

# Building the TTS defence

The BOM <http://thehumancomparator.net/TTS defence/BOM.pdf>

You can order most of the parts from Mouser.com

<http://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=4998691276>

(No DC-DC converter included! Please note that some stuff will probably be back ordered).

For the power supply the following Mouser parts are recommended - [967-PXD3024WD15](#) or [826-AEE00CC18-L](#).

You'll also need an appropriate DC adapter power supply, 12-24V 1500mA.

Rare parts can be bought from [thonk.co.uk](#) or eBay.

You'll receive a link to the schematics once you've bought your kit.

Complete building instructions will be online during December.

*General notes when building -- E.g. Read this first!*

1. Try to avoid install the slide potentiometers and jacks as longs as possible. The board is huge and everything that adds weight just makes it even more cumbersome to handle.  
There's also a risk that you break the sliders when flipping the board and moving stuff around. So -- Sliders and jacks last!
2. If you're using sockets for the LM301. It might be best solder the sockets before you solder anything else on the board.
3. When working on the big board it's a good idea to solder things from the top side. So insert the resistors, solder them from the same side you put them in. And then flip the board and cut the legs. this can also be done with some capacitors.
4. In the parts list designators written between numbers means ". ". So 3k9 means 3.9k. Values with no designator is in Ohm. So 220 is  $220\Omega$
5. It's a good idea to match all the transistor pairs before starting with everything else. You'll need 9 pairs of matched 2n3904. And 5 pairs of 2n3906. Google Ian Fritz Transistor Matching for a neat way to match those three legged trannies.

## Suggested build order

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16. [Internal Clock](#)
17. [S&H](#)
18. [Electronic Switch](#)
19. [Amplifiers](#)
20. [Finishing up](#)

# Preparations

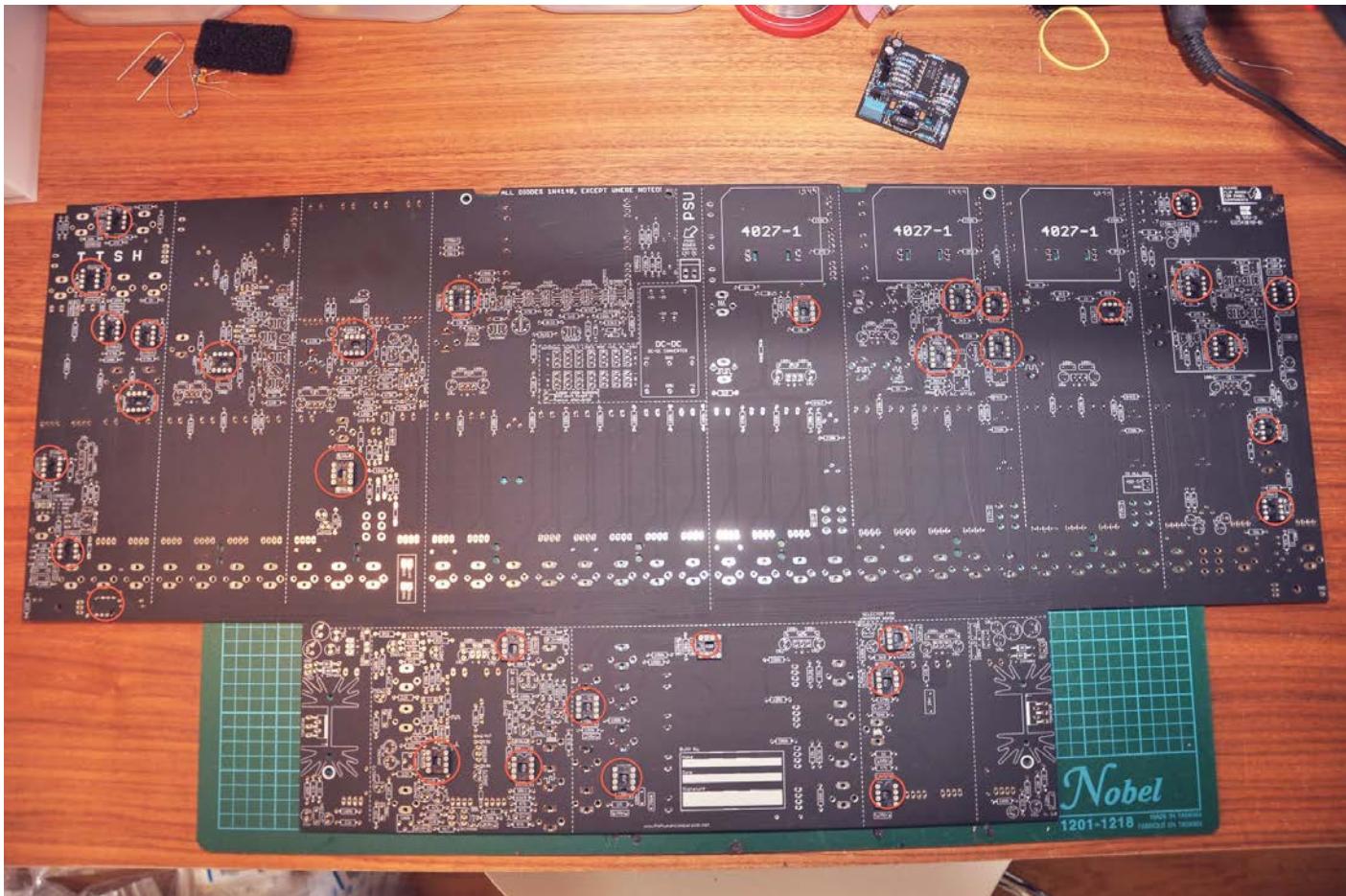
## Starting our adventure!

So you've got the boards and panel and everything. Keen to begin you flop the big PCB on the desk and heat up your soldering iron! But let's pause for a moment, because right now it's a good idea to start planning your build.

As you're already here let's assume you won't be flying solo this time. Which is good, it's always nice to hold a strangers hand on the internet.

The first thing I would recommend you to do is sort all the components. Get some rubber bands and make small bundles with all resistors starting with 1, 2 and so on. Divide the caps into electrolytic and non polarized and so on. It's pretty easy to get lost in all the different bags (trust me..).

If you're using sockets for the IC's, it's a good idea to install them first. As keeping something flush against the board once you've started mounting components will be pretty tricky.



Sockets on the PCB in red circles. Note that there's one socket on the front of the board as well, for the LED-drivers.

After this it's pretty much just to go at it! So put the big board away and start with the 3 smaller.

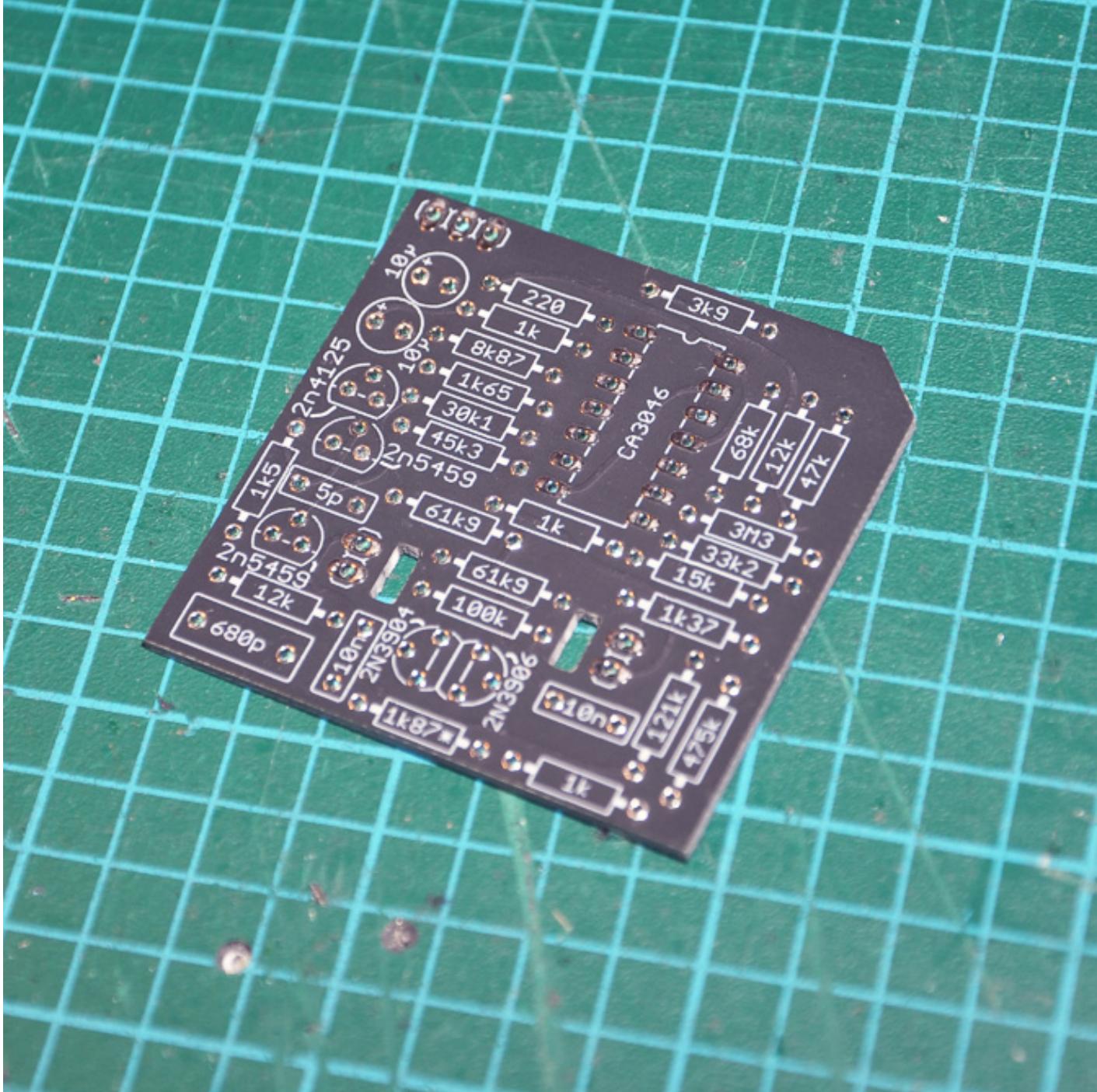
# 4027

## 4027-1

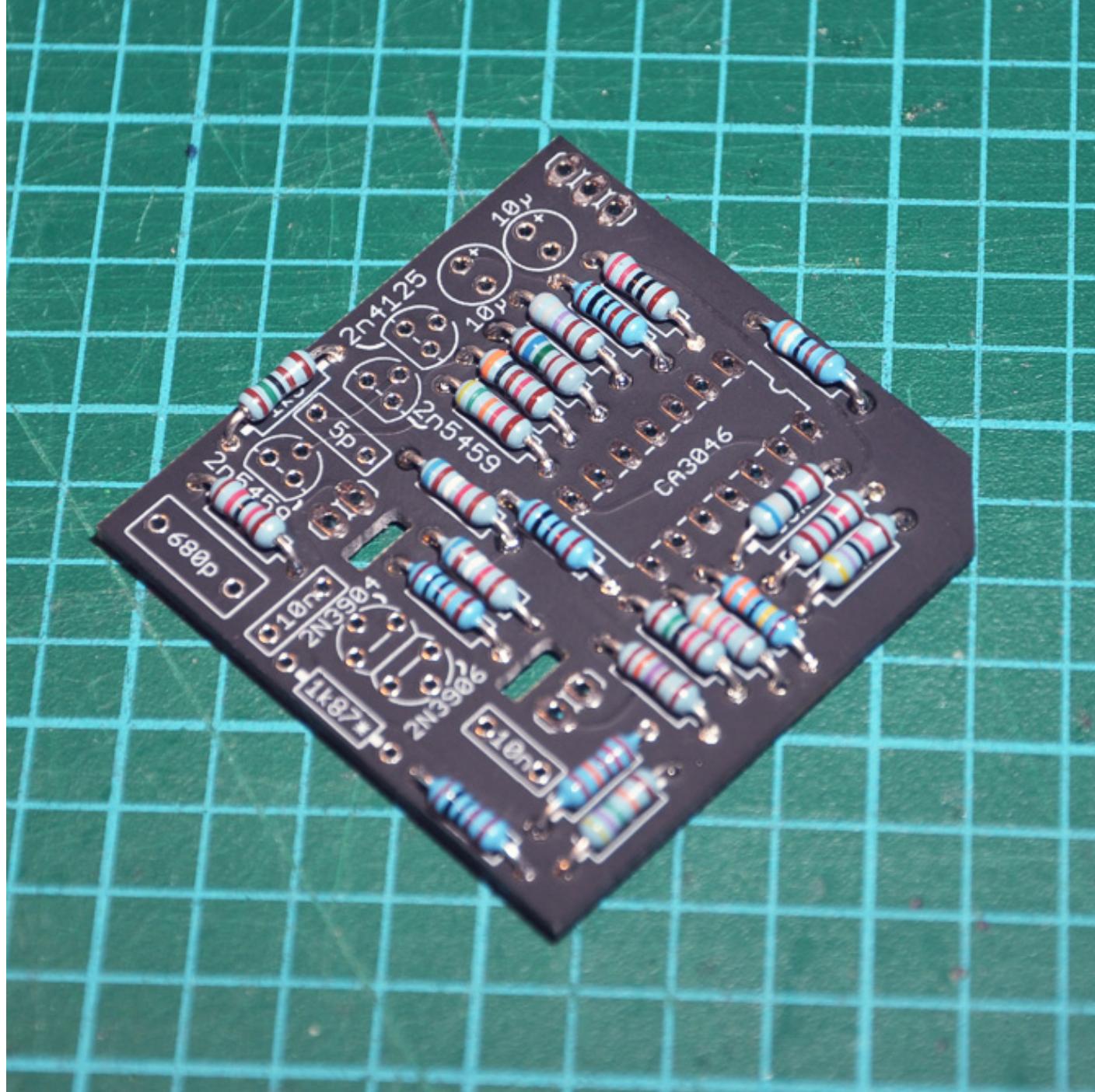
Please note that you will have to build 3 of these. So once you're done, do it two times more!

Parts list 1 x 4027-1		
Resistors	Capacitors	Semi's
<ul style="list-style-type: none"><li>■ 220 x 1</li><li>■ 1k x 3</li><li>■ 1k37 x 1</li><li>■ 1k5 x 1</li><li>■ 1k65 x 1</li><li>■ 1k87 x 1 (Tempco)</li><li>■ 3k9 x 1</li><li>■ 8k87 x 1</li><li>■ 12k x 2</li><li>■ 15k x 1</li><li>■ 30k1 x 1</li><li>■ 33k2 x 1</li><li>■ 45k3 x 1</li><li>■ 47k x 1</li><li>■ 61k9 x 1</li><li>■ 68k x 1</li><li>■ 100k x 1</li><li>■ 121k x 1</li><li>■ 475k x 1</li><li>■ 3M3 x 1</li></ul>	<ul style="list-style-type: none"><li>■ 10µ x 2 (Electrolytic)</li><li>■ 100n x 2 (SMD)</li><li>■ 10n x 2</li><li>■ 680p x 1</li><li>■ 5p x 1</li></ul>	<ul style="list-style-type: none"><li>■ 2n3904 x 1</li><li>■ 2n3906 x 1</li><li>■ 2n4125 x 1</li><li>■ 2n5459 x 2</li><li>■ CA3046 x 1</li></ul>

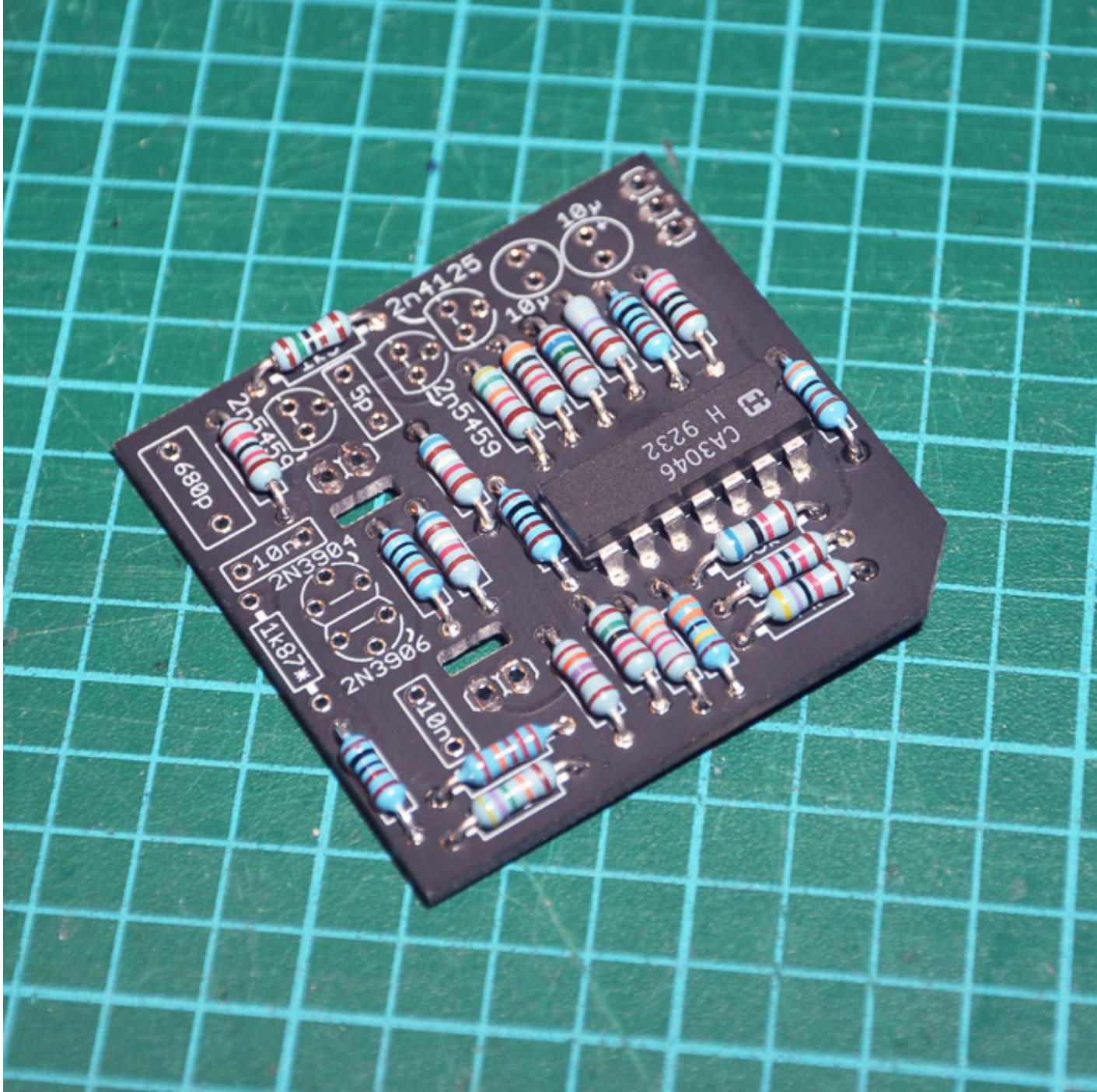
And here we go!



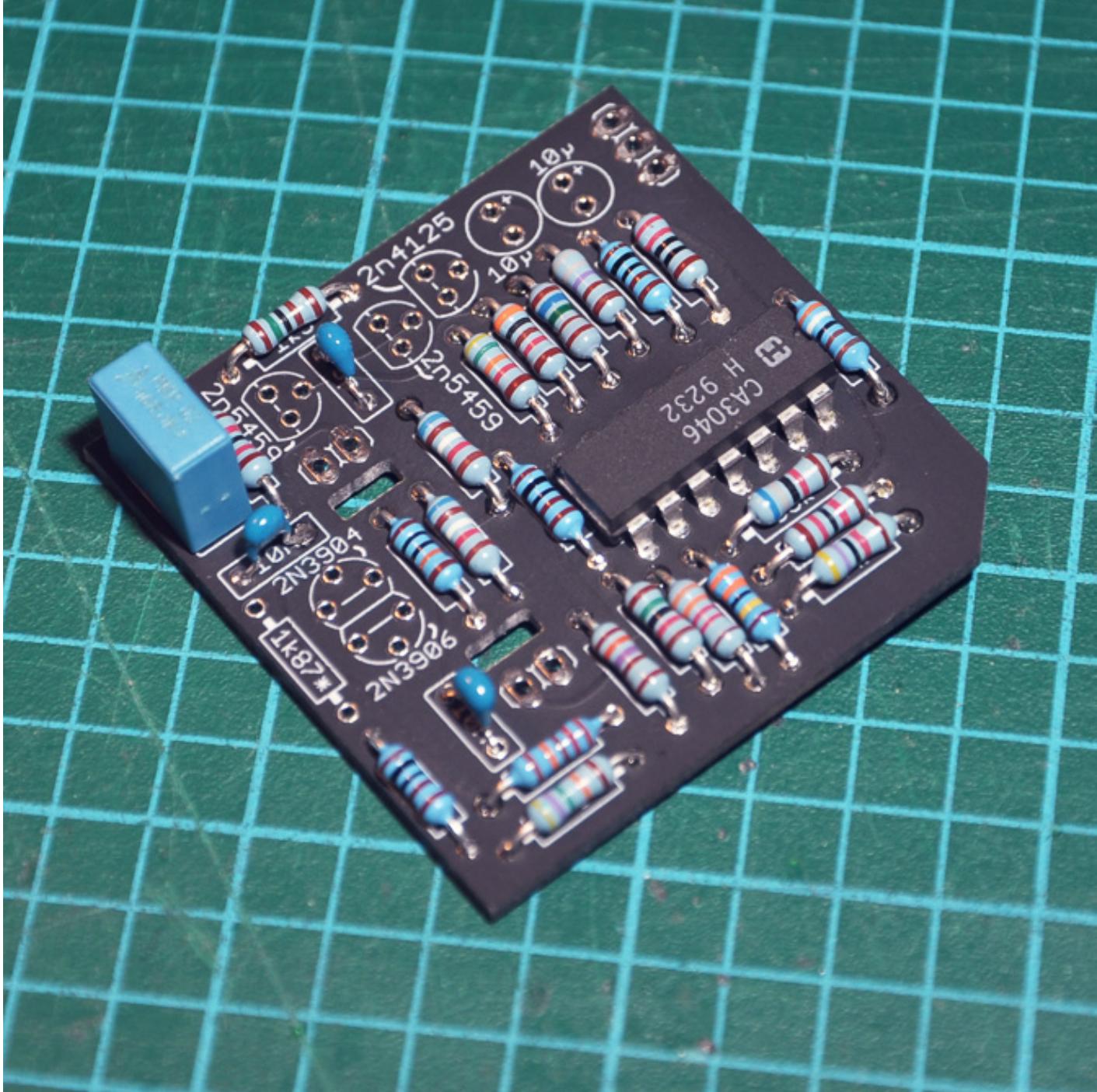
Nice board, waiting for components.



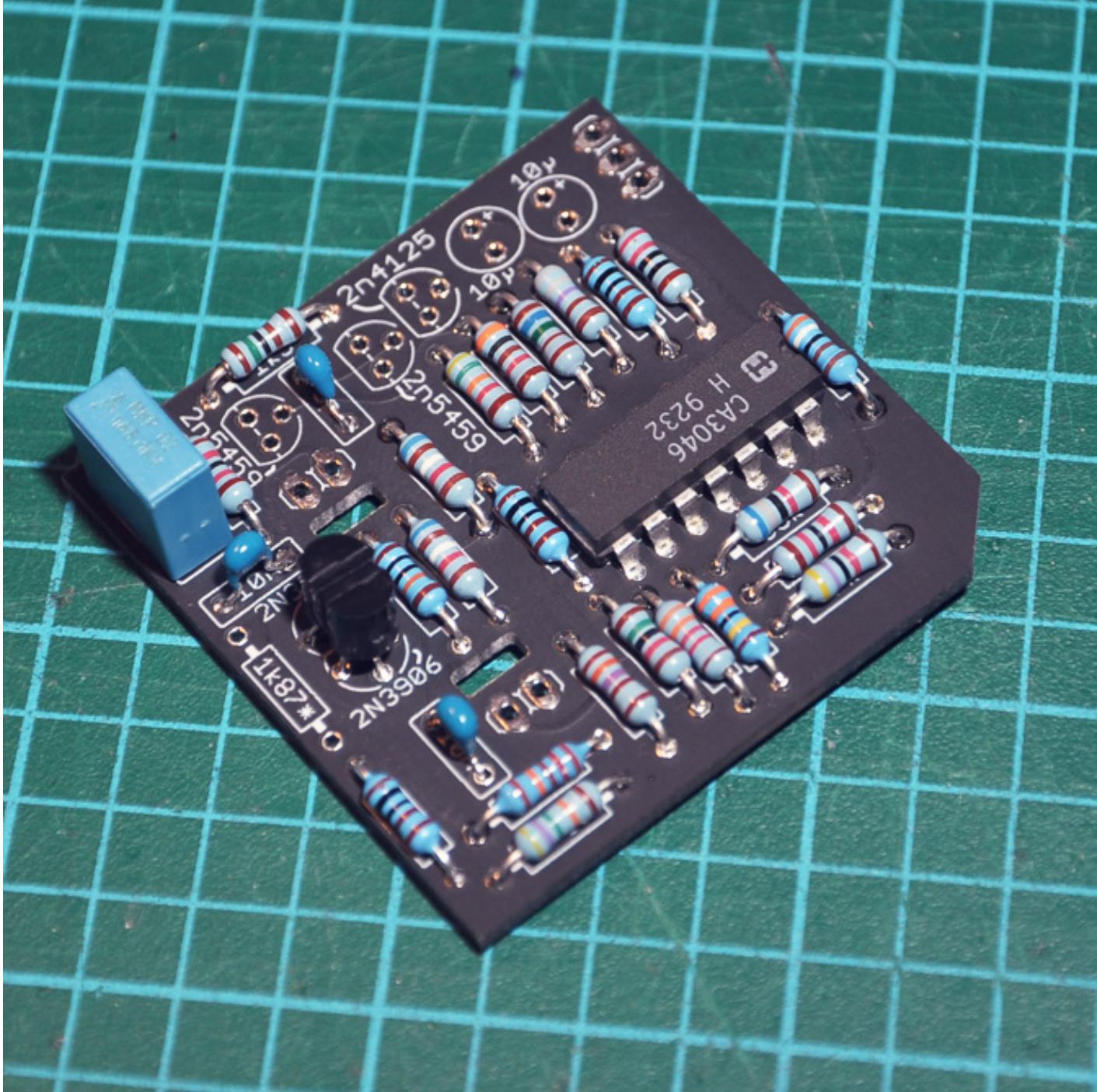
Install all resistors.



Solder the CA3046. Notice IC orientation, with notch towards the cut corner side.

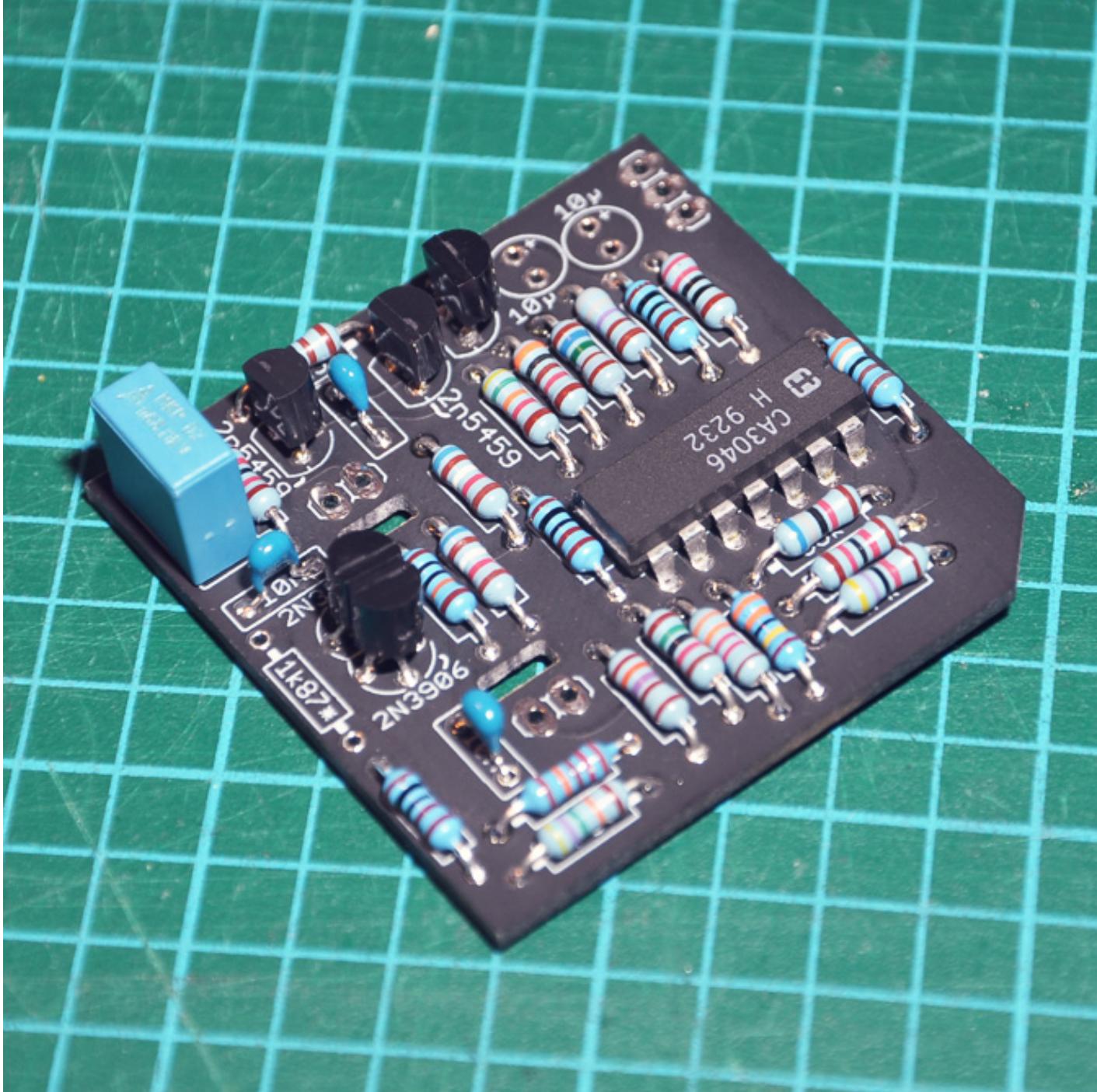


Install caps. 10n caps are called  $0.01\mu F$  when ordering from Mouser.

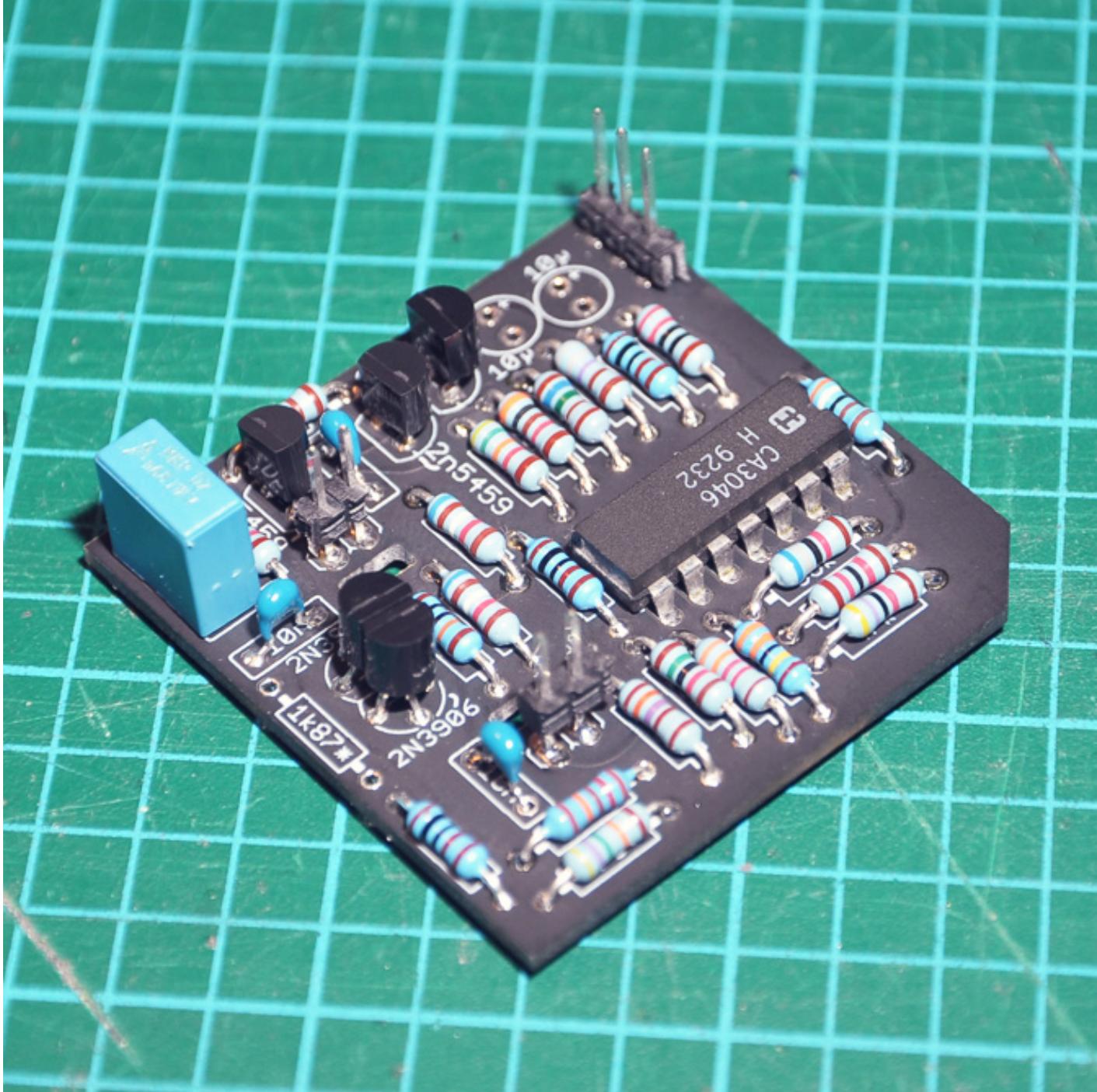


Next up are transistors. Take 2N3904 and 2N3906 first. The 04 to the left, 06 to the right. They should be pushed together for thermal contact.

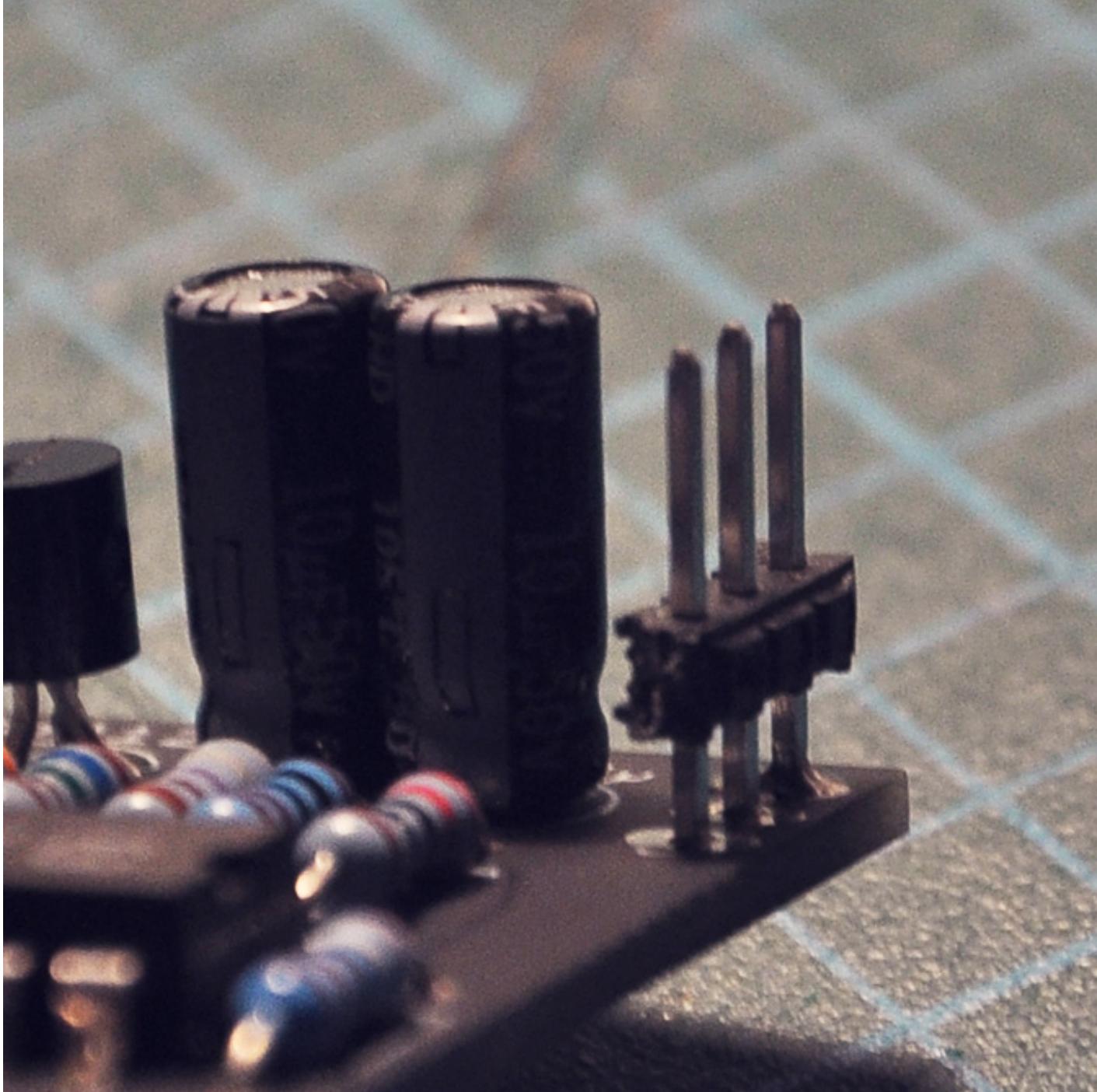
Now, instinctively you'd probably want to match these. But since it's one NPN and one PNP it's very very difficult. Plus they didn't match them in the original. So just chuck them in there.



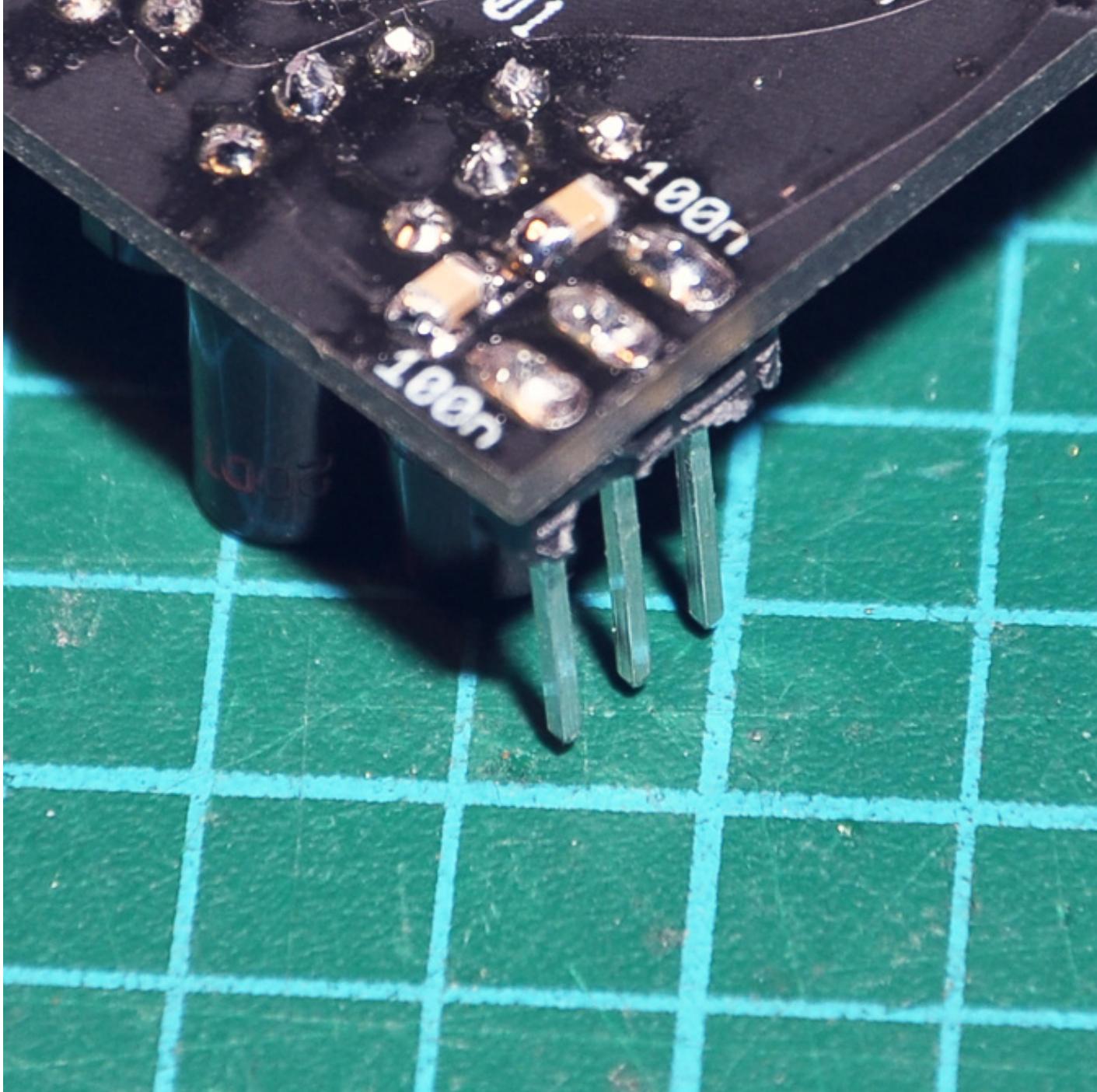
Solder in the rest of the transistors.



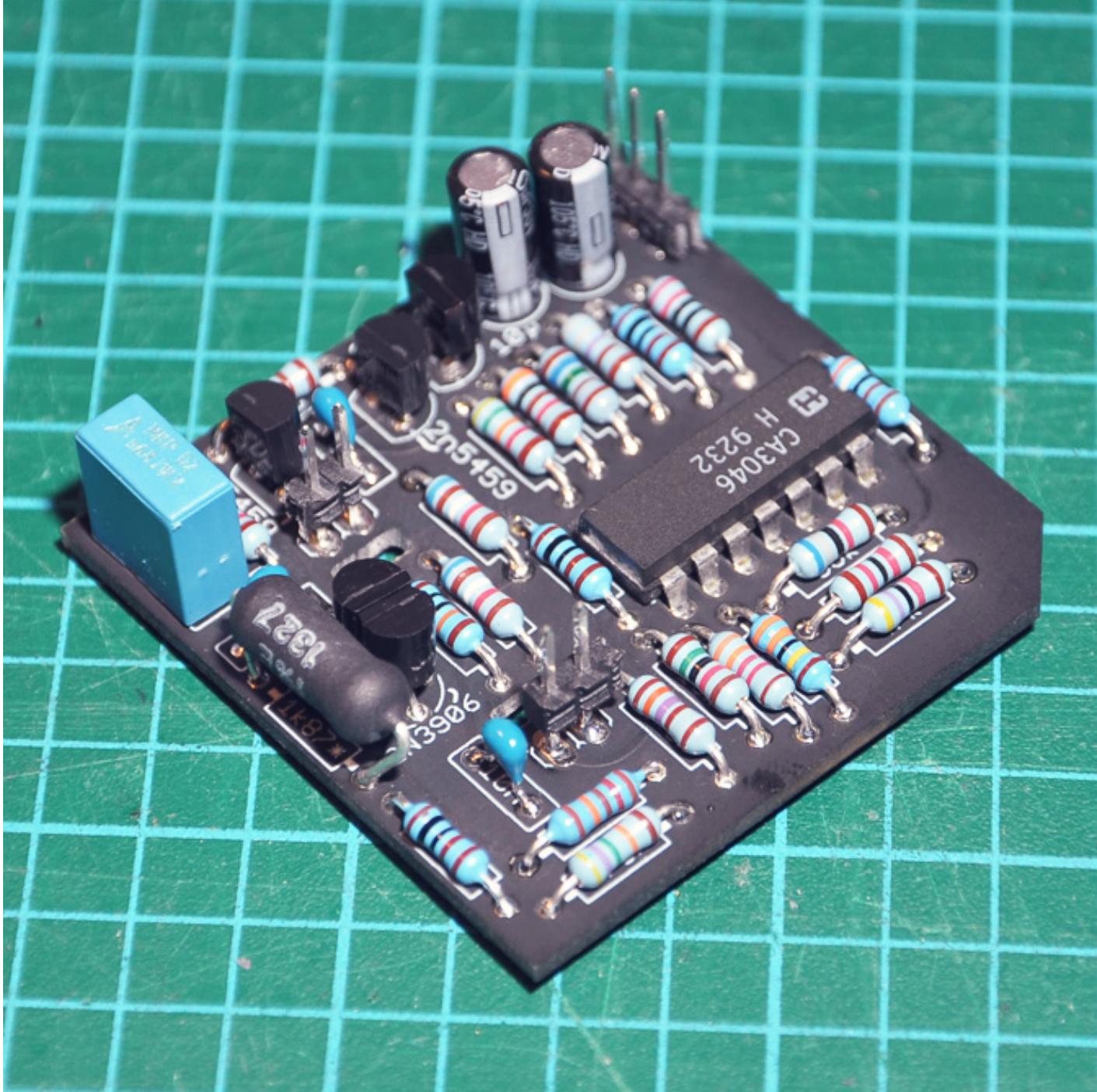
Headers are up next. These should be stacked high, so the divider hangs in mid air as seen in the next picture.



"Floating headers".



Flip the board and solder the 2 100n SMD caps.



Back to the top side and solder the 2 electrolytic capacitors. Notice orientation, plus side goes towards edge.

And lastly solder the 1k87 tempco. Push it against the two transistors, for thermal contact.

Now do it 2 more times!

# PSU

The board has room for a DC-DC converter, which will handle the power for you.

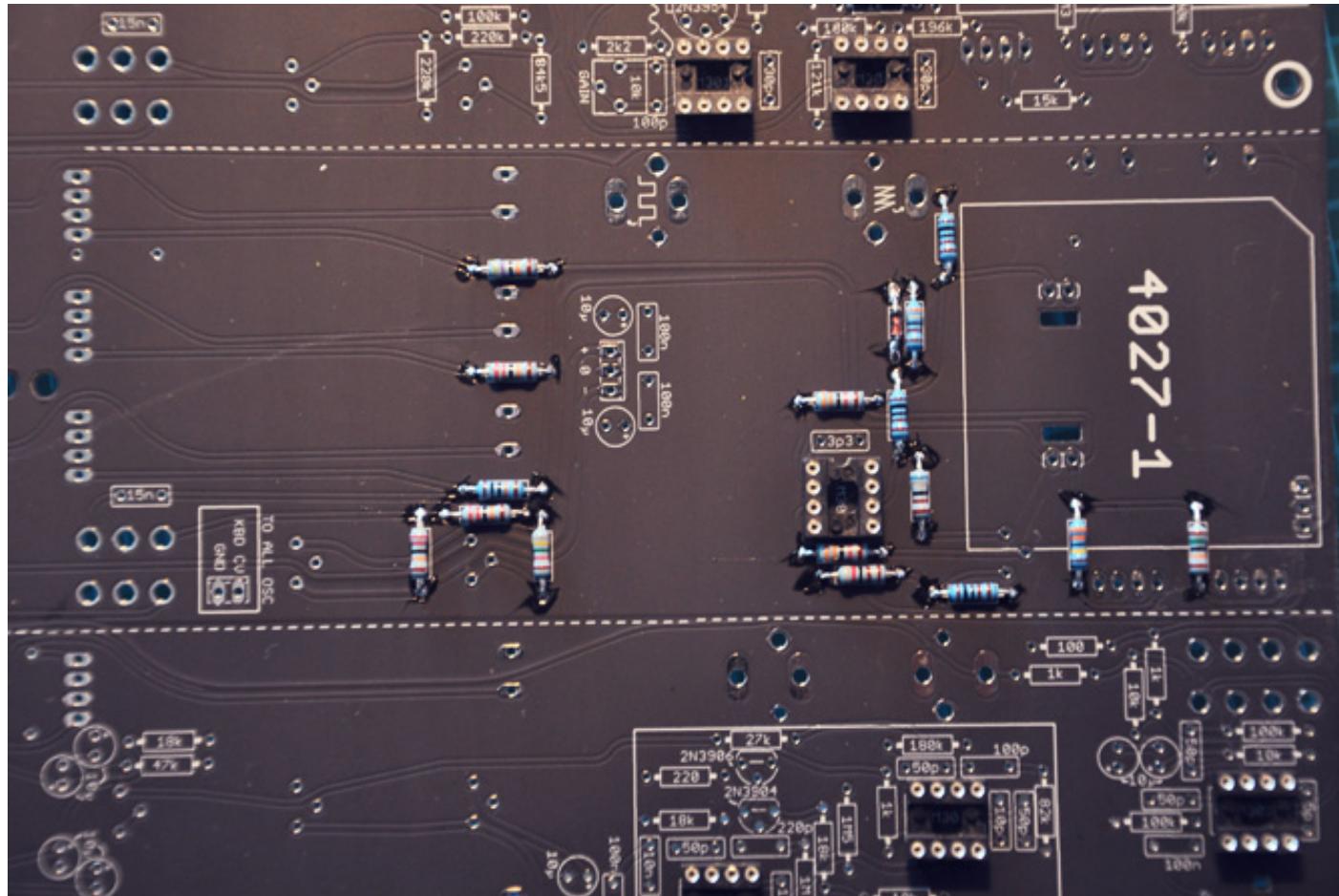
Parts list PSU			
Resistors	Capacitors	Inductors	Other
<ul style="list-style-type: none"><li>■ 10Ohm x 1</li></ul>	<ul style="list-style-type: none"><li>■ 100p x 1</li><li>■ 47μ x 1 (Electrolytic)</li></ul>	<ul style="list-style-type: none"><li>■ 12μH x 1</li></ul>	<ul style="list-style-type: none"><li>■ DC-DC converter x 1</li><li>■ 3 pin .1" connector x 12 (If you're like me, you'll skip these and solder the wires direct)</li><li>■ 2 pin .1" connector x 2 (If you're like me, you'll skip these and solder the wires direct)</li><li>■ 2 pin .156" connector x 1</li><li>■ Ferrite beads x 2</li><li>■ 12-18V 1500mA DC adaptor x 1</li></ul>

Once installed, power up and measure for ±15V between ground and V+/V-.

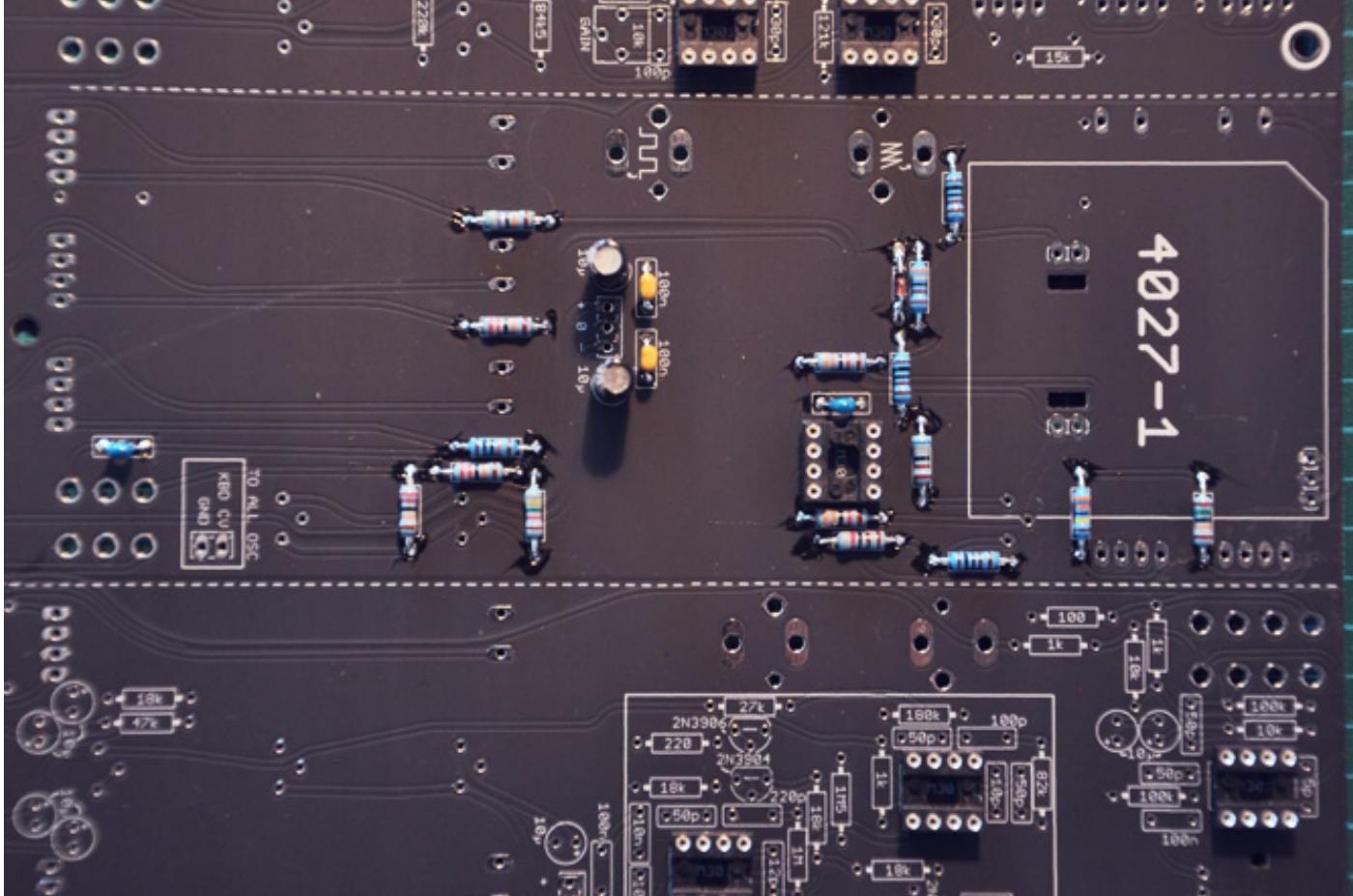
**VCO 1**

Parts list VCO 1				
Resistors	Capacitors	Semi's	Trimmers	Other
<ul style="list-style-type: none"> <li>■ 1k x 3</li> <li>■ 3k9 x 1</li> <li>■ 8k2 x 1</li> <li>■ 33k x 2</li> <li>■ 84k5 x 1</li> <li>■ 100k x 1</li> <li>■ 150k x 1</li> <li>■ 220k x 3</li> <li>■ 470k x 1</li> <li>■ 3M3 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 10µ x 2 (Electrolytic)</li> <li>■ 100n x 2</li> <li>■ 15n x 1</li> <li>■ 3p3 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ LM301 x 1</li> <li>■ 1n4148 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 100k x 2</li> <li>■ 25k x 1</li> </ul>	

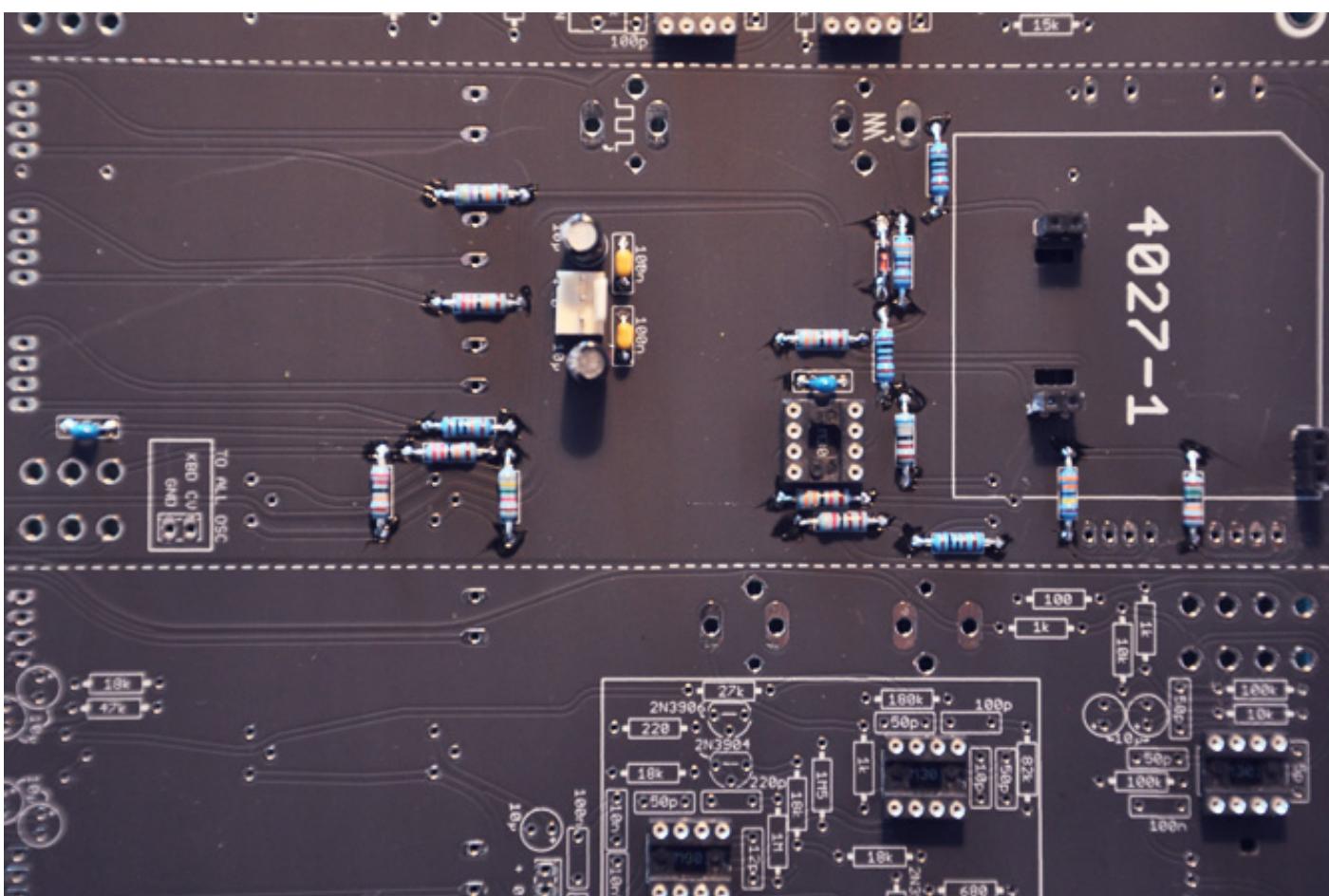
The VCO-1 is the second module from the right when the board is viewed from the backside.



