MY04-07
Vehicle: S40, V50, C30
Engine: B5244S

Functional Description

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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.

Serial communication
ECM (Engine Control Module) communicates serially with the Diagnostic Connector .

Input signals

Component	Purpose
Brake light switch	Informs Engine Control Module (ECM) and Electronic Throttle Module (ETM) that the car is braking.
Oil pressure switch	Provides information about engine oil pressure.
A/C pressure sensor (linear)	Provides information using a linear signal about any pressure changes on the high-pressure side of the A/C system.
Front heated oxygen sensor (HO2S)	Provides information about the oxygen level in the exhaust gases upstream of the catalytic converter.
Coolant temperature sensor	Provides information about Engine Coolant Temperature (ECT).
Mass air flow (MAF) sensor (heated wire principle)	Provides information about the intake mass air flow, mainly under normal driving conditions.
Camshaft sensor (CMP)	Provides information about cylinder intake and compression phase.
Knock sensor	Provides information if the engine knocks.
Flywheel sensor	Provides information about the crankshaft position and engine speed.
Accelerator pedal (AP) sensor	Senses the accelerator pedal position. The signal is used by the ECM and the ETM.
Coolant level sensor	To indicate low level in coolant water, the switch is open when the level is low.
Manifold absolute pressure (MAP) sensor	Provides information about the engine load at rapid load changes.
Rear heated oxygen sensor (HO2S)	Provides information about the oxygen level downstream of the front catalytic
Rear heated oxygen sensor (HO2S) SULEV only	Provides information about the oxygen level downstream of the front catalytic converter rear section.
Fuel pressure and temperature sensor	Provides information about the Fuel pressure and fuel temperature in the fuel rail.
Ambient temperature sensor	Provides information about ambient air temperature.
Diagnostic connector	Reading out fault codes.
Ignition coil	Provides information about an open circuit/loose connection in the respective ignition coil secondary cable via a parallel cable to the Engine Control Module (ECM).
CAN communication	Exchange of information between the Engine Control Module (ECM) and the following units: Brake Control Module (BCM), Transmission Control Modul (TCM), Can and Driver information Module (CDM), Electronic Throttle Module (ETM) and Diagnostic Connector .

Output signals

Component	Purpose
Air conditioning (A/C) relay	Connecting and disconnecting A/C compressor.
Fuel pump relay	Activation and deactivation of fuel pump.
System relay	Controlled by the Engine Control Module (ECM) provides engine sensors and functions with voltage supply.
Electronic Climate Control (ECC), Manuel Climate Control (MCC)	Signals engine coolant temperature to climate control system which can then determine how the blower fan should be controlled after cold start (through CAN).
Transmission Control Module (TCM)	Receiving signals (through CAN) from Engine Control Module (ECM). Only for automatic transmission.
Electronic Throttle Module (ETM)	Sends signals (through CAN) between Engine Control Module (ECM) and the Electronic Throttle Module (ETM).
Electric Fan Control Module (EFCM)	To control the fan speed electronically.
Instrument panel	Gives information to the driver.
Fuel injector (1-5)	Preparation and injection of fuel on a multipoint engine (one injector / cylinder).
EVAP Purge valve	To control the purge flow from the canister to the engine.
Ignition coil (1-5)	To create spark tension to the spark plugs out of a control signal from the ECM.
Malfunction indicator lamp (MIL) Engine symbol	The lamp lights up for faults affecting the emissions. The lamp flashes for misfires which cause risk of damage to the catalytic converter. Can also light up when requested by the Transmission Control Module (TCM) and the Electronic Throttle Module (ETM).
VVT Control valve exhaust	Is used to control the Exhaust VVT valve for VVT Timing.
VVT Control valve intake	Is used to control the Intake VVT valve for VVT Timing.
Spark plugs	Transfers the high-tension ignition voltage generated within the coil into the combustion chamber.
Battery	Provides the system with voltage supply.
E-box Fan	Provides the e-box with cool air.

