

RayTechAutomotive

LambdaKing MkII - Instruction Manual

Application

The LambdaKing MkII® is an automotive workshop tool for measuring the air to fuel of exhaust gas. The LambdaKing MkII® will work with any piston engine running on gasoline, diesel, LPG, E85 and methanol. The device comes with a LSU4.9 wide band sensor that can be inserted into an existing M18x1.5 socket in the vehicle's exhaust or into the weld-on socket that is supplied with the kit.

The LambdaKing MkII® is designed to provide a compact, easy to use and economical exhaust gas analyzer for home and workshop use.

This Instruction Manual must be read in conjunction with the Workshop Manual of the vehicle before using the LambdaKing MkII®. Before proceeding the user should, as a minimum, be familiar with the the device, understand the air to fuel ratio concept, and have working knowledge of adjusting the vehicle's fuel system.

CAUTION

1. **Inappropriate adjustments to the fuel system can lead to major engine damage.**
2. **The Wideband Sensor will become hot enough to cause burns or start a fire when connected to a power supply.**

Features:

1. Australian designed and manufactured.
2. High quality and robust housing.
3. Digital display for Lambda and AFR reading.
4. Bar indicator.
5. Selectable Lambda or AFR Readout.
6. Selectable fuel type (Gasoline, Diesel, LPG, E85, Methanol)
7. No separate battery required.
8. Reverse polarity protection.
9. Auto calibration function at startup.
10. 1-year limited warranty for the original Purchaser.

The package includes:

- 1 x LambdaKing MkII® device, c/w integrated power and sensor leads.
- 1 x LSU 4.9 Wide Band Oxygen Sensor.
- 1 x M18 x 1.5 socket.
- 1 x M18 x 1.5 plug.
- 1 x Tool Pouch.
- 1 x User manual.

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Device Description

1. 30 segment Bar Display - Graphical display of the air to fuel ratio (AFR). Range: Lambda 0.75- 1.25. The two centre led segments will be lit a stoichiometric point (Lambda=1). The leftmost LED will be lit for Lambda values of 1.25 and greater.
2. Main Display - Shows the current AFR or Lambda (selectable). Range 0.67 - 6.50 for gasoline.
3. Pushbutton Mode - Select Lambda or AFR mode.
4. Pushbutton Fuel - Select fuel type.
5. LEDs on the front panel indicate the current operating mode of the device.
6. Power Cable - Connects to the vehicle's battery or external battery to provide power to the LambdaKing MkII®. (Using the battery of a running vehicle is recommended.)
7. Sensor Cable - Connects the Wide Band Sensor to the LambdaKing MkII®.
8. LSU 4.9 Sensor - Wide band sensor; Screws into the M18 x 1.5 socket on the exhaust, connects to the sensor cable connector.
9. M18 x 1.5 Socket - Stainless steel socket for welding onto the exhaust.
10. M18 x 1.5 Plug - For plugging the socket when the wide Band Sensor is not connected.

