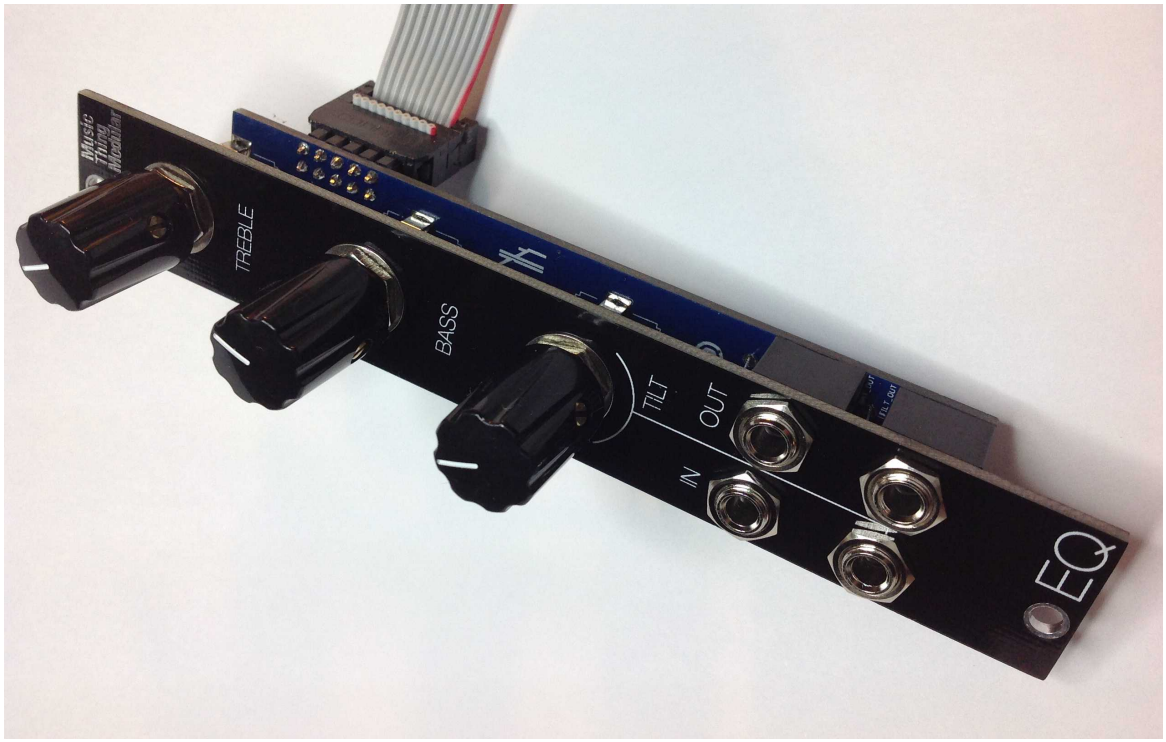
Music Thing Modular SimpleEQ Construction Guide

(1206 version)



Music Thing Modular

Useful Links

The latest version of this doc and BOM can always be found at http://thonk.co.uk/documents/eq/

A build thread on the Muffwiggler DIY forum can be found at this URL

Quickstart

If you're new to building with SMD components, skip to the detailed notes on the next page.

If you're an experienced SMD builder you'll probably want to skip the lengthy notes below, so here's some things that will probably save you time when you're building this project.

- A detailed BOM can be found on the last page of this document.
- The op-amps might not have pin 1 indicated by an adjacent dimple/dot in the package, or by a semi-circular indentation at the end nearest pin 1/pin 8, as is common with through hole ICs. SMD devices often have one of the longer sides with a sloped edge, the other with a vertical edge. If you have such a device, pin 1 is the left-most pin of the side with the sloped face when the device is pointing upwards. The silk screen on the PCB shows both the traditional circle next to pin 1 and also a line to indicate the orientation for devices with a sloped face. There are pictures on page 19 that show this.
- The suggested build order is to start with the components that have the lowest profile & work upwards, so thats
  - resistors
  - non-polarised capacitors
  - diodes & PTC fuses
  - ICs
  - electrolytic capacitors
  - through hole components and panel
- It's suggested that you regularly stop to clean and inspect your work. It's much easier to re-solder a joint when the board doesn't have the jacks and pots fitted.

Recommended Tools

To work with surface mount devices, such as those used in this kit, it's a good idea to have the following tools to hand:

- Soldering iron with a small tip. A 1-2mm chisel or point tip is preferable.
- Fine gauge solder. Ideally 0.7mm or less.
- Solder wick. This is essential for removing excess solder, especially when soldering the ICs.
- Flux pen. This isn't essential for a kit like this with only two 8-pin IC's, but it does make soldering some components easier.
- Fine point tweezers. These are essential for handling surface mount components.
- Magnifying glass or jewellers Loupe. You'll need some method of inspecting solder joints. Magnification of 10x is recommended.
- Soft haired brush and PCB cleaner for removing flux residue. The type of cleaner will depend the on the solder you use. Isopropyl alcohol usually works well.

Introduction to working with Surface Mount Components

This section isn't meant to be a definitive guide to working with surface mount technologies. You'll find plenty of tutorials online for that. This is intended to provide some tips as to how to approach building this kit.

Many surface mount components are supplied in tape packaging. For passive components such as resistors and capacitors, the tape is usually made of cardboard, whilst semiconductors, such as ICs, transistors, diodes etc will be in a anti-ESD plastic. The tape will probably have a layer of clear plastic film over one side. To remove the device, the easiest way is to carefully peel away the plastic film with a pair of tweezers or fine nosed pliers. Take care when you remove this film. These components are small, and it's easy to lose them if you jolt the tape once the film is removed. It's a good idea to remove them from the packaging & place them into a bowl or other similarly shaped container, then pick them from there as you place them onto the PCB.

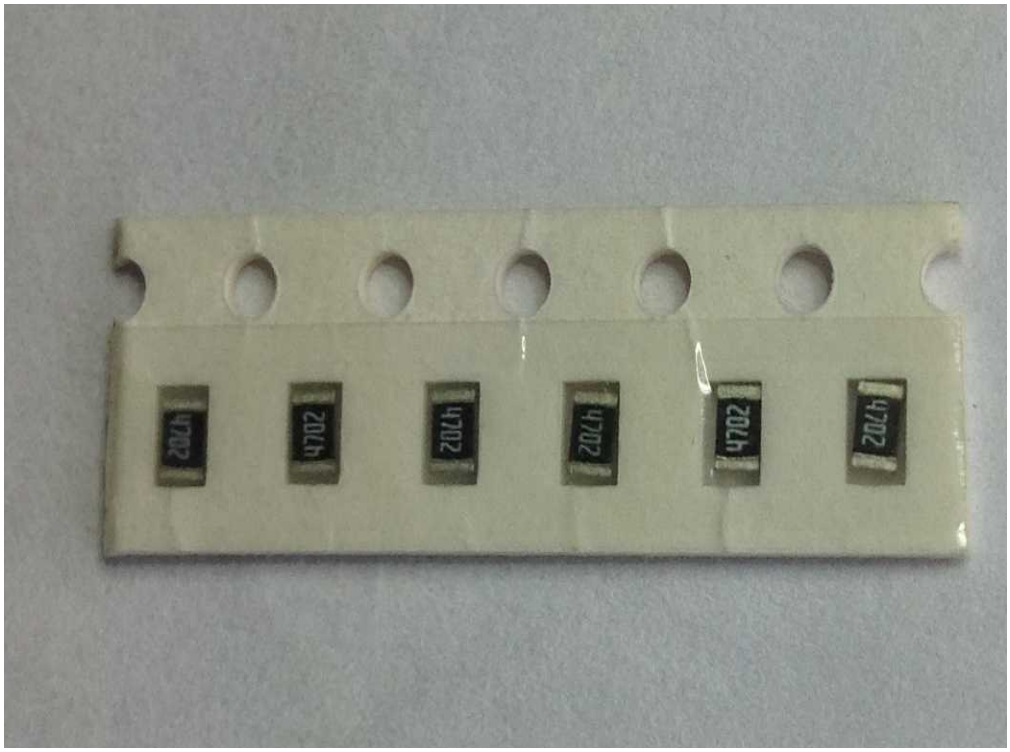


Illustration 1: SMD resistors supplied in tape

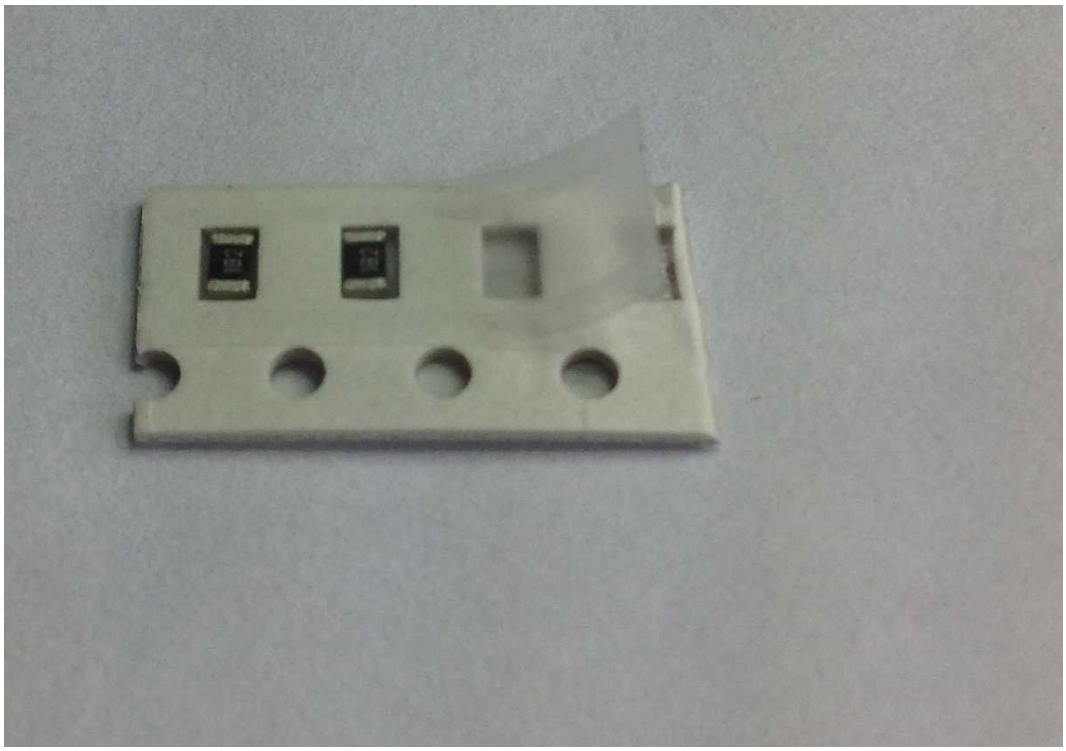


Illustration 2: SMD resistors in tape showing plastic cover partially peeled away

