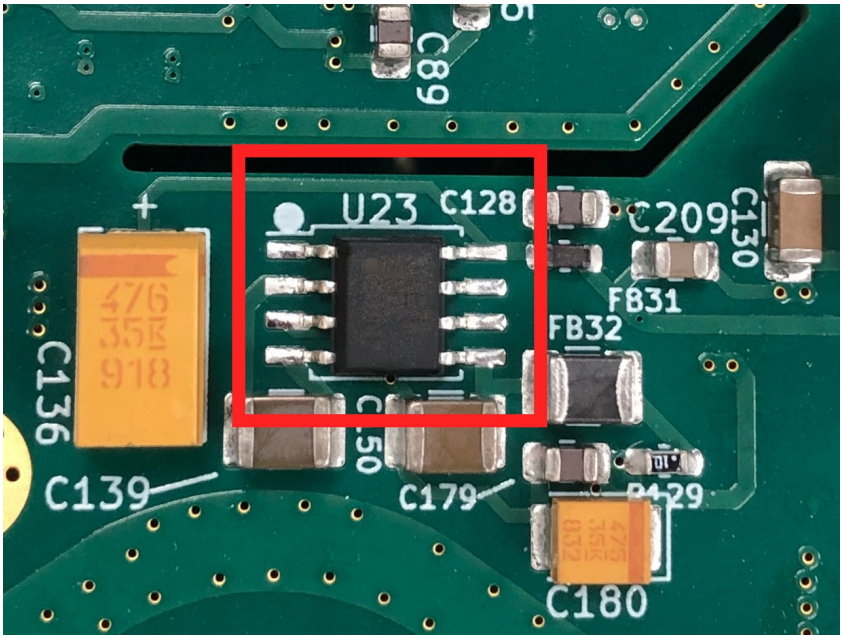
Rework Instructions for Raspberry Pi Blackbox PCB

0 Remove Incorrect IC

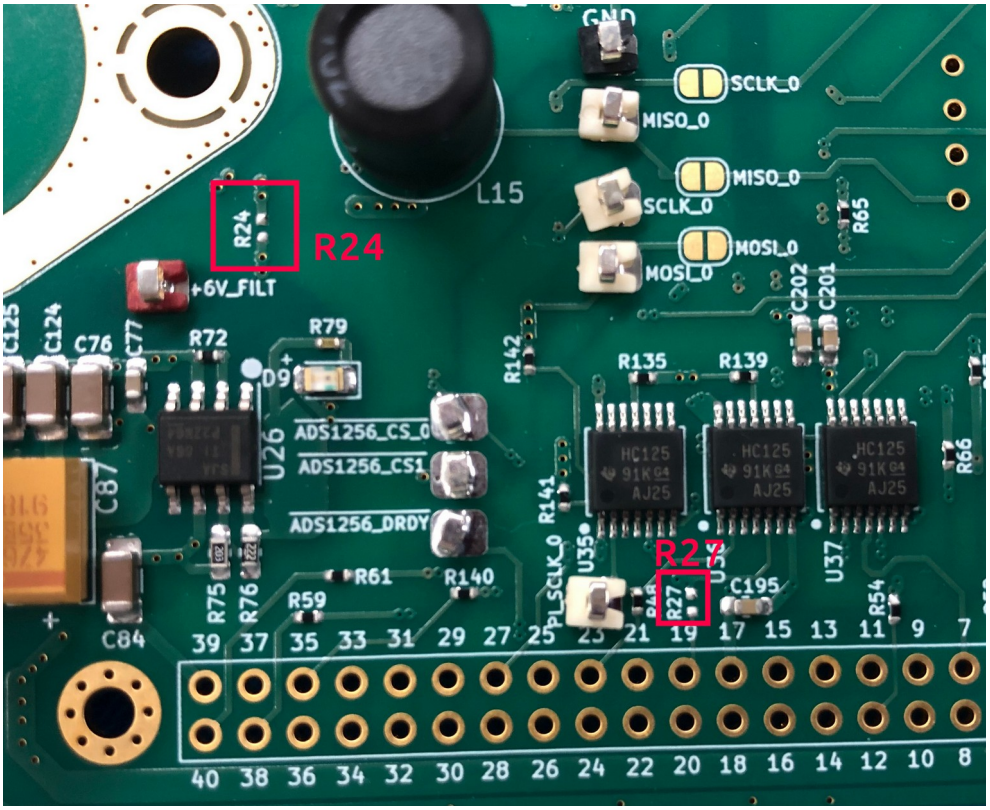
On the bottom of the board, there is an incorrect IC installed at U23. The contract manufacturer installed the wrong part. The correct part isnt here yet, but please remove this part in preparation for the installation of the correct part:

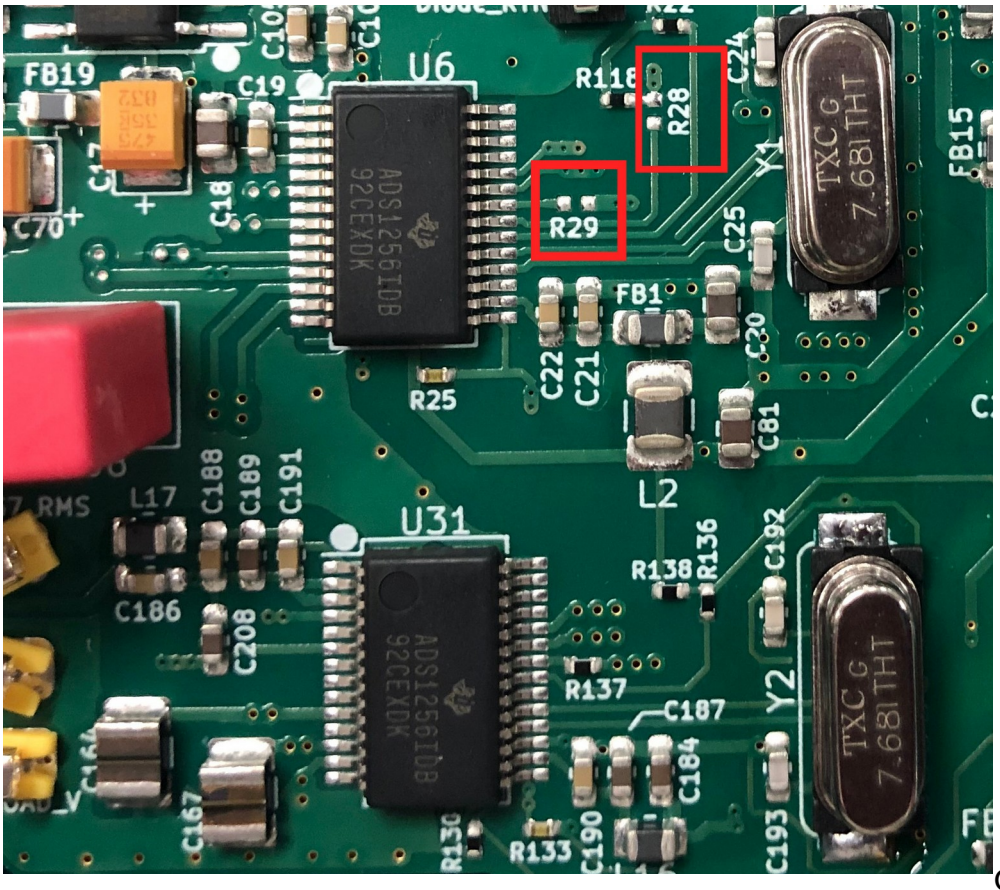


1 Install Missing Resistors

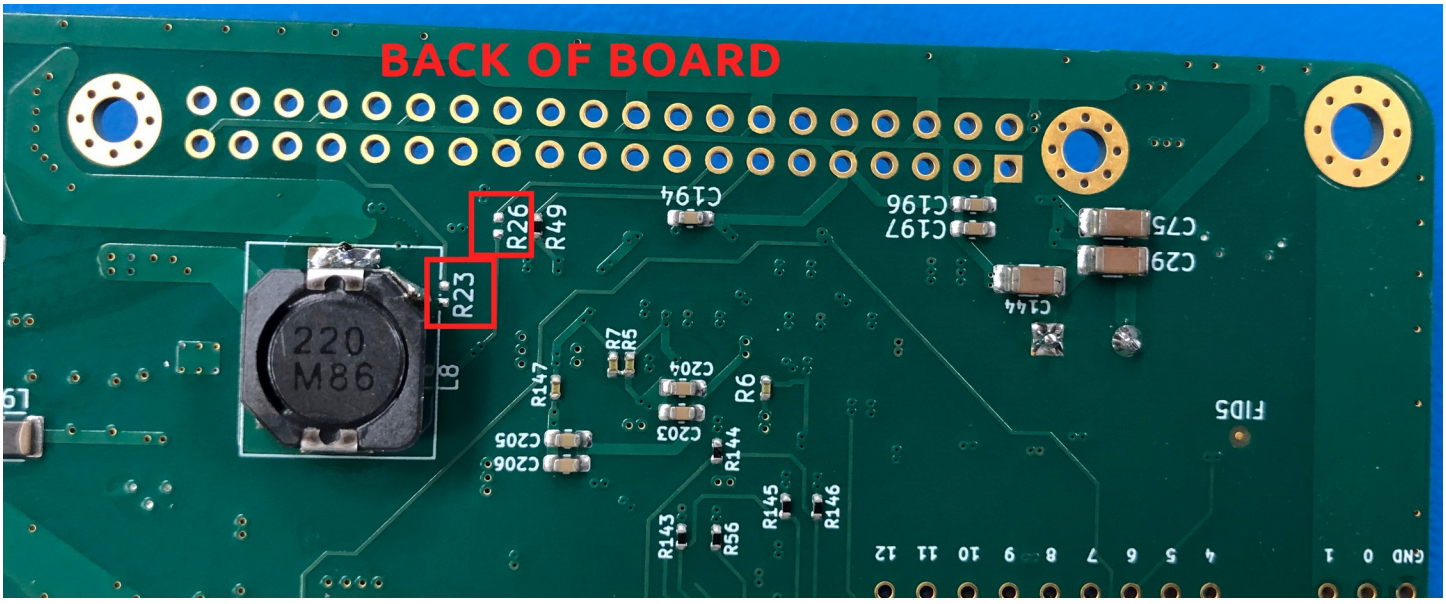
On the top side of the board, there are 4 missing resistors: R24, R27, R28, R29.

These are 47 Ohm, 0402. Install the missing resistors.



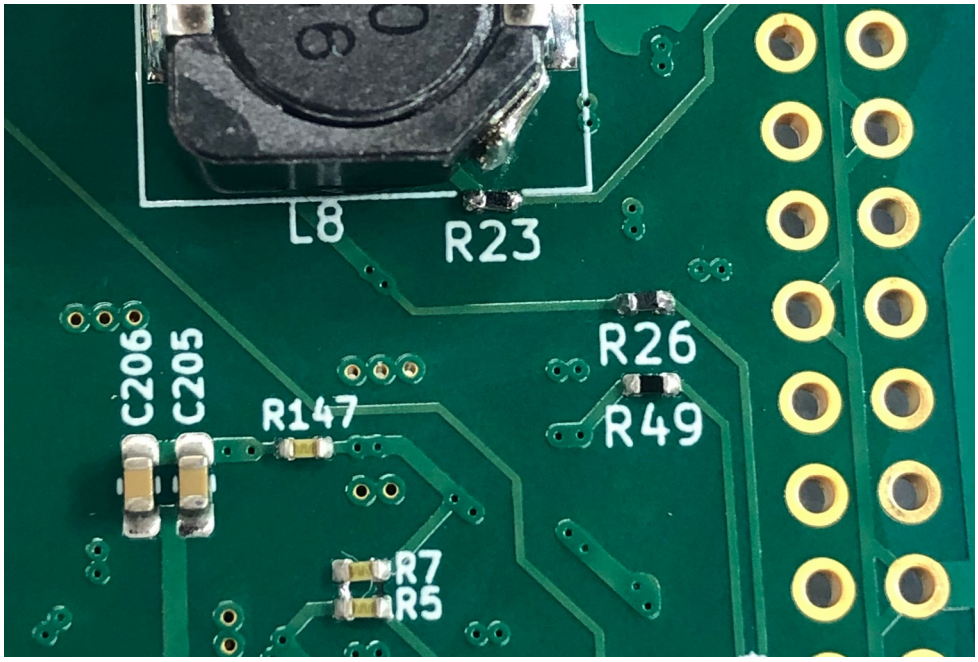


On the bottom of the board, there are two missing resistors: R23 and R26. These are 47 Ohm in 0402 size.



