Application

The RayTechAutomotive LambdaGauge® is a 53mm (2-1/16") digital wideband Air/Fuel ratio (AFR) gauge for live display of the AFR. The device is intended for permanent installation in cars and comes with all parts required for standard installation. The compact and lightweight design maximises the number of installation options. The LamdaGauge is available with a white and a black faceplate.

The LambaGauge features high accuracy, ultra wide range and many configuration features.

The user should read and understand this manual before installation.

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.**
3. **A supply voltage greater than 14.6V may cause damage to the gauge.**

Features:

1. Super compact CNC machined ABS housing.
2. Standalone unit, no need to install separate electrical boxes.
3. Selectable AFR or Lambda Display.
4. Suitable for Gasoline, Diesel, LPG, E85 and Methanol (caution notes apply). Custom fuel type programming available on request.
5. Super fast response, configurable in 10 levels to suit track, sport and road applications.
6. Resolution 0.01 Lambda, accuracy between 0.8 and 1.2 Lambda: 0.01 or better (with included wideband sensor).
7. Graduating LED ring color.
8. Wide measuring range – 0.67 to 6.5 Lambda (numerical display, gasoline)
9. Automatic brightness adjustment for day and night use, 10 levels. Automatic switching between day and nigh time settings (when connected to the vehicles light system).
10. Free air calibration function.
11. Closed-loop sensor heating control system that accurately controls the sensor temperature. The softstart function ensures the controlled gradual warmup of the sensor during startup, which prevents sensor damage and thermal shock, and maximizes sensor life.

The package includes:

- 1 x LambdaGauge® device.
- 1 x Panel mounting U-bracket.
- 2 x M5 x 10 buttonhead screws
- 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 Wiring harness.
- 4 x Wire splice connectors.
- 1 x User manual.

Device Description

1. 24 segment LED ring display – Graphical display of the air to fuel ratio (AFR). Range: Lambda 0.65 – 1.4. The LED colour gradually changes from red (lean) to green (near stochoimetric) to orange/red (rich)

2. Main Display – Shows the current AFR or Lambda (selectable). Also displays settings menu items. (see 'settings' below).

3. Pushbutton – To access and adjust settings.

4. Wire harness – 4-way power connection and 6-way sensor connection.

5. Panel mounting bracket kit.

6. LSU 4.9 Sensor – Wide band sensor; Screws into the M18 x 1.5 socket on the exhaust, connects to the sensor cable connector.

7. M18 x 1.5 Socket – Stainless steel socket for welding onto the exhaust.

8. M18 x 1.5 Plug – For plugging the socked when the wide Band Sensor is not connected.

Figure 1 – Device Overview

Installation – Sensor

1. If the vehicle is not already 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. Consider the 'Sensor Placement' notes below.

2. Drill a 22 mm hole in the desired location. (Applies only to the standard socket that comes supplied with the kit)

3. Place the socket in the hole in the exhaust.

4. Tack-weld the socket onto the exaust 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.

Sensor placement
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 prevent this, the sensor should ideally be installed at a 10 degree angle as shown below.

The wideband sensor is generally recommended to be installed near any existing AFR sensor as this ensures that the wideband sensor receives the design intended heat input. Cable length must be considered too.
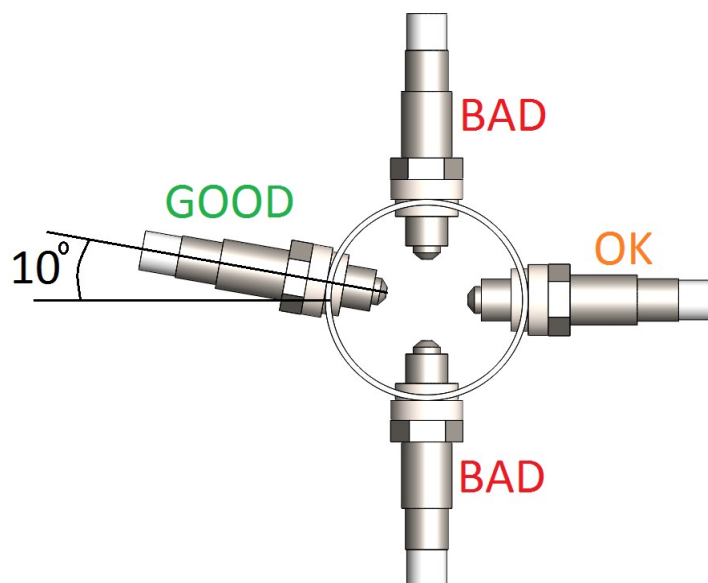
Figure 2 – Sensor Placement

About wideband sensors

Wideband sensors are sensitive devices that can be easily damaged if handled improperly and are sensive to shocks and drops. 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 800^0C 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.

