Artemis Macropad Build Instructions

To build this project, you're going to need a 3d printer, a basic soldering setup, a multimeter, a place to do painting and sanding work, and a computer with an internet connection to program the microcontroller. Most of the electronic components come from Adafruit. You'll need a Feather RP2040 microcontroller, The NeoKey 5x6 snap-apart Matrix, 8 Cherry-compatible mechanical key switches, a 3.5" Color TFT Display, a pair of Stemma QT Rotary Encoder breakouts, some rotary encoders, and two of prempremthese Illuminated toggle switches. You'll also need some basic hardware.

Bill of Materials

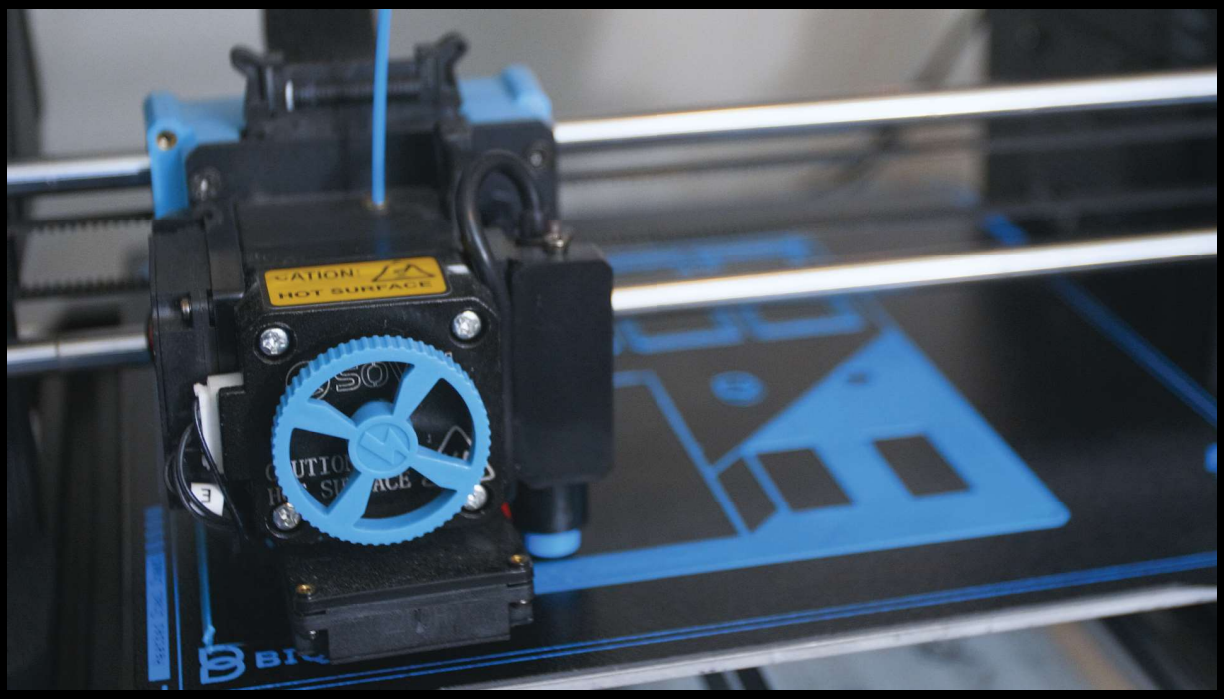
1x	Adafruit Feather RP2040	https://www.adafruit.com/product/4884
1x	3.5" Color TFT Display	https://www.adafruit.com/product/2050
1x	NeoKey 5x6 Snap-Apart Key Matrix	https://www.adafruit.com/product/5157
8x	Cherry MX RGB Key Switches	https://www.amazon.com/dp/B07KMXJ4KG
2x	I2C Stemma QT Rotary Encoder Breakout	https://www.adafruit.com/product/4991
2x	Rotary Encoders	https://www.amazon.com/Cylewet-Encoder-Digital-Potentiometer-Arduino/dp/B07DM2YMT4
2x	Stemma QT Cables	https://www.adafruit.com/product/4399
1x	Illuminated Toggle Switch (Amber)	https://www.digikey.com/en/products/detail/switch-components/RE2-1A-DC-1-AL/11493096
1x	Illuminated Toggle Switch (Red)	https://www.digikey.com/en/products/detail/switch-components/RE2-1A-DC-1-RL/11492770
4x	4mm M3 Machine Screws	https://www.mcmaster.com/94500A262/
10x	6mm M3 Machine Screws	https://www.mcmaster.com/94500A221/
4x	8mm M3 Machine Screws	https://www.mcmaster.com/94500A222/
2x	10mm M3 Machine Screws	https://www.mcmaster.com/94500A223/
6x	Heat-Set Brass Threaded Inserts	https://www.amazon.com/dp/B0BQJ6CRNJ
2x	Potentiometer Knob Caps	https://www.amazon.com/dp/B07FVLVB55
1x	Solder-type breadboard	https://www.adafruit.com/product/723

Necessary Tools:

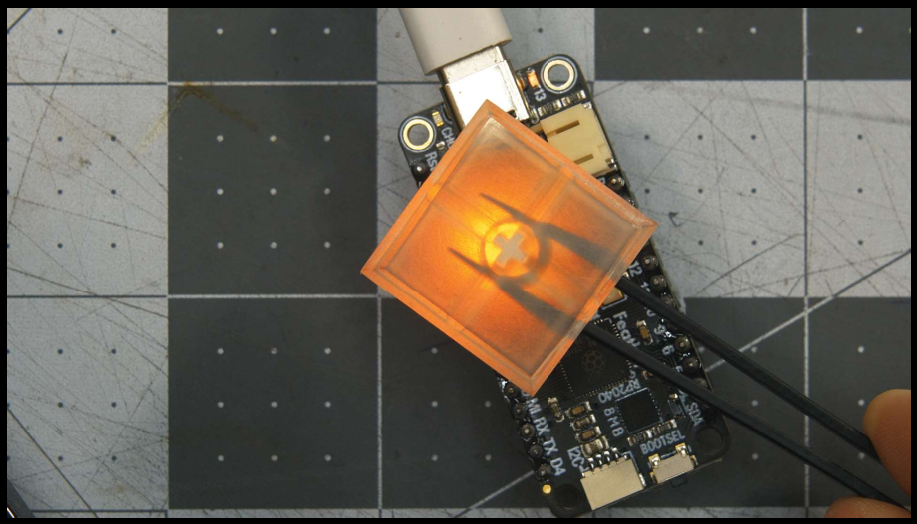
Soldering Iron
FDM 3d Printer
Wire Strippers
Sandpaper
Hot Glue Gun

3D PRINTING

The 3d printed parts will take some time to print, and the parts will help you with the electronics assembly, so it's a good idea to begin here. All of the enclosure parts are printed on an FDM printer with a 220mm square print bed. All parts are printed with a 0.2mm layer height, two outer shell layers and 35% infill.



The key caps were printed on an SLA printer in clear resin. I found it was easiest to print them flat against the build plate. Once they're post-processed, you can give them a light sanding to remove any elephant's foot from the print process. You'll also want to sand them to give them a frosted finish - they should really be translucent without any noticeable scratches - but remember that a Belter's ship should look well worn and well used.

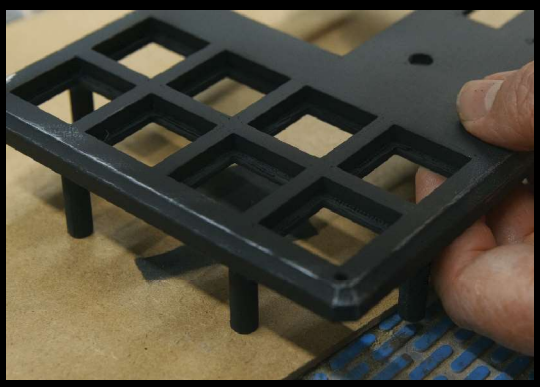


PAINTING AND WEATHERING

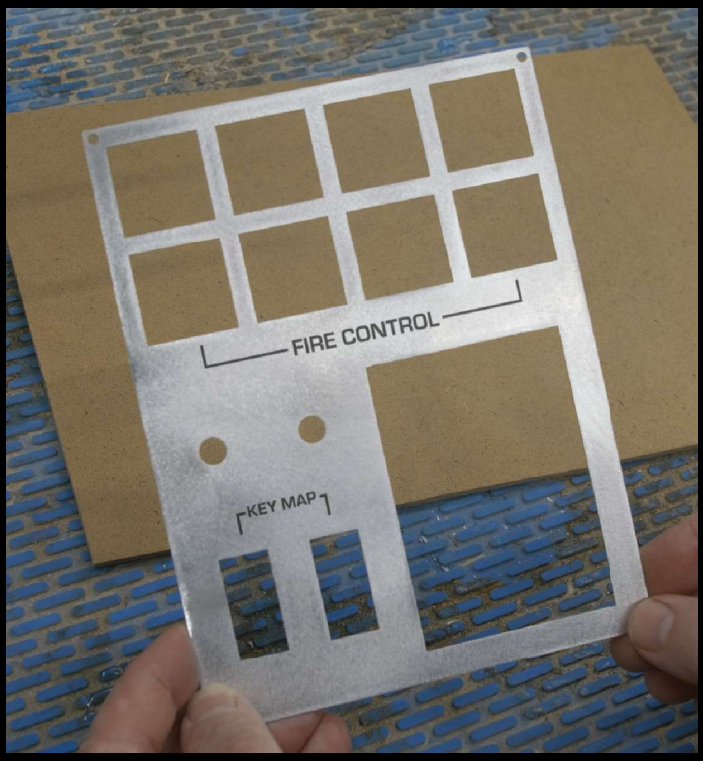
To prepare the pieces for painting, begin by building up light coats with a filler primer. This will eventually coat on fairly thick, and you'll want to sand it down between primer coats. Repeat this process until you can't see any layer lines or other printing artifacts. Don't worry about any ugly details on the top surface of the enclosure, we'll be covering those up later. This is a tedious process, but don't rush it.

When you're feeling ready to add your final coat of primer, take a file and add some wear marks and scratches to the housing. This is an optional step, but a good way to make this your own. Don't worry if you cut all the way down to the printed plastic, the final primer coat will take care of that.

Next, give both housing pieces a few coats of flat black paint. Once that's dry it's time to do some weathering, so it looks like this has been in use for a long time. I've got two different shades of silver model paint. Starting with the darker color and a detail brush, I dab these into the scratches we made before, then add in a few details with the lighter color. Then use a broader brush but wipe most of the paint off of the bristles. Lightly brush against the edges of the enclosure to leave just a little bit of paint behind on the edge. This technique is called drybrushing and it's a good way to make it look like the paint has been worn away from exposed edges. When you're happy with how everything looks, give it a few coats of satin polyurethane finish.

