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IMPORTANT NOTICE

This documents contains the latest information available at the time it was prepared. However, important information may have come to light since then. Please check the web document for the most up to date information.

Updated versions of this document are located on the web at:

<http://www.megasquirt.info/manual/mass.htm>

Assembling Your MegaSquirt

When you purchase a MegaSquirt from <http://www.bgsoflex.com/msp01.html>, you receive a PCB (the printed circuit board), plus some essential components, called a partial kit. The partial kit includes:

- printed circuit board (**PCB**),
- pre-programmed 68HC908GP32 processor (**U1**),
- MPX4250AP MAP sensor, and the (**U3**),
- 34151 FET driver (**U7**).

Ordering Components from Digi-Key

When you buy a partial kit, you will need other parts. These are available for Digi-Key, and an on-line ordering form is at:

<http://www.megasquirt.info/bom.htm>

The components arrive from Digi-Key individually packed, with Digi-Key part numbers. MegaSquirt reference tags are printed on the packing list (and below). As a result, while you should verify that you have received all you ordered, it is not necessary to identify each item by color, markings, etc.

Here is a list of some of the major components used in MegaSquirt:

- 68HC908GP32 (processor),
- MPX4250 MAP sensor,
- 4N25 optoisolator,
- MAX232 serial chip,
- MC33151P/IXDI404PI FET driver,
- LM2937 voltage regulator,
- IRFIZ34N HexFETs,
- 1N47XX series diodes,
- 1N4001 diodes,
- TIP42 flyback transistor, and LEDs.

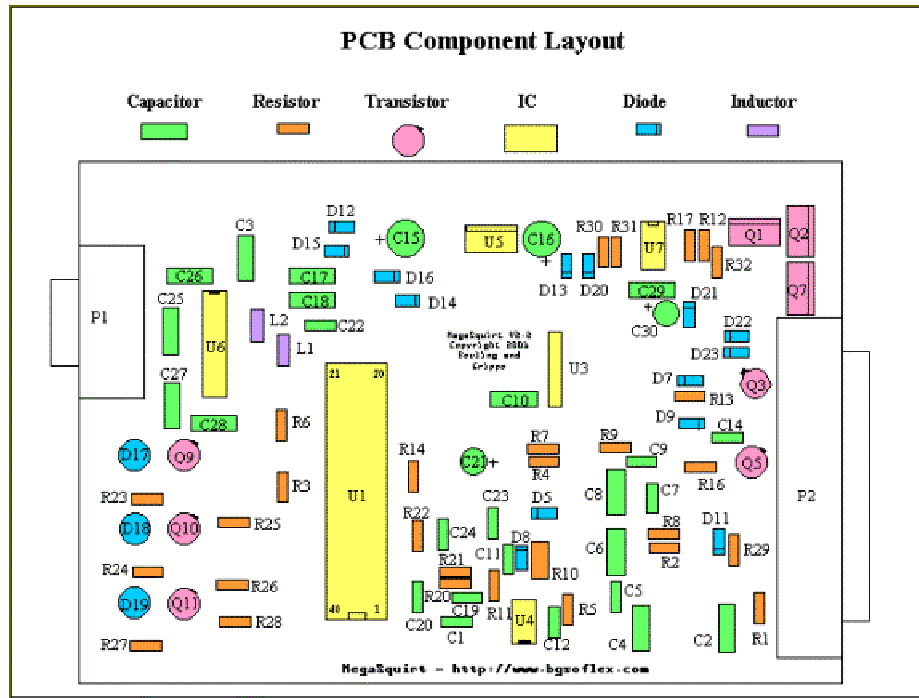
Below is a listing of all of the electrical components required for MegaSquirt.

Qty. (min. order)	MegaSquirt Reference	Description	Digi-Key Part Number
10	C1, C3, C17, C18, C22, C25 to C29	Capacitor 0.1uf	399-1880-1-ND
3	C2, C4, C10	Capacitor 0.22uf	399-1882-1-ND
5	C5, C7, C9, C12, C14	Capacitor 0.001uf	399-1818-1-ND
2	C6, C8	Capacitor 1uf	399-1887-1-ND

2	C11, C20	Capacitor 0.01uf	399-1868-1-ND
2	C15, C16	Capacitor 22uf tantalum	399-1420-ND
1	C19	Capacitor 0.033uf	399-1877-1-ND
2	C21, C30	Capacitor 4.7uf tantalum	399-1416-ND
1	C23	Capacitor 47pf	338-1053-ND
1	C24	Capacitor 20pf	338-1051-ND
6 (only 2 needed)	D1, D2, D3, D4, D8, D11	1N4733 5.1V Zener diode	1N4733AMSCT-ND
9	D5, D7, D9, D12, D13, D14, D20, D22, D23	1N4001 Diode	1N4001DICT-ND
1	D21	1N4753 36V Zener diode	1N4753ADICT-ND
1	D15	1N4749 24V 1W Zener diode	1N4749ADICT-ND
1	D16	1N4742 12V 1W Zener diode	1N4742ADICT-ND
3	D17, D18, D19	LED, red, T1-3/4 case	P301-ND
2	L1, L2	Inductor 1uH	M7010-ND
1	P1 Connector	DB-9 Female	A23305-ND
1	P2 Connector	DB-37 Male	A23289-ND
5	Q3, Q5, Q9, Q10, Q11	Transistor, PN2222A	PN2222AD26ZCT-ND
2	Q2, Q7	Transistor, IRFIZ34g	IFRIZ34G-ND
1	Q1	TIP42C	TIP42COS-ND
8 (10)	R1, R2, R9, R13, R16, R25, R26, R28	1K ohm, 5%, 1/4w,axial	1.0KQBK-ND
1 (5)	R3	51K ohm, 5%, 1/4w,axial	51KQBK-ND
2 (5)	R4, R7	2.49K ohm, 1%, 1/4w,axial	2.49KXBK-ND
2 (5)	R5, R8	2.2K ohm, 5%, 1/4w,axial	2.2KQBK-ND
5	R6, R14, R20, R30, R31	10K ohm, 5%, 1/4w,axial	10KQBK-ND
3 (5)	R23, R24, R27	330 ohm, 5%, 1/4w,axial	330QBK-ND
1 (5)	R10	390 ohm, 5%, 1/2w,axial	390H-ND
1 (5)	R11	4.7K ohm, 5%, 1/4w,axial	4.7KQBK-ND
2 (5)	R12, R17	22 ohm, 5%, 1/4w,axial	22QBK-ND
1 (5)	R21	100K ohm, 5%, 1/4w,axial	100KQBK-ND
1 (5)	R22	10M ohm, 5%, 1/4w,axial	10MQBK-ND
1 (5)	R29	1M ohm, 5%, 1/4w,axial	1.0MQBK-ND
1 (5)	R32	270 ohms, 5%, 1/2w,axial	270H-ND
1	U1 - Group Buy (pre-programmed)	68HC908GP32 Processor - 40 Pin DIP	MC68HC908GP32CP
1	U3 - B&G	MPX4250A Pressure Transducer	MPX4250AP
1	U4	4N25 opto-isolator - 6 Pin DIP	160-1300-5-ND
1	U5	LM2937ET-5.0 Regulator - 3 Pin TO-220	LM2937ET-5.0-ND

1	U6	MAX232CPE - 16 Pin DIP	MAX232CPE-ND
1	U7 - B&G	34151 FET driver - 8 Pin DIP	IXDI404PI-ND (replacement)
1	Y1	32.768 kHz Crystal	300-1002-ND
1	n/a	40 Pin DIP Socket	AE7240-ND (or A9440-ND)
1	n/a	Connector DB-37 Female	237F-ND
1	n/a	DB-37 Hood	937GM-ND
1	PCB - Printed Circuit Board - B&G	Double sided, plated holes, solder mask	n/a

Here is a color-coded diagram of how these components are located on the printed circuit board:



If you have questions about the specification or appearance of any item, check the part number at the Digi-Key site (www.digikey.com) first. Entering the part number in their search engine will give you access to both the catalog information and the data sheet from the manufacturer. You can also access this information from the ordering form at:

<http://www.megasquirt.info/msbom.htm>

by clicking on the part description.

When you get your parts kit from Digi-Key, it will contain the components listed above (minus the PCB, U1, U3, and U7). Note that you will have some extra parts. These are the result of Digi-Key minimum order quantities for some items, notably the resistors. The resistors are generally less than \$0.06 each, so the total cost of the extras is minimal.

Schematics for MegaSquirt are available on the MegaSquirt site at:

http://www.bgsflex.com/v22/megasquirt_ShemV2.2.pdf

To assemble any of these electronic kits, you will need a soldering iron, some solder, and a few other useful accessories. A 15 watt pencil iron will work fine, however a 25 watt iron heats up faster.

You can use 0.75mm resin solder (~0.030") which really helps to put just the right amount of solder in just the right places. Make sure to let the soldering iron get good and hot before using it. A hotter tip makes for quicker cleaner joints, and less heat in the components, because the temperature of the lead reaches the melting point of the solder before the component has had much time to heat up (though letting the iron heat for a while also tends to shorten the useful life of the tip). Let it sit 'powered-up' for 10-15 minutes before trying to use it. The solder should melt nearly instantly if touched to the tip.

Never try to paste solder on a joint using excess solder on the tip. Keep the tip clean, and heat the joint (try to get the tip right at the joint between the lead and the PCB) and hold the solder against the other side of the joint until it starts to melt. Feed in just enough solder to get a bit of a cone on the joint, and you are done. Get a solder wick as well - you will be glad you did!

Before plugging in your soldering iron, be sure you read and understand the assembly instructions that follow. If this is your first time soldering, read the deployment guide thoroughly. It is in a file called "deploy_guide_DRAFT_040302.pdf" in the Files section of the MegaSquirt Forums list. You do not need to use silver solder for MegaSquirt. Regular 60/40 or 63/37 solder is fine.

Note: The semiconductor components in MegaSquirt are sensitive to **electrostatic discharge** (ESD). To reduce the potential for damage from ESD, some care is needed. Interestingly, you cannot even feel an ESD shock unless the voltage exceeds 3,000 volts, far more than enough to destroy some of the MegaSquirt components. ESD events do not always destroy an electronic component immediately on the first occurrence, making the eventual failure of your MegaSquirt very difficult to troubleshoot. Where possible, make use of anti-static controls and material handling techniques, i.e., wrist-band grounding straps, anti-static foam and anti-static bags, grounded workbenches, anti-static mats, etc. Avoid handling semiconductor components more than necessary. If you are not wearing a wrist-band grounding strap, discharge yourself by touching grounded metal before handling ICs and equipment. This is especially important in the winter after taking off or putting on any garments, for example, sweaters and coats. The material of your clothing

also has an effect, as materials like silk and some artificial fibers produce a lot of "static electricity". Most commercial carpets contain a high percentage of artificial fibers, which are prone to producing static. Where possible, try to keep the room humidity at 50% or higher to reduce static problems, or use a product such as "Static Guard".

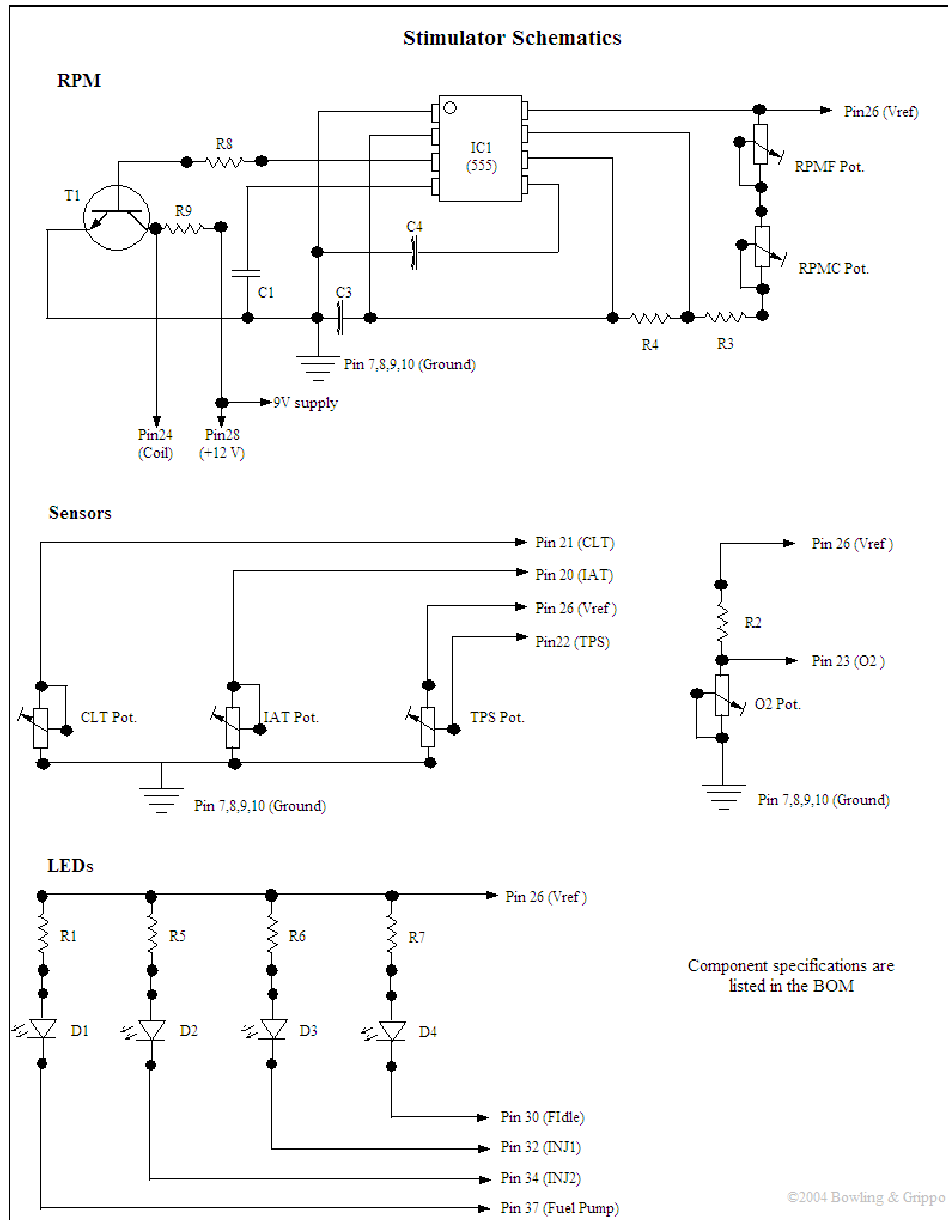
Assembling the Stimulator

Before assembling your MegaSquirt, you should assemble the stimulator, which you will use to test your MegaSquirt as you proceed.