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

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 oxidised 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. 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 detoriates 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	03
Monitor Strategy description	High air flow monitoring	

Typical catalytic converter diagnostic enable conditions		
Enable condition	*Minimum*	*Maximum*
Ambient pressure	690 hPa	
Vehicle speed	0 km/h	255 km/h
Catalyst temperature	500°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)	> 11.25

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 five periods, (on a 5 – cylinder engine), if the engine has no external load all five periods should be equal. This is to even out the signal, so that a mechanical fault in the flywheel is not registered as misfiring. After adaptation there is some interference 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.

DTC is stored for misfiring which leads to increased emissions and diagnostic trouble code is stored for misfiring which could cause damage to the TWC. The engine control module registers and stores the engine speed and load range in which the misfiring occurred. The MIL lights if misfiring occurs again within the same engine speed and load range. If misfiring ceases, the engine must go through this entire engine speed and load range without a misfire before the engine control module starts counting down to put out the MIL and erase the misfire codes.

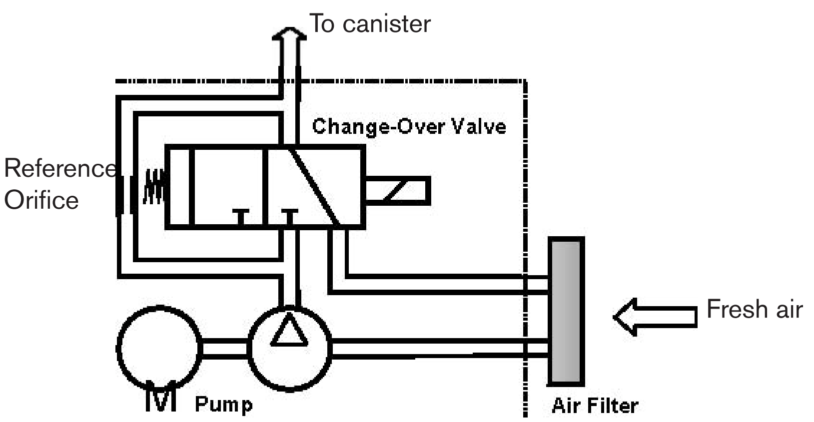
Misfire Diagnostic Operation			Corresponding MonitorID
DTCs	P0300 P0301 P0302 P0303 P0304 P0305	Multiple Cylinder Misfire Detected Cylinder 1 Misfire Detected Cylinder 2 Misfire Detected Cylinder 3 Misfire Detected Cylinder 4 Misfire Detected Cylinder 5 Misfire Detected	A1 A2 A3 A4 A5 A6
Monitor Strategy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

Typical Misfire diagnostic enable conditions		
Enable condition	*Minimum*	*Maximum*
Load	0.18 g/rev	0.43 g/rev
Engine speed	500 rpm	6500 rpm
Coolant temperature	-20°C	

Typical Misfire malfunction thresholds	
Malfunction criteria	*Threshold value*
FTP Emission threshold	> 1 % (4th exceedance or exceedance in first 1000 revolutions)
Catalyst damage threshold	> 7-33 %

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 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 diagnostic trouble code (DTC) for the component identified is stored.

Diagnosis is carried out in the following stages:
While fuel level sensors are working correctly and the fuel level is higher than 85 % all leakage tests and healing attempts are aborted. While the fuel level sensors are not working correctly, 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 when the fuel level sensor are not working correctly the attempt 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. This level is calibrated to approximate 70 %.

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.

