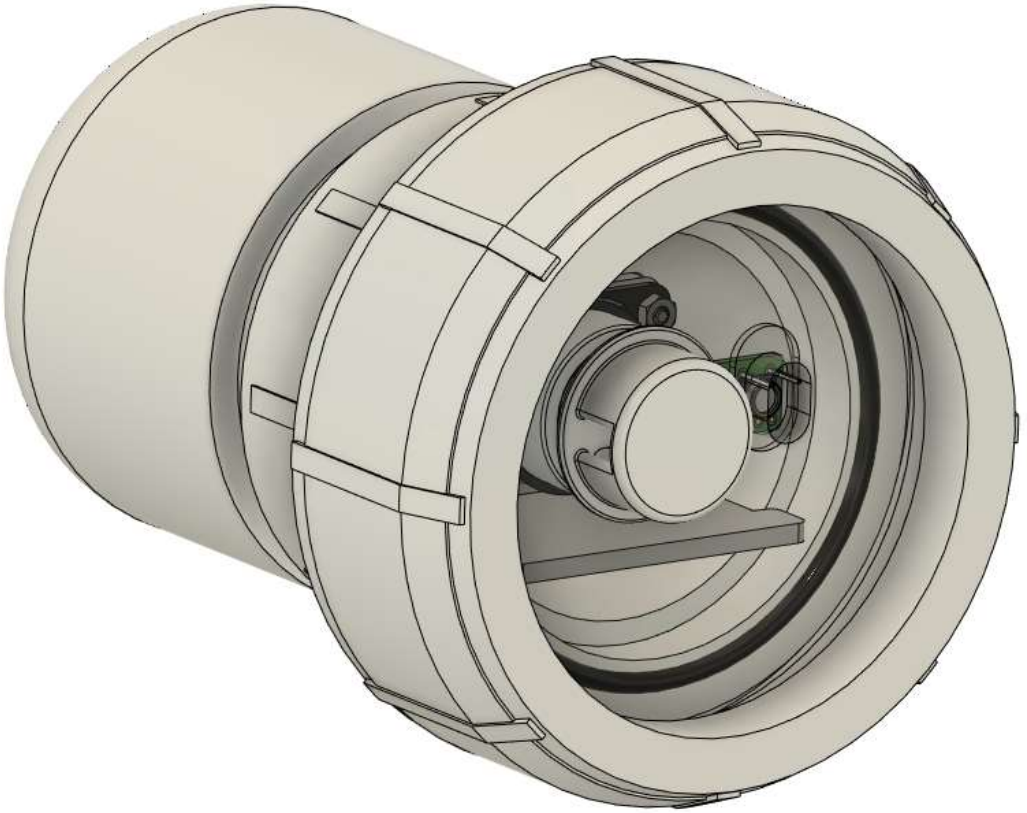
Smart Rock

User Guide



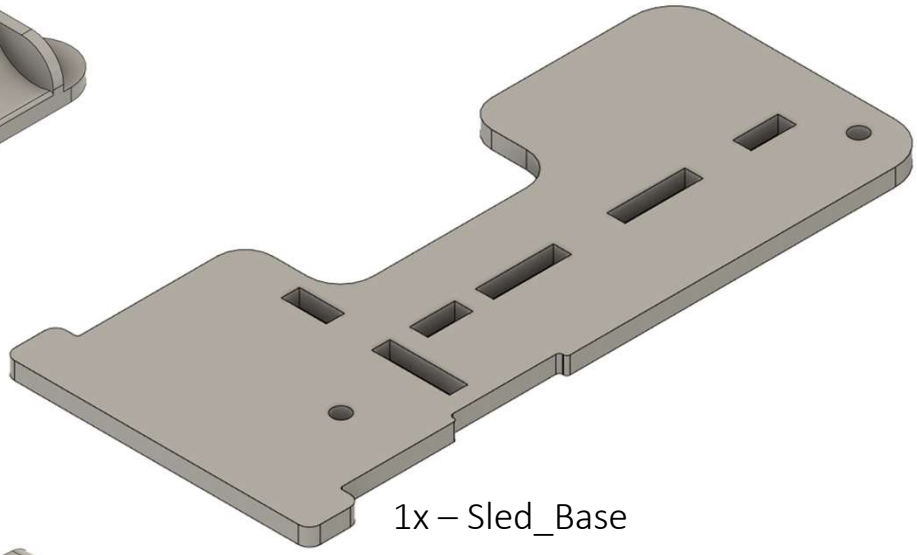
Kit Materials

Some kit contents can be found inside the enclosure.

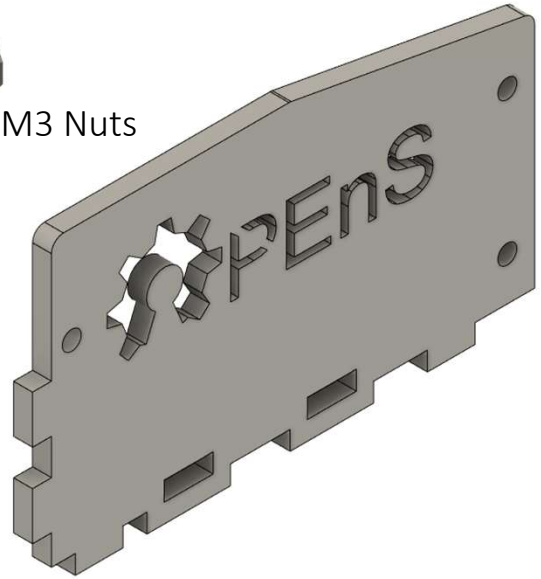
7x - M3x10mm

12x - M3 Nuts

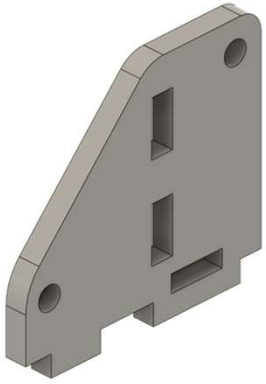
1x – Battery_Mount



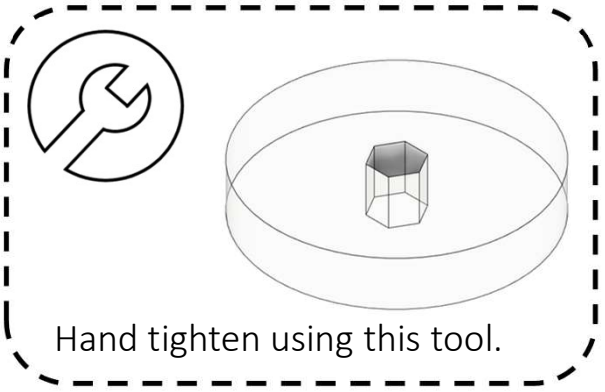
1x – Sled_Base



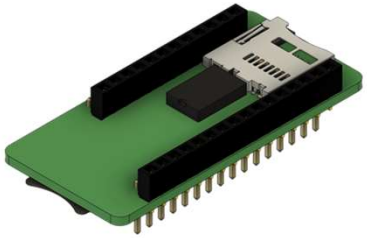
1x – Electronics_Mount



1x – Turbidity_Mount



Hand tighten using this tool.



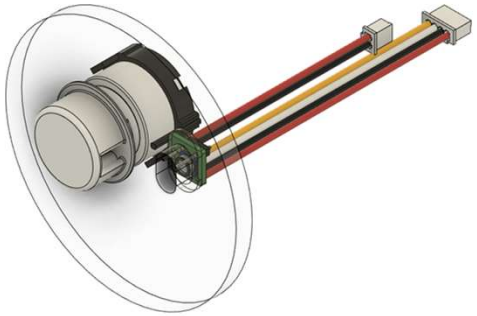
1x – Hypnos Board

1x – EC Breakout Board

1x – Turbidity Cable

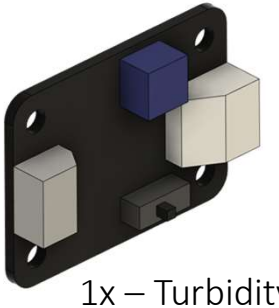
1x – CR1220

1x – Feather M0

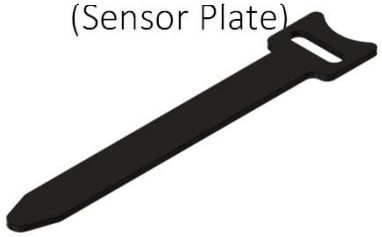


1x – Acrylic_Faceplate
(Sensor Plate)

1x – Male-Male 3-pin JST 100mm



1x – Turbidity Breakout Board



1x - 3” Cable tie

Other Materials

2x – 5g Desiccant
1x – Moisture Indicator card
1x – Micro-USB Cable
1x – Micro-SD to SD or USB Adapter
1x – LiPo Battery Charger
1x – Electrode Rinse Solution (DI water)
1x – 10 µS/cm Solution
1x – 447 µS/cm Solution
1x – 1413 µS/cm Solution
4x – Pipets
8x – Disposable Cups
10x – Coffee Creamer
1x – Ruler
1x – Digital Thermometer

1x – SD Card

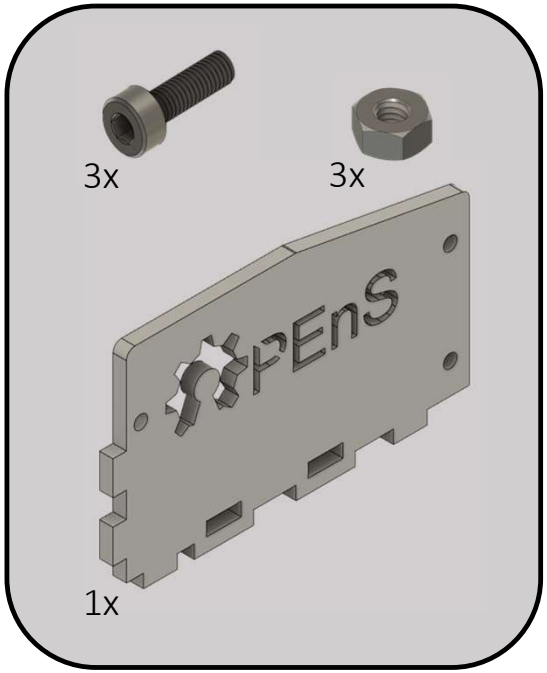

1x – LiPo Battery

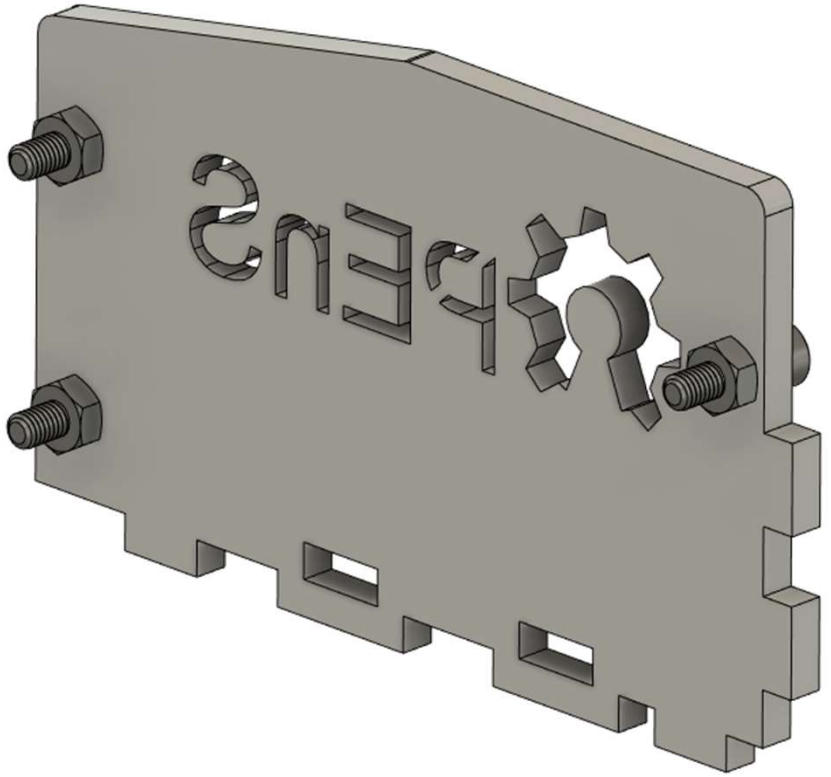
Battery Safety

Lithium batteries are safe for the most part, but we must still be aware of the risks. They are unlikely to fail during normal operation however while charging they can pose a higher risk of combustion.

Before charging or operation visually inspect the battery for any damage or bloating of the battery. If it is showing any sign of damage do not charge or use the battery, find a responsible way to recycle it to prevent spontaneous combustion.

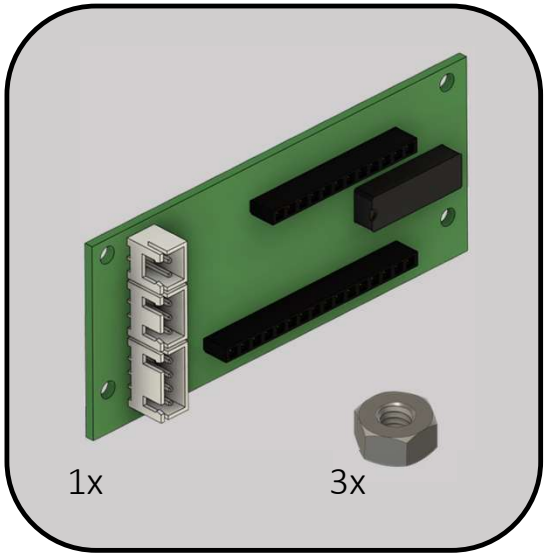
Please use a proper 3.3v LiPo battery charger. Do not use a NiMH, NiCad, or Lead-Acid charger.

