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 • •voltage • •1.081V	O2S post catalyst voltage	< 0.102V	10 sec/continuous	
	P0135/55	O2S heater current circuit continuity	calculated resistance voltage	resistance < 2.453 • • **or** resistance > 10.06 • •	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 • • 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 • •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 • • **or** resistance > 10.06 • •	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 • •69.75 °C off or on > 20 sec	Immediately/ once per driving cycle	two driving cycles

Oxygen Sensor Monitoring – Range Rover

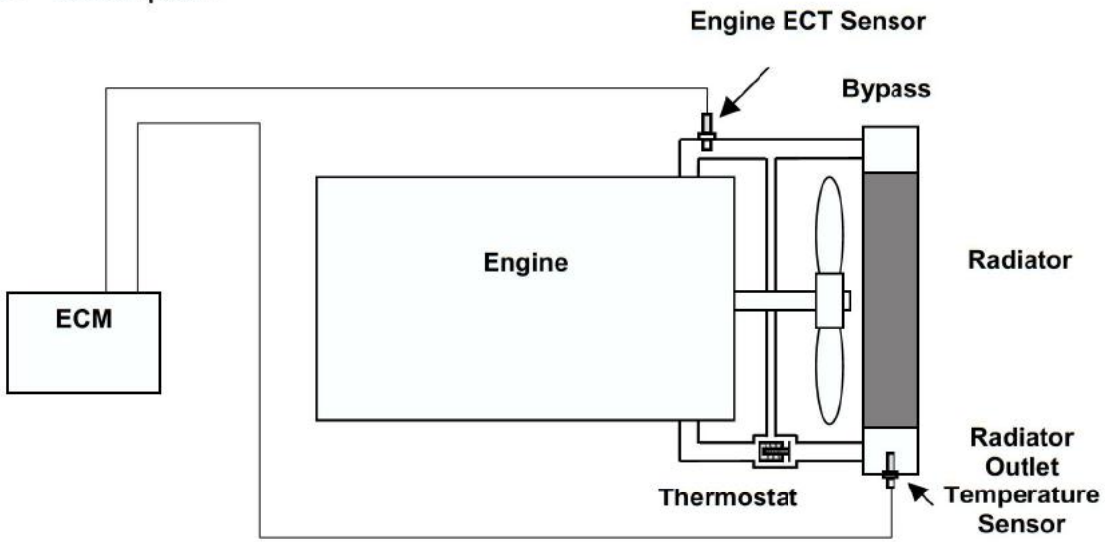
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
					transfer gears	high range		
	P1170/73	O2S ageing	rich shift delay time	< -1.0 or > 1.0 sec	O2S post catalyst control transfer gears	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	O2S post catalyst voltage	>= 0.501V	20 sec/continuous	
				Or	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 • •voltage< 0.399V	O2S post catalyst voltage	• •0.501V	20 sec/continuous	
				0.598V• •voltage • •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 • • **or** resistance > 10.06 • •	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 • • 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 • • 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 • • **or** resistance > 10.06 • •	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



