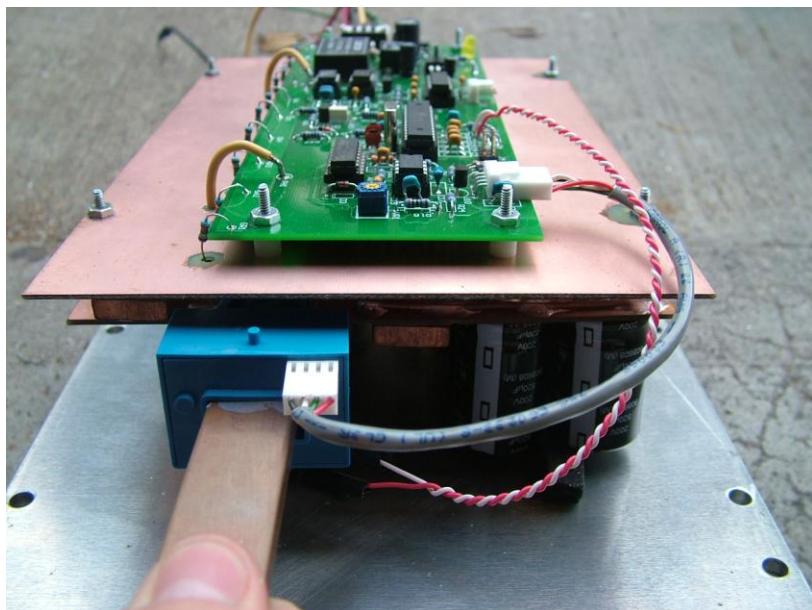




Paul & Sabrina's EV Stuff!

Motor Controller Assembly Directions



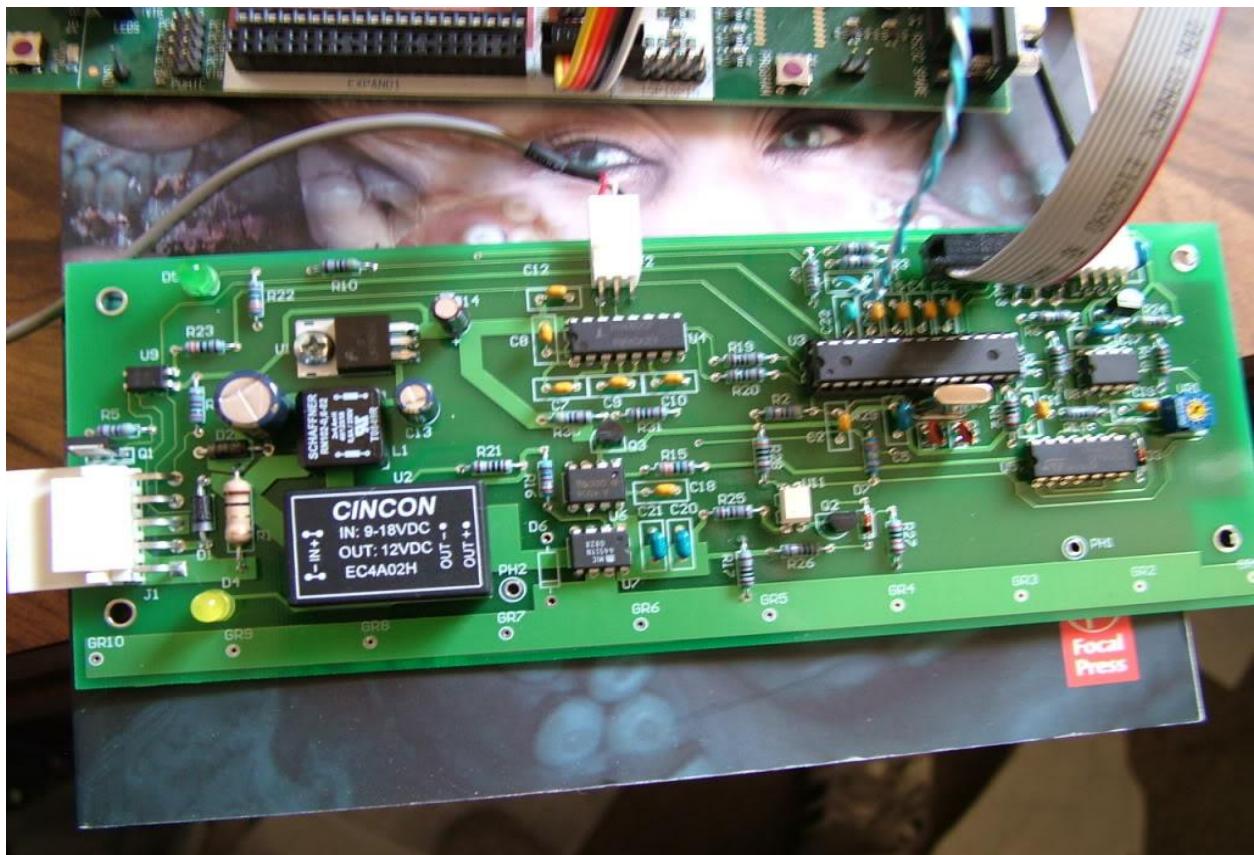
Paul & Sabrina Holmes

Paul@paulandsabrinasevstuff.com

Solder all the parts of the control board. It should look like this when you are done. Actually, D6 isn't in this picture, but you should add that too. Also, you won't need the ribbon cable. That's just for programming the microcontroller, and it will come pre-programmed. One important thing to look out for is that L1 has the orientation in the picture. Also, make sure you take care in soldering to the ground plane. It takes some heating up a bit. One other difference is that now you just solder the 5 wires right into the holes for J1. No connector. The order from bottom (in the picture) to top is RED, BLACK, YELLOW, TWISTED PAIR.

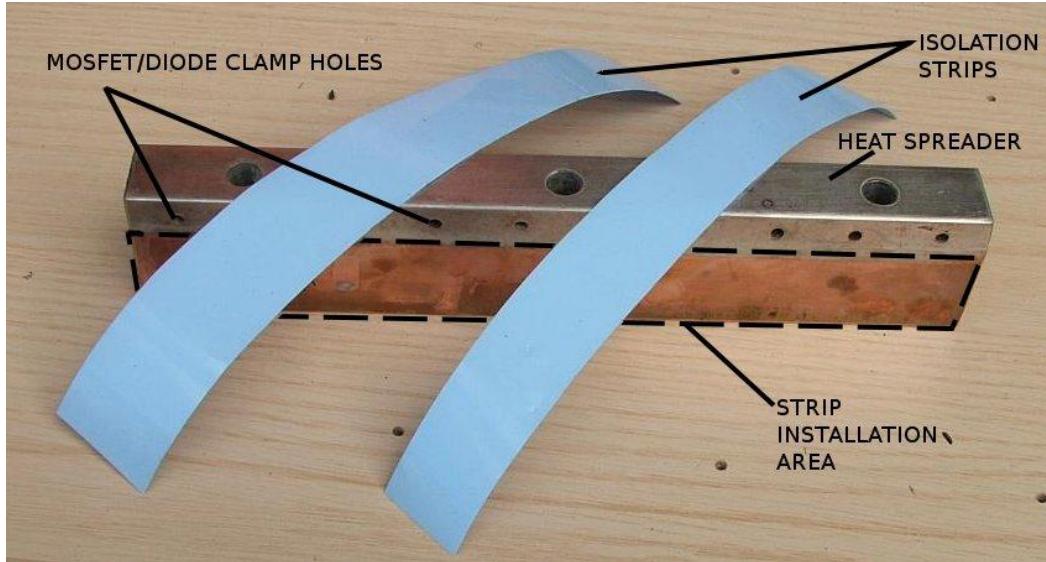
Don't worry about GR1 through GR10, PH1 and PH2 until much later.

Make sure you add the screw to bolt down U1. Either use a really short screw, or have it point up through the hole.



Cut two 8" x 1" isolation strips. Then peel the plastic off and stick one on each side of the heat spreader. Make sure they go close to the bottom of the heat spreader, and that they don't go above any of the little 10 mosfet/diode clamp holes.

