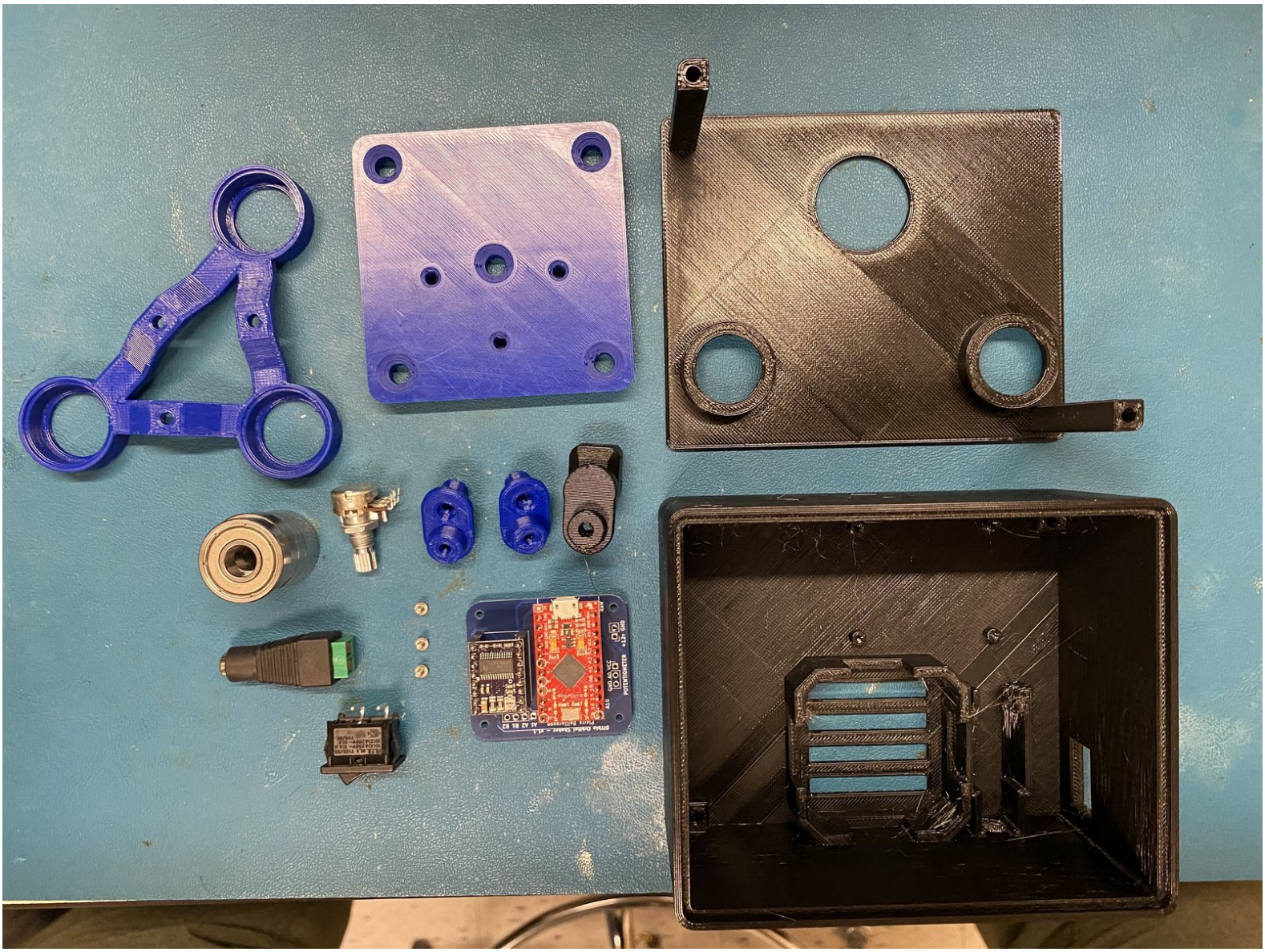
scrippsresearch-leadid

How to assemble a DIYbio orbital shaker

Written By: Pierre Baillargeon



INTRODUCTION

This guide will demonstrate how to fabricate and assemble a DIYbio orbital shaker.

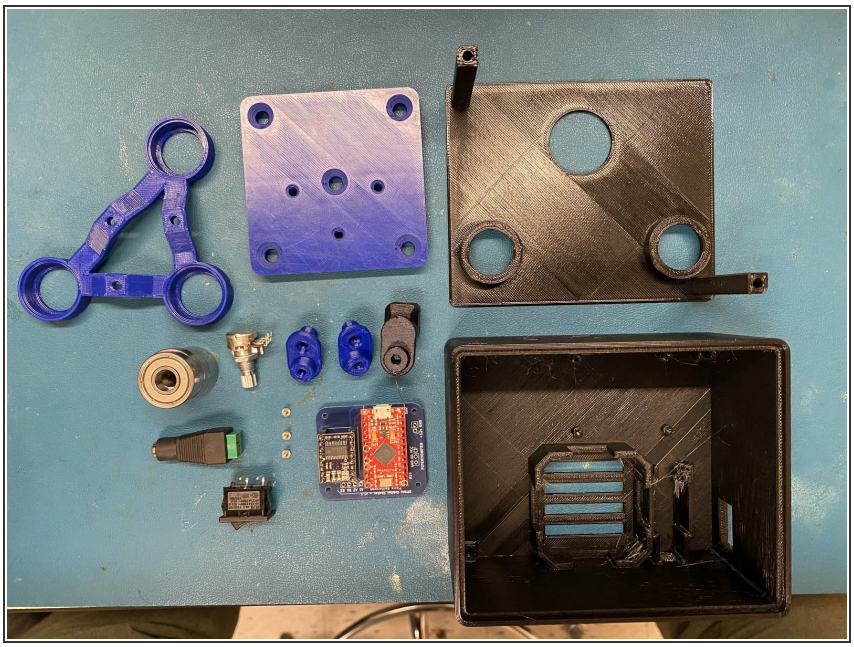
TOOLS:

- M3 allen wrench (1)
- M4 allen wrench (1)
- M5 allen wrench (1)
- Soldering iron (1)
- Philips screwdriver (1)
- Electronics or jewelers Philips screwdriver (1)
- Drill with assorted drill bits (1)
- M2 allen wrench (1)

PARTS:

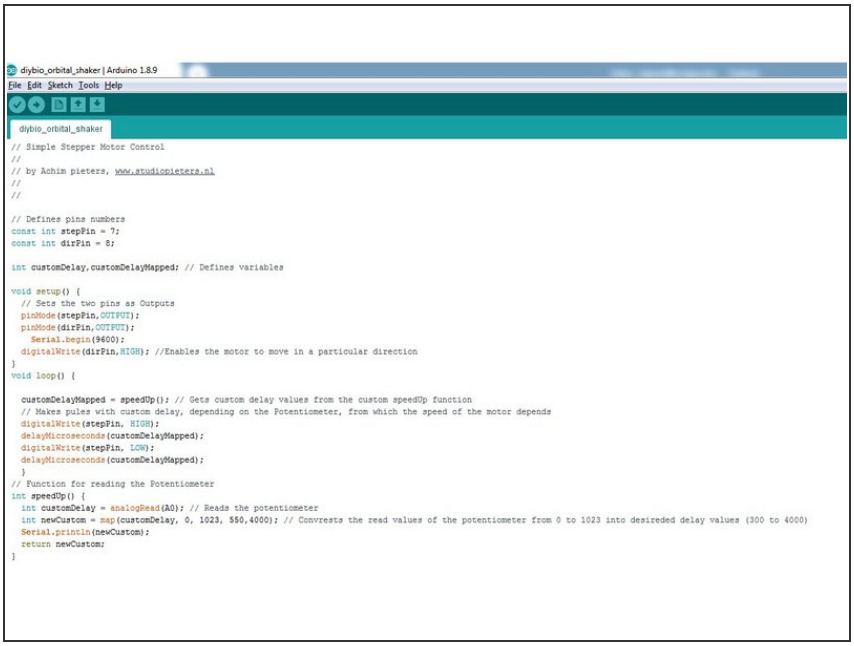
- DIYbio 3D printed components (1)
- Pololu DRV8825 (1)
- Stepper motor with cable (1)
- Sparkfun Pro Micro - 5V (1)
- Potentiometer knob (1)
- 10k rotary potentiometer (1)
- 608ZZ bearings (5)
- 12V 3A power supply with 5.5mm OD/2.5mm ID screw terminal (1)
- 8 position female PCB header connector (2)
- 12 position female PCB header connector (2)
- M5 tapered heat-set inserts (5)
- M3 washer (2)
- M5 x 0.8mm, 10mm long tapered Philips screw (5)
- M3 nut (3)
- M2 x 0.4mm, 4mm long socket head screw (4)
- M3 knurled brass threaded insert (6)
- M3 x 0.5mm, 16mm long socket head screw (6)
- M3 x 0.5mm, 14mm long tapered Philips screw (3)
- DIYbio orbital shaker PCB (1)
- SPST power switch (1)

Step 1 — Prepare all parts needed for assembly.



- 3D print all necessary components. The components shown in this guide were printed on a Prusa i3 MK3s printer and printed in PLA at 0.3 mm layer height and 100% infill.
- Order necessary fasteners and non-3D printed components (motor, bearings, electronics, etc).

Step 2 — Program microcontroller



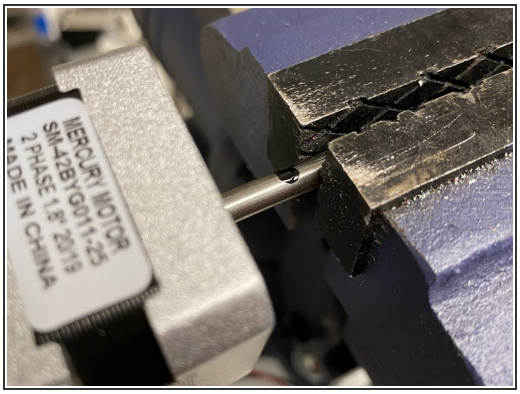
- Program the Sparkfun Pro Micro via the Arduino IDE using the DIYbio orbital shaker firmware. Additional instructions regarding Arduino IDE settings for this microcontroller can be found here: https://learn.sparkfun.com/tutorials/pro...

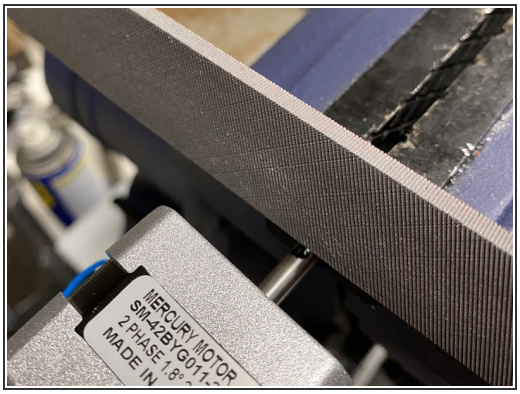
- The firmware to program on the Sparkfun Pro Micro can be found at the following GitHub repository:

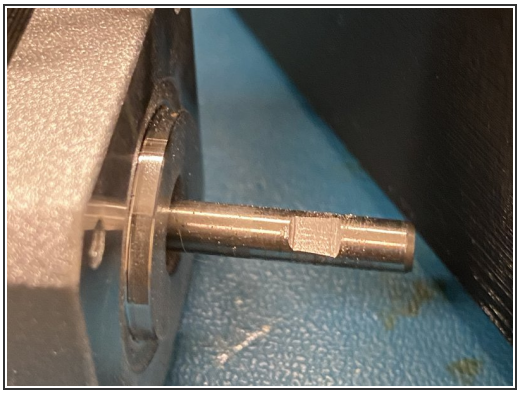
https://github.com/pierrebaillargeon/DIY...

