Instruction Manual

AEM PERFORMANCE ELECTRONICS

P/N 30-0350
X-SERIES PRO DUAL CHANNEL
LAMBDA CONTROLLER

STOP! - READ THIS BEFORE INSTALL OR USE!

WARNING:

THIS INSTALLATION MAY REQUIRE WELDING OR INTEGRATION INTO A VEHICLE'S ELECTRICAL SYSTEM. DAMAGE TO SENSITIVE ELECTRONICS, FIRE, OR EXPLOSION MAY OCCUR IF PROPER PRECAUTION IS NOT TAKEN. IF THERE IS ANY DOUBT, **DO NOT** ATTEMPT THE INSTALLATION AND CONSULT A PROFESSIONAL.

NOTE: IT IS THE RESPONSIBILITY OF THE ENGINE TUNER TO ULTIMATELY CONFIRM THE CALIBRATION USE FOR ANY PARTICULAR ENGINE IS SAFE FOR ITS INTENDED USE. AEM HOLDS NO RESPONSIBILITY FOR ANY ENGINE DAMAGE THAT RESULTS FROM THE MISUSE OF THIS PRODUCT.

The AEM X-Series Professional Dual Channel Lambda Controller features a CNC aluminum IP67 rated enclosure with an Autosport locking connector suitable for a professional motorsport environment. The AEM inline controller is ideal for all vehicles including carbureted applications and engine dynamometers. A 0-5V analog output is included and can be used with data loggers or aftermarket ECUs including the AEM Infinity Engine Management System (EMS). In addition, an AEMnet (CAN bus) is also available for logging or mixture control purposes. Bosch LSU4.9 sensors are supported but not included.

The X-Series Digital Wideband technology is US Patent #9,575,030.

Features

- X-Digital Technology
- Dual Lambda Channels
- CNC aluminum IP67 rated enclosure with an Autosport locking connector
- Accurate factory resistor trim calibration
- Fast response, 20ms typical
- 8.0:1 to 20.0:1 AFR / 0.55 to 2.00 Lambda
- Supports Bosch LSU4.9 Sensor (NOT INCLUDED)
- Supports vehicle/system voltages up to 16V
- 0-5V Analog Output
- AEMnet (CAN bus) Output

KIT CONTENTS	
PN	**Description**
10-0350	INST, X-SERIES UEGO INLINE
35-0350	ASSY, X-SERIES UEGO INLINE

OPTIONAL ACCESSORIES	
PN	**Description**
30-4008	WELD-IN FINNED BUNG, O2 LONG, STAINLESS STEEL
35-4001	BUNG PLUG,O2 SENSOR

Wiring Details

Name	TE / Deutsch Autosport Bulkhead Connector
Connector	AS012-35SN
Terminal	38943-22
Name	TE / Deutsch Autosport Connector
Mating Connector	AS612-35PN
Mating Terminal	38941-24
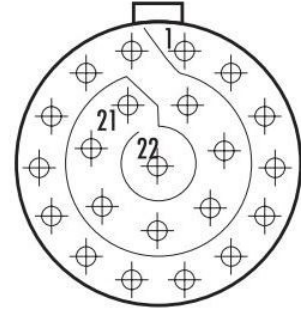
Pin	Lambda Channel	Wire	Notes
1	A	IP (PUMP)	
2	A	ANALOG OUTPUT / DAC+	
3	A	H+	3A peak / 1 A continous
4	A	H-	3A peak / 1 A continous
5	A	UN (SENS)	
6	A	VM (COM)	
7	A	IA49 (RT49)	
8	A	POWER GND	3A peak / 1 A continous
9	A	POWER 12V	3A peak / 1 A continous
10	A	ANALOG OUTPUT / DAC-	*See below
11	B	IP (PUMP)	
12	B	ANALOG OUTPUT / DAC+	
13	B	H+	3A peak / 1 A continous
14	B	H-	3A peak / 1 A continous
15	B	UN (SENS)	
16	B	VM (COM)	
17	B	IA49 (RT49)	
18	B	POWER GND	3A peak / 1 A continous
19	B	POWER 12V	3A peak / 1 A continous
20	B	ANALOG OUTPUT / DAC-	*See below
21	A / B	CANL	
22	A / B	CANH	

Important Notes on Wiring

- All signals are low current (< 50mA) unless otherwise noted.
- Use a 5A inline fuse on the switched 12V power supply line.
- *The analog/DAC outputs of the device are differential pairs; a connection to ground must be provided in the recording device (ECU, data logger, etc)
- Route harnesses carefully to avoid chafing, undue strain, or heat damage. Apply strain reliefs and wire coverings as necessary.

