

Build instructions

October 9, 2023

1. Disassembly of Frame

To begin, we will assemble the frame of the BioCloneBot. Start by opening the Ender 3 Pro box and removing all of the parts.

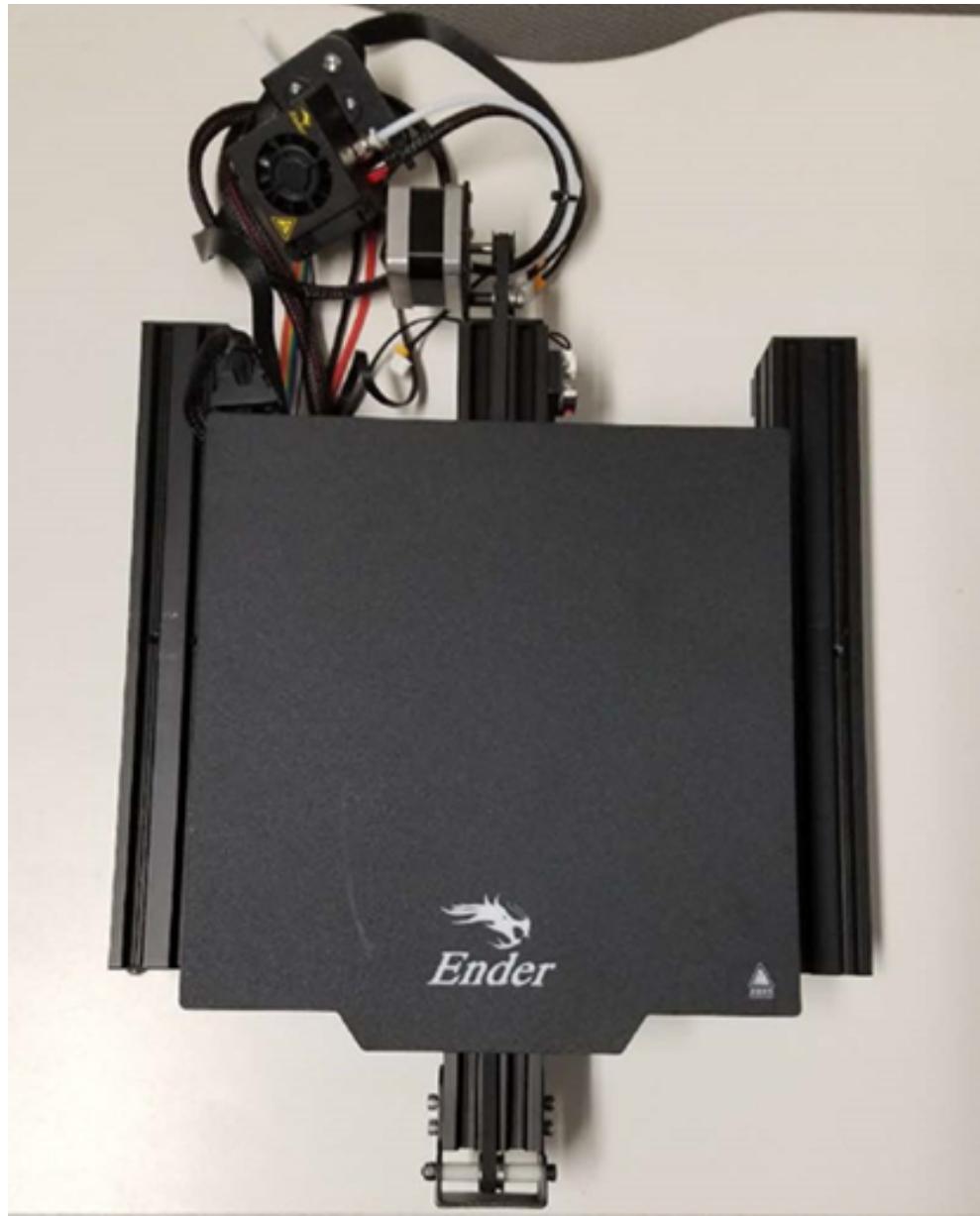
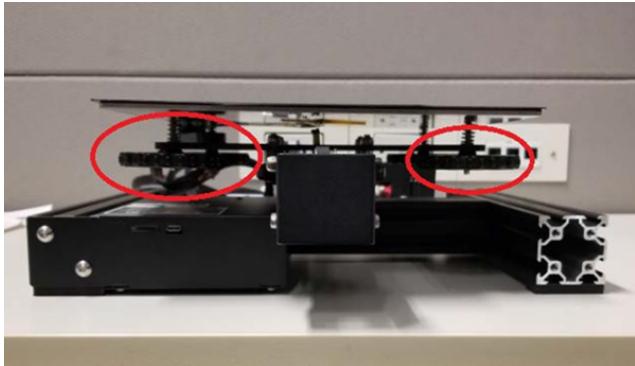


Figure 1: Enter Caption

Remove the four knobs from the bottom of the Ender 3 Pro Base. Make sure not to lose the springs. Put the knobs and springs aside for later.



(a)



(b)

Figure 2: Ender 33 Pro base knobs

Carefully remove the Ender 3 Pro bed and place it to the side.

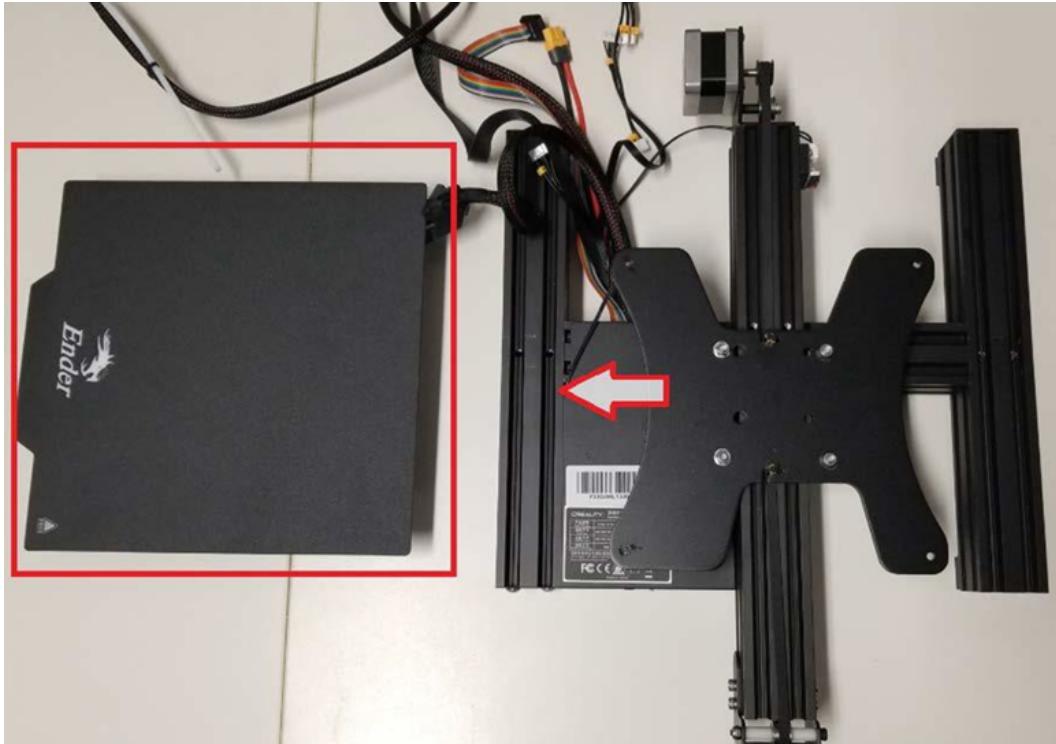


Figure 3: Ender 3 Pro Bed removal

Before removing the Y-Axis belt tensioner, feel how tight the belt is. The belt needs to be approximately this tight when attaching the new larger Y-Axis belt from the Ender Xtender kit. Remove the four screws from the Y-Axis Belt Tensioner and place them to the side for later use.

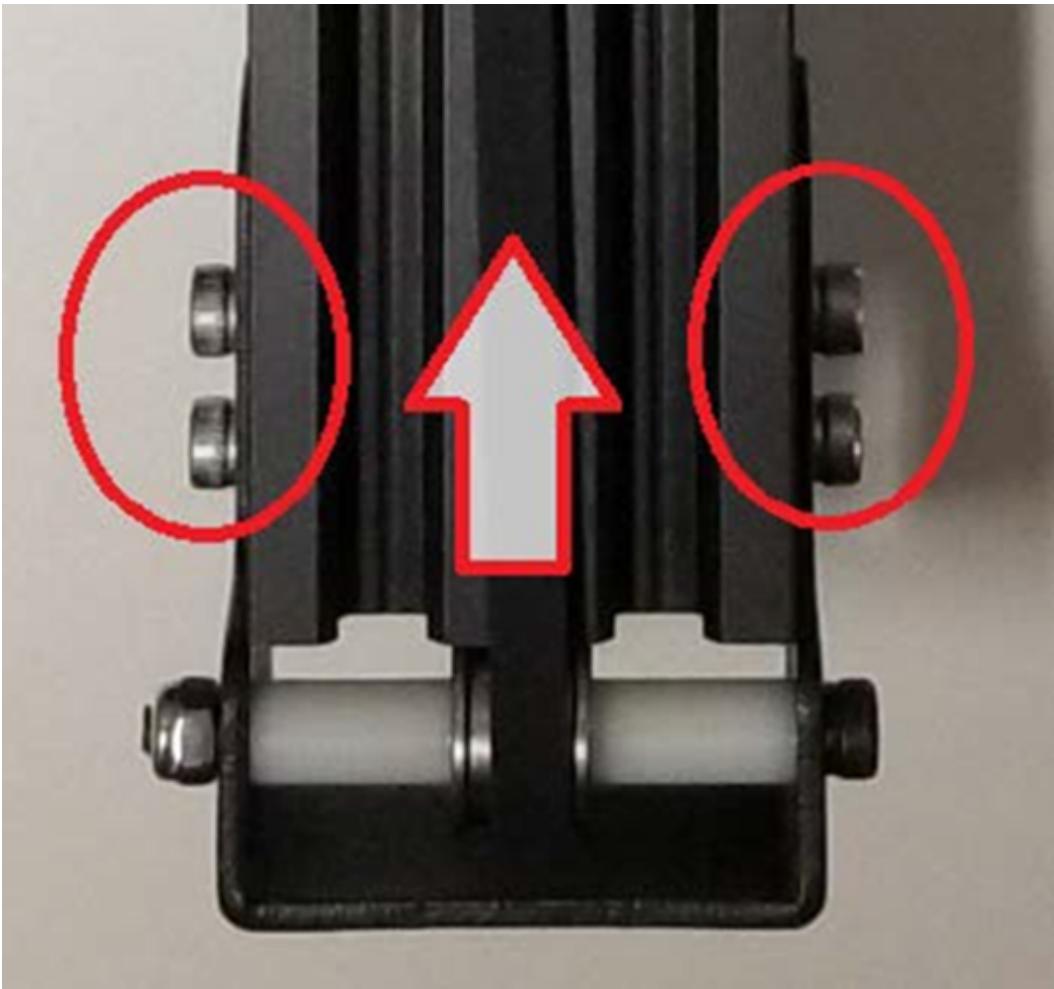
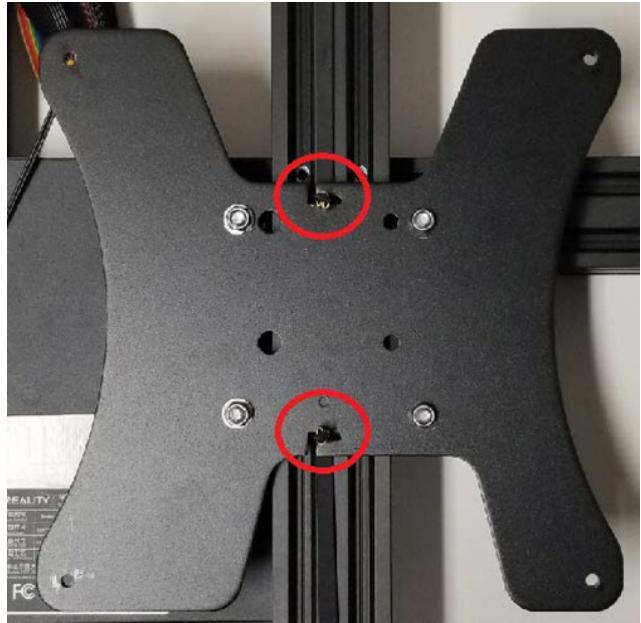


Figure 4: Y-Axis Belt Tensioner removal

Unhook both ends of the Y-Axis belt from the Y-Axis Carriage. Carefully remove the Y-Axis Belt Tensioner from Figure 5b. Place it with the four screws removed from earlier.



(a)



(b)

Figure 5: Y-Axis Belt Tensioner removal

Remove the Y-Axis Carriage from the frame and place it aside for later.

