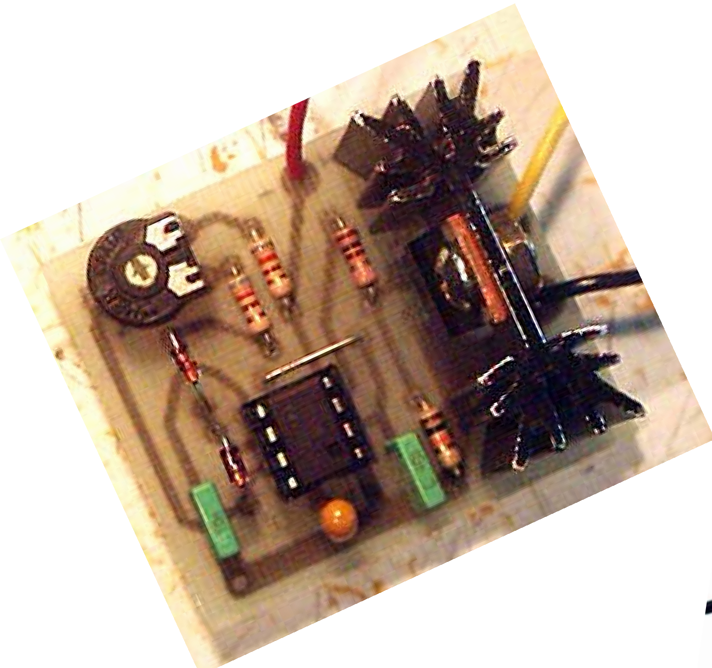
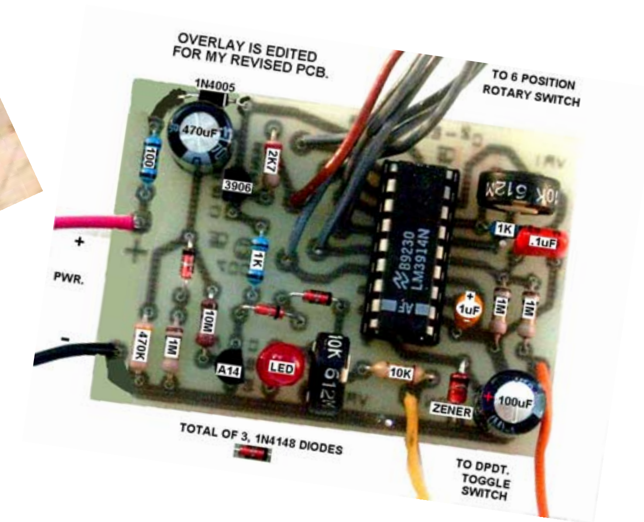




Fuel Mixture Control & Pulse Width Modulator Companion Guide

This guide is a companion to the fuel mixture control and pulse width modulator kits made available to members of the Energetic Forum.

http://www.energeticforum.com

Fuel Mixture Control & PWM Companion Guide

Energetic Forum Member "RedMeanie" has made kits available to those other members of Energetic Forum that are interested in Hydroxy Boosters. These are essential components required to get the most out of "boosting" your vehicle. These kits are put together very well and are of great quality. The end-user only needs simple tools and skills to assemble these boards. This guide will cover the highlights of these boards and the assembly procedures.

Here is what a complete kit looks like when you receive it. It consists of a regular Pulse Width Modulator (PWM), a High Power PWM and 2 Fuel Mixture Controls (sometimes called EFIE's). It contains all the necessary parts as well as detailed diagrams, schematics and part identifiers. The boards are also available individually. You need 1 fuel mixture control board for each pre catalytic converter O_2 Sensor.

