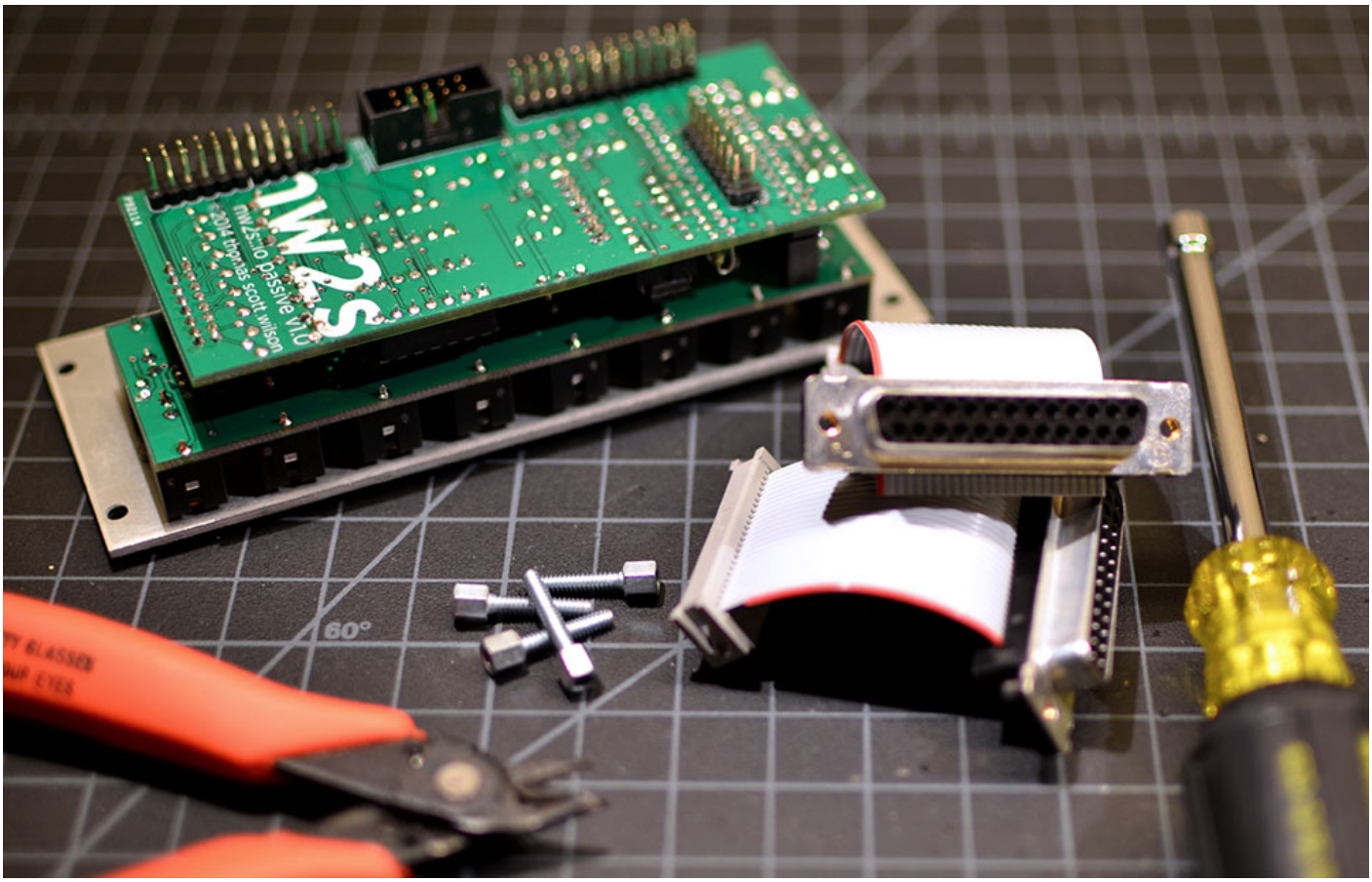


NW2S::O16 UNBALANCED KIT ASSEMBLY INSTRUCTIONS

V1.0 / 23 NOV 2020

OVERVIEW

This is a relatively simple build and while it should not be a first attempt at DIY, it can be tackled by anyone with some soldering experience, a fair amount of patience and attention to detail. It can be completed in two to four hours. It is not without its quirks, so please pay attention, read through the instructions and take note at some of the areas of attention that I have called out.

This is a surface-mount kit. If you have not done any SMT work before, then this will throw you in the deep end. While the parts are all large enough to work with the tip of a soldering iron, I prefer to work with a little syringe of solder paste, a hot air station, and some tweezers. Your techniques may vary – work as you feel comfortable. The passive components are all at least 0806 size and the ICs are at least SOIC size, so there's nothing microscopic. I've gotten to the point where I prefer SMT to through-hole work, even for prototyping.

TOOLS AND SUPPLIES

Required:

- Nice soldering setup and the skills to use it!
- Lead-free solder – make the switch – for the kids!
- Diagonal cutters
- 3/16″ socket driver
- 5/16″ socket driver
- paper towel or masking tape to cover driver

Recommended:

- Heat resistant, anti-static, silicone mat for SMD work (Similar to this, with little compartments)
- Hot air soldering station (Similar to this one from Adafruit)
- Solder paste syringe (Lead free, no-clean, silver bearing, low-temp is best)

A WORD ABOUT RESISTORS…

Even if you have experience working with surface-mount resistor packages, it's worth reviewing the labeling scheme for a minute. I say this primarily because there are a LOT of resistors in this kit. Many of them are of the same value, all lined up in a little row, and if you make a mistake in reading the value of the resistor, you may not realize it until you are 16 or 32 resistors in… and then you get to start all over.

Not that I have ever done that. If I had I certainly wouldn't tell anyone.

The resistors are always labeled with a number of digits (except occasionally I end up with an odd reel that is completely unmarked). The last digit is always the power of 10 and the prior digits make up the value. For example, "102" is 10×10^2 or 1000Ω. However, "1000" is 100×10^0 or 100Ω. Stop here and read that sentence again. Let it sink in a little while, then we can move on.

