

# diyAudio™ Power Supply Board Build Guide

*Prepared, written and compiled by JojoD818  
Build Guide revision 1.0 for use with diyAudio PSU revision 2.0*

## Introduction:

Every power amplifier project requires a power supply to make it work. It needs two things:

- **A rectifier board for discrete diode bridges.** These convert the power transformer's AC voltage to DC
- **A capacitor filter bank.** This smooths out ripples before the power is fed to your power amplifier. For some, this is the most important part of a power amplifier build.

More often than not the saying “feed your amp garbage and it spits out garbage” is true for power amplifiers. Hence, a sturdy, reliable, and well built power supply is essential to the success of a power amplifier.

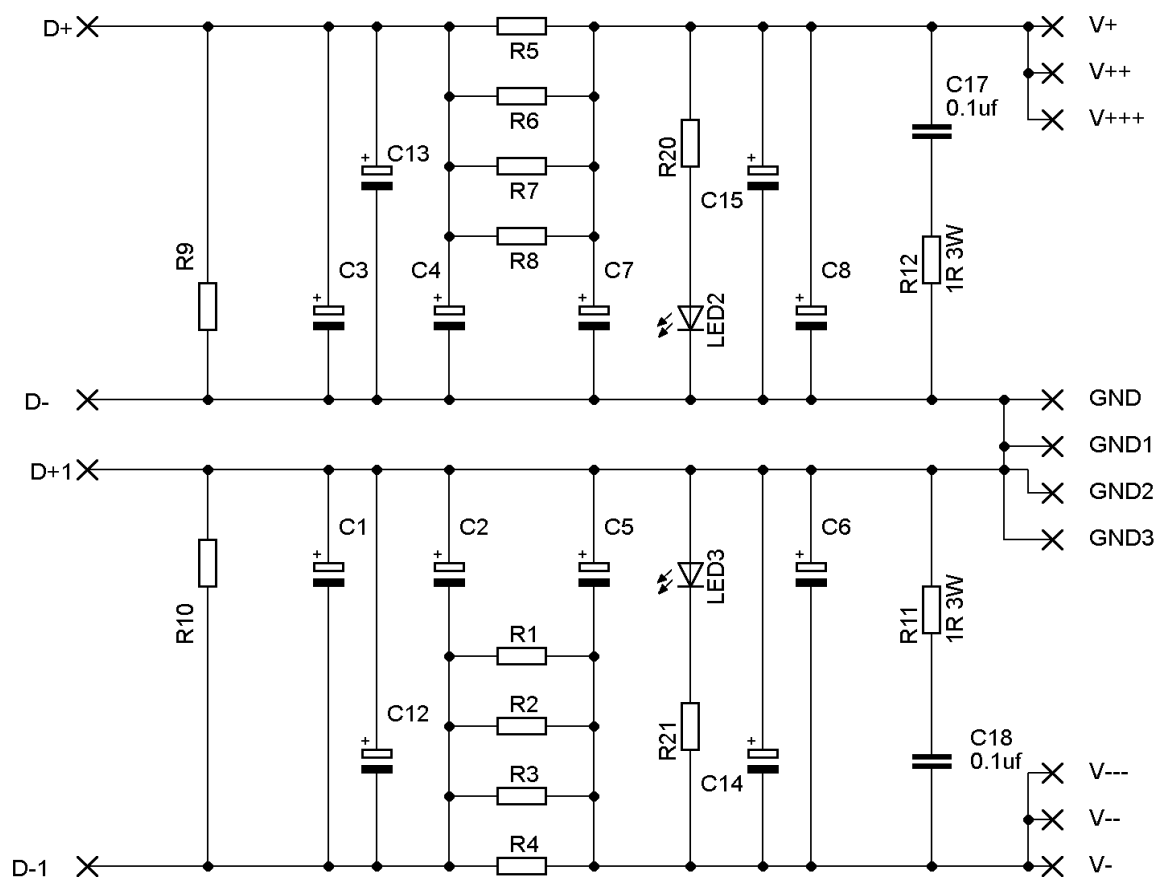
Our diyAudio Power Supply Board consists of fully independent dual discrete diode bridges and a capacitor filter bank. It has a pi-filter provision for a CRC configuration as well as a snubber network right at the output. LED indicators are provided per rail for visual confirmation that power is being supplied.

With some slight modifications in the parts values, this PSU Board is compatible for use with all power amplifiers in the diyAudio Store such as the First Watt clones, Burning Amp Class A power amplifiers, Class AB “Honey Badger” power amplifier and more. There are no limits as to how it can be configured, and it can be used with separate transformer secondary windings or center tapped transformer secondary windings.

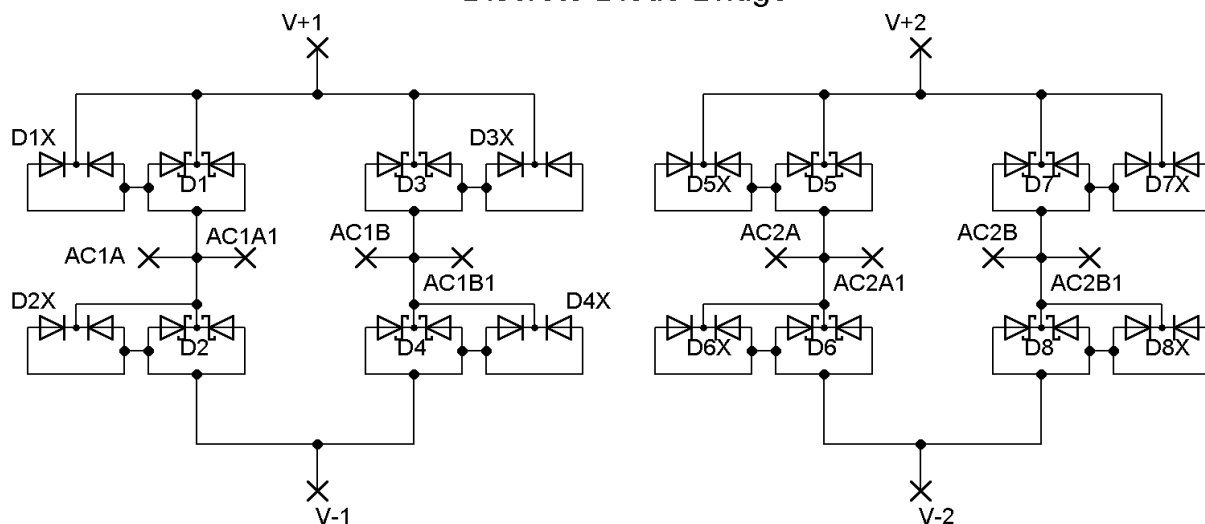
## About the circuit:

Following is the schematic of the diyAudio Power Supply Board:

### Filter Cap Bank and PI Filter



### Discrete Diode Bridge



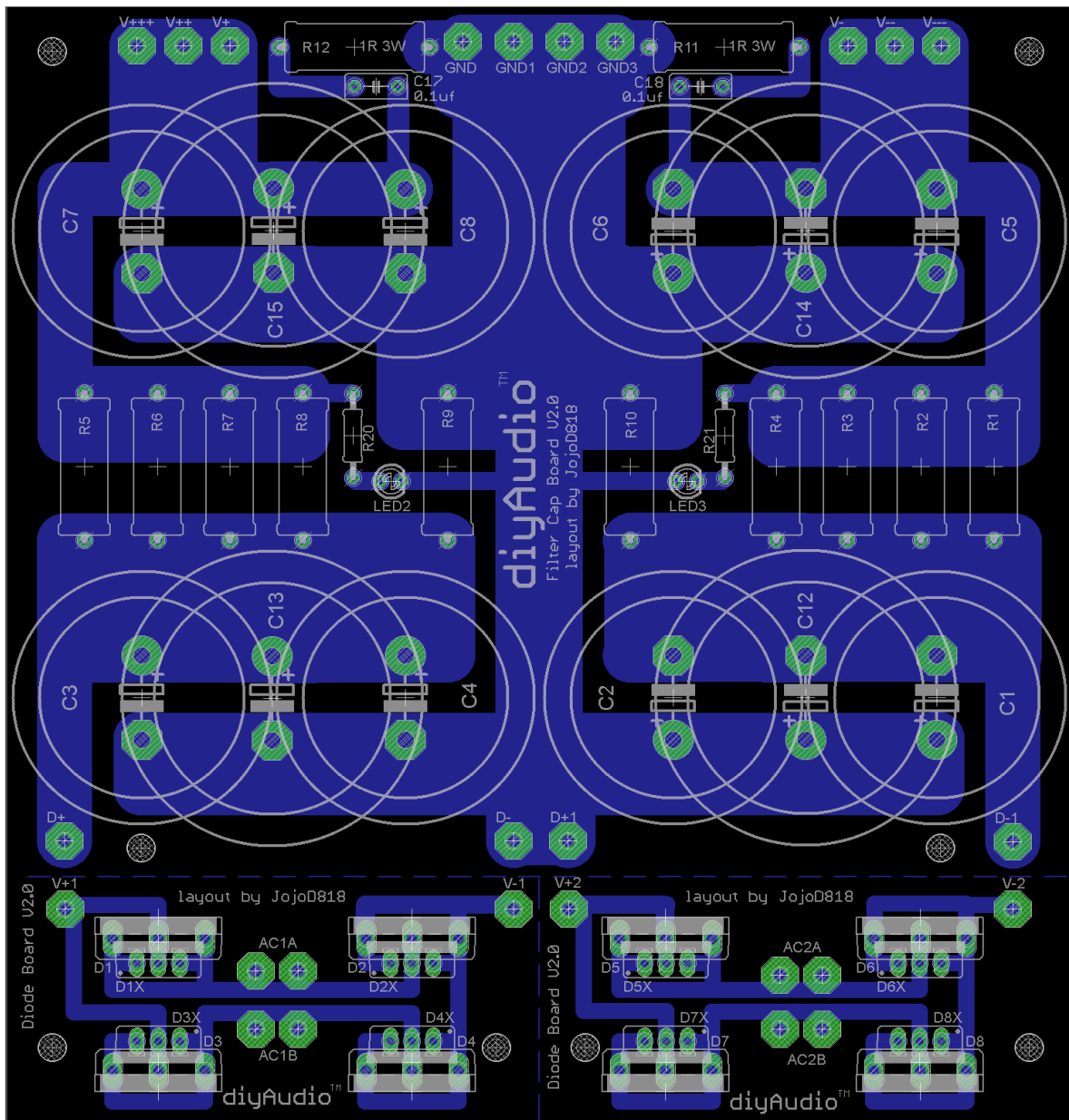
by jojod818

As you can see, aside for some modifications, the design of the PSU Board is very similar to what Nelson Pass uses in his Firstwatt and Burning Amp power amplifiers.

We've added LEDs for some visual indication of power and a snubber network for filtering out high frequency noises in the power supply.

The design and layout of the diode bridge was cleverly conceived to accommodate the use of those big TO-247 package style rectifiers or the smaller TO-220 package style rectifiers. The design calls for 3-pin devices but 2-pin devices can also be used by just bending the leads to fit in the board. If the diodes require heatsinking, the diode section can be easily separated ([see video](#)) and the diodes be mounted directly on to the heatsink.

Below is the Parts Placement Guide of the PSU Board



These boards are available and can be bought from [the diyAudio Store](#).

