Din Sync .Info

Greetings Space Cadets!

Here we have the build guide for the RE-303 v1.2 (space cadet) it's been a long road to get here but finally we have reached this milestone. We now have a working build which is comparable to the difficulty of building a x0xb0x.

Right I'm sure you are itching to get started but please read the next two pages. I've tried to make the build manual as easy as possible and some level of soldering competence is assumed. If you've never soldered before you should probably practise some before attempting this. There are some great soldering tutorials online if you search for them. I recommend you take a look at some if you've never soldered before, at least if only to learn some best practises.

If you fail one of the build tests, you should **never** proceed, it will only reduce the chances of a successful build. Try to figure out what went wrong, usually it's only a misplaced part or something missed. Or ask nicely on the forums, someone will perhaps lend a hand.

I hope you enjoy building this machine as much as I have bringing it to you. Of course this could only really be a TB if Roland were involved. I asked them (I really did) but they turned it down in favour of something else. This is a shame as it would have been nice to work with a team rather than a one man effort which this has been. I'm sure it's not perfect (it couldn't be as I remade the boards manually by hand) but electrically it is correct which is the most important aspect.

The proof is in the sound, when you build it and play it for the first time, you'll finally get what all that fuss was all about.

I have to send a big thank you to Guest, Altitude, Sunfl0wr, Herr Hewel, Sonic Potions and all of the Alpha builders who all contributed to getting the project this far.

Thanks again!

Paul

A little background and some notes

This build guide should enable you to build a RE-303, provided you have sourced all the parts in the current version of the BOM. For any updates to this guide please visit www.re-303.com

The build guide and BOM assume to build the RE-303 with an original NEC processor taken from an original TB-303. This would seem to make the most sense, since we need a known reference build and we are trying to replicate the TB-303.

This way if you have an aftermarket CPU such as the RE-303 CPU, RE-303 PX or a quicksilver CPU, you will be able to refer to the instructions with those devices and it will make sense in regards to the build document.

Some important things to note, there are no ic sockets in the BOM, so you may wish to order some in. Also do not fit a socket for the cpu if using a 3rd party cpu as vertical space is limited.

There are no pot brackets in the BOM, Adrian on the forums is currently working on making some, in the meantime you can use wire straps, this is explained later in the guide.

There currently exists no off the shelf solution for the switching sync socket, there are instructions in this guide on how to make one with a generic 5 pin din socket and a dpdt switch. These parts are not listed in the bom but should be obtainable easily.

The BA662 clone has place for an optional trimmer and resistor, we recommend fitting those parts. They are listed in the BOM but here are the needed mouser part numbers for clarity.
R3 Trimmer, Top Adjust 3223J-1-503ECT-ND
resistor R4 Chip Resistor (on back of PCB) 311-10MGRCT-ND

There has and always will be a lot of “voodoo” with the 303 circuits. Personally myself I build so called “dice roll” machines which basically have no preference to selecting parts (except for the right type) then doing one adjustment (if needed) to make them match my real TB’s. I’ve included more details on the “dice roll” at the very end of this guide, I would recommended it as it is very simple to do and you can forget the sockets and solder your transistors in (as they should be)

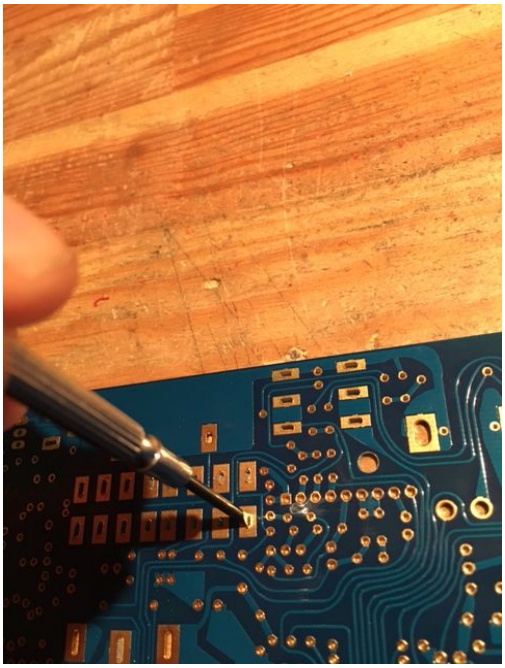
Ok let’s get started, before we start properly there’s a few things we should do to make life easier later on in the build.

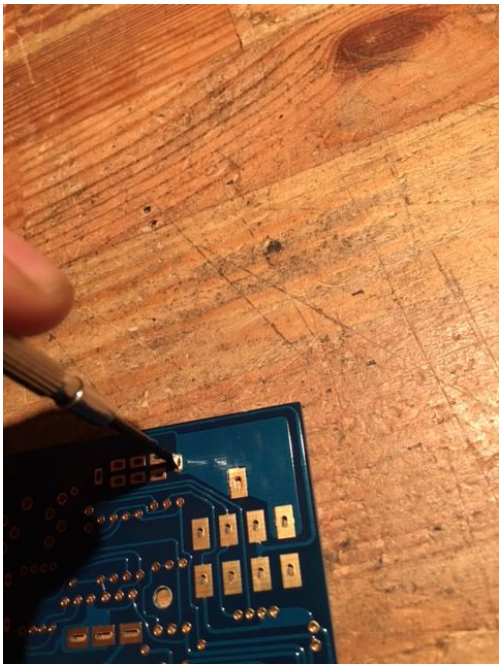
Preparation

In this section we will add all the jumpers and place a few components that would be difficult to place later on.

NOTE

Due to some fluctuations in the production run, some boards may have tighter holes for the 6.3mm jacks. Test fit them, if they fit easily move on and fit the jumpers. If they don't fit easily do not force them, instead you will need to widen the holes a small amount with a screwdriver.





Take a small flat head jewellers screwdriver and push it through the hole from the foil side, wiggle it a little to widen the hole.

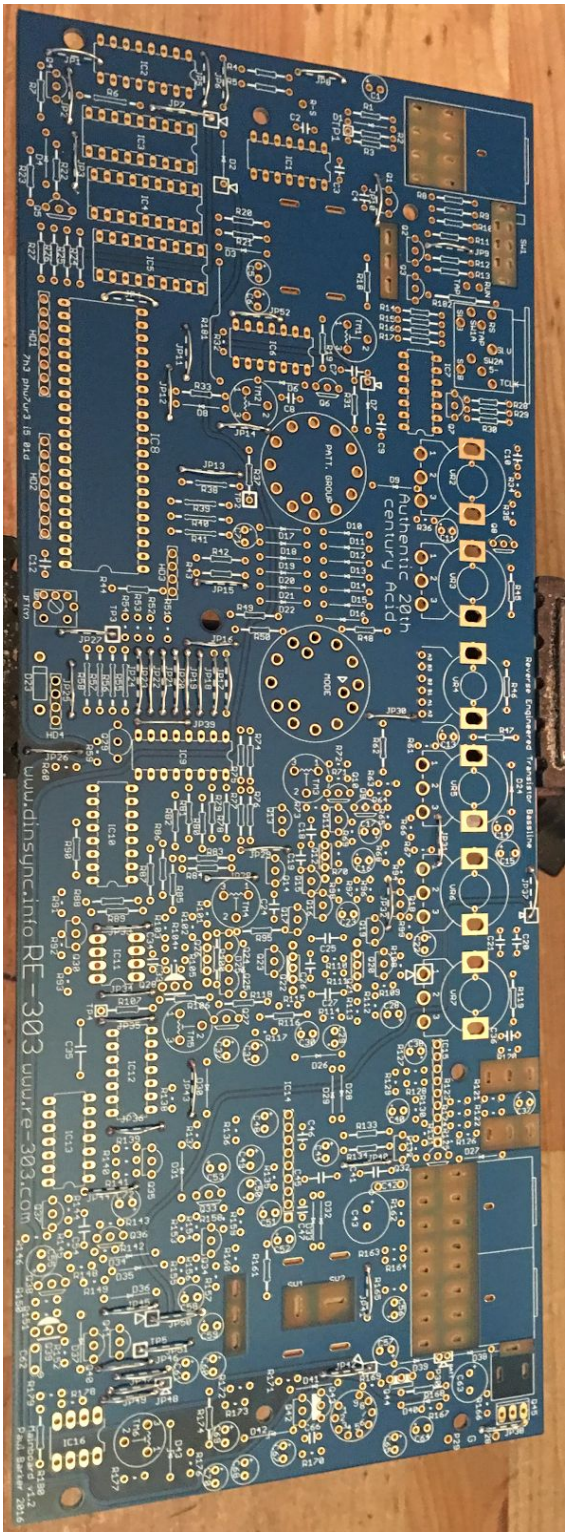
Repeat for all the 6.3mm jack holes and the two outer pins of the switch.

Your jacks should now fit with ease.

Fit the jumpers

There are 52 jumpers named JPxx where xx is the number. You can use wire straps, 0 ohm resistors (not recommended for space) or simply old resistor legs.

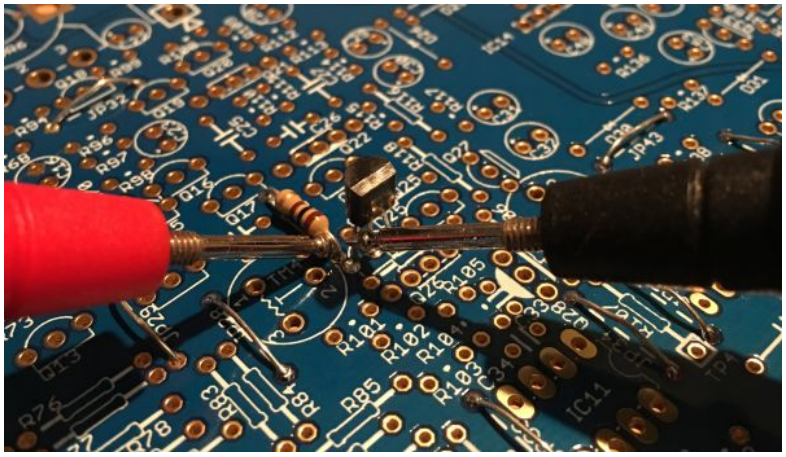
Here's some I made from resistor legs.



All 52 jumpers fitted.

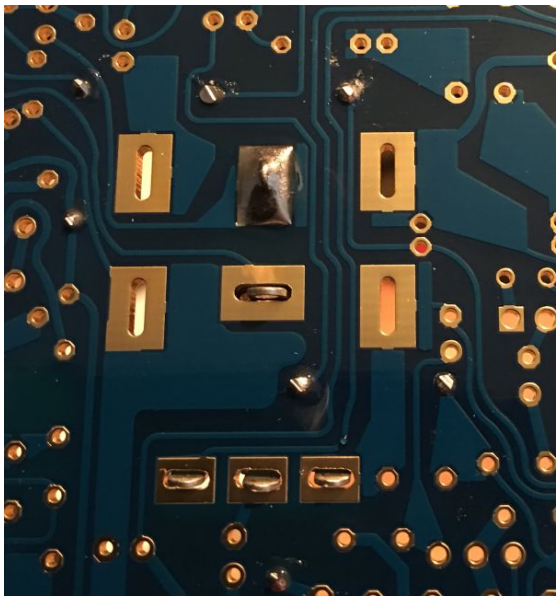
After placing and soldering the 52 jumpers we will place these parts.

R95 (100R)
R161 (1K)
R18 (47K)
D9 (1N4148)
Q24 (2SC536F or 2SC945P)

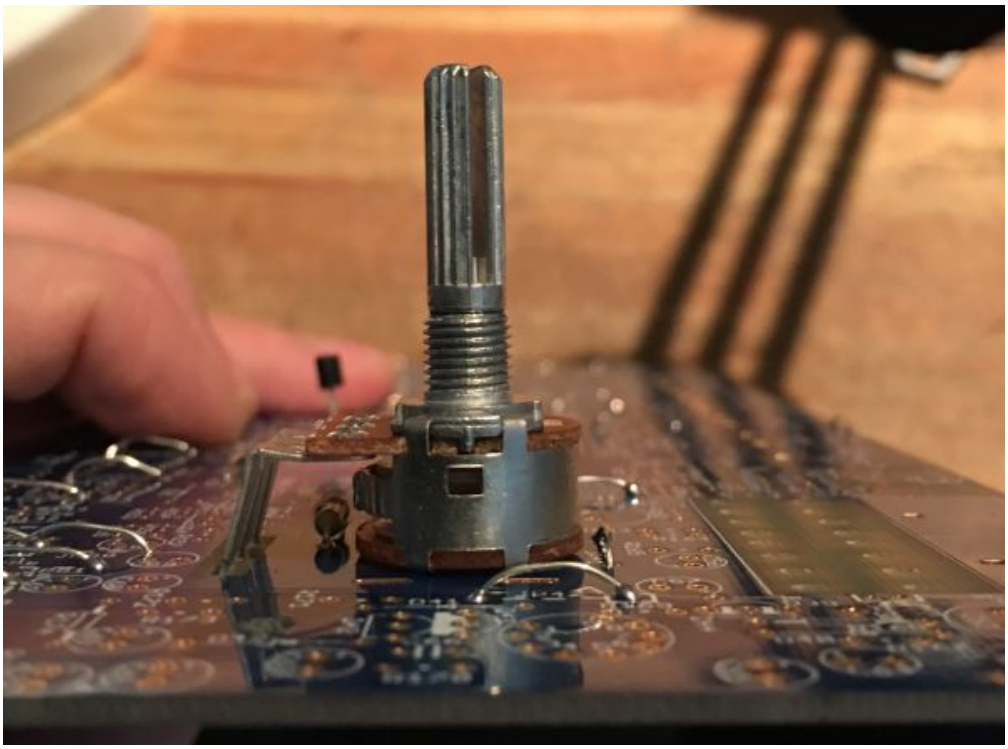


R95 is close to Q24, after fitting them both use a multimeter to make sure there is NO CONNECTION between R95 south and Q24 pin one (measure continuity as shown in the above picture).

Now take VR8 (that's the one with the integrated switch) and gently bend the legs out a little.



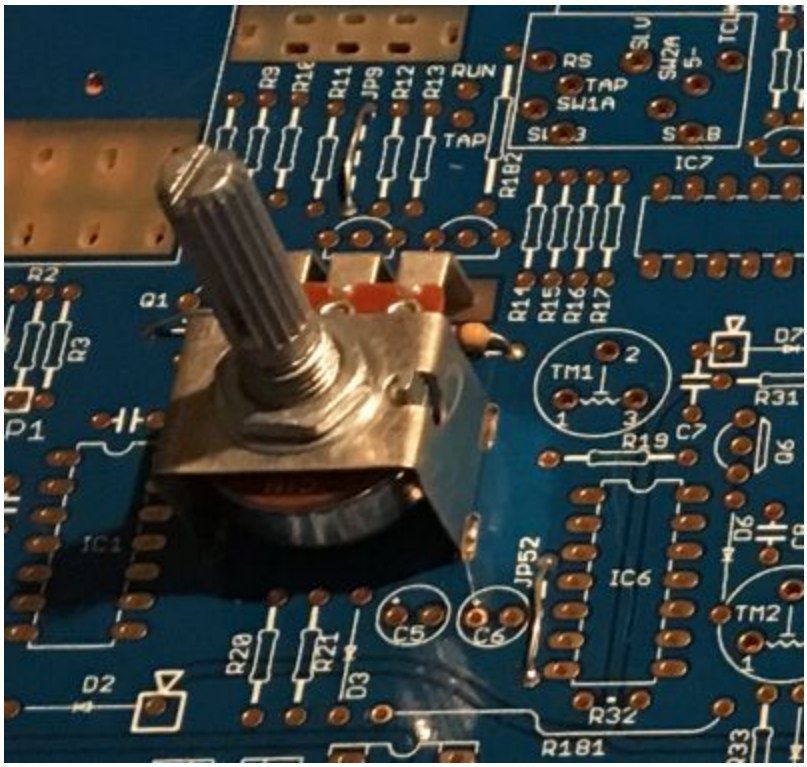
Place VR8 but only solder one pin of the switch.



Now check that VR8 is flush to the board and if so solder the remaining pins.

If you **have** metal pot brackets,

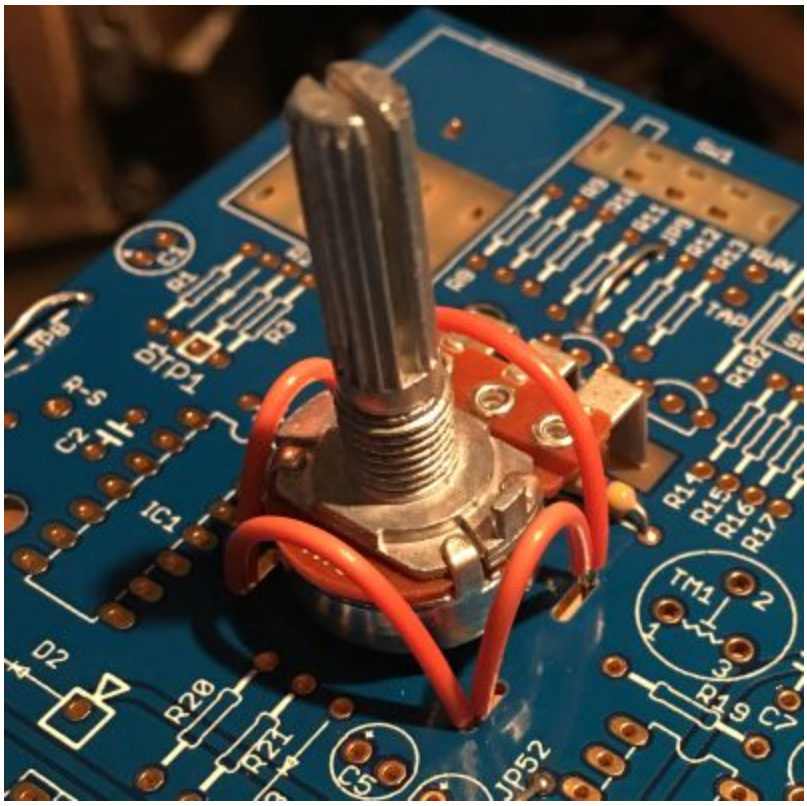
Place the bracket for VR8 and now you can also place and solder VR1 (tempo). It might be easier to loosely attach the bracket to the potentiometer before fitting.



If you **do not have** metal pot brackets:

You can now place VR1 (tempo) but do not place this flush to the board like the switch, after soldering VR1 you can use the position and height of VR8 to gently form (bend) the potentiometer to the correct height.

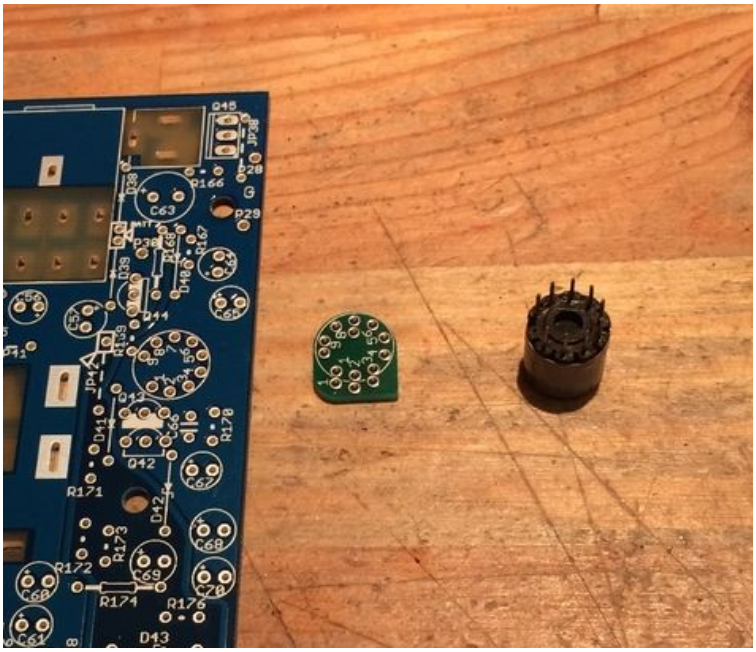
You will need to make some wire straps to complete the internal ground circuits to reduce noise. Please note, these are not intended to be tight or in anyway to hold the potentiometer down. They are simply connecting all four points. Do this for both VR1 and VR8



That’s the preparation done, time to get on with the build.

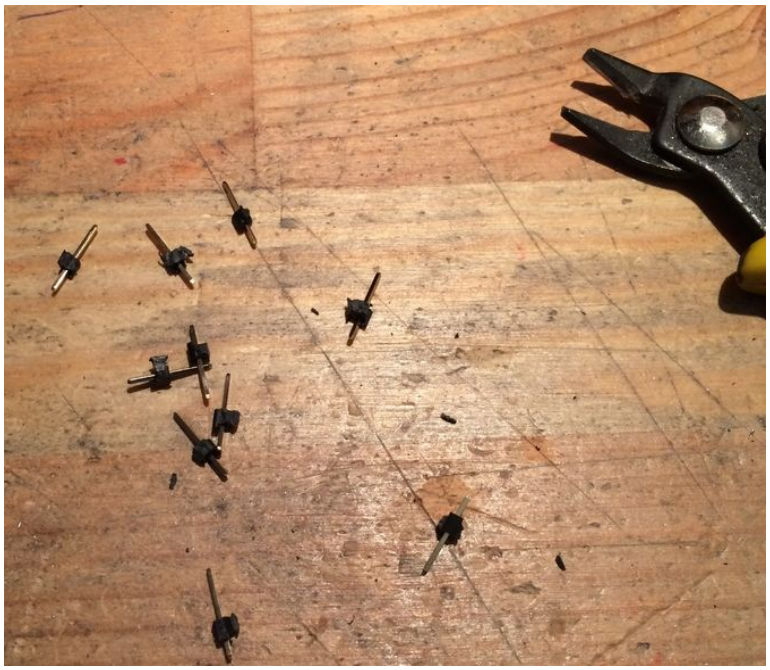
Building the power supply.

