cut off has occurred, duration	>= 3.0 sec (U/s HO2S signal must be >= 0.75 during the fuel cut)		

6.3.9 Upstream Oxygen Sensors Circuit

This monitors the upstream O2S element current. If the current is above or below a calibrated value, and the stable operating conditions are satisfied, a failure timer is incremented, otherwise a normal timer is incremented. Upon exceeding the calibrated thresholds for either the failure/normal timers, an appropriate failure/normal end judgment is set.

6.3.10 Monitoring Structure

Heated Oxygen Sensor Monitor Operation								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
U/s HO2S Bank A low input	P0131	Element current	Element current stuck low	<= - 15.0 mA	Closed loop fuelling Sub feedback control U/s HO2S voltage Engine speed	Active Active 0.2 – 0.85 volts >= 1500 RPM	10s	2 Drive Cycles
U/s HO2S Bank B low input	P0151				After start time Vehicle speed Engine Coolant Temperature Intake Air Temperature	>= 0.9s >= 9 mph >= 40 °C >= - 40 °C >= - 30 °C (2008)	10s	2 Drive Cycles
U/s HO2S Bank A high input	P0132	Element current	Element current stuck high	>= 15.0 mA	Atmospheric pressure Mass Airflow Delta load Element impedance	>= 75 kPa >= 10 g/s < 3.125 g/revolutions/s for >2s (=< 0.05 g/revolutions/s for 3.0L) 20 – 60 ohms 0 – 60 ohm (X-Type)		2 Drive Cycles
U/s HO2S Bank B high input	P0152				Purge vapor concentration or Purge Fuel cut off Disable: Bank A Bank B Disable: Bank A Bank B	>= 0.9 Not active Not active P0132 P0152 P0131 P0151		2 Drive Cycles

6.3.11 Upstream Oxygen Sensors Slow Response

The failure criteria for this monitor is the measurement of the time taken for the upstream sensor to attain a calibrated air fuel ratio reading following fuel re-instatement after an over run fuel cut off. The slow response monitor measures the response time of the sensor to react when the air fuel ratio changes from a known lean state to a known non-lean state. The monitor operates after fuelling has been reinstated and the engine management system is in ISC mode, following a period of fuel cut off. If all execution conditions are satisfied the monitor increments a response timer, if the timer exceeds a failure threshold prior to the sensor current switching back to a non-lean condition (6.97mA) a failure end judgment flag is set. If the current signal passes through the lean limit prior to the timer exceeding the failure threshold, then a normal end judgment is set. It should be noted that the slow response monitor is a single shot monitor, which only executes once per drive cycle.

Fuel Cut Off Operation

A timer is employed to ensure that a minimum period of fuel cut off is achieved prior to executing the monitor. This allows the sensors to respond to the lean air fuel ratio fuelling shift, which occurs during the period of fuel cut off.

6.3.12 Monitoring Structure

Heated Oxygen Sensor Monitor Operation – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
U/s HO2S Bank A slow response	P0133	Response time of sensor from lean to rich after over run fuel cut off	Response rate time	2.6s (4.2L NA) > 4.02s (S-Type) > 3.2s (S/C)	Engine speed Airflow Engine Coolant Temperature Intake Air Temperature Atmospheric pressure	600 – 4000 RPM < 70 g/s 70 to 110 °C -30 to 100 °C > 68 kPa	< 5s	2 Drive Cycles
U/s HO2S Bank B slow response	P0153				Element impedance Throttle closed flag Fuel cut off time Closed loop fuelling	20 to 60 ohm Set 2 – 40s Active		2 Drive Cycles
				Disable:	P1316, P0106–P0108, P0116–P0118, P0125, P0128, P1367, P1368, P0111–P0113, P1313, P1314, P0444, P0445, P1234, P1236, P1338, P0101– P0103, P1104, P1637, P1642, P0603, P0460, P1609, P1229, P1224, P0121-P0123, P0222, P0223, P1251, P1631, P1611, P1633, P0441, P0443, P0181-P0183, P0191-P0193, C1165, C1175, C1137			
				Bank A	P0132, P0131, P0137, P0138, P0140, P0172, P0171, P0351, P0353, P0355, P0357, P0201, P0203, P0205, P0207, P0031, P0032.			
				Bank B	P0152, P0151, P0157, P0158, P0160, P0174, P0175, P0352, P0354, P0356, P0358, P0202, P0204, P0206, P0208, P0051, P0052.			

Heated Oxygen Sensor Monitor Operation – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
U/s HO2S Bank A slow response	P0133	Response time of sensor from lean to rich after over run fuel cut off	Response rate time	>= 3.5s (X-Type) >= 4.0s (S-Type) >= 2.6s (XJ N/A) >= 3.2s (XJ S/C) >= 2.6s (XK8 N/A) >= 4.0s (XK8 S/C)	Engine speed Airflow Engine Coolant Temperature Intake Air Temperature Atmospheric pressure Element impedance	600 – 4000 RPM < 70 g/s 70 to 110 °C -30 to 100 °C > 68 kPa 0 to 60 ohm 20 to 60 ohm (XK8) 0 to 60 ohm (X-Type)	3.5s (X-Type) 4.0s (S-Type) 2.6s (XJ N/A) 3.2s (XJ S/C) 2.6s (XK8 N/A) 4.0s (XK8 S/C)	2 Drive Cycles
U/s HO2S Bank B slow response	P0153				Throttle closed flag Fuel cut off time Closed loop fuelling	Set 2 to 60s (X-Type) 4 to 60s (S-Type) 2 to 40s (XJ) Active		2 Drive Cycles
				Disable:	C1137, C1145, C1155, C1165, C1175, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0125, P0128, P0181, P0182, P0183, P0191, P0192, P0193, P0222, P0223, P0441, P0443, P0444, P0445, P0460, P0603, P1104, P1224, P1229, P1233, P1234, P1236, P1251, P1313, P1314, P1316, P1338, P1339, P1367, P1368, P1609, P1611, P1631, P1633, P1637, P1642			
			Disable additions (2005 model year X-Type):		P0069, P0335, P0336, P0607,P0627, P0628, P0629, P2118, P2119, P2135, P2228, P2229, P2632, P2633, P2634, P2635, P2636			
				Bank A	P0132, P0131, P0137, P0138, P0140, P0172, P0171, P0351, P0353, P0355, P0357, P0201, P0203, P0205, P0207, P0031, P0032.			
				Bank B	P0152, P0151, P0157, P0158, P0160, P0174, P0175, P0352, P0354, P0356, P0358, P0202, P0204, P0206, P0208, P0051, P0052.			

Heated Oxygen Sensor Monitor Operation – 2008 Model Year (X-Type)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Oxygen Sensors Upstream (U/S HO2S) U/s HO2S A slow response U/s HO2S B slow response	P0133 P0153	Accumulated response time to forced fuelling dither during steady state driving. (Test runs twice, 15 seconds each time, separated by a minimum of 5 seconds)	Ratio of amplitude difference between the A/F control and the u/s HO2S output	< 0.3	CL A/F control Catalyst Diagnostic Time after start Engine Speed Vehicle speed Engine Load Mass Airflow Engine Coolant Temperature Atmospheric pressure Element impedance Engine load change Throttle angle change Purge Accelerator pedal movement **Fault Codes that disable Bank A**	Active Not in Progress >= 180 s 1400 < N < 3500 rpm 0 <= v <= 420 mph 0.22 < Load < 0.80 g/s 6.2 < MAF < 35 g/s >= 68.1 degC >= 68 kPa 20 < R < 80 ohm <= 0.40 g/rev/0.128 s <= 10.0 deg/0.128 s Not active, or vapour concentration <= 1.0 >= 10 deg/0.256 s on less than 5 occasions during execution of this diagnostic P0300 P0301 P0303 P0305 P0302 P0304 P0306 P1313 P1314 P1316 P0132 P0131 P0138 P0137 P0140 P0172 P0171 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0351 P0353 P0355 P1367 P1368 P0201 P0203 P0205 P0031 P0032 P0444 P0445 P0443 P0112 P0113 P0111 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P1637 P1642 P0603 P0460 P1609 P0128 P0193 P0192 P0191 P0181 C0037 C003A P0501 P2119 P2118 P0122 P0123 P0222 P0223 P2135 P1251 P1631 P0607 P1633	35 s	2 Drive Cycles

Heated Oxygen Sensor Monitor Operation – 2008 Model Year (X-Type)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
					Fault codes that disable Bank B	P0300 P0301 P0303 P0305 P0302 P0304 P0306 P1313 P1314 P1316 P0152 P0151 P0158 P0157 P0160 P0175 P0174 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0352 P0354 P0356 P1367 P1368 P0202 P0204 P0206 P0051 P0052 P0444 P0445 P0443 P0112 P0113 P0111 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P1637 P1642 P0603 P0460 P1609 P0128 P0193 P0192 P0191 P0181 C0037 C003A P0501 P2119 P2118 P0122 P0123 P0222 P0223 P2135 P1251 P1631 P0607 P1633		

6.3.13 Upstream Oxygen Sensors Heater Circuit

The control module monitors the heater current to be within limits. If a failure is detected, the control module responds by setting the appropriate signal failure code. On detection of a failure code the monitor proceeds to increment a failure timer and a judgment is made if the failure timer exceeds a calibrated threshold. If a failure code is not present, then the monitor increments a normal judgment timer and sets a judgment upon exceeding a calibrated threshold.

6.3.14 Monitoring Structure

Heated Oxygen Sensor Monitor Operation								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Heater control circuit Bank A low input	P0031	Control module monitors heater for current to be within limits	Outside limits		HO2S control Heater on	Executing >= 1.02s (2008)	3.6s	2 Drive Cycles
Heater control circuit Bank A high input	P0032	Control module monitors heater for current to be within limits	Outside limits		HO2S control Heater on	Executing >= 1.02s (2008)	3.6s	2 Drive Cycles
Heater control circuit Bank B low input	P0051	Control module monitors heater for current to be within limits	Outside limits		HO2S control Heater on	Executing >= 1.02s (2008)	3.6s	2 Drive Cycles
Heater control circuit Bank B high input	P0052	Control module monitors heater for current to be within limits	Outside limits		HO2S control Heater on Disable:	Executing >= 1.02s (2008) P1609, P0603	3.6s	2 Drive Cycles

6.3.15 Drive Cycle Information

Upstream oxygen sensors:

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

Downstream oxygen sensors:

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

Oxygen sensor heaters:

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.4 Electronic Control Module

The control function within the ECM enables hardware checks to be performed on the sensors. These DTCs will reflect sensor open circuit and short circuit faults along with heater faults. In addition to sensor fault monitoring these DTCs will also reflect failures of the control functions themselves. The sensor impedance is also monitored to ensure that its impedance is below the required level for correct operation after the sensor has been active for the required time.

6.4.1 Monitoring Structure

Heated Oxygen Sensor Monitor Operation								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Control module open/shorted Bank A	P1646	Control module hardware checks	Heater failure Sensor open circuit Sensor short circuit Module failure	Failed Failed Failed Failed	Sensor control	Executing Ignition on	8.0s 8.0s 8.0s 8.0s All 3.6s (2004 model year)	2 Drive Cycles
Control module open/shorted Bank B	P1647		Sensor impedance	> 60 ohms	Sensor control active Disable:	>= 60s P0603	20s 20.5s (2008)	2 Drive Cycles

6.4.2 Drive Cycle Information

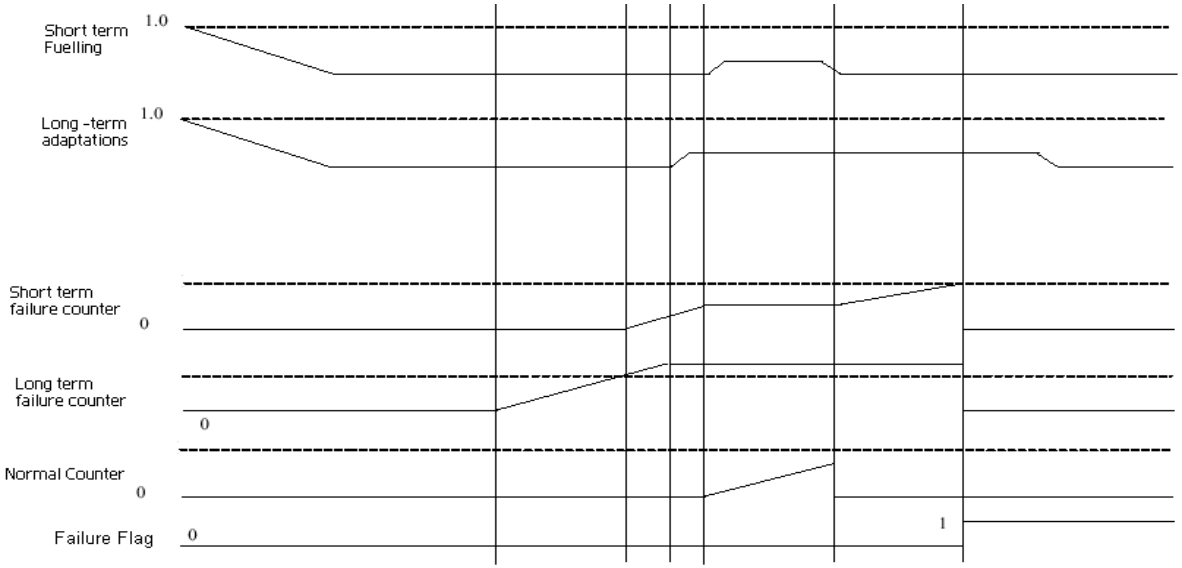
Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.5 Fuel System Monitor

The monitor operates continuously throughout the trip. The monitor timing is every 0.128 seconds. The monitor compares the long term adaptions for the current load site against a failure threshold. If the adaptions for that site are greater than the failure threshold, the long term failure counter is incremented. If this counter reaches a calibrated time, the monitor looks at the short term fuelling trim and compares this against another threshold. The short term failure counter is incremented and if this counter reaches its failure threshold then a failure is flagged.

The normal counter operates when both long term and short term fuelling is within the thresholds. If the normal counter reaches its calibrated time then both failure counters are reset.

The diagram below shows the flagging of a rich failure on Bank Aof an engine:



6.5.1 Monitoring Structure

Fuel System Monitor (V8) – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel too lean – Bank A	P0171	Long term fuelling drift and short term feedback compensation values outside limits	Long term adaptions	> +18% and	Engine Coolant Temperature Intake Air Temperature	> 75 °C > -30 °C	15s	2 Drive Cycles
Fuel too lean – Bank B	P0174		Total air fuel rate feedback compensation	> +19%	Closed loop fuelling Fuel level	Active > 11%		2 Drive Cycles
Fuel too rich – Bank A	P0172		Long term adaptions	< -17% and				2 Drive Cycles
Fuel too rich – Bank B	P0175		Total air fuel rate feedback compensation	< -16%				2 Drive Cycles
		Disable:	P1313, P1314, P1316, P0106, P0107, P0108, P0116, P0117, P0118, P0125, P1367, P1368, P0444, P0445, P0111, P0112, P0113, P1234, P1236, P1338, P0102, P0103, P1104, P0101, P1642, P0603, P0460, P1609, P0128, P0443, P0441, P0191, P0192, P0193, P0181, P0182, P0183, P1233, P1339					
		Bank A	P0133, P0137, P0138, P0140, P0351, P0353, P0355, P0357 P0201, P0203, P0205, P0207, P0031, P0032, P0037, P0038					
		Bank B	P0153, P0157, P0158, P0160, P0352, P0354, P0356, P0358, P0202, P0204, P0206, P0208, P0051, P0052, P0057, P0058					

Fuel System Monitor (V8) – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel too lean – Bank A	P0171	Long term fuel trim and short term fuel trim values outside limits	Long term fuel trim	>= +18% (XK8) >= +19% (XJ)	Fuel level Transient fuelling compensation	>= 11% <= 4 (+/-)	15s plus	2 Drive Cycles
Fuel too lean – Bank B	P0174		Short tem fuel trim	>= +19% (XK8) >= +19% (XJ)			15s	2 Drive Cycles
Fuel too rich - Bank A	P0172		Long term fuel trim	>= -17% (XK8) >= -20% (XJ)			15s plus	2 Drive Cycles
Fuel too rich - Bank B	P0175		Short tem fuel trim	>= -16% (XK8) >= -25%(XJ)			15s	2 Drive Cycles
		Disable:	P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0181, P0182, P0183, P0191, P0192, P0193, P0441, P0443, P0444, P0445, P0460, P0603, P1104, P1233, P1234, P1236, P1313, P1314, P1316, P1338, P1339, P1367, P1368, P1609, P1642.					
		Bank A	P0133, P0137, P0138, P0140, P0351, P0353, P0335, P0357 P0201, P0203, P0205, P0207, P0031, P0032, P0037, P0038					
		Bank B	P0153, P0157, P0158, P0160, P0352, P0354, P0356, P0358, P0202, P0204, P0206, P0208, P0051, P0052, P0057, P0058					

Fuel System Monitor (V6) – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel too lean – Bank A	P0171	Long term fuelling drift and short term feedback compensation values outside limits	Long term adaptions	> 18%	Engine Coolant Temperature	> 75 °C	60s	2 Drive Cycles
			Short term feedback	> 25%	Intake Air Temperature	> -30 °C		
Fuel too lean – Bank B	P0174				Closed loop fuelling	Active		
					Fuel level	> 11%		2 Drive Cycles
Fuel too rich – Bank A	P0172		Long term adaptions	< 18%				2 Drive Cycles
			Short term feedback	< 25%				
Fuel too rich – Bank B	P0175							2 Drive Cycles
		Disable:	P1313, P1314, P1316, P0106, P0107, P0108, P0116, P0117, P0118, P0125, P1367, P1368, P0444, P0445, P0111, P0112, P0113, P1234, P1236, P1338, P0102, P0103, P1104, P0101, P1642, P0603, P0460, P1609, P0128, P0443, P0441, P0191, P0192, P0193, P0181, P0182, P0183, P1233, P1339					
		Bank A	P0133, P0137, P0138, P0140, P0351, P0353, P0335, P0357 P0201, P0203, P0205, P0207, P0031, P0032, P0037, P0038					
		Bank B	P0153, P0157, P0158, P0160, P0352, P0354, P0356, P0358, P0202, P0204, P0206, P0208, P0051, P0052, P0057, P0058					

Fuel System Monitor (V6) – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel too lean – Bank A	P0171	Long term fuel trim and short term fuel trim values outside limits	Long term fuel trim	>= +18% (S-Type) >= +19% (X-Type)	Fuel level Transient fuelling compensation	>= 11% <= 4 (+/-)	30s plus	2 Drive Cycles
Fuel too lean – Bank B	P0174		Short tem fuel trim	>= +25%			30s	2 Drive Cycles
Fuel too rich – Bank A	P0172		Long term fuel trim	>= -18%			30s plus	2 Drive Cycles
Fuel too rich – Bank B	P0175		Short tem fuel trim	>= -25%			30s	2 Drive Cycles
		Disable:	P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0181, P0182, P0183, P0191, P0192, P0193, P0441, P0443, P0444, P0445, P0460, P0603, P1104, P1233, P1234, P1236, P1313, P1314, P1316, P1338, P1339, P1367, P1368, P1609, P1642.					
	Disable additions (X-Type 2005 model year):		P0069, P0627, P0628, P0629, P2228, P2229, P2632, P2633, P2634, P2635, P2636.					
		Bank A	P0133, P0137, P0138, P0140, P0351, P0353, P0355, P0357 P0201, P0203, P0205, P0207, P0031, P0032, P0037, P0038					
		Bank B	P0153, P0157, P0158, P0160, P0352, P0354, P0356, P0358, P0202, P0204, P0206, P0208, P0051, P0052, P0057, P0058					

Fuel System Monitor (V6) – 2008 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel System Fuel too lean - Bank A Fuel too lean - Bank B Fuel too rich - Bank A Fuel too rich - Bank B	P0171 P0174 P0172 P0175	Long Term Fuel Trim outside limit for time period & Short Term Fuel Trim outside limit for additional time period	Long Term Fuel Trim **And** Short Term Fuel Trim **Or** Long Term Fuel Trim **And** Short Term Fuel Trim	>= 118 % (for 30 s) >= 125 % (for 30 s) <= 82 % (for 30 s) <= 75 % (for 30 s)	Battery voltage Engine Start Ignition turned on Transient fuelling compensation Fuel level (for lean faults only)	>= 10.0 V Not in progress For at least 2.0 s < 4 % >= 11 %	60 s	2 Drive Cycles
					Fault Codes that disable P0171 & P0172	P0300 P0301 P0303 P0305 P0302 P0304 P0306 P1313 P1314 P1316 P0133 P0138 P0137 P0140 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0351 P0353 P0355 P1367 P1368 P0201 P0203 P0205 P0031 P0032 P0444 P0445 P0443 P0112 P0113 P0111 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P0054 P0038 P0037 P1642 P0603 P0460 P1609 P0128 P0193 P0192 P0191 P0181		
					Fault Codes that disable P0174 & P0175	P0300 P0301 P0303 P0305 P0302 P0304 P0306 P1313 P1314 P1316 P0153 P0158 P0157 P0160 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0352 P0354 P0356 P1367 P1368 P0202 P0204 P0206 P0051 P0052 P0444 P0445 P0443 P0112 P0113 P0111 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P0060 P0058 P0057 P1642 P0603 P0460 P1609 P0128 P0193 P0192 P0191 P0181		

6.5.2 Fuel System Secondary Trim

On the X-Type from 2004 model year, a secondary monitor also checks the sub feedback trim levels. When the entry conditions are met, the sub feed back trim level is checked against a threshold. If it is either above or below a threshold, a counter is started, if at the end of the count the level is still above or below the threshold then an appropriate DTC is flagged.