Installation – Gauge

- Select a suitable installation location and cut a hole 53-55mm hole.

- Alternatively use a gauge pod (sold seperately).

- The Gauage should not be installed in a position where it is in direct sunlight.

- The standard U-bracket and bolts (both included) allow a for a panel thickness of up to 3.2mm.

- **IMPORTANT** – Apply 2.5Nm of torque, ie finger tight.

- If the panel thickness requires longer than the included 10mm M5, then the user must make sure that the alternative bolts are **not too long and touch the circuitboard inside the gauge.**

- Run the power and sensor cables as shown in figure 3 – Ensure that the cables are kept away from the hot exhaust.

- Make the electrical connections as shown in figure 3. The 4 included splice connectors can be used. Solder connections are the most reliable and durable option.

- Plug in the power and sensor connectors at the back of the sensor. (4 and 6 way respectively, keyed).

Connections

Figure 3 below shows the LambdaGauge® connected to the wideband sensor and vehicle.
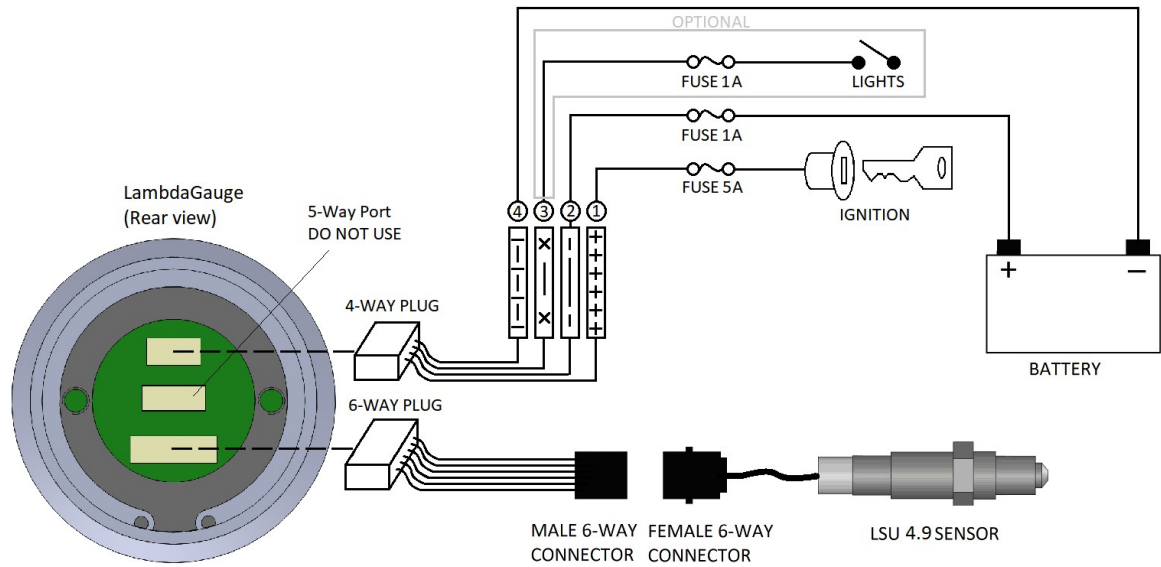
Figure 3 – Connection Schematic

Wire No	Function	Notes	Current
1	12V Power supply, switched	Brings the device out of sleep mode when powered. Supplies power to the sensor heater.	Up to 3.0A
2	12V Power supply	Sleep power supply. To be connected to 12V permanently. Disconnection will reset the device and revert back to default settings.	<20mA
3	Lights-on sense line	[Optional] – To be tee'd into the vehicle light system. Applying 12V will cause the gauge to switch brightness from day to night mode. Not connecting this wire will result in the LamdaGauge operating in daytime brightness always.	<1mA
4	Ground		Up to –3.1A

Note: Do not connect to the 5-way port. This port has no user functions.

