

Ultrasonic Screwdriver assembly guide

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Assembly

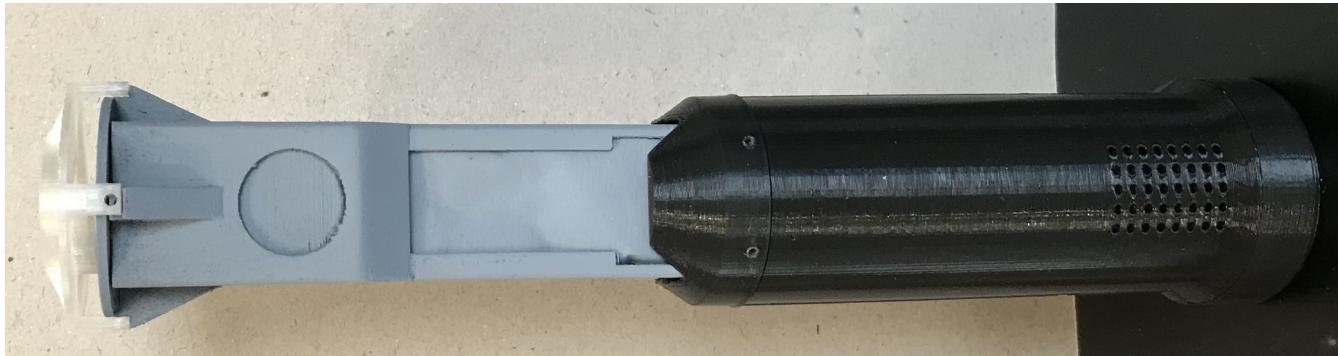
Assembly of the Ultrasonic Screwdriver

3D print

The shells of the Ultrasonic Screwdriver are printed using the STL files in the STL directory.

For the infill, I used the following settings in my CURA slicer:

- Zigzag with 50% infill**



Painting

- **The 3D printed shells were sanded, primed and painted.**
 - Primer:
 - Rustoleum 2x white primer
 - The colour scheme that I have chosen are black, copper, and red.
 - Black: Rustoleum high gloss black
 - Copper: Krylon metallic foil copper
 - Red: Dupli-color metal cast red
 - For the metallic sheen, I used a graphite powder rub.
 - Clear coat:
 - Water based clear *must* be used on the Krylon metallic foil copper and the graphite rub. I used Verathane polyurethane clear high gloss and Minwax polycrylic matt clear coat.
 - For non Krylon painted and graphite rubbed parts, I used Rustoleum gloss acrylic enamel crystal clear.
 - There are many youtube videos on how to prepare 3D printed parts for painting and how to make these parts have a metallic finish.

Painting scheme

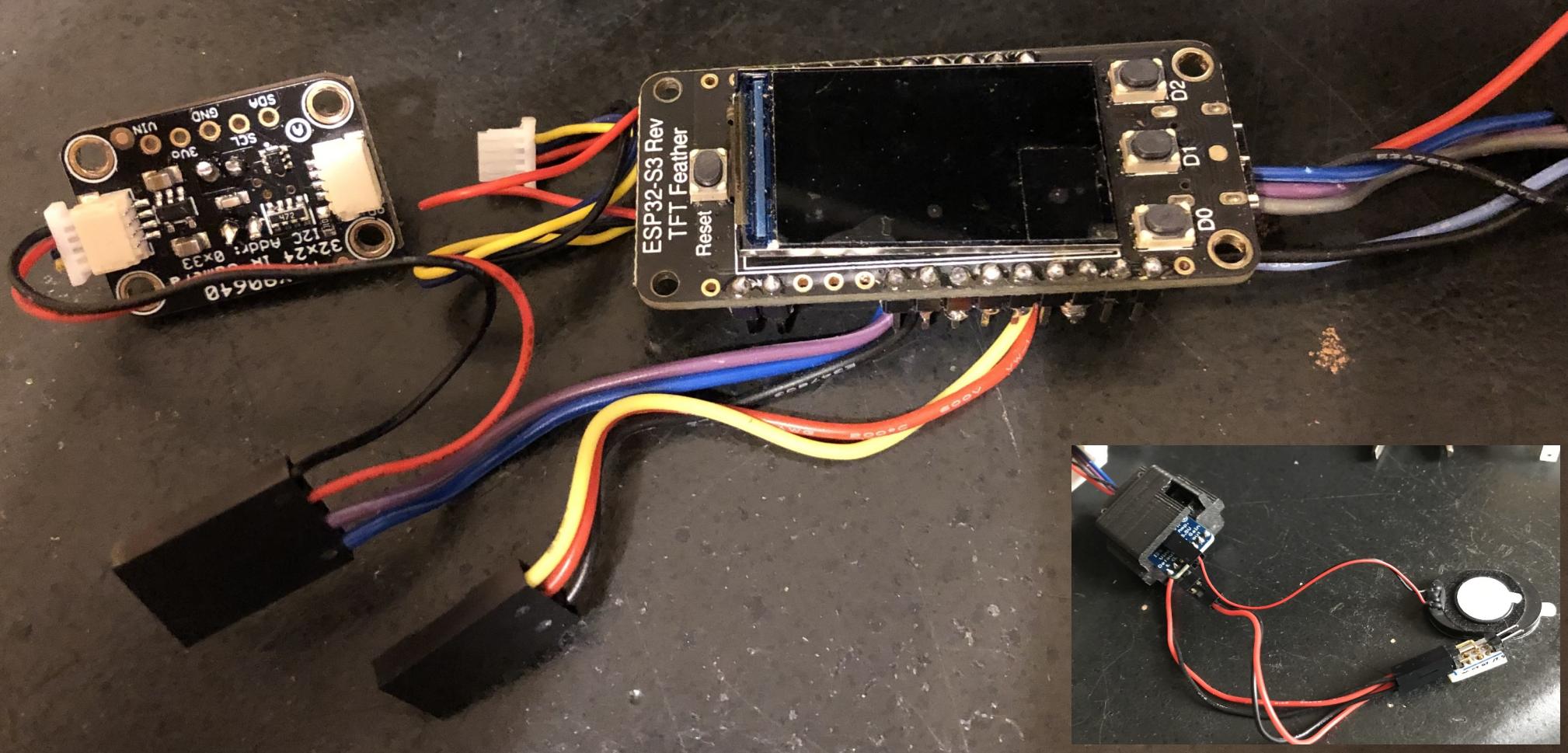


Wiring

- You'll have to do some soldering for connecting the wires to the headers and connectors.
 - I used a pair of needle nosed pliers to crimp the wires to the connectors before soldering them.
 - Here are the connectors that I used that is available from amazon:



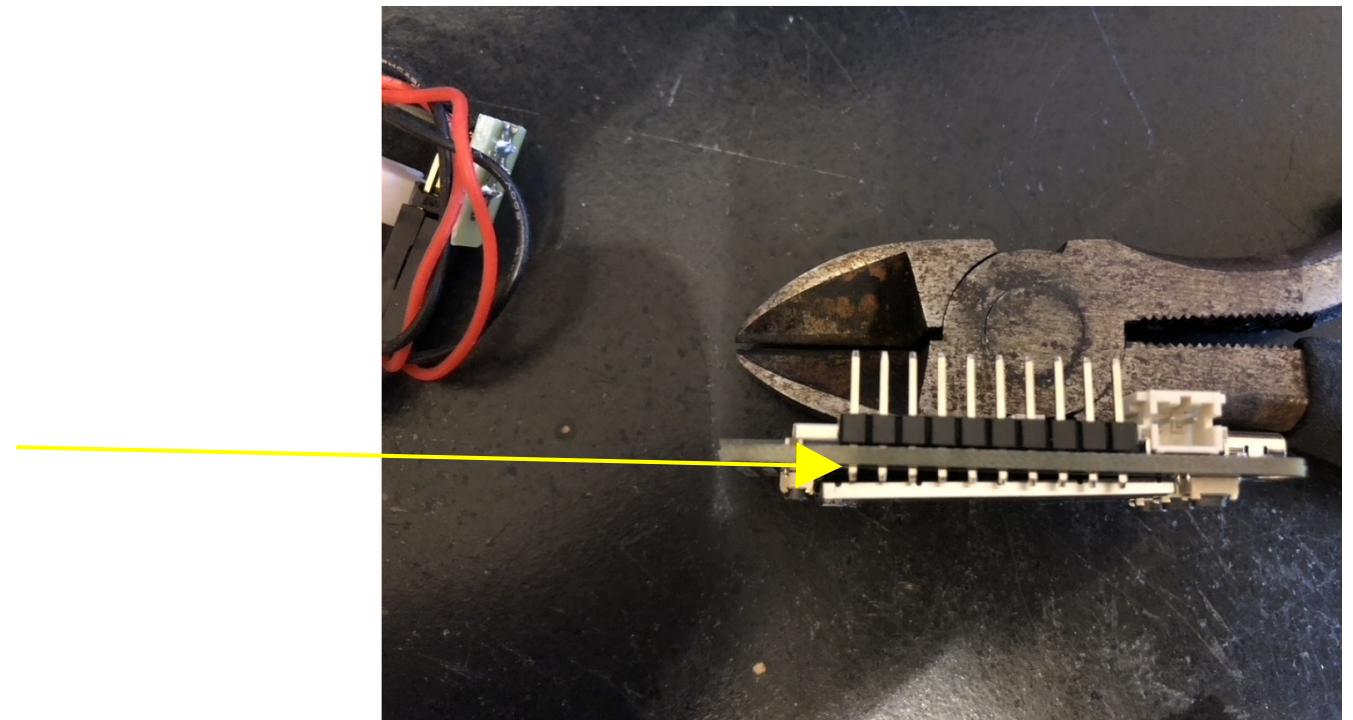
The ESP32 assembly



Trimming headers of ESP32

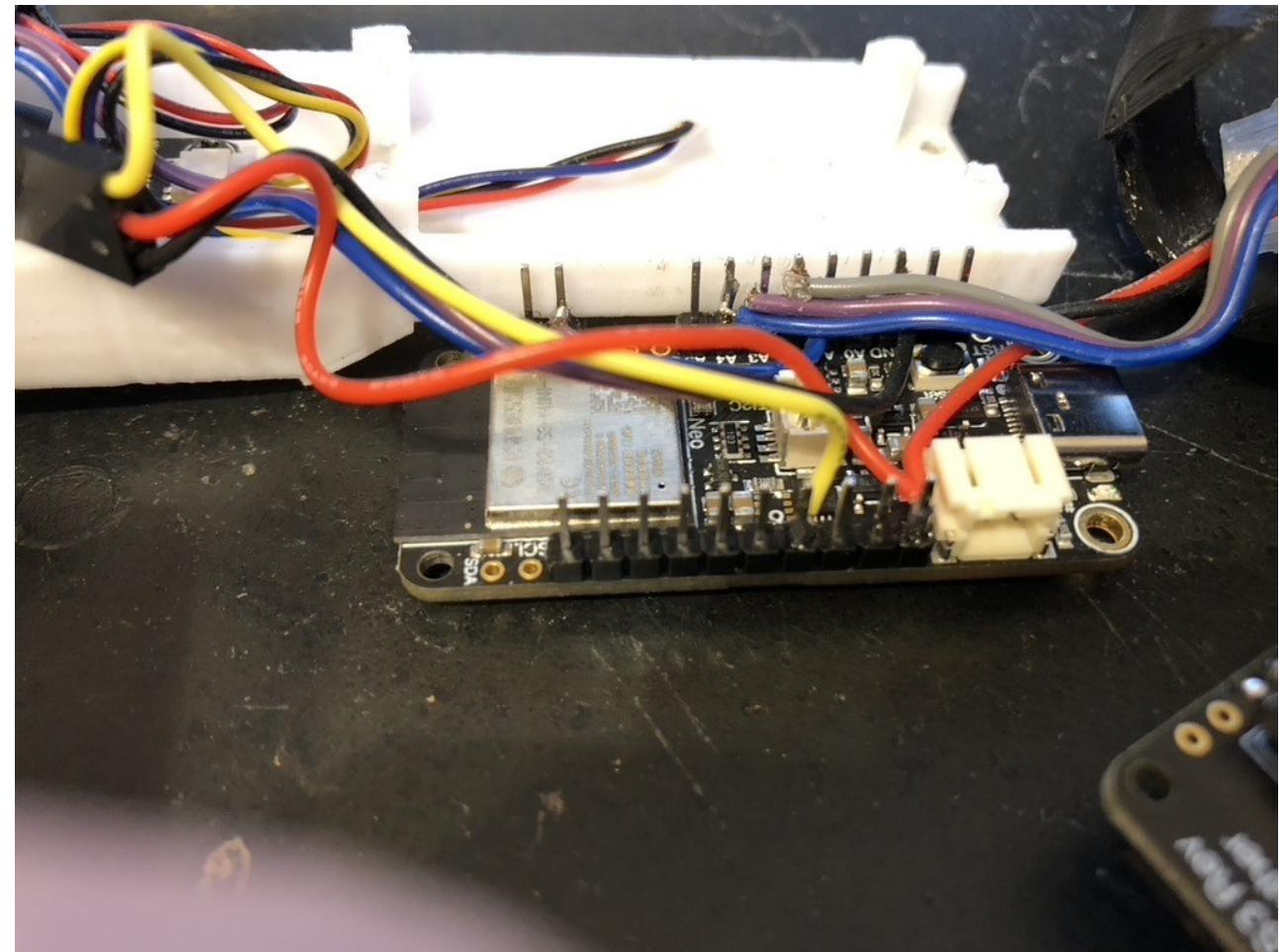
- In order to create a stronger joint between wires and the ESP32, I soldered on headers to the ESP32:
 - Before soldering the header pins were trimmed so that after soldering, the solder does not impede the cover.

These pins have to
be trimmed before
soldering

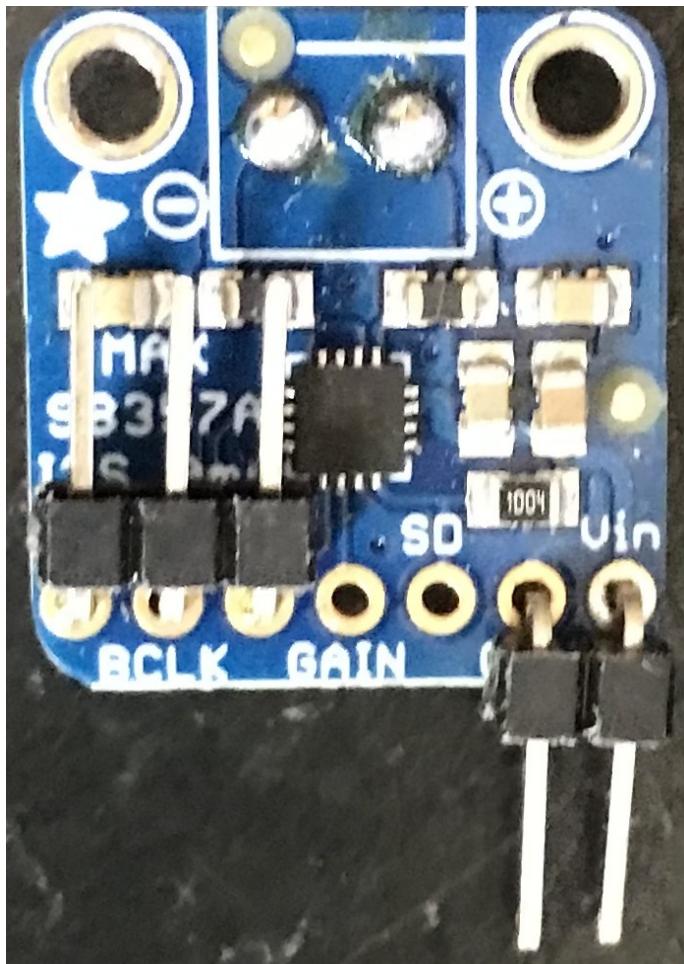


Soldering headers + wires to ESP32

Using the scheme given in circuit/circuit.pdf, the connectors are made and soldered to the ESP32. Make sure that there is enough length to reach all the parts. The wires should not be too long because there is very little space in the handle.

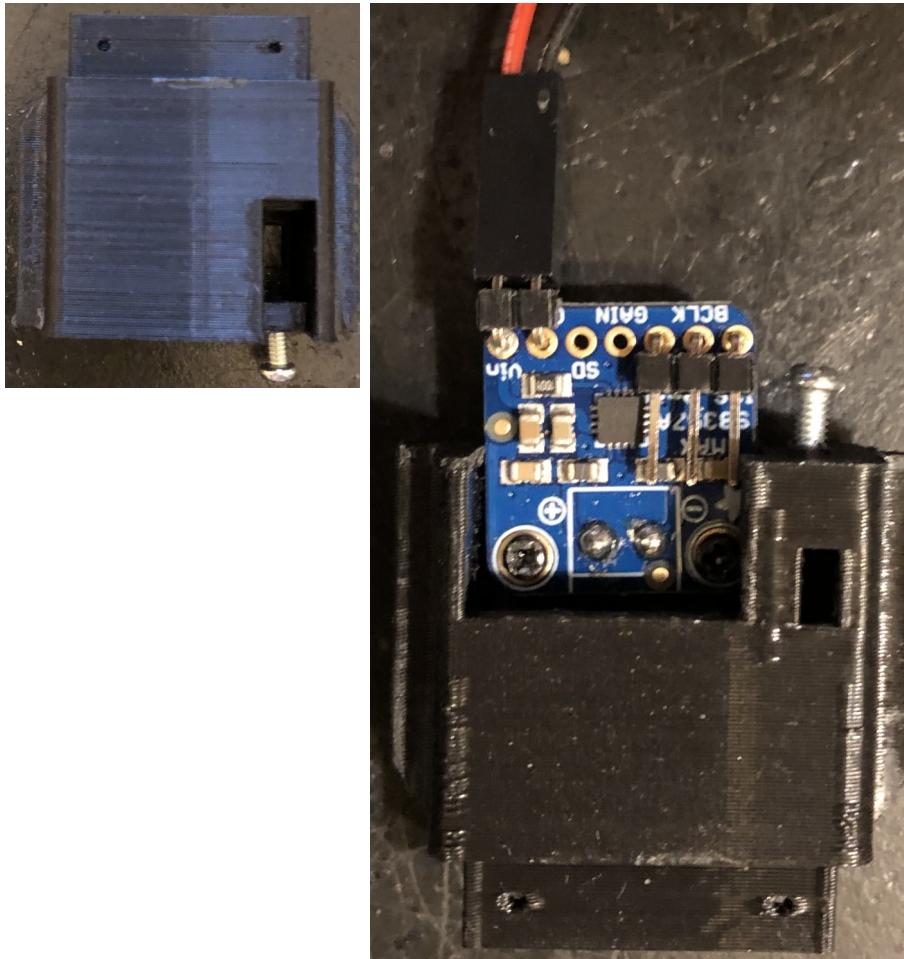


Headers on the I2S amplifier



The headers on the I2S amplifier are soldered in these directions so that the wiring can be properly distributed.