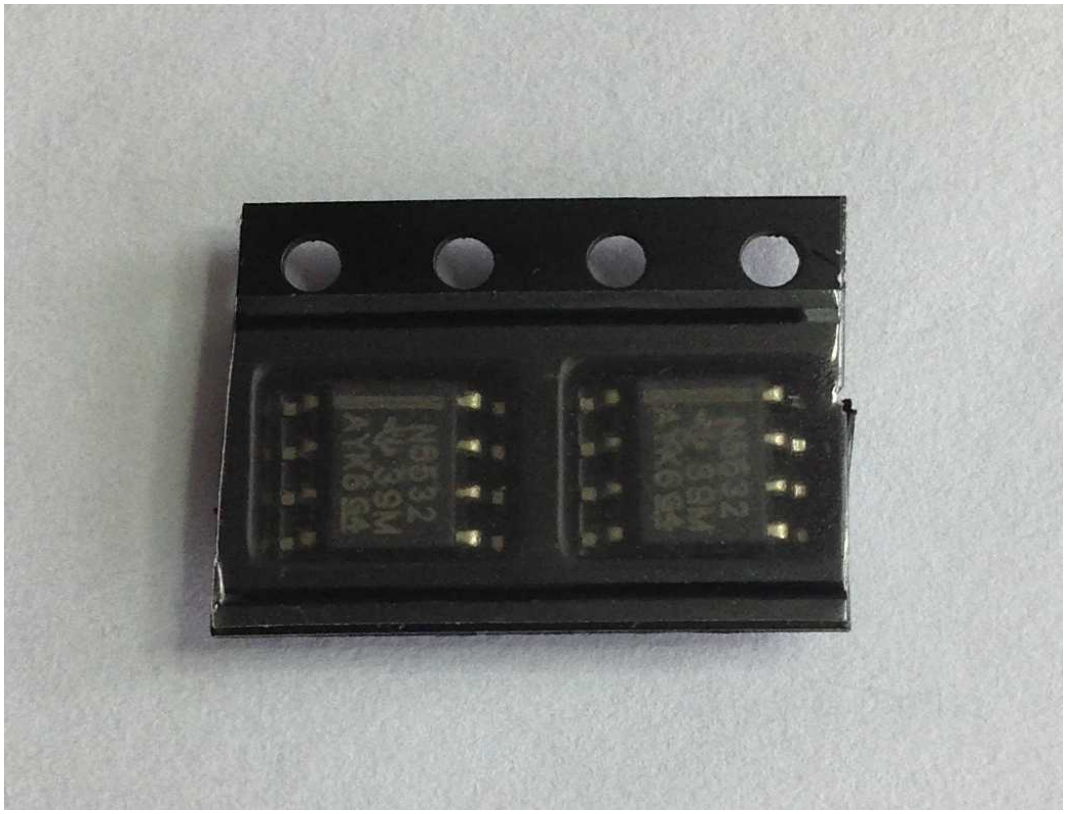


Illustration 3: SMD IC's in tape packaging

Install one component type & value at a time. Many of these components are not labelled with their values, so don't mix them up. Finish one component type & value before proceeding to the next. Don't rush. Regularly inspect your work with the magnifying glass or loupe. Clean your work as you go. You'll find it much easier to inspect your work with the solder flux residue removed.

There's many useful resources online for tutorials on working with surface mount devices. The techniques here suggested here are one way to solder surface mount devices. As you become more familiar with working with this technology, you may find other ways of working that you prefer.

So, to the kit ...

The Kit

Illustration 4: SimpleEQ 1206 kit with white panel

The PCB:

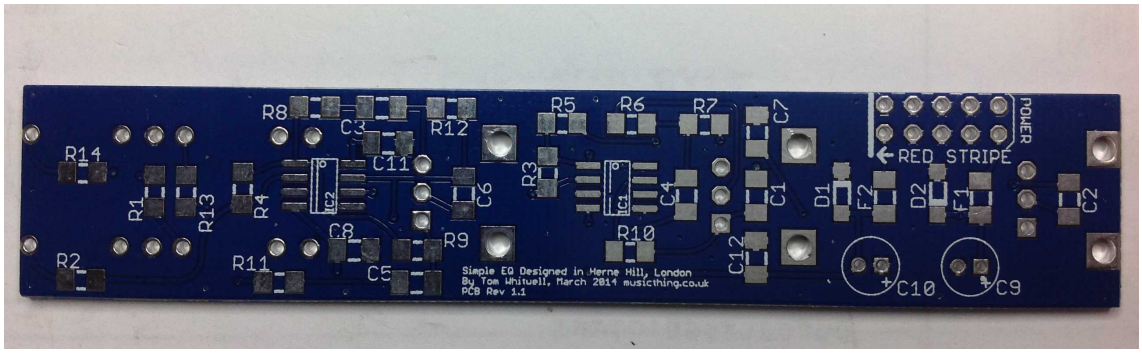


Illustration 5: PCB top view

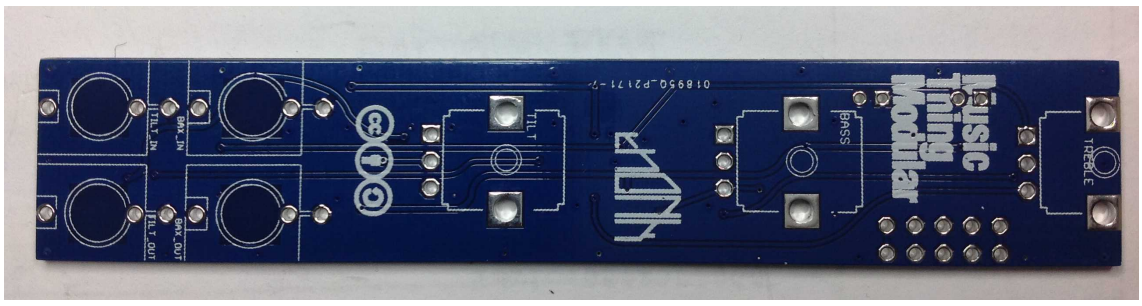


Illustration 6: PCB bottom view

The Build

We'll start with the resistors.

Find the bag that's marked “10K x4 R1 R2 R3 R4” & remove the component tape strip containing the four resistors. As described above, open up the tape strip by removing the clear film cover, tipping it's contents into a suitable container. One side will probably be a darker colour than the other. The darker side may be marked with the components value. In the image below it's “1002” (100 x 10^2 or 10,000 or 10K), though you may also see 10K marked with “103” (10 x 10^3). Whilst it doesn't matter which side of the component you have facing upwards, it's good practice to have the side with the value pointing upwards. As resistors are not polarised it doesn't matter which end of the resistor is soldered to which pad on the PCB.

Illustration 8: 10K SMD resistor top view showing the value “1002”.

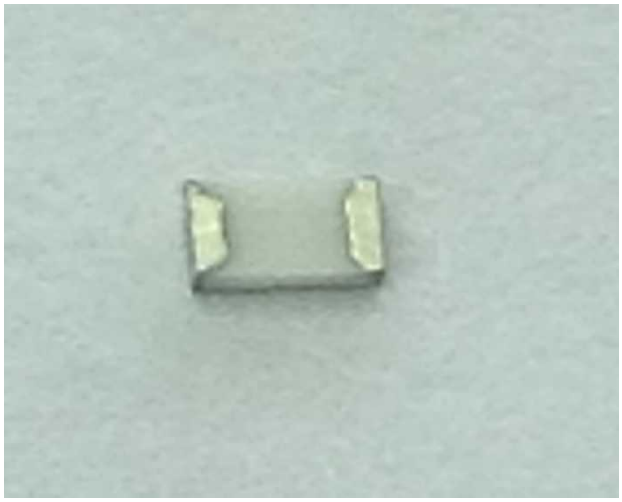


Illustration 7: SMD resistor bottom view

Before we actually solder the first of the resistors, lets take some time to actually see how the resistor will be located on the PCB. Place the PCB on a flat surface. Find the location of the first of the 10K resistors, R1. It's over towards one side of the board. Notice that the PCB has 2 pads for the component, and two white silk screen lines between the pads.

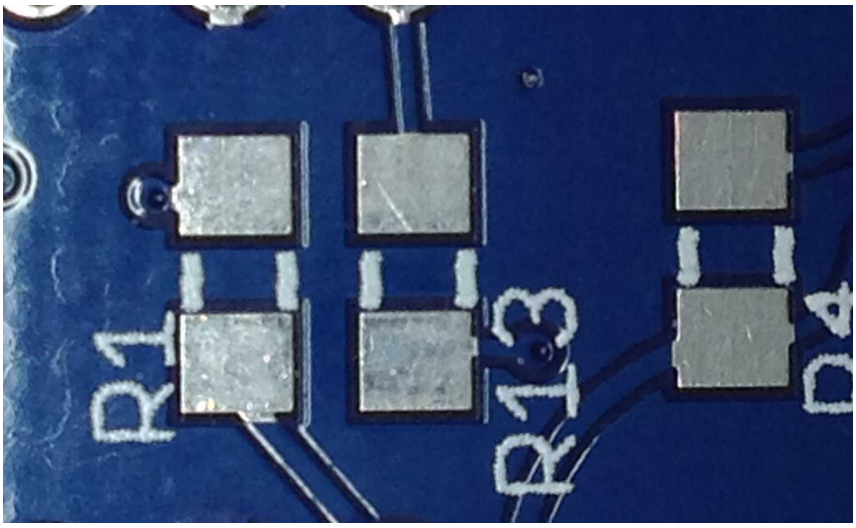


Illustration 9: SMD resistor pads and silk screen on PCB (showing R1)

Pick up one of the resistors using the tweezers, & place the ends of the resistor centrally over the two pads. Notice how much clearance you have around the outside of the resistor on the pads. When you solder the resistor in place, you'll want to get similar clearance.

