

PrintNC Build Guide

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Introduction

This build guide will walk you through the tools, materials, and process to build your own PrintNC. The guide is intended to be complete with all the information you will need for the full build process, but it is NOT built for easy digestion. Please watch a few video guides before starting your build for a better overview of the process. When doing your build the guide can be printed and used as a step-by-step checklist to help ensure no critical steps are missed or done wrong.

Tools Required

- | | |
|--|---|
| <input type="checkbox"/> Center punch | <input type="checkbox"/> Metal cutting drill bits |
| <input type="checkbox"/> Hammer | <input type="checkbox"/> M3 |
| <input type="checkbox"/> Electric Drill | <input type="checkbox"/> M4.2 |
| <input type="checkbox"/> Metal tap bits | <input type="checkbox"/> M5 |
| <input type="checkbox"/> M5 | <input type="checkbox"/> M6 |
| <input type="checkbox"/> M6 | <input type="checkbox"/> M6.5 |
| <input type="checkbox"/> Allen Key | <input type="checkbox"/> Thread-locking fluid |
| <input type="checkbox"/> M4 | |
| <input type="checkbox"/> M5 - Ball Nose with long shaft | |

High Level Build Process Overview:

1. Prepare and assemble X-Axis and Y-Axis frame pieces
2. Mount Y-Axis mechanics
3. Prepare and assemble Z-Axis
4. Prepare X-Axis gantry pieces
5. Mount X-Axis mechanics
6. Install X-Axis gantry and Z-Axis
7. Install waste board

Important Notes

- Never remove the ball screw nuts from the threaded shaft. The mechanism can be made irreparable if disassembled incorrectly!
- Several steps in the build process requires using a small allen key to pass through a small hole to tighten bolts. This limits the types of bolts in several places to button head style, since those use smaller allen keys. Please make sure you're using the correct style of bolts where needed. Ball-nose allen keys with long shafts are required for these sections.
- Some build steps can be done in alternate order to reduce tool changes or to accommodate the constraints of optional tools like drill presses. Some known alternatives include:
 - Combine steps 1 and 4: Y Axis Frame - mark corners and middle, then flip over and mark BF12. All are M6 Threaded.

1. Y-Axis Frame Prep

Summary: Create **M6 threaded holes** for mounting and **one M5 unthreaded** at the front for cable passthrough.

Hardware Needed:

- Center punch
- Drill
- M5 Drill bit
- M6 Tap bit
- Pencil
- (2) Y-Axis frame beams

Printed Parts Needed:

- Assembly Tool #1 - Y Frame Marker
- Assembly Tool #3 - Y Frame Mid Marker
- Center Line Marker Tool

When complete, verify:

- All holes drilled in this step are on the bottom surface of the beams
- Each beam should have a center line marked on the top surface.
- One end of one Y-axis frame beam should have 5 holes, as shown in Figure 1.4.
- The other end of that beam, as well as both ends of all other Y-axis frame beams should have 4 holes.
- All Y-axis frame beams should have 4 holes at the center
- All holes except for the center hole in Figure 1.4 should be threaded to accept an M6 bolt.

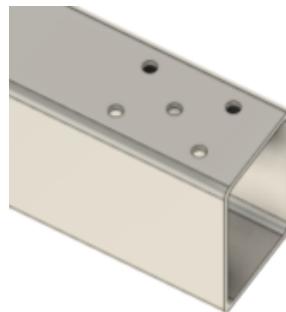


Figure 1.4

Build Steps:

1. Position Assembly Tool #1 on the top face of one Y-Axis frame beam with the number on the printed part facing down and all tabs securely holding position as shown in Figure 1.1.

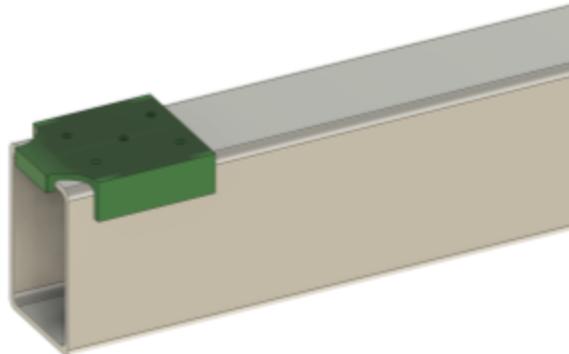


Figure 1.1

2. Mark all 4 corner holes with a center punch.
3. Mark the center hole with a center punch. The center hole is only used once and only on the first beam where a wire will be passed to connect an endstop switch.
4. Repeat steps 1.1-1.2, skipping step 1.3 on the other end of the Y-Axis frame beam and both ends of the other beam.
5. Find and mark the center point of the exposed bottom face of each beam.
6. Position Assembly Tool #3 at the middle of the frame beam as shown in Figure 1.2, using the hole in the center of the printed tool to align it precisely to the center point mark made in the previous step.

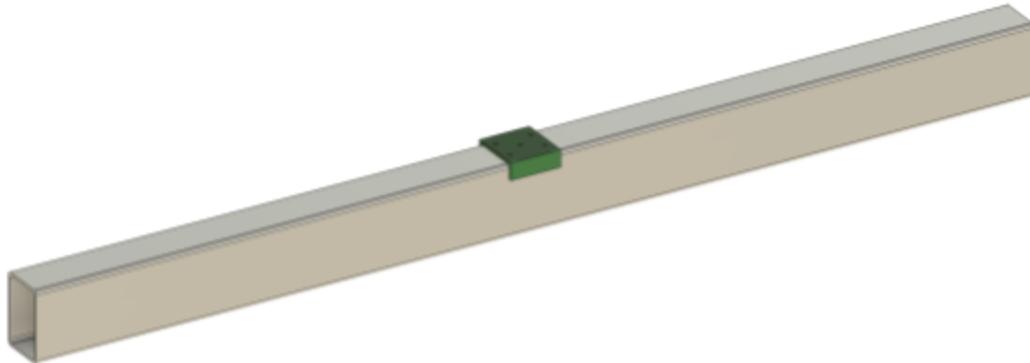


Figure 1.2

7. Mark the 4 holes around the edges with a center punch. Do not mark the center hole.
8. Drill all marked points with an M5 bit.
9. Thread all holes made in the previous step except the center hole marked in step 1.1 with an M6 tap bit. That hole can be tapped, but it's not necessary.
10. Flip the Y-Axis frame beams so the holes are facing down.
11. Position the Center Line Marker Tool on the top face as shown in Figure 1.3.
12. Place a pencil or other marking tool at the center of the v shaped grove on the Center Line Marker Tool and hold it there securely.
13. Run the Center Line Marker Tool down the length of the beam while using the marking tool to mark the center. Measure your centerline at several places to ensure it is indeed properly centered.
14. Repeat previous 3 steps for the other Y-Axis frame beam.

2. X-Axis Frame Prep

Summary: Create **M6.5 unthreaded holes** for mounting

Hardware Needed:

- Center punch
- Drill
- M6.5 Drill bit
- (3) X-Axis frame beams

Printed Parts Needed:

- Assembly Tool #2 - X Frame Marker

When complete, verify:

- One end of one X-Axis frame beam should have 9 holes, as shown in Figure 2.2.
- The other end of that beam, as well as both ends of all other X-Axis frame beams should have 8 holes, as shown in Figure 2.3.
- All holes should be 6.5 mm
- None of these holes need to be tapped.

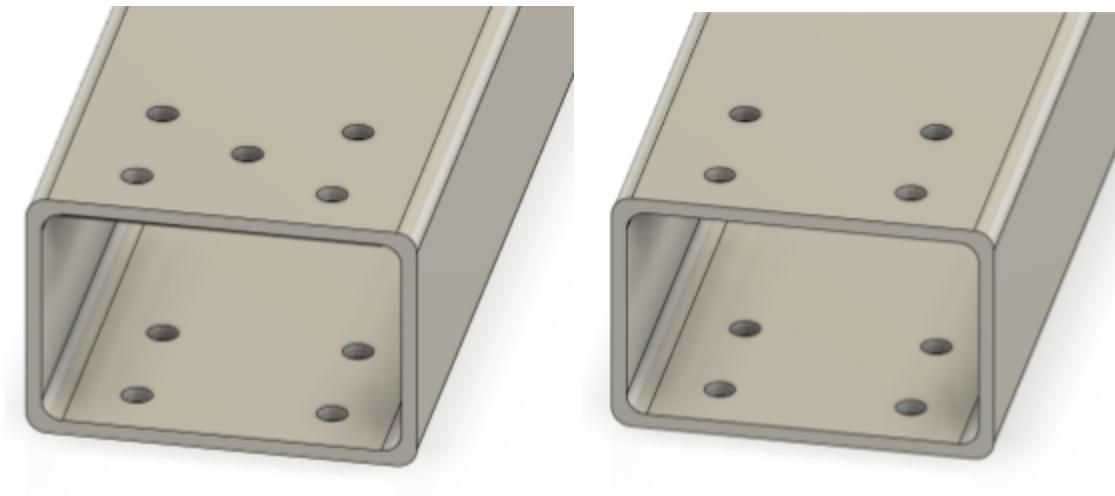


Figure 2.2

Figure 2.3

Build Steps:

1. Position Assembly Tool #2 on the top face of one beam with the number facing down and all tabs securely holding position as shown in Figure 2.1.

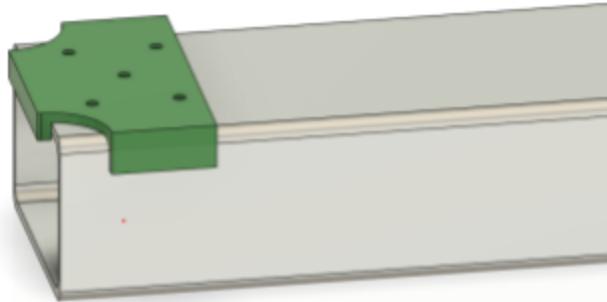


Figure 2.1

2. Mark all 4 corner holes with a center punch.
3. Mark the center hole with a center punch. The center hole is only used once and only on the first beam where a wire will be passed to connect an endstop switch.
4. Repeat steps 2.1 and 2.2 on all ends of the X-Axis frame beams, but do not mark the center hole at the other positions.
5. Flip X-axis frame piece so the side surface which was facing down ends up facing up.
6. Repeat steps 1 and 2, but do not mark the center hole at any of the positions.
7. Drill all marked points with an M6.5 bit.