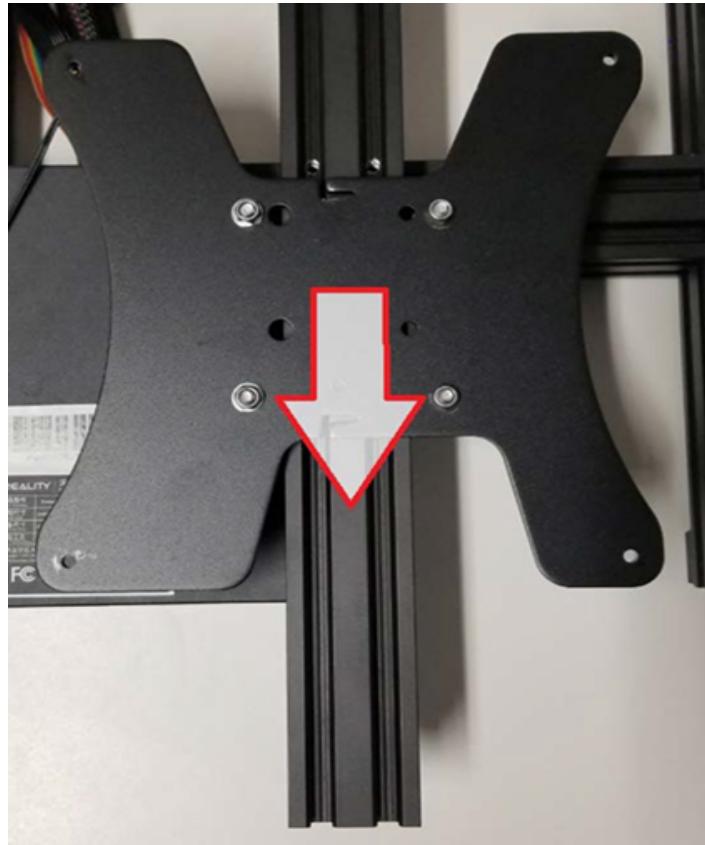
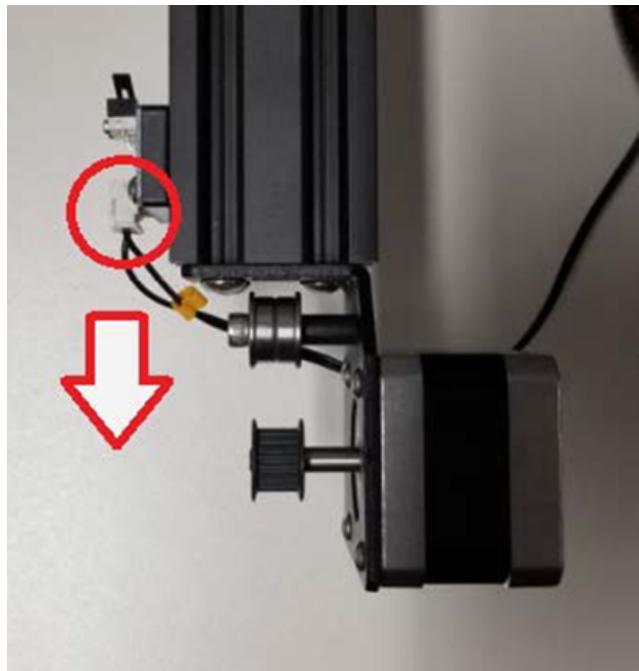
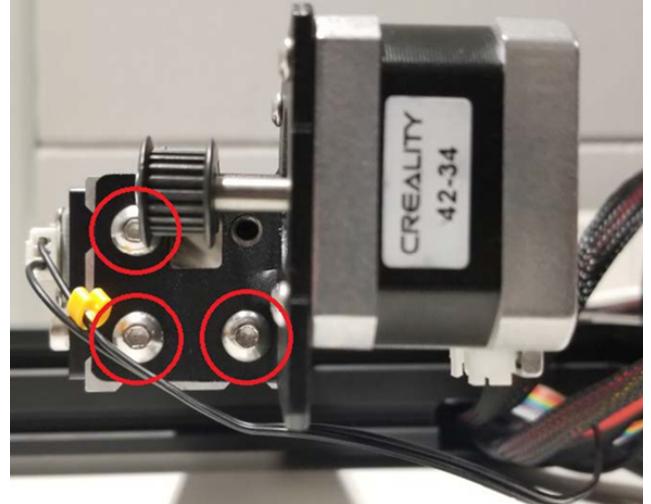


Figure 6: Y-Axis Carriage removal

On the back of the base, unplug the Y-Axis Limit Switch Connector then unscrew the three screws holding the Y-Axis Stepper Motor. Put the Y-Axis Stepper Motor and the three screws aside for later.



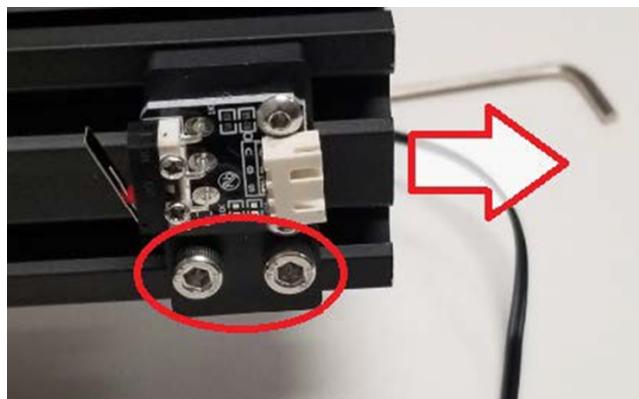
(a)



(b)

Figure 7: Y-Axis Stepper Motor removal

Remove the Y-Axis Limit switch by unscrewing the two screws and sliding the switch off the extrusion. Place the limit switch, screws, and t-nuts aside for later.



(a)



(b)

Figure 8: Y-Axis Limit Switch removal

Next, we will remove the electronic housing. Remove the two screws from the bottom and the three screws from the top of the electronic housing.



(a)



(b)

Figure 9: Electronic Housing removal

Carefully remove the bottom cover of the housing. Unplug the fan before completely removing the cover.

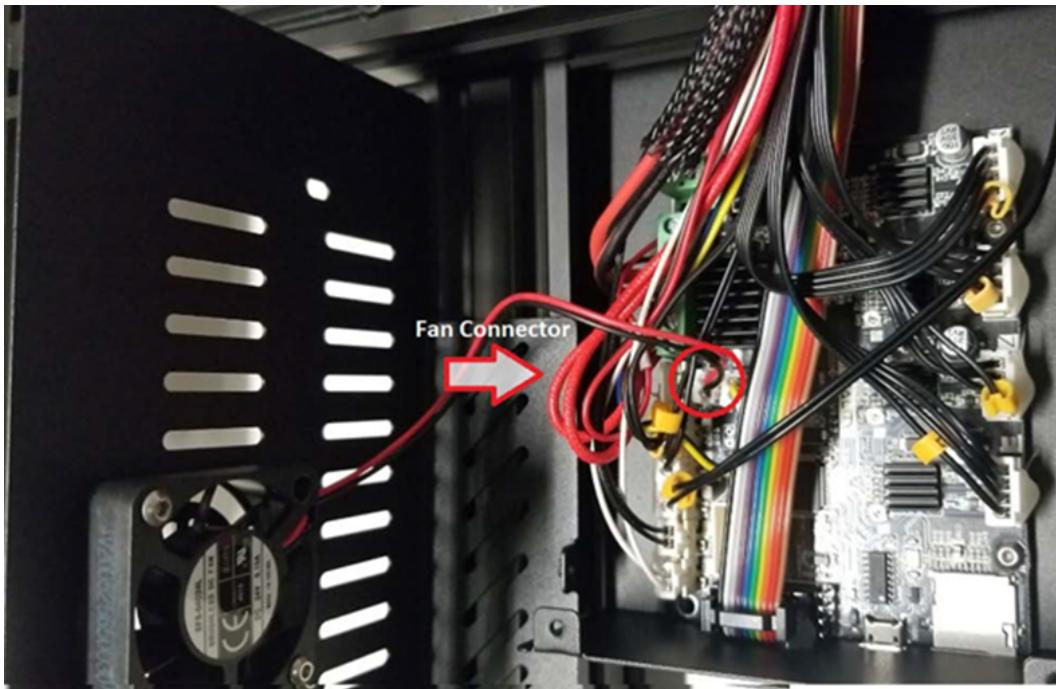
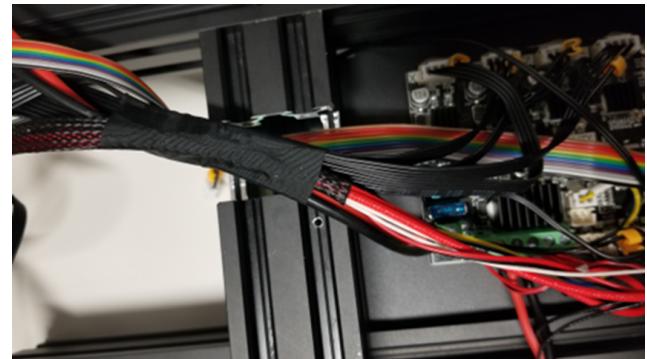


Figure 10: Housing Fan removal

Remove the two screws from the front of the Electronics Housing. The housing will no longer be attached to the frame. Remove the wiring bundle from the notch in the bottom of the frame.



(a)



(b)

Figure 11: Electronic Housing removal

Find the extruder from the big mess of wires left over. Remove the two small screws from the cover then remove the cover. Remove the two small screws holding the metal heater. You will be left with the X-axis roller. Put this aside as we will attach the syringe pump to this x-axis roller later on.

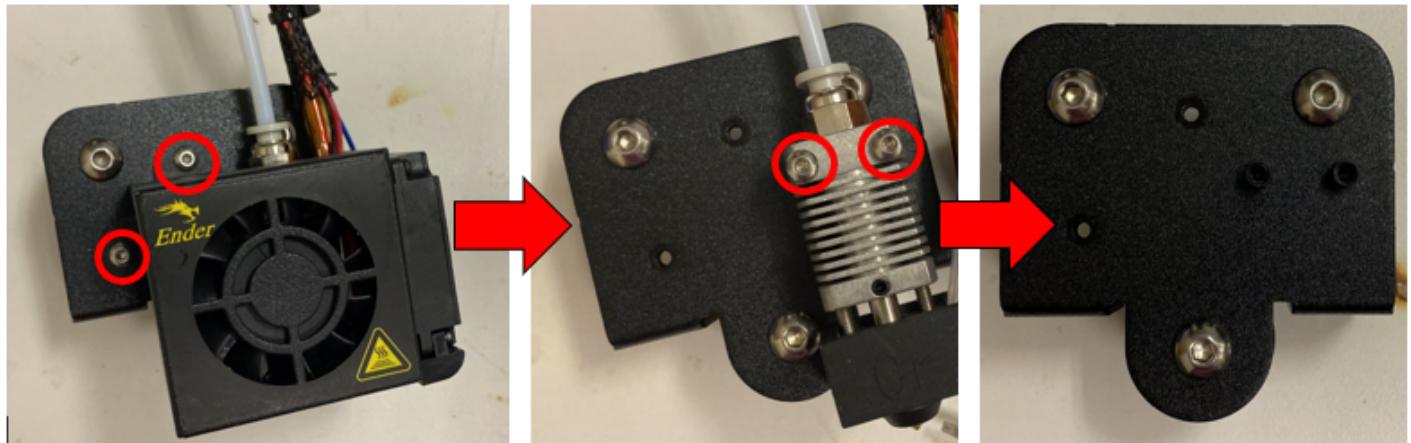


Figure 12: Extruder removal

Now, open up the electronics bay like so.

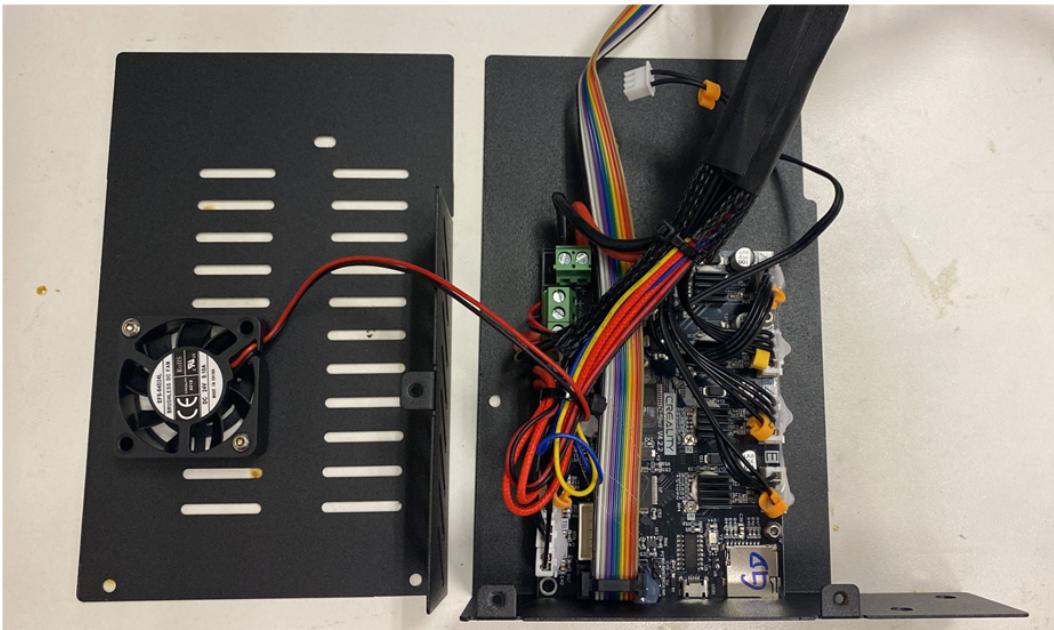


Figure 13: Electronic Bay

Cut the zip ties and remove the tape from the wire bundle.

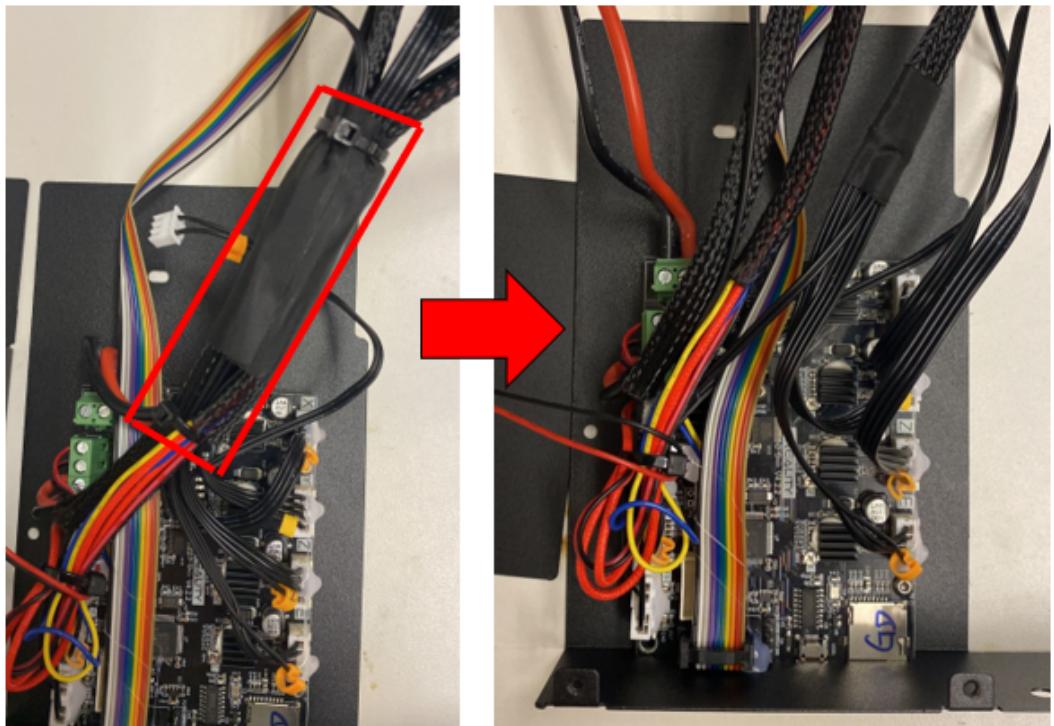


Figure 14: Zip Ties removal

Very CAREFULLY unplug the X, Y, Z, and E stepper motor wires from the mainboard. You may need to use the wire cutters to remove the glue so the connectors will come off.

