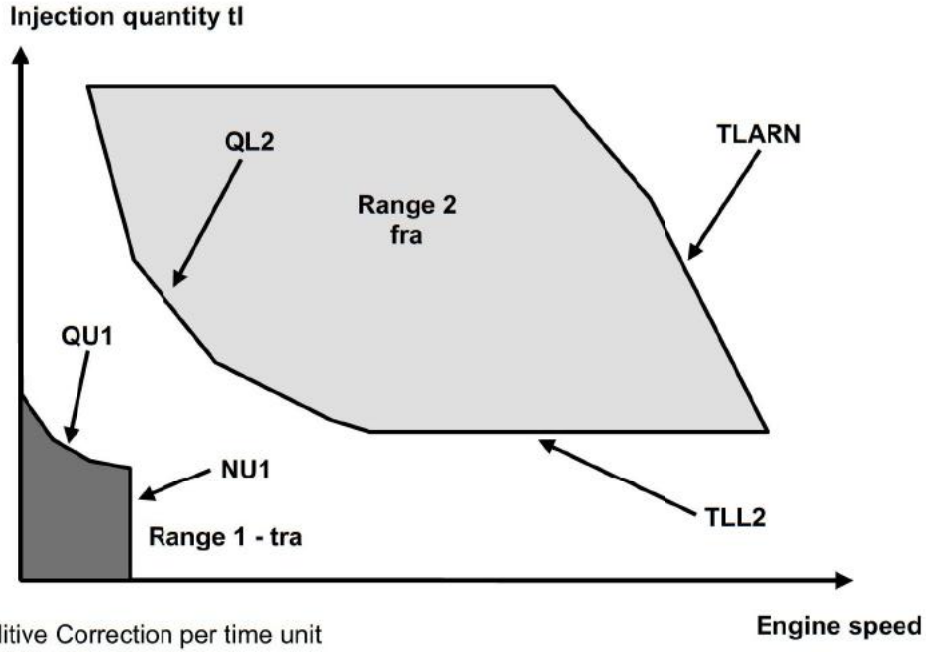
Adaptive Control

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:

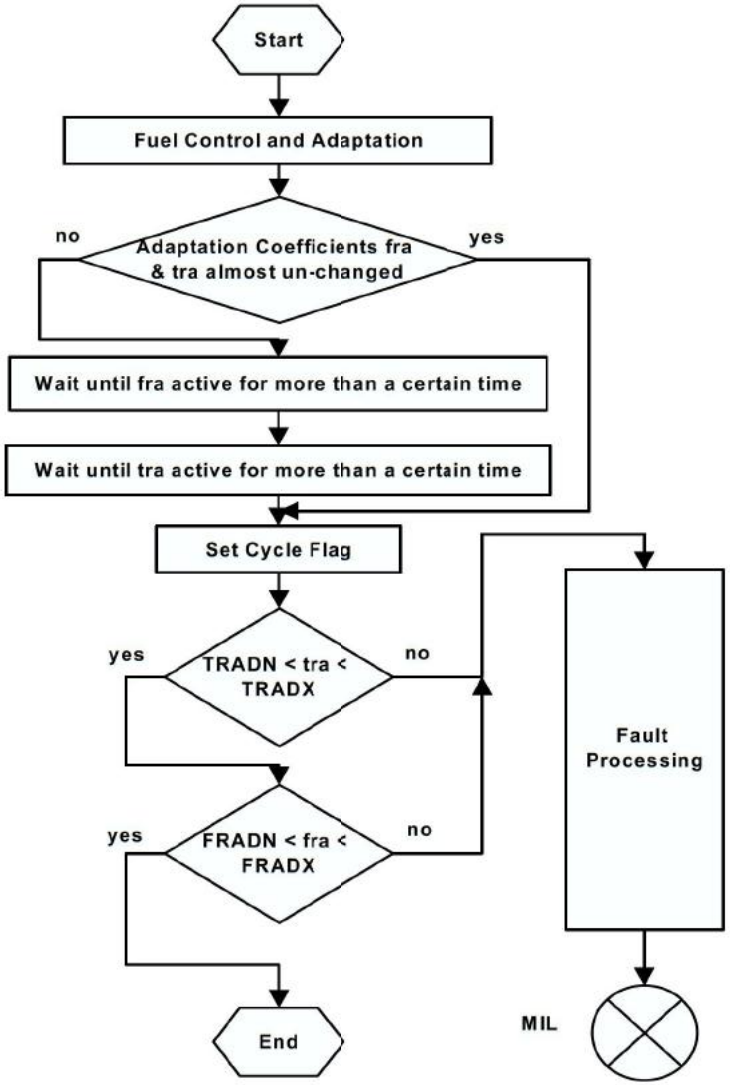
QU1 upper airflow threshold range 1
NU1 upper engine speed threshold range 1

