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.
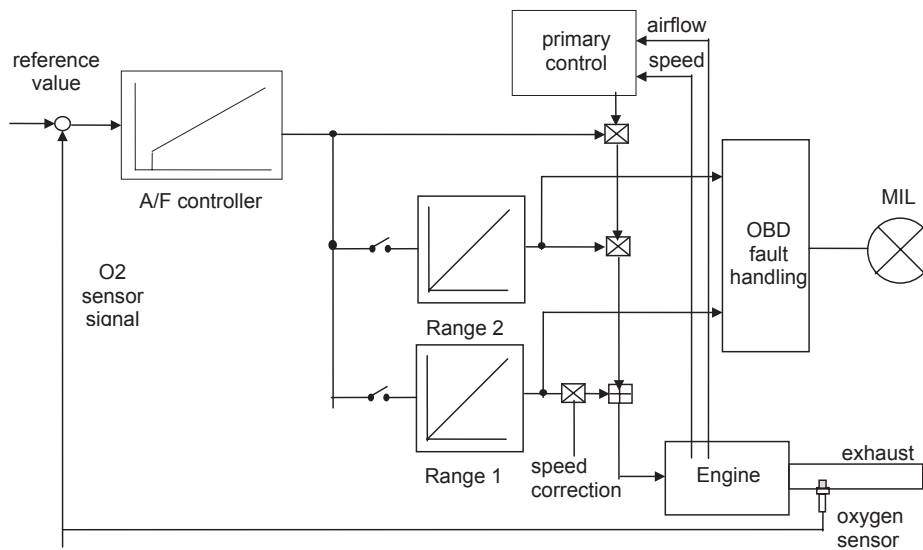
Adaptive Control

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.

Injection quantity tl

QL2

**Range 2
fra**

TLARN

QU1

NU1

Range 1 - tra

TLL2
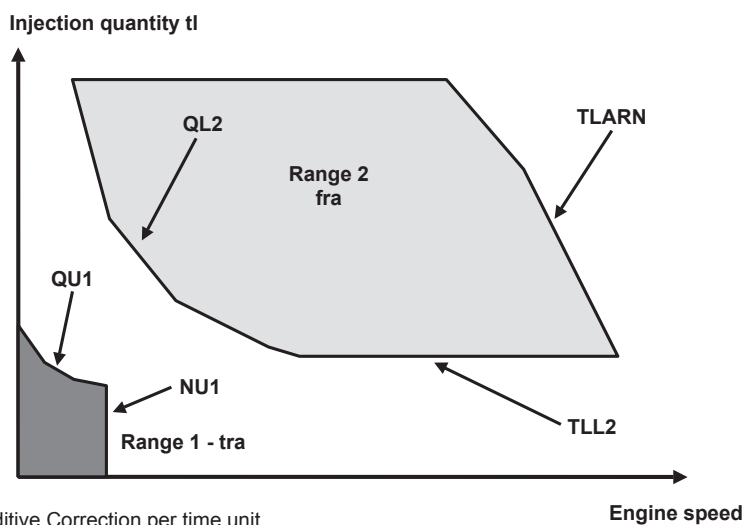
Engine speed

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

```
                              ⬡ Start

                    ┌─────────────────────────┐
                    │ Fuel Control and Adaptation │
                    └─────────────────────────┘
                                │
              no      ◇ Adaptation Coefficients fra     yes
           ┌──────────   & tra almost un-changed   ──────────┐
           │                    │                             │
           │        ┌─────────────────────────────────┐      │
           │        │ Wait until fra active for more than a certain time │
           │        └─────────────────────────────────┘      │
           │                    │                             │
           │        ┌─────────────────────────────────┐      │
           │        │ Wait until tra active for more than a certain time │
           │        └─────────────────────────────────┘      │
           │                    │                             │
           └──────────┐         │         ┌───────────────────┘
                    ┌──────────────────┐
                    │  Set Cycle Flag  │
                    └──────────────────┘
                              │
            yes      ◇ TRADN < tra <      no
         ┌──────────    TRADX       ──────────┐
         │                                     │        ┌──────────────┐
         │                                     │        │    Fault     │
         │          ◇ FRADN < fra <    no      │        │  Processing  │
         │  yes  ──────   FRADX    ────────────┤        └──────────────┘
         │    │                                         │
         └────┤                                         │
              │                                         │
           ⬡ End                                   MIL ⊗
```
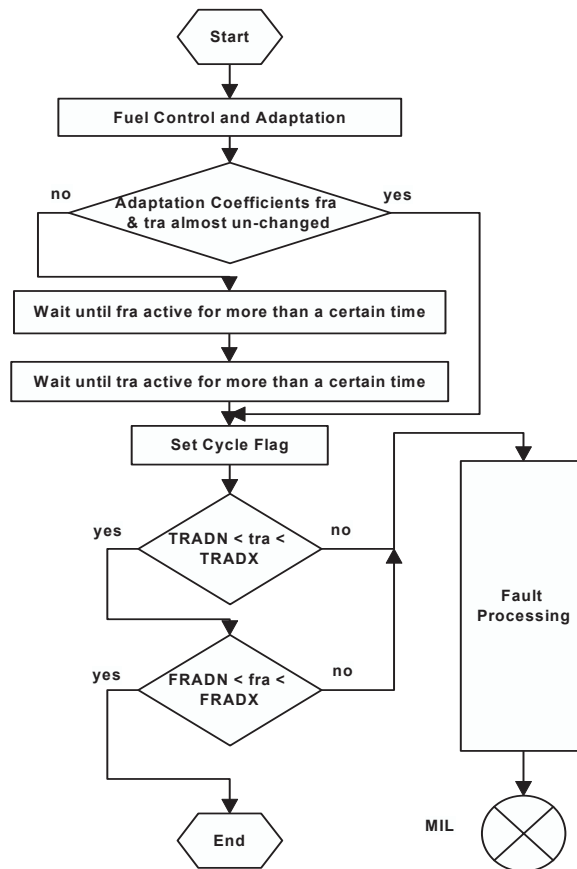
					Fuel System Monitoring			
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
Fuel System		fuel trim limits exceeded			fuel system status ECT IAT transfer gears purge diagnosis	closed loop+part 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.