What is a UEGO Wideband Sensor?

A Universal Exhaust Gas Oxygen (UEGO) oxygen sensor, also known as a wideband or lambda sensor, measures the proportion of oxygen (O2) in the exhaust of a running engine. An air to fuel ratio (AFR) or lambda value can be calculated from this measurement. Typically, when calibrating or "tuning" the fuel delivery system of an engine, a specific AFR can be targeted to achieve maximum power, economy, or emissions. The output from a UEGO sensor controller can be used to adjust a carburetor or fuel injection system to reach this target.

UEGO sensors are one of the more sophisticated sensors found in today's vehicles. The sensing element is made of a zirconium dioxide ceramic with a thin platinum coating and has an integrated heating element. An electronic controller, such as is contained in AEM's X-Series UEGO Gauge or Inline Controller, is **required** to use a UEGO oxygen sensor. The controller connects to the sensor via multiple wires (up to 6) carrying sensitive voltages and electrical currents to process and calculate an AFR value. This value may be read directly from a gauge face or data-log as recorded by an ECU or logger via several methods as discussed elsewhere in this manual.

Interpreting Wideband Sensor Readings

An internal combustion engine runs on air (which contains ~20% oxygen) and fuel. The ratio of air to fuel (AFR) that, when combusted, perfectly consumes 100% of both the oxygen and fuel is called the stoichiometric ratio. This ratio is different for every fuel. Ratios lower than stoichiometric have more fuel and are considered "rich"; ratios higher than stoichiometric have less fuel and are considered "lean."

Fuel	Stoichiometric AFR	Lambda
Unleaded Gasoline	14.65 : 1	1.00
Methanol	6.47 : 1	1.00
Ethanol	9.00 : 1	1.00
Propane	15.67 : 1	1.00
CNG	17.20 : 1	1.00

Lambda is a unitless ratio that is fuel agnostic. In other words, a lambda reading of 1.0 is stochiometric for any fuel; AFR = (Stoichiometric AFR * Lambda.)

In general, an engine will have three areas of operation: idle/cruise, wide open throttle, and fuel cut off. The exact AFR value that should be expected (or tuned to) for these areas is very specific to the type and configuration of each individual engine. However, while monitoring your AEM X-Series controller, you should see readings similar to the chart below. Fuel cutoff is generally experienced when completely lifting off the throttle, while decelerating in gear, at high RPM.

Operating Region	WOT	IDLE/CRUISE	FUEL CUTOFF
Approximate AFR	10.5 (RICH)	14.7 (STOICH)	20.0 (LEAN)

IMPORTANT NOTE: Engine tuning should only be performed by experienced individuals as engine damage, or outright failure, can be the result of an improper calibration.

Sensor Placement

The location at which the sensor is installed in the vehicle's exhaust system is critical to its performance and longevity. Please review the following placement guidelines:

- 18 inches (45cm) downstream of the cylinder head's exhaust port or turbocharger
- Upstream of any catalytic converters or emission control devices
- Downstream of any turbochargers or large contributors to exhaust pressure
- As far as possible from the exhaust exit (tailpipe) to avoid scavenging fresh air in low exhaust flow conditions such as idling
- AEM's X-Series UEGO controller is a very sensitive device and, thus, it is important to have a completely leak-free exhaust