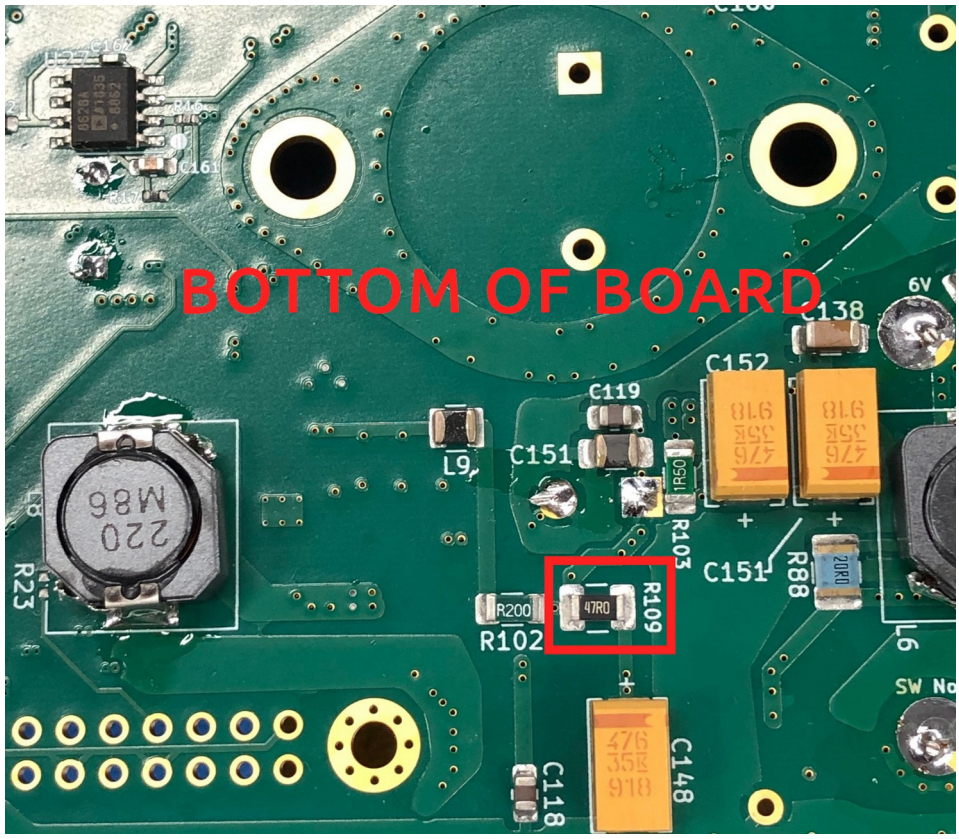
Install the missing resistors.

Finished installing:



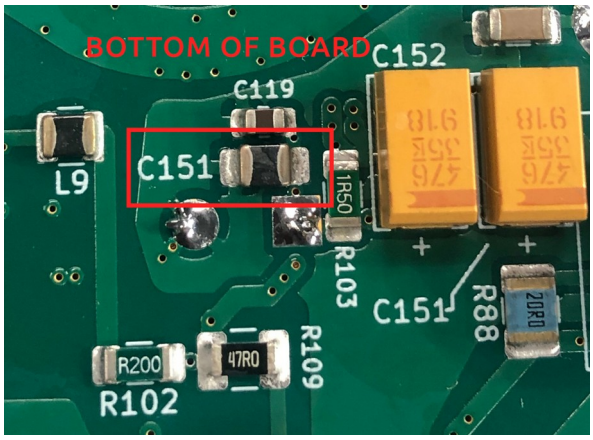
2 Replace Incorrect Resistor

The wrong value resistor was installed for R109. Installed is a 47R resistor, we need 1 Ohm or less. The package size is 1210, but either 1210 or 1206 is fine. Please remove and replace:

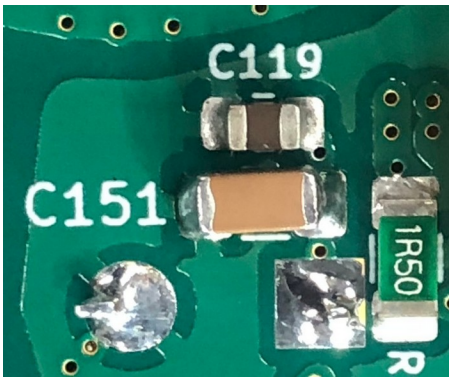


3 Replace Incorrect Component

The contract manufacturer installed a ferrite bead instead of a capacitor at C151. The footprint is for a tantalum cap which we don't have, but a ceramic cap is fine. Remove the ferrite bead and install 10uF 1206 ceramic capacitor at C151.



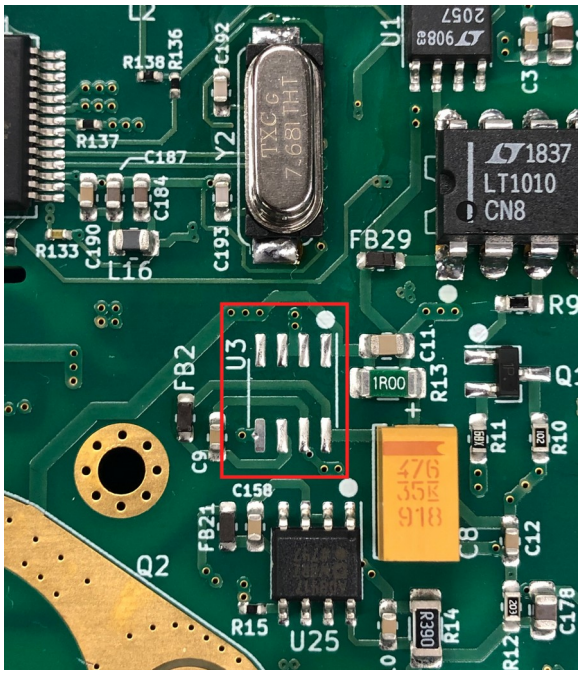
Incorrect ferrite bead installed

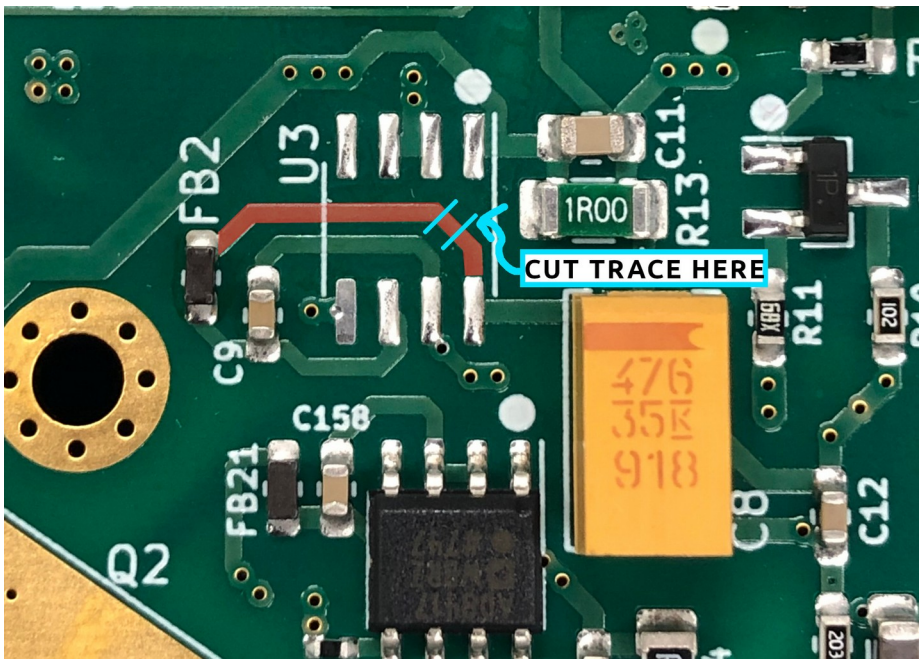


1206 ceramic cap installed

4 Install and Rework U3

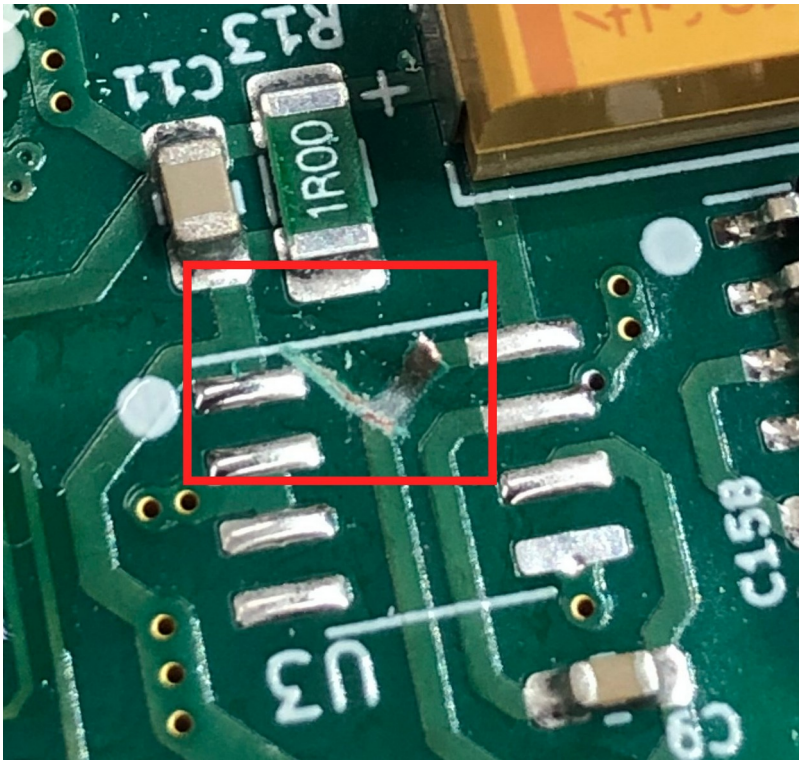
The contract manufacturer did not install the IC at U3. The component is AD8417, a current sense amplifier. This needs to be installed. Also one of the traces needs to be reworked. The power trace needs to be cut and a jumper wire added. See pictures below.





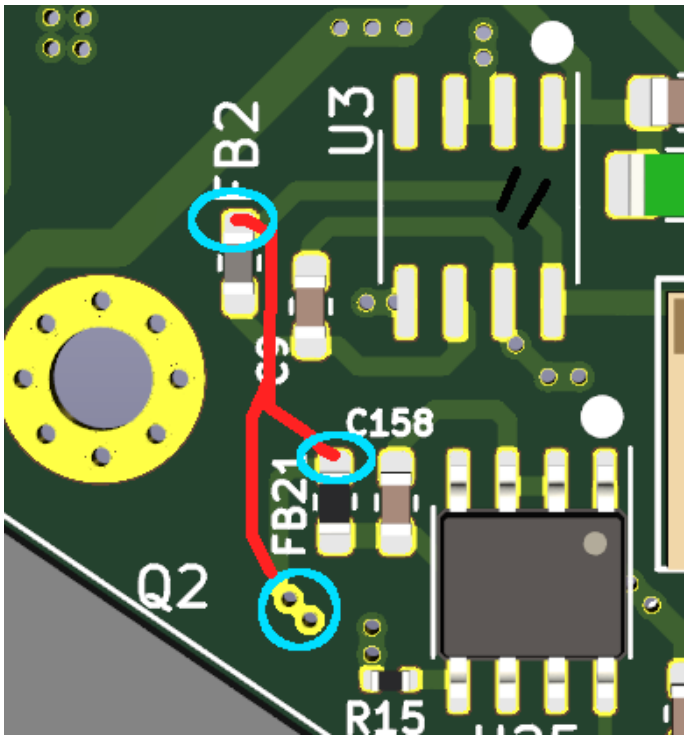
In the image to the right above, the trace to be cut is highlighted in red. Cut anywhere on the trace and verify the cut copper will not reconnect anywhere.

I cut the trace and then peeled back the copper a bit to verify no continuity.

