Birch Sliding USB Joystick
MAKER GUIDE

Overview

This document contains the necessary information to build the Birch Sliding USB Joystick, including a customization guide, 3D printing guide, assembly guide, and instructions to test the finished joystick.

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Makers Making Change
A Neil Squire Program

Contents

Maker Checklist

This list provides an overview of the steps required to build and deliver the device.

Maker To Do List

- ☐ Read through the Maker Guide to become familiar with required components, tools, supplies, safety gear, and overall assembly steps.
- ☐ Verify the user wants a USB joystick and ask the user if they would if they have a device to connect the joystick to.
    - Xbox Adaptive Controller
    - PC (for gaming)
- ☐ Ask the user if they would like any joystick toppers.
- ☐ Ask the user if they would like a specific mounting solution.
- ☐ Talk to User about customization options (e.g., colour, any special requests, etc.).
- ☐ Order hardware components.
- ☐ 3D print all 3D printed components.
- ☐ Gather tools, supplies, and safety equipment.
- ☐ Assemble the device.
- ☐ Test device.
- ☐ Print “User Guide”

Items to Give to User

- ☐ Assembled, tested device
- ☐ USB cable
- ☐ Any joystick toppers if requested.
- ☐ Any mount adapters if requested.
- ☐ “User Guide”

Tool List

- Flush Cutters
- Wire Strippers
- Soldering Iron
- Philips Head Screwdriver

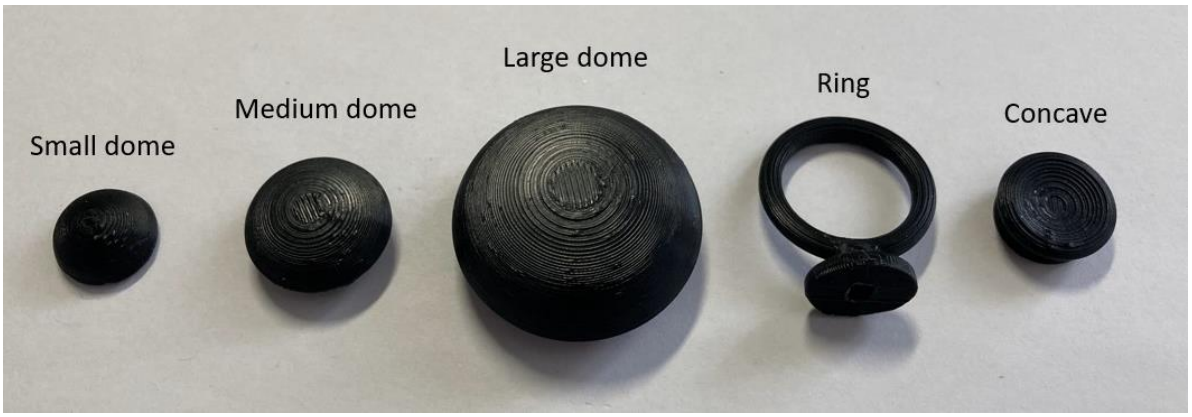
Customization Guide

Joystick

The enclosure can be printed in the user's desired colour(s). Colour swaps can be done to further customize the joystick and make the forward arrow on the top stand out more.

Toppers

3D printed joystick toppers can be added to the joystick. Current topper type include the small dome, medium dome, large dome, ring, and concave (shown left to right). These toppers can also be modified through the original design files.



Mounting

Mount adapters can be added for custom mounting solutions. Current mounting options include nonslip pads, hook and loop fastener, a ¼-20 camera mount adapter, and a RAM-B mount adapter.

3D Printing Guide

3D Printing Summary

Metrics	Joystick housing only (No optional prints)	All files including optional prints
Total Print Time (h:min)	3:11	5:33
Total Number of Components	4	10
Typical Total Mass (g)	27.7	45.9
Typical Number of Print Setups	1	1

3D Printing Settings

Joystick Enclosure - REQUIRED

Print File Name	Qty	Total Print Time (hr:min)	Mass (g)	Infill (%)	Support (Y/N)	Layer Height/ Nozzle Diameter(mm)	Notes (orientation, special settings, etc.)
Birch_Enclosure_ Bottom	1	1:46	14.9	20	N	0.2/0.4	
Birch_Enclosure_Top	1	1:07	10.6	20	N	0.2/0.4	
Inner_cover_disk	1	0:04	0.5	20	N	0.2/0.4	
Overlay	1	0:14	1.7	20	N	0.2/0.4	

Toppers and Mount Adapters* - OPTIONAL

Print File Name	Qty	Total Print Time (hr:min)	Mass (g)	Infill (%)	Support (Y/N)	Layer Height/ Nozzle Diameter(mm)	Notes (orientation, special settings, etc.)
Joystick_Camera_ Mount_Adapter	1	0:54	8.5	20	Y	0.2/0.4	
Joystick_RAM_B_ Mount_Adapter	1	1:01	9.3	20	Y	0.2/0.4	
Birch_Topper_Small_ dome	1	0:08	0.6	20	N	0.2/0.4	
Birch_Topper_ Medium_dome	1	0:17	1.7	20	Y	0.2/0.4	
Birch_Topper_Large_ dome	1	0:37	4.9	20	Y	0.2/0.4	
Birch_Topper_Ring	1	0:16	1.5	20	Y	0.2/0.4	Print with ring parallel to print bed
Birch_Topper_ Concave	1	0:10	1.0	20	N	0.2/0.4	

Post-Processing

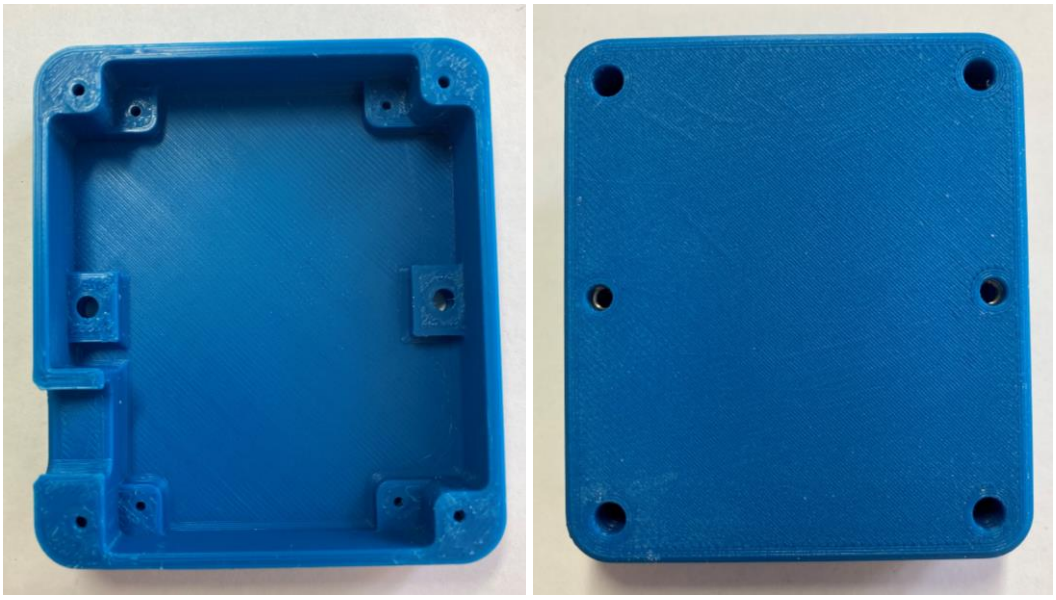
- Remove any bumps or zits from the surface where the enclosure meets the lid.
- Remove any bumps or zits from both surfaces of the inner cover disk. If any binding occurs between the joystick and the inner cover disk when assembling, sand down this part.
- Remove any supports from camera mount or toppers if printed.