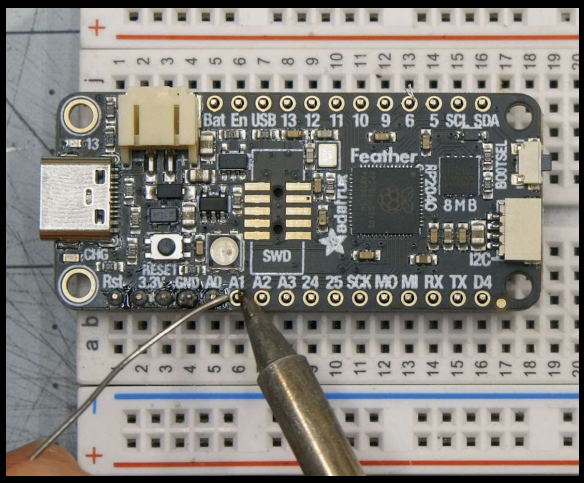


I ordered these aluminum cover plates from SendCutSend. They may be an Earther corporation but they do good work, and an easy way to get custom metal parts made if you can't make them on your own. You can find the vector file I used to make these, or you can print up a template to make your own out of thin aluminum. I'm giving them a quick sanding with 220 grit to give them a nice finish and knock down any burrs. Then I'm using a vinyl stencil to add some labels and sealing them with the same polyurethane finish.

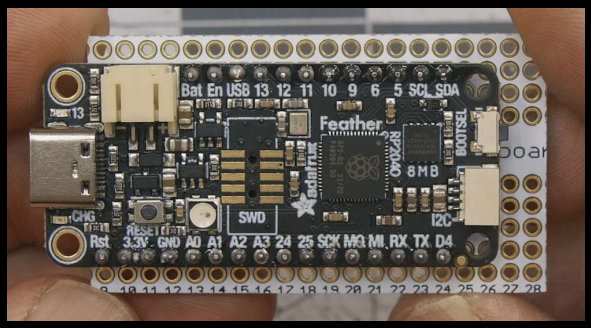


ELECTRONICS

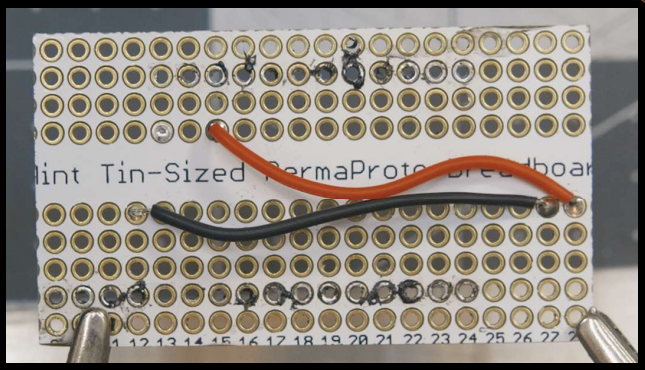
Start the electronics assembly by preparing the Feather RP2040. Solder on the header pins that are provided with it. If you have a solderless breadboard, it will help you keep them aligned. Now we'll need to set it up or Circuit Python. Go to circuitpython.org and download the current UF2 file for the Feather RP2040 (https://circuitpython.org/board/adafruit_feather_rp2040/). Connect the board to your computer using a usb-C cable. Reset the board by holding down the Boot Select button while pressing reset. You should see a new drive appear. Copy the UF2 file into that drive and let it reboot. It should now appear as a circuitpython drive. You can unplug the board for now.



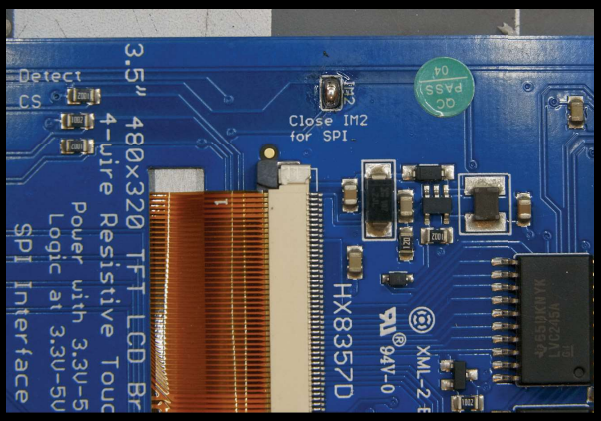
Next we'll need to set up our solder-type breadboard. This is a board that we can use to connect all of our components to the Feather. It has built-in connections for each row on the circuit board. We also need to create a power and ground rail using this board. Place the Feather into the board. The board is much larger than we need, so you can cut down the board to the size you see here.



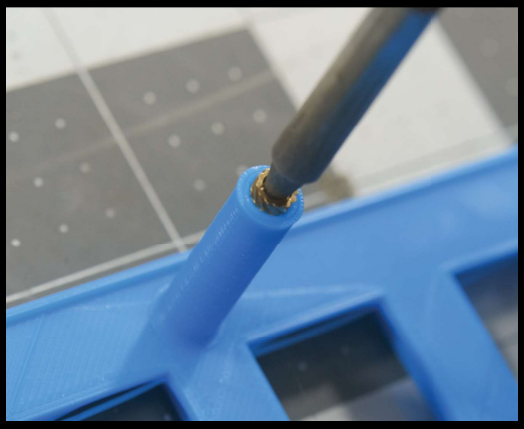
Note which rows the Ground and USB pins connect to. We'll need to solder on some wires that will connect these rows to a power and ground rail towards the bottom of the board. These wires will be underneath the board once it's soldered in place, and won't be accessible afterwards, so make sure they're lined up correctly before soldering. Trim off the header pins so they're flush with the underside of the board.

