Build Guide:
Macro Oscillator for 5U modular synthesizer

Format: MU

Version: v3b

Introduction

This module is an 5U adaption based on the famous Eurorack module "Plaits" invented by Émilie Gillet, the successor to the popular "Braids" module:
https://www.martinjankoehler.com/synthesizers/synth-macro-oscillator-in-5u/

This document describes the assembly of the ported module.

License information

- PCB, Panel & Build Guide:
  CC-by-SA-3.0 Martin Köhler
- Schematics & Firmware:
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https://mutable-instruments.net/modules/plaits/open_source/

Table of Contents

Bill of Materials

XLS version of the BOM is available over at:
https://www.martinjankoehler.com/synthesizers/synth-macro-oscillator-in-5u/

PCB Overview

There are 3 PCBs:

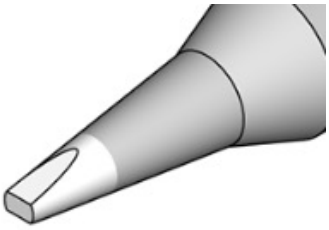
1. *Control Board:* potentiometers, push buttons and LEDs
2. *Main and Jack Board:* main circuit and jacks
3. *Daughterboard*: micro controller (SMT already soldered)

Control board and main board are electronically connected using pin headers and pin sockets.

Recommendations

Using 3 kinds of soldering wire is recommended:

1. (for SMT only) 0,4 mm solder wire with rosin flux core in combination with extra liquid rosin flux.
   This will attract dirt and humidity, therefore it will need cleaning with isopropyl alcohol and a brush. After that, wash it with deionized water.
2. (for washable THT) 0,4 mm solder wire with Kester 331 water soluable flux core.
   This is corrosive, which is a good thing as it will eat through any component oxide layer. After washing drying you should get a perfect looking shiny solder joints.
   VERIFY: Make sure to thoroughly wash the PCB with warm/hot tap water after every couple of hours, and a final wash with deionized water.
3. (for non-washable THT) 0,6mm solder wire with no clean flux core for the parts that should not better not be washed (like potentiometers, jacks, etc…)



Recommended equipment for surface mount soldering:

1. rosin core solder wire ~0,4 mm
2. liquid flux (rosin core like theTermoPasty TK83)
3. isopropal alcohol and a toothbrush
4. precision tweezer (like CK 2346D)
5. magnification glasses, like the Fancii
6. Spoon-sphaped solder tip („solder depot“)
7. Fine-pitched solder wick (rosin core) ~0,8 mm (KONTAKT CHEMIE 31975-002)

1. Soldering the SMT Parts

1.1. Control Board: SMT LED driver

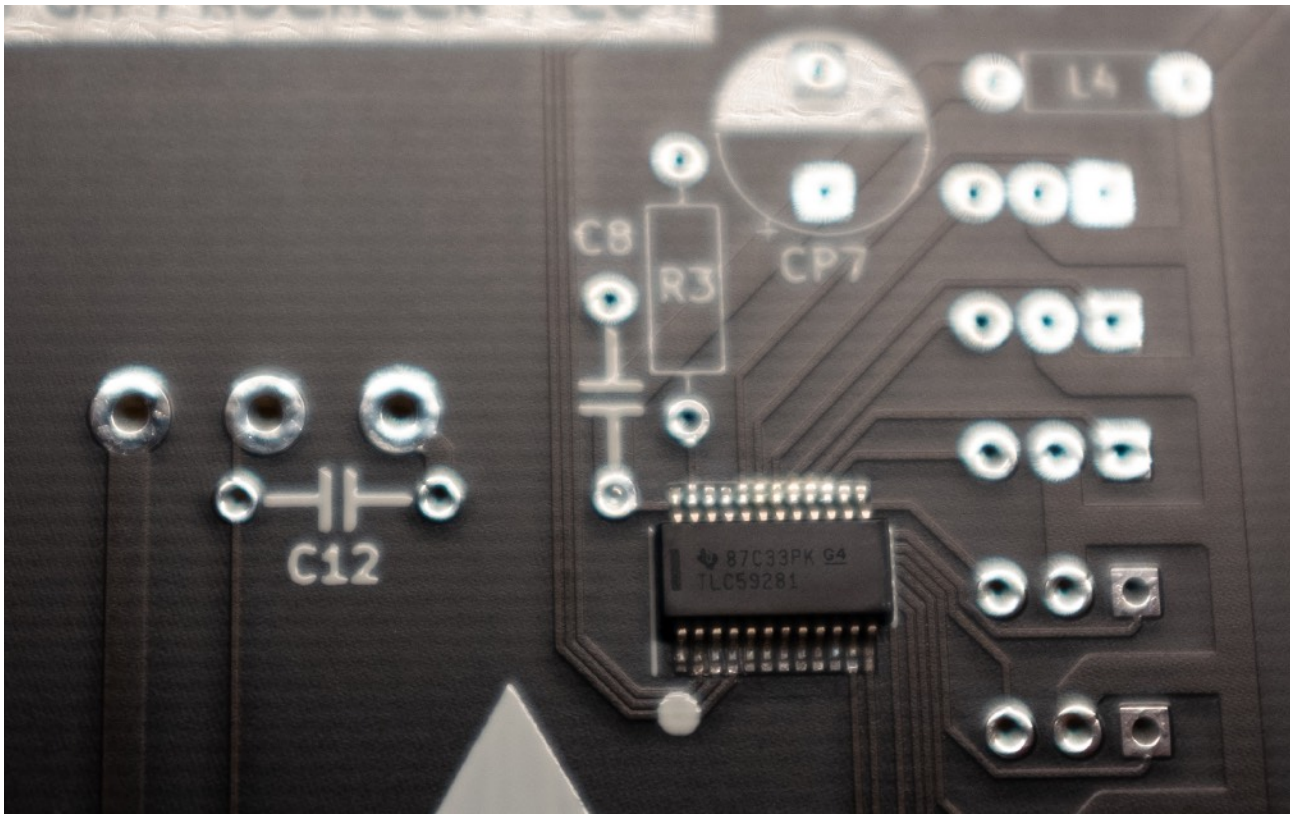
Start with soldering the SMT IC U2.

NOTE: PLEASE use extreme care!
It's important to take care not to destroy the PCB pads.
Plenty of liquid flux is key. Correct only using hot air or if you use solder wick, use very narrow ones suited for SMT.