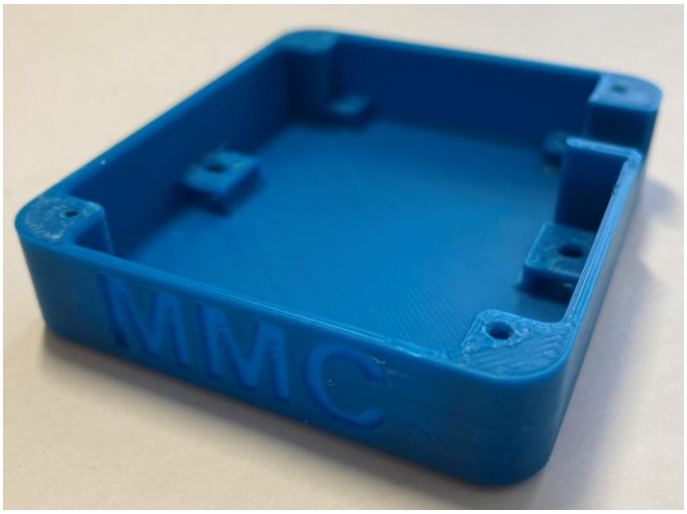
Customization Options

- Joystick housing can be printed in multiple colours.
- The joystick camera mount adapter is an optional add-on for mounting using ¼-20 threads
- The optional topper prints can customize the joystick for different users

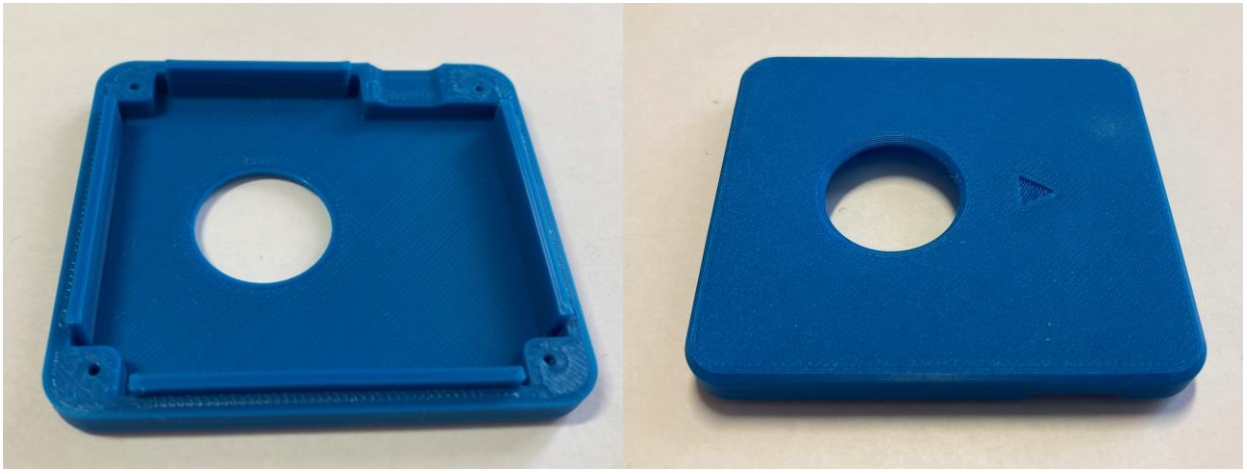
Examples of Quality Prints

Birch_Enclosure_Bottom

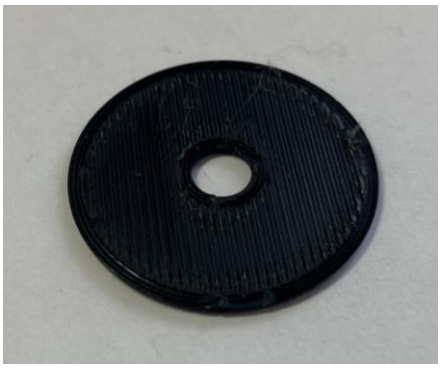




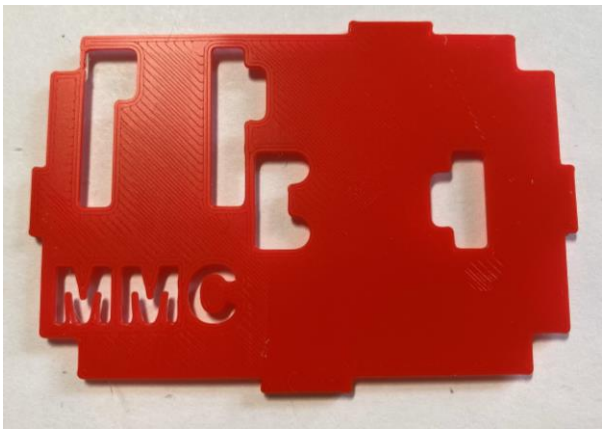
Birch_Enclosure_Top

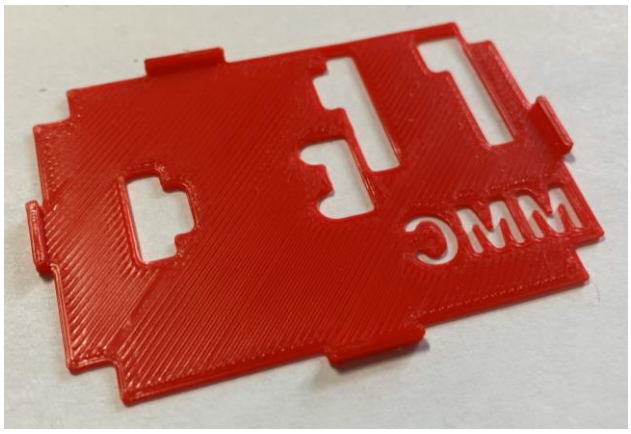


Inner_Cover_Disk

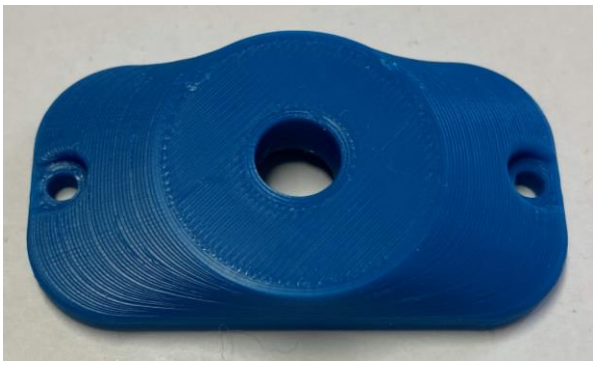


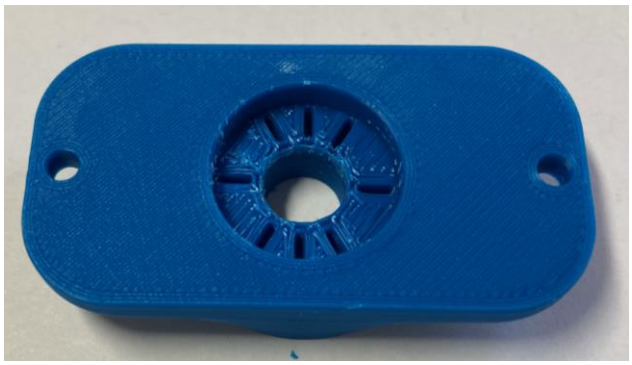
Overlay



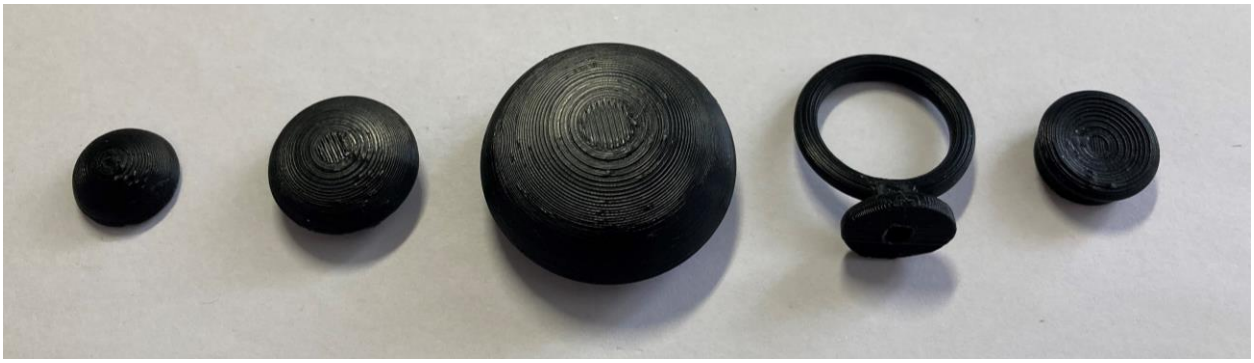


Joystick Camera Mount Adapter



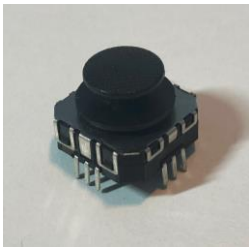
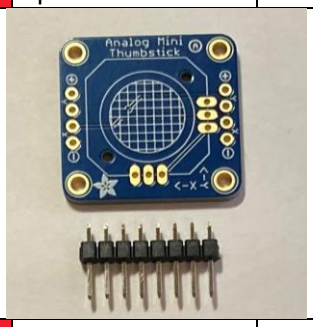
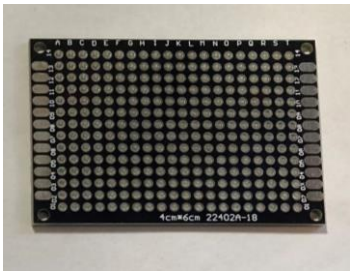
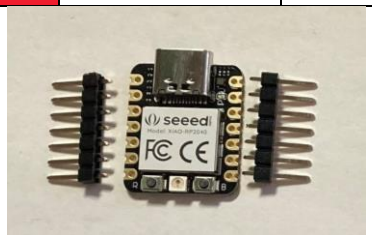
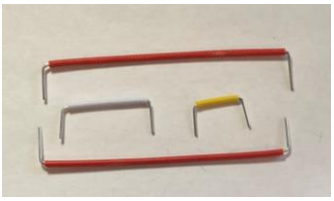
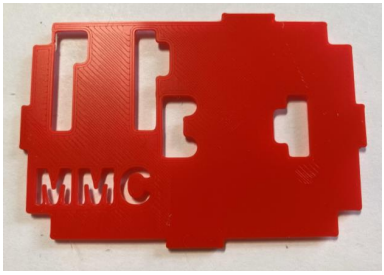