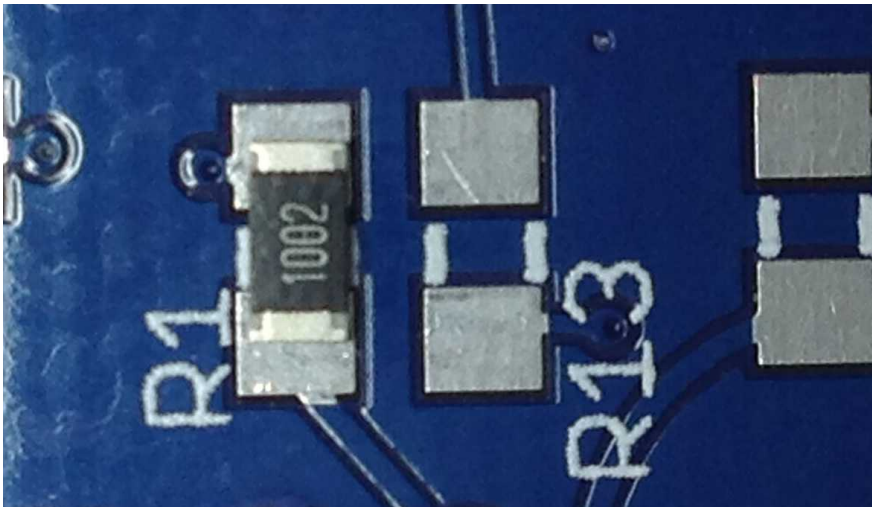
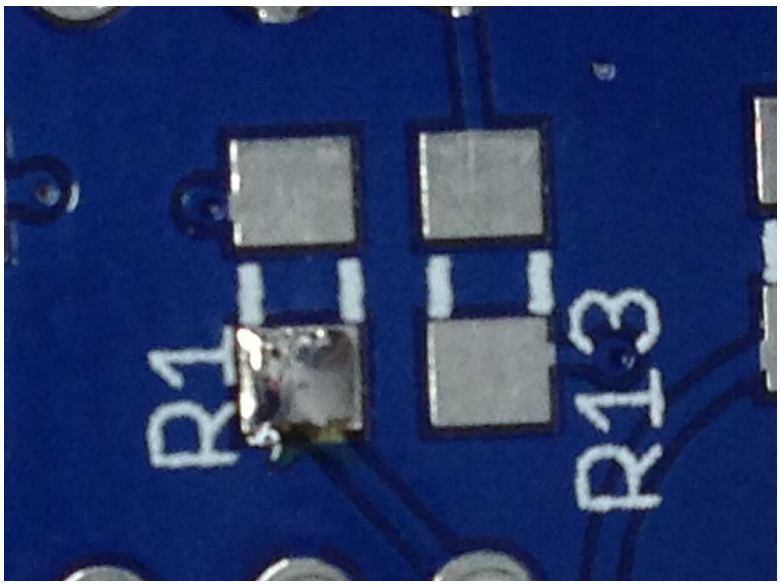


Illustration 10: SMD resistor located centrally on pads

Using the tweezers, place the resistor back in the bowl.

Place the tip of your soldering iron on one of the PCB pads for R1, & immediately apply a small amount of solder to the pad. Remove the iron tip. You should have a small rounded blob of solder on the pad.



If you think you've applied too much solder to the pad, you can remove this with solder wick. Place the wick on top of the blob of solder, apply the tip of the soldering iron briefly. The wick will soak up the solder. The wick will probably remove almost all the solder so you'll need to re-apply a small amount.

Take one of the resistors in the tweezers, ensuring the side of the resistor with the value marking is pointing upwards. Re-apply the soldering iron tip to the pad with the solder on it, & quickly slide one side of the resistor onto the pad, so that the edge of the resistor is lined up on the middle of the pad, and the resistor is approximately covering equal parts of both pads, as you practiced previously. Quickly remove the soldering iron tip.

If the resistor is not placed correctly, re-apply the tip of the soldering iron to the pad & the edge of the resistor & use the tweezers to align the resistor. Remove the iron tip. Try to do this as quickly as possible. It's much easier to move the resistor with just one pad soldered, so now is the time to get it's positioning right.

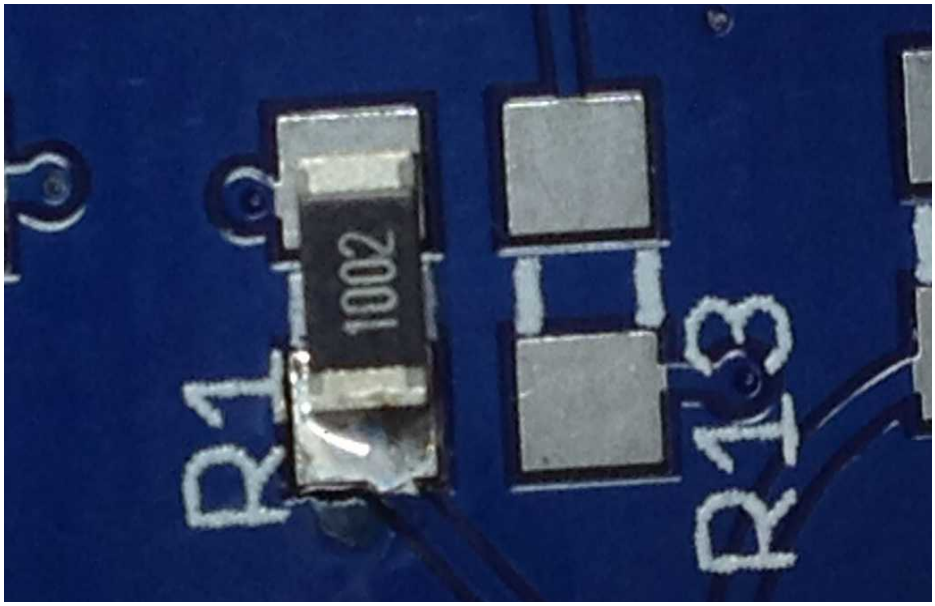


Illustration 11: resistor soldered to one pad

You might think that there isn't a lot of solder on the pad. This is fine, extra will be added once the other pad is soldered. The component is fixed firmly in place by the solder that is on there.

Now solder the other pad. Place the soldering iron tip on the R1 pad that you didn't solder, resting the end of the tip up against the side of the resistor, then immediately apply a small amount of solder to the contact point of the soldering iron tip, the pad & the resistor. The solder will flow over the pad & into the gap between the resistor & the pad. Remove the soldering iron tip. The whole action should take no more than a couple of seconds.

The resistor should now be located on top of the pads in a similar position to how you practised earlier.

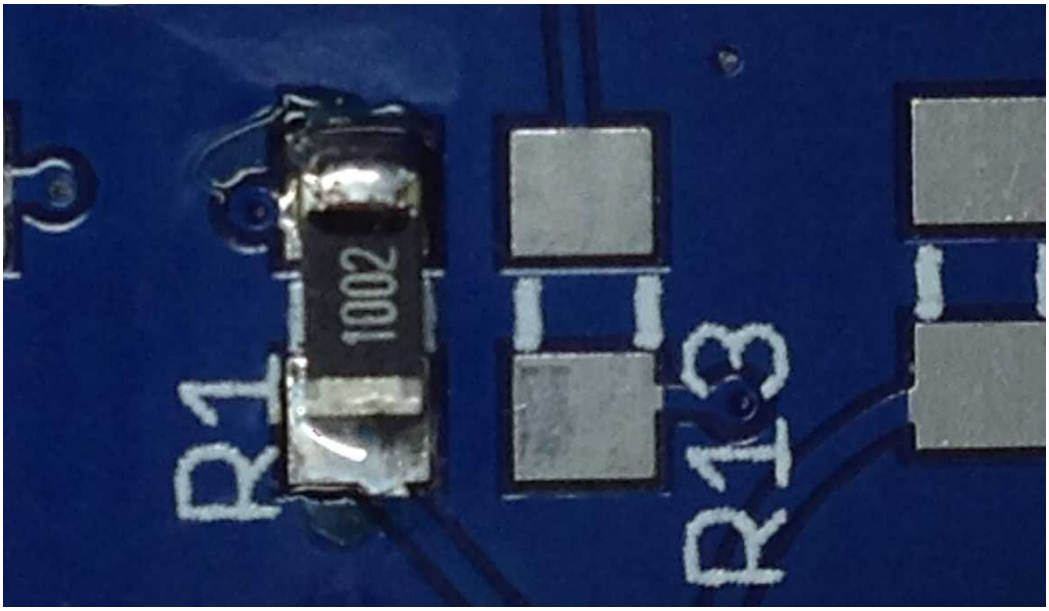


Illustration 12: resistor soldered to both pads

If you put too much solder on either pad, you can remove this using solder braid. Carefully place the braid on top of the solder blob, & briefly apply the soldering iron so the braid soaks up the solder. If the braid soaks up too much solder, re-apply a small amount of fresh solder.

Here's the resistor after some additional solder has been applied to the first pad.

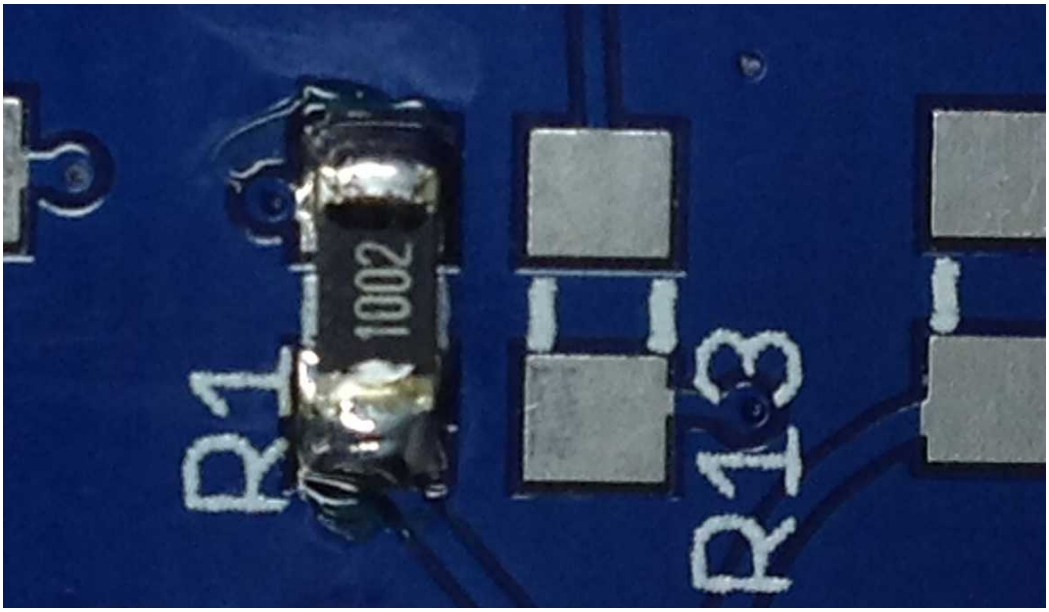


Illustration 13: extra solder applied to the first pad

As this is the first component, now remove any solder flux residue from around the resistor, using the soft brush & cleaner appropriate for your solder, as you would do for through hole boards. Apply a small amount of the cleaner to the resistor & gently brush it to remove the residue. You may need more than one application of cleaner to fully remove it. Once the residue has been removed, inspect your soldering using the magnifier. (Removing the flux residue makes the visual inspection much much easier).