6.5.3 Monitoring Structure

Fuel System Monitor - Secondary Fuel Trim (X-Type From 2004 Model Year)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Sub feedback too lean Bank A	P2096	Sub feedback outside limit	Sub feedback trim value	>= -3.49%	Mass Airflow Engine Coolant Temperature Fuel level	>= 20 g/s >= 60 °C >= 10%	5s	2DTC
Sub feedback too lean Bank B	P2098				Vapor concentration Sub feedback	< 30 % Executing	10 times	2DTC
Sub feedback too rich Bank A	P2097		Sub feedback trim value	>= 3.49%				
Sub feedback too rich Bank B	P2097							
				Disable:	P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0181, P0182, P0183, P0191, P0192, P0193, P0441, P0443, P0444, P0445, P0460, P0603, P1104, P1233, P1234, P1236, P1313, P1314, P1316, P1338, P1339, P1367, P1368, P1609, P1642.			
				Disable (2005 model year):	P0069, P0101,P0102, P0103, P0116, P0117, P0118, P0125, P0191, P0192, P0193, P0443, P0444, P0445, P0460, P0603, P0627, P0628, P0629, P1104, P1367, P1368, P1638, P1642, P2228, P2229, P2632, P2633, P2634, P2635, P2636.			
				Bank A	P0133, P0137, P0138, P0140, P0351, P0353, P0335, P0357 P0201, P0203, P0205, P0207, P0031, P0032, P0037, P0038			
				Bank B	P0153, P0157, P0158, P0160, P0352, P0354, P0356, P0358, P0202, P0204, P0206, P0208, P0051, P0052, P0057, P0058			

Fuel System Monitor - Secondary Fuel Trim (X-Type 2008 Model Year)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel System - Secondary Trim Sub feedback too lean or too rich								
Bank A	P2A01	Sub feedback outside limit in at least one region of operation. (There are 6 regions, bounded by speed and engine load limits. The speed thresholds are up to 1500 rpm, from 1500 to 3000 rpm and above 3000 rpm. The load threshold is from 0 to 4.0 g/rev and above 4.0 g/rev)	Sub feedback trim value	>= +4 %	Sub feedback	Active	5 s	2 Drive Cycles
Bank B	P2A04		**Or**	<= -4 %	Sub feedback is active, if:			
					Engine Coolant Temperature	>= 80 degC		
					Engine Speed	<= 4000 rpm		
					Time Afterstart	>= see table below		
					Feedback fuelling control	Active		
					D/s HO2S signal	Active		
					Fault Codes that disable P2A01	P0132 P0131 P0133 P0138 P0137 P0140 P0172 P0171 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0351 P0353 P0355 P1367 P1368 P0201 P0203 P0205 P0031 P0032 P0444 P0445 P0443 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P0054 P0038 P0037 P1638 P1642 P0603 P0460 P1646 P0193 P0192 P0191 P0139		
					Fault Codes that disable P2A04	P0152 P0151 P0153 P0158 P0157 P0160 P0175 P0174 P2229 P2228 P0069 P0118 P0117 P0116 P0125 P0352 P0354 P0356 P1367 P1368 P0202 P0204 P0206 P0051 P0052 P0444 P0445 P0443 P0627 P2635 P0628 P0629 P0102 P0103 P1104 P0101 P0060 P0058 P0057 P1638 P1642 P0603 P0460 P1647 P0193 P0192 P0191 P0159		

Time After Start Entry Condition – DTCs P2A01 and P2A04 – (X400 2008 Model Year)						
ECT Temperature (degC)	-30	-10	10	25	50	75
Time (s)	98.304	49.152	32.768	24.576	16.384	8.192

6.5.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.6 Evaporative Emissions System Monitor

The leak test monitor is designed to find any evaporative leak between 40 thou, (the EVAP reduces to 20 thou on V8 Sedan normally aspirated at 2001 model year) and a gross leak. The 40 thou test operates whilst the vehicle is moving and includes checks for canister closure valve stuck closed (restricted airflow on the fuel tank breather) and the EVAP canister purge valve stuck open (leaking). The EVAP canister closure valve stuck open and EVAP canister purge valve stuck closed is part of the gross leak judgment. The 20 thou leak test is an additional test, which is carried out at idle.

DTCs

P0442	40 thou (or larger) leak detected	
P0443	EVAP canister purge valve malfunction	EVAP canister purge valve leaking
P0444	EVAP canister purge valve circuit low	electrical circuit check
P0445	EVAP canister purge valve circuit high	electrical circuit check
P0446	EVAP canister closure valve malfunction	restricted airflow through tank breather
P0447	EVAP canister closure valve open circuit	electrical circuit check
P0448	EVAP canister closure valve short circuit	electrical circuit check
P0450	Fuel Tank Pressure (FTP) sensor malfunction	no change in output
P0452	FTP sensor low input	electrical circuit check
P0453	FTP sensor high input	electrical circuit check
P0455	gross leak	
P0456	20 thou leak	

6.6.1 Leak Test Operation

The leak test will be initialized when a number of entry conditions are satisfied. They will include Engine Coolant Temperature, Intake Air Temperature, engine load, vehicle speed, vapor concentration and purge amount.

40 Thou Leak Test

When the entry conditions are satisfied the EVAP canister purge valve will be closed and the EVAP canister closure valve will then close. The EVAP system is now sealed, the FTP sensor will take the initial value of pressure (P1). After 15 seconds the FTP sensor will take a further reading (P2). The difference between P1 and P2 becomes the first pressure rise.

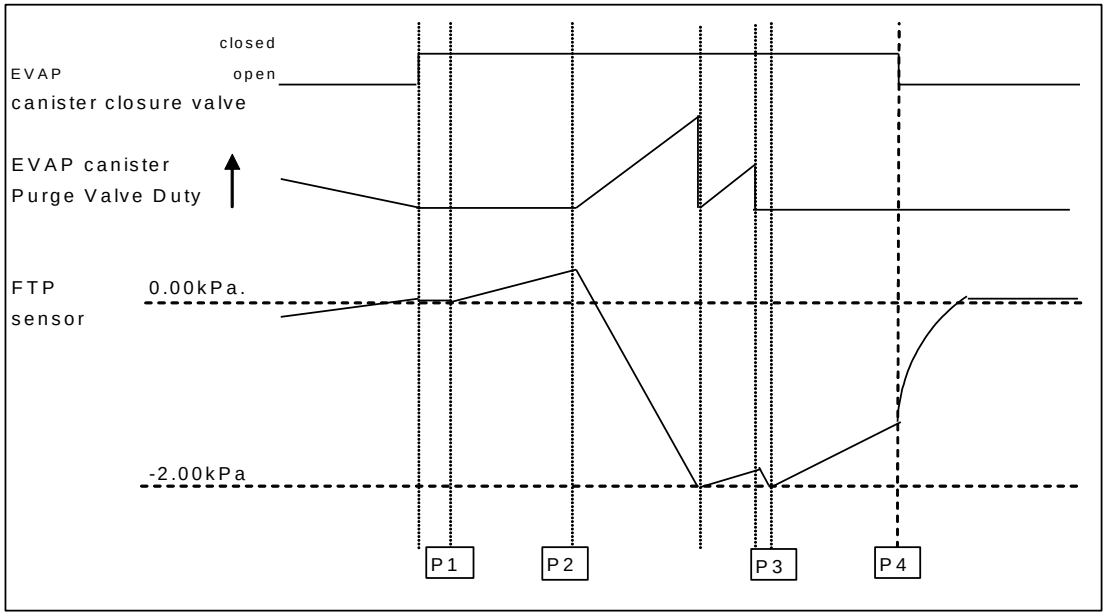
The EVAP canister purge valve will then be ramped open to pull the FTP down to –2.00 kPa; the EVAP canister purge valve will then close. If the pressure rises too quickly then a second pull down will occur. The FTP sensor then takes a further reading of the tank pressure (P3). After a further 15 seconds a final pressure reading (P4) is taken. The difference between P3 and P4 becomes the second pressure rise.

The EVAP canister closure valve is then opened and the leak value is calculated and compared with the pass/fail threshold. The result may be discarded if the vapor concentration is too high, the first pressure rise is too high or the fuel movement in the tank causes excessive vapor. If the pressure in the tank does not return close to atmospheric within a few seconds of the EVAP canister closure valve opening then the test will continue and may flag DTC P0446.

If the EVAP canister purge valve is ramped open and the tank is not pulled down to –2.00 kPa, a gross leak will be flagged. If however during the second pressure rise the tank pressure rises to a value, which would indicate that it couldn't be a gross leak.

Failure to pull the tank pressure down resulting in flagging P0455 can be due to a gross leak, vapor pipe detached / fuel cap left off etc. or the EVAP canister purge valve stuck closed or the EVAP canister closure valve stuck open.

Leak Test Diagram 40 Thou Test



20 Thou Leak Test

The 20 thou leak test is similar to the diagram above, with the exception that the tank is pulled down to –1.25 kPa rather than –2.00 kPa as above. In addition the 20 thou test is carried out at idle or with the vehicle moving at less then 9 mph. Component faults P0443, P0446, P0450 & P0455 cannot be determined from the 20 thou test.

6.6.2 Monitoring Structure

Evaporative Emission System Monitor – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
EVAP canister purge valve low voltage	P0444	Hardware check	Commanded versus actual	Wrong	Battery voltage EVAP canister purge valve duty cycle	> 6 volts < 0.102	3.2s	2 Drive Cycles
EVAP canister purge valve high voltage	P0445	Hardware check	Commanded versus actual	Wrong	Battery voltage EVAP canister purge valve duty cycle	> 6 volts > 0.7	3.2s	2 Drive Cycles
EVAP canister purge valve malfunction	P0443	Incorporated in to P0455/P0442	Pressure change	-2 kPa	Disable:	P0603, P1609, P0441	120s approximately	2 Drive Cycles
EVAP canister close valve open	P0447	Hardware check	Commanded versus actual	Wrong	Ignition on		1.28s	2 Drive Cycles
EVAP canister close valve shorted	P0448	Hardware check	Commanded versus actual	Wrong	Leak check active Disable:	P0603, P1609	1.28s	2 Drive Cycles
EVAP canister close valve malfunction	P0446	Incorporated in to P0455/P0442	Pressure change/time	< -0.4 kPa			150s approximately	2 Drive Cycles
FTP sensor malfunction	P0450	Incorporated in to P0455/P0442	Sensor activity	< -0.03 kPa			120s approximately	2 Drive Cycles
Gross leak detected	P0455	FTP during purge on, EVAP canister closure valve open and EVAP canister closure valve closed conditions	Pressure change over time	Time/pressure	Altitude change Vehicle speed Time after start	> 625 ft 6.25 to 81mph >765s	94s approximately	2 Drive Cycles
0.040" leak detected	P0442	FTP during purge on, EVAP canister closure valve open and EVAP canister closure valve closed conditions	Pressure change over time	See table TBDF_LEAK_FAL TLEVL_BASE	Fuel level Altitude Intake Air Temperature Fuel level change Airflow Engine Coolant Temperature Purge accumulative FTP	15 to 85% < 10,000 ft -8 to 100 °C < 3% 2.5 to 40 g/s 70 to 110 °C 700 > -200 kPa	70s approximately	2 Drive Cycles

Evaporative Emission System Monitor – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
0.020" leak detected	P0456	FTP during purge on, EVAP canister closure valve open and EVAP canister closure valve closed conditions	Pressure change over time	See table TBDF_LEAK_FAT LEVL_BASE20	Vehicle speed Time after start Fuel level Altitude Intake Air Temperature Fuel level change Airflow Engine Coolant Temperature Purge amount after start FTP Engine run time cumulative Idle Airflow Engine speed Purge amount Disable:	< 9 mph > 1400s 30-85% < 10,000 ft -8 to 70 °C < 3% 1.5 to 15 g/s 70 to 110 °C 1100 > -1.25 kPa 9000s Alternative entry conditions for 0.020" &0.040" > 1400s > 70g/s for > 3.5s > 3500 RPM for > 3.5s > 450 P0101- P0103, P1104, P0107, P0108, P0111- P0113, P0116- P0118, P0125, P0128, P0201- P0208, P0351-P0358, P0444, P0445, P0447, P0448, P0452, P0453, P0460, P0603, P1609, P1642, P1637, C1137, C1165, C1175, P1313, P1314, P1316, P0106, P1637, P1368, P1642, P0441	55s	2 Drive Cycles

Evaporative Emission System Monitor – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
EVAP canister purge valve low voltage	P0444	Hardware check	Commanded v actual	Wrong	Battery voltage EVAP canister purge valve duty cycle	< 10 volts < 0.05	3.2s	2 Drive Cycles
EVAP canister purge valve high voltage	P0445	Hardware check	Commanded v actual	Wrong	Battery voltage EVAP canister purge valve duty cycle	> 10 volts > 0.9 > 0.95 (2008)	3.2s	2 Drive Cycles
EVAP canister purge valve malfunction	P0443	Incorporated into P0455/P0442	Pressure change	<= -1 kPa	Disable:	P1609	120s approximately	2 Drive Cycles
EVAP canister close valve open	P0447	Hardware check	Commanded v actual	Wrong	Ignition on		1.3s	2 Drive Cycles
EVAP canister close valve shorted	P0448	Hardware check	Commanded v actual	Wrong	Leak check active Disable:	P0603, P1609	1.3s	2 Drive Cycles
EVAP canister close valve malfunction	P0446	Incorporated into P0455/P0442	Pressure change/time	<= -0. 2 kPa			150s approximately	2 Drive Cycles
FTP sensor malfunction	P0450	Incorporated into P0455/P0442	Sensor activity	< -0.03 kPa			120s approximately	2 Drive Cycles
Gross leak detected	P0455	FTP during purge on, EVAP canister closure valve open and EVAP canister closure valve closed conditions	Pressure change over time	Time/pressure	Atmospheric pressure Vehicle speed After start	>= 70 kPa (XK8 and S-type) >= 74.5 kPa (XJ and X-Type) 6 to 81mph >=766s	94s approximately	2 Drive Cycles
0.040" leak detected	P0442	FTP during purge on, EVAP canister closure valve open and EVAP canister closure valve closed conditions	Pressure change over time	See table EVAP1	Fuel level Atmospheric pressure change Intake Air Temperature Fuel level change Airflow Engine Coolant Temperature Purge accumulative FTP drop	15 to 85% <= 2 kPa -8 to 70°C < 3% 2.5 to 40g/s 70 to 110°C 700 >= -2 kPa	70s approximately	2 Drive Cycles

Evaporative Emission System Monitor – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
0.020" leak detected	P0456	FTP during purge on, EVAP canister closure valve open and EVAP canister closure valve closed conditions	Pressure change over time	See table EVAP 2	Vehicle speed After start Fuel level Atmospheric pressure Intake Air Temperature Fuel level change Airflow Engine Coolant Temperature Purge amount after start FTP Engine run time calculation Alternative entry conditions for 0.020" and 0.040" Idle Airflow Engine speed Purge amount	0 to 9 mph >= 1400s 30 to 85% >= 70 kPa (XK8 and S-type) >= 74.5 kPa (XJ and X-Type) -8 to 50 °C -8 to 70 °C (Xk8) <= 3% 1.5 to 15 g/s 70 to 110 °C >= 1000 (X-Type) >= 1100 (all other) >= -1.25 kPa >= 5000s (X-Type) >= 9000s (S-Type) >= 10000s (XK8) >= 6000s (XJ N/A) >= 5000s (XJ S/C) > 1400s > 70 g/s for > 3.5s > 3500 RPM for > 3.5s > 450	55s	2 Drive Cycles
		Disable:	C1137, C1145, C1155, C1165, C1175, P0031, P0032, P0051, P0052, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0131, P0132, P0133, P0151, P0152, P0153, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P0444, P0445, P0447, P0448, P0452, P0453, P0460, P0506, P0507, P0603, P1104, P1313, P1314, P1316, P1367, P1368, P1609, P1637, P1638, P1642, P1646, P1647					
		Disable additions (X-Type 2005 model year)	P0069, P2228, P2229.					