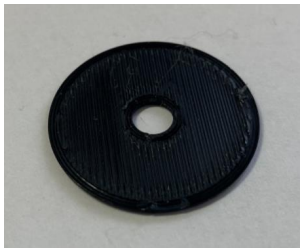
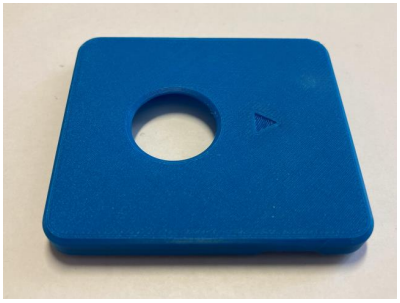
Joystick toppers



Assembly Guide

Required Components

1	Mini 2-Axis Analog Thumbstick	QTY 1	**2**	Mini Thumbstick Breakout Board with included 8 pin male header	QTY 1	**3**	Universal Proto-Board PCB 4cm x 6 cm	QTY 1
								
4	SeeedStudio XAIO RP2040 with Included male headers	QTY 1	**5**	24 Gauge Wire or Protoboard Jumper Wires	20 cm	**6**	M2 x 6 mm Self Tapping Screws	QTY 8
 *Note: (do not use SAMD substitute)								
7	M3 Hex Nuts	QTY 2	**8**	USB-C Cable	QTY 1	**9**	3D Printed Overlay	QTY 1
								

10	Birch Inner Disk	QTY 1	11	Birch Enclosure Bottom	QTY 1	12	Birch Enclosure Top	QTY 1
								

Required Tools

- Flush Cutters
- Wire Strippers
- Soldering Iron
- Philips Head Screwdriver

Required Personal Protective Equipment (PPE)

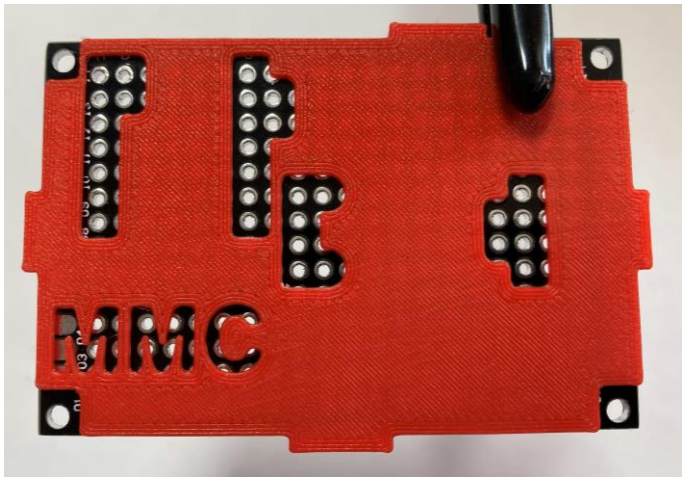
- Safety goggles

Joystick Assembly

Step 1: Position the overlay

Place the 3D printed overlay on the protoboard.

Ensure the text “MMC” is in the same orientation as the text on the protoboard.



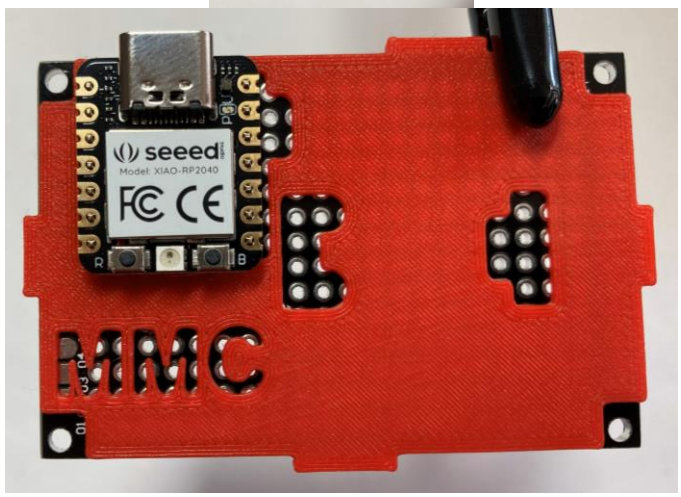
3
9

Step 2: Position microcontroller headers

Place the two 7 pin male headers on the protoboard through the overlay from the top and place the XIAO microcontroller board on the headers.

Ensure the USB port on the XIAO is oriented towards the nearest edge on the protoboard.

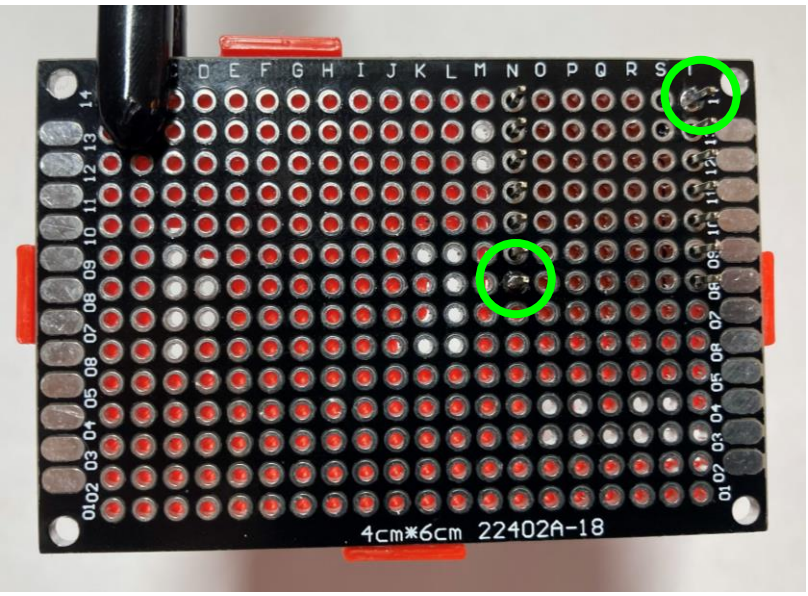
4



Step 3: Solder two header pins to board

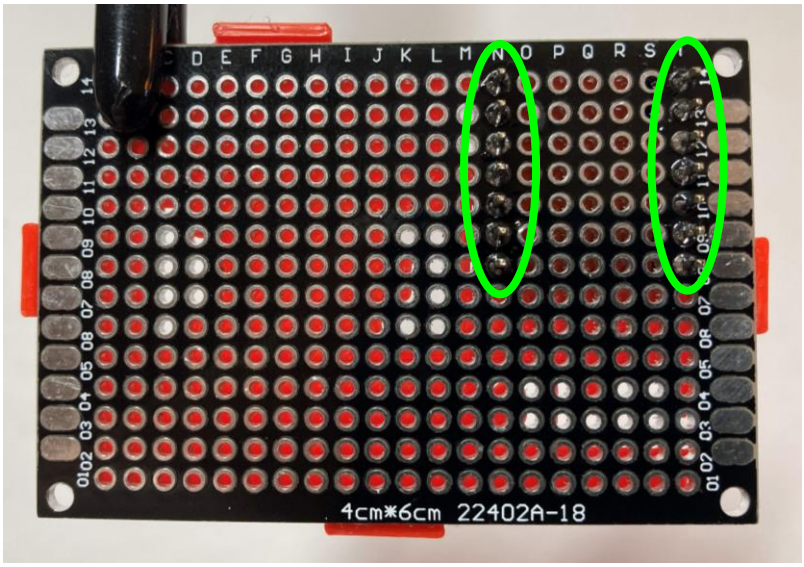
Solder one pin on each of the headers to the protoboard, ensuring the XIAO microcontroller board remains flat and straight.

Note: the header pins from the XIAO board should be located at positions N08 – N14 and T08 – T14 (from below).
(This only applies if the numbering on your board matches the photo)



Step 4: Solder remaining header pins to board

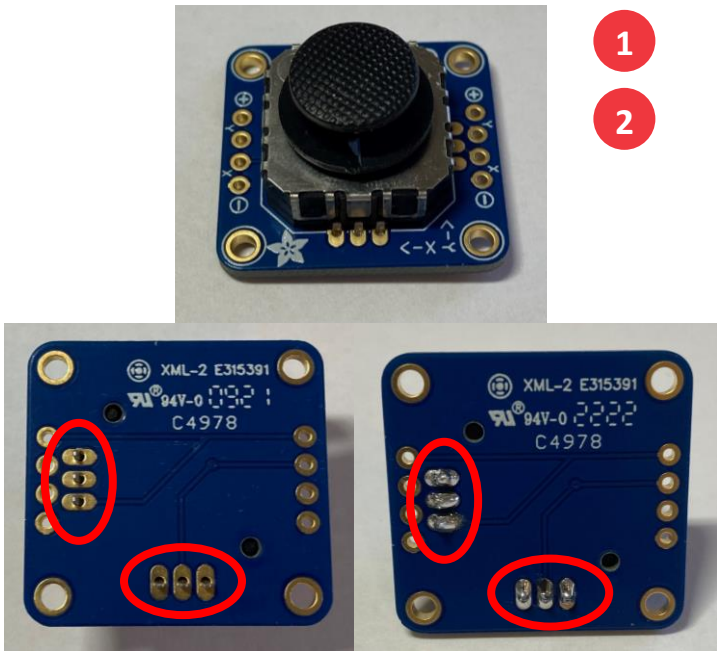
Solder the remaining pins from the XIAO board to the protoboard.



