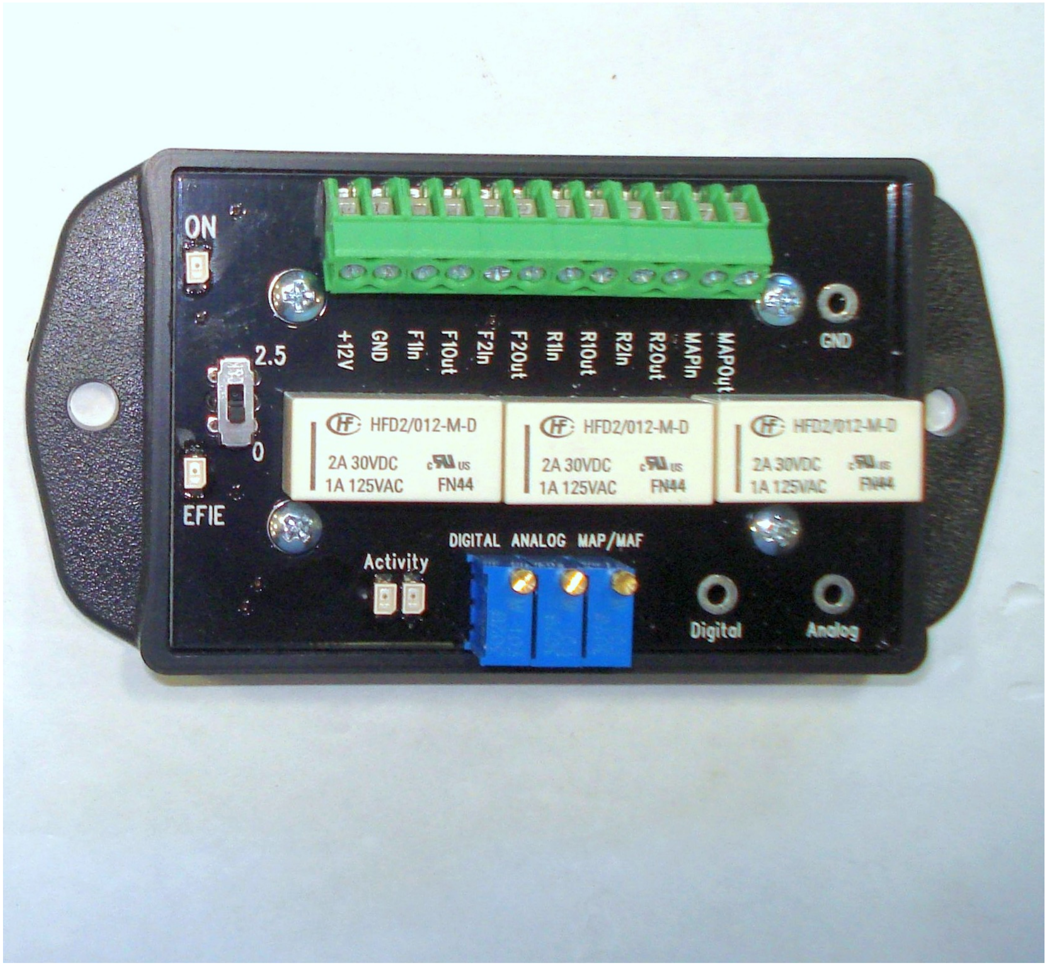


NEW SIMPLIFIED—EASY TO FOLLOW AND UNDERSTAND

Install instructions for the New GM Device #1 EFIE & MAP.

For GM Narrow Band Oxygen Sensors Only.

If you can read, you can install this device very easily.

Hi Guys

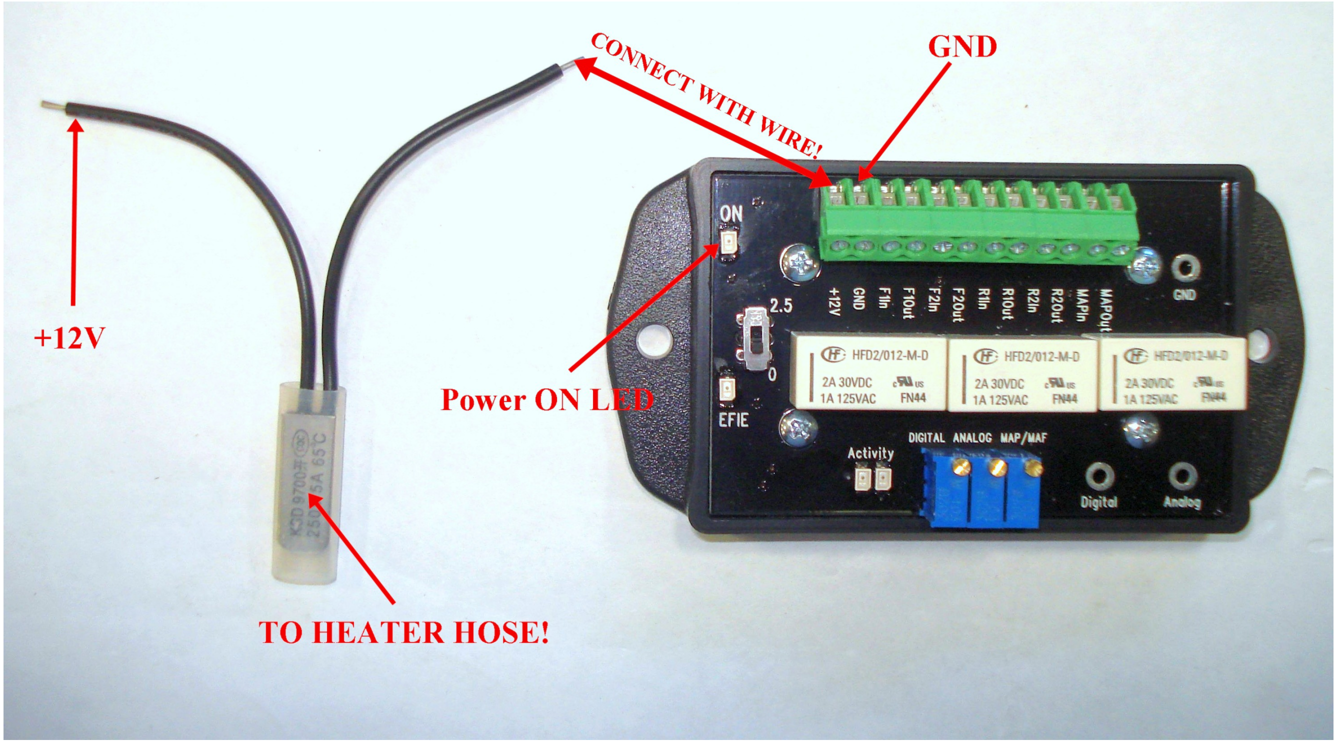
Although you can get by without a repair maunual if you are a really good experienced mechanic, I highly recommended that you purchase a Haynes, Clymer or Chilton's repair manual for your specific vehicle with schematic wiring diagrams and wire color codes for easier wire identification. It will help you a lot throughout your installation and tuning procedures. I have noticed that these companies are not including the wiring diagrams on a lot of the newer model vehicles, and you have to order the wiring diagrams separately. You may want to check this before you buy, and order them if you need to. I guess this is their way of taking a little more money out of our pockets.

Mounting your Tstat Switch.

