# Superheavy 2019

Assembly manual

Designed by Nicolas Schmit for Epic Space Models.

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# 1 Introduction

Thank you for acquiring this 1/100 scale model of Superheavy. It was a lot of work to make it available as a kit, and I hope you will have a lot a fun assembling the kit and playing around with it.

Don't forget to follow Epic Space Models on Twitter and YouTube!

Nicolas

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# 3 Warnings

## 3.1 Safety

This kit contains strong magnets. Be careful if you are wearing a pacemaker. Also, do not leave your credit card or any device sensitive to magnetic fields near the bag with the magnets.

Wear safety glasses when cutting out the plastic parts with a cutter.

## 3.2 Other

Do not use a power tool to drill holes in the plastic parts. The rapid rotation of the drill bit heats up the plastic and warps the printed part.

When connecting Superheavy to a computer using the USB cable, connect the DC power adaptor to a wall outlet BEFORE connecting the USB cable to the computer. The USB port alone is not capable of providing enough power for Superheavy.

Do not try to move the fins by hand. You might damage the mechanism.

Do not cover the top of the rocket when the engines are on. There is a fan in the engine block, and it needs to draw air from the top of the rocket to cool down the LEDs. If it cannot draw enough air the LEDs will overeat and might be damaged.

# 4 Model specifications

## 4.1 Dimensions

- Scale: 1/100
- Length: 68cm (27 inches)
- Core diameter: 9cm (3.5 inches)
- Width (including legs): 16cm (6.3 inches)

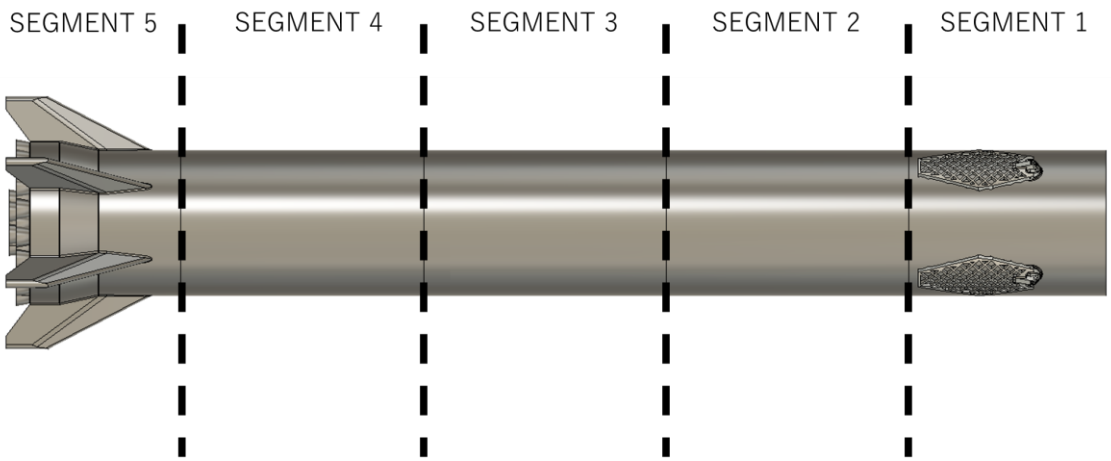
## 4.2 Functions

- Folding and rotating grid fins
- Engines lighting (RGB LEDs)

## 4.3 Main structure

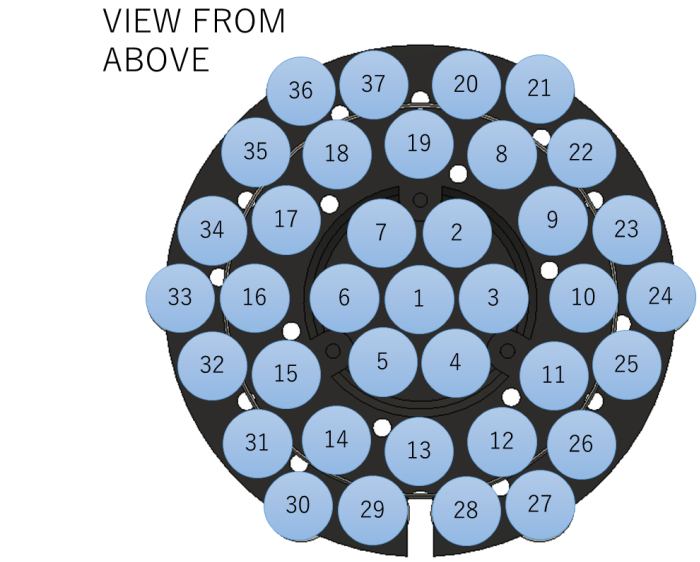
The rocket is split into five segments:

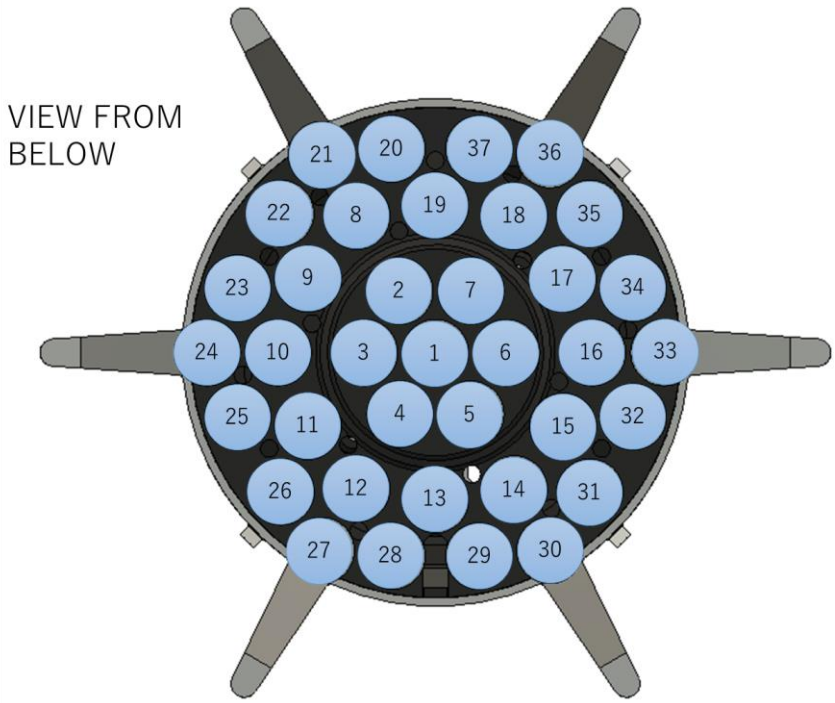
- Segment 1 (interstage): contains the servomechanism actuating the grid fins.
- Segments 2 and 3: plain tubes. The two segments are identical.
- Segment 4: contains the control board.
- Segment 5 (engine block): contains the LEDs for the engines and a cooling fan.



### 4.4 Engine layout

The engines are numbered from 1 to 37. Engines 1 to 7 make the center cluster, engines 8 to 19 make the first ring, and engines 20 to 37 make the second ring. Refer to this page when troubleshooting the LEDs.



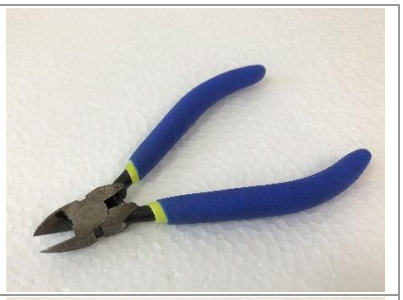



## 5 List of tools required

| Part | Photo |
| --- | --- |
| 0.8mm drill bit |  |
| 3mm drill bit |  |
| + screwdriver |  |
| Cutter |  |
| Flux (optional) |  |

| | |
|---|---|
| Hex key |  |
| Latex gloves |  |
| Marker |   |
| Office tape |  |
| Pliers |  |

| | |
|---|---|
| Q-Tip |  |
| Safety glasses |  |
| Solder |  |
| Soldering iron |  |
| Super glue |  |

| | |
|---|---|
| Wire cutter |  |
| Wire stripper |  |
| White vinyl tape |  |

### 6 Take your time!

This is a difficult model! It will probably take you three days to assemble. Take time to read carefully the instructions.

# 7 Assembly

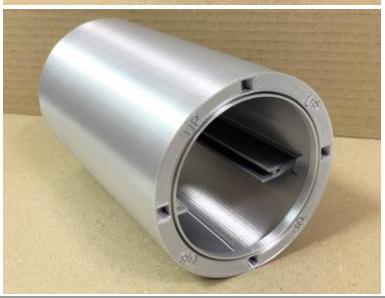
## 7.1 Magnets installation

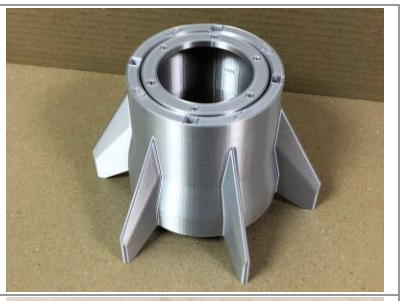
### 7.1.1 Parts & tools preparation

Superheavy uses magnets to hold the 5 segments together. Be very careful about the orientation of each magnet.

Wait for the glue to dry completely before mating the segments. Otherwise they will break loose.

Prepare the following parts

| Part | Number of parts | Photo |
|---|---|---|
| **All 5 hull segments** | 5 |     |

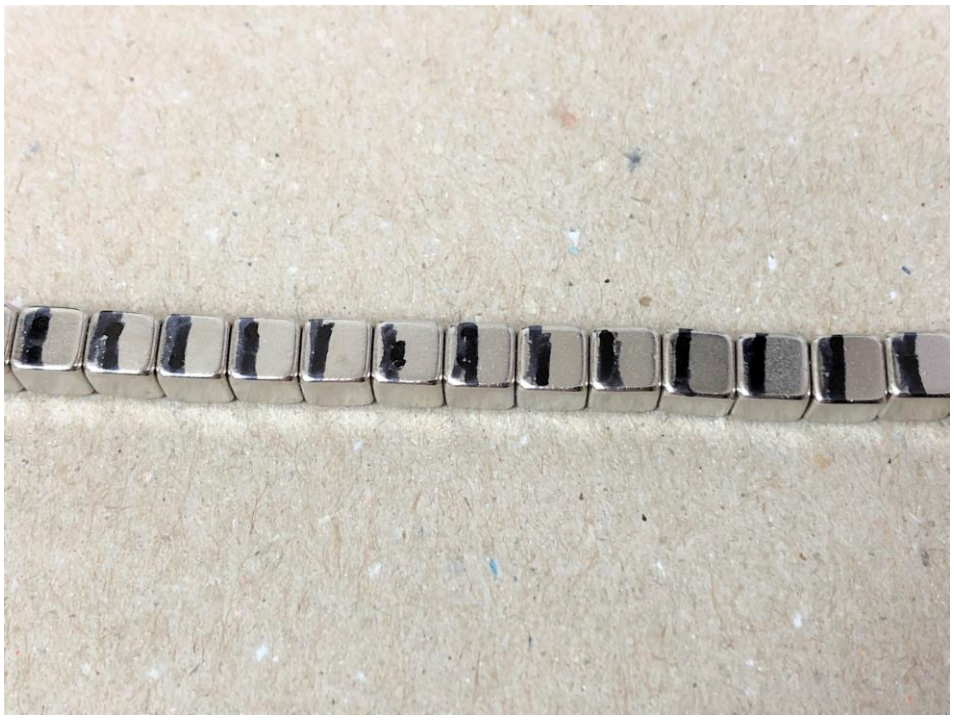
| | | |
|---|---|---|
| | |  |
| **Magnets** | 32 |  |

Prepare the following tools

| Part | Photo |
|---|---|
| **Super glue** |  |
| **Marker** |  |

### 7.1.2 Magnets preparation

Take all the magnets and arrange them in a row. Using a marker, draw a black line near one edge of each magnet like in the photo below. This line will help you identify the orientation of the magnets. For the following steps, before gluing each magnet, check that the inside of the magnet hole is clean, and check that you are orienting the magnet correctly. You can also use a compass to check the orientation of the magnets.



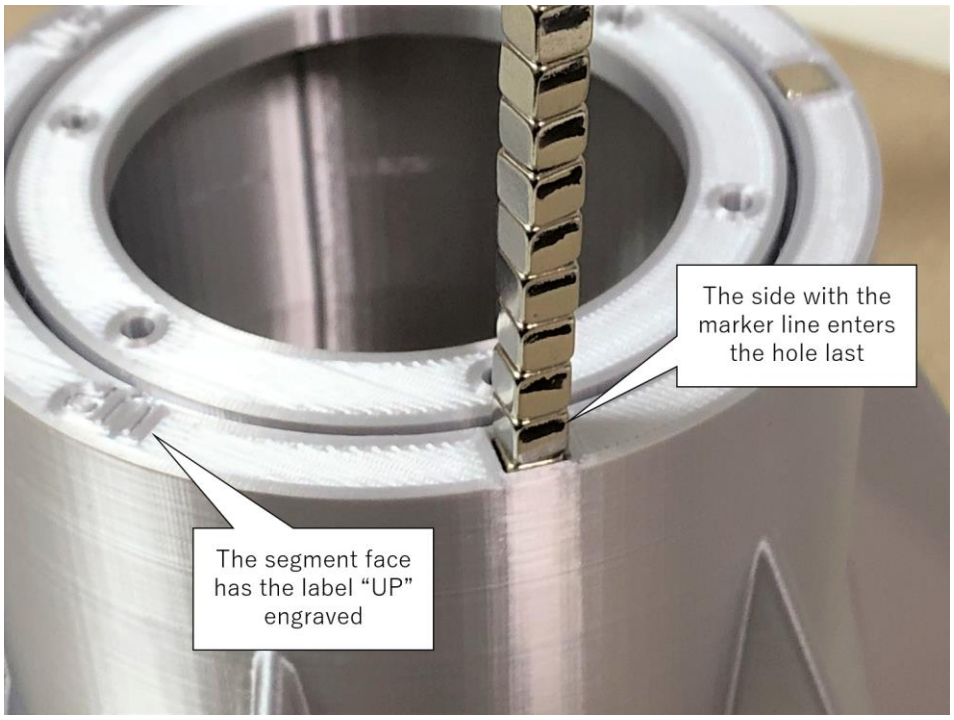
### 7.1.3 Segments face UP

Take the segments 2, 3, 4 and 5 (all segments, except the one with the holes on the side). Place them vertically so that the side with the label “UP” is facing up.

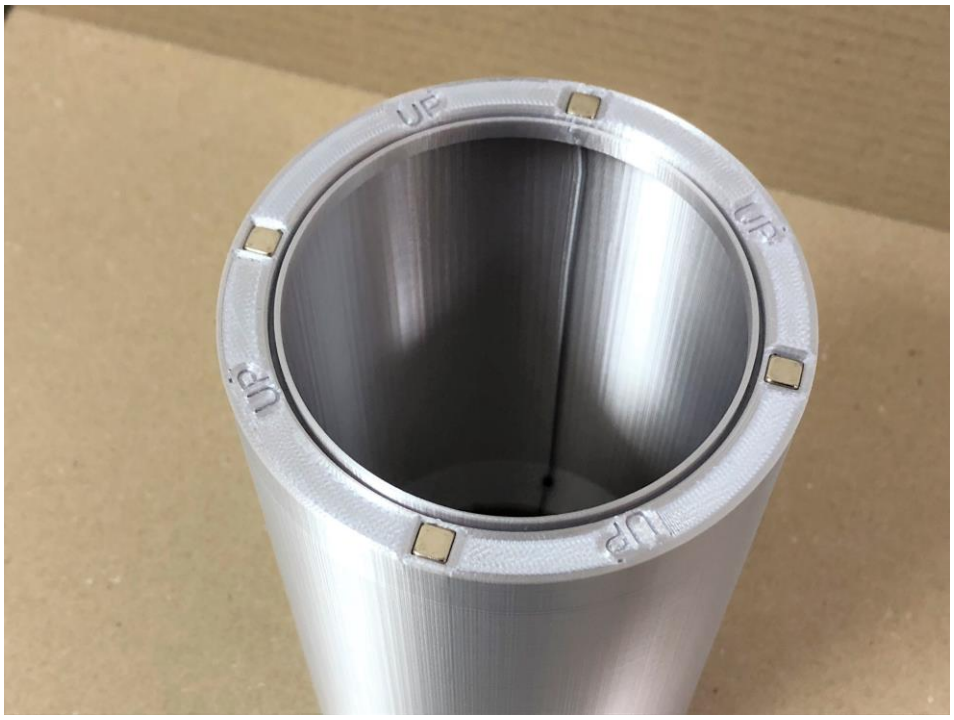
Important: check that there are no debris in the holes before inserting the magnets.

Take 16 magnets. On the side where the marker line is farther from the magnet edge, put glue on the tip of the magnet. Insert one magnet in one of the square holes of one of the segments. Pay very attention to the orientation of the magnet. The side with the maker line must enter the hole last! Once the magnet is in the hole, use the back of the marker to push the magnet to the bottom of the hole. Do this quickly before the glue dries, or you will not be able to mate the hull segments correctly. Look at the hull segment from the side. The magnet must be flush (not sticking out).

Repeat this step for each of the 4 holes of the 4 segments. You should insert 16 magnets in total.




UP
Push the magnet
using the marker


UP
UP
UP
UP

### 7.1.4 Segments face DOWN

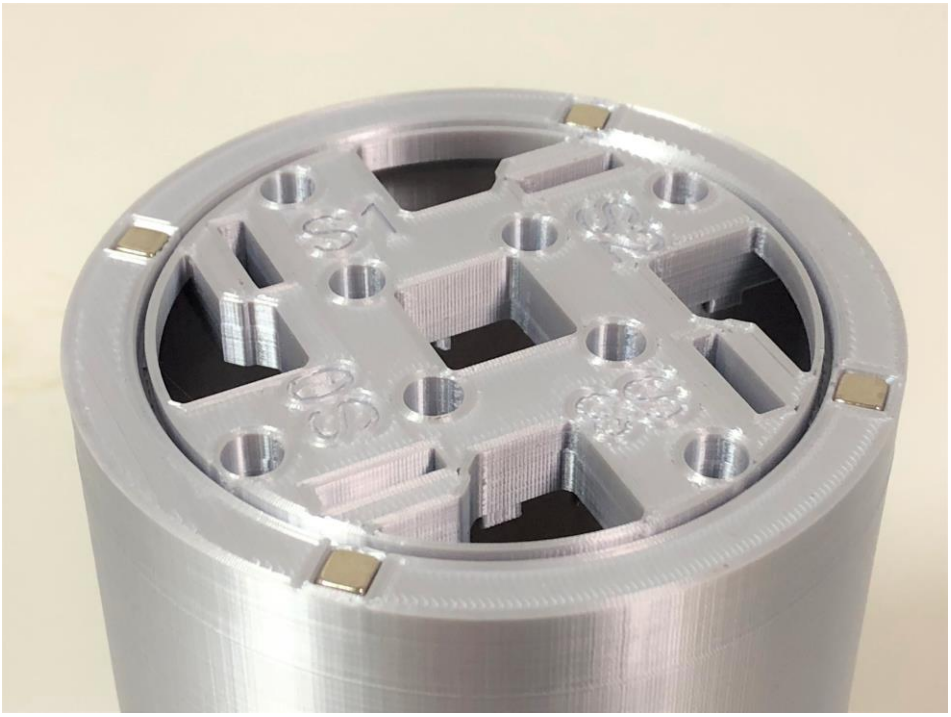
Take the segments 1, 2, 3 and 4 (all segments, except the one with the fins). Place them vertically so that the side with the label UP is facing down.

Important: check that there are no debris in the holes before inserting the magnets.

Take the remaining 16 magnets. For this part, the orientation of the magnets is reversed compared to what you did before. The edge of magnet with the marker line must enter the hole FIRST. Using the same technique as in the previous section, insert 4 magnets into each of the 4 segments.

Put the 5 segments aside. We will not need them for a while.

Do not try to mate the segments before the glue completely dries.

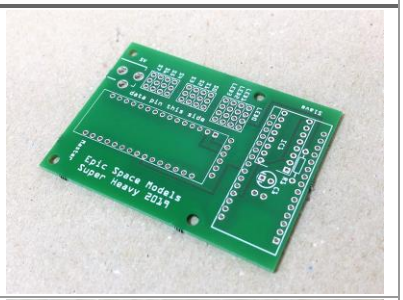
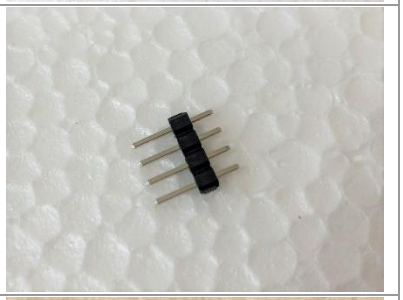
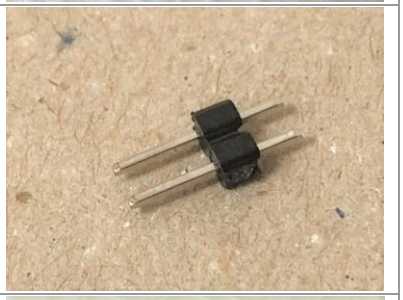
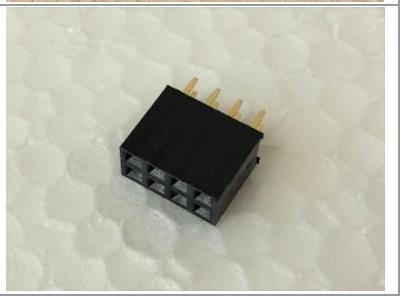

S1

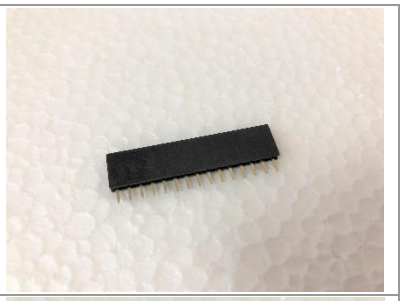
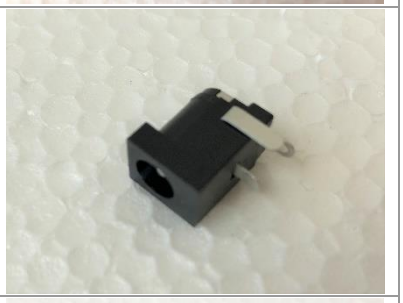
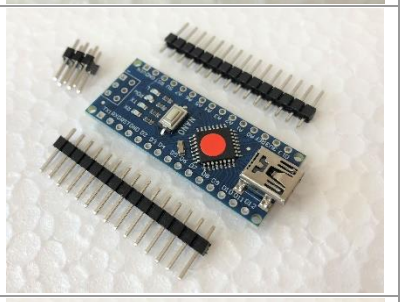
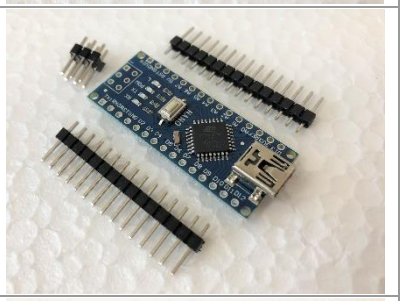
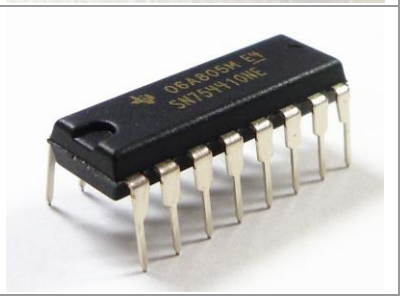
### 7.2 Control board soldering

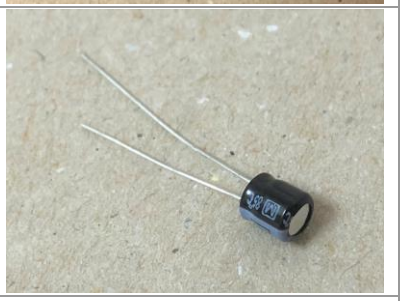
#### 7.2.1 Parts & tools preparation

The design of the control board might vary slightly, but the functionality remains the same. The male pin headers come as a single 1x40 part. Break this part to make pin headers with the required number of pins.

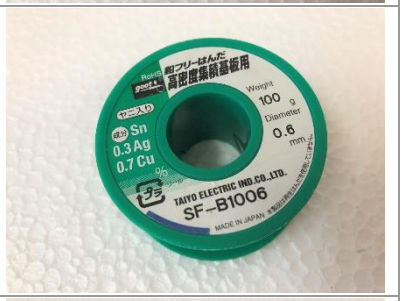
Prepare the following parts.

| Part | Number of parts | Photo |
|---|---|---|
| **Control board** | 1 |  |
| **Male pin header 1x4** | 6 |  |
| **Male pin header 1x2** | 1 |  |
| **Female pin header 2x4** | 2 |  |

| | | |
|---|---|---|
| Female pin header 1x15 | 4 |  |
| Power plug | 1 |  |
| Arduino (master) | 1 |  |
| Arduino (slave) | 1 |  |
| DC power adaptor | 1 |  |
| IC<br>SN7544 | 1 |  |

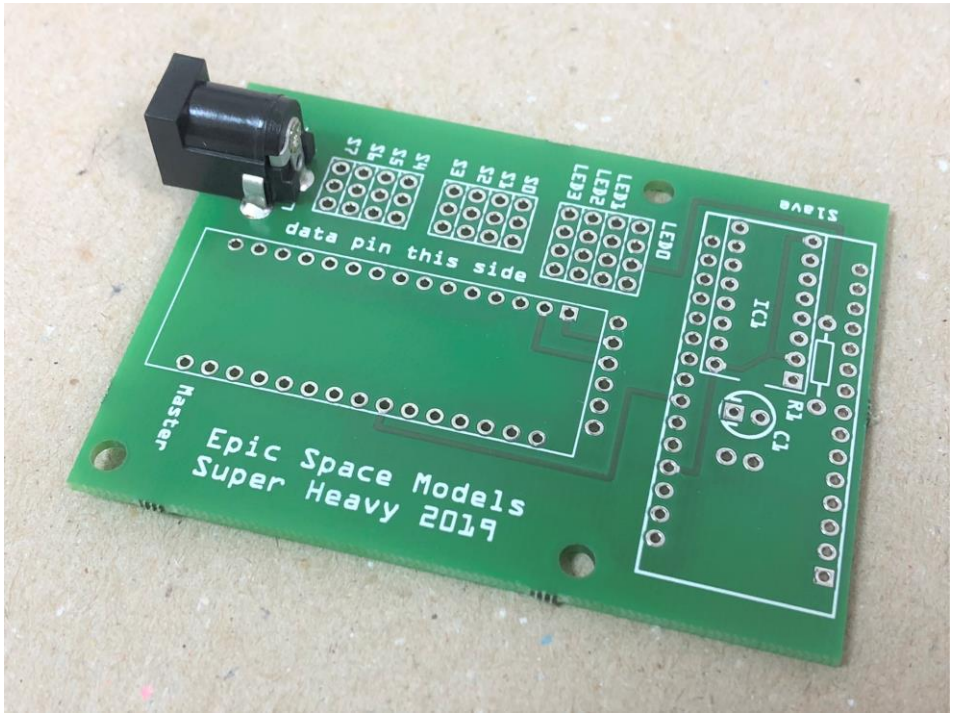
| | | |
|---|---|---|
| Resistor 470 Ohm | 1 |  |
| Capacitor 10uF | 1 |  |
| IC socket (16P) | 1 |  |
| Red wire | |  |
| Black wire | |  |

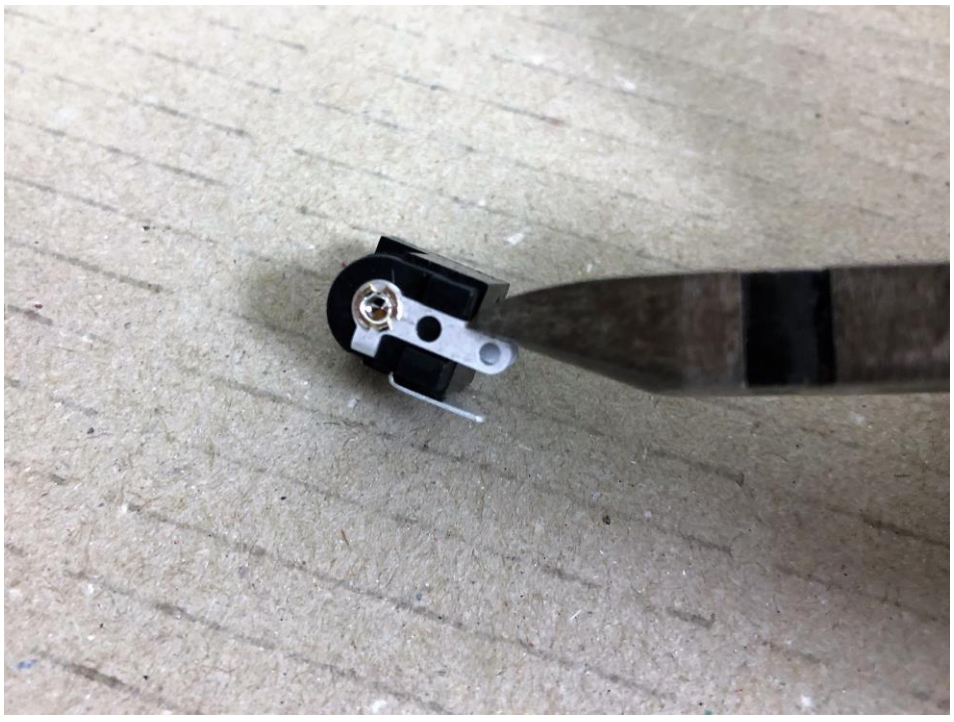
Prepare the following tools

| Part | Photo |
| --- | --- |
| Flux (optional) |  |
| Solder |  |
| Soldering iron |  |
| Vinyl tape |  |

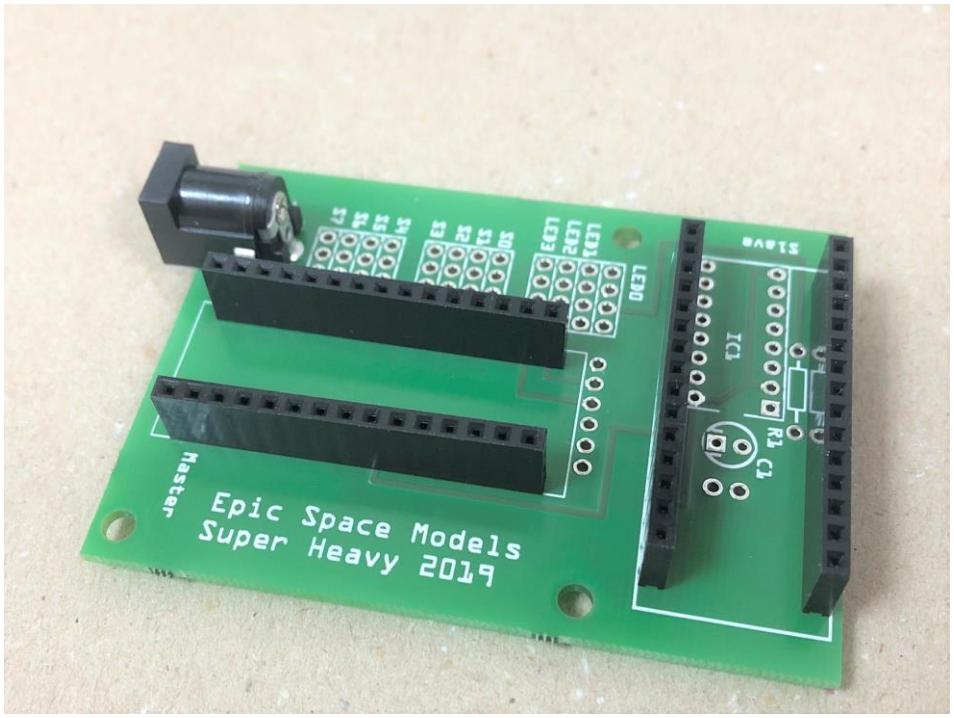
### 1.1.1 Soldering

Solder the power plug next to the “5V” label. If the contacts are too wide to go through the holes, you can use the wire cutter to trim them a little (see second photo).

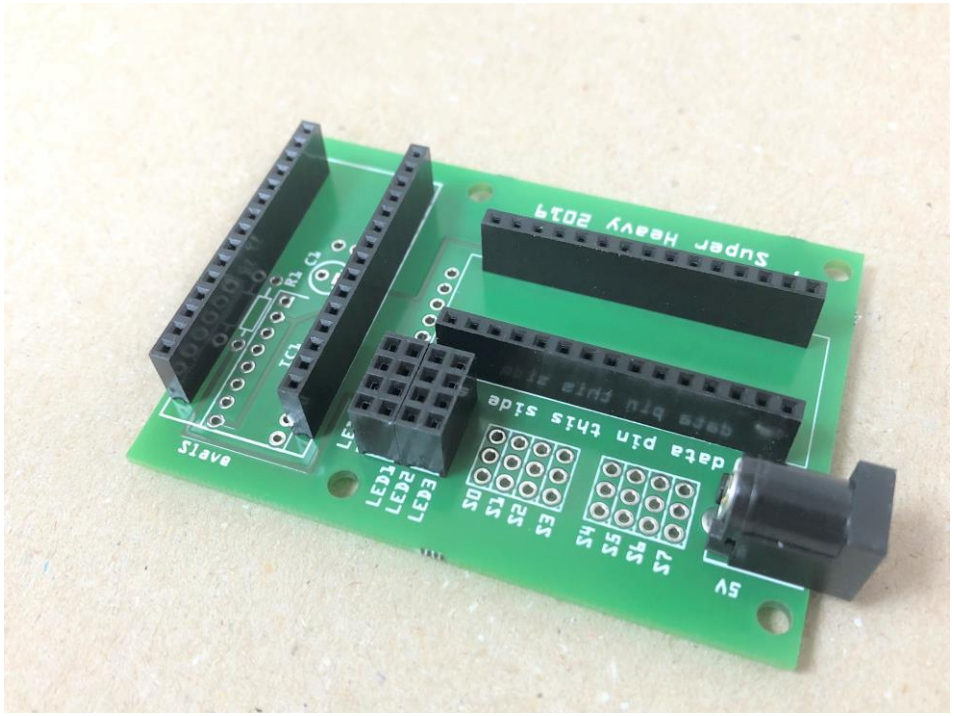


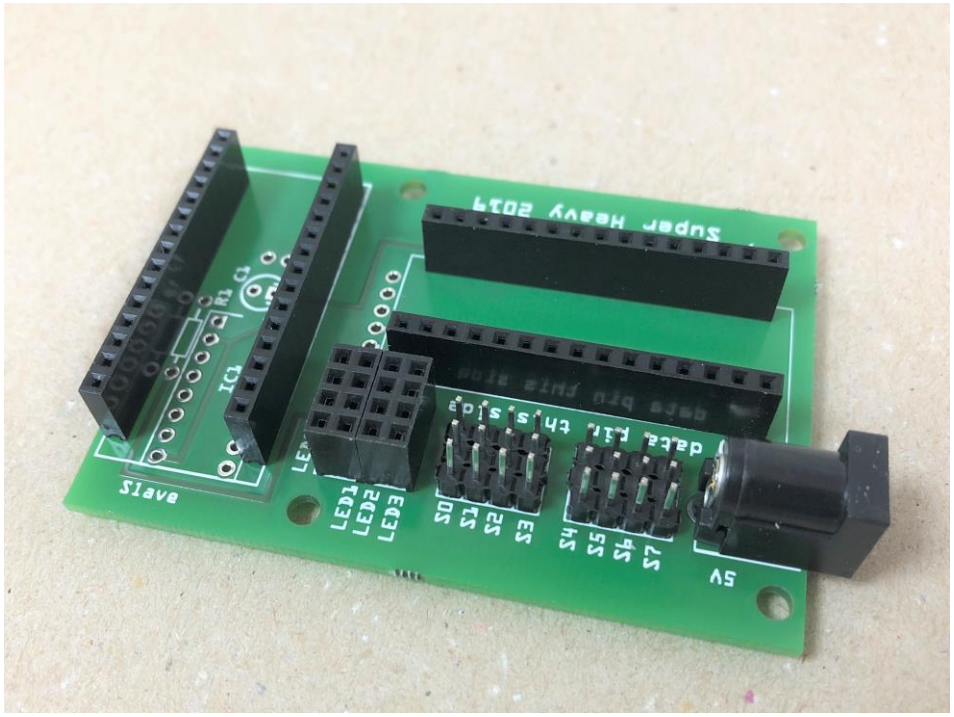
Solder the 1x15 female pin headers as shown on the photo.



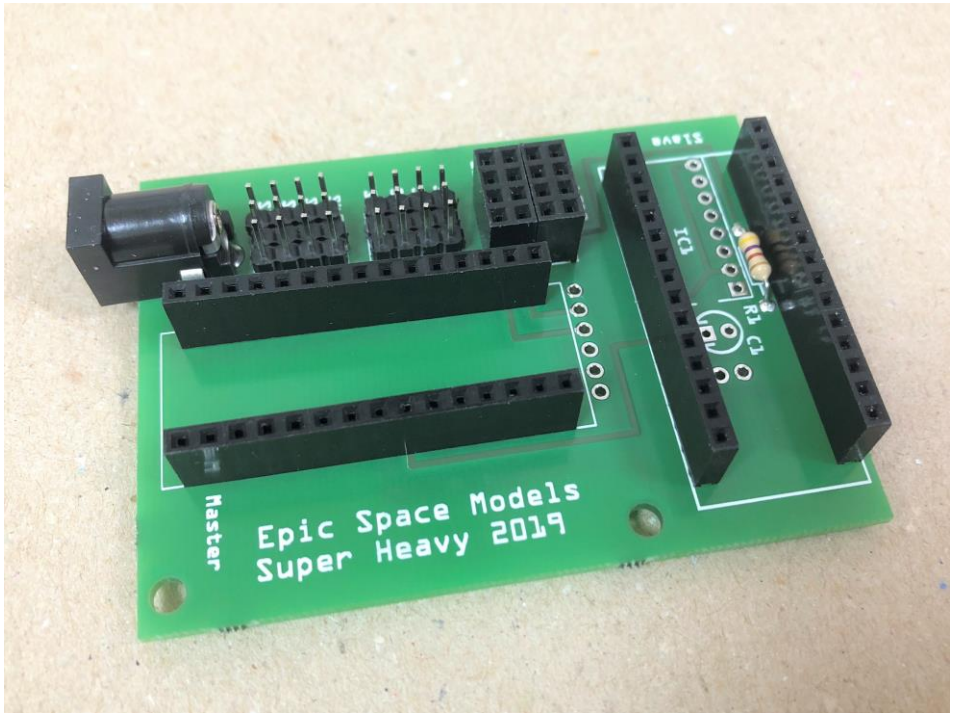

Solder the 2x4 female pin headers on as shown on the photo. Solder one on the LED0/LED1 slot and one on the LED2/LED3 slot.



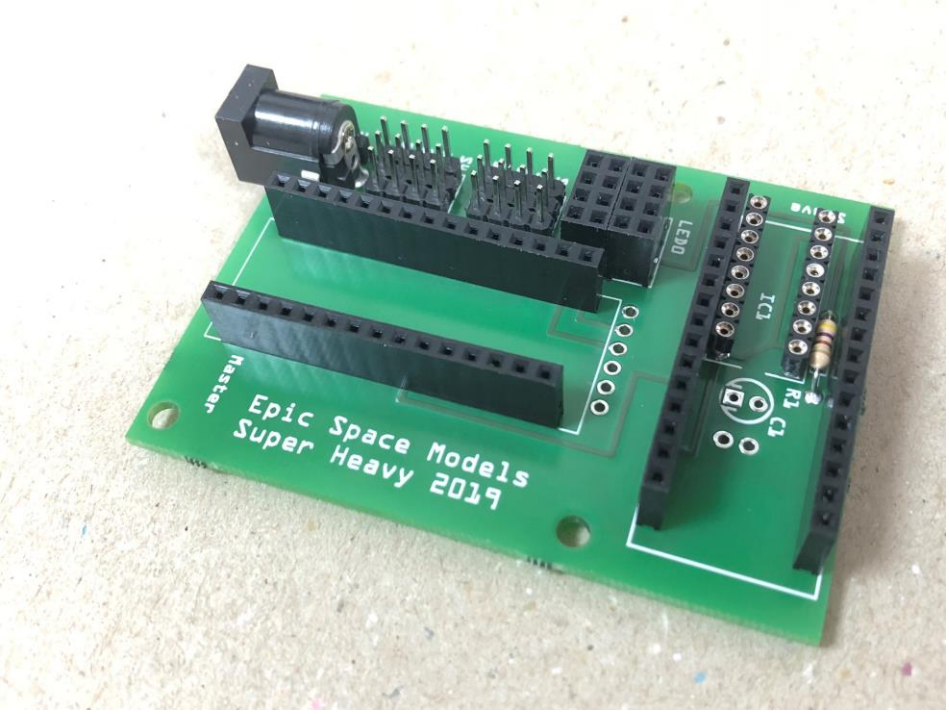
Solder the 1x4 male pin headers across the slots S0 to S3 and S4 to S7 as shown on the photo.



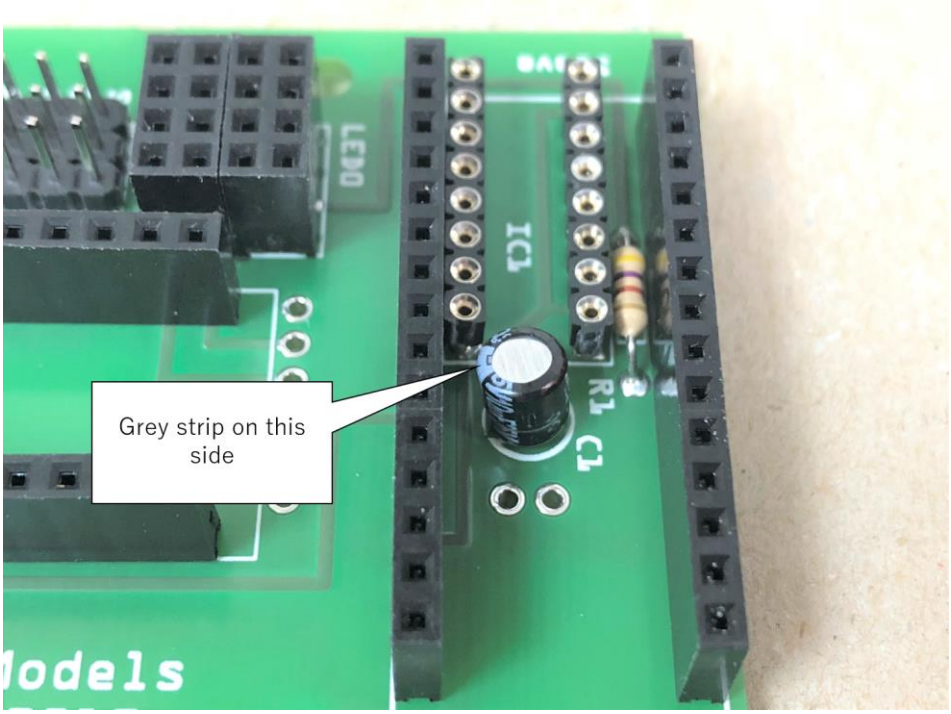

Solder the resistor next to the label R1. The orientation does not matter.



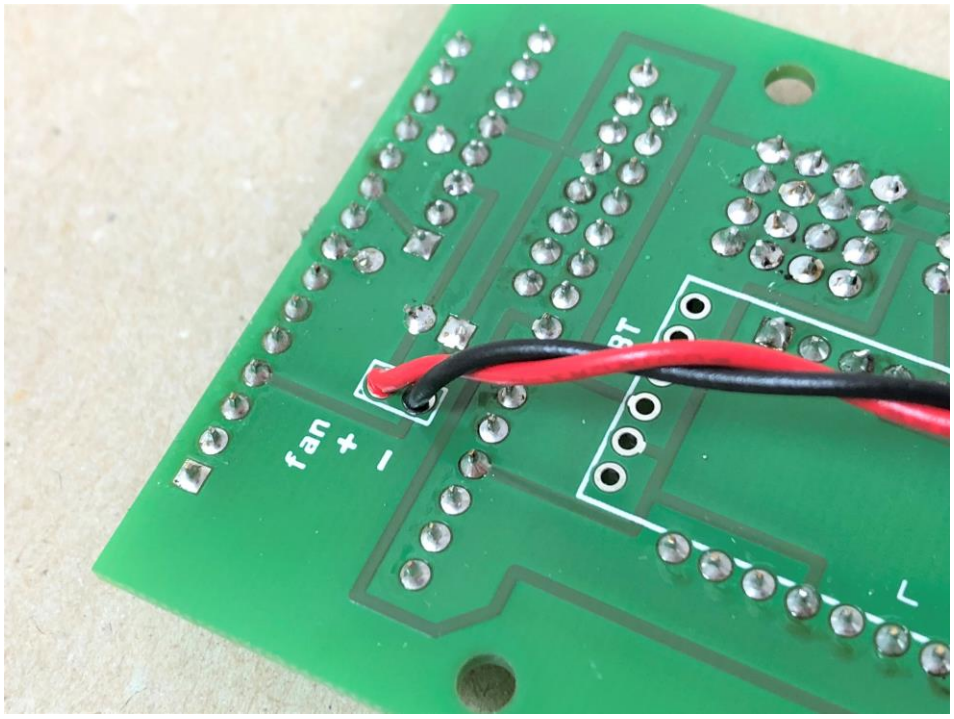
Solder the IC socket on top of the label IC1. Your socket might differ slightly from the one shown on the photo, but the functionality remains the same.

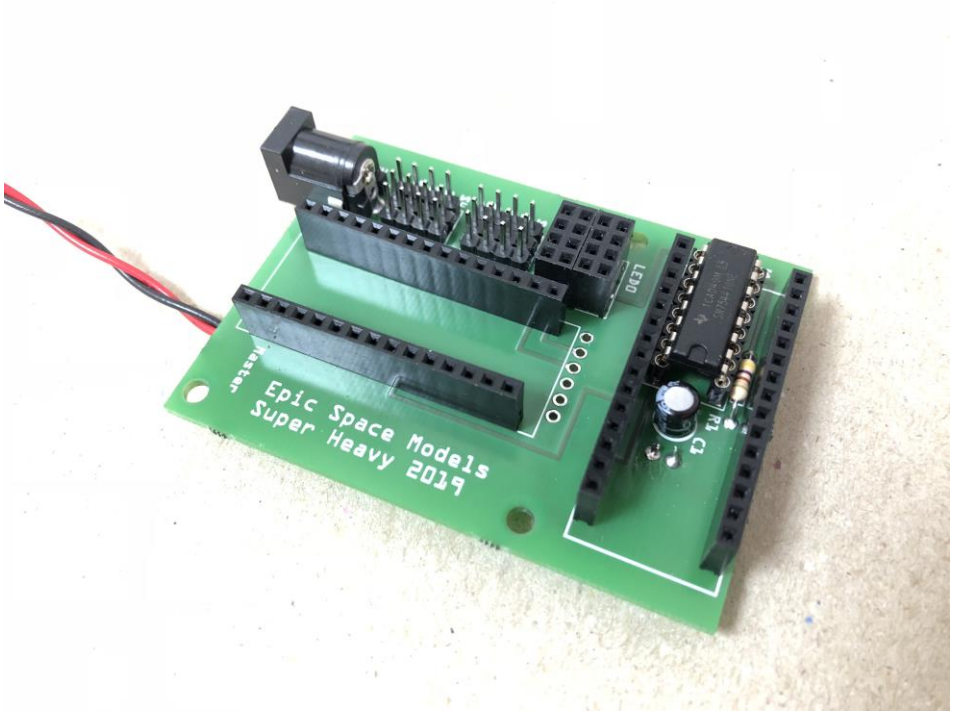



Solder the capacitor next to the label C1. Pay attention to the orientation of the part. The grey strip must be facing towards the center of the board.

