Sampler

Kit Builder's Guide for PCB v1.0

Guide v1.0a, November 15, 2023

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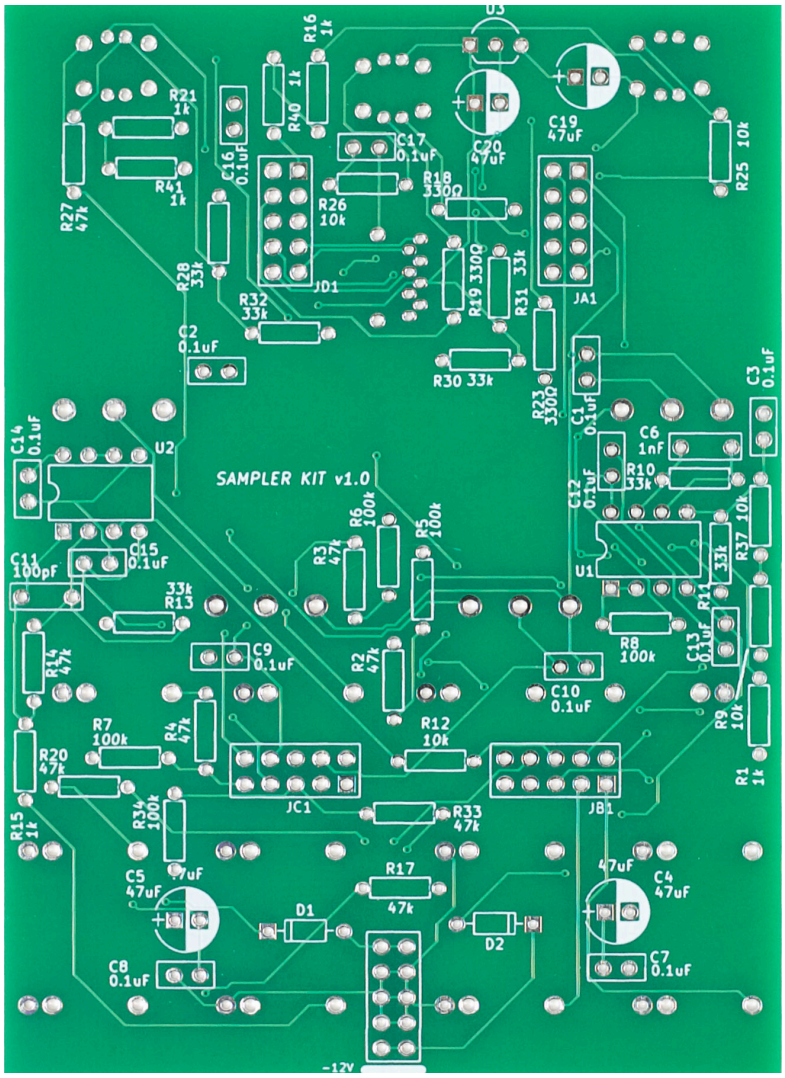


SAMPLER

This guide is for building a Sampler. You should have basic soldering skills and a basic familiarity with identifying electronic components.

Tools Needed:

- Soldering iron, solder
- Flush cut snips (for snipping leads after soldering)
- Needlenose pliers (for removing a component if you make a mistake, and for pulling leads straight)
- 10mm and 5/16" socket drivers for pot and jack nuts (pliers will work, if you're careful not to scratch the faceplate)
- Multimeter (for reading resistor values if you don't know the resistor color code chart, or for locating shorts/solder bridges)
- Tape such as masking or painters tape (for holding down the SD card holder while you solder)

Step 1: Resistors and Diodes

Insert and solder the 34 resistors and 2 diodes. Due to variations in components, you may find that some resistors are larger than others in your kit. The size is irrelevant, only the color bands matter. The orientation of the resistors does not matter. The diodes must go in with the grey band facing the line marked on the PCB. After installing the components, you may want to splay the leads a bit so they don't start to fall out when you flip the board over to solder. Or, you can put a book or piece of cardboard over the components to hold them in place while you flip the board over. After soldering, snip the leads nearly flush to the PCB.

The 34 resistors :

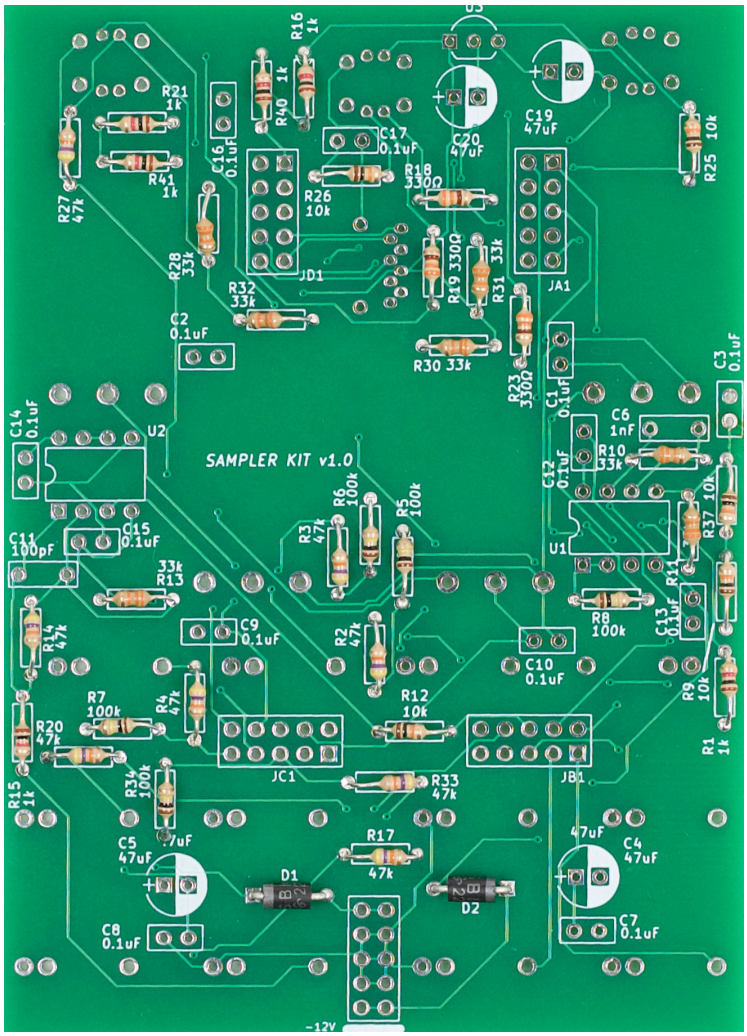
- *330 ohm x 3 (orange orange brown gold)*
- *1k x 6 (brown black red gold)*
- *10k x 5 (brown black orange gold)*
- *33k x 7 (orange orange orange gold)*
- *47k x 8 (yellow purple orange gold)*
- *100k x 5 (brown black yellow gold)*

Caution: 10k and 100k resistors have the same quantities; be careful not to get them mixed up!

The 2 diodes:

- *SB140 Schottky x 2*

Note orientation! Band on diode = stripe on footprint



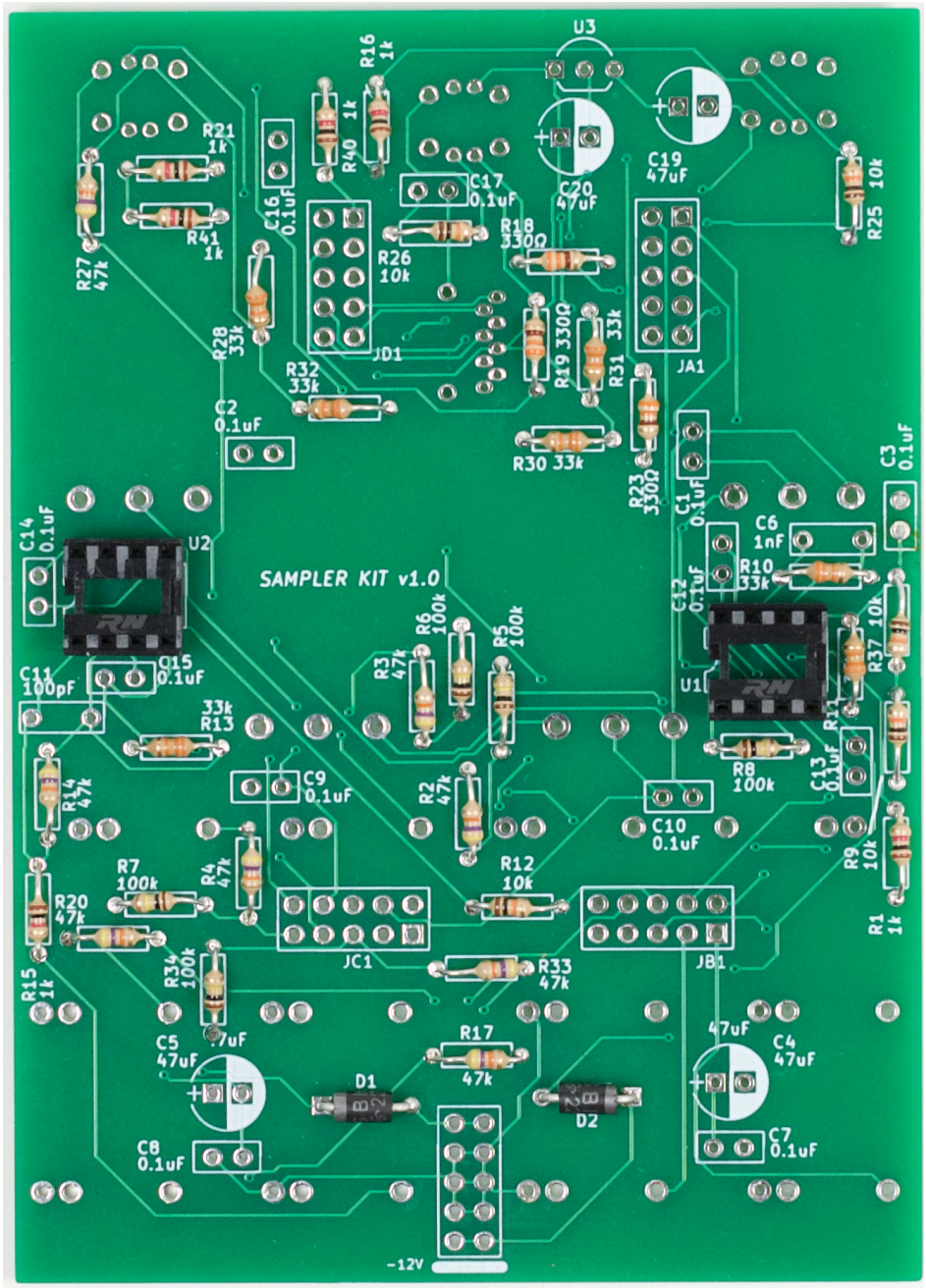
Step 2: Sockets:

Insert and solder the IC sockets. The notch in the sockets should line up with a matching notch drawn on the PCB. Both of the sockets should have the notch facing to the left. If you have trouble keeping the sockets installed while you solder them, you can bend the leads slightly, or try taping them down, or place a book or flat surface on top of them before flipping the PCB over to solder.

