Voltage to current amplifier assembly guide

Clowers Research Group WSU

Parts

*A more detailed detailed description of the following information (including digi-key #s) can be found on the google sheet titled “Amp Parts” located in the folder where you found this powerpoint

Board

IC OPAMP JFET 2 Circuit
IC OPAMP GP 1MHZ

0.1 µF capacitor (4x)
47 µF capacitor (2x)
100 pF capacitor

1.13 kΩ resistor
6.65 kΩ resistor
10 kΩ resistor (4x)
100 MΩ resistor

Diode (1N5818) (2x)

BNC Connector (2x)

Slide switch

Pin Header male (3 segments)

1000V Wire (red, black, and blue)

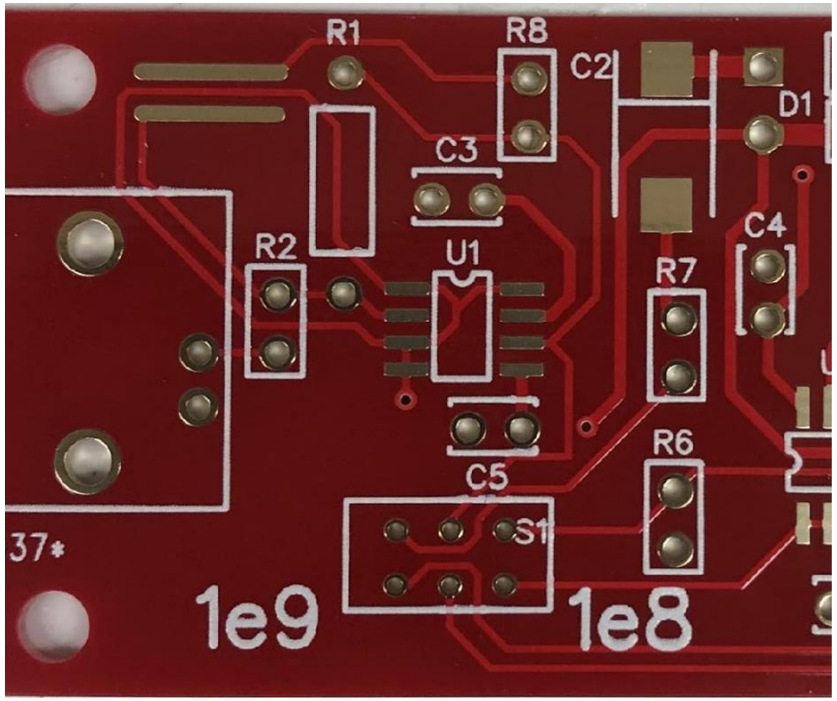
CONN TERM Male (3x)

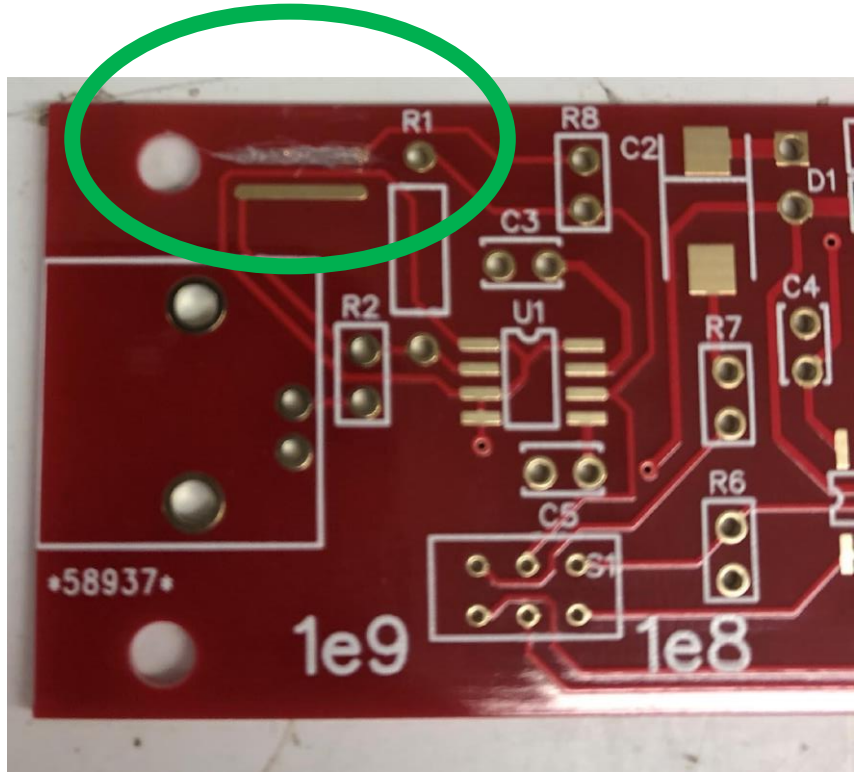
Shrink tubing (0.20/1.0)

Insulated box for amp

Male CONN housing (3pos)

Before you do anything else, scrape of the top half of the capacitor located in the upper-left corner of the board. A razor blade should suffice for this





Order of assembly

The following slides will outline the order in which I assembled the amps. You do not have to do things in this order or in any order at all, this is just my preferred method. That being said, the following are some things to keep in mind:

- Installing the “top-mounted” components will be much easier if done first (empty board)
- The capacitors are made of ceramic, avoid touching them with your fingers
- Be aware of the directionality of some components (I’ll discuss this further when it comes up)
- Check parts/connections with multimeter as you go to ensure that nothing is defective/connected improperly

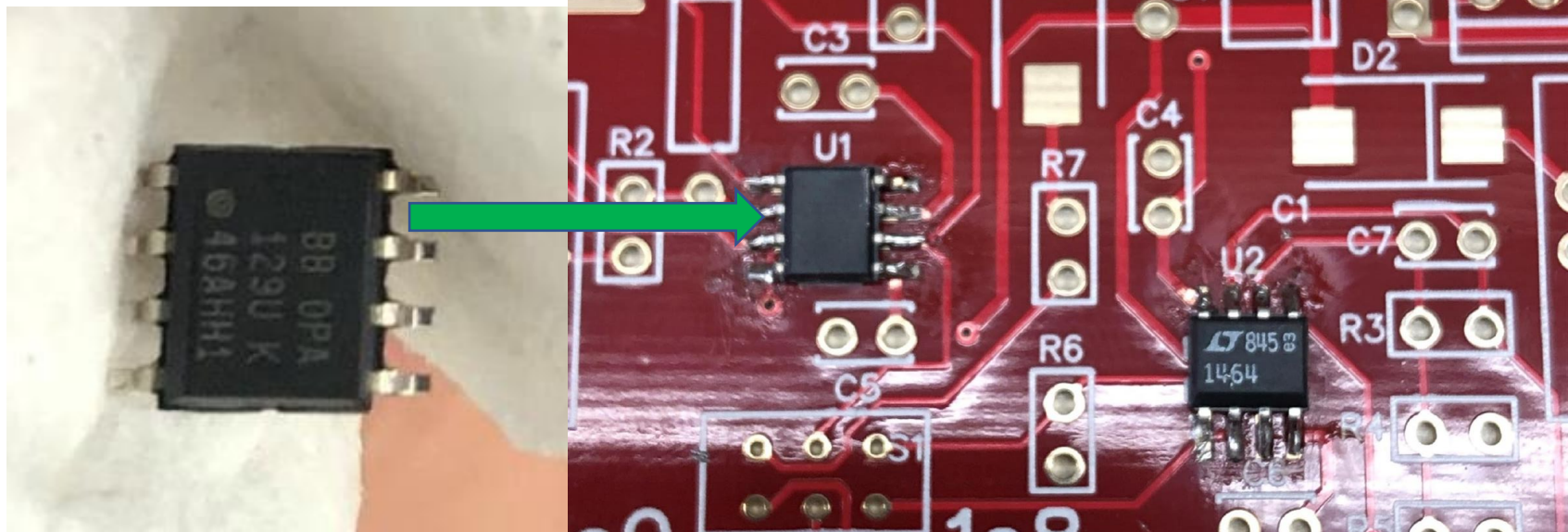
Mounting the OPAMPs

Make an effort to be as neat as possible with these (the picture I've shown here is a good example of what they should **NOT** look like). Scape off any residue left on the topboard as you go.