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



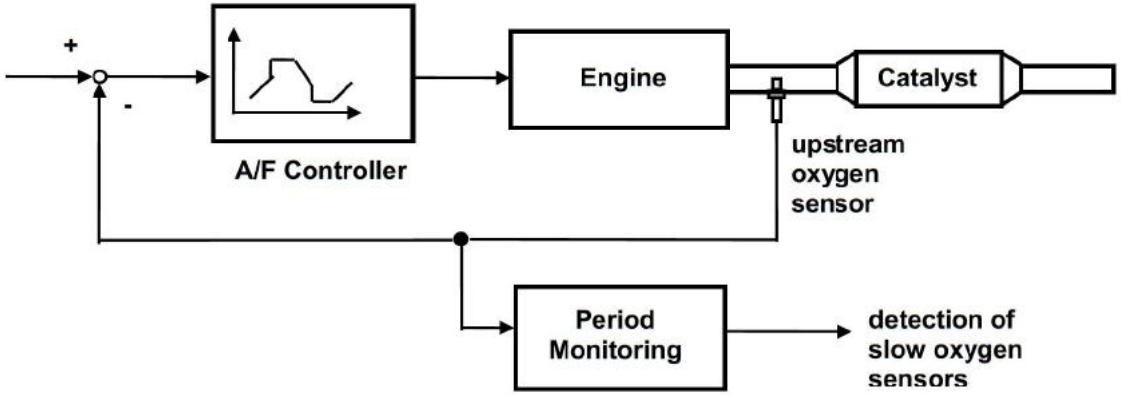
Fuel System Monitoring								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Fuel System		fuel trim limits exceeded			fuel system status ECT IAT transfer gears purge diagnosis	closed loop+part load > 80.25 °C • •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.

