Lambda Meter
Measurement of parameter $\lambda$ (Lambda)
air / fuel ratio (AFR)

Wide band lambda probe measures the numerical value of the ratio Air Fuel Ratio – AFR or parameter of $\lambda$ (Lambda) by measuring the oxygen content in the exhaust gases, but it can only work in a pair with a special controller.

Lambda Meter is an alternative to expensive gas analyzers that can calculate the value of $\lambda$. It have a very high performance that allows measurement not only on established modes of the working engine, but also on transient engine operation. Connecting the complex to a multi-channel oscilloscope, allows to compare the signals of the sensors and actuators of the engine management system with the air/fuel ratio, which make possible to identify variations of characteristics of sensors, actuators and systems that influence the fuel mixing.

The complex can be applied in adjusting the fuel systems of all types (gasoline, gas, diesel, alcohol, etc.). The most important is its use to fine-tune CNG equipment, carburettors, as well as to fine tune the air/fuel ratio in Chip-tuning.

Air/fuel ratio for petrol engines theoretically is 14.7 kilogram of air for the combustion of each kilogram of petrol (14.7: 1). During the combustion of the mixture, in theory, all the oxygen in the air reacts with the fuel. As a result the exhaust gases do not have any unburned fuel and no free oxygen. This ratio of fuel and air is called the stoichiometric. Stoichiometric air/fuel ratios for the different fuel types are different:

©Diagtools LTD, Injectorservice
The value of the coefficient $\lambda$ (lambda) is the ratio of the actual air/fuel ratio (AFR) to stoichiometric.

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Stoichiometric air to fuel ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unleaded petrol</td>
<td>14.7:1</td>
</tr>
<tr>
<td>Propane (liquefied gas)</td>
<td>15.5:1</td>
</tr>
<tr>
<td>CNG (compressed natural gas)</td>
<td>17.2:1</td>
</tr>
<tr>
<td>Diesel fuel</td>
<td>14.6:1</td>
</tr>
<tr>
<td>Methanol (methyl alcohol)</td>
<td>6.4:1</td>
</tr>
<tr>
<td>Ethanol (ethyl alcohol)</td>
<td>9.0:1</td>
</tr>
</tbody>
</table>

For gasoline engine air/fuel ratio (AFR) is equal to 14.7:1 the value of $\lambda = 1$. When the engine is running on a "rich" mixture, then $\lambda < 1$, and engine emissions contains unburnt fuel. If the engine runs on "poor" mixtures, then $\lambda > 1$ and exhaust gases contains free oxygen.

In most cases, for petrol engine best fuel-air mixture is with a value of $\lambda = 0.95.1$. If the engine management system with the two-level lambda probe, then lambda regulation (air/fuel ratio) on established modes of the engine is maintained with the mean value $\lambda = 1$.

The maximum power of the gasoline engine can be reached when the engine is running on the "enriched" fuel/air mixture in the following indicative values of the coefficient of lambda: $\lambda = 0.8 \ldots 0.9$ for atmospheric petrol engines; $\lambda = 0.75 \ldots 0.85$ for gasoline Turbo-charged engines and engines with Turbo compressor.

The maximum efficiency can be reached by the gasoline engine, when the engine is running at established medium revolutions with "poor" mixture of air/fuel with $\lambda = 1.04 \ldots 1.08$. 

©Diagtools LTD, Injectorservice
Wideband lambda probe controller allows measure the numerical value of the air/fuel ratio (AFR) or the numerical value of the coefficient $\lambda$ (lambda) on the working engine by measuring the oxygen content in the exhaust gases using a wideband lambda sensor.

Procedure for measurements.

For measurements, it is needed to install a wideband oxygen sensor in the exhaust stream and connect it to the controller.

Turn the holder of broadband lambda probe so that the sensor is in the position between 10:00 and 14:00 on the analog clock.

**Attention:**

Never install the sensor below the horizontal, as this could cause accumulations of condensation and consequent breakage of sensor.

Connect wideband lambda probe controller to the battery of the car.
Preparing the controller for use.

Before using the controller, as well as in case of replacement of the wideband lambda sensor, do the following:

- Do not connect a wideband lambda sensor to the controller;
- Connect wideband lambda probe controller to the battery of the car and wait for 10 seconds;
- Disconnect the controller from the battery;
- Connect to a wideband lambda probe;
- Make sure that the lambda probe is in pure ambient air;
- Connect wideband lambda probe controller to the battery of the car and wait 2 minutes. The controller is ready for use when the indicator changes to flashing constant glow.

For maximum accuracy, it is recommended that you periodically perform the calibration of the device by atmospheric oxygen. For calibration, you must:

- Connect to a broadband oxygen sensor;
- Make sure that the lambda probe is in pure ambient air;
- Connect wideband lambda probe controller to the battery of the car and wait for 1 minute;
- Press and release for the 1 second red button "Calibration" and wait 30 seconds. Continuous lighting indicator indicates a readiness for use.

Wideband lambda probe holder.

Make broadband lambda probe holder can be of a steel tube with a diameter of 35 mm and 400 mm long by inserting into the pipe coupling for the lambda probe controller as indicated below.
When measured insert the lambda sensor holder to the long side to the exhaust, it is necessary to exclude the possibility of air inleakage. To back his side be sure to connect the rubber pipe of suitable diameter not less than two metres long, to prevent mixing of atmospheric air to exhaust gases.

Instead of broadband lambda probe holder, you can use the pipe of Venturi for wideband lambda sensor.

Pipe of Venturi for lambda probe can be made following to the drawing above.

For the making of pipe of Venturi for wideband lambda probe would require turning and welding works.