⚠ **Note: Pay particular attention to the 5V/3V Arduino IDE setting.**

Step 3 — Key stepper motor shaft

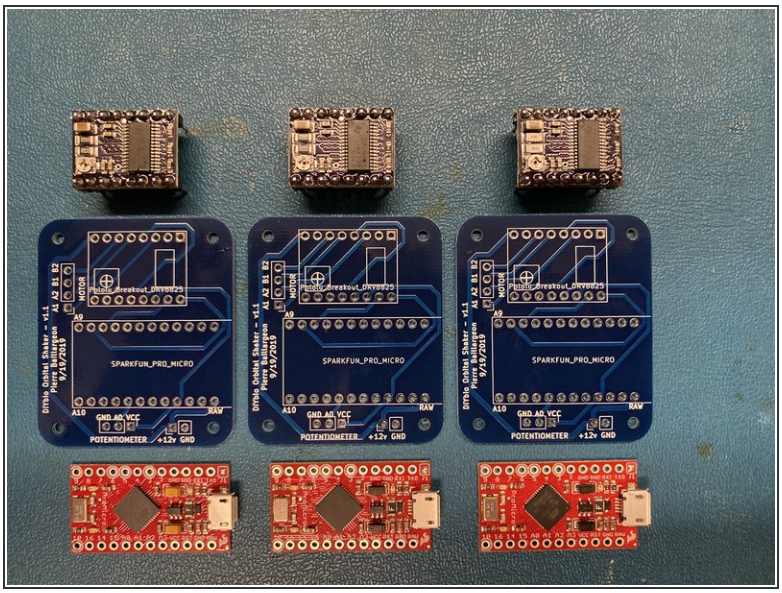


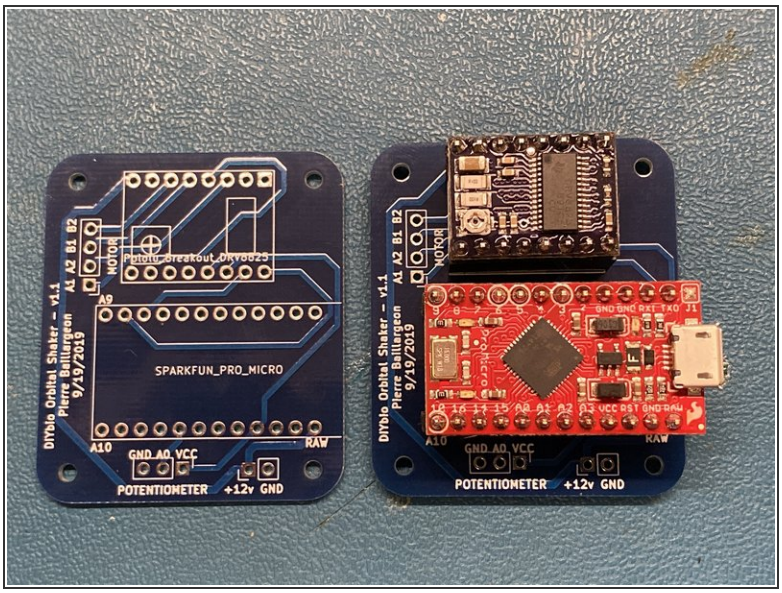




- Mark the end of a M3 screw with a sharpie, paint pen or other marking substance.
- Place the 3D printed motor coupler onto the stepper motor shaft.
- Put the marked screw into the motor coupler through the set screw location. Remove the screw, remove the motor coupler. A marking should remain on the motor shaft to indicate where the key should be created.
- Use vice clamp to hold stepper motor shaft and file or dremel marked location until a flat profile is created which is sufficiently large for M3 screw diameter.

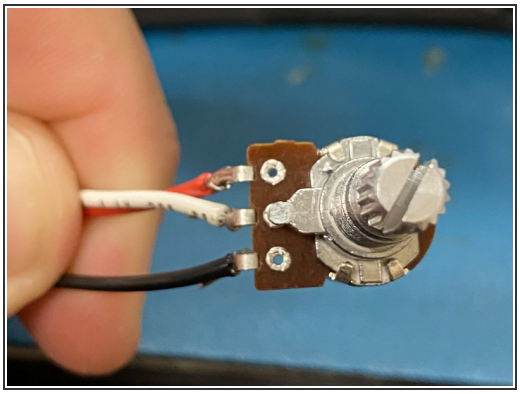
Step 4 — Solder headers to PCBs

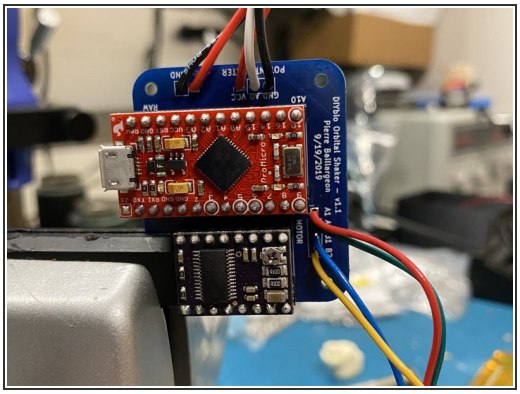


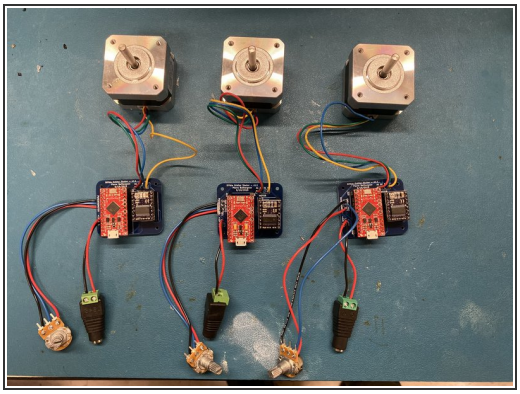


- Solder 2.54mm female headers to the DIYbio orbital shaker PCB
- Solder 2.54mm male headers to the Sparkfun Pro Micro and Pololu DRV8825 motor controller PCBs.
- Plug the Pro Micro and DRV8825 into the DIYbio orbital shaker PCB, paying attention to the orientation of the PCBs and matching them to the markings on the silkscreen of the DIYbio orbital shaker PCB.

