AFX2 Lambda/AFR Monitor User's Manual, V2.1
AFX2_Manual4-16-16.pdf

Table of Contents **Page**

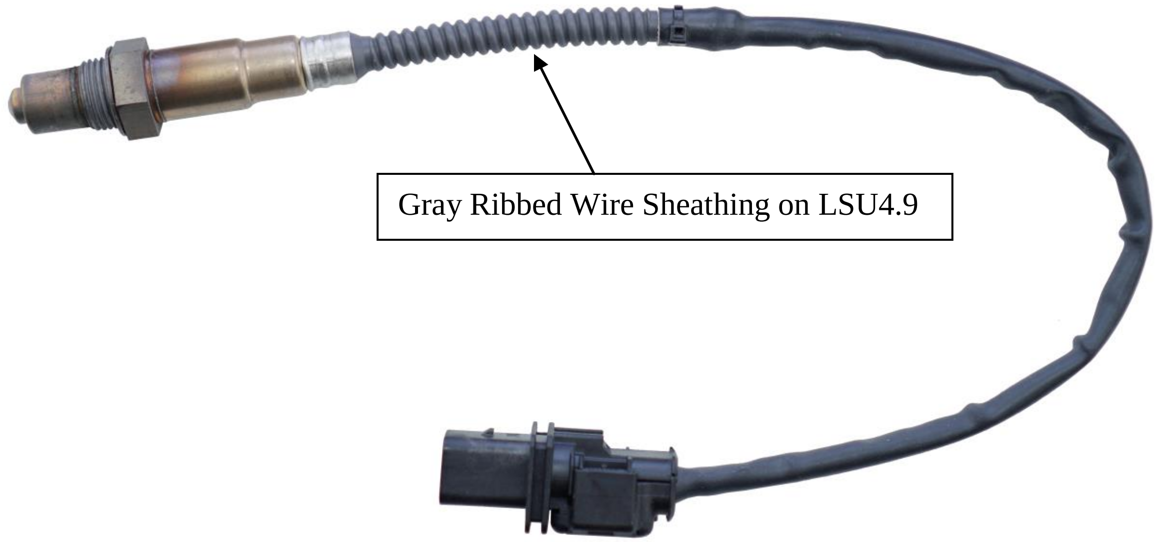
What You Get in the AFX2 Kit

With the AFX2 Kit, you get the AFX2 display module (P/N: AFX2_Display) and harness (P/N: AFX2_4.9harness). The harness has a 13’ (4m) length to the power connections, a 13’ (4m) length to the sensor, and 4” (100mm) long analog output wires. The harness will fit all Bosch LSU4.9 sensors. A sensor is not supplied.

