

# SEMTECH® LAMBDA MASTER

## ON-BOARD, IN-USE AIR FUEL RATIO ANALYZER

### Product Specifications:

MEASUREMENTS RANGE	7-100 AFR
ACCURACY	± 0.04% volume of O <sub>2</sub>
STABILITY	Better than ± 0.02% volume O <sub>2</sub> over 2 hour measurement period
RESOLUTION	± 0.01% volume O <sub>2</sub>
REPEATABILITY	Better than ± 0.02% volume O <sub>2</sub> . Typically equivalent to better than ± 0.05 AFR, ± 0.003λ (Over range 7-100 AFR)
RESPONSE RISE TIME	Air to Nitrogen; 90% change in less than 100 milliseconds.
EXHAUST SAMPLE FLOW	Approximately 5 liters per minute
WARM UP TIME	60 minutes
TYPICAL CATALYST LIFE	500 hours unleaded fuel, 50 hours leaded fuel
OPERATING TEMPERATURE	0 to 50°C
RECORDER OUTPUTS (STANDARD)	0 to 1V : 0 to full scale for λ/AFR/O <sub>2</sub> ; 0 to 1V : 0 to 10% O <sub>2</sub>
HC RATIO ADJUSTMENT RANGE	0.00 to 4.00
OC RATIO ADJUSTMENT RANGE	0.00 to 1.00
HEATED SAMPLE LINES	3 meters length standard, 1, 5, 8 or 10 meters options directly interchangeable
CONNECTING CABLE - CONTROL UNIT TO SAMPLE HANDLING UNIT	17 way x 6 meter long. 1 to 25 meters; Optional
SAMPLE FILTER	19 mm x 90 mm Whatman extraction thimble
ELECTRICAL POWER REQUIREMENTS	Electronics Module: <200W + 12V DC Cart: 1KW
DIMENSIONS (IN; W x H x D)	Control Unit : 10.5 x 6.5 x 3.5 Transducer : 13.5 x 3.0 x 3.0
WEIGHT	Control Unit : 6.50 lbs Transducer : 4.25 lbs

Note: Specifications are subject to change without notice. While due caution has been exercised in the production of this document, errors and omissions can occur.

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The **SEMTECH LAMBDA MASTER** has been redesigned to meet the needs of automotive engineers through the next decade, understanding that very fast (less than 100ms) monitoring of air fuel ratio values is critical in the engine design process.

The **LAMBDA MASTER** offers both compactness and pure simplicity of operation which is achieved by the integration of a state-of-the-art transducer that remains with a sophisticated electronic host. The unique transducer design incorporates three sensors for oxygen, pressure and temperature, measurement, together with sonic jeweled orifices and filters. The only connections to the sensor are the vacuum source, and the power and signal cables. Because of the very fast response requirements, the transducer operates under vacuum and with exceptionally low dead volume. The sample flow is nominally 500ccs/min and the speed of response is less than 100ms. Access to the sample filter is quick and simple and involves no major disassembly of the transducer. User maintenance is only limited to the routine changes of the filter and periodic cleaning of the sample and bypass orifices.

The **LAMBDA MASTER** electronics have been redesigned to take advantage of the latest advances in electronic component and design, further reducing size and power requirements, while enhancing the system's ability to control, monitor and interact with the transducer, and to calculate oxygen equivalence ratio and air fuel ratio values. The values of oxygen, pressure and temperature are updated every 4ms, with each update being an average of ten readings. The electronics control power to the transducer heater, maintaining a temperature of 710°C. The new electronics offer several communications options, including DAC output, serial/CAN, and RS232.

The system operates in a wide variety of automotive applications, i.e. a cold start testing engine cylinder development, etc.

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## Theory of Operation

The **SEMTECH LAMBDA MASTER** air fuel ratio (AFR) analyzer is a fast-response (<100ms) Zirconia-based residual oxygen sensing device.

The heated oxygen sensor, located in a discrete sensor assembly, comprises a Zirconium oxide (ZrO<sub>2</sub>) sensing element which is stabilized with 10-12% of yttria. This stabilized zirconia ceramic (forming a crystal lattice structure) acts as a solid electrolyte and at operating temperatures > 650°C, openings in the crystal lattice permit the movement of oxygen ions. When a sample gas is introduced on one side of the detector, oxygen ions migrate within the crystal lattice to form a concentration gradient from the higher O<sub>2</sub> partial pressure side to the lower pressure side. The gradient is determined by the ratio of the O<sub>2</sub> partial pressures between a sample gas on one side of the lattice and a reference gas, (typically ambient air) on the other side of the lattice. This concentration gradient of oxygen ions within the ZrO<sub>2</sub> lattice produces a voltage potential between the two platinum electrodes (E, E<sup>o</sup>) according to the Nernst Equation:

$$E = E^o - \frac{RT}{nF} \ln Q$$

where R is the Universal Gas Constant, T is absolute temperature, n is the number of molecules, F is the Faraday Constant, and Q is the concentration ratio of products to reactants.

