A/FM²

Wideband Air/Fuel Meter

DYNOCOM™

User Manual

– WARNINGS –

This manual explains the guidelines/warnings for proper operation and installation of the A/FM² wideband air fuel ratio (AFR) meter.

This product and its components may be changed to improve without notice.

Use extreme caution when handling the wideband sensor as it gets very hot. Keep the sensor away from combustible materials as it can potentially ignite them.

Use care when routing and installing associated wiring, as failure to do so may cause a fire and damage the A/FM² meter and/or sensor. Melted or damaged wiring will NOT be covered under warranty.

Care should be taken when handling the wideband sensor, as dropping or mishandling the sensor may cause serious damage to the unit. Do not expose the sensor to direct sunshine or water, as these conditions may lead to failure.

Do not open or modify the controller unit or sensor.

Do not apply excessive voltage (more than 28VDC) to the unit and only apply positive (+) voltage to the RED wire.

Do not modify the wiring harness.

If the wiring harness is damaged or burned – replace it.

If using the cigarette plug for power, do not replace the fuse in the plug with one of different amperage.

Dynocom Industries Inc. does not accept any responsibility for incurred damage as a result of tuning or in misuse of this product.

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INTRODUCTION

The A/FM² Wideband Air/Fuel Meter is a tool to measure the air-fuel ratio (AFR) produced in performance engines. Its measurement range is 9.00 to 16.00 AFR for gasoline. This range equates to 0.62 to 1.10 λ (Lambda). For maximum AFR sensor life, the sensor must be powered when in the exhaust of a running engine. One of the many great features of the A/FM² module is that it may work either with the NTK™ wideband sensor (P/N 24302) or the BOSCH™ wideband sensor (P/N 13965).

SYSTEM CONTENTS

- 1 x A/FM² Controller Module
- 1 x A/FM² Wideband Oxygen AFR Sensor
- 1 x Wiring Harness (16'/10')
- 1x Adhesive Backed Hook & Loop Fastener
- 1x Cigarette Power Plug w/Fuse
- 1x Manual

INSTALLATION

The following are recommended guidelines in mounting the sensor, however; it may be difficult to meet each recommendation exactly and some compromise in mounting may be required.

The AFR sensor should be located between 12" and 48" from the engine, upstream of any catalyst device if present. Understand that the closer you mount the sensor to the engine, the higher the probability that the sensor will be overheated, possibly shortening the sensors life. Furthermore, the further the sensor is from the engine, the more likely condensed water will enter the sensor and possibly shorten the sensors life. The sensor should be mounted a distance of at least 10 times the diameter of the exhaust tubing diameter upstream of the exhaust exit.
If the sensor is mounted less than this distance from the exhaust exit, the actual Air Fuel ratio measured will be leaner than the actual ratio by as much as two points (higher) at low engine speeds.

Furthermore, ensure there are no leaks in the exhaust system as this will create an artificially lean air fuel reading.

In turbocharged applications, it is recommended that the sensor be installed downstream of the turbine due to the fact that the high pressures before the turbine can distort the air fuel readings.

INSTALLATION (cont.)

We recommend welding in a sensor boss (M18 x 1.5mm) to the exhaust so that it will position the sensor in the upper half of the exhaust between the 10 o'clock and 2 o'clock locations (see Figure 1) to avoid liquid fuel or condensed water from getting into the sensor and thermally shocking it which will reduce the sensors life.

After welding a sensor boss to the exhaust, chase a M18 x 1.5 mm tap or thread cleaner through the boss to remove any thread distortion to prevent the sensor's threads from damage during installation or removal. Apply a small amount of anti-seize compound to the threads and tighten the sensor to 45-55 N·m (33-40 lb·ft, 1/3 – 1/2 turn).

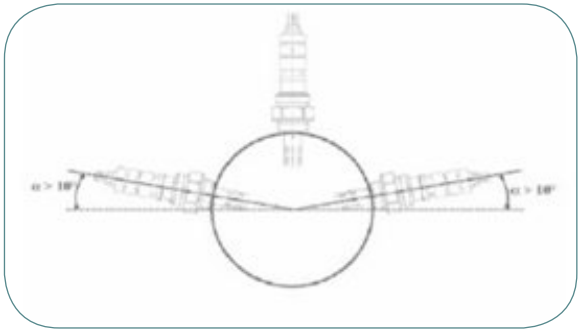


Figure 1 - sensor mounting location

The controller module should be mounted in an enclosed dry location away from ignition systems and not exposed to the elements. The wiring harness should be routed away from the exhaust system and any moving components.