Evaporative Emission System Monitor – 2008 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel Evaporative Leak Monitoring								
Gross leak detected	P0455	Fuel tank pressure during purge on, CCV open and CCV closed conditions	Pressure change over time	time / pressure	Atmospheric pressure Vehicle speed Afterstart	> 74.5 kPa 6.2 <= V < 80.7 mph > 766 s (Or Engine speed > 3500 rpm or MAF > 70 g/s for > 3.5 s)	50 s (approx)	2 Drive Cycles
	P0457	If the refuelled flag set then the diagnostic will still run as stated but this P0457 DTC is set and "Check Cap" message displayed if a fault is detected			Refuelled Flag Fuel level Delta atmos. press. Intake Air Temperature Filtered Fuel Level Change Mass Airflow Engine Coolant Temperature Engine running time since ECT < 40 degC Accumulated purge amount Fuel cut Atmospheric pressure - MAP No of attempts to run monitor this drive cycle	Not set 15 <= FL <= 85 % <= 2 kPa -8.125 <= IAT <= 70 degC <= 3 % during the test 1.5 <= MAF <= 50.0 g/s 70 <= ECT <= 110 degC <= 9000 s >= 700 (or >= 450, if Engine speed > 3500 rpm or MAF > 70 g/s for > 3.5 s) Not in progress >= 10 kPa (can be < 10 kPa for Up to 5.0 s) <= 20		

Evaporative Emission System Monitor – 2008 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel Evaporative Leak Monitoring (continued)								
0.040" leak detected	P0442	Fuel tank pressure during purge on, CCV open and CCV closed conditions	Pressure change over time	>= Table EVAP1	Atmospheric pressure Vehicle speed Afterstart	> 74.5 kPa 6.2 <= V < 80.7 mph > 766 s (Or Engine speed > 3500 rpm or MAF > 70 g/s for > 3.5 s)	58 s (approx)	2 Drive Cycles
	P0457	If the refuelled flag set then the diagnostic will still run as stated but this P0457 DTC is set and "Check Cap" message displayed if a fault is detected			Refuelled Flag Fuel level Delta atmos. press. Intake Air Temperature Mass Airflow Engine Coolant Temperature Engine running time since ECT < 40 degC Rough road Accumulated purge amount Fuel cut Atmospheric pressure - MAP Filtered Fuel Level Change Raw Fuel level change (slosh) Purge vapour concentration No of attempts to run monitor this drive cycle	Not set 15 <= FL <= 85 % <= 2 kPa -8.125 <= IAT <= 70 degC 1.5 <= MAF <= 50.0 g/s 70 <= ECT <= 110 degC <= 9000 s Not detected >= 700 (or >= 450, if Engine speed > 3500 rpm or MAF > 70 g/s for > 3.5 s) Not in progress >= 10 kPa (can be < 10 kPa for Up to 5.0 s) <= 3 % during the test <= Table EVAP3 <= 0.5 <= 20		

Evaporative Emission System Monitor – 2008 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel Evaporative Leak Monitoring (continued)								
0.020" leak detected	P0456	Fuel tank pressure during purge on, CCV open and CCV closed conditions	Pressure change over time	>= Table EVAP2	Vehicle speed	0 <= V < 2.0 mph	66 s (approx)	2 Drive Cycles
					Afterstart	> 15 s		
					Fuel level	30 <= FL <= 85 %		
					Atmospheric pressure	> 74.5 kPa		
					Intake Air Temperature	-8.125 <= IAT <= 70 degC		
					Filtered Fuel Level Change	<= 3 % during the test		
					Raw Fuel level change (slosh)	<= Table EVAP4		
					Mass Airflow	1.5 to 15.0 g/s		
					Engine Coolant Temperature	70 to 110 degC		
					Accumulated purge amount	>= 0.004		
					Tank pressure drop	>= -1.25 kPa		
					Engine running time since ECT < 40 degC	<= 5000 s		
					Fuel cut	Not in progress		
					Tank pressure	>= -2.0 kPa		
					Refuelled Flag (if set, then gross or 40 thou test must complete first)	Not set		
					First pressure rise	< 0.044 kPa		
					No of attempts to run monitor this drive cycle	< 20		
					Gross Leak Test status	Not running and didn't complete on previous drive cycle **or** requested a 0.020/0.040" test		

TBDF_LEAK_FALTLEVLBASE – 3.0L										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.55	0.55	0.563	0.599	0.63	0.672	0.727	0.776	0.801	0.825

TBDF_LEAK_FALTLEVLBASE20 – 3.0L										
Fuel level %	19	30	40	45	50	55	60	70	80	91
Threshold level (kPa)	0.25	0.25	0.251	0.251	0.25	0.251	0.251	0.27	0.288	0.318

TBDF_LEAK_FALTLEVLBASE – 4.2L										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.501	0.501	0.563	0.605	0.648	0.727	0.813	0.886	0.929	0.971

TBDF_LEAK_FALTLEVLBASE20 – 4.2L										
Fuel level %	19	30	40	45	50	55	60	70	80	91
Threshold level (kPa)	0.233	0.233	0.239	0.239	0.245	0.251	0.257	0.263	0.300	0.300

TBDF_LEAK_FALTLEVLBASE – 4.2L S/C										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.630	0.630	0.630	0.630	0.660	0.697	0.752	0.819	0.949	0.898

TBDF_LEAK_FALTLEVLBASE20 – 4.2L S/C										
Fuel level %	19	30	40	45	50	55	60	70	80	91
Threshold level (kPa)	0.331	0.331	0.331	0.337	0.343	0.343	0.343	0.349	0.361	0.361

EVAP1 – V6 (X-Type 2004 Model Year)										
Fuel level %	19	30	40	45	50	55	60	70	80	91
Threshold level (kPa)	0.20	0.20	0.21	0.24	0.26	0.27	0.28	0.31	0.33	0.34

EVAP1 (X-Type 2005 Model Year)										
Fuel level %	19	30	40	45	50	55	60	70	80	91
Threshold level (kPa)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.21	0.24	0.28

EVAP1 – 3.0L (S-Type 2004 Model Year)										
Fuel level %	19	30	40	45	50	55	60	70	80	91
Threshold level (kPa)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.27	0.29	0.32

EVAP1 – 4.2L (XJ 2004 Model Year)										
Fuel level %	19	30	40	45	50	55	60	70	80	91
Threshold level (kPa)	0.25	0.25	0.27	0.28	0.29	0.29	0.30	0.33	0.39	0.45

EVAP1 – 4.2L (XK8 2004 Model Year)										
Fuel level %	19	30	40	45	50	55	60	70	80	91
Threshold level (kPa)	0.20	0.20	0.20	0.20	0.20	0.21	0.22	0.24	0.26	0.26

EVAP1 – (X Type 2008 Model Year)										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.093	0.093	0.093	0.099	0.111	0.123	0.123	0.123	0.141	0.160

EVAP2 – V6 (X-Type 2004 Model Year)										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.90	0.90	0.90	0.98	1.05	1.13	1.20	1.28	1.31	1.36

EVAP2 (X-Type 2005 Model Year)										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.75	0.75	0.75	0.75	0.78	0.83	0.87	0.92	0.95	0.98

EVAP2 – 3.0L (S-Type 2004 Model Year)										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.55	0.55	0.56	0.60	0.63	0.67	0.73	0.78	0.80	0.82

EVAP2 – 4.2L (XK8 2004 Model Year)										
Fuel level %	10	20	30	40	50	55	60	70	80	91
Threshold level (kPa)	0.58	0.58	0.60	0.60	0.67	0.70	0.74	0.78	0.90	1.04

EVAP2 – 4.2L (XJ 2004 Model Year)										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.50	0.50	0.52	0.61	0.68	0.78	0.91	1.05	1.10	1.11

EVAP2 – (X Type 2008 Model Year)										
Fuel level %	9	15	30	40	50	60	70	80	85	91
Threshold level (kPa)	0.520	0.520	0.520	0.648	0.703	0.703	0.703	0.703	0.703	0.703

EVAP3 – (X Type 2008 Model Year)								
Fuel Level (%)	15	20	30	45	55	70	80	85
Fuel Slosh Threshold	40	40	18	15	15	14	11	10

EVAP4 – (X Type 2008 Model Year)								
Fuel Level (%)	10	20	30	40	50	60	80	90
Fuel Slosh Threshold	30	20	12	7	7	9	13	15

6.6.3 Drive Cycle Information

Evaporative emission system leak & DMTL module faults

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

EVAP Canister Purge valve & Purge flow faults

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.7 Fuel Tank Pressure Sensor Circuit

6.7.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software.

If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored. If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.7.2 Range/Performance Failure

This monitor is covered in the EVAP loss recovery system monitor section.

6.7.3 Monitoring Structure

Fuel Tank Pressure Sensor Monitor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
FTP sensor low input	P0452	Out of range check	Sensor voltage	<= 0.10 volts	Ignition on		5s 1.3s (2004 MY) 5s (2008 MY)	2 Drive Cycles
FTP sensor high input	P0453	Out of range check	Sensor voltage	>= 4.95 volts >= 4.9 volts (2004 model year)	Ignition on		5s 1.3s (2004 MY) 5s (2008 MY)	2 Drive Cycles
					Disable:	P0603, P1241, P1242, P1243, P1642, P1609, P0562, P0563		
FTP sensor malfunction	P0450	Incorporated in to P0455/P0442	Sensor activity	<= 0.03 kPa		See EVAP system		2 Drive Cycles

6.7.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.8 Exhaust Gas Recirculation System Monitor (V8 Engines)

6.8.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software.

If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored.

If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.8.2 Exhaust Gas Recirculation Valve Range/Performance Failure

The method employed to check the EGR valve operation involves forcing the valve open and closed during an over run fuel cut off. A reading from the Manifold Absolute Pressure sensor is checked before, during and after the valve operation. The difference in values between the open and closed states of the valve is checked against a map of engine speed versus the difference value. If this calculated value is below or over the threshold, a failure is judged.

6.8.3 Monitoring Structure

Exhaust Gas Recirculation System Monitor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Flow malfunction	P0400	Rationality flow check versus engine speed and atmospheric pressure	Inlet manifold pressure	See table EGR1	Atmospheric pressure Engine speed Airflow Ambient temperature Engine load Change in throttle position Throttle Position Engine Coolant Temperature Catalyst monitor EVAP leak check EGR system Over run fuel cut off	67 kPa 1200 to 2500 RPM 0.25 to 13 g/s -30 to 100 °C -11.3 to 100 °C S/C 0.1 to 0.4 g/rev 0.1 to 0.46g/rev S/C < 12.5 deg/s <= 50 deg/s (04MY) <= 4.5 deg 75 to 110 °C Not executing Not executing Not executing Invoked.	2.4s	2 Drive Cycles

Exhaust Gas Recirculation System Monitor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
				Disable:	P0101-P0103, P0111-P0113, P0131-P0133, P0151-P0153, P1313, P1314, P1316, P0171, P0172, P0174, P0175, P0106 -P0108, P0116- P0118, P0125, P1367, P1368, P0351-P0358, P0201-P0208, P0031, P0032, P0051, P0052, P0443-P0445, P1104, P0405, P0406, P1637, P1642, P0603, P1609, P0441, P1224, P1224, P1229, P0128, C1165, C1175, C1137, C1145, C1155			
EGR valve circuit low input	P0405	Out of range check	Control signals voltages	Low level (I/O)		Ignition on	0.800s	2 Drive Cycles
EGR valve circuit high input	P0406		Control signals voltages	High level (I/O)				
					Disable:	P1642, P0603, P1609		

EGR1						
Atmospheric pressure (kPa)	Engine speed (RPM)					
	1500	1700	1900	2100	2300	2500
68	4.6	4.6	4.4	4	3.6	3.5
76	5.2	4.8	4.6	4	4	3.6
95	7	6.5	6.3	6	5.3	5
101	7	6.5	6.3	6	5.3	5

6.8.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.9 Crankshaft/Camshaft Position Sensor

6.9.1 Open and Short Circuit Detection of the Crank Signal

Checks are performed to see if normal crank edge signals are detected during cranking.

6.9.2 Intermittent Crank Failure Detection

The number of crank teeth is checked every 360° of crank angle (1revolution).

6.9.3 Crank Request Signal High Input Monitor

If the crank request input is high when then the engine is running and the vehicle is moving, a high failure is flagged.

6.9.4 Open/Short Circuit

For open and short circuit detection, the monitor looks for:

- No CMP edge signal is input during cranking.
- No CMP edge signal is input during normal running.

6.9.5 Missing Phase Detection

For missing phase detection, the cylinder identification flag does not turn on or off every 360°.

6.9.6 Monitoring Structure

Crankshaft Position Sensors Monitoring Operation								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
CKP sensor malfunction	P0335	1). Crank sensor signal when engine cranking	Time to crank pulse	No pulse	Cranking Battery voltage Engine speed (RPM)	Operation 6.5 to 16.0 volts >= 600 (V8) >= 650 (V6)	2.0s	2 Drive Cycles
		2). Crank sensor during engine running	Time to crank pulse	No pulse	Engine speed (RPM)	>= 1000 >= 650 (X-Type)	0.1s	2 Drive Cycles
CKP sensor range/ performance	P0336	Crank sensor pulses judged between missing teeth	Number of pulses	Incorrect number of pulses	Engine speed (RPM) 30 deg crank angle time Disable:	>= 600 (V8) >= 650 (V6) < 0.077s (2008MY) P1245, P1246, P1609, P0616, P0617, P0340, P0341, P0512	1 revolution	2 Drive Cycles
Crank request low input	P1245 (2003 model year only)	Starter relay on while crank request off	Crank request signal Starter relay	Off On			0.512s	2 Drive Cycles
Crank request high input	P1246 P0512 (2005 model year X-Type)	Crank request active while vehicle moving	Crank request signal	On Disable:	Vehicle speed (mph) Engine speed (RPM) Engine load P0335, P0336, P0102, P0103, P1104, P0101, P1637, P0603, P1609, P0616, P0617, P1516, P1642, P0616, P0617, C1165, C1175, C1137, C1145, C1155, P0851	>= 12 (X-Type) >= 9 (all others) 1200 to 3000 (X-Type) 1500 to 4000 (all others) >= 15g/s	5 times	2 Drive Cycles

Camshaft Position Sensors								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
CMP sensor Bank A malfunction CMP sensor Bank B malfunction	P0340 P1340 P0345 (2004 model year)	1). CMP sensor at engine start	Time to CMP pulse	No pulse	Cranking Battery voltage Crank signal pulse detected Engine speed (RPM)	Operation >= 8.5 volts (X-Type) >= 6.5 volts (all others) >= 24 times >= 600 (V8) >= 650 (V6)	5s	2 Drive Cycles
		2). CMP sensor during engine running	Time to CMP pulse	No pulse	Battery voltage Engine speed (RPM) 30 deg crank angle time	>= 10.5 volts >= 600 (V8) >= 650 (V6) < 0.077s (2008MY)	5s	2 Drive Cycles
CMP sensor Bank A range/ performance	P0341	Detection of CMP sensor pulse between crank missing teeth	Pulse not detected	No pulse	Engine speed (RPM) Missing camshaft position signal Delay – reverse gear selected/deselected 30 deg crank angle time	>= 600 (V8) >= 650 (V6) >= 2 times (X-Type) >= 3 times (all others) >= 5s < 0.077s (2008MY)	2 revolutions	2 Drive Cycles
CMP sensor Bank B range/ performance	P1341 P0346 (2004 model year)							2 Drive Cycles
				Disable:	P0335, P0336, P0512, P0605, P0606, P0610, P0616, P0617, P0641, P0651, P0666, P0701, P0702, P0705, P0706, P0709, P0710, P0711, P0715, P0720, P0725, P0729, P0730, P0731, P0732, P0733, P0734, P0735, P0740, P0741, P0743, P0750, P0753, P0755, P0758, P0760, P0763, P0765, P0768, P0770, P0773, , P0780, P0781, P0782, P0783, P0784, P0787, P0788, P0815, P0829, P1245, P1246, P1572, P1603, P1605, P1609, P1642, P1643, P1719, P1774, P1796, P1797, P1783, P1798, P1799			

6.9.7 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.10 Mass Airflow Sensor and Manifold Absolute Pressure Sensor

The Mass Airflow sensor contains a hot wire resistance element that forms part of a Wheatstone bridge. Air flowing around the hot-wire cools it, so altering the value of its resistance. The consequent change in the voltage dropped across the resistance is compared with the voltage dropped by the other resistance arms of the Wheatstone bridge to determine the airflow. The Mass Airflow sensor is continually monitored by OBD routines. A DTC is recorded if the input signal from the sensor to the ECM is outside pre-defined thresholds at the high or low end of the scale.

6.10.1 High/Low Input Failure and Ground Monitor

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software. If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored. If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored. For Mass Airflow sensor ground open monitoring, the voltage on the ground pin of the Mass Airflow sensor is monitored in the same way as described above.

6.10.2 Range/Performance Failure

The monitor operates continuously whilst the entry conditions are met. Every 0.128 seconds the airflow sensor monitor compares the actual airflow with an estimated airflow, which is calculated by a model. Similarly, every 0.032 seconds the Manifold Absolute Pressure sensor monitor compares the actual Manifold Absolute Pressure with an estimated pressure, which is calculated by a model. The models to calculate the estimated airflow and pressure have look-up tables that use engine speed, throttle angle and atmospheric pressure to derive base values and compensation values by which the estimated airflow and pressure are calculated.

Whether the Mass Airflow sensor and the Manifold Absolute Pressure sensor are behaving normally is determined if the difference between the actual and estimate values are below a calibrated threshold for more than 5 seconds. Whether the Mass Airflow sensor and the Manifold Absolute Pressure sensor are behaving abnormally, as failed components, is determined if the difference between the actual and estimated values is greater than a calibrated threshold for fifteen seconds continuously. The monitors have the ability to make a normal judgments followed by failed judgments or vice versa as the monitors run continuously whilst the entry conditions are met.

6.10.3 Monitoring Structure

Mass Airflow Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
MAF high voltage	P0103	Out of range check	MAF voltage	> 4.9 volts		Ignition on	0.5s	2 Drive Cycles
MAF Low voltage	P0102	Out of range check	MAF voltage	< 0.2 volts		Ignition on	0.5s	2 Drive Cycles
MAF ground open	P1104	Out of range check	MAF ground voltage	> 1.0 volts		Ignition on	0.5s	2 Drive Cycles
MAF range/ performance	P0101	Rationality v Throttle Position and engine speed	Airflow actual versus estimated	See table MAF1 and MAF2 (X-Type) >= 20 g/s (S-type) >= 25 g/.s (XJ) >= 20 g/s (XK8)	Engine speed (RPM): Engine Coolant Temperature: Intake Air Temperature: Atmospheric Pressure: Throttle Position: Fuel level: TP change:	1050 to 5100 (X-Type) 1500 to 2500 (S-Type) 1000 to 2000 (XJ an XK8)) 60 to 119 °C (X-Type) 70 to 110 °C (all others) -30 to 100 °C >= 68 kPa 6 to 45 deg (X-Type) 7 to 30 deg (S-Type) 7 to 20 deg (XJ an XK8) >=10% <= 45 deg/s (X-Type) <= 44 deg/s (S-Type and XK8) <= 25 deg/s (XJ)	15s	2 Drive Cycles
			Disable:	P1313, P1314, P1316, P0131-P0133, P0151-P0153, P0171, P0172, P0174, P0175, P0340, P0341, P1340, P1341, P0335, P0336, P0106-P0108, P0125, P0116- P0118, P0351-P0358, P1367, P1368, P0201- P0208, P0031, P0032, P0051, P0052, P0444, P0445, P0443, P0111-P0113, P1241, P1242, P0101- P0103, P1104, P0010, P0020, P1384, P1396, P1642, P1637, P1243, P0603, P1646, P1647, P1107, P1108, P0128, P1224, P1229, P0121-P0123, P0223, P0222, P1251, P1631, P1611, P1633, C1165, C1175, C1137, C1145, C1155, P0069, P2135, P2228, P2229				

Mass Airflow Sensor – MAF1 (2.5L) MAF Upper Limit									
Throttle Angle (deg)	Engine speed (RPM)								
	1050	1540	2025	2550	3040	3560	4040	4570	5090
6	15.6	16.2	16.9	16.9	16.9	16.9	16.9	16.9	16.9
10	21.3	24.4	26.9	28.7	29.4	28.1	28.4	27.8	28.1
15	23.7	32.5	38.8	42.5	47.5	48.7	50.0	50.0	50.6
20	27.5	35.0	45.0	53.7	65.0	70.0	73.7	76.9	79.7
25	27.5	37.5	48.1	60.0	72.5	81.3	88.8	95.3	101.3
30	27.5	38.1	50.0	65.0	78.1	90.0	100.0	109.4	118.8
35	27.5	39.4	50.6	67.5	85.0	96.3	108.1	120.0	131.6
40	27.5	39.4	51.3	68.8	85.6	99.4	112.5	126.3	140.6
45	27.5	39.4	51.3	68.8	85.6	99.4	115.6	128.4	145.6

Mass Airflow Sensor – MAF2 (2.5L) MAF Lower Limit									
Throttle Angle (deg)	Engine speed (RPM)								
	1050	1540	2025	2550	3040	3560	4040	4570	5090
6	5.2	5.6	6.4	6.4	6.4	6.4	6.4	6.4	6.4
10	9.7	11.6	12.4	13.5	13.9	13.1	13.3	12.9	13.1
15	11.2	15.7	19.5	21.8	22.5	23.2	24.0	24.0	24.4
20	12.0	17.2	22.5	26.3	30.7	33.8	36.0	37.9	39.6
25	12.0	18.0	23.6	29.2	35.2	40.5	45.0	48.9	52.5
30	12.0	17.6	24.7	30.7	37.1	44.3	50.3	55.9	61.5
35	12.0	18.4	25.1	31.5	39.8	46.5	53.6	60.7	67.7
40	12.0	18.4	25.5	32.3	40.1	48.4	56.3	64.5	73.1
45	12.0	18.4	25.5	32.3	40.1	48.4	58.1	65.8	76.1

Mass Airflow Sensor – MAF1 (3.0L) MAF Upper Limit									
Throttle Angle (deg)	Engine speed (RPM)								
	1050	1540	2025	2550	3040	3560	4040	4570	5090
6	16.2	16.9	17.5	17.5	17.5	17.5	17.5	17.5	17.5
10	23.7	26.3	27.5	28.7	28.7	28.7	28.7	28.7	28.7
15	27.5	35.6	41.2	44.4	48.7	50.0	51.3	51.3	51.3
20	30.0	40.0	50.0	58.8	67.5	71.3	73.7	76.3	78.7
25	31.3	43.8	55.0	67.5	80.0	86.2	93.8	100.0	105.0
30	31.3	45.0	57.5	72.5	88.8	98.7	108.8	118.0	127.5
35	31.3	45.6	60.0	76.3	93.1	106.3	118.8	133.8	145.0
40	31.3	46.3	60.0	78.7	96.3	111.2	126.3	143.8	158.8
45	31.3	46.3	60.6	79.4	98.7	115.0	132.5	150.0	166.2

