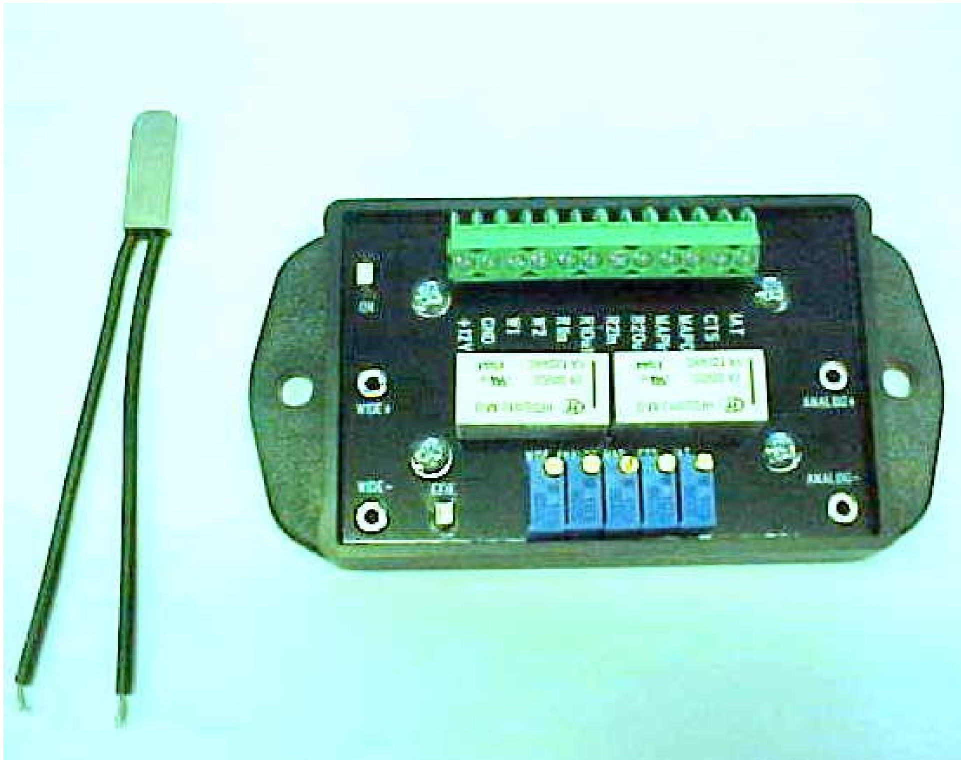


<u>Install instructions for the New 2016 Tuning 101 AFR Control Center</u>
<u>For Wide Band Oxygen Sensors Only.</u>

It is highly recommended that you purchase a Haynes or Chilton’s repair manual for your specific vehicle with a schematic wiring diagrams and color coding identification. It will prove very valuable throughout your installation and tuning procedures. You will also need to purchase a Scan Tool, capable of reading live data streams if you do not alredy own one.

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 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.

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 newer, and weren't used in any vehicles prior to 1997. Starting in about

1999, nearly all Toyota V6 models started using them. Various Japanese and German makes followed Toyota's lead. American Manufacturer's began using them around 2008 on select models.   Because they are a superior sensor, we feel it's only a matter of time before they are universally adopted by all manufacturers.

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**. Actually in Most Cases one is a reference wire and the other is the current pump wire. For the sake of simplicity, we will refer to both of them as current pump wires in this article since the current flows in both directions on your signal wire.**   The reason they're called this is a bit more technical than I want to get into in this article, However if you would like more information.
http://wbo2.com/lsu/lsuworks.htm
http://www.aa1car.com/library/wraf.htm

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 (this is actually your reference wire). 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.

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

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 Wideband AFR Control Center. We are finding that our EFIE can control wide band sensors of any type better than earlier EFIE's 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.

Repair Manuals

When I buy a new or used car, I always buy the Haynes manual for it. Included in the manual is the wiring diagrams and the color codes for all of the sensors. I assume that Chilton's, Clymer and other similar manuals will be similar. But I have always found Haynes to be the most informative. These manuals cost $20, and I have always found this to be money well spent. They can usually be gotten from your local auto parts store, or from their online site: HaynesOnline. There are a few makes and models that they don't cover, but they have a manual for most vehicles sold in the US. If you're on a budget, you might try finding your manual on Ebay, or even see if your local library has it.

AutoZone

Next, see if you can find your diagrams for free at AutoZone. AutoZone posts wiring diagrams for many cars and trucks for free. It also has a vast amount of repair information, including diagrams of part locations, detailed instructions, etc. If you don't have a repair manual for your car, you can just about get by with this all by itself. However, not all cars are covered by this service. You'll just have to look and see if yours is.

