

## PICOSYNTH MONOPHONIC SYNTHESIZER



A DIGITAL SYNTHESIZER PROJECT BASED ON RASPBERRY PI PICO

Thank you for purchasing GMLab Picosynth! Whether you bought the kit version or the pre-assembled version, please refer to this document for basic information and instructions. If you purchased the kit version, please refer to the full version of the guide that you will find online, here:

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Picosynth is a basic monophonic synthesizer, easy to learn and to operate with all the sections well defined by labelings. It also has a few nice add-ons like the presets management and a delay section. Two oscillators with 5 waveforms, L.F.O., filter, envelope, mixer and glide control. If you are reading this document or you purchased GMLab Picosynth, you're likely familiar with synthesizers, you know how to operate them and how to generate, manipulate and modify the sound.

**No power supply unit is supplied with a KIT purchase.** GMLab Picosynth requires a 12v DC 500mA minimum power supply in order to correctly operate. These are very common and it's likely that you already have one compatible laying around somewhere. Just be sure that the DC male plug is 5.5/2.1 with the positive in the central pin and the negative in the external frame of the plug.

You can also use a power supply with less voltage (for example 9v) but please don't use the ones for guitar pedals, they are normally with center negative. You can also power on your Picosynth just connecting a MICRO-USB cable into the Raspberry PI PICO port but we won't suggest to do this for a long period of time. Using a different power source than the one suggested (12v DC) won't harm your instrument, unless you connect a power supply with a voltage higher than 12v; but this will affect the audio quality because the operational amplifier circuitry used in this project is designed around 12v DC for optimal performance.

GMLab Picosynth is sending out mono audio from the headphones 3.5 jack plug and the 6.3 jack plug: you can use them at the same time.

The MIDI connector of GMLab Picosynth is a MIDI IN port, there you are supposed to plug a device capable of sending MIDI, typically MIDI NOTE ON/OFF messages. Plug there your MIDI keyboard, your computer or your sequencer. **Picosynth recognizes MIDI data on CH1** and supports MIDI USB.

It recognizes CC#1 (modulation wheel) and pitch bender, PC# from 0 to 31 and the "all note off" message.

With the "+" and "-" pushbuttons you can scroll the presets, press "STORE" to save a preset (overwrite the existing one). To activate the "MANUAL" mode press the pushbuttons "+" and "-" at the same time: when "MANUAL" mode is engaged, the instrument will sound exactly respecting the actual potentiometer's position.

If you would like to revert to factory defaults (original presets), press and hold "-" with your Picosynth off and connect the power supply.

GMLAB Picosynth is sold on-line on the web sites [www.gmlab.it](http://www.gmlab.it) and on [www.MyRigShop.com](http://www.MyRigShop.com) by V.M.Connection, an enterprise based in Italy.

You can get the project files for this and other GMLab projects on our GitHub account:

<https://github.com/ZioGuido>

If you need spare parts or blank PCBs, just let us know.

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## MOUNTING INSTRUCTIONS

Welcome to the mounting instruction sheet for the GMLAB Picosynth monophonic synthesizer. To assemble this kit correctly and set it up to work properly, a good skill and experience with electronics and computers is required, plus some tools and a little bit of patience and attention. You must be able to recognize electronic components, resistors, capacitors, integrated circuits, you must be able to solder them properly on the PCB.

Please note that we are not responsible for instruments not working due to improper mounting, improper soldering/desoldering of components or parts broken during the mounting process.

### REQUIRED TOOLS

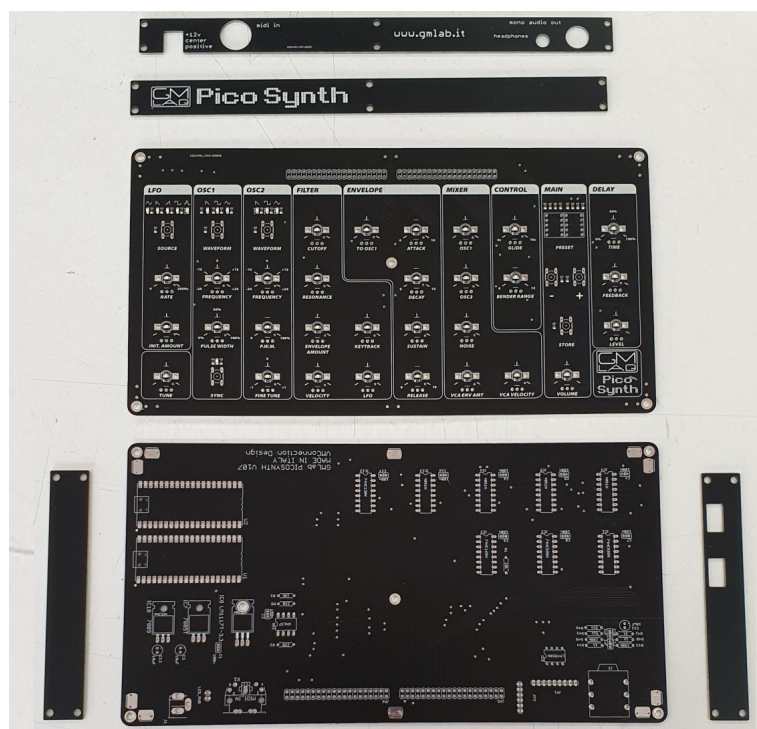
1. Soldering iron, preferably a temperature-controlled 60W iron with a 1,5 ~ 2,5 mm wide tip;
2. Solder tin wire, preferably good quality 0,8 ~ 1 mm diameter;
3. Good quality cutters, pliers, screwdrivers;
4. Patience.

### PREPARATION

Prepare a clean and tidy surface, with just the required tools handy and make sure you have discharged your body from electrostatic charge by touching some metal object that makes contact with the floor. Optionally, wear an ESD wristband.

### WHAT'S IN THE KIT

- 1x Active Panel bottom PCB
- 1x Top Panel PCB with premounted SMD components
- 1x Front panel PCB
- 1x Rear panel PCB
- 1x Left panel PCB
- 1x Right panel PCB



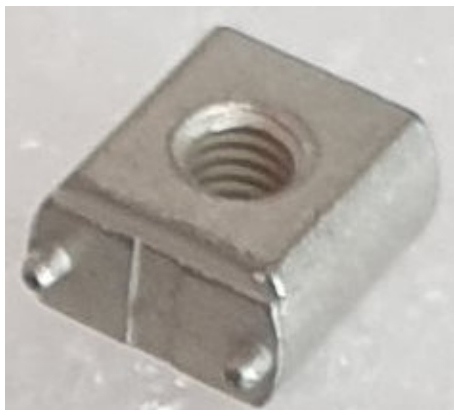


- 20x REDCUBE
- 5x Rubber feet
- 5x M3x20 M/F HEX spacers
- 28x M3x5 screws
- 3x M3 nuts
- 7x Push switch
- 2x 7-segment display
- 30x Transparent potentiometers
- 2x 40 pin long female headers
- 4x 20 pin long male headers
- 4x 20 pin short female headers
- 4x 20 pin short male headers
- 1x 2 pin short male headers
- 1x Jumper
- 1x 6 pin short male headers
- 1x 9 pin short male headers
- 1x IC LM4558 or TL072 or TL082
- 1x IC 6N137
- 1x IC 7805
- 1x IC 7809
- 1x IC 1117
- 4x IC CD4051 or equivalent
- 1x IC 74HC165 or equivalent
- 2x IC 74HC595 or equivalent
- 1x IC 74HC138 or equivalent
- 2x Raspberry PI Pico
- 1x DAC board
- 1x Jack TRS 6.3
- 1x MIDI Connector
- 1x DC Connector
- 10x 100nF ceramic capacitor
- 3x 10uF electrolytic capacitor
- 2x 1uF capacitor
- 2x 10kohm resistors
- 2x 220ohm resistors
- 2x 51kohm resistors
- 2x 100kohm resistors
- 3x 1kohm resistors

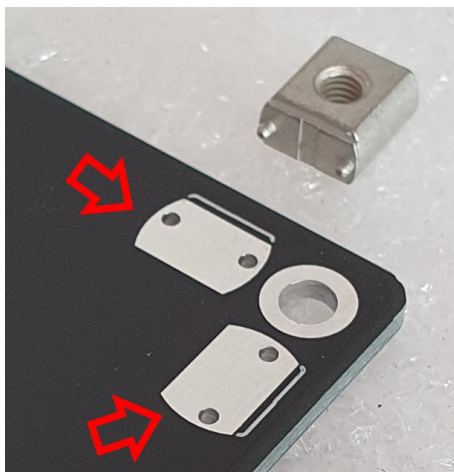


## NOTE ABOUT REDCUBES

Redcubes are little components that allow to fix the side panels of the synthesizer without compromising the aesthetical end result of the product. They need to be soldered to the bottom and top PCBs. The procedure is not very easy and we suggest to do this operation before anything else.



