Secondary Air Injection System Monitoring Operation								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Secondary Air Injection Pump Relay	P0418	circuit continuity - short to battery positive circuit continuity - short to ground circuit continuity - open circuit	voltage - drive on voltage - drive off voltage - drive off	voltage > 1/2 * Battery positive voltage < 1/3 * Battery positive 1/3 * Battery positive< voltage < 2/3 * Battery positive	engine speed battery voltage	> 80 rpm 7.5V < B+ < 17V	immediately/ continuous	two driving cycles
Secondary Air Injection Valve Vacuum Solenoid Drive	P0412 P0414 P0413	circuit continuity - short to battery positive circuit continuity - short to ground circuit continuity - open circuit	voltage - drive on voltage - drive off voltage - drive off	voltage > 1/2 * Battery positive voltage < 1/3 * Battery positive 1/3 * B+ < voltage < 2/3 * Battery positive	engine speed battery voltage	> 80 rpm 7.5V < B+ < 17V	immediately/ continuous	two driving cycles
Secondary Air Injection System (Passive Test) Bank 1 Bank 2	 P1412 P1415	the front O2S voltage Minimum value is sampled over a time of 0.100 sec .If this value is greater than a threshold, then the system is ok	system is OK if:- bank 1 O2S Value and bank 2 O2S Value	< 0.501 V (for > 55 times in 80 Samples) < 0.399 V (for > 55 times in 80 samples)	engine speed engine load engine airflow ECT front O2S secondary air time after engine start altitude factor	520 < rpm < 2520 1.5 < TL ms < 4.0 < 55.56 g/sec > 8 °C ready for operation for > 10.0 sec operating < 655 sec > 0.711	14 sec/ once per driving cycle	two driving cycles
Secondary Air Injection System		valve check:- run the secondary air	change in fuelling correction	ó 0.05	vehicle speed engine state secondary air	= 0 mph Idle not operating, but	10.5 sec/ once per driving cycle	two driving cycles

Secondary Air Injection System Monitoring Operation

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
(Active Test) Bank 1 Bank 2 Bank 1 Bank 2	 P1413 P1416 P1414 P1417	injection pump with the control valves shut and monitor the Fuelling Correction flow check:- if the valve check is successful, continue running the pump, but with the valves open and monitor the Fuelling correction.	 change in fuelling correction	 < 0.08	injection fuel system status passive secondary air diagnostic altitude factor time after engine start purge status active test counter	has operated this drive cycle Closed loop not completed > 0.711 > 580 sec ramped to zero & wait 3.0 sec > 0		

If the above table does not include details of the following enabling conditions: - IAT, ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.

4.4 Evaporative Emission System Monitoring – 0.040” (1.0mm) Diameter

4.4.1 Description

The evaporative emission system monitoring permits the detection of leaks in the fuel evaporative emission control system with a diameter of 0.040” or larger.

For this purpose, a system pressure check is performed at idle with the vehicle stationary. Since vapour generation in the fuel tank could cause the false detection of a system leak, the first step is to close the EVAP canister purge valve and EVAP canister vent solenoid valve. Any pressure build-up is then measured, so that later results can be compensated for this fuel evaporation effect.

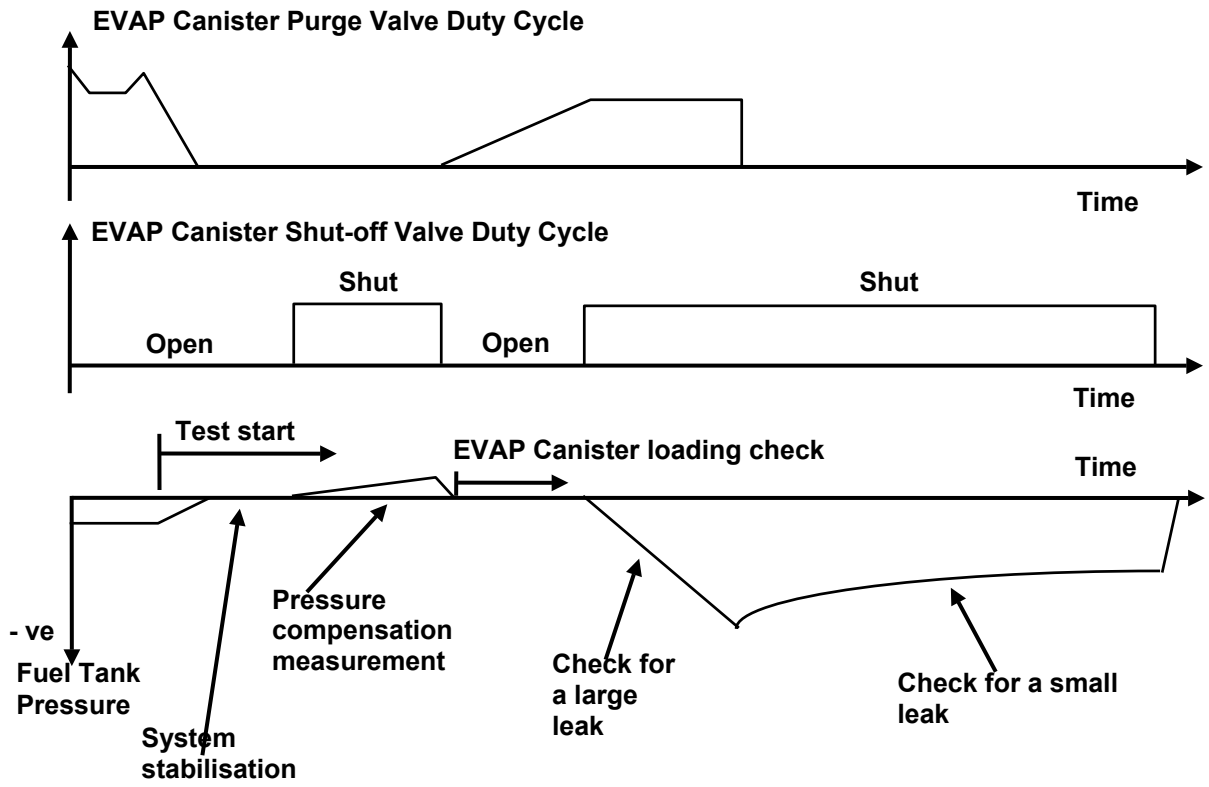
The EVAP canister purge valve is opened and the EVAP canister vent solenoid valve is closed. With this procedure a vacuum in the tank is created, which is measured by the fuel tank pressure sensor.

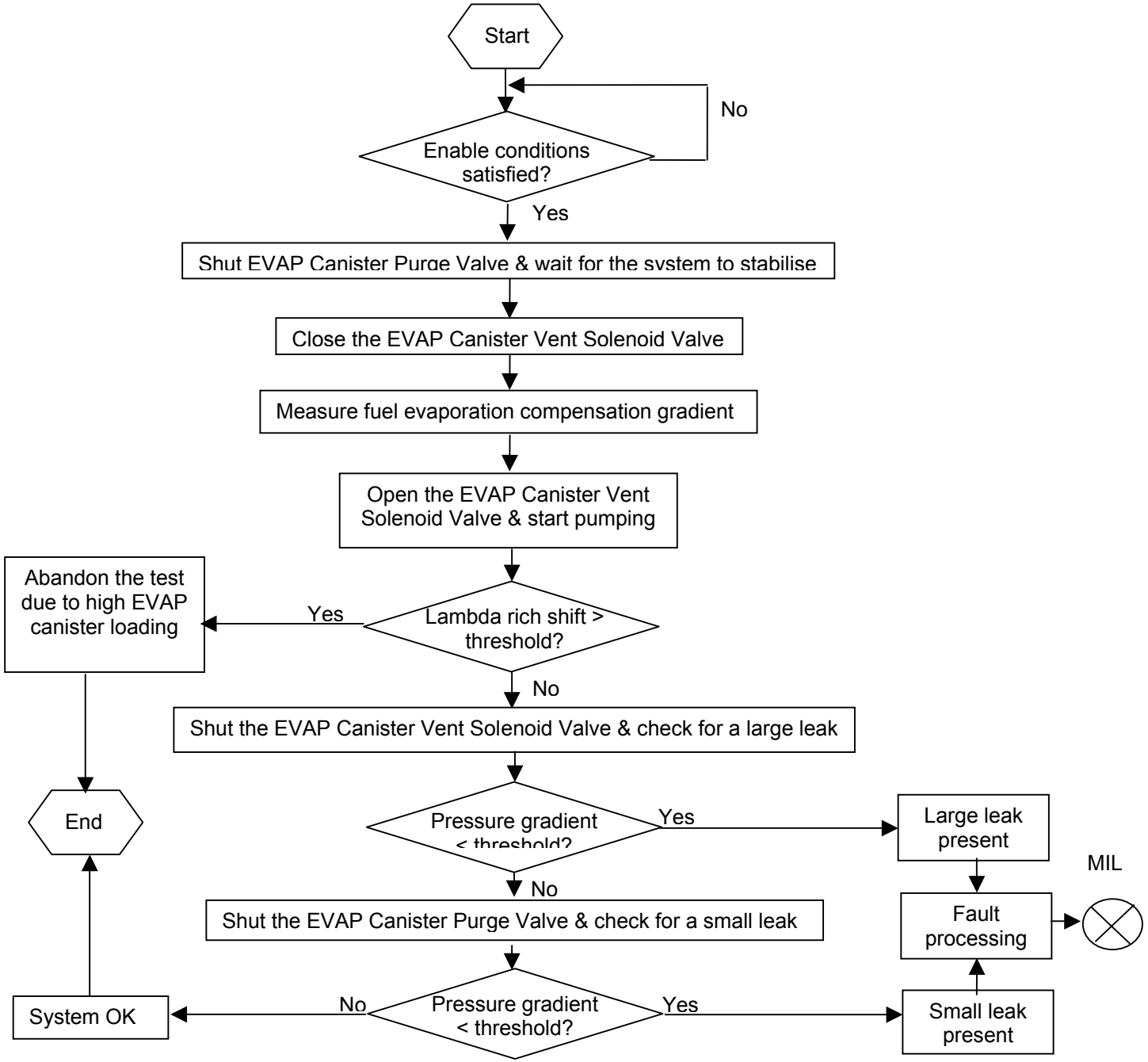
If no vacuum is detected, a large leak is assumed and the diagnosis is halted. If a large lean correction of the oxygen sensor controller is detected during the vacuum build-up, then the check is also halted, since fuel vapour is present in the system due to a high EVAP canister loading and idle instability will occur if the test is continued.