To see what they have for your vehicle, follow this link: AutoZone Select Vehicle Page. Then select your year and make/model of car. I went ahead and registered, but I think you all of the same resources without registering. However, by registering, I have saved my car's information, so when I login again, I can just select my car navigate the car selection.
I had a hard time finding the wiring diagrams, so to specifically find those, do the following:

- Locate your car, year, make and model.
- Select "Repair Info" at the left side of the screen.
- Then select, "Vehicle Repair Guides" -> Chassis Electrical -> Wiring Diagrams

I was able to locate my ECU diagram, my oxygen sensor signal wires, all of my other sensors etc. Also, I was able to look up my MAP (Manifold Absolute Pressure) sensor. It told me which kind I had (DC voltage or frequency type), and even told me what resistances = what pressure in the ECU. The same goes for it's entry on the CTS (Coolant Temperature Sensor). It told me what temperature = what resistance from the sensor. This will help you enormously if you need to do adjustments to any other sensors

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. . 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+".

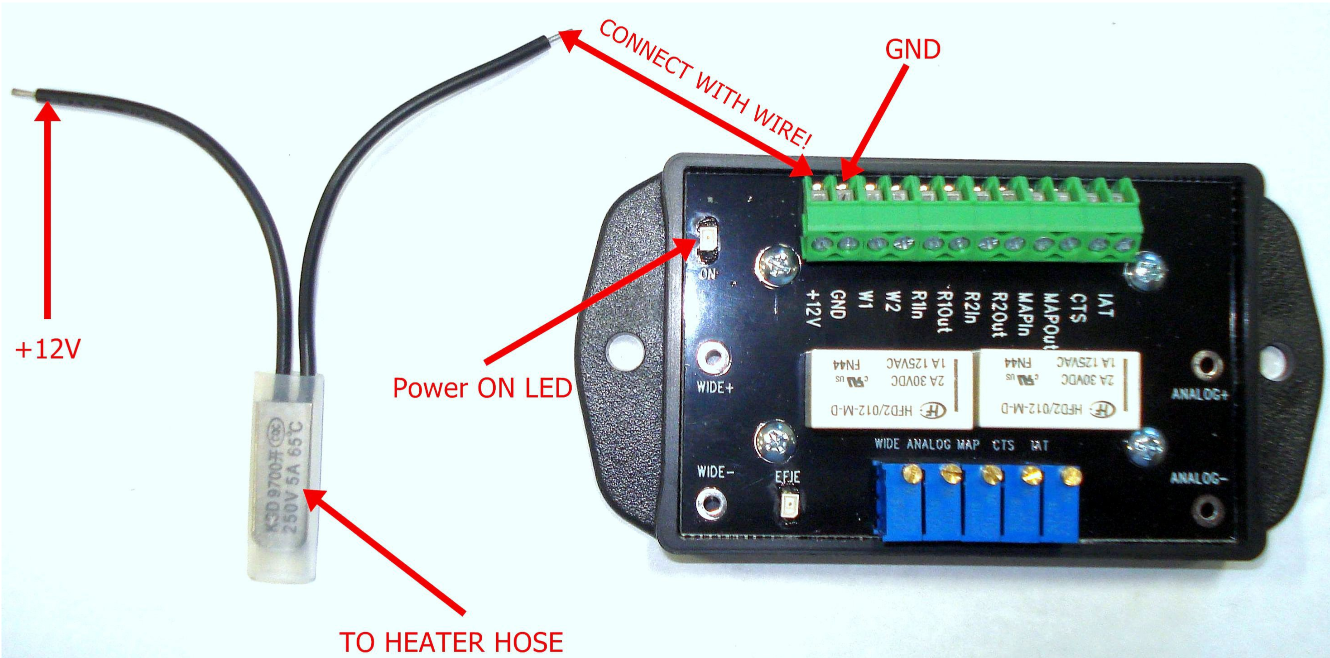
Often times the wiring diagram will not tell us specifically which wire we need, but will show which wire is paired with which. The 2 current pump wires will always be paired with one another in the diagram, and that's usually all you need to know to identify them. Then you can measure the 2 wires in the pair, **with the engine running, and you will select the one that has the higher voltage.** See the shortcut method below

Once you have located the 2 current pump wires, there is a method to make certain you have selected the correct one. Get a 5k ohm resisror. Attach one end to a 12+ volt source. Use the other end as a test probe. When you touch the test probe end to the correct wire that we are looking for, the engine's RPM' will immediately drop and alomost stall. This same method can be used safely to locate the wire you are looking for by probing and testing each wire until you find the correct one.

With this method you will not need to use your volt meter. However, we still recommend the use of your repair manual and it's wiring diagram to locate your sensor(s) and it's color codeing.

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.

Connecting your Device To a 12v. Ignition Switched Source.



It is highly recommended that you connect your 12v + (positive) line to an ignition switched source that is independent and isolated from your CCPWM or PWM. Having them on the same power source or relay or mounting them too close to each other, can affect the performance of the Wideband Control Center, and has the potential to damage it.