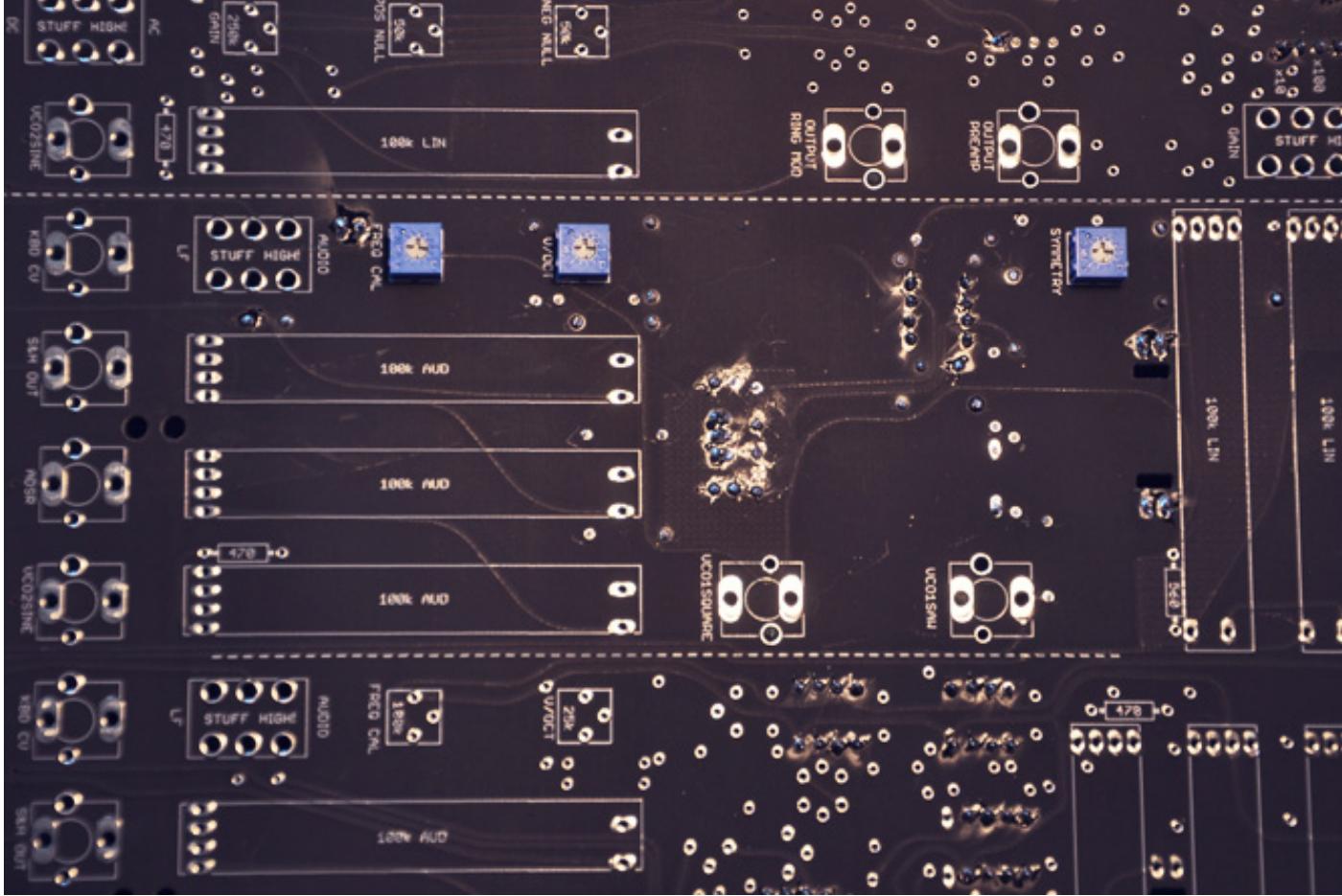
Start with resistors and the lonely 1n4148. Black stripe on 1n4148 should be pointing to the left.



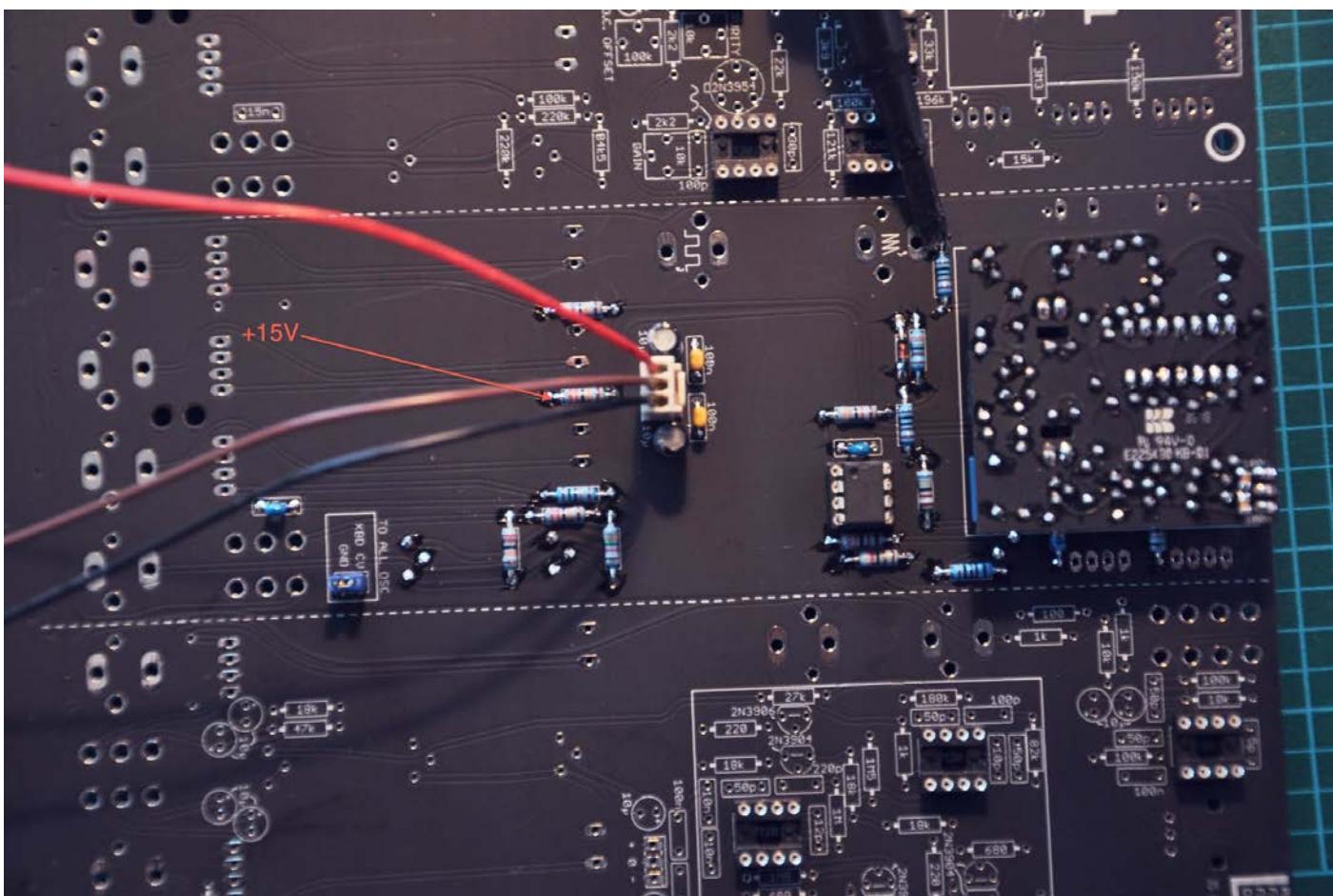
Next up capacitors. Notice orientation of polarized caps, long leg goes in the top hole.



Insert all the headers and sockets. Missing in picture is header on KBD CV and GND! It should be installed.



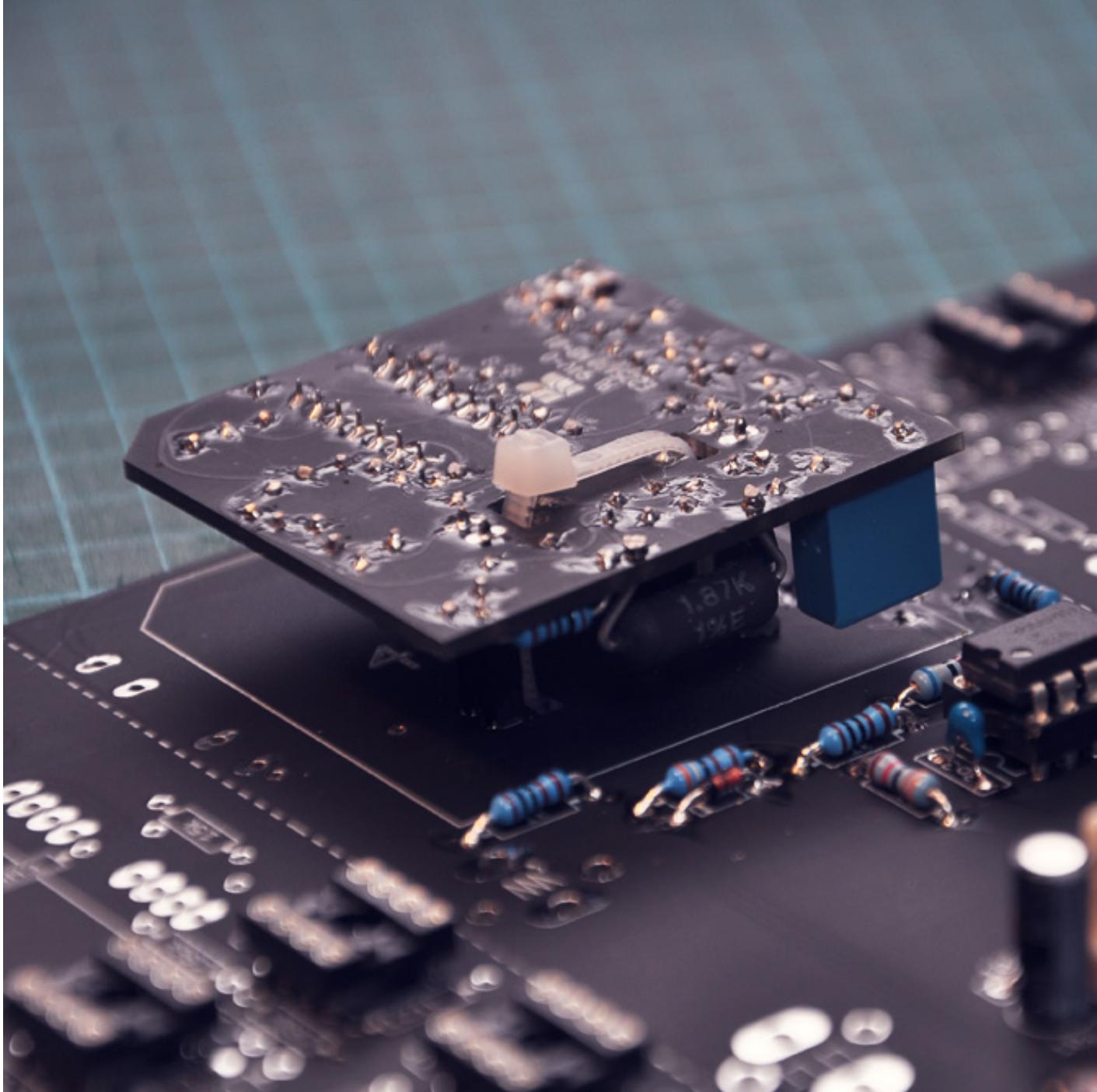
Flip board and install the 3 trimmers.



Insert the 4027-1, jumper the KBD CV to GND and apply power (The reason you're shorting this is because the KBD CV trace is long. It should terminate in a jack on the front panel, which doesn't exist right now. So instead it works like a nice antenna picking up stuff it shouldn't. Making your nice sawtooth looking funky.). And apply +15V to the marked resistor. Check the 2 pads marked with a sawtooth and a square on board and you should see the desired waveforms.



Saw!



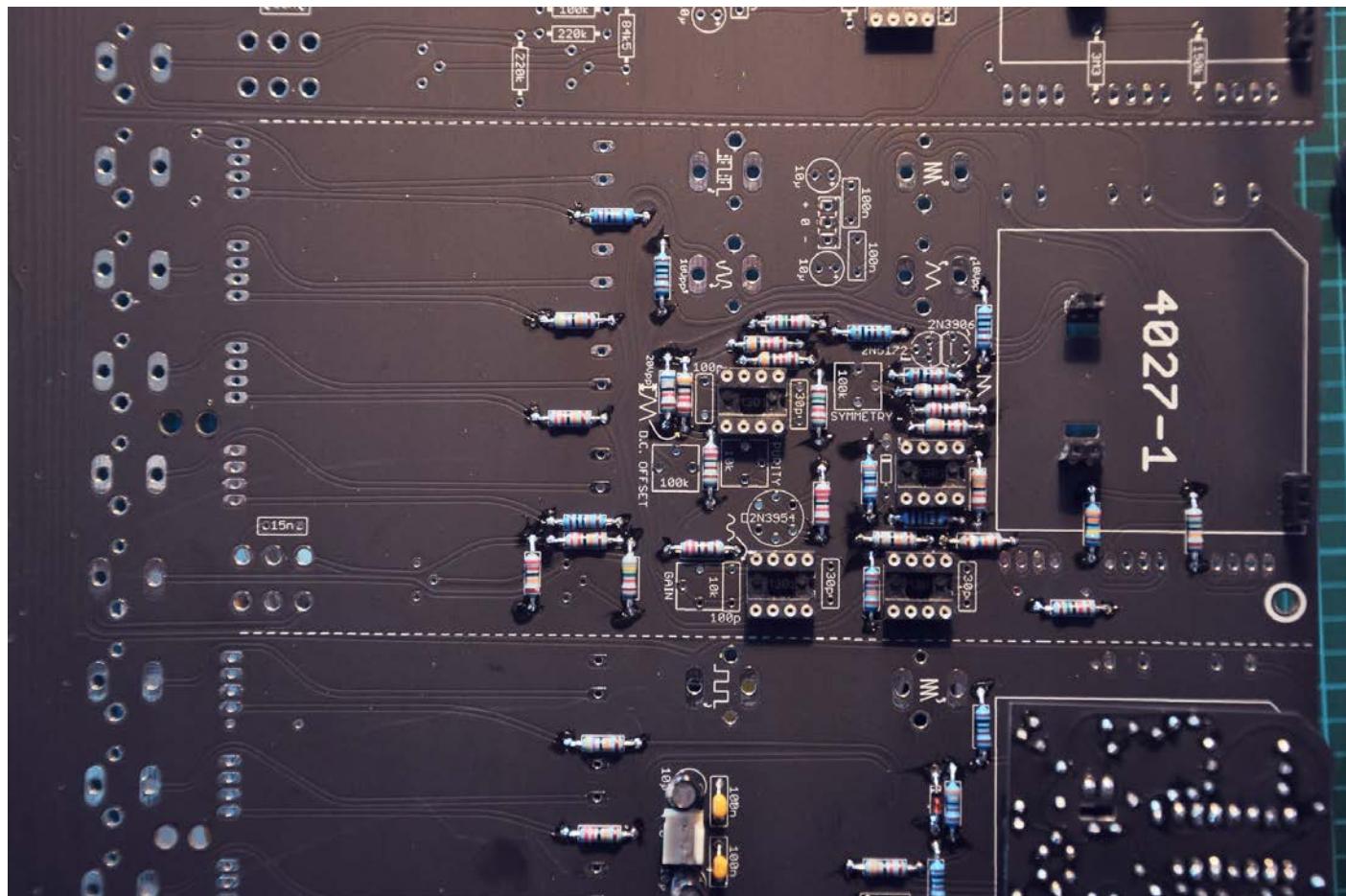
If everything is working as expected you can test all 3 sub modules in the VCO-1, to see that all of them works.

And then use a zip tie to strap the last board in.

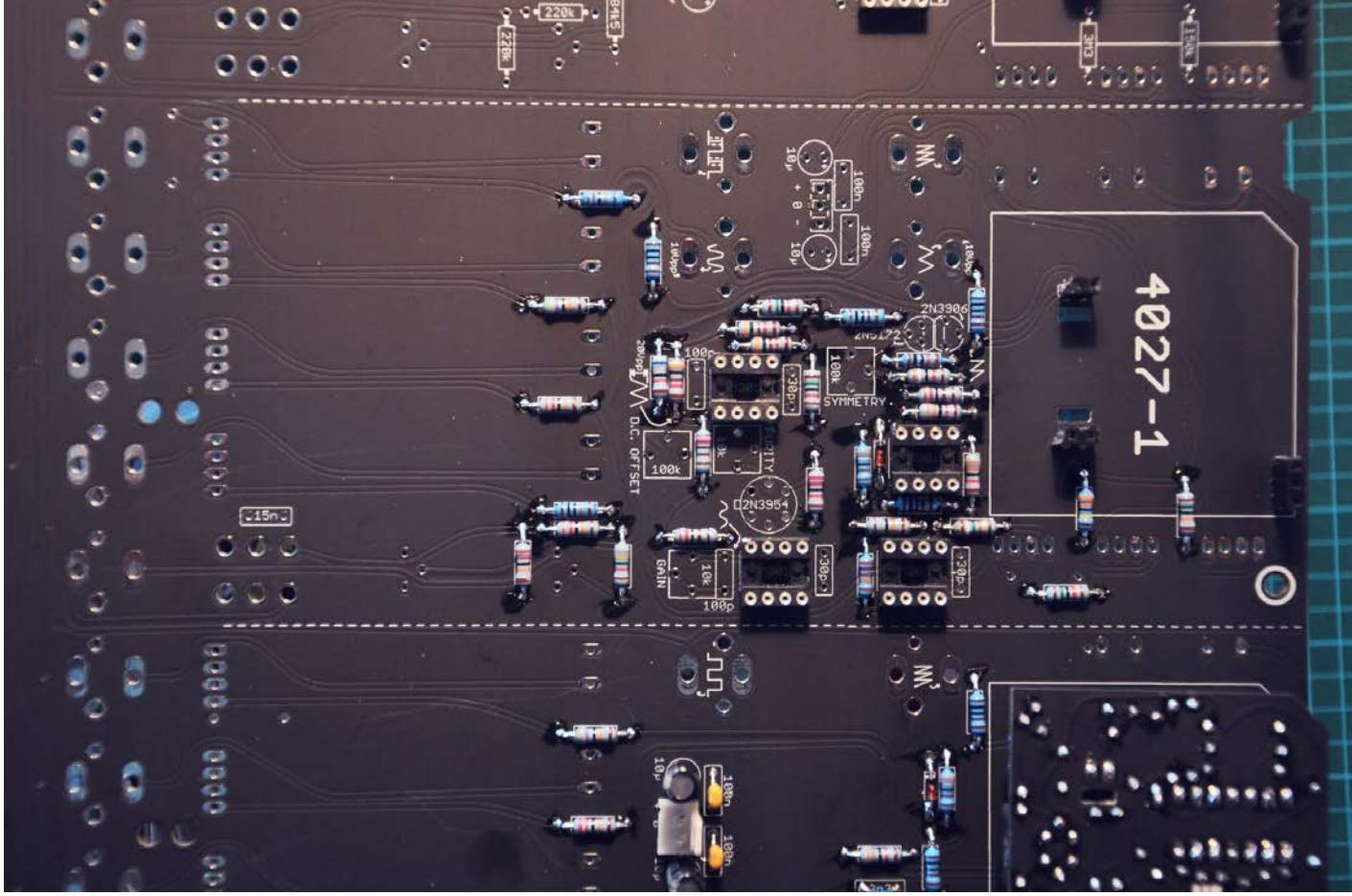
# VCO2

Parts list VCO 2

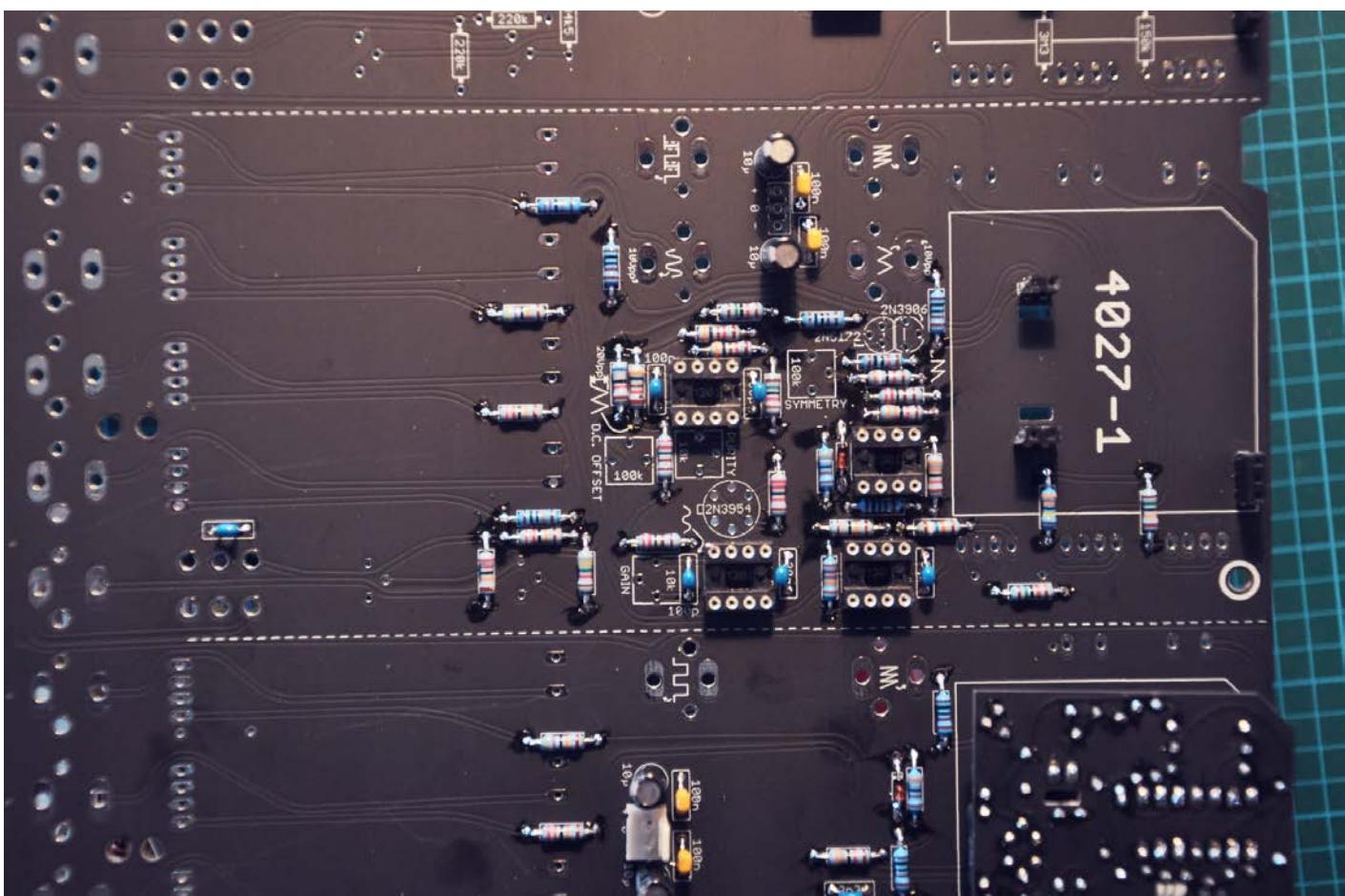
Resistors	Capacitors	Semi's	Trimmers	Other
<ul style="list-style-type: none"> <li>■ 1k x 4</li> <li>■ 2k2 x 3</li> <li>■ 3k9 x 1</li> <li>■ 10k x 1</li> <li>■ 15k x 3</li> <li>■ 22k x 1</li> <li>■ 30k1 x 3</li> <li>■ 33k x 2</li> <li>■ 39k x 1</li> <li>■ 68k x 1</li> <li>■ 84k5 x 1</li> <li>■ 100k x 1</li> <li>■ 120k x 1</li> <li>■ 121k x 1</li> <li>■ 150k x 1</li> <li>■ 180k x 1</li> <li>■ 196k x 1</li> <li>■ 220k x 3</li> <li>■ 470k x 1</li> <li>■ 3M3 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 100p x 2</li> <li>■ 30p x 3</li> <li>■ 15n x 1</li> <li>■ 100n x 2</li> <li>■ 10μ x 2</li> </ul>	<ul style="list-style-type: none"> <li>■ LM301 x 4</li> <li>■ 1N4148 x 1</li> <li>■ 2N3906 x 1</li> <li>■ 2N3954 x 1</li> <li>■ 2N5172 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 100k x 3</li> <li>■ 25k x 1</li> <li>■ 10k x 2</li> </ul>	<ul style="list-style-type: none"> <li>■ 3 pin MTA header x 1</li> <li>■ 2 Pin header x 2</li> <li>■ 3 Pin header x 1</li> <li>■ 3,5mm jack x 1</li> </ul>



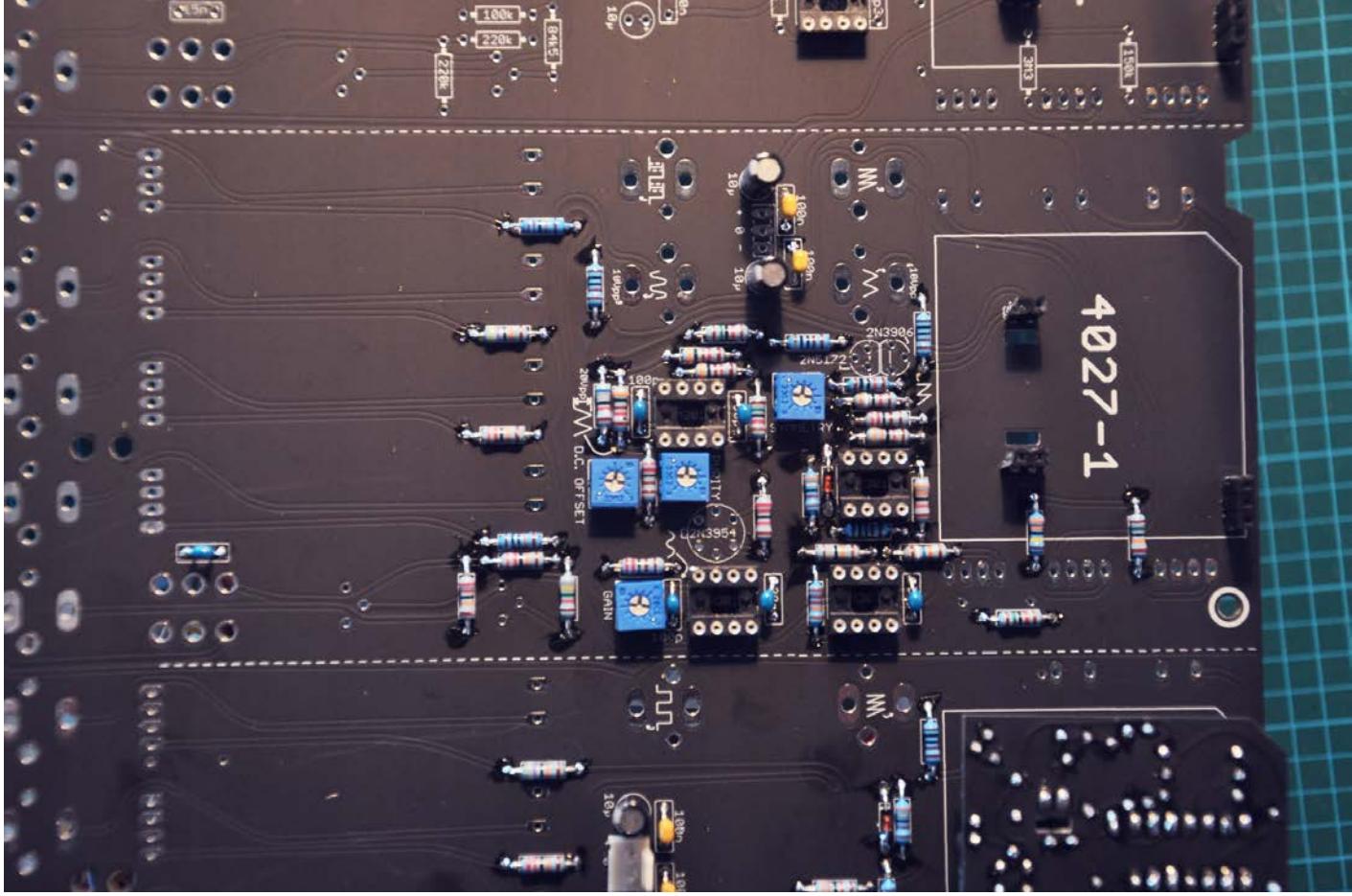
Resistors



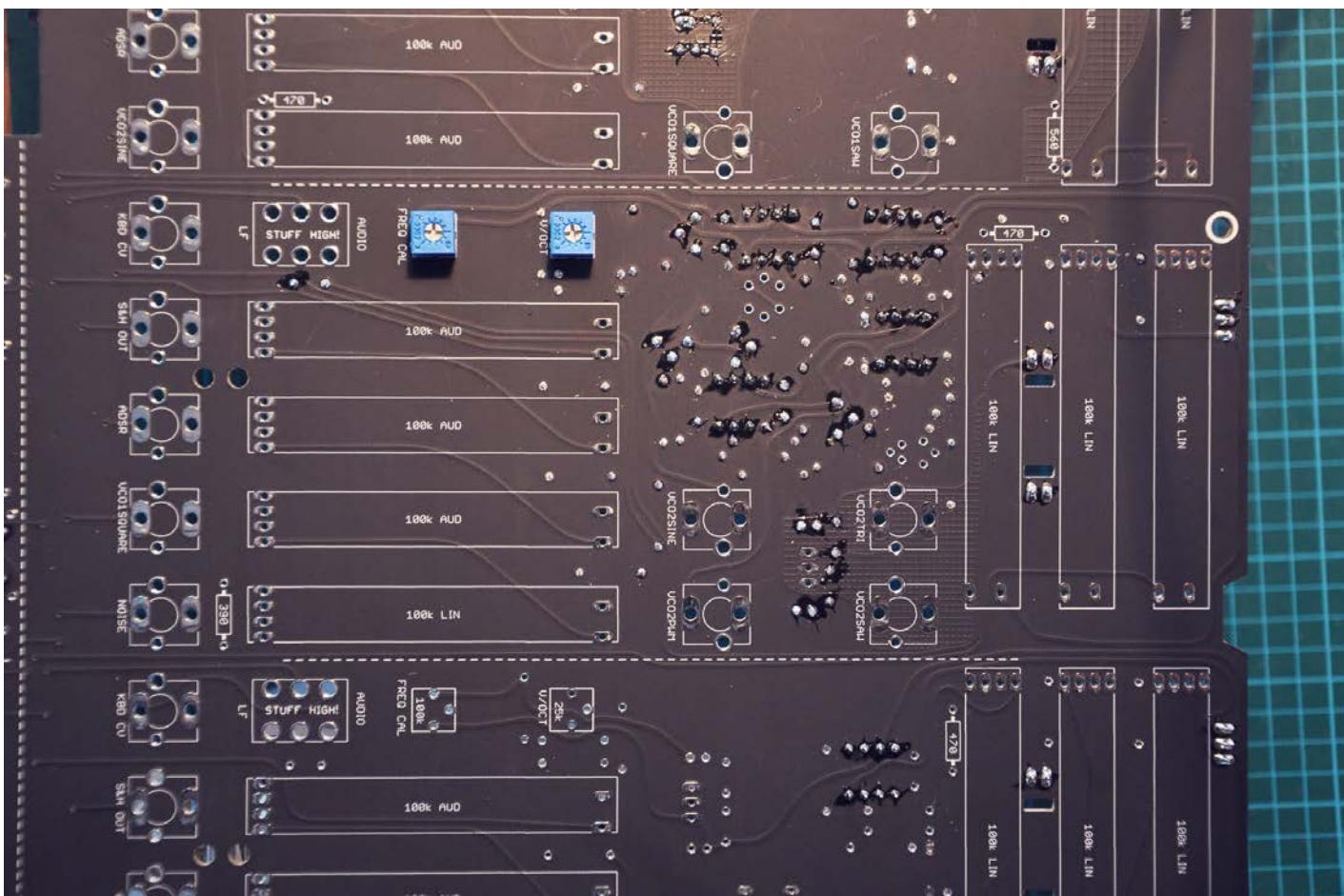
Diodes. Check polarity.



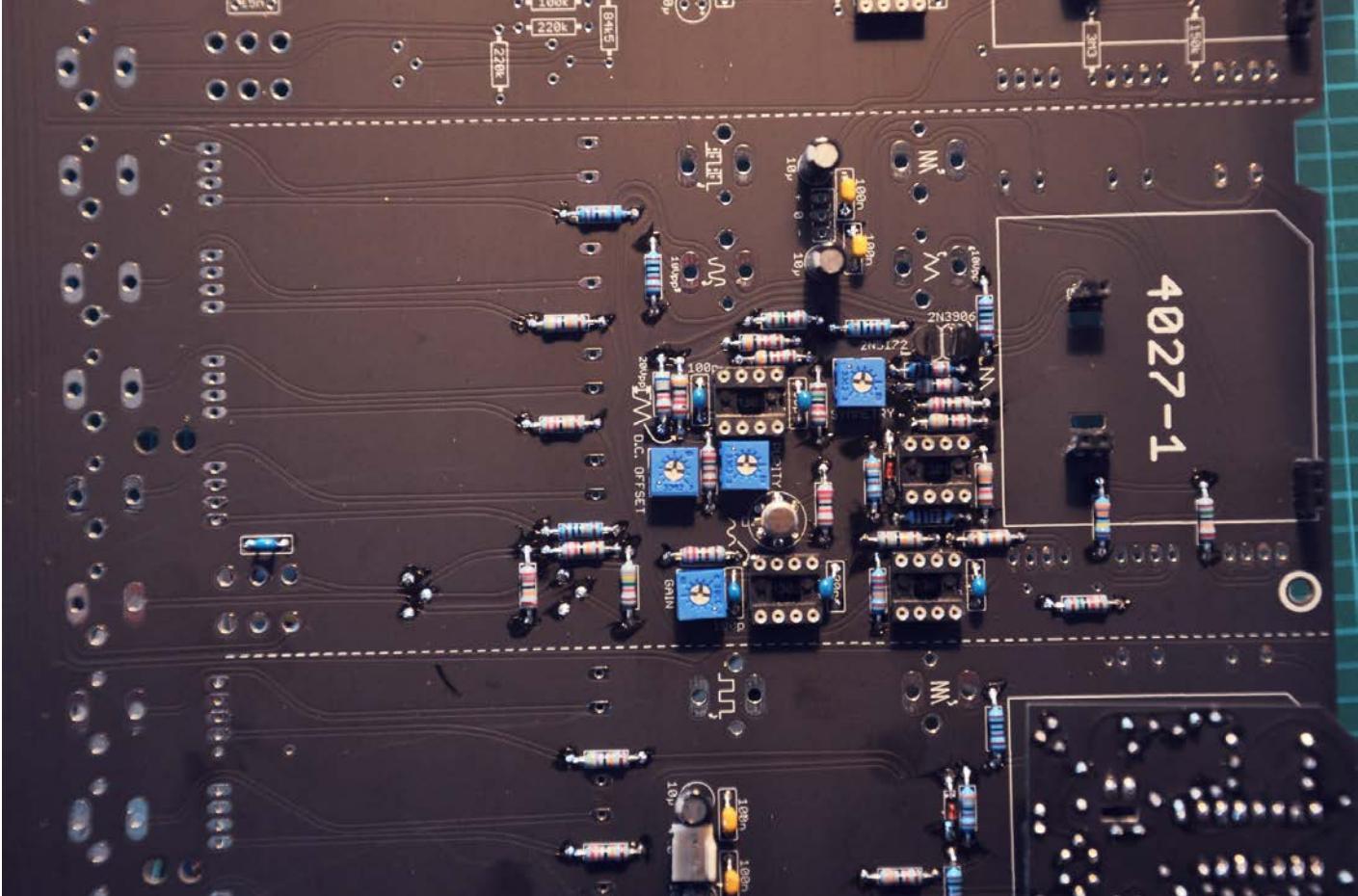
Capacitors. Be careful with polarity on electrolytic capacitors.



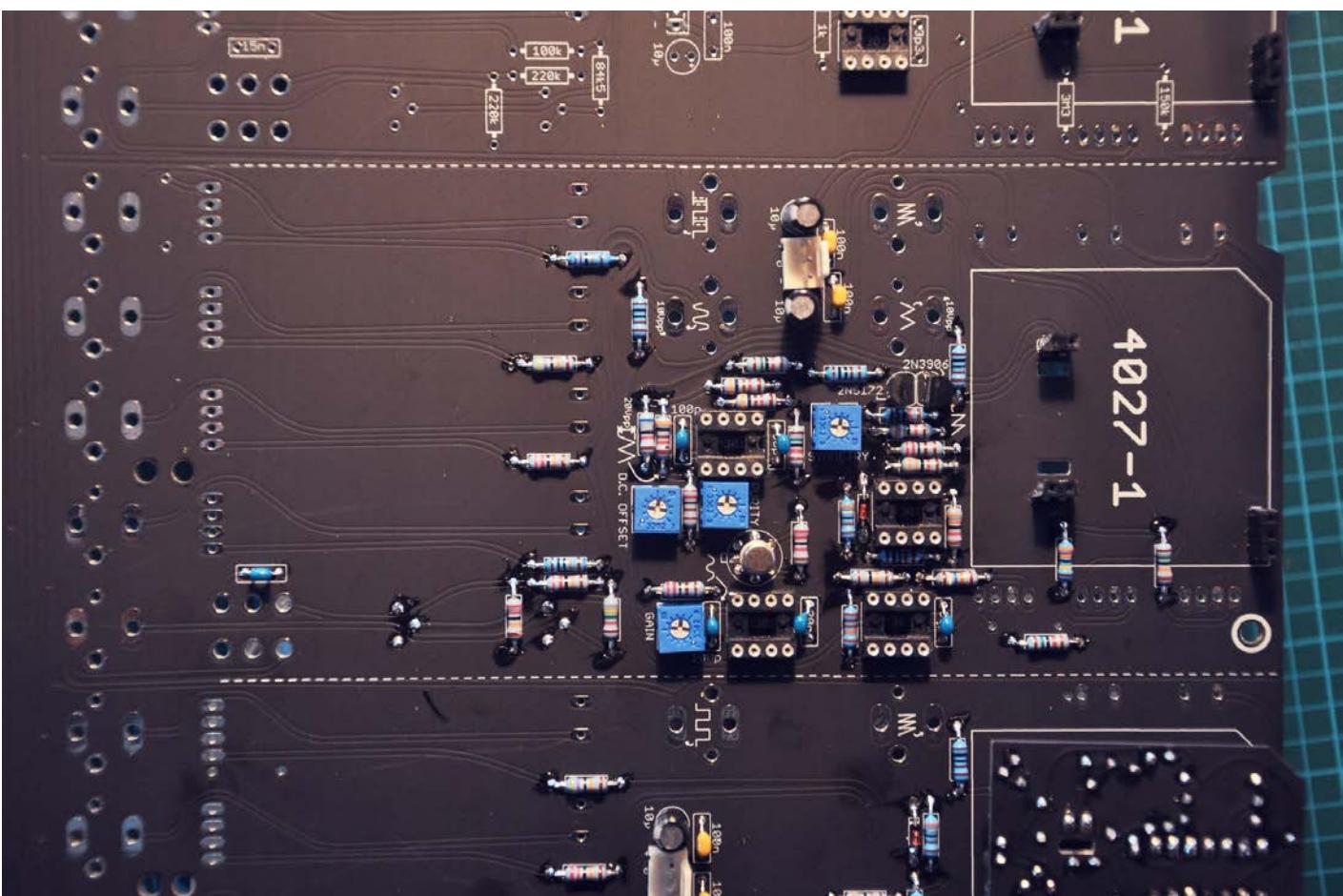
Trim potentiometers on backside of board.



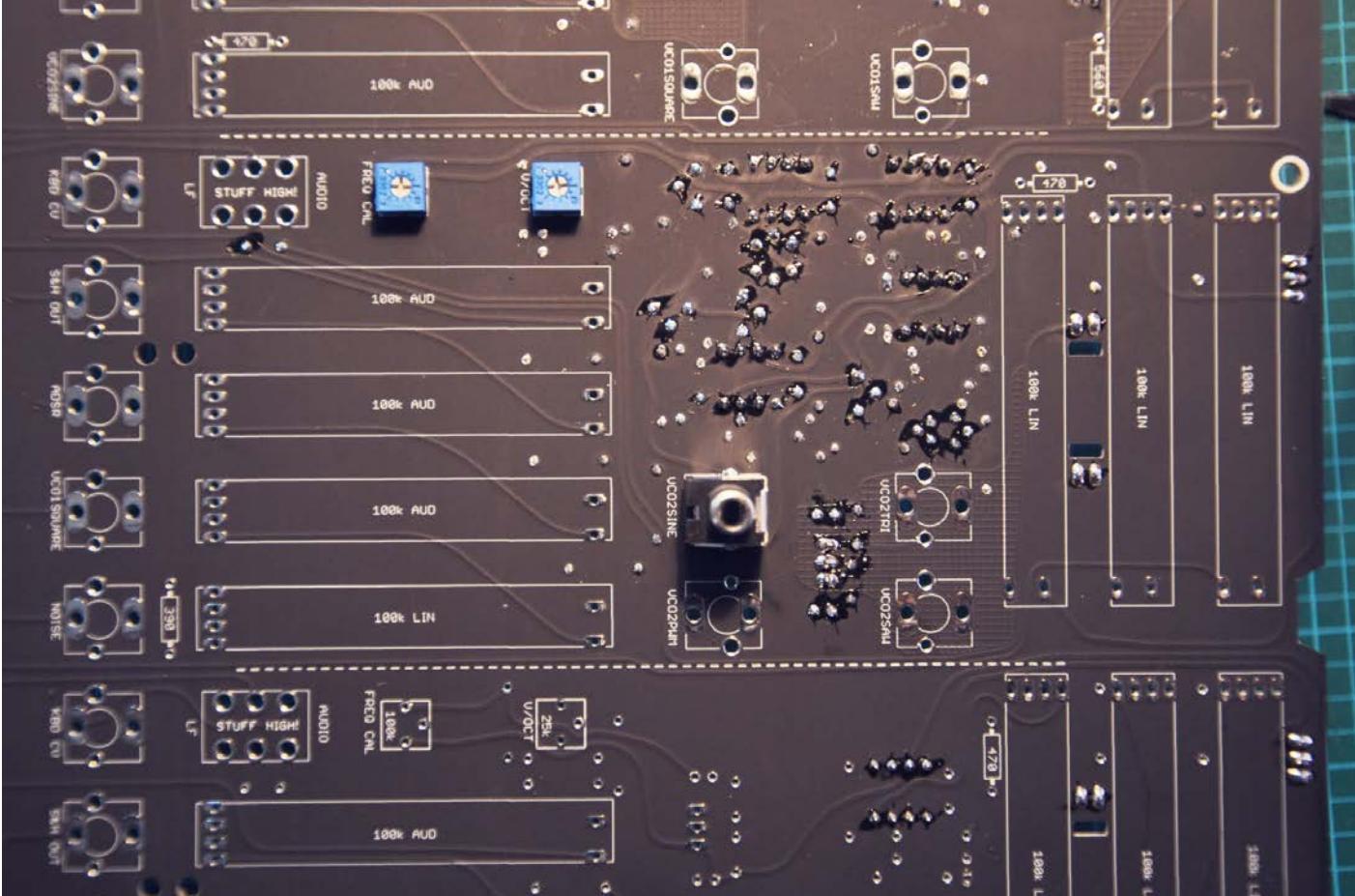
Flip board and install topside trim potentiometers.



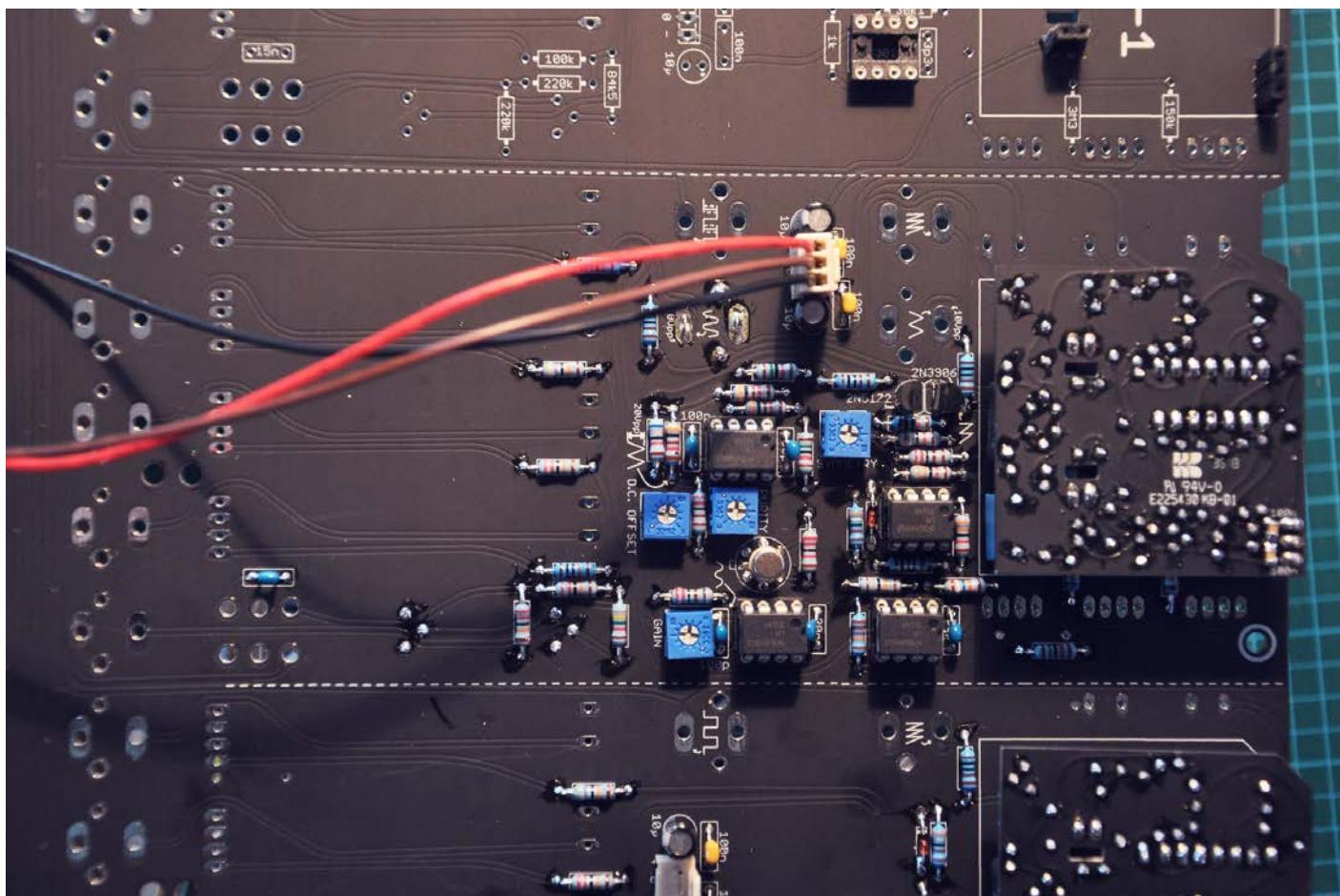
Transistors. Note orientation.



Install MTA header.



Flip board and install jack for VCO2SINE. This jack carries ground connection to the center of the module. So if you test the VCO without it, everything will probably go wrong!



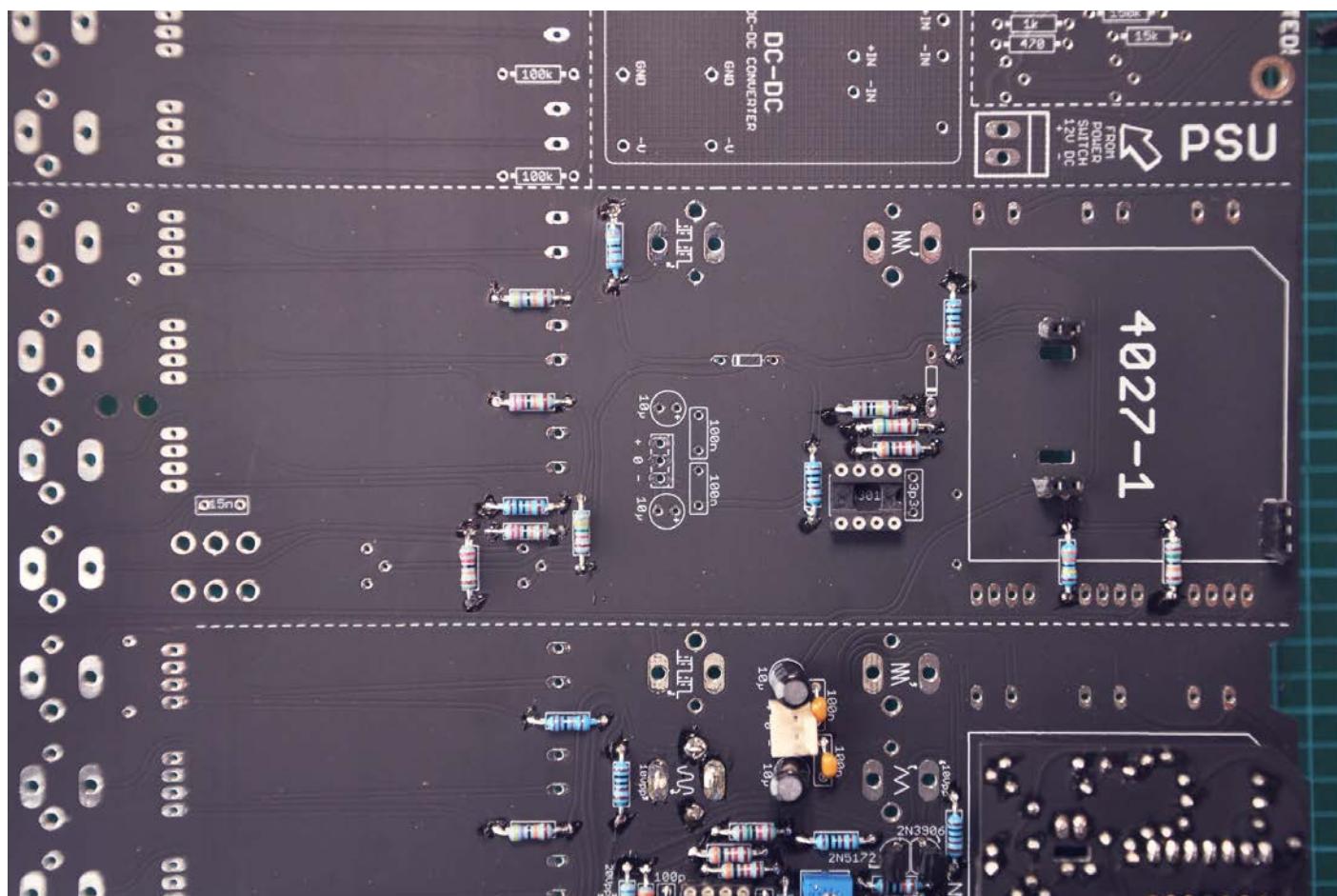
Apply power and check for signal at marked areas.

If it's working as expected, [go on to VCO3](#).