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Figure 1 - Device Overview

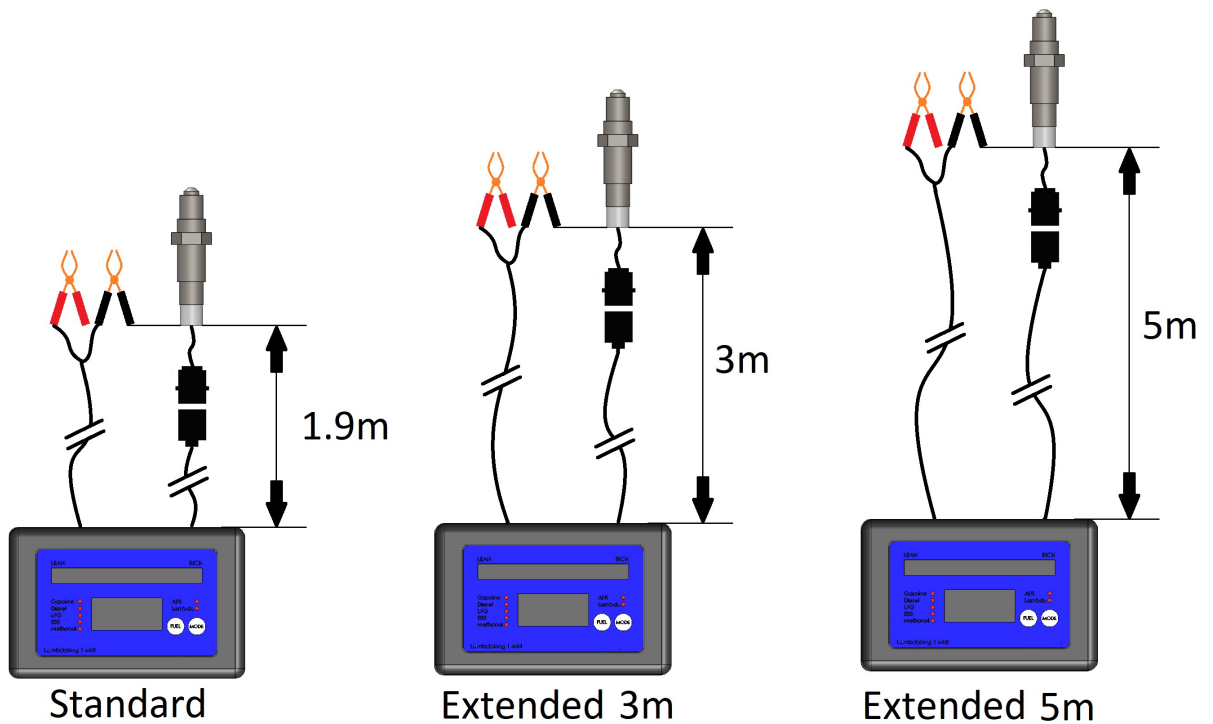


Figure 2A - Cable Lengths

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Connections

Figure 2 below shows the LambdaKing MkII® connected to the wideband sensor and battery.

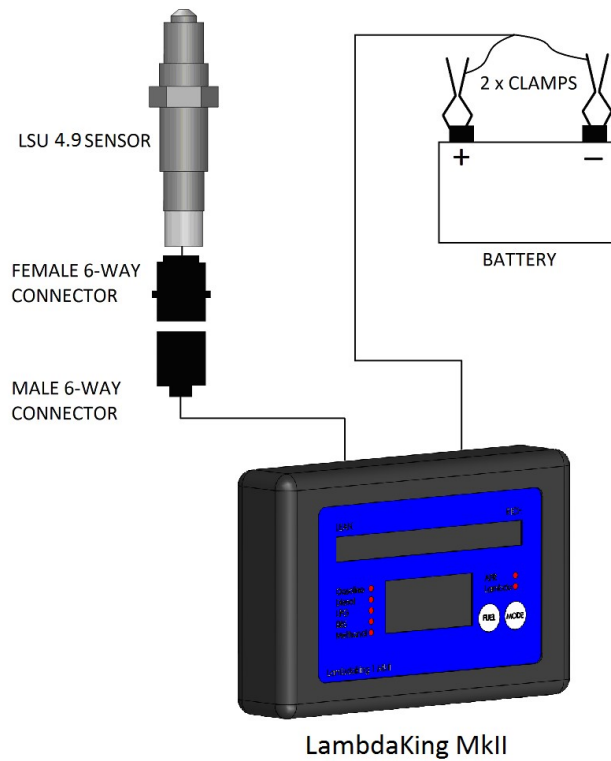


Figure 3 - Connection Schematic

Air-to Fuel ratio and Lambda

The stoichiometric ratio is the combustion of fuel with exactly the correct amount of air. For instance it takes 14.7 kg of air to fully combust 1 kg of gasoline, in which case the Air-To-Fuel (AFR) is 14.7. The stoichiometric ratio is different between fuel types; a list of ratios for fuel types covered by the LambdaKing MkII® is given in the table below.

An air to fuel ratio greater than stoichiometric ratio is referred to as a 'lean' mixture (ie 15.8 on a gasoline engine), whereas an AFR below the stoichiometric ratio is a 'rich' mixture (ie 12.9 on a gasoline engine).

The air-fuel equivalence ratio, λ (lambda), is the ratio of actual AFR to the ideal stoichiometric mixture:

$$\lambda = \text{Air to fuel ratio} / \text{Stoichiometric ratio}$$

For instance, say an engine running on methanol produces an AFR of 7.2; The stoichiometric ratio for methanol is 6.47. In that case, $\lambda = 7.2/6.47 = 1.11$, indicating that the engine is running lean.

