MY07
Vehicle: S80, XC90
Engine: B6324S

Functional Description

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June 1 - 2008
Volvo Customer Service

System overview - Design and function

The following modules communicate with the Engine Control Module (ECM) via the network:

- Electronic Throttle System (ETS) including Electronic Throttle Module (ETM) and Accelerator Pedal Module (APM)
- Transmission Control Module (TCM)
- Anti-lock Braking System (ABS)
- Central Electronic Module (CEM)
- Diagnostic Connector for connection to VADIS (Volvo Aftersales Diagnostic and Information System)
- Driver Information Module (DIM), combined instrument panel
- Climate Control Module (CCM)
- Steering Wheel Module (SWM)

- Central Electronic Module (CEM) is the central computer in the network, which handles the exchange between the network's high speed and low speed sections. The high-speed section covers the following modules: Engine Control Module (ECM), Electronic Throttle Module (ETM), Transmission Control Module (TCM), Anti-lock Braking System (ABS) and the Central Electronic Module (CEM).
- The Engine Management System contains a large number of sensors that send information by analog signals directly to the Engine Control Module (ECM).

Communication on the internal network

CAN communication
ECM (Engine Control Module) sends out and receives the following signals via the network:

Brake Control Monitoring (BCM)
Provides information so that the Engine Control Module (ECM) can determine whether any misfiring is due to road condition or to a fault in the engine management system. Also provides a vehicle speed signal.

Climate Control Module (CCM)
Informs the Engine Control Module (ECM) about A/C selection and requests A/C activation.

Central Electronic Module (CEM)
Is the "main computer" in the network and coordinates required information between other modules. It also controls diagnostic function by connecting the Diagnostic Connector to the network for programming and reading off diagnostic trouble codes (DTCs) and parameters. The CEM also includes the Immobilizer.

Steering Wheel Module (SWM)
Provides information to the Engine Control Module (ECM) that the cruise control is selected and that the driver requests changing the cruise control speed.

Transmission Control Module (TCM)
The Transmission Control Module (TCM) is only implemented in automatic transmission cars.
The following signals are being sent on the network from the Engine Control Module (ECM) and picked up by the Transmission Control Module (TCM):

- Engine load
- Throttle opening
- Response to torque limiting
- Accelerator and brake pedal position
- Cruise control status.

The following signals are sent out on the network from the Transmission Control Module (TCM) and taken up by the Engine Control Module (ECM):

- Request for torque limiting step I and II
- Request to light Malfunction Indicator Lamp (MIL)
- Signal for constant idle speed compensation (P/N position)
- Engaged gear.

Diagnostic Connector
The serial communication via the Diagnostic Connector is used when reading off the Volvo onboard diagnostic (OBD) system.

Contact	General allocation
1	Discretionary
2	Not Connected
3	MS_CAN (Manufacturer spec)
4	Chassis ground
5	Signal ground
6	CAN_H line of ISO 15765-4
7	Not Connected
8	Discretionary

Contact	General allocation
9	Discretionary
10	Not Connected
11	MS_CAN (Manufacturer spec)
12	Discretionary
13	Discretionary
14	CAN_L line of ISO 15765-4
15	Not Connected
16	Permanent positive voltage

Input signals

Component	Purpose
A/C Linear High Pressure Sensors	Provides information using a linear signal about any pressure changes on the high-pressure side of the A/C system. Not used by emission related functions.
Accelerator Pedal	Senses the accelerator pedal position. The signal is used by the ECM. The pedal is designed with two independent signals, one with analogue and one with digital output (Pulse Width Modulated – PWM).
Alternator, LIN (bus)	Exchange of information between the Engine Control Module (ECM) and the other units occurs as well with the use of LIN (Local Interconnect Network) serial communication. Not used by emission related functions.
Ambient temperature sensor	Provides information about ambient air temperature. The signal is used by the ECM.
Brake light switch	Informs Engine Control Module (ECM) that the car is braking. Not used by emission related functions.
Camshaft sensor, inlet/outlet	Provides the ECM information about the engine working cycle.
Coolant Level Switch Not EuCD	Indicates low level in coolant water, the switch is open when the level is low.
CAN (bus)	Reading out fault codes. Exchange of information between the ECM and the following units: CEM, BCM, TCM, Steering Angle Sensor (SAS), Differential Electronic Module (DEM) and Diagnostic Connector.
Engine Coolant Temp Sensor	To detect coolant temperature, which makes it necessary for the ECM to correct fuel injection.
Flywheel/Crank Sensor	Provides the ECM information about the crankshaft position and engine speed
Fuel Pressure/Temp. Sensor	To measure the fuel pressure and fuel temperature.
Heated Oxygen Sensors Front, UHEGO (One sensor for each bank)	UHEGO linear oxygen sensor detects oxygen concentration in the exhaus gas. (Universal HEGO)
Heated Oxygen Sensors, HEGO (One sensor for each bank)	Detection of lambda = 1, where the catalyst function is optimal.
Ignition Switch	Ignition starts the ECM)
Knock sensors (One sensor for each bank)	To detect harmful knocking combustions in the engine.
MAF Sensor	Provides information about the quantity of air mass passing through into the engine, mainly under normal driving conditions.
MAP Sensor	Provides information, about the engine load at rapid load changes, to the engine control unit.
Oil Quality Sensor	Provides information to the engine control unit, which will determine when to inform the driver about needed oil top-ups or required service. Not used by emission related functions.
Starter Switch	Starter switch activates the output for starter motor by the ECM
Wake Up Switch	Wake Up starts the ECM