If you are unsure, just use a multimeter to measure and check the resistor you are curious about.

KIT CONTENTS

Take a little time to look through the kit contents and make sure you have everything. If anything is missing, just send an email. The counts listed below are the required numbers. I have included extras as they have a tendency to run off when you are not looking. Or worse, when you have one held tightly in your tweezers, they will fly across the room.

Discretes	Count
Green LED	16
Shunt Regulator TL431 (SOT-23-3)	1
Diode 1N4184 (SOD-123-2)	16

Passives	
20kΩ resistor size 0805, 25 included, marked 2002	16
30kΩ resistor size 0805, 25 included, marked 3002	16
1kΩ resistor size 0805, 25 included, marked 1001	16
300Ω resistor size 1206, 3 included, unmarked resistors	1
1kΩ resistor size 1206, 3 included, marked 1001	1
3.3kΩ resistor size 1206, 3 included, marked 3301	1
100µF electrolytic capacitor	2
0.1µF ceramic capacitor size 0806, 25 included, unmarked tan ceramics	17

ICs	
Bipolar op amp TL064 (SOIC-14)	4
Audio op amp OPA4134 (SOIC-14)	4
Dual MOSFET reverse voltage protection (SOIC-8)	1

Electromechanical	
Jacks	16
Jack hex nuts	16

Connectors	
2x8 receptacle	1
1x8 receptacle	1
1x12 receptacles (or 1ea 1x12 receptacle depending on availability)	2
1x8 headers	1
2x8 header	1
2x12 headers	3
Power header	1

Other	
nw2s::o16 panel	1
panel pcb	1
main pcb	1
DB-25 connector assembly	2
DB-25 panel nuts	2
eurorack power cable	1
panel screws	4
panel washers	4

ASSEMBLY – PANEL PCB

Start with the panel PCB. It's the easiest and the best place to start for some instant gratification. The first step is to take the pin header receptacles and solder them to the bottom of the panel PCB. **Note!** Ignore the silkscreen for the pin header receptacles. They are incorrectly placed. Please be sure to put all of the pin receptacles on the BOTTOM of the PCB. They should be on the side with no screen print.

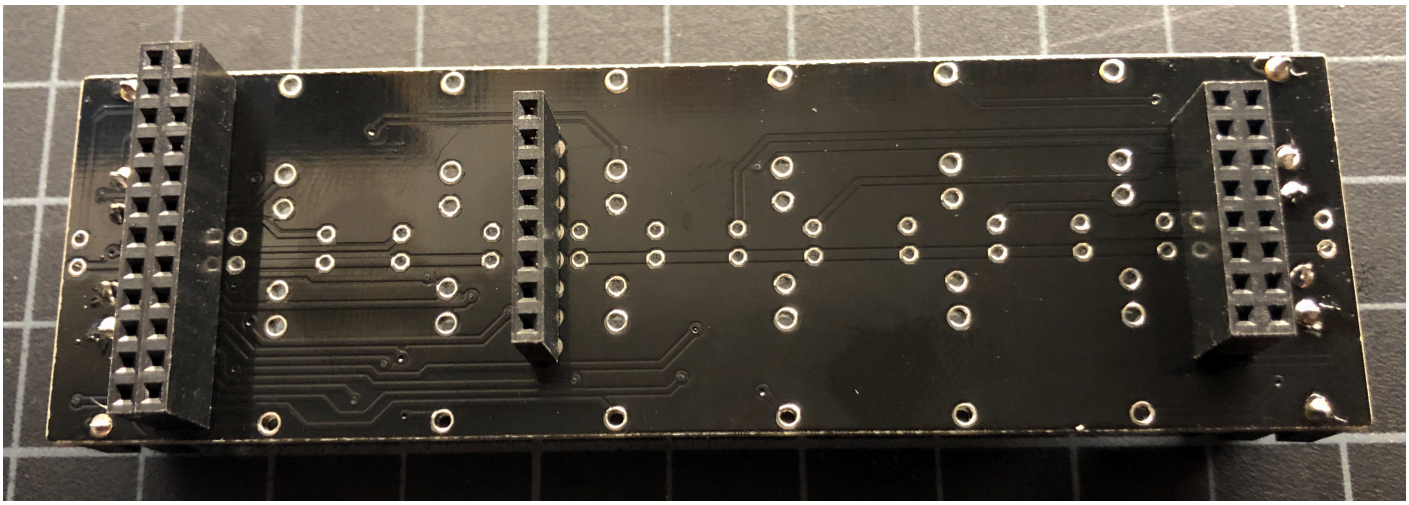


Figure 1 - Panel PCB Header Placement

Next, we'll do the jacks. It's easiest to do four corners and then use those to anchor the other 12. Start by placing the corners and solder them into place. Be careful with your soldering iron. The header receptacles poking out the solder side like to get in the way and melt in the worst way possible. Trust me though, this is easier than the other way around!