Stimulator Parts Listing:

Part	Description
CLT	10k pot, black body
IAT	10k pot, black body
O2	10k pot, black body
TPS	10k pot, black body
RPMC	1M pot, green body
RPMF	50k pot, black body, marked 50k
C1	0.01 μ F, cap
C3	0.33 μ F, cap
C4	0.01 μ F, cap
R1	330 ohm resistor, 1/8 or 1/4W, orange orange brown
R2	33k ohm resistor, 1/4W, orange orange orange
R3	1.0k ohm resistor, 1/4W, brown black red
R4	1.3k ohm resistor, 1/4 W, brown orange red
R5	330 ohm resistor, 1/8 or 1/4W, orange orange brown
R6	330 ohm resistor, 1/8 or 1/4W, orange orange brown
R7	330 ohm resistor, 1/8 or 1/4W, orange orange brown
R8	1.0k ohm resistor, 1/4W, brown black red
R9	100 ohm resistor, 1/2W, brown black brown or 390 ohm resistor, 1/2W, orange white brown
IC1	LM555CN timer IC
T1	PN2222A NPN transistor
D1	red LED, fuel pump circuit indicator
D2	red LED, injector circuit 2 indicator
D3	red LED, injector circuit 1 indicator

D4	red LED, fast idle circuit indicator
F37	female DB37 connector
9V battery holder	
9V battery clip	
2 position terminal block	power input



1. Install and solder the **DB37 female connector** to the PCB. **Be sure to get the correct connector on the stim and MegaSquirt. Do not mix them up. Do NOT use gender changers to 'fix' incorrect connectors - it WON'T work!**
2. Install and solder the **LEDs**. When looking at the LED from the top, with the flat facing towards you (towards the sensor pots), the short lead is on the right (towards the DB37) and the long lead is on the left (towards RPMC). The LED leads may be tight in the PCB, this is okay - but use caution when inserting them. Needle nose pliers can help with this.
3. Install and solder the **potentiometers** (a.k.a. "pot"). The RPM circuit has both a coarse and fine control. The combination of the 1M (RPMC) and 50k (RPMF) pots allows precise setting of rpm. **Note that the PCB is marked "10K" on both the RPMF and RPMC pot locations, but this is an error. Do not use 10k pots in these locations.** Use the 1M pot for RPMC, and the 50k pot for RPMF. The 10k and 50k pots look identical, however if you look closely on the bodies, you will find a **10k** or **50k** marking.
4. Install and solder all the **capacitors** in their respective locations as marked on the PCB. You can use the Digi-Key parts list to identify the capacitors, or use the guide below to decipher the markings:

Capacitor Identification

Capacitors may be marked directly with their capacitance. If not, they are frequently marked with numbers like:

104 K50 or 152 K100

The first two numbers are multiplied by ten to the power of the third number to getting the picoFarad capacitance.

For example, since 10 to the fourth power is $10^4 = 10 \times 10 \times 10 \times 10 = 10,000$, the first capacitor would be $10 \times 10,000 = 100,000\text{pF} = 0.1\mu\text{F}$, , since $1,000,000\text{pF} = 1\mu\text{F}$, .

The second capacitor would be $15 \times 10^2 = 15 \times 100 = 1500\text{pF} = .0015\mu\text{F}$, .

The upper case letter indicates the tolerance, M = 20%, K = 10%, J = 5%, H = 2.5% and F = $\pm 1\text{pF}$. The last numbers are the rated voltage, 50 and 100 volts in these cases.

5. Install and solder all the **resistors** in their respective locations as marked on the PCB. **Note: be careful to space R9 above the PCB by 1/4 to 3/8 inch (7mm to 10mm). This resistor can get very hot (255°F, 124°C) in use, and spacing it up allows it to cool better and protects the PCB from excess heat.** The other resistors don't get hot, and can be flush with the PCB. The resistor color band coding is as below, or you can use the chart below, and it is a good practice to verify each resistor's value with a multimeter before installing it.

Color	Band 1	Band 2	Multiplier	Tolerance
Black	0	0	1	Not used
Brown	1	1	10	Not used
Red	2	2	100	Not used
Orange	3	3	1000 = 1K	Not used
Yellow	4	4	10000 = 10K	Not used
Green	5	5	100000 = 100K	Not used
Blue	6	6	1000000 = 1M	Not used
Violet	7	7	Not used	Not used
Gray	8	8	Not used	Not used
White	9	9	Not used	Not used
Gold	Not used	Not used	Divide by 10	5%
Silver	Not used	Not used	Divide by 100	10%
None	Not used	Not used	Not used	20%

6. Install and solder the battery **terminal block**, and attach the battery **clip** and **holder**. Pay attention to the polarity of the battery leads. Verify that the lead you connect to the positive terminal (+) is the positive leads from the battery using a voltmeter. Use the double sided tape to attach the battery clip to the PCB.

7. Install and solder the **transistor** (use the diagram in the MegaSquirt assembly manual [step 62]) to see how the leads should be arranged if you have the 'Digi-Key' transistor - the flat side should face the TPS pot).

8. Install the **555 IC** in its locations as marked on the PCB. Pay careful attention to the orientation. The notch (and/or dot) on the chip goes at the end closest to C1.

Note: if you are planning on using a wide-band oxygen controller/sensor with MegaSquirt, you may want to modify your stimulator as shown in Eliot Mansfield's instructions here:

www.mez.co.uk/ms9.html

Connection of the stimulator directly to MegaSquirt can be made by removing the faceplate on the DB37 connector (*Not all connectors will need the faceplate removed, check first*). Otherwise, use an appropriate cable.

Note: Although there is a 9V battery clip and holder, this should only be used for quick checkout of the MegaSquirt. For extended use, an external 12V supply is recommended. You can use the 'wall-wart' style AC/DC adapter from discarded household electronics if it has a 9 to 12 DC Volts at 300 milliAmps DC output. (The adaptor will be labeled something like **OUTPUT: (VDC 300mA)**). Simply plug the power source into the terminal block taking care to get the polarity correct. The stimulator power supply goes directly to MegaSquirt, which returns 5V power the stimulators circuits. The stimulator will not operate independently so there is no need to disconnect the battery after each session to avoid discharge.

Assembly Guide for MegaSquirt Version V2.2

The following is a step-by-step assembly guide for the V2.2 MegaSquirt partial kit. Read through all of these directions first. Be sure to check off each step as you complete it - this way you can take breaks and know where you left off.

The first time assembler of average skill can count on spending 4 to 5 hours assembling and testing the MegaSquirt if they follow the instructions below.

To assembled your MegaSquirt, you will need:

- A MegaSquirt PCB and all associated B&G and Digi-Key parts,
- A digital multi-meter (DMM) or a voltmeter and ohmmeter,
- A DB-9 serial cable that is “straight-through” (not a null-modem cable, see step 22a). Most computer shops will have these. You need a female connector on one end and a male connector on the other end.
- A Windows 9x/ME/XP PC which has Hyperterminal (hyperterm.exe). This is normally supplied with the Windows operating systems), and is also available at [Hilgreave](#),
- MegaTune - download and install it on your computer.
- A [MegaStimulator](#) will make these checks, and several other tasks, much easier.
- General electronic kit assembly tools (screwdrivers, pliers, soldering iron, etc.). Also, if you are unsure of a resistor value (sometimes it is hard to pick out the color on a resistor), then use an ohmmeter to determine resistance - remember that most of these are 10% tolerance devices, so your readings may not be exactly as designated.
- Proper mounting of the larger heat-producing components requires the use of heat-sink compound. You can find a small tube of it at your local electronics store for under \$2.
- A drill, file, and 1/8” and 1/4” drill bits for cutting the end plates.

Do not let this be your first electronics kit. If you have not assembled such a kit before, go purchase another simple kit (like from Velleman) and practice, or assemble the MegaStim or relay board first. For tips on good soldering technique and electronics assembly hints, see the draft deployment guide by “Neon” John De Armond in the Documentation section of the MegaSquirt Forums files section.

Getting Questions Answered

When you have problems with assembly or testing, post your questions to:

MegaSquirt Forums – www.msefi.com (must be registered to post)

Make sure to mention the step number and be as specific as you can with regards to components, voltages or resistance values, temperatures, PC Configurator gauge numbers, LED flashing rates or any other information that you think might be related.

If you have all of the above items on hand, and a few hours of spare time, you can begin to assemble your MegaSquirt.

Assembly proceeds in functional blocks, with testing after each block. These blocks are:

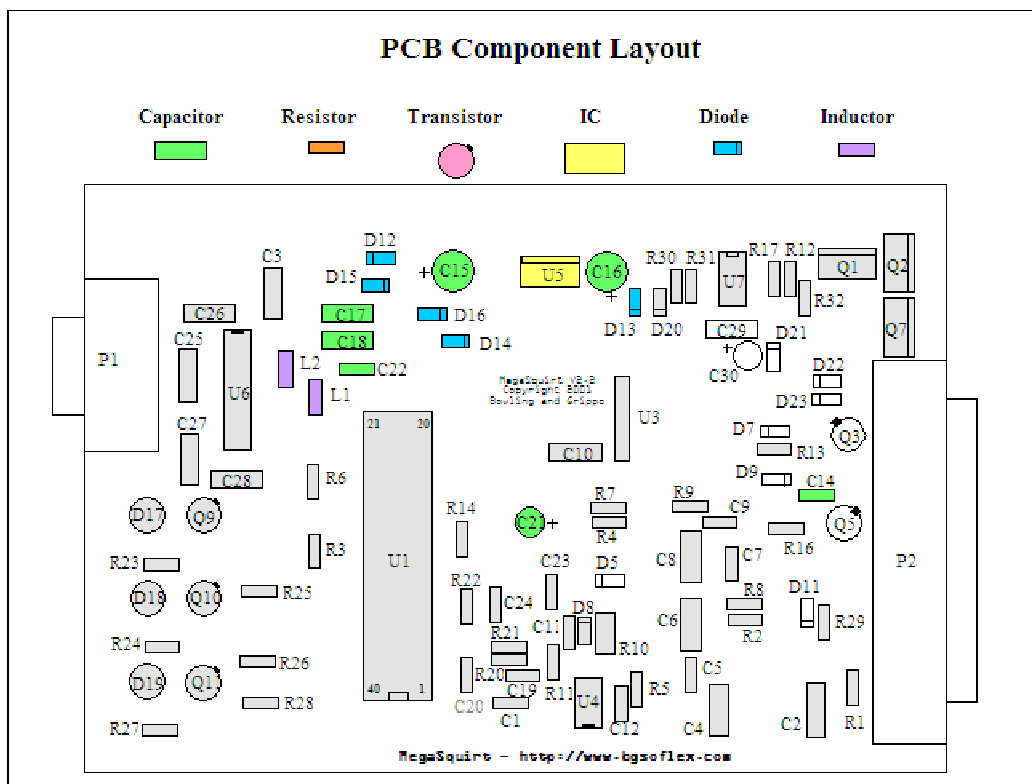
Power Supply Construction and Testing	(steps 1-19)
Serial Communications Construction and Testing	(steps 20-22)
Clock Circuit Construction and Testing	(steps 23-36)
Input Section Construction and Testing	(steps 37-56)
Output Section Construction and Testing	(steps 57-73)

Each of these will be covered in turn.

A tip for those about to assemble their MegaSquirt; whenever possible orient the numbers on the components (such as diodes) so that you can read the "important" part of them when it's all assembled. For example, with a diode 1N4753, try to make sure you can read the 4753 part of the number when the diode is installed in the PCB. With any luck it will never matter, but if a problem occurs, you'll be glad you did this.

Power Supply Construction & Testing

1. Get ready for assembling your MegaSquirt. Plan on taking 4 to 5 hours for the average person with average skills doing a first time assembly.
 - a. Familiarize yourself with the PCB, schematic, BOM, and this assembly guide - make sure you have everything available to assemble your MegaSquirt. The following color code diagram shows all of the components as they are laid out on the PCB. This can make it easier to find the proper locations, especially when the board is half done and some of the labels are hard to see. However, always verify the correct location on the PCB before assembling parts.



b. Trial fit your PCB in the enclosure before soldering anything to it. Your printed circuit board (PCB) might be slightly too wide and too long to fit into the case properly. It is designed to be 6.00" long by 4.00" wide (152.4mm x 101.6mm). The PCB manufacturer allows some tolerance, so some boards might not quite fit without a little filing. Check the width first. Note that you have to slide the board in perfectly straight or it will bind, even if it is the correct size. If you still cannot slide the board in, deburring the box sometimes makes all the difference. The boards bind if the edges are sharp, but slip right in when cleaned up. If this still does not work, then before soldering anything to the boards file the sides down a bit. Use a 12" (30cm) finishing file. Slide the board back and forth on both long sides for about 30 seconds. (If you do not have your case yet, you can proceed and check the sizes later, it will just be a more delicate job).

Note: you should also check the length of the board in the case. Slide the board into the case. The 37 pin sub D connector mounting surface should be flush with the back of the case, look at the other side of the board (DB9 connector side) and see how much needs to be filed off so the cover can be mounted flush with the case. You may need to take as much as 0.025" (0.6mm) off of this side, which may take up to 60 seconds of work with the file. When you are done the board should fit nice and snug.