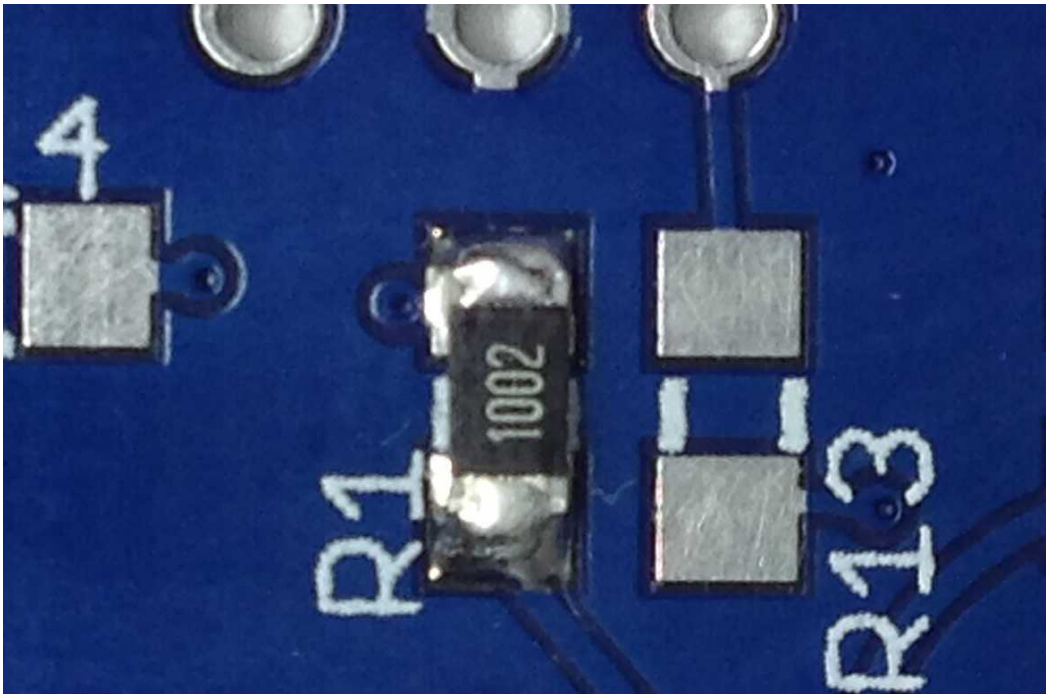
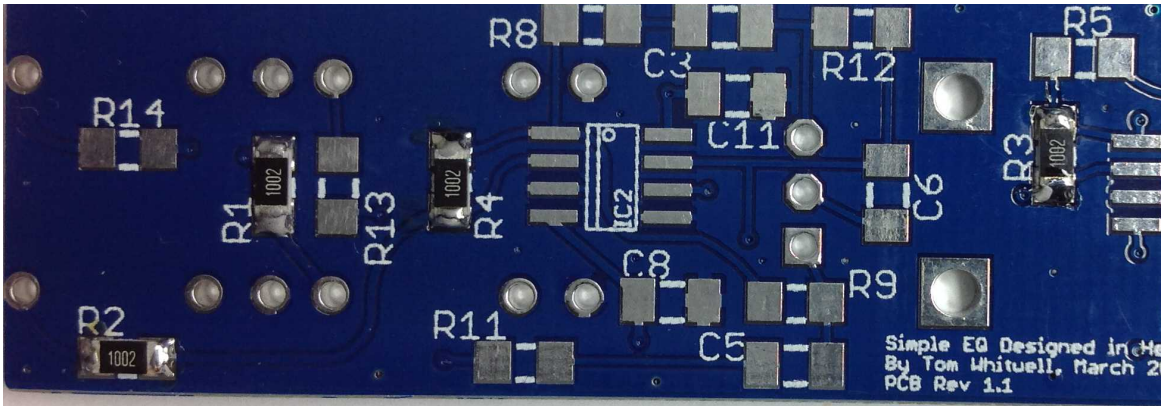


Illustration 14: R1 after cleaning

Now install resistor R2 using the same procedure as you've just done for R1 - Blob of solder on one pad ; Install the resistor ; Solder the other pad.

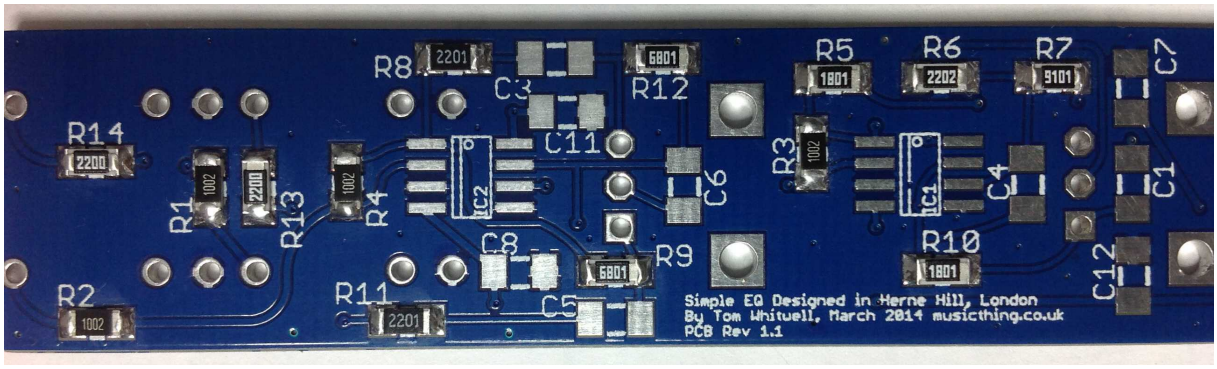
Then repeat this for R3 & R4. After which the board should look something like this:



Now install the rest of the resistors ...

2 x 220R resistors R13 & R14
2 x 1K8 resistors R5 & R10
2 x 2K2 resistors R8 & R11
2 x 6K8 resistors R9 & R12
1 x 9K1 resistor R7
1 x 22K resistor R6

With all the resistors installed, the board should look something like this:



It's a good idea now to clean up the board & then give it an inspection to check everything you've installed looks OK. Use the same cleaning technique that you used for R1.

Now use a magnifier glass or jewellers loupe to inspect your solder joints. Check that the contact points on the resistors & the pads on the PCB are covered in solder. Check that the solder doesn't short on to other tracks or pads. Excess solder can be removed using solder wick as described previously.

Once you're happy with the placement of the resistors, it's time to progress on to the ceramic capacitors. As with the resistors, these are non-polarised, meaning they can be oriented in either direction on the PCB. Unlike the resistors, you'll notice that these are not flat, but have a square profile. With these it doesn't matter which face is pointing upwards, as you'll see they don't have a value printed on any face.

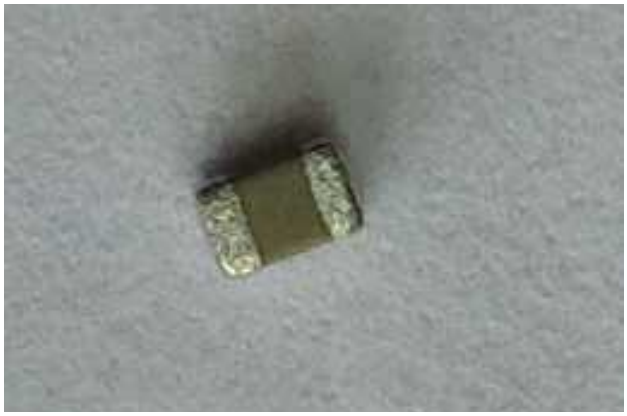


Illustration 15: surface mount ceramic capacitor

Start with the 5 x 100nF capacitors designated C1, C7, C8, C11, C12. Use exactly the same procedure to solder these capacitors as you used for the resistors. Again, you might want to offer up one of the capacitors to it's pads before you start to solder, so you get an idea of how the capacitor will locate on the pads.

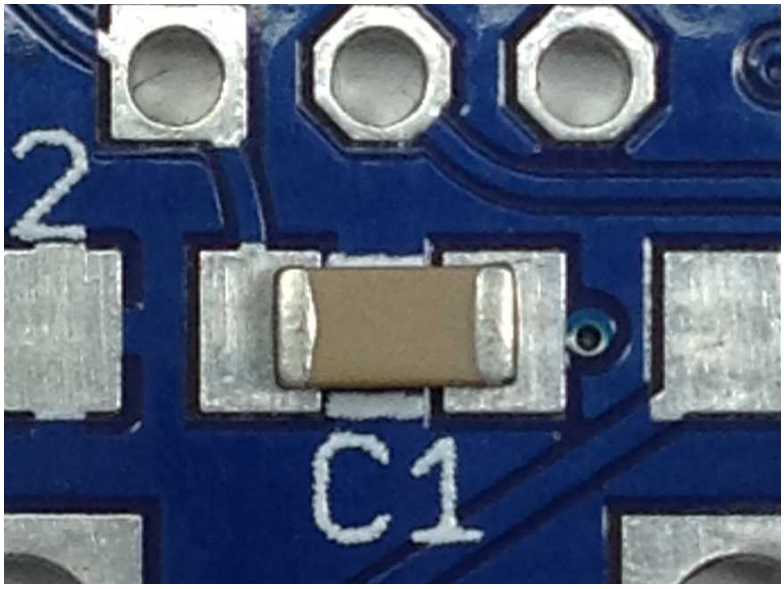


Illustration 16: ceramic capacitor aligned on PCB pads

Now solder the capacitor as you did for the resistors, one pad at a time.