Before starting the assembly of the boards, you should gather up some basic tools and supplies. You will need at a minimum:

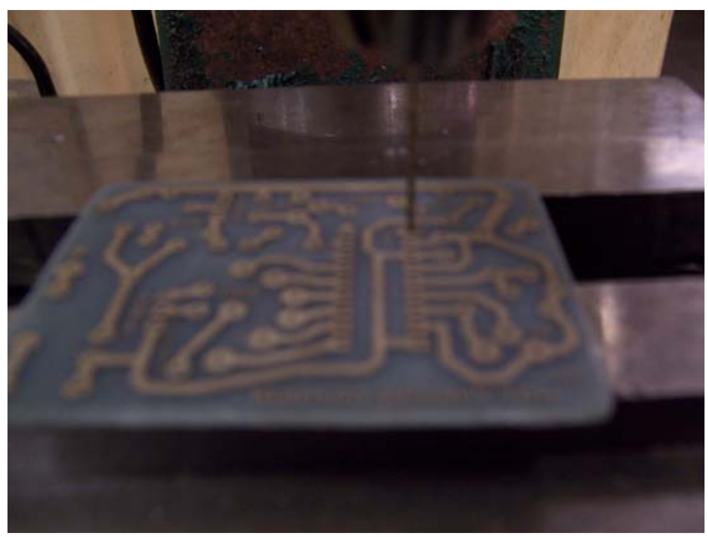
- Soldering iron.
- Rosin core 60/40 solder.
- Drill motor or Dremel tool.
- #55 drill bit (0.0520")
- #60 drill bit (0.0400")
- Mini cutters

Here is a shot of the tools and supplies I used to assemble the boards. Some of these things are items that made my life easier such as a soldering stand. A pointed soldering iron tip (preferred but not required). Some solder wick to remove any excess solder. I used a can of electrical contact cleaner to clean the boards after tinning and prior to soldering. The electrical contact cleaner is also used to remove any residual flux from the solder joints after installing all the components. You could use isopropyl alcohol as well. I trim the bristles of the acid brushes down to 0.250". It just cleans better for me. The flush cutters are not required, but makes for easier and better trimming of the excess leads of the electrical components. The mini needle nose pliers you see below help me make nice bends on the resistors, diodes etc.

Before you start soldering or tinning the boards, you must first drill holes in the boards to accept the electrical components. I used a drill press with a #60 drill bit to drill mine. You can also use a Dremel tool, a hand held drill motor or a small hobby drill.

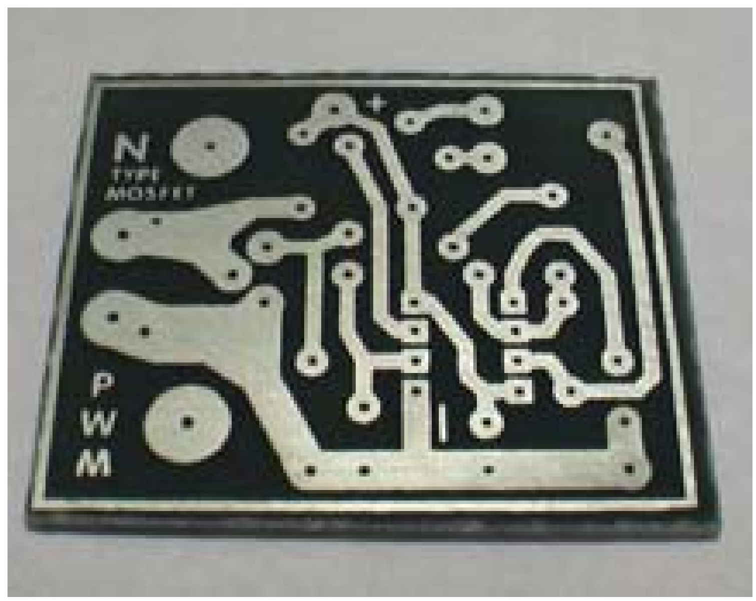
Most components will use the #60 drill bit. Drill all your holes with it first. I found it easiest to drill all the holes with the #60 bit, upsizing as needed as I went along. Some items such as the heat sink for the PWM need to have their holes up-sized with a #55 drill bit.