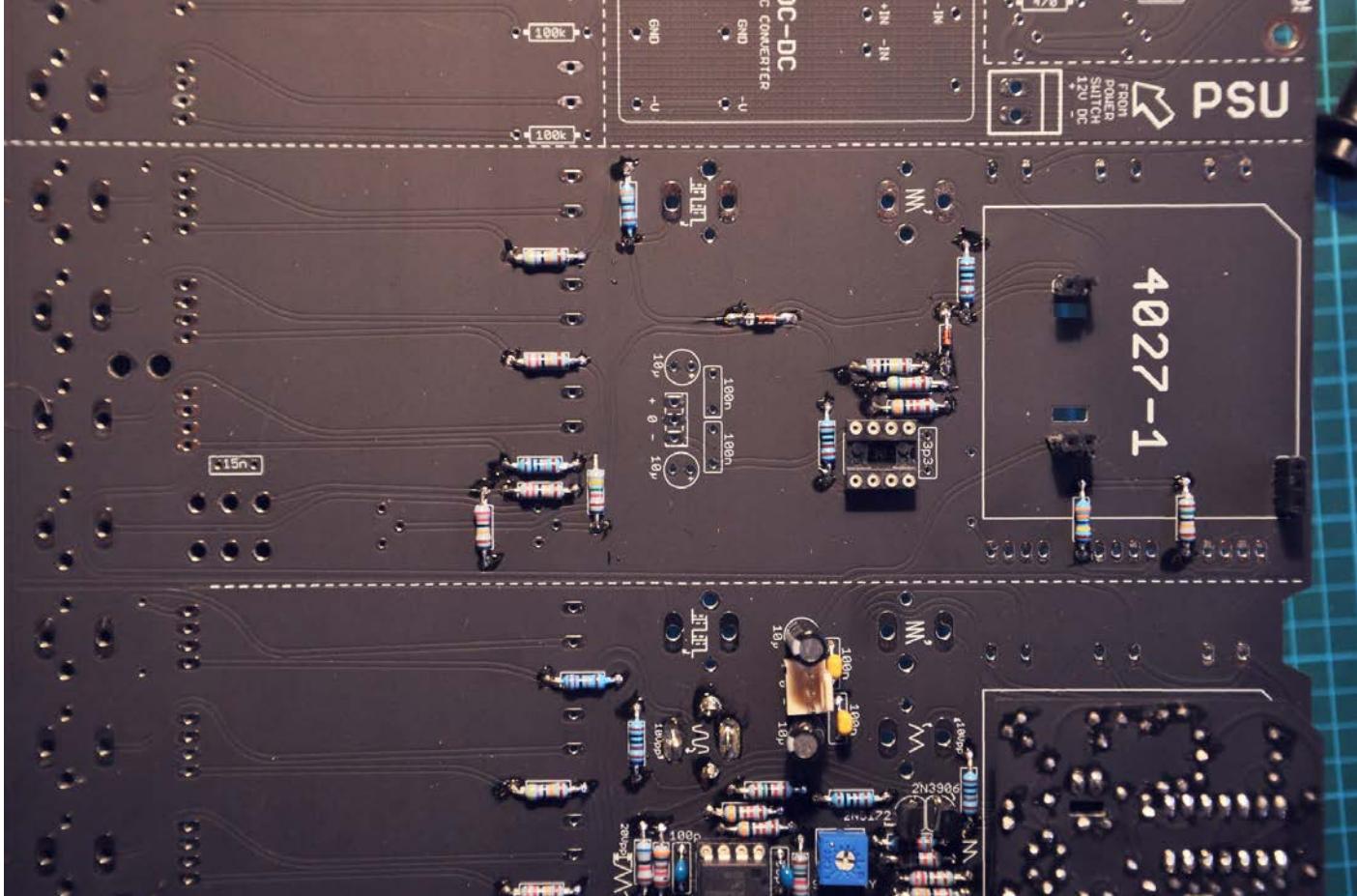
# VCO3

## Parts list VCO 3

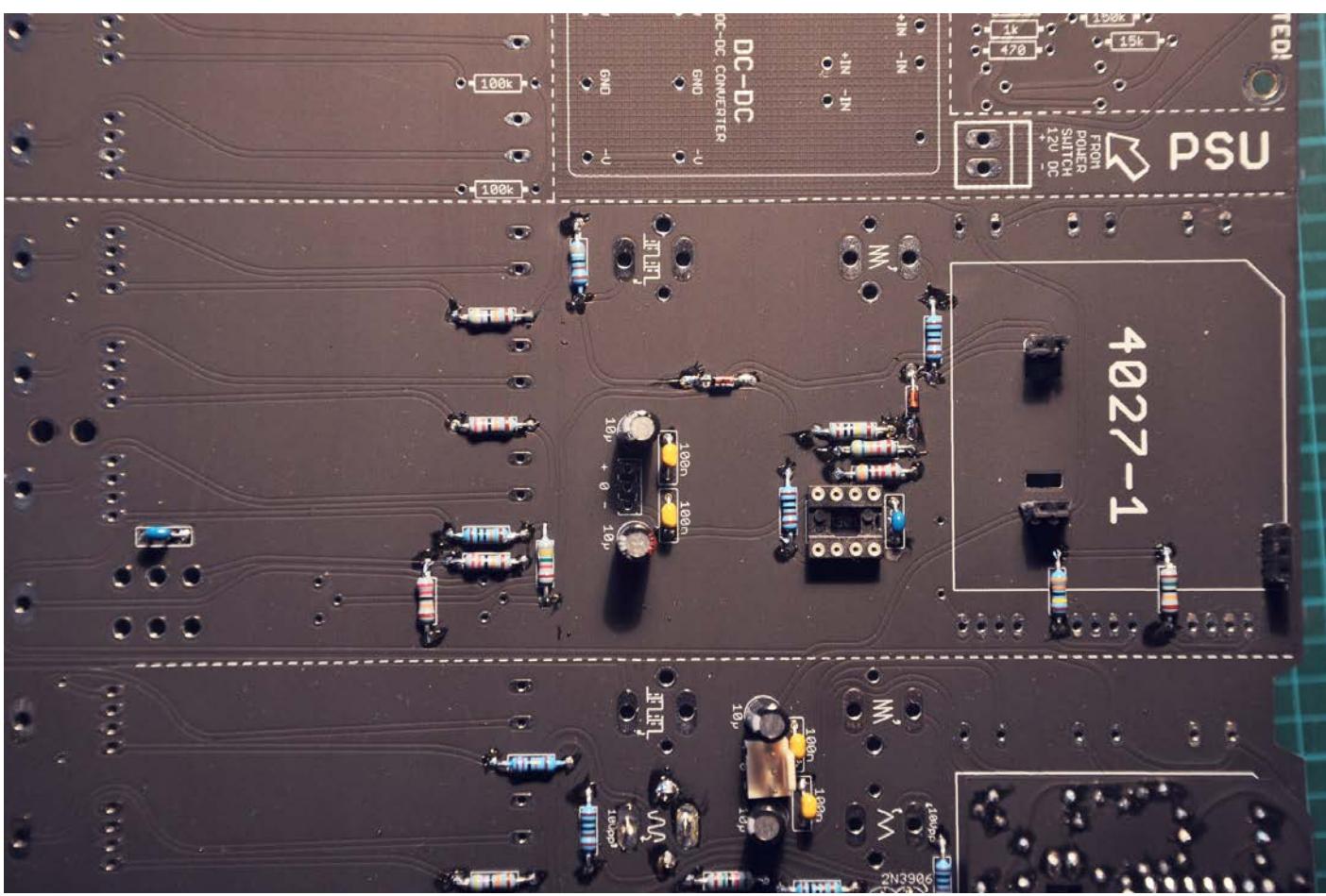
Resistors	Capacitors	Semi's	Trimmers	Other
<ul style="list-style-type: none"> <li>■ 1k x 2</li> <li>■ 3k9 x 1</li> <li>■ 30k1 x 1</li> <li>■ 45k3 x 1</li> <li>■ 470k x 1</li> <li>■ 84k5 x 1</li> <li>■ 100k x 1</li> <li>■ 150k x 1</li> <li>■ 220k x 3</li> <li>■ 1M x 1</li> <li>■ 3M3 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 3p3 x 1</li> <li>■ 15n x 1</li> <li>■ 100n x 2</li> <li>■ 10<math>\mu</math> x 2 (Electrolytic)</li> </ul>	<ul style="list-style-type: none"> <li>■ 1n4148 x 2</li> <li>■ LM301 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 25k x 1</li> <li>■ 10k x 1</li> <li>■ (Zthee forgot to list these)</li> </ul>	<ul style="list-style-type: none"> <li>■ 3 pin MTA header x 1</li> <li>■ 2 Pin header x 2</li> <li>■ 3 Pin header x 1</li> </ul>



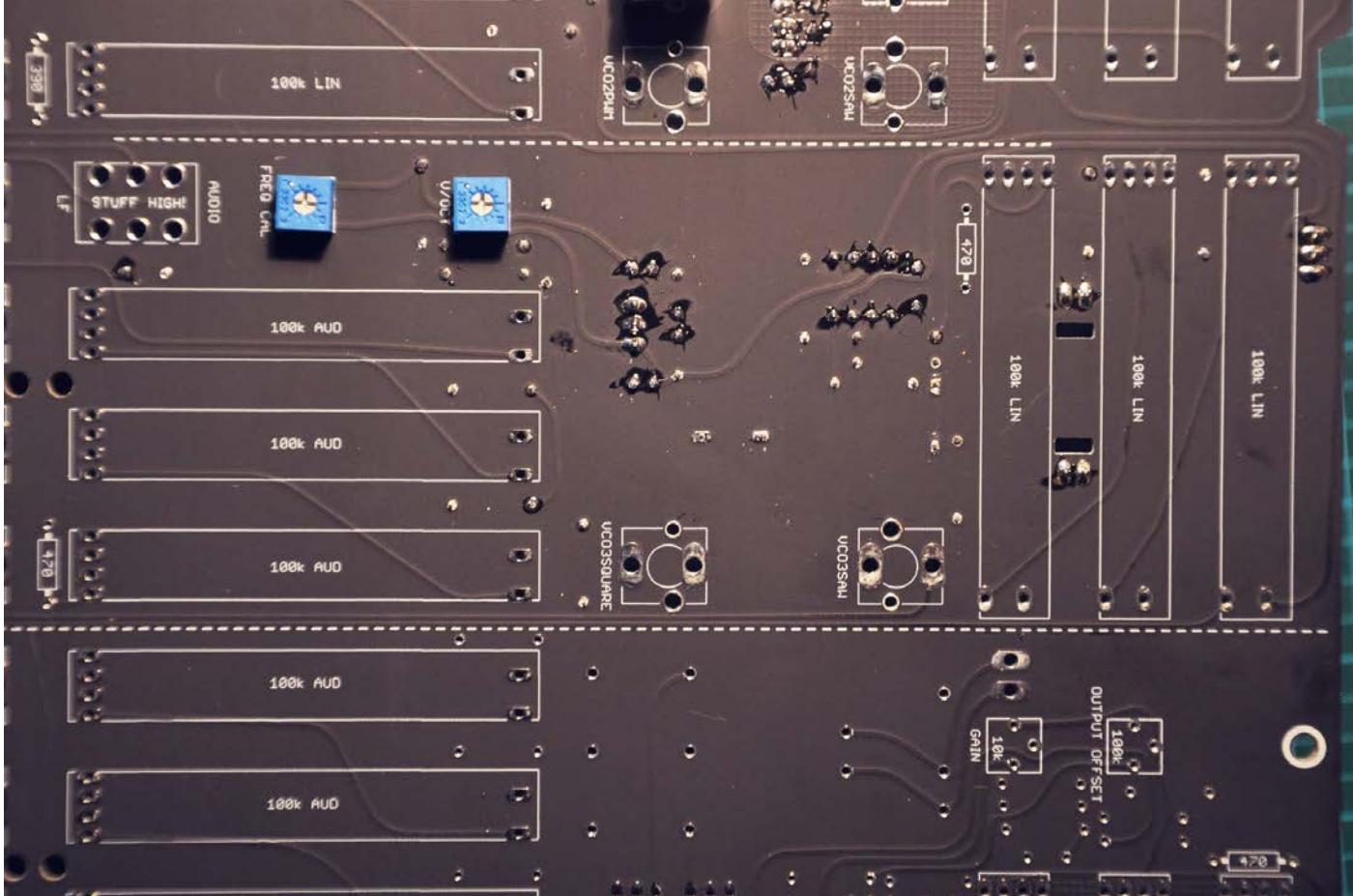
Resistors first, as usual.



Diodes. Stuff 'em the right way!



Capacitors.



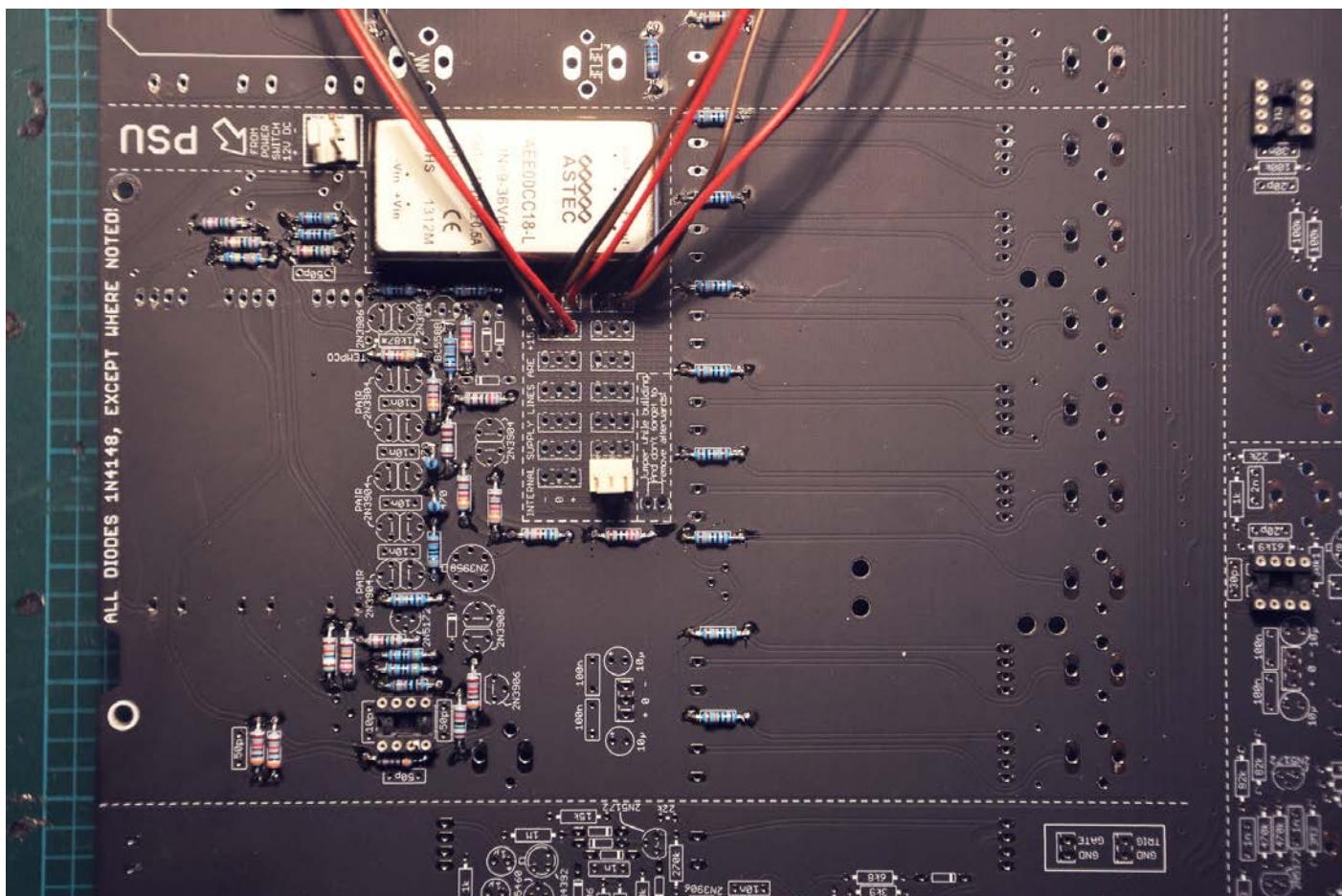
Flip board and install the trim potentiometers.

Flip back. Install headers, LM301 and the rest of the stuff. Apply power and check for signal.

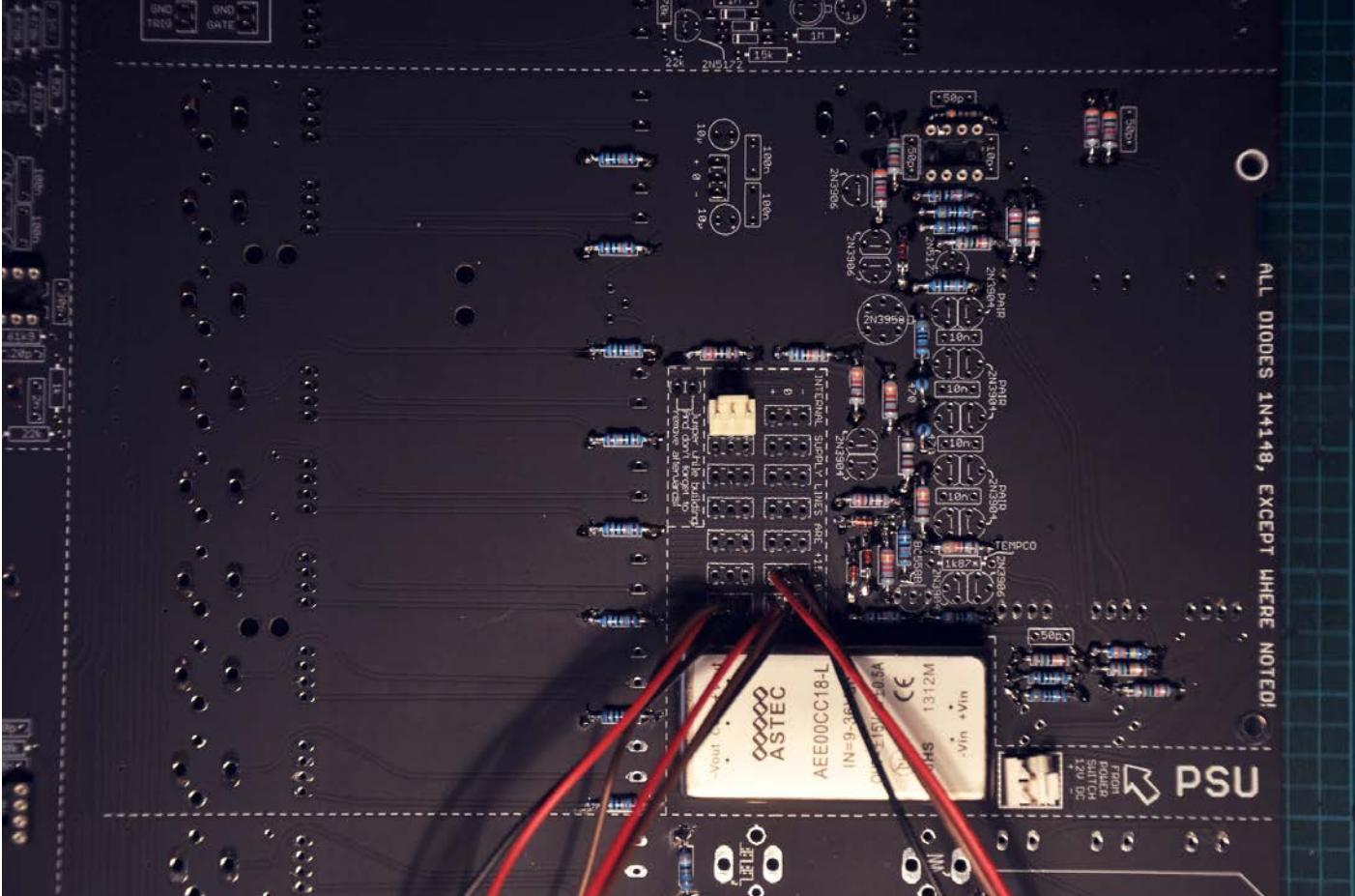
# VCF

## Parts list VCF

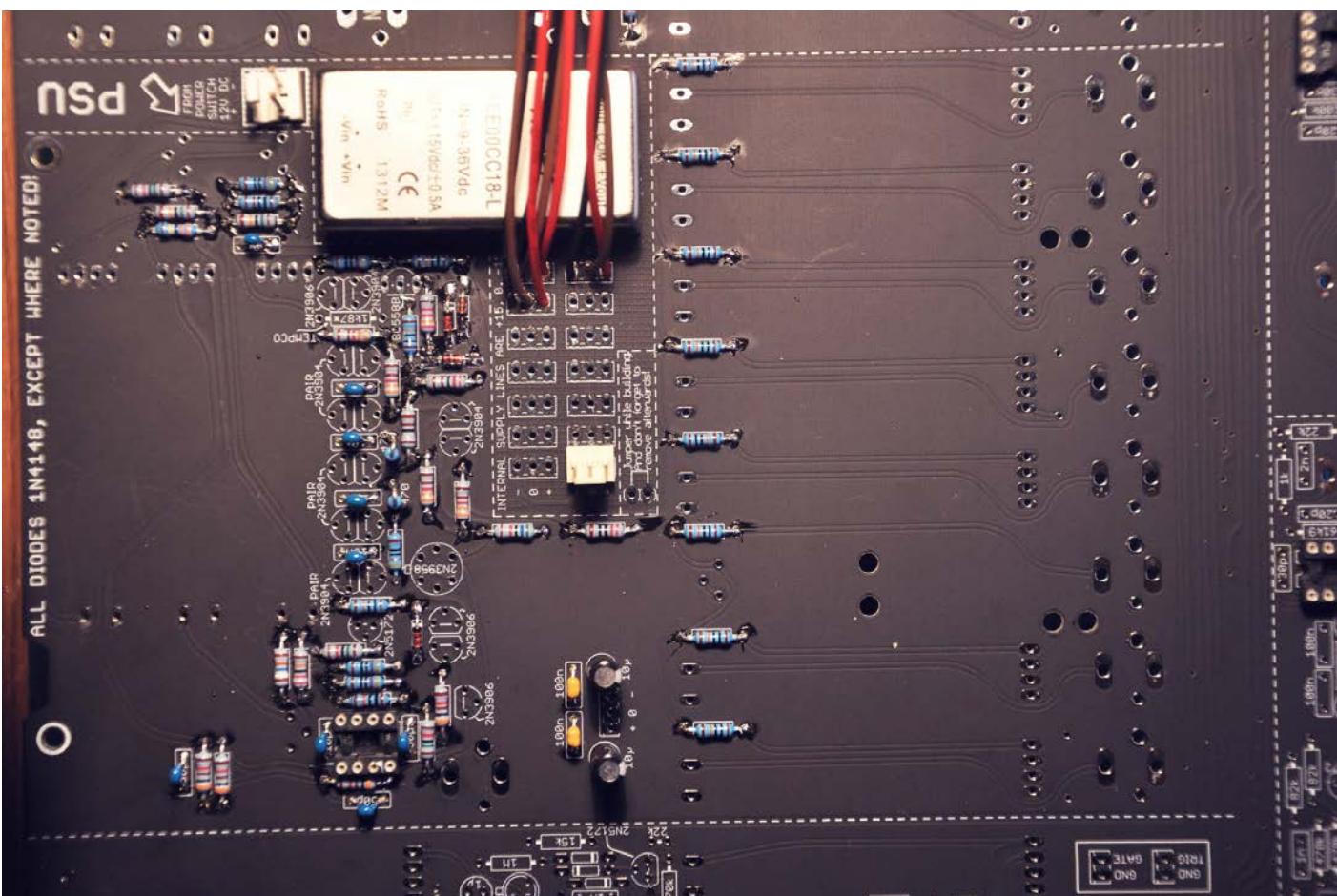
Resistors	Capacitors	Semi's	Trimmers	Other
<ul style="list-style-type: none"> <li>■ 220 x 1</li> <li>■ 470 x 6</li> <li>■ 820 x 1</li> <li>■ 1k x 1</li> <li>■ 1k8 x 1</li> <li>■ 1k87* x 1 (Tempco)</li> <li>■ 2k2 x 1</li> <li>■ 3k32 x 4</li> <li>■ 10k x 1</li> <li>■ 150k x 2</li> <li>■ 15k x 3</li> <li>■ 23k2 x 1</li> <li>■ 30k1 x 4</li> <li>■ 56k x 1</li> <li>■ 100k x 11</li> <li>■ 196k x 1</li> <li>■ 220k x 1</li> <li>■ 3M3 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 10p x 1</li> <li>■ 50p x 4</li> <li>■ 10n x 4</li> <li>■ 100n x 2</li> <li>■ 10μ x 2 (Electrolytic)</li> </ul>	<ul style="list-style-type: none"> <li>■ BC558 x 1</li> <li>■ 1n4148 x 4</li> <li>■ 2n3904 x 13</li> <li>■ 2n3906 x 4</li> <li>■ 2n3958 x 1</li> <li>■ 2n5172 x 1</li> <li>■ LM301 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 250 x 1 (500 if you've ordered from Mouser)</li> <li>■ 10k x 1</li> <li>■ 100k x 2</li> </ul>	<ul style="list-style-type: none"> <li>■ 3 pin MTA header x 1</li> </ul>



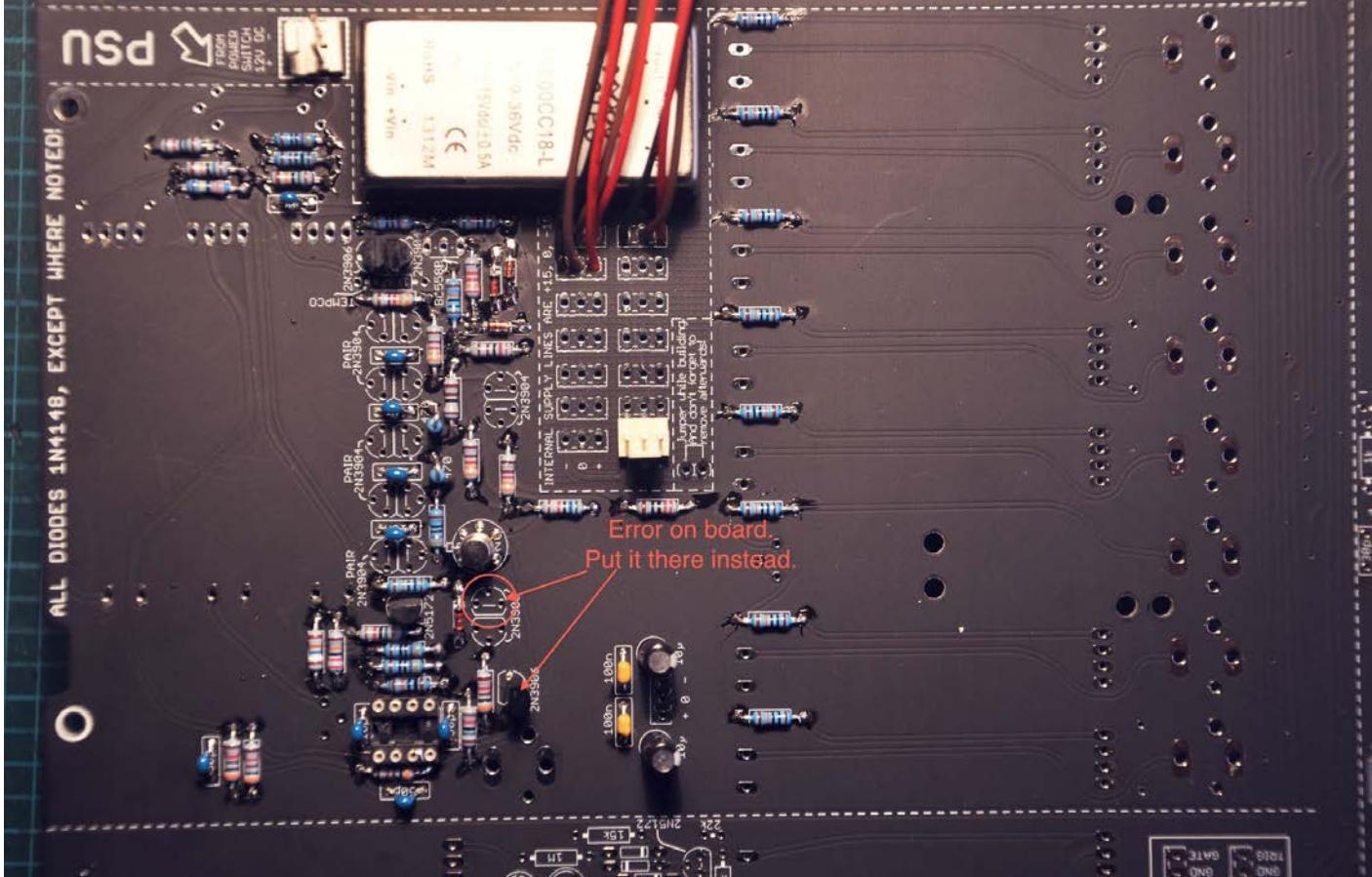
Resistors. There's a ton of 100k in here. So start with those. And wait with the tempco!



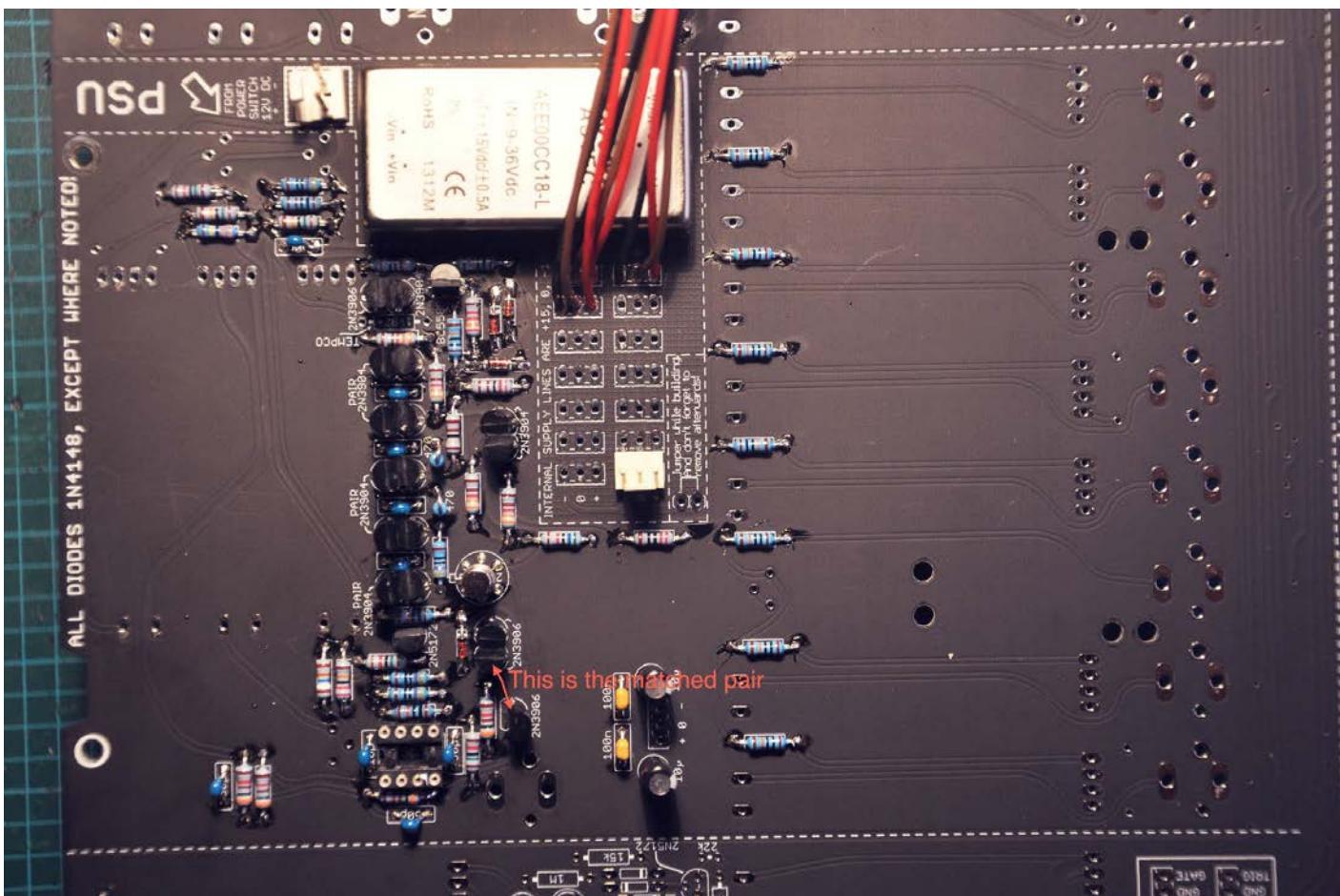
Diodes. The little black line goes towards the white line on the silkscreen.



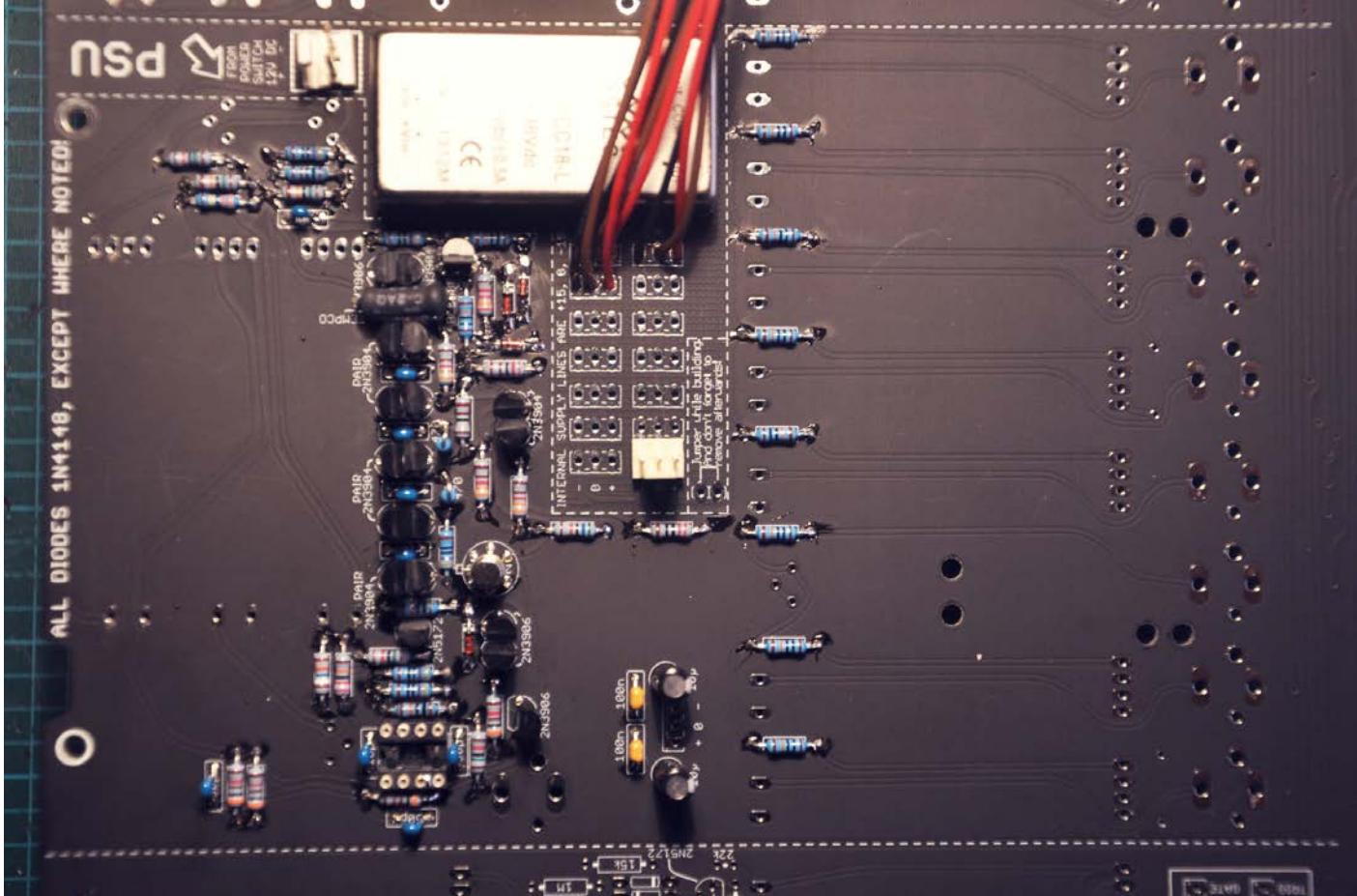
Capacitors.



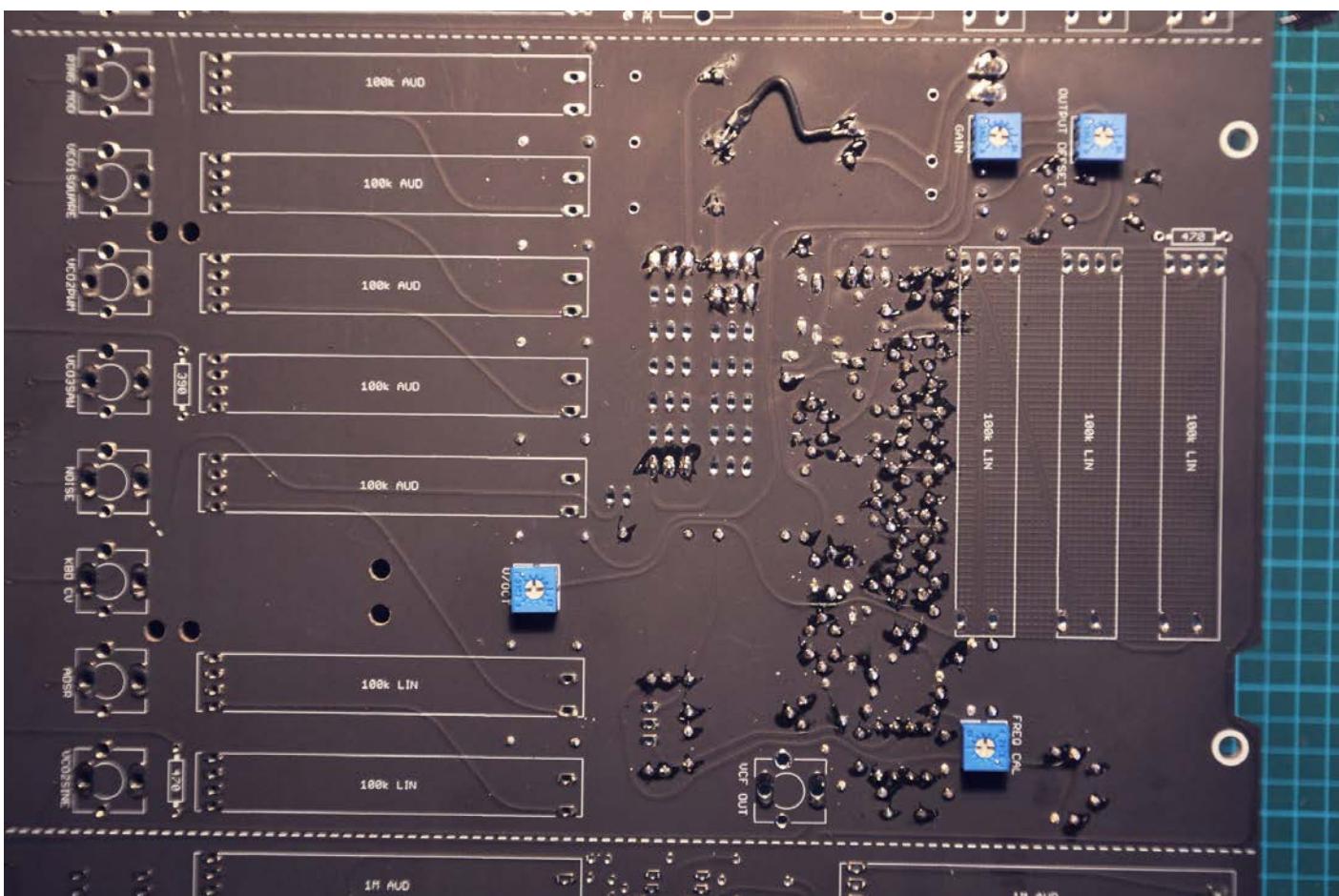
First it's the unmatched transistors. (Note the error, put the transistor where the circle is, not as in the picture!)



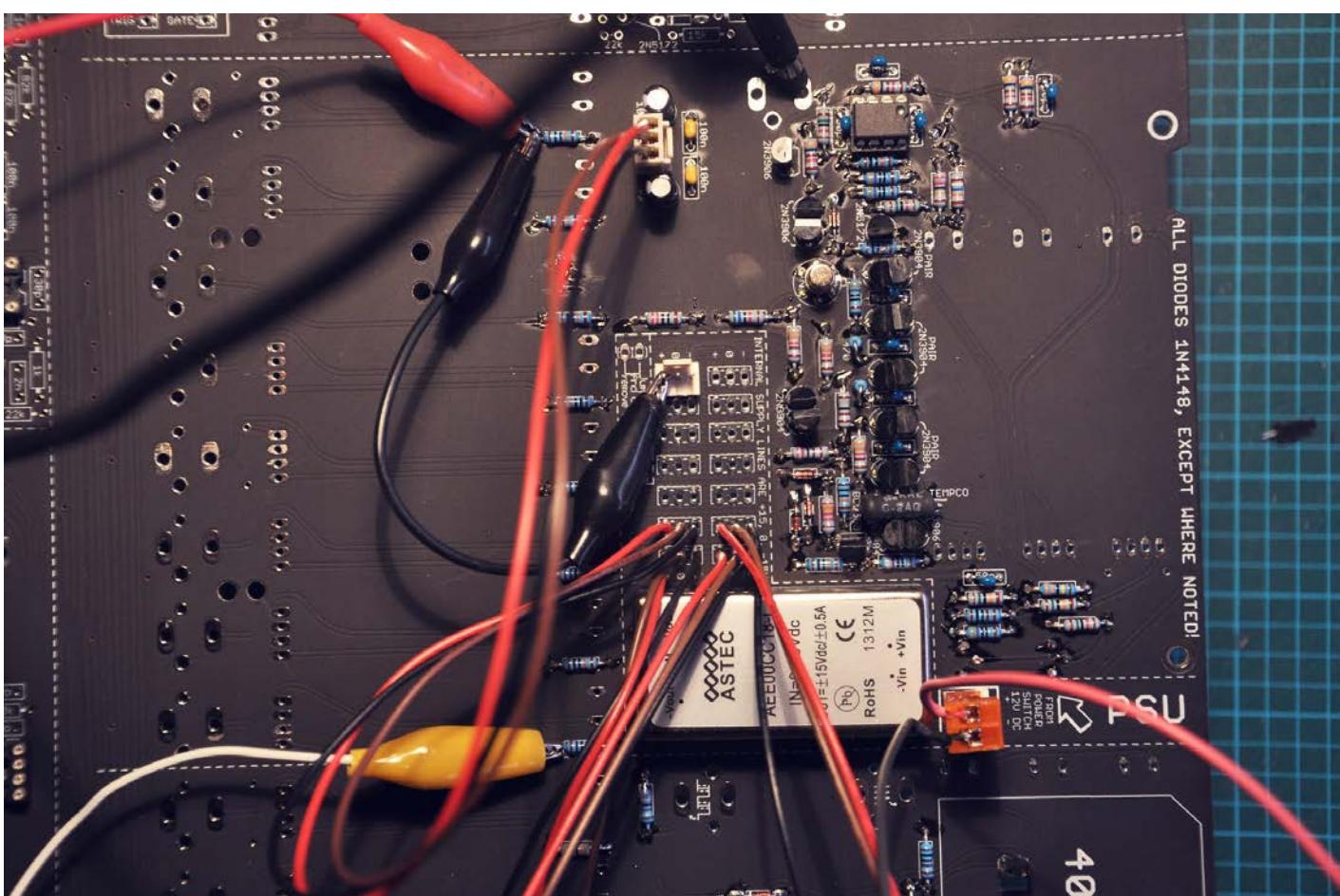
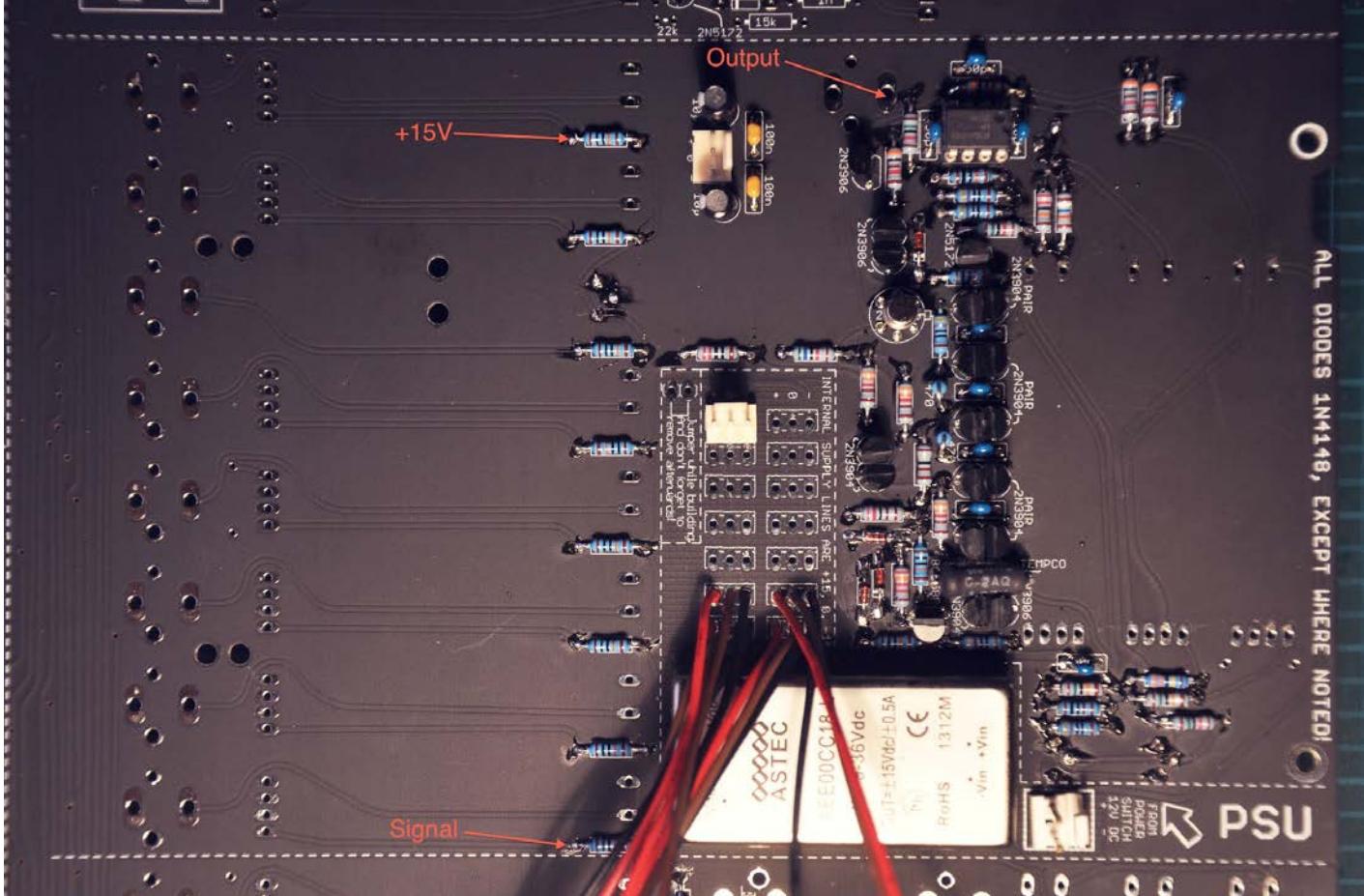
Matched transistors! (Note the error)



Install the big black tempco.



Flip board and install the topside trimmers.



Wire it up and test it! The filter should just pass whatever the incoming signal is in this configuration. E.g. saw in, saw out. It shouldn't filter it.

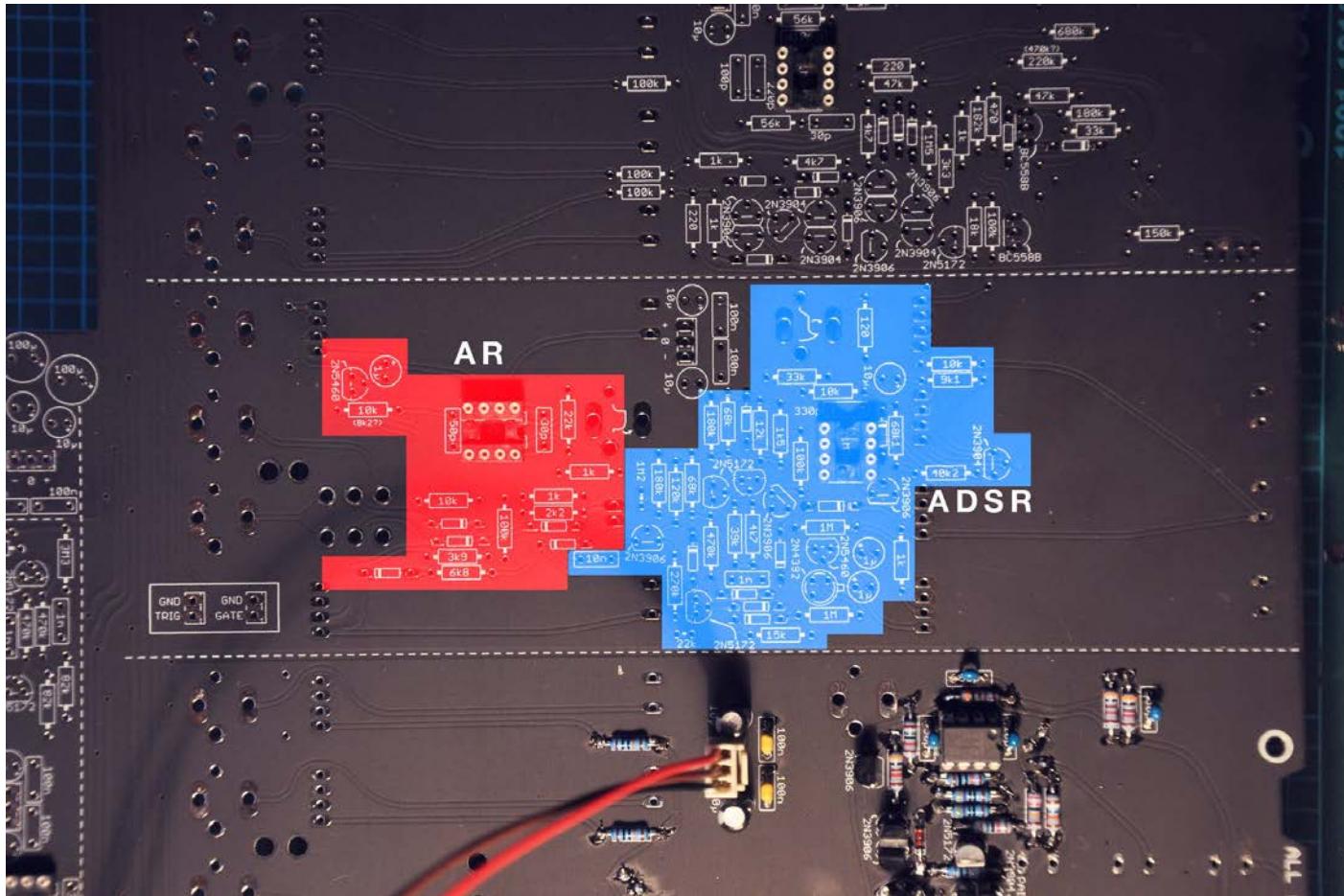
If it works, [head on to the ADSR & AR](#)

# ADSR & AR

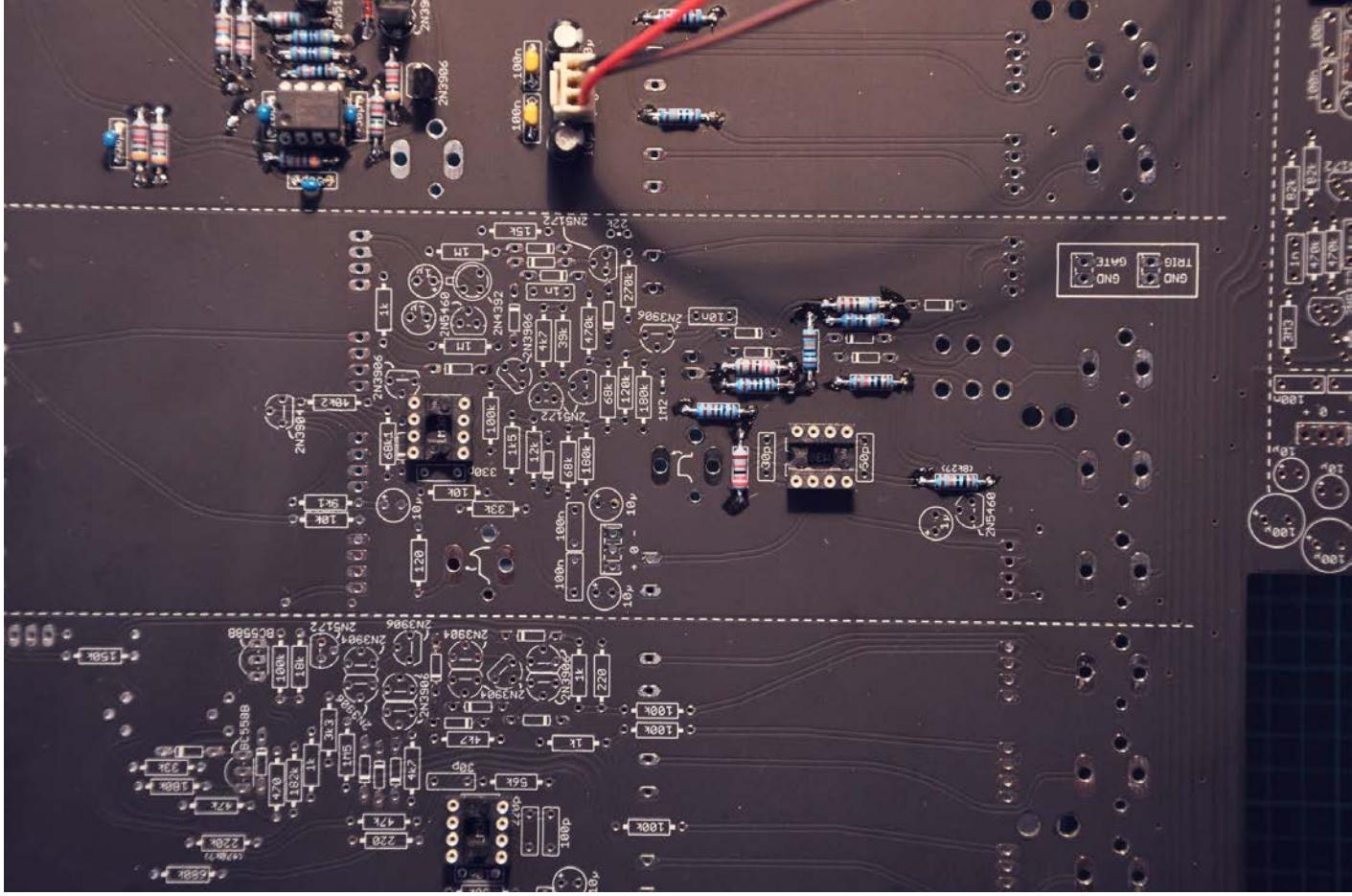
The ADSR & AR is two modules in one.

We'll start with the AR and then move on to the ADSR. This is the first module where you'll have to install the sliders to get it working!

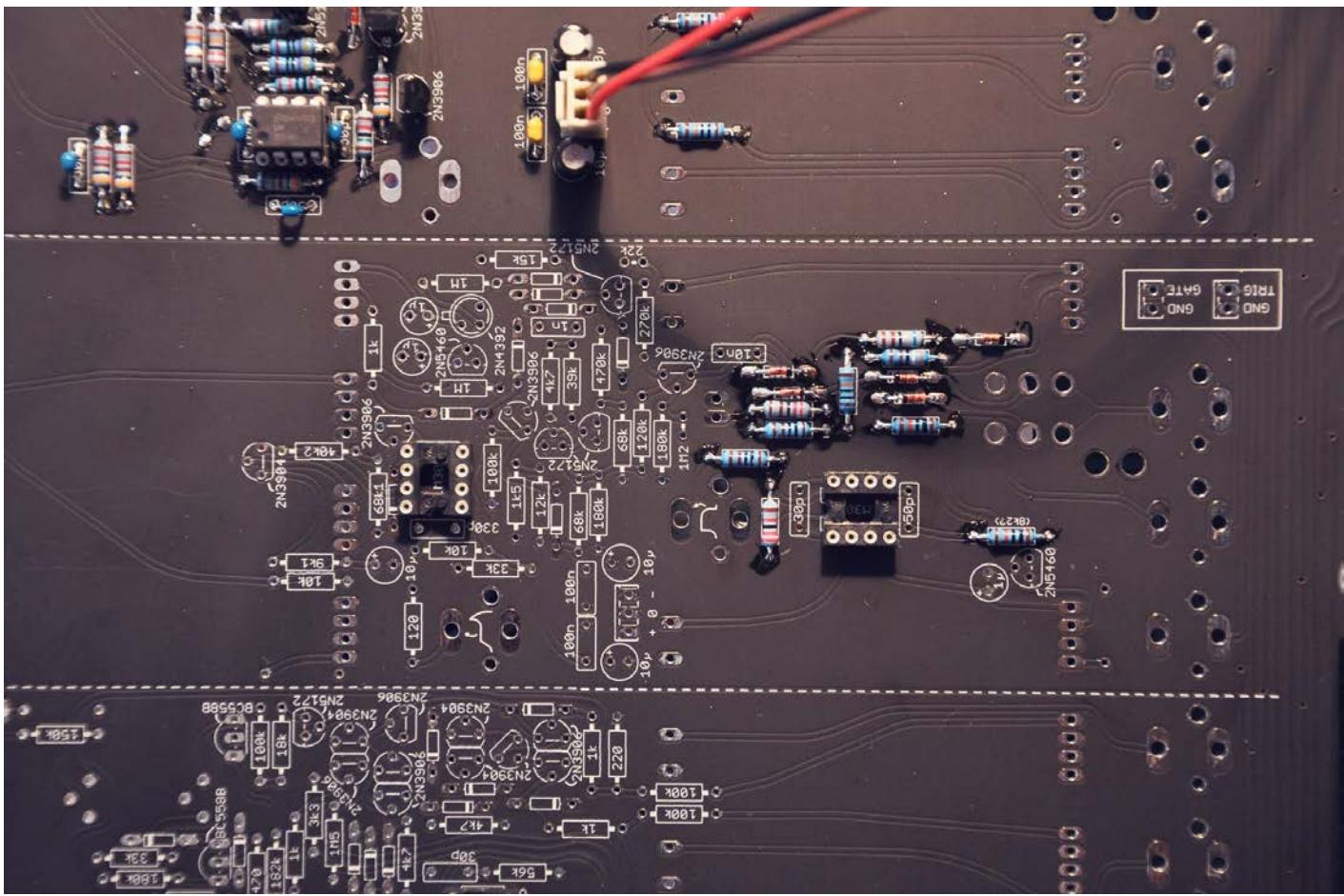
Parts list AR				
Resistors	Capacitors	Semi's	Pots	Other
<ul style="list-style-type: none"><li>■ 1k x 2</li><li>■ 2k2 x 1</li><li>■ 3k9 x 1</li><li>■ 6k8 x 1</li><li>■ 10k x 2</li><li>■ 22k x 1</li></ul>	<ul style="list-style-type: none"><li>■ 30p x 1</li><li>■ 50p x 1</li><li>■ 100n x 2</li><li>■ 1μ x 1 (Electrolytic)</li><li>■ 10μ x 2 (Electrolytic)</li></ul>	<ul style="list-style-type: none"><li>■ 1n4148 x 5</li><li>■ 2n5460 x 1</li><li>■ LM301 x 1</li></ul>	<ul style="list-style-type: none"><li>■ 1M Audio x 2</li></ul>	<ul style="list-style-type: none"><li>■ Push Button x 1</li><li>■ 3 pin MTA header x 1</li></ul>



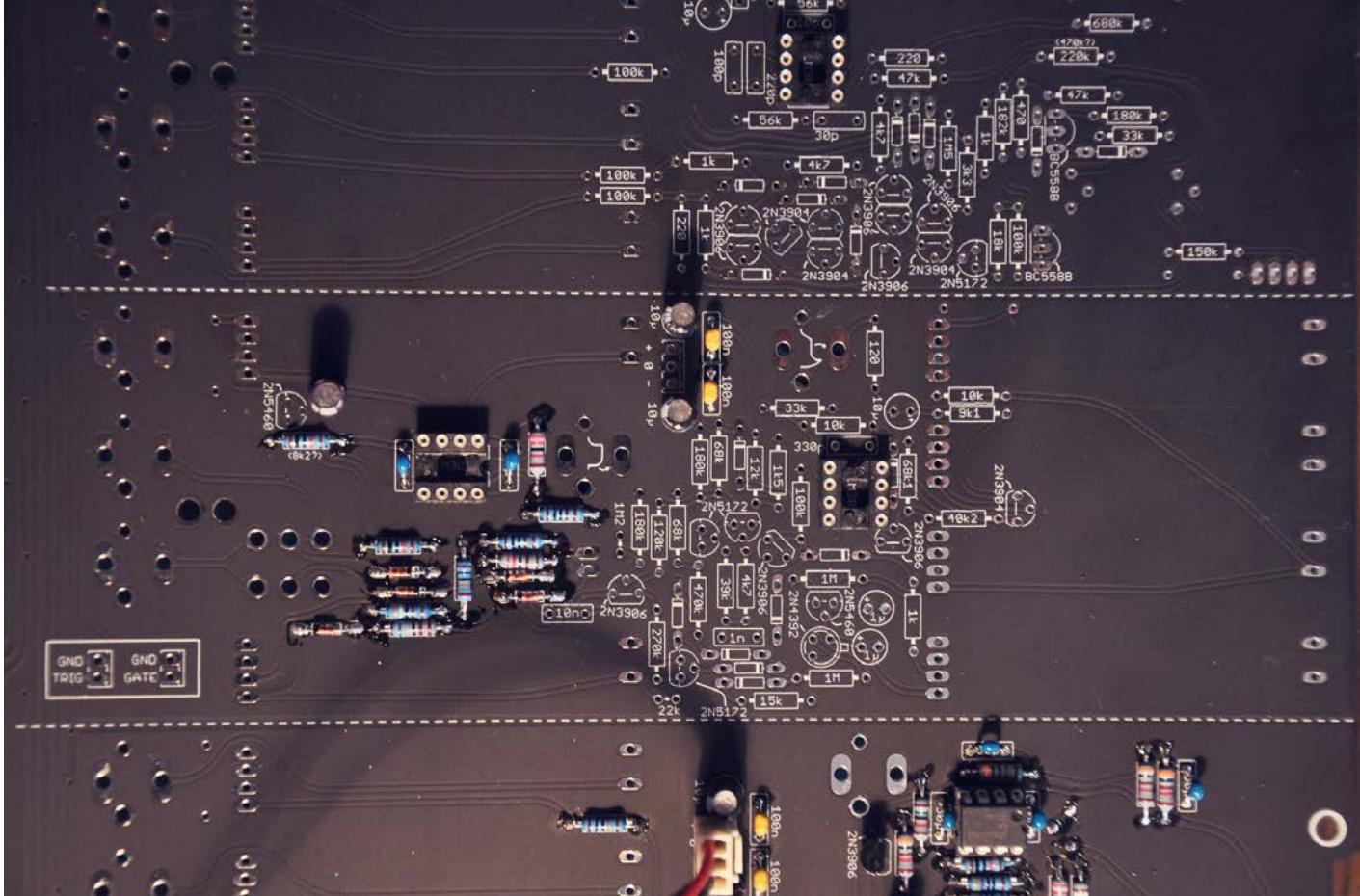
The modules.



