4 Onboard Monitoring

4.1 Catalyst Monitoring

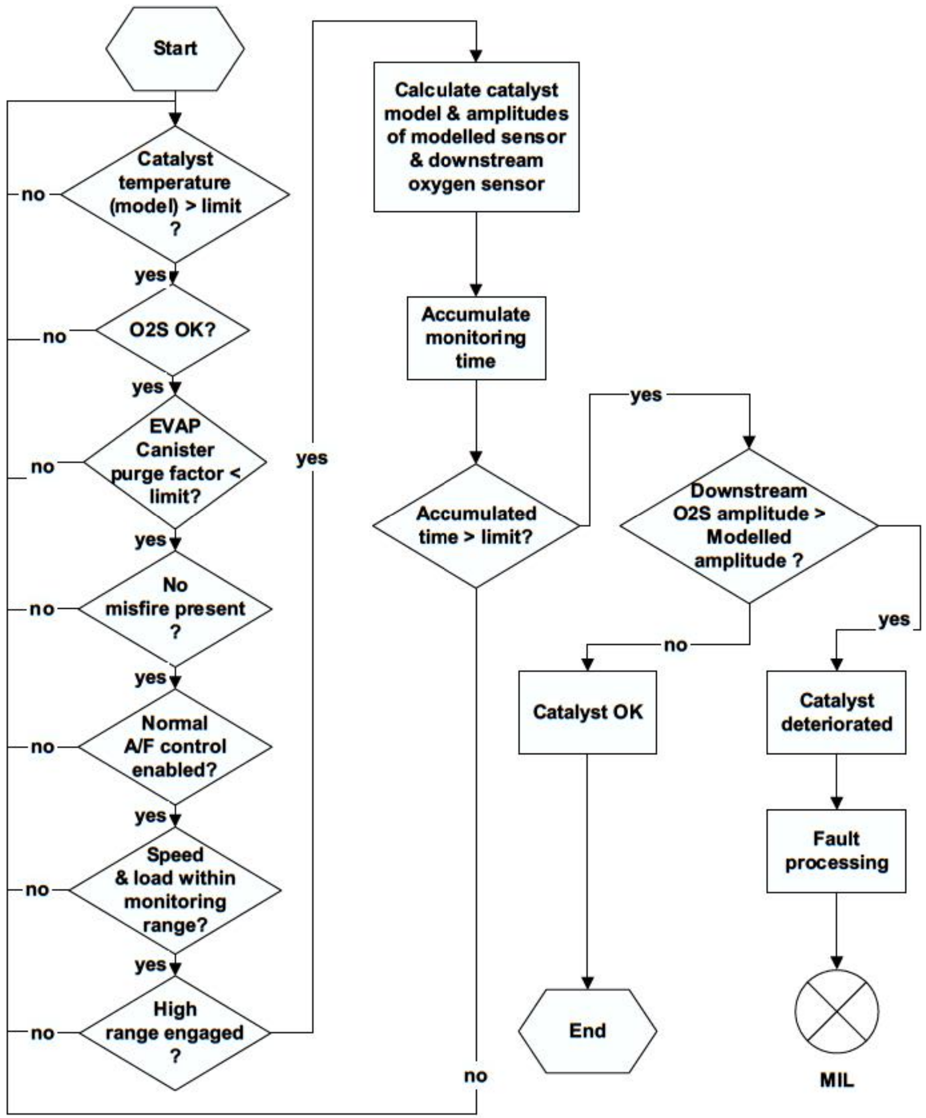
4.1.1 Description

Catalyst monitoring is based on the monitoring of oxygen storage capability. The engine closed loop feedback control generates Lambda* (air fuel ratio) oscillations in the exhaust gas. These oscillations are damped by the oxygen storage activity of the catalyst. The amplitude of the remaining Lambda oscillations downstream of the catalyst indicates the storage capability.

