3D printed AH-64 MPD V1 build guide

This guide will cover all the steps required for the construction of the MPD frame.

This build should take approximately 6-8 hours to complete.

Equipment required

In order to complete this build you will need these basic tools:

- Soldering iron.
- Wire stripper.
- Crimping tool.
- Third hands.
- Pair of pliers. (Preferably two, smooth jawed, one serrated.)
- Cutting snips.
- Flux.

Recommended video tutorials

If you don't feel confident with any of these skills, check out these videos on them.

Soldering:
PACE Worldwide has an excellent video series on soldering.
https://www.youtube.com/playlist?list=PL926EC0F1F93C1837

Crimping:
There is some variety in crimping techniques, here are videos demonstrating several different approaches. Each approach is valid.
https://www.youtube.com/watch?v=jET1QTP1B7c
https://www.youtube.com/watch?v=8sHeR4Uozck
https://www.youtube.com/watch?v=VB1CrqY_jMg

Cable lacing:
I haven't found any really good videos on the subject, but here is an excellent web page.
http://www.aeroelectric.com/articles/cable_lace/cable_lace.html

Bill of materials

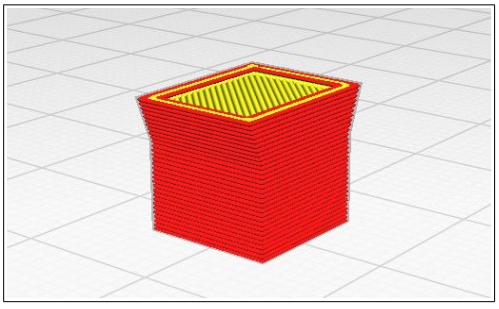
ITEM NO.	QTY.	PART NAME	DESCRIPTION	LENGTH
1	1	Front frame	3D printed	-
2	1	Middle frame	^	-
3	1	Back cover		-
4	24	square button		-
5	7	Rectangular button		-
6	31	Tactile Switch	5 x 6 x 6mm Switch	-
7	2	Potentiometer	B10K suggested	-
8	1	3 position switch	SR1712F-0103	-
9	6	Upper OSB signal wire	26AWG stranded (white)	390mm + length of harness
10	2	Potentiometer signal wir	26AWG stranded (yellow)	390mm + length of harness
11	2	3 pos. switch signal wir	26AWG stranded (blue)	390mm + length of harness
12	1	Potentiometer 5v wire	26AWG stranded (red)	390mm + length of harness
13	17	Middle OSB signal wire	26AWG stranded (white)	270mm + length of harness
14	8	Lower OSB signal wire	26AWG stranded (white)	120mm + length of harness
15	1	Ground connector wire	26AWG stranded (black)	30mm + length of harness
16	37	OSB/switch ground lead	26AWG stranded (black)	65mm
17	2	Potentiometer signal lea	26AWG stranded (yellow)	65mm
18	2	3 pos. switch signal lea	26AWG stranded (blue)	65mm
19	3	Potentiometer 5v lead	26AWG stranded (red)	65mm
20	1	Main ground conductor	22AWG solid core (bare)	800mm
21	46	Male wire connector	DuPont (0.1in pitch)	-
22	9	Female wire connector	DuPont (0.1in pitch)	-
22	8	Frame bolt	M3x25 (any head type)	25mm
23	N/A	Cable management supplie	Cable ties or lacing suggested	

The minimum recommended length for the wiring harness is 150mm.
The length of wire required is approximately 17 – 22m.

Printing information

I printed the parts on a Prusa i3 with 0.3mm layer height @ 60mm/s. Fits are sized accordingly. The largest part is 210.5 x 207.5 x 12 mm.

The button caps are designed to be printed with the outer face down (flared side up) as shown in this image.



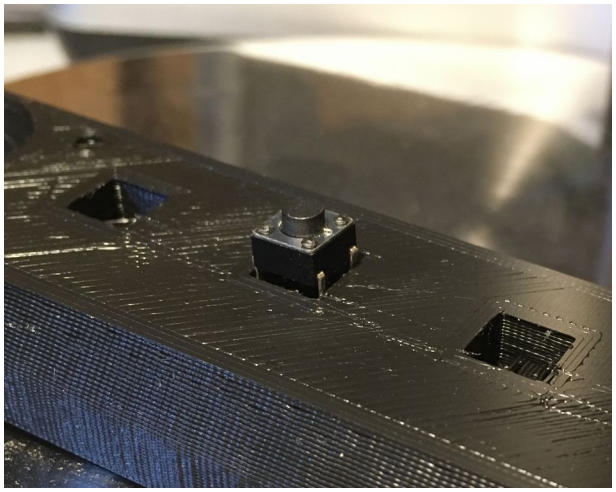
Building instructions

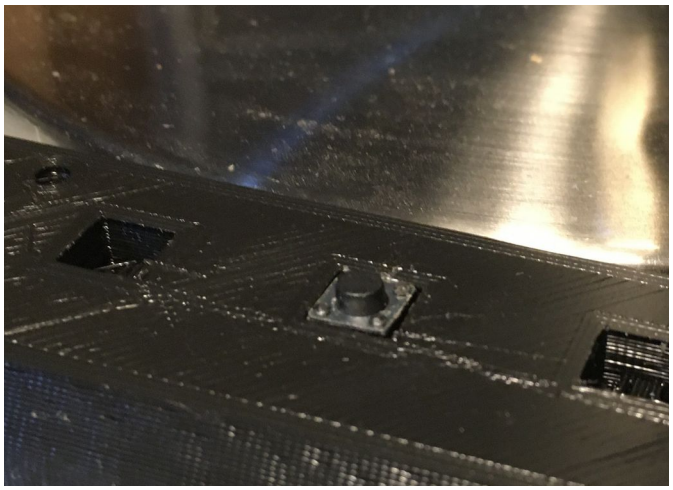
Step 1 – Check part fit

Before you get started, it would be a good idea to make sure that all of the parts fit into the printed slots well enough. Here is what to look for.

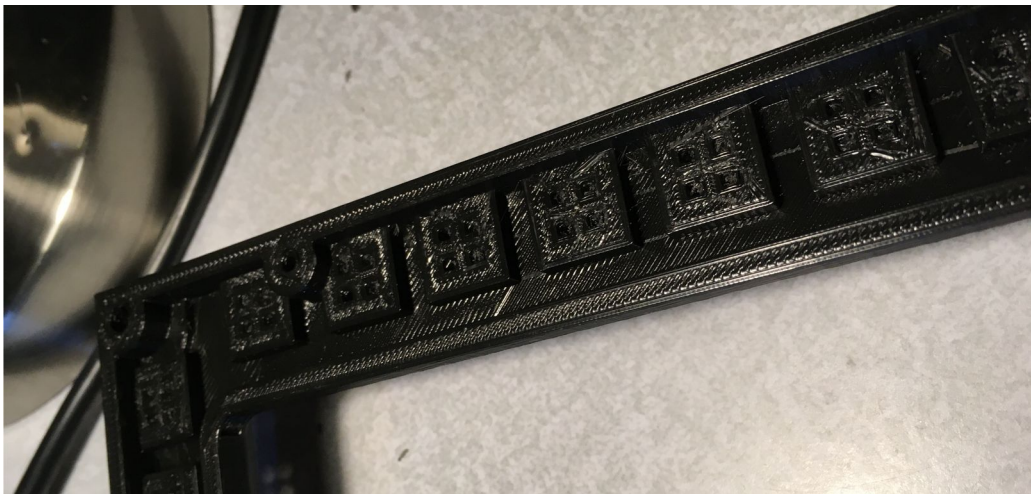
Tact switches:
The fit should be snug enough to retain the switch, but not quite tight. A loose fit is acceptable. However it may make installation somewhat more difficult if the switches are not retained by friction.

The top metal plate of the switch should be approximately flush with the edge of the cavity.



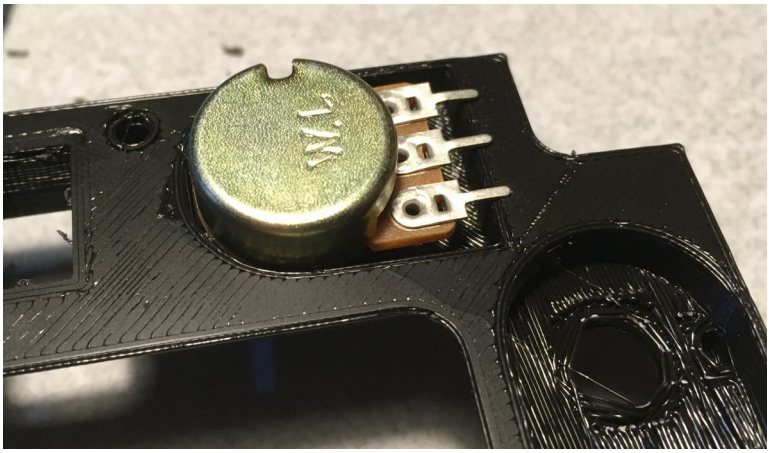


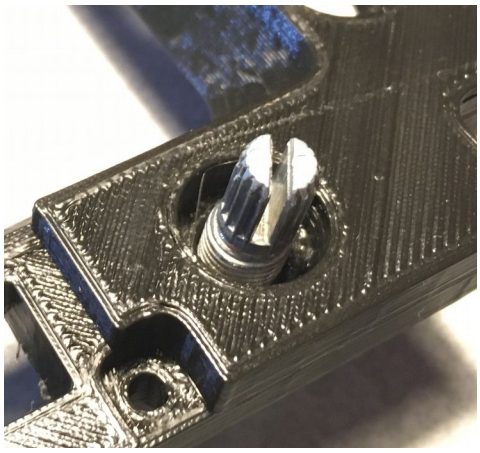
If your tolerances are a little tight or you have stringing (like I had here) you may want to drill out the four holes for the switch leads on all the slots to avoid headaches later.



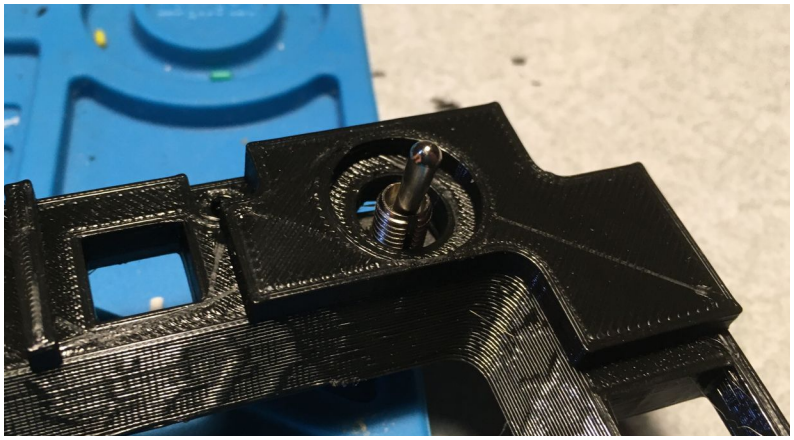
Potentiometers:

This fit isn’t very critical. Make sure the shaft can get through the cutout. Don’t worry about the pins; we’ll remove them later.