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It is up to the user to adjust the vehicle's fuel system to achieve the desired AFR under varying circumstances, but commonly used values -for gasoline engines- are:

- Lambda = 0.8 - Throttle wide open, maximum acceleration
- Lambda = 1.0 - Idle and cruise
- Lambda = 1.4 - Fuel cutoff (throttle closed and at high revs)

The Lambda = 1.00 value should not be taken as the 'ideal' or target value for all conditions.

Sensor placement (applies only to permanently installed sensors)

Wideband sensors can be damaged if powered up when wet. This can occur when the sensor is installed in an inappropriate location in the exhaust, causing water to condensate inside the sensor element. In order to minimize this risk, the sensor should ideally be installed at a 10 degree angle as shown below:

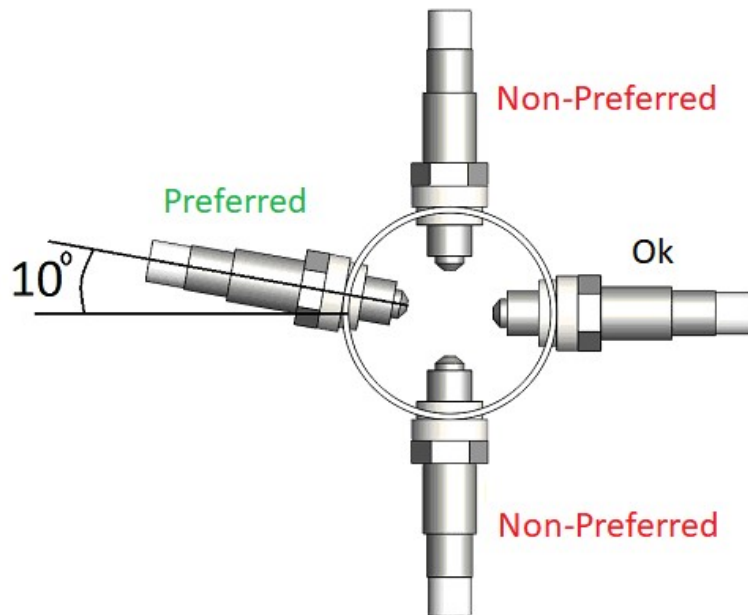


Figure 4 - Sensor Placement

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About wideband sensors

Wideband sensors are sensitive devices that can be easily damaged if handled improperly. Wideband sensors can be damaged by contaminants such as:

- Fuel
- Oil (*)
- Lead (from leaded fuel)
- Coolant
- Lubricants
- Water
- Soot

Thermal shock and excessive heat from the exhaust gas too can damage or destroy the sensor element. Prolonged exposure to gasses hotter than 800⁰C should be avoided.

Since there is no way for RayTechAutomotive to verify if the sensor has been mishandled or exposed to contaminants, the warranty on the sensor is limited to only dead-on-arrival cases. The rest of the hardware is fully covered by our 12 month Warranty.

(*) Use on 2 stroke engines: Since 2 stroke engine can eject small amounts of oil through the exhaust, RayTechAutomotive does not recommend the use of LambdaGauge® on 2 stroke engines.

Operation

The following paragraphs describe the generic procedure for measuring the AFR.

Option 1 - Welding on the socket

1. If the vehicle is not fitted with an M18 x 1.5 socket, select an appropriate location on the exhaust for it to be installed. Bear in mind the length of the Wideband Sensor.
2. Drill a 22 mm hole in the desired location. (*)
3. Place the socket in the hole in the exhaust.
4. Tack-weld the socket onto the exhaust and check the position relative to the hole.
5. Fully weld the socket onto the exhaust (consider heat input).
6. Clean up the internal thread of the socket using a M18 x 1.5 tap.

() Alternatively, the socket may be fitted flush with the exhaust, requiring only a 15mm hole. This method is not preferred.*

Option 2 - Use a tailpipe adaptor

1. Use a snifstick® tailpipe adaptor (sold seperately).

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Measure AFR/Lambda

1. Screw-in the Wideband Sensor into the socket.
2. Connect the plug on the Wideband Sensor cable to the socket at the end of the sensor cable.
3. Start the engine.
4. Connect the clamps of the power cable to the battery terminals (requires 12-14.2V).
Caution - Observe correct polarity.
5. The LambdaKing 1 MkII® will start the sensor warmup sequence. The main display will show 'H' until the sensor reaches operational temperature. Depending on the outside temperature and the line voltage, this may take up to 1 minute (**note 1**).
6. Once the sensor has reached operational temperature, the device will start displaying the current Lambda value (**note 2**).
7. Switch between AFR and Lambda mode as desired.
8. Select the fuel type as desired.
9. Adjust the vehicles fuel system as required to obtain the desired AFR.
10. Once completed, stop the engine.
11. Disconnect the LambdaKing MkII® from the power supply.
12. Allow to cool down. Disconnect the Sensor from the Sensor cable by pressing the unlatch lever on the sensor cable connector. (**note 3,4**)
13. Install the plug.