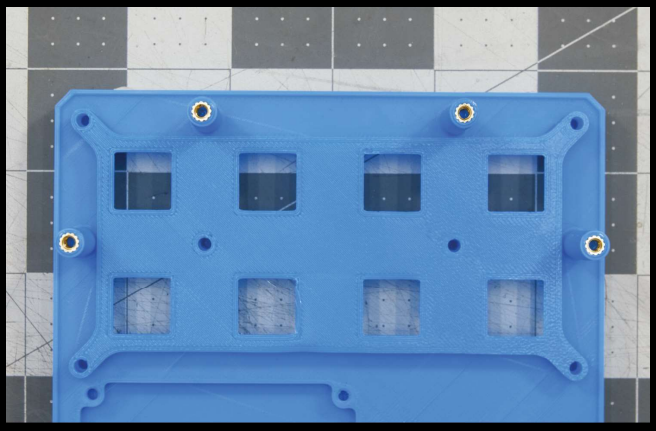


Prepare the TFT Color display ready by soldering some lengths of wire to the ground, 5 volt, Clock, MISO, MOSI, CS, DC and Reset pins. Leave these a little long, around 5-6". we can trim them down later. Also solder this pad to make sure that SPI mode is enabled for the display.

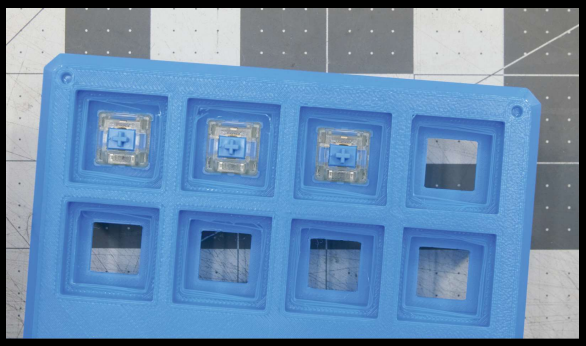


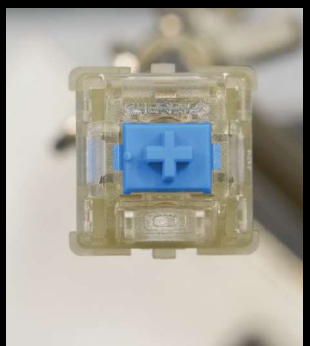
Take the top of the enclosure and place it face down on your work surface. You'll want to set six threaded inserts into each of these stems. Heat up your soldering iron and place an insert at the top of the stem. Use your soldering iron to heat up the insert, placing light pressure on it until it melts into the 3d printed part.



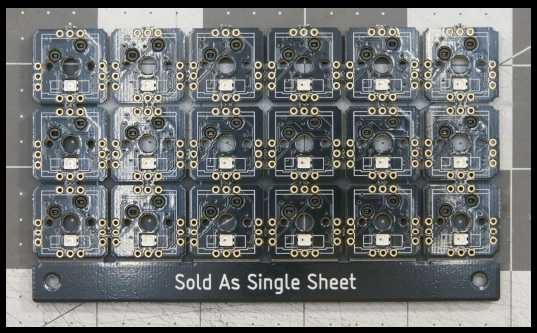


Place the Key Switch Mounting plate as you see in the above photo. Attach it in the four outermost corners using four 8mm m3 screws. Flip the part over and insert the key switches. I'm using RGB Cherry MX Blue Switches, but the important thing is that you align the switches correctly. The pins should be at the top and the LED window at the bottom. Snap all eight of them into place.