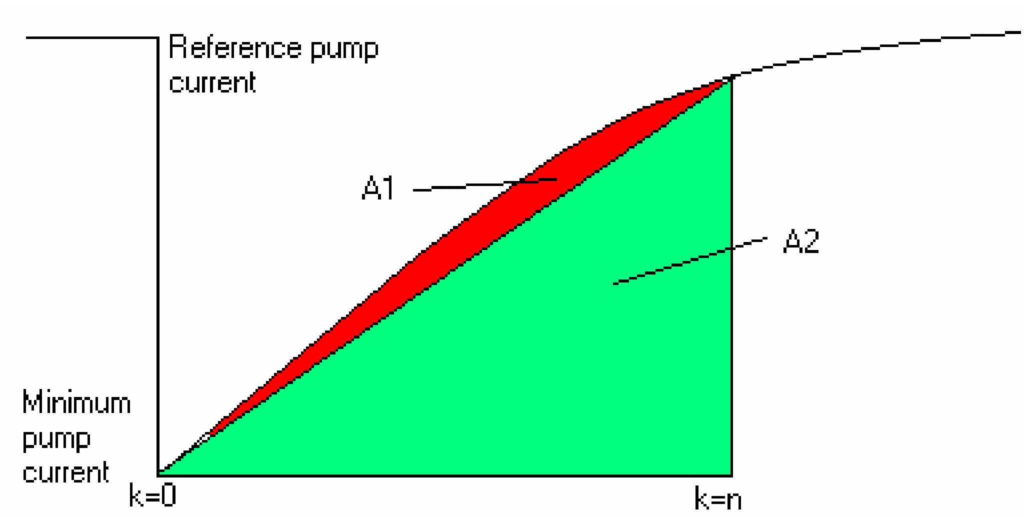
The rough leak check (≥ 0.04-inch) is performed by monitoring the pump motor current gradient. Relative pump motor current is created by using minimum pump motor current and reference pump motor current. Area ratio is created by dividing integrated relative current with ideal area, which is the linear 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*,

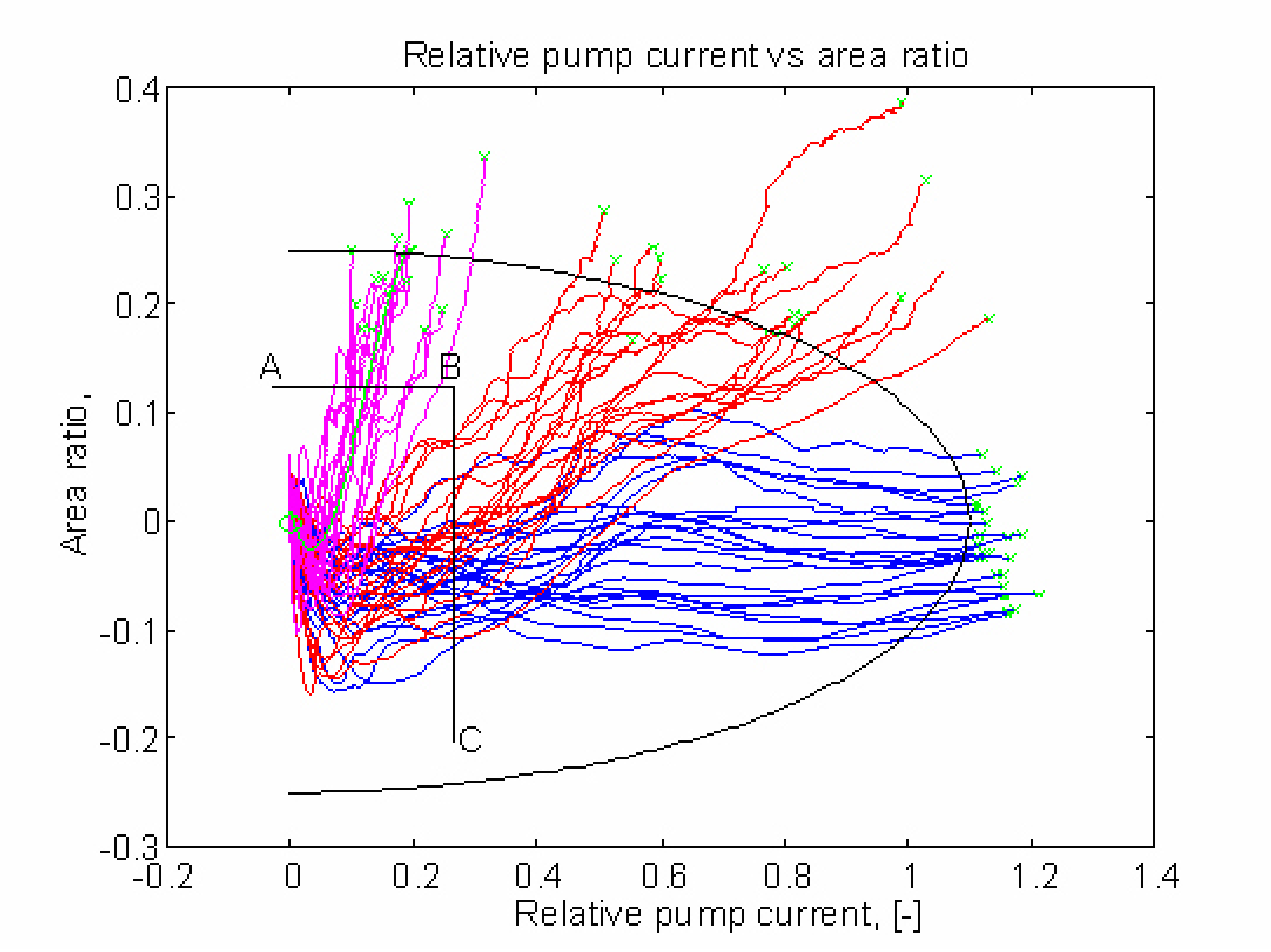
$Aideal = A2$.