You are required to solder 10 pieces on the bottom PCB and 10 pieces on the top PCB: 2 pieces on every angle plus 2 pieces in the middle. Please take a look at the PCBs in order to find out where they are located.

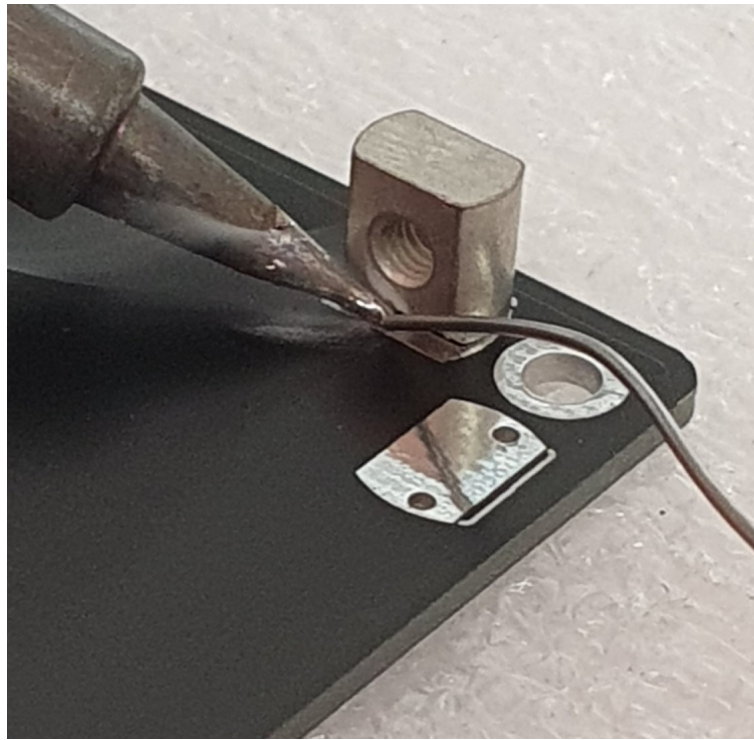


Once mounted you will be able to fix the side panels of your synthesizer with the screws to improve the overall structure and appearance.  
**The soldering procedure requires time: please follow our instructions carefully!**

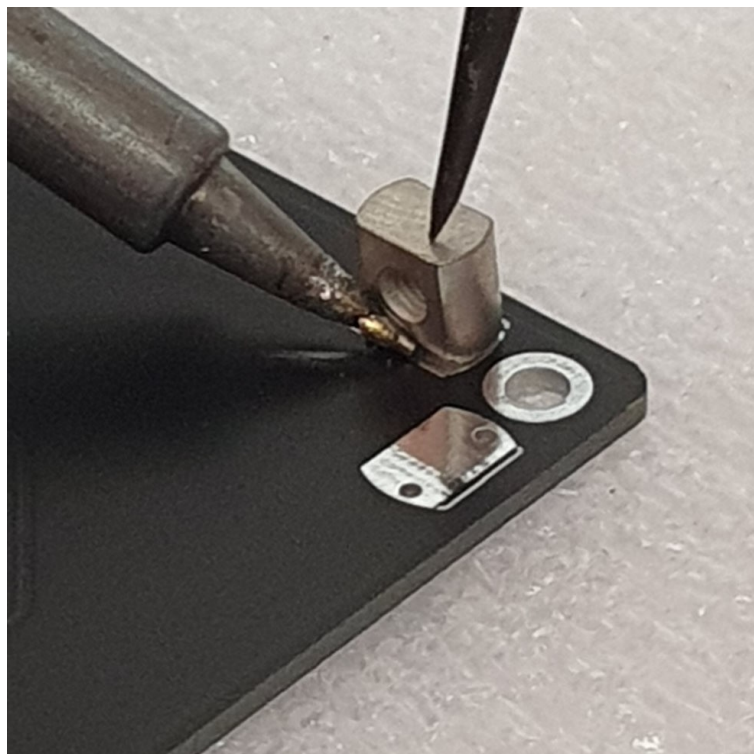
- Locate a REDCUBE pad and place one on it: be sure that the two small pins are inside the 2 small holes in the pad.



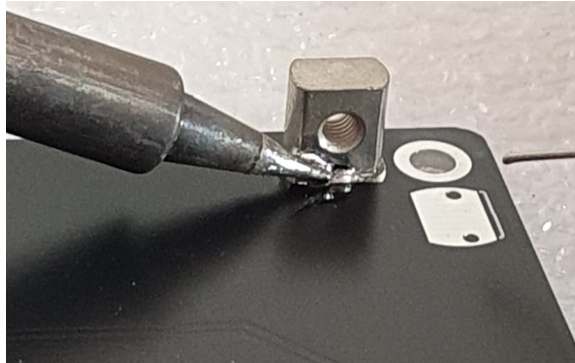
- You will notice that the pad is a little bit bigger in the inside area: that is the place where you have to start soldering it. Put the tip of your soldering iron there and start applying the soldering tin wire to it: hold them firmly, don't apply the solder tin on the pad before positioning the REDCUBE, otherwise it will be difficult then to re-position it again. Please don't forget that the area and the redcube will become very hot!



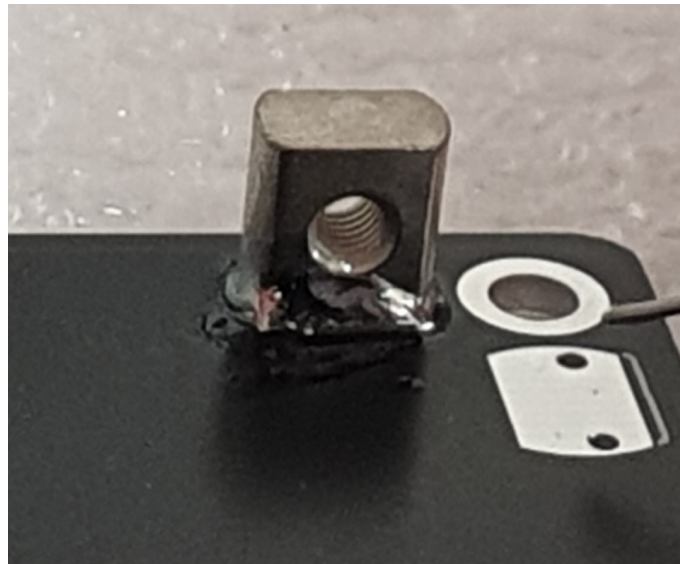
- You can help yourself in this operation using a tool to firmly hold the REDCUBE until the solder starts melting and attaches to the PCB. Don't move the soldering iron tip!



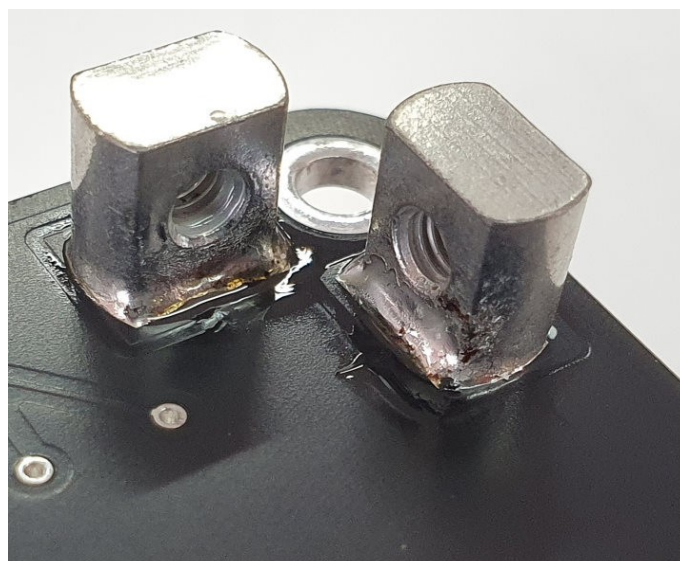
- The soldering tip needs to heat both the PCB and the REDCUBE before the tin starts melting. This requires time, it can be from 10 to 30 seconds depending on the temperature.
- When the solder tin starts melting you will see the tin going everywhere in the pad and also underneath the REDCUBE, firmly attaching it to the PCB. You need a lot of solder tin there! Wait until everything is well covered with the tin and then remove the soldering iron tip gently without dropping the REDCUBE.