Make sure all 8 pins poke through the PCB. It's easy to bend a pin when installing the socket, and it will be difficult to fix this later.

Note that if you accidentally solder the sockets in backwards (with the notch facing the right), then do not remove them: removing sockets risks damaging your board. Instead, just wait until Step 10 and insert the ICs with the notch or dot facing the correct way.

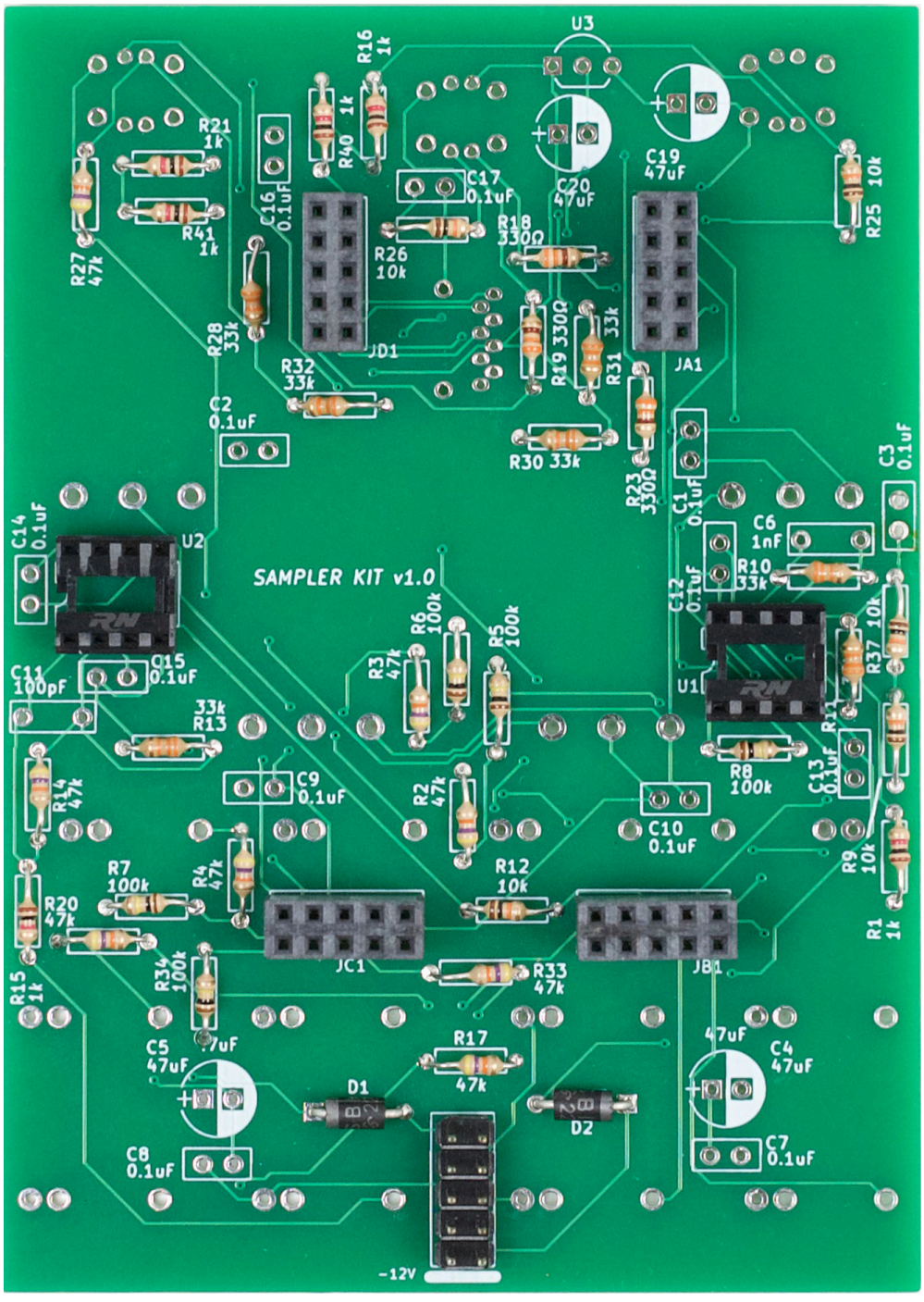
• *8 pin socket x 2*



Step 3: Pin Headers and Socket Headers

Insert and solder the pin and socket headers. Since the headers fall out easily, it helps to put a piece of cardboard or a book over the PCB, then flip over the book and PCB together before soldering. Solder one or two pins per header, then flip the board back over and check to make sure they are lined up, flush to the PCB, with the pins at a perfect right angle to the PCB. It's important that the socket headers are vertical and not tilted or angled because the Brainboard will be installed into all four of these headers. After you verify this, flip the board back over and solder the rest of the pins.

- *2 x 5 pin header x 1*
- *2 x 5 socket header x 4*



Step 4: Capacitors and Regulator

Insert and solder the 19 capacitors. The 100pF, 0.1uF, and 1nF caps can be inserted either way, but the 47uF cylindrical caps must be installed with the long lead in the square hole. All four 47uF caps are oriented the same way, with the striped side to the right, matching the white half of the 47uF capacitor footprint on the PCB.

Correctly placing the voltage regulator is extremely important. A backward regulator can damage your Brainboard or SD card if powered on. Before placing the regulator, make note of its shape: it has a flat side and a round side. The voltage regulator footprint on the PCB is shaped similarly, with a flat and a round side. Make sure to place the regulator with its flat side lining up with the flat side of the footprint on the PCB. Once inserted, bend one of the regulator's legs slightly so that the component does not fall out of place when you flip the board over to solder. Once soldered, snip the leads down to PCB level.

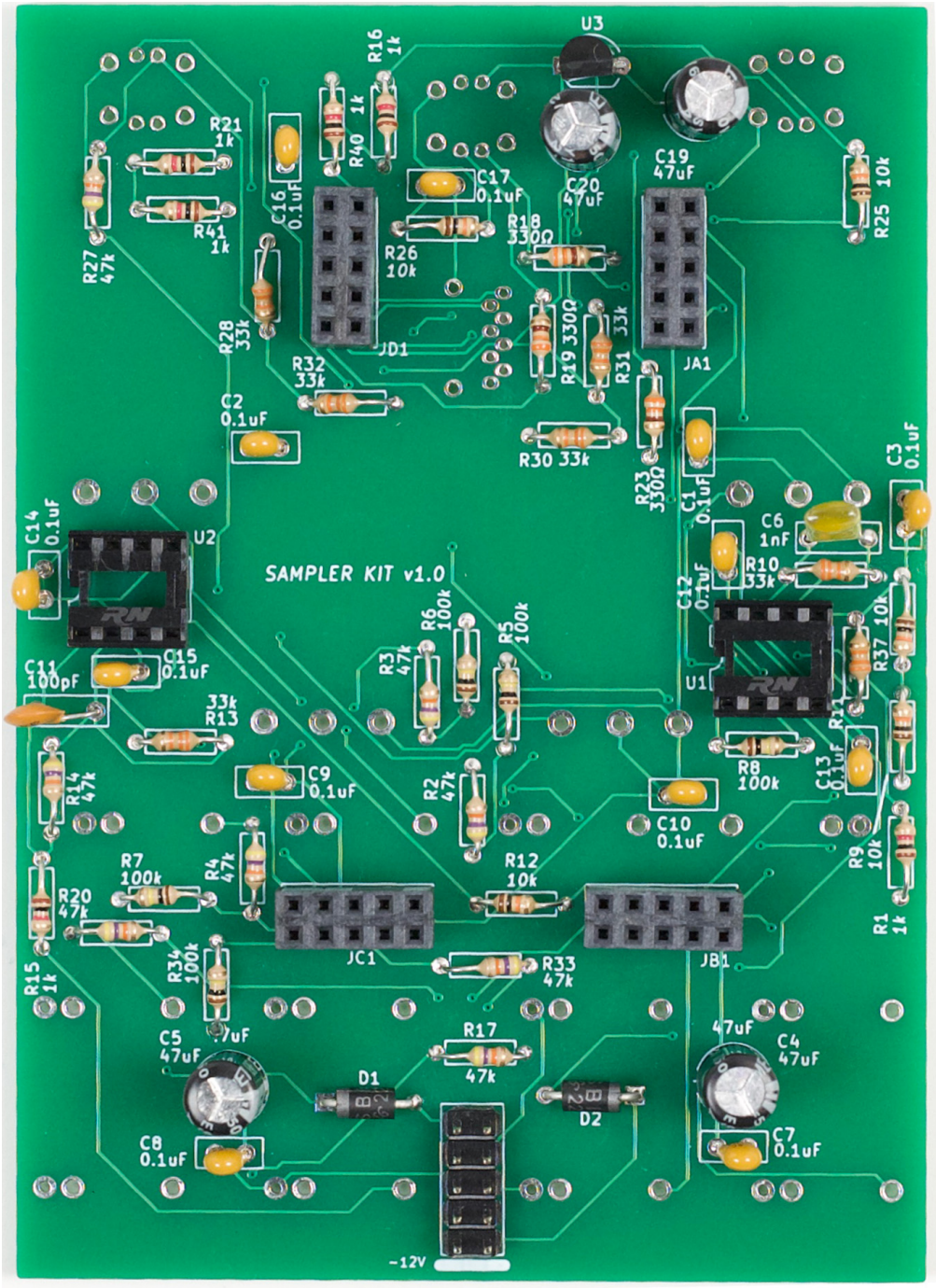
The 19 Capacitors:

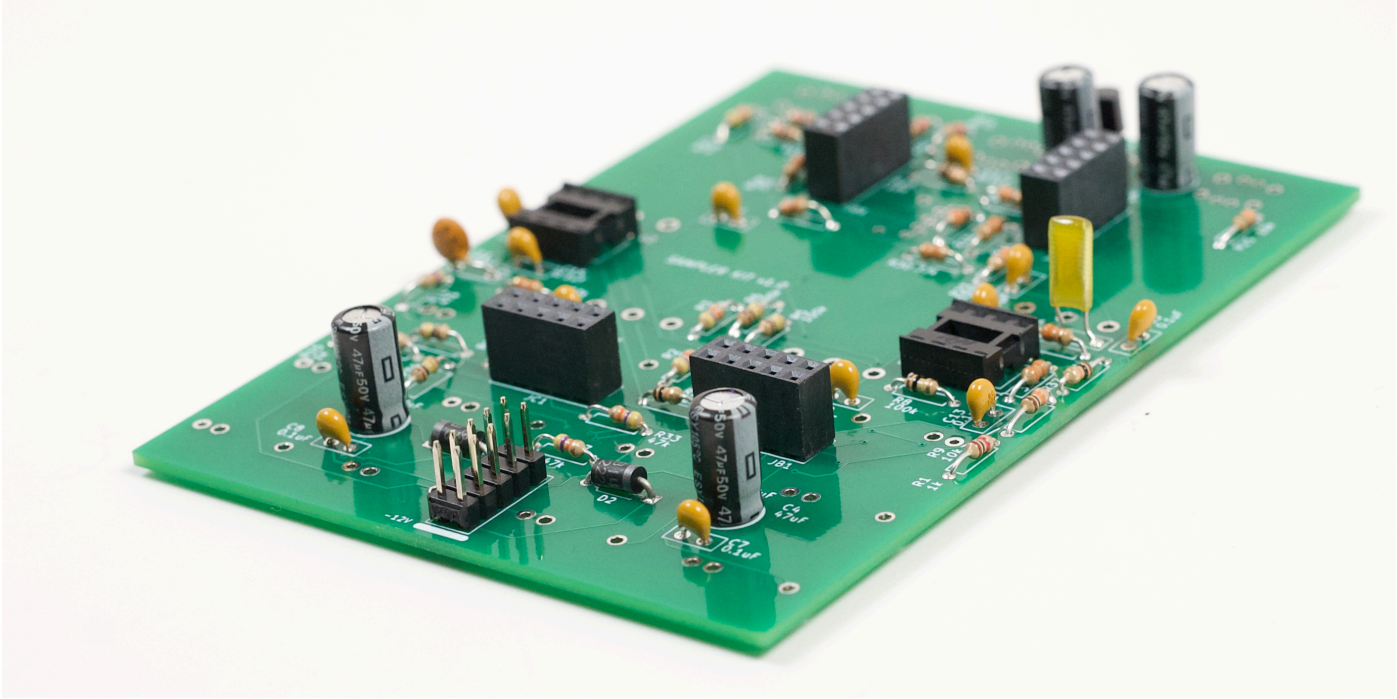
- *100pF x 1*
- *0.1uF x 13*
- *1nF x 1*
- *47uF x 4*

The Voltage Regulator

- Regulator x 1

Flat sides matched





Step 5: Check Your Work

Before moving on to the mounting steps, look at the solder joints on the side opposite the components. Confirm that all solder joints are proper. Once we mount the hardware, and cover this side with a faceplate, it will be hard to check for mistakes.

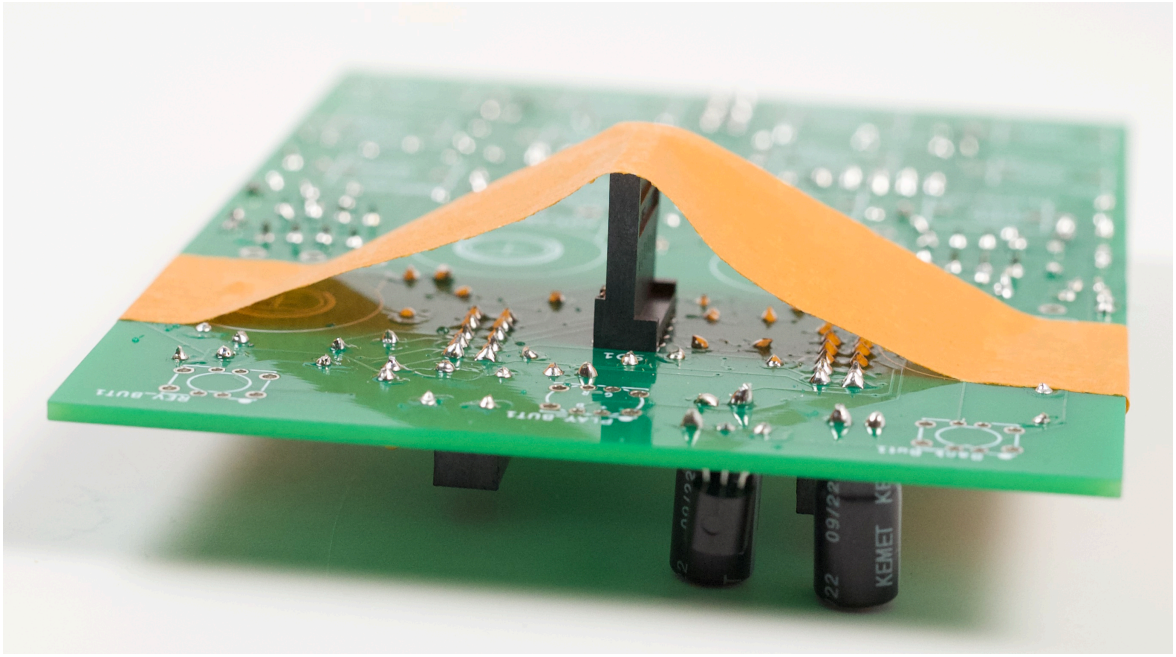
Check for missed solder joints. Make sure all the leads have been trimmed flush to the board so that they don't short on anything. Make sure you have sufficient solder on each joint, your solder points should look like smooth, shiny cones. Look out for lumpy or oddly shaped joints, spots where the solder seems dull, or spots where the joint looks more like a sphere than a cone. These are all signs of bad solder joints. Before mounting the hardware and installing the panel, we recommend checking and reflowing / reheating every one of the solder points on the hardware side of the PCB. A poorly soldered joint is very common (even for experienced kit builders) and reflowing the solder before moving to the next step (whether you think you need to or not) might save you a lot of troubleshooting later.

Step 6: SD Card Holder Mounting

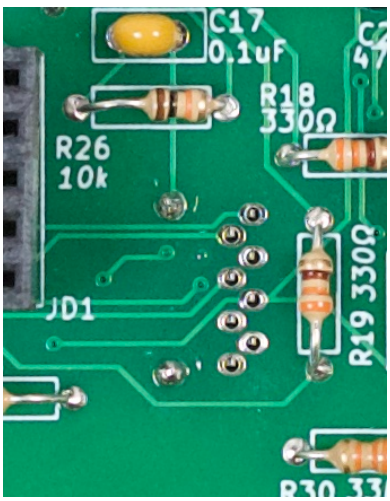
Mounting the SD card holder can be tricky and must be done with patience and care. We suggest using the smallest tip available for your soldering iron, and the thinnest solder you have on hand. If using a flathead-shaped iron tip, try soldering with the corner of the head, not the flat part.

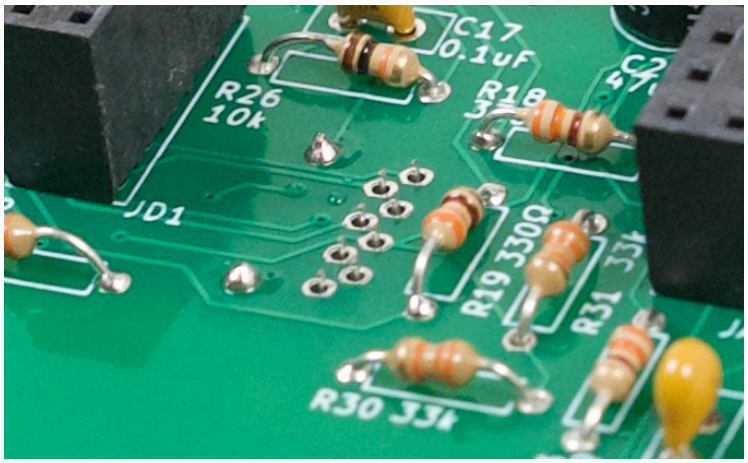
A. Insert the SD card holder into its footprint on the PCB: it will only fit one way. **Make sure it is at a right angle and perfectly flat against the PCB, as shown in the photo**. Note also that the slot on the card holder should be parallel to the vertical sides of the PCB (not at an angle).

B. Using a strip of masking or painter's tape (any tape that won't leave a residue), secure the SD card holder onto the PCB by taping it down in a tent-like fashion (see photo below).



C. Inspect your board and make sure that the card holder is still flat against the board, at a perfectly right angle, with the slot parallel to the sides of the PCB. Once you have verified all of this, flip the PCB over and solder the two mounting pins on the SD card holder (see photos below). Only solder the two large pins, **do not solder the eight smaller pins yet; this will occur at a later stage.**