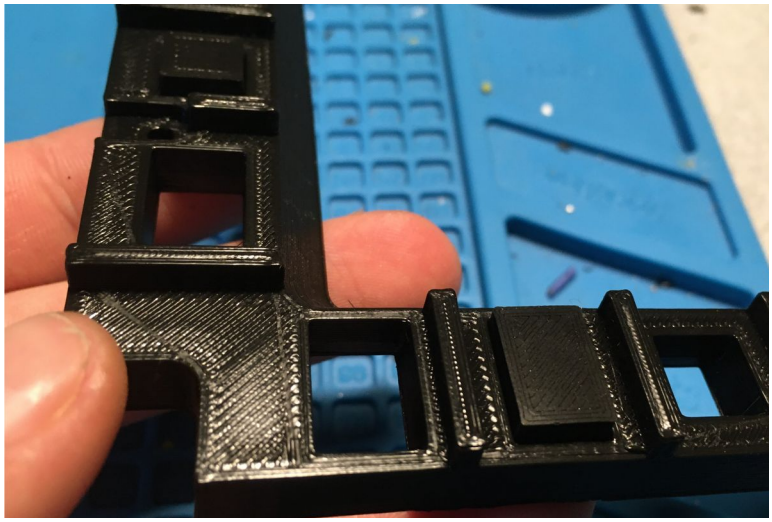


3 Position switch:
I haven’t tested this fit with the correct switch yet, so hopefully it will work.



Button caps:

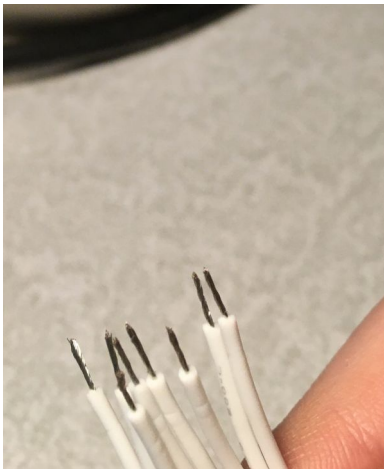
This fit is essential to good feel, but also the easiest to adjust. The button caps should move freely inside the channels.
If the button caps won't go in at all or get stuck a lot, reprint with reduced scale or sand the edges down with sandpaper.

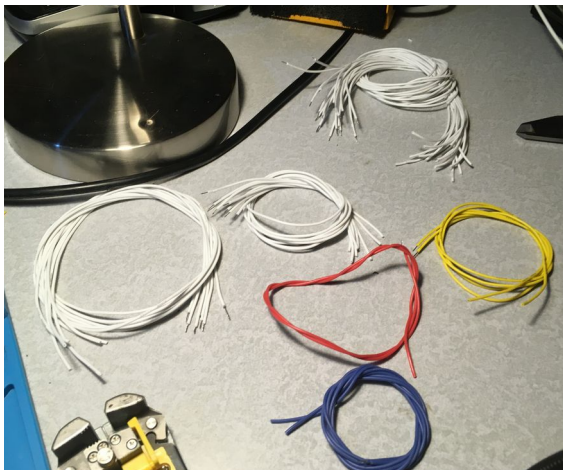


A small hang-up due to print artifacts was normal for me. If the button cap doesn't want to go in freely at first, try pushing it past the first few millimeters, then check for free movement again.

Step 2 - Strip wire ends

Strip approximately 5mm of insulation off one end of all wires except the *Ground connector wire*.
Twist the wire strands enough that they will stay straight during the next step.





Step 3 - Tin wire ends

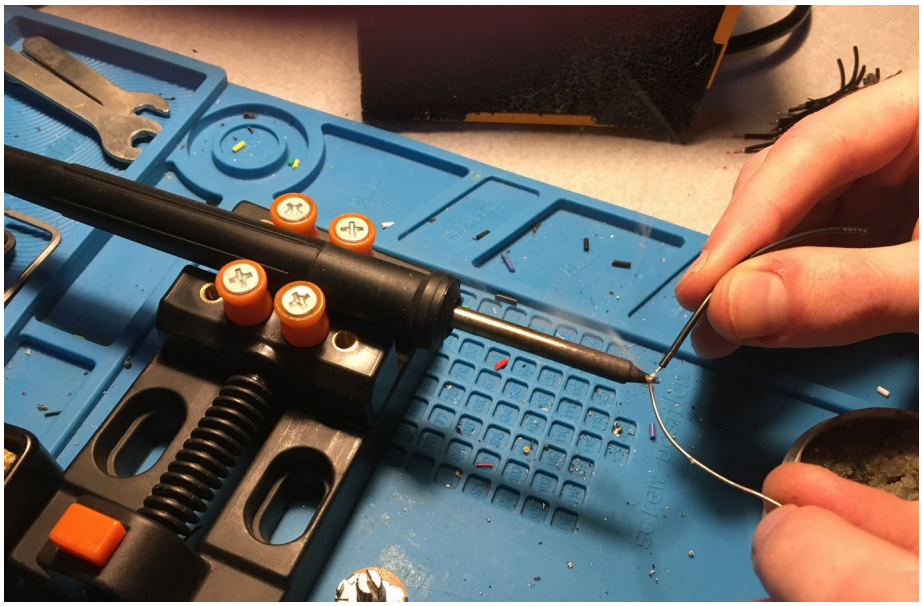
First, we will need to set aside some wires because we will be crimping a connector to both sides of them, and do not want to tin them.

Set aside for later:

3x *OSB/switch ground lead* (short, black)
1x *Potentiometer 5v wire* (long, red)
2x *Potentiometer signal wire* (long, yellow)
2x *3 pos. switch signal wire* (long, blue)

Tin all the remaining stripped wires.

I found it easiest to set the soldering iron in a vice, hold the solder in my left hand, and hold the wire or bundle of wires to be tinned in my right hand.



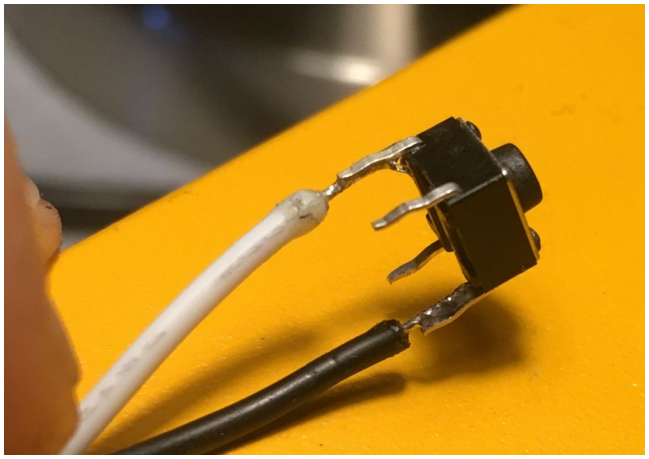
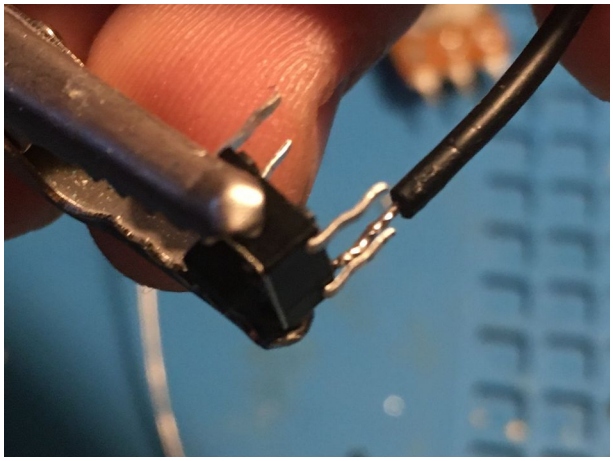
I dipped the wire to be tinned in flux, then touched it to the iron while applying solder until the solder wetted out on the strands.

You might figure out your own method for how to do this easily and quickly based on what is comfortable for you.

Step 4 – Solder wires to tact switches

First, straighten the leads on the tact switches with a pair of pliers. (If you have a loose fit with the middle frame, you may want to only straighten the two leads you'll be soldering to.)

Now solder one *OSB signal wire* (white) and *one OSB ground lead* (short black) to opposing corners, as shown in this image.

I recommend applying flux to the tinned wire ends and solder to the iron, then holding the tinned wire against the tact switch lead for soldering.

Step 5 - Install tact switches

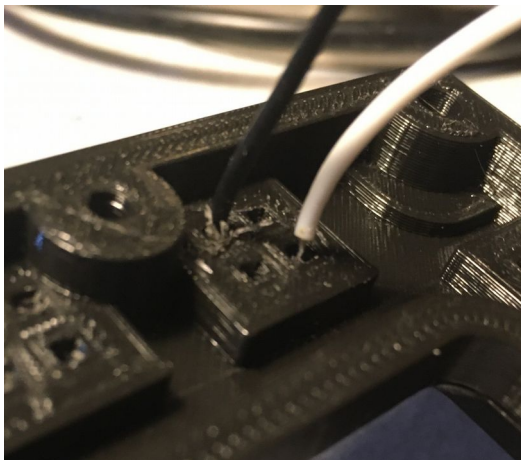
You should have three sets of tact switches with different length wires.

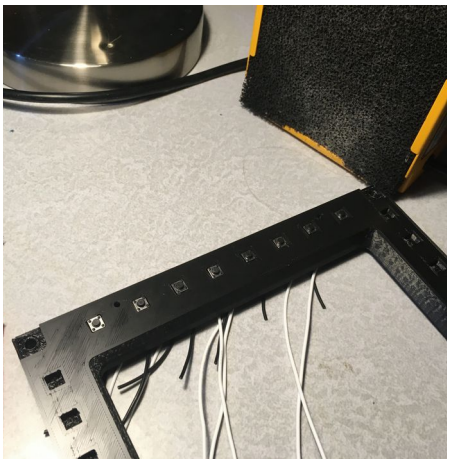
Install the switches with the long wires at the top of the frame.(In the 6 holes between the potentiometers and three position switch.)

Install the switches with the medium wires at both rows on the side of the frame. The right side has 9 buttons and the left has 8.

Install the switches with the short wires at the bottom of the frame.