2. Install and solder the DB-37 header (**P2**) {A23289-ND} on the PCB. Solder all of the pins to give the headers the maximum physical strength. Make sure you do not bridge adjacent pins with solder. **Be sure to get the correct connector on the stim and MegaSquirt. Do not mix them up. Do NOT use gender changers to 'fix' incorrect connectors - it WON'T work!**

Then install and solder the DB-9 header (**P1**) {A23305-ND}.

3. Next, install the 40-pin DIP socket {AE7240-ND (or A9440-ND)} for the processor - notice that the notch installs near the bottom of the board, corresponding to the PCB silk screen. Carefully solder the socket, and check each solder joint for shorts or cold joints.

4. Next, you are going to install the components that make up the power supply, and then verify operation. The first part to install is capacitor **C14** (399-1818-1-ND, 0.001µF, 102 marking).

This component, and many of the remaining ones, (such as resistors, capacitors and diodes) has long leads. In general, you want to install and solder the component as close as convenient to the PCB, then snip the leads off from the other side. The transistors are an exception to this, they should be about 1/8" off the PCB. Keeping the leads short helps prevent vibration-related failures down the road.

Note: Many of the component leads will have to be bent to go into the holes, use round-jawed pliers for this. Also, the part numbering does not follow strict numerical increments, so there are gaps in the numbers - do not be concerned by this. If you follow this step-by-step assembly guide, then you will not even notice. As mentioned before, do not be concerned if you have extra resistors left after assembling your MegaSquirt. This is normal due to the Digi-Key minimum ordering quantities for some items.

5. Install and solder diode **D14** {1N4001DICT-ND} - make sure banded end is installed correctly as per board.

6. Install and solder diode **D16** (1N4742ADICT-ND, 12 volt Zener diode, 1N4742 marking) - make sure banded end is installed correctly as per board.

7. Install and solder **D13** {1N4001DICT-ND} - make sure banded end is installed correctly as per board.

8. Install and solder **D15** (1N4749ADICT-ND, 24 volt Zener diode) - make sure banded end is installed correctly as shown on the printed circuit board.

Positive is:		
Capacitors:	LEDs:	Diodes:
the longer lead on polarized capacitors (not all are), sometimes marked with a small +	the longer lead on LEDs, and the lead opposite the "flat" on the case.	the end FURTHEST from the band.

9. Install and solder **C15** (399-1420-ND, a tantalum capacitor, 22 microFarads (µF)) - make sure polarity is observed. It has a small "+" near the positive lead. The longer lead is also always the positive lead.

10. Install and solder **D12** {1N4001DICT-ND} - make sure banded end is installed correctly as per board.
11. Install and solder **C16** (399-1420-ND, tantalum, 22 μ F, - make sure polarity is observed. The longer lead is positive on all of the capacitors.
12. Install and solder **C17** (399-1880-1-ND, 0.1 μ F, 104 marking).
13. Install and solder **L1** (M7010-ND, inductor, 1uh, small coil of wire with leads). Space the inductor about 1/8" (3mm) off the PCB to avoid shorts on the traces underneath.
14. Install and solder **L2** (M7010-ND, inductor, 1uH). Space the inductor about 1/8" (3mm) off the PCB to avoid shorts on the traces underneath.

The **Boot Header (H1)** on the board near Q9 is used to reprogram the CPU in MegaSquirt (not the tuning parameters, but the actually code that uses the tuning parameters). Leave it open, and do not jumper it. If you plan to just use the standard programming (V2.98/V3.000), you won't need to touch it.

Depending on what you want from your MegaSquirt, though, you may end up using the boot header to eventually to load customized code, such as MSnS-E, MSnEDIS, dual table, etc.

To load new code, put a short piece of bent wire between the two H1 holes. Some people have put a momentary switch across the boot header, and place the switch so they can go into bootloader mode simply by pressing this switch while powering up, without opening the case. (If you do this, be sure it can't be pressed accidentally.)

15. Install and solder **C18** (399-1880-1-ND, 0.1 μ F, capacitor, 104 marking).
16. Install and solder **C22** (399-1880-1-ND, 0.1 μ F, capacitor, 104 marking).
17. Install and solder **C21** (399-1416-ND, 4.7 μ F, electrolytic) - make sure polarity is observed.
18. Install the voltage regulator **U5** {LM2937ET-5.0-ND}. This part installs on the under side of the board, on the silver pad near the center of the board. Use heat-sink compound on the tab, and use the nylon screw and nut to fasten to the PCB. The leads go through the board and are soldered on the top side.
19. You now have the power supply assembled. Before you go any further, you are going to verify that the supply is operational. To test, install a battery in the stimulator, and plug

it into the DB-37 connector on the ECU board. Next, using a DMM (digital multi-meter) on DC VOLTS setting, check for 5 volts on the 40-pin processor socket (which is empty) - there should be 5 volts between pins 19 (ground) and 20 (+5), there should also be +5 on pin 1 and 31 (check against ground at pin 19), and ground potential on pins 2 and 32 (check against +5V on pin 20). An easy way to probe this is by using a component lead that you cut from one of the resistors and wrapping around the DMM probe tip, then plugging into the socket.

Remember that pin #1 on the 40-pin socket is on the lower right (at the same end with the notch), then goes up the 20 pins on that side, then over to the other side top, then down - it traces a counter-clockwise circle.

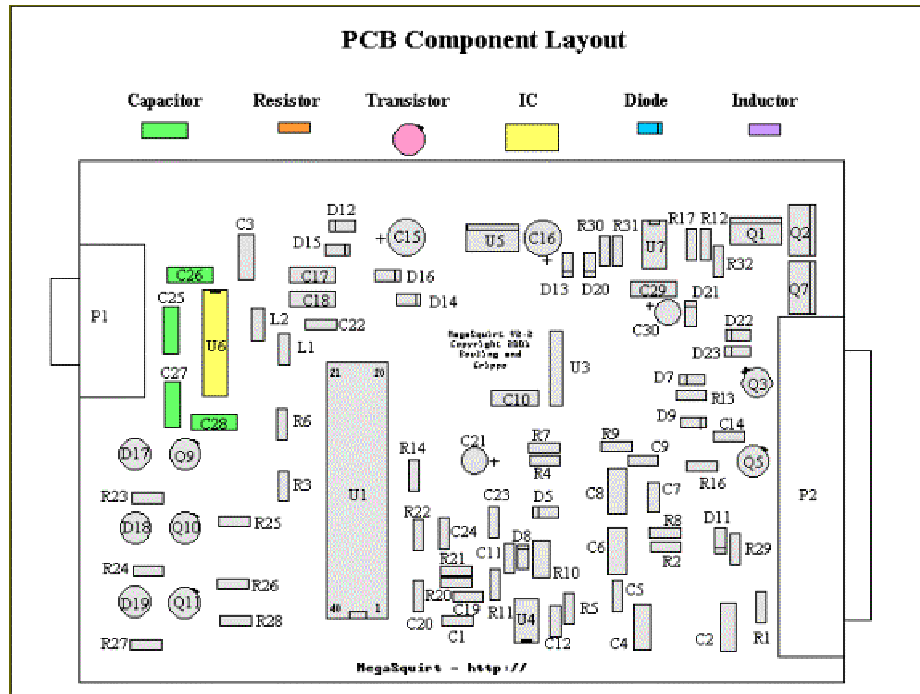
Check each box below as you measure the voltage between the ground pins across the top and the +5 pins down the left. You should get a voltage between 4.9 to 5.1 volts in each case (if your multi meter is accurate). Unplug the stimulator when finished.

Pin	2	19	32
1	_____	_____	_____
20	_____	_____	_____
31			

If you don't pass the above tests, recheck all of the assembly steps in this section, verifying the correct components are installed with the correct orientation. If everything appears fine, check the troubleshooting tips at the end of this assembly manual.

Serial Communications Construction & Testing

20. Next, you are going to assemble the serial port link and verify operation. First step, install capacitors **C25**, **C26**, **C27**, and **C28**, (all 399-1880-1-ND, 0.1µF, 104 marking) by soldering them in the appropriate locations.



21. Next, solder the **U6** {*MAX232CPE-ND*} - note the proper orientation on the silk-screening, be sure to install in the proper direction. Solder it in place.

22. You now have enough to test the serial link. Do the following steps to verify operation:

A. Using an ohmmeter, verify that your DB-9 serial cable is truly a pass-through and not a null modem. All DB connectors have the pin numbers molded into the plastic insulation around the pin holes on both male and female ends. The numbers are quite small and you may need a flashlight and magnifier to see them, but they are there. Check that pin 1 on one end is connected to pin 1 on the other end, then do the same check for pins 2, 3, 5 and 9. If all these check out, you can proceed, otherwise you need to get a different cable.

To repeat: On the cable, **pins 1, 2, 3, 5, & 9** should all be **connected** and "**straight-through**". These are the only connected pins on the PCB.

The DB9 pin functions are:

- **Pin 1** - VCC (5 volts)
- **Pin 2** - Tx (OUT)
- **Pin 3** - Rx (IN)
- **Pin 5** - ground
- **Pin 9** - ground

If your laptop has a DB-25 serial port, rather than a DB-9, you can use a DB-9 to DB-25 adapter, available from most computer stores. For the rare DB-25 PC port, a "straight through" connection has pins 2, 3 and 7 (two, three and seven) on the DB-25 connected to pins 3, 2 and 5 (three, two and five) on the DB-9, respectively.

If you do not have a serial port (some newer laptop computers do not), you may be able to use a USB port. The USB port on your computer cannot be wired to a DB-9 connector directly. You can buy a USB adapter, which may work with MegaSquirt. It is more expensive than the simple adapter solution. There have been some reports of problems when using a USB to RS232 adapter, though a few people have managed to make them work. One that some people have had success with is at:

<http://www.sewelldev.com/USBtoSerial.asp>

It is only \$20.



Others have found that the Keyspan USB to Serial Adapter model number USA-19 QW works. You have to download the new driver and go to the Keyspan Serial Assistant. In it you have to change the baud rate to 9600 and the Com port to 1. The default is 6. You can get one at CompUSA for \$49.99.

B. Connect the serial cable to your computer, but not to the MegaSquirt ECU yet. Use an alligator clip or something similar to jumper pins 2 and 3 on the loose end of the cable. This provides a loopback circuit to verify the operation of your computer and the cable without involving the MegaSquirt hardware yet.

C. Download the HyperTerminal configuration file from <http://www.megasquirt.info/manual/megasquirt.ht>, save it to your hard drive, then click on its icon to start HyperTerminal. Note that the configuration is set for com port #1, you may have to change this **OR** you can set up Hyperterminal yourself:

i. On the PC, find and run HyperTerminal (Hyperterminal is usually under Start/Programs/Accessories/Communications, but if it is not there then search for a file called "hyperterm.exe").

If you do not have HyperTerminal installed, you can get it from [Hilgraeve](#), who wrote the original for Microsoft Windows. HyperTerminal Private Edition (HTPE) is what you want, and it's free for personal use.

ii. When Hyperterm appears, click on the red telephone icon, and enter a save file name (anything you want, say, "megasquirt").

iii. When the "Connect To" dialog comes up, select under the "Connect Using" option the COM port to which the DB-9 cable is connected, i.e., COM1 or COM2. Do not worry about any of the other settings. Click OK.

iv. Next, a dialog window opens with baud rate, stop bits, etc. Set the values according to the table below. Note: the last one, **Flow Control**, is very important – be sure to set it to **None**. Click OK.

Baud Rate	9600
Data Bits	8
Stop Bits	1
Flow Control	None

D. HyperTerminal now is up and "connected."

E. Type any character - it should be echoed back to the screen, i.e. you will see it once if you do not have local echo enabled, twice if you do. *Note that the above configuration file has the local echo set to "off"*. If the character you typed appears on the screen then the link is working. If not, then check the cable connections and try different COM ports. You must see characters echoed correctly before you move on.

F. Once the connection is working with the cable loopback, it is time to connect the DB-9 cable to the MegaSquirt ECU. Remove the jumper on the loose end of the cable and plug it in to the MegaSquirt DB-9 connection.

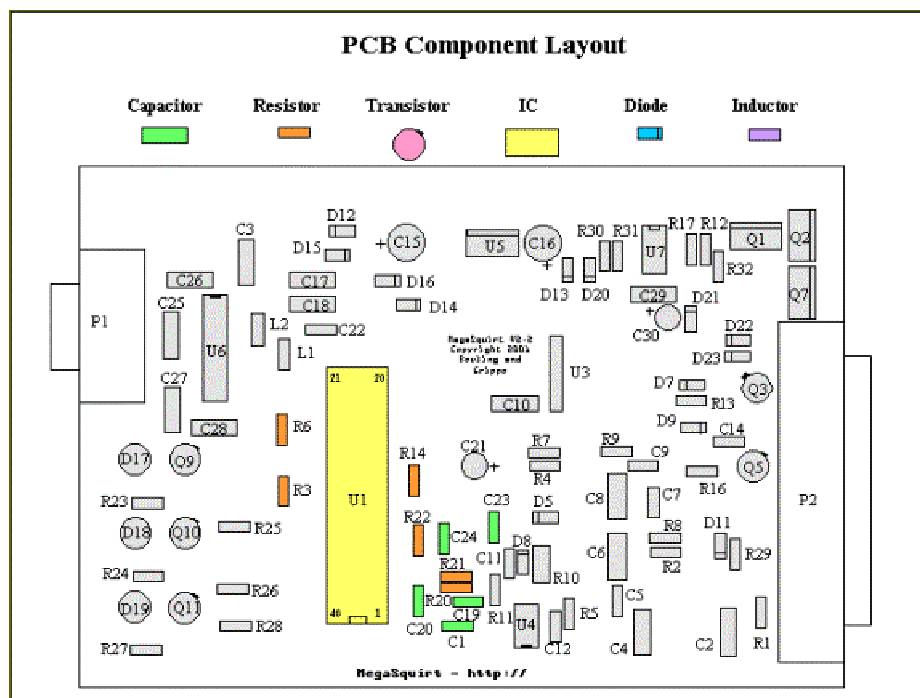
G. Jumper from pin **12** to pin **13** on the 40-pin processor socket [near **R14**], using a snipped-off component lead (i.e. the loose end from a resistor or capacitor, smaller is better to avoid damaging the socket). Be careful to count correctly to jumper the correct pins. Pin number 1 is to the left of the notch (when the notch is "up") on the chip. *Do not test the loop-back yet, you have to apply power first.*

H. Finally, **plug in the stimulator** to MegaSquirt to power the board up. This allows a full loop-back test, all data sent to pin 13 should be returned back on pin 12 through the MAX232 chip and all related communications circuits on the board.