Step 5: Solder joystick to breakout board

Insert the mini 2-axis analog thumbstick into the breakout board.

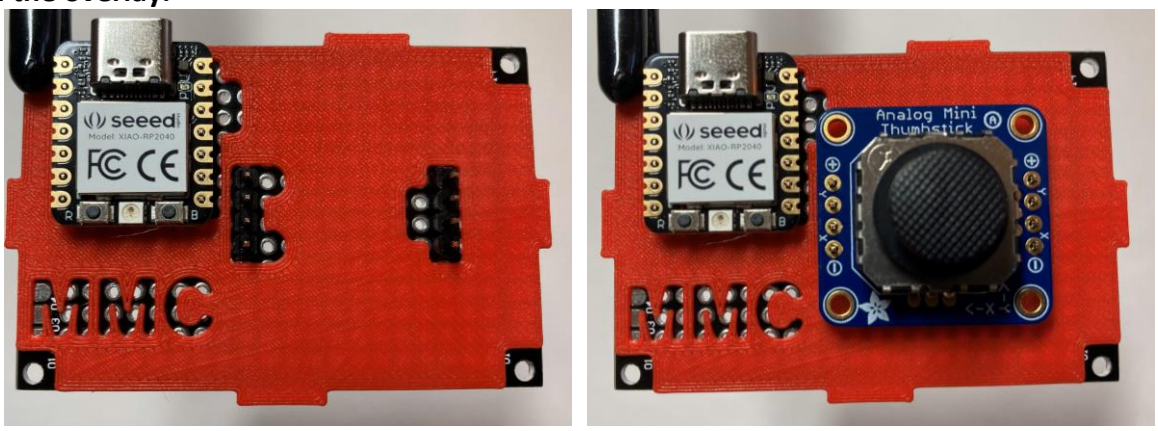
Solder the 6 pins, shown circled in red.



Step 6: Position joystick headers

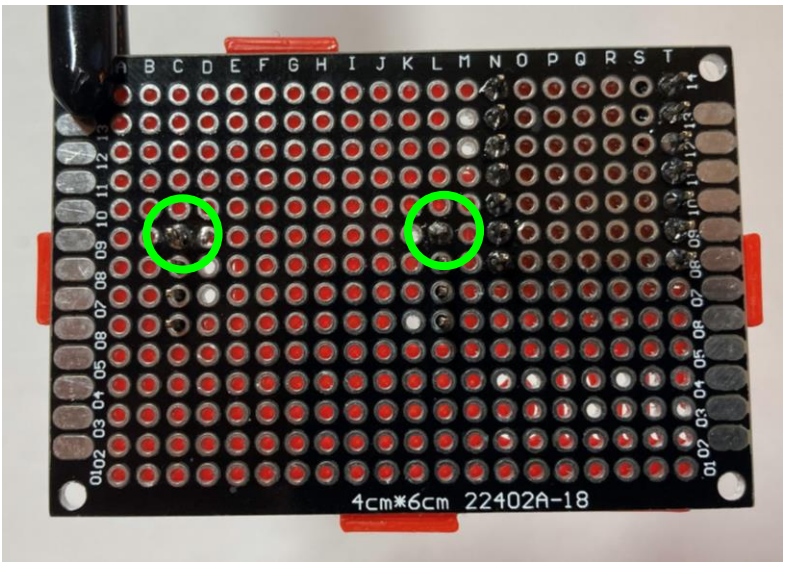
Place the two 4 pin male headers on the protoboard through the overlay and place the joystick breakout board on the headers. If you have an 8 pin male header, gently break apart into two 4 pin headers, and then place headers onto the protoboard.

Ensure the breakout board is text side up and the text is in the same orientation as the text on the overlay.



Step 7: Solder two header pins to board

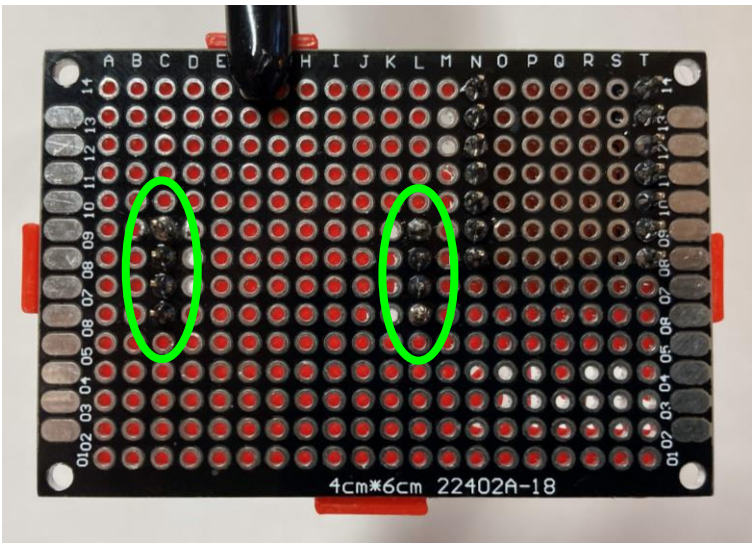
Solder one pin on each of the headers to the joystick breakout board, ensuring the board remains flat and straight.



Note: the header pins from the joystick breakout board should be located at positions C06 - C09 and L06 – L09 (from below).
(This only applies if the numbering on your board matches the photo)

Step 8: Solder remaining header pins to board

Solder the remaining pins from the joystick breakout board to the protoboard.

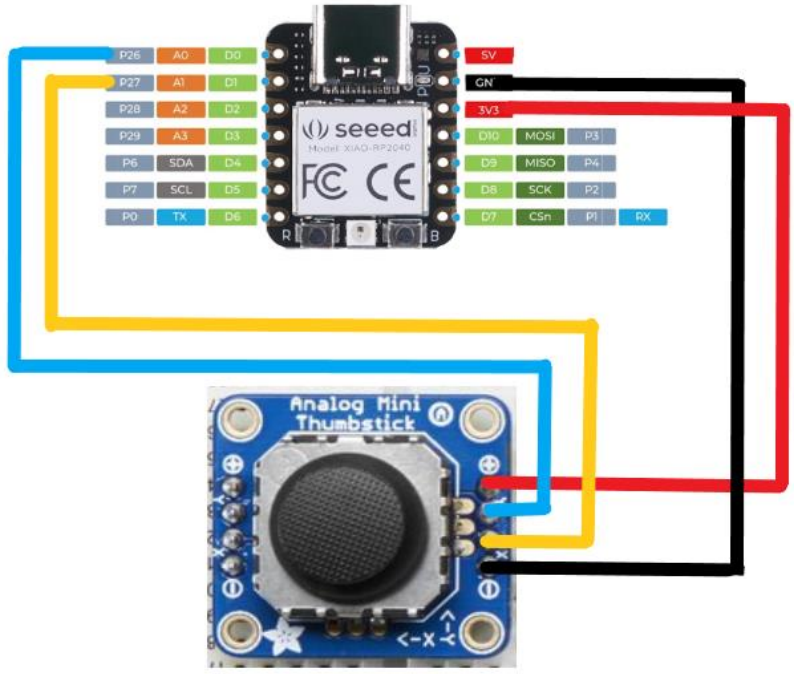


Step 9: Remove joystick and microcontroller

Flip the board around and remove the joystick breakout board and the XIAO board from the headers.

Wiring

For the next steps, this is the overall wiring diagram.