- When the solder tin is solid again, the end-result should look like this:



- You can now proceed with all 20 pieces.





ACTIVE BOTTOM BOARD

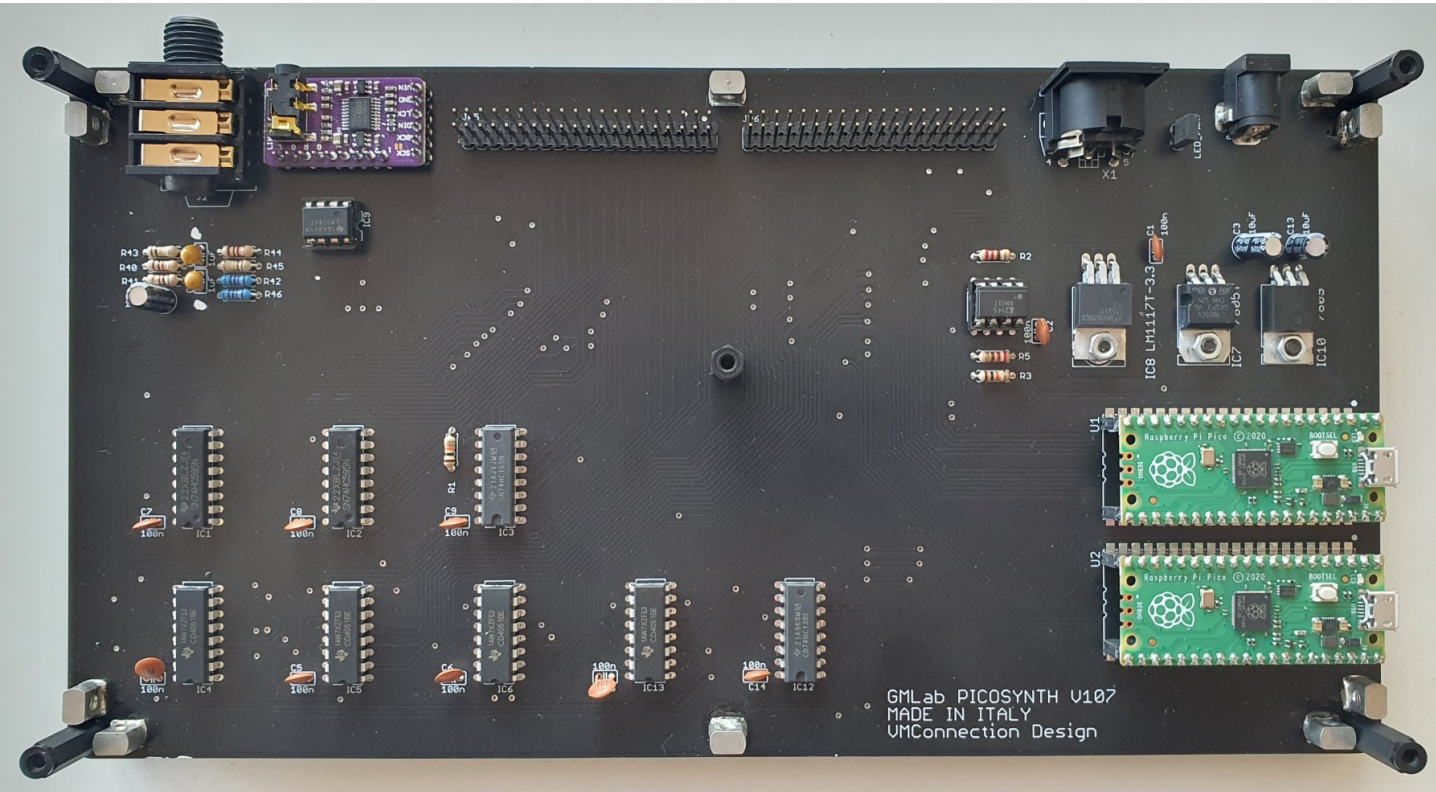


fig. 1

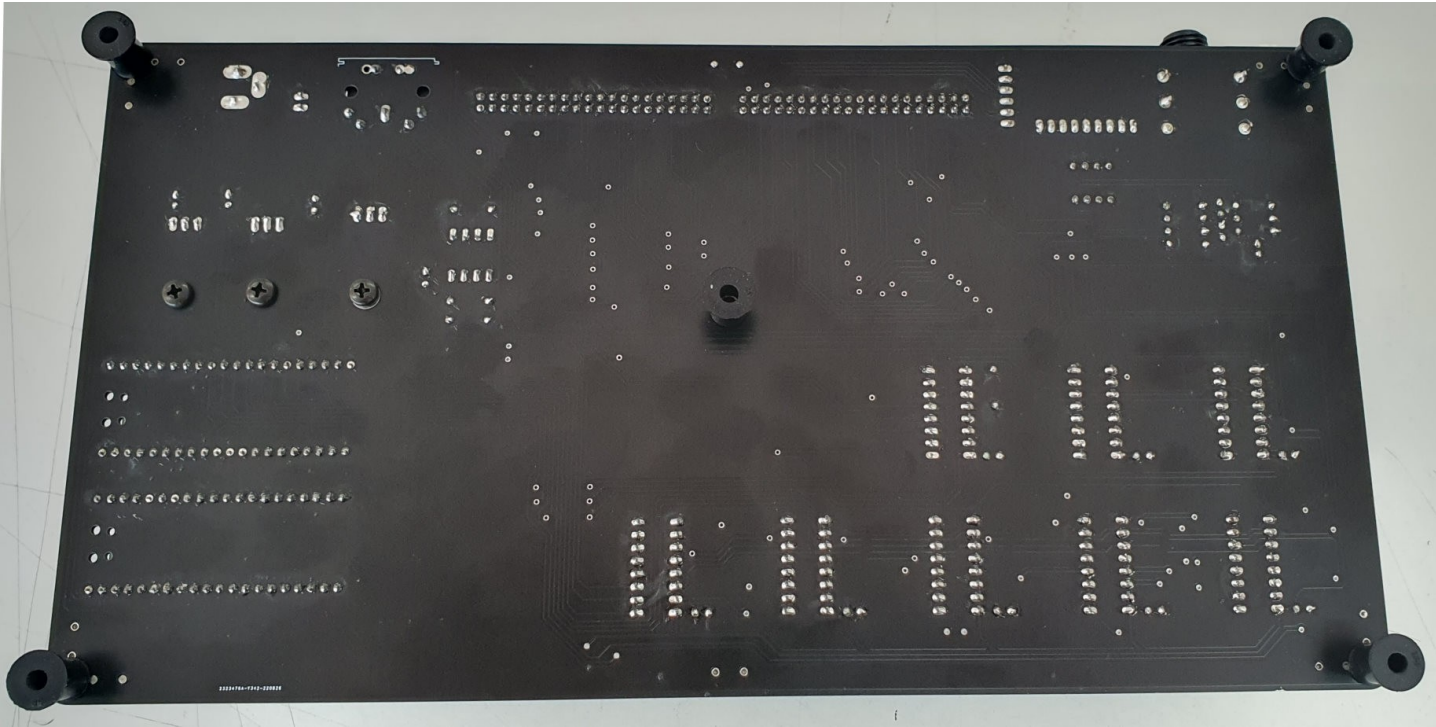
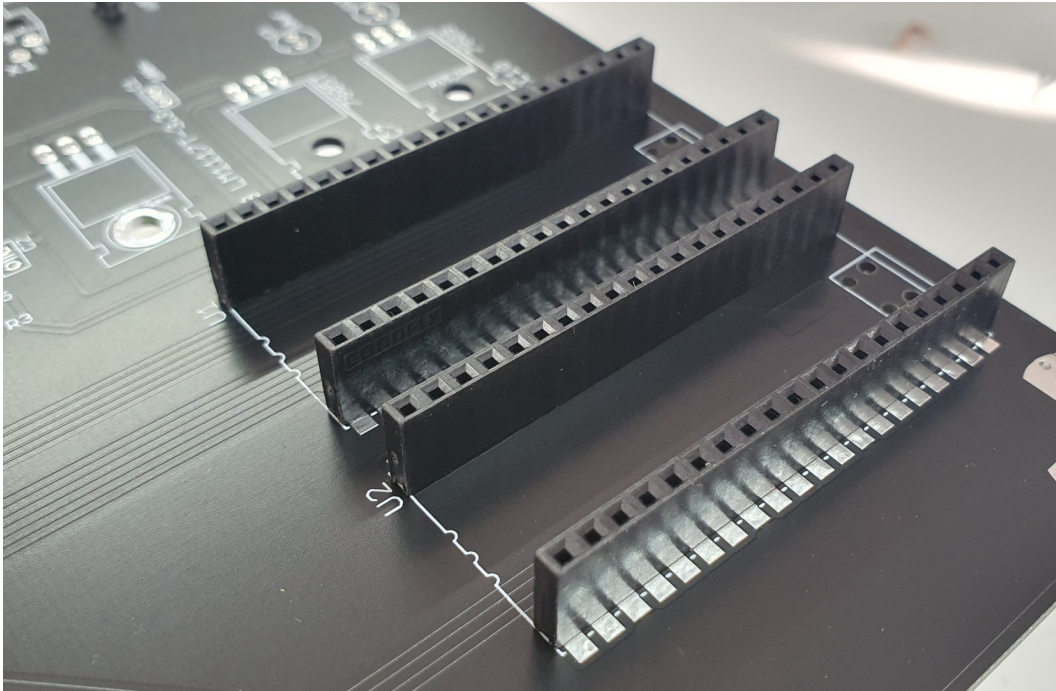