At a pre-determined vacuum the EVAP canister purge valve is closed, and the system is now considered "closed". From the gradient of the vacuum decay and the previously measured fuel vapour generation pressure rise, the presence of a leak can be inferred. The decay of the vacuum gradient also depends on the fuel level in the tank. The fuel level is roughly derived from the gradients of the vacuum build-up and vacuum decay and this information is also used when determining if a leak is present.

4.4.2 Monitoring Structure

Typical fuel tank pressure characteristic during the diagnostic test




Start
No
Enable conditions satisfied?
Yes
Shut EVAP Canister Purge Valve & wait for the system to stabilise
Close the EVAP Canister Vent Solenoid Valve
Measure fuel evaporation compensation gradient
Open the EVAP Canister Vent Solenoid Valve & start pumping
Abandon the test due to high EVAP canister loading
Yes
Lambda rich shift > threshold?
No
Shut the EVAP Canister Vent Solenoid Valve & check for a large leak
End
Pressure gradient < threshold?
Yes
Large leak present
MIL
No
Shut the EVAP Canister Purge Valve & check for a small leak
Fault processing
System OK
No
Pressure gradient < threshold?
Yes
Small leak present

Evaporative Emission System Monitoring – 0.040" (1.0mm) Diameter								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Evaporative Emission Canister Purge Valve	P0443	Circuit continuity - short to battery positive	voltage - drive on	voltage > 1/ 2 * Battery positive	engine speed battery voltage	> 80 rpm 7.5V < Battery positive < 17V	immediately/ continuous	two driving cycles
	P0445	Circuit continuity - short to ground	voltage - drive off	voltage < 1/3 * Battery positive				
	P0444	circuit continuity - open circuit	voltage - drive off	1/3 * B+ < voltage < 2/3 * Battery positive				
	P0440	Functional check – valve open or Leaking	fuel tank pressure during pressure compensation measurement for the EVAP Purge system check	< - 1.464 hPa	see evaporative emission system purge check		up to 24.5 sec/once per driving cycle	two driving cycles
			fuel tank pressure at the end of the large system leak test	< - 15.62 hPa			up to 36.5 sec/once per driving cycle	
Evaporative Emission Purge System	P0455	vacuum check uses the EVAP canister vent solenoid valve & the fuel tank pressure sensor	large system leak (e.g. missing filler cap)	vacuum build up gradient < 0.305 hPa/sec	EVAP canister purge vapour factor fuel tank pressure lambda control engine state battery voltage vehicle speed altitude factor intake air temperature engine load fuel tank level	< 5.0 Ò 15.13 hPa active idle Ó11.0V Zero Ó0.73 Ó-12.0 °C Ò2.80 msec not empty	up to 36.5 sec/once per driving cycle	two driving cycles
	P0442		small system leak (Ó1mm)	vacuum decay grad. - (pressure comp. grad. * comp. factor) > Threshold			up to 41.5 sec/once per driving cycle	

Evaporative Emission System Monitoring – 0.040" (1.0mm) Diameter								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
					engine air flow rate ECT at engine start time after engine start transfer gears	Ò40.0 kg/hr -12.0 °C < start temp. < 65.25 °C > 960 sec high range		
Evaporative Emission Canister Vent Solenoid Valve	P0449	circuit continuity - short to battery positive	voltage - drive on	voltage > 1/2 * Battery positive	engine speed battery voltage	> 80 rpm 7.5V < Battery positive < 17V	immediately/ continuous	two driving cycles
	P0448	circuit continuity - short to ground	voltage - drive off	voltage < 1/3 * Battery positive				
	P0447	circuit continuity - open circuit	voltage - drive off	1/3* Battery positive < voltage < 2/3* Battery positive				
	P0446	functional check for a blocked EVAP canister vent solenoid valve	fuel tank pressure too low during large system leak test	tank pressure < - 1.464 hPa	see evaporative emission purge system check		up to 36.5 sec/once per driving cycle	
			fuel tank pressure too low during stabilisation phase of EVAP system check	tank pressure < - 14.64 hPa			20 sec/ once per driving cycle	
Fuel Tank Pressure Sensor	P0452 P0453	fuel tank pressure signal high/low	fuel tank pressure (min) fuel tank pressure (max)	< -28.30 hPa > 29.52 hPa	transfer gears	high range	5.0 sec/ continuous	two driving cycles
	P0451	sensor functional check	filtered pressure reading	Ó 15.13 hPa	transfer gears engine state ECT at engine start	high range idle Ò 35.25 °C	5.0 sec/ once per driving cycle	two driving cycles

Evaporative Emission System Monitoring – 0.040" (1.0mm) Diameter								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
					time after start time for stabilisation	Ò 20.0 sec Ó 10.0 sec		

If the above table does not include details of the following enabling conditions: - IAT, ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.

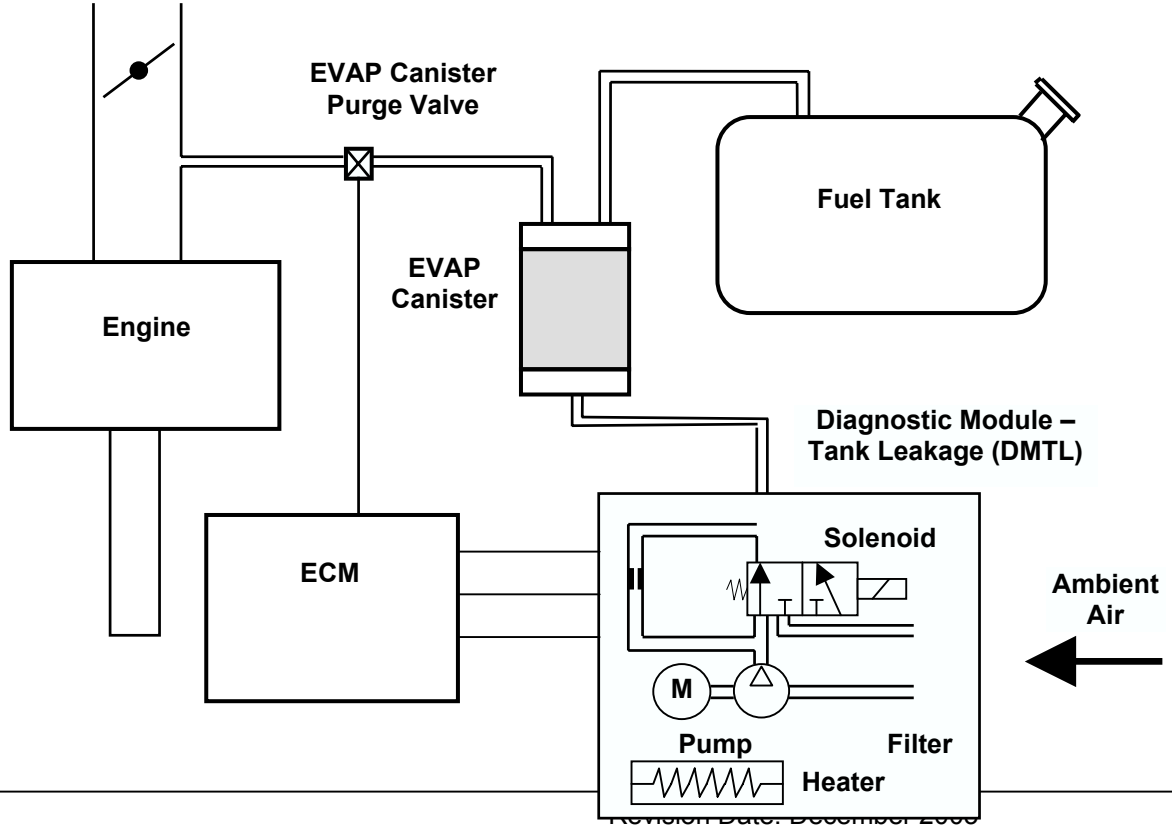
4.5 Evaporative Emission System Monitoring - 0.020” (0.5mm) Diameter