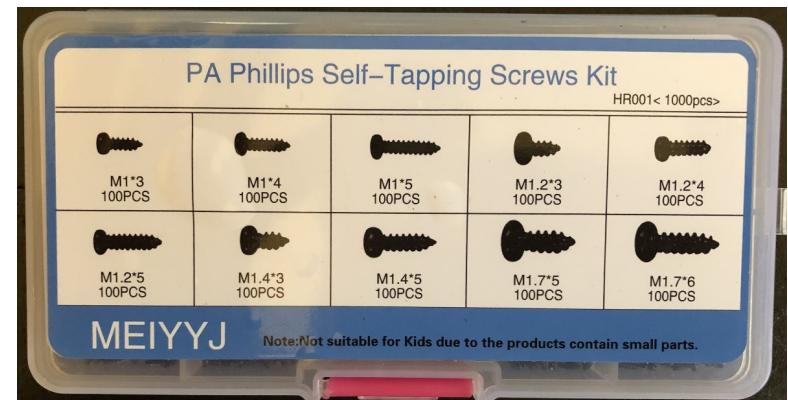
I2S amplifier and tail section



The I2S amp is screwed into the tail section using M1.7x6 screws.

A 2-56 screw for securing the toggle switch is also shown here.

The metric screws that I used are these:



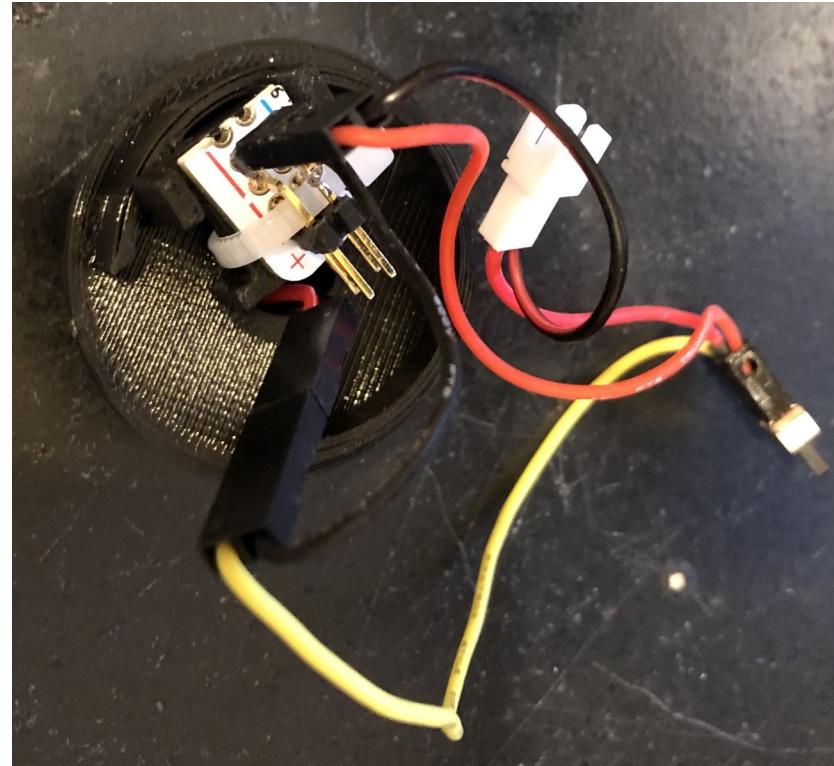
Power distribution



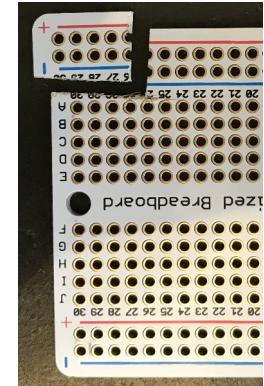
Charger side
of the endcap



Internal side of
the endcap

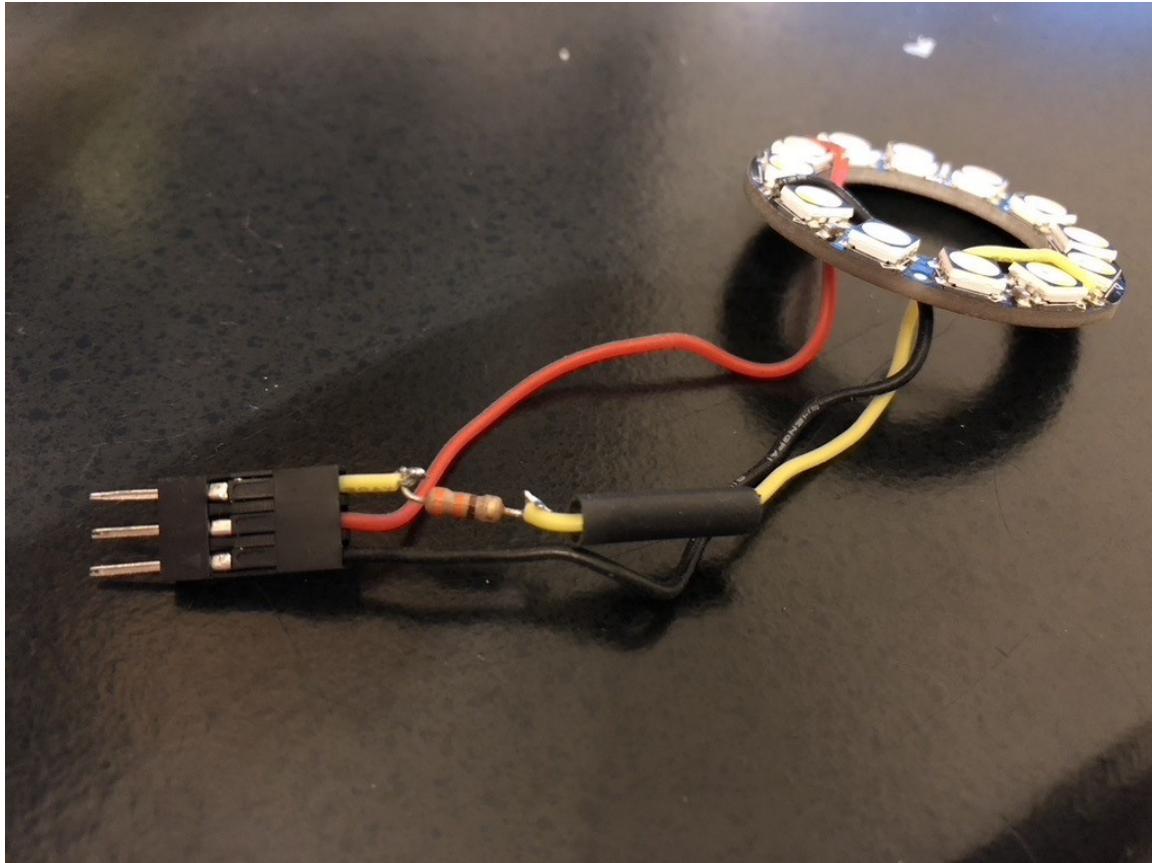


Power distribution wired according to circuit.pdf. The breadboard is secured with a zip tie.



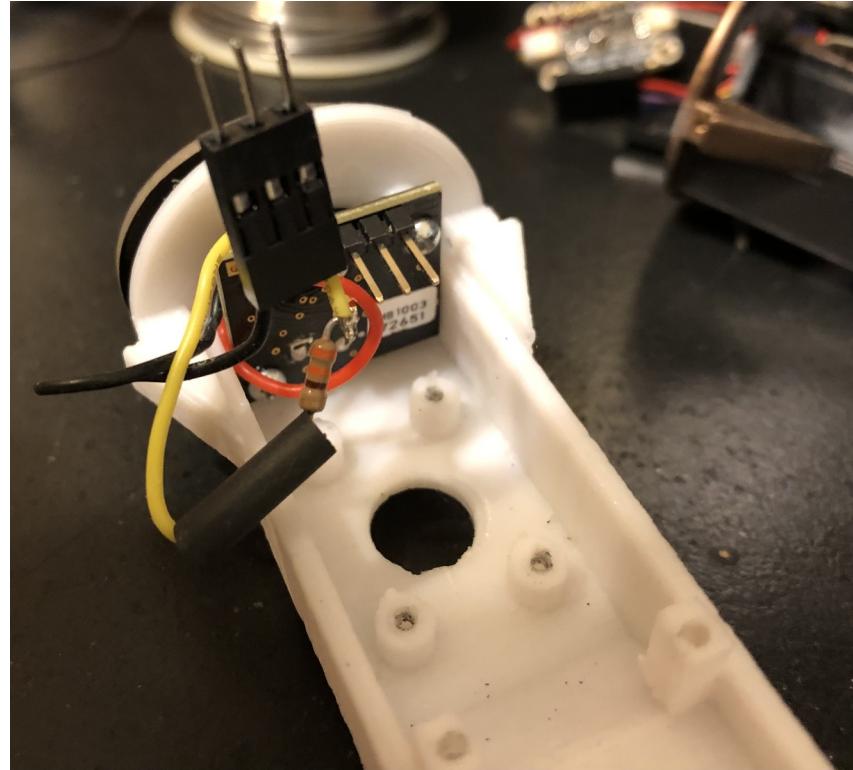
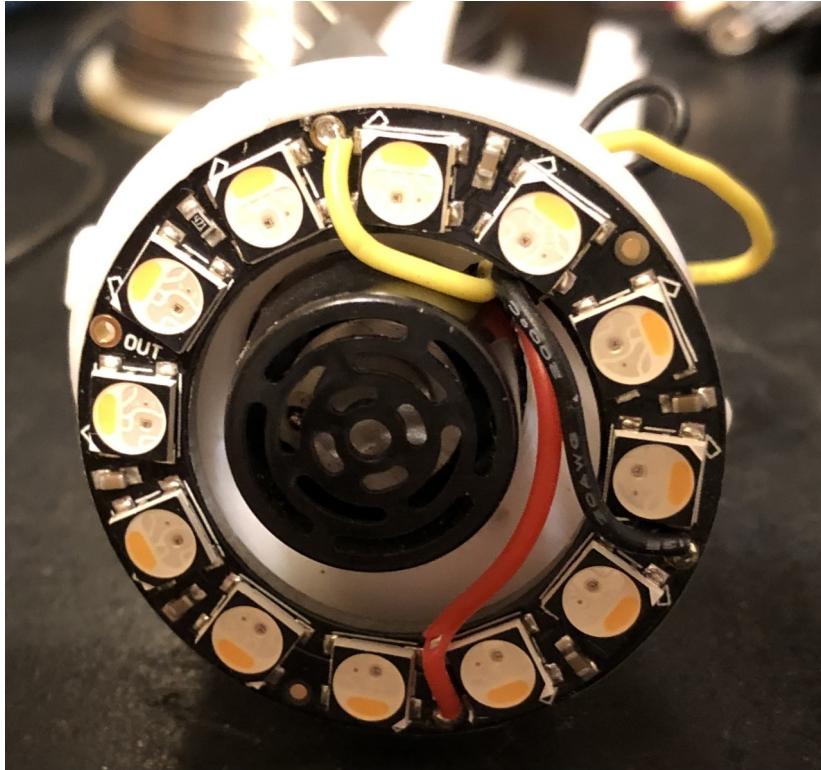
Breadboard
size