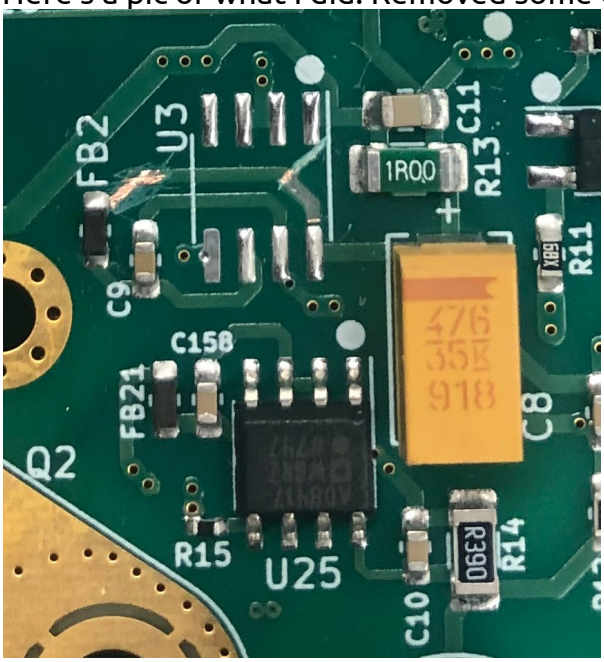


Trace peeled back then cut off

Next add a jumper wire for the power trace. In the illustration below it shows the path for the wire in red. The wire needs to connect from FB2 to FB21. The wire can connect either at the solder joint for FB21, or at two vias nearby which connect to FB21. Pick whichever location is easier for you:

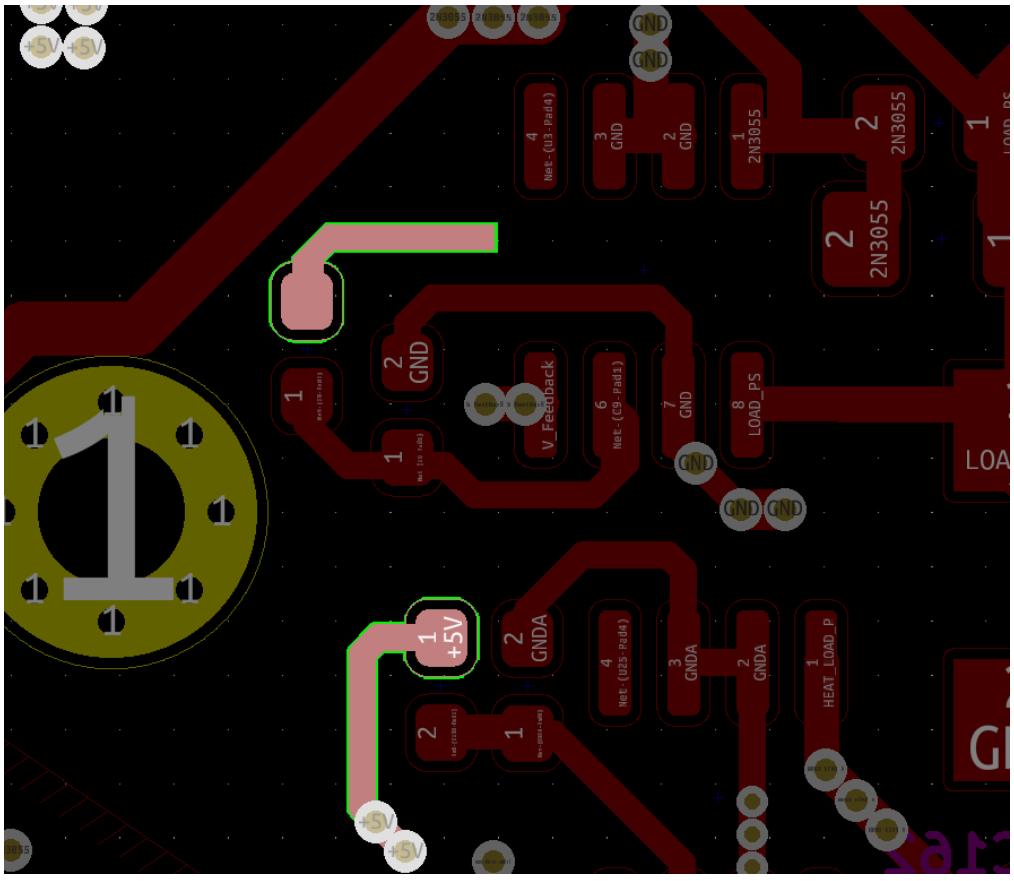


Here’s a pic of what I did. Removed some of the solder mask near FB2:



Then added a jumper wire to the two vias. Do whatever works for you though.

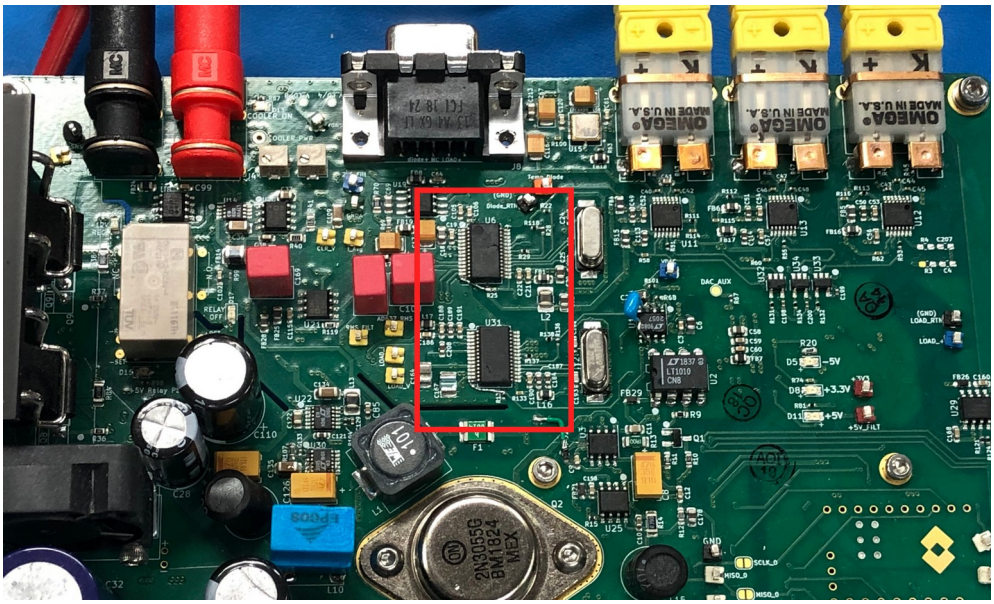
The highlighted traces below are what need to be connected. This is a snapshot of the board layout:



Lastly, install the IC for U3, which is ADS8417.

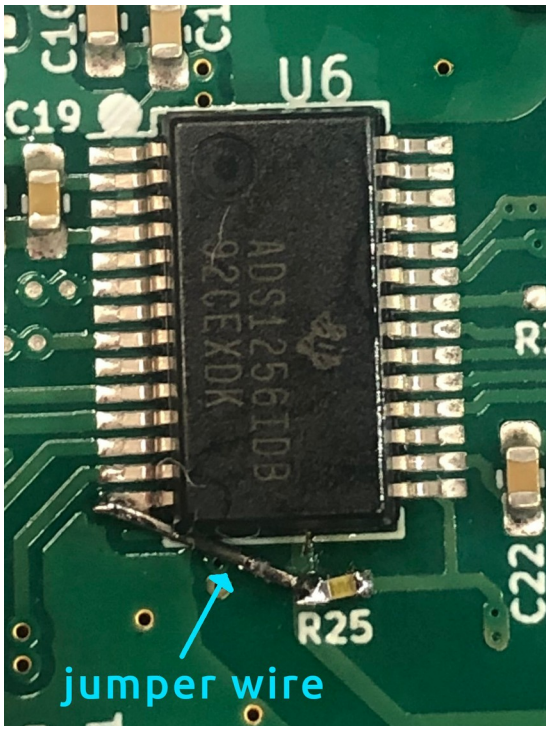
5 Add two jumper wires for ADS1256 sync line

I made a goof in the layout and forgot to add two pullup lines. There's two ADS1256 chips on the top of the board, these require the jumper wires:

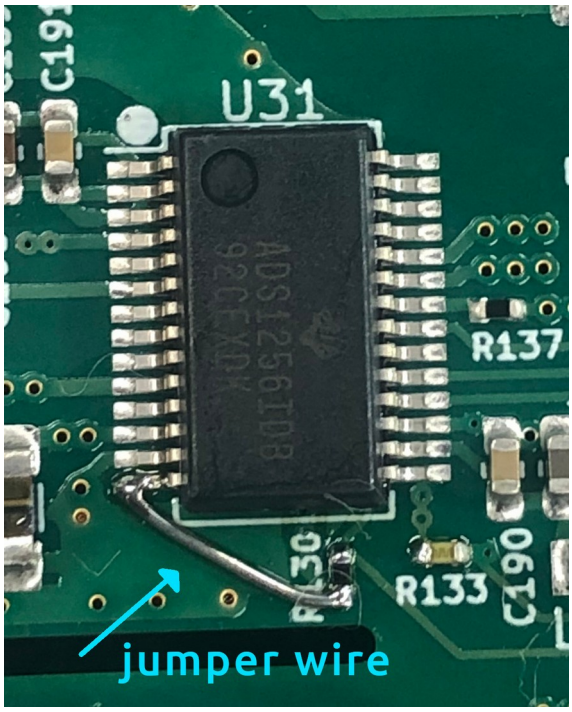


The two chips are U6 & U31. For U6, connect a jumper wire between pin 14 (bottom left) and R25:

U6

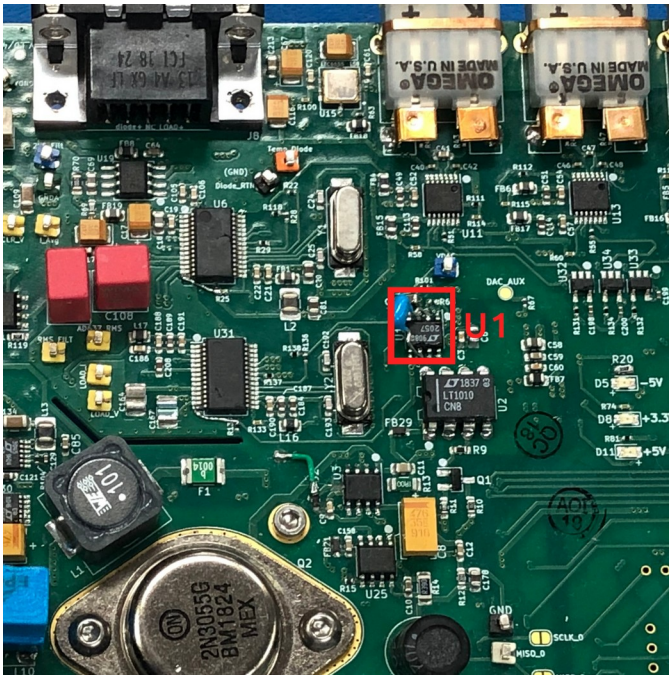


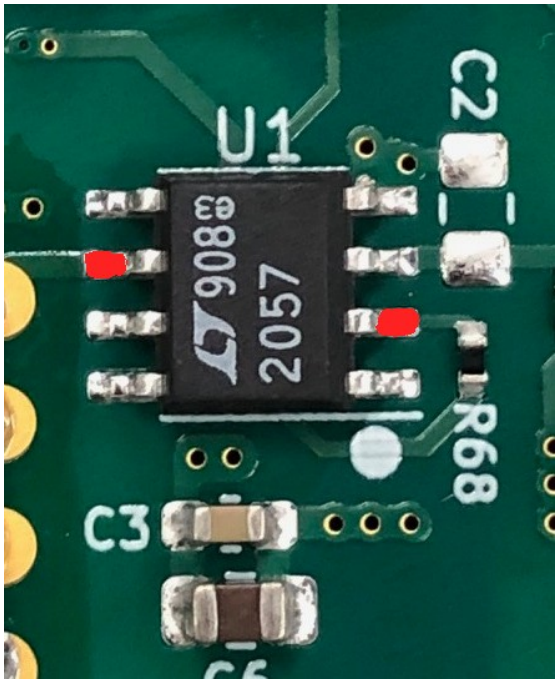
U31



6 Add 1 uF capacitor across U1

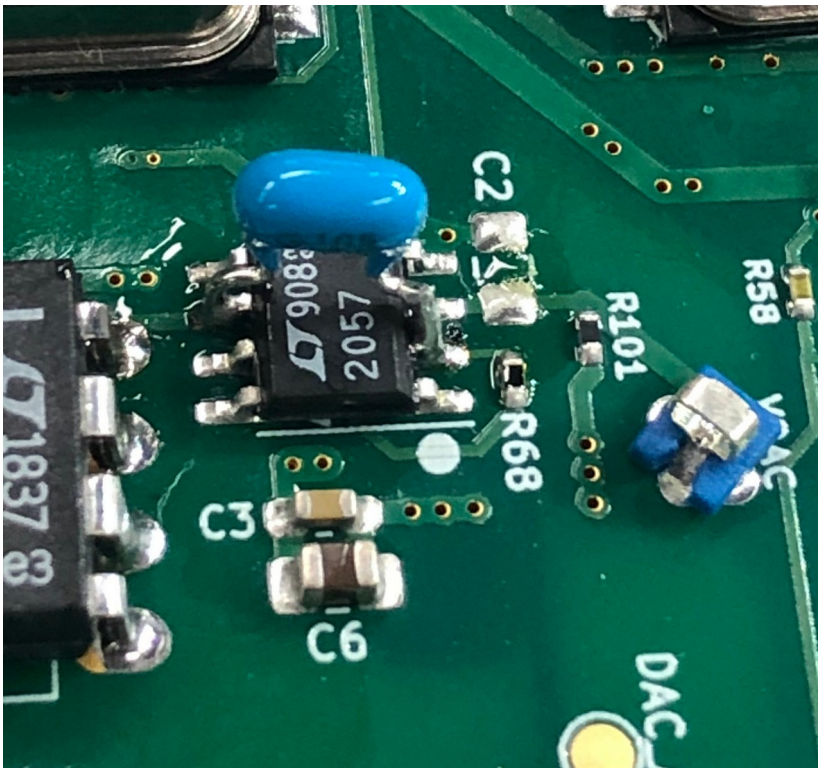
The capacitor needs to be added across pin 2 and pin 4 of U1, which is LTC2057 and has the text “2057” on the IC:





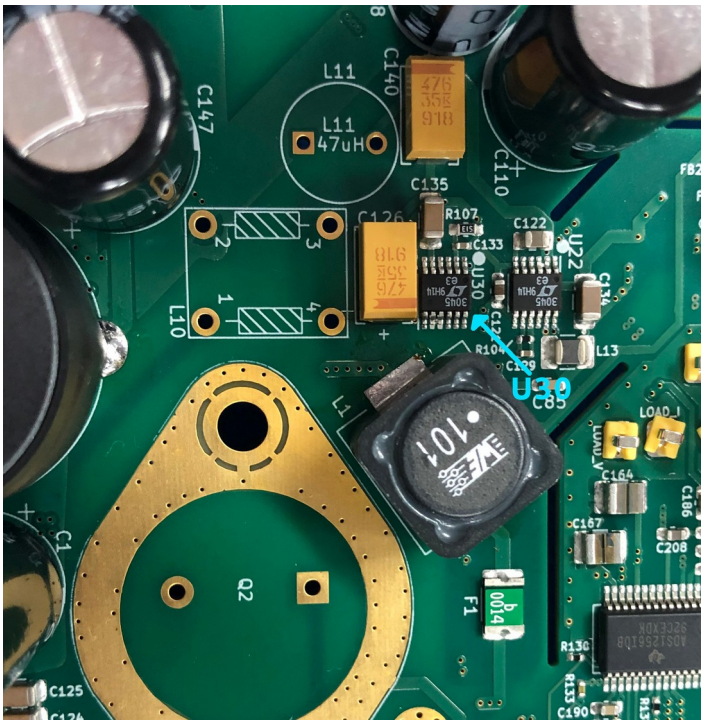
Add cap across two red pins above

Here is what it looks like when completed:



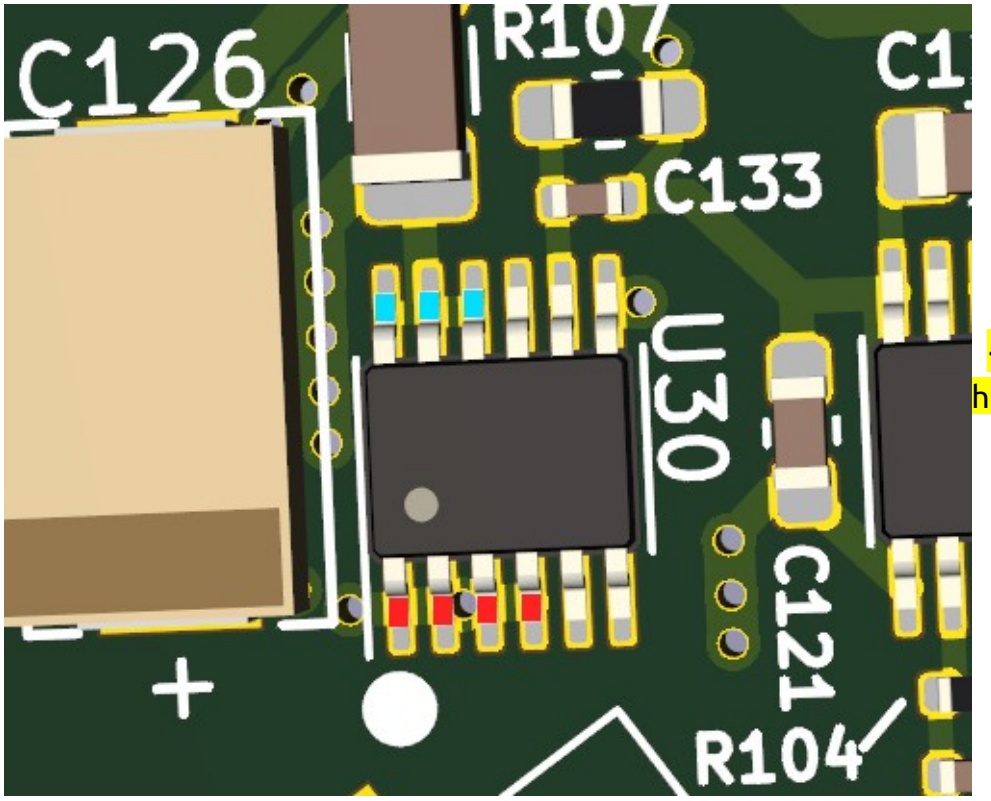
7 Flip around U30

U30 had the pin 1 indicator wrong, so the IC was installed incorrectly. It just needs to be flipped around. The IC has a center ground pad, so it needs a fair amount of heat to warm up before it will reflow. Also theres a tantalum cap right next to it that burns easily. I just covered the tantalum cap with some kapton tape to protect it from excess heat.



If L1 is installed, it may make it easier to remove L1 as well for the operation.

Some of the pins are interconnected on this IC, so some shorts are ok. Here's the pins that connect to each other:

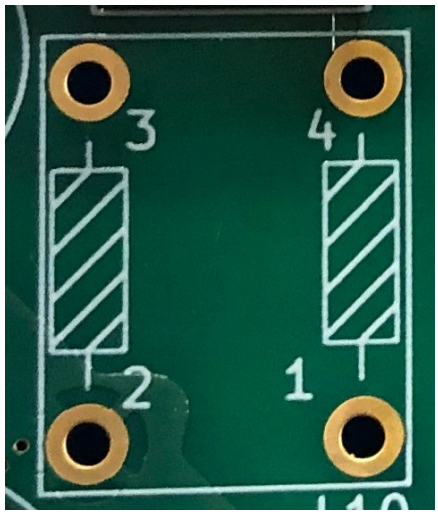


← Correct installation shown here

The pins in red all connect to each other, and the pins in blue all connect to each other.

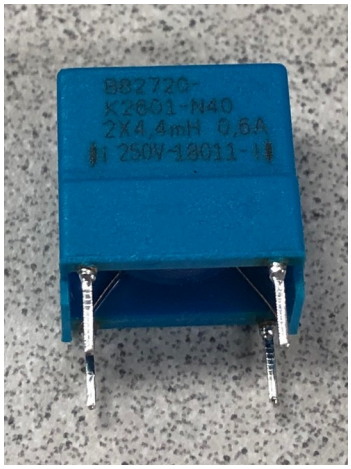
8 Install modified L10 choke

I goofed on the footprint orientation for L10. Its off by 90 degrees. You can see the rectangular footprint below:

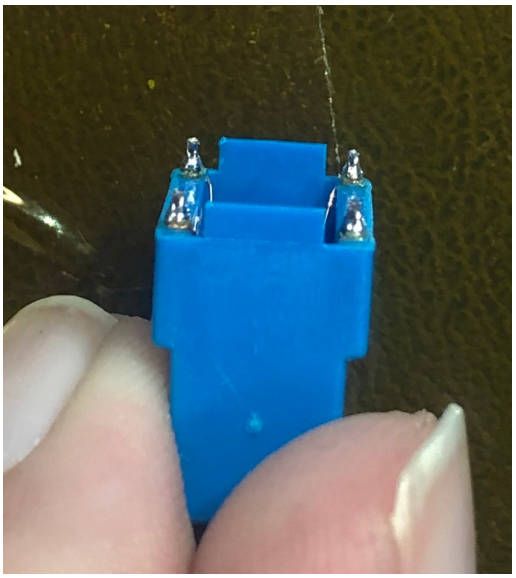


The silk screen shows pins 2 & 3 go together, and pins 1 & 4 go together. This is a mistake, pins 1 & 2 go together, and pins 3 & 4 go together. To correct we just have to spin the common mode choke 90 degrees.

This is what the component looks like. You can see it has the 4 corner pins. If we flip it 90 degrees, the legs won't align with the holes in the pcb, so we have to add some lead length. Also, The plastic frame has two protrusions on the body for the part to rest on. We'll use this to our advantage.

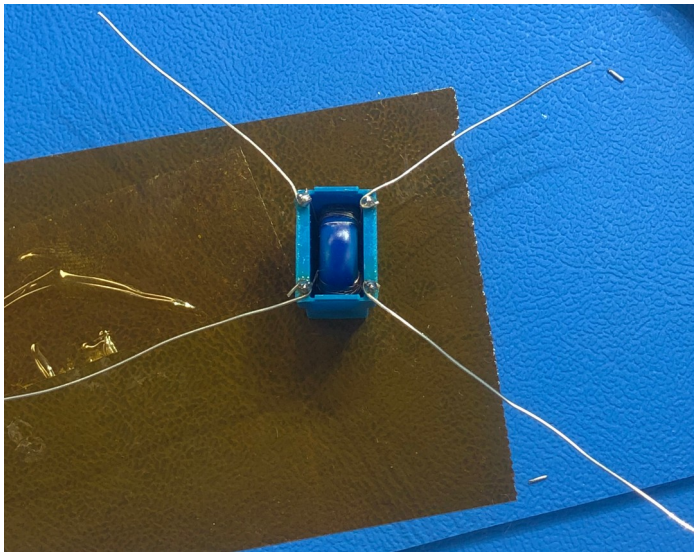


First I thing I do is clip the legs until they are flush with the end of the plastic body. Then, using bus wire, I start adding additional length to the legs.

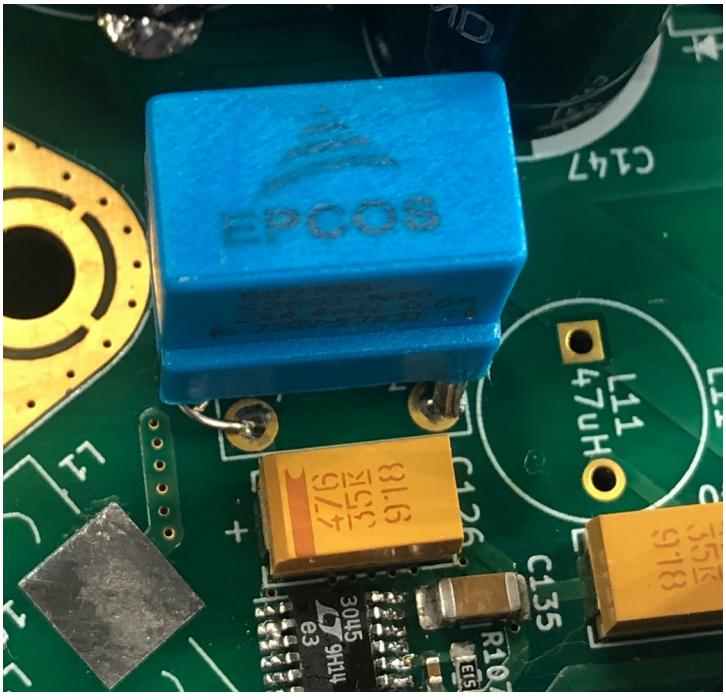


It helps to make a small loop on the end of the bus wire where it connects to the leg.