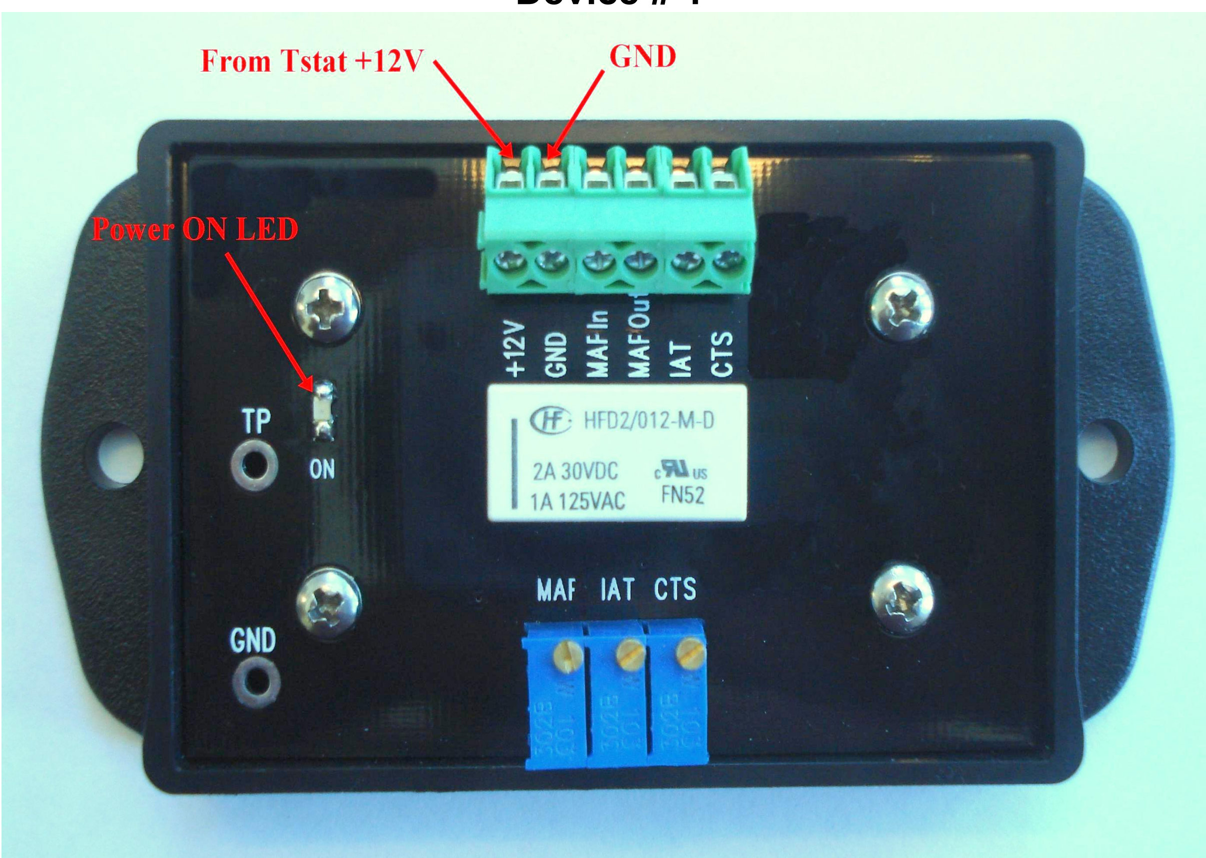
You must mount your Tstat switch on your Inlet Heater hose. If you do not know which hose this is, then just do the following. It is very easy to tell. Start your engine and let it warm up a little. While it is warming up, I want you to find the 2 hoses that run from your water pump to your heater, Your 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 Tuner +12v connector on device #1, and your FREQUENCY MAF device to attach to the +12v connector on Device #2 See Photos below.



Device # 1



Device #2

Connecting Your 12 V. Ignition Switched Source

Use 18 AWG Stranded Copper Wire for All connections.

With the new Tstat switching device, you will need to solder on lengths of wire to the Tstat stub wires long enough in length to reach your chosen 12 volt ignition switched power source on one side of the Tstat, and long enough to reach the 12v input of your EFIE & MAP Combo and your Frequecy based MAF, IAT, and CTS tuner to the other wire of the Tstat. You will need to make a "Y" type connection with your +12v power wire coming from the Tstat to feed both devices. Refer to above photo. Connect your terminal marked GND to either the negative terminal of the battery or a GOOD clean chassis ground. No dirty or rusty bolts. **You will need a very good ground connection.** So take your time and make sure it is. When you make your solder connections to the Tstat stubs, please uses heat shrink tubing to insulate and weather proof your connections. Please do not use electricians tape unless you absolutely have to.

It is now time to figure out how many 02 (oxygen) sensors your vehicle has. You can use your repair manual to determine this. If you are uncertain and can not determine this on you own, you should call your favorite auto parts house, and most would be glad to supply you with this information. If you happened to have purchased a "Haynes Repair Manual" it will have photos showing you where your sensors are and how many.

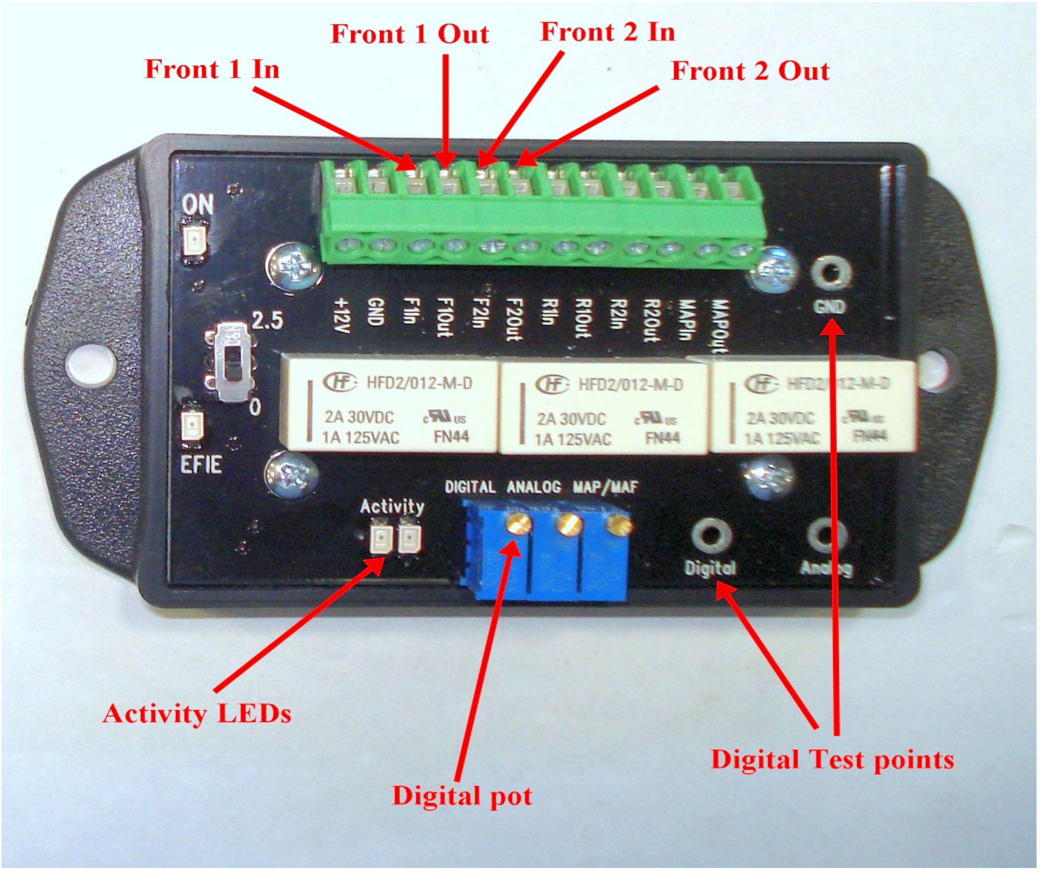
I hope you took the time to read the article that we sent called Locate your 02 signal wire. It is very helpful. Specially if you did not buy a repair manual. If you follow the manual check method, all you will need are some straight pins and a voltmeter to locate your signal wire on each 02 (oxygen) sensor.

An upstream oxygen sensor is an oxygen sensor that is located between the catalytic converter, and the exhaust manifold(s). Depending on the Year, Make, Model, and Engine Size of your particular vehicle, you will either have 1 or 2 upstream 02 (oxygen) sensors.

Any oxygen sensors located between the catalytic converter and the end of your tail pipe are called Downstream 02 (oxygen) sensors. You will normally have either 1 or 2 of these, depending once again on your particular vehicle.

We will now proceed and connect your upstream 02 sensors.