Neopixel ring assembly



A 330 ohm resistor is soldered between the “IN” of the ring assembly and the pin. A heat shrink tubing is heat shrunk over the resistor to prevent shorts to other components.

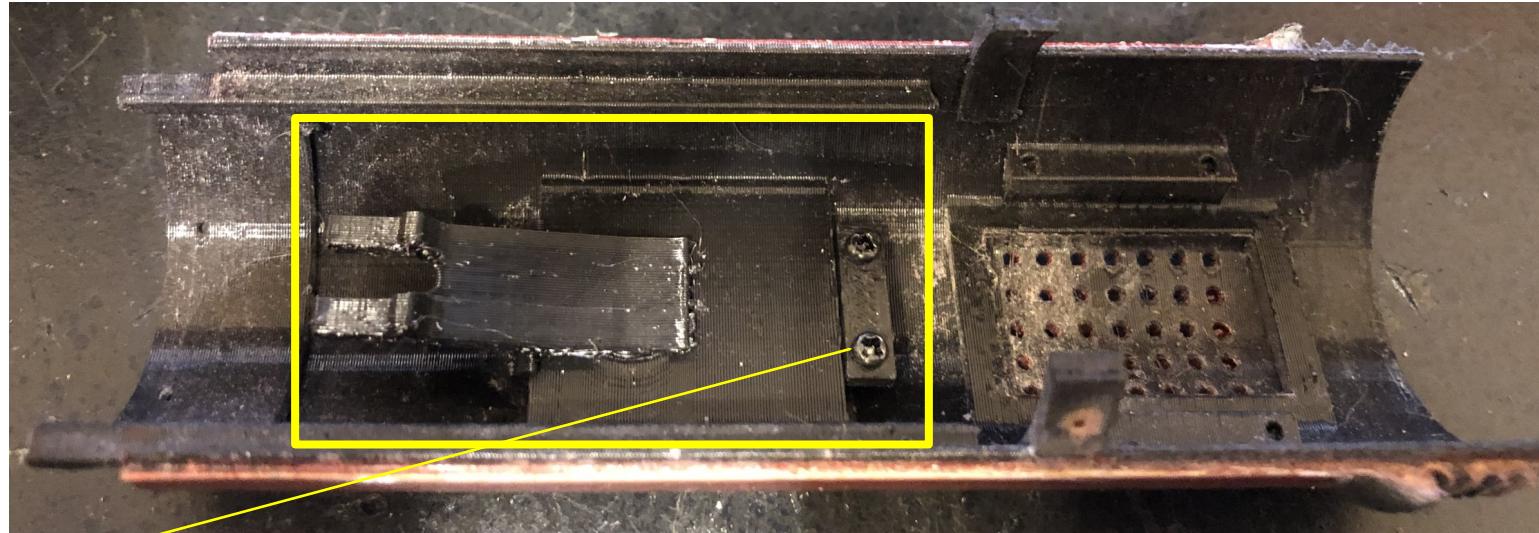
Neopixel and ultrasonic ranger assembly



The ultrasonic range finder is secured to the inner shell after the wires from the neopixel are slipped out behind it.

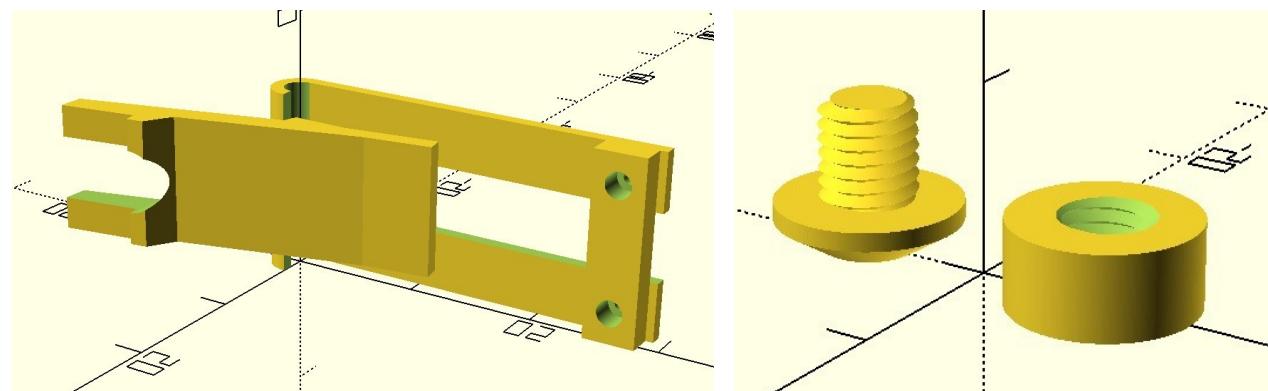
The range finder is secured using 2-56 screws.

Spring assembly

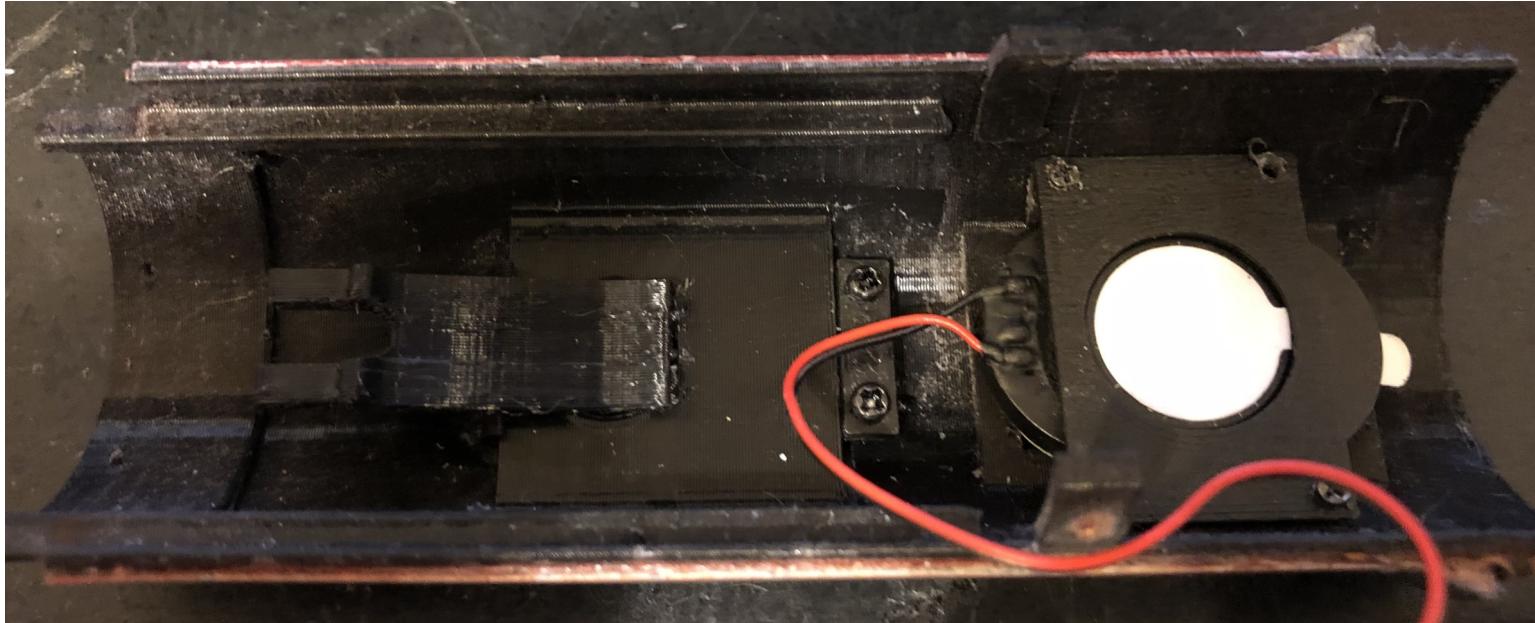


The crossbar is secured using M1.7x5 screws.

