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Granatelli Air/Fuel Ratio Monitor Installation Instructions (Read Carefully Before Starting Project)

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1.0 Introduction.

Congratulations on purchasing a Granatelli Air/Fuel Ratio meter, the ultimate engine tuning aid. When used correctly this instrument offers uncompromising performance surpassing all comparably priced products. This unit may be used in a stand-alone manner, or with Granatelli Engine Management systems, a remote Analog Meter Air Fuel ratio readout, data acquisition systems, telemetry systems, dynamometer systems and most other engine management systems.

IMPORTANT! Please read this manual to understand its operation and extract its true performance potential.

2.0 Understanding Air/Fuel Ratio & Tuning Techniques

2.1 Air/Fuel ratio

Air/Fuel ratio and Lambda are indicators of the relative proportions of Fuel and Air undergoing combustion. Air/Fuel ratio is the ratio by weight of Air to Fuel. A large value indicates an excess of Air and is known as a lean mixture. Under lean mixture condition more than sufficient air is present to burn all the fuel in the air fuel mixture, not all the oxygen is consumed in the combustion process. Under rich mixture conditions there is insufficient oxygen in the mixture to consume all the fuel. An Air/Fuel mixture that contains neither an excess of fuel or air, having just sufficient air being present to burn all the fuel is called a "STOICIMETRIC" mixture. This is also known as a chemically correct mixture.

Stoicimetry	Petrol	14.7
	LPG	15.5
	Alcohol	6.5
	Diesel	14.5

2.2 Lambda

A chemically correct mixture is given by a Lambda value of 1. Lean mixtures have a value greater than 1. Rich mixtures have a value less than 1.

2.3 Engine Tuning Techniques

The Air/Fuel ratio required by an engine depends upon the engine type and the operating conditions of the engine. Spark ignition petrol (gasoline) fuel engines require an air/fuel ratio value of around 12.7 for best power, 15 to 17 for best economy and 13 to 15 for best idle and light throttle smoothness.

Note:- Some engines especially turbocharged and race engines require mixtures richer than indicated above in order to reduce exhaust, exhaust valve and piston temperatures, and to reduce the risk of destructive detonation.

3.0 Front Panel.

3.1 Status Messages.

The readout front panel has a 4 digit display, bar graph display and 4 push-buttons. At power-on the readout presents a scrolling "Granatelli wake-up message followed by the units firmware version number (Following this message, either normal Air/Fuel ratio or Lambda is displayed. The following status messages are displayed only if it is impossible to measure Air/Fuel ratio.

MESSAGE	CAUSE

"FACTORy rECAL" supplier)	Readout needs factory re-calibration (return to
"bAttErY Lo"	Battery voltage too low (i.e.:- below 10.6 volts)
"bAttErY Hi"	Battery voltage too high (i.e.:- above 23.5 volts)
"too Hot"	Readout too hot (move to cooler location)
"HEATER O-C"	Sensor cable not connected to readout (reconnect), or sensor cable not connected to sensor (reconnect), or sensor heater element faulty (replace sensor), or sensor cable broken (check cable)
"HEATER S-C"	Sensor cable short circuited (check cable), or sensor heater element faulty (replace sensor).
"SEnSor CoLd"	Sensor not up to operating temperature (wait until warm. approx 3 minutes)
"SEnSor FAuLtY"	Replace sensor.
"ErXX"	Readout faulty. Fatal error number "XX" (record number XX and contact supplier)

The left side push buttons labeled "FUNCTION SELECT" perform set-up function selection indicated on the display by "FnXX". The right side push buttons labeled "SET" allow adjustment of the selected setting function. While "FnXX" is displayed depress either of these buttons to enter setting mode, release button and then use either upper button to increase setting value or the lower button to decrease the setting. Use left side buttons to terminate setting or select another function.

If left undisturbed the unit automatically reverts back to "FUNCTION SELECT" mode and after a further 5 seconds from "FUNCTION SELECT" mode back to status or normal Air/Fuel ratio display

At any time depress all 4 buttons simultaneously to force all Function settings back to the factory default settings. These Factory default settings are the correct analog output settings for direct compatibility with all Granatelli Engine Management Systems.