## Bill of Materials:

### Diodes:

#### Important Notes:

- 1. All D# diodes are TO-247/TO-3P packages**
- 2. All D#X diodes are TO-220 packages**
- 3. Only one package style must be used at a time!**
- 4. Please consult Ideas and Alternatives section for choosing other diodes.**

D1 or D1X - FEP30DP (TO-3P) or MBR20200CT (TO-220)

D2 or D2X - FEP30DP (TO-3P) or MBR20200CT (TO-220)

D3 or D3X - FEP30DP (TO-3P) or MBR20200CT (TO-220)

D4 or D4X - FEP30DP (TO-3P) or MBR20200CT (TO-220)

D5 or D5X - FEP30DP (TO-3P) or MBR20200CT (TO-220)

D6 or D6X - FEP30DP (TO-3P) or MBR20200CT (TO-220)

D7 or D7X - FEP30DP (TO-3P) or MBR20200CT (TO-220)

D8 or D8X - FEP30DP (TO-3P) or MBR20200CT (TO-220)

LED1 - Light Emitting Diode (3mm or 5mm) Green or Red

LED2 - Light Emitting Diode (3mm or 5mm) Green or Red

### Resistors: *(Please consult Ideas and Alternatives section for choosing other resistors)*

R1 - 0.47R - 1R/3W(Replace with jumper if CRC filtering not required)

R2 - 0.47R - 1R/3W (Replace with jumper if CRC filtering not required)

R3 - 0.47R - 1R/3W(Replace with jumper if CRC filtering not required)

R4 - 0.47R - 1R/3W(Replace with jumper if CRC filtering not required)

R5 - 0.47R - 1R/3W(Replace with jumper if CRC filtering not required)

R6 - 0.47R - 1R/3W(Replace with jumper if CRC filtering not required)

R7 - 0.47R - 1R/3W(Replace with jumper if CRC filtering not required)

R8 - 0.47R - 1R/3W(Replace with jumper if CRC filtering not required)

R9 - 4.7K - 22K/3W (Use higher resistance values for high voltage outputs)

R10 - 4.7K - 22K/3W (Use higher resistance values for high voltage outputs)

R11 - 10R/3W

R12 - 10R/3W

R20 - 4.7K - 10K - 1/4W

R21 - 4.7K - 10K - 1/4W



**Capacitors: (*Please consult Ideas and Alternatives section for choosing other capacitors*)**

C1 - 10Kuf - 15Kuf (30mm Diameter/10mm Lead Spacing) Omit C12 when used!  
C2 - 10Kuf - 15Kuf (30mm Diameter/10mm Lead Spacing) Omit C12 when used!  
C3 - 10Kuf - 15Kuf (30mm Diameter/10mm Lead Spacing) Omit C13 when used!  
C4 - 10Kuf - 15Kuf (30mm Diameter/10mm Lead Spacing) Omit C13 when used!  
C5 - 10Kuf - 15Kuf (30mm Diameter/10mm Lead Spacing) Omit C14 when used!  
C6 - 10Kuf - 15Kuf (30mm Diameter/10mm Lead Spacing) Omit C14 when used!  
C7 - 10Kuf - 15Kuf (30mm Diameter/10mm Lead Spacing) Omit C15 when used!  
C8 - 10Kuf - 15Kuf (30mm Diameter/10mm Lead Spacing) Omit C15 when used!

C12 - 15Kuf - 22Kuf (35mm D/10mm Lead Spacing) Omit C1 & C2 when used!  
C13 - 15Kuf - 22Kuf (35mm D/10mm Lead Spacing) Omit C3 & C4 when used!  
C14 - 15Kuf - 22Kuf (35mm D/10mm Lead Spacing) Omit C5 & C6 when used!  
C15 - 15Kuf - 22Kuf (35mm D/10mm Lead Spacing) Omit C7 & C8 when used!

C17 0.1uf 63V - 100V  
C18 0.1uf 63V - 100V

**Tools Required:**

Screwdrivers - Phillips and Flat

Miniature Screwdrivers - Phillips and Flat

Small Diagonal Cutters

Insulation Strippers

Needle-nose Pliers

Solder 60/40 Rosin cored or better

Soldering iron about 30 - 40 Watts

Digital Multi Meter

**Miscellaneous Tools:**

Electric Hand Drill

Assorted Files

Solder Sucker

Solder Remover Braid (Solder Wick)

Extra Flux

Lacquer Thinner

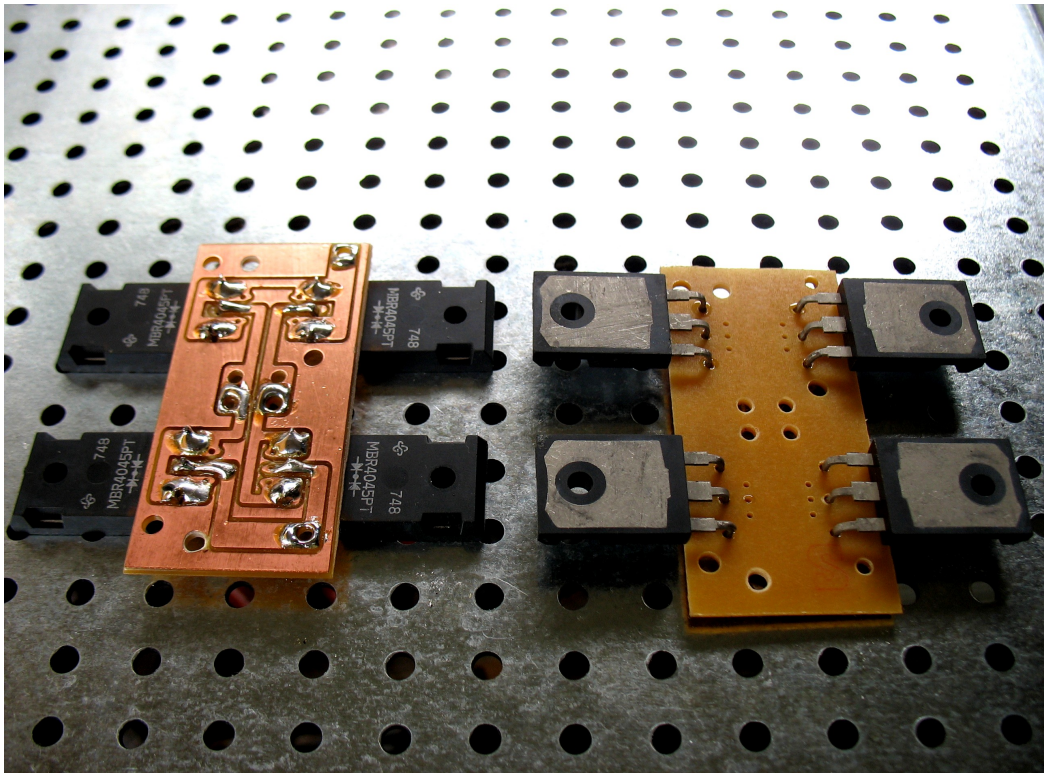
Please see <http://www.diyaudio.com/recommended> for lists of recommended tools

## Ideas and Alternatives:

### Choosing your Diodes

Diodes have current and PIV (Peak Inverse Voltage) ratings. It's good practice to always allow for 3 to 4 times the ratings. For example, if you expect a DC output of +/-50VDC, choose diodes with PIV ratings of 200V and above. Your diode's current ratings are also important and choosing diodes with 3 to 4 times the current you expect to draw from the power supply is also a good practice.

Heatsinking the diodes is done especially if you expect to have sustained high current draw like when using the power supply with Class A power amplifiers. You can avoid using separate heatsinks by using the chassis or the power amplifier's own heatsinks. However, for sustained high current draw, it is wise to give the diodes their own heatsinks. It can be a single piece of heatsink as long as all the diodes are isolated by using mica insulators and nylon bushings (for TO-220 and other non-isolated tab diodes) during installation.



The image on the left shows an example of the diode bridge aligned and ready to be installed in the DFB (DIY Friendly Base). Don't forget to use Mica insulators and thermal grease when installing the diodes!

### Choosing your Resistors

You need to decide on the values of the PI Resistors and Bleeder Resistors first before building the Power Supply Board.

PI Resistors are used in conjunction with the filter capacitors to form what is called a CRC filter. It's a practical way of reducing ripple in the output of the power supply. However, these resistors produce a voltage drop and heat, so values in between 0.47 ohm to 1 ohm are used. The higher the value, the bigger the voltage drop and heat produced when large

amounts of current are drawn from the power supply. Install these resistors elevated or with some breathing space from the board in order to help them to dissipate heat. For Class AB amps, I personally like to make it just a capacitor bank style CRC filter without the PI resistors so I replace the resistors with a jumper wire.

There are also a couple of bleeder resistors used in the board. These resistors are used to safely discharge the capacitors when there is no load connected. Their value can be between 4.7K to 22K at 3 watts. For higher output voltages like +/-40V and up, 22K should be safe and well within limits and won't heat up the resistors. Use a lower resistance and the resistor will heat up during operation, so remember to use larger values and install the bleeder resistors with some space between the board and the resistor. The LED indicators also help discharge the capacitors.

A 5mA to 10mA current flow through the bleeder resistors should be more than enough to discharge the caps when the PSU has no load. It will also keep the resistors cool. To calculate the values for the bleeder resistors:

$$V_{OUT} = \text{Output Voltage of your PSU}$$
$$I = 10\text{mA} = 0.01\text{A}$$

$$R = V_{OUT}/I$$

As an example:

PSU's  $V_{OUT}$  is +/-50V;

$R = 50\text{V}/0.01\text{A} = 5,000 \text{ Ohms}$ , so get the next largest value available which is 5.6K-3W. Larger values can also be considered and will result in a longer discharge time and a guaranteed cool resistor.

The power dissipation of the bleeder resistor would be:

$$P = VI = 50\text{V} \times 0.01\text{A} = 0.5\text{W}, \text{ which is way below our } 3\text{W} \text{ rated bleeder resistor.}$$

## Choosing your Capacitors

The most important thing to keep in mind when choosing your capacitors is their working voltage rating. Exceeding this rating can result in catastrophic failure of the capacitors. Thankfully, choosing the working voltage of your capacitor is fairly easy to do assuming your PSU is a dual rail power supply.

Let's consider the positive rail only. The important thing to know is your power transformer's secondary voltage where the capacitor will be used.

For example:

Transformer Secondary = 32VAC

We simply multiply this by the Square Root of 2 (approx 1.4142), hence;

Working Voltage  $WV = 32VAC \times 1.4142 = 45.25V$

Use the next higher standard value available which is 50V. 63V capacitors can also be used in the example, as long as you go higher but not lower than the computed Working Voltage. Adding extra headroom by choosing the next higher voltage value guarantees the safe operation of your power supply.