4.5.1 Description

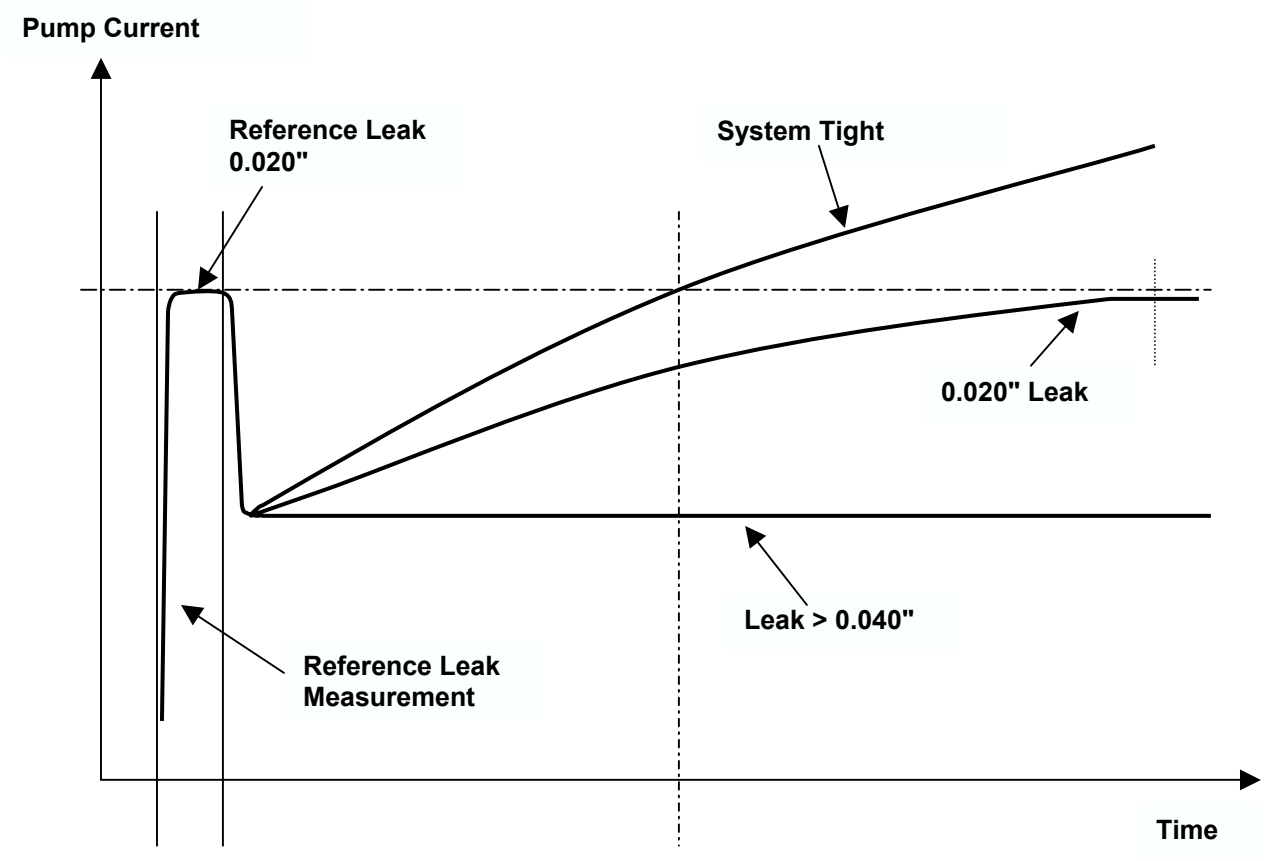
The evaporative emission monitoring system used for the Discovery 2001MY onwards permits the detection of leaks with a diameter of 0.020" or greater. This is achieved by means of a pressure test of the system. This is performed by the DMTL, which is an electrically operated pump fitted to the atmospheric air intake of the EVAP Canister. From the 2002MY this unit contains an electric heater to prevent condensate formation.