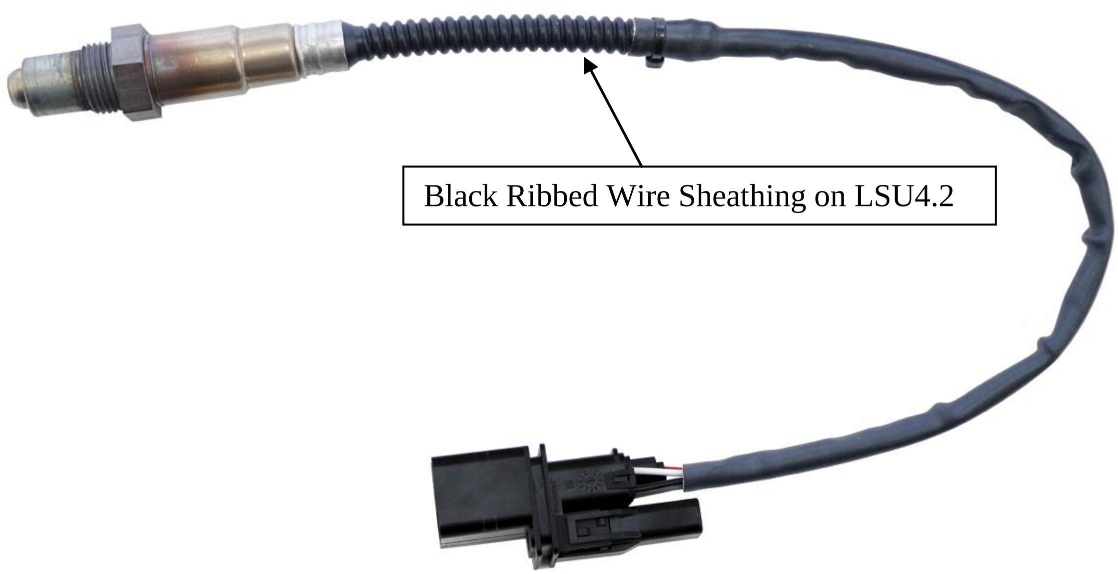
What You Need to Get

The AFX2 Kit is not supplied with a lambda sensor or a sensor mounting boss. The reason a sensor is not supplied is because there are thousands of used but good Bosch LSU4.9 sensors in automotive wrecking yards that you can buy for about $5 each and the AFX2 has the ability to check out and recalibrate the sensor. All LSU4.9s have the same connector. Bring your AFX2 to the yard with a motorcycle battery to test the sensors. If the AFX2 doesn’t show any trouble codes for the sensor and the sensor calibrates, you can use it. So for the price of a new LSU4.9 sensor, you can buy a lifetime supply of perfectly good used sensors. If you have an old AFX, you can use its harnesses and sensors with the AFX2. But if you want a new sensor, drive to your local parts store and buy the least-expensive LSU4.9 sensor they have (ex. Bosch P/N 17025).

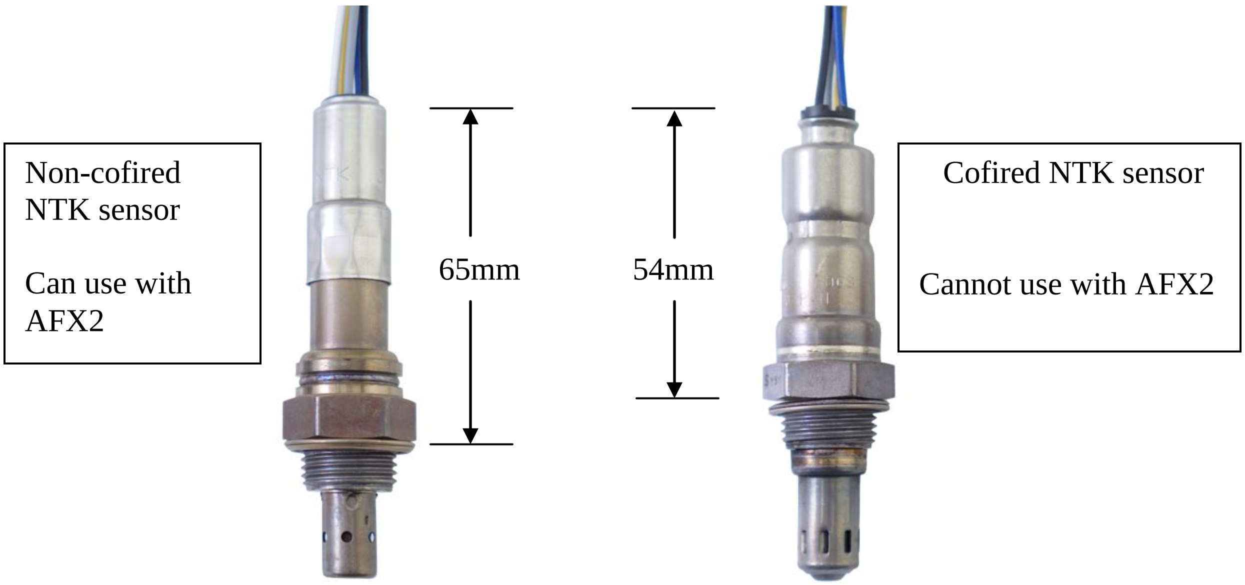
Bosch LSU4.9 sensors can be easily identified by having five wires and a gray ribbed wire sheathing at the sensor.



A Bosch LSU4.2 sensor looks like a LSU4.9 sensor except the ribbed wire sheathing is black with the LSU4.2. The Bosch LSU4.2 sensor can come with several different connectors and is being phased out by Bosch. So unlike the LSU4.9, one harness will not cover all the LSU4.2s out there. For this reason, a harness is not offered for the LSU4.2. However, you can use an LSU4.2 sensor with the AFX2 if you make an adapter cable for the harness. See the "Making a Lambda Sensor Adapter Cable" section.



NGK Spark Plugs (NTK) has two families of wideband sensors, non-cofired and cofired. Both have five wires and can be identified by appearance. The non-cofired sensor has a longer portion sticking out of the exhaust pipe and a thinner body. The non-cofired is the most common and the AFX2 will operate with it. Like the Bosch LSU4.2, there is no standard NTK connector but you can use your old AFX harness (and sensors) or make an adapter cable for any non-cofired NTK sensor. See the "Making a Lambda Sensor Adapter Cable" section.



The thread on all lambda sensors is 18mm x 1.5mm. Mounting bosses are widely available.

<u>Warnings</u>

- The lambda sensor gets very hot when power is applied and it stays hot for a while after power is disconnected. It can burn you and potentially ignite combustible vapors. Be careful when handling the sensor.
- Route and tie the harness to keep it away from moving, hot, or high energy (ex. ignition systems) objects.
- Do not open or modify the AFX2 display module.
- If the wiring harness is damaged, do not use it. Repair or replace it.
- Do not open or modify a lambda sensor.
- Do not have an unpowered lambda sensor in the exhaust of a running engine for more than one minute as this will plug up and perhaps permanently damage the sensor.
- Do not apply excessive voltage (more than 28V DC) to the AFX2.
- Do not distract yourself by watching the AFX2 display when driving a vehicle.