Output signals

Component	Purpose
A/C Compressor Control Valve	Controlling the A/C compressor displacement. Not used by emission related functions.
A/C Relay	Connecting and disconnecting A/C compressor. Not used by emission related functions.
Alternator, LIN (bus)	Exchange of information between the ECM and the other units occurs as well with the use of LIN serial communication. Not used by emission related functions.
Battery (Kl.30)	Provides the ECM with RAM backup voltage.
CAN	Exchange of information between the ECM and other Control Units.
CPS - Cam Profile Shifting	Is used to control the CPS valves for variable inlet valve lift.
Diagnose Module – Tank Leakage (DMTL)	Detects leakages above 0.5 mm in tank using overpressure.
ECM Power	Main ECM power supply
Electronic Throttle Module	To control the engine torque at all driving conditions by regulating the throttle plates, and hence air flow to the engine, with an electrical motor.
Electronic Fan Control Module (EFCM)	The EFCM allows continuously variable control of the fan motor'srotation rate.
EVAP Canister Purge Valve	To control the purge flow from canister to engine.
Ignition Coils/Power Stages (1-6)	The ignition coils store energy from the battery and transform to a high voltage ignition pulse to the spark plugs out of a control signal from the ECM.
Instrument panel	Displays the MIL.
Starter Motor Relay	Relay to switch on and off starter motor.
System relay	Controlled by the ECM. To switch on and off EMS components.
VVT Control Valves, intake (One for each bank)	Is used to control the Intake VVT valve for VVT Timing.
Pump Electronic Module (PEM)	The PEM is a component within a demand controlled fuel supply system (DECOS). It's a power stage that is used to control the flow rate and pressure of the fuel pump continuously.
Spark plugs (1-6)	Transfer the high-tension ignition voltage generated within the coil into the cumbustion chamber. No output signal directly from the ECM.
TCM (Automatic transmission only)	Receiving signals (through CAN) from ECM. Hard wired Park/Neutral signal from TCM to ECM.
VIS - Variable Intake System	Is used to control the variable intake systems two electricaly controled tuning valves.

DIAGNOSE FUNCTIONS – OVERVIEW

The Engine Management System fuel/ignition system control module has an on-board diagnostic system for self- diagnosis, continuously monitoring input and output signals and several other functions.

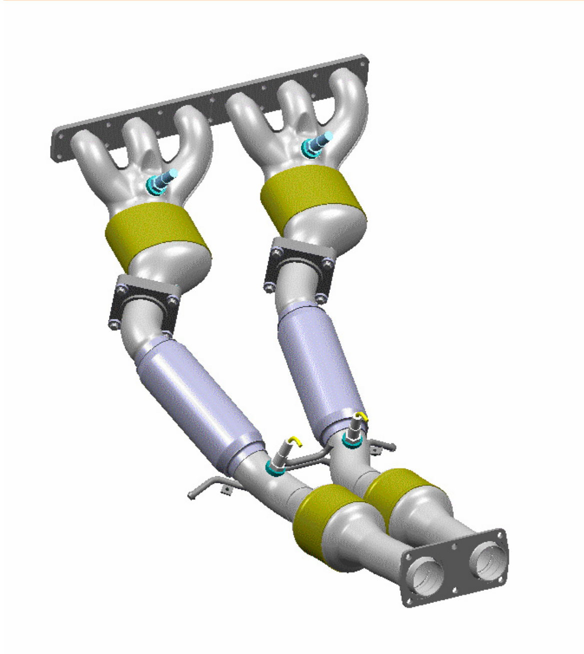
If the engine control module (ECM) detects a fault, some parameters will switch to predetermined, default values, to allow as normal as possible operation. At this time a pending diagnostic trouble code (DTC) will be stored together with a number of relevant parameters, to help the fault tracing operation. If the same fault occurs during the next driving cycle then the DTC will be set as permanent and if the fault is emission relevant the malfunction indicator (MIL) will be activated.

If a fault disappears after the DTC has been stored, information about the fault is stored in the ECM. Every time the fault reoccurs a counter counts it. After three consecutive driving cycles without the fault it is allowed to turn off the MIL. For every warm-up cycle that is driven without the fault reoccurring a second counter counts down. It begins with 40 and counts down to 0. When the second counter has counted down to 0 the diagnostic trouble code can be erased from the ECM memory.If the fault reoccurs the second counter is reset to 40.