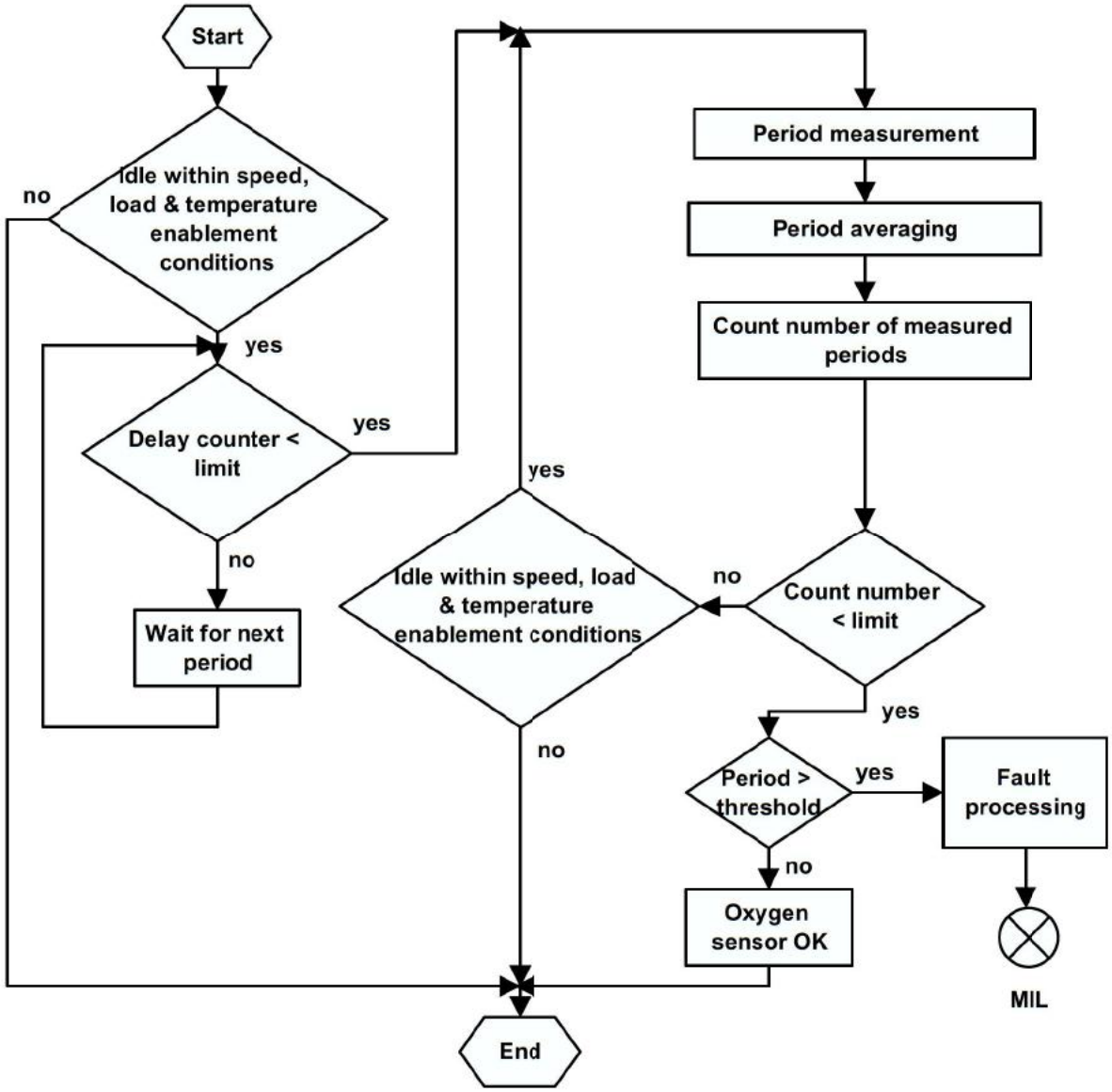
4.7 Oxygen Sensor Monitoring

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.

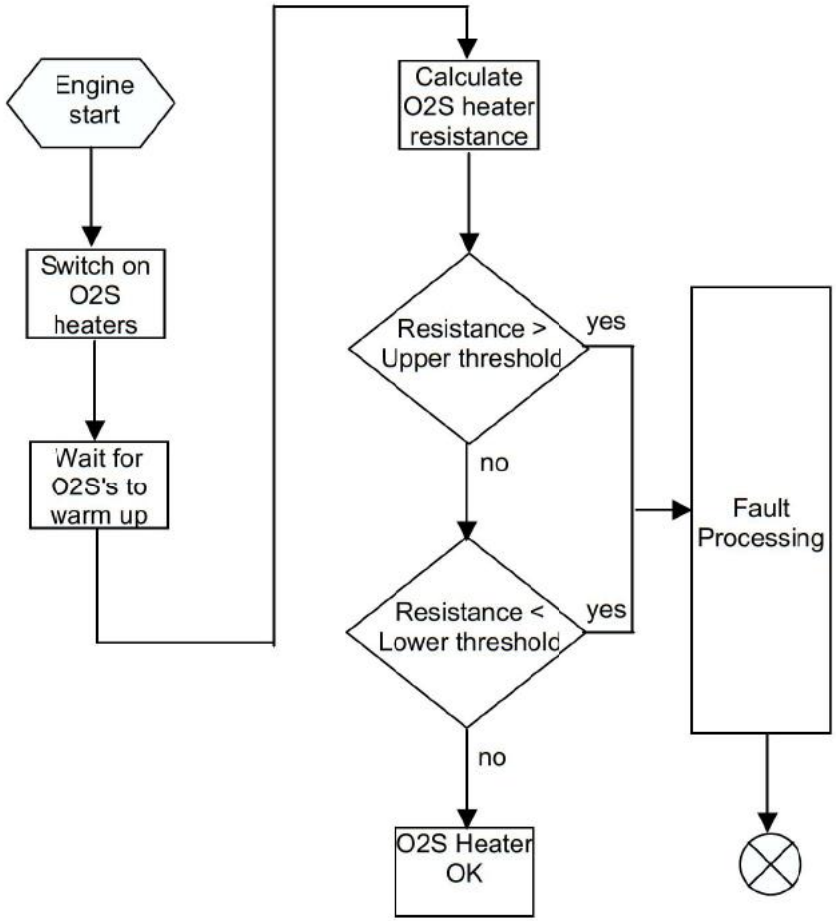
The monitoring function measures both oxygen sensor heater current (voltage drop over a shunt) and the heater voltage (heater supply voltage), so that the oxygen sensor heater resistance can be calculated. If the oxygen sensor heater resistance is exceeds a minimum or maximum threshold an oxygen sensor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

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

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 • •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	• •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 • •voltage < 0.399V	O2S post catalyst voltage	• •0.501V	20 sec/continuous	