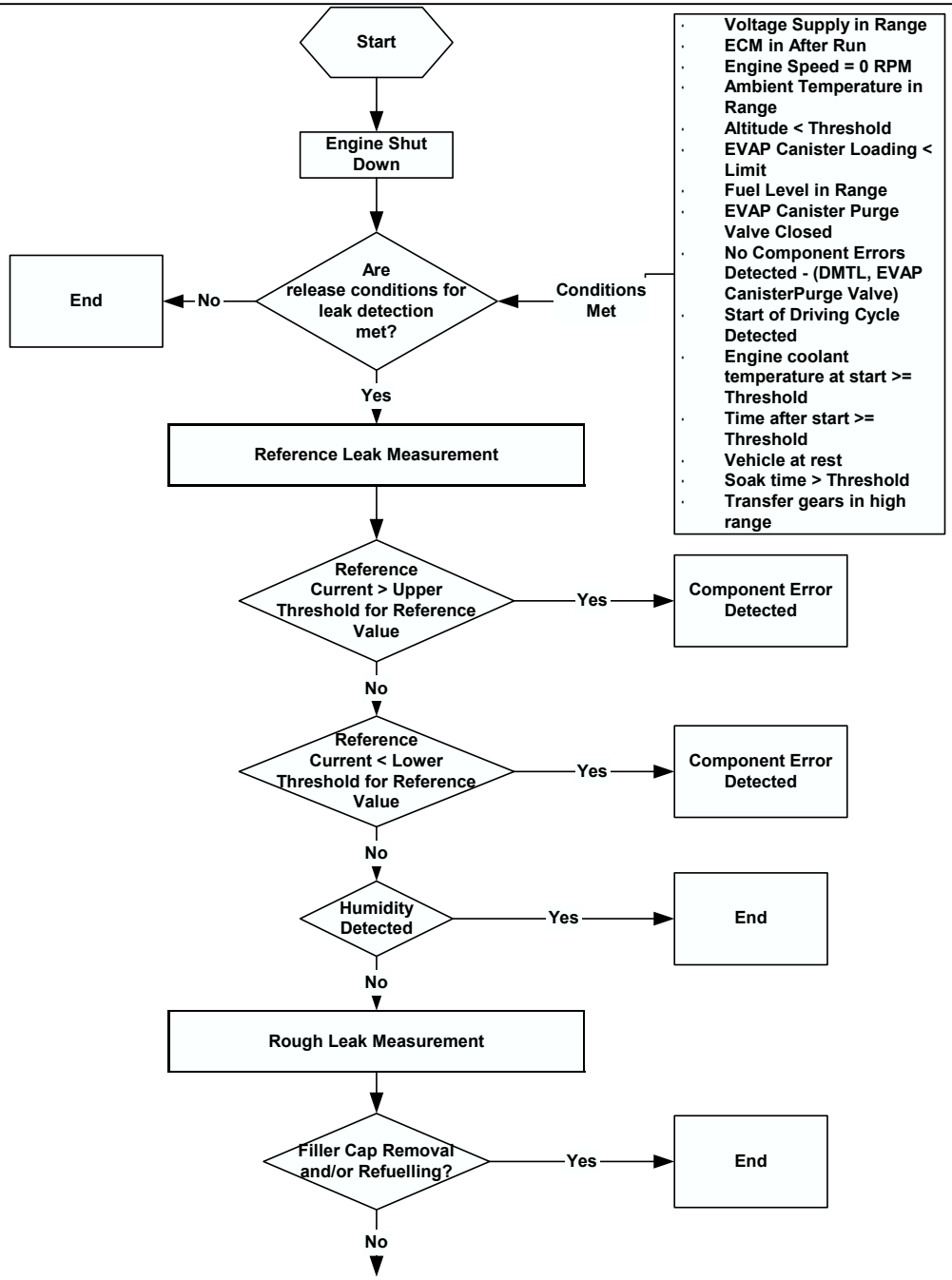
The test proceeds in 2 stages:-

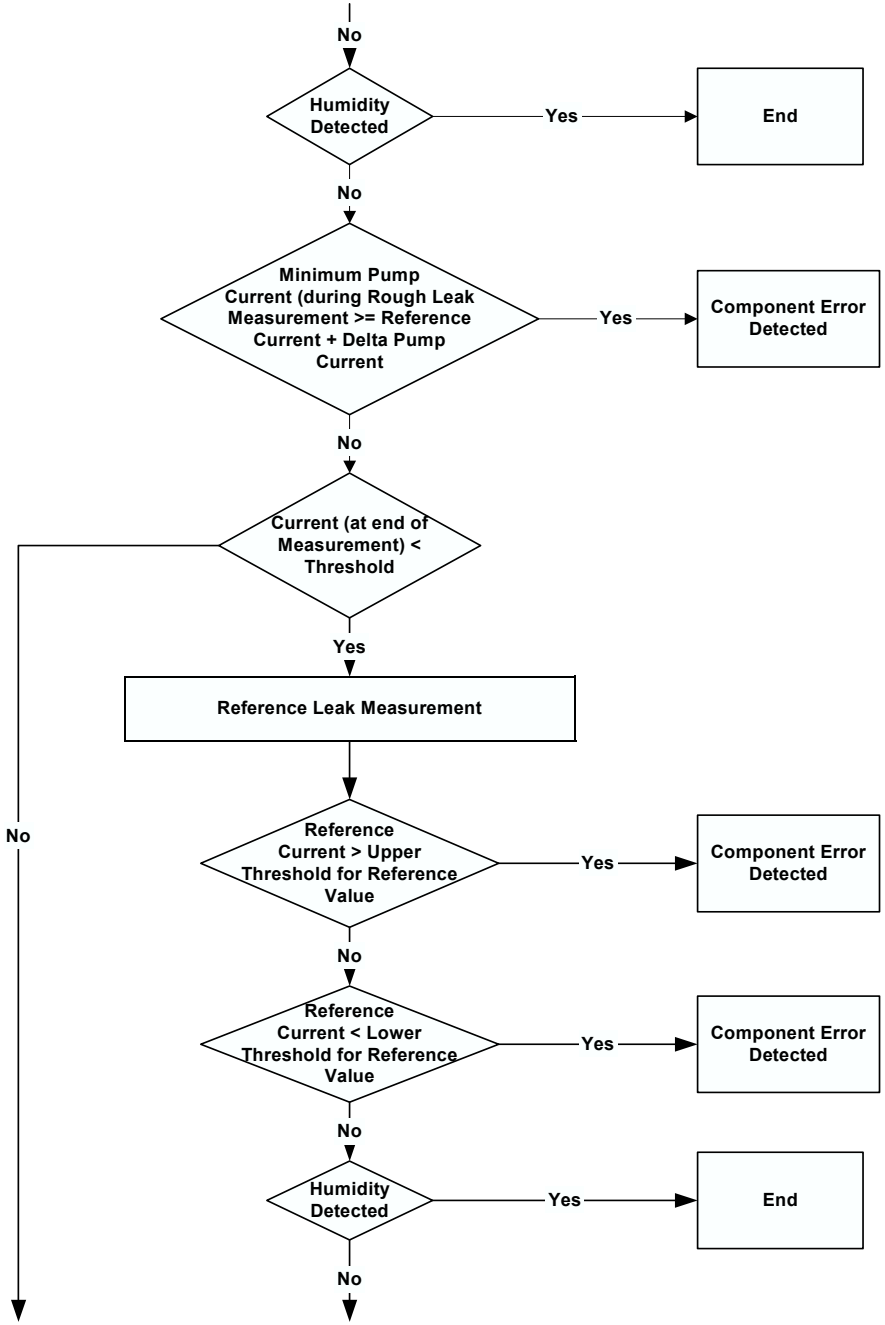
- Reference Leak Measurement - The pump operates against the reference restriction within the DMTL. The ECM measures the current consumption of the pump motor during this phase.
- Leak Measurement (see diagram below) - The solenoid in the DMTL is operated in order to shut off normal purge airflow into the EVAP Canister. The pump can now pressurise the fuel tank and vapour handling system. The ECM again measures the current consumed by the pump motor and by comparing this with the reference current, determines if a leak is present or not. A high current indicates tight system and a low current indicates a leaking system.

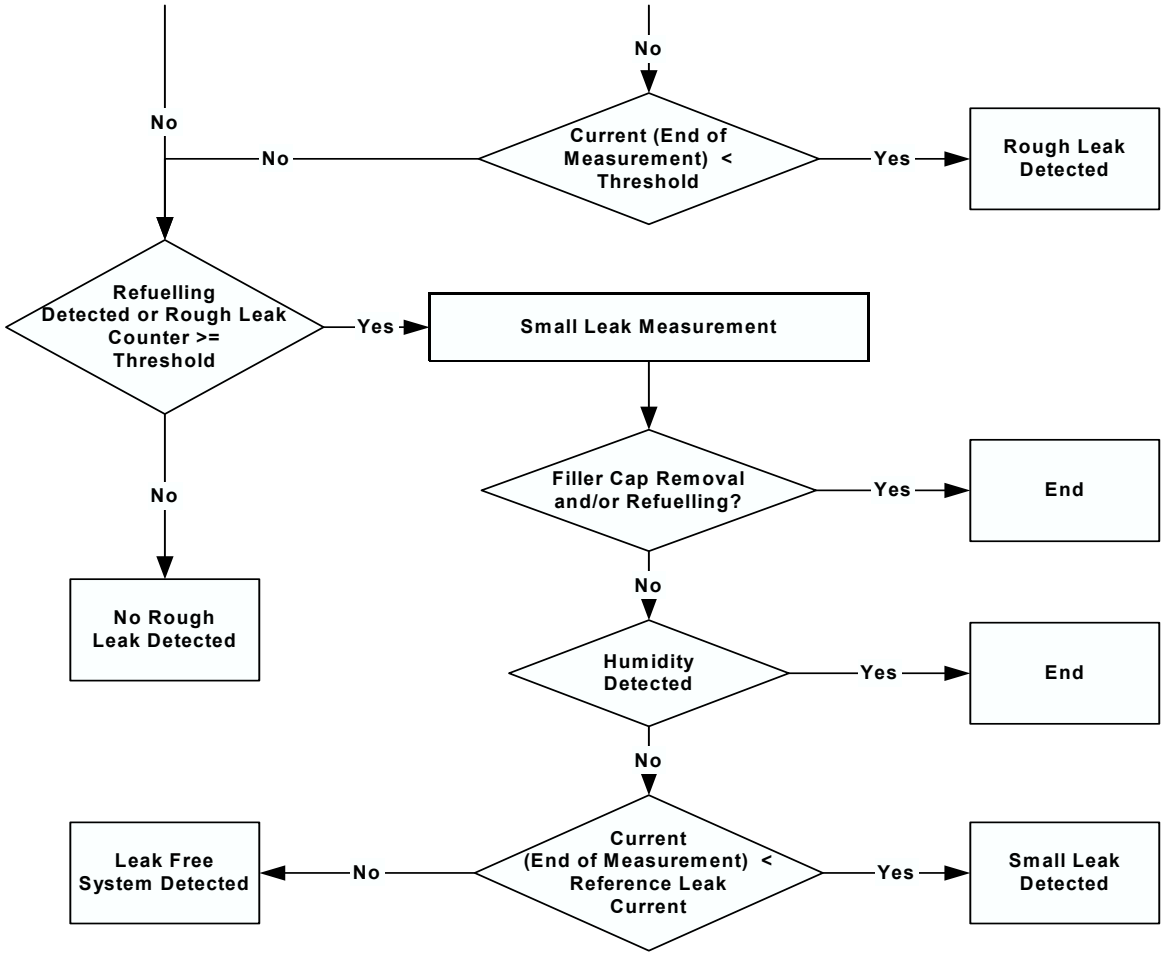


Typical Pump Current




Start
Engine Shut Down
Are release conditions for leak detection met?
No
End
Conditions Met
Voltage Supply in Range
ECM in After Run
Engine Speed = 0 RPM
Ambient Temperature in Range
Altitude < Threshold
EVAP Canister Loading < Limit
Fuel Level in Range
EVAP Canister Purge Valve Closed
No Component Errors Detected - (DMTL, EVAP CanisterPurge Valve)
Start of Driving Cycle Detected
Engine coolant temperature at start >= Threshold
Time after start >= Threshold
Vehicle at rest
Soak time > Threshold
Transfer gears in high range
Yes
Reference Leak Measurement
Reference Current > Upper Threshold for Reference Value
Yes
Component Error Detected
No
Reference Current < Lower Threshold for Reference Value
Yes
Component Error Detected
No
Humidity Detected
Yes
End
No
Rough Leak Measurement
Filler Cap Removal and/or Refuelling?
Yes
End
No


No
Humidity Detected
Yes
End
No
Minimum Pump Current (during Rough Leak Measurement >= Reference Current + Delta Pump Current
Yes
Component Error Detected
No
Current (at end of Measurement) < Threshold
Yes
Reference Leak Measurement
No
Reference Current > Upper Threshold for Reference Value
Yes
Component Error Detected
No
Reference Current < Lower Threshold for Reference Value
Yes
Component Error Detected
No
Humidity Detected
Yes
End
No