Step 5 — Prepare wiring

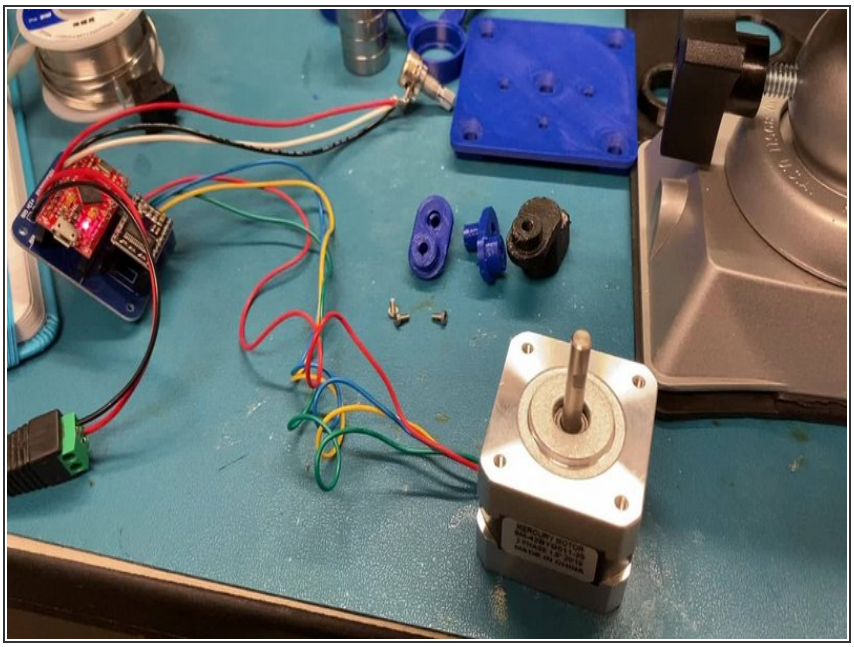






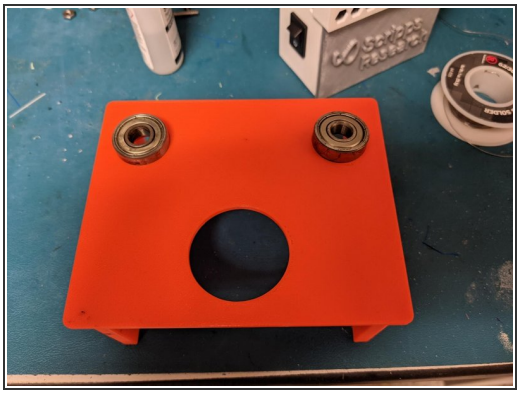
- Cut stepper motor wiring to length - measure approximately 250mm of wire from the motor and cut excess.
- Strip the ends of the cut stepper motor wiring.
- Solder the stepper motor wiring to the DIYbio orbital shaker PCB after confirming the A1/A2 and B1/B2 motor coil pairs. For the Sparkfun motor ROB-09238, solder as follows: A1 - red, A2 - green, B1 - blue, B2 - yellow.
- Cut 3x ~150mm of wire for use in wiring potentiometer to PCB. Recommend using different colors (red, blue or white, black) for the different connections to be made. Strip ends of wiring after cutting.
- Solder potentiometer wiring to potentiometer on one end and to DIYbio orbital shaker on other end.
- Cut and strip 2x ~150mm red wire, 1x ~150mm of black wire. These wires are to be used to connect power switch to the microcontroller and the barrel jack connector.
- Solder 1 red wire and 1 black wire to the DIYbio orbital shaker PCB where labeled (GND, +12V). Connect the other ends of these wires to the appropriate locations of the barrel jack connector

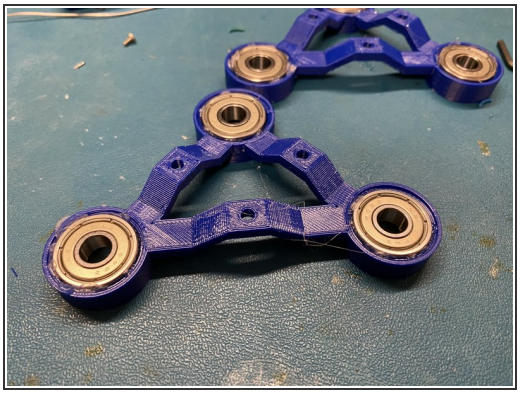
Step 6 — Test electronics and adjust DRV8825 current limit

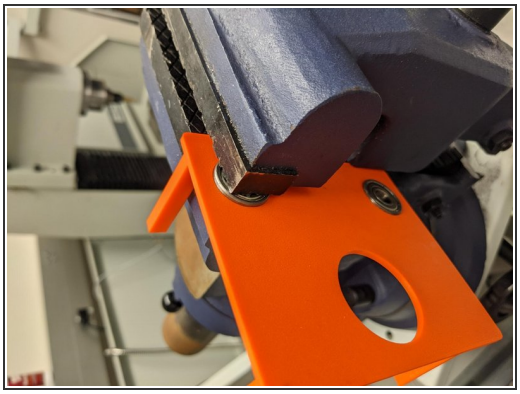


- Electronics assembly is complete, test functionality by connecting barrel jack connector to power supply. Motor shaft should rotate with speed adjustable via potentiometer knob.
- If motor is spinning as expected and speed is controllable via the potentiometer knob, proceed to adjusting the DRV8825 current limit via the potentiometer as described under the 'Current limiting' section here: https://www.pololu.com/product/2133

Step 7 — Mechanical assembly - bearing install

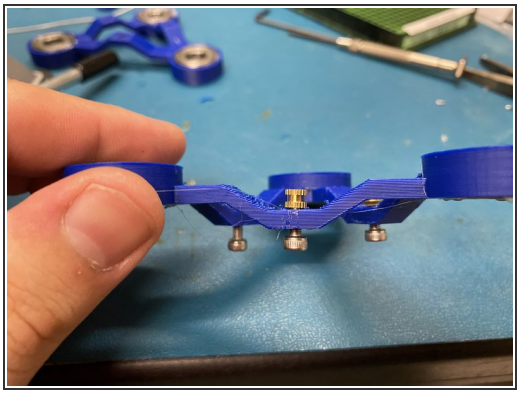
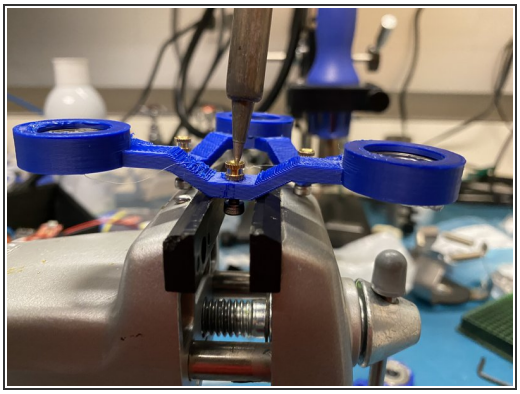
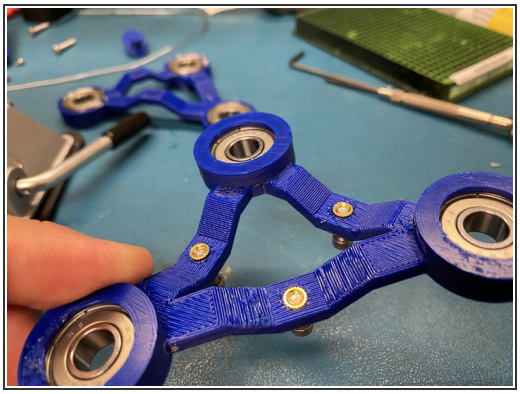