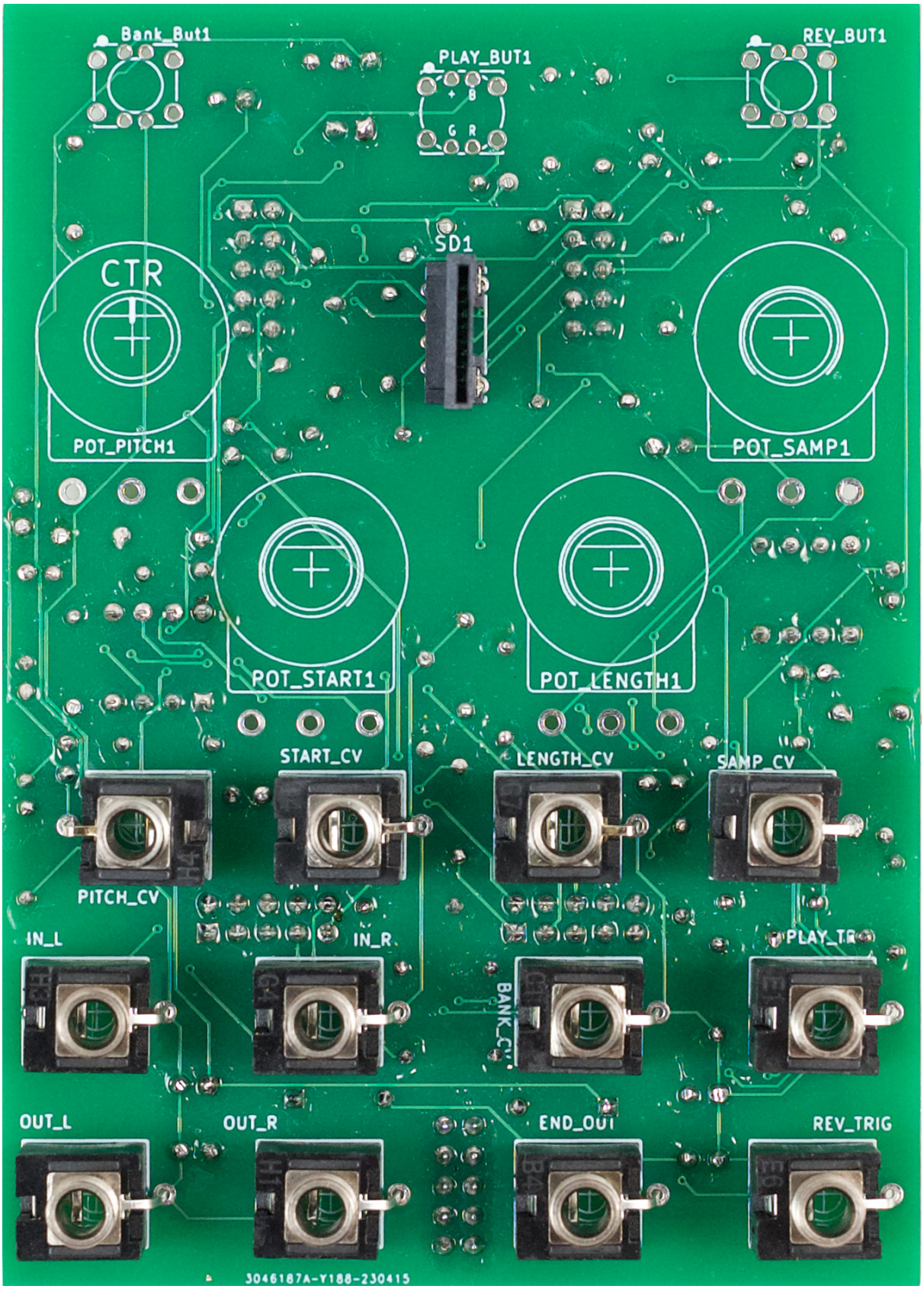




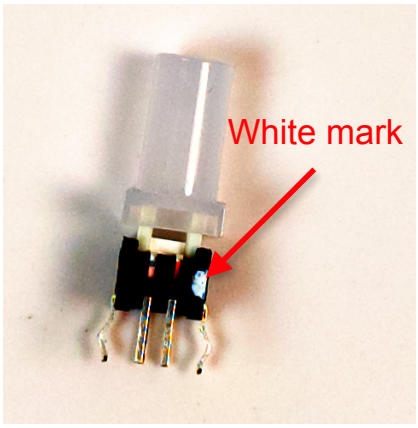
Step 7: Prep Mounting

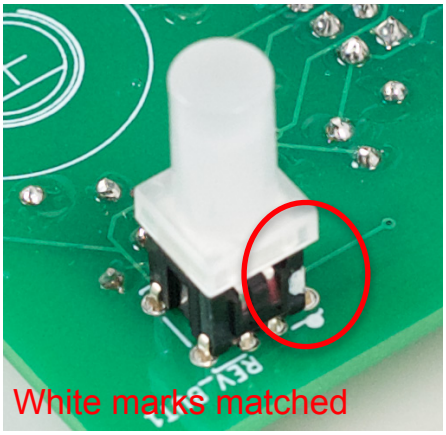
For this step we will insert the jacks, buttons and pots into the PCB, but we won't solder them until after we install the faceplate. This gives us a chance to align everything and catch mistakes before soldering.

A. Insert the 12 jacks into the PCB. Do not solder yet.

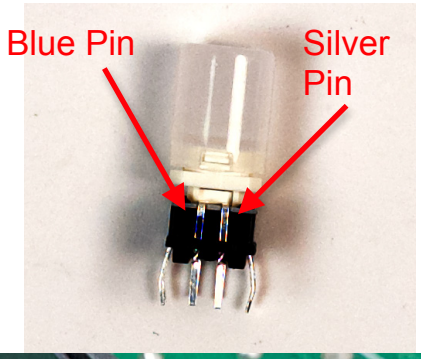


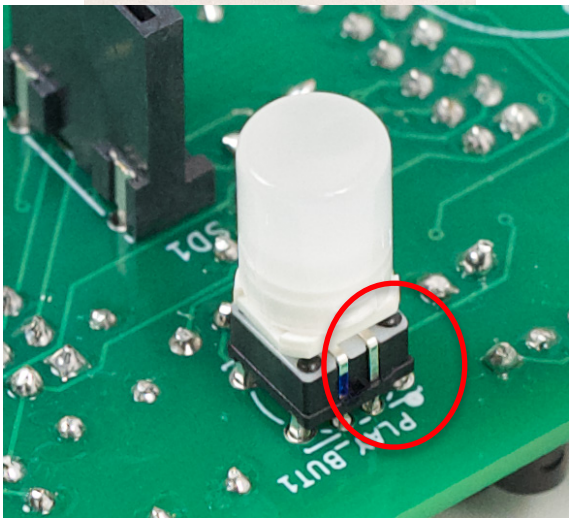
B. Look closely at the three buttons. The two smaller buttons have a white mark near one of their corner pins. On the PCB, you will see a white marking on the top left corner of the REV_BUT1 and BANK_BUT1 button footprints. When placing the small buttons, line up the white marking on the button with the white marking on the PCB. See photo. Insert the small buttons into the PCB, being careful that they go in the right way, white marks facing each other, and that no pins are bent.



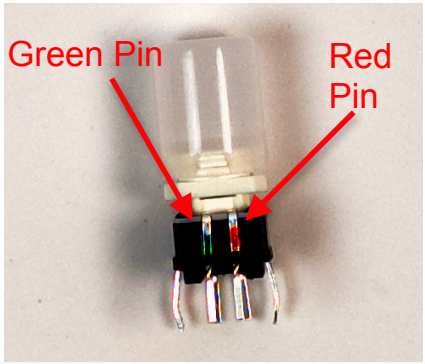


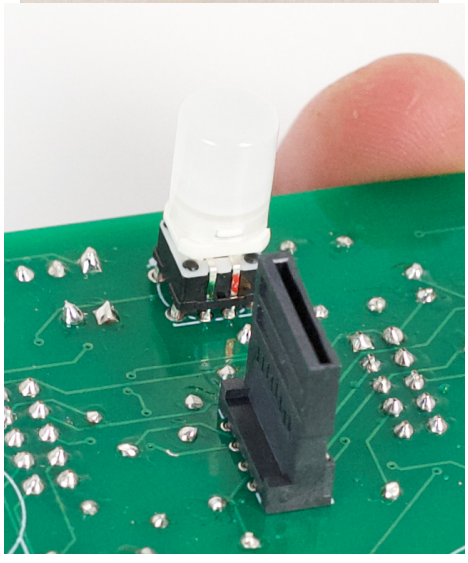
The larger button has green and red pins on one side, blue and silver pins on the other. On the PCB, you will see that the PLAY_BUT1 button footprint has a white marking at the top left corner, and inside the footprint the symbols +, B, G, R. When placing this button, line the silver pin up with the white dot. The green and red pins on the opposite side should be sitting over their respective letters G and R, facing the SD card holder. See the photos below. Insert the button into the PCB, being careful to ensure that it goes in the right way, silver pin facing the white mark, and that no pins are bent.





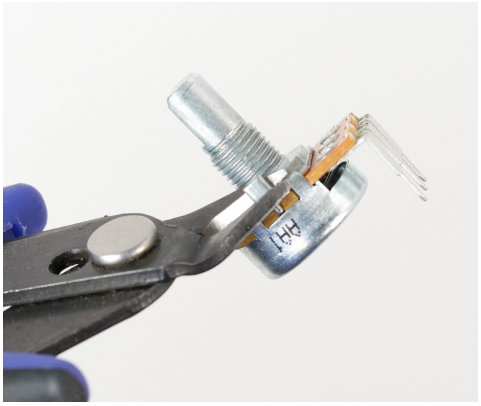
Silver pin matched to white mark

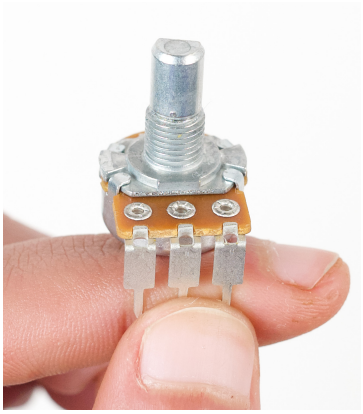




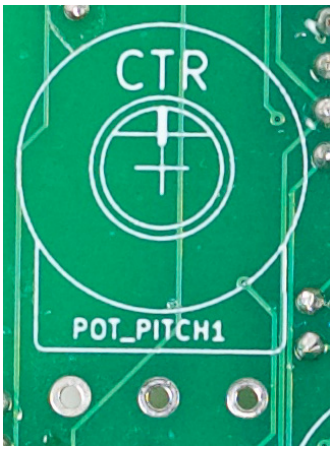
Green and Red pins facing SD slot

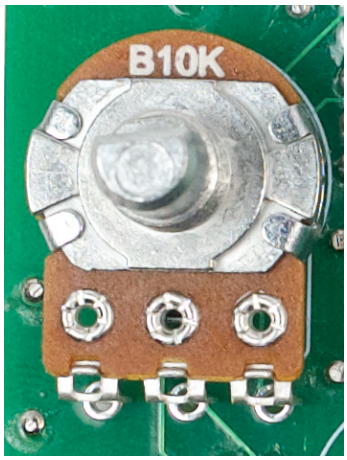
C. Take a look at the four pots. The three 100k pots come with a tab that must be removed before mounting (see photos below). You can do this using flush snips or pliers. Make sure to snip the tab as close to the base of the pot as possible. Insert the three 100k pots into the PCB. Do not solder yet.