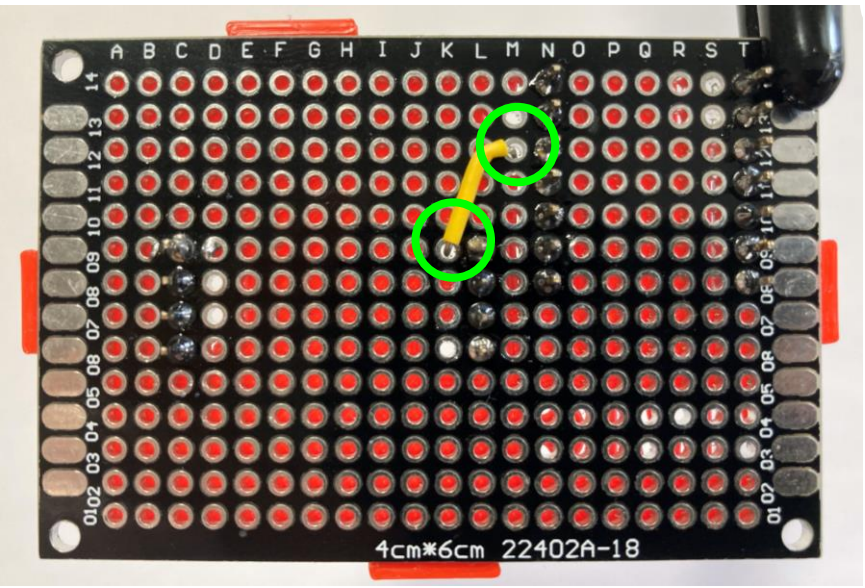
Seeed XIAO baord	Joystick breakout board
3v3	+
GND	-
D0	Y
D1	X

Step 10: Position first wire

Insert a wire from hole M12 to hole K09.

NOTE: All hole positions are in reference to the bottom of the board.

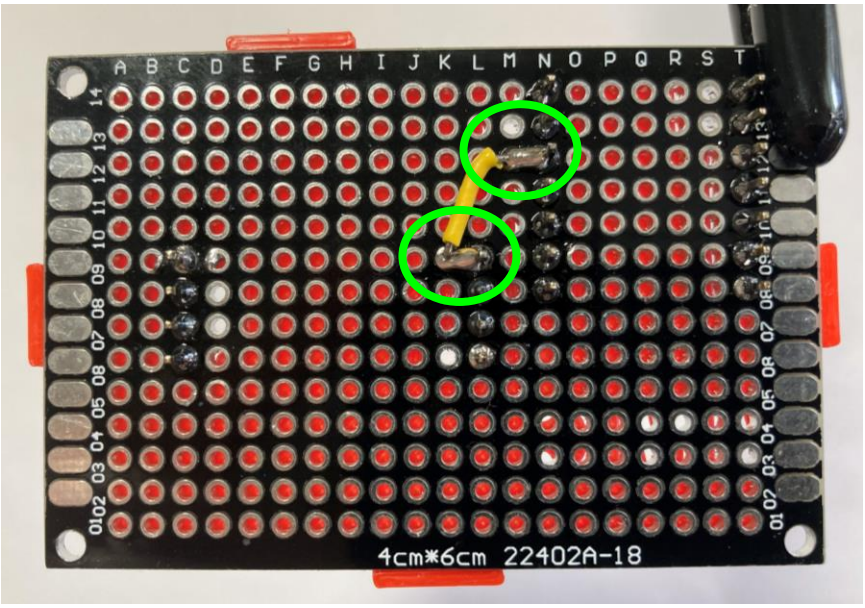
If the numbers and letters on your protoboard don't match this photo go from the holes next to: Joystick board, right header, top pin **TO** *XIAO board, left header, 3rd pin from top.*



Step 11: Solder first wire

Solder the wire in place and create solder bridges from the wire ends to the adjacent pins. From M12 to N12, from K09 to L09.

If the numbers and letters on your protoboard don't match this photo, go from your new wire to the pin directly to the right.

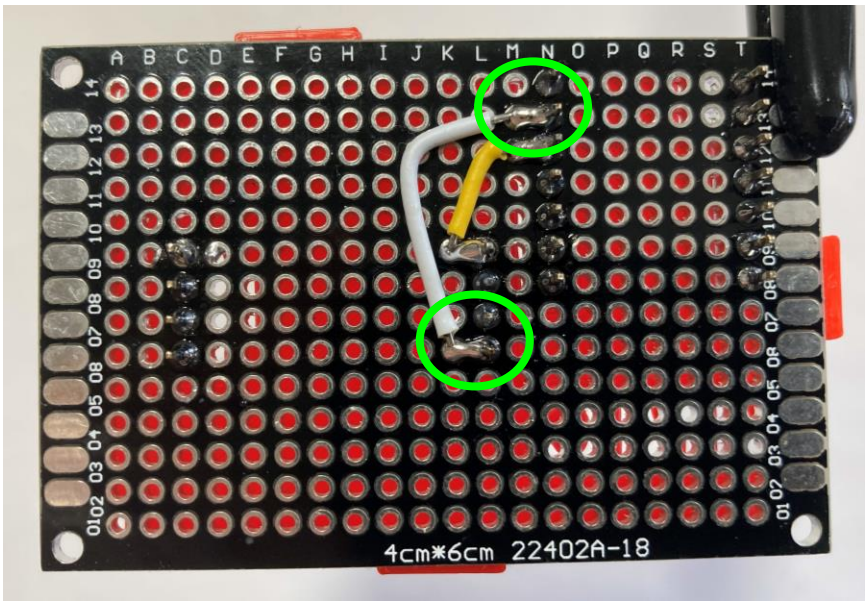


Step 12: Position and solder second wire

Insert a wire from M13 to K06.

Solder the wire in place and create solder bridges from the wire ends to the adjacent pins. From M13 to N13 and from K06 to L06.

If the numbers and letters don't match this photo go from the holes to the left of: Joystick board, right header, bottom pin **TO** *XIAO board, left header, 2nd pin from top.*

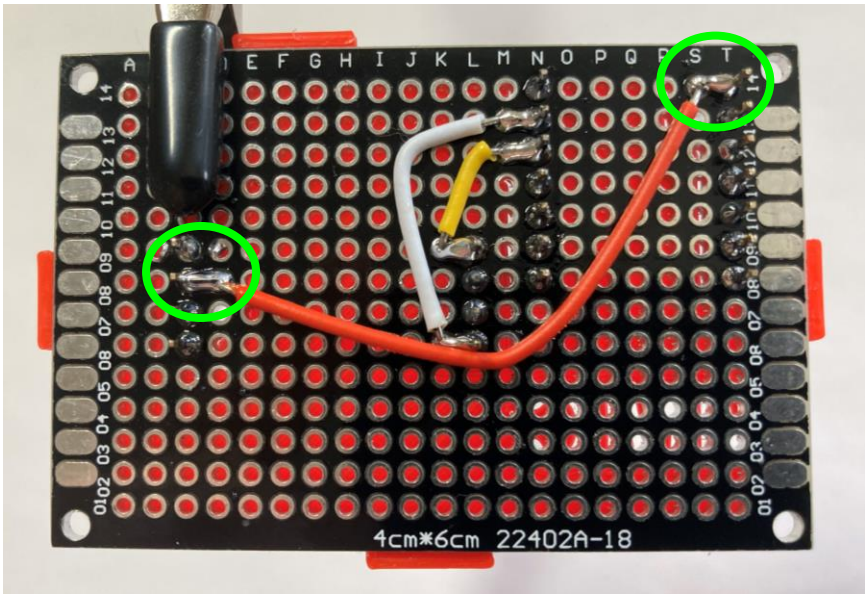


Step 13: Position and solder third wire

Insert a wire from S14 to D08.

Solder the wire in place and create solder bridges from the wire ends to the adjacent pins. From S14 to T14 and from D08 to C08.

If the numbers and letters don't match this photo go from the holes next to: Joystick board, left header, 2nd pin from top **TO** *XIAO board, right header, top pin.*

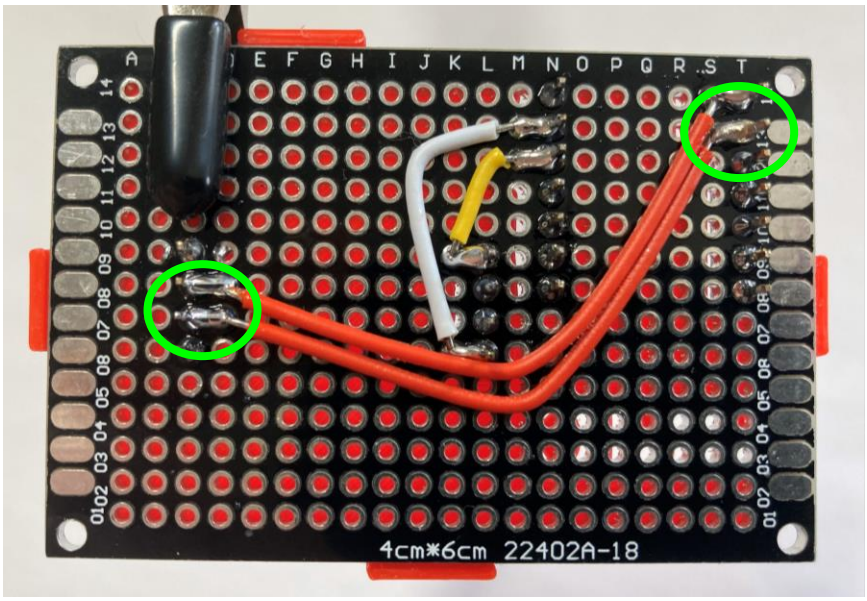


Step 14: Position and solder fourth wire

Insert a wire from S13 to D07.