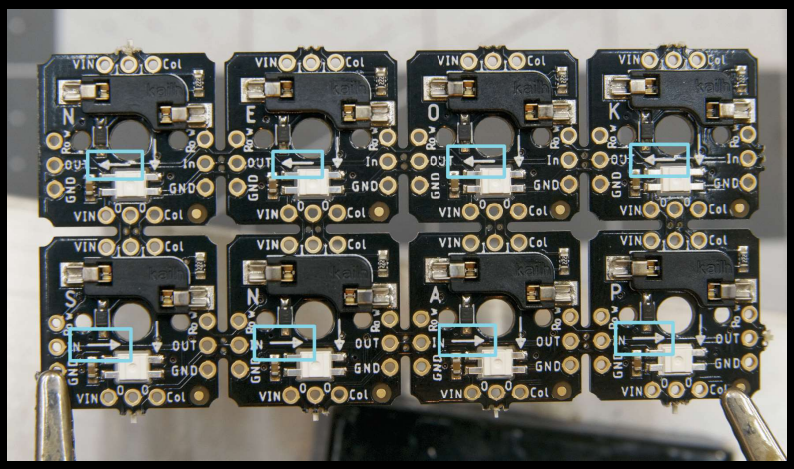


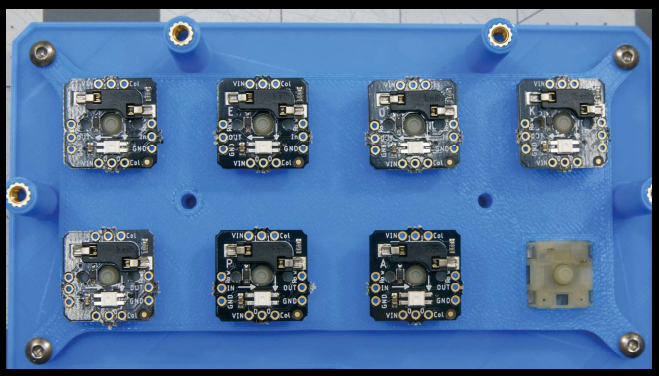


The Interface for the key switches is provided by this NeoKey 5x6 Snap-apart Matrix. This is a grid of key switch interfaces you can use to create a macro pad or keyboard, any size you like. We're going to be creating a keypad that is four keys wide and 2 keys tall. Use a pair of pliers or your hands to snap the boards apart.

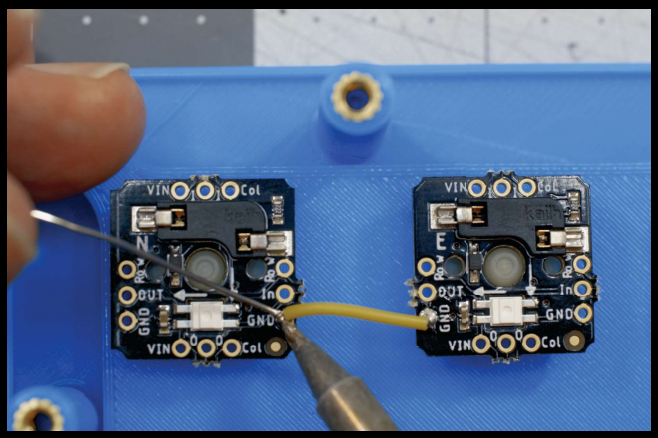


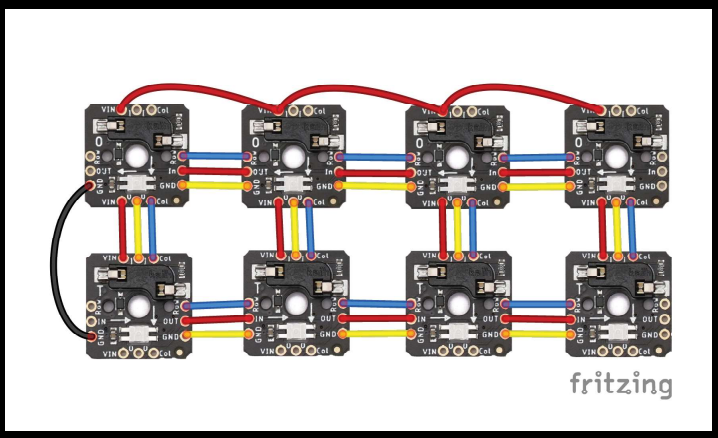
Because of the size of our key caps, we actually need to break these down into their individual keys. But pay attention to the direction of these arrows! Each one on the top row need to be pointing left, and the bottom should all be pointing right. This refers to the data routing of the RGB LEDs in the matrix. If they're not aligned correctly, your LEDs won't light up.



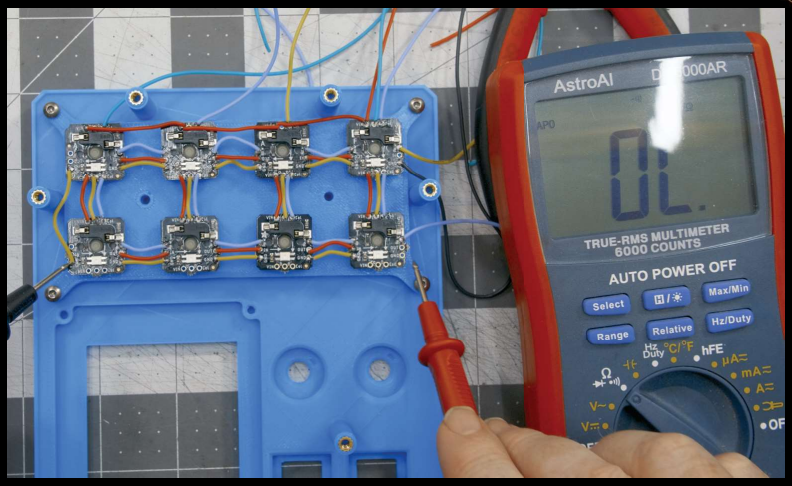


Once they're all apart, we need to solder them back together. Snap them into place on the pins of the key switches. You'll need to re-solder the wire connections, both horizontally and vertically between each key pad. You'll also need to connect each of the ViN connections along the top row, and the ground connections on the left side. This will take a while. Be patient, listen to a good audio book and take your time.