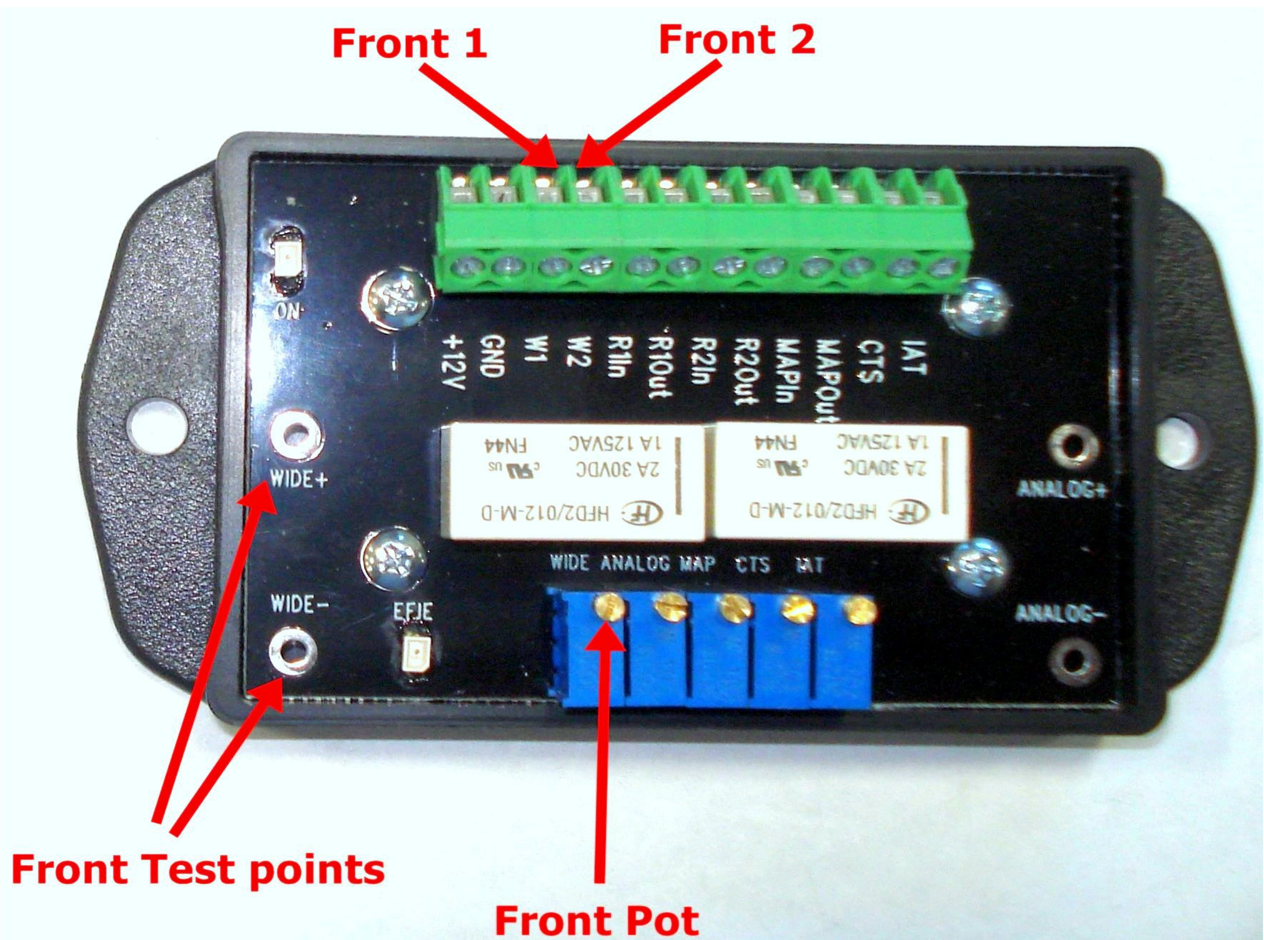
Mounting your Tstat Switch.

You must mount your Tstat switch on your Inlet Heater hose. If you do not know which hose this is, then just do the following. It is very easy to tell. Start your engine and let it warm up a little. While it is warming up, I want you to find the 2 hoses that run from your water pump to your heater, Your heater is normally mounted inside the passenger compartment behind the firewall. When your vehicle is warmed up a little, I want you to turn your heater on. I don't care if it is 98 degrees outside, go ahead and turn it on. Now go back under the hood and feel the 2 heater hoses that you found before. One of them is going to be warmer than the other one. This will be your inlet heater hose. This is the hose you will mount your Tstat switch to. We recommend using a universal hose clamp to hold it in place. DO NOT over tighten. Locate the Tstat as close to the water pump as possible. ***DO NOT let any part of the metal sensor come in contact with the vehicles Ground or ANY metal part of the vehicle. The metal part of the sensor is "HOT" carrying 12+ volts of positive current. Grounding it will immediately destroy the Tstat switch. We do not want to have to SELL you another one.***

If you live in a cool climate, it is a good idea to wrap some fiberglass pipe insulation around your hose and Tstat Switch, and then wrap your insulation, and Tstat Switch with black electricians tape. This will insulate your Tstat Switch from cold air flow when you are driving in very cold or below freezing Freezing temperatures.

