www.mazdarotaryparts.com
The Old Rectory Business Centre
Springhead Road, Northfleet, Kent
DA11 8HN t: + 44 [0] 1474 361800

RX-0713

MRP DATASHEET: THE LAMDA SENSOR

What it does and how it works

The Lambda sensor is a post-engine sensor fitted into the exhaust system of a vehicle that measures the amount of Oxygen in the exhaust stream. It signals the ECU (Electronic Control Unit) with a voltage signal relevant to this Oxygen level. The ECU interprets this as an indication of the vehicle's air/fuel mixture strength. It is an essential part of the vehicle's engine management system and the longevity of the catalytic converter is dependant upon its correct operation.

All petrol engined vehicles made for the UK market since 1993 have at least one Lambda sensor fitted. They are normally fitted into the exhaust manifold or down pipe of the vehicle in a position that is as close to the engine as possible. The body shape resembles that of a spark plug.

Vehicles with EOBD (European on Board Diagnostics, year 2000 onwards, for the UK market) may have two sensors fitted, one before and one after the catalytic converter.

The sensor is comprised of a ceramic element, protected by a steel guard-tube that allows gasses to pass through, all housed in a stainless steel casing.

The sensing element in the Lambda sensor is a thimble shaped ceramic tip made from a material known as Zirconium Dioxide (hence the name Zirconia). Mounted on both the outer and inner surfaces are permeable Platinum electrodes. These electrodes carry the sensor's signal through the wires and on to the ECU. The outer surface of the element (thimble) is open to the exhaust gasses and the inside of the element (thimble) is open to atmosphere.

The design of the sensor's tip is such that (when it's up to operating temperature) a difference in Oxygen level between the inner and outer surfaces results in a small electrical voltage being generated. It is this voltage that the ECU measures, the higher the difference in Oxygen levels, the higher the voltage generated. The sensor is "self generating"; hence it acts as a stand-alone part that doesn't need an input for it to operate. The voltage generated is very small with a minimum to maximum output range of only one volt.

Zirconia sensors can have one to five wires. They all have an output wire (normally black). The two and four wire sensors have a separate earth (normally grey). The three and four wire sensors have an internal heater element (to get to operating temperature quicker - normally the two white wires). Please note that wire colours can vary between Lambda sensor manufacturers, the most common ones have been referred to.

Reasons for failure:

There are two principles areas of failure:

1. Heater element

Failure of this results in an elongated warm-up period, increased emissions from cold and possible catalytic converter damage.

2. Sensor element

Contamination of the porous ceramic tips by becoming blocked/polluted, results in poor response to mixture changes or in extreme cases total failure. The pollution can be as a result of chemical pollution from exhaust paste, antifreeze and gasket sealant or from excessive carbon build up due to engine wear or extended service life.

Testing:

The heater can be checked with an Ohmmeter, comparing the reading to known data. A heater failure usually results in an open circuit heater element, thus rendering the heater completely inoperative. This type of failure is very common with the Lean-Burn sensor fitted to the Toyota Carina “E” and Avensis.

Check the output circuit response time by monitoring the output voltage with varying engine load (blip the throttle). There should be an almost instantaneous response. Output voltage can be measured with either a voltmeter or an oscilloscope and should rapidly fluctuate in the region of 0.2 to 0.8 volts. Output response time errors commonly cause MOT failures. The Lambda sensor does not react quickly enough to changing engine loads and speeds, hence at MOT, when the emissions are being checked at a fast idle, the emission levels will rise above the legal limit before settling back down to, possibly, pass the second fast idle test. The cause of this fault is almost always the Lambda sensor.

Bench testing:

Zirconia sensors can also be tested off the vehicle using the gas torch method. For this you will need an accurate digital voltmeter, a bench vice and a gas torch.

Secure the Lambda sensor in the vice; attach the voltmeter positive wire to the Lambda sensor’s output wire (normally black), attach the volt meter negative wire to either the lambdas ground wire (normally grey) or the body of the sensor. Select a voltage scale on the meter suitable to display a 0-1.5 volt reading. Heat up the tip of the Lambda sensor (the part that fits into the exhaust) with the torch and monitor the voltage reading.

Once the sensor is up to operating temperature (usually just as the sensor shield gets to red hot) the sensor will generate an output signal. You should expect the voltage to get close to 1.0 volt (i.e. 0.9+ volts) and then react quickly when moving the torch away from the tip. The test will display if the sensor is operative and its reaction to changing Oxygen levels. Further, resistance checks are necessary to check the heater circuit operation if appropriate.