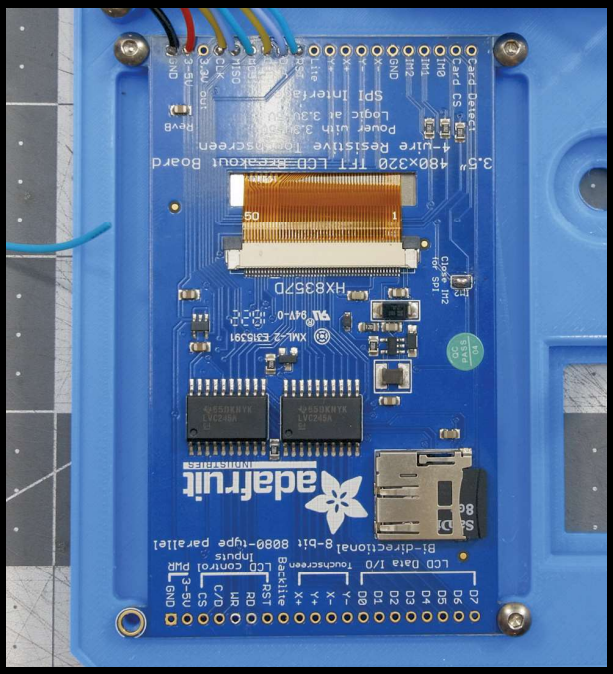




When you're done, put your multimeter into continuity mode and check your wire connections. Inyalowda who don't double check their wiring end up outside, sasa ke?

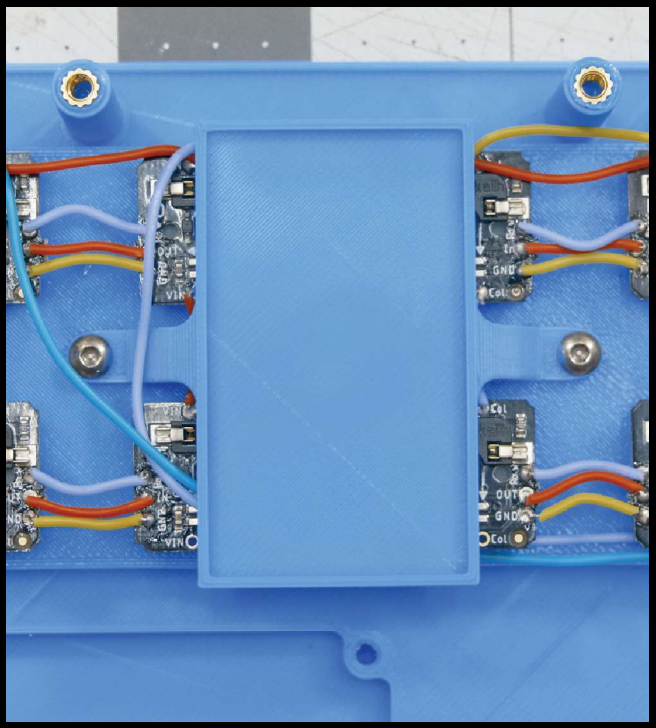


Now we need to prepare the keypads to be wired to the controller. Like we did with the display, solder some lengths of wire with plenty of slack to the Data In pin, each of the column pins on the top row, the two row pins on the right side, and the power and ground pins.

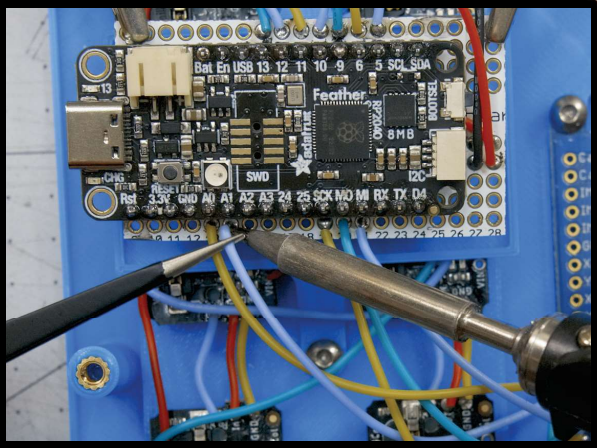


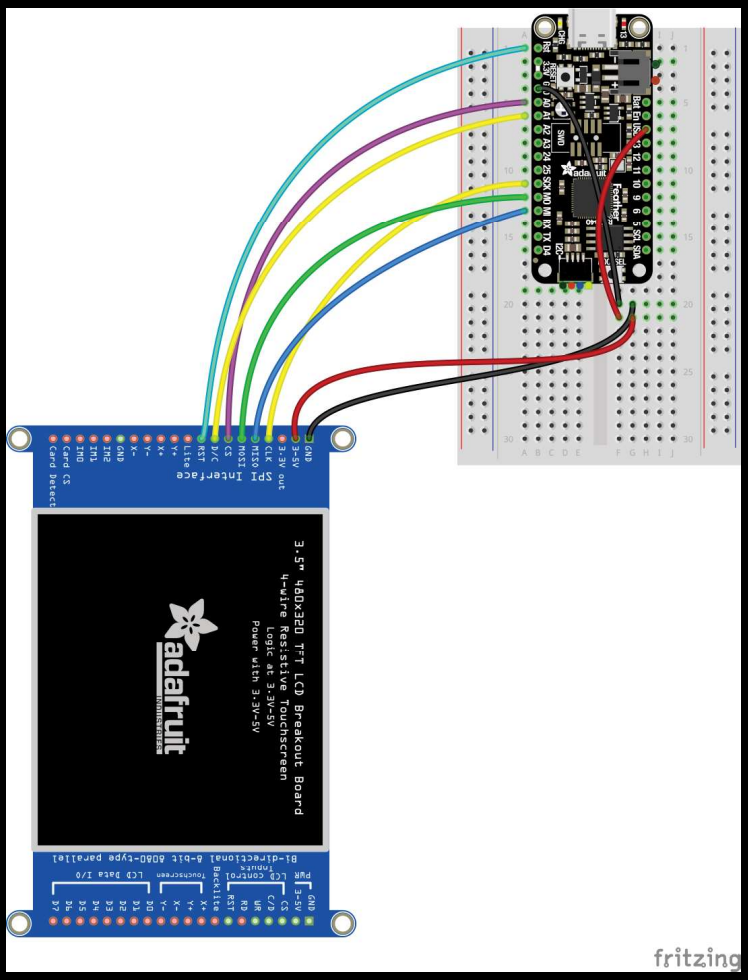
Attach the screen to the enclosure top using 6mm M3 screws, making sure your soldered connections are facing upwards.