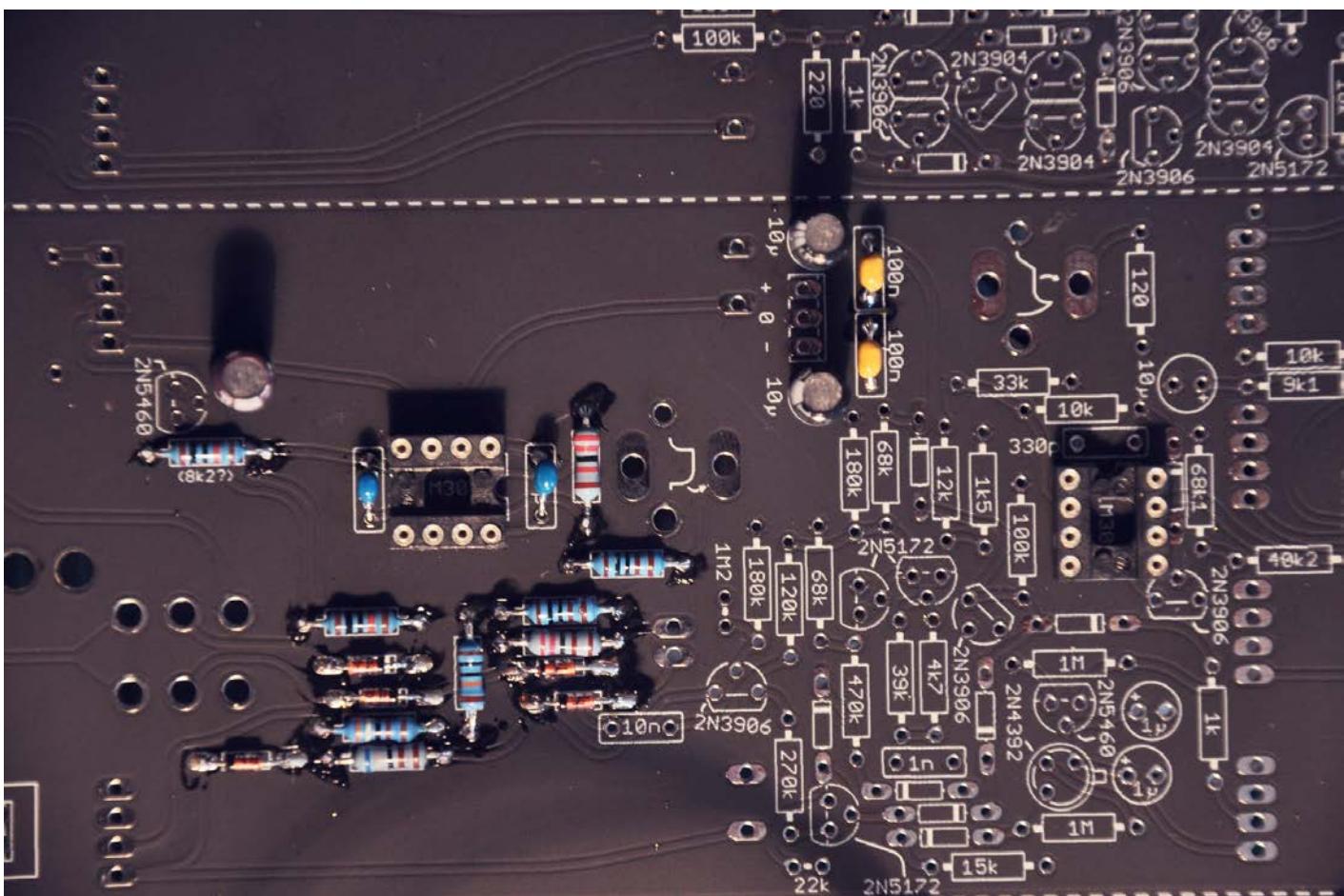
Start with resistors.



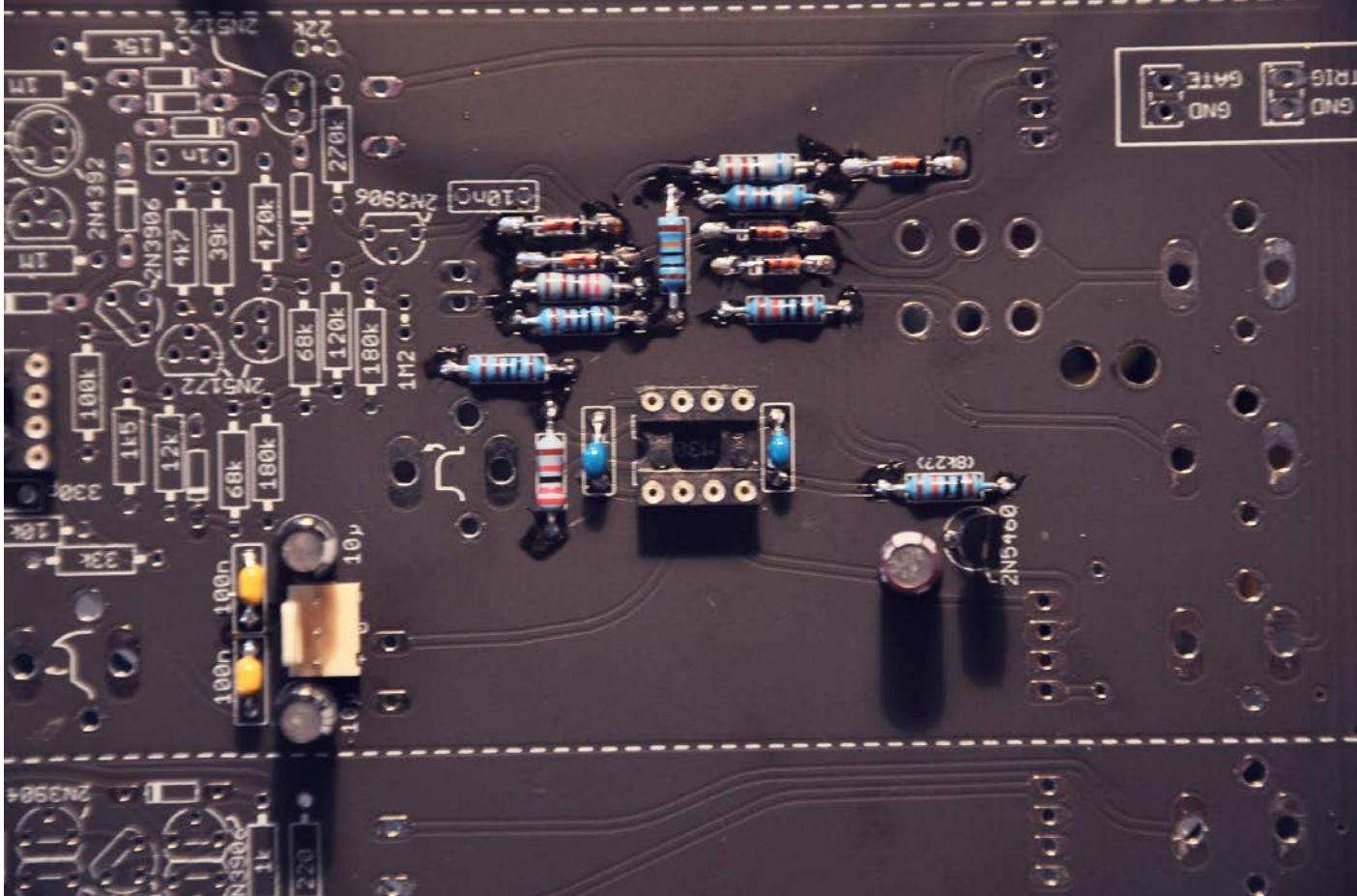
Diodes. Remember to put them in the right way!



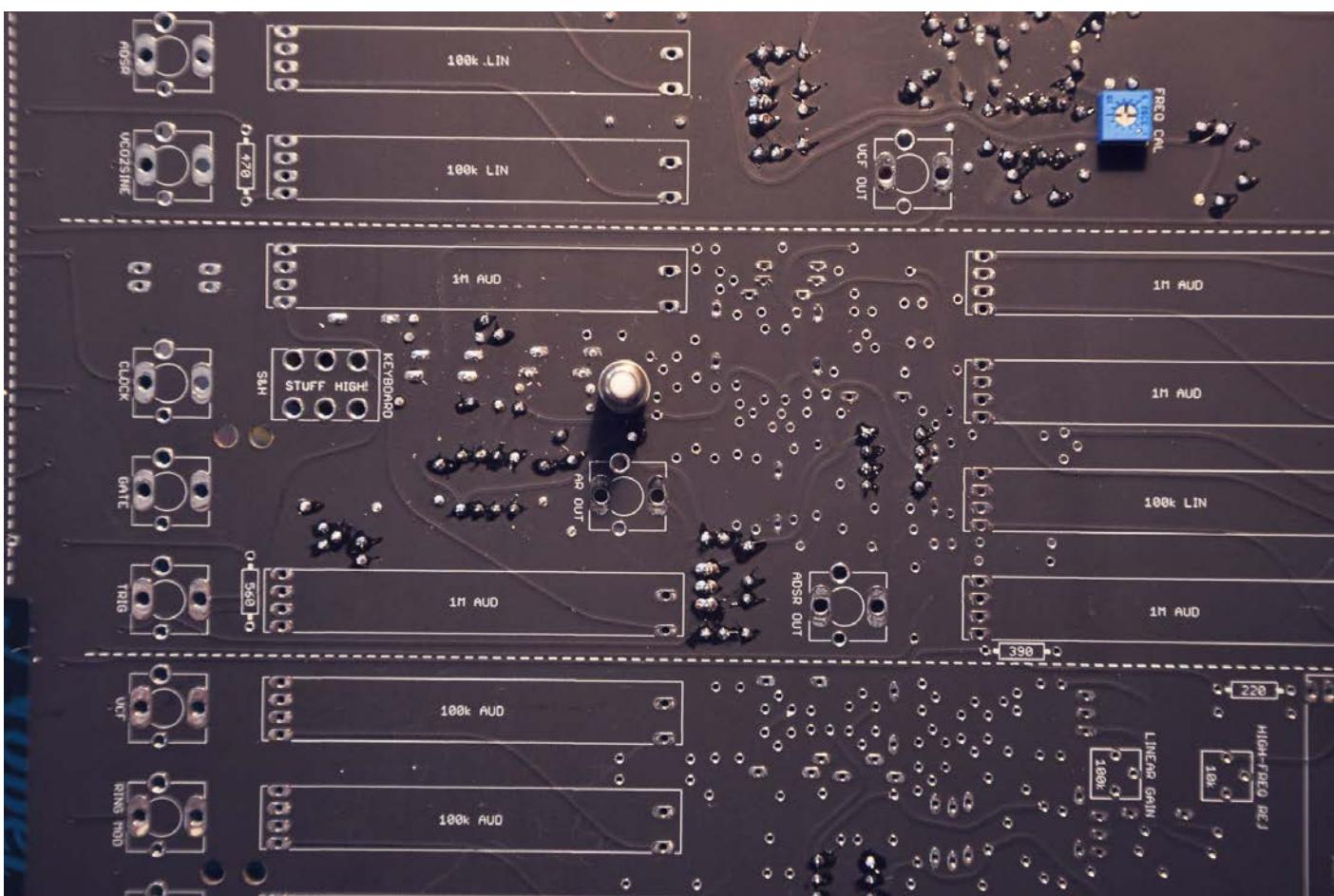
Capacitors. Again, polarity, polarity and polarity!



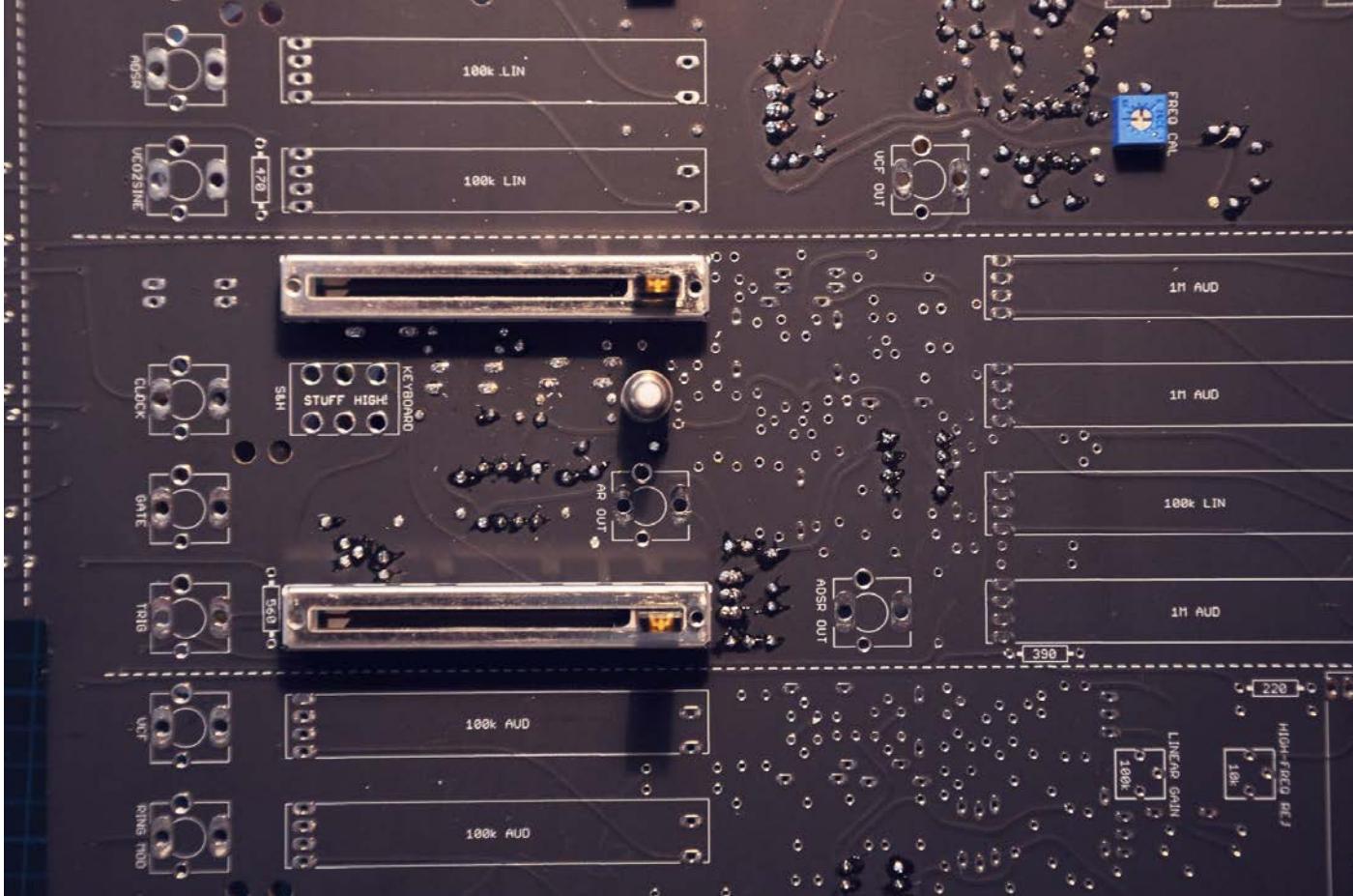
Close up.



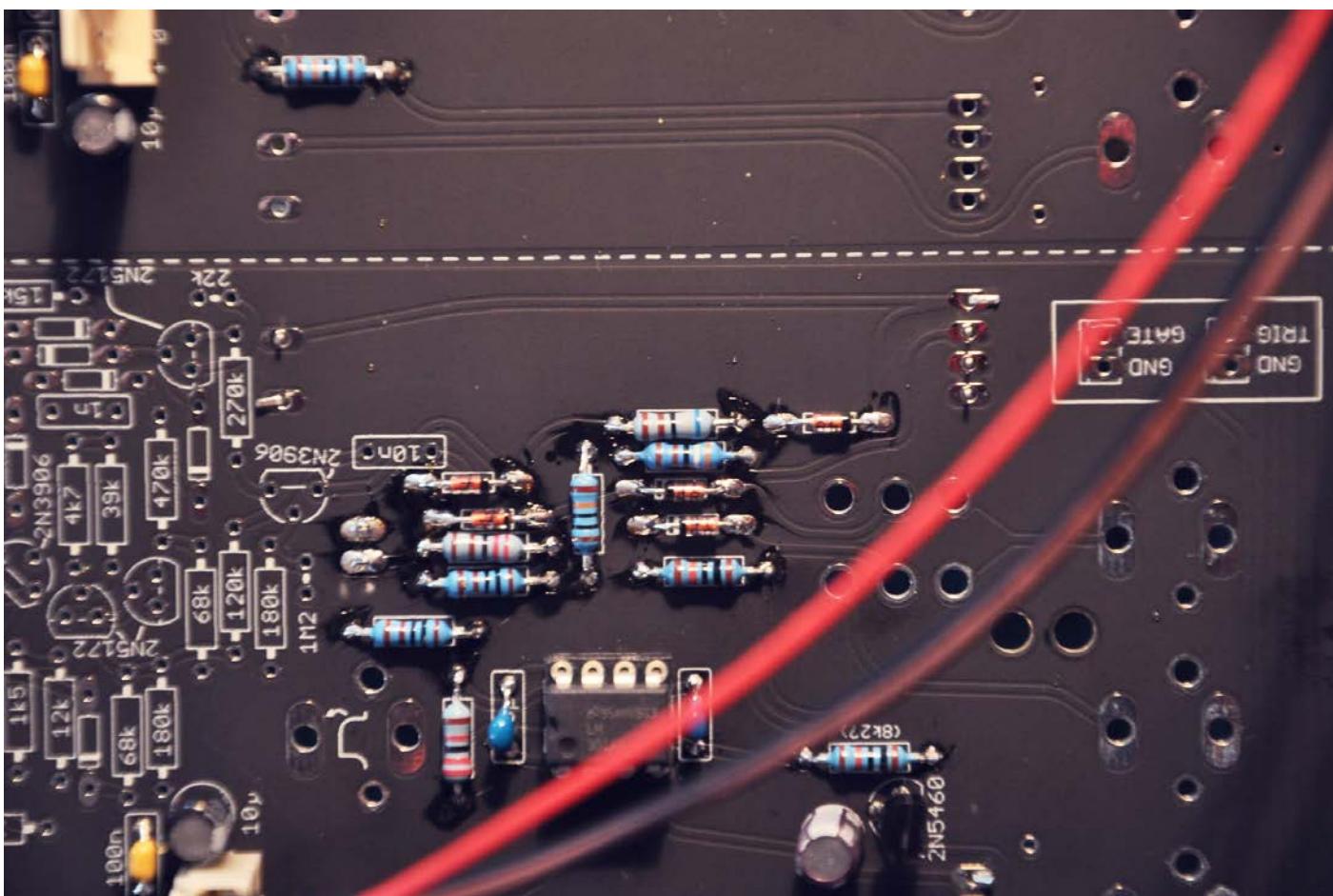
And the 2n5460 FET.



Install the push button. You don't have to mount the panel to get it straight, it should be pretty easy to get it standing anyway.



Install the 2 sliders.

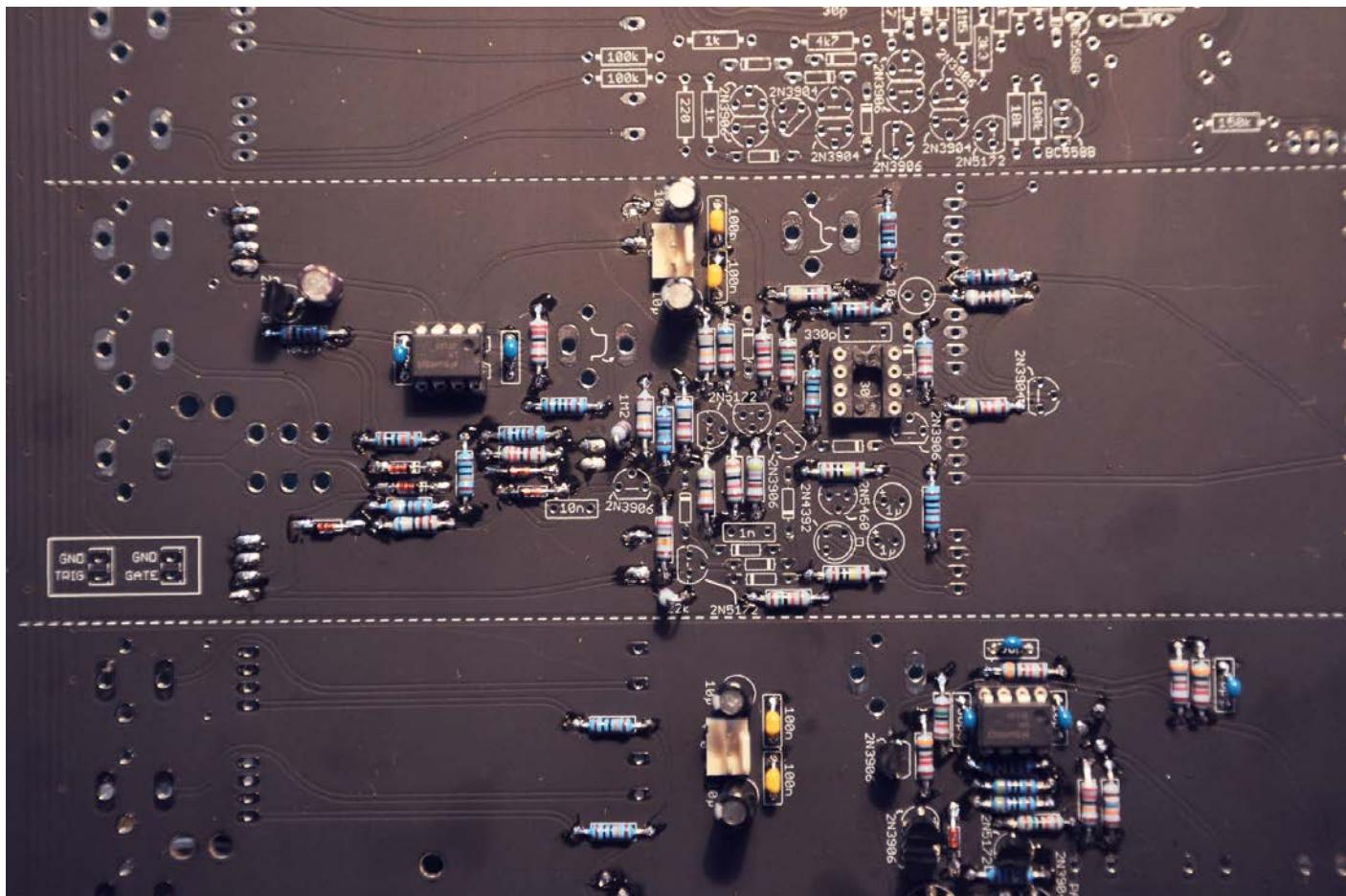


Bend the pins on the sliders to get them to stay in place! Then solder them in. You can apply some pressure to the slider while soldering, to make sure it's flush against the board.

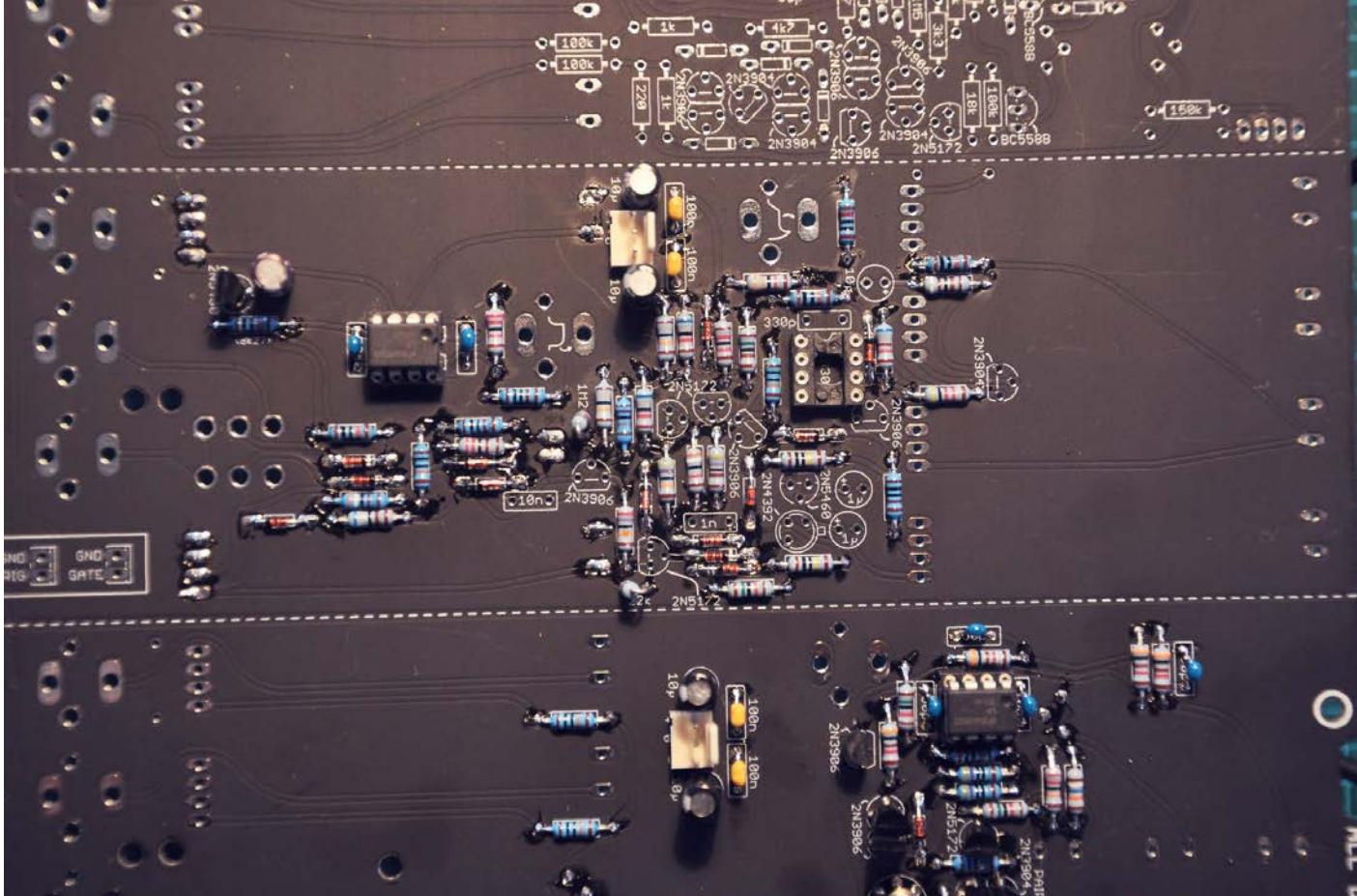
**Next up is the ADSR.**

## Parts list ADSR

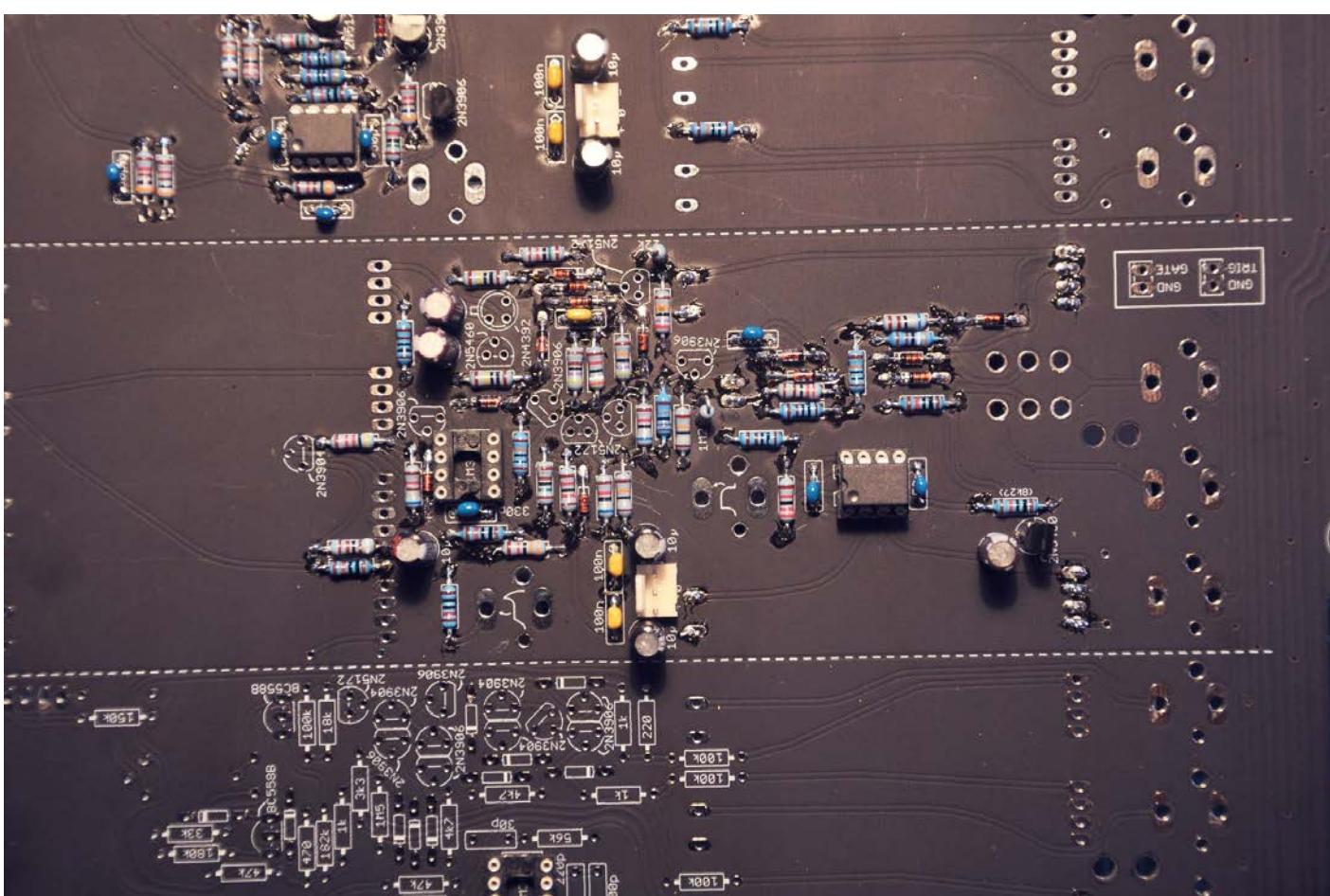
Resistors	Capacitors	Semi's	Pots	Other
<ul style="list-style-type: none"> <li>■ 120 x 1</li> <li>■ 1k x 1</li> <li>■ 1k5 x 1</li> <li>■ 4k7 x 1</li> <li>■ 9k1 x 1</li> <li>■ 10k x 2</li> <li>■ 12k x 1</li> <li>■ 15k x 1</li> <li>■ 22k x 1</li> <li>■ 33k x 1</li> <li>■ 39k x 1</li> <li>■ 40k2 x 1</li> <li>■ 68k x 2</li> <li>■ 68k1 x 1</li> <li>■ 100k x 2</li> <li>■ 120k x 1</li> <li>■ 180k x 2</li> <li>■ 270k x 1</li> <li>■ 470k x 1</li> <li>■ 1M x 2</li> <li>■ 1M2 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 330p x 1</li> <li>■ 1n x 1</li> <li>■ 10n x 1</li> <li>■ 1μ x 2 (Electrolytic)</li> <li>■ 10μ x 1 (Electrolytic)</li> </ul>	<ul style="list-style-type: none"> <li>■ 1N4148 x 8</li> <li>■ 2N3904 x 1</li> <li>■ 2N3906 x 3</li> <li>■ 2N4392 x 1</li> <li>■ 2N5172 x 3</li> <li>■ 2N5460 x 1</li> <li>■ LM301 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 1M Audio x 3</li> <li>■ 100k Linear x 1</li> </ul>	



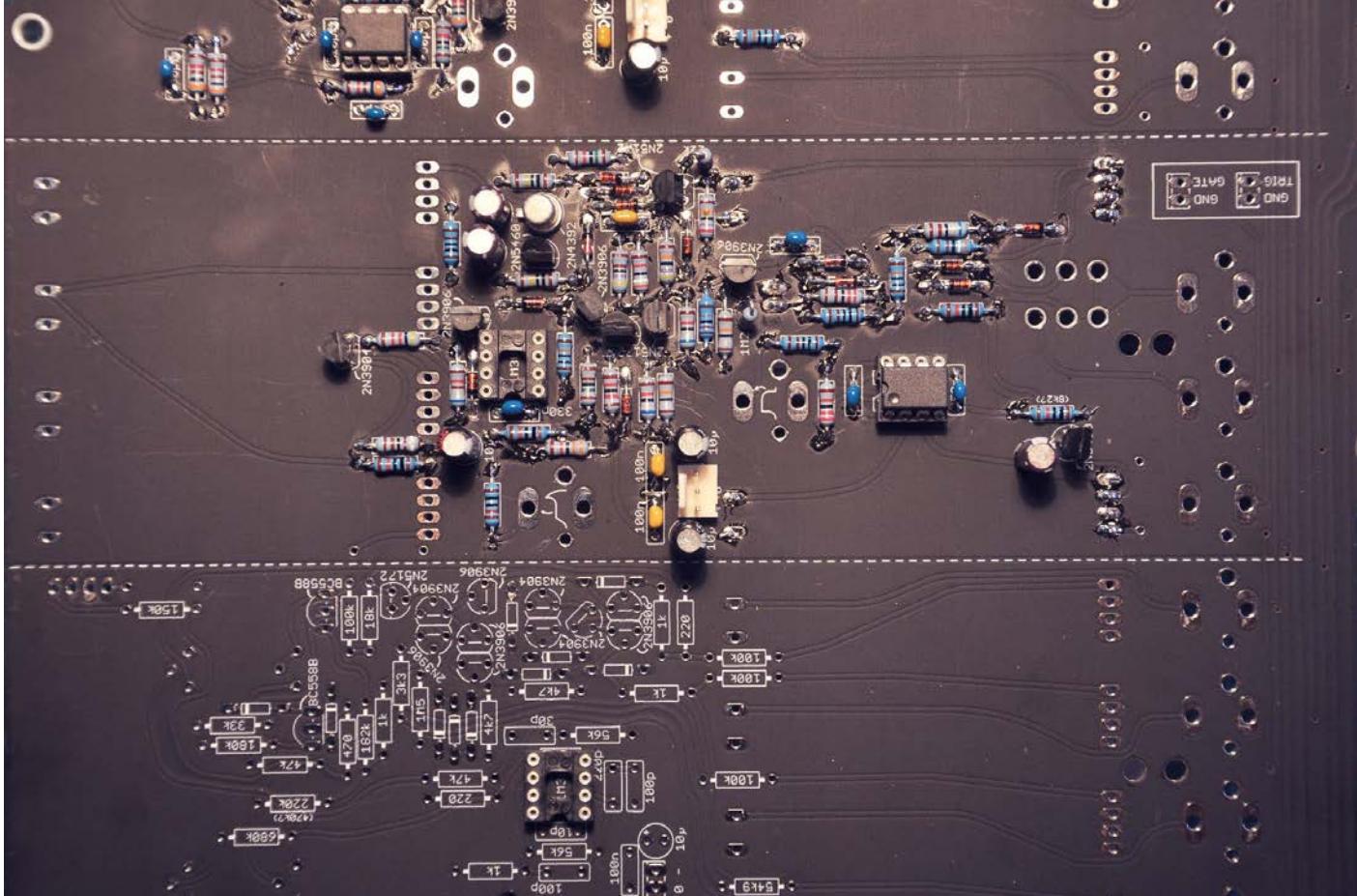
Start with resistors



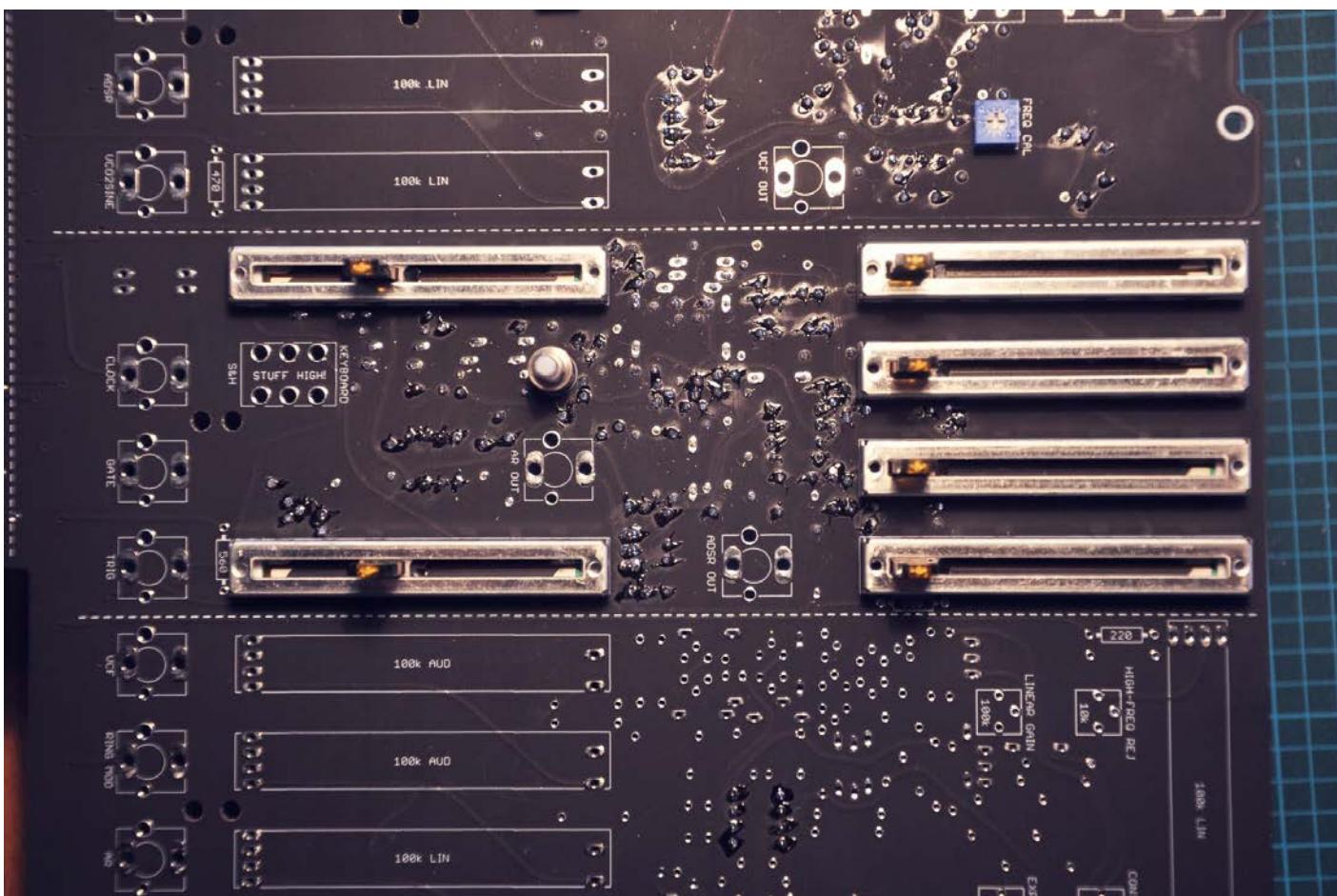
Next up diodes. Check orientation as usual.



Caps. Long leg in plus hole when installing electrolytes.



Transistors!



Flip the board and install the 4 sliders.

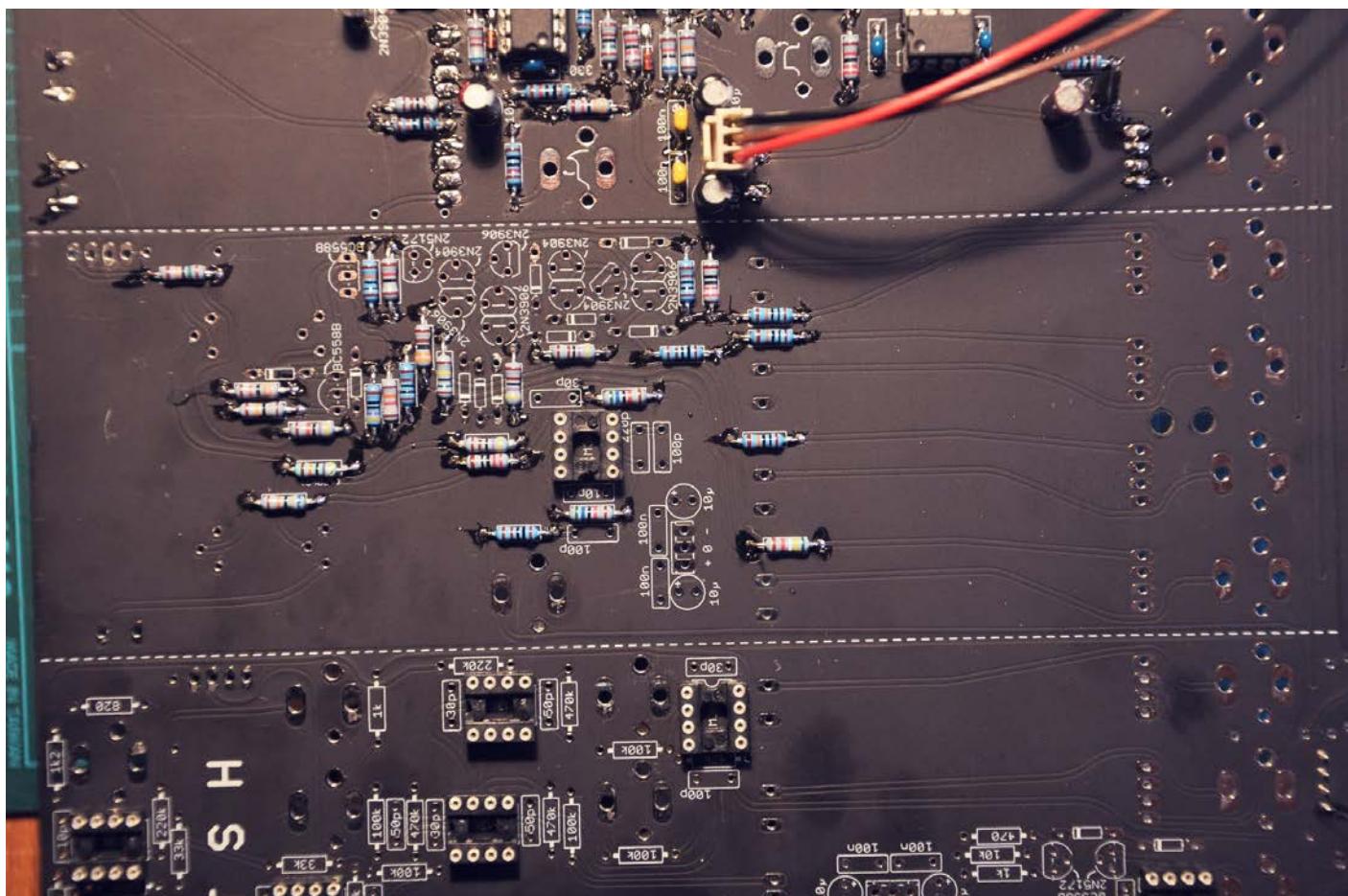
Testing -

Apply power and push the button. This should trigger both modules. Check respective output for signal

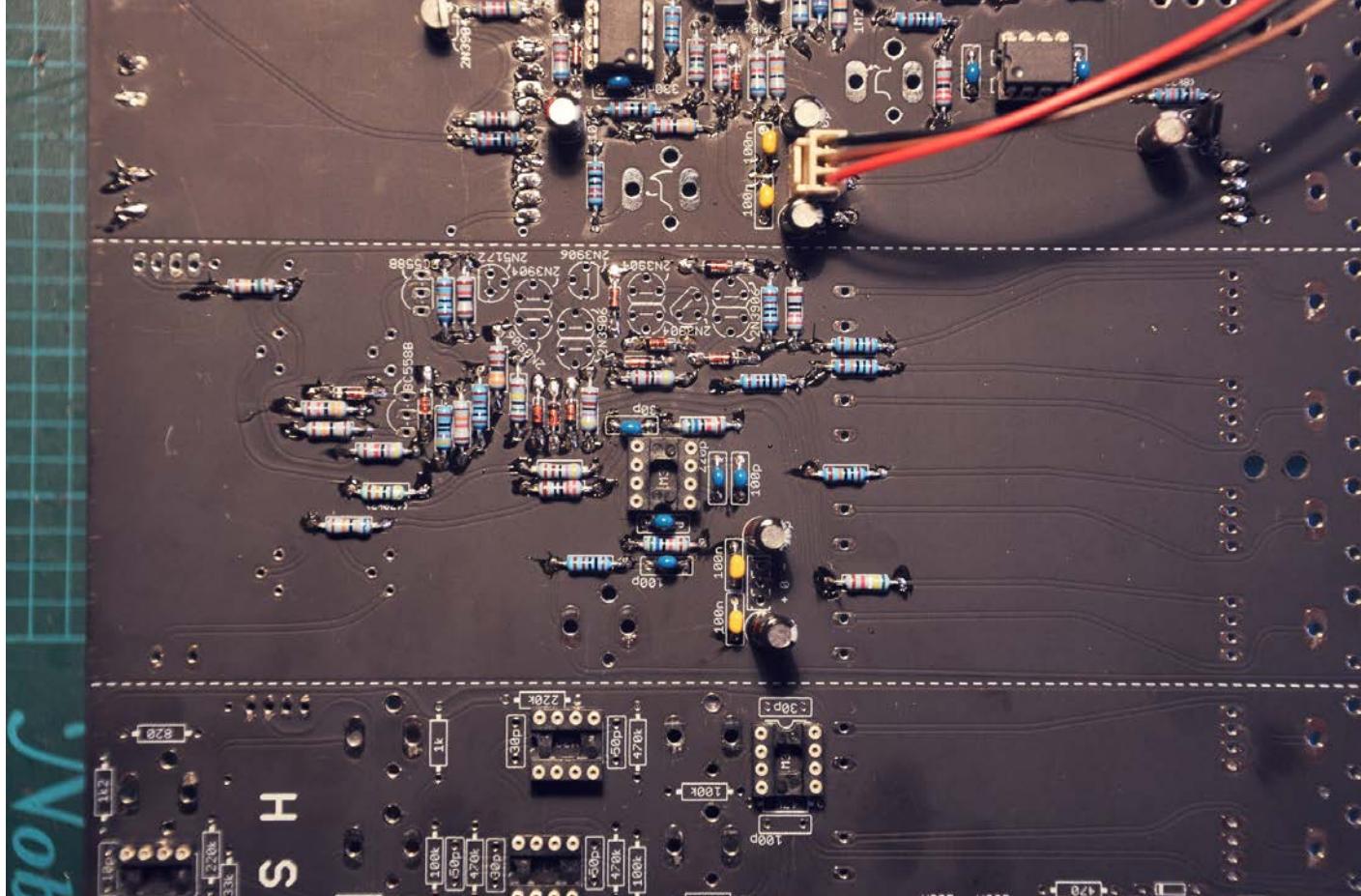
# VCA

Parts list VCA

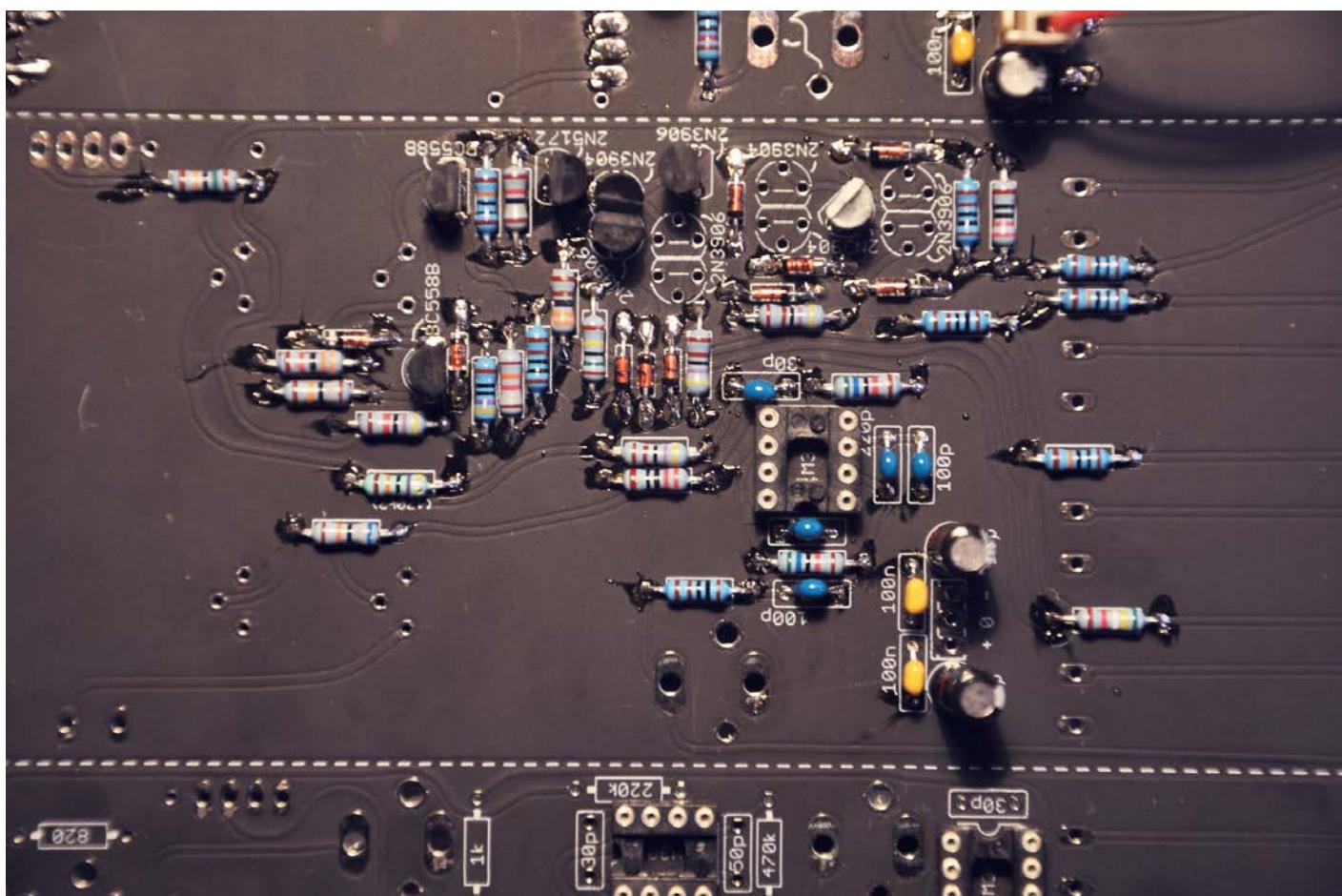
Resistors	Capacitors	Semi's	Trimmers	Other
<ul style="list-style-type: none"> <li>■ 220 x 2</li> <li>■ 470 x 1</li> <li>■ 1k x 4</li> <li>■ 3k3 x 1</li> <li>■ 4k7 x 3</li> <li>■ 18k x 1</li> <li>■ 33k x 1</li> <li>■ 47k x 1</li> <li>■ 54k9 x 1</li> <li>■ 56k x 2</li> <li>■ 100k x 4</li> <li>■ 150k x 1</li> <li>■ 180k x 1</li> <li>■ 182k x 1</li> <li>■ 220k x 1</li> <li>■ 680k x 1</li> <li>■ 1M5 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 100n x 2</li> <li>■ 100p x 2</li> <li>■ 10p x 1</li> <li>■ 10<math>\mu</math> x 2 (Electrolytic)</li> <li>■ 220p x 1</li> <li>■ 30p x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ BC558 x 3</li> <li>■ LM301 x 1</li> <li>■ 1N4148 x 10</li> <li>■ 2N3904 x 4</li> <li>■ 2N3906 x 5</li> <li>■ 2N5172 x 1</li> </ul>	<ul style="list-style-type: none"> <li>■ 100K x 3</li> <li>■ 10K x 2 (Zthee forgot to list these)</li> </ul>	<ul style="list-style-type: none"> <li>■ 3 pin MTA header x 1</li> </ul>



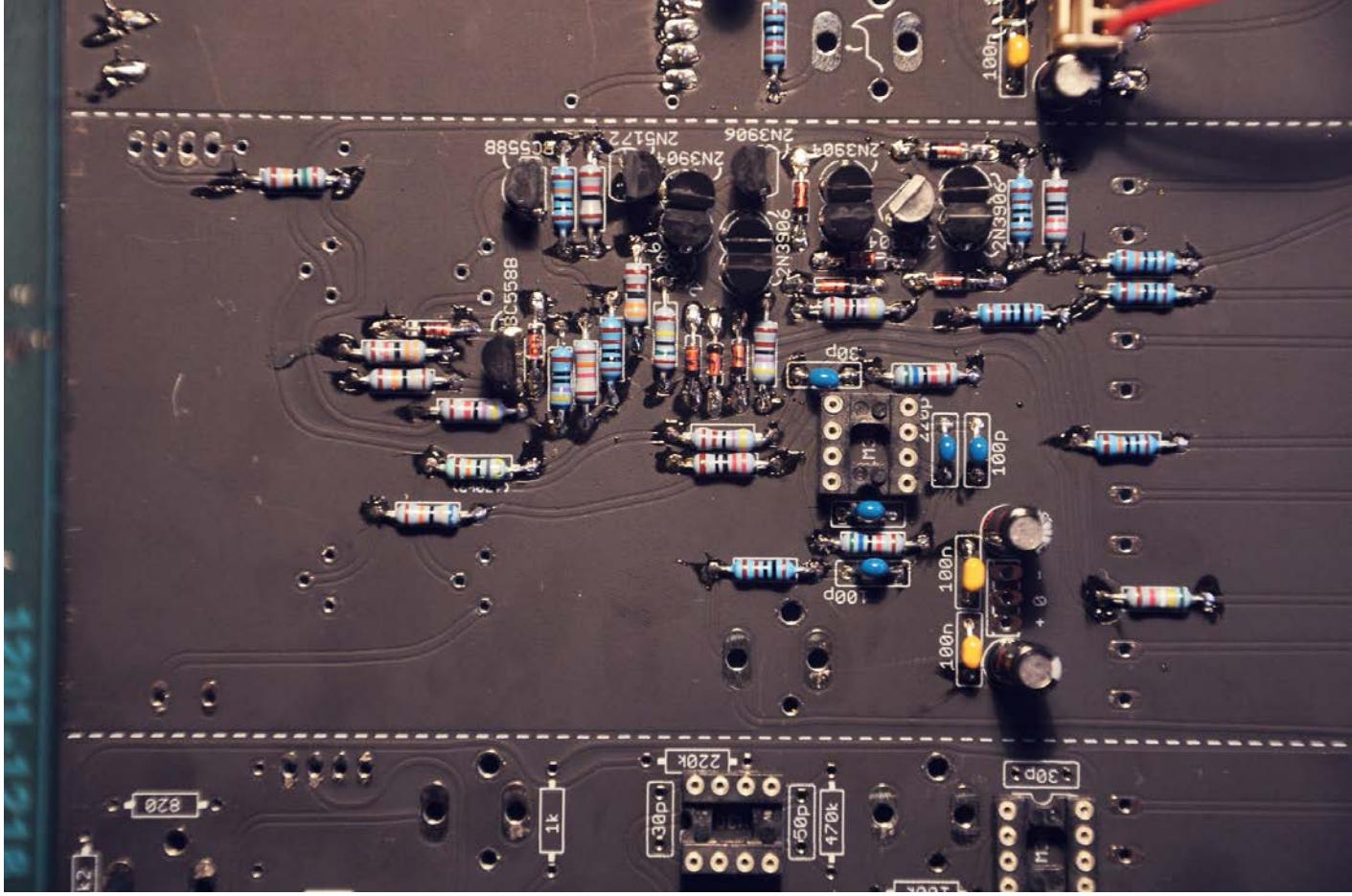
R-e-s-i-s-t-o-r-s!