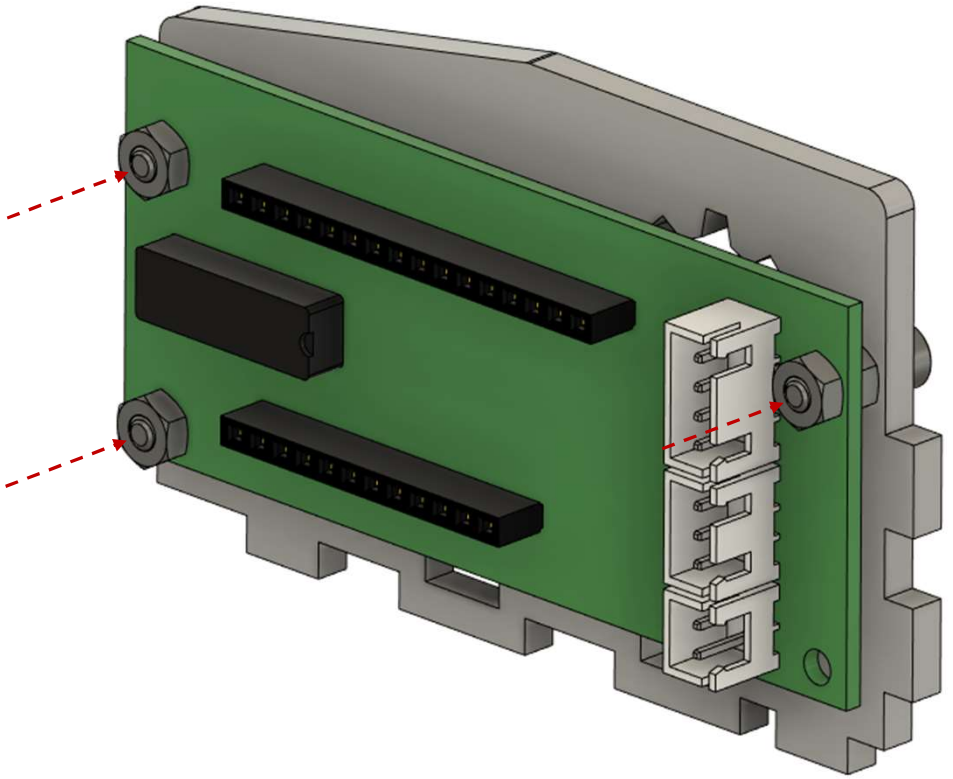


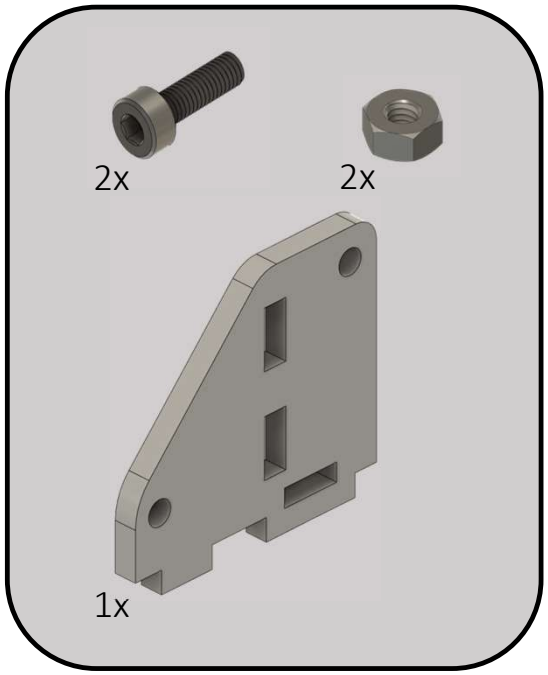


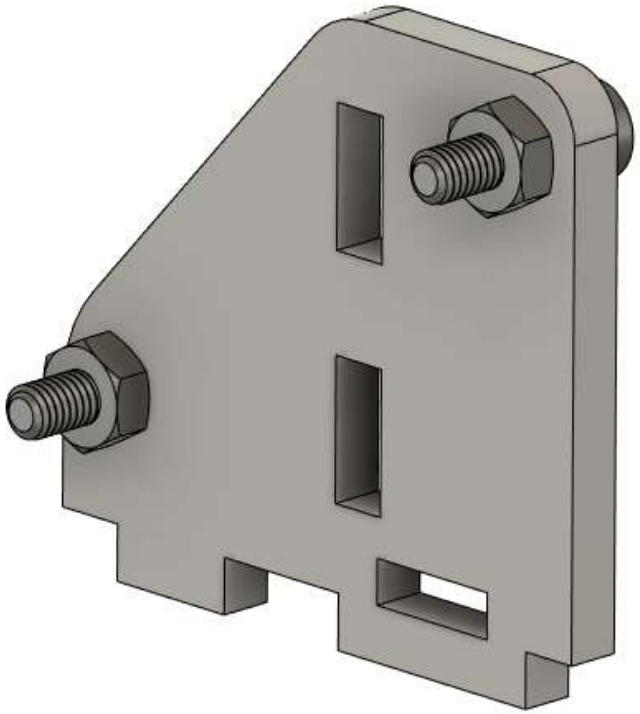
1.1

1.2



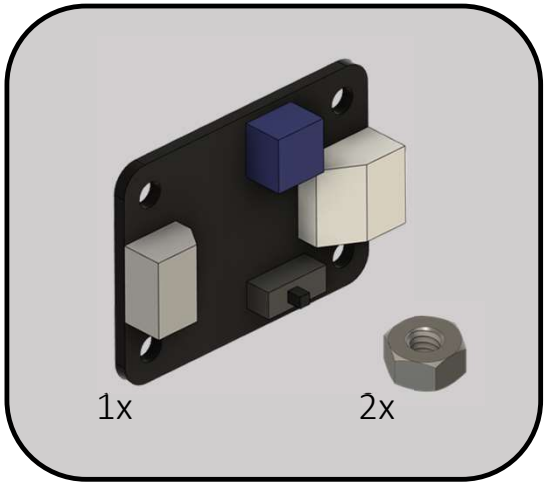


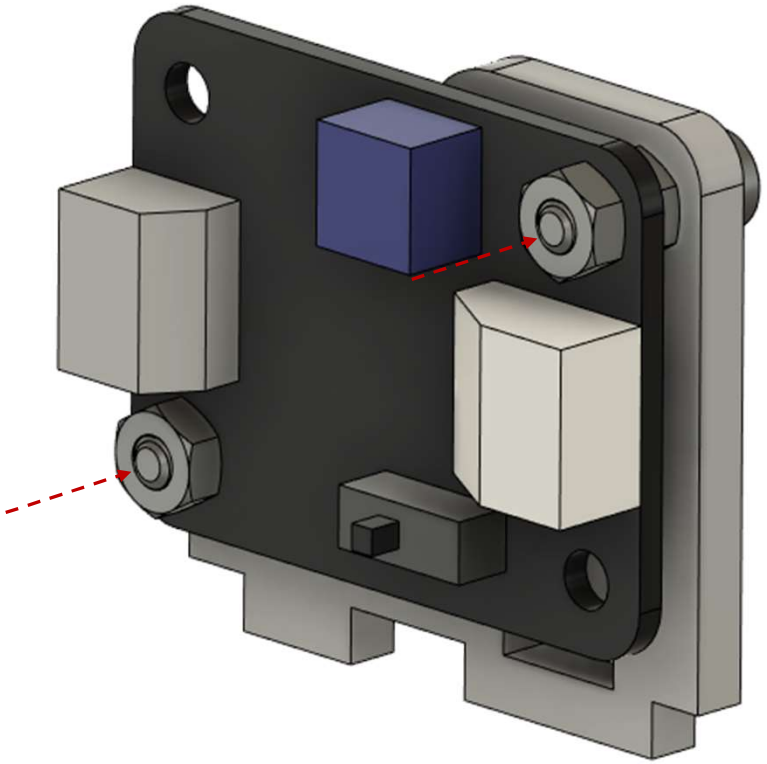




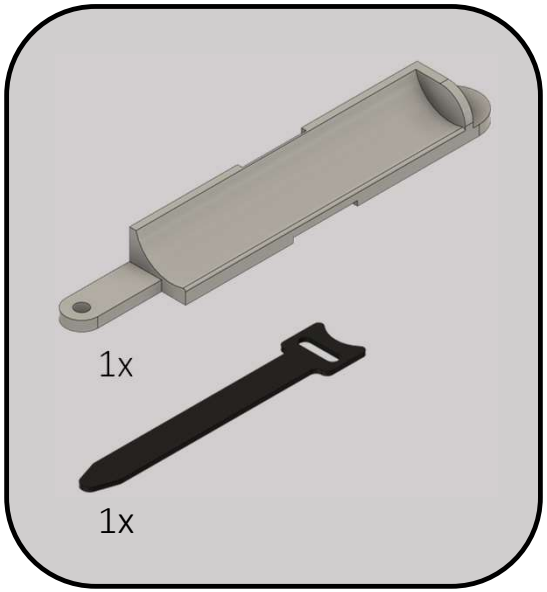
2.1

2.2



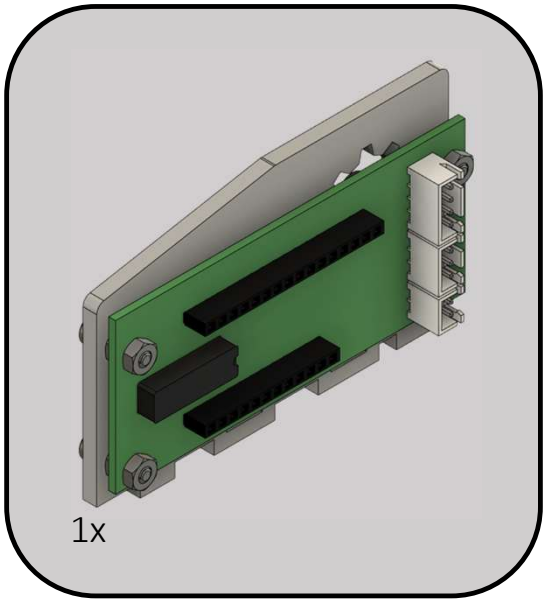


3.1

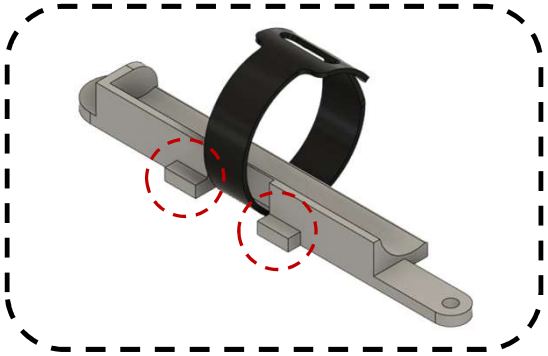


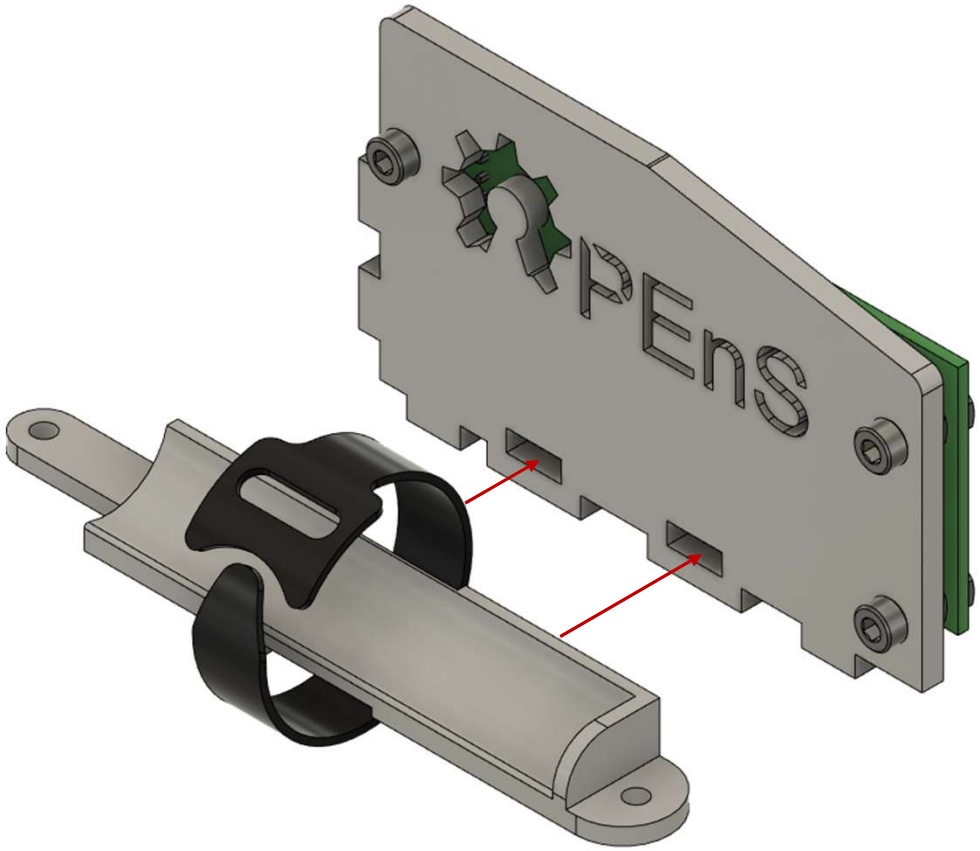
*rough side of the Velcro facing in