CUTTING ISOLATION STRIPS TO SIZE



INSTALLING THE M- BUS BAR

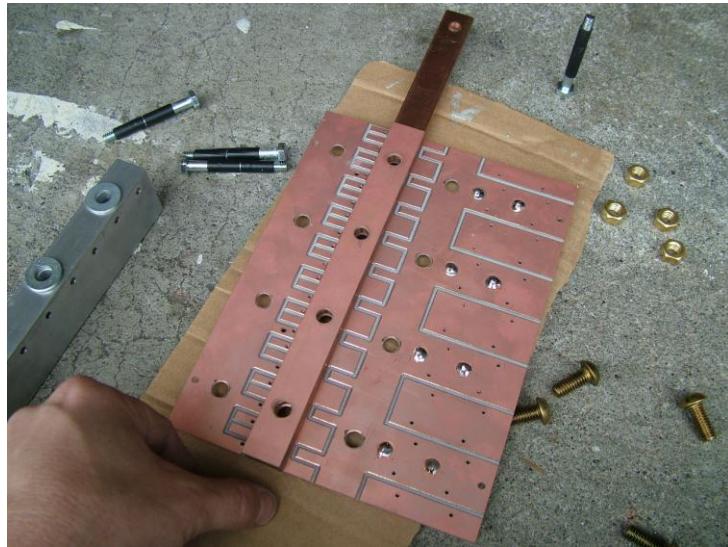
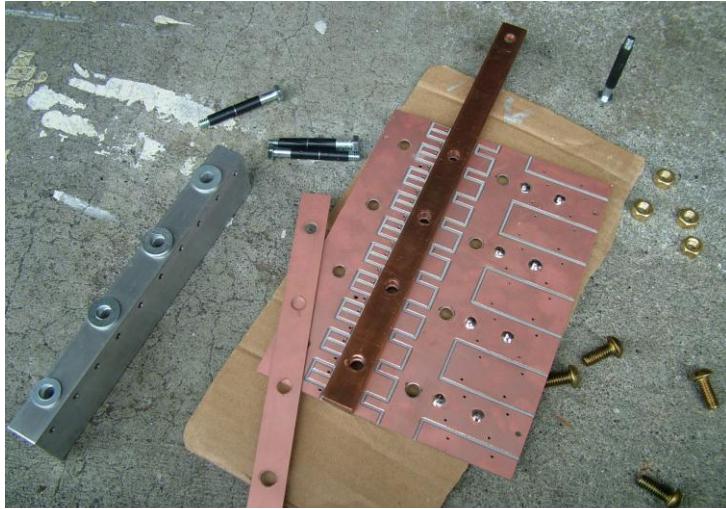
Gather together the M- bus bar, power section PCB, conductive silver epoxy, four 5/16" x 3/4" brass machine screws and nuts



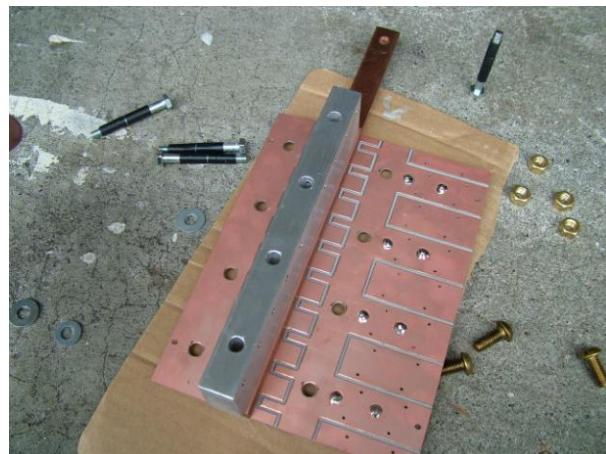
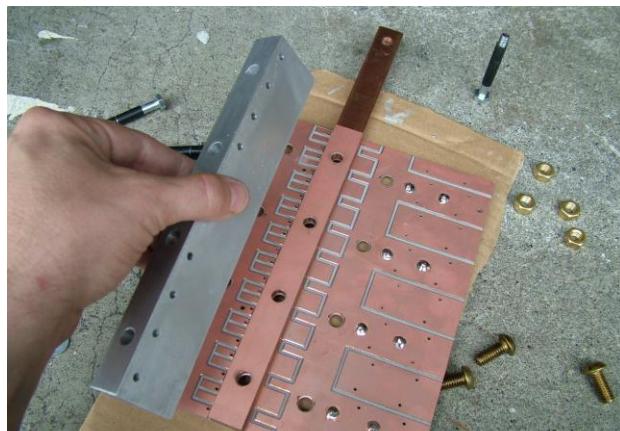
Mix one third of the contents of the two electrically conductive silver epoxy containers together and add it to where the M- bus bar will sit. Just use a very small amount, staying far away from the holes AND far from the edges. I may have slightly overdone it here. DON'T use the 4 brass machine screws like in this picture. Instead, just follow the steps below.



Now, you will need the four 1/4" x 2.5" bolts with the heat shrink on them (but that have more of their threads exposed), the heat spreader, and one of the two 0.75" x 8" PCB isolation strips, the M- copper bus bar, and the 8 inch long steel bar. Put one of the 0.75 inch x 8 inch PCB isolating strips on top of the M- bus bar.

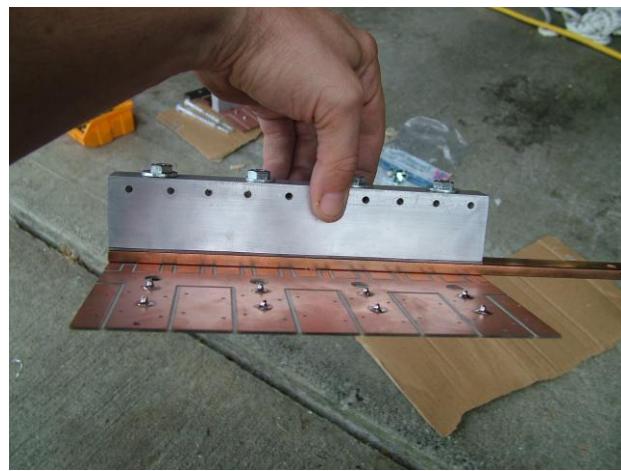


Put the 8 inch steel piece on the underside of the PCB power section. Place the heat spreader on top of the PCB isolating strip. Make sure the 1/8 inch diameter hole in the 0.75" x 1.5" face of the heat spreader is on the same side that the M- bus bar is sticking out. Put the four 2.25" x 0.25" bolts through the four holes, and bolt the whole thing down "snugly", but don't over-tighten. You don't want to crush the PCBs. Here is what it should look like:



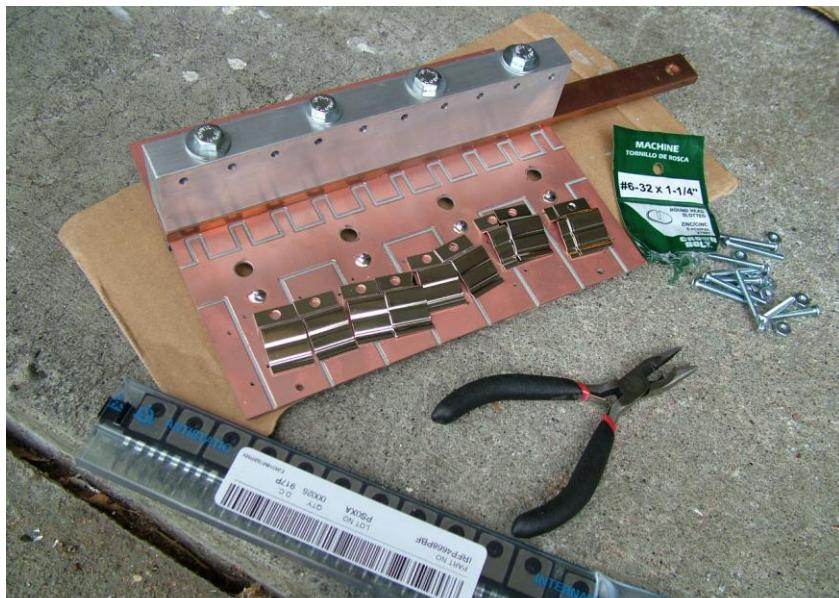
After you have tightened the bolts down, make sure no silver conductive epoxy is squishing across any etches.





Note: Don't bother to use the washers like in the picture. That proved to be unnecessary.

Next, get this stuff together:



You also need to add the mosfet and diode isolation strips. The ones in the kit are dark grey. The ones in the picture below are light blue. You will have to peel off the thicker plastic back and stick them onto the heat spreader on both sides. Peel off the other thinner plastic protective layer only when you are ready to add the mosfets and diodes (after you have bent their legs).