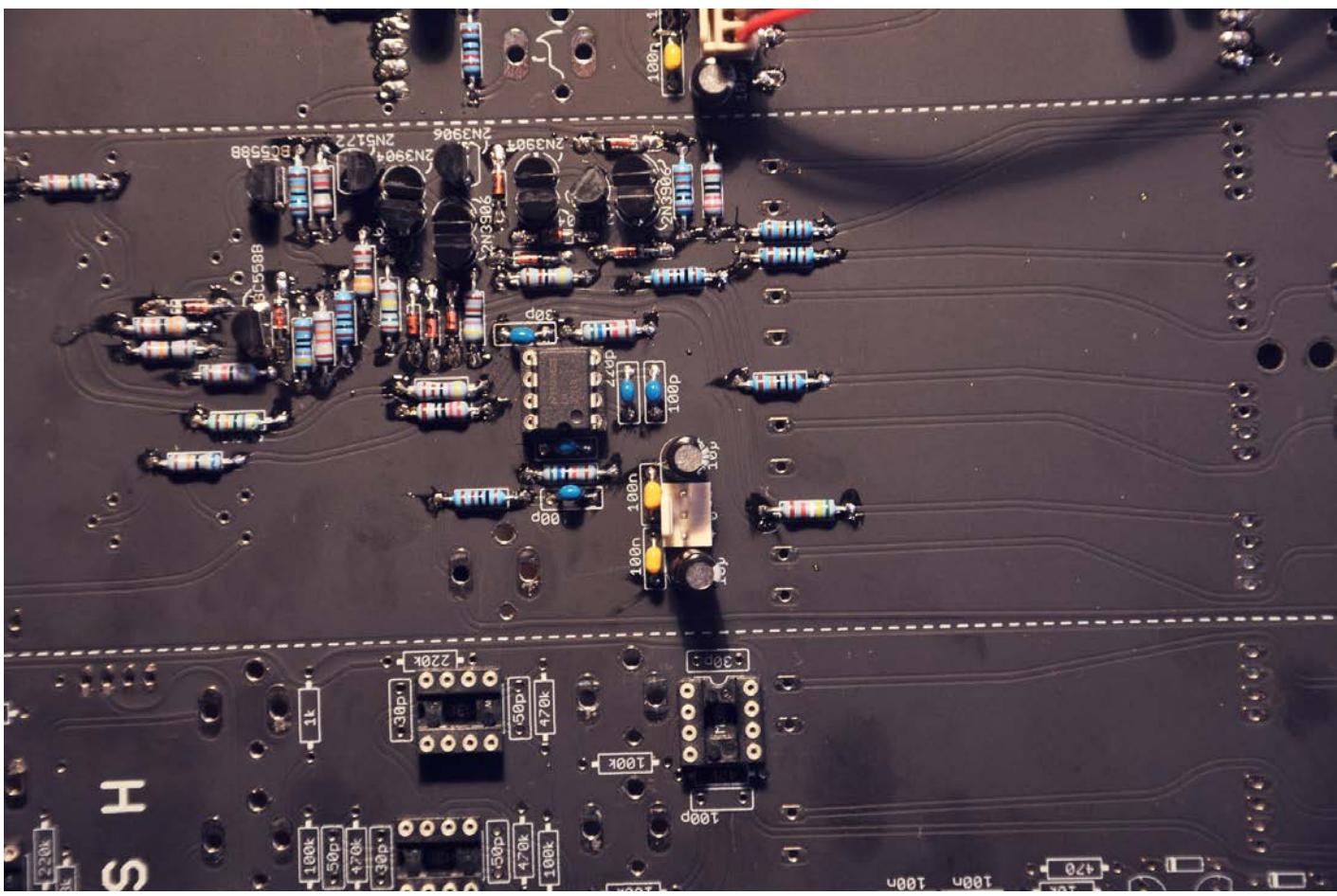
Diodes and capacitors.



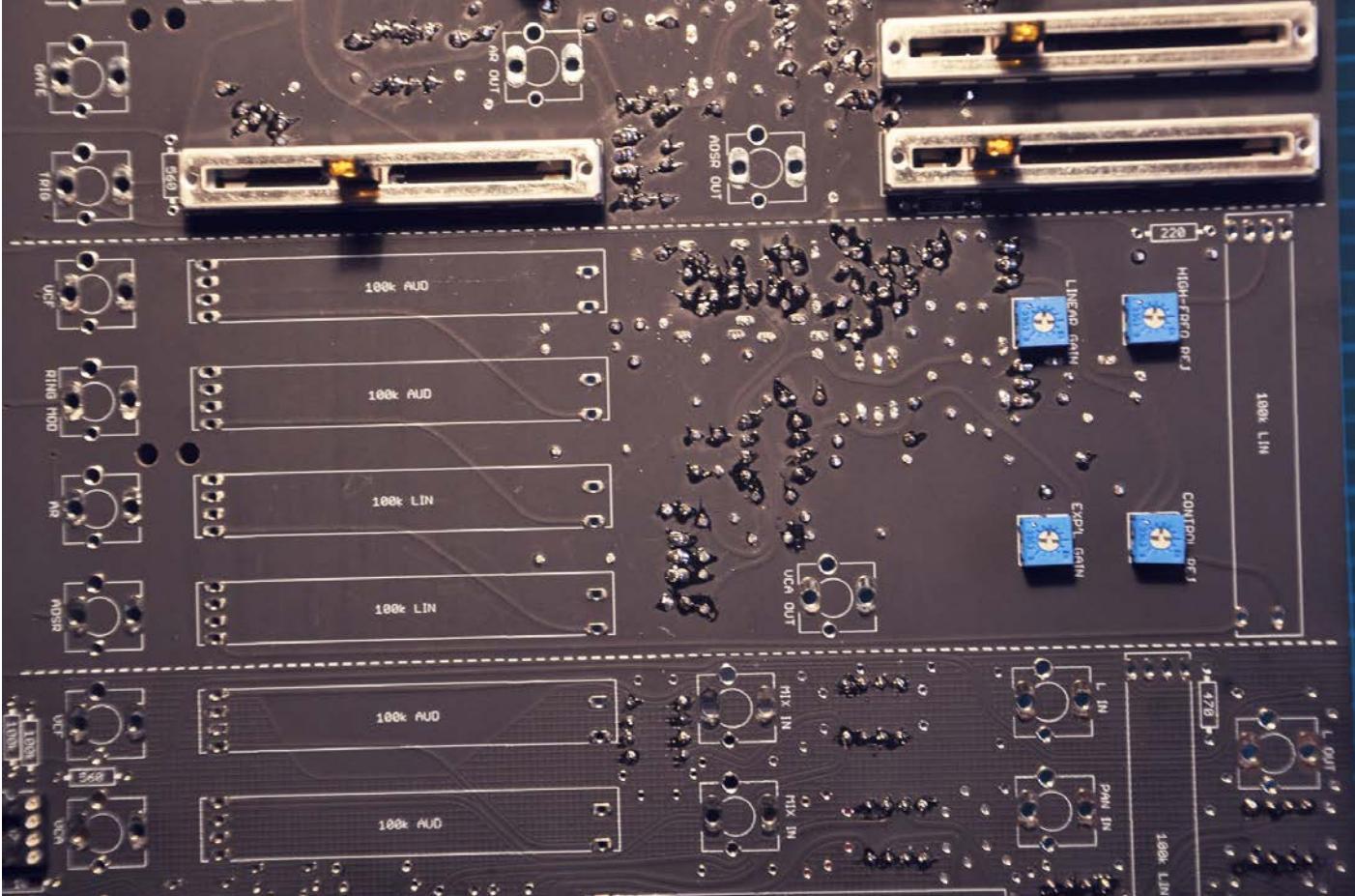
Regular trannies.



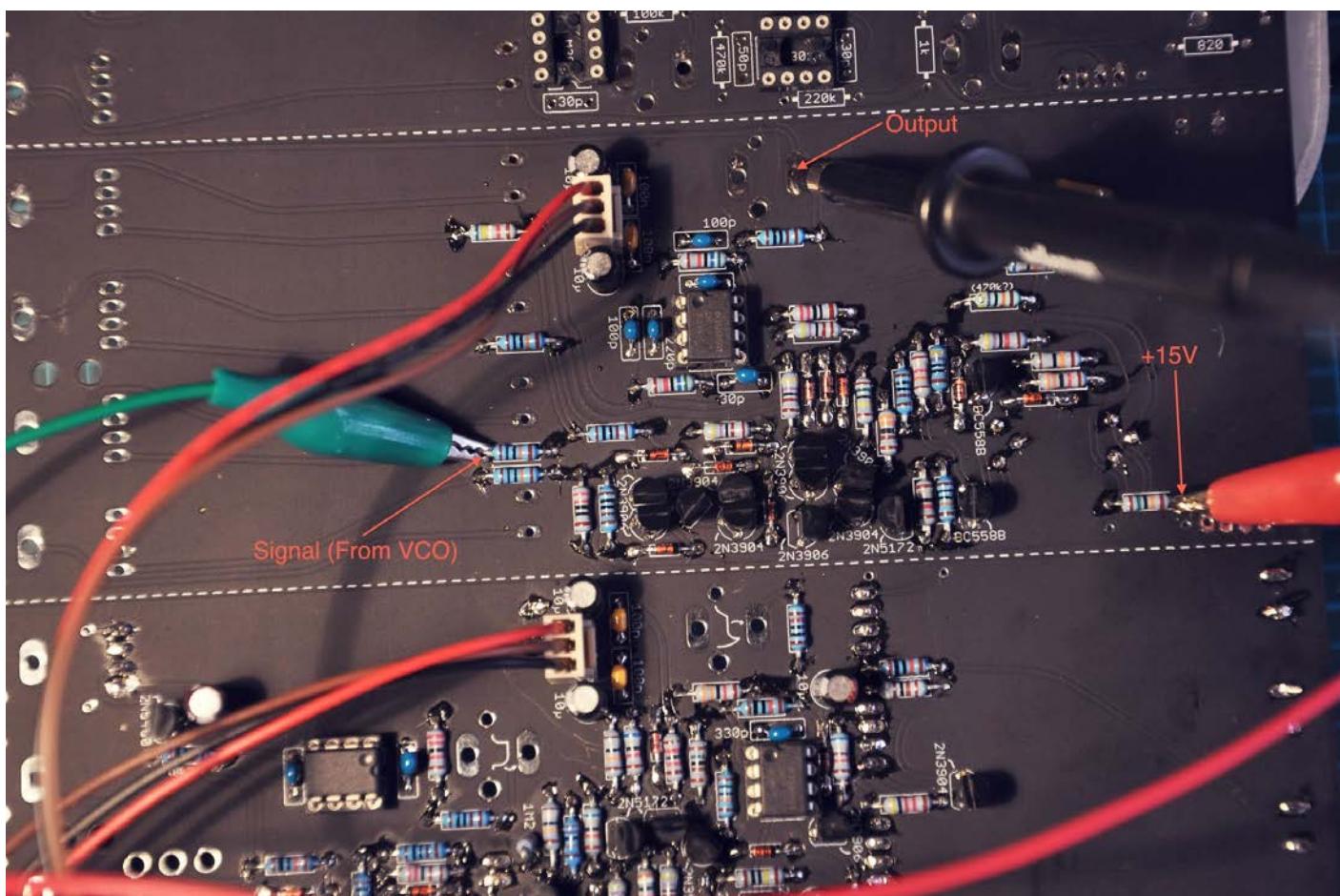
Matched trannies.



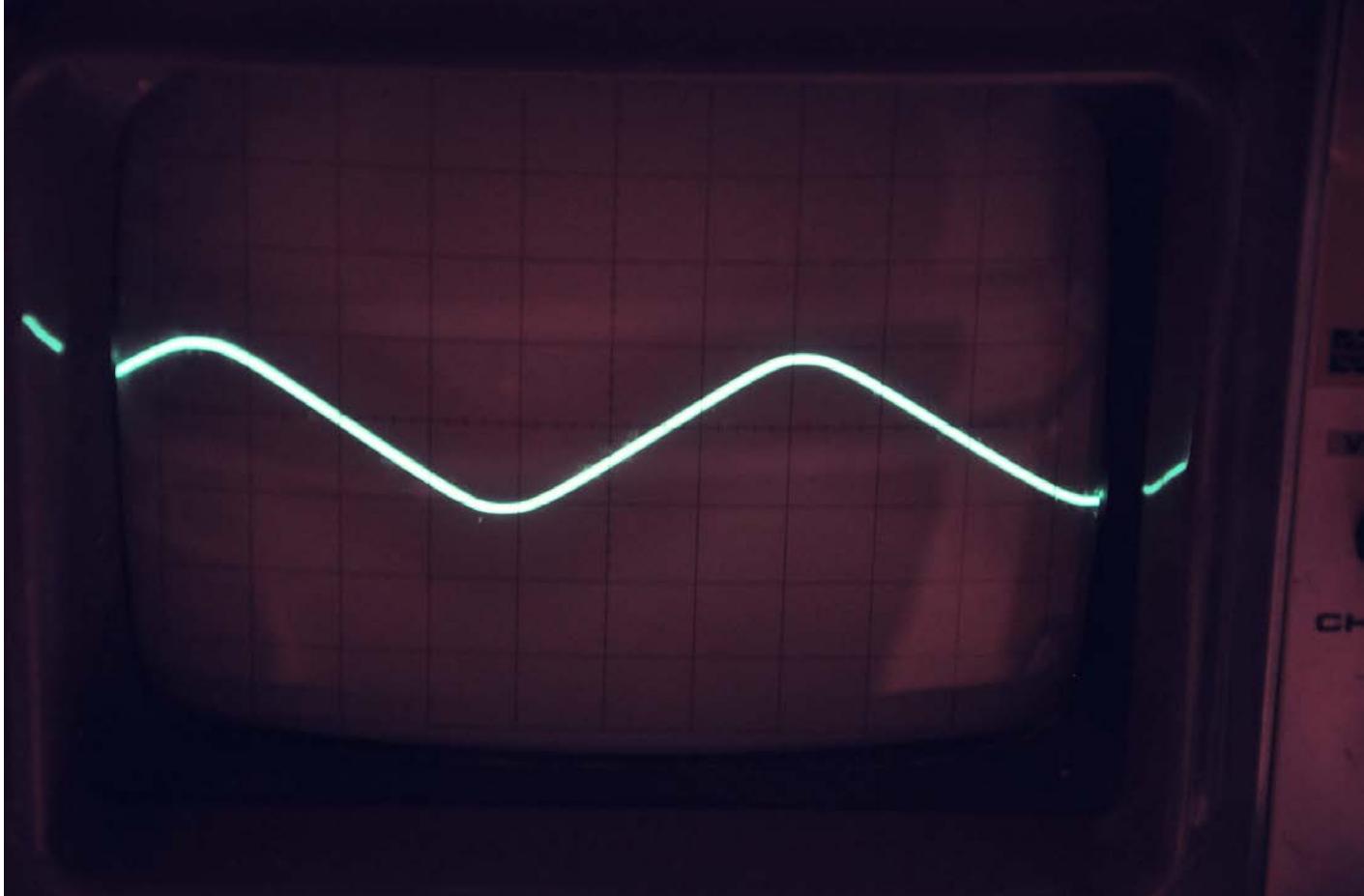
Insert IC's and header.



Flip board and install topside trimmers.



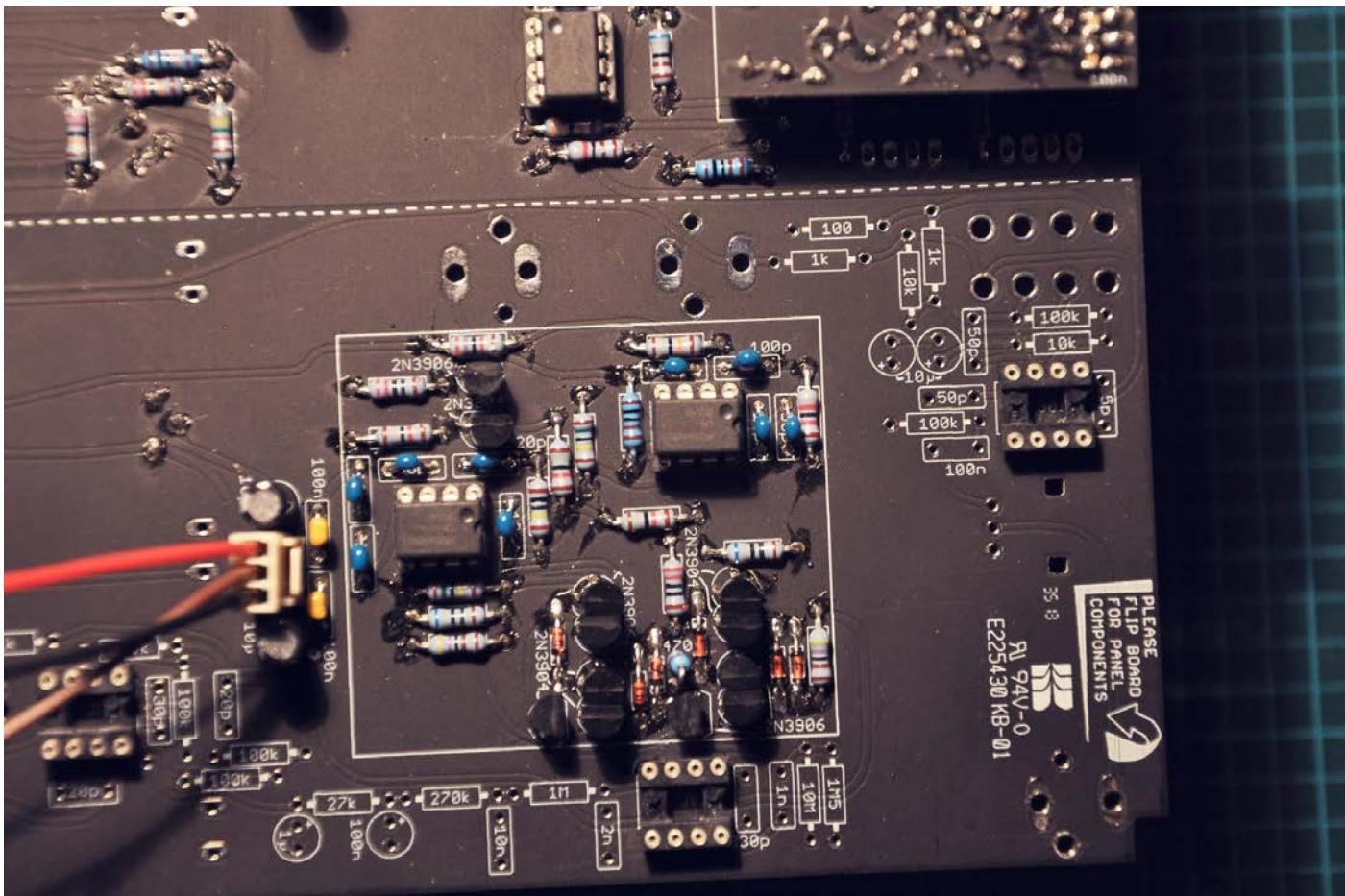
Wire it up as in the picture to make it pass signal.



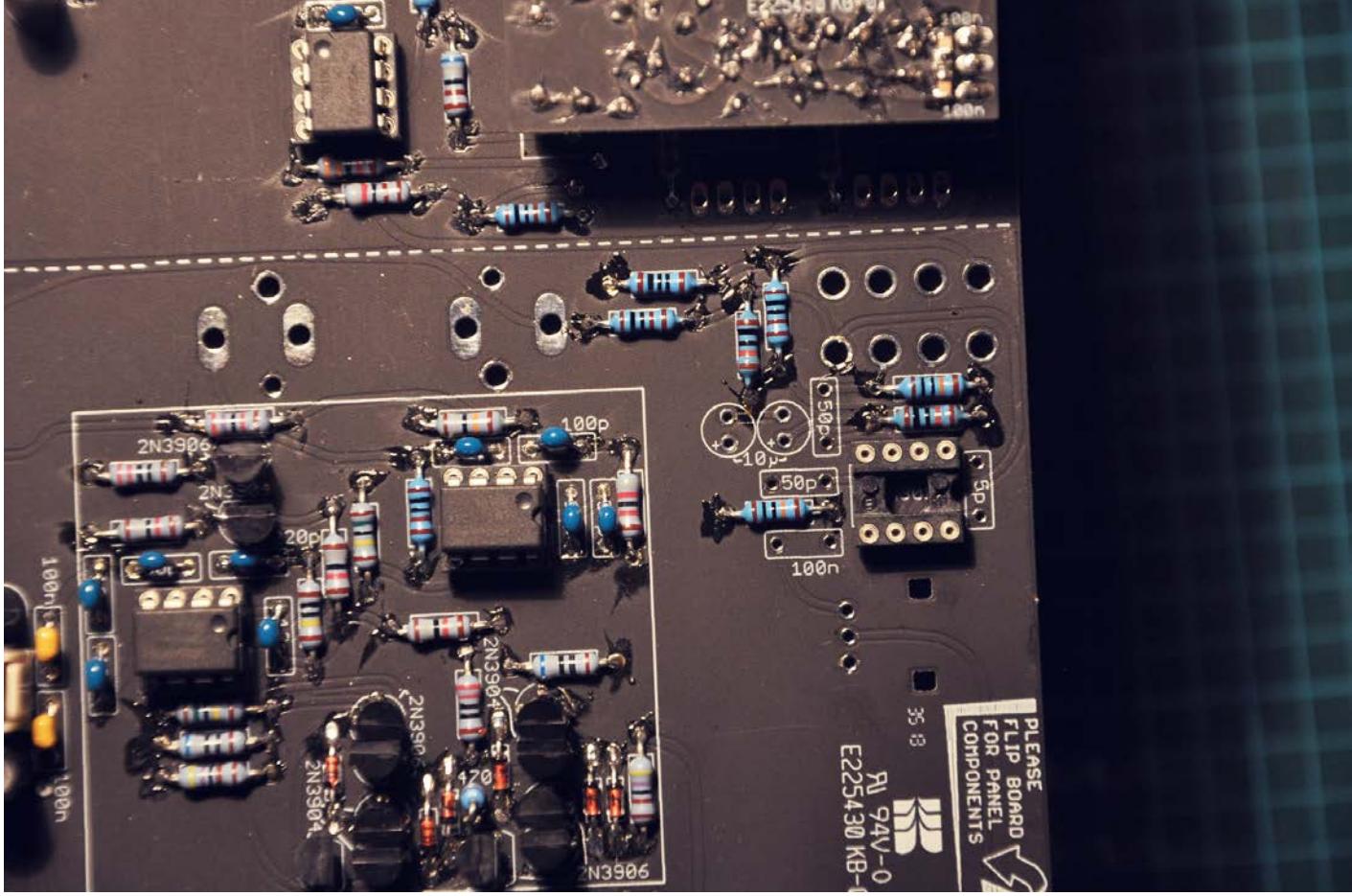
Sine in, sine out!

# Preamplifier

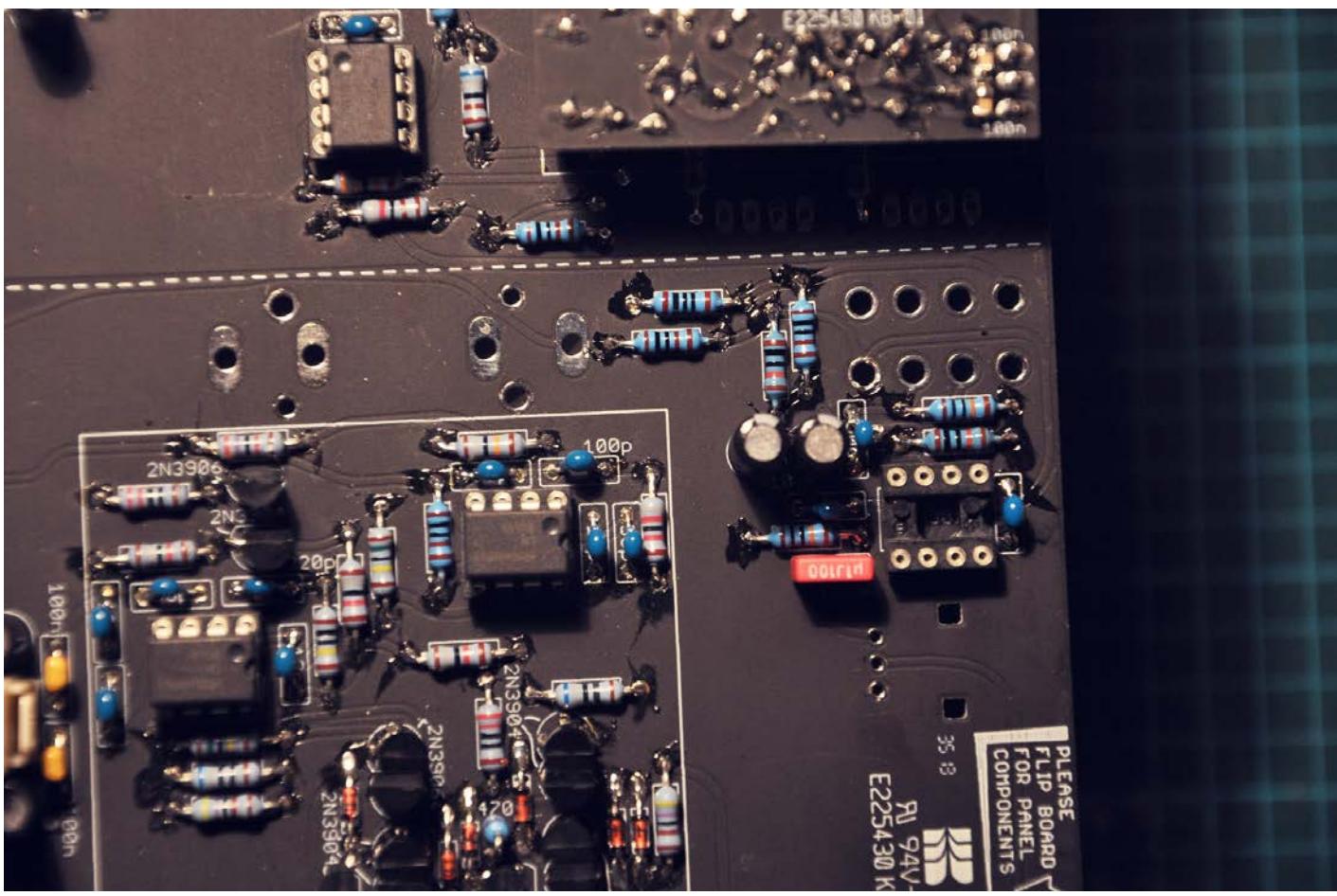
Parts list PREAMP			
Resistors	Capacitors	Semi's	Other
<ul style="list-style-type: none"><li>■ 100 x 1</li><li>■ 1k x 2</li><li>■ 10k x 2</li><li>■ 100k x 2</li></ul>	<ul style="list-style-type: none"><li>■ 5p x 1</li><li>■ 50p x 2</li><li>■ 100n x 1</li><li>■ 10μ x 2</li></ul>	<ul style="list-style-type: none"><li>■ LM301 x 1</li></ul>	<ul style="list-style-type: none"><li>■ 3,5mm jacks x 2</li><li>■ 100k audio Potentiometer x 1</li><li>■ DP3T slide switch x 1</li><li>■ 11mm M3 standoffs x 5</li></ul>



The preamp is located in the top left corner.



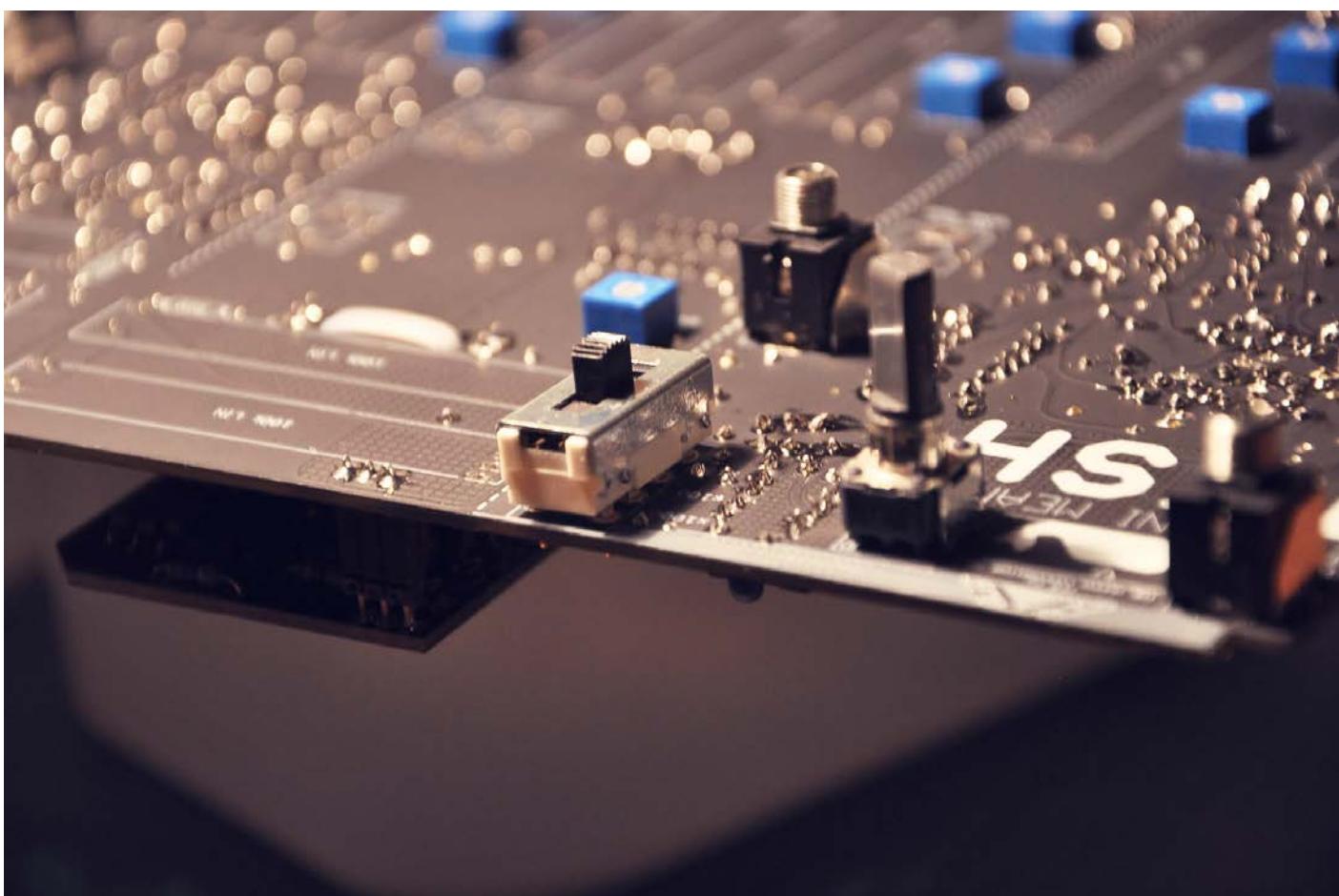
Starting with resistors.



Capacitors.



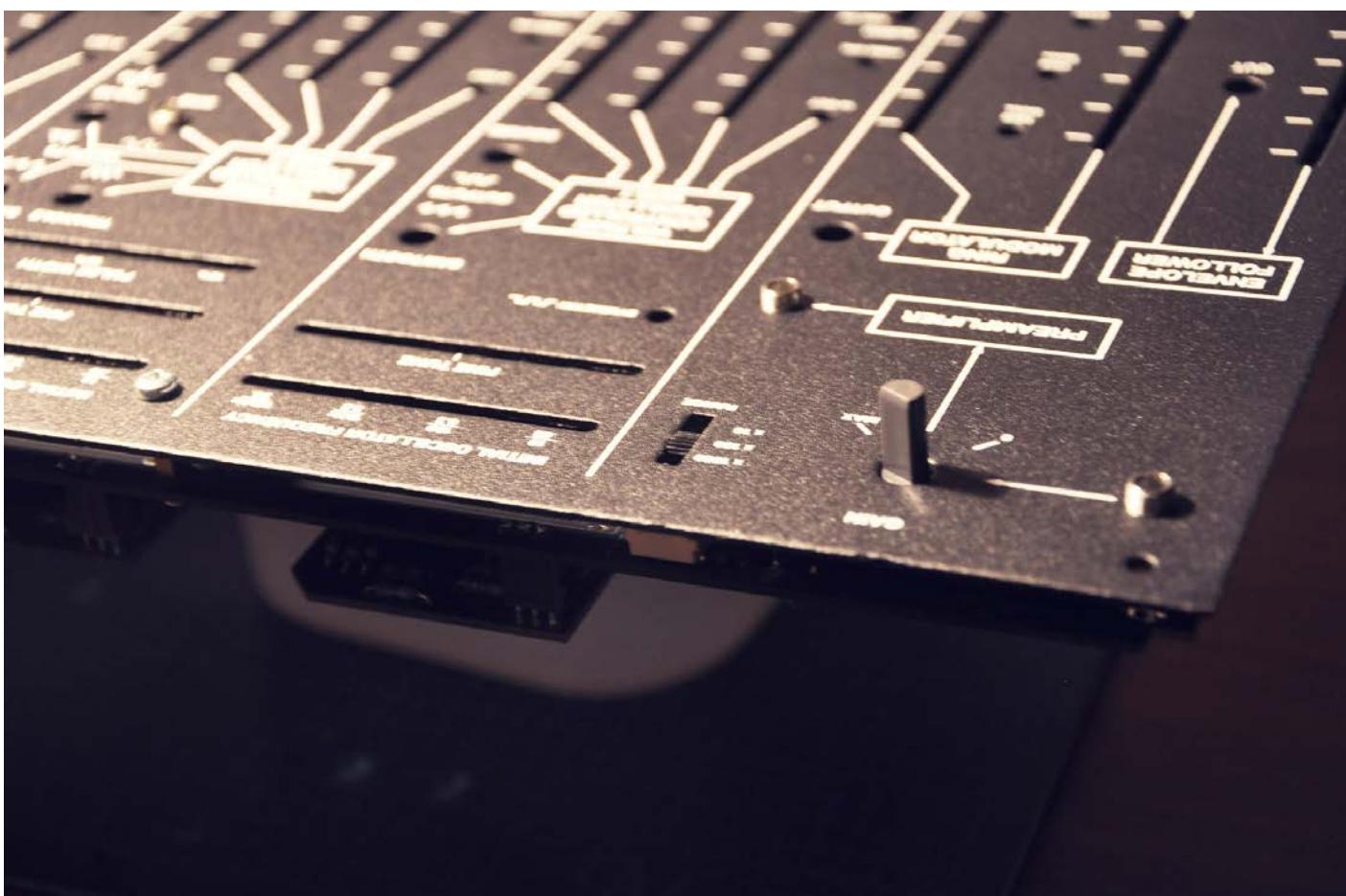
Flip and install the 100k potentiometer and the 2 jacks.



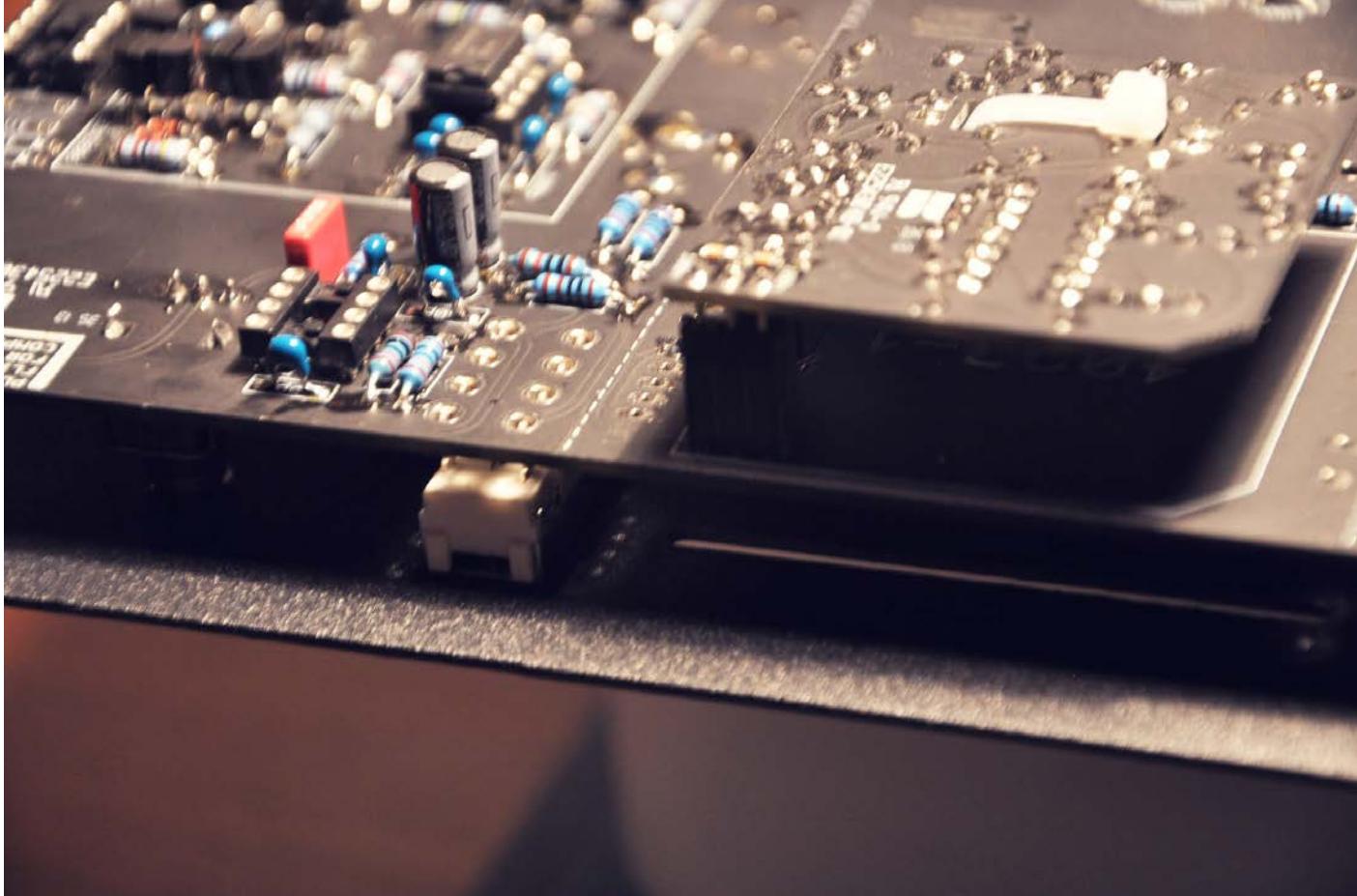
Insert the DP3T slide switch. But don't solder it in yet!



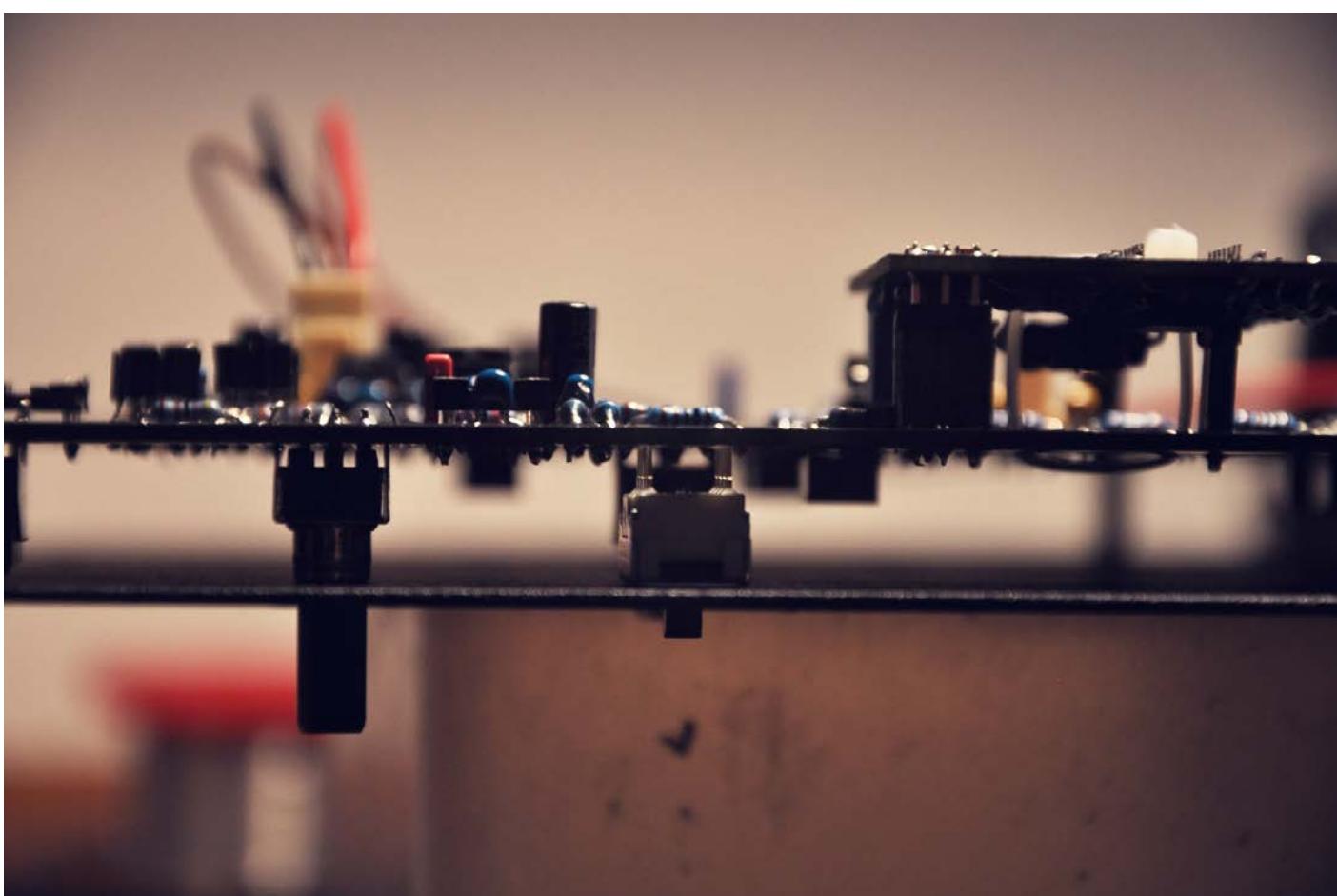
Mount the 5 M3 11mm standoffs. All holes are located near the edges and are circled with a ring.



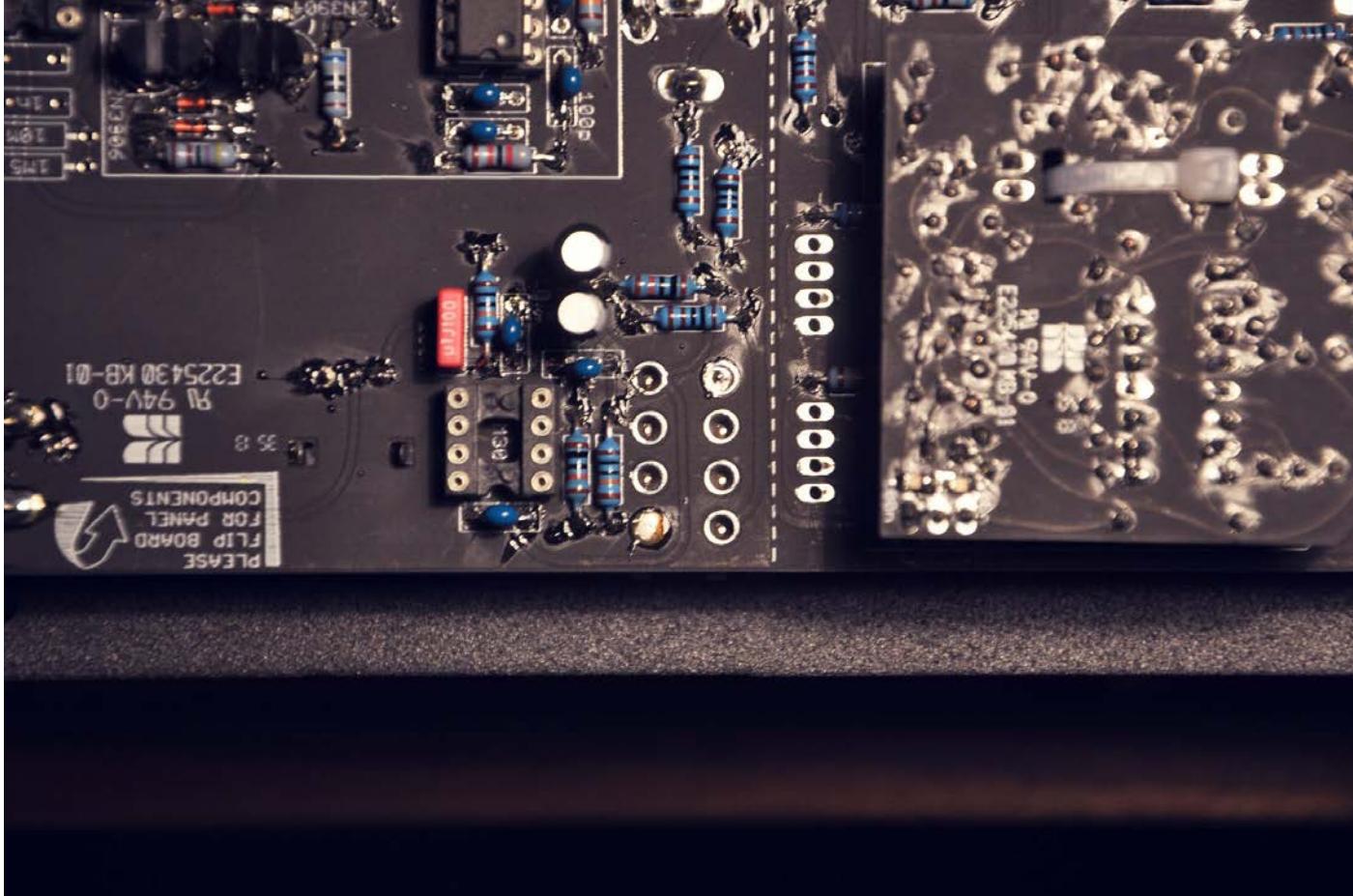
Break out the panel and slap it on there. Mount it with 5 screws, if the board bends a bit over by the preamp, mount a hex nut on one of the jacks. Don't overtighten things!



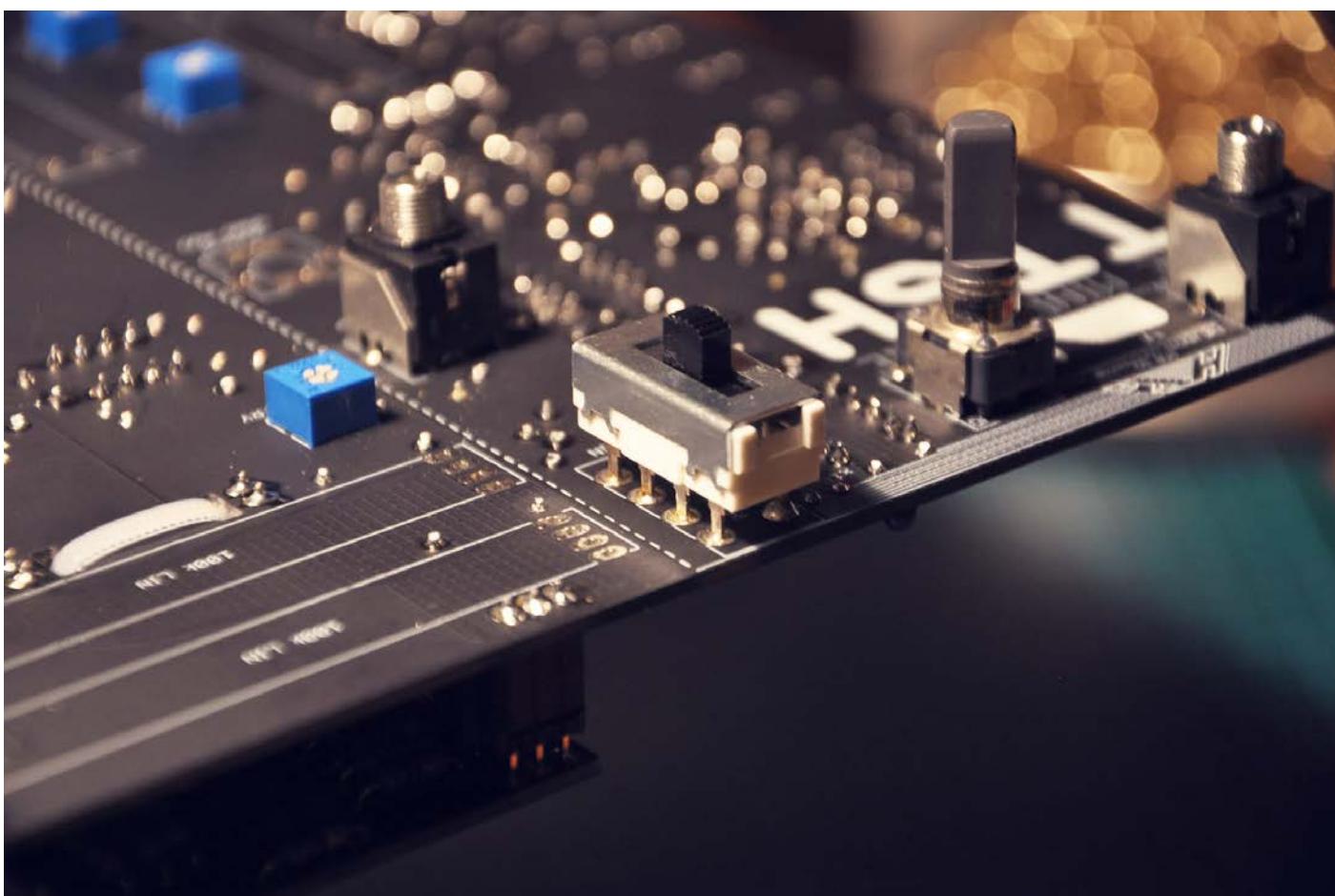
Flip the whole thing and the slide switch should fall down towards the panel.



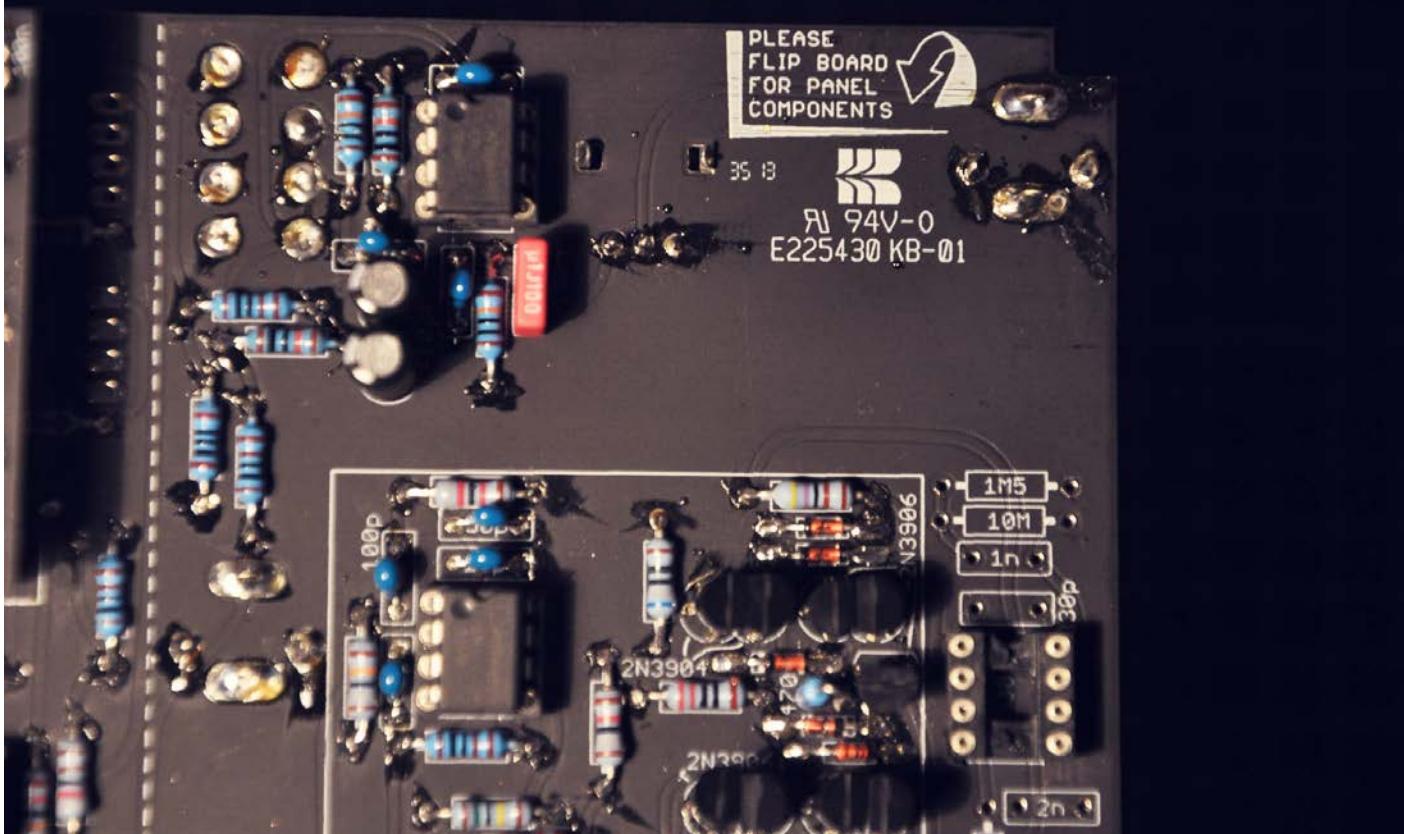
Switch is flush against the panel.



Solder 2 pins and check that the switch goes straight and that you can toggle it. After that solder all pins.