CARE MUST BE TAKEN WITH THE COIL

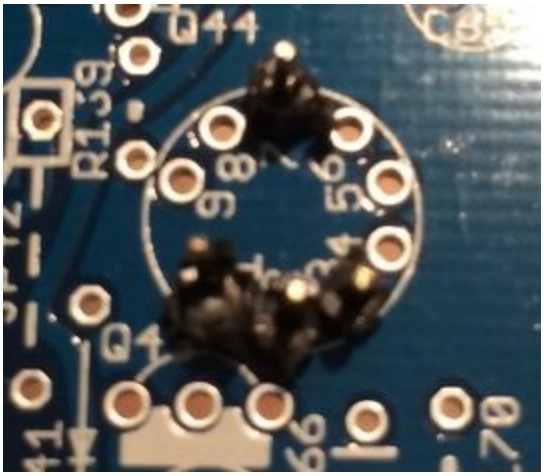


The coil is a 30 year old "new old stock" part, so care should be taken when soldering, the pins themselves will not take much to break or overheat.

Before we attach the coil, take the header



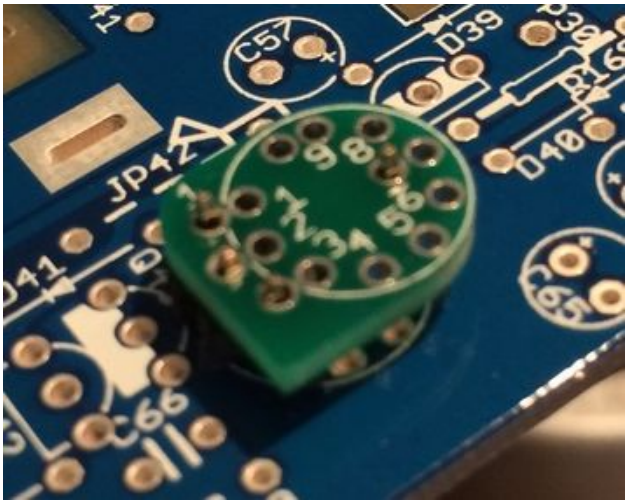
And cut it up into single legs.



Now place 4 pins with the long part into the hole in pin locations 1,2,3 and 7 as shown in the image.

DO NOT SOLDER ANYTHING TO THE MAIN BOARD YET!

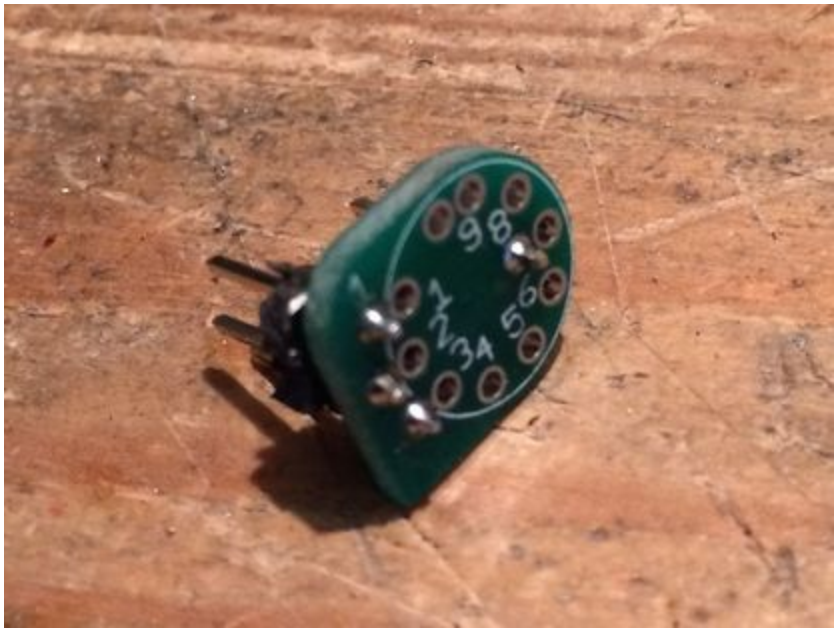
(we are just using it to hold the pins for us)



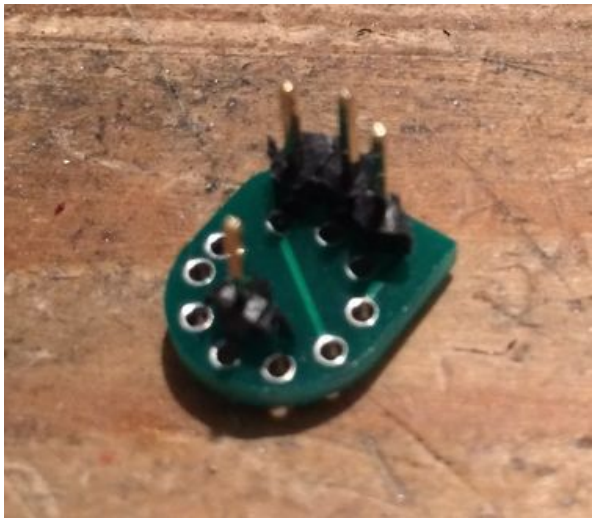
now place the adaptor on top of the pins as shown. Check that the orientation is correct and that there is a clear place for the coil to sit.

If everything looks good, solder the adaptor to the pins.

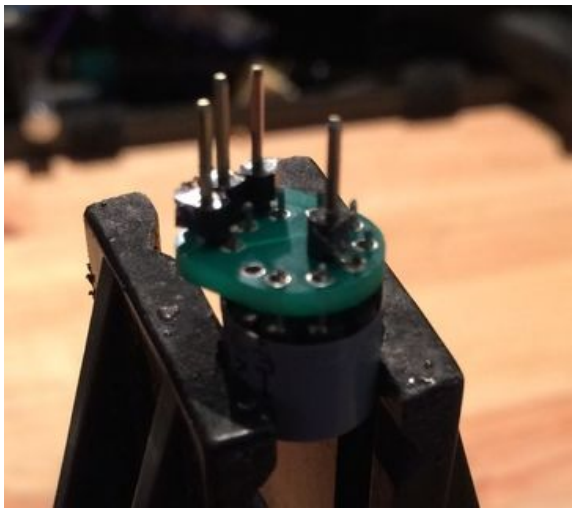
DO NOT SOLDER ANYTHING TO THE MAIN BOARD YET



remove the adaptor and check your work

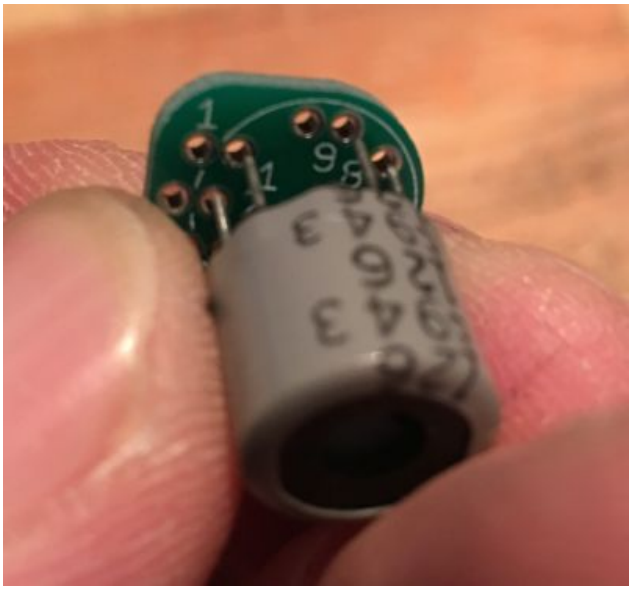


here's another angle

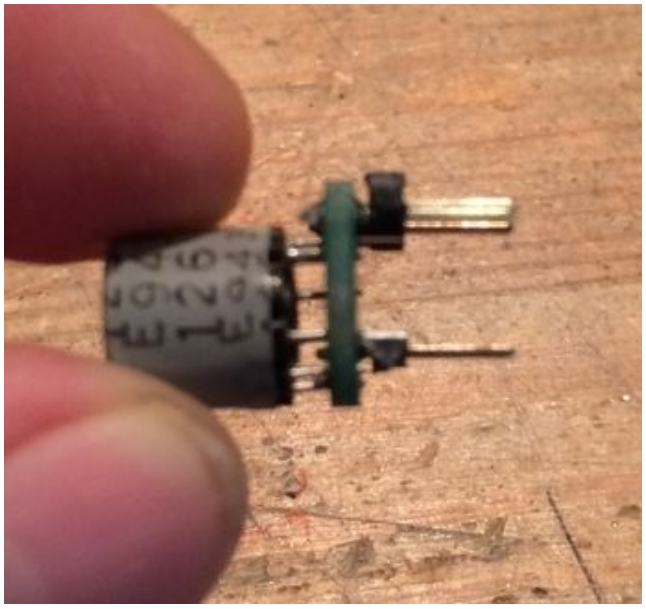


now place the adaptor on the coil as shown, **ONLY SOLDER ONE LEG** to the adaptor

BE SURE TO ALIGN PIN1 OF THE ADAPTOR (first pin in the gap) TO PIN 1 ON THE ADAPTOR (do not align the gap from the pin9 side, as there is an extra support pin next to pin 9 we don't use. It won't fit directly this way but can be accidentally forced to fit.)



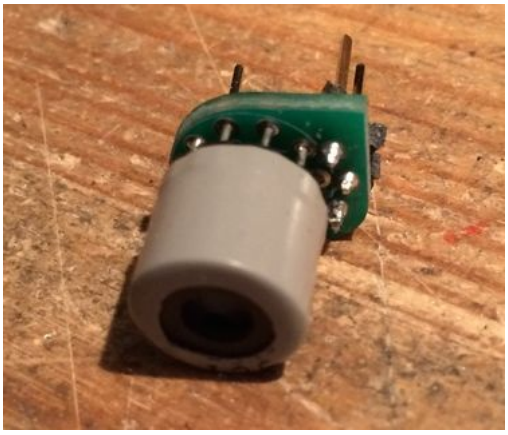
Note the empty hole between pin 1 and pin 9.



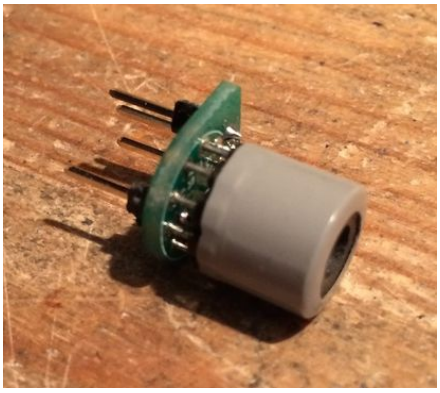
now carefully heat that soldered pin and adjust so that the coil is straight and does not touch the adaptor anywhere and also that the legs of the coil do not protrude as to be able to touch the main board.

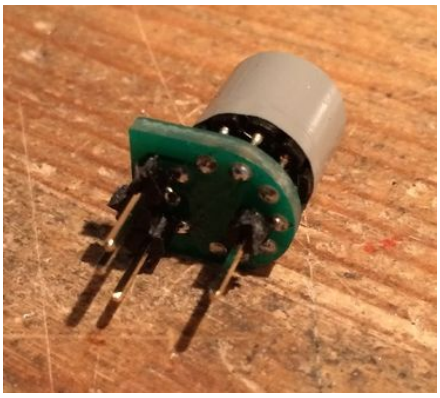
DO NOT BEND IT STRAIGHT AS YOU MAY BREAK ONE OF THE PINS

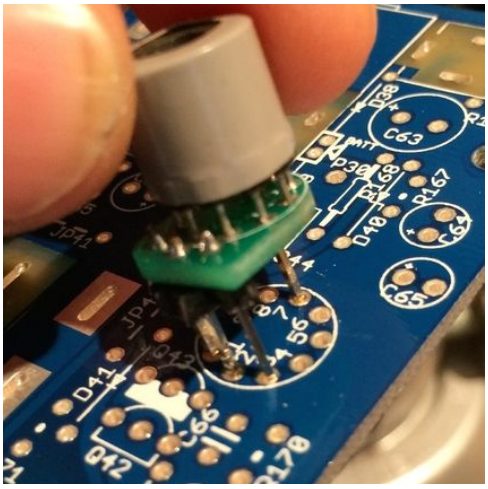
if it looks like the picture then solder the remaining pins.



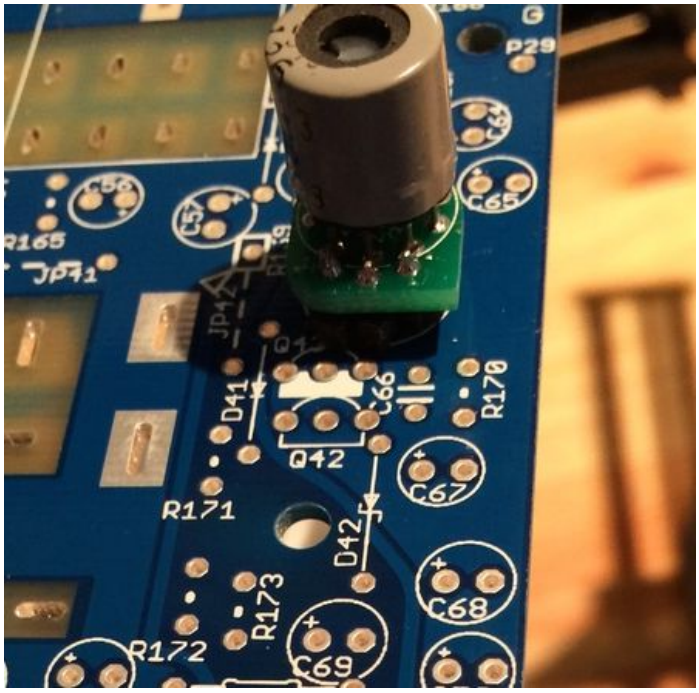
Inspect your work,



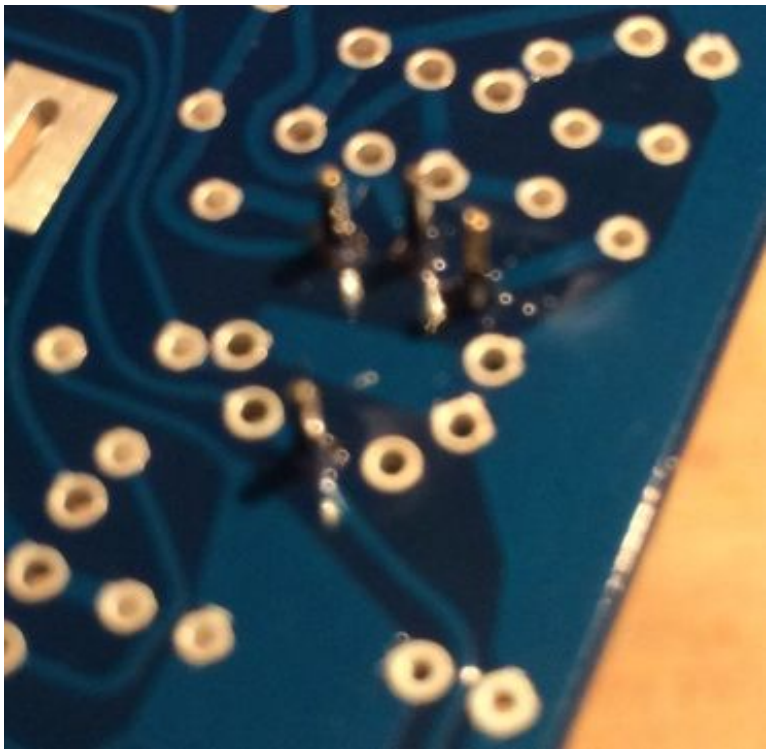




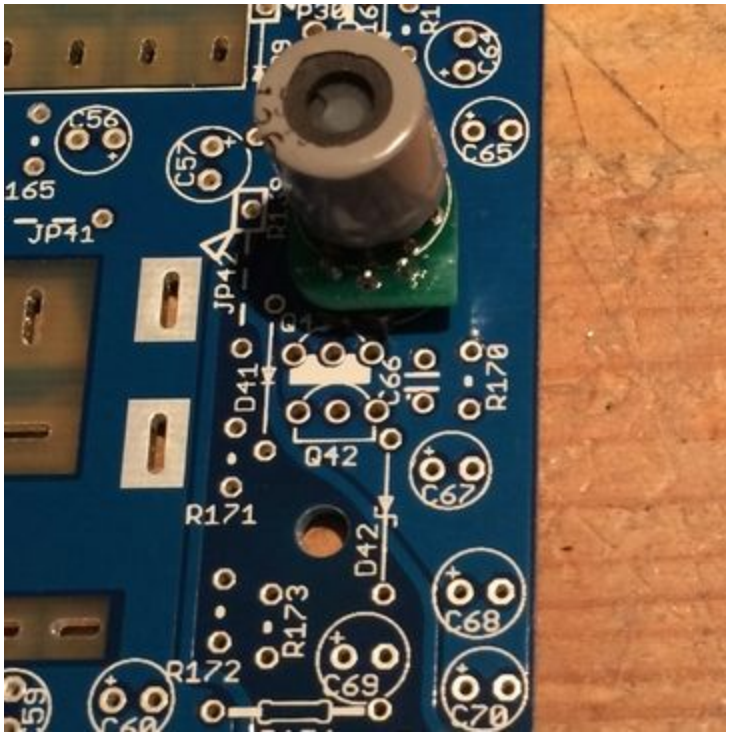
Now place the coil and adaptor on the main board.



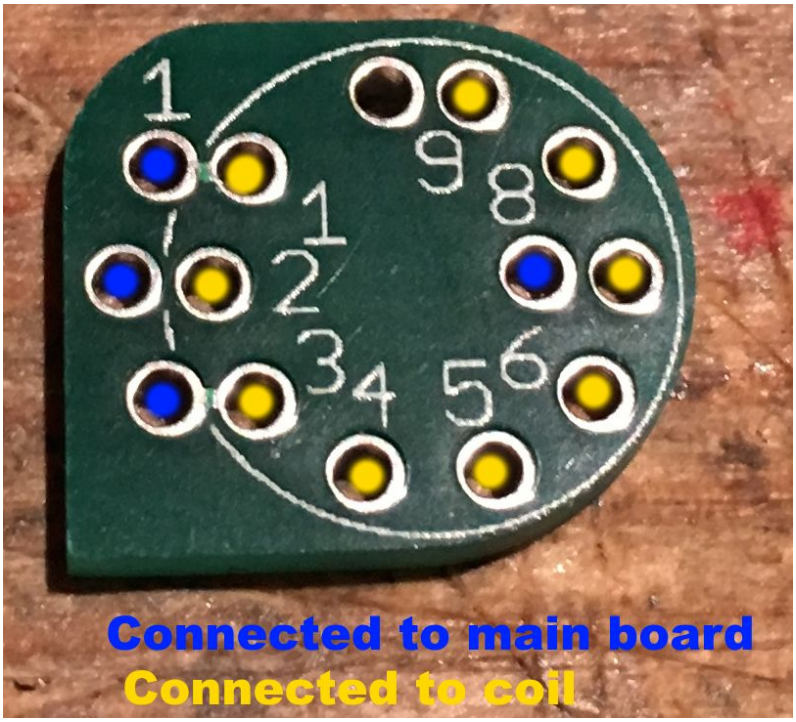
Note the orientation of the pointer.



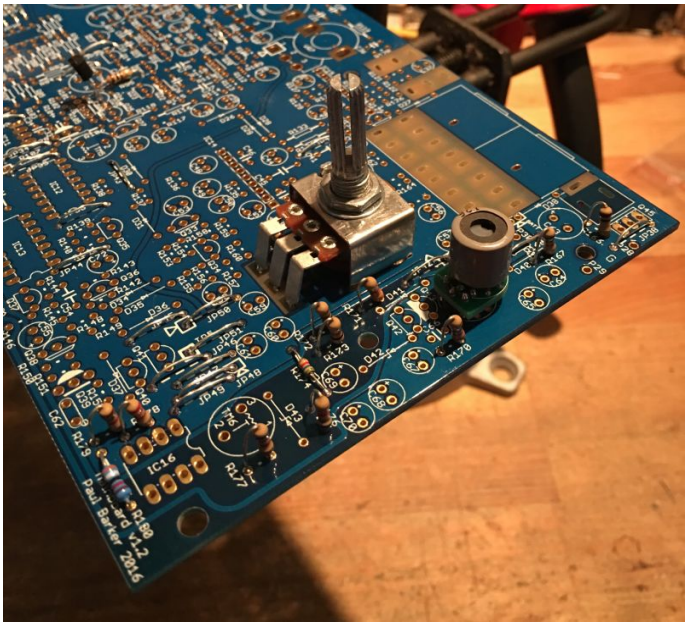
Solder and clip the 4 legs.



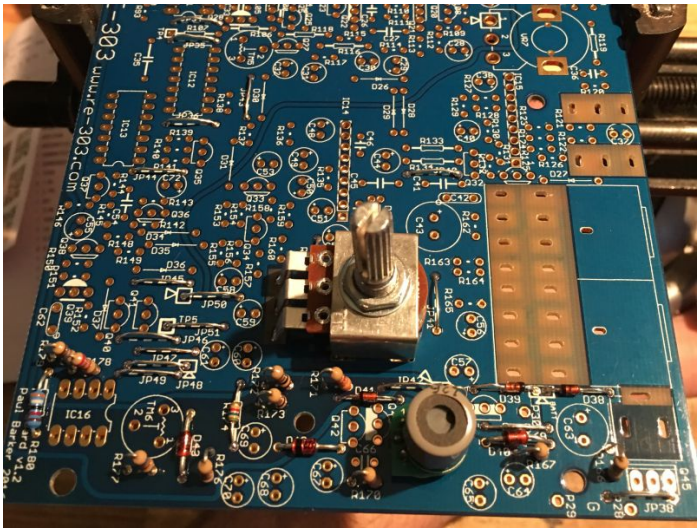
ready for the next step.