Some people have mentioned that the small Dremel drill bit kit has bits of a suitable size. These bits are readily available at tool supplies & home centers such as Home Depot and Lowes.

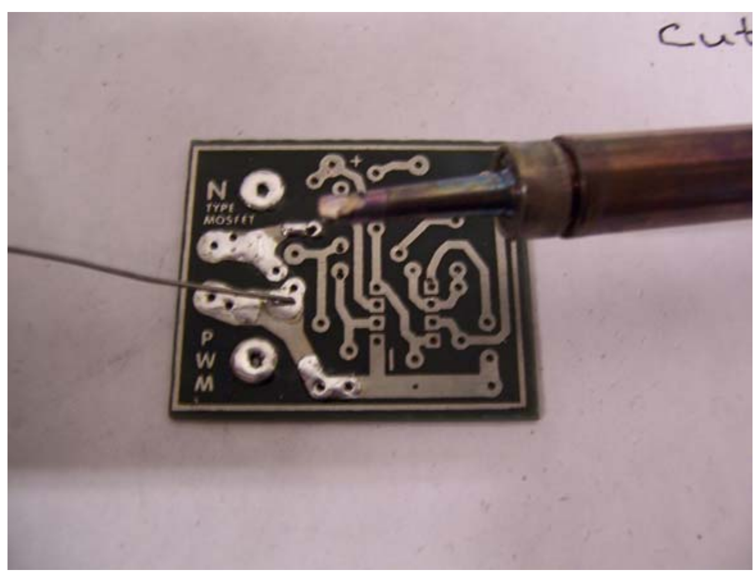


Before I start talking about soldering, you should have a look at the following internet site for some good tips on soldering.

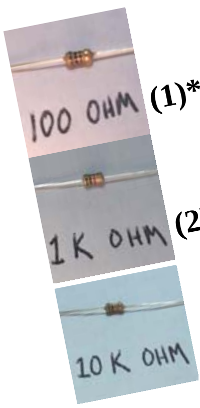
"How to Solder Circuit Boards Properly, and Make it Stick and Conduct!"
available at <u>http://www3.telus.net/chemelec/Soldering/Soldering.htm</u>



After all the holes have been drilled, it is time to clean the board and tin the traces where the electrical components come through. Using the electrical contact cleaner or isopropyl alcohol, wet the board and scrub it with an acid brush. Cleaning the traces makes for better solder connections. The copper should be bright and shiny. Apply a bit of heat to the traces and apply a small amount of solder. You are not looking for globs of solder here, just enough to apply a thin coat to the traces. You will know you are doing ok when the solder flows evenly across the trace area. Use solder wick to remove excess solder if needed.