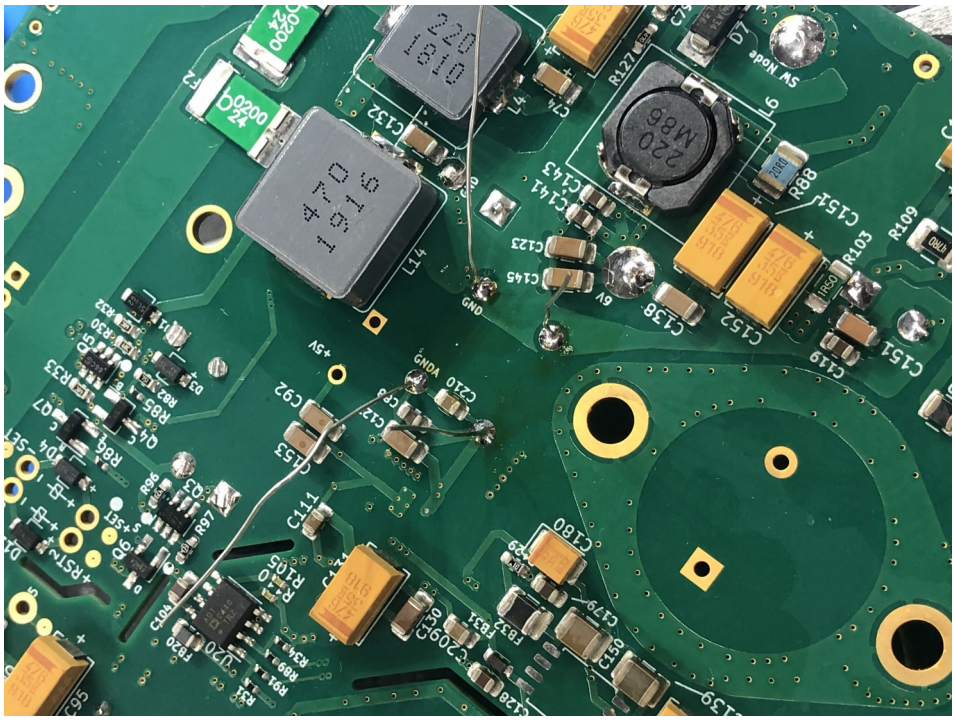
After preparing 4 pieces of bus wire with loop s on their end, put the loop around each leg and solder:



Then the bus wire can be fed through the holes, with the choke turned 90 degrees. Here's what it looks like:



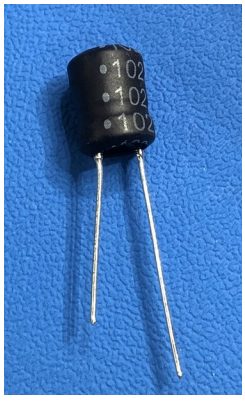
Pull the bus wire on the bottom of the board to take up the slack, then solder from the bottom of the board. Be careful not to apply too much heat or it might desolder the bus wire from the legs. Also, try to keep the choke body from infringing into the footprint for L11 & Q2, as these parts need to be placed as well. Here's what it looks like from the bottom.

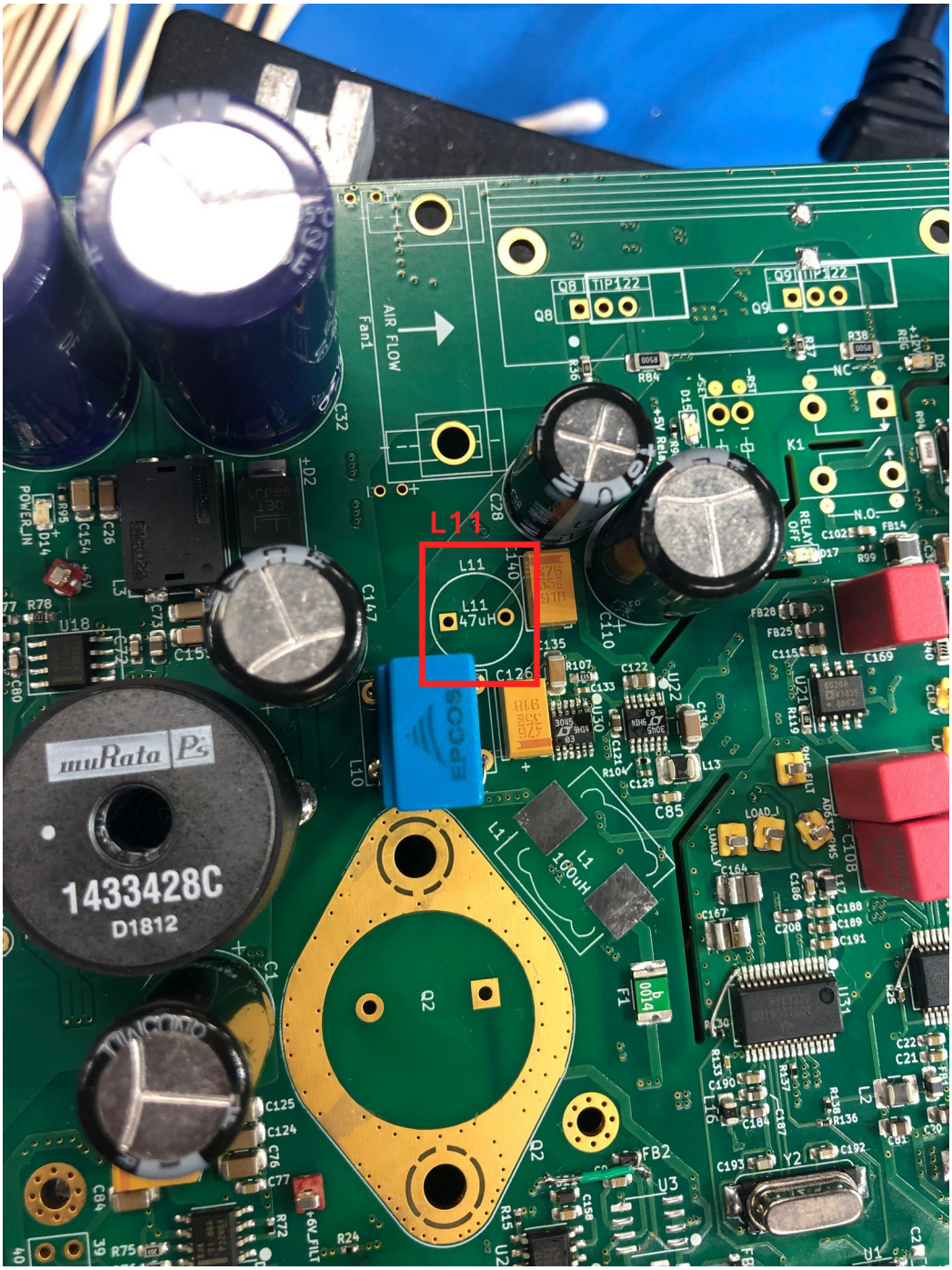


Good job.

9 Install L11

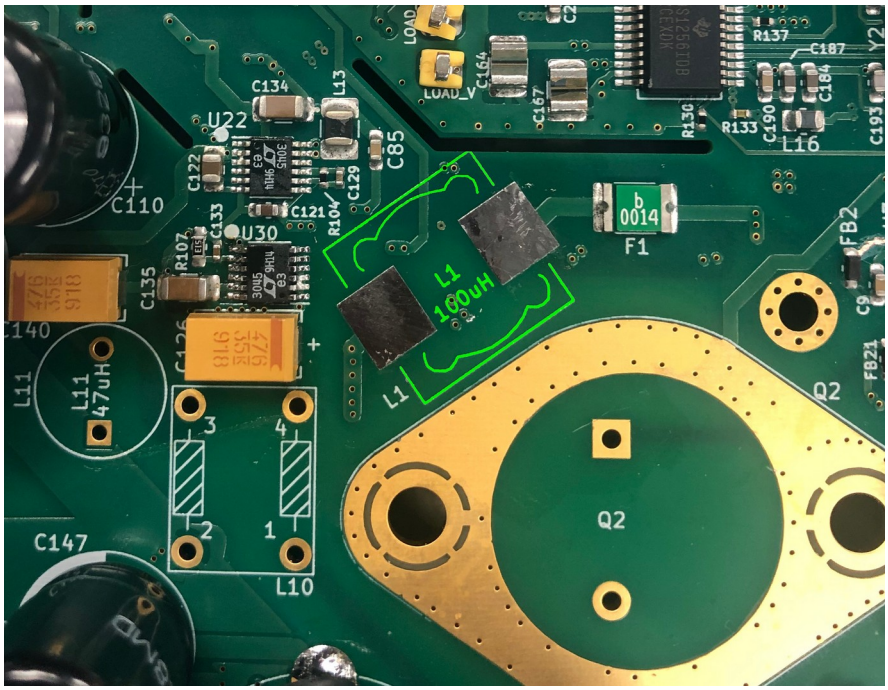
This one is super easy. Just put the legs through the holes and solder. There's no polarity to the choke so don't worry about that. L11 is right next to the common mode choke from the last step.





10 Install L1

Install 100uH choke at L1.

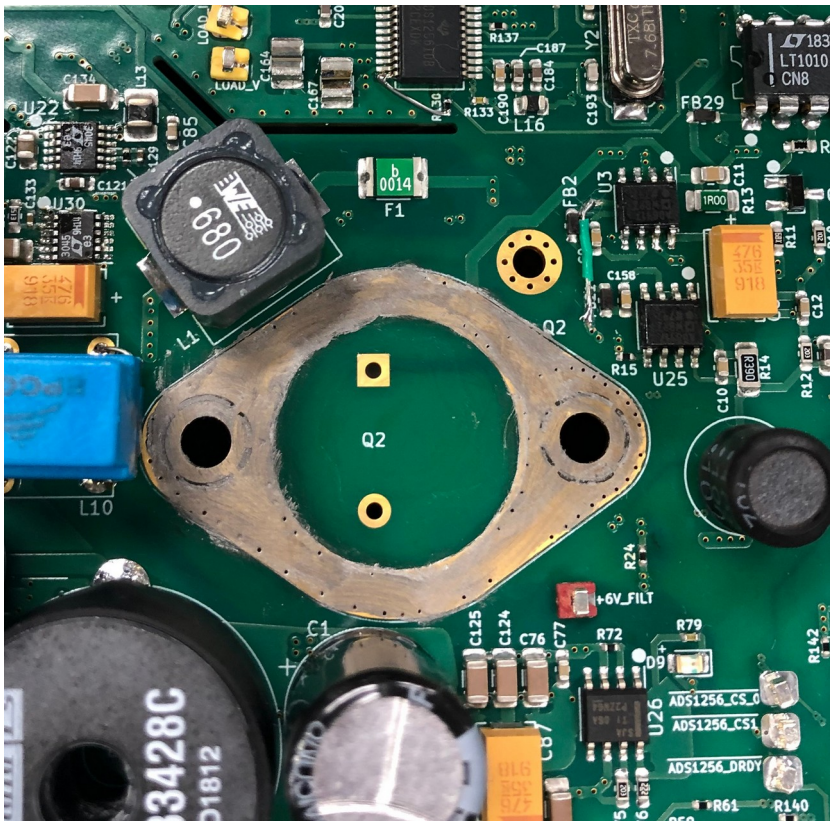


11 Install Q2, 2N3055 transistor

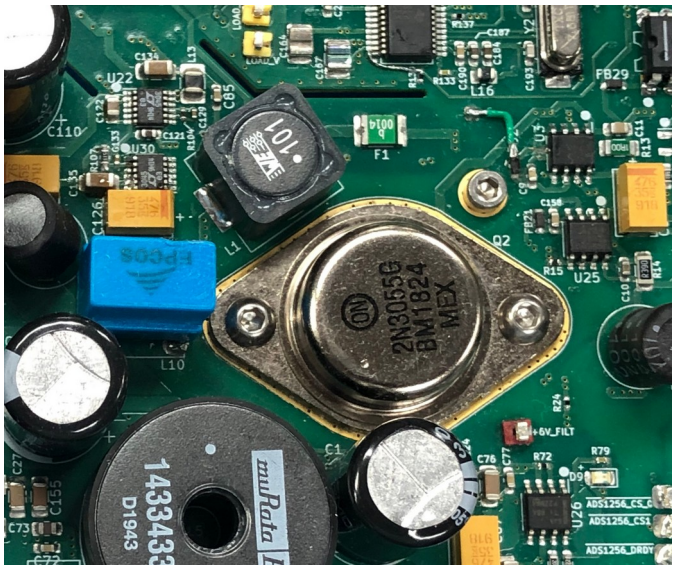
This large transistor is installed at Q2. The metal shell of the transistor is a lead and makes electrical contact with the large gold footprint. Some conductive grease needs to be applied to improve contact.