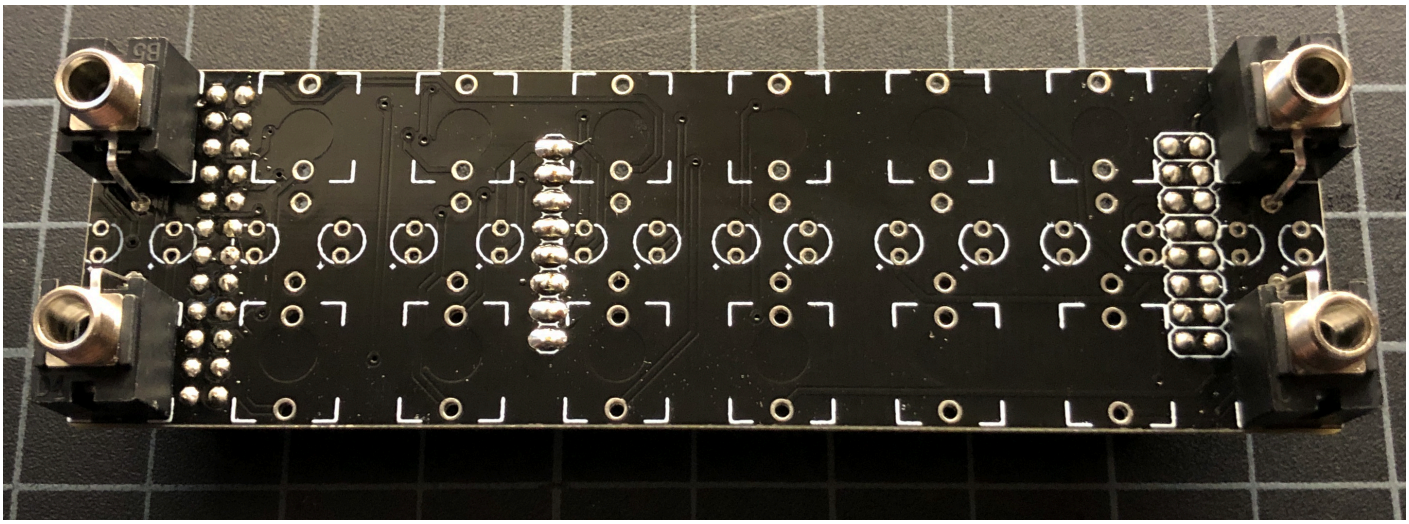


Figure 2 - First Four Jacks at the Corners

After they are firmly affixed, you can place the rest of the jacks and use the panel to hold them in. You only need to loosely tighten the hex nuts on the four corners. Note that the panels for the 'o16 are laser cut and do not have a protective plastic film. The panels are easy to scratch while you are working with tools.

Solder them and then remove the panel.

Next, you'll want to place the LEDs. It is VERY important that these go in the right direction. The board does indicate which side the flat side should face, but it may not be obvious because of the pads. I've included a shot of the layer screen print layer just to make sure it's clear which direction the LEDs should be placed. The LONG leg of the LED is

always opposite of the flat side. When the board is oriented as the image shows, the flat side (negative, cathode) faces up and the long pin (positive, anode) faces down.

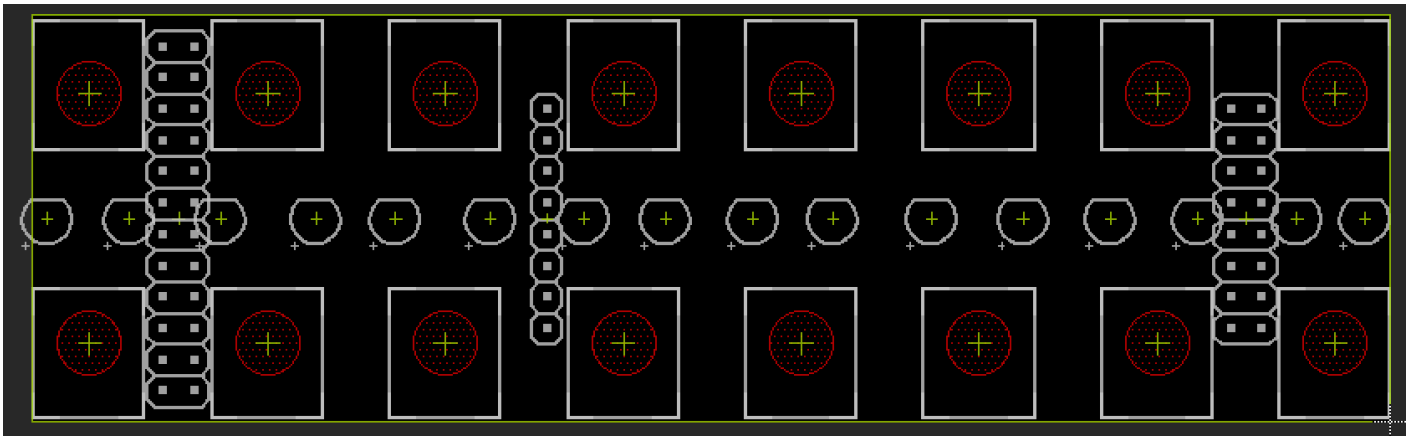
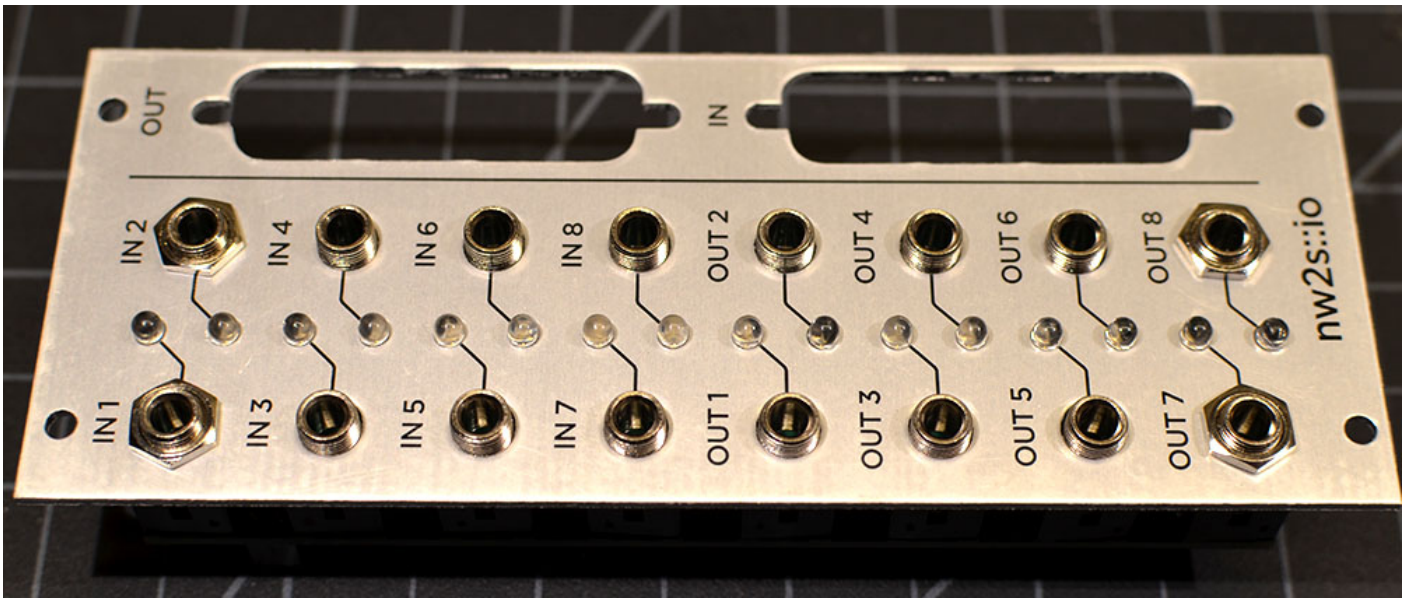


