# Wide Band EFIE Installation Instructions

## Install your fuel efficiency device

The EFIE is not intended to be a fuel saver by itself. You should install a device that is designed to get more energy out of the same fuel, such as a hydrogen gas electrolyzer, a fuel vapor production unit, fuel heater, or other device that gets more power out of the same fuel by increasing the efficiency of the petroleum's burn.

## Locate the wide band oxygen sensor current wire

The most important point in installing any EFIE, is to correctly identify the wire on the sensor that must be connected to the EFIE circuit. This is also the most common mistake made when an installation is not successful.. In general, the easiest way to locate the correct wire is by use of a wiring diagram. If you don't have a set of wiring diagrams that includes your oxygen sensor wires, then see this article: Wiring Diagrams. Once you think you have found the correct wire, I still recommend that you test it to be sure. The correct wire will often be marked "A/F+", or perhaps "IP+".

Often times the wiring diagram will not tell us specifically which wire we need, but will show which wire is paired with which. The 2 current pump wires will always be paired with one another in the diagram, and that's usually all you need to know to identify them. Then you can measure the 2 wires in the pair, with the engine running, and you will select the one that has the higher voltage. One other trick, is that on 4 wire wide band sensors, the wire colors on the sensor itself are often standardized as black, black, blue, and white. In these cases the blue wire is the one you need.

Please see below for more information on identifying and testing your sensor wires. This article describes how to find the wire you'll need to attach to your Wide Band EFIE without a diagram. You are looking for the "current pump" pair of wires, which should be around 2.7 and 3.0 volts, or 3.0 and 3.3 volts. The wire we need is the one that has the higher voltage of this pair. We will call this the "current return wire", and this is the one that we will connect the EFIE's signal wire to.

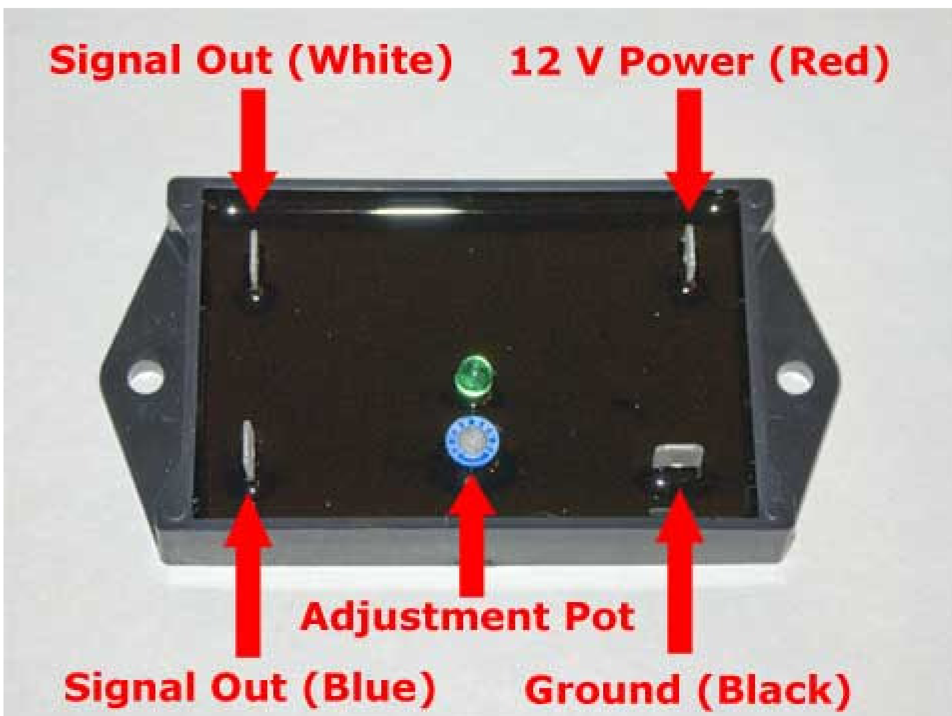
## Locate 12 volt power and ground

You need to ensure that you have switched power, not power directly from the battery. You don't want the EFIE running 100% of the time. Most of the fuel efficiency devices need switched power as well, and you can then piggy back onto them. Note that the EFIE draws negligible power. You can attach it to any circuit. The best choice for a voltage source is a fuel efficiency device, such as a Hydrogen generator. That way the EFIE only activates when the fuel efficiency device is turned on. Note that when power is shut off to the EFIE, the signal from the oxygen sensor to the computer is not affected. The EFIE has no affect on this circuit when it's powered off.

Ground should be to a wire that leads back to the battery.  Bonding to the body is sometimes problematic in that the body is sometimes not well bonded to battery ground. However, you can usually find a good ground wire existing that you can tie into. Just make sure that whatever you choose to use for ground has a negligible resistance when tested against the negative battery terminal of your car.

## Our Original Wide Band EFIE:

The wide band EFIE has only power and ground connections, and one output wire for each sensor. Below is a picture of a Dual Wide Band EFIE. It is shown with just the lugs and no wires attached, but the colors indicate which wire color plugs in at each location. The white and blue wires are the output wires, and each of these will be connected to a wide band oxygen sensor's current return wire. Note, if you are installing a dual EFIE and only have one wide band sensor to handle, then only use one of the output wires. Leave the other one disconnected.



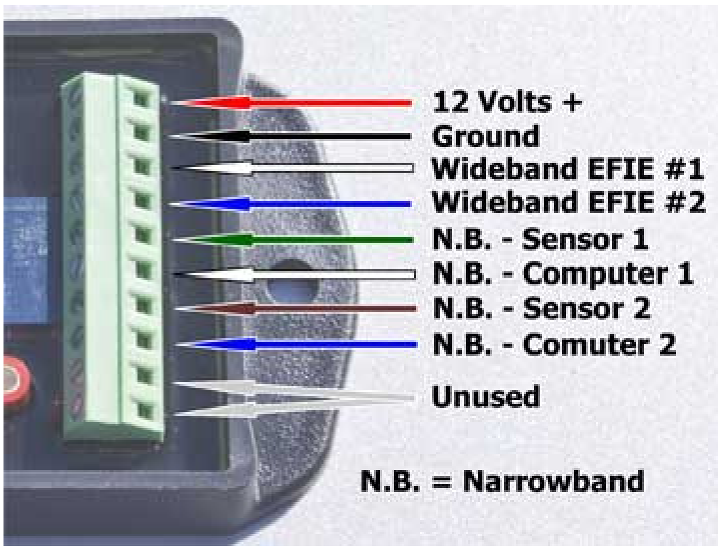

The EFIE's signal out wire connects to your wide band sensor's current pump return wire, as located in the step above. In your wiring diagram, the current return wire will often be labeled AFS+ or IP+. Connect the white wire to one wide band sensor's current return wire, and the blue wire to the current return wire of your other sensor. These EFIE wires are tapped into the sensor's current pump return wire. The original path of the current return wire between sensor and ECU is maintained, and the EFIEs signal wire is also connected to that wire, forming a "Y".

The signal out for both wideband outputs is controlled with a single pot. When turned counter-clockwise all the way to the stop, it has no effect. When turned clockwise all the way it will add about 1.5 milliamps. This is the full lean position and you should never need to set your EFIE this high. Most vehicles use between 1/4 and 1/2 of the EFIE's full output. This means you wouldn't set the pot past the 12 o'clock position when first setting the EFIE.

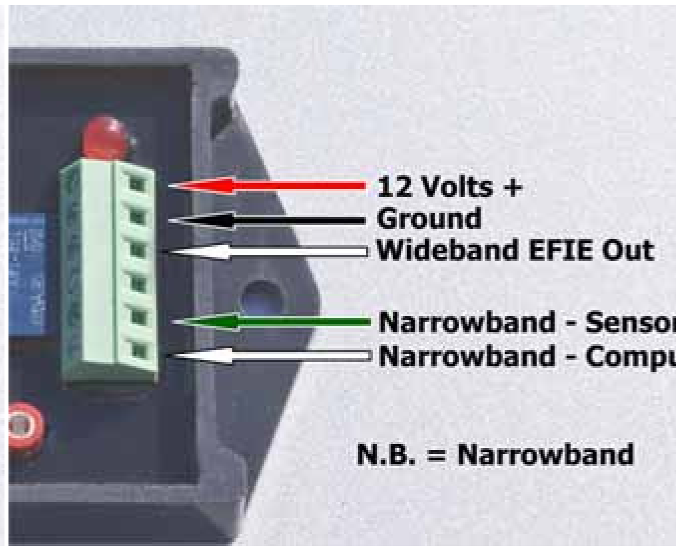
## Our New EFIE Models:

The following images show our new series of wideband EFIEs that include both wide band and narrow band EFIEs. These models allow you to treat both the upstream and downstream sensors using one device. The first images show the wiring keys for the Wideband Quad and Wideband Dual EFIEs.