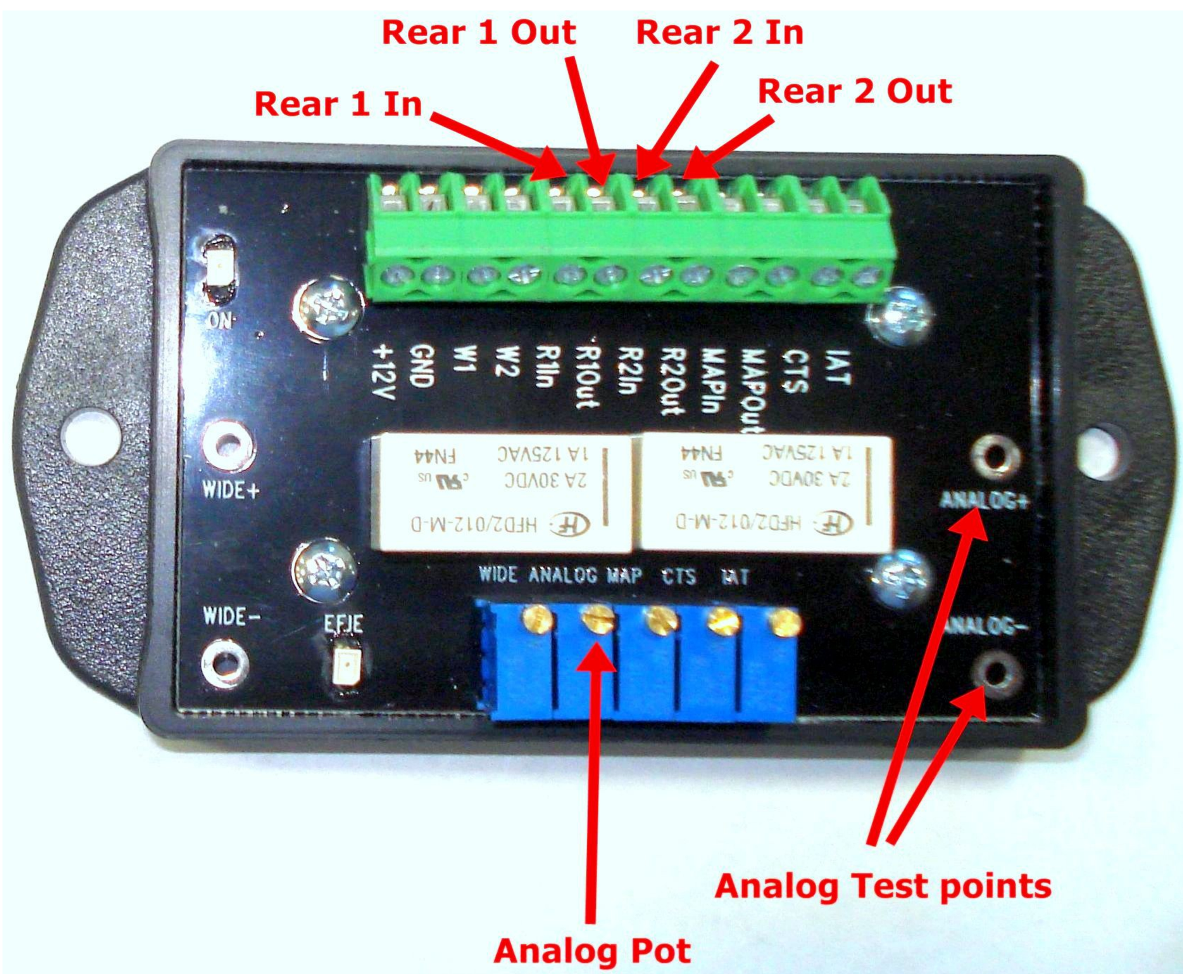
Before you mount your Tstat, you are going to have to solder some wire on each of the 2 wires on your Tstat. One of them has to be long enough to reach your 12 volt (ignition switched) power source, and the other one has to be long enough to comfortably and safely reach your EFIE& MAP/MAF Tuner and attach to the 12+ connector on the Tuner. See Photo Above.

Connecting your Wideband Upstream 02 sensors.



Locate your signal wire as identified in the introduction of this set of instructions. You can connect to the signal wire anywhere from the sensor plug on the wiring harness to the plug on the ECU. Use the location that is most easily accessible to you. Once you have located your signal wire on your 1^{st} upstream sensor, skin back enough insulation to allow you to solder on a length of 18 AWG wire, sufficient in length, to reach your AFR Control Center **DO NOT CUT THE SIGNAL WIRE.** Attach the other end of the wire that you have just soldered on to your signal wire, to the terminal marked **W1** Repeat this procedure if you have a 2^{nd} upstream 02 sensor's, and connect your 2^{nd} wire to the terminal marked **W2** After you have made your solder connections MAKE CERTAIN that you heat shrink your connections to protect them from the elements and the possibility of shorting out.
NO ELECTRICAL TAPE " PLEASE".