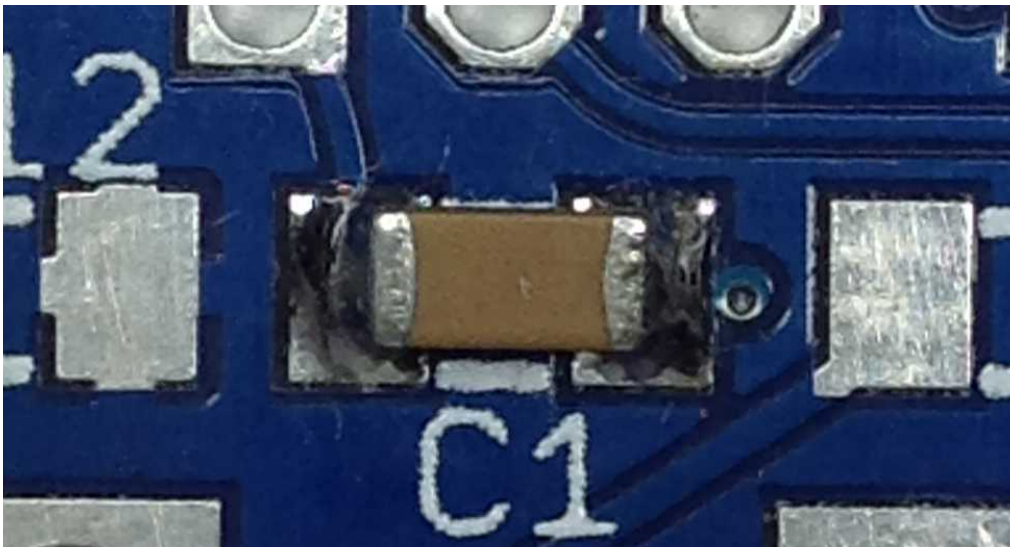


Illustration 17: 100n ceramic capacitor C1 soldered on both pads

Now install the rest of the ceramic capacitors:

2 x 22pF capacitors C4 & C6
2 x 33nF capacitors C3 & C5
1 x 4.7nF capacitor C2

The board should now look like this:

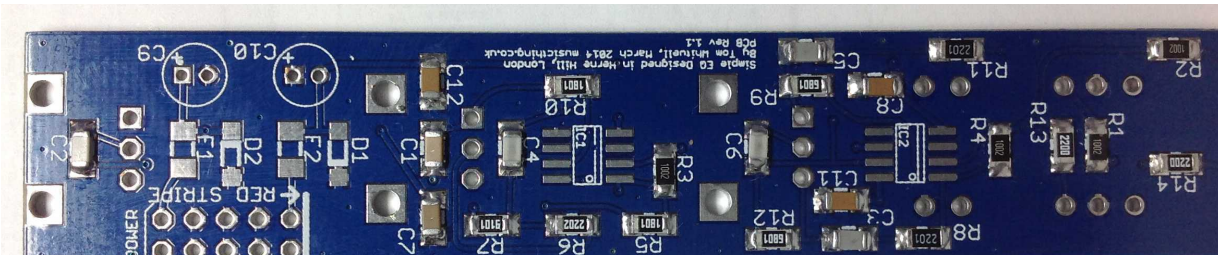


Illustration 18: All resistors and ceramic capacitors soldered

Next install the PTC fuses, F1 & F2, which are installed adjacent to the power header. As with the resistors and capacitors you've installed so far, these devices are not polarised so they can be installed in either orientation. Use the same technique for these as for the resistors and the ceramic capacitors, but try to avoid overheating them, as they can be damaged by excess heat.

Note that the colour and the markings of the fuses shipped in the Thonk kit may differ from the ones pictured in this build guide.

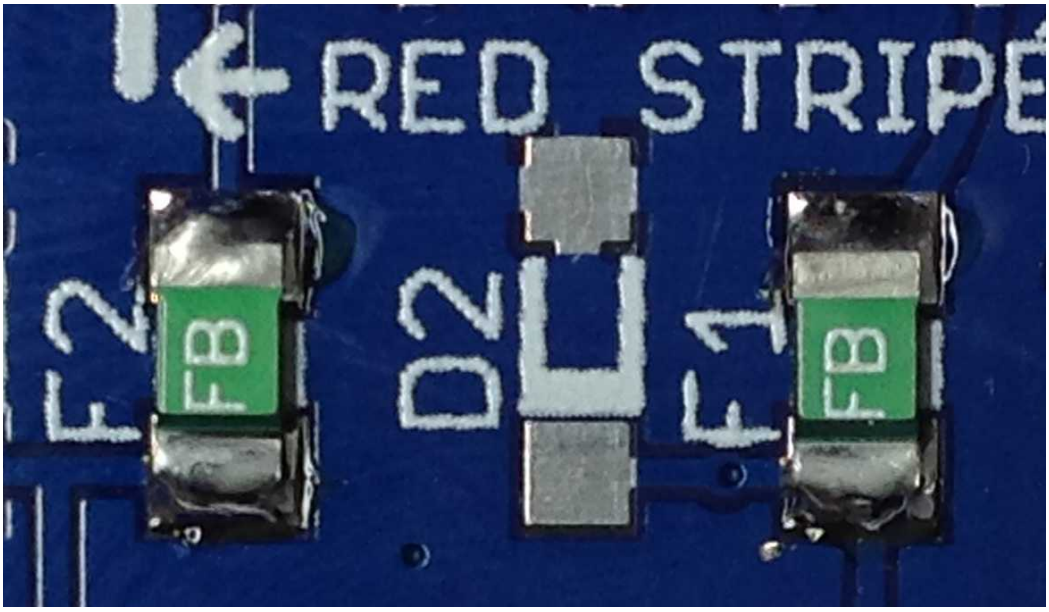


Illustration 19: PTC fuses F1 & F2 installed on the PCB

Next, install the two 1N5819 diodes, D1 & D2. Remove the diodes from the tape, & place them in the bowl. You'll notice that unlike the resistors and capacitors you've installed already, these diodes have a metal tab protruding outwards at an angle from the device. When you solder the diode onto the PCB, you want these metal tabs in contact with the pads on the PCB.

In addition, unlike the components you've installed up to now, these are polarised devices, meaning they must be installed on the PCB with the correct orientation. If you look at one closely, you'll notice a line marked on the top of the package, with the line closer to one of the tabs than the other. (The line may be faint, so the use of a magnifying glass or loupe will help). This end of the diode marked with the line is known as the cathode.

Illustration 20: Surface mount diode facing upwards, showing the angled pins, and the line identifying the cathode end (in this case on the left hand pin)

On the PCB, the cathode is indicated by a line in the silk screen adjacent to one of the pads. On this PCB, the cathode for diode D1 points towards the power header, and diode D2 away from the header.

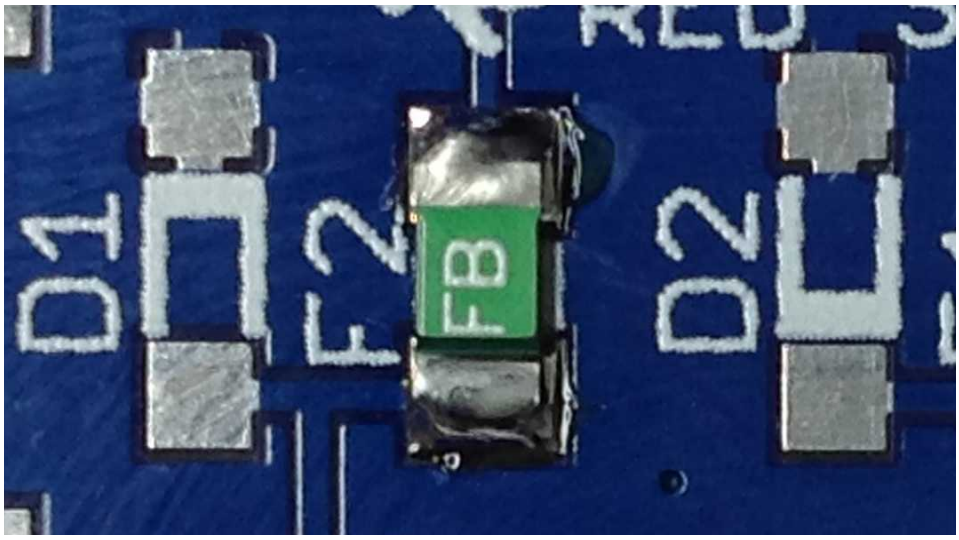


Illustration 21: Surface mount diodes, showing line identifying cathode in silk screen, at top on D1, bottom on D2

So, now you know which way the diode needs to be installed on the PCB, solder them using the same technique as the resistors and capacitors.

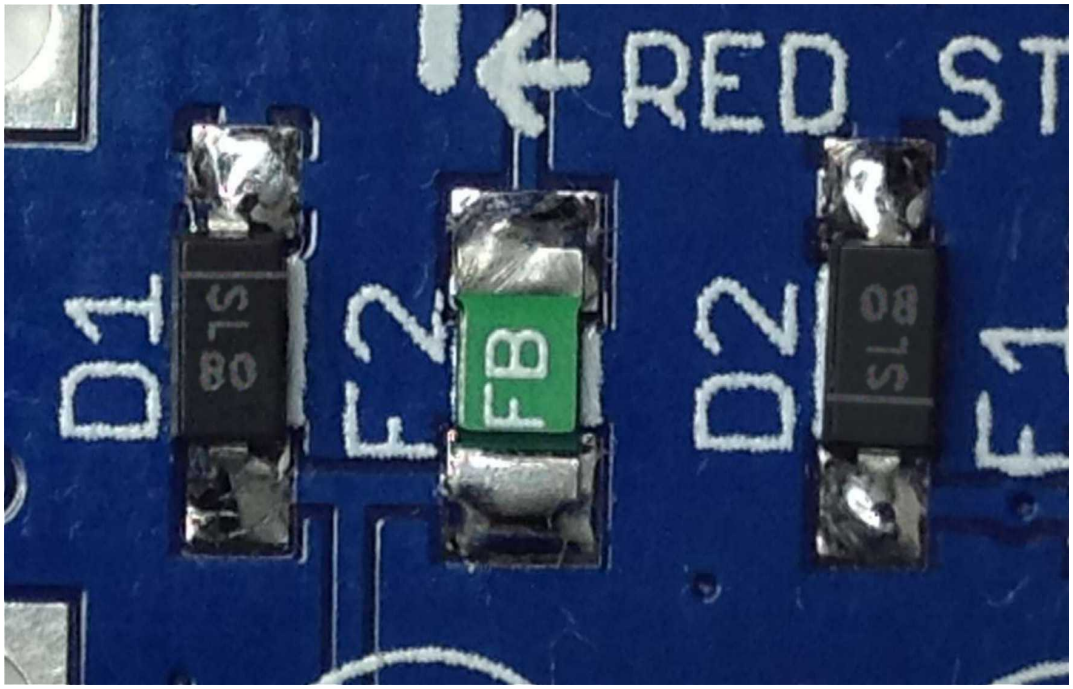


Illustration 22: Diodes D1 & D2 installed, with line identifying cathode, upwards for D1, downwards for D2

Now take some time to clean the board as before & inspect your soldering on the diodes, capacitors & fuses.

Next we'll do the two IC's, NE5532 dual op-amps. Remove one from the tape. Take some time to inspect the device.

Similar to the diodes that you just installed, you'll notice that the IC legs are bent outwards and downwards, much like the diodes you just installed. As with the diodes, you need to install the device with these legs in contact with the pads on the PCB.