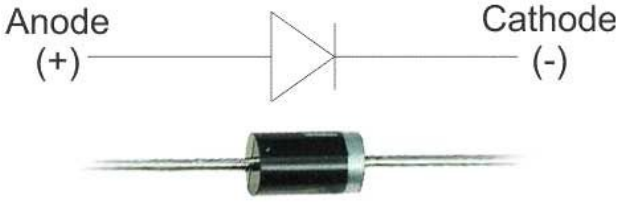
Adaptor reference



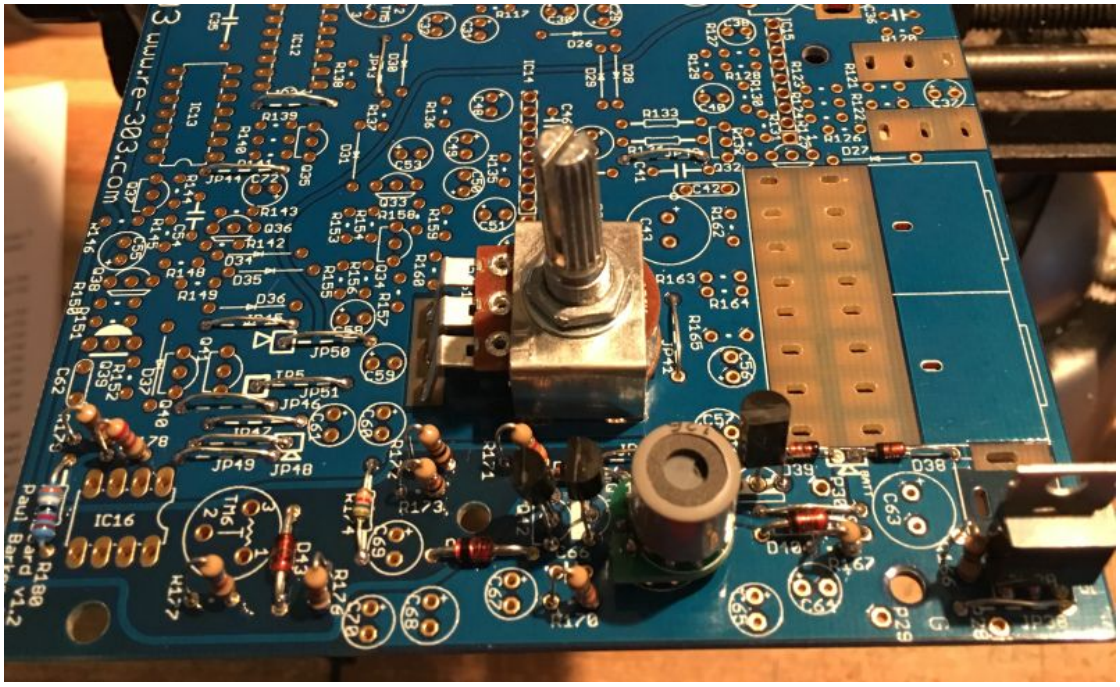
Fit the resistors.



Fit the diodes.



The diodes are polarised, be sure to match the band to the silkscreen



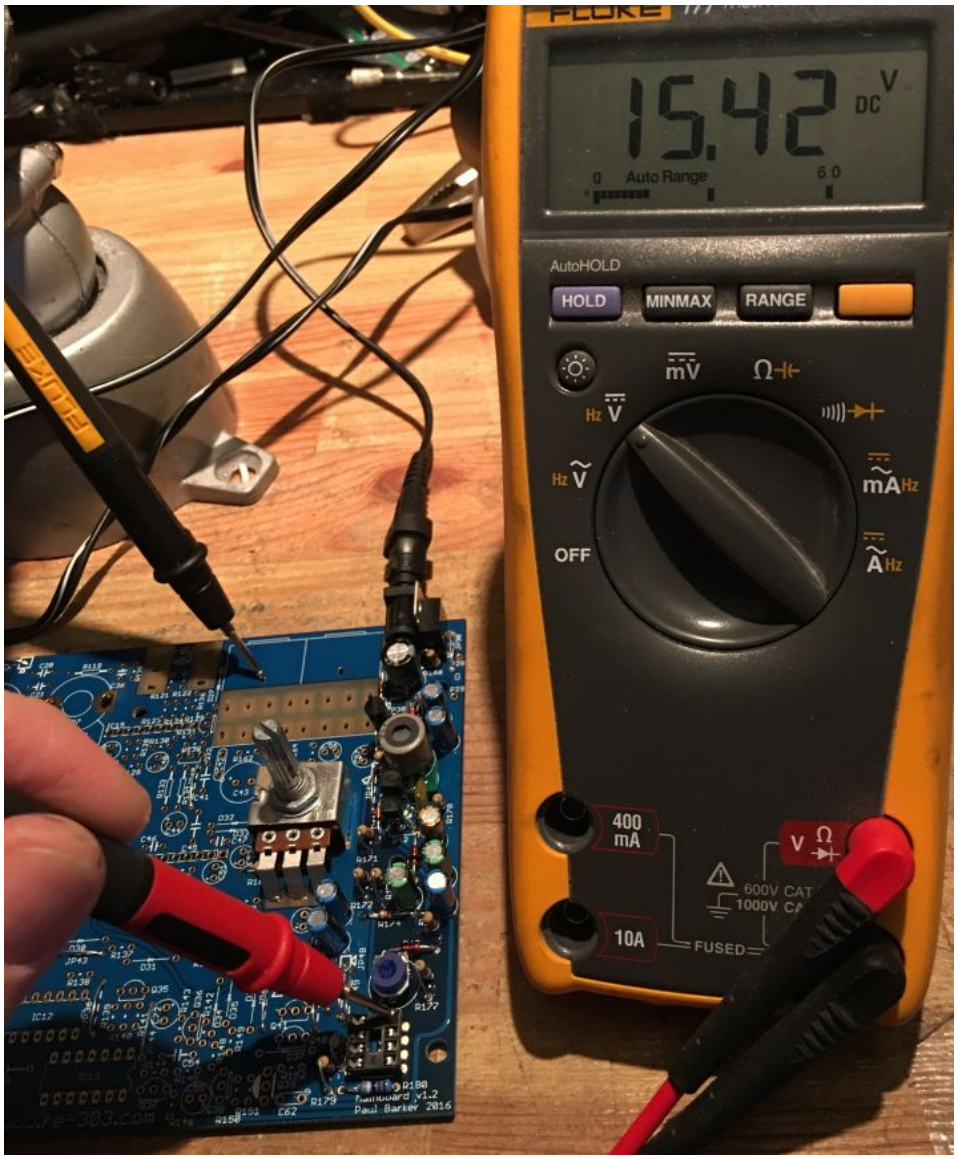
Fit the transistors, check the silkscreen to make sure you orient them correctly

Fit the capacitors.
The electrolytic are polarised. The long leg must go to the hole marked with the + symbol.

Finally solder TM6 and the DC jack, then carefully inspect your work so far. Make sure all the diodes and capacitors are the correct way. Check for solder bridges and mistakes. If everything looks ok, it’s time to test the power section.

Without IC16 fitted, connect a 9v DC power supply (center pole negative) a guitar style 500ma is suitable.

Power on and measure voltage on the socket of IC16 pin 8. Your voltage should be around 15v DC.



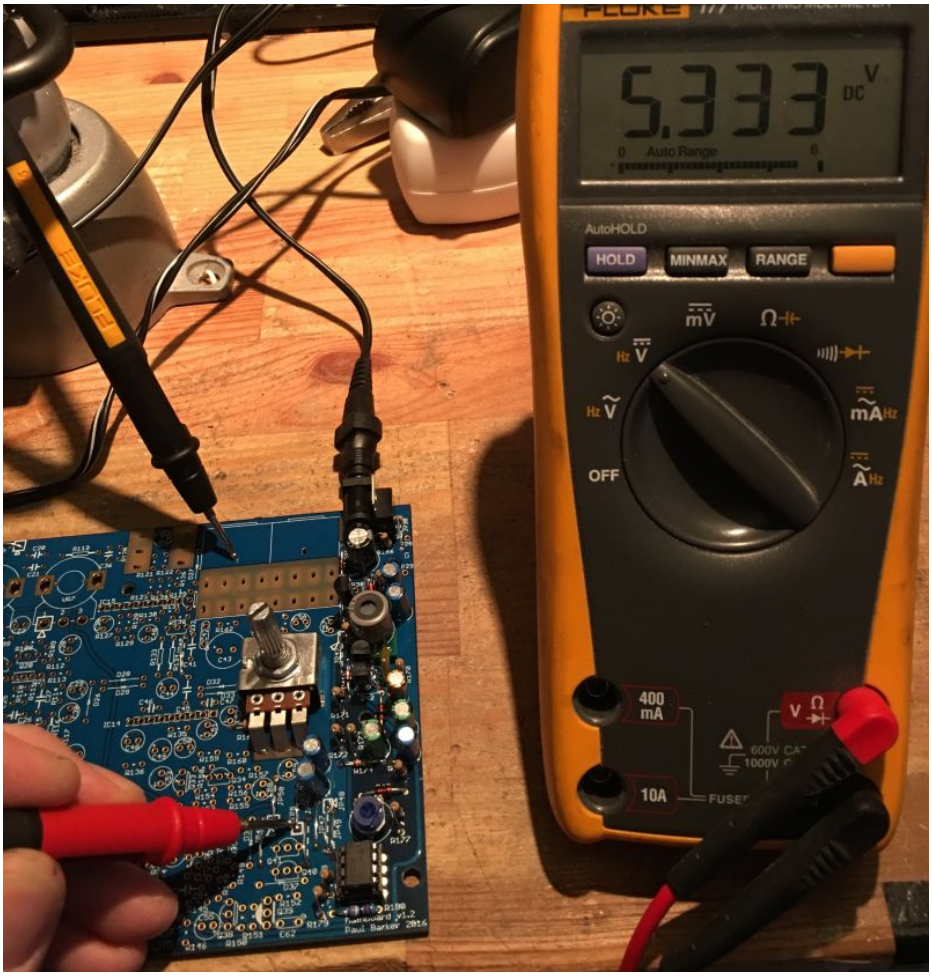
You can take the ground from one of the jack footprints as shown in the pic.

Did you get the expected voltage? If so, congratulations, you are well on your way. And can continue below.

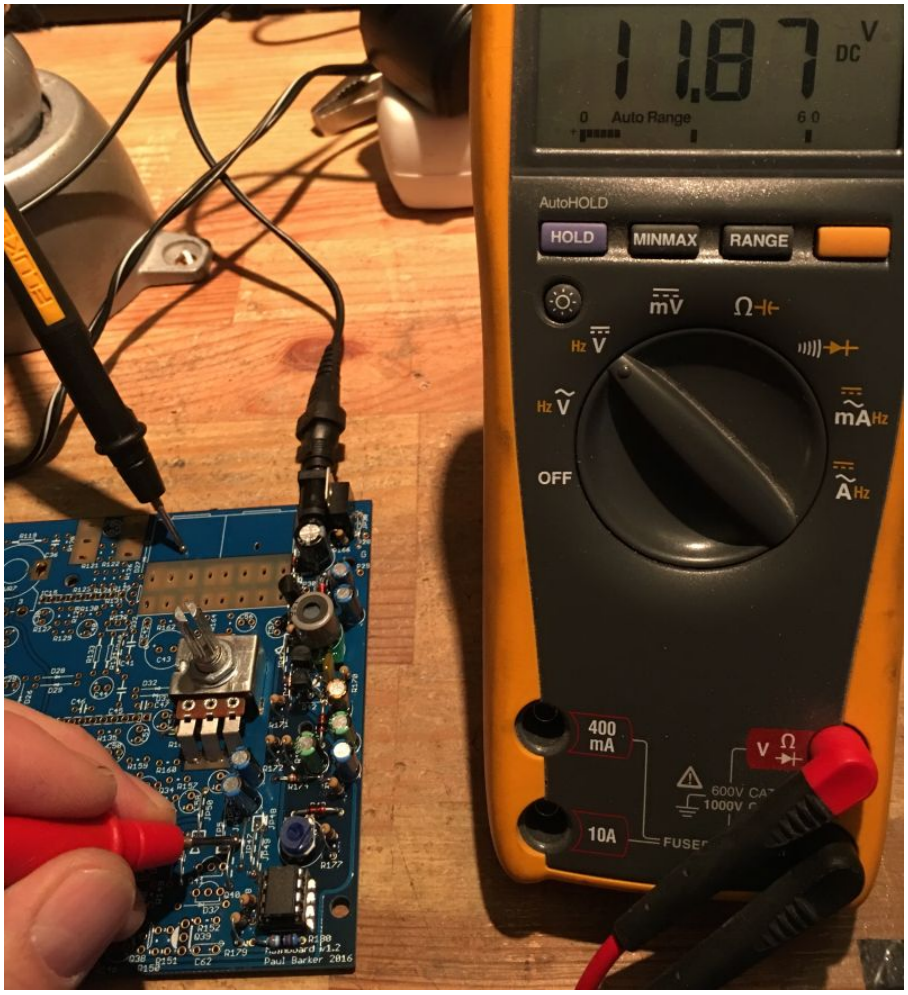
If you don’t have the correct voltage, check that your power supply is the correct type, that it’s also working.

Did you turn on the power switch by rotating VR8 fully? Is something placed backwards? Finally did you solder the coil correctly? Check again for missing parts or solder bridges.

Once you have the correct reading, disconnect the power and place IC16.



Reconnect the power supply, turn on the power again and measure from TP5 (this is jumper JP51). Adjust TM6 for 5.333v.



Now measure from JP47 and you should see a voltage around 12v. As you can see mines a little shy of the 12v mark, this is normal and nothing to worry about.

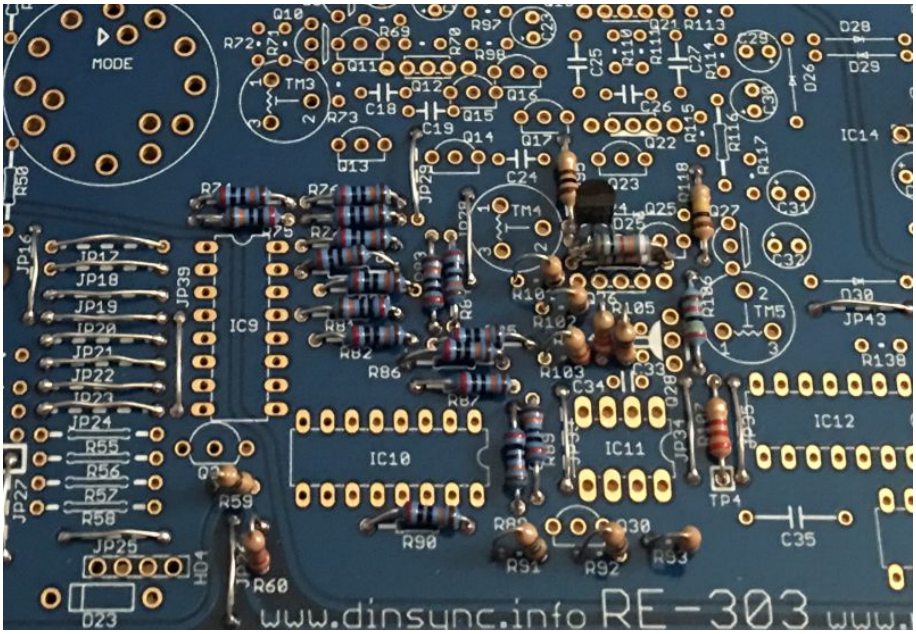
If you have all the tested voltages then congratulations, you just completed the power supply section.

Building the VCO

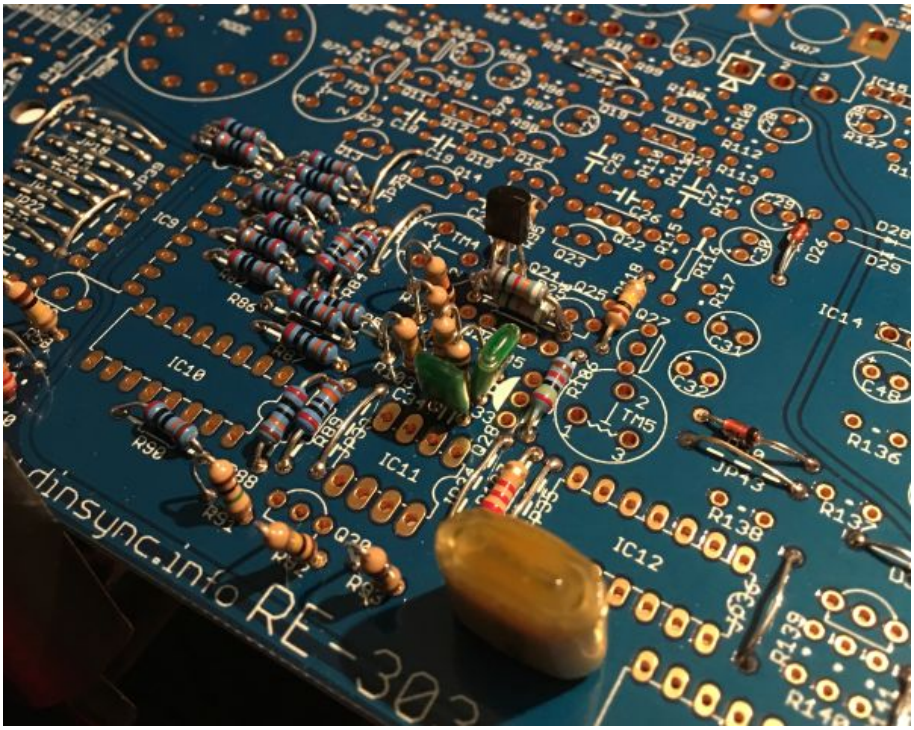
One small preparation stage for the VCO, we need to make the two 1K PTC tempco into a single 500R tempco that will fit in the available space.

Form the parts as shown and solder each side.

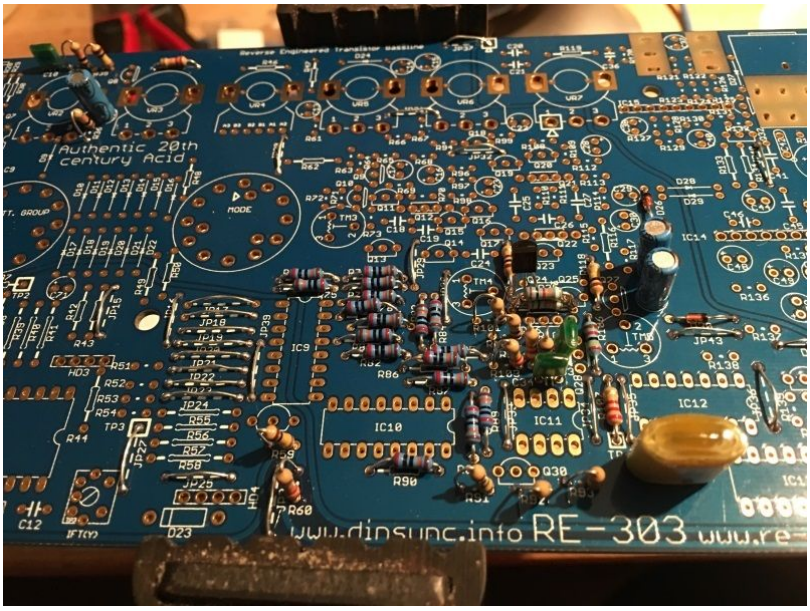
Trim the outer legs so that we end up with essentially a “tall” part ready for fitting.



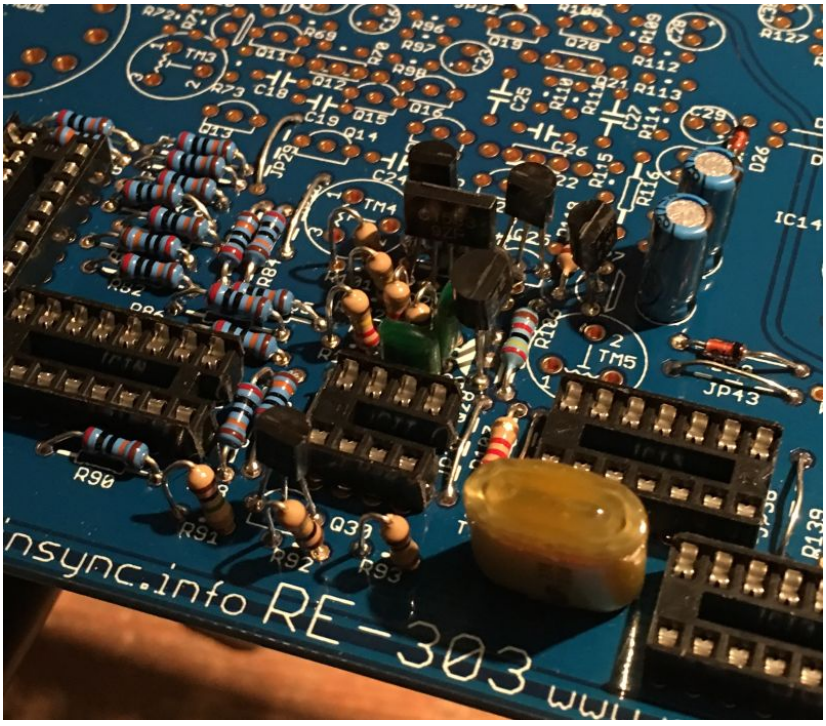
Fit the resistors and the tempco.