DIRECTIONALITY

-Note the orientation of the OPAMPS in these pictures, be sure that they are oriented in the same way on your board

U1- IC OPAMP GP
U2- IC OPAMP JFET



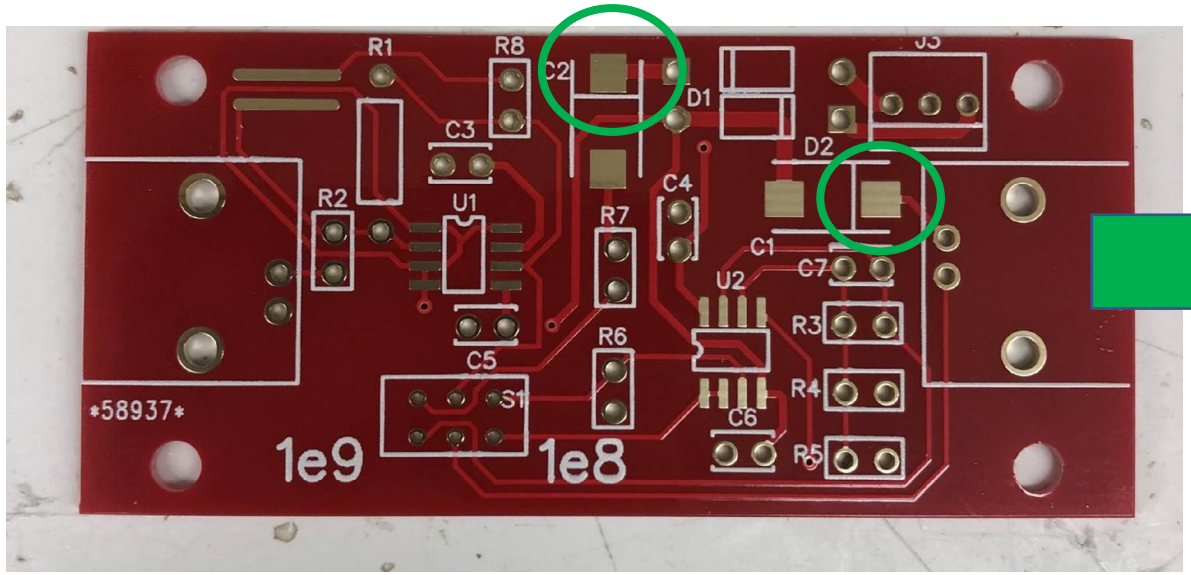
Top-mount capacitors

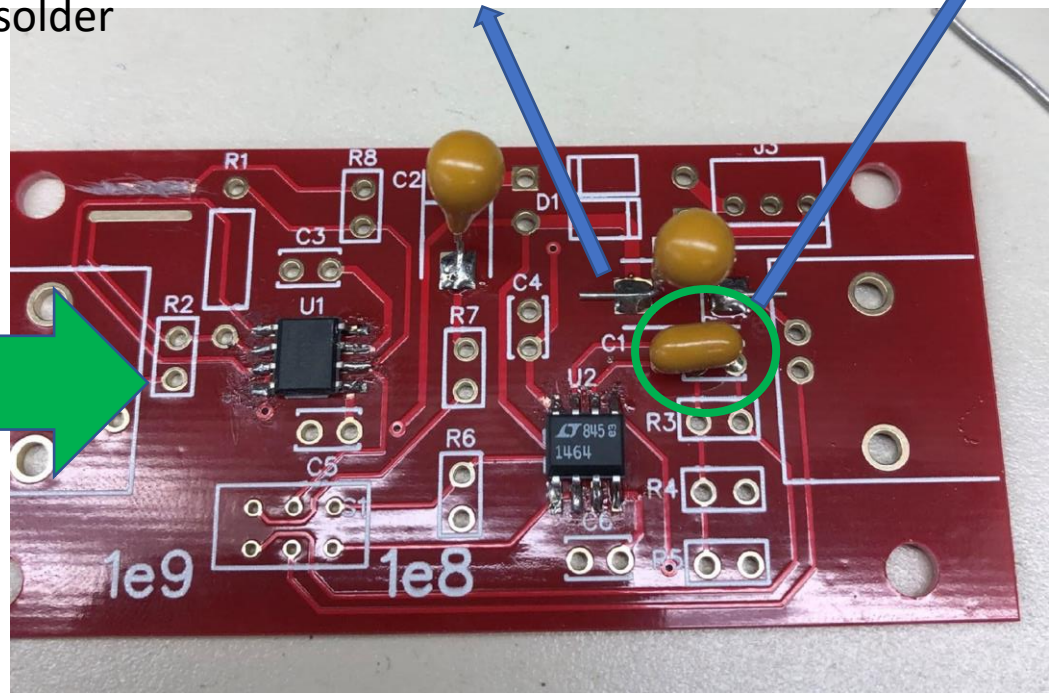
Directionality- Note that for the C1 and C2 spaces on the board, one of the points of contact has a white line alongside it (circled below). One of the leads on the 47 µF capacitor is longer than the other, this longer lead needs to be soldered to the points of contact alongside the line

C1 and C2: 47 µF capacitor

Be sure to trim any excess lead that sticks out from the solder

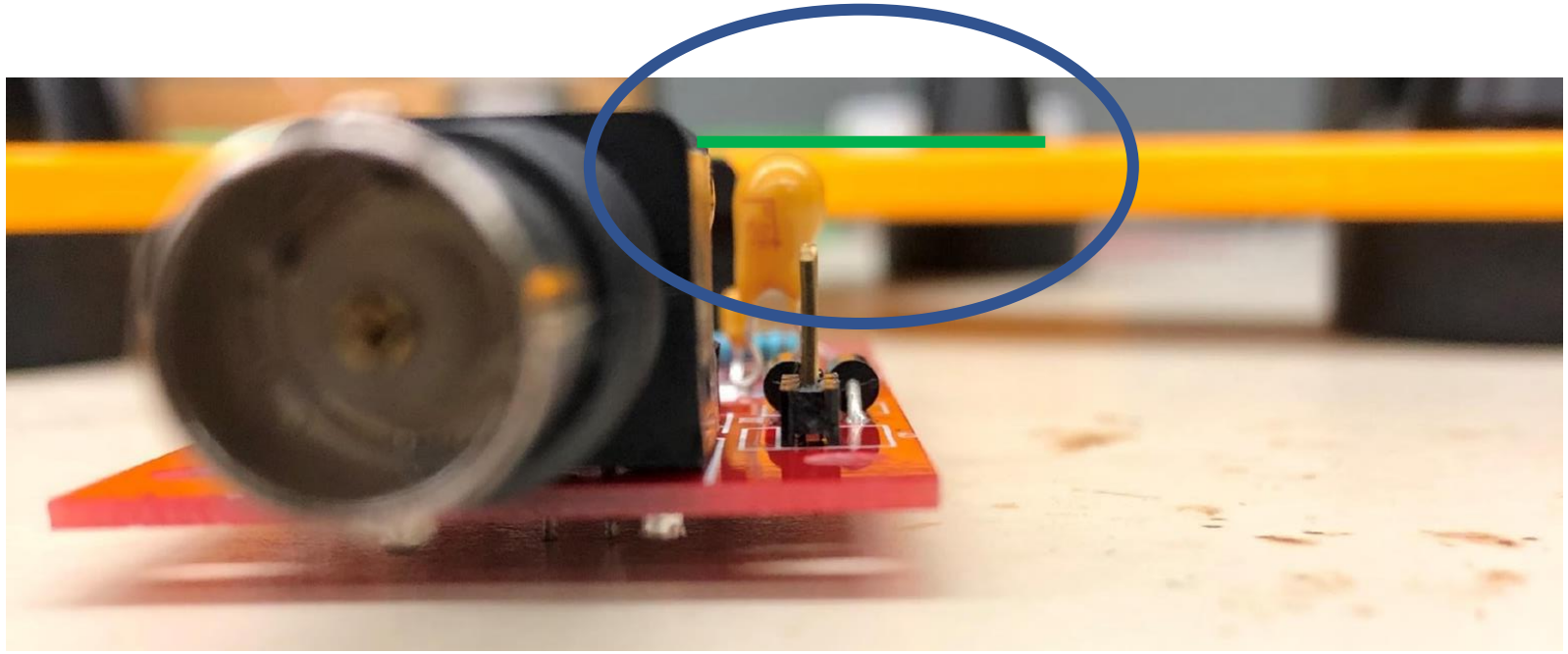
Ignore this one for now





Top mount Capacitors

One final note about the top-mounted capacitors, you may want to trim the leads before mounting them. I prefer for the mounted capacitors to not exceed the height of the BNC connecters, as they may get bent when you flip the board over to solder the other parts (see image below).