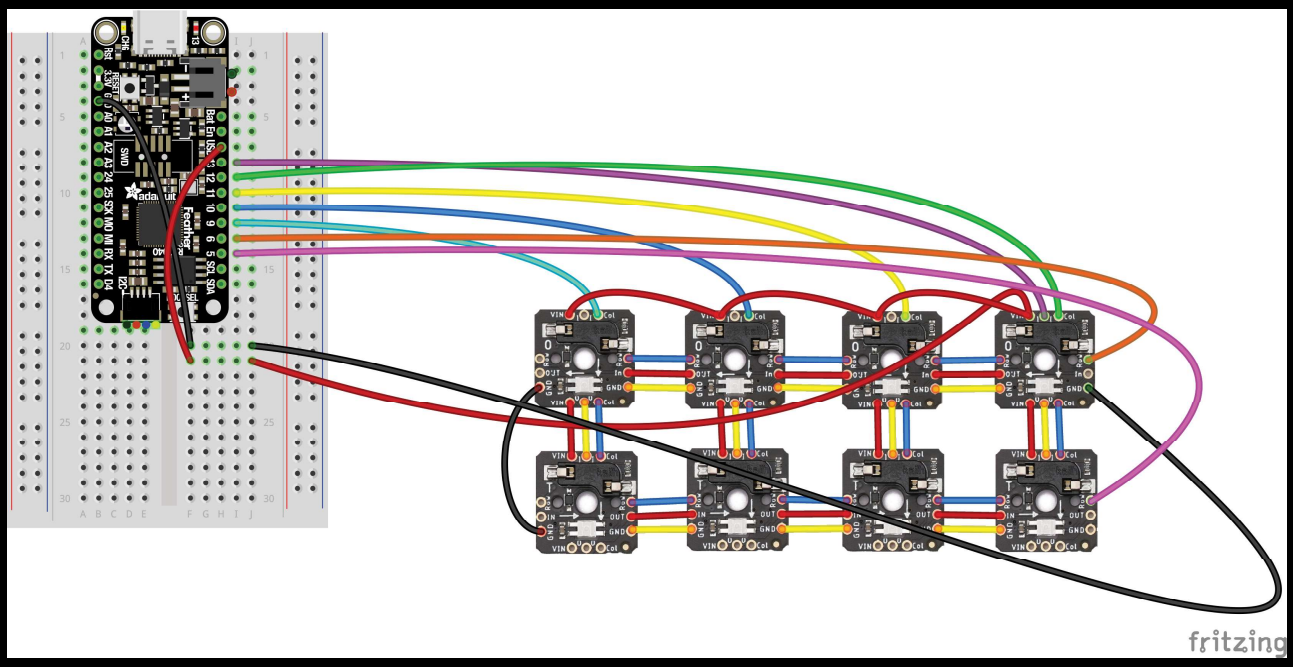
This feather mount might be a tricky print. It should print in this orientation and it will need a good amount of support material. Mount it in place, making sure it isn't pinching any wires, using a pair of 10mm M3 screws.



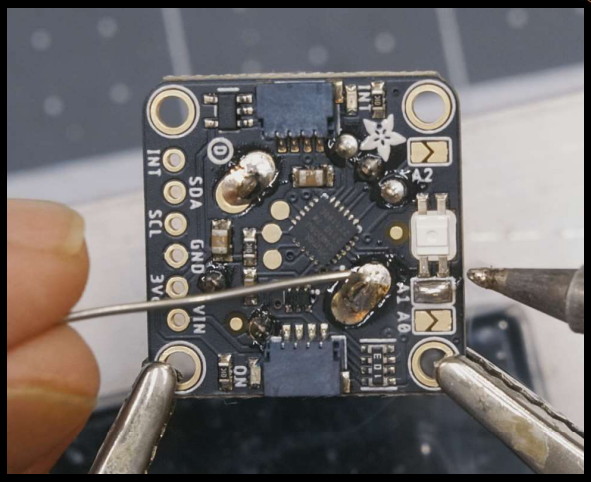
Use a 3rd hand tool to hold the feather just above the 3d printed feather mount. While it's suspended in place, trim each of the connecting wires for the screen and key matrix, and then solder them to their corresponding pins on the breadboard. Refer to the provided wiring diagrams so see where everything should connect to the Feather RP 2040.