“As Shipped” Configuration

Sensor: Bosch LSU4.9
Display: Lambda
Range: 0.411 to 1.373 Lambda
Analog Output: 0V = 0.411 Lambda, 5V = 1.373 Lambda, Lambda = 0.1924 V + 0.411

Configurations

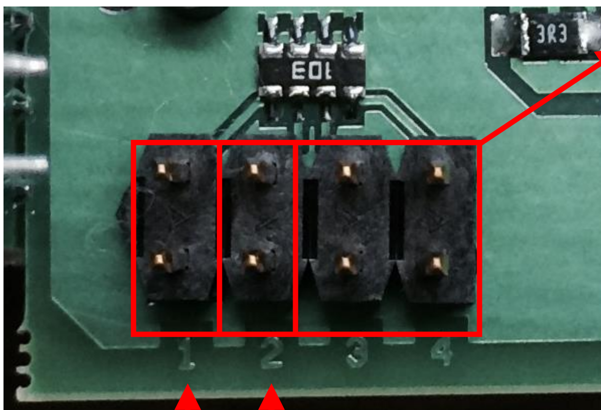
Using jumpers inside the AFX2, the AFX2 can be configured to control different sensors, Lambda or AFR can be displayed, AFRs for different fuels can be selected, and different ranges can be selected.

During start-up, the display indicates (in sequence):

1. The display test (8.8.8.8.)
2. The current configuration. For example, the display below shows that a Bosch LSU4.2 or NTK non-cofired sensor is to be used (i.e. 4.2), the measurement range is that of the original AFX (i.e. _) which is 9 to 16 AFR, and the units are AFR for Gasoline (i.e. G, which looks like a 6).
3. The revision number of the software (ex. 4.00).

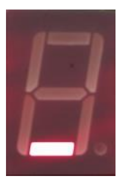
Changing the configuration of the AFX2 is done as follows:

1. Disconnect AFX2 from power.
2. Remove the 2 screws on the back of the display module and slide the circuit board out from enclosure.
3. Locate the jumper header as shown below.
4. Jumper 1 selects sensor type. Jumper 2 selects range. Jumpers 3 and 4 selects units of stoichiometry (i.e. AFR for gasoline, AFR for methanol, or Lambda for all fuels)
5. Insert or remove the appropriate jumper(s)
6. Slide circuit board back into enclosure and reinstall screws.



3	4	DISPLAY
OPEN	OPEN	GASOLINE
JUMPER	OPEN	METHANOL
OPEN	JUMPER	LAMBDA
JUMPER	JUMPER	N/A






OPEN = Original AFX Range

9.0-16.0 GASOLINE AFR
4.00-7.10 METHANOL AFR
0.618-1.098 LAMBDA
(0 to 5V linear with range)

JUMPER = WIDE RANGE

6.0-20.0 GASOLINE AFR
2.66-8.88 METHANOL AFR
0.411-1.373 LAMBDA
(0 to 5V linear with range)

OPEN = LSU4.2 or
NTK non-cofired

JUMPER = LSU4.9

Installation

The lambda sensor should be located between 300mm (12”) and 1200mm (48”) from the exhaust valve(s) and upstream of any catalyst device if so equipped. The closer the sensor is to the engine, the more likely it will be overheated (maximum exhaust gas temperature 850°C), possibly shortening its life. The further it is from the engine, the more likely condensed water will get into the sensor and thermally shock it, again possibly shortening its life. The sensor should be mounted at least ten exhaust diameters upstream of the exhaust exit. If the sensor is mounted between one and ten exhaust diameters from the exhaust exit, the Lambda measured will be leaner (i.e. higher) than the actual Lambda at low engine speeds (i.e. less than 3000 rpm) due to air reversion effects at the exit of the exhaust system. This is particularly acute with single and two-cylinder engines where mounting within 100mm (4”) of the exhaust valve is often needed to avoid the effects of reversion.

In turbocharged applications, it is recommended that the sensor be installed downstream of the turbine. This is because the high pressures before the turbine cause Lambda reading errors. Pressure moves the readings away from Lambda = 1. So rich readings will read richer and lean readings will read leaner due to pressure.

Make sure there are no leaks in the exhaust system, as this will create an artificially lean Lambda reading. Also, install the sensor upstream of any factory air-injection if so equipped, as this too will cause a false lean reading.

The sensor requires an 18mm x 1.5mm boss. Weld the sensor boss to the exhaust so that it will position the sensor in the upper half of the exhaust (i.e. not the side facing the ground). This is to avoid liquid fuel or condensed water from getting inside the sensor and thermally shocking it.