Again, type any character and again it should be echoed back to the screen. If characters appear on the screen then everything is fine, if not, then check solder joints on the sockets and components, verify voltages at the MAX232 chip connections and so on. **If everything appears fine, check the troubleshooting tips at the end of this assembly manual.**

Clock Circuit Construction & Testing

23. Next, you are going to assemble clock circuit for the processor as well as the battery voltage reading circuit. First, install **C1** (399-1880-1-ND, 0.1 μ F, 104) and solder.



24. Install and solder **C19** (399-1877-1-ND, 0.033 μ F, 333 marking).

25. Install and solder **C20** (399-1868-1-ND, 0.01 μ F, 103 marking).

26. Install and solder **C23** (338-1053-ND, 47 pf, 47 marking).

27. Install and solder **C24** (338-1051-ND, 20 pf, 20 marking).

28. Install and solder **R14** and **R20** (10KQBK-ND, 10K, brown-black-orange).

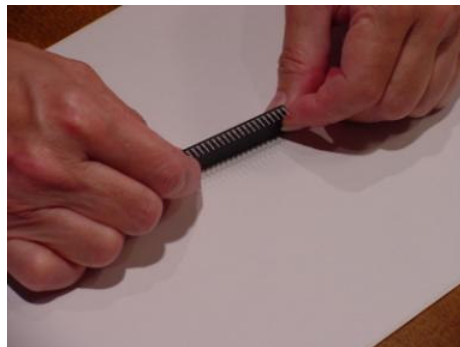
29. Install and solder **R21** (100KQBK-ND, 100K, brown-black-yellow).

30. Install and solder **R22** (*10MQBK-ND*, 10M, brown-black-blue).
31. Install and solder **R3** (*51KQBK-ND*, 51K, green-brown-orange-gold/silver).
32. Install and solder **R6** (*10KQBK-ND*, 10K, brown-black-orange).
33. Install and solder **Y1** (*300-1002-ND*, 32768 Hz crystal, the very small silver can with the tiny wires). **Note that Y1 is physically fragile, do not drop it.** Some people have also reported that the crystal will fail to operate if it touches other components, so be sure it is clear of these. Bend the leads at a 90-degree angle so that the crystal lies parallel to the PCB. You can use a very small drop of RTV silicone to stabilize the crystal (though this will make it more difficult to replace, if you need to in the future). (Note that Y1 is not shown in the diagram above for space reasons, it is located between C23 and C24.)

Note: You may want to “glue” the crystal to the printed circuit board with a cushion of PCB-safe silicone rubber adhesive (RTV). A small "blob" on the under side of the crystal will cushion the crystal and dampen any mechanical vibrations.

34. Insert the CPU **U1** into the socket - the notch faces downward (line up with silk screen and socket notch). You may have to bend the leads inward a bit to get it into the socket - be careful not to break one off.

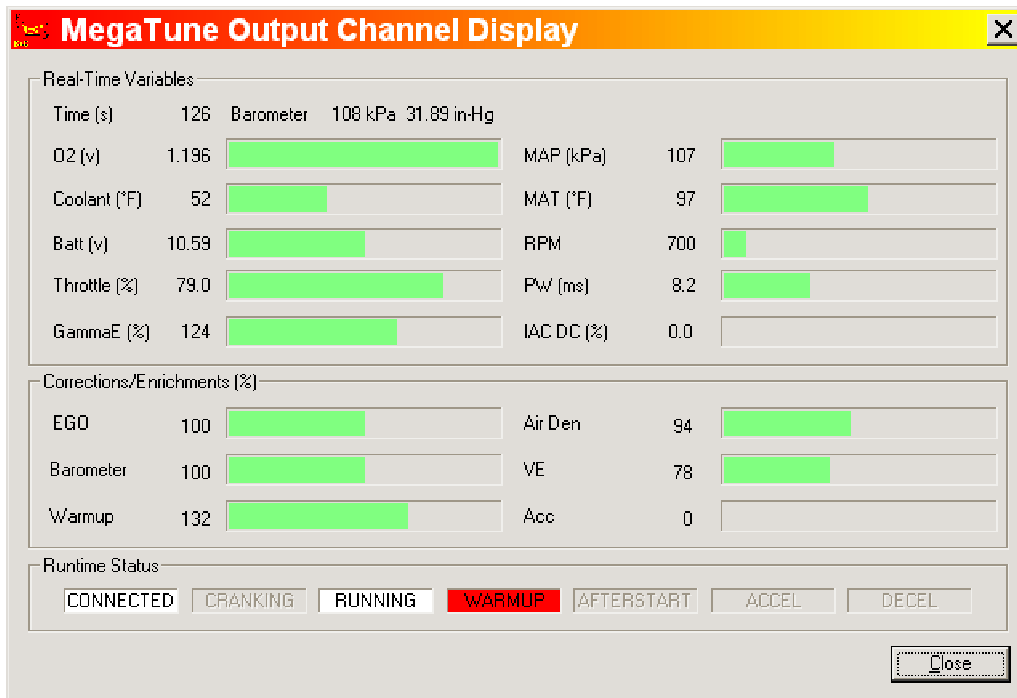
Note that bending the CPU leads can be tricky. Your objective is to have the width of the CPU leads exactly match the width of the socket pins, precisely 0.6 inches, before you attempt to firmly push the CPU into the socket. Ideally, you want to bend all pins at the same time. One technique is to hold the CPU with your thumb and index finger of each hand, so that one side of all the pins are against a rigid flat surface. Your thumbs are on the top of the CPU at each end and your index finger is underneath between the pins. By firmly tilting the CPU against the flat surface you will bend all the leads on one side of the CPU. Go slowly, a mini bend of a few degrees each time. Be careful not to bend the pins too far. Make several checks for fit in the socket as you go along. If you are having a difficult time visualizing this technique, place the CPU on a flat surface as if it were in the socket. Now turn the CPU up 90 degrees so that it is standing on the flat side of half its pins.



A second method to bend all the CPU pins at once is to use an extra long needle nose pliers and grab all the pins at once. A twisting motion applied to the pliers will bend all the pins simultaneously. With care, this will also work if the needle nose pliers are only long enough to grab half the pins. Just make the bends in two steps.

35. You are now ready to test the operation of the processor. Plug in the DB-9 serial cable into the board and to the PC. On the PC, run PC Configurator. Go into the "Communications" window and select the proper COM port (the "Verify ECU operation" does not operate, so do not be fooled). Exit this screen (back to the main window). Note: If your com port is on COM5, you will notice that the Configurator only offers COM1 through COM4. Modify the configuration file so that the first line says "COM5". (Use Wordpad, Notepad or something similar, be sure to save as a plain text file.) For PCC this file is "megasquirt.cfg", for MegaTune it is "megatune.cfg".

36. Plug in the stimulator into the ECU. On the PC, click the "Runtime/Realtime Display" button, which brings up a new screen. Look at the "Time(s)" near the top left corner of the Realtime Display - it should be counting up, incrementing every second (it will roll over at the value of 255, back to zero). If the seconds count is there, you are running! If not, check the cable, make sure there is power, and check the COM port. The only other value on the screen which is working correctly is the "Batt V" box - it should be displaying the battery voltage (from about 7.0 - 8.5 volts, depending on the 9-volt battery condition). All other boxes will have nonsense for numbers.



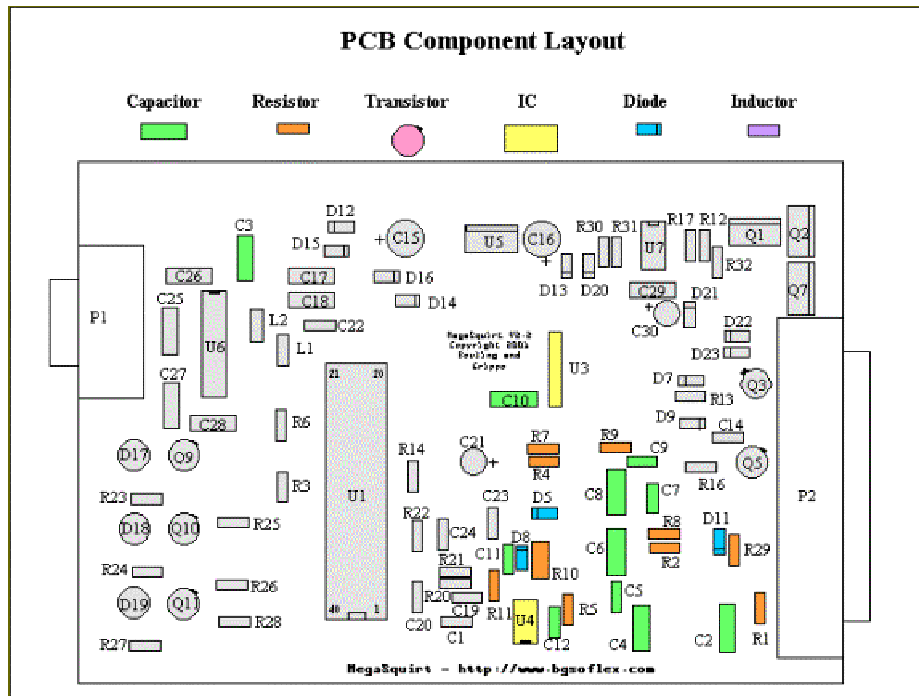
If you don't pass the above tests, recheck all of the assembly steps in this section, verifying the correct components are installed with the correct orientation. If

everything appears fine, check the troubleshooting tips at the end of this assembly manual.

Input Section Construction & Testing

37. Remove the processor from the 40-pin socket - use a thin screwdriver and pry it from the socket, first one end, then the other - place back on foam pad.

38. Now, you are going to install all of the input sensor components. First, install and solder **C3** (399-1880-1-ND, 0.1 μ F, 104 marking).



39. Install and solder **C5**, **C7**, and **C9** (399-1818-1-ND, 0.001 μ F, 102 marking).

40. Install and solder **C11** (399-1868-1-ND, 0.01 μ F, 103 marking).

41. Install and solder **C2**, **C4** and **C10** (399-1882-1-ND, 0.22 μ F, 224 marking).

42. Install and solder **C6** and **C8** (399-1887-1-ND, 1.0 μ F, 105 marking).

43. Install and solder **R5** and **R8** (2.2KQBK-ND, 2.2K, red-red-red).

44. Install and solder **R1**, **R2**, and **R9** (1.0KQBK-ND, 1K, brown-black-red).

45. Install and solder **R11** (4.7KQBK-ND, 4.7k, yellow-violet-red).

46. Install and solder **R29** (1.0MQBK-ND, 1M, brown-black-green-gold).

47. Install and solder **R10** (390H-ND, 390 ohm, ½ watt, orange-white-brown). This resistor should be mounted roughly 1/8" (2mm) above the surface of the PCB.

Also, the value of this resistor may have to be changed depending on application - start with the supplied value, and if gets hot while the engine is running, then increase the value, in steps, up to 10K (like 470 ohms, 560 ohms, 680 ohms, 1K, ...), or even more in some applications (consult the MegaSquirt Forums list at www.msefi.com for advice). However, do not adjust this resistor on assembly, unless you have a good reason to do so.

48. Install and solder **D5** {1N4001DICT-ND}. This is the famous **Wing Diode** - you will want this (reduces tach signal false-triggering).

49. For most installations, diode **D8** (1N4733AMSCT-ND, the **John Zener**, 5.1V, marked 1N4733) is not needed. If you do not install D8, you must install a jumper (made from a snipped off lead) in its place.

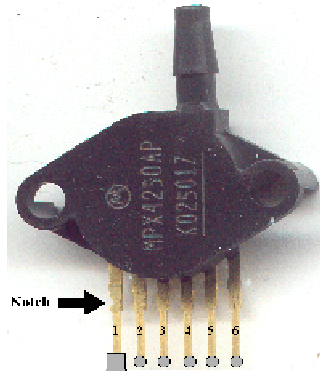
Note: this diode (D8) is needed only if the ignition system has a large offset bias - most systems do not have such a bias. So, to start, you can either solder in a jumper wire in this location, or, you can install the diode D8, and then install a jumper around the two leads of the diode - in effect shorting it out. The latter will allow you to snip the jumper later on if needed, putting the diode back in circuit. Solder the diode in observing the banded end as on the board, then solder a wire jumper across the diode itself.

50. Install/solder opto-isolator **U4** (160-1300-5-ND, 4N25) - observe the proper orientation (**notch** matches PCB, or **dot** for pin #1 which is the square pad on PCB at the notched end of the silk screen). If neither are there, hold the chip so that the writing is facing you and the right way around. Pin #1 is on the top left.