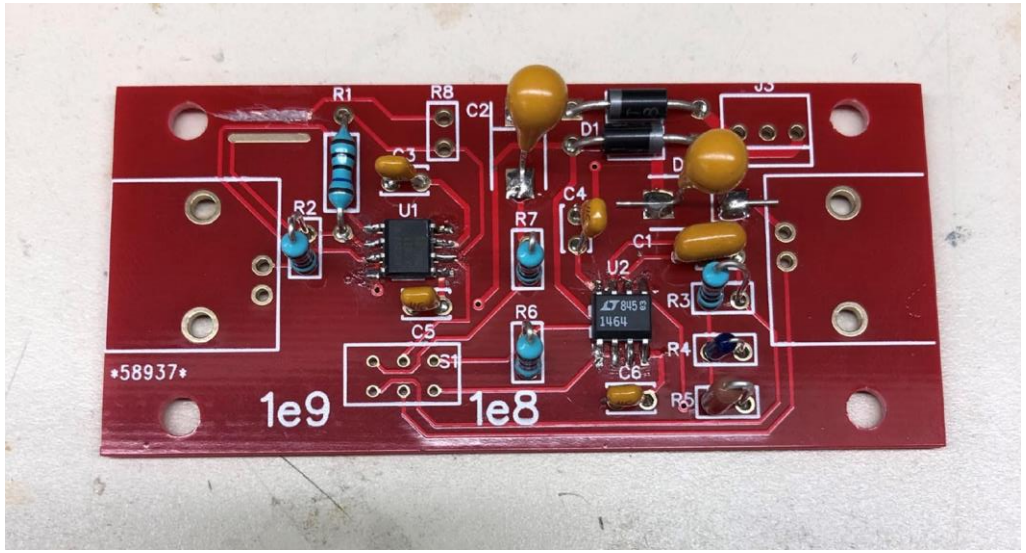
Resistors, capacitors, and diodes

R_2,R_3,R_6,R_7- 10 kΩ

R_1- 100 MΩ

R_4- 1.13 kΩ

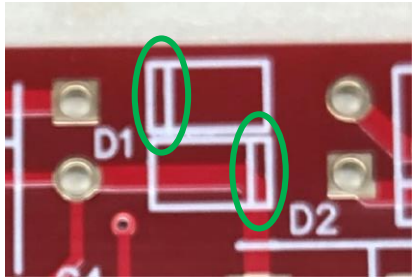
R_5- 6.65 kΩ



C_3,C_4,C_5,C_6- 0.1 µF

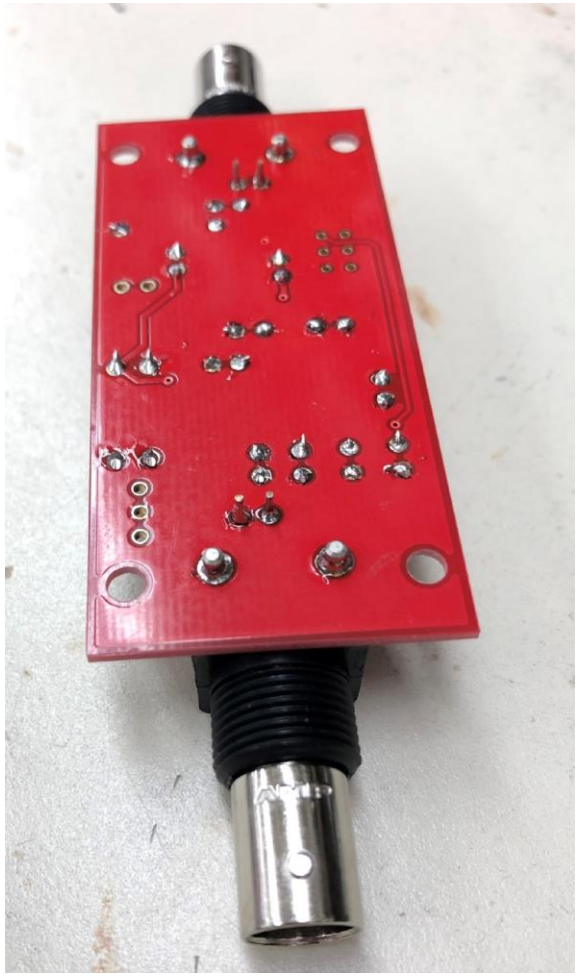
C_7- 100 pF

D_1,D_2- 1N5818 **DIRECTIONALITY**- the silver tip of the diodes should be placed over the tiny rectangles. The picture above shows their correct orientation



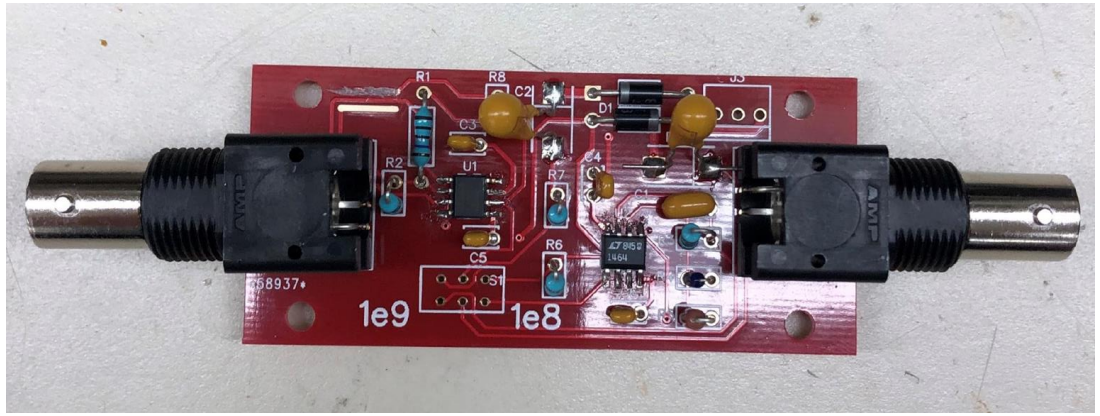
Resistors, capacitors, and diodes

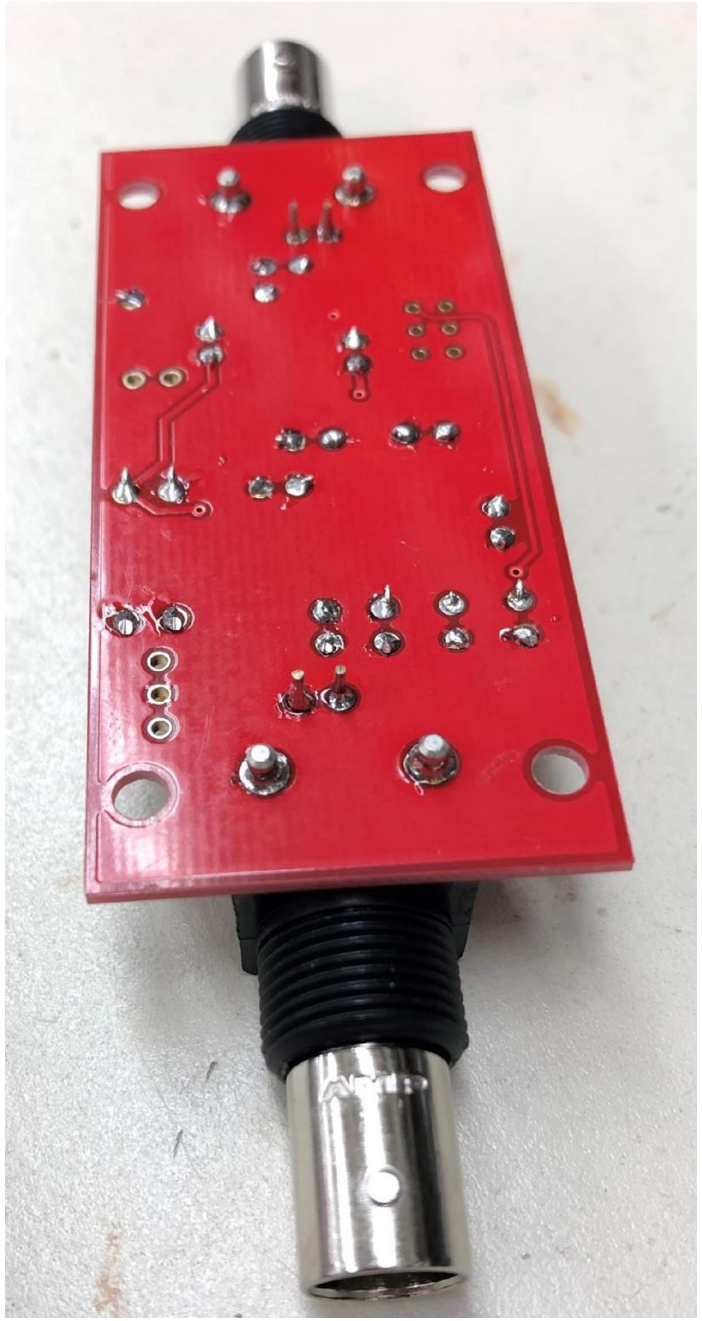
When you go to solder on these components, it may be helpful to let the board rest on the BNC connectors (see picture on the right). You can solder on the BNC connectors prior to this step, however it may be more difficult to attach some of the components with the BNC connectors present.



Attaching the BNC connectors

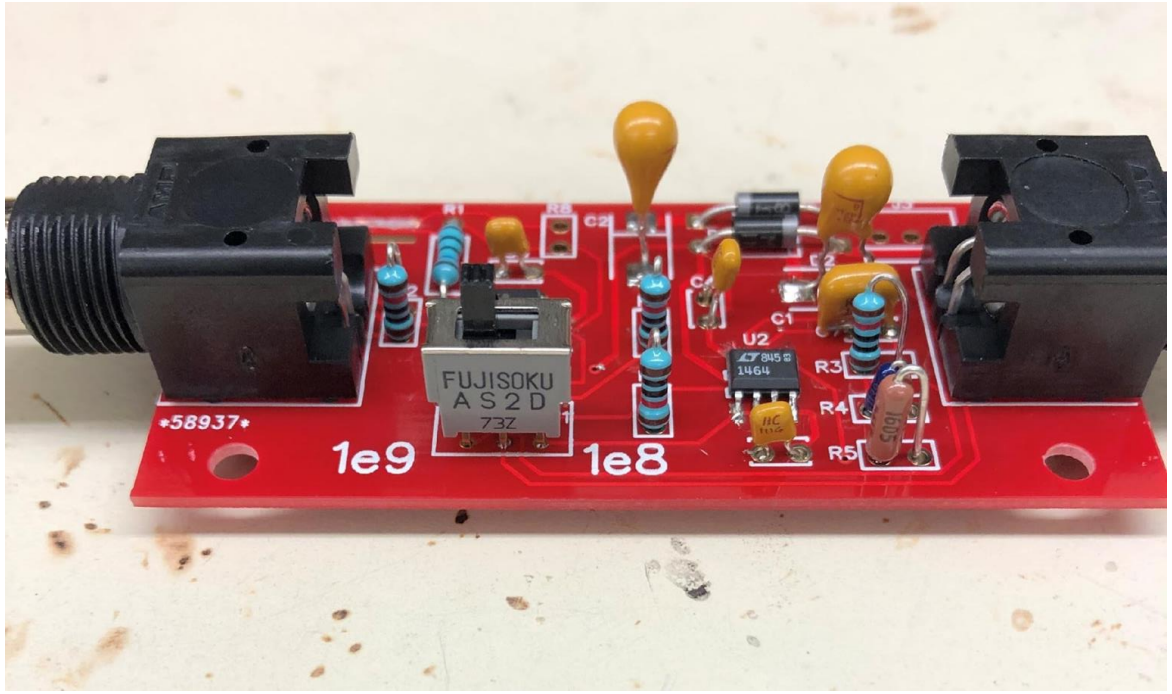
When mounting BNC connectors, make an effort to ensure that they lay flat on the board.