After welding the sensor boss to the exhaust, run a tap or thread cleaner through the boss to remove any thread distortion. If this is not done, the sensor’s threads may be damaged during installation or removal. Apply a small amount of anti-seize on the threads, install and tighten the sensor to 15-20 N·m (11-15 lb·ft). Caution must be taken not to over-tighten the sensor. During a reinstallation, if the sensor shows any resistance to being screwed back into the boss, run the tap or thread cleaner through the boss, clean the threads of the sensor with a fine wire brush, and apply a small amount of anti-seize to the threads before installation. If the threads on the sensor are damaged, run the sensor into a die.

The display module has an operating temperature range of -40 to 85°C and is splash-proof but not water-proof. Mount it accordingly. The display module and the harness should be kept away from ignition systems and the harness should be routed away from the exhaust system and moving engine components.

The quality of the Lambda measurement depends on the quality of the power you supply the AFX2 with. The ground terminal should be connected directly to the battery’s negative terminal or the body of the vehicle (if metal). Do not use the ground in the "cigarette lighter" (i.e. the "12V" power plug) if the analog output is going to be used. The power terminal should have 11 to 28V DC attached (via a switch or relay) whenever the engine is running. Getting the power (i.e. 12V) from the "cigarette lighter" is okay but not the ground if the analog output is going to be used. If the sensor is not powered when the engine is running, sensor life will be shortened due to material collecting in the sensor. The AFX (including sensor) draws less than 2 amps.

Before the AFX2 is used for the first time, or for the first time before a lambda sensor is used, it should be calibrated. See the "Calibrating the AFX2" section.

Powering the AFX2

The AFX2 requires 12 to 28V DC power. A voltage of 15 is preferred. Higher voltages put more heat into the AFX2 which for any electronic device is to be avoided.

The AFX2 needs 2A (at 12V or 1A at 24V) for a 30 second period after start-up. Once the sensor warms up, it requires a little over 1A (at 12V or 0.5A at 24V). Budget 2A (at 12V or 1A at 24V) per AFX2.

Electrical noise degrades the accuracy of Lambda information given by the AFX2. With electrical noise, the displayed and analog output will jump around more than it normally jumps around due to actual Lambda variations. Electrical noise gets into the AFX2 either through the power wires (conducted noise) or via electromagnetic radiation.

For mobile applications in which you use the vehicle's battery, the results of conducted and radiated noise created by an aftermarket ignition system can be jumpy data or a non-functioning AFX2. Keep the display and harness away from the noisy source. In extreme cases, use a separate battery (ex. a motorcycle battery) for the AFX2 and your data acquisition system.

Do not use the ground in the "cigarette lighter" (i.e. the "12V" power plug) if the analog output is going to be used. See the "Connecting Analog Output and Ground Loops" section for more information.

For non-mobile applications (i.e. chassis dynamometer or engine dynamometer testing), power the AFX2 from its own AC/DC supply. Switching power supplies, identified by the lack of a heavy transformer, should be avoided because they are noisy. Linear power supplies, like the Tripp Lite PR series, are electrically quieter and are preferred for data acquisition applications. A Tripp Lite PR4.5 supply (or higher, like a PR12) is a good linear AC/DC supply. Power just AFX2s with it. The PR4.5 has the capacity to power two AFXs.

Analog Output Formulas

Wide Range:

i. If AFR for gasoline selected: 0V = 6 AFR, 5V = 20 AFR, AFR = 2.8 V + 6
ii. If AFR for methanol selected: 0V = 2.66, 5V = 8.88 AFR, AFR = 1.256 V + 2.66
iii. If Lambda selected: 0V = 0.411 λ, 5V = 1.373 λ, Lambda = 0.1924 V + 0.411
(iii. is the default range and units when the AFX2 leaves the factory)

Original AFX range:

i. If AFR for gasoline selected: 0V = 9 AFR, 5V = 16 AFR, AFR = 1.4 V + 9
ii. If AFR for methanol selected: 0V = 4 AFR, 5V = 7.11 AFR, AFR = 0.622 V + 4
iii. If Lambda selected: 0V = 0.618 λ, 5V = 1.098 λ, Lambda = 0.096 V + 0.618

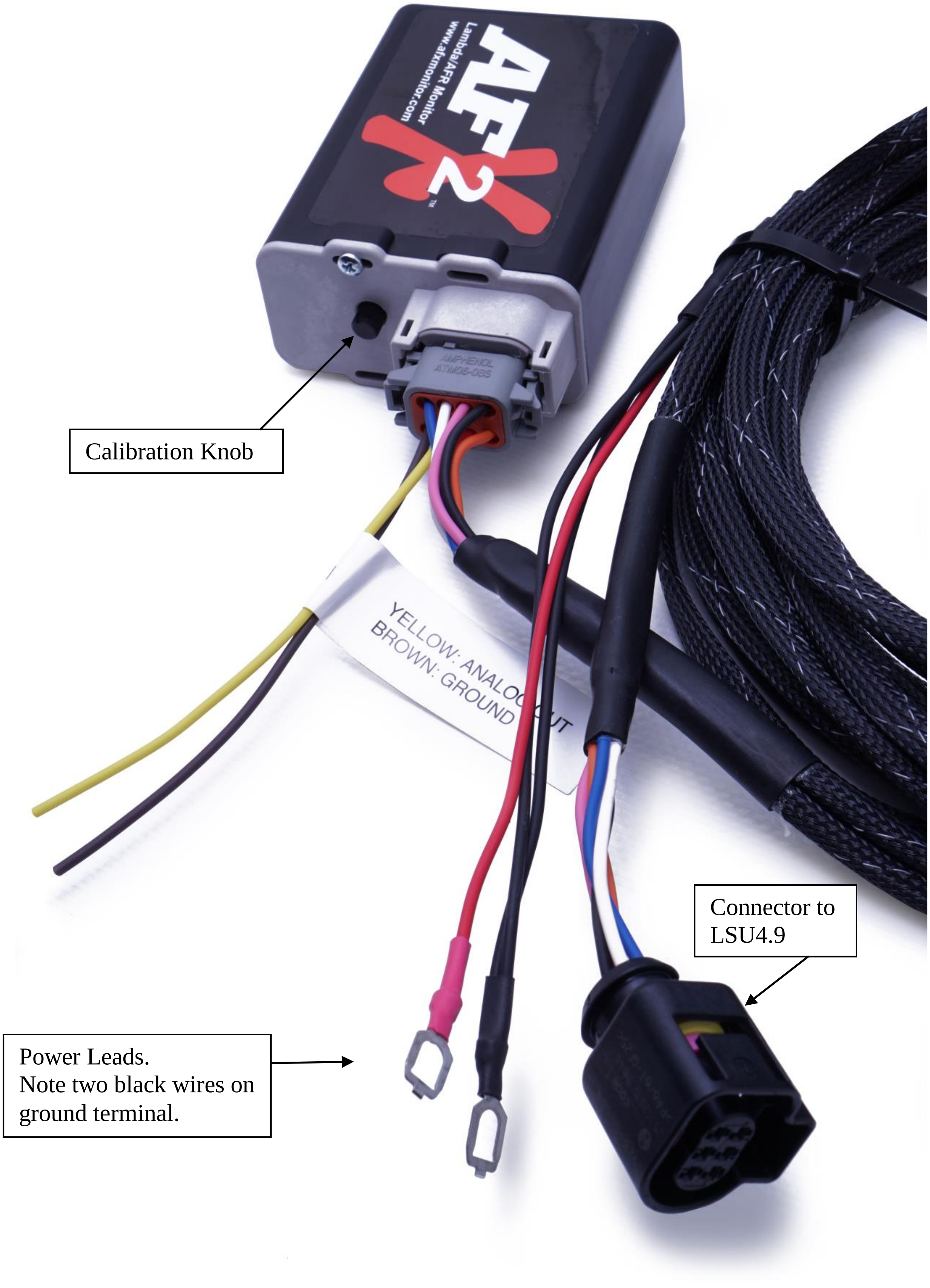
Connecting the Analog Output and Ground Loops

The analog output of the AFX2 can be fed to a data acquisition system or an engine controller. The analog output consists of two wires:

1. The analog output signal wire. That's where you get the 0 to 5V signal (i.e. the "V") that you use to calculate the AFR and Lambda from the analog output formulas. This wire is yellow and is on terminal 3 of the display module connector.

2. The analog output ground wire. This is the ground reference from which the analog output signal is to be measured. This wire is brown and is on terminal 4 on the display module connector. The analog ground wire is connected to the power ground wire inside the display module.

The analog output impedance is 0 Ohms.


Lambda/AFR Monitor
www.afxmonitor.com
BROWN: GROUND
Calibration Knob
Connector to LSU4.9
Power Leads.
Note two black wires on ground terminal.

Now here is the important stuff…When you hook up the analog output (the signal and the ground) of an AFX2 to a data acquisition system or an engine controller, you must be careful where the power ground spade connector of the AFX2 harness is connected. If you are not, the analog output measured by your data acquisition system or engine controller will not match the correct value (as shown by the display). This is called a "ground loop" problem and is caused by a voltage difference between the power ground spade connector and the point you are hooking the analog output ground to. This voltage difference can only be measured when the AFX2 is powering a sensor and the analog ground wire of the AFX2 is not connected. Measure the voltage between the power ground spade connector and where you are about to hook the analog output ground wire to. This voltage should be less than 0.030 V (absolute value).

Generally speaking, to avoid a ground loop problem with the AFX2, hook the power ground spade connector directly to the chassis of the car or negative terminal of the battery. "Directly" means direct! No wire extensions. If this doesn't eliminate the problem, cut the power ground spade connector off and connect the black wire that loops back to the sensor to the chassis of the car (or negative terminal of the battery) and the other black wire to the analog ground terminal of the data acquisition system or engine controller that is reading the analog output from the AFX2.

Here are some things not to do:

- Do not connect the power ground spade connector to a cigarette adapter or you will have a ground loop problem. You can get 12V power from the cigarette adapter but not the ground.

- Do not connect the power ground spade connector to the engine or you may have a ground loop problem.

- Do not extend the ground from the power ground spade connector with a single wire or you will have a ground loop problem.

After you power-up the AFX2, the analog output will read:

1. 1.000 V for 10 seconds, then
2. 4.000 V for 10 seconds, then
3. 0V until the sensor countdown warm-up is completed, then
4. 5V if the sensor is in air.

The 1.000V and 4.000V values allow you to see if your data acquisition system is correctly reading the AFX2's analog output.

Making a Lambda Sensor Adapter Cable

The standard harness supplied with the AFX2 mates to a Bosch LSU4.9 sensor. If you want to use a Bosch LSU4.2 sensor or a non-cofired NGK Spark Plug sensor with your AFX2, you need to make an adapter for your harness.

To make an adapter, you need:

1. A dead LSU4.9 sensor. Cut the leads off close to the sensor.
2. The mating connector to the sensor you want to use.
3. The sensor that you want to use.
4. Five butt splice connectors for 22 AWG wire.

The easiest way to get the mating connector to the sensor you want to use is to clip it off (with about 6" of wire) the harness of a car in a wrecking yard that uses the sensor. Yes, it is possible to get this connector, the terminals, and the seals from a car dealership but it is far easier to go the wrecking yard route. Also, with the connector clipped off a harness, you will not need to get the specialized crimping tool for the terminals.

Connect the sensor you want to use to the mating connector and butt splice the mating connector to the leads cut off the LSU4.9 sensor according to the following table. The wires on the leads of the LSU4.9 sensor are stainless steel so common lead soldering isn't going to work. Use butt splices then wrap them with electrical tape.

Color of Wire on LSU4.9 Leads	Color of Wire on your Sensor (if it's a LSU4.2 Sensor)	Color of Wire on your Sensor (if it's an NTK non-cofired Sensor)
Red, (Ip+)	Red	White
Yellow, (Ip-, Vs-)	Yellow	Black
White, (Heater-)	White	Yellow
Gray, (Heater+)	Gray	Blue (older sensors are Orange)
Black, (Vs+)	Black	Gray (older sensors are Red)

The bracketed terms above (ex. (Ip+)) are the functional names of the wire. The color of the wires on the mating connector may or may not match the colors of the wires on the sensor you want to use. The important thing is that the connections above must be made. For example, the red wire on the LSU4.9 leads must be electrically connected to the red wire of the LSU4.2 sensor (or the white wire of the NTK sensor).

Now you just plug the adapter into the end of your harness, change jumper #1 inside the display module to match the sensor you will be using, and you're ready to go. Making this adapter is better than modifying your harness because now you can quickly go back in forth with the sensor you are using.

Calibrating the AFX2

The AFX2 was designed to be calibrated using ambient air which we assume is 20.7 %O2 (not 20.945 %O2 because we are accounting for some humidity).

The procedure to calibrate the AFX2 is as follows:

1. Clean the lambda sensor's threads. This is because the antiseize will outgas and dilute the air that you are calibrating with.

2. Hang the sensor in stationary air with the sensor pointing down. Do not calibrate in the wind. You cannot reliably calibrate the AFX2 with the sensor mounted in the exhaust of an engine, even if the engine has been off for several days. Nor can you reliably calibrate the AFX2 during a fuel shut-off, motoring condition. Take the sensor out!

3. Attach power to the harness. In about 10 seconds, you will start to notice the lambda sensor getting hot. **Use CAUTION, the sensor can burn you**.

4. How long to wait before calibrating is an interesting question. The safe answer is 24 hrs! This gives the sensor time to burn off material that may have condensed on it. If the sensor is smoking or you can smell it, it is not seeing pure air, so you will have to wait until it stops smoking (or smelling). New sensors will smoke due to antiseize outgassing. As a short-cut general rule, calibrate as close as possible to 3 minutes after a cold (i.e. room-temperature) sensor has been powered *if it is not smoking*.

5. Turn the calibration knob on the back of the display 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 unit the display reads "CAL-".

6. Disconnect power from the harness. When the lambda sensor cools down, install it in the exhaust and do not touch the calibration knob until the next time you calibrate the AFX2.

It is impossible to predict how often the AFX2 needs to be calibrated without knowing the conditions under which the lambda sensor was used. However, here are some calibration rules-of-thumb:

- The first time before a sensor is used: calibrate.
- For every 2500 ft. change in altitude: calibrate.
- For race engines: calibrate before every race or tune session.
- For wild, street performance engines: calibrate once every week of use on the street.
- For mild street engines: calibrate once every month of use on the street.
- For use with leaded fuel: calibrate once every hour.

Experience will teach you if you need to shorten or lengthen these times by how much you had to turn the calibration knob to recalibrate. If you did not have to turn the calibration knob more than $1/16^{th}$ of a turn (20 degrees), you can lengthen the time between calibrations.

The AFX2 has been designed to extend the lambda sensor's life as long as possible. However, since sensor life depends on sensor operating conditions, it impossible to predict sensor life without knowing the conditions under which the lambda sensor will be used. Certainly, leaded fuel will shorten the sensor's life. So will using the sensor in a tailpipe probe where it will see a lot of liquid water. There is a statistical component to sensor life. For example, a plug may foul and the sensor may (or may not) be sprayed with raw fuel and thus be thermally shocked. Therefore, the lambda sensor should be considered an expendable part; a cost of tuning, just like fuel and your time. Some tuners will never kill a sensor. Some tuners will kill two sensors a year. Some tuners will kill a sensor every tuning session or race. If you are not using the sensor to tune or control the engine, take it out. Do not have an unpowered lambda sensor in the exhaust of a running engine for more than one minute as this will plug up and perhaps permanently damage the sensor.

Tuning Engines with the AFX2

People who tune spark ignition engines for racing applications are concerned with decreased lap times, lower e.t.s, higher speeds, and fuel economy. Once an engine is physically built, the fuel delivery (i.e. jetting or fuel pulse duration), and spark timing are the two principle tuning parameters used to optimize the engine for the type of racing it will participate in.

One way to tune the fuel delivery is to do a lot of track testing. However, because the relationship between Lambda measurements and maximum horsepower, best throttle response, engine life, and best fuel economy are well known, it is faster to first tune to specific Lambdas and then to use actual track performance for final fuel delivery adjustments.

Gasoline Burning Engines

For most spark ignition engines, there is a specific small window of Lambda in which maximum horsepower and best throttle response will be found. For gasoline, that range is Lambda 0.85 to 0.89 (AFR 12.4 to 12.9). For reasons such as engine life and fuel economy, some engines are not operated within that range. Here are some examples:

- At high load conditions, air-cooled engines are often operated at a Lambda as low as 0.68 in order to reduce engine temperatures that may lead to engine damage.

- At high load conditions, forced-induction engines are often operated at a Lambda as low as 0.68 (sometimes even less) in order to reduce engine and turbocharger temperatures which may lead to engine and turbine damage. When mounting the sensor on a turbocharged application, it is recommended that the sensor be installed downstream of the turbine.

- Engines operated at loads beyond their original design or at their maximum load for periods longer than they were designed for may be operated at a Lambda as low as 0.68 in order to reduce engine temperatures that may lead to engine damage.

- In racing where fuel stops are made, engines can be operated at a Lambda greater than 0.89 at light loads in order to improve fuel economy. Fuel economy is maximized at a Lambda of about 1.1. However, at these leaner Lambdas (i.e. higher numbers), internal engine temperatures will increase and this may lead to engine damage at high loads.

- With low octane fuels, engines are often operated at a Lambda less than 0.85 in order to suppress detonation that may lead to engine damage.

- Engines that have a centralized fuel delivery system (i.e. a carburetor) will have some cylinders operating at a Lambda greater or less than the engine average. The fuel delivery and induction should be tuned so that the average of the cylinders is between 0.85 and 0.89, and to avoid a specific cylinder(s) from operating at a leaner Lambda (i.e. closer to Lambda = 1) that could lead to overheating or detonation.

In summary: If you have a gasoline-burning, water-cooled, naturally aspirated engine, start with a Lambda of 0.85 and tune from there. With forced induction, start at 0.68 and tune from there. "Tune from there" means adjusting the Lambda and then testing for benefits such as increased hp, decreased lap times, lower e.t.s, and higher speeds while watching for issues leading to unsatisfactory engine life or fuel economy. Always keep in mind that Lambdas closer to 1 (i.e. 14.57 AFR for gasoline) increase engine temperatures and if caution is not taken, can lead to engine damage at high engine loads.

The preceding discussion pertains to race engines operating under race conditions. When race engines are idling, a Lambda less than 0.89 can lead to plug fouling or unhappy pit neighbors (the smell). Often increasing the idle Lambda (to say, 0.9, or 13.1 AFR for gasoline) will eliminate plug fouling. At idle, the engine is operating far below its maximum temperature and pressure limits, so increasing idle Lambda is unlikely to lead to engine damage at idle unless the engine is wildly misfiring. With carburetors, idle Lambda adjustments will influence off-idle Lambda and may cause detonation during initial throttle opening (i.e. tip in). Therefore, and especially with carburetors, the choice of idle Lambda will be based on tradeoffs between spark plug fouling, idle smoothness, off-idle Lambda, and detonation.