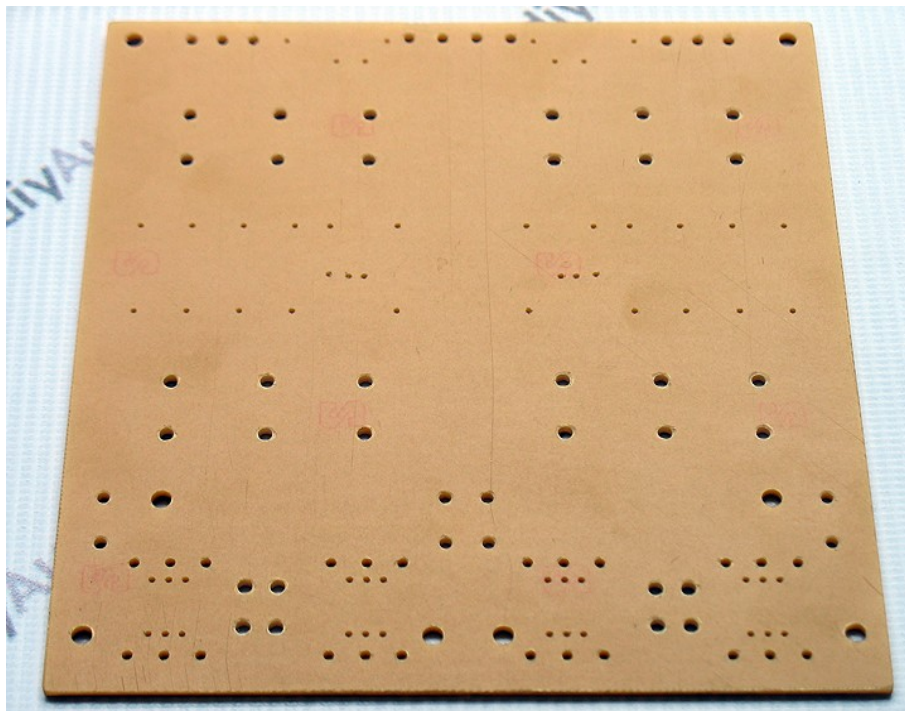
Choosing the capacitance value of your capacitors depends mostly on your intended application. Recent advances in capacitor manufacturing have resulted in increasing capacitance values being squeeze into ever smaller packages while at the same time remaining low cost. It is a no-brainer to get the largest capacitance for your Working Voltage that has the correct diameter and lead spacing for your board.

Some would argue that the law of diminishing returns will fall on you for using oversized caps but that was more the case when capacitor prices were very high. Nowadays (May 2012), with the falling prices, using large value capacitance tends to compensate that law. My philosophy is that it's better to have extra capacitance and not need it, than need that extra capacitance and not have it.

Nevertheless, if you are going to use large amounts of capacitance in your power supply board, I would also like to recommend the use of diyAudio's Softstart board to help prevent too much inrush current. ☺

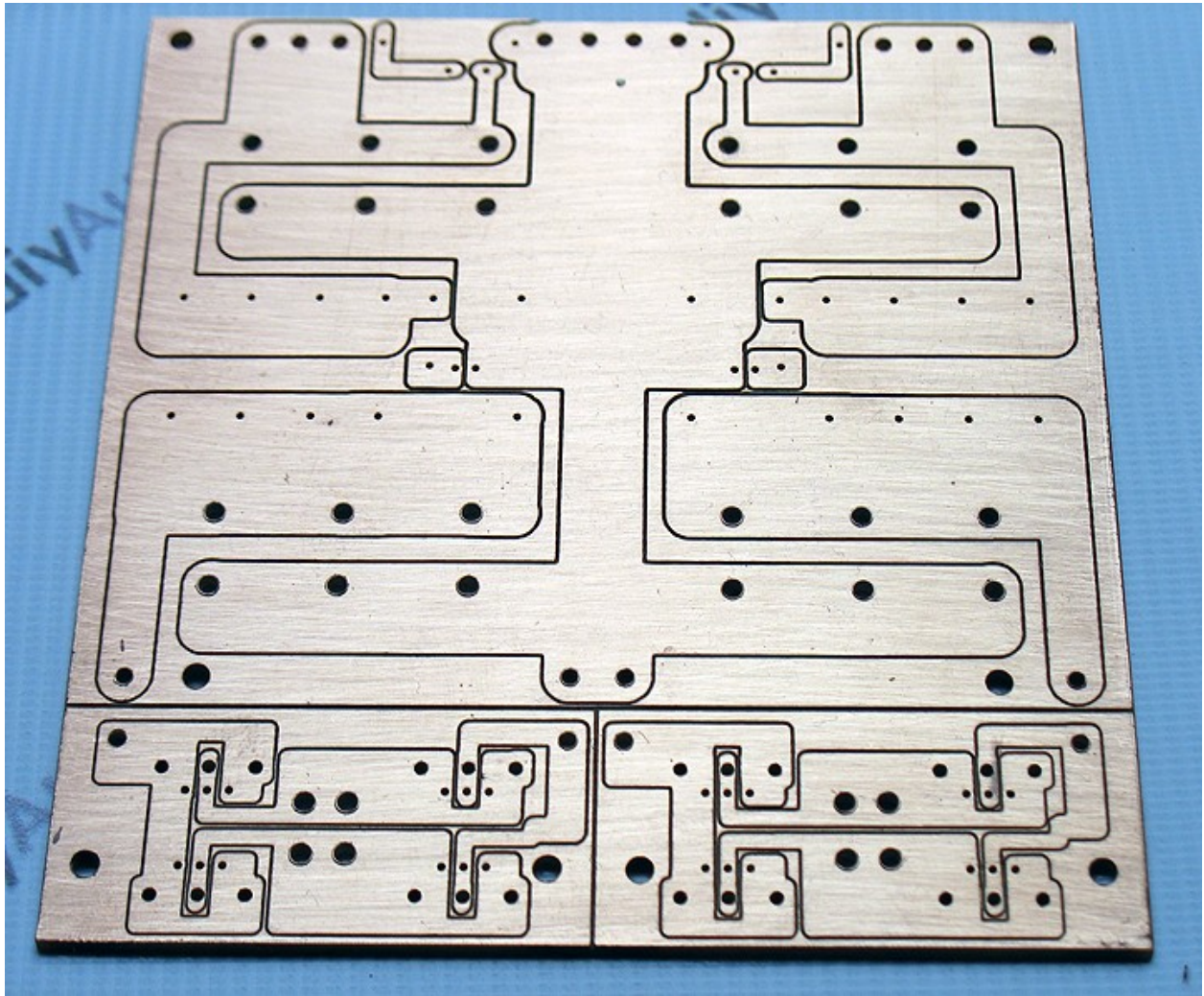
### **Construction:**

It is always good practice to inspect for cracks, hairline shorts or other errors in your PCB before doing any major construction with it. Check the actual PCB against the Parts Placement Guide and the bottom Foil Pattern Layout and make sure all vias and holes are in place and properly drilled.



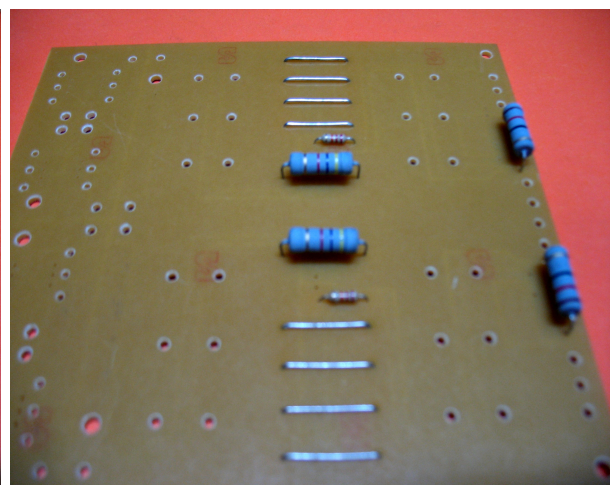
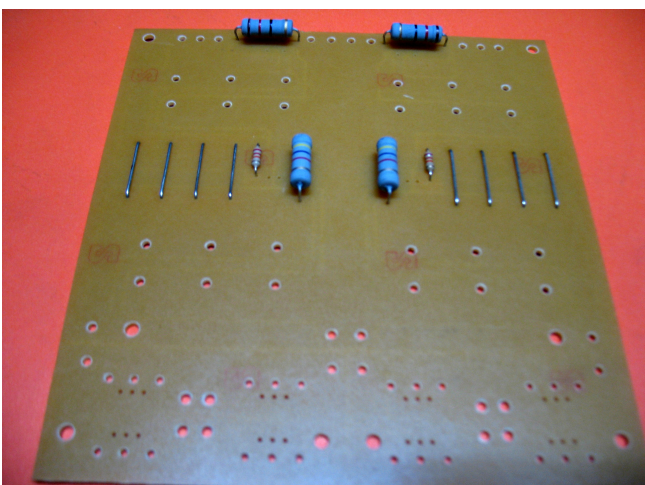
Parts placement side of the prototype PSU Board





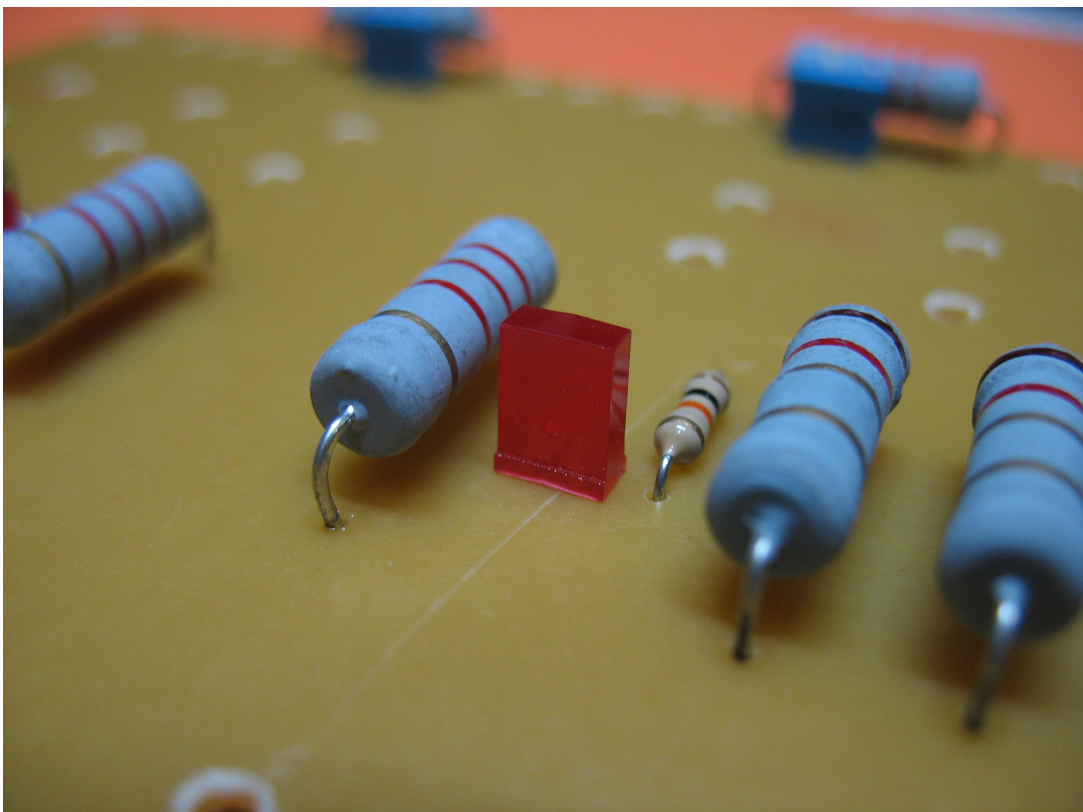
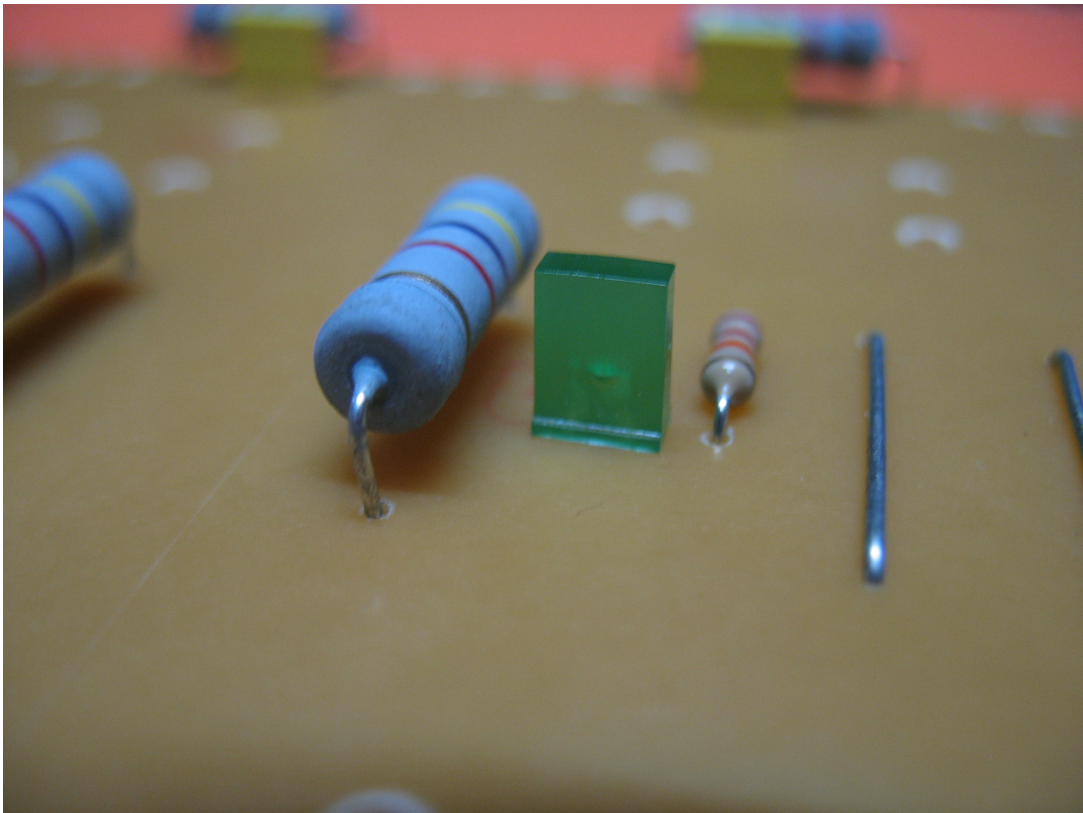
Solder side of the prototype PSU Board