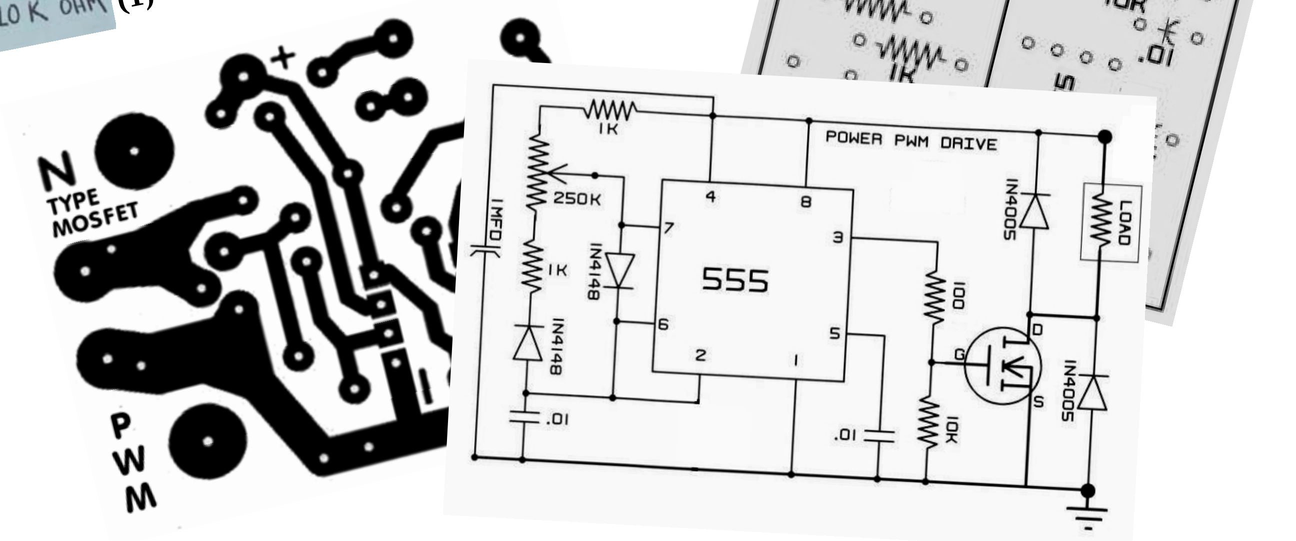
RedMeanie has made it easy for you to follow the electrical schematic and chose the correct component. Here is a sample of the documentation that is included in the PWM kit. Each kit is done the same way.