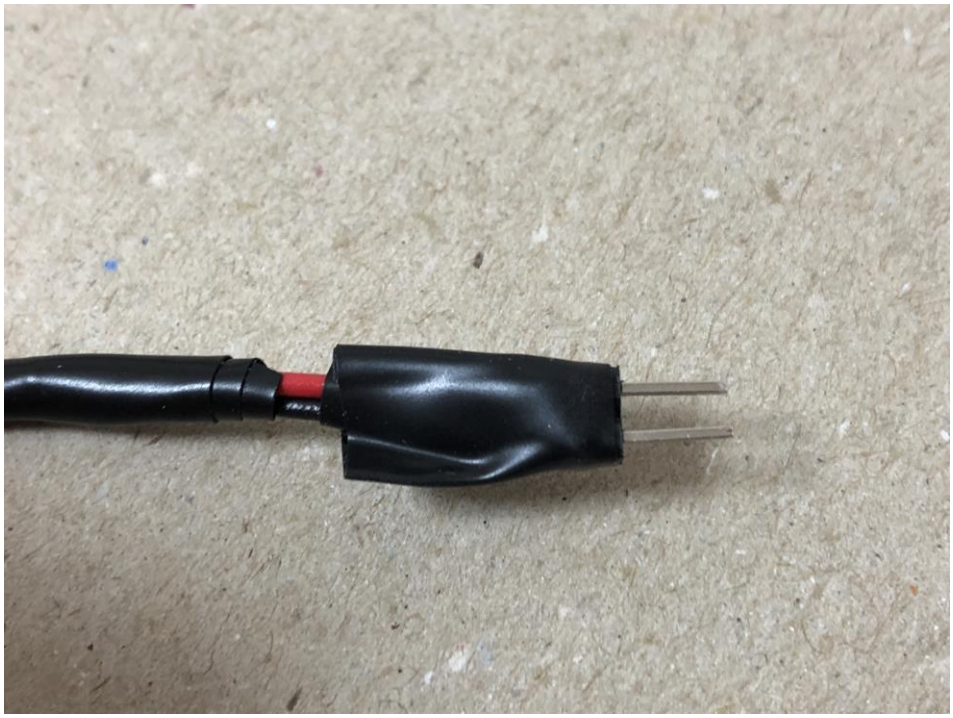


Cut 25cm of red and black wire. Solder one end of each wire on the opposite side the board, next to the label “fan”. Solder the red wire in the + hole and the black wire the – hole. Bundle the two cables together. The bundle should leave the board on the side that has the power pug.



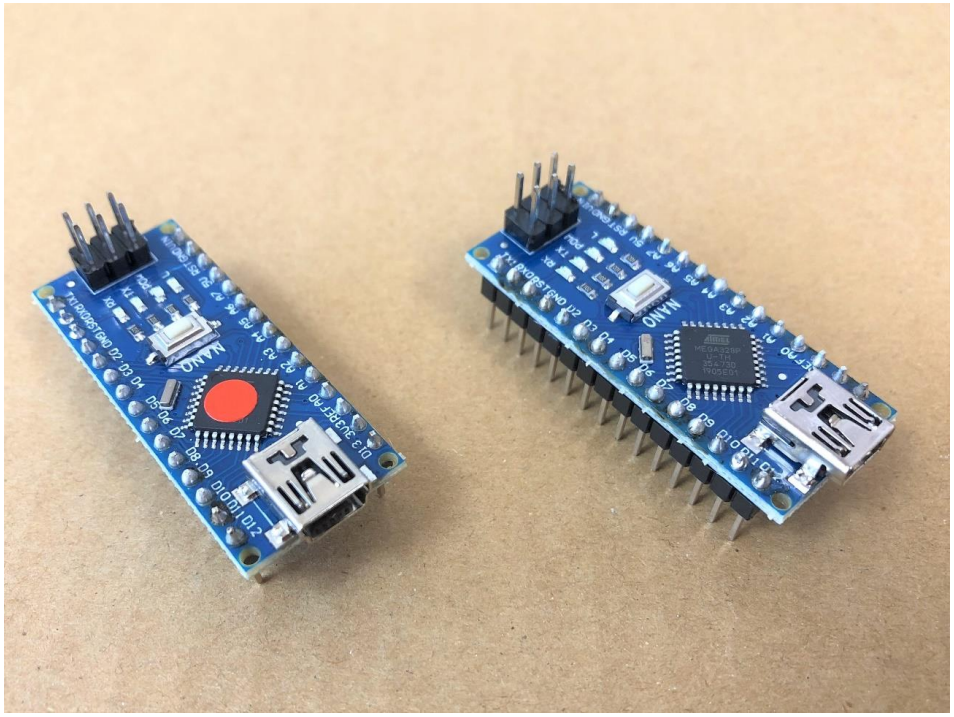



Solder the 1x2 male pin header at the end of the cable bundle. Wrap vinyl tape around the solders.



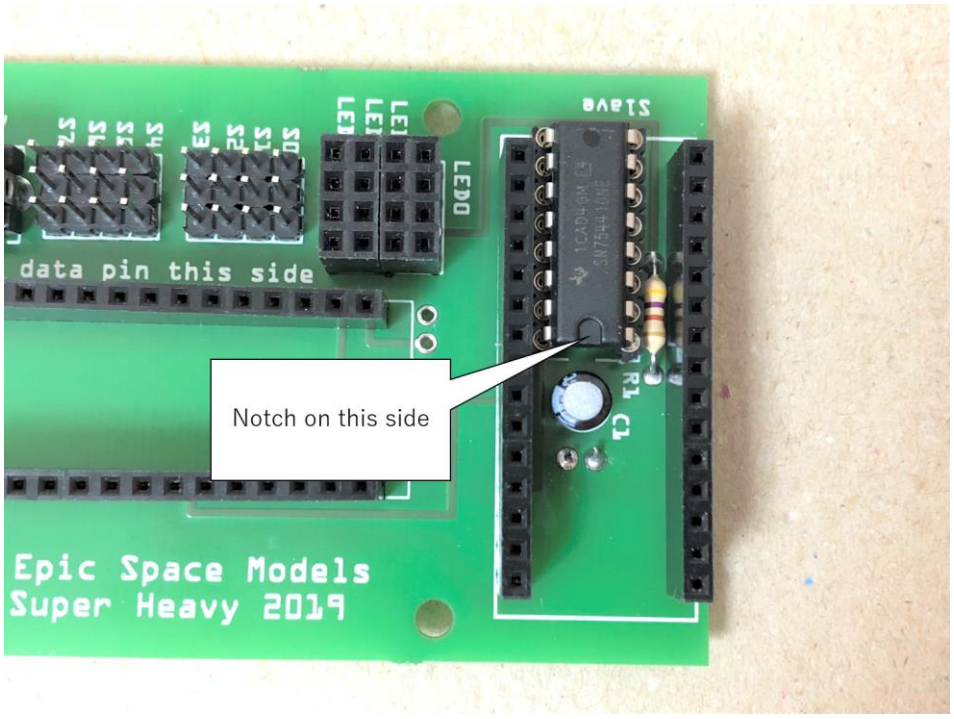
Take the 2 Arduinos out of their bag. One has a colored dot on it. Do not remove the dot! The 2 Arduinos run different programs, and Superheavy will not work if you swap them. Apart from the Arduino boards there are also pin headers in the bag. Solder the 1x15 pin headers below the boards, and the 2x3 pin headers above the boards.

The pin headers might already be soldered. If this is the case, go directly to the next step.

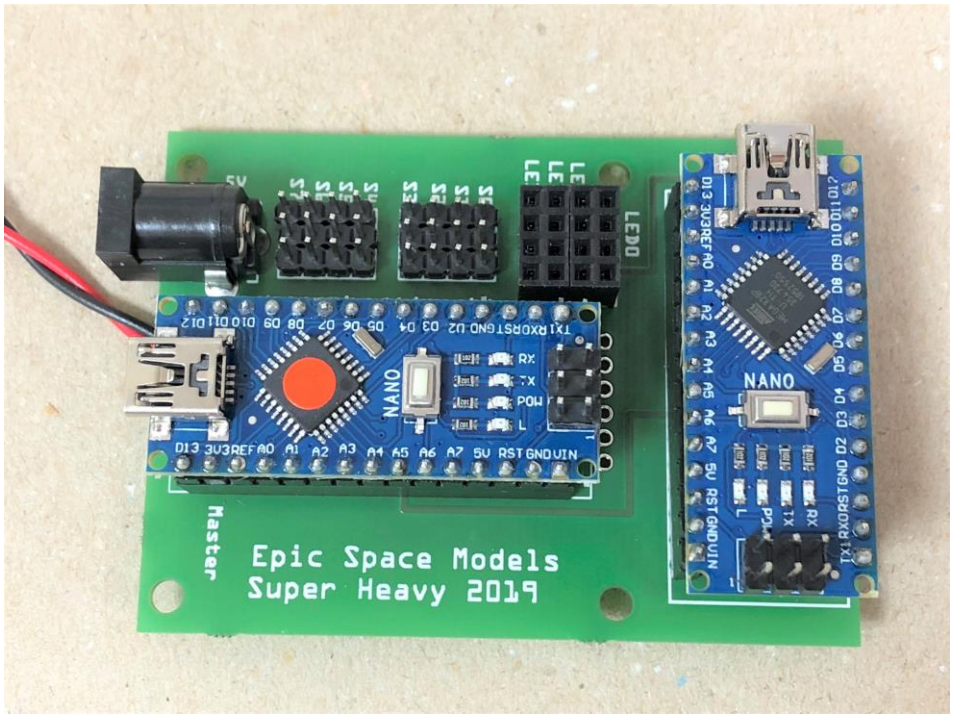


### 7.2.2 IC & Arduinos installation

Take the IC and insert it on its socket. The notch in the IC must be facing towards the capacitor.



Insert the Arduinos into the pin headers as shown on the picture below. The Arduino with the dot must be parallel to the servo and LED connectors, with the USB connector on the same side as the power plug. The other Arduino must sit on top of the IC, with the USB connector on the side with the label “slave”.



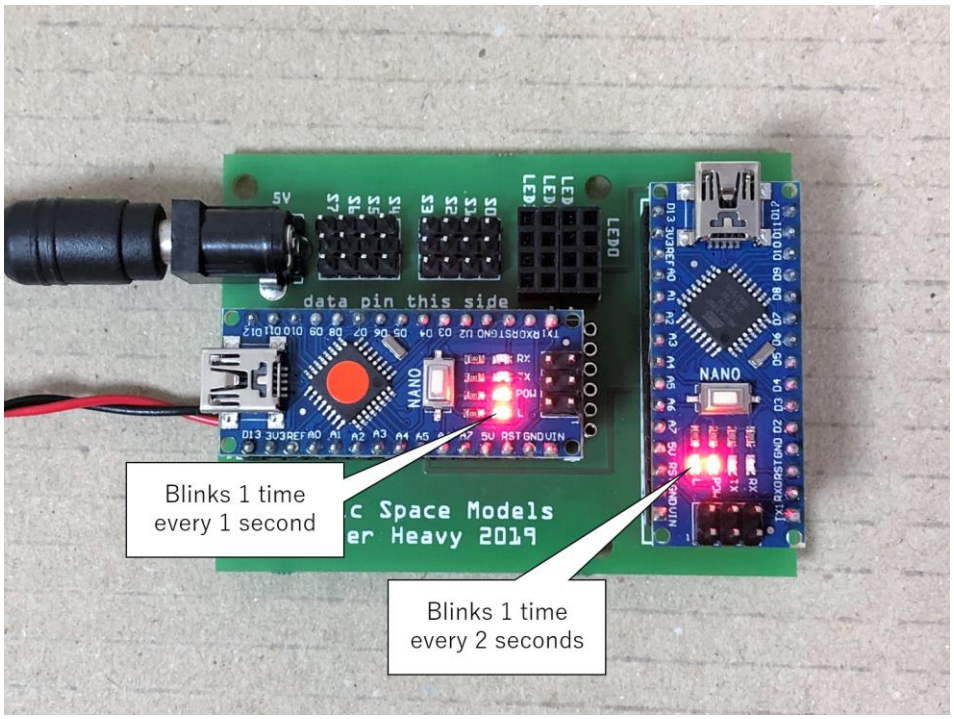
### 7.2.3 Testing

Take the DC power adaptor. Connect the 5V plug (round plug) to the control board. Connect the power adaptor to a wall outlet. Depending on your country, you might need to insert a plug adaptor.

After plugging the DC power adaptor, wait a few seconds. The red LED on the Arduino with the dot should blink 1 time per second. The led on the other Arduino should blink 1 time every 2 seconds (two times slower). Once you checked that the LEDs blink as expected, unplug the control board.

There is a USB cable included in the kit, but you do not need it for the moment.

Put the control board in a safe place out of reach of your cat.



### 7.3 Engine cluster assembly

#### 7.3.1 Parts & tools preparation

The kit comes with spare nozzles in case you break one during the assembly.

The kit comes with spare LEDs in case one burns out.

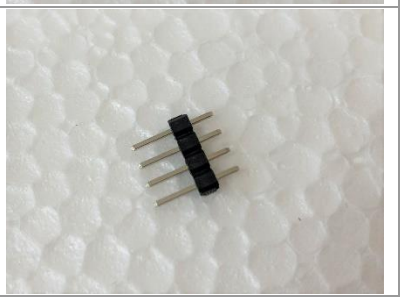
Solder the LEDs quickly. If you heat them up too much and for too long, they might be damaged.

The mount plate has both small holes and big holes. The big holes are for attaching the nozzles, the small ones are for cooling.

Tip: before soldering a LED, pre-tin the pads on the LED and the stripped part of the wires. This will make it easier to solder.

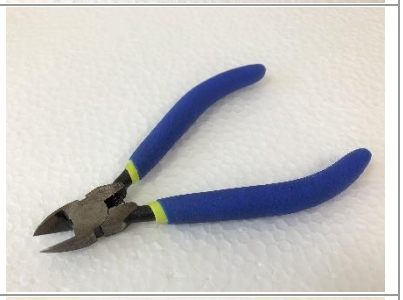
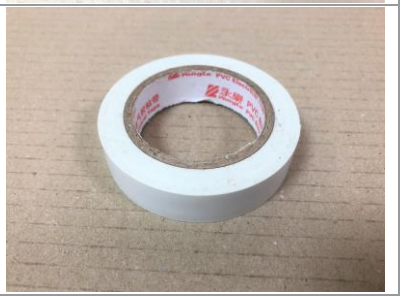
Prepare the following parts

| Part | Number of parts | Photo |
|---|---|---|
| **Engines mount plate** | 1 |  |
| **Nozzles** | 37 |  |
| **Red wire** | 1 |  |

| | | |
|---|---|---|
| Black wire | 1 |  |
| White wire | 1 |  |
| LED | 37 |  |
| Male pin header 1x4 | 3 |  |

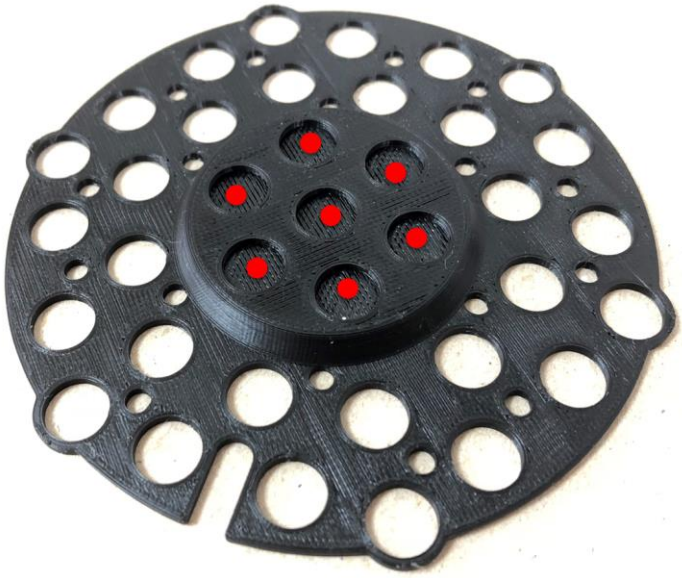
Prepare the following tools

| Part | Photo |
| --- | --- |
| Cutter |  |
| Flux (optional) |  |
| Latex gloves |  |
| Marker |  |
| Q-Tip |  |

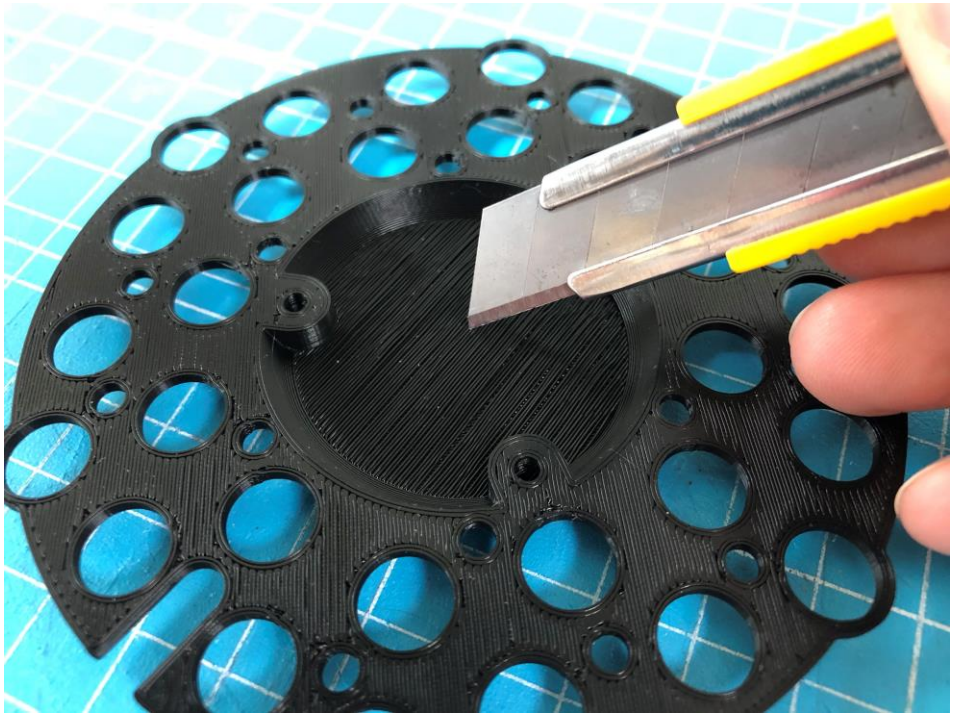
| | |
|---|---|
| Solder |  |
| Soldering iron |  |
| Wire cutter |  |
| Wire stripper |  |
| White vinyl tape |  |

### 7.3.2 Opening the engine holes

Take the engines mount plate. Locate the 7 holes of the center cluster.



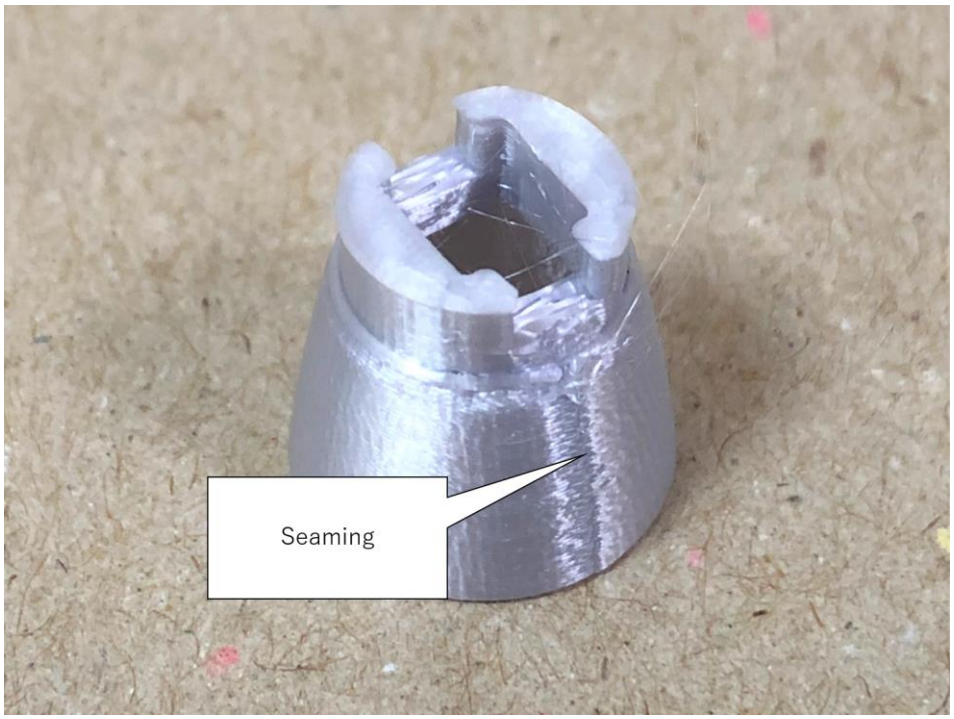
Flip the part so that the central disk lays flat on the table. Using a cutter, open the holes by carefully cutting through the layer covering them. The result should look like the second photo.



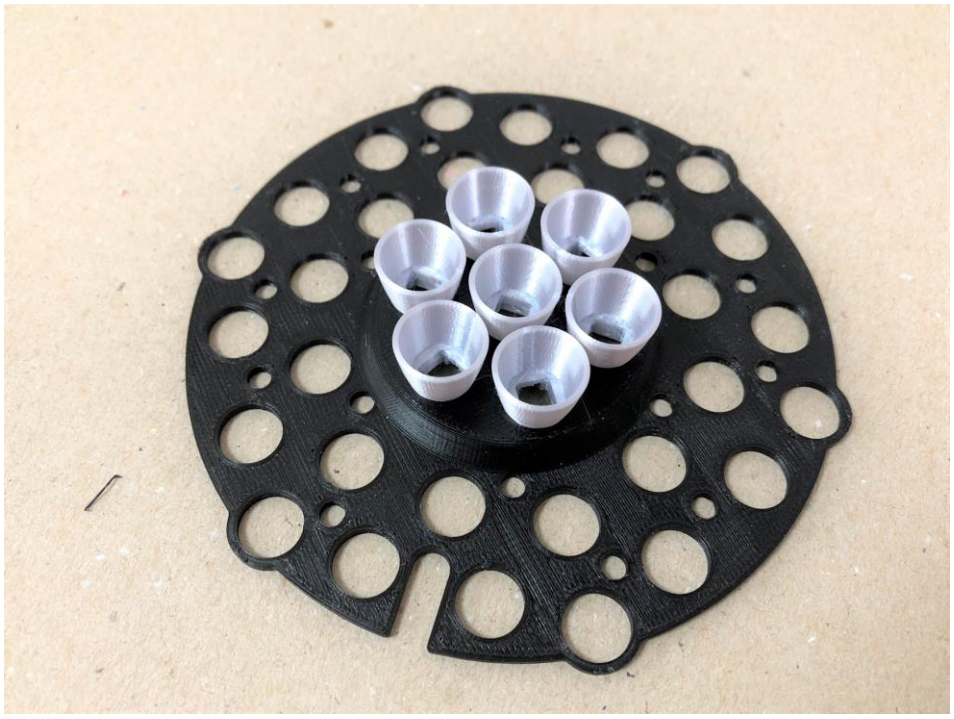
### 7.3.3 Attaching the nozzles

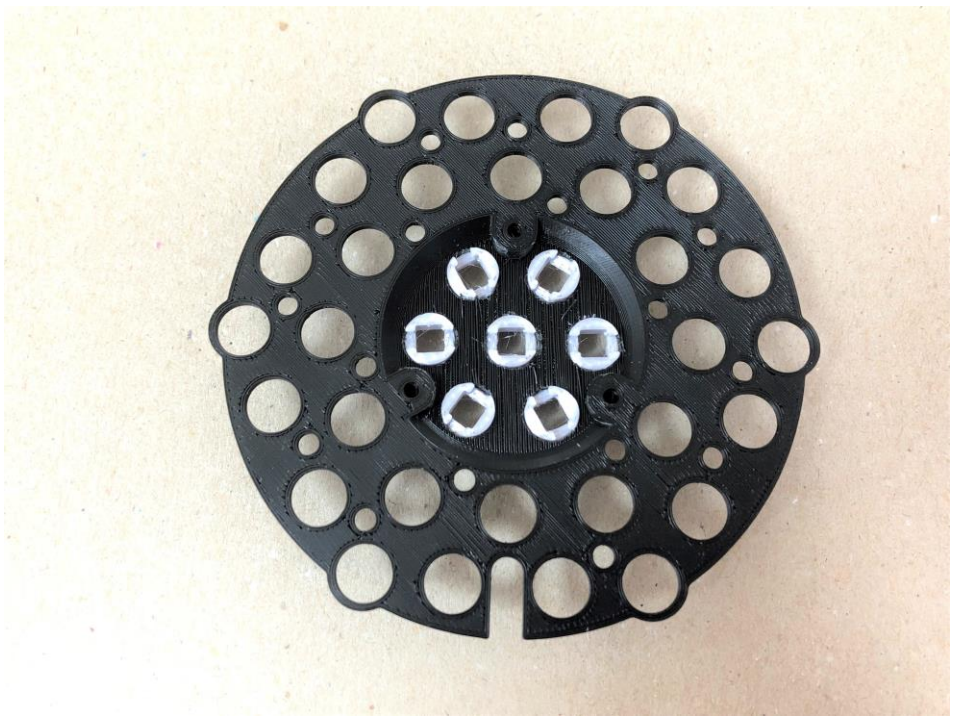
Tip:

The nozzles have a seaming line on the side. This is an artefact of the 3D printing. When inserting the nozzles (except for the one in the center), orient the nozzles so that the seaming is towards the center of the mount plate. This way, it will be almost invisible.



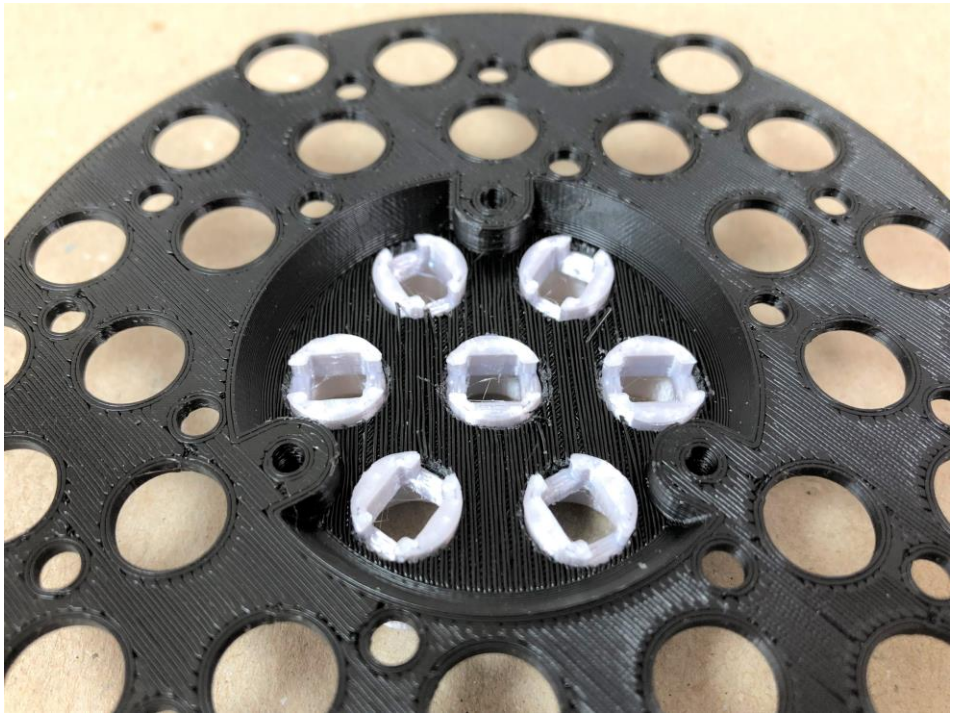
Take 7 nozzles. Insert them in the 7 holes that you opened in the previous section. Orient the nozzles like in the photos below. Placing the nozzles in the correct orientation will make the soldering easier. For the 6 nozzles around the center one, orient the seaming towards the center nozzle.

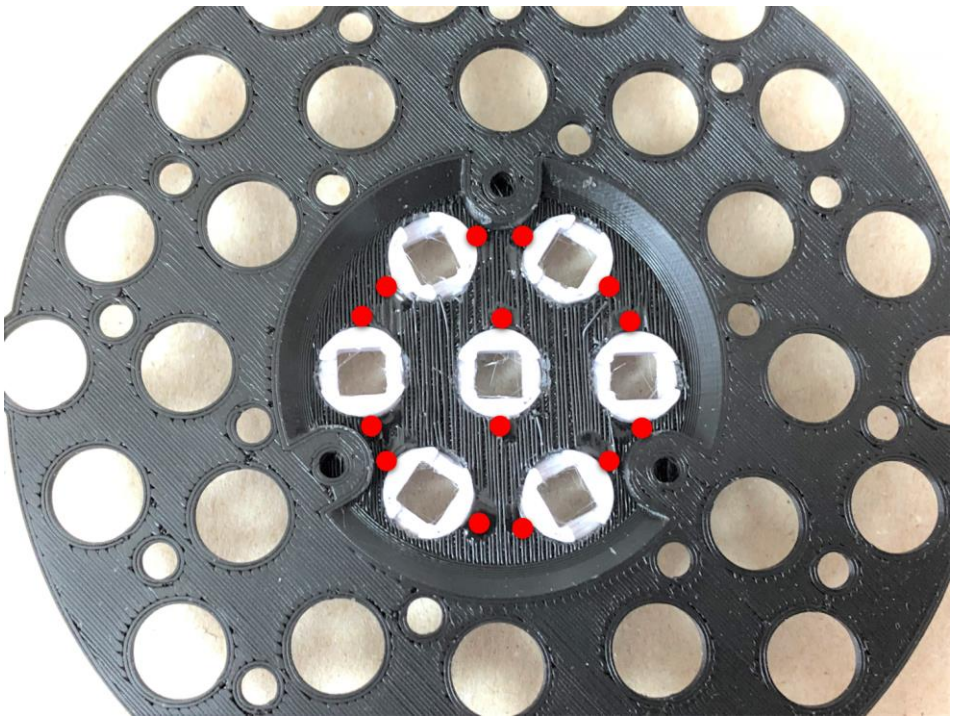




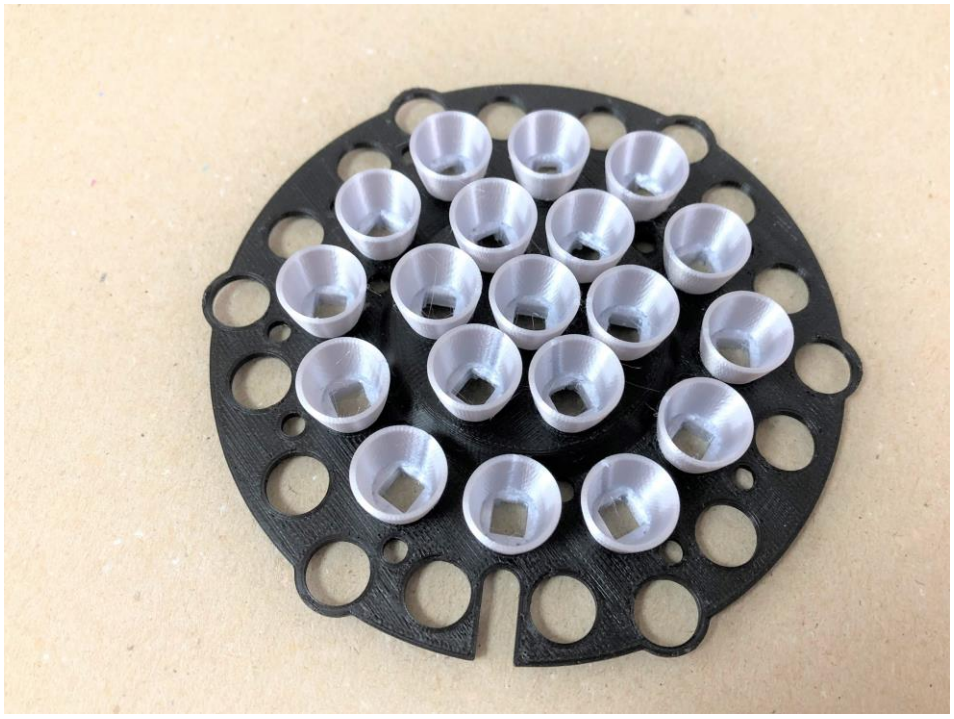
Verify that the nozzles are fully inserted with the correct orientation, then use super glue to secure the nozzles in place. Apply two drops of super glue to each nozzle at the location indicated by the red dots on the second photo below.

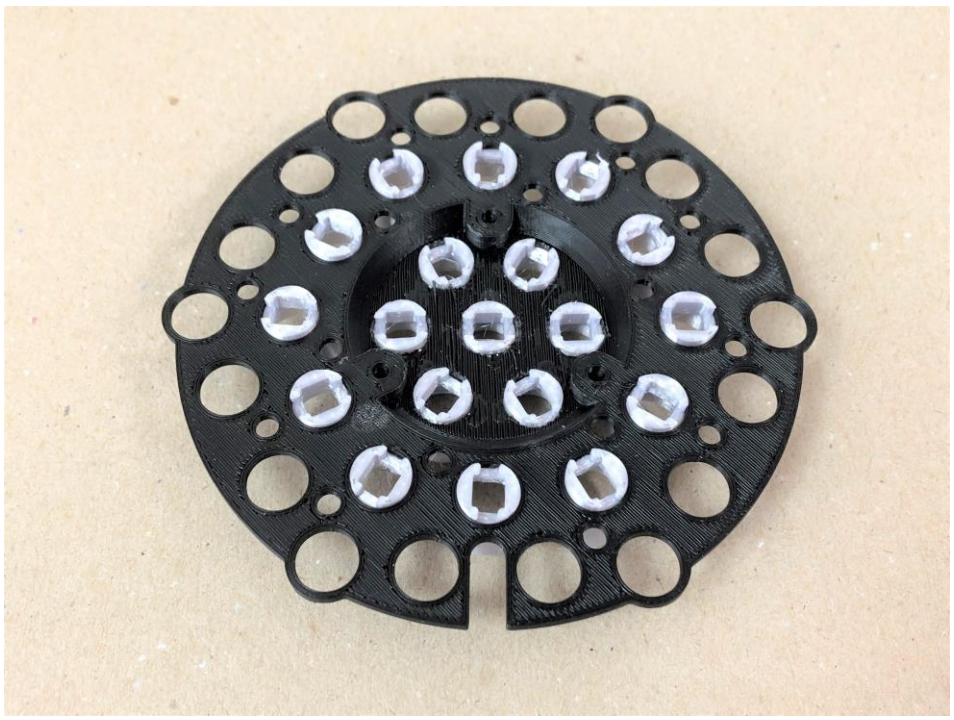
Do apply glue to the other side of the mount plate. The glue leaves ugly white traces when drying.



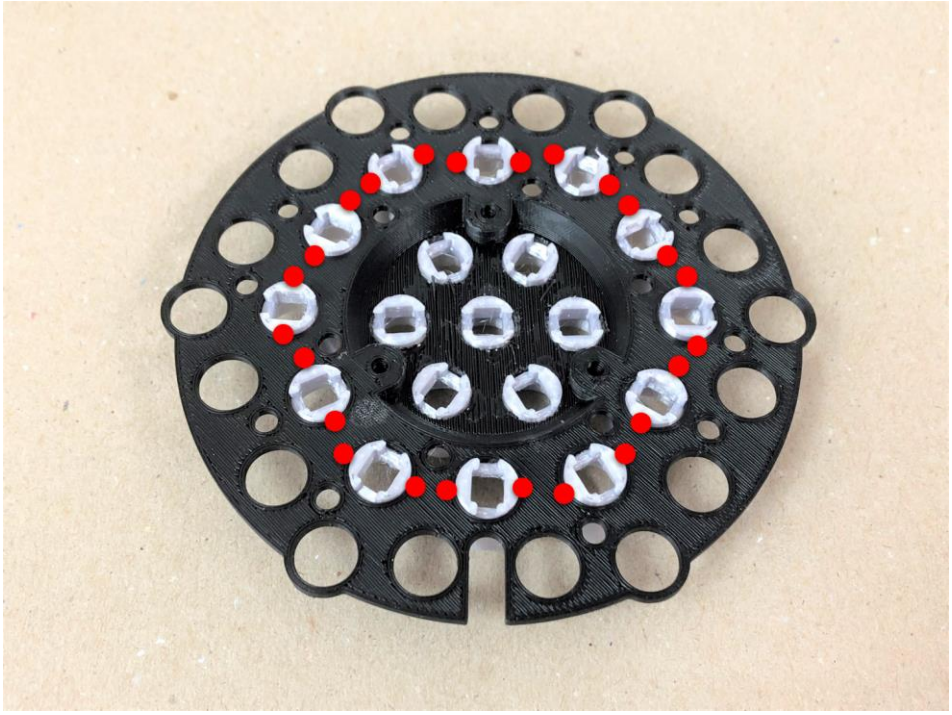


Take 12 nozzles. Insert them into the holes of the first ring. Orient the nozzles like in the photos below, paying attention to the orientation of the notches. Like for the center cluster, orient the seaming towards the center of the assembly.

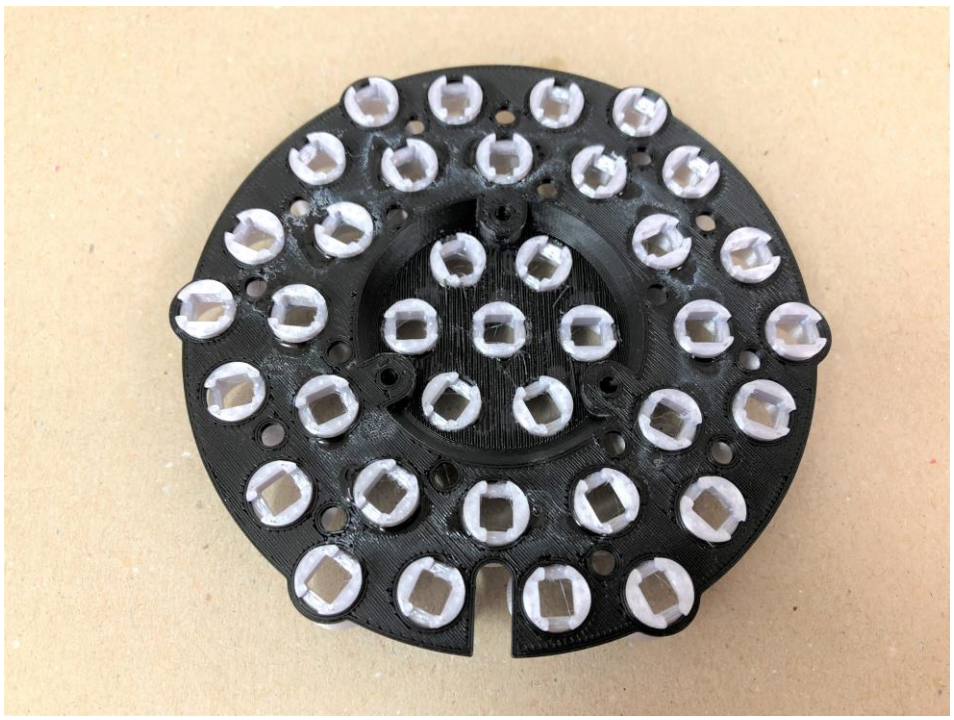




Verify that the nozzles are fully inserted with the correct orientation, then use super glue to secure the nozzles in place like you did before. Apply glue at the locations indicated by the red dots on the photo below. If a nozzle is loose, hold the nozzle using one hand and apply the glue with the other hand.

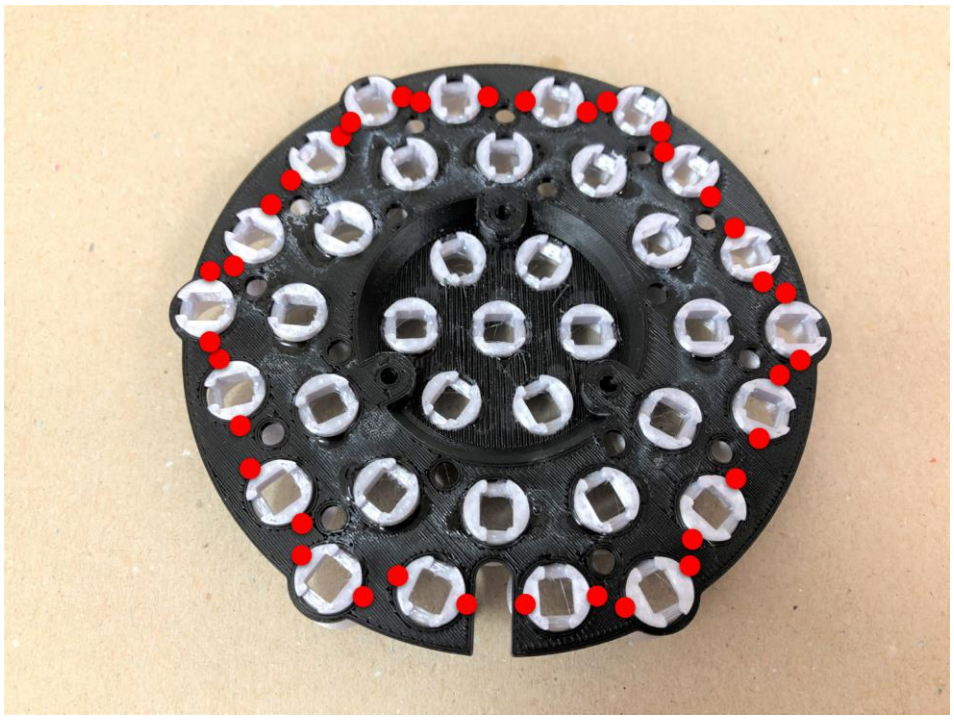


Take 18 nozzles. Insert them into the holes of the second ring. Orient the nozzles like in the photo below, paying attention to the orientation of the notches. Like for the center cluster, orient the seaming towards the center of the assembly.

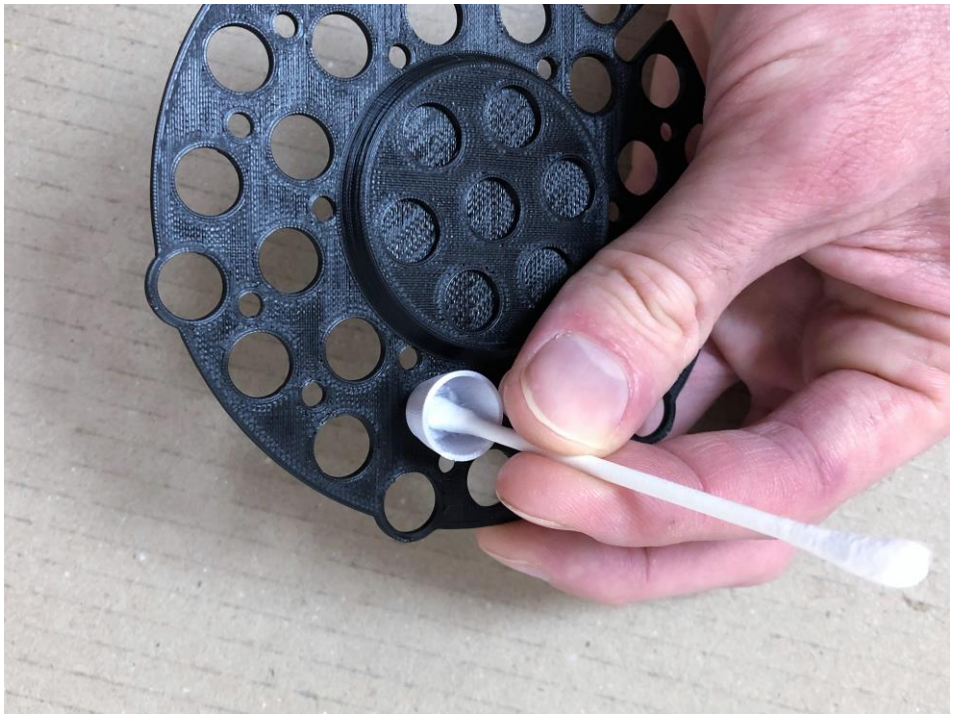


Verify that the nozzles are fully inserted with the correct orientation, then use super glue to secure the nozzles in place like you did before. Apply glue at the locations indicated by the red dots on the photo below. If a nozzle is loose, hold the nozzle in place using one hand and apply the glue with the other hand.

Do not drop glue too close to the edge of the mount plate, as the thickness of the dried glue might prevent you from correctly inserting the mount plate into the hull segment later.



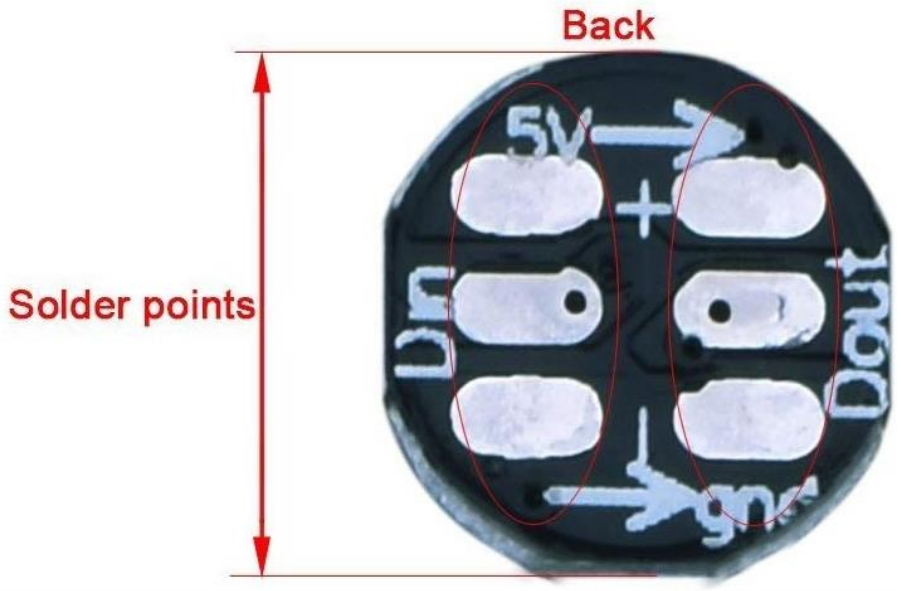
Verify that there is no filament obstructing the nozzles. If there is, draw a Q-tip through the nozzle to remove them.