3.2

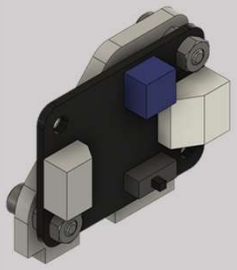


1x

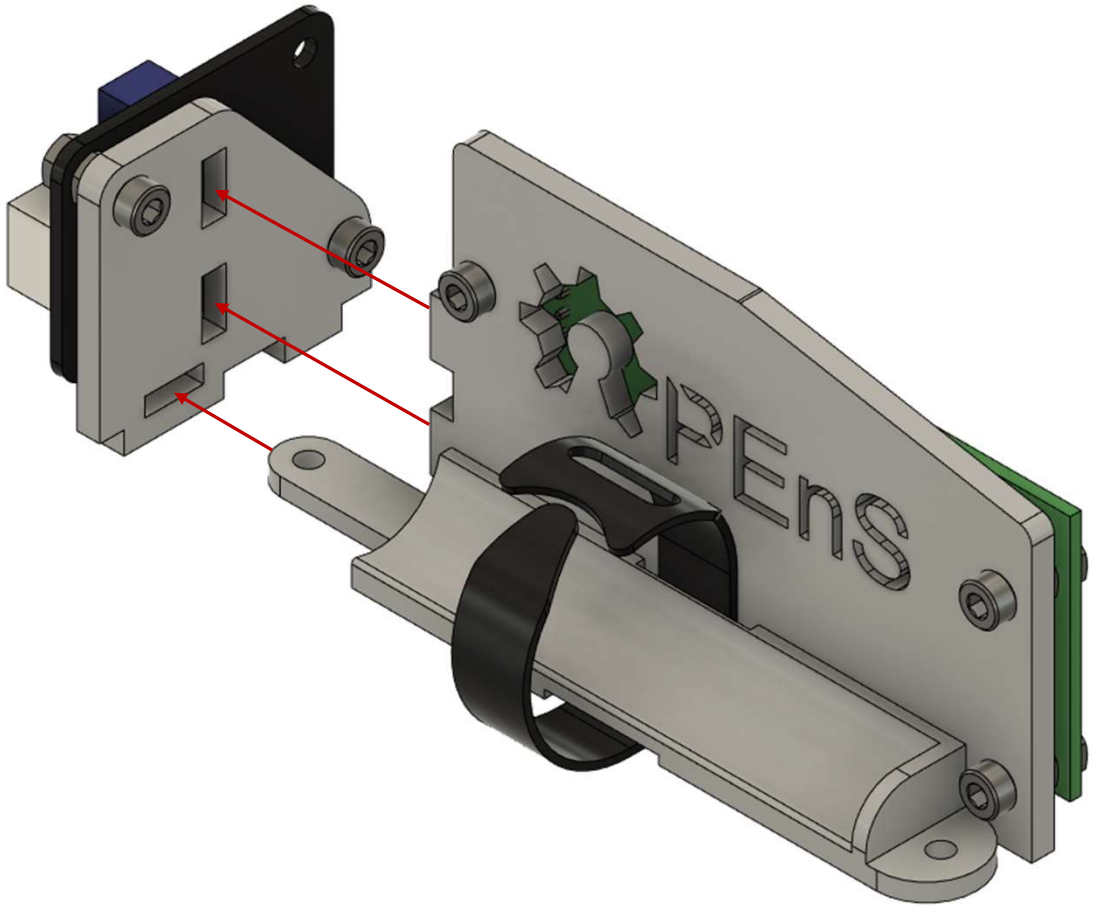




3.3



1x



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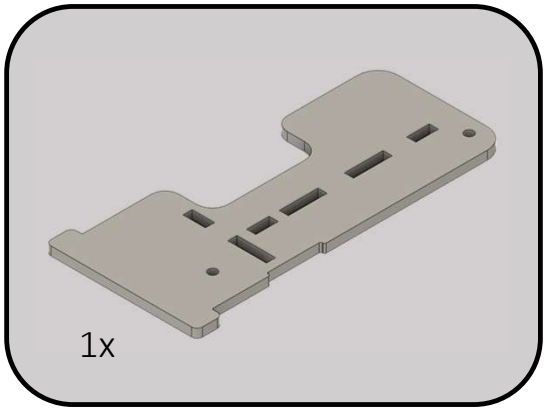
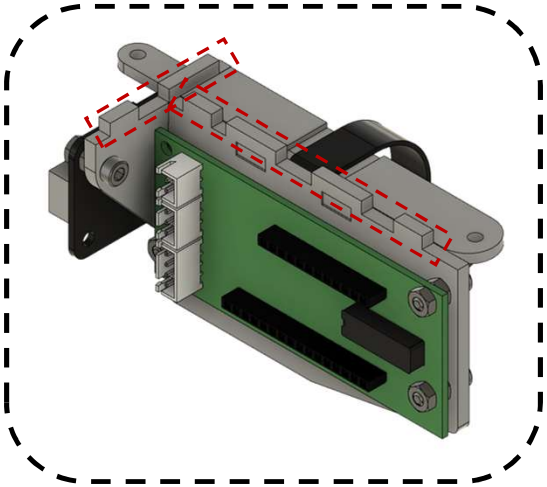
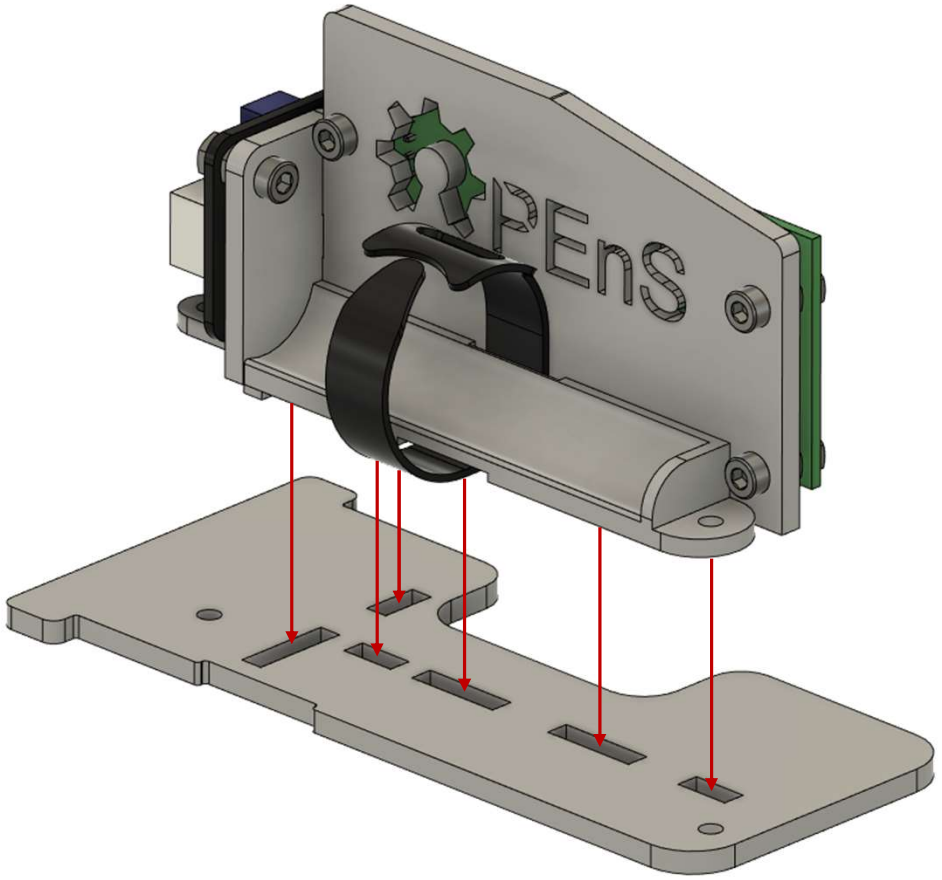
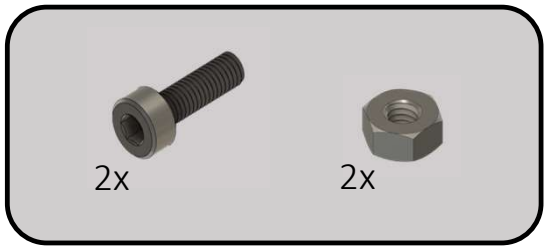
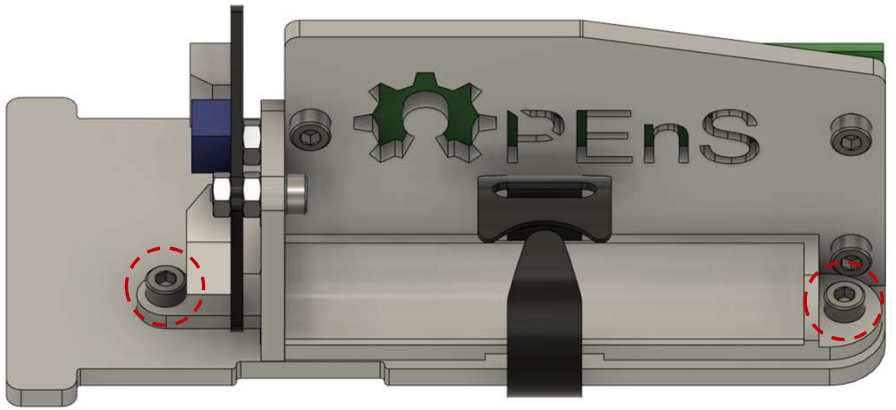
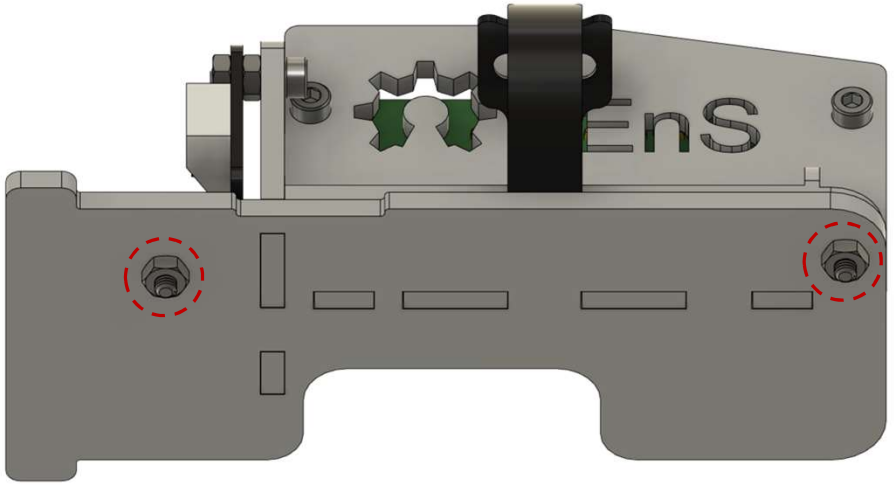