The quality of the AFR measurement depends on the quality of the power you supply to the unit. The ground terminal should be connected directly to the battery's negative terminal or the metal body of the vehicle. Supplying power and ground through the vehicle's cigarette lighter is not ideal; however, a cigarette lighter plug is provided for customers who do not permanently mount the unit.

INSTALLATION (cont.)

The power terminal (RED wire) should have 12 to 28VDC attached via a switch or relay whenever the engine is running. If the sensor is not powered when the engine is running, the sensor life will significantly be shortened.

The unit ground wires (2x Black & 1xBrown) should ideally be connected directly to the negative battery terminal to avoid any possible ground loops or a ground level shift. This will cause the output signal from the YELLOW analog output wire (data acquisition or engine controller) to be incorrect.

Maintain the supply voltage above 12VDC, as the A/FM² module will reset itself if the voltage drops below 12VDC. It is important to note that the system requires up to 3 A for one minute at start-up to heat up the sensor but then requires less than 1.5 A for continuous operation.

The sensor and unit must initially be calibrated for the first time before a new air fuel sensor is used. Failure to do so will result in incorrect air fuel readings.

CALIBRATION

The following is the procedure to calibrate the A/FM² system:

1. Connect the harness to the control module and the AFR sensor. With power disconnected from the harness and the sensor removed from the exhaust, hold the sensor by its wires hanging free in the air. You cannot reliably calibrate the system with the sensor mounted in the exhaust of an engine, even if the engine has been off for several days.

2. Supply power to the harness. The sensor will begin to become very hot. Use CAUTION as the sensor can burn you.

3. Wait approximately 5 minutes to allow the sensor to reach operating temperature.

CALIBRATION (cont.)

4. Turn the calibration knob on the back of the module until the display reads "CAL-" If the display reads "Air_" when the sensor is in air, turn the knob clockwise until the display reads "CAL-." If the display reads "Air¯" when the sensor is in air, turn the knob counterclockwise until the display reads "CAL-."

5. Disconnect the power from the harness. When the AFR sensor cools down, install it in the exhaust and do not touch the calibration knob until the next time the system needs to be calibrated or when replacing the units AFR sensor with a new one.

It is impossible to predict how often the A/FM² system needs to be calibrated without knowing the conditions under which the sensor was used. The following are some timing guidelines for when to perform a calibration procedure:

- The first time before a new sensor is used.
- For every 3000 ft. change in altitude.
- For race/off road engines, every tuning session.
- For wild street performance engines once every week of use.
- For mild street performance engines every month of use.
- For continuous use with leaded fuel once every hour.

CALIBRATION (cont.)

Sensor life depends on sensor operating conditions. It is impossible to predict sensor life without knowing the conditions under which the sensor was used. Leaded fuel will shorten the sensor life. Having conditions in which the sensor is sprayed with raw fuel will thermally shock the sensor and shorten or terminate the sensor life. If a sensor is dropped the thermal shock will shorten or terminate the sensor life. Thus, the sensor should be considered an expendable part (a cost) in tuning, just like gasoline and labor.

The A/FM² system may be used as a constant air fuel ratio monitoring meter, but this will consume the sensor faster. If you are not using the sensor for tuning of an engine or in a dynamometer application we recommend you take it out. Furthermore, it is recommended to obtain a backup sensor if you tune constantly or if you use the sensor within a dynamometer application.

ANALOG OUTPUT

The A/FM² unit has a 0-5VDC, linear analog output for AFR that can be used as an input to a controller, data acquisition system, or dynamometer system. The YELLOW wire is the positive signal output of the A/FM² unit and the BROWN wire is the negative signal output of the A/FM² unit. For single ended data acquisition systems the BROWN wire should be connected to ground or the negative (-) power supply.

An output of 0 VDC means 9.00:1 AFR (gasoline) and an output of 5 VDC means 16.00:1 AFR (gasoline). When in free air the analog output should be fixed at 5VDC.