Sensor Bung

The supplied mild steel sensor bung must be welded into the vehicle's exhaust. An optional stainless steel sensor bung is available for purchase from AEM dealers and may be useful in specific installation scenarios. The taller geometry of this bung helps bring the sensing element further out of the exhaust stream when used in small diameter tubing such as header primaries. In addition, the finned body helps dissipate heat when used in extreme applications. As an alternative to welding, users may purchase a P/N 30-2355-XXX No Weld UEGO Clamp Kit.
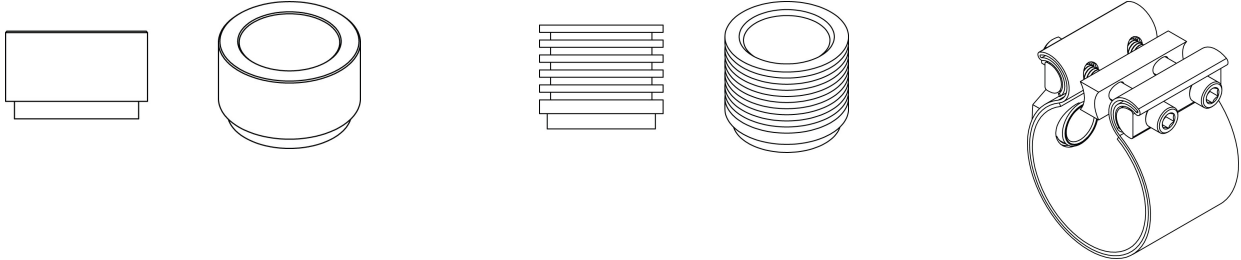
P/N 35-4001 Mild Steel Sensor Bung   P/N 30-4008 Stainless Steel Tall Sensor Bung w/ Fins   P/N 30-2355-XXX No Weld UEGO Clamp Kit
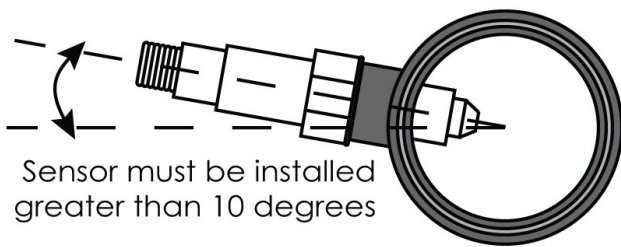
Sensor must be installed greater than 10 degrees

The bung should be welded in such a way that the installed sensor orientation is greater than ten degrees from horizontal to allow any condensation to properly drain from the sensor. In addition, it is recommended to avoid a completely vertical sensor orientation to prevent overheating the sensor. Failure to heed these recommendations may result in premature sensor failure.

Important Notes on Wideband Sensors

The sensor contains an integrated heating element and will become hot enough to produce burns, when powered, even without the presence of exhaust gas. Sensors can remain hot enough to burn or start a fire for quite some time after removing power -- handle with caution.

UEGO sensors are very sensitive devices that must handled and installed with care. Listed below are several contaminants and conditions which will shorten the life of the sensor or result in outright failure.

The following may damage or destroy oxygen sensors:
- o Leaded (tetraethyl) fuel
- o Silicone
- o Oil
- o Engine coolants
- o Particulates, carbon (e.g. excessively rich mixtures)
- o Mechanical shock (e.g. dropping a sensor on the ground)
- o Thermal shock (e.g. blown head gasket)
- o Extreme exhaust temperatures (Greater than 930 degC/1700 degF)
- o Unheated sensor in exhaust stream. Sensors that are installed in an exhaust must be connected to a properly functioning controller during engine operation.

0-5V Analog Output

WHITE WIRE = Analog Positive +
BROWN WIRE = Analog Negative -

0-5V Analog Output Scaling Formulas		
AFR	=	(2.3750 * Volts) + 7.3125
Lambda	=	(0.1621 * Volts) + 0.4990

The 0-5V analog output is suitable for output to devices such as loggers or ECUs. This differential output requires

0-5V Analog Output Scaling Table		
Volts	**Lambda**	**AFR (Gasoline)**
<0.50	SENSOR NOT READY	
0.50	0.58	8.50
0.75	0.62	9.09
1.00	0.66	9.69
1.25	0.70	10.28

1.50	0.74	10.88
1.75	0.78	11.47
2.00	0.82	12.06
2.25	0.86	12.66
2.50	0.90	13.25
2.75	0.94	13.84
3.00	0.99	14.44
3.25	1.03	15.03
3.50	1.07	15.63
3.75	1.11	16.22
4.00	1.15	16.81
4.25	1.19	17.41
4.50	1.23	18.00
>4.50	SENSOR ERROR	

special care to ensure proper operation. The WHITE signal wire should be connected to the positive of the analog input of the logging device or ECU; the BROWN wire must be connected to the negative of the analog input of the logging device or ECU. If the logging device or ECU does not have a differential analog input (both a dedicated positive and negative terminal for the analog input) then connect the BROWN wire to the shared signal ground. If the device does not have a dedicated signal ground then as a last course of action, connect it to the power ground of the logging device.