This is the conductive grease to use:

You only need a tiny bit of this stuff. It spreads out really far. If too much is applied, it starts to come out the via holes on the bottom of the board, and also gets squeezed out when the transistor is installed. Apply the grease sparingly with the syringe, then spread it out with a cotton swab. Here's what it looks like after spreading out:



After the grease has been spread out, place the transistor on the footprint. The legs will only install one way.
Then fasten the 2N3055 with (2) M3x6 bolts and nuts. Tighten the bolts. Do not solder the legs until after tightening the bolts.

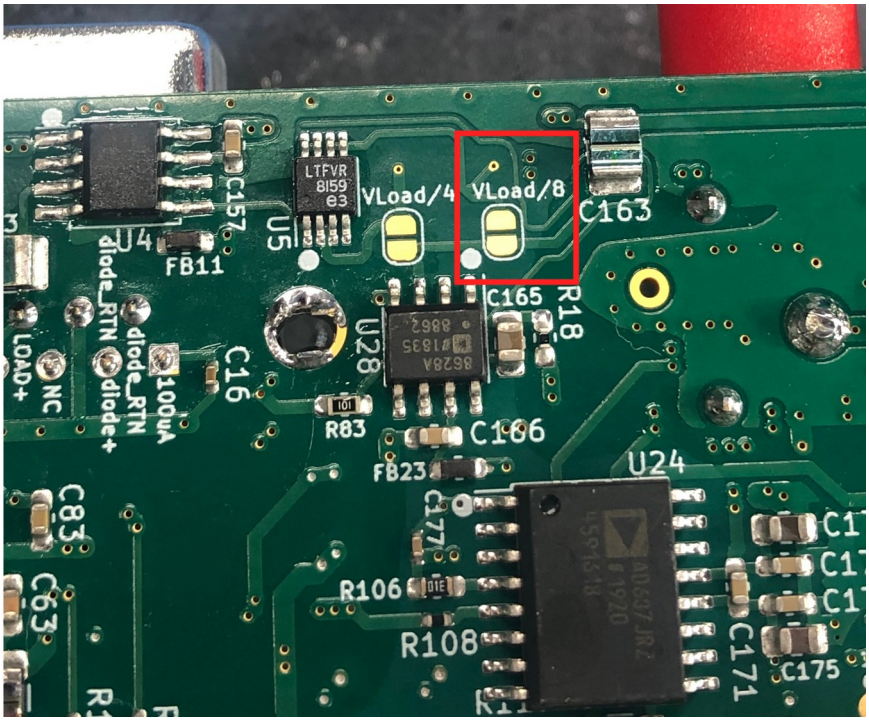


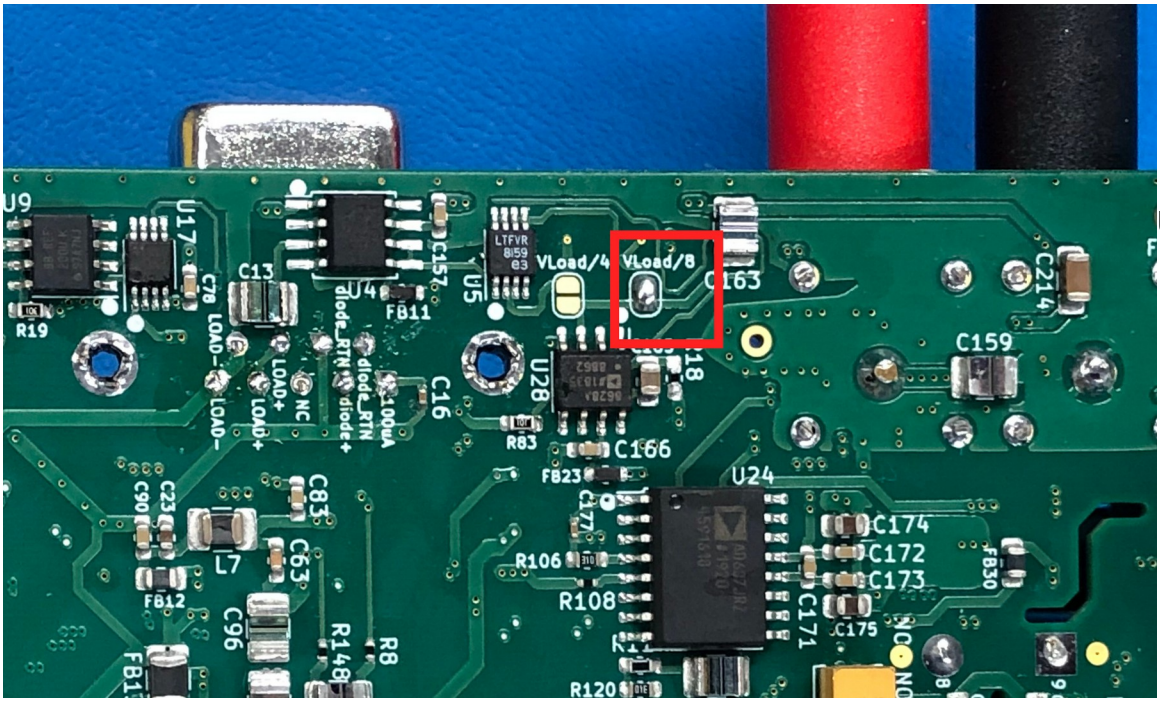
After tightening the nuts, use a cotton swab and IPA to clean any grease that squeezed out from underneath the transistor body.

Solder the legs from the bottom of the board, then clip off the legs.

12 Add solder blob to bridge a jumper on the board

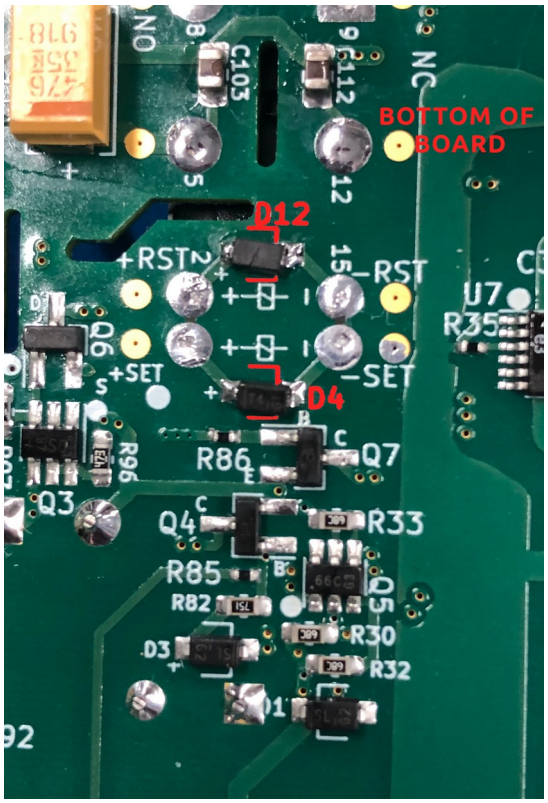
On the bottom of the board, near the DB9 and banana plug connectors is are two solderable jumpers. One is labeled “V/4” and one is labeled “V/8”. Add a solder blob to bridge the jumper “V/8”.



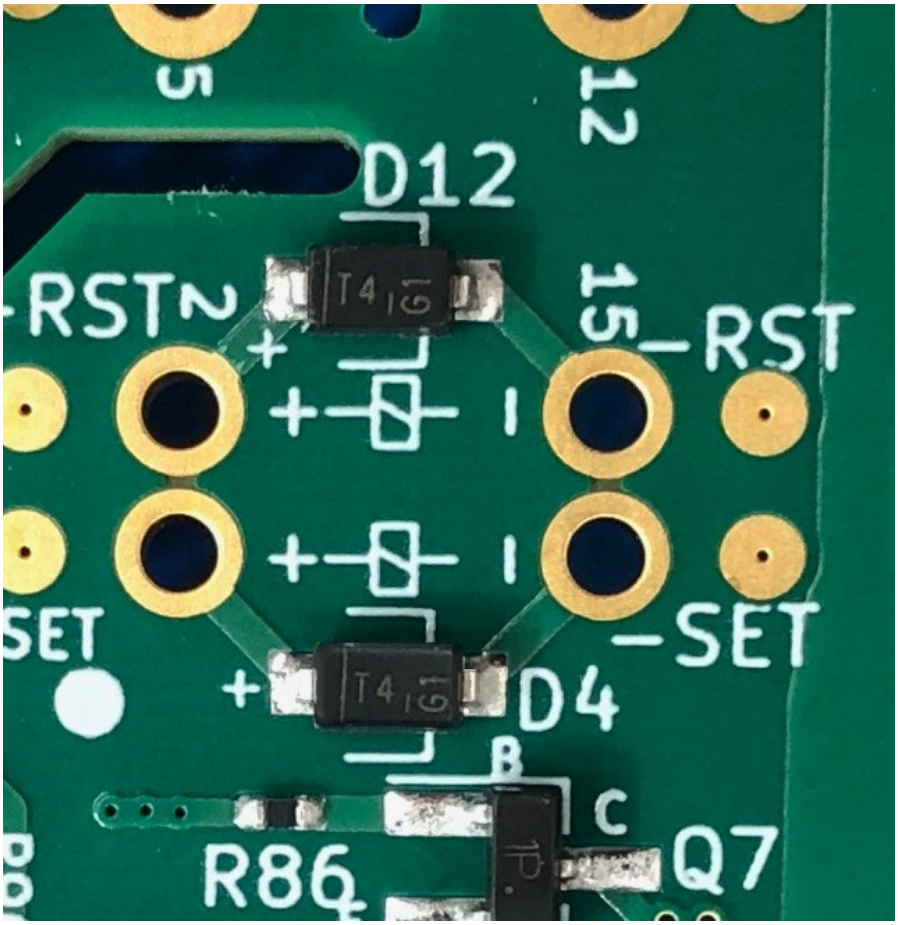


Solder blob added to V/8

13 Flip diodes D4 & D12 (on bottom of board)

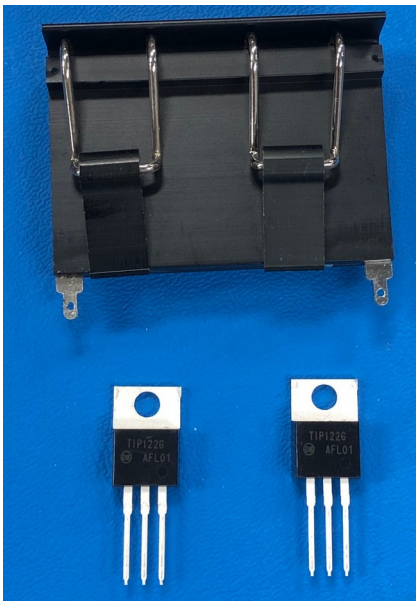


The correct orientation of the diodes is with the line facing the “+” sign. So on line on the diode body should be closest to the “+” sign. **Correct orientation:**