3.2 Calibration Functions.

Fn 0 "NORMAL" Readout

Fn 1 Select 7 SEG display mode;
Lambda, A/F Petrol, A/F Gas, A/F Alcohol, A/F Diesel.

Fn 2 Select 7 SEG display update rate & filtering Time Constant.

Setting	Filtering TC	Update Rate
0	6.4 SEC	1.25/SEC
1	3.2 SEC	2.5/SEC
2	1.6 SEC	2.5/SEC
3	0.8 SEC	2.5/SEC
4	0.8 SEC	2.5/SEC
5	0.4 SEC	5.0/SEC
6	0.2 SEC	5.0/SEC
7	0.03SEC	5.0/SEC

Fn 3 Select BAR GRAPH Display Mode;

Setting	
0	Off
1	Left to Current
2	Left to Current & Max
3	Min to Max
4	Min & Max
5	Min & Max & Current
5	Current Val

Add 6 to value for filtering. $TC = (\text{peak hold time}/10) + 40\text{mSEC}$
(range 0.05 to 0.20 SEC)

Fn 4 Select BAR GRAPH peak hold time.
Setting range 0.1 to 1.60 SEC

Fn 5 Select BAR GRAPH display range minimum.
Value for 0.00 volts left end of Bar Graph.

Fn 6 Select BAR GRAPH display maximum.
Value for right end of Bar Graph.

Fn 7 Select ANALOG O/P error signaling mode;

Mode = 0 gives 0.0V for error & 0.0V to 5.2V normal O/P range.

Mode = 1 gives 0.0V for error & 0.156V to 5.2V normal O/P range.
Mode = 2 gives 5.2V for error & 0.0V to 5.0V normal O/P range.

To calibrate Analog O/P

Following are factory defaults and correct scaling for Autronic ECUs

Set to 0	Whilst 0 is displayed ECU should read 10% ie A/F 12
Set to 1	Whilst 1 is displayed ECU should read 50% ie A/F 20
Set to 2	Whilst 2 is displayed ECU should read 10% ie A/F 28

No greater than a 0.1 A/F discrepancy should be seen.

To calibrate, Fn. 9 to scale A/F 12 (rich end)
Fn. 10 to scale A/F 28 (lean end)

Fn 8 Select ANALOG O/P filter TC.
Setting range 0.005 to 0.500 SEC.

Fn 9 Select ANALOG O/P minimum value
Value for 0.00 volts O/P.

Fn 10 Select ANALOG O/P maximum value
Value for 5.00 volts O/P.

UEGO ONLY

Fn 11 Select Cal UEGO Air Cal O2 %

% O2 in AIR for sensor calibration in Air. Setting range 18 - 22%
Nominal value 20.9%. (After setting % value press both setting buttons while "AIR" displayed to effect calibration.)

Fn 12 Select UEGO rich side calibration;
+/- 12.7% rich side span correction.

Fn 13 Select Cal UEGO at stoic.

Offsets all UEGO CALIBRATION +/- 0.127 LAMBDA.
Best set at Stoic.

Fn 14 Select UEGO lean side calibration
+/- 12.7% lean side span calibration

NOTES:-To restore unit to factory default settings depress all buttons simultaneously. For fast return from "Function" setting to "Normal" operation depress both "FUNCTION SELECT" buttons.

Analog output filtering (Fn8) should generally be set for the fastest response (0.005 seconds). If erratic engine operation causes large Air/Fuel ratio fluctuations choose a longer time to smooth out readings (eg:- 0.10 seconds).

Error status signaling (Fn7) should be set to a value of 2 for maximum output voltage (5.2volts) to indicate an invalid or fault status.

4.0 Power Supply

Sensor Connection

SENSOR:-	UEGO NTK	Part No. TL7111W1
	Bosch Wide Band	Part No. 0 256 104 002

IMPORTANT:-

When using above sensors, an electrical connection must exist between the sensor body and the negative terminal of the power supply. When the readout is powered by the vehicle battery an electrical connection normally exists via the engine block and exhaust system. No further connection is required. If an external battery or power source is used, the connection should be made between the negative supply terminal and this sensor body, either directly or via the exhaust and or engine block. Failure to make this connection will result in reduced measurement accuracy.