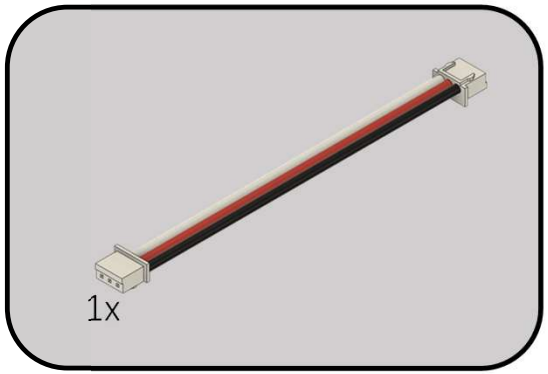


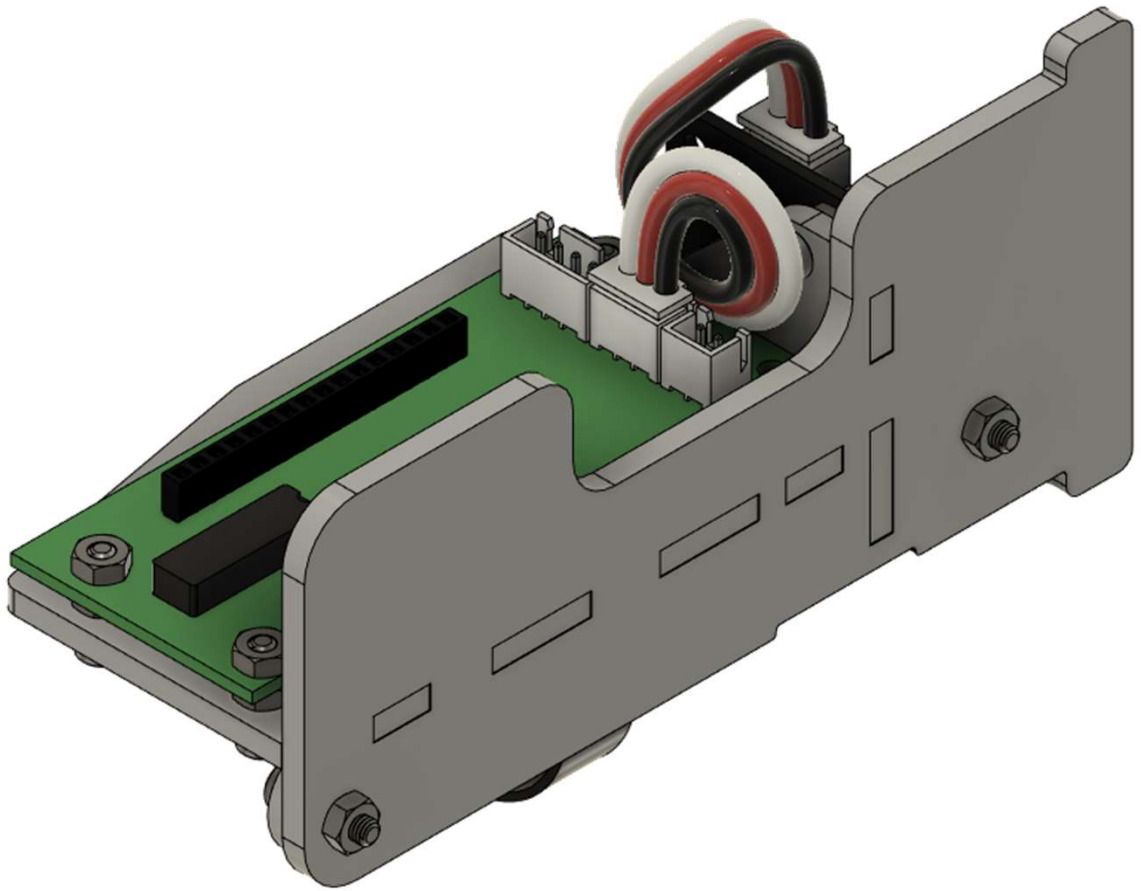




3.5

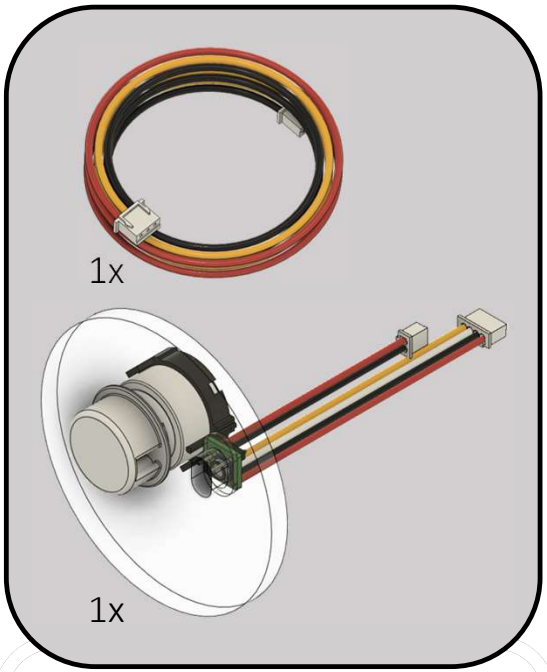
4.1

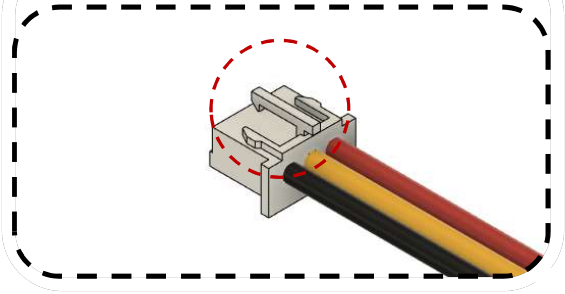


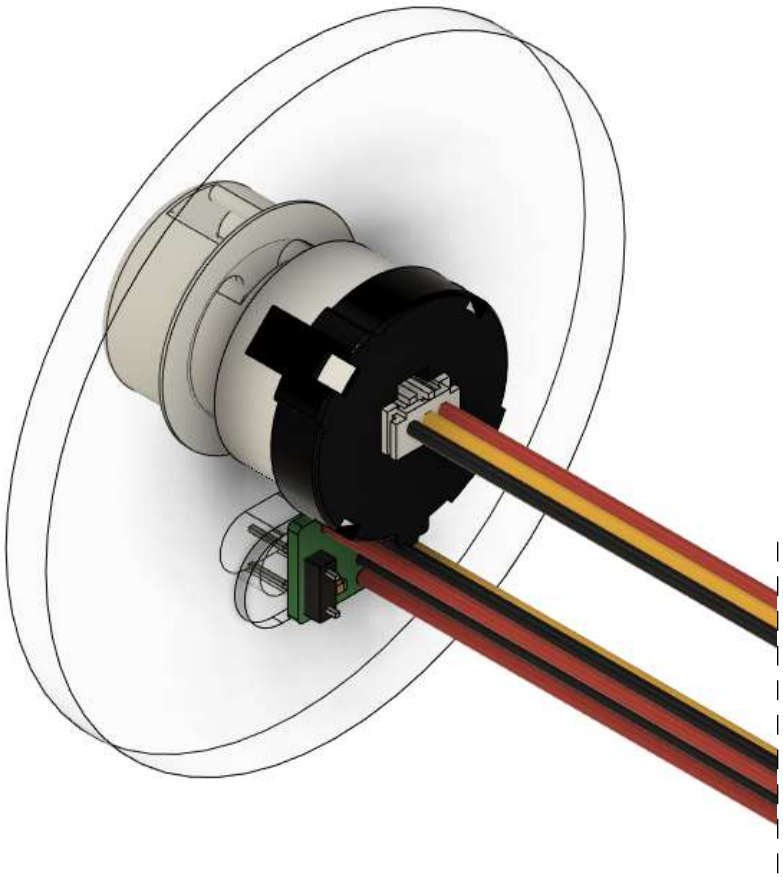


*loop the cable once tucking it in

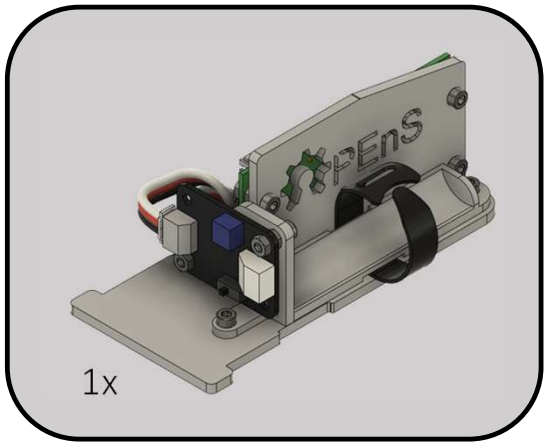
4.2

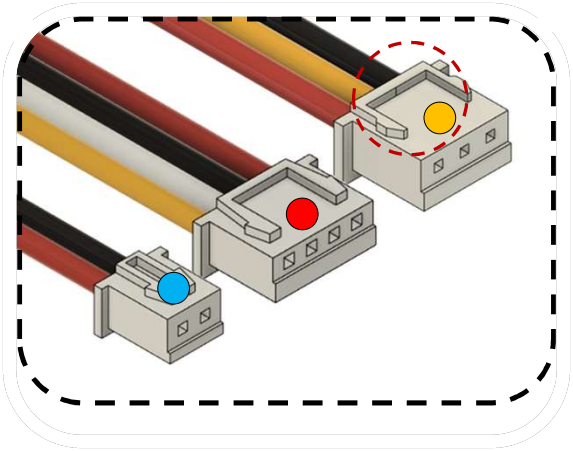




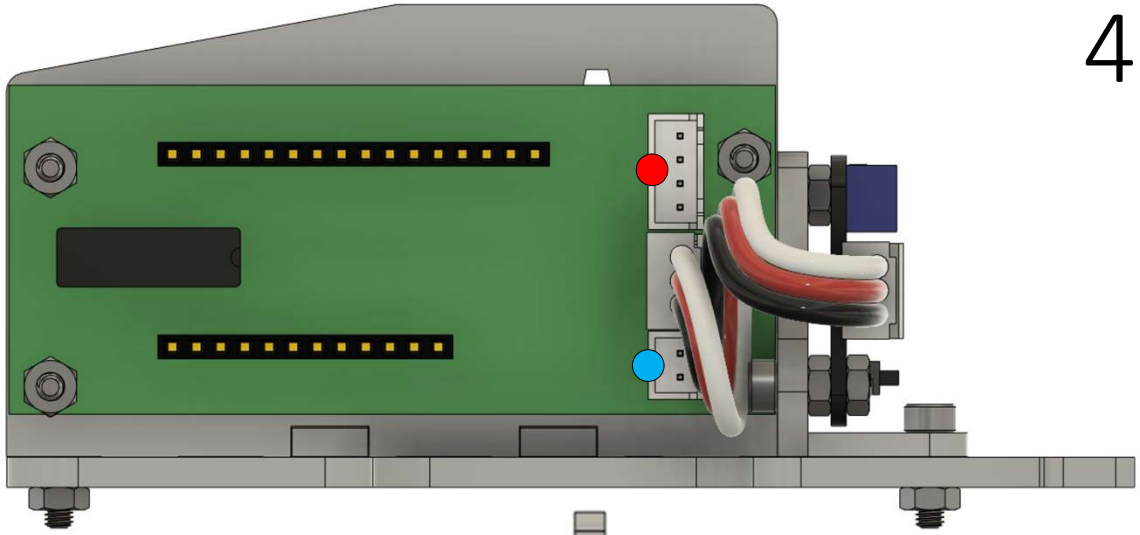


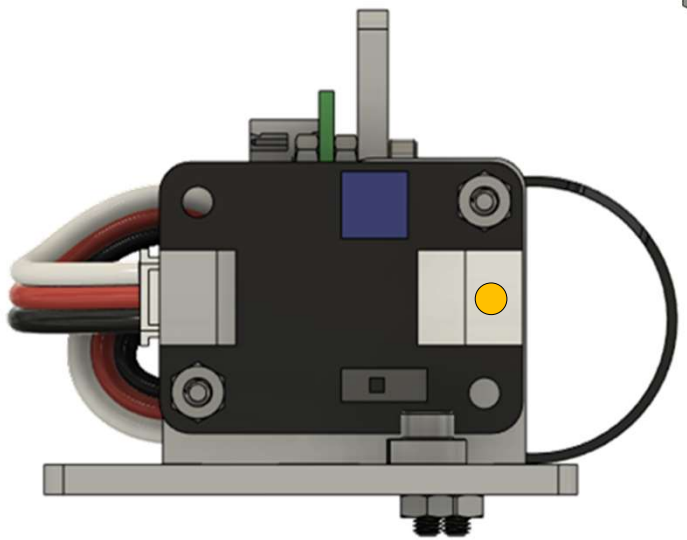
4.3



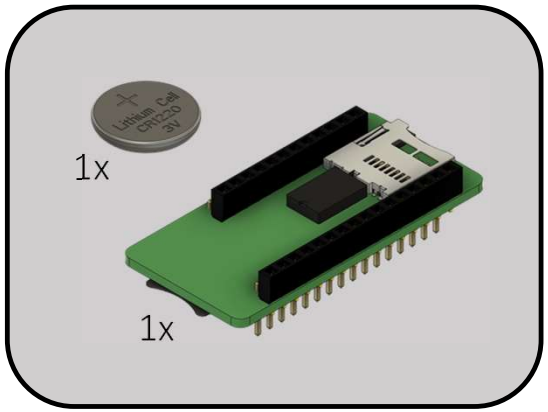


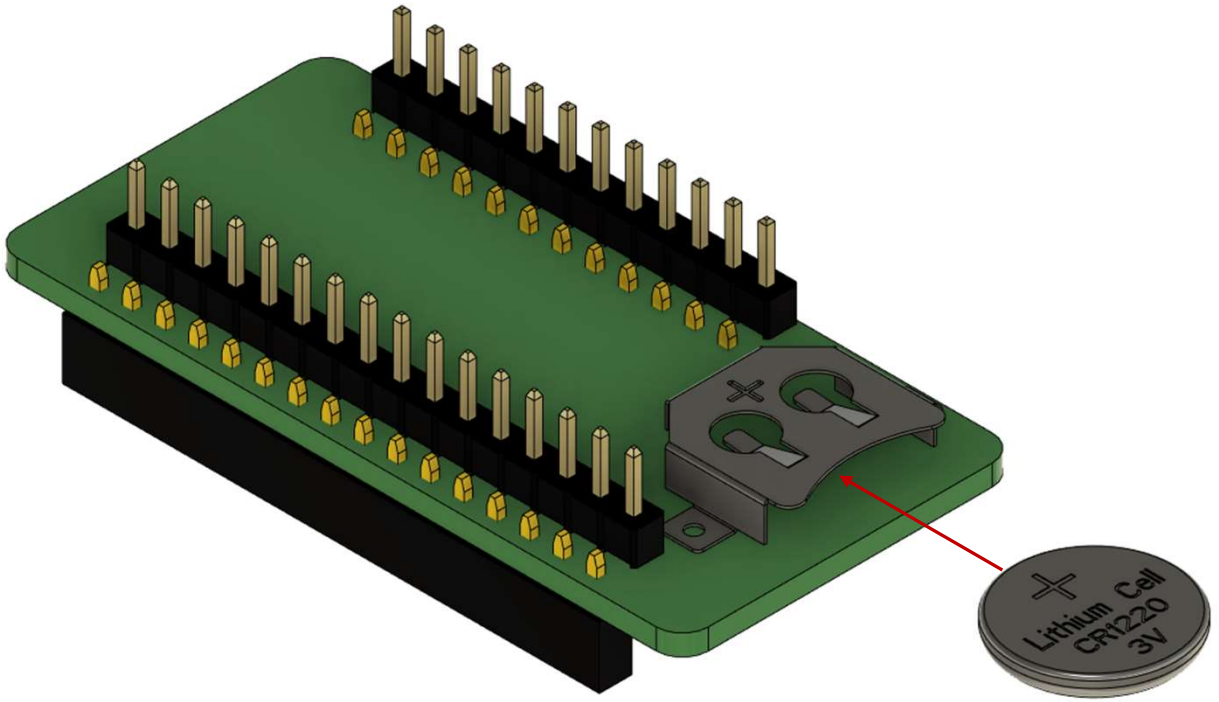
*cables click in easily, do not force them