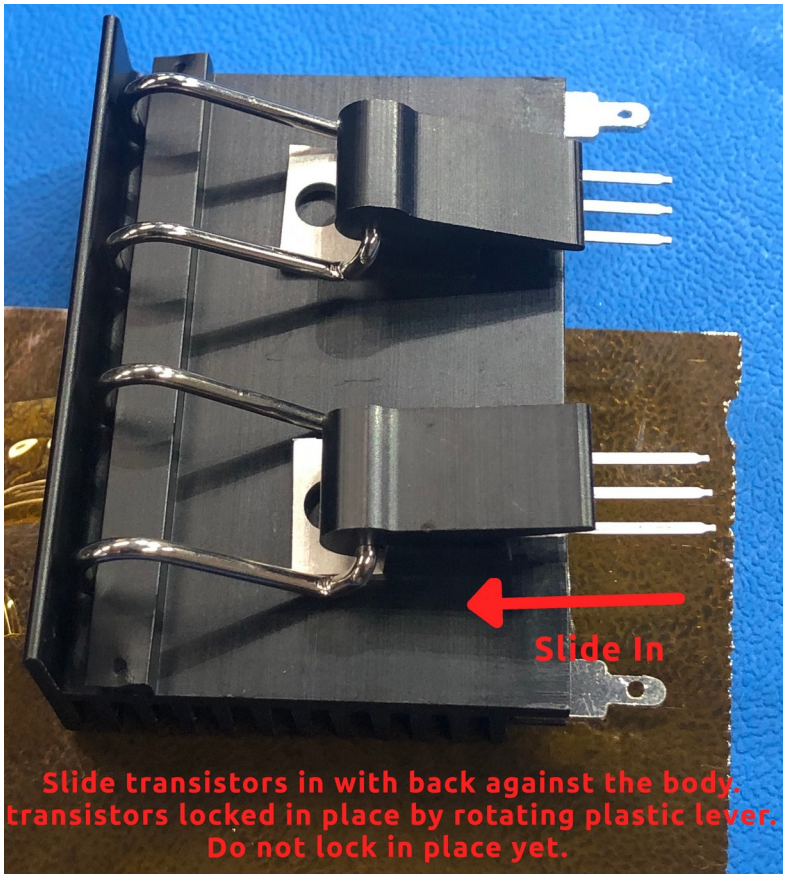


14 Install Q8, Q9, and Heat Sink

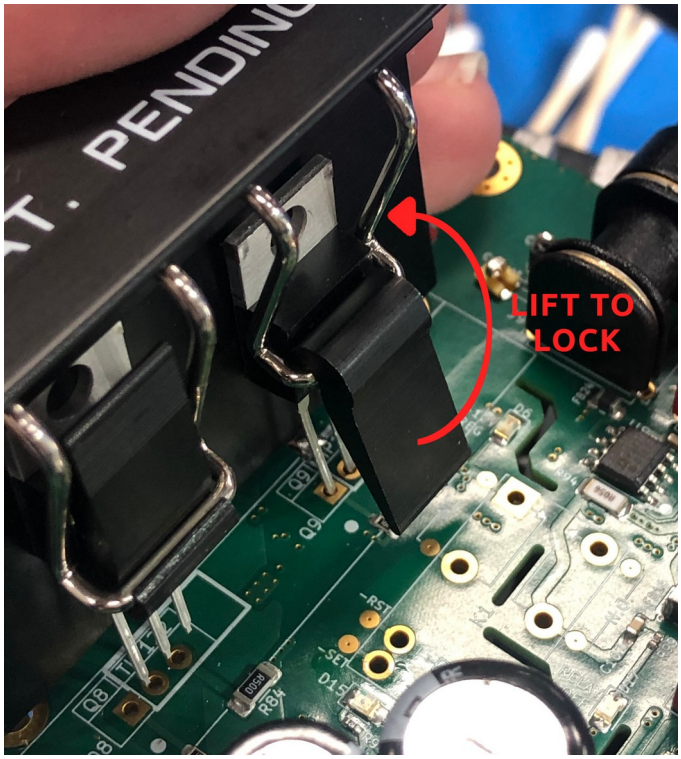
For this step you need the large black heat sink and (2) TIP122 transistors:



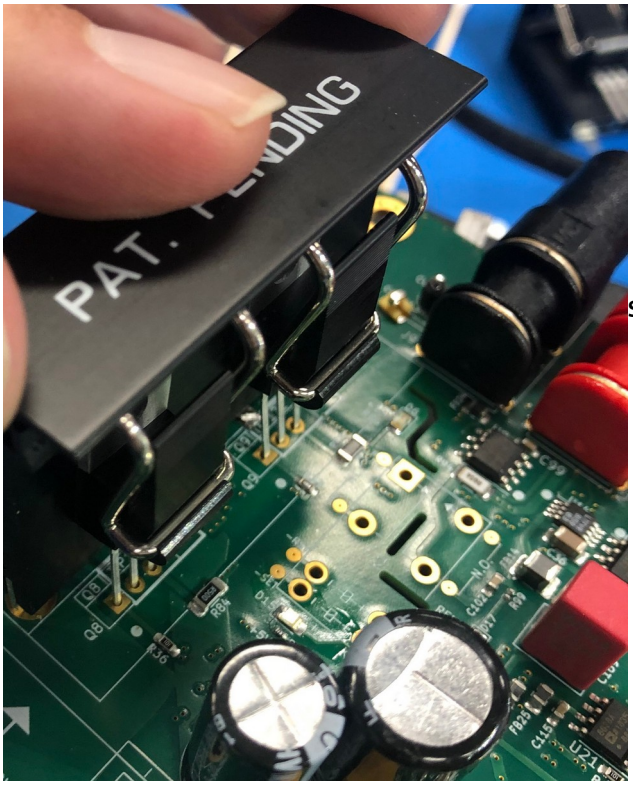
First install the transistors on the heat sink, but do not lock the transistors in place yet. Keep them loose.



Place the heat sink on the board with transistors, and adjust the transistors until the legs fit into their footprint and are seated.



Once both transistors are seated, and the heat sink is seated against the board as well, then lock the transistors in place by lifting the plastic locking lever. When both transistors are adjusted properly and locked, they should look like this:

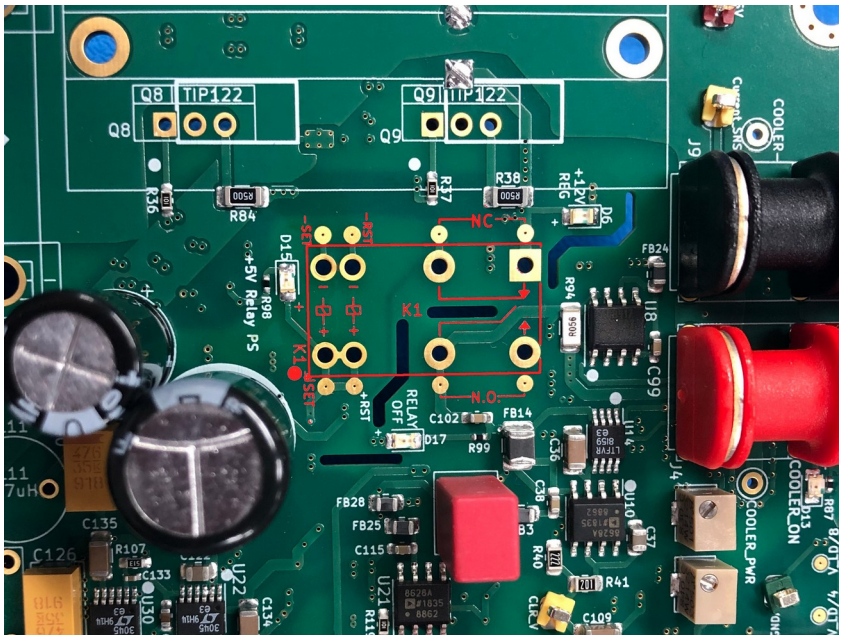


Make sure enough of the legs extend into the holes to solder.

Solder everything in place, the heat sink and transistor legs. Try to keep the heat sink perpendicular with the board if possible, but not absolutely necessary. Finished it looks like this:

15 Install relay

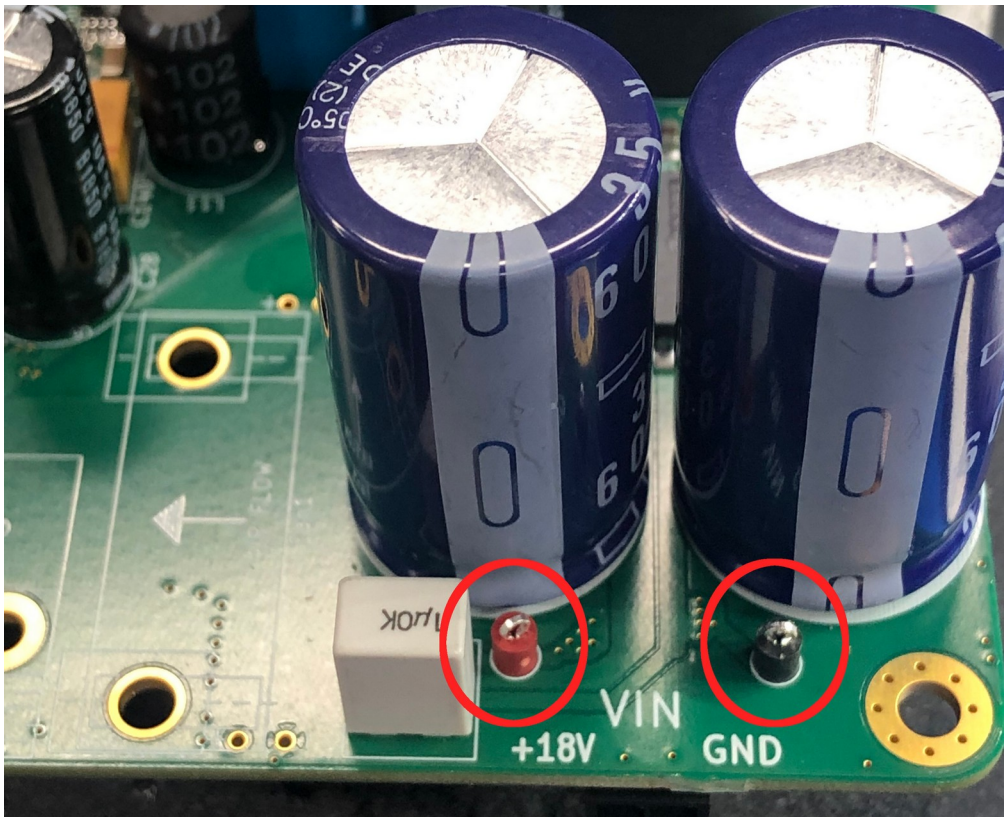
The relay only fits in one way, so should be pretty easy. Slide into place and solder the legs.



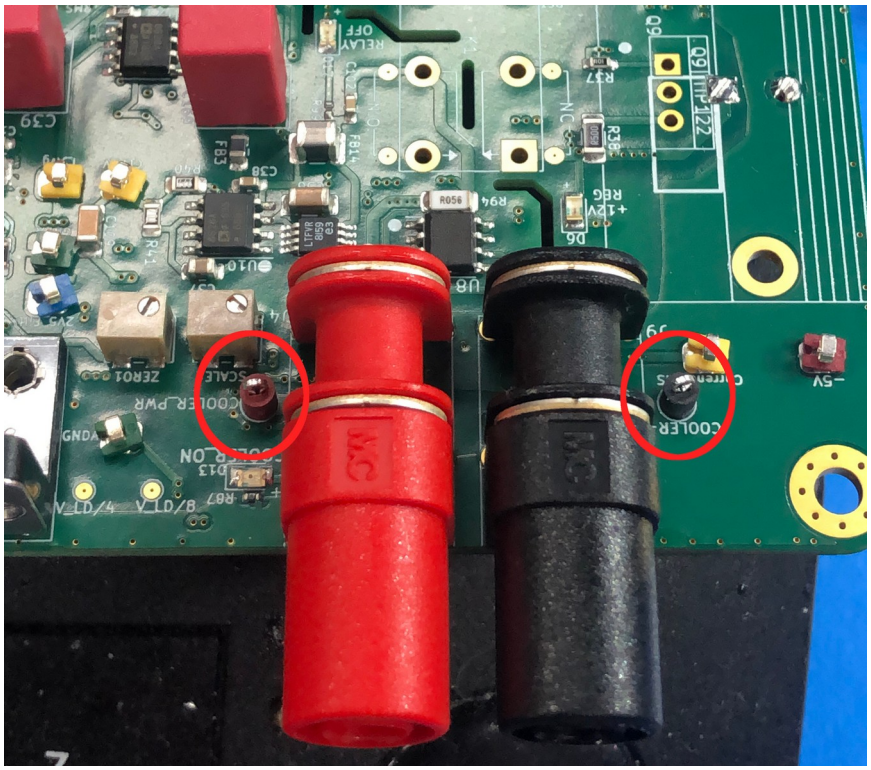
Relay footprint highlighted in red.