Figure 3 - Panel PCB LED orientation

Once they are all placed, but before you solder anything, replace the panel, flip the whole thing over, and make sure that the LEDs are all in their holes and are pushed through as far as they will go so that they are evenly poking out the other side. Make double sure and then start soldering. I will typically only do one leg of each LED in a pass so that if one gets maladjusted, you only have to reheat one leg at a time to get it to reposition. Once in place, you may trim the legs.

Again, be careful of the pin header receptacles as you're soldering. You are done with the panel, but don't yet put all the hex nuts on. You may need to debug, and if so, you don't want to have to take them all off over and over again.



ASSEMBLY – MAIN PCB

Set the panel to the side for now. We'll need it to help line up some pin headers shortly. The final page of this document includes a diagram showing the placement of each component on the board. Please use that page as a reference.

Start with the resistors and diodes across the top of the PCB – nearest the 2x12 pin headers. This is D9 – D16 and RL1 – RL8. Below them are RP1A and RP1B through RP8A and RP8B.

D9 – D16 are the 1N4148 diodes. The line on the diode faces down. Instead of trying to screen print that onto the board, I have provided a shot of the silkscreen layer below.

RL1 – RL8 are 1000Ω resistors that provide a load on the LED circuit. We are able to use a higher resistance because we are using high-efficiency green LEDs that require less current for a given lumen value.

RP1A – RP8A are 20kΩ resistors and are interleaved with the 'B' resistors. Moving left to right you start with an A and then place a B, alternating for all 8 channels.

RP1B – RP8B are 15kΩ resistors.

The RP#A and RP#B resistors form a voltage divider pair to reduce the incoming signal to better match studio equipment and ADCs.

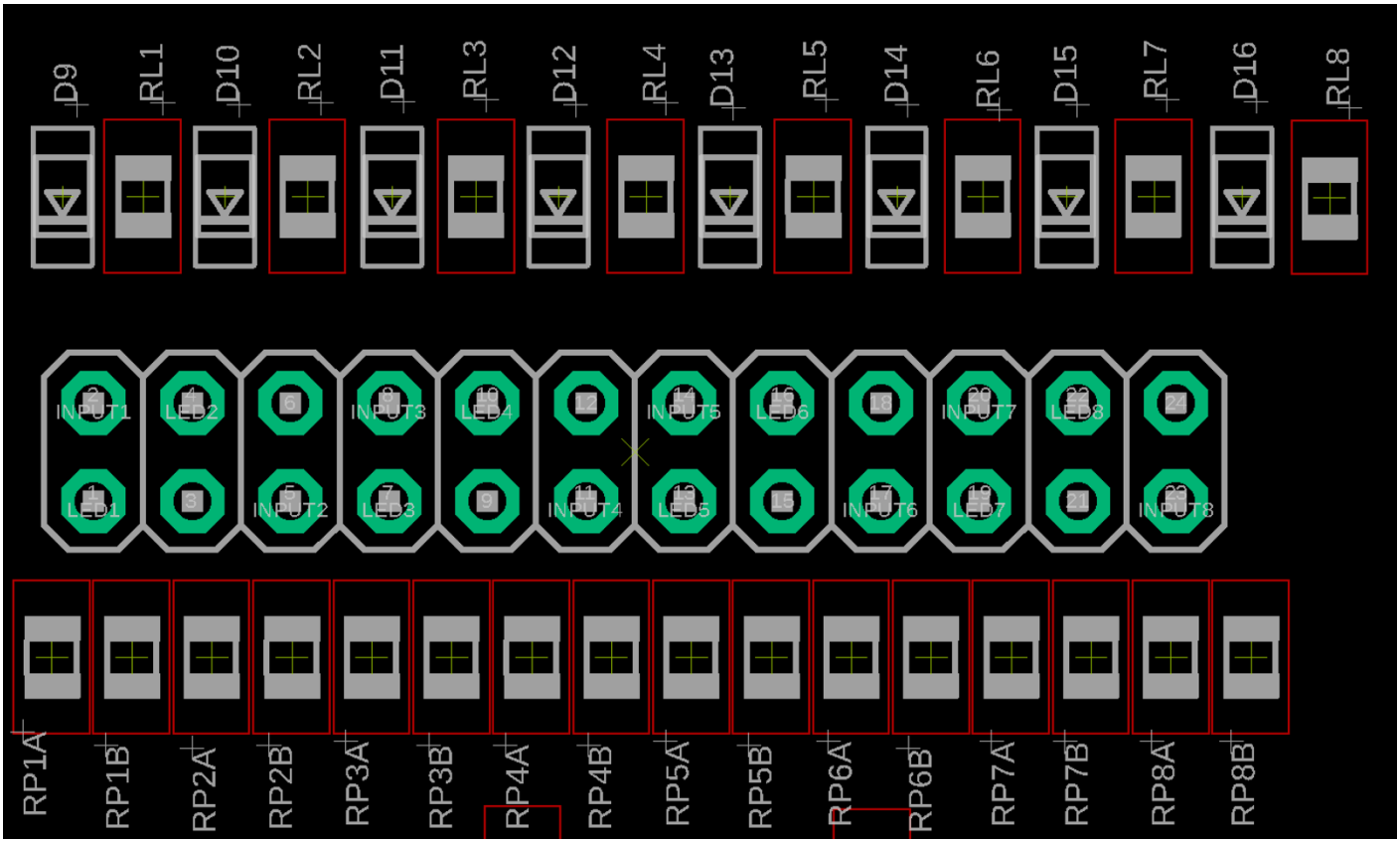
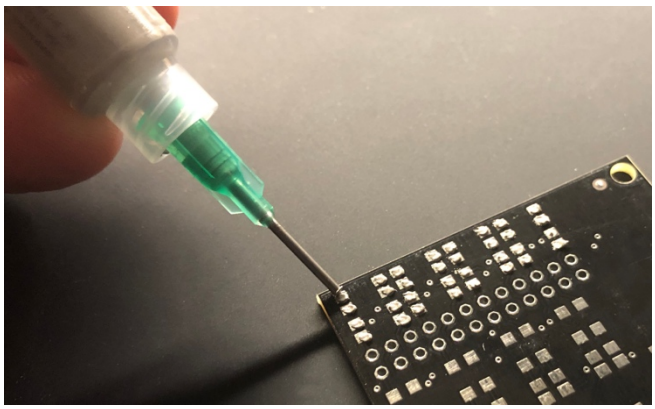