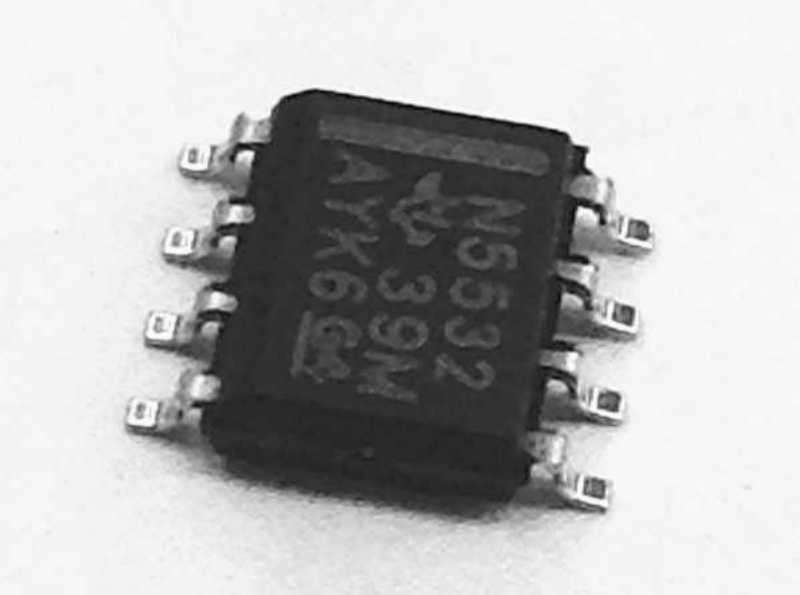


Illustration 23: Surface mount dual op-amp, NE5532

Unlike through hole IC's, many surface mount IC's don't have a dimple or crescent embossed into the casing to identify the location of pin 1. Instead, they have a sloped upper edge on the side with pin 1. The other side has a vertical face. If you look at the silk screen for the two ICs on your PCB, you'll notice that it has both the usual dot adjacent to pin 1, but also a second line along one side. This second line represents the sloped edge. The sloped edge on the IC should be placed along this.

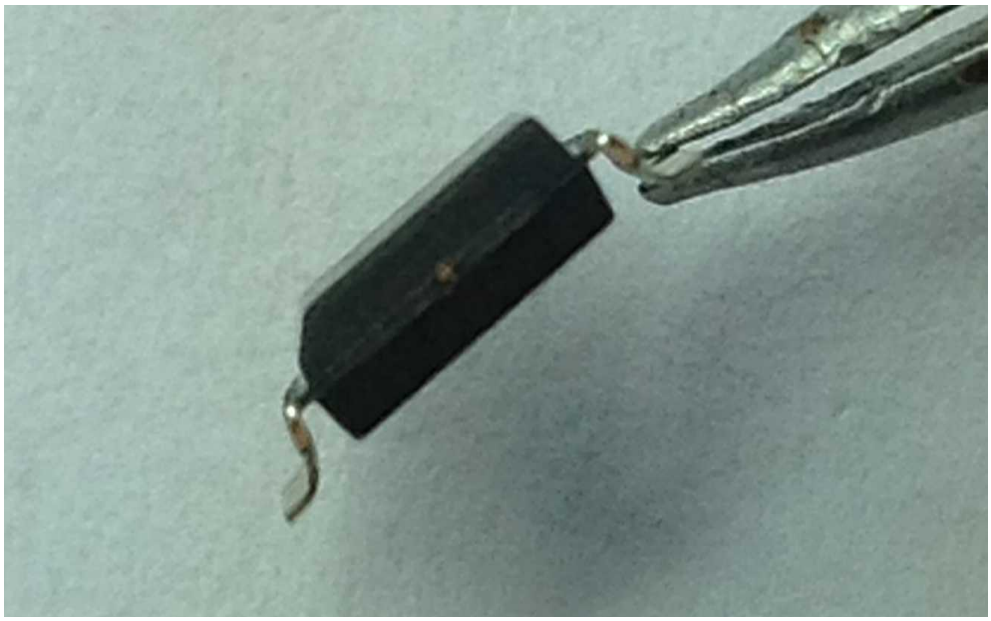


Illustration 24: Surface mount op-amp showing sloped edge on the top left corner of the packaging.

Again, before you start soldering these devices, offer one up to it's destination on the PCB. Familiarise yourself with how the device should be orientated, also how the device's pins should sit on the pads.

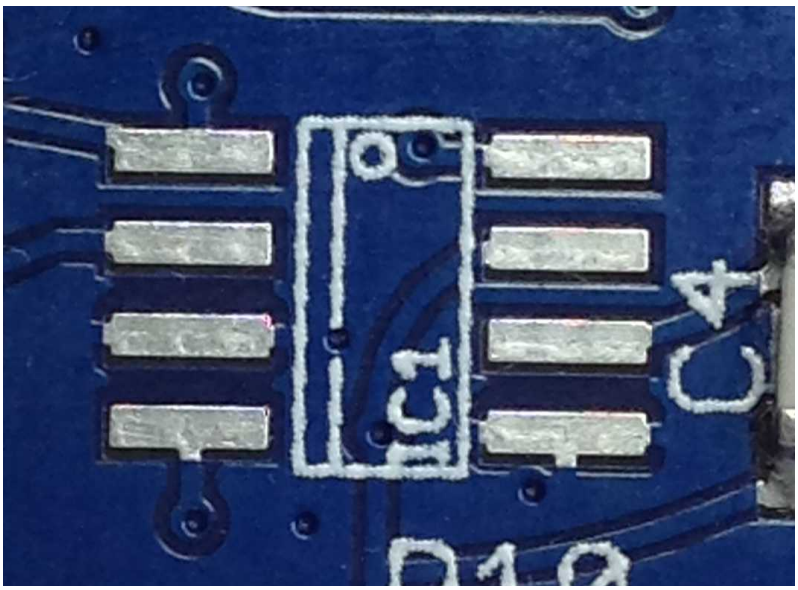


Illustration 25: PCB silk screen for IC1 showing the dot marking the location of pin 1, and the second line for devices that have a sloping edge on the package

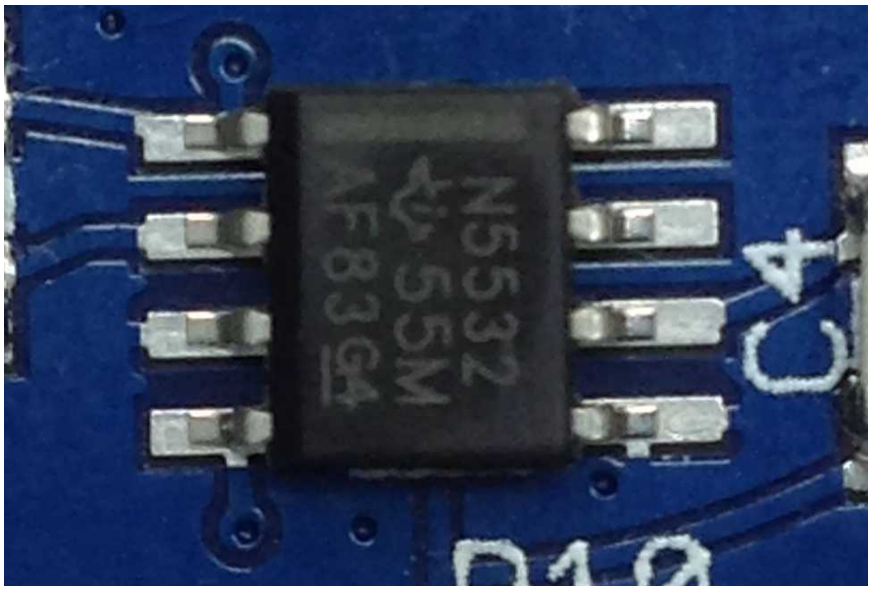


Illustration 26: NE5532 op-amp located on the pads at IC1 prior to soldering

Now it's time to solder the first IC, IC1.

If you have a flux pen, the application of flux to the pads will help soldering the ICs. If you're going to use one, apply some flux to the pads of both IC1 & IC2.

In a similar way to how you soldered the previous components, place a small blob of solder to one of the outer pins of IC1.

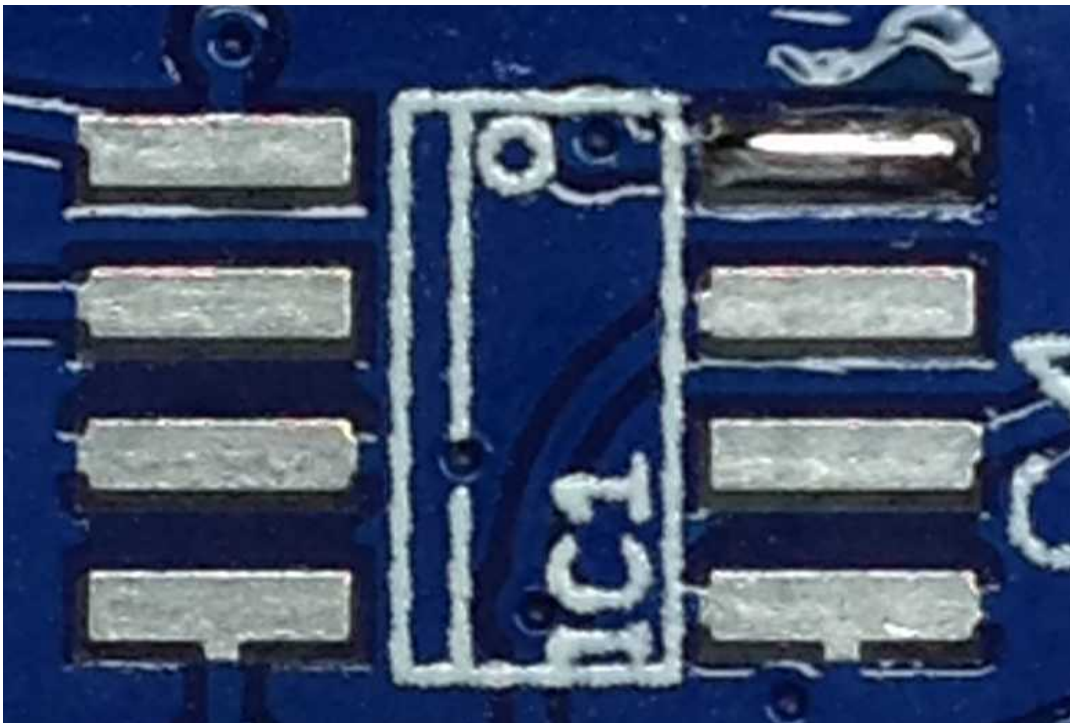


Illustration 27: IC1 pads showing the pad of pin 8 pre-soldered

Gently take one of the NE5532 ICs in the tweezers. Place it on the PCB close to IC1 location, ensuring that you know which side has pin 1. Orient the IC so that it's ready to slide into place. Place the tip of the soldering iron on the outside edge of the soldered pad, so that the solder melts. Quickly slide the IC into place, ensuring that the IC's other legs are sat squarely on the other pads. Remove the soldering iron as quickly as you can to avoid overheating the IC. If the IC isn't quite sat squarely on the pads, re-apply the soldering iron to the soldered pad, & gently nudge the IC into place with the tweezers. Again, try to minimise the time that the IC is being heated up. If you've used it, the stickiness of the flux will help hold the IC in place. Don't worry too much about the soldering itself on this joint right now, we're really aiming to hold the device in place with this joint right now. We can redo this later once the other pins are soldered. The important thing right now is that the IC pins are precisely aligned on the PCB pads.