5.0 Installation

5.1 Readout Installation.

The readout should be installed in a location protected from water, condensation, corrosive chemicals and oil. Ambient temperature must not exceed 85 degC. Operation in temperatures above 65 degC or in close proximity to radiant heat sources will activate a protective shutdown mechanism that inhibits normal readout operation. While shutdown, the readout will occasionally display a "TOO HOT" error message. Case damage will occur if the readout is left inside a motor vehicle exposed to direct sunlight on a hot sunny day. Mounting is best done using the supplied mounting plate. This plate can be permanently attached by screw fasteners or temporarily attached using cable ties. The "VELCRO" brand fastening then allows quick mounting and dismounting of the readout. Alternatively "VELCRO" brand self adhesive mounting tape can provide a convenient mount on any flat surface.

5.2 Sensor Installation.

In order to ensure accurate air fuel ratio measurement the following factors must be given due consideration:-

1. Mount the exhaust gas sensor in a position where it is directly exposed to exhaust gas flow. The sensor element must protrude into the exhaust. Failure to do this will give poor accuracy and sluggish response to air fuel ratio change.
2. Do not mount the sensor in exhaust systems that are highly pressurised. Exhaust pressure effects measurement accuracy. High pressures can damage the sensor. Generally it is preferable to install the sensor after the turbo-charger on engine so equipped.
3. Exhaust system leaks, between the sensor and engine will introduce air that dilutes the exhaust gas resulting in measurement errors. Mounting positions too close to the open end of the exhaust system will also result in similar errors when pulsations introduce air from the open end. Engines fitted with equipment for injection of air into the exhaust system for secondary combustion of hydrocarbon pollutants, must have these systems disabled to avoid measurement errors.

5.3 Sensor Care

Sensor life can span many years generally being in excess of 1000 hours or 50,000 Km. This expectancy is only possible if the following precautions are stringently adhered to:-

1. Avoid exposure to leaded fuels. Highly leaded fuel will POISON all types of sensors, reducing life to less than 50 HOURS.
2. Avoid using SILICON engine sealant for sealing intake and exhaust system joints. Poisoning will occur when silicon is washed from the intake system or burnt from the exhaust system and deposited on the exhaust sensor. Some sealant manufacturers offer low volatility sensor safe sealants that may be safe - even these should be used sparingly.
3. Engines having excessive oil consumption can cause sensor poisoning that results in permanent damage.
4. Choose a mounting position that avoids **HIGH** exhaust gas temperatures. Exhaust gas temperature in excess of 950degC will cause permanent sensor damage. Short duration excursions above 850 degC are permissible. If exhaust gas temperatures are in excess of this, choose a mounting position further from the engine.
5. Exposure of a sensor at operating temperature to direct contact with water will result in instant sensor destruction. The thermal shock from sudden chilling by water impact on the red hot element will cause it to shatter. BEWARE of engines with internal water leaks or blown cylinder head gaskets.
6. Avoid mounting the sensor in the exhaust system a long distance from the engine. Condensation accumulating in cool piping, especially during warm-up, is equally as dangerous.
7. NEVER mount the sensor from the under side of a pipe. Direct contact with water running along the inside of the pipe is possible at any distance from the engine.
8. NEVER mount the sensor in a confined space without proper ventilation or from directly above the exhaust pipe. This will avoid subjecting the sensor body, where the lead wires are attached, to excessive temperatures (> 200degC) that would damage either the sensor body seals or the lead wires.
9. ALWAYS disconnect power supply from readout before connecting or disconnecting any sensor connection.
10. To avoid temporary or permanent sensor poisoning, cold sensors should not be exposed to exhaust gas. DO NOT run engine without having the sensor connected to an operating readout.