fig. 2

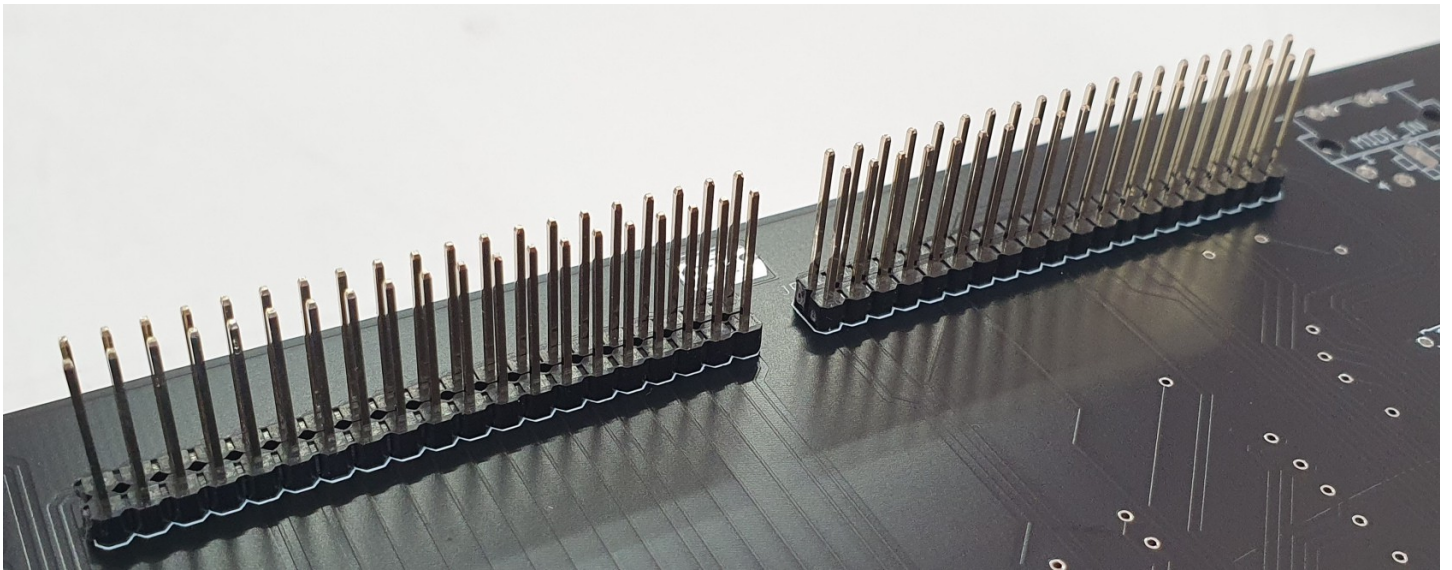


**STEP 1:** Let's start from the electronics. All passive components first, starting from the lowest till the tallest. Take the resistors, bend the terminals 90 degrees (if not already bent) and add them to the main PCB in the correct positions (check the schematics, silkscreen on the PCB and the component numbering and value). Do the same with the capacitors and keep in mind that electrolytic capacitors do have a polarity.

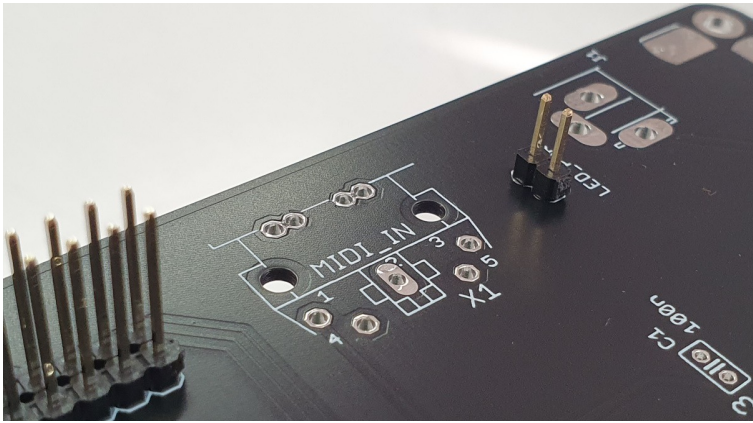
**STEP 2:** Let's place and solder all the connectors (male and female SIL and DIL headers). Let's start from the two 2x20 pins female headers for the two Raspberry PI PICO boards.



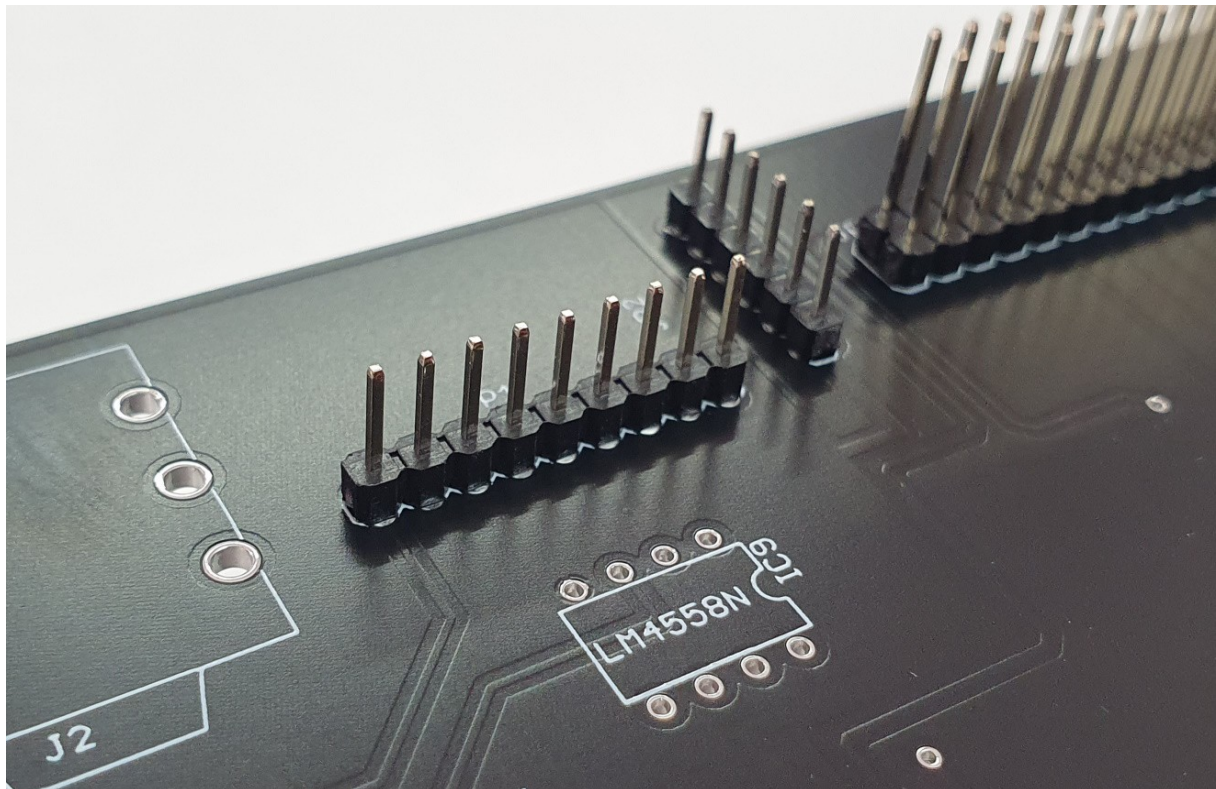
Then you can proceed with the two 2x20 **long** male headers (these are used to connect the bottom board to the top board).