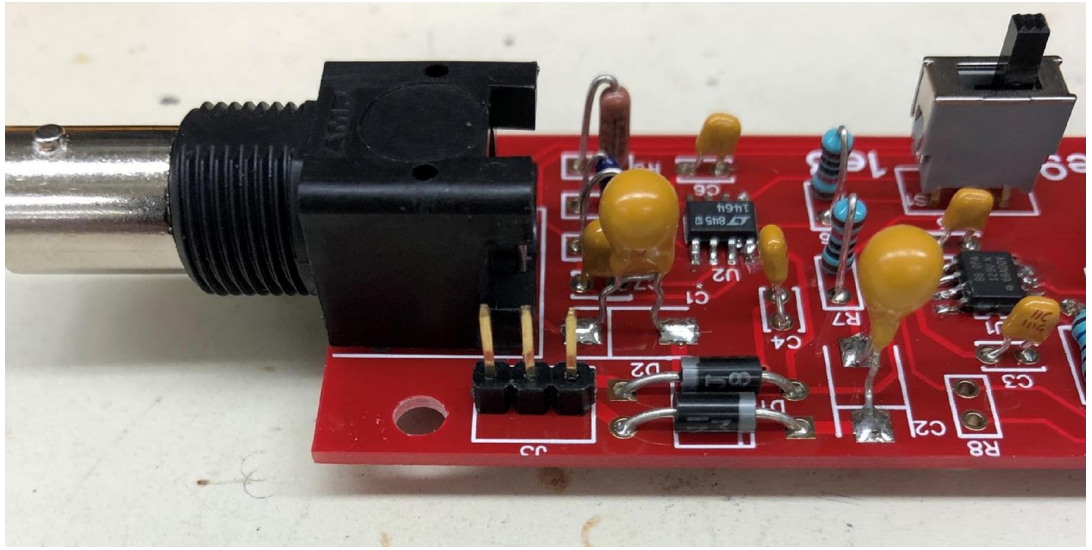
Slide switch

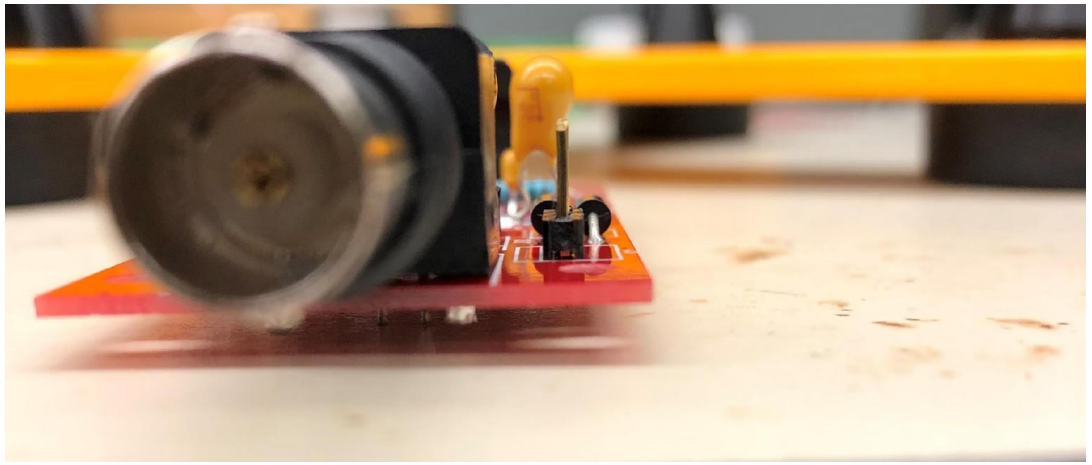
As with the BNC connectors, ensure that the slide switch is mounted as evenly as possible on the board. I would suggest soldering one of the corners first, adjusting the switch to make sure that it isn’t tilted, and then soldering the opposite corner.



Male pin header

The male pin headers often come in long strips, you will need to clip off a set of 3. When you apply heat to the bottom of the pins during the soldering process, the black plastic encased around the pins tends to bend and flex which can cause the pins themselves to shift and become non-perpendicular to the board . Do your best to minimize the distortion of the plastic and maintain the perpendicular orientation of the pins relative to the board (it will make things easier for you in later steps).

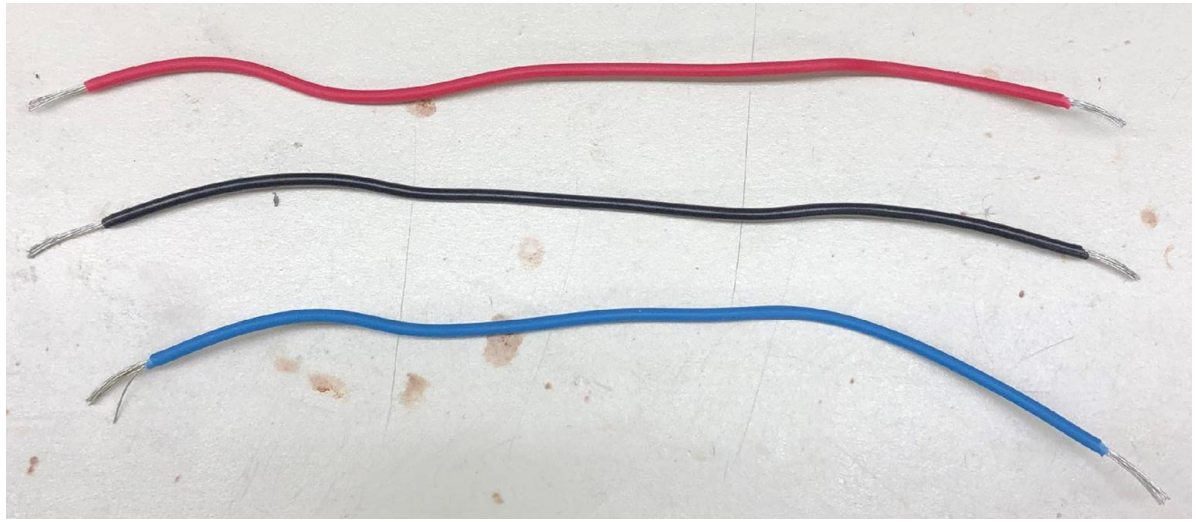




Wire Prep

1.Cut approximately 14 cm of red, black, and blue wire.

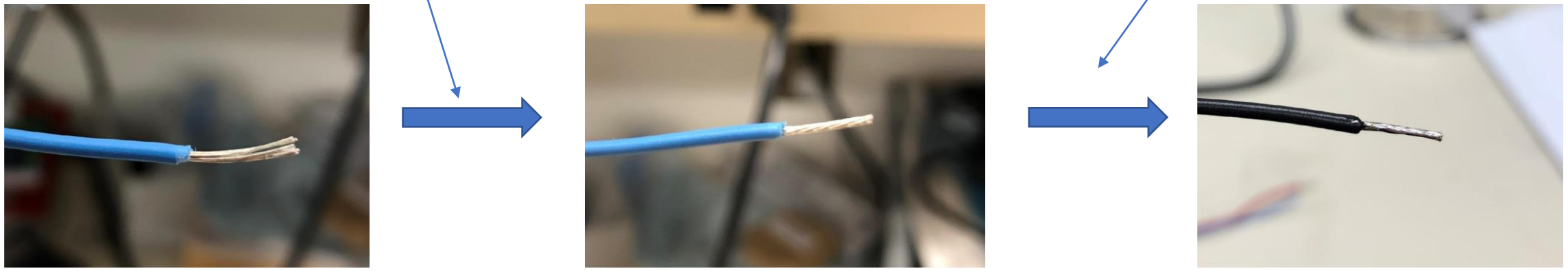
2. Strip approximately 0.75cm of insulation off of each end of the wires. This will be more than you need but that is okay, it is better to have too much (you can easily trim it down later), than too little.