Connecting your Down stream Narrowband Analog Sensors



You will now be connecting your downstream (**after the catalytic converter**) 02 sensors if your vehicle has them. Locate the signal wire of your First downstream sensor and cut it. You will need to add lengths of wire to each side of your cut signal wire in order to reach your EFIE mounting location. The wire that goes directly to the downstream 02 sensor, is inserted into **R1 -IN** and the wire that goes to the computer is inserted into **R1 -Out.**

If you have a second downstream 02 sensor, once again locate the signal wire, cut it, add sufficient wire to each end of the cut signal wire to reach the mounting location of your EFIE. The wire that goes directly to the 02 sensor is inserted into the connector marked **R2 IN,** and the wire that goes to the computer is inserted into the connector marked **R2 OUT,** You are now finished with the wiring for the EFIE

- **Note: Down stream sensors are Narrow Band sensors. If you do not know how to locate the signal wire on a narrow band sensor and your repair manual does not indicate which wire is the signal wire, contact us and we will send you instructions for locating the signal wire on Narrow Band sensors.**
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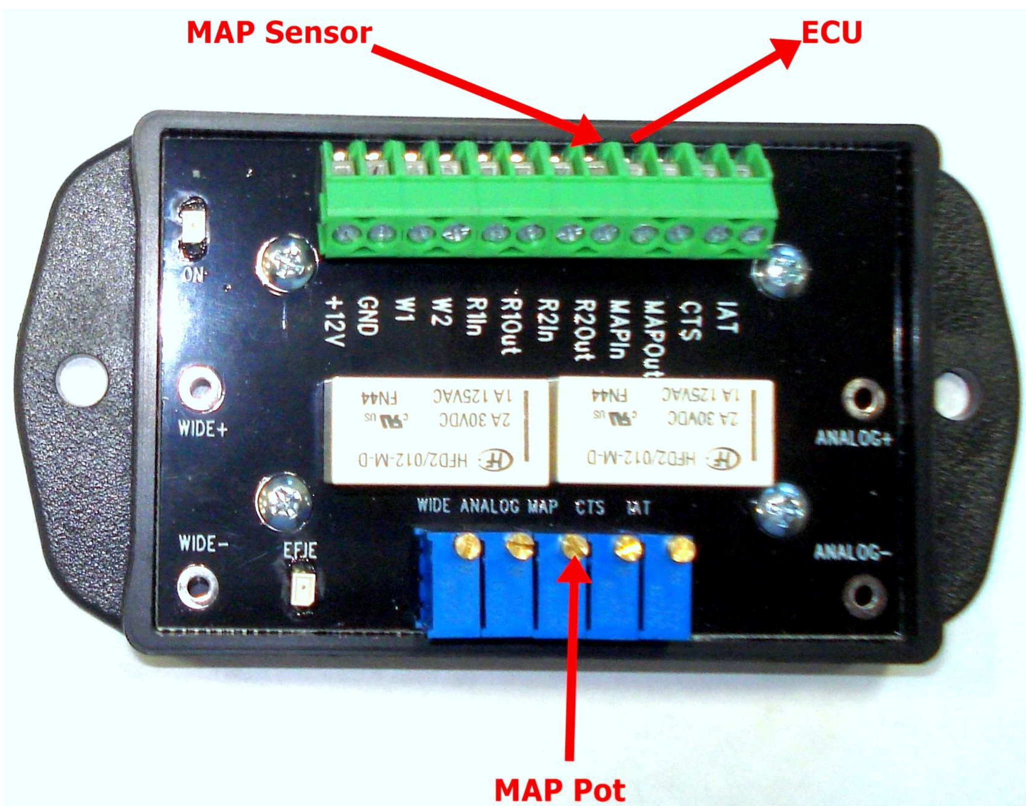
  We recommend the use of Made in The USA. (or equal quality) 18 AWG stranded copper wire on all of your connections. ***Avoid Chinese junk wire with a high tin content.***

Connecting your MAF/MAP Enhancer



This EFIE contains a voltage based MAF/MAP enhancer, which is prevalent in most vehicles today. There are some that use a frequency based MAF sensor and a voltage based MAP sensor. These are rare, and are usually found in some Ford products. If your vehicle has this combination, use which ever of the two sensors is voltage based.   You do not need to adjust the signals of both. Either the MAF or the MAP will suffice. If your vehicle has a voltage based MAF sensor we recommend using the MAP.
Locate your MAF or MAP sensor. They will normally have three wires.

+ 5volt
- Ground
Signal Wire

Cut the signal wire. Add additional wire if necessary to reach your EFIE mounting location. The wire that goes directly to the MAF or MAP sensor is inserted into **MAP In** connector. The wire that goes to the computer is inserted into the **MAP Out** connector.