Connecting Your Upstream 02 Sensors



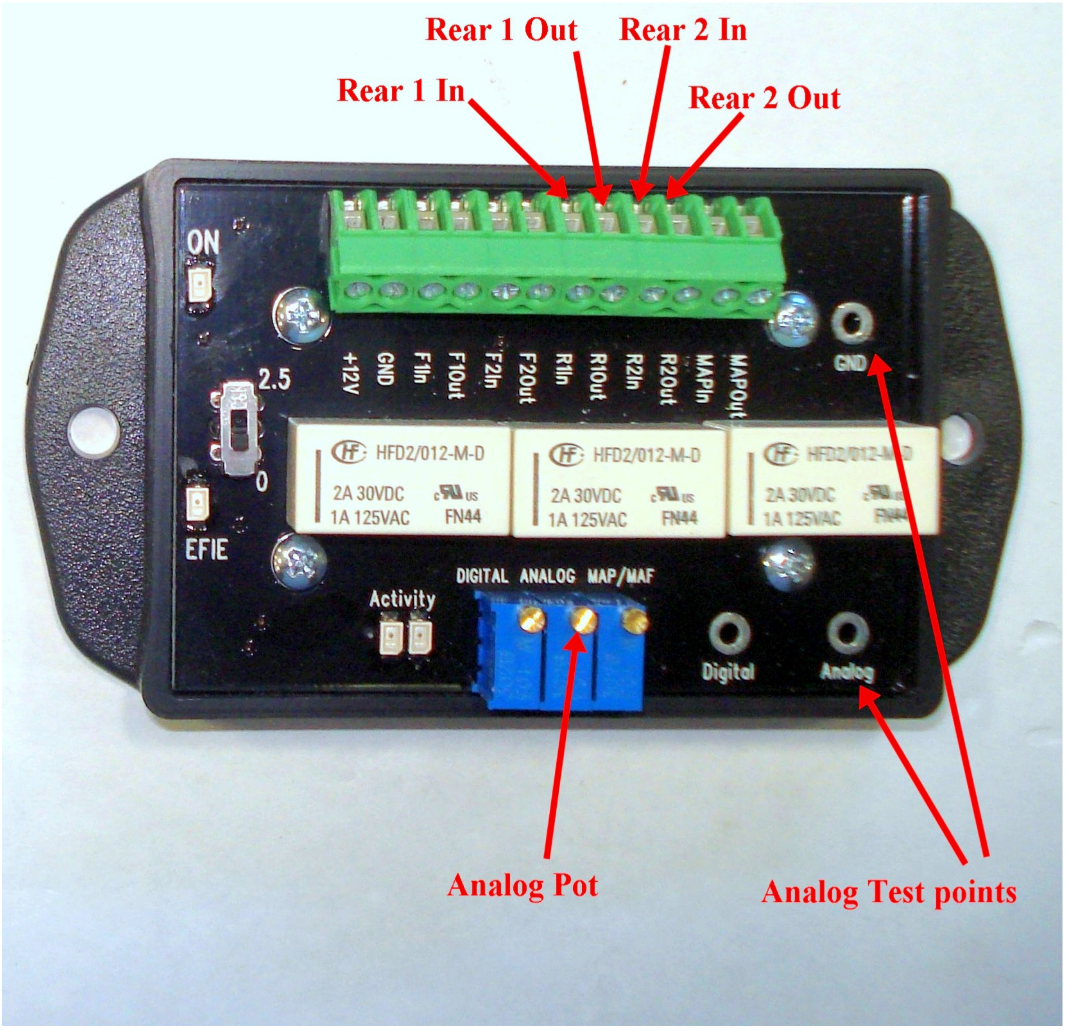
We have included in a separate document, instructions for determining all of your signal wires with your volt meter and as a double check to your Haynes or Chilton's Service Manual diagram.

Now that you have located your upstream oxygen sensor(s) You will now cut the signal wire of your upstream 02 sensor above the plug in block on the 02 sensor wiring harness anywhere between the plug in block and the computer. What ever location is easiest for you to get to. Now that you have cut the wire, we will call the part of the wire that goes to the sensor, " The sensor wire" and the other part of the cut wire will be called " The computer wire " You will need to solder on a length of wire to the "Sensor wire" long enough to reach the **F1in** connector on your tuner. You will now solder on a length of wire to the "Computer Wire" long enough to reach the **F1out** connector on your EFIE tuner. Connect both of these wires to their proper connector on the EFIE tuner.

If your vehicle has Two 02 upstream (**before the catalytic converter**) sensors you will repeat the same process that you have just completed. Locate the signal wire and cut it. This time The "Sensor Wire" connects to the **F2in** connector and the "Computer Wire connects to the **F2out** connector. **If your vehicle only has 1 upstream sensor, leave the F2 connectors empty and do not use them.**

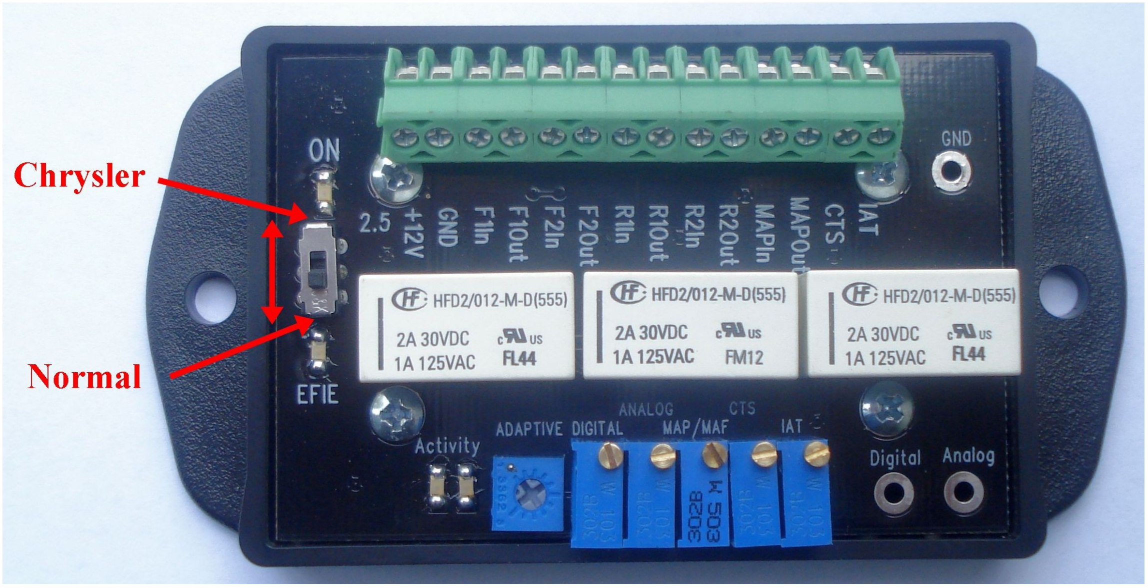
We highly recommend that you heat shrink or silicone seal, all of your wiring connections after you have completed your soldering.

Connecting Your Downstream 02 Sensors



We will now be connecting your downstream (**after the catalytic converter**) 02 sensors if your vehicle has them. This is done exactly the same as your upstream sensors. 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 Control mounting location. The “Sensor Wire” is inserted into **R1In** and the “Computer wire” is inserted into **R1Out.**

If you have a second downstream 02 sensor, once again locate the signal wire, cut it, and add enough wire to each end of the cut signal wire to reach the mounting location of your EFIE Control. The “Sensor Wire” is inserted into the connector marked **R2In,** and the “Computer” wire is inserted into the connector marked **R2Out.** You are now finished with the wiring of the EFIE portion of the Control Center.



New Updated Tuning 101 Narrow Band AFR & NB Combo

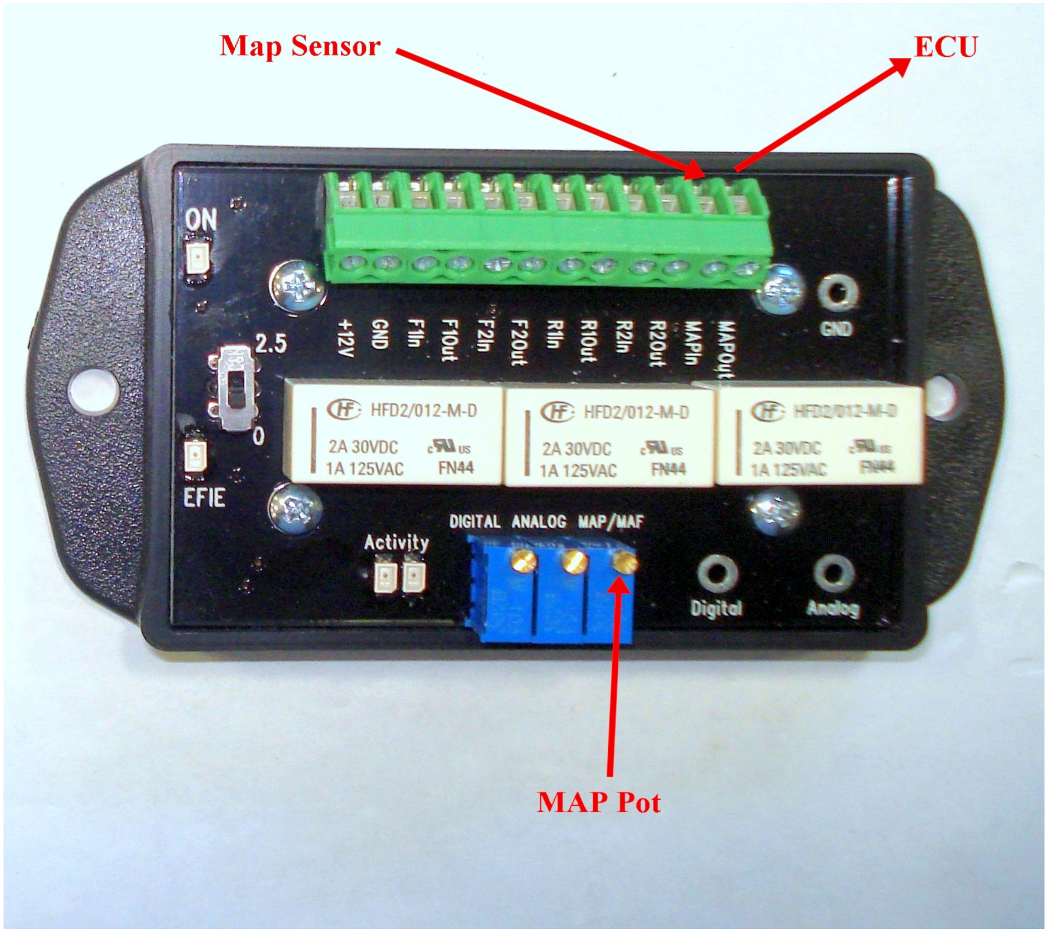
We have upgraded the Narrow Band AFR Control & the 2 in 1 Combo to accommodate certain Chrysler/Dodge/Plymouth/Jeep models that use a 2.5 volt bias voltage on their 02 sensors.