### 7.3.4 Inserting the LEDs

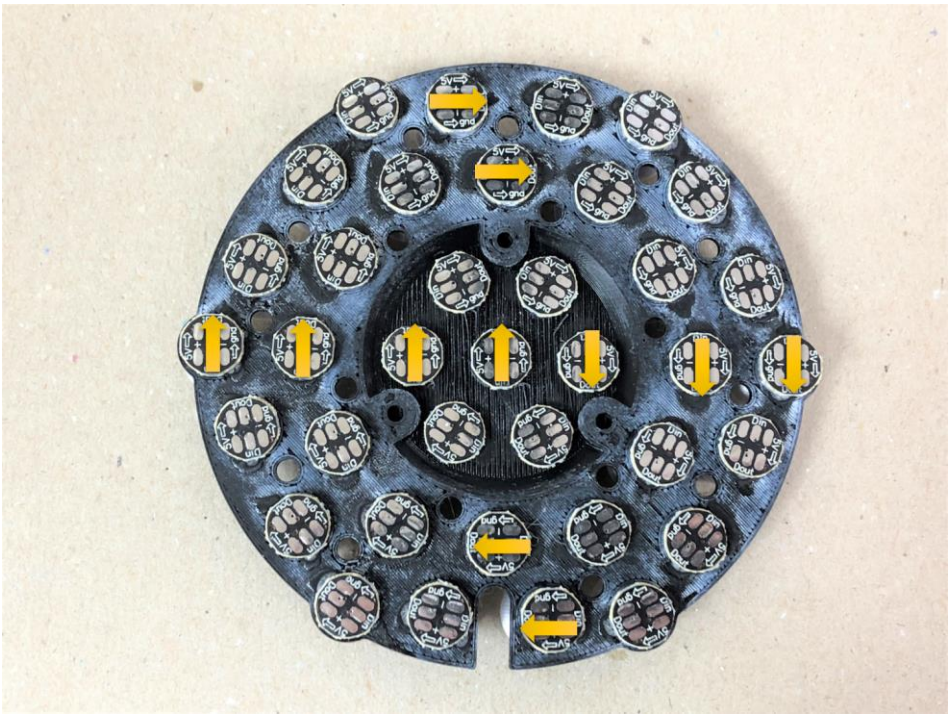
Put the latex gloves on your hands. This will prevent you from putting sweat on the contacts. Take one LED and flip it to have the soldering pads upwards. Look carefully at the markings on the LED. The red wire goes on the “5V” side, the black wire goes on the “gnd” side, and the white wire goes in between. Notice the labels “Din” and “Dout”. They indicate the data input and data output pad respectively. The LED also have arrows on the side to indicate the direction of the data line. When chaining several LEDs, the arrows must always “flow” in the same direction (the Dout pad of one LED is connected to the Dint pad of the next one).

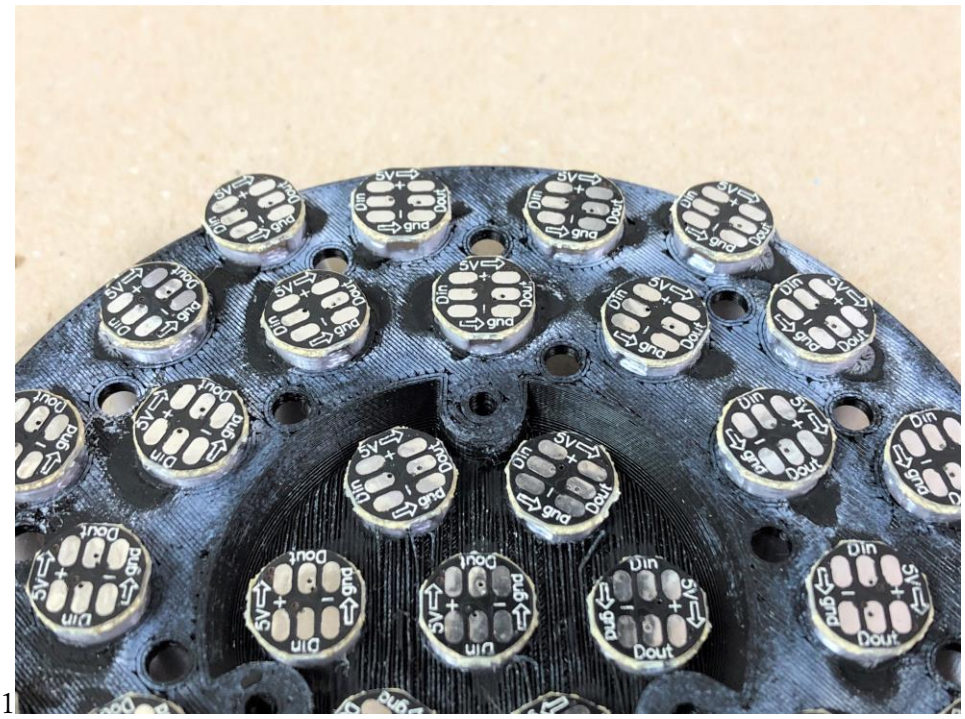
Each LED has two + pads and two gnd pads. Each pair is connected internally, so you can use any pad of the pair to solder.



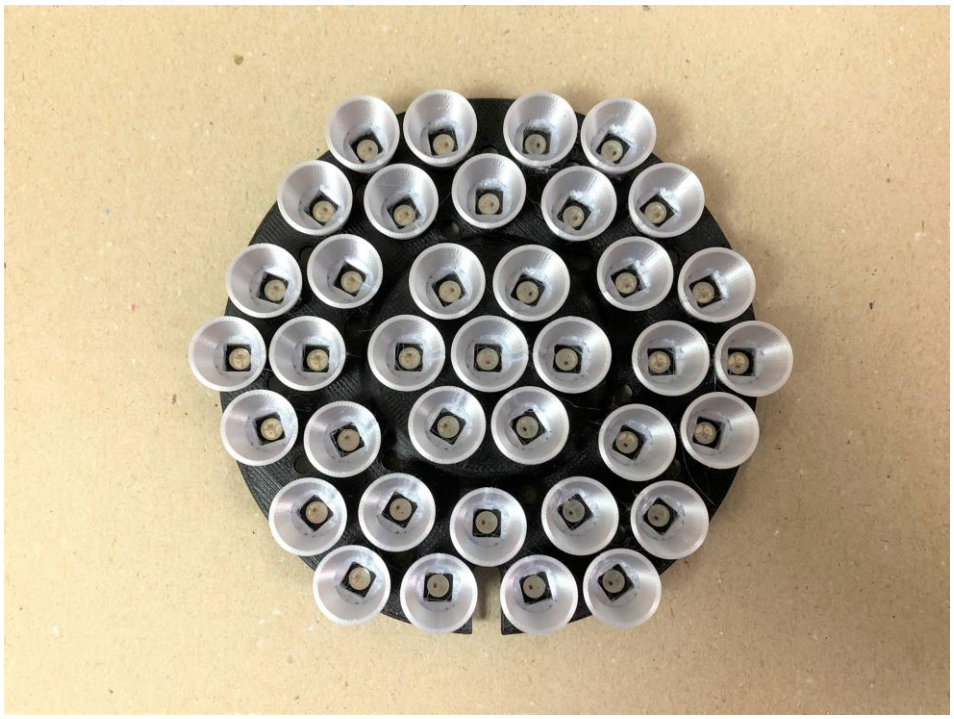
Take 37 LEDs and insert them at the back of the nozzles. The white square frame of the LED must snap into the square opening of the nozzle. Pay attention to the orientation of the LEDs! With the notch on the side of the mount plate facing towards you, **the arrows of the center LEDs must point away from you, while the arrows of the other LEDs must flow clockwise**.

Once the LEDs are in place, you can remove the latex gloves.





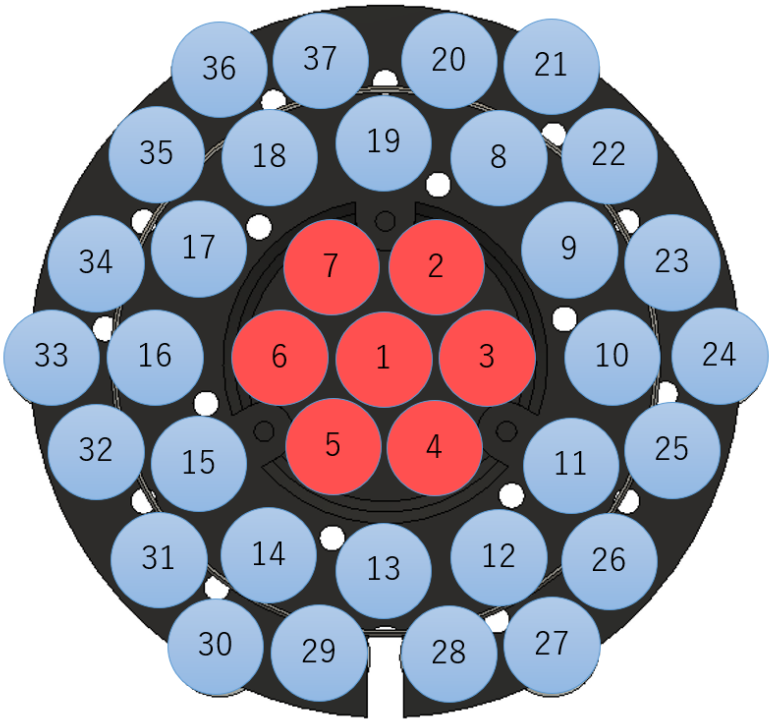
1



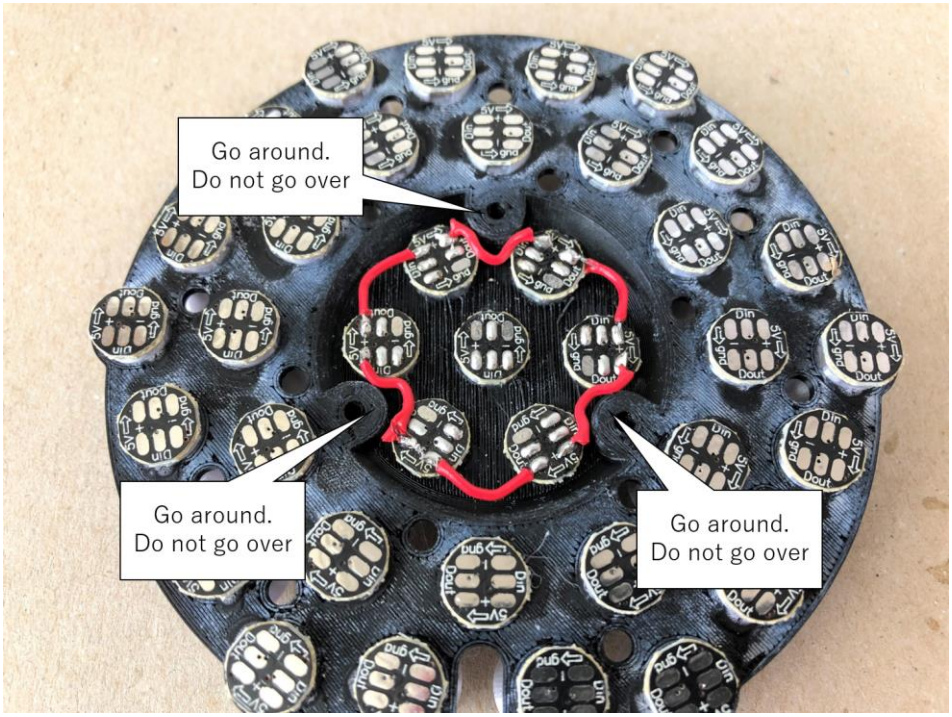
### 7.3.5 Wiring the center cluster

For reference, the figure below shows the numbering of the LEDs, with the center cluster in red (seen from the side where you do the soldering)

Pre-tin the soldering pads of the 7 LEDs of the center cluster. You can apply flux before pre-tinning to make things easier.



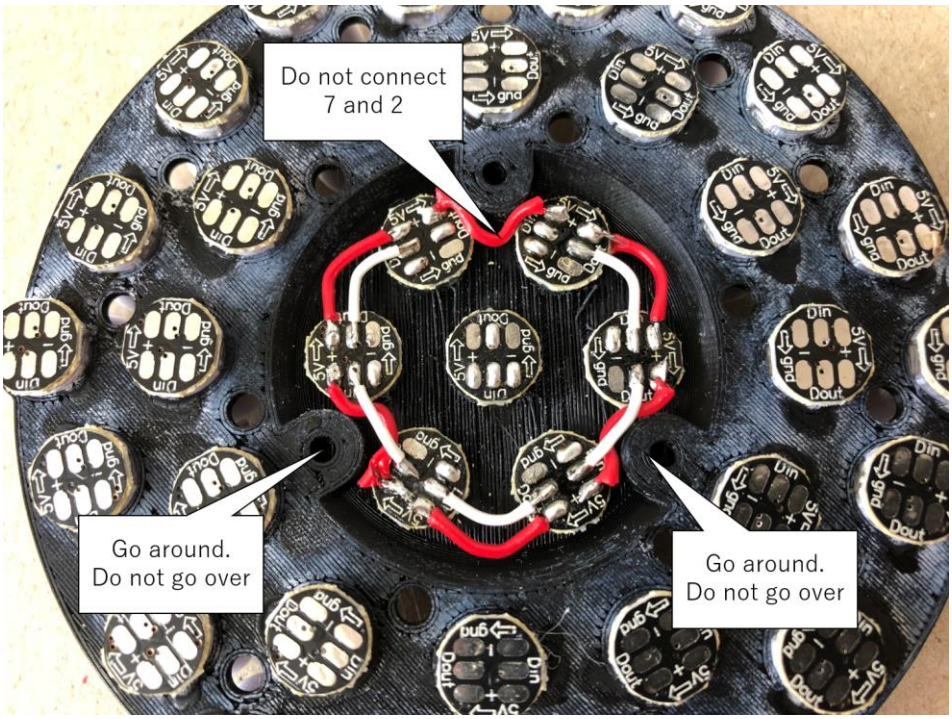
Using the RED wire, connect the + pads of the LEDs 2 to 7. Make a ring like in the photo below. Be careful not to cover the flat surfaces with the mount holes.



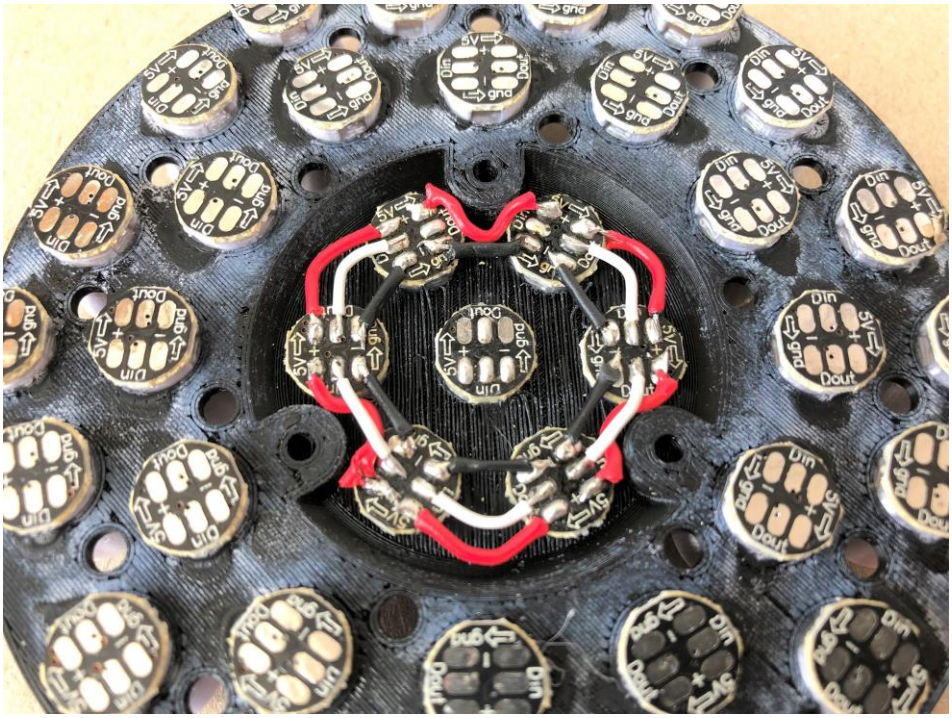
Using the WHITE wire, connect the Dout pad of LED2 to the Din pad of LED3. Repeat this operation by connecting the Dout pad of LED3 to the Din pad of LED4, then the Dout pad of LED4 to the Din pad of LED5… until you connect the Din pad of LED7.

Do not connect LED7 back to LED2. Leave the loop open.

Be careful not to cover the flat surfaces with the mount holes

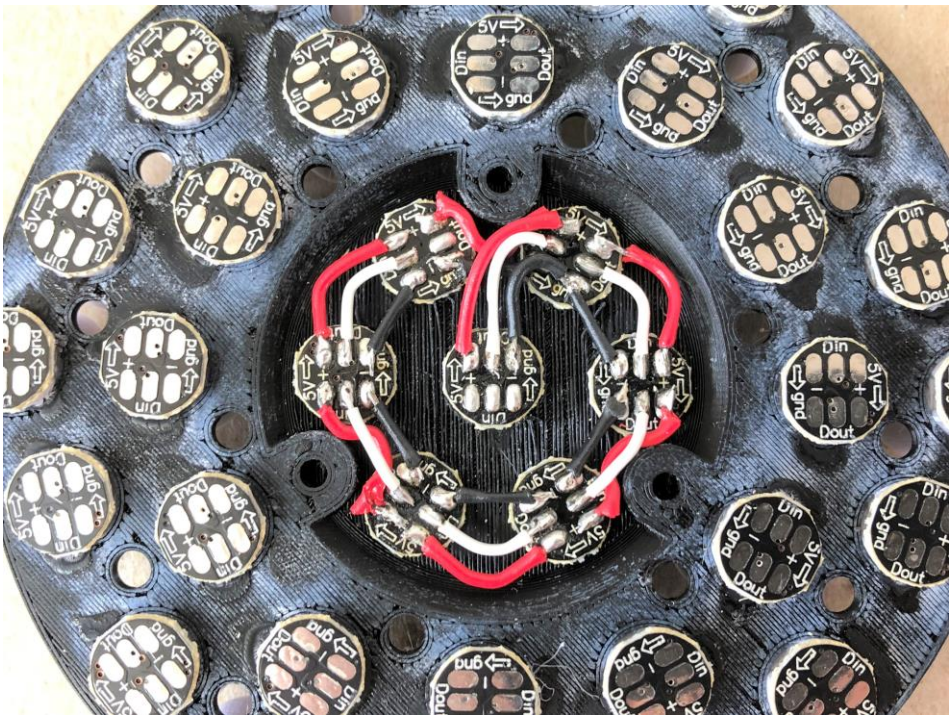


Using the BLACK wire, connect the gnd pads of the LEDs 2 to 7. Make a ring like in the photo below. Be careful not to cover the flat surfaces with the mount holes.



Add the following connections.

- Using BLACK wire, connect the gnd pad of LED1 to the gnd pad of LED 2.
- Using WHITE wire, connect the Dout pad of LED1 to the Din pad of LED2.
- Using RED wire, connect the + pad of LED1 to the + pad of LED 2.



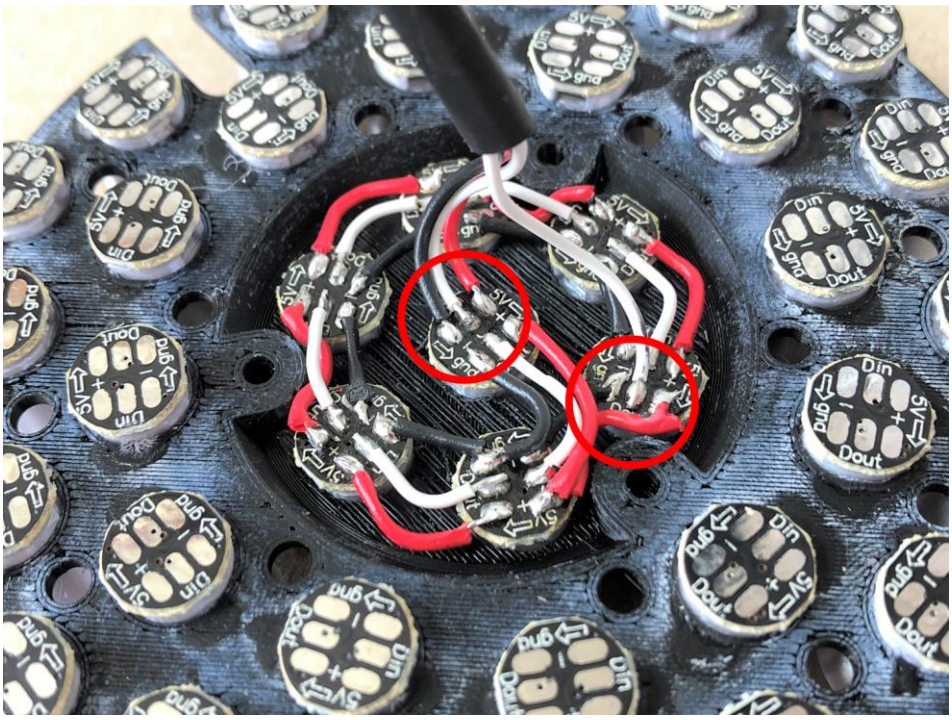
Cut 40 cm of RED wire. Solder one end to the + pad of LED 1.

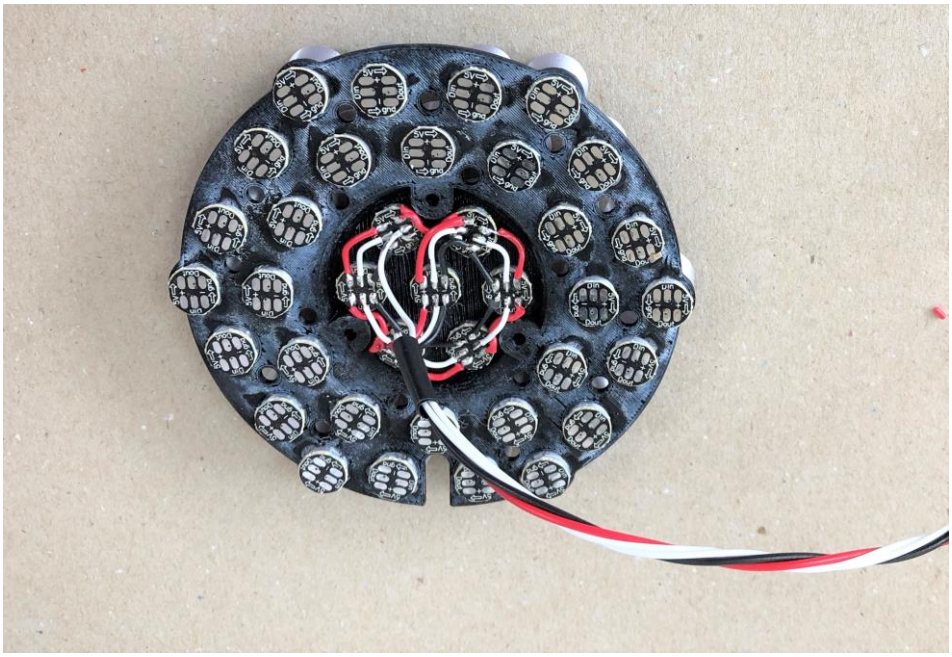
Cut 40 cm of WHITE wire. Solder one end to the Din pad of LED 1.

Cut 40 cm of BLACK wire. Solder one end to the gnd pad of LED1.

Cut 40 cm of WHITE wire. Using the black marker, make a black mark at both ends. This will help you differentiate this wire from the other white one. Solder one end to the Dout pad of LED 7.

Wrap vinyl tape approximately 2 cm from the solders, then bundle the 4 wires together.

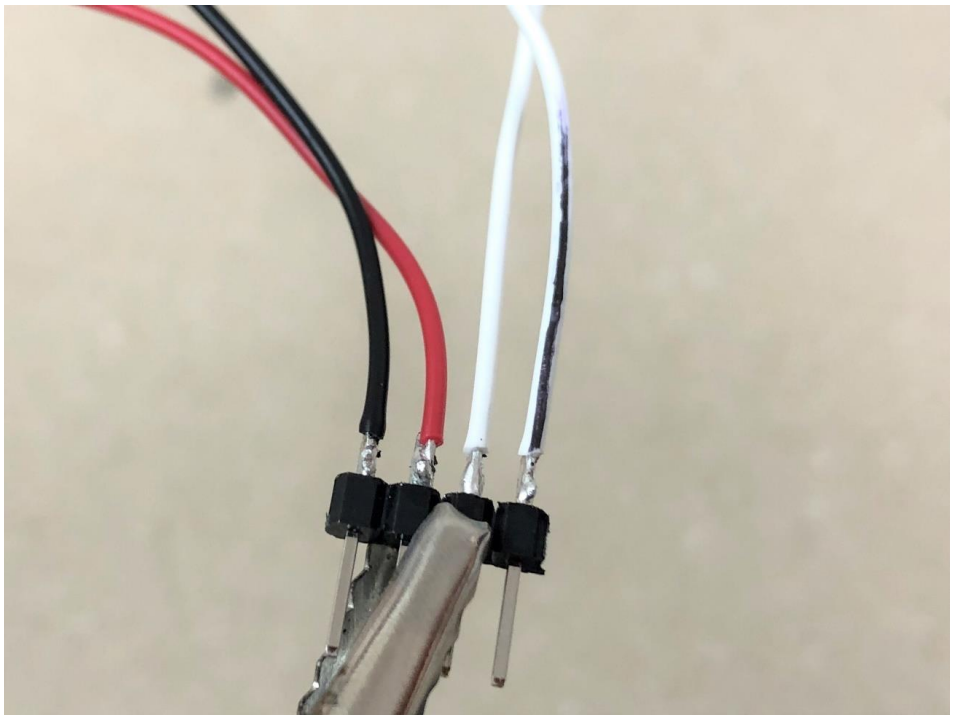


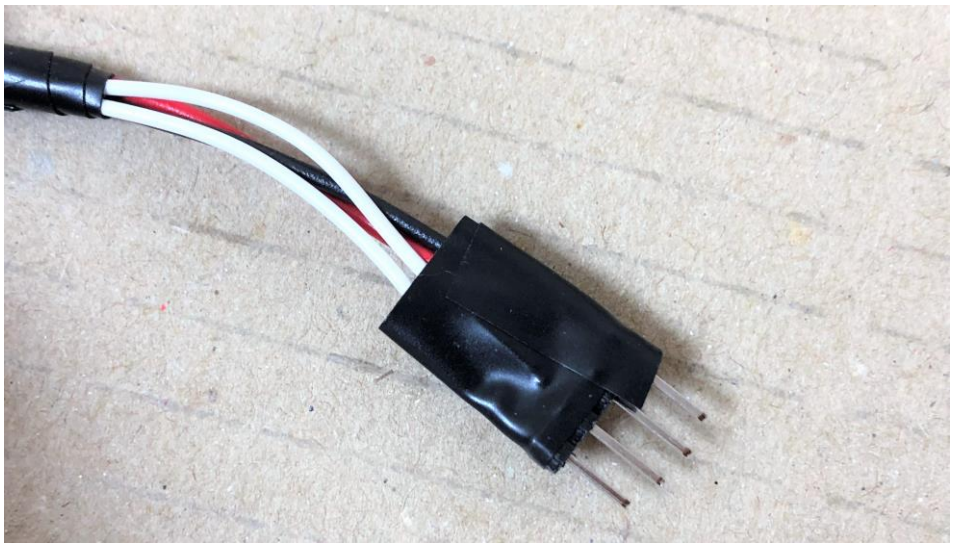


Strip the end of all 4 wires. Take a 1x4 male pin header and solder the cables in the following order.

1. Black (GND)
2. Red (+)
3. White, without mark (Din)
4. White, with mark (Dout)

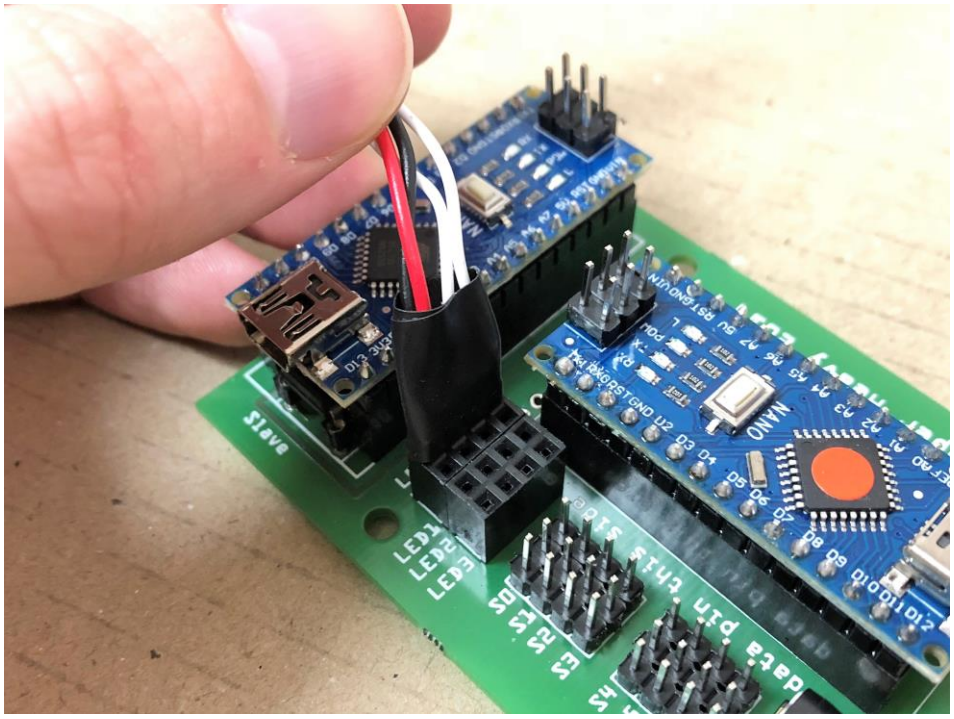
When you are done soldering, wrap vinyl tape around the connector.





### 7.3.1 Testing the center cluster

Plug the connector to the LED0 slot of the control board. The black wire must be closest to the board edge, while the white wires must be closest to the Arduino.



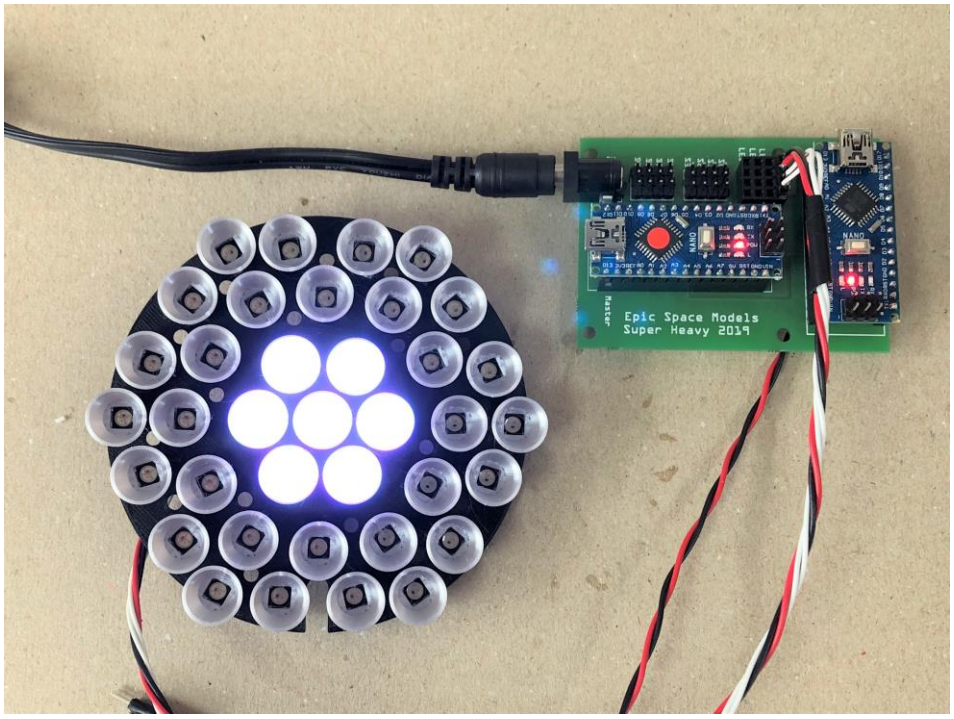
Power on the control board. After a few seconds, the engines of the center cluster should light up. If one or several engines do not light up, power off the control board, and check the soldering of the LEDs.

All the LEDs will flicker. This is normal! The control board constantly changes the brightness of the LEDs to make the engines flicker as if the light was coming from a combustion reaction.

The LEDs will periodically switch on and off every 20s. This is on purpose.

If one or several LEDs do not work, follow the procedure in section 11.1.

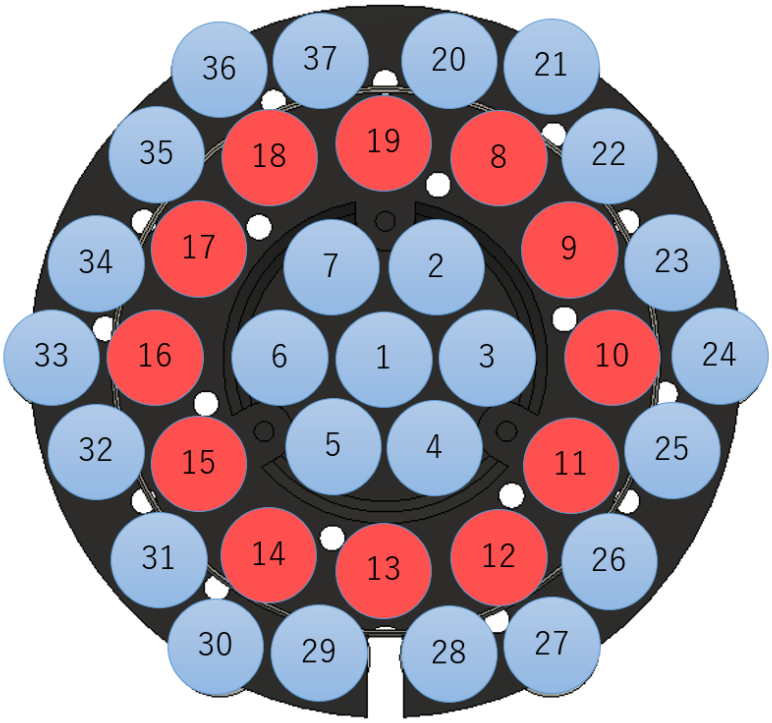
Power off the control board and unplug the cable bundle from the control board.



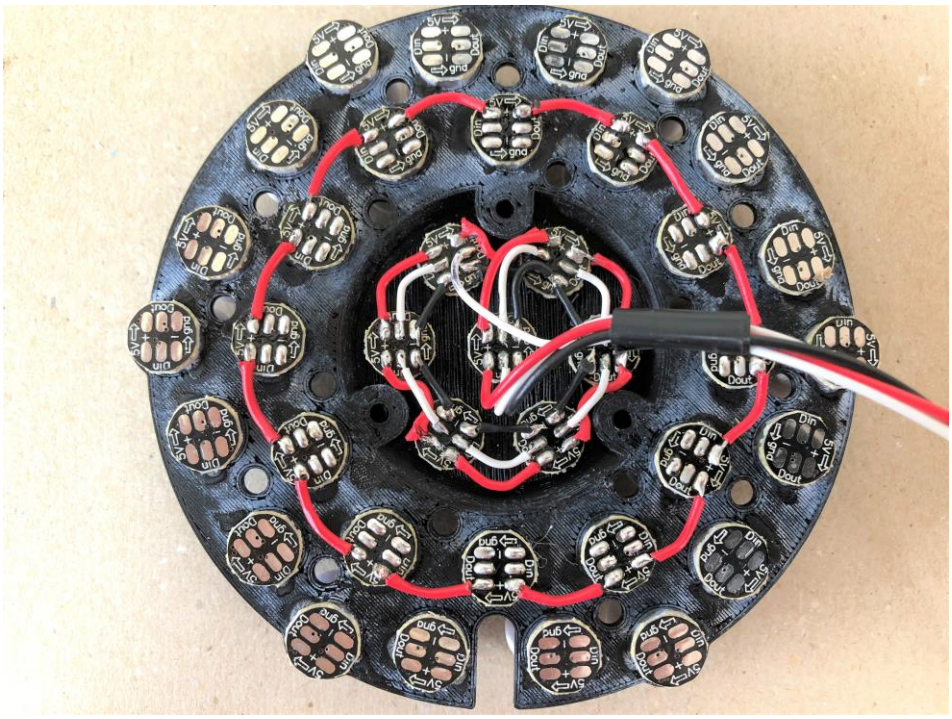
### 7.3.2 Wiring ring 1

For reference, the figure below shows the numbering of the LEDs, with the ring1 in red (seen from the side where you do the soldering).

Pre-tin the soldering pads of the 12 LEDs of the ring 1. You can apply flux before pre-tinning to make things easier.

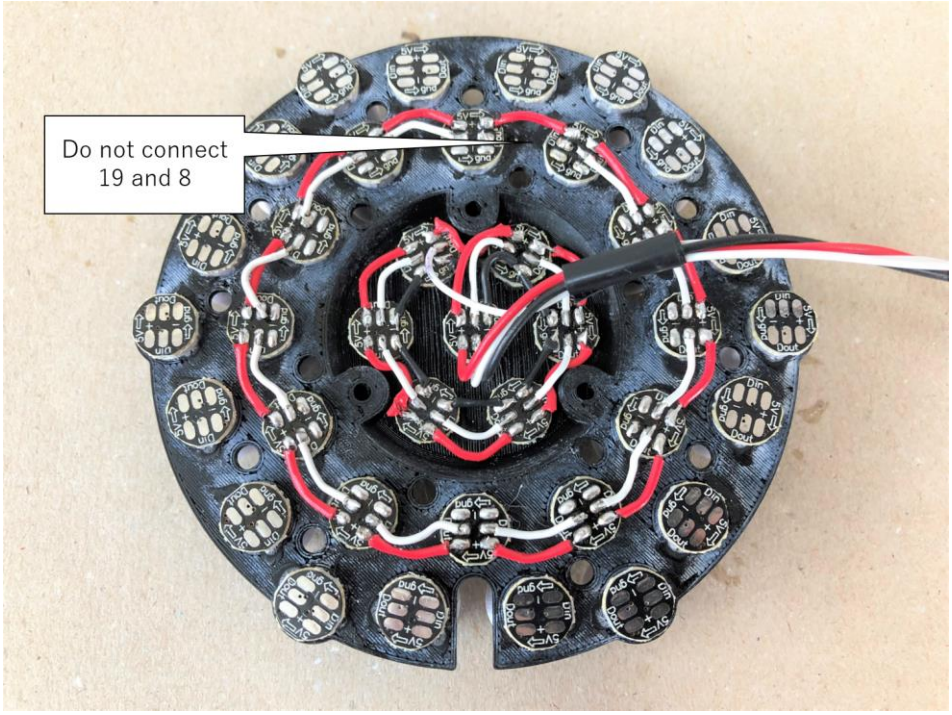


Using the RED wire, connect the + pads of all the LEDs. Make a ring like in the photo below.

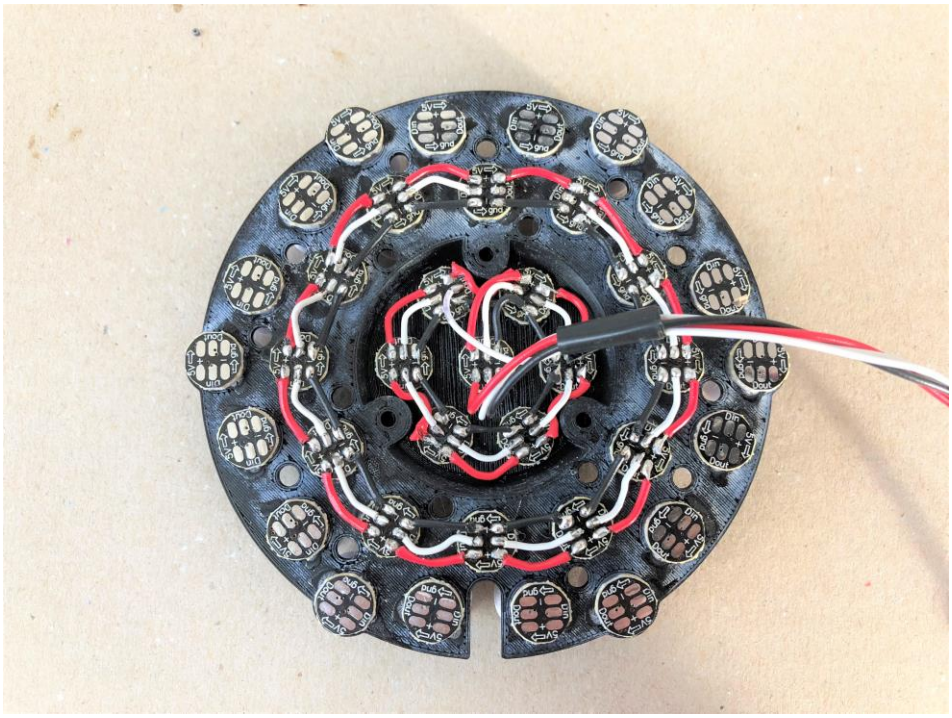


Using the WHITE wire, connect the Dout pad of LED8 to the Din pad of LED9. Repeat this operation by connecting the Dout pad of LED9 to the Din pad of LED10, then the Dout pad of LED10 to the Din pad of LED11… until you connect the Din pad of LED19.

Do not connect LED19 back to LED8 (do not close the loop).



Using the BLACK wire, connect the gnd pads of all the LEDs. Make a ring like in the photo below.



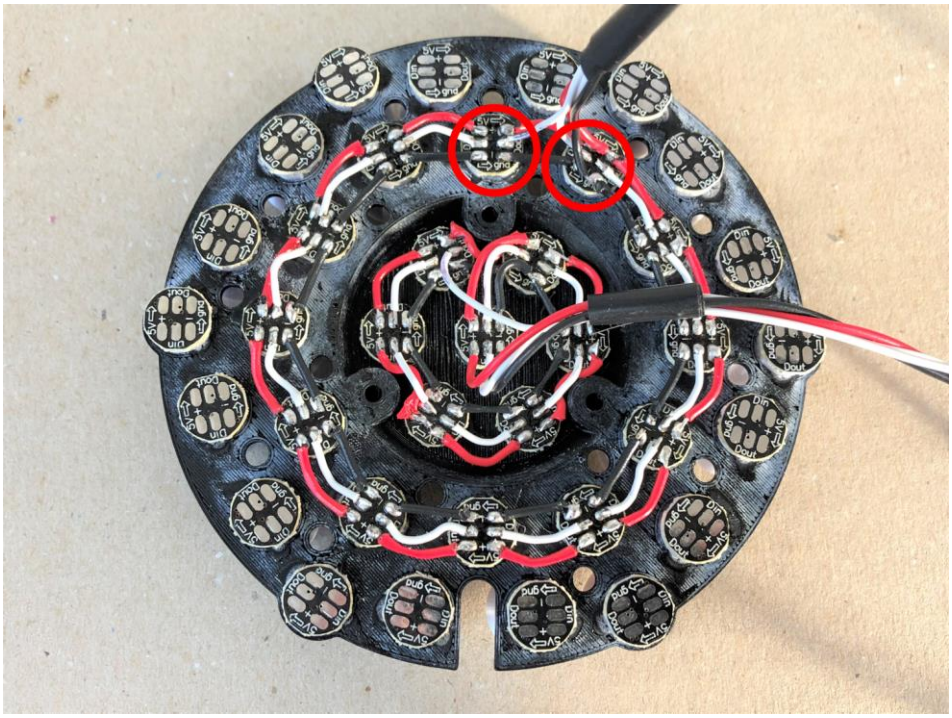
Cut 40 cm of RED wire. Solder one end to the + pad of LED 8.

Cut 40 cm of WHITE wire. Solder one end to the Din pad of LED 8.

Cut 40 cm of BLACK wire. Solder one end to the gnd pad of LED8.

Cut 40 cm of WHITE wire. Using the black marker, make a mark at both ends. This will help you differentiate this wire from the other white one. Solder one end to the Dout pad of LED 19.

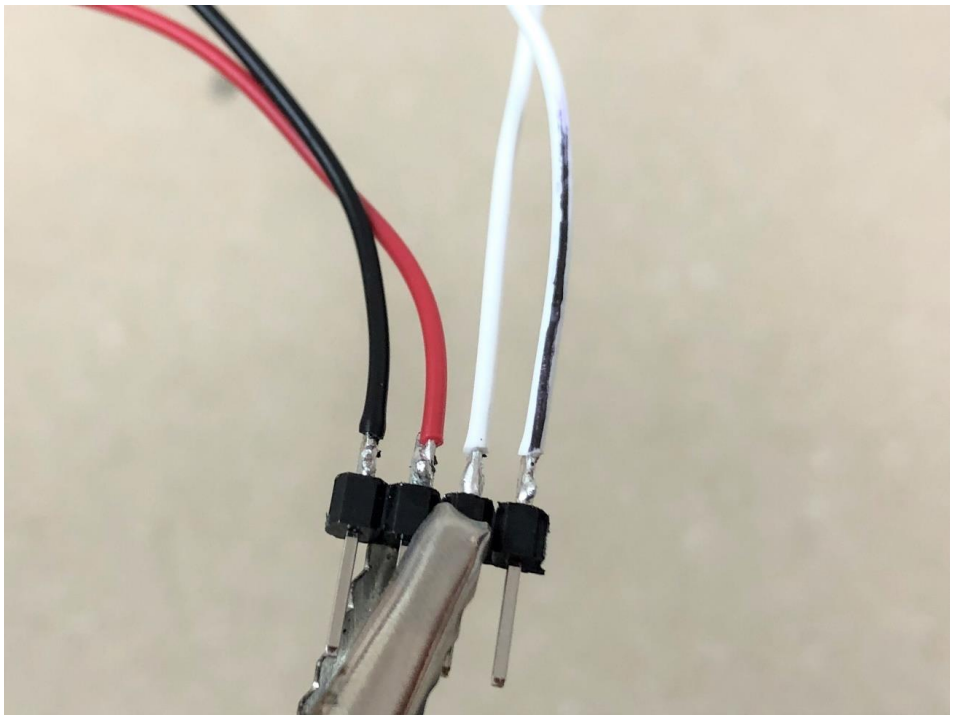
Wrap vinyl about 2 cm from where you soldered, then bundle the 4 wires together like you did for the center cluster.

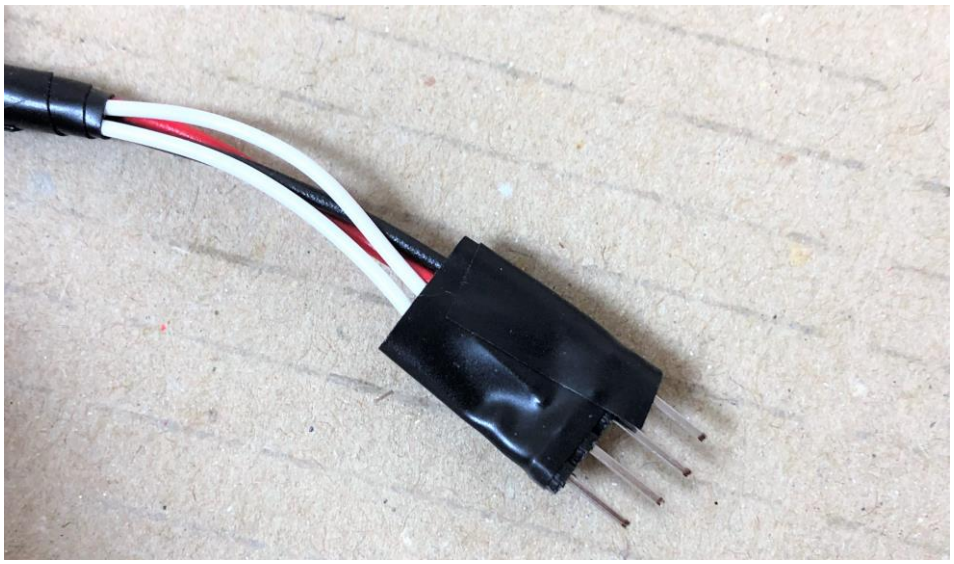


Strip the end of all 4 wires. Take a 1x4 male pin header and solder the cables in the following order.