5.4 Sensor mounting.

The sensor should be mounted in the exhaust system at a point after all the cylinder branch pipes join together. Typically 1 metre from the engine. The sensor axis should be within 45deg of horizontal using a mounting boss with a M18 x 1.5 tapped hole. The mounting boss should preferably be made from stainless steel to avoid corrosion problems. To avoid problems with thread seizure and damage, apply one of the following sensor safe high temperature lubricants sparingly to the threads:-

AC-DELCO Part No:- 1#5613695
or
BOSCH Part No:- 5 964 080 112

6.0 Specifications

DIGITAL READOUT:- 4 Digit 0.52" Hi-intensity red LED

Range:- **UEGO** 0.62 - 4 approx. Lambda or 10-36 A/F (petrol)
Bosch 0.65 - 1.5

Update rate:- 1.25 - 5 samples/sec (user selectable)

Effective Filtering
Time constant:- 0.1 - 6.4 SEC (user selectable)

BAR GRAPH READOUT:- 20 segment multi-color LED

Range:- 10 - 40 A/F or 0.68 - 2.1 Lambda

Response time:- 40mSEC approx.

Display modes:- instantaneous value and/or max value, min & max,
min & max & actual, min to max

Max, Min Hold Time:- 0.1 - 1.6 SEC

ANALOG OUTPUT:- Twin voltage O/P that is tolerant of system
grounding errors

Output Range:- 0 - 1 & 0 - 5 volts (both available simultaneously)
user can define A/F values for min & max O/P limits

Resolution:- better than 0.1% FSD

Effective Filtering
Time constant:- 0.04 - 0.5 SEC (user selectable)

Signal Ground voltage
range:- +/- 3.0 volts

SUPPLY VOLTAGE:-

Normal operation:- 10.3 - 23 volts
Safe limits:- +/- 24 volts (5 min)
+/- 80 volts (alternator load dump 0.5 sec)
+/- 1000 volts (inductive spike 10 μ sec)

CURRENT DRAIN:- 1 amp + sensor heater current (approx.)

OPERATING TEMPERATURE RANGE:-

Minimum:- - 25 deg C (non condensing)
Maximum:- + 70 deg C

SIZE:- 200 * 112 * 31 (l * w * h mm)

WEIGHT:- 0.5 Kg

7.0 Use with Granatelli Engine Management Systems.

This instrument is compatible with all Granatelli Engine Management Systems, and can be directly connected for remote Air/Fuel ratio readout, telemetry, logging or closed loop mixture control. Simply make connection between the readouts Analog output and the management systems O2 input, and select the output calibration appropriate to the management system.

7.1 Connection to Granatelli Engine Management Systems.

For correct operation three electrical connections must exist between the readout and the management system.

These connections are as follows:-

1. Air/Fuel ratio signal.
Connect the readouts 1 volt O/P to Management Systems O2 sensor I/P White wire to SMC Pin 7 SM2 Pin 20
2. Air/Fuel ratio signal ground.
Connect readout analog O/P signal ground to the Management System sensor ground.
Brown wire SMC Pin 17
SM2 Pin 9 or 10
3. Chassis ground
A ground connection must exist between the Readout and the management system. Installations where the Readout and management systems share the same power source already have the required connection and therefore no further connection is required. If separate power supplies are used, a connection must be made. Either make a connection between the negative terminals of each of the supplies or connect the readout chassis ground to the case of the Engine Management System. Do not make both connections since a circulating path may be setup that is potentially a cause of damage to the readout.

7.2 Set-up for use with Granatelli Engine Management Systems.

All CAPA ECUs compatible with A/F default settings

1. Analog output filtering (Fn8) should generally be set for the fastest response (0.005 seconds). If erratic engine operation causes large Air/Fuel ratio fluctuations choose a longer time to smooth out readings (eg:- 0.10 seconds).
2. Error status signaling (Fn7) should be set to a value of 2 for maximum output voltage (5.2volts) to indicate an invalid or fault status
3. 0.00 volts represents 10:1 Air/Fuel ratio. (Analog output zero voltage - Fn9)
1 volt representing 30:1 Air/Fuel ratio. (Analog output full scale voltage Fn10)