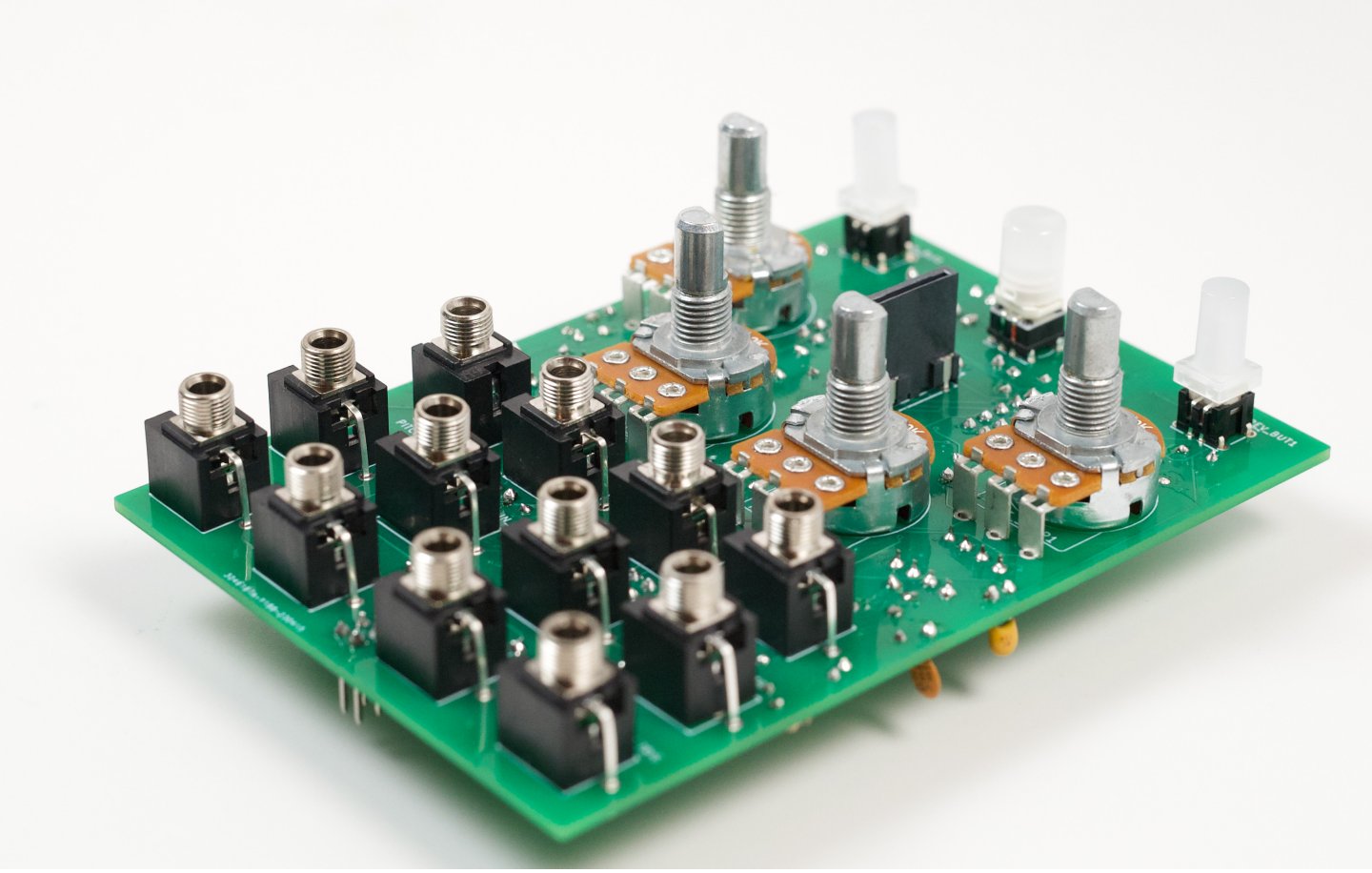


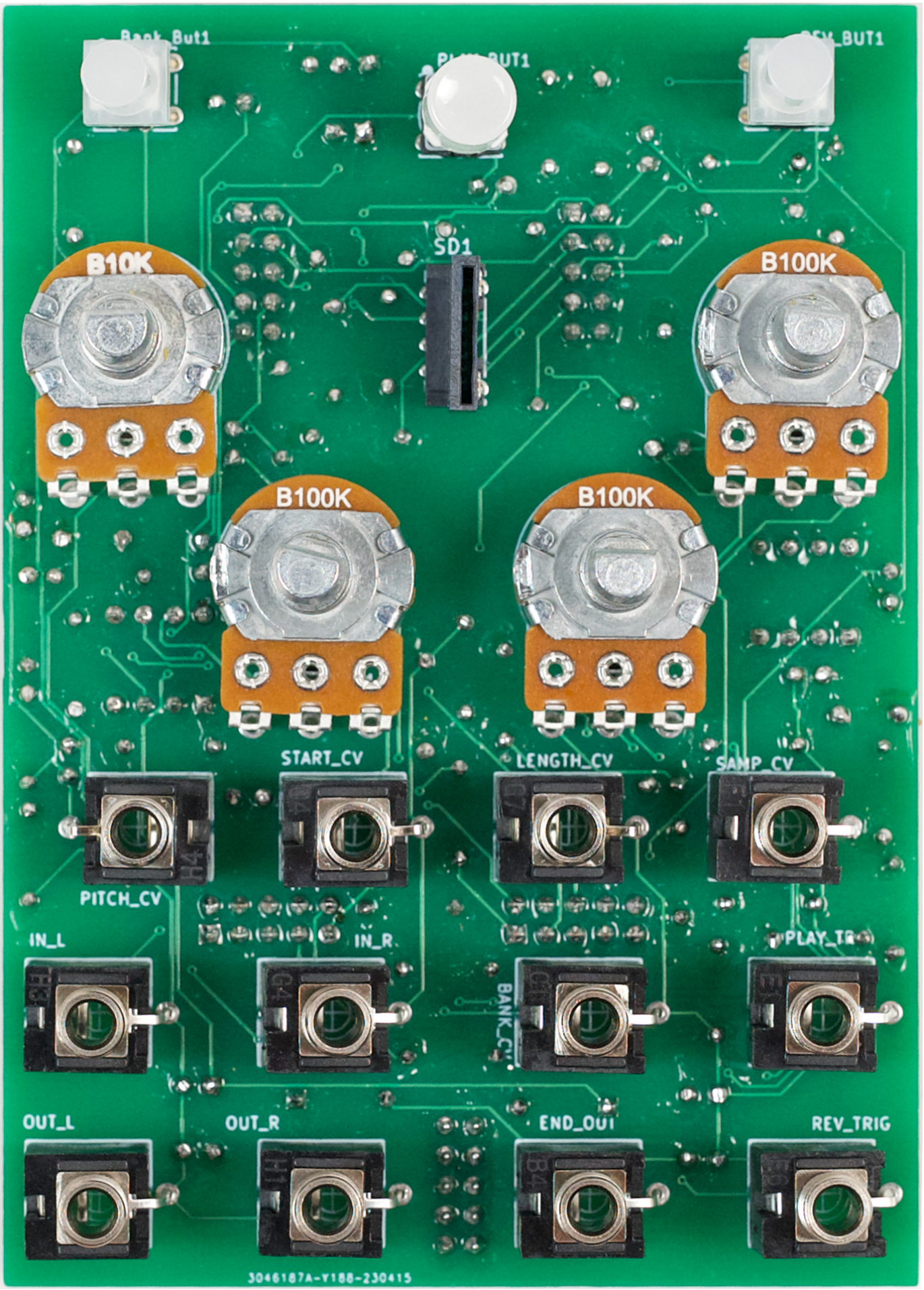
Note that the fourth pot does not have a tab to be removed. This is a center detent pot, marked with B10K. Insert it into the pot footprint on the lefthand side of the PCB, marked with the letters CTR. Do not solder yet.





D. Verify that your buttons are in correctly and that all eight of their pins are fully passing through the holes in the PCB. The pins are very small and it is easy to bend one over when placing the button. It's also easy to place the button into the PCB the wrong way, since it's easy to miss the subtle coloring of pins. A bent pin or a backwards button is extremely hard to fix. When removing a button, you risk causing permanent damage to the thin copper traces on the PCB and/or button. On the other hand, it's very easy to double-check your work before soldering. Do this now, and check again before you solder the buttons. If you are unsure, take a break and look again later.

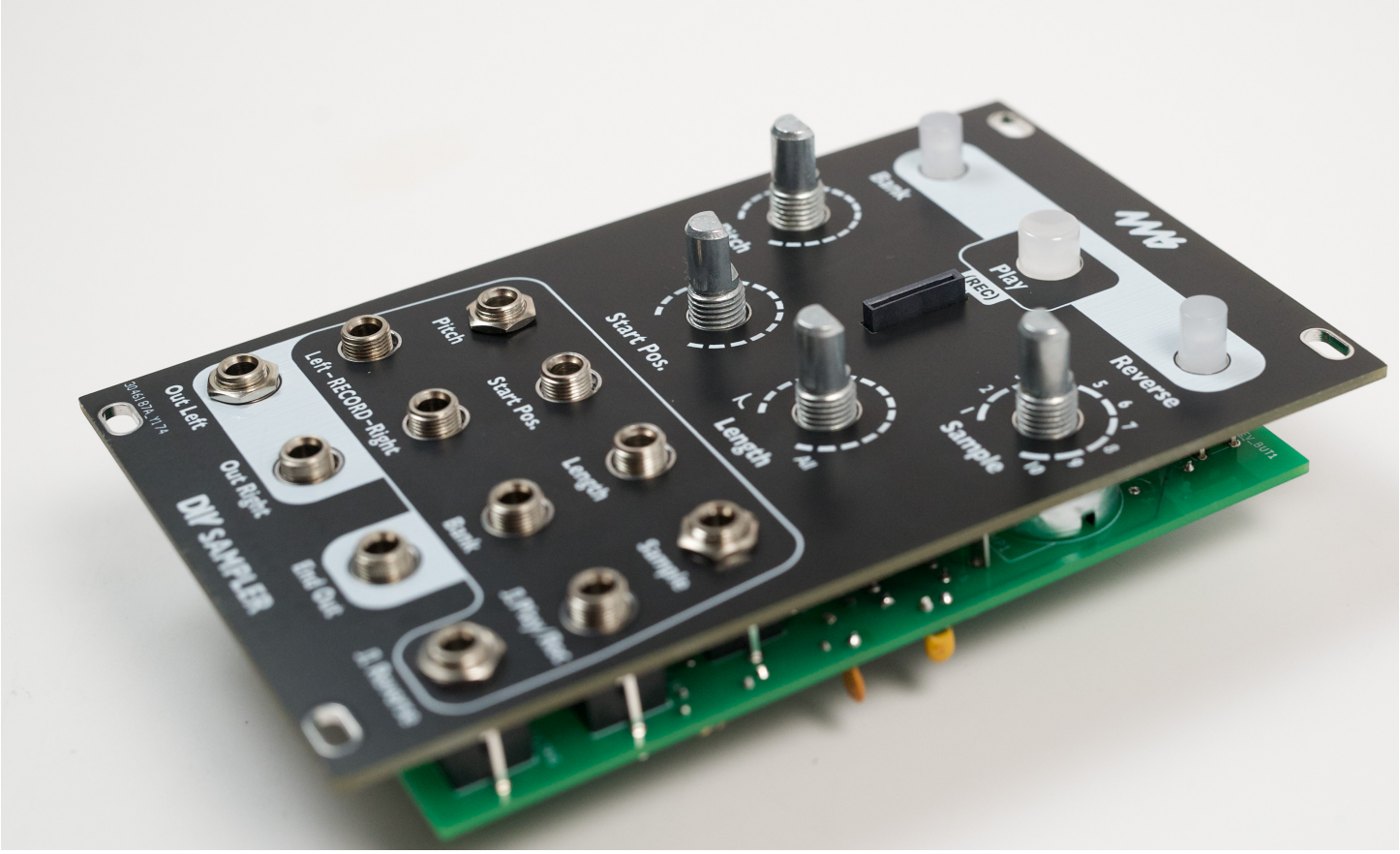



B10K
SD1
B100K
B100K
B100K
START_CV
LENGTH_CV
SAMP_CV
PITCH_CV
IN_L
IN_R
PLAY_TR
BANK_CV
OUT_L
OUT_R
END_OUT
REV_TRIG
3046187A-Y188-230415

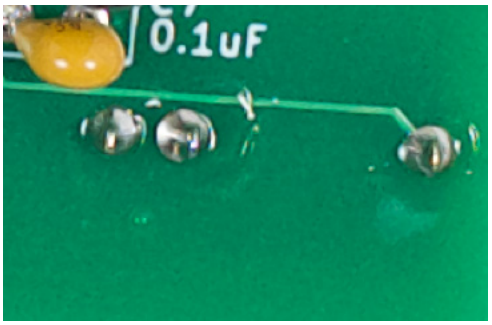
Step 8: Mounting Part 1

A. Take the panel and gently lower it down on the PCB. Wiggle it slightly so that it fits over the SD card holder, the pot shafts, the buttons, and the jacks.

B. Once the panel is on, anchor the PCB to the panel by placing four nuts: one on each of the bottom corner jacks (Out Left and Reverse), and one on each of the top corner jacks (Pitch and Sample). Tighten the nuts down **slightly (1/8 turn)** with a 5/16" socket, pliers, or your fingers (be careful not the scratch the panel!).