Note: The fuses shown in the diagram above are not necessarily dedicated newly installed fuses; The LamdaGauge should be powered from existing, fused circuits already on the vehicle wherever possible to keep the installation clean and simple.

Settings

The LambdaGauge has a number of settings that can be adjusted by the user to make the device best suit the vehicle and user preferences.

The device comes pre-programmed with default settings that will suit most applications.

Each setting can be accessed by **pressing and holding** the pushbutton until the required setting is displayed. See figure 4 for the complete menu structure. Once the required setting is displayed, the value can adjusted by a **short press** on the pushbutton.

Operating mode
Shows live measurement.

Display mode [d 0]
Switch between Air Fuel Ratio (AFR) and Lambda display.
D 0 – Show Lambda
d 1 – Show AFR
Default: AFR

Brightness Daytime [bd7]
Sets the desired brightness level during daytime operation (lights off).
Range: 0 (dim) to 9 (bright).
Default: 7

Brightness Nighttime [bn3]
Sets the desireds brightness level during nighttime operation (lights on).
Range: 0 (dim) to 9 (bright).
Default:3

Fuel Mode [F 1]
Sets the fuel type.
1 – Gasoline
2 – Diesel
3 – LPG
4 – E85
5 – Methanol
Default: 1

Responsiveness [r 5]
Sets the desired responsiveness
Range: 0 (dynamic) to 9 (stable).
Default: 5

Selecting a small responsiveness setting will result in a fast but less stable reading and vice versa.

Calibration [Ca5]
Initiated the free air calibration (see below).
Shows '5' initially. Each button press will decrease the number by one. Once 0 is reached, the device will start the free air calibration sequence. This will be confrirmed by 'CaL' flashing on the display.

```
            ▼
    ┌─────────────────────┐
    │   Operating Mode    │
    └─────────────────────┘
            ▼
    ┌─────────────────────┐
    │  Display Mode [D 0]  │
    └─────────────────────┘
            ▼
    ┌─────────────────────┐
    │ Brightness Day [bd ] │
    └─────────────────────┘
            ▼
    ┌─────────────────────┐
    │Brightness Night [bn ]│
    └─────────────────────┘
            ▼
    ┌─────────────────────┐
    │    Fuel Mode [F ]    │
    └─────────────────────┘
            ▼
    ┌─────────────────────┐
    │  Responsiveness [r ] │
    └─────────────────────┘
            ▼
    ┌─────────────────────┐
    │   Calibration [Ca ]  │
    └─────────────────────┘
```
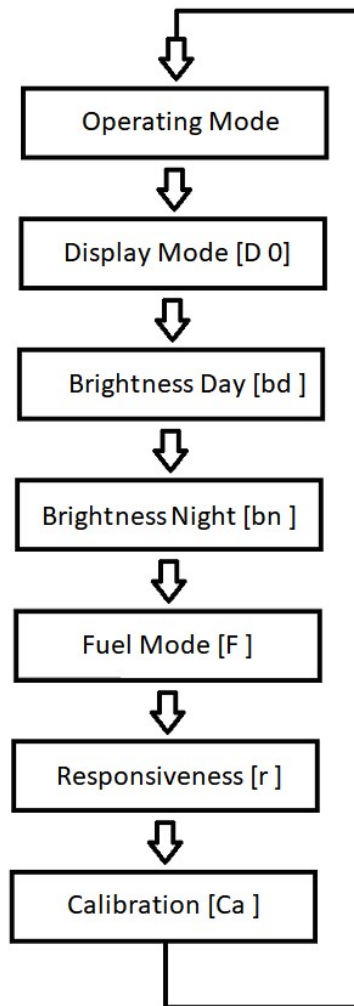
Figure 4 – Menu Structure

Free air calibration

The LambdaGauge is factory calibrated with the wideband sensor and **will not require** free air calibration. The free air calibration function is provided for:

1. When sensor wear is suspected. This will be made evident when a permanent drift of the sensor is observed due to aging of the sensor. This is not to be confused with an offset caused by actual changes in AFR.