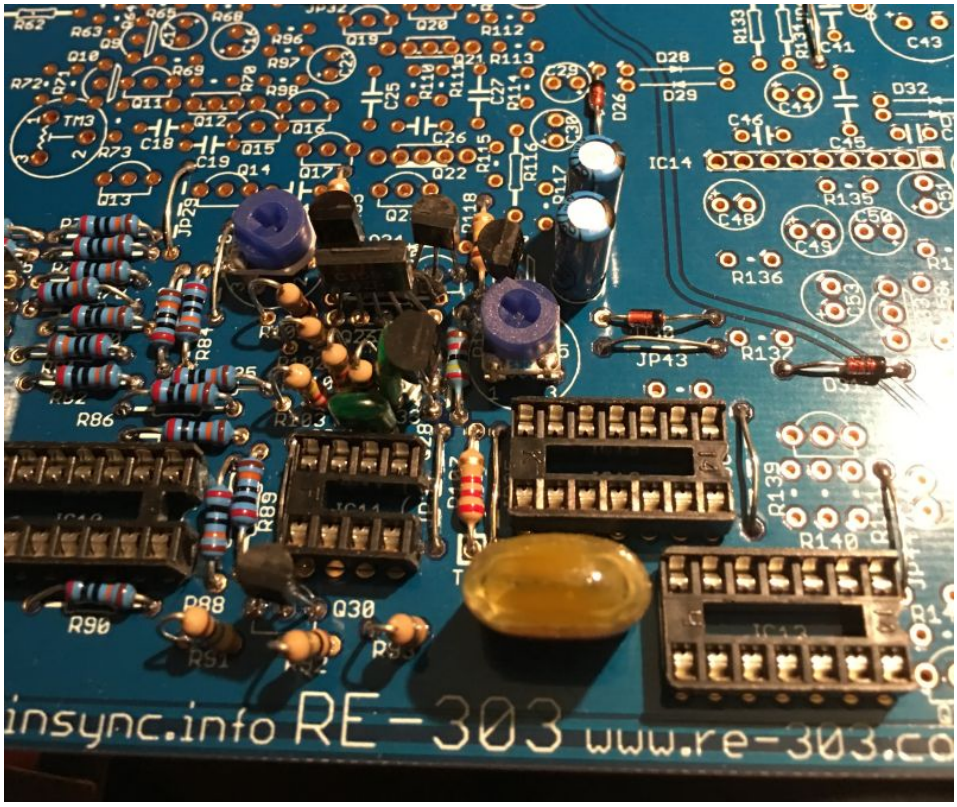
Fit the diodes and the poly capacitors.



Fit the electrolytic capacitors.

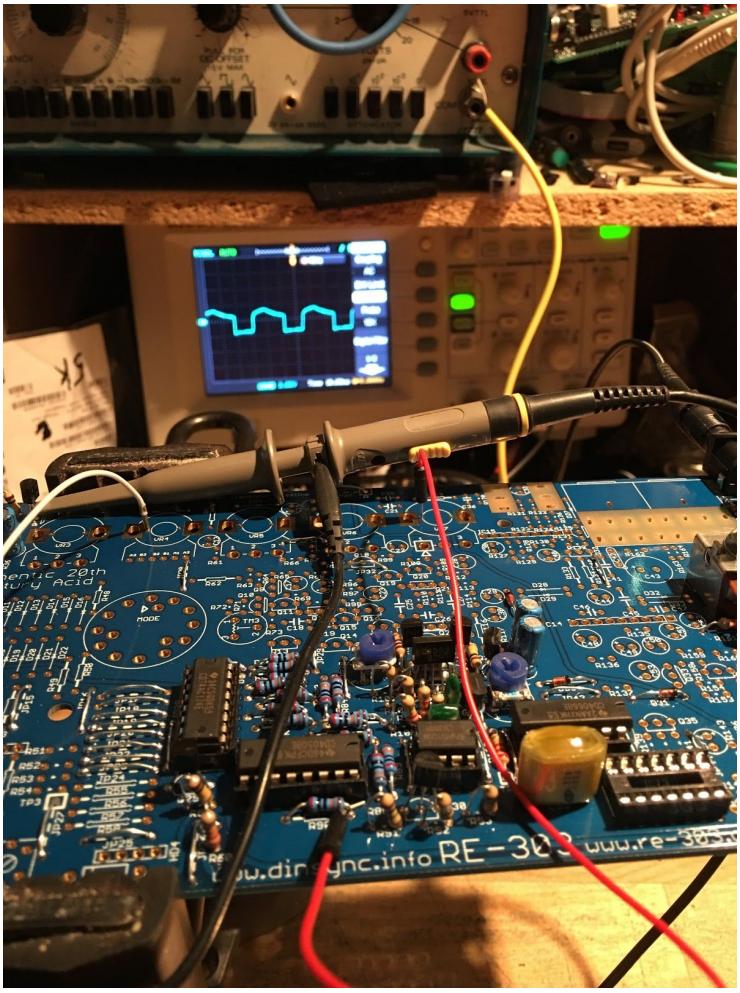


Fit the transistors. (and IC sockets if you are using them)



Place the trimmers and inspect your work so far, if you are satisfied everything looks ok then place the IC´s, VR2 and the waveform switch.

Double check everything as it’s time to test the oscillator.



The picture shows me reading the square waveform from Q8 pin 2

Hook up the power as before. There are various places to measure the oscillator waveforms but perhaps the easiest is the center pole of the fitted waveform switch.

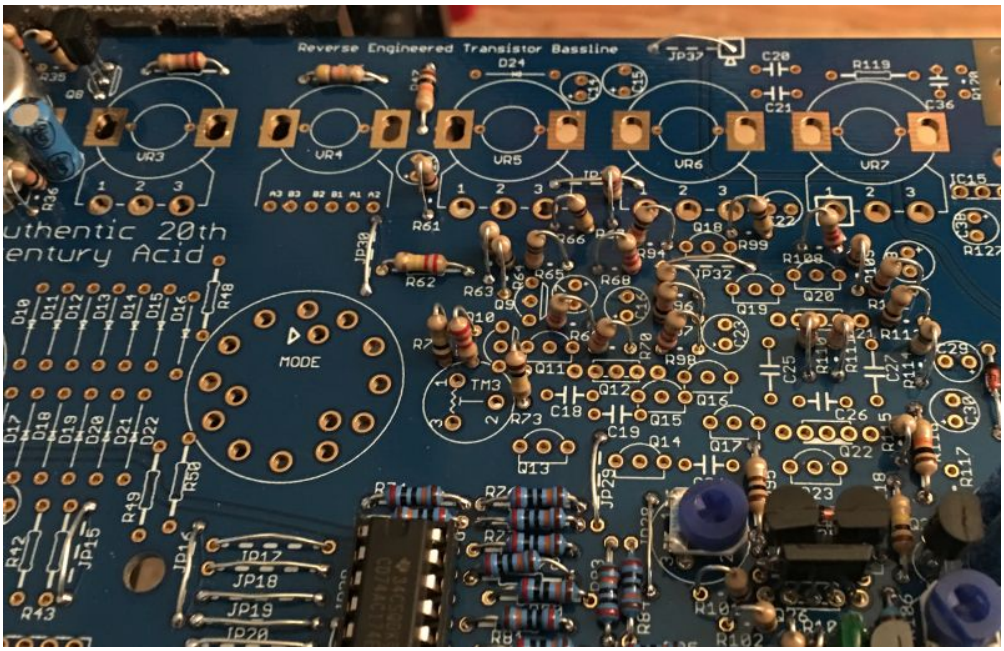
Set your scope to AC, 2v, 10ms and measure at the center pole of the switch, if you don't see a waveform at this time you may need to ground the DAC to start the oscillator. You can do this by connecting the right side of R90 to ground.

If the oscillator fails to run, check your measurements are correct, check that you grounded R90. Check for solder shorts, or missing or misplaced parts. Check the power section is still ok.

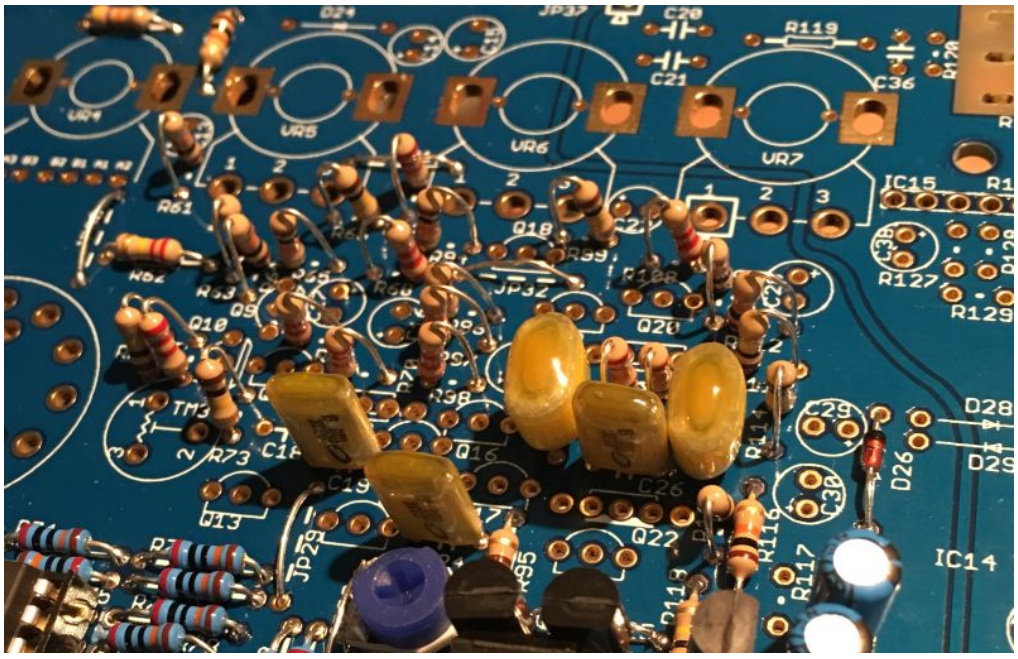
Do not proceed until the oscillator is working as it will be more difficult to solve with a fully populated board.

If the oscillator runs, try turning VR2 and watch the frequency changes, switch the waveform switch and you should see either a saw or that special 303 square. If everything looks good, congratulations it's time to build the filter.

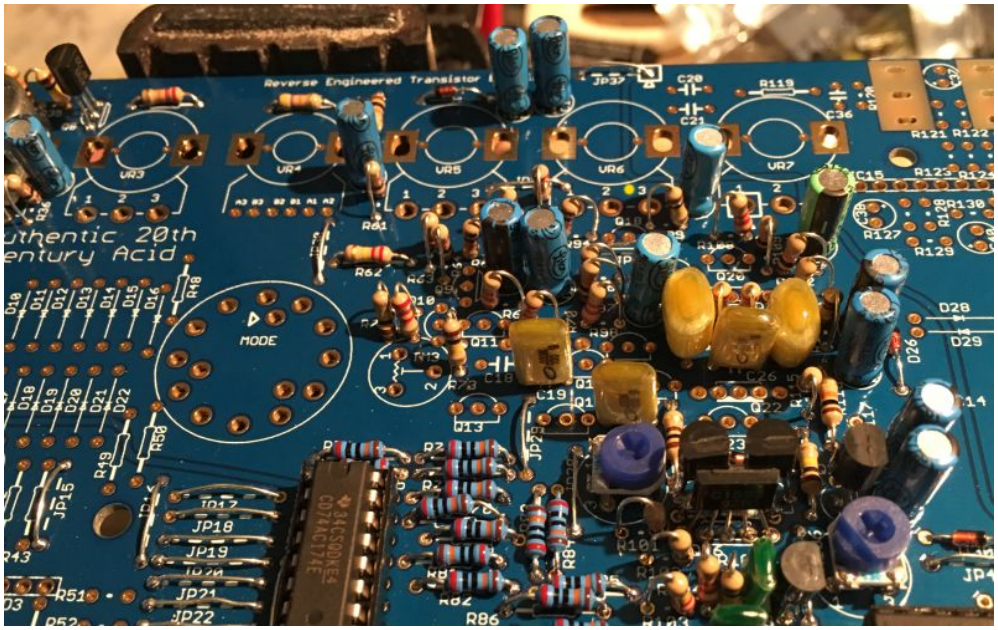
Building the VCF



Fit all the resistors (R95 was fit in the preparation stage)

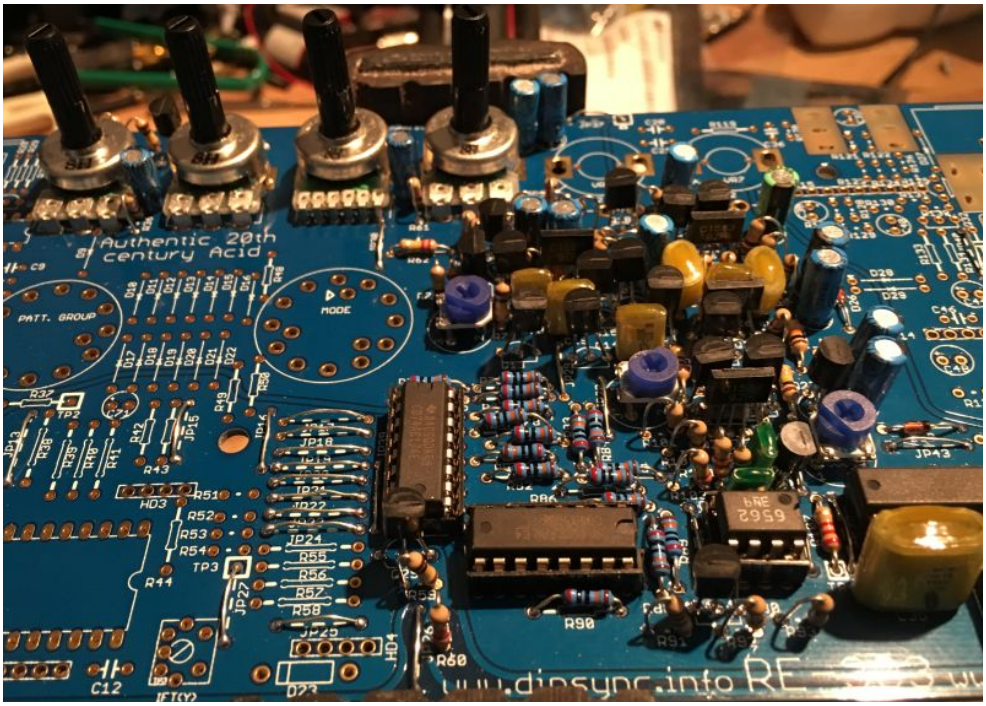


Fit the metal film capacitors.



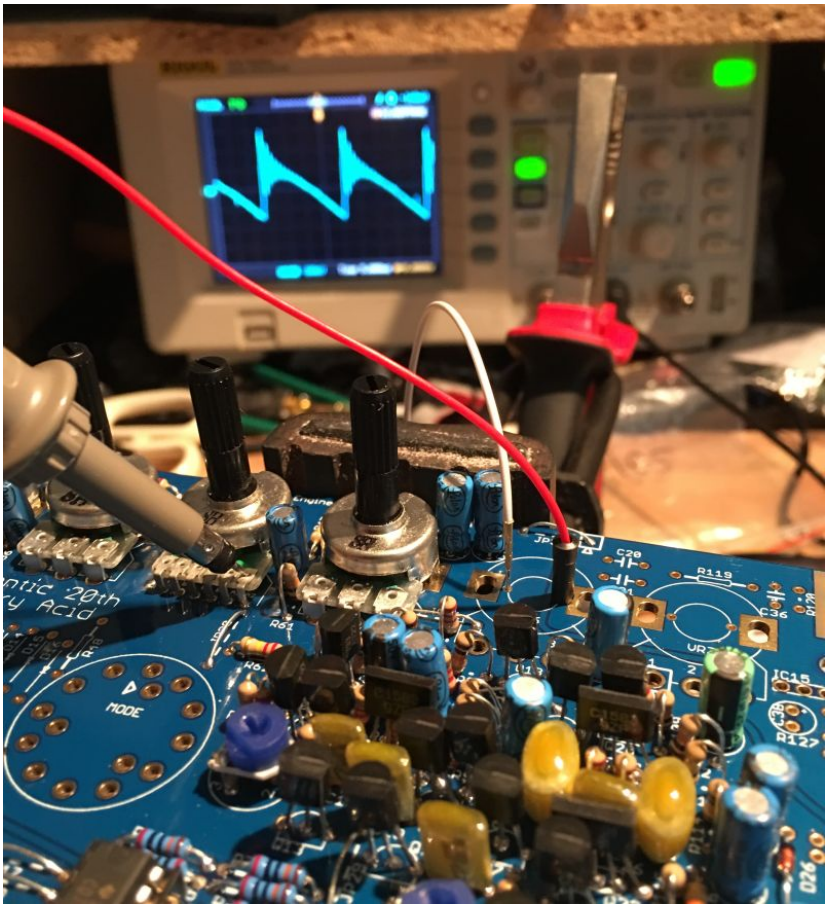
Fit the diodes and electrolytic capacitors.

Fit the transistors.



Fit the trimmers and potentiometers.

Take a moment to check your work, make sure nothing is missing and that there are no solder shorts or splashes. If you are satisfied then it’s time to test the VCF.



As before, connect the power supply and ground R90 (if your oscillator wasn't running)

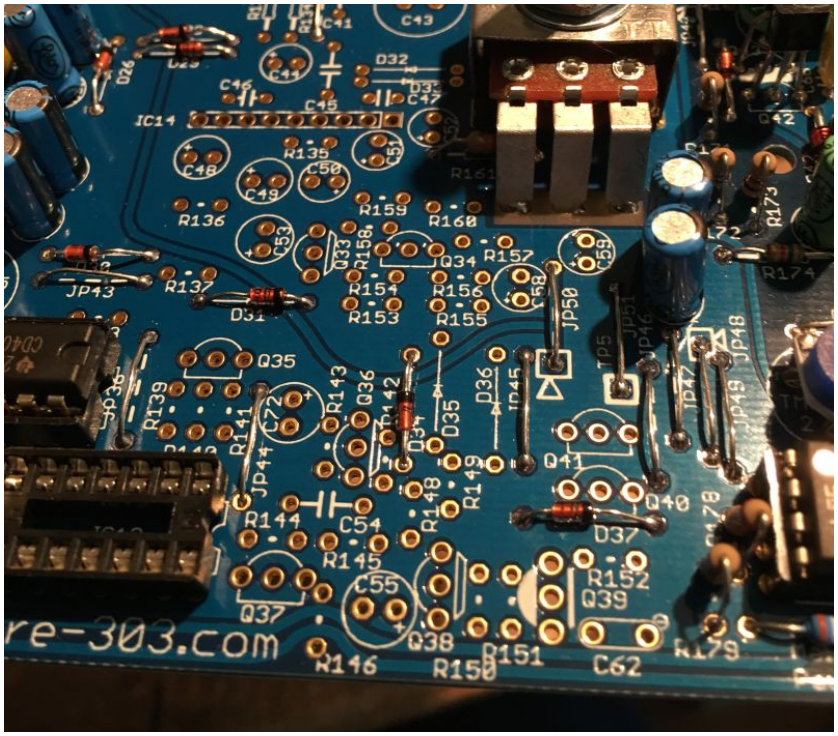
Set your scope to 100mv / 5ms AC and take some measurements from TP6 (the pins of VR4 resonance)

Turn the cutoff and resonance potentiometers and observe your oscilloscope. You should see the waveform changing from sinus looking to pronounced with resonance peaks with different knob positions.

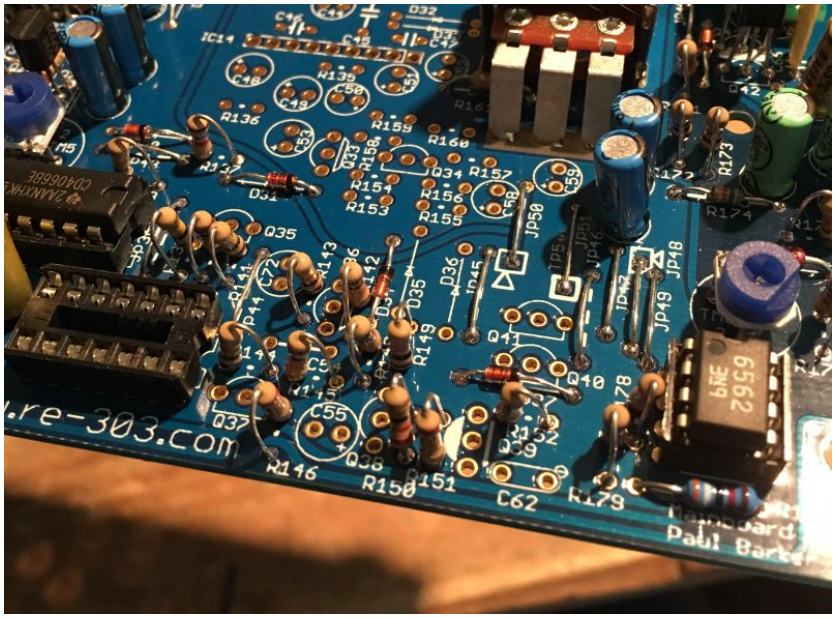
If you see the changing waveform, you are all set and ready to proceed to the next section.

