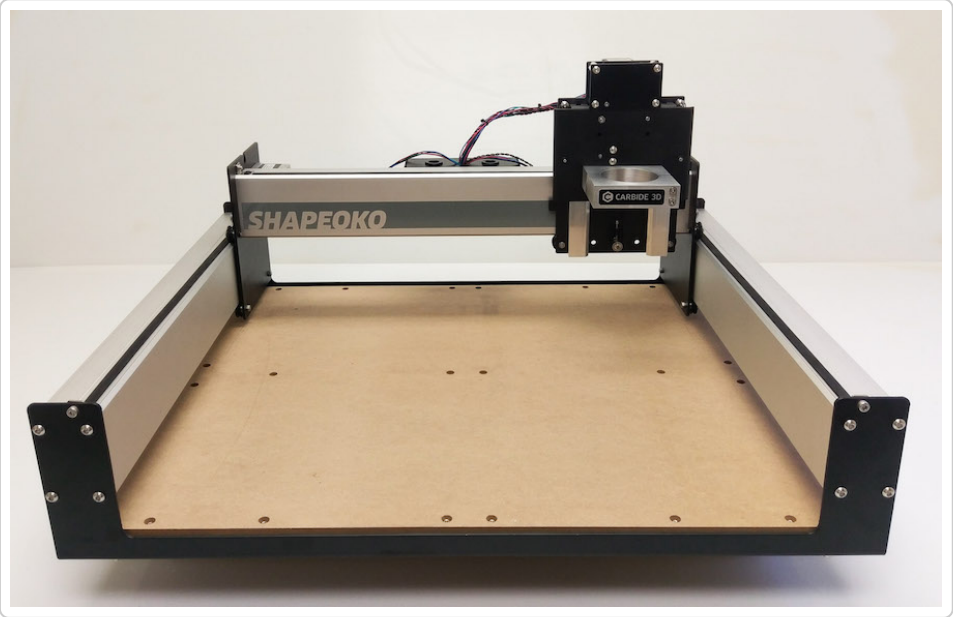
Shapeoko Assembly Guide (Original Full Kit)



Packing List

Package	Part	Qty	Description
Y-Axis Left Assembly	Y-Carriage (LEFT)	1	
Y-Axis Right Assembly	Y-Carriage (RIGHT)	1	
X/Z Assembly	X and Z Assembly	1	
Unlabeled wrapped cardboard	600mm Rail	3	1 rail has mounting holes for controller
Loose at bottom of box	Wasteboard	1	3/4 MDF wasteboard
Unlabeled wrapped box	End Plates	2	to secure Y-axis extrusions and wasteboard

Package	Part	Qty	Description
Standard Final Assembly	Final Assembly Box	1	Contains several parts, listed below

Standard Final Assembly box contents:

Part	Qty	Description
Power Supply	1	24V 5A with locking DIN connector
Power Cord	1	To connect power supply to mains
USB Cable	1	To connect controller to computer
Spindle Mount & Hardware	1	To hold router
Controller	1	Carbide Motion USB CNC controller, 2 M6 BHCS to secure to extrusion, 3 rubber grommets
6 Belt Clips with 6 M5 x 12	1 pack of 6	To Secure belting (M5x10 SHCS)
3 800mm Belts	3	800mm GT2 Belting for Y and X axis movement
4 Leveling Feet	4	install on underside of end plates
18 M5 x 20 - Base frame	1 Pack of 18	BHCS to Secure Wasteboard to Cross Straps

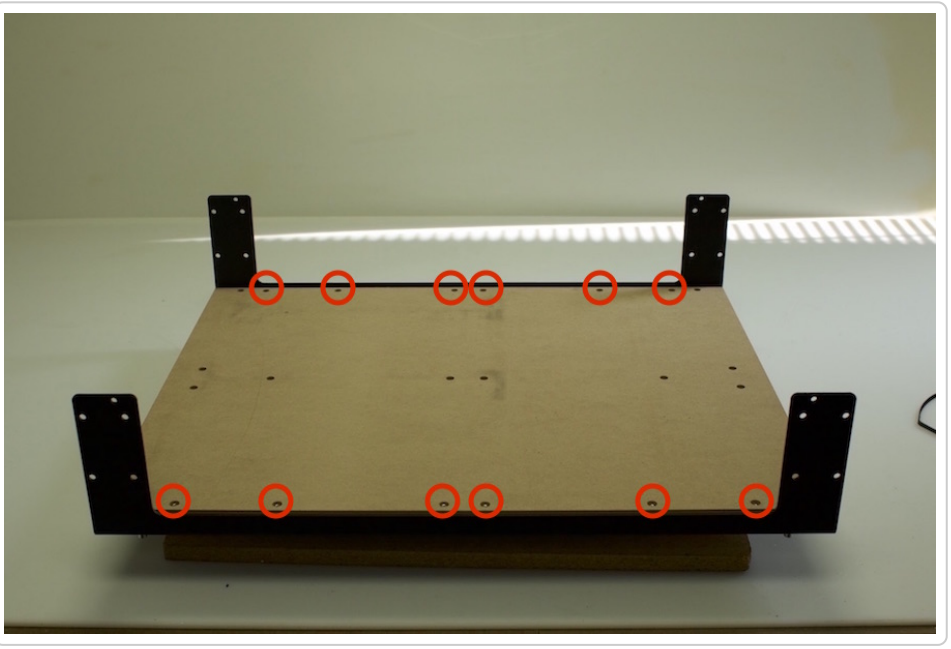
Part	Qty	Description
24 M6 x 12 - Extrusion Assembly	1 Pack of 24	BHCS to Secure plates to extrusions
Serial Tag	1	Serialized Tag and Carbide 3D Badge
Thread locker	1	for any hardware that may come loose
5 Mounts with 10 zip ties	1 pack	To secure wiring (in Homing switch bag)
Tool Kit	1	6 Allen Keys and 3 Single Use Wrenches to assemble machine
Sharpie	1	Black permanent marker

Additional hardware and descriptions

Part	Qty	Description
Homing switch kit	1	Includes mounts and small zip ties
M5x55 BHCS	2	To secure router
M5x16 BHCS	1 Pack of 2	To secure router mount to Z-plate
Zip ties	2	
#201 Square 1/4” endmill	1	Nomad Tools Carbide 3D endmill
Idler assembly	1	(in X/Z Assembly box)

Part	Qty	Description
Z-axis springs	2	(in X/Z Assembly box)
Z-axis 520mm endless GT2 belt	1	Installed on Z-axis Spindle Carriage Plate (in X/Z Assembly box)
M4 Z-axis tension bolt	1	M4 SHCS 25mm (installed on Z-axis)

Base Frame Assembly



Using the hardware found in the package labeled ‘WASTEBOARD’, assemble the base frame of the machine.

Note: There are 18 screws in the bag, but you will only be using 12.

Begin by installing the leveling feet in the corners of each End Plate. Set the 3/4” wasteboard across the front/rear plate.

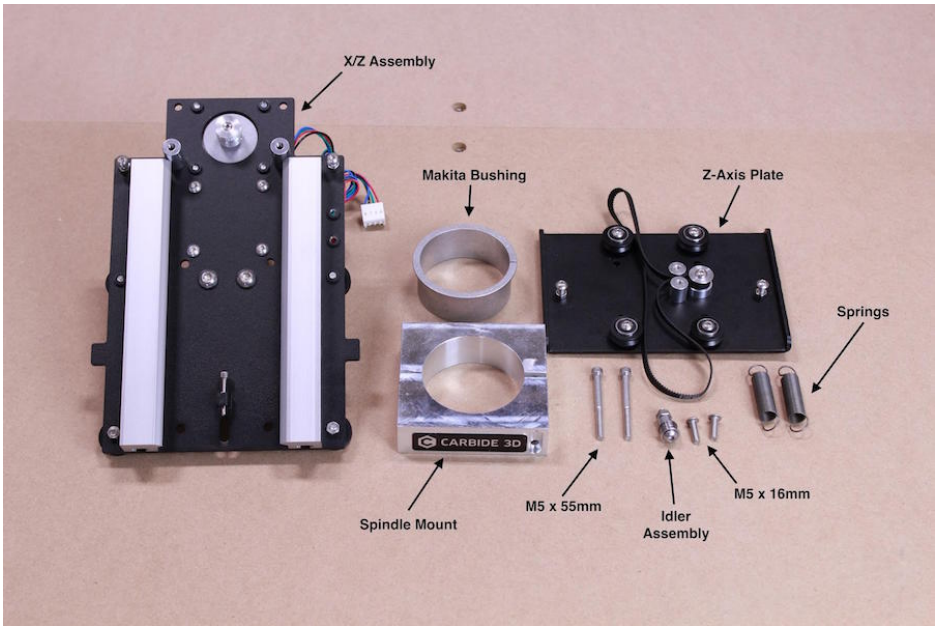
Loosely attach the wasteboard into the End Plates with the included M5x20mm screws. (Note: you will have 6 extra screws)

NOTE: *One side of the wasteboard has countersunk holes. This is the top. The countersinks are to provide clearance for the heads of the button head caps screws. Installing the wasteboard upside down will result in clearance issues with the hardware.*

XZ Assembly

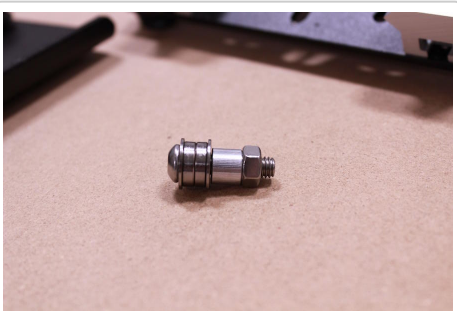
The X Carriage and Z Carriage are shipped together in the same box along with two small bags that contain two springs and the Idler Assembly.

The Z Carriage is the smaller of the two carriages shown in the image below. Carefully remove the Z Carriage from its protective wrapping; ensure that the belt is not damaged or removed from its initial installation location.



Install Idler

The Idler Assembly ships already assembled in the proper order. See the image below to verify the ordering of the various components.

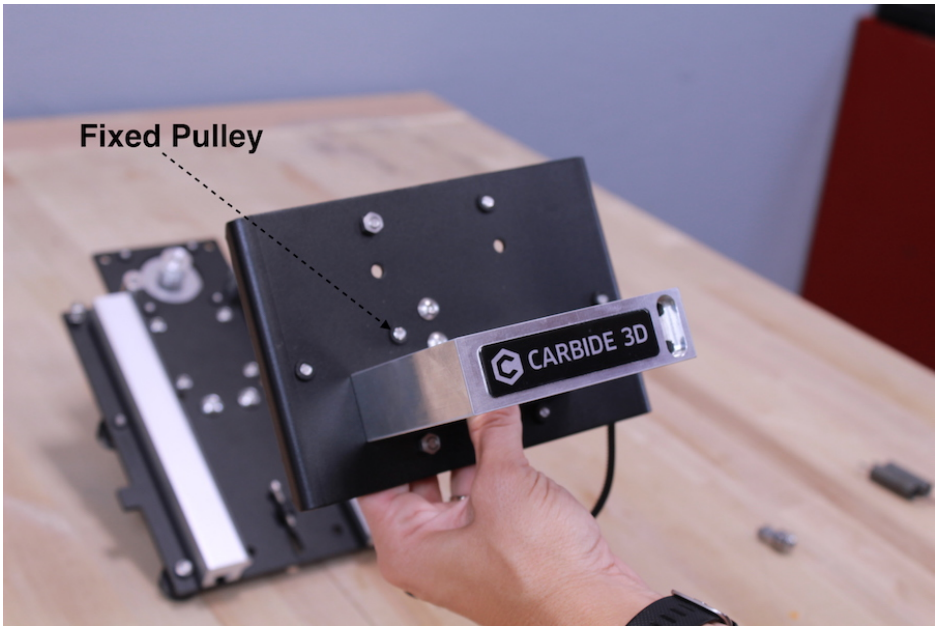


Carefully remove the nut while ensuring the remaining components stay on the bolt. Insert the bolt through the slot located at the bottom of the plate - shown in the image below. Secure in place by finger-tightening the nut on the opposite side of the X Carriage.

Once the idler assembly is through the slot, loosely attach the nut on the backside of the plate. Some

adjustability will be required to get the belt in place, so leave this lightly finger tight for the time being.