Wideband Quad EFIE




Wideband Dual EFIE




The Wideband Dual EFIE has the same controls as the Wideband Quad EFIE. However, the Dual model has only one of each type of EFIE whereas the Quad has 2 of each type..

# Setting the Wide Band EFIE:

I'll start this section with a word of caution. Setting too high can cause your engine to run too lean and this can cause the valves to overheat. So you must be careful. If you set this EFIE above 1/2 power, be very careful you do not have any signs of an over-lean condition, such as loss of horsepower or misfiring at any engine speed. Some vehicles will tell you right away when you have set the EFIE too high. The engine revolutions will lug down and the engine may misfire. However, many modern ECUs are programmed to never allow this. They use inputs from other sensors to set minimum fuel levels that will be provided, and no matter how high you set the EFIE the engine will not lug down. The statistic you will use to set the correct level of adjustment on your EFIE will be the fuel mileage gains as described below.

We should review a little of the basic theory of why we are using an EFIE: When you add a fuel efficiency device, such as an HHO generator, one of the results will be that there is more intake air in the exhaust per amount of fuel. This equates to more oxygen, that the oxygen sensor then detects. The additional oxygen means that the air/fuel ratio appears lean to the computer, and it will react my adding more gas. This causes you to lose some of the gains you should be getting from your fuel efficiency device. The purpose of the EFIE is to counteract this effect. The EFIE makes the signal look richer than it is, causing the computer to lean the mix. The point of this is, that all we are trying to do with the

EFIE is to counter the effect caused by your HHO. We're not actually trying to lean the mix. We just don't want the HHO to cause it to run rich.

So take it easy in setting this device on your car. I think you'll find that the correct setting will be between 1/4 and 1/2 power. Some cars will go over 1/2. The thing to do is to start low, and test your mileage. Then raise it a bit and see if you've mileage improves. Continue to test in this way until you get no increase of mileage, or a decrease. Then go back to the last point that increased mileage. That's where you want to be.

## Setting The Analog (Downstream) EFIEs

Downstream sensors must be treated with narrow band type EFIEs. Analog EFIEs work better on downstream sensors than digital EFIEs due to the nature of the signal they generate, so our downstream EFIEs are analog. But narrow band EFIEs work differently than the wide band EFIEs and must therefore are adjusted differently.

To keep things simple, all of our EFIEs make the mix leaner when you turn the adjustment screw clockwise, and richer when you turn the adjustment counter clockwise. When you turn the wide band EFIE's pots clockwise, the mix gets leaner. When you turn the narrow band EFIE's pots clockwise the voltage at the test points goes higher, and the mix gets leaner. When adjusting the down stream sensors, we recommend using your volt meter in the 2 test points so you can see what voltage you are adding. You can, if you wish, use pot positions to keep track of your EFIE settings. However, I find using a volt meter to be more precise and easier to keep track of in my notes.

We recommend starting out your rear sensors at about 200 mV. Once again, you will need to experiment with the settings on these sensors, and make adjustments based on your fuel mileage gains. In general, you shouldn't ever need to go above 350 mV on any analog EFIE. We also recommend fine tuning the front EFIEs first, with the rear EFIEs set at about 200 mv. Then, you can try experimenting with raising the rear EFIEs to see if you get better results. But realize that the bulk of your results will come from the front sensors.

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# Wide Band Oxygen Sensors

## Introduction

Up until relatively recently, all oxygen sensors were of a type known as narrow band sensors. The reason these sensors are called "narrow band" is because they are only able to tell us if the air/fuel ratio is above or below a single known amount or a single narrow
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range. It can tell us that the mix is either rich or lean, but it doesn't tell us how rich or how lean the mix is. More information about narrow band sensors can be found in the article, Oxygen Sensor Adjustment - General Information.

Wide band oxygen sensors are also called wide range oxygen sensors, air fuel ratio (AFR) sensors, or just A/F sensors. They are called "wide band" sensors due to the fact that unlike narrow band sensors, they are not only able to tell the computer if the air/fuel mix is rich or lean, but how rich or how lean it is. It is able to signal to the computer a wide range of air/fuel mix readings. This makes it much easier for the computer to make adjustments to the fuel trim to achieve it's targeted air fuel ratio.

These sensors are new, and weren't used in any vehicles prior to 1997. Starting in about 1999, nearly all Toyota models started using them. However, other than various Japanese and German makes, most automobile manufacturers have yet to adopt them. Because they are a superior sensor, we feel it's only a matter of time before they are universally adopted by all manufacturers.