Finding the MAF/MAP Signal Wire
Of course the easiest way to find the signal wire is to use your manual's wiring diagram for your vehicle. This can tell you the exact wire, and it's color code, and save you some time. But if you didn't take our advice and don't have a wiring diagram, you can still find your signal wire by measuring it

A MAP or a MAF will have 3 wires. One will by 5 volts, which powers the device and is supplied by the ECU. One will be ground, or 0 volts. So if you measure the 3 wires, just eliminate the 5 volt wire and the 0 volt wire, and the remaining wire is the signal wire.
This is slightly complicated by the fact that many MAF sensors today also include an Intake Air Temperature sensor in the same housing. In this case you'll have 5 wires going to the sensor. But it's OK, it's easy to find the correct wires you need. The temp sensor will have a ground wire and a signal wire. The signal wire will be up near 5 volts when the sensor is cold, but as it heats up that voltage gets lower. But a temp sensor's voltage will not change when you goose the engine, and that's how you can tell the difference. Also, if you unplug the sensor, and measure the signal wire on the computer side, it will read 5 volts.

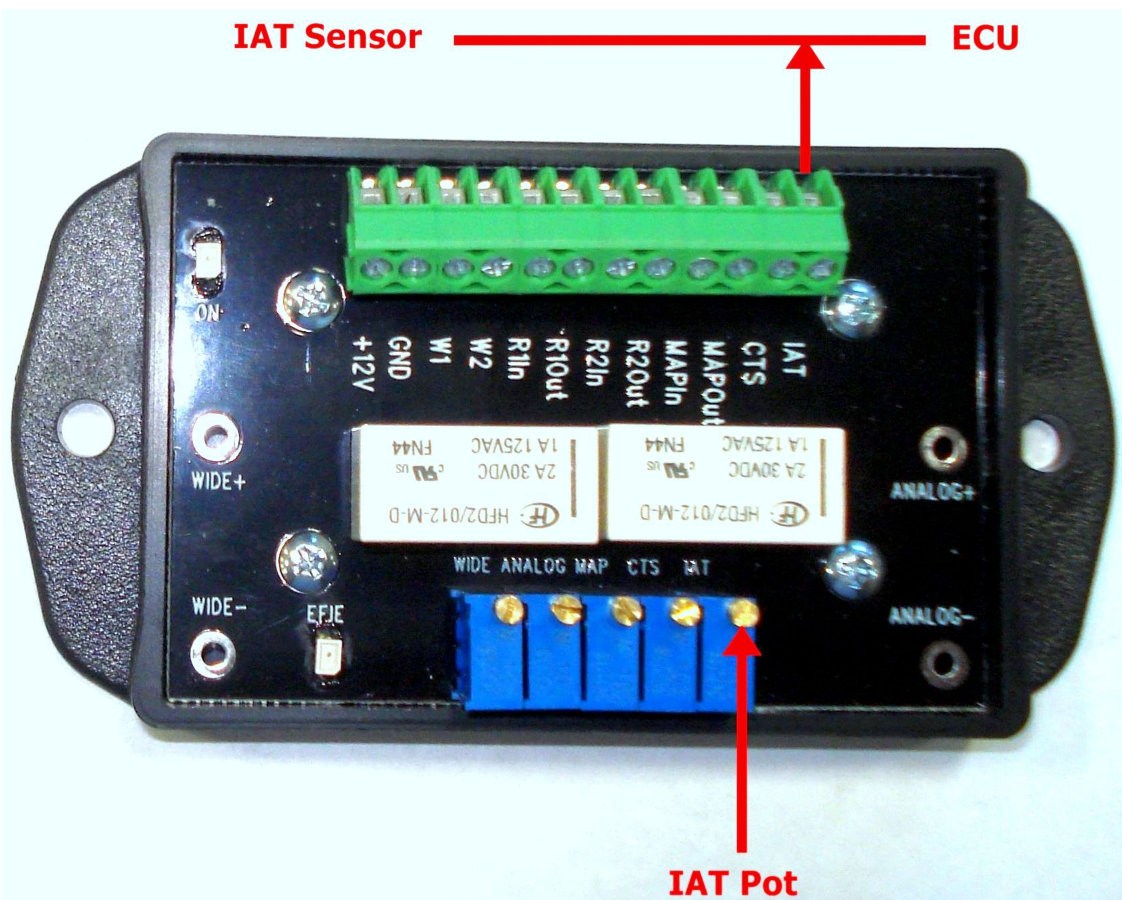
Now, how do you make sure your MAP is a voltage type, and not a frequency type? You will need to watch the voltage as you make changes to the engine's RPMs. The best way is to goose the engine. The voltage will change dramatically on either a MAP or a MAF if it is voltage type. You will see a small or no change in DC voltage for a frequency type device too, but the changes will be slight, like tenths of a volt. Whereas the changes on a voltage type will be much more dramatic. Changes of over a volt indicate a voltage type MAP or MAF.