Then mount the 2 pin header that is used to give or remove power to the LEDs underneath the potentiometers in the TOP panel. Adding a jumper the LEDs will lit, without the jumper the LEDs will stay off.



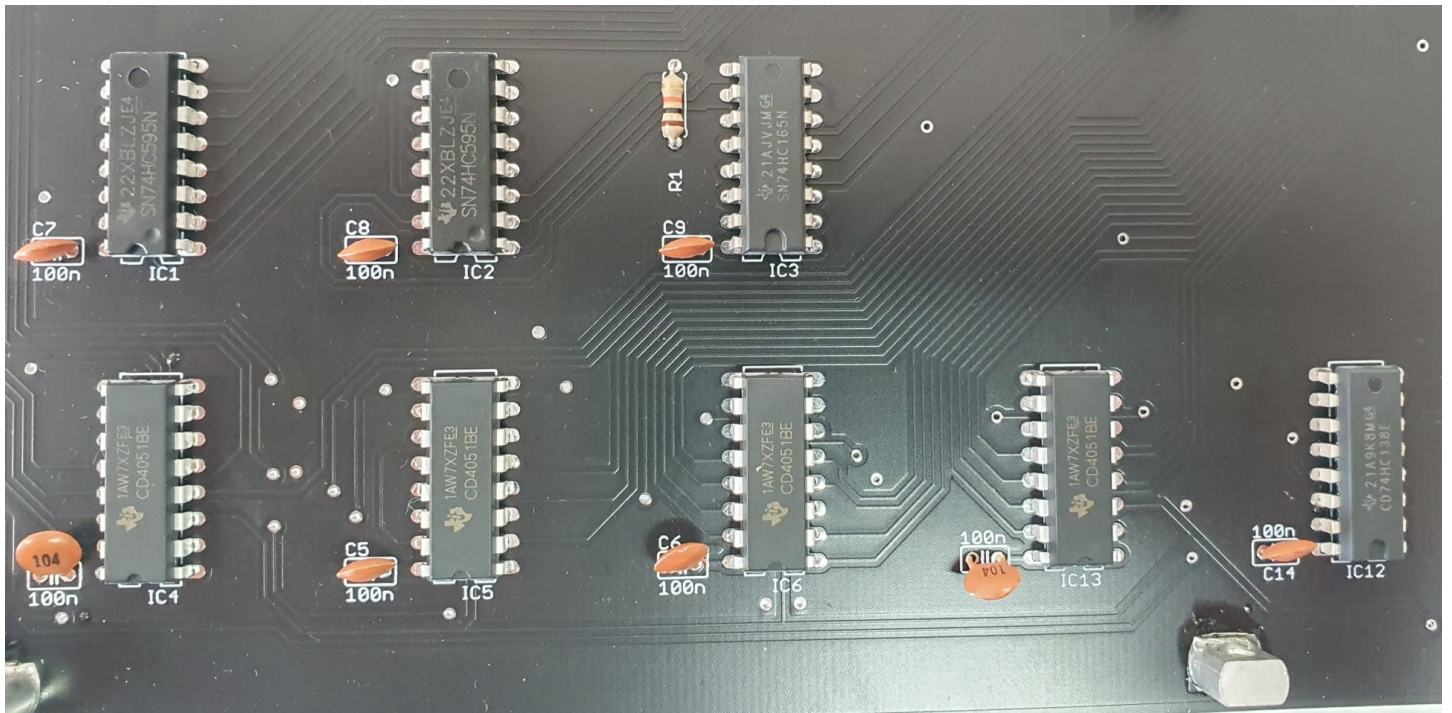
There are two more headers that you need to add: they are those for the DAC board:



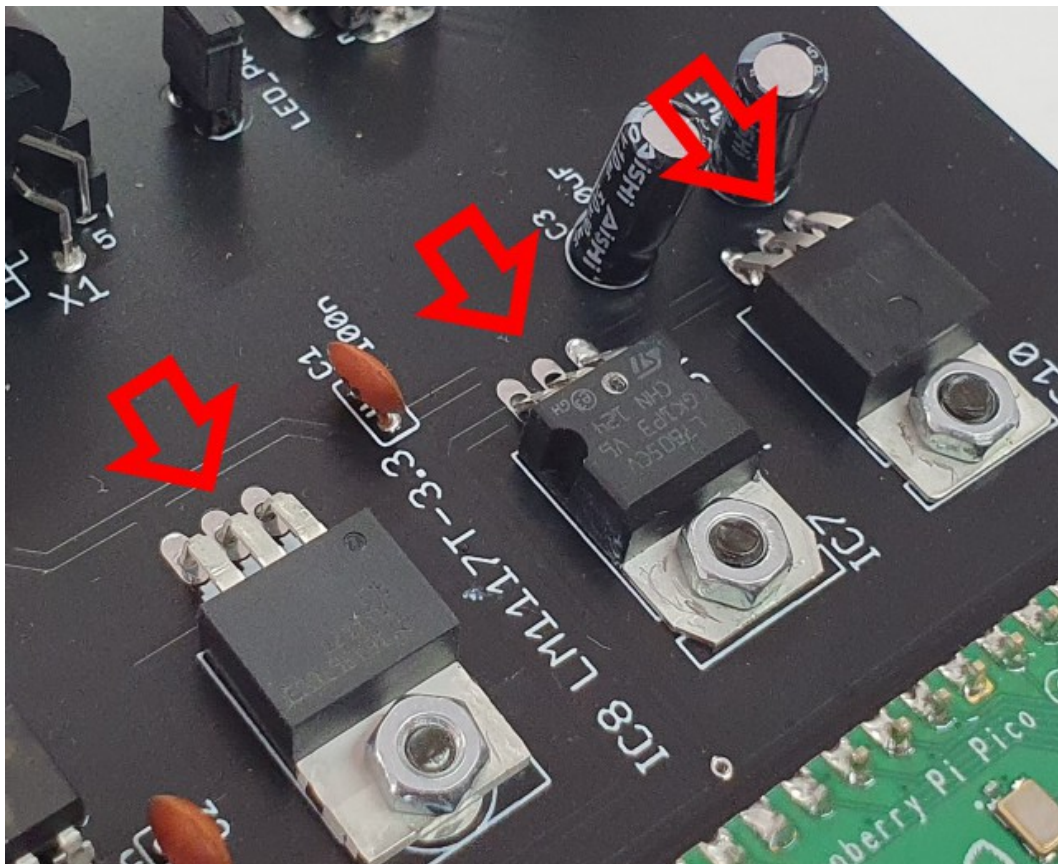
Now we are ready for the next step: integrated circuits and the two Raspberry Pi Pico boards.

**STEP 3:** Add the Integrated Circuits. Pay attention not to keep the solder pin for too long, and that all pins have been soldered correctly. Do not solder two or more pins together, each pin is soldered separately from the surroundings. Also pay attention to the direction and polarity. Drawings on the PCB have a notch on a side indicating where pin 1 goes. The same notch is generally present in the IC itself, or you'll also find a small dot. Please take a close look at the codes in the integrated circuits (they all look the same but they have different codes, 4051 is not 595, 6N137 is not the OPAMP!). This is a delicate step, do not make mistakes!