You will notice a slide switch on the left had side of your unit. For the majority of all narrow band vehicles, you will want your slide switch in the “Downward” position. For the very Few selected Chrysler Corporation vehicles that use the aforementioned 2.5 volt bias voltage, you will need to slide the switch to the “Upward” position.

Select the proper switch position BEFORE attaching your upstream 02 sensor wires. If you are uncertain if your Chrysler product has this bias voltage, use the “ Locate Your Signal Wire document included with your instructions. If your signal wire is indicating a fluctuating voltage in the 2.5 to 3.4 volt range you have the Bias voltage and should select “2.5” ***FOR ALL “OTHER” NARROW BAND VEHICLES MAKE CERTAIN THAT YOU USE THE “ 0 “ POSITION.***

NEVER CHANGE THE SWITCH POSITION WHILE THE VEHICLE IS RUNNING.

Connecting your MAP Enhancer



This AFR Control device contains a <u>voltage based MAP enhancer</u>, which is what is used in your GM V8 or V6 engine Your GM vehicle uses a frequency based MAF sensor and a voltage based MAP sensor.

Locate your MAP sensor. They will normally have three wires.

\+ 5volt
\- Ground
Signal Wire

Once again, cut the signal wire. Add additional wire if necessary to reach your EFIE mounting location. The “Sensor Wire of the MAP sensor is inserted into **MAP In** connector. The “Computer Wire” is inserted into the **MAP Out** connector. If you have any doubts about your signal wire, here is the easiest way to find it.

Finding the 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 will have 3 wires. One will be 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. 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 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.

*All of Your Control Potentiometers Have been pre-set to their " 0 " positions

Sequential Timing: What to expect.
When you start your vehicle your ECU will take a barometric reading from your MAF/MAP sensor.

1. When your engine temperature reaches approximately 160 degrees farenheit, Your Tstat switch will switch on and send power to your EFIE & MAP control device, as well as your Frequecy MAF, IAT and CTS control device.
2. Your power indicator's LED's will light up.

2. 30 Seconds later your EFIE-- LED will light and activate the EFIE controls.

Tuning Your EFIE and making Adjustments

Unless you are going to be waiting to install device #2, DO NOT DO ANY TUNING UNTIL YOU HAVE BOTH DEVICES INSTALLED . WE WILL BE REVIEWING THE 02 SENSOR TUNING LATER IN THESE INSTRUCTIONS.

Use the following tuning instructions ONLY if you are going to be waiting until a later time to install device 2.

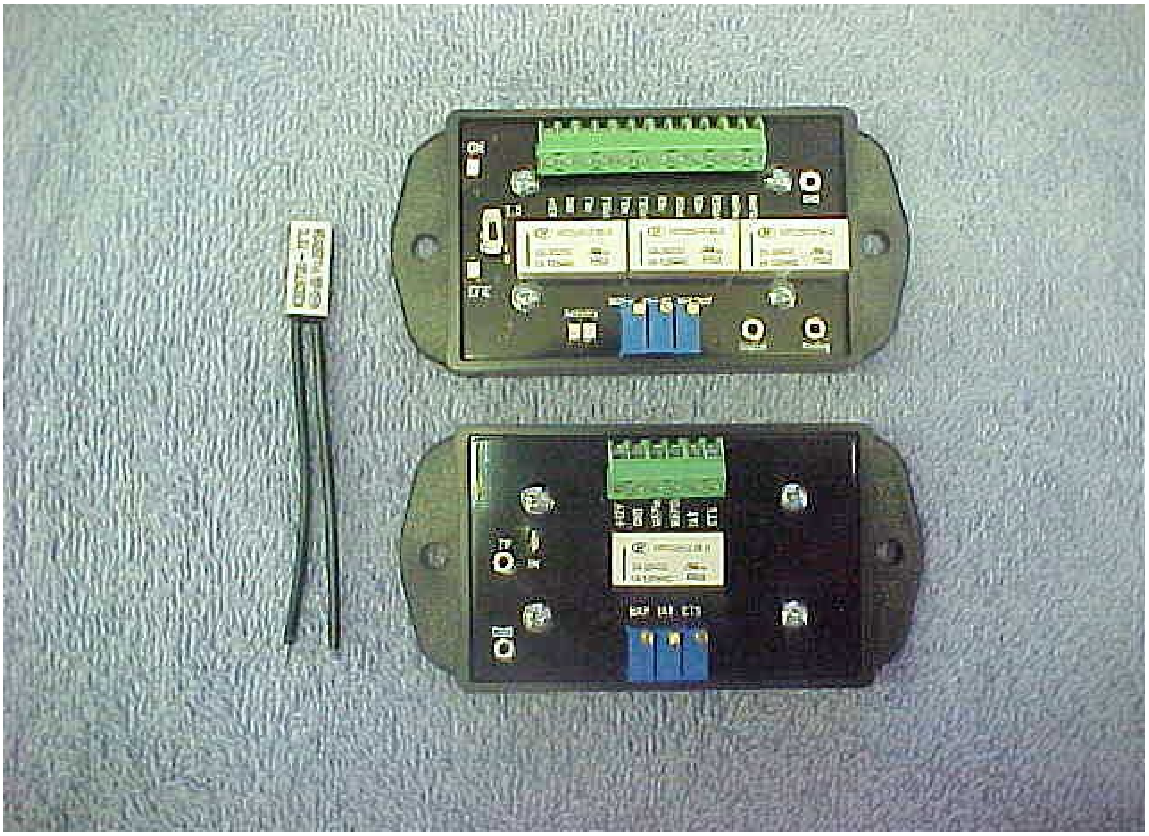
Start you vehicle and let it warm up to operating temperature. You will know when it is warm enough, because the power indicator and the EFIE LED will be lit, and the ACTIVITY--LED's begin to blink, (They will not blink until your 02 sensors have reached 600 F. and start to emit a signal) You will begin to make your adjustments to your Upstream 02 sensors. It is a very simple process if you follow my directions. Get out your volt meter and set it to it's lowest DC voltage scale, If you have a newer automatic voltmeter it will automatically choose the correct voltage range. Now I want you to place the positive probe of your volt meter into the hole of the **"Digital Test Point"** then place your negative probe into the **"GND" Test Point.** Find your Digital pot, and while viewing your volt meter, I want you to begin turning your Digital Pot Clockwise. The more you turn, the lower the voltage reading will be. If you have a normal vehicle and not a bias voltage Chrysler, keep turning clockwise until your volt meter displays **.350 volts. The lower the voltage is, the leaner the fuel mixture will be. Too low a setting can possibly trigger a Check Engine Light. Please refer to previous photos for reference.**

We are now going to adjust our Downstream 02 Sensors. You can leave your negative probe in the "GND Test Point, but move your Positive Probe to the Analog Test Point, Now find your analog adjusment Pot and begin turning it Clockwise. This time the voltage will rise as you are turning it clockwise. The downstream 02 sensors work differently than the upstream. I want you to set your voltage so that your volt meter shows **.200 volts** On your downstream sensors, the higher the voltage is the leaner the the fuel mixture will be.
These are preliminary settings, your fine tuning settings will be made after your have made all of your connections to Device 2, Your Frequency based GM tuning device.