Thread the white and black wires through the holes in the bottom of the switch cavity. The white wire should be inserted on one of the holes on the inside of the frame.





Ensure the tact switches are inserted into the cavities in the frame so that the top metal part is flush with the frame edge.

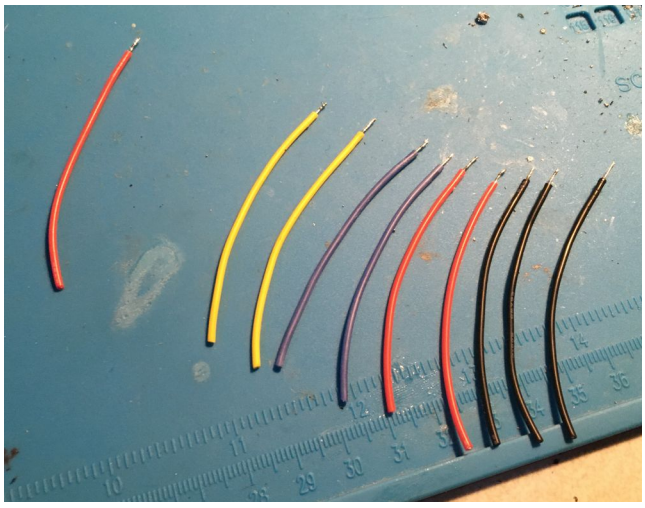
Installation might be difficult if your solder joints are large or your fit with the frame was tight. Take care to ensure the unused pins are going through the holes and are not being crushed under the switch body.

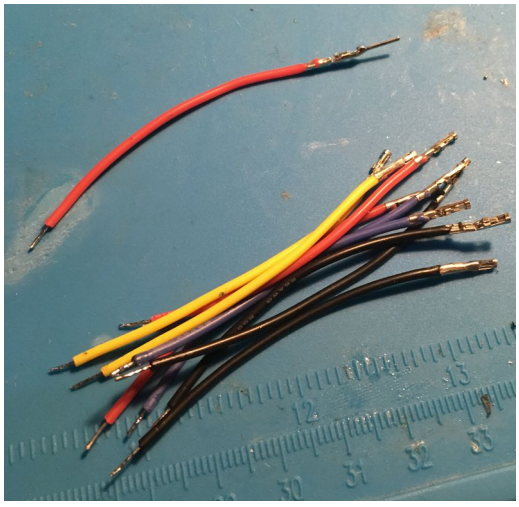
Step 6 - Add connectors to leads

Gather and strip 5mm of insulation off of:

- 3x *Ground lead* (black)
- 3x *Potentiometer 5v lead* (red)
- 2x *Potentiometer signal lead* (yellow)
- 2x *3Pos switch signal lead* (blue)

This should be all the wires except the *Ground connector wire* and the wires you set aside earlier.

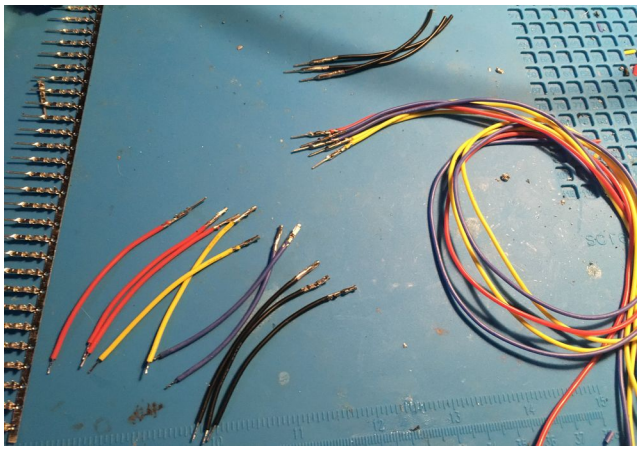




Crimp a female DuPont connector on to the non tinned side of all wires except one *Potentiometer 5v lead.*

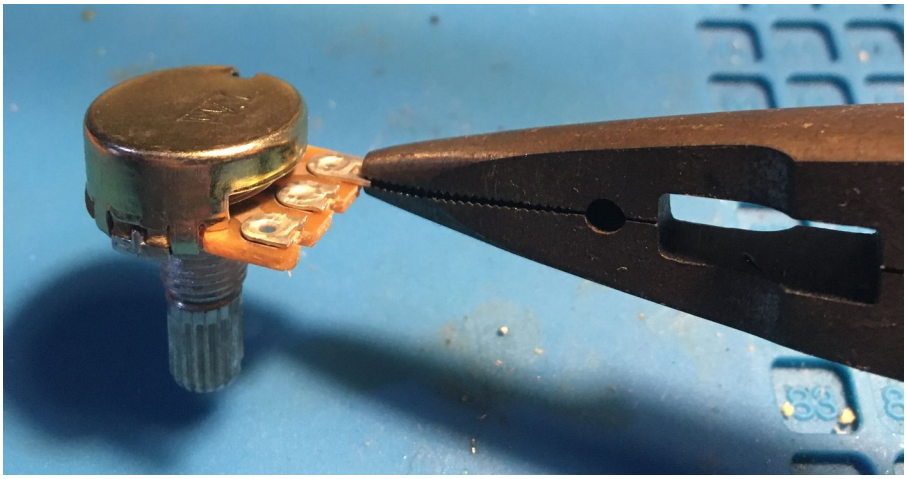
Now crimp a male DuPont connector to the remaining *Potentiometer 5v lead.*

Take the group of wires you set aside earlier, and crimp a male Dupont connector on to all of them.



Step 7 - Solder leads to switch and pots

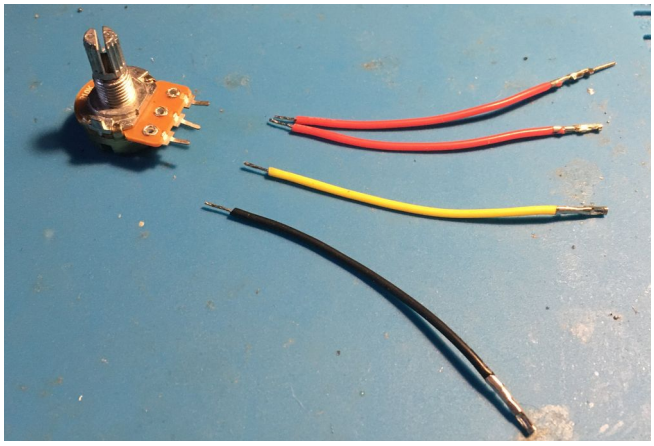
Remove the pins from the potentiometers. We will not have room to use them.

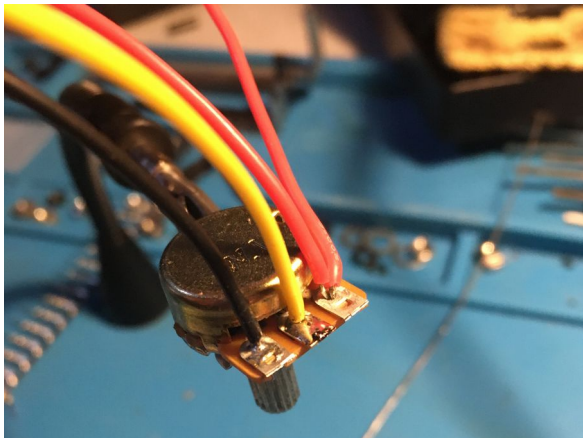


I recommend grabbing the pins with pliers and bending back and forth until they snap from metal fatigue.
Snipping the pins is also doable but watch out for the pin that is cut off as it can fly away very fast. (Eye hazard.)

Take one potentiometer and solder:
- *1x Ground lead* (black, female)
- *1x Signal lead* (yellow, female)
- *2x 5v lead* (red, 1x male, 1x female)

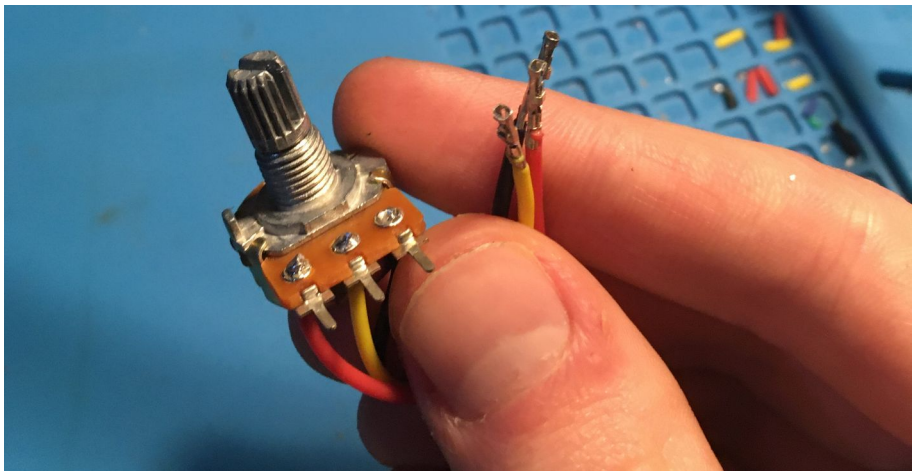
As shown in the image.



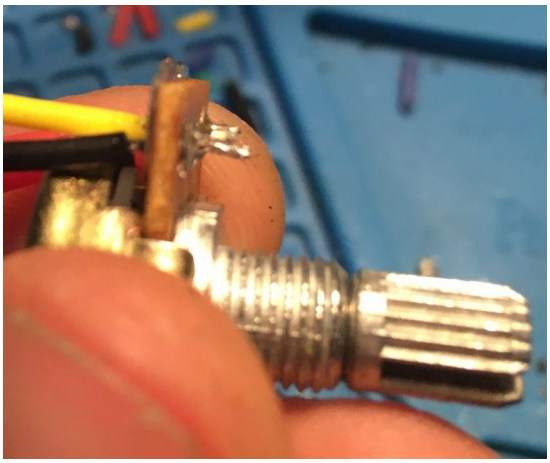


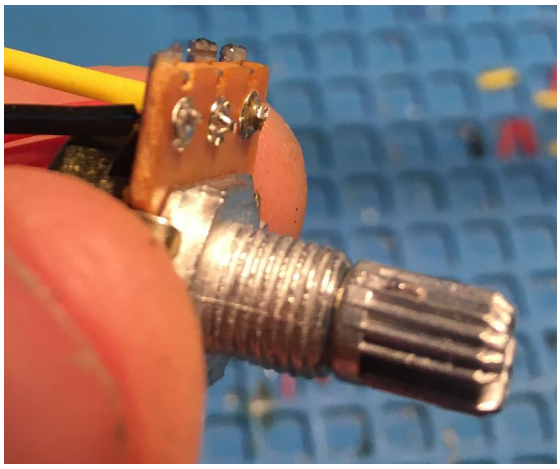
Take the other potentiometeter and solder:
- *1x Ground lead* (black, female)
- *1x Signal lead* (yellow, female)
- *1x 5v lead* (red, female)

As shown in the image.

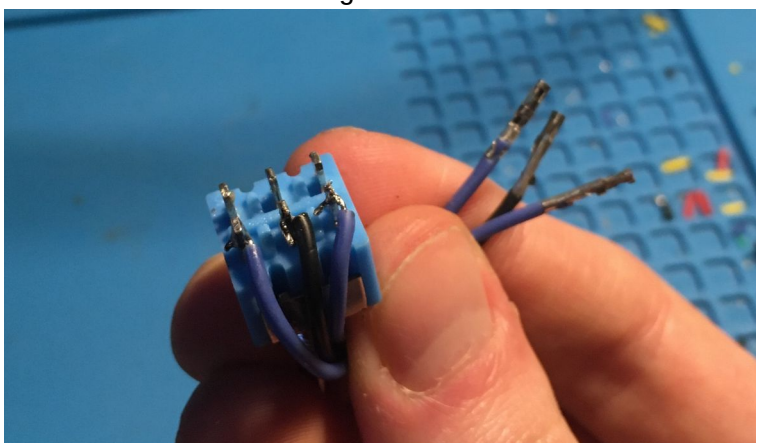


Clip off any long wire parts protruding past the top edge of the potentiometers.
(This is not best practice, but should do for our application. For extra reliability, reflow solder after clipping, or cut to length before installation.)





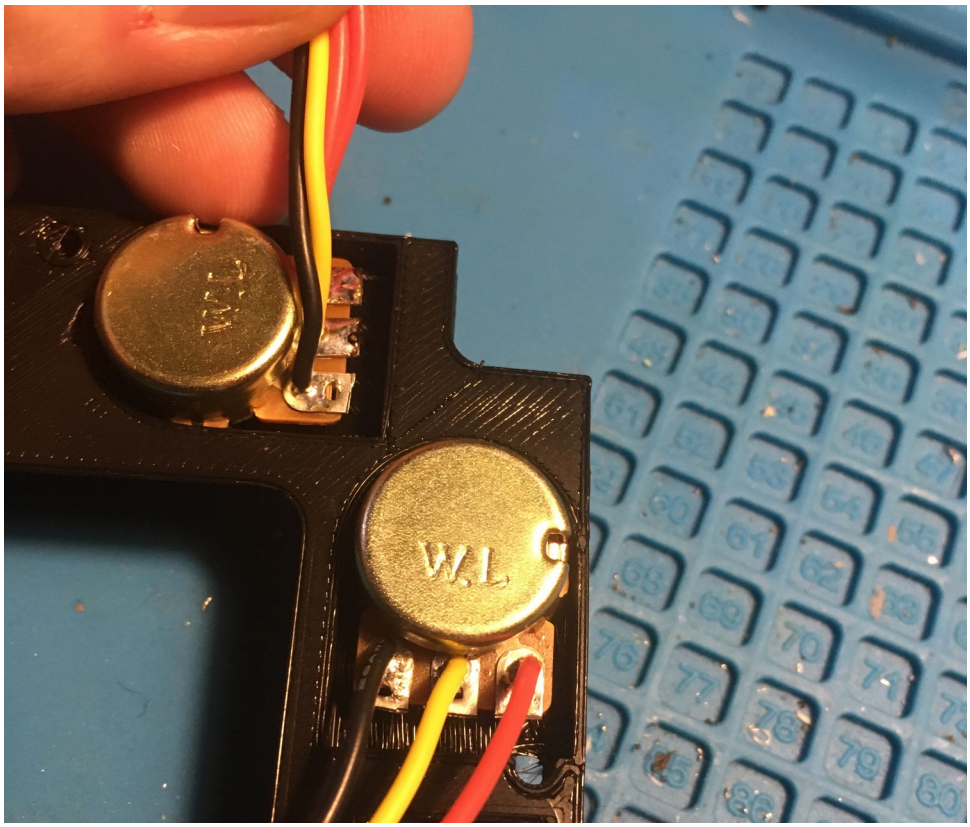
Take the three position switch and solder
    2x *3 pos. switch signal lead* (blue, female)
    1x *Ground lead* (black, female)
As shown in the image.



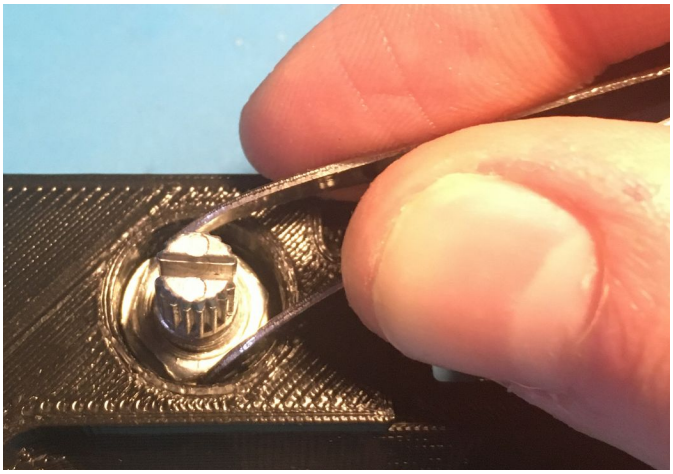
I am substituting a switch I have on hand for the SR1712F-0103 3 position switch specified on the datasheet, but the procedure should be pretty much identical.

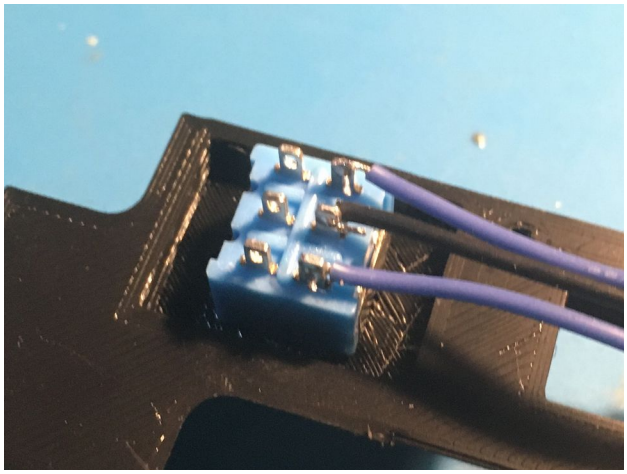
Step 8 - Install potentiometers and switch

Retrieve the front frame.
Install the potentiometer with 3 leads in the lower recess of the front frame. (For the BRT knob.)
Install the potentiometer with 4 leads in the upper recess. (For the VID knob.)

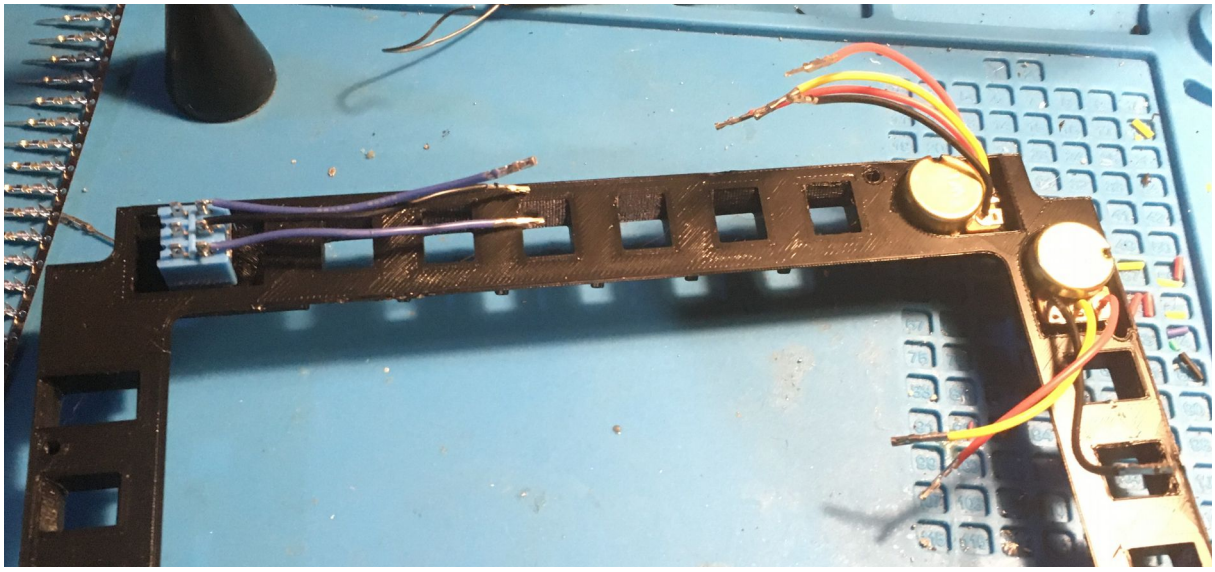


The installation procedure should be fairly simple. Just twist on the nut with some tweezers. The nut should spin freely up until it is tight. Be careful not to apply too much pressure and damage your tweezers.





Install the 3 position switch as described above.



Step 9 - Initial cable management

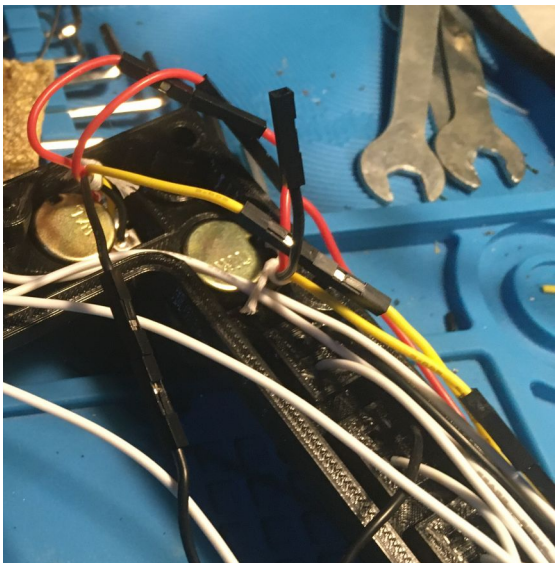
Take the front frame and install it over the middle frame. Once you thread the wires for each component through their corresponding holes the two frames should simply slip together.

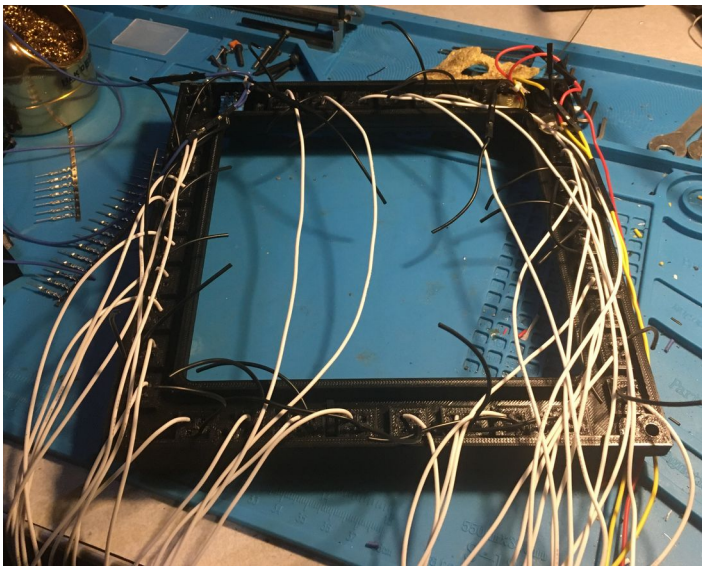
Set the two frames down on your work surface.

Plug in the wires for signal and supply to the connectors on the potentiometers and 3 position switch.

Tuck the connectors in so they are not in the way.

Now you should be ready to begin cable management.

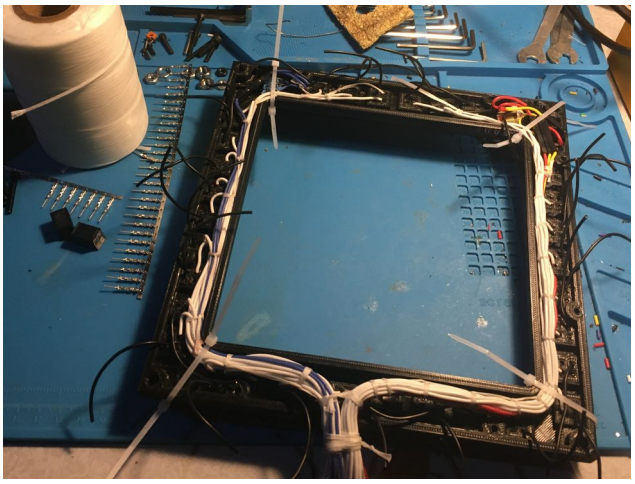


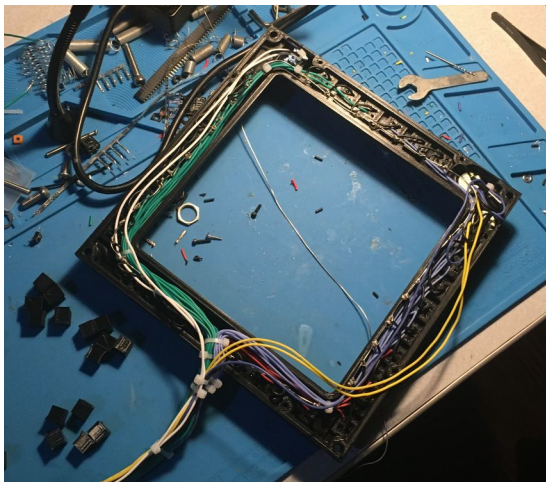


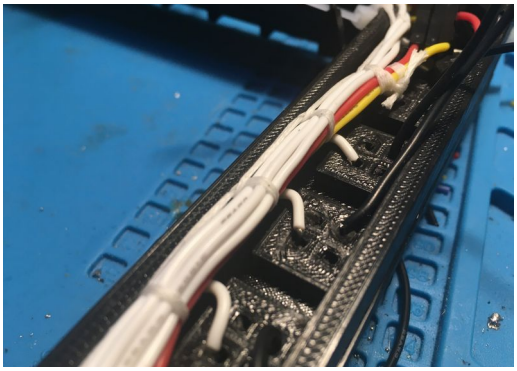
For this build, I used cable lacing. But zip ties also work fine.

You should have two main bundles of cables, one for the left, and one for the right. Split the wires at the middle of the six top OSBs and work your way down following the frame of the case.

The critical points for cable management in this build are the corners. Make sure you secure the wires there. If you really want to go for minimal cable management, a few zip ties at the corners would be sufficient, but more cable ties placed on the straight runs are suggested.



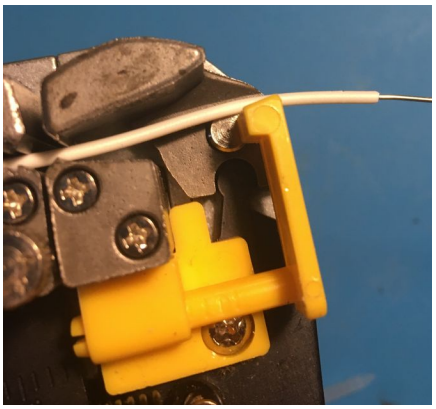
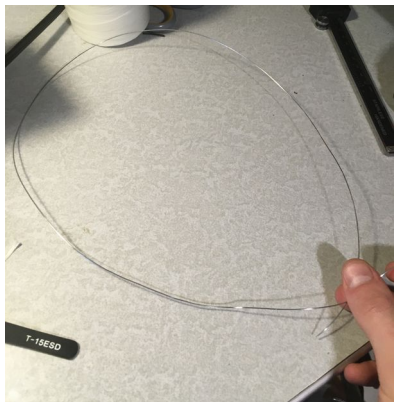




Step 10 - Add main ground conductor

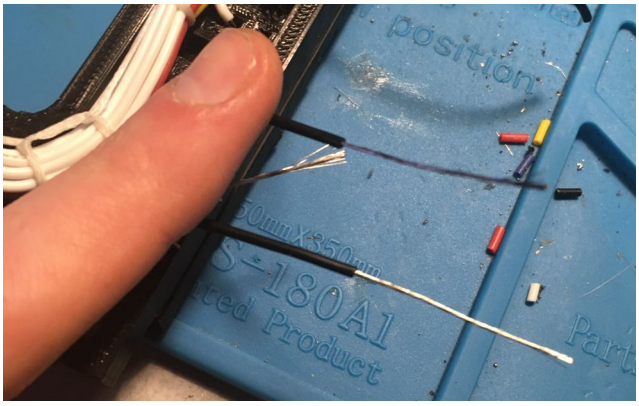
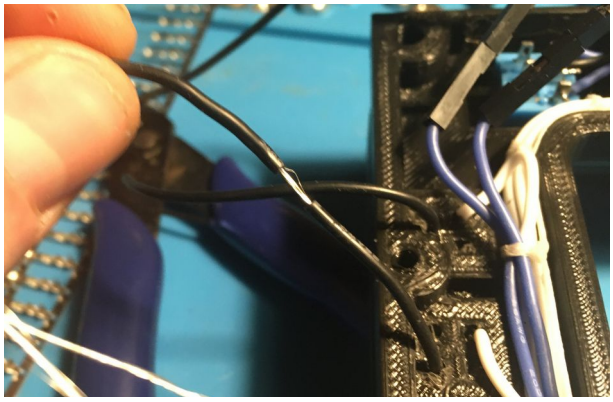
Prepare the main ground conductor.
I didn't have any bare wire of the right size so I had to strip some. I found it is easiest to strip the insulation in small sections and pull one or two off at a time.

Now, using the frame as a guide, bend the bare wire into a square shape, and twist the ends around to form a loop as shown in this image.

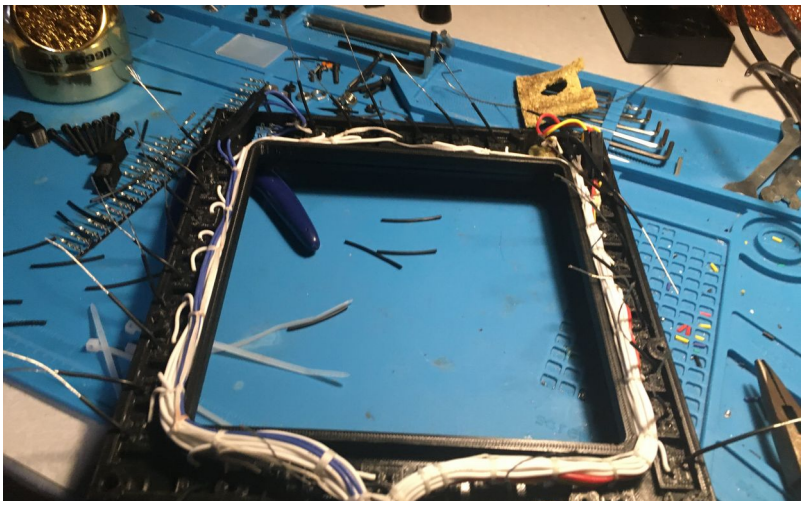

Step 11 - Tie off grounds

First, we will need to strip the ground leads so we can lash them on the main ground conductor.
Strip off around 30mm of insulation from all the wires, twisting the strands to prevent fraying. Do not remove the insulation completely after stripping: Leave it on the end, and use the improved grip the insulation provides to twist the strands.

Now that we have all of the leads prepared, we can lash them to the main ground conductor.

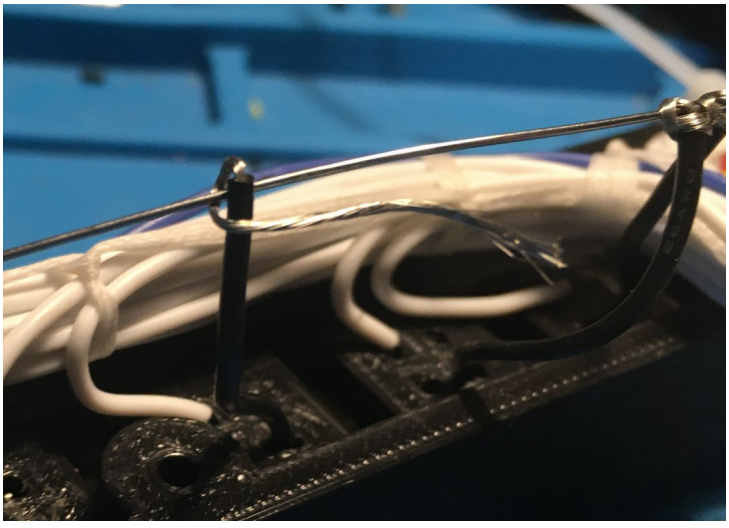
Install the main ground conductor with the join at the bottom of the frame near where the cables meet.



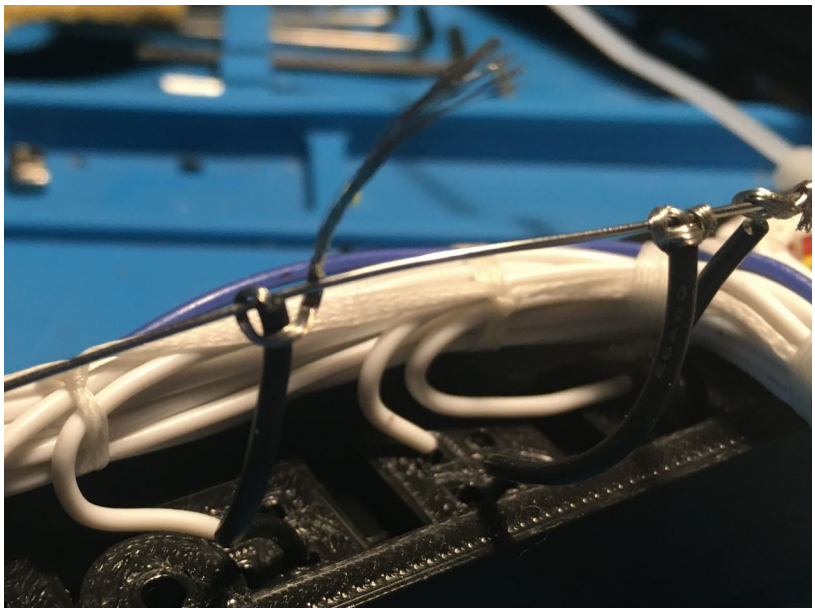
Now we are ready to tie off the grounds.

First, bring the lead to the outside of the main conductor.

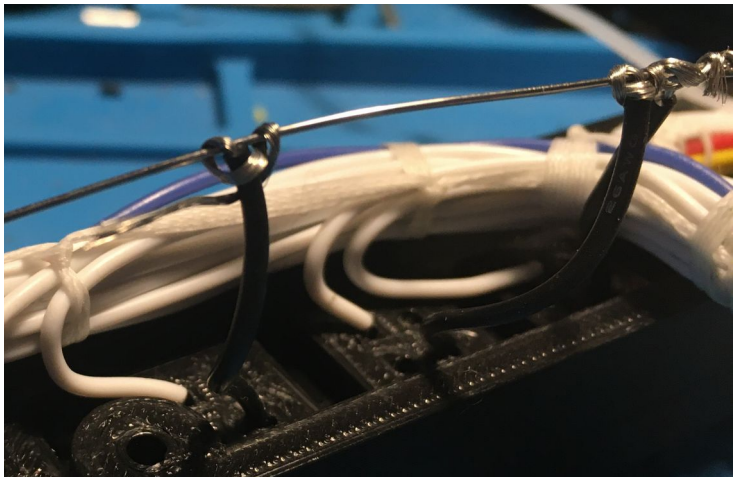
Loop the lead around the left side.



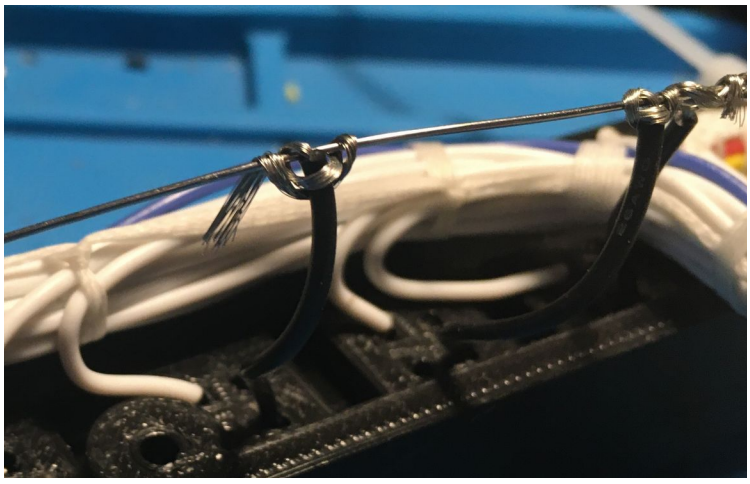
Bring the lead down around the front of the tie, and back up behind the right side.



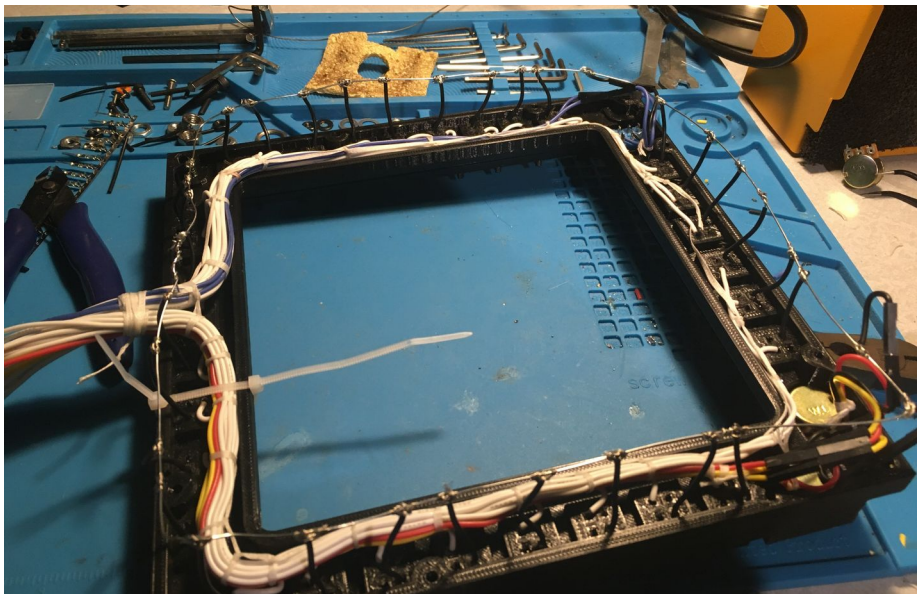
Now bring the lead down again over the right side, looping around the main conductor, and around the back of the tie.

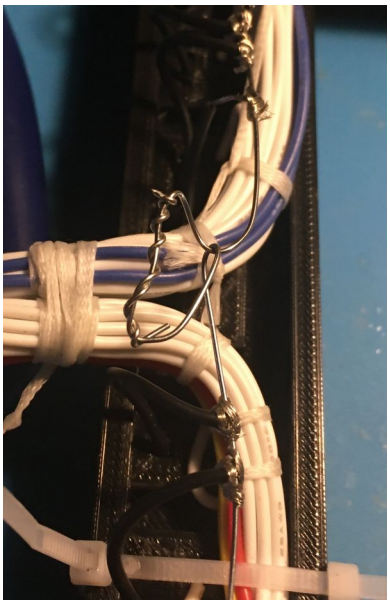


Finally, bring the lead over the main conductor on the left side. Wrap any excess around the knot.



Repeat this process for all of the ground leads. (Including the ground connectors for the potentiometers and 3 position switch.)
You should now have something resembling this.

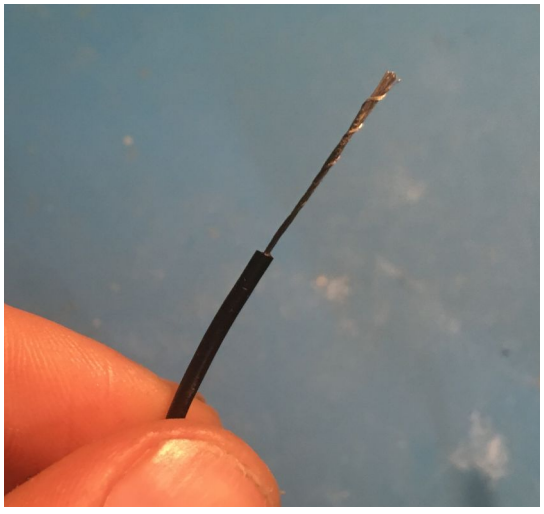


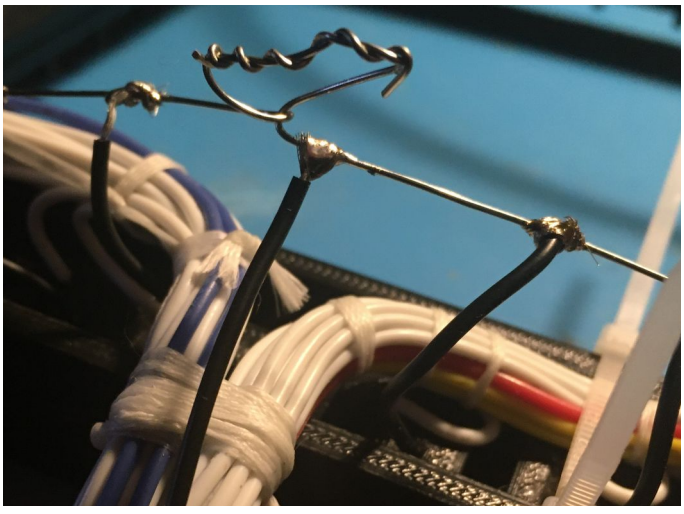


If the main ground lead is too long, you can twist it at the bottom near the join to tighten it up.