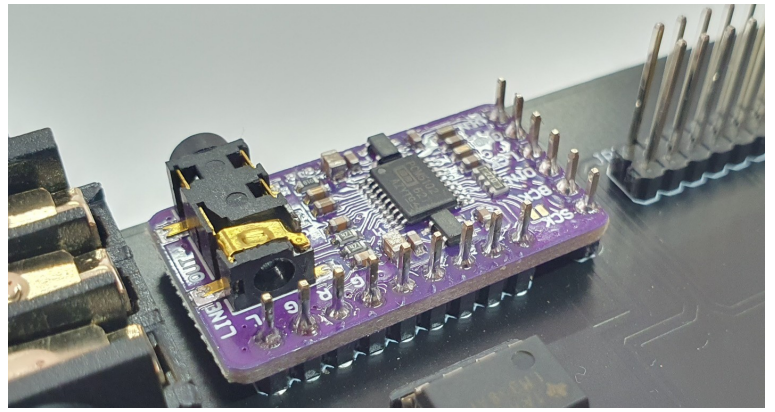
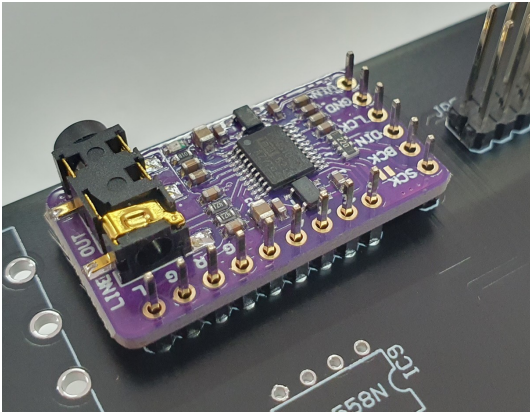


Let's now proceed with the voltage regulators: they are special integrated circuits that, in this case, also need to be screwed onto the PCB using three 3x5 screws and three M3 nuts. Before soldering them, you have to bend the pins; please also pay attention on their codes, they are three different ones.

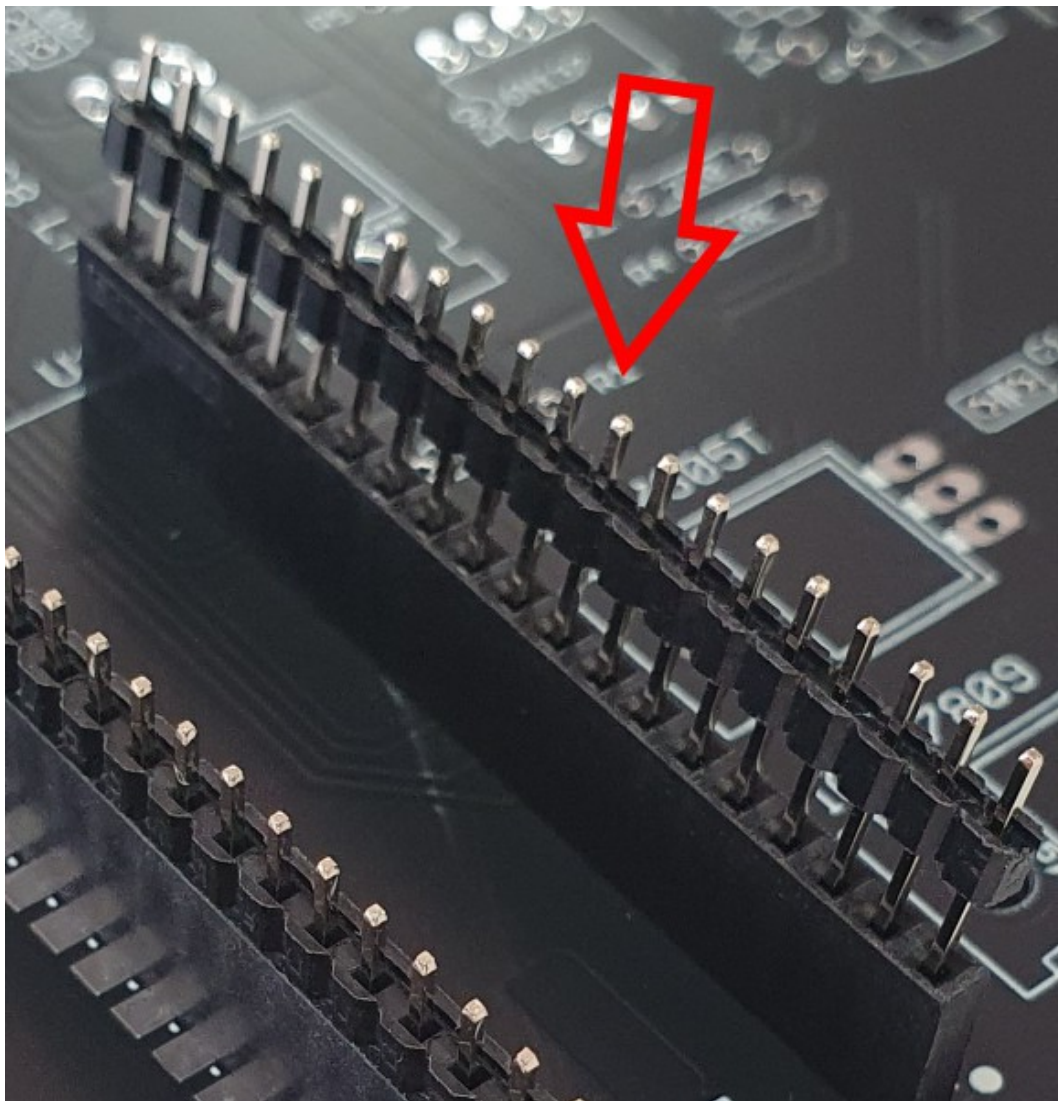


Now it's time to add the DAC board: you already soldered two male headers, one with 9 pins and one with 6 pins. Now plug the DAC board and solder it: please note the the board needs to touch the plastic enclosure of the SIL headers so it will reach the correct height.

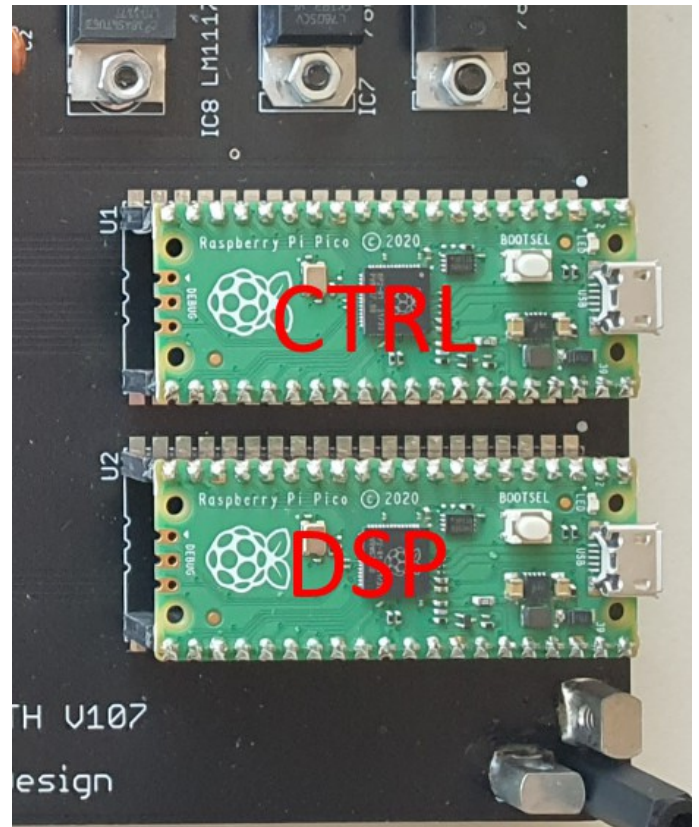
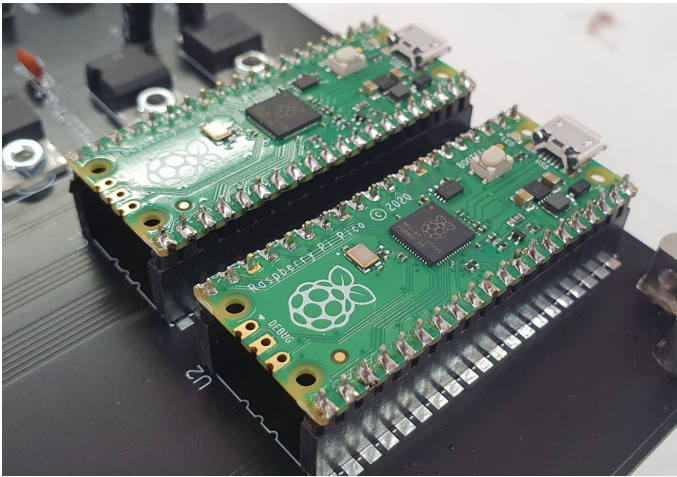