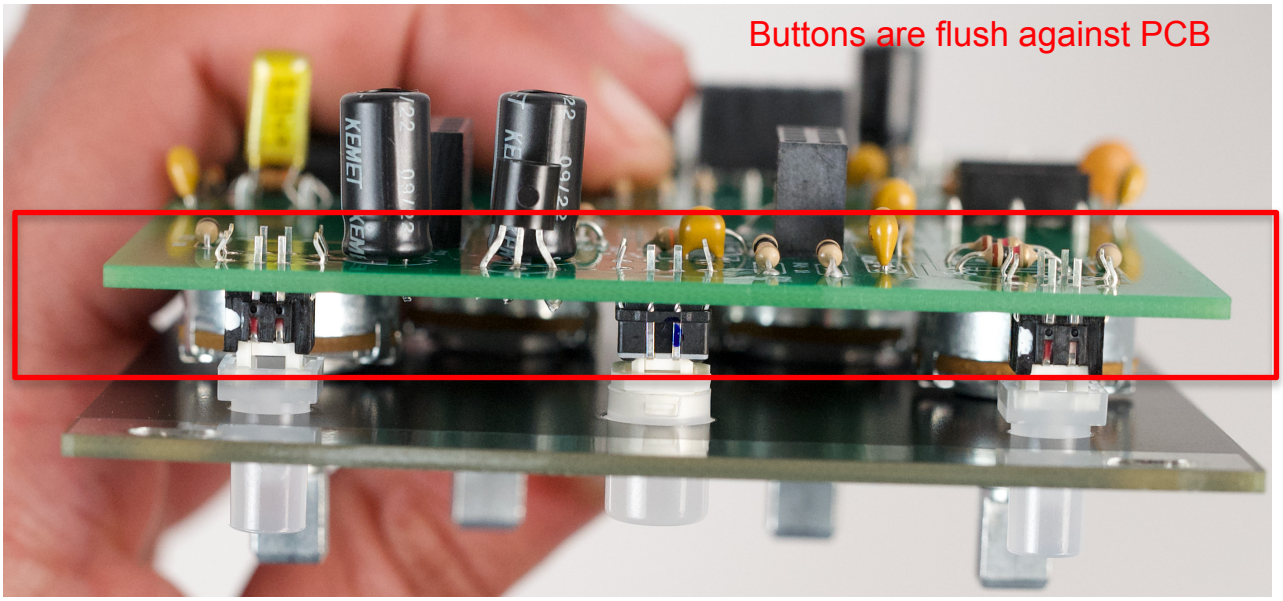


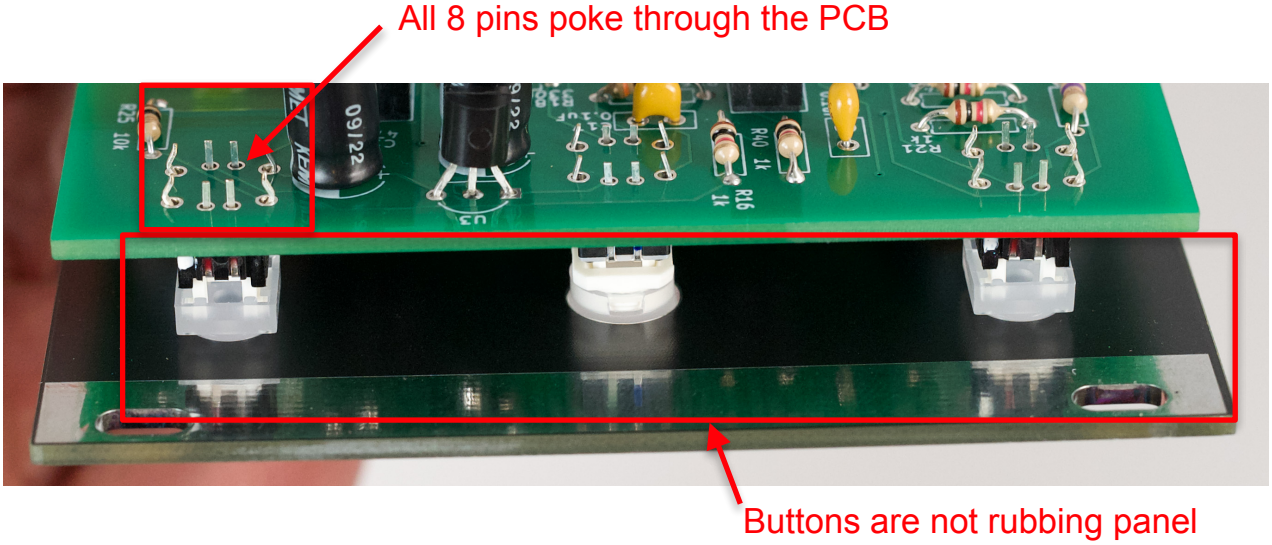
C. Flip it over and solder all three pins on each of the four jacks that you just put a nut on. See photo below for an example of one soldered jack.



Step 9: Mounting Part 2

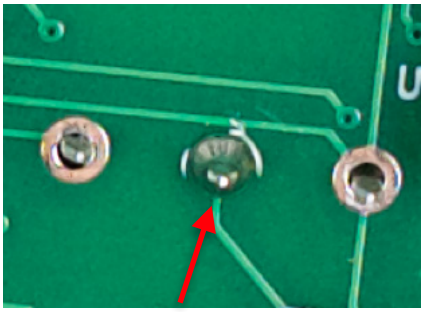
A. Push up on the heads of the 3 buttons to verify they are flat against the PCB, confirm that the buttons are not rubbing against the front panel, and that all 8 pins are passing through their holes. See photos below.

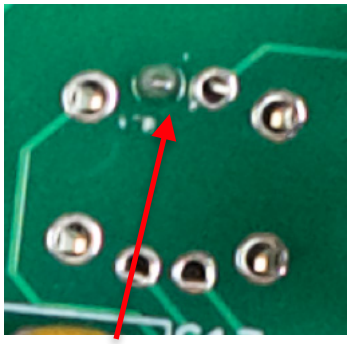




B. Now solder one joint on each component:

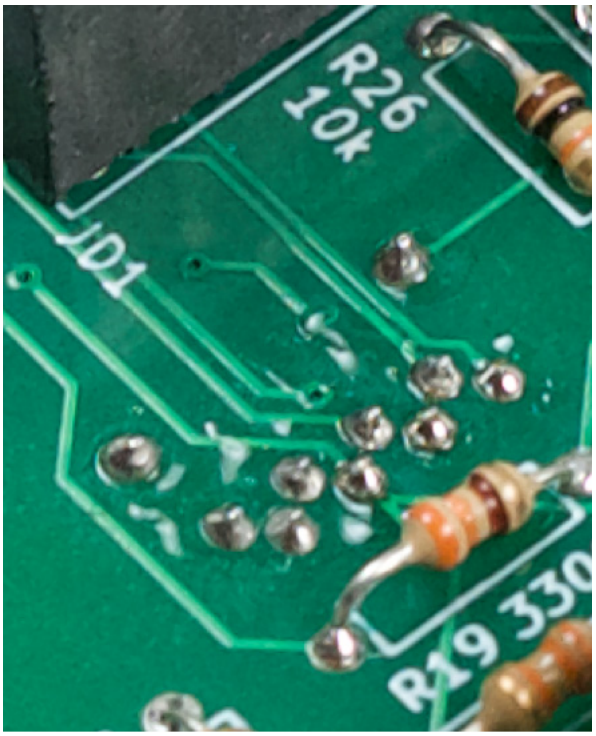
- The center pin of each pot
- One of the middle-ish pins of each button





Verify that each button can be pressed without rubbing on the panel. If necessary, re-position a control by heating up the one pin you soldered in the previous step. (Step 8C). Next, verify that the SD card holder lines up with the slot on the front panel. Take a look at the SD card holder and note the placement. Confirm that the card holder is sitting nicely within the panel, that the SD card holder slot is parallel to the sides of the slot on the panel, and that the the card holder is more or less centered within its slot. If you need to make any adjustments, do so while heating up the mounting pins you had soldered previously.

Once you are certain that the SD card holder is placed correctly, solder the remaining SD card holder pins. Note that these pins are quite small and very close together. It is easy to accidentally short them together by creating a solder bridge, so take your time and be careful, use the narrowest part of your iron tip. We suggest soldering these pins in columns (solder one column and then the other, as opposed to going in a zig-zag pattern), and approaching them with your iron from the outer edge of each column, (as opposed to approaching them from the middle where the two columns meet). When you're done, inspect your work and make sure there is no solder bridging any of the pins and that all the pins are soldered properly, as shown in the photos below.



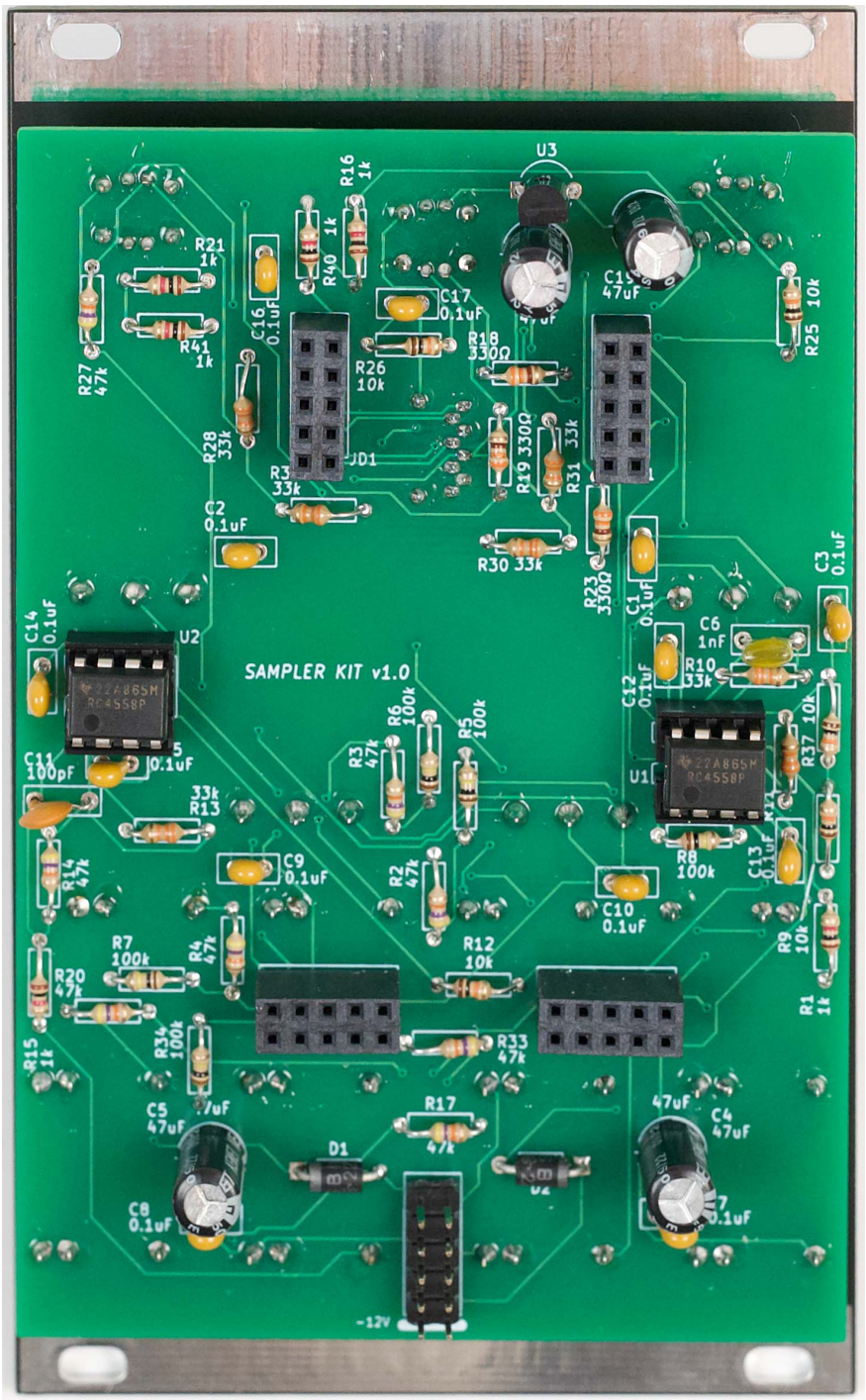
F. When you're sure all the pots, jacks and buttons are placed perfectly, install the rest of the jack nuts and the pot nuts. Go around and tighten all the nuts with a socket or pliers (careful not to scratch the panel!)