If you don't see a waveform, check that you are testing correctly. Did you ground R90? Do you still have a waveform at the switch as before (this is before the VCF and should let you know if the problem is in the VCO or VCF)

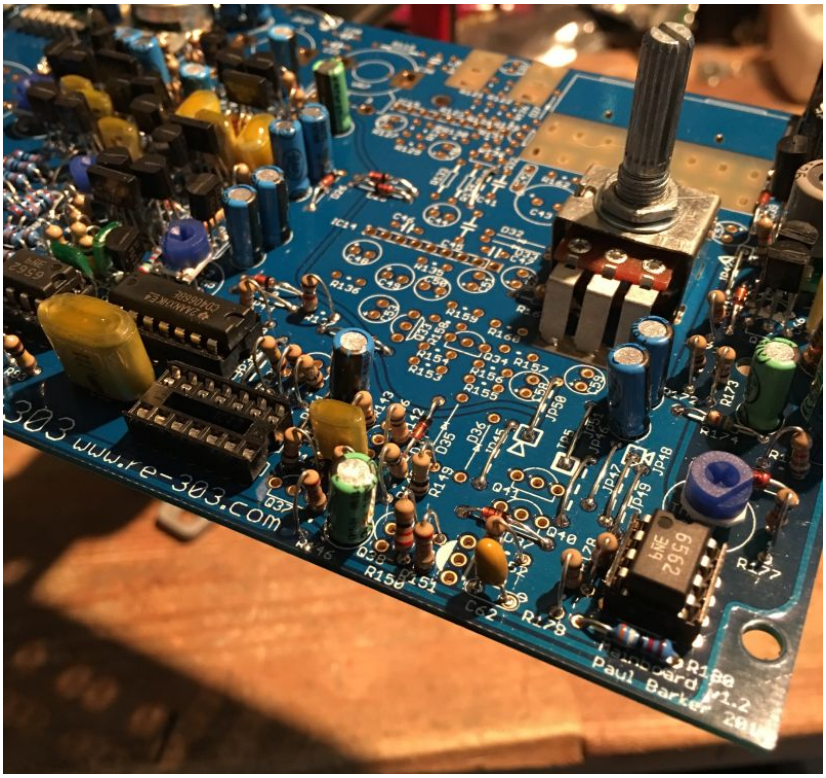
Building the ENVELOPE



Fit the diodes.



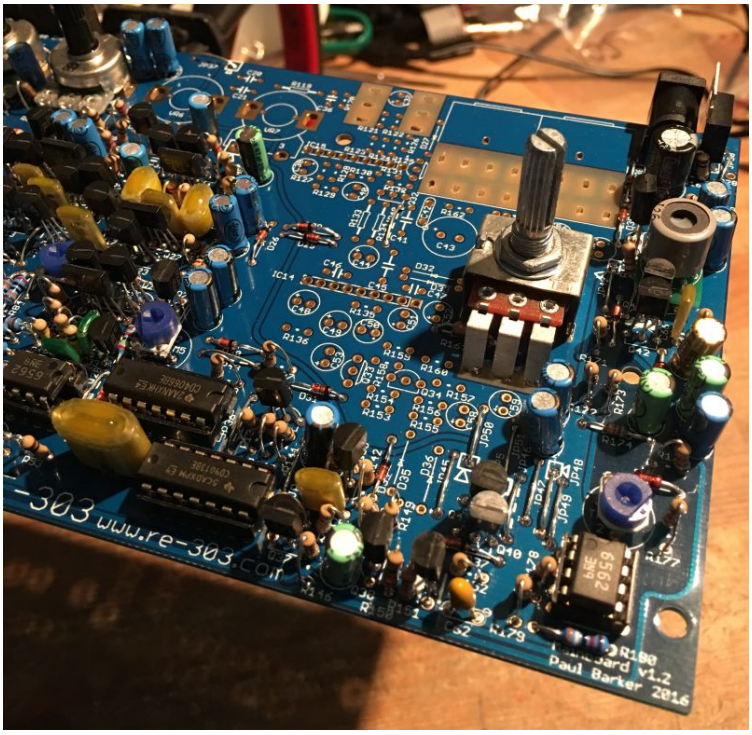
Fit the resistors.



Fit the metal film, electrolytic and tantalum capacitors.

Don’t forget that the electrolytic and tantalum capacitors are polarised. The black band on the electrolytic is negative (short leg). The tantalums positive legs are marked. The silkscreen for the tantalum shows a negative symbol so be sure NOT to place the positive end into the negative side.

Double check or experience fire! :-O

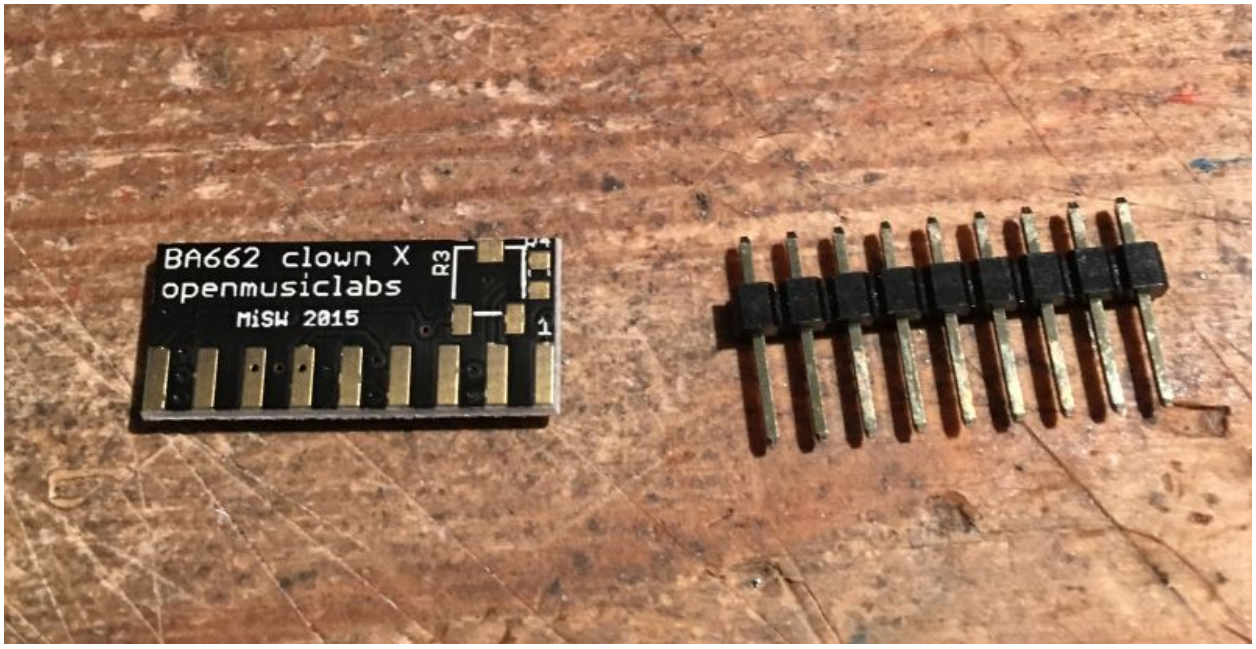


Fit the transistors

After you have fit the transistors you can place VR6.

Take a moment to check your work, make sure nothing is missing and that there are no solder shorts or splashes. If you are satisfied then it’s time to move on since we will test this section after the Mixer/Headphone section is built.

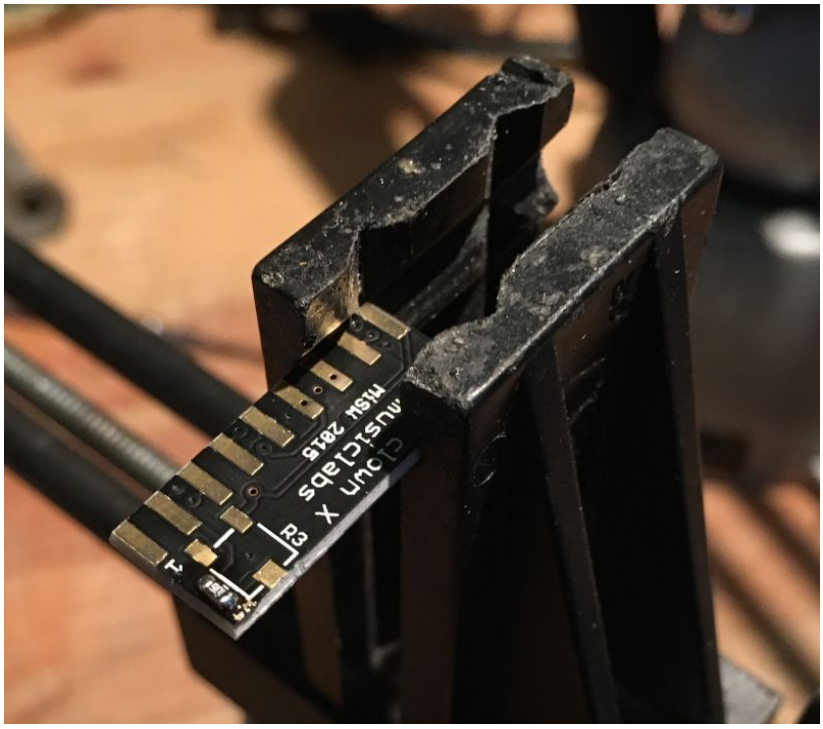
Building the VCA



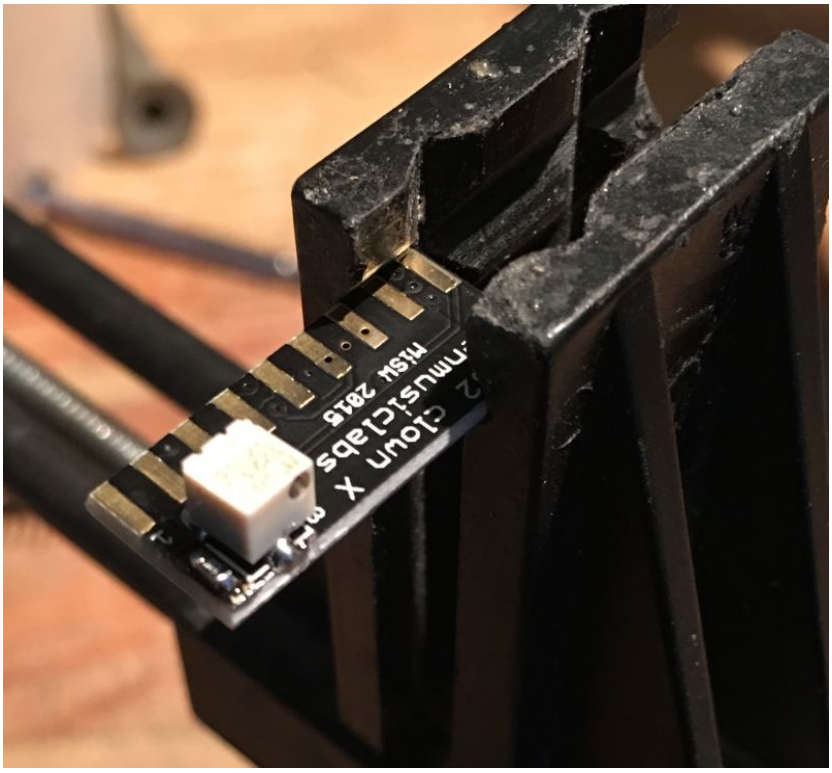
Before you attach the legs to the BA662 clown you should decide if you will fit the optional trimmer and resistor. It will be next to impossible to fit it later unless you place the BA662 clown in an IC socket..

The trimmer and resistor are not needed necessarily but can be fitted in order to trim DC offset thump (reducing clicking when notes are struck)

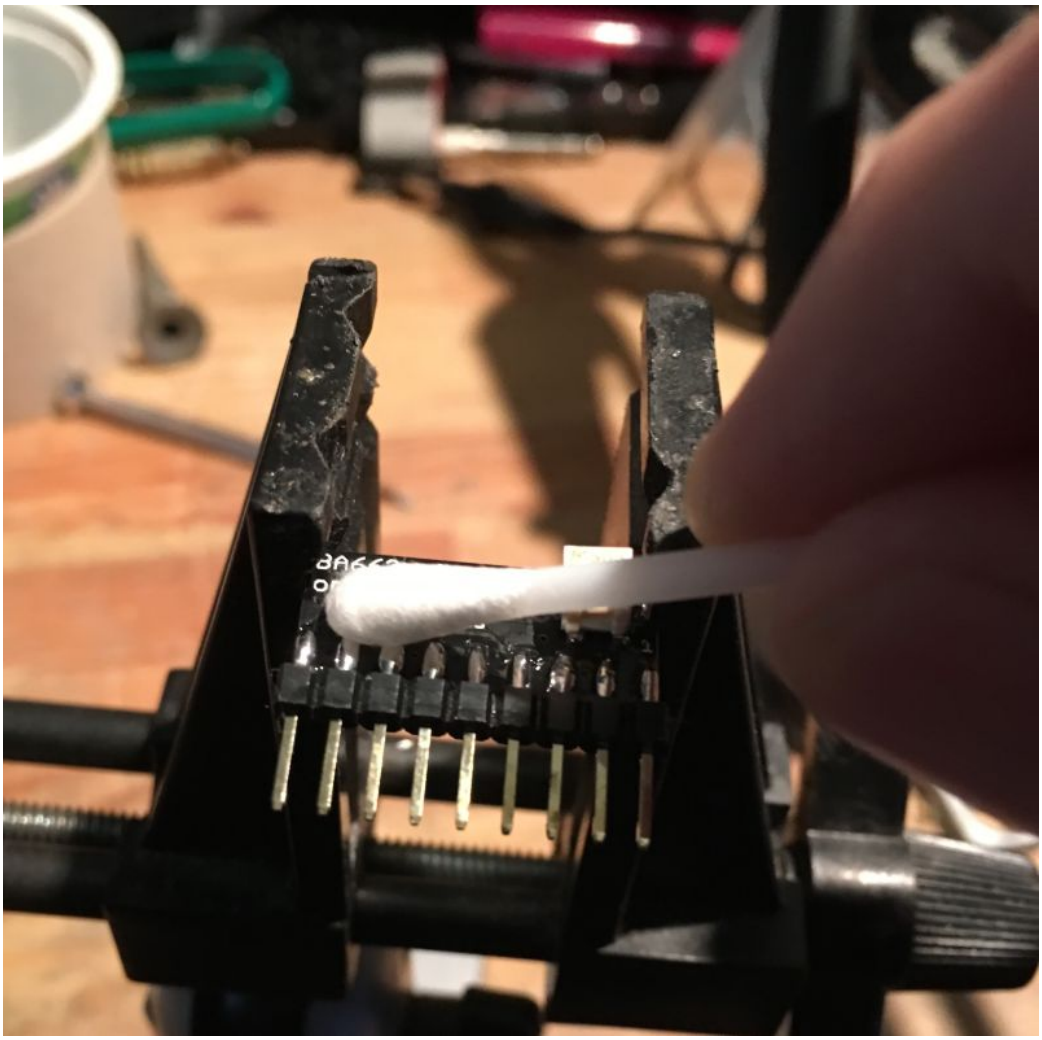
We recommend fitting these optional parts and doing so before fitting the legs..



First fit the 10M chip resistor (mouser 311-10MGRCT-ND)

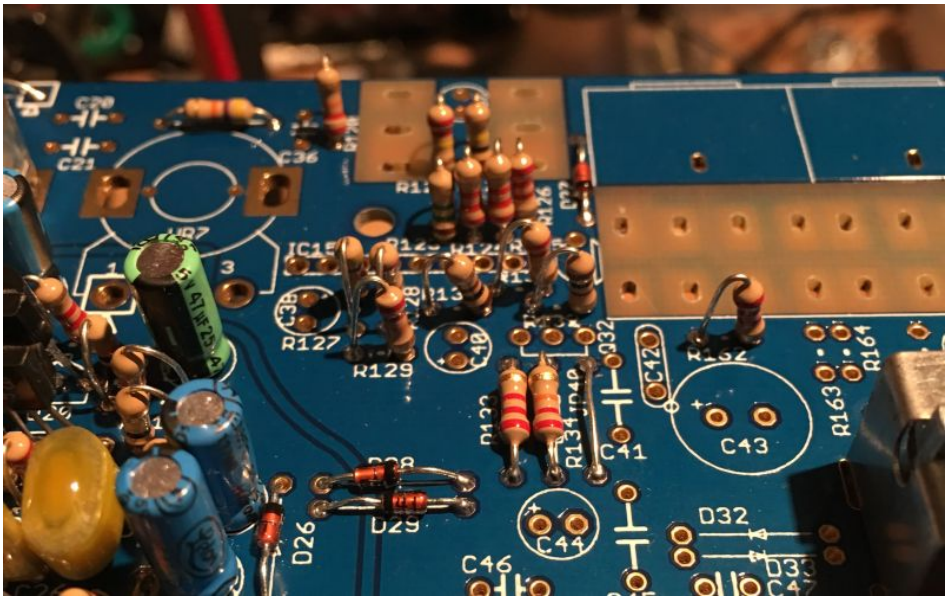


Now fit the 50K trimmer (mouser 3223J-1-503ECT-ND)

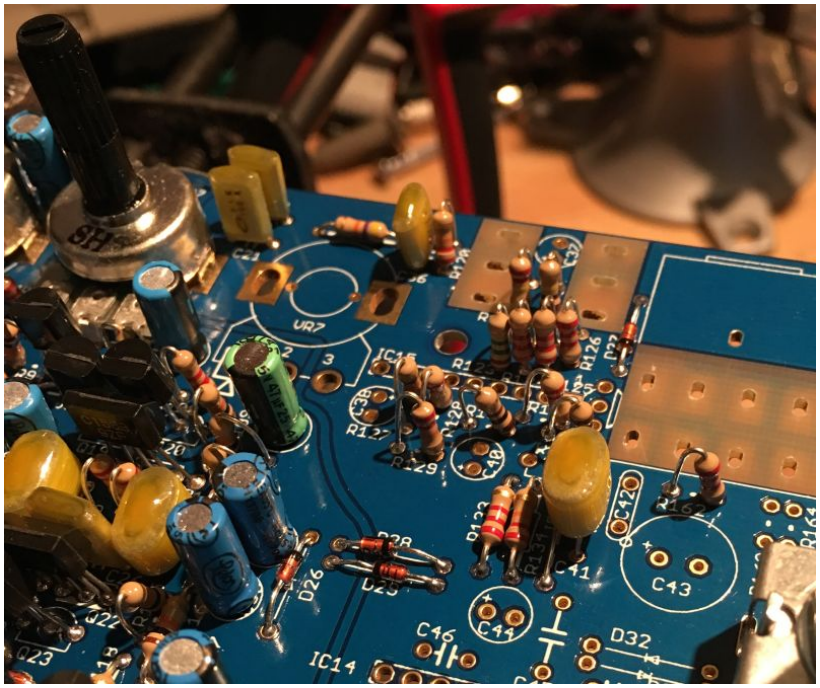


Fit the legs and clean away the leftover flux with some isopropanol.

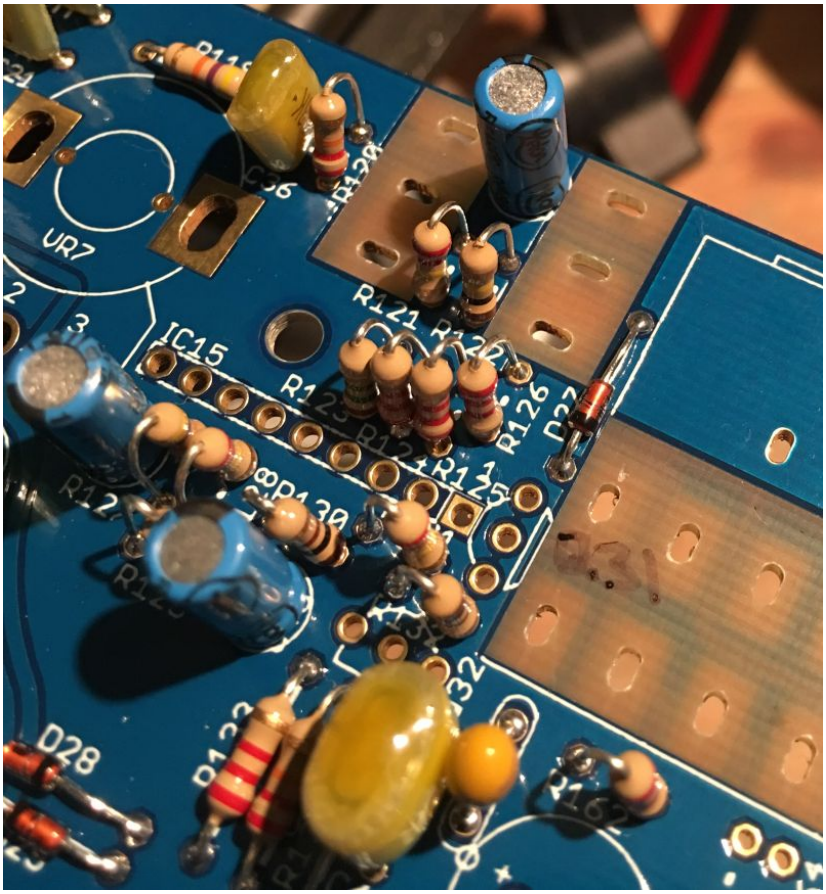
Set the chip aside until we need it later on.



Fit the diodes and resistors.