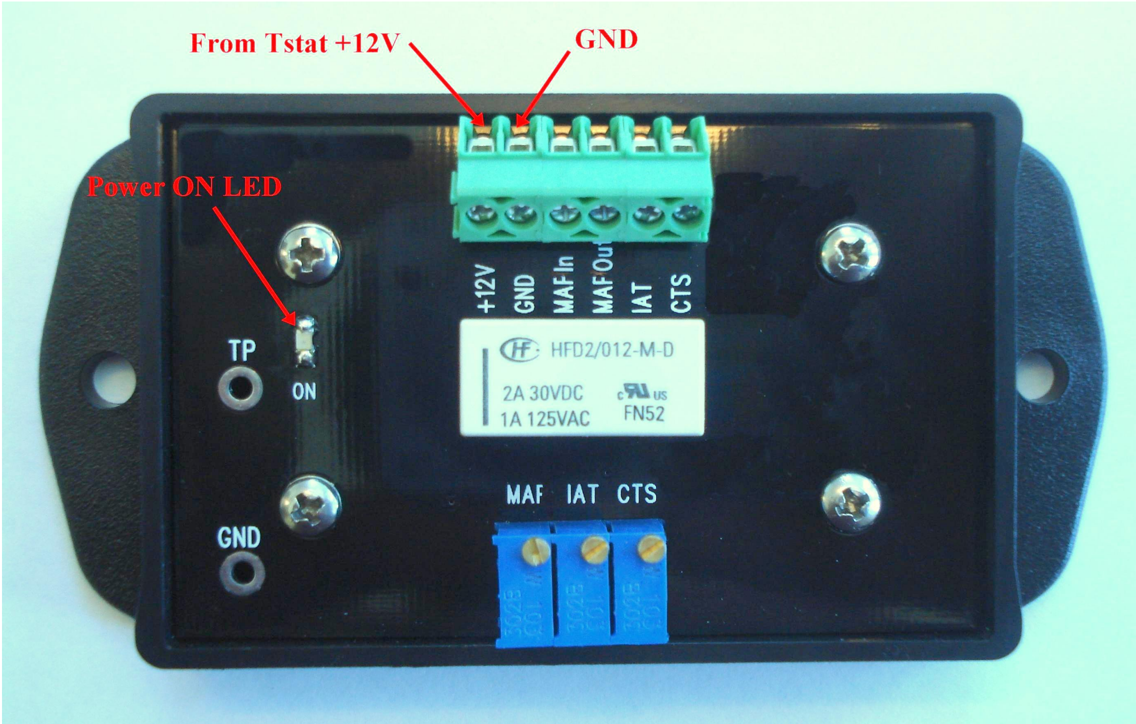
CAUTION. There is only so far that you can adjust your 02 sensors before your computer will not belive your adjusted signal. Every vehicle is slightly different as to how much adjustment it will take. When the Computer no longer believes your adjusted signal you will trip a trouble code, and your computer will go into "Open Loop" mode. If this happens you will need to reduce your adjusment and clear the trouble code from your vehicles computer.

MAP Adjustment:

Do not make this adjustment until you have installed your Frequency based MAF enhancer. The MAF enhacer will be your primary "load" tuning control. You will only do fine tuning with your MAP after your have tuned your MAF. Complete tuning instructions are in the next section

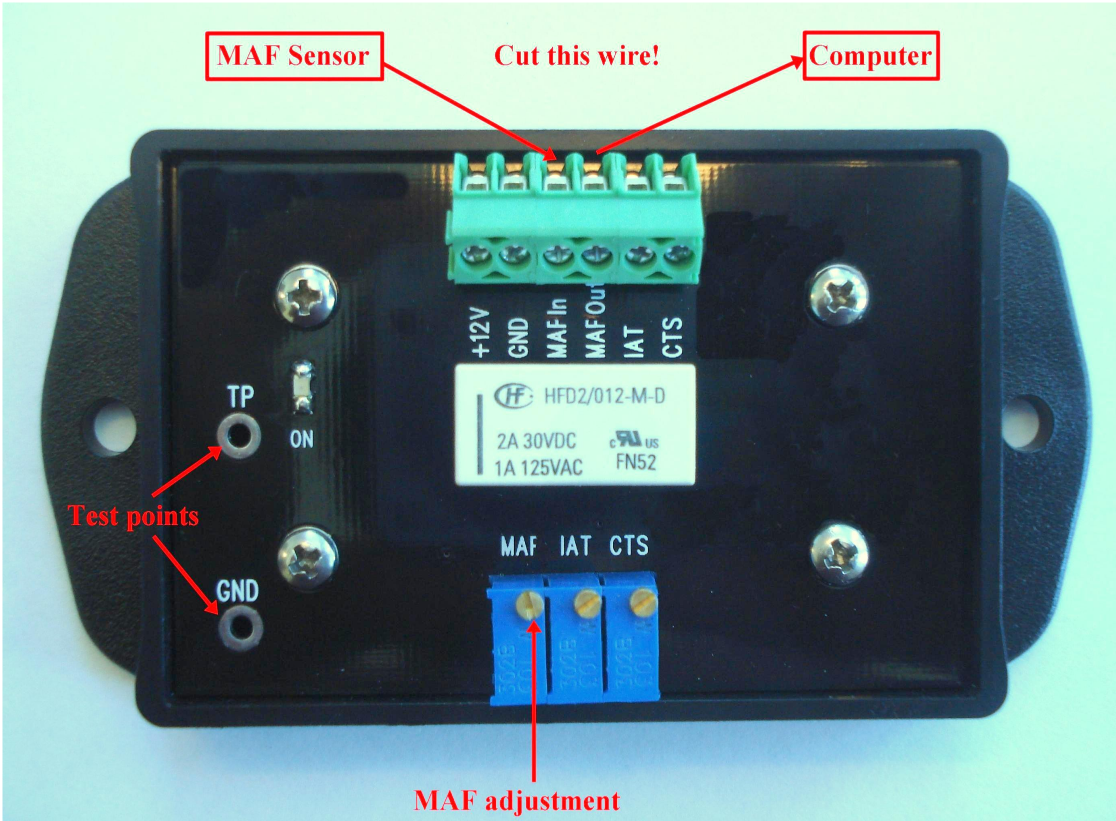


Your Complete GM Tuning Package
Device 1 (upper) controls 02's and MAP Sensors
Device 2 (lower) controls MAF, IAT, and CTS Sensors
Tstat (left with wires) controls the power to both Devices



Wiring and Installing Device 2
Your GM Frequency MAF sensor and your IAT & CTS sensor.

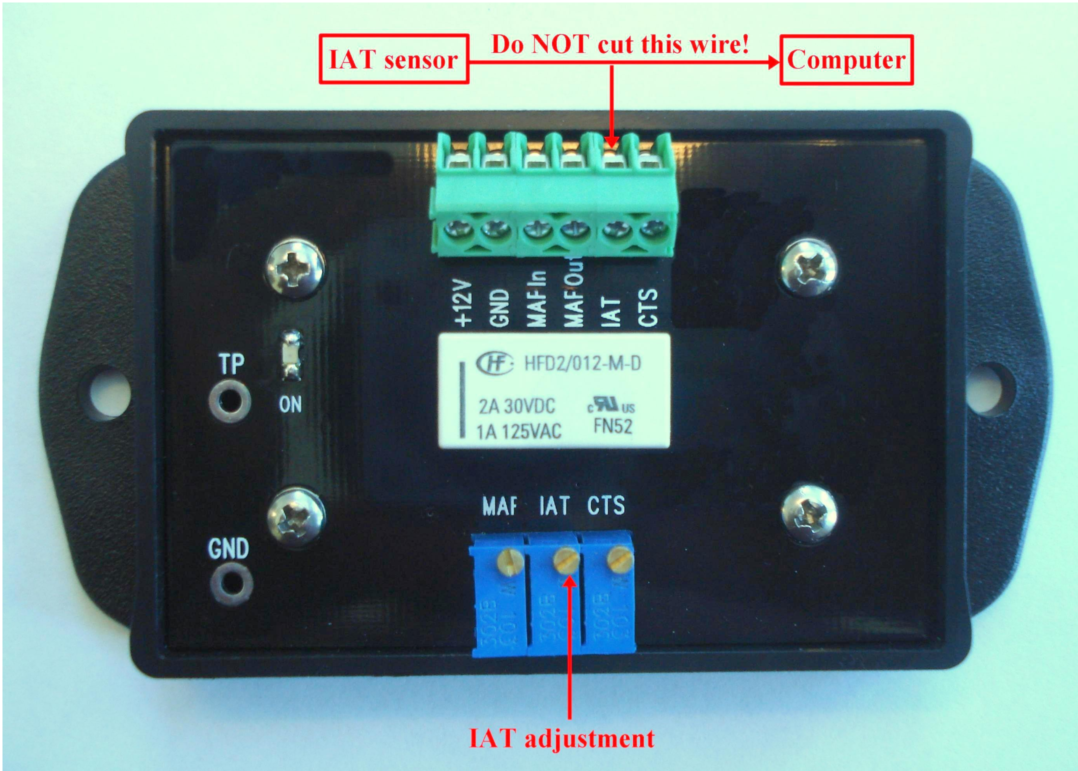
If you recall, we had you make a split “Y” +12v wire coming from your Tstat. You should have connected one of the two wires to Device 1 for your 02 and MAP sensors, and now you will be attaching the other of the two +12v wires to your +12v terminal on the terminal block pictured above. Once again connect your GND (ground) terminal to your Negative battery post or a VERY CLEAN and good chasis ground. If you use a chassis ground, I can not emphasize strongly enough how important it is that it be a very clean, solid, and semi-protected ground.