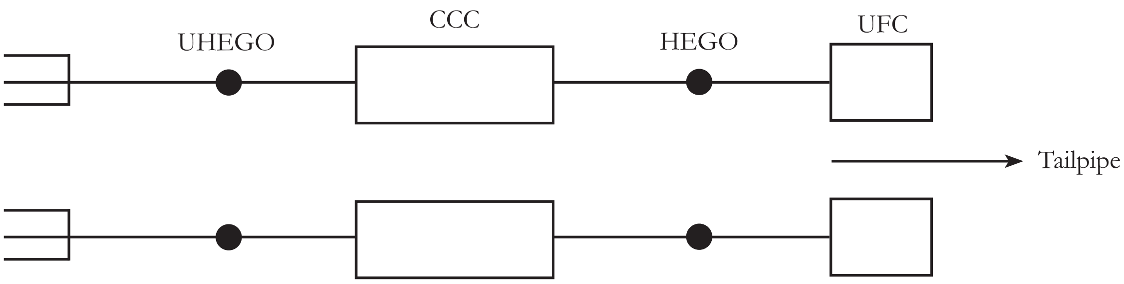
The OnBoard Diagnostic (OBD) system also makes it possible to read out the values and status of a number of parameters through the diagnostic link connector (DLC) using standardized protocol and a standardized scan tool, or the manufacturers diagnostic tool.

Catalytic converter diagnostic

General Description



Exhaust system with a total of four sensors – two-sensor method stereo.



HEGO = Universal Heated Exhaust Gas Oxygen Sensor = ”Binary sensor”
UHEGO = Universal Heated Exhaust Gas Oxygen Sensor = ”Linear sensor”
CCC = Close Coupled Catalyst
UFC = Under Floor Catalyst

The three-way catalytic converter (TWC) stores oxygen found in the exhaust gases and uses it to make toxic gases less dangerous. The catalytic converter is a TWC converter in which hydrocarbons (HC) and carbon monoxide (CO) are oxidized and oxides of nitrogen (NOx) are reduced.
As the TWC ages its ability to store oxygen drops. This reduces the conversion capacity of the TWC. To avoid dangerous emissions the ECM checks TWC efficiency. This check is carried out as follows.
The two-sensor method stereo makes use of one upstream and one downstream oxygen sensor for each cylinder bank, each bank has one sensor before the catalytic converter (UHEGO) and one after (HEGO).

Rich and lean lambda pulses are sent through the TWC. For a TWC with good gas converter and large oxygen storage capacity, it will take a long time for the rich/lean pulse to reach the rear oxygen sensor. The rear oxygen sensor will then have long rich and lean pulses and a long time between switches. When the TWC detoriate and oxygen storage capacity drops will the rear oxygen sensor switching frequency increase. The rear oxygen sensor voltage will be used to calculate a test value of the TWC performance and a malfunctioning TWC will be detected by OBD II system.

Catalytic Converter Monitor Operation		Corresponding MonitorID
DTCs	P0420 - Catalyst System Efficiency Below Threshold (Bank 1) P0430 - Catalyst System Efficiency Below Threshold (Bank 2)	21 22
Monitor Strategy description	High air flow monitoring	

Typical catalytic converter diagnostic enable conditions		
Enable condition	*Minimum*	*Maximum*
Ambient pressure	74 kPa	
Vehicle speed	0 km/h	655 km/h
Catalyst temperature	550°C	1000°C

Typical catalytic converter malfunction thresholds	
Malfunction criteria	*Threshold value*
Accumulated signal fluctuation on secondary O2 sensor during A/F modulation (shift from lean to rich /rich to lean)	Bank 1 > 22.5 Bank 2 > 22.5

Misfire diagnostic

If the fuel/air mixture does not burn correctly, then the generated torque will be less than intended and the engine rpm will drop suddenly, (decelerate) the engine is said to be misfiring. The control module can detect misfiring by measuring the time between successive segments on the flywheel /carrier plate.

If there is a misfire then there will be a stepchange in the size of these successive time measurements, if there is a misfire the lost torque will be noticed as a slowing down of the flywheel rotation. The prerequisite for reliable misfire detection is accurate segment period measurement. However, the period between two top dead centers (TDC), at constant speed, is also subject to variations due to manufacturing tolerances and off center installation. These inaccuracies are systematic, so they can be "learned" during fuel cut off periods and used for compensation. By this way, the systematic error introduced by the tolerances of the target flywheel is largely eliminated. The segment time can vary due to the following reasons:
- Misfiring
- Flywheel mechanical tolerances
- Driveline oscillations
- Normal variations caused by uneven combustion
- Poor roads.