In order to determine catalyst efficiency, the amplitude ratio of the signal oscillations of the upstream and downstream Lambda sensors is determined. This information is evaluated separately in different engine load and speed ranges. If there is an indication of low storage capability in a certain number of operating ranges, a defective catalyst is diagnosed.

*Definition of Lambda: The stoichiometric air fuel ratio is the mass ratio of 14.7 kg of air to 1kg of gasoline theoretically necessary for complete combustion. The excess air ratio • •(Lambda) indicates the deviation of the actual air fuel ratio from the theoretical air fuel ratio. Thus • •= actual inducted air mass/ theoretical air requirement

4.1.2 Monitoring Structure



Computation of the Amplitude Ratio

The first step is the computation of the amplitude of the signal oscillations of the oxygen sensors upstream and downstream of the catalyst. This is accomplished by extracting the oscillating signal component, computing the absolute value and averaging over time. The result of dividing the downstream amplitude value by the upstream amplitude value is called the Amplitude Ratio (AV). This AV value is the basic information necessary for catalyst monitoring. It is computed continuously over a certain engine load and speed range. The signal paths for both sensor signals are identical, so that variations, like an increase in the control frequency, affect both signal paths in the same way and are compensated for by the division.

Post Processing

The actual amplitude ratio is compared with a limit value according to the load and speed range the engine is operating in. The result of this comparison, which is the difference of the two values, is accumulated separately for each range. Thus, even short time periods of driving in a certain range yield additional information.

By using separate load and speed ranges in combination with the accumulation of information a monitoring result can be obtained during a Federal Test Procedure (FTP) cycle.

Fault Evaluation

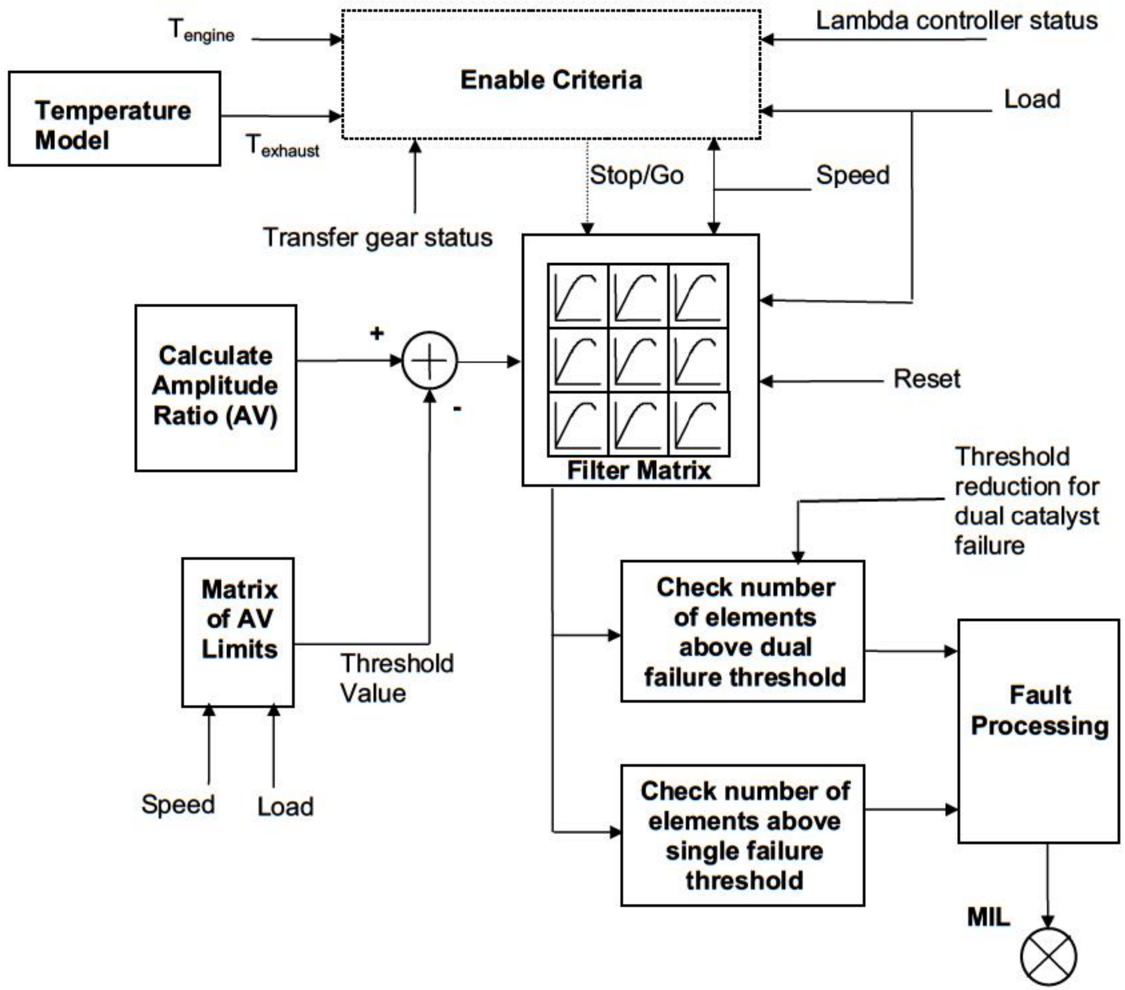
The accumulated information about the amplitude ratio becomes more and more reliable as different load and speed ranges are used during a driving cycle. If the amplitude ratio is greater than fixed map values a fault is detected and an internal fault flag will be set. If the fault is detected again in the next driving cycle the MIL will be illuminated.