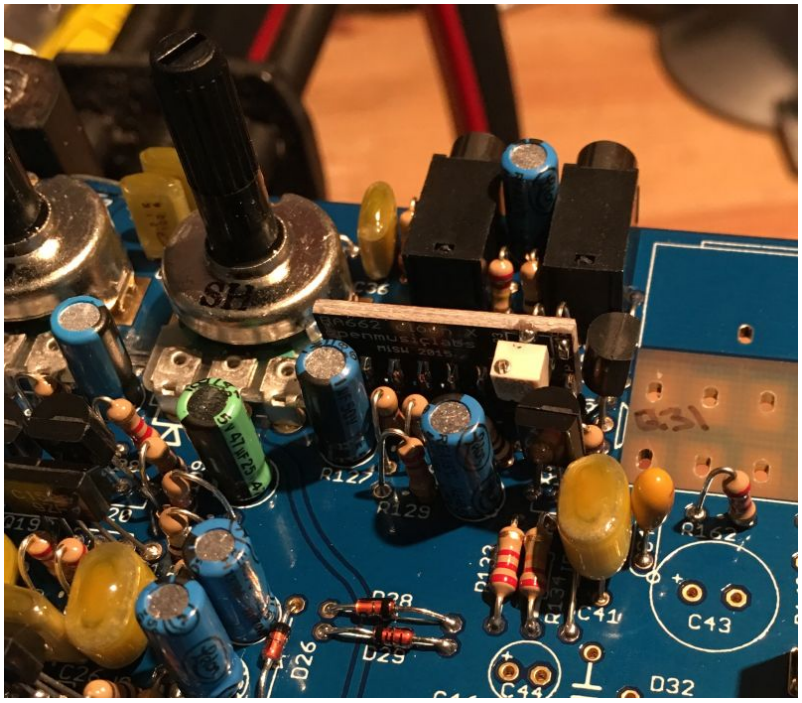


Fit the metal film capacitors.



Fit the electrolytic capacitors and transistors.

Note that Q31 doesn’t have a designator, you can see it is the transistor to the right of IC15 and marked in pen in the above picture.



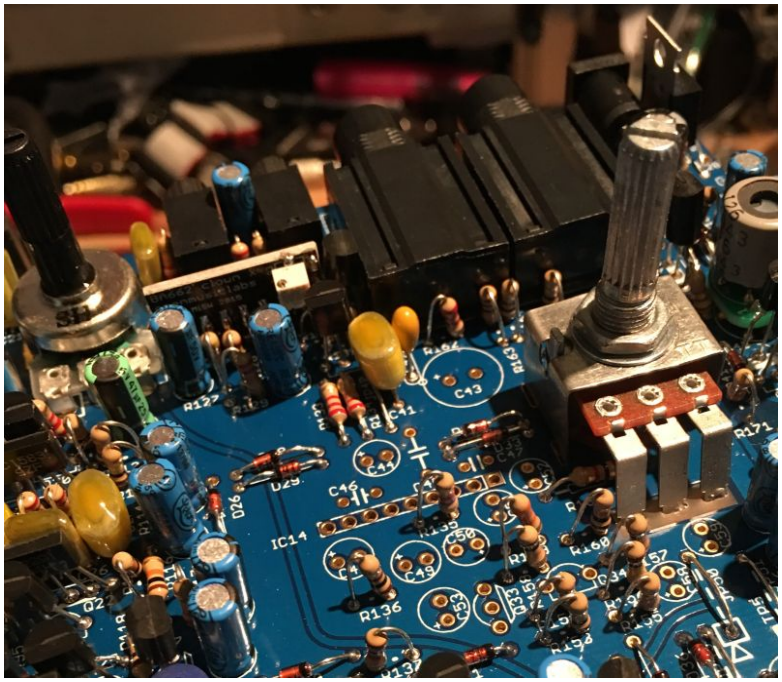
Now you can fit the BA662, note the orientation (pin 1 is to the right in the above picture)

The clone hangs over the edge a little compared to the original chip and is close to the case post, take care not to hit the parts on the side of the chip when assembling with an original case.

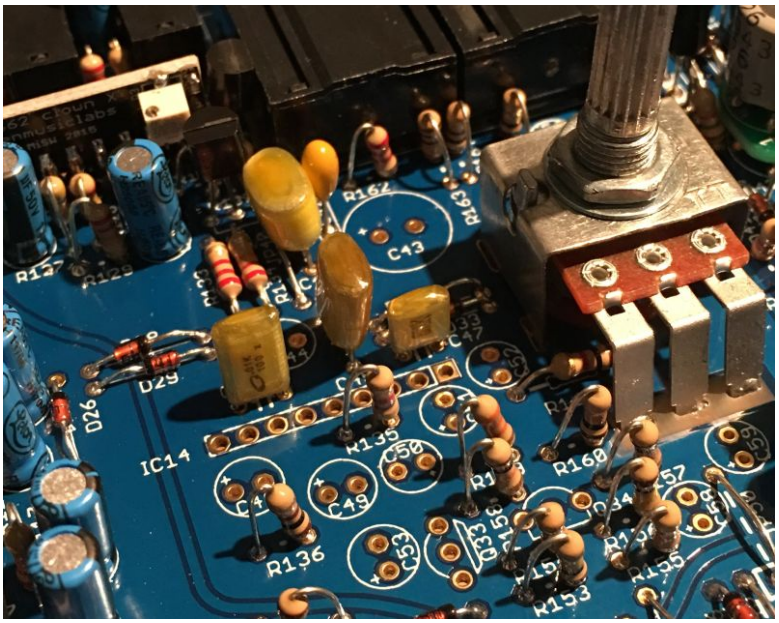
Finally you can fit VR7, then the 3.5mm and 6.3mm jacks.

Take a moment to check your work, make sure nothing is missing and that there are no solder shorts or splashes. If you are satisfied then it’s time to move on since we will test this section after the Mixer/Headphone section is built.

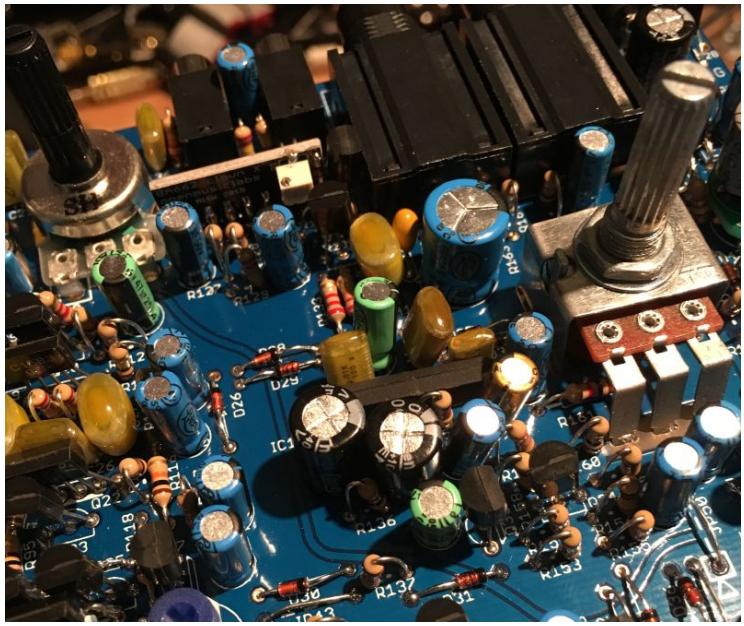
Building the mixer/headphone



Fit the diodes and resistors. R161 was fitted in the preparation stage.



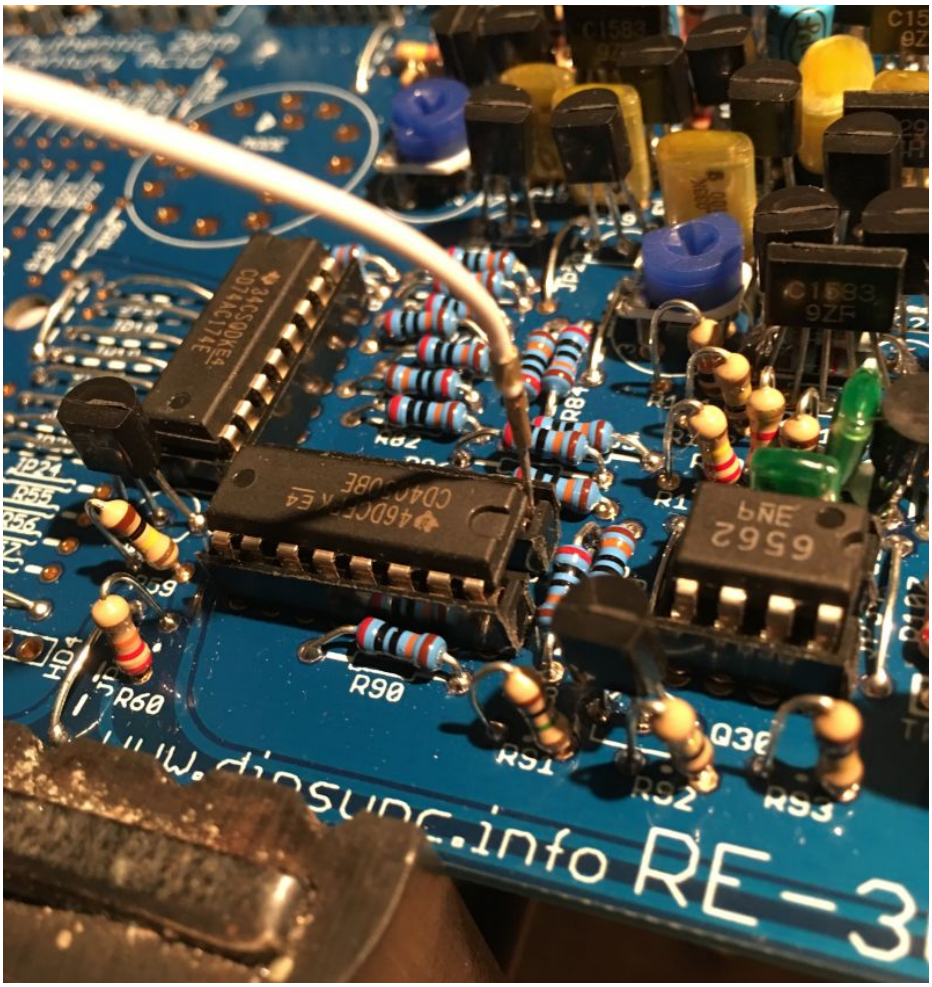
Fit the film capacitors.



Fit the remaining parts. Note that the slanted edge of the LA4140 designates pin 1 and should be facing to the right (square hole in IC14 pcb footprint)

Take a moment to check your work, make sure nothing is missing and that there are no solder shorts or splashes. If you are satisfied then it’s time to test the last three sections all at once.

Testing the Envelope, VCA and mix/headphone.



DO NOT DO THIS TESTING PROCEDURE WITH A CPU FITTED!

Connect up the power as before.
Ground R90 (if needed) to start the oscillator running.
Connect audio out or headphones.

You will need a voltage source to test the gate, this can be taken from IC10 pin 1, connect one end of a test lead as shown in the above picture (this is the 5.333v reference and is enough to trigger the gate)

Touch the other end to the south side of R146, you should hear a note play, just like in this instagram video. Test both the audio out and headphone out in this way.

http://www.instagram.com/p/BMjRuHghctM/

If you don’t hear anything then try the other socket (audio out of headphone) If there is no signal at all then there may be a problem with the envelope or the vca.

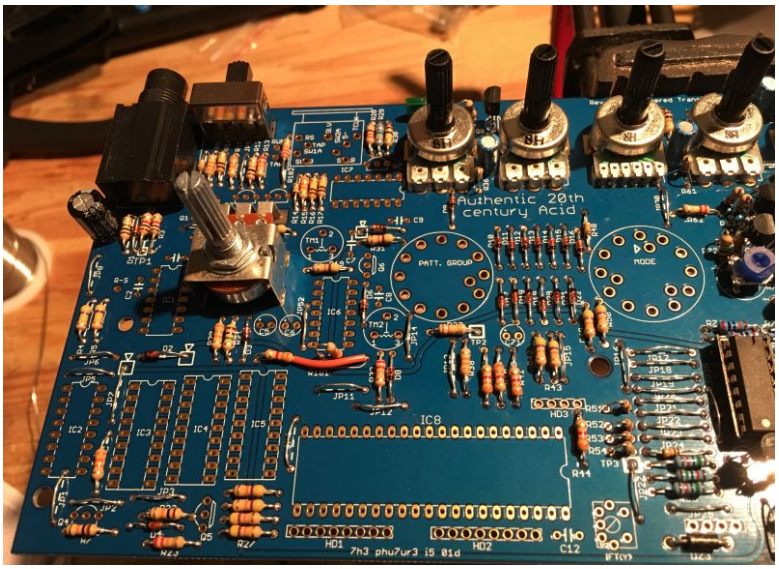
To test if the envelope is firing you can scope Q39 pin3 and repeat the test, you should see an envelope with decay between 200ms and 2.5 sec (depending on the setting of the decay pot)

If you don’t see the envelope then the problem is most likely in the envelope section, review your work and try again.

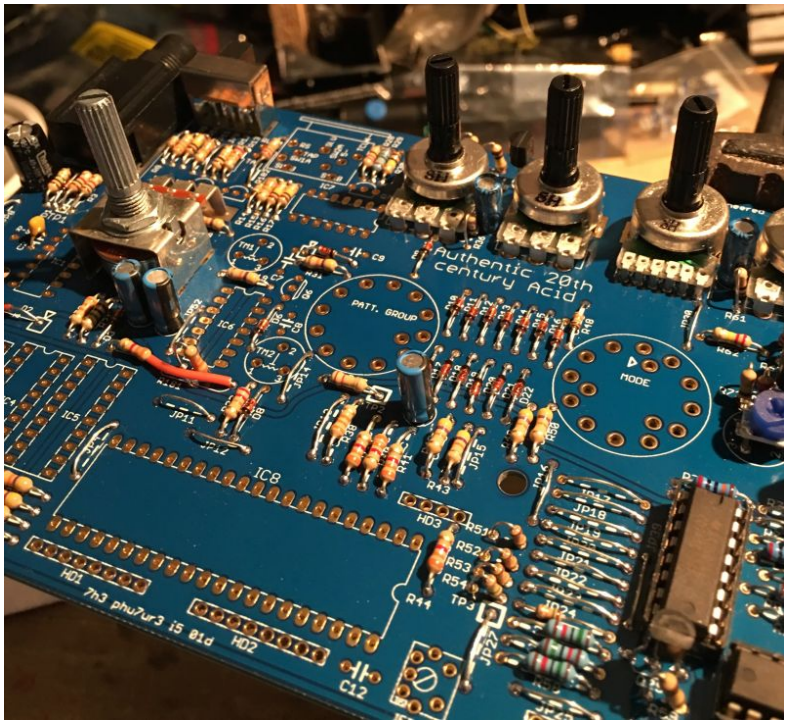
If you do see the envelope then the problem is most likely after the envelope section, review your work in the VCA and Mix/Headphone sections and try again.

Once the test is completed we have finished the analog section.

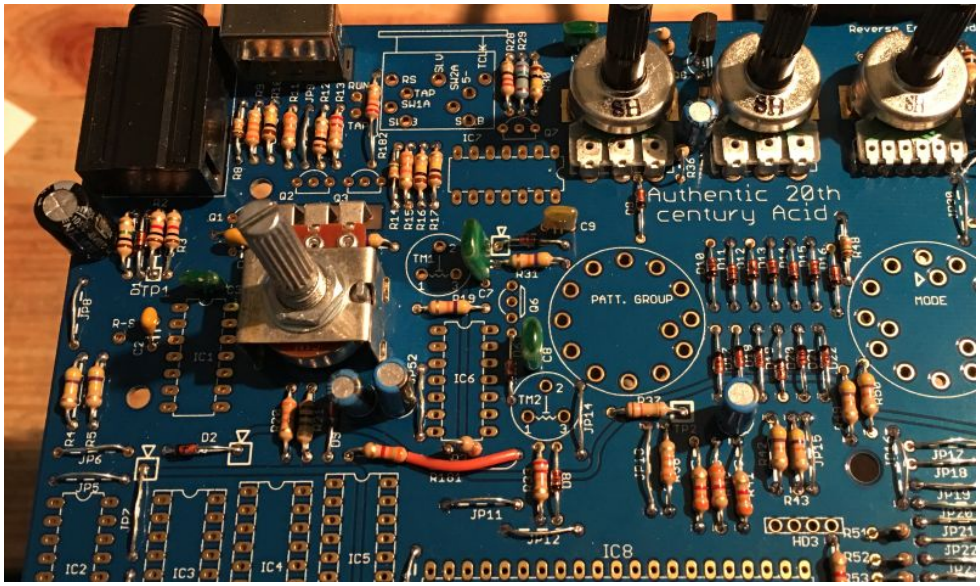
Building the Digital section.



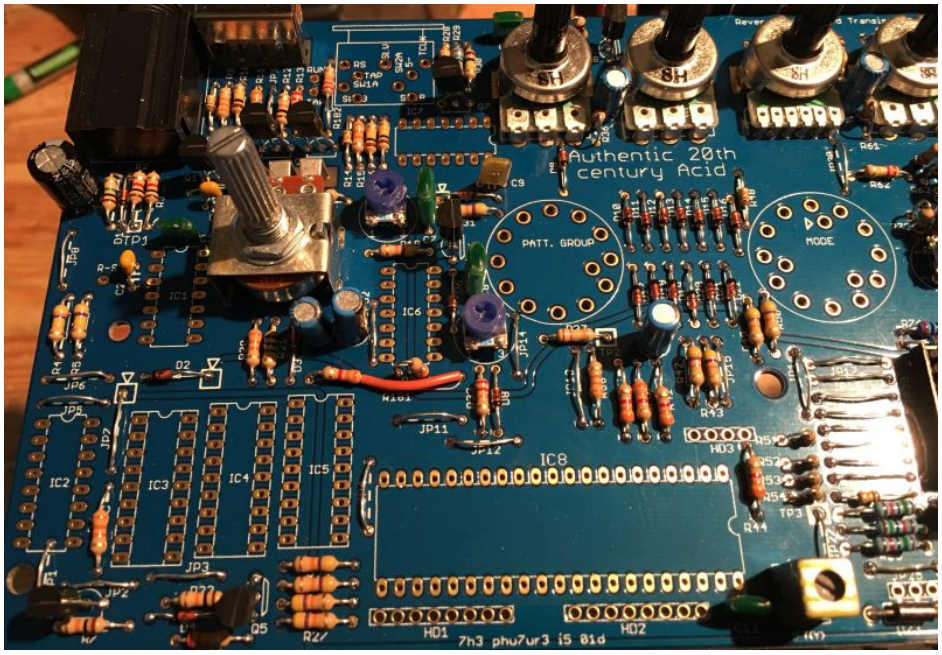
Fit the diodes and resistors. Note the extra insulation on R181.



Fit all the electrolytic capacitors.



Fit the metal film capacitors.

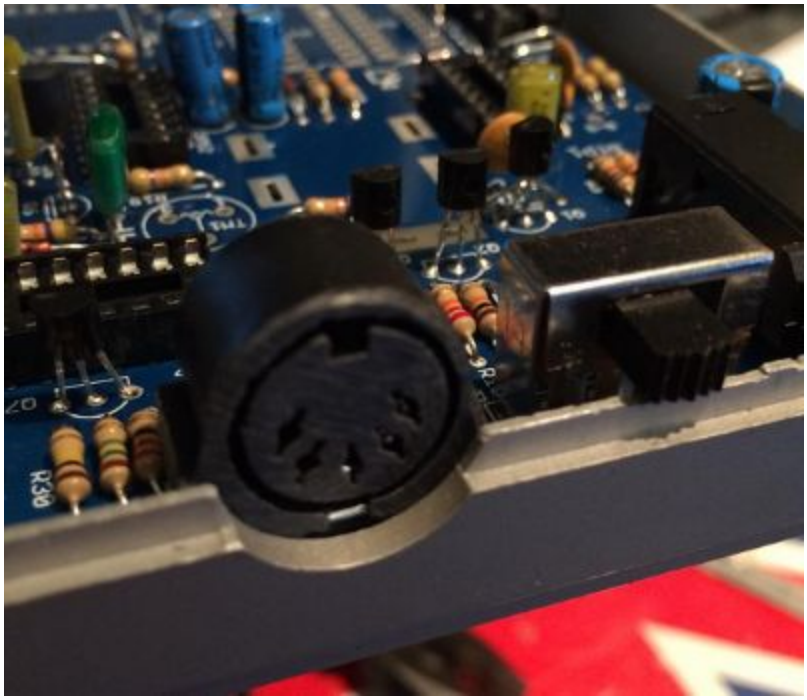


Fit the transistors, trimmers and yellow IFT coil.

About the switching sync socket

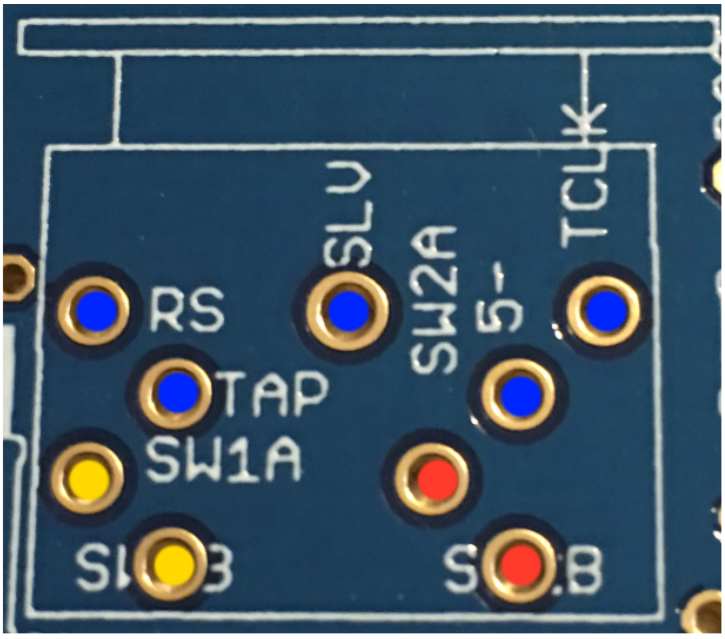
Unfortunately this part is obsolete, the only option is to fabricate the part from existing materials. Any standard 5-pin din pcb mount connector should be fine for the socket section. However the front ground pins and couling usually have to be trimmed as shown in the following pics.