Since mechanical tolerances and driveline oscillation interfere with the signal, it is difficult to ascertain whether or not this interference is due to misfiring. To eliminate mechanical faults in the flywheel the flywheel signal is adapted. Two crankshaft revolutions are divided into six periods, (on a 6 – cylinder engine), if the engine has no external load all six periods should be equal. This is to even out the signal, so that a mechanical fault in the flywheel is not registeredas misfiring. After adaptation there is someinterference in the signal due to oscillations in the drive train and normal engine irregularities.The flywheel signal is adapted when:

- Engine speed is between two targets
- The fuel shut-off system is operating and has been active for 100 revolutions.

A DTC is stored when misfiring leads to increased emissions and a DTC is stored when misfiring could cause damage to the TWC. The engine control module registers and stores the engine speed, load and warm-up status in which the misfiring occurred. See part ”Diagnostic functions, Overview”.
If misfire exceeds catalyst damage threshold, the system will cut the fuel on those cylinders that experience misfire if one of the two following conditions are fulfilled:
1. Misfire on single cylinder
2. One or two cylinders misfiring all the time.

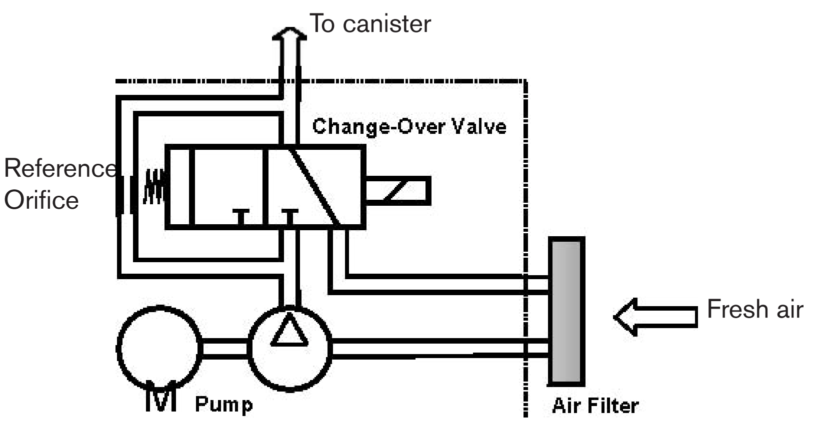
Misfire Diagnostic Operation			Corresponding MonitorID
DTCs	P0300	Multiple Cylinder Misfire Detected	A1
	P0301	Cylinder 1 Misfire Detected	A2
	P0302	Cylinder 2 Misfire Detected	A3
	P0303	Cylinder 3 Misfire Detected	A4
	P0304	Cylinder 4 Misfire Detected	A5
	P0305	Cylinder 5 Misfire Detected	A6
	P0306	Cylinder 6 Misfire Detected	A7
Monitor Strategy description	Emission related Catalyst damage		

Typical Misfire diagnostic enable conditions		
Enable condition	*Minimum*	*Maximum*
Load	0.29 g/rev Depending on altitude and coolant temperature	0.65 g/rev Depending on altitude and coolant temperature
Engine speed	500 rpm	6600 rpm
Coolant temperature	-20°C	

Typical Misfire malfunction thresholds	
Malfunction criteria	*Threshold value*
FTP Emission threshold	> 1.5 % (4th exceedance or exceedance in first 1000 revolutions)
Catalyst damage threshold	8 - 25 %

Leakage diagnostic

Vapor that evaporates from the fuel in the fuel tank is routed to and stored in the EVAP canister from where it is introduced into the combustion process via the Canister Purge (CP) valve.
A leak diagnostic has been introduced in certain markets to ensure that there are no leaks in the fuel tank system. The diagnostic is designed to detect leakage corresponding to a 0,20 inch or larger hole. The fuel tank system consists of fuel tank, fuel filler pipe, EVAP canister, CP valve and all pipes between these components. To be able to diagnose the fuel tank system, it is also equipped with a diagnostic module (DMTL = Diagnostic Module Tank Leakage) including the electrical driven air pump.



Leakage diagnostic (LD) is performed in after run mode, when key off.

The diagnostic is divided into different phases as follow:
Reference leak measurement, performed every LD
Rough leak test, performed every DCY
Small leak test performed every second DCY when enabling conditions are met.

The diagnostic is performed by measuring the LD Pump Module Motor current and then compares it to a specified reference current. If a fault is detected in any of the phases the diagnostic is interrupted and the DTC for the component identified is stored. Diagnosis is carried out in the following stages: At the first engine stop after refueling, the module DMTL will start if conditions are met (conditions for soak time and fuel level are over ridden). When the fuel level sensors are working correctly and the fuel level is higher than 85 % or smaller than 15 % all leakage tests are aborted. Also, the test is aborted if the initial rate of change is higher than a calibrated level due to a combination of high fuel level and high evaporation. In case of healing attempt the test is aborted when the fuel level is too high, which is calibrated lower than 85 %. While the fuel level sensors are not working correctly the test only will be aborted if the initial rate of change is higher than a calibrated level.