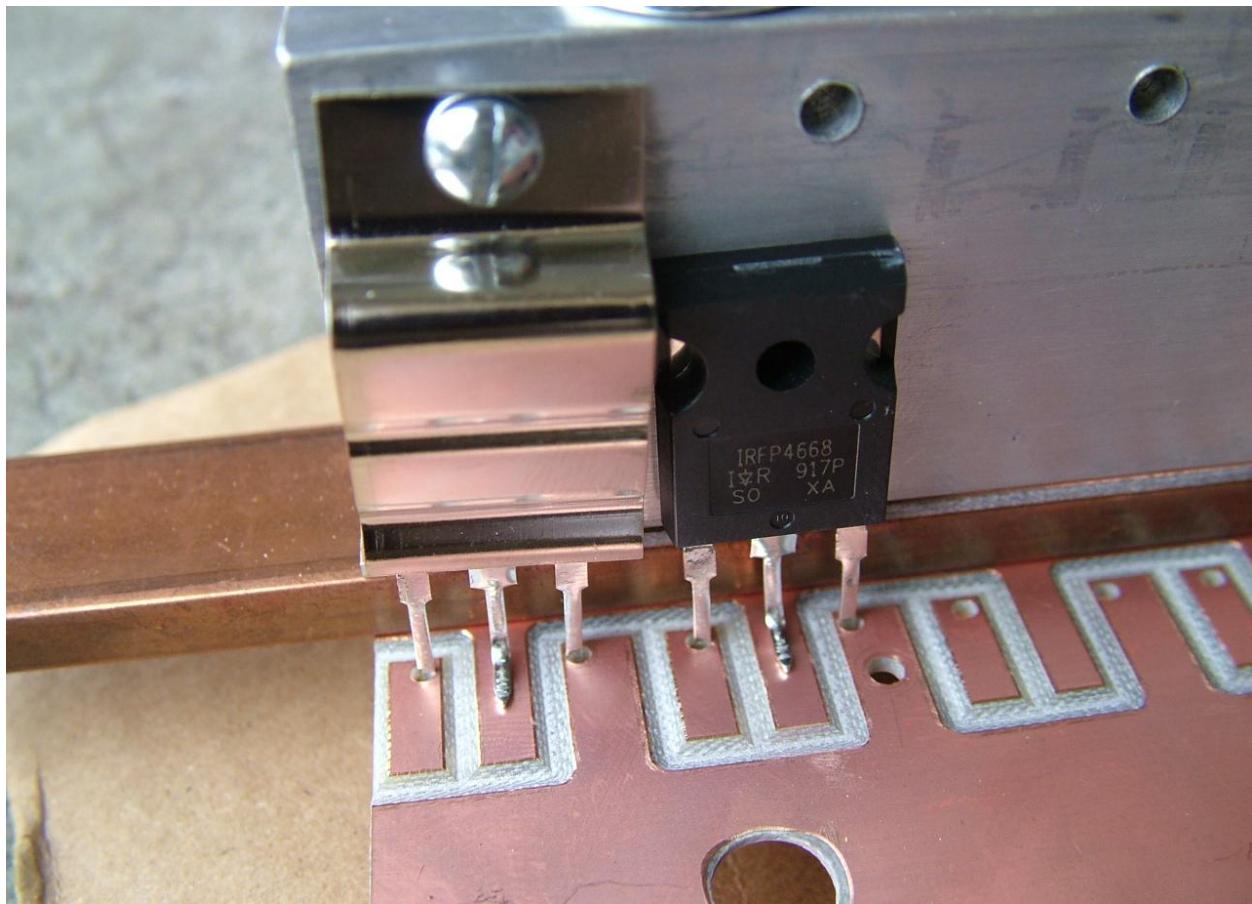


INSTALLING THE MOSFETS:

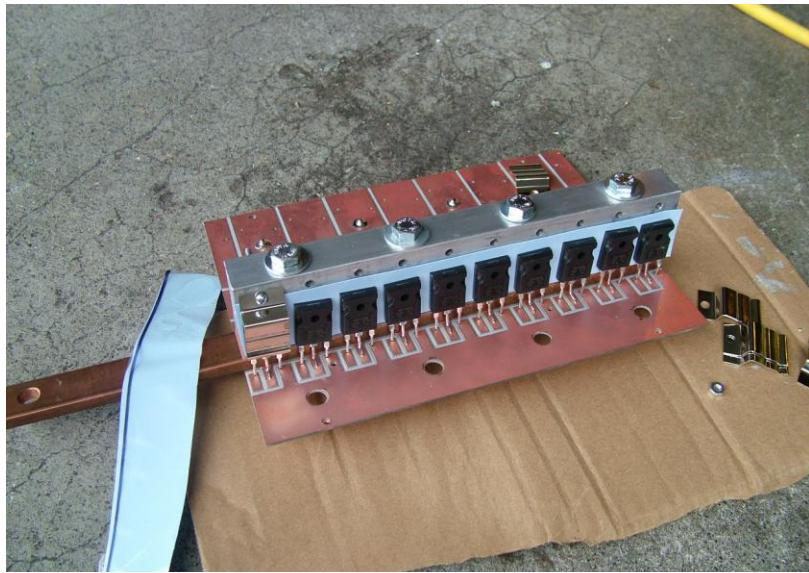
Bend the legs as follows...



Note: I did a booboo here by not yet sticking the isolation material between the mosfets and the heat spreader. The backs of the mosfets and diodes need to be kept from touching the heat spreader directly.



Clamp the mosfets so they are snug against the heat spreader then solder them. DON'T SOLDER THE GATE LEGS YET. The gate legs are the ones that go through each isolated island. (The leg on the left side of each mosfet)



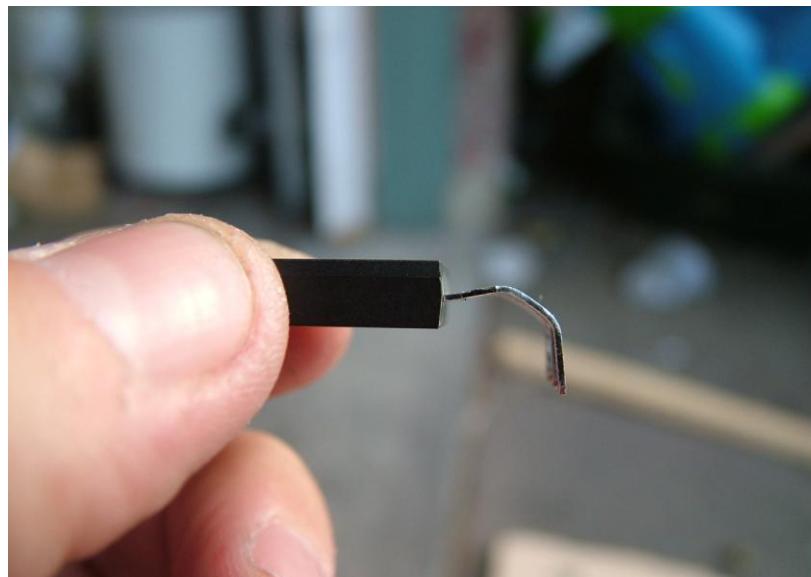
In this picture I soldered the gate legs too, which made it tougher to add the gate resistors later). In the picture, I hadn't yet soldered the legs that were near the ground wire holes. Go ahead and solder those legs now. I need a new picture! ☺

Note: You will need a pretty high-powered soldering gun. I used a 230 watt gun from Radio Shack. It was \$29.99.