Wire Prep

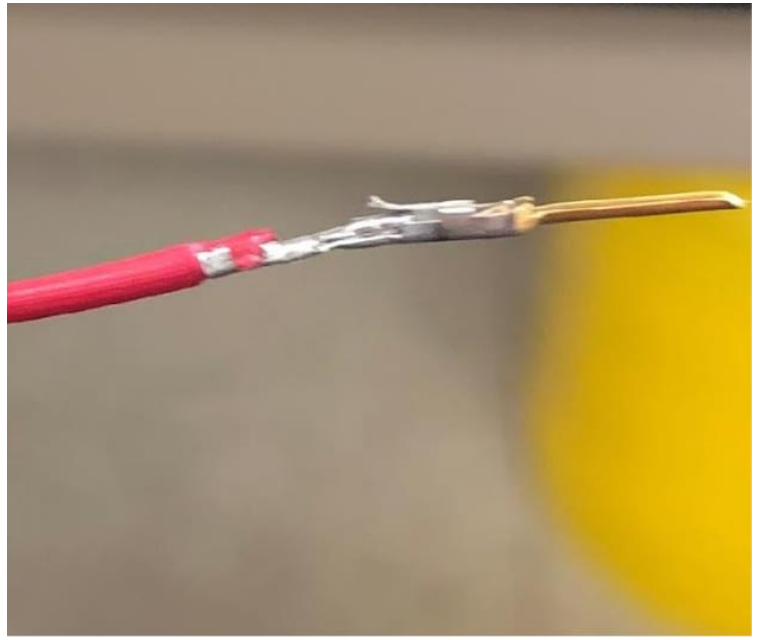
After stripping the insulation, you will see that the wire isn't as tightly wound as it could be. In order to correct this, pinch the end of the wire and twist it tightly. The end result should look like the middle image

After "tightening" your wire, you now need to coat the exposed wire in solder. Don't go overboard here, the wire should have a full and relatively smooth coating of solder. If it looks "chunky" then run the soldering iron over it until it is more uniform

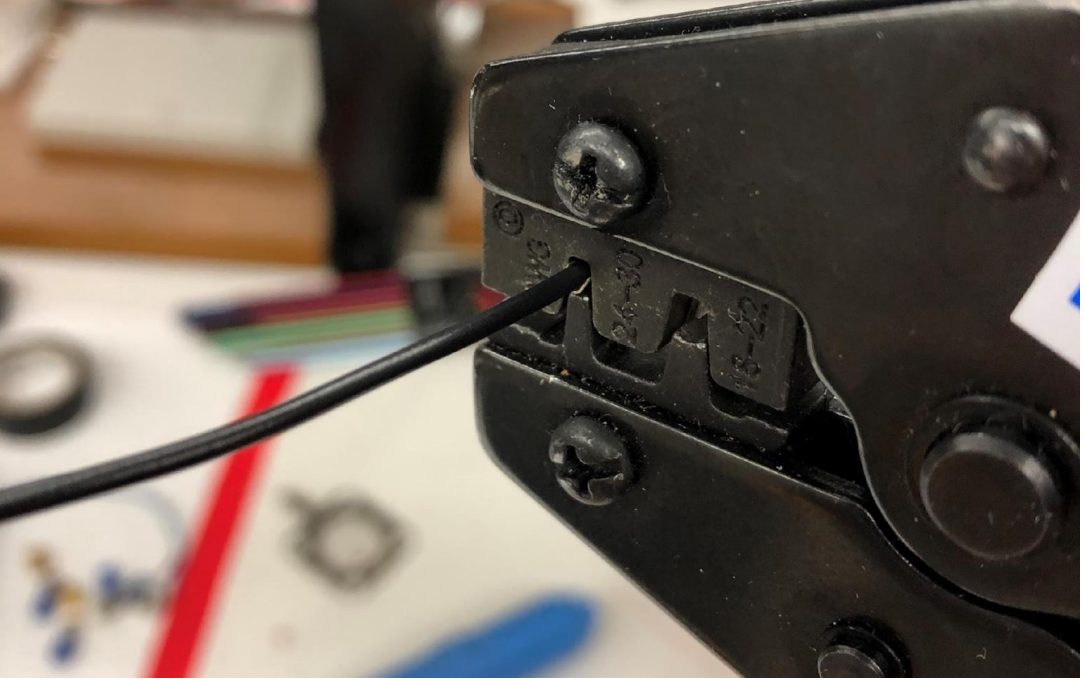


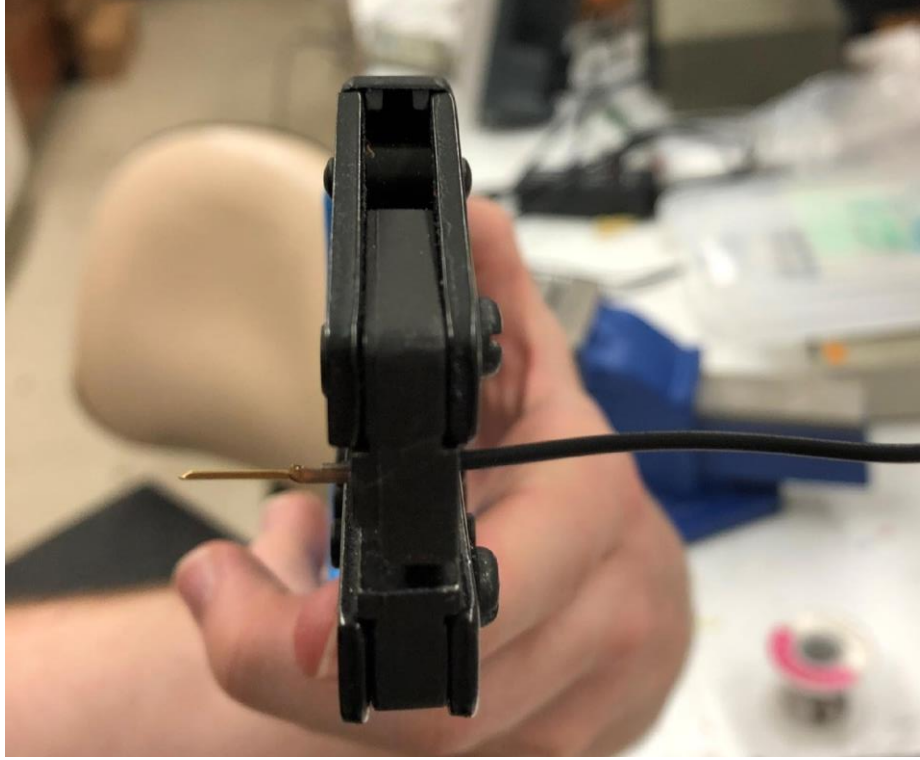
Molex

With our wires prepped, we can now attach our male CONN terminal to one end of each wire. Slide the wire into the terminal so that it fits snuggly with the insulation going just past the opening in the terminal. This will most likely require you to trim your wire down a bit.



With the CONN terminal now in position, grab this tool and place the terminal in the first opening (see green circle). The end of the terminal should be along the edge of the crimping zone. I understand that this may be confusing so I have attached some pictures on the next slide to show you what it should look like. Once it is in position, squeeze the handle as far as it will go and then release. The end result should look like the image you see above and to the right.

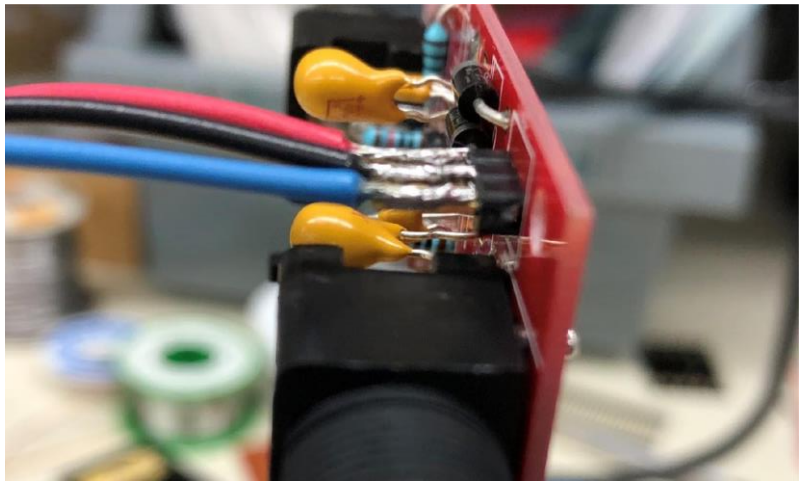


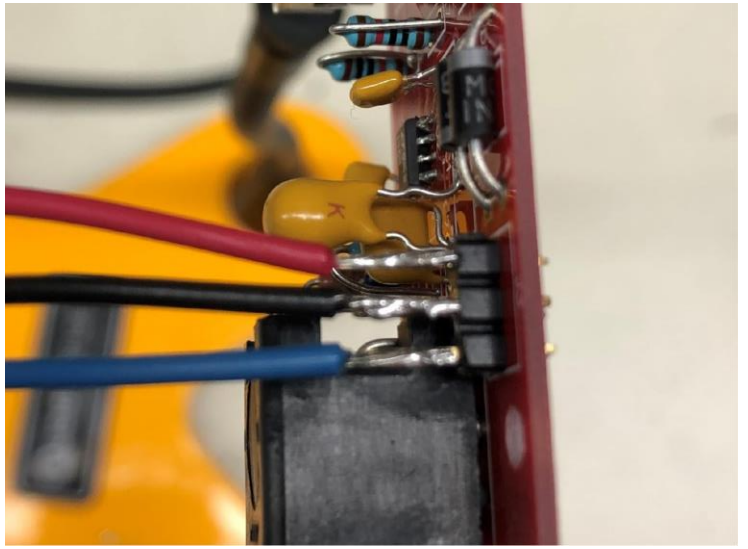



EX ONLY

Attaching wires to the amp

Solder the other end of the wire to the pinheaders that you installed previously. The order from left to right should be blue, black, red, as shown below. After soldering each wire on, give them a tug to ensure that they are securely attached to the pin header.