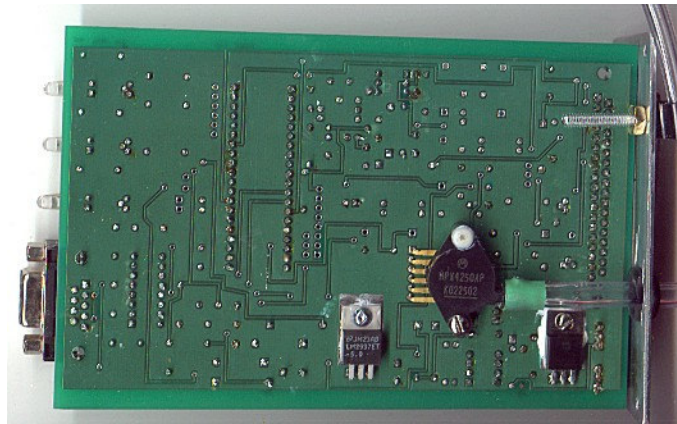
51. Install and solder **C12**, the Ed capacitor (399-1818-1-ND, 0.001µF, 102 marking). The value of this capacitor may need to be increased if there are noise problems with the tach signal - values up to 0.1uf will work. The 0.001uf value is a good starting point.

52. The MAP sensor, **U3** (MPX4250AP), is next. It mounts on the under side of the PCB, with the vacuum port facing the DB37 connector, and the markings on the sensor facing away from the PCB. The leads are bent toward the PCB, and soldered on the top-side. The notch on the lead indicates pin #1 - this corresponds to the square pad on the PCB.

Note: it may be easier to install the MAP sensor AFTER you have built the output section, as several components have leads that terminate under the MAP sensor and which can make it difficult to trim the leads, etc. It can be done either way, however, and the choice is up to you.



Here is how the MAP sensor should look in a fully assembled unit.



The MAP sensor is held to the PCB with two nylon screws - do not tighten the MAP sensor too tight, this will distort the case and introduce an offset in the readings by flexing the load cell inside the device. And, yes, solder the leads on the top side of the PCB. You will have to devise a scheme to run a tube from the barbed MAP fitting to your intake manifold.

Note: if you do not like the idea of mounting the MAP sensor on the PCB in the passenger compartment, and the long vacuum hose, because you feel it will cause a delay in engine response, you can remotely mount the MAP sensor. Bruce has tested this with about 30 feet of 1/8" tubing and almost no lag, certainly no more than 1 millisecond.

If you mount the MegaSquirt inside of the passenger compartment (inside firewall), then the length of tubing is only about 3 - 4 feet. Additionally, if one figures that many MAP sensor installs have the sensor mounted on the firewall on the passenger side near the heater core (many General Motors, Toyota, Nissan, etc. do this), then compare the extra length of tubing to go through the firewall to the MegaSquirt, it is not a large difference.

If you want to remotely mount the MAP sensor, use one of the unused connector pins for the MAP signal, there is Vref and ground coming out already for the TPS which you can share with the MAP sensor. The V2.2 boards have jumper "holes" to the output connector unused pins - you can use one to bring the MAP signal out quite easily. If you do remote-

mount the sensor, be sure not to put any type of strain on the MAP sensor case - according to Motorola this can introduce DC offsets in the readings.

53. Install and solder **R4** and **R7** (2.49KXBK-ND, 2.49K, red-yellow-white-brown-brown).

Note: these are the two bias resistors that can be changed for use with different coolant (R7) and air temperature (R4) sensors. The 2.49K Ohm values are for the standard GM sensors (#12146312).

If you want to use other sensors, you can either:

- change the transfer-function files in the ECU processor by using EasyTherm to change MegaSquirt's code to match your temperature sensors), **OR**
- switch these resistors, which may be easier in some cases.

Also, changing resistors allows you to mix and match sensor types between air and coolant (e.g., use a Ford for air and a GM for coolant).

Normally, you should use EasyTherm, it's generally more accurate, as the curve is based on three points, rather than the one point of a resistor swap. However, if you have different sensor curves for the air and coolant sensors, then you have to change the resistors to match the sensors.

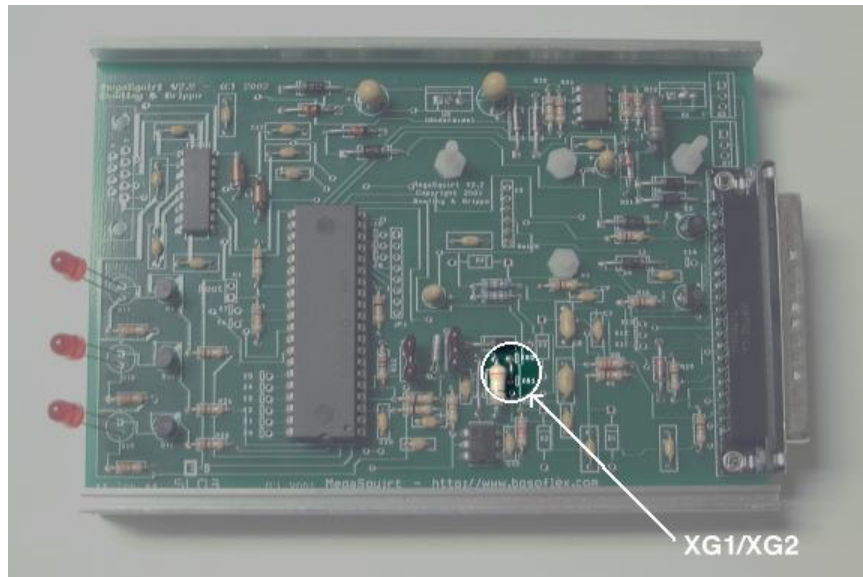
Sensor	Makes	Resistor (ohms)
AC Delco/GM	Daewoo, Buick, Cadillac, Chevrolet, Oldsmobile, Pontiac, GMC	2.49K
Ford	Ford, Lincoln, Mercury	27K
Bosch and Nippon Denso	Acura, Audi, BMW, Honda, Infiniti, Jaguar, Kia, Lexus, Mazda, Mitsubishi, Nissan, Suzuki, Toyota, Volkswagen, Volvo (96-up)	2.2K
Mopar	Chrysler, Dodge, Plymouth	9.31K

Also, it is important to note that cross branding and cross licensing affect the sensor type. For example, the Mercury Villager is actually a Nissan Quest. The Ford Probe is actually a Mazda. The Chevy Sprint was actually a Suzuki Swift. There are many other examples. When in doubt, measure the resistance.

To avoid changing the tables in the MegaSquirt code with EasyTherm, the bias resistors at R4 and R7 should have a value equal to that of the thermistor sensor you will be using when it is at **81° Fahrenheit, 27° Celsius**. However, the preferred method is to use EasyTherm whenever possible.

54. Now, it is choice time again, this time regarding the opto-isolator installed at U4. The LED inside of the opto-isolator is fired by a signal provided by the ignition system. The pulses existing on an ignition, especially when pulled directly off of the coil primary, can spike to very high voltages. The return path of the LED is terminated to jumper pad XG1. This return path can either go directly to the board ground (by placing a jumper from XG1 to XG2), or, the return can be brought out of one of the jumper slots on the DB-37 connector (like X11), and then grounded with a separate wire on the DB-37 connector, thus isolating the ground. Note: for the ECU to work on the stimulator, then the XG1 terminal needs to be hooked to XG2, and right now we are doing stimulator testing, so install a jumper from XG1 to XG2. Now, when you install the ECU, if you need isolation because the tach signal is resetting the ECU (for those installs tapping right off of the ignition coil (-) terminal), then you can remove this jumper and connect XG1 to X11, and ground this pin (#25 for X11) with a separate return wire. Note: if you are using a tach output from an aftermarket or many OEM setups, the tach signal is a nice +12V pulse - these will work fine with the XG1 terminal jumpered to XG2 in the install. Again: for testing right with the stimulator, hook XG1 to XG2. Later, after you install this on your vehicle, if you have reset problems, then remove this jumper and jumper XG1 to X11, and bring out a separate return ground wire.

Note: Do not mistake **XG1** and **XG2** for **X1** or **X2**. **XG1** and **XG2** are near **R10**.



Some installations have reported problems with low rpm “spikes”. Typically this sees the reported rpm at 1100 rpm jump to 5000+ rpm for short periods. This can make idle and off-idle tuning difficult. To fix this, install the “Dave” capacitor. This is a 0.22 μ F, cap across the junction of D5/R10 to XG1. (See the ignition triggering section of the Sensor and Wiring section of this manual for details).

55. Install and solder **D11** (1N4733AMSCT-ND, 5.1 Zener diode, marked 1N4733).

Note: diodes D1, D2, D3, & D4 are not installed or included with the Digi-Key BOM. Do not place jumpers in their place, just leave these locations open. The processor provides sufficient input protection, these diode are not needed. Motorola has confirmed that the MC68HC908GP32 has protection diodes on the inputs of the Analog-to-Digital Converter channels, and these are sufficient to prevent voltage spikes from damaging the processor or ADC channels.

56. Time for a little testing. Install the processor, hook up the stimulator, hook up the DB-9 to the board and PC, fire up MegaTune, and bring up the "Realtime Display" window. You should be able to see responses when you move the knobs on the stimulator. First, look at the RPM - it should change when you move the RPM pots on the stimulator. All sensors should react to the corresponding pots on the stimulator. When the O2 pot is moved, the O2 voltage moves irrespective of the other settings. The O2 voltage (top bar on the MegaTune Realtime dialog) is just the raw data coming in. On the other hand, the EGO correction bar (or equivalent gauge on the tuning screen) WILL NOT move away from 100% unless you have the EGO correction parameters set properly and MegaSquirt senses the proper inputs to activate EGO correction. Note that if you have not connected a TPS to your MegaSquirt, (testing in car, for example) the TPS value will slowly creep up to a maximum value, and O2 correction will be disabled.

You should check that MegaTune reads approximately the correct barometric pressure when no vacuum is applied. Below is a chart of the 'normal' barometric pressures for various elevations above sea level. MegaSquirt should generally be within 4 or 5 kPa of the values below at your elevation.

Barometric Pressure vs. Elevation

Elevation Above Sea Level		Atmospheric Pressure
Feet	Meters	KiloPascals (kPa)
0	0	101.33
500	150	99.5
1000	300	97.6
1500	450	95.9
2000	600	94.2
2500	760	92.5
3000	920	90.8
3500	1070	89.2
4000	1200	87.5
4500	1400	85.9
5000	1500	84.3
6000	1800	81.2

If the MAP sensor doesn't appear to read correctly, you can check:

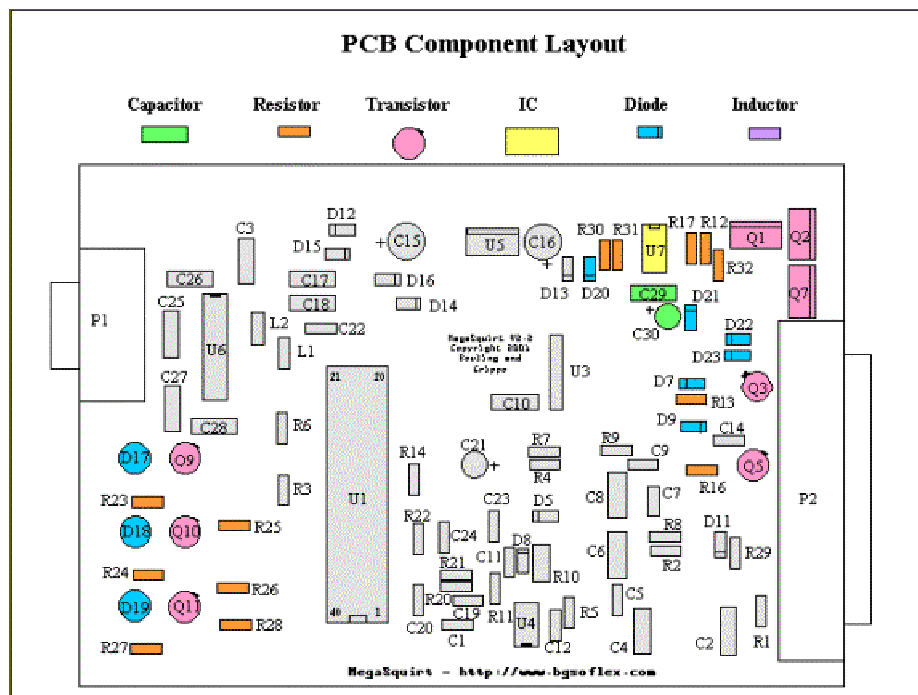
- If your MegaSquirt MAP sensor is reading too low, but responds to vacuum and pressure, then you have the wrong ".inc" files in your MegaTune folder. Copy the files (you need are "**kpafactor.inc**" and "**barofactor.inc**") from the "Turbo" sub-folder into your MegaTune folder, and everything should work. Place the correct files in your MegaTune directory (for older versions), or in the **mtCfg** folder (if it exists). (The "turbo" files refer to the ability of the MPX4250 MAP sensor to sense boost, not to the actual configuration of the engine.)
- If your MAP sensor reads low and doesn't respond to vacuum or pressure, it is likely in backwards. Verify that it is in correctly. If it isn't, unsolder it, turn it around, and solder it back in. You will have to bend the pins the other way - be careful not to break them. You probably haven't damaged any components by installing the MAP sensor backwards.

If you don't pass the above tests, recheck all of the assembly steps in this section, verifying the correct components are installed with the correct orientation. If everything appears fine, check the troubleshooting tips at the end of this assembly manual.

You now have all of the inputs wired up. Next we are going to hook up the outputs and machine the case panels. Unhook the stimulator and DB-9 cable from the board, and remove the processor again.

Output Section Construction & Testing

57. Install and solder **R30** and **R31** (*10KQBK-ND*, 10K ohm, brown-black-orange).



58. Install and solder **R13, R16, R25, R26, and R28** (*1.0KQBK-ND*, 1K ohm, brown-black-red).

59. Install and solder **D7, D9, D20, D22, and D23** (*1N4001DICT-ND*) - observe the proper polarity.

60. Install and solder **R12 and R17** (*22QBK-ND*, 22 ohm, red-red-black).

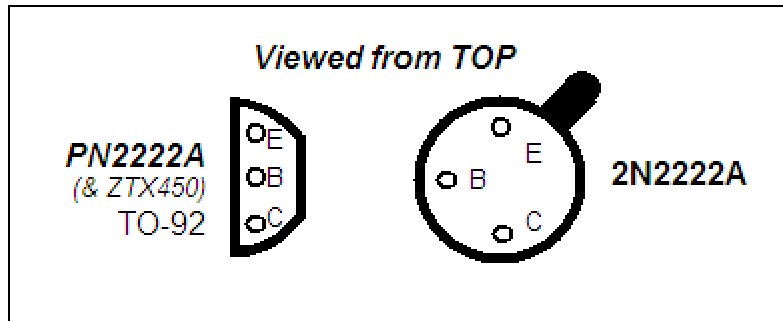
61. Install and solder **R23, R24, and R27** (*330QBK-ND*, 330 ohm, orange-orange-brown).