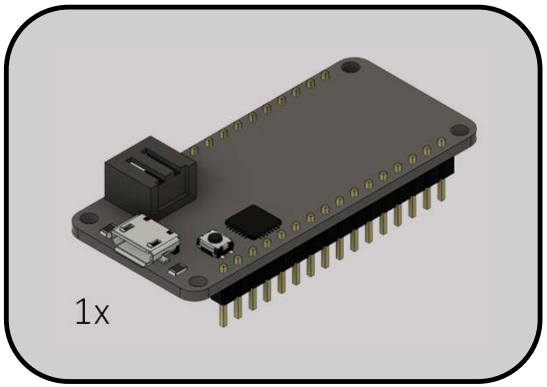


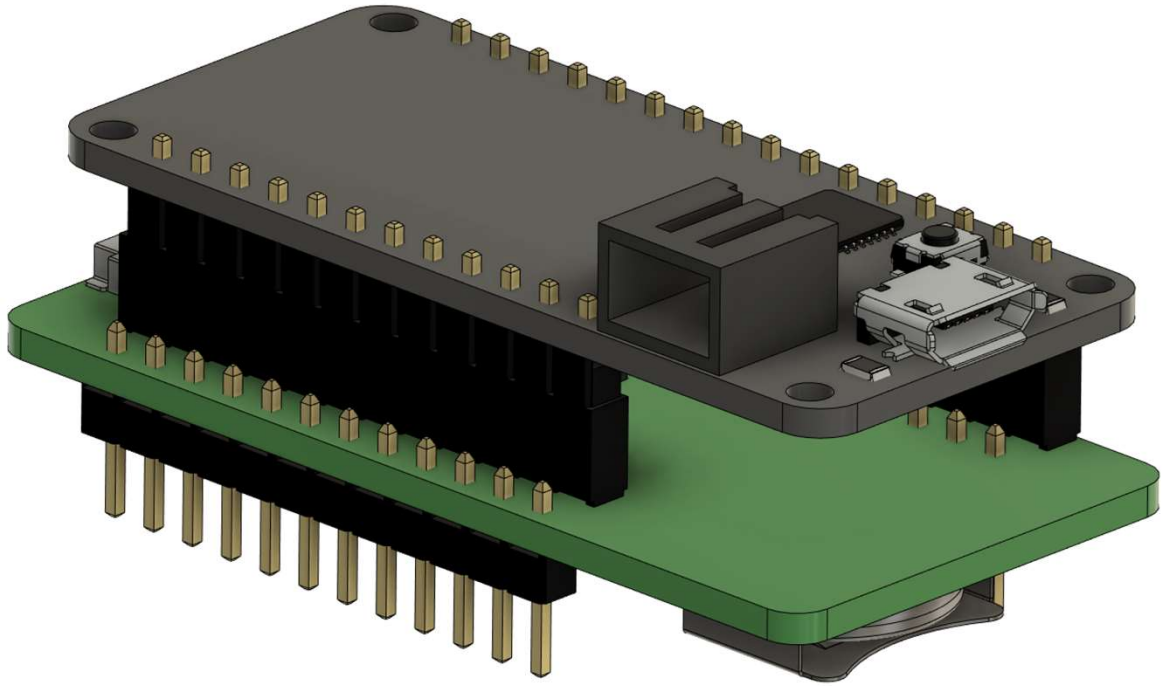
5.1



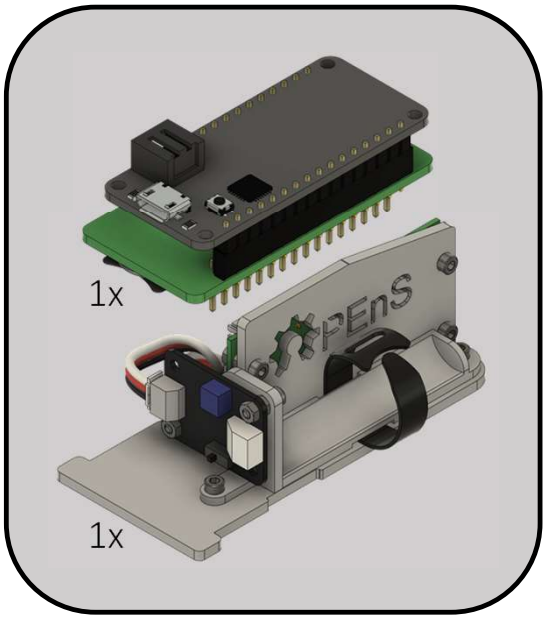


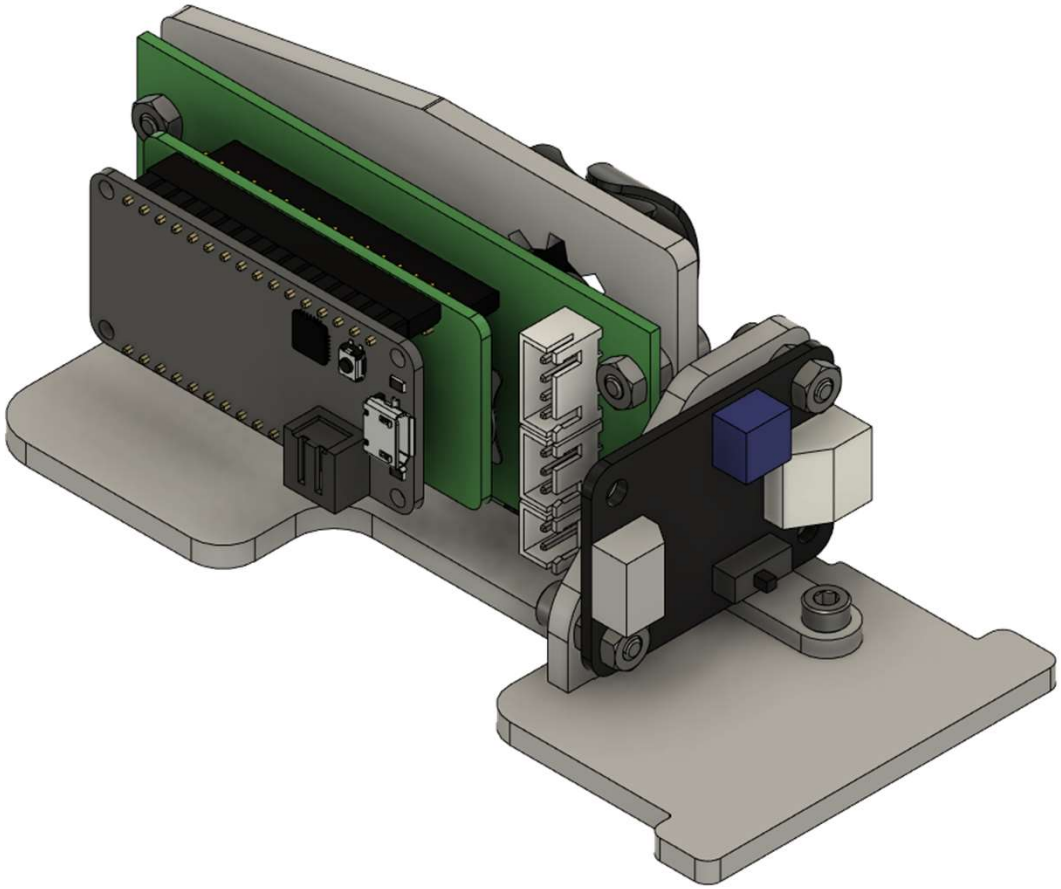
5.2





*every pin on the feather has a corresponding hole





5.3

Arduino IDE and Serial Monitor

6.1

Start by going to Arduino's official website and downloading the Arduino IDE

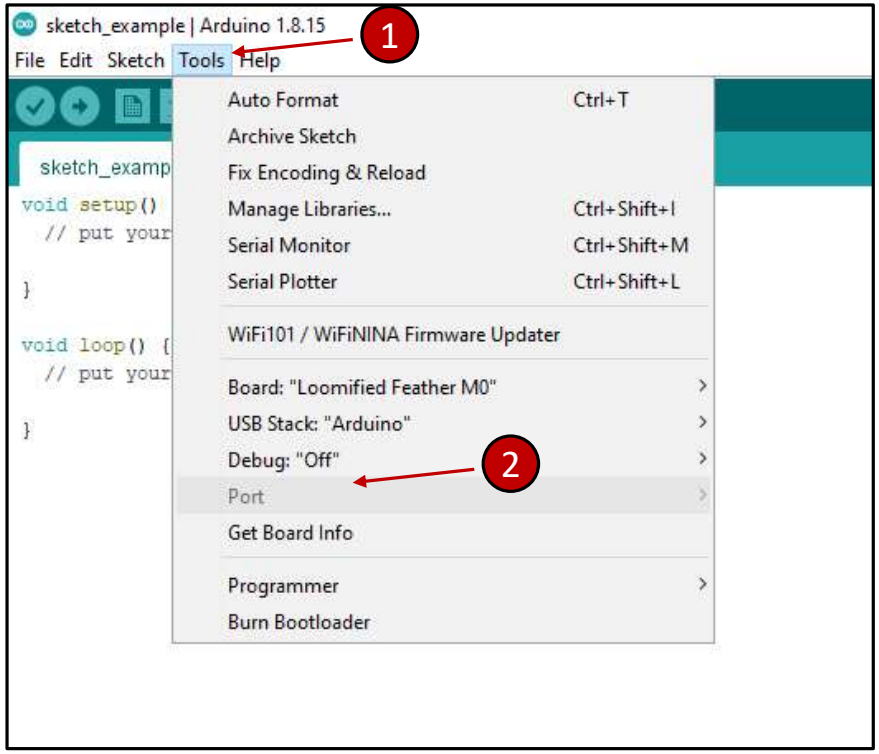
https://www.arduino.cc/en/software

Select the version of the program for your machine. You will need admin permission to correctly download the software and drivers.

Plug in the Feather to the computer using the included micro-USB cable.

6.2

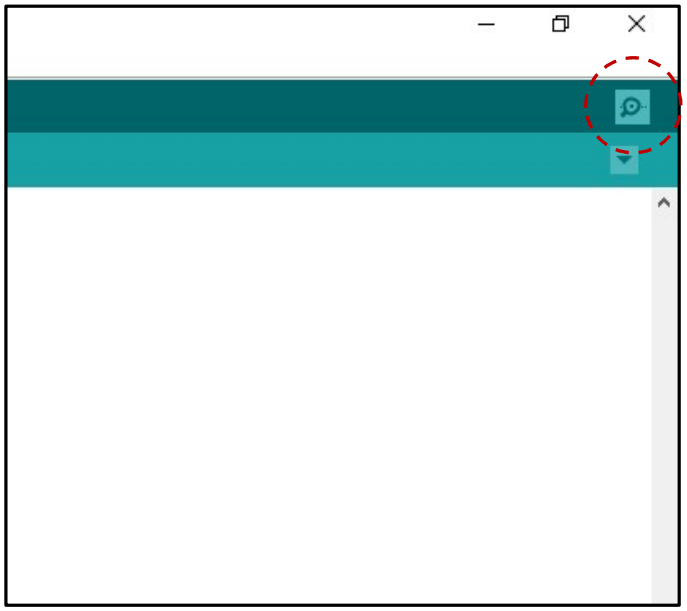
Select the port of the feather, if there are multiple unplug the feather and check to see what port is added by plugging it in again.



Open the serial monitor by clicking on this icon on the right side of the screen.

6.3

If the Smart Rock is plugged in and the correct port is selected, you should see the debug info for your unit.



EC Setup

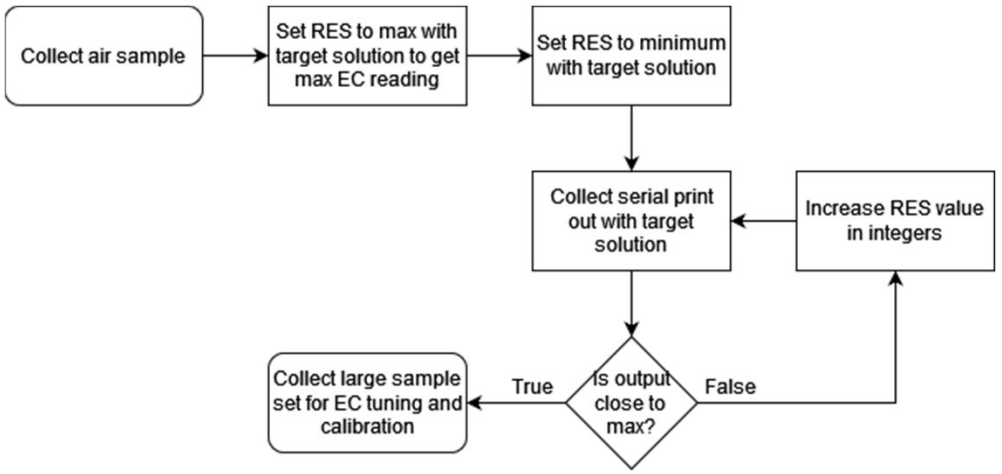
7.1

The EC setup process is about calibrating the smart rocks sensor to the correct range you expect to see from your deployment. Think about the EC sensor as a meter with a set number of ticks. We can change what the maximum reading of this dial. The higher the resolution the smaller the maximum EC reading on the meter. This gives you more points in that given range.

The EC setup and tuning follows a simple process that can be modified for any desired solution. In this workshop we are going to be tuning for an EC of 1413 µS as our target max solution.

Objective: Tuning your EC circuit.
Take samples of buffer solutions noting the Analog A0 and Temp values. You'll need the EC Calibration EXCEL file to perform this task.

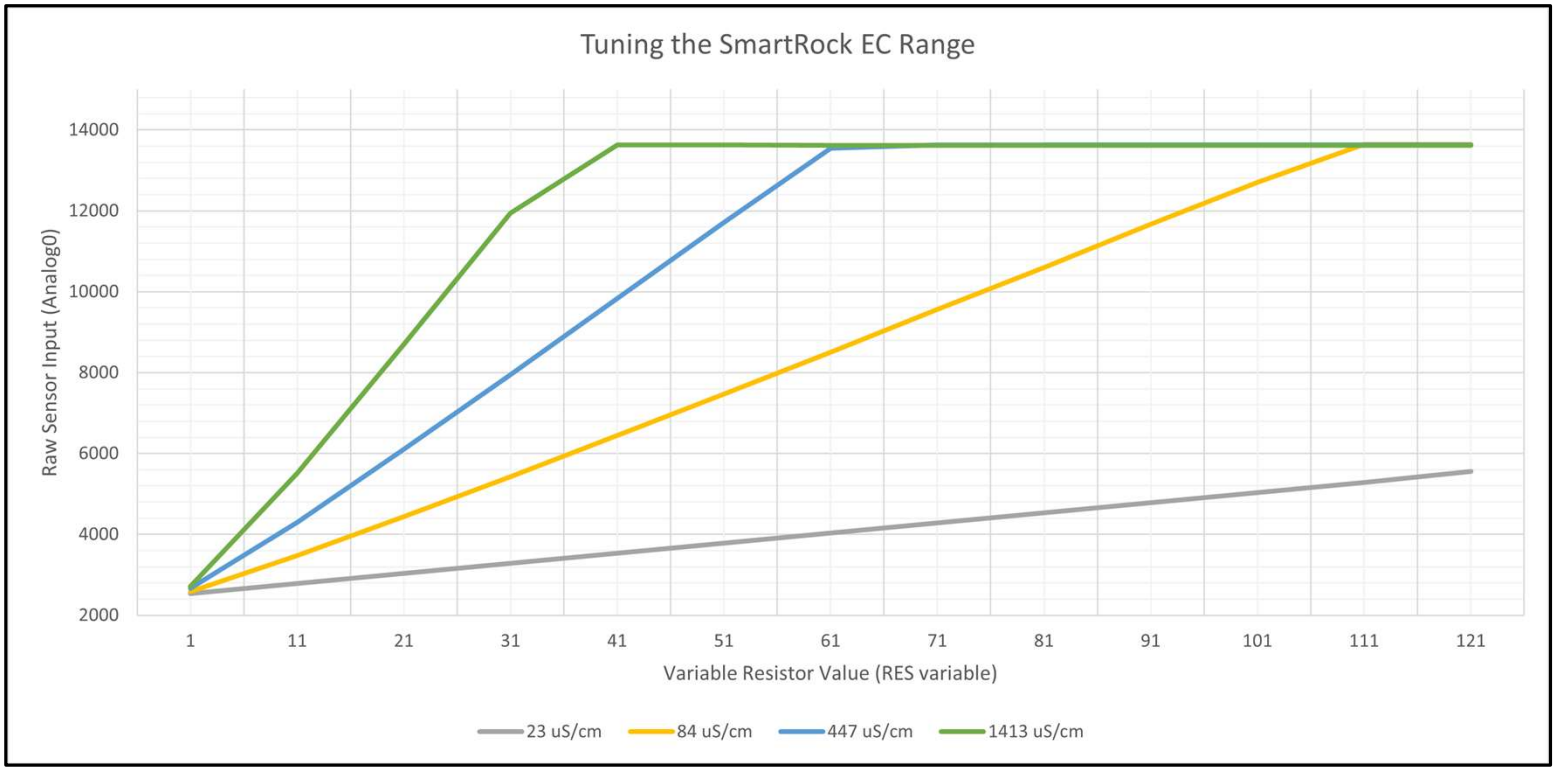
Have your computer setup and ready to read from the serial monitor for these steps.



EC Setup

7.2

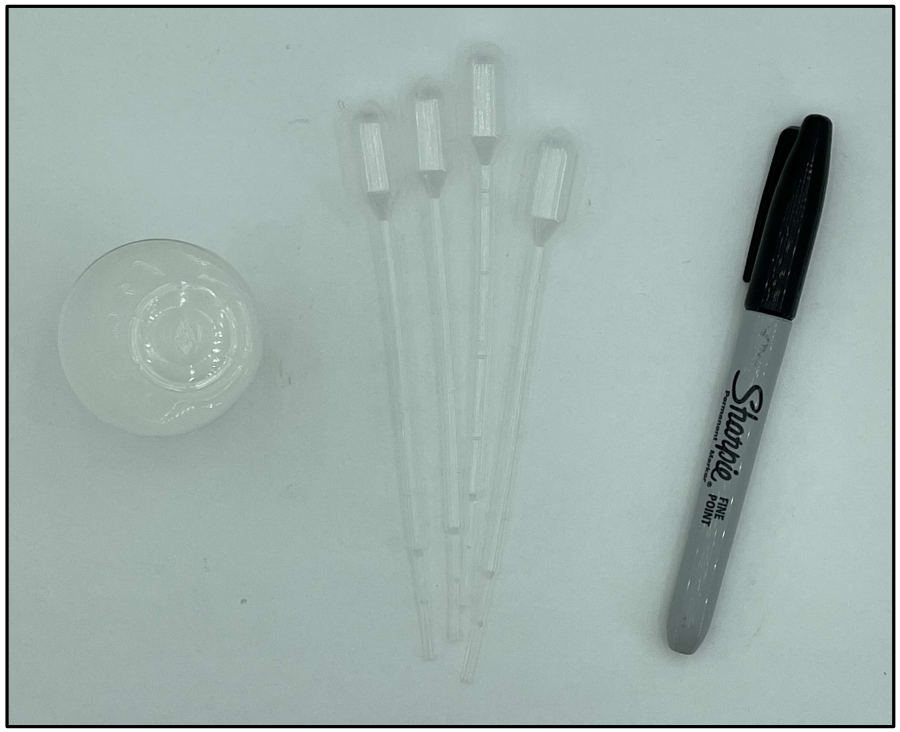
This chart shows the relationship with RES and different solutions. This can be used to give you a ballpark of where to look for your desired RES value for your target solution.