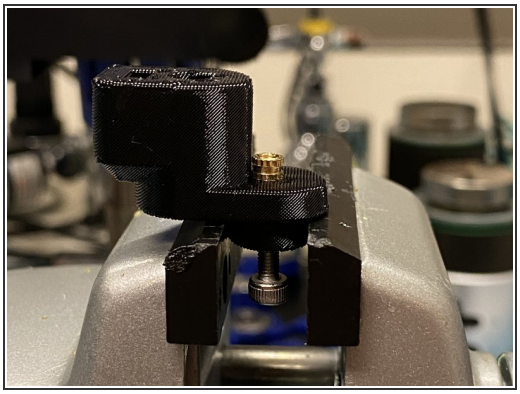
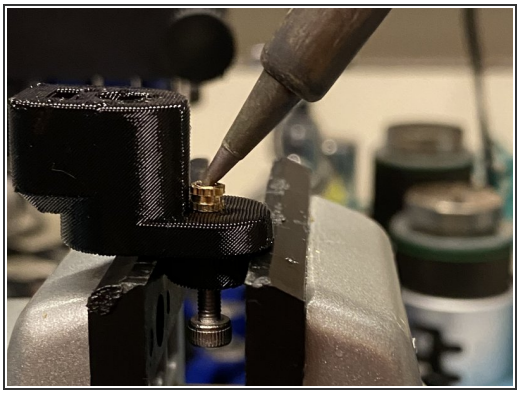
- Press bearings into slots.
- If more force is required, push the raised bearing against a flat surface or use a vice in order to seat the bearings.
- Verify that the bearings are flush with the top of the 3d printed component.

Step 8 — Mechanical assembly - knurled inserts in bearing linkage

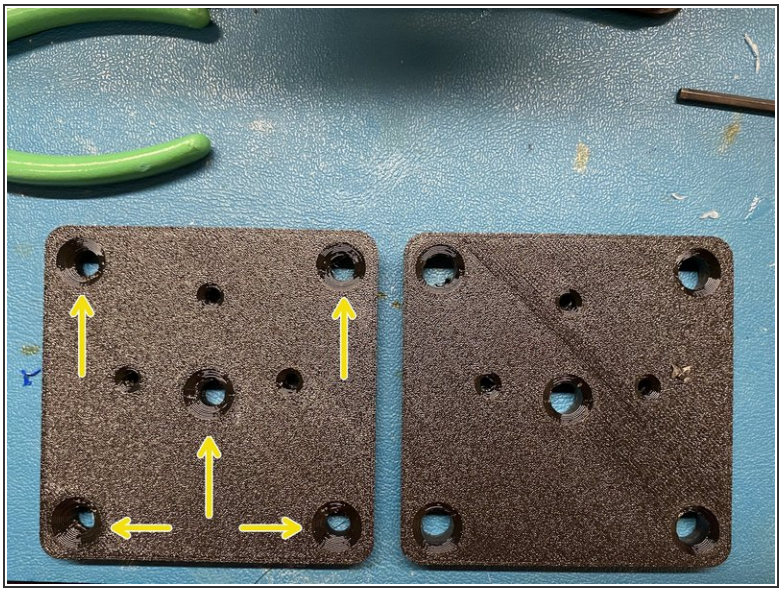
- Put M3 screws through each of the three holes of the bearing linkage part with knurled inserts screwed into the back side as pictured.
- Use soldering iron to heat screw + insert and apply gentle force until the insert has been pushed into the plastic part and the surface of the insert is flush with the plastic part.
- Make sure that inserts are properly installed by checking screw angles relative to plastic part. If screws are not perpendicular to plastic surface they can be gently pushed to correct orientation using caution as screws will still be hot from soldering iron.
- Allow parts (plastic/screw/insert) to cool (~5 minutes), then use allen wrench to remove screws.

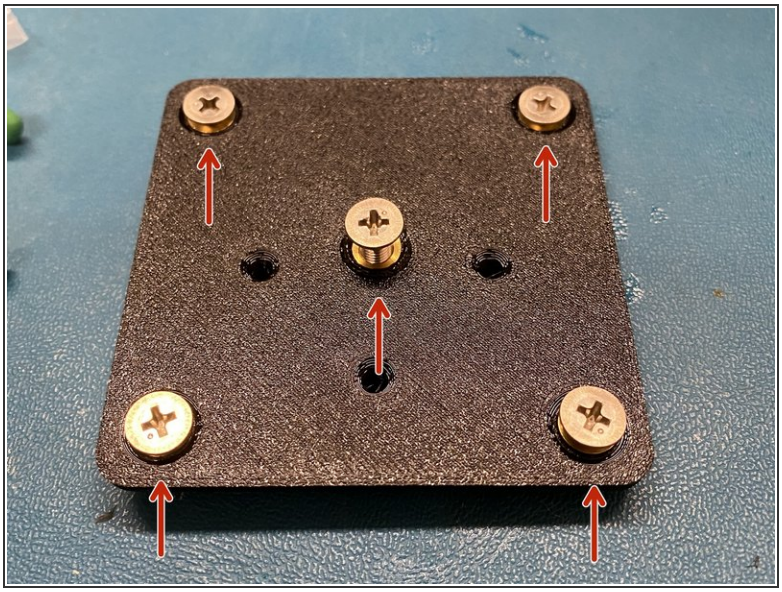
Step 9 — Mechanical assembly - knurled inserts in motion links


- Put M3 screws through hole where knurled insert is to be installed.
- Install knurled insert onto screw.
- Use soldering iron to heat screw/insert and apply gentle pressure to set insert into plastic part. Continue applying pressure until knurled insert is flush with part.
- Allow parts to cool (plastic/screw/insert) for ~5 minutes then use allen wrench to remove M3 screw.
- After completing for motor coupler, repeat process for two motion links.

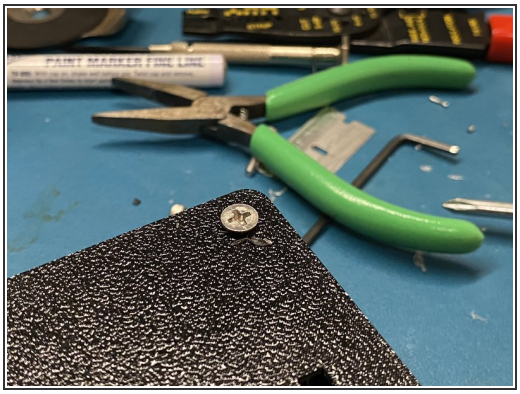
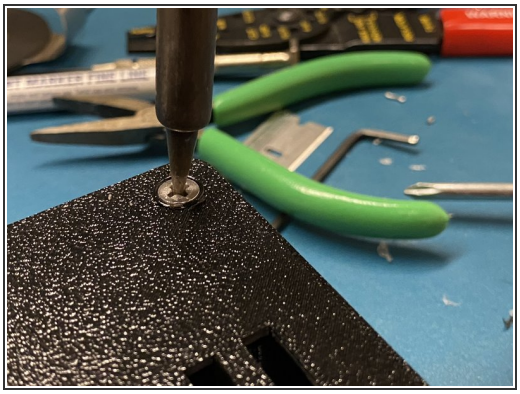
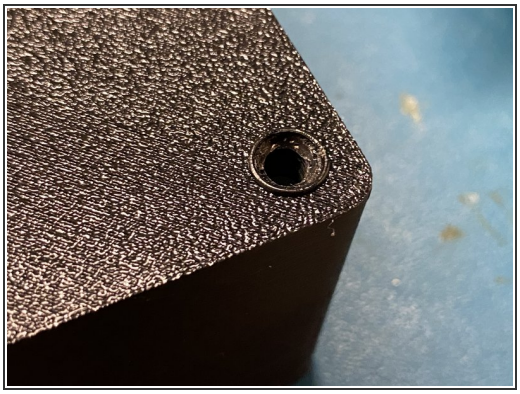
Step 10 — Mechanical assembly - flask holder plate





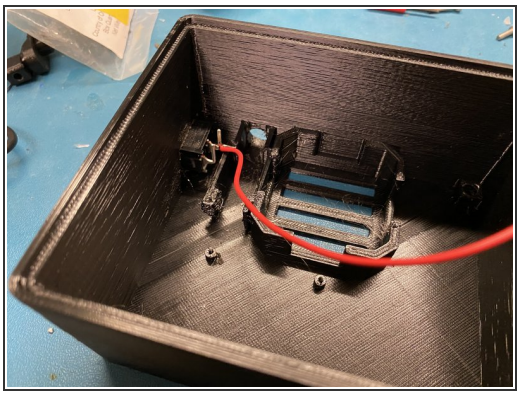
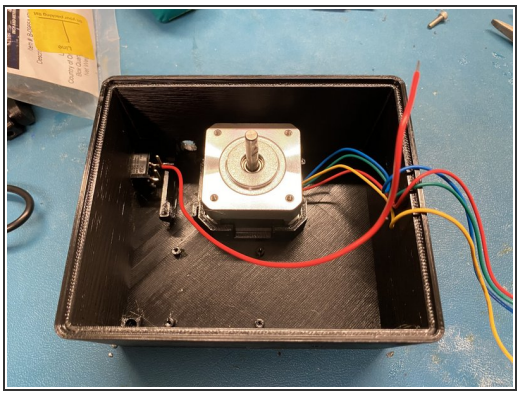
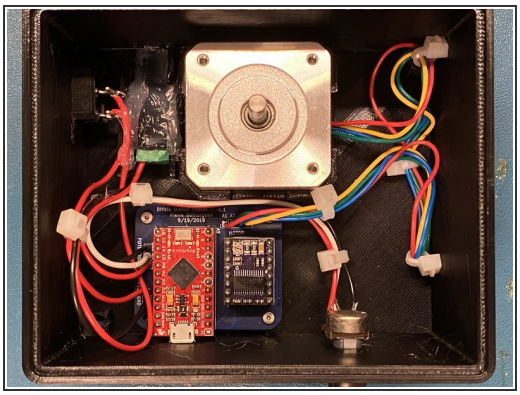
- Use 19/64" drill bit or similar to drill out 4 corner holes and center hole for M5 inserts.
- Use soldering iron to install 5 M5 inserts in drilled out locations.
- Allow inserts and plastic to cool (~5 minutes) then add M5x10 screws.

Step 11 — Mechanical assembly - orbital shaker enclosure

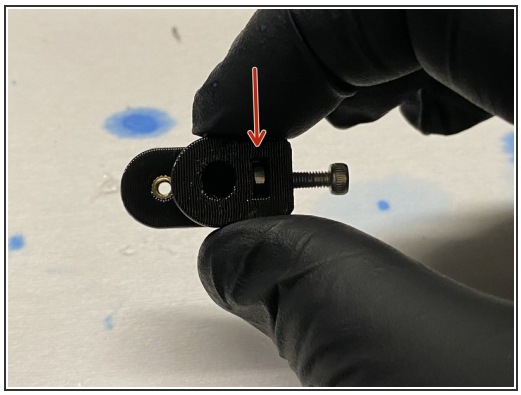
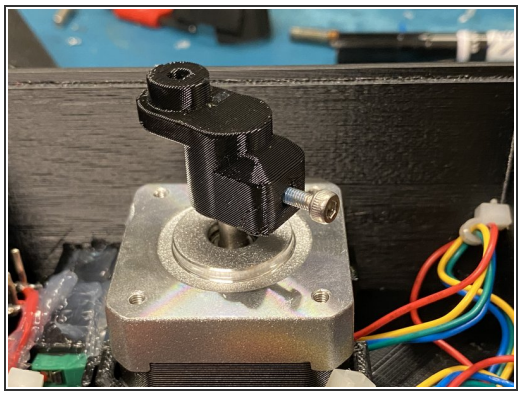
- Drill/clean out potentiometer knob hole with 17/64" bit.
- Drill/clean out power dongle hole with 21/64" bit.
- Sand or file power button opening until power button fits snugly.
- Drill out bottom corner holes out with #12 bit (.189)
- (Optional) Use soldering iron with M4 tapered screw to create tapered seat for M4 screw to be flush with bottom of enclosure. Allow to cool then remove screw.
- (Optional) Clean out bottom corner holes with #12 bit again after creating tapered seat -- soldering iron will have melted some plastic onto threads of screw and these need to be cleaned out.

