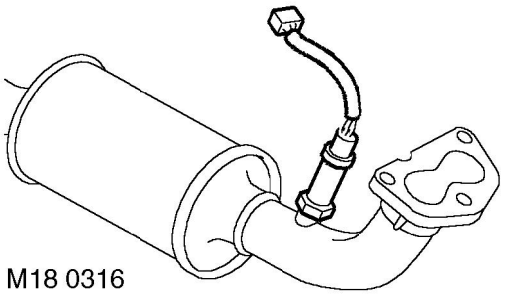
Heated Oxygen Sensors (HO_2S) (C0642)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The market requirement dictates how many HO_2S are fitted to the vehicle.

- 4 sensors are fitted to all NAS and EU-3 vehicles.
- 2 sensors fitted to all UK, European, Australia and Japanese pre EU-3 specification vehicles.
- No sensors fitted to ROW vehicles.

The HO_2S monitor the oxygen content of the exhaust gases. By positioning the sensors one for each bank upstream of the catalytic converter in the exhaust pipe, the ECM can control fuelling on each bank independently of the other. This allows greater control of the air:fuel ratio and maintains optimum catalyst efficiency. On NAS vehicles the ECM also uses two HO_2S positioned downstream of the catalytic converters in the exhaust pipe to monitor catalytic converter efficiency. The ECM is able to achieve this by comparing the values of the upstream HO_2S and the down stream sensor for the same bank. These comparative values form part of the ECM OBD strategy.

The HO_2S uses zirconium contained in a galvanic cell surrounded by a gas permeable ceramic, this produces an output voltage proportional to the ratio difference between the oxygen in the exhaust gases and to the ambient oxygen.

The HO_2S operates at approximately 350 °C (662 °F). To achieve this temperature the HO_2S incorporate a heating element which is controlled by a PWM signal from the ECM. The elements are activated immediately after engine starts and also under low engine load conditions when the exhaust gas temperature is insufficient to maintain the required HO_2S temperature. If the heater fails, the ECM will not allow closed loop fuelling to be implemented until the sensor has achieved the required temperature.

This value equates to an HO_2S output of 450 to 500 mV. A richer mixture can be shown as $\lambda = 0.97$, this pushes the HO_2S output voltage towards 1000 mV. A leaner mixture can be shown as $\lambda = 1.10$, this pushes the HO_2S output voltage towards 100 mV.

From cold start, the ECM runs an open loop fuelling strategy. The ECM keeps this strategy in place until the HO_2S is at a working temperature of 350 °C (662 °F). At this point the ECM starts to receive HO_2S information and it can then switch into closed loop fuelling as part of its adaptive strategy. The maximum working temperature of the tip of the HO_2S is 930 °C (1706 °F), temperatures above this will damage the sensor.

HO_2S age with use, this increases their response time to switch from rich to lean and from lean to rich. This can lead to increased exhaust emissions over a period of time. The switching time of the upstream sensors are monitored by the ECM. If a pre-determined threshold is exceeded, a failure is detected and the MIL illuminated.

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Input/Output

The upstream and downstream HO_2S are colour coded to prevent incorrect fitting. The tips of the upstream sensors are physically different to the tips of the downstream sensors.

The HO_2S are colour coded as follows:

- Upstream sensors (both banks) - orange.
- Downstream sensors (both banks) - grey.

The four HO_2S have a direct battery supply to the heater via fuse 2 located in the engine compartment fuse box.

The heater is driven by the ECM providing an earth path for the circuit as follows:
- Upstream LH bank via pin 19 of connector C0635 of the ECM.
- Upstream RH bank via pin 13 of connector C0635 of the ECM.
- Downstream LH bank via pin 7 of connector C0635 of the ECM.
- Downstream RH bank via pin 1 of connector C0635 of the ECM.

The HO_2S output signal is measured by the ECM as follows:
- Upstream LH bank via pin 15 of connector C0635 of the ECM.
- Upstream RH bank via pin 16 of connector C0635 of the ECM.
- Downstream LH bank via pin 17 of connector C0635 of the ECM.
- Downstream RH bank via pin 14 of connector C0635 of the ECM.

The HO_2S earth path for the signal is supplied by the ECM as follows:
- Upstream LH bank via pin 9 of connector C0635 of the ECM.
- Upstream RH bank via pin 10 of connector C0635 of the ECM.
- Downstream LH bank via pin 11 of connector C0635 of the ECM.
- Downstream RH bank via pin 8 of connector C0635 of the ECM.

The HO_2S voltage is difficult to measure using a multimeter, the output can be monitored using TestBook. A rich mixture would read 500 to 1000 mV, a weak mixture would read 100 mV to 500 mV, the reading should switch from rich to weak. The open loop default voltage is 450 mV, this is used by the ECM to set the air/ fuel ratio until the tip of the HO_2S reaches operating temperature.

The HO_2S can fail the following ways or supply incorrect signal:
- Sensor open circuit.
- Short circuit to vehicle supply.
- Short circuit to vehicle earth.
- Sensor disconnected.
- Stoichiometric ratio outside the correct operating band.
- Contamination from leaded fuel.
- Air leak into the exhaust system.
- Wiring loom damage.
- Sensors fitted incorrectly or cross wired.

In the event of a HO_2S signal failure any of the following symptoms may be observed:
- Default to open loop fuelling on defective bank.
- If the sensors are crossed over (LH bank to RH bank), the engine will run normally after initial start up, but performance will become progressively worse as the sensors go towards maximum rich for one bank of cylinders and maximum lean for the other. The ECM will eventually default into open loop fuelling.
- High CO reading.
- Excess emissions.
- Strong hydrogen sulphide (H_2S) smell until the ECM defaults to open loop fuelling. .
- MIL illuminated (NAS market only).

A number of diagnostic tests are performed by the ECM with regards to the HO_2sensors:
- HO_2 sensor and system diagnostics
- HO_2 sensor heater diagnostics
- HO_2 sensor switching period (ageing) diagnostics
- Rear HO_2 sensor adaption diagnostic (NAS only)
- Catalyst monitoring diagnostic

For further details of the heated oxygen sensors and exhaust emission control, refer to the V8 Emission Control section of this manual.

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