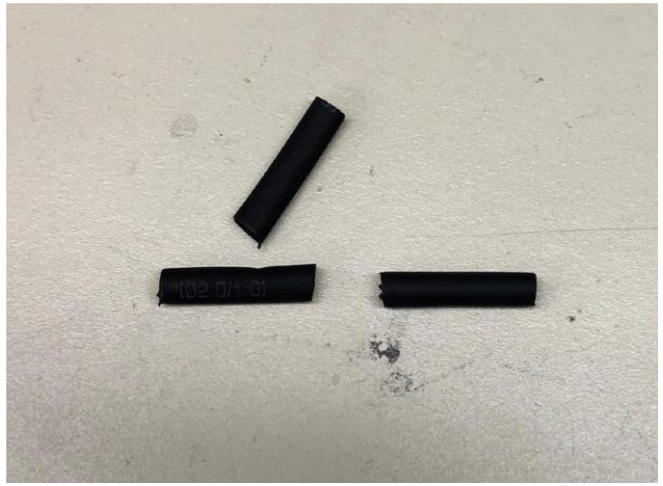


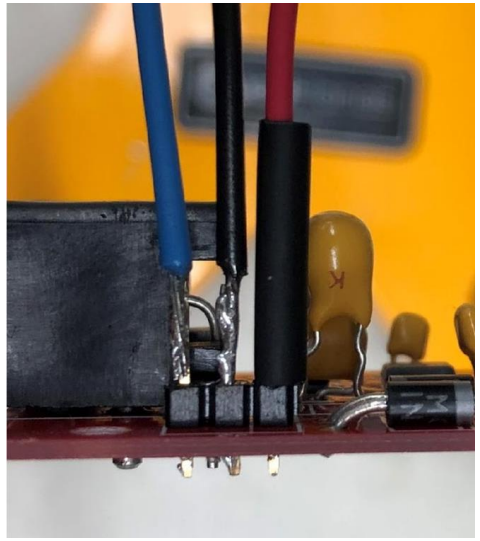
Adding some insulation

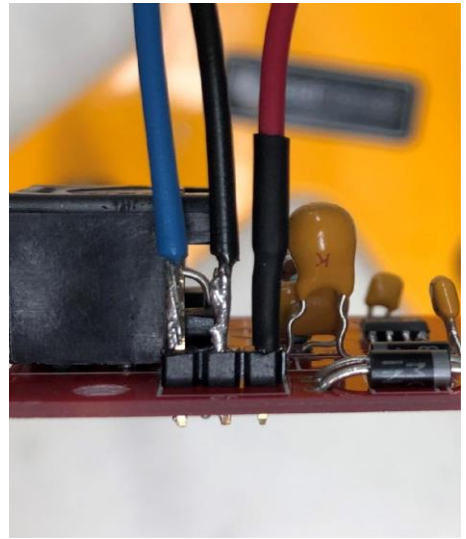
In order to insulate the connection between the wires and pinheaders, you will need to grab some shrink tubing and a heat gun (both shown below)

Adding some insulation

Begin by cutting 3, 13mm (doesn't need to be exact) segments of 0.20/1.0 shrink tubing (picture on the left). Then, slide the shrink tubing over the CONN terminal down to the base of the wire (middle picture). Once the tubing is in place, hit it on all sides with the heat gun and it should quickly form to shape of the wire (picture on the right). I would suggest doing this one at a time to ensure that pieces of shrink tubing do not bind together when exposed to heat.

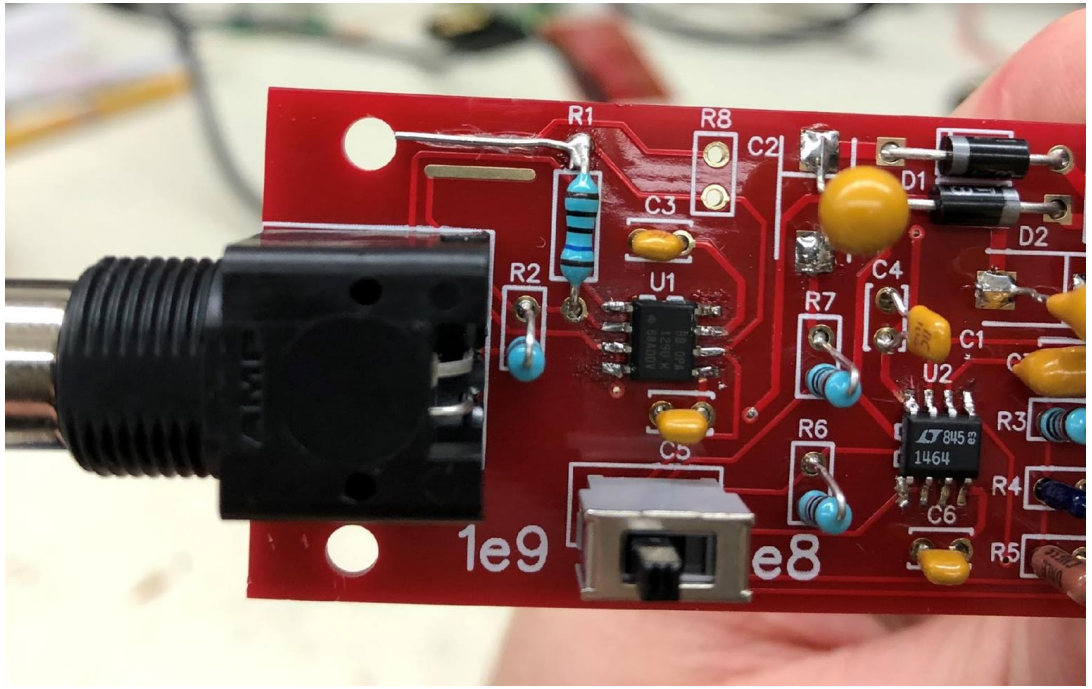


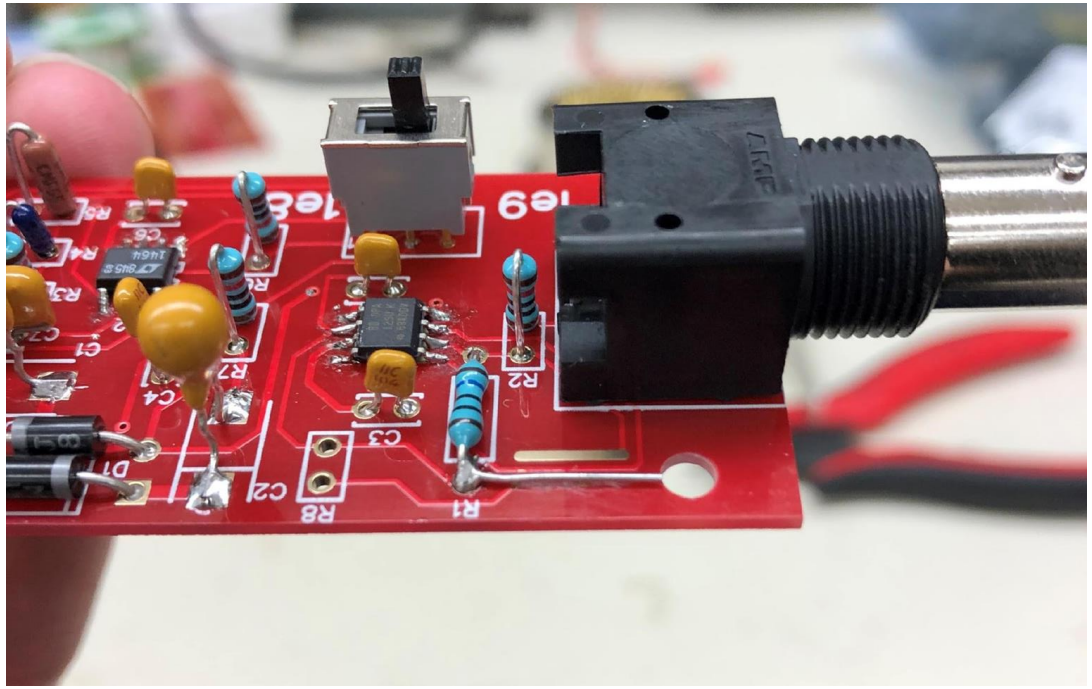




Making an adjustable capacitor

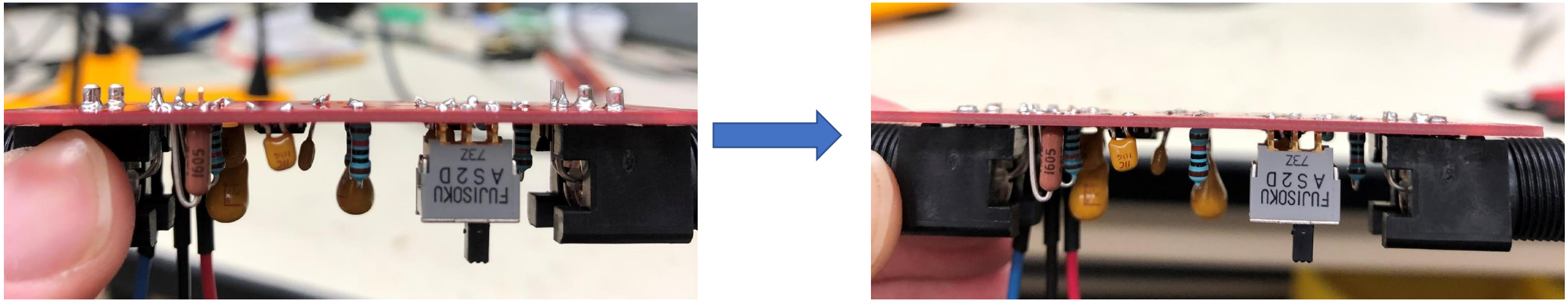
Clip off a lead from a resistor (one of the cheap ones, I used the 10 kΩ). Solder the lead onto the exposed lead of the 1 ΩM resistor as shown below.