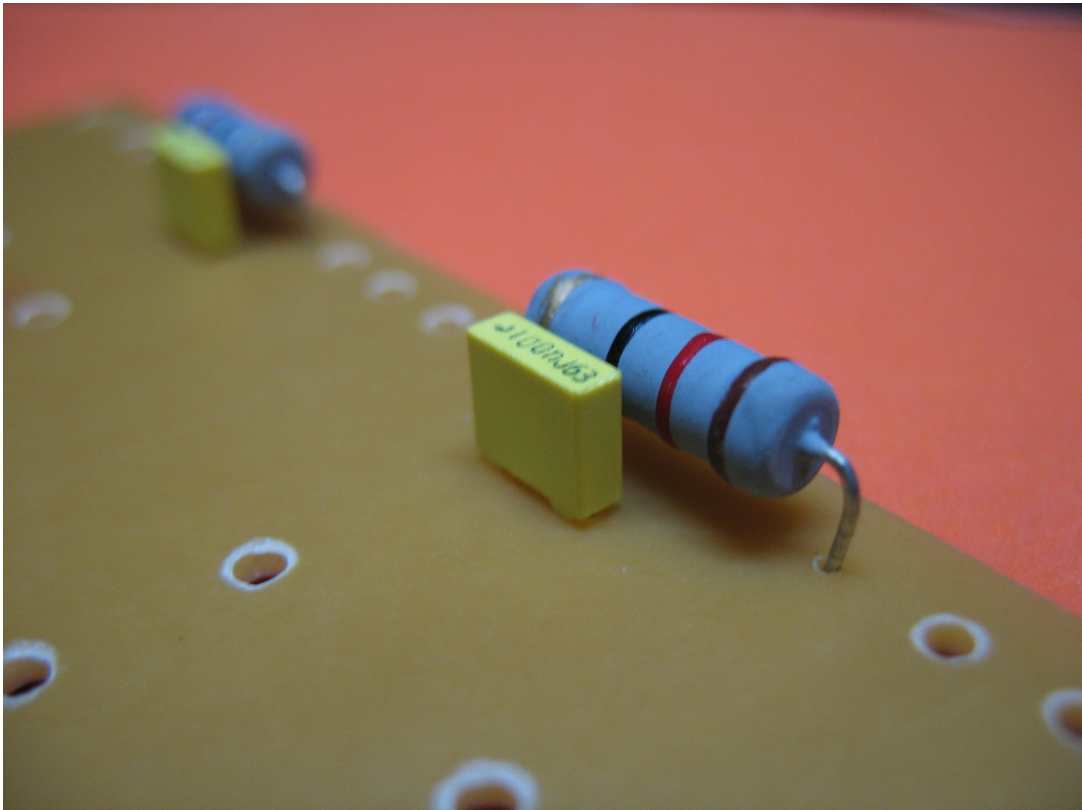
Start populating your board with the resistors first. A quick verification of their resistance using a DMM could save you a lot of time later on when a problem occurs because of a wrong value resistor! This is also a good time to install and solder any jumpers in the board.





Next install the LEDs and small capacitors (part of the snubber). The LEDs are for visual indication that power is applied to the board so you can use whatever color you like; rectangular, square, 3mm or 5mm - choose your poison. Pay particular attention to the polarity of the LEDs - they won't light up if they're installed the wrong way.





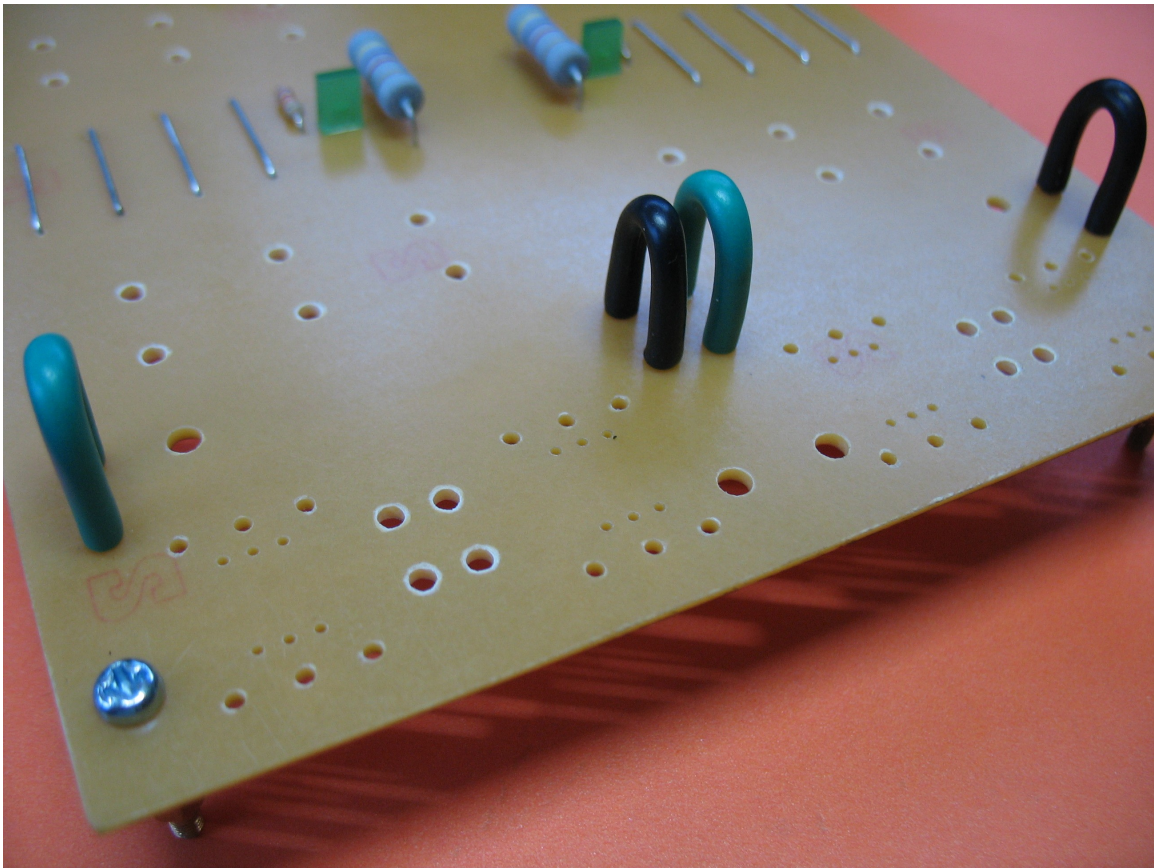
The Diode section of the board can be snapped off using a sharp, high quality cutter and separated from the Capacitor section of the board. Scoring the board with a ruler is easy, just be extra careful not to cut your fingers. [An instructional video of this process is available on the diyAudio website.](#) However, in this prototype, the Diode section wasn't removed from the Capacitor board and the whole PCB was used as is when it arrives to you from our store.

With that configuration, I installed large gauge wire jumpers between the Diode board and the Capacitor board. You'll need to connect the following:

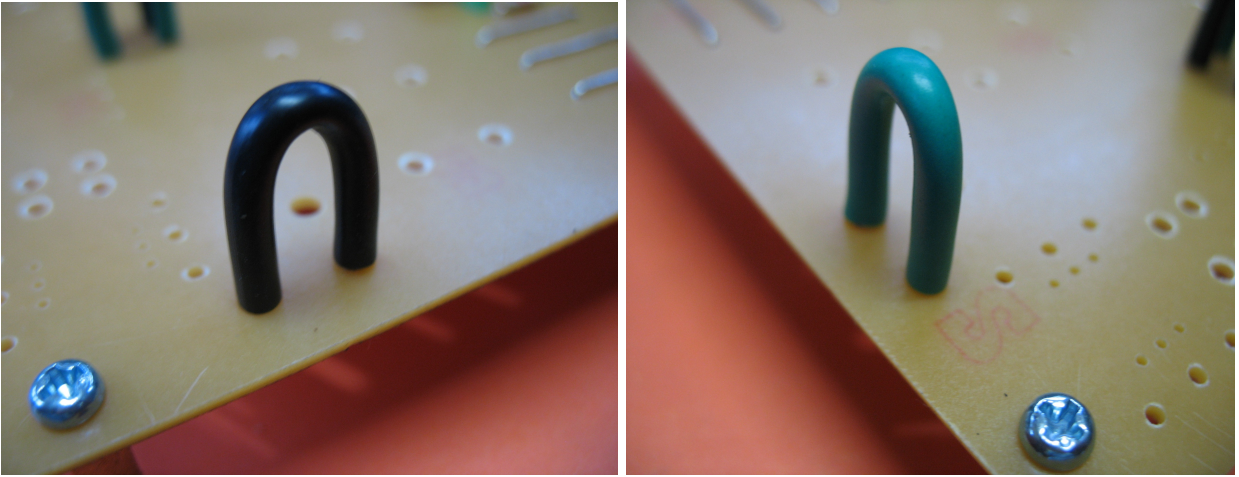
1. V+1 of the Diode board to D+ of the Capacitor Board.
2. V-1 of the Diode board to D- of the Capacitor Board.
3. V+2 of the Diode board to D+1 of the Capacitor Board.
4. V-2 of the Diode board to D-1 of the Capacitor Board.