Since the monitored engine has a catalyst for each of two cylinder banks, two evaluations are made with differing fault thresholds, one test is for deterioration in one of the catalysts and the second is at a reduced threshold to check for deterioration in both catalysts.

Check of Monitoring Conditions

The monitoring principle is based on the detection of relevant oscillations of the downstream oxygen sensor signal during regular Lambda control. It is necessary to check the driving conditions to ensure that regular lambda control is possible, e.g. fuel cut off not present. For a certain time after enabling Lambda control, the computation of the amplitude values and their post processing is halted, in order to avoid a distortion of the monitoring information.

4.1.3 Block Diagram of system Operation



Catalyst Monitoring Operation – Discovery Series II

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Catalyst Bank 1	P0420	oxygen storage capability	rear oxygen sensor amplitude exceeds the modelled amplitude of a borderline catalyst (1.75 x standard (Hydrocarbon - (HC) emissions))	> 0.4023	engine speed engine load catalyst temperature (model) transfer gears fuel system status EVAP canister purge vapour factor enable conditions	1200 < rpm < 1800 between 1.8 and 3.8 msec at 1200 Rpm to between 1.9 and 4.15 msec at 1800 rpm > 332 °C high range closed loop < 10.0 valid for > 0.8 sec	100 sec/ once per driving cycle	two driving cycles
Bank 2	P0430			> 0.4023				

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.

Catalyst Monitoring Operation – Range Rover 38A

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Catalyst Banks 1 and 2 (Dual catalyst deterioration)	P0420 P0430	oxygen storage capability	amplitude ratio of O2S, rear/front (1.5 x standard + 4K (HC emissions))	> 0.5 (min. 4 of 4 samples per cylinder bank)	engine speed engine load catalyst temperature (model) IAT transfer gears fuel system status EVAP canister purge vapour factor time after start	1000 < rpm < 2800 1.2< TL msec <4.0 > 300 °C > -9.75 °C high range closed loop < 10.0 > 69.12 sec	250 sec/ once per driving cycle	two driving cycles
Bank 1 or 2 (Single catalyst deterioration)				> 0.75 (min. 4 of 4 samples for one cylinder bank)				

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.