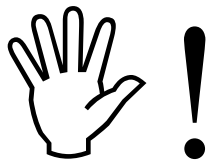
# *Installation Instructions for 30-4100*

# Gauge-Type UEGO Controller

**WARNING:**



**This installation is not for the electrically or mechanically challenged! Use this sensor with <u>EXTREME</u> caution! If you are uncomfortable with anything about this, please refer the installation to an AEM trained tuning shop or call 800-423-0046 for technical assistance. You should also visit the AEM Performance Electronics Forum at http://www.aempower.com**

**NOTE: AEM holds no responsibility for any engine damage that results from the misuse of this product!**

**This product is legal in California for racing vehicles only and should never be used on public highways.**

**AEM Gauge-Type UEGO Controller Parts**

1 x UEGO Gauge Assembly
1 x UEGO Sensor
1 x O2 Sensor Bung
4 x Butt Connectors
1 x Installation Instruction

**Replacement O2 Sensor Components**

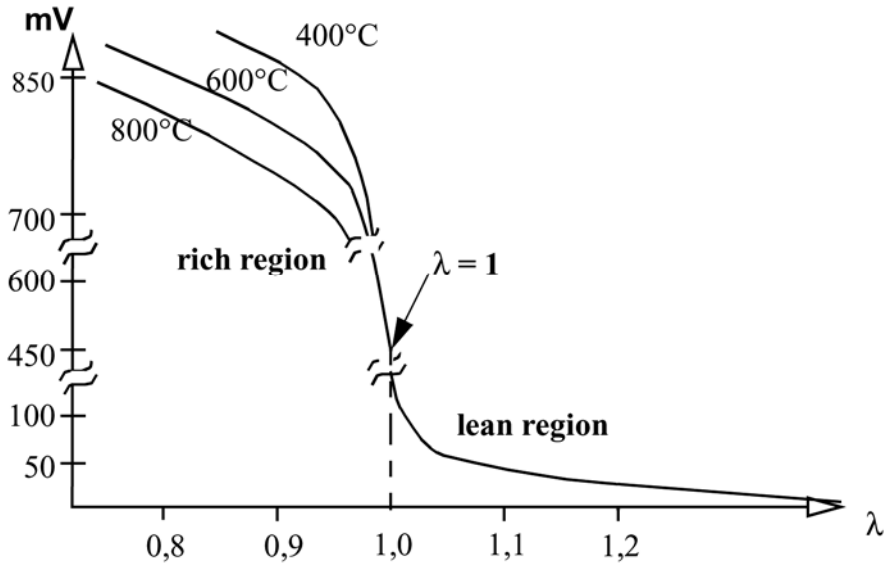
30-2001 UEGO Sensor
35-4005 Mild Steel Oxygen Sensor Bung (welding required)

**ADVANCED ENGINE MANAGEMENT INC.**
2205 126th Street Unit A, Hawthorne, CA. 90250
Phone: (310) 484-2322 Fax: (310) 484-0152
http://www.aempower.com
Instruction Part Number: 10-4000 Rev 4

Congratulations! The 52mm (2-1/16”) AEM Universal Exhaust Gas Oxygen (UEGO) Gauge features a digital readout and sweeping 24 color-coded light emitting diode (LED) display, providing immediate reference to the engine air fuel ratio (or lambda) in real-time. The AEM gauge is ideal for all vehicles including carbureted applications and engine dynamometers. A user-programmable 0-5V analog output is included and can be used with data loggers as well as most Electronic Fuel Injection (EFI) systems including the AEM Engine Management System (EMS). A serial data stream is also integrated for air fuel (or lambda) ratio output to a RS-232 com port.

Because the AEM gauge utilizes the internal AEM UEGO controller and Bosch UEGO Sensor, it is accurate and repeatable to 0.1 of an air/fuel ratio point! With this, there is no abrupt oscillation as found in many competitor gauges, which utilize a narrow band oxygen sensor detecting only stoichiometry.