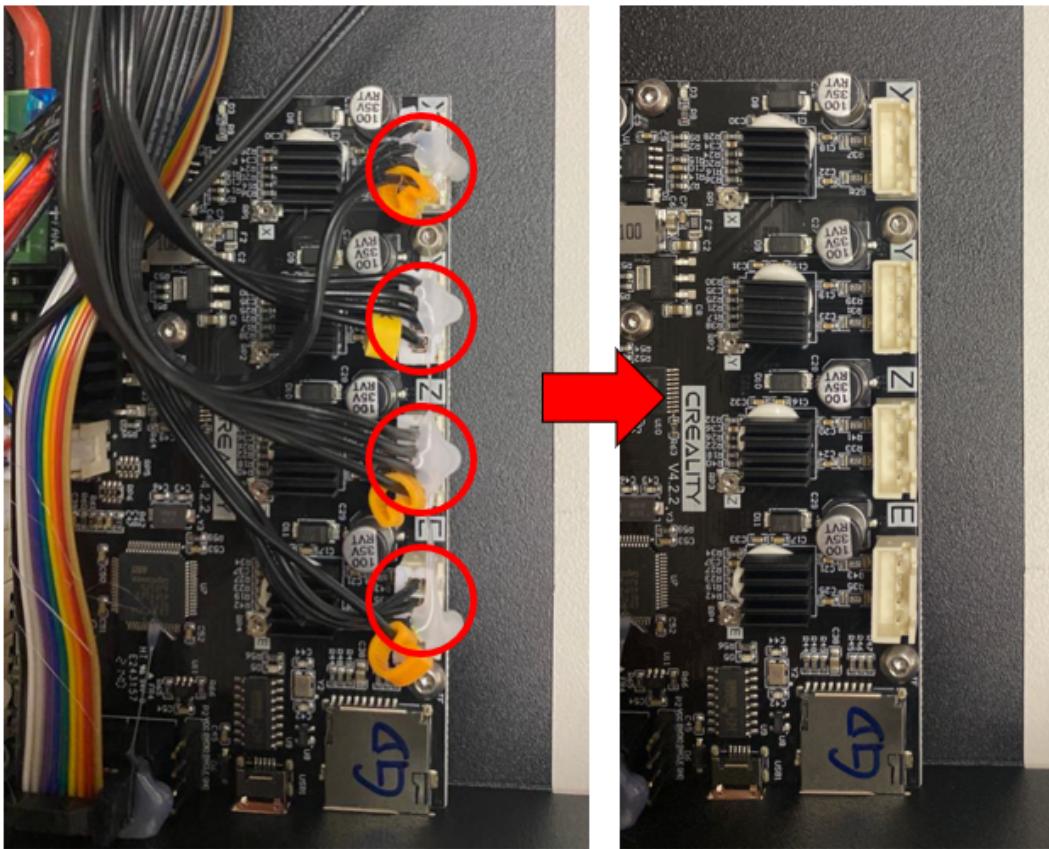


Figure 15: Stepper Motor removal

Cut the zip tie holding the last wire bundle together and CAREFULLY unplug the X, Y, and Z limit switch connectors from the mainboard. Again, you may need to remove some of the glue for the connectors to come off.

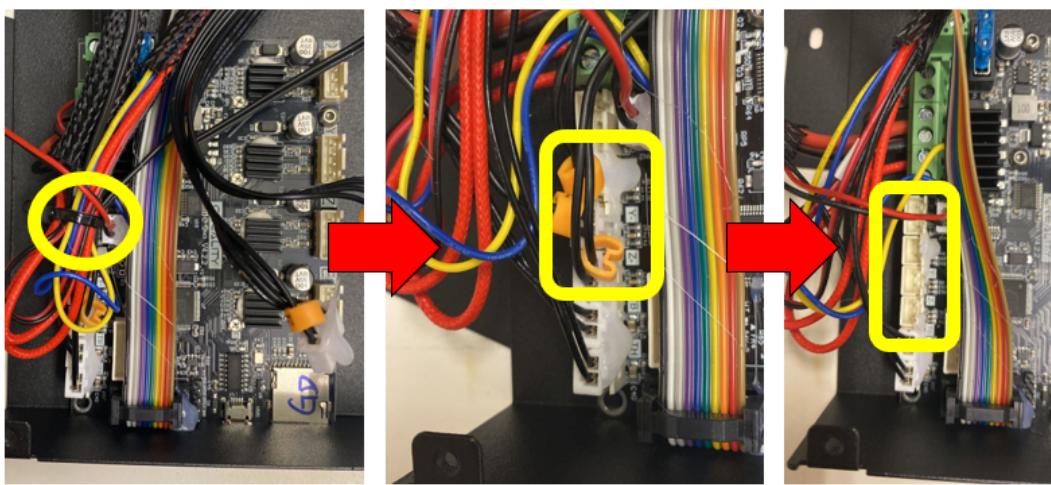


Figure 16: Limit Switch removal

Remove the power cable from the original board

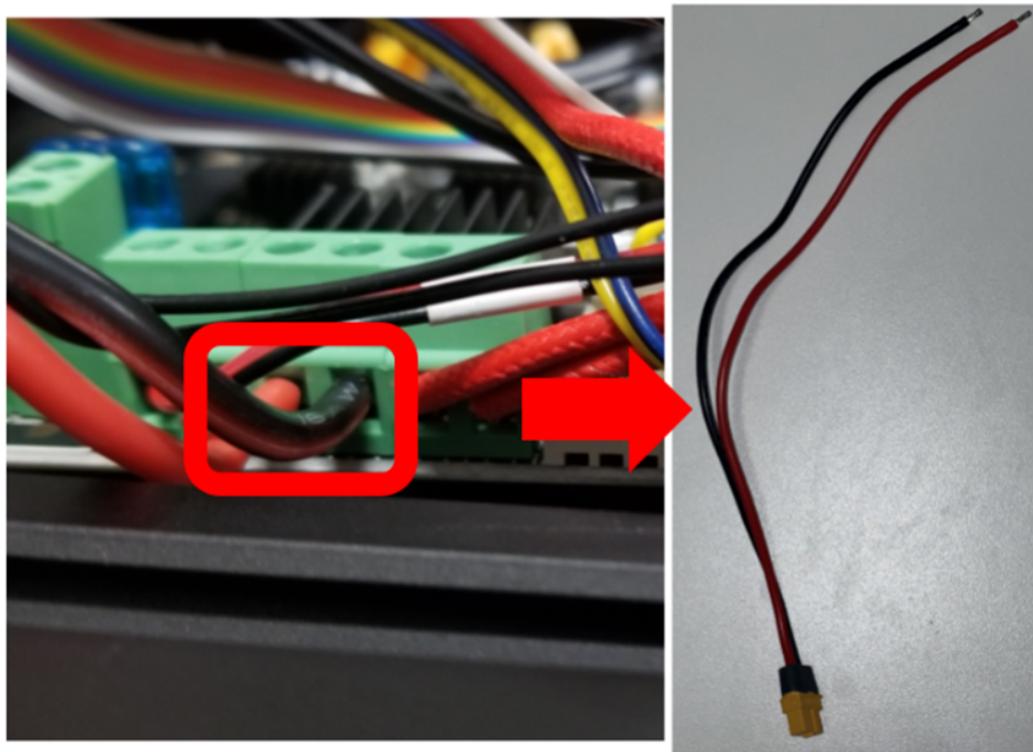


Figure 17: Power Cable removal

Place these six wires to the side. We will use them later. Everything else from the electronics box can be placed back inside the Ender 3 Pro box. These components are not required, but you may find a way to use them later on for your project.

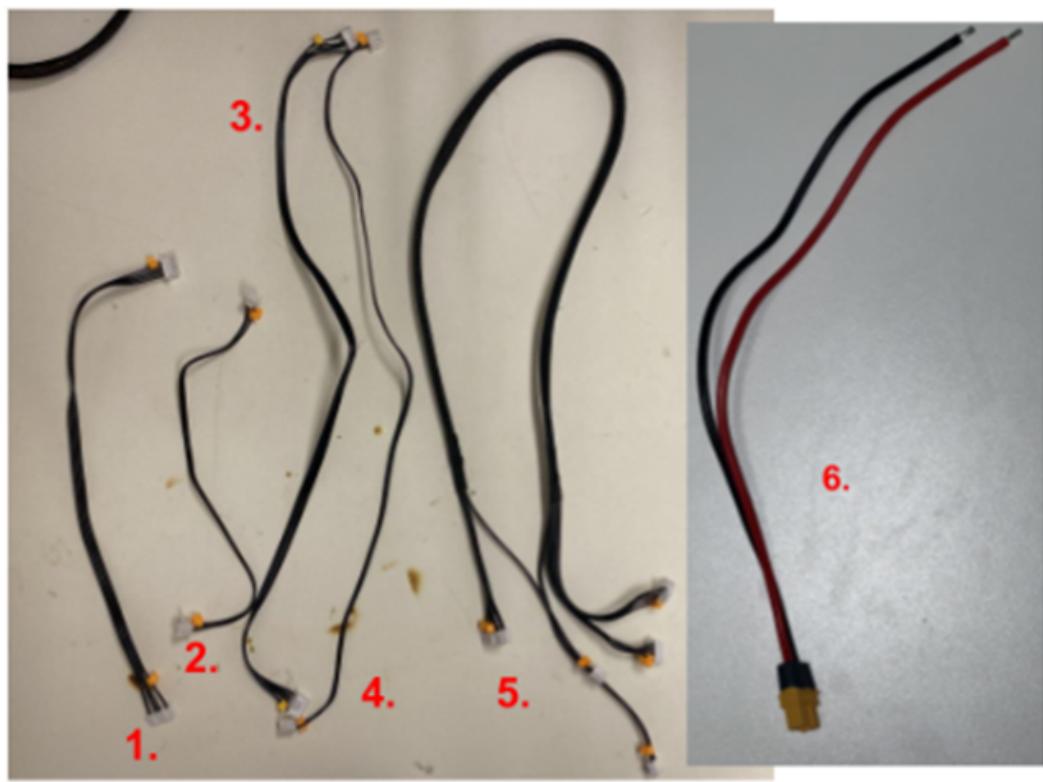


Figure 18: Removed Wires

2. Syringe Assembly

Next we are going to assemble the syringe pump. Here are all the parts with their name.

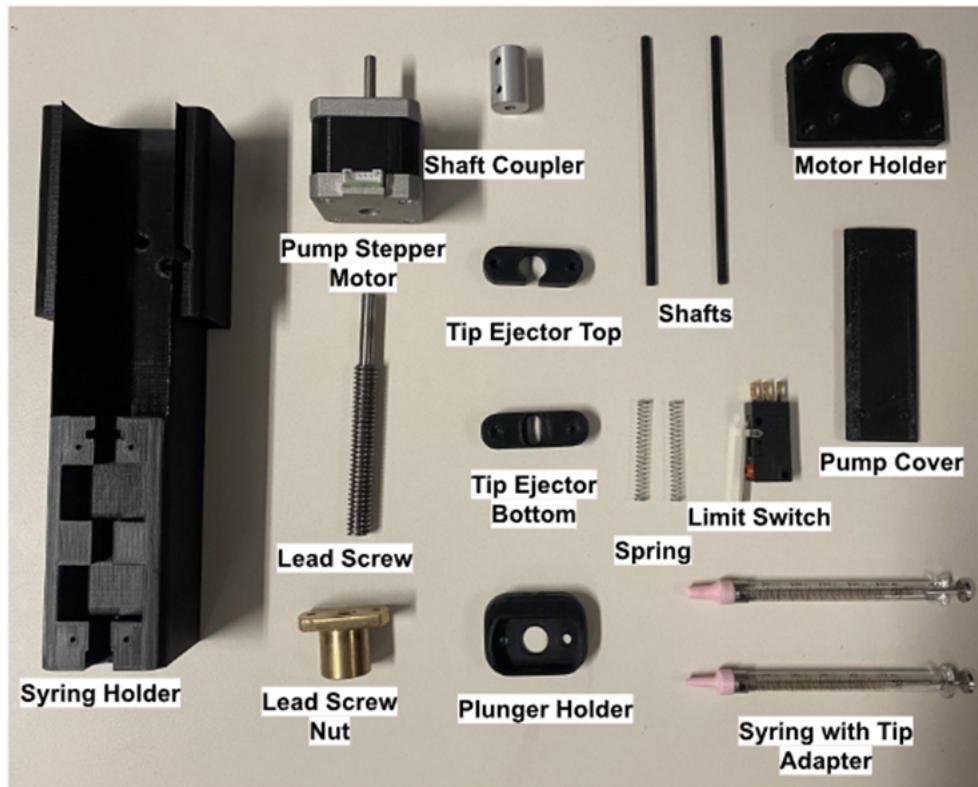


Figure 19: Syring Pump parts

Attach the Syringe Pump Holder to the Syringe Pump Base using four M3x12 screws.

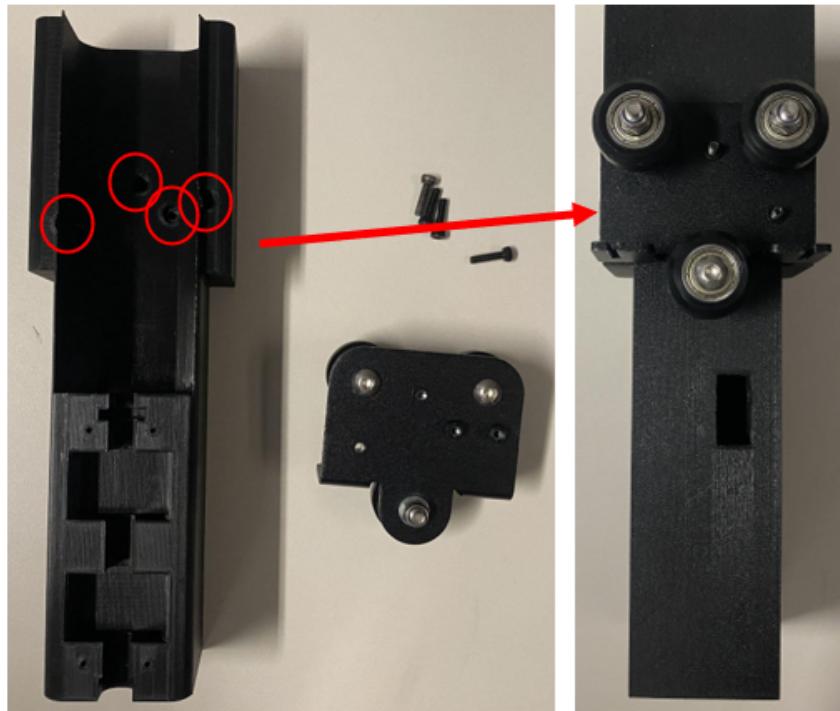


Figure 20: Syringe Pump Base attachment to Syringe Pump Holder

Attach the Syringe Pump Stepper Motor to the Motor Holder using four M3x8 screws.