Important Note: If bench testing the analog output outside of a vehicle, a multimeter's positive lead may be connected to the WHITE wire however the BROWN wire must be connected to BOTH the multimeter's negative lead AND power ground going to the X-Series UEGO device. This connection is usually made by the circuitry inside an ECU or data logger.

AEMnet (CAN Bus) Output

WHITE WIRE WITH BLACK STRIPE = AEMnet+ / CANH
GREEN WIRE WITH BLACK STRIPE = AEMnet- / CANL

The AEMnet output is suitable for output to AEM devices such as the AQ-1 data logger or Infinity ECU. The following CAN configuration and message definition information is provided below to facilitate interface with third-party devices.

Message ID
These are the default settings unless your unit has been custom ordered/configured by AEM. The IDs will be assigned sequentially as 29-bit identifiers 0x0000180, 0x0000181, 0x0000180, ..., 0x000018F.

Bus Termination
All AEMnet/CAN networks must be terminated to have an equivalent of approximately 60 Ohms of resistance. Generally, this means a 120 Ohm resistor connected in parallel to AEMnet+/AEMnet- (or CANH/CANL) at both physical ends of the bus run. The X-Series controller does not have any internal termination and is intended to be connected to a pre-existing, properly terminated network. Please refer to the Bosch CAN2.0B specification for further detail.

bit rate	500	kb/sec
format	29	bit ID
transmit rate	100	hz
terminating resistor	none	
endianness	big / Motorola	
Message/Arbitration ID	0x00000180 to 0x0000018F	
DLC	8	

Byte	Bit	Bitmask	Label	Data Type	Scaling	Offset	Range
0-1			Lambda	16 bit unsigned	.0001 Lambda/bit	0	0 to 6.5535 Lambda
2-3			Oxygen	16 bit signed	0.001%/bit	0	-32.768% to 32.767%
4			System Volts	8 bit unsigned	0.1 V/bit	0	0 to 25.5 Volts
5			Reserved	---	---	---	---
6	0 (lsb)	0	Reserved	---	---	---	---
	1	2	Bosch LSU4.9 Detected	Boolean	0 = false, 1 = true	0	0/1
	2 - 4	4	Reserved	---	---	---	---
	5	32	Free-Air cal in use	Boolean	0 = false, 1 = true	0	0/1
	6	64	Reserved	---	---	---	---
	7 (msb)	128	Lambda Data Valid	Boolean	0 = false, 1 = true	0	0/1
7	0 - 5	0	Reserved	---	---	---	---
	6	64	Sensor Fault	Boolean	0 = false, 1 = true	0	0/1
	7 (msb)	128	Reserved	---	---	---	---

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. 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 Merchandise Authorization (RMA) number. Product must be received by AEM within 30 days of the date the RMA is issued.

UEGO oxygen sensors are considered wear items and are not covered under warranty.

Please note that before AEM can issue an RMA for any electronic product, 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 RMA requested before the above process transpires.

AEM will not be responsible for electronic products that are installed incorrectly, installed in a non-approved application, misused, or tampered with.

Any AEM electronics product can be returned for repair if it is out of the warranty period. There is a minimum charge of $50.00 for inspection and diagnosis of AEM electronic parts. Parts used in the repair of AEM electronic components will be extra. AEM will provide an estimate of repairs and receive written or electronic authorization before repairs are made to the product.

Specifications

Dimensions	length	4.9 / 126	in / mm
	width	1.7 / 43	in / mm
	height	1.2 / 30	in / mm
	mass	0.3 / 136	lb / g
Supply Voltage	min	10	VDC
	max	18	VDC
Supply Current (13.8V)	nominal	1.0	A
	peak	2.0	A
Operating Temperature	min	-4 / -20	degF / degC
	max (16V Supply)	185 / 85	degF / degC
Sensor Temperature	max (sensor element)	1706 / 930	degF / degC
Range	min	0.55	lambda
	max	2.00	lambda
Response Time	typical	20.00	ms
Stoichiometric Constant		14.65	gasoline
Analog Output	resolution	10	bit
	update rate	500	hz
**CAN 2.0B Output	bit rate	500	kb/sec
	format	29	bit ID
	transmit rate	100	hz
	terminating resistor	none	
	endianness	big / Motorola	
	Message/Arbitration ID	0x180-0x18F	
	DLC	8	

**Default configuration; does not apply to custom orders/configurations