INSTALLING THE DIODES:

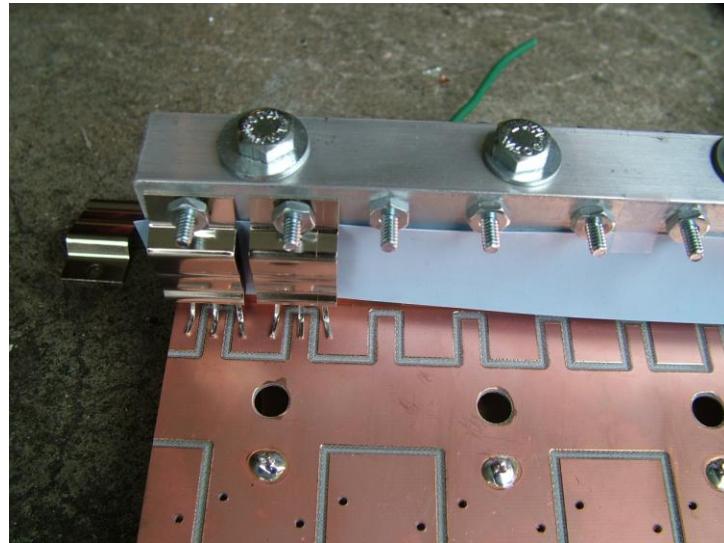
Bend the legs of the diodes as follows. I use needle-nose pliers:



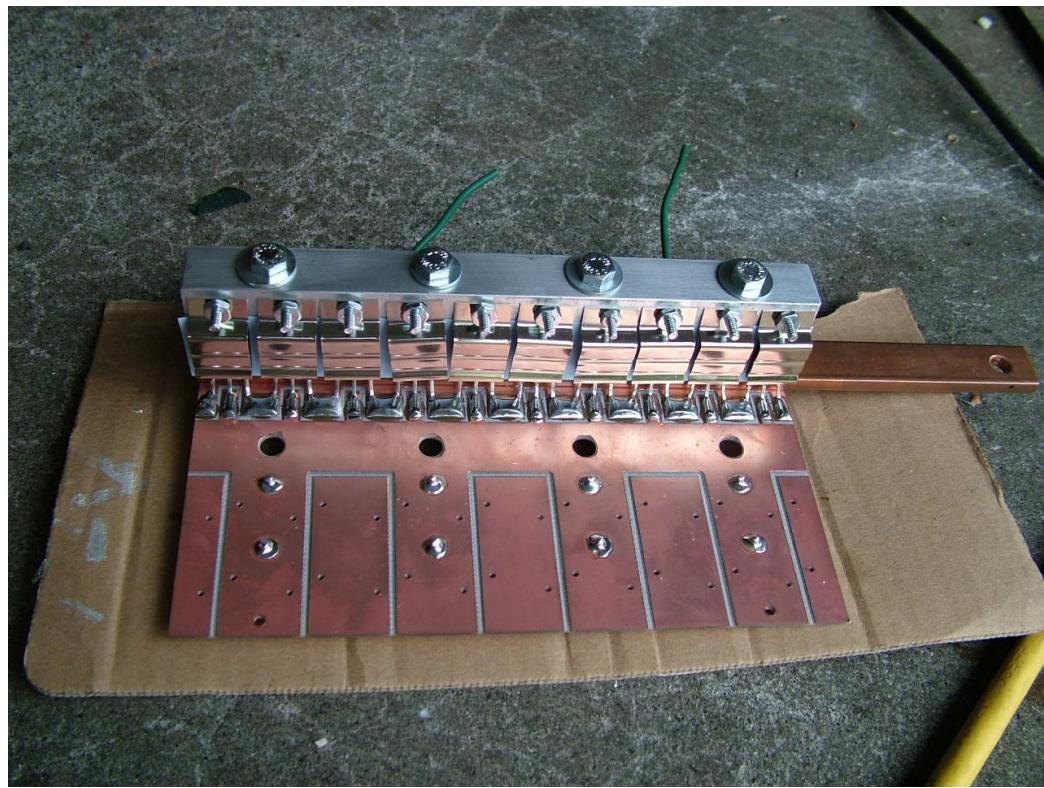
Get ready to solder the diodes!

Using the ten **#6 x 1.25"** screws and nuts, Clamp the diodes against the heat spreader with the clamps. Make sure the diodes are snug against the heat spreader, and that their 3 legs are lying flush against the PCB. Also, make sure the back of each diode is completely on the heat spreader

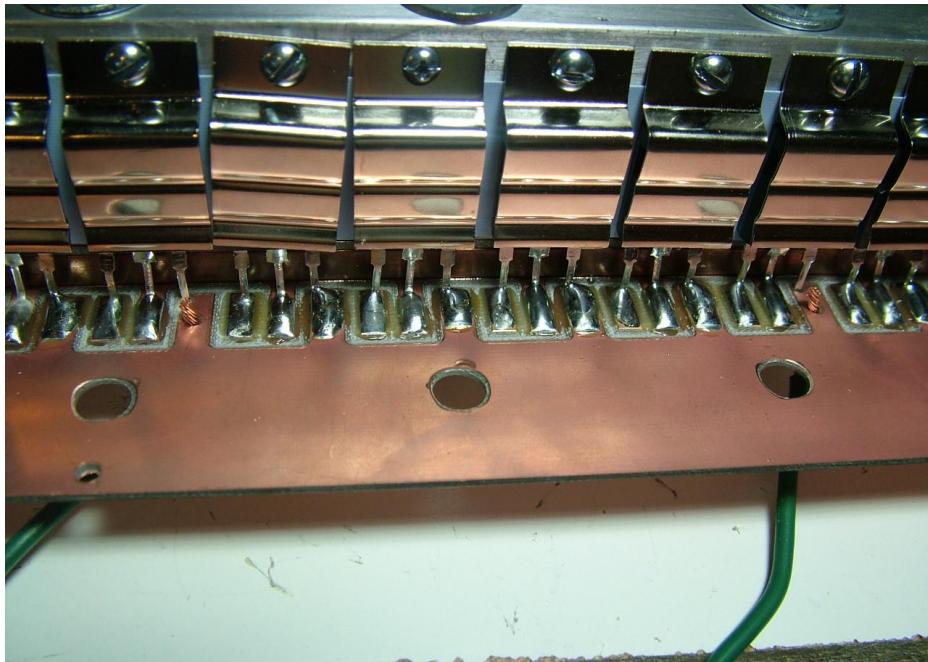
isolation material. You might need to flex the legs out a bit so that they are all completely on the copper, and not on the edge of an etching.



Solder the diode legs. Be REALLY careful about not getting solder where the B+ bus bar will be:



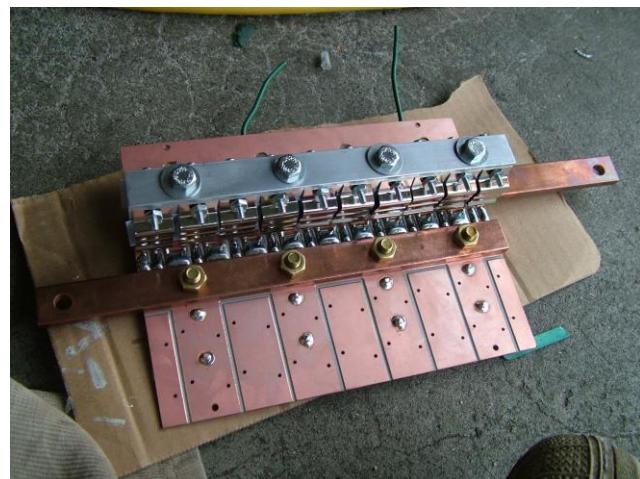
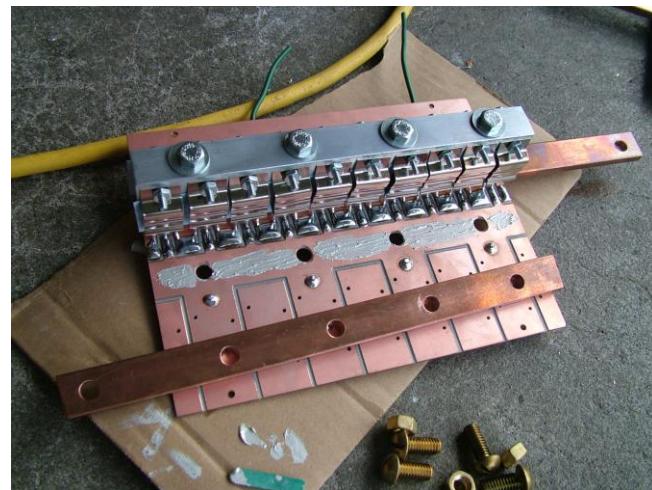
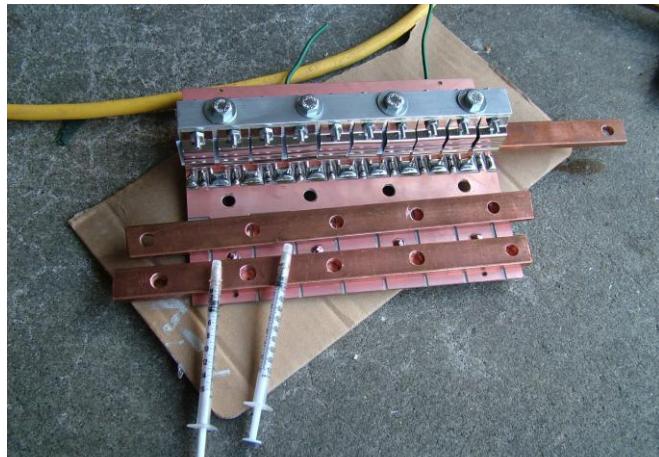
Now solder the 2 pieces of 16 gauge wire:

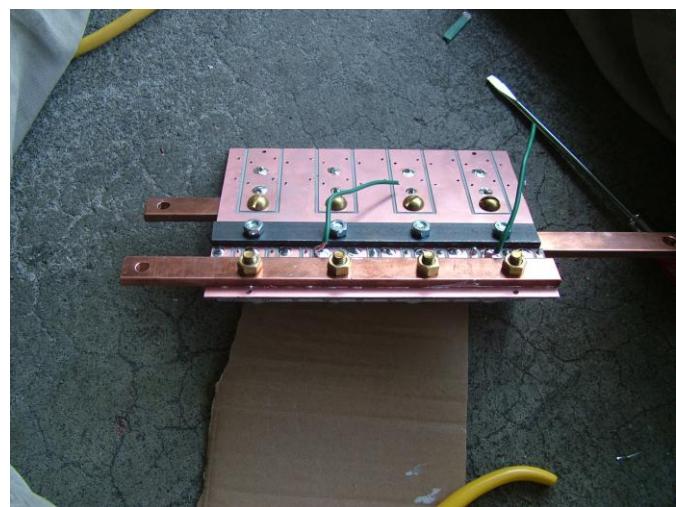


NOW, CLAMP THE MOSFETS AND DIODES ALL THE WAY AS TIGHT AS THE SCREWS WILL GO. This is very important that all the clamps are all tightened equally all the way. I've blown up a mosfet that wasn't tightened as much as the others before.

[INSTALLING THE B+ AND B- BARS](#)

Now, add silver conductive epoxy to the B+ and B- bus bars and bolt them to the PCB. You don't have to be careful this time about getting the epoxy too close to the holes, since the top and bottom of the PCB don't need to be isolated near the B+ and B- holes. Still be careful not to get much near the edges so it won't squish out and possibly cross an etching. Make sure both B+ and B- are pointing out the opposite direction as M-. Also, make sure B- is attached to the bottom, and B+ is attached to the top.





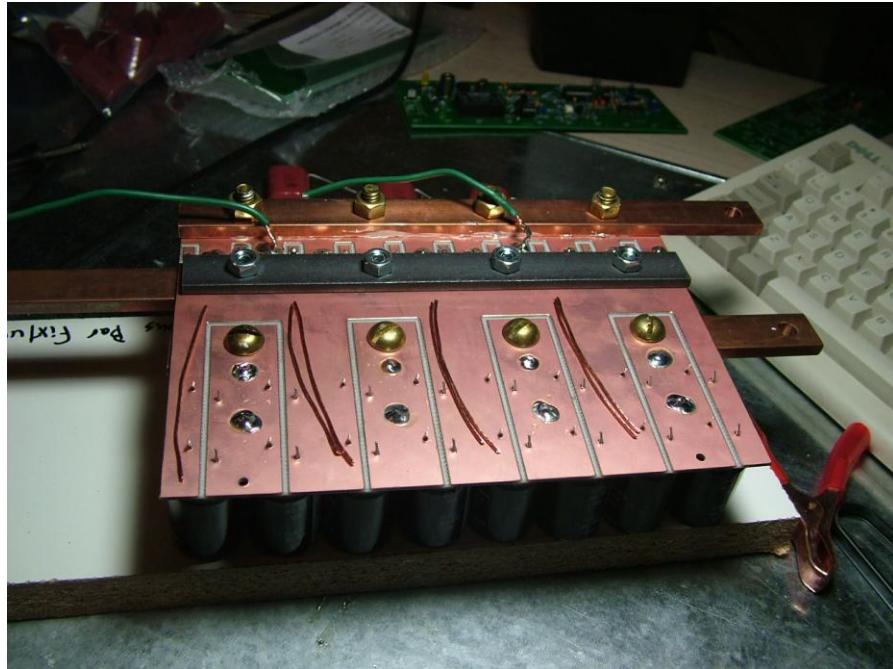
INSTALLING THE CAPACITORS

Time to attach the big black capacitors: Be **VERY CAREFUL** about + and – orientation. Poke them through the holes.





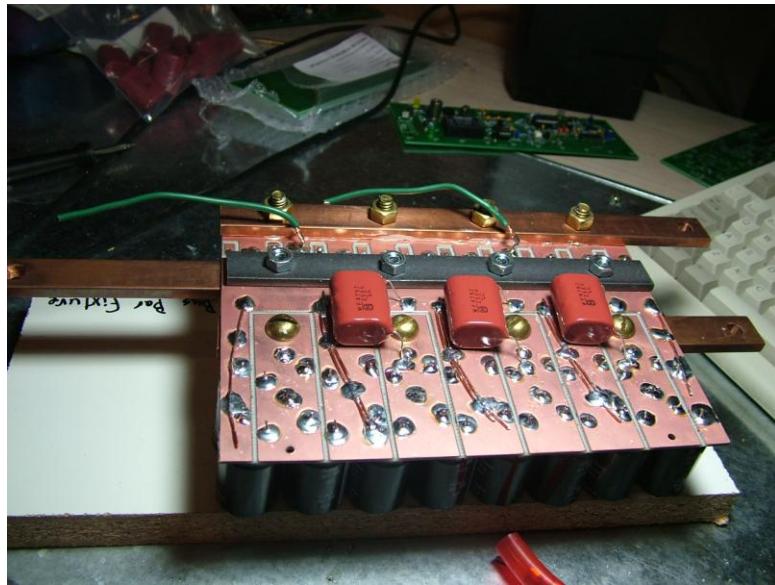
Flip it over, add the re-enforcing wire. Then solder the wire and the capacitors...



Now add the Polypropylene caps... Their orientation (+/-) doesn't matter.



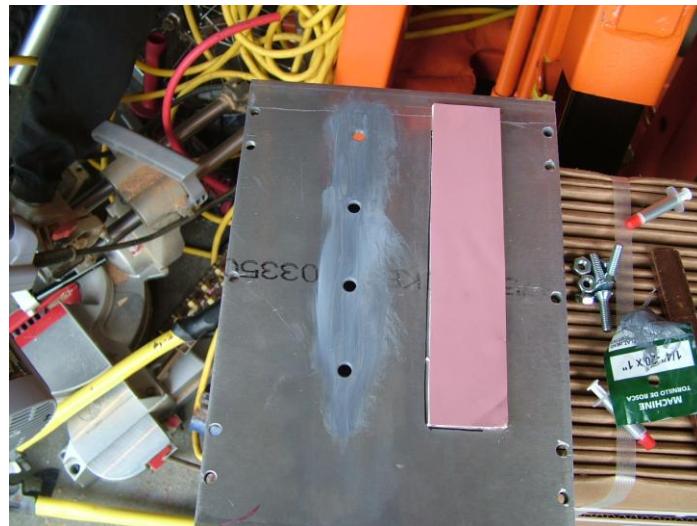
You might be able to fit the 4th capacitor on the left side. You should glue the 3 (or 4) red polypropylene caps down so they won't vibrate around. Now is also a good time to add the gate resistors



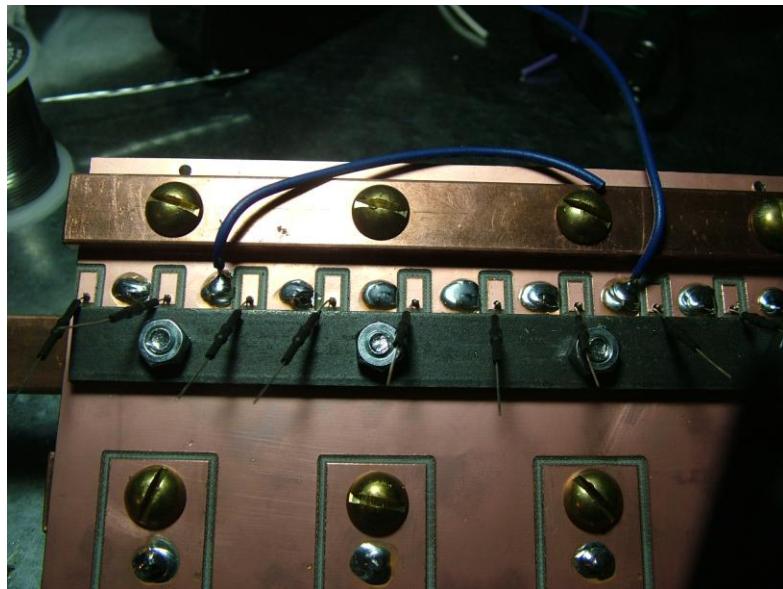
Now sand the base plate so there will be very good contact when it gets bolted to the heat spreader.