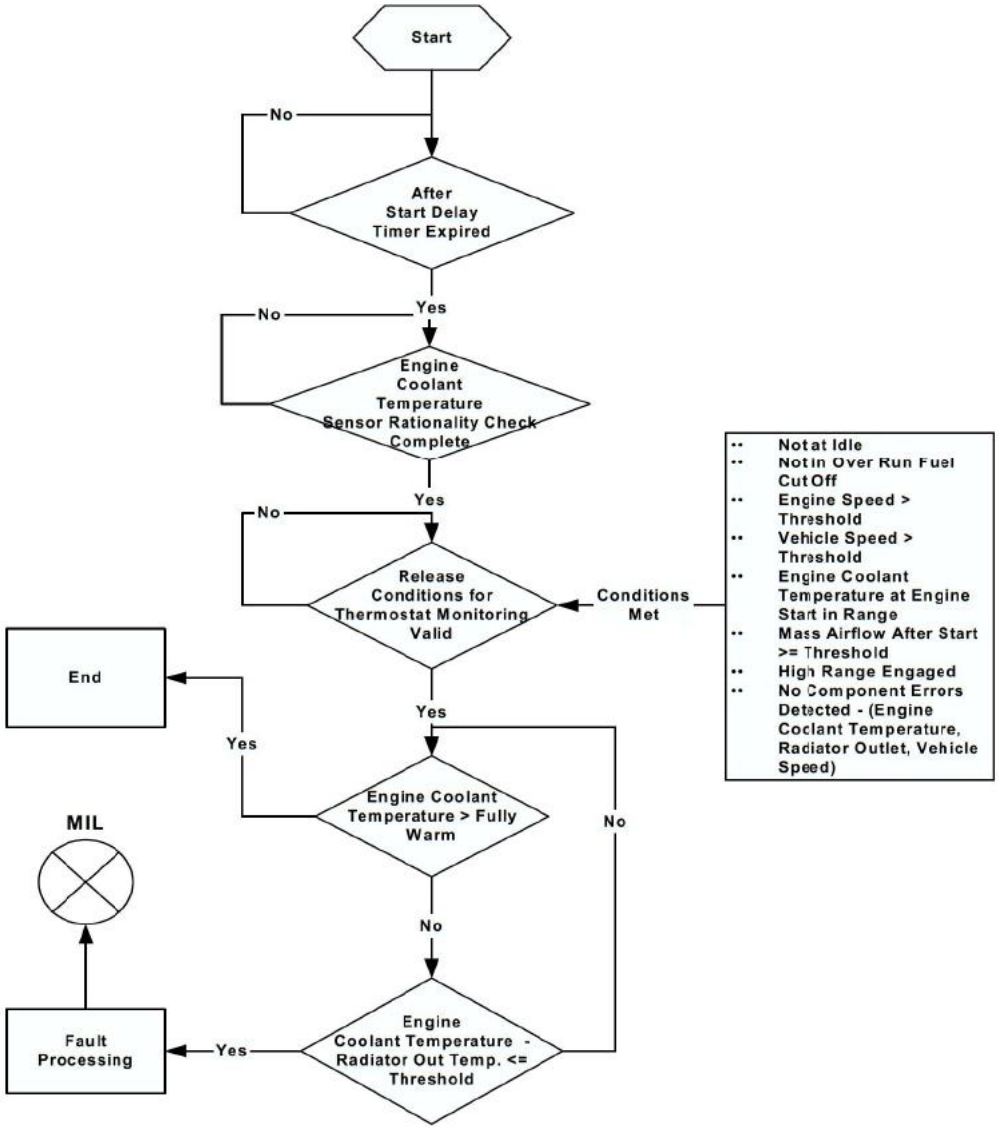
The diagnostic checks for a partially open thermostat, under conditions when the thermostat would be expected to be shut.

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



Thermostat Monitoring								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Thermostat stuck open	P0126	engine not fully warm and temperature drop across the radiator less than a threshold	engine coolant temperature - radiator outlet temperature (TKA)	• •45°C @ -10 °C TKA • •40 °C @ 0 °C TKA • •45 °C @ 10 °C TKA • •30 °C @ 20 °C TKA • •30 °C @ 30 °C TKA • •25 °C @ 40 °C TKA • •25 °C @ 50 °C TKA • •25 °C @ 60 °C TKA	ECT sensor plausibility test ECT time after Start engine Speed vehicle Speed ORFCO engine State airflow after start ECT at start transfer Gears	complete < 81.75 °C > from 220 sec @ 40 °C TKA to 270 sec @ -10 °C TKA > 400 rpm > 15.54 mph not True not Idle • •from 3.0 kg @ 40 °C TKA to 10.0 kg @ -10 °C TKA -9.75 °C • •start temperature • •81.75°C high Range	1.0 sec/ continuous	two driving cycles
Radiator Outlet Temperature Sensor	P1118	circuit continuity range check (max)	voltage resistance	> 140.25 °C			1.0 sec/ continuous	two driving cycles
	P1117	range check (min)		< -33.0 °C	intake air temperature	> -32.25 °C		
Engine Coolant Temperature Sensor High Sided Rationality Check Range Rover Only	P0116	checks for higher than expected engine temperature. Potential fault determined by the Power	<u>power up check</u> engine coolant temperature at start	> ECT at stop - (50.25 x Factor) intake air temp at start / factor -30 °C / 0.9961 -15 °C / 0.9727 0 °C / 0.9492	radiator outlet temperature at start absolute value of (radiator outlet temperature at start - intake air temperature at start) time after start	< 39.75 °C < 9.75 °C < 2.0 s	7.54 sec/ continuous	two driving cycles