Step 12 — Install electronics

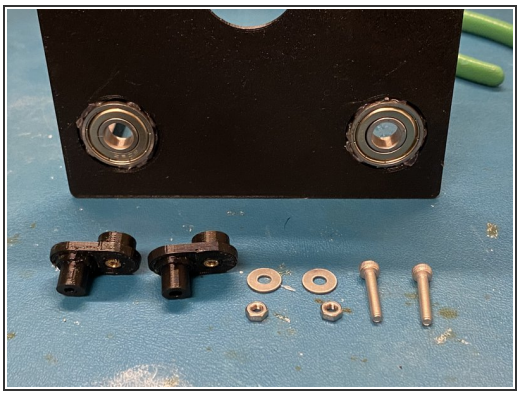
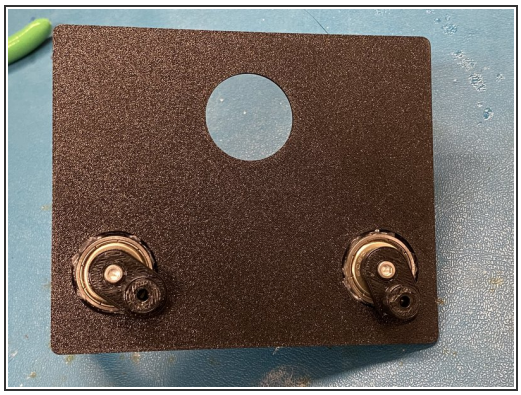
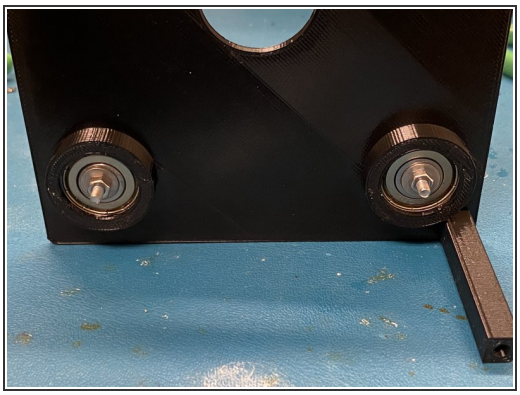
- Insert motor into proper position in orbital shaker enclosure.
- Push potentiometer through hole in front of enclosure and secure with washer and nut. Install potentiomer knob.
- Screw DIYbio orbital shaker PCB into place using M2 x 0.4mm screws.
- Solder previously cut & stripped ~150mm red wire to power switch lead closest to rear of enclosure and push power switch into enclosure.
- Solder red lead from DIYbio orbital shaker +12V connection to the second lead of power switch.
- Connect the free end of the red power lead wire from the power switch to the barrel jack connector & tighten screw. Repeat for black wire from DIYbio orbital shaker. Note: tin both red and black wires going into barrel jack connector before screwing them into place.
- Connect power adapter to barrel jack connector & verify electronics still function as expected. Power barrel jack adapter into slot next to motor. Optionally add adhesive to hold in place if loose.
- Add zip ties to wiring as needed.

Step 13 — Install motor coupler

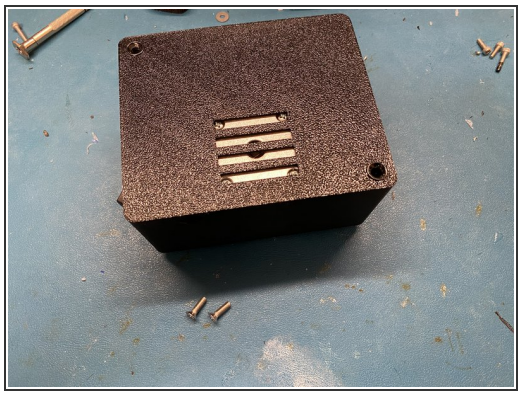
- Insert M3 nut into bottom of motor coupler and push in until hole of nut lines up with hole for coupler screw.
- Apply Loctite blue 242 nut & bolt locker to M3 x 16 screw.
- Thread screw into M3 nut until screw is held in place.
- Slide motor coupler onto motor shaft taking care to align the coupler screw to the notch previously cut into the motor shaft.
- Tighten M3 screw until resistance is felt against motor shaft. Be careful not to over tighten as this can damage the motor coupler.

Step 14 — Add motion links to top of orbital shaker

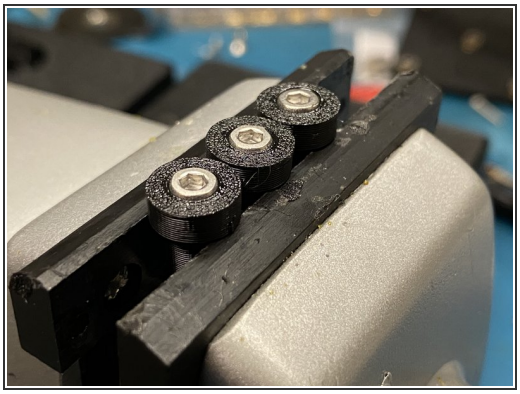
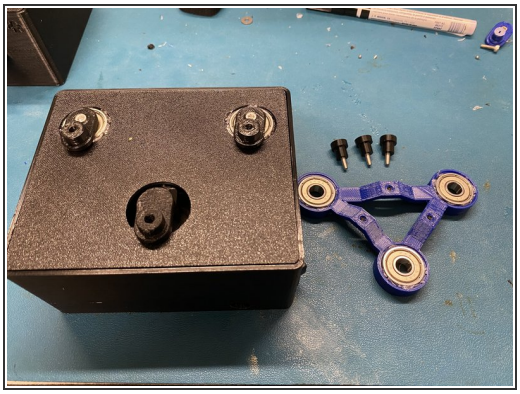
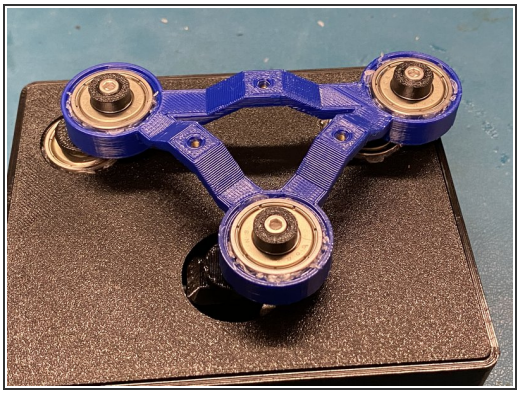
- Apply Loctite blue 242 threadlocker to two M3 x 16 screws.
- Insert 3D printed motion link into bearing.
- Insert M3 screw into motion link.
- Add M3 washer on reverse side, followed by M3 nut.
- Use allen wrench to tighten M3 screw & nut until, but be careful not to over tighten as this can damage bearing.
- Repeat process for second bearing.
- Ensure both motion links spin freely.