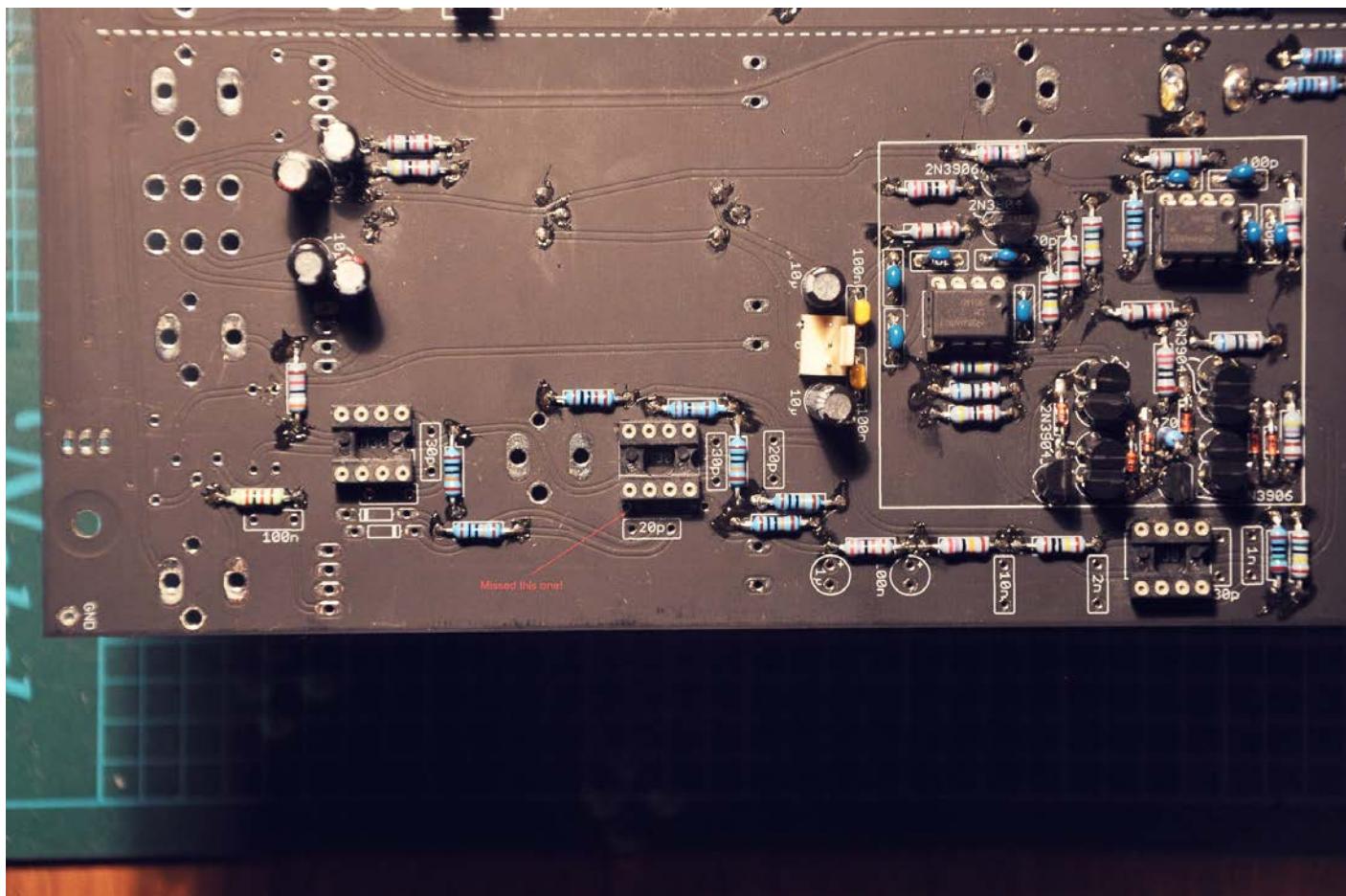
Remove the panel and feel proud!



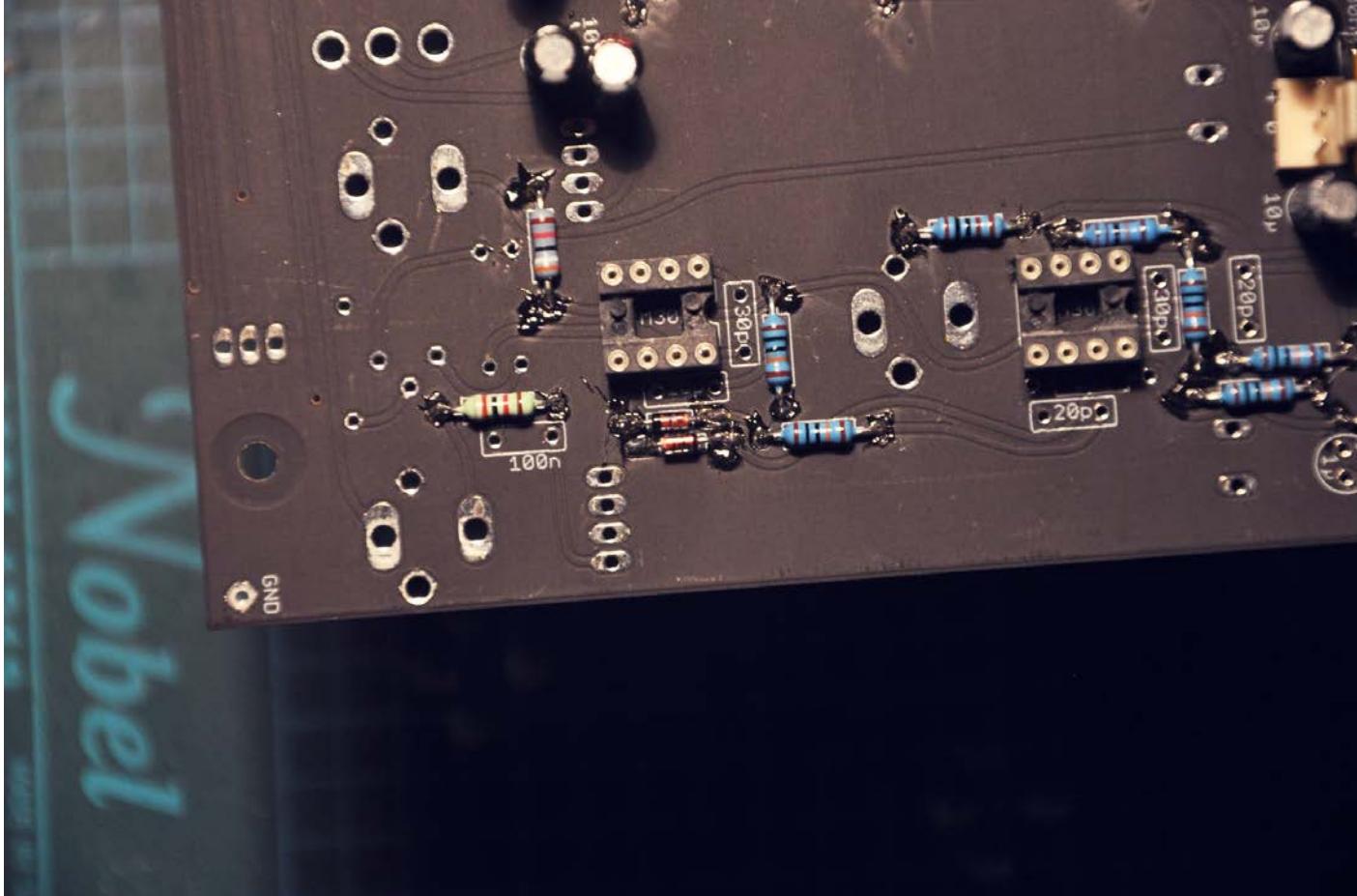
Install IC and test it by inputting a signal while monitoring the output.

# Envelope Follower

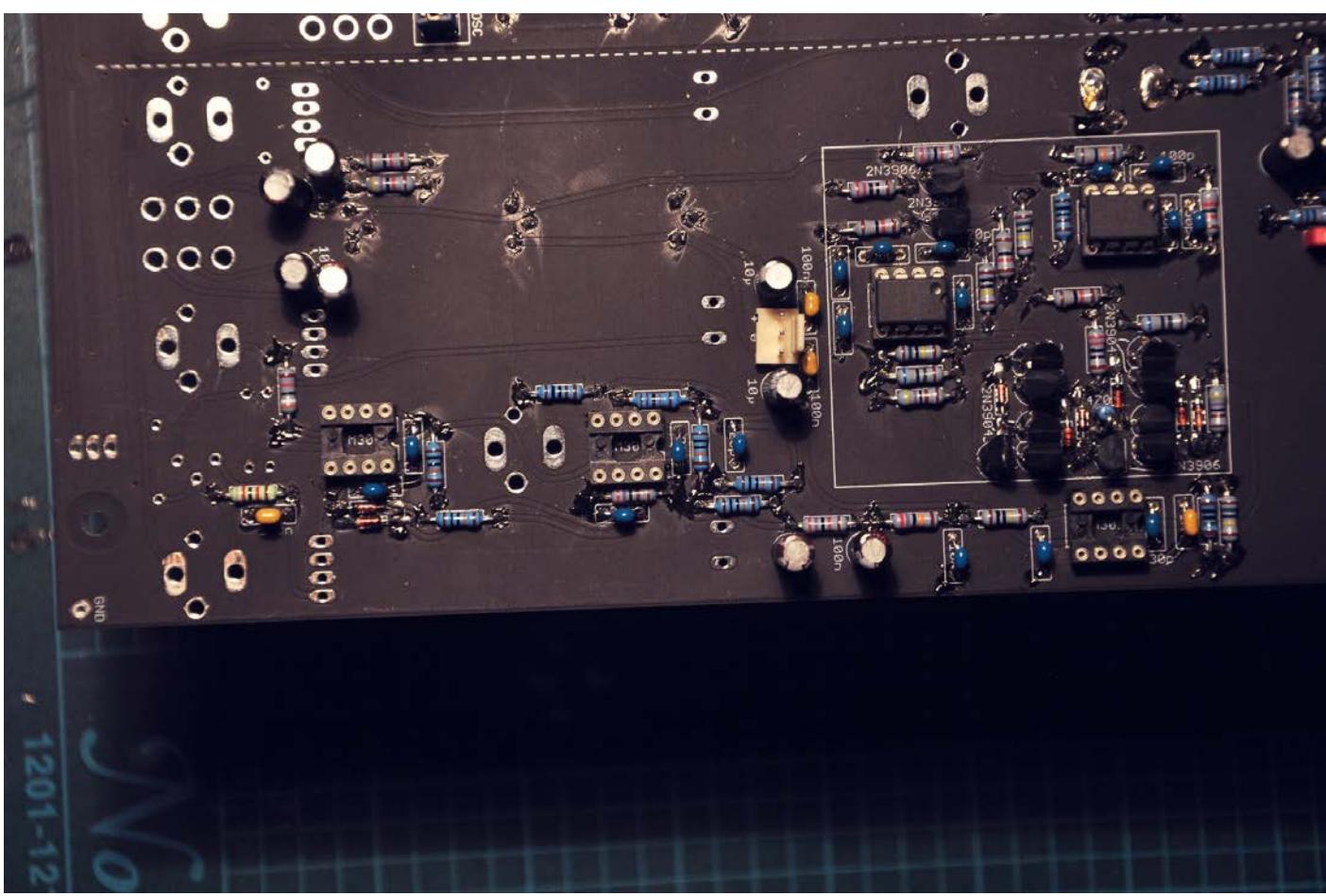
Parts list PREAMP		
Resistors	Capacitors	Semi's
<ul style="list-style-type: none"><li>■ 1k x 1</li><li>■ 2k7 x 1</li><li>■ 27k x 1</li><li>■ 39k x 1</li><li>■ 82k x 1</li><li>■ 100k x 5</li><li>■ 120k x 1</li><li>■ 270k x 1</li><li>■ 1M x 1</li><li>■ 1M5 x 1</li><li>■ 10M x 1</li></ul>	<ul style="list-style-type: none"><li>■ 20p x 3</li><li>■ 30p x 2</li><li>■ 330p x 1</li><li>■ 1n x 1</li><li>■ 2n x 1</li><li>■ 10n x 1</li><li>■ 100n x 1</li><li>■ 100n x 1 (Electrolytic)</li><li>■ 1μ x 1 (Electrolytic)</li></ul>	<ul style="list-style-type: none"><li>■ LM301 x 3</li><li>■ 1N4148 x 2</li></ul>



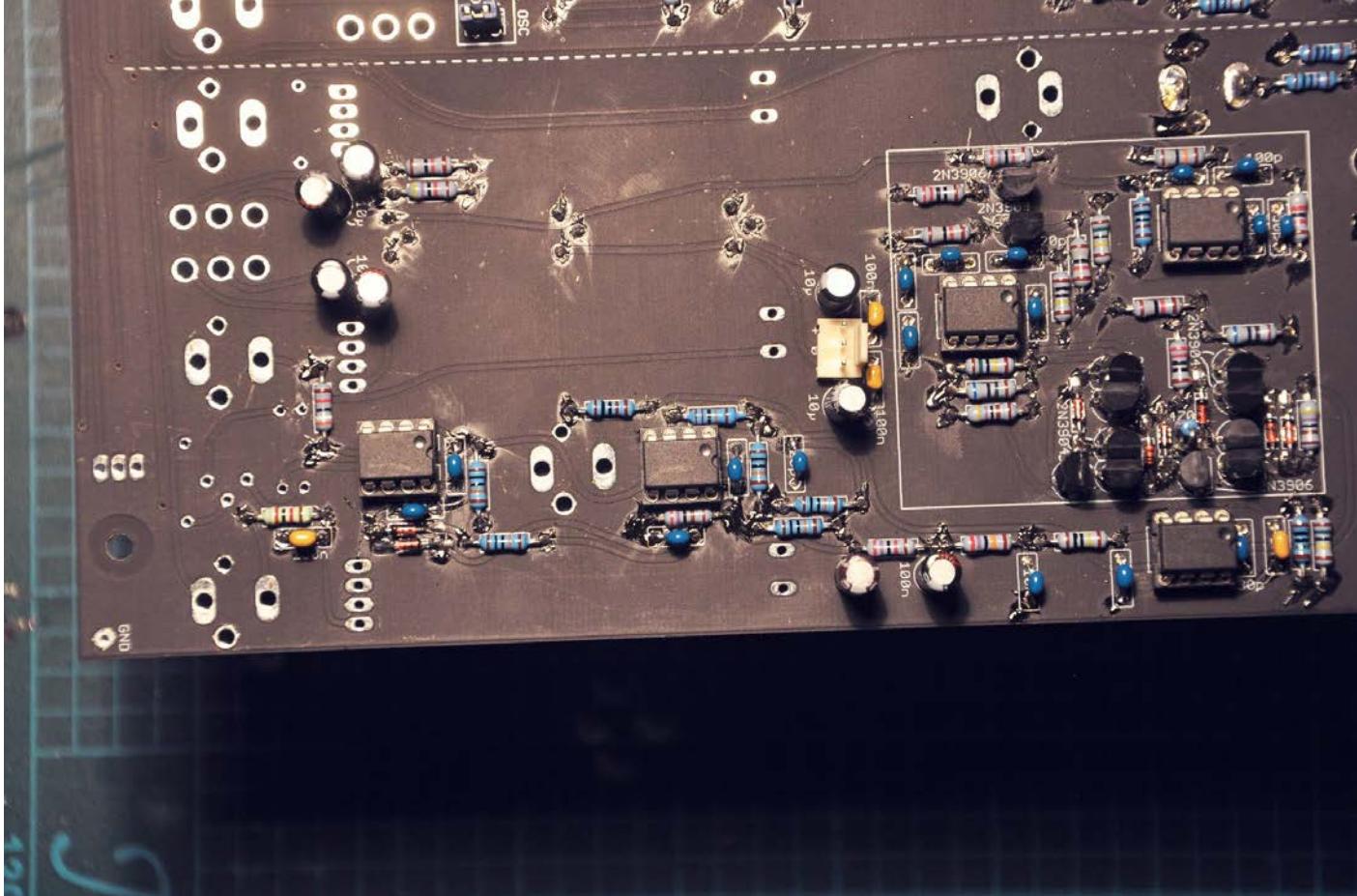
Resistors. Don't miss the one in the shade...



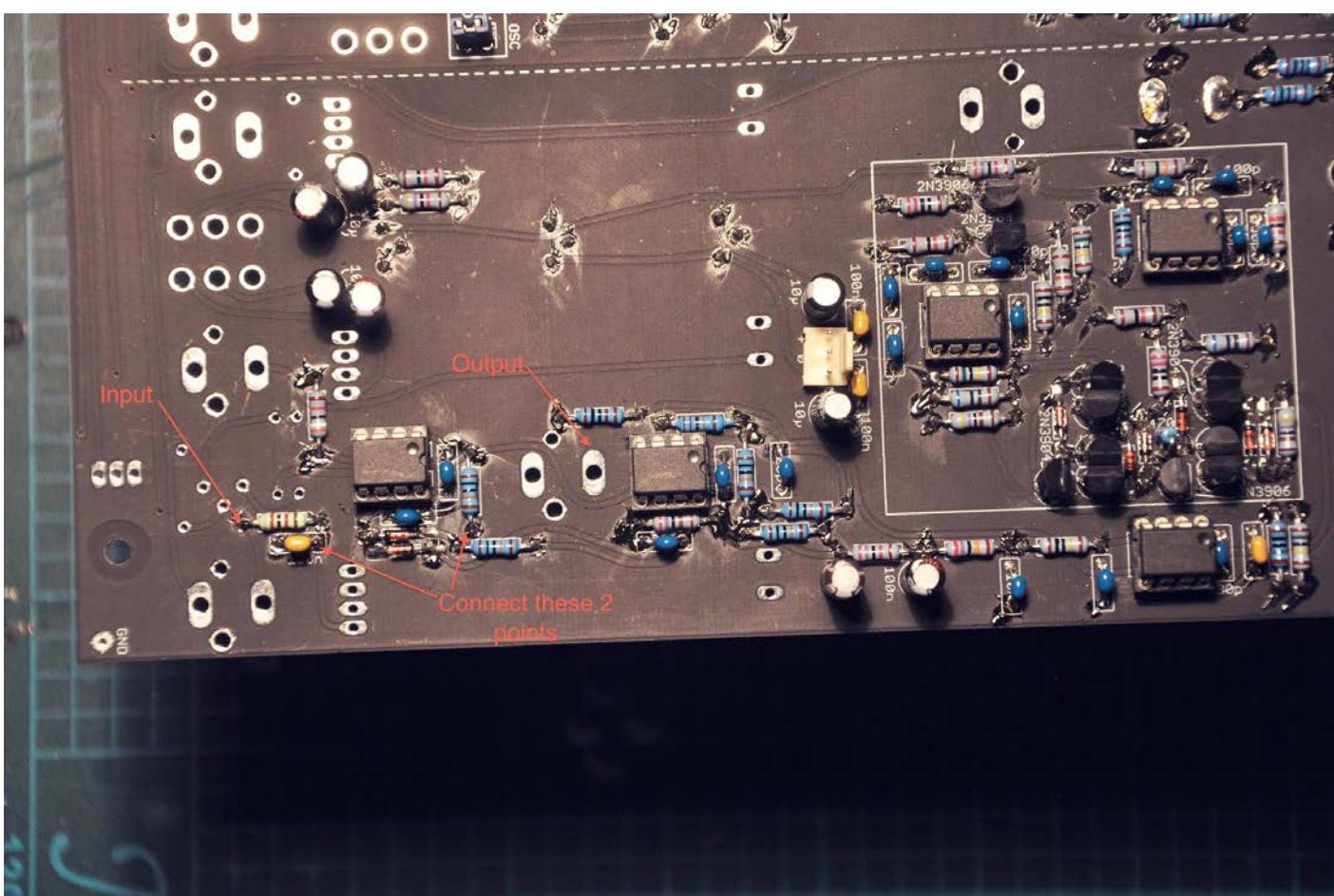
The 2 diodes.



Caps.



And ICs.

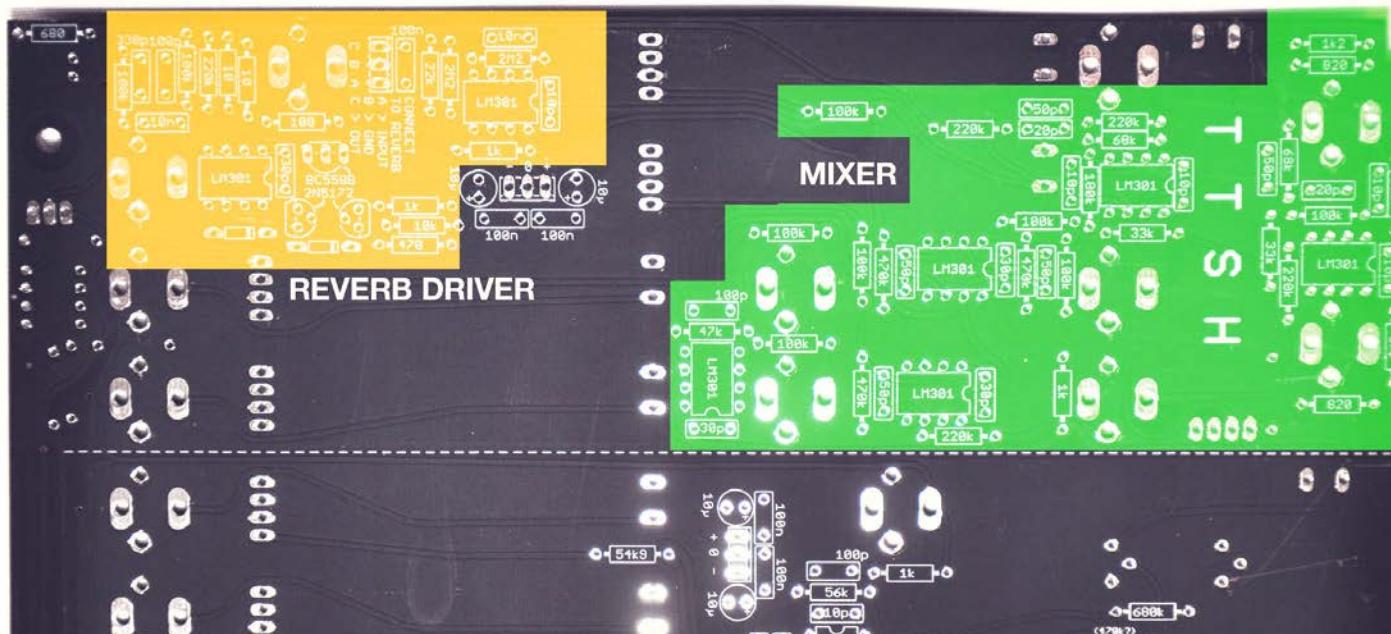


Test it by connect an alternating signal to the resistor, jumper (with a crocodile clip for example) the cap to the resistor and monitor the output.

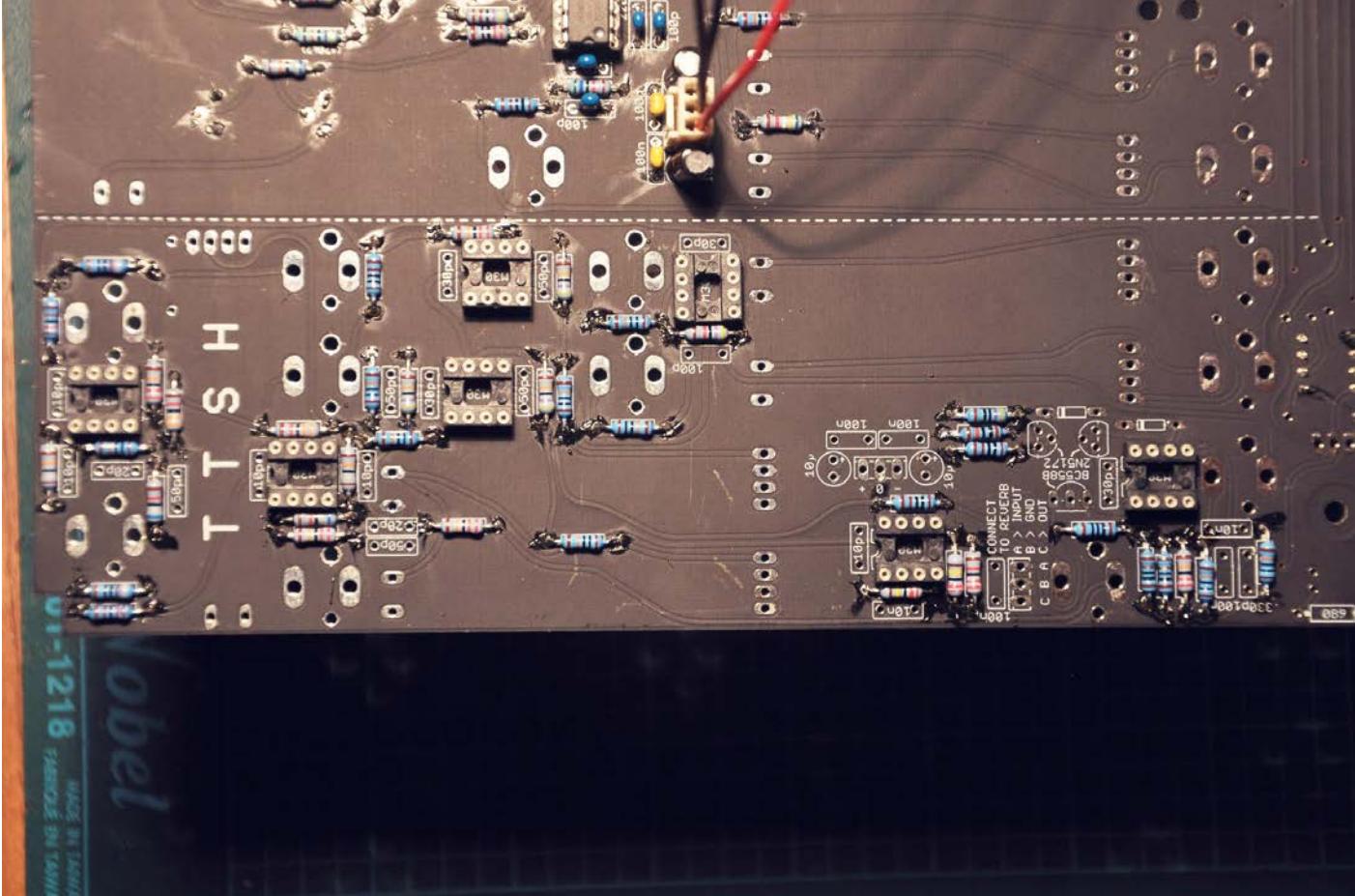
With that we're ready to jump to the other side of the board **and build the mixer.**

# Mixer

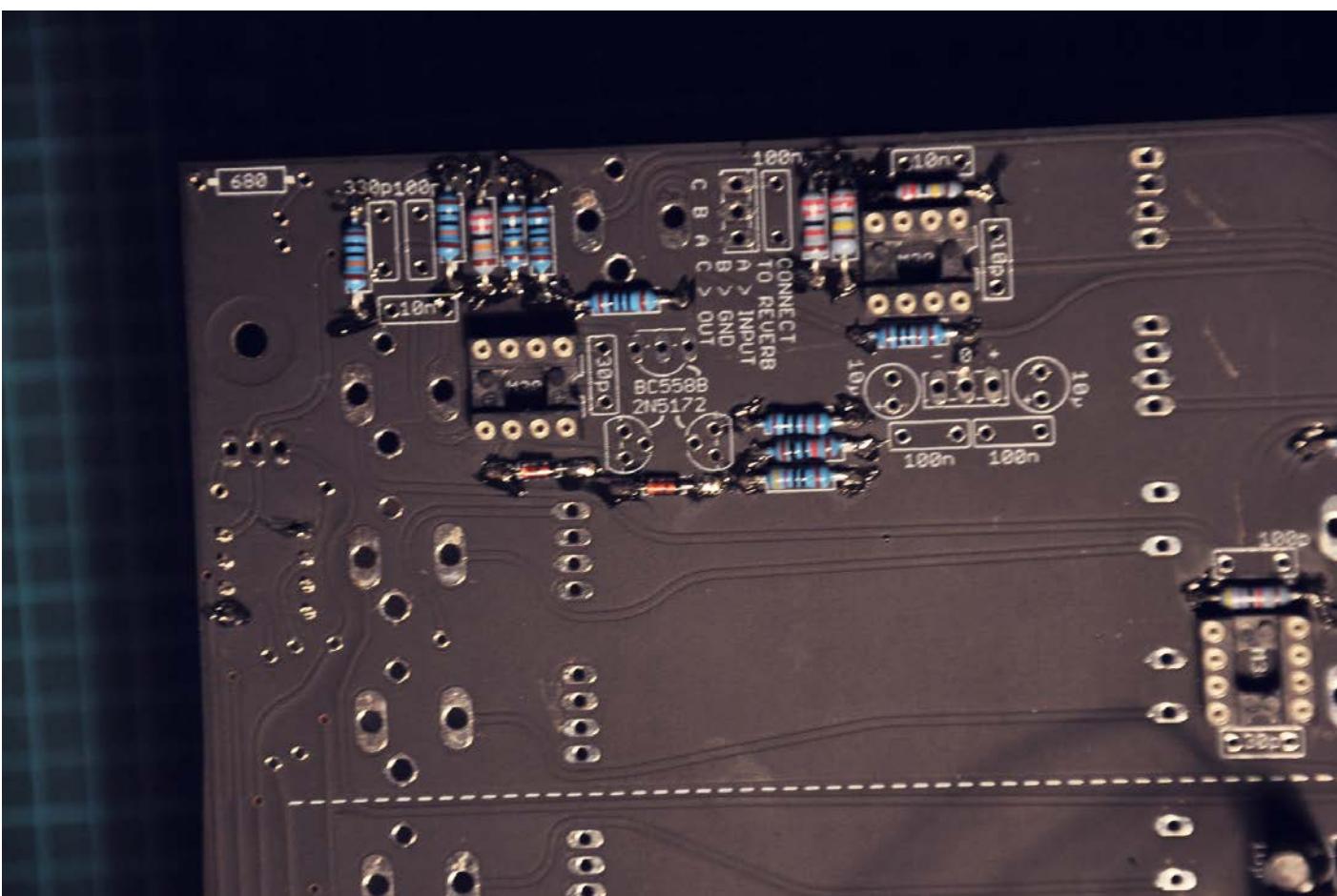
Parts list MIXER			
Resistors	Capacitors	Semi's	Other
<ul style="list-style-type: none"> <li>■ 10 x 2</li> <li>■ 100 x 1</li> <li>■ 470 x 1</li> <li>■ 820 x 2</li> <li>■ 1k x 3</li> <li>■ 1k2 x 2</li> <li>■ 10k x 1</li> <li>■ 22k x 1</li> <li>■ 33k x 2</li> <li>■ 47k x 1</li> <li>■ 68k x 2</li> <li>■ 100k x 9</li> <li>■ 180k x 2</li> <li>■ 220k x 5</li> <li>■ 470k x 3</li> <li>■ 2M2 x 2</li> </ul>	<ul style="list-style-type: none"> <li>■ 10p x 5</li> <li>■ 20p x 2</li> <li>■ 30p x 4</li> <li>■ 50p x 5</li> <li>■ 100p x 2</li> <li>■ 330p x 1</li> <li>■ 10n x 2</li> <li>■ 100n x 3</li> <li>■ 10μ x 2 (Electrolytic)</li> </ul>	<ul style="list-style-type: none"> <li>■ BC558 x 1</li> <li>■ LM301 x 7</li> <li>■ 1N4148 x 2</li> <li>■ 2N5172 x 2</li> </ul>	<ul style="list-style-type: none"> <li>■ 3 pin MTA header x 2</li> </ul>



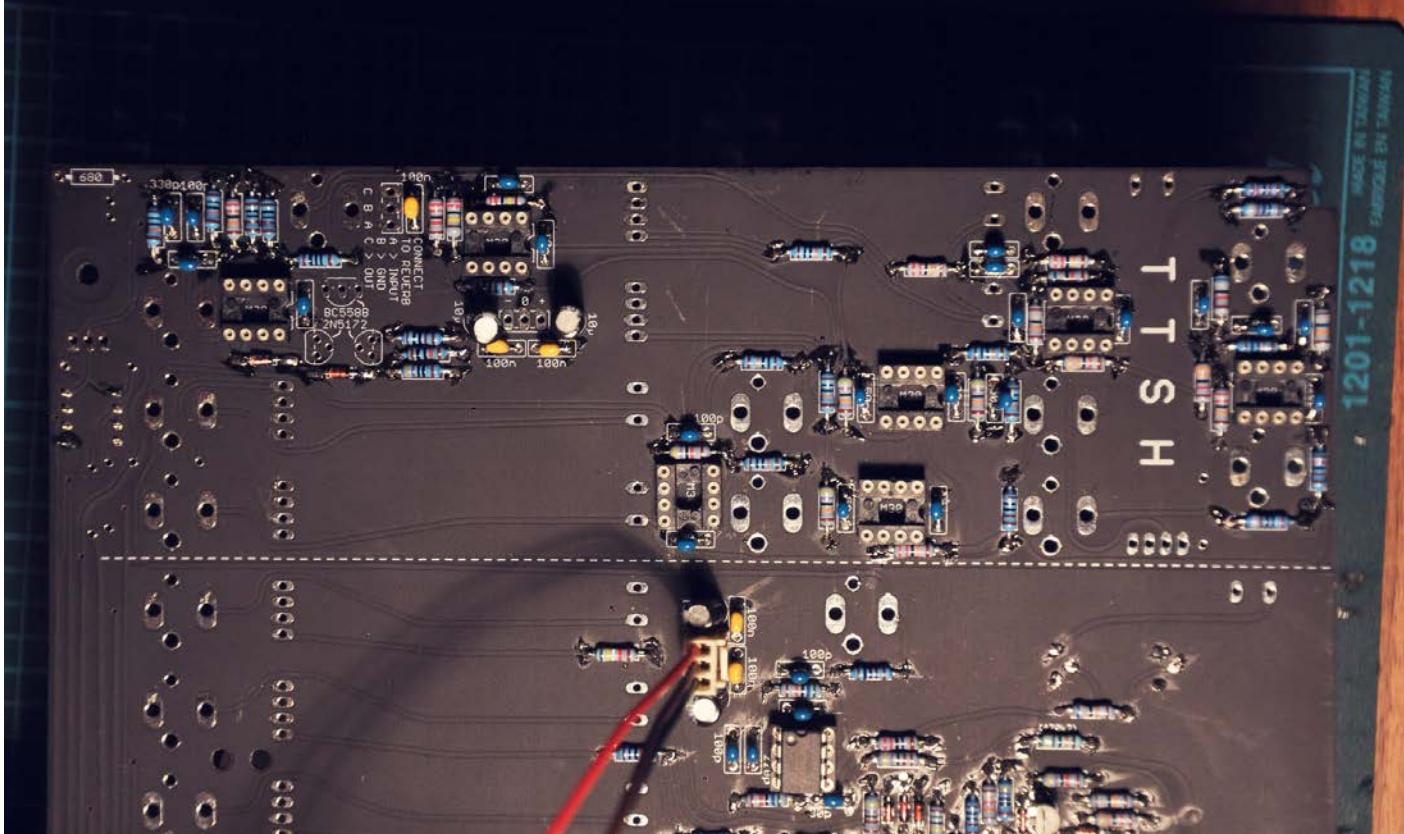
The mixer is split into 2 sections, the reverb driver and the real mixer. Now these 2 interact a bit, so it's best to build them both at the same time. Though I prefer to leave testing it until the whole thing is complete, it just feels easier... Wiring the reverb is done in the [Finishing Up](#) section.



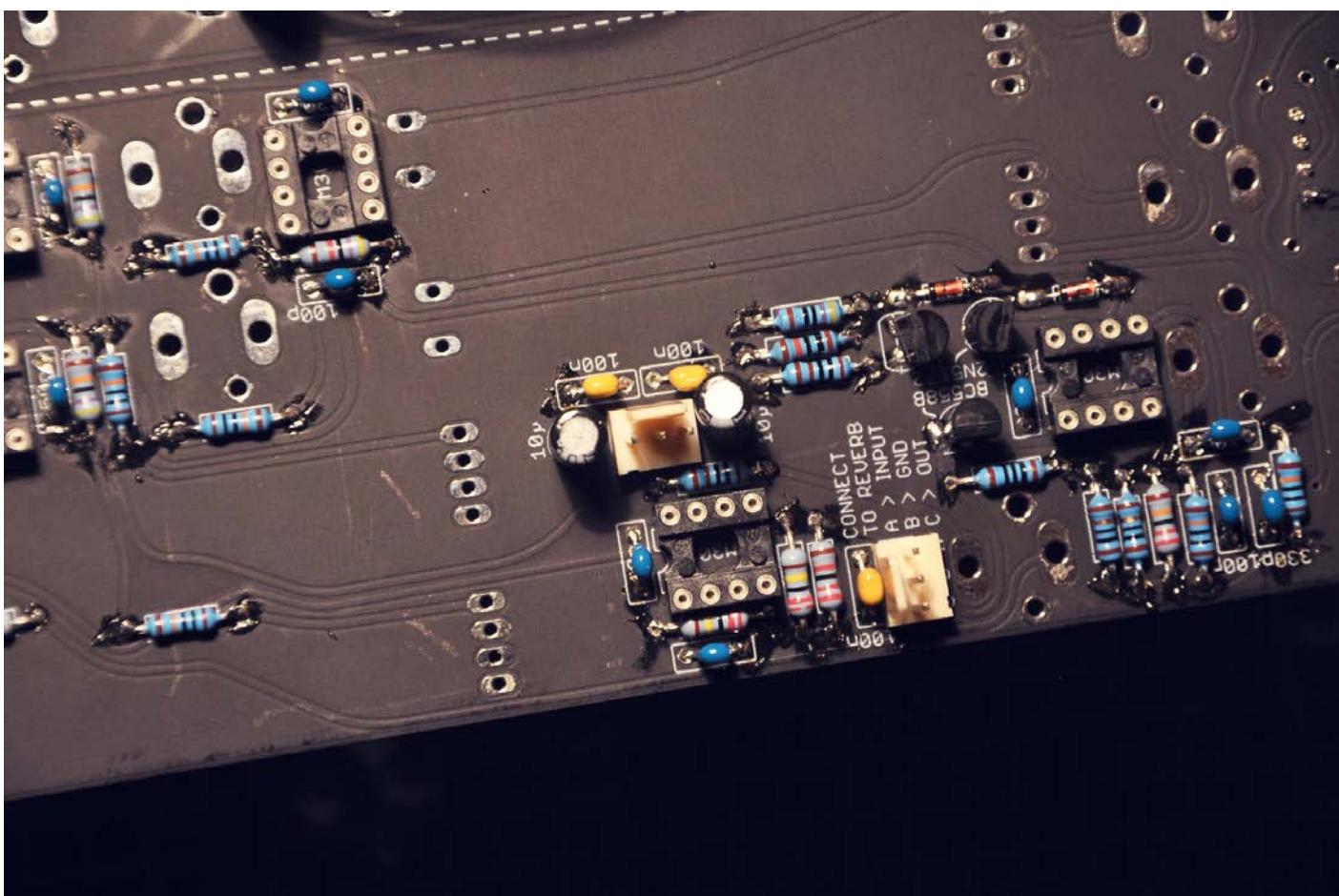
Resistors as usual.



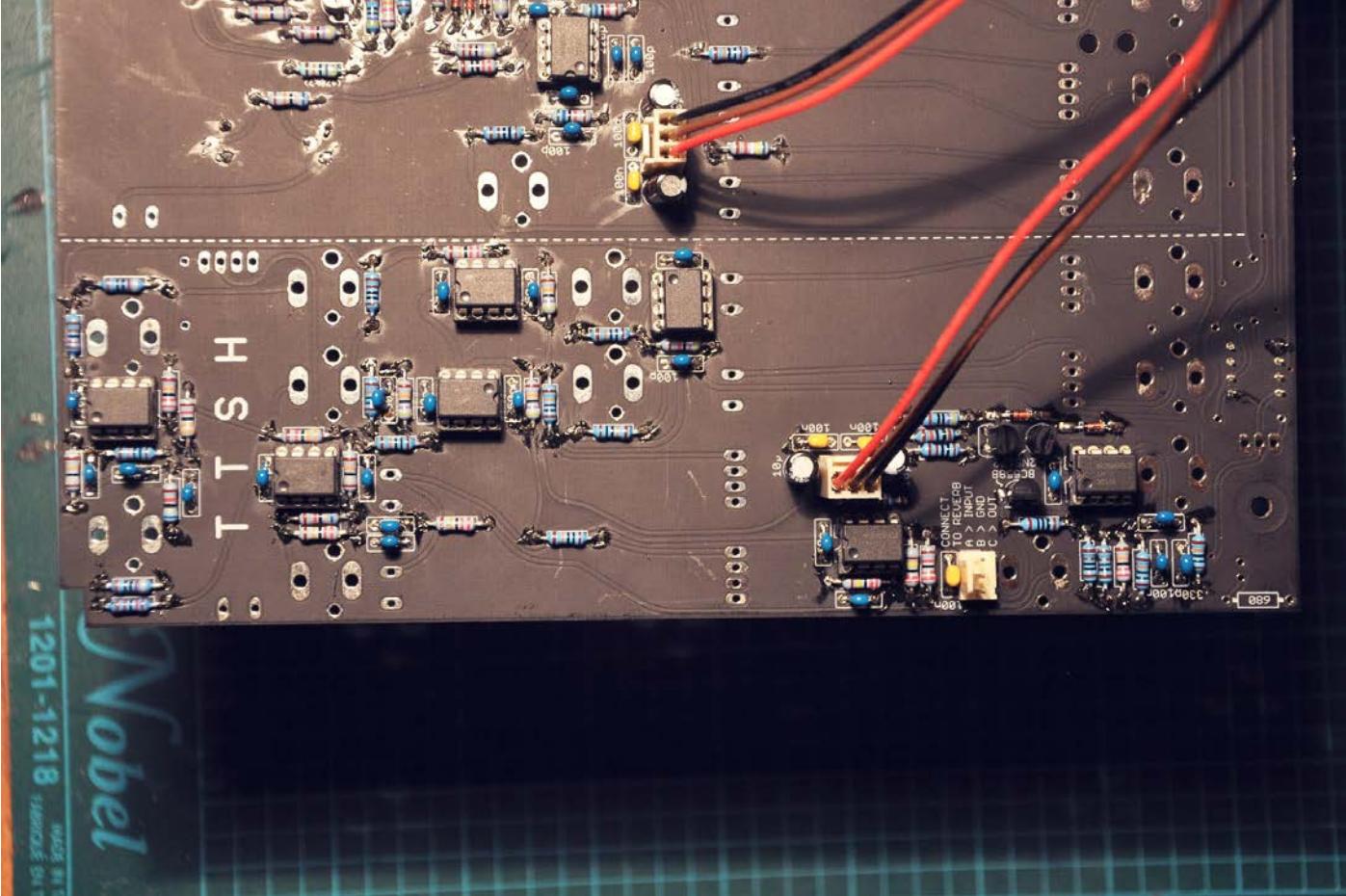
The 2 diodes in the reverb driver. Check orientation, polarity, direction, markings etc.



Capacitors.



The 3 transistors in the reverb driver and the MTA headers.

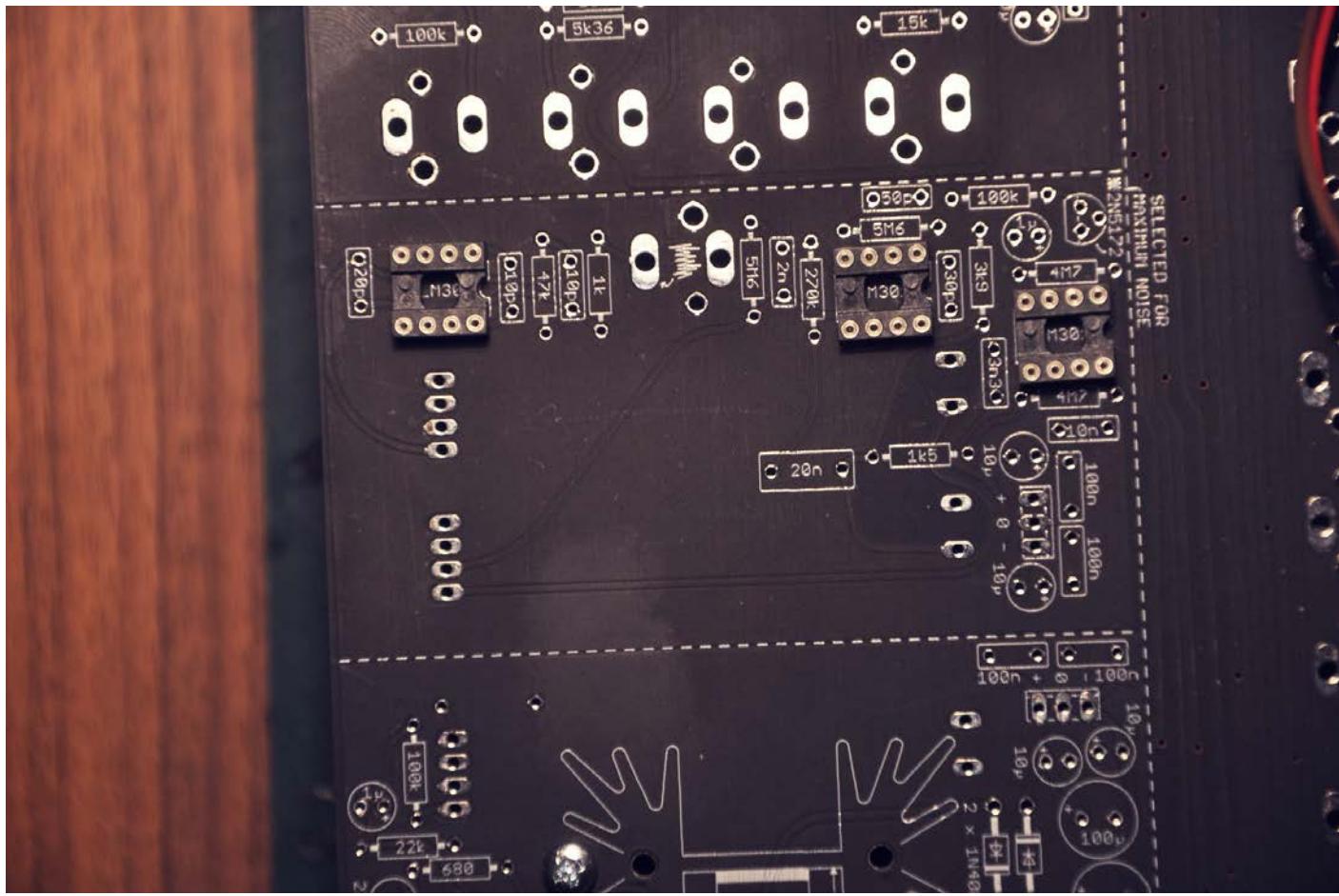


Done!

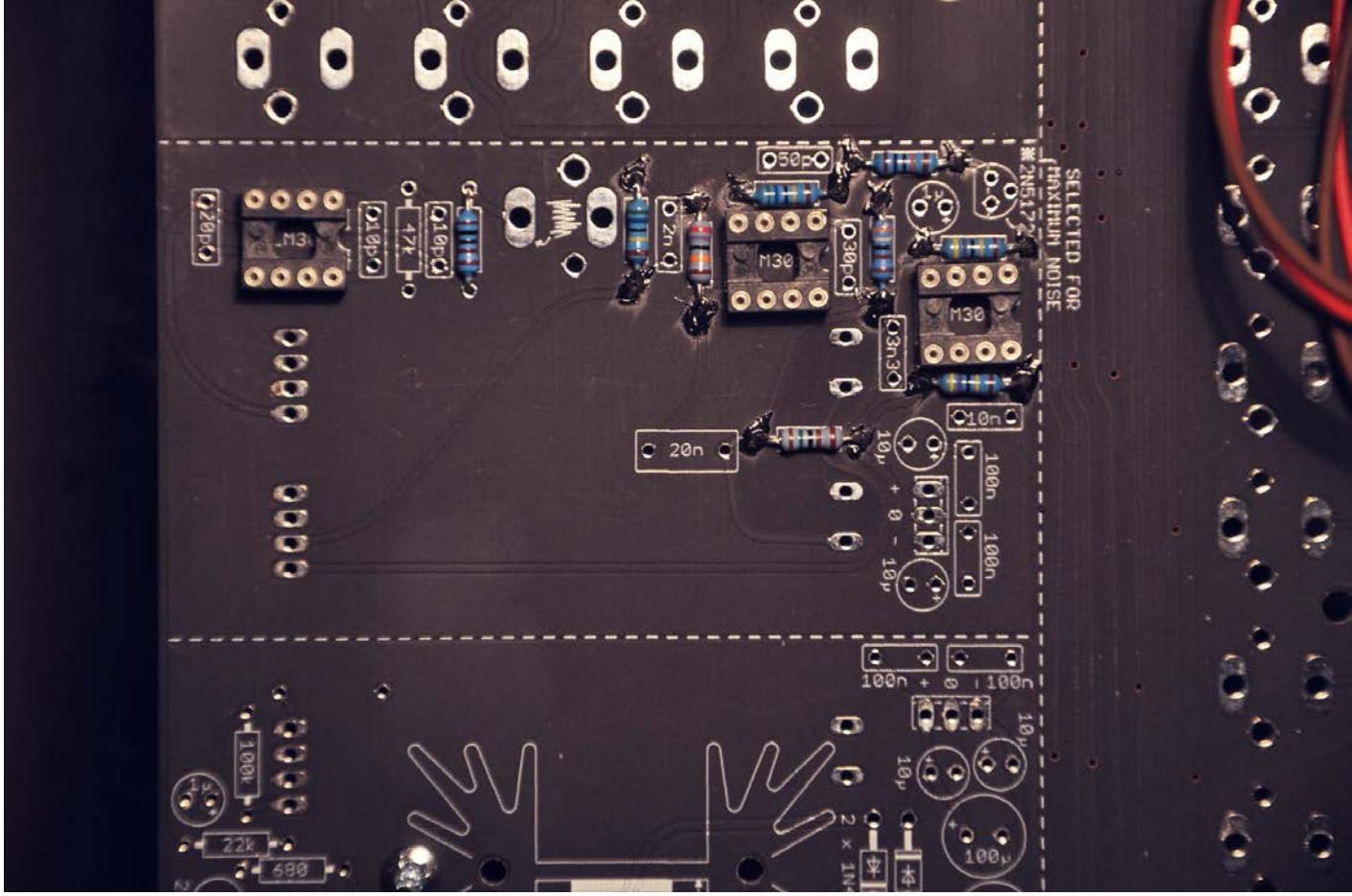
And as I said, I prefer to test this once I'm finished with everything.  
So forwards and onwards, or perhaps I should say downwards to the bottom of the board!  
**Let's make some noise..**

# Noise

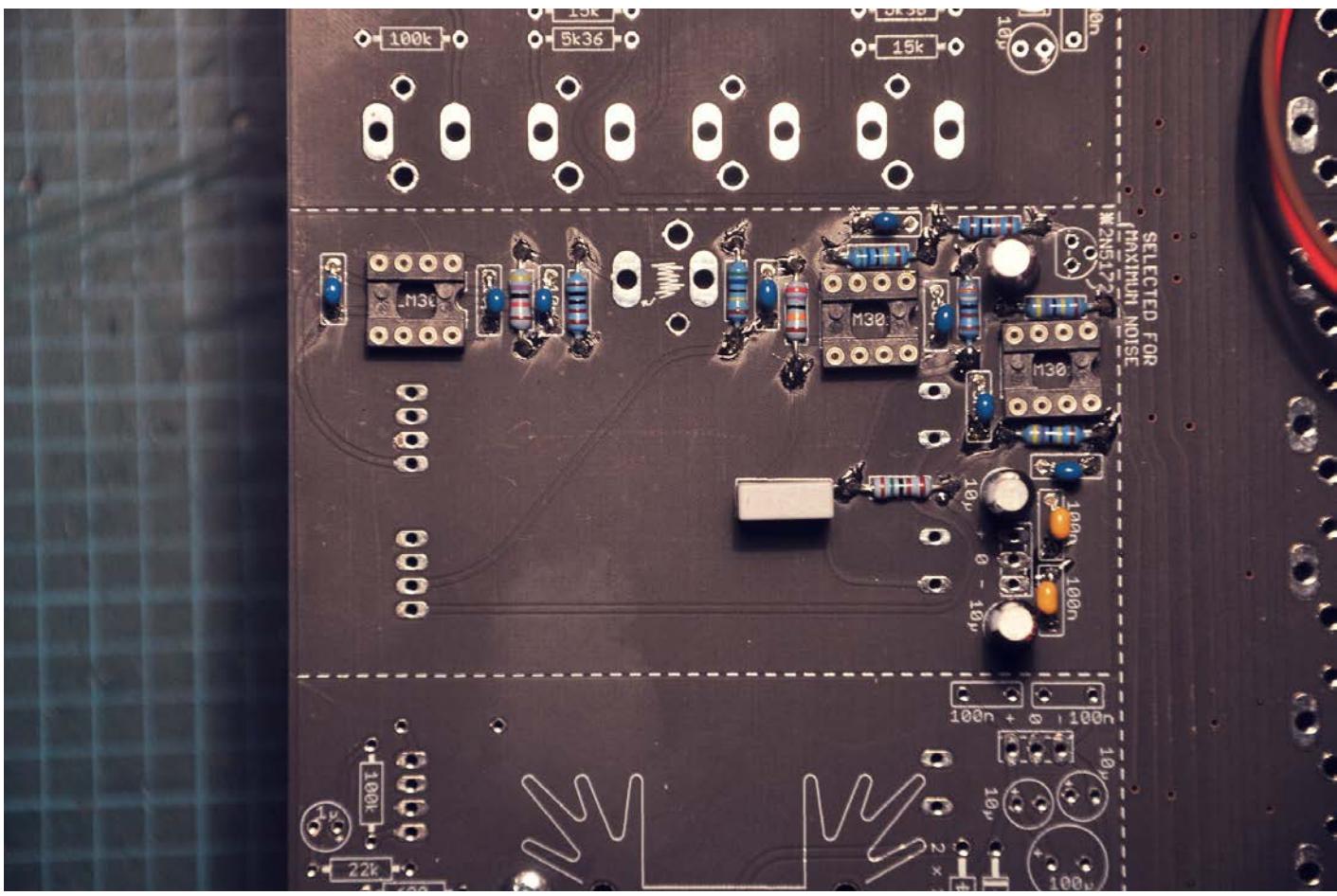
Parts list NOISE			
Resistors	Capacitors	Semi's	Other
<ul style="list-style-type: none"><li>■ 1k x 1</li><li>■ 1k5 x 1</li><li>■ 100k x 1</li><li>■ 270k x 1</li><li>■ 3k9 x 1</li><li>■ 47k x 1</li><li>■ 4M7 x 2</li><li>■ 5M6 x 2</li></ul>	<ul style="list-style-type: none"><li>■ 10p x 2</li><li>■ 20p x 1</li><li>■ 30p x 1</li><li>■ 50p x 1</li><li>■ 2n x 1 (2n2 is OK)</li><li>■ 3n3 x 1</li><li>■ 10n x 1</li><li>■ 20n x 1 (22n is OK) 7.5mm</li><li>■ 1μ x 1 (Electrolytic)</li><li>■ 10μ x 2 (Electrolytic)</li></ul>	<ul style="list-style-type: none"><li>■ LM301 x 3</li><li>■ 2N5172 x 1</li></ul>	<ul style="list-style-type: none"><li>■ 3 pin MTA header x 1</li></ul>



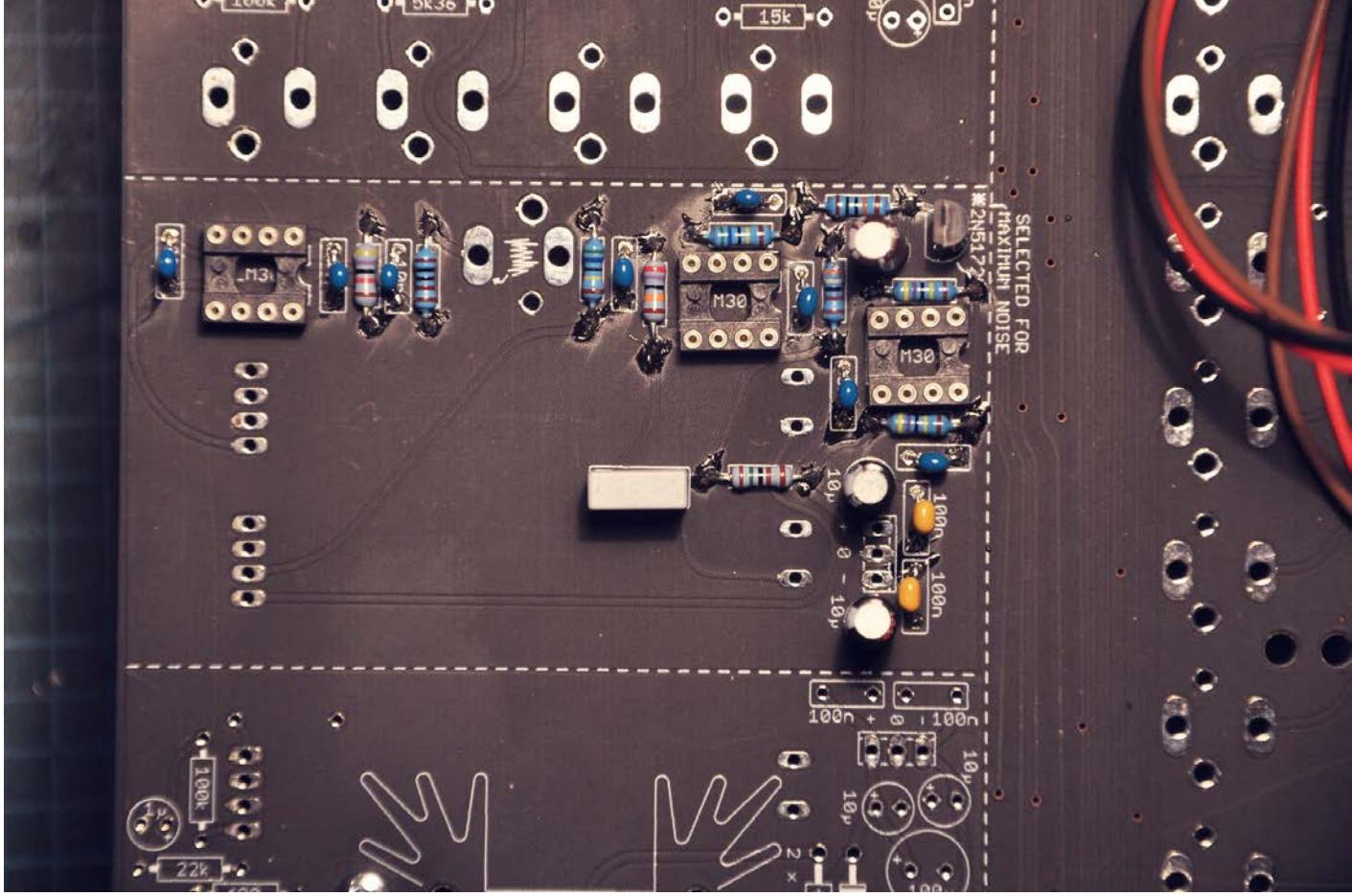
The noise module is the second to right on the bottom.