This used to be an adafruit din socket.



Here it is fitted.

For the switch part you can simply use a standard DPDT switch.



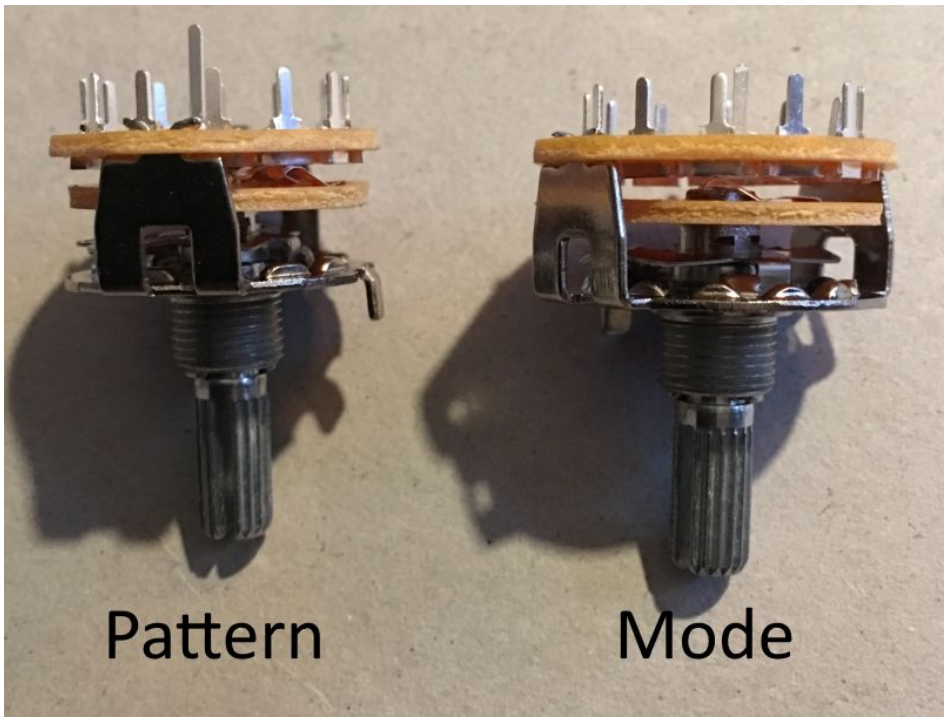
Din connections

SW1

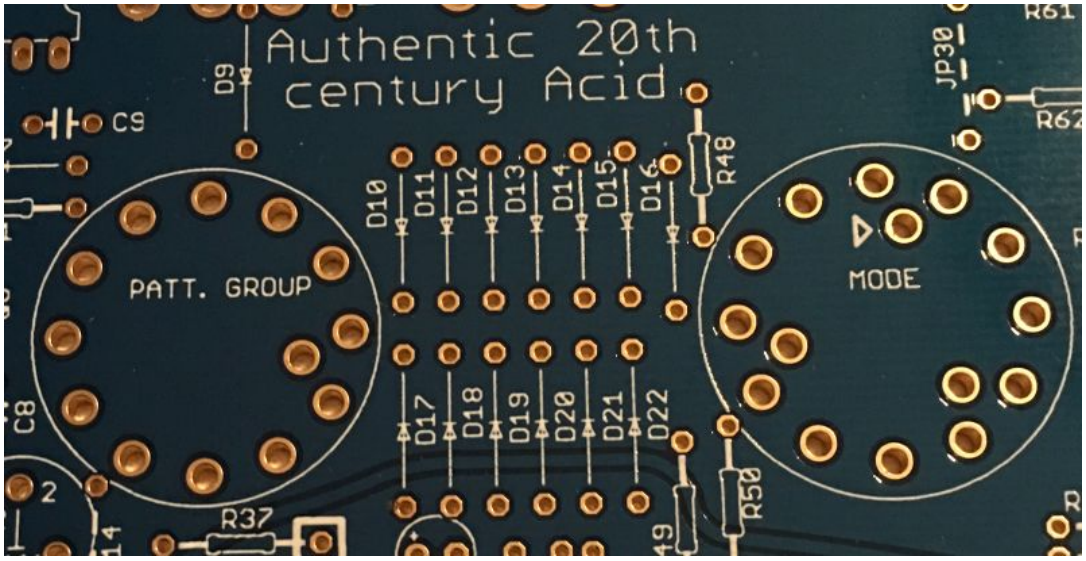
SW2

Wire SW1 and SW2 to the DPDT so that they are both switched on or off in unison.

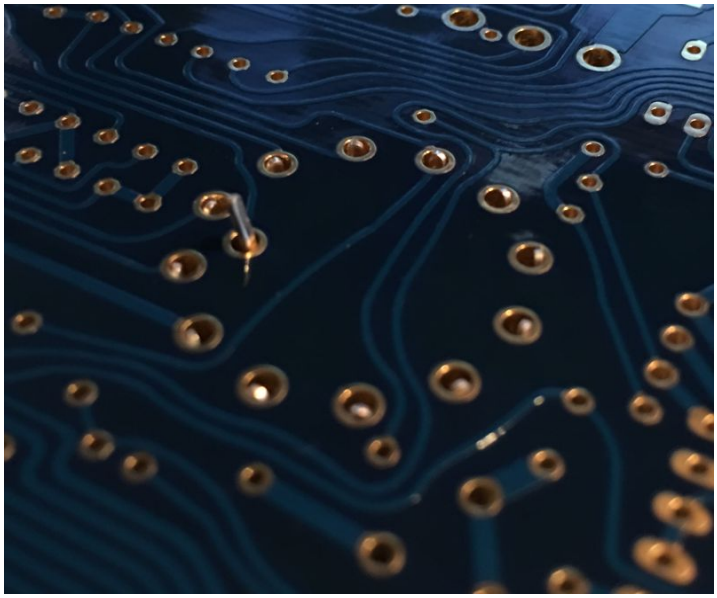
Fit the rotary switches



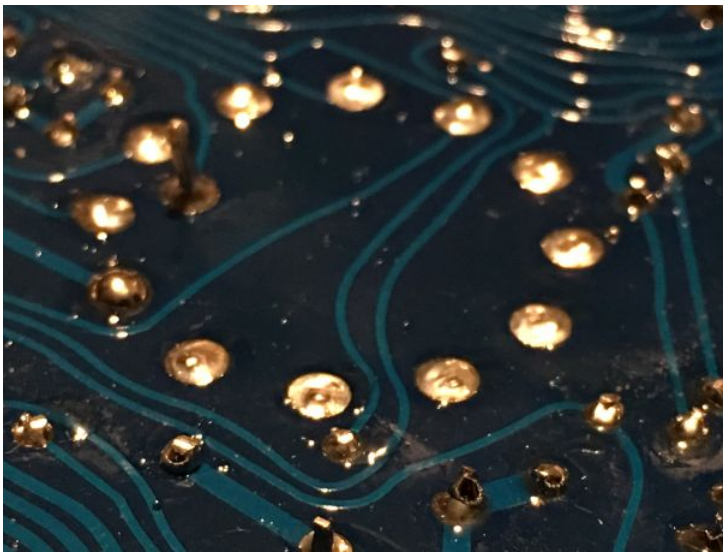
Notice the pattern switch not only has more clicks but also has a longer switch pin.



The pattern switch can only go one way but pay attention when fitting the mode switch. The switch pin must fit where the hole is marked with a triangle. **Read on before fitting**.



Fit the switch but do not push it down too far, try to keep the rotary pins even to the top of the pads as shown above.

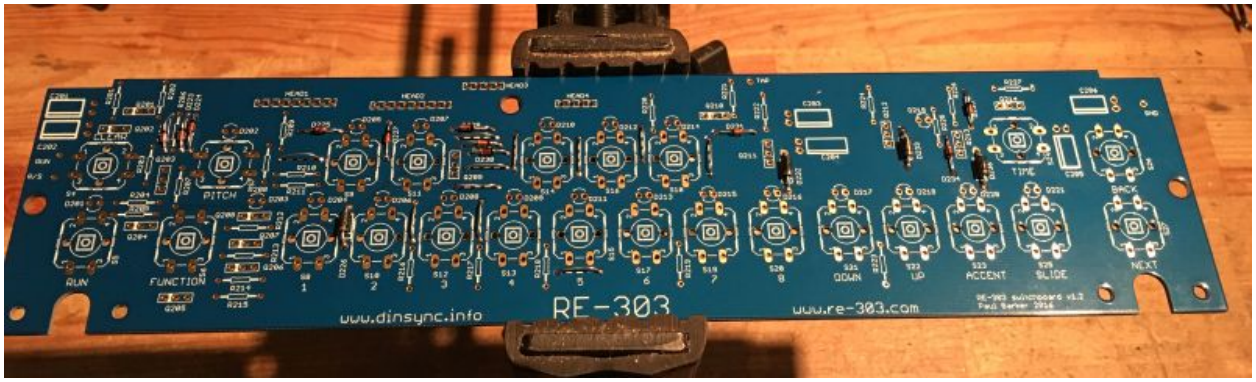


Solder only the switch pin and then form the part to the correct place and solder the rotary pins. Repeat for both switches. If you are fitting a real 303 case etc you might want to test fit and form before soldering the rotary pins. Don’t worry if you can’t line them up perfectly, Roland wasn’t able to do that either ;-)

Now that’s done take a moment to check your work, make sure nothing is missing and that there are no solder shorts or splashes. If you are satisfied then the digital section is done except for the IC’s. We will fit them after the switchboard is completed.

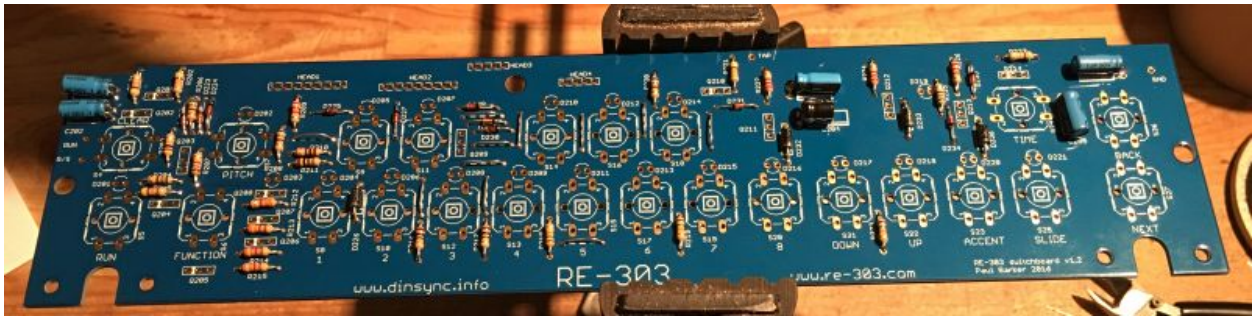
Building the switchboard

Fit the 11 jumpers.

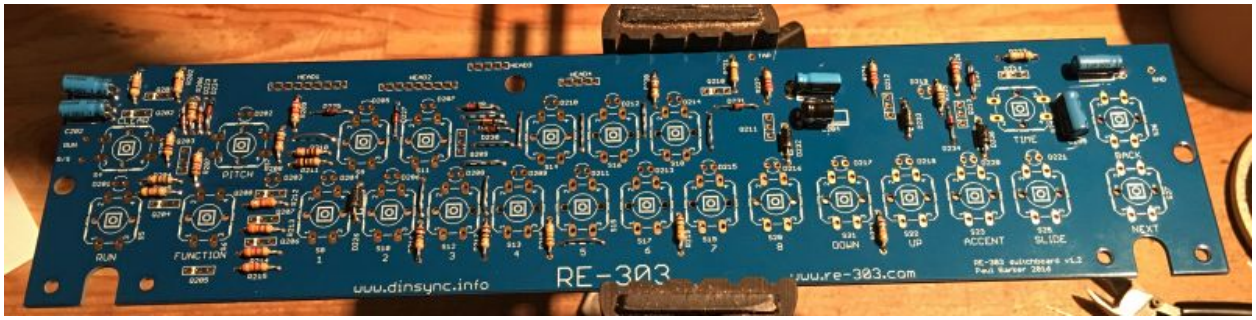


Fit the diodes.

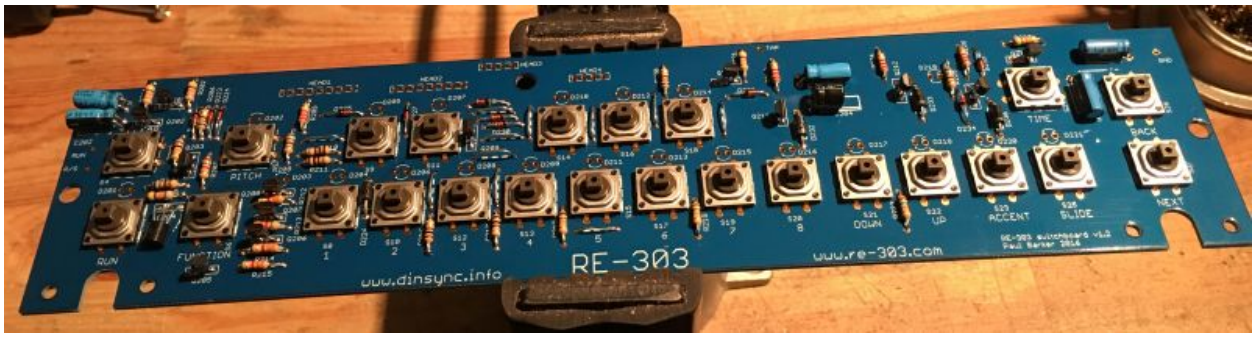
Fit the resistors.



Fit the Electrolytic caps, make sure the negative bands match on the silkscreen.



Fit the transistors.



Fit the tact switches.

Fit the leds with standoffs, note that D202 is fitted without standoff. Depending on what case you intend to use, it may be better for you to fit the LEDs once you are placing your unit into a case, therefore you may also not need the standoffs.

Q204 should be bent flat if using original style buttons.

As before, inspect you work. This section was quite straightforward so that's actually extra reason to double check ;-)

If you are satisfied then it's time to finish off the build.

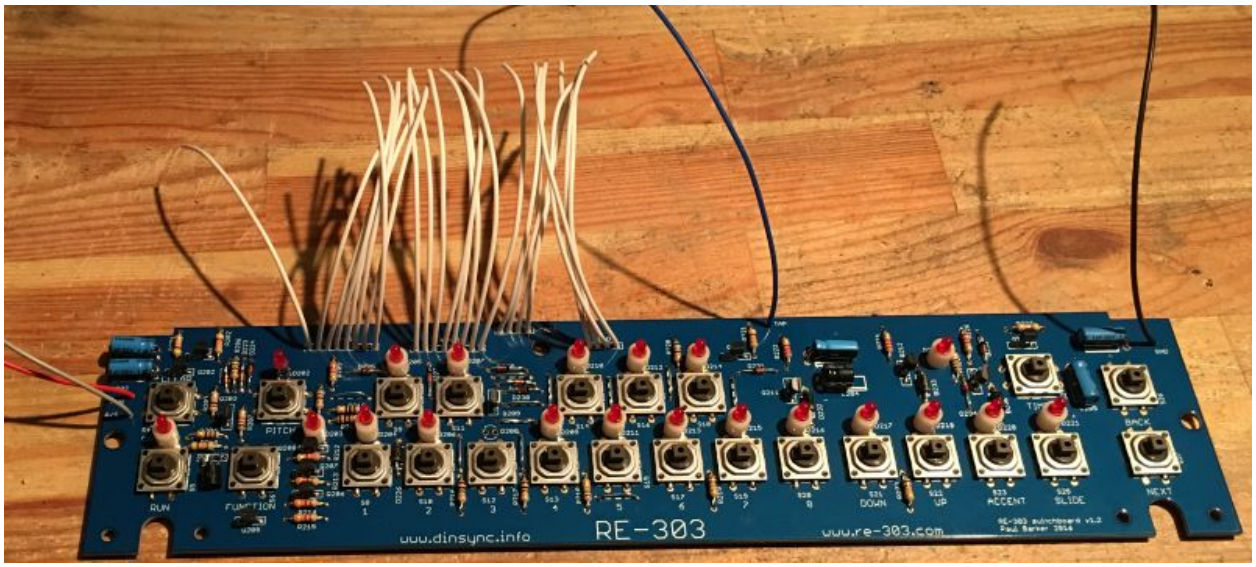
Interconnection wires

For this you'll need some hookup wire, AWG24 should suffice. The colour doesn't really matter but it's less esoteric if we use different colours for the different sections. And it makes the utmost sense to use red and black for the battery connections.

Here's a list of what you need to prepare.

CPU 24x 100mm
RS 1x 115mm
GND 1x 140mm
RUN 1x 150mm
TAP 1x 230mm

We will fit the battery wires at the very end so no need to cut them yet.



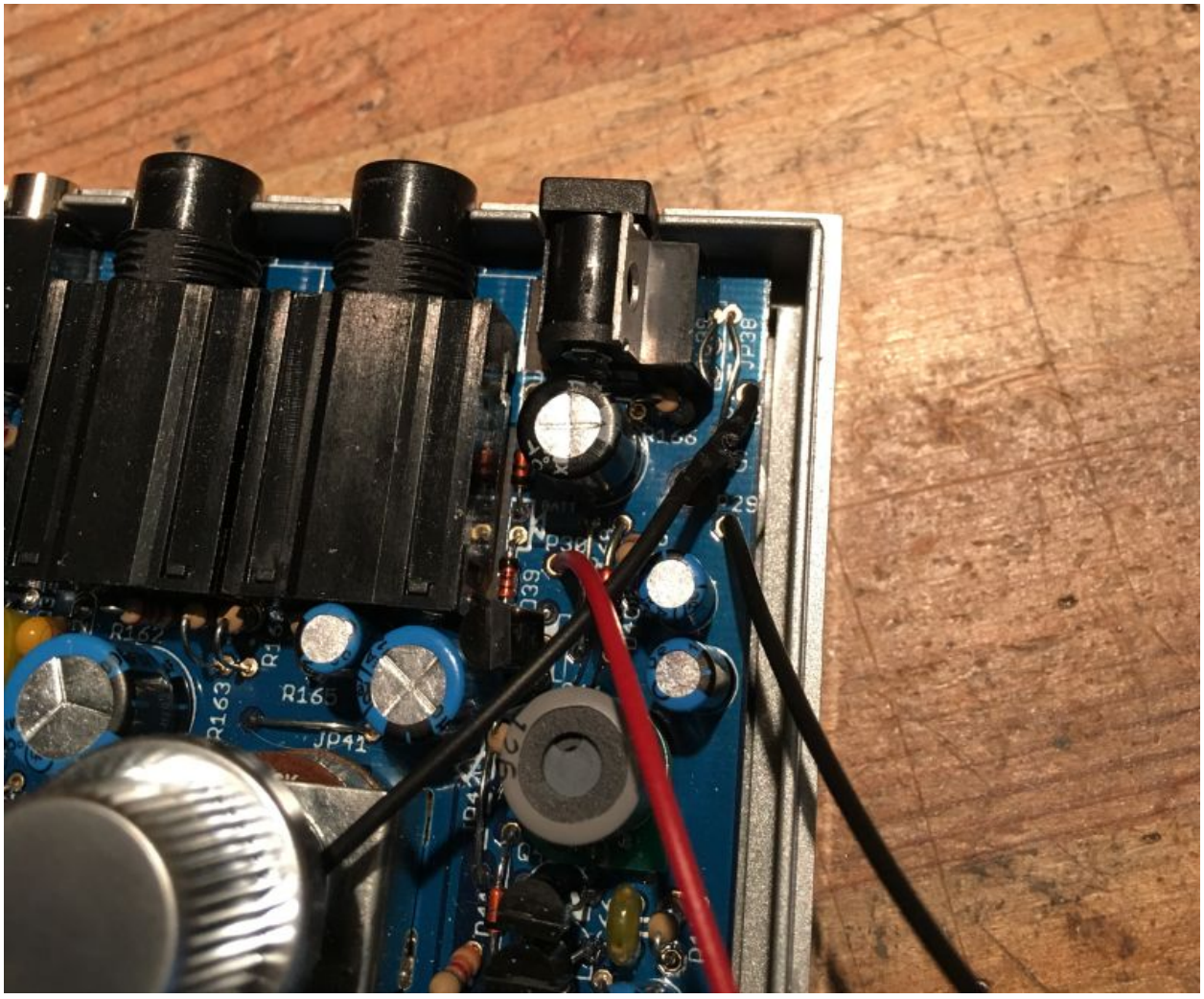
Attach all the wires to the switchboard. Before you attach them to the mainboard you should place all the IC's on the mainboard as it will be simpler to do before the wires are fitted.

The best place to start is the CPU lines, start at one end and solder all 24, then place the standoffs on, fit the boards together then solder the remaining wires.