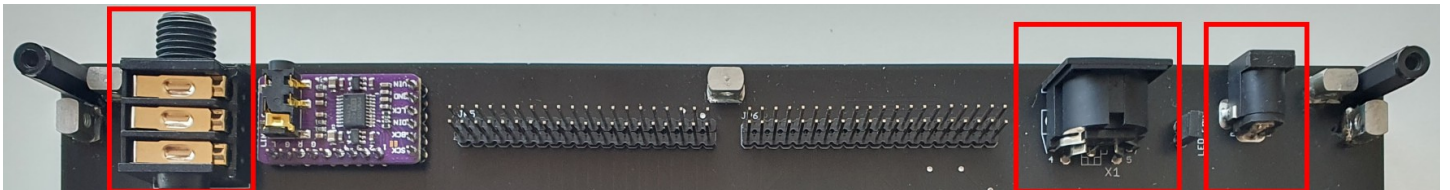
Last thing to do in this step is adding the brains of your synthesizer: the two Raspberry PI PICO boards. There's a smart way to do this. First of all, plug the four 1x20 male headers in the four 1x20 female headers you previously soldered, like this:



Then insert there the two Raspberry PI PICO boards. Please note that the USB connectors are facing outside the board. The two boards delivered with this kit are pre-programmed and they are labeled "CTRL" and "DSP". Mount them in the correct position!



**STEP 4:** Add the MIDI connector, the DC plug and the TRS 6.3 jack and solder them: this is an easy procedure.

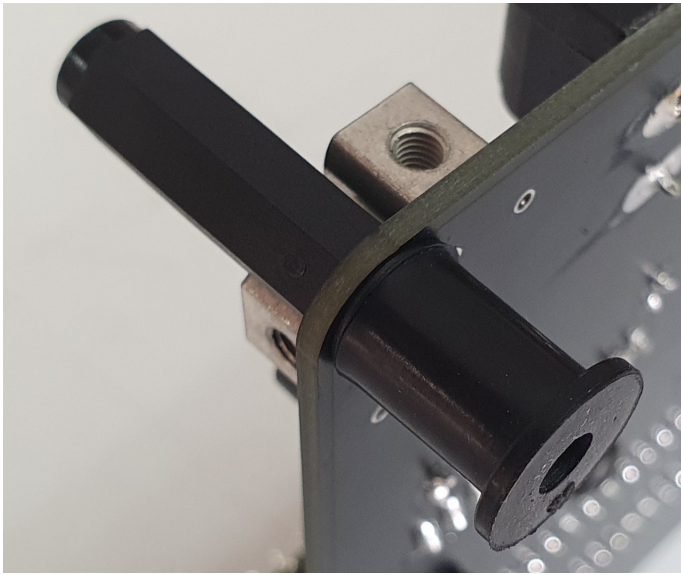


**STEP 5:** this is the last step for the bottom board and consists in mounting the 5 plastic Hex spacer and the 5 rubber feet, one for each corner of the PCB and one in the middle.





This should be the end-result:



Now your bottom board is complete and it should look as the fig. 1 and fig. 2 on page 8. Let's now proceed with the top board.



TOP PANEL BOARD



Fig. 3

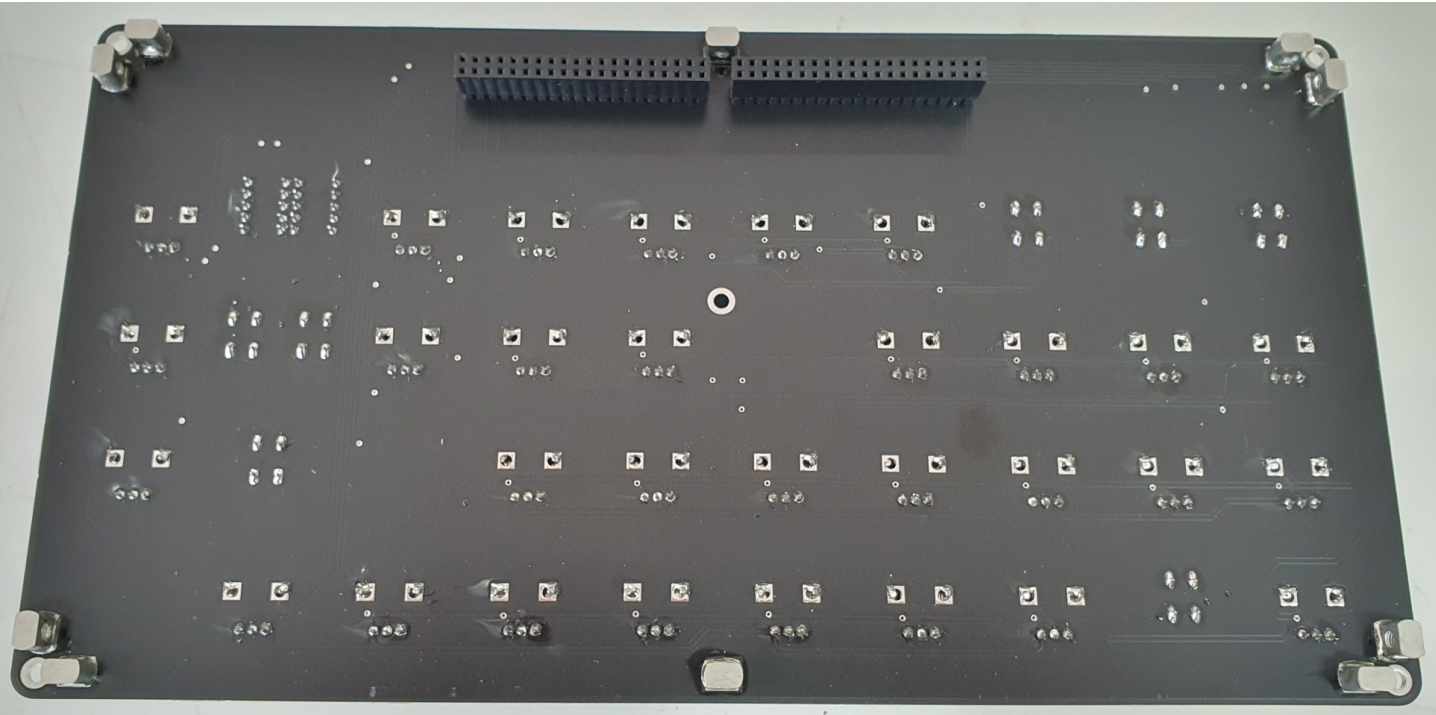
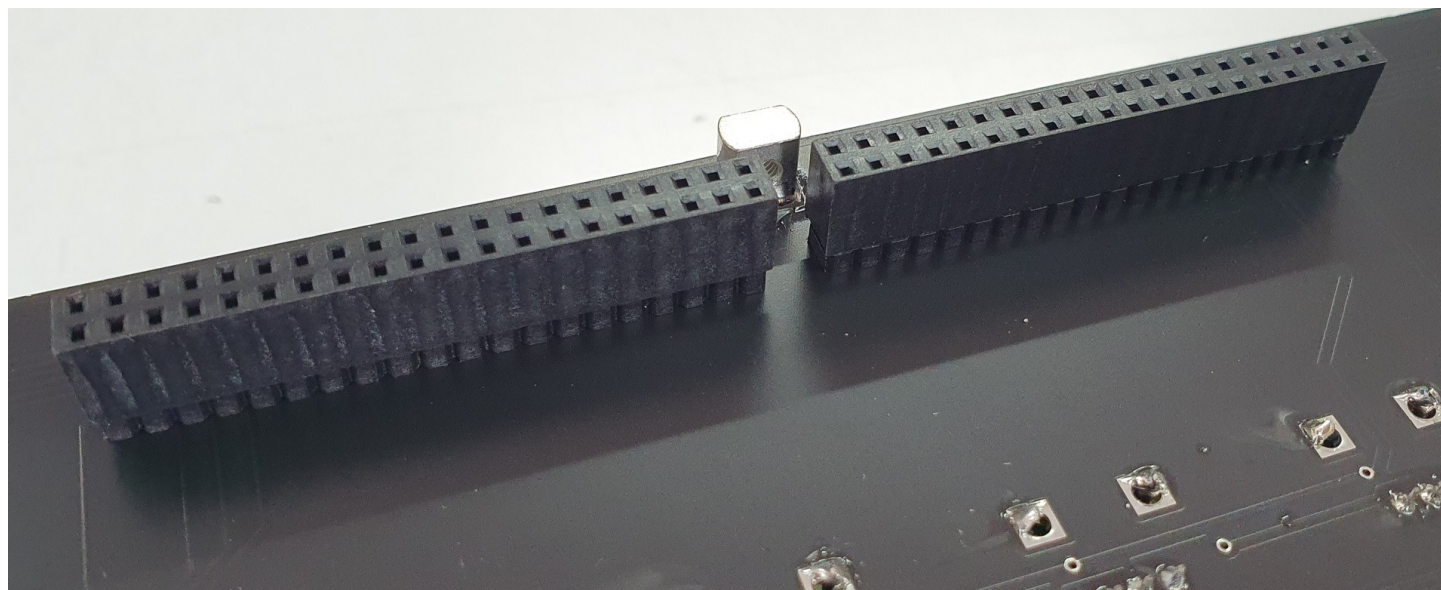