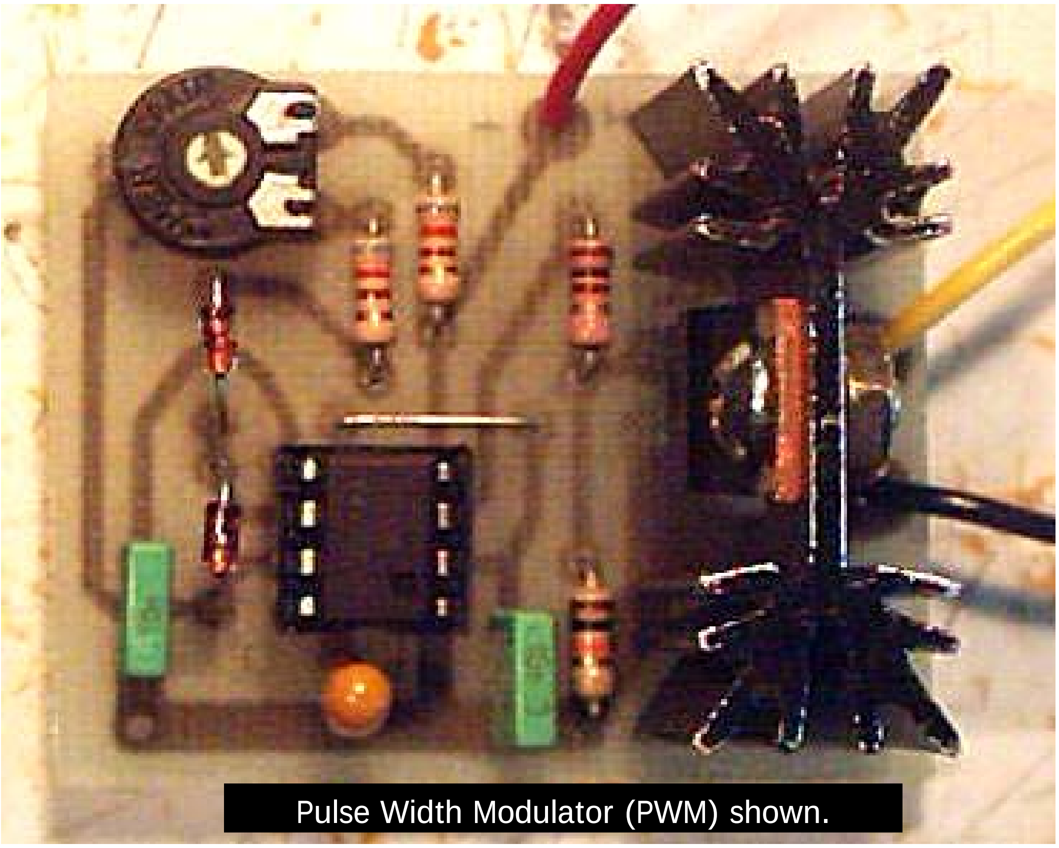


(1)* BROWN / BLACK / BROWN / GOLD

(2)* BROWN / BLACK / RED / GOLD

(1)* BROWN / BLACK / ORANGE / GOLD





Pulse Width Modulator (PWM) shown.

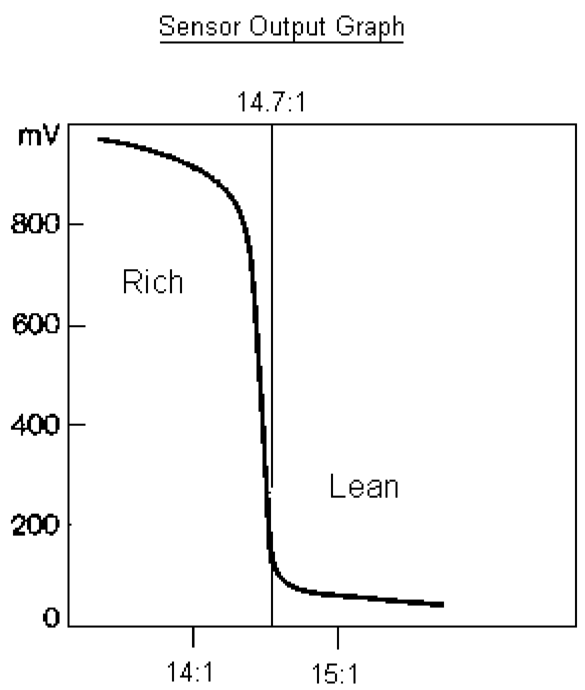
Insert and solder the components one at a time as per the included diagrams and schematic until you end up with something that looks like these...

Fuel Mixture Controller (FMC)

Electronic Fuel Mixture Controller Manual

HOW THE SYSTEM WORKS

The car's computer is expecting to see an oscillating signal from the oxygen sensor which goes from zero volts to plus one volt approximately. The fuel flow is adjusted to maintain the average voltage at close to 0.5 volts The signal from the sensor isn't a square wave, but more like a smooth triangular wave form. The computer doesn't care about the exact shape but simply tries to maintain the average.



The Electronic Fuel Mixture Controller is installed in the system between the oxygen sensor and the car's computer. What this device does is convert the wave form into a square wave, but more importantly it sets up a threshold voltage that is lower than 0.5 volts. Then the sensor output is above the threshold, which is set quite low, say 0.1 volts, then the device will send a high signal to the computer. When the sensor signal drops below the threshold, the device signal out will be low. The computer adjusts the fuel flow accordingly and now is **actually maintaining the average voltage from the sensor at 0.1 Volts (100mV) instead of 0.5 volts. (500mV)**

From the Sensor Output graph you can see that the mixture is now slightly leaner than it was. The operating range is shifted to the right. We have cut the fuel quantity by no more than few percent, perhaps 5 %. This by itself will produce some mileage improvement but not a lot. The greatest benefit occurs when applying the device in support of some other high mileage system. Especially cold vapor systems and water injection. The computer will normally fight these systems to compensate for the added exhaust oxygen. This device fools the computer and enables the max possible mileage improvements.