Typical production vehicle oxygen sensors rely on “Nernst Cell” technology, commonly called “Narrow Band” and sometimes erroneously described as “Wide Band”. This is a very cost effective method that outputs a voltage based on the oxygen content of the gas being sampled. It is accurate in the region surrounding stoichiometric operation and leaner. Unfortunately, in the rich region where high performance engines usually operate, their accuracy and repeatability is virtually non-existent.




***Characteristic curve of a Nernst Cell O2 Sensor***

The rich region output of narrow band O2 sensors is temperature dependant, which renders it useless if an accuracy better than 1.5:1 AFR is desired. This is immediately obvious given the fact that a single output voltage actually represents wildly different air fuel ratios depending on the unregulated and unmeasured sensor temperature. These sensors were designed for operating closed loop around stoichiometry (14.64:1 for gasoline), and for performance tuning they are useless.

The heart of the AEM gauge is the Bosch LSU4.2 Universal Exhaust Gas Oxygen (UEGO) sensor. This type of sensor is commonly referred to as “laboratory grade” and works on a different principle than the narrow band oxygen sensor found in most

vehicles. Its unique design makes precision AFR measurements possible over the entire operating range.

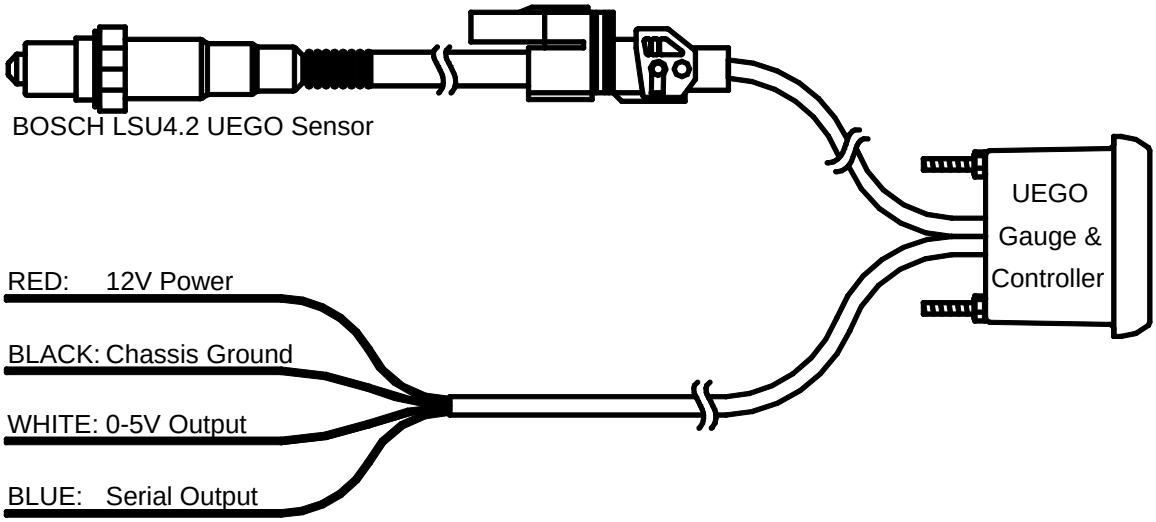
UEGO sensors use a “current pump” to determine the actual oxygen concentration within the sensing element or. The output is in the form of a very small current, which varies depending on the air-fuel ratio. This is completely different from a narrow band oxygen sensor, which directly outputs a voltage. The UEGO sensor design allows measurement of the exact air fuel ratio over the entire operating range.

Each AEM UEGO sensor is individually calibrated and a resistor integral at the connector body is laser trimmed with this value. This process replaces the traditional “free air” calibration procedure when changing sensors and implements a sensor specific calibration for unparalleled accuracy.


***UEGO Sensor laser etched calibration resistor***

## INSTALLATION

Disconnect the negative (-) battery cable. There are four flying leads from the AEM UEGO Gauge. Connection for two of the wires is mandatory and optional for the other two, as shown below.



RED <*Power*>
Connect to a switched 10-18 volt power source utilizing a 10A fuse.

BLACK <*Ground*>
Connect to a clean power ground.

*WHITE <*Analog Output*><***optional hookup***>
Connects to any Stand Alone ECU unit that accepts a 0-5 volt input.