Fig. 4



**STEP 6:** the top panel board, once mounted, will be the the control surface of your GMLab Picosynth, where you will find all the potentiometers, display and the pushbuttons. The potentiometers we selected, have a transparent shaft, when the jumper in the header named "LED\_PWR" in the bottom board is plugged in, the SMD LEDs premounted on this PCB will lit illuminating the potentiometer's shaft. Let's suppose that you already soldered the 10 Redcubes on this board (see page 5) so let's proceed. First of all insert and solder the two 1x40 long female headers:

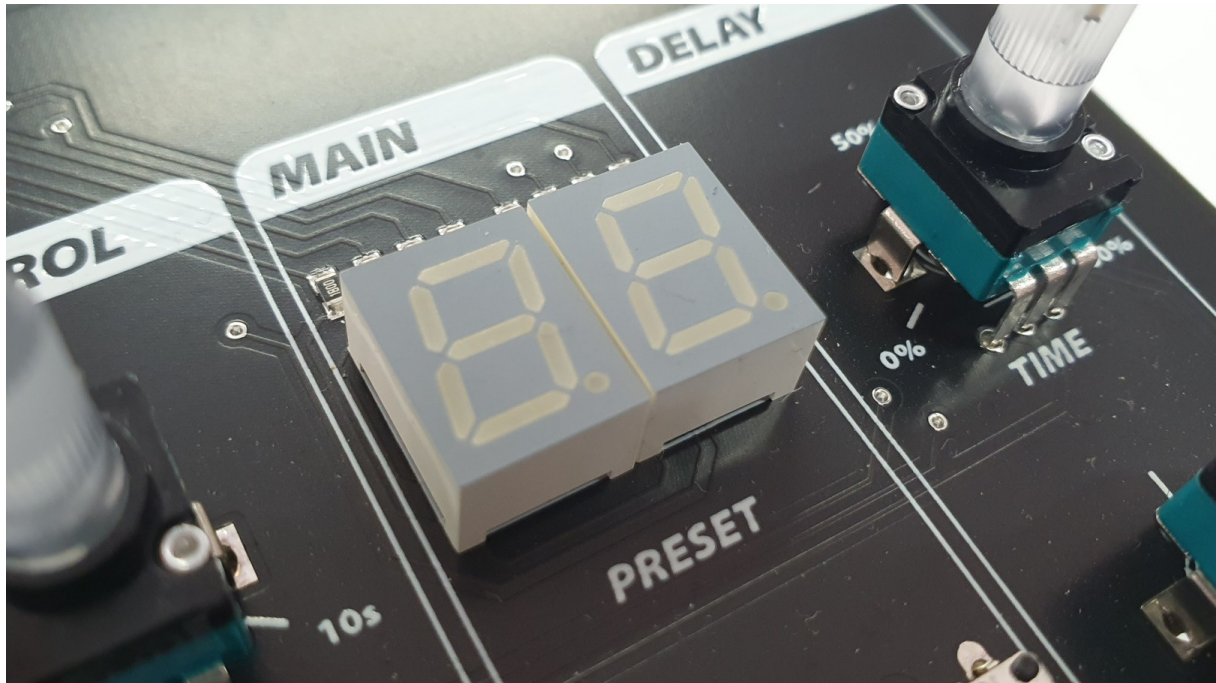


**Step 7:** Now it's time to mount all potentiometers and pushbuttons. Once again, pay much attention to have them sit perfectly on the surface of the PCB, so they will pass through the panel holes correctly. Our advice is to keep them with a finger and solder just one pin, repeat this operation for all buttons and potentiometers, at the end solder the rest of the pins. Start with the pushbuttons, insert them in the PCB and solder.





Then insert the two displays and solder them: PLEASE PAY ATTENTION TO THE DIRECTION! The two dots must face towards the bottom. See this photo.



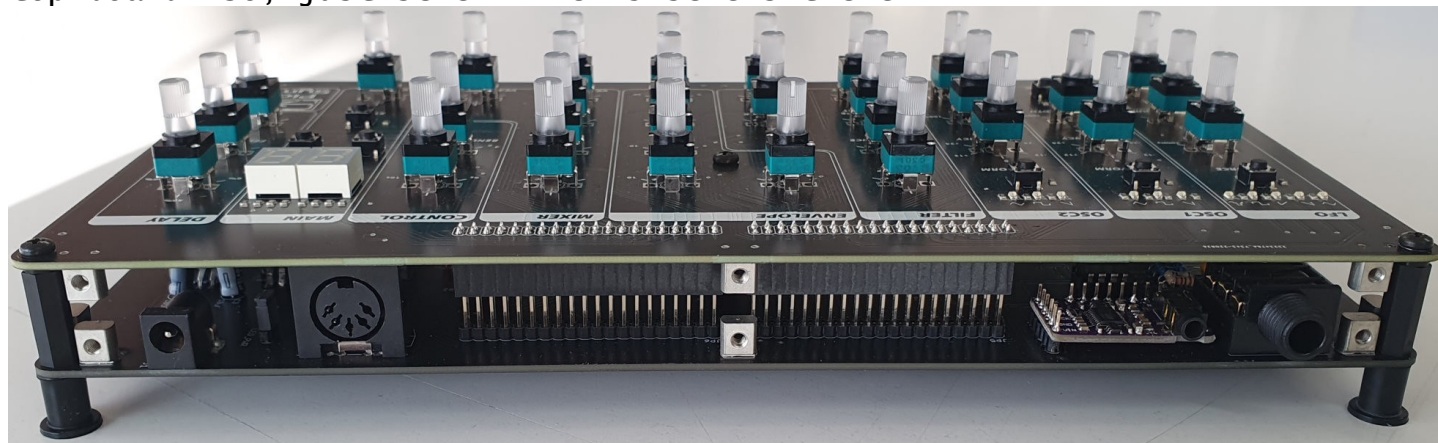
Then insert the potentiometers one by one in the board and start soldering them.



When you are done, the board should look as the photos fig. 3 and fig. 4 on page 15.



**STEP 8:** In this step, you are required to connect together the bottom board and the top board you just finalized. The electric connection between the two boards is made by the two 1x40 pin female and male headers: they need to be connected together. Once the two boards are connected, you will notice that also the five plastic Hex spacers will be in the correct position, just underneath the corresponding holes of the top board. So, just screw five M3 screws there.



**STEP 9:** The very last step is mounting the four side panels for your Picosynth. Please note that they are all different. You have one for the rear side, where you will also find the labelings for the connections.



One completely black for the left side, another one for the left side with two small windows for the USB connectors of the PI PICO boards.



The last one in the front panel with the Picosynth logo. They are fixed in the synthesizer just with M3 screws that will go in the Redcubes.

The mounting procedure is over! Good Job!