Step 12 - Install ground wire for loom

Strip 30mm of insulation off the *ground connector wire.* (black)



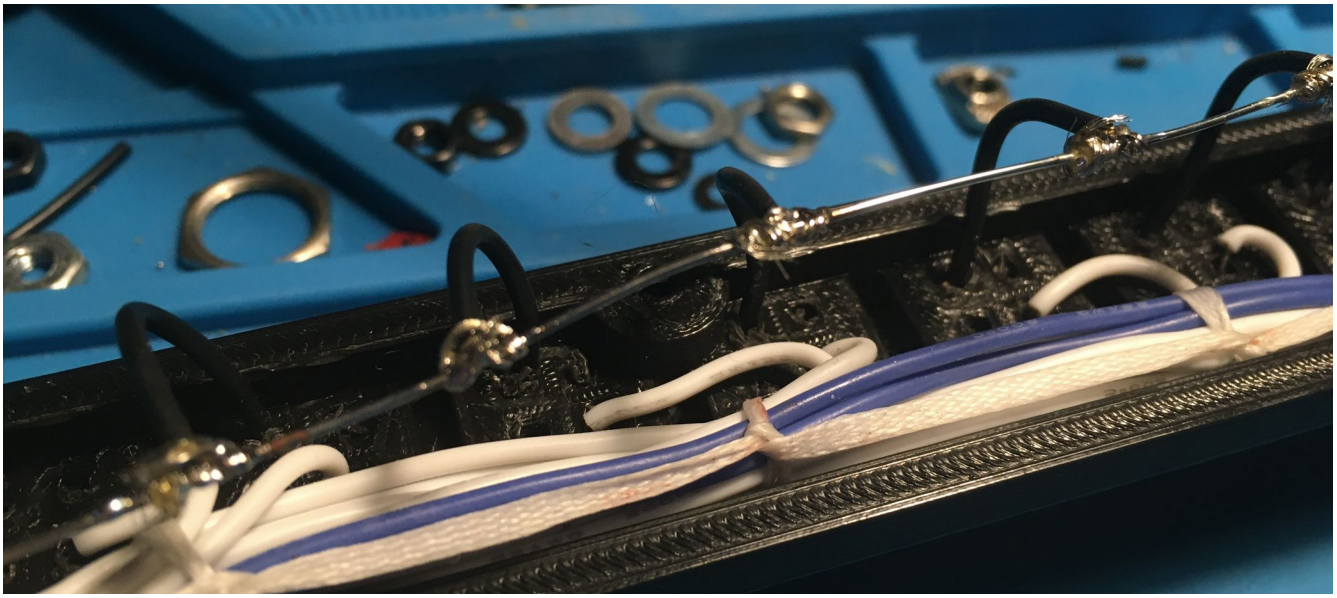


(This photo is from after soldering,but it is the only one I have)

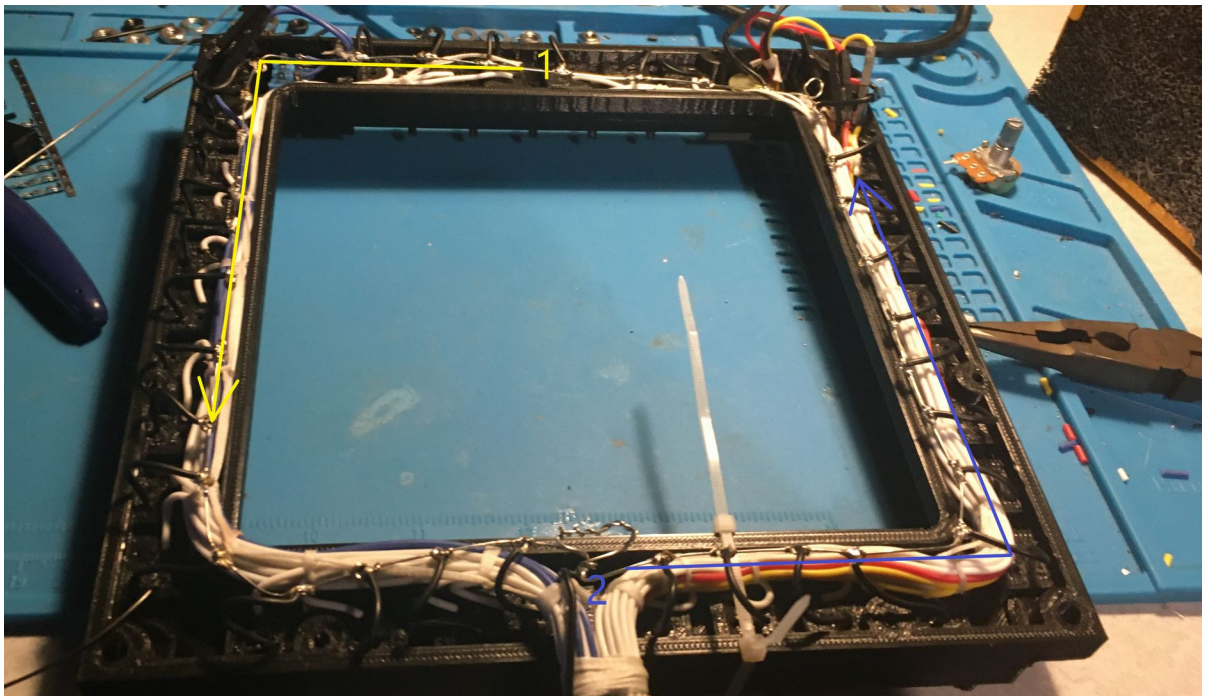
Lash the ground connector wire to the main ground conductor at the join. (Same lashing procedure as last step.)

Step 13 - solder grounds

Solder all the lashed wires to the main ground conductor.



Be careful while adding solder to avoid dripping solder on the wires or plastic casing.
I suggest starting from two points and moving back and forth to avoid heat buildup



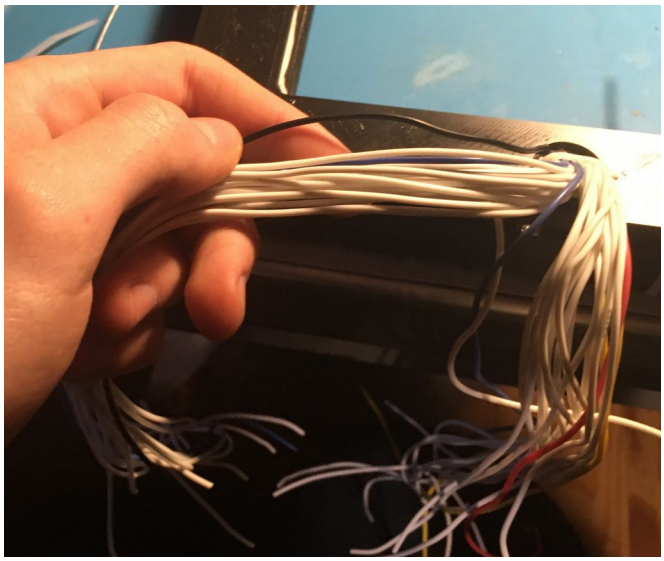
Once you are done, check each connection by attempting to slide it back and forth a bit.

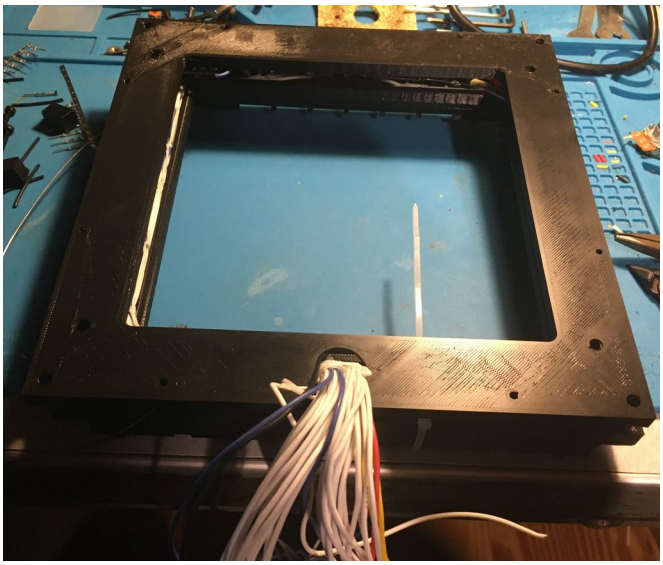
You may also want to tie the main ground conductor to the wire bundles for more stability.

Step 14 - Install back cover

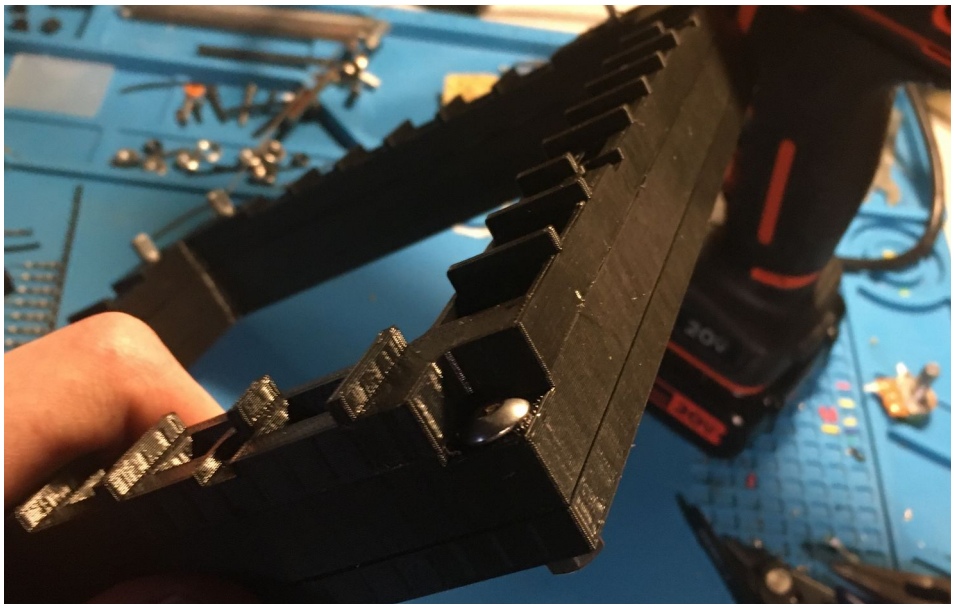
Take the wires at the bottom and thread them through the wire hole in the bottom plate.

Now, align the back cover with the middle frame, ensuring that no wires are squished between the two.





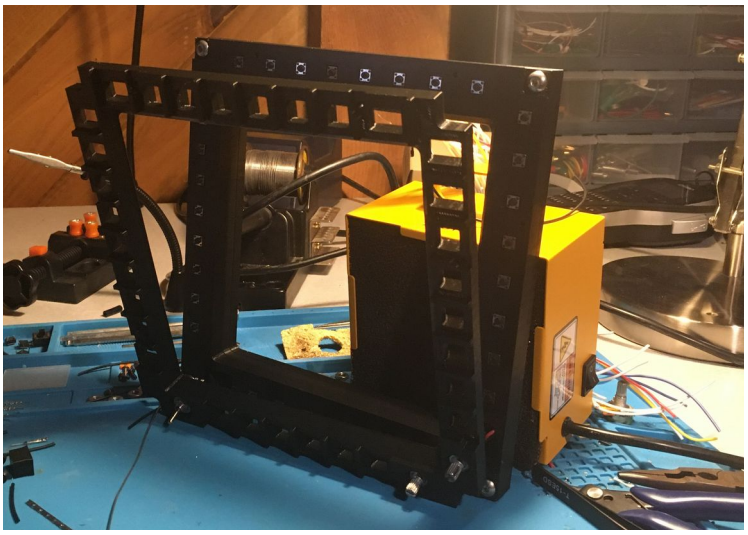
Once they are aligned and close to flush, temporarily secure the back cover with fasteners or zip ties in the mounting holes.



Step 15 - Install button caps

Slightly lift off the front frame to allow space to insert the button caps.