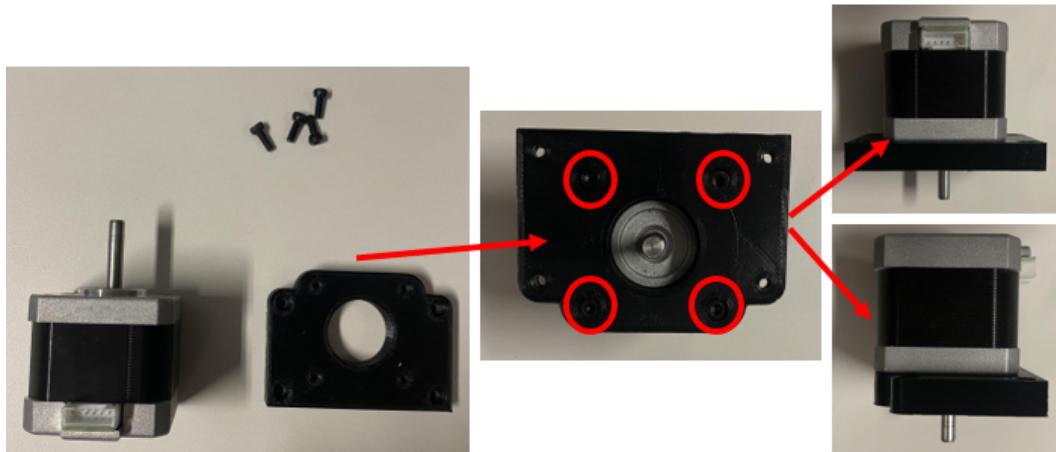


Figure 21: Pump Stepper Motor attachment to Motor Holder

Attach the Shaft Coupler to the Lead Screw using the two set screws. Attach the Shaft Coupler to the stepper motor shaft using the last two set screws. It's important to attach the Lead Screw first so the motor shaft fits the Shaft Coupler properly.



Figure 22: Lead Screw attachment to Pump Stepper Motor

Attach the Lead Screw Nut to the Plunger Holder using two M2x12 screws, two M2 nuts, and two M2 washers. Note that the Lead Screw Nut should fit very tightly - it will require some force to push it all the way in.



Figure 23: Lead Screw Nut attachment to Plunger Holder

Now we will assemble the Tip Ejector. Screw on two of the Tip Ejector Shafts to the Tip Ejector Top using two M2x8 screws. Then slide the two springs around the shafts. If the springs do not fit smoothly, sand down the shafts until the spring moves easily with little to no resistance.



Figure 24: Tip Ejector preparation

Next, insert the shafts into the Syringe Pump Base, then compress the springs with your hand. With the springs compressed, screw the Tip Ejector Bottom to the Tip Ejector Shafts using two M2x8 screws.

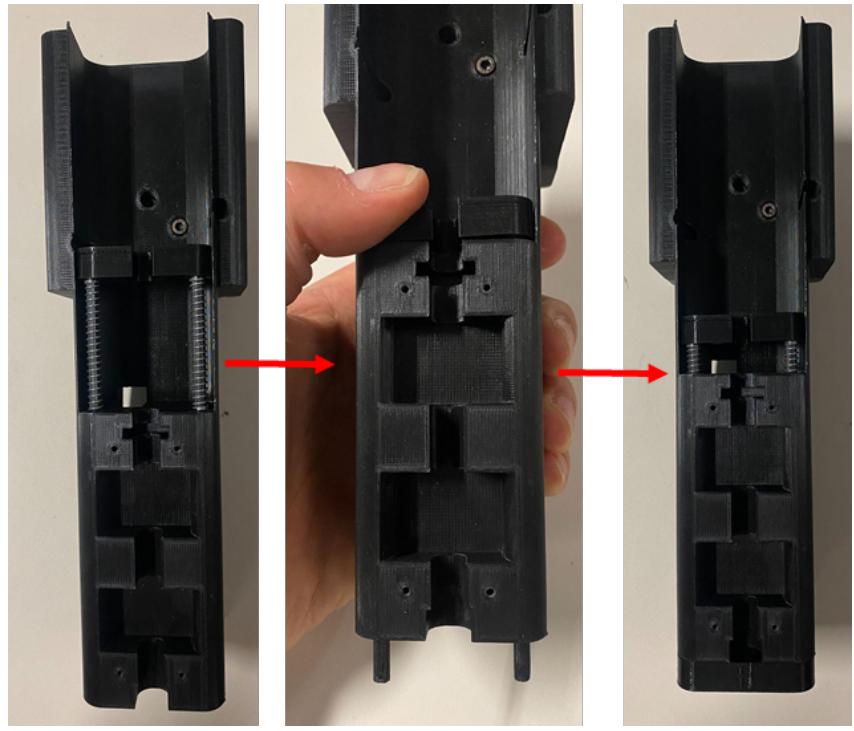


Figure 25: Tip Adapter Installation

Rotate the Plunger holder and Lead screw nut to the Lead Screw.

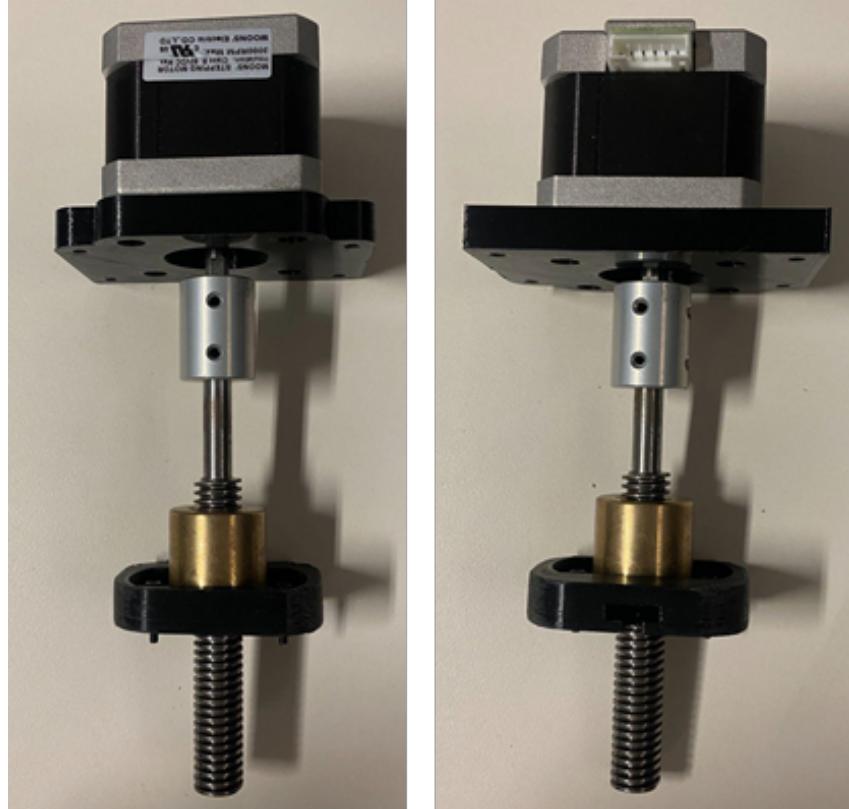


Figure 26: Lead Screw with Plunger

Continue screwing in the Lead Screw until the Motor Holder is flush with the Syringe Pump Base. Screw the Motor Holder to the Syringe Pump base using four M3x8 screws.



Figure 27: Pump Motor attachment

Put the syringe cover and four M2x8 screws on.

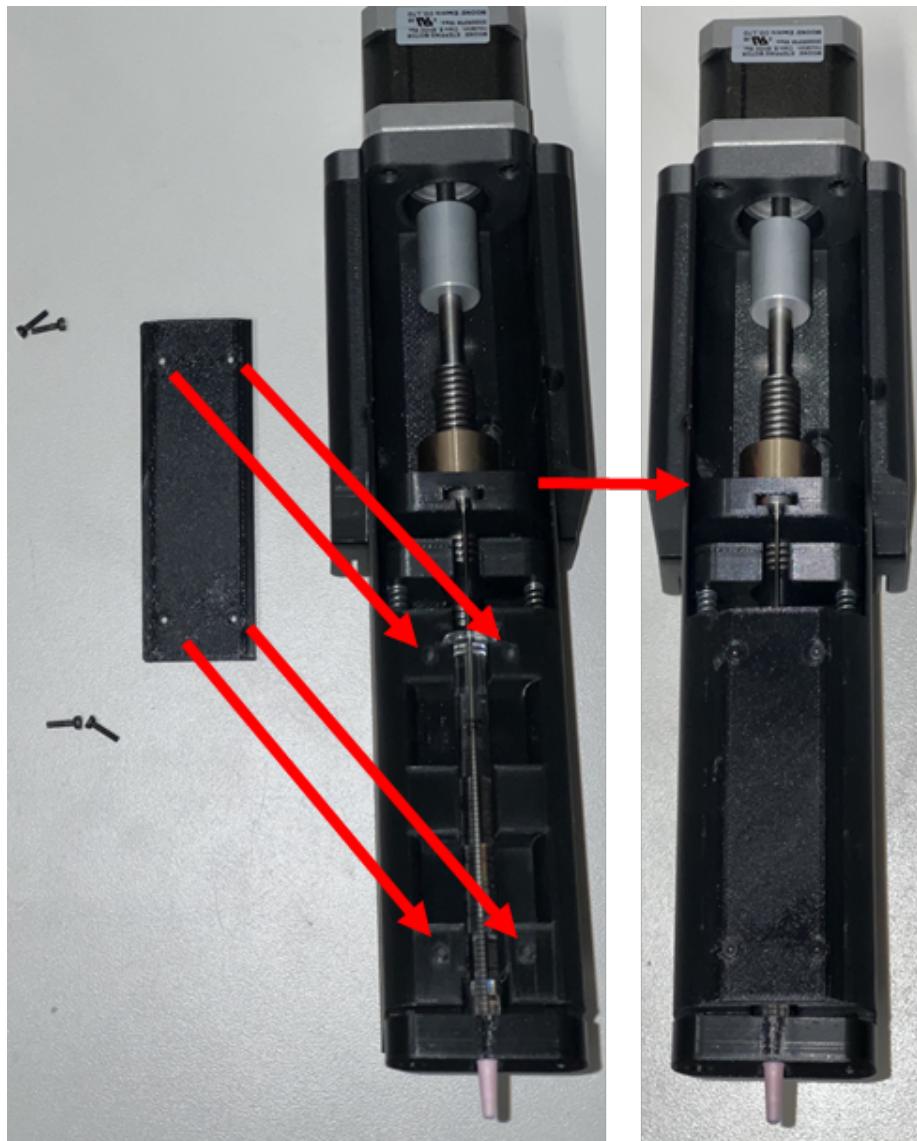


Figure 28: Syringe Cover installation

Next, install the limit switch as shown below.

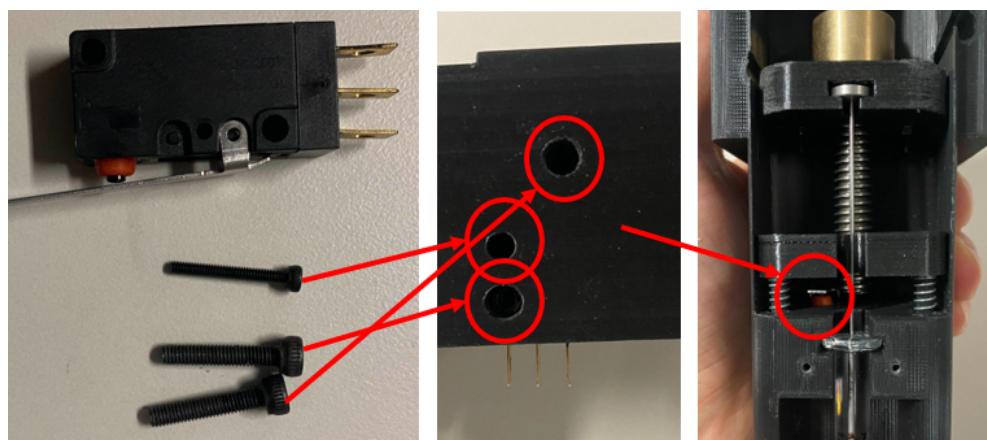


Figure 29: Limit Switch Installation

3. Frame Assembly

The remaining frame should look like this.

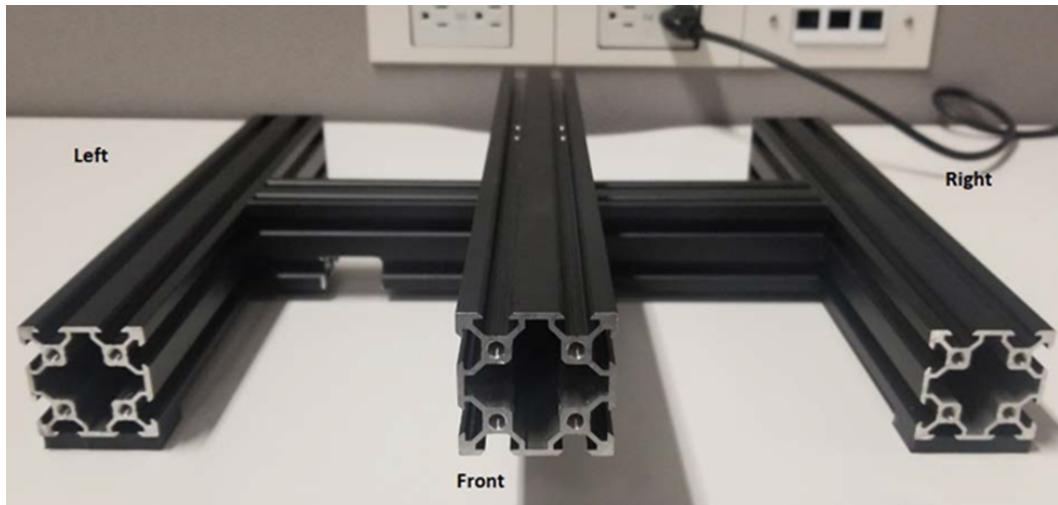


Figure 30: Ender 3 Partial Frame

Remove the eight screws from the left and right extrusions. There are four screws on each side.



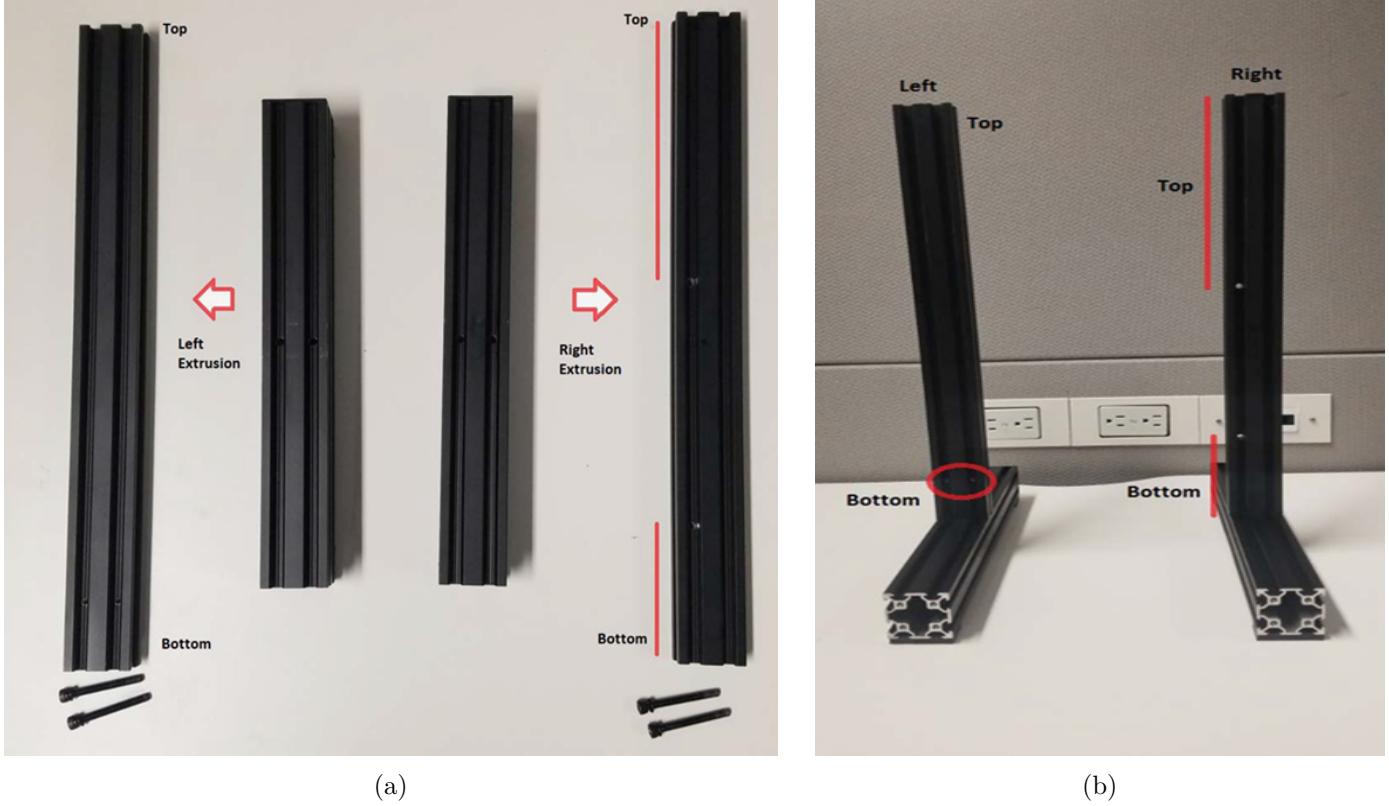
(a)



(b)

Figure 31: Partial frame side removal

Next, install the Vertical Extrusions to the two side extrusions from the previous step using the parts provided with the Ender 3 Pro. Each side requires two M4x16 screws

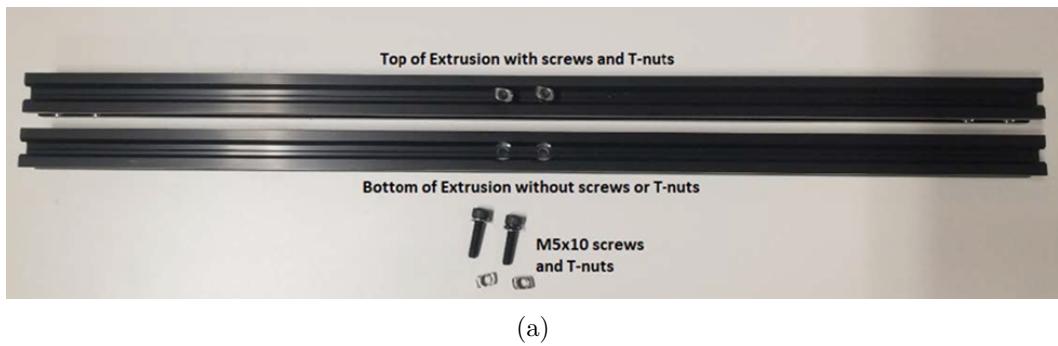


(a)

(b)

Figure 32: Ender 3 Pro Vertical Extrusion install

Grab the two Horizontal Extrusions, eight M5x25 screws and M5 star lock washers, two M5x10 screws, and two T-nuts from the Ender Xtender kit. Both extrusions are identical. Add two M5x15 screws to both of the Horizontal Extrusions as seen in the figure below. Using four of the M5x25 screws and M5 star washers, screw one extrusion to the front of the frame using the bottom sets of holes.



(a)



(b)

Figure 33: Ender 3 Pro Horizontal Front Extrusion Install

Turn around the frame and remove the two end covers from the end of the extrusions.



Figure 34: Rear frame extrusion cover removal

Install the remaining extrusion to the bottom sets of holes on the rear of the frame using the remaining four M5x25 screws and M5 star lock washers.



Figure 35: Rear Horizontal Extrusion install

Grab the large Y-Axis Extrusion from the Ender Xtender kit. Using the T-nuts you previously installed to the Horizontal Extrusions, attach the Y-Axis Extrusion to the frame. Note that this part can be a little bit tricky. I like to use the small allen key included with the Ender 3 Pro to help line up the T-nuts properly

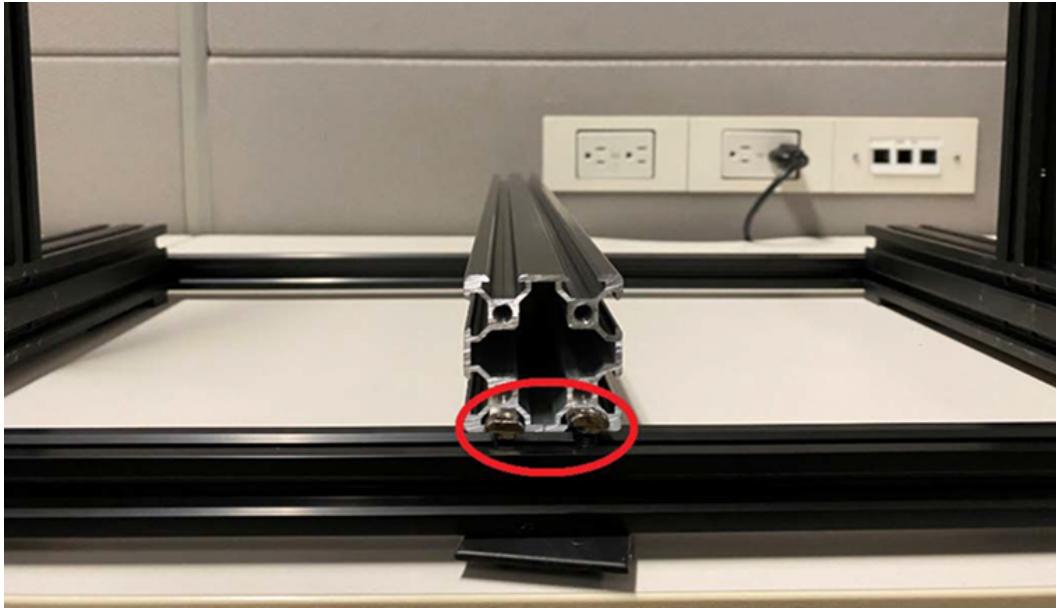


Figure 36: Enter Caption

Once the T-nuts are properly attached, use a ruler and offset the Y-Axis Extrusion by 170mm. Once aligned properly, tighten the T-nuts using the appropriate allen key from the Ender 3 Pro kit.



Figure 37: Y-Axis Extrusion alignment

Re-attach the Y-Axis Carriage ensuring that the thin corner is in the back left.

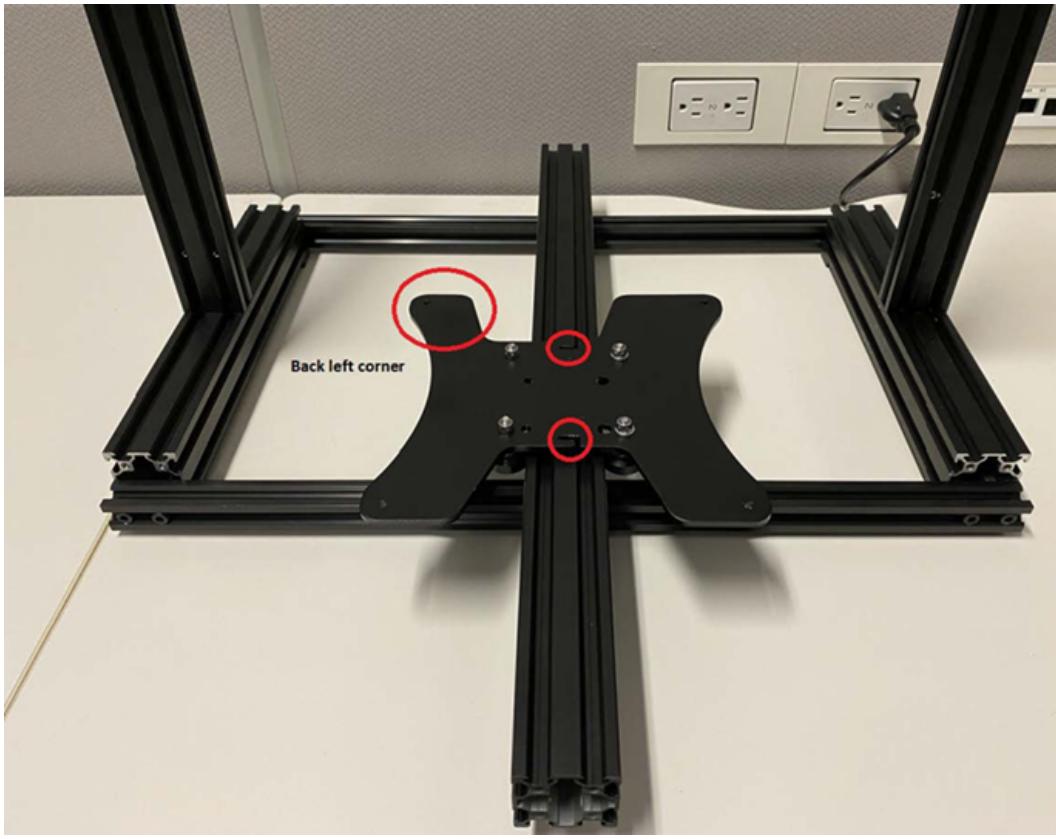


Figure 38: Y-Axis Carriage reattachment

Next, feed the Y-Axis Belt that comes with the Ender Xtender kit through the Y-Axis Extrusion.

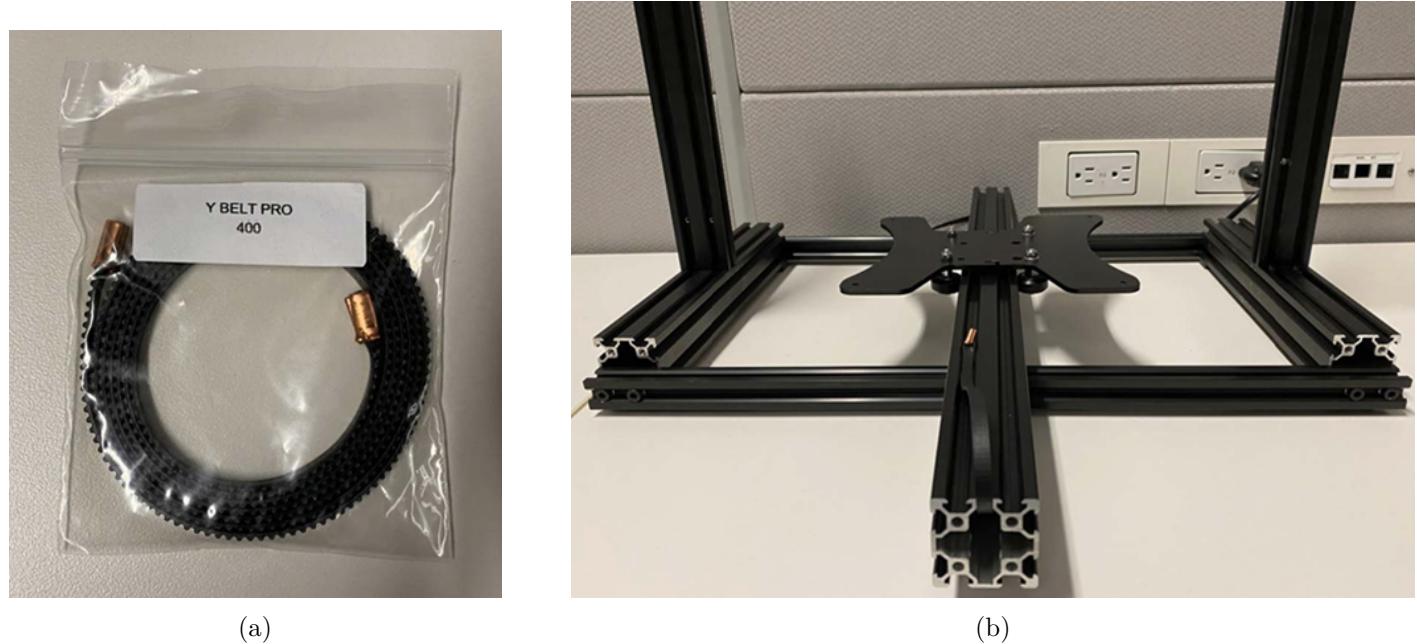


Figure 39: Ender Xtender Y-Axis Belt replacements

On the back left of the Y-Axis Extrusion, re-attach the Y-Axis Limit Switch using the two screws from 19. Your screws should be silver (I lost the originals and had to use two different ones). Align the switch so it is flush with the end of the Y-Axis Extrusion.