1. Black (GND)
2. Red (+)
3. White, without mark (Din)
4. White, with mark (Dout)

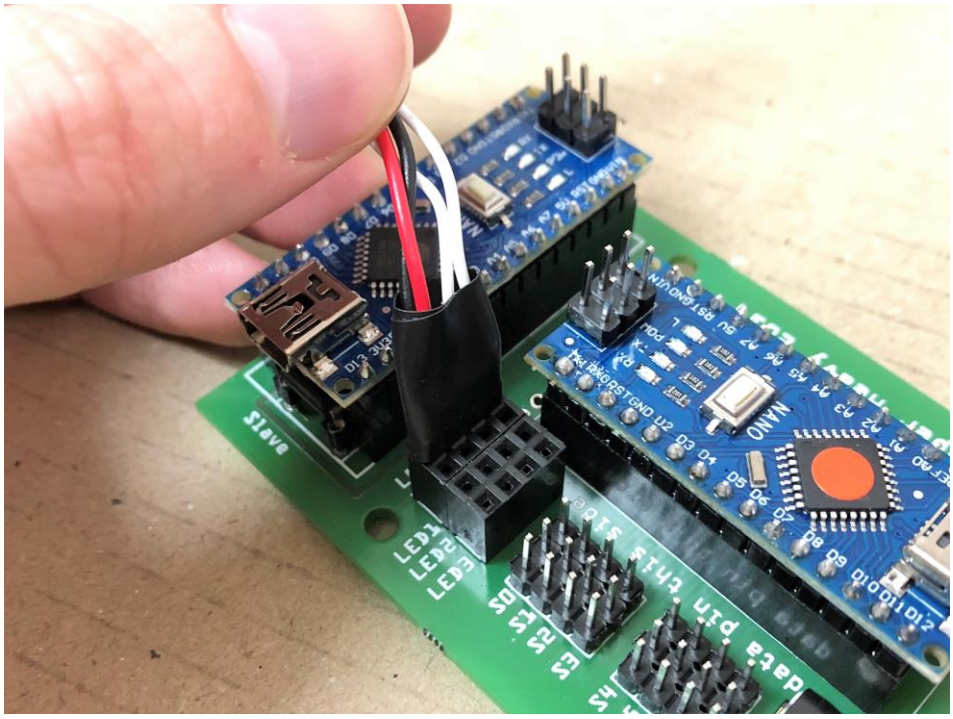
When you are done soldering, wrap vinyl tape around the connector.





### 7.3.1 Testing ring 1

Plug the connector of ring 1 to the LED0 slot of the control board (same slot as when you tested the center cluster). The black wire must be closest to the board edge, while the white wires must be closest to the Arduino.

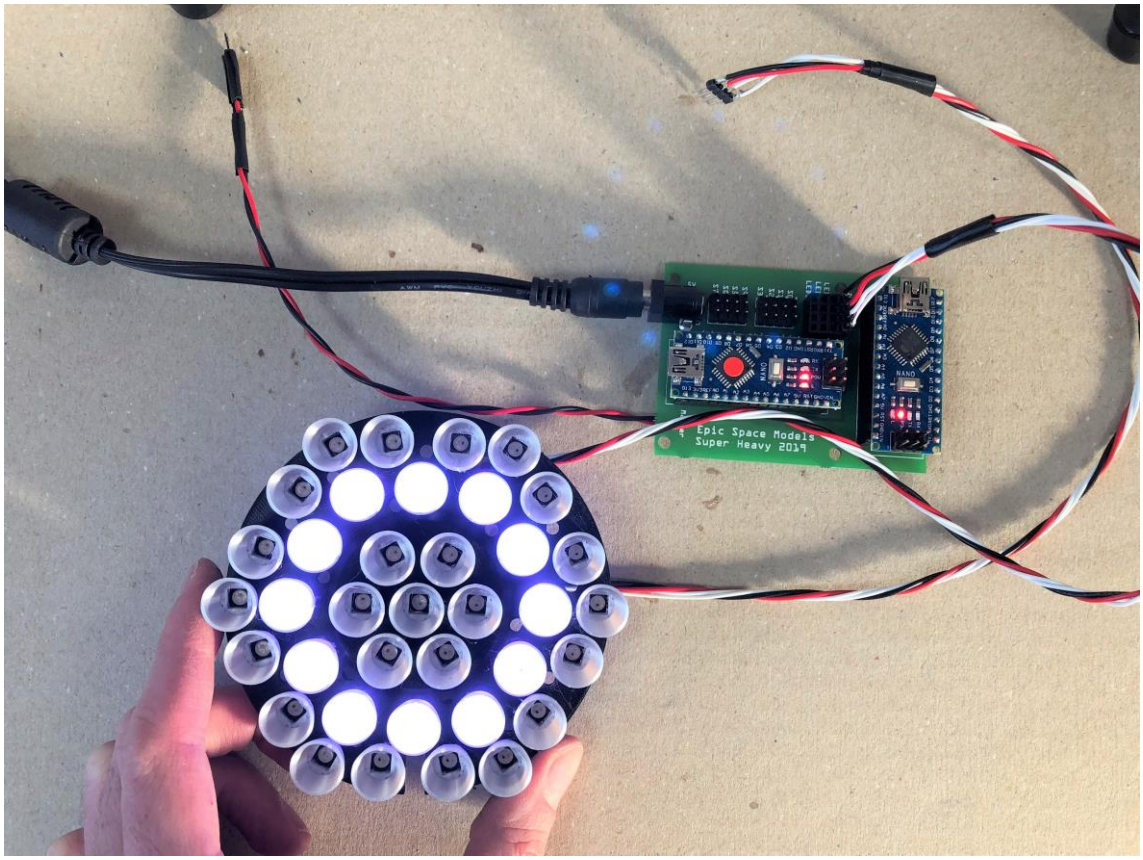


Power on the control board. After a few seconds, the engines of the ring 1 should light up. If one or several engines do not light up, power off the control board, and check the soldering of the LEDs.

The engines will not all light up at the same time. This is normal. This problem will disappear once the cluster 1 is connected in series with the center cluster (wait for further instructions).

If one of several engines do not work, follow the procedure in section 11.1.

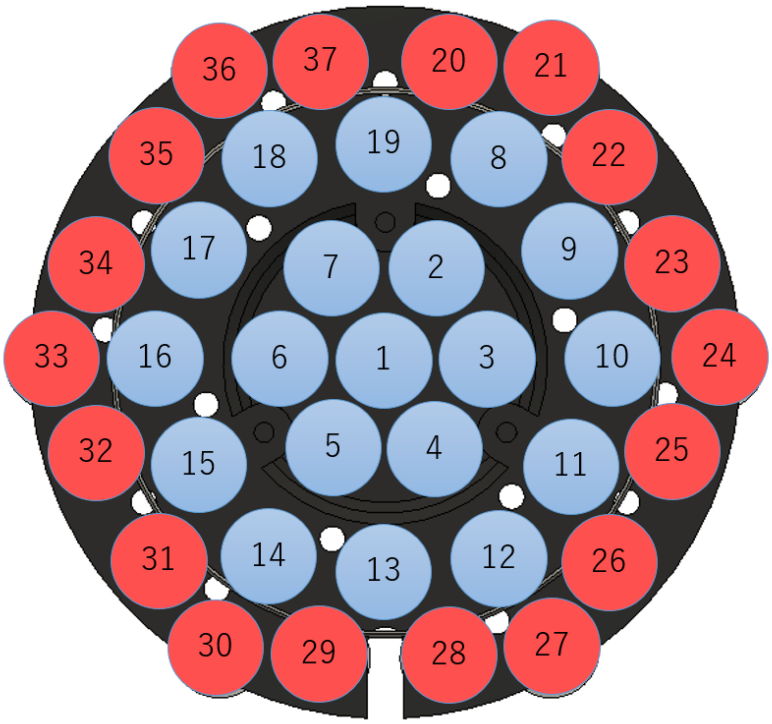
Power off the control board and unplug the cable bundle from the control board.



### 7.3.1 Wiring ring 2

For reference, the figure below shows the numbering of the LEDs, with the ring2 in red (seen from the side where you do the soldering).

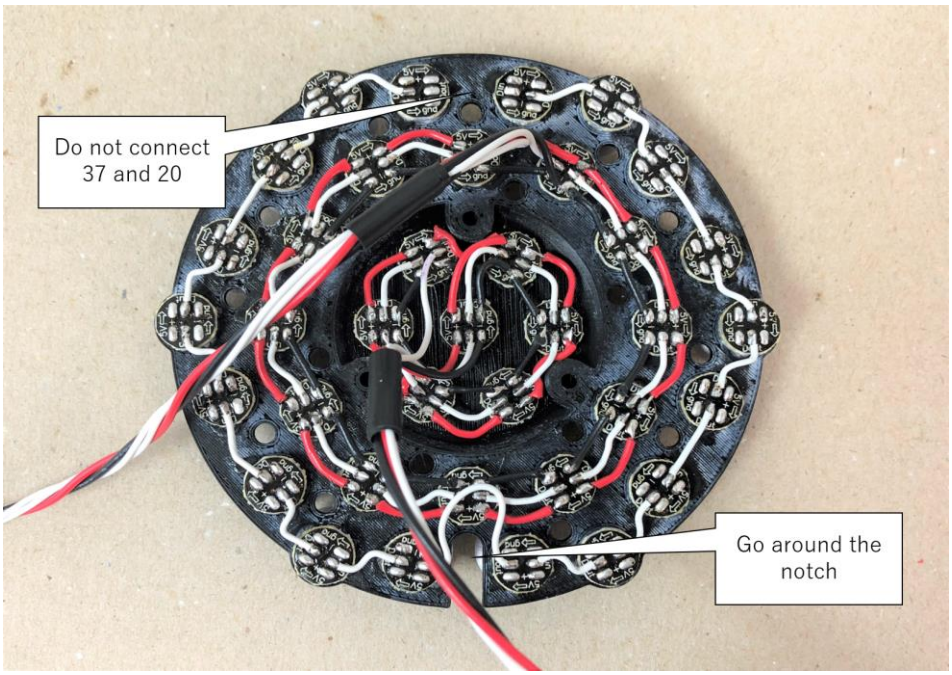
Pre-tin all the 18 LEDs of the ring 2. You can apply flux before pre-tinning to make things easier.



Using the WHITE wire, connect the Dout pad of LED20 to the Din pad of LED21. Repeat this operation by connecting the Dout pad of LED21 to the Din pad of LED22, then the Dout pad of LED22 to the Din pad of LED23… until you connect the Din pad of LED37.

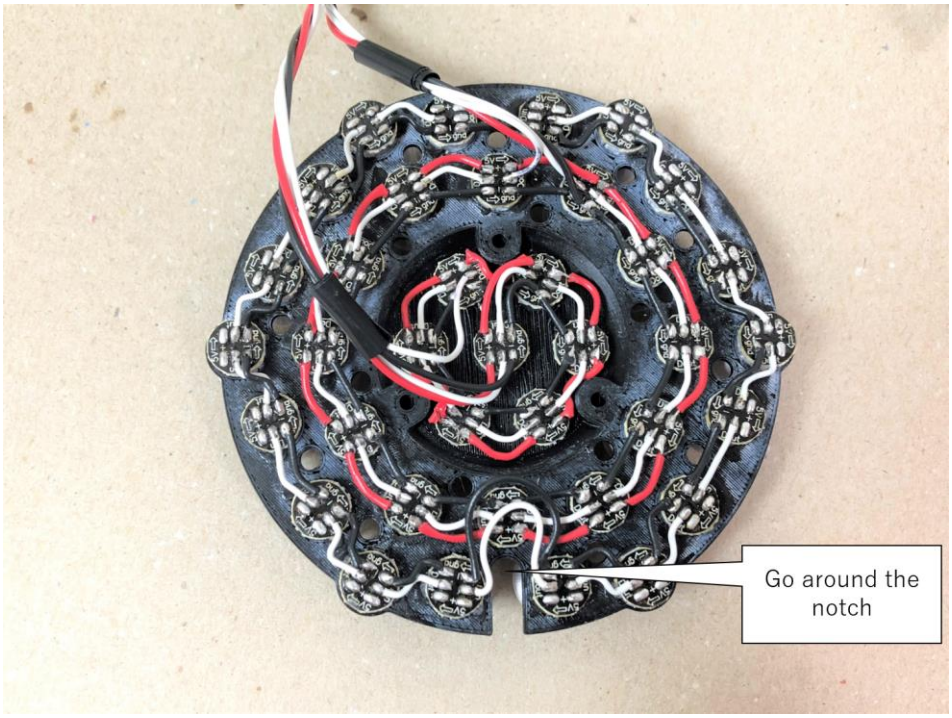
When you reach the notch on the side of the mount plate, make a look in the wire to go around the notch. The wire must not cross the notch!

Do not connect LED37 back to LED20 (do not close the loop).

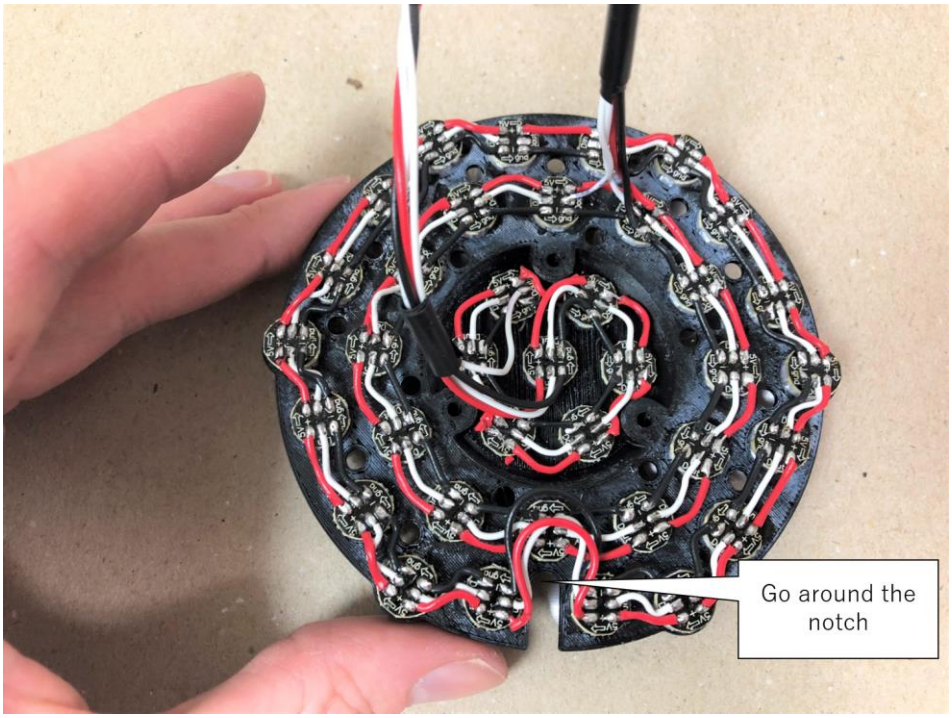


Using the BLACK wire, connect the gnd of all the LEDs. Make a ring like in the photo below.

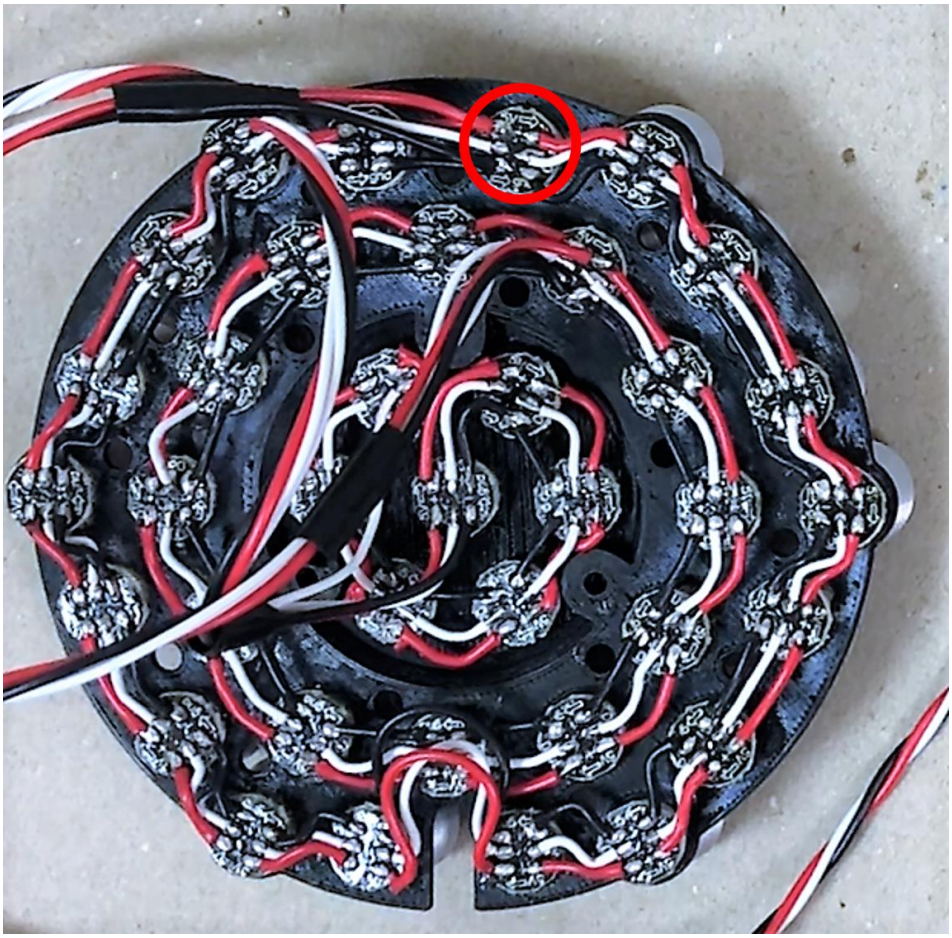
When you reach the notch on the side of the mount plate, make a look in the wire to go around the notch. The wire must not cross the notch!



Using the RED wire, connect the + pads of all the LEDs. Make a ring like in the photo below. When you reach the notch on the side of the mount plate, make a look in the wire to go around the notch. The wire must not cross the notch!



Cut 40 cm of RED wire. Solder one end to the + pad of LED 20.
Cut 40 cm of WHITE wire. Solder one end to the Din pad of LED 20.
Cut 40 cm of BLACK wire. Solder one end to the gnd pad of LED 20.
Bundle and tress the 3 cables together.



Take a 1x4 pin header. Solder the wires in the following order

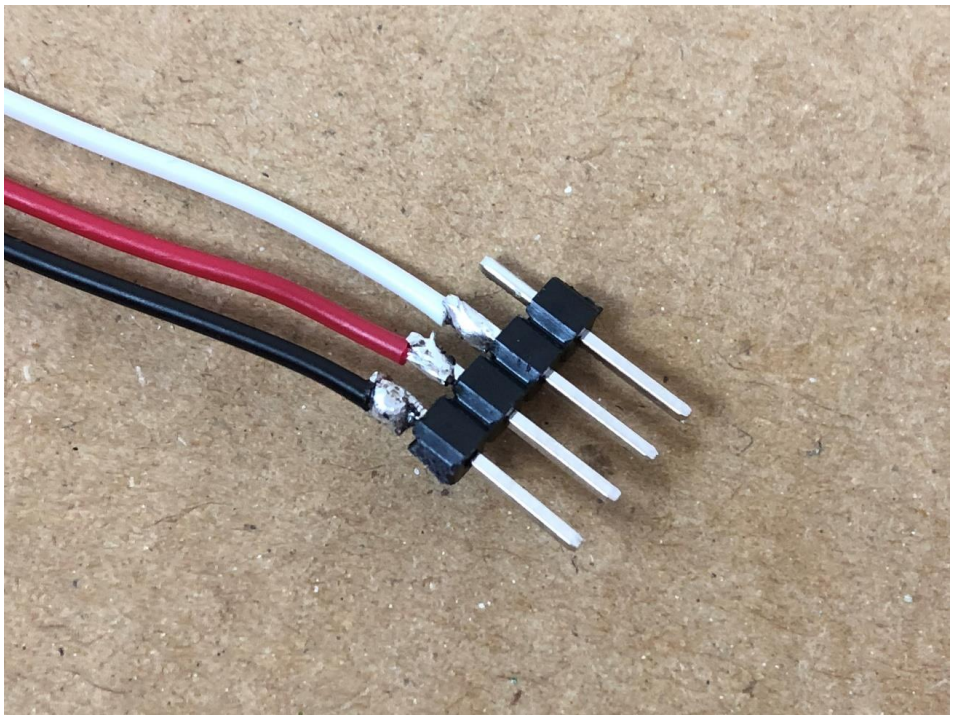
1 Black (GND)

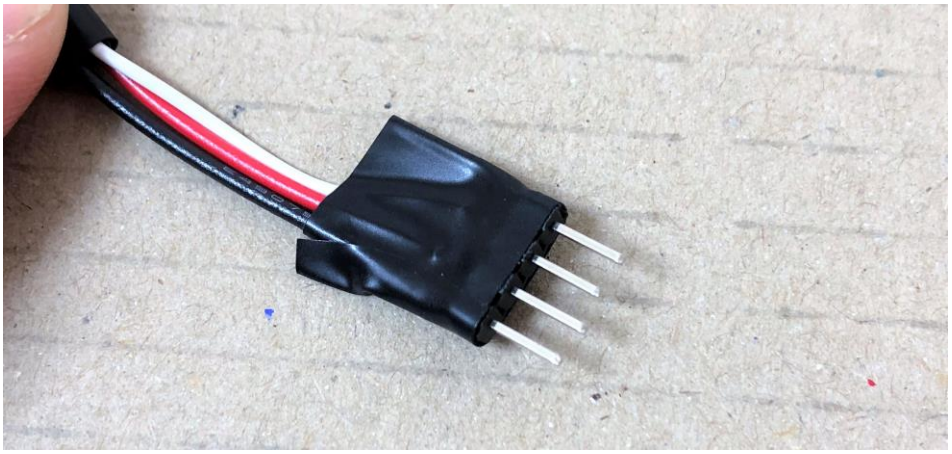
2 Red (+)

3 White, without mark (Din)

Leave the last terminal free.

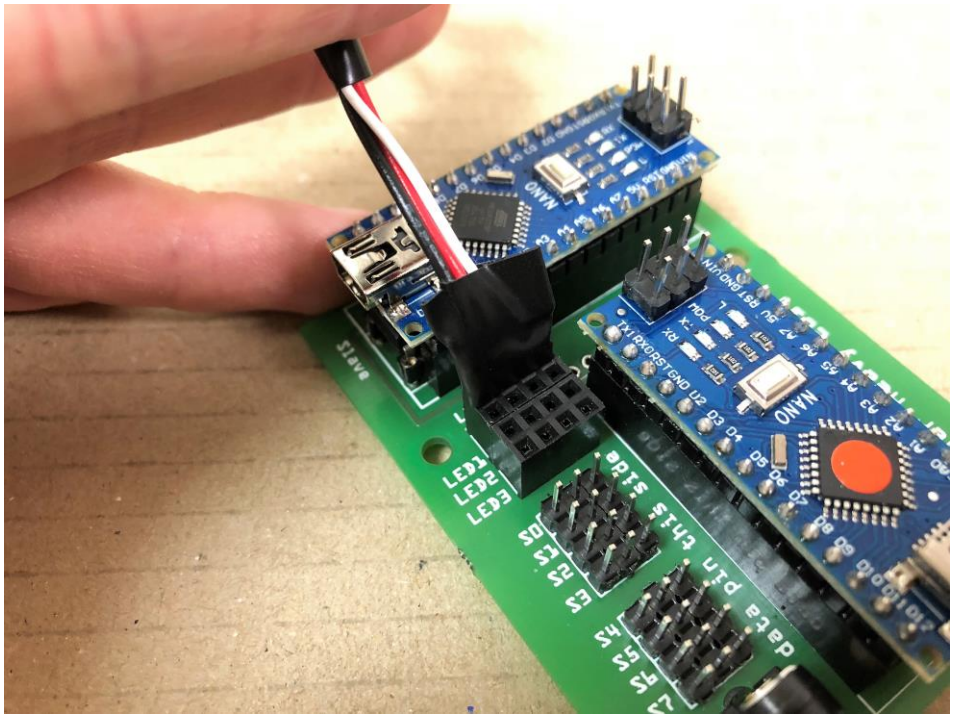
When you are done soldering, wrap vinyl tape around the connector.





### 3.1.1 Testing ring 2

Plug the connector of ring 2 to the LED0 slot of the control board (same slot as when you tested the center cluster). The black wire must be closest to the board edge, while the white wires must be closest to the Arduino.

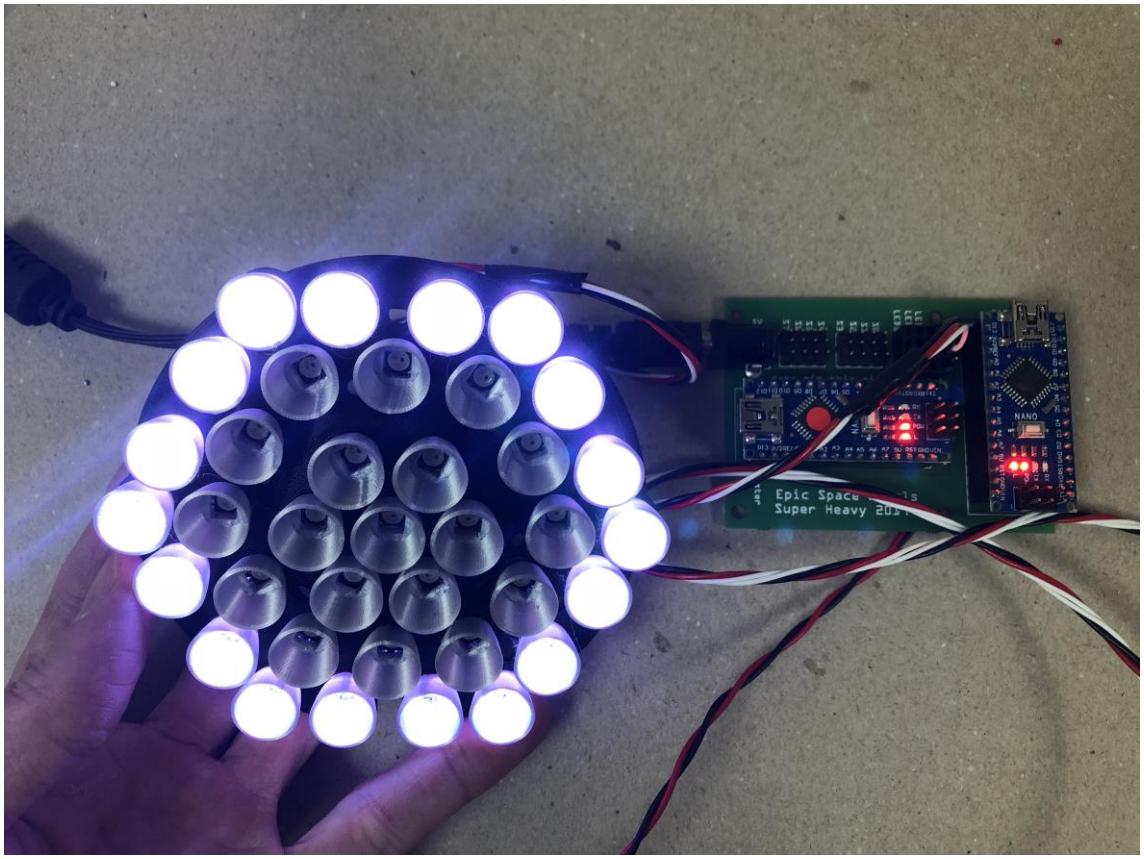


Power on the control board. After a few seconds, the engines of the ring 2 should light up. If one or several engines do not light up, power off the control board, and check the soldering of the LEDs.

The engines will not all light up at the same time. This is normal. This problem will disappear once the cluster 2 is connected in series with the rest of the engines (wait for further instructions).

If one of several engines do not work, follow the procedure in section 11.1.

Power off the control board and unplug the cable bundle from the control board.

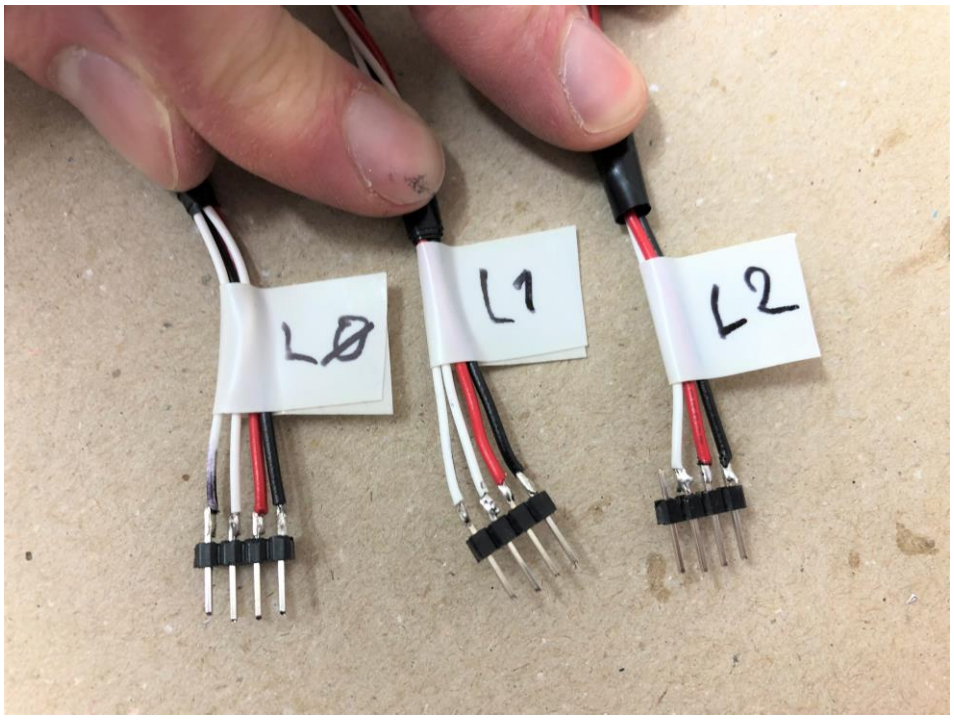


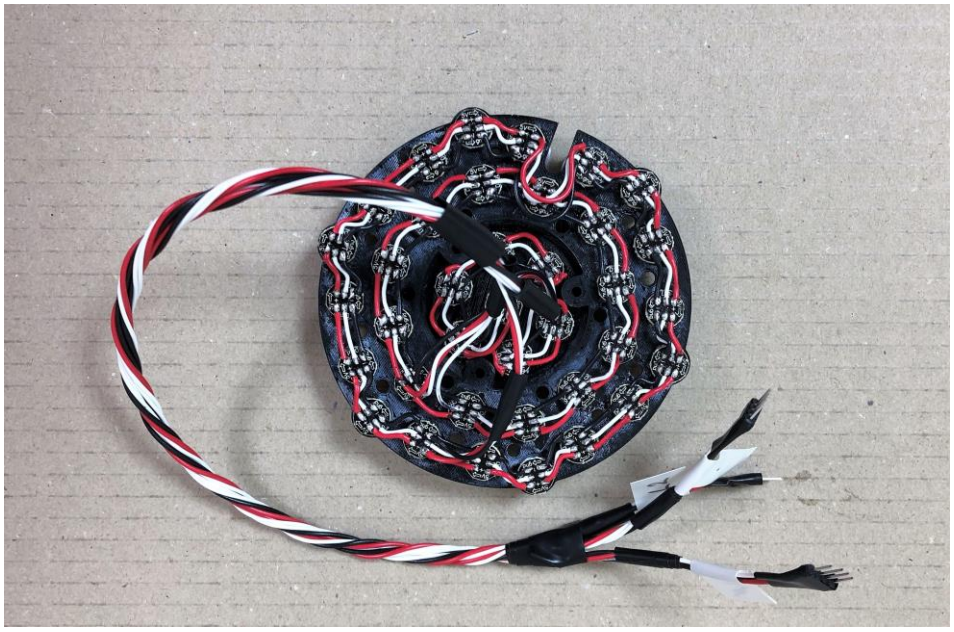
### 3.1.1 Cable management

Using the white vinyl tape and the marker, label the cables as follows (the photo shows the connectors without protective tape, but you should have wrapped tape around the solders).

- Center cluster: L0
- Ring1: L1
- Rind2: L2

After labeling the cables, bundle the 3 cables together.

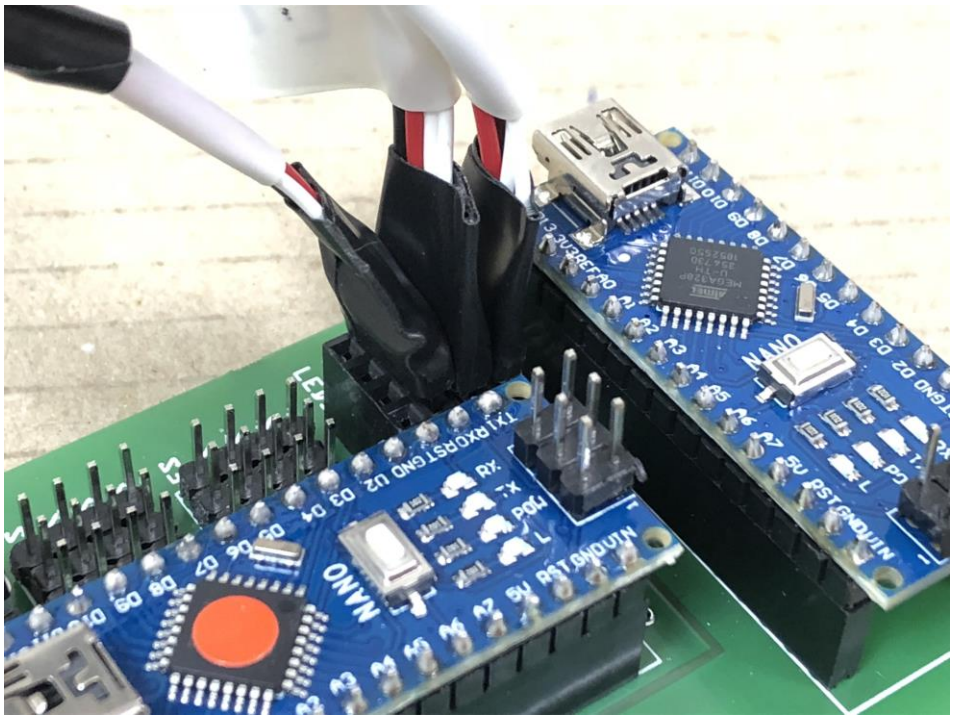


### 7.3.2 Testing all the engines

Connect the 3 wire bundles to the control board as follows. The black wire must be closest to the edge of the board.

- Center cluster (L0): board LED0
- Ring 1 (L1): board LED1
- Ring 2 (L2): board LED2



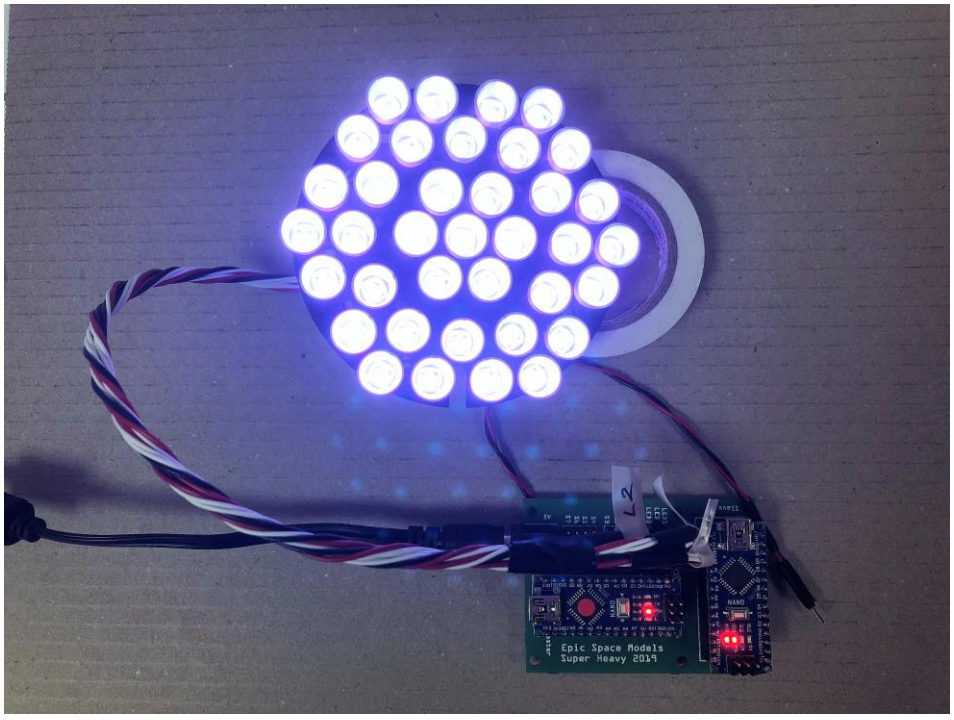
Power on the control board. After a few seconds, all the engines should light up. If one or several engines do not light up, power off the control board, and check the soldering of the LEDs.

If one of several engines do not work, follow the procedure in section 11.1.

Once you have checked that all the engines are working, immediately power off the control board.

Do not let the engines running continuously for more than 20 seconds. Without the cooling fan, the LEDs are vulnerable to overheating and can be damaged if powered on for too long. (I understand your desire to take photos, but please be patient).

Power off the control board and disconnect all the cables from the board.



## 7.4 Fins preparation

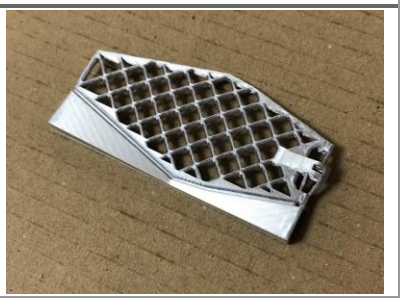
### 7.4.1 Parts & tools preparation

The fins are printed with a support structure that must be removed before assembling the mechanism. Read carefully the instructions about how to remove the supports, as the fin can break if too much force is applied to the lattice structure.

There are spare fins in the bag in case something goes wrong.

Repeat the steps of section 7.4 for the 4 fins.

Prepare the following parts

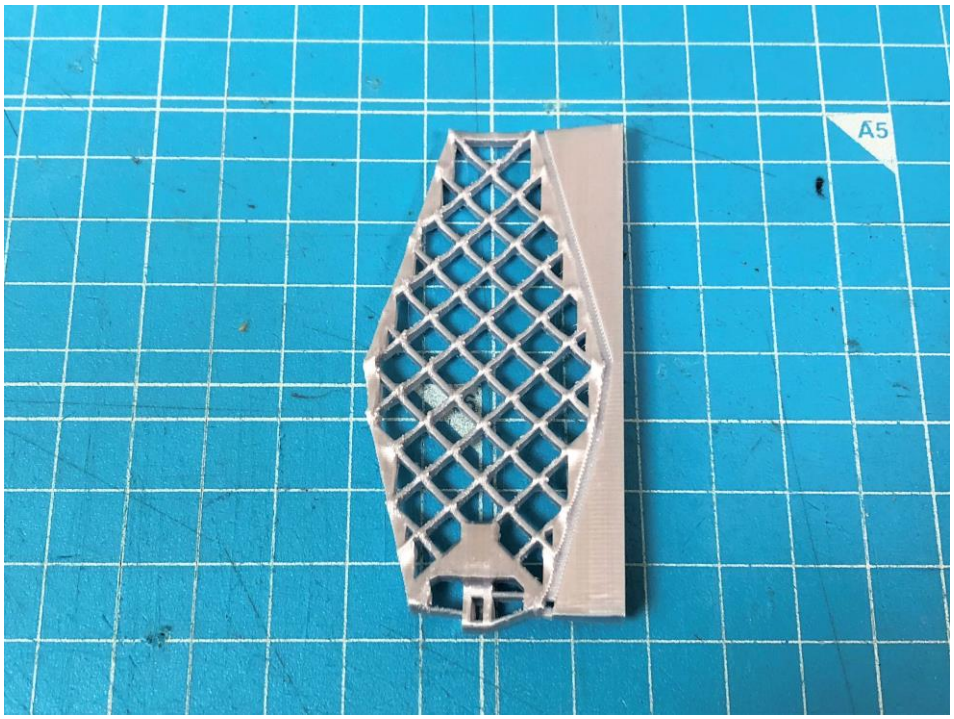
| Part | Number of parts | Photo |
|---|---|---|
| **Grid fins** | 4 |  |

Prepare the following tools

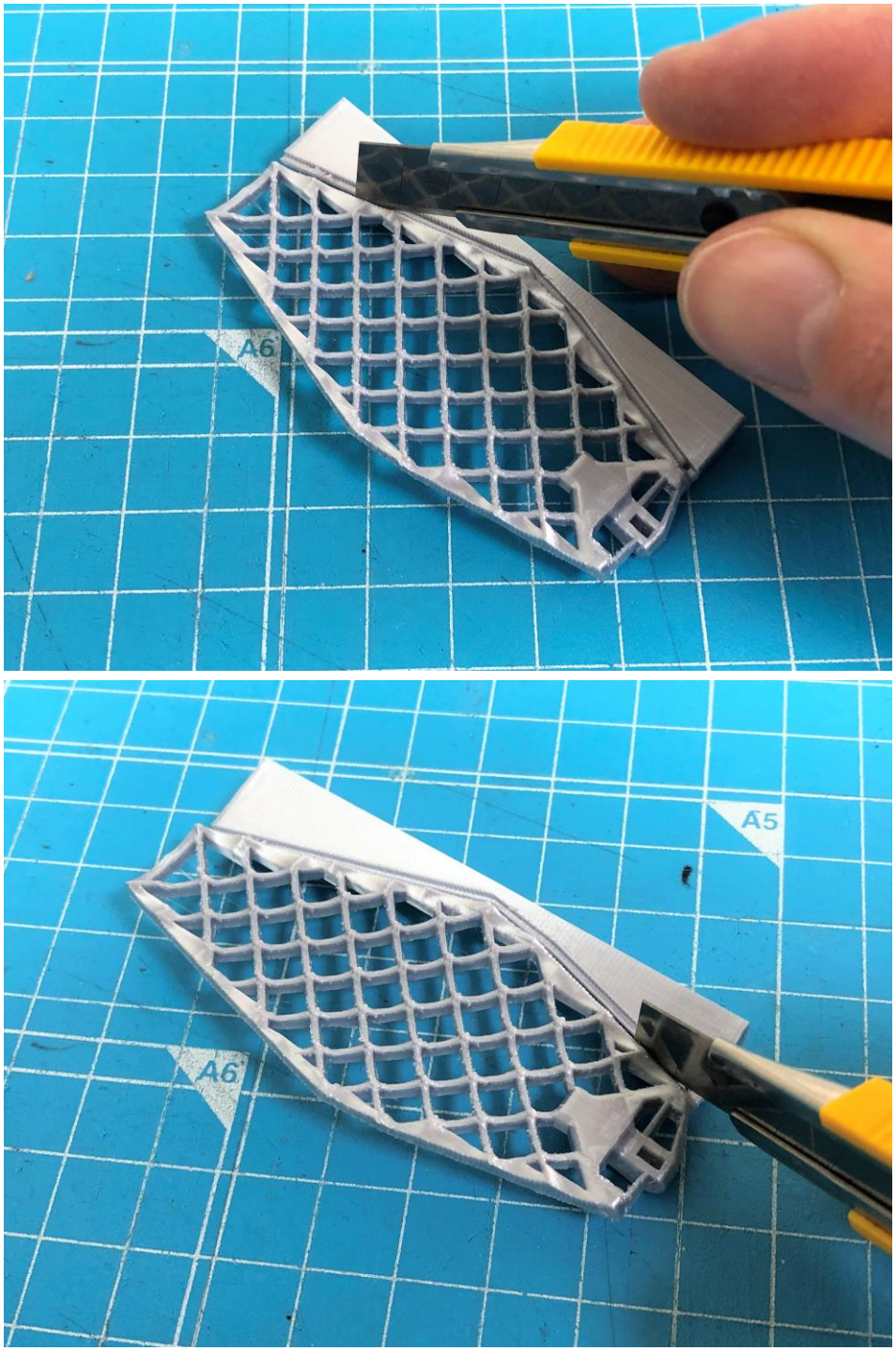
| Part | Photo |
|---|---|
| **0.8mm drill bit** |  |
| **Cutter** |  |

### 7.4.2 Removing the foot

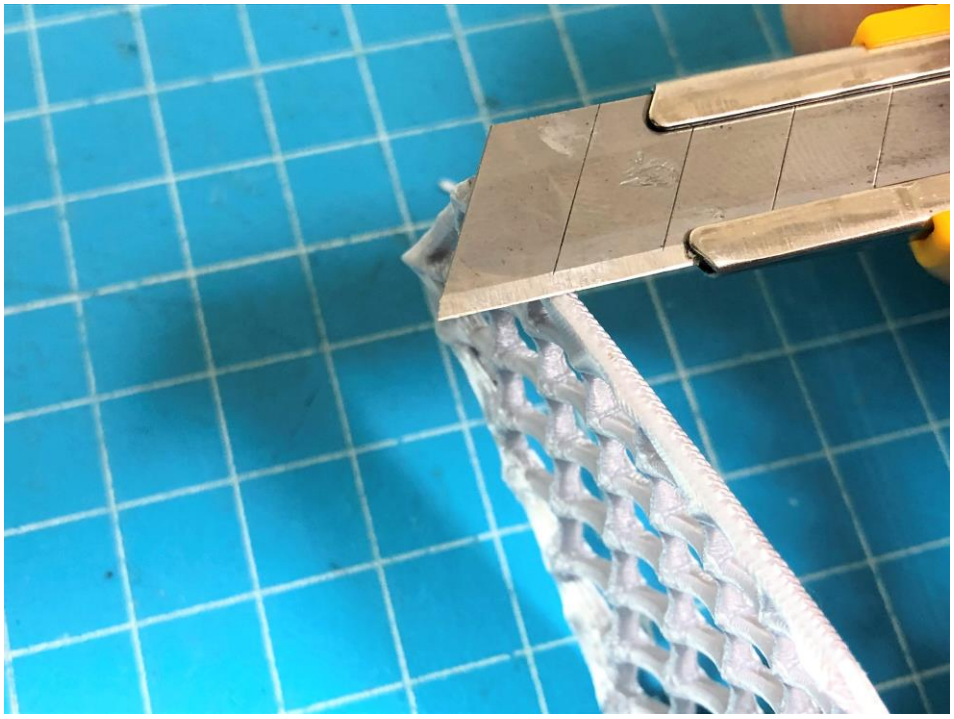
Place the fin as show below. The concave shape must be facing up.