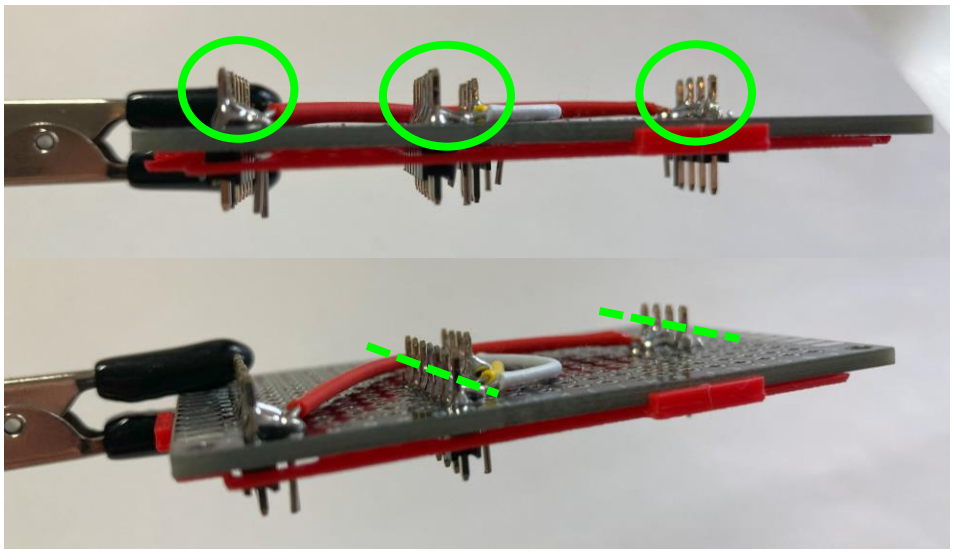
Solder the wire in place and create solder bridges from the wire ends to the adjacent pins. From S13 to T13 and from D07 to C07.

If the numbers and letters don't match this photo go from the holes next to: Joystick board, left header, 3rd pin from top **TO** *XIAO board, right header, 2nd pin from top.*



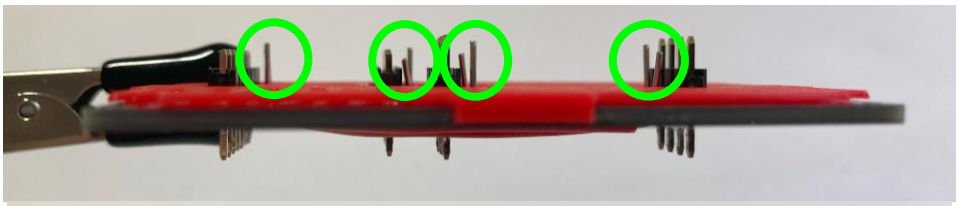
Step 15: Trim pins on the bottom of the board

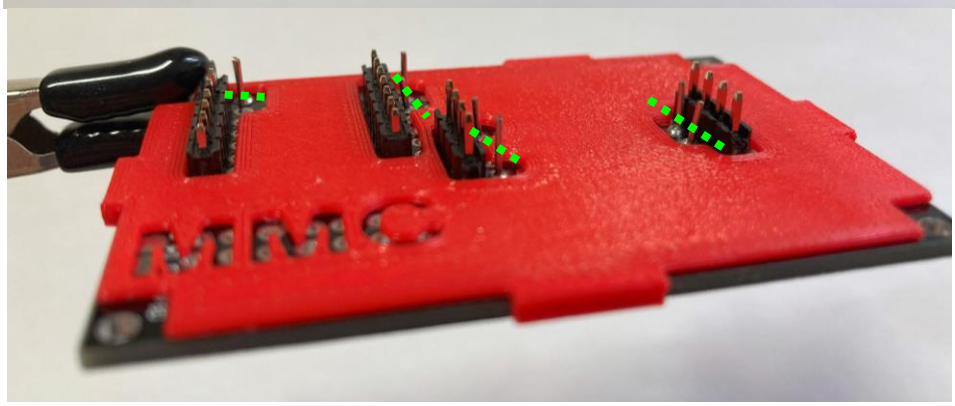
On the bottom of the board, trim the header pins for both the joystick board and the XIAO board, as shown circled in green.



Step 16: Trim excess wire on the top of the board

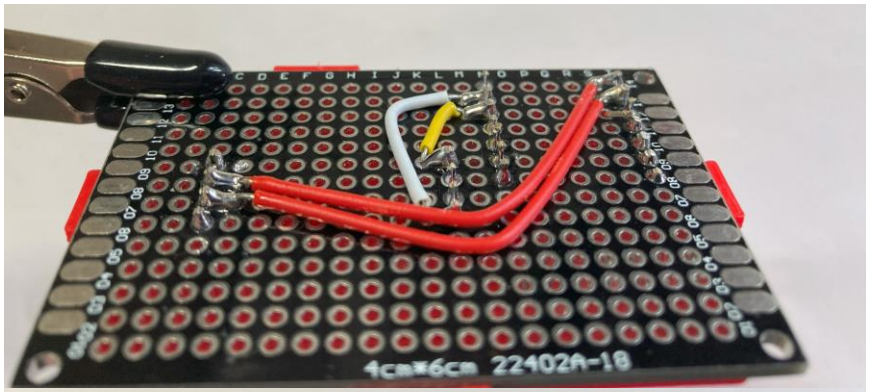
On the top of the board, trim the extra length from the jumper wires, as shown circled in green.

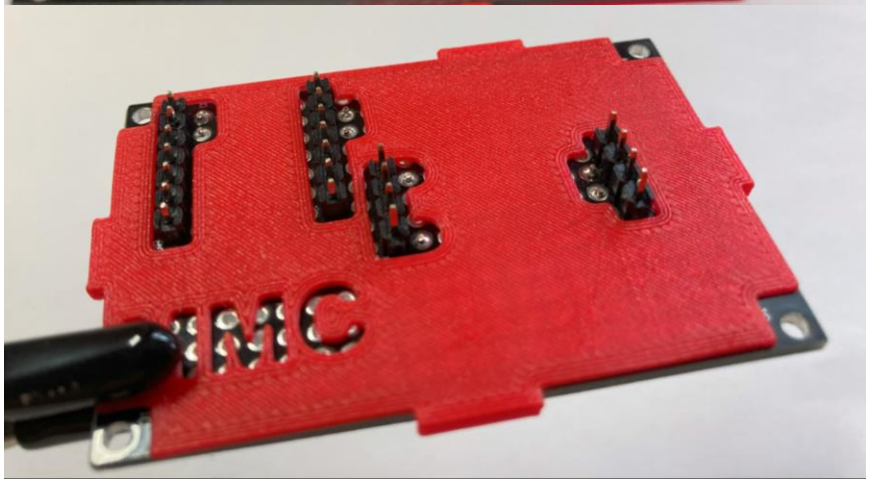




Do no trim the male headers on the top of the board.

Below is how the board should look once the wires and bottoms of headers are trimmed.





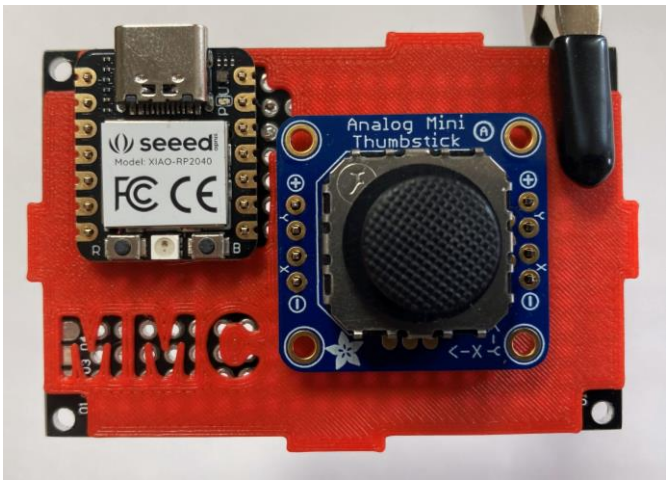
Step 17: Position microcontroller and joystick

If you wish to re-use the 3D printed overlay you may remove it, or it may be left on.

Place the XIAO microcontroller board and the joystick breakout board onto their respective headers.

Ensure the USB port on the XIAO is oriented towards the nearest edge on the protoboard.