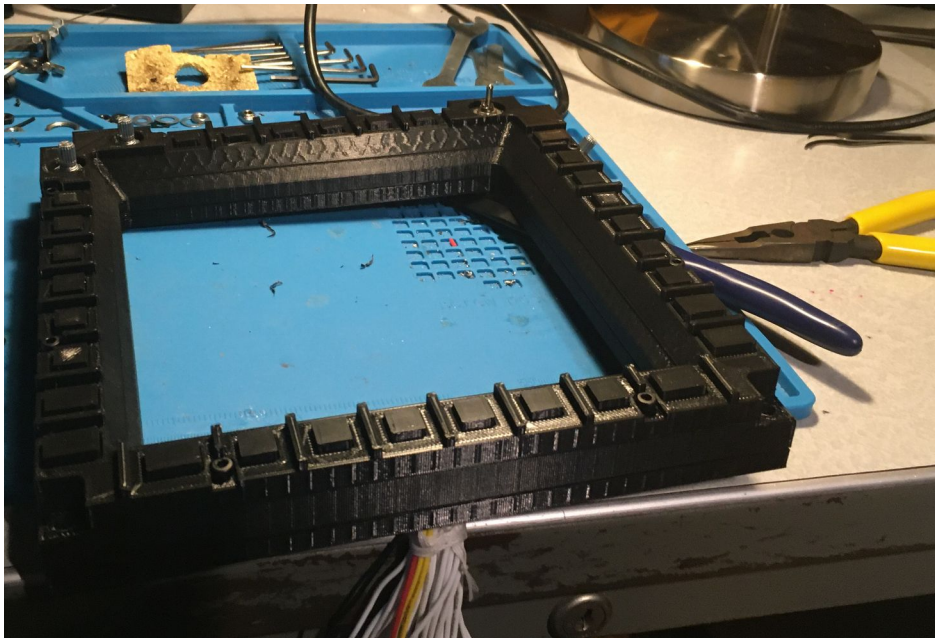
Insert the button caps into the spaces in the frame. This step is easiest if the MPD is vertical, with the front frame hanging down slightly as shown here:



If a button cap doesn't fit in a slot, try a different slot or a different button. Slight variations in the prints can affect fit.

Step 16- Final bolt installation

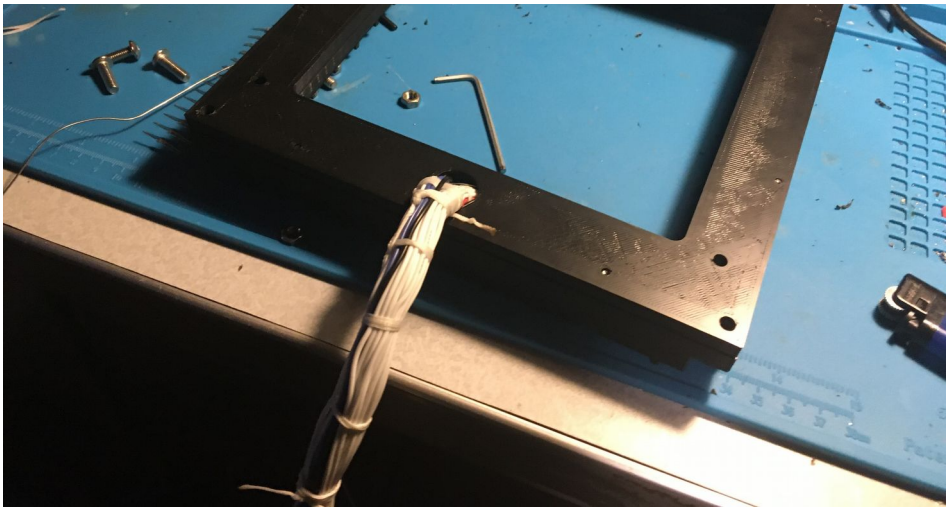
Install the 8x M3x25 bolts into the holes in the frame.
Tighten down until the bolts are snug. (No torque specs here, sorry.)



You can now remove any temporary fasteners from the previous step.

Step 17 - Cable management II (Electric Boogaloo)

use your preferred cable management solution to groom the main wire loom coming from the MPD.



Step 18 – Check button feel

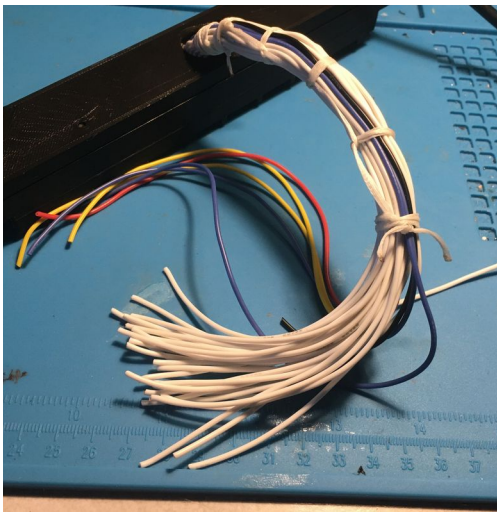
Ensure that all buttons can be pressed easily and return to the released state after being pressed.

If some buttons stick or can’t be pressed, you can remove the top plate and swap the caps with other button caps that have a looser fit.
You can also reprint the button caps scaled down slightly.

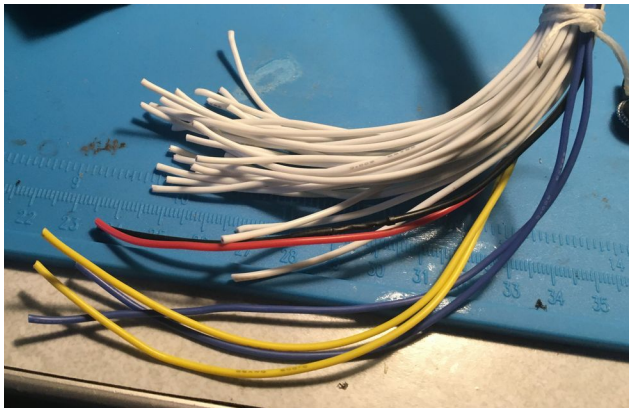
Step 19: - Connector installation

The details of this step may vary somewhat depending on the electronics you intend to connect the MPD to, but here is what I did:

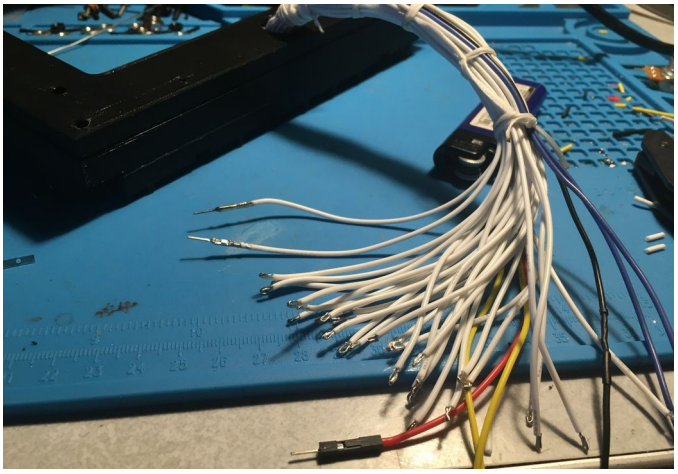
Cut all white wires down to the length of the shortest wire.



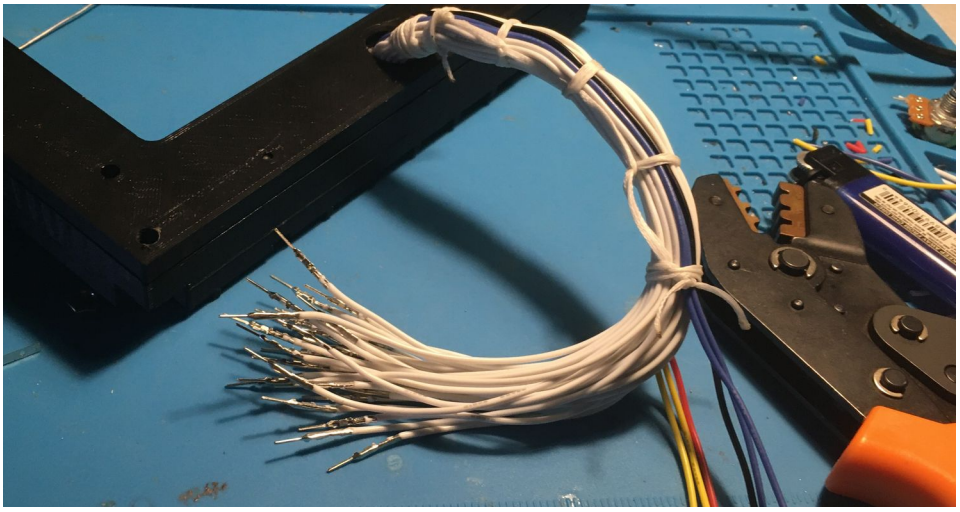
Trim colored wires. (Allow room for the longer path to their connectors.)



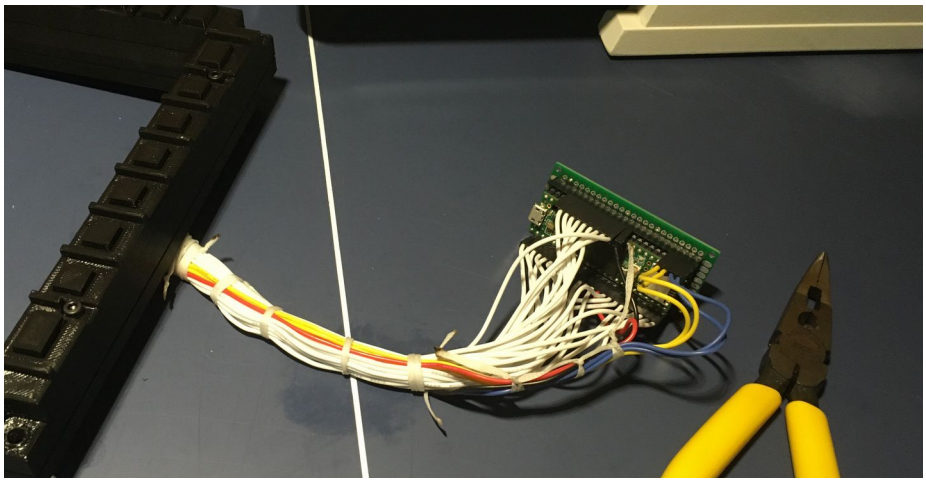
Strip insulation on all wires and prepare for crimping.



Crimp male connector onto all wires.



Install connector housings.



The MPD frame should now be complete.

This build guide does not cover connection to a controller because of the variety of solutions people are likely to use.

I have included a brief overview of my setup, along with my code files, in the electronics sub-folder in case you would like to review it.