See the next pictures for reference:



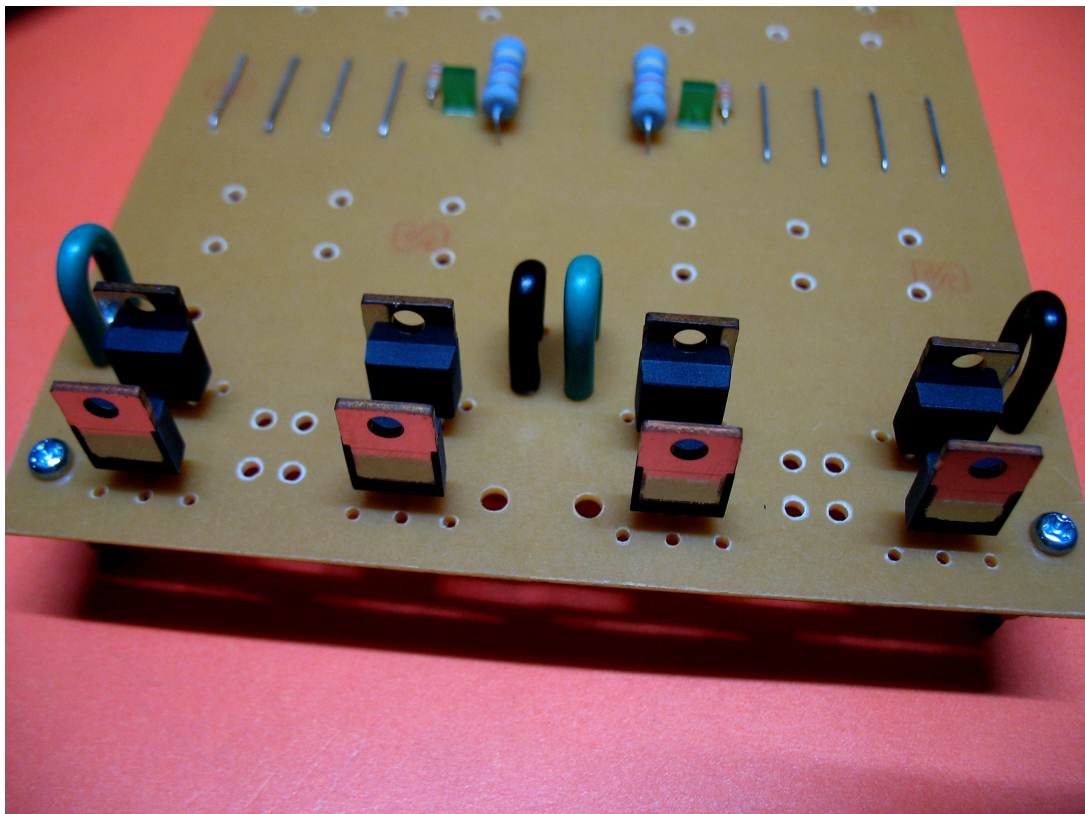




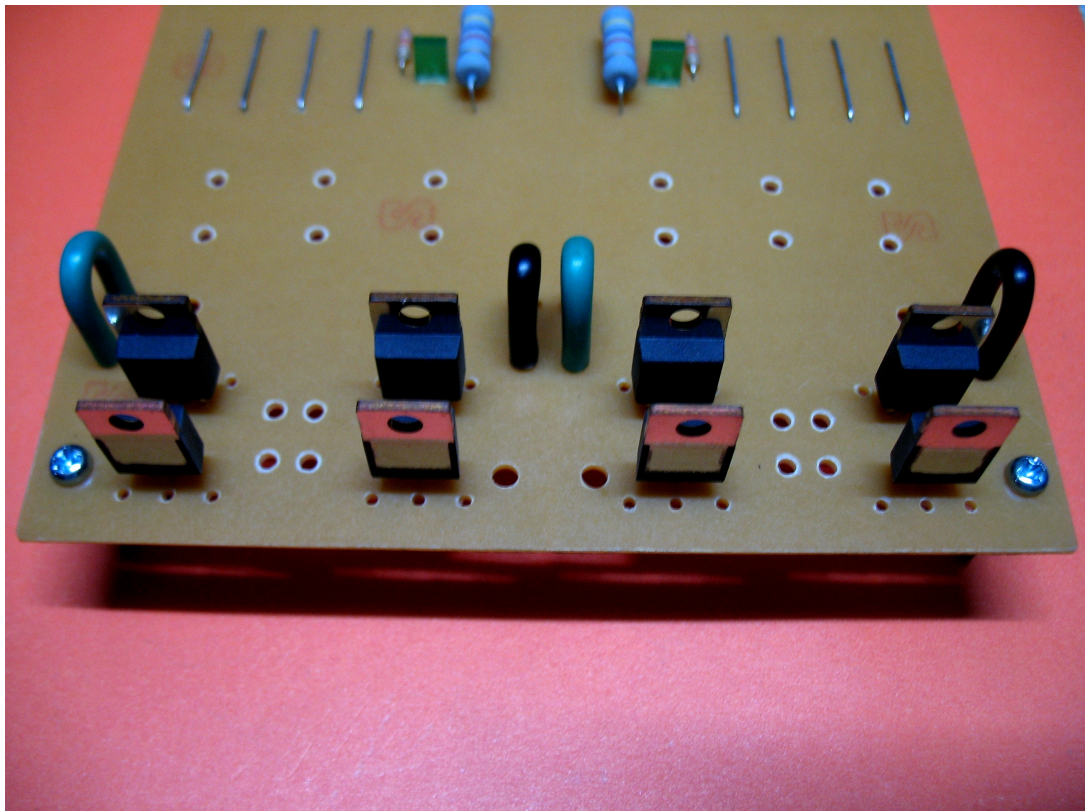
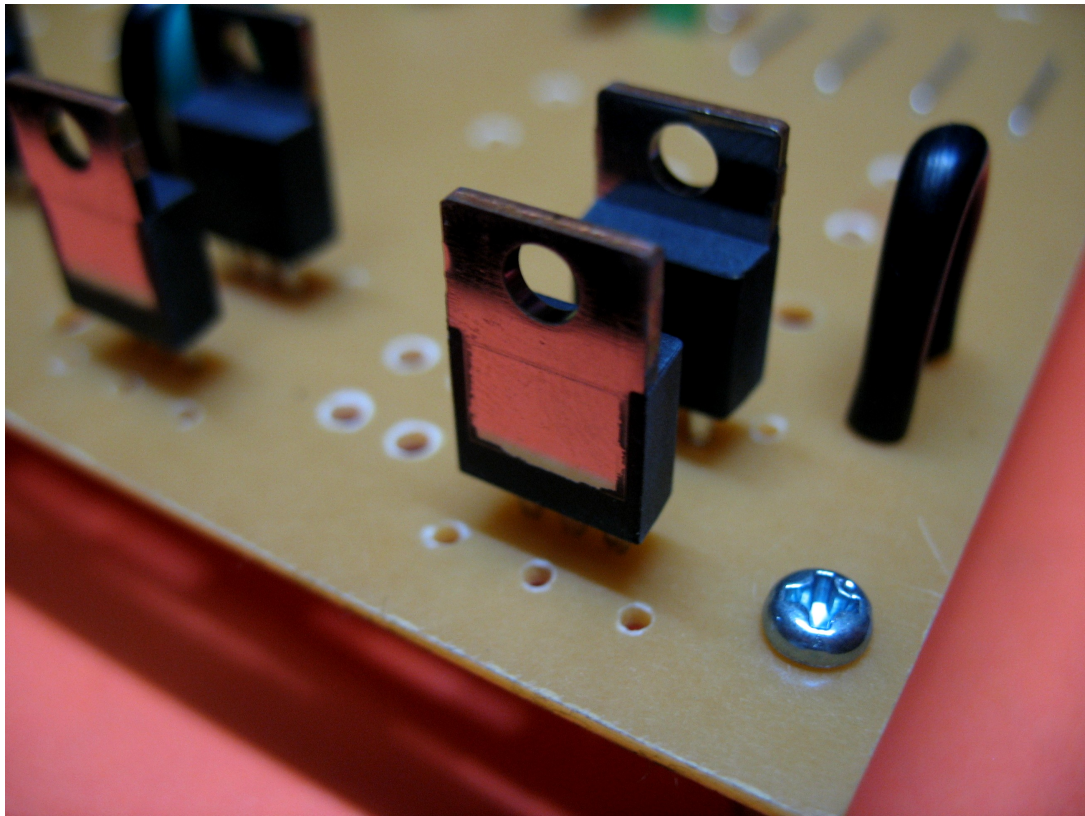


The Diodes for our prototype used TO-220 package style devices. Since our board was going to be used for the DA Honey Badger Power Amplifier which is a Class AB power amp, I opted not to use any heatsink as it won't be necessary. But installing heatsinks won't hurt though so it's up to you.

Notice that there are multiple holes for the Diodes; these were placed to accommodate both TO-220 and TO-247 package style devices.

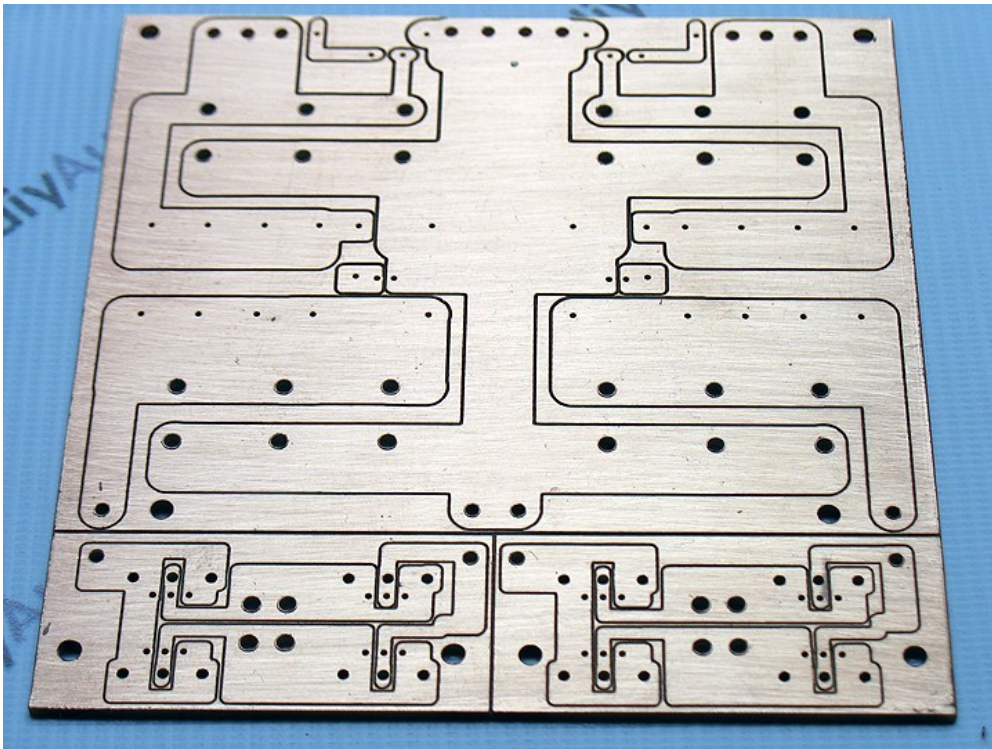




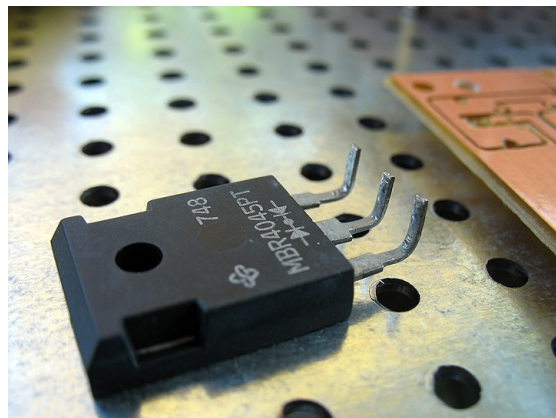
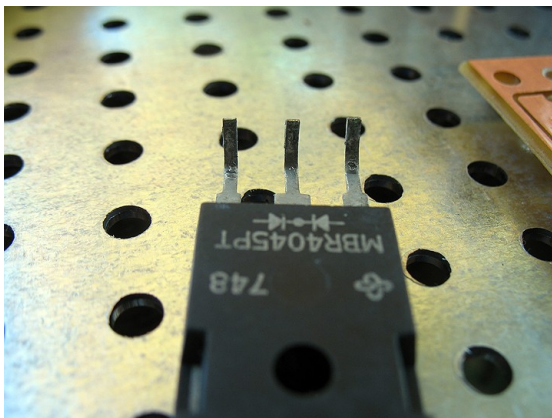


Here is an example of using the PSU Board with the Diodes section snapped off from the Capacitor section. Notice in the next picture the scoring of the PCB along the edges of the Diodes section.