Install Spindle Mount



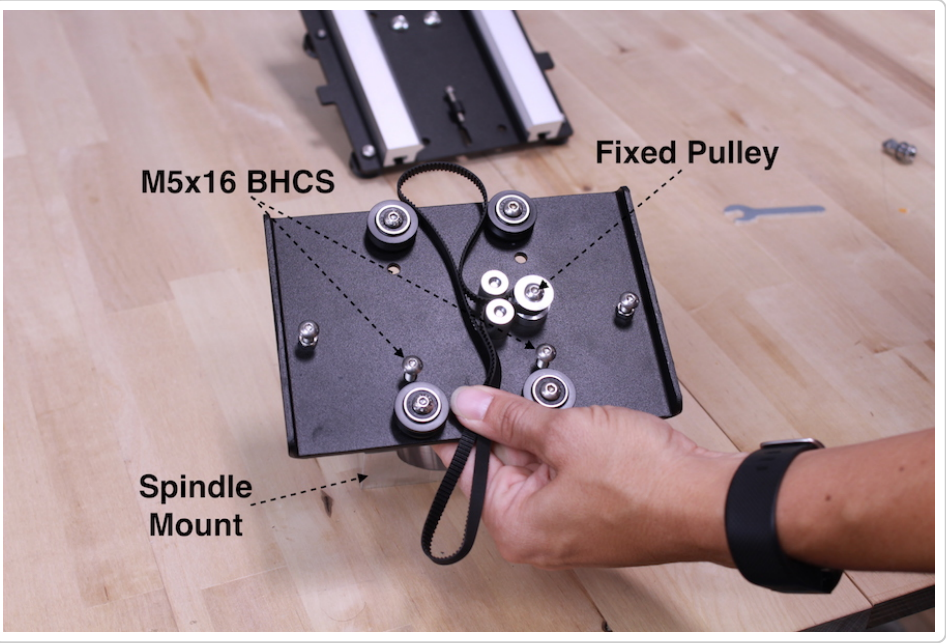
Align the spindle mount with the bottom set of through holes on the z-carriage. The Carbide 3D logo should go right side up, but the position of the pocketed hole on the spindle mount does not matter (left or right is fine).

The fixed pulley location `should` be on the left side of the plate, as shown in the photo. For further reference: the eccentric nuts will be on the left side as well.

> **NOTE:** If you were to install the Z-carriage backwards (with the screws on the right), the Z-axis will operate in reverse.

Turning the Z-carriage over, secure the spindle mount by installing (2x) of the M5x16mm screws through the back

of the plate and into the rear of the spindle mount.

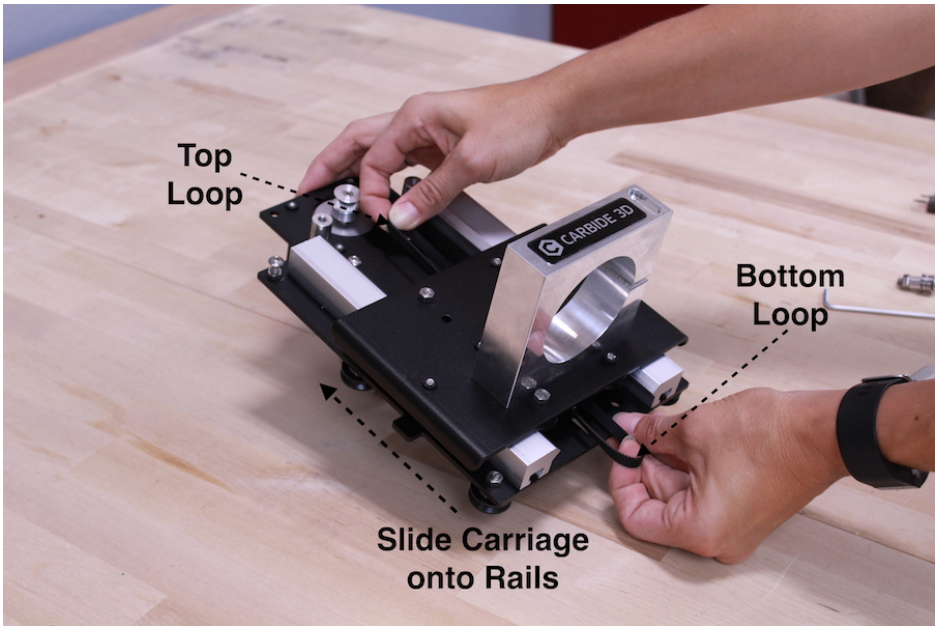


Tighten these screws down at this point in the assembly. Using some thread locker will help keep them secure and reduce the chance of vibration causing the screws to become loose.

Z-Carriage

Flip the Z Carriage and orient the Z Carriage so it is as shown in the image below.

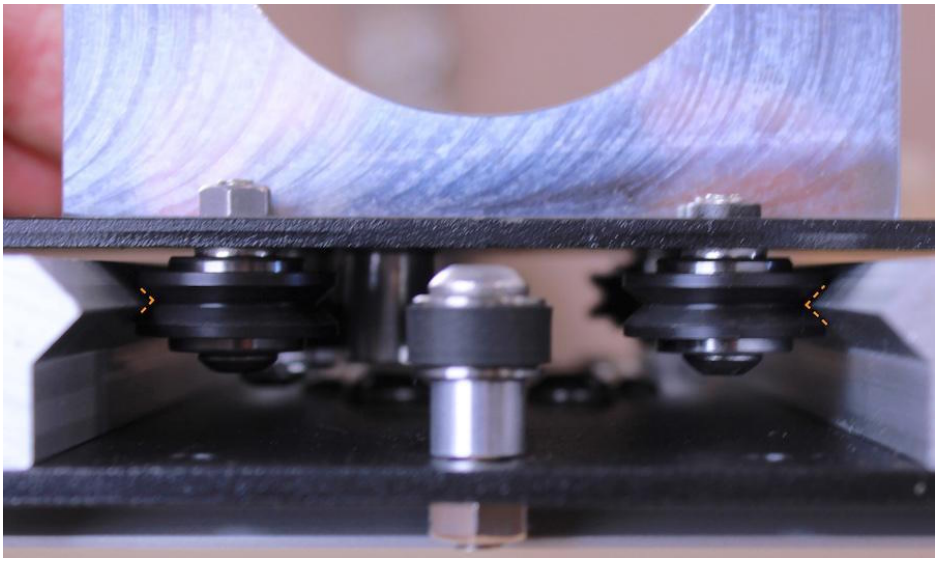
> **NOTE:** The bearings and belt will now be on the underside.



Align the Z-carriage with the bottom of the X-carriage, making sure the eccentrics on the Z-carriage are positioned on the left side, as shown in the image below.

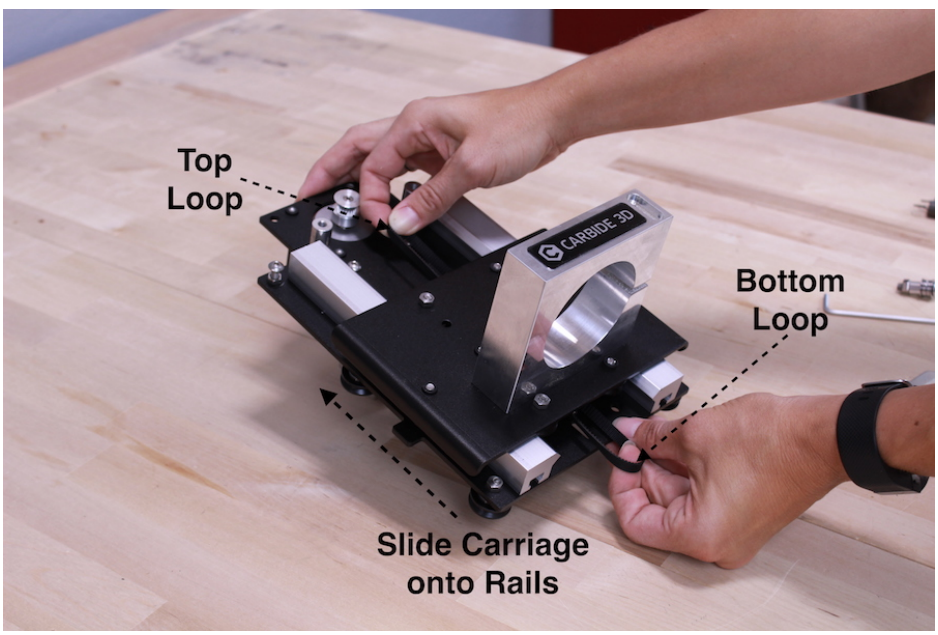
When aligning the carriages, make sure the groove in the V-wheel is aligned with V-rail on the X-carriage. The wheels will slide up the V, seating evenly and securely on both sides.

Examine the four bearings on the Z Carriage and take note of the V-shaped gap between the two black wheels as shown in the image below.

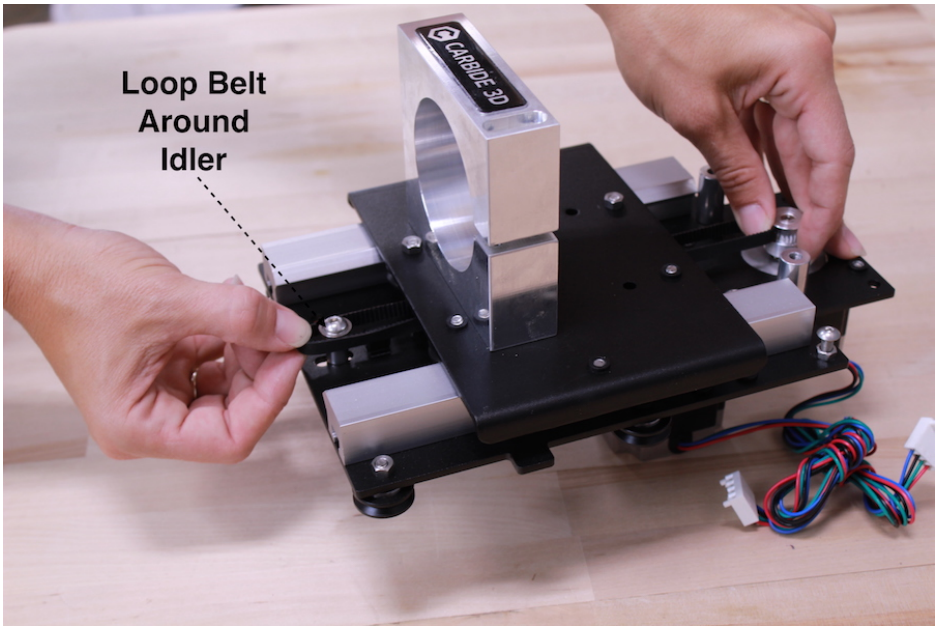


Routing the Belt

When the Z Carriage is attached to the rails properly, a portion of the belt should be exiting the top and bottom of the Z Carriage as shown in the image below.

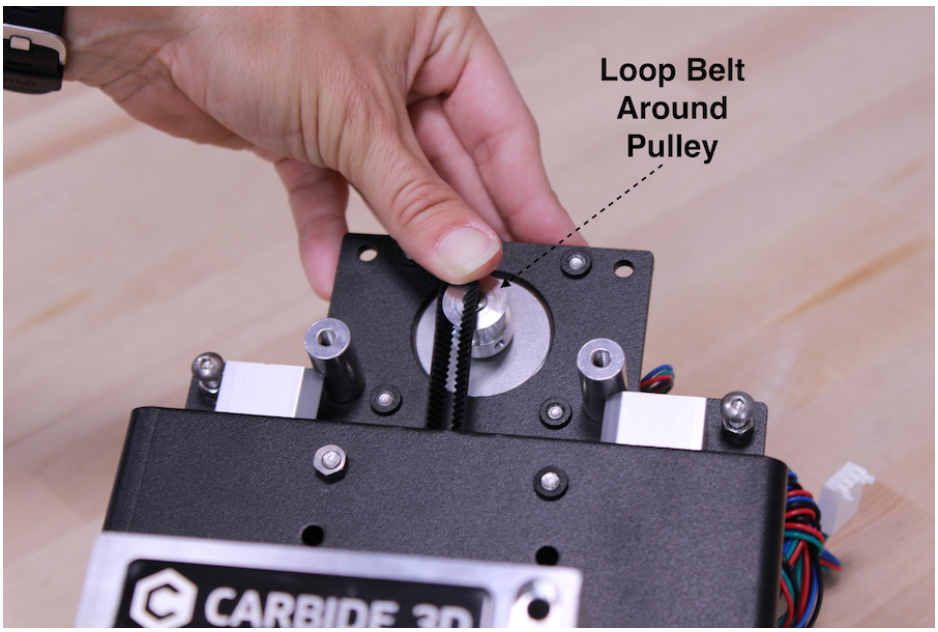


Slowly pull the bottom portion of the belt and loop it over the Idler as shown.