Note 1 - Do not leave the device powered up without also running the engine. Doing so will require all heat for the sensor element, in absence of hot exhaust gas, to be supplied electrically through the device. This can result in thermal shutdown of the electronics and/or draining of the battery.

Note 2 - The default display settings are Gasoline and Lambda.

Note 3 - Never pull on the cables directly.

Note 4 - Caution the sensor will be extremely hot after use.

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Error Codes

The following error codes will appear on the screen if an abnormal condition is detected.

C	<p>(Blinking). Indicates low sensor temperature that can affect the measurement. Occurs when the electrical heat supply cannot keep up with the heat drawn away from the sensor element by the exhaust gas.</p> <ul style="list-style-type: none"> • Wait for the engine to warm up • Increase supply voltage. It is best to run from the vehicle's own power supply
E.01	<p>Sensor connection fail - Faulty connector or wiring, faulty sensor</p> <ul style="list-style-type: none"> • Check wiring and connections • Replace sensor
E.02	<p>Under Voltage – Supply voltage below 12.0 V for 3 or more seconds</p> <ul style="list-style-type: none"> • Check connections • Measure supply voltage • Check vehicle charging system
E.03	<p>Over voltage – Supply voltage greater than 15.0 V 3 or more seconds</p> <ul style="list-style-type: none"> • Measure supply voltage • Check vehicle charging system
E.04	<p>Abnormal sensor output – Faulty sensor or wiring</p> <ul style="list-style-type: none"> • Check wiring and connections • Replace sensor
E.05	<p>Voltage spikes detected. – Vehicle's charging system producing voltage surges.</p> <ul style="list-style-type: none"> • Inspect/repair vehicle's charging system • Use an external power source.

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Specifications

Dimensions	122 x 78 x 26	mm
Sensor/Plug thread size	M18 x 1.5	mm
Plug thread torque	28	Nm
Sensor cable length (including sensor lead) - Standard	1900	mm
Power cable length - Standard	1900	mm
Sensor cable length (including sensor lead) - Extended 3m	3000	mm
Power cable length - Extended 3m	3000	mm
Sensor cable length (including sensor lead) - Extended 5m	5000	mm
Power cable length - Extended 5m	5000	mm
Supply Voltage Min (*)	12.5	V
Supply Voltage Max	14.8	V
Current draw, peak	2.2	A
Current draw, typical (engine running)	0.8	A
Operating temp, controller Min	-5	deg C
Operating temp, controller Max	50	deg C
Operating temp, sensor Max (sensor tip)	925	deg C
Measuring range AFR (main display)		
<i>Gasoline</i>	9.9...95.5	-
<i>Diesel</i>	9.7...94.1	-
<i>LPG</i>	10.5...99.9	-
<i>E85</i>	6.4...63.7	-
<i>Methanol</i>	4.1...42.2	-
Measuring range Lambda (main display)	0.67...6.50	-
Measuring range Lambda (bar graph)	0.75...1.25	

(*) Under circumstances where there is a high demand on the heater element (ie due to a cold exhaust), the minimum voltage to maintain sensor temperature might be higher. In most cases the demands reduces as the engine heats up. It is recommended to run from the vehicles's own electrical system.

Limited Warranty -

The LambdaKing 1 MkII® comes with a limited 1-year warranty for the original purchaser. An exception applies for the wideband sensor as described in section 'About Wideband Sensors' above. RayTechAutomotive will repair, replace or refund any unit that has been determined to be faulty by RayTechAutomotive in material or workmanship during the warranty period. Any warranty claims must be submitted to info@raytechautomotive.com. Opening of the Device will void the Warranty.

The customer is liable for return shipping. RayTechAutomotive will pay for shipping back to the customer, only if the device has been determined to be defective by RayTechAutomotive.

RayTechAutomotive does not guarantee the fitness of its products for any purpose other than described in this manual. RayTechAutomotive shall not be liable for any loss from use of the product or accidental or consequential damages.