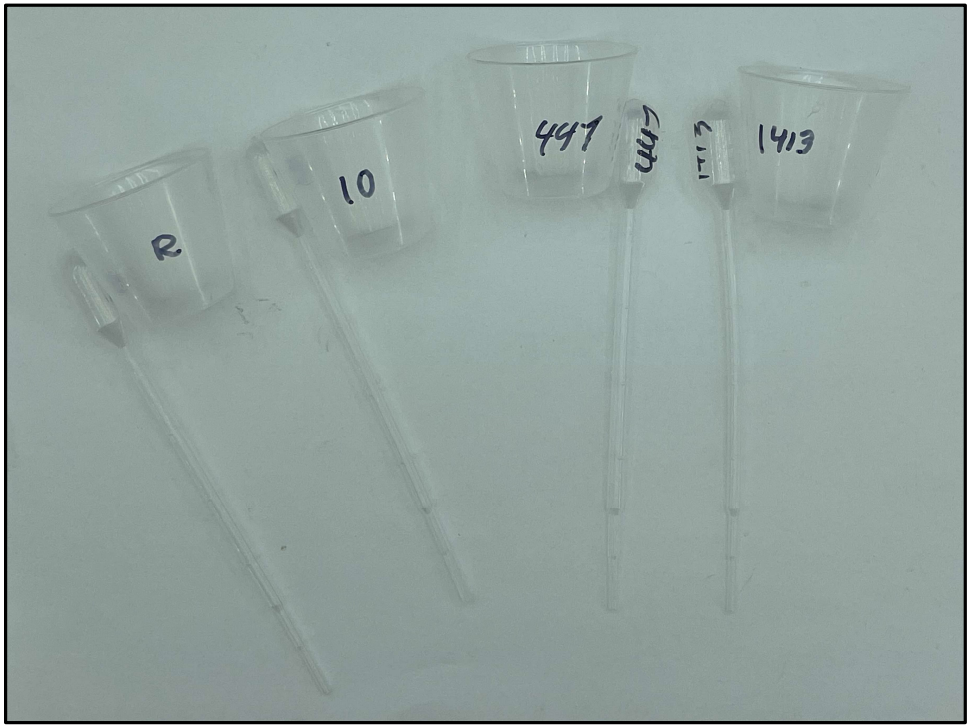


EC Setup

7.3

Start by labeling 4 cups and the 4 pipettes with the solution they will be used in.

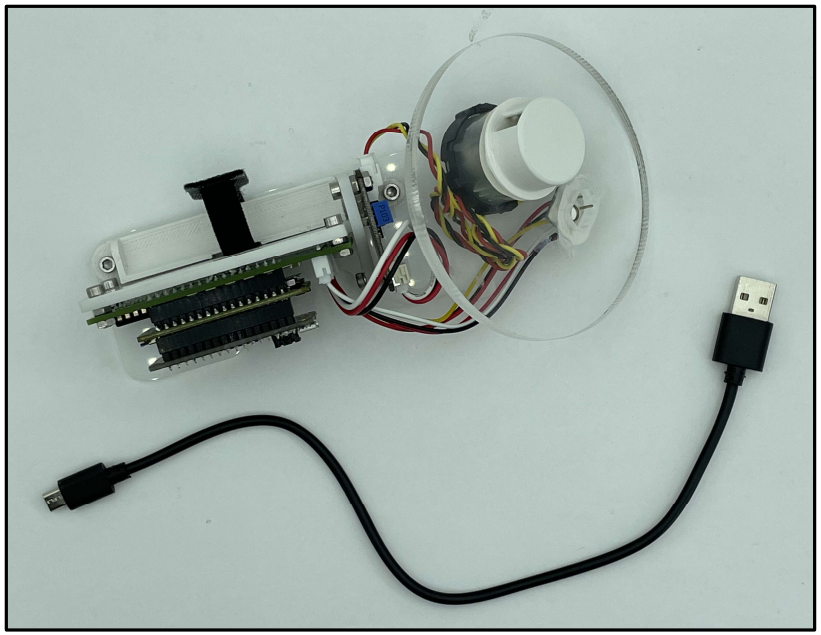


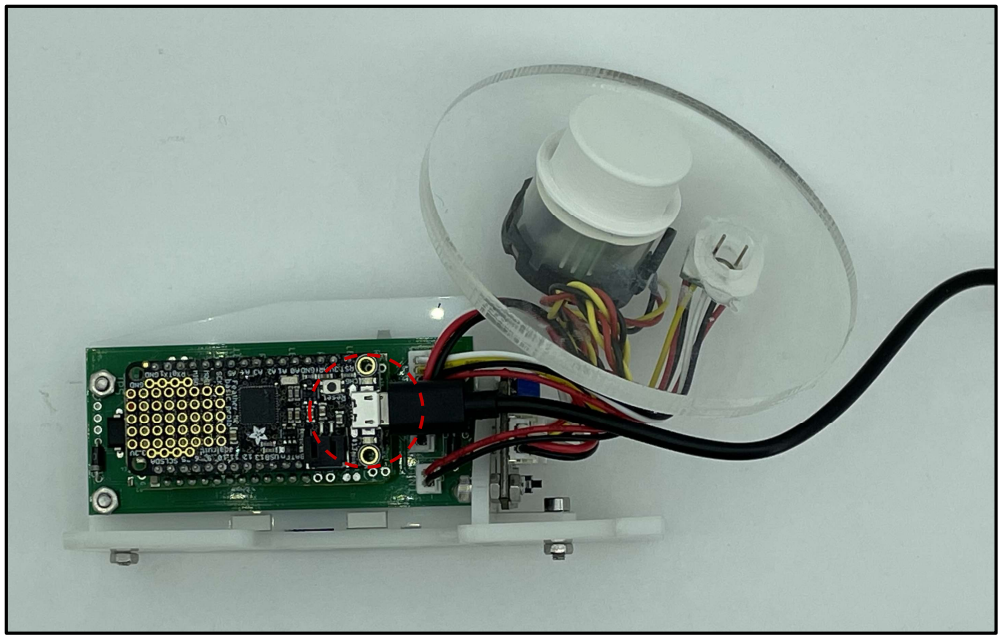


EC Setup

7.4

Connect the Micro-USB cable to the feather, we recommend for these tests using the USB-A side of the cable to power it on and off. The end connected to the feather is more delicate than the one on your computer.



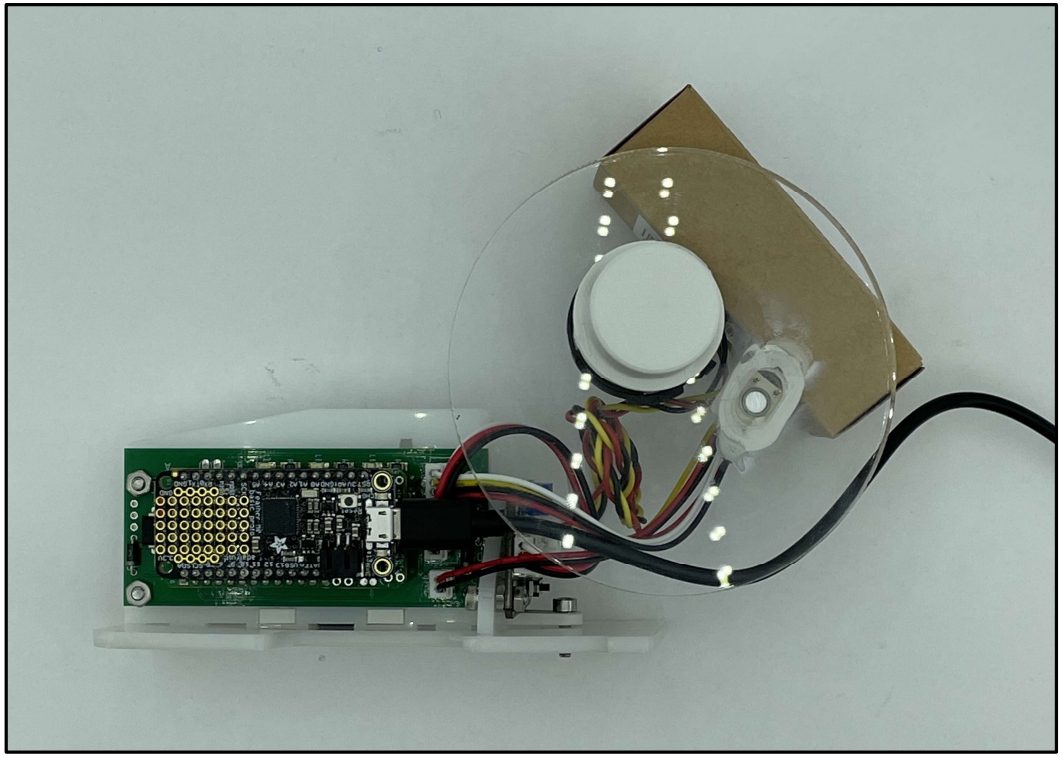


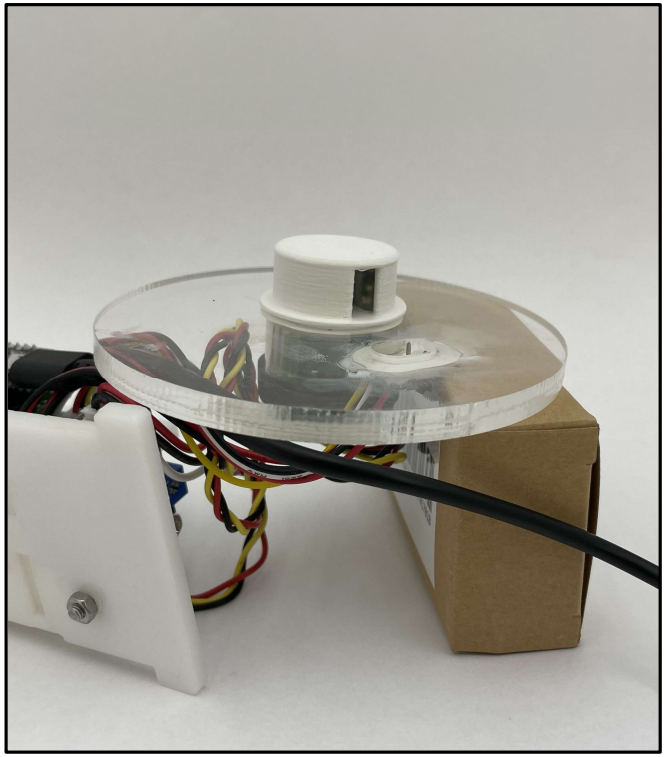
*The cable in these photos is shorter for demonstration purposes

EC Setup

7.5

Prop up the Sensor plate so it can hold solution. An empty battery box works great for this.

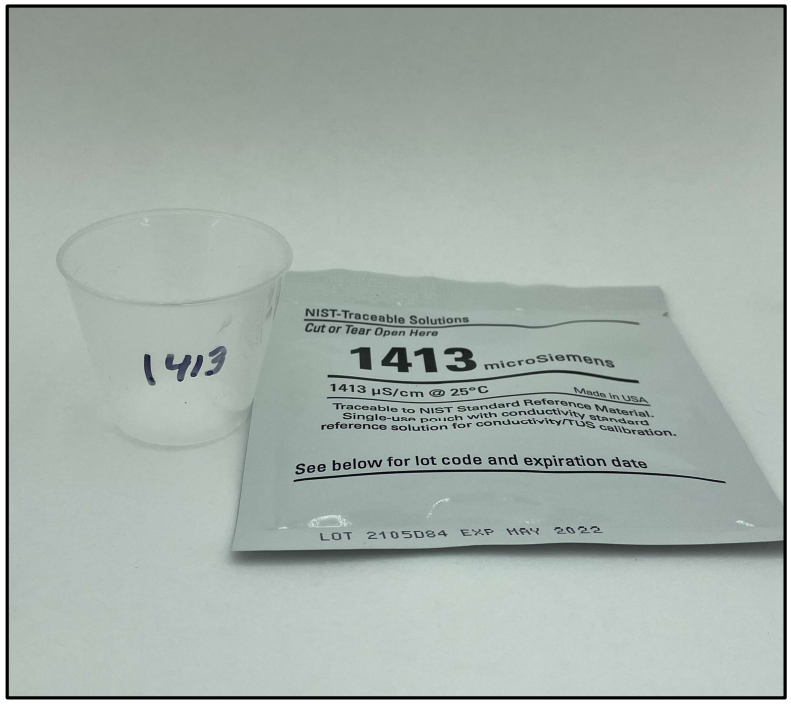


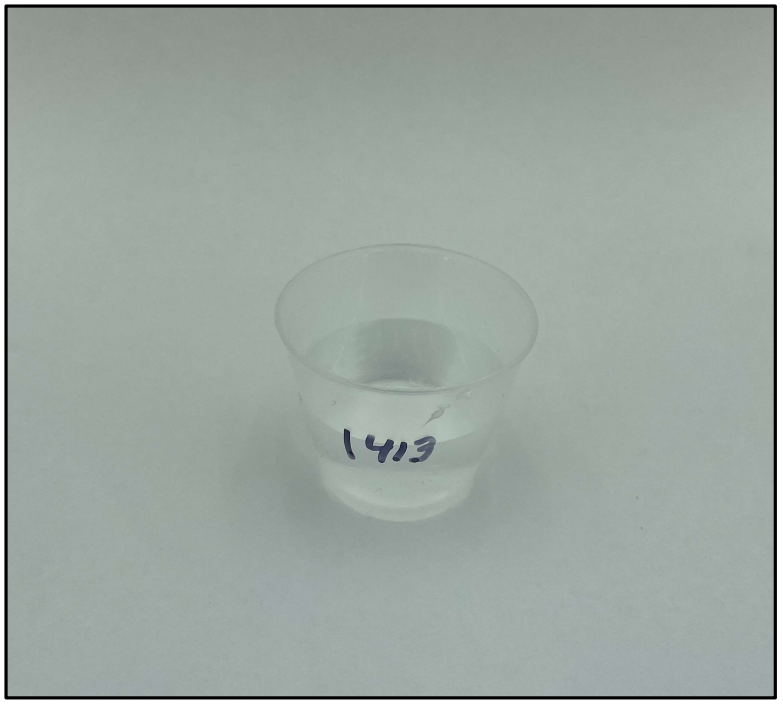


EC Setup

7.6

Open and empty the 1413 solution into the appropriately labeled cup. This is our target max EC.