G. Check all the pots and buttons a third and final time. This is your last chance to verify none of the buttons are installed backwards (check for the white dot on the PCB matching the white dot or silver pin on the button). Flip the unit over and solder the rest of the PCB.

Step 10: Insert ICs

The two ICs have an orientation, the dot or notch should be pointed towards the notch in the IC socket. In this case, the dot/notch should be pointed toward the left. Verify you didn't put the IC socket in backwards by checking that the notch on the socket lines up with the notch drawn in white on the PCB. **Note: if you did happen to place the IC socket backwards, don't remove the socket!** Removing the socket once it has been soldered into place is difficult and can be quite destructive. The orientation of the socket is arbitrary, but the orientation of the IC is not. So, if you placed the socket backwards, it won't be a problem as long as you make sure to orient the IC correctly - with the dot/notch on the IC pointing toward the notch marked on the PCB (both ICs should be oriented with the dot/notch facing left). See photo below.

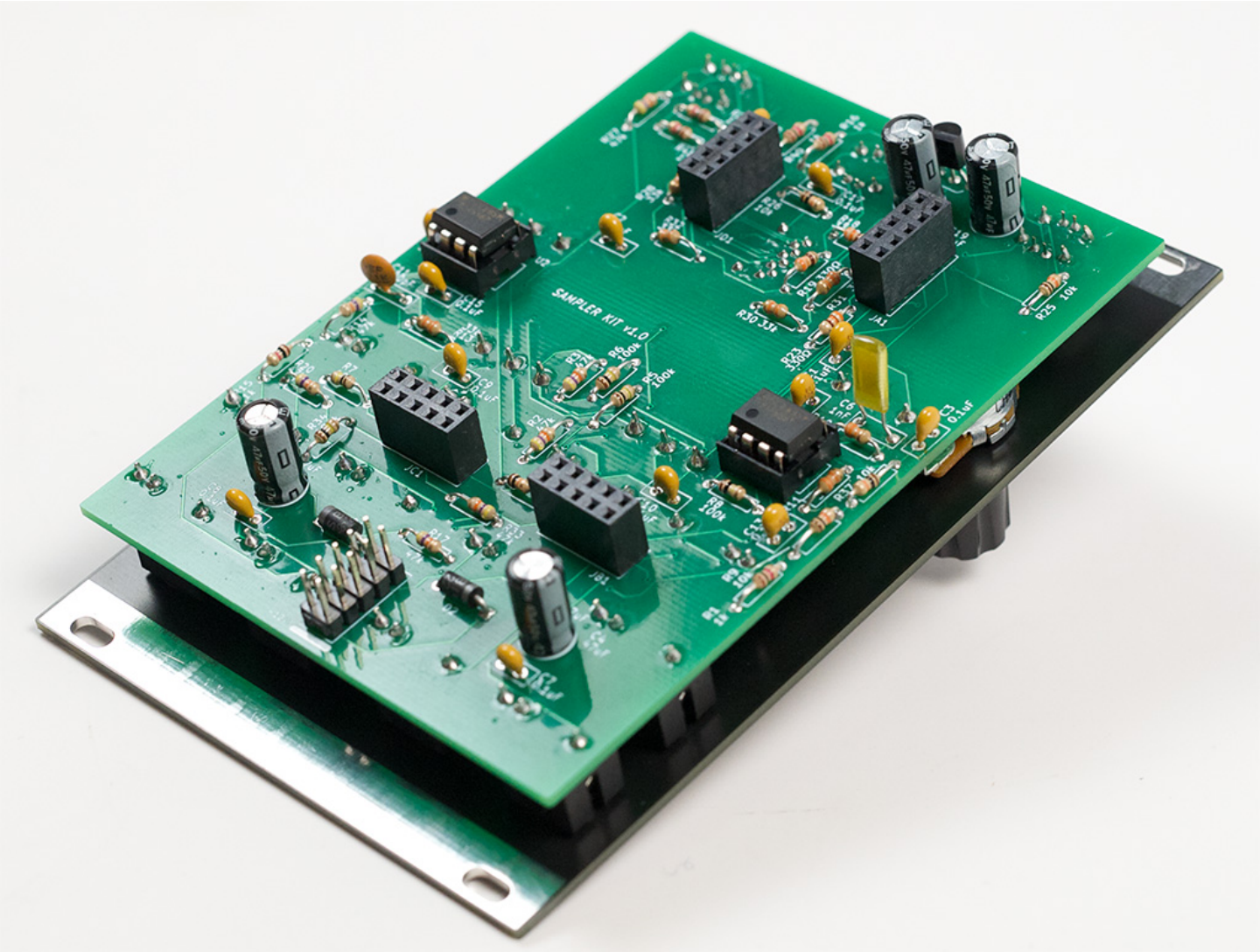
- *Opamp x 2: notch or dot facing left*

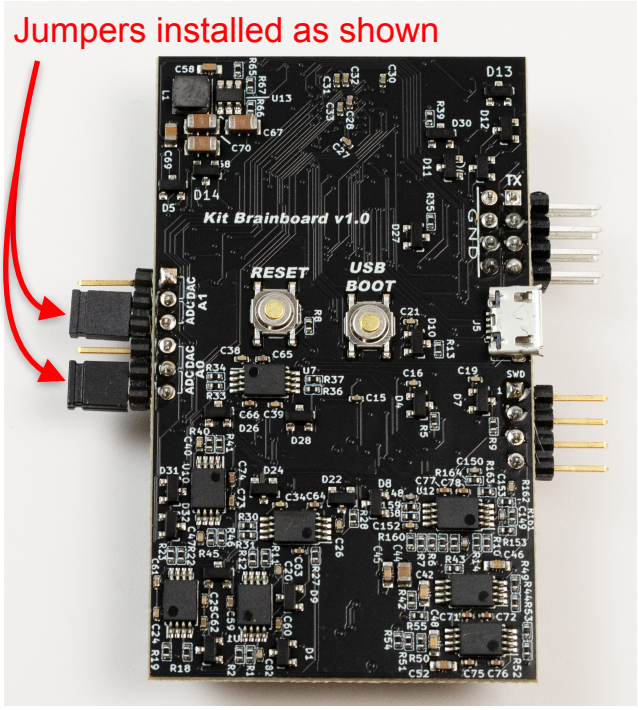


Step 11: Take a Break

That's right, walk away and do something else. This is a critical step **especially if you are an advanced kit builder or electronics person** (beginners tend to check their work with more skepticism!). There are many things you can do wrong in building a kit that causes it to smoke and destroy components. So don't rush, have a clear head, and check your work. Come back refreshed. Look over everything:

- Check all the solder joints, it's easy to miss one
- Check for shorts or solder bridges
- Verify the ICs are not in backwards
- Verify the diodes have the band pointing to the line on the PCB
- Verify the 47uF caps are not in backwards (stripe to the right).
- Verify the voltage regular is placed correctly (flat side of regular facing flat side of footprint)
- Verify the header pins are not bent.
- Verify no components are sticking up and potentially able to short out to something



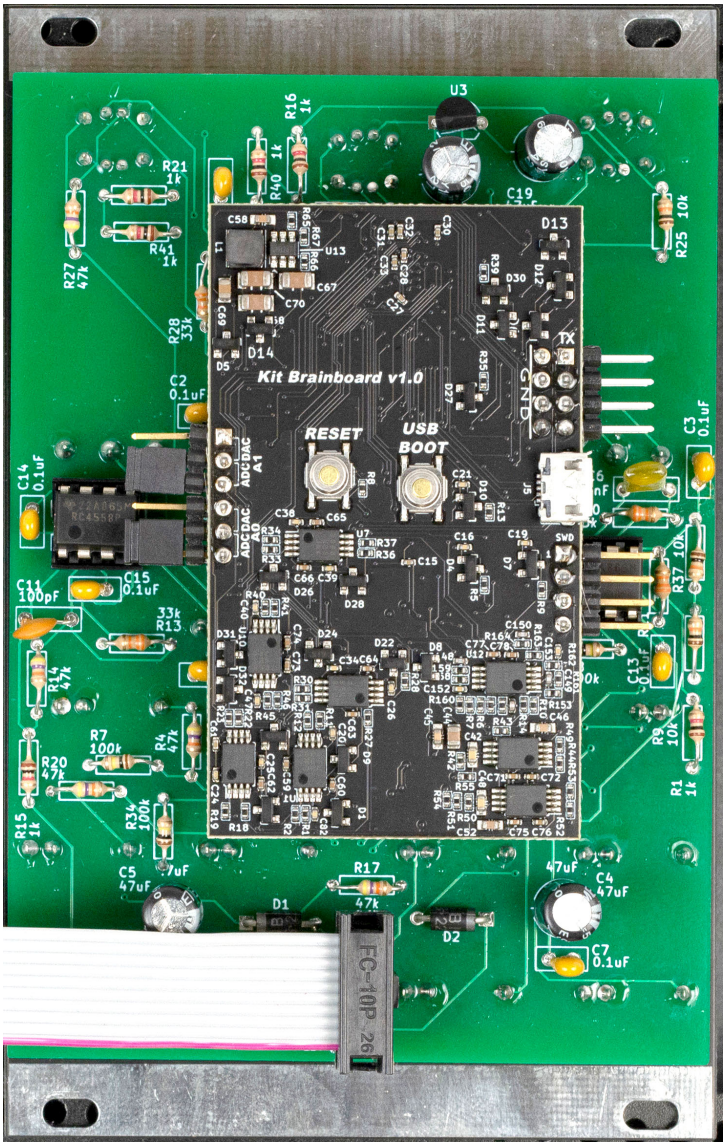


Step 12: Prepare Brainboard

Take a look at the Brainboard that came with your kit, it should have arrived with two black or blue jumpers that have been installed at the factory. One jumper should be attached between the 2nd and 3rd pins (marked ADC), and the other jumper should be attached between the 5th and 6th pins (also marked ADC). Verify that these jumpers are present, and that they are placed correctly (see photo). If a jumper is missing or placed on a different set of pins, the Brainboard will not be damaged, but the Sampler will not behave normally (some knobs and CV jacks will not work).