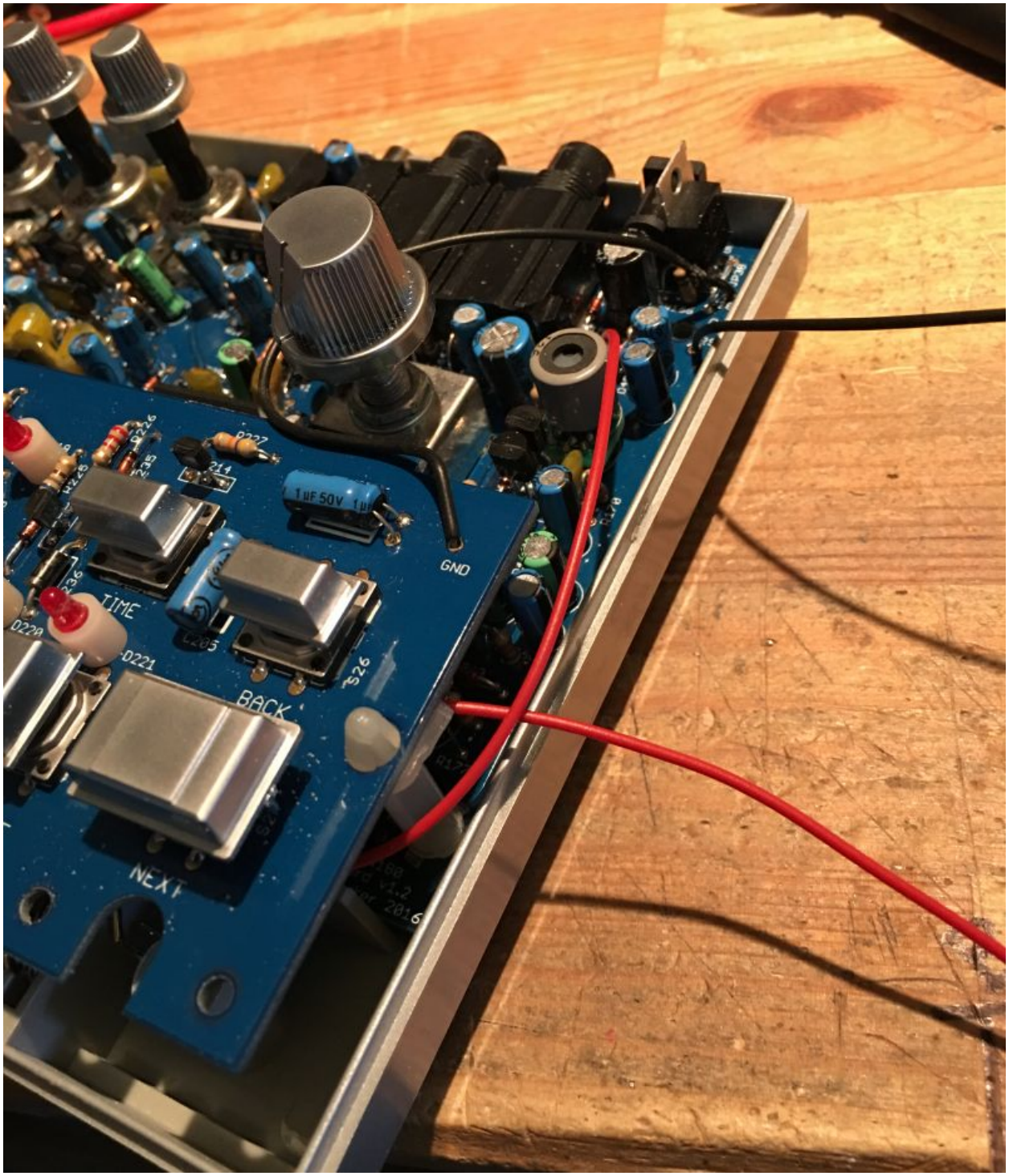
Once that’s done we can fit the battery wires.

Fitting the battery wires.

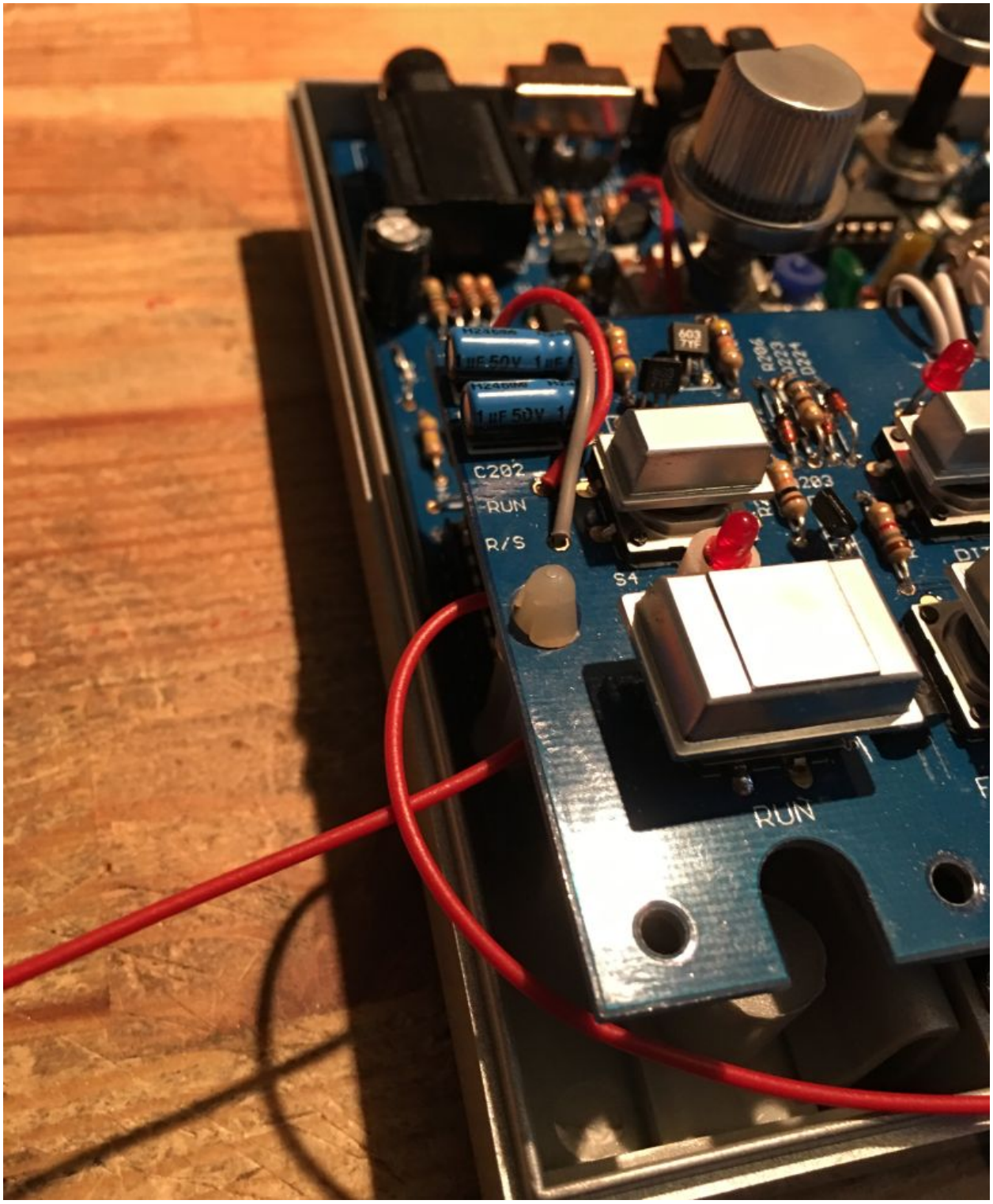
The ground wire should be around 17cm and the positive should be around 70cm this gives a little extra so that you can trim to the correct length after placement.



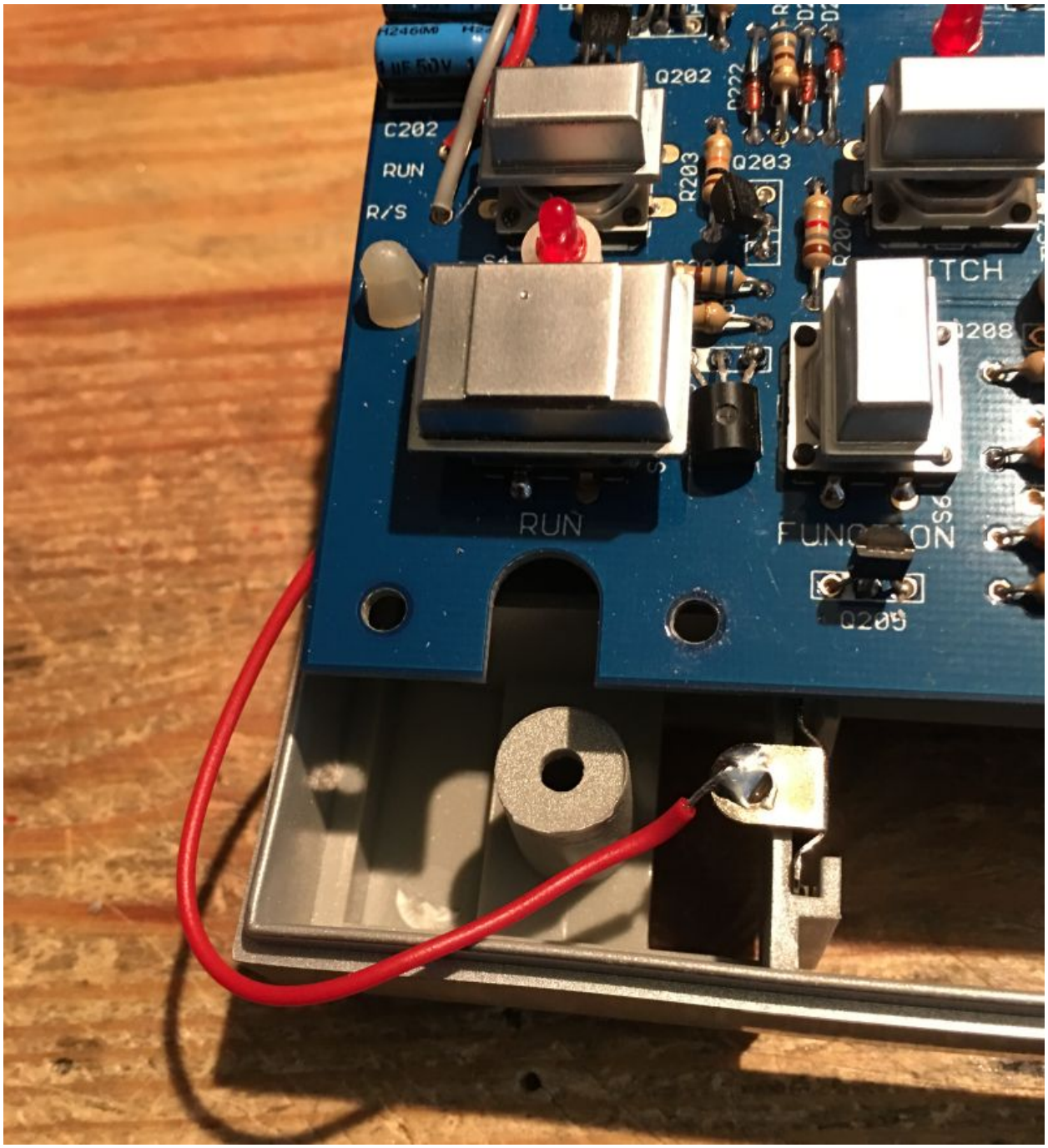
Connect the wires as shown. The positive lead goes to P30 and the ground is either P28 or P29 depending on which ground you used for the switchboard (it doesn’t matter which ground point you use).



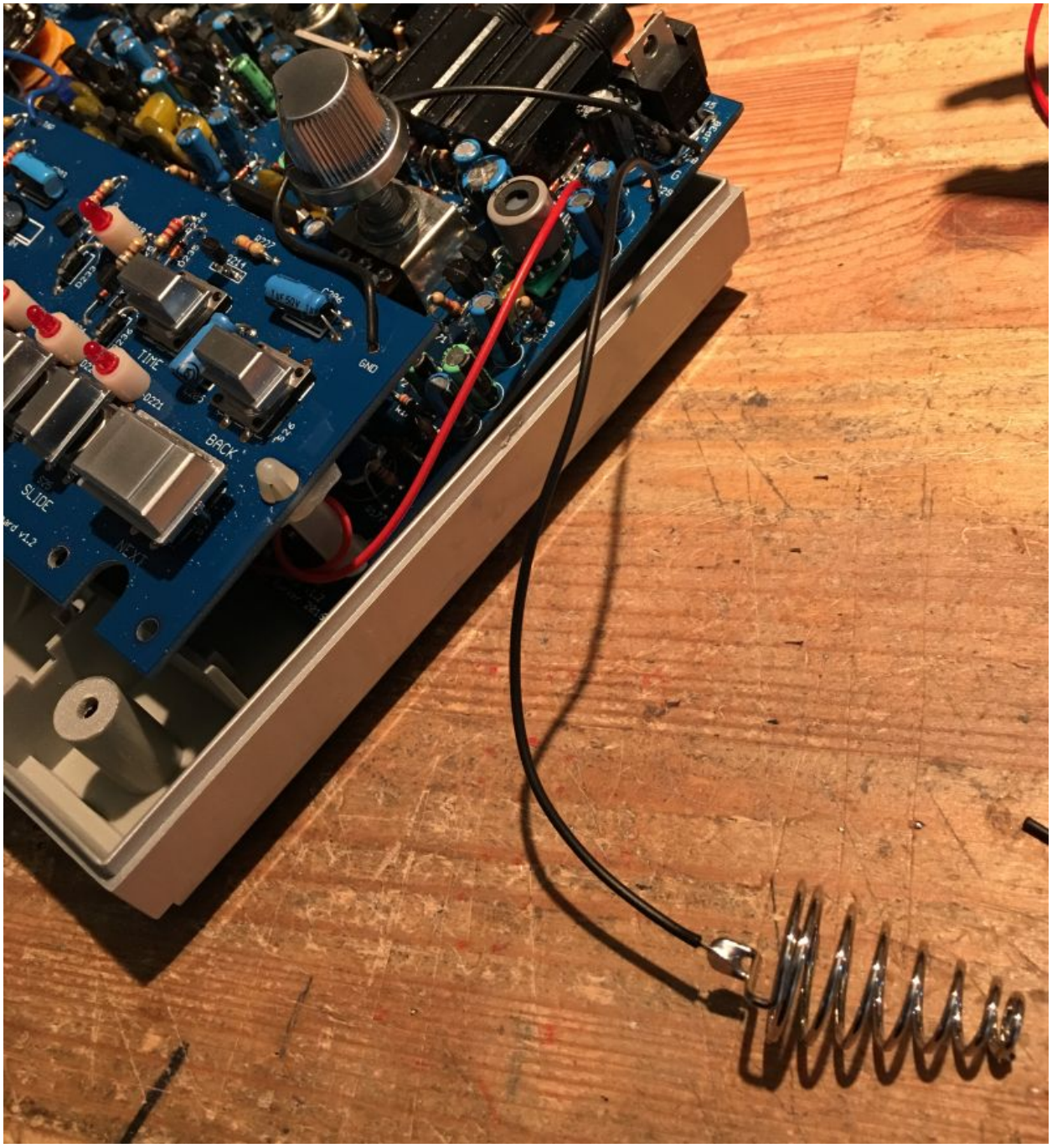
Wrap the red wire around the standoff



And around the other standoff



Take up some of the slack and then cut to length and solder. No need to pull it super tight, we aren’t fitting curtains.



Now solder and fit the ground terminal. All done.

All that remains is to calibrate your machine

The official way is explained in the service manual here, if you are using a real CPU you should look at page 8 and first do the CPU timing adjustment, the rest of the adjustments are on the following pages of the service notes or just read on below.
http://privat.bahnhof.se/wb447909/dinsync/service_manuals/TB-303.pdf

The “fast” way if you don’t need to calibrate the CPU timer.

First check and set the power level as you did in the build but now with a populated machine you should check that you have the correct 5.333v reference (see the power supply section of this guide)

Next set the tune knob to its middle position. Program a C note and then high octave C note into the sequencer and and set the time mode to play long alternating notes. Connect up your scope to the middle post of the waveform switch and adjust TM5 so that the frequency of the higher C is double that of the lower C.

Now program an A into the sequencer and adjust TM4 so that the frequency is 110hz. You can then check by programming a shifted down A that the frequency is around 55hz and that a shifted up A is reading around 220hz.

Now you need to set the center frequency of the VCF, many people like to set this by ear or open it fully. Personally I think the service notes version is the best way to set this as some filter interaction is lost if this is open fully. So,

Connect scope to TP6
Set waveform to sawtooth
Set CUTOFF FREQ to center
Set RES fully clockwise
Set ENV MODE, DECAY, ACC fully counter clockwise
Program A (110hz) as before and observe the waveform as notes are hit, adjust TM3 until you have 2ms gaps between the resonant peaks (see picture on page 7 of the service notes).

Now all that remains is the vca trimming if you fitted the optional trimmer. This is quite simple, once the machine has warmed up, run the sequencer so that notes are playing. Now move the waveform switch half way until the waveform is silent but you hear the chirp and dc thump of the filter and vca. Now adjust the trimmer to minimise the thump (it will always be a small amount).

That’s it, by now you should have a working RE-303, information on the dice roll is below.

Congratulations on completing the mission Space Cadet!

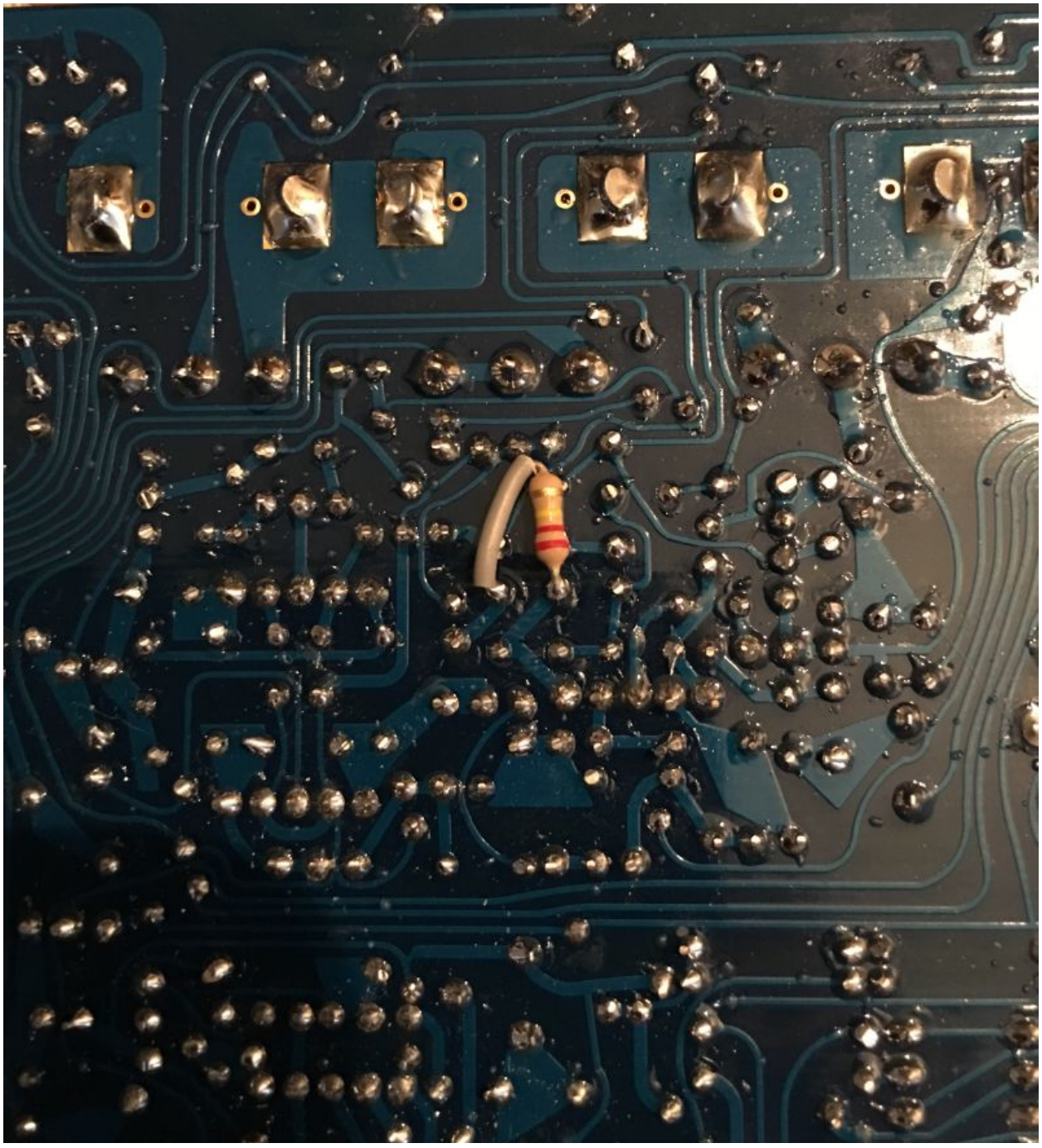
Building a dice roll machine

When Roland made the TB-303 there was not really any thought of audio fidelity. It was more about creating products based on existing technology. There are at least three variants of transistors known to have been used in the short production run. There could have been more, there simply is not enough available data.

So essentially all TB-303s are dice rolls, the components were not specifically picked, there was no voodoo involved. What this leads to is quite some swing between machines. Over the years many have passed my bench and all sound great but some sound incredible.

The mother machine that was used to create the RE-303 is a good example of a stock 303, but I also have another (whitey) that just sounds incredible. Why is that? It’s not really totally clear to anyone and it leads to lot of speculation and the inevitable voodoo tricks.

So I came up with the dice roll concept, you just build your machine and do one tweak.



220K resistor in parallel with R97

That’s it? Pretty much, it drives the resonance a bit more and to me it’s that little extra difference you could have between a good 303 and an awesome one from the factory.

Of course ymmv :-P