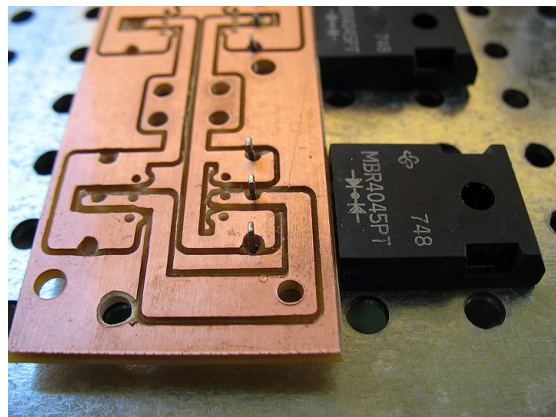
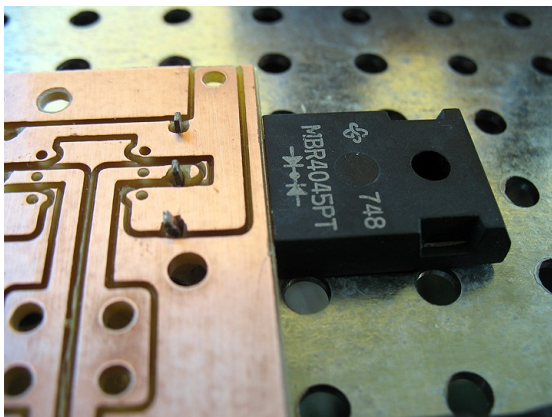




We used the DIY Friendly Base (DFB) of our chassis as a heatsink for the TO-247 package style diodes. Shown next is a diode with the leads bent upward.

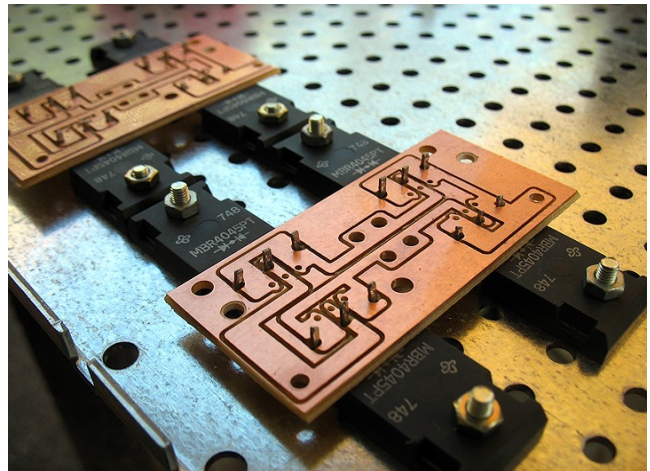
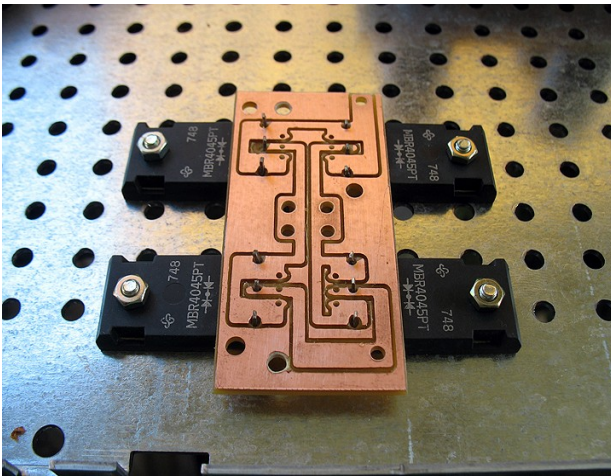


The diodes are then aligned to the holes of the DFB.

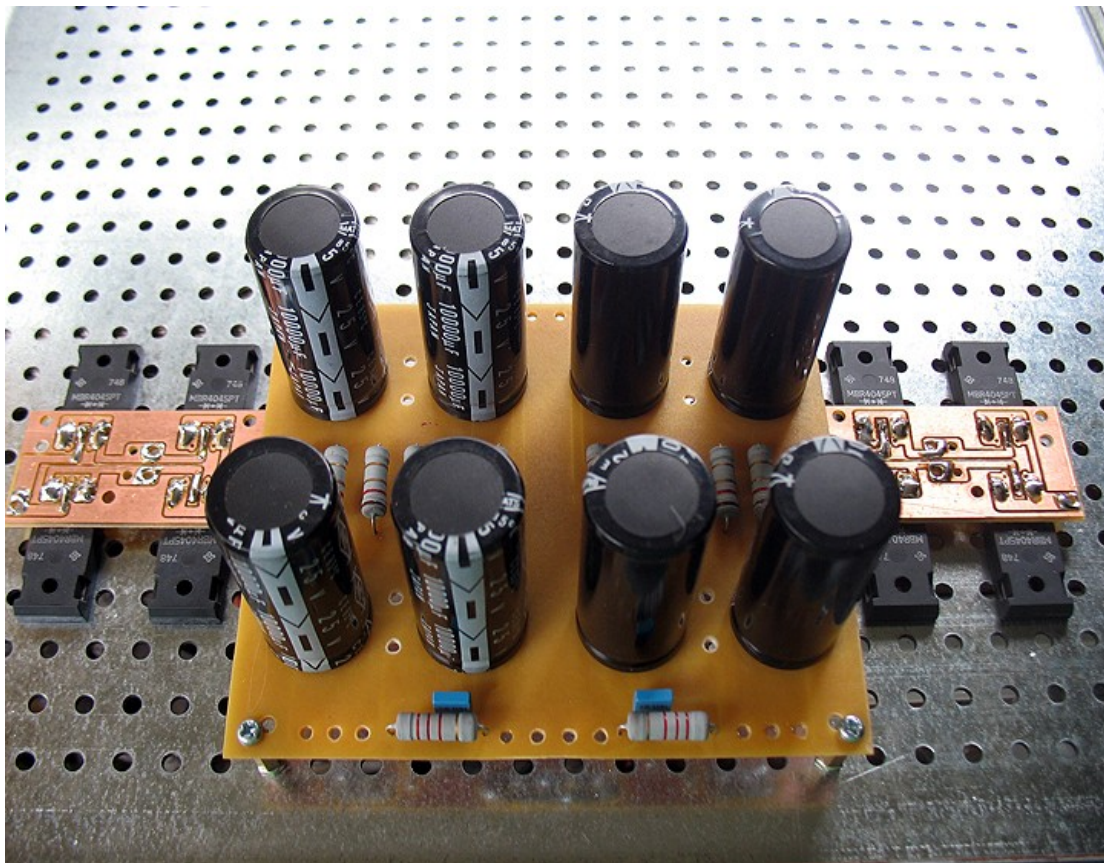




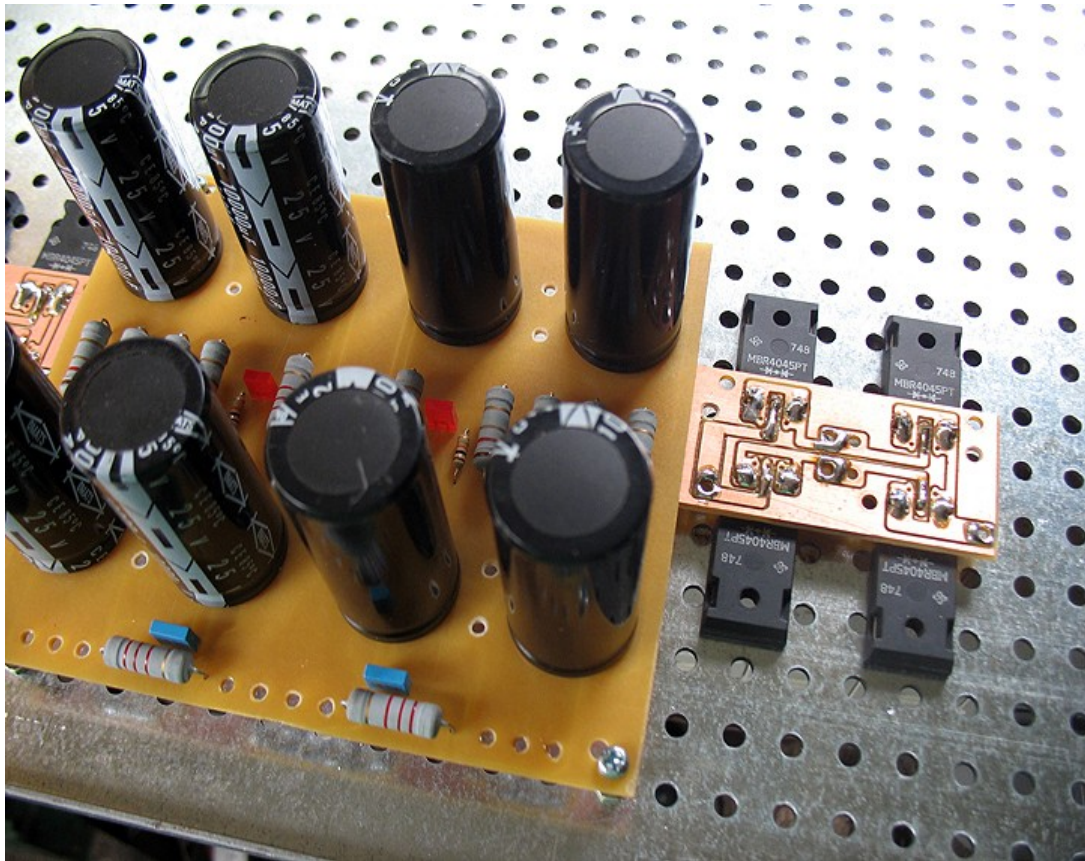
After aligning the diodes is completed, the Diode section is now ready for soldering. **(Note that this is just for alignment of the diodes with respect to the holes of the DFB, Mica insulators and thermal grease should be used during the final assembly to isolate the metal tab of the diodes from the DFB or heatsink!!!)**