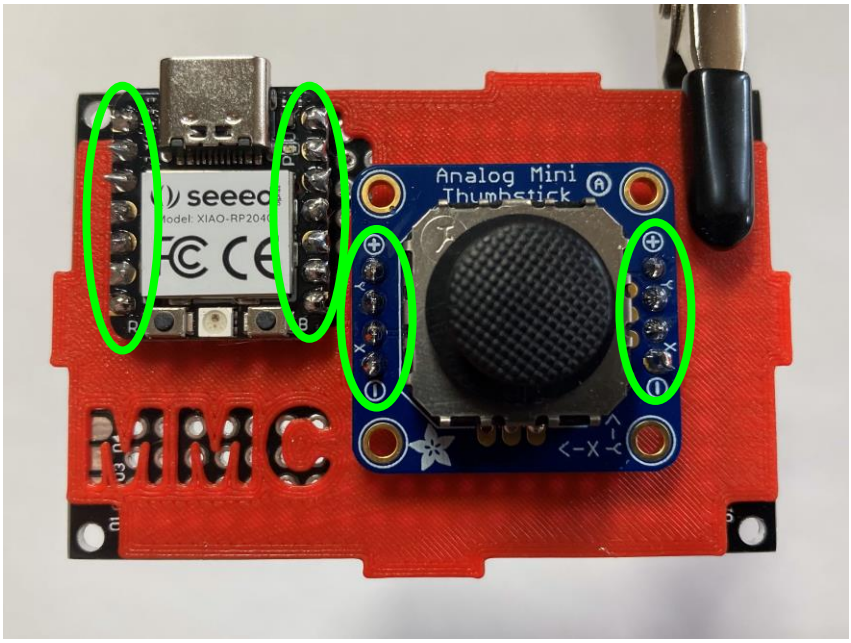
Ensure the text on the joystick board is in the same orientation as the text on the overlay/protoboard.



Step 17: Solder pins on microcontroller and joystick breakout board

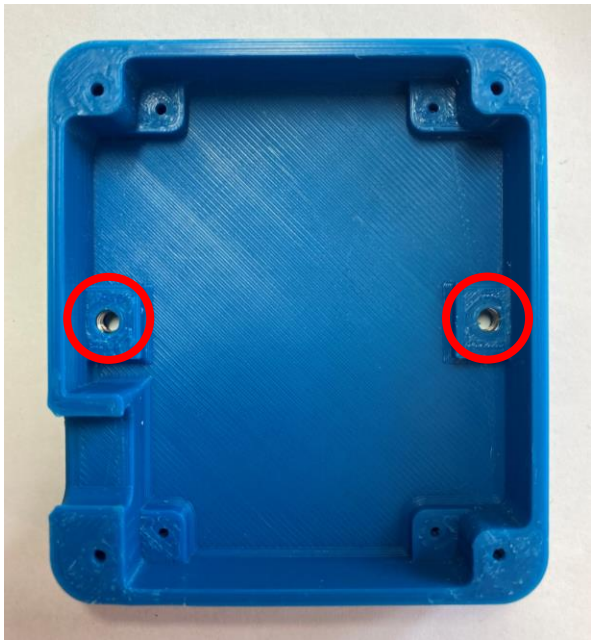
Solder the XIAO microcontroller board and the joystick breakout board to their headers.

Ensure the boards stay flat while soldering.



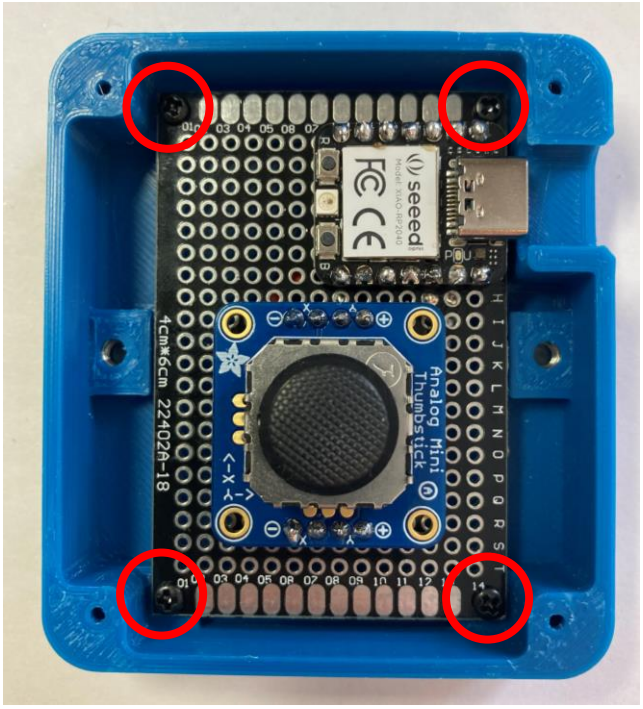
Step 18: Insert M3 nuts

Take the two M3 nuts and slide them into the slots inside the enclosure as shown.



Step 19: Screw protoboard into enclosure bottom

Take the protoboard and the bottom of the 3D printed enclosure and insert M2 screws in each of the four corners of the board, as shown circled in red.

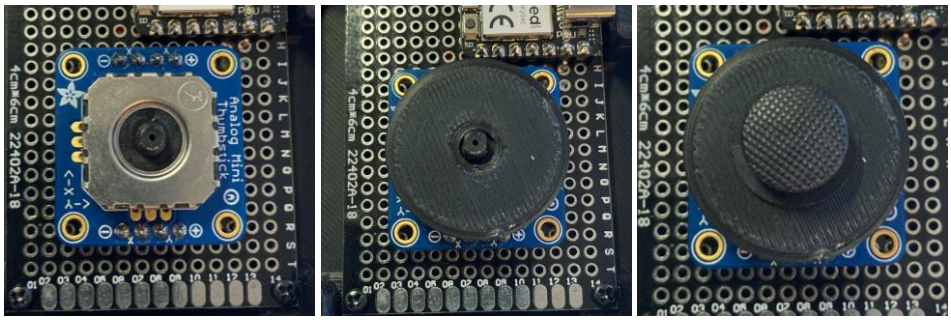


Step 20: Position inner disk

Remove the joystick topper.

Place the 3D printed inner disk on the joystick, around the joystick post.

Replace joystick topper.



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Note: if the joystick is difficult to move after this step, sand down the inner cover disk so it is smooth and does not have bumps or zits.

Step 21: Position enclosure top

Place the 3D printed enclosure lid on top of the enclosure base.

12

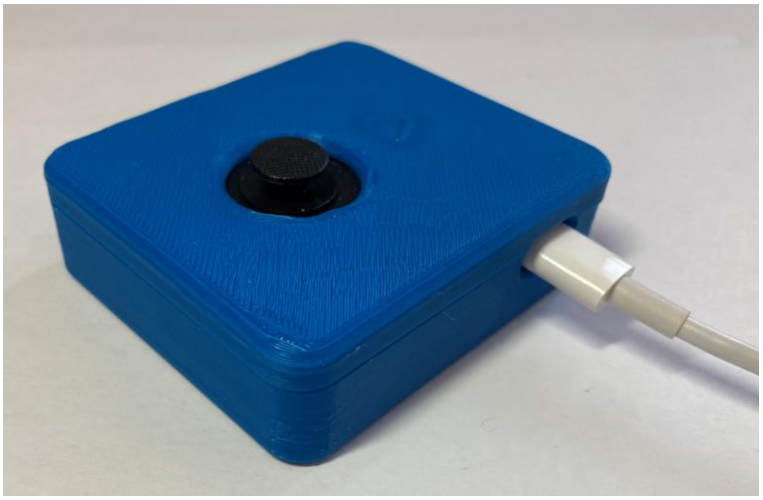
Step 22: Screw enclosure together

Flip the joystick around and insert an M2 screw into each of the 4 screw holes circled in red and tighten them.

6

Step 23: Plug in USB-C cable

Plug the USB C cable into the joystick, and proceed to programming the joystick.



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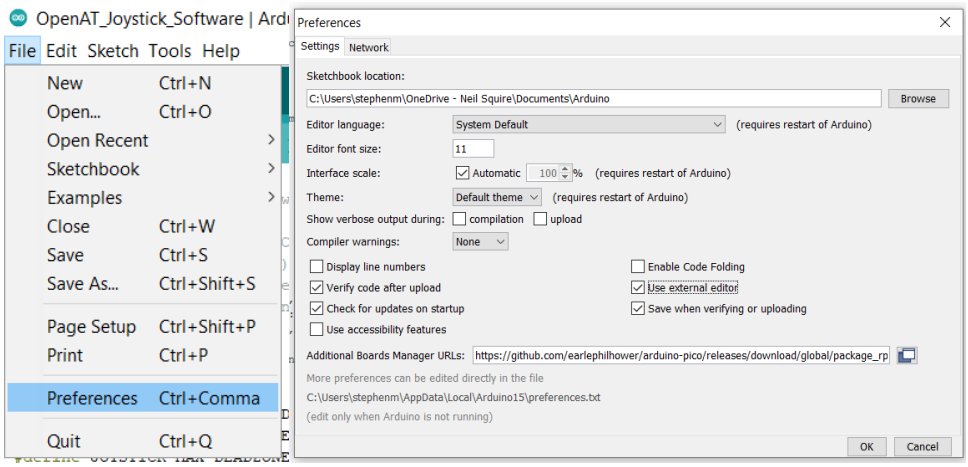
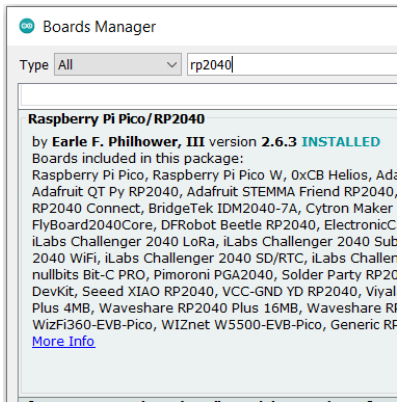
Programming instructions