*BLUE <*Serial Output*><***optional hookup***>
Connects to a RS-232 com port for hyper-terminal data logging.

**optional (see below)*

**Analog Output**
If the AEM UEGO gauge is to be connected to an AEM EMS, the UEGO gauge's WHITE Analog Output wire shall be connected to an EMS Lambda input. Locating a suitable Lambda input channel can be done using the Application Notes provided with the EMS. If the Application Notes are not readily accessible, a current list of AEM Engine Management Systems is illustrated below.

***Lambda input channel locations of current EMS application list ( see EMS instructions for ECU connector pictures)***

| AEM EMS P/N | Lambda #1 Pin | Lambda #2 Pin |
|---|---|---|
| 30-1000/1001/1002/1040 | D14 | D16 |
| 30-1010/1012/1050/1052 | C16 | A23 |
| 30-1020/1060 | D7 | D14 |
| 30-1030/30-1070 | C13 | C14 |
| 30-1100/1101 | B47 | B48 |
| 30-1110 | 1C | 9C |
| 30-1120/1121/1130 | B6 | B14 |
| 30-1300 | 4 | 66 |
| 30-1310/1311/1312/1313 | 76 | 75 |
| 30-1400 | 29 | 43 |
| 30-1401 | 44 | 43 |
| 30-1510 | C2-31 | C2-33 |
| 30-1600/1601/1602/1603 | 19 | NA |
| 30-1610/1611/1612 | 46 | 52 |
| 30-1620/1621/1622 | 29 | 55 |
| 30-1710 | 2N | 4J |
| 30-1720 | C3 | D3 |
| 30-1800 | C3 | A2 |
| 30-1810 | D19 | B17 |

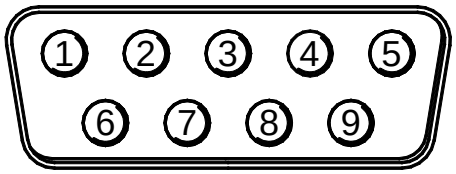
Below is a list of AFR values that should be entered into the 02 Sensor #1(#2) Cal Table if inputting the analog signal to an AEM EMS. These calibration table(s) are found in the AEMPro software: Setup | Sensors | Oxygen Sensor | Oxygen Sensor #1(#2)

When connecting to AEM's EMS, make sure to verify that the O2 #1 Gain option is set so the voltage from the O2 #1 Volts parameter matches the voltage input at the EMS from the O2 sensor. An easy way to do this is to disconnect the UEGO sensor from the UEGO gauge. When in this state, the UEGO gauge will output 2.35 volts. You can then adjust the O2 #1 Gain until the O2 #1 Volts display in AEMPro reads 2.35 volts.