Step 13: Install Brainboard

Connect the Brainboard to your Sampler. Line up the four 10-pin headers on the Brainboard with the four 10-hole socket headers on the Sampler. Push firmly so that the pins go all the way into the sockets and no metal is exposed. View each header from two different angles to verify you didn't miss a row or column of pins.



Step 14: Ribbon Cable and Knobs

Install the 10-pin ribbon cable with the red stripe at the bottom, oriented toward the white line marked on the PCB (-12V).

Flip your unit over and attach the four knobs by lining up the flat side of each pot shaft with the notches inside the knob, and pushing firmly downwards.

Step 15: Power Up

When turning on your Sampler for the first time, make sure there is no SD card inserted. This will prevent the SD card from getting damaged in the event that something went wrong with the build. Power up the Sampler and be ready to turn it off if something goes wrong. You should immediately see the Bank button turn red, followed by a very quick sequence of Play and Reverse flashing red one at a time, and finally the Bank button will shine white. If no lights turn on within one second, unplug your Sampler and check around for errors, especially near the power connector. Consider removing the faceplate and making sure everything around the power header is soldered properly. Check that the diodes and 47uF capacitors are oriented correctly.

Once you have confirmed that the unit powers up, turn it on and leave it on for about 10 seconds. This is long enough so that the ICs will get hot if something is wrong, but not so long that they get damaged. Now turn the unit off, flip it over, and touch the ICs with your finger tip. The IC should be warm, you should be able to hold your finger there with no trouble, it should not hurt. If the IC has overheated it will be obvious, holding your finger on it will be unambiguously painful. If this is the case, check that the ICs are oriented correctly. Check for shorts, check your solder joints, check that the values of nearby components are correct.
Note: If you have a volt meter and you understand DIP-8 IC pinouts, check that pin 8 of each opamp has about 11.6V, and pin 4 has about -11.6V. Check the voltage regulator has 3.3V, 0V, 11.6V on its pins (left to right). Ground can be taken from the threaded portion of any jack.

If the unit powers up with no issue, turn it off, insert the SD card and power the Sampler back up. This time, at the end of the light sequence, you will see that the bank button fades on and off in various colors, and other buttons will flash periodically. This means that the SD card files are being read. Do not power off your Sampler while it is reading the SD card, this may damage the card. When using a brand new SD card for the first time, this process can feel a bit slow, reading the card may take 40 or more seconds. Wait it out, do not interrupt. When the Sampler is done reading the card, the Bank button will shine a solid white. It’s now safe to power off. Power cycle your unit a few times, allowing the SD card to be read each time without interruption. Note that the waiting period will get shorter every time you do this. Once the wait time drops to about 15 seconds, you can move on (it will continue to shorten to around 10 or 11 seconds). This will take about 3 or 4 power cycles. You only need to execute this step when using a brand new SD card, and once the card is “broken in”, you will not need to repeat this process.

Step 16: Run Hardware Test

Now that you have successfully powered up your Sampler for the first time, we recommend running a complete Hardware Test. This test checks that all the hardware on your Sampler is functioning properly, and can be a useful troubleshooting tool when trying to diagnose an issue.

1) Enter Hardware Test
Power up your Sampler while holding down the Play and Reverse buttons. The buttons will quickly flash red, and the unit will automatically begin the SD Card Test.

2) SD Card Test
This is an automatic test that writes a file called “test.txt” and then reads it back. This test happens rapidly and requires no extra action on your part. If the test succeeds, Play will be flashing green. Press the Play button to proceed to LED Test.

Fail: Reverse light is red or pink, Play button is flashing green. If this is the case, install a valid SD card (FAT32 or ExFAT) and press Play to repeat the test. If the test still fails, check the SD card holder for shorts, and make sure it is soldered properly in general. Otherwise, check the resistor values of R28, R30, R31, R32. Check for unsoldered or shorted header pins.
If the Play or Reverse buttons are not working, then you won’t be able to enter Hardware Test mode, or perhaps you won’t be able to proceed past the SD Card Test. Check the buttons are soldered, no pins are bent under the PCB, and the header pins are soldered correctly (remove the faceplate to verify this). Also check values of resistors R26, and R27 by inspecting the color bands and comparing to the diagram in Step 1 and/or other resistors of the same value.

3) LED Test
This test checks that LEDs inside the push buttons are working properly. Press Play to step forward through the test. First, with each press of the Play button, Bank will turn red, then green, then blue. Next, Play will run through the same three colors, and finally Reverse will do the same. Once all three buttons have been tested for red, green, and blue, the next push of Play will turn each button white, one at a time.

Once you have pressed Play for the final time, Play will shine green again (not blinking). At this point, if the colors looked good, you may tap Play to proceed to the Button Test. However, if you wish to adjust the red, green, and blue mix of one or more of the button lights, you can hold down Play for 3 seconds and release. You will now enter LED Calibration Mode (step 3b).

Fail: If any lights do not turn on, or if one color is significantly dimmer or brighter than the rest. In this case, check for shorted pins, and that the correct resistor values were installed. Check for unsoldered or shorted header pins.
For Bank check R40, R16
For Play check R18, R19, R23
For Reverse check R41, R21

3b) LED Calibration Mode (optional step)
This step is optional and not recommended unless you have already been playing with the Sampler for some time and wish to make minor adjustments to the color balance of the lights. If you entered this step accidentally, hold down Reverse or Bank for 2 seconds to proceed to the Button Test without saving changes.

Turn Sample to select a color. The colors are the same as the bank colors (see Sampler User Manual). Start with Sample at 1 to select white.
Tap one of the buttons to adjust the relative brightness of its red, green, and blue.
The Pitch knob adjusts red, Start Pos knob adjusts green, and Length knob adjusts blue.
When the knob is centered, there is no adjustment (default position).

NOTE: The red color for Play and Reverse cannot be adjusted. It is on or off.

Tip: Do not try to match the colors of two buttons. Instead, make each button look good across the range of colors it normally displays (i.e. Play is green or cyan, Reverse is blue, etc.)

Hold down Play for 2 seconds to save. Changes will be saved permanently in non-volatile memory.
To cancel, hold down Rev or Bank for 2 seconds and no changes will be made.

4) Button Test
In this test you will push each button as it lights up to test for mechanical functionality. The test begins with Bank shining green. Press Bank, then Play will shine green. Now press Play, and then Reverse will shine green. Once you press Reverse, Play will flash green and the Bank button will be yellow, indicating that the unit has automatically proceeded to the Audio Output Test.

Fail: If one of the buttons turns green but pressing it does not advance the test. In this case, make sure that the button is oriented correctly. Check that none of the pins are bent, all eight are poking out of the PCB. Make sure none of the pins are shorting onto anything. Check for unsoldered or shorted header pins.

5) Audio and Gate Output Test
During this portion of the test, Play will be flashing green and Bank will be yellow. Patch your mixer or headphones into the Out Left jack. You should hear a loud tone. If you have a tuner, it should read as A4 or 440Hz. If you have an oscilloscope you should measure an amplitude of about 20Vpp (anywhere between 19.6V and 20.4V is OK). Now plug into the Out Right jack. You should hear a tone of the same volume (same amplitude), but at two octaves plus a fifth up (E7, or 2637Hz).

Next, patch into End Out. You should hear a tone that is quieter than the others, with a frequency in between Out Left and Out Right. A tuner will read somewhere between F#6 and G6. On an oscilloscope, look for a square wave at about 1.5kHz, 50% duty cycle, 0V to +8V in amplitude. When you complete the test, press Play to continue.

Fail: If any of the tones are missing, if the pitch (frequency) is off, or if their loudness / amplitude varies drastically. In this case, check that your jacks and headers are soldered properly.

6) Audio Input Test
During this portion the test, Play will be flashing green and Reverse will be yellow. Patch your mixer or headphones into the Out Left jack. You should hear silence. Some faint 377Hz tone background bleed is OK.

Now patch Out Right into Record Right. You should hear a 377Hz sine wave (somewhere between an F#4 and a G4). If using an oscilloscope you should measure the amplitude at about 8Vpp. Now, keeping the cable from Out Right to Record Right patched, patch a new cable from End Out into Record Left. You should now hear a harsh waveform with a beat frequency of 2Hz. That is, there should be two subtle beats, pulses, or swells every second. If using an oscilloscope, you should see the 2Hz beat frequency manifested as the overall amplitude

reaching a minimum every 500ms.
When you complete the test, press Play to continue.

Fail: If any of the tones are missing or appearing where they shouldn't be, if the pitch (frequency) is off drastically (small difference may be due to variations in measurement equipment), or if the loudness / amplitude varies drastically from what is described. In this case, check that your jacks and headers are soldered properly.

7) Knob and CV Test
This test begins with Bank and Reverse shining red, Play will be green. One of the lights might be off depending on the position of the Pitch knob. This is ok. The purpose of this test is to confirm that the Knob and CV controls are hitting their peak values. Start by turning the Pitch knob all the way down, the Bank light should turn off. Now turn Pitch all the way up and the Reverse light will turn off. Next, center the Pitch knob and Play will turn off. Immediately, you will see the buttons rapidly flash white/green to indicate that the knob has passed. This is called the "success animation". The test will automatically proceed to the next knob. Repeat the procedure for each knob in the following order: Pitch, Start Pos., Length, Sample.

After the Sample knob has passed, the test will automatically proceed to the CV jacks. Patch Out Left into the Pitch jack. You will see the lights blink off, and then the success animation. Remove the cable and patch Out Right to Start Pos. Once you get the success animation, repeat this procedure (using Out Right) with Length, then Sample, and then Bank. Watch for the success animation after testing each jack. Once the Bank CV has passed, the Play button will turn dark blue, indicating that the unit has begun the Trigger Input Test.

Fail: If at any point when testing a knob or jack the lights do not turn off and the success animation does not occur, this means that the particular knob or jack you are on has failed the test. If this is the case, check that the control is soldered properly, look for shorts. In the case that a CV jack fails, check that the associated resistors are the correct values:
Start CV: R2, R5
Length CV: R3, R6
Sample CV: R4, R7
Bank CV: R33, R34
Pitch CV: R1, R9, R8, R10, R11

8) Trigger Input Test
This test begins with Play shining dark blue. Start by patching End Out into Play/Rec. Play will turn off and Reverse will turn blue. Next, patch End Out to Reverse. Reverse will turn off, and Bank will momentarily shine white, indicating that the test has automatically proceed to the final step.

Fail: If patching into a trigger input does not advance the test, so if Play does not turn off, or if Reverse does not turn off. In this case, check that the jacks in question have been soldered properly, look for shorts, check the values of R17 for Reverse, R20 for Play.

9) RAM Test
This is an automatic test and requires no action on your part. When the Trigger Input Test is complete, Bank will turn white momentarily, turning off within about 5 seconds. If not, the RAM has failed, indicating a problem with the Brainboard. If this occurs, please email us at 4ms (at) 4mscompany (dot) com, or send us a message through our website https://4mscompany.com.

Once all the lights are off, the Hardware Test is complete. Power cycle your Sampler, and you are ready to play.