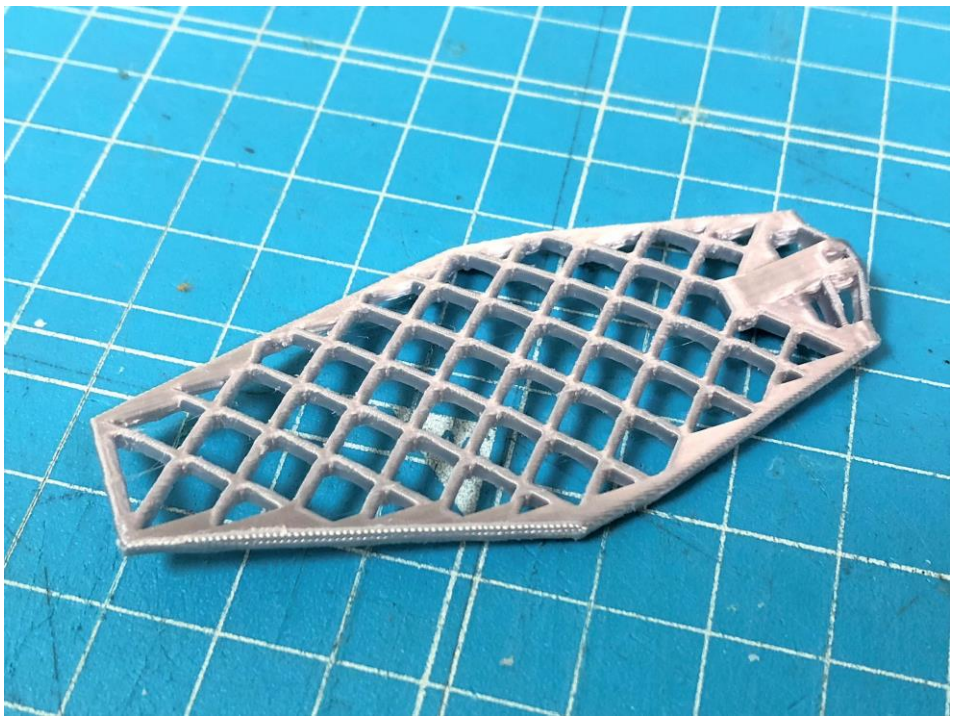


Using a cutter, cut the thick foot attached to the right side of the fin. Do not try to cut it in one strike! Make several successive cuts going a bit deeper at each time until the foot breaks away.



Once the fin is free, use the cutter to remove the remains of the foot from the side of the fin. Try to have the side of the fin as a smooth as possible. The result should look like the second photo. I do not recommend using sand paper for this operation. I tried sand paper, and the result looked worse than when using a cutter.

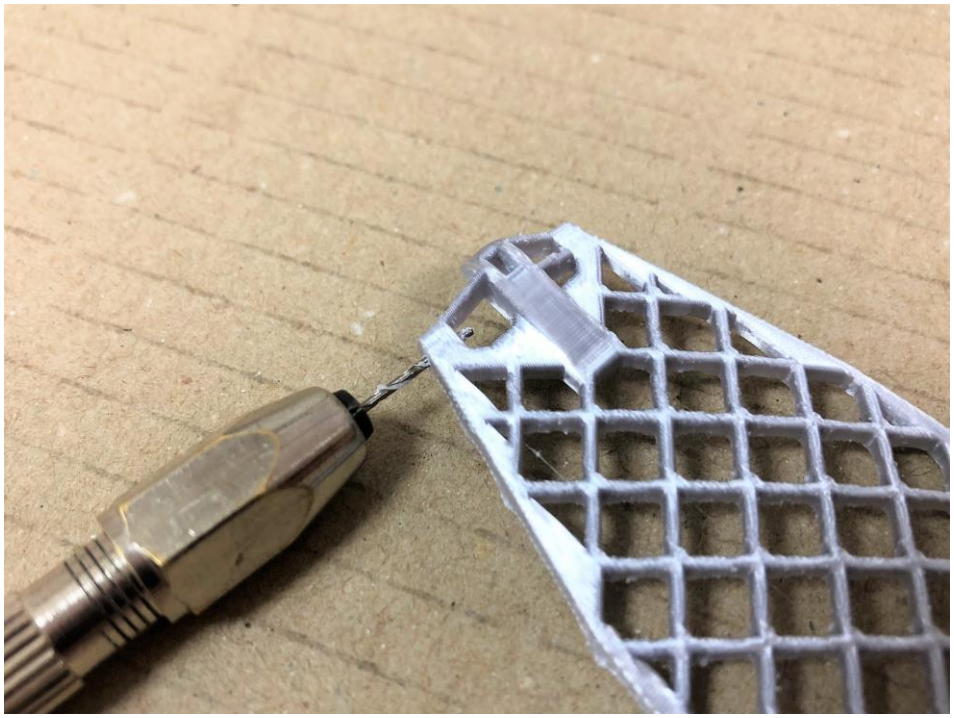


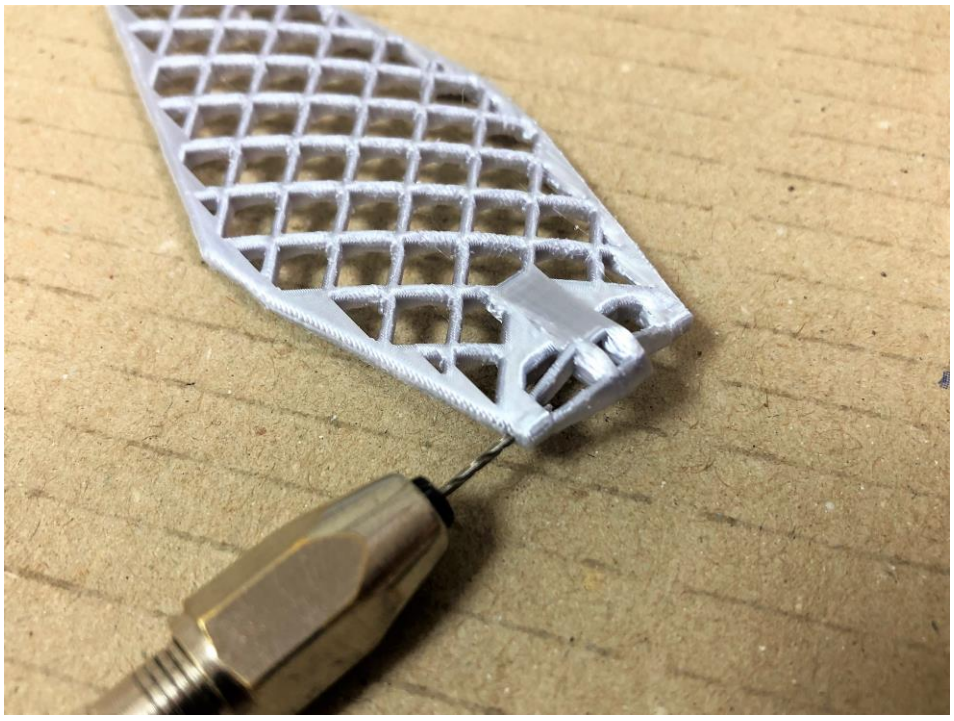


### 7.4.3 Drilling the side holes

Locate the hole on the side of the fin show in the first photo below. Using the 0.8mm drill bit, gently drill through the hole. Be sure to orient the drill correctly.

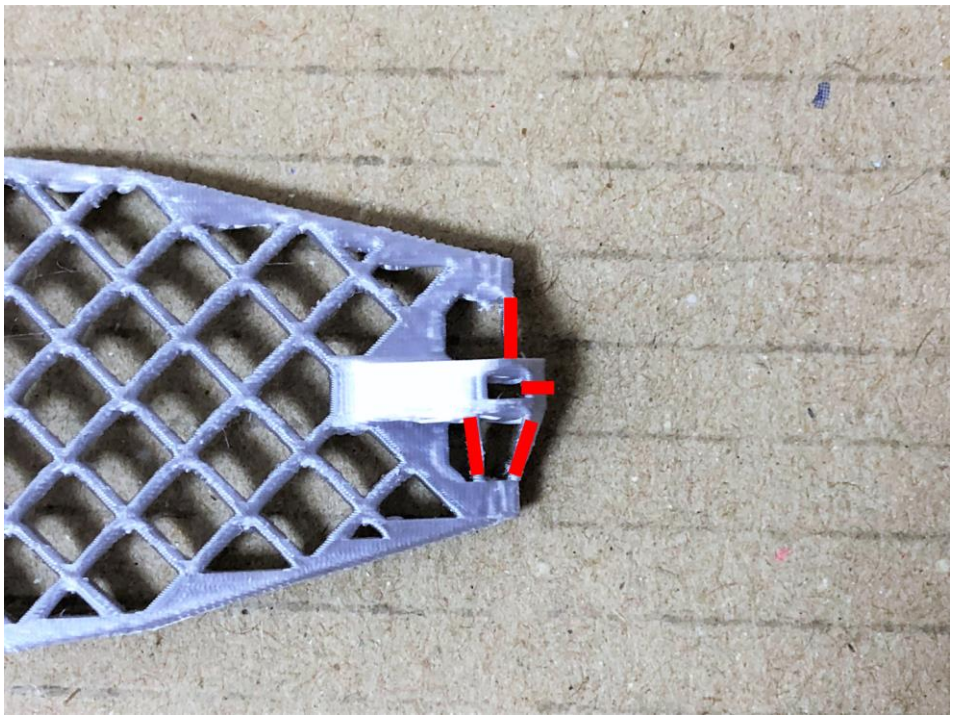
Locate the hole on the opposite side of the fin (second photo). It might be partially covered by the remains of the foot. If so, cut a bit the side of the fin using the cutter to find where the hole is. Drill through the hole like you did for the first one.





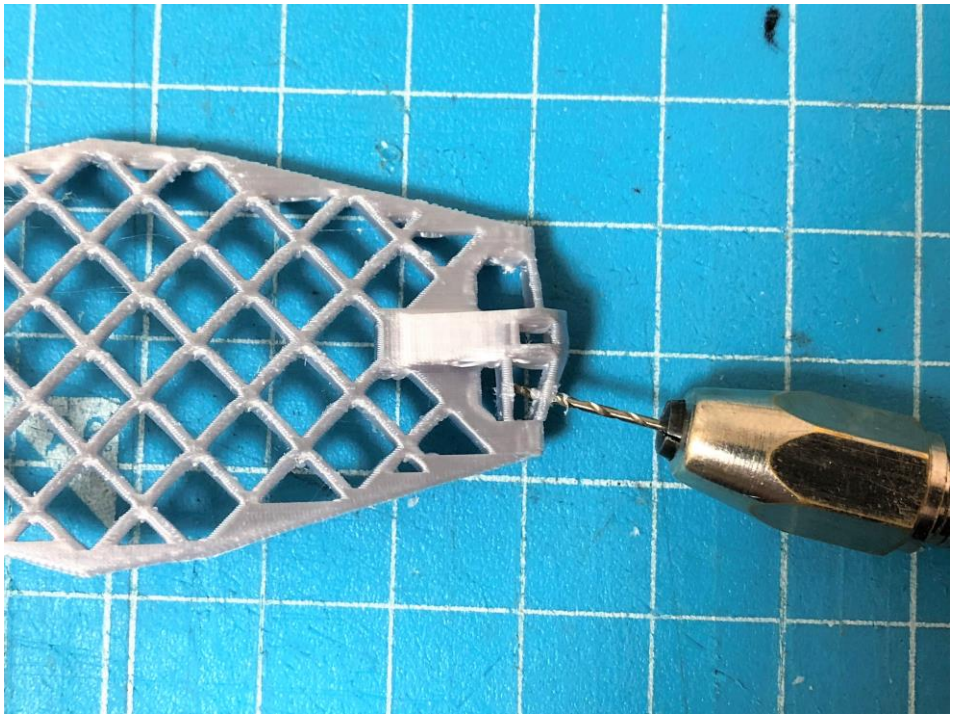
### 7.4.4 Removing the supports

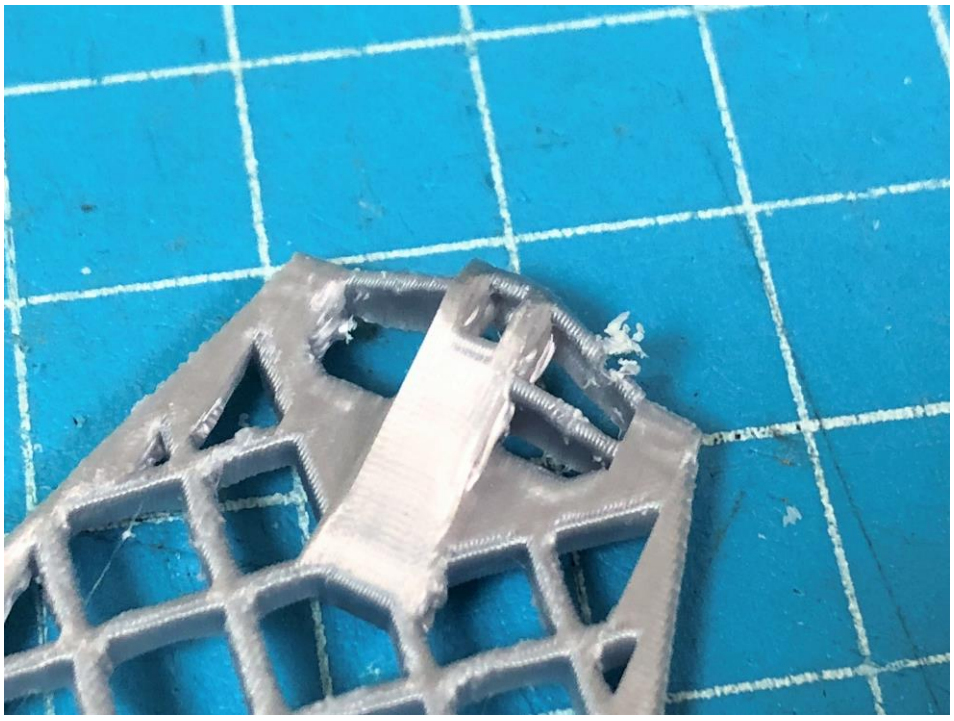
There are 4 supports to remove. They are shown in red on the photo below.

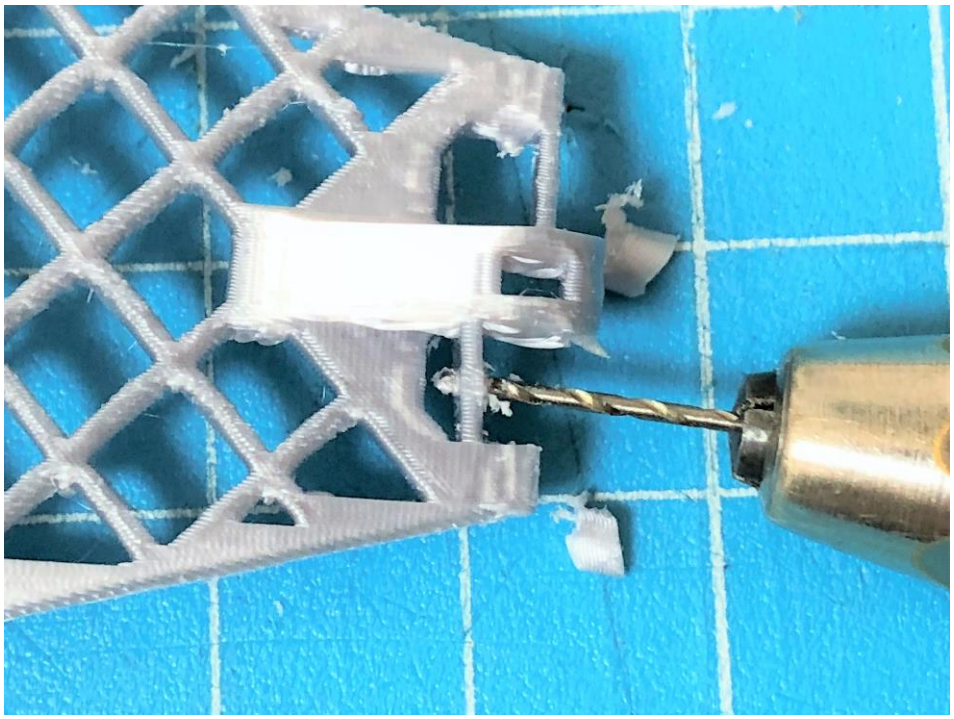


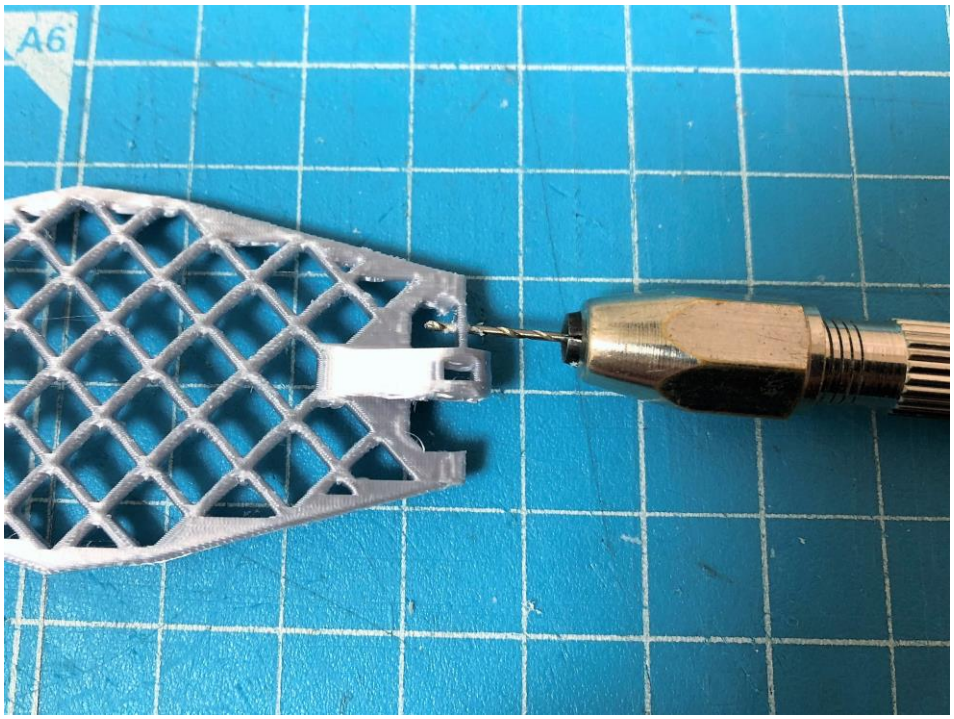
Do not try to cut the supports directly with the cutter, as this put too much stress on the lattice. Instead, use the following technique. Hold the fin in one hand, then using the 0.8mm drill bit slowly drill through the middle of the support. Repeat this task until there is a gap in the middle of the support. Finally, use the cutter to cut both sides of the support from the fin.

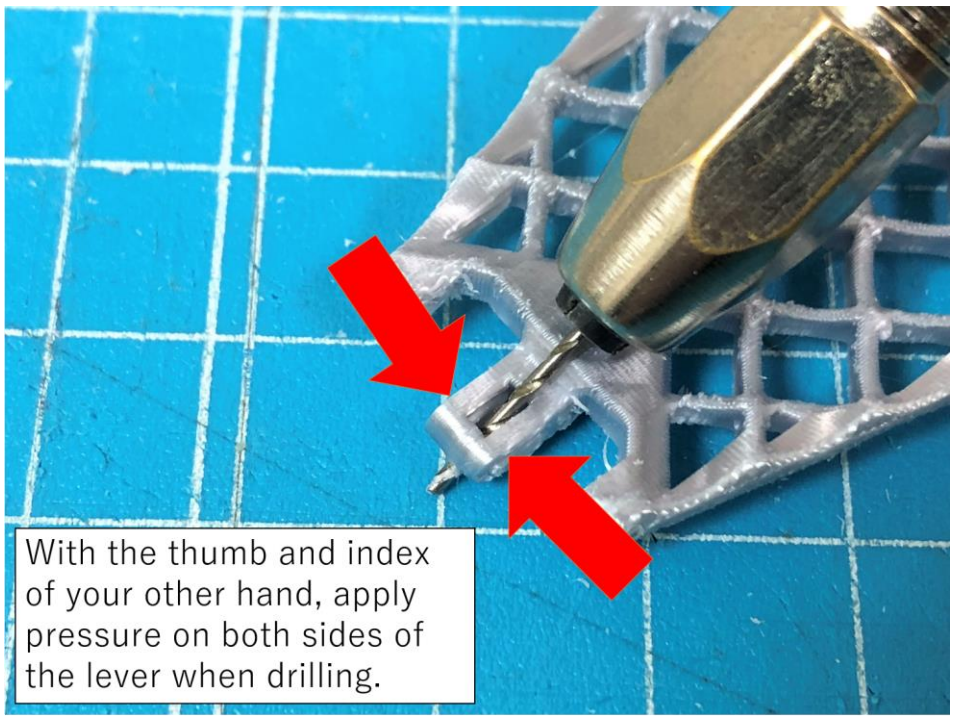
When drilling the last support (lever in the middle), pinch the two sides between your thumb and index while drilling. This will prevent the layers from splitting.



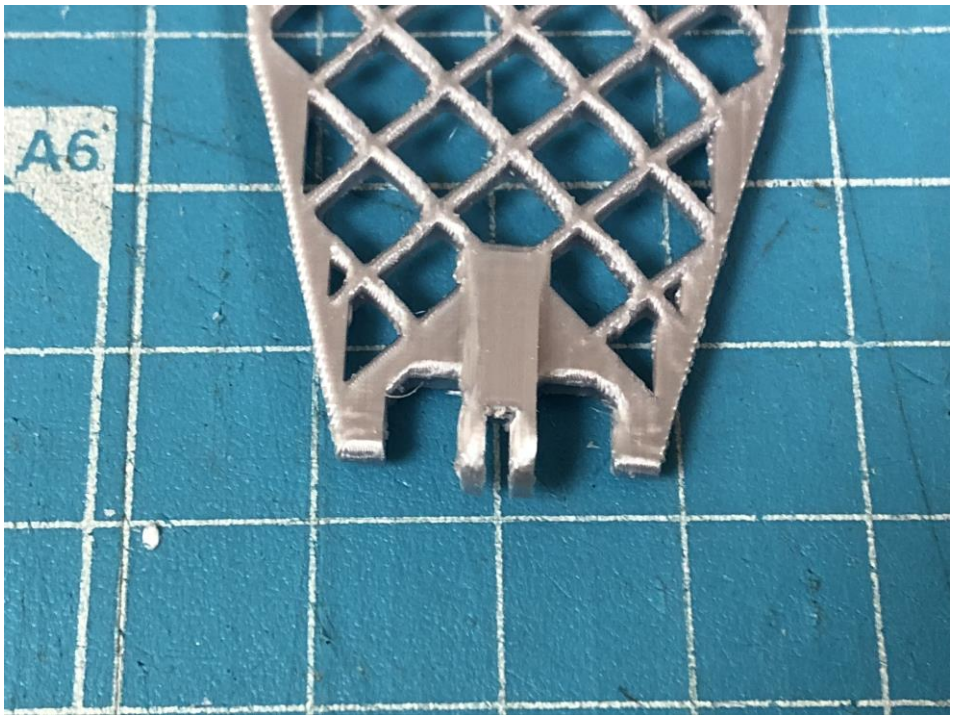





A6


With the thumb and index of your other hand, apply pressure on both sides of the lever when drilling.

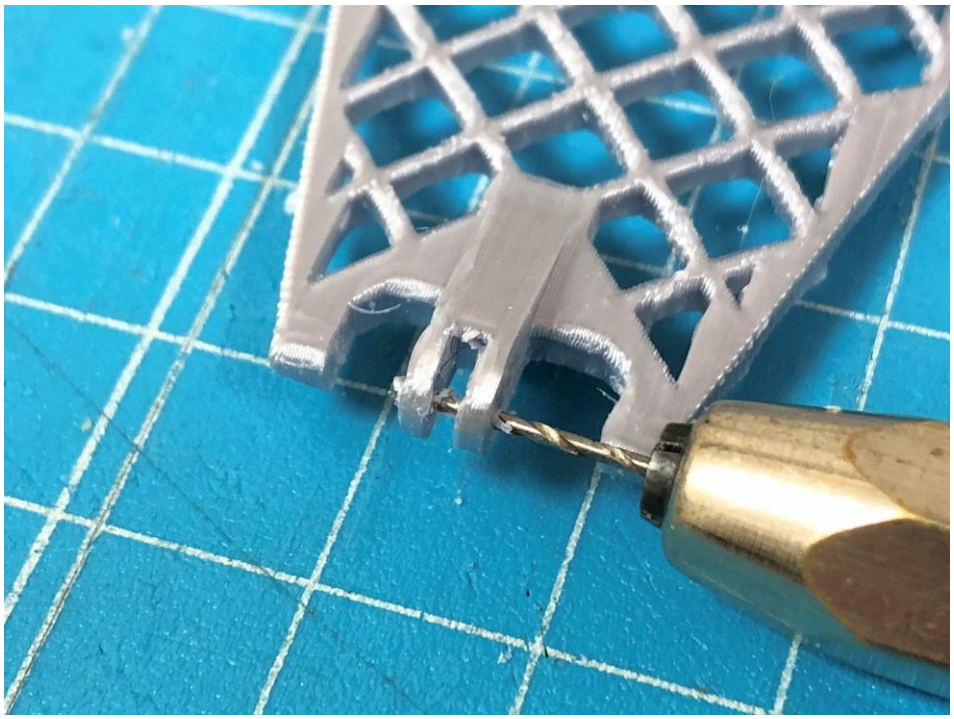
The fin should look like the in photo below. Make sure that the supports are completely gone.

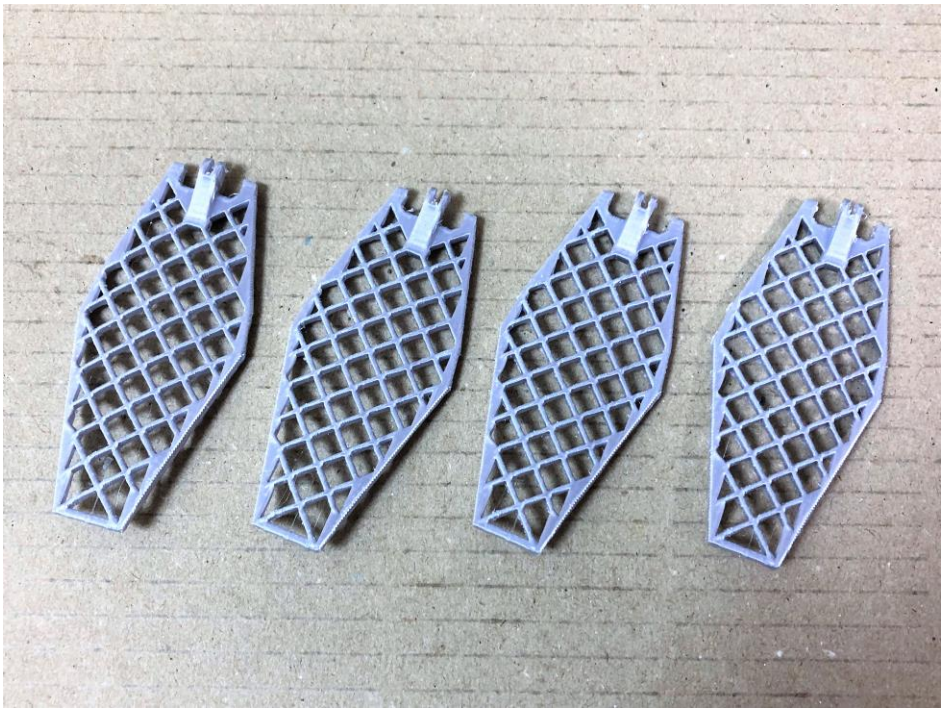


### 7.4.5 Drilling the lever holes

Now, locate the hole on the side of the fin lever. Drill through both sides of the lever like in the photo below.

Repeat these steps to make 4 fins





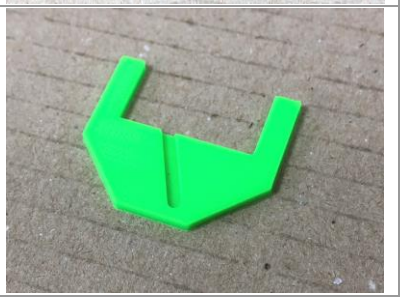
## 7.5 Fins mechanism assembly

### 7.5.1 Part & tools preparation

There are spares for all the plastic parts in case something goes wrong.

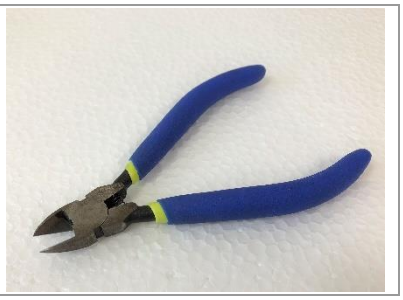
Prepare the following parts

| Part | Number of parts | Photo |
|---|---|---|
| **Folding linkage (short linkage)** | 4 |  |
| **Fin hub** | 4 |  |
| **Servomotors (with servo horns in the bag)** | 8 |  |
| **Servo pin wire** | 1 |  |
| **Rotation linkage (long linkage)** | 4 |  |

| | | |
|---|---|---|
| Hub lever | 4 |  |
| Ball bearing | 4 |  |
| Servo aligner | 1 |  |

Prepare the following tools

| Part | Photo |
| --- | --- |
| 0.8mm drill bit |  |
| + screwdriver |  |
| Cutter |  |
| Office tape |  |
| Pliers |  |

| | |
|---|---|
| Wire cutter |  |

### 7.5.2 Folding linkages preparation

Take the 4 folding linkages (the short linkages). Using the 0.8mm drill bit, re-drill the holes at both ends of the 4 linkages.

Look at the tip of the linkages. On one side, you might see that the part is a bit wider. This is a 3D printing artefact called “elephant foot”. Using the cutter, carefully remove the elephant foot from the part.

Take the 4 servomotor bags. Take out the smaller bags inside with the servo horns and screws. From each bag, take the smallest servo horn (see photo). They should have 6 holes.

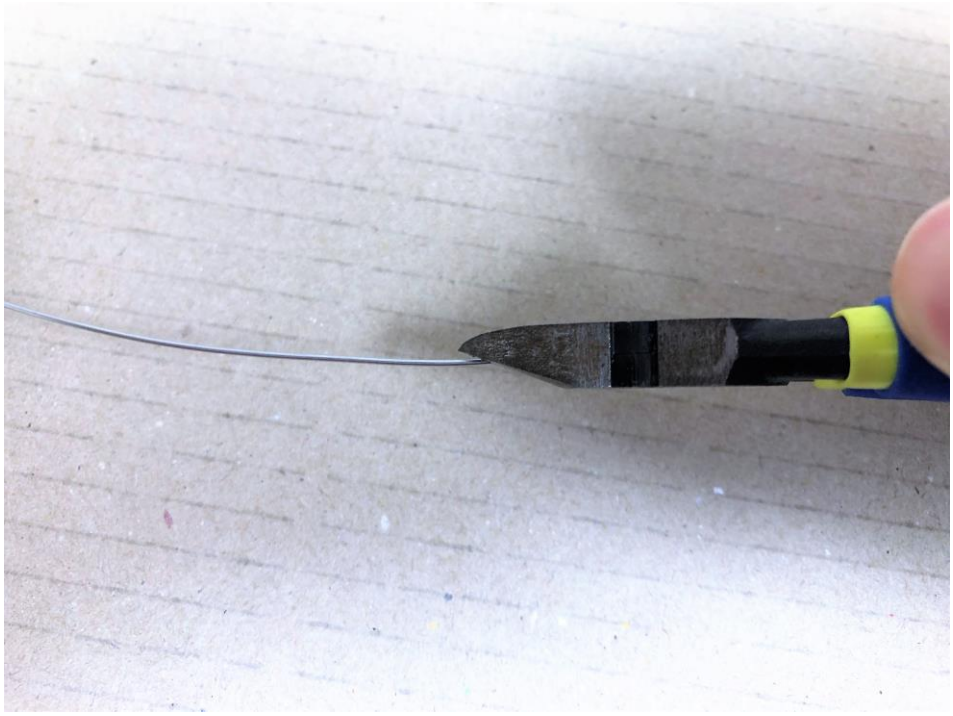
Using the wire cutter, cut across the third hole counting from the from the axis of the servo horn.

Take the servo pin wire.

Before inserting the wire, look carefully at the photos and orient the parts correctly!

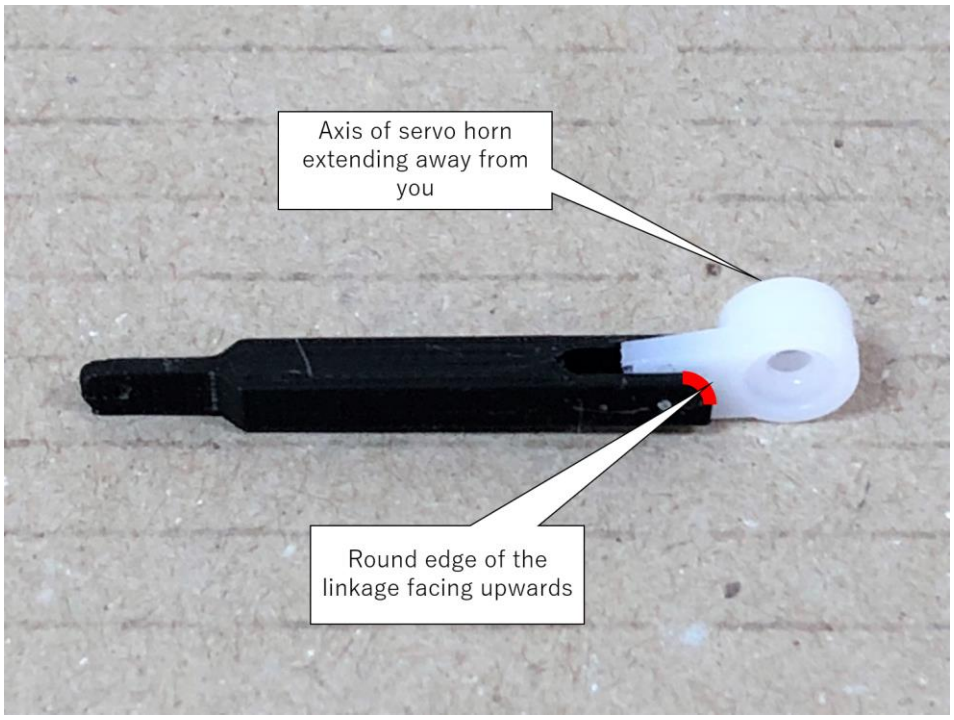
Tip:

Using the wire cutter, cut the wire at an angle like in the photo below. This makes the wire much easier to insert in the holes. Use this trick every time you have to insert the wire to make a hinge.



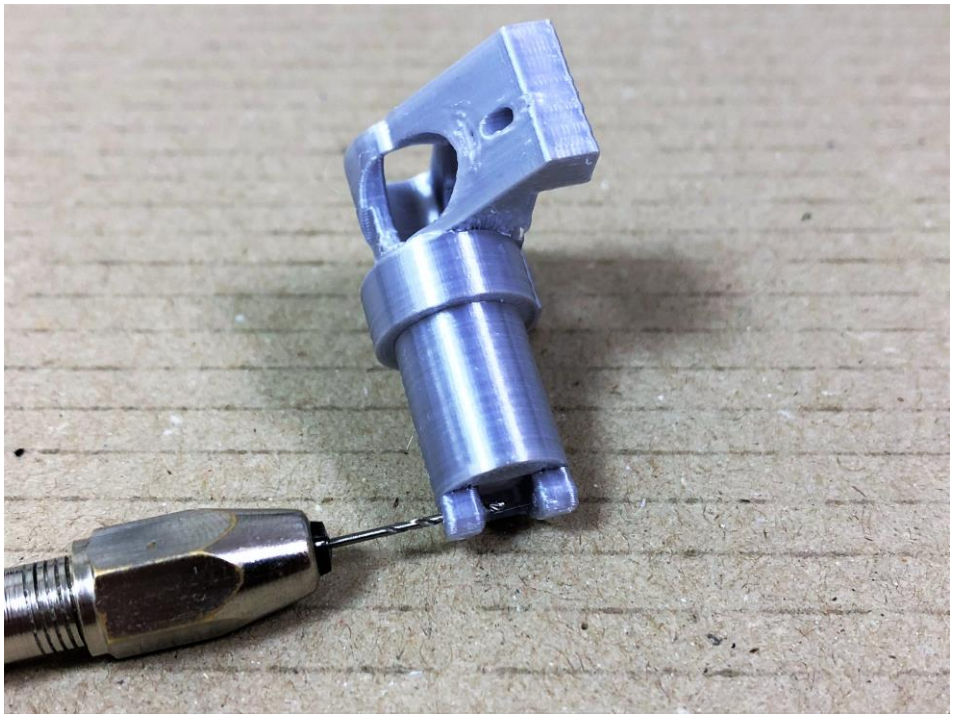
Hold the wire using a plier, and carefully insert it into one hole of the linkage, where the linkage splits into two parts. When the wire is through the first hole, insert the servo horn in the linkage. Be careful to the orientation of the parts! Push the pin until it goes all the way through. The pin must go through the hole that is furthest from the rotation axis of the horn. Cut the wire using the wire cutter so that the wire is flush. Check that the servo horn can rotate freely in the linkage.

Assemble the 4 linkages this way.

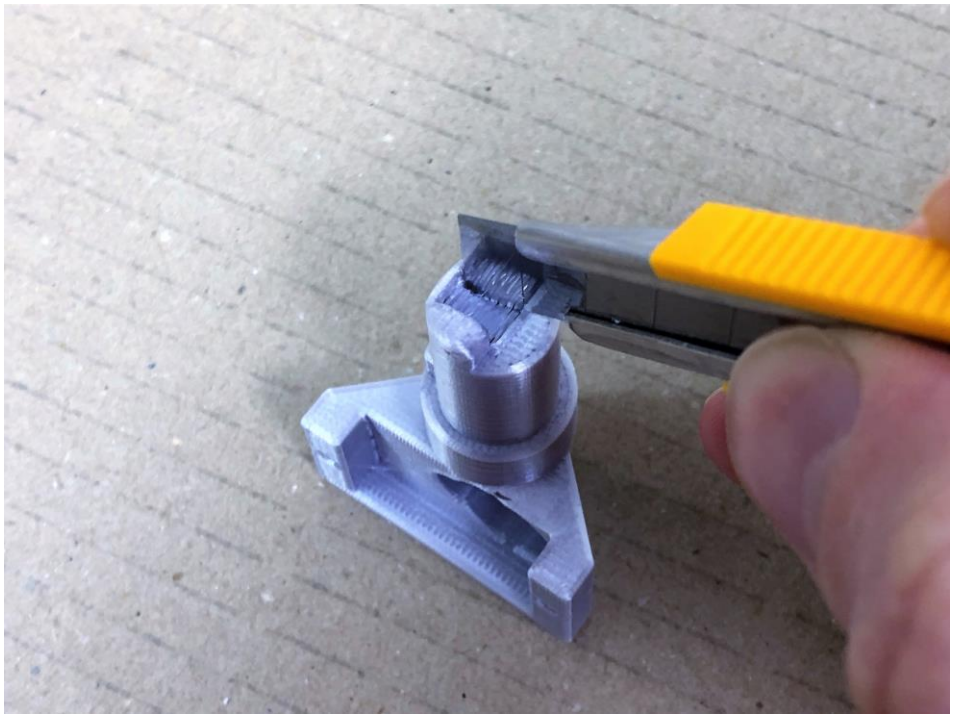


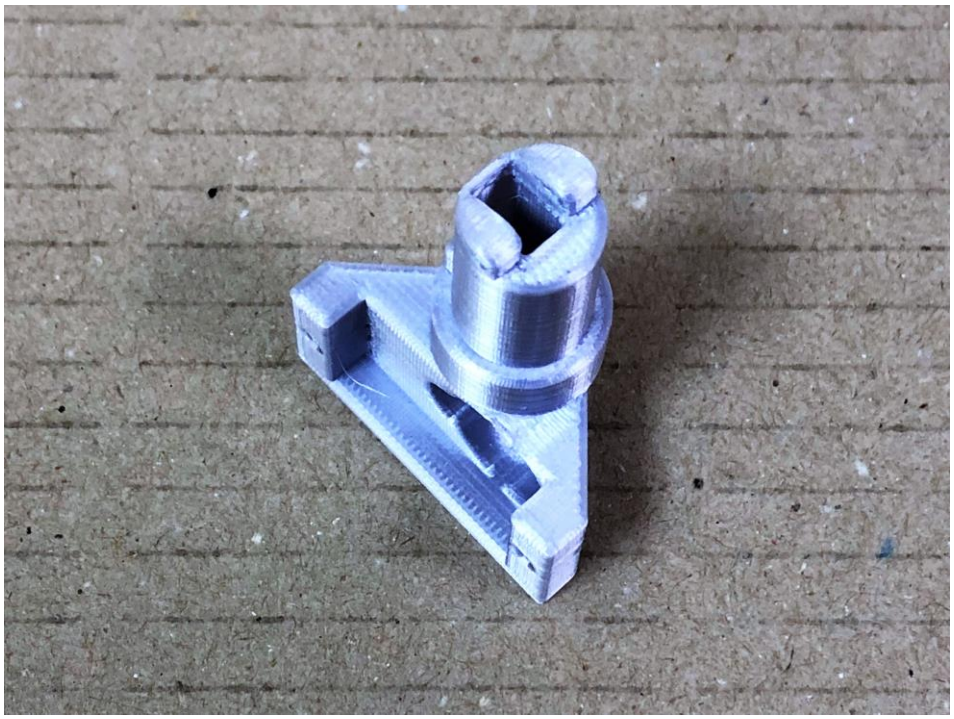

### 7.5.3 Hubs preparation

Take the 4 fin hubs. Using the 0.8mm drill bit, drill the holes on both sides of the hubs like on the photos below.

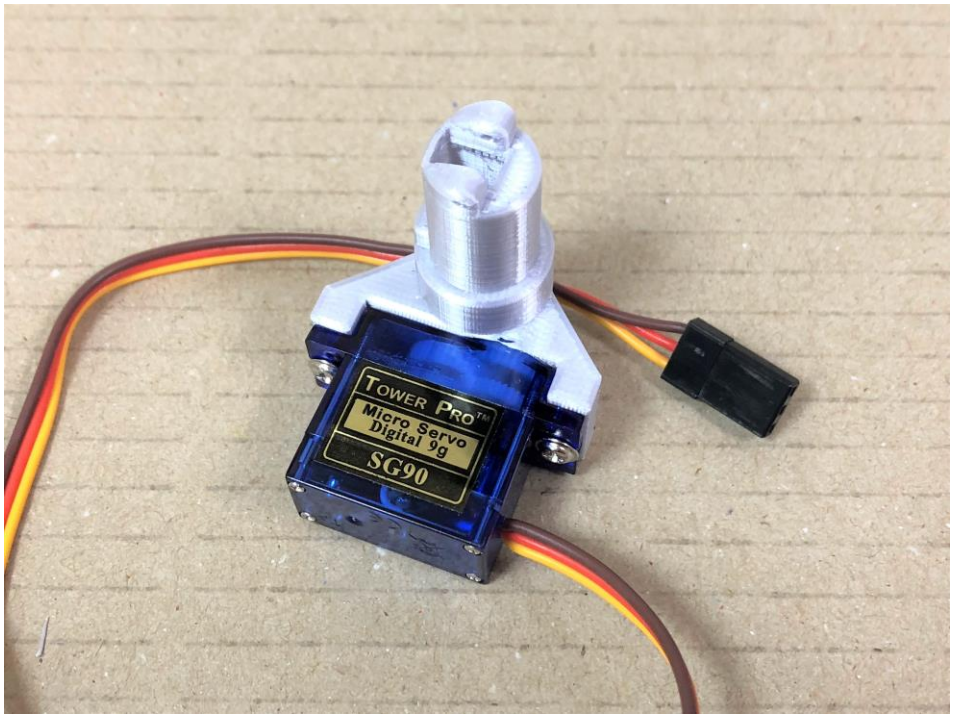


Using the cutter, open the square hole at the top of the hubs.



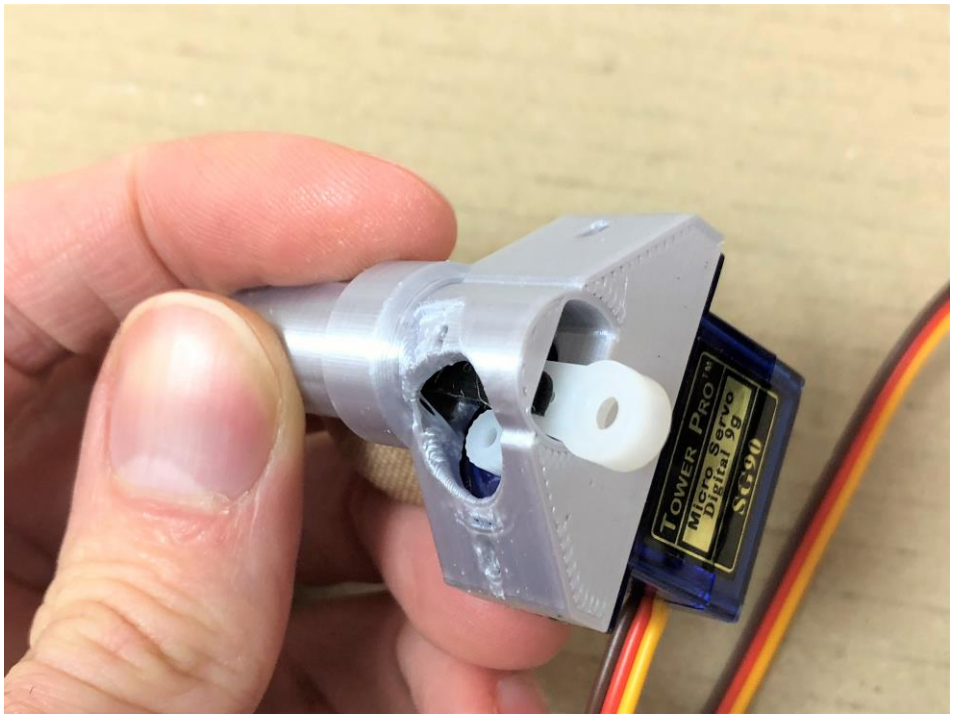


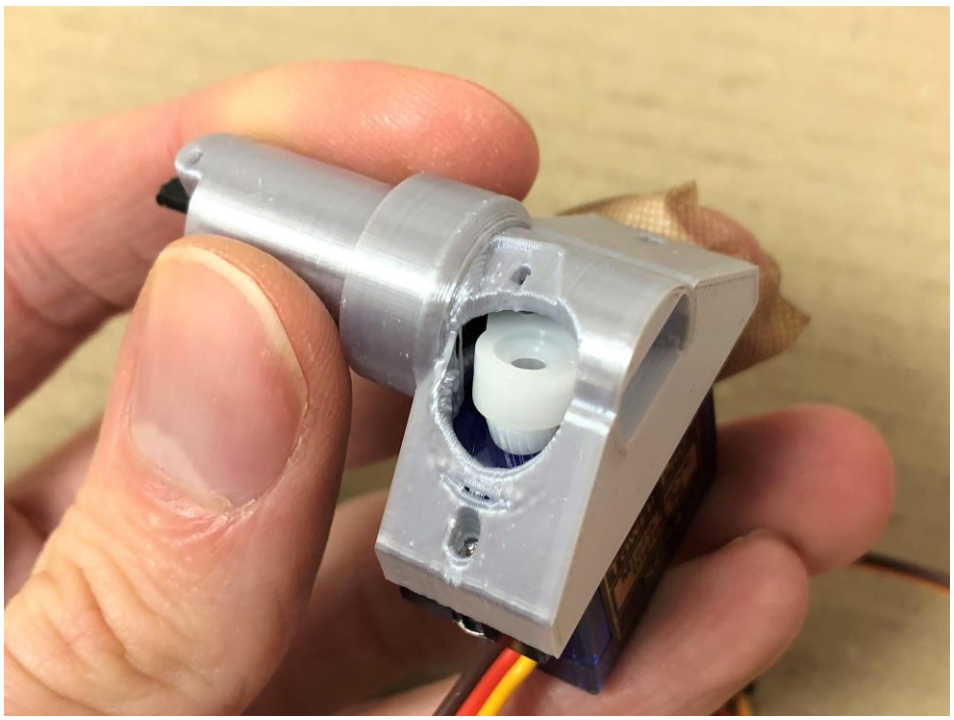
Take a servomotor and two screws from the small bag containing the servo horns and screws (take the two long screws). Screw the servomotor on the hub like on the photo below.