FuelSaver-MPG now offers "Wide Band EFIEs" to deal with these new sensors. We have found that it's actually much easier to control the air/fuel ratio of a vehicle with wide band sensors and our new product than with our earlier EFIEs on older style vehicles. But we still need to know the basics of how these sensors operate, so we can work with them.

# How the Sensor Signals the Computer:

Unlike narrow band sensors that communicate to the computer by means of a voltage on a single wire, the wide band sensor uses two wires and signals the computer by means of a current flow. An air/fuel ratio of 14.7 to 1 (by weight), is considered to be the optimum air/fuel ratio. When the ratio is above this value, the current flows in one direction, and when it is below this value it flows in the other. When the air/fuel ratio is exactly 14.7 to 1, the current doesn't flow at all. In order to signal increasing rich or lean conditions, the current flow increases in ratio to how rich or lean the air/fuel ratio is.

The two wires we are discussing are called the current pump wires. The reason they're called this is a bit more technical than I want to get in this article, but if you'd like to know more about this you can read this article.

The voltages on these current pump wires varies from manufacturer to manufacturer. One of the 2 current pump wires will have a voltage supplied to the sensor by the ECU. The other wire will be a return wire from the sensor to the ECU. Toyotas have 3.0 volts on their reference wire and the 3.3 volts on the current return wire. Note that the 3.3 volts will vary slightly as the current flows, but these changes are very tiny. Likewise, Nissans use 2.7 volts on their reference wire, and the current wire is approximately 3.0 volts. So far, in all of the 4-wire wide band sensors we've seen, the difference between the 2 current pump wires has been a nominal .300 (300 millivolts), that fluctuates slightly based on current flow.

## 5-Wire Wide Band Sensors

There is another type of wide band sensor that uses 5 wires, and sometimes 6 wires (rare). In this case there is a 5th wire that gives a voltage representation of the current flow on the current pump wires. When a 5th wire is used in this way, it will usually be called the "signal wire". The 6-wire versions also supply a ground reference for the signal wire. In both of these cases, there is circuitry to convert the current flow on the current pump wires into a voltage. But this type still uses the current pump pair of wires to control the voltage on the 5th wire.

The simplicity, as far as installation of our Wide Band EFIEs goes, is that we are looking for the two current pump wires, and we are attaching our device to the wire that has the higher voltage of that pair. If you find a sensor that uses voltages that are much higher or lower than those described above, you may have a misidentified wire or device. In this case, you should contact support@fuelsaver-mpg.com to get help identifying your vehicle's sensor wires.

## The Heater Circuitry:

Wide range sensors require a tip temperature over twice as hot as narrow band sensors. The temperature also must be maintained within a predefined range. To achieve this, the 12 volts is pulsed to the sensors heater, and the "on" time of the pulse is varied as needed to keep the temperature in the proper range. We've also seen examples where the 12 volts is supplied constantly, but the ECU makes and breaks the ground connection in a similar manner. Either way allows the ECU to control the exact temperature at the tip.

Identifying the heater wires can be a bit tricky. When the 12 volts is being pulsed, and you read the voltage on your multi-meter, you will not see 12 volts. You will see a lower voltage, like 6 or 8 volts for instance. This is because the meter is trying to give you the average voltage over a period of time. If you have a frequency function on your meter, you would see the frequency of the pulses to verify that you had the heater wire. If the ground is being pulsed, then you will see 12 volts on the heater wire, and a ground reading that might not be stable.

## Downstream Sensors

So far, every vehicle we've seen that uses wide band sensors, only uses them upstream of the catalytic converter. The downstream sensors have always been narrow band sensors. Further, with modern vehicles, we have found that you must treat both the upstream and the downstream sensors to be successful. This means that you must have an EFIE for each type of sensor, and if you have 2 upstream wide band and 2 downstream narrow band sensors, you'll need a dual wide band and a dual narrow band EFIE. At some point we will make this configuration in a single device, but at present you can find these EFIEs packaged together for a reduced price in our online store.

## Summary:

Making modifications to wide band sensors has been a problem for people adding fuel saving devices to their cars. Particularly the 4-wire version of the wide band sensor (or AFR sensor) has just had no workable handling for modifying the air/fuel ratio. This has now changed with the development of our new Wide Band EFIEs. We are finding that these EFIEs can control wide band sensors of any type better than earlier EFIEs are able to control narrow band sensors. We are now able to achieve lower air/fuel ratios and hold to them more exactly than ever before.