1. Reference leak measurement phase
For the reference current measurement, the motor-pump is switched on. In this mode fresh air is pumped through a 0.02-inch reference orifice, situated internally in the module, and the pump motor current is measured. At some unusual operating conditions the pump current may not stabilize. In this case the leak check is aborted and a new leak check will be performed in the next after run. To prevent a permanent disablement of the leak check due to a DM-TL module problem, the number of subsequent irregular current measurements is counted and a module error is set as soon as the counter exceeds a calibrated value.

2. Rough leak test phase
In this monitoring mode the changeover valve is switched over (the purge control valve remains closed). The motor current drops to a zero load level. Fresh air is now pumped through the canister into the tank. This creates a small overpressure at a tight evaporative system, which leads to a current increase.

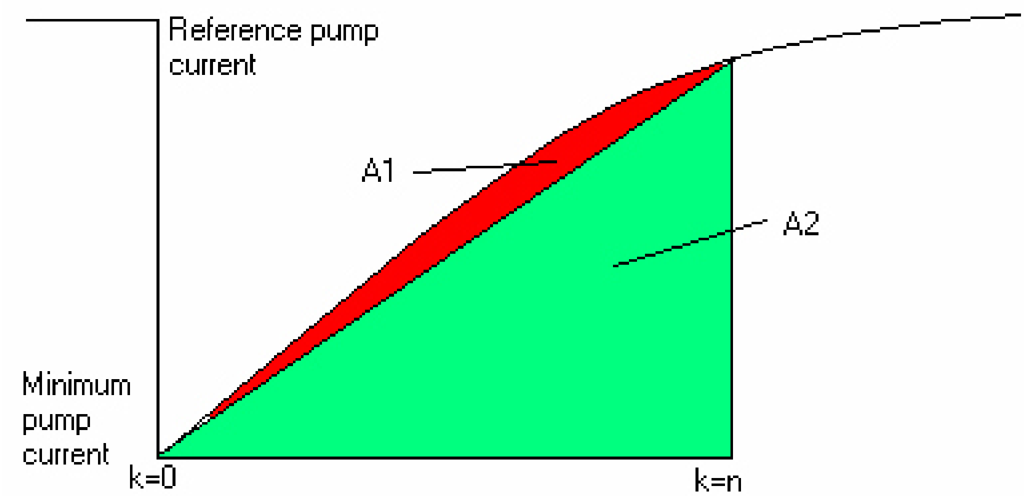
The rough leak check (≥ 0.04-inch) is performed by monitoring the pump motor current gradient. Relative pump motor current is created by using minimum pump motor current and reference pump motor current. Area ratio is created by dividing integrated relative current with ideal area, which is the linear integrated area from minimum pump current to current sample of the current. If the relative current has increased above an upper limit but not exceeded a calibrated area, within a calibrated time, the rough leak check has passed without a fault. If the calibrated area ratio is reached before the relative pump current limit, within the calibrated time, a rough leak fault code is set.
The integrated relative pump current area *Aint* is defined by;

$Aint = A1 + A2$

and the ideal area *Aideal* ,

$Aideal = A2$.

See figure below.



3. Small leak test phase

If the conditions for a small leak check (^{3}0.02- inch) are set the pump motor remains on in monitoring mode until an elliptic combination of the relation pump current and area ratio are fulfilled, or a maximum time limit has been reached. The judgment is based on a test value which is a combination of the actual area ratio and gradient of area ratio with respect to relative pump current. If the estimated leak size is close to the fault limit (0.020" leaks) the monitor may decide to extend the run time of the pump to encrease the build up pressure. This will make the judgement of a small leak safer.

If the test value is very near to set 0.02 inch leakage the reference leak measurement phase is performed again in order to compensate test value and make a final judgment. If the motor current decreases or increases too much during one of the tests, the test is aborted and a new leak test will be performed in the next after run.

Monitoring conditions

To carry out the leak diagnostic it is necessary that:
- Engine-on time is at least 20 minutes and last engine-off time is more than 5 hours.
- ECM (=Engine Control Module) is in after run mode
- Engine speed is 0 rpm
- Vehicle speed is 0 km/h
- Altitude is less than (or equal to) 2500 meters
- Engine coolant temperature is above (or equal to) +4°C
- Ambient temperature is between +4°C and +35°C
- Fuel level between 15% to 85% when no fuel level fault
- Fuel level is not used if fault on fuel level
- Rate of change of the initial relative pump current is low enough
- Concentration of fuel vapor in the EVAP canister is not excessive
- Battery voltage between 11.0 V and 14.5 V
- Purge valve is closed.