Mass Airflow Sensor – MAF2 (3.0L) MAF Lower Limit									
Throttle Angle (deg)	Engine speed (RPM)								
	1050	1540	2025	2550	3040	3560	4040	4570	5090
6	6.0	6.4	6.8	6.8	6.8	6.8	6.8	6.8	6.8
10	10.5	12.8	13.5	13.5	13.5	13.5	13.5	13.5	13.5
15	12.8	18.0	21.4	24.7	24.7	25.5	25.5	25.5	25.5
20	14.3	21.0	26.3	31.5	36.0	39.0	41.2	42.0	42.7
25	15.0	21.8	27.8	34.5	42.0	47.2	51.0	55.5	59.3
30	15.0	22.5	29.2	36.7	45.0	52.5	58.5	65.3	71.3
35	15.0	22.5	30.0	38.3	47.2	55.5	63.8	72.7	80.2
40	15.0	22.5	30.7	39.8	49.5	57.8	66.7	78.7	88.5
45	15.0	23.2	30.7	39.8	49.5	59.3	69.0	81.8	92.2

Mass Airflow Sensor – MAF1 (2008MY) MAF Upper Limit									
Throttle Angle (deg)	Engine speed (RPM)								
	1050	1540	2025	2550	3040	3560	4040	4570	5090
6	16.25	16.88	17.50	17.50	17.50	17.50	17.50	17.50	17.50
10	23.75	26.25	27.50	28.75	28.75	28.75	28.75	28.75	28.75
15	27.50	35.63	41.25	44.37	48.75	50.00	51.25	51.25	51.25
20	30.00	40.00	50.00	58.75	67.50	71.25	73.75	76.25	78.75
25	31.25	43.75	55.00	67.50	80.00	86.25	93.75	100.00	105.00
30	31.25	45.00	57.50	72.50	88.75	98.75	108.75	118.75	127.50
35	31.25	45.62	60.00	76.25	93.13	106.25	118.75	133.75	145.00
40	31.25	46.25	60.00	78.75	96.25	111.25	126.25	143.75	158.75
45	31.25	46.25	60.63	79.38	98.75	115.00	132.50	150.00	166.25

Mass Airflow Sensor – MAF2 (2008MY) MAF Lower Limit									
Throttle Angle (deg)	Engine speed (RPM)								
	1050	1540	2025	2550	3040	3560	4040	4570	5090
6	6.00	6.37	6.75	6.75	6.75	6.75	6.75	6.75	6.75
10	10.50	12.75	13.50	13.50	13.50	13.50	13.50	13.50	13.50
15	12.75	18.00	21.37	24.75	24.75	25.50	25.50	25.50	25.50
20	14.25	21.00	26.25	31.50	36.00	39.00	41.25	42.00	42.75
25	15.00	21.75	27.75	34.50	42.00	47.25	51.00	55.50	59.25
30	15.00	22.50	29.25	36.75	45.00	52.50	58.50	65.25	71.25
35	15.00	22.50	30.00	38.25	47.25	55.50	63.75	72.75	80.25
40	15.00	22.50	30.75	39.75	49.50	57.75	66.75	78.75	88.50
45	15.00	23.25	30.75	39.75	49.50	59.25	69.00	81.75	92.25

Manifold Absolute Pressure Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
MAP high	P1108	Out of range check	MAP voltage	> 4.9 volts		Ignition on	0.5s	2 Drive Cycles
MAP low	P1107	Out of range check	MAP voltage	< 0.1 volts		Ignition on	0.5s	2 Drive Cycles
MAP malfunction	P0105	Rationality versus Throttle Position and engine speed	Pressure actual versus estimated	See tables MAP1 and MAP2 (X-Type) >= 20 kPa (all others))	Engine speed (RPM):	1050 to 4550 (X-Type) 1500 to 2500 (S-Type) 1000 to 2000 (XJ and XK8)	15s	2 Drive Cycles
					Engine Coolant Temperature:	70 to 110 °C 60 to 119 °C (X-Type)		
					Intake Air Temperature:	-30 to 100°C		
					Atmospheric pressure:	>= 68 kPa		
					Throttle Position:	7 to 20 deg 6 to 40 deg (X-Type)		
					Fuel level:	>= 10%		
					TP change:	<= 44 deg/s		
					Variable camshaft timing advance	<= 160 deg (X-Type only)		
					EVAP canister purge valve duty	<= 100% (X-Type only)		
					Manifold Absolute Pressure	> 0 kPa (X-Type only)		
			Disable:	P1313, P1314, P1316, P0131- P0133, P0151- P0153, P0171, P0172, P0174, P0175, P0340, P0341, P1340, P1341, P0335, P0336, P0106- P0108, P0125, P0116- P0118, P0351-P0358, P1367, P1368, P0201- P0208, P0031, P0032, P0051, P0052, P0444, P0445, P0443, P0111- P0113, P1241, P1242, P0101- P0103, P1104, P0010, P0020, P1384, P1396, P1642, P1637, P1243 P0603, P1646, P1647, P1107, P1108, P0128, P1224, P1229, P0123, P0122, P0223, P0222, P0121, P1251, P1631, P1611, P1633, C1165, C1175, C1137,C1145, C1155, P2118, P2119, P2135, P2228, P2229				

Manifold Absolute Pressure Sensor (2008MY)

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
MAP high input MAP low input	P0108 P0107	Out of range check Out of range check	MAP voltage (>= 200 kPa) MAP voltage (<= 10 kPa)	>= 4.86 V <= 0.12 V		Ignition on	0.5 s	2 Drive Cycles
MAP range / performance	P0106	Rationality - measured versus estimate based on TP & RPM with compensation for altitude and temperature. Where: Estimate = ManiP * (1 - AltitudeDifComp * AtmoPComp) * InAirTComp See Appendix for settings of ManiP, AltitudeDifComp, AtmoPComp and InAirTComp	Measured MAP deviation from estimate: Estimate - Measured **Or** Measured - Estimate Where: MapDiff = MaxDiff * 30 kPa See table for setting of MaxDiff	 > MapDiff > MapDiff	Engine Speed Engine Coolant Temperature Intake Air Temperature Atmospheric pressure Throttle Position Fuel level TP change VVT advance Purge valve duty Manifold Absolute Pressure Vehicle speed **Fault Codes that disable MAP Monitoring**	1050 < N < 4550 rpm 60 < T < 119 degC -30 < IAT < 100 degC >= 68 kPa 6 < TP < 40 degrees >= 10 % <= 1.4 deg/0.032 s for at least 1.024 s <= 160 degCA <= 99.6 % >= 0 kPa 0 <= V <= 420 mph P0300 P0301 P0303 P0305 P0302 P0304 P0306 P1313 P1314 P1316 P0132 P0131 P0133 P0152 P0151 P0153 P0172 P0171 P0175 P0174 P0340 P0341 P0345 P0346 P0335 P0336 P2229 P2228 P0118 P0117 P0116 P0125 P0351 P0353 P0355 P0352 P0354 P0356 P1367 P1368 P0201 P0202 P0203 P0204 P0205 P0206 P0031 P0032 P0051 P0052 P0444 P0445 P0443 P0112 P0113 P0111 P0562 P0563 P0102 P0103 P1104 P0101 P0010 P1384 P0011 P0012 P0020 P1396 P0021 P0022 P1637 P1638 P1642 P1243 P0603 P0460 P1646 P1647 P0107 P0108 P0128 C0037 C003A P0501 P2119 P2118 P0122 P0123 P0222 P0223 P2135 P1251 P1631 P0607 P1633	15.0 s	2 Drive Cycles

Manifold Absolute Pressure Sensor – MAP1 (2.5L) MAP Estimate								
Throttle Angle (deg)	Engine speed (RPM)							
	1050	1540	2025	2550	3040	3560	4040	4570
6	55.0	47.5	40.0	33.0	23.5	22.2	19.8	18.8
10	73.0	66.0	59.5	48.5	40.5	35.5	30.3	25.5
15	92.0	86.0	78.0	70.5	60.0	51.0	47.0	41.5
20	97.0	94.0	90.0	84.0	76.2	71.3	65.5	59.5
25	98.0	97.0	94.0	90.2	85.7	82.0	77.0	72.5
30	99.0	98.0	96.7	94.3	91.5	88.0	85.0	81.5
35	99.5	98.5	98.0	96.3	94.5	92.8	90.0	87.8
40	99.5	99.0	99.0	97.5	96.5	95.3	93.2	91.5

Manifold Absolute Pressure Sensor – MAP1 (3.0L) MAP Estimate								
Throttle Angle (deg)	Engine speed (RPM)							
	1050	1540	2025	2550	3040	3560	4040	4570
6	55.0	42.0	35.0	24.0	19.5	18.0	17.0	14.5
10	72.0	61.0	50.0	40.0	32.0	31.0	26.5	20.0
15	90.5	82.5	72.5	62.0	50.0	48.0	41.0	34.5
20	95.0	90.5	85.5	78.5	68.0	65.0	58.5	51.0
25	97.0	94.5	91.5	87.5	79.5	76.5	70.5	64.0
30	98.0	96.5	94.5	92.0	87.0	84.5	79.5	75.0
35	98.5	97.5	96.5	94.5	91.5	89.5	86.5	83.0
40	98.5	98.0	97.5	96.5	94.0	92.5	90.0	88.5

Manifold Absolute Pressure Sensor – MAP2 (2.5Land 3.0L) MAP Limit								
Engine speed (RPM)	1050	1540	2025	2550	3040	3560	4040	4570
Maximum difference (kPa)	39	36	33	30	27	24	21	18

Manifold Absolute Pressure Sensor – MAP1 (2008MY) Estimate value (kPa)								
Throttle Angle (deg)	Engine speed (RPM)							
	1050	1540	2025	2550	3040	3560	4040	4570
6	55.0	42.0	35.0	24.0	19.5	18.0	17.0	14.5
10	72.0	61.0	50.0	40.0	32.0	31.0	26.5	20.0
15	90.5	82.5	72.5	62.0	50.0	48.0	41.0	34.5
20	95.0	90.5	85.5	78.5	68.0	65.0	58.5	51.0
25	97.0	94.5	91.5	87.5	79.5	76.5	70.5	64.0
30	98.0	96.5	94.5	92.0	87.0	84.5	79.5	75.0
35	98.5	97.5	96.5	94.5	91.5	89.5	86.5	83.0
40	98.5	98.0	97.5	96.5	94.0	92.5	90.0	88.5

Manifold Absolute Pressure Sensor – MAP2 (2008MY) Fault limit (MaxDiff)								
Camshaft Advance Angle (deg)	Engine speed (RPM)							
	1050	1540	2025	2550	3040	3560	4040	4570
0.0	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6
4.0	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6
8.0	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6
12.0	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6
16.0	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6
20.0	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6
24.0	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6
30.0	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6

Manifold Absolute Pressure Sensor – MAP3 (2008MY) Altitude correction (AltitudeDifComp)								
Throttle Angle (deg)	Engine speed (RPM)							
	1050	1540	2025	2550	3040	3560	4040	4570
6	55.0	42.0	35.0	24.0	19.5	18.0	17.0	14.5
10	72.0	61.0	50.0	40.0	32.0	31.0	26.5	20.0
15	90.5	82.5	72.5	62.0	50.0	48.0	41.0	34.5
20	95.0	90.5	85.5	78.5	68.0	65.0	58.5	51.0
25	97.0	94.5	91.5	87.5	79.5	76.5	70.5	64.0
30	98.0	96.5	94.5	92.0	87.0	84.5	79.5	75.0
35	98.5	97.5	96.5	94.5	91.5	89.5	86.5	83.0
40	98.5	98.0	97.5	96.5	94.0	92.5	90.0	88.5

Manifold Absolute Pressure Sensor – MAP4 (2008MY) Atmospheric pressure correction (AtmoPComp)					
Atmospheric Pressure (kPa)	60	70	80	90	100
Correction Factor	1.203	0.898	0.602	0.297	0.000

Manifold Absolute Pressure Sensor – MAP5 (2008MY) Inlet air temperature correction (InAirTComp)														
Inlet Air Temperature (deg C)	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
Correction Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1

6.10.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.11 Barometric Pressure Sensor

The barometric pressure (BARO) sensor (also referred to as the high altitude compensation sensor) is located within the ECM.

6.11.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software. If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored. If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.11.2 Range/Performance Failure

The signal from the sensor is compared to the signal from the Manifold Absolute Pressure sensor at ignition on only. During this time the pressure within the inlet manifold should be at atmospheric, and therefore should match the value from the barometric pressure sensor.

The following conditions must be met first before the monitor can execute:

- Engine speed = 0
- Vehicle speed = 0
- Monitor is not inhibited
- Ignition is on
- Engine is not cranking
- Battery voltage exceeds the minimum threshold
- Engine Coolant Temperature above minimum threshold
- Atmospheric pressure within limits
- Inlet manifold pressure value has settled

If the absolute value of the difference between the signal from the barometric pressure sensor and the Manifold Absolute Pressure sensor differ by more than a defined amount, then a timer is executed. If the timer exceeds a calibrated amount, a temperature failure is judged. Providing there is no failure of the Manifold Absolute Pressure sensor, a DTC is then stored.

6.11.3 Monitoring Structure

Barometric Pressure Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Barometric pressure sensor low input	P0107 P2228 (X-Type 2005 model year)	Out of range check	Sensor voltage	<= 0.1 volts		Ignition on	0.5s	2 Drive Cycles
Barometric pressure sensor high input	P0108 P2229 (X-Type 2005 model year)	Out of range check	Sensor voltage	>= 4.9 volts		Ignition on	0.5s	2 Drive Cycles
Barometric pressure sensor range/ performance	P0106 P0069 (X-Type 2005 model year)	Comparison with MAP sensor signal and barometric pressure signal		10 kPa	Intake Air Temperature Engine Coolant Temperature Engine speed Vehicle speed Battery voltage Time after ignition on Delta MAP Manifold pressure Crank request flag	>= - 30 °C >= - 30 °C 0 RPM 0 MPH >= 10 volts 192 to 0.992s <= 0.72 kPa/s 61.5 to 106 kPa Not set	0.5s	2 Drive Cycles
				Disable:	C1137, C1145, C1155, C1165, C1175, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0125, P0128, P0222, P0223, P0335, P0336, P0460, P0603, P0616, P0617, P1104, P1107, P1108, P1224, P1229, P1245, P1246, P1251, P1609, P1611, P1631, P1633, P1637, P1642, P0512, P0607, P2118, P2119, P2135, P2228, P2229			

6.11.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.12 Intake Air Temperature Sensor

The Intake Air Temperature sensor is a thermistor device mounted inside the Mass Airflow sensor. It provides an input signal to the ECM proportional to the temperature of air passing through the inlet duct into the engine. A DTC is recorded if the voltage input signal from the sensor to the ECM is outside pre-defined thresholds at the high or low end of the scale.

6.12.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software. If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored. If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.12.2 Range/Performance Check 1

If engine speed and intake airflow is sufficient, the Engine Coolant Temperature is low enough and the air temperature sensor voltage is lower than calibrated constants, then a monitoring failure judgment is made.

If after a calibrated period has elapsed the voltage from the sensor is greater than a calibration constant then a monitoring normal judgment is made.

6.12.3 Range/Performance Check 2

At intervals of approximately 2 seconds, the Intake Air Temperature is sampled to monitor for rapid drop in air temperature. If the change in Intake Air Temperature (over a 6 second period) is greater than a calibration constant then a monitoring failure judgment will be made. A normal judgment is made if the change in Intake Air Temperature change is less than this calibrated value.

6.12.4 Monitoring Structure

Intake Air Temperature Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
IAT high input	P0113	Out of range check	Sensor voltage	<= 0.1 volts		Ignition on	0.5s	2 Drive Cycles
IAT low input	P0112	Out of range check	Sensor voltage	>= 4.9 volts		Ignition on	0.5s	2 Drive Cycles
IAT range/ performance	P0111	1 - Rationality versus run time	Sensor voltage	<=- 0.3 volts (> 100°C)	Engine speed Mass Airflow Engine Coolant Temperature	> 1000 RPM > 5 g/s < 40°C	17.5s	2 Drive Cycles
		2 – Two sided other check	Sensor voltage change/2 seconds	>= 20°C (X-Type) >= 45°C (V8) >= 35°C (S-Type)		Ignition on	6s	
					Disable:	P0101, P0102, P0103, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0335, P0336, P0562, P0563, P0603, P1104, P1241, 1243, P1609, P1642,		

Intake Air Temperature Sensor (2008MY)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
IATS low input IATS high input	P0112 P0113	Out of range check Out of range check	IAT voltage (>= 4.86 V) IAT voltage (<= 0.12 V)	<= -40 degC >= 119.4 degC	Ignition	On	0.512 s	2 Drive Cycles
IATS range / performance	P0111	Range Performance IAT stuck high	IAT Signal	<= 0.33 V (>= 100 degC)	Engine speed Mass Airflow Engine Coolant Temperature Time after start	>= 1000 rpm >= 5 g/s <= 40 degC >= 1.28 s	17.5 s	2 Drive Cycles
IATS range / performance	P0111	Range Performance Readings taken every 2 seconds and compared (unexpected step change in Signal)	IAT(i - 3) - IAT(i) **And** IAT(i - 4) - IAT(i-1) **And** IAT(i - 5) - IAT(i-3)	> 40 degC > 40 degC > 40 degC	Battery voltage Engine Start Ignition turned on	>= 10.0 V Not in progress Not in last 2.0 s		2 Drive Cycles
IATS range / performance	P0111	Rationality versus ECT and Engine oil temperature	Average_IAT - (average_ECT + average_EOT)/2 **Or** (average_ECT+ average_EOT)/2 - Average_IAT	> 20 degC > 20 degC	Engine Stall Condition Block Heater Time after start Engine off time Difference between Engine Coolant Temperature average and Oil temperature average at ignition on	Not set Not detected 120 <= time <= 200 s 28800 <= time <= 655000 s <= 10 degC	Dependent upon drive cycle	2 Drive Cycles

6.12.5 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.13 Intake Air Temperature Sensor 2 Monitor (V8 Supercharged Only)

6.13.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software.

If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored.

If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.13.2 Range/Performance Check 1

If engine speed and intake airflow is sufficient, the Engine Coolant Temperature is low enough and the air temperature sensor voltage is lower than calibrated constants, then a monitoring failure judgment is made.

If after a calibrated period has elapsed the voltage from the sensor is greater than a calibration constant then a monitoring normal judgment is made.

6.13.3 Range/Performance Check 2

At intervals of approximately 2 seconds, the Intake Air Temperature is sampled to monitor for rapid drop in air temperature. If the change in Intake Air Temperature (over a 6 second period) is greater than a calibration constant then a monitoring failure judgment will be made. A normal judgment is made if the change in Intake Air Temperature change is less than this calibrated value.

6.13.4 Range/Performance Check 3

The monitor examines the integrity of IAT 2 sensor, by comparing it with the temperature signal from IAT 1 sensor, during the initial engine start up period (first 60 sec). The monitor will only execute after a cold start has been detected and appropriate cold soak flag has been set. The cold soak flag is set when the absolute of value (IAT – ECT < 10 °C), and a cold start has been initiated. Once a cold start has been identified and the monitor entry conditions are satisfied, the monitor proceeds to compare the two sensor readings. If the absolute value of IAT 2 – IAT 1 is less than the threshold then a normal counter is incremented, and upon exceeding a calibrated threshold, a normal judgment is set. If the absolute value is greater than the threshold, then a failure counter is incremented, and upon exceeding a calibrated threshold of the counter, a failure judgment is set.