No
No
Current (End of Measurement) < Threshold
Yes
Rough Leak Detected
No
Refuelling Detected or Rough Leak Counter >= Threshold
Yes
Small Leak Measurement
Filler Cap Removal and/or Refuelling?
Yes
End
No
No Rough Leak Detected
No
Humidity Detected
Yes
End
No
Leak Free System Detected
No
Current (End of Measurement) < Reference Leak Current
Yes
Small Leak Detected

Evaporative Emission System Monitoring – 0.020" (0.5mm) Diameter								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Evaporative Emission Canister Purge Valve	P0443	circuit continuity - short to battery positive	voltage - drive on	voltage > 1/ 2 * Battery positive	engine speed battery voltage	> 80 rpm 7.5V < Battery positive < 17V	immediately/ continuous	two driving cycles
	P0445	circuit continuity - short to ground	voltage - drive off	voltage < 1/3 * Battery positive				
	P0444	circuit continuity - open circuit	voltage - drive off	1/3 * Battery positive < voltage < 2/3 * Battery positive				
Evaporative Emission Canister Purge Valve	P0441	functional check - no purge flow detected. Open EVAP canister purge valve and check for feed-back shift, if shift is within a window, check for stoichiometric purge by monitoring idle speed control. If air flow has not changed due to the purge flow then a fault exists	feedback correction factor OR AND idle air flow change	Ò 1.125 > 0.875 Ò0.17 g/sec	engine state ECT at start altitude factor engine load engine air flow vehicle speed speed fluctuation (time after start) OR (time after start & mixture adapt. & purge factor & ISC diagnostic)	Idle Ó-12.0 °C Ó0.7266 Ò2.80 msec Ò12.5 g/sec 0 mph Ò80 rpm > 1000 sec > 590 sec complete Ò3.0 complete	15 sec/ once per driving cycle	two driving cycles
Leak Detection	P1451	circuit continuity - open circuit	voltage - drive off	1/3 * Battery positive < voltage < 2/3 * Battery positive	engine speed battery voltage	> 80 rpm 7.5V < Battery	0.5 sec/ continuous	two driving cycles

Evaporative Emission System Monitoring – 0.020" (0.5mm) Diameter								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Pump Power Stage		circuit continuity - short to ground	voltage - drive off	voltage < 1/3 * Battery positive		positive <17V		
		circuit continuity - short to battery positive	voltage - drive on	> 3.998V	battery voltage	Ò15.47V (max for pump control)	0.07 sec/ continuous	
Leak Detection Pump Heater Circuit	P1483	circuit continuity - short to battery positive	voltage - drive on	voltage > 1/2 * Battery positive	engine speed battery voltage	> 80 rpm 7.5V < Battery positive< 17V	immediately/ continuous	No MIL illumination (leak detection defaults to enabled)
	P1482	circuit continuity - short to ground	voltage - drive off	voltage < 1/3 * Battery positive				
	P1481	circuit continuity - open circuit	voltage - drive off	1/3 * Battery positive < voltage < 2/3 * Battery positive				
EVAP Canister Purge System (Discovery only)		over-pressure system using an ECM driven Pump			ECM state engine state altitude factor ECT at engine start ambient temp. (calculated) EVAP canister purge vapour factor time after start vehicle speed battery voltage	In After Run for > 3.0 sec At Rest Ó0.7266 Ó2.25 °C 0.0 °C < Amb Temp < 40.0 °C < 3.0 Ó1200 sec 0 mph 10.94V < Battery positive <14.52V (for 3.0 sec)		four driving cycles
	P1452	Pump hardware Fault	pump ref. current	< 15.002 mA				
	P1453	Pump hardware Fault	pump ref. current	> 40.002 mA				
	P1450	Pump hardware Fault	pump current (during rough leak)	Ó ref current - 2.002 mA				

Evaporative Emission System Monitoring – 0.020" (0.5mm) Diameter								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
					fuel level in window transfer gears	15 % < fuel level < 85 % high range		
	P0455	rough leak Measurement	pump current at end of test stage 1 stage 2	< idle current + K1(ref. current - idle current) < ref. current + K2(ref current - idle current) K1 = 0.26 +/- 0.09 K2 = 0.52 +/- 0.13	soak time no gas cap removal (during test) no re-fuelling (during test)	Ó9000 sec change of pump current< -0.598 mA change of pump current > 0.598 mA	160 sec/ once per driving cycle	
	P0442	small leak Measurement	pump current	Òreference Current OR	re-fuelling (prior to test) rough leak counter no gas cap removal (during test) no re-fuelling (during test)	detected Ó14 change of pump current < -0.598 mA change of pump current > 0.598 mA	rough leak + 375 sec/ once per driving cycle	

If the above table does not include details of the following enabling conditions: - IAT, ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.

4.6 Fuel System Monitoring

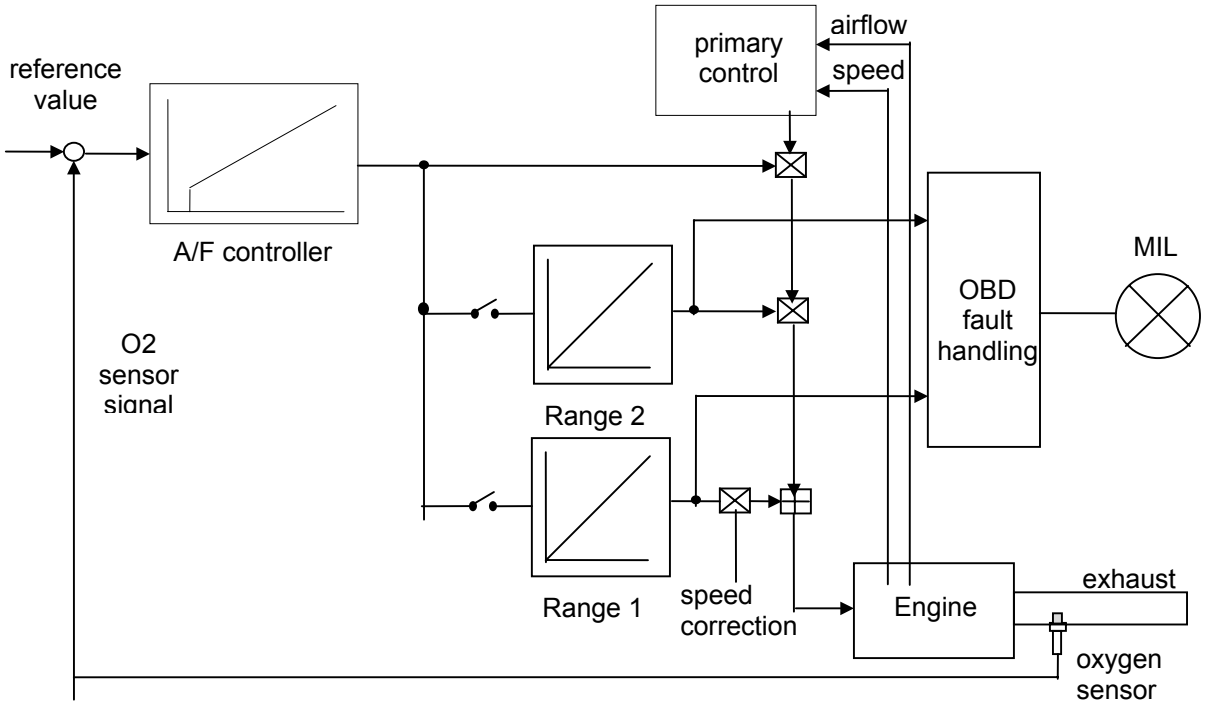
4.6.1 Description

Primary Mixture Control

The air mass taken in by the engine and the engine speed are measured. These signals are used to calculate an injection signal. This primary mixture control follows fast load and speed changes.