Connecting your MAF controller

Your MAF sensor will be located somewhere in your air intake system. Please refer to your service manual for location on your particular GM vehicle. It varies throughout the different model years. On many of the newer model years after 1996, GM encloseD the MAF & IAT sensors in the same housing. When this is the case you will normally have either 5 or 6 wires coming from this combination of sensors. **It is definitely best to refer to your service manual to identify the MAF signal wire and the IAT signal wire.** If you were foolish enough to have not purchased a Repair Manual with Schematic diagrams, your procedure for finding your MAF signal wire is exactly the same as finding your MAP signal wire covered earlier in these instructions.

Once again, cut the signal wire. Add additional wire if necessary to reach your EFIE mounting location. The "Sensor Wire of the MAF sensor is inserted into MAP In connector. The "Computer Wire" is inserted into the MAF Out connector.



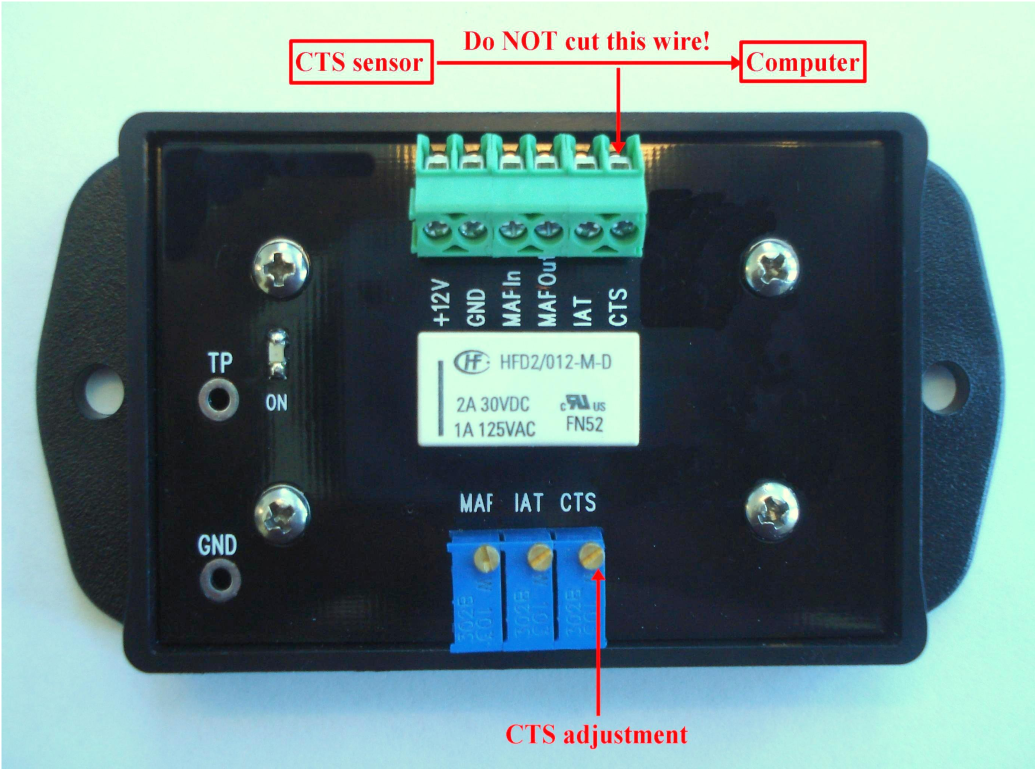
Connecting Your IAT sensor.

If your IAT sensor on your model GM vehicle is not located in a combined housing with your MAF sensor, and is a stand alone sensor, it will have two wires. The wire that we are looking for is the one that is closest to 5 volts when the key is turned on, and the engine is not running. This will be your IAT signal wire. **DO NOT CUT THE SIGNAL WIRE.**

If your IAT sensor is located in the same housing as the MAF sensor, you will still be looking for the 5 volt wire. **CAUTION.** Some GM vehicles might have two 5 v. wires going into this combined sensor housing. If this is the case, you will definitely NEED a schematic diagram indicating which is for the IAT.

You will now "skin back" enough of the insulation on the signal wire to allow you enough room to solder on a length of wire to the IAT signal wire. The other end of this wire will connect to the IAT terminal on the terminal block. So it is a good idea to measure the length you will need before soldering and making the connection to the terminal block.

Note:
If you did not purchase a Repair Manual with Schematic Diagrams, I will explain in detail later in the tuning instructions, how you can determine which of two 5 volt wires is your IAT signal wire. It will be a lot more work for you, but it will work.



Connecting Your CTS control

This is by far your easiest connection. Locate your CTS sensor. If you have purchased a Haynes Repair manual, there will be pictoral views of the sensor, and where it is locate on your particular GM vehicle. It is a 2 wire sensor. Once again, you are looking for the wire that is closest to 5 volts with the key on, and the engine not running.

You will now “skin back” enough of the insulation on the signal wire to allow you enough room to solder on a length of wire to the CTS signal wire. The other end of this wire will connect to the CTS terminal on the terminal block. So it is a good idea to measure the length you will need before soldering and making the connection to the terminal block.

Warning
CTS WIRING HOOKUP

There are a few GM vehicles that use dual (2) CTS sensors. One of them is used to furnish the signal to the ECU, and the other is used to run a temperature gauge or a warning indicator light. It is EXTREMELY IMPORTANT that you attach to the correct CTS sensor. The sensor you will be attaching to will have a 5 volt input to the sensor. SOME, but not all of the manufacturers use a 12 volt input to the other sensor that powers your temperature gauge or indicator (idiot) light. If you accidentally attach the 12 volt sensor to your AFR Control Center, you will destroy the unit.

Always check the voltage going to the sensor before connecting your wires to the CTS terminals on you AFR Control center. You can skin off a little insulation from one of the wires. Using your volt meter, attach your positive probe to the wire and your negative probe to ground. If your meter shows 5 volts or less you are safe and probably have the correct sensor. Although there are some model vehicles that use a 5 volt feed to both of the CTS sensors. If this is the case you will need to refer to your repair manual to identify which sensor is which. We have already had one person that made this mistake and hooked to the wrong sensor and blew up his AFR Control Center. PLEASE DO NOT BE THE SECOND. We will repair it for you at areasonable cost, but it will not be covered under warranty.

I am going to attempt to give you your basic beginning set up, and the numbers you should be starting with. After your basic setup that I am going to give you, you will then most likely need to do some tweaking and fine tuning adjustments. **REMEMBER, ALL OF THE SENSORS SIGNALS YOU ARE MODIFYING MUST BE IN AGREEMENT FOR THE COMPUTER TO BELIEVE ALL THE SIGNALS YOU HAVE MODIFIED.** This is why it is important to make your adjustments exactly in this order.

All of Your Control Potentiometers Have been pre-set to their " 0 " positions

The important point to remember is that turning any of the potentiometers clockwise, leans out your fuel mixture, and turning them counter clockwise, richens the fuel mixture. If you attempt to lean your fuel supply too much, your vehicles ECU will go into open loop mode, and usually a CEL (check engine light) will appear. You will need reduce your setting that triggered the CEL and clear the Trouble code for the computers memory. On some vehicles this can be done by disconnecting the Negative battery cable for 15 to 20 minutes and then reconnecting it. On other vehicles you will need a code reader or scan tool to clear the codes. Refer to your Repair manual that you purchased for clearing trouble codes for your vehicle.

We Have added the following instructions to Greatly Simplify your installation. These are Short Cuts that we have learned over the past 4 years, since the introduction of our very first AFR Control Center. All Initial Tuning should be done with your engine at full operating temperature, and at idle speed. You should then do a 50-100 mile test run under your normal driving conditions. For greater mileage gains you MUST follow the Tuning Tips file that was sent to you with all the rest of your instructions, as well as the Tuning 101 Modified file.

Your first adjustment should be to your CTS, (ECT, CHT) your setting should be a maximum of 10 degrees Fahrenheit higher than the engines coolant thermostat. Example: Your vehicle has a thermostat that controls the flow of coolant from the radiator to the engine block. It could be anywhere from 180 F. to 210 F. depending on your vehicle. At it's rated temperature, it will open up and let the cooler coolant from the radiator flow into the block. If you already know what temperature your thermostat is great. If not, use your scan tool to monitor your coolant temperature sensor. As your engine is getting warmed to maximum temperature, you will note the temperature reach a certain point and then begin to fall. The maximum temperature that it reached before it began to fall is the number we are looking for. Adjust your CTS control so that your scan tool shows a temperature 10 degrees F. higher than that number.

Note: If this setting causes your electric radiator fans to run continuously, you will need to lower the setting until they turn off.