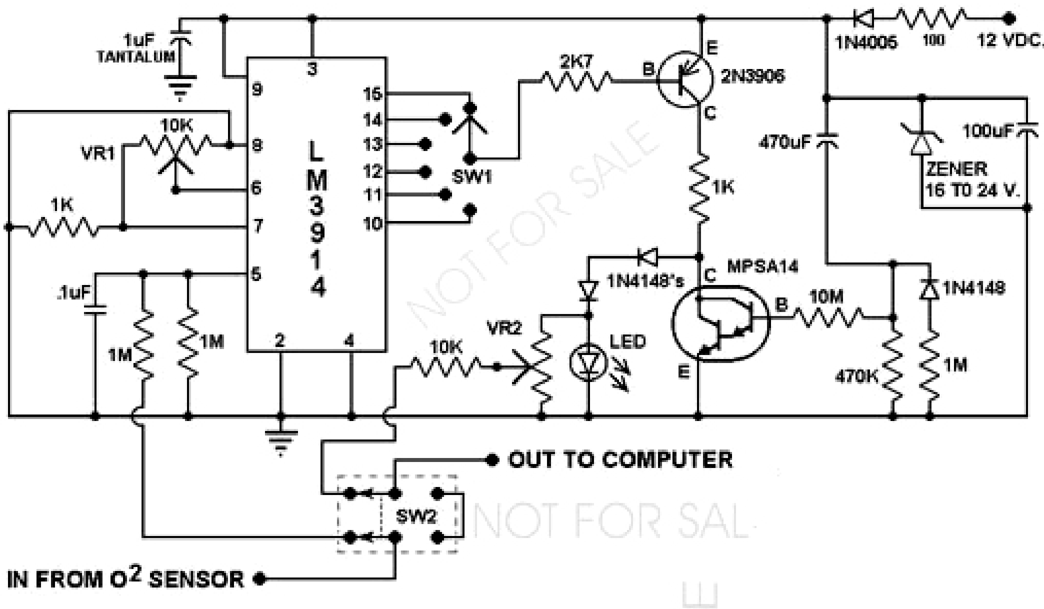
If your oxygen sensor is old and sluggish this device will also improve the reaction time. Because it instantly tells the computer when the sensor output is below or above the threshold, there is less overshoot. Smaller, quicker corrections to the mixture occur rather than long slow corrections.

CIRCUIT DESCRIPTION

The heart of the circuit is the LM3914 linear LED dot/bar Driver IC, which we operate in bar mode. This is the same IC as is in the Mixture Display circuit. We set the sensitivity to 500mV full scale for this controller.

If you want to be able to adjust your mixture richer for more power rather than leaner then you should adjust the sensitivity to a greater voltage, around 700mV. It is not recommended to set the threshold too high, because it is quite possible that your sensor output may never reach that high. The computer will keep adding fuel expecting the signal to go high. Remember, excess fuel will be burnt inside the catalytic converter which could cause a meltdown. Don't risk a fire under your seat. Or it may simply ignore the sensor and operate in open loop mode.

Electronic Mixture Controller Circuit Diagram



WARNING!

This is a static sensitive device.

Handle it carefully and always use an IC socket to mount it. Don't directly solder the IC into the printed circuit board. Install this component last.

We use this IC to sample the sensor voltage and provide outputs at various thresholds that we can select from. The trim pot R1 sets the sensitivity and we adjust this for 500 mV full scale. Each LED output then is 50 mV apart. We don't actually install LED's on each output, and any unused outputs are left open circuit. The front panel rotary switch selects which ever output we choose. We only need 2 or 3 to choose from. You can leave out this rotary switch and simply select one of the outputs to connect if you prefer.