Figure 4 - Channels 1-8 Diode Orientation – At the top of the PCB

When soldering resistors and diodes using a solder paste syringe, I place a small dot on each pad in the area I will be working in. Typically, that will simply be one line of components. Work in contained batches to keep the work stable.

Once the dots of solder are placed, then you can use tweezers to move the components into place. Don't worry if the dots are too big or there are smears that span pads. As soon as you apply heat, the surface tension of the solder will force it to collect on the solder pads. Anything left can be cleaned up easily afterwards.



When the components are placed, you can begin to apply heat. When using a hot air station, you can use the tweezers to ensure the components stay in place. With some practice you will be able to use the solder surface tension to your advantage. Getting the temperature and air flow to where you like it will take practice. I typically work at about 400°C with the air flow at the lowest setting.

Afterward, you can do the same on the second set of 8 outputs. These are towards the bottom of the circuit board near the 2x8 headers.

D1 – D8 are 1N4148 diodes. The lines should face towards the top of the PCB.

RL9 – RL16 are 1000Ω LED load resistors.

RP9A – RP16A are 20kΩ resistors and are interleaved with the other half of the voltage dividers. Moving left to right you start with an A and then place a B, alternating for all 8 channels.

RP9B – RP16B are 15kΩ resistors.

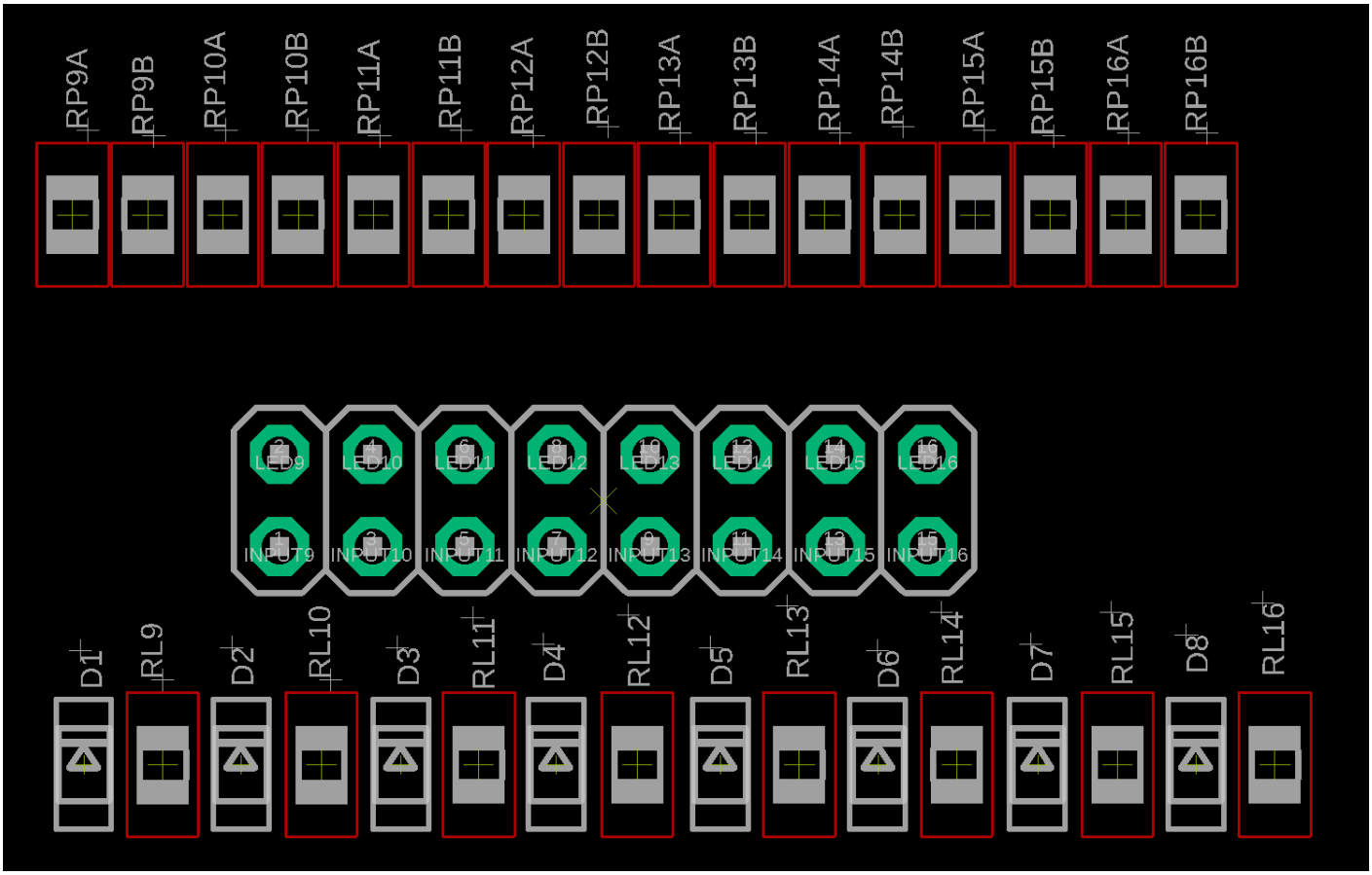


Figure 5 - Channels 9-16 Diode Orientation – At the bottom of the PCB

Next, you can move on to the power supply and reverse voltage protection. I typically will do all of the components except for the large electrolytics in one pass and then do the electrolytics last.