| 02 Volts | Gasoline AFR | Methanol AFR | Propane AFR | Ethanol AFR | CNG AFR |
|---|---|---|---|---|---|
| 0.00 | 10.00 | 4.42 | 10.72 | 6.14 | 9.90 |
| 0.16 | 10.32 | 4.56 | 11.06 | 6.34 | 10.21 |
| 0.31 | 10.62 | 4.69 | 11.38 | 6.52 | 10.51 |
| 0.47 | 10.94 | 4.83 | 11.72 | 6.72 | 10.83 |
| 0.62 | 11.24 | 4.96 | 12.05 | 6.91 | 11.12 |
| 0.78 | 11.56 | 5.11 | 12.39 | 7.10 | 11.44 |
| 0.94 | 11.88 | 5.25 | 12.73 | 7.30 | 11.76 |
| 1.09 | 12.18 | 5.38 | 13.05 | 7.48 | 12.06 |
| 1.25 | 12.50 | 5.52 | 13.40 | 7.68 | 12.37 |
| 1.40 | 12.80 | 5.65 | 13.72 | 7.86 | 12.67 |
| 1.56 | 13.12 | 5.79 | 14.06 | 8.06 | 12.99 |
| 1.72 | 13.44 | 5.94 | 14.40 | 8.26 | 13.30 |
| 1.87 | 13.74 | 6.07 | 14.72 | 8.44 | 13.60 |
| 2.03 | 14.06 | 6.21 | 15.07 | 8.64 | 13.92 |
| 2.18 | 14.36 | 6.34 | 15.39 | 8.82 | 14.21 |
| 2.34 | 14.68 | 6.48 | 15.73 | 9.02 | 14.53 |
| 2.50 | 15.00 | 6.62 | 16.08 | 9.22 | 14.85 |
| 2.65 | 15.30 | 6.76 | 16.40 | 9.40 | 15.14 |
| 2.81 | 15.62 | 6.90 | 16.74 | 9.60 | 15.46 |
| 2.96 | 15.92 | 7.03 | 17.06 | 9.78 | 15.76 |
| 3.12 | 16.24 | 7.17 | 17.40 | 9.98 | 16.07 |
| 3.27 | 16.54 | 7.30 | 17.73 | 10.16 | 16.37 |
| 3.43 | 16.86 | 7.45 | 18.07 | 10.36 | 16.69 |
| 3.59 | 17.18 | 7.59 | 18.41 | 10.55 | 17.00 |
| 3.74 | 17.48 | 7.72 | 18.73 | 10.74 | 17.30 |
| 3.90 | 17.80 | 7.86 | 19.08 | 10.94 | 17.62 |
| 4.05 | 18.10 | 7.99 | 19.40 | 11.12 | 17.91 |
| 4.21 | 18.42 | 8.13 | 19.74 | 11.32 | 18.23 |
| 4.37 | 18.74 | 8.28 | 20.08 | 11.51 | 18.55 |
| 4.52 | 19.04 | 8.41 | 20.40 | 11.70 | 18.85 |
| 4.68 | 19.36 | 8.55 | 20.75 | 11.89 | 19.16 |
| 4.83 | 19.66 | 8.68 | 21.07 | 12.08 | 19.46 |
| 4.99 | 19.98 | 8.82 | 21.41 | 12.27 | 19.78 |

**Connecting to Stand alone ECU's**
When connecting to a third party EFI system, the AEM UEGO gauge's WHITE Analog Output wire shall be connected to the analog O2 sensor input of that system. Consult the documentation provided with the system for detailed instructions. (for AEM EMS see page 4)

**Serial Output (optional)**
The serial output can be used for data logging when an EFI system is not accessible. To run the data stream, a RS-232 (DB-9) Female Receptacle shall be purchased.