See figure below.



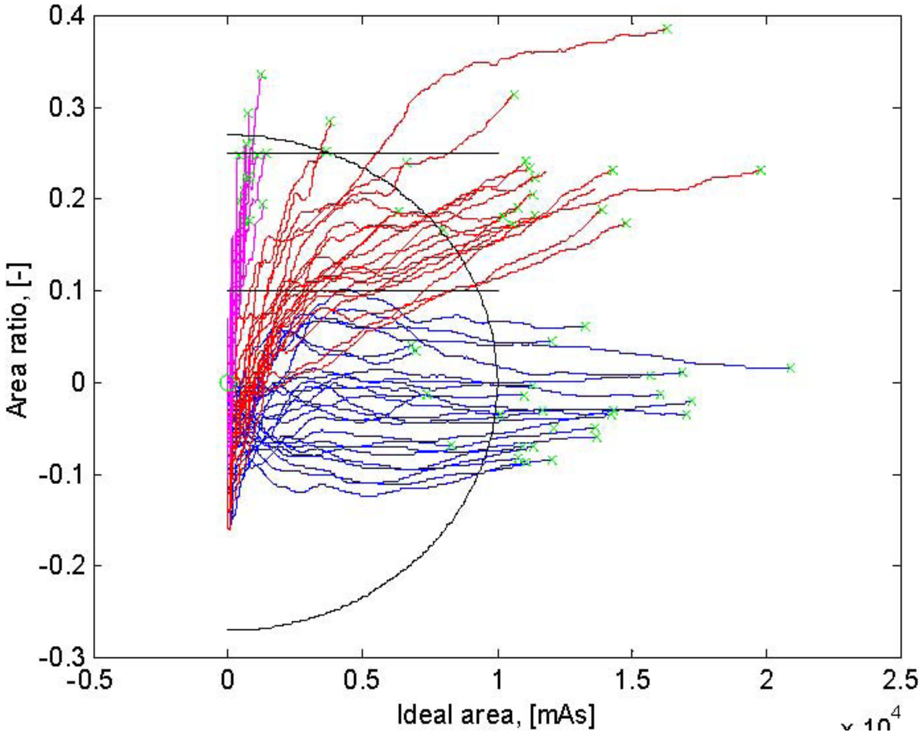
3. Small leak test phase
If the conditions for a small leak check (≥0.02-inch) are set the pump motor remains on in monitoring mode until an elliptic combination of the relation pump current and area ratio are fulfilled, or a maximum time limit has been reached.

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.