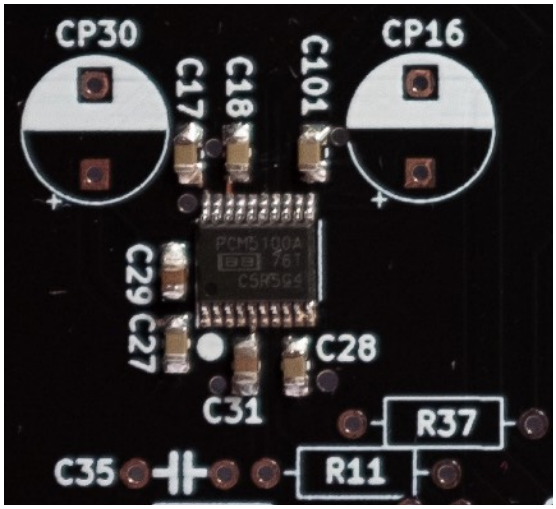
Recommended steps:

1. Place IC and align with an ESD tweezer
2. **VERIFY:** silkscreen dot marking pin 1 is aligned with the chip and all pads are aligned correctly (the line on the IC indicates the side with the pin 1)
3. Solder the pin 1 at the dot
4. **VERIFY:** alignment of pads/pins
5. Solder the pin diagonally on the other side
6. **VERIFY:** alignment of pads/pins
7. Apply flux
8. Add tiny amounts of solder (if you use too much, you risk bridging pins)
9. Apply flux
10. Use hot air gun to reflow
11. **VERIFY:** there are no shorts between using the continuity testing function of your multimeter

Finally, wash your Control PCB with IPA and rinse with deionized water.



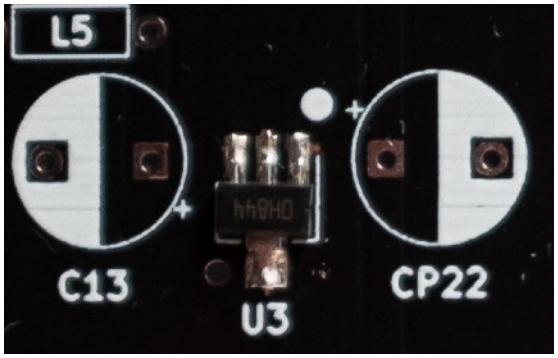
1.2. Main Board: SMT parts



Start with soldering the SMT IC U5.

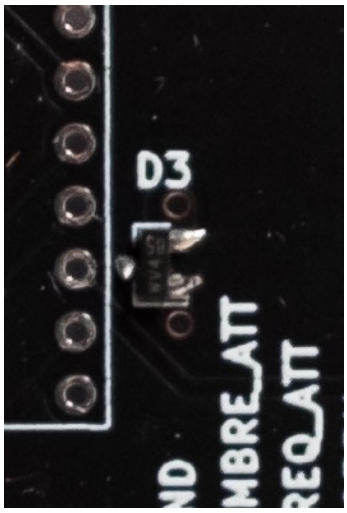
NOTE: PLEASE use extreme care!
It's important to take care not to destroy the PCB pads. Plenty of liquid flux is key.
Should this goes wrong, there is no point in continuing. The mainboard PCB is a 4-layer PCB and mistakes can not always be MacGyver'ed in every case. Correct only using hot air or if you use solder wick, use very narrow ones suited for SMT.

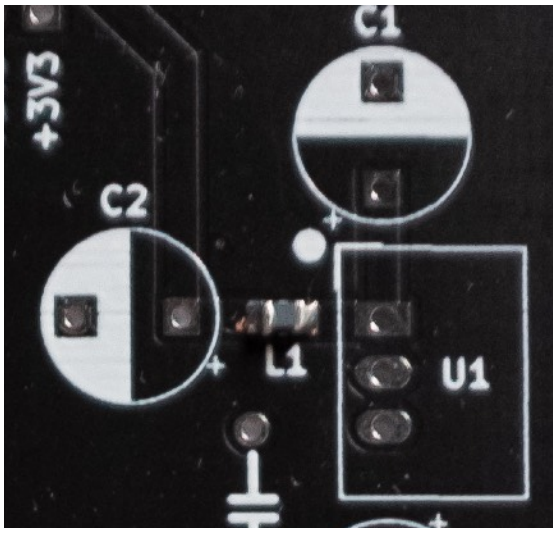
Awesome! You did it!
From now on, it's a piece of cake.

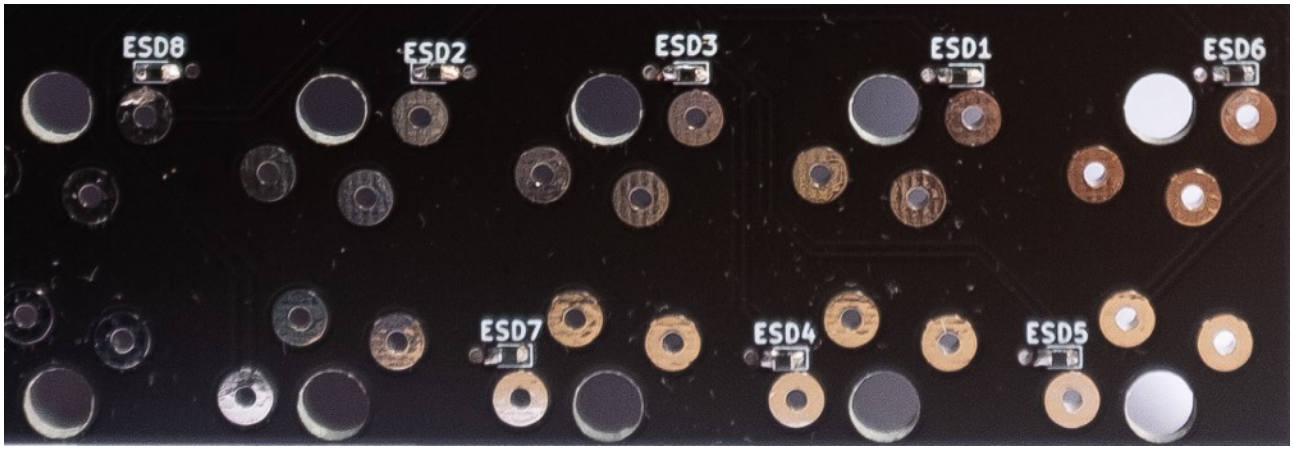


Continue with the remaining SMT parts :

1. L1, D3, U3, 0805 SMT Caps,
   (optional) 0603 ESD protection diodes.
2. **VERIFY:** there are no undesired shorts against the schematics using the continuity testing function of your multimeter
3. Wash your Mainboard PCB with IPA and rinse with deionized water