Thermostat Monitoring								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold Value		Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
		up check at engine start and confirmed by driving check		10 °C 15 °C 20 °C 25 °C 30 °C 35 °C 45 °C 55 °C 65 °C	0.9180 0.8984 0.8789 0.8477 0.8203 0.8516 0.7617 0.6758 0.3008	radiator outlet temperature at stop ECT at stop transfer gears	> -9.75 °C > 66.75 °C high range		
			driving check engine coolant temperature	> 102.0 °C		engine load engine speed calculated ECT vehicle speed time after start intake air temperature radiator outlet temperature transfer gears	2.0 < TL msec < 4.0 1200 < rpm < 2120 • 60.0 °C • 40 km/h > 290 sec • 60 °C • 55.5 °C high range		

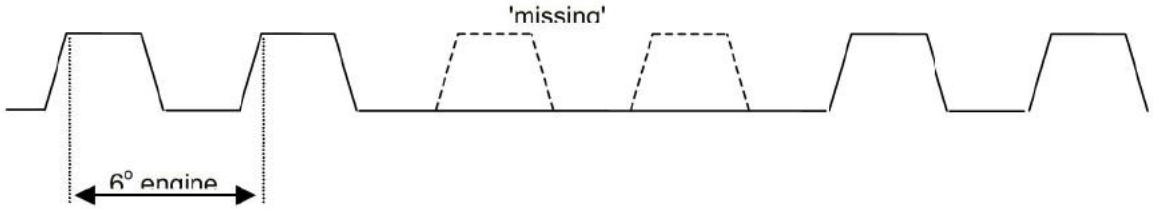
If the above table does not include details of the following enabling conditions: - IAT, ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.

4.9 Engine Speed and Position Sensor (Crankshaft Sensor)

4.9.1 Description

This sensor is the most important sensor on the vehicle, without it the engine cannot run. There is no backup strategy or limp home facility should it fail. The sensor produces the signal which enables the ECM to determine the angle of the crankshaft, and the engine rpm. From this, the point of ignition, fuel injection, etc. is calculated. If the signal wires are reversed a 3° advance in timing will occur, as the electronics within the ECM uses the falling edge of the signal waveform as its reference/timing point for each tooth.

The reluctor is machined and has a tooth pattern based on 60 teeth at 6° intervals and 3° wide: two of the teeth are removed to provide a hardware reference mark which is 60 degrees before top dead centre No. 1 cylinder.



The sensor operates by generating an output voltage caused by the change in magnetic field, which occurs as the teeth pass in front of the sensor. The output voltage varies with the speed of the teeth passing the sensor; the higher the engine speed, the higher the output voltage. Note that the output is also dependent on the air gap between the sensor and the teeth (the larger the gap, the weaker the signal, the lower the output voltage).

There are two diagnostic checks on the output signal of this sensor: -

1. The hardware reference mark created by the missing teeth is outside the search window and the engine speed is greater than 500 rpm.
2. The hardware reference mark is outside the search window by more than one tooth and the engine speed is greater than 500 rpm.

The ECM transmits the engine speed to the automatic TCM using CAN, while all other control modules are hardwired.

Engine Speed and Position Sensor								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Engine Speed and Position Sensor	P0335	rationality check	reference mark outside search window	> 2 occurrences	engine speed	> 500 rpm	2 revolutions/continuous	two driving cycles
	P0336		counted teeth – actual number of teeth	+ 1 tooth			1 revolution/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.