3. Frame Assembly

Summary: Bolt together the prepared X and Y Axes, aligning the cable pass through hole.

Hardware Needed:

- M4 Allen key
- Thread-locking fluid
- (24) M6X10mm Button Head Bolt
- (2) Prepared Y-Axis frame beams from step 1
- (3) Prepared X-Axis frame beams from step 2

When complete, verify:

- Your frame is fully squared after assembly.
- Each X-Axis beam has 4 bolts on each side attaching it to the Y-Axis beams, for a total of 8 bolts on each X-Axis beam
- A wire can be passed through the spare hole between the 4 bolts circled in Figure 3.2 and Figure 3.3

Build Steps:

1. Place the prepared Y-Axis frame pieces parallel to each other with the holes facing up as shown in Figure 3.1. Please note the location of the Y-Axis frame beam which has 5 holes, circled in red.

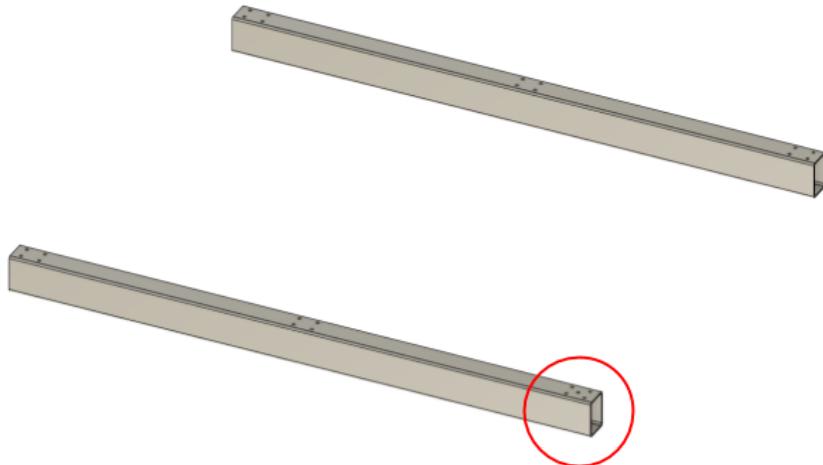


Figure 3.1

2. Place the prepared X-Axis frame pieces on top of the Y-Axis frame pieces so that the holes align as shown in Figure 3.2. Ensure the X-Axis frame beam which the extra hole aligns with the Y-Axis frame beam, as circled in red.

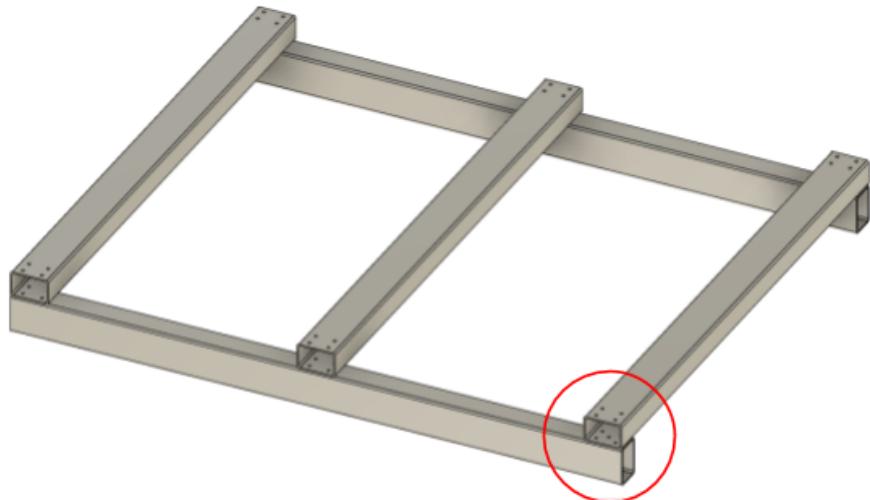


Figure 3.2

3. Screw M6x10mm bolts into the Y-Axis frame beams to lightly fasten the X-Axis beams to the Y-Axis beams as shown in Figures 3.3 and 3.4.

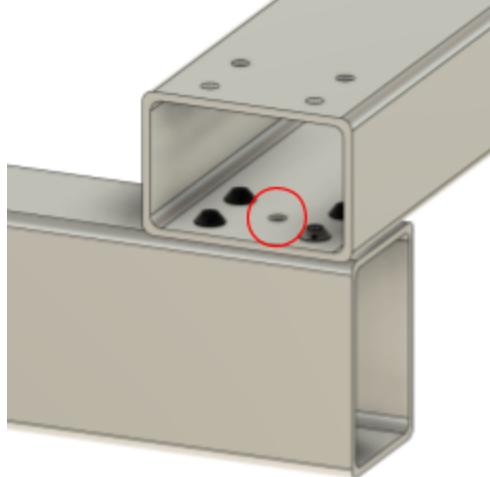


Figure 3.3



Figure 3.4

4. Verify your frame is squared. Use the oversized M6.5 holes in the X-Axis to align the beams as needed.
5. Apply thread-locking fluid to all bolts
6. Flip the frame right side up so the X-Axis frame beams are on the bottom.

4. Y-Axis BF12 Mounting Prep

Summary: Create **M6 threaded holes**

Hardware Needed:

- ~6mm diameter marking tool (if used gently an M6 bit and a hammer can be used or a center punch with a compatible spacer)
- M5 Drill bit
- M6 Tap bit
- Prepared Frame Assembly from step 3
- (6) **M6x40mm Bolt**

Printed Parts Needed:

- (2) BF12 Mount

When complete, verify:

- Both BF12 Mounts are installed with 3 bolts each
- Both BF12 Mounts are oriented correctly as shown in Figure 4.3 (bolts make a triangle pattern pointing towards the back of the machine)
- Neither BF12 Mount is mounted over the cable access hole between the Y-Axis frame beam and the X-Axis frame beam

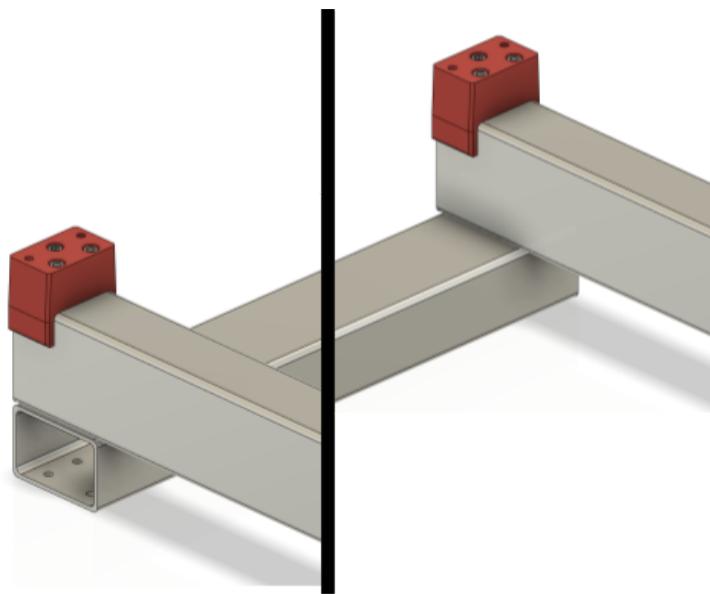


Figure 4.3

Build Steps:

1. Place the BF12 Mount on the Y-Axis frame far from the side which has the cable pass through hole as shown in Figure 4.1. The end of the frame with the cable pass through hole is marked prohibited in red in the figure. The locations where BF12 Mounts should be marked and placed are circled in green.

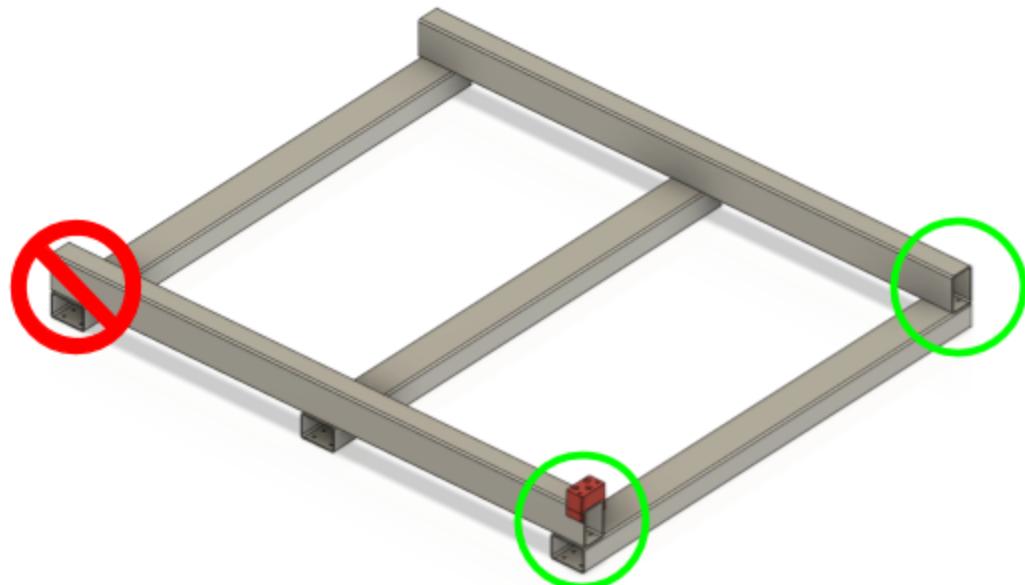


Figure 4.1

2. Ensure the BF12 mount is oriented correctly, as shown in Figure 4.2. The three counterbored holes make a triangle pattern pointing towards the back of the machine.