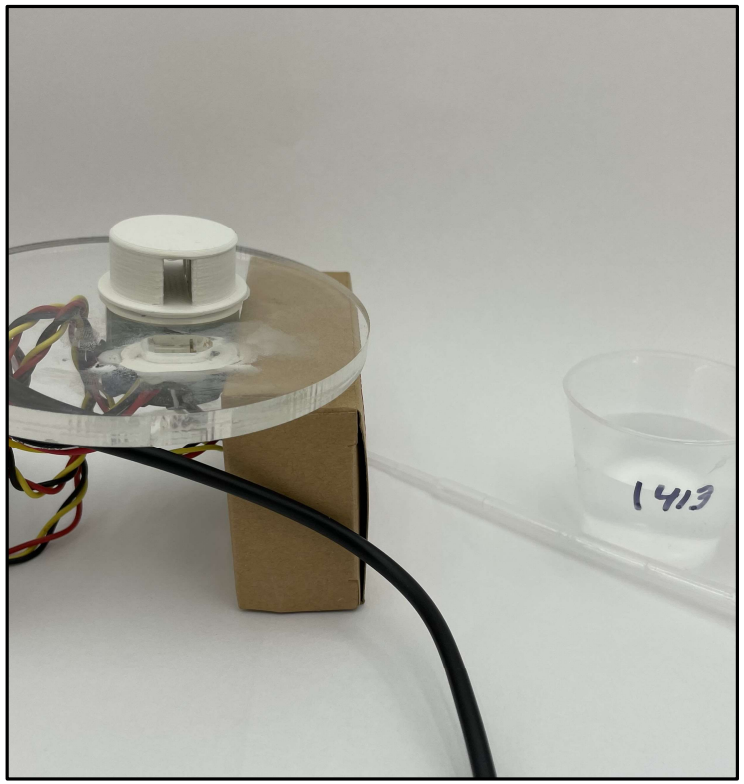


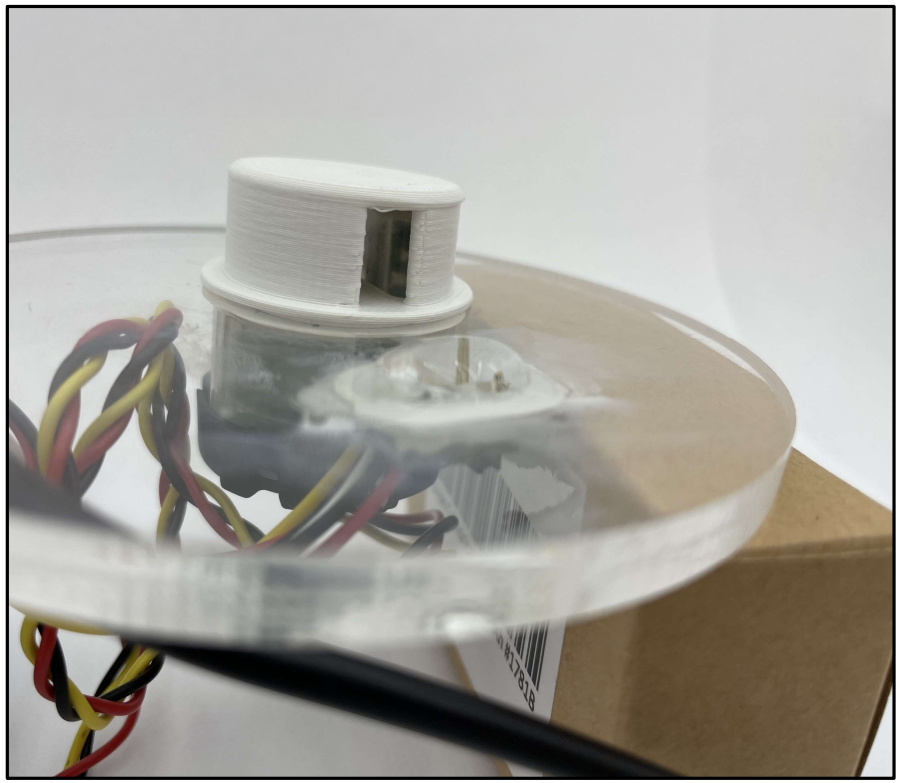


EC Setup

7.7

Using your pipette, fill the EC probe area with the 1413uS solution

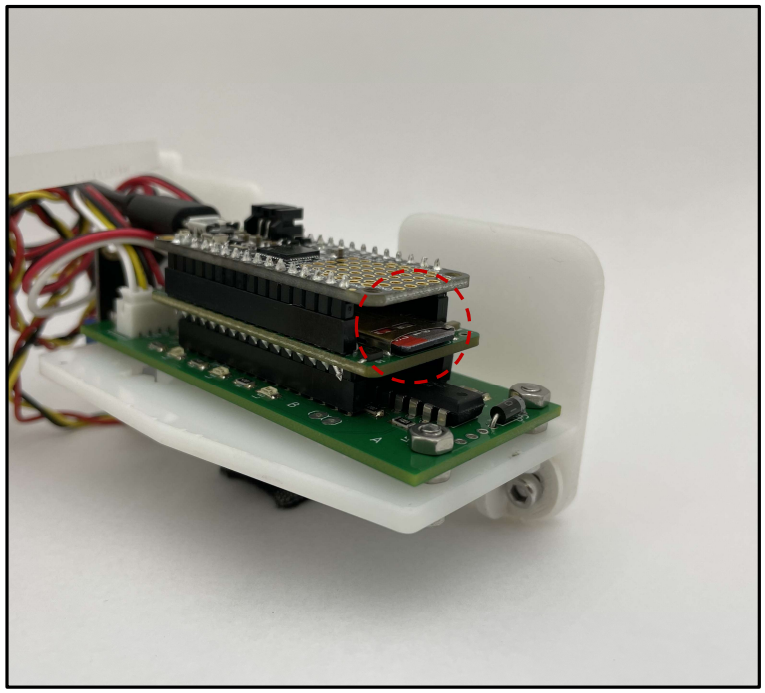




EC Setup

7.8

Remove the micro-SD card from the hypnos board if it is already installed and load it into the computer.
On the SD card there is a file called SD_config.txt. In that text file modify the last variable “RES”.
Change the RES to be 121.

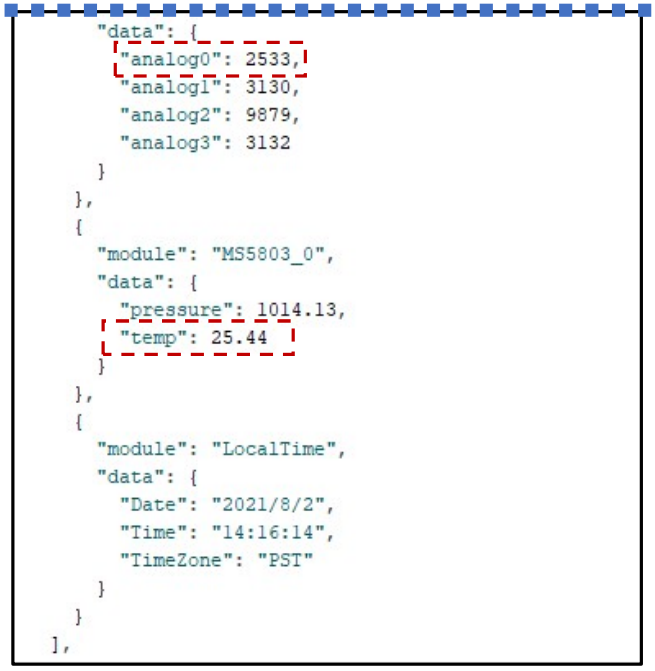


Eject the micro-SD card and install it back in the hypnos board.

EC Setup

7.9

Connect the USB cable to the computer and open the serial monitor (6.3). You may need to scroll up to see what you are looking for.



Note the RES, Temperature, and analog0 values. Unplug the Smart Rock from the computer after collecting data. The Smart Rock must be powered off before removing the micro-SD card.

EC Setup

7.10

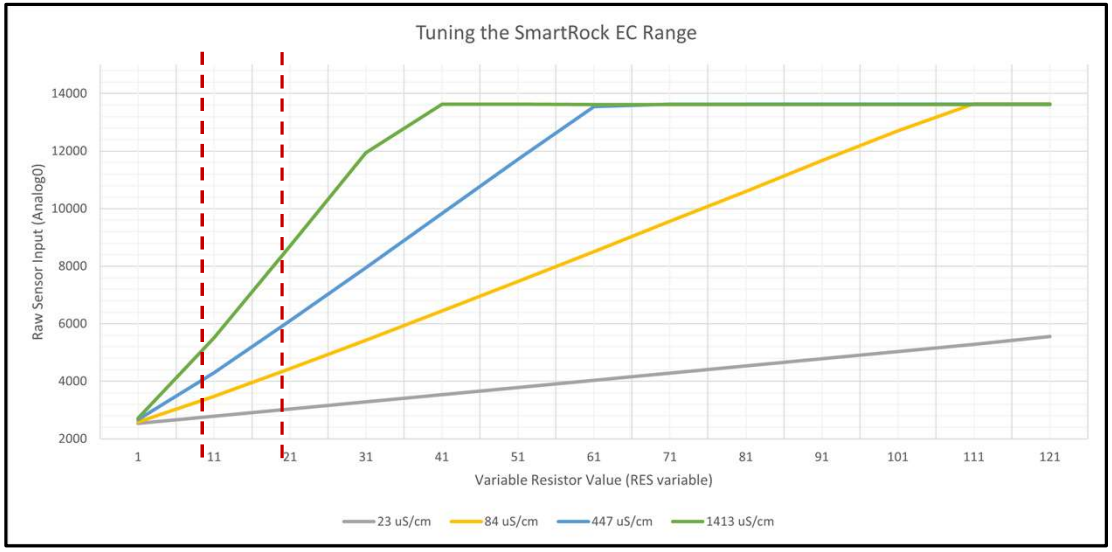
Repeat steps 7.8 to 7.9 with a RES value of 1 this time.

The analog output with a RES of 121 is your maximum analog value. The analog output with a RES of 1 is the smallest value that target max solution 1413 will output. These give you an idea of what to expect while tuning the sensor.

EC Setup

7.11

With the maximum and minimum readings for your sensor with the target max solution written down we can start tuning. For our target max value of 1413 µS according to the tuning chart we expect a RES value between 10 and 20 however that is not always the case.



Repeat steps 7.8 & 7.9 modifying the RES value until you get your analog0 output just below your sensor max. Say the sensor Analog0 maximum was 10,000 aim for the target max solution to land between 9,000 and 9,500.

EC Setup

7.12

With the RES value determined in the step above, rinse the electrodes with DI water using the pipet. We will now test each solution for 5 min, rinsing electrodes with DI water in between. Use the pipets assigned to each solution to prevent contamination.

Repeat this procedure for 10 µS, 447 µS, and 1413 µS solutions:

1) Apply your target solution with a pipette into the EC probe area
2) Plug in battery or computer
3) Set a 5 minute timer and ensure it in not disturbed
4) Power off the unit by unplugging the battery
5) Rinse EC probe with DI and repeat

The data files written to the Micro-SD card will be numbered based on which time it was turned on. These will be the files with the last 3 consecutive numbers on the SD card. If you power the feather using a computer and open the serial monitor the Smart Rock will not write anything to the micro-SD card and only take one data point.

EC Setup

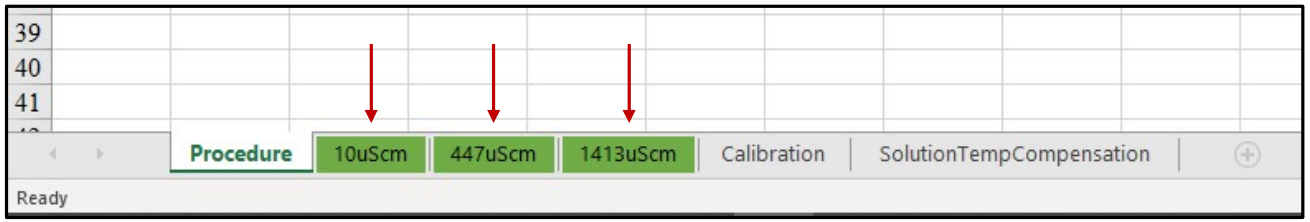
7.13

Retrieve files from the SD card by removing the micro-SD card from the hypnos and plugging it into your computer. For each of the files corresponding to the 10 µS, 447 µS, and 1413 µS solutions, paste 50 consecutive samples from data sheet. Include the Packet number, Analog0, and Temp columns into the tab that corresponds to the solution that was sampled.

data##.csv

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	ID		Timestamp		Packet	ADS1115				MS5803_0		LocalTime		
2	name	instance	date	time	Number	analog0	analog1	analog2	analog3	pressure	temp	Date	Time	TimeZone
3	Device	1	9/7/2021	10:01:28	2	2726	3145	8636	3146	1001.71	23.11	9/7/2021	2:01:28	PST
4	Device	1	9/7/2021	10:01:30	3	2725	3143	8610	3145	1002.05	23.11	9/7/2021	2:01:30	PST
5	Device	1	9/7/2021	10:01:32	4	2725	3144	8606	3148	1001.88	23.12	9/7/2021	2:01:32	PST

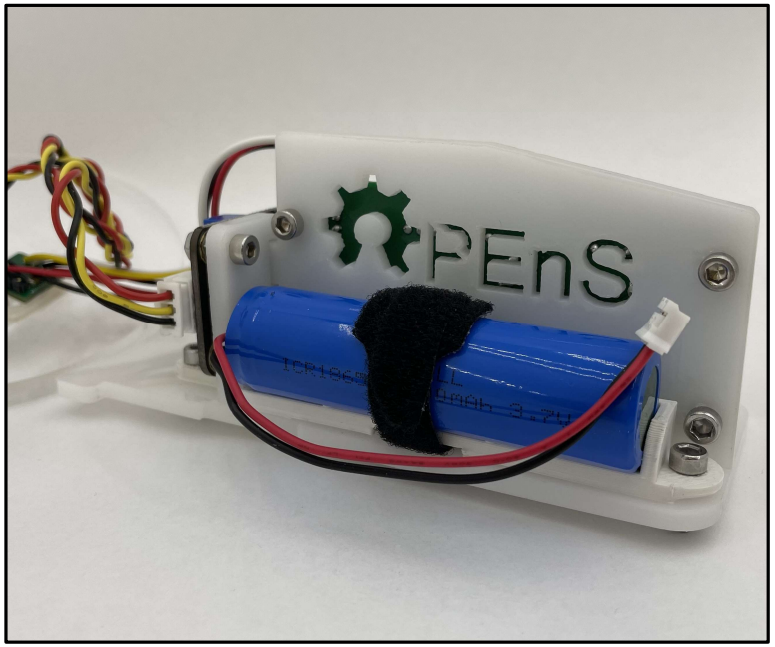
EC_calibration_CUAHSI_SmartRock_2021.xlsx

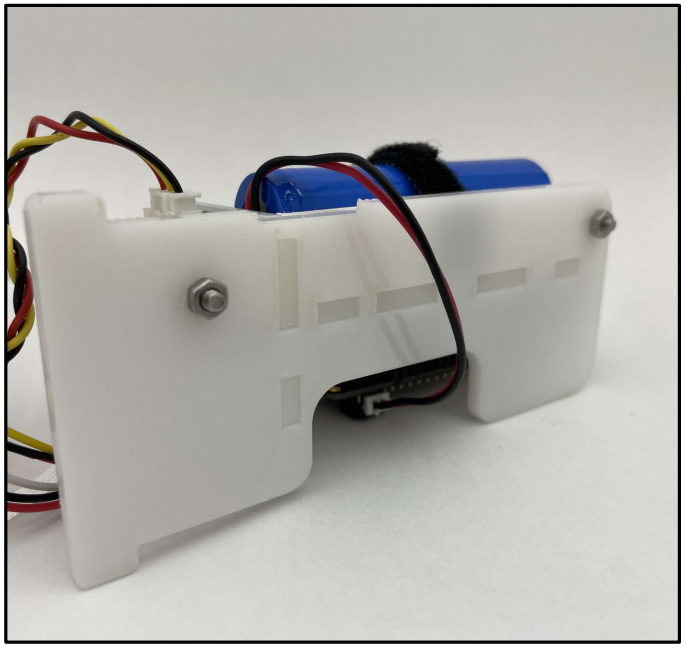


Operation

8.1

To install the battery, open the Velcro tie. With the cable end of the battery against the Turbidity Mount fit it into the 3D print.