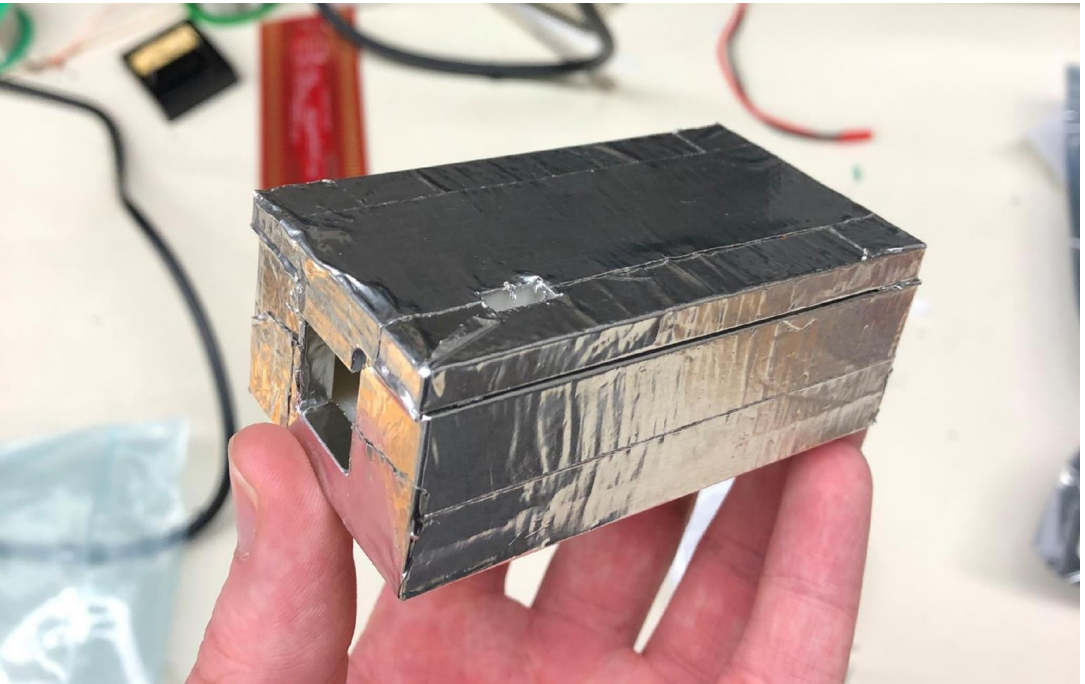
Tidying up

Take a moment to look the amp over and clean up any sloppy soldering jobs or residue. When it comes to evaluating soldering jobs, one of the key things your looking for is jagged or pointed globs of solder (some examples of what I'm talking about can be seen on the picture on the left) as they may cause arcing. Snip the solder flast and srape of any residue with tweezers.

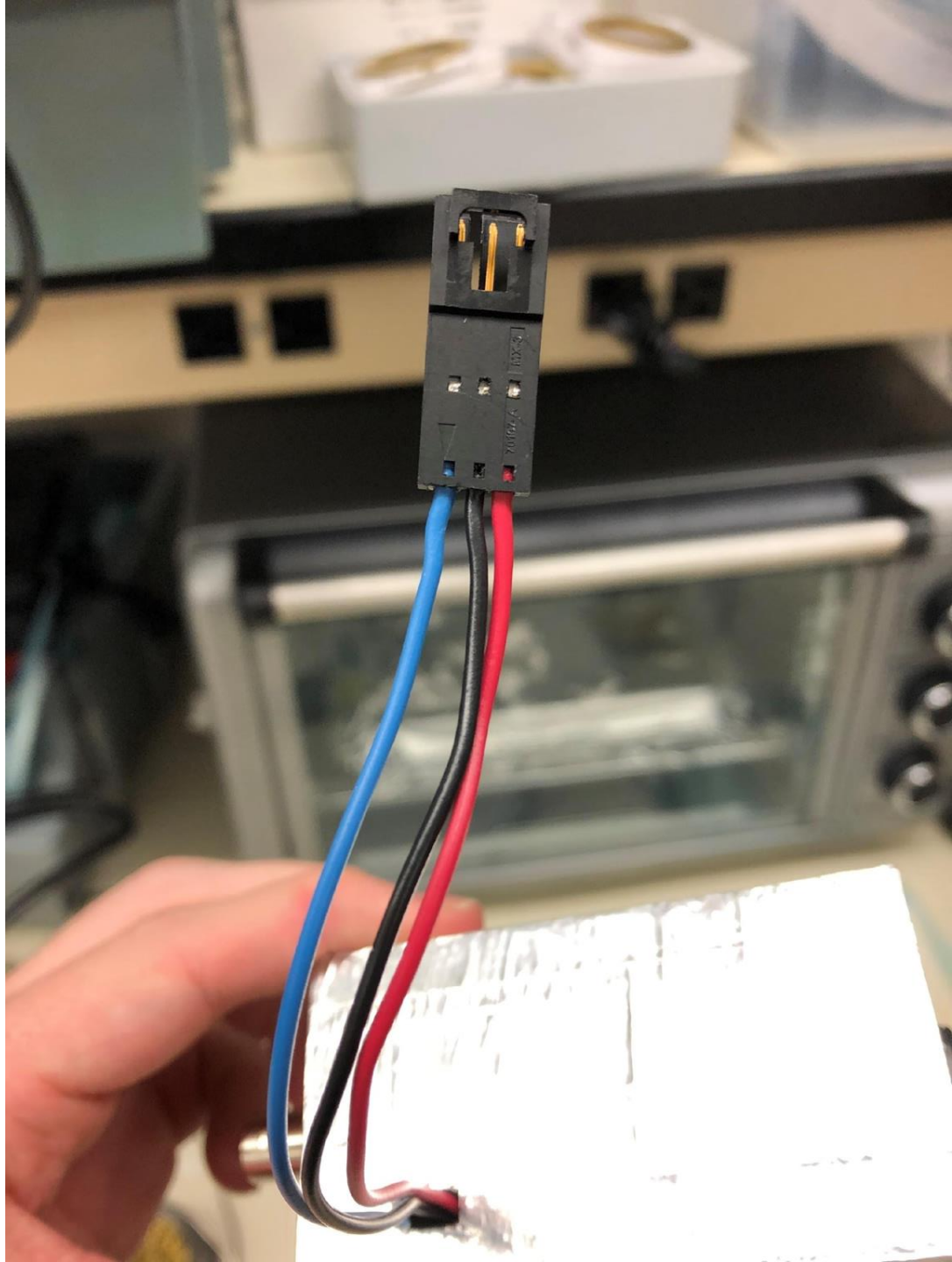


Housing

The next step is to place your amp into its insulated box. The boxes are 3D printed and we insulated them by wrapping them with silver tape. The hole in the box's lid is for the wires



Feed the wires into a Male CONN housing (3pos) as shown on the right. Orientation of the pins is important, orient them as they are in the picture. You should here a snap/click once they are locked into position, however this is not always the case. The pins should be relatively uniform if they are positioned correctly. Give them a tug to ensure that they are secure in the housing

