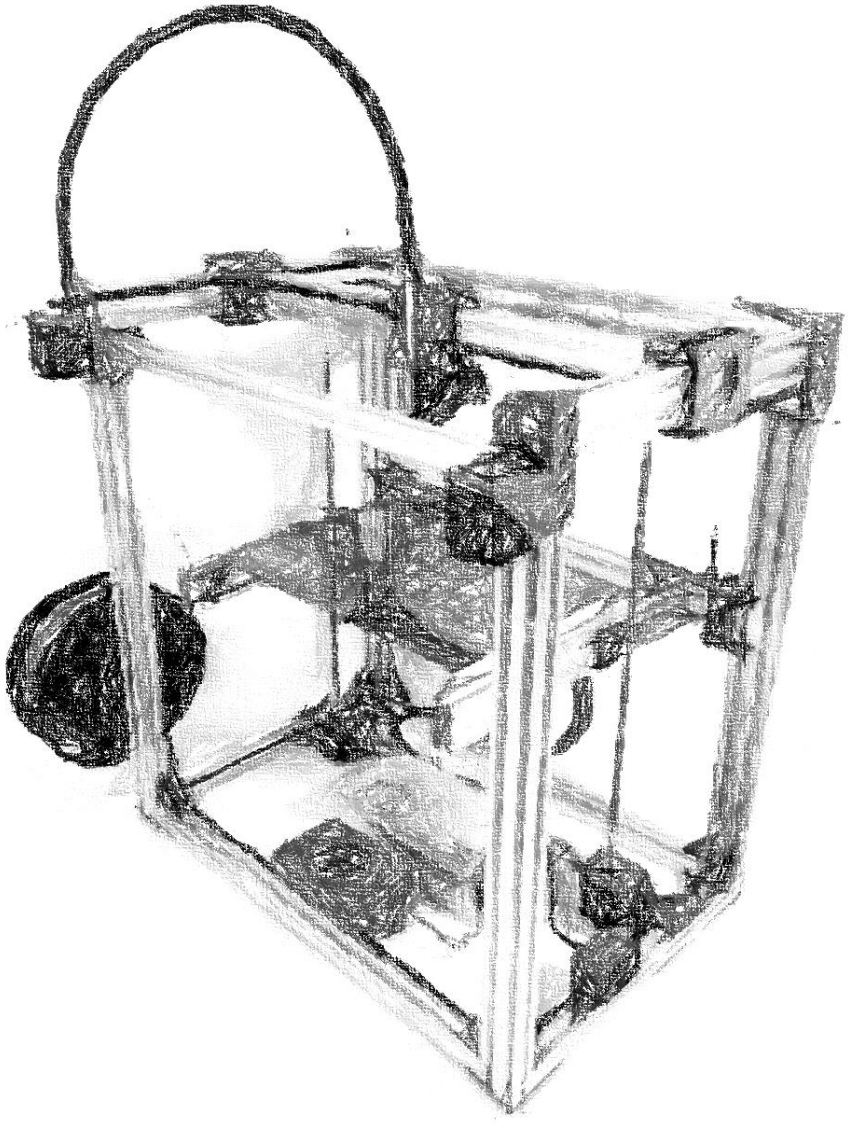
D-Bot Core-XY 3D Printer

Build and Configuration Guide



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D. Spaulding

Disclaimer

This guide is meant to serve as an informational resource for building a D-Bot 3D printer. It is not meant to be a 100% complete instructional manual. This is not a commercial 3d printer kit, it is an experimental prototype design. If you have no experience with power tools, mechanical assembly, electronics, or electrical wiring, please do ***not*** attempt this project. Incorrectly wiring electrical components, especially those involving AC line voltage can start fires or cause fatal injury.

Table of Contents

1. Introduction

- Format
  This guide contains multiple hyperlinks for file downloads and reference videos. The recommended viewing method is via PC rather than printout.

- Background
  The D-Bot printer is based on cfeniak's C-Bot printer, which was designed with the goal of making a robust scalable Core-XY 3D Printer. The D-Bot is just one example of a printer which uses that base design and builds upon it. The original C-bot design featured a cantilevered bed and the D-bot design attempts to have a more stable build platform by moving the Z motors forward so that the print bed is lifted from its center of gravity. The secondary goal of the D-Bot design was to reduce the overall cost of the printer without sacrificing build quality. Other differences include changing some rails to 20mm height instead of 40mm, relocation of the X and Y endstops to simplify homing, and modifications to printable parts either for structural or aesthetic reasons.

- Required Tools
  1. Metric Tape Measure
  2. Metric Allen Wrenches
  3. Miter Saw or Hacksaw
  4. M5 Thread Tap
  5. Phillips Screwdriver
  6. Adjustable Crescent Wrench
  7. Needle Nose Pliers
  8. Digital Caliper
  9. Utility Knife
  10. Wire Strippers
  11. Wire Crimping Tool
  12. Soldering Iron w/ Solder (Lead free recommended)
  13. Multimeter

- Recommended Assembly Related Items
  1. Heat Shrink Tubing
  2. Electrical Tape
  3. Zip Ties
  4. Super Glue
  5. JB Weld Epoxy
  6. 3-In-1 Oil

2. Ordering Parts

Read this build guide completely before ordering parts in case alternatives/ variants are wanted. Review the bill of materials, make sure you can buy all of the parts or find good alternatives and decide on optional components. Cheap ebay parts from china can take a month or more to arrive.

More information on parts selection:

- Hot End: This design uses an E3D V6 all metal hot end which can print PLA, ABS, and other filaments such as nylon. A cheaper option is the E3d lite6 which can print PLA and ABS for around half the cost.
- Control Board: This design uses a RAMPS/Arduino setup, which is one of the most common among DIY 3D printers, it is very cheap and simple and it works. Other options include Rumba/Rambo boards which are essentially RAMPS+Arduino on one board. Smoothieware based boards such as Smoothieboard or Azteeg X5 offer a different firmware option. Choose a control board which will give a good performance/cost ratio. This guide is written for a build using a Ramps 1.4 board.
- Heated Bed – The heated bed chosen for this design works well enough for PLA and PETG but it takes very long to reach ABS temps (100C) and it has trouble maintaining that temperature. For ABS printing, research different 200x300mm heated beds which are well reviewed for use in printing ABS.
- Other potential Extras:
    - Auto bed leveling (aka crooked bed compensation) is not needed for this printer. This design features an X Y gantry which is very stable in the Z direction. Manual bed leveling only needs to be performed occasionally and it only takes a minute to achieve nearly perfect leveling with a playing card and an Allen wrench.
    - LCD Display/SD storage can be implemented depending on the control board chosen. Many Ramps kits come with an LCD display. The default configuration for this printer is operating via a PC connection to Repetier Host for slicing, Gcode transmission, and print monitoring.

3. Cutting V-Slot Extrusions

- Layout, measure, and mark the six V-slot rails to the proper lengths as shown in Figure 1. Label alphabetically as shown, these labels will be referenced during assembly.

- Cut V-slot railing pieces before printing plastic parts. If there are incorrect cuts made, plastic parts adjacent to the affected rail(s) can be modified to compensate for slightly incorrect cuts (this may or may not have happened to the author of this guide).

- Alternate frame railing lengths sized for a 300x300mm bed are shown in the appendix.

- Options for cutting:
  1. Cut with a hacksaw – ok quality, if done carefully
  2. Miter saw with a wood blade – somewhat ok, if done correctly
  3. Miter saw with non-ferrous blade – best, this approach can give perfect clean cuts
  4. If you do not have access to the proper tools, contact a local metal shop, mechanic, welder, or other professional that can cut aluminum railing to length for a (hopefully small) fee.

- Do not use an abrasive blade chop saw meant for cutting steel. It will leave very jagged rough cuts because it melts aluminum when cutting through.

- Measure twice, cut once!

- 20x40mm V-slot Railing pieces needed:

  (4) at 520mm - A, B, C, D
  (1) at 463mm - G
  (1) at 488mm - R
  (1) at 448mm - Q
  (2) at 333mm - E, F
  (2) at 313mm - O, P

- 20x20mm V-slot Railing pieces needed:

  (3) at 463mm - L, M, N
  (1) at 503mm - K
  (2) at 313mm - H, J

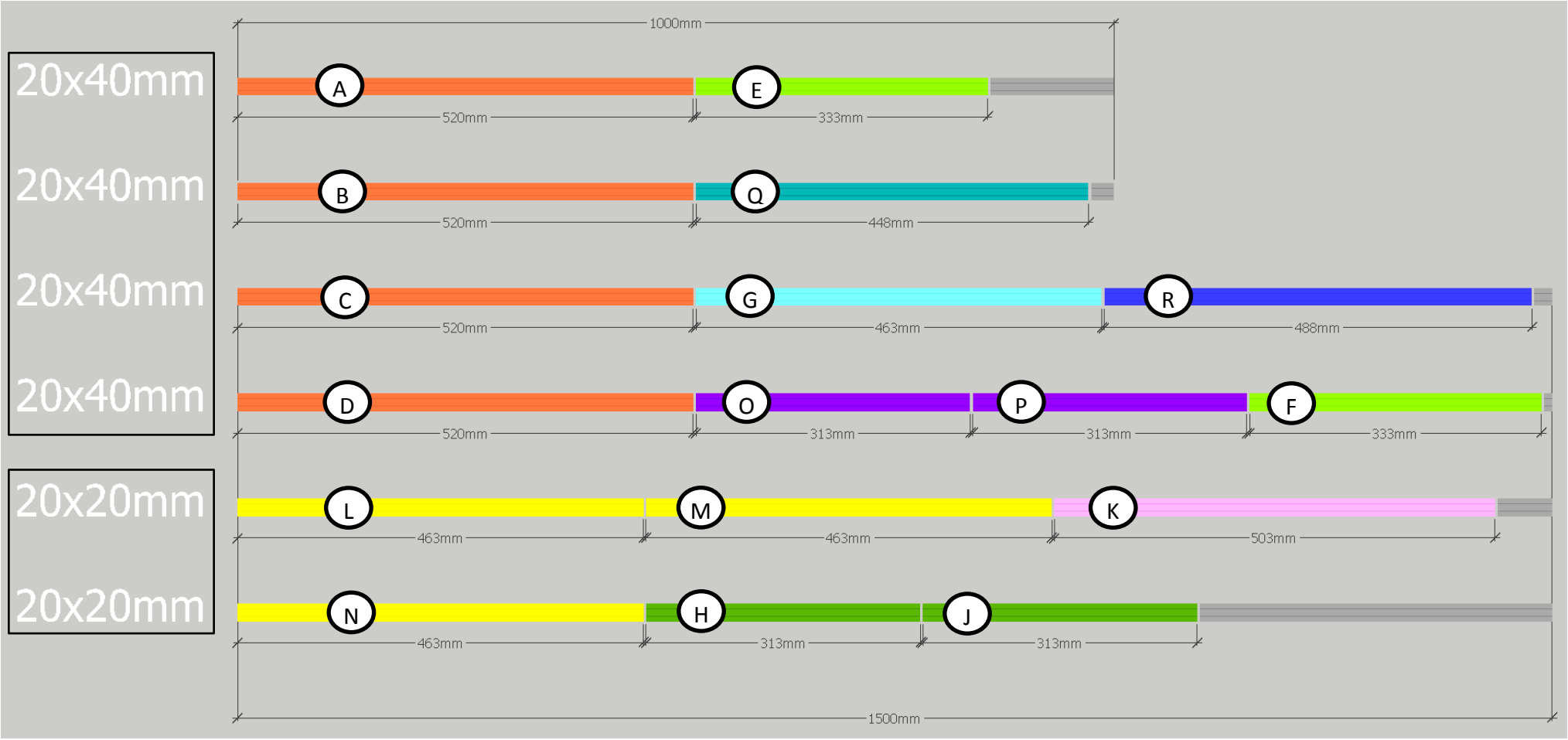


Figure 1: V-slot railing cut diagram

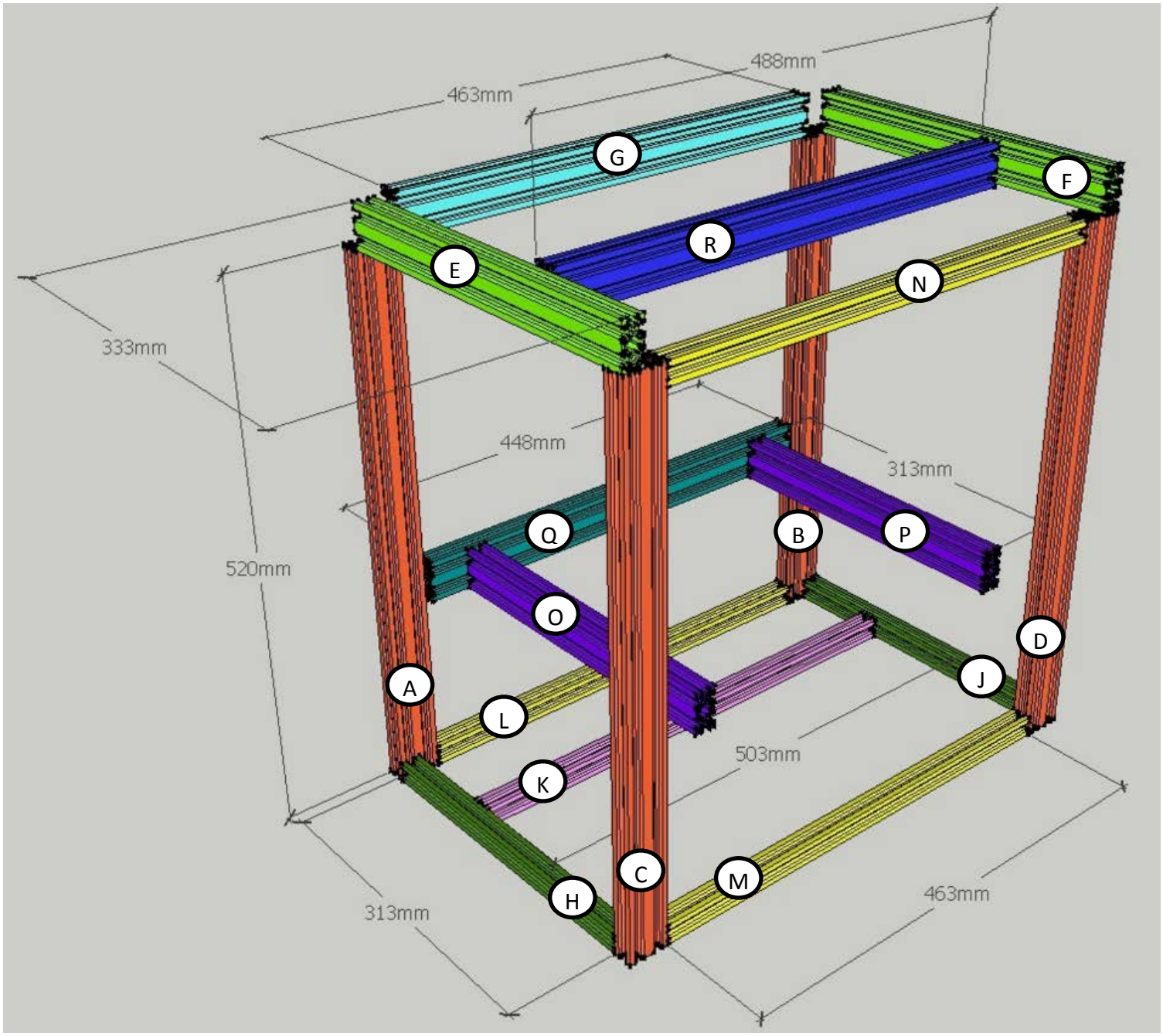


Figure 2: V-slot frame reference diagram

- Figure 3 shows which locations on the V-slot rails need to be M5 thread tapped. V-slot ends are predrilled correctly to the size needed for M5 threads. Use oil on the thread tap, repeatedly reverse the tap to avoid jamming and breaking. Practice thread tapping on some of the leftover scrap V-slot pieces. [Here is an example thread tapping video.]

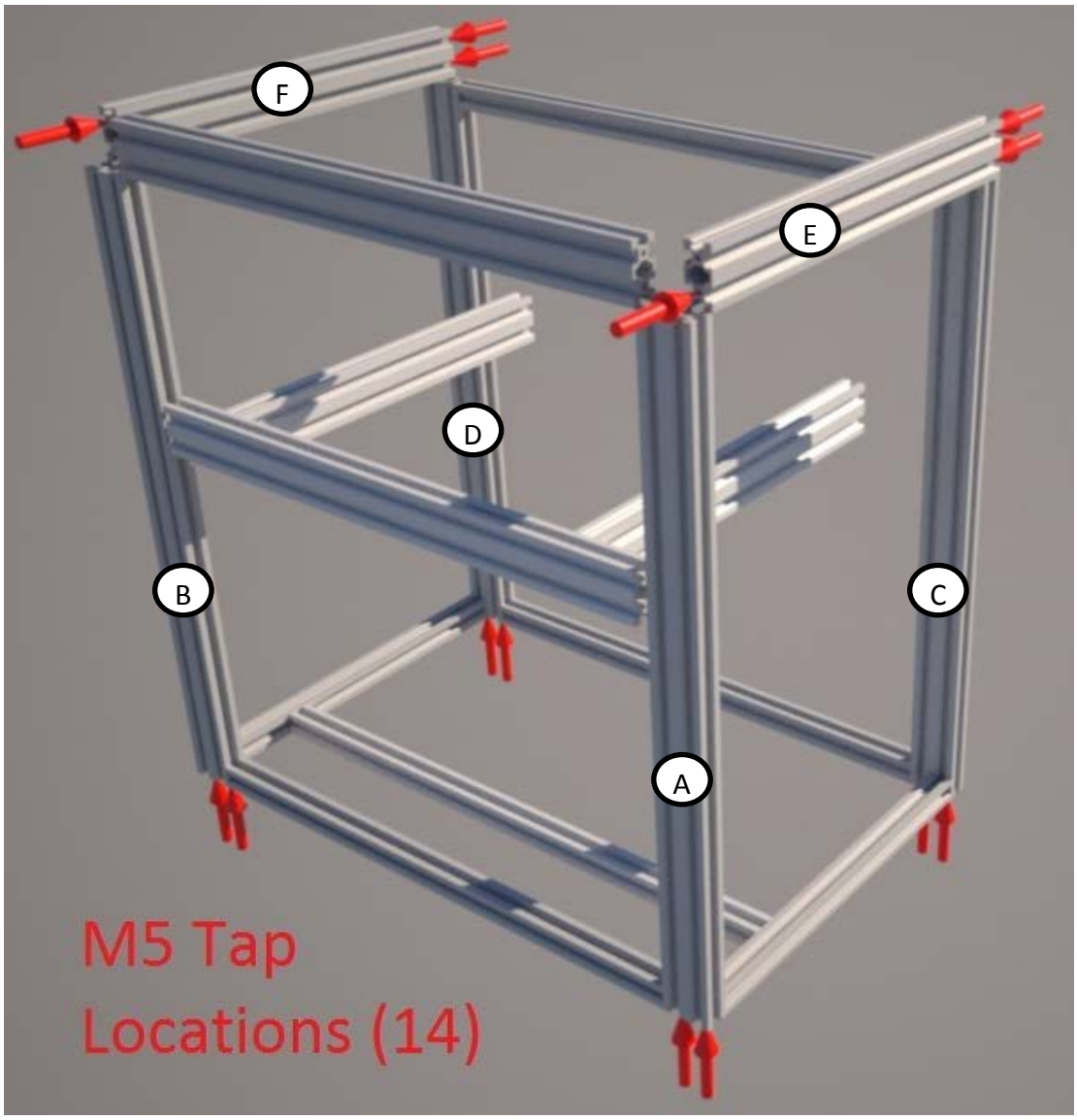


Figure 3: M5 Thread Tap Locations

4. Printing Parts

- All printable parts required are on the D-Bot Thing Files Page. The required quantity for each part type is indicated by the number at the beginning of each file name.

- Parts with stacked countersink holes will print with a single solid layer in between the openings. This is to allow smaller cylinders to print on top of larger cylinders without print failure. Filler material layers can be removed with a knife or screwdriver.

- Optional components can be printed on the D-Bot itself and added later to avoid extra initial printing. This is especially helpful when parts must be printed on a shared public printer or bought from a third party.

- Any part which will be bolted to the aluminum frame has the potential to crack when tightened. This can be avoided by printing structural parts at 100% infill or at least a high infill percentage and several shells which will provide more structure behind mounting holes. It will take more plastic but it is worth it to have all parts as rigid as possible for a strong frame.

- If possible, print structural parts in PETG or ABS rather than PLA. After a few months of use, printers with PLA components exhibit cracked edges due to vibration even when printed at 100% infill.

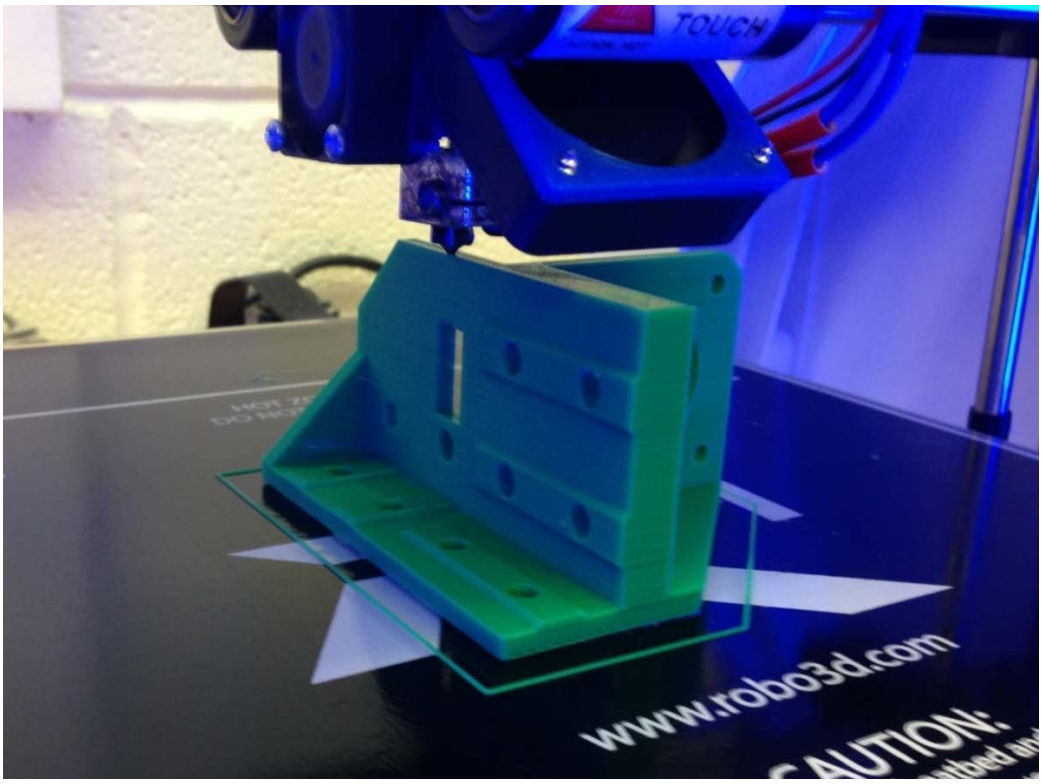


Figure 4: Printing the Right Front Motor Mount

5. Mechanical pre-assembly

- Assemble Wheel Units (20 total)
  Each wheel unit consists of an openbuilds mini V wheel with a MR105ZZ bearing inserted on each side and a 1mm plastic shim in between the two bearings. Do not forget the 1mm shims, without them the spacers will push in on the bearings and they will bind when tightened, the shim gives something for the bearings to push against so they will not bind. Assemble all 20 wheel units per Figure 5.

  Parts Needed:
  (20) OpenBuilds mini V wheels
  (20) Printed Bearing Shims
  (40) MR105ZZ Bearings

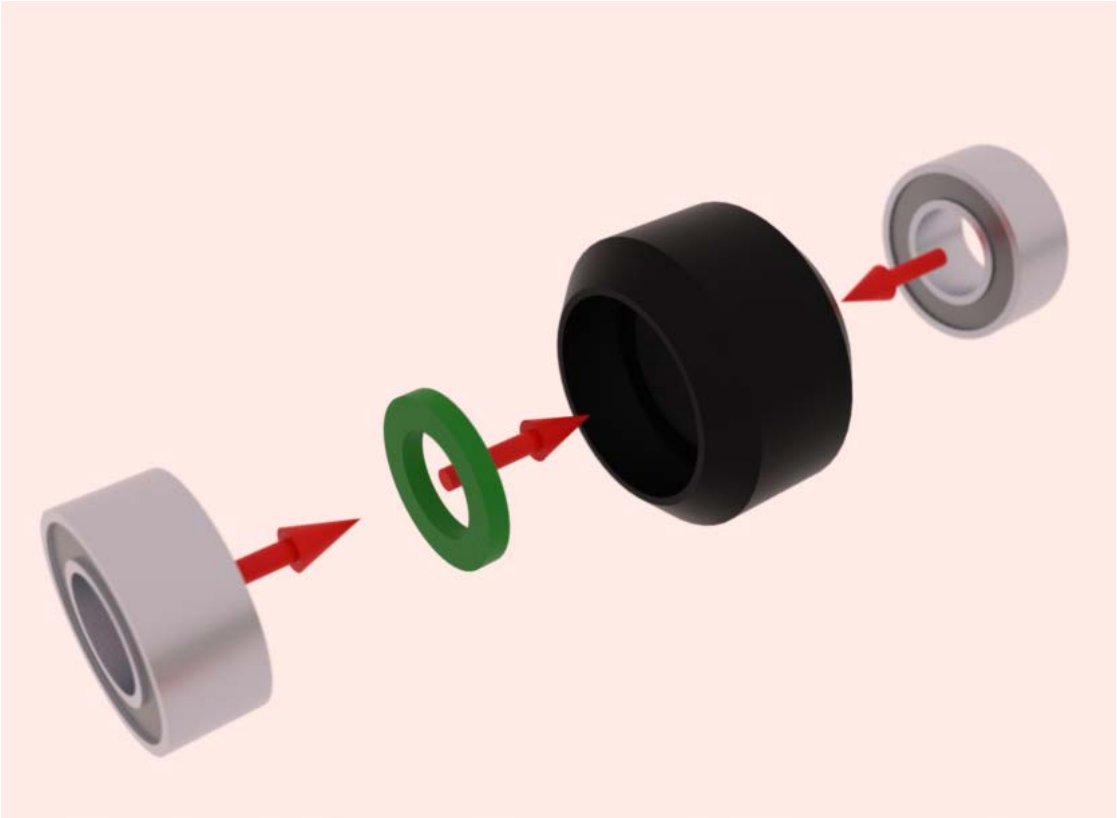


Figure 5: Wheel unit Assembly

- Rear Idler bearings

  Insert idler bearing assemblies into the rear *left and right* idlers (4 locations) as shown in Figure 6. The idler bearing assembly is: (bolt > plastic > flange bearing > washer > flange bearing > plastic > nut), mounted in each rear idler housing. One bolt is inserted from above and one is inserted from below. The lower idler bolt is inaccessible after frame assembly.

  Parts Needed:
  (8) F623ZZ Flanged Bearings
  (4) M3 25mm bolts
  (4) M3 Nuts (standard)
  (4) M3 washers

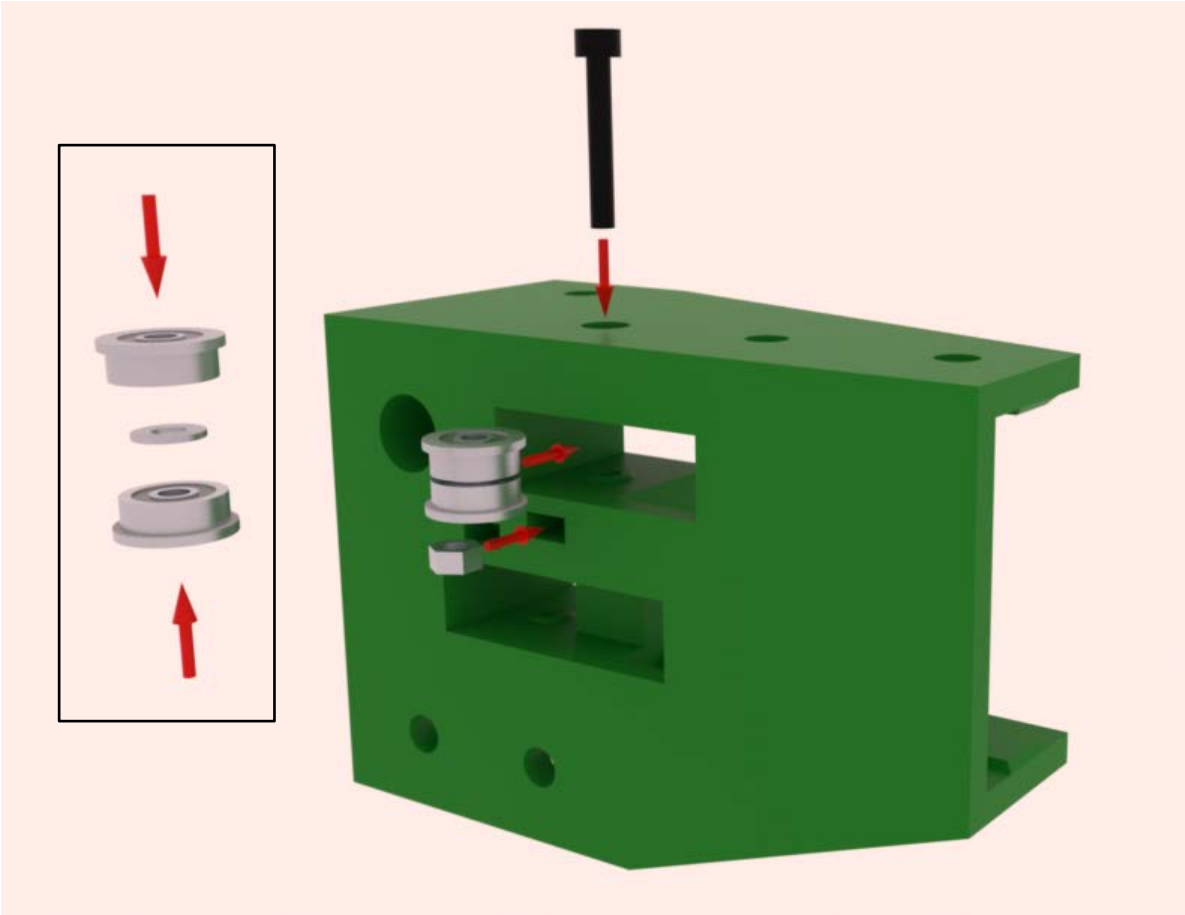


Figure 6: Rear Idler Bearing Assembly

- H-Bar End Idler bearings

  Insert idler bearing assemblies into the *left and right* H Bar Ends (4 locations) as shown in Figure 7. The H-Bar idler bearing assembly is: (bolt > washer > plastic > flange bearing > washer > flange bearing > plastic > washer > nylock nut), mounted in each H Bar end. One bolt is inserted from above and one is inserted from below.

  Parts Needed:
  (8) F623ZZ Flanged Bearings
  (4) M3 25mm bolts
  (4) M3 Nuts (nylock)
  (12) M3 washers

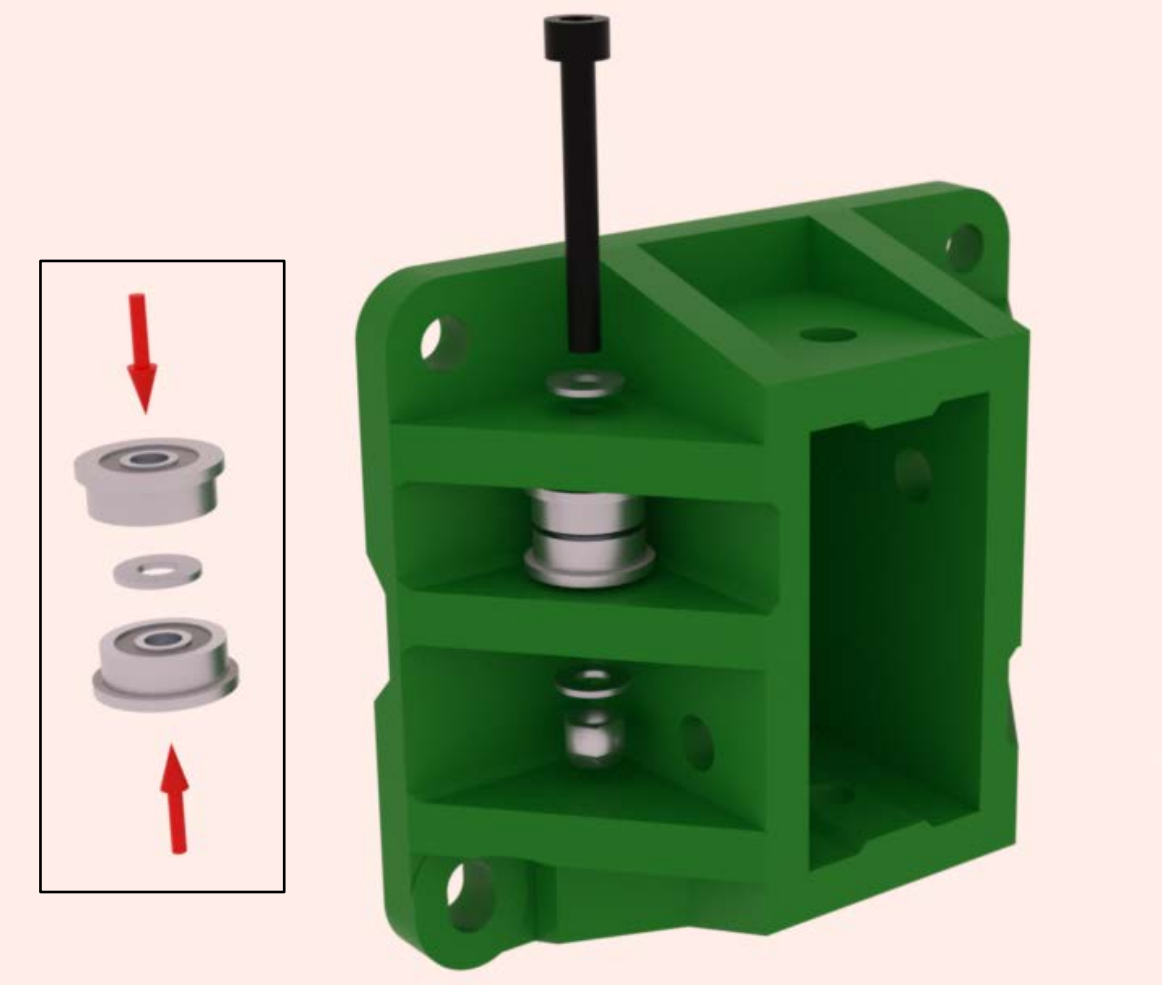


Figure 7: H-Bar End Idler Bearing Assembly

6. Frame Assembly

- Put an M5 10mm bolt with an M5 washer through each plastic frame part where needed and put a square nut on the end of the bolt. Leave off the 14 bolts which attach to tapped holes for now. Some M5 bolt mounting locations are countersunk and do not need M5 washers. Once nuts and bolts are placed on plastic pieces, slide each part onto the V-slot rail from the open end as shown in Figure 8. The square nuts need to be lined up with the V-slot ends.

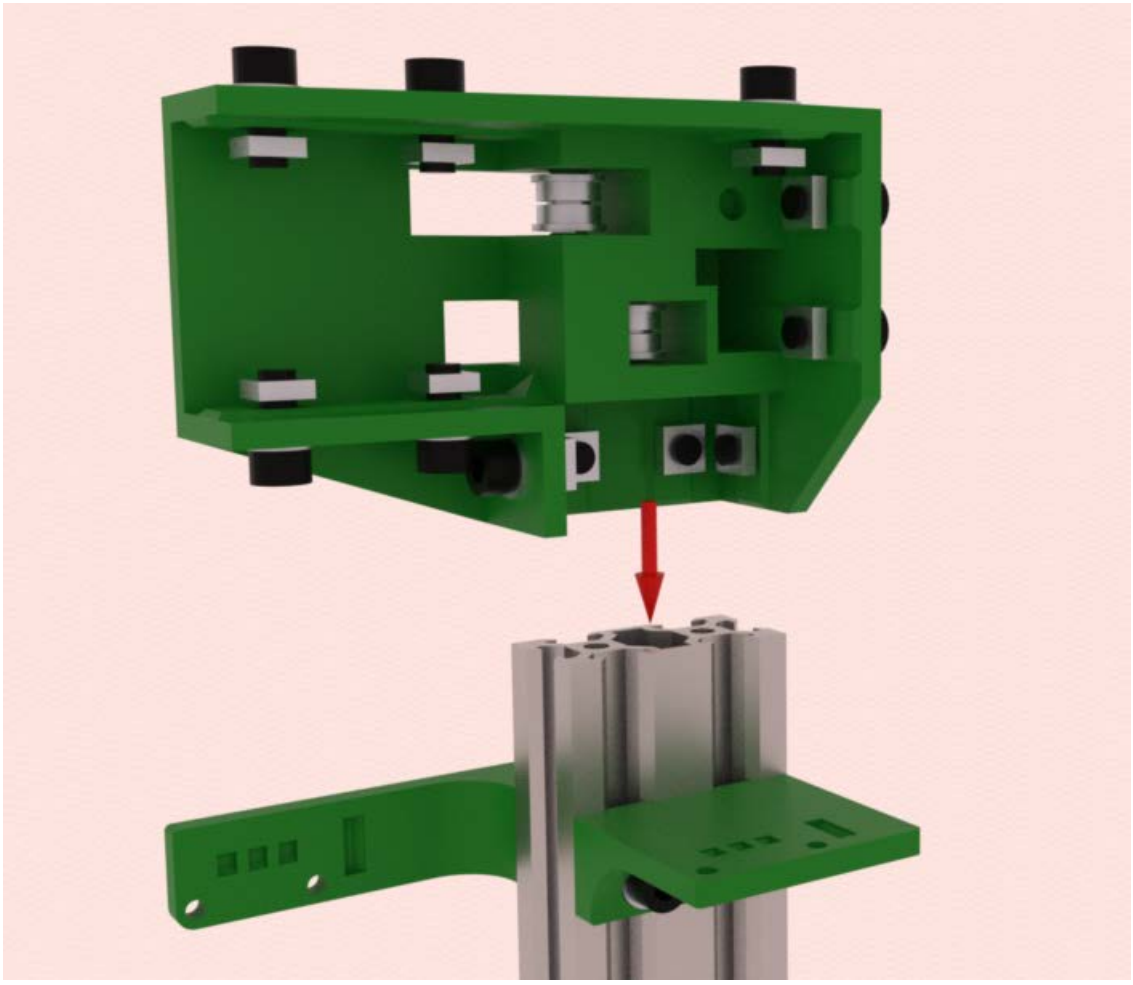


Figure 8: V-Slot and square nut alignment

- For future add-ons or changes, square nuts can be inserted into the face of the V-slot rails after the frame has been assembled. Insert the square nut into the slot at an angle and tilt up, a small tap pushes it past the lip of the railing.

- Attach the Right Rear Idler, Z Endstop Bracket, Y Endstop Bracket, two Corner Brackets, and one 3x3 Plate onto Rail B.
- Attach a 2x1Plate and a 3x3Plate onto Rail J.
- Attach Rails F and J to Rail B.
- Tighten Rear Idler bolts which are blocked by adjacent bolts with needle nose pliers.

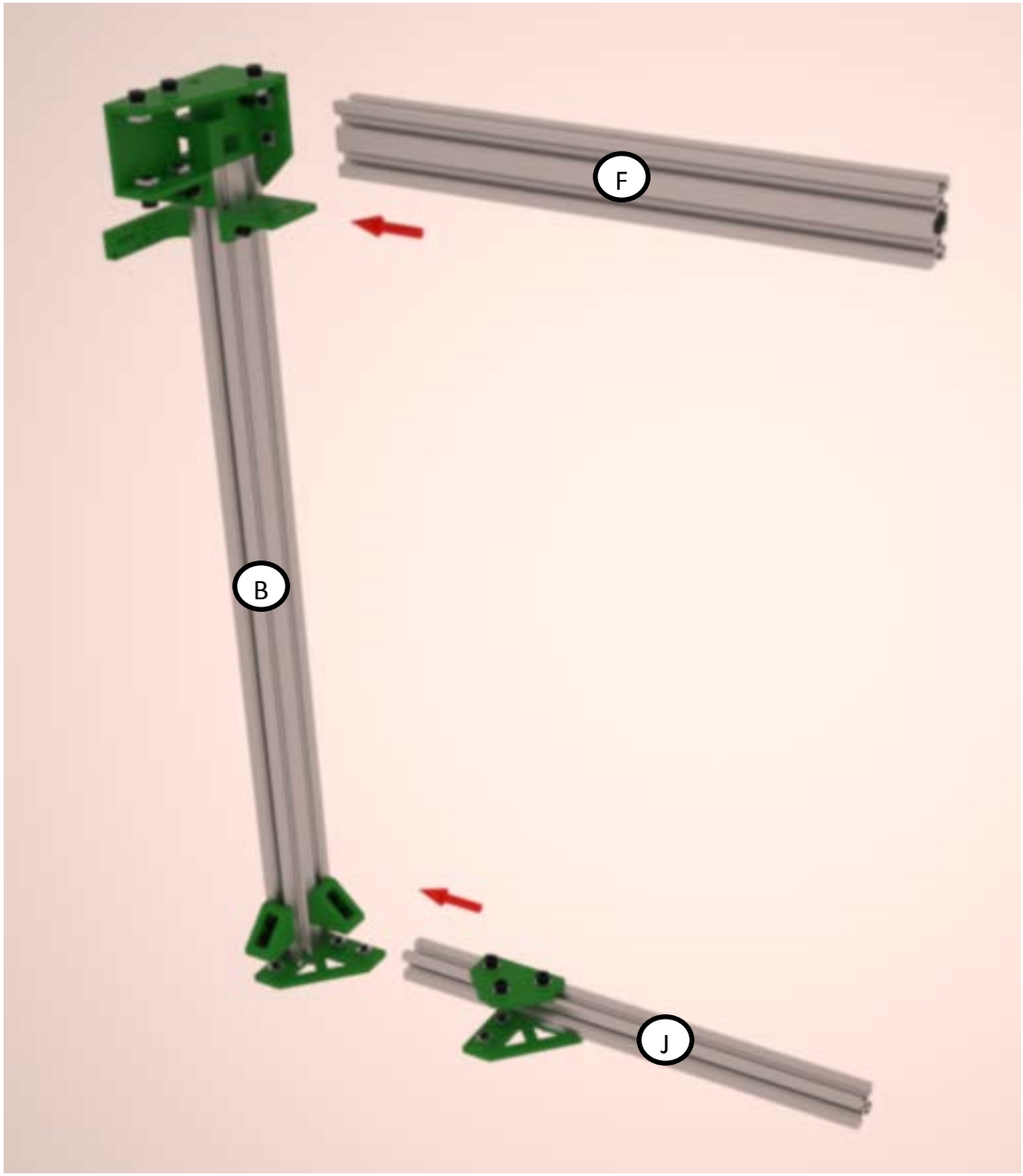


Figure 9: Right Side Frame Assembly

- Attach the Right Motor Mount, two Corner Brackets, and one 3x3Plate to Rail D.
- Attach Rail D to complete the right side of the frame.

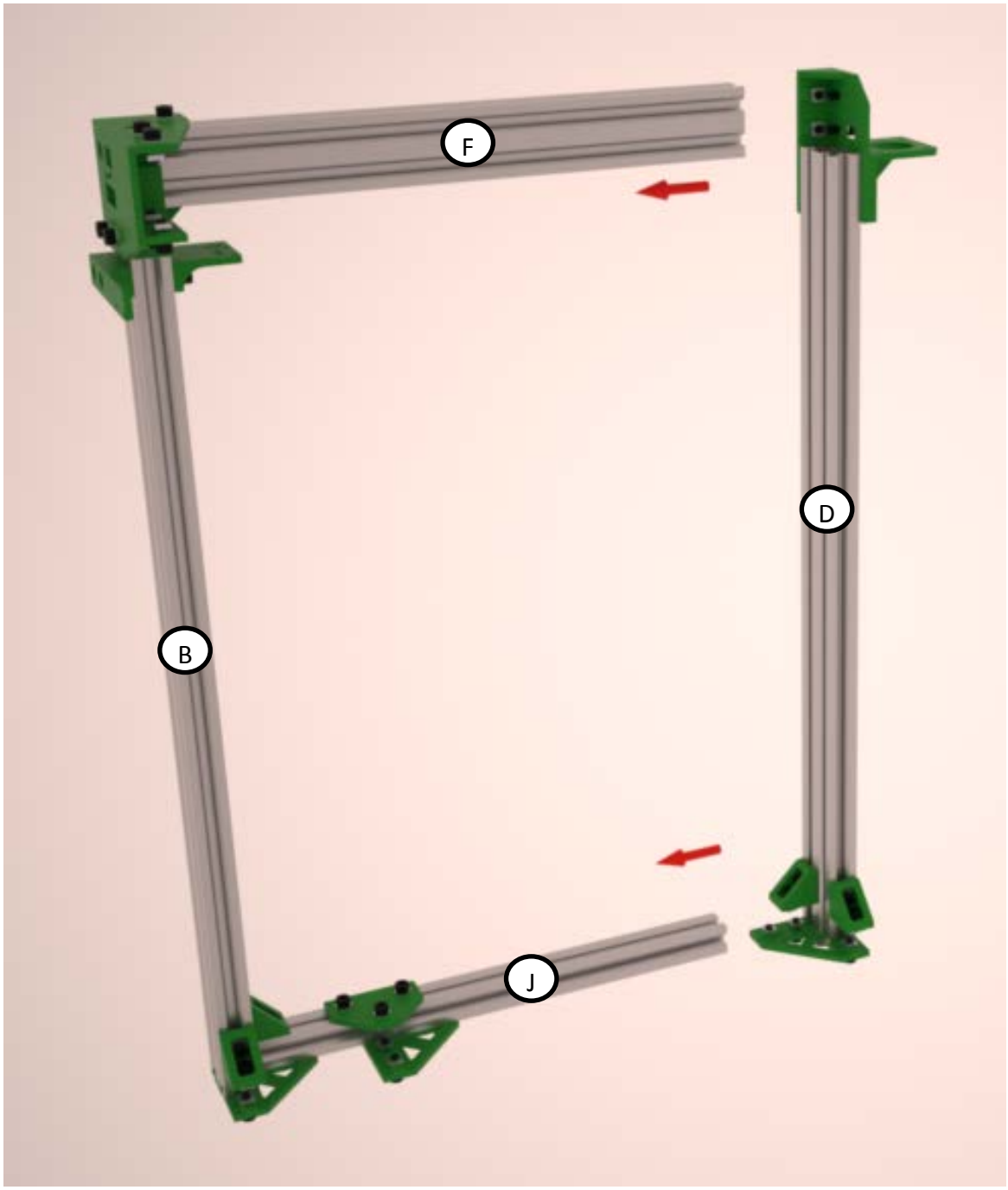


Figure 10: Right side Frame Assembly Continued

- Attach the Left Rear Idler, two Corner Brackets, and one 3x3Plate onto Rail A.
- Attach a 2x1Plate and a 3x3Plate onto Rail H.
- Attach Rails E and H to Rail A.

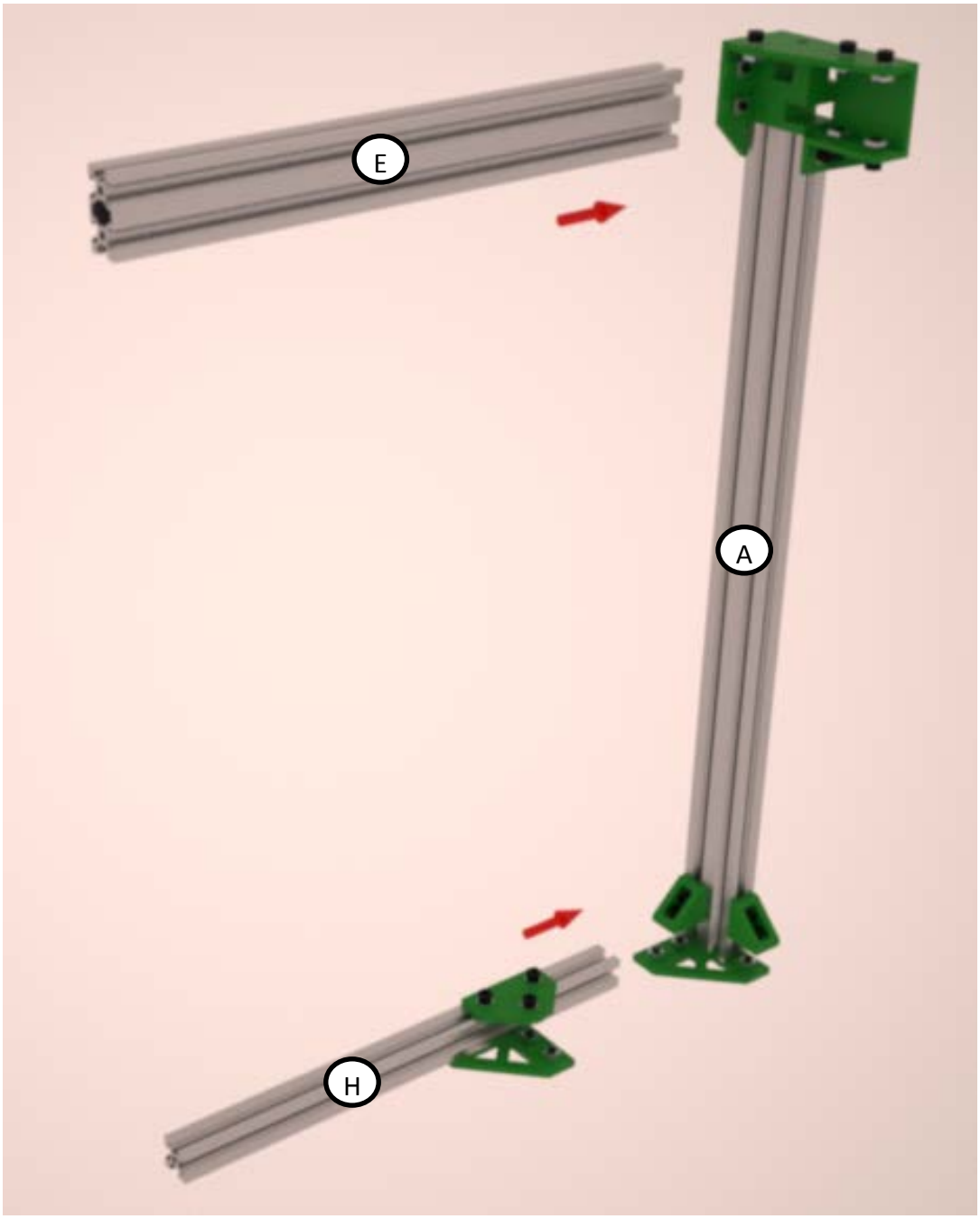


Figure 11: Left Side Frame Assembly

- Attach the Spool Holder to Rail C. The spool holder is composed of an M5 75mm bolt, an M5 nylock nut, an M5 15mm washer, and an M5 square nut as shown in Figure 12

Figure 12: Spool Holder

- Attach the Left Motor Mount, the Extruder Bracket, two Corner Brackets, and one 3x3Plate onto Rail C.
- Attach Rail C to complete the left side of the frame.

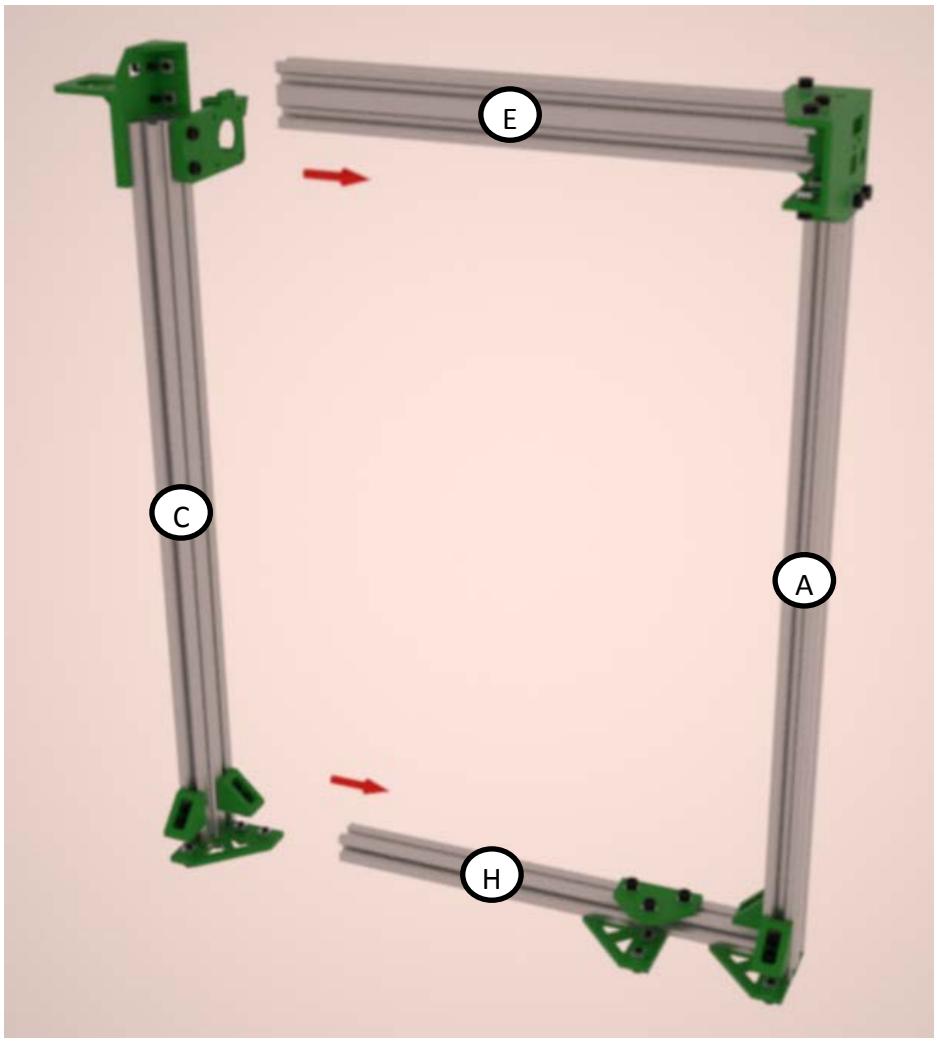


Figure 13: Left side continued

- Attach two Z Motor Mounts to Rail K.
- Attach Rails G, L, K, and M to the right side frame assembly.

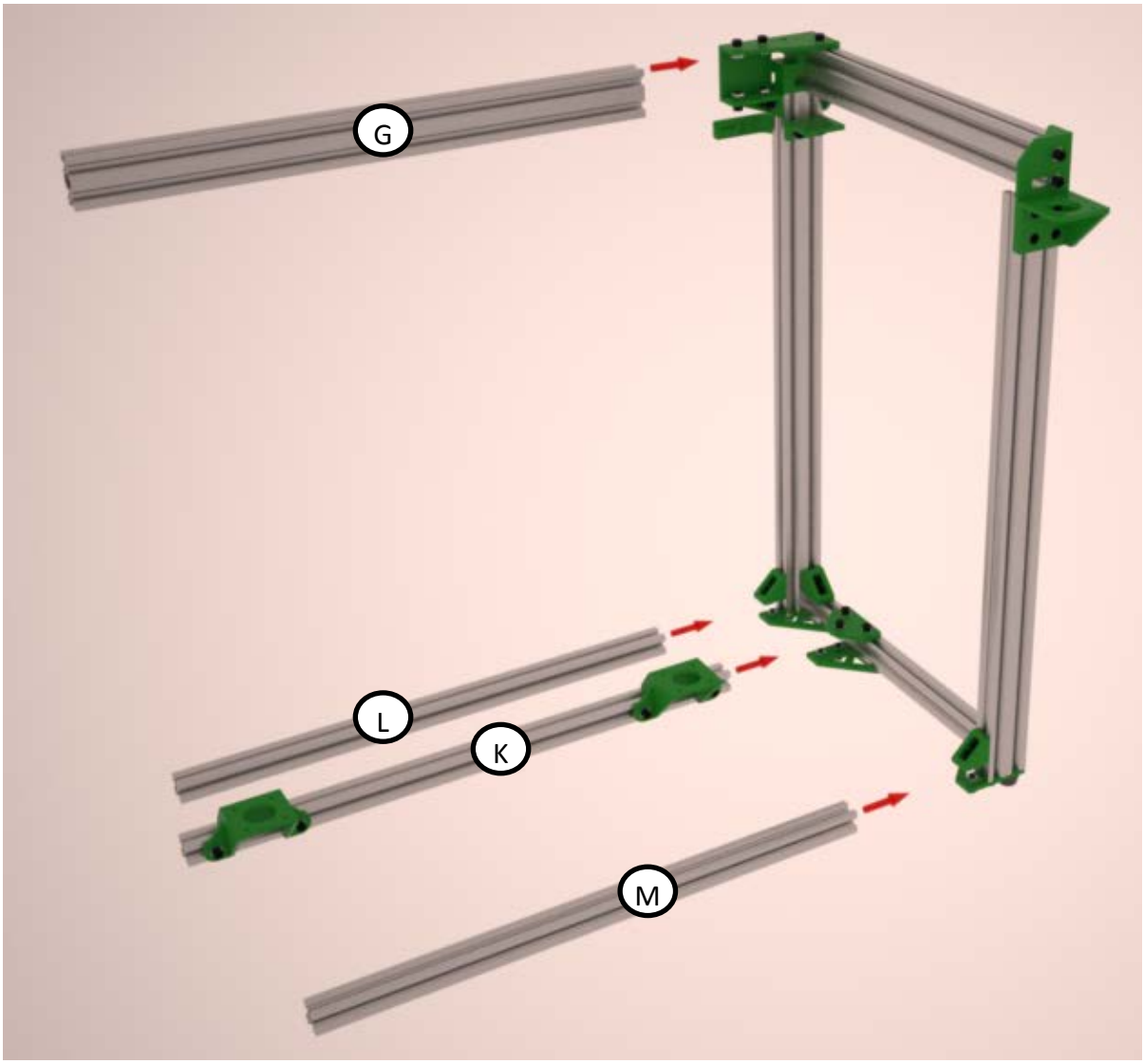


Figure 14: Middle Rail Assembly

- Attach Rails G, L, K, and M to the Left side frame assembly.

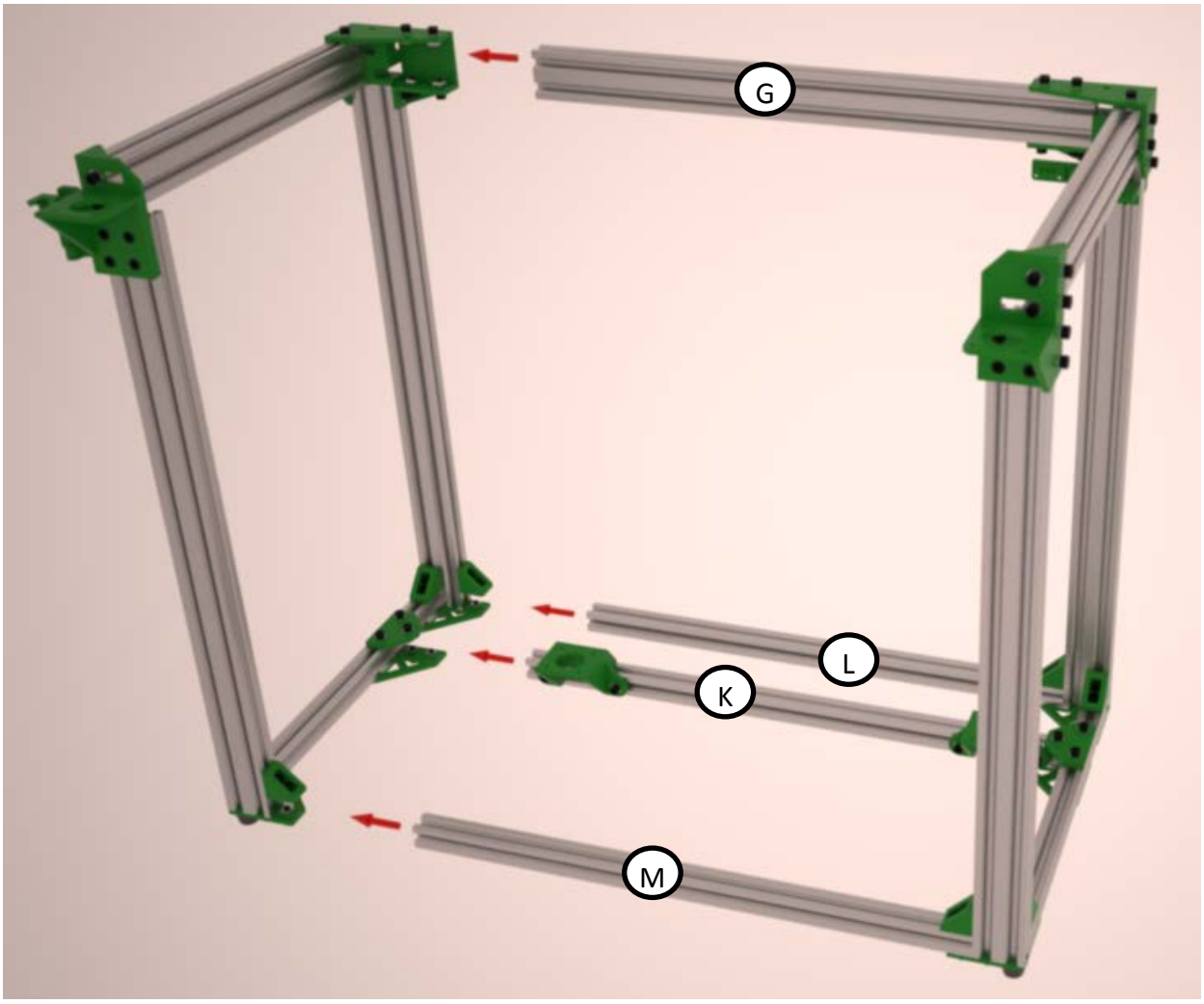


Figure 15: Left and right sides

- Attach two Corner Brackets onto Rail N.
- Attach Rail N to the front of the frame assembly

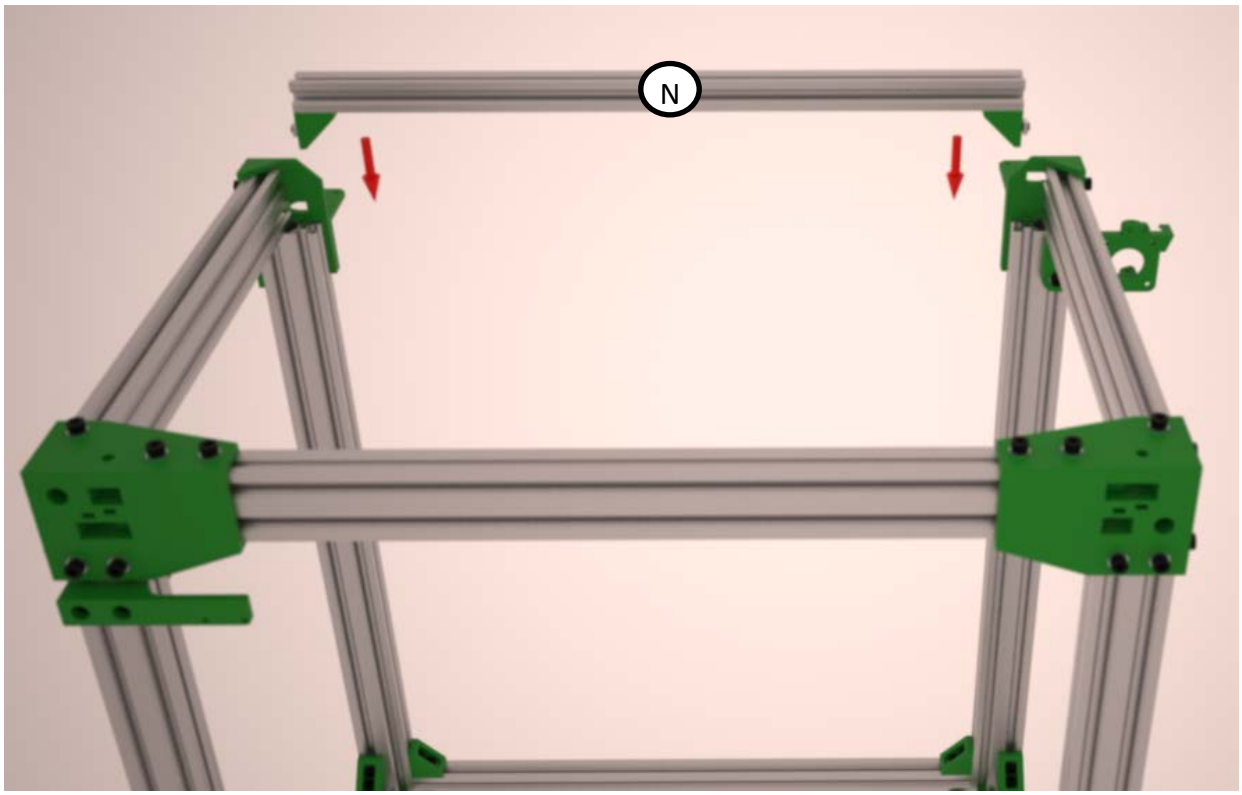
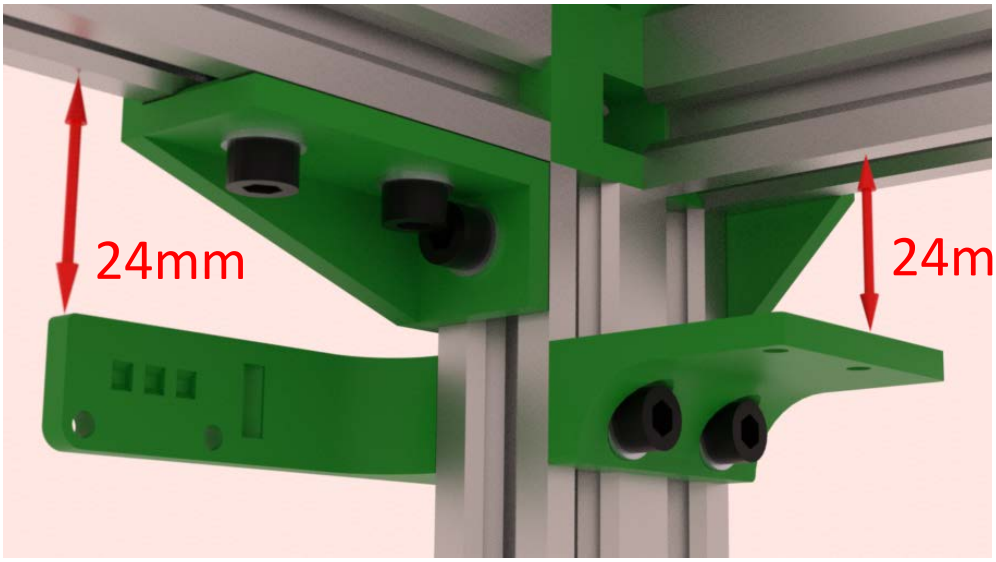
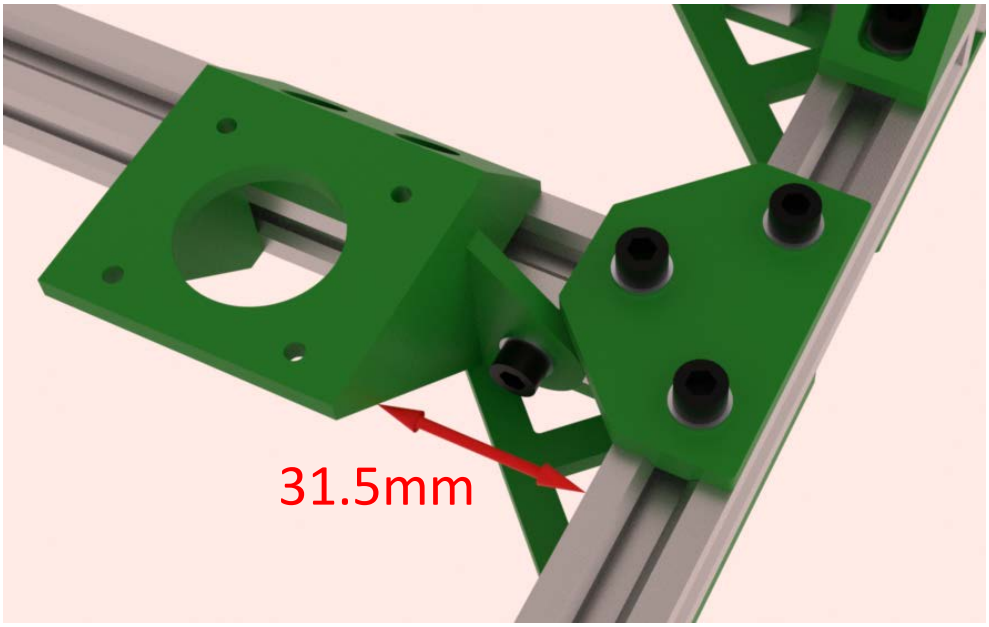
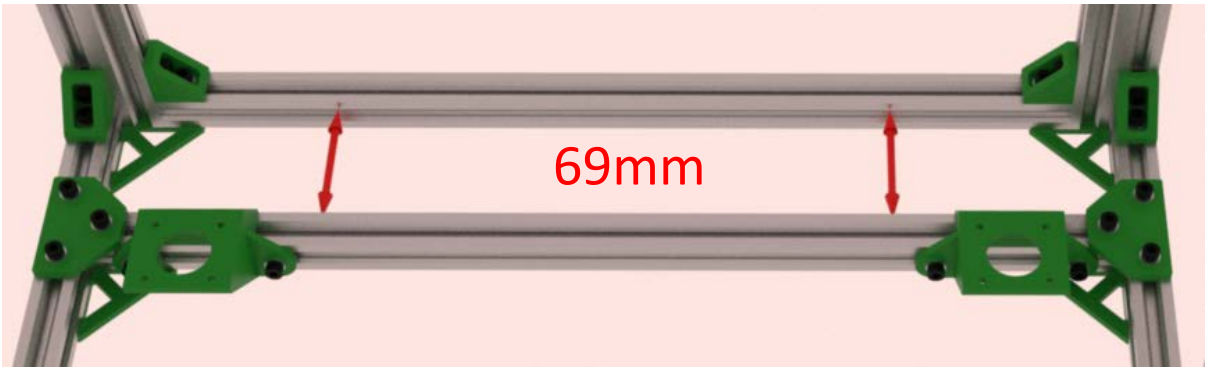


Figure 16: Center front rail

- Adjust the following parts according to the dimensions shown. Tighten bolts.







- Attach four rubber feet to the four corners of the bottom with M5 10mm bolts.
- Attach remaining bolts which thread into tapped ends indicated in Figure 3 (14 total).
- Tighten all M5 frame bolts snugly but not tight enough to cause cracking of plastic parts.
- Measure between Rails A and B at the top and bottom of the frame, verify that the two rails are parallel to within 0.5mm. Loosen up lower corner brackets or rear idlers to make adjustments and leave a slight gap at the end of either Rail L or G in order to make rails A and B parallel.
- Measure between Rails E and F using the same technique, make adjustments to the gaps at the end of Rails G or N so that Rails E and F are parallel to within 0.5mm.

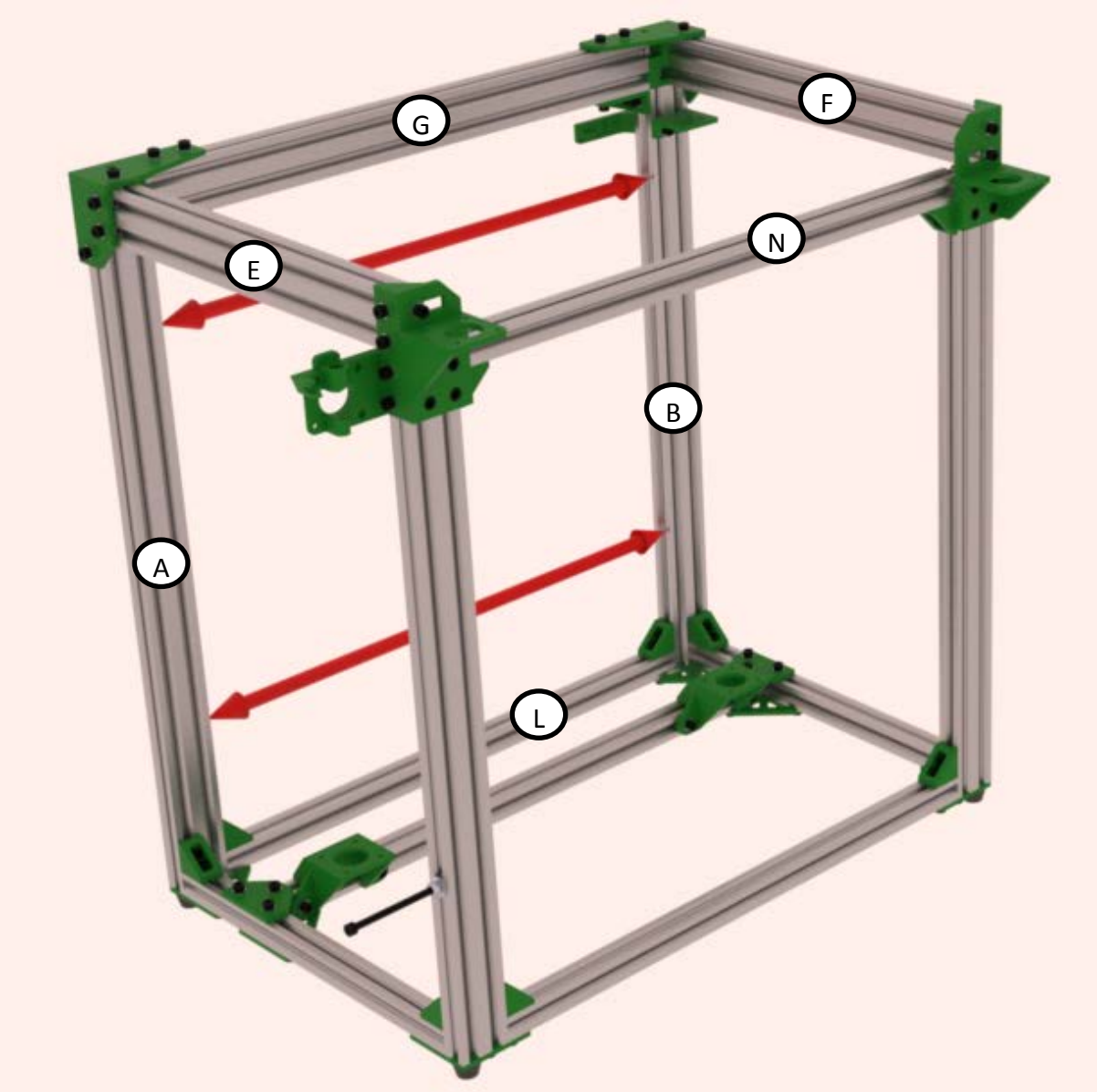


Figure 17: Assembled Frame

7. Z Platform Assembly

- Place a standard M3 nut into each of the four bed supports.

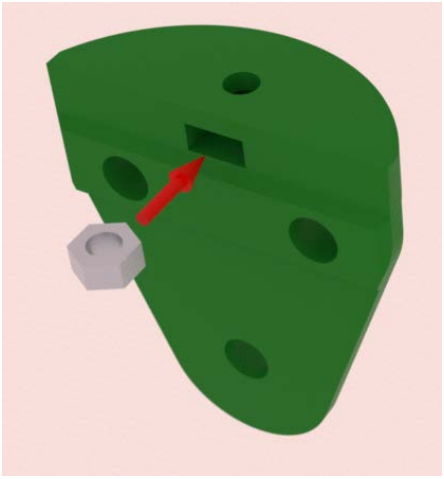


Figure 18: Bed Support

- Attach four 3x3 Plates, four Corner Brackets, and the Z Endstop Bolt Holder to Rail Q.
- Attach two Bed Supports and a Lead screw Bracket to Rail O.
- Attach two Bed Supports and a Lead screw Bracket to Rail P.
- Attach Rails O and P to Rail Q.

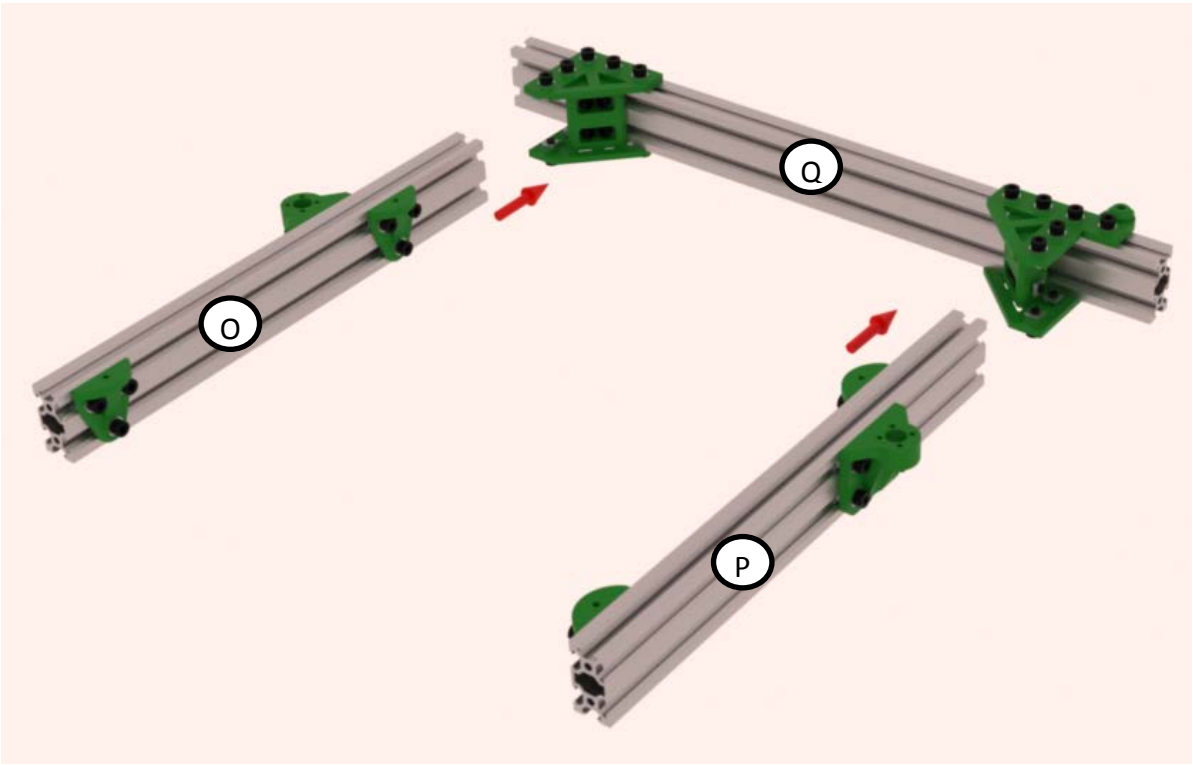


Figure 19: Z Platform Frame assembly

- Adjust Z platform parts according to Figure 20. Both sides are symmetrical.
- Verify that the distance between rail O and rail P is 317mm.

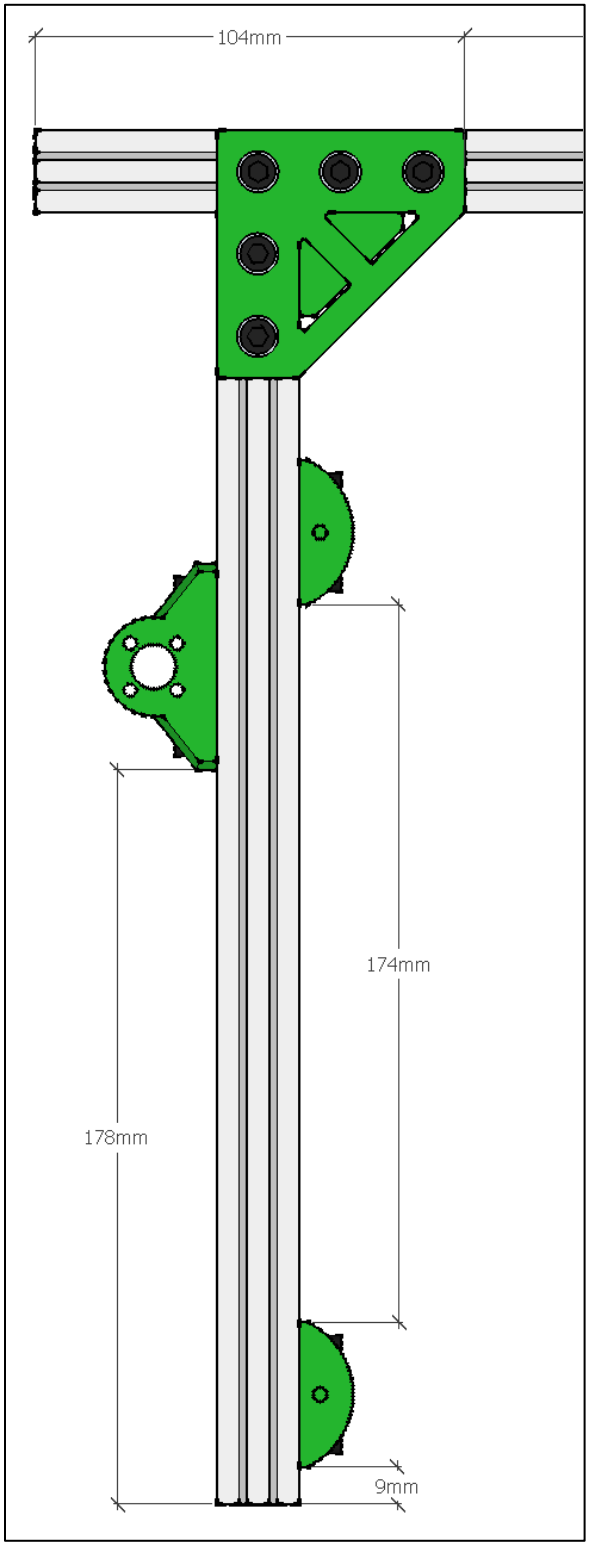


Figure 20: Z Platform Dimensions

- Attach four Z Wheel Guides to rail Q (two on each end). Lightly tighten bolts, final adjustment and tightening will occur after Z platform is aligned within the frame.

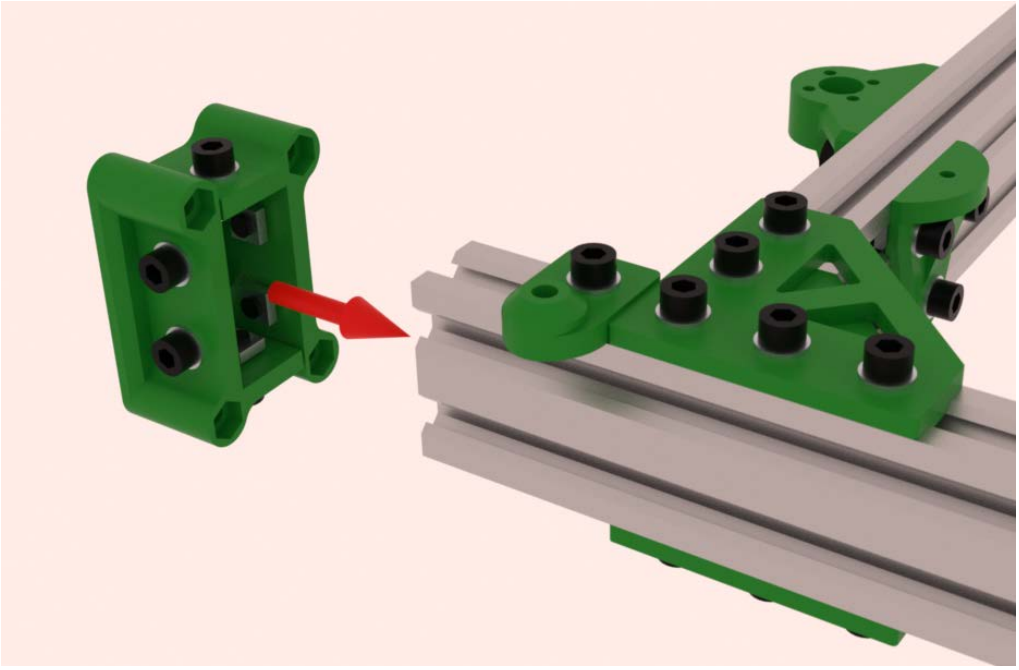


Figure 21: Z Wheel Guide installation

- Insert four wheels into the front facing Z Wheel Guides. Set aside parts for the four rear wheels to be used after Z platform installation.

  Parts Needed:
  (8) Wheel Units (assembled on page 9)
  (8) M5 nuts
  (8) Wheel Spacers
  (8) M5 40mm Bolts

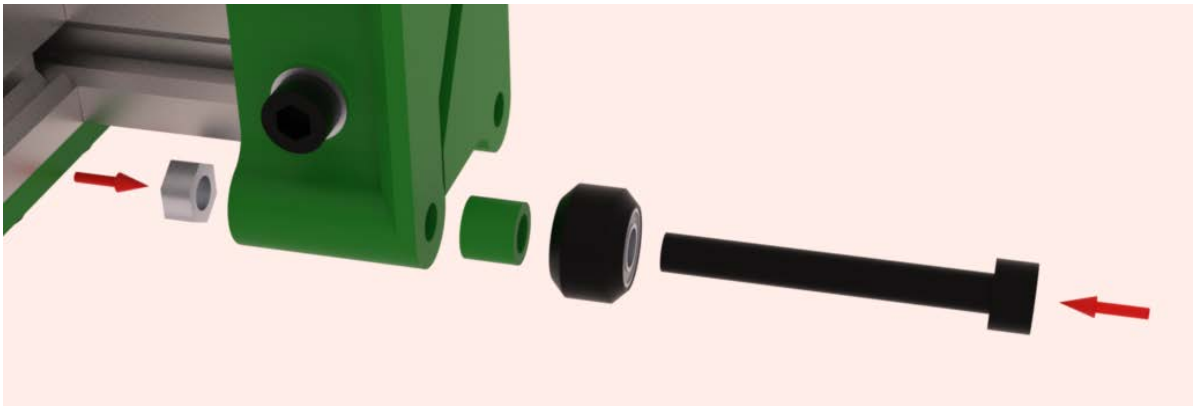


Figure 22: Z Wheel Assembly

- Install the Z platform into the frame, rest platform on the Z motor mounts.
- Line up the four Z wheels with the rear legs. Loosen the Z Wheel Guide bolts and adjust as needed to align the Z wheels with the V-slot grooves in the legs.

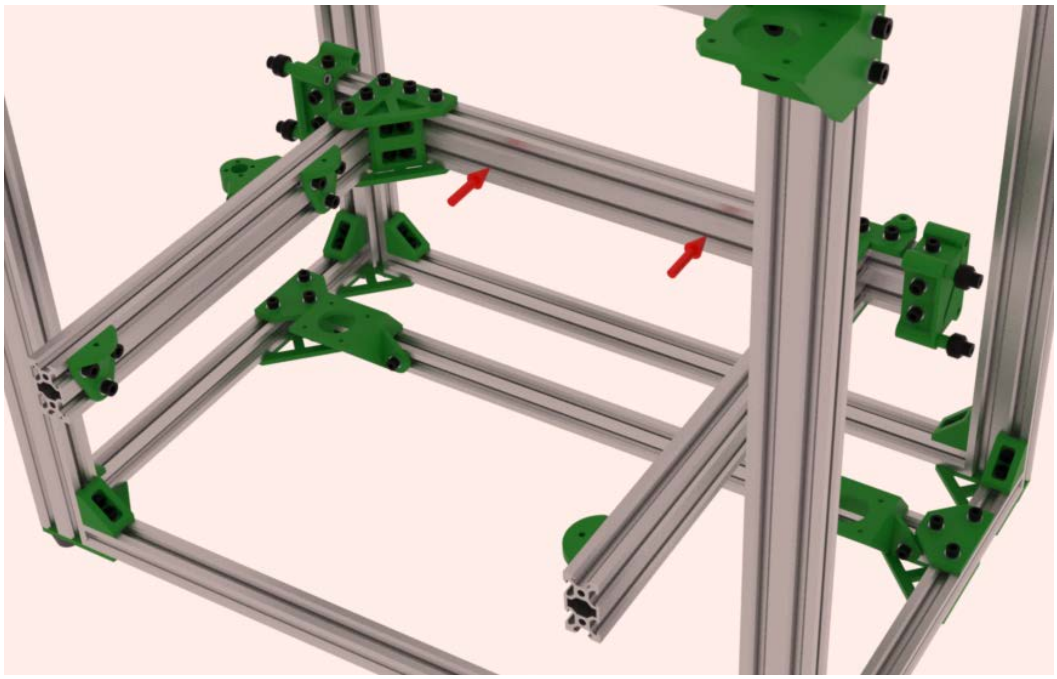


Figure 23: Z Platform installation into frame

- Insert four wheels into the rear Z Wheel Guides.

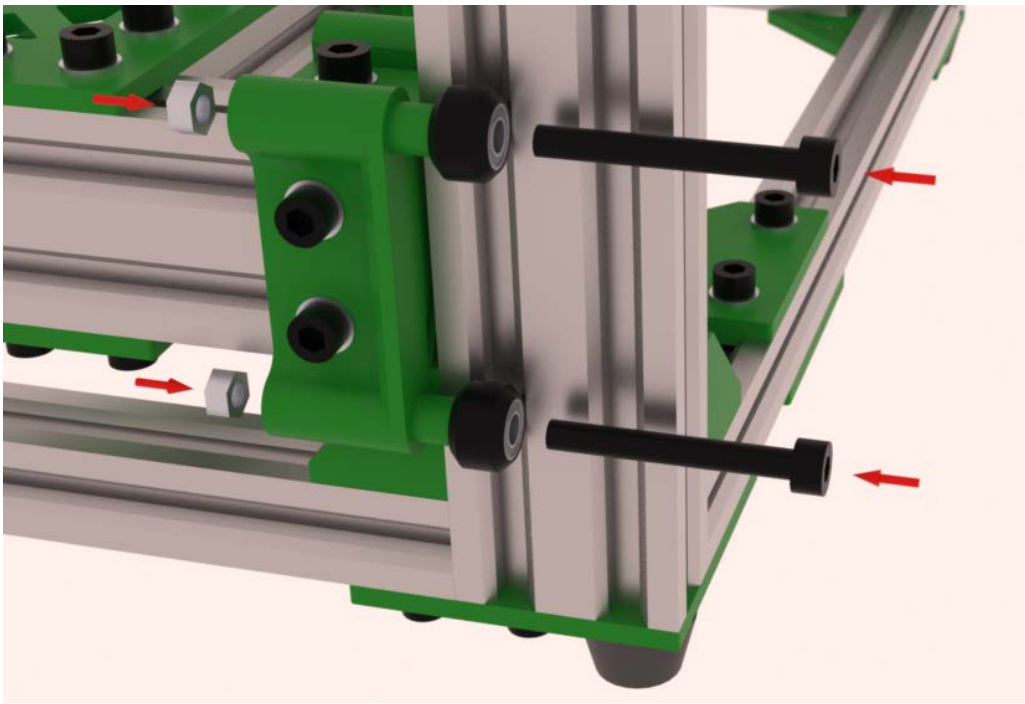


Figure 24: Rear Z Wheel installation

- Tilt the frame forward.
- Roll the Z platform from the top of the frame to the bottom and back.
- Adjust Z wheels and Z guide M5x10 bolts as needed for smooth motion.
- Wheels should be snug against the V-slot grooves but not too tight as to resist motion.
- The pairs of M5x10 Z guide bolts control the tightness of the wheels against rails.
- All 8 wheels should have equal pressure against the legs when rotated by finger.
- These steps may require multiple fine tunings to get all wheels aligned and evenly tight.

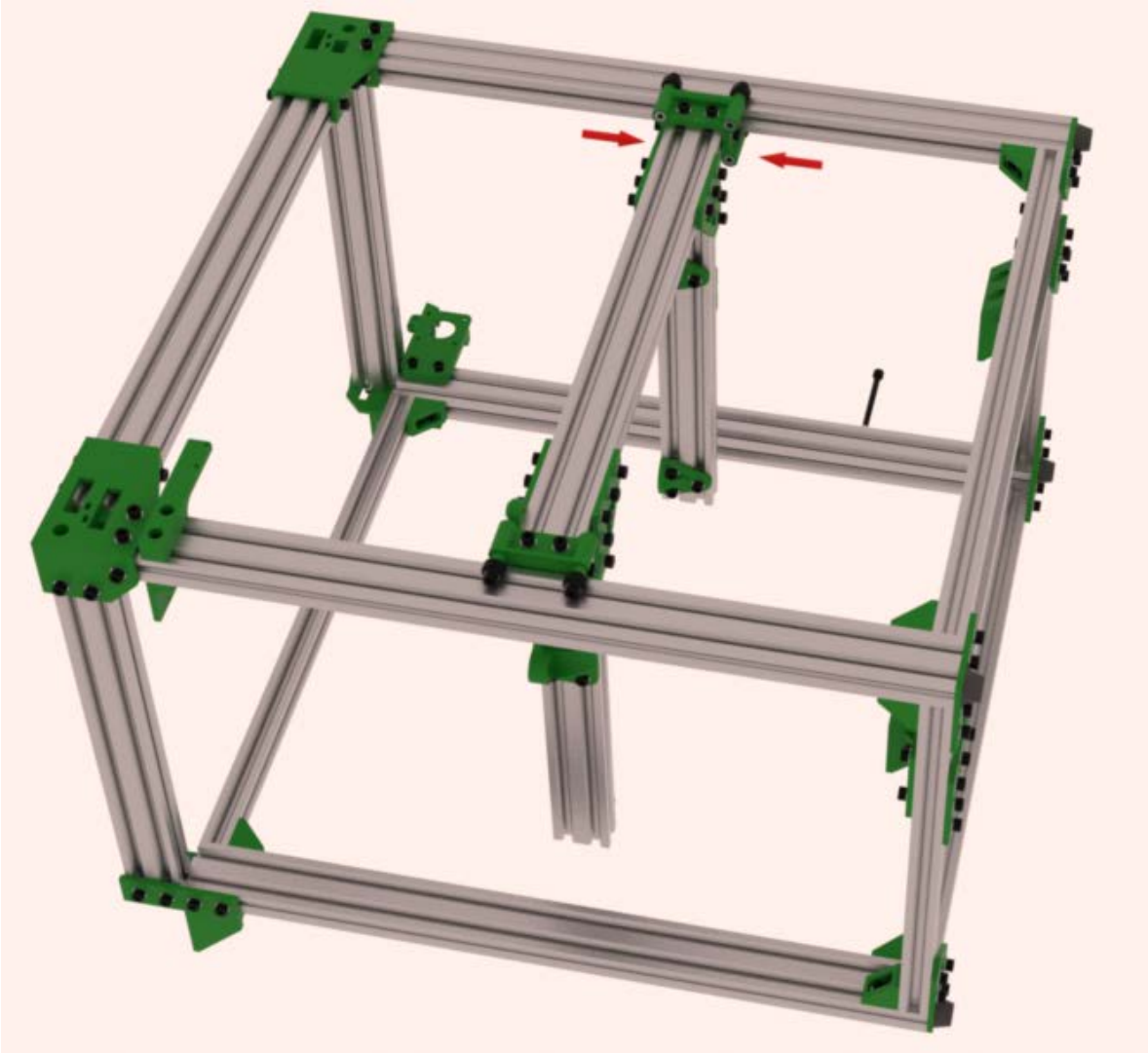


Figure 25: Z Platform Movement Testing

- Insert two brass lead screw nuts into the lead screw brackets and bolt in place as shown in Figure 26.

  Parts Needed:
  (2) Brass lead screw nuts
  (8) M3 20mm Bolts
  (8) M3 Nylock nuts

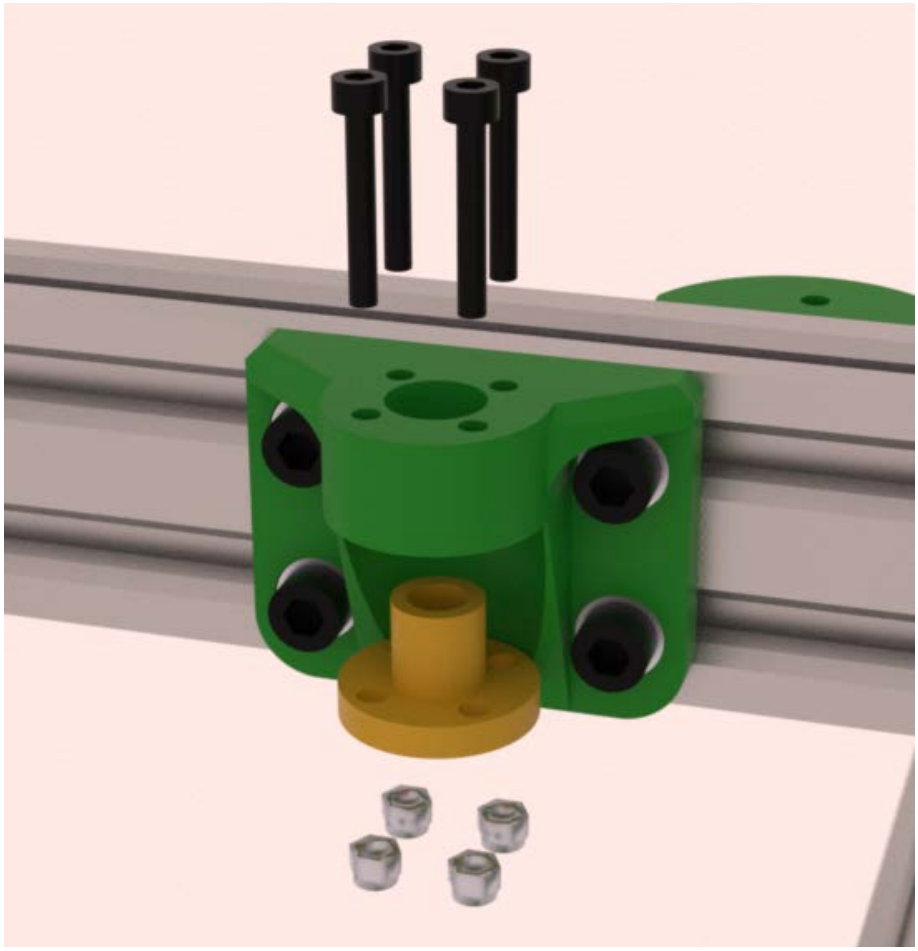


Figure 26: Leadscrew Nut Installation

- Connect the two lead screws to two motors using 5mm x 8mm flex couplings.
- The end of the lead screw should be seated against the top of the motor shaft.
- If there is space between the lead screw and motors shaft, the bed will not be stable.
- Thread the lead screws into the brass lead screw nuts as shown.

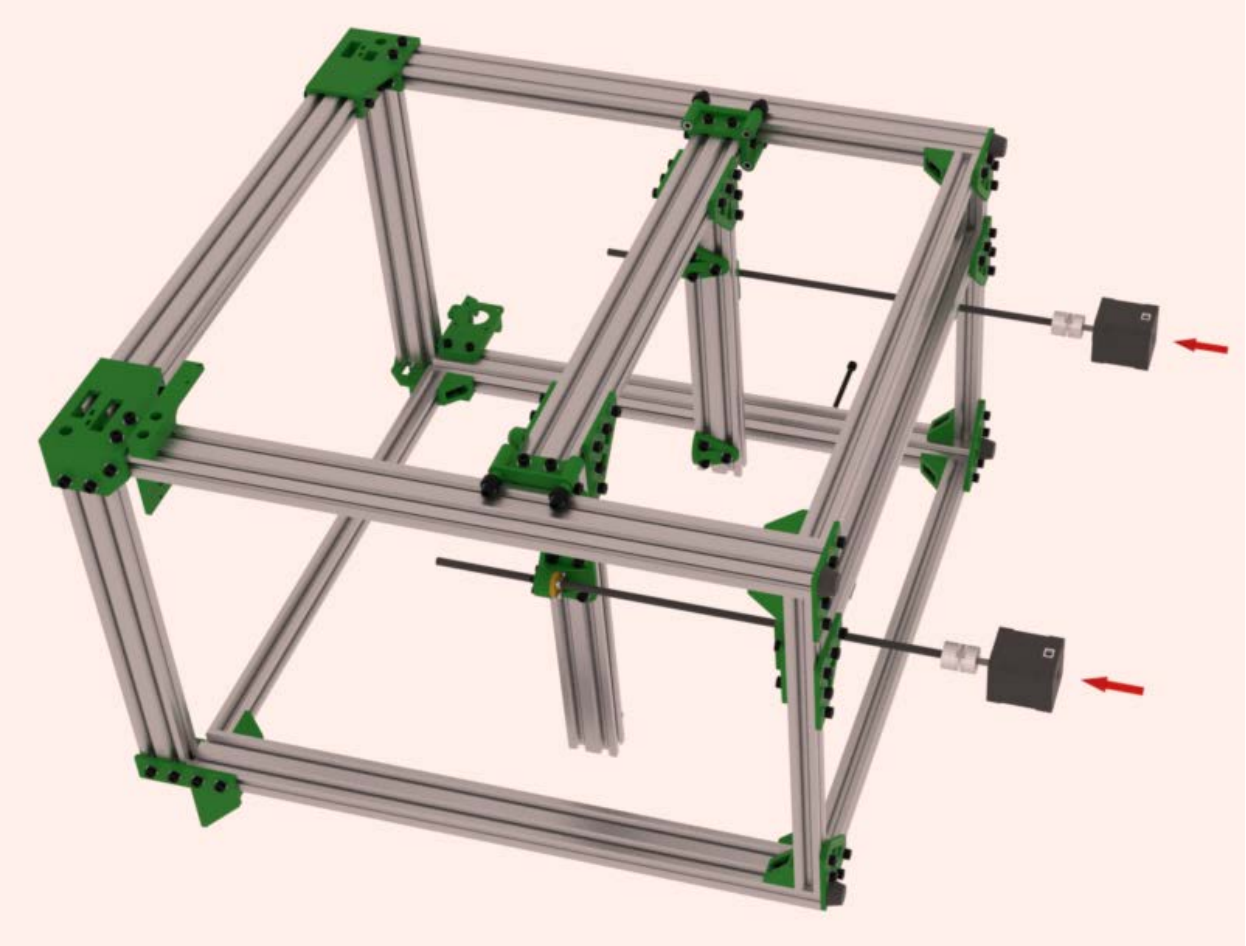


Figure 27: Z Motor and lead screw installation

- Bolt the Z motors to the Z motor brackets with M3 8mm bolts.

  Parts Needed:
  (8) M3 8mm bolts
  (8) M3 Washers

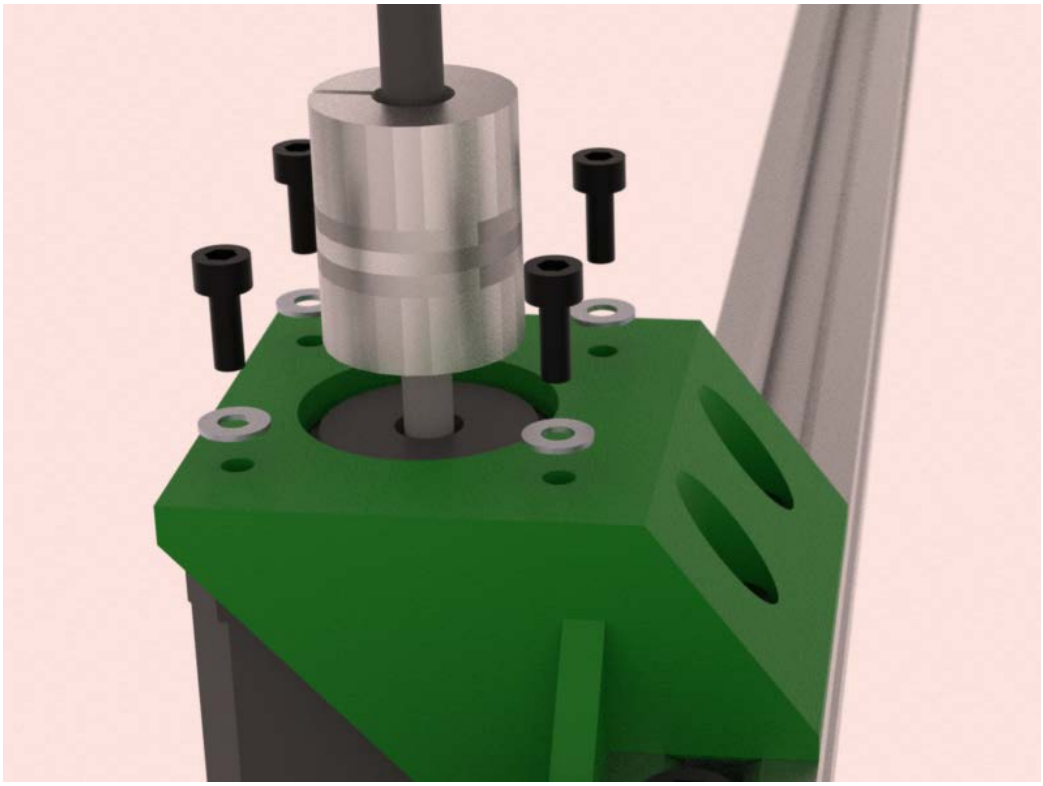


Figure 28: Z Motor bolts installation

- Move the Z platform all the way to the bottom of the frame.
- The brass lead screw nuts need to be centered over the Z motors as shown in Figure 29.
- Adjust the lead screw brackets in the Y direction as needed.
- Adjust the motor mounts in the X direction as needed.
- When aligned properly, the bed should move from the top of the frame to the bottom without binding, and the lead screws should be vertically straight when the bed is at the bottom of the frame as shown in Figure 30.

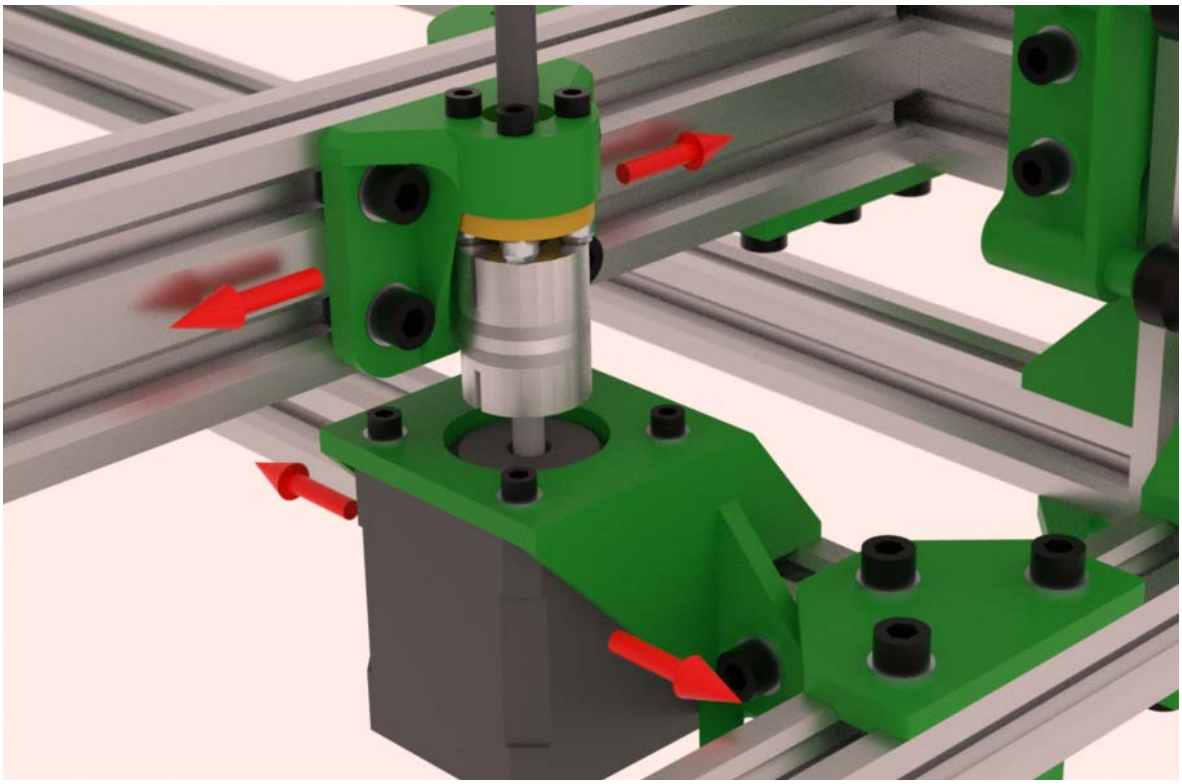


Figure 29: Lead Screw centering alignment

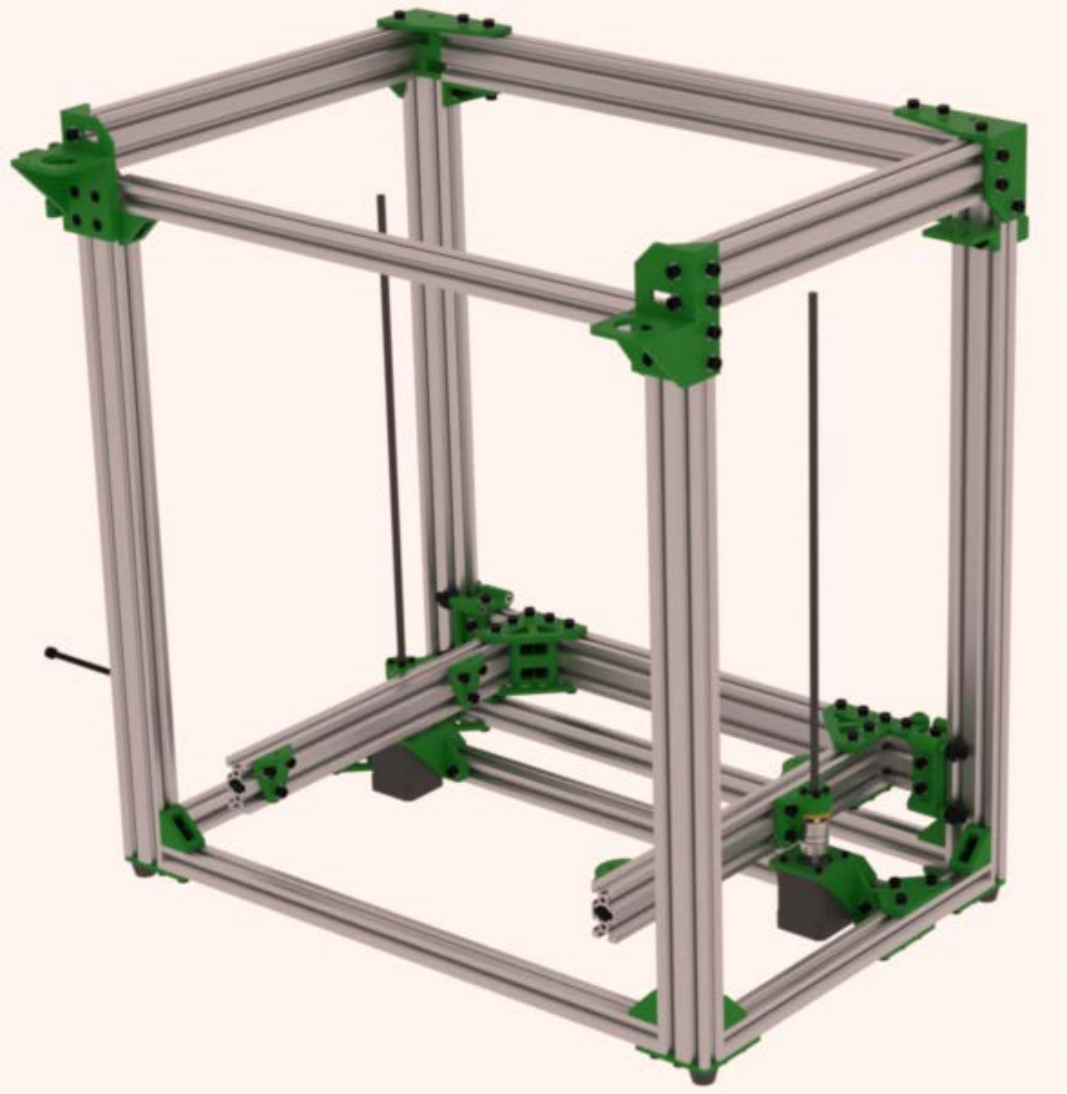


Figure 30: Lead Screw alignment

- Install the heated bed PCB as shown in Figure 31.
- The bed will be removed later to attach wiring.
- The distance between the bottom of the bed and the top of the bed bracket is ~8mm.

Parts Needed:
(4) M3 20mm bolts
(8) M3 Washers
(4) Bed Leveling Springs, similar to the dimensions below:
~4.7mm outside diameter
~12.6mm uncompressed length
~6.10mm fully compressed length

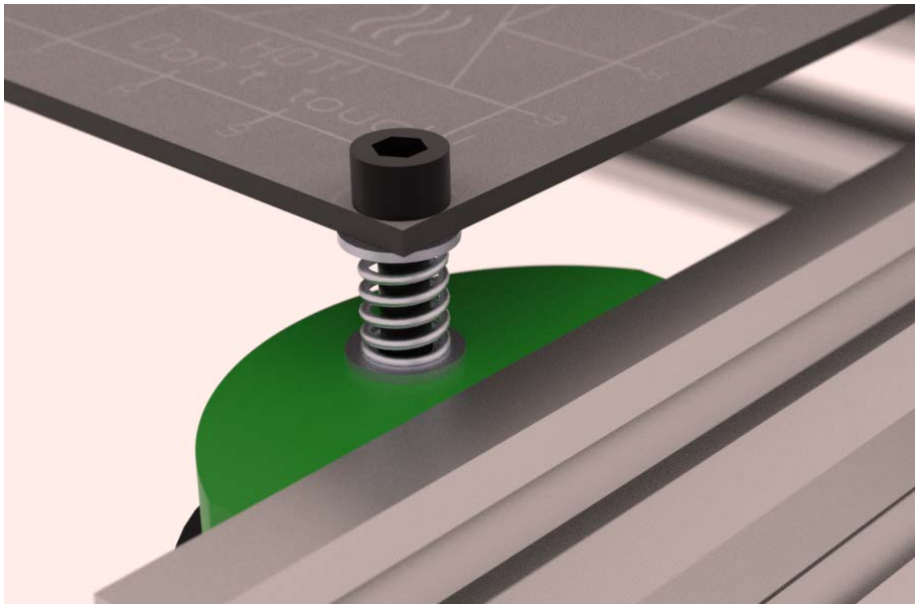


Figure 31: Heated Bed PCB Installation

- Attach glass plate to the bed with small binder clips.
- Standard ~3mm thick window glass works well.
- Match glass dimensions to the dimensions of the bed and have the glass corners notched to avoid hitting the bed mounting bolts. If notching glass corners is not an option, use a rectangular glass plate which will fit in between the mounting bolt heads.

8. Print Carriage Assembly

- Insert 10 M3 standard nuts into the openings of the front print carriage plate.
- Insert 8 M3 standard nuts into the openings of the rear print carriage plate.
- A small amount of adhesive on the outer edge of each nut helps them stay in place during assembly.

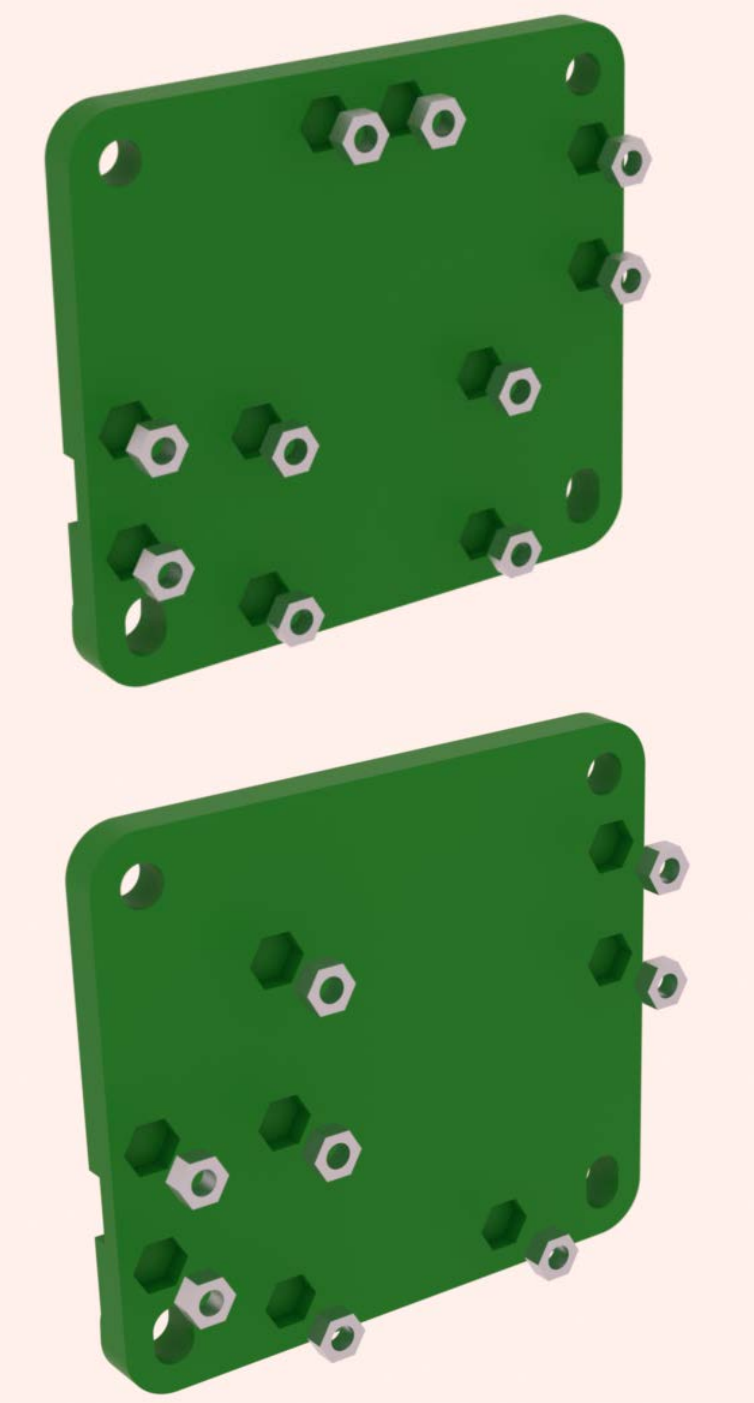


Figure 32: Front and Rear Print Carriage M3 nuts

- Assemble the E3D V6 Hot End according to this guide.
- Attach the hot end to the front carriage plate as shown in Figure 33.

Parts Needed:
(2) M3 8mm bolts
(2) M3 25 mm bolts
(2) Printed hot end clamp pieces

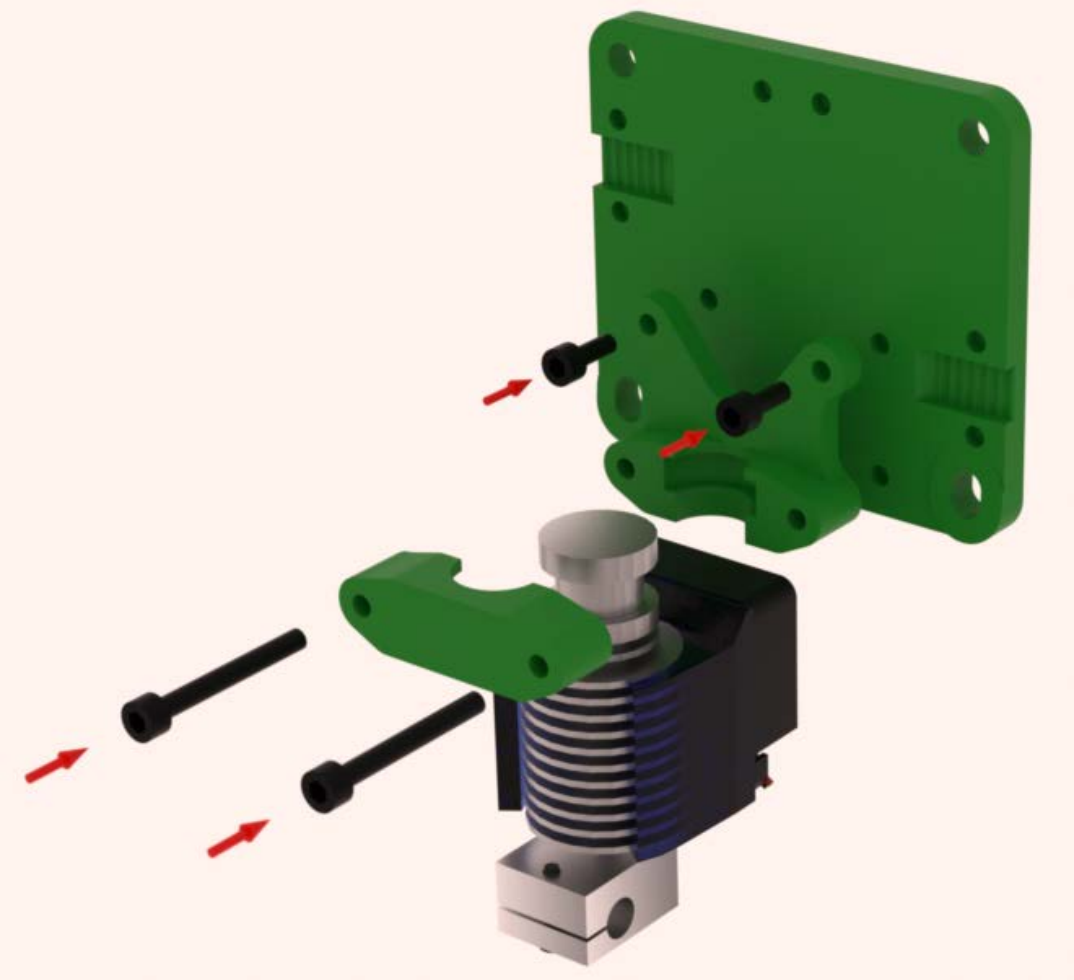


Figure 33: Hot end installation

- Install the tubing holder with two M3x8mm bolts as shown in Figure 34.

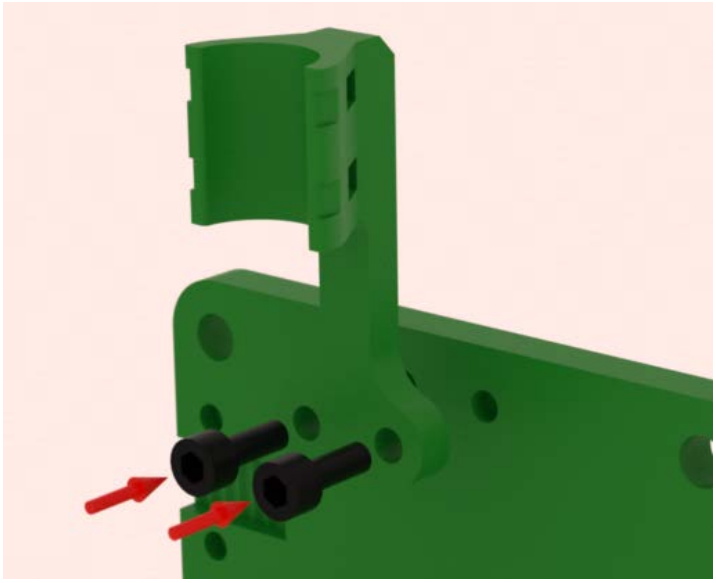


Figure 34: Tubing holder installation

- Attach the X Endstop to the rear print carriage plate using two M3x8mm bolts and 6 M3 washers to avoid having the bolts hit the V-slot rail behind the carriage.

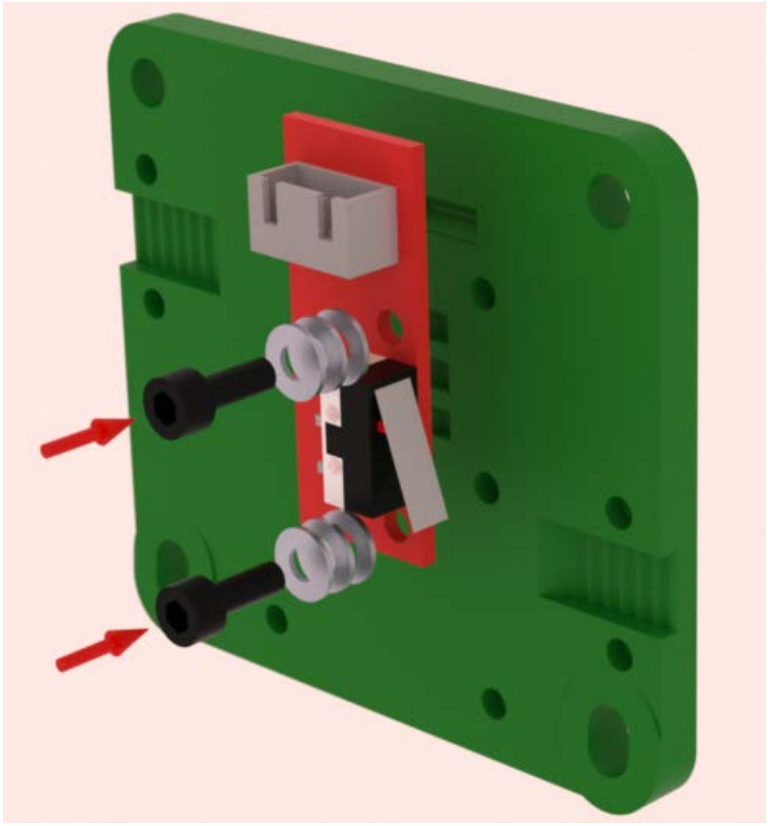


Figure 35: X Endstop Installation

- Attach the 40mm fan to the duct as shown in Figure 36.
- Airflow direction arrow on fan should point towards duct.

Parts Needed:
(4) M3 20mm bolts
(4) M3 Nylock Nuts
(8) M3 Washers

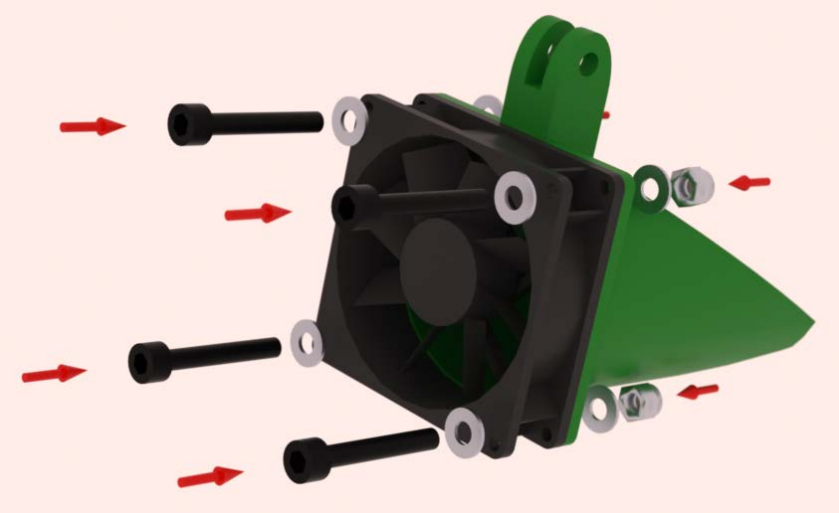


Figure 36: Part Cooling Fan Assembly

- Attach the fan duct to the fan swivel bracket as shown in Figure 37.

Parts Needed:
(1) M3 20mm bolt
(1) M3 Nylock Nut
(2) M3 Washers

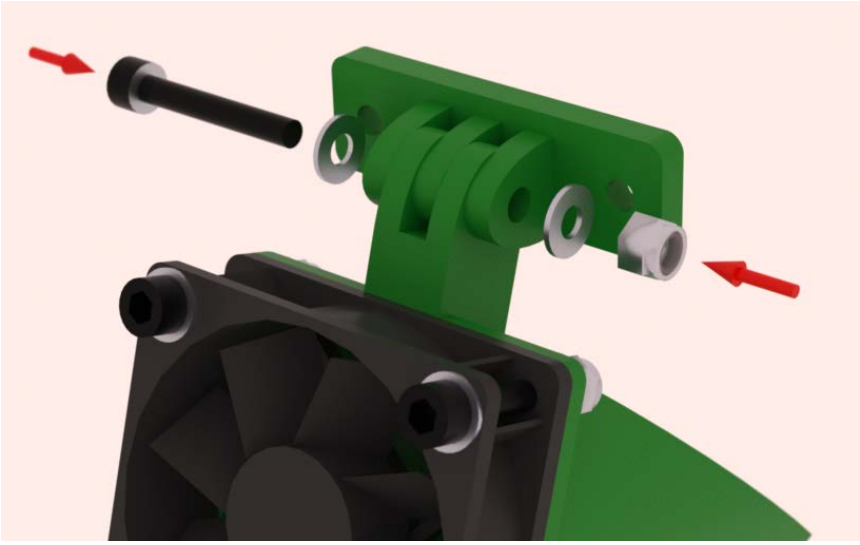


Figure 37: Part Cooling Fan and Swivel Bracket Assembly

- Attach the fan swivel bracket to the rear print carriage plate with two M3x8mm bolts as shown in Figure 38.

Figure 38: Part Cooling Fan Swivel Mount Assembly

- Attach four belt clamps to the front and rear print carriage plates as shown in Figure 39.
- Leave the clamps loose for later belt attachment.

Parts Needed:
(8) M3 10mm bolts
(8) M3 Washers
(4) Printed Belt Clamps

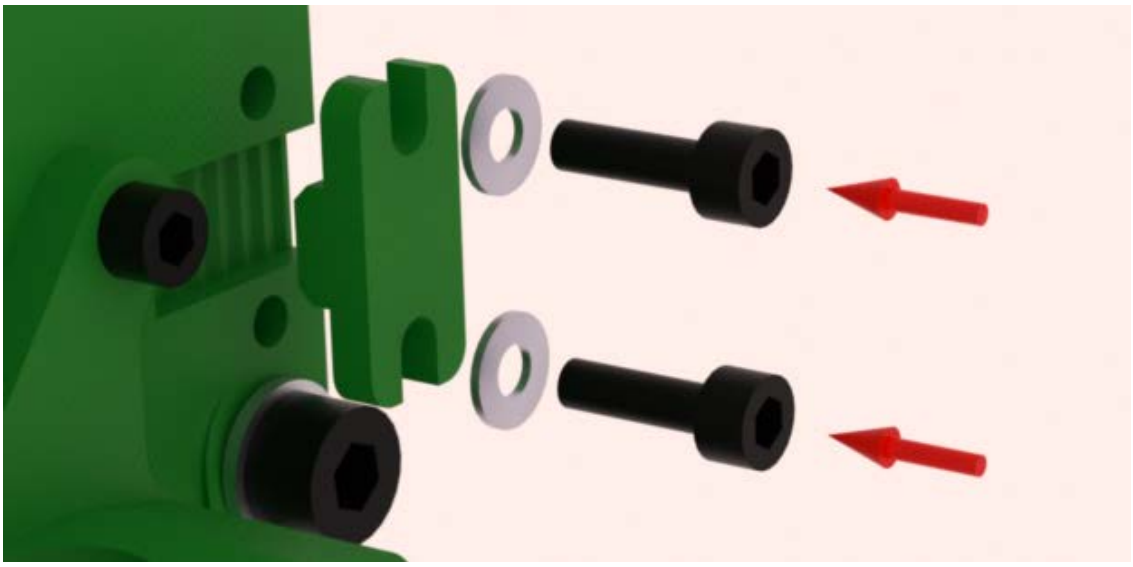


Figure 39: Belt Clamp Installation

- Bolt the front and rear print carriage plates together as shown in Figure 40.
- Verify that there are no M3 bolts extending beyond the backside of each plate.
- The final print carriage assembly is shown in Figure 41.

Parts Needed:
(4) M5 40mm bolts
(8) M5 Washers
(4) M5 Nylock nuts
(8) Printed Wheel Spacers (7mm tall)
(4) Wheel Units (assembled on page 9)

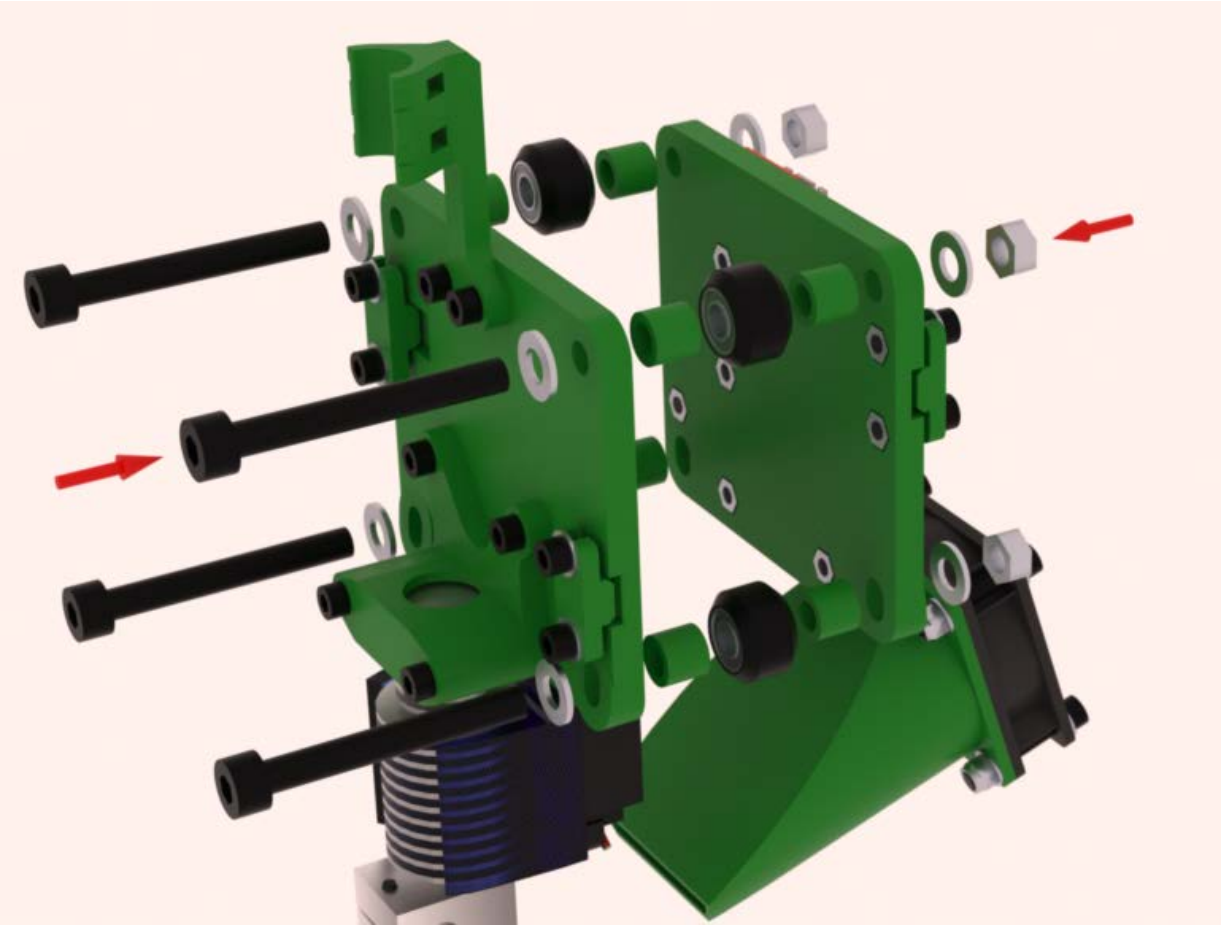


Figure 40: Print Carriage wheel assembly exploded view

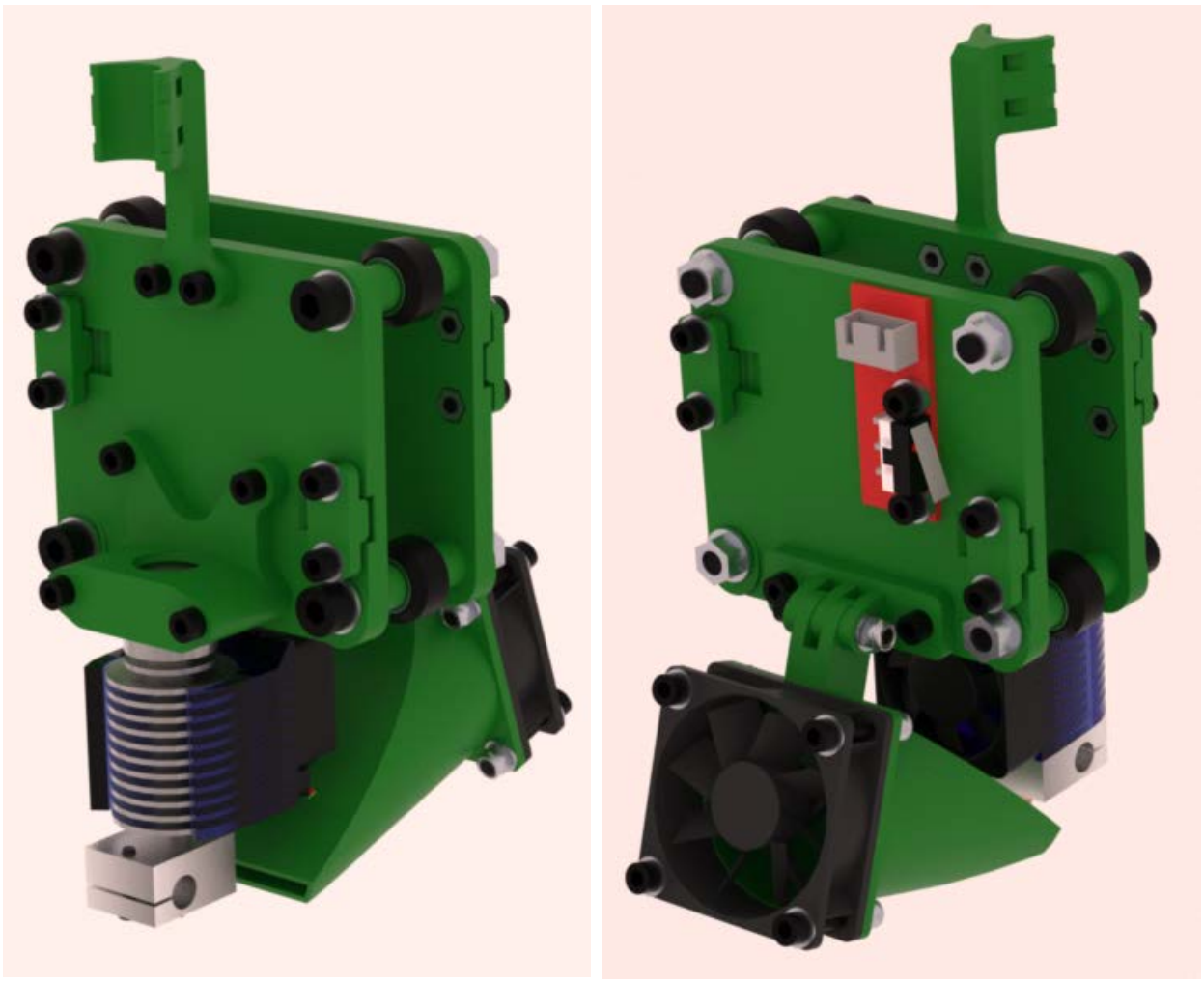


Figure 41: Completed Print Carriage Assembly

9. XY Gantry Assembly

- Attach the LED strip onto rails E, G, and F using double sided tape.
- The LED strip is easier to install before the XY gantry is in place.
- Cut the LED strip only at the pre-marked black vertical lines.

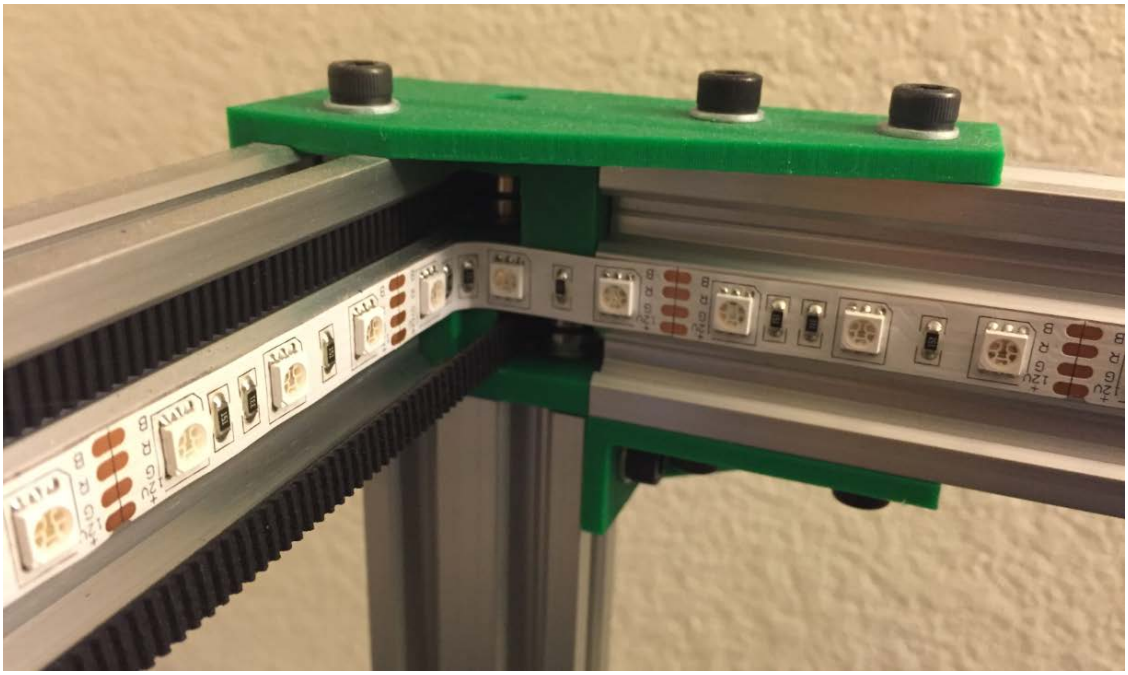


Figure 42: LED Strip

- Slide the print carriage onto Rail R.

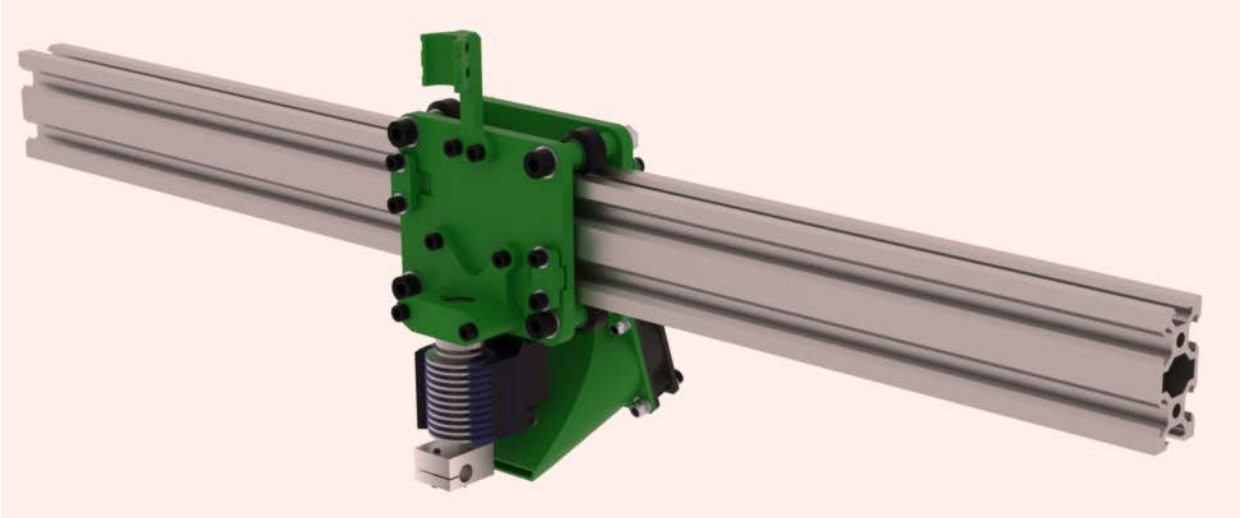


Figure 43: Print Carriage on Rail R

- Attach the X Endstop Flange on the backside of Rail R as shown in Figure 44.
- The Endstop flange should be 37mm from the end of the rail

Parts Needed:
(1) M5 10mm bolt
(1) M5 Square Nut
(1) M5 Washer
(1) M3 25mm bolt

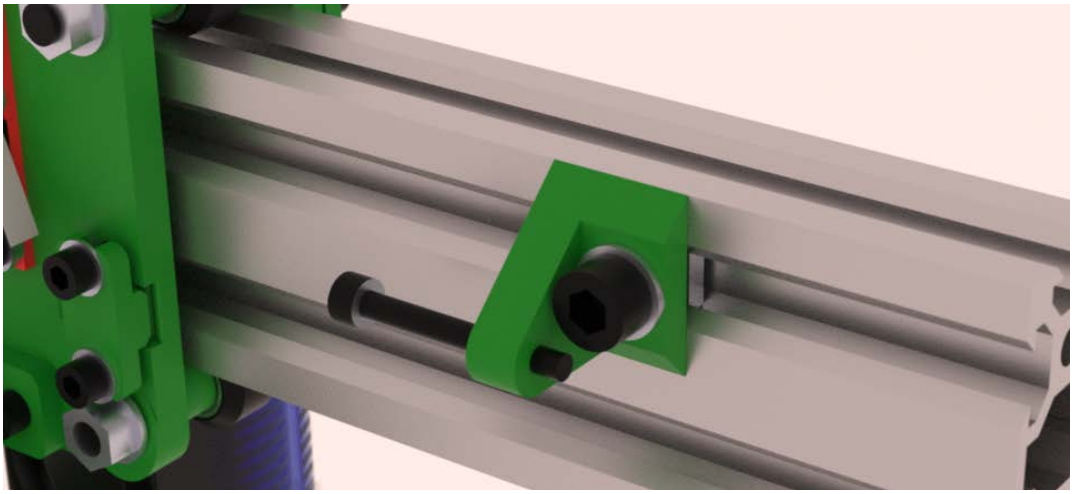


Figure 44: X Endstop Flange placement

- Insert an M5 20mm bolt in the bottom side of the Right H-Bar End as shown.
- This bolt will make contact with the Y Endstop switch.

Figure 45: Y Endstop Bolt placement

- Attach the right H-bar end piece to the right end of rail R as shown in Figure 46.
- Attach the left H-bar end piece to the left end of Rail R.
- Tapered mounting holes should be at the bottom of the H-bar ends.
- Loosely tighten bolts, final tightening will happen later.

Parts Needed:
(8) M5 10mm bolt
(8) M5 Square Nut
(8) M5 Washer

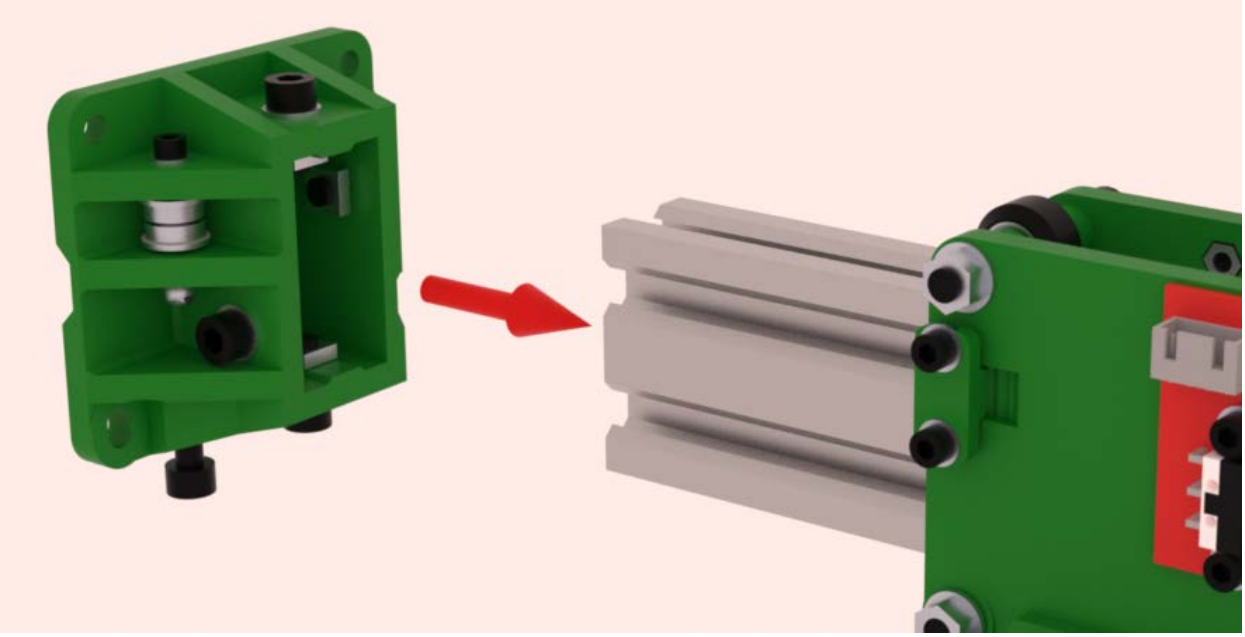


Figure 46: Right side H-bar end installation

- Attach an H-bar end plate and wheels to the right H-bar end as shown in Figure 47.
- Attach an H-bar end plate and wheels to the left H-bar end.
- Tapered mounting holes should be at the bottom of the H-bar endplate and point out.
- Leave the four lower wheels off until after the XY gantry is installed in the frame.

Parts Needed:
(4) M5 40mm bolts
(8) M5 Washers
(4) M5 Nylock nuts
(8) Printed Wheel Spacers (7mm tall)
(4) Wheel Units (assembled on page 9)

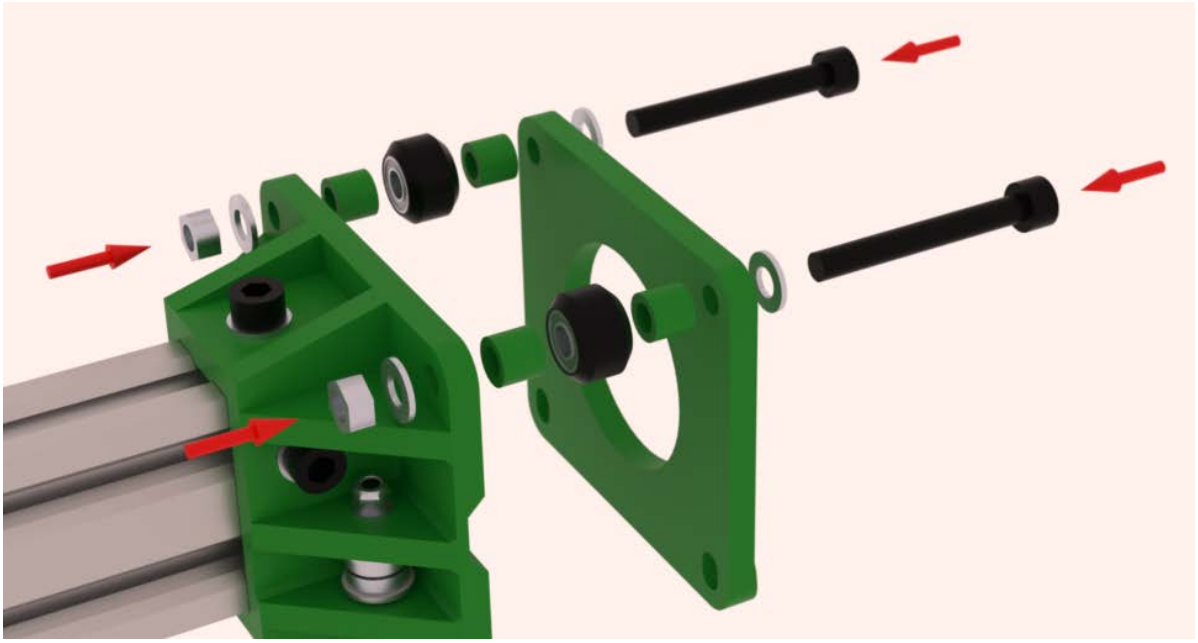


Figure 47: Right side H-bar endplate installation

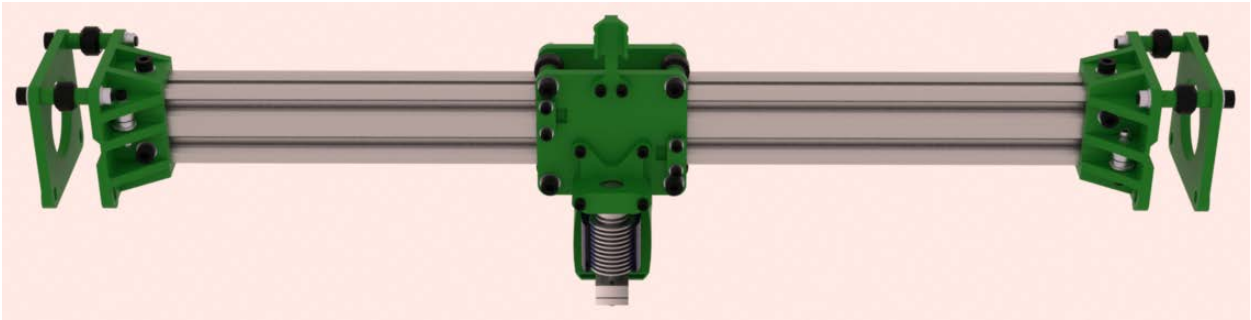


Figure 48: Assembled XY Gantry before frame installation

- Loosen the 8 M5 bolts which hold the H-bar ends to rail R.
- Install the XY gantry into the frame as shown in Figure 49.
- Adjust the H-bar ends until the wheels are centered on the V-slot grooves.

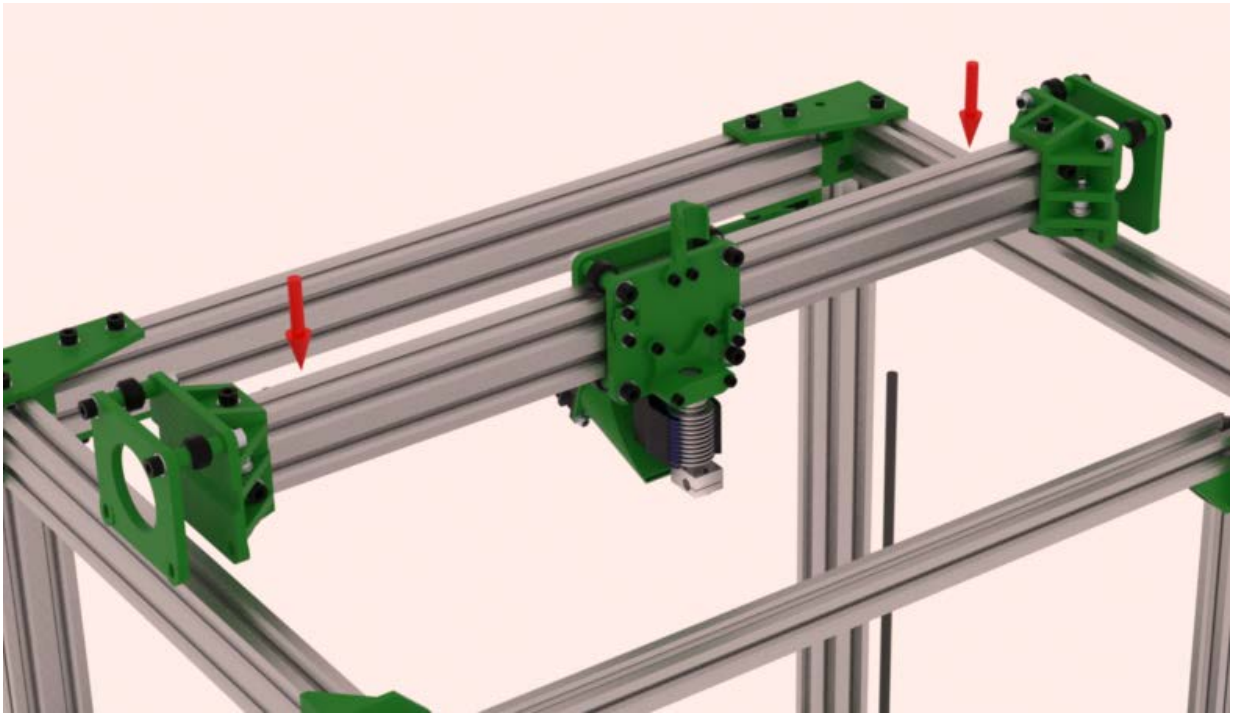


Figure 49: XY Gantry installation into frame

- Install the four lower wheels on the left and right H-bar ends as shown in Figure 50.
- The tapered slopes around the lower wheel mount holes allow the wheels to be tightened against the V-slot by tightening the M5 40mm bolts.

Parts Needed:
(4) M5 40mm bolts
(8) M5 Washers
(4) M5 Nylock nuts
(8) Printed Wheel Spacers (7mm tall)
(4) Wheel Units (assembled on page 9)

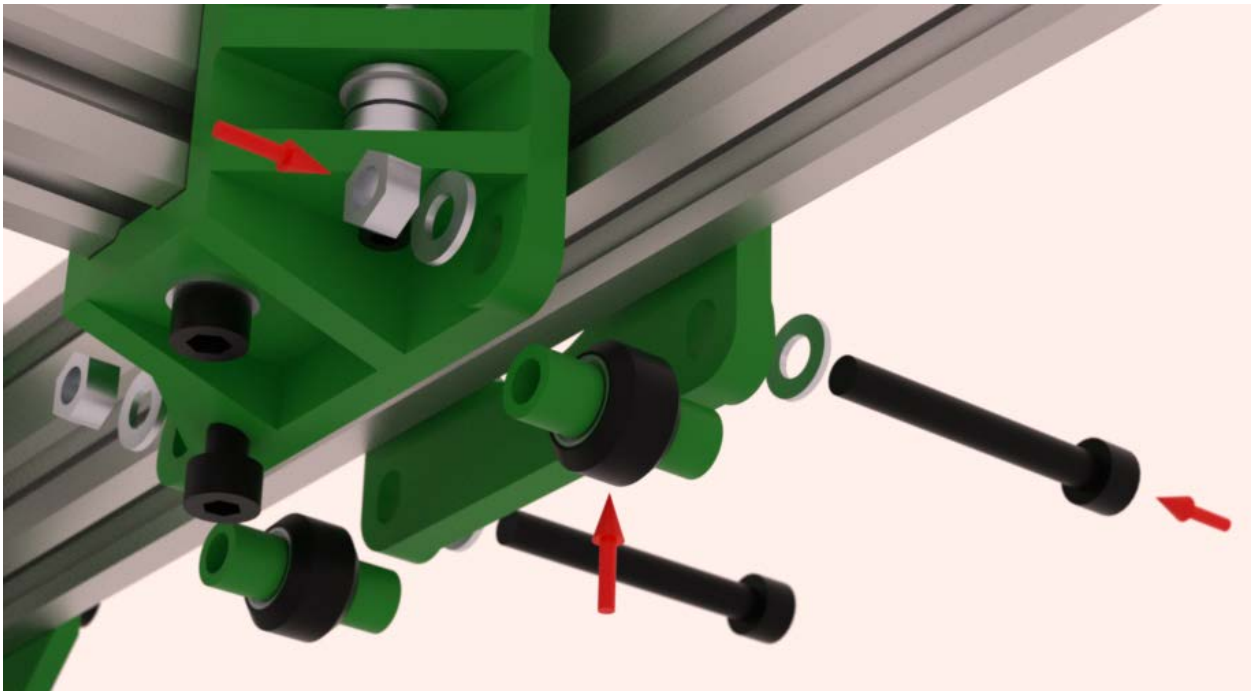


Figure 50: Lower XY gantry wheels installation

- Adjust all 12 XY gantry wheels until each wheel has equal tension against the V-slot rails.
- Slide the print carriage and the XY gantry back and forth to verify proper motion.
- Tighten the eight M5 10mm bolts which hold the H-bar ends to rail R.
- Install the two Core-XY motors on the front of the frame as shown in Figure 51.
- Install a 16 tooth GT2 pulley on each of the two Core-XY motors.

Parts Needed:
(8) M3 8mm Bolts
(8) M3 Washers

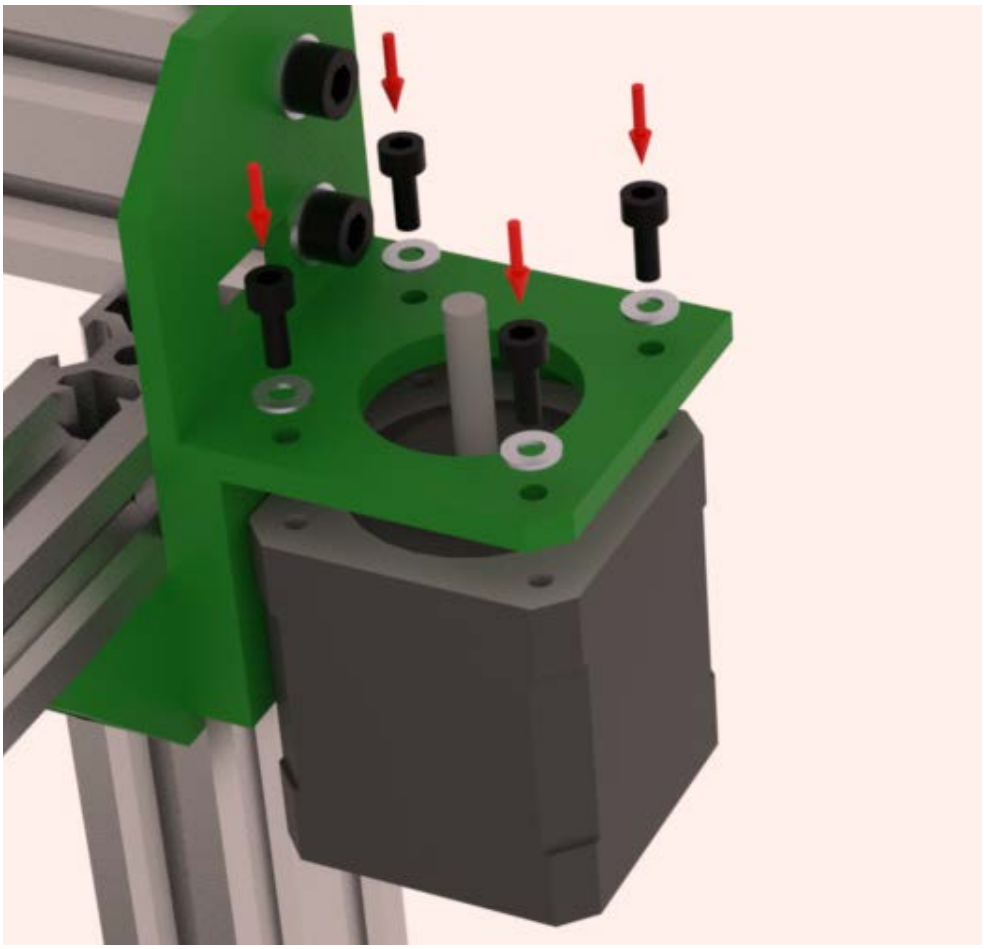


Figure 51: Core-XY Motor Installation

- Route the two GT2 belts around pulleys and bearings as shown in Figure 52.

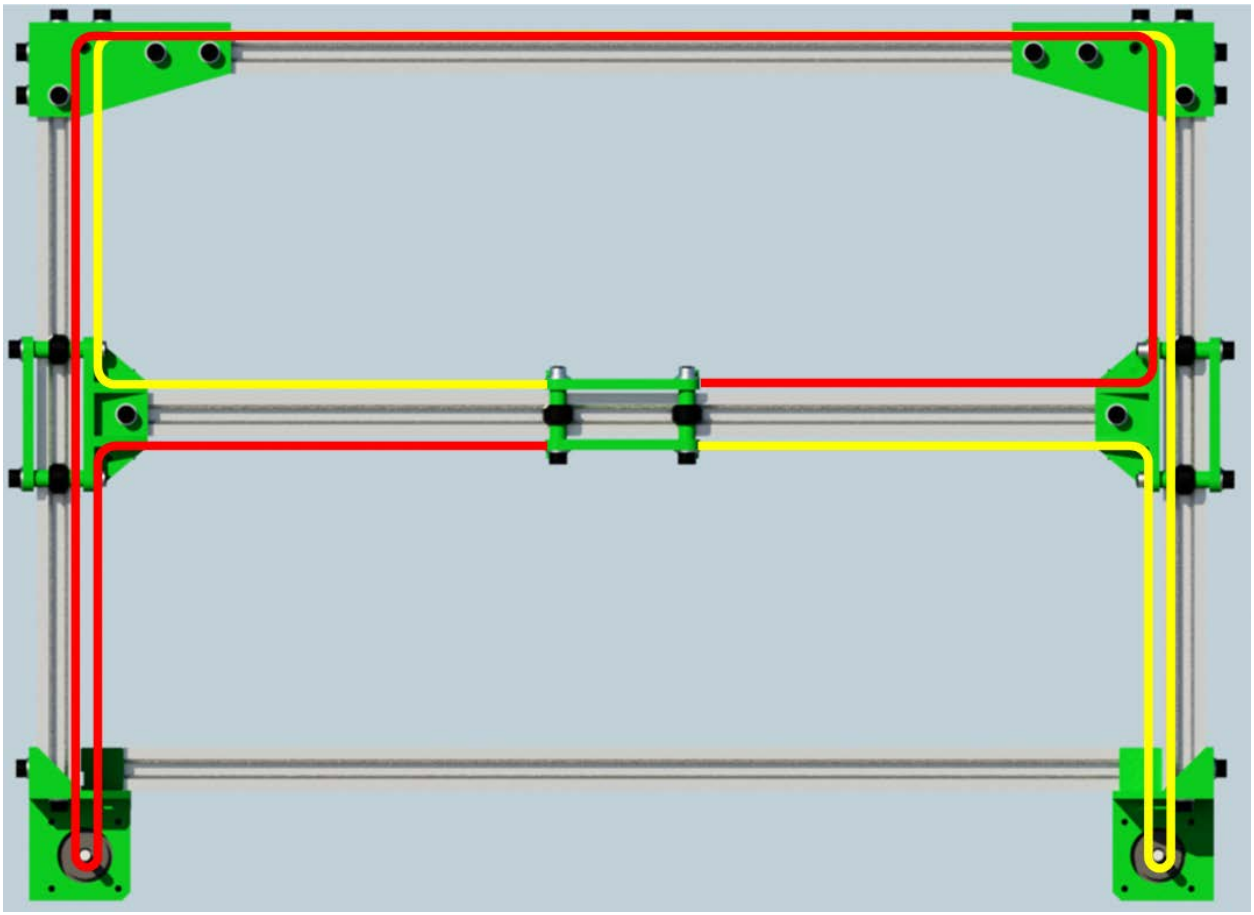


Figure 52: Core-XY Belt Routing

- Connect belts to the print carriage and secure with belt clamps as shown in Figure 53.
- Both belts should be fairly tight with little slack. Some trial and error may be required.
- Belt clamps do not need to be excessively tight or they will crack.

Figure 53: Core-XY Belt clamps

10. Extruder Assembly

- Install the extruder stepper motor with three M3x8mm bolts as shown in Figure 54.
- Attach the MK8 extruder gear to the motor, align teeth with filament holes.

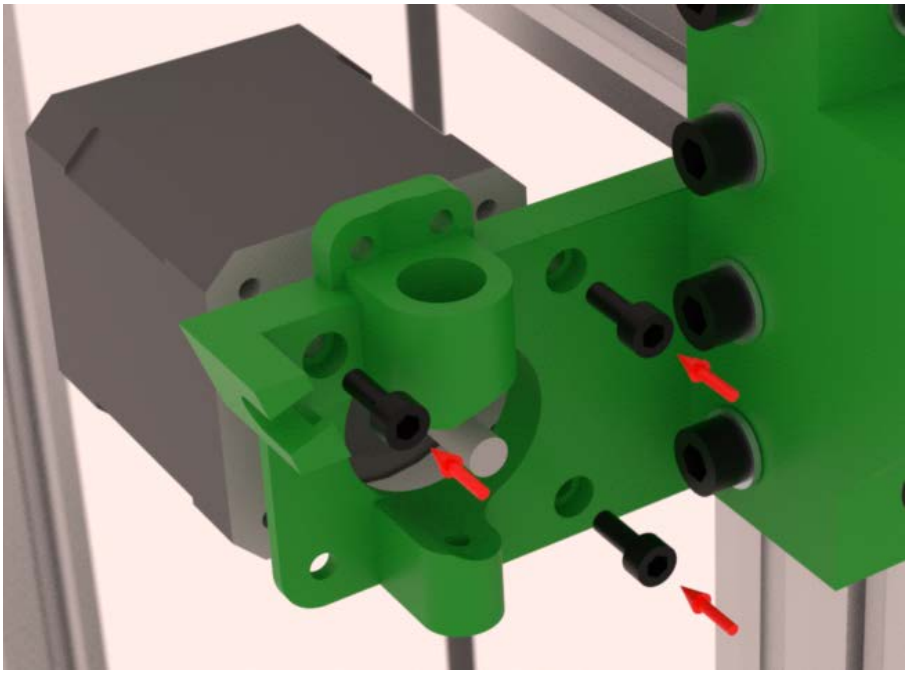


Figure 54: Extruder motor

- Install the extruder tubing holder with two M3x8mm bolts as shown in Figure 55.

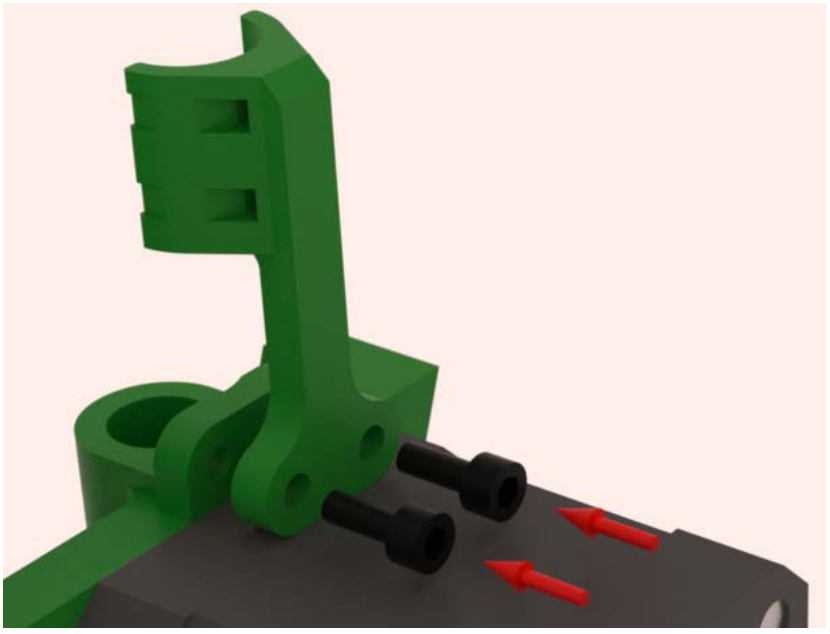


Figure 55: Extruder tubing holder

- Assemble the extrusion tensioner flange as shown in Figure 56.

  Parts Needed:
  (1) 625ZZ Bearing
  (1) M5 12mm Bolt
  (1) M5 Nylock Nut

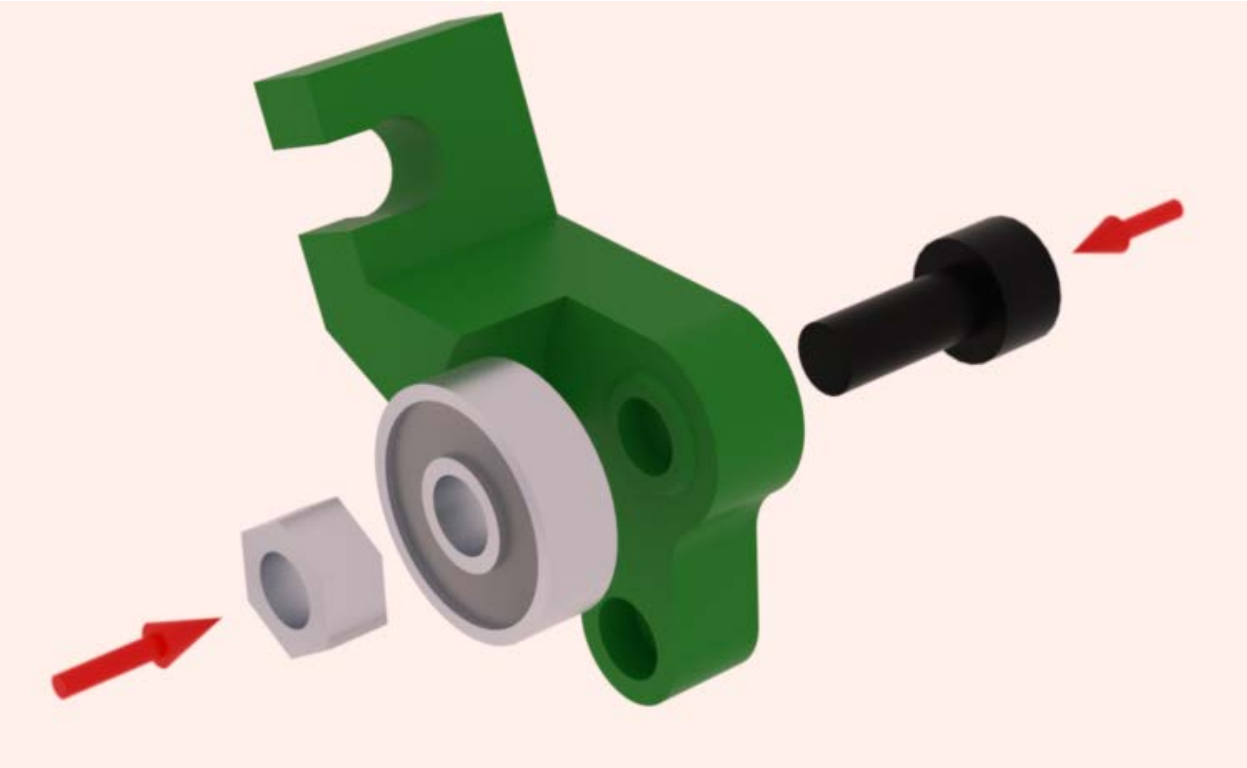


Figure 56: Extruder tensioner flange assembly

- Attach the tensioner flange to the extruder with an M3x10mm bolt as shown.

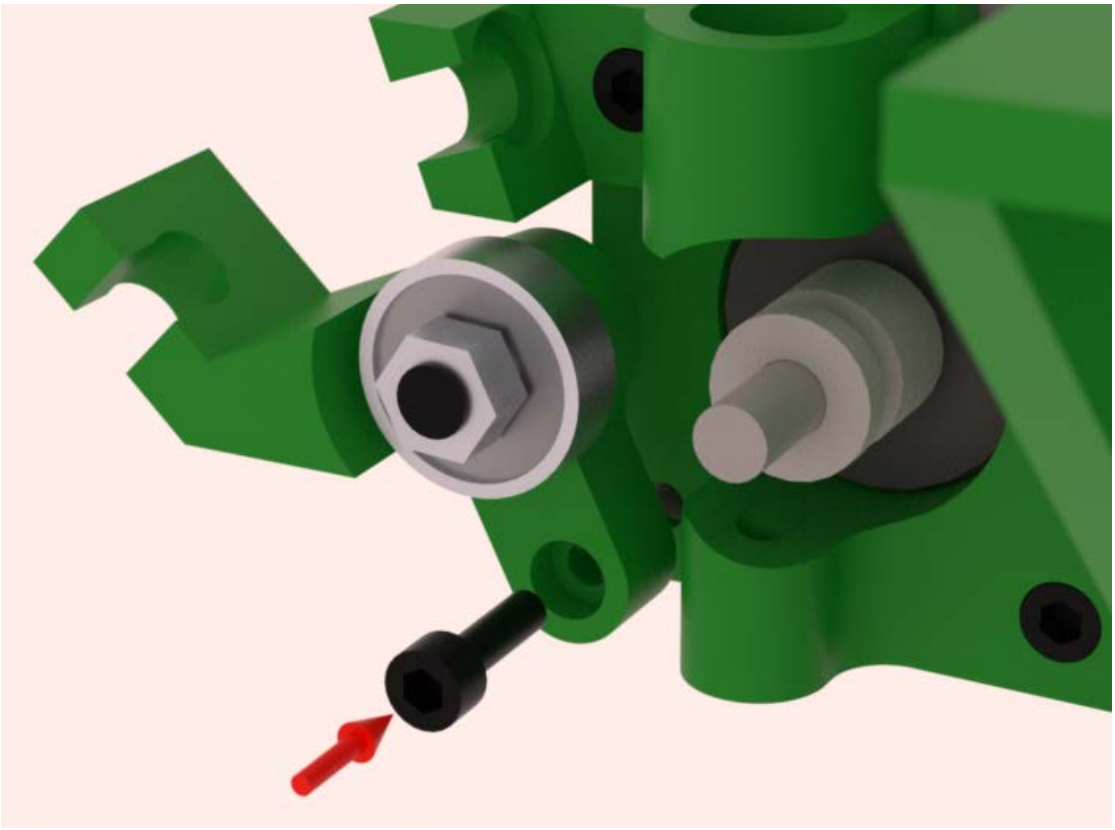


Figure 57: Extruder tensioner flange Installation

- Install the black bowden tube connector fitting into the top of the extruder as shown.
- The printed opening for the bowden tube connector may need to be widened with a file or knife blade to allow a good fit of the connector threads since the printed part is prone to cracking if the opening is too small. If the connector is too loose in the opening, super glue can be applied to the threads before inserting the bowden connector.
- Insert the bowden tube into the black bowden tube connector, leave the other end disconnected until later.
- Install the extruder tensioner spring as shown in Figure 58.

  Parts Needed:
  (1) M5 40mm Bolt
  (2) M5 Washers
  (1) M5 Standard or Square Nut
  (1) Spring, similar to the dimensions below:
  ~8.5mm outside diameter
  ~25mm uncompressed length
  ~13.8mm fully compressed length

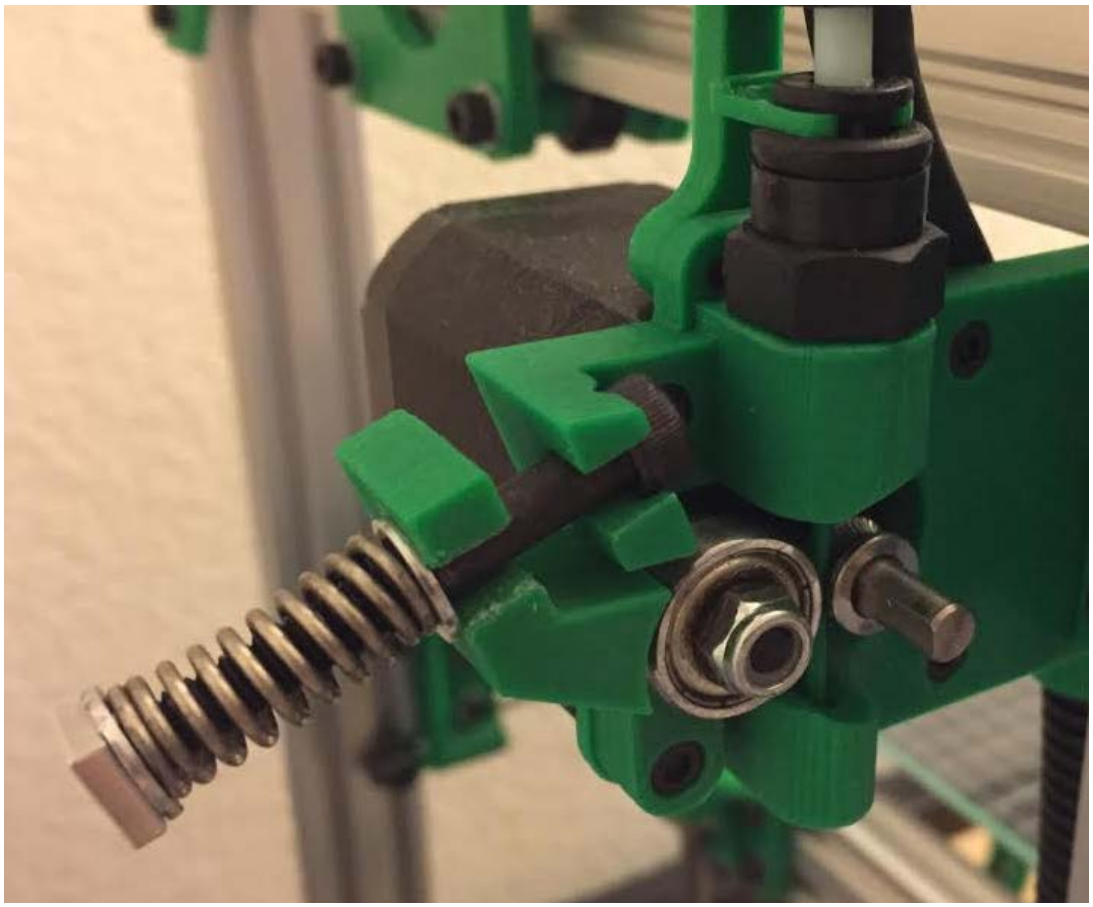


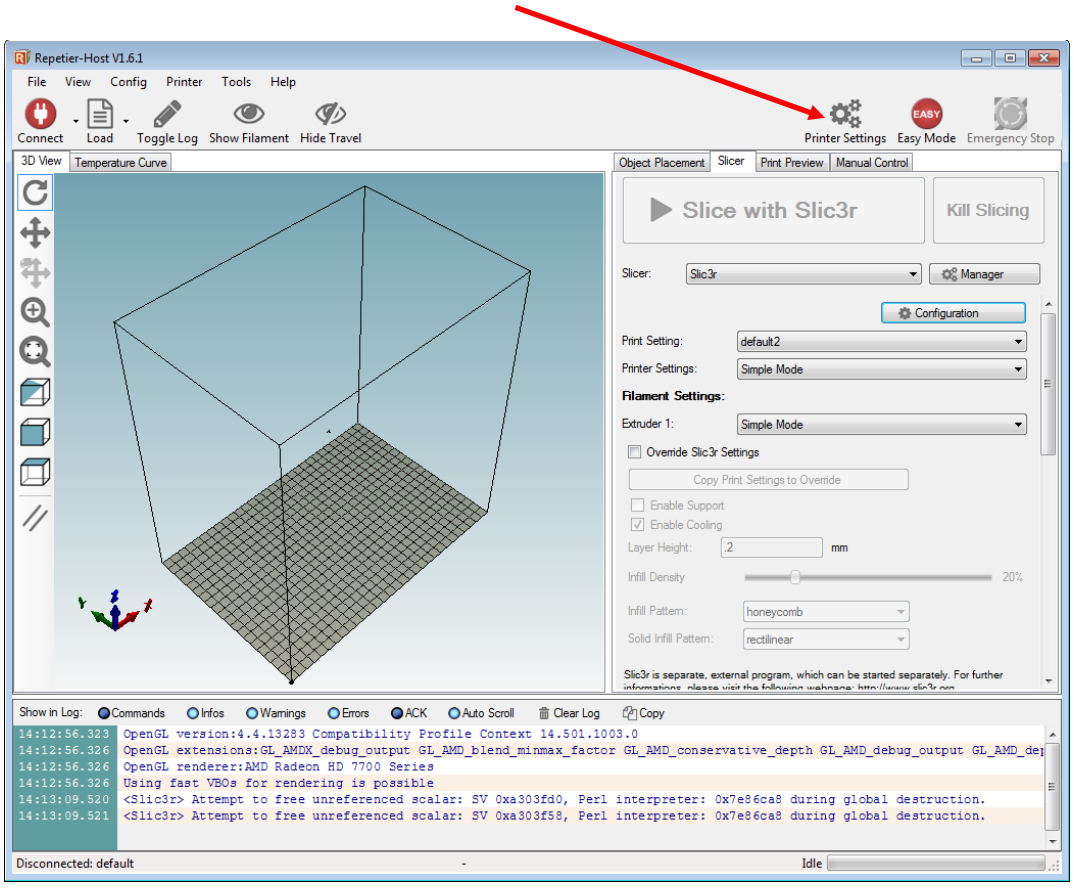
Figure 58: Tensioner spring and bowden connector

11. Wiring and Electrical Components

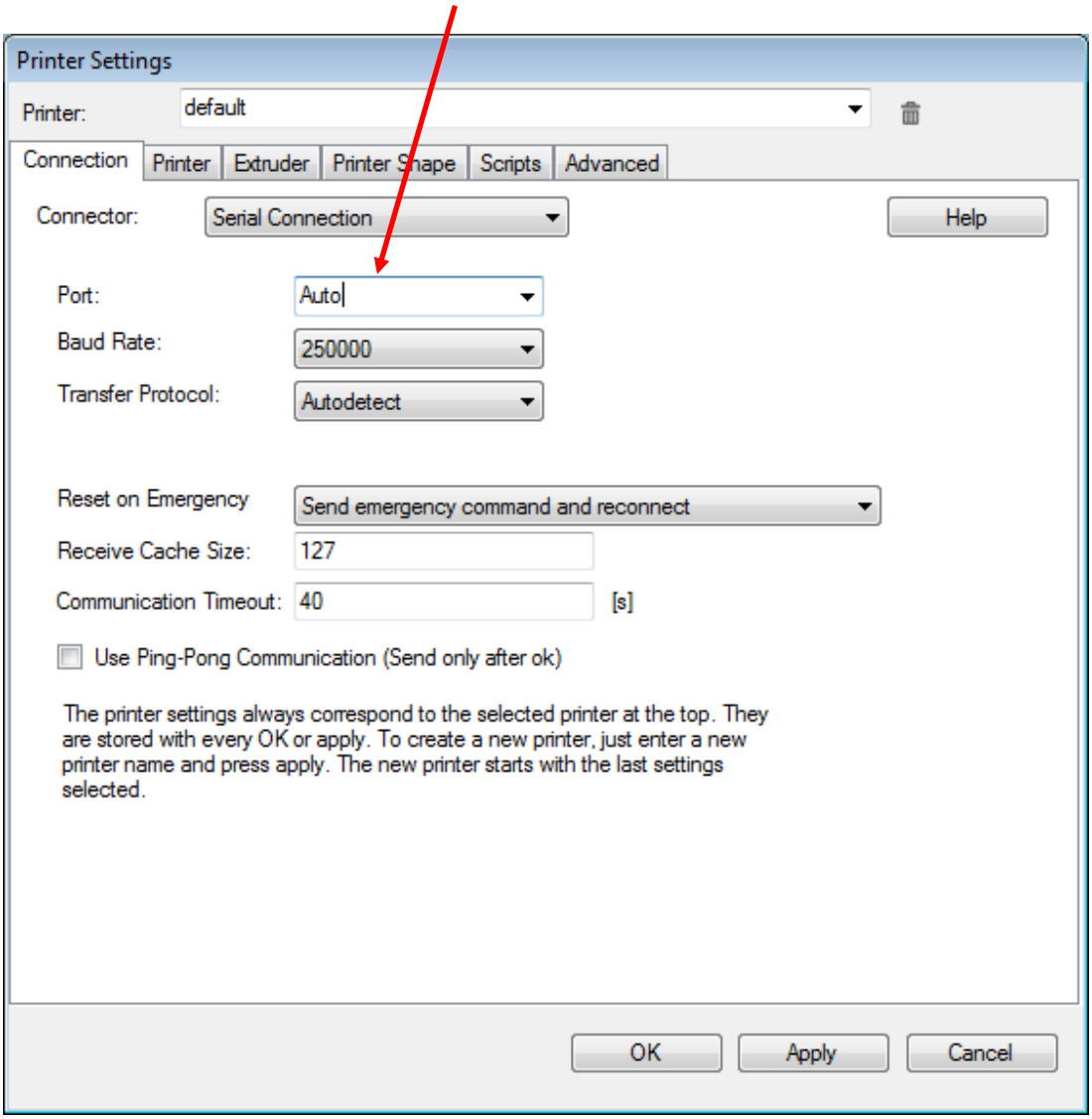
- Wire all components according to the D-Bot Electrical Configuration Diagram.
- Leave most wiring loose until all functionality can be confirmed so that fixing and troubleshooting wiring can be done easily.
- Keep low voltage wiring and line voltage AC wiring separate and isolated.
- Wiring which connects to moving components needs to be properly supported so that repeated movement of the wire will not degrade it or cause failures at connections.
- Never rely on solder joints or electrical connectors to secure wiring.
- This instructional video gives an excellent explanation on the different types of header connectors and how to crimp Dupont connector pins.
- The best way to secure wiring to the print carriage is to zip-tie wires to the bowden tube or place wiring and bowden tube in a flexible conduit.
- Verify jumpers are placed on all pairs of pins under each of the stepper driver boards.
- The solid state relay must be bolted to an aluminum rail for heat dissipation.
- Attach the corkboard insulator to the bottom of the heated bed using JBweld epoxy.
- Place the bed thermistor in the hole in the center of the heated bed so that it touches the glass, secure the thermistor in place with thermally conductive epoxy.
- Stepper motor wiring needs to be extended, cover solder splices with heatshrink tubing.
- The hot end heatsink fan is connected to 12V supply power as shown in the diagram. It does not cycle on and off with the part cooling fan because only the negative lead to the part fan is being switched by the microcontroller. The hot end fan will run full time as long as supply power is on.
- Install the Y and Z endstops with two M3x8mm bolts and two M3 nuts each.
- An alternative way to wire the endstops is to remove the white connector housing and solder wires directly to the endstop boards.
- If the Ramps cooling fan is connected as shown in the electrical diagram, it will need to have a two pin header soldered to the ramps board. The fan can also be connected to the ramps input power jack.
- A partial wiring diagram is shown in the appendix for an AC heated bed setup.
- Line voltage power jack wiring is also shown in the appendix.

12. Software Configuration and Initial Set Up

- Connect Arduino/Ramps 1.4 board to PC via USB-B cable. Do not turn on 12v power yet.
- Tune stepper motor drivers using the technique shown here. The D-Bot stepper drivers are set to approximately 0.55 volts.
- Download and install Arduino from https://www.arduino.cc/en/Main/Software
- Download D-Bot_Marlin.zip from http://www.thingiverse.com/thing:1001065/#files
- Unzip *D-Bot_Marlin.zip*
- Open *D-Bot_Marlin>Marlin>Marlin.ino*
- Set Tools>Board>Mega 2560
- Set Tools>Port> (Change to the COM port used, this may require some trial and error)
- Click verify (checkmark), then upload (arrow).
- If you cannot connect or if you receive a timeout error, you may need to download and install the CH341SER driver. Some Chinese knockoff Arduino boards use a serial chip which is not the same as normal Arduino boards.
- Download Repetier Host from http://www.repetier.com/download-now/ and install, skip the installation of Repetier Server.
- Open Printer Settings and configure per the following 4 pages.



Set Port to the same COM port used to upload the firmware via Arduino.



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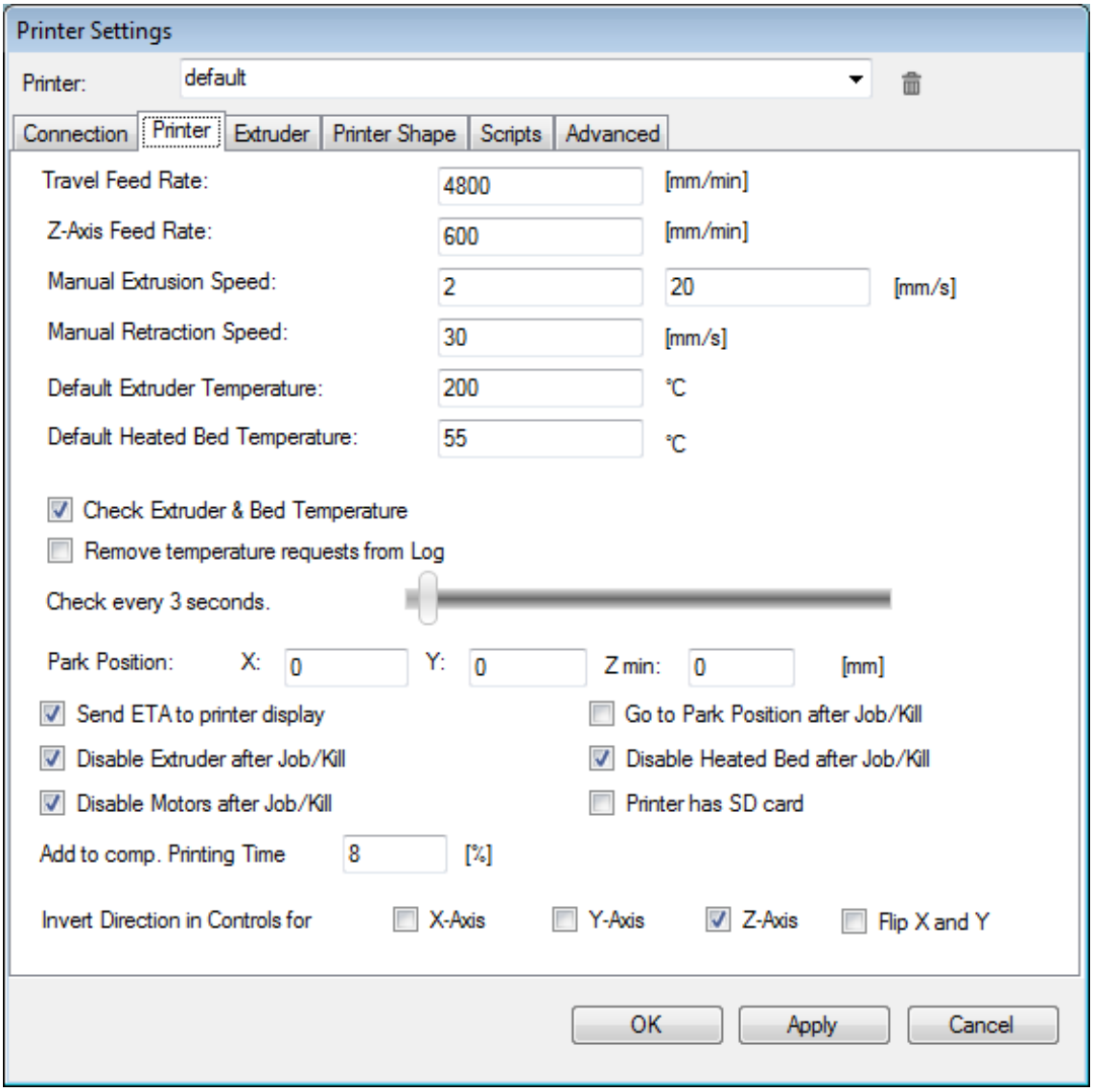

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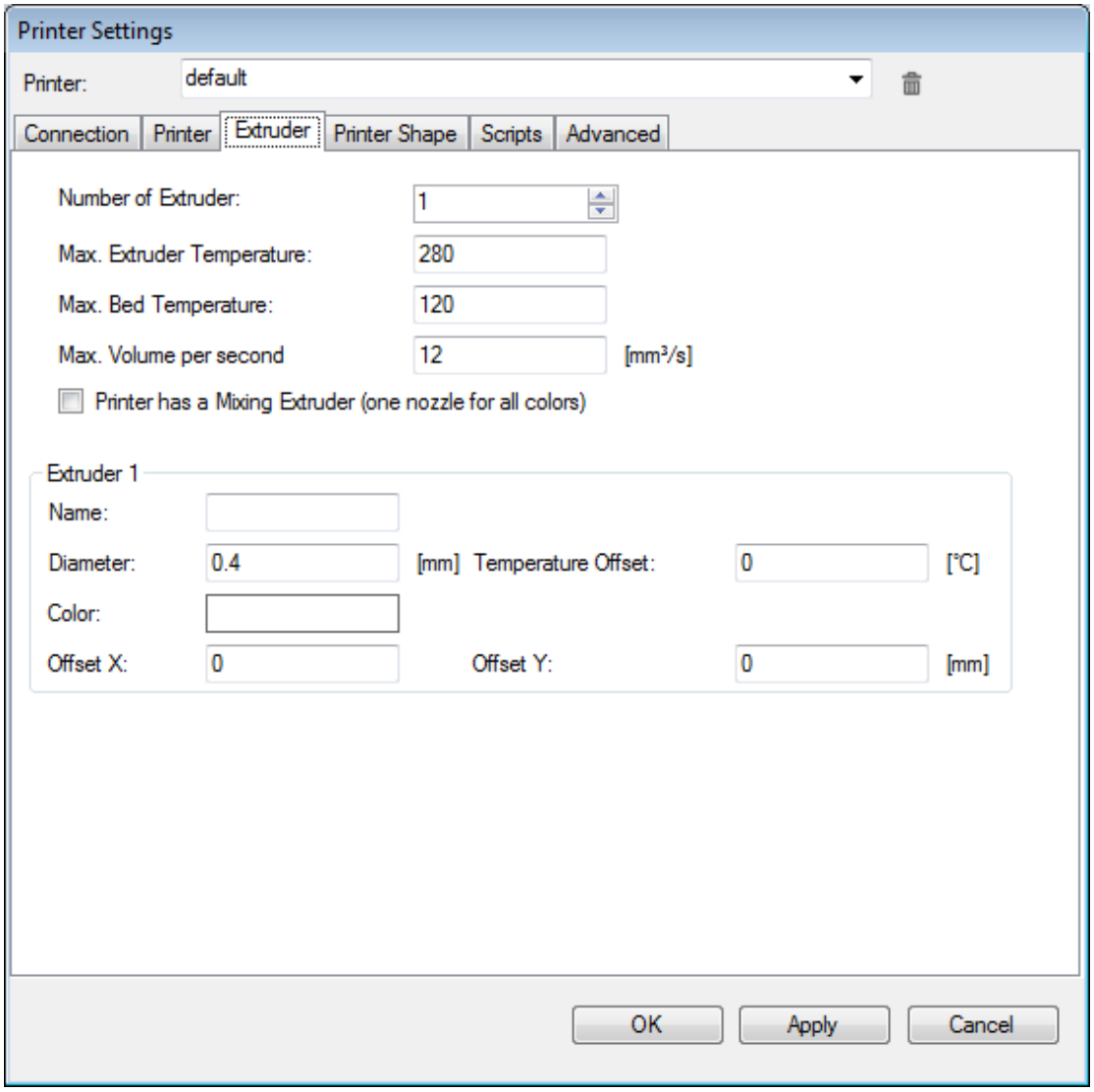

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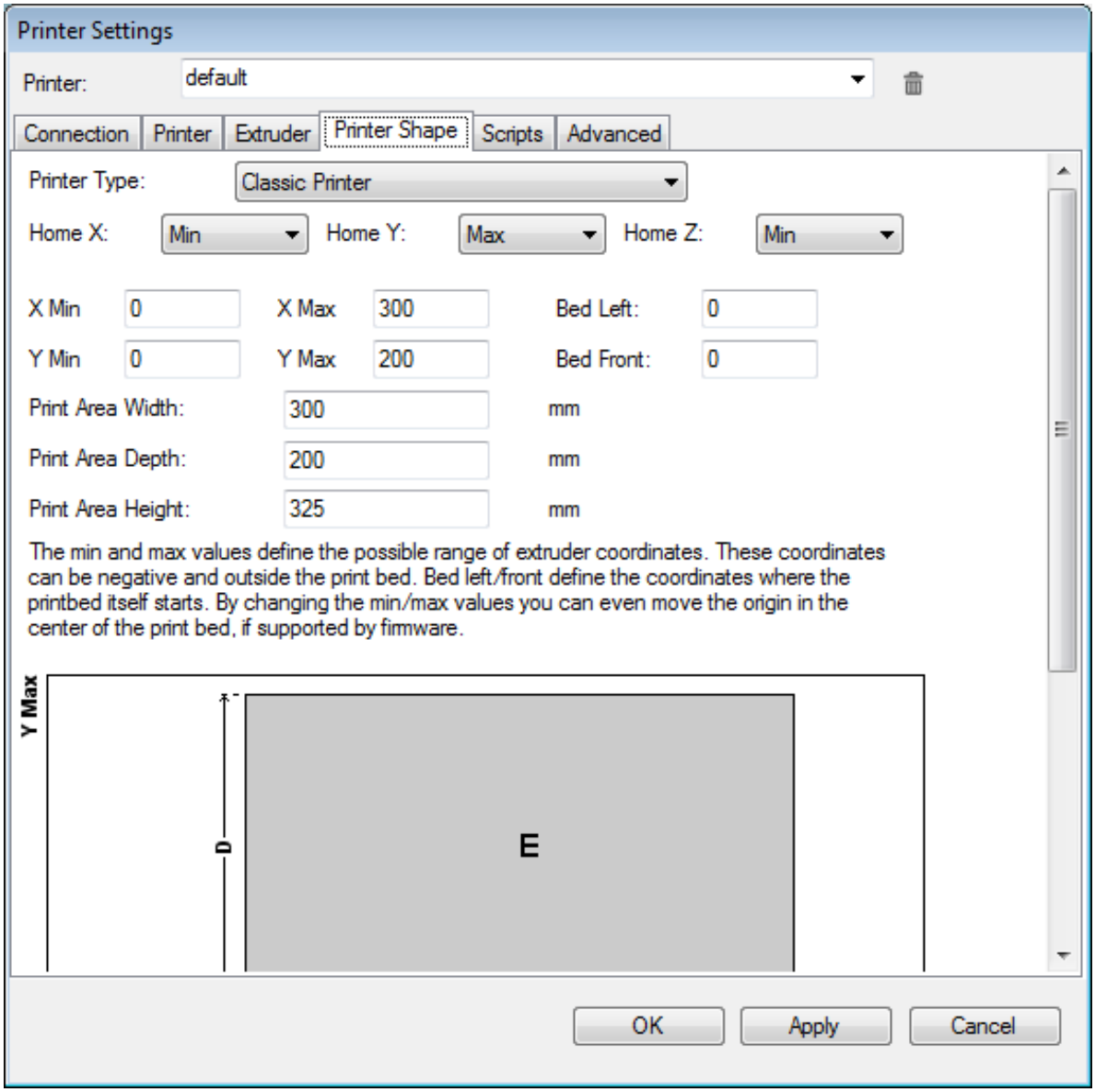
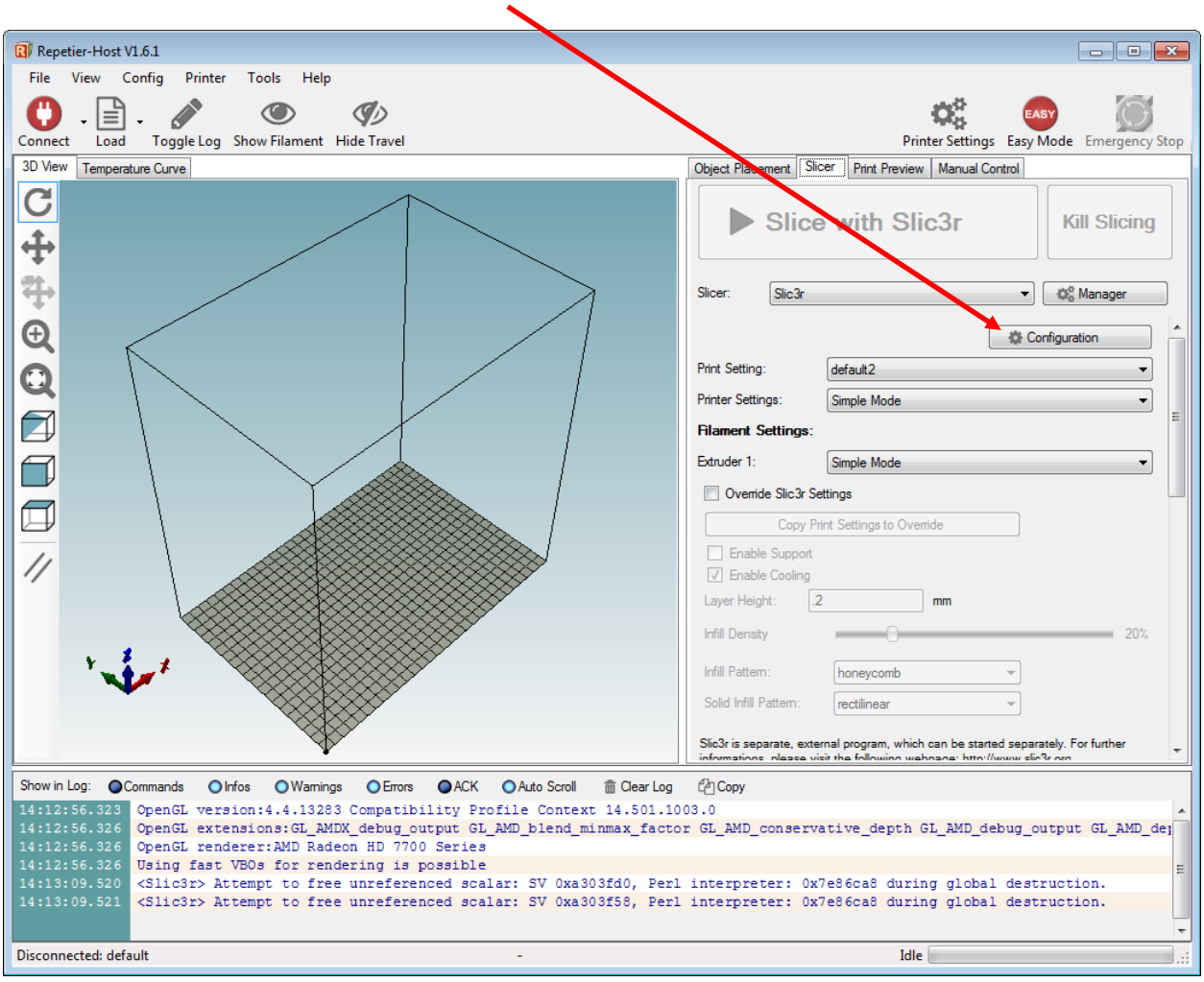
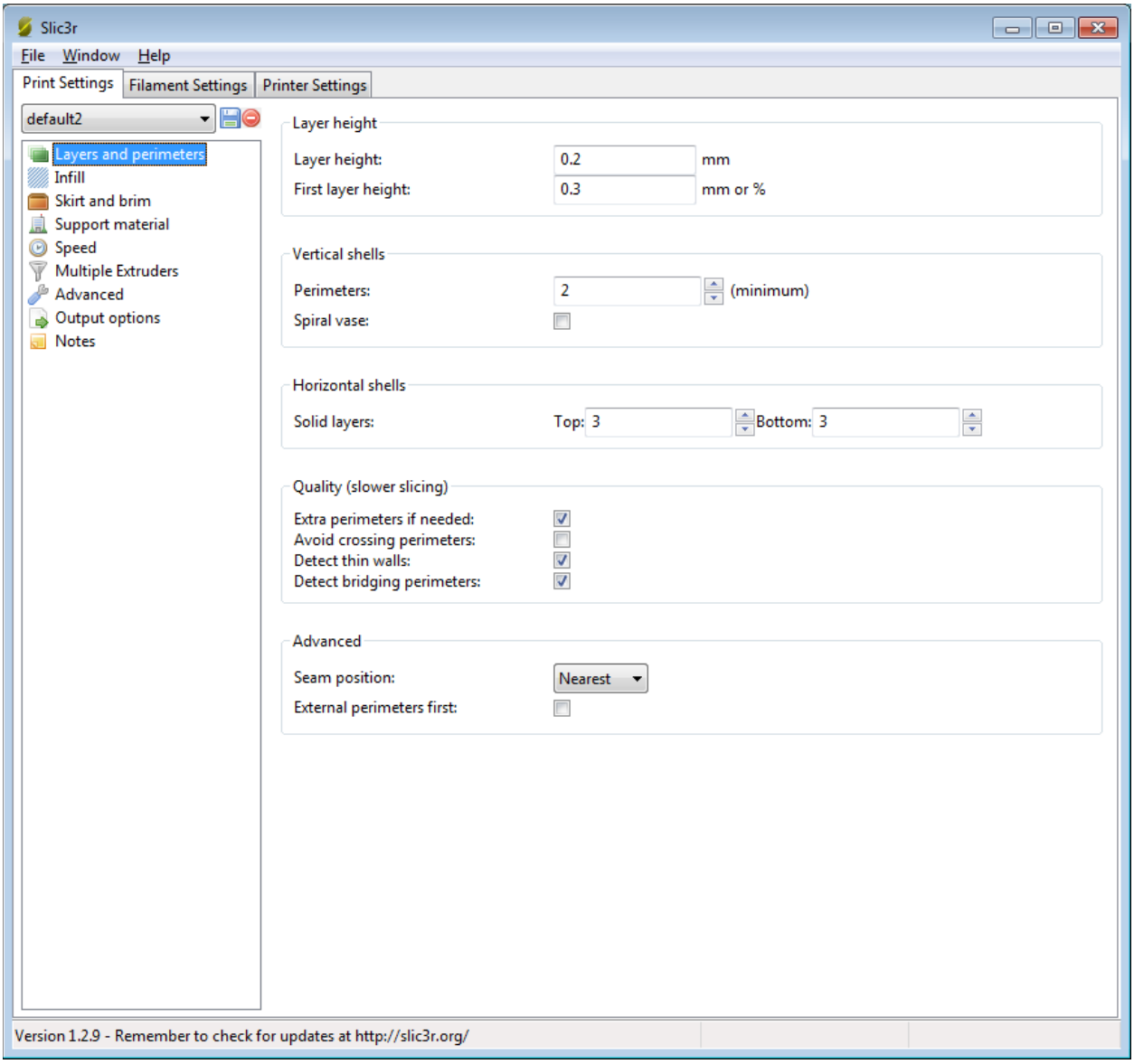


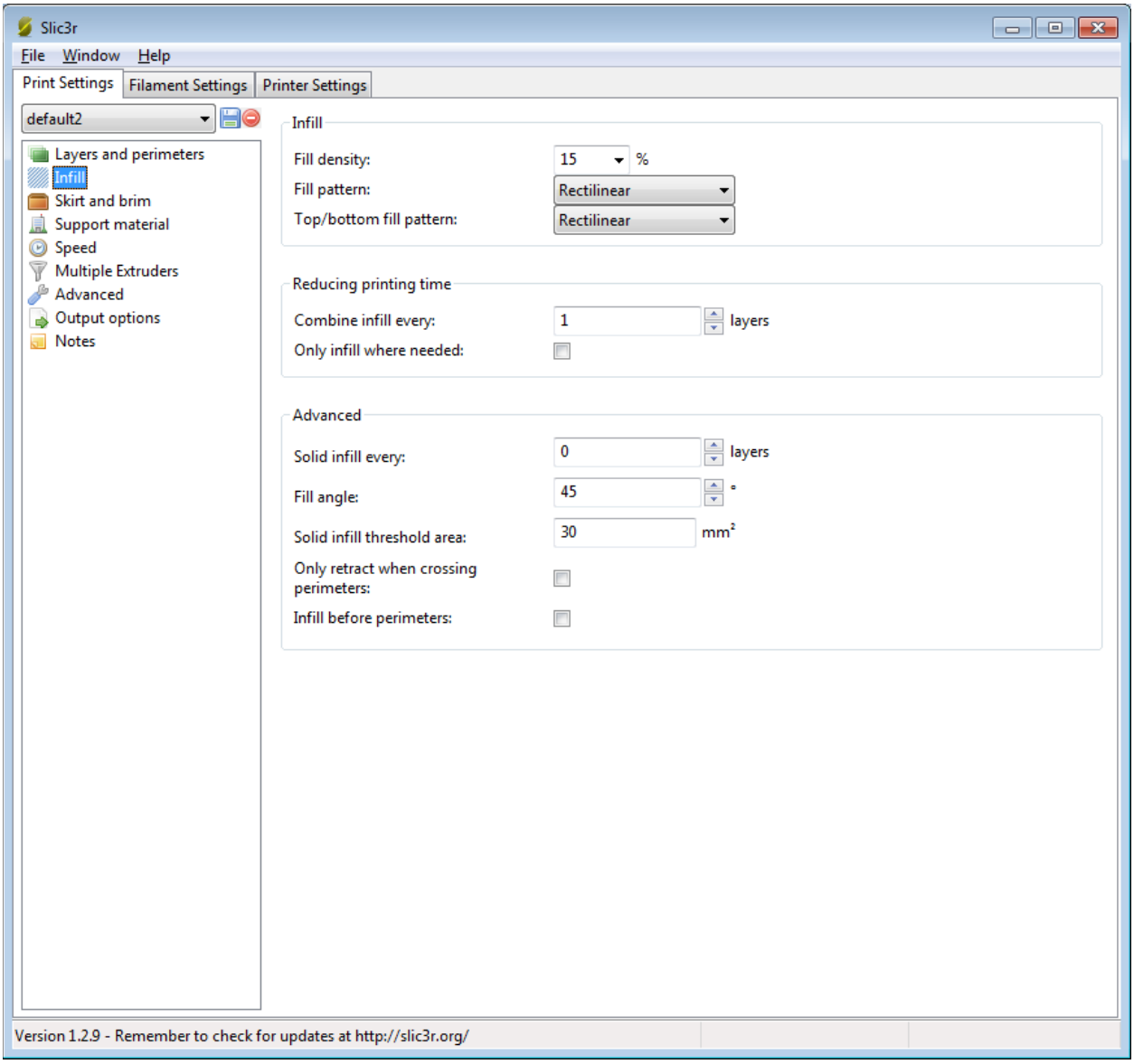
Configure Slic3r per the following 9 pages. These settings serve as a good starting point for D-Bot printing. Some settings are required for proper function (bed shape, retract) and some settings can be adjusted based on further testing or based on individual print requirements (infill, layer height, etc).



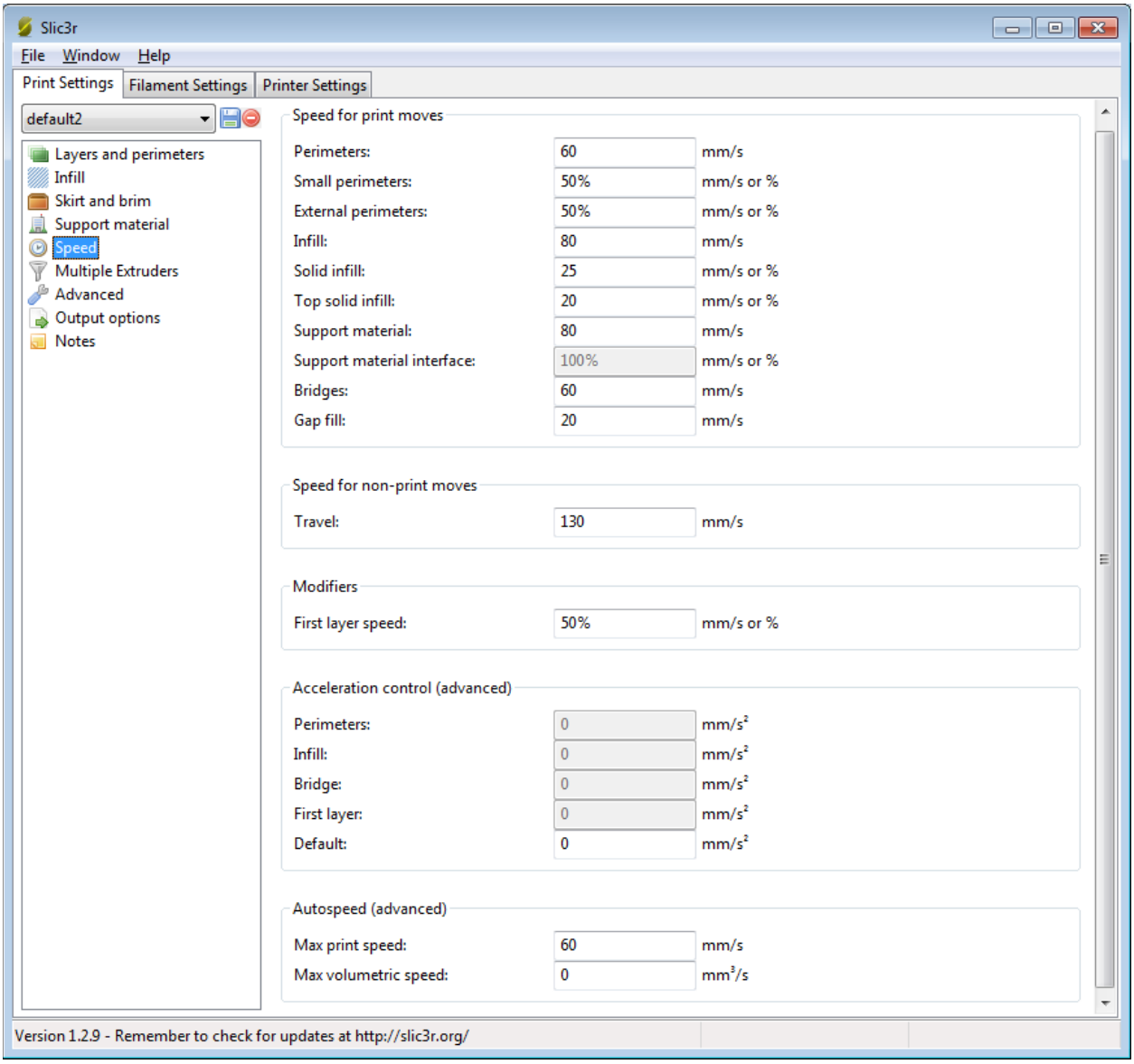
Slic3r Settings Page 1 of 9



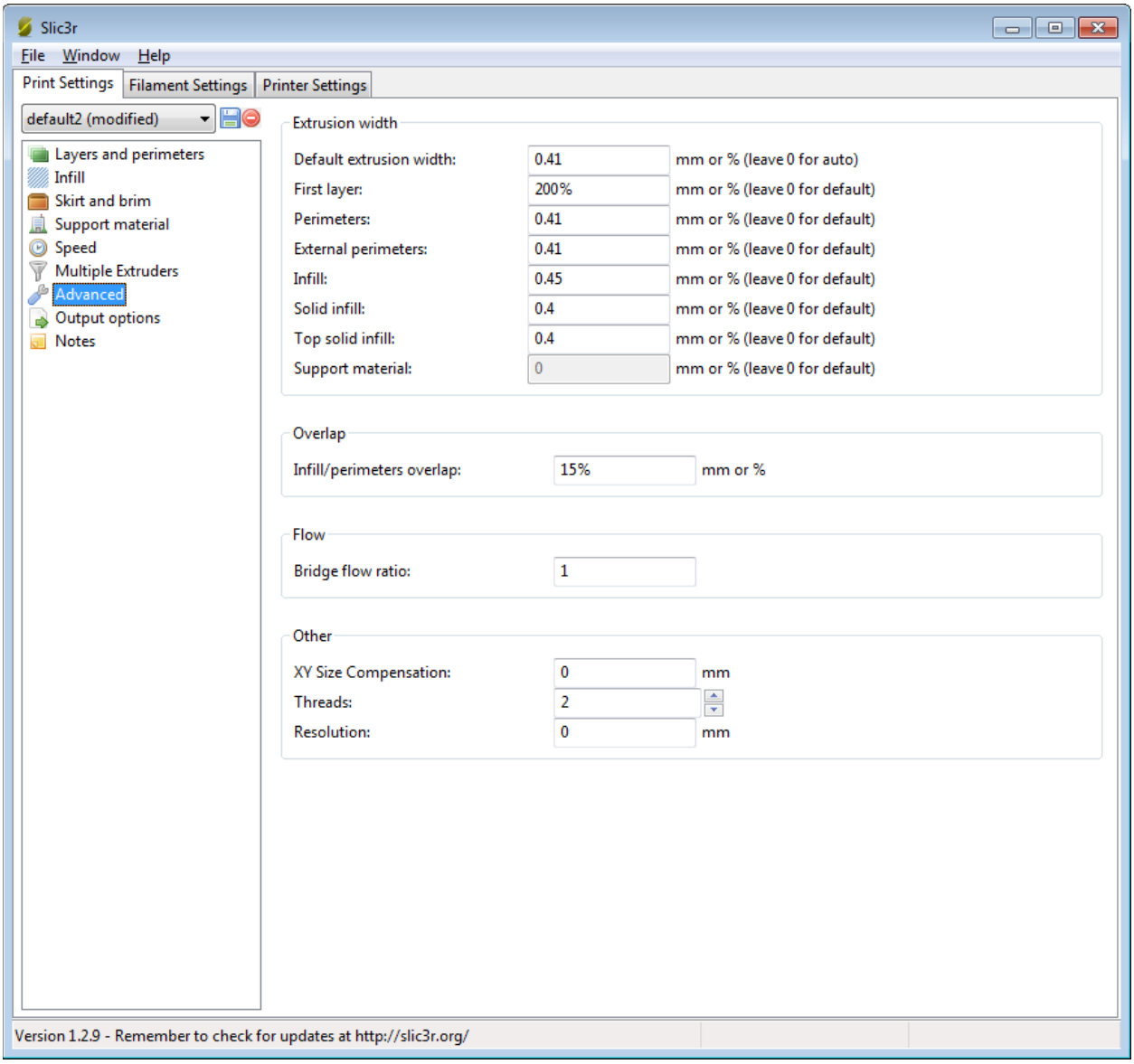
Slic3r Settings Page 2 of 9



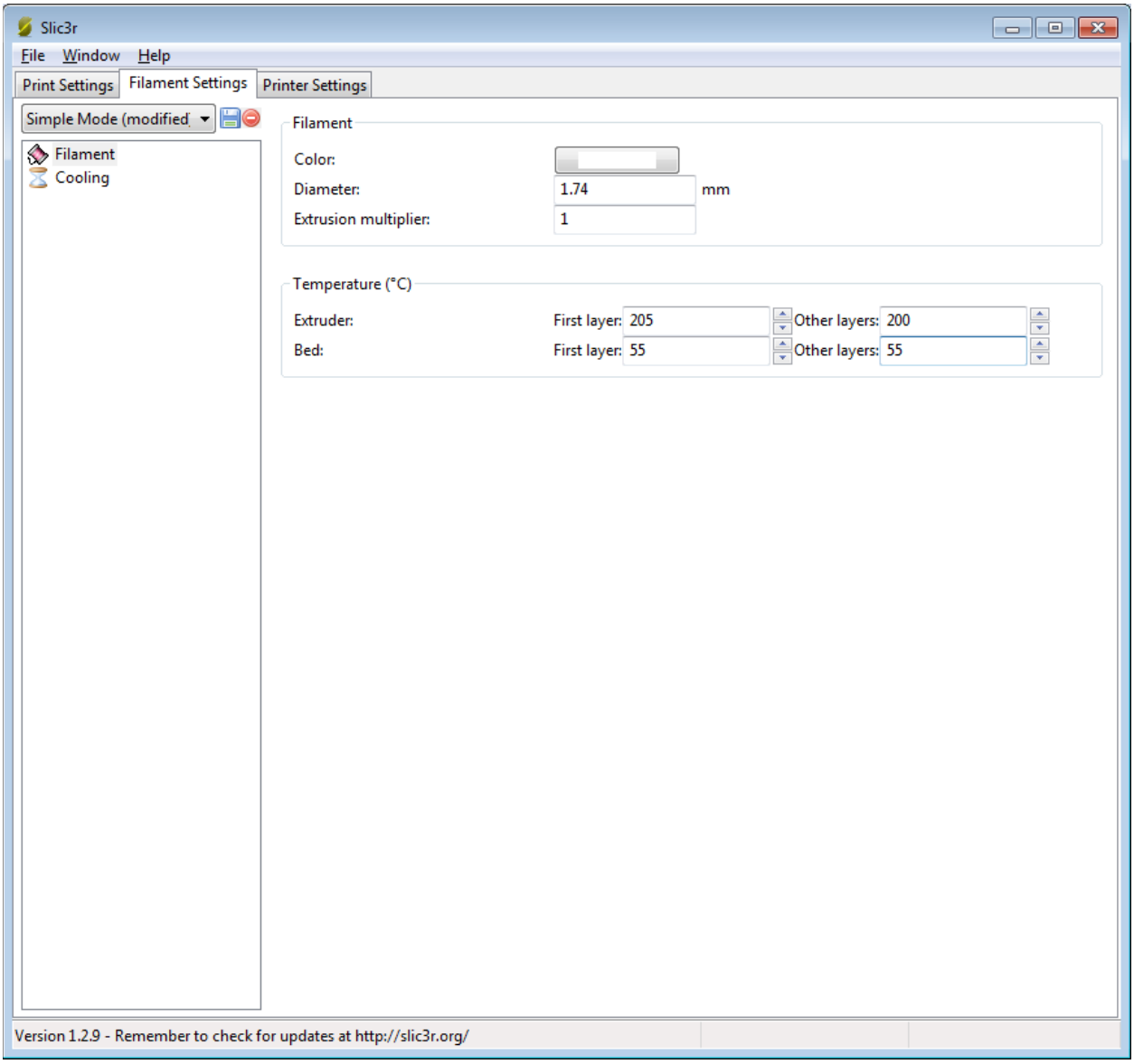
Slic3r Settings Page 3 of 9



Slic3r Settings Page 4 of 9



Slic3r Settings Page 5 of 9



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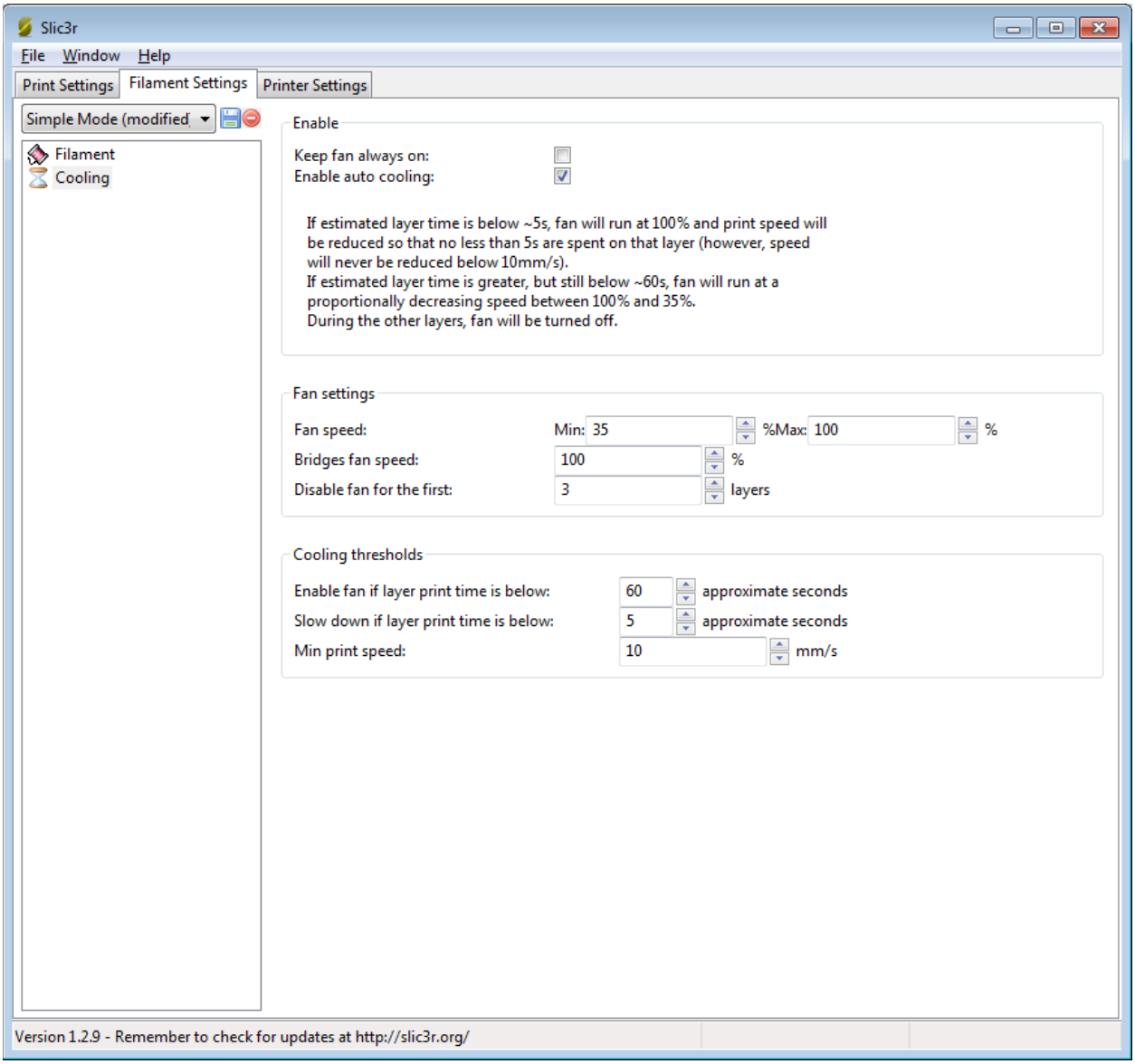

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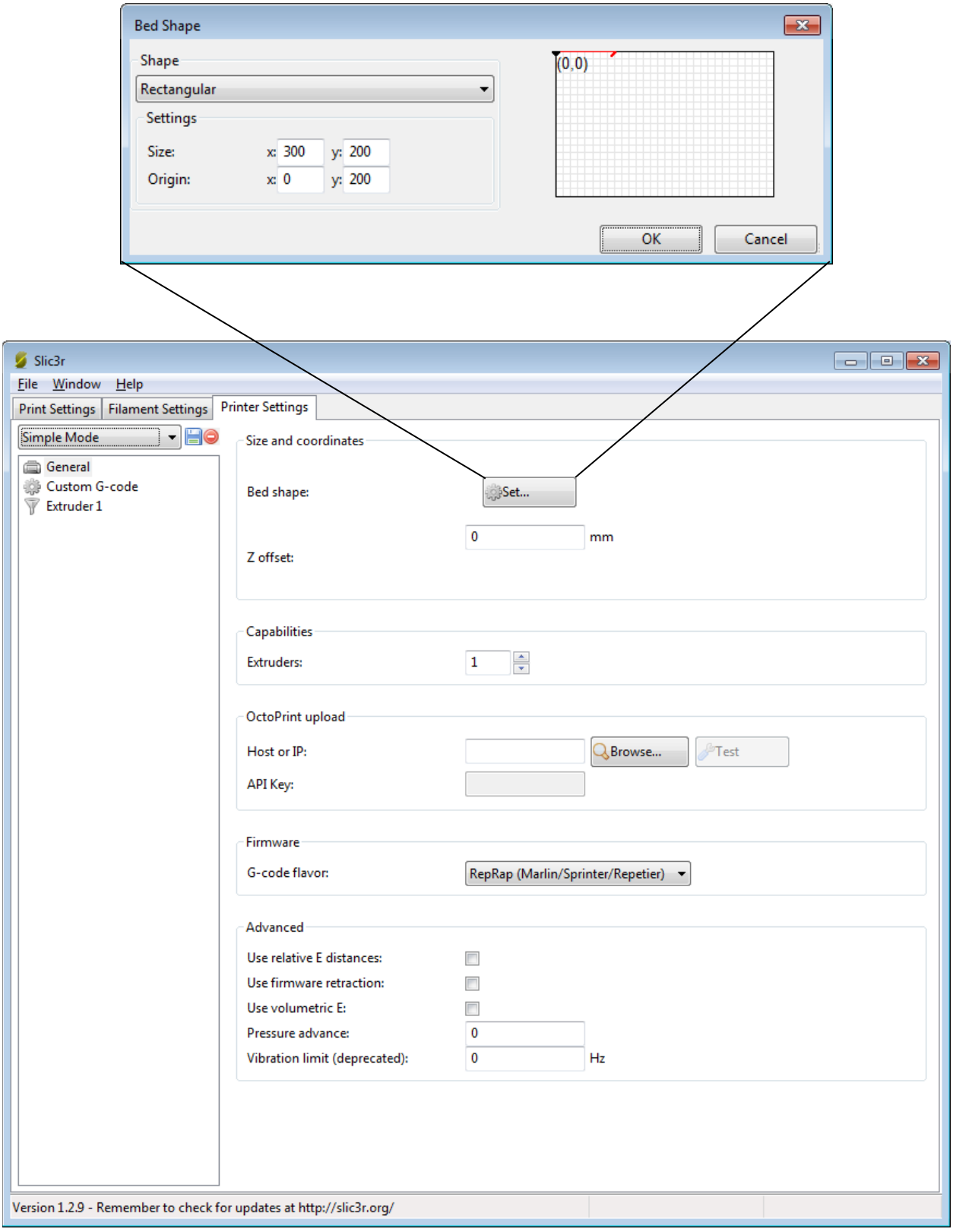

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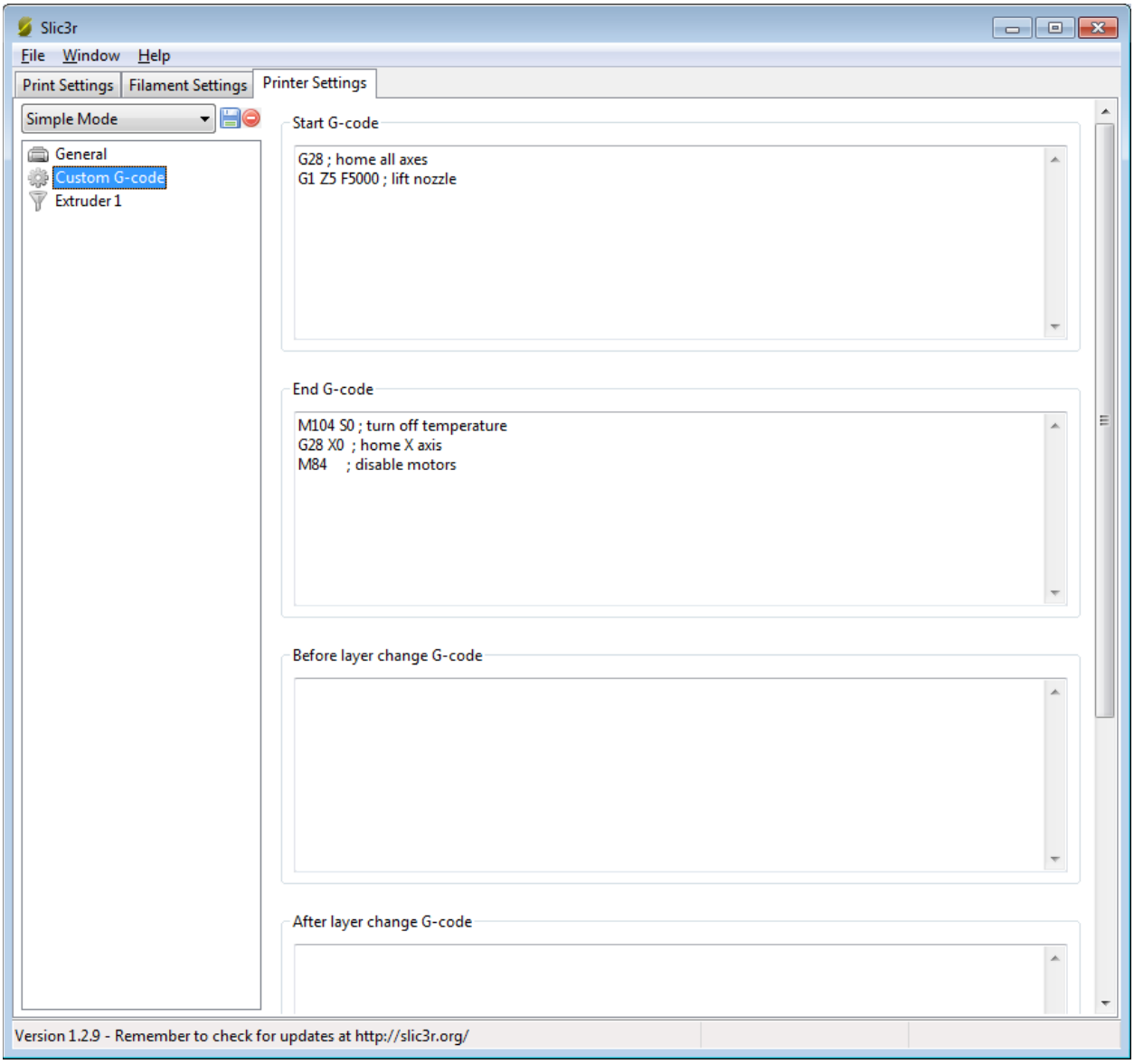

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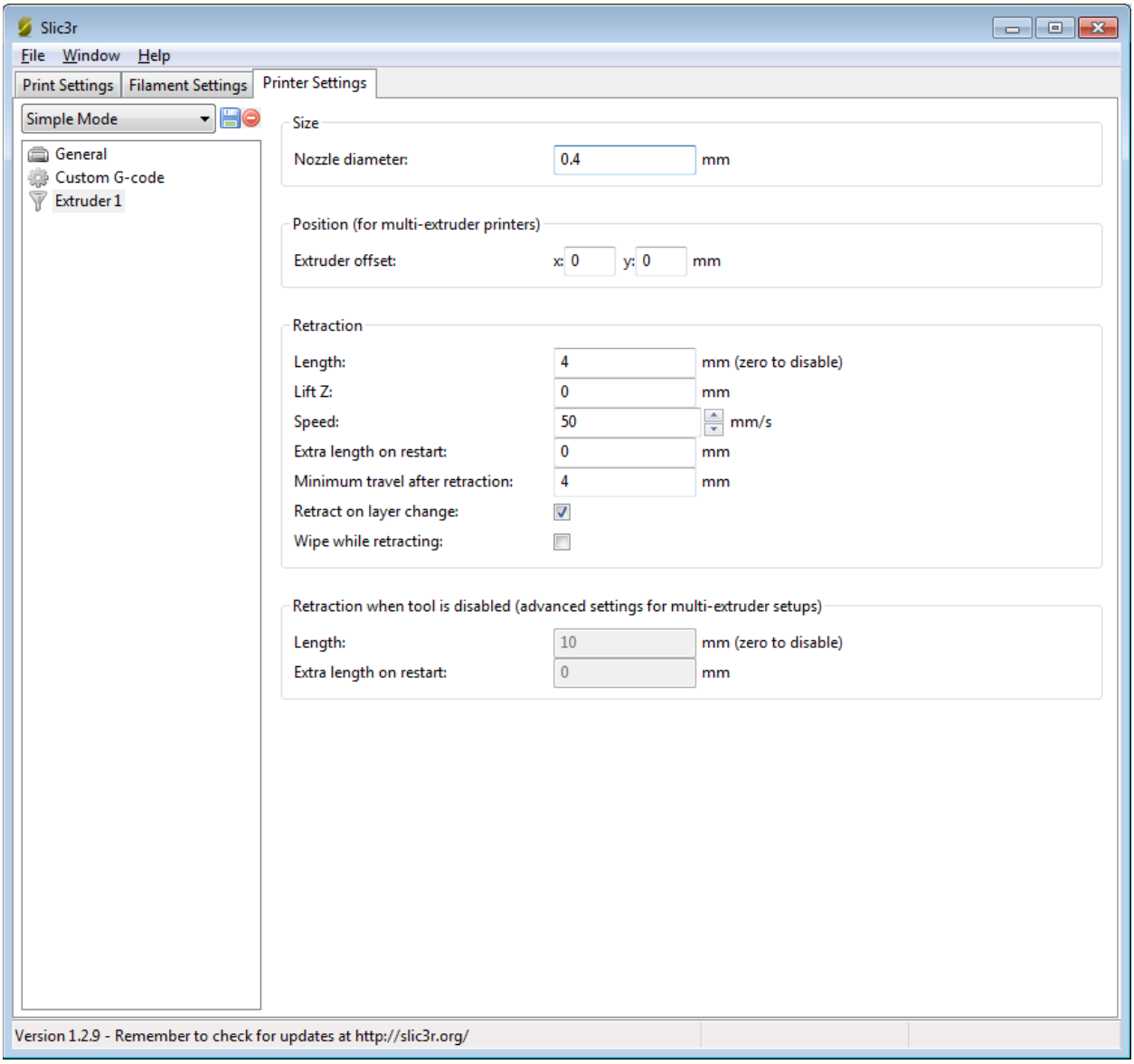
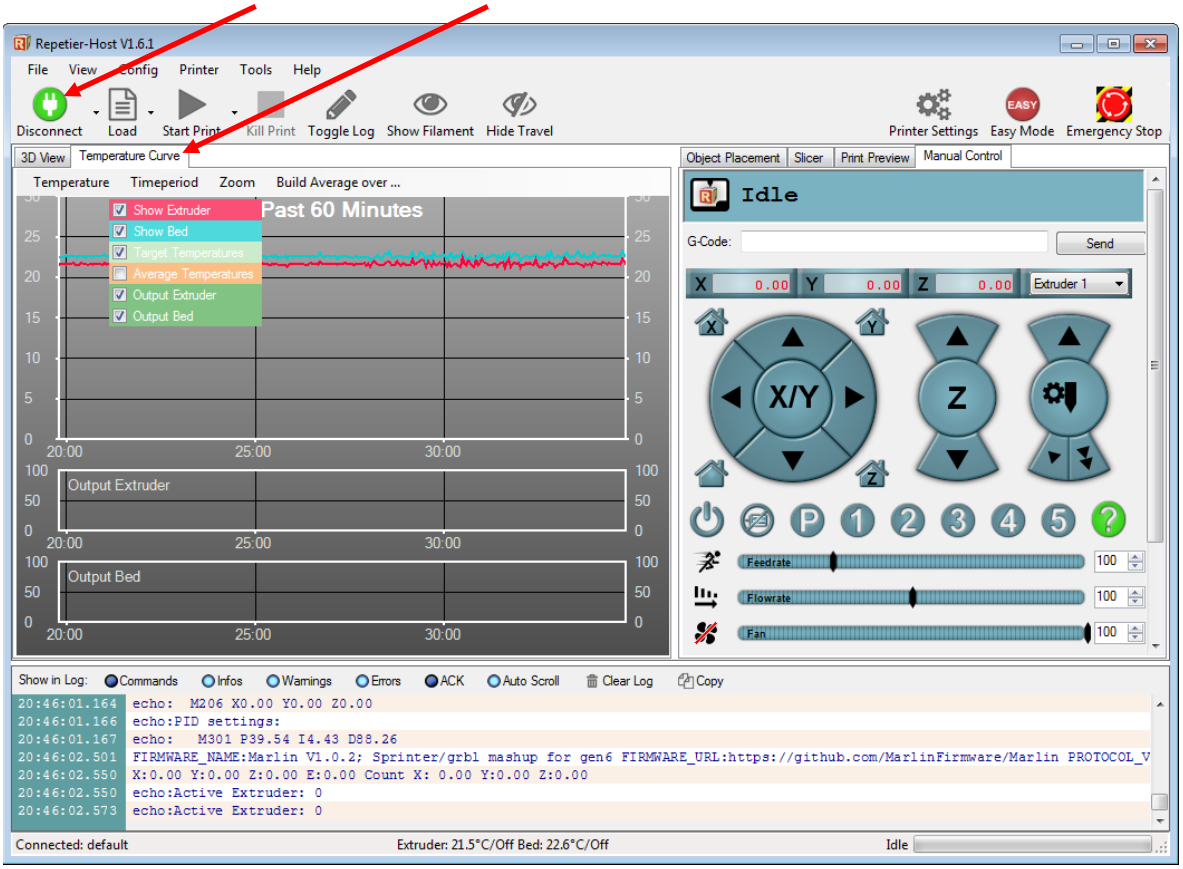


13. Initial Testing

- Turn on the 12v power supply and verify when powered up that the hot end heatsink fan runs and that it does not shut off as long as main power is turned on. If the hot end heatsink fan shuts off at any point then something may be wired incorrectly.

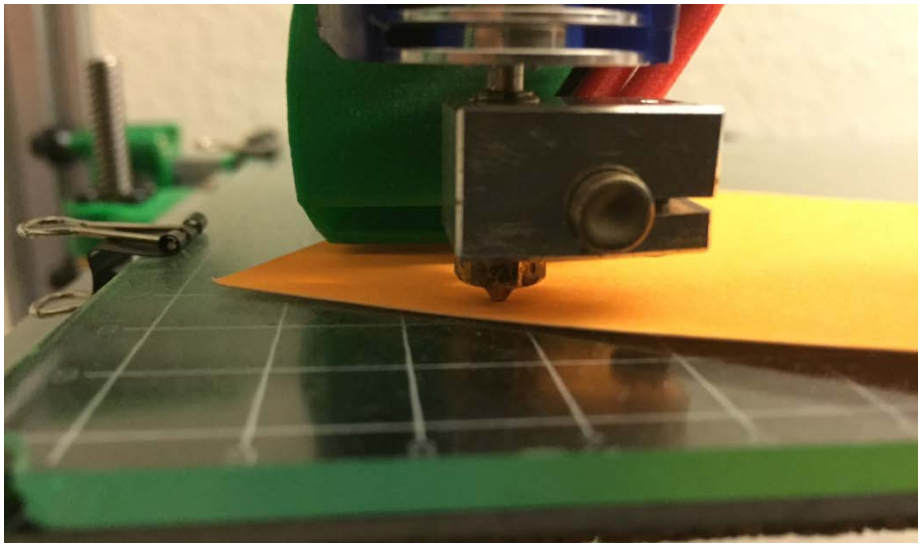
- Click the Connect/Disconnect button to enable communication with the printer. On the Temperature Curve tab of Repetier Host, verify that the Extruder and Bed temperature plots are steady at ambient temperature (between 20C to 25C). If they do not correspond to ambient temperature, thermistor settings may not be correct in *configuration.h* or thermistors may be wired incorrectly. If the bed or extruder temperature is ramping up without being enabled via Rep Host, something may be wired incorrectly or the Ramps board may be faulty.



- Review the Repetier Host manual control guide to become familiar with the interface and icons http://www.repetier.com/documentation/repetier-host/rhmanual-control/

- Install an M5x40mm bolt in the Z endstop bolt holder and raise the bolt as high as possible to guarantee that the nozzle will not impact into the bed during initial test movements.

- Initial Z endstop calibration and bed leveling:
  1. Home the Z axis and make sure that the bed stops several millimeters away from the nozzle. Keep your mouse over the Emergency Stop button in Repetier Host and stop the movement if needed, you don't want the nozzle to crunch into the glass.
  2. Lower the Z endstop bolt by a couple millimeters and home Z. Repeat this process until the nozzle is close to the bed, almost touching. See video demonstration here
  3. Move the print carriage by hand near each corner of the bed and verify distance between nozzle and glass is approximately 0.2mm (thickness of an index card). You should feel slight resistance when an index card is inserted between the nozzle and glass. If you can't move the XY gantry by hand, click the motor disable button in Rep Host (just left of the P button).
  4. Adjust the M3 corner bolt nearest the nozzle to either raise or lower the bed to achieve the correct distance.
  5. Repeat for each of the corners, then at each of the four corners again to verify perfect leveling.
  6. You should not need to adjust the Z endstop bolt again, all bed leveling and adjustment will be done via the four M3 bed screws.



- Using Repetier Host controls, move all three axes and verify proper direction of movement. If the hot end moves in the wrong direction, wiring or firmware configuration may be incorrect.
  (Never disconnect or change control board wiring while the power is on, this includes power supplied via USB cable also.)

- Verify operation of all three endstops, if the hot end or bed moves away from the end stop instead of towards it, a parameter may be wrong in the Rep Host settings or the

Marlin configuration files. The X endstop position can be fine-tuned by adjusting the M3 25mm bolt that points at the X endstop. The nozzle should line up with the left edge of the bed grid when homed.

- If the print carriage is pushed all the way to the back and the Y endstop is activated, the printer will not home to X when commanded. This is an issue with Marlin/ Repetier. Manually push the print carriage away from the Y endstop until the LED turns off before engaging the homing command.

- Calibrate Bowden extrusion steps per this example video. Extrusion length calculation is in the last half of the video, ignore stepper driver tuning directions, this has already been completed for the D-Bot. When inserting the Bowden tube into the hot end, make sure that the tubing inserts all the way in and is seated into the heatbreak.

- PID Temperature Feedback Tuning:

  Proportional Integral Derivative Tuning is an essential step to guarantee proper operation of the temperature feedback loops of both the hot end and the heated bed. Do not skip this step and do not assume that the values preloaded in the configuration file can be reused; each printer derives different PID values based on slight differences in wiring and hardware.

  PID tuning - Hot End:

  Begin the PID autotune routine for the hot end by typing `M303 E0 S200 C8` into the Rep Host G-code interface, then click Send. The nozzle will automatically heat up to 200C and cycle around that set point 8 times then it will cool down.

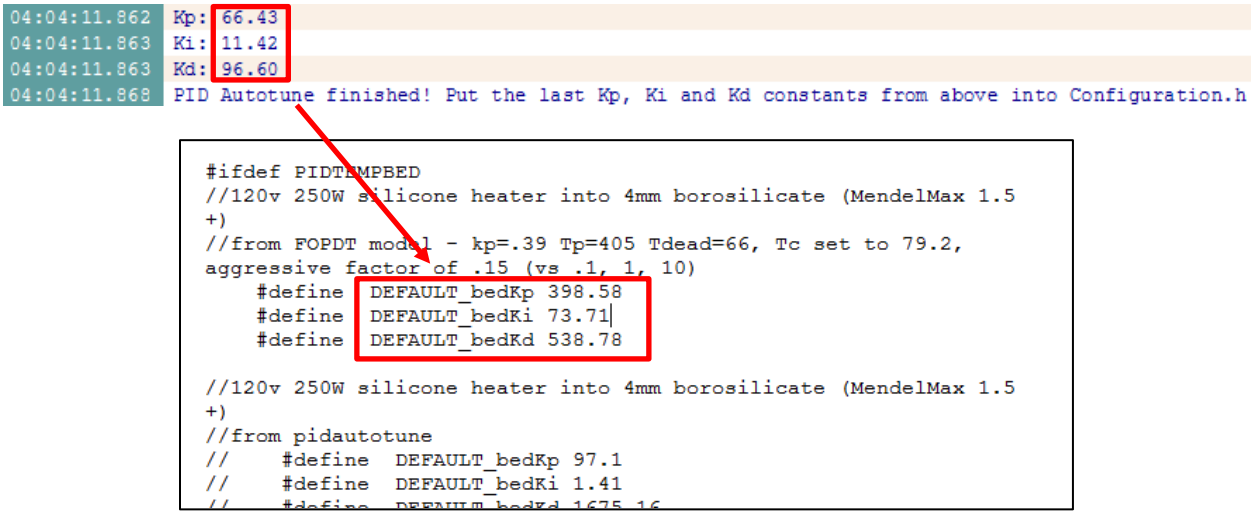
Once complete, Repetier Host will report three final Kp Ki and Kd values as shown below. Enter these values into the indicated section of the configuration file stored at *D-Bot_Marlin>Marlin>configuration.h.* Marlin lists these as Ultimaker settings but that is just a default name.

```
04:04:11.862  Kp: 66.43
04:04:11.863  Ki: 11.42
04:04:11.863  Kd: 96.60
04:04:11.868  PID Autotune finished! Put the last Kp, Ki and Kd constants from above into Configuration.h
```

```
PID_FUNCTIONAL_RANGE then the PID will be shut off and the
heater will be set to min/max.
  #define PID_INTEGRAL_DRIVE_MAX PID_MAX  //limit for the
integral term
  #define K1 0.95 //smoothing factor within the PID
  #define PID_dT ((OVERSAMPLENR * 10.0)/(F_CPU / 64.0 / 256.0))
//sampling period of the temperature routine

// If you are using a pre-configured hotend then you can use one
of the value sets by uncommenting it
// Ultimaker
    #define  DEFAULT_Kp 39.54
    #define  DEFAULT_Ki 4.43
    #define  DEFAULT_Kd 88.26

// MakerGear
//    #define  DEFAULT_Kp 7.0
//    #define  DEFAULT_Ki 0.1
//    #define  DEFAULT_Kd 12

// Mendel Parts V9 on 12V
//    #define  DEFAULT_Kp 63.0
//    #define  DEFAULT_Ki 2.25
//    #define  DEFAULT_Kd 440
#endif // PIDTEMP

// Bed Temperature Control
// Select PID or bang-bang with PIDTEMPBED. If bang-bang,
BED_LIMIT_SWITCHING will enable hysteresis
//
// Uncomment this to enable PID on the bed. It uses the same
```

PID tuning – Heated Bed:

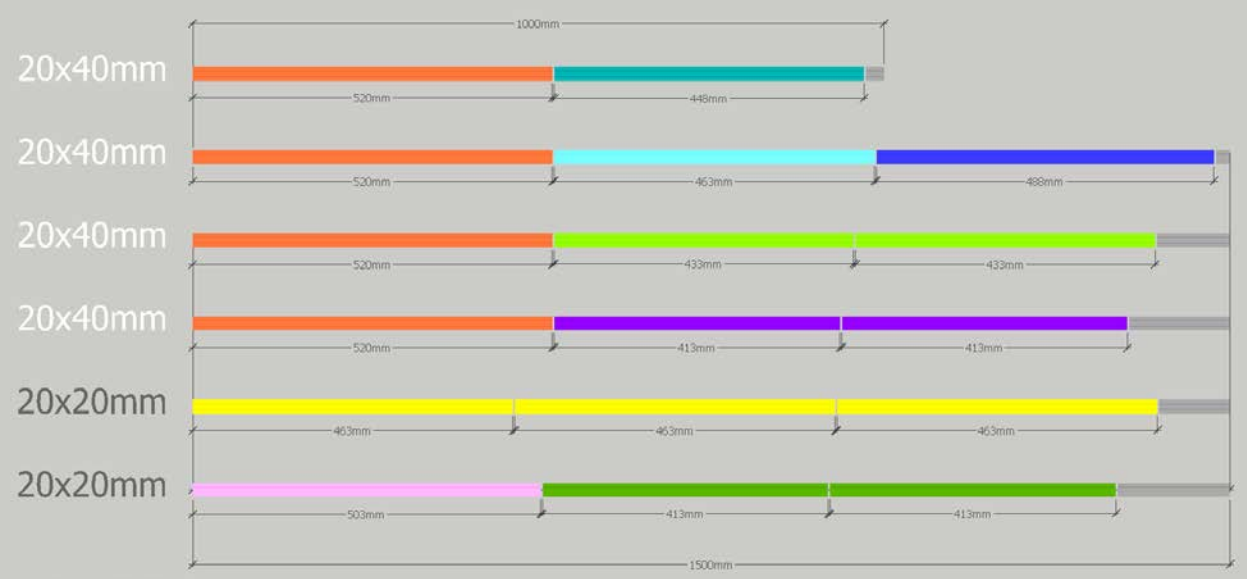
Similar to the hot end PID tuning, begin the PID autotune routine for the heated bed by typing `M303 E-1 C8 S60` into the Rep Host G-code interface, then click Send. The heated bed will automatically heat up to 60C and cycle around that set point 8 times then it will cool down. This will take several minutes longer for the bed compared to the hot end. Once complete, Repetier Host will report three final Kp Ki and Kd values as shown below. Enter these values into the PIDTEMPBED section of the configuration file stored at *D-Bot_Marlin>Marlin>configuration.h.* Note: this is not the same section used above, these parameters begin with `DEFAULT_bed`.



- Once the six parameters for the hot end and bed Kp Ki Kd settings are entered into *configuration.h,* save the file and close. Reupload *D-Bot_Marlin>Marlin>Marlin.ino* by using the same process as the initial firmware upload. Rep Host needs to be disconnected (connect/disconnect button under the File menu) or closed completely in order for Arduino to connect to the Mega 2560/Ramps.

14. Appendix

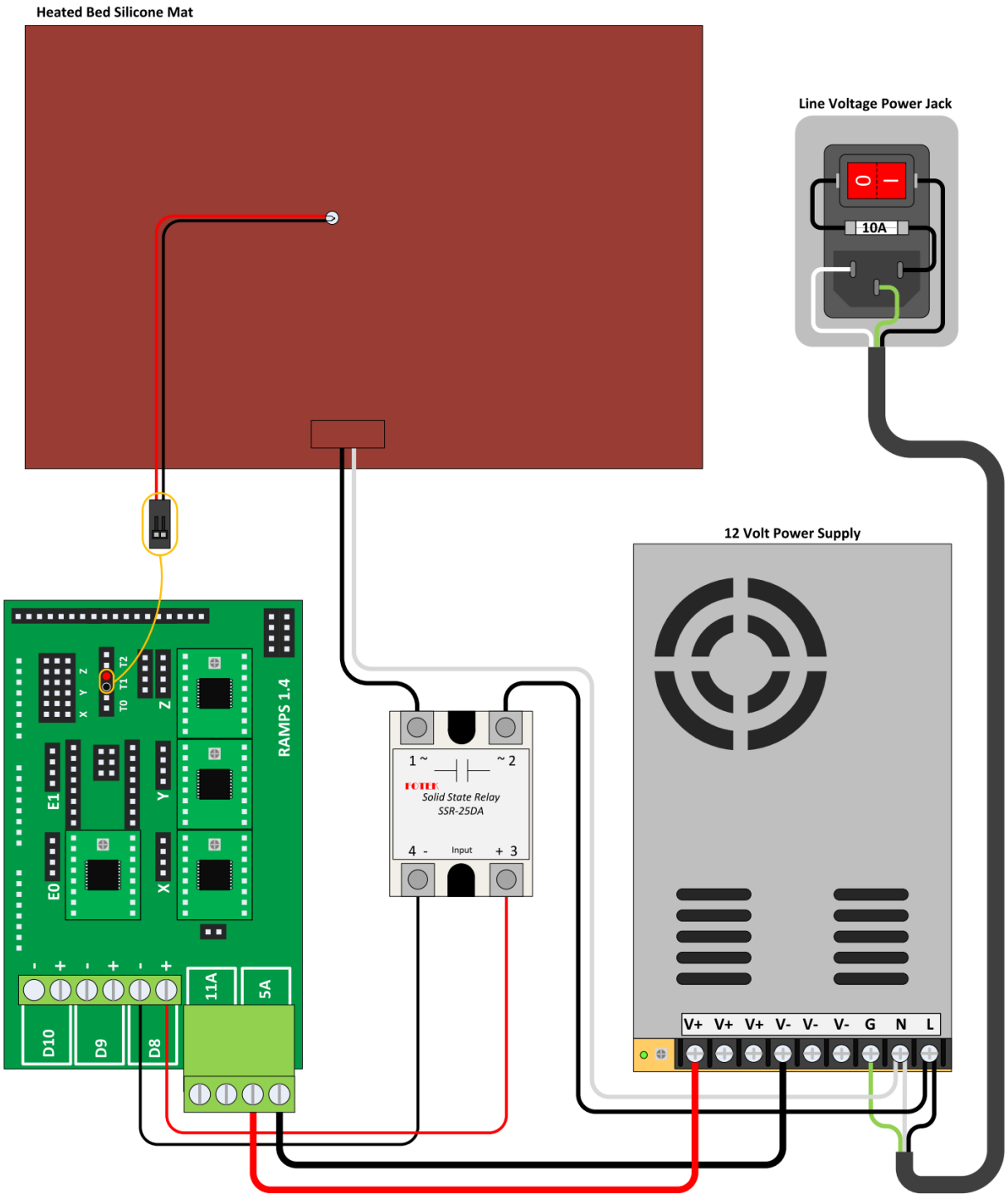
- Railing lengths required for a build based on a 300x300mm bed:



- For a 300x300mm bed, the Z motors will need to be moved forward so that the Z platform is supported at or near the center of gravity for uniform raising and lowering.
- Longer GT2 belts will also be needed for a larger build.

- Line voltage power jack/fuse/switch module wiring is shown below:

- Electrical diagram for an AC voltage heated bed is shown below.
- Use an AC SSR, not a DC SSR, they look very similar.



Please show your appreciation for this design and all of the volunteer work that went into this documentation by uploading your finished printer to the Thingiverse page and please try to help future builders who may have questions, thank you.

Change log:

Revision 0, 5-11-16: Initial Release

Revision 1, 5-12-16: Previously linked to the wrong AC SSR