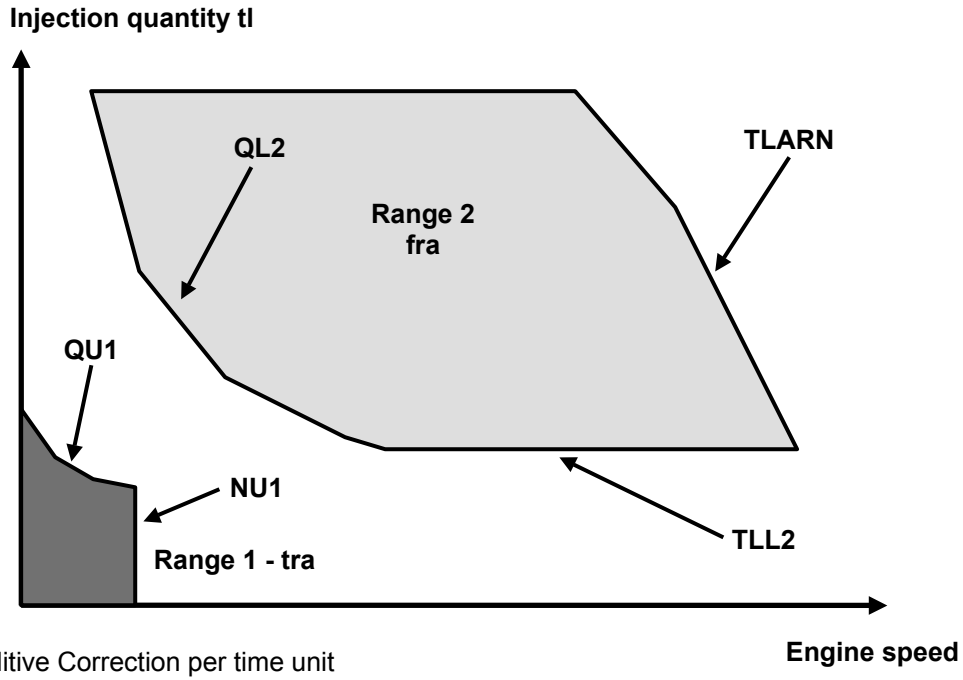
Lambda-control

The ECM compares the oxygen sensor signal upstream of the catalyst with a reference value and calculates a correction factor for the primary control.



Adaptive Control

Drifts and faults in the sensors and actuators of the fuel delivery system, as well as un-metered air leakage into the intake system influence the primary control. This causes deviations in the air to fuel ratio. The adaptive control determines the controller correction in two different ranges.



Range 1 - Additive Correction per time unit
Range 2 - Multiplicative Correction

Lambda deviations in range 1 are compensated by an additive correction value multiplied by an engine speed term. By this means an additive correction per time unit is derived.

Lambda deviations in range 2 are compensated by a multiplicative factor.

Each value is determined only within its corresponding range. But each adaptive value corrects the primary control within the whole load and speed range of the engine. After the next start, the stored adaptive values are included in the calculation of the primary fuel control; just before closed-loop fuelling control is activated.

Abbreviations for the Fuel Delivery System:

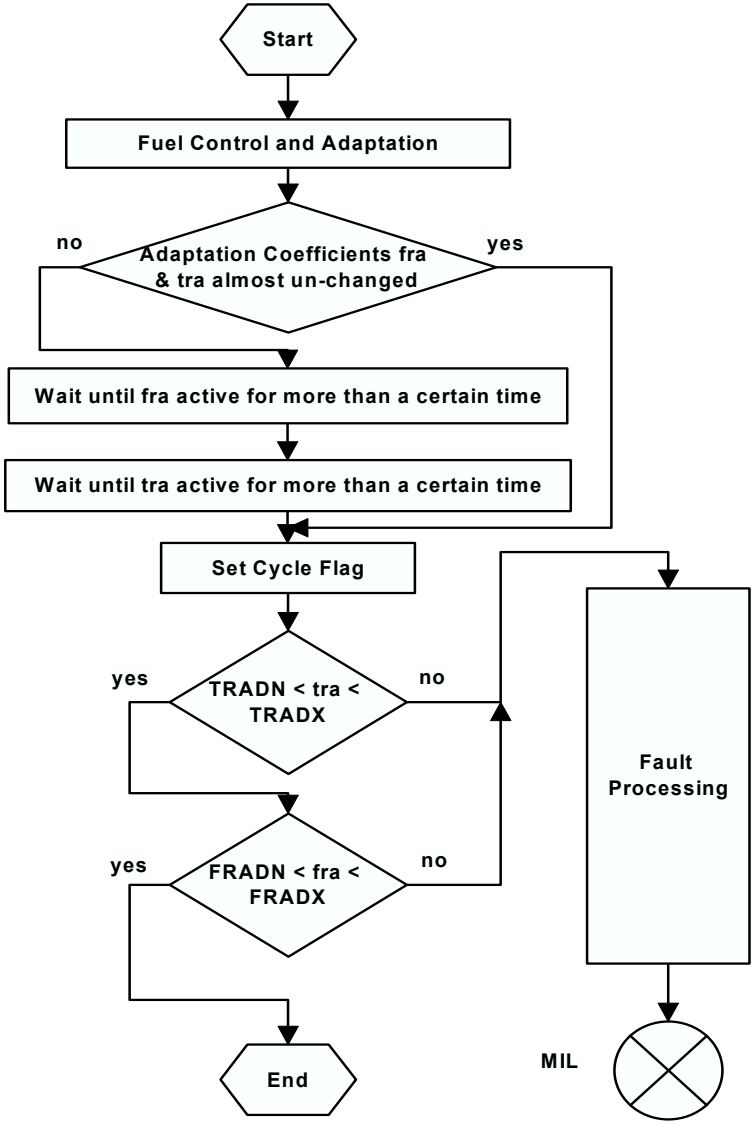
QU1 upper airflow threshold range 1
NU1 upper engine speed threshold range 1

tra additive learning correction coefficient per time unit (range 1)
TRADN lower diagnosis threshold of tra
TRADX upper diagnosis threshold of tra
TLARN upper engine load threshold f(n), range 2
QL2 lower airflow threshold range 2
TLL2 lower engine load threshold range 2
fra multiplicative learning correction coefficient (range 2)
FRADN lower diagnosis threshold of fra
FRADX upper diagnosis threshold of fra

Diagnosis of Fuel Delivery System

Faults in the fuel delivery system can occur which cannot be compensated for by the adaptive control. In this case the adaptive values leave a predetermined range. If the adaptive value is outside this predetermined range, and then if the condition is again present on a subsequent drive cycle, the MIL is illuminated and the appropriate diagnostic trouble codes are stored.

4.6.2 Monitoring Structure



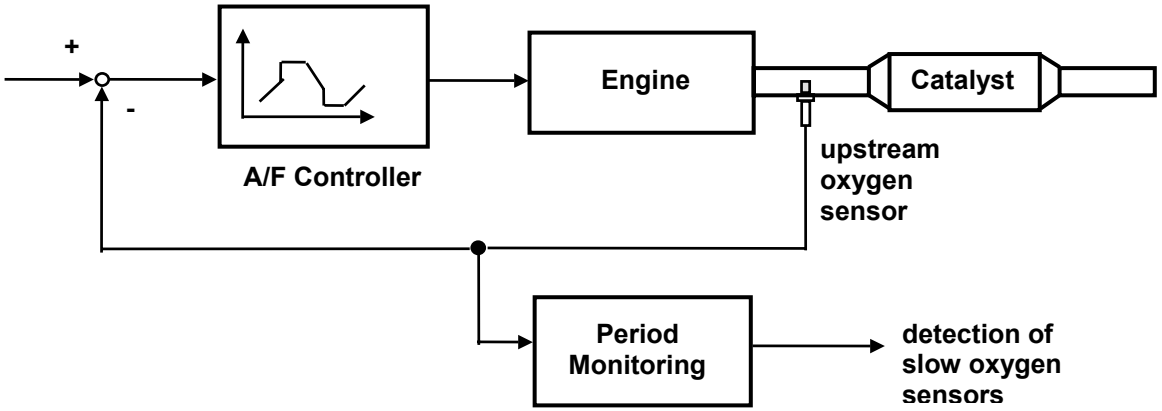
Fuel System Monitoring								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Fuel System		fuel trim limits exceeded			fuel system status ECT IAT transfer gears purge diagnosis	closed loop+part load > 80.25 °C Ò 69.75 °C high range not active		two driving cycles
	P0171/2 P0174/5	bank 1 lean/rich bank 2 lean/rich	fra value (multiplicative correction) outside limit	> ± 22.7 %	engine speed engine load engine airflow rate	< 3800 rpm 2.0 < TL ms < 10.0 > 16.67 g/sec	10.0 sec	
	P1171/2 P1174/5	bank 1 lean/rich bank 2 lean/rich	tra value (additive correction) outside limit	> ± 0.452 ms /engine rev	engine speed engine airflow rate	< 960 rpm < 8.33 g/sec	8.0 sec	

If the above table does not include details of the following enabling conditions: - IAT, ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.