62. Install and solder the transistors **Q3, Q5, Q9, Q10, and Q11** (*PN2222AD26ZCT-ND* or *ZTX450-ND*).

Note: Digi-Key parts kits use the ZTX450 as a drop-in replacement for the 2N2222A used in the group buy #1 and #2. The package is different (TO-92) such that the leads are in-line, but it is in the "E-B-C" order just like the 2N2222A. For the metal-can 2N2222A, if you hold the device, looking from the top, with the tab pointing towards the 2:00 position on the clock, the emitter is at 12:00, the base is at 9:00, and the collector is at 6:00.

For the PN2222A/ZTX450, if you hold the "flat" side facing 9:00 on the clock, looking from the top again, the emitter is on the top or 12:00 position, the base is in the center, and the collector is down at 6:00. Note that the "curved" side has the printing on it. Simply bend out the center lead towards the flat side (towards the 9:00 position) and the

part will drop right in the hole. Also, it is very important to space the transistors $\frac{1}{8}$ " to $\frac{1}{4}$ " off of the surface of the PCB, to prevent shorting of the traces below.



If you use any other transistor other than PN2222AD26ZCT-ND or ZTX450-ND from the MegaSquirt/Digi-Key parts ordering page, you MUST check the pin orientation, as the order can be different for apparently identical parts!

63. Install **C29** (399-1880-1-ND, 0.1 μ F, 104) - and solder.
64. Install and solder **C30** (399-1416-ND, 4.7 μ F, , observe polarity. Recall that the longer lead on the capacitor is the positive lead.
65. Install and solder **D21** (1N4753ADICT-ND, 36V Zener, 1N4753). Mount this one $\frac{1}{8}$ - $\frac{1}{4}$ off of the surface of the board. This Zener diode sets the flyback breakdown voltage.
66. Install/solder **Q1** (TIP42COS-ND, PNP power transistor, TO-220 package, TIP42C). This part installs on the bottom-side of the PCB, in the remaining "silver pad" area near the top corner of the PCB. Use heat-sink compound here on the tab, we want a good heat conduction path to the ground plane. Use the nylon screw/nut to mount. Solder on the top-side of the PCB.
67. Install and solder **R32** (270H-ND, 270 ohm, $\frac{1}{2}$ watt). This resistor is mounted $\frac{1}{4}$ " to $\frac{1}{2}$ " off of the PCB - you may have to do a little bending to get it to fit in the holes. When the ECU is installed in the vehicle, we will monitor this resistor (like the tach resistor) to make sure it does not get too hot for your application - if it does, then the value can be increased, or the Zener D21 can be replaced with a lower breakdown value.
68. Install and solder **U7** (34151/IXDI404PI) FET driver.

If you delayed installing the MAP sensor at step #52, install it now.

We now have everything installed, other than the FETs and the LEDs - these mount on the case ends. We need to cut these out before we can proceed with the assembly.

If you do not want to cut your own end plates, you can get them CNC-made from Front Panel Express (<http://www.frontpanelexpress.com/>). Download their Frontpanel designer software at:

<http://www.frontpanelexpress.com/download/index.htm>

Then use the following files:

Bowling and Grippo Panels

Front Panel <http://www.bgsoflex.com/msfront.fpd>

Rear Panel <http://www.bgsoflex.com/msback.fpd>

Colin Gebhart - Revised Panels

Front Panel <http://www.thegebharts.com/colinmsfront2.fpd>

Rear Panel <http://www.thegebharts.com/colinmsback2.fpd>

Bare Bones Panels

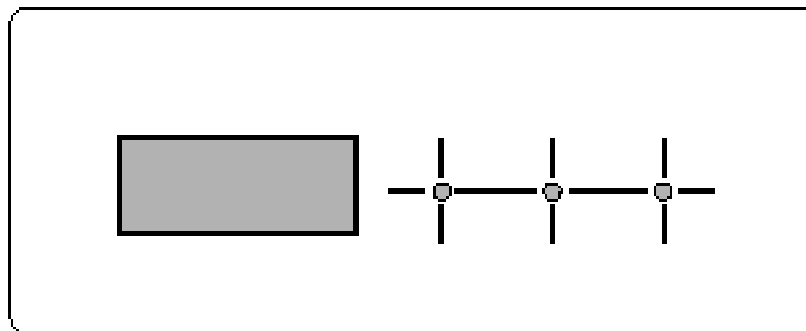
Front Panel <http://www.megasquirt.info/msfront.fpd>

Rear Panel <http://www.megasquirt.info/msback.fpd>

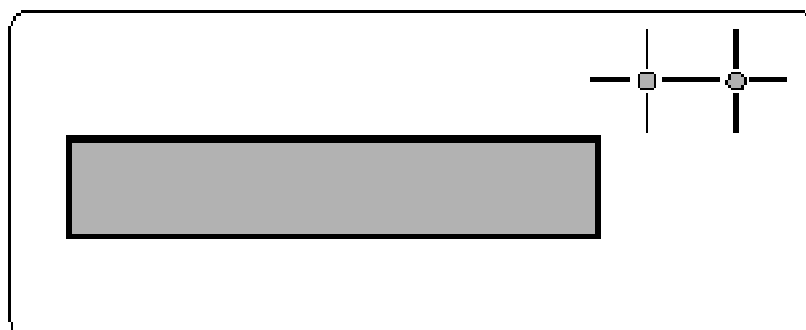
The Frontpanel Designer software lets you modify the files, get an exact quote, and send the order over the Internet. It is a very nice system.

To cut the end plates for the MegaSquirt yourself, do the following:

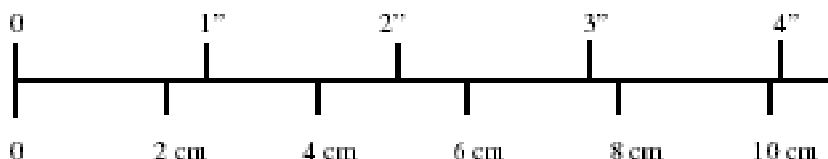
- a. Print out the template below, and use it as a cutting guide (Please Note: *.PDF files do not maintain size integrity. Verify printed sizes before cutting!).



Front Panel Cut-out Template
LED Hole Size = 1/4 inch = 6mm
DB-9 cut-out is 1.23" x 0.50" (~31mm x ~13mm)



Back Panel Cut-out Template
MOSFET Mounting Hole Size = 1/8" = 3mm
DB-37 cut-out is 2.75" x 0.50" (~70mm x ~13mm)



Use a jigsaw to cut out the DB connector slots, or drill several smaller connected holes and file them out to a rectangle. Clean off any burrs and rough edges with a file - especially around the FET mounting holes. Also drill a hole for your chosen MAP sensor vacuum line bulkhead fitting (You can get suitable "fuel line" bulkhead fittings for R/C planes at your local hobby store. See <http://www.mcnaabs.com/ebay/bulkhead.jpg>)

b. Stick the printout onto the case ends using double-sided tape (line them up in front of a bright light so you can get them exactly central).

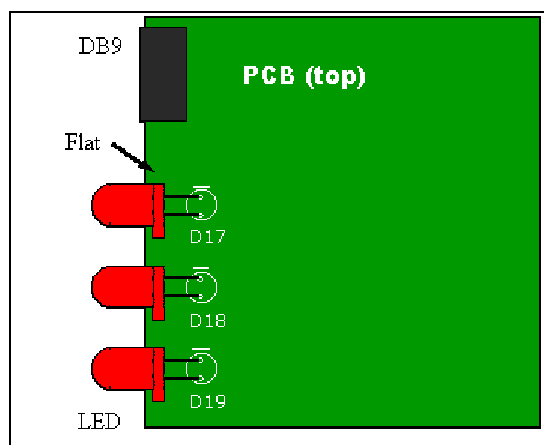
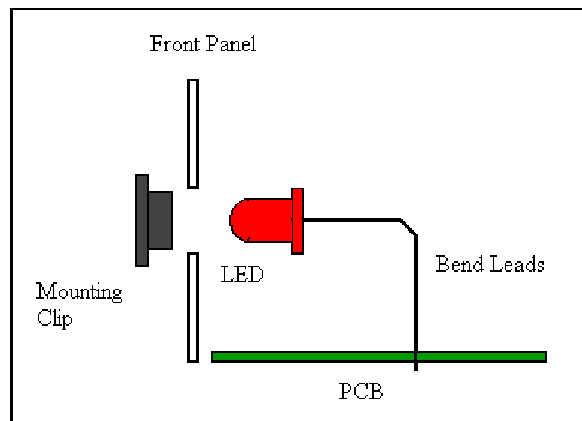
- c. Drill out the LED (1/4") holes (make center punch marks for the drill to start).
- d. Drill a few holes in the DB connector squares to be cut.
- e. Get hold of a piercing saw with a coarse blade (used in model making - looks like a G clamp with a blade where the screw thread goes)
- f. Practice using piercing saw on something else if this is your first time!
- g. Cut around the printout, leaving a small bit of extra material to file down later.
- h. Remove tape and glue with white spirit
- i. Clean up the connector openings with files. (Your cutting out probably was not good enough to leave it that way)
- h. Drill whatever hole is required for the MAP sensor hose scheme you have devised.

(Steps **a** through **d** are a great start to the drill and file method, as you will have a layout to follow. You can also drill more holes and proceed directly to filing the openings, if you prefer. The aluminum is very soft, and files quickly and easily).

69. Now, take one of the case halves, and run the PCB in the second-down slot down from the top.

Note: you will want to orient the lip/slot on the top rail section of the case half such that the lip is on top and the slot is on the bottom (closer to the processor). In other words, the section halves of the case, where they join together with each other to make the complete case, have a lip on one side and a ridge on the other, to form the interlock. The other side has the opposite. The top side of the PCB (side with C15, the FET driver, etc) goes where the "lip" is. This gives more room for the FETs - oriented the other way, the groove may put stress on the side of the FET.

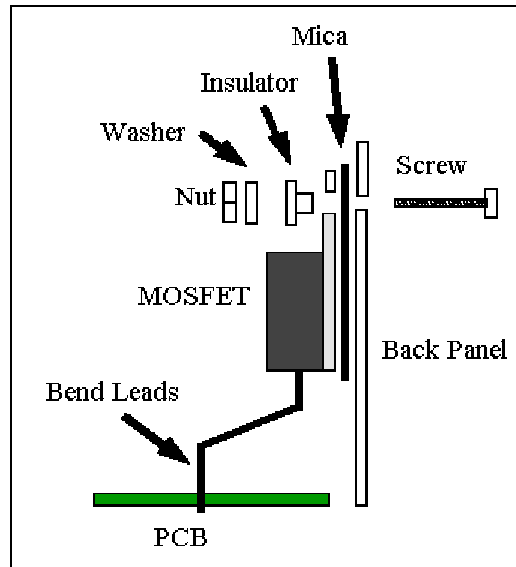
70. Next, mount the LEDs - **D17**, **D18**, and **D19** {*P301-ND*} to the case front, and bend the leads down to the board and solder. First, install the LED holders on the front panel, through the front. Next, the LEDs press into the rear of the holder. Mount the case front panel to the case half (which has the PCB). Orient the FLAT on the side of the LED lip (the side with the shorter lead) towards the DB-9 socket (each LED). You will see that the PCB silk screen also has a "dash" above the LED circle symbol indicating the side of the flat. Bend the LED leads down to enter the PCB holes for them - you will have to do a trial fit, then trim the leads down a bit. See the illustrations below. Then solder the LEDs to the PCB from the top of the PCB. It is a little tricky - take your time.



71. Now, finally, its time to mount the two FETs - **Q2** and **Q7** {*IFRIZ34G-ND* or *IRFIZ34N-ND*}. If you received the plastic FET case variety (*IRFIZ34G*), then you can just screw them to the case. These are insulated case variety, so they just mount on the back panel. Use nylon screws, as metal screws can cut through the insulation and lead to shorts.

If you have substituted the metal-tab TO-220 type (*IRFZ34G*), then you need to use a mica insulating set-up to prevent the tab from touching the metal case back. Use the illustration below as a guide. (Insulating kits that include the mica, insulator, washer, nut, and screw are available from electronics shops for about \$2).

Note that the FETs mount to the component (top) side of the PCB, on the same side as the DB37, processor, etc.



72. In either case, the FETs mount on the back panel, held in with nylon screws/nuts. Be sure to apply heat-sink compound between the FET and the case. The leads are bent out from the FET at a 90° angle, and then bend the leads down to enter the holes in the PCB.

Congratulations! you are ready to test it all! Plug in the MegaSquirt processor, DB-9 cable, and stimulator (with its battery attached).

On the stimulator, you should see the injector LEDs light up, tracking the RPM. Also, the fuel pump light should be glowing, and if you are above 500 RPM (check on the MegaTune Runtime display) and below 145 degree coolant temperature (adjust on the stimulator), the fast-idle LED should also glow.

On MegaSquirt:

- D17 will light each time an injector is fired .
- D18 is warm-up enrichment (WUE). It will light if your in a warmup situation (i.e. if the coolant pot on the stim is set to a value where the warm-up enrichment is greater than 100%).
- D19 is accel enrichment (AE). It will light briefly if you turn the TPS pot on the stim from idle to full throttle.

If you don't pass the above tests, recheck all of the assembly steps in this section, verifying the correct components are installed with the correct orientation. If everything appears fine, check the troubleshooting tips at the end of this assembly manual.