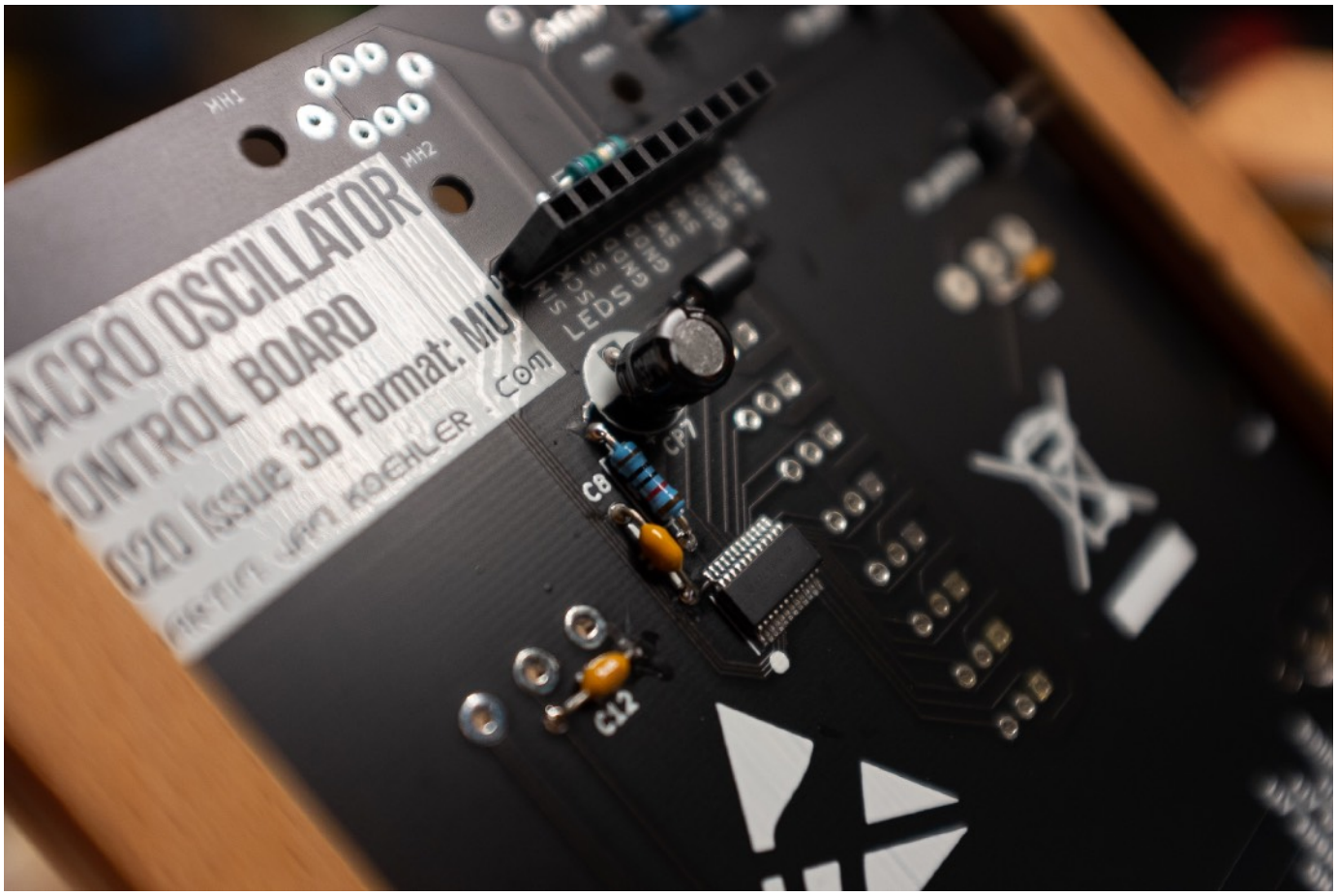
2. Control Board: Washable THT parts

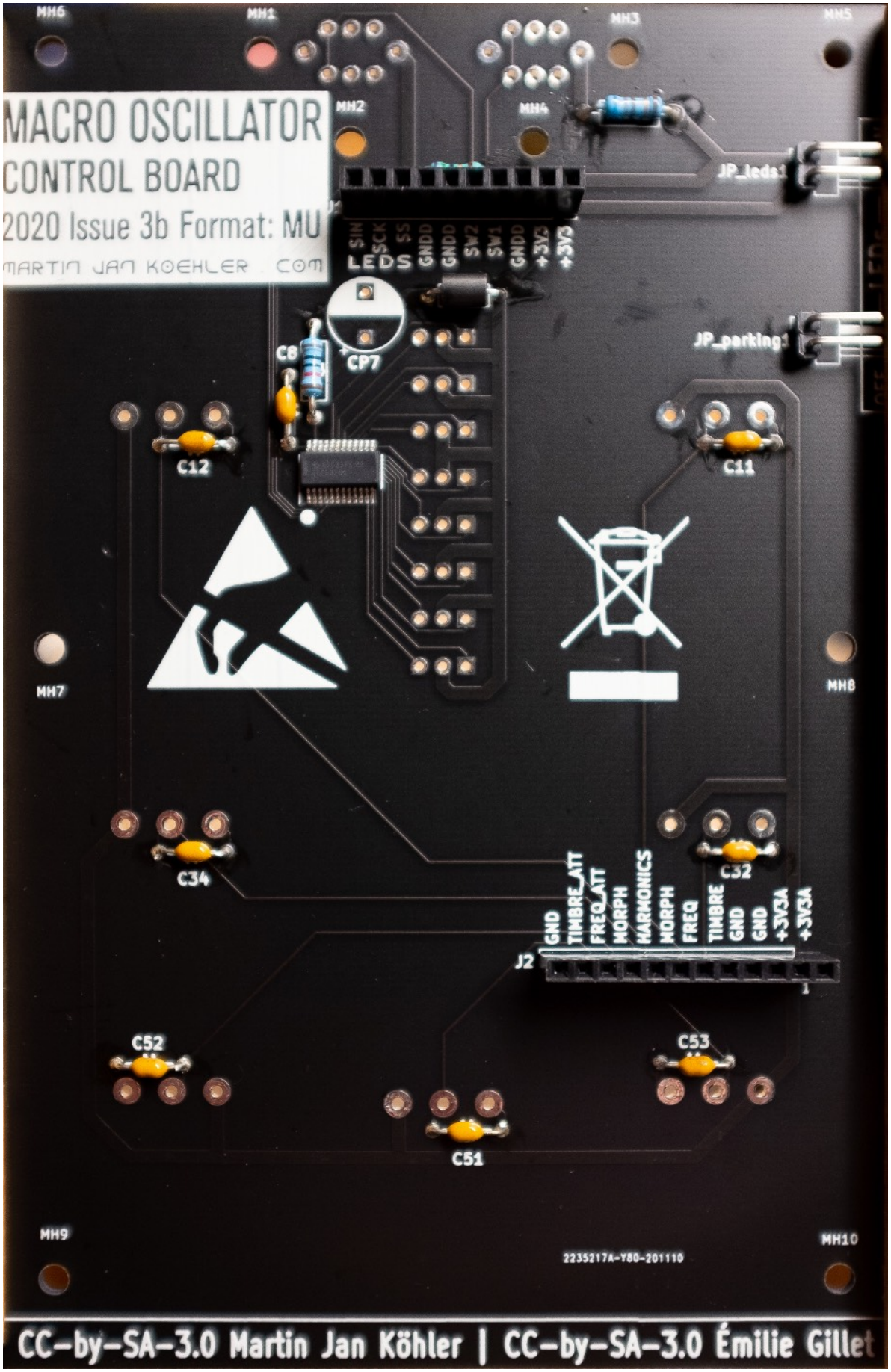
We now switch to water soluable solder (no need for extra flux) and a 3 mm solder tip.
A wire bending tool can come in handy.

Populate the PCB in the recommended order:

1. Resistors
2. Axial bypass MLCCs (yellow)
3. Ferrite beads
4. Pin Sockets
5. Electrolytic Capacitors

NOTE: we leave off the potentiometers, LEDs and switches for now.