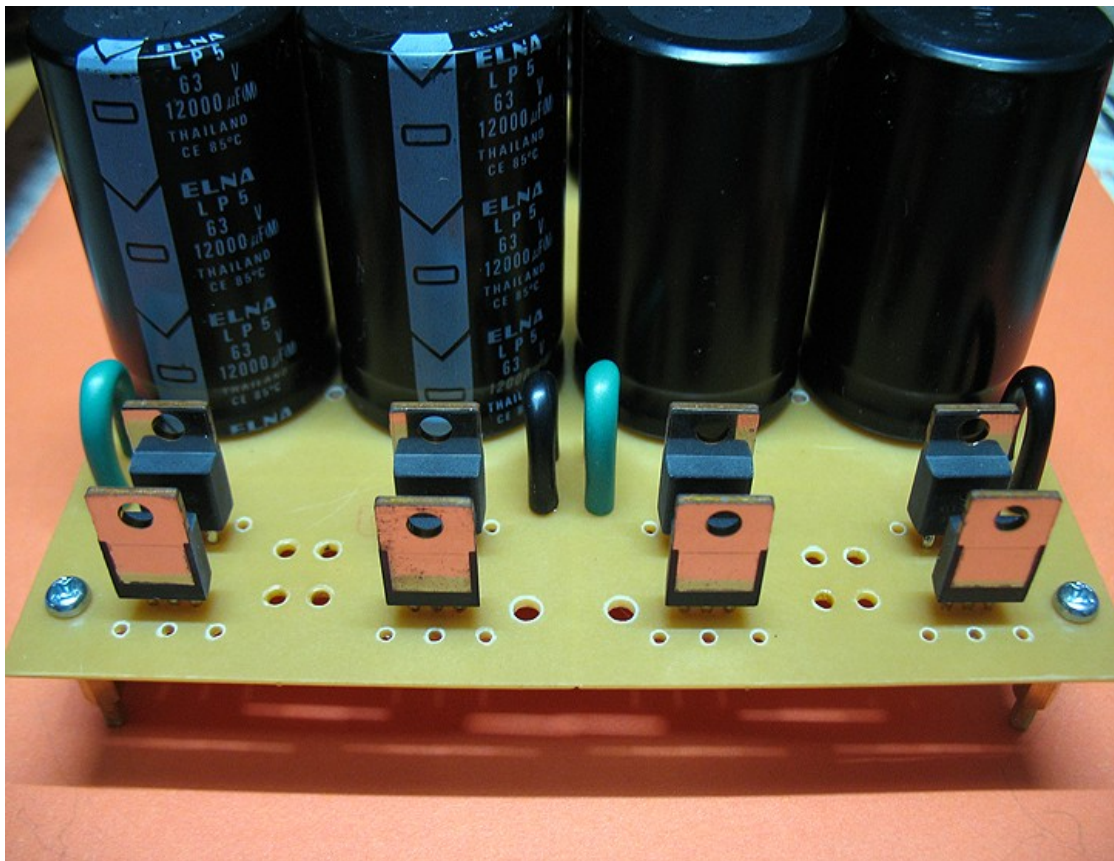
Finally, install the filter capacitors while paying close attention to their lead orientation and polarity. Your board should now look something like this if you snapped off the Diode and Capacitor sections.



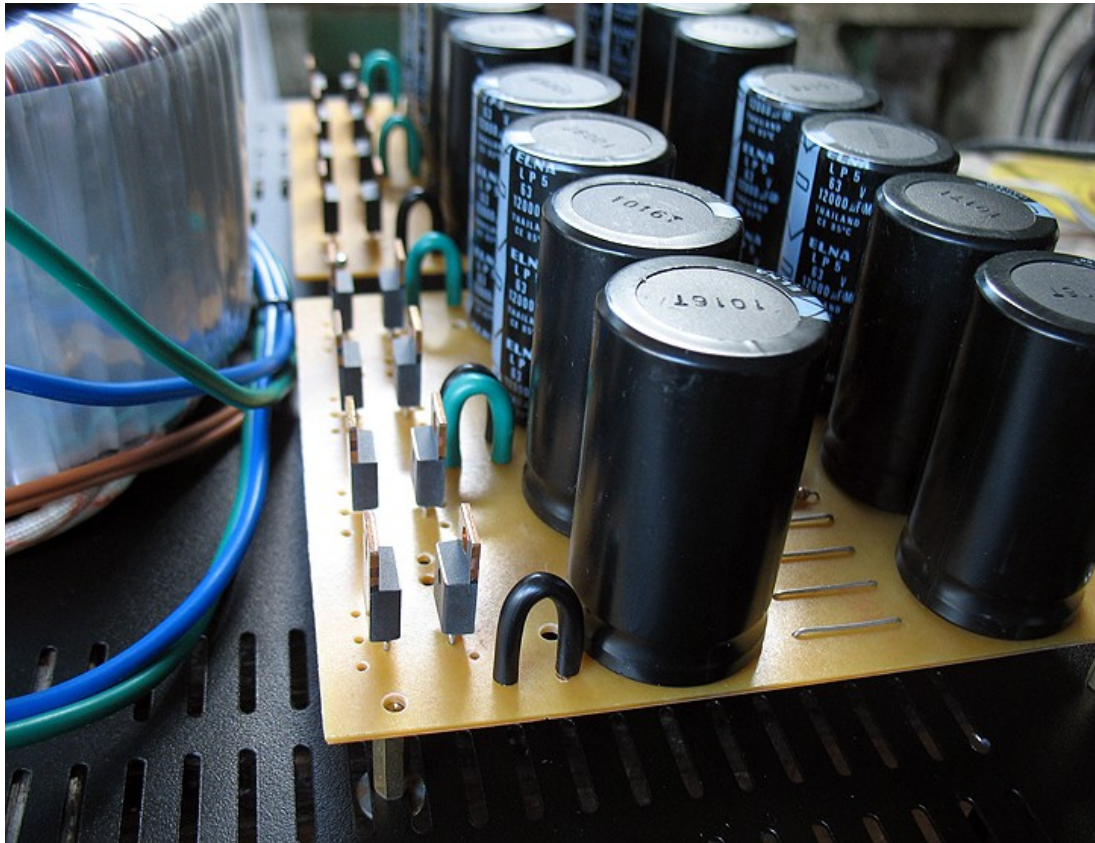




Or if you used TO-220 package style diodes and kept the Capacitor and Diode sections intact.



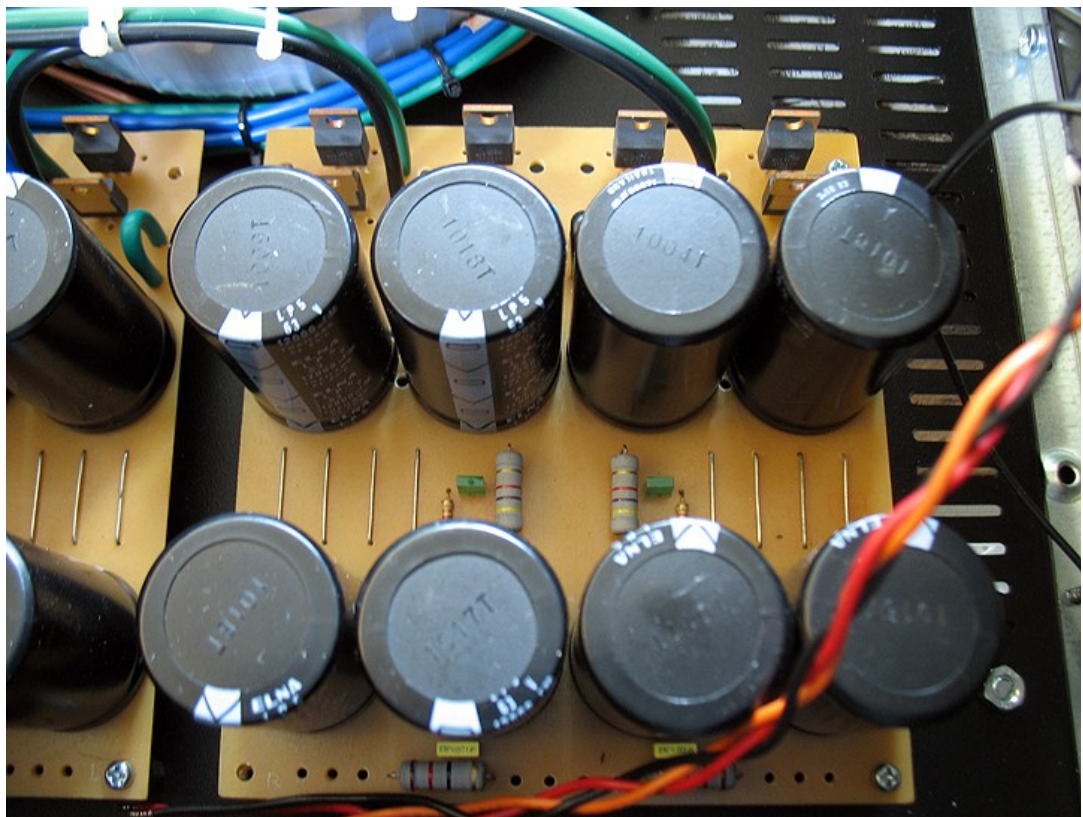


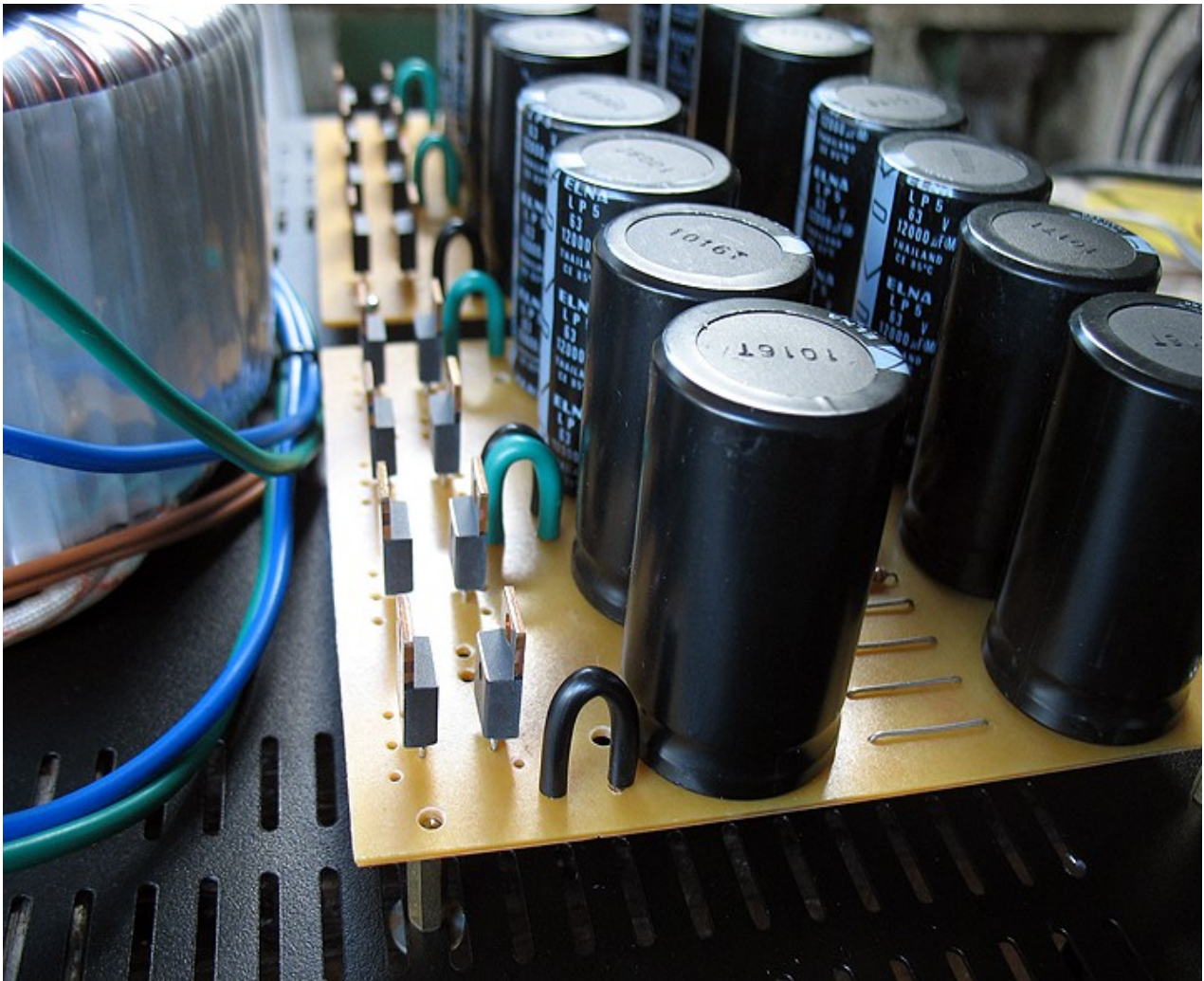






Wired and ready for testing. Notice I used two boards for a dual-mono approach in the PSU for the DA Honey Badger Power Amplifier prototype.