Tip: You can steal a straight pin from your wife's sewing box and push it through the insulation of the wire you want to test. Make sure you get into the conductor (wire) inside. This will be much easier than scraping away the insulation to test the wire

Even if you find your signal wire using a diagram, you should still test it before proceeding. You must make sure that you see a voltage change when you rev the engine, and that the voltage drops back down when the engine slows back down again. If you see this phenomena, you can proceed to install the circuit. If you don't see this phenomena, then you have the wrong wire, or an incompatible sensor type. Do not try to use this circuit unless you find a signal wire that matches this phenomena. The biggest single cause of failure for any sensor modification project is to mis-identify the signal wire. So it's best to be absolutely sure.

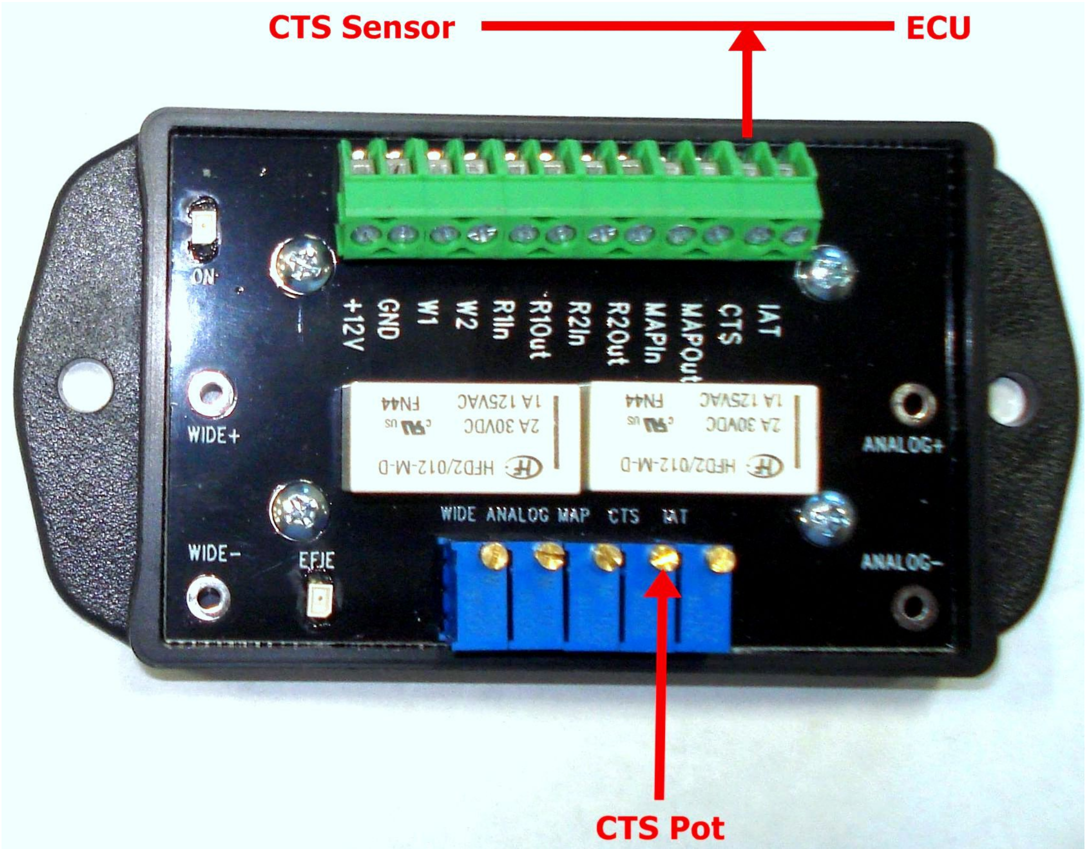
*Note If your vehicle is one of the very rare models that uses frequency based circuitry for both the MAF & MAP sensor this MAF/MAP enhancer will not work with your vehicle. Contact us and we will advise you where you can purchase a frequency based MAF/MAP enhancer.

Connecting your IAT enhancer.



Locate your IAT (intake air temperature) sensor. There will be 2 wires going to the sensor. You will **NOT** be cutting any wires. Using your wiring diagram and your volt meter, locate your signal wire. Carefully skin back enough of the insulation on the wire to enable you to solder on a wire sufficient in length to reach you AFR Control Centers IAT input connector. <u>To help you easily identify the proper wire. Turn on the ignition key without starting the engine. Measure the voltage on each wire. The wire that is the closest to 5 volts is the one you will be making your connection to.</u>

Connecting your CTS.