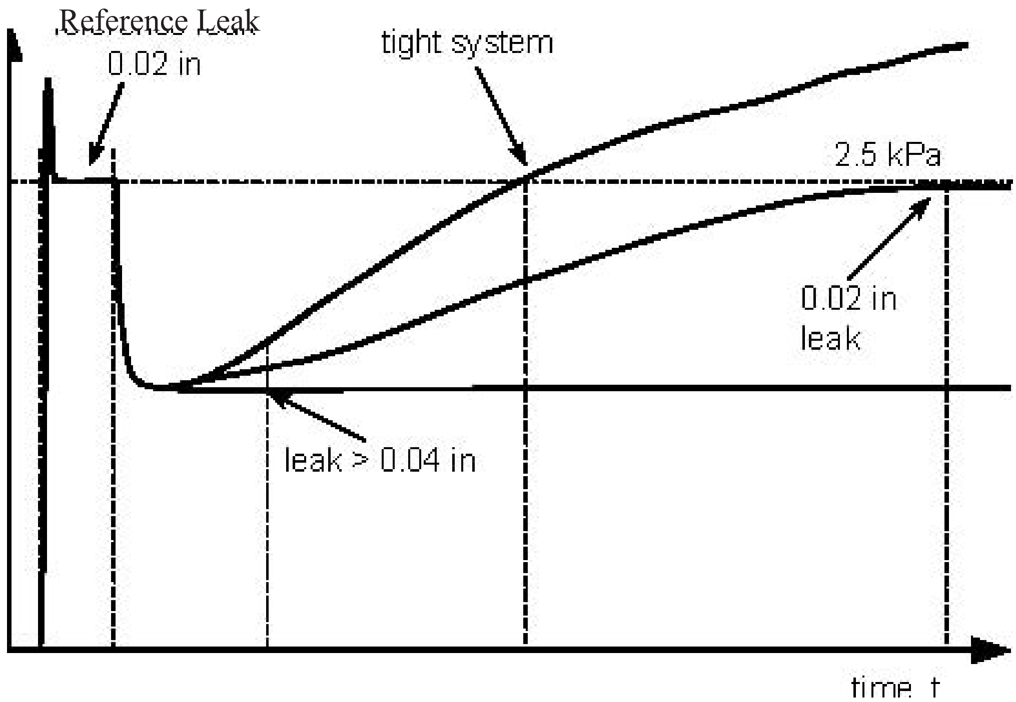
Results from simulation using old measurements and creating the area ratio and relative pump current and plot them versus each other.

Blue curves correlates to no leakage, red curves to 0,5 mm leakage and the magenta to 1,0 mm leakage.



Results from simulation using old measurements and plotting the area ratio vs. the ideal area.

Blue curves correlates to no leakage, red curves to 0,5 mm leakage and the magenta to 1,0 mm leakage.



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 afterrun.

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	3.8°C	35°C
Battery voltage	11.0 V	15.0 V

Typical Leakage malfunction thresholds	
Malfunction criteria	*Threshold value*
Reference current above limit	36.0 mA
for specified time	10.05 s
Reference measurement could not be performed within specified TIME even though running conditions were satisfied	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 trim Adaption	*Monitor Strategy description*	
	P0171 P0172	System too Lean System too Rich	81

Typical Fuel System diagnosis enable conditions		
Enable condition	*Minimum*	*Maximum*
Time after start.	20 s	
Engine speed	700 rpm	

Typical Fuel System diagnosis malfunction thresholds	
Malfunction criteria	*Threshold value*
Long term fuel trim (P0171)	> 1.23 for 2.0 s
Long term fuel trim (P0172)	< 0.78 for 2.0 s

Heated oxygen sensors diagnostic

A car with EMS system that meets ULEV2/EURO4 legal demands is fitted with two heated oxygen sensor. The upper sensor is fitted before the TWC (tree way catalyst) and the second in the middle of the TWC. The upper sensor is linear type and the second is a binary type.