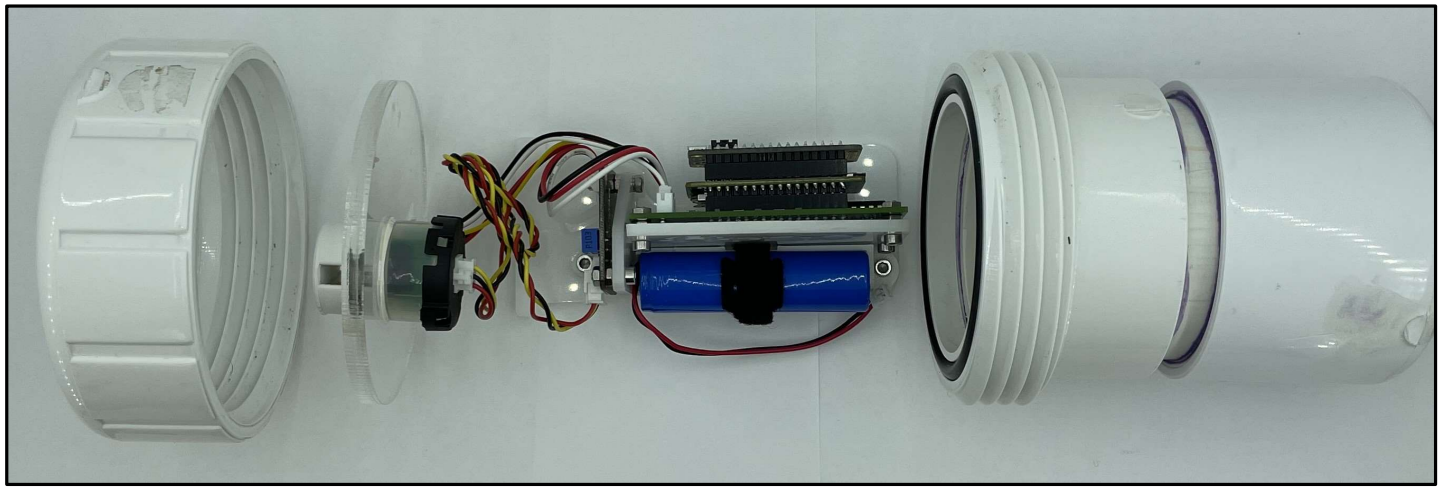


Secure the battery with the Velcro tie and wrap the cable under the Sled_Base where it plugs into the feather M0. There is a notch for the battery's cable to route.

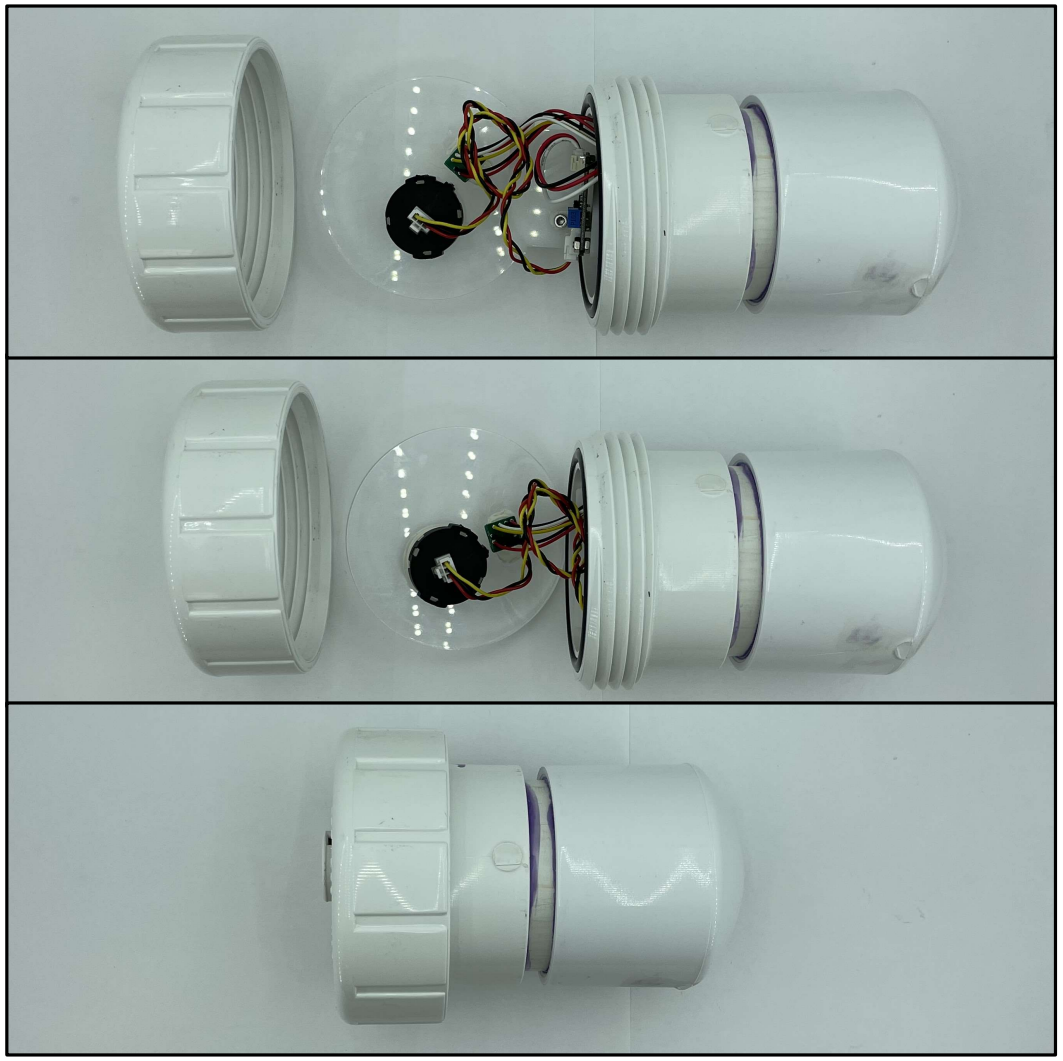
Operation

8.2

With the sensor plate loose, insert the Sled Assembly into the Smart Rock. The assembly will go in easily until it reaches the end, where it may require more force to lock it in. Ensure the battery wires do not get pinched outside of their notch.



Operation



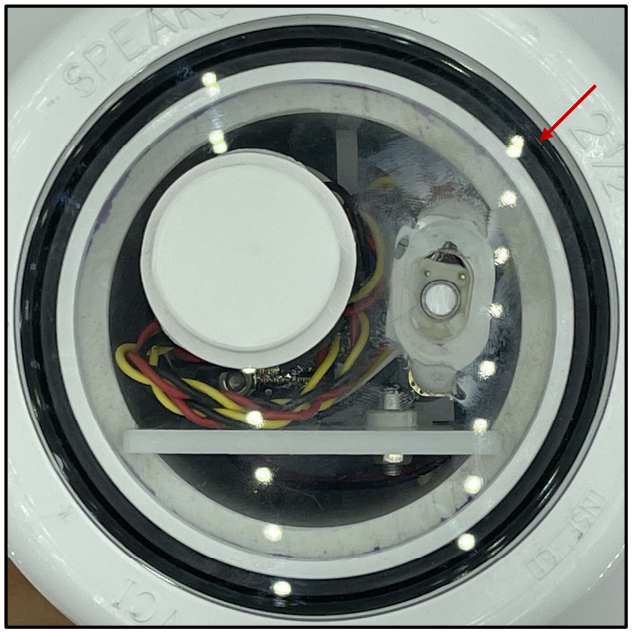
8.3

Operation

8.4

For tests or deployments less than 1 day it is fine to seal the Smart Rock without any o-ring lubrication. For longer deployments, the O-ring MUST be lubricated with silicone grease or similar.

Compressed



Uncompressed

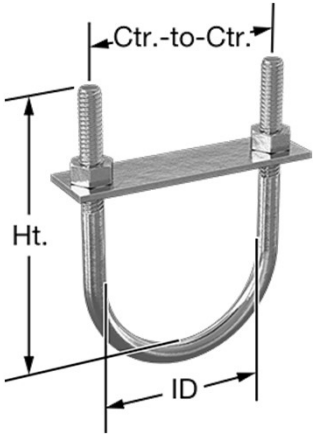
Set the Acrylic_Faceplate housing the sensors against the O-ring and screw on the union fitting cap. Through the acrylic you should be able to see the O-ring compress against the acrylic.

Operation

8.5

For the pressure sensor to give useful data it must be deployed at a fixed distance from the river or stream bed. We recommend a method that fixes the Smart Rock to a consistent location with respect to the stream bed.

We have tested putting stakes into the riverbed and mounting the Smart Rock to it with a U-bolt. We have also had success piling rocks around and on top if it, we tied it to the bank incase it came lose.

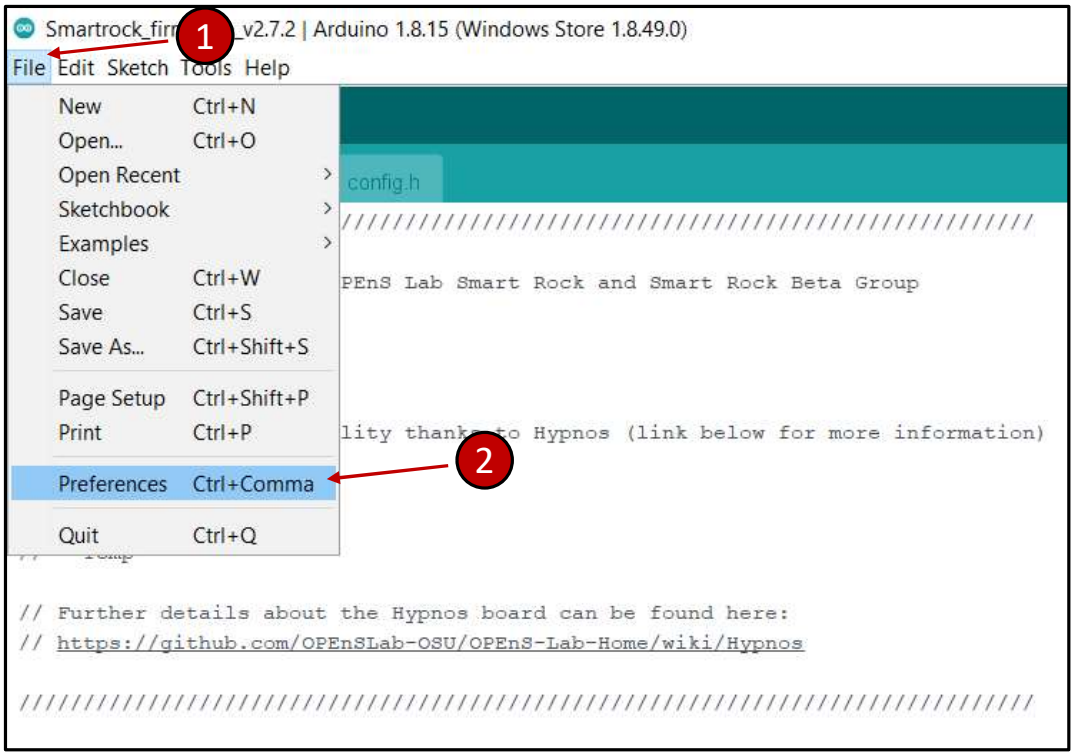


ID: 2.5”

Source: McMaster-Carr

Complete Software Setup

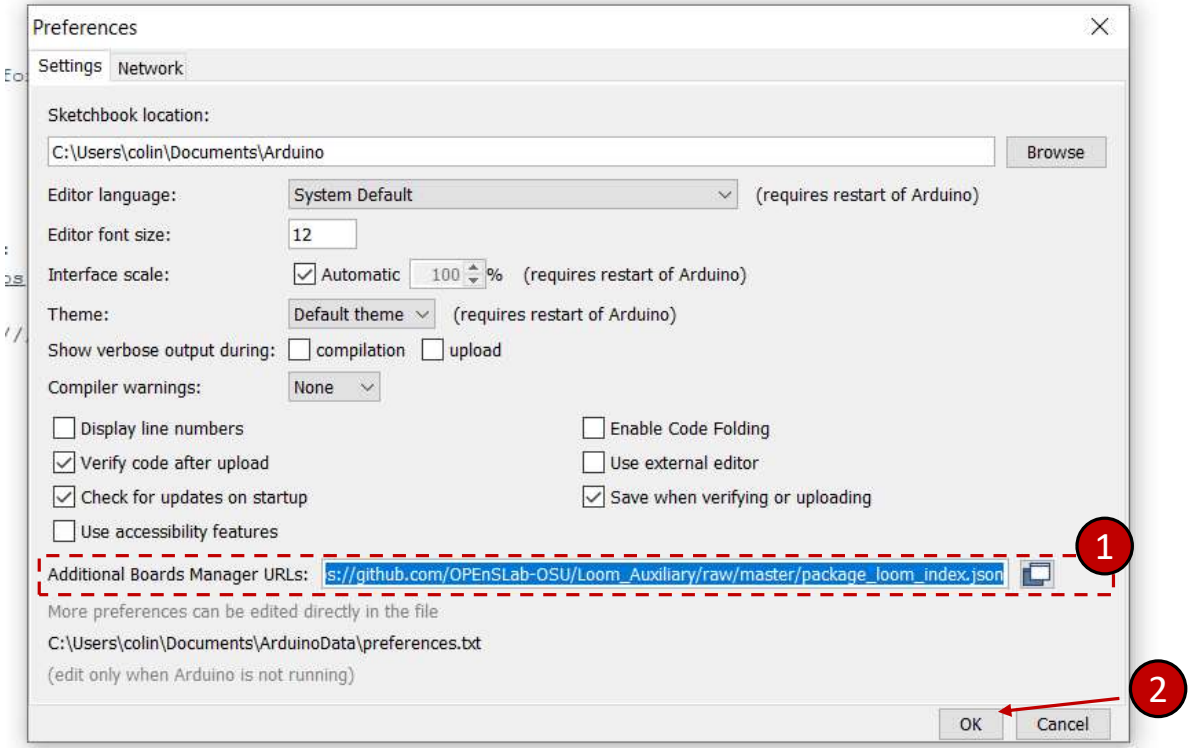
The software setup guide assumes you have already installed the Arduino IDE.



Navigate in the Arduino IDE to the preferences (File -> Preferences) or Ctrl + Comma as a short cut.

10.2

Copy and paste the text below into the Additional Boards Manager URLs box in the Preferences box. Then hit okay to save the add the new boards to the IDE.



https://adafruit.github.io/arduino-board-index/package_adafruit_index.json,
https://github.com/OPEnSLab-OSU/Loom_Auxiliary/raw/master/package_loom_index.json

10.3

Navigate to the board manager and add….

Arduino SAMD Boards (32-bits ARM Cortex-M0+) – Latest

Adafruit SAMD Boards – Version 1.5.7

Loom SAMD Boards – Version 2.5.1

Double check the specific versions and boards for the code you wish to upload.

With the boards installed open the version of code you wish to install

10.4

With the code you wish to upload open, under tools select “Loomified Feather M0” as the board.

10.5

With the correct board and code selected plug in your Smart Rock and ensure the correct port is selected.

10.6

Hit upload and after compiling the code it will upload to the Feather.

10.7