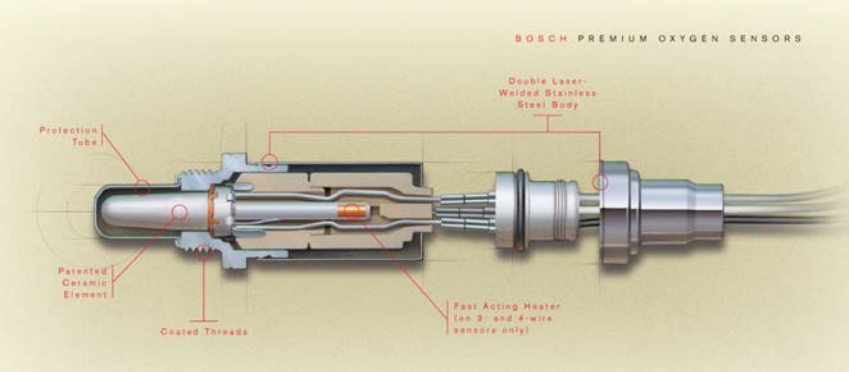
Testing Lambda/Oxygen Sensors



By the time you read this, the mystery of the dodgy-fuel crisis should have been solved, however, at the time of writing; Trading Standards has confirmed that silicone has been found in a fuel sample taken from Cambridgeshire.

Just how much fuel polluted with silicone was sold to motorists is unknown, but it appears that the presence of excessive silicone in petrol is contaminating the engine management system's Lambda / Oxygen, sensor.

Leaded fuel also causes similar problems, so it's little wonder that I for one first blamed lead contamination for the crisis. Anyway, one thing for sure is that the industry will be testing suspect Lambda sensors for some time to come, so to assist you we have put together a few diagnostic reminders:

The Sensor:

The lambda or oxygen sensor is one of the most important sensors on the Engine Management System. It is responsible for maintaining an air to fuel ratio of 14.75 to 1, which is also known as Lambda, hence the name of the sensor. Keeping the engine at Lambda is necessary to achieve the maximum combustion and catalyser efficiency.

The rule with Lambda sensors used to be if it's switching then the engine's mixture or air to fuel ratio is correct. Contamination of the sensor causes it to stop seeing oxygen, so therefore it stops switching and constantly produces 0.8-volts, the engine management system believes that the mixture is rich and therefore progressively weakens the mixture, thus the engine looses power and stops.

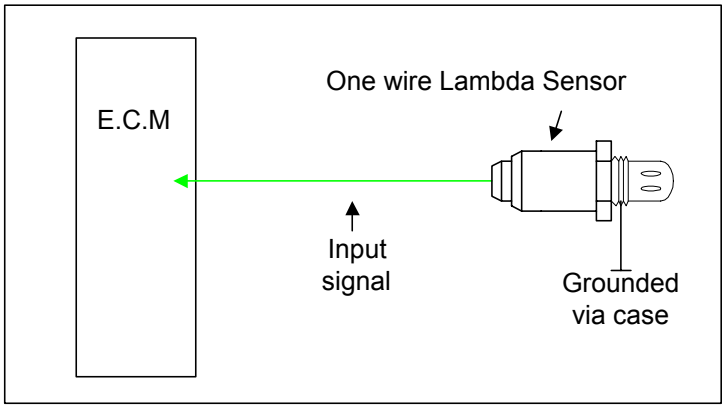
For the last few years we have been seeing two lambda sensors being used, one in front of the catalyst (up-stream) and one behind (down-stream). The up-stream sensor is normally known as a Linear or Broad Band type and is slightly different, in that it doesn't switch, for example, and is explained later.

The original Lambda sensor, known as a switching or planar type, was until a few years ago the only lambda sensor on the vehicle; these however, are still used today on modern twin sensor systems, but are normally positioned after the catalyst and act as a faulty catalyst detection device.

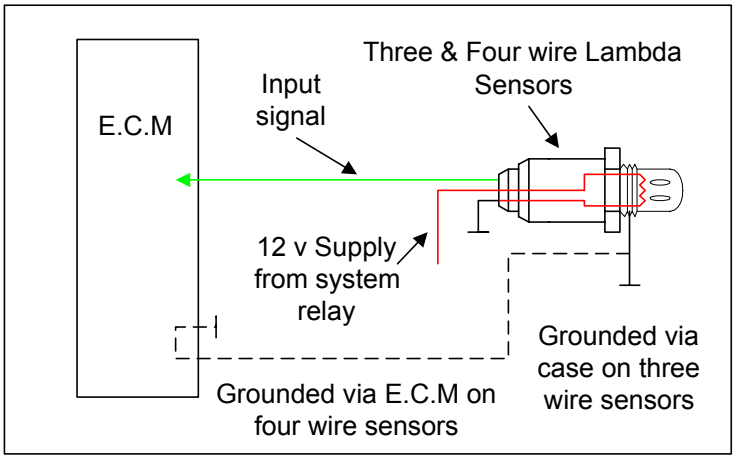
Testing switching or planar type sensors:

Switching or planar type sensors are always terminated using one, three or four wires. Very early designs used just one live wire to transmit the signal to the E.C.U, the sensor's earth was provided by the exhaust pipe. Because Lambda sensors only operate at temperatures above 400 degrees Celsius, it was found beneficial to add a heating element. Therefore, most sensors have three terminals: the first is connected to the sensor's heating element supply wire, the second to the heating element's ground wire and the third is the sensor's signal wire. Again these sensors rely on the exhaust pipe to provide the sensor ground; however, to improve reliability all modern sensors use an independent sensor wire, thus making them four wire devices.

Wiring diagram (single wire switching type)



Wiring diagram (three and four wire switching type)



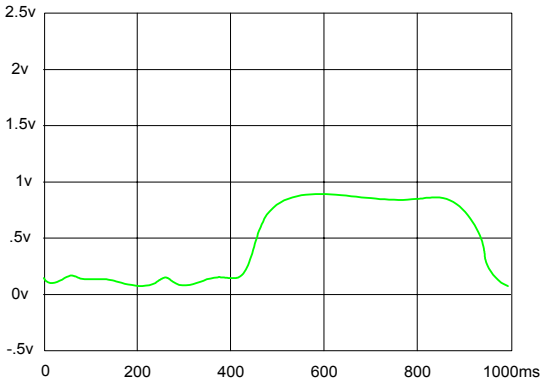
Diagnostic procedure switching or planar type:

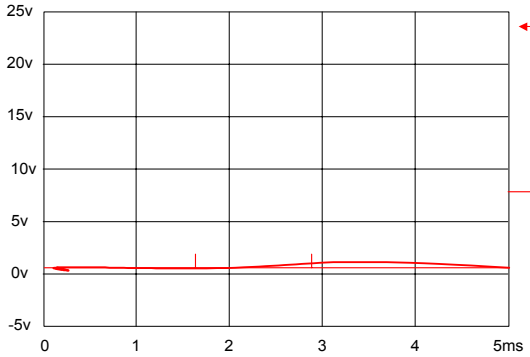
Remember its good policy to check for fault codes before getting involved with in-depth diagnostic voltage checks, however if you need to test an individual sensor then follow this procedure:

Firstly, set the voltmeter to the D.C voltage scale and with all sensor wires connected; connect the voltmeter's positive probe to the sensor's signal wire. Connect your voltmeter's negative probe to the battery's negative connection, and start the engine.

Once hot, Lambda sensors transmit a DC voltage of 0.8 volts when detecting a rich mixture, or 0.2 volts when detecting a weak mixture. Therefore, when the E.C.M receives a voltage of 0.8, it weakens the mixture, and when it detects 0.2 volts, it enriches the mixture. The signal produced by a good sensor, which is operating fault free, should constantly switch between 0.2 to 0.8 volts when operating at normal temperature.

Because the signal from the sensor should be constantly switching, the Oscilloscope is a perfect device for diagnosis. In the waveform shown in green below you can clearly see that the sensor is switching correctly:





Make sure that the engine is hot, if switching signal is still absent but showing a fixed output at .8v then suspect a rich mixture, lead contamination on sensor or faulty sensor.
If showing a fixed output at 0v then suspect weak mixture, hole in exhaust upstream of sensor, open circuit signal wire, no supply/earth to heating element or faulty sensor.

Broad band type:

As mentioned earlier, the broad band or Linear lambda sensor has been used for the past 3 to 4 years as the primary mixture-sensing device and is normally the sensor positioned just in front (up-stream) of the catalyst. They use 5 wires in general and are more difficult to test individually because they transmit a varying current back to the ECU. However, during the past 4 years the vehicle's on board diagnosis system (OBD) has become much more reliable and on the latest systems a faulty or contaminated sensor will always flag a fault code. So it's the best policy with these devices to interrogate the engine management system using your scan tool.

About the GEA:

The GEA was established in 1945 and since then we have been upholding the standards of equipment sold and services provided by our members. All of our members follow a strict Code of Practice, which is agreed to on an annual basis.

So for peace of mind we recommend you purchase your equipment from a GEA Member.

For a full list of members please visit: www.gea.co.uk

Please see listed the GEA members who can advise you on testing Lambda Sensors, Engine Management diagnosis and Scan Tools in general: