Spruce Mini Joystick
MAKER GUIDE

Overview

This document contains the necessary information to build the device.

Spruce Mini Joystick
MAKER GUIDE

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, and safety gear and overall assembly steps.
- ☐ Talk to User about customization options (e.g., colour, any special requests, etc.)
    - Enclosure Colour
    - Joystick Toppers
    - Mounting Options
    - USB Interfaces (e.g., Forest Hub)
- ☐ 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 joystick
- ☐ Joystick toppers (if requested)
- ☐ Mounting Adapters (if requested)
- ☐ “User Guide”

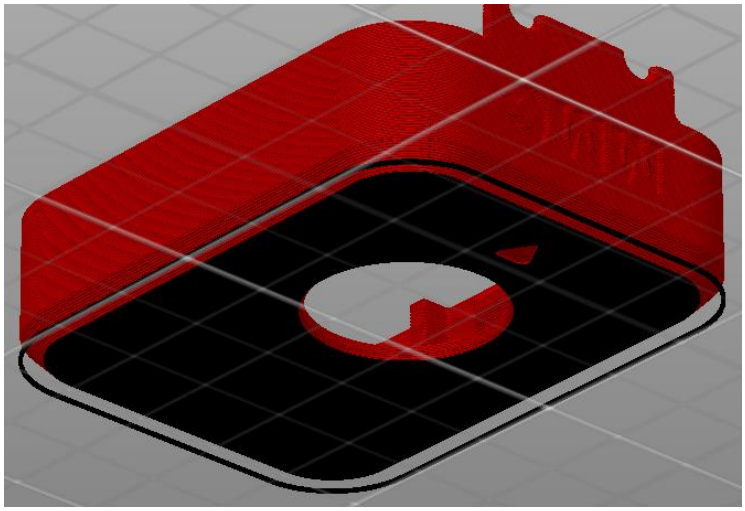
Tool List

- Flush Cutters
- Wire Strippers
- #3 Philips Head Screwdriver
- Pliers
- Soldering Iron and Solder
- Multimeter

Customization Guide

Joystick

The enclosure can be printed in the user's desired colour. Using a colour swap after the first few layers can help to make the Up/Forward arrow stand out more.



Toppers

3D printed joystick toppers can be added to the joystick.

Any PS2 style thumbstick toppers will work here, one example is this set of toppers designed by AbleGamers[1].

Mounting

Mount adapters can be added for custom mounting solutions.

[1] https://www.printables.com/model/501869-analog-thumbstick-topper-collection

3D Printing Guide

3D Printing Summary

Metrics	Single Unit
Total Print Time (min)	3h08m
Total Number of Components	2
Typical Total Mass (g)	28
Typical Number of Print Setups	1

3D Printing Settings

Spruce Mini Joystick Enclosure - Single Unit

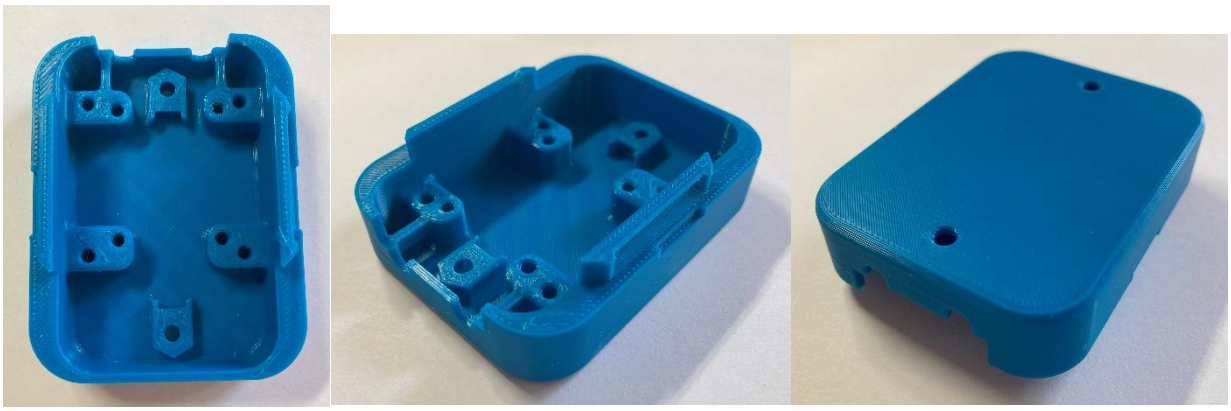
Print File Name	Qty	Total Print Time (hr:min)	Mass (g)	Infill (%)	Support (Y/N)	Layer Height/ Nozzle Diameter(mm)	Notes
Spruce_enclosure_bottom.stl	1	1:46	16	20	N	0.2/0.4	Print in given orientation
Spruce_enclosure_top.stl	1	1:22	12	20	N	0.2/0.4	Print in given orientation

Post-Processing

- Remove any stringing or blobs

Examples of Quality Prints

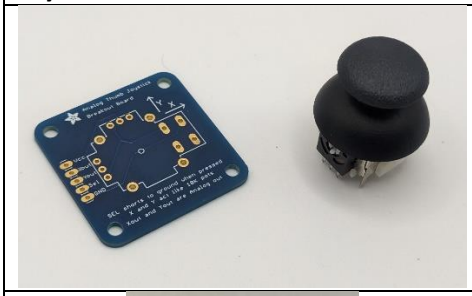
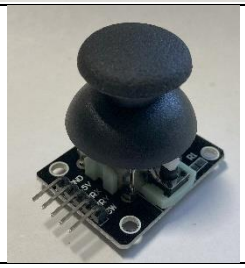
Spruce_enclosure_bottom.stl



Spruce_enclosure_top.stl

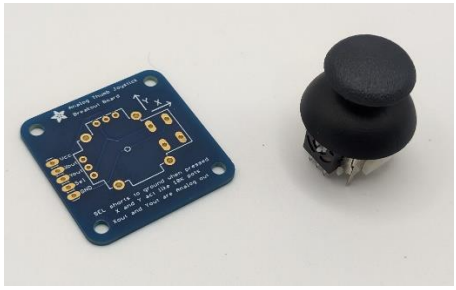
Assembly Guide

Follow the instructions that correspond to the joystick module that you have.

Joystick Module	Assembly Instructions
	Spruce Mini Joystick Assembly – Adafruit PS2 Joystick– Page 10
	Spruce Mini Joystick Assembly – Generic PS2 Joystick – Page 20

Spruce Mini Joystick Assembly – Adafruit PS2 Joystick

Required Components

1	Adafruit PS2 Joystick	QTY 1	2	TRRS Audio Cable	QTY 1	3	Mono cable	QTY 1
								
4	4” cable tie	QTY 2	5	#4 3/8” Screws, self threading	QTY 4	6	M3 Hex Nuts	QTY 2
								
7	3D Printed Enclosure Bottom	QTY 1	8	3D Printed Enclosure Top	QTY 1			
								

Tools and Personal Protective Equipment (PPE)

Required Tools

- Flush Cutters
- Wire Strippers
- #3 Philips Screwdriver
- Pliers
- Soldering Iron and Solder
- Multimeter

Optional Tools

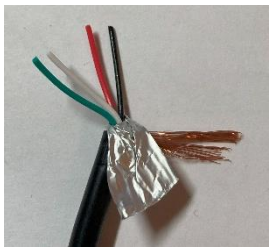
- Electrical Continuity Tester (e.g., Multimeter)

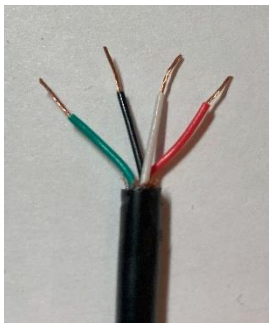
Required Personal Protective Equipment (PPE)

- Safety Goggles

Assembly Steps – Adafruit Joystick

Step 1: Prepare Audio Cable





If you are using the pre-prepared TRRS cable from DigiKey, pictured in the component list, you can skip this step.

If using a different cable, prepare the wires for soldering:

- Cut the TRRS cable to length (typically 1 m).
- Strip off approximately 2 cm of the outer insulation.
- Then, separate the 4 individual inner wires. If there are three insulated wires plus copper strands, twist these copper strands together to be one of your wires. If there are 4 insulated wires plus loose copper stranded wires, cut off these copper wires.
- Strip off approximately 0.5 cm of insulation from the inner wires.
- For each inner wire, twist the inner strands together

Step 2: Identify Audio Cable Wires

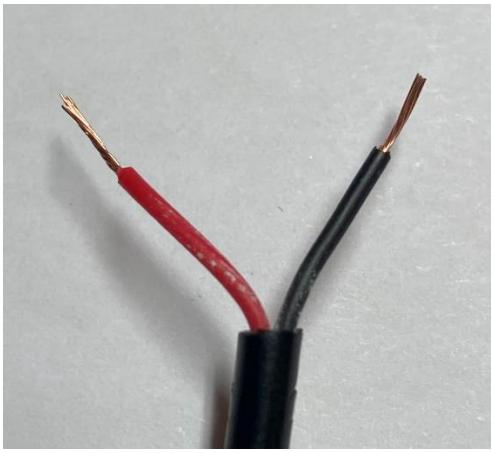
If using the pre-prepared DigiKey cable, you can skip this step.

You should use a multimeter or other continuity tester to confirm which wire corresponds to which part of the plug. Follow this guide for checking continuity to determine which wire corresponds to the Sleeve, Ring 1, Ring 2, and Tip of the TRRS cable plug.

TRRS Plug	DigiKey cable	Your cable
Sleeve	Black	
Ring 2	Green	
Ring 1	White	
Tip	Red	

Step 3: Prepare Mono Cable

If you are using the pre-prepared mono cable from DigiKey, pictured in the component list, skip this step.

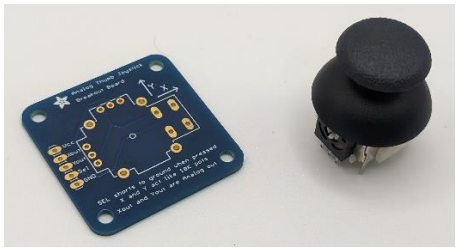


If using a different cable, you'll need to prepare the wires for soldering:

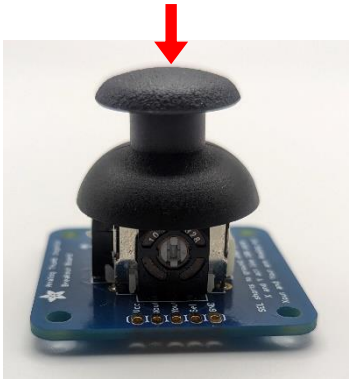
- Cut the mono cable to length (typically 1 m).
- Strip off approximately 2 cm of the outer insulation.
- Then, separate the 2 individual inner wires. If there is one insulated wire plus copper strands, twist these copper strands together to be one of your wires.
- Strip off approximately 0.5 cm of insulation from the inner wires.
- For each inner wire, twist the inner strands together

Step 4: Insert Joystick into Breakout Board and Solder

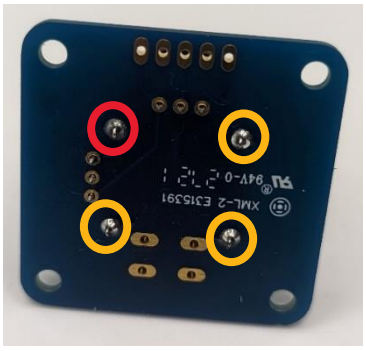
The Adafruit Joystick needs to be soldered to the Joystick breakout board before it is ready for use.



Carefully insert the joystick module into the joystick breakout board, ensuring all pins are inserted and the joystick is sitting flat.



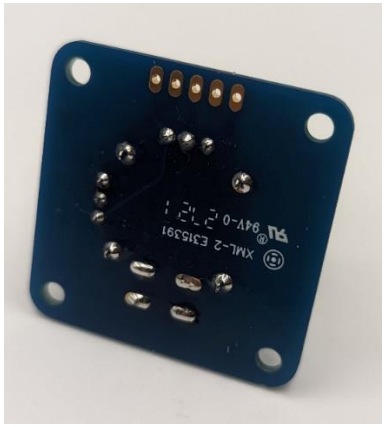
Solder one (1) of the main joystick lugs. Ensure the joystick is flat against the breakout board, and then solder the remaining three (3) main lugs.



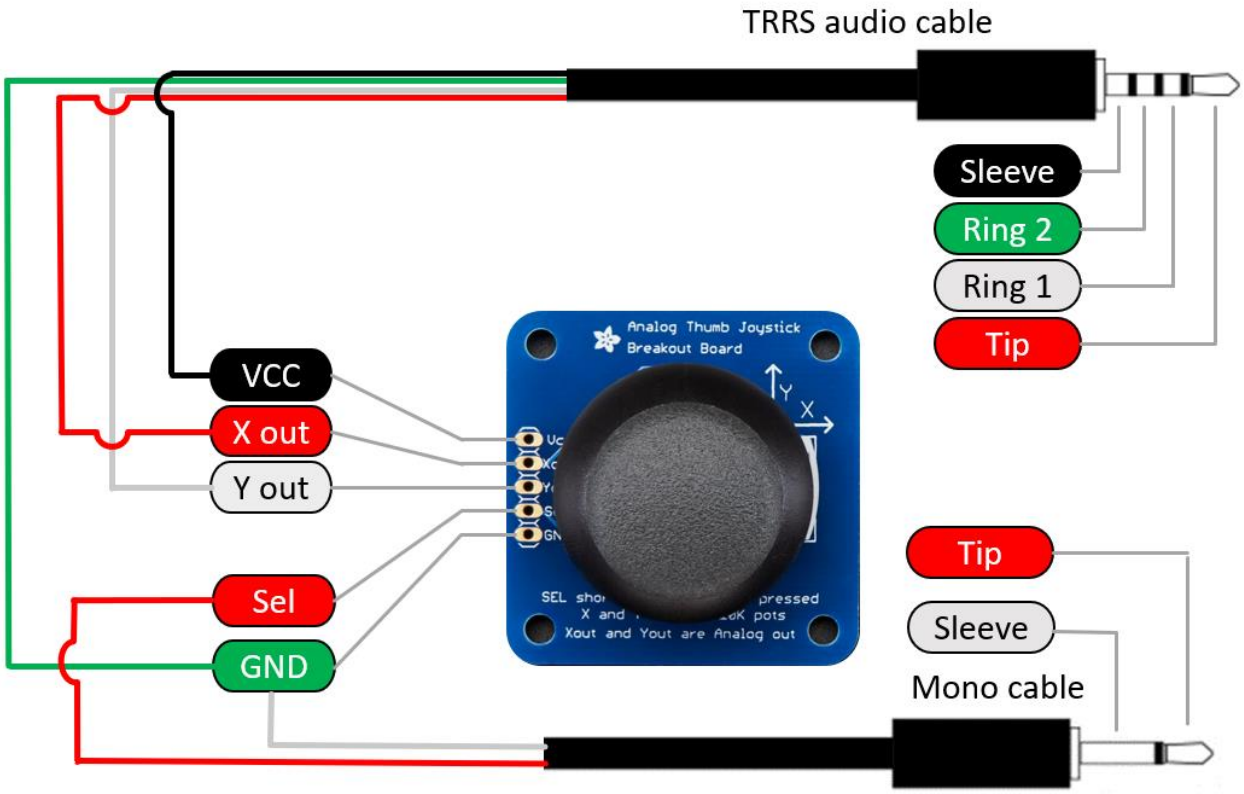
Solder the four (4) lead for the joystick switch.

Solder the three (3) leads for the X-axis potentiometer and three (3) leads for the Y-axis potentiometer.

The prepared joystick module.



Adafruit Joystick Wiring diagram

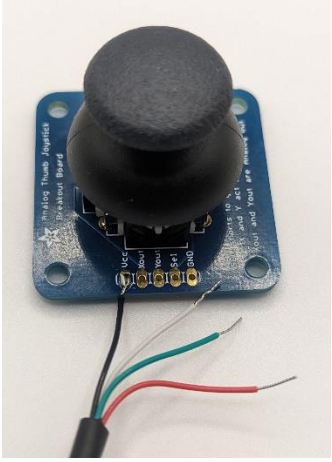


JOYSTICK BOARD Label	TRRS Plug	DigiKey TRRS Cable	Your TRRS CABLE	Mono PLUG	Mono CABLE	Your Mono Cable
Vcc	Sleeve	Black		---	---	---
Xout	Tip	Red		---	---	---
Yout	Ring 1	White		---	---	---
Sel	---	---	---	Tip	Red	
GND	Ring 2	Green		Sleeve	White	

Step 5: Solder TRRS Sleeve to Voltage (Vcc) Pad

Insert the TRRS audio cable **sleeve** wire (black) into **Vcc pad** on the joystick breakout, with the wire going in from the bottom of the board to the top.

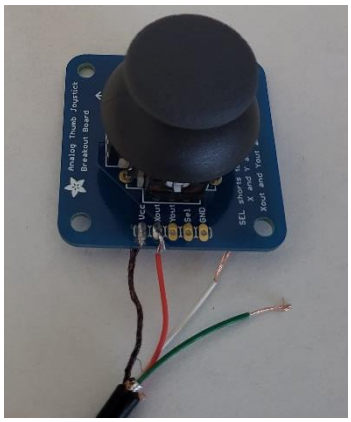
Solder the wire to the pad on the top of the board.



Step 6: Solder TRRS Tip to X (Xout) Pad

Insert the TRRS audio cable **tip** wire (red) into the **Xout pad** on the joystick breakout, with the wire going in from the bottom of the board to the top.

Solder the wire to the pad on the top of the board.

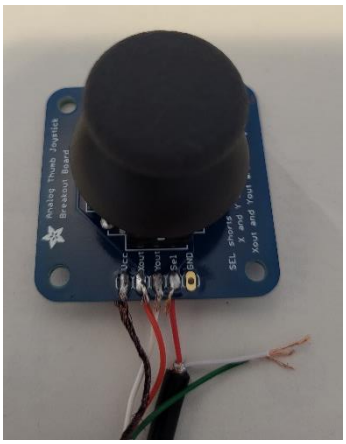


Step 7: Solder TRRS R1 to Y (Yout) Pad

Insert the TRRS audio cable **ring 1** wire (white) into the **Yout pad** on the joystick breakout, with the wire going in from the bottom of the board to the top.

Solder the wire to the pad on the top of the board.

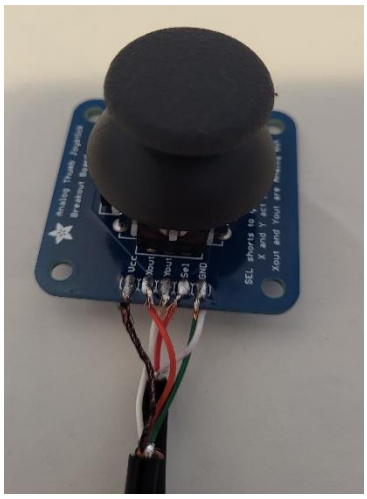
Step 8: Solder Mono Cable Tip to Switch (SW) Pad



Insert the Mono audio cable **tip** wire (red) into the **Sel pad** on the joystick breakout, with the wire going in from the bottom of the board to the top.

Solder the wire to the pad on the top of the board.

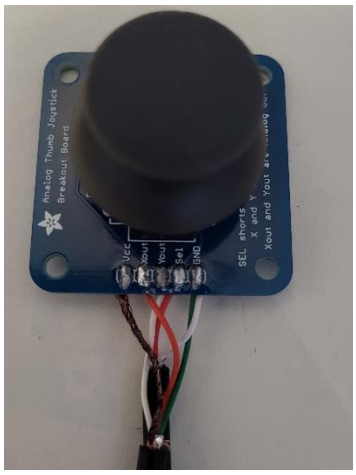
Step 9: Solder Mono Cable Sleeve and TRRS Cable R2 to Ground (GND) Pad



Take both the mono audio cable **sleeve** wire (white) and the TRRS audio cable **Ring 2** wire (green) and twist together and insert into the **GND pad** on the joystick breakout, going from the bottom of the board to the top.

Solder the wires to the pads on the top of the board.

Step 10: Clean up Wires



Use flush cutters to trim any excess wires from the soldered pads.

Step 11: Check for Shorts

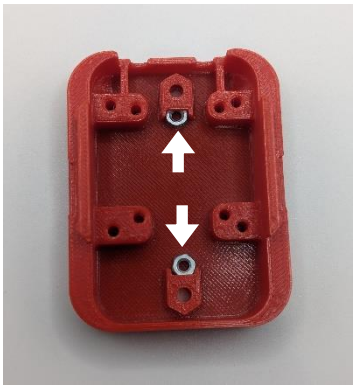
Inspect the board and check that none of the connections are shorted.

There should be no bridges/connections between adjacent pins.

If you have a multimeter, you can use it to double check continuity.

Step 12: Insert M3 Hex Nuts into Enclosure Bottom

Take the enclosure bottom and insert the M3 nuts into the slots as shown. You may require a tool such as needle-nosed pliers or a screwdriver to push the nuts into place.



Step 13: Position Joystick Unit

Thread the two cables from the joystick unit out the two cutouts at the back of the enclosure.

Ensure that the cables go between the screw holes and the captive nut piece and won't interfere with screwing down the joystick.

Step 14: Screw in joystick unit

Position the joystick unit over the screw holes, with the cables running underneath. There are two (2) sets of screw holes for two different joystick units, find the set that matches your joystick.

Check the orientation of the joystick, and make sure that it matches the photo. The text on the board should be upright when the cables are coming out of the case away from you.

Screw in all four (4) screws through the joystick unit and enclosure. Be careful not to over tighten.

Step 15: Fasten First Cable Tie

Thread the cable tie under the left cable and the 3D printed beam, going from the middle towards the edge.

Tighten the cable tie as much as you are able with your hands. The cable should now feel secure and unable to wiggle around.

Lastly, cut off the excess cable tie using flush cutters.

Step 16: Fasten Second Cable Tie

Repeat with the second cable tie, thread the cable tie under the left cable and the 3D printed beam, going from the middle towards the edge.

Tighten the cable tie as much as you are able with your hands. The cable should now feel secure and unable to wiggle around.

Lastly, cut off the excess cable tie using flush cutters.

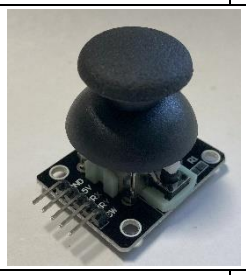
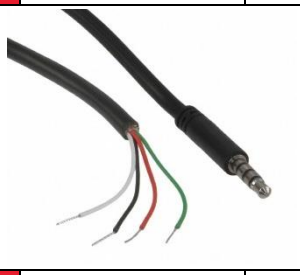
Step 17: Assemble Enclosure

Line up the enclosure top and apply downward pressure to snap it into place.

Proceed to Testing.

Spruce Mini Joystick Assembly – Generic PS2 Joystick

Required Components

1	Generic PS2 Joystick	QTY 1	2	TRRS Audio Cable	QTY 1	3	Mono cable	QTY 1
								
4	4” cable tie	QTY 2	5	#4 3/8” Screws, self threading	QTY 4	6	M3 Hex Nuts	QTY 2
								
7	3D Printed Enclosure Bottom	QTY 1	8	3D Printed Enclosure Top	QTY 1			
								

Tools and Personal Protective Equipment (PPE)

Required Tools

- Flush Cutters
- Wire Strippers
- #3 Philips Screwdriver
- Pliers
- Soldering Iron and Solder
- Multimeter

Optional Tools

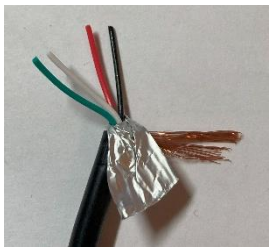
- Electrical Continuity Tester (e.g., Multimeter)

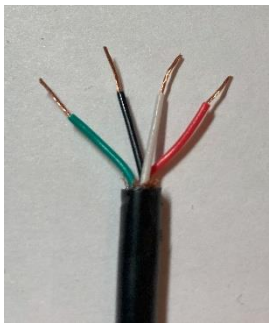
Required Personal Protective Equipment (PPE)

- Safety Goggles

Assembly Steps – Generic PS2 Joystick

Step 1: Prepare Audio Cable





If you are using the pre-prepared TRRS cable from DigiKey, pictured in the component list, you can skip this step.

If using a different cable, prepare the wires for soldering:

- Cut the TRRS cable to length (typically 1 m).
- Strip off approximately 2 cm of the outer insulation.
- Then, separate the 4 individual inner wires. If there are three insulated wires plus copper strands, twist these copper strands together to be one of your wires. If there are 4 insulated wires plus loose copper stranded wires, cut off these copper wires.
- Strip off approximately 0.5 cm of insulation from the inner wires.
- For each inner wire, twist the inner strands together

Step 2: Identify Audio Cable Wires

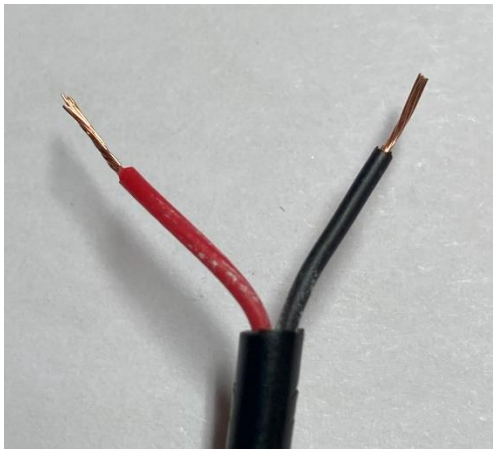
If using the pre-prepared DigiKey cable, you can skip this step.

You should use a multimeter or other continuity tester to confirm which wire corresponds to which part of the plug. Follow this guide for checking continuity to determine which wire corresponds to the Sleeve, Ring 1, Ring 2, and Tip of the TRRS cable plug.

TRRS PLUG	DIGIKEY CABLE	YOUR CABLE
SLEEVE	Black	
RING 2	Green	
RING 1	White	
TIP	Red	

Step 3: Prepare Mono Cable

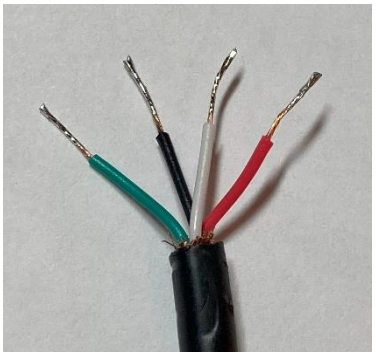
If you are using the pre-prepared mono cable from DigiKey, pictured in the component list, skip this step.

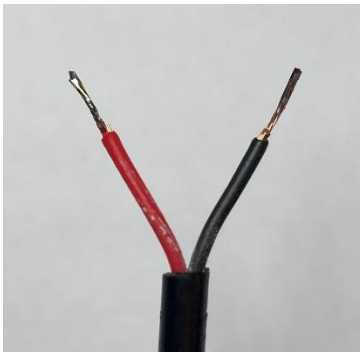


If using a different cable, you'll need to prepare the wires for soldering:

- Cut the mono cable to length (typically 1 m).
- Strip off approximately 2 cm of the outer insulation.
- Then, separate the 2 individual inner wires. If there is one insulated wire plus copper strands, twist these copper strands together to be one of your wires.
- Strip off approximately 0.5 cm of insulation from the inner wires.
- For each inner wire, twist the inner strands together

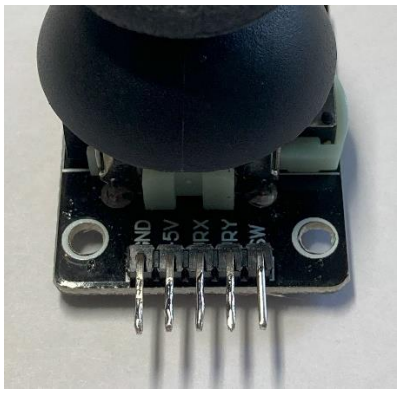
Step 4: Pre-tin Wires and Header Pins



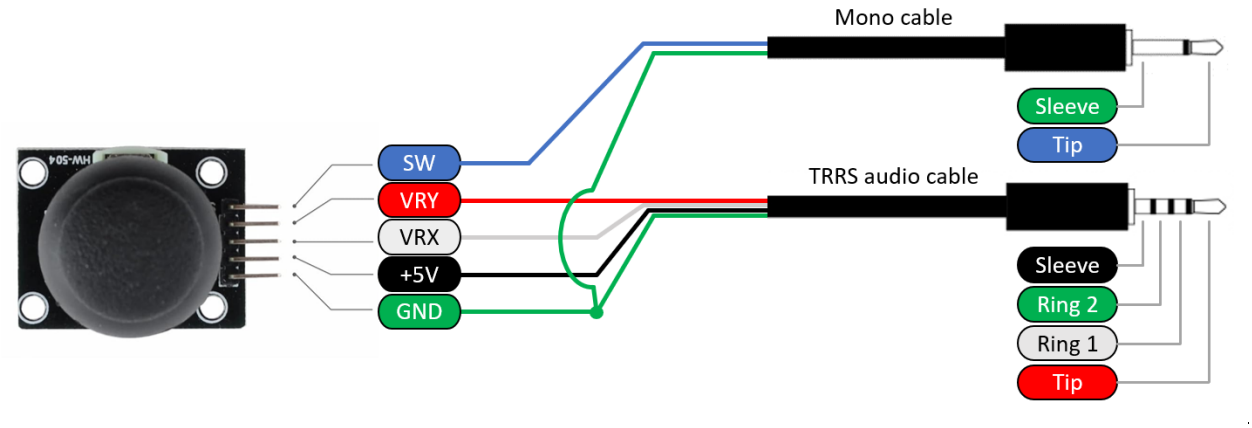


Pre-tin the wires and the headers by melting a small amount of solder onto them so they are silver and shiny.

Do this to each of the 4 wires on the audio cable, both wires on the mono cable, and each of the 5 pins on the joystick unit.



Wiring diagram



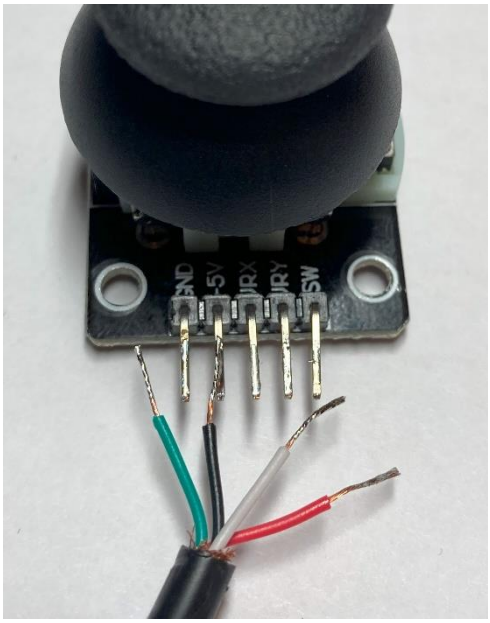
JOYSTICK BOARD LABEL	DIGIKEY TRRS CABLE	TRRS PLUG	MONO CABLE	MONO PLUG
SW	---	---	Red	Tip
VRY	Red	Tip		---
VRX	White	Ring 1		---
+5V	Black	Sleeve		---
GND	Green	Ring 2	White	Sleeve

Step 5: Solder Voltage (+5V) Pin

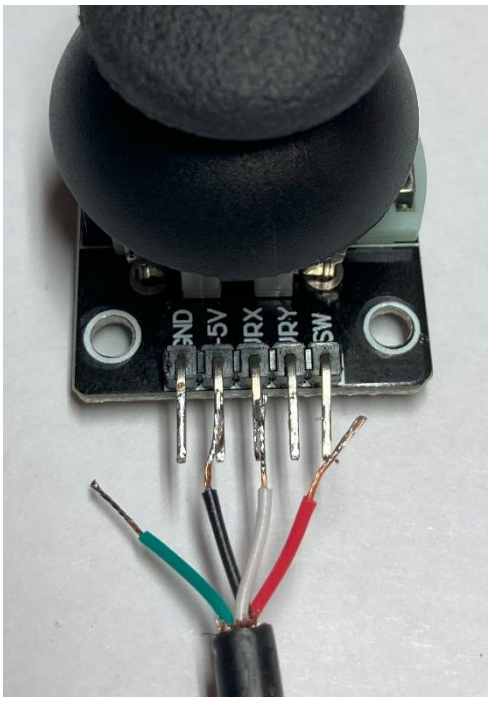
Take the wire from the TRRS audio cable that corresponds to the **sleeve**, line this wire up with the **+5V pin** on the joystick unit, and solder together.

On the audio cable from DigiKey, this will be the **black wire.**

Note: Try to get the insulation on the wire as close as possible to the edge of the header pin, so there is less wire that can move and touch other wires.



Step 6: Solder X (VRX) Pin

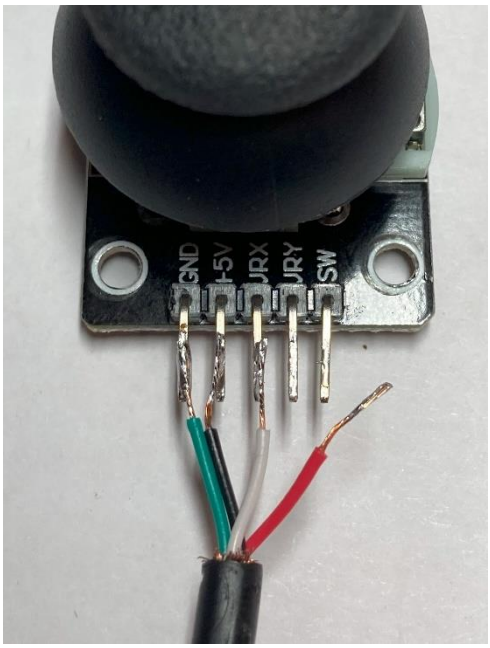


Take the wire from the TRRS audio cable that corresponds to **ring 1**, line this wire up with the **VRX pin** on the joystick unit, and solder together.

On the audio cable from DigiKey, this will be the **white wire.**

Note: Try to get the insulation on the wire as close as possible to the edge of the header pin, so there is less wire that can move and touch other wires.

Step 7: Solder Ground (GND) Pin

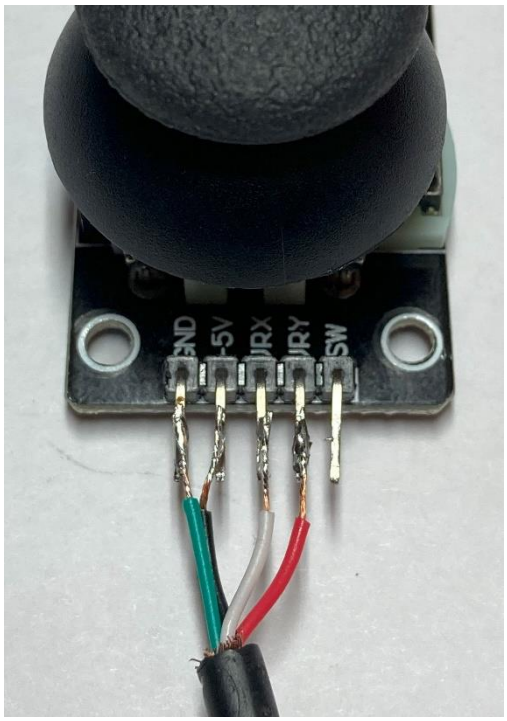


Take the wire from the audio cable that corresponds to **ring 2**, line this wire up with the **GND pin** on the joystick unit, and solder together.

On the audio cable from DigiKey, this will be the **green wire.**

Note: Try to get the insulation on the wire as close as possible to the edge of the header pin, so there is less wire that can move and touch other wires.

Step 8: Solder Y (VRY) Pin

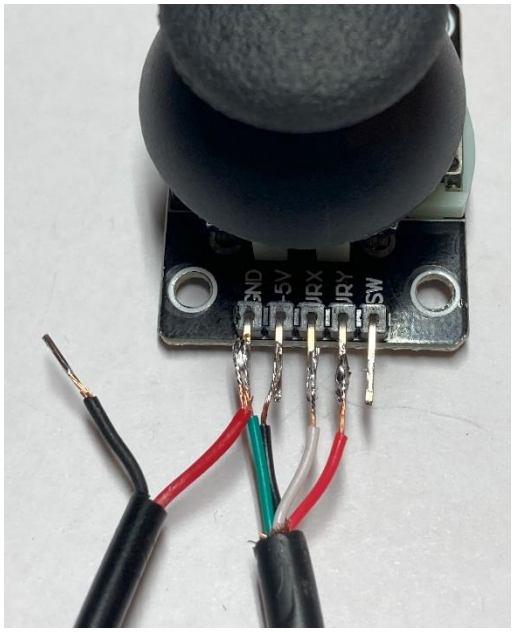


Take the wire from the audio cable that corresponds to **the tip**, line this wire up with the **VRY pin** on the joystick unit, and solder together.

On the audio cable from DigiKey, this will be the **red wire.**

Note: Try to get the insulation on the wire as close as possible to the edge of the header pin, so there is less wire that can move and touch other wires.

Step 9: Solder Mono cable to Ground (GND) Pin



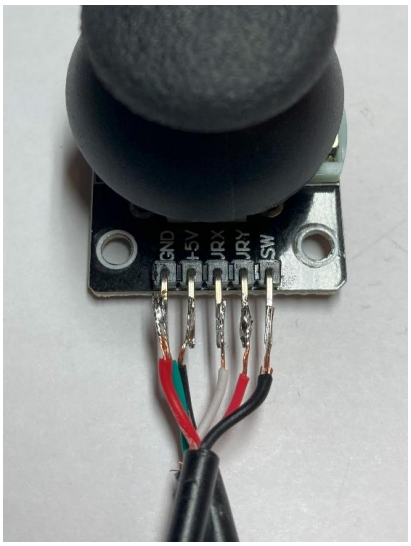
Take either one of the wires from the mono cable, line it up with the **GND pin** on the joystick unit, and solder together.

Note: Try to get the insulation on the wire as close as possible to the edge of the header pin, so there is less wire that can move and touch other wires.

Step 10: Solder Mono Cable to Switch (SW) Pin

Take the remaining wire from the mono cable, line it up with the **SW pin** on the joystick unit, and solder together.

Note: Try to get the insulation on the wire as close as possible to the edge of the header pin, so there is less wire that can move and touch other wires.



Step 11: Check for Shorts

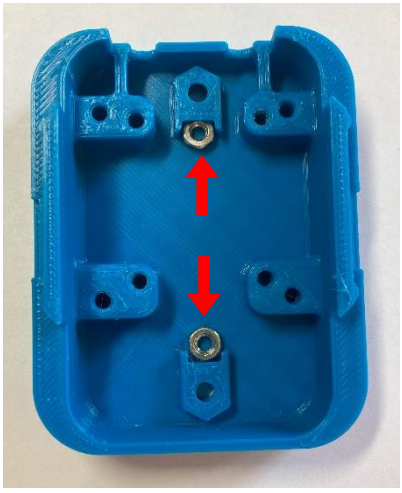
Inspect the board and check that none of the connections are shorted.

There should be no bridges/connections between adjacent pins.

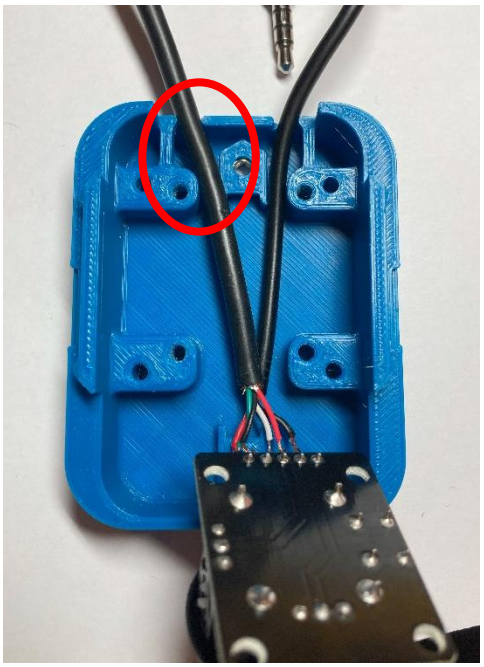
If you have a multimeter, you can use it to double check continuity.

Step 12: Insert M3 Hex Nuts into Enclosure Bottom

Take the enclosure bottom and insert the M3 nuts into the slots as shown. You may require a tool such as needle-nosed pliers or a screwdriver to push the nuts into place.



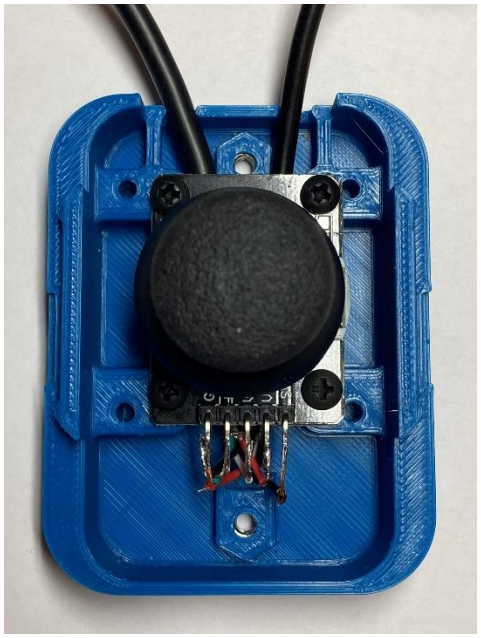
Step 13: Position Joystick Unit



Thread the two cables from the joystick unit out the two cutouts at the back of the enclosure.

Ensure that the cables go between the screw holes and the captive nut piece and won't interfere with screwing down the joystick.

Step 14: Screw in joystick unit



Position the joystick unit over the screw holes. There are two sets of screw holes for two different joystick units, find the set that matches your joystick module.

Screw in all four screws through the joystick unit and enclosure. Be careful not to over tighten.

Step 15: Check for Shorts

Visually inspect the board and check that none of the connections are shorted.

There should be no bridges/connections between adjacent pins.

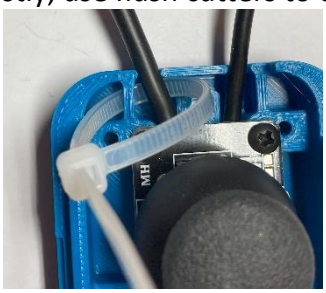
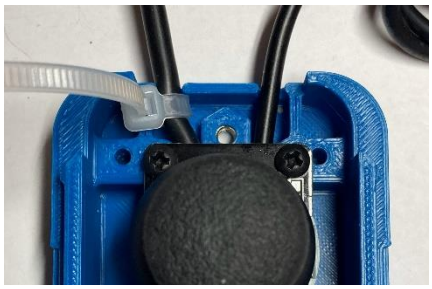
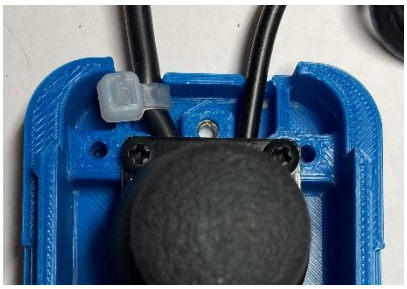
If you have a multimeter, you can use it to double check continuity.

Step 16: Fasten First Cable Tie

Thread the cable tie under the left cable and the 3D printed beam, going from the middle towards the edge.

Tighten the cable tie as much as you are able with your hands. The cable should now feel secure and unable to wiggle around.