There is a dual MOSFET IC which will only turn on when voltage is applied to the power header correctly. The benefit of the MOSTFET over simple diode protection is that there is almost zero voltage drop across the transistors when they are turned on. This ensures the power rails are running as high as possible which in turn gives your circuit the highest headroom possible.

There is also a shunt regulator network which provides a -2V bias for the LEDs. This ensures that even the smallest signals will cause the LEDs to glow. Without it, the signal would need to be at least 4V peak to peak for the LED to turn on.

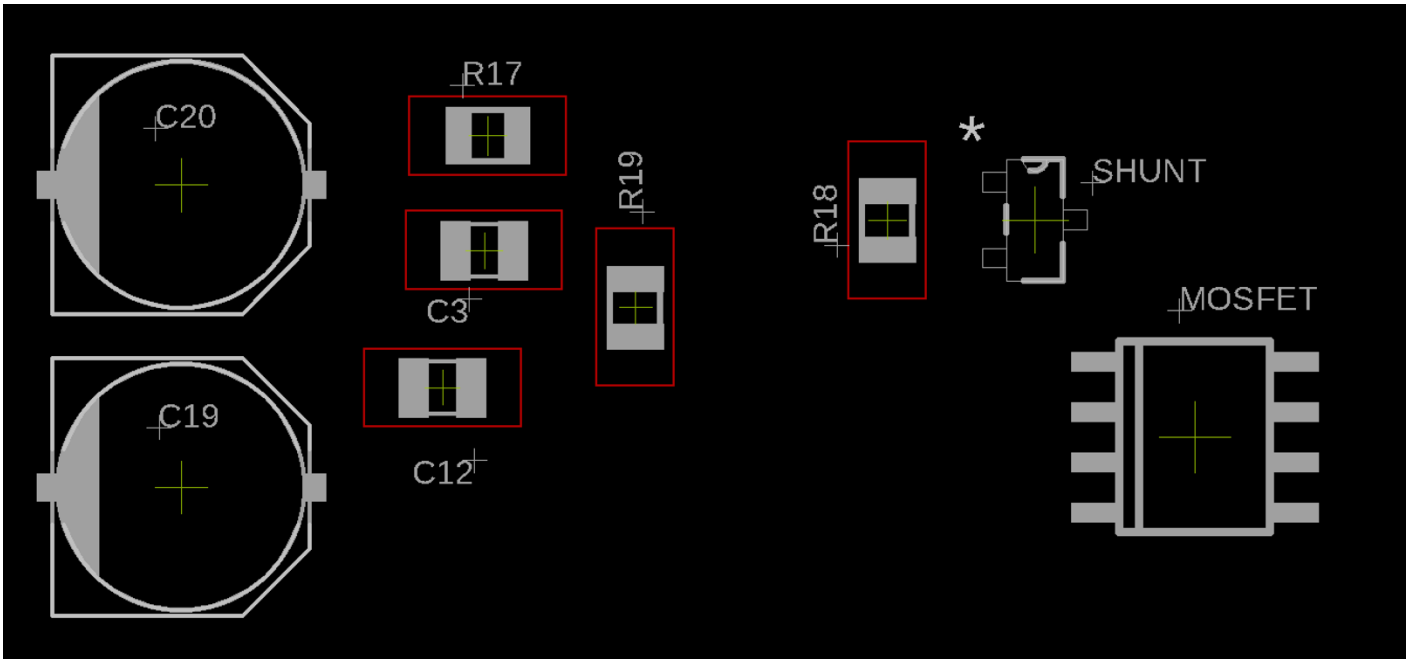


Figure 6 - Power Section Component Orientation

R17 is 300Ω 1206 sized resistor. Note that my batch of 300Ω resistors have no markings.

R19 is 1000Ω 1206 sized resistor.

R18 is 3300Ω 1206 sized resistor.

C3 and C12 are 0.1µF 0805 sized MLCC capacitor.

The shunt is a TL431.

The MOSFET is the only SOIC-8 in the kit. Note that pin 1 is designated either by a dot or by a beveled edge. Pin 1 should face away from the power header and towards the large electrolytics.

C19 and C20 are both 100µF electrolytics. These need to be oriented as shown in the silkscreen above with the angled base facing towards the power header. These must be oriented correctly, or smoke will ensue.

The last bit of surface mount soldering will be the op amps and their respective bypass capacitors. These can be done in groups of 4. The first 8 channels are above the center power section and the second 8 channels are below. In both cases, the op amps must not only be oriented correctly, but must be placed correctly.

The op amps labeled LED are used to drive the LEDs and the op amps labeled AUDIO are the audio buffer circuits. While the circuit will work perfectly fine if you put an op amp in the wrong position, you just will not get the benefit of a nice $7 Burr Brown IC over a $0.50 utility op amp.