The Idler can move up and down in its groove. You may have to loosen the nut to move the Idler.

Carefully wrap the upper portion of the belt around the top pulley as shown.

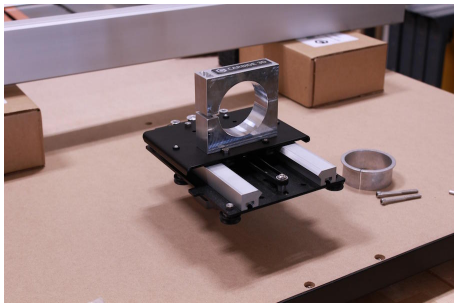


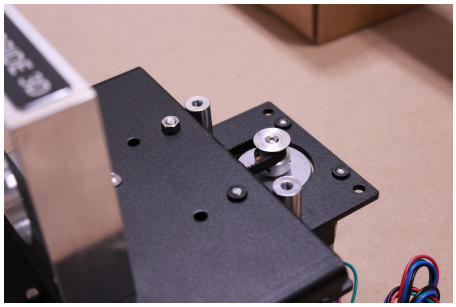
NOTE: If you had to loosen the Idler nut to move it, move the Idler down to provide some tension on the

belt and finger-tighten again so the belt does not come off the Idler.

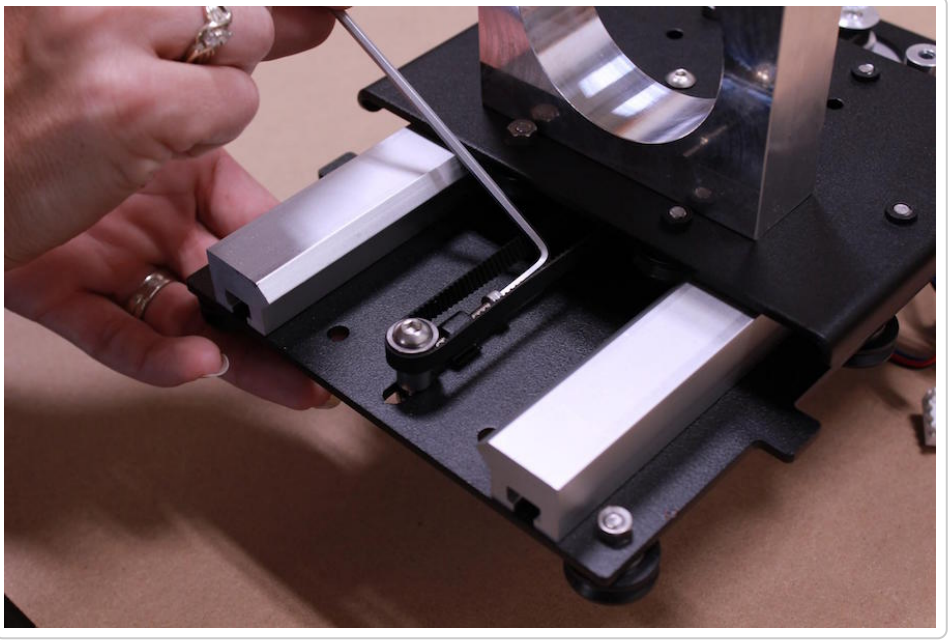
Tension Screw

Carefully place the X/Z Carriage on its back (resting on the motor) as shown in the image below. Slide the Z Carriage all the way to the top until it stops at the two posts shown in the image below.





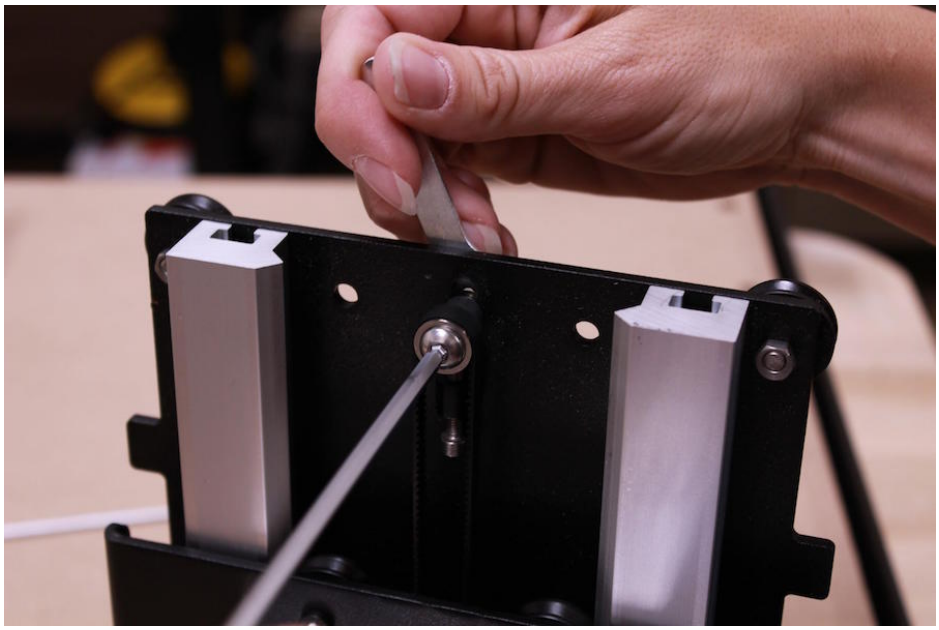
Ensure that you have only finger-tightened the Idler Assembly before tightening the Tensioning Screw.



Use the hex wrench to tighten the Tensioning Screw as shown in the image below. As the Tensioning Screw is tightened, it will push on the Idler Assembly.

The belt should be tight enough that it doesn't slip off the Idler and does not flex as the carriage moves up and down.

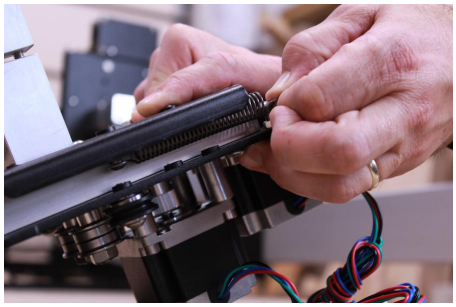
When the belt is tight, use a 4mm hex key and 10mm wrench to tighten the Idler Assembly as shown in the image below.



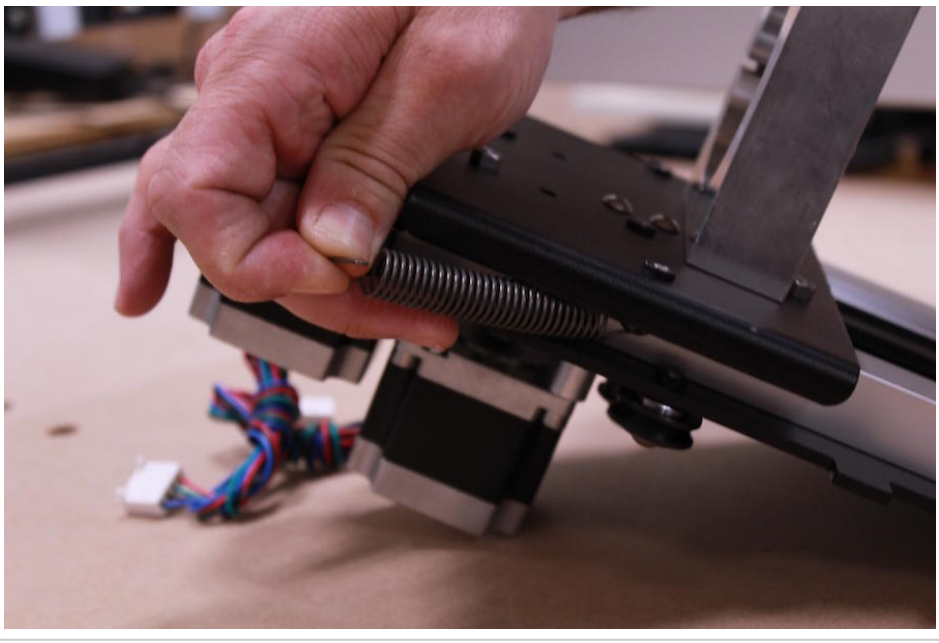
Install Springs

Lay the X/Z Carriage on one of its sides as shown in the image below. Place one of the spring's loops around the Z Carriage post as shown in the image below.

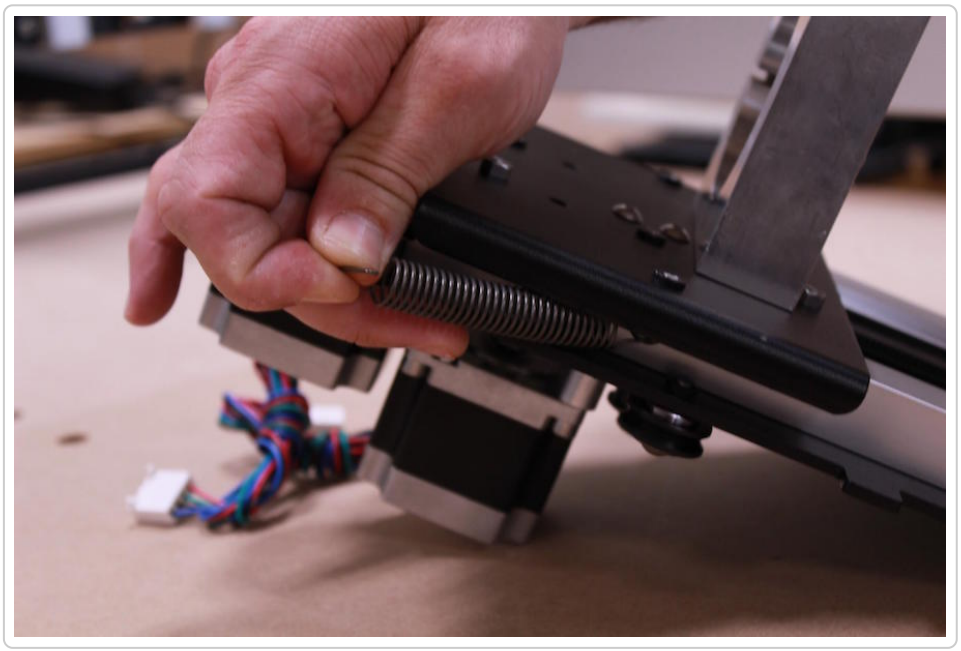
Pull up on the spring and attach the other loop to the X Carriage post as shown in the image below.



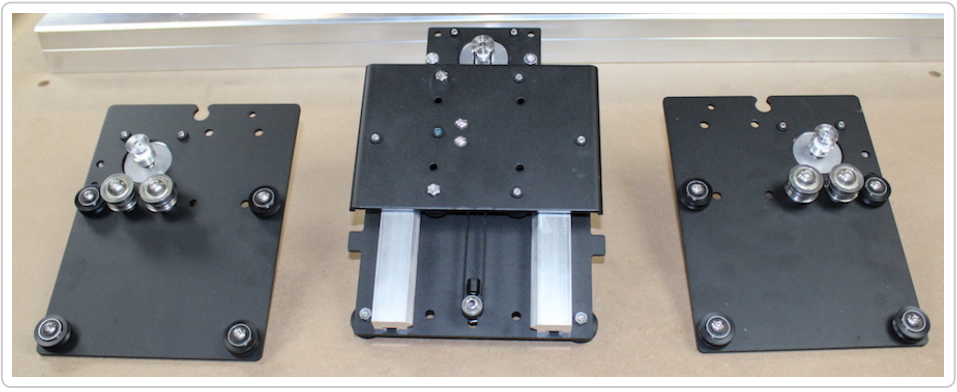
Turn the X/Z Carriage on its other side and attach second spring in identical manner as shown in the image below.



Using the 2x M5x55mm screws, install into spindle mount. Do not tighten at this point, we will secure these screws after we install the spindle later in this guide.



Preparing the Plates



Open the Left and Right Y-Axis carriages and the X/Z carriage. Set carriages on the table as shown.

The 3 carriages are shipped to you as complete sub-assemblies. Thread locker has already been used on all threaded connections.