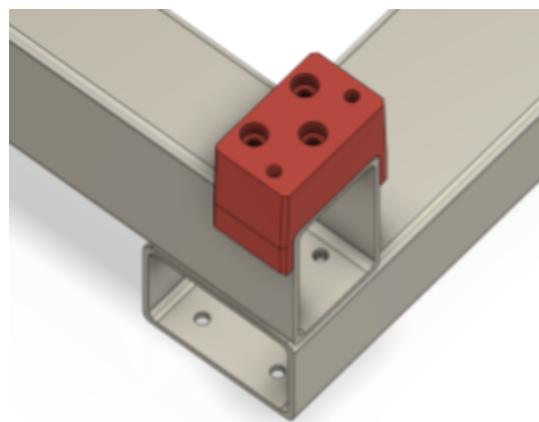


Figure 4.2

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3. Mark the three counterbored holes with your marking tool. Ensure the marks are adequately centered. If you're doing this with a drill bit, be careful to hit the bit very lightly.
 4. Repeat steps 4.2 and 4.3 on the other Y-Axis frame beam where circled in green in Figure 4.1.
 5. Drill all 6 marked points with an M5 bit.
 6. Thread all holes made in the previous step with an M6 tap bit.
 7. Install both BF12 Mounts with M6x40mm bolts.

5. Y-Axis Linear Rail Prep

Summary: Create **M5 threaded holes**

Hardware Needed:

- M4 Allen key
- M4.2 Drill bit
- M5 Tap bit
- ~6mm diameter marking tool (if used gently an M6 drill bit and a hammer can be used or a center punch with a compatible spacer)
- (2) HGR20 Linear Rail
- M5x20mm bolts (comes with rail)

When complete, verify:

- All M5 holes drilled in this step are properly placed to align to the holes in the HGR20 rails
- All M5 holes for the HGR20 rails are centered on their Y-Axis frame beams
- The HGR20 rails have some wiggle room so the final position and alignment can be adjusted later when mounting the X-Axis gantry

Build Steps:

1. Double check the center line created in step 1.12. If inaccurate or missing please follow steps 1.10-1.13 to (re)create it.
2. Position HGR20 rail against the BF12 Mount as shown in Figure 5.1



Figure 5.1

3. Ensure the HGR20 rail is centered on the Y-Axis frame beam. Use the center line to validate.
4. Using the 6mm marking tool, mark the center of the holes in the HGR20 rail which are closest and furthest from the BF12 Mount.
5. Repeat previous 3 steps for the other Y-Axis frame beam.
6. Drill the point marked in step 5.4 on both Y-Axis frame beams with an M4.2 bit.
7. Thread the holes made in the previous step with an M5 tap bit.
8. Remount the HGR20 rails and install M5xmm bolts into the holes made in the previous step.
9. Using the bolts installed above as soft anchors, mark the remaining mounting holes on the HGR20 rail. Ensure the rail maintains centered and positioned correctly throughout the entire marking process.
10. Remove the bolts and dismount the HGR20 rail again.
11. Drill the points marked in step 5.9 on both Y-Axis frame beams with an M4.2 bit
12. Thread the holes made in the previous step with an M5 tap bit.
13. Remount the HGR20 rails and loosely install all M5xmm bolts.

6. Y-Axis BK12 Mounting Prep

Summary: Create **M6 threaded holes**

Hardware Needed:

- ~6mm diameter marking tool (if used gently an M6 drill bit and a hammer can be used or a center punch with a compatible spacer)
- M5 Drill bit
- M6 Tap bit

Printed Parts Needed:

- (2) BK12 Mount

When complete, verify:

- All M6 threaded holes for the BK12 mount are properly placed to align to the HGR20 rails

Build Steps:

1. Double check the HGR20 rail is tightly pressed against the BF12 mount so that minimum play exists between them.
2. Position BK12 Mount against the HGR20 rail as shown in Figure 6.1.

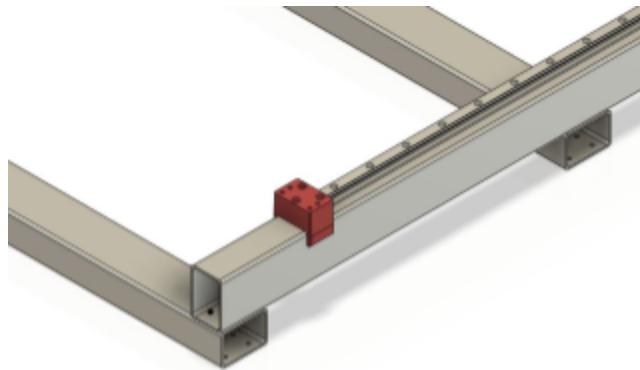


Figure 6.1

3. Ensure the mount is positioned correctly. The three counterbored holes should form an arrow pointing away from the HGR20 rail as shown in Figure 6.2.

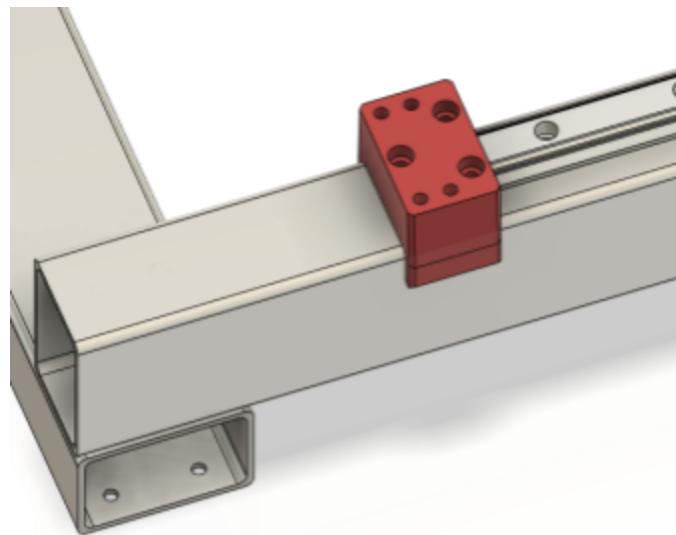


Figure 6.2

- 
4. Mark the three counterbored holes with your marking tool. Ensure the marks are adequately centered. If you're doing this with a drill bit, be careful to hit the bit very lightly.
 5. Repeat the previous three steps on the other Y-Axis frame beam.
 6. Drill all 6 marked points with an M5 bit.
 7. Thread all holes made in the previous step with an M6 tap bit.
 8. Set the BK12 mount aside, it will be installed later.

7. Y-Axis Roller Beam Prep

Summary: Create **4 M6 threaded holes & 1 M6.5 unthreaded hole** on the top side. Create **4 M6.5 unthreaded holes** on the bottom side. Mount HGW20 block to bottom side.

Hardware Needed:

- Center punch
- Drill
- M6.5 Drill bit
- M5 Drill bit
- M6 Tap bit
- (2) Y-Axis roller beams - 70 mm
- (2) HGW20 Block
- (4) M6x20mm Button Head Bolt
- (1) M6x12mm Bolt
- Thread-locking fluid
- (Optional) Pencil

Printed Parts Needed:

- Assembly Tool #4 - Y Roller Bottom
- Assembly Tool #5 - Y Roller Top

When complete, verify:

-

Build Steps:

1. (Optional) Mark the side of the beam with an arrow pointing up to ensure you don't lose orientation of the beam. All figures in this section will be marked so for ease of interpreting
2. Position Assembly Tool #4 on the bottom face of the Y-Axis frame beam with the number on the printed part facing the beam and all tabs securely holding position as shown in Figure 7.1.

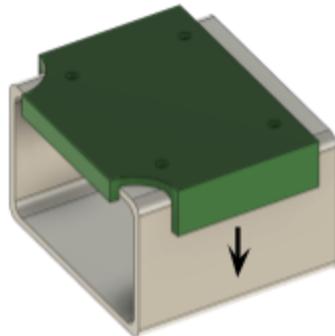


Figure 7.1

3. Mark all holes with a center punch.
4. Drill the marked points with an M6.5 drill bit.
5. Position Assembly Tool #5 on the top face of one Y-Axis frame beam with the number on the printed part facing the beam and all tabs securely holding position as shown in Figure 7.2.

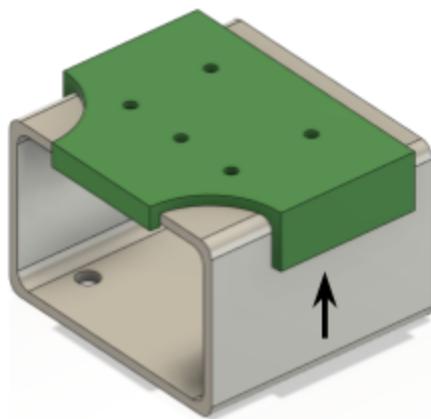


Figure 7.2

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6. Mark all holes with a center punch.
 7. Drill the marked center hole with an M6.5 bit.
 8. Drill the remaining marked points with an M5 drill bit.
 9. Thread all holes made in the previous step except the center hole with an M6 tap bit.
 10. Apply thread-locking fluid to the M6x20 button head bolts.
 11. Mount the HGW20 block to the bottom of the beam using the M6x20mm button head bolts as shown in Figure 7.3.

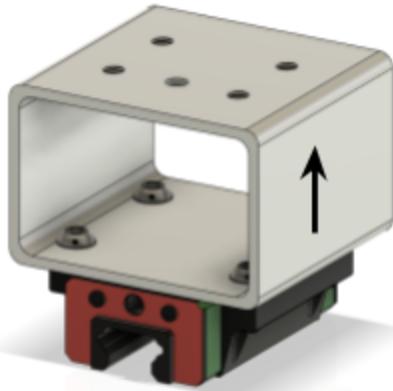


Figure 7.3

12. Install an M6x12mm bolt into the HGW20 on the side closer to the unthreaded center hole on the top surface of the frame beam as shown in Figure 7.4.

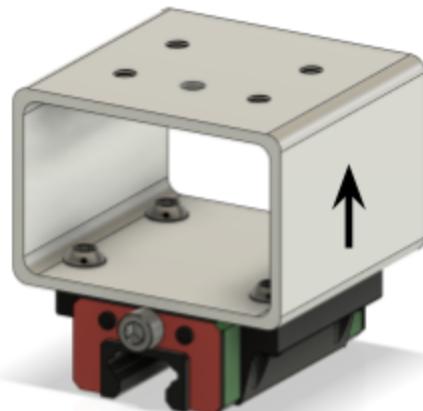


Figure 7.4

8. Y-Axis Mechanics Assembly

Hardware Needed:

- Mallet or hammer with a soft buffer
- Assembled and prepared frame from step 6
- (2) Assembled Y-Axis Roller from previous step
- (2) BF12
- (2) BK12

- (2) Ball screw with attached nut
- **NEVER SEPARATE!**

- (6) M6x40mm bolt
- (12) M5x95mm bolts

Printed Parts Needed:

- (2) BK12 Mount
- (2) Ball Screw Face Plate Front
- (2) Ball Screw Face Plate Rear

When complete, verify:

-

Build Steps:

1. Ensure the assembled frame has two BF12 mounts and both HGR20 rails installed. The BK12 mount should not be installed as it will block the HGW20 block from being installed onto the rails. The frame should look like Figure 8.1.



Figure 8.1

2. Gently install both of the assembled Y-Axis rollers onto the HGR20 rail as shown in Figure 8.2. Their location on the rail does not yet matter.

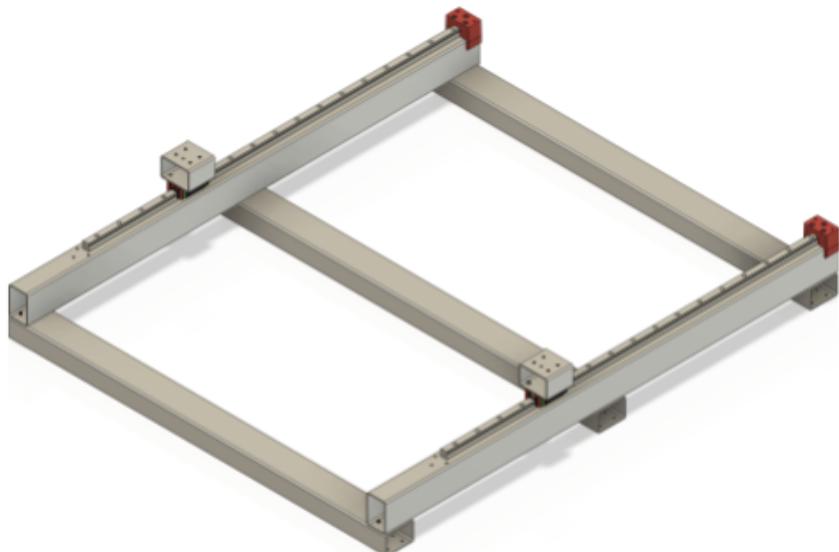


Figure 8.2

3. Install both BK12 Mounts onto the tapped holes created in step 6 using M6x40mm bolts as shown in Figure 8.3.

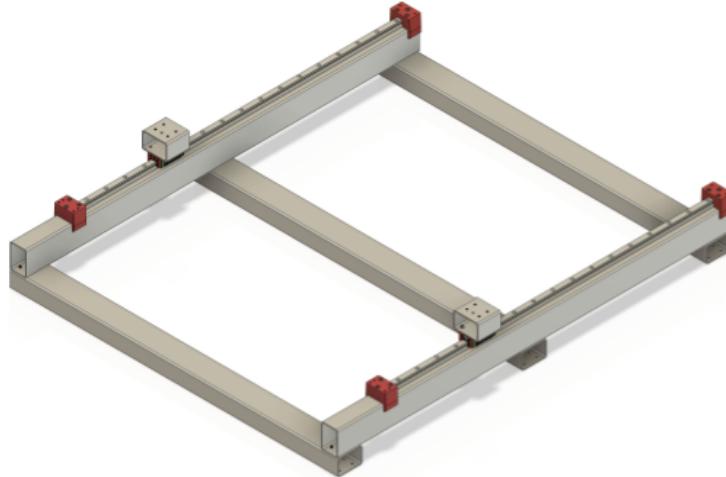


Figure 8.3

4. Insert a ball screw into a BK12 oriented as shown in Figures 8.4, 8.5, and 8.6. You will likely need to lubricate the ball screw and the bearing inside the BK12 and gently persuade the BK12 on. Be very careful to maintain proper alignment as the low tolerances mean any misalignment will cause the parts to jam and become damage.

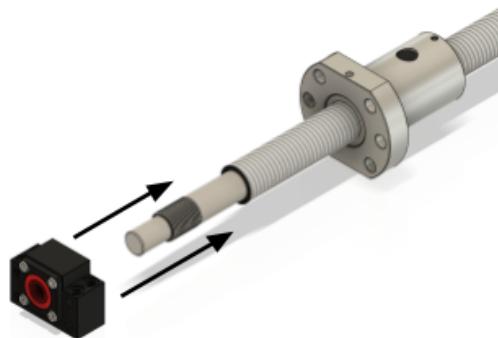


Figure 8.4



Figure 8.5



Figure 8.6

5. Screw the retainer nut onto the ball screw behind the BK12 as shown in Figure 8.7 and 8.8. Ensure it is securely tightened against the BK12.

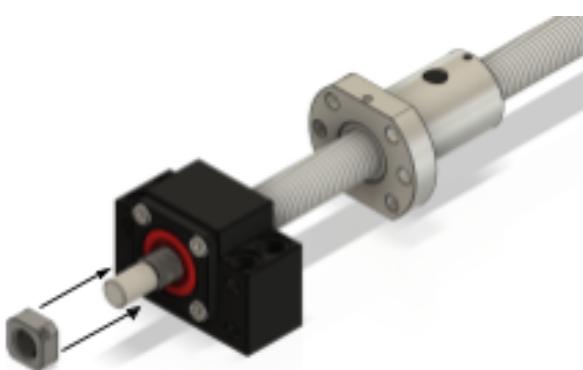


Figure 8.7

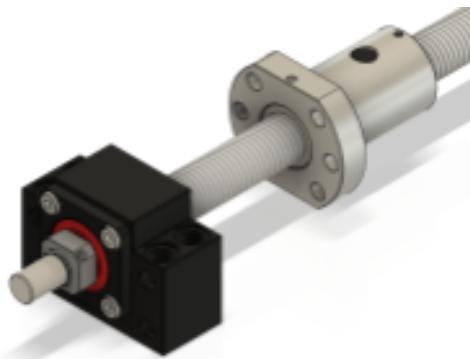


Figure 8.8

6. Tighten the set screw in the retainer nut so the retainer nut can no longer move.
7. Move the ball screw nut close to the BK12 to minimize future work to accomplish the same.
8. Place the Ball Screw Face Plate Front directly behind the ball screw nut as shown in Figures 8.9 and 8.10.

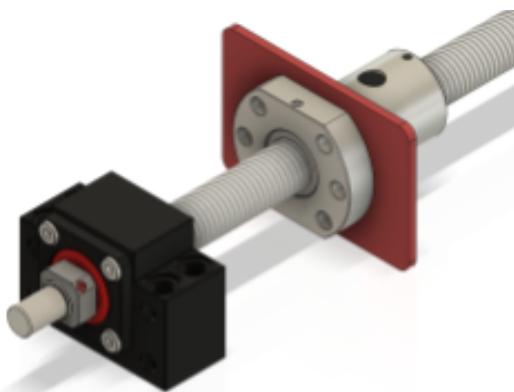


Figure 8.9

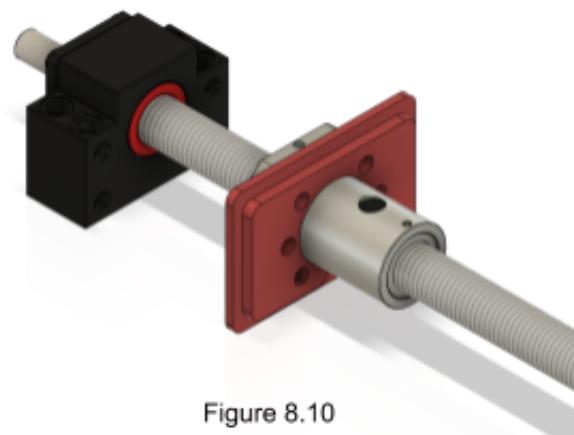


Figure 8.10

9. Pass the empty end of the ball screw through one of the Y-Axis roller beams, the result should look like Figure 8.11 and 8.12.



Figure 8.11

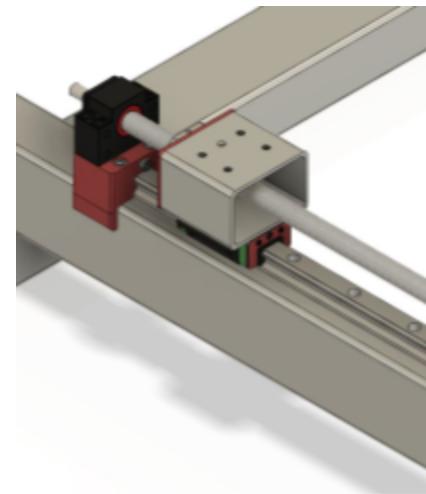


Figure 8.12

10. Pass the inset face of the Ball Screw Face Plate Rear over the unused side of the ball screw and slide it all the way up the screw. Insert the inset side of the printed part into the Y-Axis roller beam as shown in Figure 8.13.

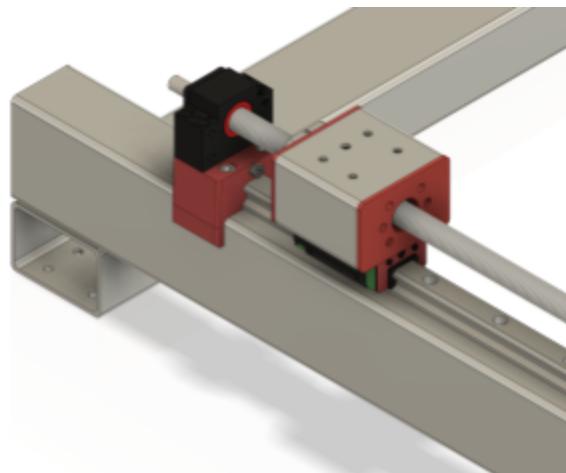


Figure 8.13

11. Attach the ball screw nut to the Y-Axis roller assembly using M5x95mm bolts passing the bolts all the way through both printed plates and M5 nuts on the other side as shown in Figure 8.14 and 8.15. Only screw these finger tight as they will need to be removed again later to install the endstop wire.

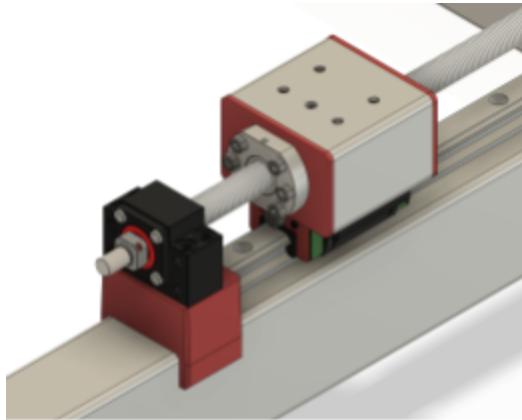


Figure 8.14

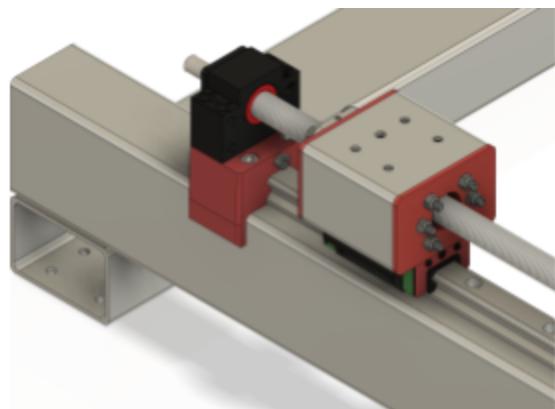


Figure 8.15

12. Finally install a BF12 onto the empty end of the ball screw.
13. Repeat previous 7 steps with other ball screw.
14. Install both BF12s onto their mounts using M6x50mm bolts. These screw directly into the plastic. **NOTE:** If you used PLA for the printed mounts be careful to screw the bolts in slowly so as not to cause the plastic to melt around the thread due to friction. To avoid this, you may wish to pre-thread the printed parts with a tap bit or by preinstalling an M6 bolt and removing it.
15. Install both BK12s onto their mounts using M6x50mm bolts. These screw directly into the plastic. **NOTE:** If you used PLA for the printed mounts be careful to screw the bolts in slowly so as not to cause the plastic to melt around the thread due to friction. To avoid this, you may wish to pre-thread the printed parts with a tap bit or by preinstalling an M6 bolt and removing it.
16. Bring the Y-Axis rollers as close as possible to the BK12 end of the rail as shown in Figure 8.16



Figure 8.16

9. Z-Axis Roller Beam Prep

Summary: Create **M6 threaded holes** and **M6.5 unthreaded holes**

Hardware Needed:

- Center punch
- Drill
- M5 Drill bit
- M6.5 Drill bit
- M6 Tap bit
- Pencil
- (2) Z-Axis roller beams - 130 mm
- Z-Axis Faceplate
- (8) M6x15mm Button Head Bolts
- ~6.5mm diameter marking tool (if used gently an M6.5 drill bit and a hammer can be used or a center punch with a compatible spacer)
- ~5mm diameter marking tool (if used gently an M5 drill bit and a hammer can be used or a center punch with a compatible spacer)
- (2) HGR20 Linear Rail
- M5x20mm bolts (comes with rail)

Printed Parts Needed:

- Assembly Tool #7 - X Axis Roller
- Assembly Tool #8 - Z Face/Rail Top
- Assembly Tool #9 - Z Face/Rail Bottom
- Center Line Marker Tool
-

When complete, verify:

-

Build Steps:

1. (Optional) Mark the side of each beam uniquely so they do not get mixed up. All figures in this section will be marked with a "T" and "B" on the side which will touch the faceplate for ease of interpreting.
2. Position the Center Line Marker Tool on the top face as shown in Figure 9.1.
3. Place a pencil or other marking tool at the center of the v shaped grove on the Center Line Marker Tool and hold it there securely.
4. Run the Center Line Marker Tool down the length of the beam while using the marking tool to mark the center. Measure your centerline at several places to ensure it is indeed properly centered.
5. Repeat previous 3 steps for the other Z-Axis roller beam.
6. Find and mark the center point on the lines on each of the faces marked above.
7. Position Assembly Tool #8 on the front face of the top Z-Axis roller beam with the number on the printed part facing the beam and all tabs securely holding position as shown in Figure 9.2.

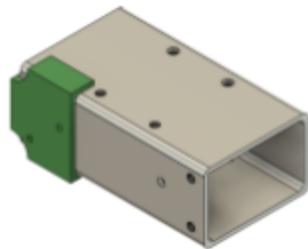


Figure 9.2

8. Mark all three holes with a center punch.
9. Position Assembly Tool #9 on the front face of the bottom Z-Axis roller beam with the number on the printed part facing the beam and all tabs securely holding position as shown in Figure 9.3.

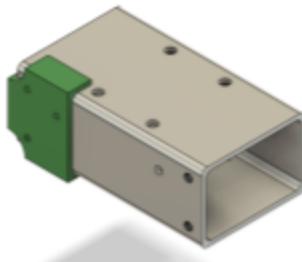


Figure 9.3

10. Mark all three holes with a center punch.
11. Drill the marked points on the ends both beams with an M5 drill bit. You should have created 4 M5 holes in total in this step.
12. Drill the marked points on the inside of both beams with an M6.5 drill bit. You should have created 2 M6.5 holes in total in this step.
13. Thread the 4 M5 holes created above with an M6 tap bit.
14. Position Assembly Tool #7 on the top or bottom face of a Z-Axis roller beam with the square hole in the center of the printed part aligned to the center mark made in step 9.6.
15. Mark the 4 circular holes with a center punch.
16. Repeat previous 2 steps for all top and bottom faces of both Z-Axis roller beams.
17. **ON BOTH BEAMS ONLY ON THE BOTTOM FACES** drill all four marked points of each Z-Axis roller beam with an M6.5 drill bit.
18. **ON THE BOTTOM BEAM ONLY ON THE TOP FACE** drill all four marked points with an M6.5 drill bit.
19. **ON THE TOP BEAM ONLY ON THE TOP FACE** drill **ONLY THE TWO POINTS AWAY FROM THE FACE MARKED** with an identifying letter with an M6.5 drill bit.
20. Drill the remaining two points on the top face with an M5 drill bit.
21. Thread the two holes made in the previous step with an M6 tap bit.
22. Mount the top and bottom roller beams onto the Z-Axis faceplate using 4 M6x15mm button head bolts as shown in Figure 9.4.

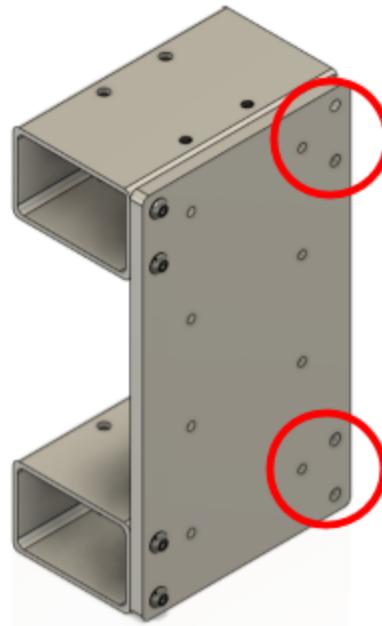


Figure 9.4

23. Get the top and bottom roller beams as parallel as possible.
24. Mark the 6 holes circled in Figure 9.4 with a self centering marking tool.
25. Dismount the top and bottom roller beams from the faceplate.
26. Drill the marked points on the ends both beams with an M5 drill bit. You should have created 4 M5 holes in total in this step.
27. Drill the marked points on the inside of both beams with an M6.5 drill bit. You should have created 2 M6.5 holes in total in this step.
28. Thread the 4 M5 holes created above with an M6 tap bit.
29. Remount the top and bottom roller beams onto the Z-Axis faceplate using 8 M6x15mm button head bolts.
30. Mount HGR20 rail on the Z-Axis faceplate using M5x20mm bolts as shown in Figure 9.5.

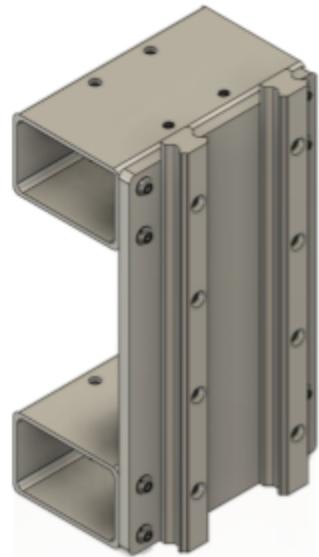


Figure 9.5

31. Mount the HGW20 block to the inside faces of top and bottom beams using the M6x20mm button head bolts as shown in Figure 9.6 and 9.7.

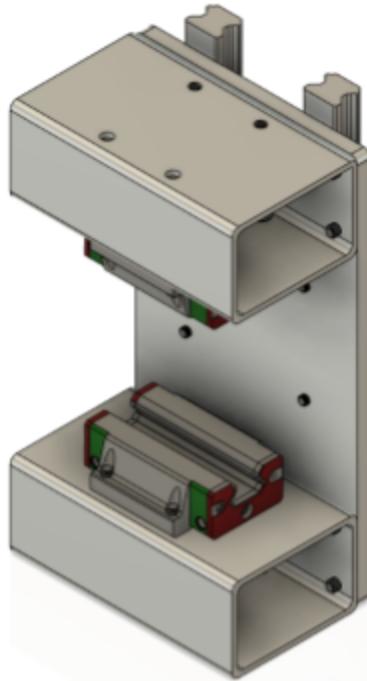


Figure 9.6

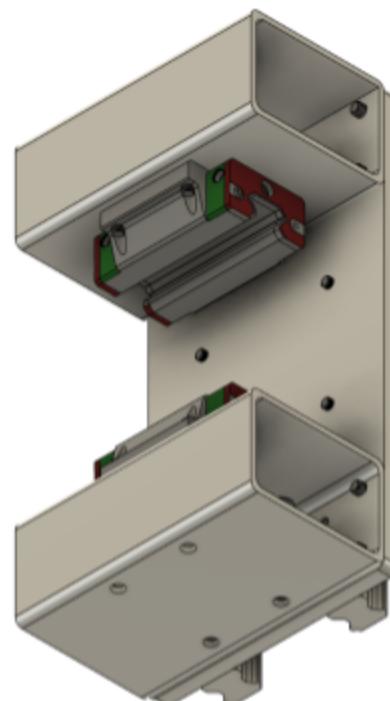


Figure 9.7



10. X-Axis Gantry Prep

Summary: Create **M6 threaded holes** and **M6.5 unthreaded holes**

Hardware Needed:

- Assembled frame from step 8
- Prepared Z-Axis Faceplate from step 9
- X-Axis gantry beam
- Double sided tape
- Center punch
- ~6mm diameter marking tool (if used gently an M6 bit and a hammer can be used or a center punch with a compatible spacer)

Printed Parts Needed:

- Assembly Tool #6 - X Gantry
-

When complete, verify:

-

Build Steps:

1. The X-Axis gantry components need to be testfit in order to find the locations they will be affixed. To begin, place the gantry beam on the Y-Axis roller beams in the frame completed in step 8.
2. Place one HGR20 rail on the top surface and position a BK12 mount and a BF12 mount around it. Finally, place a X-Axis motor mount on the beam and reposition all components until desired configuration is found. Figure 10.1 shows an example of this process with the NEMA 17 dual motor option.

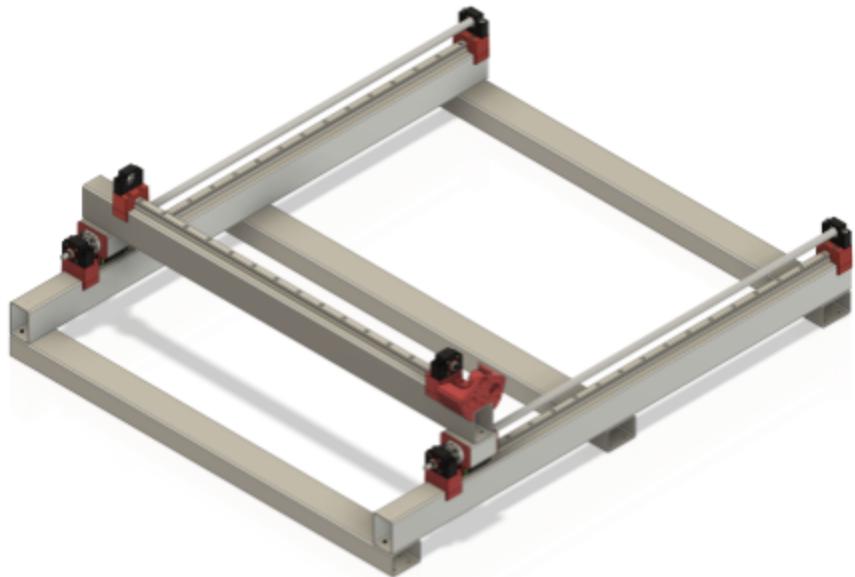


Figure 10.1

3. Ensure the BF12 mount is oriented correctly, as shown in Figure 10.2. The three counterbored holes make a triangle pattern pointing away from the HGR20 rail.

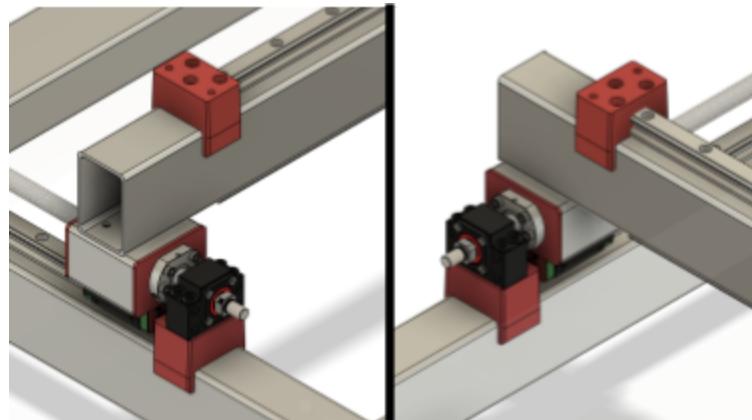


Figure 10.2

4. Mark the three counterbored holes with your marking tool. Ensure the marks are adequately centered. If you're doing this with a drill bit, be careful to hit the bit very lightly.
5. Ensure the BK12 mount is oriented correctly. The three counterbored holes should form an arrow pointing away from the HGR20 rail as shown in Figure 10.3.

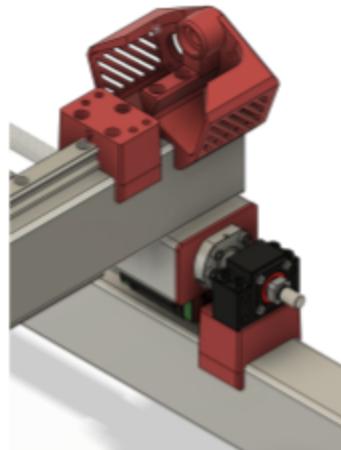


Figure 10.3

6. Mark the three counterbored holes with your marking tool. Ensure the marks are adequately centered. If you're doing this with a drill bit, be careful to hit the bit very lightly.
7. Ensure the motor mount is oriented correctly. If you are using the dual NEMA 17 mount it should be oriented as shown in Figure 10.3. If you are using the NEMA 23 mount it should be oriented as shown in Figure 10.4.

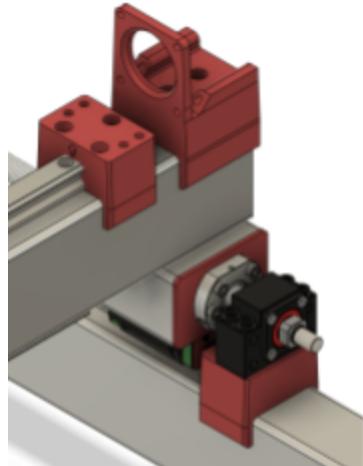


Figure 10.4

8. Mark the two counterbored holes with your marking tool. Ensure the marks are adequately centered. If you're doing this with a drill bit, be careful to hit the bit very lightly.
9. Mark the positions of the BK12 mount and BF12 mount on the gantry where they meet the HGR20 rail.
10. Dismount all components and remove the rail from the frame assembly.
11. Drill all points marked above with an M5 bit.
12. Thread all holes made in the previous step with an M6 tap bit.
13. Place Assembly Tool #6 on the Y-Axis roller as shown in Figure 10.5. Ensure all holes on the assembly tool align to the holes already existing in the Y-Axis roller beam.
14. Place a piece of double sided tape on the assembly tool.
15. Place the X-Axis gantry beam back in position it aligns with the Y-Axis roller beams. The double sided tape should stick to the gantry beam and hold the position of the assembly tool.
16. Gently lift the gantry and assembly tool so their relative positions do not shift.
17. Mark the 5 holes with a center punch.
18. Repeat previous 5 steps on the other Y-Axis roller and unmarked end of the X-Axis gantry beam.
19. Drill all marked points with an M6.5 bit.

11.X-Axis Gantry HGR20 Mount

Summary: Create **M6 threaded holes** and **M6.5 unthreaded holes**

Hardware Needed:

- X-Axis gantry beam
- (2) HRG20 rail
- Center punch
- ~6mm diameter marking tool (if used gently an M6 drill bit and a hammer can be used or a center punch with a compatible spacer)

Printed Parts Needed:

- Center Line Marker Tool
-

When complete, verify:

-

Build Steps:

1. Position the Center Line Marker Tool on the top face of the gantry beam as shown in Figure 11.1.
2. Place a pencil or other marking tool at the center of the v shaped groove on the Center Line Marker Tool and hold it there securely.
3. Run the Center Line Marker Tool down the length of the beam while using the marking tool to mark the center. Measure your centerline at several places to ensure it is indeed properly centered.
4. Flip the beam over and repeat previous 3 steps for the underside of the gantry beam.
5. Position HGR20 rail on the top face within the marks made in step 10.9.
6. Ensure the HGR20 rail is centered on the X-Axis gantry beam. Use the center line to validate.
7. Using the 6mm marking tool, mark the center of the first and last holes in the HGR20 rail.
8. Flip the beam over and repeat the last 2 steps for the underside of the gantry beam.
9. Drill the points marked in the last two steps on both sides of the gantry beam with an M4.2 bit.
10. Thread the holes made in the previous step with an M5 tap bit.
11. Remount the HGR20 rails and install M5xmm bolts into the holes made in the previous step.
12. Using the bolts installed above as soft anchors, mark the remaining mounting holes on the HGR20 rail. Ensure the rail maintains centered and positioned correctly throughout the entire marking process.
13. Remove the bolts and dismount the HGR20 rail again.
14. Drill the points marked in step 11.12 on both sides of the gantry beam with an M4.2 bit
15. Thread the holes made in the previous step with an M5 tap bit.
16. Remount the HGR20 rails and loosely install all M5xmm bolts.

12.X-Axis Gantry Assembly

Summary: Create **M6 threaded holes** and **M6.5 unthreaded holes**

Hardware Needed:

- Prepared Z-Axis Faceplate from step 9
- Prepared X-Axis gantry beam with HGR20 rails mounted from step 16
- Assembled frame from step 8

Printed Parts Needed:

- Center Line Marker Tool
-

When complete, verify:

-

Build Steps:

1. Place the X-Axis gantry beam with the HGR20 rail attached onto the Y-Axis roller beams on the frame.
2. The HGR20 rail should be lightly attached to the X-Axis gantry so that it can be wiggled without much force.
3. Slide the assembled Z-Axis onto the X-Axis gantry HGR20 rail as shown in Figure 12.1.

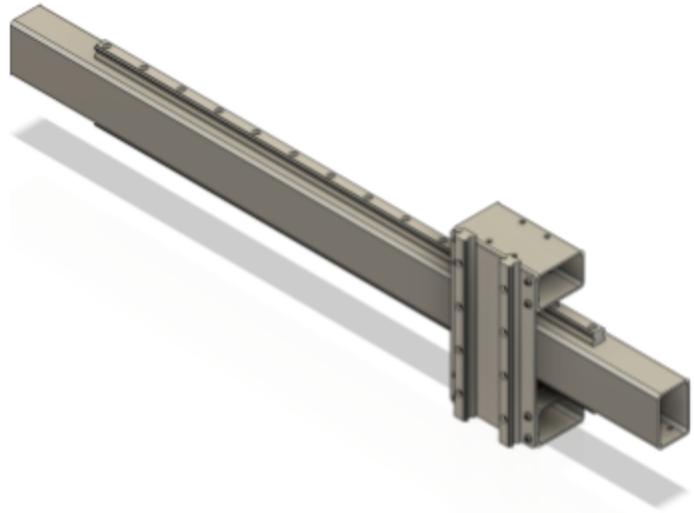


Figure 12.1

4. Slide the Z-Axis assembly back and forth across the X-Axis rails to self align. You may need to readjust the bolts holding the HGW blocks on the Z-Axis.
5. Tighten the bolts on the X-Axis gantry HGR20 rail as you slide the Z-Axis assembly back and forth. When all the bolts on the HGR20 are tightened the Z-Axis should be able to smoothly slide along the X-Axis gantry.
6. Attach the X-Axis gantry to the Y-Axis rollers as shown in Figure 12.2 using M6x10mm button head bolts on both ends. You will need to put a long allen key through the M6 threaded holes created for mounting the BK12, BF12, and X-Axis motor to access the bolts.



Figure 12.2

7. Install the BF12 mount onto the tapped holes using M6x40mm bolts.
8. Install the BK12 mount onto the tapped holes using M6x40mm bolts.
9. Insert a ball screw into a BK12 oriented as shown in Figures 12.3, 12.4, and 12.5. You will likely need to lubricate the ball screw and the bearing inside the BK12 and gently persuade the BK12 on. Be very careful to maintain proper alignment as the low tolerances mean any misalignment will cause the parts to jam and become damage.

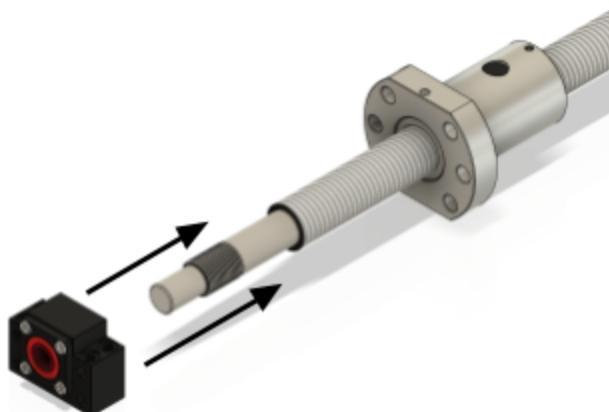


Figure 12.3



Figure 12.4

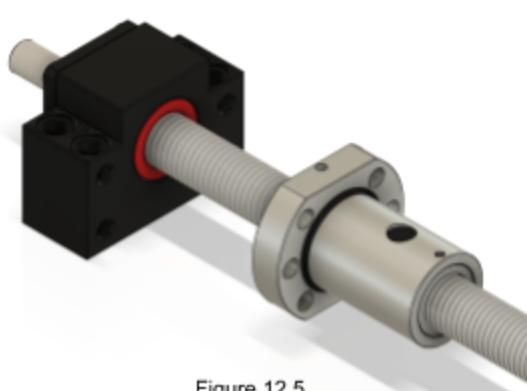


Figure 12.5

10. Screw the retainer nut onto the ball screw behind the BK12 as shown in Figure 12.6 and 12.7. Ensure it is securely tightened against the BK12.

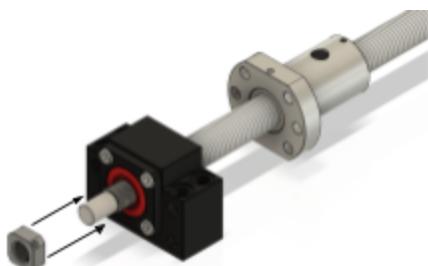


Figure 12.6

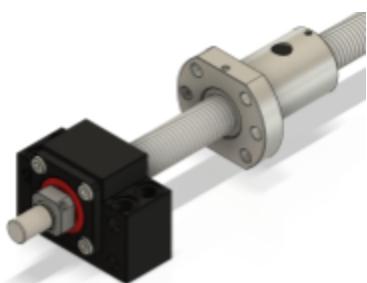


Figure 12.7

11. Tighten the set screw in the retainer nut so the retainer nut can no longer move.
12. Place the Ball Screw Face Plate Front directly behind the ball screw nut as shown in Figures 12.8 and 12.9.

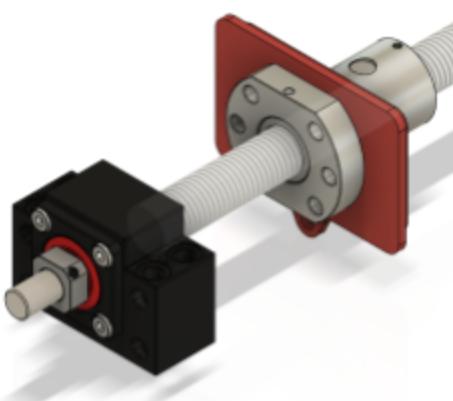


Figure 12.8

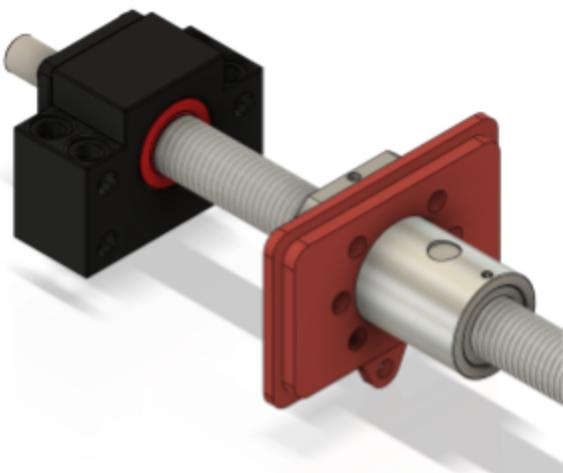


Figure 12.9

13. Pass the empty end of the ball screw through the top X-Axis roller beam, the result should look like Figure 12.10 and 12.11.

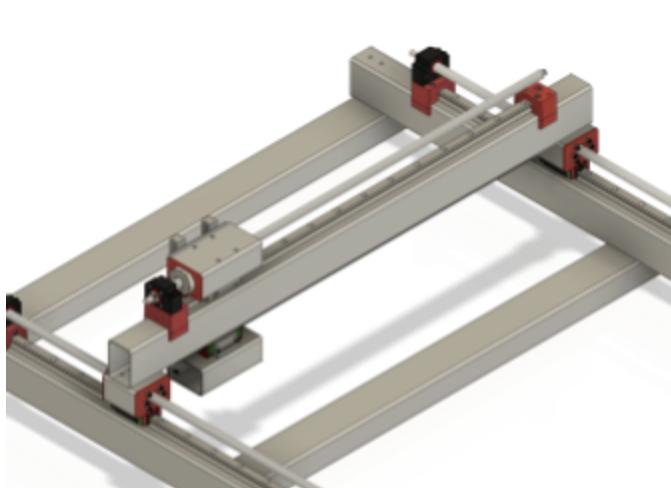


Figure 12.10

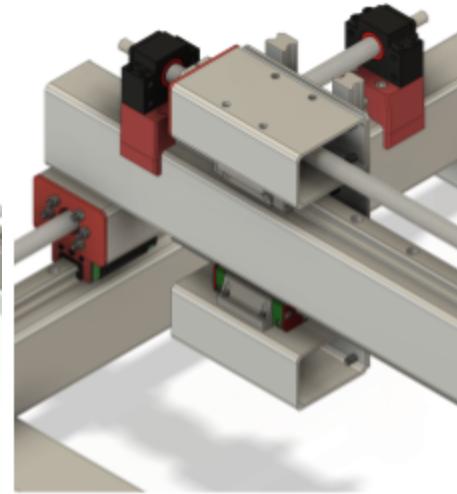


Figure 12.11

14. Pass the inset face of the Ball Screw Face Plate Rear over the unused side of the ball screw and slide it all the way up the screw. Insert the inset side of the printed part into the X-Axis roller beam as shown in Figure 12.12.

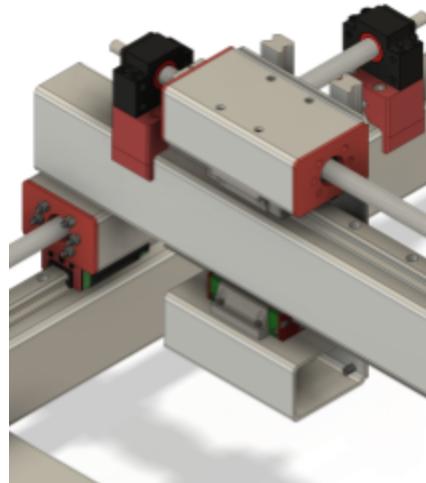


Figure 12.12

15. Attach the ball screw nut to the X-Axis roller assembly using M5 threaded rod, passing the bolts all the way through both printed plates. Attach M5 nuts both ends of the threaded rod as shown in Figure 12.13 and 12.14. Only screw these nuts finger tight as they will need to be removed again.

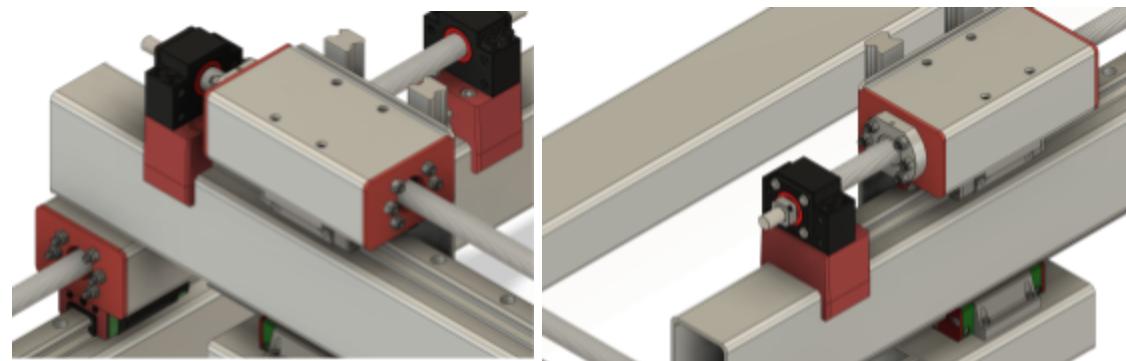


Figure 12.13

Figure 12.14

16. Finally install a BF12 onto the empty end of the ball screw. Your assembly should look like Figure 12.15.

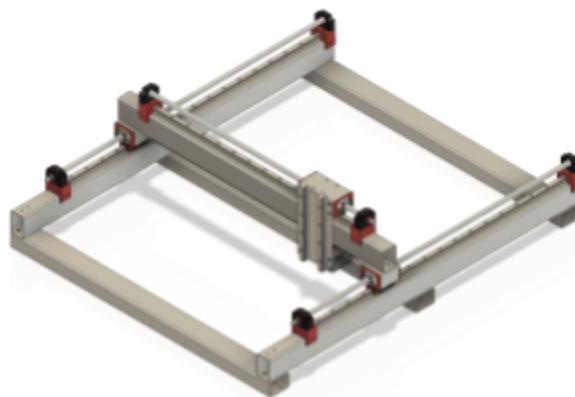


Figure 12.15

13.Z-Axis Motor Mount

Summary: Create **M6 threaded holes** and **M6.5 unthreaded holes**

Hardware Needed:

- Prepared frame from step 12
- 608 bearing
- Motor-to-T8 coupler
- (4) M3x10mm (NEMA 17 version only)
- (4) M5x20mm (NEMA 23 version only)

Printed Parts Needed:

- Z-Axis NEMA mount
- Bearing washer (NEMA 23 version only)
-

When complete, verify:

-

Build Steps:

1. Insert the 608 bearing into the Z-Axis NEMA mount as shown in Figure 13.1.

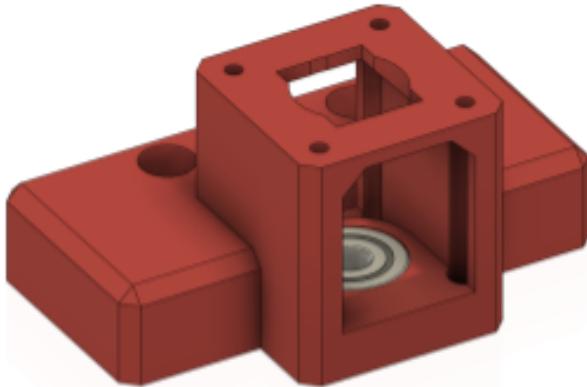


Figure 13.1

2. *NEMA 23 only* - Add the 3d printed washer to allow the bearing to support and rotate with the motor coupler.

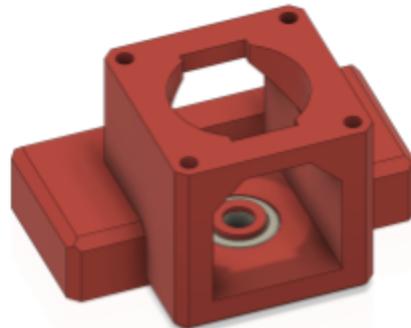


Figure 13.2

3. Place the coupler over the 608 bearing as shown in Figure 13.3. Ensure the coupler is oriented to accept the motor shaft on the top and the Z-Axis threaded rod below.



Figure 13.3

4. Place NEMA motor on mount and ensure the shaft seats into the coupler.
5. Tighten the set screw on the motor end of the coupler to affix it to the motor shaft.
6. Insert motor mounting screws. For the NEMA 17 version these will be M3x10mm bolts inserted into the motor through the holes on the bottom of the printed part. These are marked in Figure 13.4. For the NEMA 23 version these will be M5x20mm bolts inserted through the motor into the 3d printed motor mount from above as shown in Figure 13.5

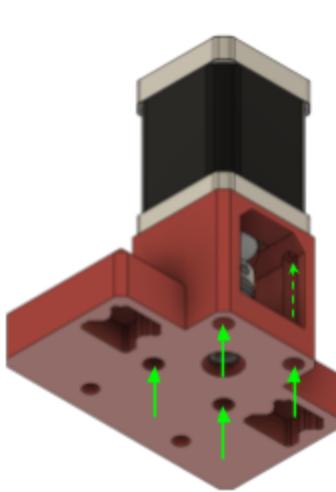


Figure 13.4 - NEMA 17

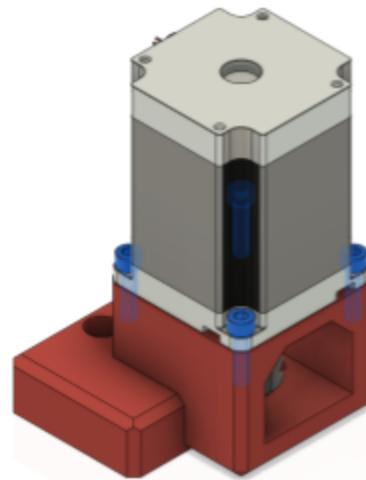


Figure 13.5 - NEMA 23

7. Install the assembled mount onto the Z-Axis assembly. Ensure the HGR20 rail fully seats into the slots on the underside of the mount.

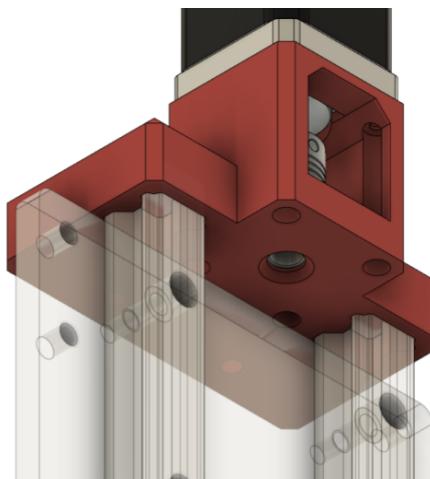


Figure 13.6

8. Secure the mount to the Z-Axis assembly with two M6x30mm bolts as shown in Figure 13.7.

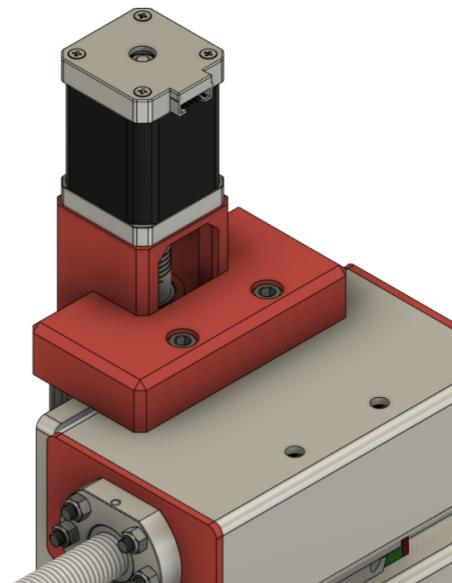


Figure 13.7

14.Z-Axis Mechanics Assembly

Summary: Create **M6 threaded holes** and **M6.5 unthreaded holes**

Hardware Needed:

- Prepared frame from step 13
- T8 threaded rod
- T8 nut
- Lighter or Blowtorch
- (2) HGW20 Block
- (4) M2x30mm bolts

Printed Parts Needed:

- T8 Riser
-

When complete, verify:

-

Build Steps:

1. Heat the T8 nut with the lighter or blowtorch and press fit it into the printed T8 riser.
2. Secure the T8 nut in place with 4 M2x30mm bolts.
3. Install the T8 threaded rod into the Z-Axis coupler and tighten the set screw to secure it.
4. Align the two HGW20 blocks on either side of the assembled T8 riser as shown in Figure 14.1.

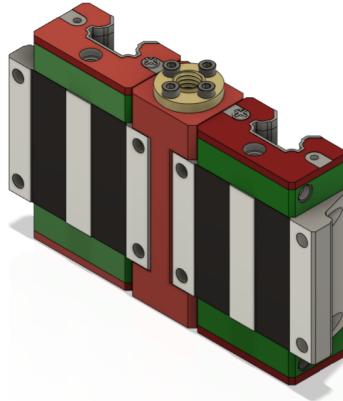


Figure 14.1

5. Slide the assembled T8 riser and HGW20 blocks onto the Z-Axis HGR20 rails from below as shown in Figure 14.2.

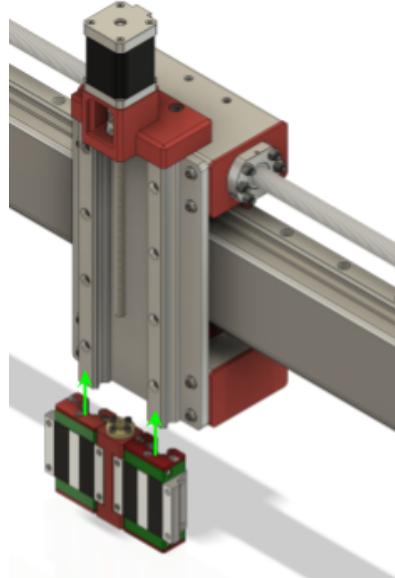


Figure 14.2