## Checking Your Work:

Building electronics stuff is fun and enjoyable, up to the point when you are about to power it on for the first time. To help in reducing the risk of failures and boost a builder's confidence, this is my usual procedures in checking a finished board.

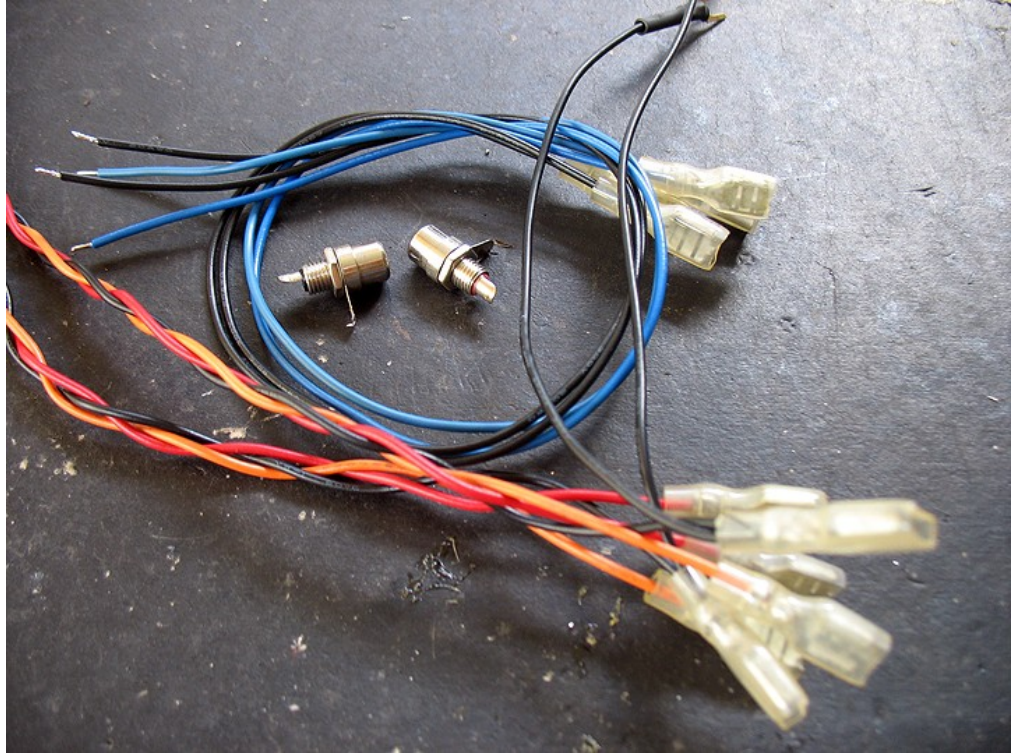
**Resistors** – Visually check each resistor, cross reference it with the BOM and make sure that you placed the right value in the right spot. It is also good practice to do a quick resistance test of a resistor using a DMM before soldering it in place. It's very easy to mistake a 5-band 68K resistor with a 68R resistor!

**Capacitors** – Electrolytic capacitors are polarized so check and pay careful attention to their pin orientation. Make sure the markings on the capacitor matches the polarity marked on the board.

**Diodes** – It's so easy to overlook the lead orientation of diodes especially those small signal types and zener types. Check and make sure that their polarity matches the assigned polarity markings on the board.



**Wiring** – it helps if the wires you use are of different colors. For example, all V+ wires are Red, Ground wires are Black, and V- wires are Orange. That way, there won't be any confusion when doing tests and assembly of your amp. Also, use wires of a suitable thickness, but do not overdo it. Remember that it's harder to



dress a thick wire. Use at least AWG#16 stranded hookup wires for high current carrying wires. Of course no one's stopping you from using those ultra high end cables for wiring the amp. Use shielded wires for all small signal carrying wires.

## **Testing and Calibration:**

### ***Things you'll need:***

1. Digital Multi Meter (DMM). Two of these would come in handy.
2. Suitable Power Transformer.
3. Variac if you have one.

### ***Checklist before connecting your PSU board:***

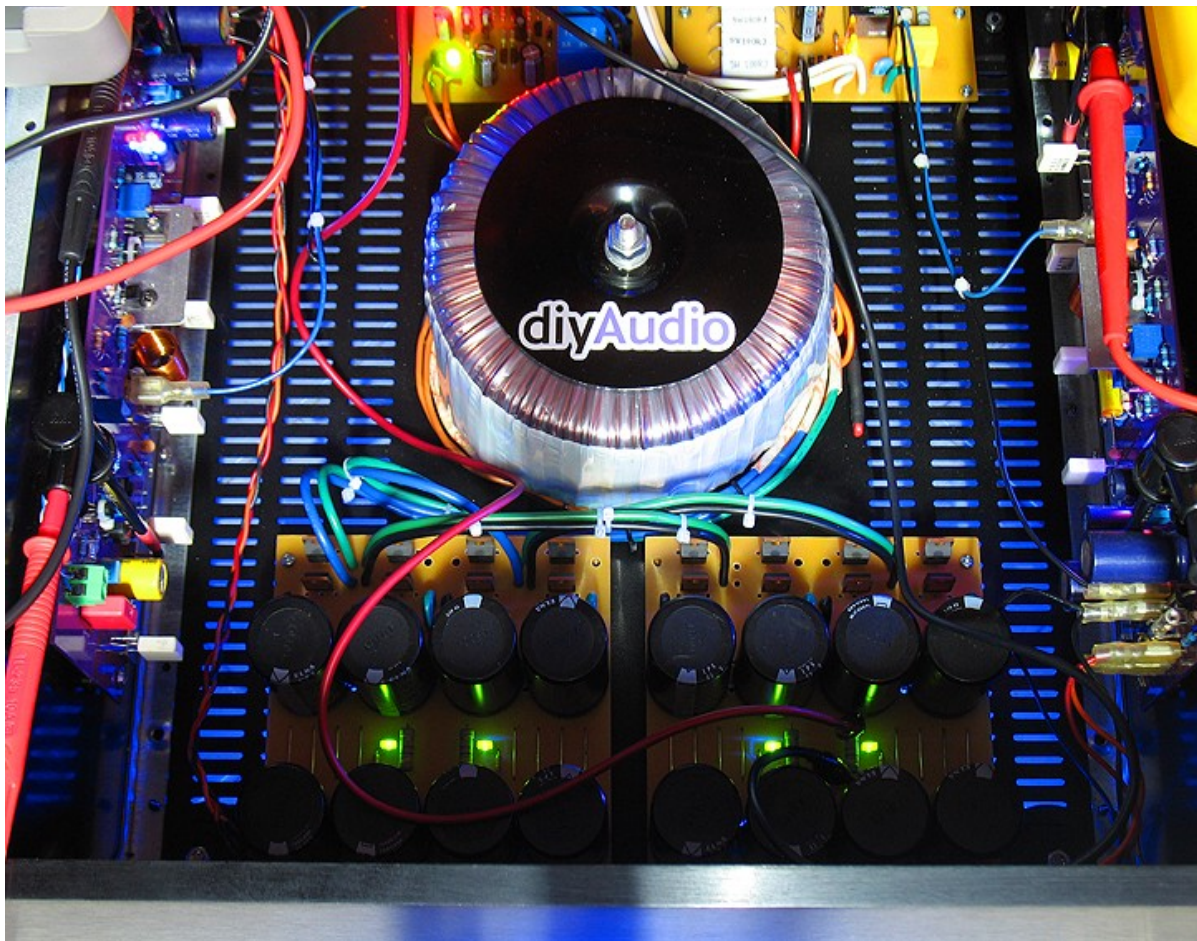
1. Using your DMM, measure the resistance between V+ and GND, it should show a very high resistance. If you installed the bleeder resistor, it should be close to the resistance of the bleeder resistor.
2. Using your DMM, measure the resistance between V- and GND, it should show a very high resistance. If you installed the bleeder resistor, it should be close to the resistance of the bleeder resistor.
3. V+1 of the Diode board connected to D+ of the Capacitor Board.
4. V-1 of the Diode board connected to D- of the Capacitor Board.
5. V+2 of the Diode board connected to D+1 of the Capacitor Board.
6. V-2 of the Diode board connected to D-1 of the Capacitor Board.
7. Connect a power transformer with dual secondary windings, one winding to AC1A/AC1B and the other winding to AC2A/AC2B.

### **Powering your PSU board for the first time:**

1. If you have a Variac (or can borrow one), plug the primary of your power transformer to the output of the Variac.
2. Connect a DMM to the output of the PSU board. Clip the positive probe to V+ and the negative probe to GND.
3. If another DMM is available, clip the positive probe to V- and the negative probe to GND.
4. Slowly turn up the Variac output while monitoring your DMMs. The first DMM should show a positive voltage while the second DMM should show the same (or very close to) voltage but with a minus sign (-) before it (negative rail).
5. At the same time, the Power On LEDs should also lit up indicating power is present.
6. If a Variac is not available, just make sure that your power transformer has a working fuse and you have gone over the checklist for connecting your PSU board. Then momentarily power up your power transformer by “briskly” plugging and unplugging your power transformer. You should see the same readings on both DMMs as above. If no readings show, check your connections and try again. If there is a problem, the fuse will blow. ☺

### **Listening Tests and Reviews:**

The very first prototypes of the PSU boards were used in the Honey Badger power amplifier, First Watt Class A power amplifiers and to test several Gainclone prototype boards.



As you can see in the picture on the previous page, a couple of PSU Board PCBs were used to make a “dual mono” power supply. The advantage of this is better channel separation and independence, as well as an extra power reserve for those loud music passages that are completely separate for each channel. The “dual mono” configuration proved to be a better choice for me, using a single PSU Board will work of course, but the additional benefits of using a dual mono configuration were just too great for me to pass up!

## **Feedback and Final Notes:**

The amount of capacitance to use in an amplifier power supply has been debated many times over the ages. With the recent manufacturing developments and price reductions in capacitors agonizing over capacitance is mostly a thing of the past. The price difference between medium capacitance and large capacitance capacitors has somewhat become negligible in DIY terms. Personally, I like having lots of capacitance in my power supply as reserve so my power amplifier has enough headroom for those transient passages. It’s like the saying, “it’s better to have it and not need it, than need it and not have it”.

Enjoy!

JD