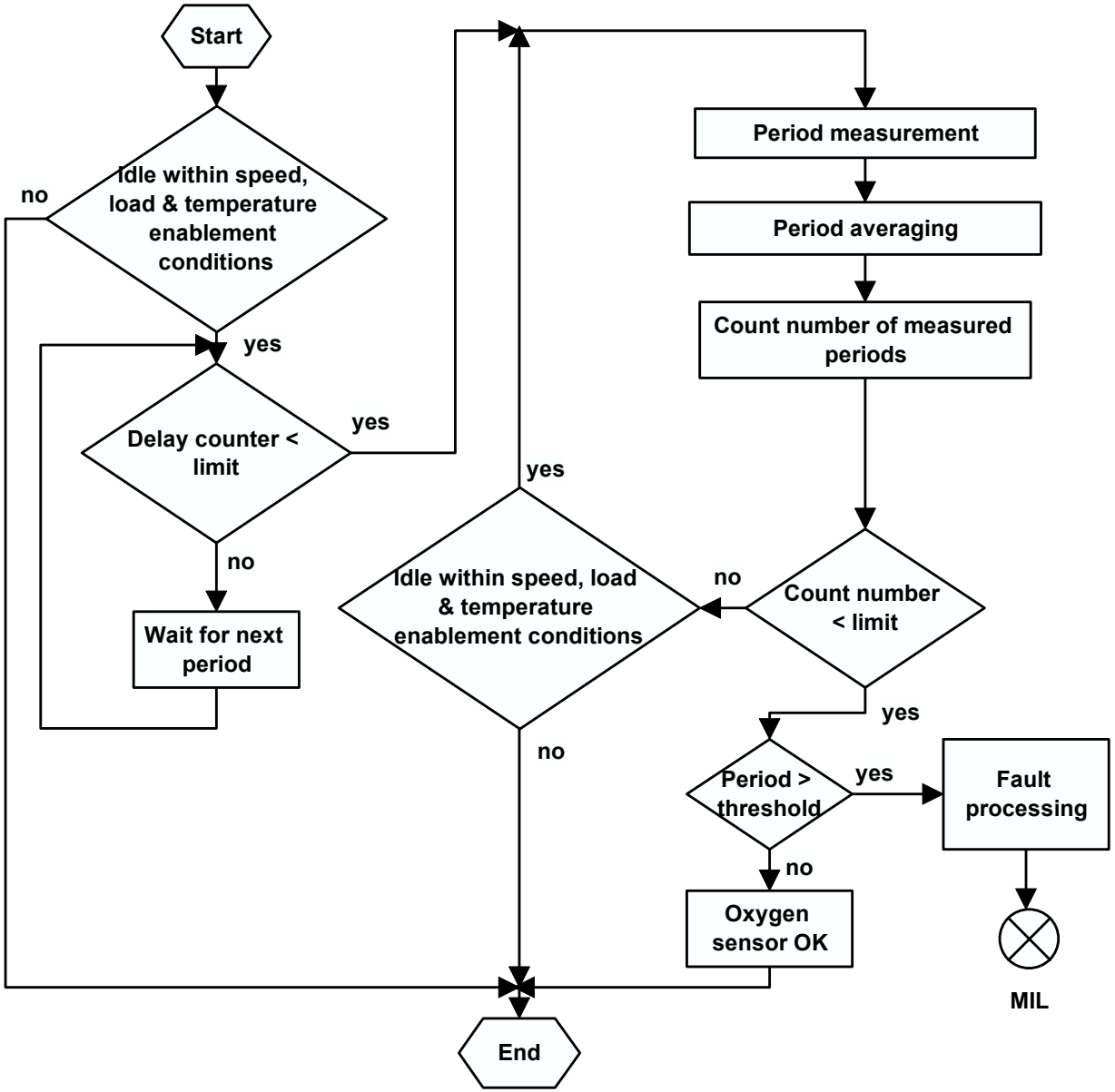
4.7 Oxygen Sensor Monitoring

4.7.1 Description

The response rates of the upstream O2 sensors are monitored by measuring the period of the Lambda control oscillations. This period monitoring allows the detection of a slow O2 sensor.



4.7.2 Monitoring Structure



4.7.3 Oxygen Sensor Heater Monitoring Description

For proper functioning of an oxygen sensor, its element must be heated. A non-functioning heater delays the oxygen sensor's readiness for closed loop control and influences emissions.

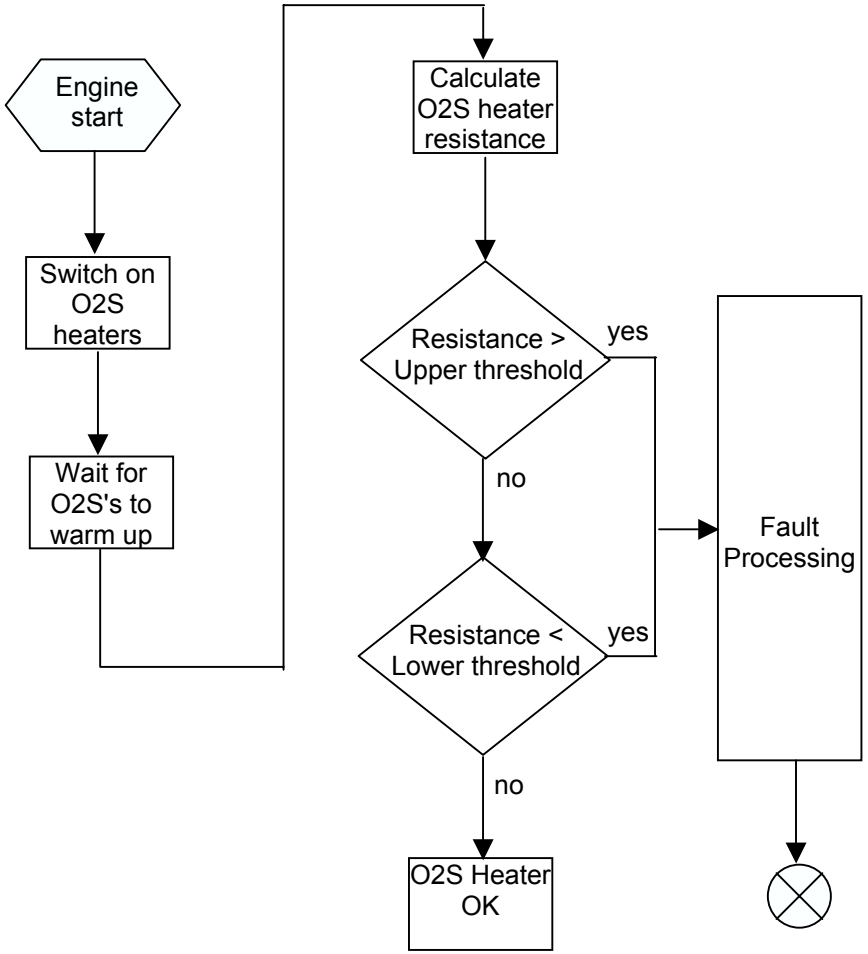
The monitoring function measures both oxygen sensor heater current (voltage drop over a shunt) and the heater voltage (heater supply voltage), so that the oxygen sensor heater resistance can be calculated. If the oxygen sensor heater resistance is exceeds a minimum or maximum threshold an oxygen sensor heater fault is detected.

The monitoring function is activated once per drive cycle, as long as the heater has been switched on for a certain time period and the current has stabilized.

Characteristics:-

- ECM controlled switching of the oxygen sensor heater.
- One shunt for each pair of oxygen sensors upstream and downstream of the catalysts for current measurement.

4.7.4 Oxygen Sensor Heater Monitoring Structure



The oxygen sensor heater resistance is calculated from the following equation:-

$$\text{Resistance}_{\text{sensor heater}} = \frac{\text{Voltage}_{\text{battery}}}{\text{Voltage}_{\text{shunt}}} \Delta\,\text{Resistance}_{\text{shunt}}$$

Oxygen Sensor Circuit Monitoring

Monitoring for electrical faults in the oxygen sensors both upstream and downstream of the catalyst.

Implausible voltages:

- Analogue to Digital Converter (ADC) voltages exceeding the maximum threshold VMAX are caused by a short circuit to battery positive.
- ADC voltages falling below the minimum threshold VMIN are caused by a short circuit of the oxygen sensor signal or oxygen sensor ground to the ECM ground.
- An open circuit of the oxygen sensor can be detected if the ADC voltage remains within a specified range after the oxygen sensor has been heated for a certain time.