Note that stimulator's resistor **R9** is heavily loaded in operation and will get very hot (125°C/255°F). This is generally not a problem, as stimulators have been proven to run for a year continuously like this without failing. However the body of the resistor will

discolor over time. If this level of heat is a concern for you, a change in value of one or more of **R9** to 390 or 1K Ohms.

Note: normal MAP readings in kPa for the MegaSquirt when the engine is not running (or is on the stimulator) should be somewhere around 85-103, depending on your altitude. You can check the tuning section of this manual for the details of how pressure varies with altitude.

If your MAP reading is around 47 kPa or 200 kPa, you have the wrong `kpafactor.inc` in the MegaTune directory. Grab the `megatune.zip` and extract the `kpafactor.inc` file that lives in the appropriate "turbo" directory (for all version 2.2 kits with the MPX4250 "turbo" MAP sensor). If the above checks out, you are finished.

This is a good time to clean the excess flux from the board. A common problem with boards that were working and quit for no apparent reason is flux residue. Unscrew the FETS from the case, and remove the PCB. Remove the processor. Wash your board with:

- **99% isopropyl alcohol** (isopropyl alcohol is rubbing alcohol, any drugstore will have it - don't use the 70% isopropyl alcohol, it is much less effective),
- **acetone**, or
- **dishwashing detergent**

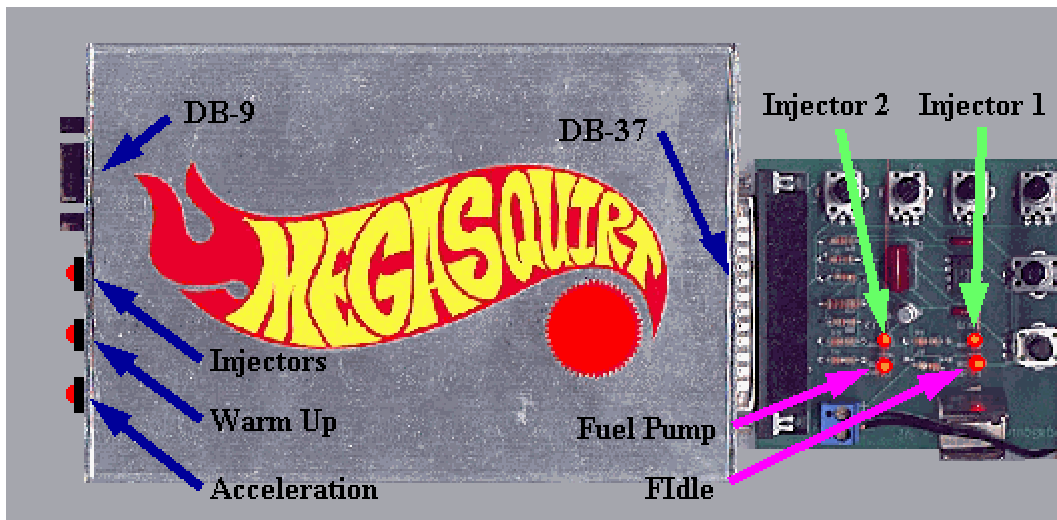
Lightly scrub both sides of the PCB with an old toothbrush. When cleaning flux, it is sometimes impossible to wash it all off, some of it has to be scraped lightly to remove it. Use a round toothpick broken in half for scraping the tough parts. This gives a small pointy end and large end to work with and reduces the chance of damaging the PCB. Be very careful not to damage the silk screen or traces. Rinse the PCB in hot water, then allow the PCB to dry completely. There should be very little haze left once it dries. Compressed air can speed the drying process, but be aware that some of the commercial compressed air cans have a solvent that can saturate any remaining flux and cause problems.

If you want to seal the finished board, use a conformal coating. Wait until you have tested the board thoroughly though. If you do not think you will be doing much repair work on the board, you can not beat silicone conformal coating. It does require some digging to get it off for repair, however. Avoid the urethane coatings, as they are considered permanent and are a pain to try to work through. You can also buy a spray can of acrylic lacquer conformal coating at most local electronics suppliers for around \$10.00. If you are going to be working the board, "Krylon Krystal" clear spray works very well. Several coatings, preferably baked at 175-200 degrees in between. This should slow down or prevent "solder bloom" and other deterioration of the PCB. Condensation is a fact of life for an outdoor component undergoing temperature changes. You can solder right through the stuff and the residue cleans well with pure grain alcohol.

Your next job is to mount the unit in the car, tune, and go!

The MegaSquirt enclosure is 6.25" × 4.25" × 1.75". You also need access on both ends, one for the harness to the motor and vehicle electric system (the DB37) for which the hood of the connector is about 2.25" long. On the other end you have the DB9 to go to your laptop (~2"). You cannot install the MegaSquirt box under the hood. Engine bay temperatures are just too high. The recommended place to install the MegaSquirt box is in the passenger compartment (like under the seat, kick panel, etc), this is where many OEM boxes are located. In addition, you will need access to the RS-232 serial connector for tuning, which is hard to access under the engine hood. If you put the MegaSquirt box in the passenger compartment, you will not have heat-related problems (unless you mount it directly in the path of the air stream of the car heater). The limitation is the 68HC908GP32 processor itself (the part is rated to +70 degrees C), as well as other components like the MC33151P FET driver, MAX232 chip, etc.. They are all limited to the commercial temperature range of +70 degrees C. maximum. MegaSquirt should be connected with a pass-through hole (and grommet) to the engine compartment for the wiring to the injectors, sensors, fuel pump, etc.

Understanding the MegaStimulator



There are 4 LEDs on the Stimulator, and 3 on the MegaSquirt. On the Stimulator, the 4 LEDs are:

- **Injector #1** - lights when the first injector bank is grounded [injectors firing].
- **Injector #2** - lights when the second injector bank is grounded [injectors firing].
- **Fuel Pump** - lights when the fuel pump relay is grounded.
- **FIdle** - lights when the Fast Idle solenoid is activated.

On the MegaSquirt, there are three LEDs, which are:

- **Injector** - lights when either injector bank is instructed to be grounded [firing].

- **Warm-Up** - lights when Warm-up Enrichment (WE) is activated.
- **Acceleration** - lights when Acceleration Enrichment (AE) is activated.

Note that these LEDs all do separate things.

The *Injector LED* on the MegaSquirt lights when either Injector bank is commanded to fire, while the injector LEDs on the Stimulator light when each injector bank actually is grounded. The MegaSquirt LED will flash synchronously with the Stimulator Injector LEDs in simultaneous mode, and will flash twice as fast as either LED in alternating mode.

The *Warm-up Enrichment* values are separate entries in the software from the *Fast Idle Threshold* value, so these two LEDs will generally light at different, though similar, coolant temperatures.

The *Fuel Pump LED* is light whenever the fuel pump relay is grounded. Since the Stimulator puts out about 1 pulse per second minimum, and the MegaSquirt leaves the pump on for 2 seconds after the last ignition event, the fuel pump LED should be light whenever the Stimulator is plugged into the MegaSquirt.

By using these LEDs, and adjusting the RPM, coolant and air temperature, EGO, and throttle potentiometers on the MegaStimulator, while viewing the PC Configurator or MegaTune tuning software, you ought to be able to test every function of your MegaSquirt, except MAP function [for which you can suck and blow].

Note that the stim generally only allows you to turn the MegaSquirt temperatures down to ~30°F or so (because of it's particular electrical design), and if you turn the pot all the other way around, you'll get 170°F. However this is the 'fault mode', which defaults to 170° when the sensor is shorted to ground. If you turn the pot back a bit, you should be able to get readings of at least 215°F in MegaTune.

Putting it All Together

If you have not yet done so, go get the latest version of MegaTune at

not2fast.wryday.com/megasquirt/mt/

Note that the ".inc" files installed with MT are those for the standard GM temperature sensors and for the 250 kPa MAP sensor, if you have different sensors you will need to copy your customized include files over these.

Once you have MegaTune installed and talking to the MegaSquirt/MegaStim system, you have some homework to do. Start by going through the menus and familiarizing yourself with the various dialogs and their contents. Change things to see what happens. There is nothing you can screw up that you cannot fix here (the stimulator provides a benign

hardware environment, so you cannot accidentally fry anything, which cannot be said for a real installation). Although you should set the agenda for your experimentation, here is a list of high points that you should try:

1) Before you change anything, go to File -> Save (or just type Ctrl-S) and save the initial configuration. Call it something like '**default.msq**'. Later on you will want to do this a lot as you configure and tune your engine, just to be safe and to have a reference point when things go wrong. Right now, you are saving a known-good configuration to save yourself from a bunch of typing later. (If you lose the default settings, you can download them from [here](#).)

2) Datalogs are your best friend, so go to Files -> Datalogging and create both some classic and full data logs. Examine them with the MegaSquirt Logfile Visual Viewer (MSLVV) if you can, or just edit them and view their contents with a spreadsheet.

3) Go to Settings -> Constants and change various values (MegaTune has context sensitive help, so press F1 and you can see information about the settings; this same material will be covered in depth later in this manual, but knowing about the online help is useful). Make a preliminary set-up for your installation, set the number of cylinders, port injection and all that. (See the tuning section for more information.)

4) You may have already done this, but make sure to pop up **Runtime -> Realtime Display**. This is the best window to watch when you are debugging sensor problems. The top box on this dialog shows the sensor values that MegaSquirt is using and is invaluable when you are first setting up the system to confirm correct operation.

5) Become familiar with all of the capabilities of **Runtime -> Tuning**, this is where you will spend the bulk of your time once the engine starts. Type "F1" and read through the list of keystrokes; type "Z" a couple times to zoom the tuning map; change the RPMs with the stim and then type "F" to see that the cursor follows the spot. You will be using the arrows and shifted-up and shift-down arrows a lot, so get used to that.

6) Try out **Tools -> Generate Throttle Pos Inc**. Set the TPS pot on your stim to some low value and hit the "Get Current" button next to the "Closed Throttle" field; move the pot up and do the same with "Full Throttle" button/field. You will be doing this again in the car, expect the actual values in the car to be about 30 for idle and 225 for WOT.

7) Do a Tools -> Dump, then look in your Megatune directory for "MegaTune.dmp". Open it up with your favorite text editor, such as NotePad or WordPad. This file is appended every time you perform the dump, and the contents can be invaluable when you ask for help on the Yahoo! e-mail list.

8) While you are looking in your MegaTune directory, edit the *megatune.ini* file. Read through the various sections of that file and change things that you think might make life easier for you (most notably those in metric locations will probably want to change temperature units to "C"). In addition to the above you can change values on the

Enrichments dialog, change VE values, set the RPM and MAP bins for the VE table and anything else you think is interesting. Once you are familiar with the overall operation of MegaTune and configurations, go install some hardware on your engine!

Troubleshooting

The most common mistakes people make in building and using MegaSquirt are listed [here](#).

If you have put your MegaSquirt together, but it does not work, **don't panic**, follow the instructions below. **Before anything, make sure your stimulator has a fresh battery - many problems are traced to a low battery voltage!** Before starting, have a look at the schematics and PCB layout PDF files - you may want to print some sections to help you troubleshoot. Read ALL of the troubleshooting tips first, then go through the steps:

- 1) Verify that you have a **XG1 to XG2** jumper in place on the MegaSquirt PCB. MegaSquirt will not receive ignition pulse if this jumper is not there. See assembly step #54 for more details.
- 2) The stimulator doesn't have the voltage to 'overpower' the "John" Zener diode (**D8**), so it must be 'jumpered' to test MegaSquirt on the stimulator. This diode (D8) is needed if your ignition system has a large offset bias - most systems do not have such a bias. So, to start, you can either solder in a jumper wire in this location, or, you can install the diode D8, and then install a jumper around the two leads of the diode - in effect shorting it out. The latter will allow you to snip the jumper later on if needed, putting the diode back in circuit.
- 3) If your oxygen sensor feedback doesn't seem to work, recall that the O2 voltage (top bar on the MegaTune Runtime dialog) is the raw data coming in (and it should respond to stimulator input). On the other hand, the EGO correction bar (or equivalent gauge on the tuning screen) WILL NOT move away from 100% unless you have the EGO correction parameters set properly and MegaSquirt senses the proper inputs to activate EGO correction. Don't confuse EGO and O2 voltage. EGO is a kind of integrator function that acts on the O2 voltage. So, O2 should respond, EGO will only respond if MegaSquirt has:
 - been on for more than 30 sec,
 - the current rpm (adjusted on the stimulator) above the EGO 'active above' rpm threshold,
 - EGO step and limit do not equal 0, and
 - the coolant temperature above the 'coolant temp. activation'.

These are set on the enrichments window of MegaTune.

- 4) Start troubleshooting the electronics by reviewing the assembly guide. Check each step to make sure that you have not missed any components. Also check all solder joints

visually for solder bridging and excess flux. Verify that each component is the correct item for each location.

- Pay particular attention to make sure the correct diodes are in the correct locations. Their markings are very small and they are easily mistaken.
- Be sure you have not swapped some of the 0.1 μ F, capacitors at C1, C3, C17, C18, C22, and C25 to C29 (marked 104) with the 0.01 μ F, capacitors at C11 and C20 (marked 103). They are very similar looking and the markings are very small.

5) Verify that all components that have a particular orientation (polarized) are installed correctly - this includes all ICs, all polarized capacitors, all diodes and LEDs, the MAP sensor, the voltage regulator, and the transistors.

In particular, check:

Capacitors:

- **C15:** The positive lead (it will be marked with a small “+” on the right side of the label) is closest the DB9 connector.
- **C16:** The positive lead is nearest the U3 MAP sensor.
- **C21:** The positive lead is closer to the DB37 connector.
- **C30:** The positive lead is furthest away from the DB37 connector.