There is also a system that meets SULEV legal demands, with three heated oxygen sensors. The upper sensor is fitted before the CCC (Close Coupled Catalytic). The second is situated between stone one and two in the CCC and the third just before the UFC (Under Floor Catalytic). The upper sensor is linear type, the second and the third is binarytype.
The upper (first) sensor have the following monitoring:

- Slow activation (DTC P0133). The impedance in the element is checked and must drop below a calibrated value a short time after start to check that the sensor gets activated fast enough. Continues monitoring.
- Slow response (DTC P0133). 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 (DTC P0031, P0032). The sensor heater is continuously monitored. Fault will be detected if circuit is: Open, short to ground or short to battery.
- Sensor circuit (DTC 131, 132). The sensor circuit is continuously monitored. Fault will be detected if sensor circuit is: Open, short to ground or short to battery.

The second sensor have the following monitoring:

- Sensor circuit (DTC P0137, P0138). The sensor working range is checked to detect if sensor have a problem to work in its normal voltage range. Sensor must be able to work in catalyst monitoring area to be judged as normal. Function also monitor if sensor is stuck in range. Continues monitoring.
- Heater circuit (ULEV has DTC P0036- P0038 and SULEV has DTC P0042- P0044). The sensor heater is continuously monitored. Fault will be detected if circuit is: Open, short to ground or short to battery.

The third sensor (SULEV only) have the following monitoring:

- Sensor circuit (DTC P0143, P0144). The sensor working range is checked to detect if sensor have a problem to work in its normal voltage range. Sensor must be able to work in catalyst monitoring area to be judged as normal. Function also monitor if sensor is stuck in range. Continues monitoring.
- Heater circuit (DTC P0042-P0044). The sensor heater is continuously monitored. Fault will be detected if circuit is: Open, short to ground or short to battery.

Heated Oxygen Sensor Operation			Corresponding MonitorID
DTCs	HO2S Heater Control Circuit	*Monitor Strategy description*	
	P0031 P0032	Low High	41
	O2 Circuit Slow Response, P0133	UHEGO Slow activation	

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	20 s	60 s

Typical Heated Oxygen Sensor malfunction thresholds	
Malfunction criteria	*Threshold value*
O2 Sensor Heater fault flag.	Set for 5.12 s 1 time
Element impedance too high	≥ 95 Ω during 10 s

MY04-MY07
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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	82	P0133	01	0000	65535	1 per bit hex to decimal unsigned	
02	Oxygen Sensor Monitor Bank 1 - Sensor 2	81	P0138/P0139	01	0000	65535	1 per bit hex to decimal unsigned	
		80	P0137	01	0000	65535	1 per bit hex to decimal unsigned	
03	Oxygen Sensor Monitor Bank 1 - Sensor 3	81	P0143/P0144	01	0000	65535	1 per bit hex to decimal unsigned	PZEV only*
		80	P0142	01	0000	65535	1 per bit hex to decimal unsigned	
21	Catalyst Monitor Bank 1	83	P0420	01	0000	65535	1 per bit hex to decimal unsigned	
3B	EVAP Monitor	84	P0441	01	0000	65535	1 per bit hex to decimal unsigned	

* PZEV: Partial Zero Emissions Vehicle

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0-16384 = normal deviation
16385-30720 = aged system
30721-32767 = close to faultlimit
32768-65534 = fault
65535= not active

Monitor ID	Description	Test ID	PCode	Unit ID	Min	Max	Unit	Remarks
3C	EVAP Monitor (0.020")	84	P0455 / P0442	01	0000	65535	1 per bit hex to decimal unsigned	
3D	Purge Flow Monitor	85	P0496 / P0497					
41	Oxygen Sensor Heater Monitor Bank 1 - Sensor 1	86	P0031-P0032	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	
43	Oxygen Sensor Heater Monitor Bank 1 - Sensor 3	86	P0042, P0043, P0044	01	0000	65535	1 per bit hex to decimal unsigned	PZEV only*
81	Fuel System Monitor Bank 1	87	P0171 / P0174	01	0000	65535	1 per bit hex to decimal unsigned	

* PZEV: Partial Zero Emissions Vehicle

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The test values shows the distance to fault limit (normalized values).
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16385-30720 = aged system
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32768-65534 = fault
65535= not active

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

* PZEV: Partial Zero Emissions Vehicle