Step 15 — Install top of orbital shaker

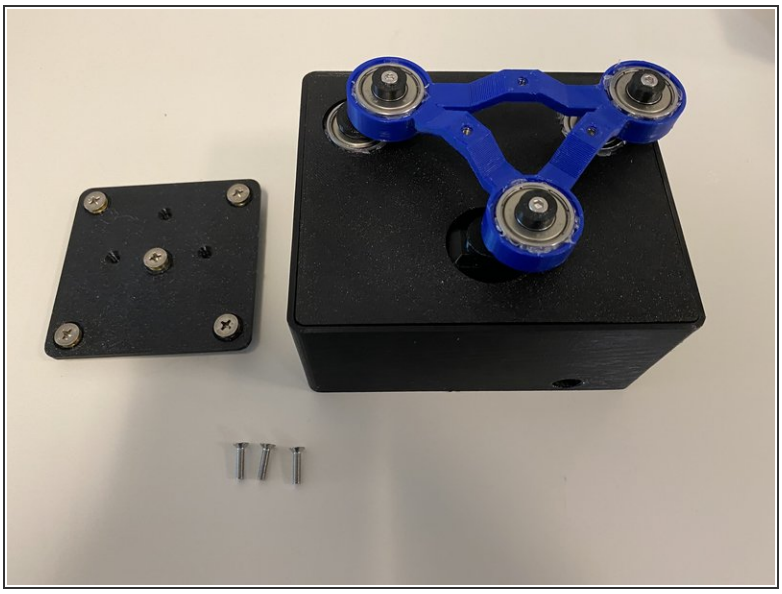

- Insert top orbital shaker piece into place. The top piece will need to be flexed slightly to pass over the top of the motor coupler and then should shift over into the correct location once the coupler is cleared.
- Use two tapered M4 x 12 screws to fix the top of the orbital shaker in place.

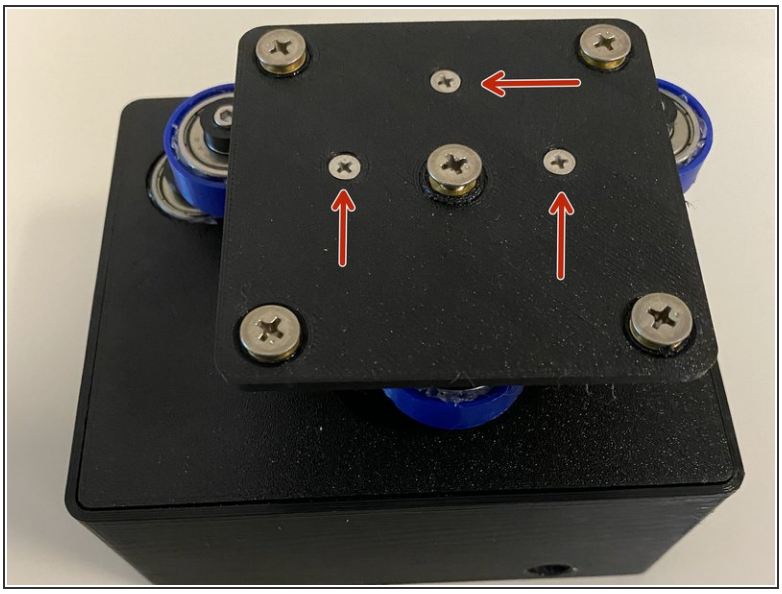
Step 16 — Install top bearing linkage

- Insert M3 x 16 screws into 3D printed screw holders. If top of M3 screw does not sit flush with 3D printed part, use soldering iron to heat & gently push screws down into place.
- Align motor coupler and two motion links to have same orientation.
- Place bearing linkage over motor coupler and motion links. Use M3 screws with 3D printed screw holders to fix the bearing linkage into place. You will need to hold the motor coupler and motion links to keep them from rotating while screwing the M3 screws in.
- Check the assembly by manually moving the top bearing linkage in an orbital path. If there is any resistance noticed in a portion of the path the bearings may be out of alignment and need to be removed and re-glued in place.

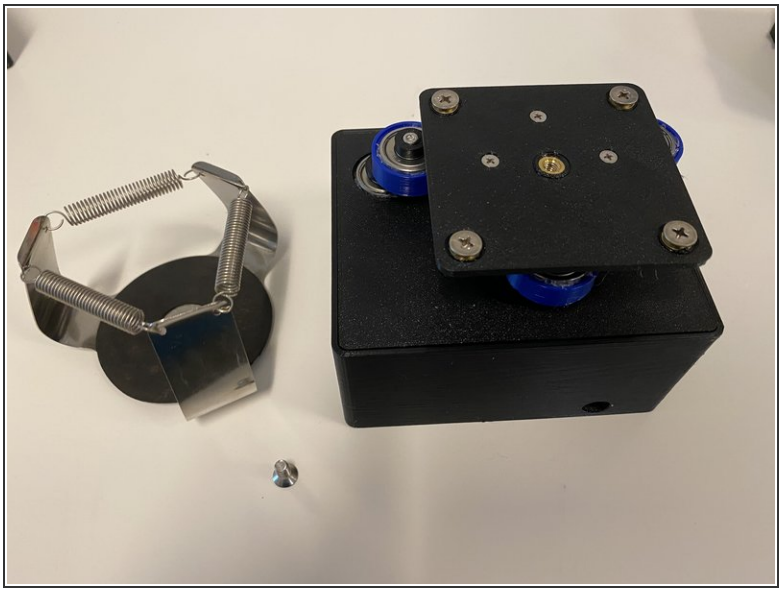
Step 17

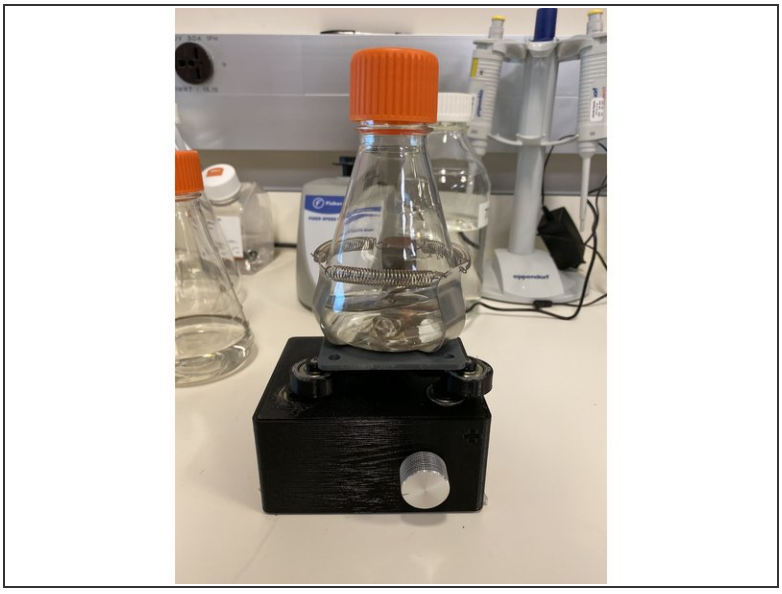




- Use 3 tapered M3 x 12 screws to attach the labware adapter plate onto the bearing linkage.

Step 18 — Install flask holders or other top mounted fixtures





- Remove M5 screws needed to hold flask adapter into place.
- Place flask adapter onto orbital shaker and install M5 screws.
- Congratulations, your orbital shaker is now ready for use!