With the following errors the leakage detection monitoring can not be performed. These errors will therefore disable the leakage detection monitoring and the MIL (and the corresponding fault code) will be set. The disable conditions are:

- Error on power stages DM-TL pump
- Error on power stage purge valve
- Error on purge valve
- Error on change-over valve

Leakage diagnostic operation		
	Leakage detection pump, mechanical error	*Monitor Strategy description*
DTCs	P043E P043F P2407	Continuous, high Continuous, low Noisy during reference

Typical Leakage diagnostic enable conditions		
Enable condition	*Minimum*	*Maximum*
Ambient temperature	3°C	36°C
Battery voltage	11.0 V	15.0 V
Fuel level	0%	80%
Atmospheric pressure	69 kPa	

Typical Leakage malfunction thresholds	
Malfunction criteria	*Threshold value*
Reference current above limit	$\geq$ 36 mA
for specified time	$\geq$ 10 s
Reference measurement could not be performed within specified TIME even though running conditions were satisfied	$\geq$ 200 s

Fuel system diagnosis

The fuel system diagnosis monitor the long term fuel trim adaptions, to check if any of the adaption points has reached it's limits (rich or lean), and no more adaption is possible. This will not immediately lead to higher emissions, because the short-term fuel trim can take care of additional faults. The long term fuel trim is calculated from the front linear oxygen sensor, and there are 6 times 6 (depending on load and engine speed) different adaptation points. Each point is monitored in order to check if it is higher/lower than the threshold value.

Below are some faults that illustrate cases, which could cause higher emissions:

- Fault leading to lean A/F mixture.
- Air leakage after MAF sensor.

If there is an air leakage after the Maf sensor, this will lead to unmeasured air is added to the combustion. Short term and long term fuel trim will adjust fuel amount to homogenous A/F mixture, and if the leakage is large enough, the diagnosis will detect a lean fault. Greatest influence of this fault is at low load. Fault leading to low fuel pressure.

If for example there is a fault which decreases the fuel pressure from required pressure, this could also affect the short term and long term fuel trim, and if this difference is a large deviation from the required fuel pressure, then the diagnosis will detect a lean fault. Greatest influence of this fault is at high load.

- Fault leading to rich A/F mixture.
- Maf sensor which is rich.

If the Maf sensor measure more air than is actually passing the sensor, then this will result in a rich combustion, and the consequence if the fault is great enough, the diagnosis will detect a rich fault.

Other fault leading to rich A/F mixture

If the fuel pressure regulator is broken, injectors are broken or there is another fault that will result in a rich A/F mixture, then the diagnosis will detect rich.

Fuel system diagnostic operation			Corresponding MonitorID
DTCs	Fuel system adaptation error	*Monitor Strategy description*	
	P0171	Lean fault, bank 1	81
	P0172	Rich fault, bank 1	81
	P0174	Lean fault, bank 2	82
	P0175	Rich fault, bank 2	82

Typical Fuel System diagnosis enable conditions		
Enable condition	*Minimum*	*Maximum*
After start delay	20 s	
Air flow	1.99 g/s	
Engine coolant temp	60°C	110°C

Typical Fuel System diagnosis malfunction thresholds	
Malfunction criteria	*Threshold value*
Adaptive fuelling value above limit	≥ 1.24
for specified time	≥ 5 s
Adaptive fuelling value below limit	≤ 0.78
for specified time	≥ 5 s

Closed loop fuel trim

To be able to activate closed-loop lambda control after engine start the following must be true:

- Oxygen Sensor readiness detected (sensor heating must be completed).

- No errors present for the Oxygen Sensor.

- The engine start sequence must be completed (engine rpm risen close to idle).

- It is required that the engine is running.

- No catalyst damaging misfire detected.

- Not too big deviation of target lambda.

- Engine load not too low.

- No F/C (Fuel cut) recovery enrichment effect.

Heated oxygen sensors diagnostic

An S80 car with EMS system that meets ULEV2/EURO4 legal demands is fitted with two heated oxygen sensors per bank. The upper sensor is fitted before the CCC and the second sensor after the CCC and before the UFC (under floor catalyst). The upper sensor is linear type and the second is a binary type.
The upper sensors have the following monitoring:

- Slow activation (P-code P0134 and P0154). When the Oxygen sensor heater circuit start to heat up the element, a delay counter is activated. After a specified time of heating is a judgment done by evaluating sensor element impedance. Continues monitoring.

- Slow response (P-code P0133 and P0153). A dither is added to target lambda. The diagnose will then check if the lambda value can follow this square wave. When the sensor is slow enough to give high emission it will be detected as malfunctioning. Performed once per driving cycle.

- Heater circuit (P-code P0031, P0032 and P0051, P0052). The sensor heater is continuously monitored. Fault will be detected if circuit is: Open, short to ground or short to battery.

- Sensor circuit (P-code P0131, P0132 and P0151 and P0152). The sensor circuit is continuously monitored. Fault will be detected if sensor circuit is: Open, short to ground or short to battery.
- The second sensors have the following monitoring:

- Sensor circuit (P-code P0137, P0138 and P0157, P0158). The sensor working range is checked to detect if sensor have an amplitude/range problem to work in its normal voltage range. Sensor must be able to work in catalyst monitoring area to be judged as normal and be close to 0V after fuel cut. Function also monitor if sensor is stuck in range.