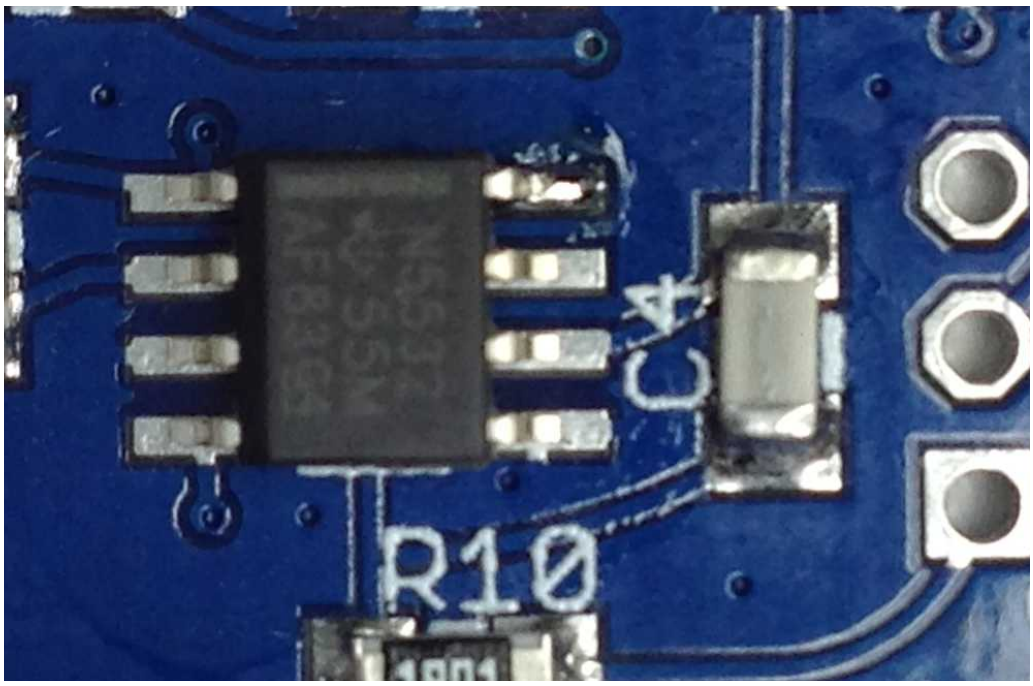


Illustration 28: NE5532 with pin 8 soldered in location IC1

Once you're happy with the orientation of the device, it's time to solder the rest of the legs. If you're using a flux pen, apply some flux to the legs of the IC. This will help the solder flow into the joints. Start on the legs on the other side from the one you've already soldered. Put the tip of the soldering iron at the end of the pad & apply a small amount of solder. The solder should flow down the pad & over the IC leg. Repeat this for the other pins on that side of the IC, then rotate the board & do the other pins.

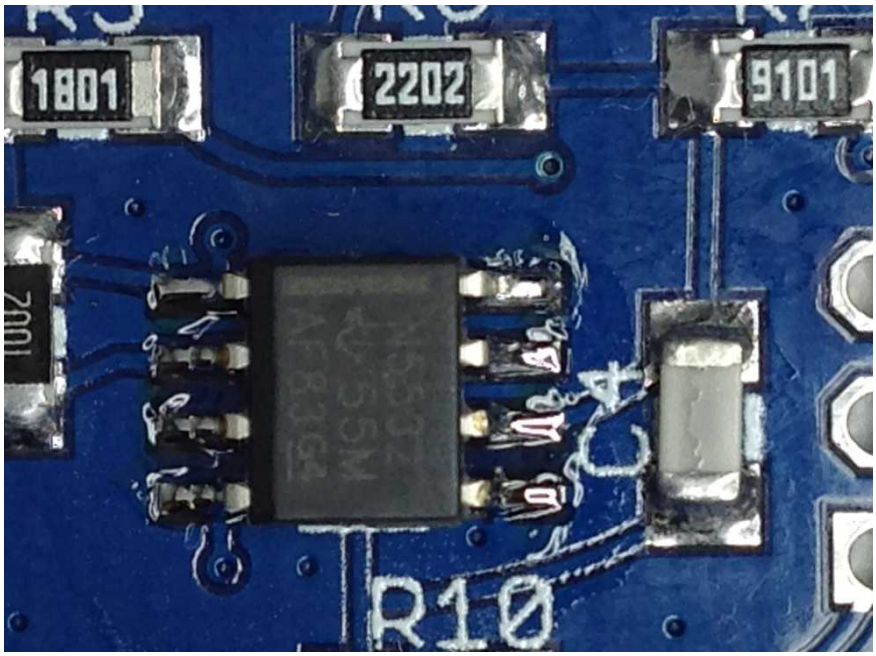


Illustration 29: NE5532 with pins soldered. Note the flux residue on the pins. This will be cleaned off shortly.

Don't worry if you accidentally solder two pins together, it's easy to do. Use the solder wick to remove the excess solder by placing the wick on top of the joined pins, & apply the tip of the soldering iron on top of the wick. Almost immediately you'll see the solder flow into the wick. Remove the soldering iron and the wick. Usually there is still sufficient solder on the pads & the pins that you won't have to re-apply any solder.

Now install IC2 using the same procedure as you did for IC1.

Once both IC's are soldered, thoroughly clean the PCB around both ICs, especially if you've used a flux pen. Take your magnifying glass/loupe & inspect the soldering on the IC pins. Check no pins are shorted. Using solder wick to repair any joints that are shorted.

Congratulations, that's the surface mount components installed !.

Now they're done, give the board another clean to remove any flux residue. Give the soldering another inspection with the magnifier or loupe. It's much easier to correct any mistakes without the through hole components installed, so now is the time to do this.

Your PCB should now look something like this:

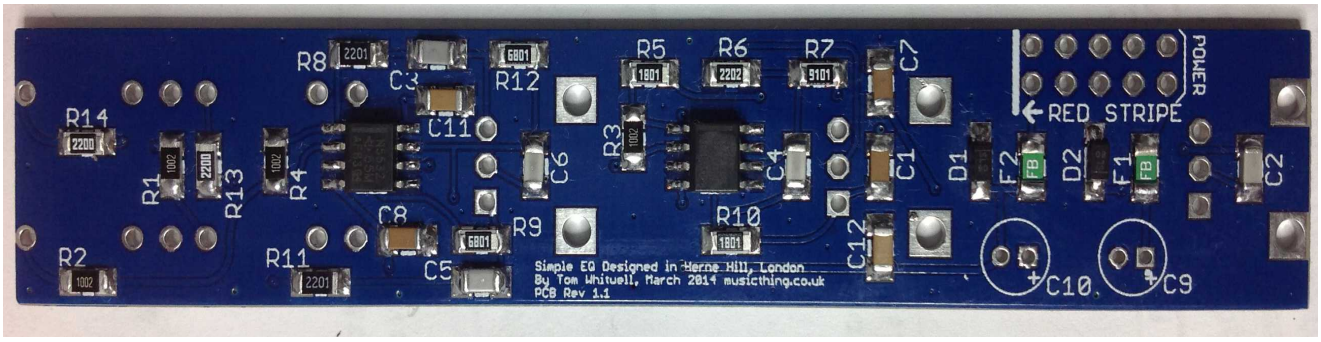


Illustration 30: PCB with all SMD components installed

Now it's time to do the through hole components that are mounted on the component side of the PCB.

First install the 2x5 pin power header. Install this first as it's shorter than the electrolytic capacitors.

Now install the two 47uF electrolytic capacitors, C9 and C10. These are polarised devices, so they have to be installed with the correct orientation. On the PCB, the silk screen is marked with a “+” for the positive leg. On the device, the positive leg is the longer one, and the negative leg will be marked with a “-” on the side of the case.

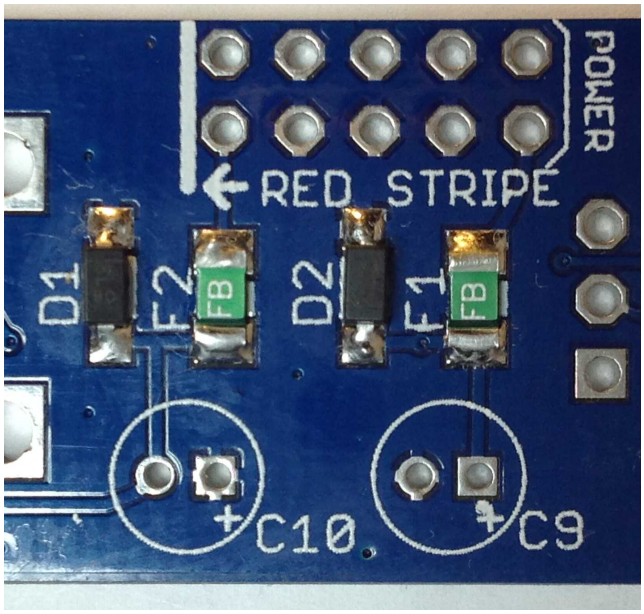


Illustration 31: PCB showing electrolytic capacitor orientation and power header location

Illustration 32: electrolytic capacitors showing marking on can for negative; longer leg is positive