Insert a linkage from the back of the hub and orient the servo horn like on the photo below. Do not push the servo horn on the servomotor shaft yet! We first need to set the servomotor to the correct position.

Repeat this step for the three other hubs and linkages.

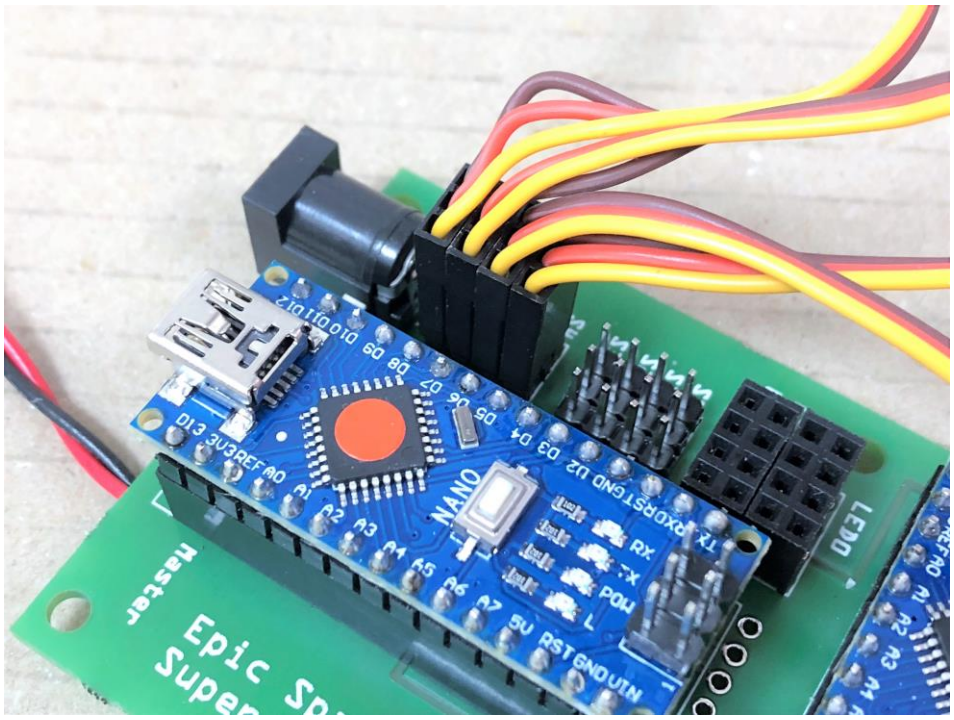


### 7.5.4 Folding servomotors connection

Check one more time that the servo horns are not connected to (meshed with) the servo shafts.

Connect the four servomotors to the control board, using the slots S4 to S7. The black wire must be closest to the board edge. This is temporary, so the order in which you connect the servomotors does not matter. Do not use the slots S0 to S3.

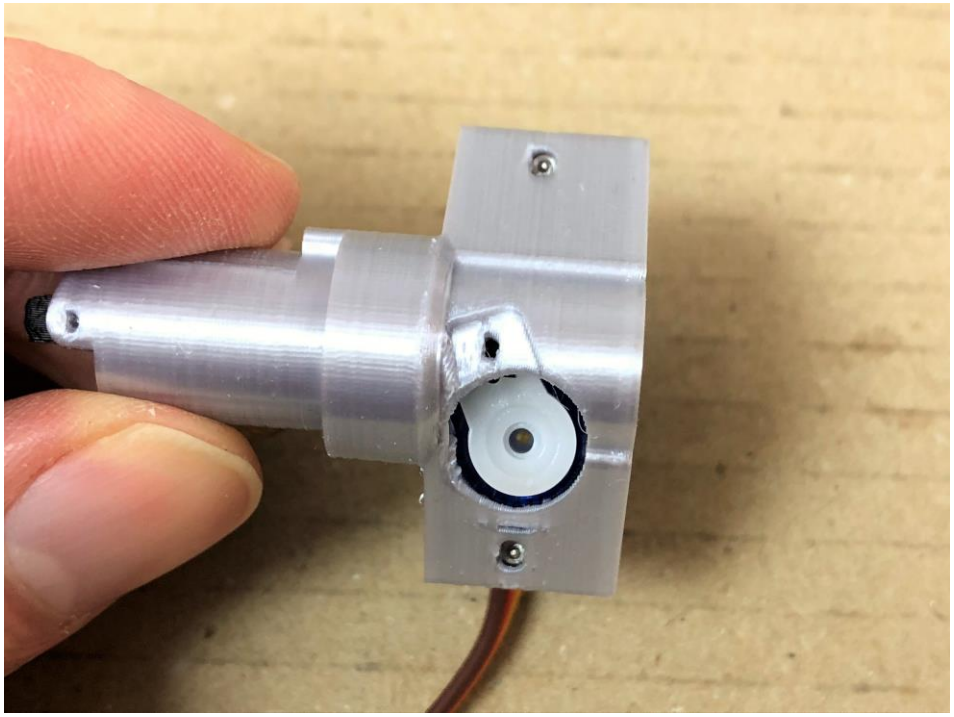



Power up the control board. The servomotors will move for a fraction of a second then stop at their default position. Once the servomotors stop moving, wait 4 seconds then power off the control board (disconnect the DC power adaptor). If you wait more than 10 seconds the servomotors will start moving continuously. In this case, power off the board and start again.

The purpose of this step is to place all servomotors at their default position before connecting the linkages. This is very important for the fins to move correctly.

*During the following step, be careful not to rotate the servo shaft itself.*

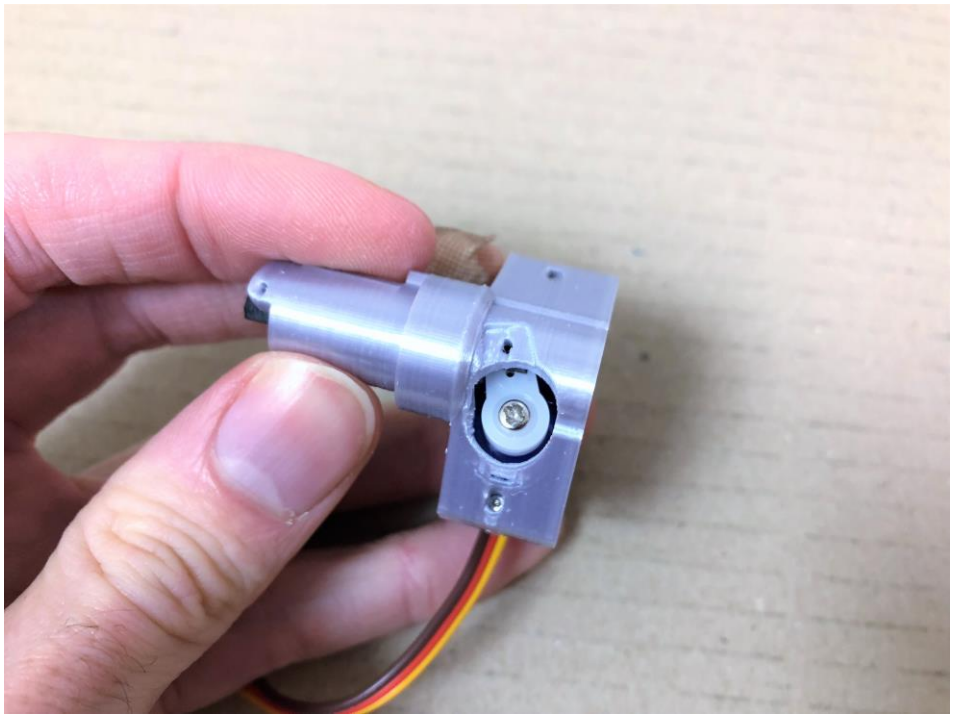
On the side of the hub, you will see the shape of the servo horn engraved. Align the servo horn as best as you can without rotating the servo shaft. Because the parts are toothed, you cannot align them perfectly but this is OK. At a moment, you will feel the servo horn meshing with the servo shaft. Push the servo horn fully on the servo shaft. Do not try to rotate the servo shaft to align the parts.



Take the remaining screw from the small bag (the smallest one), and use it to secure the servo horn on the shaft of the servomotor.

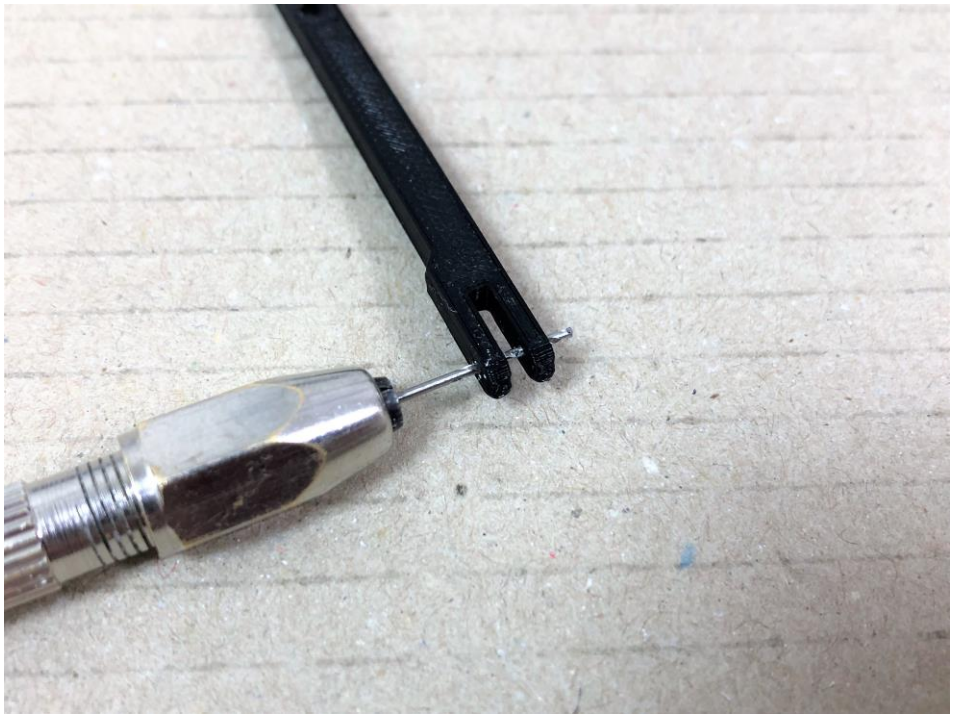
Repeat this step for the three other hub/fin assembly.

Once you are done with the 4 hubs, disconnect the servomotors from the control board.

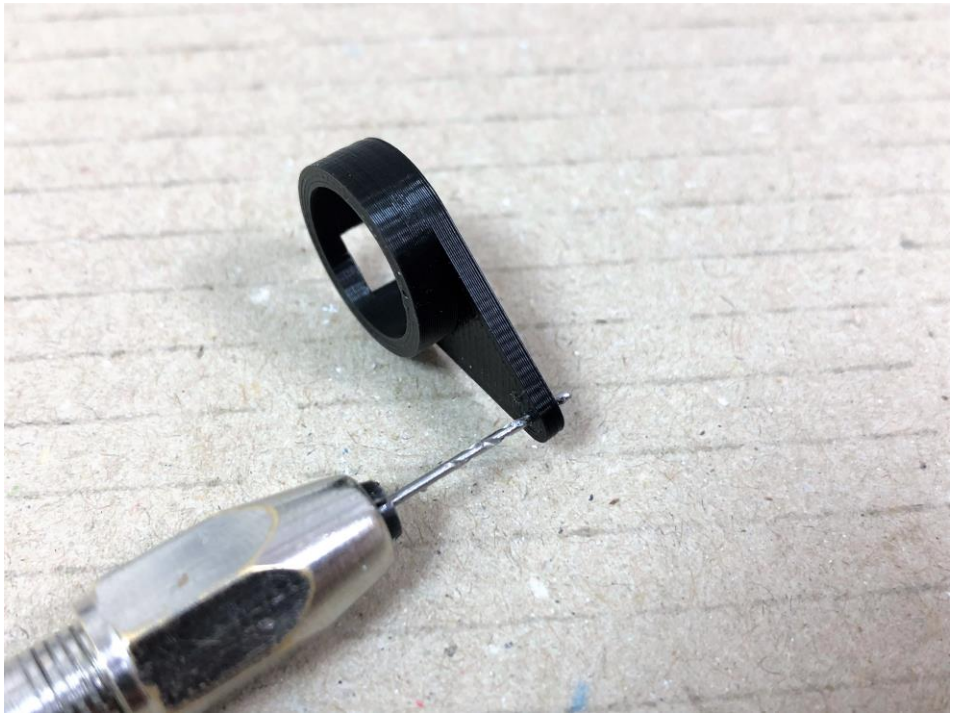


### 7.5.5 Rotation linkages preparation

Take the 4 rotation linkages (the long linkages). Using the 0.8mm drill bit, drill the holes at both ends.

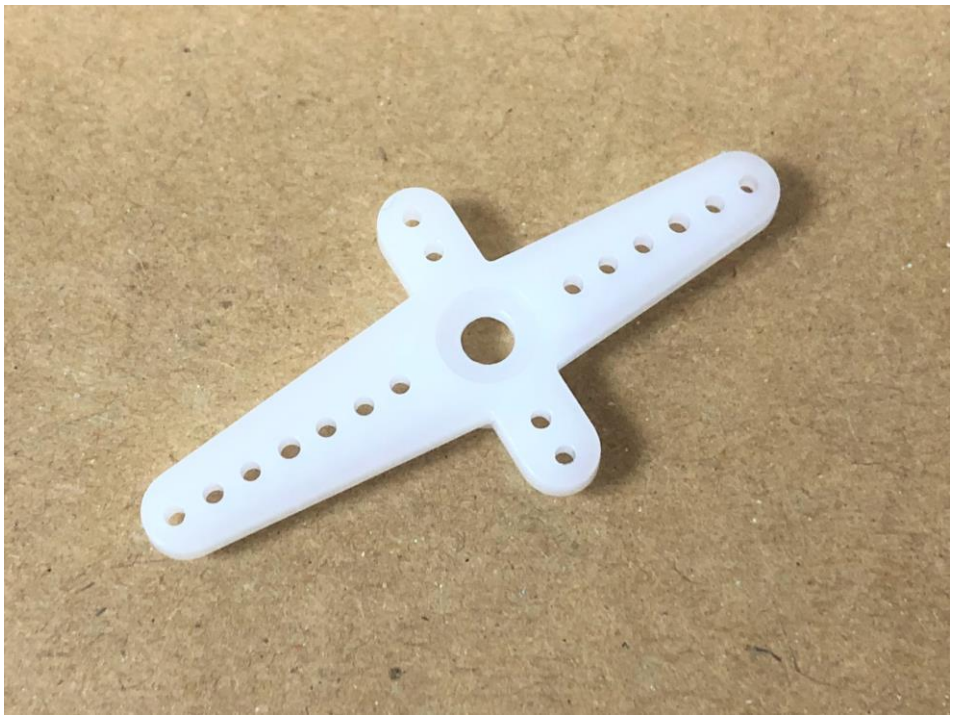


Take the 4 hub levers. Using the 0.8mm drill bit, drill the hole at the end of the arm.



Using the pin wire, connect the pitch linkages and pitch levers. Look carefully at the orientation of the parts. The round edge of the linage must face upwards.

From the small bags with the servo horns, take the cross-shaped servo horns.



From this part, we want to keep only the longest of the 4 arms. Using the wire cutter, cut out the three arms marked in black in the first photo. The result should look like the second photo.

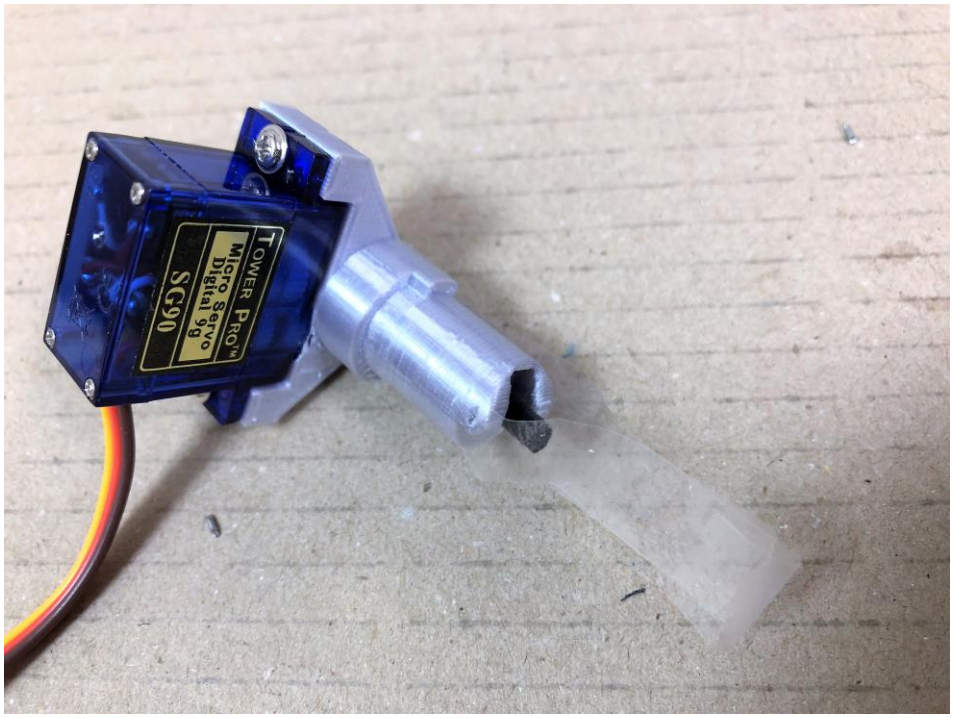
Repeat this step for the 3 other servo horns.

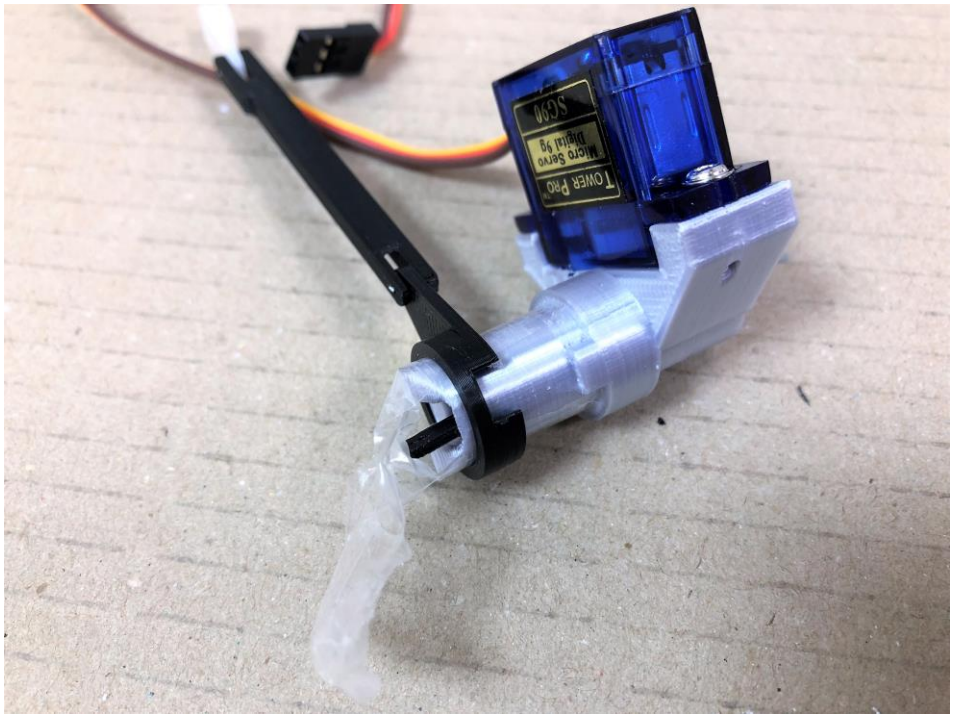
Using the pin wire, attach the servo horn to the end of the linkage. Pay very attention to the orientation of the parts. The pin must go through the hole in the servo horn that is furthest from the horn axis. Cut the wire flush to the linkage. It must not stick out.

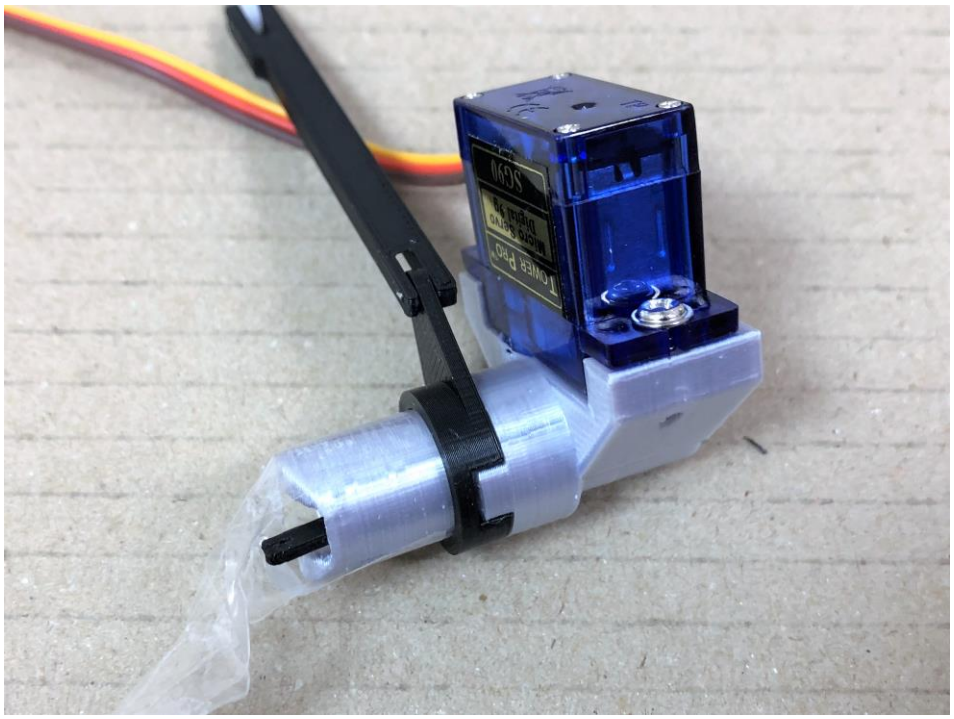
### 7.5.6 Rotation linkages connection

Take one of the hubs. Wrap tape on the hub like in the photo below. Insert the hub lever and align the notch with the corresponding shape in the hub. Make sure that the tape does not buckle.

If you feel that the lever is loose, wrap more tape!

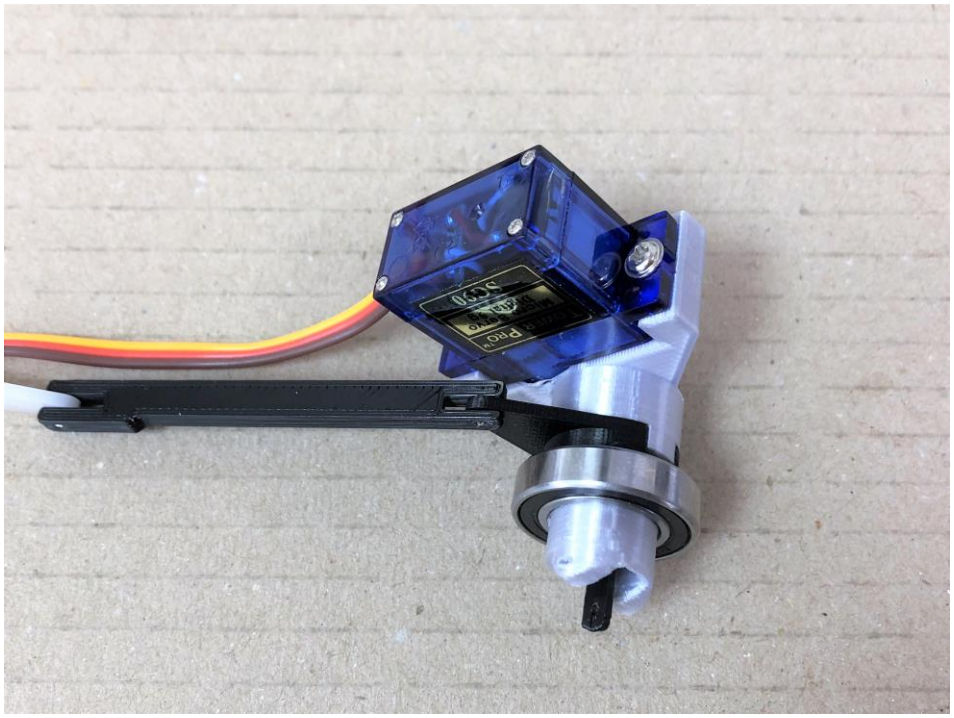



TOWER PRO
MICRO SERVO
SG90

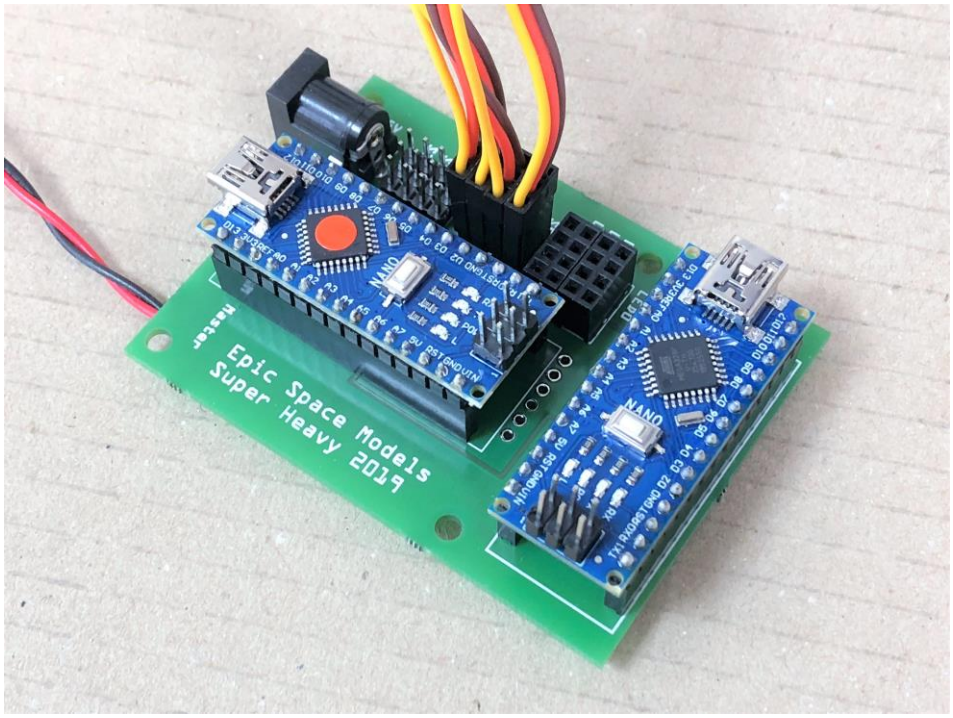
Take one of the ball bearings. Use the same technique to secure the ball bearing to the hub. If the tape is too tight, cut the tape flush to the lever using a cutter, then wrap new tape with just the number of layers needed to tight fit the ball bearing. Make sure that the tape does not buckle between the lever and the bearing. Once the bearing is secured, use a cutter to cut the tape sticking out between the bearing and the hub so that the tip of the hub is clean.

Repeat this step for the 3 other hubs



### 7.5.7 Rotation servomotor connection

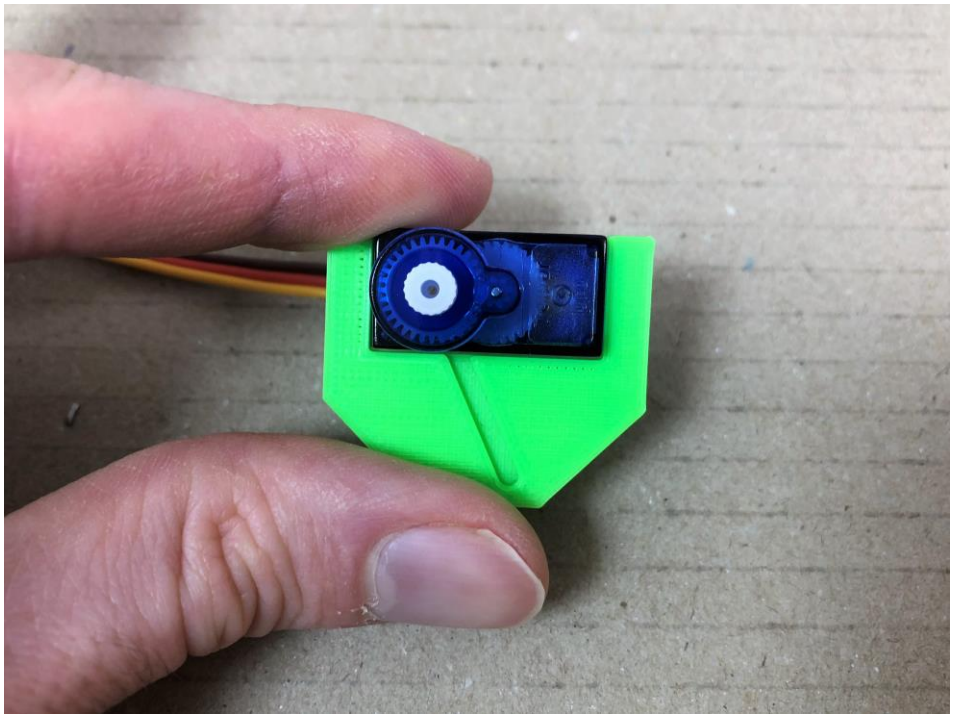
Take the 4 remaining servomotor bags. Take the servomotors out of their bags, and connect the four servomotors to the control board, using the slots S0 to S3. The black wire must be closest to the board edge. This is temporary, so the order in which you connect the servomotors does not matter. Do not use the slots S4 to S7.

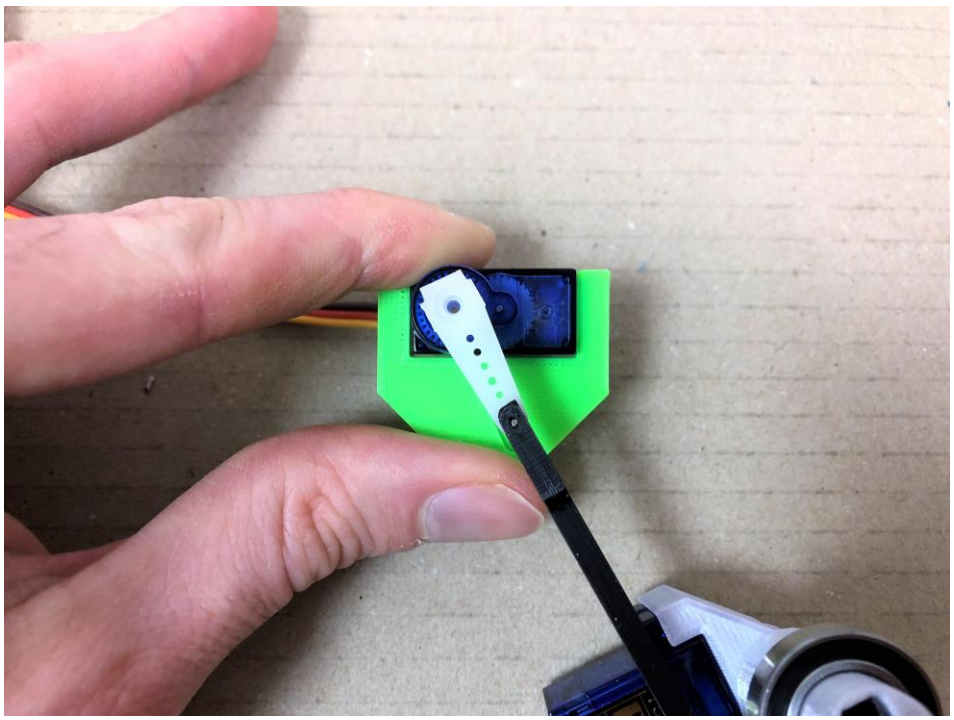



Power up the control board. The servomotors will move for a fraction of a second then stop at their default position. Once the servomotors stop moving, wait 4 seconds then power off the control board (disconnect the DC adaptor). If you wait more than 10 seconds the servomotors will start moving continuously. In this case, power off the board and start again.

The purpose of this step is to place all servomotors at their default position before connecting the servo horns. This is very important for the fins to move correctly.

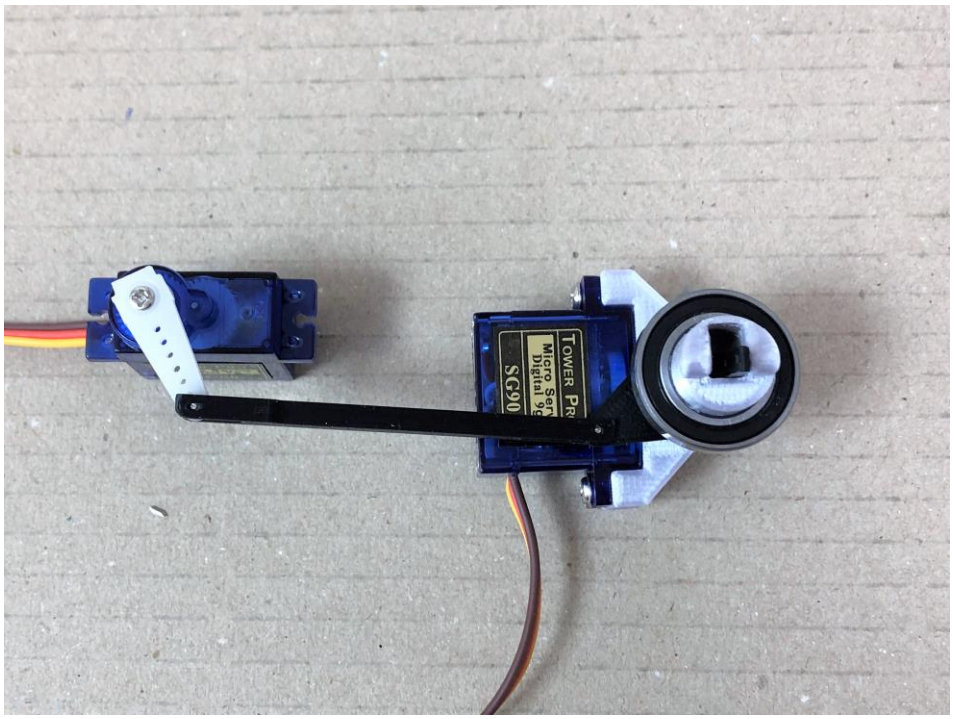
Take the servo aligner, and place it on top of one of the servos like in the photo below. Take one of the assembled linkages. Place the servo horn on top of the servo shaft and try to align it with the notch in the servo aligner as best as possible. Do not manually rotate the servo shaft. When the parts are aligned, push the servo horn on the shaft.





From the small bag with the servo screws and horns, take the smallest screw and use it to secure the servo horn on the servo shaft. The mechanism should look like the photo below.

Assemble the 3 other linkages and servomotors using the same technique.



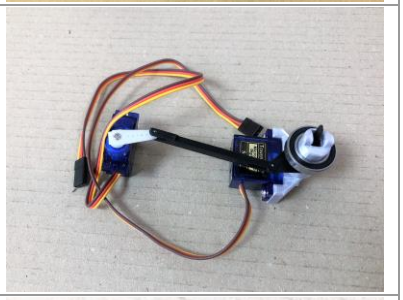
## 7.6 Interstage assembly

### 7.6.1 Parts & tools preparations

Caution! Do not start this part if you are tired! This is going to be a memorable 3D Tetris game.

The fins will probably not be aligned at the end of the assembly. This is expected. We will precisely align them during the calibration step.

Prepare the following parts

| Part | Number of parts | Photo |
|---|---|---|
| **Hull segment 1** | 1 |  |
| **Fins mechanism** | 4 |  |
| **Servo bracket** | 4 |  |
| **M3x30mm screw** | 8 |  |

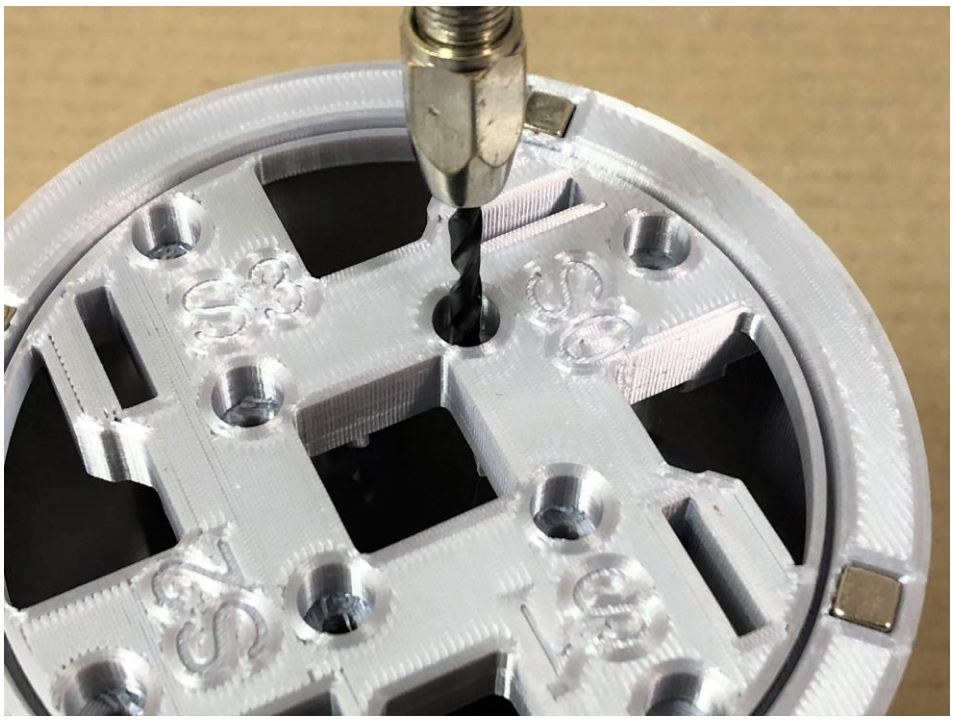
| | | |
|---|---|---|
| M3x8mm screw | 8 |  |
| Bearing holder | 4 |  |
| Fin | 4 |  |

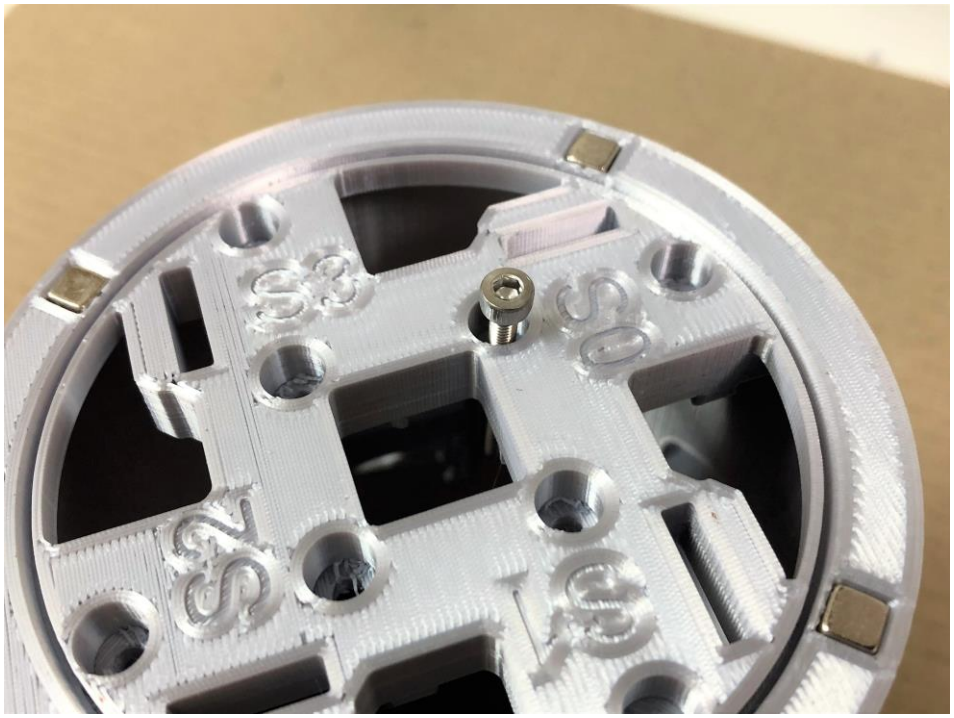
Prepare the following tools

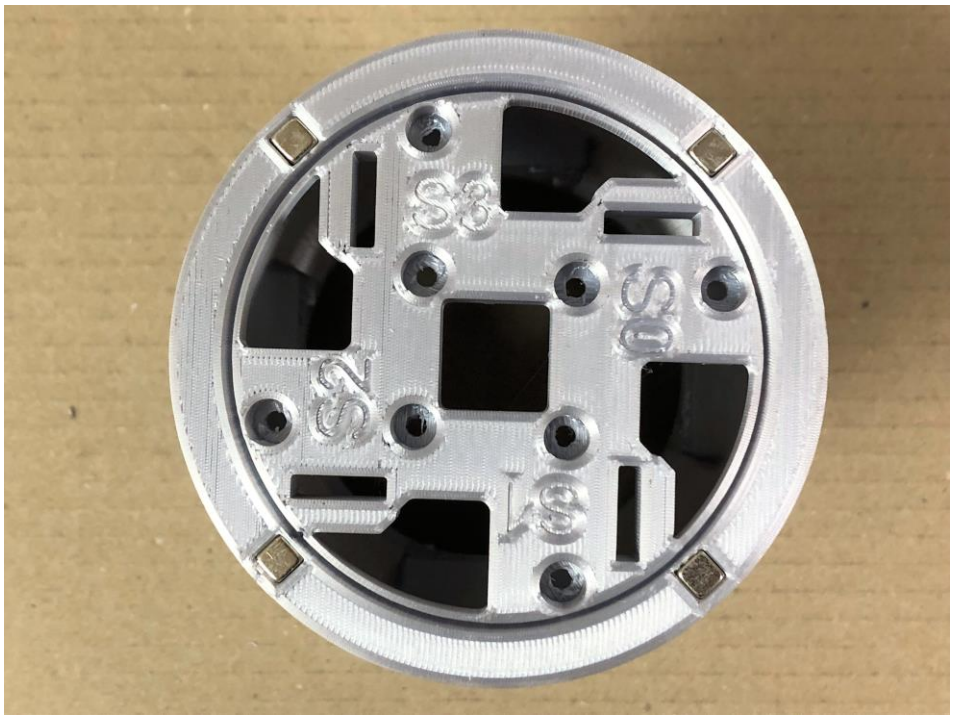
| Part | Photo |
| --- | --- |
| 3mm drill bit |  |
| Black marker |   |
| Hex key |  |
| White vinyl tape |  |

### 7.6.2 Poking the servo mount holes

Take the hull segment 1. On the side where you inserted the magnets, locate the 8 holes for the servomotor screws. Using the 3mm drill bit, drill through the thin layer covering the 8 holes. Take a M3x30mm screw, and check that the screw can go through all the holes. Put the M3x30mm screw back with the other parts to avoid losing it.



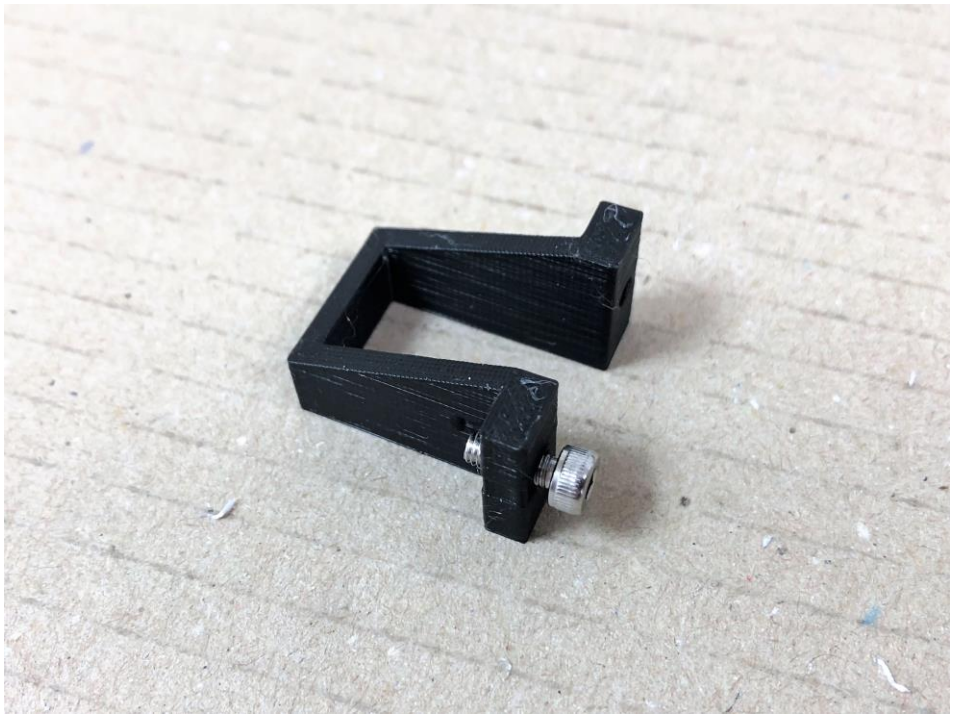

S3
S0
S2
S1

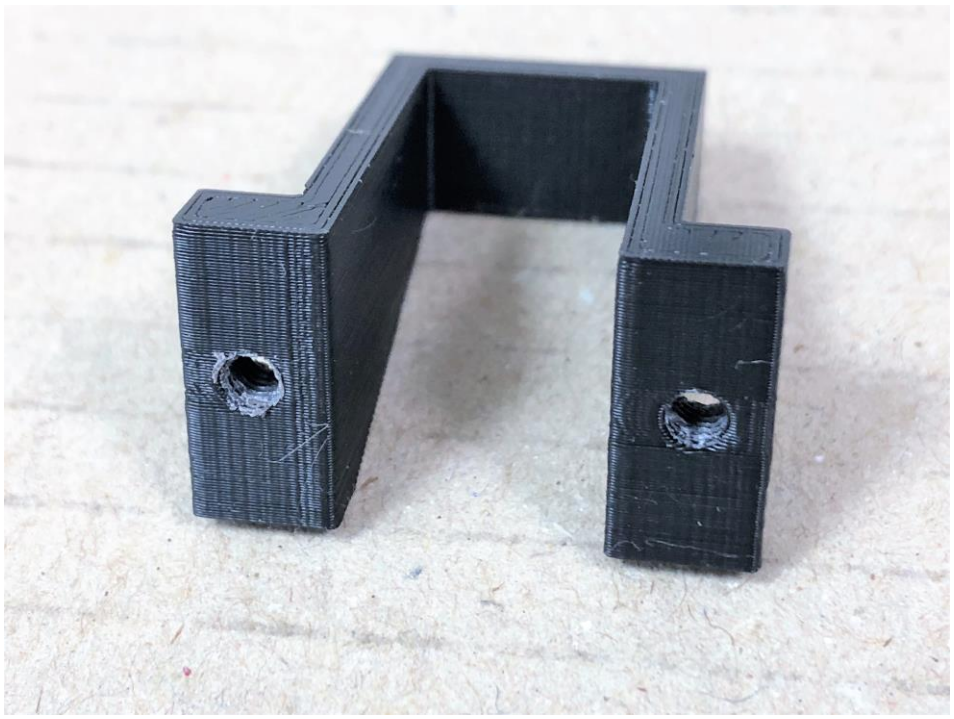

S3
S0
S2
S1

### 7.6.3 Tapping the servo bracket holes

Take the 4 servo brackets, one M3x8mm and the hex key. Carefully screw the screw through the base of the bracket like in the photo below. Once the screw starts emerging from the other side of the bracket, remove the screw. You do not need to screw until the head of the screw reaches the plastic part. Do this for both holes of all servo brackets.

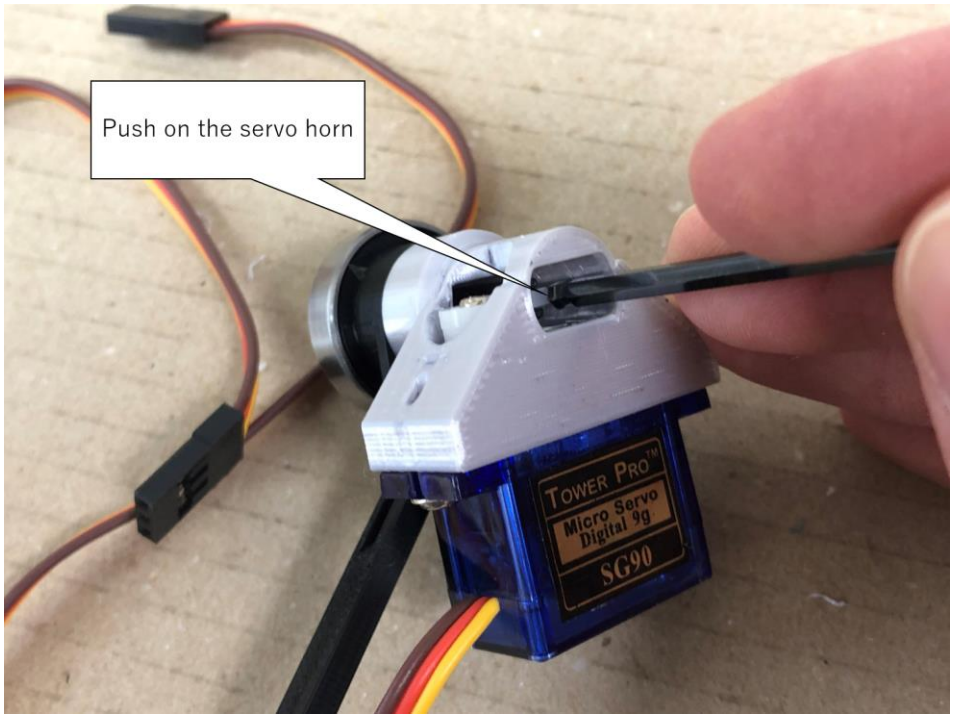
Tapping the holes like this will make the servomotor installation much easier…

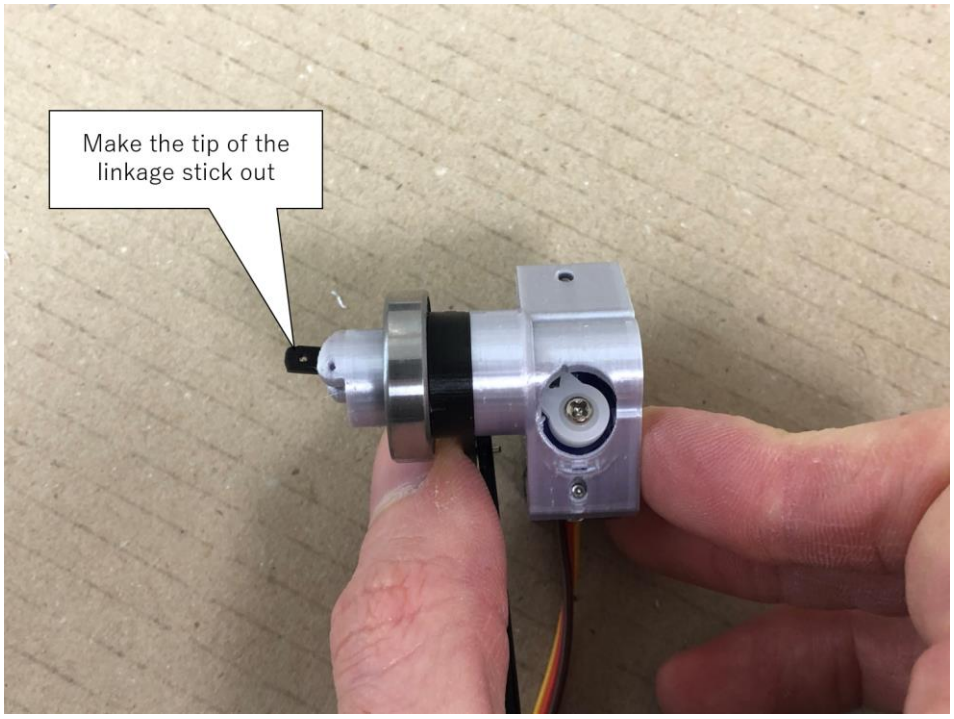




### 7.6.4 Folding linkage positioning

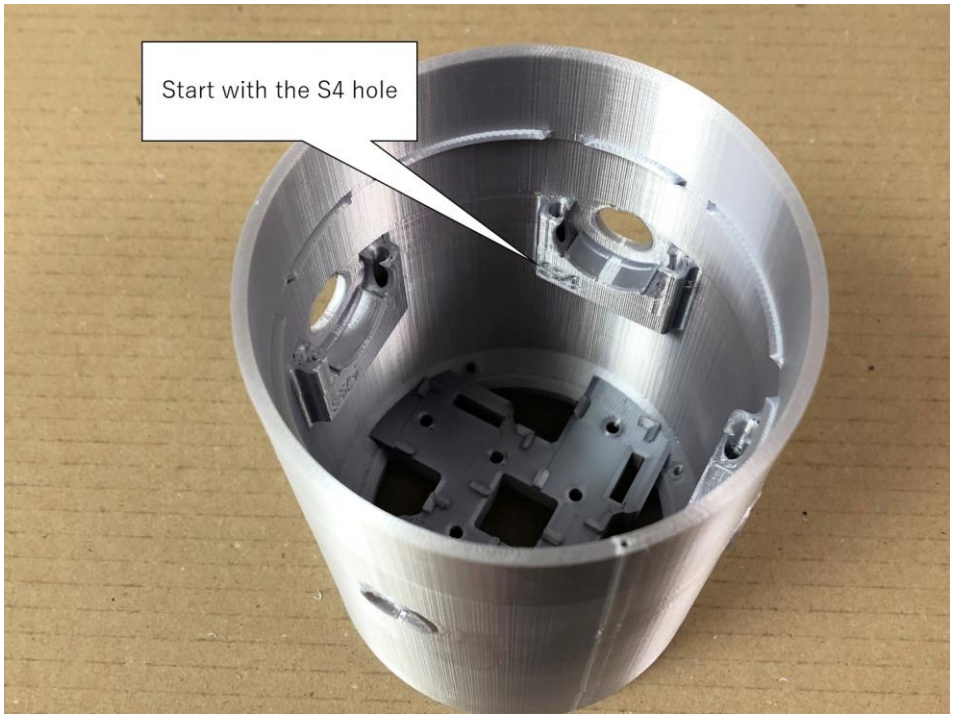
Take the 4 fin mechanisms. Using the hex key, gently push on the tip of the servo horn from the back of the hub to rotate the servomotor. This will push the tip of the linkage out of the hub, making it easier to attach the fin later.



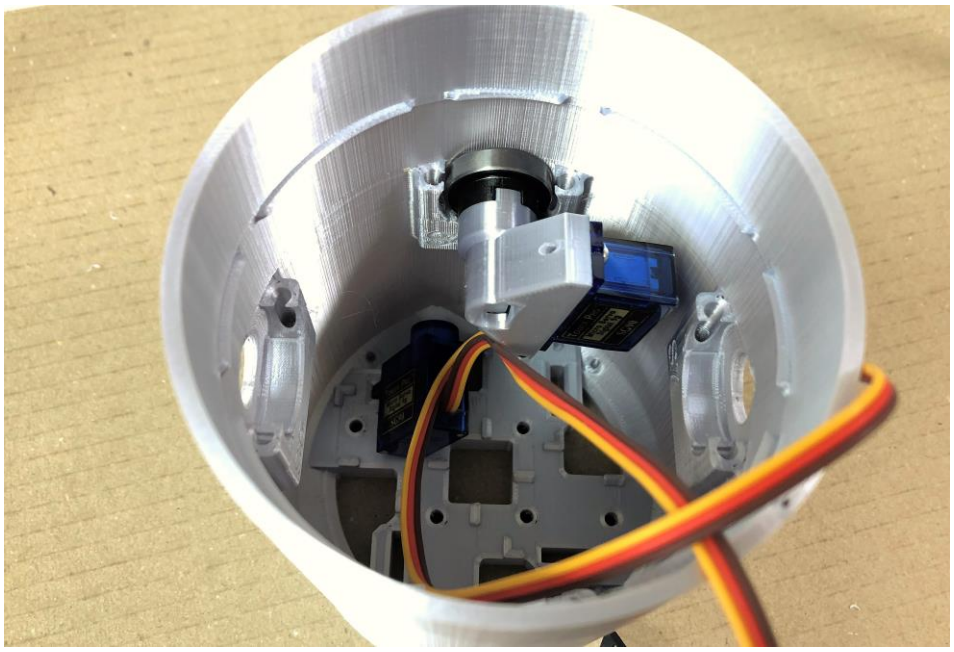
### 7.6.5 Fin mechanism installation S0-S4

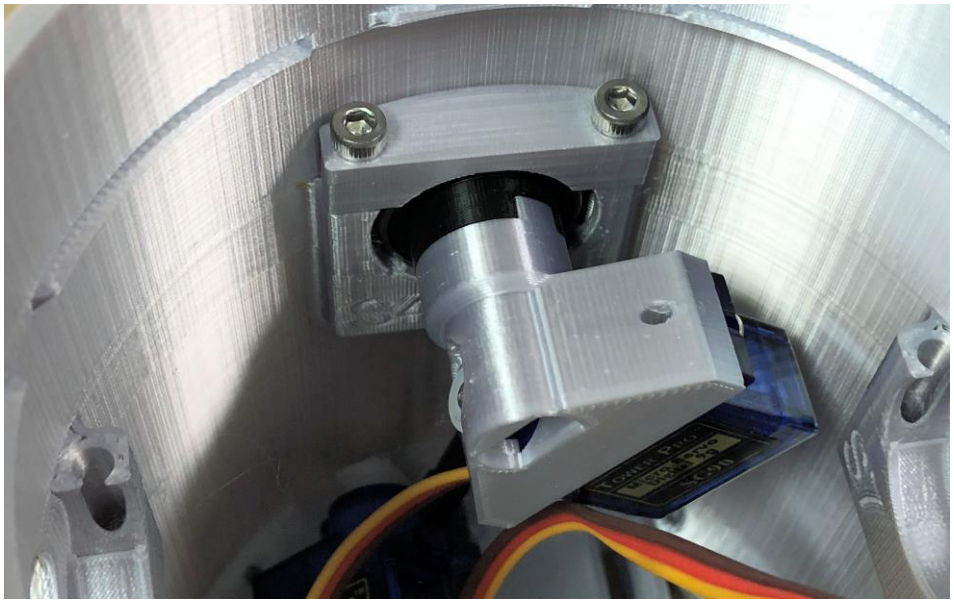
Place the hull segment vertically. On the inner side, locate the label “S4” next to one of the side holes. This is where we will install the first fin mechanism.



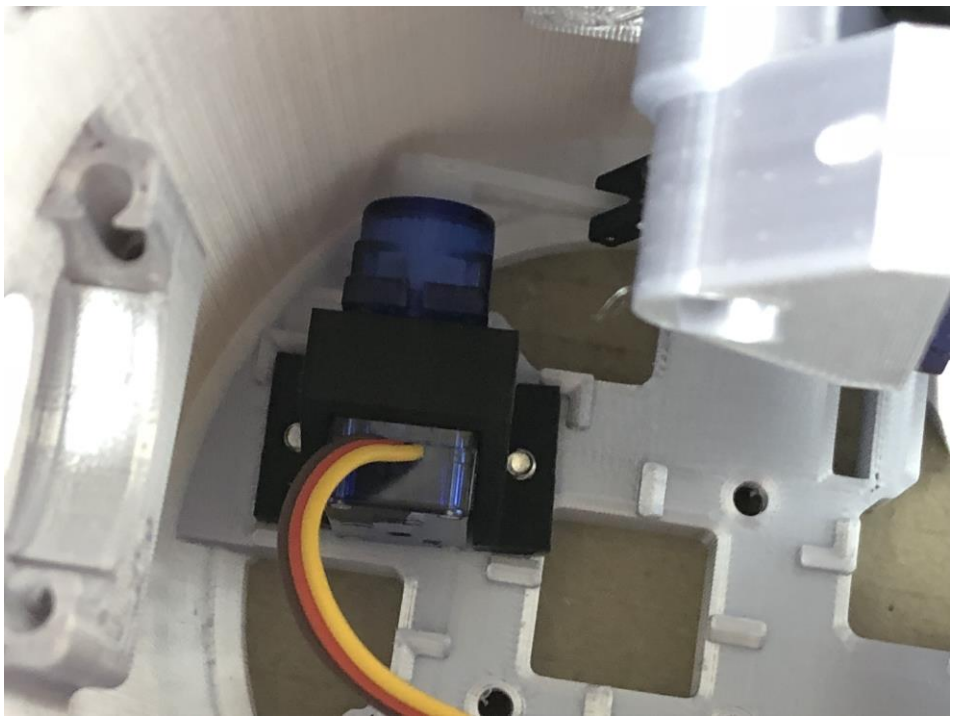
Take one of the fin mechanisms. Insert the end of the hub into the hole from the inside of the hull segment. The cable coming out of the servomotor attached to the hub must be going towards the bottom of the segment. The cable of the other servomotor (the one attached to the long linkage) must be going up.

Take one of the bearing holders, and place it on top of the ball bearing. Orient the part so that the curved side matches the curvature of the hull segment. Using two M3x30mm screws, secure the fin mechanism. Make sure that the bearing is pushed against the wall of the segment. Tighten the screws until the bearing is secured, but do not overtight the screws either.





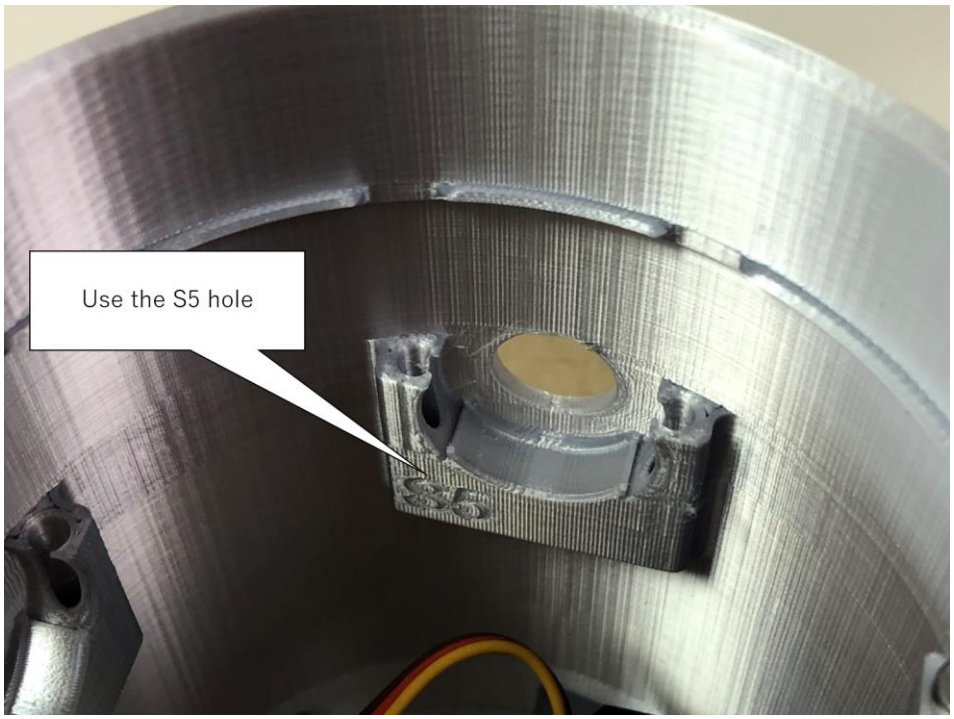
Check that the servomotor is correctly seated at the bottom of the segment. Place a bracket on top of the servomotor so that the holes in the bracket align with the holes in the segment. Insert two M3x8mm screws from the back of the segment using the holes on both sides of the label “S0”. Tighten the screws until the servo is secured.




Insert screws from the
back of the segment

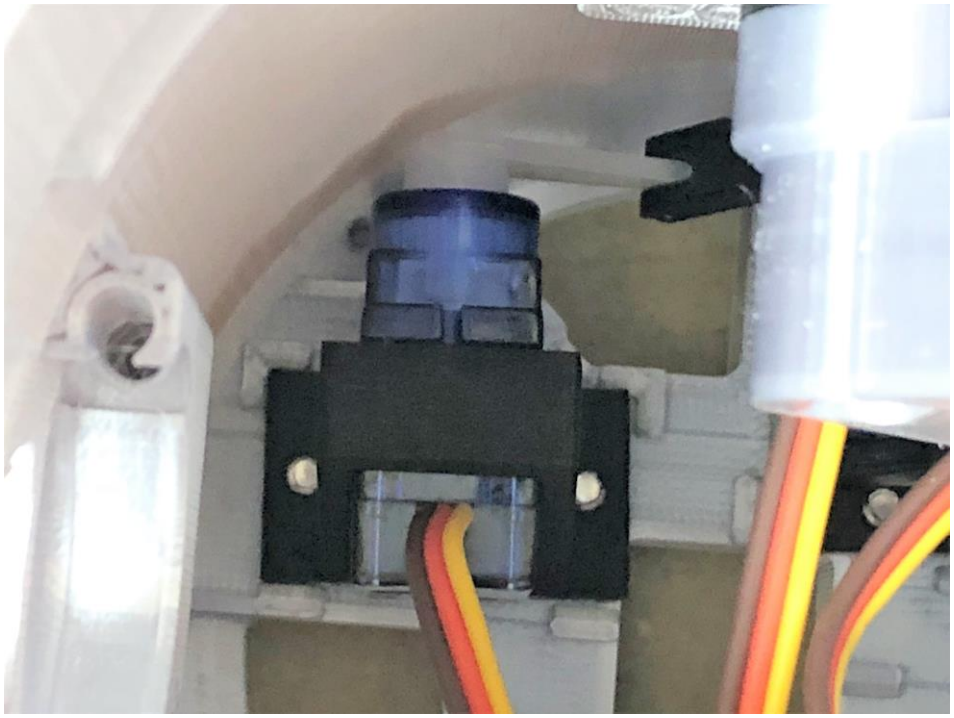
### 7.6.6 Fin mechanism installation S1-S5

The next mechanism will be inserted through the “S5” hole.



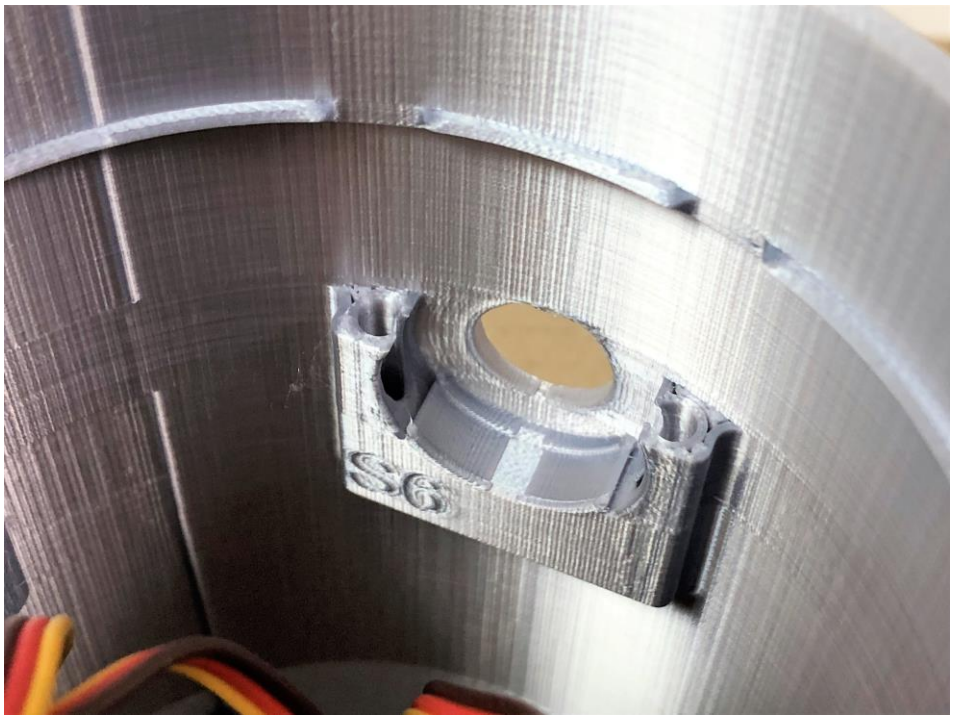
Take one of the fin mechanisms, and insert the tip of the hub through the hole with the label “S5”. Check that the rotation servo is correctly seated, then secure the ball bearing using one bearing holder and two M3x30mm screws like you did for the first mechanism. Make sure that the ball bearing is pushed against the segment wall.

Place a bracket on top of the servomotor. Insert two M3x8mm screws through the back of the segment using the holes on both sides of the label “S1”. Tighten the screws until the servo is secured to the segment.

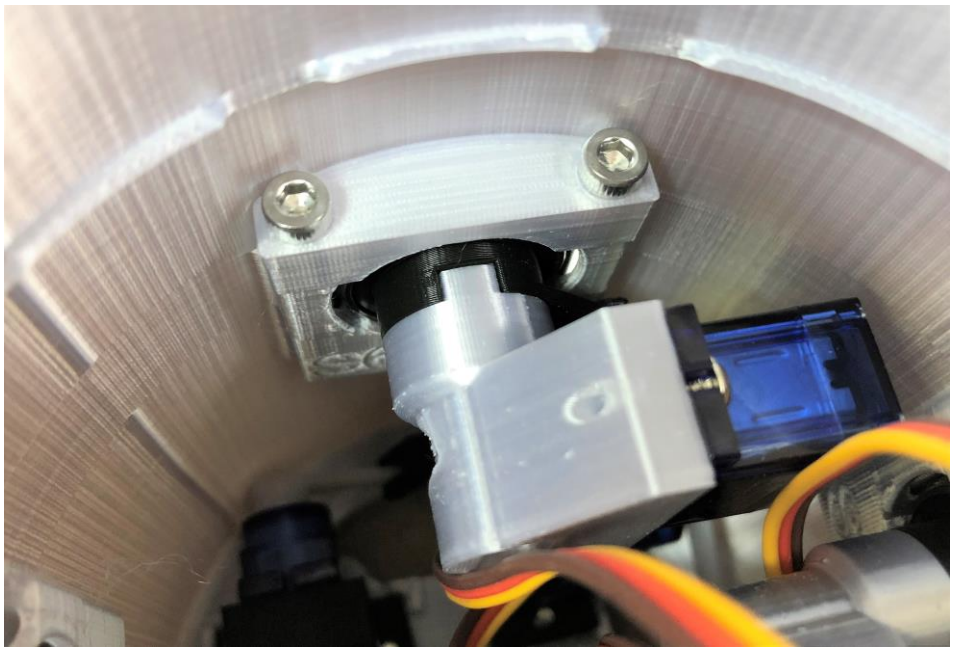
### 7.6.7 Fin mechanism installation S2-S6

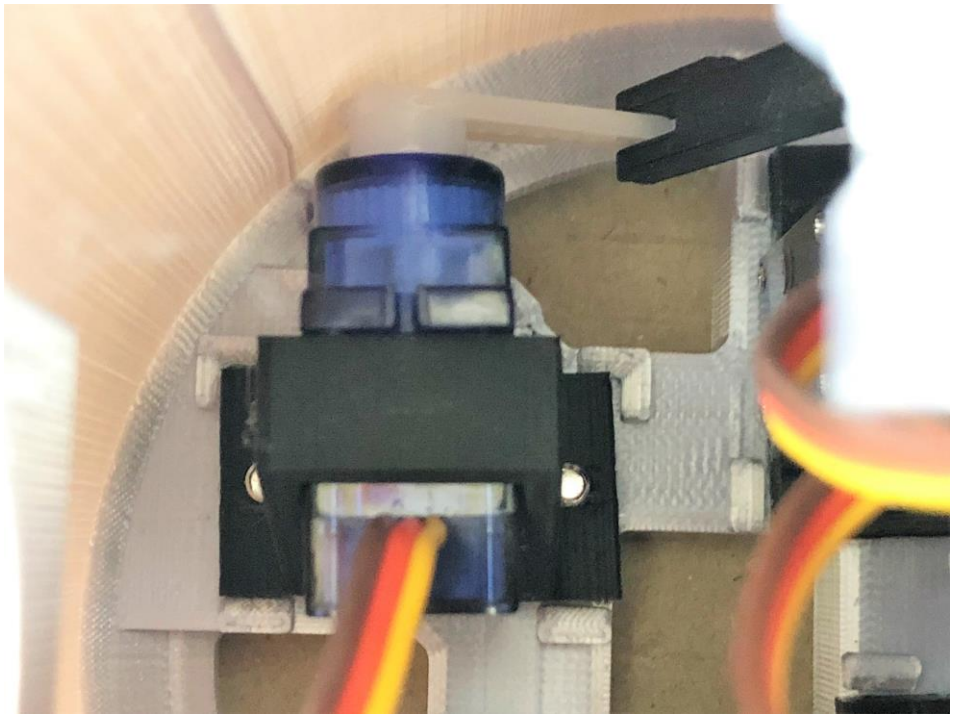
The next mechanism will be inserted through the “S6” hole.



Take one of the fin mechanisms, and insert the tip of the hub through the hole with the label “S6”. Check that the servo is correctly seated, then secure the ball bearing using one bearing holder and two M3x30mm screws like you did for the first mechanism.

Place a bracket on top of the servomotor. Insert two M3x8mm screws through the back of the segment using the holes on both sides of the label “S2”. Tighten the screws until the servo is secured to the segment.

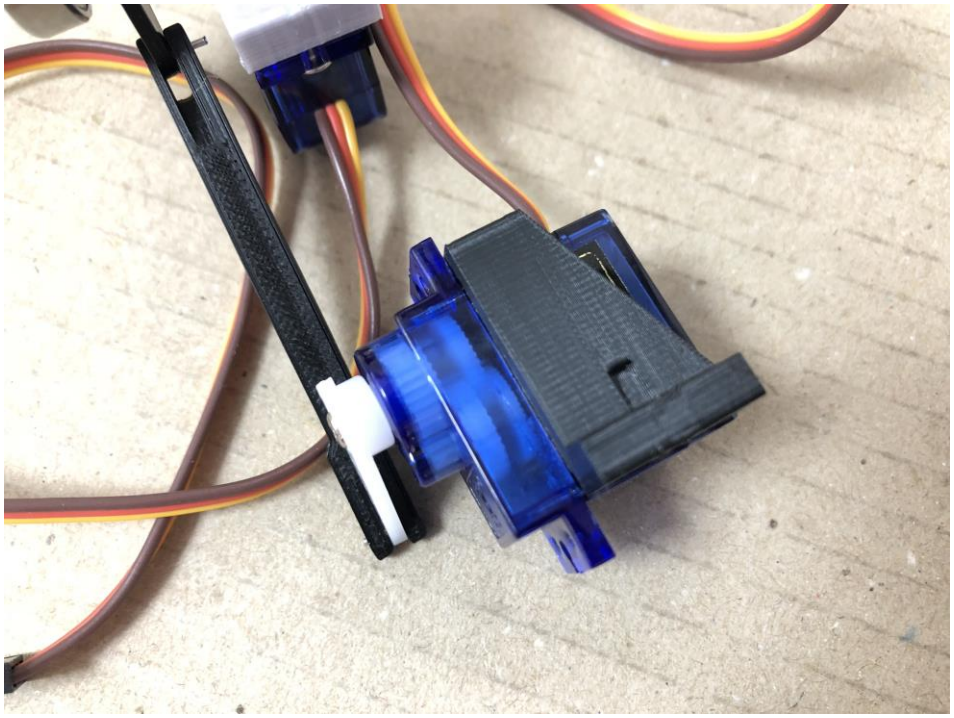


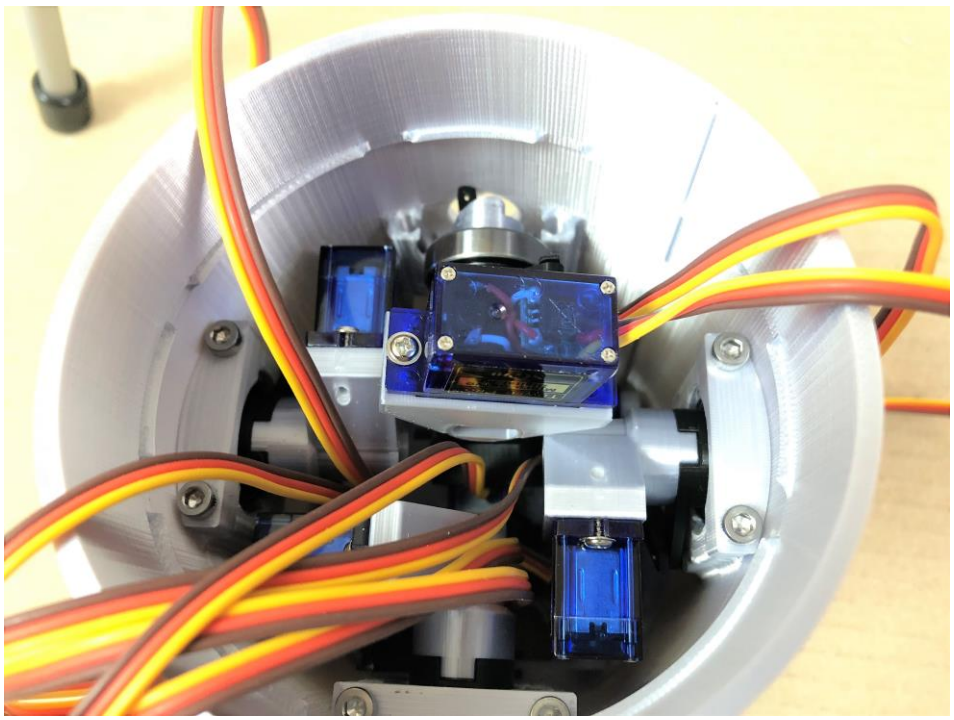


### 7.6.8 Fin mechanism installation S3-S7

Take the last fin mechanism, and place the servo bracket on the rotation servo. Carefully insert the servomotor into the hull segment, and place the hub like in the photo below.

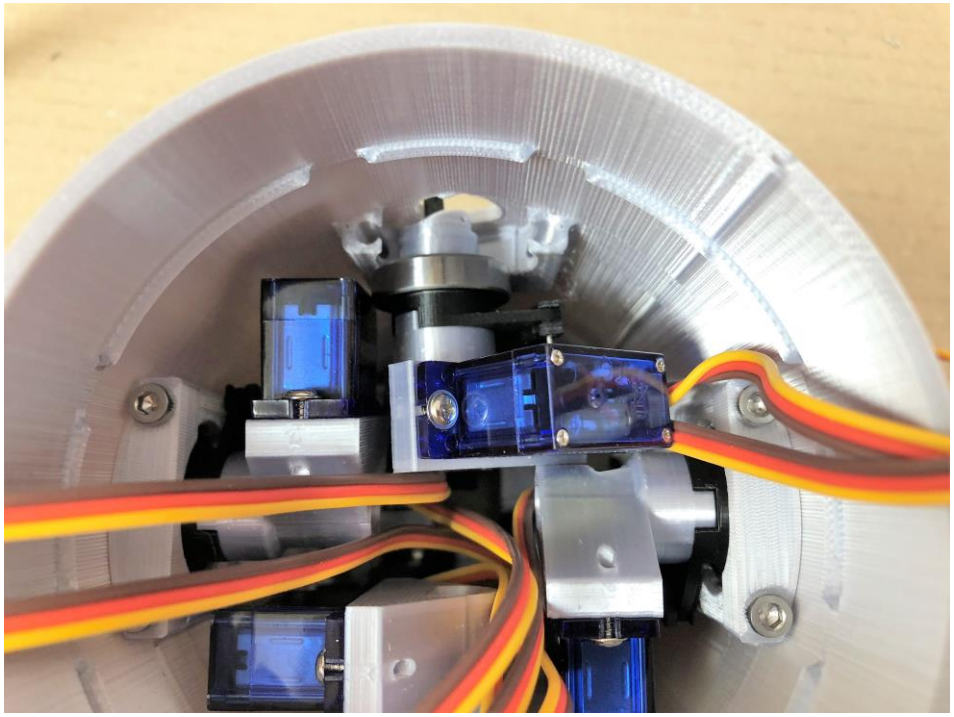
This part is tricky! Take your time.

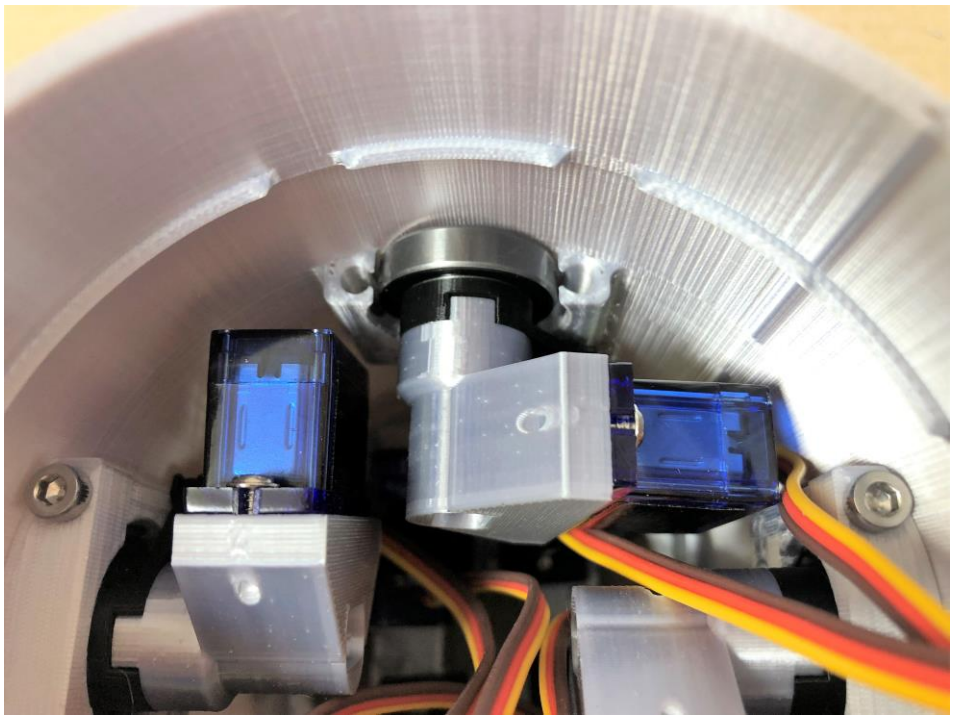


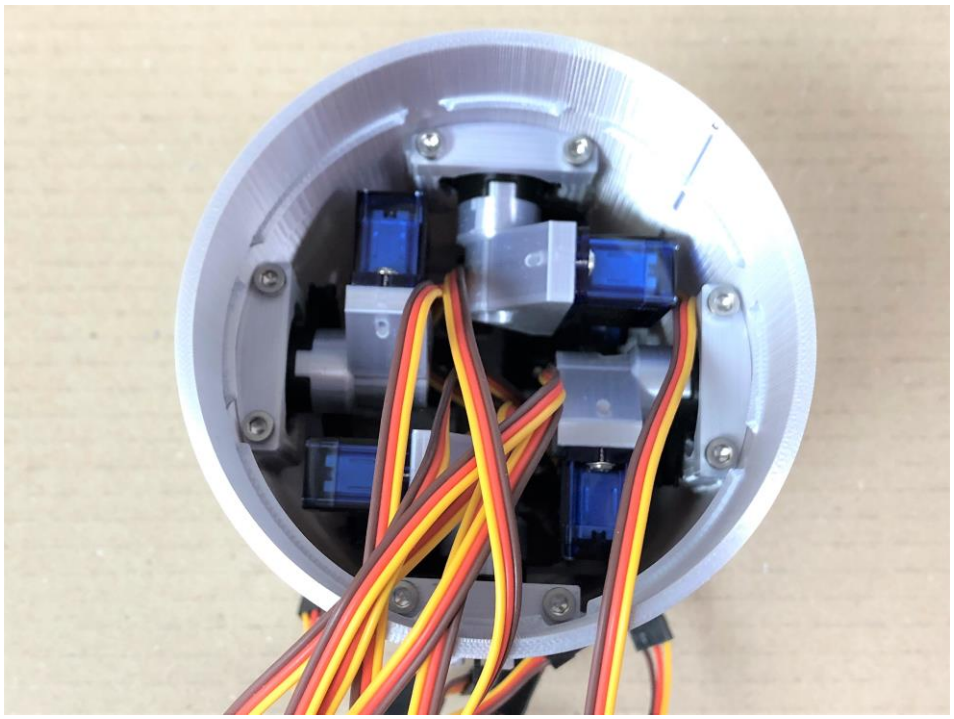


Gently push the servomotor to the left while rotating the hub. When the servomotor is at the correct location, finish inserting the hub into the hull segment and secure the bearing using a bearing holder and two M3x30mm screws.

Finally, secure the servomotor by inserting two M3x8mm from the back of the segment on both sides of the label “S3”.

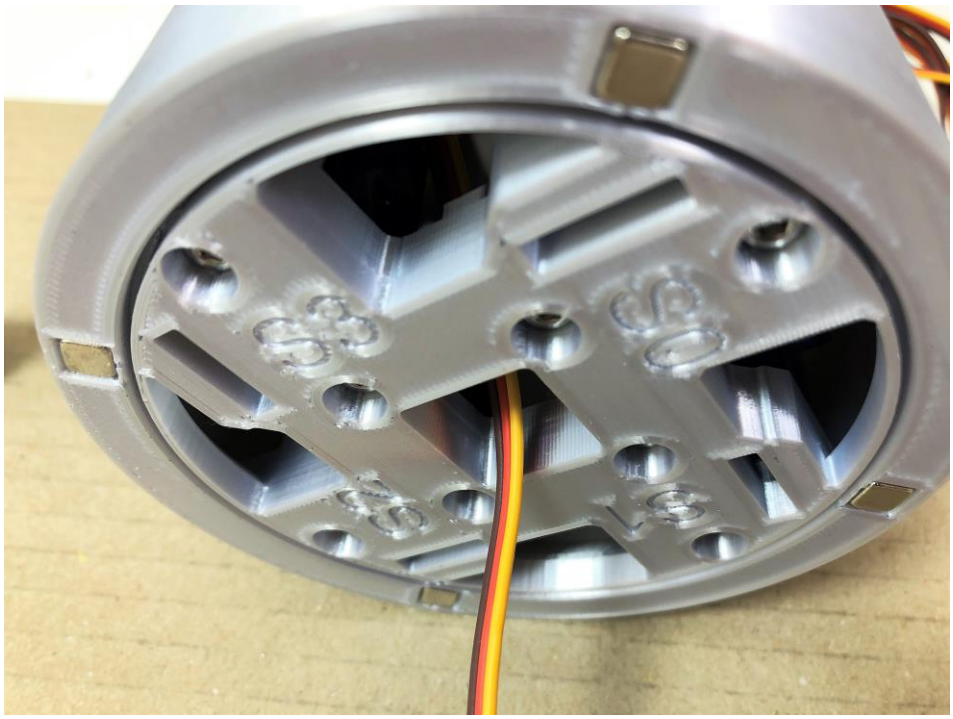


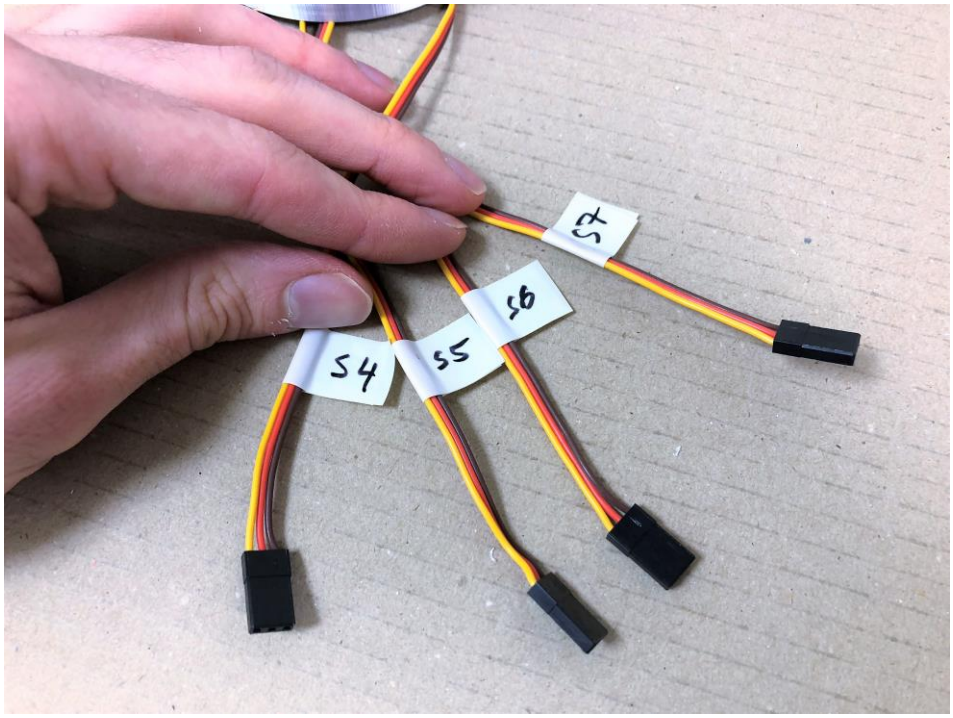




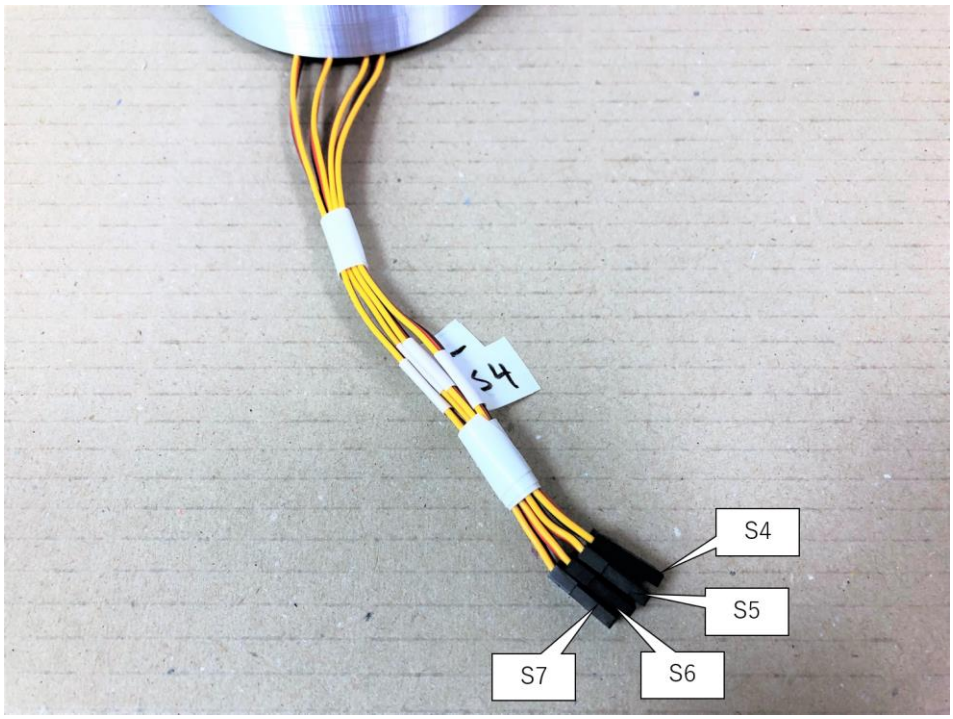
### 7.6.9 Labelling the wires

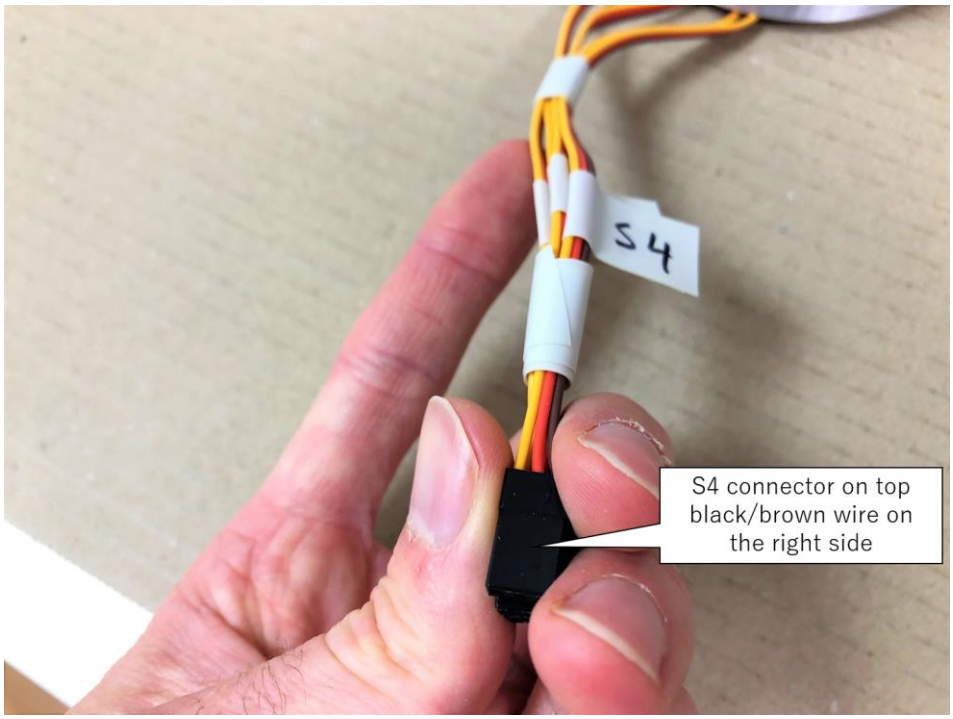
Locate the hub inserted in the hole with the label “S4”. Draw the wire of the servo attached to the hub through the hole at the bottom of segment. Using the white vinyl tape and the black marker, label the wire “S4”. Do the same for the three other hubs, labeling the wires, S5, S6 and S7.





