

Cycloid Pen Plotter – Assembly

3D Printing:

- Any material / settings should work for this project. Here is what I typically use:
 - Material: PLA
 - Layer Height: 0.2mm
 - Perimeters: 4
 - Top / Bottom Solid Layers: 4
 - Infill: 20% Gyroid
 - Supports are needed on some parts
 - Parts are oriented the way you should print them

Heat Set Threaded Inserts:

- Add inserts to these parts:
 - XY Joint (L + R): Two 3mm inserts to mount the 400mm horizontal rail.
 - Carriage: Two 3mm inserts for belt clamps. Two 2mm inserts for 40mm rail.
 - Note: Put a long 3mm screw in the top hole (no insert required). This will hold the end of the spring in place.
 - Pen Holder: One 3mm insert for pen locking screw. There are several STL's on the web for a knob you can use on a 3mm SHCS.
 - Enclosure: Four 3mm inserts for lid. Four 2mm inserts for circuit board.

Pulleys:

- 3D printers usually have trouble making accurate holes, so drill out the ones for the bearing shafts. I used a 4.8mm drill bit on the thick areas and a 5mm drill bit on the thin areas.
- Push the pulleys in the appropriate slots and use a vice or hammer to gently push / tap the shafts in place. Note: Use one 0.5mm thick washer between the stacked pulleys in the top corner parts.

Dry Erase Board:

- The dry erase board I purchased was not flat, so I removed the thin sheet metal from the cheap "wood" it was glued to and attached it to some MDF. If you want to do this:
 - Pull off the aluminum frame from the edges.
 - Soak the "wood" in water overnight and then scrape it off the metal. Be careful with this as you can easily bend / dent the thin sheet metal.
 - The corners of the sheet metal may be bent down slightly. If so, drill some shallow holes in the MDF so everything will lay flat.
 - Watch some videos on how to bond laminates with the contact cement you are using. This is a critical step! Once the sheet metal touches the MDF you can't adjust it.

- o Seal all exposed surfaces of the MDF to keep moisture out.

Frame:

- Drill holes in the MDF to mount the aluminum extrusions around the dry erase board. Counter bore from the back side for the flat head screws.
- Put the flattest side of the extrusion on the MDF and attach with 5mm screws and T nuts.
- It will help if you mount the frame square.

Linear Rails:

- Keep the end caps on until you mount the linear rails in place. Otherwise, you will be picking up tiny ball bearings off the floor. DAMHIKT.
- Most rails come with a sticky coating. This isn't a lubricant, but a rust preventer. Remove with 99% Isopropyl Alcohol, let dry, and apply your favorite grease. I used Super Lube Multi-Purpose Grease. If you use less than 99% IPA, the water in it will rust your rails. DAMHIKT.
- Center one 500mm vertical rail on the aluminum extrusion and tighten in place. Place the other 500mm rail at the **exact** vertical position as the other and "finger" tighten.
- Mount the Corner pieces to the aluminum extrusion. Place them flush to the rails.
- Mount the XY Joints on the rails. Mount the 400mm rail between the two, but leave the screws loose.
- If your frame is square and your Corner pieces are at the same exact position, you can use this to square your 400mm rail. Push the rail up until both sides touch the Corner pieces and tighten the 4 screws on the 400mm rail.
- Loosen the screws on the second 500mm rail that you lightly tightened. Run the horizontal rail up and down until everything moves easily, then tighten in place.

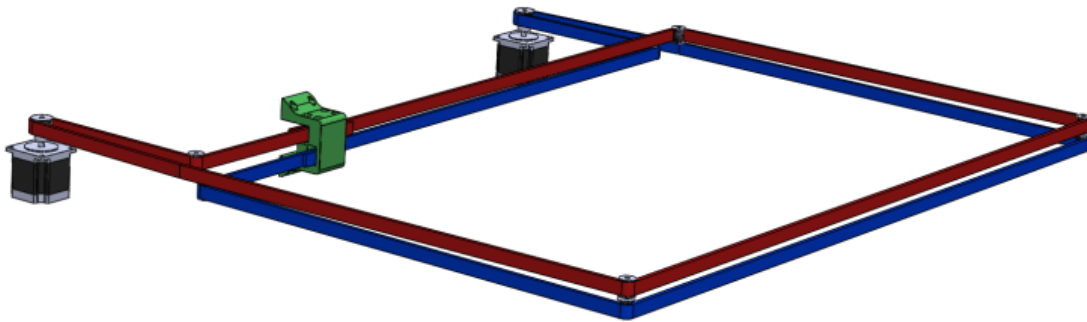
Stepper Motors:

- Attach the stepper motors to the 3D printed mounts.
- Place the mount flush to the end of the rail and lightly tighten.
- Add the 16 tooth pulley to each stepper motor as shown in the pictures. Note: You may need to adjust the height later so belt is parallel to the aluminum extrusion.

Belts:

- Mount the 40mm rail and pen holder to the carriage. Mount this assembly to the 400mm rail.
- Cut the belt in half. Mount one end of each belt to the carriage with a belt clamp.
- Thread each belt thru the pulleys following the picture below.
- Pull the ends tight near the carriage while you tighten the other belt clamp.
- Move the carriage in all directions and make sure the belts are properly engaged with all pulleys. Retighten belts if needed.

- You can use the motor mounts as a belt tensioner. Since this is slow speed, the belts don't need to be super tight and you can just pull the motor mounts down by hand and then tighten the bolts.
 - Note: Both belts need to have the same tension. If not, it will actually twist the 400mm rail out of square. To check this, push the 400mm rail to the top and check the gap between the 500mm rail carriage and the Corner pieces. Adjust one of the stepper motors so this gap is the same.



Operation:

- To start, move the pen assembly to the lower left corner and then apply power.
- The program will take a minute or two to calculate the scale and then move to a new position.
- Once it stops, add the pen, and then push the button to start drawing.