16 Install Test Points

There's 4 test points that need to be installed, 2 red and 2 black.
Install a red and black test point at the front corner of the board where it says "Vin" :



Also install a red and black test point next to the banana connectors:

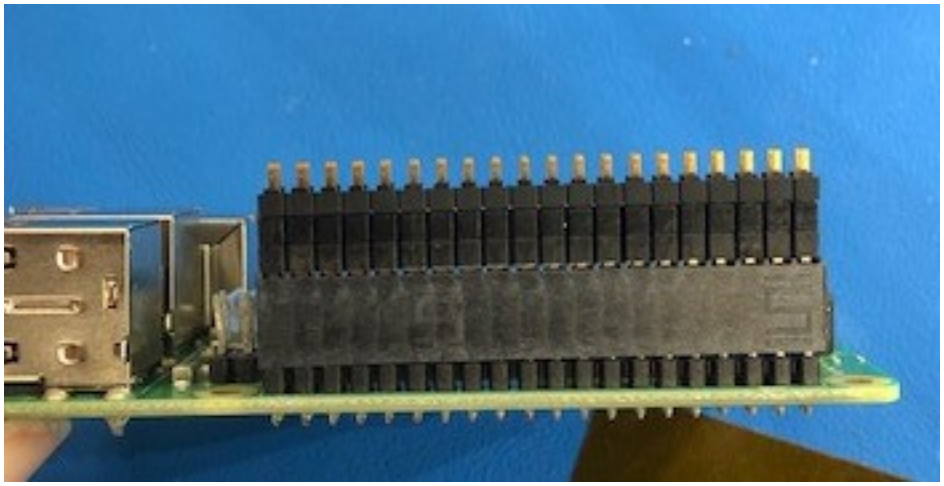


17 Install Raspberry Pi:

For this step you need the Raspberry Pi, extension header, QTY 8 of M2.5x8 screws, QTY 4 hex standoffs, and QTY 8 washers. First install the standoffs to the bottom of the board with the 8 washers, 4 bolts, and 4 standoffs.

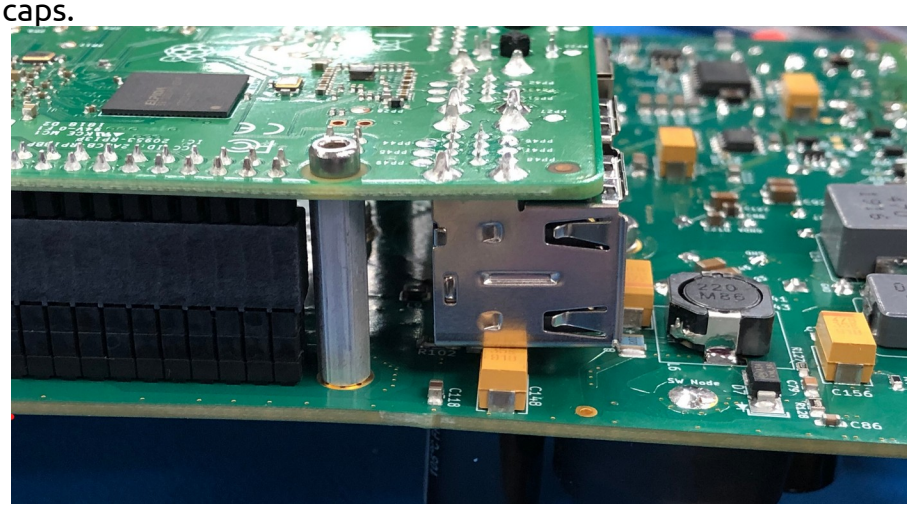
Remove the Raspberry Pi from the clear plastic case:

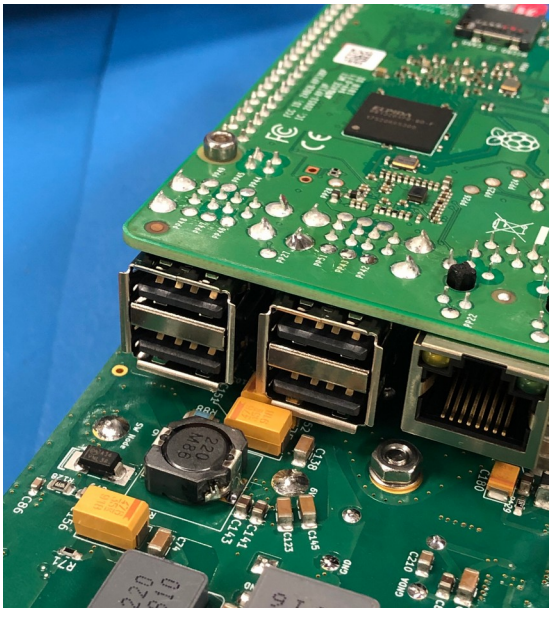
Install the extension header on Pi header pins:



Now install the Pi onto the bottom of the board. The header pins will fit into the footprint on the board, and the holes on the Pi will line up with the threaded holes of the standoffs. Use (4) M2.5x8 screws and tighten the screws, securing the Pi on to the standoffs. Lastly, solder over the header pins, to make the connection between the Pi and the board.

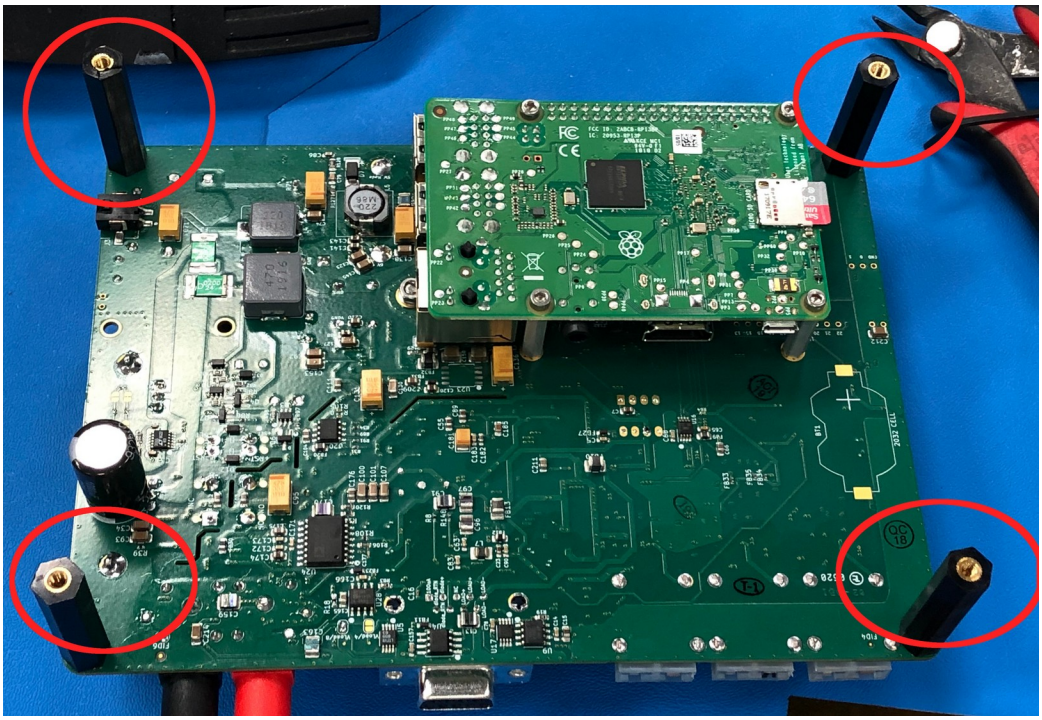
The clearance between the Pi and the board will be close. It's ok if the Pi touches the tantalum caps.





18 Install Black Standoffs

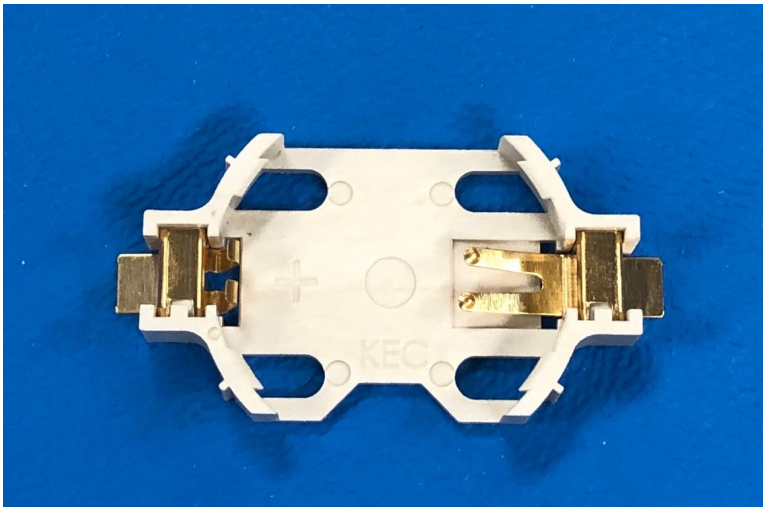
Last step: install 4 black standoffs on the 4 corners of the board to be used as legs for the board to stand on. Use the supplied M3X8 bolts.



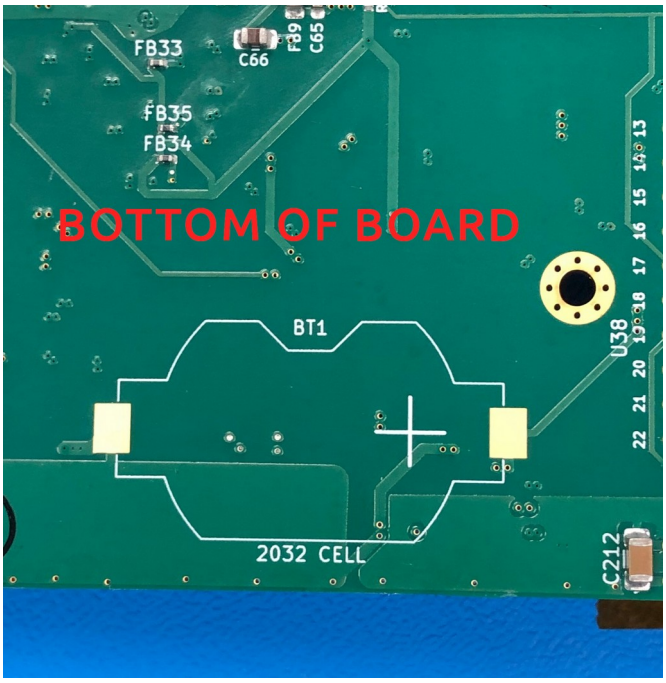
Excellent work!

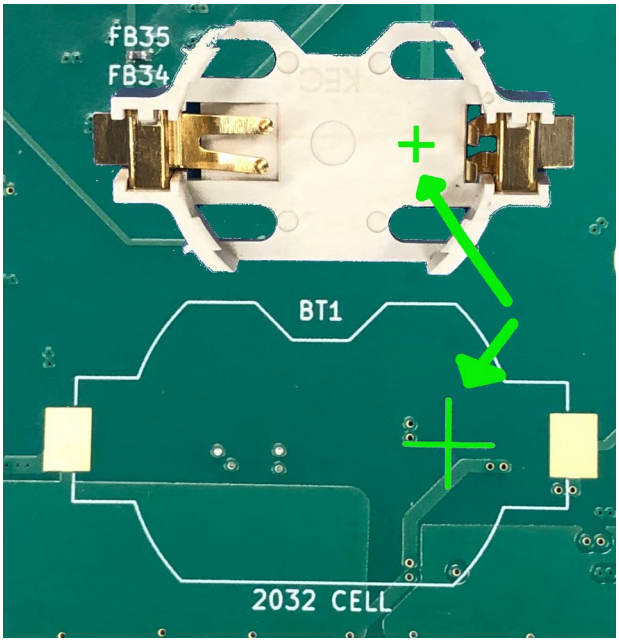
19 Install Battery Holder

Install the coin cell battery holder on the bottom of the board. Make sure to align the (+) sign on the battery holder with the (+) sign silk screen on the board.



Align the two (+) symbols when installing


FB33
C66
FB39
C65
FB35
FB34
BOTTOM OF BOARD
BT1
U38
2032 CELL
C212


FB35
FB34
BT1
2032 CELL