7.3 Analog Output Connections

Analog O/P Connections

RED	0 to 5 volt O/P
WHITE	0 to 1 volt O/P
BROWN	Signal Ground
YELLOW	Chassis Ground

LIMITED WARRANTY:

Granatelli Motor Sports warrants that all products shall be free from defects in materials and/or workmanship for ninety days from the date of purchase (except in-tank and in-line fuel pumps purchased at dealer or wd prices as these items have no warranty and roller rocker arms which have a 12-month limited warranty). The following requirements and exclusions apply: (1) You must be the original purchaser and must complete the warranty registration form (located at www.GranatelliMotorSports.com/warranty.asp) and return the defective product within 10 days after the expiration of the product warranty. Failure to do so voids all warranty, either express or implied set forth herein. (2) You must reside in the United States or Canada and use the product as described in the warranty registration. (3) The product must not have been altered, disassembled, modified, or converted for any other use than intended by Granatelli Motor Sports. (4) The product, or any part thereof, is not used in accordance with the operating parameters specified by Granatelli Motor Sports (5) The product or any part thereof is damaged or rendered unserviceable due to negligence, vandalism, theft, fire, debris, flood, Act of God, or other peril, malfunction of equipment, or by any cause within the Customer's control. (6) The serial number (if applicable) must not have been altered or removed. The extent of Granatelli Motor Sports' liability under this warranty shall be limited to the prompt correction or replacement, at Granatelli Motor Sports' option and at no cost to the customer other than return shipment, of any defective part of the product determined to be necessary by Granatelli Motor Sports. This only applies if written Granatelli Motor Sports received notice of the claimed defect prior to expiration of the warranty period. All warranties of merchantability and fitness for a particular purpose are expressly excluded. The duration of any and all implied warranties is limited to the duration of this express warranty. All incidental and consequential damages including but not limited to loss profits even if it has been advised of the possibility of such damages are hereby excluded. Regardless of the form of the claim, Granatelli Motor Sports liability for any damages to the customer for such product is limited to the guidelines herein. This stated, expressed warranty is in lieu of all liabilities or obligations of Granatelli Motor Sports for damages arising out of or in connection with delivery, use or performance of the product. This warranty cannot be amended or changed by any Granatelli Motor Sports representative, employee, or agent and any promises inconsistent with this warranty are void and unenforceable against Granatelli Motor Sports. Some states do not allow limitations of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may have other rights that vary from state to state. Your sole remedy for the above warranties is the repair or replacement of the defective product only, at Granatelli Motor Sports' sole discretion.

RETURN POLICY:

Before you return a product for a warranty claim, contact our service department M-F 8AM-5PM (PST) at 805-486-6644 or techsupport@GranatelliMotorSports.com for an RGA number. No returns are accepted without a pre-approved RGA (return goods authorization). No returns on special orders, electrical items or after 90 days from date of original shipment. All returns must be safety packaged in original packaging (if available) and clearly marked with your RGA number on the top and two sides of the box. Please insure your shipment for full replacement value as lost, stolen or items damaged in shipment are not covered by our limited warranty. We recommend using FedEx (www.FedEx.com) or UPS (www.UPS.com) for shipping. Lost, stolen or damaged items claims must be made by the customer and resolved by the freight company and not Granatelli Motor Sports. All returns may be subject to a restocking fee of up to 25%. The balance will be returned in the form of a company check or may be applied as credit towards another purchase.

PERFORMANCE CONSUMER'S BILL OF RIGHTS:

Legally, a vehicle manufacturer cannot void the warranty on a vehicle due to an aftermarket part unless they can prove that the aftermarket part caused or contributed to the failure in the vehicle (per the Magnuson Moss Warranty Act, www.GranatelliMotorSports.com/magnusonmoss.htm (15 U.S.C. 2302(C))). For best results, consider working with performance-oriented dealerships with a proven history of working with customers. If your vehicle manufacturer fails to honor emission/warranty claims, contact EPA at (202) 260-2080 or www.epa.gov. If federal warranty protection is denied, contact the FTC at (202) 326-3128 or www.ftc.gov. For additional information, check out www.GranatelliMotorSports.com/TechSupport.htm.

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