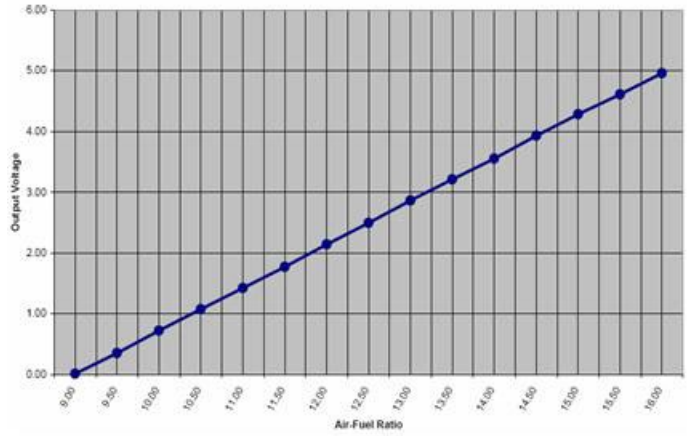
ANALOG OUTPUT (cont.)

Mathematically Analog Output Functions:

Gasoline	AFR = $1.4 \times \upsilon + 9.0$
Methanol	AFR = $0.616 \times \upsilon + 3.96$
LAMBDA	$\lambda = 0.096 \times \upsilon + 0.62$

where υ = Analog Output Voltage

A/FM² Linear Output for Gasoline



COMPATIBLE FUEL

The A/FM² system is compatible with fuels other than gasoline. However, the AFR display is set up to show AFR values based on a gasoline scale with 14.57:1 AFR as the stoichiometric ratio. Even though the display shows the AFR on a gasoline scale, other fuels with different properties (stoichiometry for methanol is approximately 6.5:1) can be used with the unit as long as the user understands how to interpret the values. Hence, the same understanding applies to other fuels such as ethanol, propane, CNG, LPG, etc.

The A/FM² unit is also compatible with leaded race fuels; however, the sensor deteriorates faster with leaded fuels than with unleaded fuels.

Furthermore, the A/FM² unit will also work with diesel fuel. Generally running lean by design, you may experience a problem with the limits of range as the lean limit of the unit is approximately 1.10λ and many diesel engines run leaner than this.

Lambda (λ) is a universal unit of measurement for AFR regardless of fuel. A λ value of 1 equals stoichiometry. Lambda is derived by dividing the actual AFR by the stoichiometric AFR for the specific fuel type. For example, the stoichiometry for gasoline is 14.57:1 AFR. Hence, a gasoline engine running at 12.5:1 AFR, as shown on the display, would mean that it is at 0.86 Lambda (divide 12.5 by 14.57). Since, the unit operates on the principle of Lambda, it is simple to interpret the display values and adapt it to any fuel type that is being used.

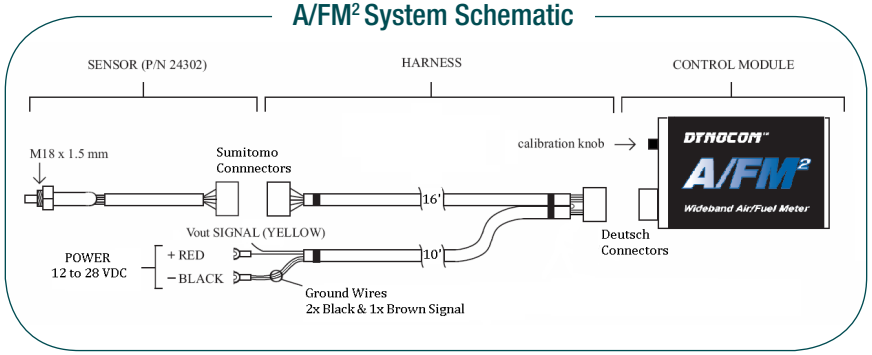


Figure 3 - A/FM² System Schematic

A/FM² DYNAMOMETER WIRING AND USE

The A/FM² wideband AFR meter is and can be used with most dynamometer systems to measure AFR during tuning and use on a dynamometer. Dynocom Dynamometers are designed to exclusively use the A/FM² system with the NTK™ wideband sensor which is understood to be the most accurate and reliable sensor in the marketplace. Other dynamometer systems can be adapted to use the A/FM² system. The YELLOW positive (+) output signal and the BROWN negative/ground (-) wire are all that is required to hook up to an analog input channel of the dynamometer system. Power must be applied to the A/FM² wiring harness to power on.