6.13.5 Monitoring Structure

Intake Air Temperature 2 Sensor (4.2L Supercharged Only)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
IAT 2 low input	P0097	Out of range check	IAT 2 voltage	< 0.1 volts		Ignition on	0.5s	2 Drive Cycles
IAT 2 high input	P0098	Out of range check	IAT 2 voltage	> 4.9 volts		Ignition on	0.5s	2 Drive Cycles
IAT 2 range/ performance	P0096	1 – Rationality versus run time	IAT 2 voltage	<= 0.3 volts (>= 100°C)	Engine speed Airflow Engine Coolant Temperature	>= 1000 RPM >= 5 g/s <= 40°C	18s 0.5s (2004 model year)	2 Drive Cycles
		2 – Two sided other check	IAT 2 voltage change/2 seconds	>= -45°C	Intake Air Temperature	Ignition on <= 40°C	6s	
		3 – Comparison check	IAT 2 versus IAT 1	>= 35°C	Engine Coolant Temperature Engine soak judged ECT – IAT 1 Manifold pressure Engine after start count	<= 40°C <= 10°C <= 70 kPa (2003 model year only) <= 60s		
					Disable:	P0097, P0098, P0101, P0102, P0103, P0105, P0111, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0335, P0336, P0603, P1104, P1107, P1108, P1240-P1242, P1243, P1245, P1246, P1474, P1642, P1609		

6.13.6 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.14 Engine Coolant Temperature Sensor

The sensor is a thermistor, a solid-state variable resistor that changes resistance in response to a rise or fall in temperature. It is mounted in the engine block coolant system. The sensor is supplied with a reference voltage through a fixed resistor. As the current passes through the thermistor resistance, the ECM measures the voltage drop across the fixed resistor and translates this into a temperature using a pre-programmed table of values.

6.14.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software.

If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored.

If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.14.2 Range/Performance Failure

There are two parts to the range/performance monitor. The first part ensures that the Engine Coolant Temperature reaches the level required for closed loop fuelling. The second part ensures that the Engine Coolant Temperature reaches 80°C. Both parts of the monitor operate with the same strategy, are one shot monitors and each part has its own calibration values. If the Engine Coolant Temperature and intake air temperature are above the required level for each monitor part then the following strategy will be carried out otherwise the counters for that monitor part are reset.

There are two counters associated with each monitor - the load conditions met counter increments when the engine speed and load are above the required level - the load conditions not met counter increments when any of those conditions is not met.

A normal judgment is made if the Engine Coolant Temperature reaches the required level before the load conditions met counter reaches the value held in the judgment table.

A failure judgment is made if the load conditions met counter reaches the value held in the judgment table and the Engine Coolant Temperature has not yet reached the required level.

The judgment table holds the values that the load conditions met counter must reach, mapped against minimum Engine Coolant Temperature (and minimum intake air temperature for the range/performance monitor), for a failure judgment to be made.

The load conditions not met counter has a value associated with it which if exceeded will reset both the load conditions met counter and the load conditions not met counter.

6.14.3 Monitoring Structure

Engine Coolant Temperature Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
ECT high input	P0118	Out of range check	ECT voltage	<= 0.14 volts		Ignition on	0.5s	2 Drive Cycles
ECT low input	P0117	Out of range check	ECT voltage	>= 4.86 volts		Ignition on	0.5s	2 Drive Cycles
ECT range/ performance	P0116	1) Time for ECT to reach 80 °C check	ECT/time	See table ECT1	Engine speed (RPM)	>=1600 (X-Type) >=1400 (V8) >=1500 (S-Type)	See table ECT1	2 Drive Cycles
					Engine load	> 0.4 g/revolutions (X-Type) > 0.5 g/revolutions (XJ) > 0.6 g/revolutions (XK8) * If these conditions are not met for > 1100s then the monitor is reset.		
					Engine Coolant Temperature Intake Air Temperature	-15 to 80 °C >= - 15 °C		
	P0116	2) – Two sided other check	ECT voltage change/ 2s	> - 20 °C		Ignition on	6 s	2 Drive Cycles
	P0125	Time to closed loop fuelling enable temperature (-15 °C)	ECT/time	See table ECT2	Engine speed (RPM) Engine load	> 500 * > 0.2 g/revolutions * * If these conditions are not met for >300s (>60s 2008MY) then the monitor is reset.	See table ECT2	2 Drive Cycles
					ECT Intake Air Temperature	-40 to –15 °C >= - 30 °C		
				Disable:	P0031, P0032, P0051, P0052, P0069, P0106, P0107, P0108, P0111, P0112, P0113, P0117, P0118, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P0562, P0563, P0603, P1241, P1242, P1243, P1367, P1368, P1609, P1642, P2228, P2229			

Engine Coolant Temperature Sensor (P0116 – 2008MY)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
ECT range / performance	P0116	Coolant temperature biased high	ECT signal Voltage	< ECT3	Time after engine start Engine Oil Temperature Fuel Rail Temperature Intake Air Temperature Oil temperature at ignition off - current oil temperature Difference between oil temperature and Intake Air Temperature Difference between oil temperature and Fuel rail temperature Difference between Fuel rail temperature and IAT Oil temperature at ignition off	< 3.584 s -15 < EOT < 40 degC -15 < FRT < 40 degC -15 < IAT < 40 degC > 40 degC < 10 degC < 10 degC < 10 degC < 100 degC	1.02 s	2 Drive Cycles
ECT range / performance	P0116	Range Performance Readings taken every 2 seconds and compared (unexpected step change in Signal)	ECT(i - 3) - ECT (i) **And** ECT(i - 4) - ECT(i-1) **And** ECT(i - 5) - ECT(i-3)	> 20 degC > 20 degC > 20 degC	Battery voltage Engine Start Ignition turned on	>= 10.0 V Not in progress Not in last 2.0 s		2 Drive Cycles
ECT range / performance	P0116	Time for the coolant to reach 80 degC (i.e. Coolant temperature biased low)	ECT **And** Entry conditions true for	< 80 degC >= Table ECT1	Time to closed loop or ECT biased high faults Engine Coolant Temperature Intake Air Temperature Engine Speed Engine load	Not set >= -15 degC >= -15 degC >= 1200 rpm* >= 0.4 g/rev* *If these conditions are not met for >= 1100 s, then the monitor is reset	ECT1	2 Drive Cycles

Engine Coolant Temperature Sensor Range Performance (4.2L) – ECT1												
Start ECT (°C)	-15	-10	0	10	20	30	40	50	60	70	80	90
Failure time counter (sec)	1350	1350	1200	1050	1000	950	800	700	700	400	400	400

Engine Coolant Temperature Sensor Range Performance (3.0L) – ECT1												
Start ECT (°C)	-30	-15	-5	5	15	25	35	45	55	65	75	80
Failure time counter (sec)	3212	2888	2658	2418	2325	2107	2157	1658	1492	1380	1380	1380

Engine Coolant Temperature Sensor Range Performance (X-Type From 2004 Model Year) – ECT1								
	Start ECT (°C)							
Min. IAT (°C)	-15	0	15	30	45	55	65	75
-15	2165	2045	1930	1765	1525	1285	930	365
0	2165	1310	1190	1065	885	715	505	185
15	2165	1310	880	755	620	495	345	140
30	2165	1310	880	595	455	360	250	95
40	2165	1310	880	595	455	360	250	95

Engine Coolant Temperature Sensor Range Performance (S-Type From 2004 Model Year) – ECT1								
	Start ECT (°C)							
Min. IAT (°C)	-15	0	15	30	45	60	75	80
-15	2570	2405	2245	2025	2025	2025	2025	2025
0	2570	2000	1840	1775	1775	1775	1775	1775
15	2570	2000	910	785	785	785	785	785
30	2570	2000	910	630	630	630	630	630
40	2570	2000	910	630	630	630	630	630

Engine Coolant Temperature Sensor Range Performance (XK8 From 2004 Model Year) – ECT1									
	Start ECT (°C)								
Min. IAT (°C)	-15	0	15	30	45	50	60	70	80
-15	2250	2150	1950	1750	1550	1550	1550	1550	1550
0	2250	1400	1250	1100	950	950	950	950	950
15	2250	1400	950	800	650	650	650	650	650
30	2250	1400	950	625	625	625	625	625	625
45	2250	1400	950	625	625	625	625	625	625

Engine Coolant Temperature Sensor Range Performance (New XJ From 2004 Model Year) – ECT1									
	Start ECT (°C)								
Min. IAT (°C)	-15	0	15	30	45	50	60	70	80
-15	4404	4404	4404	4205	4205	4205	4205	4205	4205
0	4404	1744	1548	1358	1093	1093	1093	1093	1093
15	4404	1744	1021	882	733	733	733	733	733
30	4404	1744	1021	655	514	514	514	514	514
45	4404	1744	1021	655	396	396	396	396	396

Engine Coolant Temperature Sensor Range Performance (X400 2008 Model Year) – ECT1													
	Minimum coolant temperature (°C)												
Min. IAT (°C)	-15	0	25	30	40	45	55	65	75	80	80	80	-15
-15	2337	2295	2272	2225	2012	1906	1677	1290	625	625	625	625	2337
0	2337	1310	1190	1065	945	885	715	505	220	220	220	220	2337
15	2337	1310	880	755	665	620	495	345	140	140	140	140	2337
30	2337	1310	880	595	502	455	360	250	115	115	115	115	2337
40	2337	1310	880	595	502	455	360	250	95	95	95	95	2337

Engine Coolant Temperature Sensor Range Performance (4.2L) – ECT2				
Start ECT (°C)	-30	-25	-20	-15
Failure time counter (seconds)	200	200	200	200

Engine Coolant Temperature Sensor Range Performance (3.0L) – ECT2												
Start ECT (°C)	-30	-20	-10	0	10	20	30	40	50	60	70	80
Failure time counter (seconds)	326	326	324	324	324	324	324	324	324	324	324	324

Engine Coolant Temperature Sensor Range Performance (New XJ From 2004 Model Year) – ECT2						
Start ECT (°C)	-40	-32	-23	-20	-15	-15
Failure time counter (seconds)	600	300	120	120	120	120

Engine Coolant Temperature Sensor Range Performance (XK8 From 2004 Model Year) – ECT2						
Start ECT (°C)	-40	-40	-30	-25	-20	-15
Failure time counter (seconds)	300	200	200	200	200	200

Engine Coolant Temperature Sensor Range Performance (S-Type From 2004 Model Year) – ECT2						
Start ECT (°C)	-40	-30	-20	-15	-15	-15
Failure time counter (seconds)	240	120	120	120	120	120

Engine Coolant Temperature Sensor Range Performance (X-Type From 2004 Model Year) – ECT2						
Start ECT (°C)	-40	-40	-32	-23	-20	-15
Failure time counter (seconds)	600	600	300	120	120	120

ECT (P0116) Time to closed loop enable temperature (X400 2008 Model Year) – ECT2												
Min Coolant Twmperature (°C)	-40	-40	-31.9	-23.1	-20	-15	-15	-15	-15	-15	-15	-15
Time (seconds)	600	600	300	120	120	120	120	120	120	120	120	120

Engine Coolant Temperature Sensor – Fault limit (X400 2008 Model Year) – ECT3								
Average Temperature (degC)	-15	-5	5	25	35	45	55	65
Fault Limit (V)	2.632	2.129	1.689	1.011	0.781	0.601	0.464	0.361

6.14.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.15 Thermostat Monitor

The monitor operates once per trip and is not a continuous monitor. Every 1 second the monitor compares the actual Engine Coolant Temperature with an estimated temperature. This is derived from a model and accumulates the error between the two temperatures. The model to calculate the estimated Engine Coolant Temperature has look-up tables, which use various engine and vehicle parameters to derive compensation values by which the estimated Engine Coolant Temperature is increased or decreased. These look-up tables' takes into account engine speed, engine airflow, vehicle speed and temperature difference between Intake Air Temperature and Engine Coolant Temperature.

A judgment of whether the thermostat is behaving normally or not is made when the estimated Engine Coolant Temperature reaches a judgment level which is 35^{o}C above starting Engine Coolant Temperature or 80^{o}C, whichever is reached first. The monitor has the ability to make one of three judgments once the judgment point is reached. The judgment made can be "normal", "fail" or "null". The normal judgment is made if the accumulated error is below the calibratable normal level and the actual Engine Coolant Temperature has reached 80^{o}C at the judgment point. The failure judgment is made if the accumulated error equals or exceeds the calibratable failure level at the judgment point. A null judgment is made if the accumulated error is above the normal level and below the failure level at the judgment point. The null judgment is included to allow for the gray area that exists between normal and failed thermostats, as in extreme conditions a failed thermostat may resemble normal behavior and a normal thermostat could resemble failed behavior.

6.15.1 Monitoring Structure

Thermostat Monitor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Thermostat range/ performance	P0128	Comparisons of actual warm up profile with estimated profile. Judgment performed when estimated ECT increases by 35 °C or reaches 80 °C	Accumulated difference between estimated ECT and actual ECT is too large	See table	Intake Air Temperature Engine Coolant Temperature ECT at engine start Airflow Engine Speed	- 8 to 100 °C - 8 to 100 °C - 8 to 60 °C >= 1 g/s >= 400	Dependent on drive cycle (typically 460s)	2 Drive Cycles
			Disable:	C1137, C1145, C1155, C1165, C1175, P0010, P0020, P0031, P0032, P0051, P0052, P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0125, P0128, P0131, P0132, P0133, P0151, P0152, P0153, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0335, P0336, P0340, P0341, P0345, P0346, P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P0443, P0444, P0445, P0460, P0603, P1104, P1107, P1108, P1224, P1229, P1241, P1242, P1243, P1251, P1313, P1314, P1316, P1367, P1368, P1384, P1396, P1611, P1631, P1633, P1637, P1638, P1642, P1646, P1647, P0562, P0563, P0607, P2118, P2119, P2135, P2228, P2229				

Thermostat Monitor – P0128 Fault limit threshold (X400 2008 Model Year)										
	Coolant temperature (°C)									
IAT (°C)	-10	0	10	20	25	30	40	50	60	-10
-30	10110	7300	5110	3400	2700	2000	1200	1000	900	10110
-20	10110	7300	5110	3200	2500	1800	1100	900	850	10110
-10	10110	7300	5110	3100	2375	1650	1000	850	800	10110
0	10110	7300	5110	2980	2240	1500	1000	750	750	10110
10	10110	7300	4500	2500	1850	1200	750	750	750	10110
20	10110	7300	3500	1400	920	600	600	600	600	10110
30	10110	7300	3500	1400	920	600	600	600	600	10110
40	10110	7300	3500	1400	920	600	500	500	500	10110

6.15.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.16 Throttle Position Sensor

The Throttle Position sensor comprises of a potentiometer with a pointer that is rotated by the throttle shaft. The ECM supplies the potentiometer with a nominal 5 volts. The signal output from the Throttle Position sensor to the ECM depends on the position of the pointer and ultimately the position of the throttle shaft. The sensor's position in relation to the shaft cannot be adjusted and the ECM compensates for wear and aging in service.

6.16.1 Monitoring Structure

Throttle Position Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Throttle position 1 low input	P0122	Out of range check	Output voltage	<= 0.35 volts		Ignition on	1.0s	2 Drive Cycles
Throttle position 1 high input	P0123	Out of range check	Output voltage	>= 4.9 volts		Ignition on	1.0s (V6) 0.1s (V8)	2 Drive Cycles
Throttle position 2 low input	P0222	Out of range check	Output voltage	<= 0.35 volts		Ignition on	1.0s	2 Drive Cycles
Throttle position 2 high input	P0223	Out of range check	Output voltage	>= 4.9 volts		Ignition on	1.0s (V6) 0.1s (V8)	2 Drive Cycles
Throttle position 1 (2) range / performance	P0121 P2135 (2005 model year X-Type)	Rationality 1 to 2	Signal 1 versus signal 2	See table TPS1	Battery voltage Disable:	9 to 18v P1241, P1242	0.1s	2 Drive Cycles

Throttle Position Sensor Range Performance – TPS1								
Throttle angle (degrees)	0.00	2.00	2.13	4.25	9.0	20.5	32.0	84.0
Value (degrees)	3.2	3.2	3.2	6.7	7.1	10.0	11.1	11.1

Throttle Position Sensor Range Performance (2008MY) – TPS1								
Throttle angle (degrees)	0.00	2.00	2.13	4.25	9.00	20.50	32.00	84.00
Value (degrees)	4.23	4.36	4.36	6.37	8.8	12.89	13.61	19.23

6.16.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.17 Engine Oil Temperature Sensor

6.17.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software. If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored. If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.17.2 Range/Performance Failure

The EOT movement is monitored during the warm up phase of a trip. If the Engine Coolant Temperature is cool enough at start and rises by the required amount then a judgment is made on the EOT. If the EOT movement (maximum reading for the trip – minimum reading for the trip) has not been sufficient then a failure judgment will be made.

6.17.3 Monitoring Structure

Engine Oil temperature Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
EOT high input	P0198	Out of range check	Sensor voltage	<= 0.03 volts		Ignition on	0.5s	2 Drive Cycles
EOT low input	P0197	Out of range check	Sensor voltage	>= 4.6 volts		Ignition on	0.5s	2 Drive Cycles
EOT range/ performance	P0196	Rationality versus ECT	EOT rise too low compared to ECT rise	<= 2.5 °C	EOT Engine Coolant Temperature ECT rise Intake Air Temperature	<= 130°C -30 - 100°C >= 45 °C -30 - 100°C	Dependent on drive cycle	2 Drive Cycles
		EOTS stuck (2008MY)	EOTS change (2008MY)		Delta oil temperature	-30 - 50°C (2008MY) <= 0.015 V in 0.128 s (2008MY)		
EOT range/ performance	P0196	Rationality versus Engine Coolant Temperature and Inlet air temperature (2008MY)	Average_EOT - (average_ECT + average_IAT)/2 **Or** (average_ECT+ average_IAT)/2 - Average_EOT	> 20 degC > 20 degC	Engine Stall Condition Block Heater Time after start Engine off time Difference between Engine Coolant Temperature average and inlet air temperature average at ignition on	Not set Not detected 120 <= time <= 200 s 28800 <= time <= 655000 s <= 10 degC	Dependent upon drive cycle	2 Drive Cycles
					Disable:	P0111, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0562, P0563, P1241, P1242		

6.17.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.18 Fuel Rail Temperature Sensor

6.18.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software. If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored. If the voltage is over the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.18.2 Range/Performance Failure

The monitor checks that the fuel rail temperature sensor signal is not stuck within the normal operating range. It checks that the signal has varied by a calibrated amount before the Engine Coolant Temperature signal has increased by 40°C and twenty minutes of engine running has elapsed. Maximum and minimum values of fuel rail temperature and Engine Coolant Temperature are continually calculated. If the difference between the fuel rail temperature maximum and minimum values is greater than the calibrated threshold then normal judgment is made. For failure judgment, the monitor can only flag a failure if a cold start is detected. A cold start is detected when the difference between the Intake Air Temperature and Engine Coolant Temperature is less than a calibrated value, and the Engine Coolant Temperature is less than a second calibrated value.