Your second adjustment should be your IAT. I recommend setting your IAT so that your scan tool sees a temperature of 195 F. as your starting basic setting. If you were one of those who did not purchase a schematic wiring diagram and your IAT is enclosed in the same housing as your MAF sensor with two 5 volt feed wires. Please follow these instructions to locate the IAT signal wire.

You will need to use your scan tool IAT gauge to locate which of the 2 wires is your IAT signal wire. To do this test, you will need to start your engine, and let it warm enough that the Tstat engages and sends power to both control devices. While you are waiting for the engine to warm, I want you to raid your wife's or lady friend's sewing box and get a couple of straight pins. You are going to be pushing these pins through the two 5 v wires that you have found, making certain they are penetrating the center wire. You will now attach a wire to the IAT terminal on the terminal strip of Device 2. Strip about ½ inch of insulation from the opposite end of the wire, and carefully wrap the exposed wire around one of your straight pins. Now, while observing the IAT (intake air temperature) on your scan tool, turn your IAT potentiometer clockwise at least 10 turns or until you see the temperature reading showing a significant increase. If it does, you have the correct IAT signal wire. If not test the other wire. It has to be one or the other.

Your next setting will be the Digital setting of your EFIE. When setting this portion of the device, use the TEST POINTS ON THE BOARD ONLY. Do not measure incoming or outgoing voltage on the terminal strip. Set your volt meter to it's lowest DC voltage setting (normally 2 volts) and place your positive probe into the DIGITAL test point, and then place your negative probe into the GND test point. Now adjust your digital potentiometer until you have a reading on your voltmeter of .300. Now you are going to adjust

your ANALOG setting for your down stream 02 sensors. With your negative probe still in the GND test point on the board, insert your Positive probe in the Analog test point on the board. Now adjust your Analog potentiometer so that you see a reading of .250 on all vehicles.

Your next and most difficult setting will be your MAF adjustment. The MAF enhancer in this device is for FREQUENCY based sensors ONLY, and the MAP enhancer is for Voltage based sensors. Using your Scan Tool, observe the engine MAF load readings. Now using your MAF potentiometer on the board of device 2, adjust this number to read 15% lower. This will be your primary “load” adjustment. Your MAP plays a secondary role on GM vehicles.

Adjustment of your MAP could be a problem if you do not have a very good quality scan tool. Most of your inexpensive scan tools are not capable of recognizing the MAP sensor or it's data stream on GM V6 & V8 engines. They will attempt to group it together with your MAF data stream. If your scan tool does not recognize the MAP sensor individually, and you do not have access to a professional quality scan tool, it is best not to make any adjustment to the MAP. However if you are a bit venturesome, you can do the following.

This will be the **ONLY** time that you will be taking any voltage readings from the terminals on the terminal strip.

After your engine has warmed to operating temperature, and the Tstat has engaged and is sending power to both devices, use your volt meter to measure the MAP in voltage. Next, measure the MAP out voltage. You want your MAP out voltage to be 15% lower than your MAP in voltage. To accomplish this turn your MAP potentiometer clockwise until you achieve a 15% voltage reduction.

I am not even going to begin to attempt to explain the Why's or How's these devices work to you. I am 81+ years old, and I am not certain that I would have enough time left here on earth, to complete it.

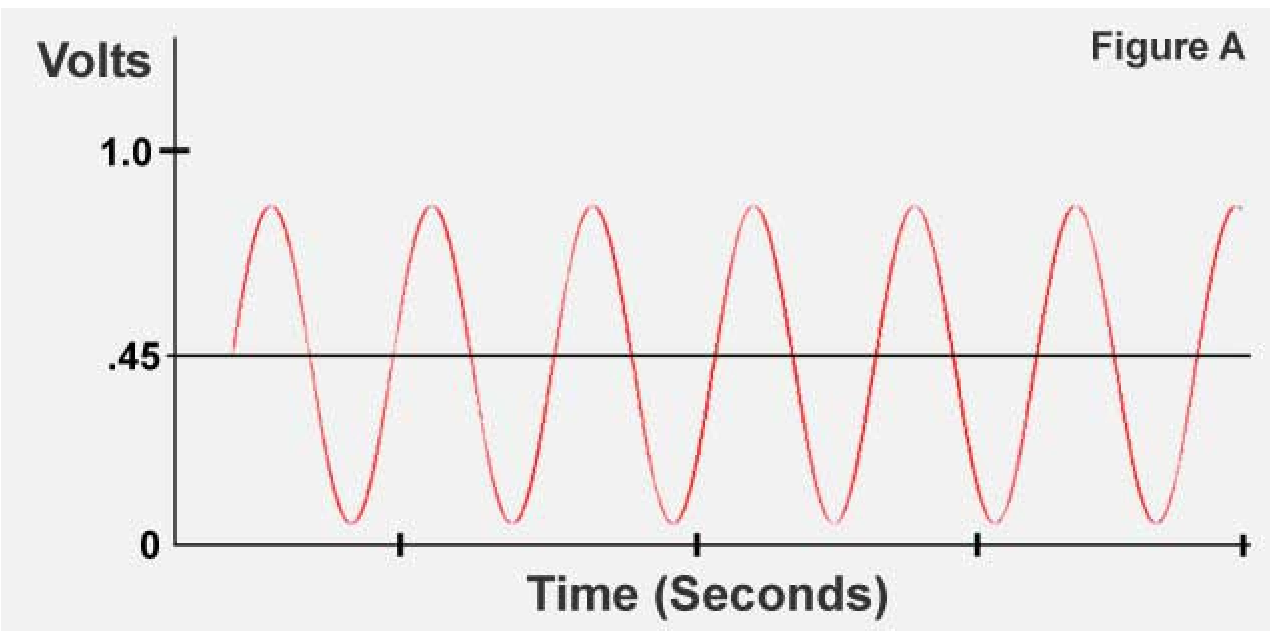
God Bless
and Good Luck with your project
D&N Automotive Engineering.

For all of you who would like to know
Why you Need a Digital EFIE and
How it works, I have included. the following.

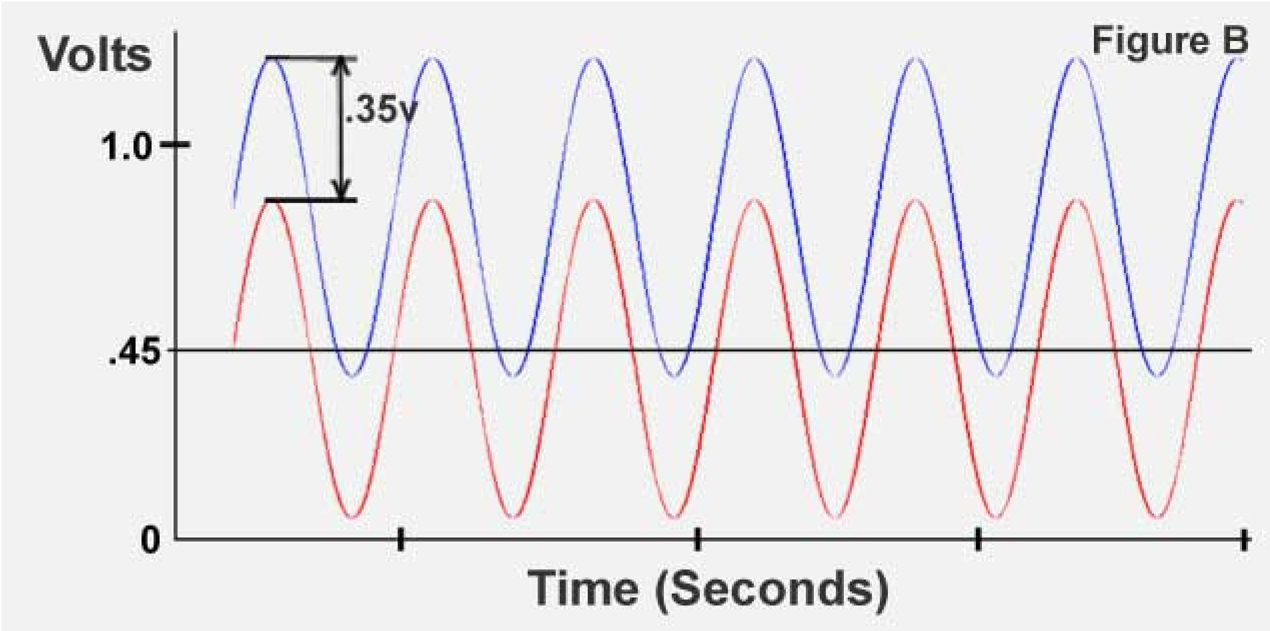
Previous EFIE Designs

First, lets have a look at how oxygen sensors work. Have a look at Figure A below. Here we have a graph that is a *representation* of the voltage output of a typical oxygen sensor while the engine is running. Note, that this is only an approximation of a real voltage graph. A real graph would be much more jagged and would not be so regular as this one. But I'm using this graph to make it easier to visualize the concept of what the sensor is doing.