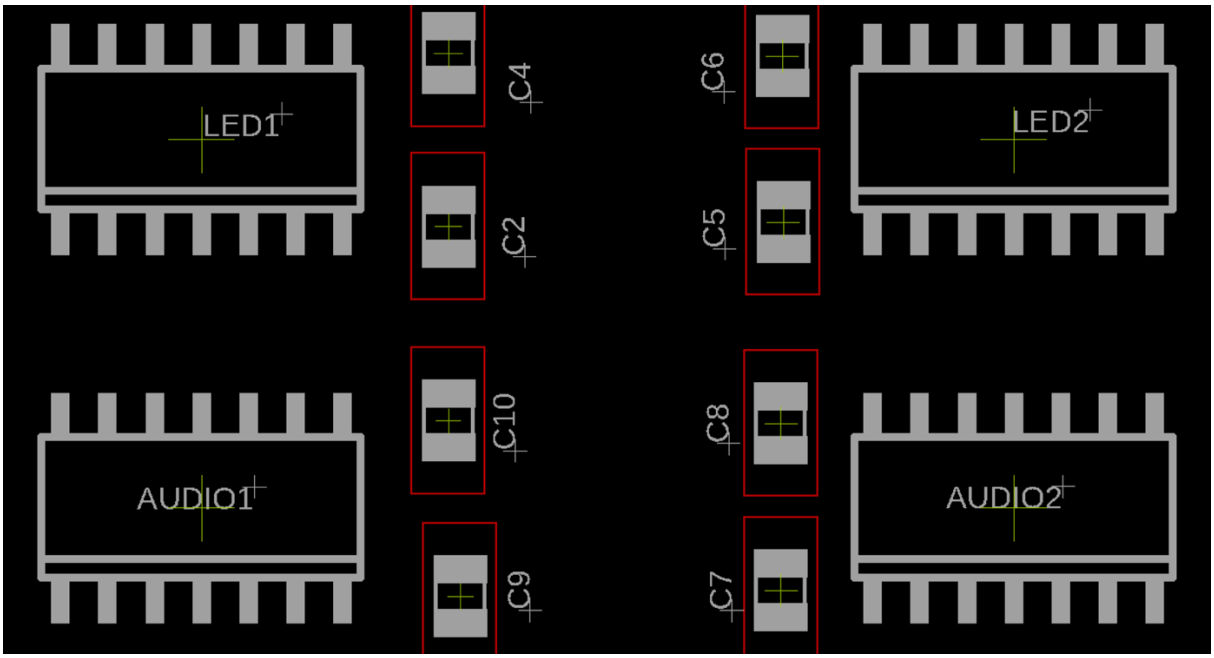
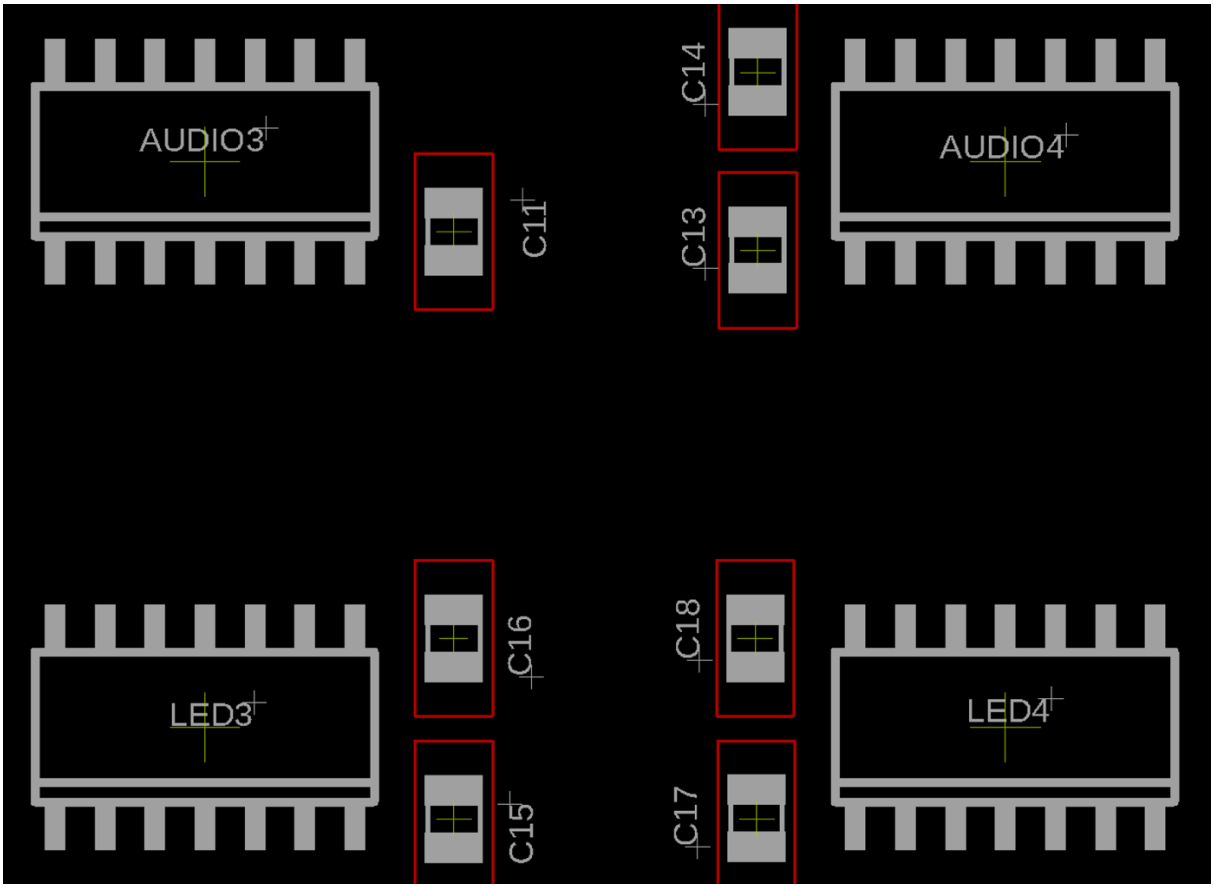