6.18.3 Monitoring Structure

Fuel Rail Temperature Sensor

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel rail temperature sensor low input	P0182	Out of range check	Voltage too low	<= 0.03 volts		Ignition on	0.5s	2 Drive Cycles
Fuel rail temperature sensor high input	P0183	Out of range check	Voltage too high	>= 4.6 volts		Ignition on	0.5s	2 Drive Cycles
Fuel rail temperature sensor range/ performance	P0181	No activity check	Fuel rail temperature; maximum-minimum	<= 1.9°C	Fuel rail temperature ECT rise ECT at engine start After start time Difference between IAT and ECT at engine start Engine Coolant Temperature Intake Air Temperature	<= 100°C >= 40°C <= 40°C >= 1200s <= 5°C -30 to 100°C -8.13 to 100 °C -30 to 100°C -8.13 to 100 °C	1200s (S-Type 2004 MY) (S-Type 2004 MY)	2 Drive Cycles

Fuel Rail Temperature Sensor								
Fuel rail temperature sensor range/ performance	P0181	Fuel rail temperature rationality compared to ECT and IAT (2008MY)	Average_FRT - (average_ECT + average_IAT)/2 **Or** (average_ECT+ average_IAT)/2 - Average_FRT	> 20 degC > 20 degC	Engine Stall Condition Block Heater Time after start Engine off time Difference between ECT average and inlet air temperature average at ignition on	Not set Not detected 120 <= time <= 200 s 28800 <= time <= 655000 s <= 10 degC	Dependent upon drive cycle	2 Drive Cycles
Fuel rail temperature sensor range/ performance	P0181	Fuel rail temperature stuck (2008MY)	EOTS Change **And** Engine Coolant Temperature	< 1.9 degC > 80 degC	Cold Start Identified at engine start Engine Coolant Temperature Intake Air Temperature Delta FRT Delta ECT Fuel Temperature Change in ECT Time after start	ECT < 40 degC **And** Difference Between ECT & IAT <= 10 degC -30 < T < 100 degC -30 < IAT < 50 degC <= 0.015 V in 0.128 s <= 0.015 V & <= 20 degC in 0.128 s < 100 degC >= 50 degC > 1200 s	Dependent upon drive cycle	2 Drive Cycles
				Disable:	P0111, P0112, P0113, P0116, P0117, P0118, P0125, P0128, P0182, P0183, P0460, P0562, P0563, P0603, P1241, P1242, P1243, P1609			

6.18.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.19 Fuel Rail Pressure Sensor

6.19.1 High/Low Input Failure

These are continuous monitors. The voltage from the sensor is compared to a failure threshold defined in the software. If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored. If the voltage exceeds the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

6.19.2 Stuck Detection

Stuck at monitoring executes when closed loop fuel pump control is executing. It checks that the fuel rail pressure signal has varied by at least 5 kPa over a range of demanded fuel pump duties. The maximum and minimum fuel rail pressures are updated each time. The change in demand duty is integrated and when the integral reaches 4%, the variation between the maximum and minimum values is checked. If it is less than 5kPa, failure judgment is made; otherwise, a normal judgment is made.

6.19.3 Offset Detection

This part of the monitor executes when the vehicle is idling. When closed loop fuel pump control is executing, a settle timer is incremented. After the counter reaches 5 seconds monitoring can be started. This is to allow the system time to settle after a transition from open to closed loop fuel pump control. Once the counter is greater than 5 seconds the target pressure is checked against the actual fuel rail pressure. If the error is less than the failure threshold, a normal counter is started. If the normal counter reaches 1 second, normal judgment is made. If the target to actual error is greater than the failure threshold, a failure counter is started. If the failure counter reaches 5 seconds then failure judgment is made.

6.19.4 Monitoring Structure

Fuel Rail Pressure Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel rail pressure sensor low input	P0192	Out of range check	Voltage too low	<= 0.1 volts		Ignition on	0.5s	2 Drive Cycles
Fuel rail pressure sensor high input	P0193	Out of range check	Voltage too high	>= 4.9 volts		Ignition on	0.5s	2 Drive Cycles
Fuel rail pressure sensor range/ performance offset detection	P0191	Comparison with target pressure	Error	>= 30 kPa	Fuel level Idle flag set Fuel pump feedback control	>= 11% >= 5s Executing	5s	2 Drive Cycles
Fuel rail pressure sensor range/ performance stuck detection	P0191	Rationality versus fuel pump duty integral	Pressure change too low when fuel pump integral duty above threshold	<= 5 kPa	Fuel level Fuel pump feedback control Fuel pump integral duty	>= 11% Executing >= 4%	Dependent on drive cycle	2 Drive Cycles
					Disable:	P1241, P1242, P1243, P0603, P0460, P1609, P0192, P0193, P0562, P0563		

6.19.5 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.20 Fuel Injectors

The fuel injector monitor operates on a continuous basis. Open and short detection of each injector is possible by comparing the actual injection signal with a target injection signal. The actual injection signal is derived from a change in injector voltage when the injector is turned off and the target injection signal is derived from an injection set flag.

A normal judgment is made when the injector voltage moves from the on to off position i.e. on the signal edge. If the target signal and the actual signal are both set to one, a normal judgment is made. This process is repeated for each injector in firing order. A failure judgment is made when no injector signal edge is detected i.e. no change in voltage but the injector has been triggered.

6.20.1 Monitoring Structure

Fuel Injector Monitor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Cylinder 1	P0201	Drive hardware check	Commanded versus actual	10 times	Engine speed	200 – 7000	20 revolutions	2 Drive Cycles
					ECT	>= - 30°C		
Cylinder 2	P0202	Drive hardware check	Commanded versus actual	10 times	IAT	>= - 30°C		
					Airflow change	< 2g/s/s (up to 2004 model year)		
Cylinder 3	P0203	Drive hardware check	Commanded versus actual	10 times	(not 2008MY)	< 31g/s/s (2004 model year)		
					Injector pulse width	0.0005s –upper limit (see INJ1)		
Cylinder 4	P0204	Drive hardware check	Commanded versus actual	10 times	Battery voltage	10 to 16v		
					TP sensor change	< 22 deg/s		
Cylinder 5	P0205	Drive hardware check	Commanded versus actual	10 times	(not 2008MY)	<= 44 deg/s (V8 2004 model year)		
						<= 56 deg/s (S-Type 2004 model year)		
Cylinder 6	P0206	Drive hardware check	Commanded versus actual	10 times		<= 37 deg/s (X-Type 2004 model year)		
					Fuel cut-off	Not active		
Cylinder 7 (V8 only)	P0207	Drive hardware check	Commanded versus actual	10 times	Time after start	>= 0s		
					MAF rate of	<= 2.0 g/s/0.064 s		
Cylinder 8 (V8 only)	P0208	Drive hardware check	Commanded versus actual	10 times	change (2008MY)			
					MAF (2008MY)	0 <= MAF <= 400 g/s		
					TP rate of change (2008MY)	< 0.30 deg/s/0.008 s		
					Engine starting	Not active		
				Disable:	P0101, P0102, P0103, P0111- P0113, P0121- P0123, P0222, P0223, P0336, P0351- P0358, P1367, P1368, P0603, P0607, P1104, P1224, P1229, P1251, P1367, P1368, P1609, P1611, P1631, P1633, P1637, P1642, P2118, P2119, P2135, C1165, C1175, C1137			

INJ1 - 4.2L (All from 2004 Model Year)											
Engine speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	5000	6000	7000
Injector pulse width (us)	42000	21000	14000	10500	8400	7000	6000	5300	4200	3500	3000

INJ1 – 3.0L											
Engine speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	5000	6000	7000
Injector pulse width (us)	56000	28000	18700	14000	11200	9300	8000	7000	5600	4700	4000

6.20.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.21 Fuel Pumps

6.21.1 Primary Fuel Pump - No Commands Received

The rear electronics module drives the fuel pump motor. It also monitors the circuit and sends its status to the ECM via the communications network buses. As part of this status, the ECM receives flags indicating invalid input and open circuit on the battery supply. If either of these flags indicates a fault for longer than a set time, then a fault judgment is made and P1234 is logged.

6.21.2 Primary Fuel Pump - Not Working When Requested

The ECM also receives a 'fuel pump loss of ground' flag via the CAN network from the rear electronics module. If this flag is set for longer than a pre-defined time a fault judgment is made and P1236 is logged.

6.21.3 Primary Fuel Pump Circuit High/Low Fault

The ECM also receives the following flag via the CAN bus from the rear electronics module:

- Fuel pump monitor line open circuit.
- Fuel pump monitor line short circuit to battery.
- Fuel pump monitor line short circuit to ground

If any of these flags indicate a fault for longer than a set time, then a fault is registered and P1338 is logged.

6.21.4 Monitoring Structure

Primary Fuel Pump – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
No fuel pump commands received	P1234	Monitor control module control line	Control module control line invalid input	Battery voltage	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Fuel pump not working when requested	P1236	Control module circuit	Control module loss of ground	No signal	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Circuit low input	P1338	Monitor control module monitor line	Control module monitor line high	Battery voltage	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Circuit high input	P1338	Monitor control module monitor line	Control module monitor line low	No signal	Battery voltage Delay counter Fuel pump duty Disable:	10 volts 3.5s 25% to 75% P1609	4.5s	2 Drive Cycles

Primary Fuel Pump – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
No fuel pump commands received	P1234	Monitor control module control line	Control module status line duty cycle	< 39.2% (X-Type) < 35.2% (all others)	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Fuel pump not working when requested	P1236	Control module circuit	Control module status line duty cycle	> 60.8% (X-Type) > 64.8% (all others)	Battery voltage Delay counter Fuel pump duty Disable:	10 volts 3.5s 25% to 75% P1609	4.5s	2 Drive Cycles

Primary Fuel Pump – X-Type 2005 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
No fuel pump commands received	P0627	Monitor control module control line	Control module status line duty cycle	< 39.2% (X-Type) < 35.2% (all others)	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Fuel pump not working when requested	P2635	Control module circuit	Control module status line duty cycle	> 60.8% (X-Type) > 64.8% (all others)	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Circuit low input	P0628	Monitor control module status line	Control module status line high	Battery voltage	Delay counter Battery voltage Fuel pump duty	Ignition on 3.5s 10 volts 25% to 75%	4.5s	2 Drive Cycles
Circuit high input	P0628	Monitor control module status line	Control module status line low	No signal	Delay counter Battery voltage Fuel pump duty Disable:	Ignition on 3.5s 10 volts 25% to 75% P1609	4.5s	2 Drive Cycles

6.21.5 Secondary Fuel Pump Monitor

A status flag monitors the Pulse Width Modulation (PWM) signal from the secondary fuel pump driver module. When this status flag is stuck low for a set time, then a fault is flagged and P1233 is logged. When this status flag is stuck high, or the PWM duty is outside a calibrated range for a set time, then a fault is flagged and P1339 is logged.

6.21.6 Monitoring Structure

Secondary Fuel Pump – Supercharged Vehicles Only								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel pump driver circuit input circuit fault	P1233	Monitor control module control line	Control module control line duty cycle	< 0.392s	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Fuel pump driver circuit output fault	P1339	Control module circuit	Control module control line duty cycle	608 – 1.000s	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Circuit low input	P1339	Monitor control module monitor line	Control module control line duty cycle	No signal	Battery voltage Delay counter Fuel pump duty	10 volts 3.5s 25% to 75%	4.5s	2 Drive Cycles
Circuit high input	P1339	Monitor control module monitor line	Control module control line duty cycle	No signal	Battery voltage Delay counter Fuel pump duty Disable:	10 volts 3.5s 25%>Duty>75% P1609	4.5s	2 Drive Cycles

6.21.7 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.22 Fuel Level Sensor

There are two parts to the fuel level sensor monitor. The output of the fuel level sensor is monitored to detect if its output does not change as fuel is used. It is also monitored when the vehicle is stationary and fuel movement is expected to be at a minimum to check for a noisy signal.

6.22.1 Fuel Level Stuck Monitor

The fuel level is monitored continuously and it needs to change by more than a set percentage before a calculated amount of fuel is used. This process will operate through cumulative trips if necessary. Once the fuel level changes by the amount required the process is reset and starts again. If the fuel used threshold is reached before the fuel level changes by the required percentage, a temporary fault will be stored. A second occurrence will cause the Malfunction Indicator Lamp (MIL) to be illuminated.

6.22.2 Fuel Level Noisy Monitor

Once the fuel level percentage has changed to satisfy the stuck monitor described above and a few other entry conditions have been met, the system will complete a fuel level noisy test in the next available idle period. When the vehicle comes to rest the fuel movement will be allowed to subside. The output of the fuel level sensor will be monitored for a short period. During this period the output of the fuel level sensor will be integrated and compared to a threshold, which is set to find faulty fuel level sensors. This process is repeated as the fuel level falls. If the failure threshold is exceeded a first trip temporary failure flag will be set. A further failure in the next trip will illuminate the MIL.

6.22.3 Monitoring Structure

Fuel Level Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Fuel level sensor circuit	P0460	Rationality versus fuel used	Fuel level change	<= 3% <= 6% (S-Type)	Fuel used (calculated) After start Battery voltage Disable:	>= 45L >= 20L (X-Type) >= 20s 8 to 16 volts 10 to 16 volts (2004 model year) P0603, P1609, P1642, P1638	Dependent on drive cycle	2 Drive Cycles
Fuel level sensor malfunction	P0460	Fuel level sensor noisy	Change in raw fuel signal	>= 5000/20s (XK8) >= 5000/20s (S-Type) >= 2500/20s (X-Type) >=11000/20s (XJ)	After start Fuel level change Battery voltage Vehicle speed Fuel level Then Vehicle speed Entry delay Monitor period Vehicle speed delta (2008MY) Delta wheel speed (2008MY) Tank pressure delta (2008MY) Disable:	>= 20s >= 3% >= 6% (S-Type) 8 to 16 volts 10 to 16 volts (2004 model year) > 31mph for >20s 15 to 85% 5 to 95% (2008MY) = 0 10s 20s <= 410 mph/0.064 s <= 0.25 mph (between CAN messages) <= 320 V/0.064 s C1137, C1145, C1155, C1165, C1175, P0450, P0452, P0453, P0561, P0562, P0563, P0603, P1240, P1241, P1242, P1609, P1637, P1638, P1642, P0441	20s	2 Drive Cycles

6.22.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.23 Knock Sensor

'Knocking' or 'pinking' is caused by uncontrolled combustion and can result in engine damage as well as excessive emissions. Knocking noises are essentially vibrations with frequencies that are detected by a piezo-electric sensing element and converted into electrical signals. Two knock sensors are strategically located on the engine casing and switched to the firing sequence so that knocking from any cylinder may be detected.

6.23.1 High/Low Input Failure

High and low input failure of the knock sensor is detected in the knock sensor processor and is then transmitted to the ECM. The Direct Current (DC) voltage of the sensor is compared with the upper and lower limits in order to judge high or low input failure.

6.23.2 Knock Sensor Processor Failure

Knock sensor processor failure is detected within the processor and is then transmitted to the ECM.

6.23.3 Monitoring Structure

Knock Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Knock sensor A low input	P0327	Out of range check	Sensor output low and knock sensor processor reporting failure	<= 1.25 volts <=1.3v (2004 model year)	After start Engine speed	>= 3s >= 500 RPM	8 revolutions 64 revolutions (2004 model year)	2 Drive Cycles
Knock sensor B low input	P0332	Out of range check						
Knock sensor A high input	P0328	Out of range check	Sensor output low and knock sensor processor reporting failure	>= 3.75 volts >= 3.8v (2004 model year)	After start Engine speed	>= 3s >= 500 RPM	8 revolutions 64 revolutions (2004 model year)	2 Drive Cycles
Knock sensor B high input	P0333	Out of range check						
Knock sensor processor failure	P1648 P0324 (2005 model year X-Type)	Knock sensor processor self check	Knock sensor processor reporting self-check failure		After camshaft and crank sensors judged normal Engine speed Disable:	>= 5s >= 500 RPM P1609	8 revolutions 64 revolutions (2004 model year)	2 Drive Cycles

6.23.4 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.24 Variable Valve Timing

VVT is a mechanically operated, electronically controlled system and is fitted to all current Jaguar engines except the 4.2L V8 supercharger.

The system comprises an actuator (phaser) built into the camshaft chain sprocket and an oil control valve which controls the flow of oil to the camshaft phaser. The system is controlled via the oil control valve and CMP sensors. The oil control valve varies the oil flow into the camshaft phaser and creates a variable offset between the camshaft and the camshaft sprocket, feedback for this system is provided by the CMP sensors.

The monitors for this topic are best described in two sections. The first section is concerned with VVT position failure and normal operation counters. If calibratable conditions are met for a failure condition then fault counters are incremented. The same applies for normal operation of the VVT system. The counters are then compared to a calibratable constant (threshold) and a judgment made. For a failure judgment, the failure counter has to be of an equal or higher value than the threshold constant and likewise, for a normal judgment the normal counter has to be equal or greater than the normal counter. Once these comparisons have been carried out, the relevant failure/judgment flags are set.

The second section of this monitor is concerned with monitoring the oil control valve on both banks 1 and 2. The oil control valve duty output is compared to an upper and lower threshold and the state of the latch port (1 = output, 0 = no output). If oil control valve duty output is outside of the upper/lower band and the latch has no output then a failure counter is incremented. If the conditions are not met, the monitor moves on to the next comparison. The oil control valve duty output is compared to an upper and lower threshold and the state of the latch port (output/no output). If the oil control valve duty output is outside of the upper/lower band and the latch has an output then the failure counter is set to zero, normal judgment flag set to 1 and failure judgment flag set to zero. If the conditions are not met, the monitor moves on to the next comparison. The failure time counter is compared to the failure judgment time threshold and if equal or greater than the threshold a failure flag is set and a present failure flag is set. If none of the comparison conditions are met then the oil control valve latch port is set to zero. This is also performed after the comparisons have been carried out. The monitor now moves onto the flag control section and restarts.

6.24.1 Monitoring Structure

Variable Valve Timing – Normally Aspirated Engines Only								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
VVT Bank A circuit malfunction	P0010	Hardware check	Commanded versus actual	Different	Oil control valve duty cycle	30 to 70%	5s 3s (2004 model year)	2 Drive Cycles
VVT Bank B circuit malfunction	P0020							2 Drive Cycles
VVT Bank A malfunction	P1384	Actual cam position compared with target position	Target versus actual	Error > 20 degrees of crank angle	Engine speed > 0		10s	2 Drive Cycles
VVT Bank B malfunction	P1396	Actual cam position compared with target position	Target versus actual				10s (note: this is 5s before cleaning and 5s after cleaning)	2 Drive Cycles
					Disable:	P0335, P0336, P1609, P0196, P0197, P0198		
					Bank A Bank B	P0340, P0341 P1340, P1341 (P0345, P0346 from 2004 model year)		

6.24.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.25 Ignition Amplifiers/Coils

The ignition amplifiers monitor is very similar in operation to the injectors monitor, albeit with different enable conditions. Please refer to the fuel injectors monitor explanation. The ignition amplifiers have two monitor lines that carry multiplexed ignition amplifier monitor signals whereas the injectors can be monitored individually. It is for this reason that the ignition amplifiers monitor does not operate over such a wide range of engine speeds as the injectors monitor.

6.25.1 Monitoring Structure

Ignition Amplifiers/Coils								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Ignition amplifiers cylinder 1 Bank A	P0351	Hardware check	Primary coil current		Engine speed	< 2500 RPM <= 3000rpm (2008MY)	40 revolutions	2 Drive Cycles
Ignition amplifier cylinder 2 Bank A	P0353	Hardware check	Primary coil current		Battery voltage	> 10 volts		2 Drive Cycles
Ignition amplifier cylinder 3 Bank A	P0355	Hardware check	Primary coil current					2 Drive Cycles
Ignition amplifier cylinder 4 Bank A	P0357	Hardware check	Primary coil current					2 Drive Cycles
Ignition amplifier cylinder 1 Bank B	P0352	Hardware check	Primary coil current					2 Drive Cycles
Ignition amplifier cylinder 2 Bank B	P0354	Hardware check	Primary coil current					2 Drive Cycles
Ignition amplifier cylinder 3 Bank B	P0356	Hardware check	Primary coil current					2 Drive Cycles
Ignition amplifier cylinder 4 Bank B	P0358	Hardware check	Primary coil current					2 Drive Cycles
Ignition amplifier group 1	P1367	Hardware check	Primary coil current				20 revolution	2 Drive Cycles
Ignition amplifier group 2	P1368	Hardware check	Primary coil current		Disable:	P1642, P1609, P0336		2 Drive Cycles

6.25.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.26 Charge Air Cooler Water Pump

The charge air cooler water pump monitor has been implemented to prevent engine damage, in the event of water pump failure. The monitor is only present on supercharged variants and operates continuously during each drive, with a sample rate of 2.048 seconds. The basic operation of the monitor is to compare the value of the intercooler IAT 2 against the IAT 1, at the end of a period of steady state operating conditions. Once the defined steady state conditions are satisfied, a drive delay counter is incremented. Upon exceeding a calibrated threshold, if the difference between the two temperature values (IAT 2 – IAT 1) is greater than the mapped threshold, a failure counter is incremented. If the counter exceeds a calibrated threshold, a failure judgment is made. A normal judgment is made if the two temperature values are below the failure threshold, at the point of judgment.