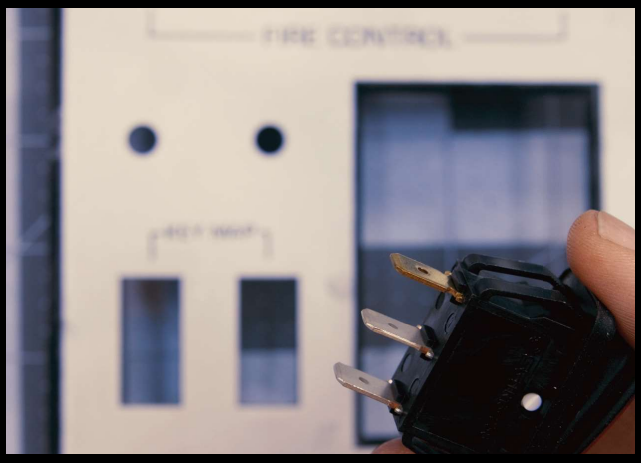


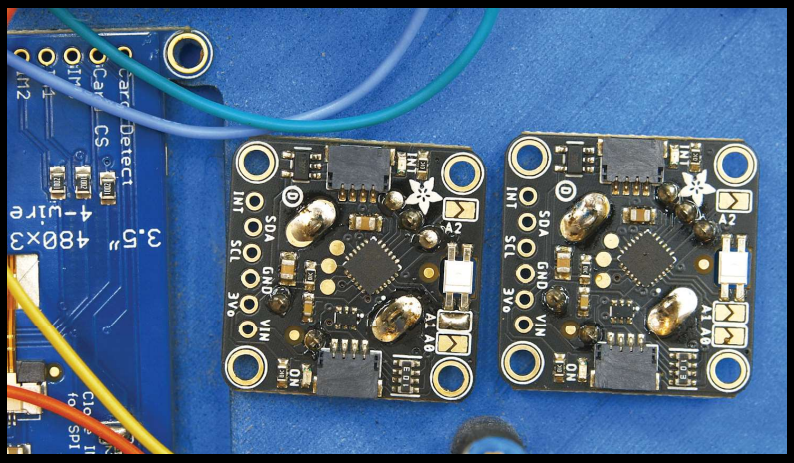


Solder two rotary encoders to the two Stemma QT rotary encoder breakouts. On only one of them, place some solder across the A1 solder pad. This will make sure they have different i2c addresses.

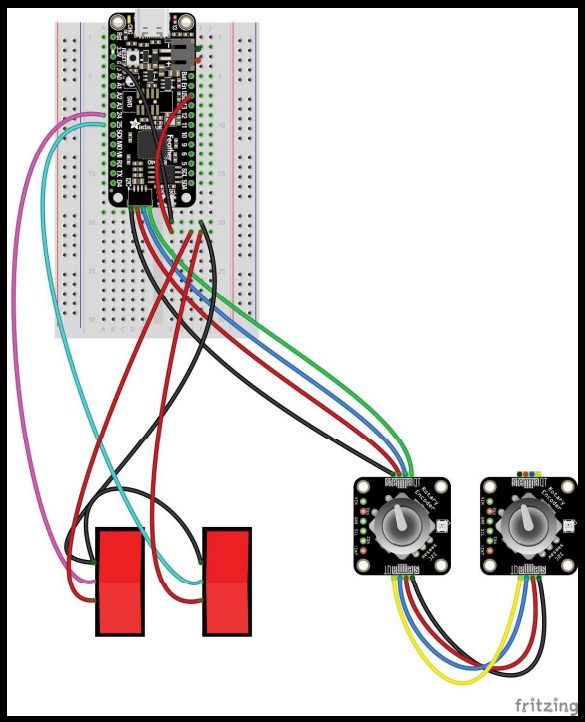


Attach the cover plate to the enclosure top using four, 4mm M3 screws. Making sure that the one gold pin is facing upwards, snap the two toggle switches into their mounting holes. Then, using their washers and retaining nuts, attach the two rotary encoders in their mounting holes. The one with the soldered address pad should be closer to the screen, and the Stemma connectors should be arranged vertically. Use the short stemma connectors to connect the two rotary encoders together, and to the Feather.





Wire up the two switches to ground, power and pins 24 and 25 on the feather. Trim off any loose wires off of the back of the circuit board, and secure it in place with a few blobs of hot glue.



Your hardware is now complete. Feel free to attach the bottom enclosure, or if you'd prefer to do the final steps with everything still exposed, you can print up a few standoff feet to make sure everything is clear of your work surface.

Connect the macropad to your computer again using a USB-C cable. Download the project bundle and copy the entire contents to the CircuitPY drive, overwriting any file duplicates. You should see the board and screen reboot as our macro pad.

To change the key mappings and labels, open the code.py file in any text editor - or download the Mu IDE for circuitpython for an easier experience. You should see the tables for each of the key mappings. When you're ready to dig deeper into the code, you can program in your own key macros, or access mouse or media control functions. Circuit Python is well documented and there's a ton of community resources. If you ever mess anything up, just download the project bundle and copy the files back over to reset the device.

Also you should know that there is a known bug with circuit python devices and the 3d printing software Cura. Cura will attempt to communicate with the device as if it were a 3d printer, and this can cause it to crash. Be sure to close cura when you're using it.

I hope you've enjoyed this build video and that you'll be inspired to build your own macro pad. If you do, be sure to share it with The Expanse community. I can't wait to see it - the more you share, the more your bowl will be plentiful.

HELPFUL LINKS

https://learn.adafruit.com/welcome-to-circuitpython
https://learn.adafruit.com/numpad-4000-mechanical-keyswitch-data-entry-device
https://learn.adafruit.com/adafruit-neokey-5x6-ortho-snap-apart
https://learn.adafruit.com/deluxe-4x4-neopixel-neokey-keypad