The input resistor/capacitor circuit provides filtering of the sensor signal. Because the entire circuit comprises high impedance components, including the sensor and IC input, the input line is susceptible to induced noise. Ignition noise in particular will affect the circuit and cause incorrect operation. If you install a LED Mixture Display as recommended, you will see that until the sensor heats up all the LED's will be dimly lit. This is showing that there is a lot of noise on the line. When the sensor heats up, the signal becomes cleaner and then only the appropriate LED will be lit. We also include a delay circuit so that after start up, the output is held low for a few minutes to simulate a cold sensor. **The sensor must be operating correctly before we send signals to the computer.** The most common problem, if we don't have this delay, is that the output will be high simply from the noise on the signal line. The computer will think the sensor is working, because it is high, and will cut back the fuel to make the signal go low. When this happens we end up with a very lean condition and very poor acceleration.

The front panel switch is very important. It doesn't switch the power to the device. What it does is allow the sensor signal to bypass the device altogether. This is an essential feature. You can switch your vehicle back to it's unmodified state instantly if you suspect that there may be a problem with the device or if the vehicle simply isn't performing as it should. Remember, only you know what you have done to your car and other family members that drive the car may not be able to fix any problems that may arise. Just show them the switch.

The front panel LED is not just to show that the device is operating, but forms a simple voltage regulator for the output signal to the computer. In operation the LED is lit when the output is high. So the correct state for the LED to be in is flashing. This LED can be wired off the board to a spot in your vehicle that is more visible, like the instrument panel.

BEFORE BEGINNING

This is a simple test you should perform first. The oxygen sensor earth connection is the exhaust system, which is firmly bolted to the engine. The computer earth is the vehicle body. We have seen that 0.5 volts can make a large difference to the mixture. If the engine is not well and truly earthed to the body then a voltage difference can exist between the two, and 0.5 volts would normally go unnoticed. We can't afford to have that sort of voltage difference when trying to accurately control the mixture.

Start the engine, switch the headlights on high beam, then measure the voltage between the engine and the body. Use an accurate digital volt meter. Any more than 50 mV will mean you have a bad earth connection which will need cleaning and tightening. Modern cars usually have more than one connection so look around. If you have trouble achieving this then use an engine earth connection for your circuit rather than a body connection. What is most important is the signal voltage from the sensor, since we are operating at such low voltages.

CONSTRUCTION

Read this through completely before beginning.

You will require a soldering iron, a 12 volt power supply such as a small power pack and an accurate digital volt meter for this project. No other test equipment will be needed. The 12 volt supply should be well filtered. You want proper DC, not simple rectified AC, which contains too much ripple. Lastly you will require a variable voltage source that can go from 0 to 1 volt to simulate a sensor input. It's simple enough to make this using a resistor and a variable resistor.

Start with the IC socket, and mount it slightly in from one end. The circuit diagram can give an indication of the general layout of the components. You will have to decide for yourself where and how you mount the front panel components, the rotary switch, the on/off switch and the LED indicator.
The IC legs are numbered 1 to 9, left to right across the bottom as seen on the diagram, and 10 to 18, right to left across the top. The notch shows the left end, this is standard for all IC's.

Don't connect the wires to the front panel rotary switch just yet, except for one which connects to pin 10 on the IC. This is the full scale output and will be connected to the rotary switch in the position of FULL RICH, whichever you prefer, fully clockwise or anticlock-wise position. You are going to test your device first on the bench, then decide which outputs you will use for the other switch positions.

Don't install the delay capacitor C3 yet. Don't install the IC yet.
Now install all the other components and double check every single solder connection. Check the quality of the joints and check that the circuit complies with the circuit diagram. Before installing the IC, you can apply power to the circuit to check for any overheating components. The circuit has been designed such that none of the components will get even slightly warm in operation. If any parts do get excessively hot then there is a problem.

With the IC not installed the output transistor should be off, and the output LED off. The Darlington transistor should be off because the capacitor is not installed.

<u>ADJUSTING ON THE BENCH</u> ***"FOLLOW EXACTLY!"***

Disconnect the power before installing the IC.

You can now install the IC, the correct way round or it will be destroyed instantly.
Apply 12 V power to the device.

Set up the *"Test Voltage"* source to 0.5 volts and apply to the input.