Locate your **CTS.** <u>**A word of caution:**</u> Some vehicles have 2 almost identical **CTS**. (coolant temperature sensor's) One is for operation of a temperature gauge or indicator, and one that supplies information to the ECU. Make certain that you locate and connect to the one that is supplying information to the ECU. The one you are looking for will have 2 wires, To help you easily identify the proper wire. Turn on the ignition key without starting the engine. Measure the voltage on each wire. The wire that is the closest to 5 volts is the one you will be making your connection to.
your connection will be exactly the same as you performed on your **IAT** sensor. This time you of course run your connecting wire to the connector marked **CTS.** If you are having trouble locating your CTS, refer to your repair manual for it's location. If you are still unable to locate it, it would probably be a good idea to contact your favorite mechanic or repair facility.

Sequential Timing: What to expect.

When you start your vehicle no power is applied to your AFR Control Center, until the Tstat Switch reaches operating temperature then the following series of events will happen.

1. The power ON LED will light and **activate the IAT & CTS controls.**
2. 30 Seconds later your EFIE LED will light and activate the EFIE controls.

Although your Wideband Sensors use a current (amperage) pump, DO NOT ATTEMPT TO TAKE AMPERAGE READINGS FROM YOUR TEST POINTS ON YOUR AFR CONTROL CENTER. We have converted the test points to VOLTAGE. **Use your DC voltmeter ONLY**. Amperage readings will not be accurate

Preparation for tuning your device.

All Control Potentiometer (Pots) have been Pre-Set to their "0" setting. You will begin your tuning by turning each Pot Clockwise. This device has a Tstat switch to allow your engine to warm to operating temperature before any adjustments to the 02, MAP or MAF, IAT & CTS sensors take effect. It has a 30 second delay before the EFIE engages after the Tstat engages and sends power to the device, and any adjustments can be made or take effect. You will know when the EFIE is engaged by the lighted EFIE LED. After the EFIE LED is lit, Insert the probes from your Volt meter as follows. Insert your positive probe in the test point marked **Wide +,** located in the center left hand hand of the board. Next insert your negative probe into the **Wide -** test point located in the lower left hand corner of the board. Set your volt meter on the lowest DC voltage scale (1 or 2 volts). You will now adjust your Wideband potentiometer. Turning it clockwise raises the voltage, leaning the fuel supply, and counter clockwise lowers the voltage, richening the fuel supply. You want to start with an initial setting of 100 mV. You will notice that we use a single 25 turn Wideband potentiometer, which will give you pin point accuracy, as opposed to our competitor who uses 2 single turn potentiometers.

Down Stream Sensors

Downstream sensors should be treated with analog EFIE's. Analog EFIE's work better on downstream sensors than due to the nature of the signal they generate. To keep things simple, all of our EFIE's make the mix leaner when you turn the adjustment screw clockwise, and richer when you turn them counter clockwise. Once again, using your Volt Meter, place the Negative probe in the Analog- Test Point, and the Positive probe in the Analog + test point. Now adjust your ANALOG potentiometer. We recommend starting out your rear sensors at about 200mV. 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 EFIE's first, with the rear

EFIE's set at about 200 mV. Then, you can try experimenting with raising the rear EFIE's to see if you get better results. But realize that the bulk of your results will come from the front sensors.

MAF/MAP Adjustment:

Adjustment of your MAF/MAP Enhancer. With the engine running, and using your Scan Tool, turn the MAF/MAP potentiometer clockwise until you see a 10 to 15% reduction in air flow (or Load) of the MAP% gauge on your Scan Tool. Further adjustments are covered in Tuning 101 for The AFR Control Center..

IAT & CTS

It is highly recommended that with the use of your scan tool and adjustment tool of screwdriver, that you adjust the IAT pot so that the reading on your scan tool shows 190 F. We recommend that you adjust your CTS pot to the point that it is reading 10 degrees farenheit, higher that your vehicles coolant thermostat. If you do not know what your thermostat is rated for it is easy to find out. While your vehicle is warming up, and with your scan tool set to monitor the CTS (coolant temperature sensor) watch the temperature as it rises. It will reach a certain temperature, and then it will drop. The temperature it reached before the drop is the temperature that we are looking for. Now you will need to adjust your CTS pot, so that your scan tool is reading a temperature 10 degrees higher than this number.

We are now recommending the following starting settings. These will get you in the ball park. This will save you a great deal of time, and then all you will need to do is small incremental tweaking of the various sensors.

Upstream sensors	**Setting as measured at test points on the board 100mV**
Downstream Sensors	**measured at test points on the board 200 mV (.200 V)**
MAP/MAF	**10% to 15% lower than Factory Load % (MAP %) reading**
IAT	**195 F.**
CTS	**10 Degrees warmer than the rating of your Coolant Thermostat.**

For more precise and fine tuning, read the Modified Tuning 101 instructions that were sent with this document.

We have discovered a Scan Tool that appears to have all of the necessary functions that are necessary to properly tune your Tuning 101 AFR Control Center. We are not endorsing this product or any other, however this Scan Tool sells for about one half the price of a ScanGuageII. It is well worth looking at ultra-gauge.com This of course is for OBD II systems only. 1996 and newer USA. vehicles.