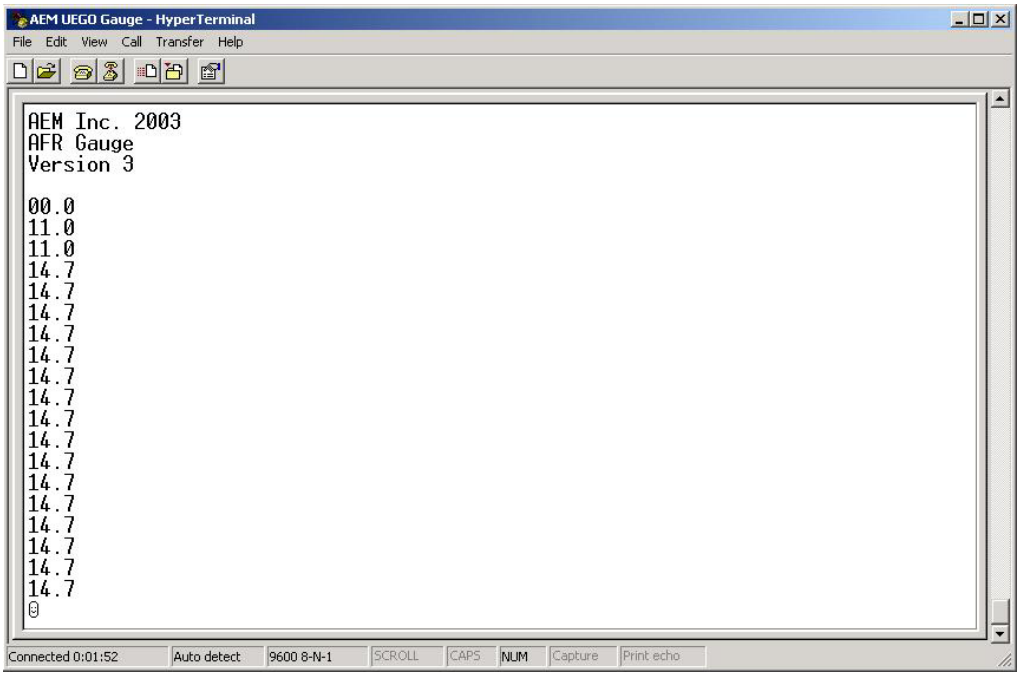

***Wire View of RS-232 (DB-9) Male Plug***

Two wires need to be connected to a RS-232 serial port. The BLUE wire from the AEM UEGO Gauge shall be connected to Pin #2 (RX) on the serial port for receiving data. Pin # 5 (GND) on the serial port shall be grounded. If a standard 9-pin serial cable is to be cut instead, the (RX) wire is typically RED and the (GND) wire is typically GREEN. However, this should be confirmed with a continuity tester before attempting.

Use HyperTerminal for testing the data stream. This software is found on most PCs. To find HyperTerminal go to: Start | All Programs | Accessories | Communications | HyperTerminal. Name the New Connection and click OK. Set the COM port to the one being used and click OK.

Bits Per Second = 9600
Data Bits = 8
Parity = None
Stop Bits = 1
Flow Control = Hardware

Verify the settings above and click OK. When power is supplied to the AEM UEGO Gauge, AFR (or Lambda) data will be displayed, as shown below.




***Data logging with HyperTerminal***

**UEGO Sensor**

If attempting to route the UEGO Sensor through a tight space, AEM recommends temporally removing the light grey latch from the Bosch connector, as shown below.

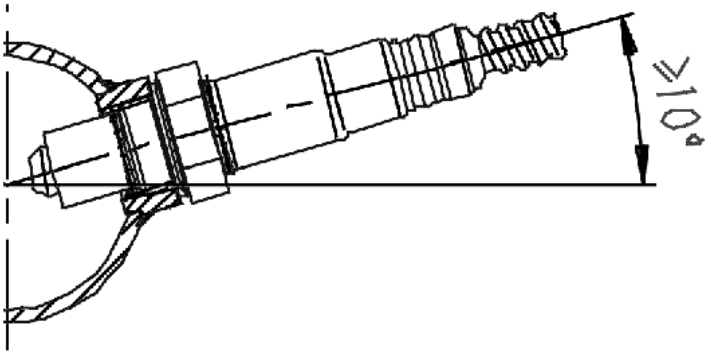
***Gently pull the latch out away from the UEGO Sensor connector***

***UEGO Sensor connector without latch***

If the UEGO sensor is to be put through a conduit or firewall, a 1.05in (26.7mm) drill is required. Refer to the two diagrams above when reassembling the connector.

A weld-in M18 X 1.5 boss is supplied for sensor installation. Mount the O2 sensor in the exhaust system at least 18 inches downstream from the exhaust port. If you anticipate high EGT's (over 800C), run a turbocharger, run at high RPM for extended periods of

time or plan on running leaded race fuel then you must mount the sensor at least 36 inches or more downstream of the exhaust port as all of these can cause the sensor to overheat. On turbocharged engines the UEGO sensor must be installed after the turbo charger, if not, the pressure differential will greatly effect the accuracy of the unit. For accurate readings, the sensor must be mounted before catalytic converters and/or auxiliary air pumps. To prevent collection of liquids between the sensor housing and sensor element during the cold start phase, the installation angle should be inclined at least 10° towards horizontal with the electrical connection upwards, see below.