The pushbutton with plunger pushes the spring mechanism out

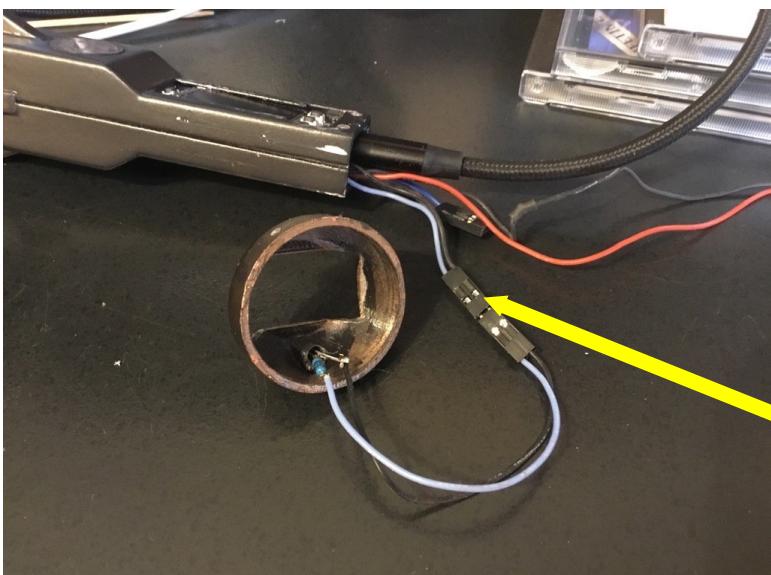


Speaker assembly



The speaker is secured to the outer shell using M1.4x5 screws. I only secured 2 corners because the depth of the standoffs here is quite shallow and it was hard to get the screws into them.

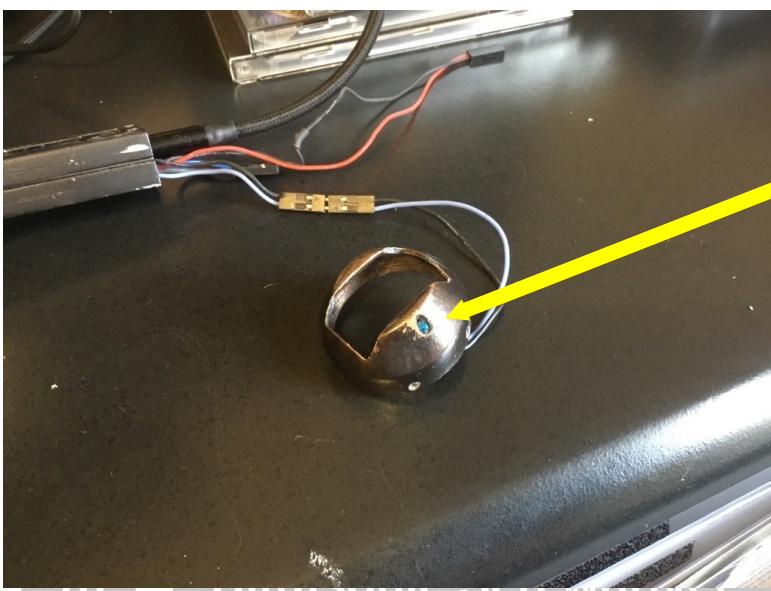
IR diode and battery assembly



There is a 100 ohm resistor soldered to the anode of the IR diode (1.8 mm).

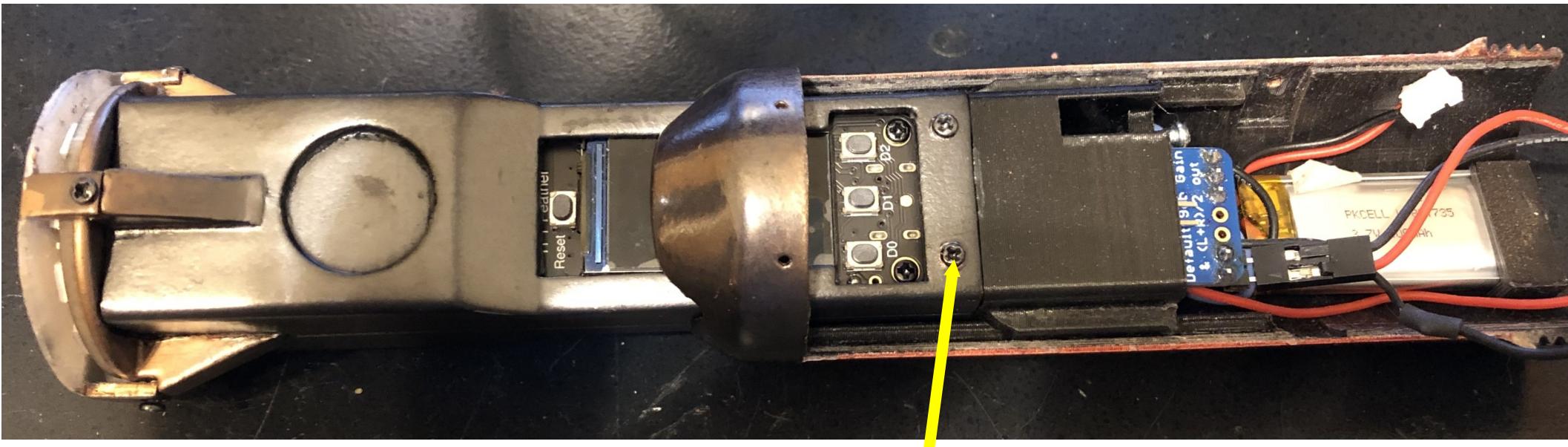
The diode has to be inserted and mounted into the cone and then the resistors and wires soldered. This has to be done very carefully because if the soldering iron touches the cone, it will melt/damage it.

The IR diode is connected to the ESP32 with this connector



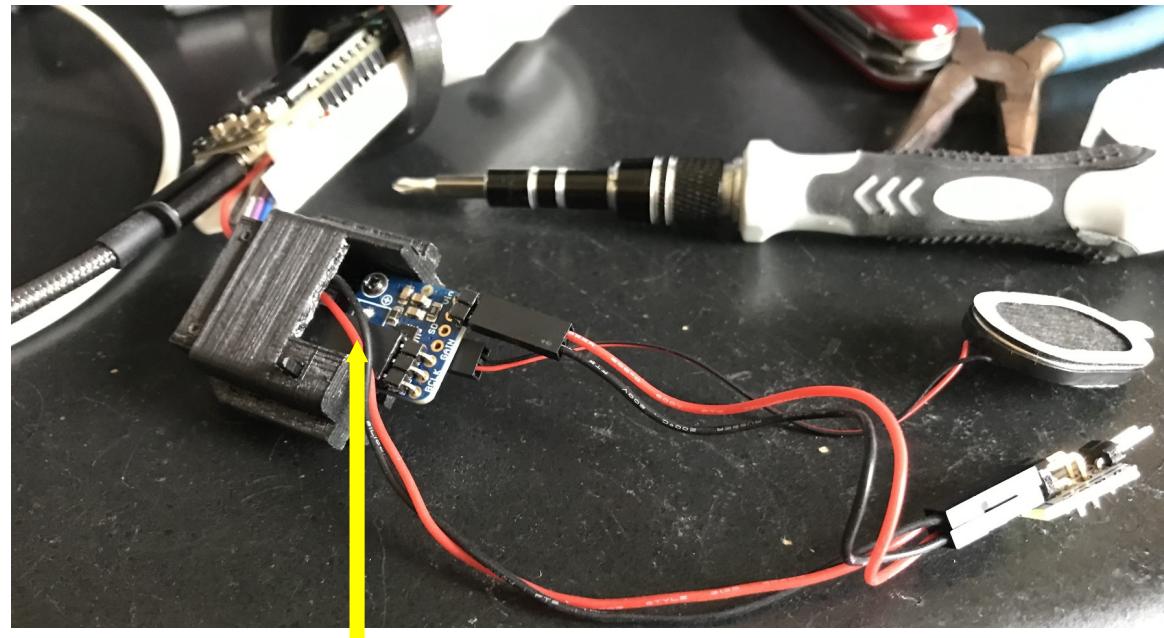
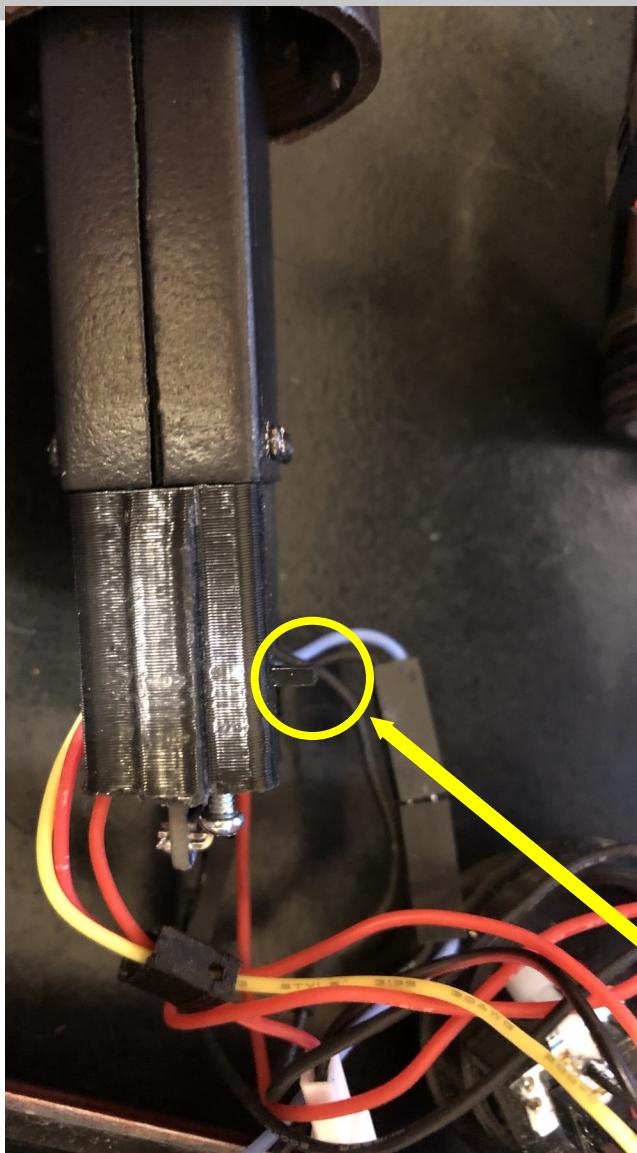
The diode is inserted it from into the hole of the cone from the “outside” in.