2. When a 3rd party sensor is used.

The free air calibration fuction will apply a small offset to compensate for any sensor deviations.

Removing power from standby power wire No.2 will nullify the free air calibration offset and the free air calibration will need to be repeated.

To run the auto calibration, proceed as follows:

1. Remove the wideband sensor from the exhaust (when cold and powered off) and connect it to the LamdaGauge. Ensure that the wideband sensor is hanging in clean outside air.

2. Switch the ignition on which will power up the LamdaGauge. Do not start the engine. Note that the Wideband sensor will draw all current from the battery at this stage. **Ensure that the battery can maintain at least 12.8V for a few minutes. Use an external power supply as required.**

3. Wait for the LamdaGauge to complete the warmup cycle and to start indicating.

4. Call up the free air calibration from the menu options [Ca5]. Press the button 5 times to initiate the calibration sequence. The gauge wil flash 'CaL' for a few minutes. The sensor will get very hot.

5. After completion, reinstall the sensor and resume normal operation.

Operation notes

- When starting cold, the LamdaGauge will gradually ramp up the electrical power supply to the wideband sensor. During this phase the display will show ' H ' and the LED ring will indicate the sensor temperature from cold (full left) to hot (full right). Measurement will start when Wideband sensor reaches operational temperature. This process takes about 1 minute depening of outside and exhaust gas temperature.

- The gauge will take a few seconds to stabilize after the heating sequence is completed. This is normal.

- The LED ring colors do not suggest the AFR to be 'good', 'bad', 'too high', 'too low' etc. The user is responsible for interpretation of the readings inconsideration of their tuning objectives and the operational conditions.

- Bypass valves, exhaust recirculation valves, bleed valves, ECU switching cruise/fuel cutoff/full acceleration modes, power mode, economy mode, slow or inhomogeneous exhaust gas, exhaust leaks can all affect the AFR reading.

- Diesel Engines can produce very high AFR numbers due to the nature of their combustion process. Values significantly greater than Lamba 1 or AFR 14.5:1 are not abnormal.

- The LamdaGauge has error messaging for various abnormal conditions as listed below. The error message will override the normal reading until the fault is cleared.

Error Codes

E.01	Sensor connection fail - Faulty connector or wiring, faulty sensor • Check wiring and connections • Replace sensor
E.02	Under Voltage – Supply voltage below 11.2V for 3 or more seconds • Check connections • Measure supply voltage • Check vehicle charging system
E.03	Over voltage – Supply voltage greater then 14.6V 3 or more seconds • Measure supply voltage • Check vehicle charging system
E.04	Abnormal sensor output - Faulty sensor or wiring • Check wiring and connections • Replace sensor

Specifications

Dimensions		
Maximum panel thickness with standard bolts	3.2	mm
Sensor/Plug thread size	M18 x 1.5	mm
Sensor torque	28	Nm
M5 bolt torque	2	Nm
Sensor cable length (including sensor lead)	3000	mm
Power cable length	1500	mm
Supply Voltage Min.	12.5	V
Supply Voltage Max.	14.6	V
Current draw, peak	3.0	A
Current draw, typical (engine running)	0.8	A
Current draw, sleep made	6	mA
Operating environment temp, Gauge Min	-5	deg C
Operating environment temp, Gauge Max	40	deg C
Operating temp, sensor Max (sensor tip)	925	deg C
Measuring range AFR (main display)		
Gasoline	9.8...95.5	-
Diesel	9.7...94.1	-
LPG	10.5...99.9	-
E85	6.3...64.5	-
Methanol	4.1...44.4	-
Measuring range Lambda (main display)		-
Gasoline	0.67…6.50	-
Diesel	0.66...6.48	-
LPG	0.66...6.46	-
E85	0.65…6.58	-
Methanol	0.63…6.84	-
Measuring range Lambda (LED ring)	0.65...1.4	-

Limited Warranty -

The RayTechAutomotive LambdaGauge® 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 resulting from use of the product or accidental or consequential damages.