MACRO OSCILLATOR
CONTROL BOARD
2020 Issue 3b Format: MU
MARTIN JAN KOEHLER . COM
MH1
MH2
MH3
MH4
MH5
MH6
MH7
MH8
MH9
MH10
LEDS
SIN
SCK
SS
GNDD
GNDD
SW2
SW1
GNDD
+3V3
JP_leds1
JP_parking1
CP7
C8
C12
C11
C34
C32
C52
C53
C51
J2
GND
TIMBRE_ATT
FREQ_ATT
MORPH
HARMONICS
MORPH
FREQ
TIMBRE
GND
GND
+3V3A
+3V3A
2235217A-Y80-201110
CC-by-SA-3.0 Martin Jan Köhler | CC-by-SA-3.0 Émilie Gillet

3. Main Board: Washable THT parts

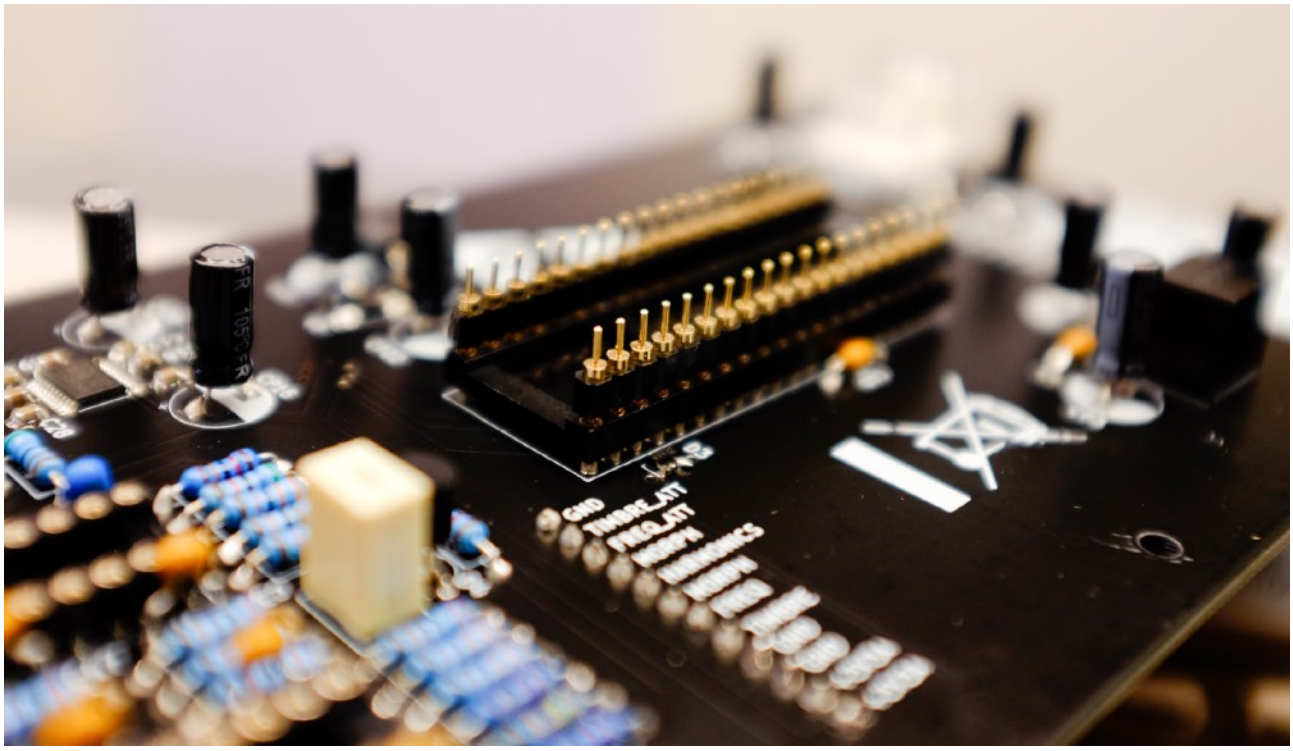
Populate the PCB according to the recommended order:

1. Resistors
2. Axial bypass MLCCs (yellow)
3. THT diodes
4. Ferrite beads
5. IC sockets
6. Radial MLCCs (be sure to use C0G where specified)
7. Voltage reference (D4)
8. Polyester Capacitors
9. Pin Headers
10. MU Power Header (optional)
11. DC-DC converter (U1)
12. Electrolytic Capacitors

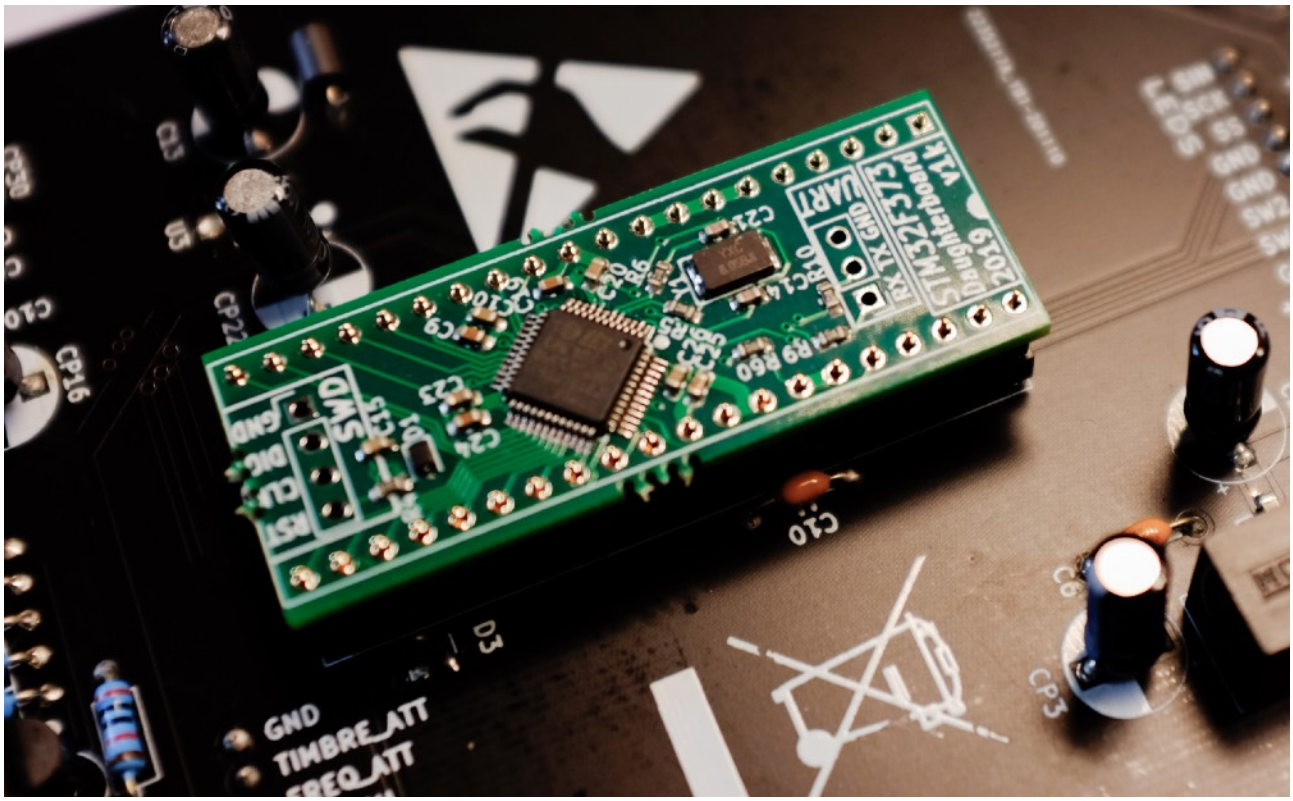
13. MOTM Power Header (optional)

4. Daughter Board: Washable Pins

Insert both socket pin headers (double-sided-male, 1 row, 20 pins) into the IC socket.