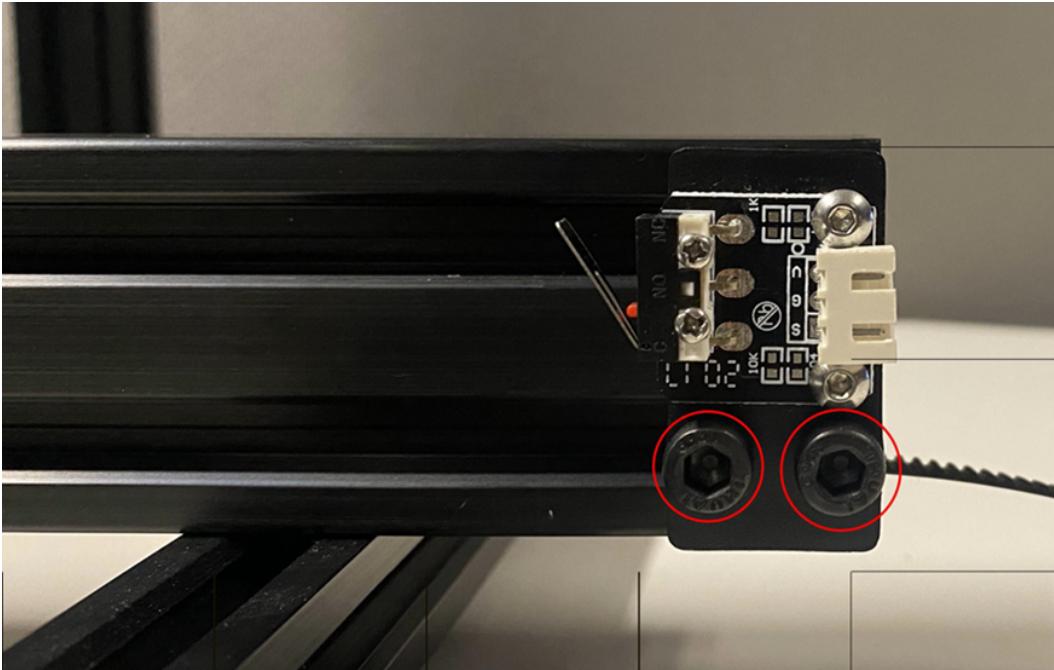
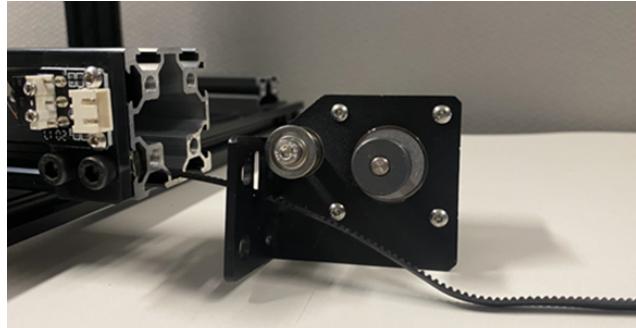
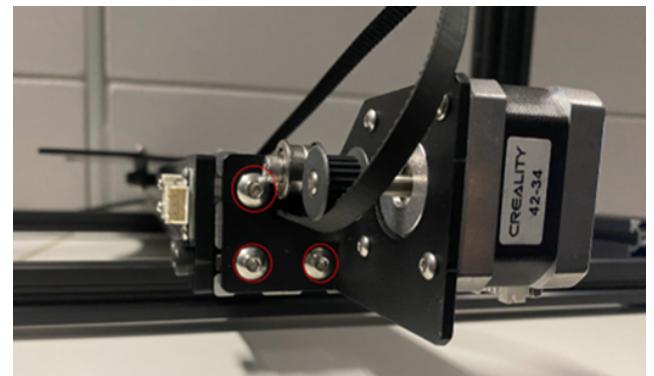


Figure 40: Y-Axis Limit Switch re-attachment

Feed the Y-Axis Belt through the hole Y-Axis Stepper Motor Assembly then re-attach the Y-Axis Stepper Motor Assembly with the three screws.



(a)



(b)

Figure 41: Y-Axis Stepper Motor Assembly re-attachment

Attach the Y-Axis Belt to the Y-Axis Carriage.

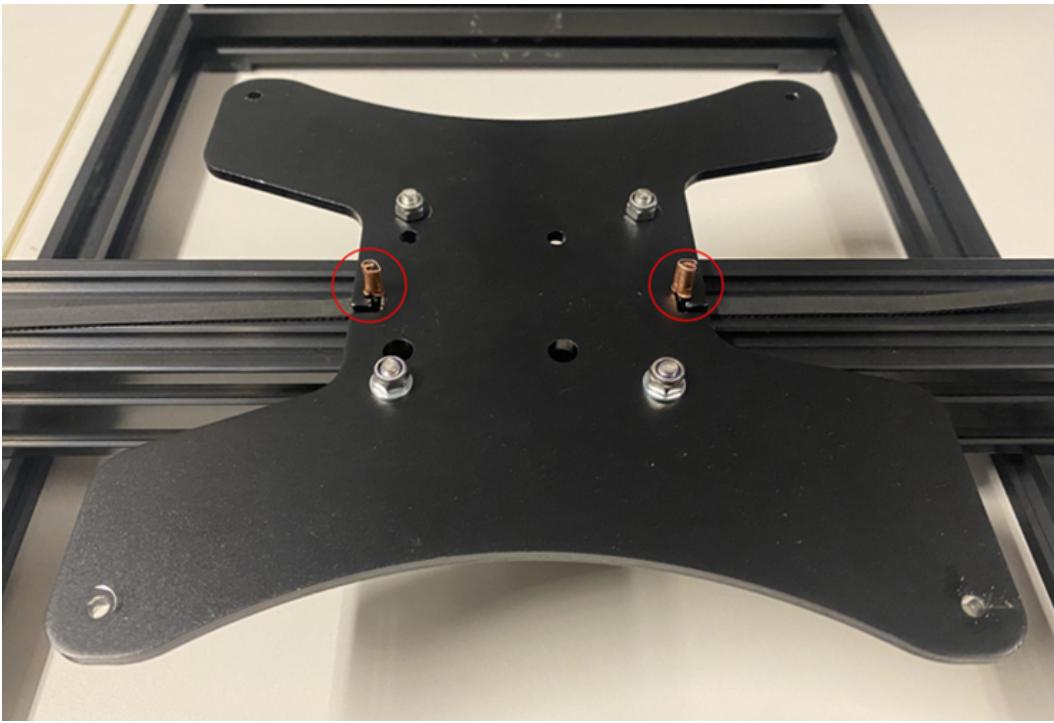


Figure 42: Y-Axis Belt re-attachment

Feed the Y-Axis Belt through the hole in the Y-Axis Tensioner, then re-attach the Y-Axis Tensioner using the by partially tightening two screws on each side from 4. Once the all four screws are in, pull on the Y-Axis Belt Tensioner to tighten the belt and firmly tighten the screws.

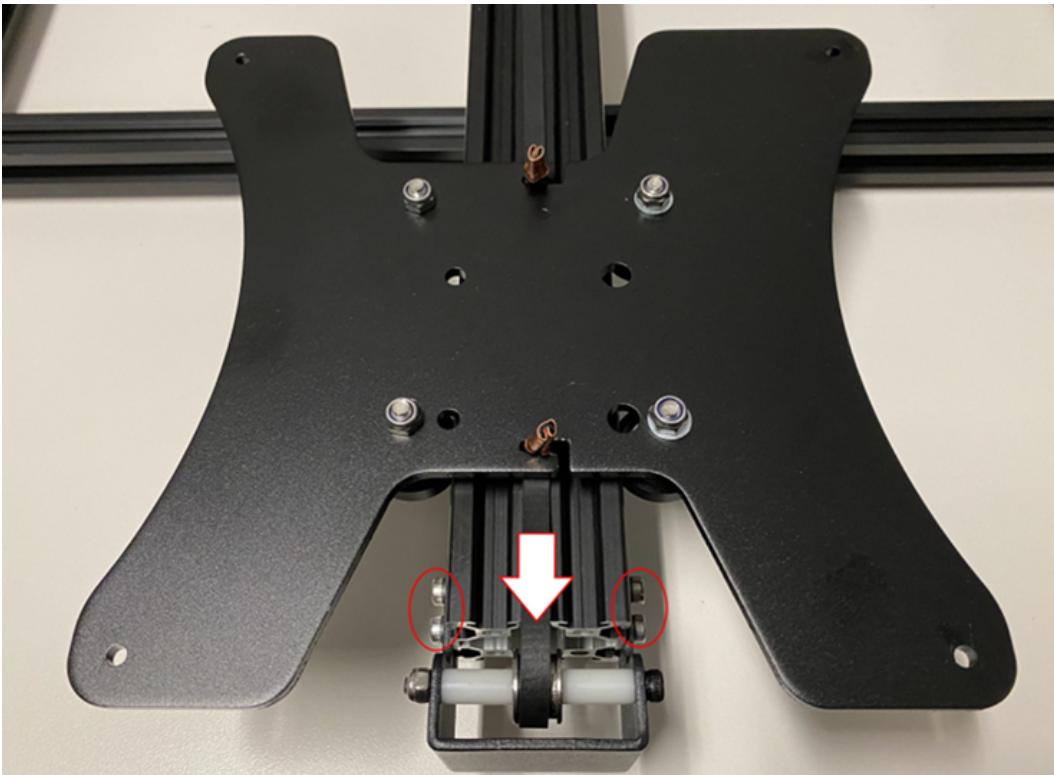


Figure 43: Y-Axis Belt Tensioner re-attachment

Remove the magnetic bed from the Heated Bed and remove the four screws by cutting holes around the screw heads.

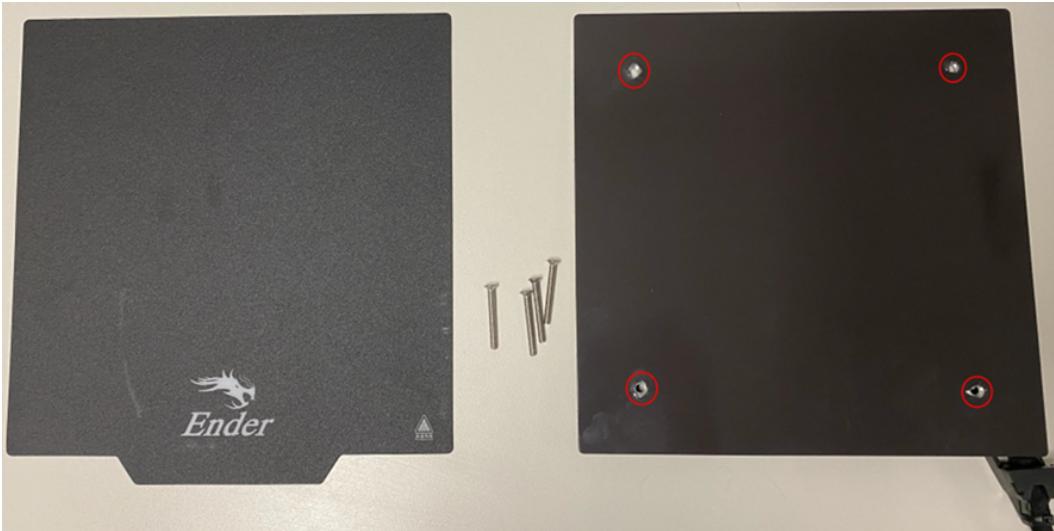


Figure 44: Heated Bed screw removal

Insert the four screws into the top face of the Ender Xtender Platform.



Figure 45: Heated Bed screw placement onto Ender Xtender Platform

Place the Heated Bed onto the Ender Xtender Platform.



Figure 46: Heated Bed placement over Ender Xtender Platform

Cut the ziptie and remove the plastic part from the wires.



Figure 47: Removing plastic part from Heated Bed wires

The Ender Xtender kit comes with four washers and four nuts.



Figure 48: Ender Xtender Platform nuts and washers

Place the washers on the screws then tighten the nut around the screws. This attaches the Heated Bed to the Ender Xtender Platform. Tape the remaining wires to the bottom of the Ender Xtender Platform and replace the four springs from 2.



Figure 49: Heated Bed attachment to Ender Xtender Platform

Place the Ender Xtender Platform onto the Y-Axis Carriage being careful not to lose the springs. Attach the knobs from 13 and tighten each knob until they are no longer loose. The platform is leveled with these knobs.

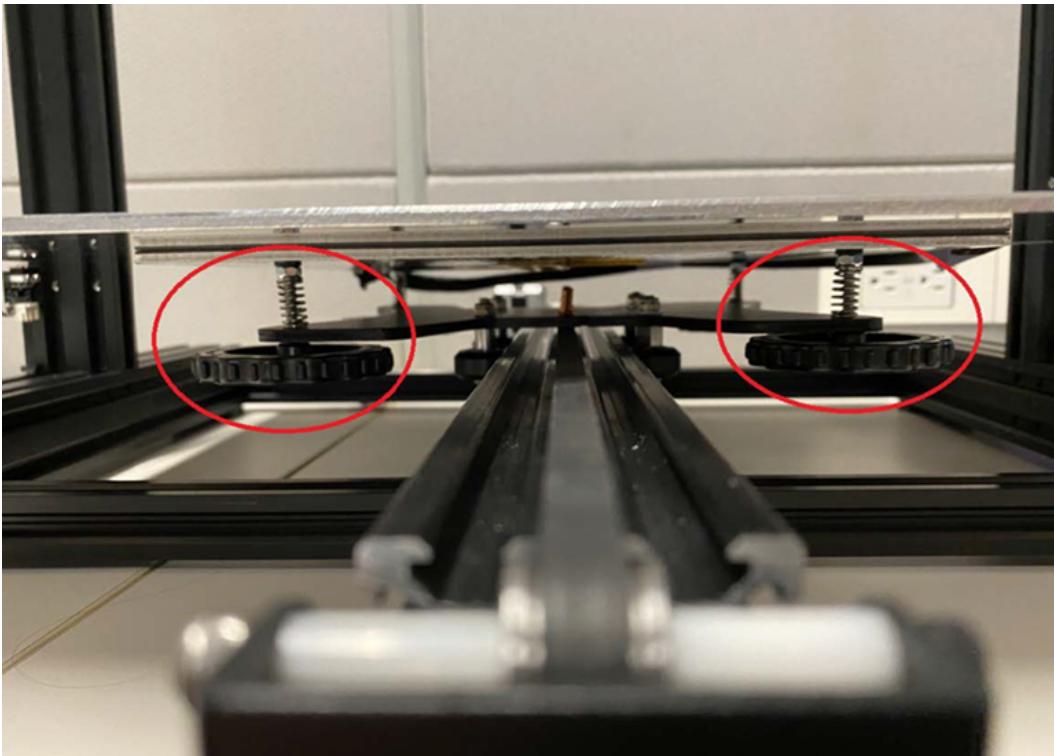


Figure 50: Ender Xtender Platform attachment

Gather the X-Axis Stepper Motor Assembly, the Z-Axis Roller and four M4x16 screws from the Ender 3 Pro supplies. Also grab the X-Axis Extrusion from the Ender Xtender kit.



Figure 51: X-Axis Components

Attach the Z-Axis Roller to the right side of the X-Axis Extrusion using two of the M4x16 screws.

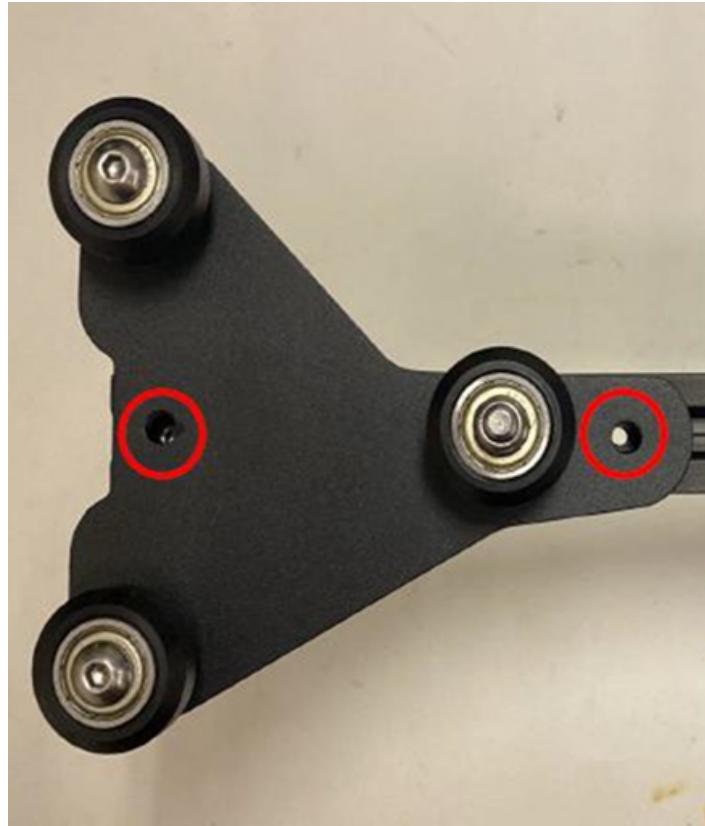


Figure 52: Z-Axis Roller attachment

Slide the Syringe Pump onto the X-Axis Extrusion. Feed the two wires from the limit switch through the Syringe Pump Holder as seen in the figure below.

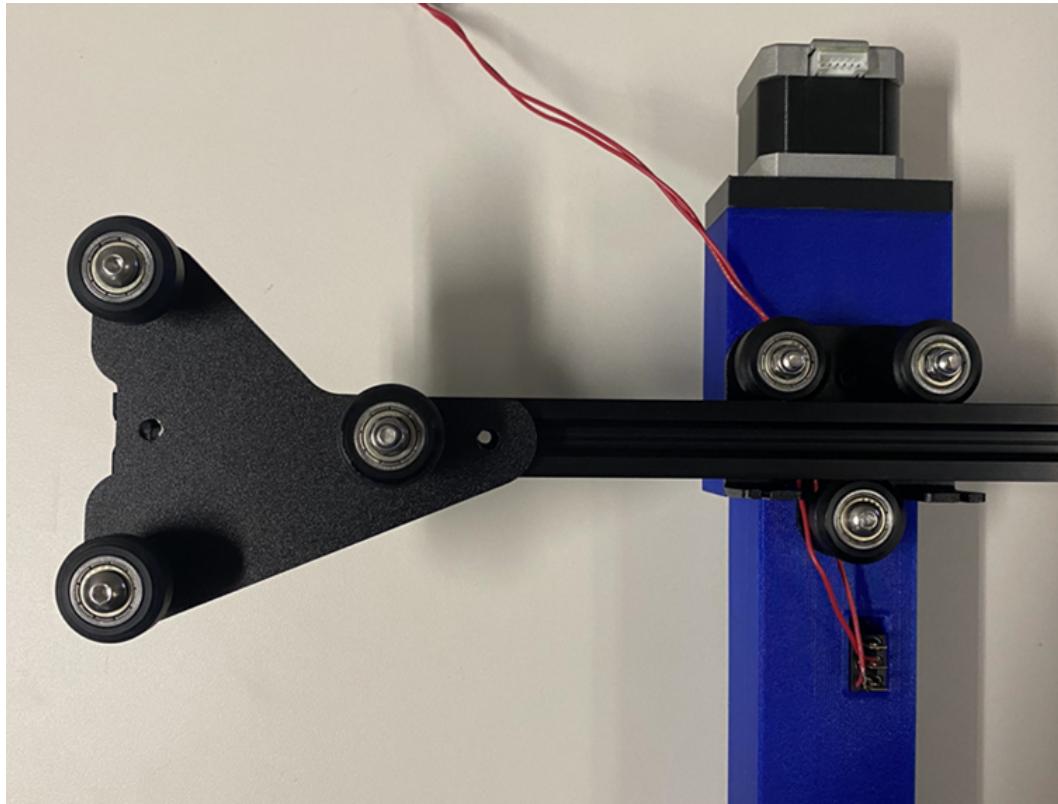


Figure 53: Pump attachment to X-Axis Extrusion

Attach the X-Axis Stepper Motor Assembly to the left side of the X-Axis Extrusion using two of the M4x16 screws.

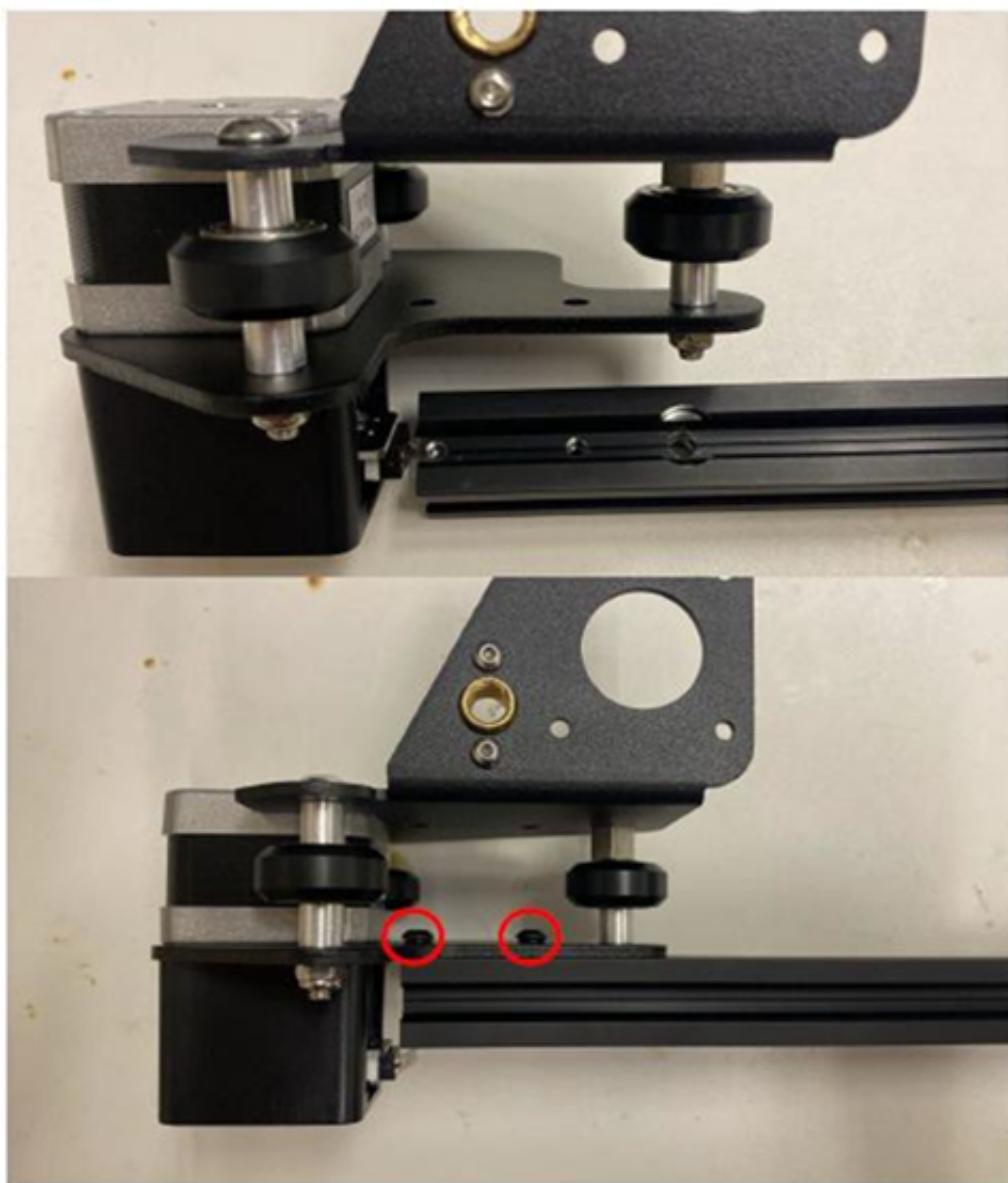


Figure 54: X-Axis Stepper Motor Assembly attachment

The result should be like this:

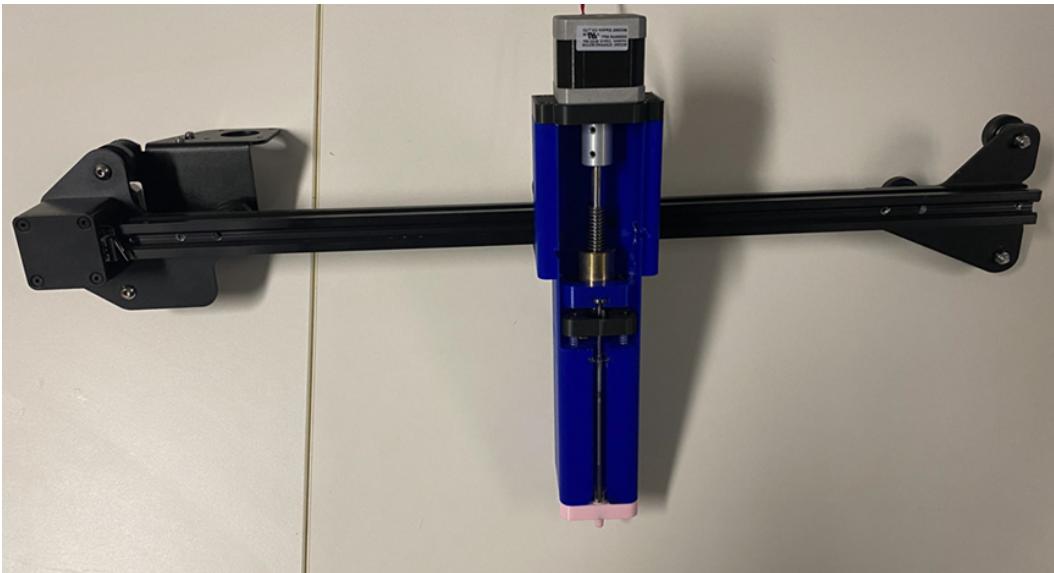


Figure 55: X-Axis Components assembled

Line up the rollers on each side with the two Vertical Extrusions to attach the X-Axis components to the frame

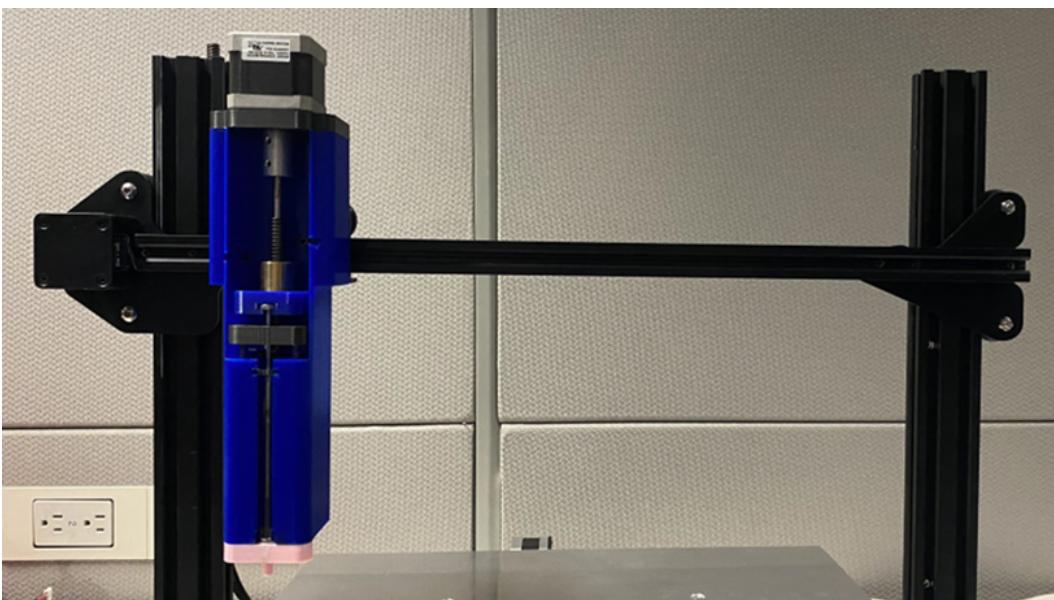


Figure 56: X-Axis components attached

Attach the Top Extrusion to the frame by using the four M5x25 screws provided with the Ender 3 Pro.

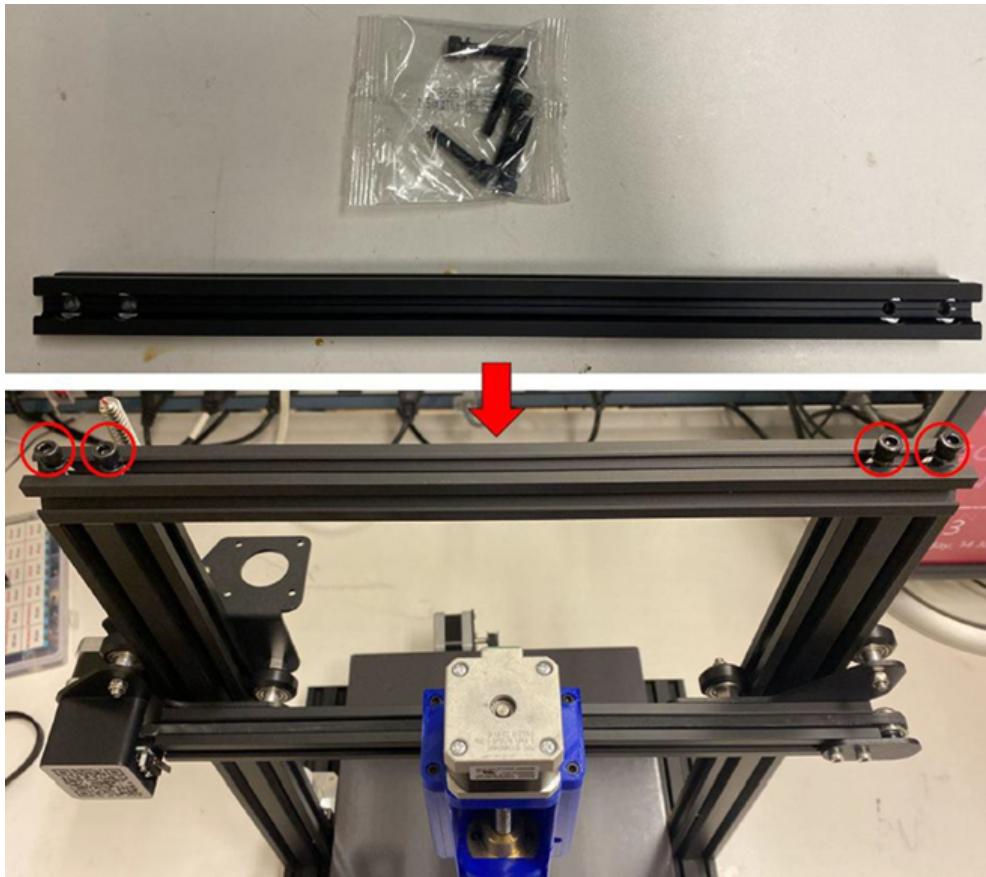


Figure 57: Top Extrusion Attachment

Disassemble the Z-Axis Limit Switch that comes with the Ender 3 Pro by unscrewing the two screws holding the switch and the two screws and T-nuts. Attach the switch to the new Z-Axis Limit Switch Holder using the two screws. Last, Attach the screws and T-nuts.