- Heater circuit (P-code P0037, P0038 and P0057, P0058). The sensor heater is continuously monitored. Fault will be detected if circuit is: Open, short to ground or short to battery.

- Sensor out of range (P-code P1137, P1138 and P1157, P1158). If sensor doesn't work in its normal range, fault will be detected. Continuous monitoring.

Typical Heated Oxygen Sensor diagnostic enable conditions

Enable condition	*Minimum*	*Maximum*
UHEGO heater On operation Duty Low Level	7.7 ms	
UHEGO heater On operation Duty High		120ms
After start delay		30s

Typical Heated Oxygen Sensor malfunction thresholds

Malfunction criteria	*Threshold value*
O2 Sensor Heater fault flag.	5.12s
Element impedance too high	$\geq$ 80 Ω during 10 s

Heated Oxygen Sensor operation			
DTCs	Upper O2 Heater Control Circuit	*Monitor Strategy description*	Corresponding MonitorID
	P0031 P0032 P0051 P0052	Heater low fault, bank 1 Heater high fault, bank 1 Heater low fault, bank 2 Heater high fault, bank 2	41 41 45 45
	Upper O2 Sensor Circuit		
	P0131 P0132 P0151 P0152	Element low fault, bank 1 Element high fault, bank 1 Element low fault, bank 2 Element high fault, bank 2	01 01 05 05
	Upper O2 Circuit Slow Response		
	P0133 P0153	UHEGO Slow response, bank 1 UHEGO Slow response, bank 2	01 05
	Upper O2 Circuit Slow Activation		
	P0134 P0154	UHEGO Slow activation, bank 1 UHEGO Slow activation, bank 2	01 05
	O2 Heater ControlCircuit		
	P0037 P0038 P0057 P0058	Heater low fault, bank 1 Heater high fault, bank 1 Heater low fault, bank 2 Heater high fault, bank 2	42 42 46 46
	O2 Sensor Circuit		
	P0137 P0138 P0157 P0158	Element low fault, bank 1 Element high fault, bank 1 Element low fault, bank 2 Element high fault, bank 2	02 02 06 06
	O2 Sensor Out Of Range		
	P1137 P1138 P1157 P1158	Out of range high, bank 1 Out of range low, bank 1 Out of range high, bank 2 Out of range low, bank 2	

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Request on-board monitoring test results for specific monitored systems

The purpose of this service is to allow access to the results for on-board diagnostic monitoring tests of specific components / systems that are continuously monitored (e.g. misfire monitoring) and non-continuously monitored (e.g. catalyst system).

The request message for test values includes an On-Board Diag ostic Monitor ID, see Annex D (ISO/DIS 15031-5.3) that indicates the information requested. Unit and Scaling information is included in Annex E (ISO/DIS 15031-5.3).

The vehicle manufacturer is responsible for assigning ”Manufacturer Defined Test IDs” for different tests of a monitored system. The latest test values (results) are to be retained, even over multiple ignitions OFF cycles, until replaced by more recent test values (results). Test values (results) are requested y On-Board Diagnostic Monitor ID. Test values (results) are always reported with the Minimum and Maximum Test Limits. The Unit and Scaling ID included in the response message defines the scaling and unit to be used by the external test equipment to display the test values (results), Minimum Test Limit, and Maximum Test Limit information.

If an On-Board Diagnostic Monitor has not been completed at least once since Clear/reset emission-related diagnostic information or battery disconnect, then the parameters Test Value (Results), Minimum Test Limit, and Maximum Test Limit shall be set to zero $00) values.

Not all On-Board Diagnostic Monitor IDs are applicable or supported by all systems. On-Board Diagnostic Monitor ID $00 is a bit-encoded value that indicates for each ECU which On-Board Diagnostic Monitor IDs are supported. On-Board Diagnostic Monitor ID $00 indicates support for On-Board Diagnostic Monitor IDs from $01 to $20. On-Board Diagnostic Monitor ID $20 indicates support for On-Board Diagnostic Monitor IDs $21 through $40, etc. This is the same concept for PIDs/TIDs/InfoTypes support in services $01, $02, $06, $08, and $09. On-Board Diagnostic Monitor ID $00 is required for those ECUs that respond to a corresponding service $06 request message as specified in Annex A ISO/DIS 15031-5.3). On-Board Diagnostic Monitor ID $00 is optional for those ECUs that do not respond to additional service $06 request messages.