The micro-processor electronics system (Infineon C167) measures the electrode voltage on a 4ms time-base and thus provides a high-speed response system. Temperature is precisely controlled using a full PID embedded algorithm.

The **SEMTECH LAMBDA MASTER** utilizes the residual oxygen approach to augment the operating range (AFR, Lambda etc) of the Zirconia Sensor for engine test development studies.

The heated exhaust sample is diluted using a high-precision “dope” orifice with ambient air prior to being oxidized over a platinum catalyst. Note that, both the sample and “dope” flow rates are accurately controlled using critical orifice metering, thus maintaining accurate control of this dope ratio.

Since the mass flow rate through a critical orifice is predominately affected only by the upstream pressure (parameter measured), this technique can be used for sampling from a wide range of pressure / temperature environments. The GUI-based system calibration procedure solves for both the Oxygen partial pressure – voltage relationship (Nernst Equation) as well as the dope flow ratio.

## LAMBDA MASTER FEATURES

### FEATURES

- Extremely Fast Response Time with High Accuracy (<100 ms)
- Automatic Range Change and Calibration
- Operation on all HC and Alcohol Fuels
- Externally Controllable
- Built-in Statistical Functions
- Heated Sampling for Durability and Accuracy
- Wide Sample Pressure Tolerance
- RS232 & CAN Interface as Standard
- Simple to Operate, with Pre-set Programs
- Microprocessor Based

### APPLICATIONS

- Performance Monitoring
- Transient Phase Examination
- Checking of Mixture Quality in Engine Fueling Systems
- Driveability Characteristics Monitoring Catalytic Exhaust Control Systems Checking

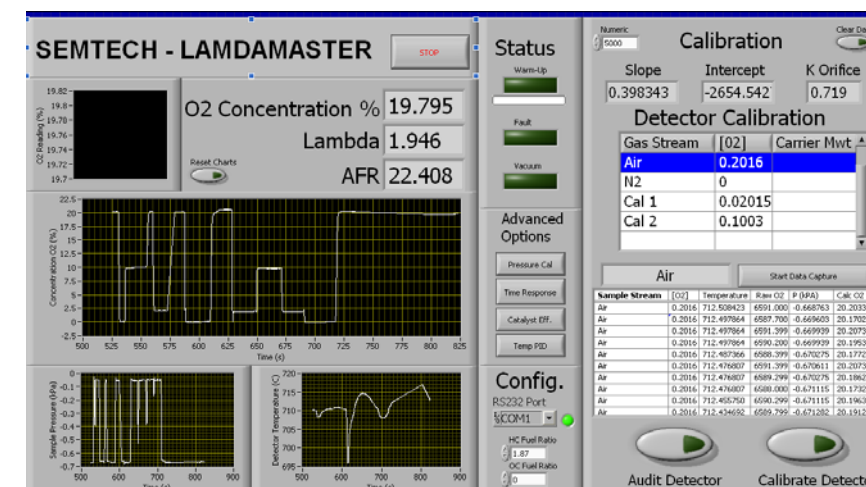
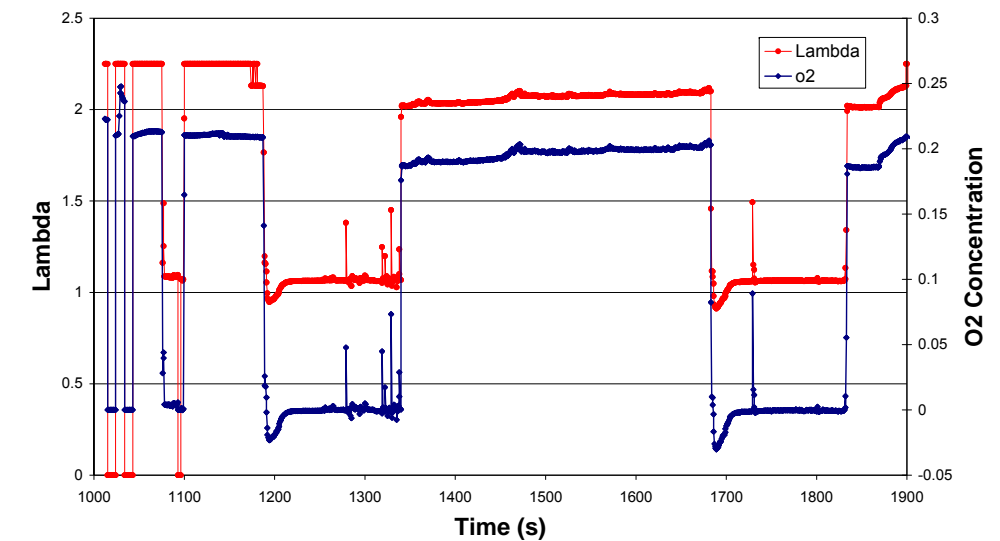
### OPTIONS

- Mobile Cart, including:
  - Vacuum pumps
  - Power Supply
  - Articulated Transducer holder
- CAN-Based Datalogger
- Heated Line: 12' or 16' Line

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## Free Acceleration Tests (Gasoline Engine)



Calibration Screen from computer interface



Lambdamaster with mobile cart and options