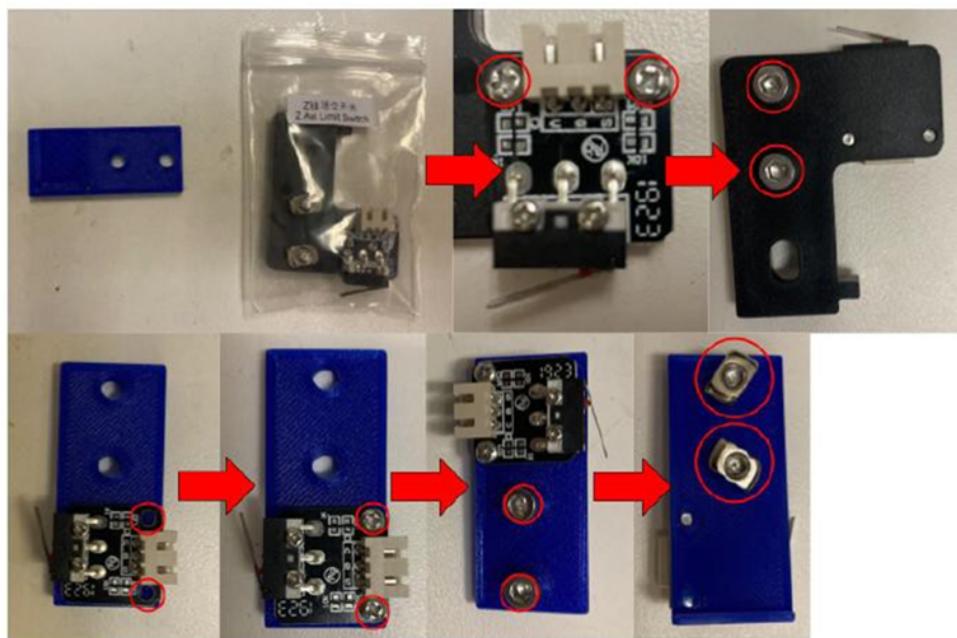


Figure 58: Z-Axis Switch assembly

Attach the Z-Axis Limit Switch to the back left of the Top Extrusion. Ensure it is flush with the Top Extrusion

then tighten the T-nut screws.

Assemble the pieces of the BioCloneBot platform together and place them over the platform.

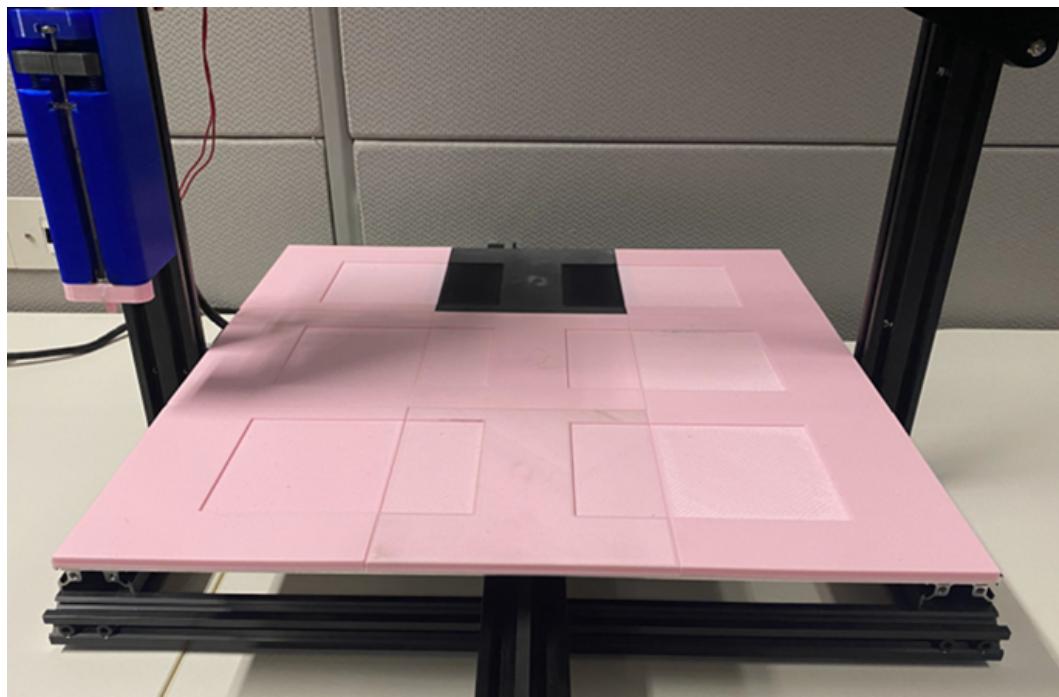


Figure 59: Platform attachment

4. Electronic Connection

Before connecting all the electronic parts with the board, you need to tune the stepper motor drivers. For the stepper motor in the X, Y and Z axis, the max current is 840 mA and the set point is 700 mA. For the syringe pump max current is 400 mA and the set point is 350 mA. Test one motor at a time and if adjustment is needed, turn off the power of the board before adjusting. Otherwise, the motor will likely be burned.

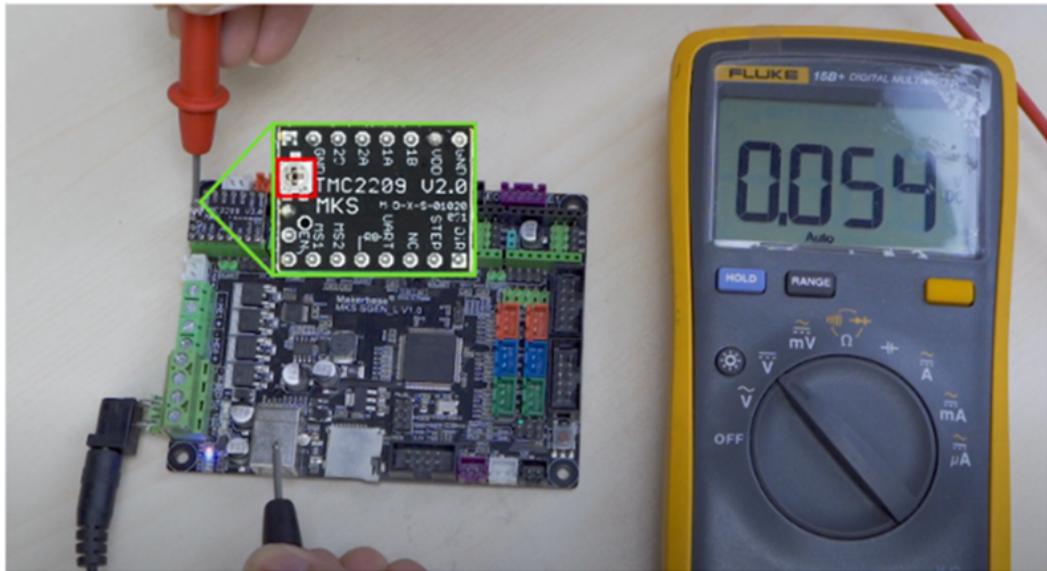


Figure 60: TMC2209 Stepper Motor Adjustment

Now Connect all the electronic parts with the MKS GEN L V2.1 board according to the following figure.

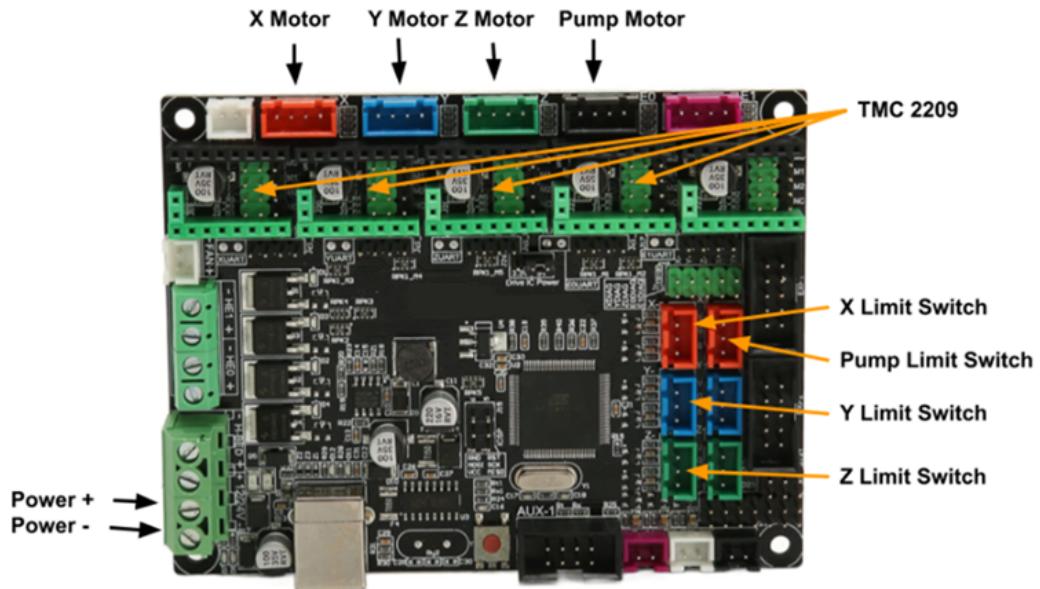


Figure 61: MKS GEN L V2.1 Connection

The original limit switch wires do not work and you need to follow the figure below to correctly configure the wire connection.

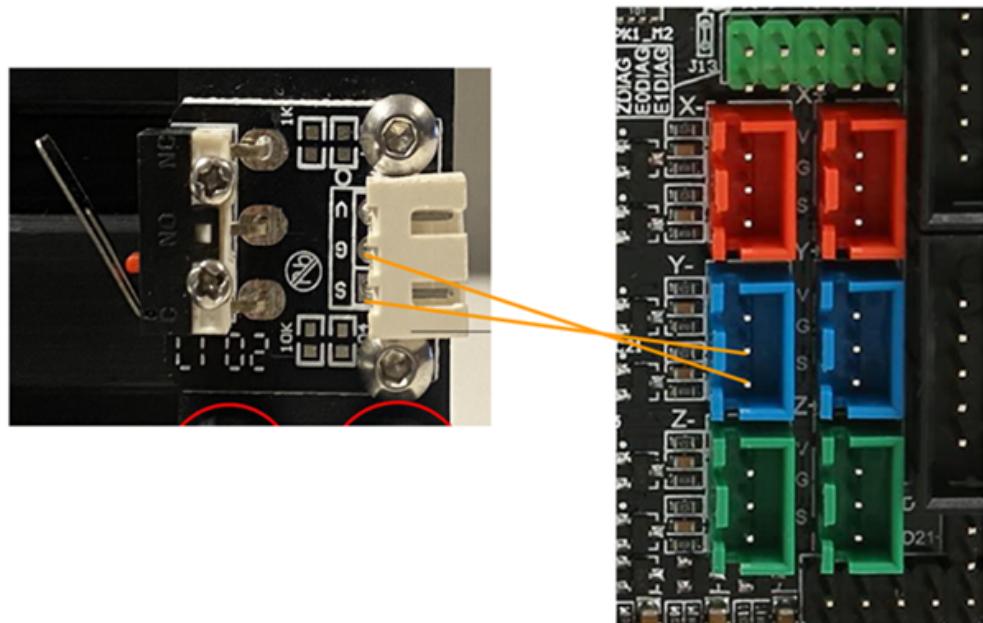


Figure 62: Limit Switch Connection

Now the BioCloneBot frame and pump are fully assembled

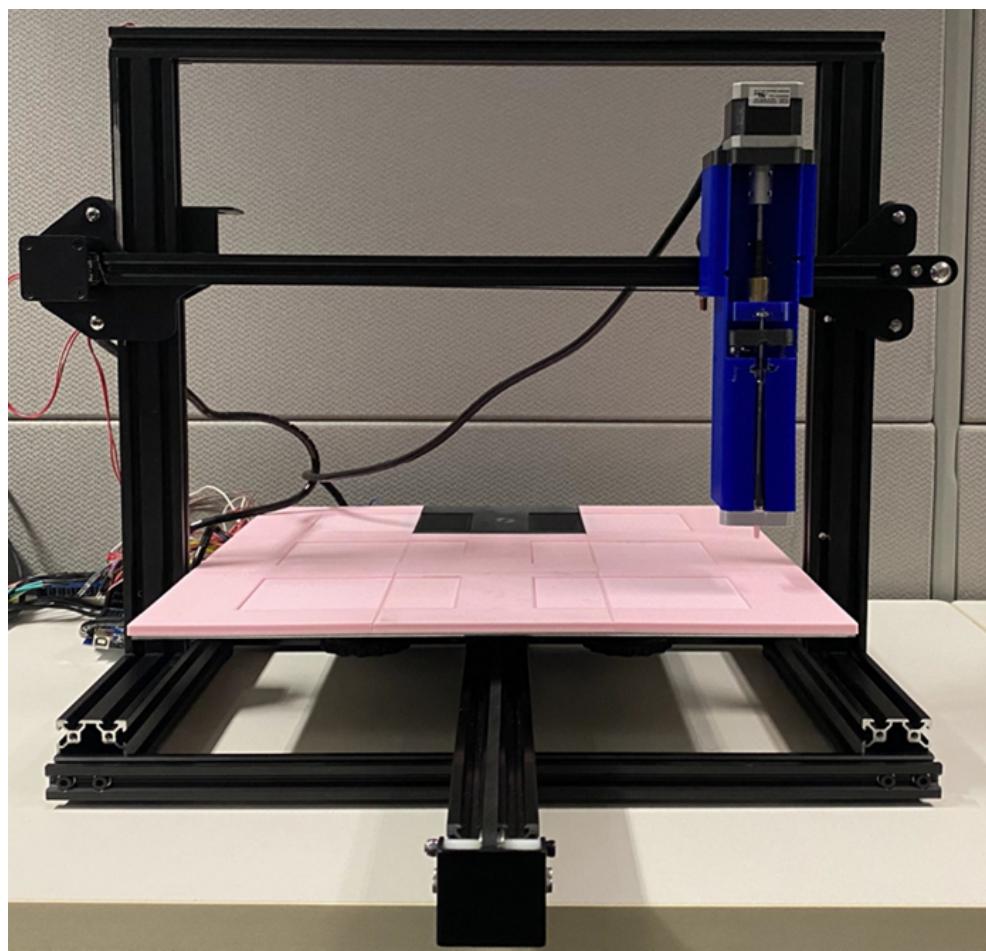


Figure 63: BioCloneBot frame and pump fully assemble