1. Setup Arduino IDE
   1.1. Download Arduino IDE for your operating system at https://www.arduino.cc/en/software
   1.2. Install Arduino IDE

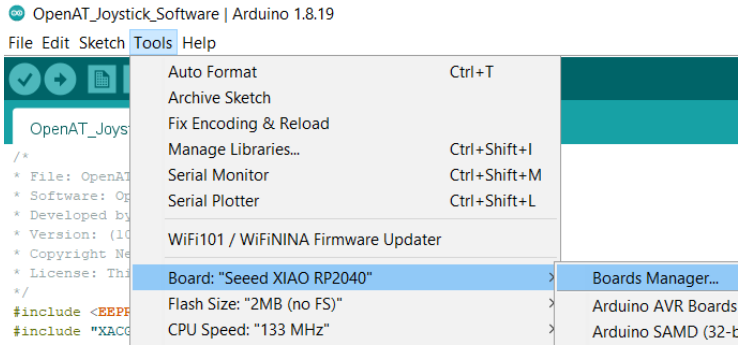
2. Setup Core
   2.1. Open Arduino IDE
   2.2. Click on **File -> Preferences**
   2.3. Locate the text field that says **Additional Boards Manager URLs** beside it.
   2.4. Copy and paste the following link into the field as a new line: https://github.com/earlephilhower/arduino-pico/releases/download/global/package_rp2040_index.json



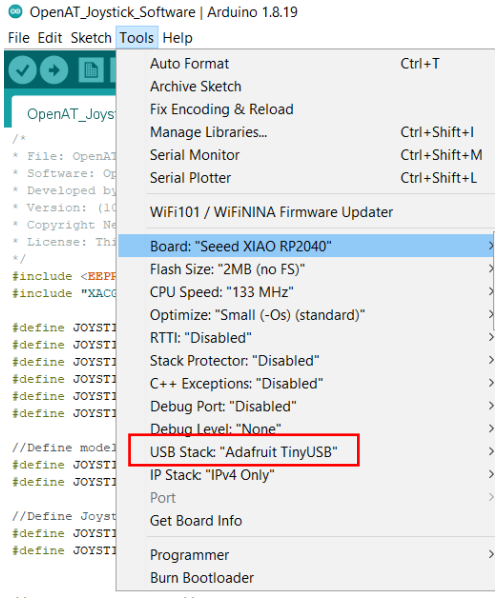
   2.5. Click on **OK**
   2.6. Restart the Arduino IDE
   2.7. Open the **Boards Manager** option from the **Tools-> Board-> Boards Manager...,** search for “Seeed Xiao” and select the package called “Raspberry Pi Pico/RP2040” by Earle F. Philhower, III



2.8. Select **Seeed XIAO RP2040** from **Tools -> Board -> Raspberry Pi RP2040 Boards** menu.



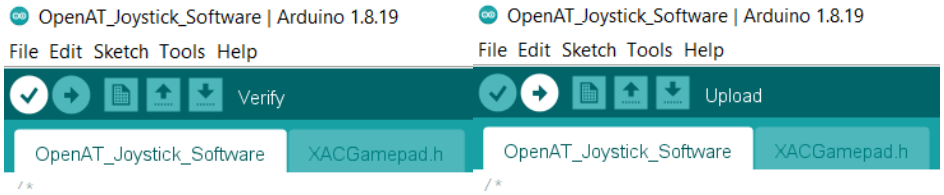
2.9. Click on **Tools -> USB Stack** and select **Adafruit TinyUSB**



More Information: https://wiki.seeedstudio.com/XIAO-RP2040-with-Arduino/

3. Upload the Code to the joystick

3.1. Open OpenAT_Joystick_Software_Birch.ino with Open Arduino ID.
3.2. Select **Seeed XIAO RP2040** from **Tools -> Board -> Raspberry Pi RP2040 Boards** menu.
3.3. Connect the joystick using the USB cable to the computer.
3.4. Select the correct port from **Tools -> Port** menu.
3.5. Verify and upload the code.



Testing

1. Connect the joystick using the USB C cable to the computer.
2. If using Windows, open “Set up USB Game Controllers” from the Control Panel. You can find this by searching your computer in the search bar next to the Windows icon.
3. Ensure that the joystick is registered as a game controller and select your joystick from the list and go to “Properties”.
4. Move your joystick and observe the movement of the cross hatch in the “Axes” window. Ensure it moves in the proper directions when you move the joystick (the arrow points in the up direction). If not, open the joystick and check your connections.

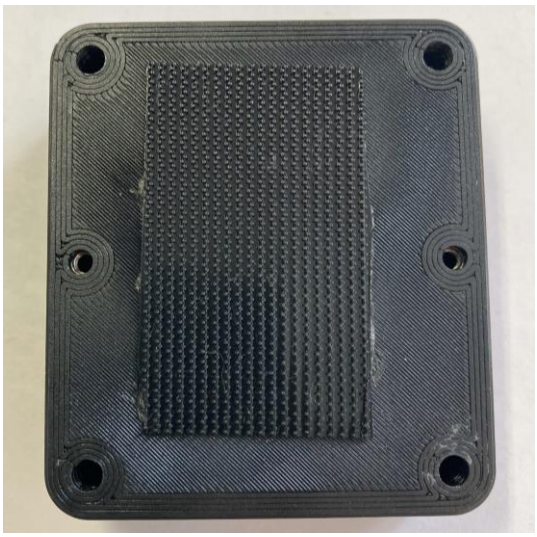
Optional – Mounting

Table Top Mounting – Non-Slip Pads

If using the joystick on a tabletop, and height of the joystick is not a concern, nonslip pads can be added in each of the four corners on the bottom, as shown.

Table Top Mounting – Hook and Loop Fastener

If using the joystick on a tabletop or other surface with hook and loop fasteners, such as Velcro, stick the hook side (rough side) to the joystick and the loop side (soft side) to the surface to mount to.



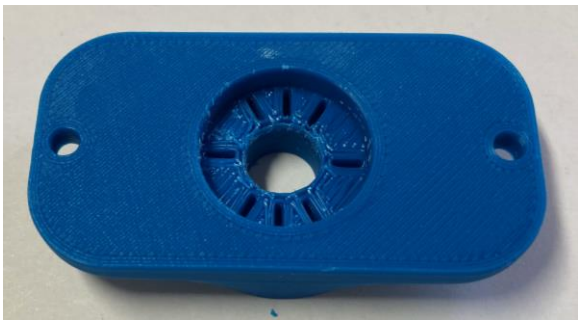
Camera Mount

To mount the joystick on a camera mount, the optional Joystick Camera Mount Adapter can be used.

Step 1

Flip the camera mount adapter around to reveal the recess with small slots.

Ensure all supports are removed from the 3D print.

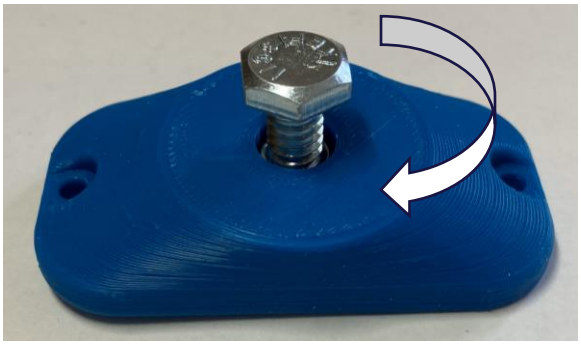


Step 2

Insert the tee nut, lining up the barbs with the small slots in the 3D print.

Step 3

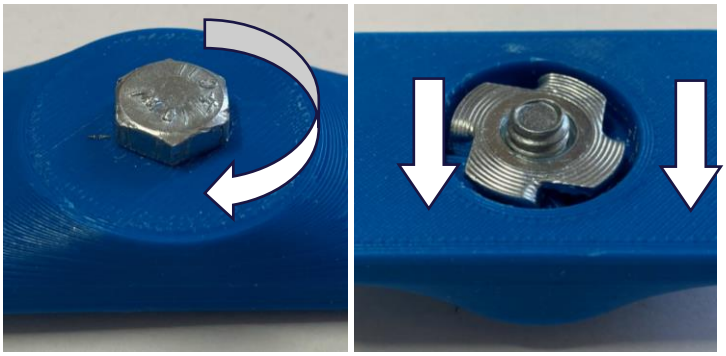
Flip the part around and screw in a ¼-20 hex bolt.



Step 4

Tighten the bolt until the tee nut is seated down as far as possible.

(Alternatively, if you do not have acces to a bolt, the tee nut may be press fit as long as it sits flush with the 3D print.)



Step 5

Using 2 M3 screws, screw the camera mount adapter to the bottom of the joystick in the two middle holes.