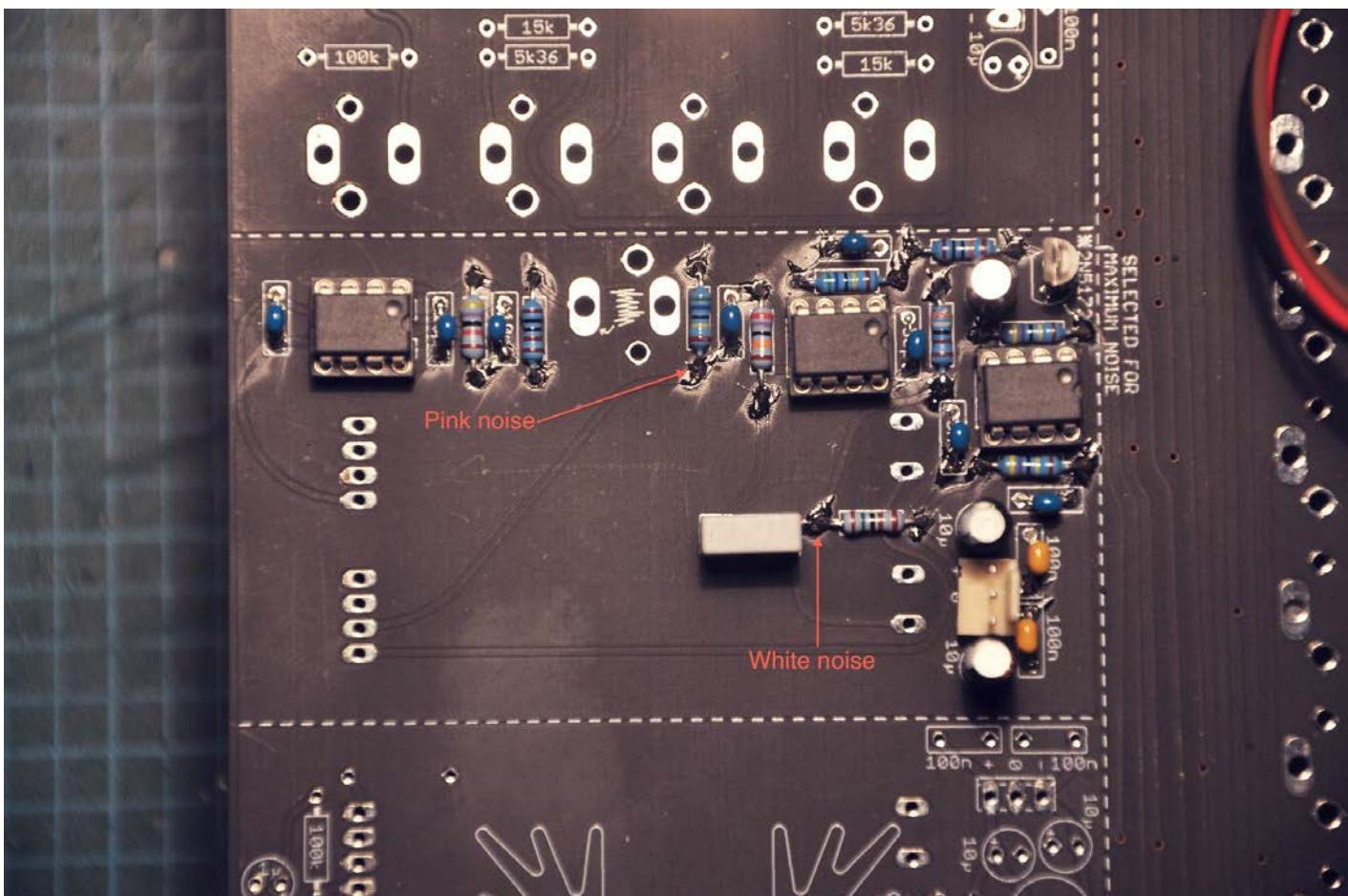
Resistors.



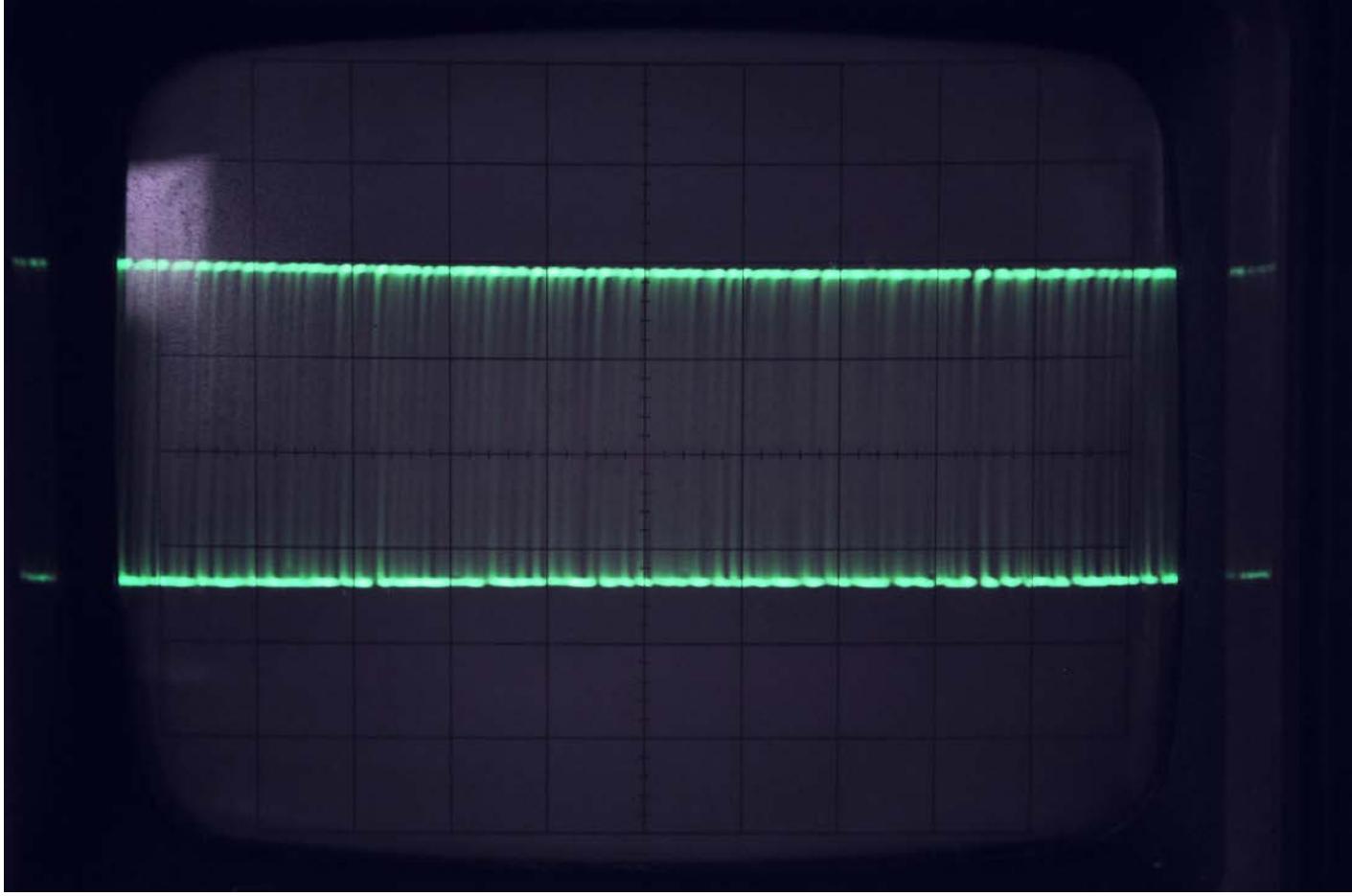
Capacitors.



The transistor. It should be selected for maximum noise. All 2n5172 I've tried have worked on the first try.



Done! Test it by probing the 2 different spots for white and pink noise. It takes a few seconds to get it going though, so no worries if you don't see it right away.



White noise.



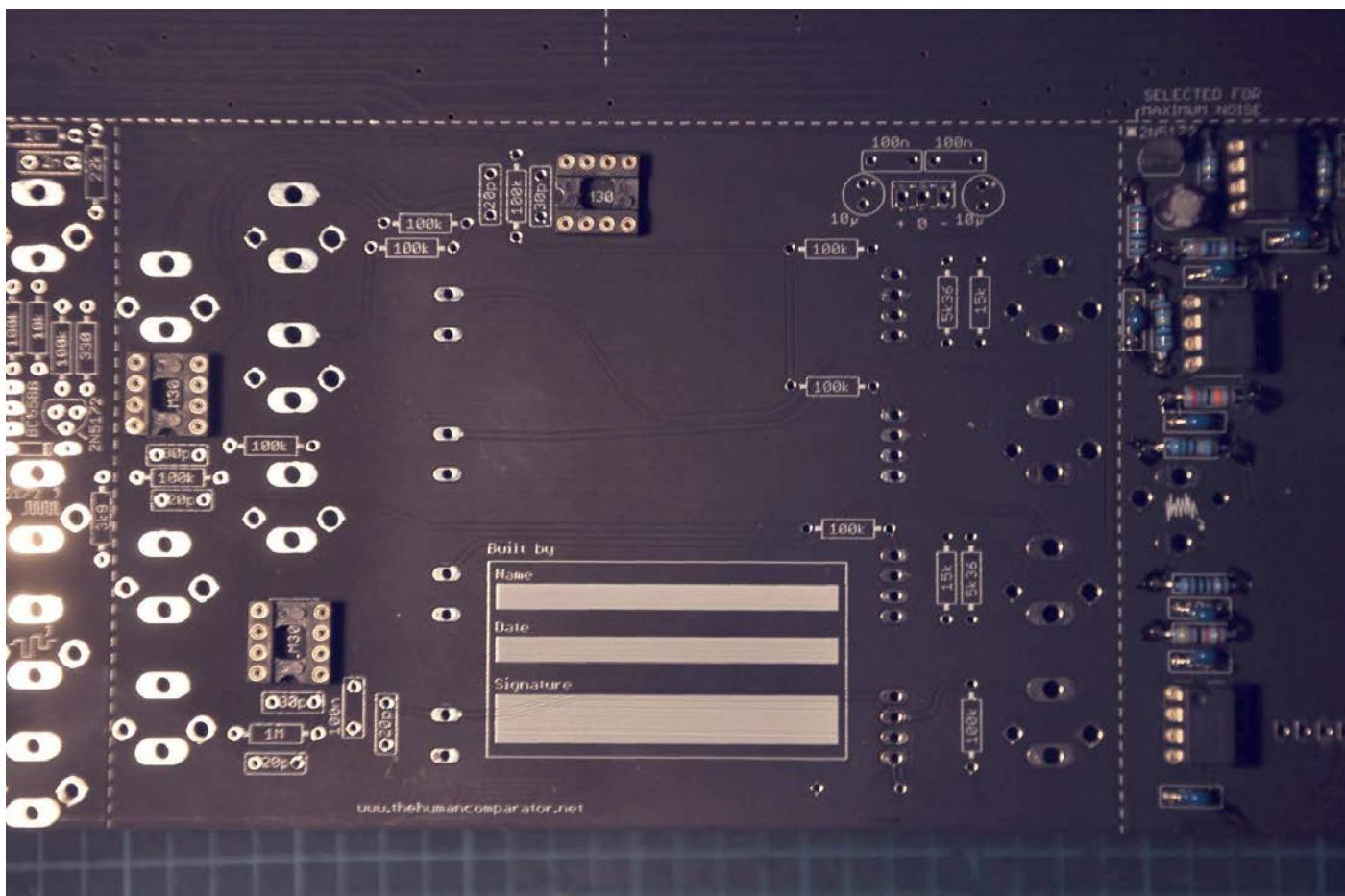
Pink noise.

So with this, let's move on to the Voltage Processors.

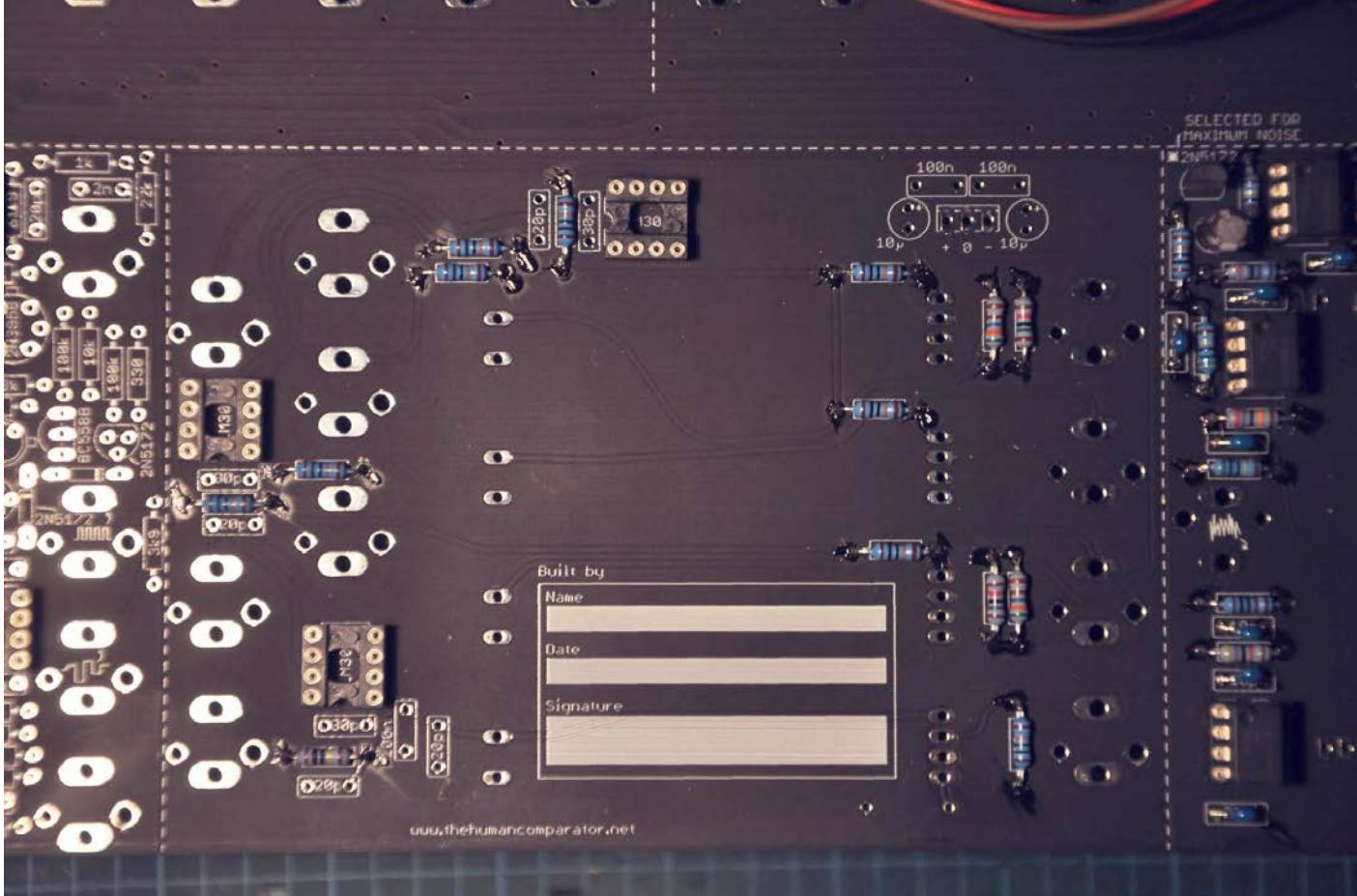
# Voltage Processors

Parts list VOLTAGE PROCESSORS

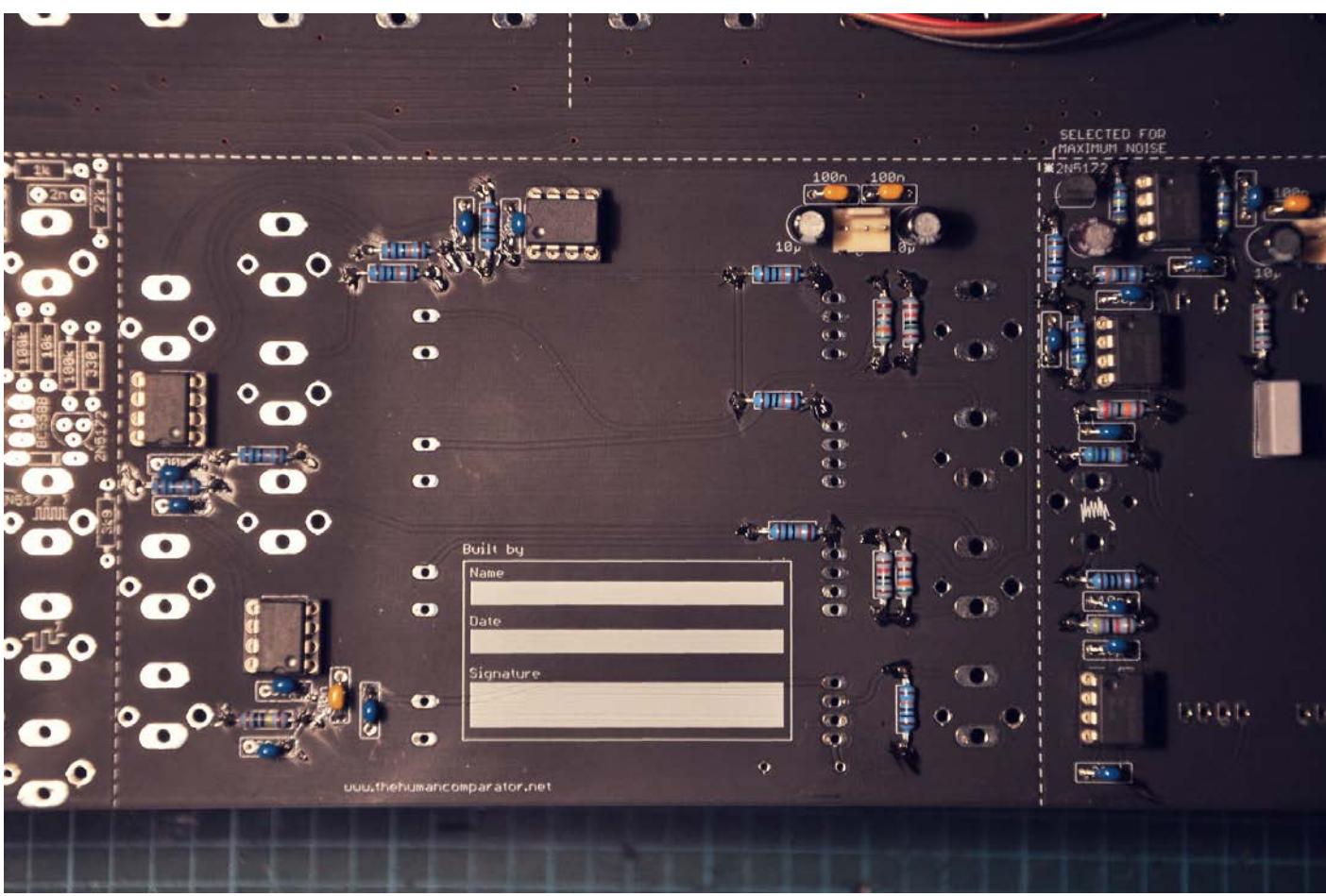
Resistors	Capacitors	Semi's	Other
<ul style="list-style-type: none"><li>■ 5k36 x 2</li><li>■ 15k x 2</li><li>■ 100k x 9</li><li>■ 1M x 1</li></ul>	<ul style="list-style-type: none"><li>■ 20p x 4</li><li>■ 30p x 3</li><li>■ 100n x 3</li><li>■ 10μ x 2 (Electrolytic)</li></ul>	<ul style="list-style-type: none"><li>■ LM301 x 3</li></ul>	<ul style="list-style-type: none"><li>■ 3 pin MTA header x 1</li></ul>



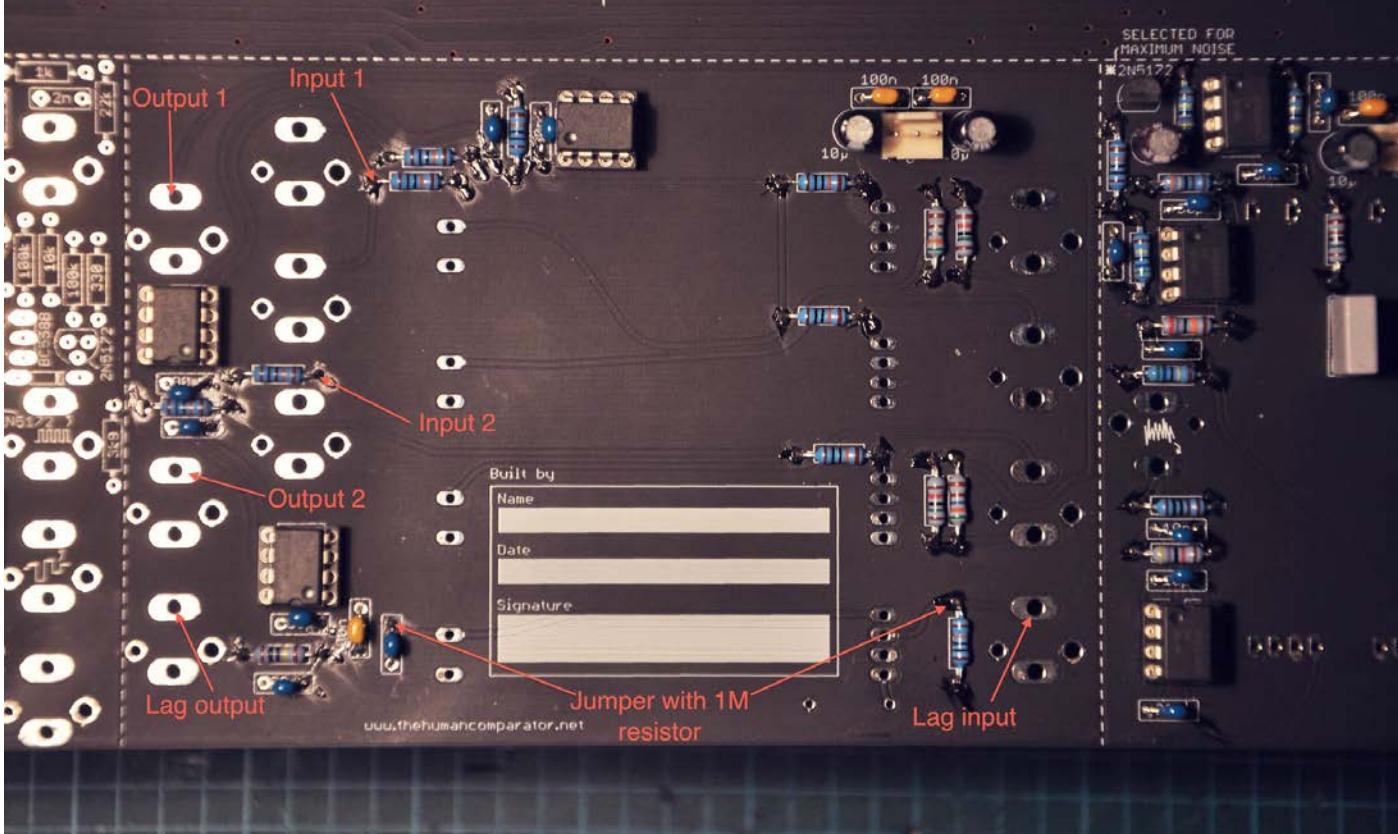
The voltage processors are the middle module at the bottom. It's basically 2 inverters and a lag circuit.



Resistors.



Capacitors and headers and ICs! Done!



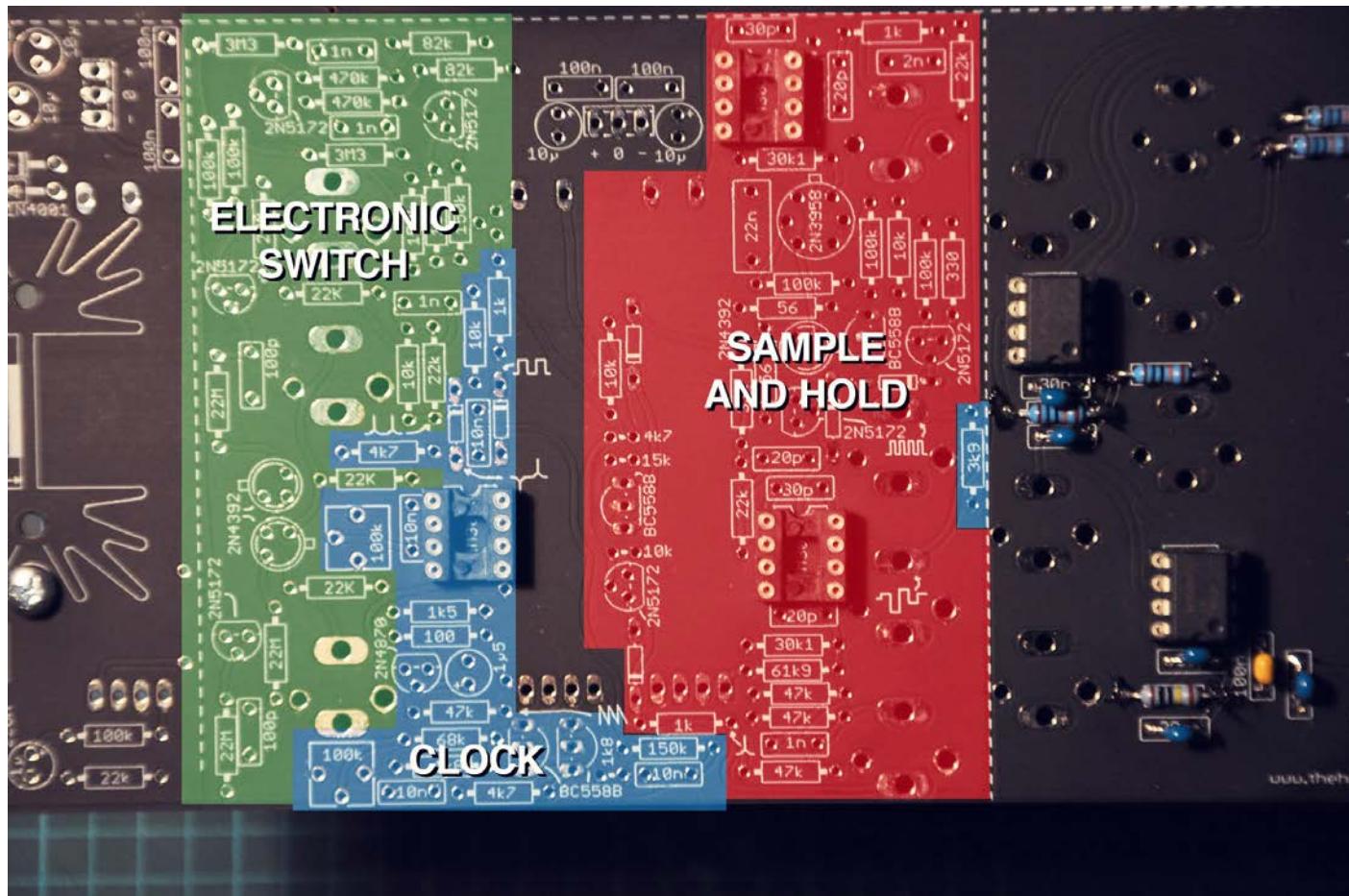
This is also probably best to test once you're done with everything. But if you'd like to test it anyway here's some pointers. Anything you feed into the 2 inverters will come out inverted (Surprise!). And the lag circuit should slew the input. You can vary the 1M resistor with anything between that and 1kOhm.

So we move left to the [Internal Clock](#).

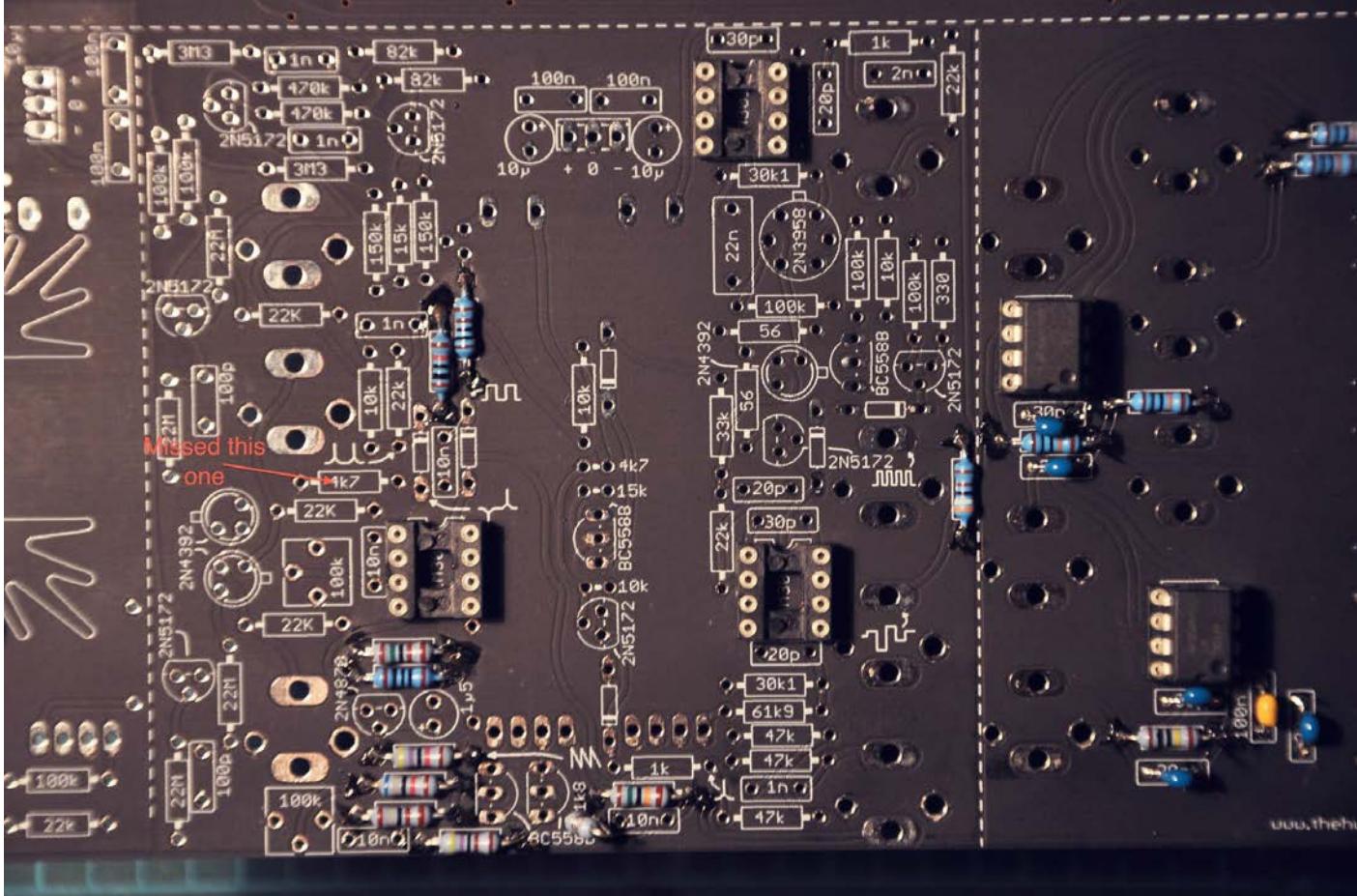
# Internal Clock

Parts list INTERNAL CLOCK

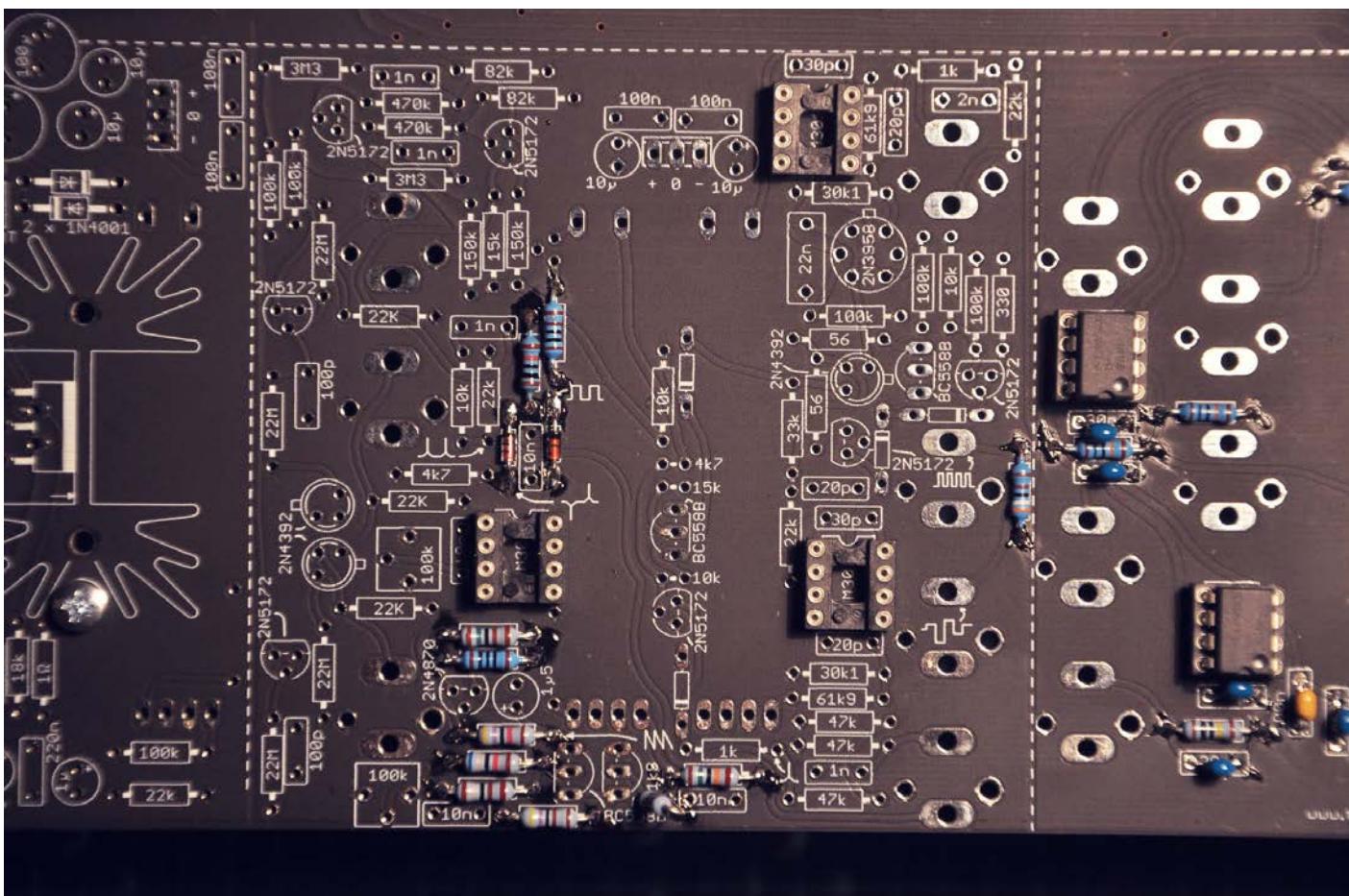
Resistors	Capacitors	Semi's	Trimmers	Other
<ul style="list-style-type: none"><li>■ 100 x 1</li><li>■ 1k x 1</li><li>■ 1k5 x 1</li><li>■ 1k8 x 2</li><li>■ 3k9 x 1</li><li>■ 4k7 x 2</li><li>■ 10k x 1</li><li>■ 47k x 1</li><li>■ 68k x 1</li><li>■ 150k x 1</li></ul>	<ul style="list-style-type: none"><li>■ 10n x 4</li><li>■ 100n x 2</li><li>■ 1μ5 x 1 (Electrolytic)</li><li>■ 10μ x 2 (Electrolytic)</li></ul>	<ul style="list-style-type: none"><li>■ BC558 x 2</li><li>■ 2N4870 x 1</li><li>■ LM301 x 1</li><li>■ 1N4148 x 2</li></ul>	<ul style="list-style-type: none"><li>■ 100k x 2</li></ul>	<ul style="list-style-type: none"><li>■ 3 pin MTA header x 1</li></ul>



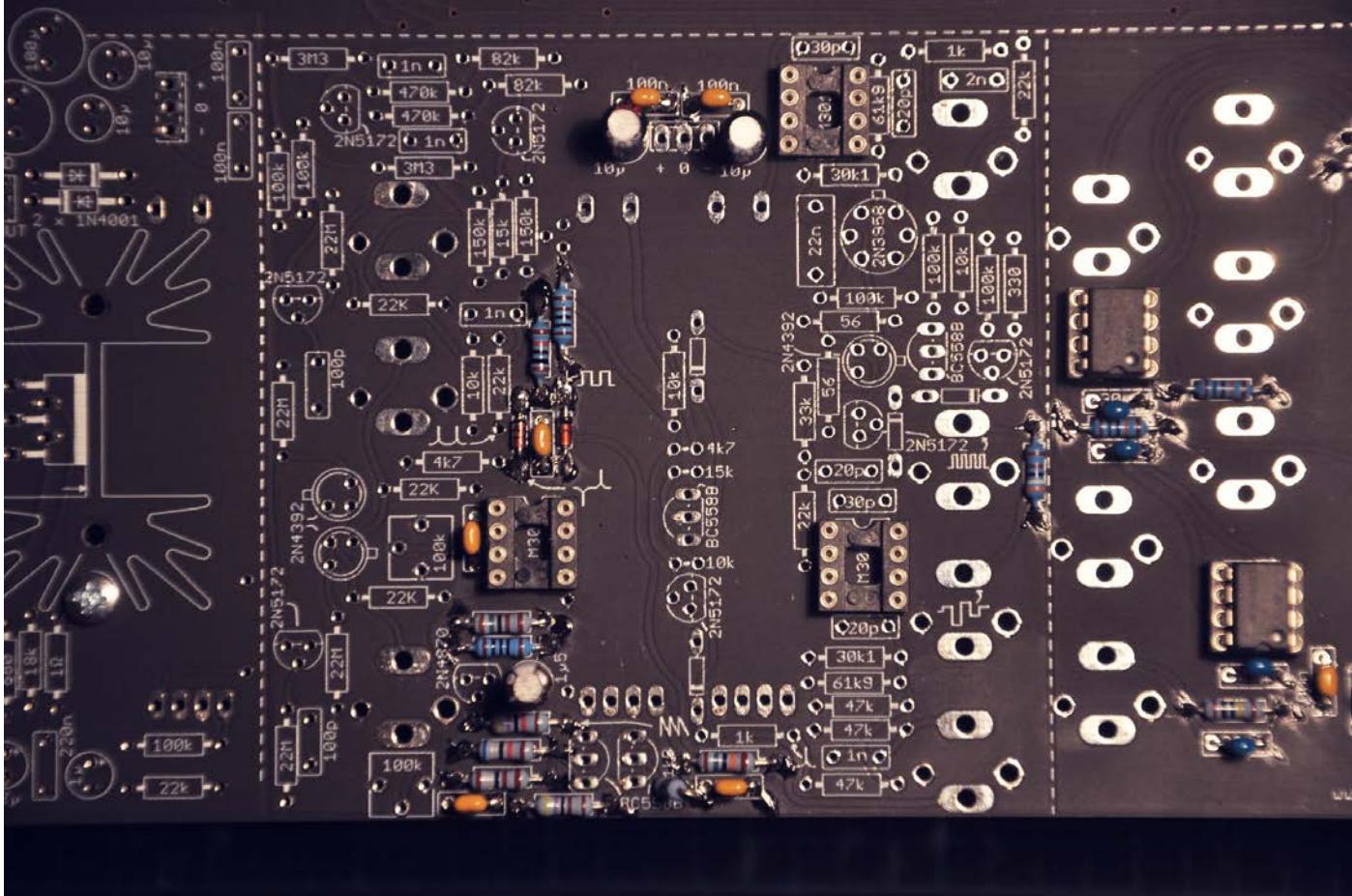
The internal clock, sample and hold and electronic switch is all part of this module. You can see the different sections in the image above.



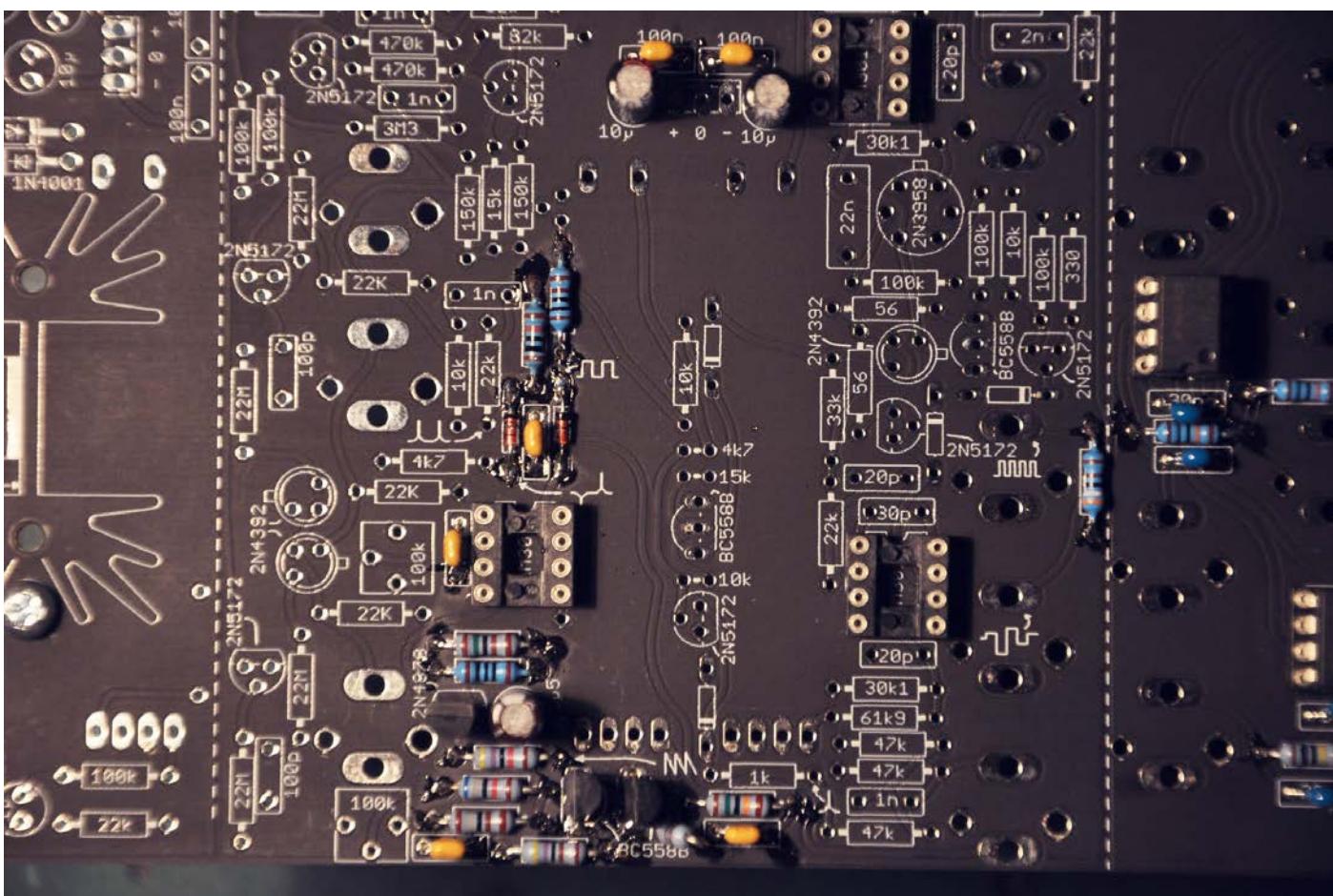
So, resistors.



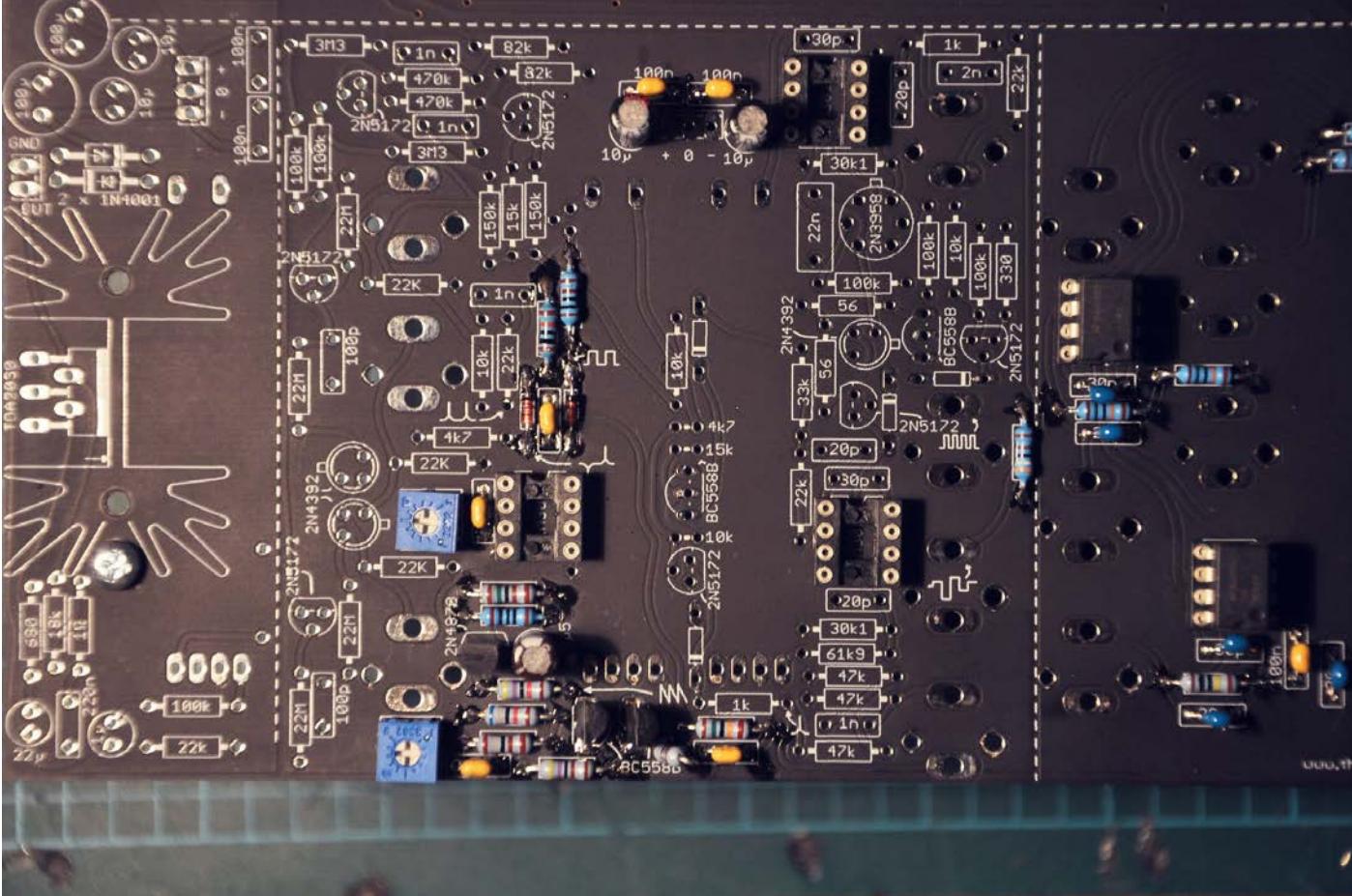
The 2 diodes.



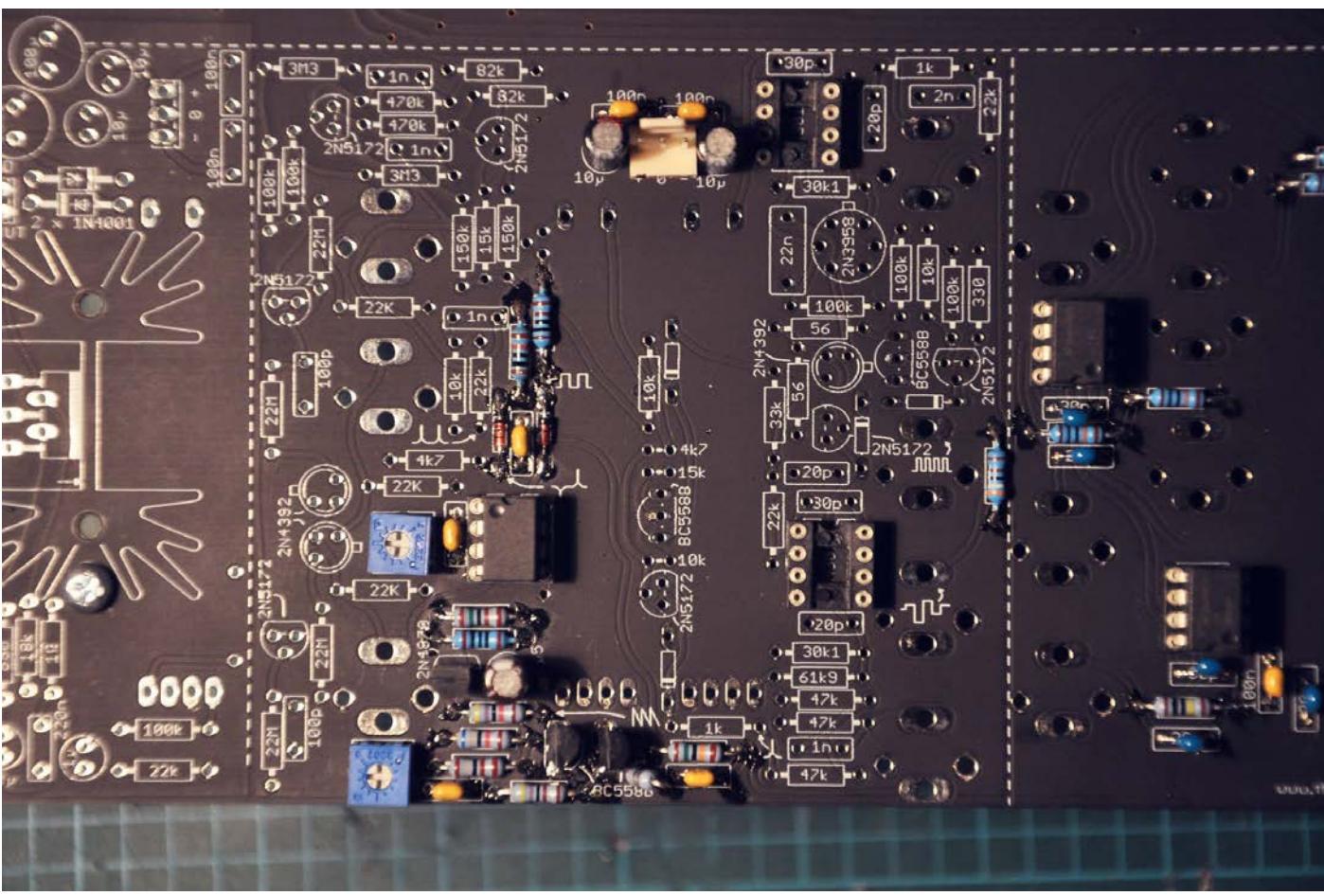
Capacitors.



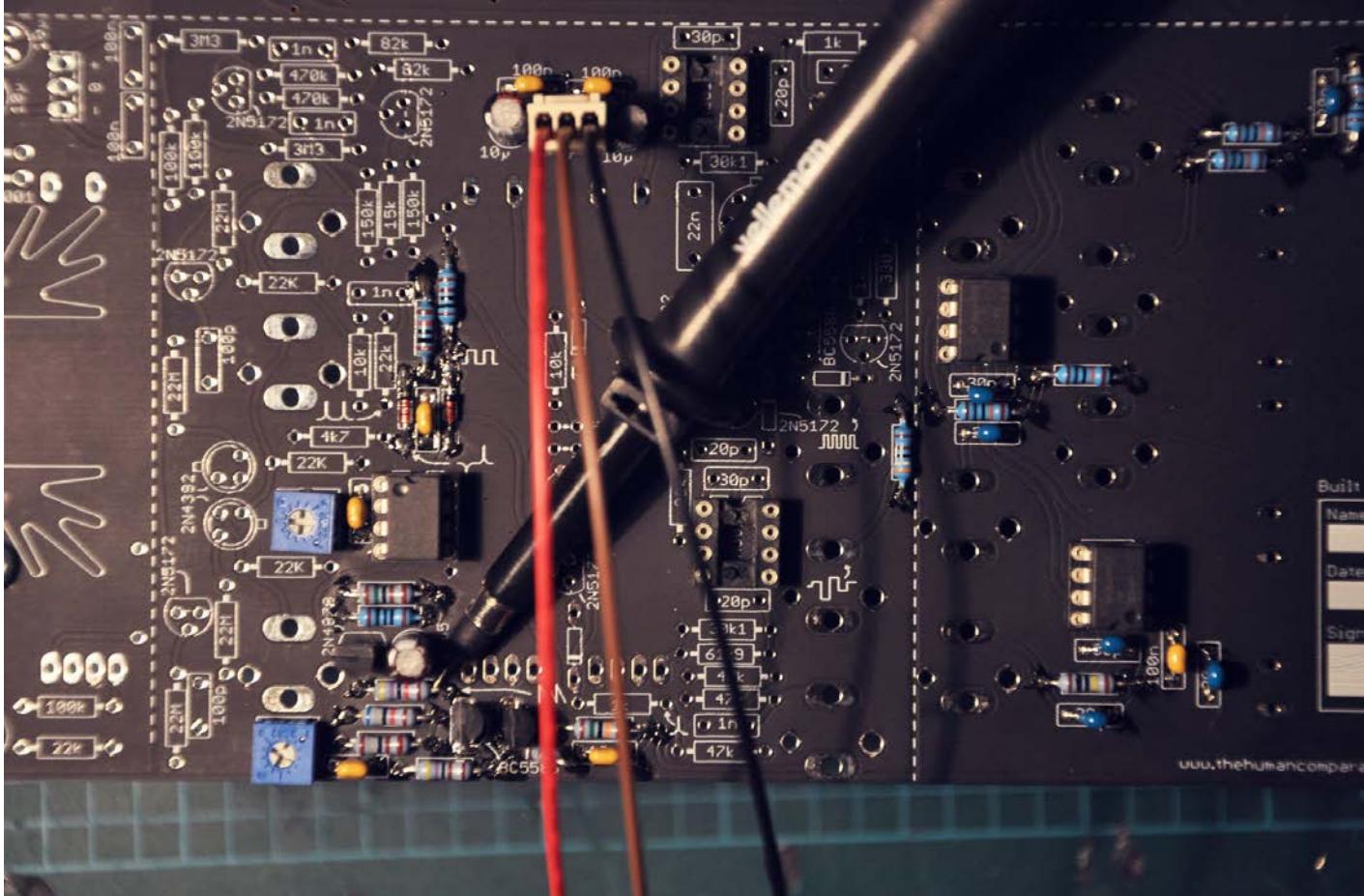
Transistors.