Assembling half the screwdriver



The screws used here are M1.7x6 and M1.7x5. The M1.7x5 screws are only used to secure the tail piece to the inner shell.

Toggle switch and connecting to I2S amp



I2S is connected to the ESP32 with a 3 pin header connector

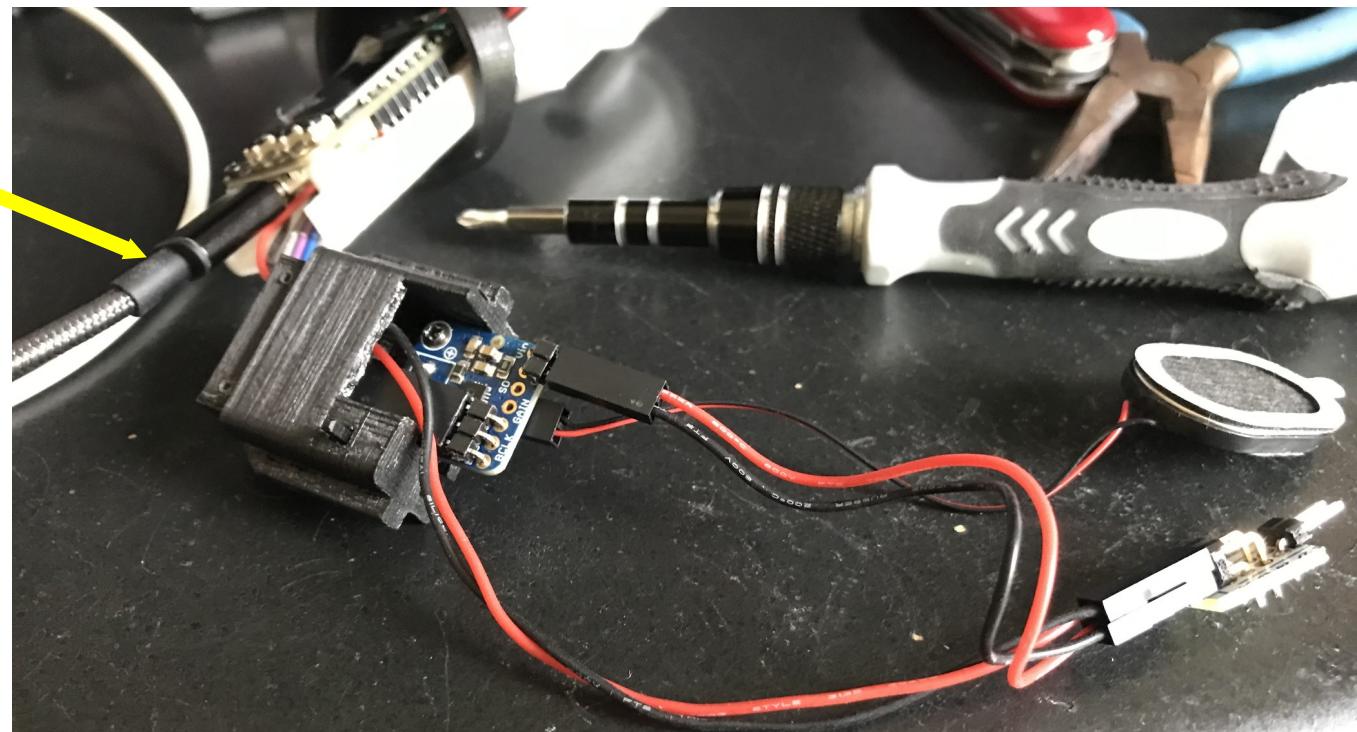
Make sure the toggle switch sticks out squarely before securing it with the 2-56 screw.

Programming

Unfortunately, the Ultrasonic Screwdriver can only be programmed when the screwdriver is mostly disassembled.

The USB C cable is connected like this

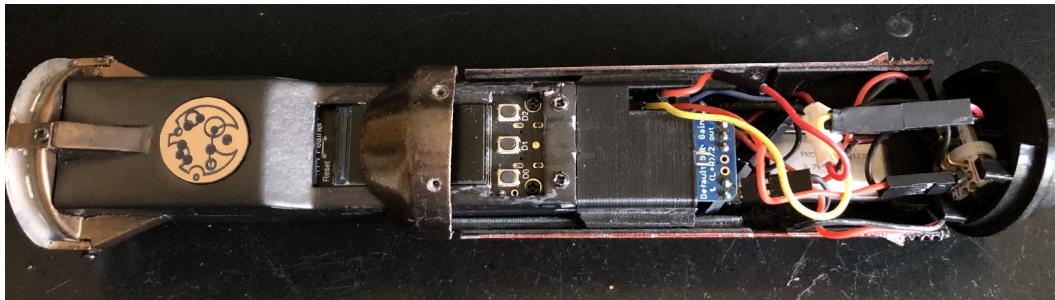
Use the source code in ultrasonic_screwdriver to program the ESP32.



Everything together

If everything is done correctly, the assembly should fit properly and the screwdriver will turn on when the screwdriver is extended and shutoff when the screwdriver is closed.

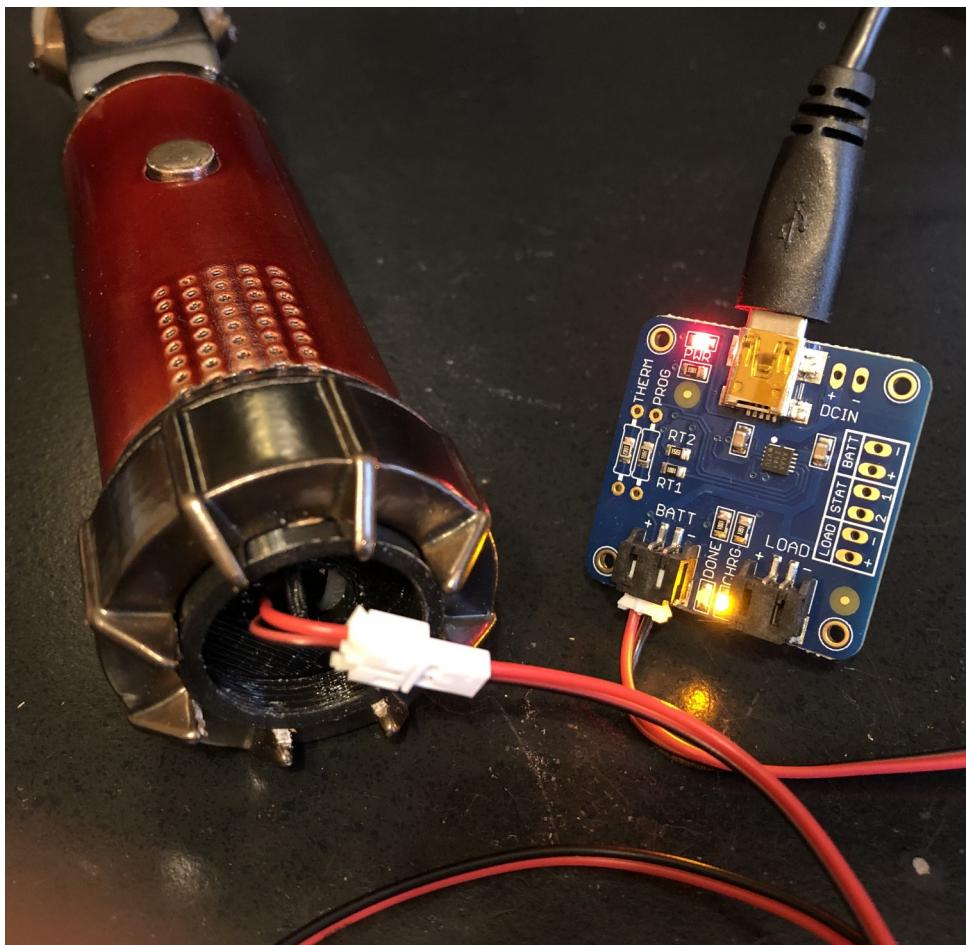
Note: It is critical to arrange the wires and connectors so that the sliding mechanism is clear of obstructions. I do this by having either the top or bottom half of the handle removed and then moving the wires and connectors to clear them away from the slides. When I do this properly, I can easily extend the screwdriver with a flicking motion.



I have made a [youtube video](#) to show what the screwdriver can do.



Charging the LiPo battery



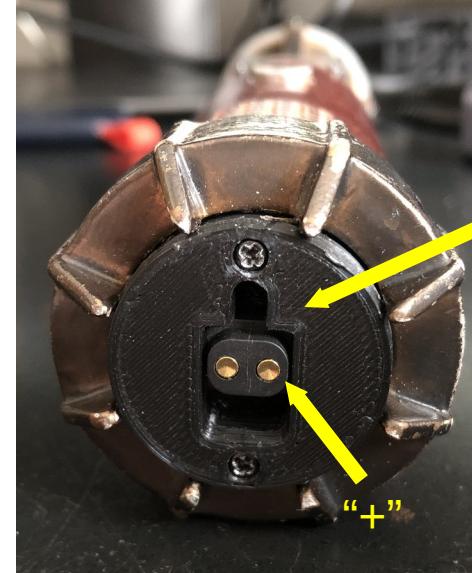
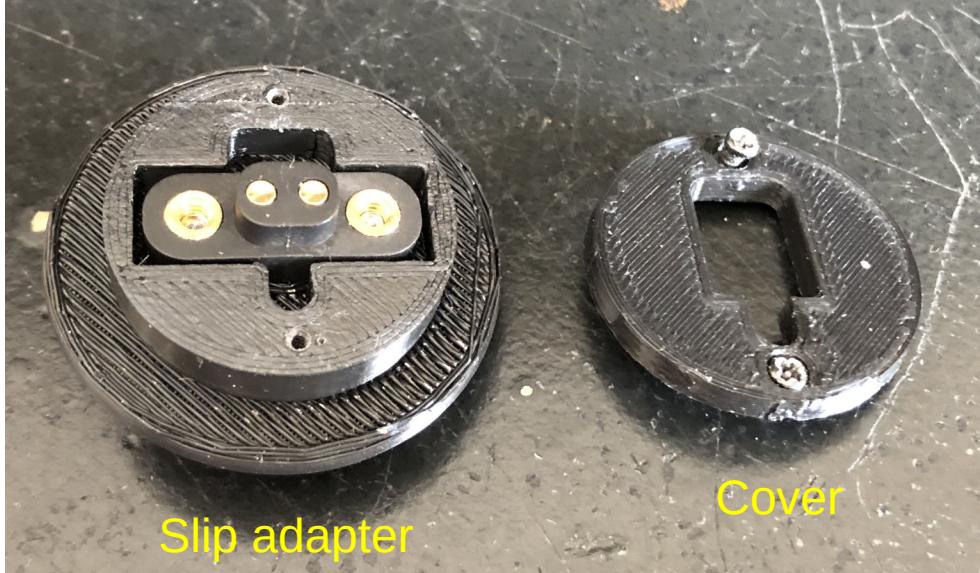
The LiPo is charged using
[Adafruit Lilon/LiPo charger \(part #259\)](#).

Note: The screwdriver ***must*** be in the closed position for charging.

Do not turn on the screwdriver while charging. It will cause damage to the ESP32 onboard charging circuit. I did not use the onboard charger because of the way I wired up the parts.

Note: In version 2, it is no longer necessary to unscrew the bottom to connect its plug to the LiPo charging socket. This is discussed in the next slides.

Power charger v2



Cover
screwed
onto the slip
adapter.

In v2 of the power charging circuit, the LiPo charging plug is replaced with a spring connector made by Mill-Max. What is shown here is the “female” connector of the spring connector. The “female” spring connector is not springy but looks like cups.

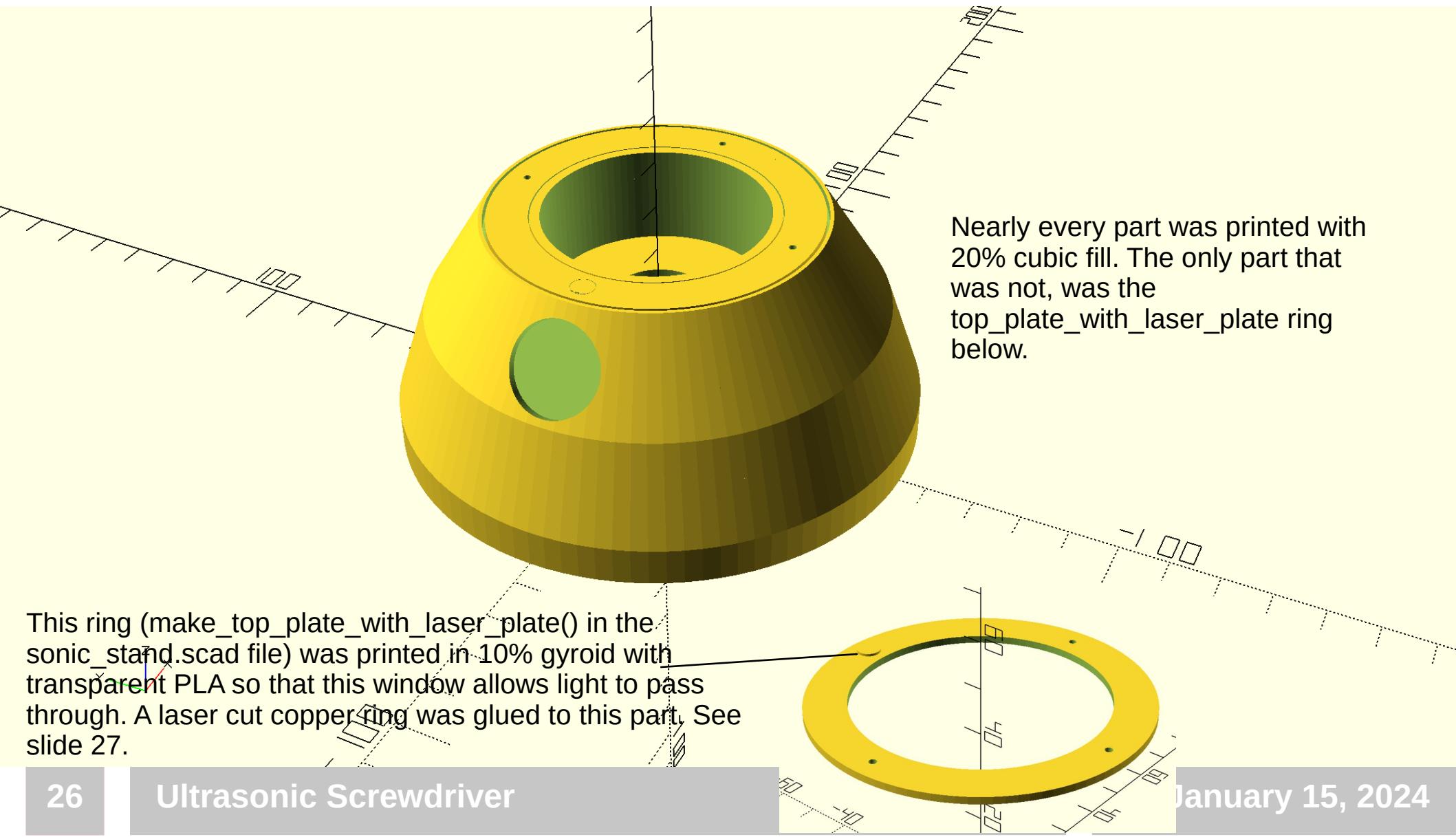
For reference, the “+” is on the right in this photo. **It is critical that “+” matches the spring connector in the charging stand.**

The “female” connector is connected to the 3D printed part with a $\frac{1}{4}$ ” 4-40 screws. The cover is screwed onto the slip adapter. The usefulness of the cover is that it can be sanded, filled and painted separately.

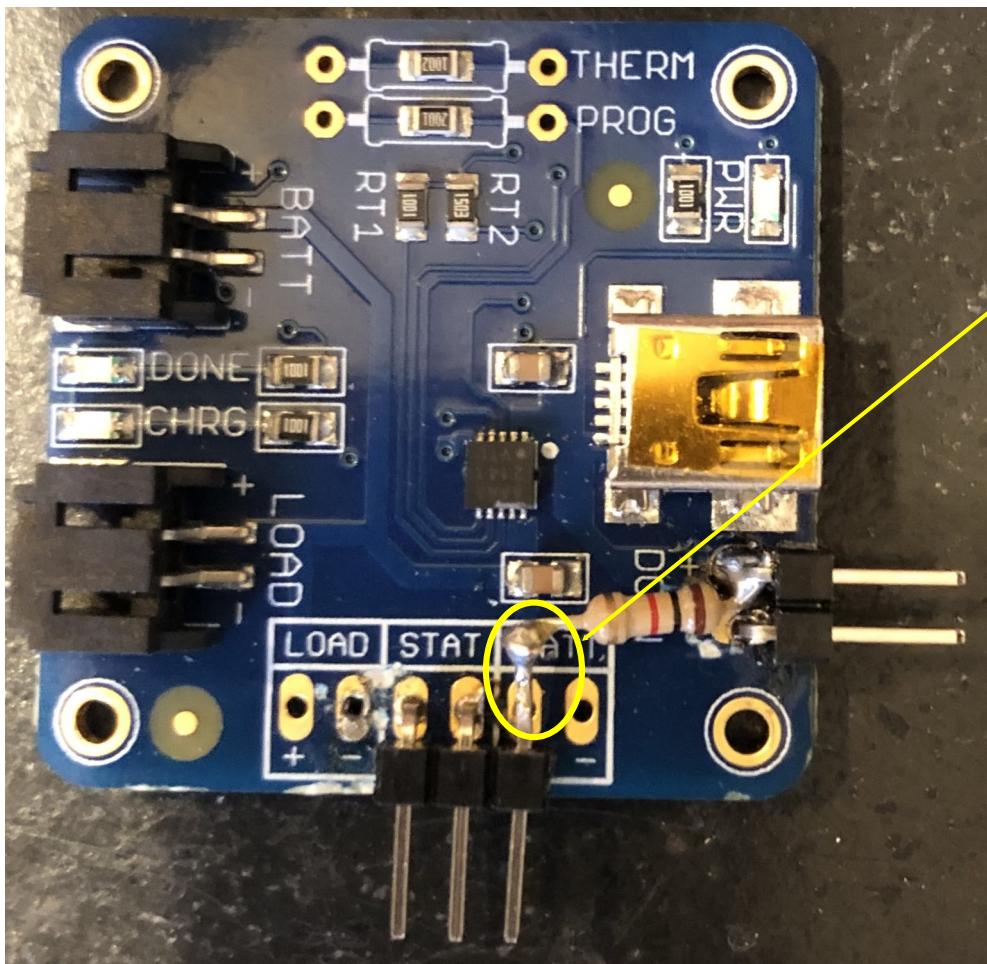
Assembly

Assembly of charging stand

Charging stand



Charging circuit modification



The 3 pin header has one of its legs straightened so that a $1\text{ k}\Omega$ resistor can be soldered between the 5V (one of the 2 pin power in header) and this leg. See photo.

Gallifreyan top ring



The top ring for decorating the charging stand is made using the SVG file: top_plate_ponoko2.svg

The svg file was sent to www.ponoko.com for laser cutting. The material is 0.5 mm copper on black adhesive-backed plastic.

The copper ring is then adhered onto a 3D printed translucent ring. See slide 25.

I inserted screws into the laser cut decoration ring for aligning it into the 3D printed ring.

Painting scheme



Primer + copper +
metal cast red + acrylic
enamel crystal clear

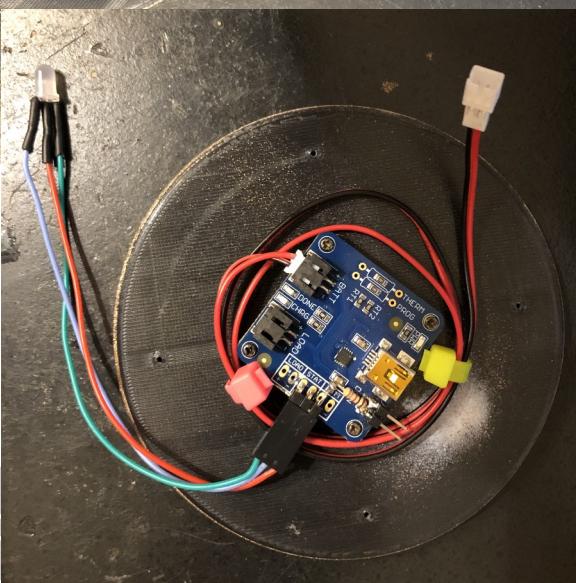
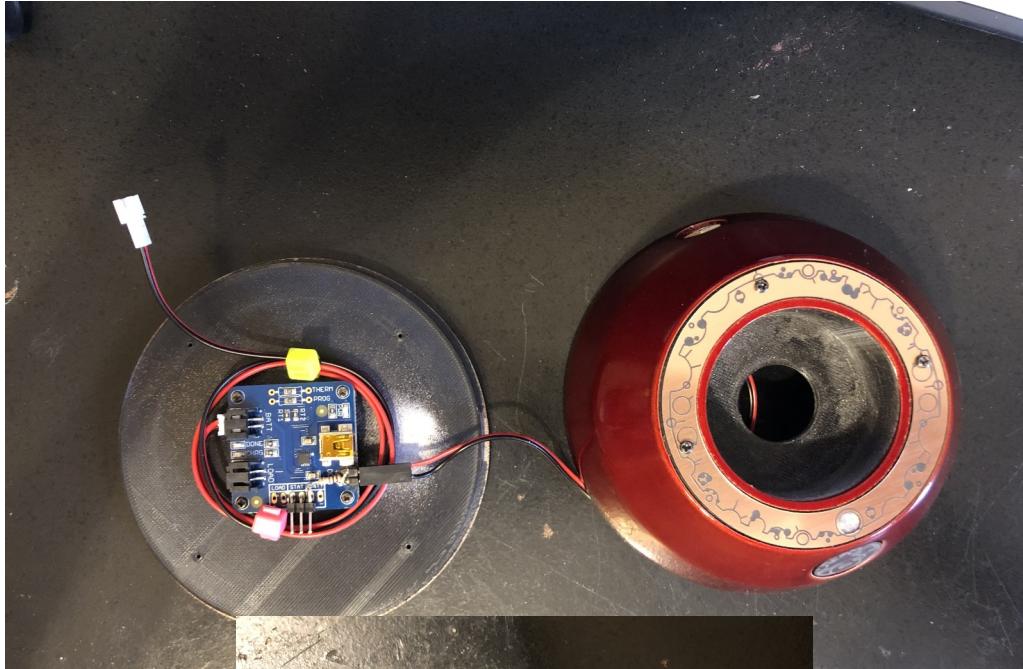
Primer + copper +
graphite +
polyurethane (high
gloss)

Bottom of the stand



One anti-skid pad is adhered to the centre island on the bottom cover.

3D stand assembly (v1)



The 3D printed stand was sanded and painted.

The charging circuit was attached onto the bottom cover.

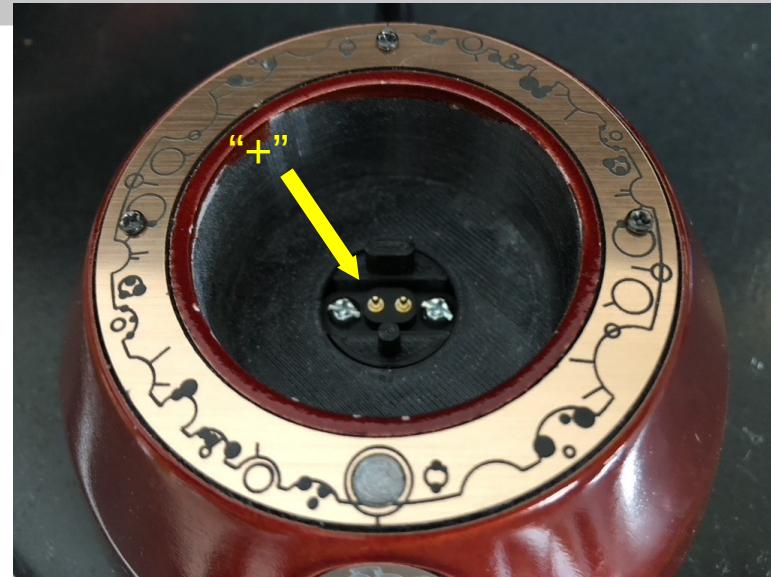
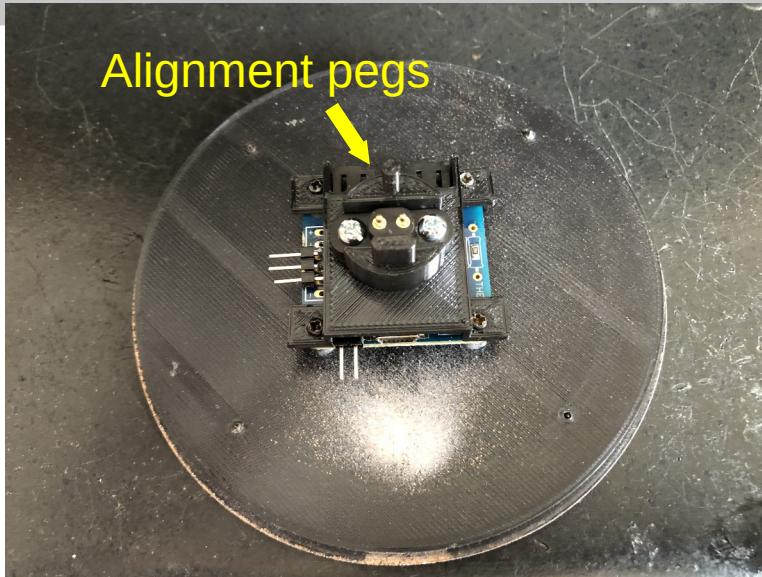
The decorating ring was screwed onto the stand.

A signature piece was glued into the recess of the stand.

A 2.1 mm power jack was screwed into the the stand.



3D stand assembly (v2)



In the upgraded version 2 of the charging stand, a new part *alignment_pegs.stl* is screwed together with the LiPo charging PCB into the cover of the charging stand.

Note: The spring connector made by Mill-Max is connected to the alignment_pegs with 3/8" 4-40 screw+nut.

In this photo, the "+" connector is on the left. **It is critical that that the "+" connector here matches the "+" at the end of the Ultrasonic screwdriver.**

Charging the ultrasonic screwdriver



Charging
(LED is red)



Done
(LED is green)

A 5 V DC wall wart charger with a 2.1 mm barrel plug is plugged into this unit for charging the ultrasonic screwdriver.

Completion

The completed ultrasonic screwdriver in its charging stand

The completed ultrasonic screwdriver in its stand