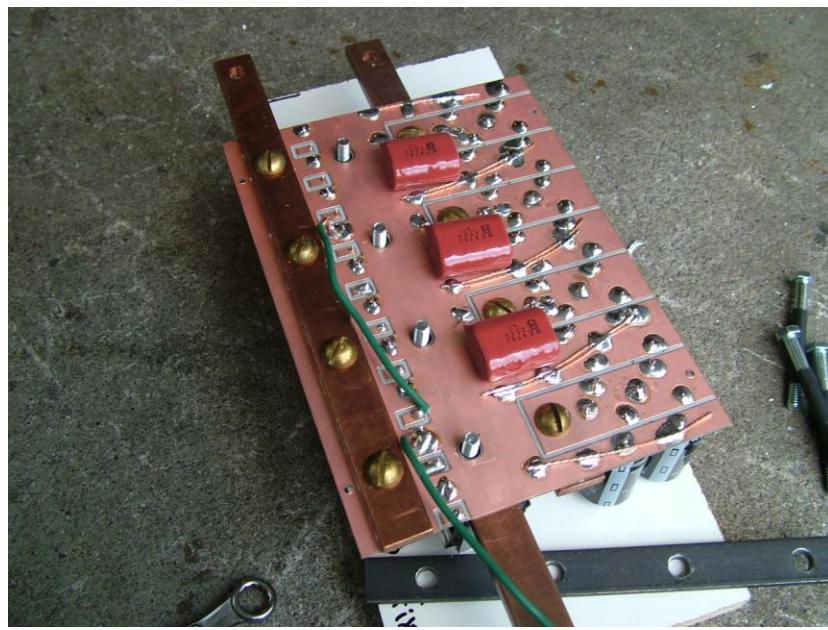
Also, add some thermal grease if you have that available, and the pad on the right side. Some people just have a sticky piece of foam that acts like a shock absorber for the capacitors, since there is a little space between the capacitors and the base plate. In this picture I used something a little different... It doesn't really matter.



Now, just before adding the base plate, solder the little legs sticking out on the bottom of the board... Also, poke the gate resistors through the holes that the gate legs are coming out of. Push them in so that the gate resistor legs poke out the other side about 2mm. The gate resistors in this picture had heat shrink tubing around them. That proved unnecessary. Then flip it over and solder the other island where the gate resistor legs go through.



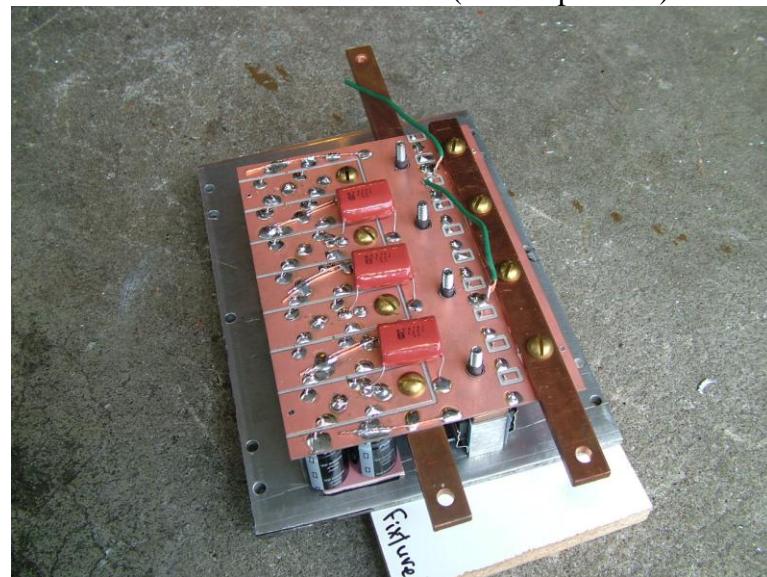
Now remove the 4 previous bolts that were holding the base plate to the heat spreader, remove the steel bar, and take out the 4 bolts. (note: In this picture, the gate resistors aren't there. Just ignore that)



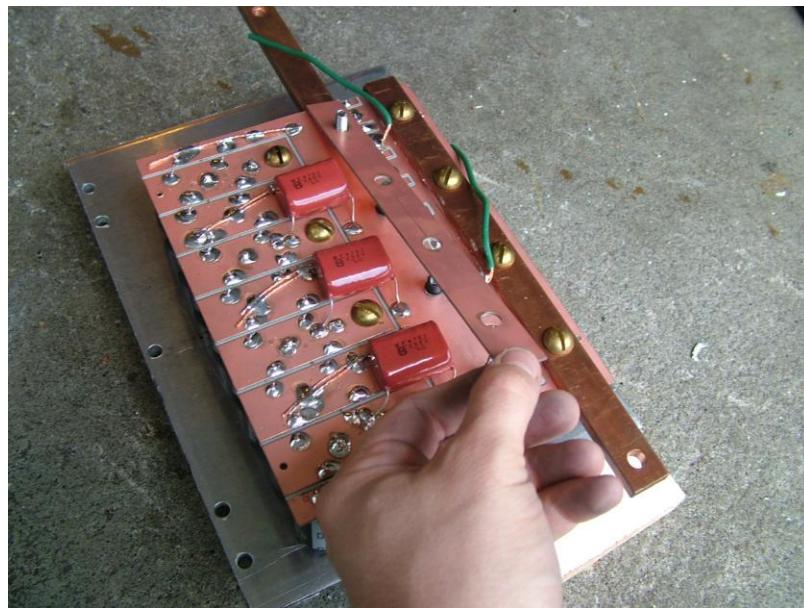
Now, put in the 2.5" x 0.25" bolts with the heat shrink that goes right near the top. There should barely be any threads showing (like 2 or 3). In this picture, I was using longer bolts, so there are more threads showing.



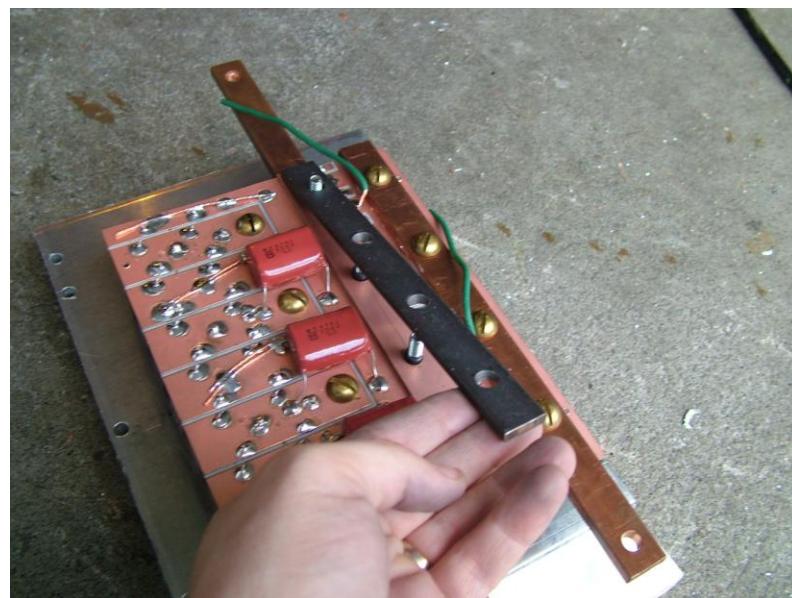
Now slide the bolts through the heat spreader holes. Make sure that you do it so that the M- bar sticks out the correct end. (see the pictures)