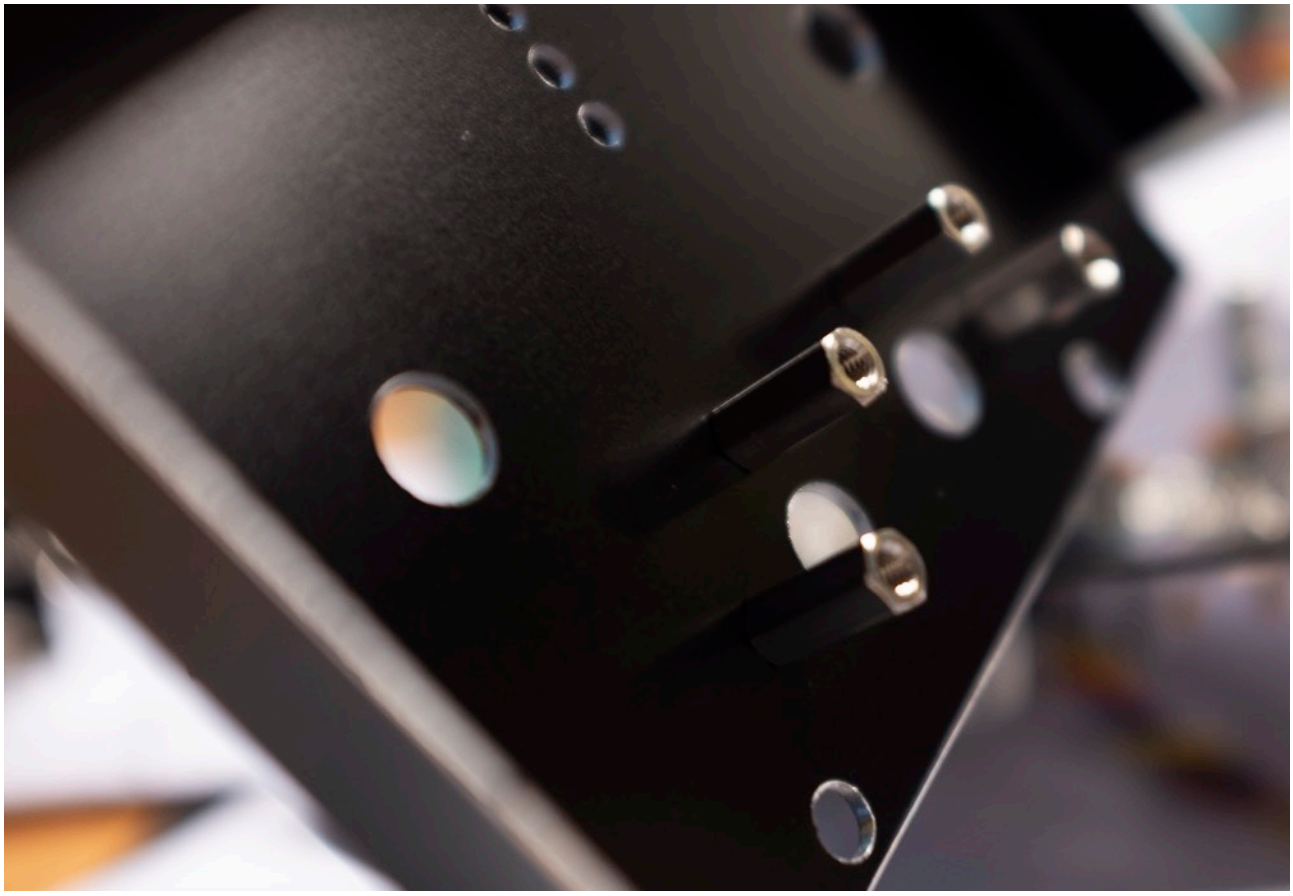
Place the daughterboard onto the pins and solder them. Be sure to keep the daughterboard down. Remove the daughterboard for washing (please be careful not to bend the fragile pins).



5. Front panel: preparation and hex nuts

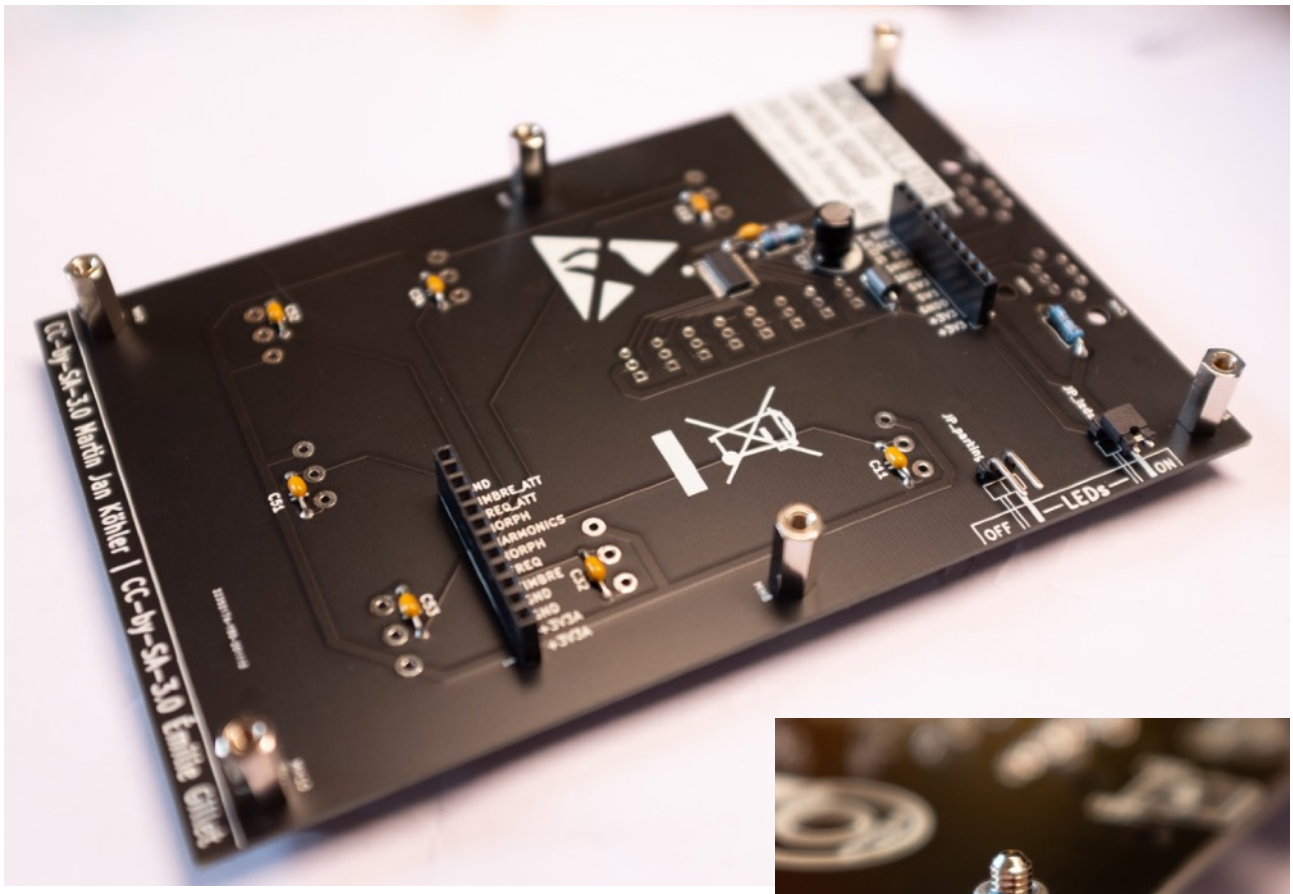
Remove the plastic foils on both sides protecting the front panel.