Furthermore, when using the A/FM² system with a dynamometer it is very important to ensure that all grounds are tied together to avoid ground loops or a floating ground which may not only effect the dynamometer electronic circuitry but the A/FM² units analog output voltage may be skewed. Hence, always ground the vehicle to earth using a suitable sized ground cable. Battery jumper cables are a quick and convenient way to ground the vehicle chassis to earth.

Dynocom Dynamometers will have a slightly modified A/FM² system that is already pre-wired to plug (Figure 3) directly into the Dynocom Dynamometer Control Box having the following pin-out:

Figure 4 - Dynocom Dynamometer A/FM²

A/FM² TROUBLESHOOTING

In the event of a system problem, error codes will be displayed on the A/FM² module display. The following table illustrates the various trouble error codes that will be displayed:

Error Code	Description
SEn1	Heater open (wire open or sensing element cracked) or no sensor connected
SEn2	Heater shorted (wiring problem, H+ wire connected to GND)
SEn3	Supply voltage out of range (28V max)
SEn4	Vs voltage > 1.7V (sensor too cold/not ready for measurement or Vs+ electrode cracked or Vs+ wire open)
SEn5	N/A
SEn6	IP+ voltage out of range (sensing element cracked or IP+ wire open)
Bat_	The supply voltage is too low (<11 VDC)
Bat‾	The supply voltage is too high

When using the A/FM² on modern fuel injected engines, the controller may momentarily display “Air_”, “Air‾”, or “CAL-“ during deceleration or upon releasing the throttle. This is normal operation and is caused by the fuel injection system shutting down fuel delivery to the combustion chambers of the engine during deceleration.
If you cannot calibrate the A/FM² or if the display continuous to show Error Codes, first check if the sensor is completely plugged into the wiring harness and that the wiring harness is not damaged. If Error Codes persist, replace the AFR sensor as it may have reached its end of life or may have been damaged. A damaged sensor CANNOT be repaired.

In the event of a system problem, error codes will be displayed on the A/FM² module display. The following table illustrates the various trouble error codes that will be displayed:

- Bad Sensor due to tuning too rich and/or raw fuel hitting the sensor possibly cracking the ceramic or contaminating the ceramic element
- Bad Sensor due to having the sensor in the exhaust stream with no heating control which will almost immediately foul the sensor
- Bad Sensor due to being dropped possibly cracking the ceramic element within the unit
- Unit not reading within range due to sensor being too hot or cold (to close to the exhaust combustion chamber or too far down the exhaust stream)
- Damaged wiring
- Bad ground, power connections, supply voltage too low

A/FM² SPECIFICATIONS (P/N: DC–A/FM²)

Application	4-stroke Cycle Engines
Dimensions	Controller: Approx. 86mmx67mmx32mm Controller weight: 120g Wiring Harness Length: Sensor side = 16 ft. Power side = 10 ft
Measurable AFR Range	9.00:1 – 16.00:1 AFR
Measurable Lambda Range	0.62 – 1.10 λ
Supply Voltage	12-28 VDC
Supply Current	1.5 A continuous / 3.0 A warm-up
Controller Temperature Tolerance	-40° to 185° F (-40° to 85° C)
Max. Exhaust Temperature	1650° F (900° C)
Compatible Fuel Types	Gasoline (leaded or unleaded), alcohol (methanol), ethanol, CNG, LPG, propane

Dynocom A/FM² System Warranty

Dynocom warrants this product, which it sells to the distributor, seller, reseller or customer, shall be free from defects in workmanship and materials within a period of sixty (60) days from the delivery thereof to the aforementioned parties. This does not apply to modified, altered, abused, damaged during transit or subjected to conditions in excess of their intended environment. There is no warranty on the AFR sensor whatsoever.

Dynocom Industries Inc. (U.S.A.) shall not be liable for any economic damages or losses resulting from the improper use of its products.

This warranty is valid only in the U.S.A.

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