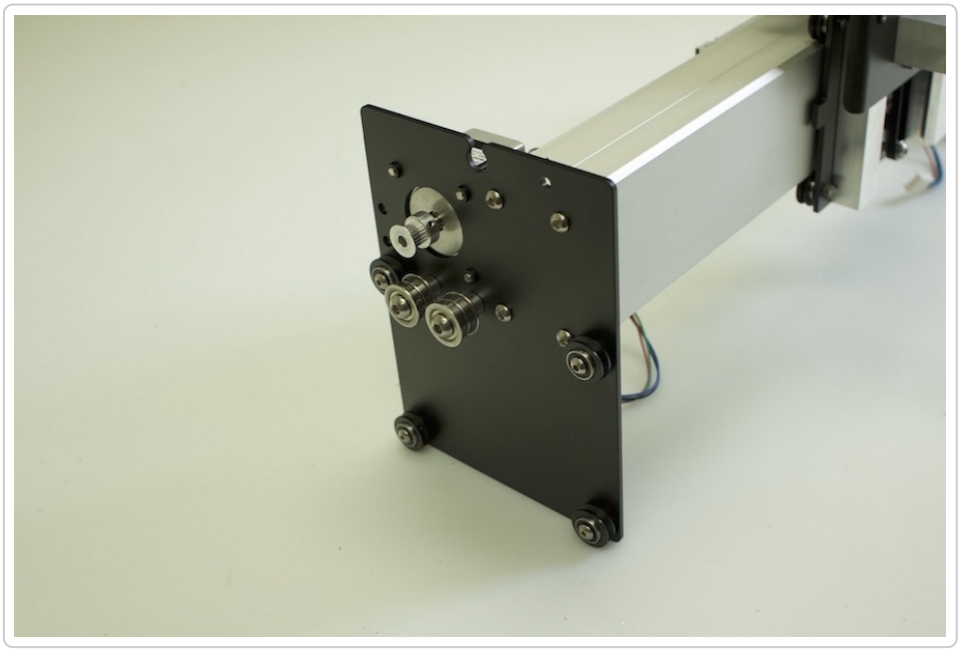
Eccentric Nuts

Before proceeding, turn the eccentric nuts so the wheels are at their widest position.

Rotate the nut clockwise until the screw is at the most bottom point of the rotation. as shown in the image below. It is important to only rotate the nuts clockwise. If you rotate the nut counter-clockwise you risk loosening the bolted connection.

Adjust the eccentric nuts for all 3 of the plates (6 eccentrics total).

Installing the Left Y-Carriage



In this step, you will be installing the extrusion with the threaded mounting holes on the back side!

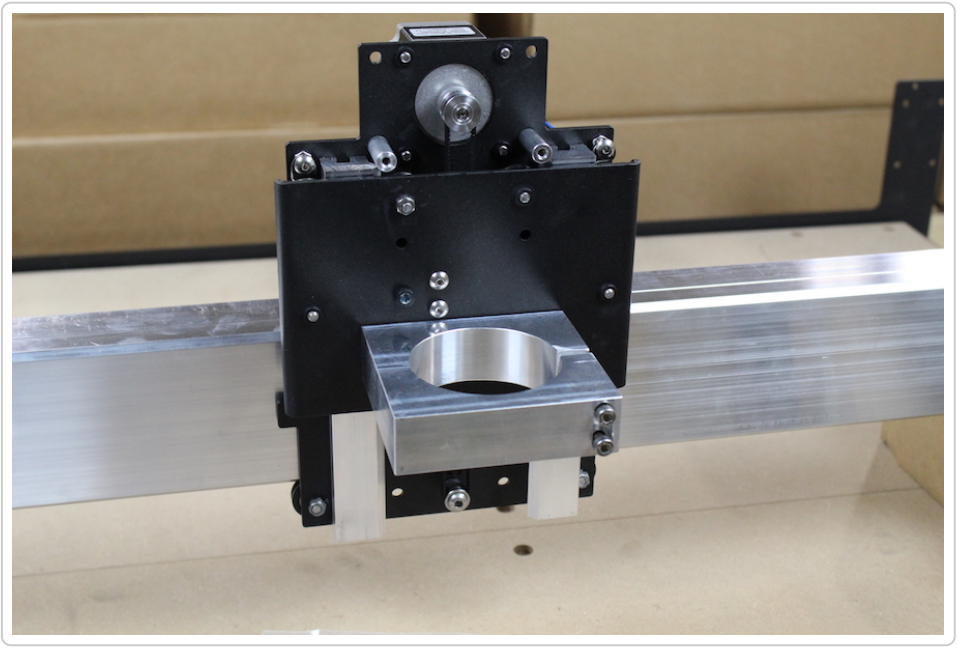
The bag labeled ‘extrusions’ contains 24 pieces of M6x12mm button head cap screws. These screws are used to attach the carriages, and the base frame to the extrusions. These screws require the 4mm hex key.

NOTE: *the V-rail on the extrusion should be facing the front, with the stepper motor on the opposite side.*

Using 4 pieces of M6x12mm screws, attach the left Y-Axis plate to the X-axis rail by installing the screws through the 4 open holes on the assembly. Be careful not to cross-thread the screws as you install them.

Using the carriage boxes as supports at each end of the rail will help hold the rail at the proper height for you to install the screws. You don’t need to tighten these screws all the way. We’ll do that in the ‘squaring the machine’ section.

Installing the X/Z Carriage

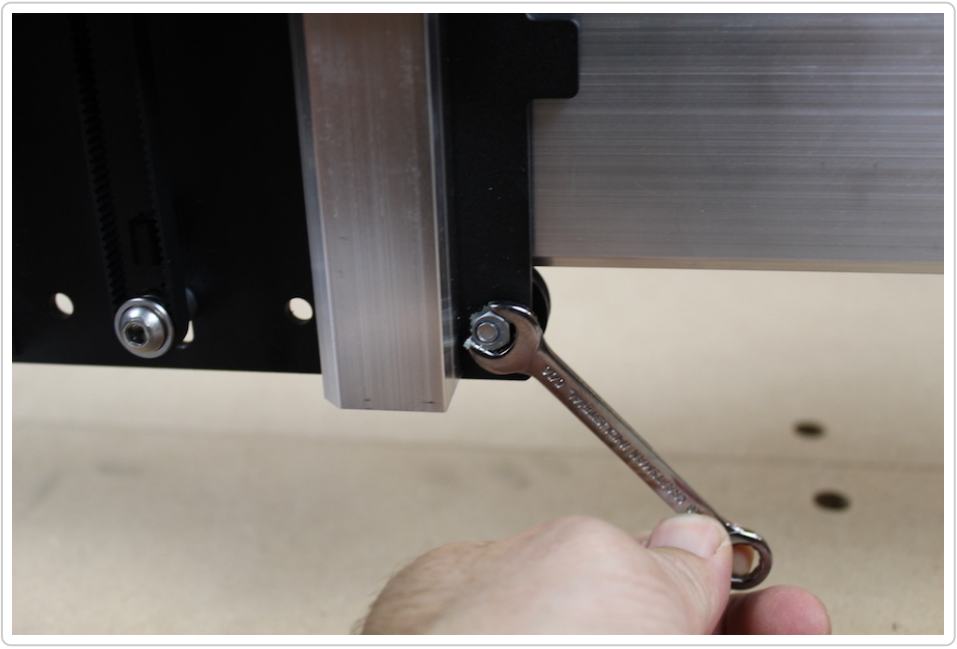


Slide the X/Z Carriage on the rail from the right hand side. Because the V-wheels will be as loose as they can, the carriage will slide easily down the rail — be careful not to tip the rail too high causing the carriage to slam into the left Y plate.

Tension the V-Wheels

Once the carriage is on the rail, support the right end with another 9x7x4 box and center the carriage on the rail.

Using the M8 (or 5/16”) wrench, turn the eccentric nuts clockwise until the wheels engage with the rail. The eccentric nuts should be in the position shown in the following image.

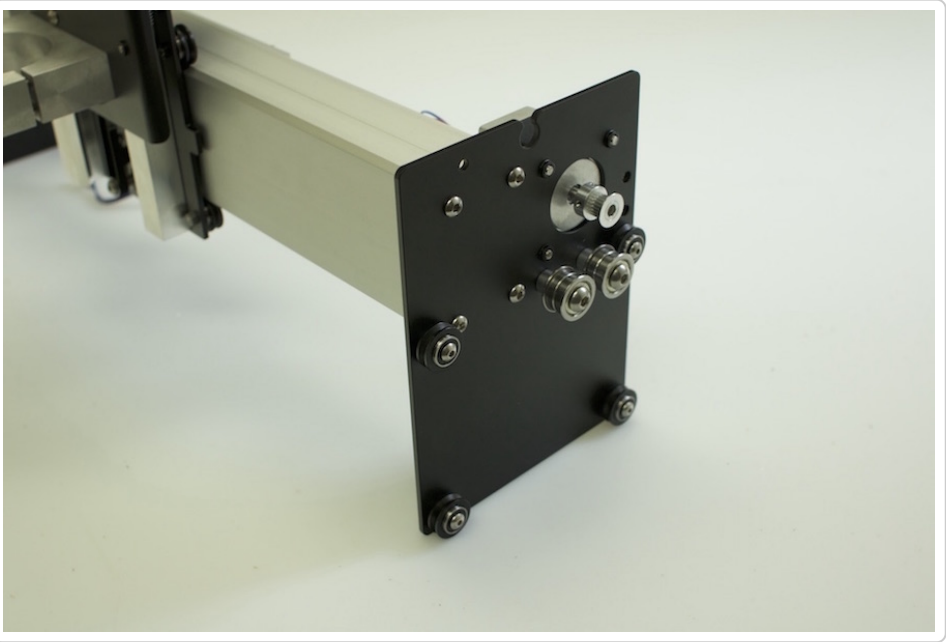


You do not need much tension in order for the carriage to be secure. The wheels should only be snug against the rail.

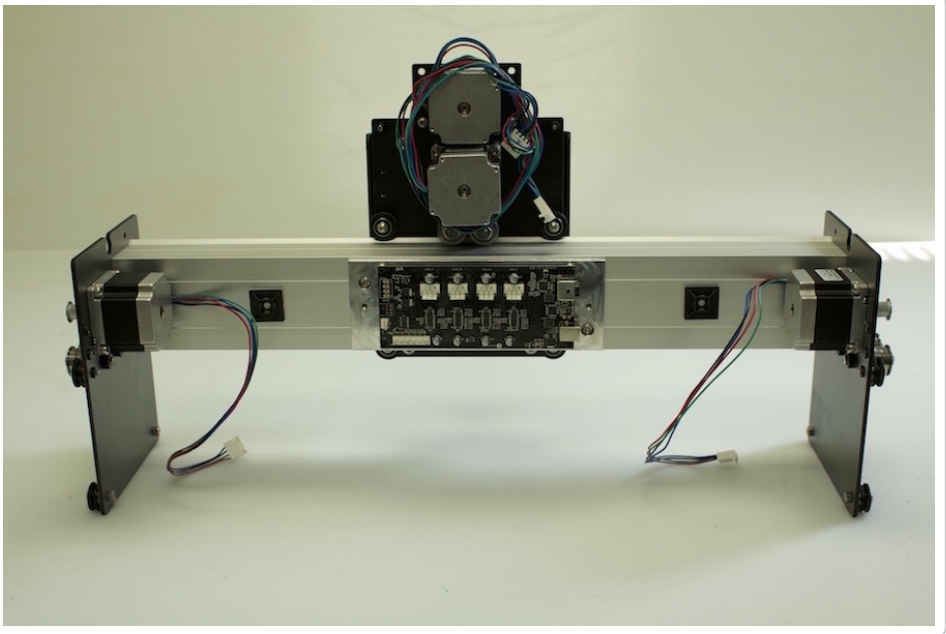
After tensioning, the carriage should still slide smoothly across the rail, with only slightly more resistance than without the wheels tightened. The travel should be smooth and ‘bump’ free.

Using the M6x12mm screws (from the bag labeled ‘extrusions’), install the right Y carriage to the right end of the X-Axis rail. Using the Y-Right Box to support the rail will help prevent the X/Z carriage from sliding around as you work.

Installing the Right Carriage

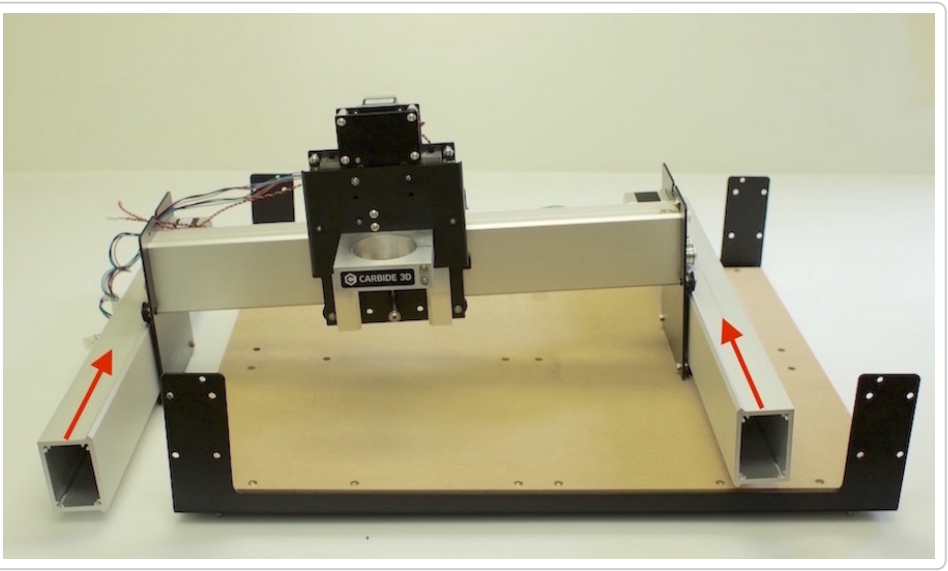


The gantry is now completely assembled.

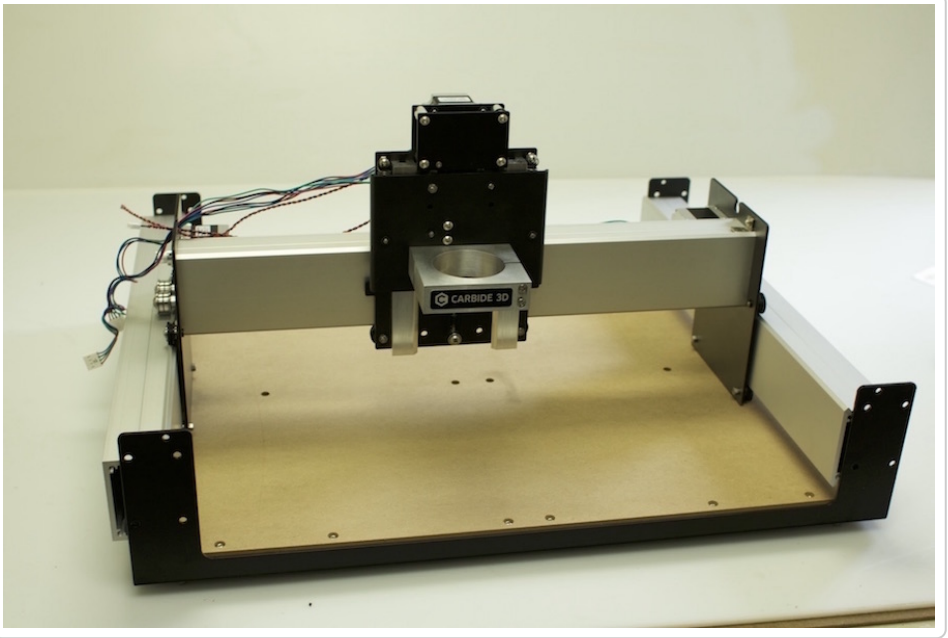


Installing the Gantry System

Slide both the left and right Y-Axis rails through the left and right Y-Axis plates.

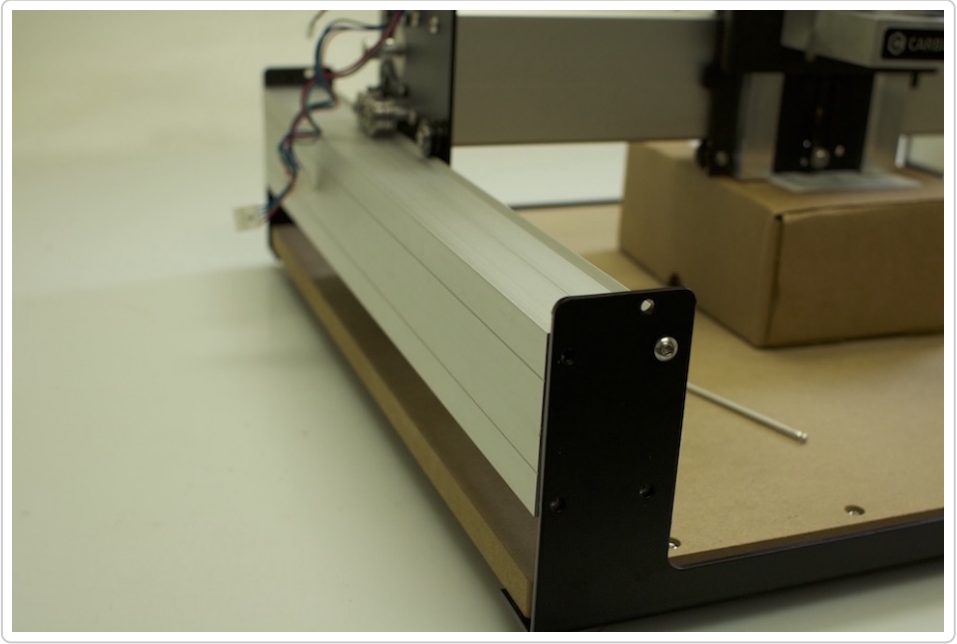


Using the box as a support, position the gantry system into the base frame. You may need to loosen the base frame assembly if there is not enough clearance to insert the rails. Slide the gantry system in from the side. If you have two people, you can also set it in from the top.



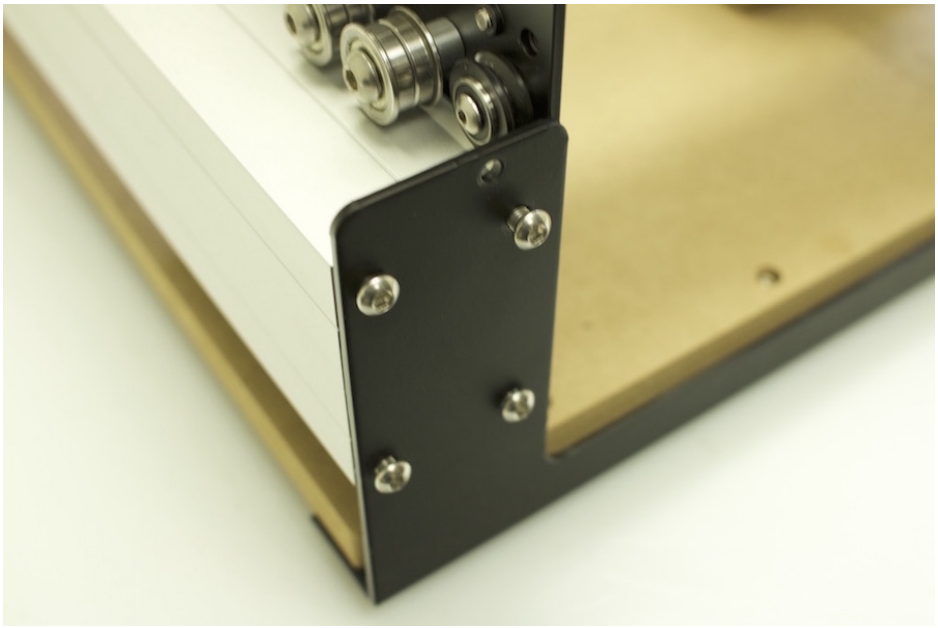
Using a carriage box to support the entire gantry (from the center) Install 2 screws, diagonal from each other, on

both sides of the front plate. The screws should only be finger tight at this point.



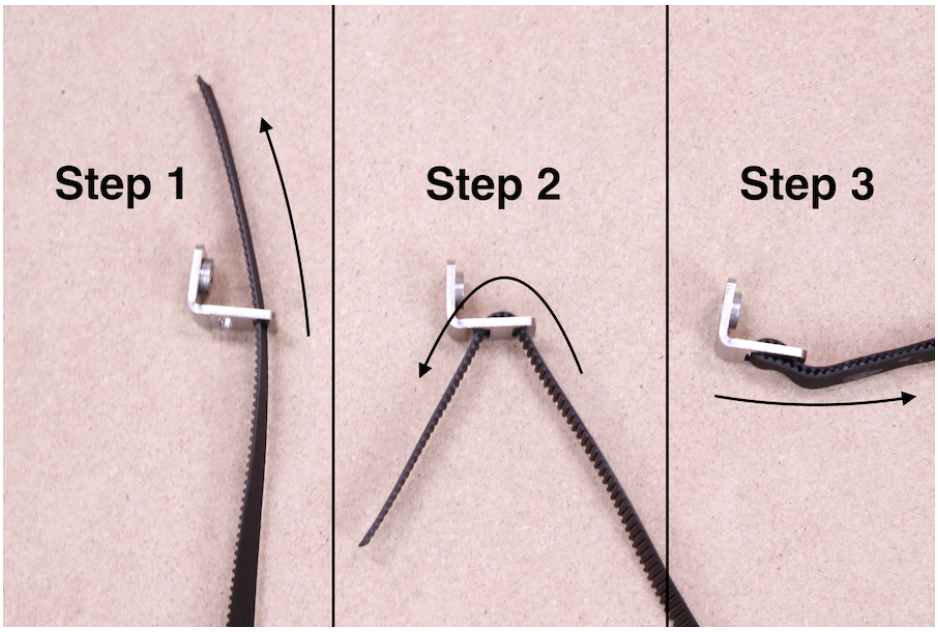
After the front is finished, move around to the back of the machine and install all 4 screws on each side of the gantry. Again, these screws should not be fully tightened. We will do that in the ‘squaring your machine’ section.

Moving back to the front of the machine, install the remaining 2 screws on each side of the End Plate.



Running the Belts

Using the bag labeled ‘belt clips’, begin on the left side of the gantry by running a 9mm GT2 belt (9mm width) through the belt clip.



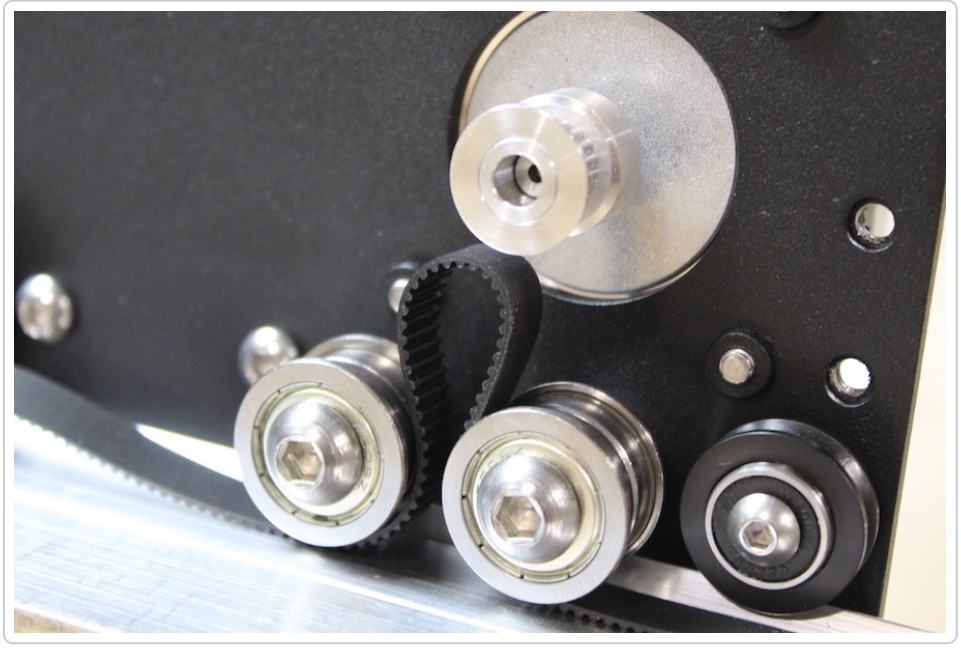
The proper routing is: Up from the bottom, Down through the top, Back towards the front. Pull about 2″ of

belting back towards the front. Ensure the overlapping teach line up and interlock.

After the belt has been run through the clip, ensure the teeth have interlocked with each other and there is roughly 2 inches (50mm) of underlapping belting.

Using one of the M5x10mm screws, tighten the belt clip against the plate. Double check the teeth remained interlocked.

Working your way towards the other end of the Y-Axis Rail, run the belt between the rail and the flanged idlers. Pushing from both sides of the idler, force the belt up and towards the idler. You can also use the 1.5mm hex key to lift the belt between the idlers. Once the belt is accessible, wrap around idler.



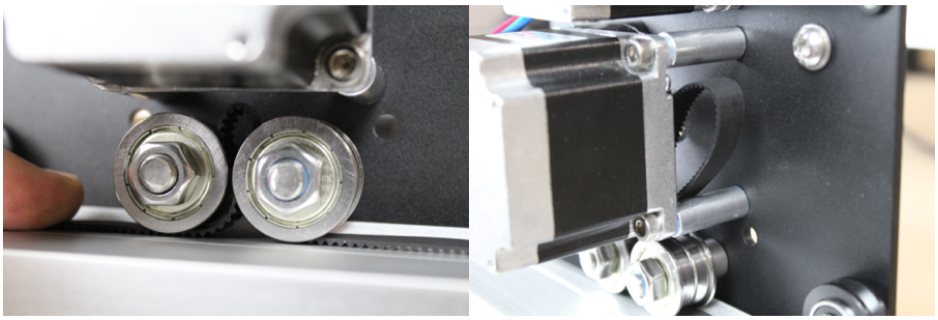
Using another M5x10mm screw, tension the belt clip against the front of the machine.

To get the proper tension on the belt, pull enough belting through the clip (underlapping) so you can push the belt clip, with your finger to within about 1/4” of the End Plate or close enough where the M5x10mm screw can catch a thread into the belt clip nut (as shown).

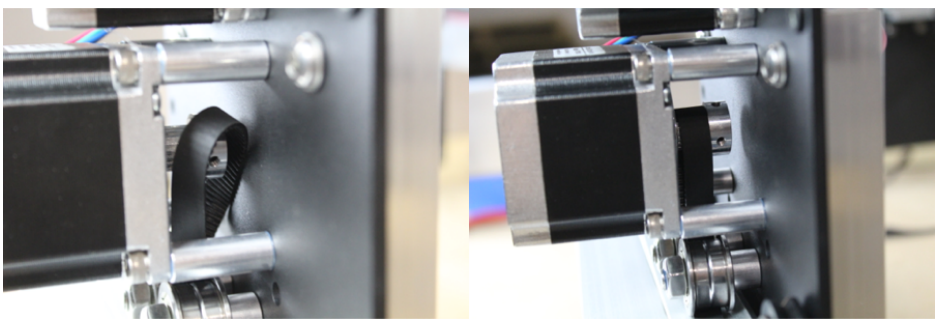
Once the screw is engaged with the nut, tighten the clip with a 4mm allen key.

Routing the X Axis Belt

- Lay the belt across the entire extrusion, threading it below the idlers with the teeth facing down.
- Using the 1.5mm hex key as a lever, push the timing belt between the idlers.



- Using both hands, push the belt in from the outside of the idlers. The belt will bubble up as it travels through the thin gap.
- Once accessible, grab the loop with your fingers or the allen key and pull enough out so you can grab it with your fingers.



- Twisting the belt slightly, slide one edge between the pulley and the plate until half of the loop is around the pulley.
- Align the belt with the pulley and pull one end of the belt while holding the other to secure the belt around the pulley.

After stringing the belt over the X-Axis motor pulley, route the other end through another belt clip. Use the same method as the other side to properly route the belt through the clip.

To get the proper tension on the belt, pull enough belting through the clip (underlapping) so you can push the belt clip, with your finger to within about 1/4” of the End Plate.

This should be just close enough where the M5x10mm screw can catch a thread into the belt clip nut (as shown above, left image). Once the screw is engaged with the nut, tighten the clip with a 4mm allen key.

WARNING: DO NOT OVER-TIGHTEN THE BELT. OVER TIGHTENING THE BELT CAN BEND THE STEPPER MOTOR SHAFT!

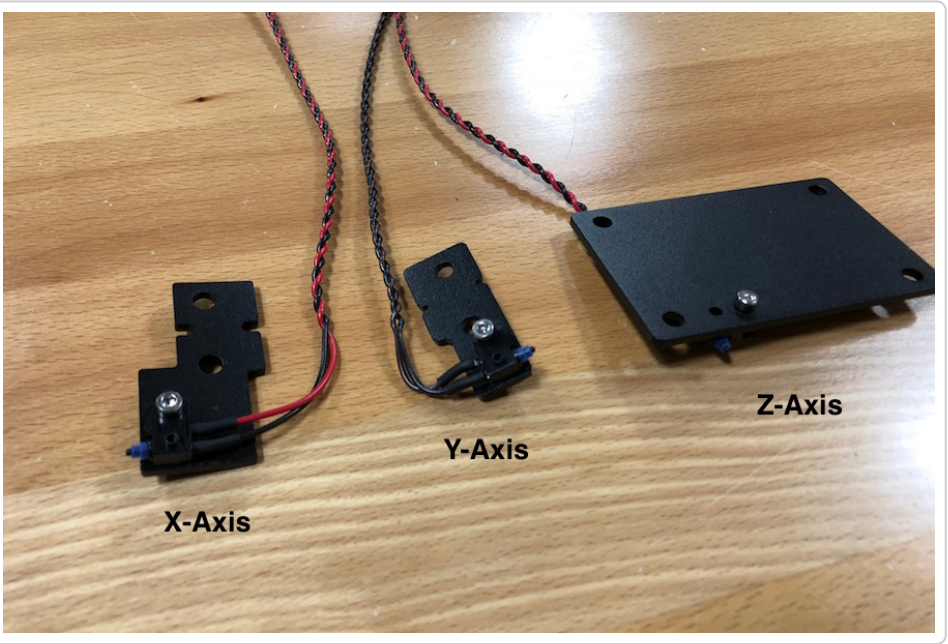
Home Switches

There is 1 home switch per axis of your machine (3 total). Install in the order shown below.

Assemble the Switch Plates

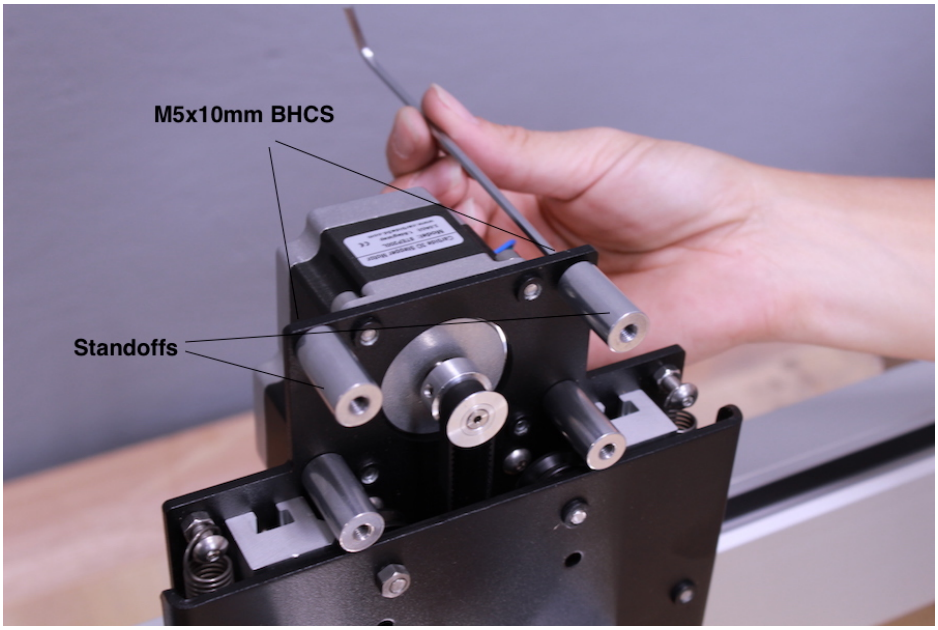
Note the cables are color coded for easier assembly. The red/black cables go on the X and Z-axis, and the longer brown cable goes on the Y-axis.

It is easiest if you install the switches onto the switch plates prior to installing the switch plates onto the machine. Install each switch as shown in the photo below.



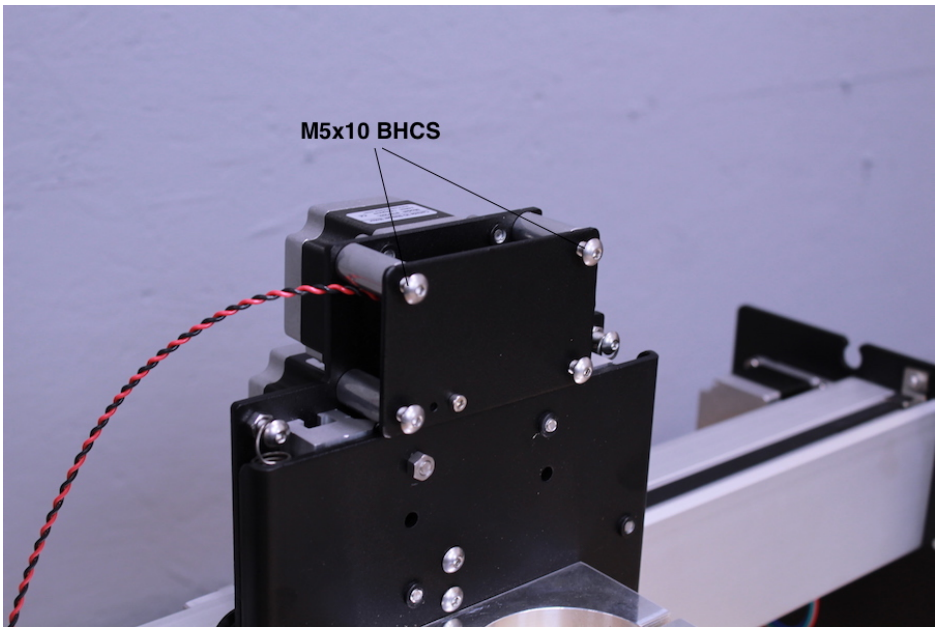
Install Z-Axis

Install the Z-axis switch plate by first installing 2 25mm x 1mm standoffs, using the M5x10mm BHCS included with the kit.



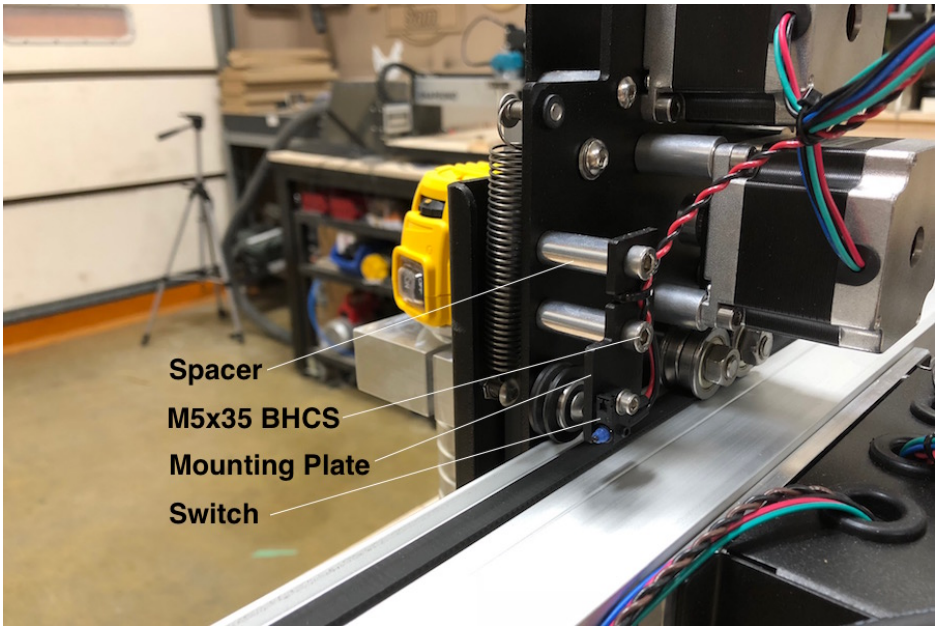
PROTIP: It will be easier to install the plate if you do not tighten the standoffs at this time.

With the standoffs installed, place the Z-axis plate in place, and secure with 2 more M5x10mm BHCS as shown in the photo below.

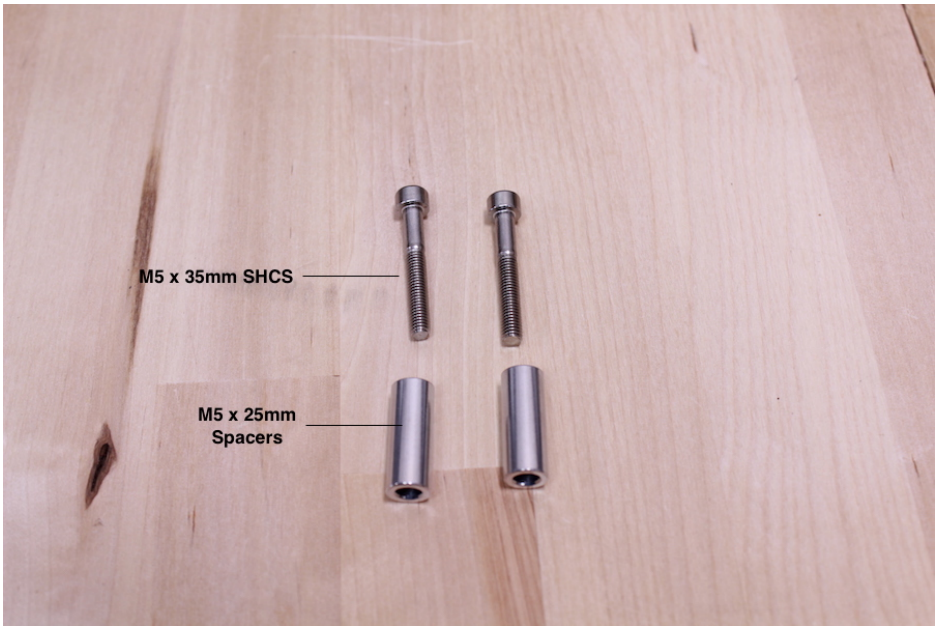


Install X-Axis

Install the X-axis plate by using 2 M5x35mm BHCS and 2 M5x25mm spacers, shown below in the photo.

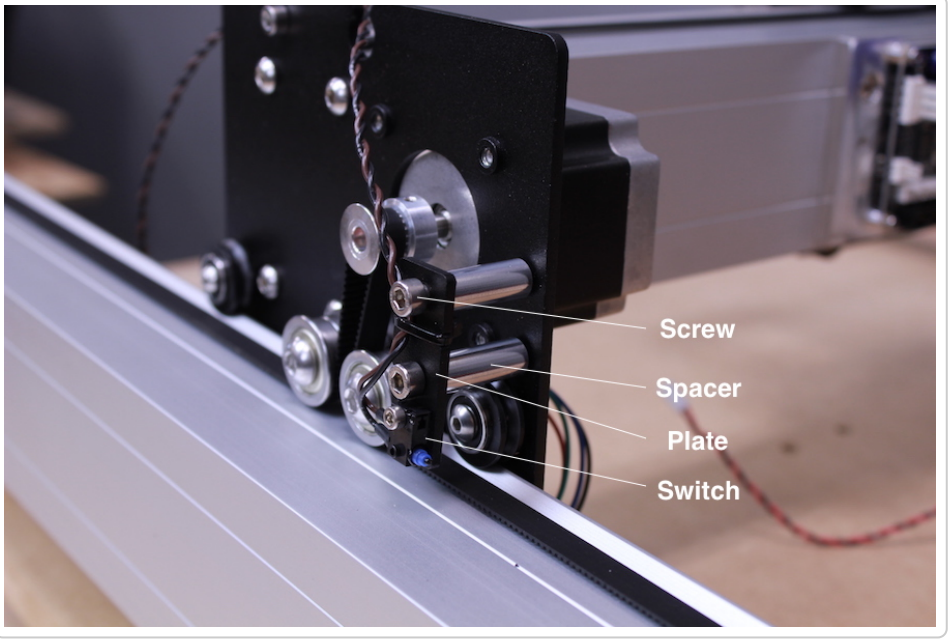


Slide the screws through the X-axis plate, attach spacers, then attach entire assembly to the back of the X-axis plate, using the built in nuts.



Install Y-Axis

Using 2 M5x35mm BHCS and 2 M5x25mm Spacers, install the Y-axis switch and plate to the **outside** of the Right Y-axis plate.



PROTIP: Before you can use the homing feature, homing will need to be enabled in the software configuration.

After assembly is complete, head over to the Enable Homing Article to configure your software.

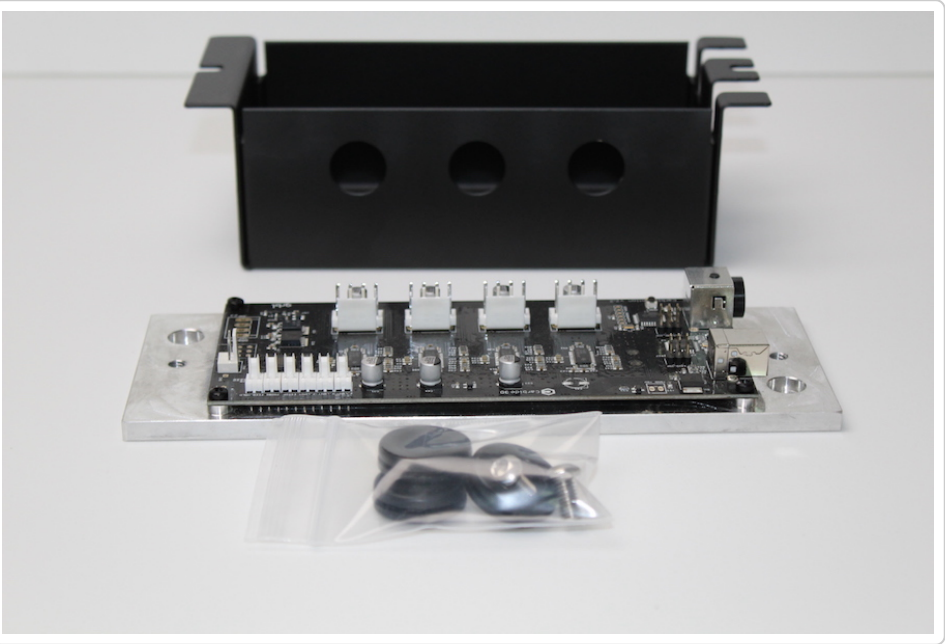
Enable Homing Article

NOTE: If you are having problems with your limit switches, please refer to the Homing Switch Troubleshooting article for help

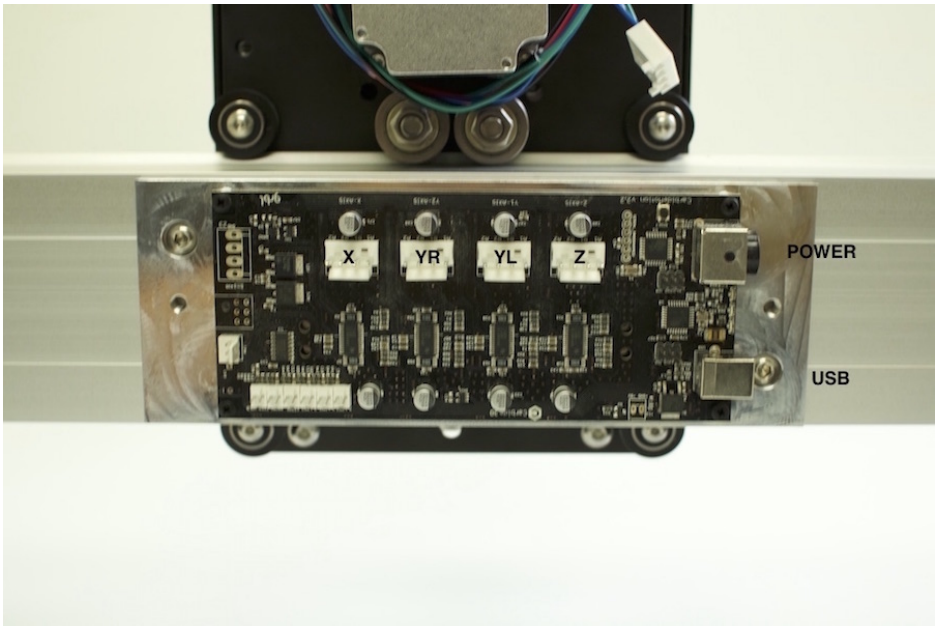
Homing Switch Troubleshooting

Wiring

If you have not already, remove the shroud from the controller by removing the M6x8mm Socket Head Cap Screws. Inside the shroud you will find a small self-sealing bag containing 3 rubber grommets and 2 M6x12mm screws.

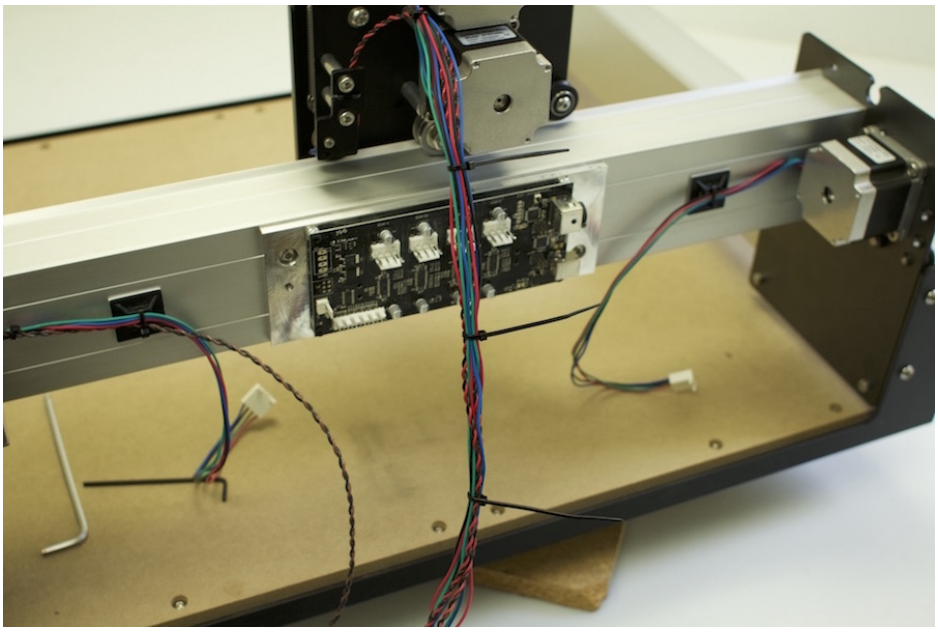


Install the controller on the back of the X-rail. The controller is connected with two M6x12mm screws (button head).

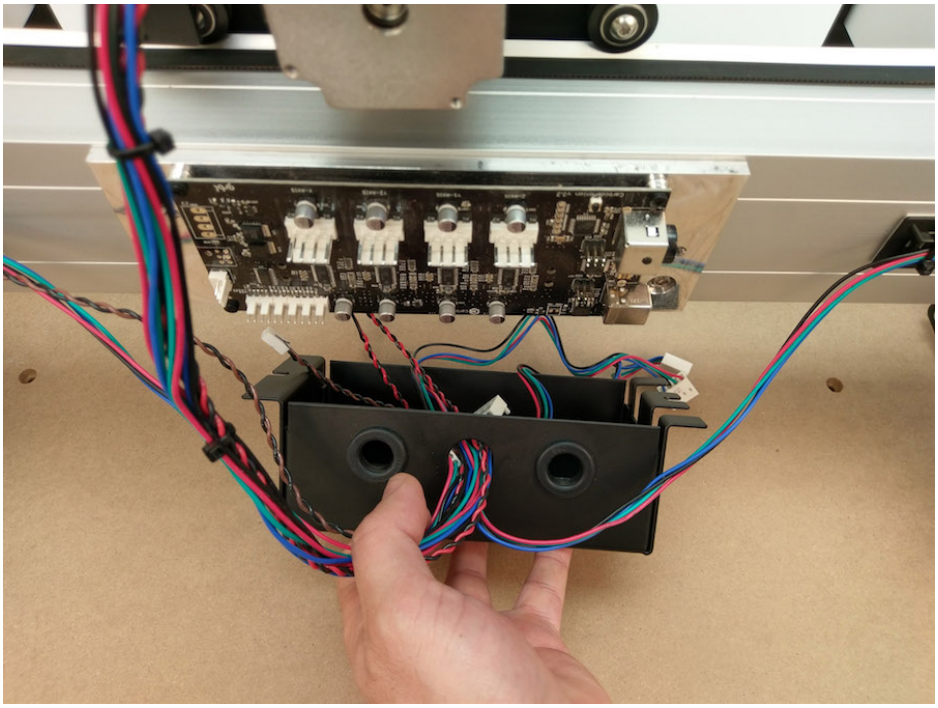


When installing the controller, ensure the orientation matches what is shown in the picture. The USB and Power ports should be facing to the right (as viewed from the same direction as the picture)

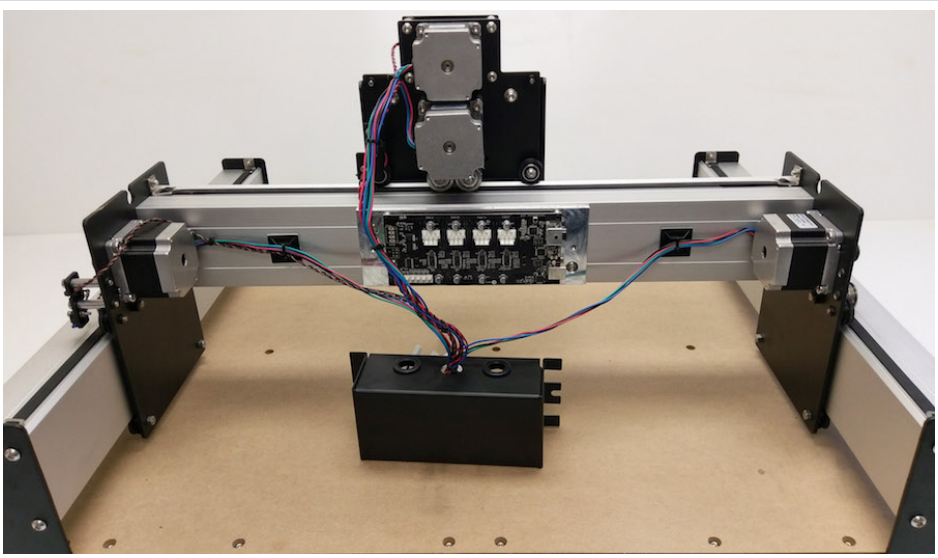
After the controller has been installed, route the cables from the stepper motors to the controller.



The X/Z Assembly works best by using 4 of the zip-ties to create a wire bundle, with a zip tie placed ever 4–6 inches down the bundle.

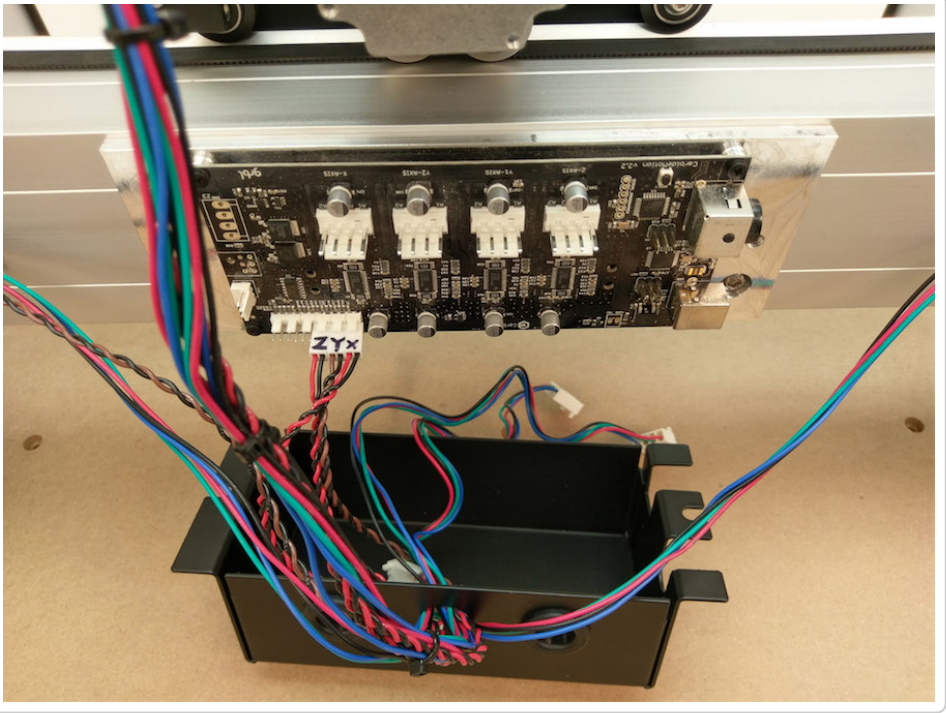


Route all of the wires through the top of the enclosure.

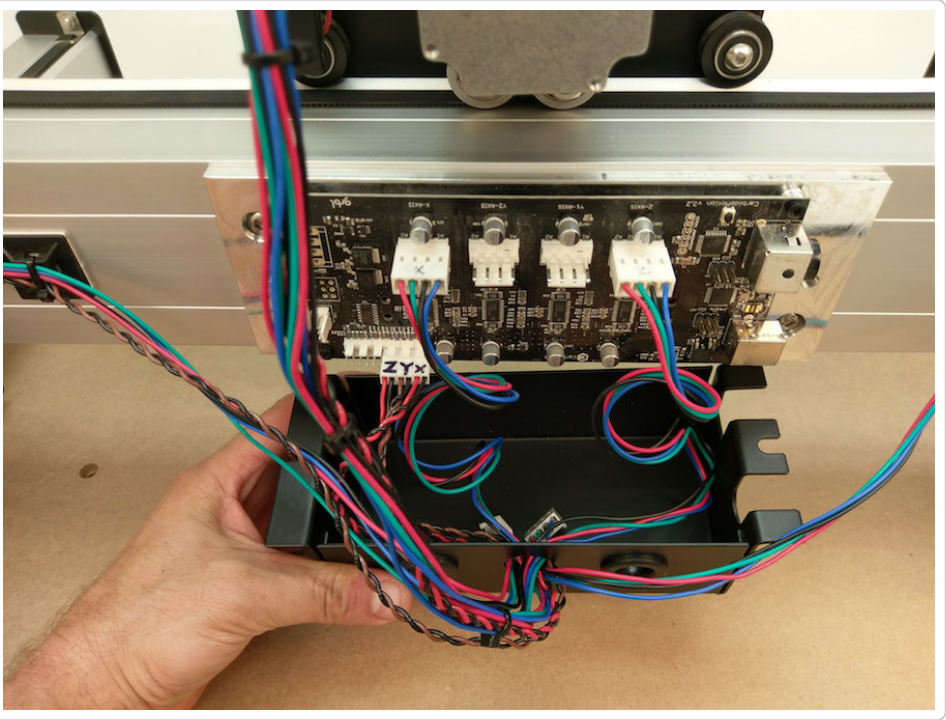


All of the cables can be routed through the center port opening, it's easiest if you run cables through the

grommet one at a time until the entire bundle is together. Leave the grommet out of the port opening until all of the cables have been routed, and travel has been tested.

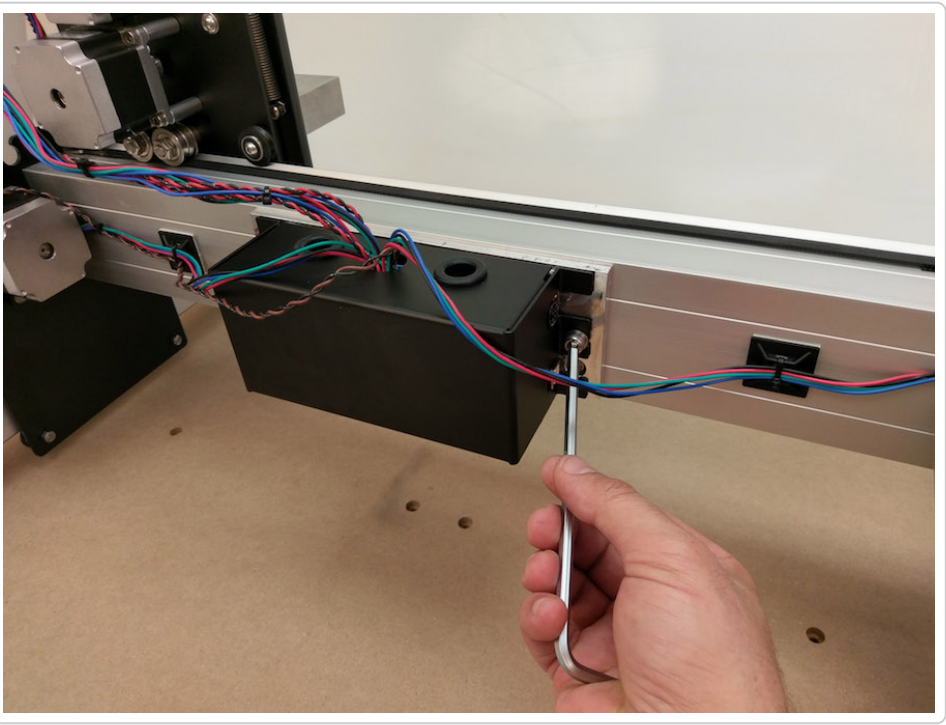


If you are installing homing switches at this time, route those through the port opening and to their connection points. Notice the orientation of the cables and the order (X/Y/Z from right to left).



Attach the X and Z axis stepper motors to their respective ports (labeled on the silkscreen as well).

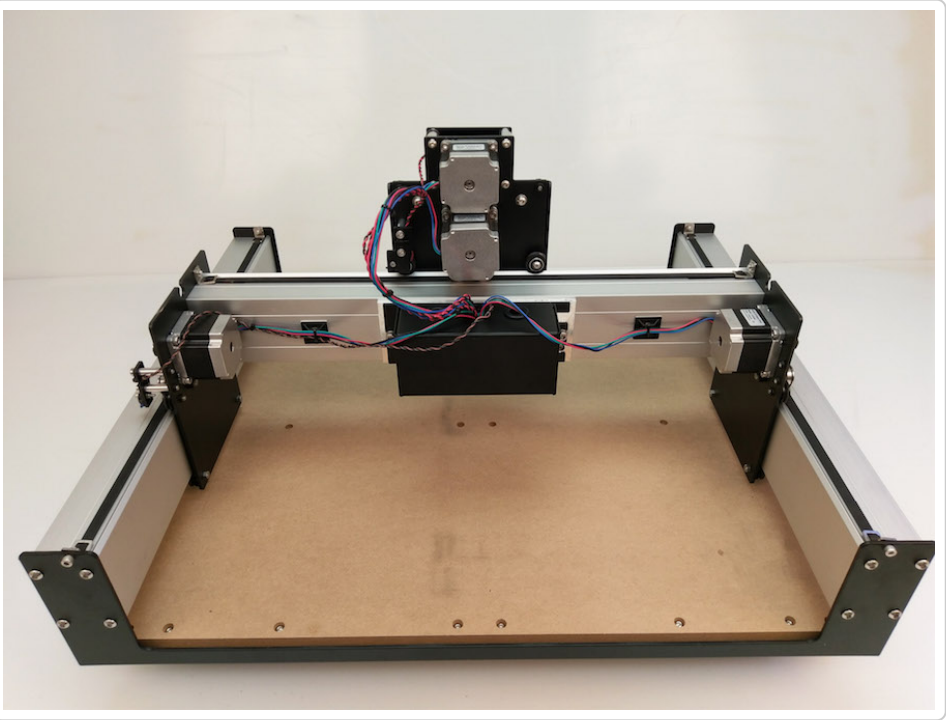
Then, connect the Y1 and Y2 stepper motors to their ports. NOTE: these wires do not cross each other. If you install them in the wrong port, your machine will run in the opposite direction for the Y axis.



After your wires have been connected to the correct ports, install the enclosure cover using the included M6 x 8mm Socket Head Cap Screws (one on each side).

After the enclosure is on, check the travel of your X axis to make sure there is enough slack in the wire bundle to allow full travel. Just slide the X-axis to its farthest extent on both sides and ensure the wires do not pull.

When you are happy with the travel, and wire routing, pull the grommet down the bundle and push it into place on the port. This will keep your wires together and provide a litte bit of strain relief on the bundle.



Squaring Gantry

1. Loosen all of the screws that hold the gantry together (4 on each side), these should still be loose from the initial assembly.
2. Loosen the screws that hold the Y axis rails in place (16 total). These should also still be loose from the initial assembly.
3. Slide the gantry to the front, so both Y plates are touching the front plate.
4. While holding the gantry against the front of the machine tighten the front of the Y rails (8 total)
5. Now — systematically begin tightening the 8 bolts on the gantry. Work your way from left to right, going back and forth in an X pattern (similar to tightening the lug nuts for the wheel of a car).
6. After the gantry has been secured, slide the gantry to the rear of the machine and tighten the 8 screws

while keeping the gantry pressed against the rear plate

Finishing

Your machine should now be completed! What now?

> **PROTIP:** Remember to enable homing in the software configuration to configure your software.

Enable Homing Article

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2. Carbide Motion User Guide
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4. Make a set of clamps!
5. See other’s projects for inspiration

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