***Minimum mounting angle for the UEGO Sensor***

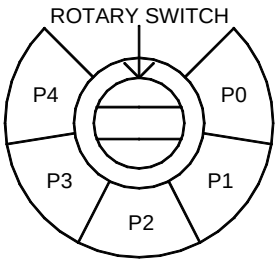
**Configuring Calibration Outputs**

If a different O2 sensor calibration is desired, the AEM calibration can be changed to one of three available. The AEM default position is (P0) if an AFR Gauge was purchased and (P1) if a Lambda Gauge was purchased. These settings implement a linear calibration with the most useful voltage range possible (0-5V). The AFR calibration (P2) is linear and similar to (P1) with a slightly smaller voltage range (1-2V). The AFR calibration (P3) emulates the Autronic Wideband O2 Sensor calibration (0-1V). The AFR calibration (P4) emulates a non-linear Nernst Cell calibration (0-1V). Refer to the Table and Graph for specific calibration details.

To change the calibrations, a precision flat head screw diver is needed. Locate the small hole located on the back of the AEM gauge, as shown below.

***Calibration position screw location***

With the screw driver, clock the rotary switch into the desired calibration position, referring to the diagram below, and watch the alphanumeric readout, which will display the new position when entered.




***Calibration screw position settings***

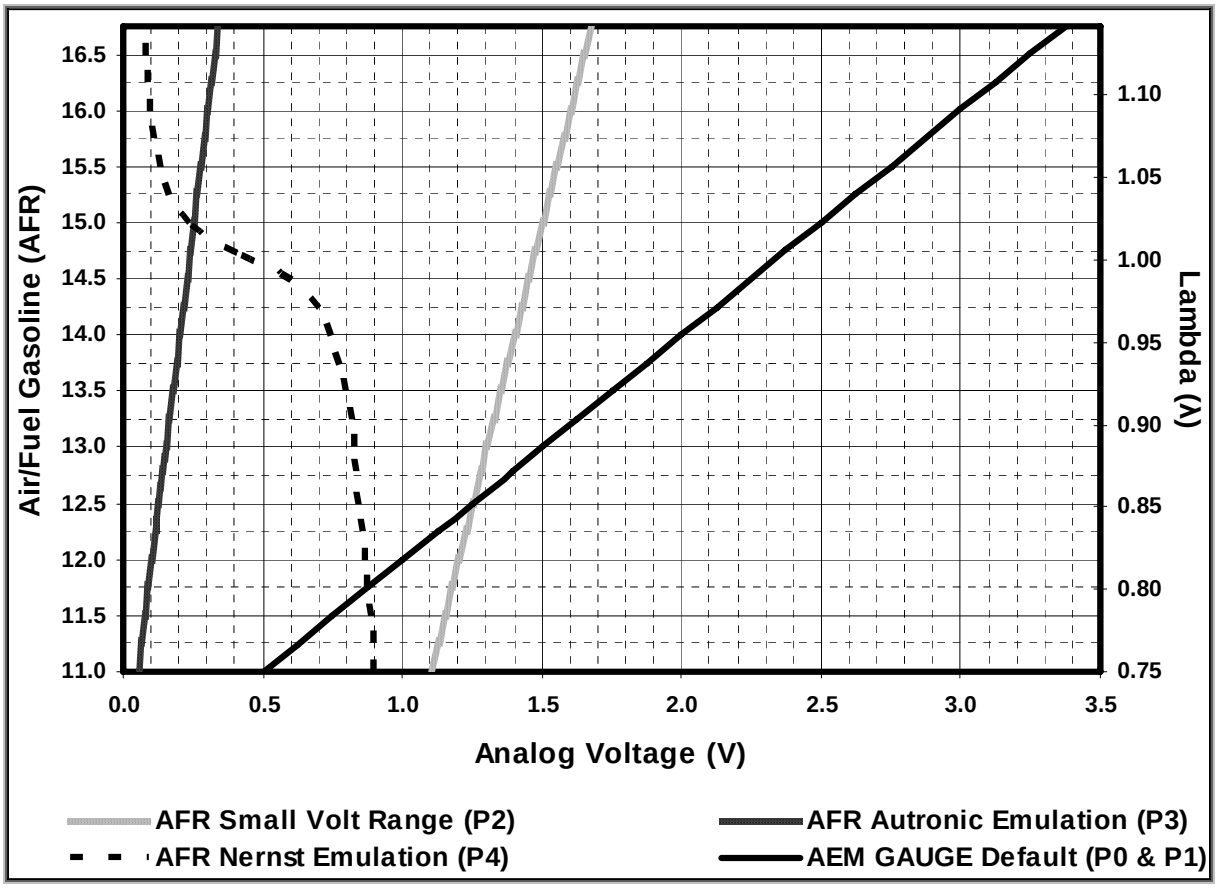
The calibration will not be changed until the rotary switch reaches the middle of the new position.