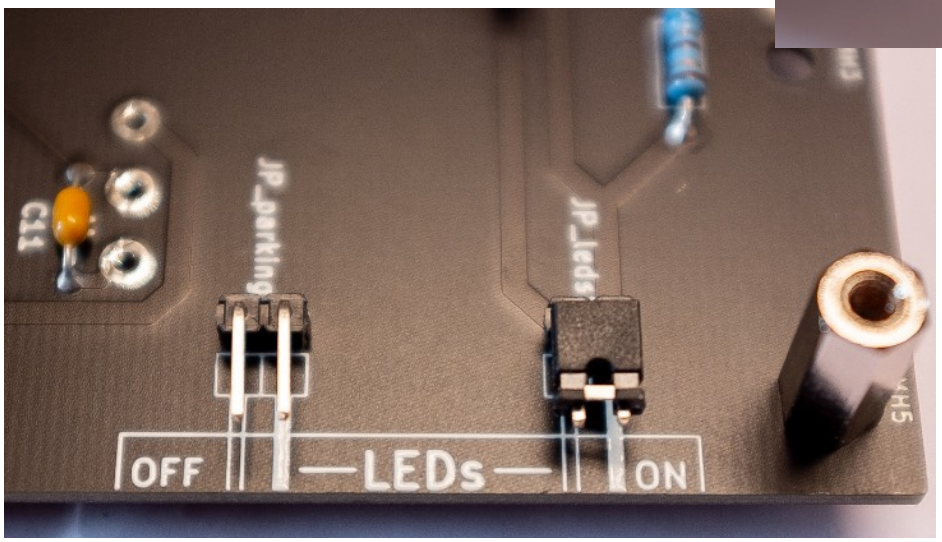
Fit the four M3x11 hex nuts to the back side front panel to secure the switch board.
On the front side, use a black screw and washer to mount the nuts.
NOTE: there is a smooth and a rough side of the washer. Be sure to orient the smooth side towards the front panel



6. Control Board: hex nuts and jumper

Next fit M3x12 hex bolts (with one side male) through the back side of the PCB and secure them with locking nuts.
Place a jumper over the LEDs-ON pin header.



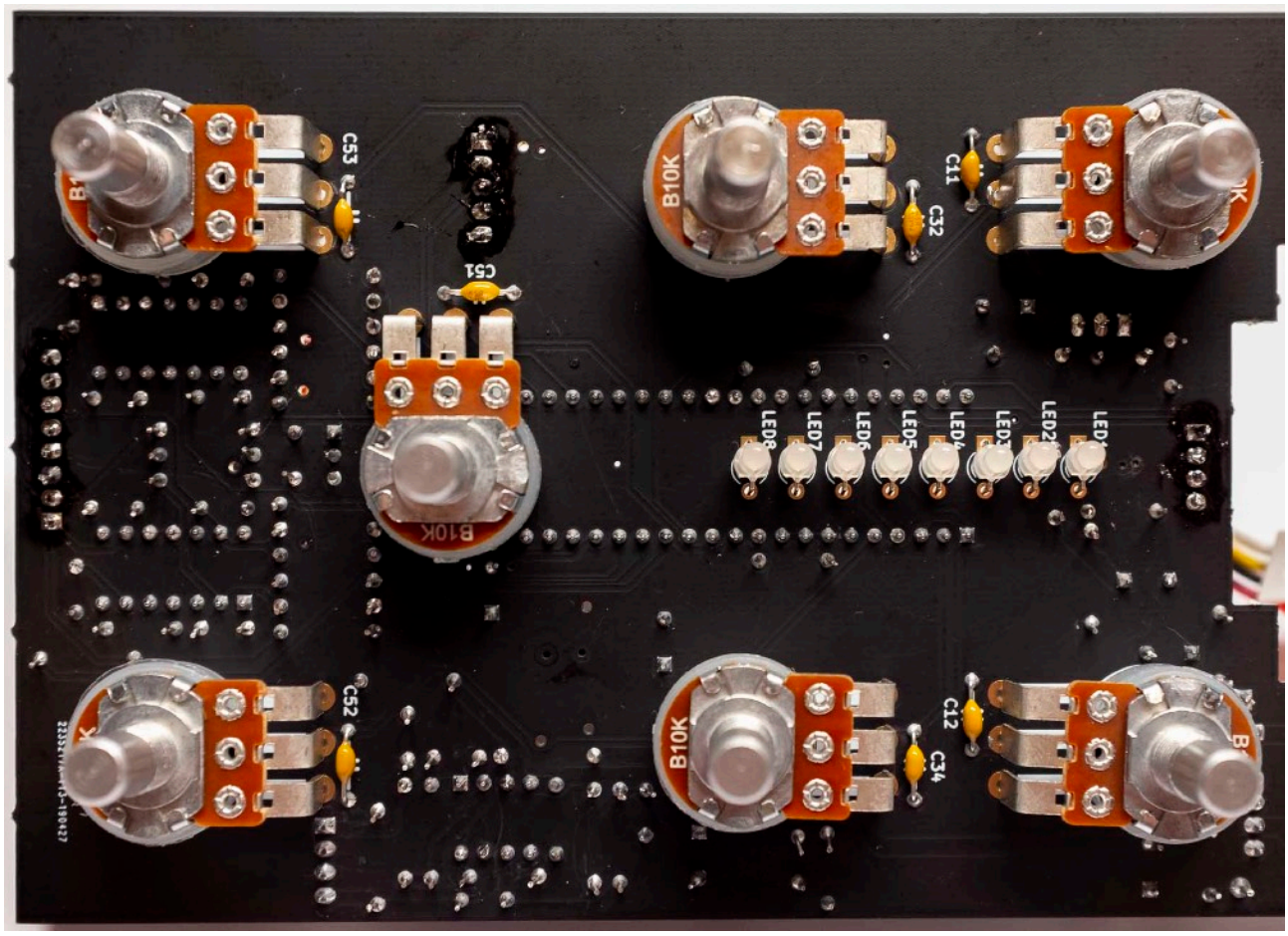


7. Control Board: Potentiometers

We now switch to no clean solder (no additional flux is used).