Set the Rotary Switch to the FULL RICH position.

Now adjust the *Sensitivity Control Trim Pot* (VR1) so that the output LED is just lit.

Now adjust the *"Test Voltage"* lower then higher to test the adjustment. The LED should come on at 0.5 volts, and go off just below 0.5 volts.

All the outputs on the Rotary Switch should make about 50mV Diference in their threshold points (LED On/Off Range)

Now adjust the “Test Voltage” above 0.5 volts, (LED lit)

Now adjust the “Output Voltage” to the computer by adjusting the Trim Pot (VR2). You want to set the output to 1.0 volts.

Next, adjust the “Test Voltage” below 0.5 volts to turn off the LED. The output voltage should be zero volts.

If all the above happens as it should then your circuit is working correctly. Next install the delay capacitor (470 uF). Set the test voltage above 0.5 volts and turn the power on. It should take about 60 - 120 seconds before the LED comes on. You can adjust the delay by changing the value of the 470uF capacitor (100 uF has a delay of about 30 secs). If you find the oxygen sensor heats up quickly then set the timer to a lesser value. Having too long a delay is bad, since the computer could be adding extra fuel to try and make the mixture rich.

The next task is to select which other outputs you want to use, and connect these to the front panel rotary switch. We recommend you be VERY conservative at first until you are sure you can support more radical changes, depending on driving habits and what other high mileage devices you use.

If you want you can alter the sensitivity to say 400 mV full scale to make available settings like 80 or 120mV.

Thoroughly test the device on the bench to be certain it functions as it should.

TESTING IN THE CAR

You can now test the device in the car. Don't install it yet though. Lift the hood and locate the oxygen sensor. Don't cut the sensor wire. Find a convenient place along the wire where you can strip back some of the insulation. You are going to cut it here later, but not yet. Connect this point to the input of your mixture controller and attach the power leads to the battery.

Start the car and allow the sensor to warm up. Remember there is a delay built in so after a few minutes you should see the LED start to flash. Rev the engine and the LED will stay on. When you release the throttle, the LED will go out for a while. A flashing LED is what you want to see. The rate of flashing will be somewhere between 1 and 10 times per second, most likely around 2 per second.

Check that the LED goes out when you switch the front panel switch off.

Now comes the exciting bit, cutting the oxygen sensor wire and inserting the controller. Cut the wire in a convenient place. You are going to use crimp connectors to finish the installation. Use a matching set on the wire you just cut, in case you need to reconnect it back together.

Don't drive the car yet, do this test in the driveway.

With the front panel switch off, start the car and check it runs normally.
Set the front panel rotary switch to the FULL RICH position (the position connected to the last LED output, 500mV) and switch the device on. The car is now running with a modified oxygen sensor signal although the mixture is still the same. Try the other positions in order and see how it runs.

INSTALL THE CONTROLLER

Fit the controller to the vehicle and finish hooking up the wiring. **For the 12 volt supply find a connection which is switched with the vehicle ignition**. You don't want to have to turn it off every time you stop.

Return to the FULL RICH setting and road test the car. Drive a few miles at each setting to see how it performs. If you have also installed a separate **Dash Mounted Mixture Display,** you can also see at which level your output LED comes on. It is very reassuring to see the actual sensor output displayed in real time, and to see the Electronic Mixture Controller actually make a difference to the sensor output.

IMPORTANT

Only connect the display input to the raw sensor output, not the controller output.

The display is independent of the controller, and is not switched off when the controller is switched off. We can at all times see on the display what the sensor is putting out.

The controller doesn't directly change the sensor output, it fools the computer into cutting back the fuel.

It is up to you to decide which setting you will use for normal driving. If you have not installed any other high mileage device or water injection then you should be conservative in your adjustment. When installed with a GOOD “Booster” Design then a setting around 340mV to 300mV is a Good starting point and then changes made after

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CREDITS

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