Figure 7 - Channels 1-8 Op Amp Orientation

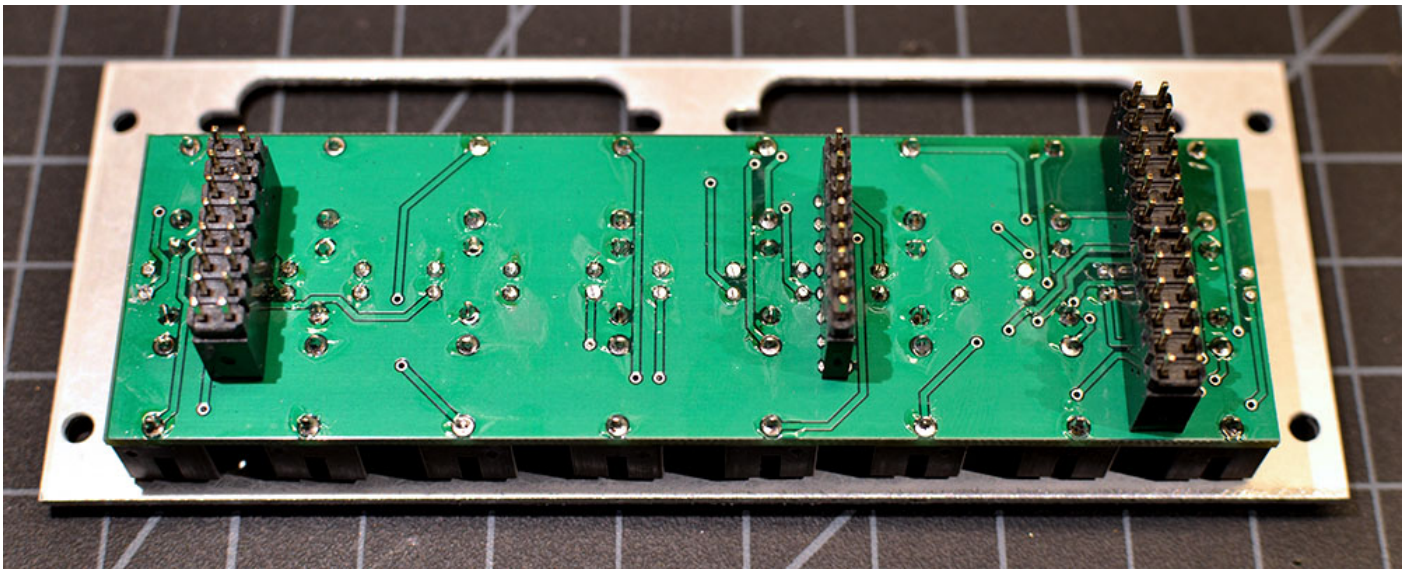
LED1 – LED4 are TL064 op amps.

AUDIO1 – AUDIO4 are OPA4134 op amps.

C2, C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15, C16, C17, C18 are 0.1µF 0805 sized MLCC capacitors.



Once you have completed the surface mount components, the only remaining components will be the pin headers. Since you placed the receptacles on the panel board, you will need to place the headers on the main board. The most reliable way to do this is to insert the headers into the receptables, then place the main board onto the headers such that it fits. Make sure that the component side of the main board faces the panel. You will be soldering on the logo side of the main board.



When that's done, remove the main board from the panel and turn it over. Now you will need to solder the ribbon cable headers which are above and below the power header. These headers will face DOWN. The headers will face up from the logo side and you will be soldering them on the component side. This is important as you do not want to get these on the wrong direction for sure!

Since there is no mating PCB for these headers, you will need to be a little more creative to make sure they are soldered on straight. This can be done in a number of ways including stacking something underneath the PCB or rocking it back and forth until you feel it is aligned.

To be 100% sure, simply solder ONLY two pins on opposite corners so that you can inspect and manually correct before attacking the rest and permanently affixing the header.

Finally, solder on the power header as shown below. The header will face up on the logo side. You will be soldering on the component side again. The notch will face inward, towards the logo.

FINAL ASSEMBLY AND TESTING

Assemble the PCBs and attach the DB-25 ribbon cables as shown. Final testing is easier without attaching the DB-25 to the panel. Connect the power cable and power on. Ensure no white smoke escapes from any of the components and you will now begin testing.

To test signal path, you will want to start by testing the outputs. Connect a snake to the OUT port and connect all 8 outputs to your recording device. Arm 8 inputs so that you can monitor them all at once. Then, one by one, plug an oscillator into each IN jack and ensure that the signal is present on that one channel and no others.

Assuming all of the outputs pass audio, and the LEDs light up successfully, then the easiest way to test the inputs is to create a loopback where the input jacks are each connected to the output jacks. Then, using your DAW with the same setup, send a signal to each of the inputs, routed to the outputs, you should get the signal back into your DAW. Note that the signal will be about 18dB lower due to the gain reduction in the circuit, but the signal should still be audible.

Now that everything is working, you should complete the front panel. Start with the DB-25 nuts and then move to the jack nuts. While the DB-25 nuts might need to be tightened down a bit, don't go overboard as you will see they start to go a bit off center when torqued too much.

BE EXTRA CAREFUL TIGHTENING ALL OF THE NUTS!!! The aluminum face panel is easily marred, and a socket driver will make a funny circular mark around each of the nuts. Some people put masking tape over the end of the nut, but I will cut squares of paper towels and cover the panel as I tighten, preventing any marks from forming.

The jack nuts should not be overtightened as the jacks can deform, break, or make poor connections when over tightened. You only need to make contact with the panel and then turn about ¼ turn further.

There you have it. Enjoy!