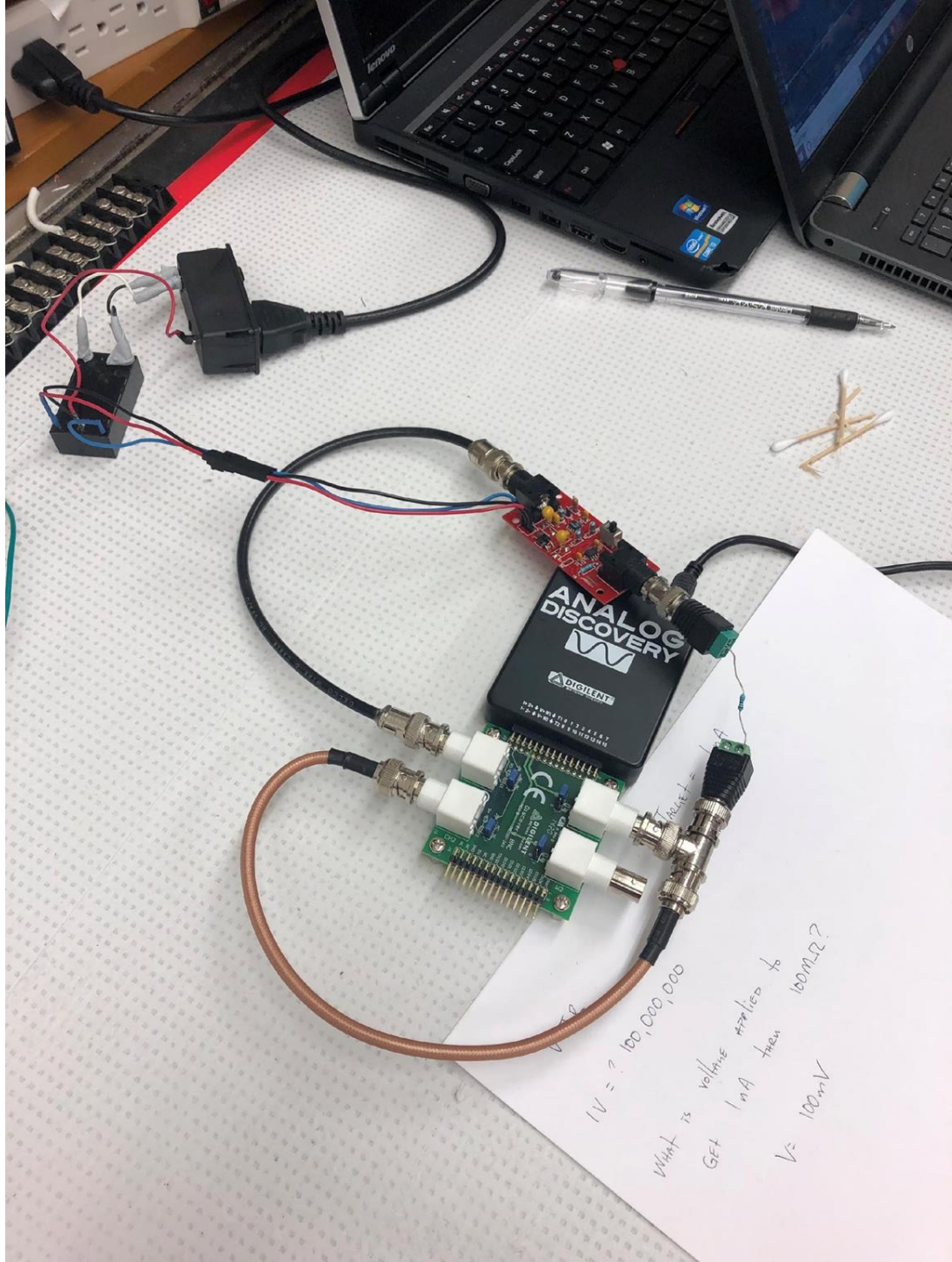


Testing the amp

You’re amp is now assembled and ready to be tested, the following slides will detail our process for doing so.

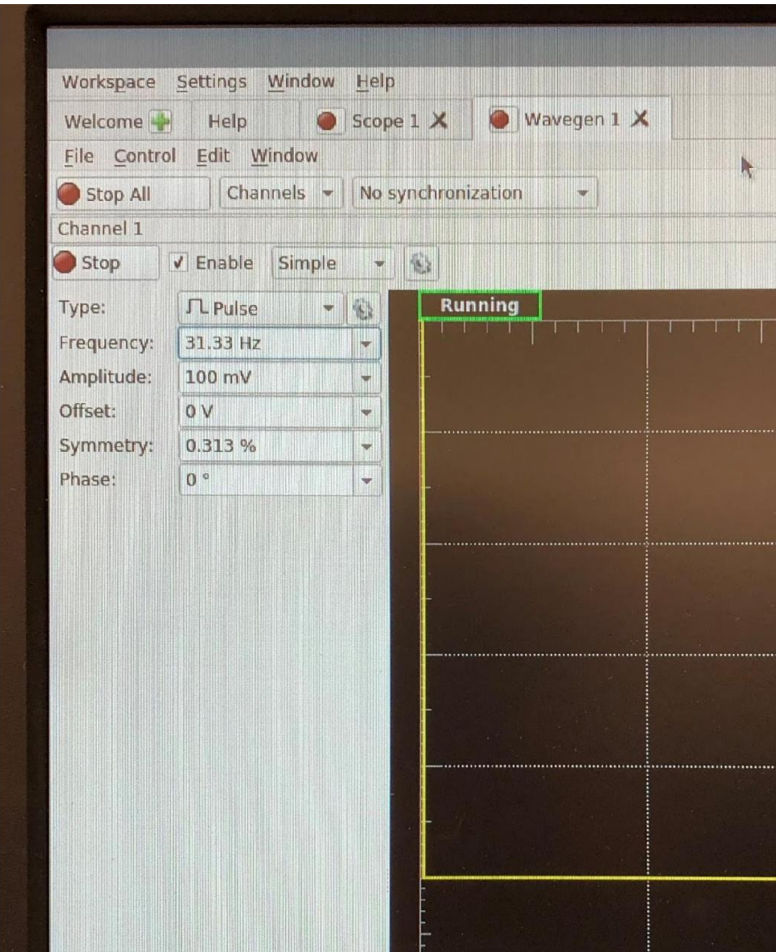
Hardware setup

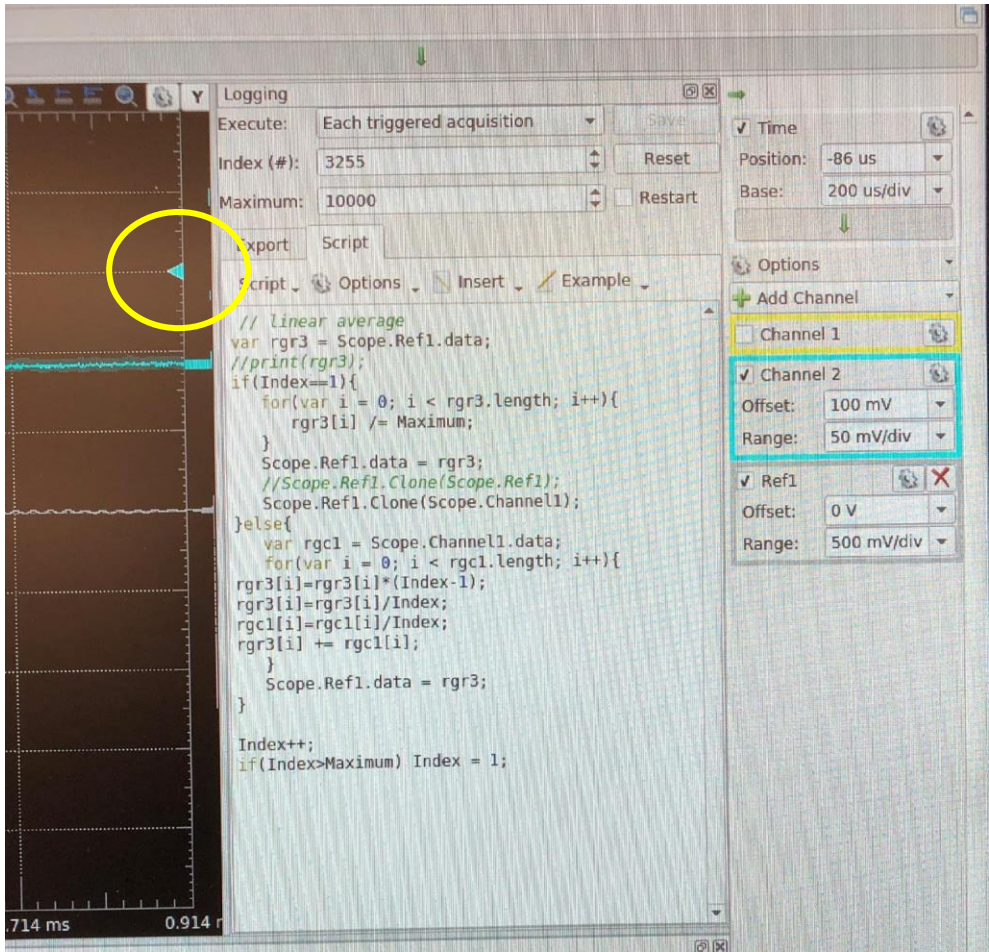
- Note: the resistor used *must* be 100 MΩ
- V=ir
- If 0.1 V is required for the input, and I required is 1n Amps, then a 100 MΩ resistor is needed



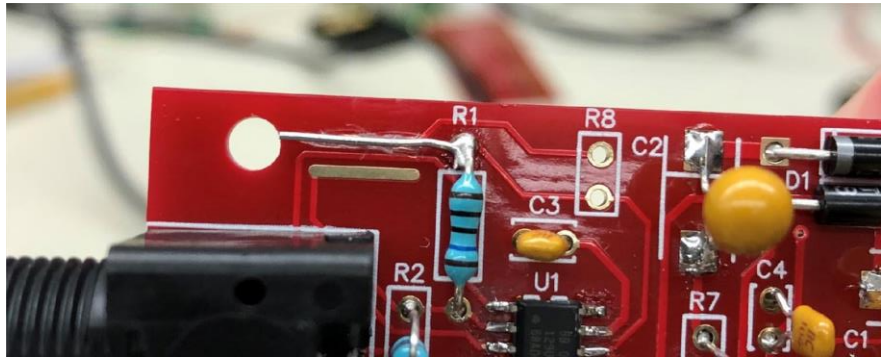
Software setup-

We have a workspace titled “AmpTest_Framework_v1” which if loaded should allow you to just jump right in and start testing (the image on the next slide will show you what a functioning amp should look like). **PLEASE NOTE** the setting are for testing the amp operating at 1E9 amplification. If you are unable to load the aforementioned workspace, the images below show the “scope” and “wavelength” settings that you will need. Don’t forget to adjust the trigger (yellow circle).





If you see something that looks like the image on the right, then you're amp is working. If you are preparing to use an amp for analysis, you may want to take the time and play around with the lead piece we installed towards the end of the build (see image below)



Shifting the position of the lead relative to the other half of the capacitor can serve to reduce the fronting we observe (yellow circle)