Diodes:

- **D9, D14, D15, D16:** have their banded end closer to the DB37 connector.
- **D5, D7, D12, D22, D23:** have their banded end closer to the DB9 connector.
- **D8** (if installed - should be jumpered for testing), **D21:** have their banded end closer to the top of the PCB (when the DB37 is on the right and you can read the copyright notice on the board).
- **D11, D13, D20:** have their banded end towards the bottom.

LEDs:

- **D17, D18, D19:** There is a small flat spot on the plastic base of the LED. In all cases, this flat is nearest the DB9 connector.

Transistors:

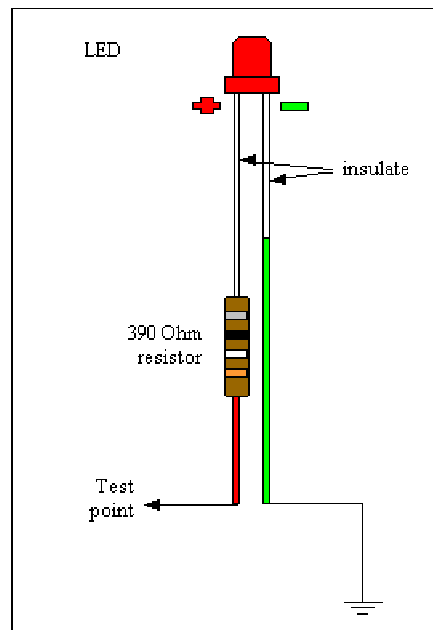
- **Q3:** The flat side should face away from D23.
- **Q5:** The flat side should face away from the DB37.
- **Q9, Q10, Q11:** The flat side should face the corresponding LED.

ICs:

- **U1:** The notch in the chip should be closest to the “**MegaSquirt** – <http://www.bgsoflex.com>” label.
- **U3:** The notch in the pin #1 should be in the square pad nearest the empty space for D4.
- **U4:** The notch should be towards the bottom of the board. If you have a “dot” instead of a notch, the dot should be on the lower left (in the square pad closest to the “**www**” in the web site address).
- **U5:** Should be on the under side of the board, with the flat side on the metal pad.
- **U7:** The notch should face away from C29.

If you find some that are incorrectly installed, de-solder them and turn them the right way around - it is likely that they are not damaged - EXCEPT for the tantalum capacitors (C15 & C16) that should be replaced if installed incorrectly.

6) You can use an LED in series with a 330 ohm (or 270 ohm) resistor and probe the input and output of various circuits, like the injector driver, to make sure that these are working. Solder the resistor to either leg of the diode, then solder a lead (20-22 gauge wire) to other end of the resistor, and another to the other end of the diode. Use heat shrink tubing or electrical tape to ensure that the leads cannot contact each other. Strip a bit off each end of the wires to use as probes, or solder on a bit of the leads you have cut off other components while assembling MegaSquirt, etc.



Test the probe by connecting it across your power supply. It should light when connected one way, but not light when connected the other way around.

Now you can use the ends of the wires to probe the circuits for signals - the led will light (or flash) if it gets a signal (positive voltage). The longer lead of the diode goes to the

circuit you want to probe (for a positive signal) the other lead (from the side of the LED case with the flat on it) goes to a good ground (such as the through holes at the non-banded end of **D1** to **D4** - the diodes you didn't install).

7) Check to see what (if any) functions work. Try the loopback test, the serial communications test, the clock count-up of the processor, and check for power and ground to the pins of the MC68HC908GP32 processor (see the assembly guide steps for details). Verify that no components are touching the crystal (Y1), which might prevent it from working properly.

8) Note which (if any) of the LEDs light on the Stimulator, and under what conditions. If you are able to isolate the problem to a particular area of the MegaSquirt, check the schematics for that function, and double check all the related components for correct value, orientation, and proper soldering,

9) If you discover odd behavior from your MegaSquirt (especially random or fluctuating sensor values) after you have installed the vacuum hose to the MAP sensor, it may be that the rubber hose used to connect your MAP sensor has an low surface resistance (about 2K per inch). If it touches any pins on the bottom of the board, it will short a lot of stuff out. Also check step #13.

To fix this, pick up a length of 3/32" (~2.5mm); hollow brass tubing at the hobby shop - used in model R/C work. Cut off a piece long enough to run out of the back. Then use a flare tool to make a small lip on both ends to act as a barb. You can then hook it up with a short piece of vacuum tube, and ran the brass tube out the back panel.

Or you can insert the rubber (or vinyl) MAP-Bulkhead tubing in a short length of heat shrink tubing before installing it, and shrink it carefully once it is in place. This insulates the tubing, and holds the tubing tighter on the barbs. You can also use it to hold it on the barbs on both sides of your bulkhead fitting. Heat shrink tubing is non-conductive [by design] and relatively resistant to puncture and abrasion. Choose an appropriate size so you do not collapse the tube.

10) The most common cause of a MegaSquirt failing after it has been working for a while is excessive flux residue. The flux residue can absorb water from the air and short MegaSquirt internally. The solution is to clean the PCB with:

- 99% isopropyl alcohol (rubbing alcohol),
- acetone, or
- dish detergent,
- and a soft toothbrush.

Remove the entire PCB from the case first, and remove the CPU. Clean it gently, being sure to get the alcohol around each of the components on both sides. Then allow it to dry completely before reassembling and testing it again.

11) If you suspect problems with the stimulator (for example, everything seems to work, but there is no RPM indication in MegaTune) follow these steps:

- a. Do you have RPMC installed? Some people have had trouble finding a supplier for one, and assumed the stim would work without it. It doesn't.
- b. Are you absolutely sure you have the battery wired in correctly? Use your LED tester (see step 6 to make one) to verify.
- c. Check the orientation of the transistor (T1) - the flat side should face the TPS pot. See step #62 in the MegaSquirt assembly guide for some notes on transistor orientation. If it is in correctly, plug the battery into the stimulator, and connect the stimulator to MegaSquirt.
- d. Using the LED tester, you should be able to get a signal to one side of R10, though possibly not the other (depending on the LED and resistor you used).
- e. However, you should definitely have a flashing LED at both sides of D5. If not, no signal is getting to the 4N25.
- f. So, assuming D5 is the correct item and installed the right way around, the next place to check is a small 'via' hole, just to the right of R29. Put your tester + lead into this hole, and the - lead into the non-banded hole for D1 (ground). The LED should flash. *Note that the LED tester will appear to stay light continuously if the rpm is above about 400 rpm. Try to turn the rpm pots down so that the rpm is 100 or so - then you should see distinct flashing.* If the LED tester doesn't flash (it stays on, or doesn't come on at all), then you need to check your soldering of the DB37 very, very carefully to make sure there are no bridges and no solder flux left in the pins. If it does flash, check the soldering, PCB traces, etc. between the via and D5. Use the schematics and PCB layout to help you.
- g. If that checks out, connect the + lead of the tester to the very small via hole near the backside of the stim connector (- lead in non-banded end of D1 again), in line with the "Pump" label, adjacent the resistor R1. The LED should flash. If it doesn't, you need to check that the 555 timer on the stim is operating. If it does flash, check the soldering of the pins on the stim's DB37 connector.
- h. The stim is not actually powered by the battery. Instead, the 12 volt supply powers the MegaSquirt, which then powers the stim via the +5Vref lead. So check that you have 5.00 ± 0.07 volts at the MegaSquirt regulator (assuming your multimeter is accurate). This is installed on the under side of the MegaSquirt PCB. The outer pins are +12 Volts (actually 9V) from the stim and +5 Volts to the stim. The middle one is ground. So check the outer two ones against the center (or the non-banded end of D1), with the LED, or preferably with a meter. You should get ~9 volts and 5.00 ± 0.07 volts.
- i. If you don't get 5.00 ± 0.07 volts on the regulator pin closest C16, the stim (and most of MegaSquirt) isn't getting any power. Check the DB37 soldering of the regulator, as well as the soldering, flux, etc. of pins 26 and 28. If you do have 5.00 ± 0.07 volts, then check that it makes it to the 555 on the stim.

- j. **Pin 8** on the 555 chip on the stim is its power supply. Without 5 volts on pin 8, the 555 will not operate, even if it is in working condition. Pin 8 is closest the **CLT** pot. Check the voltage on pin 8 (light the LED or 5 volts), using the non-banded end of D1 for a ground. If you don't have 5 volts (after checking all the previous items), check for inadequate soldering and excess flux around pins 26 and 28 of the stim's DB37.
- k. If there is 5 volts at the 555, then it is likely that the 555 or the T1 transistor (2N2222 or ZTX450) is fried (if you don't have 5 volts, see the previous step). You can get these at low cost at any electronics shop, like Radio Shack, etc. (5 for ~\$3) Cut the legs off the old one while it's still on the board, and de-solder the pins (a braided copper "wick" or a vacuum "sucker"), also available at Radio Shack, etc. Then put a new 555 in and you ought to be functional! *(You might want to solder in an 8-pin socket, then insert the 555 into that - it makes later repairs easier.)*

12) If everything seems to work in MegaTune, including the RPM, but the injector LEDs don't light, the most likely problems people have is either the LEDs are in backwards, or the PWM% is set to near zero.

If these are okay, then you need to check that the FET driver (U7) is receiving signals from the CPU. Then you need to check that the FET driver is sending the proper signals to the FETs. Then you need to check that the FETs ground the pins properly, so that the LEDs are getting the correct signal.

To do this, build an LED tester as shown above (step #6). Set the stimulator's RPM pots to indicate about 1500 RPM on MegaTune. Put the ground end of the tester in the hole where the non-banded end of D1 would have gone.

- a. The CPU sends out signal to the FET driver on pins #21 (INJ1) and pin #22 (INJ2), near the L1 inductor. Recall that the pins are numbered starting with #1 at the corner with the dot, and are numbered counter-clockwise from there. Check these on the LED tester, by putting the positive end of the tester against the pin, and be sure they flash.
- b. The FET driver receives the CPU signals on Pin#2 (INJ1) and Pin#4 (INJ2), on the side of U7 closest to R31. Check these on the LED tester and be sure they flash.
- c. The FET drivers sends out signals on Pin #5 (INJ2) and #7 (INJ1), on the side of U7 closest to R32. Check these on the LED tester and be sure they flash. Note that the driver inverts the signal, so the flashing may look a bit different, but it should still flash at the same frequency.
- d. The signals arrive at Pin #1 of the FETs, and are fed out to the LEDs through pin #2. Both of these should flash with the LED tester.

If the output pins are flashing, then you have a problem with either the DB37, or the stimulator itself. Recheck the LED orientation, and the soldering of the DB37 connectors, and the LEDs (D2, D3) and resistors (R5, R6).

13) If the injectors stay on all the time, check that the diode D21 is correctly oriented. It should have the banded end towards the R12 and R17 resistors at the top of the PCB. Also verify that D22 and D23 have their banded ends away from the DB37 connector. If those are all good, verify that you don't have any solder bridges or excess flux on the FET pins (Q2, Q7) or the FET driver (U7) pins. If those are good, follow the instructions in step #12 to trace the signal from the CPU to the FETs.

14) If you have trouble with the Throttle Position Sensor reading in MegaTune, the problem is most likely with the wiring at the TPS. Refer to the TPS section of the wiring guide for more information.

However, if it also gives problems on the stim, you need to look at the following components to make sure they are correct: **C9** (0.001), **C10** (0.22), and **R9** (1Kohm). Check all the solder joints as well. Also, make sure **D4** is not installed, and that there is no excess flux around the affected components. If all of these are okay, you need to look a bit deeper.

Disconnect the stimulator and remove the 68HC908 processor. The TPS signal connects to pin 26 of the CPU, so you might check that this pin is soldered properly. You can measure the resistance of **R9** directly on the board (it should be about 1K Ohm \pm 50 Ohms). **R9** is near the MAP sensor screw in the middle of the PCB. You can also check the resistance from the CPU pin #26 (near the H1 boot header) to **R9** - on the side of R9 nearest the DB37 you should have less than 1.0 ohm (0.1 is better), - on the side of R9 nearest the DB9 you should have ~1kOhm.

You can check if the capacitors are shorted by connecting your ohmmeter from CPU pin#26 to C10. You should get very low ohms on one side (furthest from the CPU), and very, very high ohms on the other side (nearest the CPU), though it may take a few seconds to climb to its final value. If you get a finite resistance after a dozen or so seconds, **C10** and/or **C9** are shorted.

You can also check the resistance from the side of **C10** nearest the CPU to the non-banded end of D1 (which is ground). You should get a low number - about 0.3 Ohms - this means the solder connection is good.

The capacitors really have to be disconnected to test the capacitance values (if your meter even measures capacitance, many don't), though. If you are going to remove them, you might just go ahead and replace them....

15) If you have reversed the stimulator (or in-vehicle) polarity, even momentarily, for MegaSquirt, you may find the Fast Idle Led on the stimulator appears to be reversed, i.e. it is off when it should be on and vice-versa. The Warm Up LED on the case should work okay. Also the fuel pump LED may not come on anymore. This behavior is caused by damage from the reversed polarity, and can usually be fixed by replacing **Q3** and **Q5** (the ZTX450/PN2222AD26ZCT transistors).

16) If you are having trouble getting values to 'stick' in your MegaSquirt, check your power supply. Typically, a bad power supply will allow you to set values, but they will revert to the previous values after powering down. PC power supplies are especially notorious for this, and should be avoided.

17) Finally, if none of this helps to discover and solve your problem, send a message (including any information you found from doing any of the above) to the MegaSquirt Forums at www.msefi.com. Feel free to ask for help, that is why the MegaSquirt forums are there - just realize that you may be sent back for more information. You will solve your problem much faster if you provide as much detail as possible when asking questions the first time around. And, following the assembly steps, you will discover problems and correct them as you go along.

If all else fails, you can have someone else troubleshoot and repair your MegaSquirt. **Peter Florance**, who runs an electronic repair business, and who is a very active and informed member of the MegaSquirt community, has offered to troubleshoot and repair MegaSquirts for those in need. The fee is based on standard shop rates, with a ½ hour minimum.

You can contact Peter at: peter@firstfives.org.