Using the pliers, break off the little tabs of the potentiometers.
Then check the potentiometers legs, sometimes they come bended, if so, bend them correctly.

Place each of the 7 potentiometers according to the silk screen image.
Solder it while making sure the pins sit flush on the PCB (start with the middle pin, then re-check, etc).

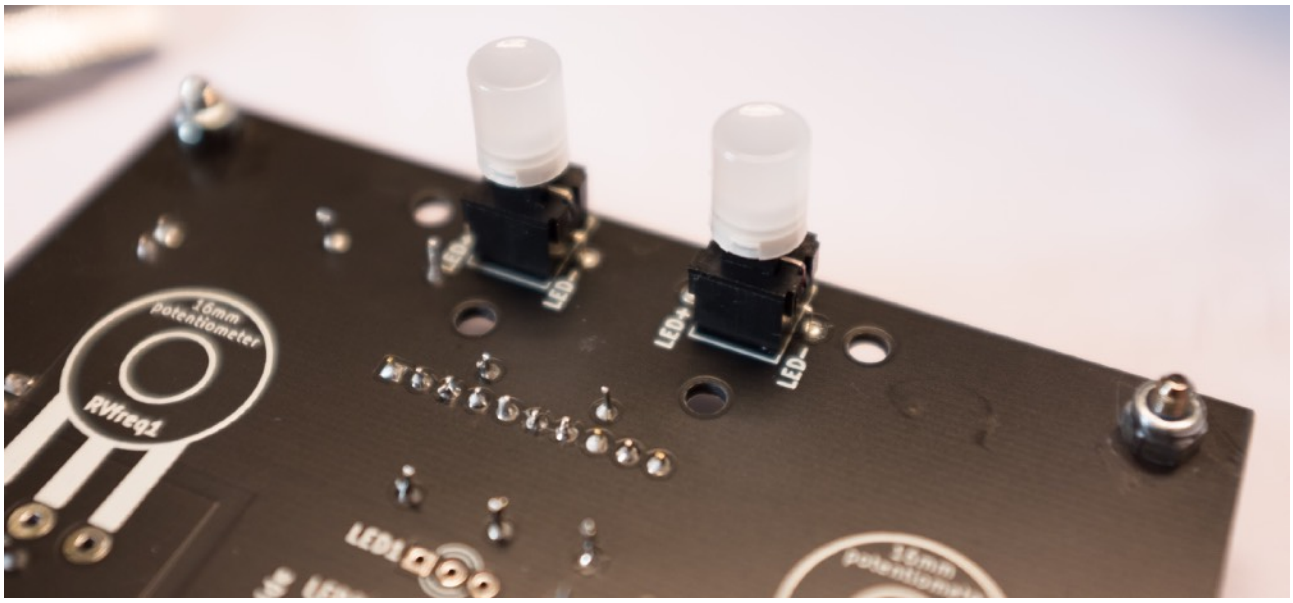


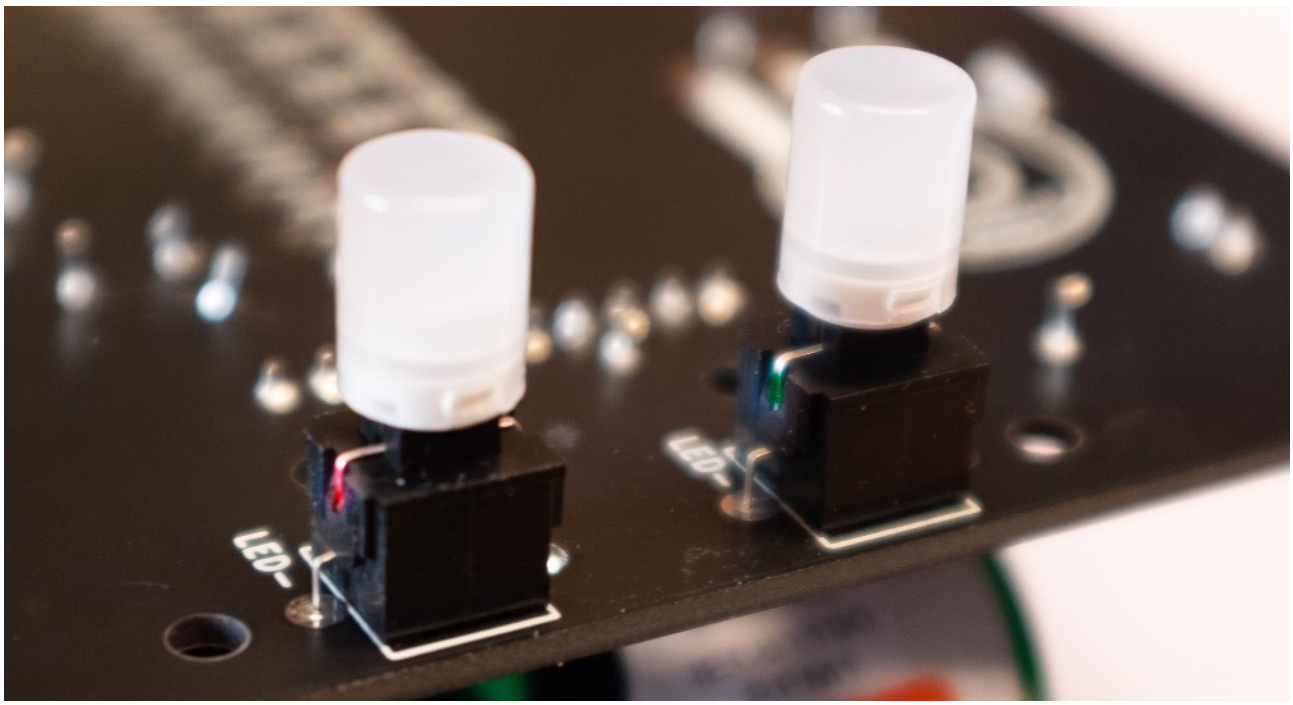
(photo shows earlier version of the PCB)

8. Control Board: Switches

Solder the switches:

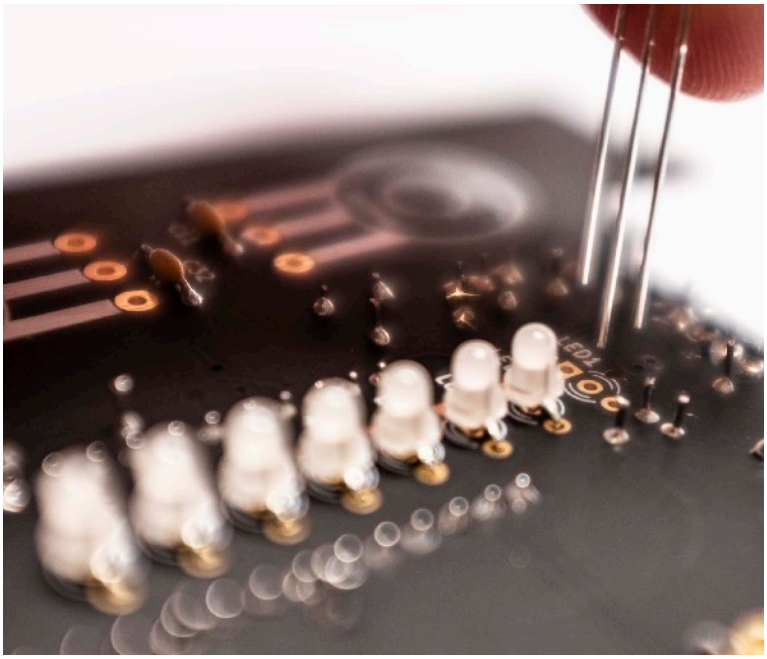
1. Orient the switches so that the colored leg is at LED–
2. Left Switch is green (seen from the front)
3. Right Switch is red (seen from the front)
4. Double check that the switch sits completely flat on the PCB
5. Solder one pin in the middle
6. Check (4) again, otherwise reposition while reflowing (don't heat it up too long, 2 sec max)





9. LED preparation

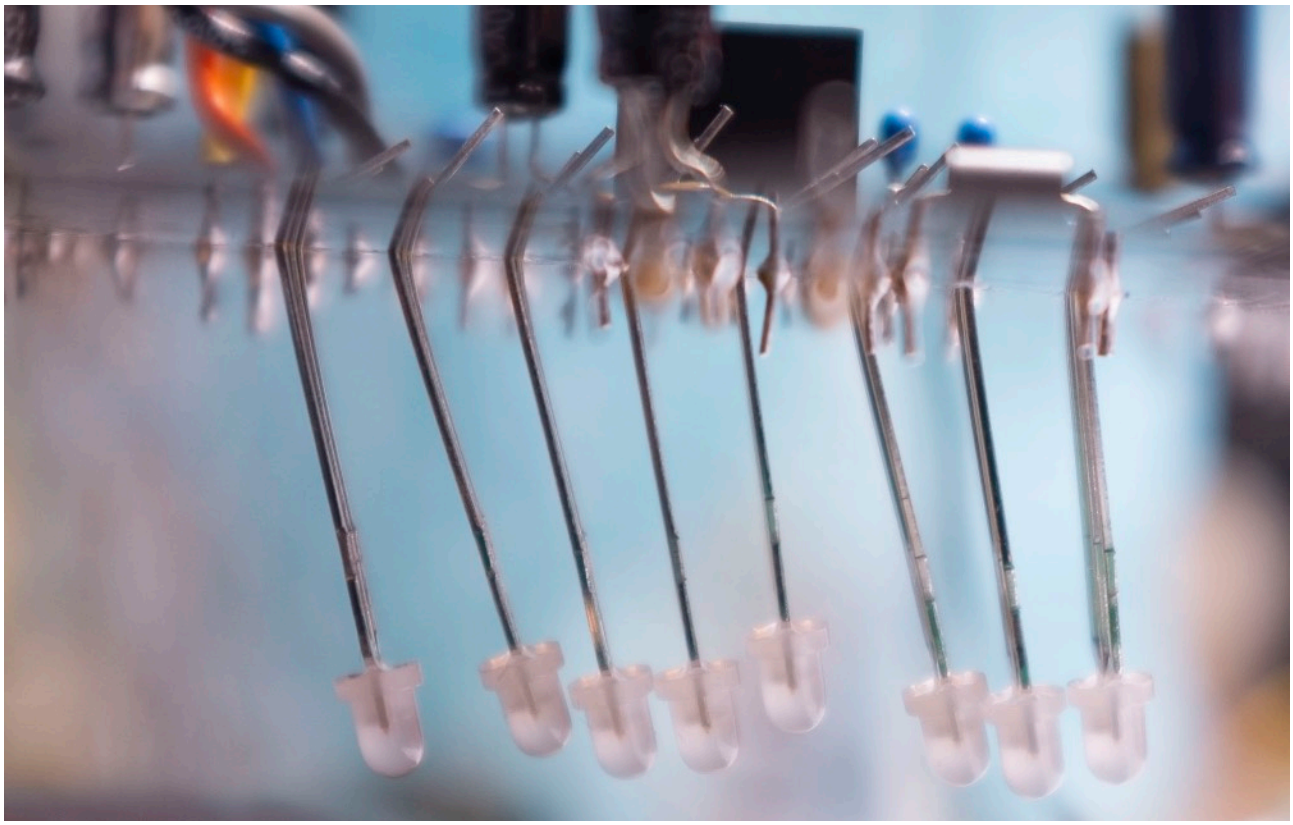
Fit the LEDs through the footprints on the front side of the PCB.
VERIFY: Match the orientation according to the silkscreen and picture (shorted lead goes through the square-shaped left-most hole).



Place something like a solid piece of cardboard against the LEDs to secure them while turning the PCB upside down (or hold them in place with your fingers).

Then with a fine flat plier, bend the end portion of the LED leads 90°.
This will keep them in place and prevent them from falling out.

Later, after the potentiometers are done, this will help us to perfectly align the LEDs.



10. Control Board: Panel Mount

For securing the potentiometer nuts, a hex key tool is recommended to avoid scratching the front panel.
10mm is needed for the Alpha potentiometers.

Place the smooth side of the Alpha washers towards the panel and lock the potentiometers with the nuts first by finger, then with the hex key tool.
VERIFY that they are centered before tightening them down.

11. Control Board: LEDs follow-up

Wiggle around the bent side of the LEDs until they fit through their holes, pin down their position with a dip of solder, then clip the leads and solder the rest.

12. Main Board: Jacks

Place the jacks through the jack board.
Then slide the front panel over and carefully use pliers to align them to fit through the mounting holes.

Hold the sandwich in place and flip it around.
Then pin the jacks down in place with a dab of solder on just one pin.
Place the washers (smooth side towards the panel) and tighten down the nuts with a 12mm hex tool.
Start with the middle (FM, V/OCT), then work your way towards the edges.
VERIFY: to conform to MJK's OCD, make sure to align the hex nuts with one corner facing top ;-)

The backside of the finished modules should look somewhat like the photo below.

Tests and Calibration

Set your lab power supply to +15V (current limit 70mA) and -15V (current limit 15mA)
and turn it on and verify that the current limit is not reached (which could mean that there are shorts), and that no parts are getting hot or magic smoke escapes.

After programming the push buttons should cycle through the LEDs, it's normal that the LEDs do strange things at this point before calibration.

Follow the „Calibration Procedure" from the official manual:
https://mutable-instruments.net/modules/plaits/manual/

1. *Disconnect all CV inputs.*
2. *Connect the note CV output of a well-calibrated keyboard interface or MIDI-CV converter to the V/OCT input. Leave all the other CV inputs unpatched.*
3. *Press both buttons (A). The first LED slowly blinks in green.*
4. *Send a voltage of 1.000V to the V/OCT input.*
5. *Press any button. The first LED now blinks in orange.*
6. *Send a voltage of 3.000V to the V/OCT input.*
7. *Press any button.*

The module should work by now.

In case of issues there's a thread on muffwiggler:
https://www.muffwiggler.com/forum/viewtopic.php?t=216177