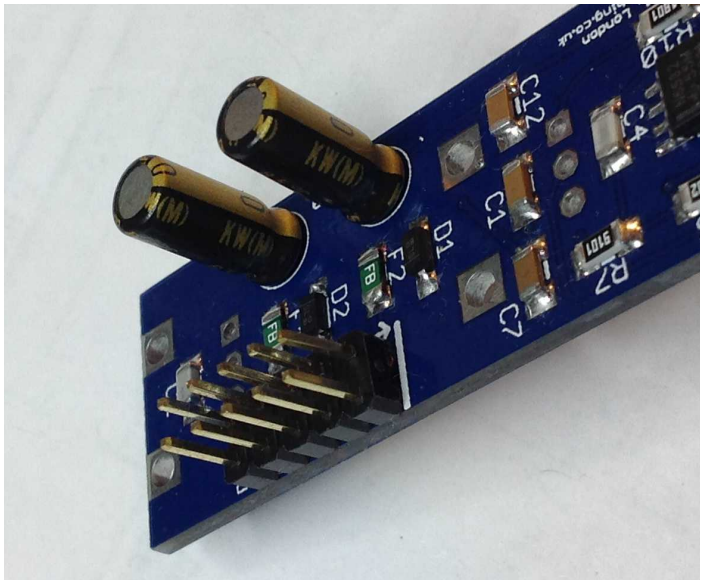
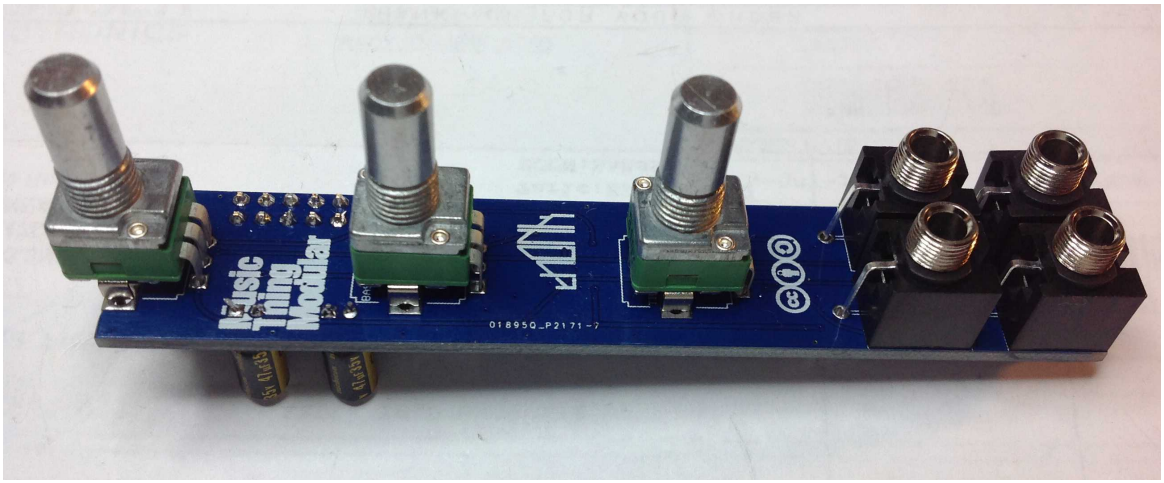


Illustration 33: power header and electrolytic capacitors installed

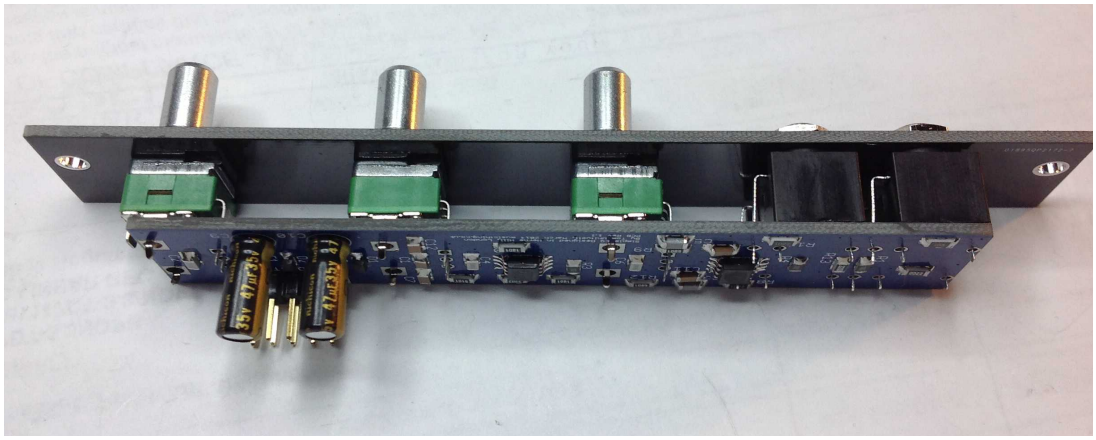
Before the panel components are installed on the “solder” side of the PCB, clean any flux residue from the header and electrolytic solder joints.

Now fit the pots and the jacks. These are mounted on the reverse side of the PCB to the components. Start by removing the nuts and washers if they're still fitted. If the pots have the small tab on them, remove it with a pair of cutters.

Fit the pots and the jacks to the board, but don't solder them.



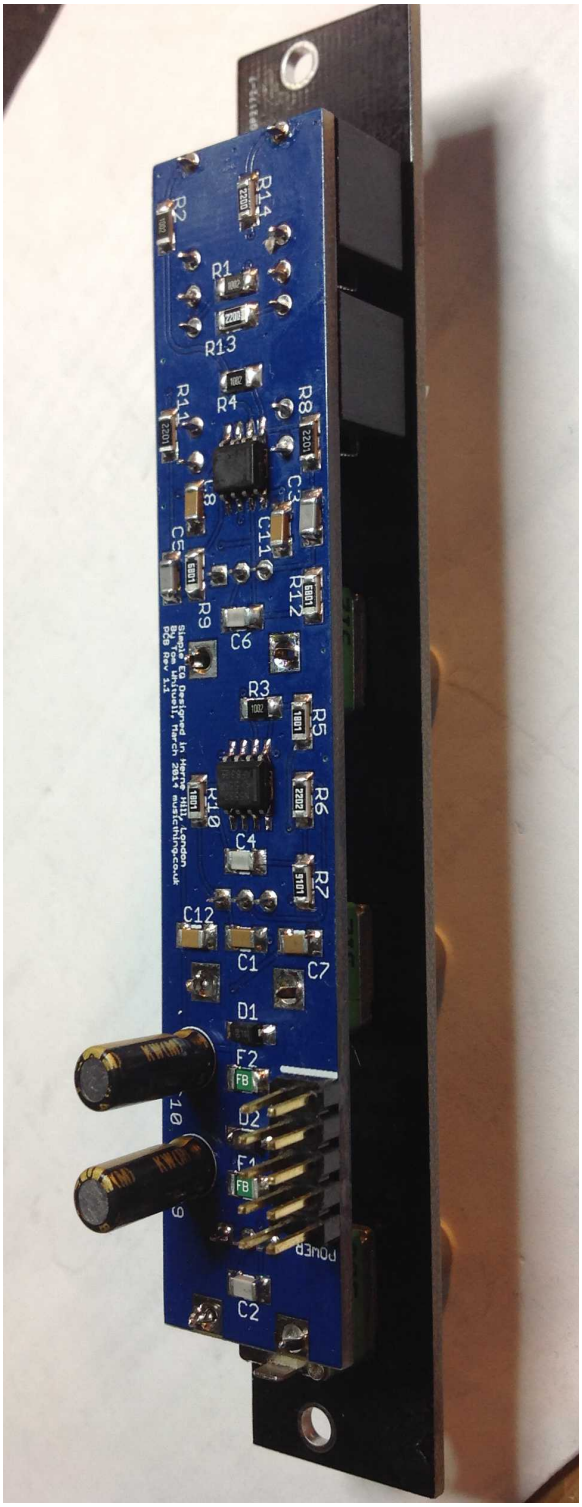
Fit the panel over the pots & jacks, then fit the washers & nuts onto the pots and jacks. Do the nuts up finger tight. The retaining clips on the pots should keep everything in place whilst you do this. The panel should now be parallel to the PCB.



Turn the assembly over so the component side of the PCB is facing upwards. Solder one of the Tilt jack pins nearest the bottom of the PCB. Turn the assembly on it's side & check that the jack is in contact with the PCB. If there's any gap between the jack & the PCB, apply the soldering iron to the pin whilst squeezing the panel & PCB together so that the jack is sat flush to the PCB. Solder the bottom pin of the other Tilt jack.

Go back & check the panel & the PCB are parallel for one last time. This should be the case now if the pots are still fully clipped into the PCB. Solder the other pins of the jacks, the 3 pins and 2 retaining clips of each of the pots.

And thats the soldering done. All you need to do now is tighten up the nuts on the jacks and on the pots, then fit the knobs.



BOM

Qty	Value	Parts	Package / Description	Thonk / Mouser SKU
2	220R	R13, R14	R1206 resistor	667-ERJ-8ENF2200V
2	1.8k	R5, R10	R1206 resistor	667-ERJ-8ENF1801V
2	2.2k	R8, R11	R1206 resistor	667-ERJ-8ENF2201V
2	6.8k	R9, R12	R1206 resistor	667-ERJ-8ENF6801V
1	9.1k	R7	R1206 resistor	667-ERJ-8ENF9101V
4	10k	R1, R2, R3, R4	R1206 resistor	667-ERJ-8ENF1002V
1	22k	R6	R1206 resistor	667-ERJ-8ENF2202V
2	22pf	C4, C6	C1206 capacitor	81-GRM31A5C2H220JW1D (5% C0G NP0)
1	4n7	C2	C1206 capacitor	81-GRM315C1H472JA01D (5% C0G NP0)
2	33nf	C3, C5	C1206 capacitor	81-GRM315C1H333JA01D (5% C0G NP0)
5	100n	C1, C7, C8, C11, C12	C1206 capacitor	81-GRM319R72A104KA1J (100V, 10% X7R)
2	47u	C9, C10	Polarised Cap >25V, 2mm pitch, 5mm dia	647-UKW1V470MDD (35V, 5mm dia, 2mm pitch)
2	NE5532	IC1, IC2	SO08 op-amp	595-NE5532D
2	1N5819	D1, D2	SOD123 Diode	621-1N5819HW-F
2		F1, F2	1206 Resettable Fuse PTC	652-MF-PSMF020X-2
1		POWER	2x5 2.54mm Pin Header	649-67996-410HLF
4			Thonkiconn PJ301M Jack	http://www.thonk.co.uk/shop/3-5mm-jack-sample-bags/
3	B10k		Alpha B10K 9mm vertical linear potentiometers	http://www.thonk.co.uk/shop/alpha-9mm-pots/
3	Knobs		Black 1900h knobs (6.35mm round shaft)	http://www.thonk.co.uk/shop/knobs-davies-1900h-clone-metal/
1	Eurorack power cable		10-way to 16-way	http://www.thonk.co.uk/shop/eurorack-power-cables/

Build document & images by Graham Biswell, <graham@gbiswell.com>