Oxygen Sensor Monitoring – Discovery Series II

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Oxygen Sensor (front)	P0133/53	response rate	oxygen sensor signal period (over 50 periods)	> 2.2 sec	engine speed engine load catalyst temperature (model) IAT EVAP canister purge status transfer gears	1400< rpm <2600 2.0< TL msec <5.0 > 340 °C Ò 65.25 °C Off or on > 20 sec high range	immediately/ once per driving cycle	two driving cycles
	P1170/73	sensor ageing	rich shift delay Time	< -1.0 or > 1.0 sec	O2S post catalyst control transfer gears	active high range	30 sec	
	P1129	exchanged oxygen sensors connector	fuel control factor **or**	bank 1 > 1.22 and bank 2 < 0.77 bank 1 < 0.77 and bank 2 > 1.22			8.0 sec	
					heater on transfer gears	> 90 sec high range		
	P0134/54	O2S circuit continuity	voltage **or** voltage (front & rear)	0.399V < voltage <0.598V voltage > 0.199V	over run fuel cut off	> 3.0 sec	15 sec/continuous 0.1 sec/continuous	
	P0132/52	range check (high)	voltage	voltage > 1.081V			5.1 sec/continuous	
	P0130/50	O2S short circuit	voltage	voltage < 0.0399V **Or**	O2S post catalyst voltage	Ó 0.501V	20 sec/continuous	
					ECT battery voltage time after start ECT at power down	< 39.75 °C > 8.016V > 1.0 sec > 60 °C	0.1 sec/continuous	
				0.062V Ò voltage < 0.399V	O2S post catalyst voltage	Ó 0.501V	20 sec/continuous	

Oxygen Sensor Monitoring – Discovery Series II

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Heater				0.598V Ò voltage Ò 1.081V	O2S post catalyst voltage	< 0.102V	10 sec/continuous	
	P0135/55	O2S heater current circuit continuity	calculated resistance voltage	resistance < 2.453 Ý **or** resistance > 10.06 Ý	after engine start up transfer gears	> 180 sec high range	10 sec/continuous	
Oxygen Sensor (rear)					O2S heater on transfer gears	> 90 sec high range		two driving cycles
	P0140/60	O2S circuit continuity	voltage	0.399V < voltage < 0.501V			500 sec/ continuous	
	P0138/58	range check (high)	voltage	voltage > 1.081V			5.1 sec/continuous	
	P0137/57	range check (low)	voltage	voltage < 0.501V	engine air flow O2S post catalyst control	> 16.67 g/sec Active	210 sec/ continuous	
	P0136/56	O2S short circuit	voltage	voltage < 0.0399	O2S post catalyst control	Active	200 sec/ continuous	
	P0139/59	oscillation capability check			O2S post catalyst control catalyst temperature (model) engine air flow rear O2S ready for at least rear O2S heater test rear O2S rich & lean flags not set	Active > 300 °C > 13.89 g/sec 30.0 sec completed successfully > 120 sec		
			if rear O2S voltage not ó 0.625V for	enrichment request still present after 25 sec	catalyst temperature (model)	> 300 °C	2.0 sec/continuous	

Oxygen Sensor Monitoring – Discovery Series II								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Heater			0.52 se c request enrichment					
			if rear O2S voltage not Ò 0.625 V for 0.52 sec wait for over run fuel cut off (ORFCO)	rear O2S voltage > 0.200V	fuel system status integrated engine air flow whilst in ORFCO front O2S check	in over run fuel cut off (ORFCO) for > 4.0 sec > 35.0 g completed successfully	0.20 sec/ continuous	
	P0141/61	O2S heater current circuit continuity	calculated resistance voltage	resistance < 2.453 Ý **or** resistance > 10.06 Ý	after engine start up transfer gears	> 180 sec high range	10 sec/continuous	

If the above table does not include details of the following enabling conditions: - IAT, ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.

Oxygen Sensor Monitoring – Range Rover								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Oxygen Sensor (front)	P0133/53	response rate	O2S signal period (over 30 periods)	> 2.2 sec	engine speed engine load catalyst temperature (model) intake air temperature EVAP canister purge status	1400 < rpm < 2600 2.0 < TL msec < 5.0 > 340 °C Ò 69.75 °C off or on > 20 sec	Immediately/ once per driving cycle	two driving cycles

Oxygen Sensor Monitoring – Range Rover

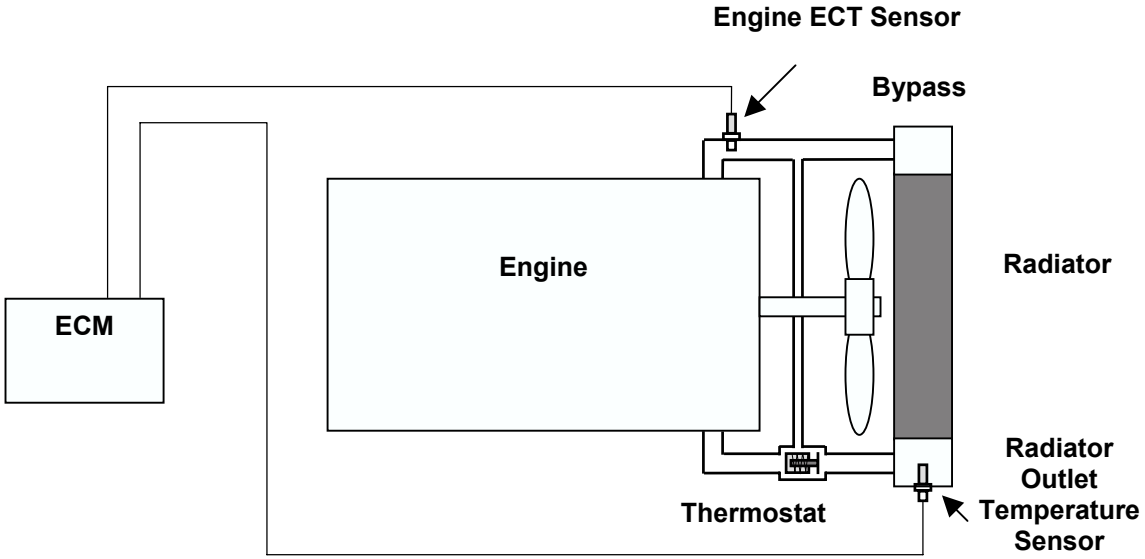
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
					transfer gears	high range		
	P1170/73	O2S ageing	rich shift delay time	< -1.0 or > 1.0 sec	O2S post catalyst control transfer gears	active high range	30 sec	
	P1129	exchanged O2S connectors	fuel control factor **or**	bank 1 > 1.22 and bank 2 < 0.77 bank 1 < 0.77 and bank 2 > 1.22	O2S heater on transfer gears	> 120 sec high range	8.0 sec	
	P0134/54	O2S circuit continuity	voltage **or** voltage (front & rear)	0.399V< voltage < 0.598V voltage > 0.199V	over run fuel cut off	> 3.0 sec	15 sec/continuous 0.1 sec/continuous	
	P0132/52	range check (high)	voltage	voltage > 1.081V			5.1 sec/continuous	
	P0130/50	O2S short circuit	voltage	voltage < 0.0399 **Or**	O2S post catalyst voltage	>= 0.501V	20 sec/continuous	
					ECT battery voltage time after start ECT at power down	< 39.75 °C > 8.016V > 1.0 sec > 80.25 °C	0.1 sec/continuous	
				0.062V Ò voltage< 0.399V	O2S post catalyst voltage	Ó 0.501V	20 sec/continuous	
				0.598VÒ voltage Ò 1.081V	O2S post catalyst voltage	< 0.102V	10 sec/continuous	
Oxygen Sensor (front) Heater	P0135/55	O2S heater current circuit continuity	calculated resistance voltage	resistance < 2.453 Ý **or** resistance > 10.06 Ý	after engine start up transfer gears	> 185 sec high range	10 sec/continuous	two driving cycles
Oxygen Sensor (rear)	P0140/60	O2S circuit continuity	voltage	0.399V < voltage< 0.501V			500 sec/ continuous	two driving cycles
	P0138/58	range check (high)	voltage	voltage > 1.081V			5.1 sec/continuous	
	P0137/57	range check (low)	voltage	voltage < 0.501V	engine air flow post-cat control	> 60 kg/hr Active	210 sec/ continuous	
	P0136/56	O2S short circuit	voltage	voltage < 0.0399	post-cat control	Active	100 sec/ continuous	

Oxygen Sensor Monitoring – Range Rover								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
	P0139/59	oscillation capability check			O2S post catalyst control catalyst temperature (model) engine air flow rear O2S ready for at least rear O2S heater test rear O2S rich & lean flags not set	Active > 300 °C > 50 kg/h 30.0 sec completed successfully > 120 sec		
			if rear O2S voltage not Ó 0.625v for 0.52 sec request enrichment	enrichment request still present after 25 sec	catalyst temperature (model)	> 300 °C	2.0 sec/continuous	
			if rear O2S voltage not Ò 0.625v for 0.52 Sec wait for ORFCO	rear O2S voltage > 0.20V	fuel system status integrated engine air flow whilst in ORFCO front O2S check	in ORFCO for>4.0sec > 35.0 grams completed successfully	0.20 sec/ continuous	
Oxygen Sensor (rear) Heater	P0141/61	O2S heater current circuit continuity	calculated resistance voltage	resistance < 2.453 Ý **or** resistance > 10.06 Ý	after engine start up transfer gears	> 185 sec high range	10.0 sec/ continuous	two driving cycles

If the above table does not include details of the following enabling conditions: - intake air and ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.

4.8 Thermostat Monitoring

4.8.1 Description



The diagnostic checks for a partially open thermostat, under conditions when the thermostat would be expected to be shut.

A second ECT sensor is installed in the outlet from the radiator. If the enablement criteria are met and the ECT is less than the normal thermostat opening temperature the diagnostic will run.

The diagnostic compares the difference between ECT and the radiator outlet temperature. This gives the temperature drop across the radiator.

If the temperature drop is less than a threshold, and there is flow across the radiator, this is caused by leakage through the thermostat.

4.8.2 Monitoring Structure