Narrow band oxygen sensors don't tell the ECU what the air/fuel ratio is. They only tell if the mixture is rich or lean. The line that is marked ".45" volts denotes the make/break point for the sensor's voltage output. Any voltages that are higher than .45 volts is considered to be rich, and any voltages that are less than .45 volts is considered to be lean. When the sensor produces .45 volts, that is considered to be the correct air/fuel mixture which happens to be 14.7 to 1, air to fuel (by weight). The trouble with narrow band sensors is that they can't tell the ECU how rich or how lean the mix is. They only tell the ECU "rich" or "lean". Therefore, in normal operation, they are constantly changing voltages similarly to the graph in Figure A.



Now look at Figure B. The blue line in this graph represents how an EFIE changes the voltage graph of the sensor. As the sensor produces its voltages (as represented by the red graph), the EFIE adds additional voltage. We are showing an EFIE set to 350 millivolts (.35 volts). Therefore the output of the EFIE that goes to the computer will be the voltages in the blue line on the graph. Because higher voltages mean a richer mix to the ECU, the ECU will then lean the mix when it "sees" these "richer" mixture signals coming from the oxygen sensor.



Almost all EFIE designs that are in use today work like the above graph, by adding a voltage to the output of the oxygen sensor. While this approach does work, and has been the only solution available for many years, it has 2 problems that make it not the ideal design.

1. There is a definite limit to the amount of voltage you can add. Notice that if we added .5 volts in the above graph, that the blue line would never dip below the .45 volt line. This is an illegal condition and the ECU will quickly stop using the oxygen sensor if it never sees the voltage transitioning from rich to lean. In actual fact many ECUs need to see voltages lower than .45 volts before it will consider that the mix is lean, and so often you can't set an EFIE higher than 250 millivolts or so without throwing engine error codes.
2. It takes a relatively large change in the voltage to make a small change in the air/fuel ratio. This wouldn't be a problem in itself, but coupled with the fact that we can only add a limited amount of voltage, this causes an end result of a small change in air/fuel ratio.

There is one other approach in EFIE design in use today, and that is to use an amplifier. Instead of adding voltage to the sensor's output, EFIEs of this type will amplify the signal. This, in effect, multiplies the signal. This is a better approach in that the lower voltages are not increased as much as the higher voltages, and you should be able to shift the air/fuel ratio further than with a voltage "adder". However, it is still limited to the amount it can shift the voltage before all voltages are higher than .45 volts. Also, the amplified voltages at the top of the graph can get quite high, possibly high enough that it will set off alarms in the ECU.

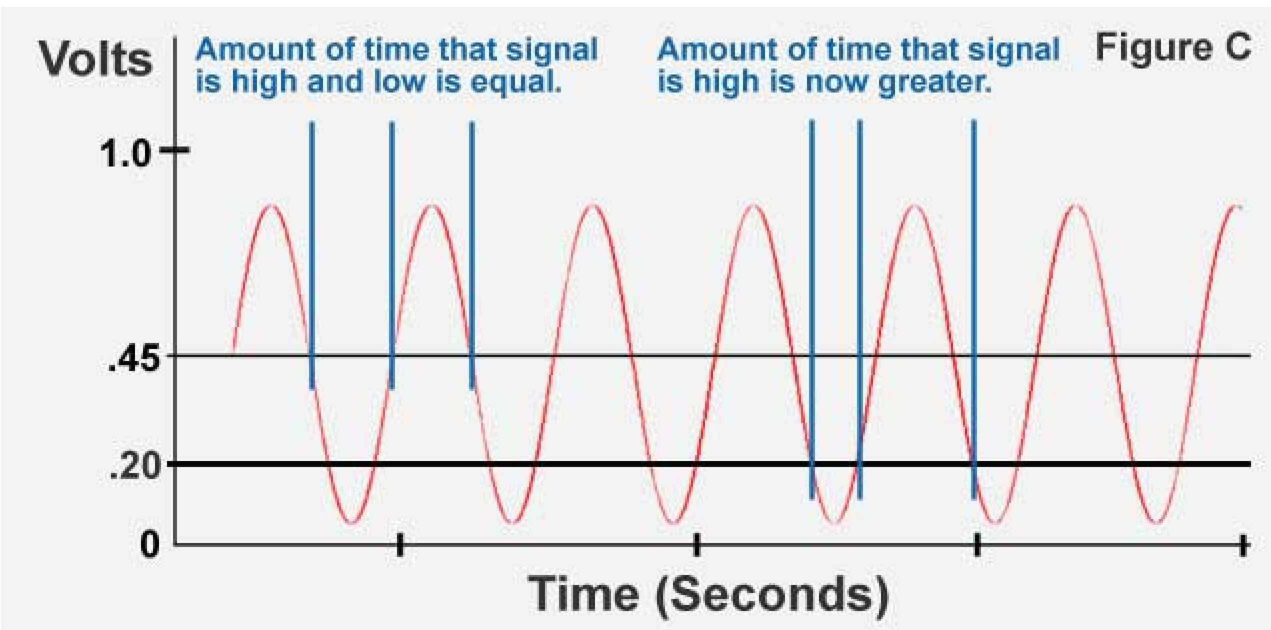
Enter the Digital Narrow Band EFIE

There are other EFIE designs being marketed as "digital". In each case, as of this writing, the only thing digital about them is the pot used to control the EFIE. It's a digital pot and will have one of 64 or 128 resistance values, or possibly more depending on the resistor chip design. While this is cool, it makes no difference in the operation of the EFIE. It will still be operating like one of those described in the section above.

Our new Digital Narrow Band EFIE operates completely differently from any other EFIE made. Our new EFIE is called digital, because it's output is either on or off. Or in other words is either high or low. Or to put in terms the ECU will understand, the output will be either rich or lean. Or to put it in terms of voltage, the output is either going to be .100 volts or .900 volts. This is perfectly acceptable to the ECU and tells it exactly what we want it to see. But because it's output is only one of 2 states, we rightfully call this device a "digital" device.

So how do we know when to switch from the high state to the low state? We have a comparator in the EFIE that "decides" when to switch states. If the EFIE were to be set so that there was no change in air/fuel ratio, the comparator would be set to .45 volts. This would mean that if the voltage coming in from the sensor were below .45 volts, the output would be low, and likewise if the voltage coming in from the sensor were above .45 volts, the output would be set to high. This would cause a flat response in the ECU where it would provide the same air/fuel ratio as if the EFIE were not involved.

To lower the air/fuel ratio we need to make the mix appear richer. In order to do this, we make the EFIE transition to a high output even though the input is below .45 volts. In other words, instead of using .45 volts as the switching threshold, we use .20 volts (see Figure C). By adjusting the pot on our new EFIE, we are adjusting at which voltage the comparator will use to determine if the output should be set to high or low. In the graph below, we show 2 comparator voltages for comparison. At .45 volts, we can see that the output will be high about 1/2 of the time. This is the same as it would be without the EFIE. Now notice the line at .2 volts. By setting the EFIE's comparator at .2 volts, the EFIE output will be low for about 30% of the time and high about 70% of the time. This will make the air/fuel mix look richer than it is, and the ECU will respond by leaning out the mix.



Note that .2 volts is probably too low for your vehicle. You will probably not need to set it this low. We only set it here to make it easy to see the principal involved with our new Digital EFIE. An actual setting would probably be closer to .300 - .325 volts.

Note: When downstream sensors need to be treated, do not use this device. Use an older style, voltage adding type of EFIE. The reason for this is that we're not certain how the downstream sensor information is used by the ECU. In some cases, we have read the voltages from downstream sensors and they don't jump up and down as shown in the graphs above. We've seen them just float around in the .2 to .3 volt range, not changing much. This is not the behavior that the Digital EFIE was designed *for. It may work fine. But we prefer that the ECU just see the same behavior, but shifted up a bit, the way a voltage adding type of EFIE will do. Any of our Narrow Band EFIEs that aren't labeled "Digital" will work for this application.*

Using this device, some people have been able to lean the mix to the point that the engine will die. However, in some cases, it is still necessary to do other treatments to get the leaning results needed. For instance many ECUs use the downstream sensors as part of the air/fuel calcs, and many more will use the downstream sensors to verify the upstream sensors and throw odd engine errors. In these cases, downstream EFIEs are needed to get the needed results. That's why we created the Digital EFIE & MAP/MAF Combo It has 2 digital EFIEs for the upstream sensors and 2 analog EFIEs for the downstream sensors. This will give you the optimum treatment for each sensor, and is the most powerful solution we've seen yet for optomizing your engine for use with HHO or other fuel combustion enhancement technologies.