6.26.1 Monitoring Structure

Charge Air Cooler Water Pump – 4.2L Supercharged Only								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Charge air cooler water pump malfunction	P1474	Comparison check	IAT 2 versus IAT 1	See table WTP1	Engine Coolant Temperature Intake Air Temperature Mass air flow Engine speed Vehicle speed Vehicle drive counter Disable:	80 to 110 °C -8 to 100 °C 6 to 40 g/s 600 to 4000 RPM 18.6 to 74.5 MPH > 400s P0335, P0336, P0096-P0098, P0111-P0113, P0101-P0103, P1104, P1637, P1642, P1609, P0116-P0118, P0125, C1137, C1145, C1155, C1165, C1175	30s (430s including drive counter)	2 Drive Cycles

WTP1 (Up to 2004 Model Year)										
IAT °C	-10	0	10	20	25	30	40	50	60	70
Delta temperature (IAT 2 - IAT 1)	70	70	70	70	70	70	70	70	70	70

WTP1 (From 2004 Model Year)										
IAT °C	-10	0	10	20	25	30	40	50	60	80
Delta temperature (IAT 2 - IAT 1)	75	70	70	70	70	70	70	70	70	70

6.26.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.27 Idle Speed Control

If all the entry conditions are satisfied, then the monitor will start execution.

If the actual engine speed is more than 100 RPM lower than the target engine speed then a counter is started and once this exceeds the failure time limit a failure judgment is made for idle speed lower than expected.

If the actual engine speed is greater than 200 RPM higher than the target engine speed then a counter is started and once this exceeds the failure time limit a failure judgment is made for idle speed higher than expected.

Idle Speed Control – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
ISC	P0506	Idle speed lower than expected	Idle speed versus target	100 RPM too low	Engine Coolant Temperature Atmospheric pressure	80 to 110 °C < 75.5 kPa	2.8s	2 Drive Cycles
	P0507	Idle speed higher than expected	Idle speed versus target	200 RPM too high	After start Transmission oil temperature Intake Air Temperature ISC Stable condition Vehicle speed	> 13.76s -8 to 125 °C -8 to 110 °C Active > 4.86s See below <= 0.6 mph	2.8s	2 Drive Cycles
				Disable:	P0336, P0603, P1245, P1246, P1642, P1643, P1609, P0116- P0118, P0106-P0108, P0125, P0111-P0113, P1240-P1242, P1516, P1637, P1642, P0460, P1224, P1229, P0121, P1251, P1631, P1611, P1633, P0128, P1699, P0122, P0123, P0222, P0223, P0616, P0617, P0702, P0651, P0606, P0741, P0750, P0753, P0755, P0758, P0760, P0763, P0765, P0768, P0770, P0773, P0740, P0743, P0787, P0788, P0730, P0731, P0732, P0733, P0734, P0735, P0729, P0780, P0781, P0782, P0783, P0784, P0829, P1798, P1799, P1797, P0666, P0641, P1605, P0815, P0815, P1774, P0706, P0709, P0610, P1783, P1572			

Idle Speed Control - From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
ISC	P0506	Idle speed lower than expected	Idle speed versus target	200 RPM too low	Engine Coolant Temperature	80 to 110 °C	15s	2 Drive
					Atmospheric pressure	>= 74.8 kPa	3s (XK8)	Cycles
	P0507	Idle speed higher than expected	Idle speed versus target	200 RPM too high	After start	>= 14s	15s	2 Drive
					Transmission oil temperature	-8 to 125 °C	3s (XK8)	Cycles
					Intake Air Temperature	-8 to 110 °C		
					ISC	>= 4.9s Active		
					Stable condition	See below		
					Vehicle speed	<= 0.6 mph		
			Disable:	C1137, C1145, C1155, C1165, C1175, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0125, P0128, P0222, P0223, P0336, P0460, P0603, P0605, P0606, P0610, P0641, P0651, P0666, P0701, P0702, P0705, P0709, P0710, P0711, P0715, P0720, P0725, P0729, P0730, P0731, P0732, P0733, P0734, P0735, P0740, P0741, P0743, P0750, P0753, P0755, P0758, P0760, P0763, P0765, P0768, P0770, P0773, P0780, P0781, P0782, P0783, P0784, P0787, P0788, P0815, P0829, P1224, P1229, P1241, P1242, P1516, P1572, P1603, P1605, P1609, P1611, P1631, P1633, P1637, P1642, P1643, P1699, P1719, P1774, P1783, P1796, P1797, P1798, P1799				
			Disable additions (X-Type 2005 model year):	P0069, P0562, P0563, P0851, P1251, P2118, P2119, P2135, P2228, P2229.				

Stable condition: The idle speed system is deemed unstable for a period of 1 second, following a change in state of any of the following parameters:

- Park/neutral switch
- Heated screen
- A/C clutch
- Cooling fan fast mode
- Cooling fan slow mode
- Headlamp
- Main beam
- Side lamp
- Footbrake

6.27.1 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.28 Starter Relay

During normal starting, the ECM should pull the low side of the starter motor relay coil to ground. If this voltage is high when starting is being requested, a fault is logged.

6.28.1 Monitoring Structure

Starter Relay								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
High input	P0617	Rationality, relay versus drive circuit	Starter relay is off but starter relay request is on		Ignition Starter relay Starter relay request Time since initialization Battery voltage Disable:	On Off On >0.064s (2008MY) >6.48 (2008MY) P1245, P1246, P1609	1.2s (1.3 s 2004 model year)	2 Drive Cycles

6.28.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.29 Air Conditioning Clutch Relay

This monitor checks to confirm that the A/C control relay is responding to a request from the ECM to switch it on or off. When the entry conditions have been met the ECM compares the state of the A/C compressor clutch relay to the commanded state. If they do not agree then a timer is started. If at the end of the period the commanded and actual relay states do not agree then the DTC is flagged.

6.29.1 Monitoring Structure

Air Conditioning Control Relay								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Low input	P0646	Rationality, relay versus drive circuit	Relay on but ECM is requesting relay off		Disable:	P1609	1.3s	2 Drive Cycles
High input	P0647	Rationality, relay versus drive circuit	Relay off but ECM is requesting relay on		Disable:	P1609	1.3s	2 Drive Cycles

6.29.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.30 Park/Neutral Switch

During the engine crank operation if the park/neutral input is low, with the CAN signal from the transmission indicating park/neutral is selected; the low fault timer is enabled. When the low fault timer reaches the calibrated time, the low fault flag is set. If the park/neutral input is high, and the vehicle is detected as moving with an appropriate engine load, then the high fault timer will be enabled. When the high fault timer reaches the calibrated time, the high fault flag is set.

6.30.1 Monitoring Structure

Park/Neutral Switch								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Park/neutral switch high Input Park/neutral switch low Input (2004 model year)	P1516 P0851 (2005 model year X-Type)	Malfunction during driving	Park/neutral switch during driving	Park/neutral	Vehicle speed Engine speed Engine Coolant Temperature Transmission type Engine load	>= 9 <= 160 mph 1500 to 4000 RPM >= -30 °C Automatic > 0.4 g/revolutions	5s	2 Drive Cycles
				Disable:	C1137, C1145, C1155, C1165, C1175, P0101, P0102, P0103, P0116, P0117, P0118, P0125, P0128, P0335, P0336, P0512, P0603, P0605, P0606, P0610, P0616, P0617, P0641, P0651, P0666, P0701, P0702, P0705, P0706, P0709, P0710, P0711, P0715, P0720, P0725, P0729, P0730, P0731, P0732, P0733, P0734, P0735, P0740, P0741, P0743, P0750, P0753, P0755, P0758, P0760, P0763, P0765, P0768, P0770, P0773, P0780, P0781, P0782, P0783, P0784, P0787, P0788, P0815, P0829, P1104, P1245, P1246, P1572, P1603, P1605, P1609, P1637, P1642, P1643, P1719, P1774, P1783, P1796, P1797, P1798, P1799			
Park/neutral switch low input (2001 to 2003 model year)	P1517	Malfunction during starting	Park/neutral during starting	Park/neutral	Gear selected Actual gear	0 or 2 0	0.256s	2 Drive Cycles
				Disable:	P0335, P0336, P0118, P0117, P0116, P1245, P1246, P0102, P0103, P0101, P0104, P1643, P1637, P0603, P1609, P0128, P0616, P0617, P1799, P1224, P1229			

6.30.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.31 Accelerator Pedal Position Sensor Monitor

During ignition on conditions, the voltages from the two-track APP sensor are monitored. If the input voltage stays above a calibration value for more than a calibratable period, the high input failure judgment is made. If the input voltage stays below a calibration value for more than a calibratable period, the low input failure judgment is made. If the angle obtained from sensor 1 differs from the angle obtained from sensor 2 by more than a calibratable amount for more than a calibration period a range/performance failure judgment is made.

6.31.1 Monitoring Structure

Accelerator Pedal Position Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
APP circuit 1 low input	P1122	Out of range check	Output voltage	< 0.35 volts		Ignition on	01s	2 Drive Cycles
APP circuit 1 high input	P1123	Out of range check	Output voltage	> 4.9 volts		Ignition on	0.1s	2 Drive Cycles
APP circuit 2 low input	P1215	Out of range check	Output voltage	< 0.10 volts		Ignition on	0.1s	2 Drive Cycles
APP circuit 2 high input	P1216	Out of range check	Output voltage	> 4.55 volts		Ignition on	0.1s	2 Drive Cycles
APP circuit 1(2) range/performance	P1344	Rationality of 1 to 2	Signal 1 versus 2	See table DDS1	Battery voltage Disable:	Ignition on 9 to 18 volts P1241, P1242	0.1s	2 Drive Cycles

Accelerator Pedal Position Sensor - X-Type 2005 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
APP circuit 1 low input	P0227	Out of range check	Output voltage	< 0.35 volts		Ignition on	01s	2 Drive Cycles
APP circuit 1 high input	P0228	Out of range check	Output voltage	> 4.9 volts		Ignition on	0.1s	2 Drive Cycles
APP circuit 2 low input	P2122	Out of range check	Output voltage	< 0.10 volts		Ignition on	0.1s	2 Drive Cycles
APP circuit 2 high input	P2123	Out of range check	Output voltage	> 4.55 volts > 4.9V (2008MY)		Ignition on	0.1s	2 Drive Cycles
APP circuit 1(2) range/performance	P0226	Rationality of 1 to 2	Signal 1 versus 2	See table DDS1	Battery voltage Disable:	Ignition on 9 to 18 volts P1241, P1242	0.1s	2 Drive Cycles

DDS1						
Pedal angle (degrees)	0	1	3	71	74	80
Value (degrees)	12.8	13.6	13.7	13.9	11.6	11.6

6.31.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.32 Throttle Control

6.32.1 Sensor Power Supply Monitor

High/Low Input Failure

These are continuous monitors. The voltage from the supply is compared to a failure threshold defined in the software. If the voltage is below the low threshold, then a timer starts to increment. Once this timer exceeds another threshold, then a failure flag is set and a DTC is stored. If the voltage exceeds the high threshold defined in the software, then a timer starts to increment. Once this timer exceeds a threshold, then a failure flag is set and a DTC is stored.

Malfunction

The outputs from two Throttle Position sensors and one pedal demand sensor are checked. If they ALL fall below a threshold value then a counter is incremented, otherwise the counter is reset to zero. If the counter reaches a calibrated value, a failure judgment is made.

6.32.2 Analogue Ground Monitor

The output voltages from the following sensors are checked:

- Throttle Position sensor 1
- Throttle Position sensor 2
- APP sensor 2
- FTP sensor (on USA market cars)
- Intake Air Temperature sensor
- Engine Coolant Temperature sensor
- Intake Air Temperature sensor after charge air cooler (on supercharged cars)
- Fuel rail pressure sensor
- Intake manifold pressure sensor
- Oil temperature sensor

If they all fall below a threshold value then a counter is incremented, otherwise the counter is reset to zero. If the counter reaches a calibrated value a failure judgment is made.

6.32.3 Throttle Actuator Control Monitor

Throttle Actuator Control OBDII Position Error

During ignition on conditions the calculated target throttle voltage is compared to the actual Throttle Position sensor voltage. If the voltage of the target and actual throttle signal differ by more than a calibratable amount for more than a calibratable period a failure judgment is made.

Throttle Actuator Control OBDII Circuit Malfunction

During ignition on conditions, the throttle motor current signal is monitored by hardware. If an over current condition is detected for more than a calibratable period, a failure judgment is made. During ignition on conditions, the throttle motor current is monitored by software. If the throttle motor current is more than a calibration level for more than a calibratable period a failure judgment is made. During ignition on conditions, the PWM throttle motor duty is monitored. If 100% duty cycle is detected for more than a calibratable period a failure judgment is made.

6.32.4 Throttle Motor Relay Monitor

DC Motor Relay Off Failure

During ignition on the relay driver signal is compared with the relay output signal. If the ECM is commanding the relay on and detecting the relay as off for more than a calibratable period, a failure judgment is made.

DC Motor Relay On Failure

During ignition on the relay driver signal is compared with the relay output signal. If the ECM is commanding the relay off and detecting the relay as on for more than a calibratable period, a failure judgment is made.

6.32.5 Throttle Motor Relay Driver Monitor

DC Motor Relay Driver Off Failure

During ignition on the relay driver target flag is compared with the relay driver signal. If the ECM is commanding the relay on and detecting the relay driver as off for more than a calibration period, a failure judgment is made.

DC Motor Relay Driver On Failure

After ignition off, the ECM sets the relay driver off. This is compared with the relay driver monitor. If the ECM is commanding the relay off and detecting the relay driver as on for more than a calibration period, a failure judgment is made.

6.32.6 Throttle Return Spring Monitor

After ignition off, the throttle blade is moved by the throttle motor to a calibrated position. The motor is then turned off. The monitor checks that the throttle blade is moved by the return spring. If movement of less than a calibrated amount is detected, a failure judgment is made.

6.32.7 Throttle Limp Home Spring Monitor

After ignition off, the throttle blade is moved by the throttle motor to a calibrated position. The motor is then turned off. The monitor checks that the throttle blade is moved by the limp-home spring. If movement of less than a calibrated amount is detected, a failure judgment is made.

6.32.8 Throttle Watchdog Monitor

After ignition off, the watchdog pulse is stopped in order to check whether the throttle motor relay driver will be disabled. If the throttle motor relay driver command is detected on for more than a calibratable period, a failure judgment is made.

6.32.9 Monitoring Structure

Throttle Control – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Throttle control position error	P1224 P2119 (2005 model year X-Type)	Rationality sensor out versus target	Sensor out v target difference	> 1.001 volts >= 1v (2004 model year)	Battery voltage	Ignition on 9 to 18 volts	See table THC1	2 Drive Cycles
Throttle control circuit malfunction	P1229 P2118 (2005 model year X-Type)	1) Detection of over current by hardware	Number of times over current	30	Battery voltage	Ignition on 9 to 18 volts	0.5s	2 Drive Cycles
		2) Detection of over current by software	Current	8.3A >= 8A (2004 model year)			15s	
		3) Duty 100% failure	100% duty cycle	100%	Battery voltage	Ignition on 9 to 18 volts	See table THC2	2 Drive Cycles

Throttle Control – Up to 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Throttle control sensor power supply malfunction	P1240	Throttle pedal, A/C pressure, TP, FTP, MAP sensor, Fuel rail pressure sensor voltage irrational	Sensor output voltages: Pedal position TP 1 TP 2 FTP MAP sensor Fuel rail pressure A/C pressure	 < 0.35 volts < 0.35 volts < 0.35 volts < 0.2 volts < 0.3 volts < 0.4 volts < 0.3 volts		Ignition on	3s	2 Drive Cycles
Throttle control low input	P1241	Out of range check	Output voltage	<= 3.0 volts		Ignition on	3s	2 Drive Cycles
Throttle control high input	P1242	Out of range check	Output voltage	>= 4.5 volts		Ignition on	3s	2 Drive Cycles
Throttle control analogue ground malfunction	P1243	Throttle pedal, TP, FTP, IAT, ECT, fuel rail pressure and MAP sensor voltages	Sensor output voltages: Pedal position 3 TP 1 TP 2 FTP IAT ECT Fuel rail pressure MAP Charge air cooler (S/C only) EOT	 >= 4.9 volts >= 4.9 volts >= 4.9 volts >= 4.9 volts >= 4.9 volts >= 4.9 volts >= 4.9 volts >= 4.9 volts >= 4.9 volts >= 4.6 volts		Ignition on	1s	2 Drive Cycles
					Disable:	P0603, P1609, P1642		
Throttle return spring failure	P1250	Monitoring of throttle blade angle when throttle motor turned off at fully open throttle	Throttle blade movement	< -0.6 degrees	Ignition Idle condition Throttle limp home Valve sensor offset adaptions Valve sensor normal judgment DC throttle motor Throttle over current Throttle DC motor relay	On to off Idling Not in limp home Complete Complete No failure No over current No failure	0.760s	2 Drive Cycles
				Disable:	P1609, P1224, P1229, P0122, P0123, P0222, P0223, P0121, P1251, P1631, P1611, P1633,P0607, P2118, P2119, P2135			

Throttle Control – Up to 2004 Model Year - Continued								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Throttle control DC motor relay off fail	P1251	Rationality, commanded versus actual	Commanded versus actual	Different		Ignition on	0.352s 0.4s (V6 2004 model year) 0.5s (V8 2004 model year)	2 Drive Cycles
Throttle control DC motor relay on fail	P1658				Battery voltage Disable:	9 to 18 volts P0603	0.496s 0.5s (2004 model year)	2 Drive Cycles
Throttle control DC motor relay driver off failure	P1631	Rationality, commanded versus actual	Commanded versus actual	Different		Ignition on	0.352s 0.4s (V6 2004 model year) 0.5s (V8 2004 model year)	2 Drive Cycles
Throttle control DC motor relay driver on failure	P1657				Battery voltage Disable:	9 to 18 volts P0603	0.496s 0.5s (2004 model year)	2 Drive Cycles
Throttle limp home spring failure	P1254	Monitoring of throttle blade angle when throttle motor turned off at fully closed throttle	Throttle blade movement	< +0.6 degrees	Ignition Idle condition Throttle DC motor relay Throttle limp home Throttle motor over current Valve sensor offset adaptions Valve sensor normal judgment	On to off Idling No failure No No over current Complete Complete	0.640s	2 Drive Cycles
					Disable:	P1224, P1229, P0122, P0123, P0222, P0223, P0121, P1251, P1631, P1611, P1633, P0607, P2118, P2119, P2135		
Throttle watchdog circuit failure	P1634	Rationality of throttle watchdog pulse train	Watchdog pulse train not present when throttle relay on	> 1 cycle	Throttle DC motor driver Disable:	Ignition on No failure P1609, P1657	0.304s	2 Drive Cycles

Throttle Control – From 2004 Model Year								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Throttle control sensor power supply malfunction	P1240	Out of range check	Pedal position 2 TP 1 TP 2	< 0.35 volts < 0.35 volts < 0.35 volts		Ignition on	3s	2 Drive Cycles

Throttle Control – 2005 Model Year X-Type								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Throttle control sensor power supply malfunction	P0561	Out of range check	Pedal position 2 TP 1 TP 2	< 0.35 volts < 0.35 volts < 0.35 volts		Ignition on	3s	2 Drive Cycles
Throttle control low input	P0562	Out of range check	Output voltage	<= 3.0 volts		Ignition on	3s	2 Drive Cycles
Throttle control high input	P0563	Out of range check	Output voltage	>= 4.5 volts		Ignition on	3s	2 Drive Cycles
Throttle watchdog circuit failure	P2107	Rationality of throttle watchdog pulse train	Watchdog pulse train not present when throttle relay is on	> 1 cycle	Throttle DC motor driver Battery voltage Disable:	Ignition on No failure 9V to 18V P1609, P1657	0.304s	2 Drive Cycles

THC1				
Battery voltage (v)	6.48	8.98	9.06	12.03
Voltage deviation for failure judgment (seconds)	0.992	0.992	0.192	0.192

THC2			
Battery voltage (v)	6.48	8.98	9.06
Time for failure judgment (seconds)	10.000	10.000	0.352 (1.248 (V8))

6.32.10 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.33 Intake Manifold Tuning Valve System

When the entry conditions have been met, the control module checks the commanded versus actual position of the Intake Manifold Tuning (IMT) valves. If they are not matched, a timer is started. If at the end of the set time the commanded and actual positions of the IMT valves do not match then the relevant DTC is flagged and the IMT valve affected is disabled.