**AEM Lambda Gauge Owners**

Because the Lambda gauge faceplate is calibrated for (λ) and all other calibration positions are for AFR (Gasoline), AEM does not recommended changing the controller calibration, as instructed above.

Below is the multiplier for calculating the Air Fuel Ratio (AFR) of common fuels from the Lambda value.

| | | |
|---|---|---|
| Gasoline AFR | = | Lambda x 14.65 |
| Methanol AFR | = | Lambda x 6.47 |
| Propane AFR | = | Lambda x 15.7 |
| Ethanol AFR | = | Lambda x 9.00 |
| CNG AFR | = | Lambda x 14.5 |




***Calibration graph of available outputs***

## Specifications

### Gauge

| | |
|---|---|
| Supply Current (nominal): | 1.3 amps |
| 0-5V Analog Outputs: | 1 |
| Measuring Range: | 0.751 to 1.143 Lambda |
| Harness & Connector Temp Limit: | 120C |

### Sensor

| | |
|---|---|
| Type: | Bosch UEGO LSU4.2 |
| Accuracy: | +/- 0.7% |
| Exhaust Temp Limit: | 1030C |
| Cable & Protector Sleeve Temp Limit: | 250C |
| Connector Temp Limit: | 120C |
| Initial Warm-up Time: | Less than 20 seconds |
| Weight: | 80 grams |
| Heater Current: | 1.2A at 12.0V (each sensor) |
| Mounting: | M18 X 1.5 thread, Torque to 30 ft-lbs |
| Nominal Service Life: | 80,000 km for Unleaded Fuel |
| | 50,000 km for Leaded Fuel 0.15g Pb/l |
| | 20,000 km for Leaded Fuel 0.40g Pb/l |
| | 10,000 km for Leaded Fuel 0.60g Pb/l |

### Notes

The sensor contains a ceramic module and should not be subject to mechanical or thermal shock or it may be damaged. The sensor is not designed for operation on leaded fuels, doing so will dramatically shorten sensor life. Long term running in the rich region (Lambda < 0.95) will shorten sensor life. High exhaust temperatures (over 850C) will shorten sensor life. Engine oil consumption at a rate greater than 1 quart per 1,000 miles will shorten sensor life. With the UEGO Sensor installed, do not run the engine without power applied to the gauge.

## 12 MONTH LIMITED WARRANTY

Advanced Engine Management Inc. warrants to the consumer that all AEM High Performance products will be free from defects in material and workmanship for a period of twelve (12) months from date of the original purchase. Products that fail within this 12-month warranty period will be repaired or replaced at AEM's option, when determined by AEM that the product failed due to defects in material or workmanship. This warranty is limited to the repair or replacement of the AEM part. In no event shall this warranty exceed the original purchase price of the AEM part nor shall AEM be responsible for special, incidental or consequential damages or cost incurred due to the failure of this product. AEM does not warranty the UEGO sensor. Warranty claims to AEM must be transportation prepaid and accompanied with dated proof of purchase. This warranty applies only to the original purchaser of product and is non-transferable. All implied warranties shall be limited in duration to the said 12 month warranty period. Improper use or installation, accident, abuse, unauthorized repairs or alterations voids this warranty. AEM disclaims any liability for consequential damages due to breach of any written or implied warranty on all products manufactured by AEM. Warranty returns will only be accepted by AEM when accompanied by a valid Return Goods Authorization (RGA) number. Credit for defective products will be issued pending inspection. Product must be received by AEM within 30 days of the date the RGA is issued.

Please note that before AEM can issue an RGA for a UEGO Gauge, it is first necessary for the installer or end user to contact the EMS tech line at 1-800-423-0046 to discuss the problem. Most issues can be resolved over the phone. Under no circumstances should a system be returned or a RGA requested before the above process transpires.