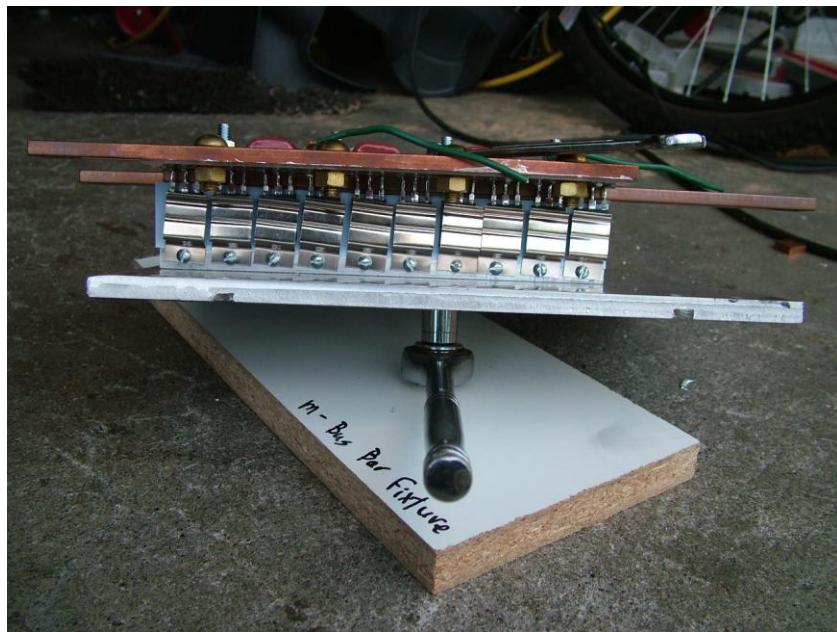
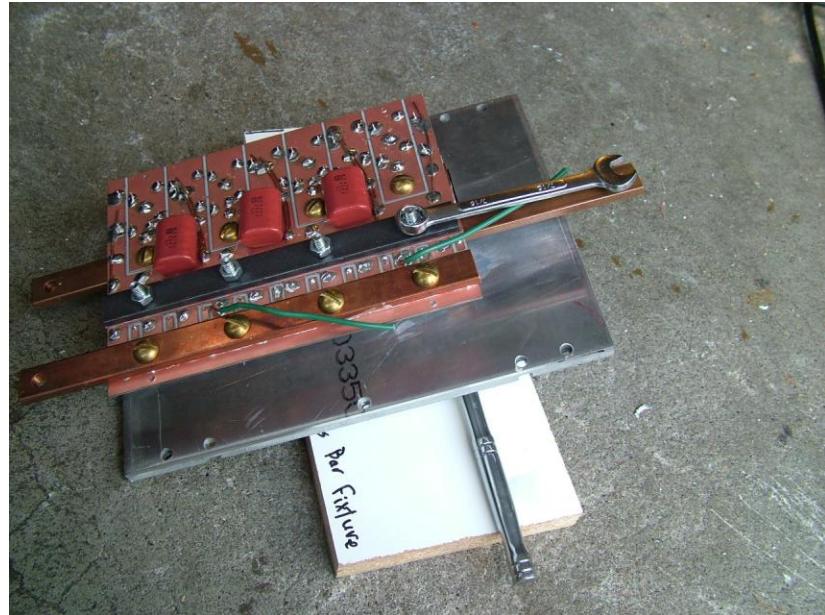
Now, put on the other PCB isolation strip.



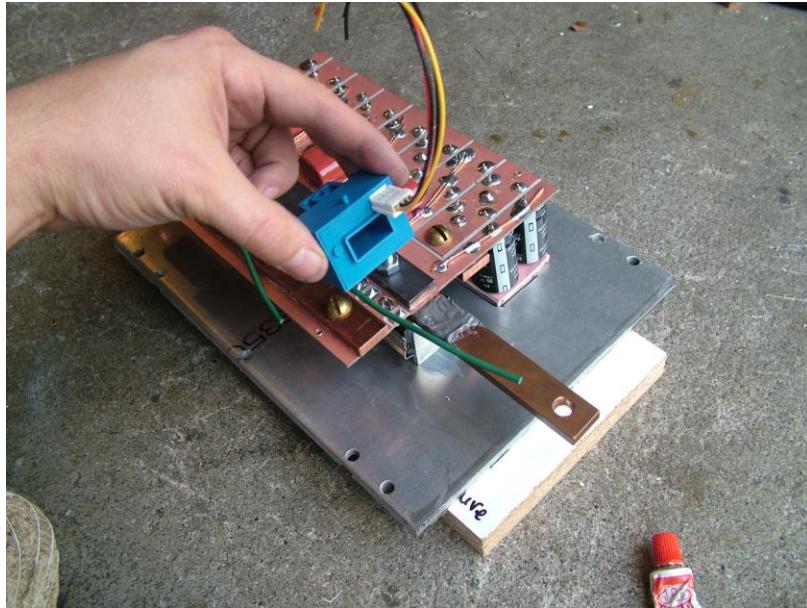
Now add the steel bar...



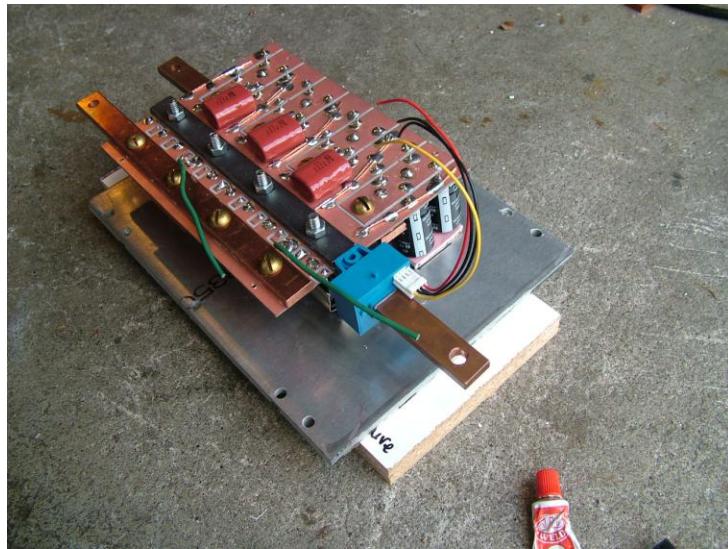
Now, tighten down the bolts. You will need a ratchet with a 7/16" socket, and a 7/16" wrench. Tighten it firmly, but don't over tighten.



Now that the heat spreader is bolted to the base plate nice and snugly, it's time to add the blue LEM current sensor. Add some JB weld or some other good glue to the M- bar as the picture shows. (Ignore the connector with the red, black and yellow wires sticking out. Yours will be different.)

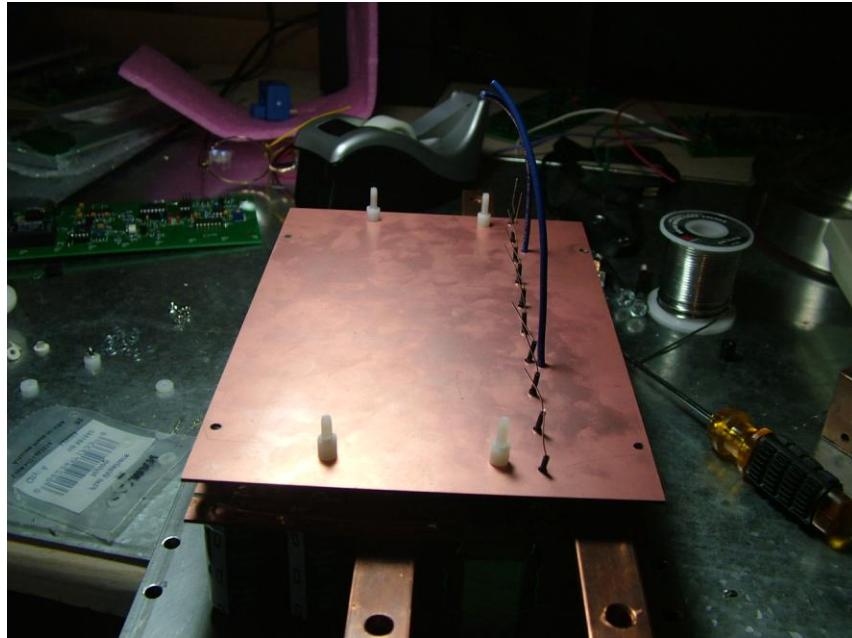


Now slide on the LEM and let the glue dry. Note the orientation of the LEM. (Upside down with so that the connector will be on the right side.)