6.33.1 Monitoring Structure

Intake Manifold Tuning Valve (V6 Only)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
IMT valve 1 low/high input IMT valve 2 low/high input	P1549 P1532	Hardware check	Commanded versus actual	Different	Duty cycle Battery voltage Disable:	10 to 90% >10 volts P1609	10s	2 Drive Cycles

6.33.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.34 Generator Monitor

6.34.1 Generator Charge Line Monitor (V6 Only)

The generator used with the V6 engine can operate in two output modes. The high charge mode provides an output of 15.3 volts, whilst the low charge mode provides an output of 13.6 volts. This monitor checks the output of the generator to confirm it matches the mode selected. When the entry conditions have been met the rationality of the actual charge mode is compared to the commanded mode, if they do not match then a timer is started. If at the end of the timed period the commanded and actual modes still do not match the relevant DTC is flagged.

6.34.2 Generator Field Line Failure (V6 Only)

Once the entry conditions have been met, the ECM checks the duty cycle of the generator field line against pre-defined thresholds. If the duty cycle is outside the threshold limits for more than a defined period then the field line failure DTC is logged.

6.34.3 Charging System/Generator Load Failure

On V6 engines, this monitor checks the charge line for irrational behavior, these being charge line off when engine running and charge line on when the engine is not running. If either of the above conditions exist for more than a predefined time then the DTC is set and the charge warning lamp is illuminated.

The V8 engine uses an alternative strategy due to differences in the generator used. This generator provides a variable voltage output dependent on the temperature of the generator itself. Once the entry conditions have been satisfied, the average charge voltage over a predefined time is checked. If this falls below a defined threshold value then the DTC is logged and the charge warning lamp is illuminated.

6.34.4 Monitoring Structure

Generator Monitor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Charge line low input	P1146	Rationality of charge mode versus requested mode	Requested high mode against actual mode	Regulator in low mode	Battery voltage	> 10 volts	1.3s	2 Drive Cycles
Charge line high input	P1244	Rationality of charge mode versus requested mode	Requested low mode against actual mode	Regulator in high mode	Battery voltage	> 10 volts	1.3s	2 Drive Cycles
Field line failure	P1629	Generator output duty cycle rationality	Driver duty outside valid duty range	< 5% or > 45%	Battery voltage Engine RPM Ignition switch	> 10 volts < 200 RPM On	0.320s	2 Drive Cycles
Charging system/generator load failure	P1632 (V6)	Charge line status rationality	Charge monitor line off when engine running		Ignition switch Battery voltage After start time	On > 10 volts > 1.28s	5s	2 Drive Cycles
			Charge monitor line on when engine not running		Ignition switch Battery voltage Engine speed	On > 10 volts < 200 RPM	0.320s	2 Drive Cycles
		Regulator control rationality	Voltage difference between high and low charge modes	< 0.7 volts	Engine RPM Charge mode	> 1000 while Low for 10s and High for 10s	> 20s	2 Drive Cycles
	P1632 (v8)	Continuous voltage rationality	Average battery charge below limit	< 13.9 volts	Engine RPM Charge mode	> 650 Low	15s	2 Drive Cycles
					Disable:	P0335, P0336, P1609, P1146, P1244, P1629, P1632		

6.34.5 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.35 Engine Control Module

The engine management system is centered on an ECM. The ECM receives input signals from engine sensors to evaluate engine-operating conditions. In addition, the ECM communicates with other powertrain systems and vehicle systems. The ECM then processes the sensor information and the information received from other systems using programmed software strategies and issues control output signals to the engine and emission control functional systems.

At it's very basic level of control the ECM:

- Takes engine speed and load input signals.
- Applies correction factor inputs and emissions control feedback signals.
- Processes the signals to access pre-programmed software strategies.
- Outputs control signals to the various engine and emission components.
- During this process, the ECM employs diagnostic tests to monitor and report engine management system faults. Faults are stored in ECM memory as codes. Technician access to the DTCs and data is gained through a diagnostic data link.

6.35.1 ECM Control Relay Monitor

After the vehicle ignition has been turned off, the ECM can maintain its own power source by holding on the ECM relay. The ECM turns itself off by releasing this relay. If it has done this but is still operating then there is a fault with the ECM control relay circuit and this is logged.

6.35.2 Main Processor Monitor

At processor initialization, this monitor checks whether the Read Only Memory (ROM) checksum for the sub processor monitor is OK. If the checksums do not agree, a failure judgment is made. The same check is performed for the Random Access Memory (RAM) area for the sub processor monitor. If the checksums do not agree, a failure judgment is made. During ignition on, the main processor mirror checks certain sequence, RAM and ROM calculations with the sub processor. If the mirror checks do not agree, a failure judgment is made.

6.35.3 Sub Processor Monitor

This monitor duplicates various sections of the throttle control functions performed by the sub processor in the main processor and continuously compares the results during ignition on. In case of the sub processor value differing from the main processor value by more than a calibratable amount, a failure judgment is made.

The following functions are checked:

- Throttle target calculation.
- Throttle offset voltage differential failure.
- Throttle target voltage differential failure.
- Throttle valve angle input.
- Pedal angle input.
- Digital servo control.
- Total sub processor calculation.
- Speed control mode cancel.
- Sub processor self-check.

6.35.4 Battery Back Up Monitor

The ECM supply input status is checked after the system initialization with ignition applied. If the supply input is low, the status flag is set. When the ignition is cycled the fault timer is incremented until the timer reaches the calibrated time, thus the fault flag is set.

6.35.5 Processor Communications Monitor

At regular intervals, the validity of all RAM data is checked. Any corruption of RAM data will result in a monitoring failure judgment being made. If all RAM data is verified then a monitoring normal judgment is made.

6.35.6 Engine Control Module Keep Alive Memory Monitor

Every data value stored in the Electrically Erasable Programmable Read Only Memory (EEPROM) is duplicated in a 'mirror' EEPROM location. If all the data values and their mirrors match, a normal judgment is made. If any of the EEPROM data values differ from the value stored in their mirror location then a failure judgment is made and P0603 is logged.

6.35.7 Monitoring Structure

Engine Control Module								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Battery back up	P0560	No permanent power to ECM	Port monitor flag	Not set	Processor communications Battery Voltage Disable:	Main and sub processor communications. Correct 9 to 18V P1642, P1609	10s	2 Drive Cycles
Keep alive memory error	P0603	Mirror check	Mirror check	Not correct	Ignition on Disable:	P1642, P1609	1.024s	1 Drive Cycle
ECM control relay	P1606	Relay operating when not requested	ECM relay energized		Ignition switch Disable:	Accessory on, ignition off P1609	7.2s	1 Drive Cycle
ECM processor communications error	P1609	Internal communications check	Keyword	Not correct	Ignition on		5s	2 Drive Cycles
Sub processor failure	P1611 P0607 (2005 model year X-Type)	Throttle target calculation failure	Sub processor throttle target calculation versus Main processor		Speed control DC motor relay Processor to processor communications.	Not active On No failure	0.128s	2 Drive Cycles
		Throttle offset voltage differential failure	Differential of valve offset voltage 1 too large	> 5 volts >=0.40 volts (2004 model year)	DC motor relay Processor to processor communications.	On No failure	0.128s	2 Drive Cycles
		Throttle target differential failure	Differential of target voltage too large	> 5 volts >=3.36 volts (2004 model year)	Traction, acceleration and power limitation DC motor relay Processor to processor communications.	Not active On No failure	0.128s	2 Drive Cycles
		Throttle valve angle input failure	Sub processor throttle angle calculation versus Main processor	> 4.58 degrees n/c > 5.48 degrees (2004 model year) > 10.66 degrees (2005 model year X-Type)	DC motor relay Processor to processor communications.	On No failure	0.128s	2 Drive Cycles

Engine Control Module								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
		Pedal angle input failure	Sub processor pedal angle calculation versus main processor	> 8.02 degrees n/c > 11.22 degrees (2004 model year)	DC motor relay Processor to processor communications	On No failure	0.128s	2 Drive Cycles
		Digital servo control failure	Throttle sensor 1 output voltage versus final target voltage	> see table SUB1	DC motor relay Processor to processor communications	On No failure	0.128s	2 Drive Cycles
		Total sub processor calculation failure	Throttle valve angle versus pedal angle	1.07 degrees	DC motor relay	On	0.128s	2 Drive Cycles
		Speed control mode cancel failure	Speed control active with P/N switch set or brake switch set or park-brake on or vehicle speed < 16.1mph	0.496s	DC motor relay Processor to processor communications	On No failure	0.5s	2 Drive Cycles
ECM main processor failure	P1633	RAM/ROM checks	Failure detected in RAM check or ROM check or sequence check or mirror data check		Battery voltage	9 to 18V	0.08s	2 Drive Cycles
ECM amplifier failure for valve sensor	P1656	Amplifier output voltage rationality	Output voltage versus 4 X input voltage	> 0.483 volts difference	Amplifier input voltage Disable:	>= 0.3 V <=1.15 V P1241, P1242	0.496s	2 Drive Cycles

SUB1 (for P1611 or P0607)				
Final target voltage (volts)	2	3	4	5
Deviation voltage (Volts)	1.0	2.0	3.0	4.0

6.35.8 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

6.36 Communications Network Monitors

If the ECM does not receive any messages from the required module for a set time, then a fault is flagged.

6.36.1 Monitoring Structure

Communications Network Monitors								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
CAN link ECM/Anti-lock Braking System (ABS)	P1637	No CAN signal from ABS module	ABS CAN identifier not received	No ID	Crank request flag Battery Voltage Disable:	Not set >=10V Ignition on P1642, P1609	2.5s 1.5s (2004 model year)	2 Drive Cycles
CAN link ECM/ IPK	P1638	No CAN signal from IPK	IPK CAN identifier not received	No ID	Crank request flag Battery Voltage Disable:	Not set >=10V Ignition on P1642, P1609	2.5s 1.5s (2004 model year)	1 Drive Cycle
CAN link failure	P1642	CAN circuit failure	All modes missing	No IDs	Crank request flag CAN bus off line flag Communications failure flag TCM mode missing flag Transmission ABS mode missing flag Climate control mode missing flag IPK mode missing flag Gearshift selector module mode missing flag Adaptive speed control mode missing flag Disable:	Not set Set Set Set Auto Set Set Set Set Set Set P1609	2.5s 1.5s (2004 model year)	2 Drive Cycles 1 Drive Cycle (2004 model year)
CAN link ECM/Transmission Control Module (TCM)	P1643	No CAN signals from TCM module	TCM CAN identifier not received	No ID	Transmission Crank request flag Battery Voltage Disable:	Automatic Not set >=10V Ignition On P1642, P1609	2.5s 1.5s (2004 model year)	2 Drive Cycles
CAN link ECM/Rear Climate Control (RCC)	P1699	No CAN signals from RCC module	Climate control CAN identifier not received	No ID	Crank request flag Battery Voltage Disable:	Not set >=10V Ignition On P1642, P1609	2.5s 1.5s (2004 model year)	2 Drive Cycles

6.36.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

7 Anti-lock Braking System

This section includes the ABS codes that are reported as part of the vehicle emissions certification.

7.1 Wheel Speed Sensors

The ABS modulates brake pressure on each wheel independently to maintain vehicle stability during braking.

The ABS continually monitors the rotational velocity of each wheel anytime the ignition switch is in the on position and determines if a tire is skidding when the brakes are applied. Only then does the ABS intervene to modulate the brake pressure to the skidding wheel. The modulation continues until the wheel rotates freely. The brake pressure is then restored and the modulate/restore cycle is repeated whenever skidding is detected. This cycle occurs at a rate of several times per second.

The ABS module is capable of detecting the following system conditions:

- Hydraulic valve failure.
- Wheel speed sensor failure.
- ABS power relay short circuit.
- Interconnect failures to the ABS sensors, power and ground to the ABS module.
- Over/under voltage conditions.

The ABS provides failure messages, via the ABS indicator, in the ipk. Failure of the ABS module, for whatever reason, will not compromise the normal operation of the brake system.

7.1.1 Wheel Speed Sensor Monitoring (XJ Range, XK Range and S-Type)

The ABS system monitors all four wheel speed censors continuously. A number of checks are performed, the failure of any one will cause the ABS system to be disabled and the ABS warning lamp together with the MIL to be illuminated. The monitors are performed differently on the X-Type and, therefore, the description for this system is dealt with separately.

Sensor Signal Current Out of Range

The current from each sensor is continually monitored against an upper and lower threshold. If the current is outside the threshold limits a counter is incremented and the check re-run. When the counter reaches its predefined limit the DTC for the appropriate wheel speed sensor is logged.

Missing Wheel Speed Sensor Input

If any of the wheel speed signals is lost (assuming normal signals from the other three wheels) for more than 0.007 seconds, the DTC for the appropriate wheel speed sensor is logged.

Wheel Speed Sensor Signal Continuously too Low

If the signal current from any wheel speed sensor is identified as being too low for more than a defined period then the DTC for the appropriate wheel speed sensor is logged.

Comparison of Maximum Wheel Speed Versus Minimum Wheel Speed

This monitor compares the difference in wheel speed of the sensors over a long period (180 seconds). If the difference between the maximum and minimum wheel speeds continuously exceeds the defined threshold the DTC for the appropriate wheel speed sensor is logged.

Wheel Speed Signal Changes Erratically

Erratic wheel speed signals are monitored by checking the variation in successive samples. If the difference in signal from each successive sample is greater than 15.5 mph or the signal interrupt is detected (no sample) then a software counter is incremented. If the counter reaches its defined limit the DTC for the appropriate wheel speed sensor is logged.

Periodic Drops of Wheel Speed Signal

At wheel speeds above 12.4 mph, each sensor is monitored for loss of wheel speed signal. If the signal is lost for more than 15 revolutions then the DTC is logged.

7.1.2 Monitoring Structure

Wheel Speed Sensors (XJ, XK8 and S-Type)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Right rear wheel speed plausibility	C1165	Sensor signal current out of range or	Sensor signal current	>= 4.5 mA <= 20mA	Supply voltage	7.5 to 8.5 volts	19 software loops	2 Drive Cycles
Left rear wheel speed plausibility	C1175	Missing wheel speed sensor input or			Supply voltage	7.5 to 8.5 volts	1 software loop (approximately 0.007s)	
Right front wheel speed plausibility	C1145	Wheel speed sensor signal continuously too low or			Supply voltage	7.5 to 8.5 volts	1 software loop	
Left front wheel speed plausibility	C1155	Comparison of maximum wheel speed versus minimum wheel speed or	Vehicle speed or	> 6.2 mph	Vmax. Vmin1 Vmin2 Vmin3	< 6.2 mph < 1.2 mph < 1.2 mph < 1.2 mph	180s	
			Vehicle speed or	> 9.3 mph	Vmax. Vref.	< 4.3 mph < 3.7 mph	180s	
			Wheel speed or	<= 0.4 Vmax.	Vmax.	> 9.3 mph		
			Wheel speed	<= 0.6 Vmax.	Vmax.	24.8 mph	180s	
		Wheel speed signal changes erratically or	Erratic step of wheel speed or	Vx(n) – Vx(n-1) > 15.5 mph			22 software loops	
			Number of interrupts per loop	> 40			22 software loops	
		Periodic drops of wheel speed signal or			Wheel speed Supply voltage	> 12.4 mph 7.5 to 8.5 volts	15 wheel revolutions.	
		Long time monitoring of the ABS control phases	Pressure reduction too long following pressure hold phase				28s	

7.1.3 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

7.1.4 Wheel Speed Sensor Monitoring (X-Type)

Dynamic Monitoring

The monitor runs when the vehicle speed reaches 24.8 mph. If any of the wheel speed signals is lost (assuming normal signals for the other 3 wheels) for more than 20 ms the DTC for the appropriate wheel speed sensor is logged.

Static Start-up Monitoring

This monitor checks for the loss of the wheel speed signal at ignition on. If any wheel speed signal is not present for more than 20 seconds then the appropriate DTC is logged.

Drive-off High Speed

This monitor checks for loss of a wheel speed sensor signal during rapid acceleration from being stationary. The monitor looks for one wheel speed signal being stuck at 0 mph when the other three are greater than 11 mph. If this situation occurs, a timer is started. If after 0.020 seconds the situation still exists then the DTC for the appropriate wheel speed sensor is logged.

Drive-off Low Speed

This monitor checks for the loss of a wheel speed sensor signal during slow acceleration from being stationary and during continued low speed driving. If the difference between the maximum and minimum wheel speed continuously exceeds any of the defined thresholds for more than 20 seconds the DTC for the appropriate wheel speed sensor is logged.

Static Wheel Slip

This monitor compares the difference in the wheel speed of the sensors over a longer period of time (5 seconds) during normal driving. If the vehicle speed is below 62 mph, then the wheel speed sensors are checked for either the deviation of the two wheel speeds at either side of the vehicle being greater than 3.7 mph, or the deviation of the wheel speed at the front axle being greater than 6.2 mph. If at least one wheel is at 3 mph or lower, a wheel speed deviation of adjoining wheel of 7.4 mph is permitted. If the detected deviation exists for more than 5 seconds then the appropriate DTC is logged. If the vehicle speed is greater than 62 mph then the wheel speed sensors are checked for either the deviation of two wheels speeds at either side of the vehicle being greater than 6% or the deviation of wheel speeds at the front axle being greater then 2.5 mph +6%. If the detected deviation exists for more than 5 seconds then the appropriate DTC is logged.

Ohmic Monitoring

This monitor performs a static impedance check on each wheel speed sensor when the ignition is switched on. If the impedance of any sensor is outside of its defined limits, then the appropriate DTC is logged.

7.1.5 Monitoring Structure

Wheel Speed Sensors (X-Type)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Right rear wheel speed plausibility	C1165	Dynamic monitoring or Static start-up monitoring	No wheel speed signal for: Wheel speed not present	0.010 to 0.020s	Vehicle speed	24.8 mph	0.020s 20s 2 Drive Cycles	2 Drive Cycles
Left rear wheel speed plausibility	C1175	or Sensor supply, signal quality or					0.240s	2 Drive Cycles
Right front wheel speed plausibility	C1145	Drive–off high speed or Drive-off low speed	1 wheel at 0 mph with 3 wheels at > 11 mph (V1 = fastest wheel				0.020s 20s 2 Drive Cycles	2 Drive Cycles
Left front wheel speed plausibility	C1155	or	V4 = slowest wheel) V2>= 7.4 mph and V3> 3 mph and V4< 3 mph or V2>= 14.9 mph and V3<= 3 mph or V3> 55.8 mph and V4= Vmin or V1,V2,V3= 7.4 mph and V4= Vmin					

Wheel Speed Sensors (X-Type) continued								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
		Static wheel slip or	*Deviation of the two wheel speeds at either side of the vehicle > 3.7 mph or at the front axle > 6.2 mph * If at least one wheel is at 3 mph or lower, a wheel speed deviation of adjoining wheels of 7.4 mph is permitted		Vehicle speed	< 62 mph	5s	2 Drive Cycles
			Deviation of two wheels speeds at either side of vehicle > 6% or at the front axle > 2.5 mph +6%		Vehicle speed	> 62 mph		
		Ohmic monitoring	Broken Shorted to ground Short to supply voltage Short between sensor lines				0.280s	2 Drive Cycles

Wheel Speed Sensors (X-Type – 2008MY)								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
Invalid signals Front Left Front Right Rear Left Rear Right	C0031 C0034 C0037 C003A	CAN signal 'error marker' received from ABS	ABS Unable to Transmit Valid Data		Ignition Switch Battery Voltage Engine Start	On for at least 2.0 s >= 10 V Not in progress	5.0 s	2 Drive Cycles

7.1.6 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).

7.2 Control Module Failure

The ABS control module runs a number of internal power on initialization self-tests when the ignition is switched on. If any of the self-tests fail then DTC C1137 is logged and the ABS is disabled.

7.2.1 Monitoring Structure

Control Module								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
ABS control module failure	C1137	Defective control module	Major ABS control module internal fault			Power applied	0.7s	2 Drive Cycles

Control Module – X-Type								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL
ABS control module failure noise detection	C1137	Long term interference	Interference on one or more wheels					2 Drive Cycles

7.2.2 Drive Cycle Information

Refer to the generic drive cycle (see 2.1 *Generic OBD-II Drive Cycle*).