Methanol Burning Engines

We have had less feedback from methanol users but the general trends are as follows:

- Water-cooled, naturally-aspirated race engines are operated (under load) at a Lambda of 0.77 (AFR 5).

- Water-cooled, forced-induction race engines (i.e. Outlaw 10.5 engines) are operated (under load) at a Lambda of 0.54 (AFR 3.5).

- Street methanol engines are operated at the same Lambdas as gasoline street engines. To convert to AFR for methanol, multiply by 6.47.

Street Applications

Be aware that it is illegal to modify many vehicles and then operate them on the street. If legal, performance street engines should be tuned the same way as race engines are except during non-WOT or non-idle operation, the Lambda should be increased. The reasoning here is that it makes no sense to pollute the air and waste fuel unless maximum engine power is required. For non-WOT and non-idle conditions, a Lambda of about 1 will often give satisfactory performance, will pollute less, and will use less fuel.

Effect of Pressure

Exhaust pressure pushes the measured Lambda or AFR number away from Lambda 1 (14.57 AFR for gasoline, 6.47 AFR for methanol). So if you are reading rich (Lambda less than 1), pressure forces the AFX2 to read richer (i.e. to a lower number) than it really is. If you are reading lean (Lambda greater than 1), the pressure forces the AFX2 to read leaner (i.e. to a higher number) than it really is. The amount it reads richer or leaner depends on the sensor family (i.e. LSU4.9 versus NTK non-cofired), the pressure, the fuel composition, and the lambda the engine is running at. There is no effect of pressure at Lambda = 1. As a rule of thumb, if the pressure is less than 5 psi (34 kPa) above (or below) the atmospheric conditions at which you calibrated the sensor, don't worry about it. If you are measuring before a turbo, worry about it. But the only reason you would be measuring before a turbo would be because you are trying to measure the Lambdas of all of the engine's cylinders. For this application, add a single AFX2 to after the turbo to give you the correction for the effect of pressure. For example, if the average of all cylinders (measured before the turbo) is Lambda 0.75, and the Lambda measured after the turbo is 0.85, then add 0.1 Lambda to each cylinder's reading to get the pressure-corrected reading. This is a lot simpler and cheaper than using several pressure transducers and a bunch of math.

Trouble Codes and Troubleshooting

If you cannot calibrate the AFX2 or if the display shows "SEn#" ("#" is a trouble code number. See below.), you should:

1. Check if the sensor is attached.

2. Check if the wiring harness or terminals in the connectors are damaged.

3. If steps 1. and 2. show no problems, replace the lambda sensor.

If the display shows "bAt_", the supply voltage is too low (below 11V).

If the display shows "bAt¯", the supply voltage is too high (above 28V).

If the display shows a steady value at the upper or lower Lambda (or AFR) measurement range, the Lambda (or AFR) might be outside of the AFX's measurement range or the result of pressure "pushing" the data outside of the AFX's measurement range.

Meanings of Trouble Codes

Sen1: Heater Circuit Open
Sen2: Heater Shorted
Sen4: Vs > 1.7 or Wiring Fault (often a sensor failure)
Sen6: Vp greater or less than 2V (common cracked sensor error)

You cannot repair a lambda sensor.

AFX2 Specifications

Measurable Lambda Range	0.411 to 1.373 Lambda
Accuracy	Within 0.01 Lambda
Supply Voltage	11 to 28V DC
Sensor Tightening Torque	15-20 N·m (11-15 lb·ft)
Maximum Exhaust Gas Temperature	850°C
Display Operating Range	-40 to 85°C
Display Environmental	Splash-Proof, not Water-Proof
Analog Output Range and Impedance	0 to 5V, 0 Ohms

Warranty

We warrant that the AFX2 Kit (display and harness) will be free from defects in workmanship and materials for a period of sixty (60) days from date of purchase. This does not apply to components that have been modified, damaged, or subjected to conditions in excess of their intended environment. If you believe a warranty issue has arisen, send the entire AFX2 Kit (display and harness) and the following information:

1. Proof of purchase showing date of purchase.
2. An explanation of the issue.
3. Your return address.
4. Your contact information (email and/or telephone number).

to: ECM, 5191 Lafayette St, Santa Clara, CA 95054.

All of the above (1. through 4.) are required for a warranty to be considered.

User agrees that he/she will be solely responsible any economic damages or losses resulting from use of the AFX2 kit.

Repair Policy

AFX2 Display

Send your AFX2 display, a check for $120, and your return address to:

ECM, 5191 Lafayette St, Santa Clara, CA 95054.

When you check clears, we repair and send back your display.

Harness

We do not repair harnesses because they are usually too damaged to make it cost effective.