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The test values shows the distance to fault limit (normalized values).
0-16384 = normal deviation
16385-30720 = aged system
30721-32767 = close to faultlimit
32768-65534 = fault
65535= not active

Monitor ID	Description	Test ID	DTCs	Unit ID	Min	Max	Unit	Remarks
01	Oxygen Sensor Monitor Bank 1 - Sensor 1	80	P0132/P0131	01	0000	65535	1 per bit hex to decimal unsigned	
	Oxygen Sensor Monitor Bank 1 - Sensor 1	82	P0133	01	0000	65535	1 per bit hex to decimal unsigned	
	Oxygen Sensor Monitor Bank 1 - Sensor 1	83	P0134	01	0000	65535	1 per bit hex to decimal unsigned	
02	Oxygen Sensor Monitor Bank 1 - Sensor 2	84	P0137/P0138	01	0000	65535	1 per bit hex to decimal unsigned	
41	Oxygen Sensor Heater Monitor Bank 1 - Sensor 1	90	P0031/P0032	01	0000	65535	1 per bit hex to decimal unsigned	
42	Oxygen Sensor Heater Monitor Bank 1 - Sensor 2	91	P0037/P0038	01	0000	65535	1 per bit hex to decimal unsigned	
05	Oxygen Sensor Monitor Bank 2 - Sensor 1	80	P0051/P0052	01	0000	65535	1 per bit hex to decimal unsigned	
	Oxygen Sensor Monitor Bank 2 - Sensor 1	82	P0153	01	0000	65535	1 per bit hex to decimal unsigned	
	Oxygen Sensor Monitor Bank 2 - Sensor 1	83	P0154	01	0000	65535	1 per bit hex to decimal unsigned	

MY07
Vehicle: S80, XC90
Engine: B6324S

The test values shows the distance to fault limit (normalized values).
0-16384 = normal deviation
16385-30720 = aged system
30721-32767 = close to faultlimit
32768-65534 = fault
65535= not active

Monitor ID	Description	Test ID	DTCs	Unit ID	Min	Max	Unit	Remarks
06	Oxygen Sensor Monitor Bank 2 - Sensor 2	84	P0157/P0158	01	0000	65535	1 per bit hex to decimal unsigned	
45	Oxygen Sensor Heater Monitor Bank 2 - Sensor 1	90	P0051/P0052	01	0000	65535	1 per bit hex to decimal unsigned	
46	Oxygen Sensor Heater Monitor Bank 2- Sensor 2	91	P0057/P0058	01	0000	65535	1 per bit hex to decimal unsigned	
42	Oxygen Sensor Heater Monitor Bank 1- Sensor 2	86	P0036, P0037, P0038	01	0000	65535	1 per bit hex to decimal unsigned	
3B	EVAP Monitor (0.040”)	8B	P0455	01	0000	65535	1 per bit hex to decimal unsigned	
3C	EVAP Monitor (0.020”)	8D	P0442	01	0000	65535	1 per bit hex to decimal unsigned	
3D	Purge Flow Monitor	8E	P0458/P0459	01	0000	65535	1 per bit hex to decimal unsigned	
	Purge Flow Monitor	95	P0441	01	0000	65535	1 per bit hex to decimal unsigned	
21	Catalyst Monitor Bank 1	88	P0420	01	0000	65535	1 per bit hex to decimal unsigned	
22	Catalyst Monitor Bank 2	88	P0430	01	0000	65535	1 per bit hex to decimal unsigned	
81	Fuel System Monitor Bank 1	91	P0171/P0172	01	0000	65535	1 per bit hex to decimal unsigned	
82	Fuel System Monitor Bank 2	91	P0174/P0175	01	0000	65535	1 per bit hex to decimal unsigned	

MY07
Vehicle: S80, XC90
Engine: B6324S

The test values shows the distance to fault limit (normalized values).
0-16384 = normal deviation
16385-30720 = aged system
30721-32767 = close to faultlimit
32768-65534 = fault
65535= not active

Monitor ID	Description	Test ID	DTCs	Unit ID	Min	Max	Unit	Remarks
A1	Misfire Monitor General Data	93	P0300	24	0000	65535	1 count per bit	
	Misfire Monitor General Data	94	P0300	24	0000	65535	1 count per bit	
A2	Misfire Cylinder 1 Data	0B	P0301	24	0000	65535	1 count per bit	
	Misfire Cylinder 1 Data	0C	P0301	24	0000	65535	1 count per bit	
A3	Misfire Cylinder 2 Data	0B	P0302	24	0000	65535	1 count per bit	
	Misfire Cylinder 2 Data	0C	P0302	24	0000	65535	1 count per bit	
A4	Misfire Cylinder 3 Data	0B	P0303	24	0000	65535	1 count per bit	
	Misfire Cylinder 3 Data	0C	P0303	24	0000	65535	1 count per bit	
A5	Misfire Cylinder 4 Data	0B	P0304	24	0000	65535	1 count per bit	
	Misfire Cylinder 4 Data	0C	P0304	24	0000	65535	1 count per bit	
A6	Misfire Cylinder 5 Data	0B	P0305	24	0000	65535	1 count per bit	
	Misfire Cylinder 5 Data	0C	P0305	24	0000	65535	1 count per bit	
A7	Misfire Cylinder 6 Data	0B	P0306	24	0000	65535	1 count per bit	
	Misfire Cylinder 6 Data	0C	P0306	24	0000	65535	1 count per bit	