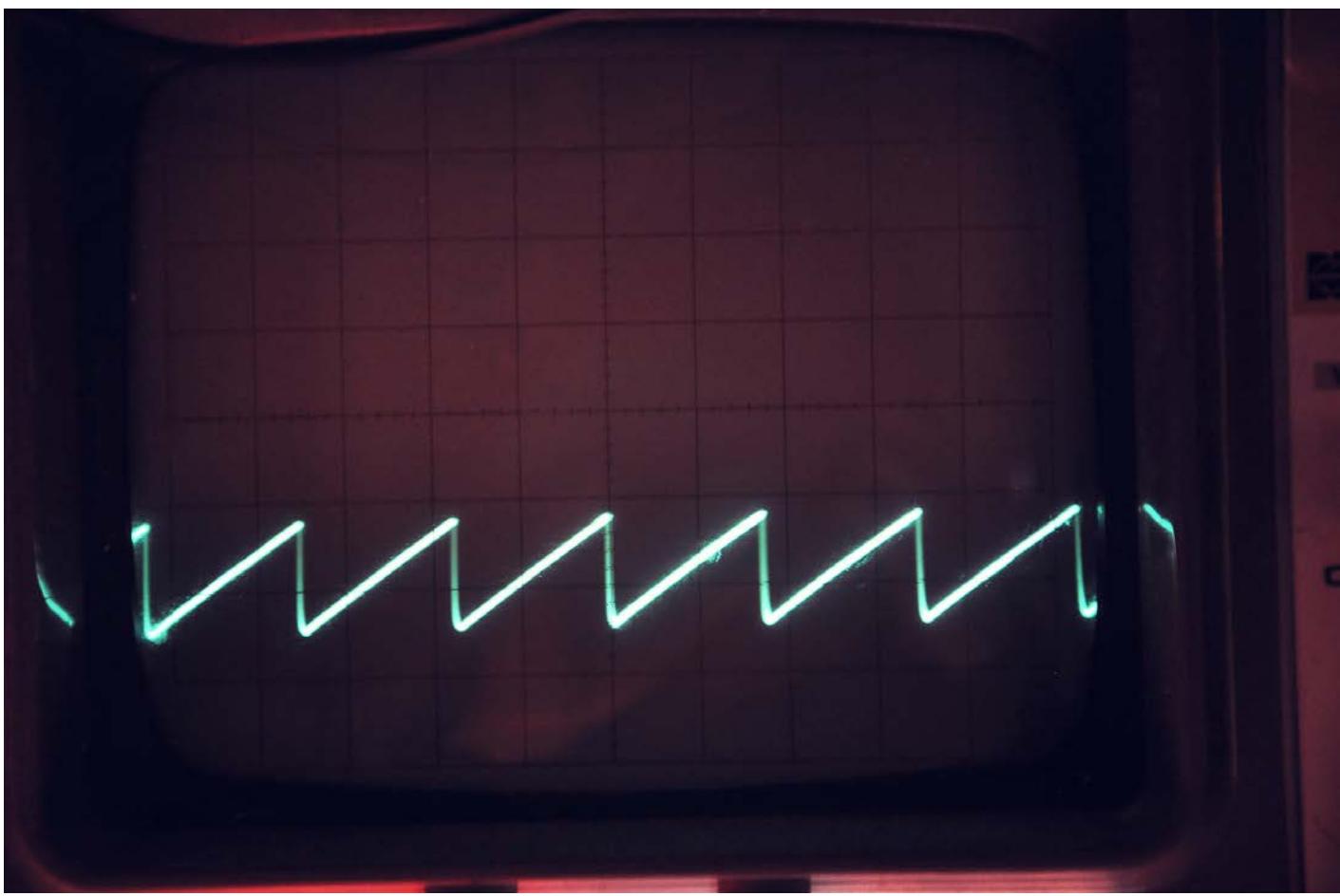
The 2 trimmers. The top one is for setting the pulse width, and the bottom is for rate.



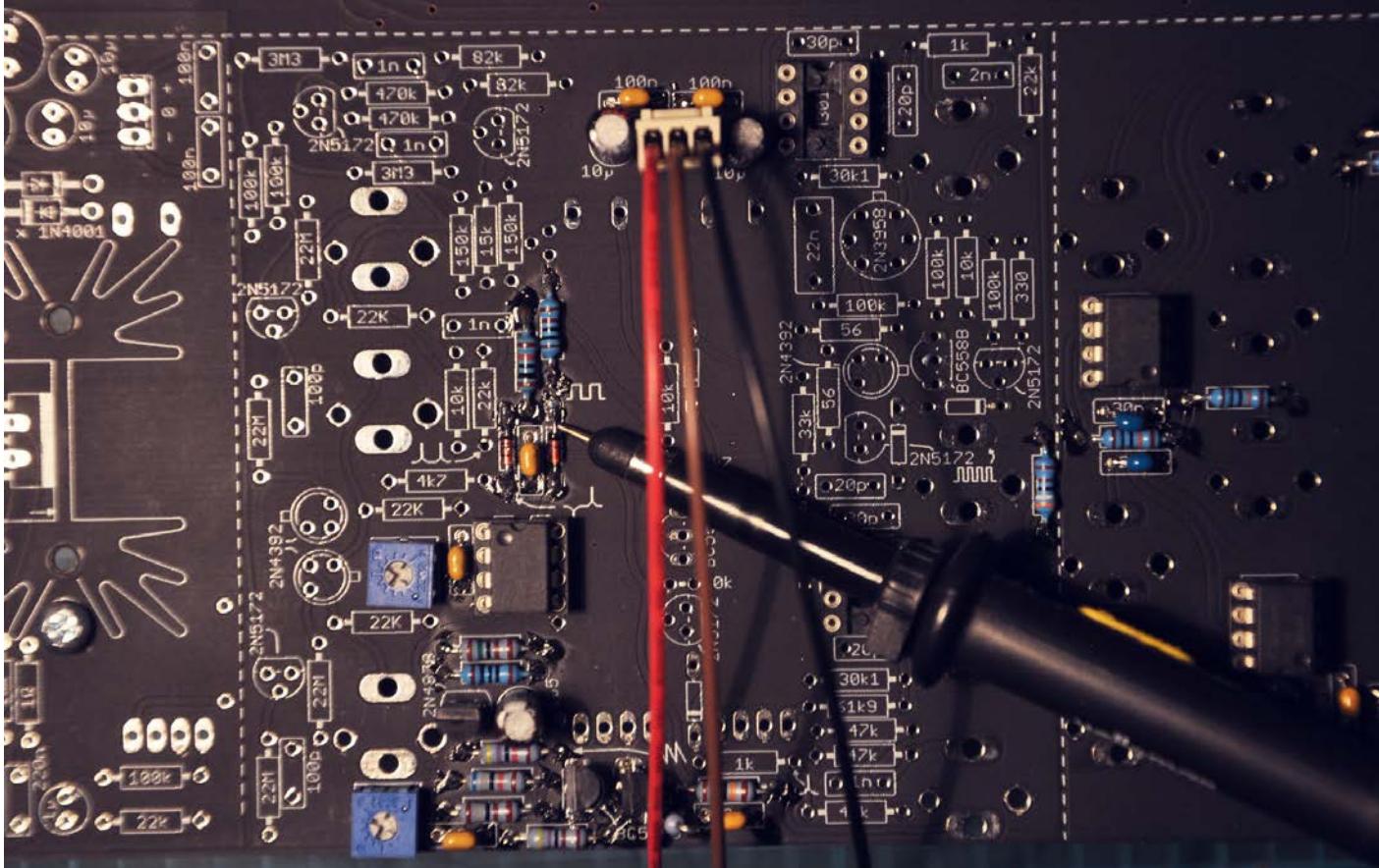
Stuff the IC, and we're ready to go!



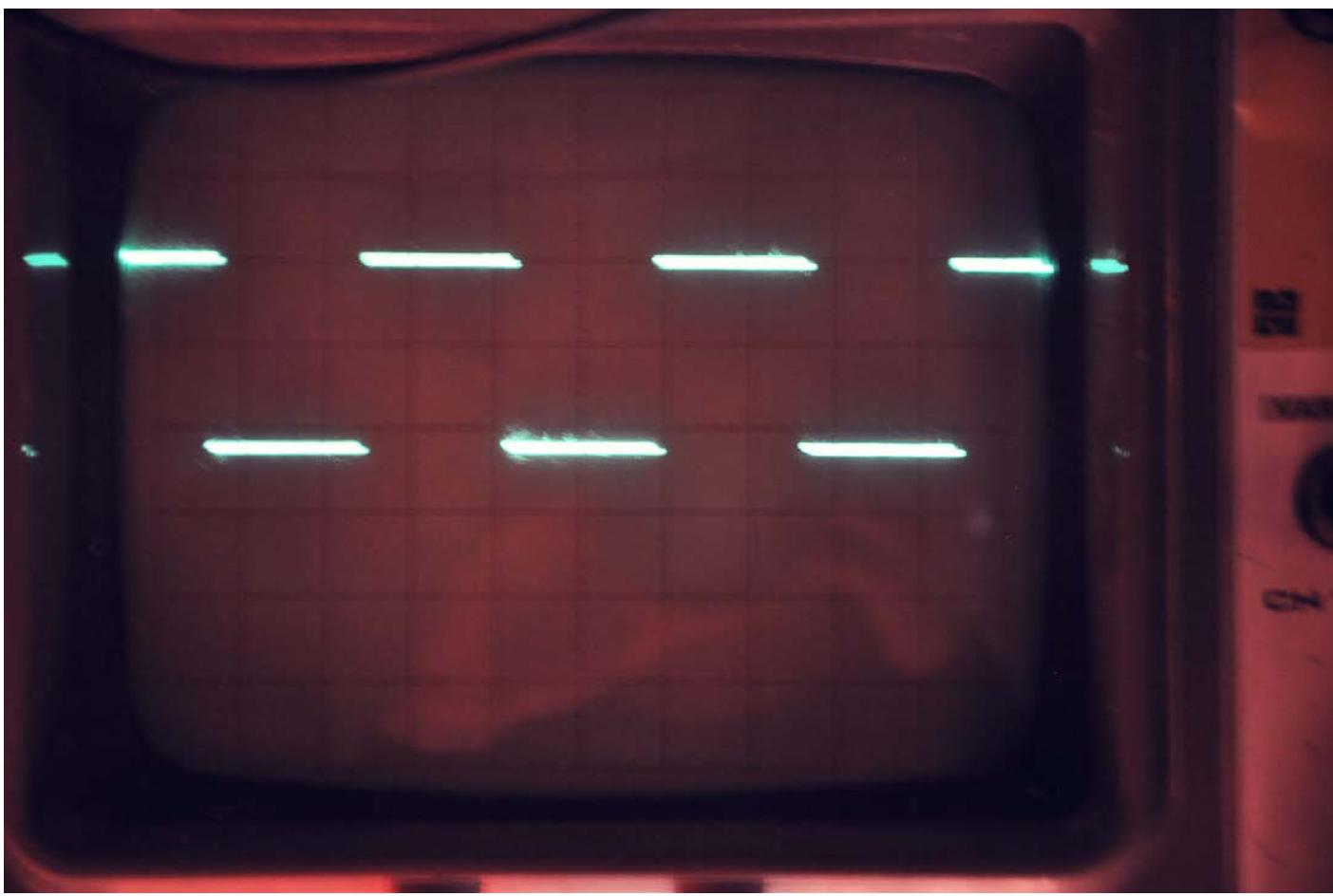
Power it up and check for sawtooth coming out of the 2n4870.



It will have a noticeable DC offset and ramp from the bottom rail up a few volts. If you can't see it, try adjusting the trimmer closest to the edge and it should come to life.



Check for pulse signal.

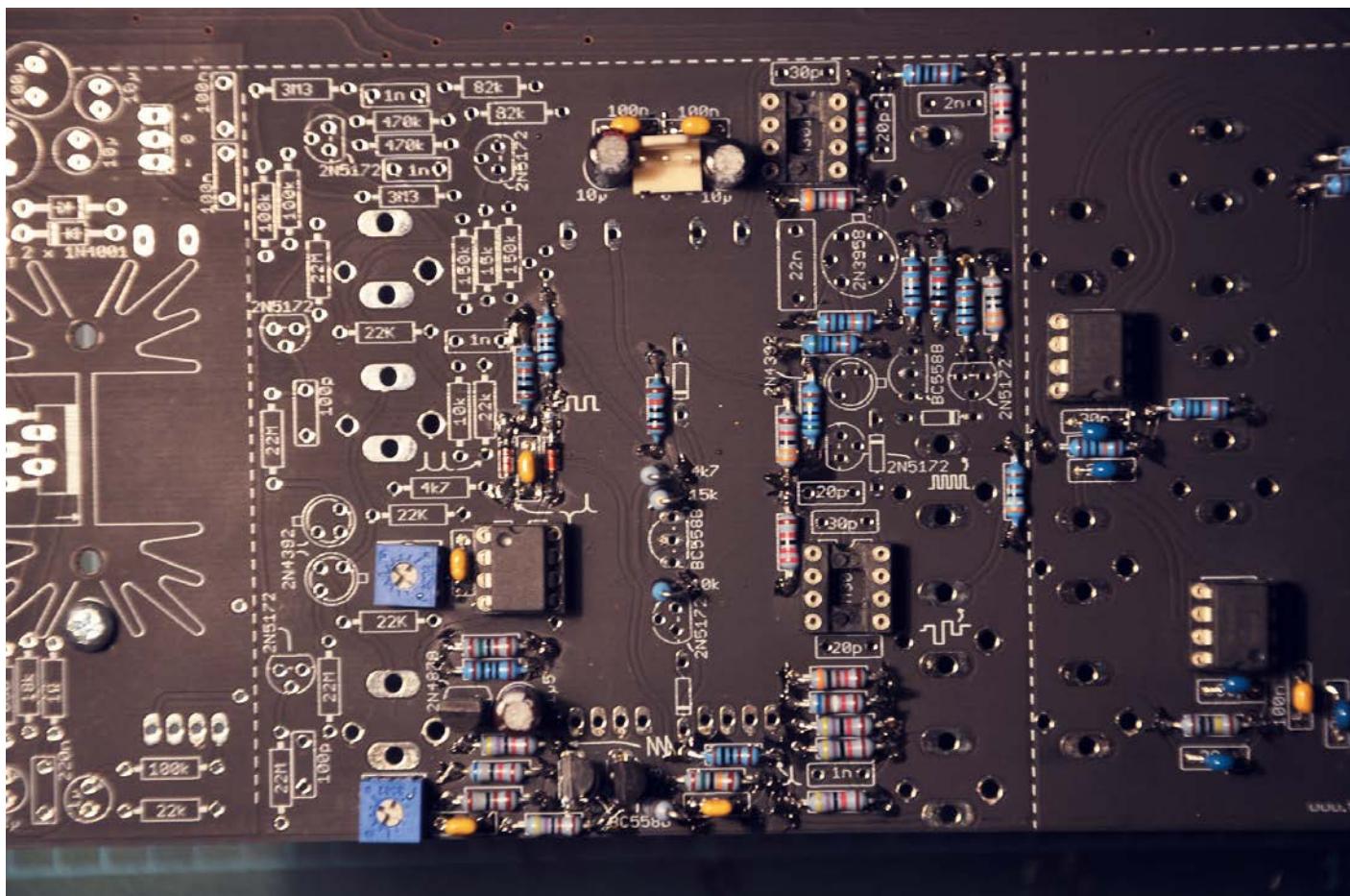


Adjust the trimmer adjacent to the LM301 until the pulse width is 50%.

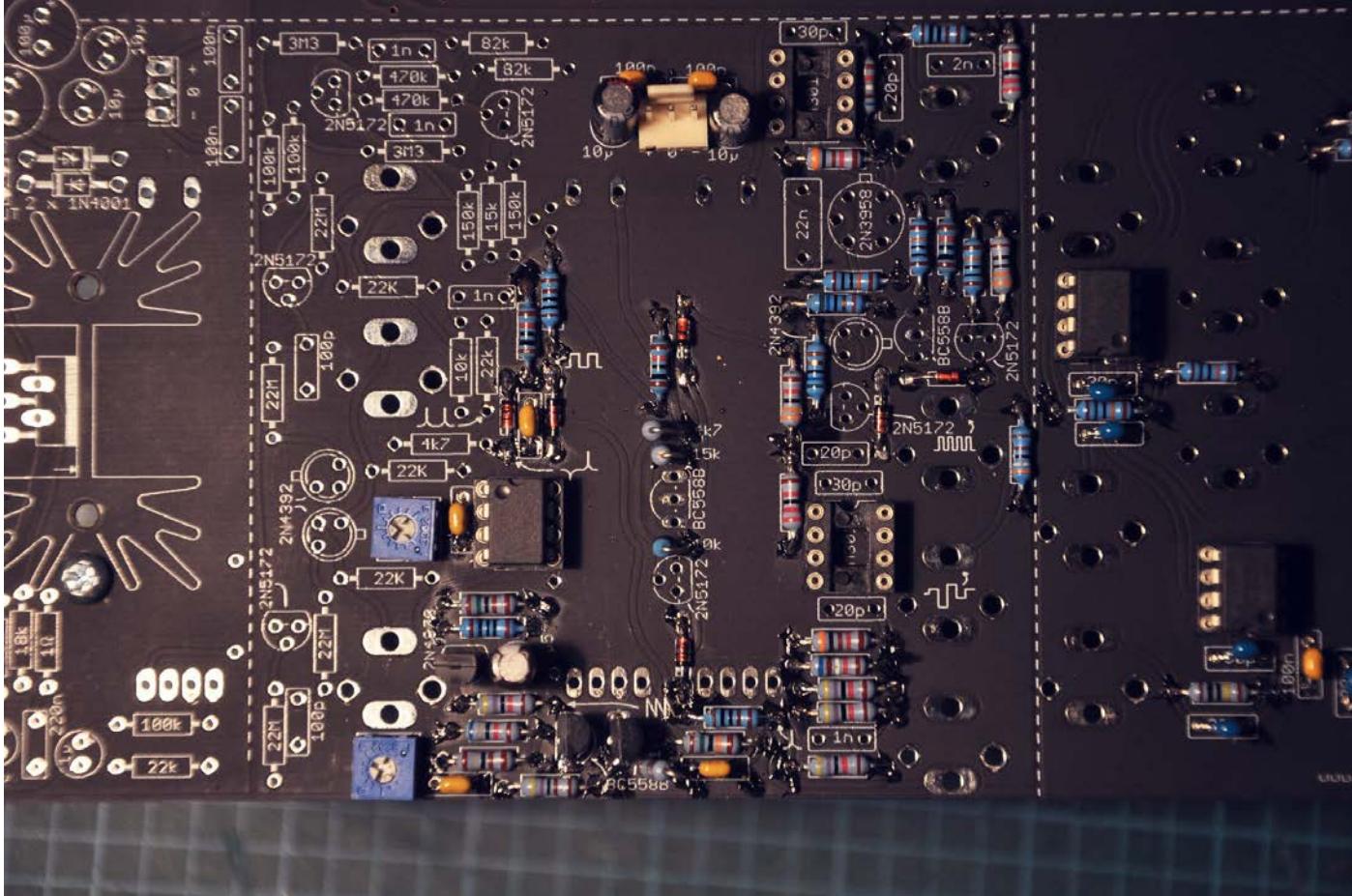
Now you've got an internal clock! **So let's fix the Sample & Hold.**

# S/H

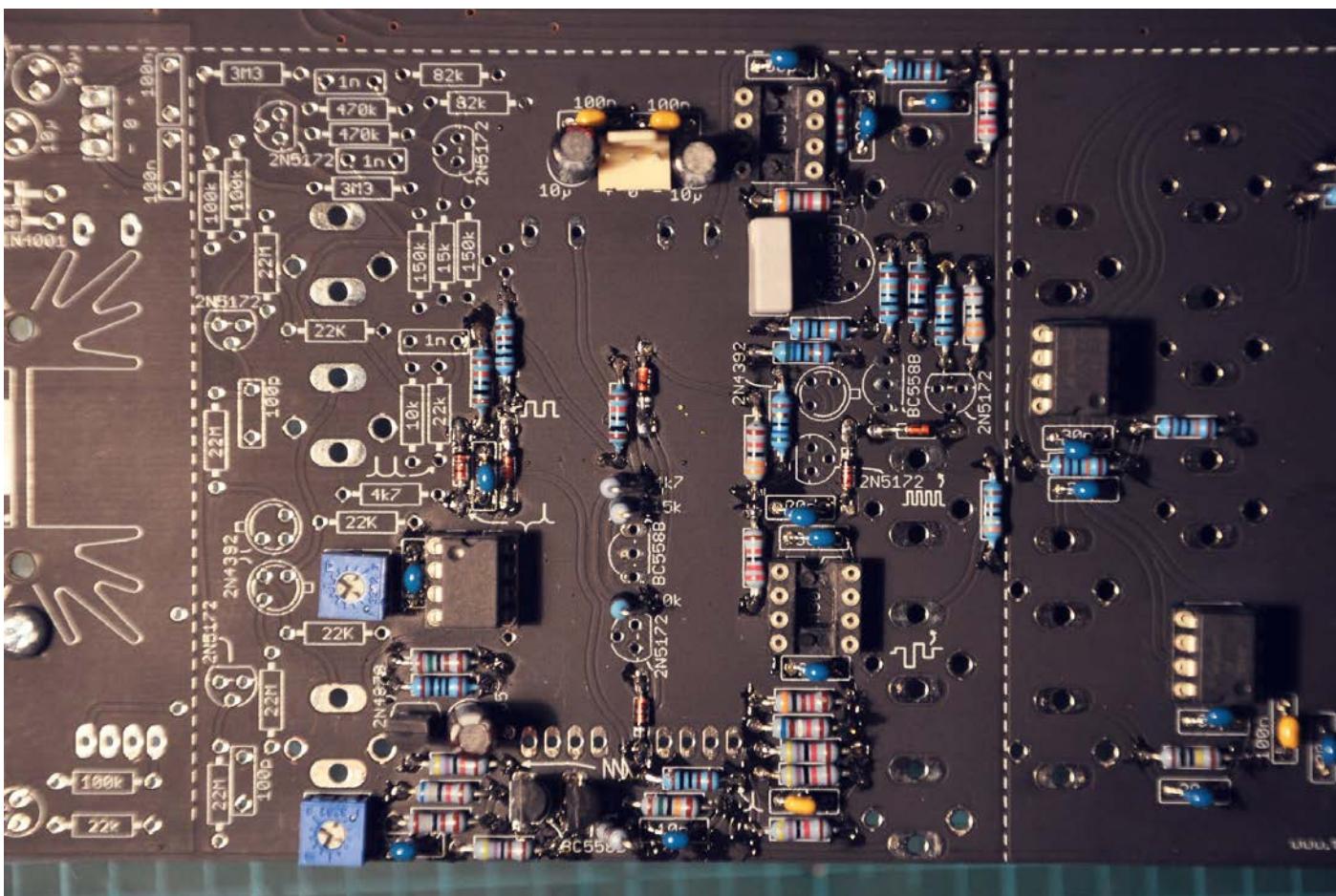
Parts list S/H			
Resistors	Capacitors	Semi's	Other
<ul style="list-style-type: none"><li>■ 56 x 2</li><li>■ 330 x 1</li><li>■ 1k x 2</li><li>■ 4k7 x 1</li><li>■ 10k x 3</li><li>■ 15k x 1</li><li>■ 22k x 2</li><li>■ 30k1 x 2</li><li>■ 33k x 1</li><li>■ 47k x 3</li><li>■ 61k9 x 2</li><li>■ 100k x 3</li></ul>	<ul style="list-style-type: none"><li>■ 20p x 3</li><li>■ 30p x 2</li><li>■ 22n x 1</li><li>■ 1n x 1</li><li>■ 2n x 1</li></ul>	<ul style="list-style-type: none"><li>■ BC558 x 2</li><li>■ LM301 x 2</li><li>■ 2N3958 x 1</li><li>■ 2N4392 x 1</li><li>■ 2N5172 x 3</li><li>■ 1N4148 x 4</li></ul>	<ul style="list-style-type: none"><li>■ 3.5mm jack x 1</li></ul>



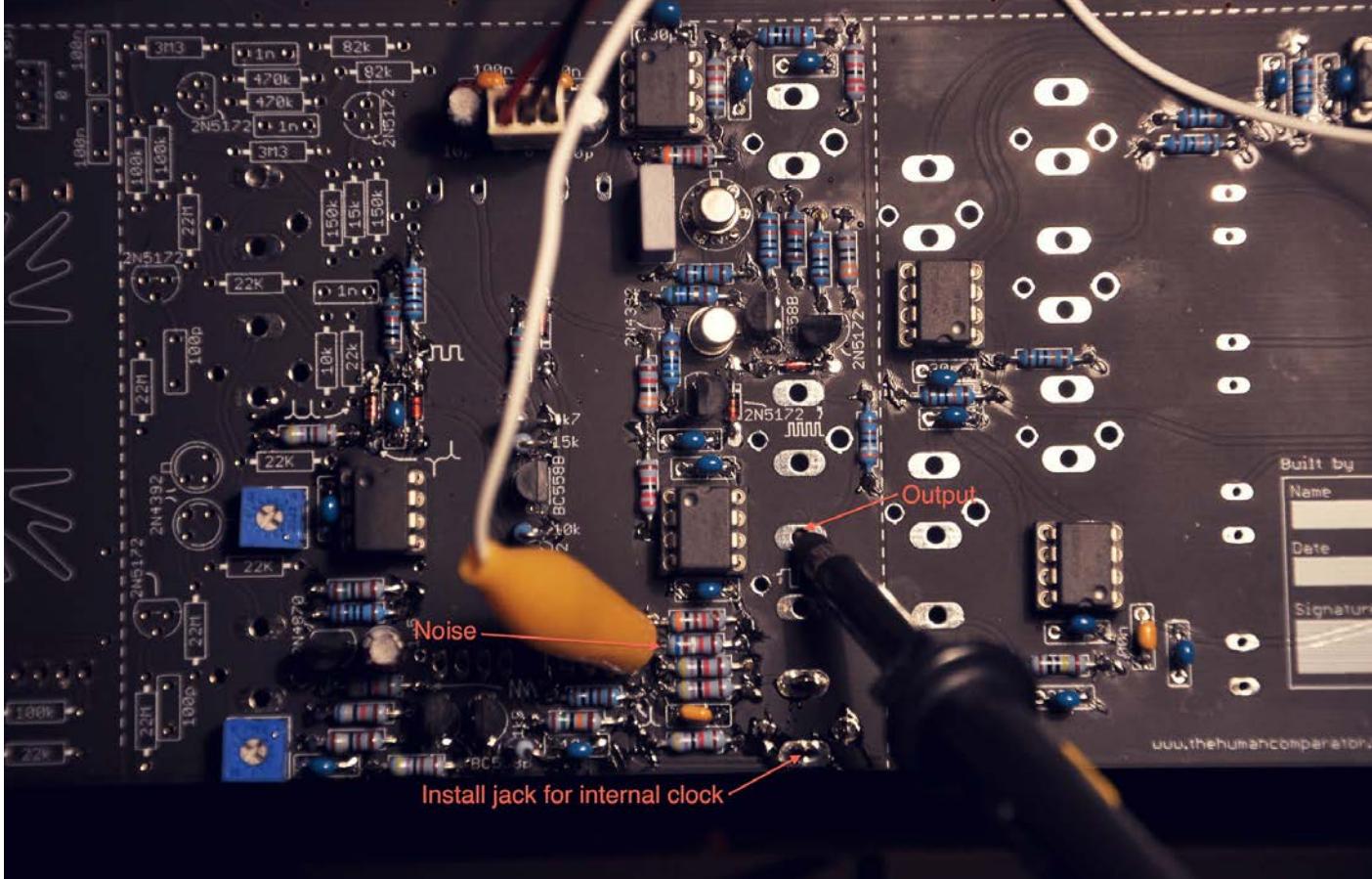
Resistors.



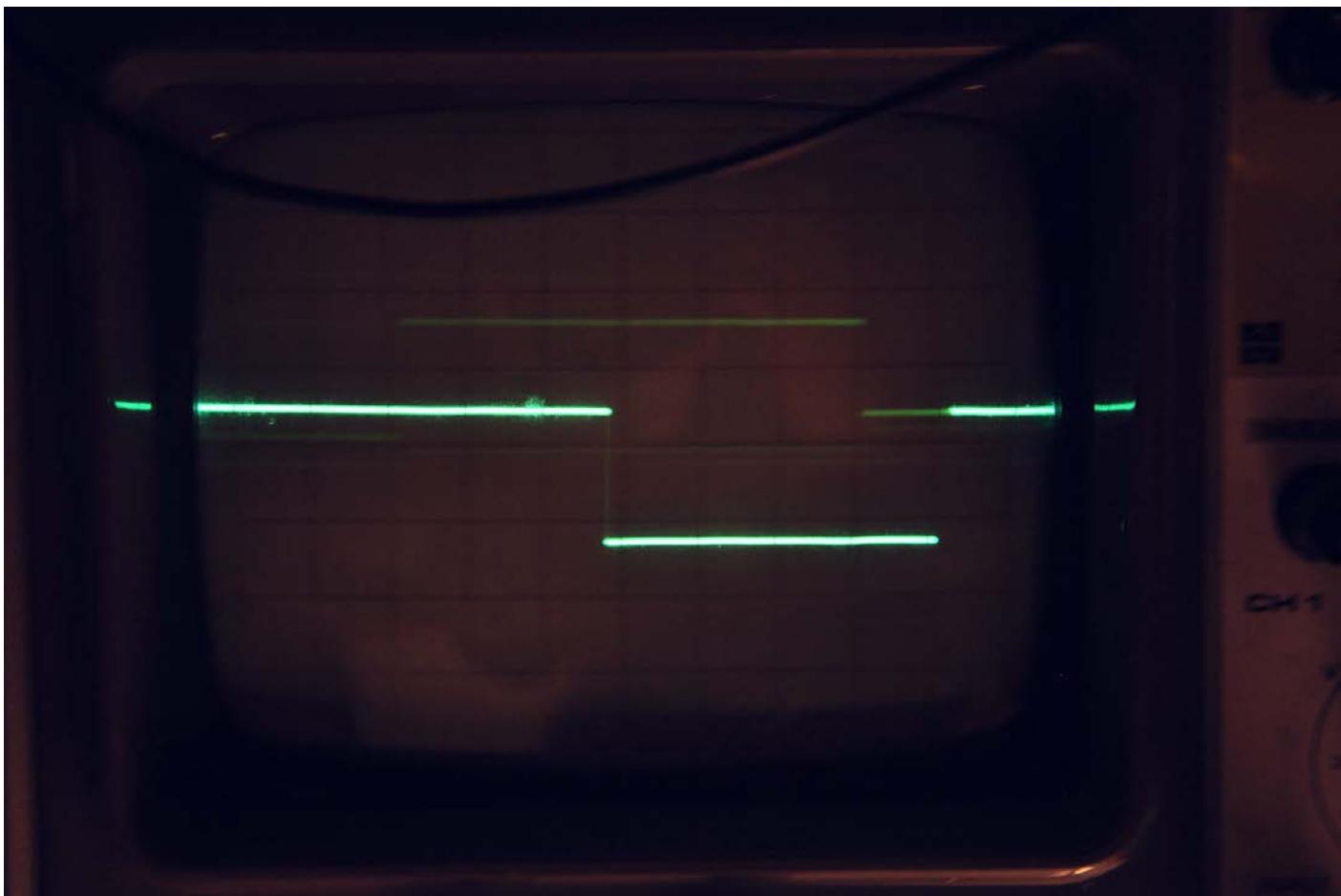
Diodes. Remember to check orientation. No reason for slacking off now, we're almost done!



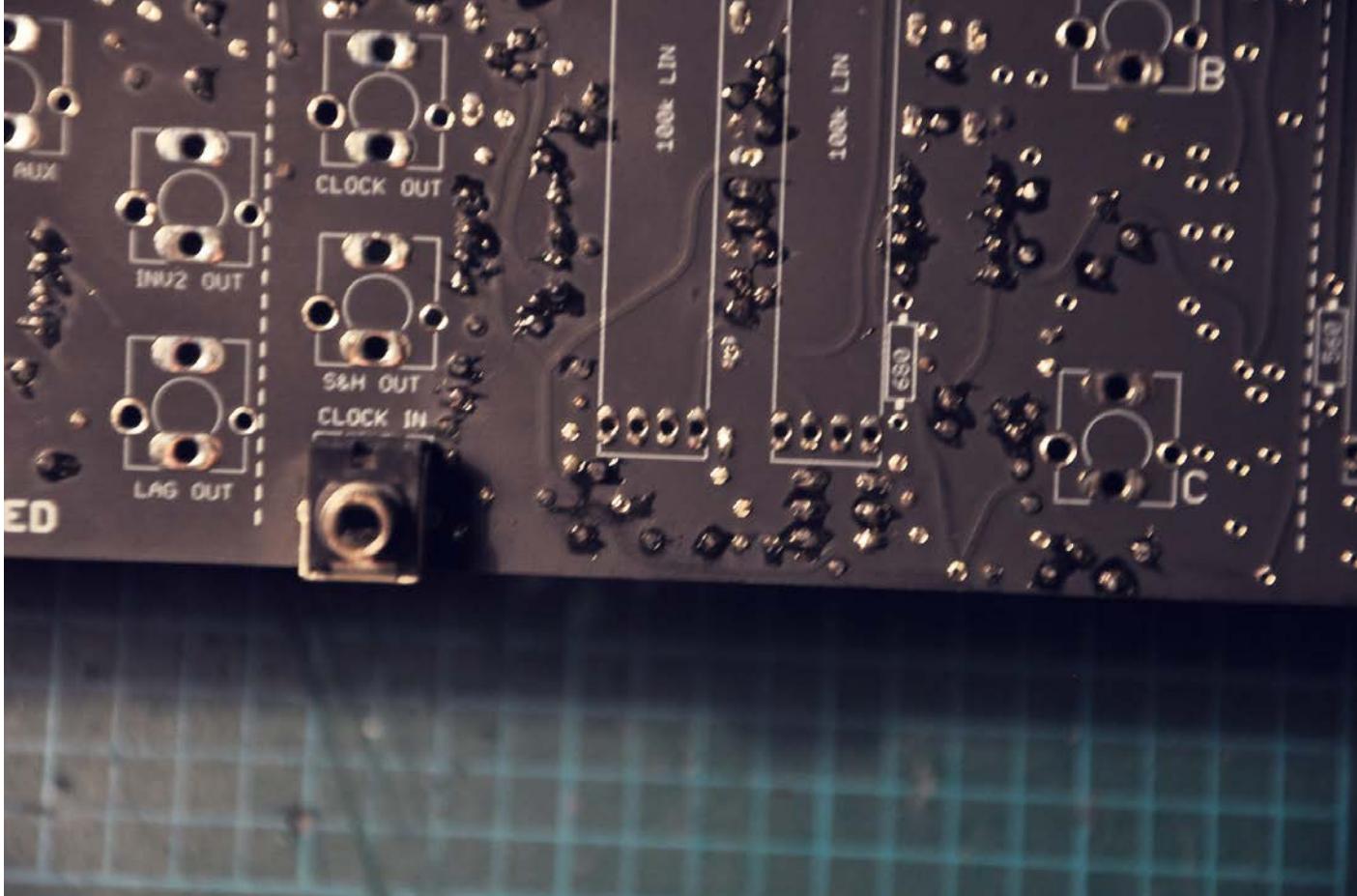
Capacitors.



Transistors and LM301 and testing! Feed noise (Or any other varying signal) at the resistor showed above. It's a good idea to install the 3,5mm jack normalled to the internal clock.



You should have a shifting level output in sync with the internal clock.



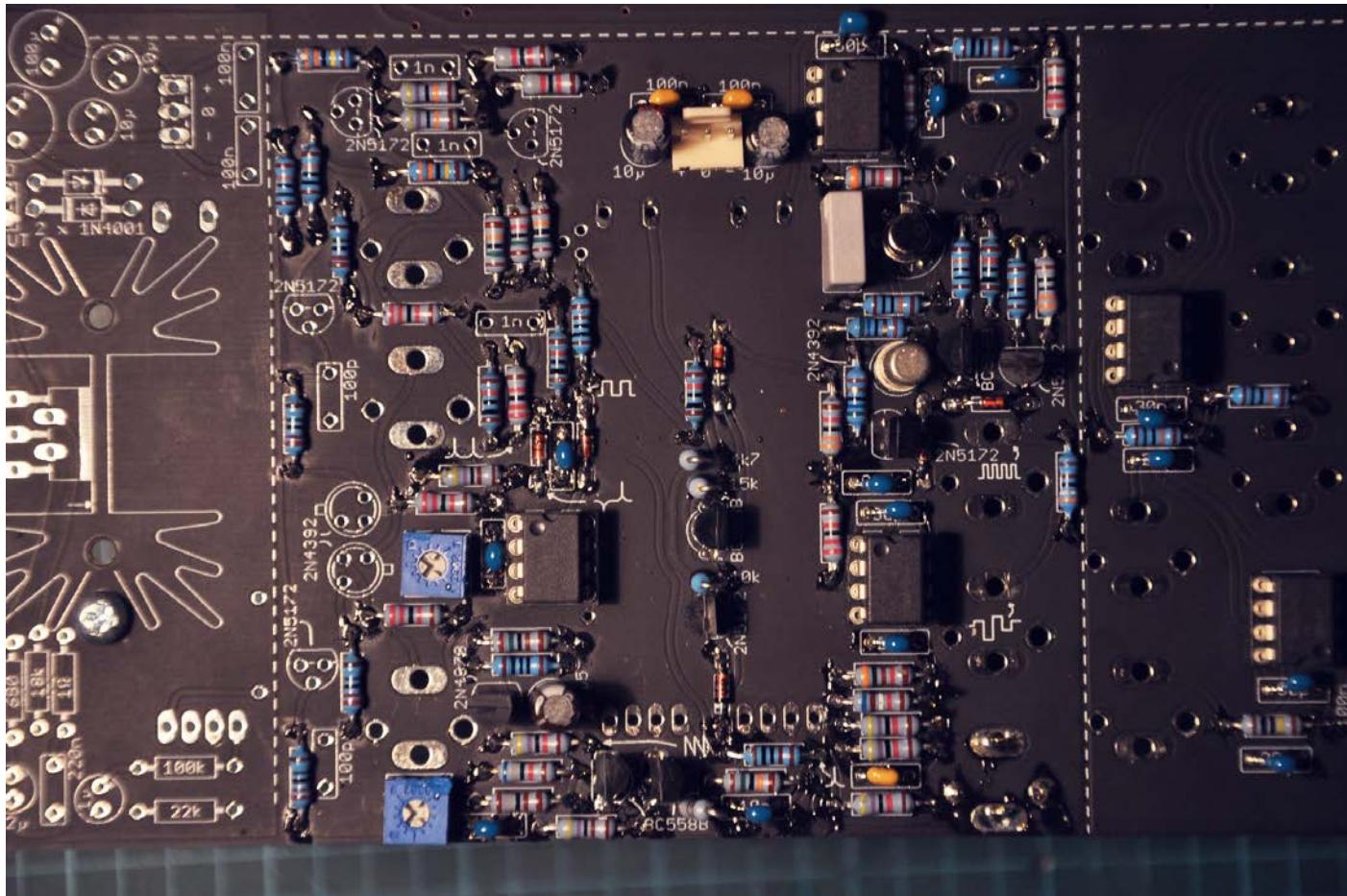
3,5mm jack for the internal clock.

And that's that! You've now finished the heart of R2D2.

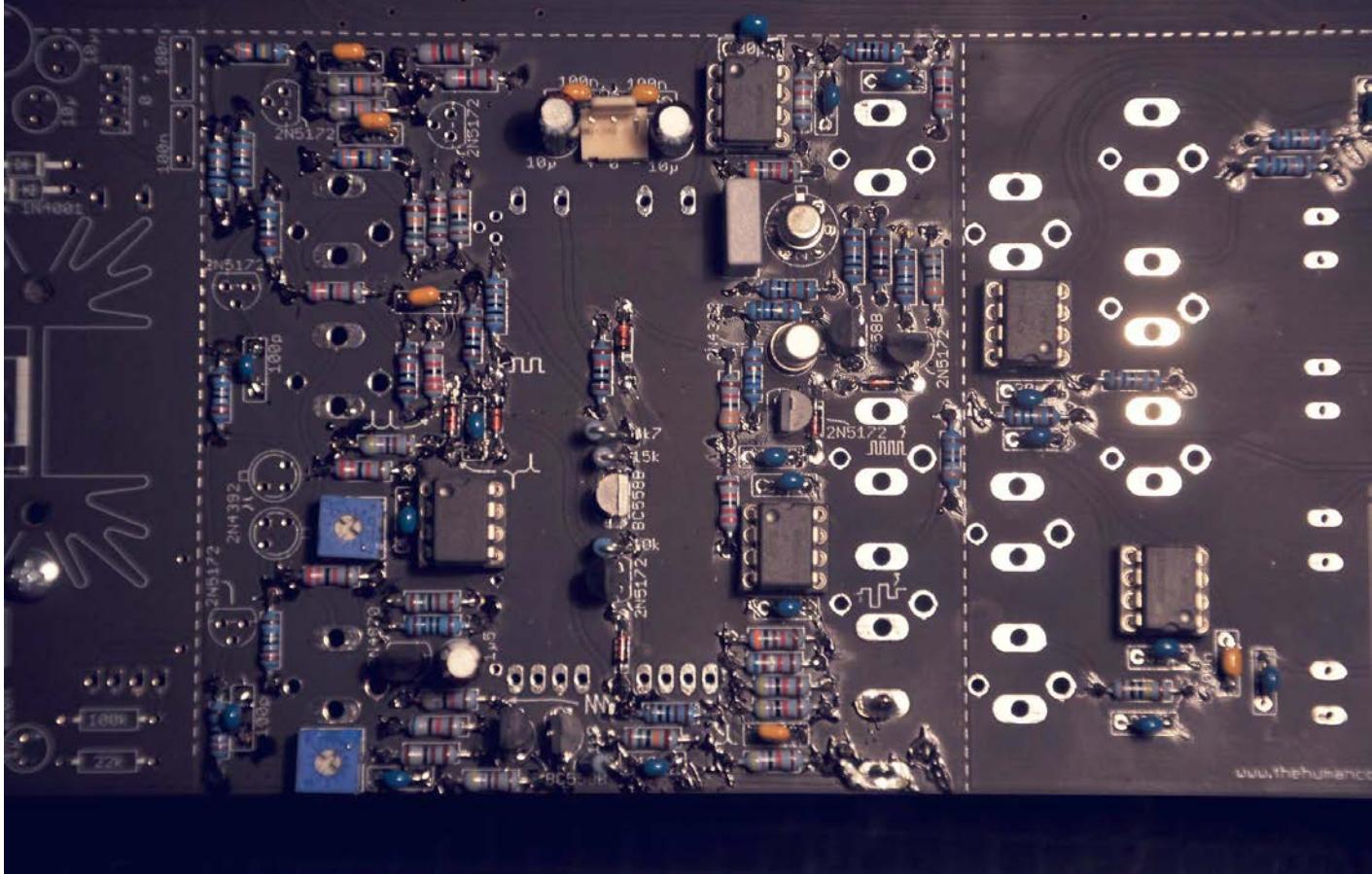
# Electronic Switch

Parts list SWITCH		
Resistors	Capacitors	Semi's
<ul style="list-style-type: none"><li>■ 10k x 1</li><li>■ 15k x 1</li><li>■ 22K x 4</li><li>■ 82k x 2</li><li>■ 100k x 2</li><li>■ 150k x 2</li><li>■ 470k x 2</li><li>■ 3M3 x 2</li><li>■ 22M x 4</li></ul>	<ul style="list-style-type: none"><li>■ 100p x 2</li><li>■ 1n x 3</li></ul>	<ul style="list-style-type: none"><li>■ 2N4392 x 2</li><li>■ 2N5172 x 4</li></ul>

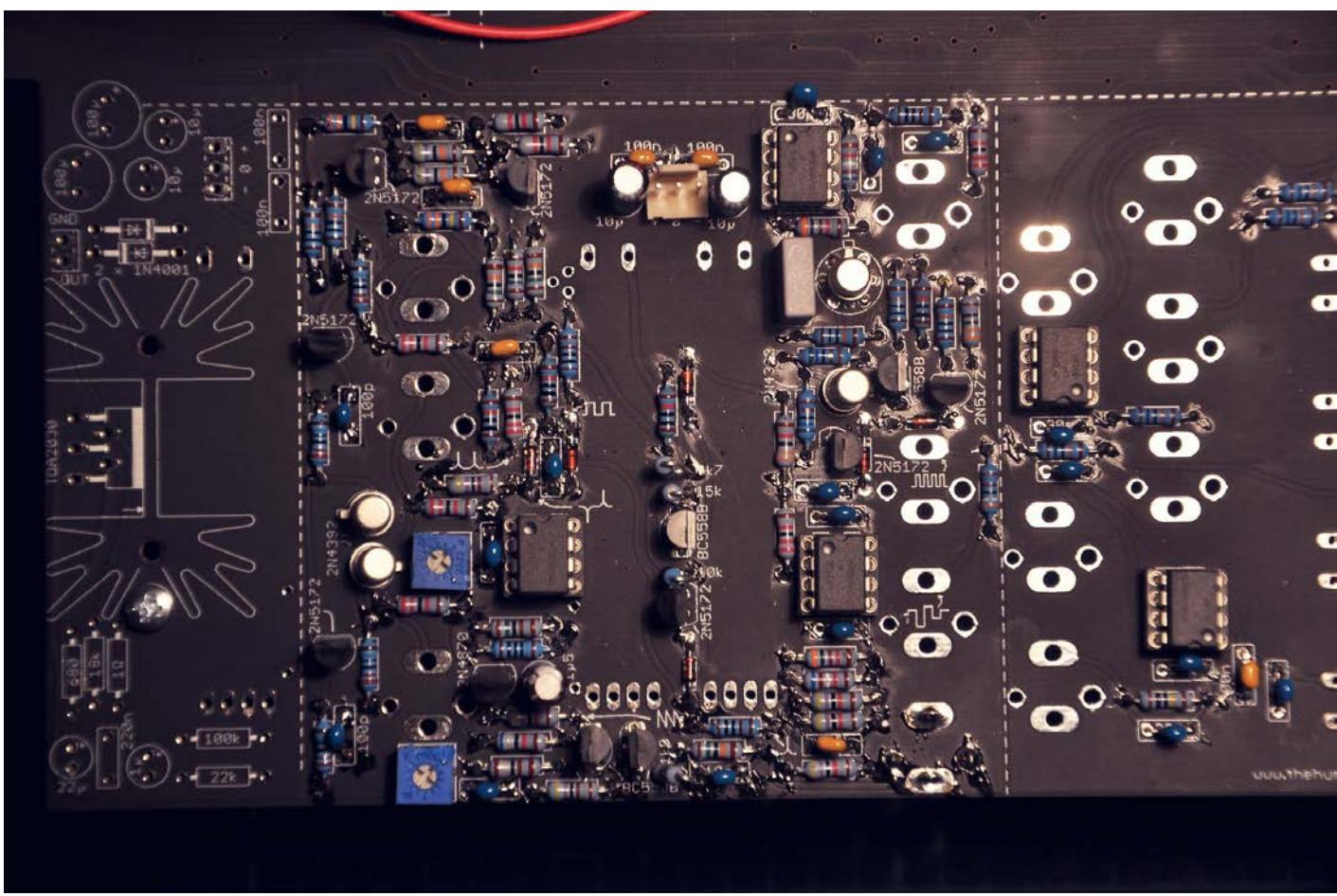
The Electronic Switch is the last section in this module.



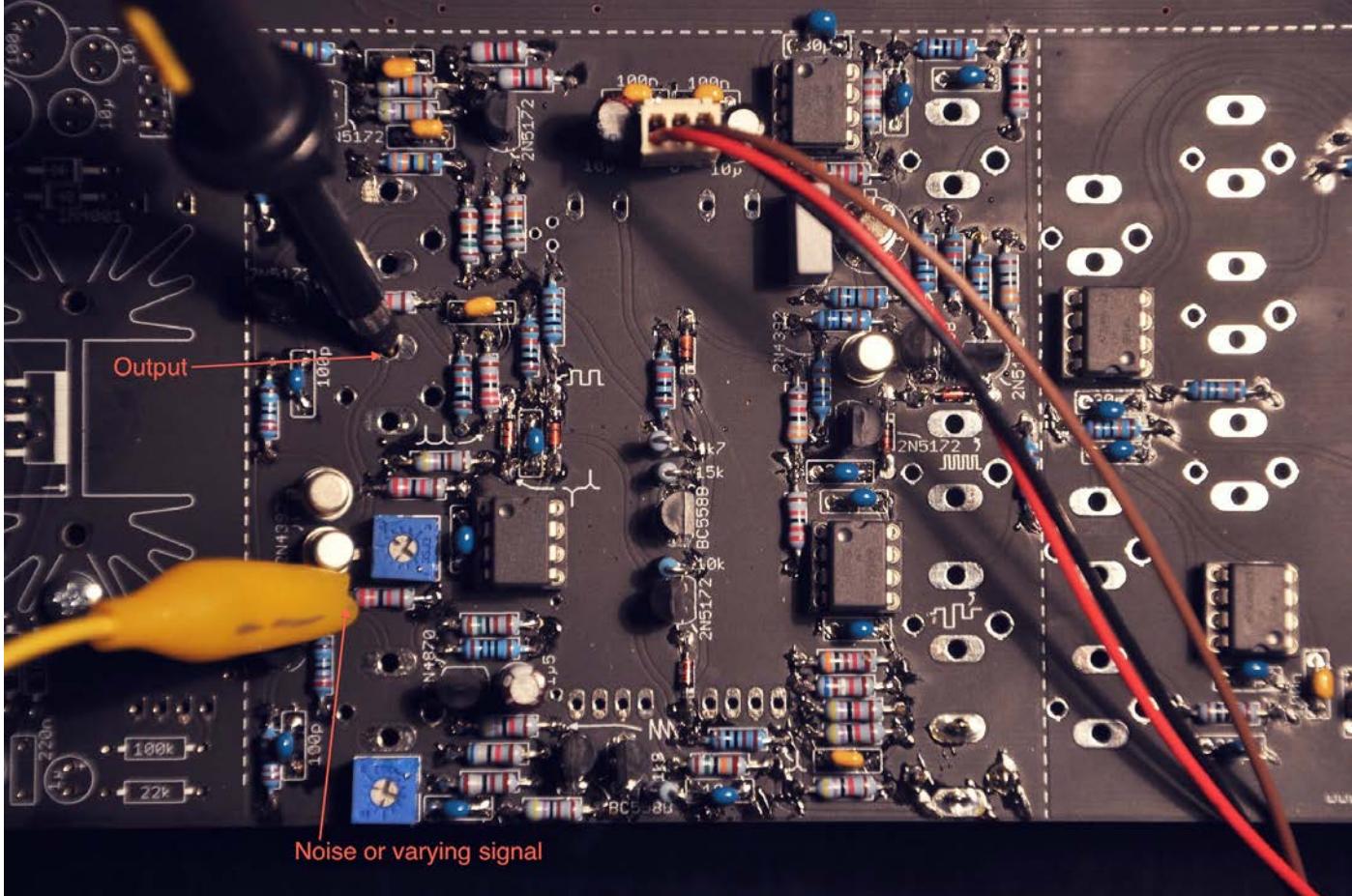
We'll start with resistors as usual.



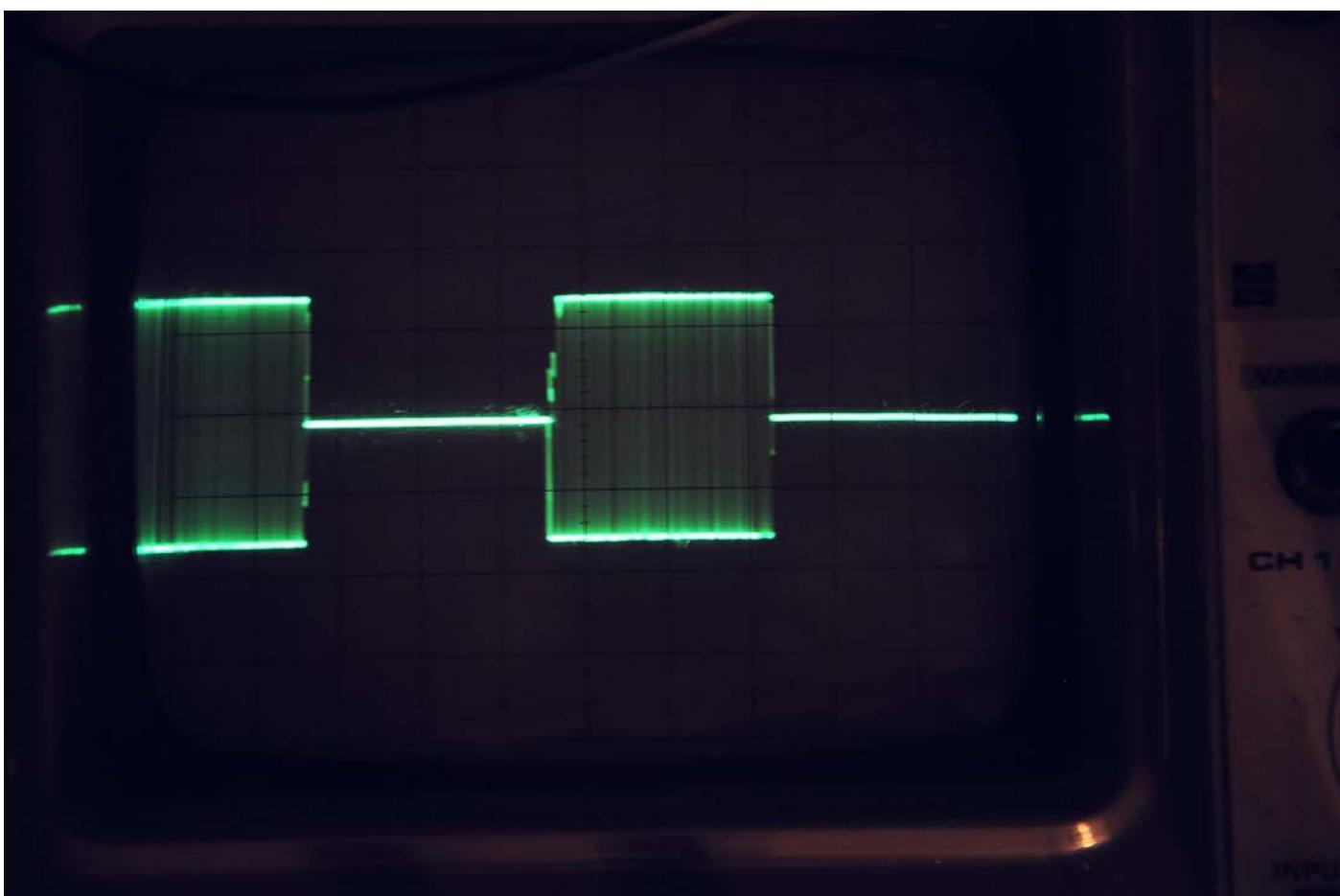
And then capacitors. No diodes in this one.



Transistors.



Test it! Input a varying signal (Like noise, but a VCO is also OK) and monitor one of the outputs.



The result should look like this. If it isn't 50% then you have to adjust the pulse width in the Internal Clock.

And we're done with this module! If you haven't done it before, now it's time for your first bathroom break.  
**Let's do the Amplifiers** before it's time to finish up!

# Amplifiers

Parts list AMPLIFIERS			
Resistors	Capacitors	Semi's	Other
<ul style="list-style-type: none"><li>■ 100k x 4</li><li>■ 120k x 1</li><li>■ 1k x 1</li><li>■ 1Ohm x 1</li><li>■ 33k x 1</li><li>■ 4k7 x 1</li></ul>	<ul style="list-style-type: none"><li>■ 100n x 1</li><li>■ 220n x 1</li><li>■ 1µ x 1 (Electrolytic)</li><li>■ 2µ2 x 1 (Electrolytic)</li><li>■ 22µ x 1 (Electrolytic)</li><li>■ 100µ x 1 (Electrolytic)</li><li>■ 2200µ x 1 (Electrolytic)</li></ul>	<ul style="list-style-type: none"><li>■ TDA2030 x 1</li><li>■ 1N4001 x 2</li></ul>	<ul style="list-style-type: none"><li>■ 2 pin MTA header x 3</li><li>■ Heat sink x 1</li></ul>

This is for 1 set of Amplifier, so you'll have to do this twice.

Each builder might want to experiment with the gain of the circuit to get it working to his/her preference.

So, done with this we'll move over to [Finishing Up!](#)

# Finishing Up

Parts list LED Driver			
Resistors	Capacitors	Semi's	Trimmers
<ul style="list-style-type: none"><li>■ 220 x 1</li><li>■ 390 x 4</li><li>■ 470 x 9</li><li>■ 560 x 4</li><li>■ 680 x 2</li><li>■ 1k x 3</li><li>■ 10k x 1</li><li>■ 100k x 2</li></ul>	<ul style="list-style-type: none"><li>■ 47µ x 1 (Electrolytic)</li></ul>	<ul style="list-style-type: none"><li>■ BD236 x 1</li><li>■ BD237 x 1</li><li>■ TL071 x 1</li><li>■ 2n5172 x 1</li><li>■ LED 5mm x 1</li></ul>	<ul style="list-style-type: none"><li>■ 10k x 1</li></ul>

We'll start our adventure on the topside of the board by installing the parts for the LEDs.