Lastly, use flush cutters to cut off the excess cable tie.

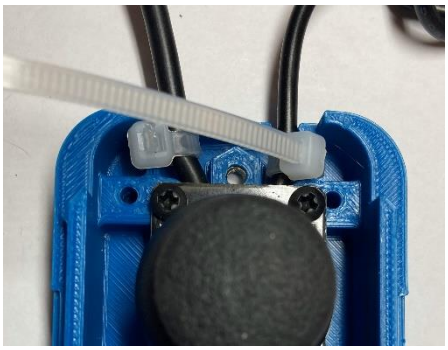




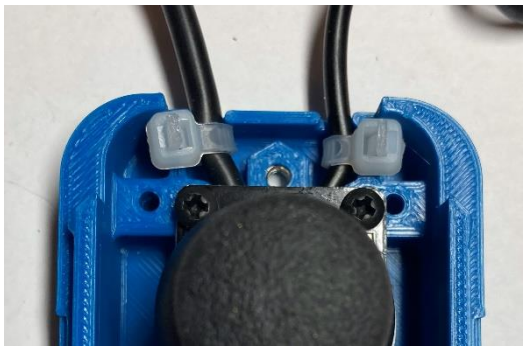
Step 17: Fasten Second Cable Tie

Repeat with the second cable tie, thread the cable tie under the left cable and the 3D printed beam, going from the middle towards the edge.

Tighten the cable tie as much as you are able with your hands. The cable should now feel secure and unable to wiggle around.

Lastly, use flush cutters to cut off the excess cable tie.





Step 18: Assemble Enclosure

Line up the enclosure top and apply downward pressure to snap it into place.

Proceed to Testing.

Testing

Testing using a Multimeter

A multimeter can be used to test if the wires are connected and soldered correctly. It is most important to ensure that there is no short circuit between the Sleeve (Ground) and Tip (Voltage), as this can damage the host device. It can be tricky to place the probes and move the joystick, so tape, or a second person can be helpful here.

Note: The intended joystick for this build has two 10 KΩ potentiometers, but some joysticks use 5 KΩ potentiometers, which will result in the expected multimeter readings to be halved

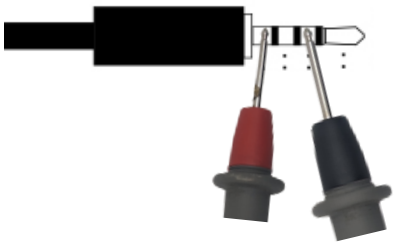
Test 1: Testing for Short Circuits

1. Set the multimeter to measure resistance in the 1-10 KΩ range.
2. Hold the tip of the red probe of the multimeter to the Sleeve (Voltage) of the TRRS cable.
3. Hold the tip of the black probe of the multimeter to Ring 2 (Ground) on the TRRS cable.
4. Confirm that the resistance is between 4 – 5 KΩ.
    a. Between 4 – 5 KΩ: No shorts. Proceed to next test.
    b. Less than 50 Ω: There is a short circuit between a Ground and Voltage pin (Pins 1, 3, 4, and 6). This must be fixed to prevent damaging a host device. Open the joystick and review/fix your soldering joints.
    c. Other values: There is a wiring problem. Open the joystick and review/fix your soldering joints.

If you have no short circuits, you can move on to testing the joystick directions. This can be done with either the multimeter, or with a USB-HID gamepad that accepts an analog joystick.

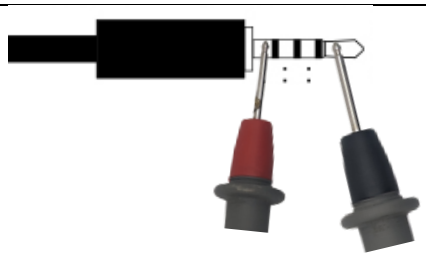
Test 2: Testing Vertical Joystick Axis

1. Hold the tip of the red probe of the multimeter to the Sleeve (Voltage) of the TRRS cable.
2. Hold the tip of the black probe to Ring 1 (Y-axis) on the TRRS cable.
3. While holding the multimeter probes in place, move the joystick fully in the UP ↑ direction.



a. You may require a second person to hold the probes in place or move the joystick. b. Otherwise, the joystick can be held in place with some tape to leave your hands free to hold the multimeter probes in place. 4. Read the resistance on the multimeter: a. Less than .05 KΩ: The Y-axis potentiometer is wired correctly. b. Otherwise, review the wiring diagram and ensure your wiring matches. 5. Release the joystick back to neutral position.	

Test 3: Testing Horizontal Joystick Axis

1. Hold the tip of the red probe of the multimeter to the Sleeve (Voltage) of the TRRS cable. 2. Hold the tip of the black probe to Tip (X-axis) of the TRRS cable. 3. While holding the multimeter probes in place, move the joystick fully in the RIGHT → direction. a. You may require a second person to hold the probes in place or move the joystick. b. Otherwise, the joystick can be held in place with some tape to leave your hands free to hold the multimeter probes in place. 4. Read the resistance on the multimeter. a. Less than .05 KΩ: The X-axis potentiometer is wired correctly. a. Otherwise, review the wiring diagram and ensure your wiring matches. 5. Release the joystick back to neutral position.	

Test 4: Testing Push Button

1. Change the multimeter to continuity checking mode.
2. Hold the tip of the red probe to the Sleeve (Sel) of the mono cable.
3. Hold the tip of the black probe to the Tip (GND) of the mono cable.
4. While holding the probes in place, push on the joystick to activate the button.
  a. You may require a second person to hold the probes in place or push the joystick.
  b. Otherwise, the joystick can be held down with some tape to leave your hands free to hold the multimeter probes in place.
5. Listen for the multimeter to beep.
  a. While the joystick is pressed, the multimeter should emit a sound.
  b. When not pressed, the multimeter should be quiet.
	

Testing using an USB-HID Gamepad Device

1. Plug the joystick into analog joystick input for the host device.
   a. X1 or X2 on an Xbox Adaptive Controller.
   b. Plug the mono cable into the A switch jack on an Xbox Adaptive Controller.
2. Plug the host device into your laptop.
3. 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.
   a. If using a Mac, use https://hardwaretester.com/gamepad
4. Select the host device from the list of controllers and go to “Properties”.
5. 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.
6. Push the joystick to activate the button.
   a. You should see the button activate on whichever testing system you are using, respective of which switch port you plugged the cable into.