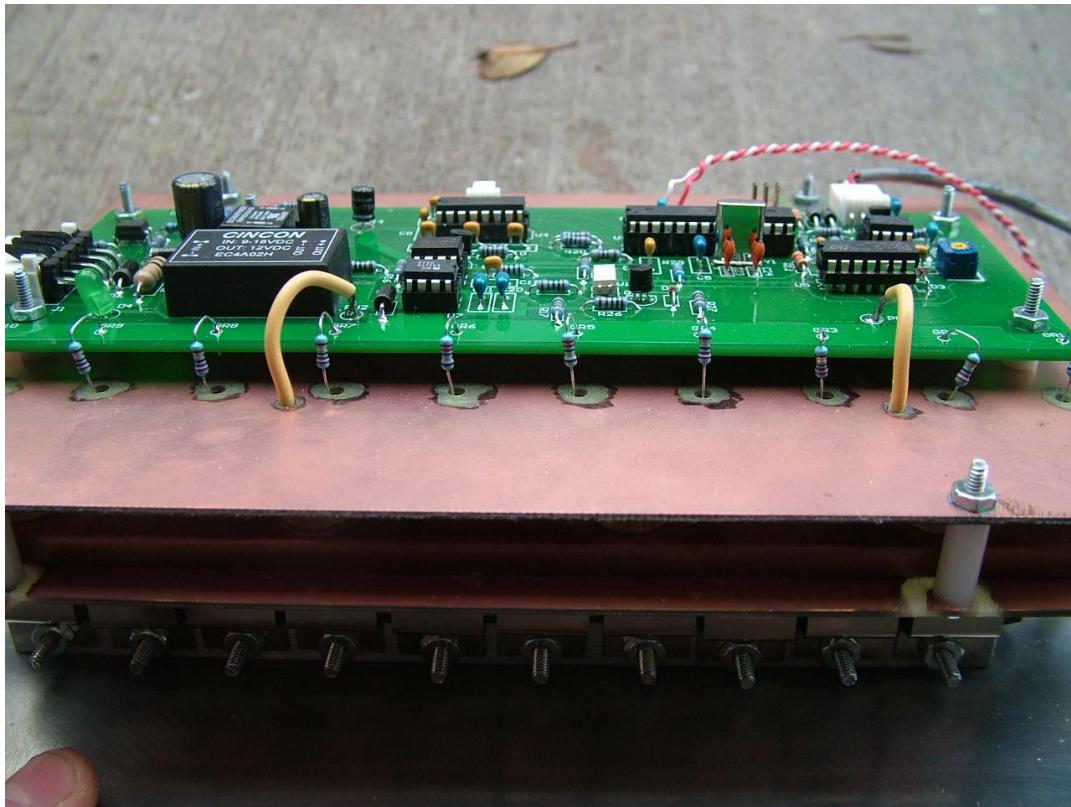


Now add the mounting board that the control board will sit on. It will have the same holes as seen in this picture, but should not have copper on it. If you do have copper on it, then the holes should have been isolated to allow the gate resistors and mounting bolts to go through without touching copper. To

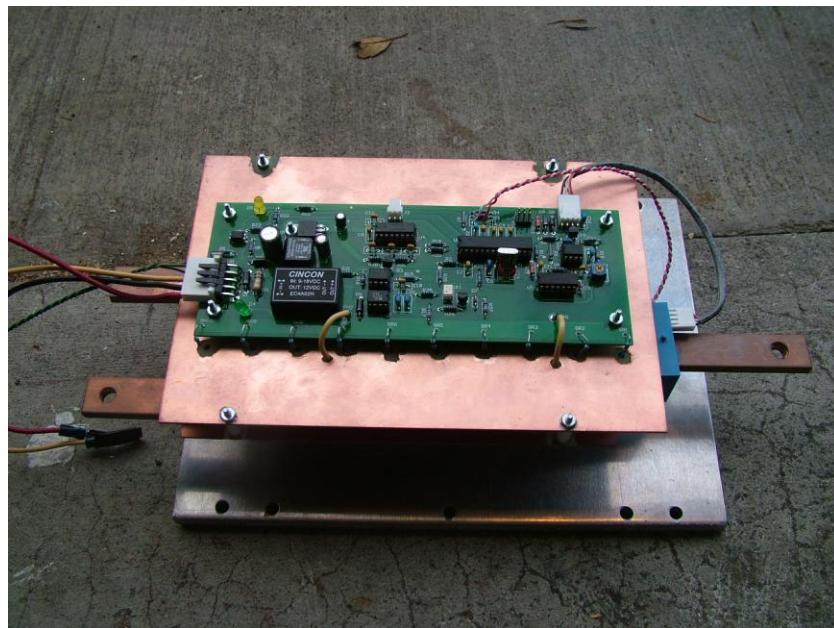
mount it, you will need four 1" #4 screws, and four 0.625" nylon spacers. Also, make sure you have put the four 0.75" screws through, and the four 0.25" spacers that sit on top of the mounting board.



Now add the control board. Take the gate resistors and poke them through their respective holes, poke the 2 ground wires into PH1 and PH2, and then solder them all into place. Make sure to allow for a little flex with the gate resistors and ground wires.



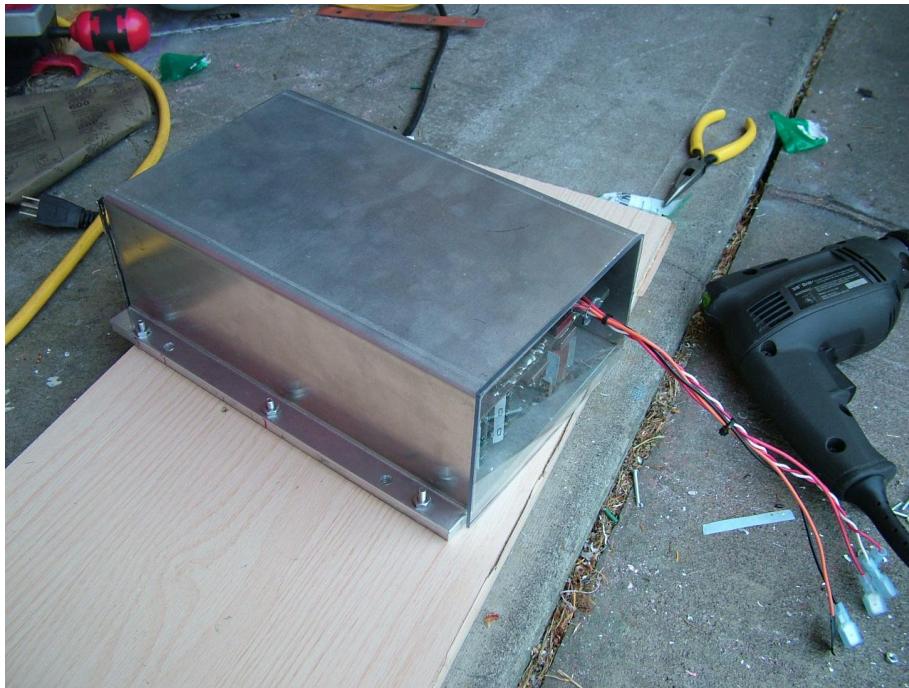
Here's a picture from the top:



Next, push the thermistor head into the hole in the heat spreader that is on the 0.75 inch x 1.5 inch face that is just behind the current sensor. Glue the thermistor head into the heat spreader. JB weld works well.

ATTACHING THE ENCOLSURE

Take the metal enclosure with inner dimensions 11 inch x 6.75 inch x 4 inch, and 0.75 inch wide wings. Bolt it down with the six 0.25" diameter cone-shaped head machine screws. The 4 unused holes are so the controller can be bolted down. Glue on the end caps.



VEHICLE INSTALLATION

The black wire gets connected to 12v battery ground.

The red wire gets connected to 12v battery plus.

The yellow wire is a relay for the 12v contactor. So, if you want to have the controller control the main contactor, use the yellow wire. This is not supported in software as of 10/23/09.

The twisted pair of wires connects to the 5k potentiometer. 0 Ohms means 0 throttle, and 5000 Ohms means full throttle. It doesn't matter which wire gets connected to which lead of the 5k pot.

TURN-ON AND TURN OFF SEQUENCE:

For startup, turn on the 12v power to the controller. Then pre-charge the capacitor bank. Finally, close the main contactor and drive away.

For turning off, open the main contactor (and the pre-charge circuit if it isn't already open). Then turn off the 12v power to the controller.

I don't think the order matters, but I just try to make sure the microcontroller is in control of the power section as long as pack voltage is applied to the power section.