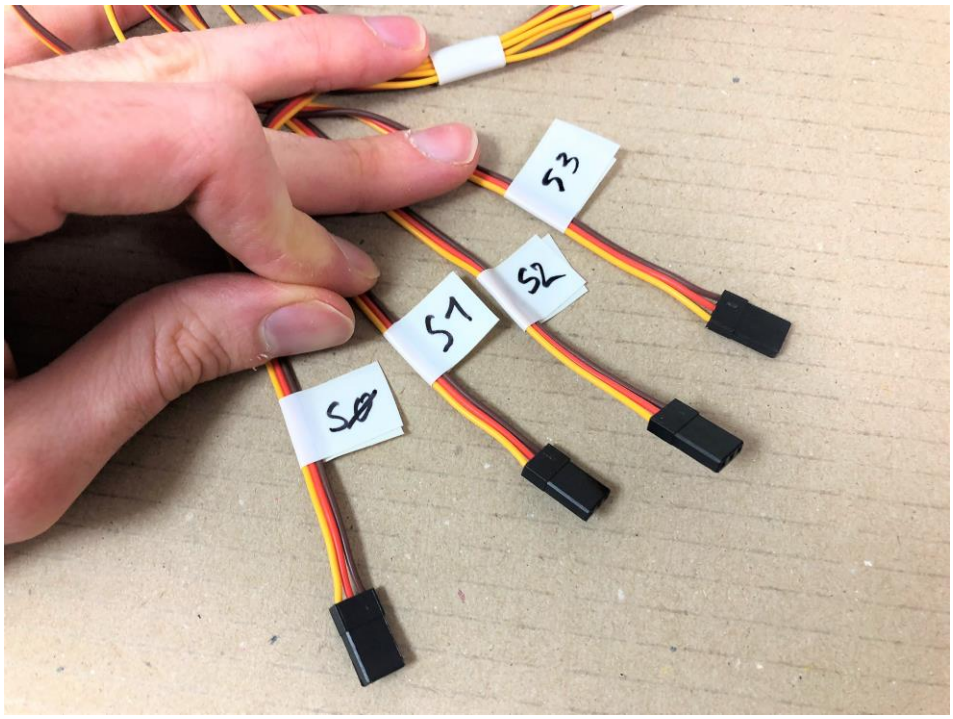
Using tape, bundle the 4 wires together. Place the connectors in the order S4, S5, S6, S7. Orient the connectors like in the photos below.

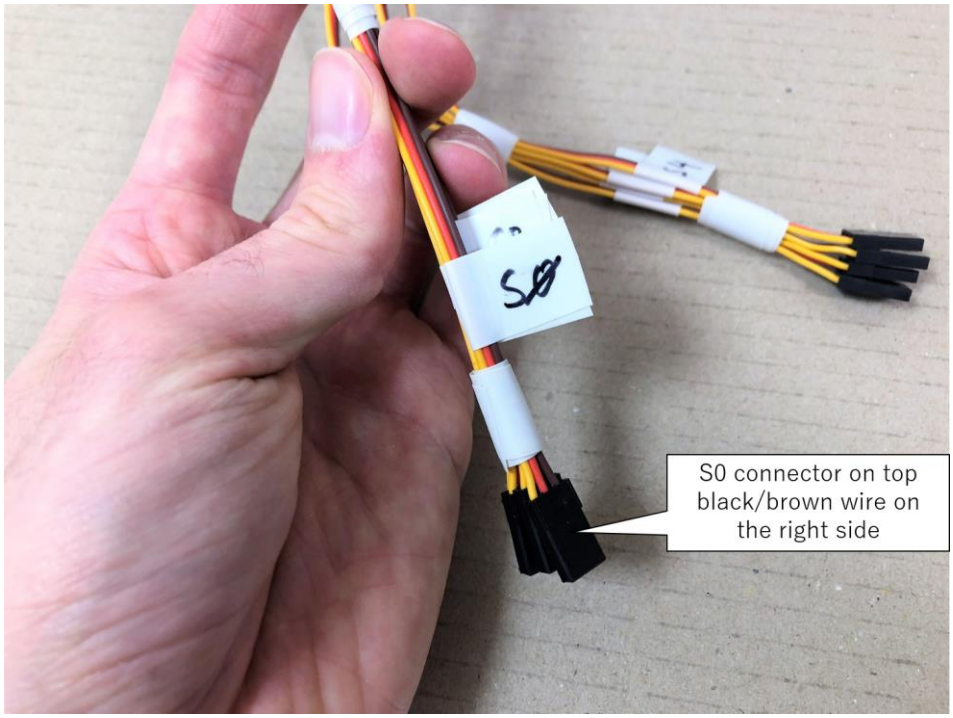


Locate the servomotor secured at the S0 location. Draw the servomotor wire through the center hole, then label the wire “S0”. Do the same for the three other servomotors, labeling the wires S1, S2 and S3.

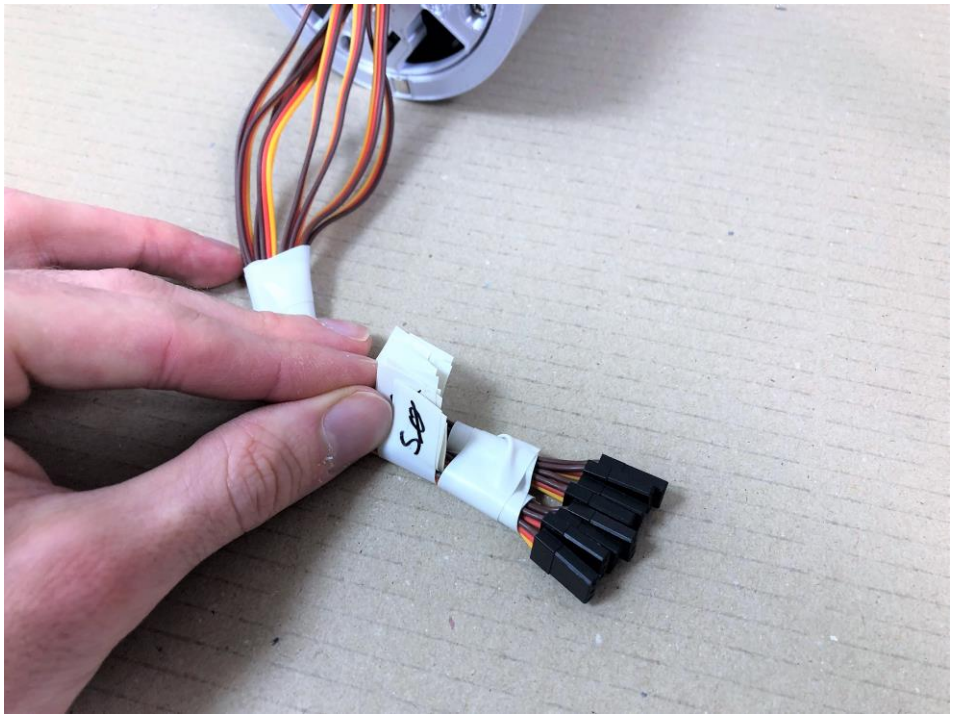
Using tape, bundle the 4 wires together. Place the connectors in the order S0, S1, S2, S3. Orient the connectors like in the photos below.

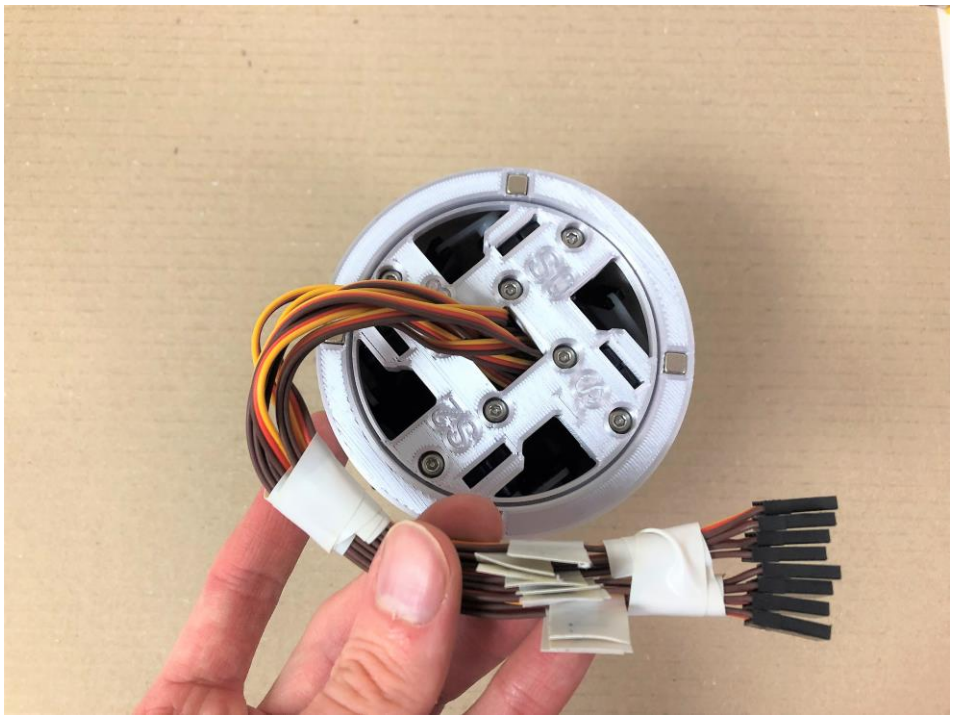


Finally, bundle all the cables together. Make sure to have the connector S3 next to the connector S4. Do not wrap tape too close to the hull segment, as this would prevent the hubs from rotating.

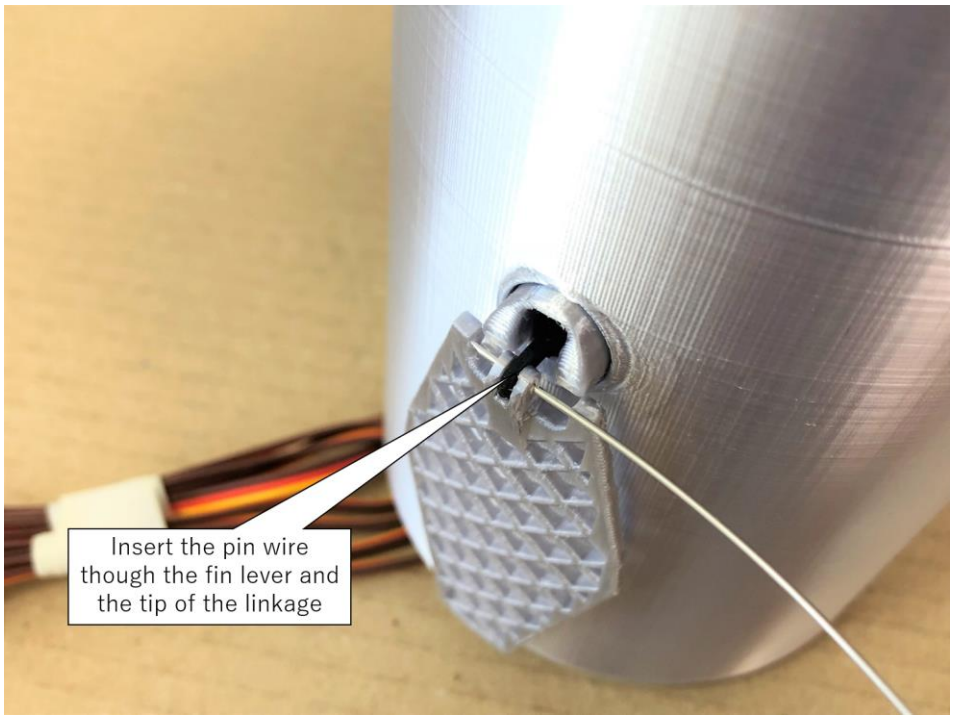
*Bundling the wires is not just for aesthetic. Messy wires prevent air from flowing through the rocket, resulting in the engines LEDs overheating.*

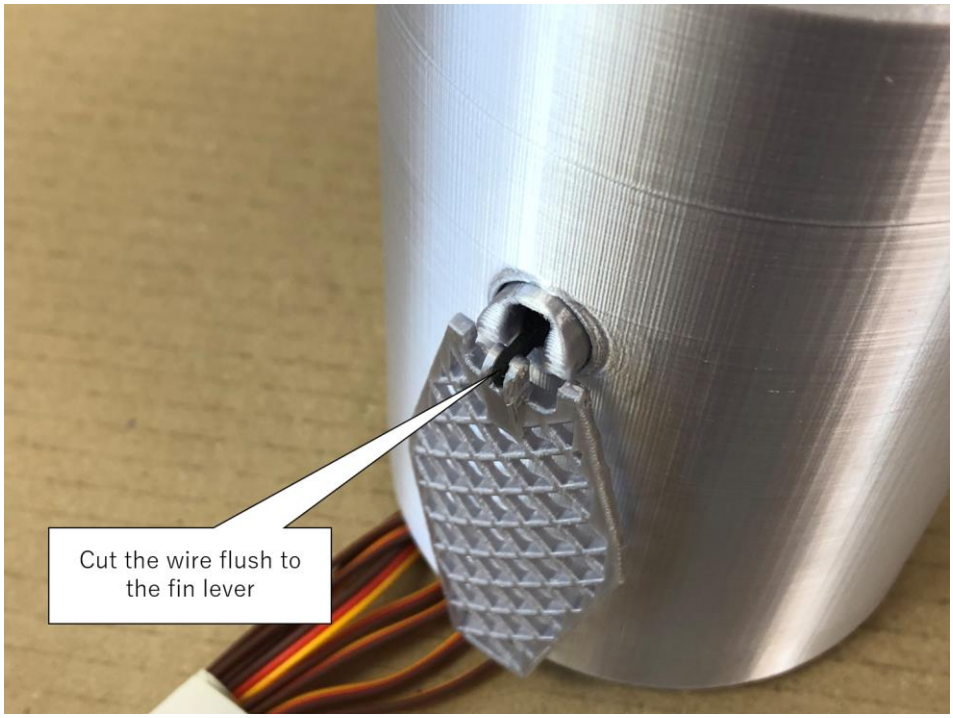




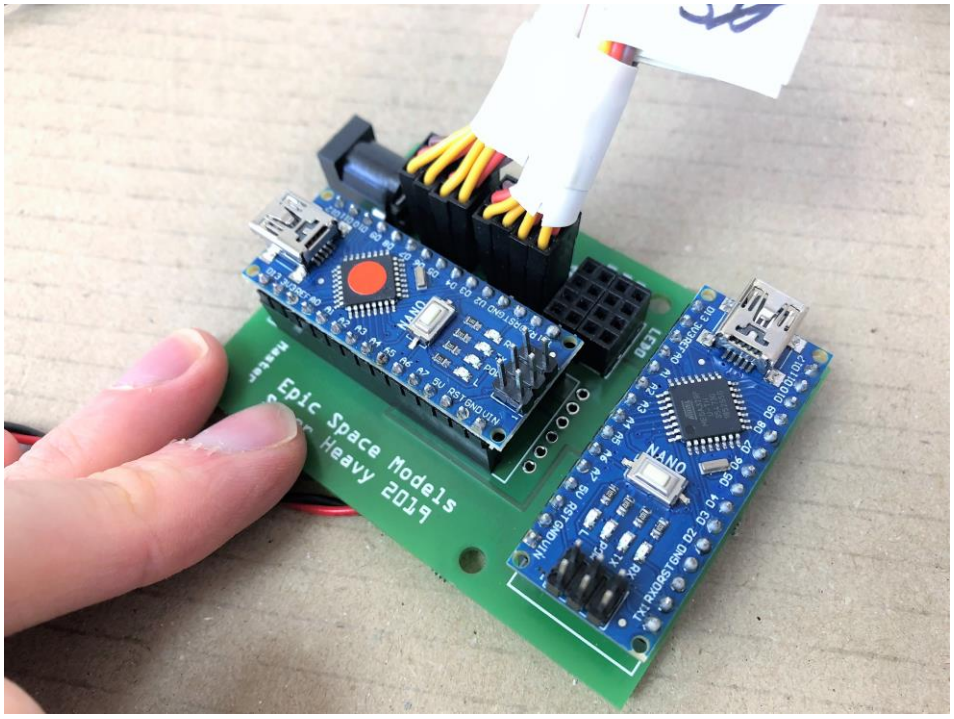
### 7.6.10 Fins installation

Take the 4 fins. Using the pin wire, connect the fin levers to the folding linkages. First, insert the wire through one side of the fin lever, then guide the wire through the tip of the folding linkage and through the other side of the lever. Finally, use the wire cutters to cut the wire sticking out on both sides of the fins. Do not connect the fin to the hub yet.



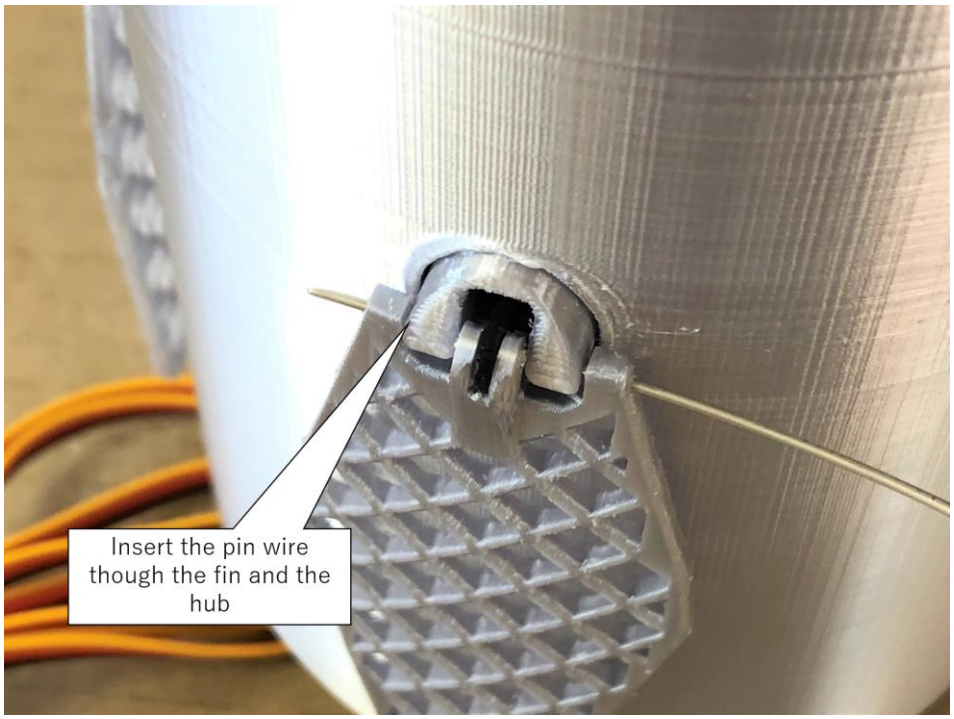
Before connecting the fins to the hubs, we need to set the folding linkages to their startup position. Connect the servomotors to the control board. Make sure to match the labels of the wires with the labels of the control board. The black/brown wire must be closest to the board edge.

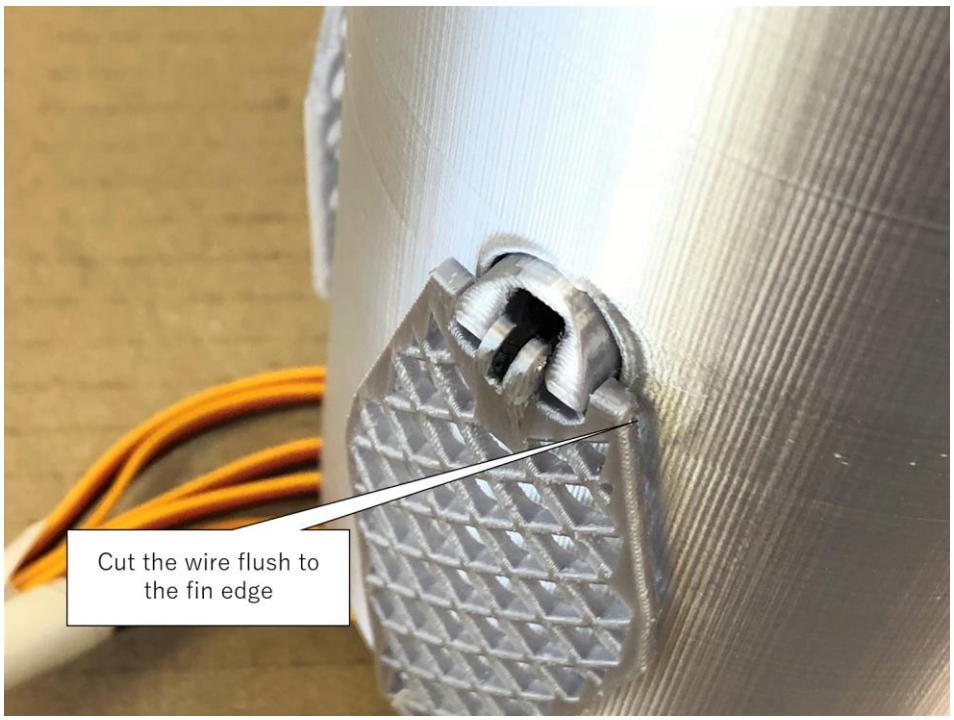



Power up the control board. The servomotors will move for a fraction of a second then stop at their default position. Once the servomotors stop moving, wait 4 seconds then power off the control board (disconnect the DC power adaptor). If you wait more than 10 seconds the servomotors will start moving continuously. In this case, power off the board and start again.

**On power up, the folding linkages will retract a few millimeters inside the hubs.**

Now, use the pin wire to connect the 4 fins to their hubs. Carefully guide the wire through the hole on the side of the fin, then through the hole in the hub. Once you are halfway through, keep pushing the wire into the hole on the other side of the hub. When you exit on the other side of the hub, align the fin so that the wire goes through the hole in the other side of the fin. Finally, use the wire cutters to cut the wire.



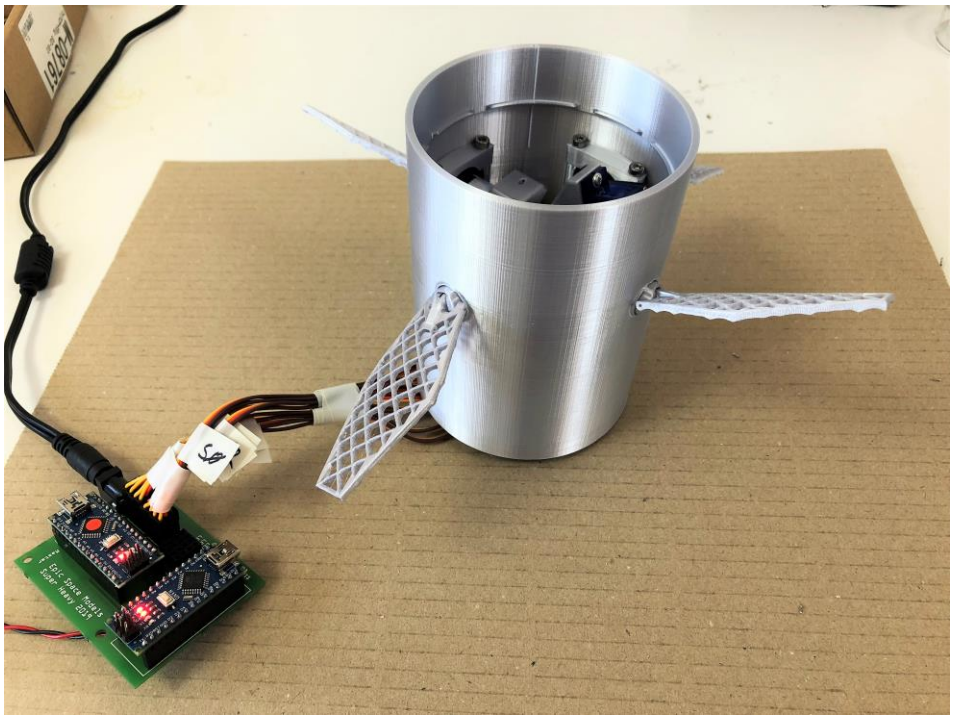
### 7.6.11 Testing

Power up the control board. After 10 seconds, the fins will unfold and rotate around the hub axis for a while. Once the fins fold again, power off the control board. Make sure to wait until the fins are folded to power off the control board. Having the fins folded will reduce the risk of damaging them during the final assembly.

Since the fins are not calibrated yet, you will probably get something asymmetrical like the photo below. Precise calibration of the fins is done by connecting the control board to a PC aand using the Superheavy Control software.

Since the servomotors are already connected the control board, you can choose to calibrate the fins now, or once the assembly is finished.

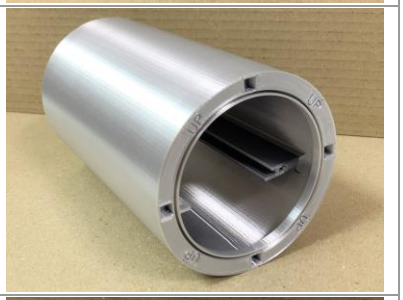
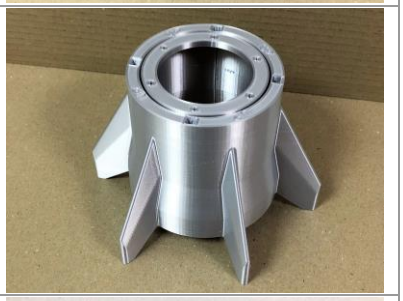
- If you wish to calibrate the fins now, go to section 8. When the calibration is done, proceed to section 7.7.
- If you want to finish the assembly before calibrating the fins, disconnect the servomotors from the control board and proceed to the next step.

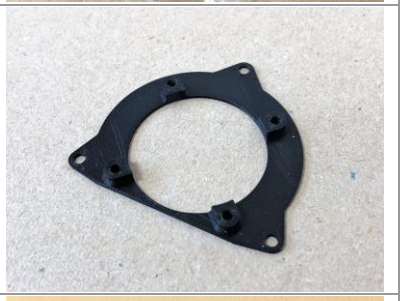
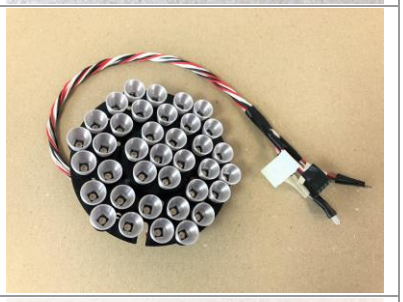


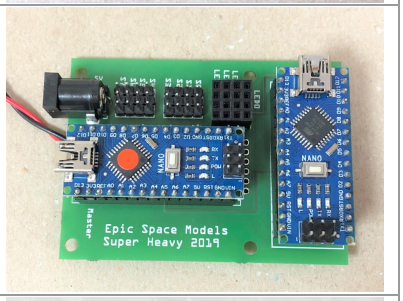
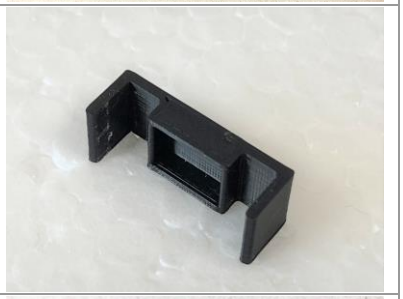
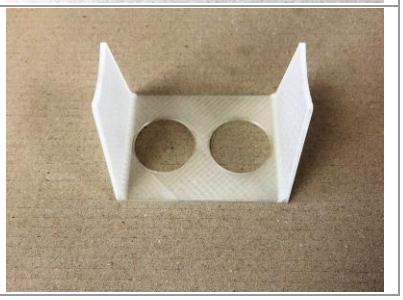
## 7.7 Final assembly

### 7.7.1 Parts & tools preparations

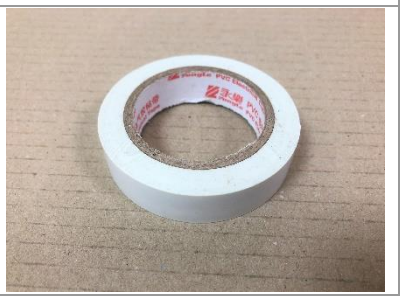
Prepare the following parts

| Part | Number of parts | Photo |
|---|---|---|
| **Hull segment 1** | 1 |  |
| **Hull segment 2/3** | 2 |  |
| **Hull segment 4** | |  |
| **Hull segment 5** | 1 |  |
| **Servo cable extension** | 8 |  |

| | | |
|---|---|---|
| Fan | 1 |  |
| Fan mount | 1 |  |
| Engine cluster | 1 |  |
| USB cable | 1 |  |
| M3x8 screw | 8 |  |
| M3x16 screw | 4 |  |

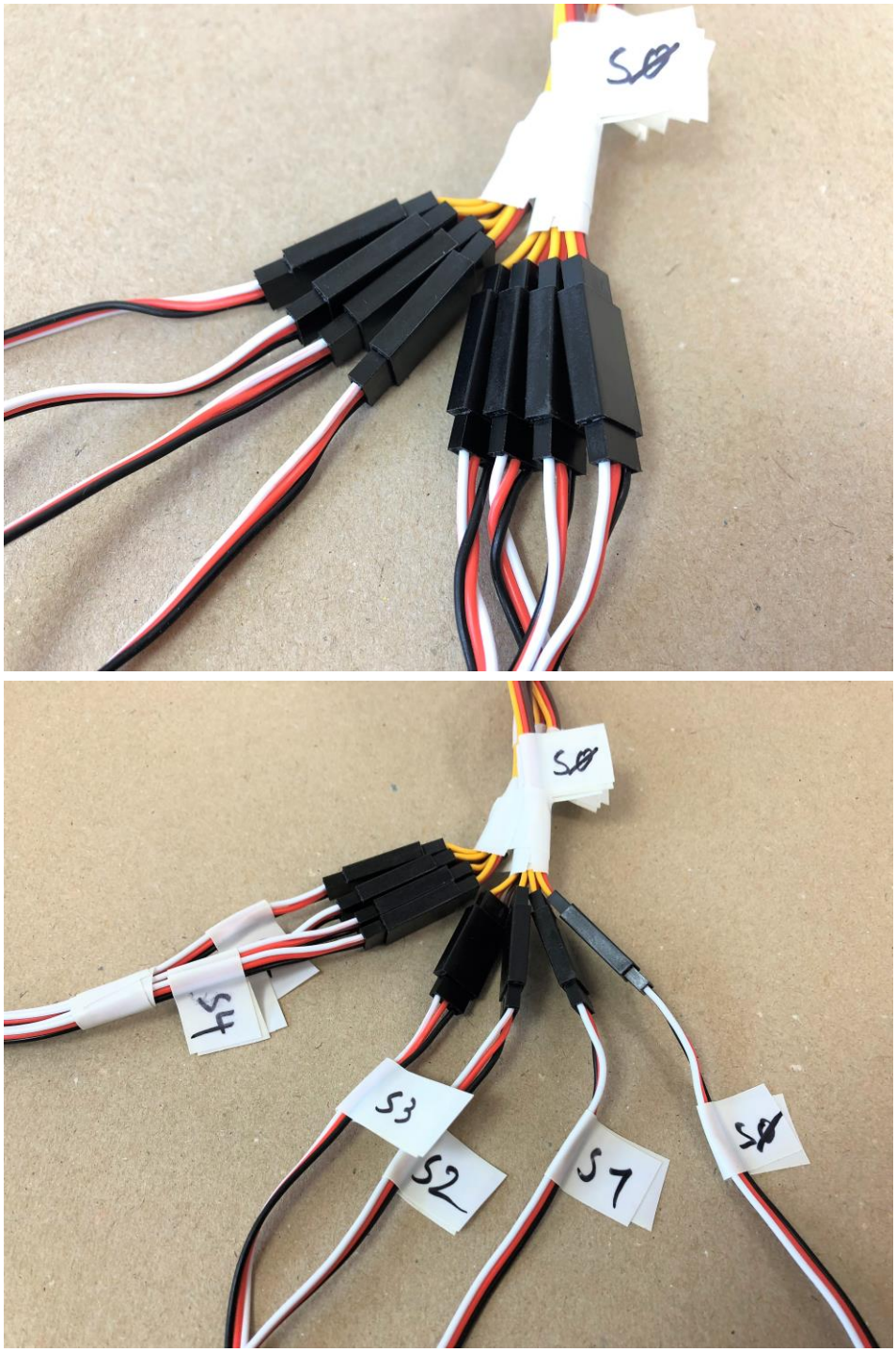
| | | |
|---|---|---|
| M3x30 screw | 3 |  |
| Seal | 4 |  |
| Control board | |  |
| Arduino LED cover | 2 |  |
| PCB lock | 1 |  |
| Horizontal stand | 2 |  |

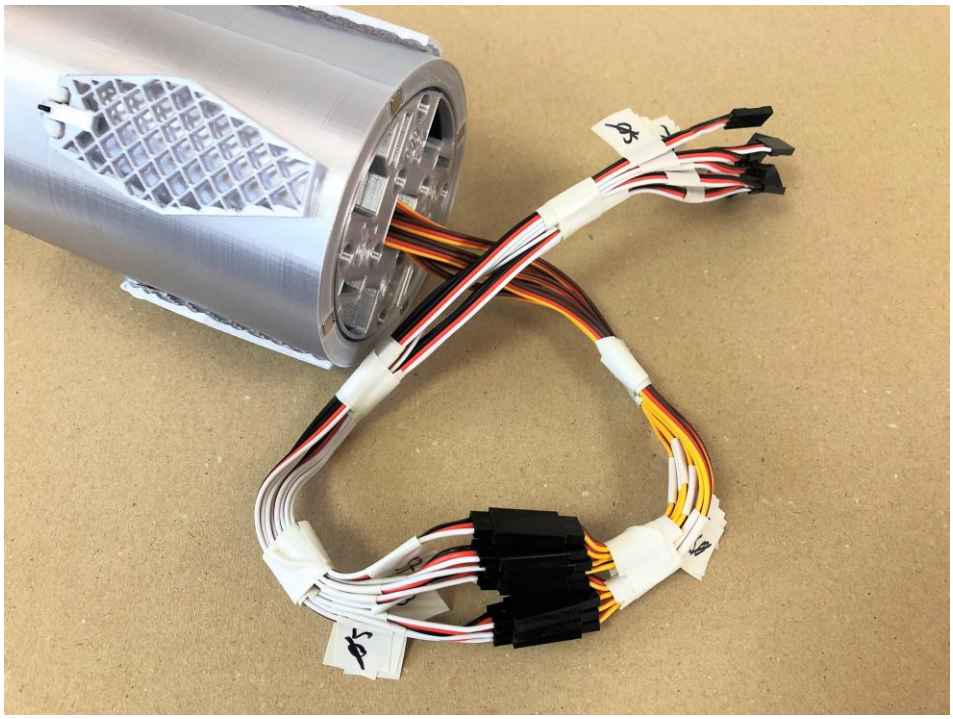
Prepare the following tools

| Part | Photo |
| --- | --- |
| 3mm drill bit |  |
| Hex key |  |
| Marker |   |
| White vinyl tape |  |

### 7.7.2 Servo cable extension

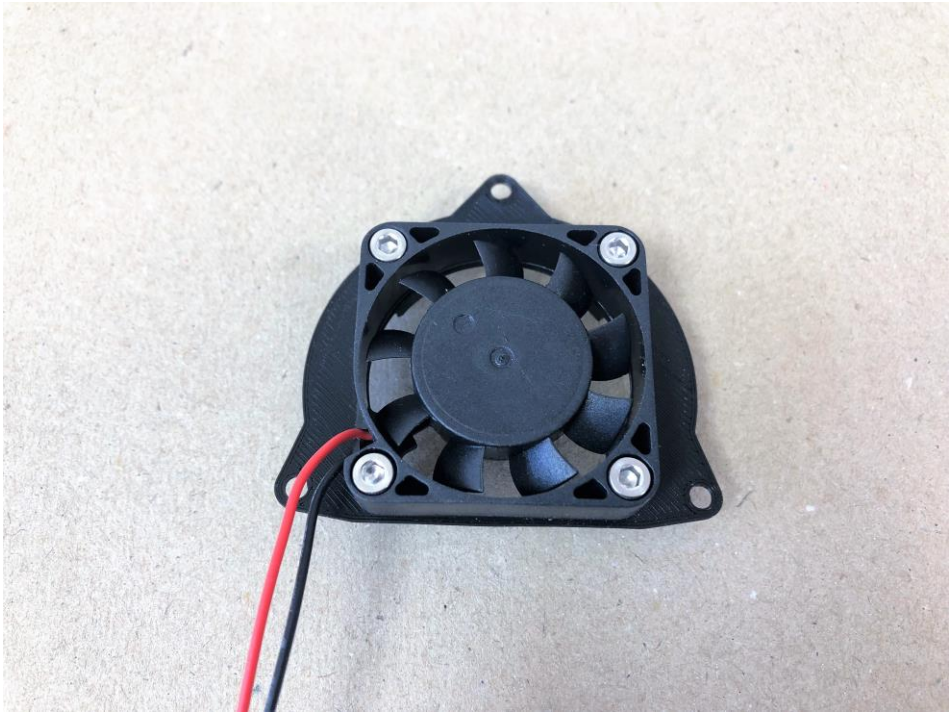
Take the servo extension cables. Connect one cable to each servomotor plug. Label The extension cables at both ends, matching the labels of the servo cables. Bundle the cables together like you did for the 8 servo cables.





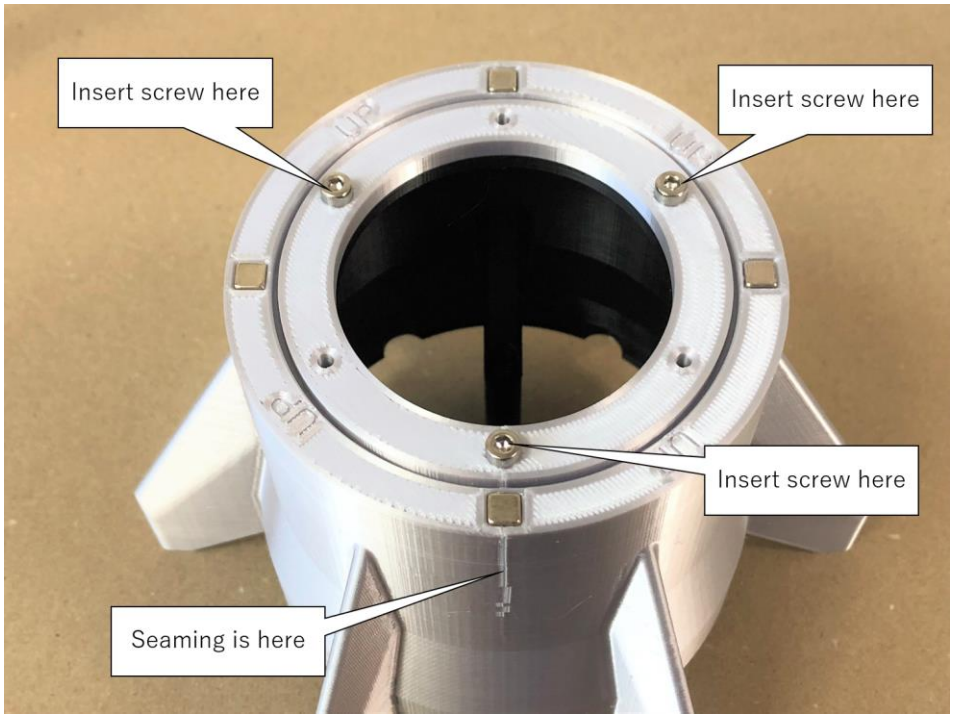
### 7.7.3 Fan assembly

Take the fan and the fan mount. Use 4 M3x16mm screws to bolt the fan to the fan mount. Pay attention to the orientation of the parts. The fan must be attached on the flat side of the fan mount. The fan label must be facing against the flat side of the fan mount.

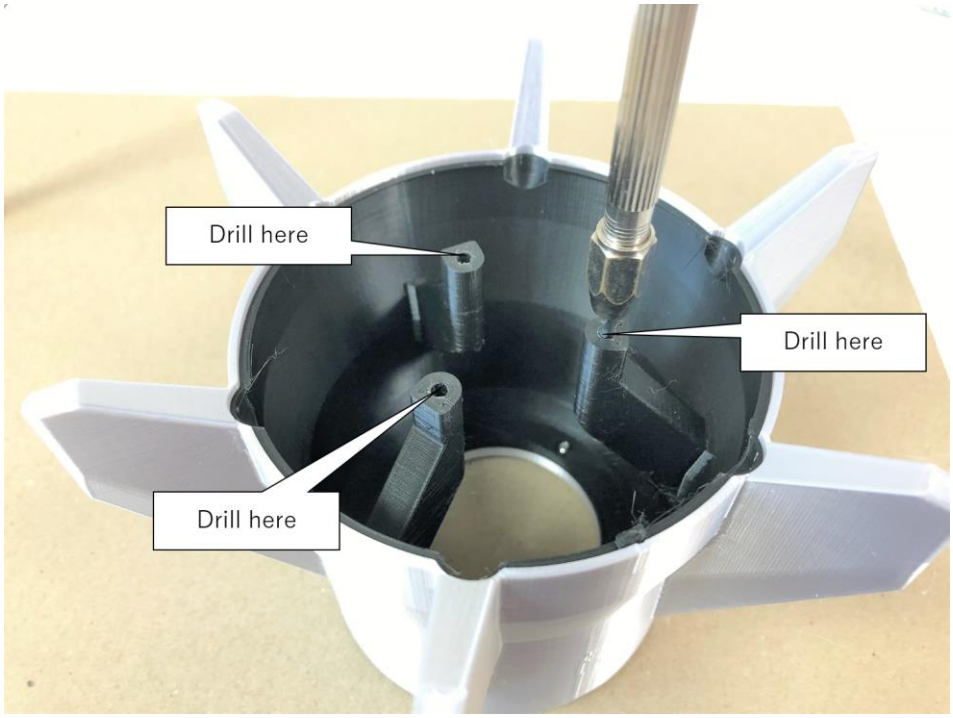


### 7.7.4 Engine block assembly

Take the hull segment 5 (the one with the fins). The segment has a black shade inside. Do not try to take it out. Place the hull segment vertically with the seaming towards you. Insert and tighten 3 M3x8mm screws at the locations indicated on the photo to secure the shade.



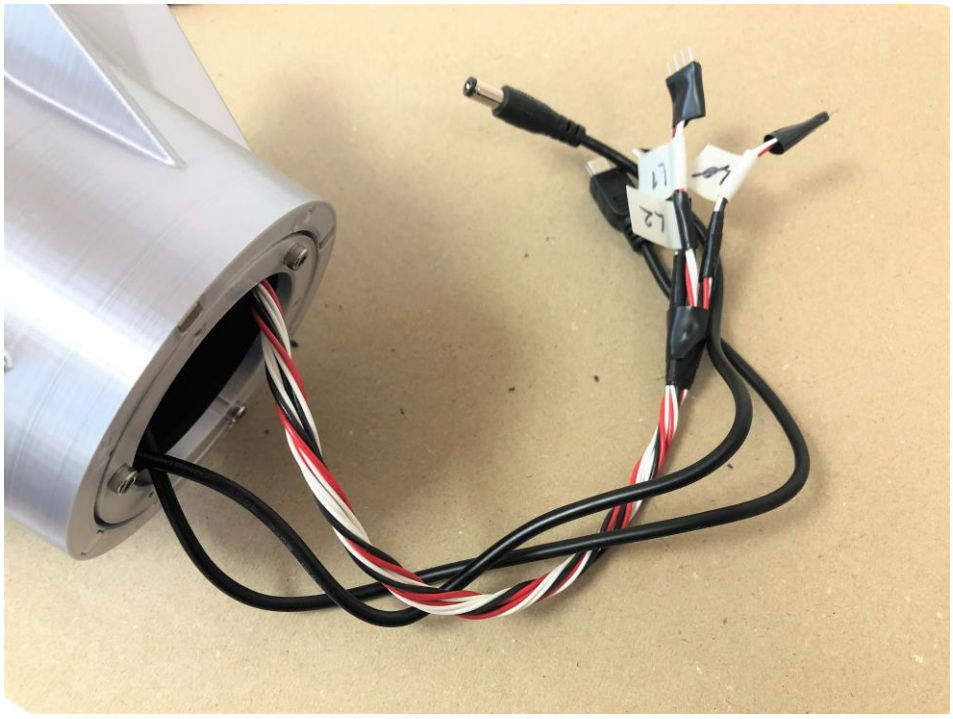
Flip the hull segment so that the fins are pointing up. Using the 3mm drill bit, drill through the 3 arms extending from the shade. Take one of the M3x30mm screws and check that the screw can go all the way through each hole.

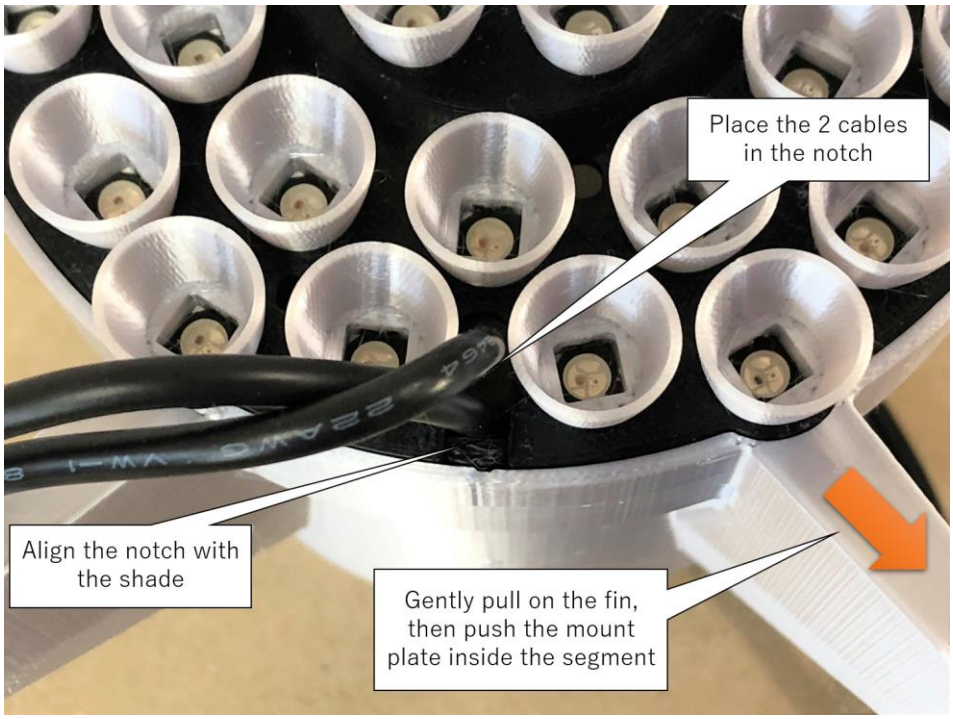


Take the USB cable and the DC power adaptor cable. Insert them inside the segment so that the round plug of the DC power adaptor and the small plug of the USB cable are on the side with the magnets.

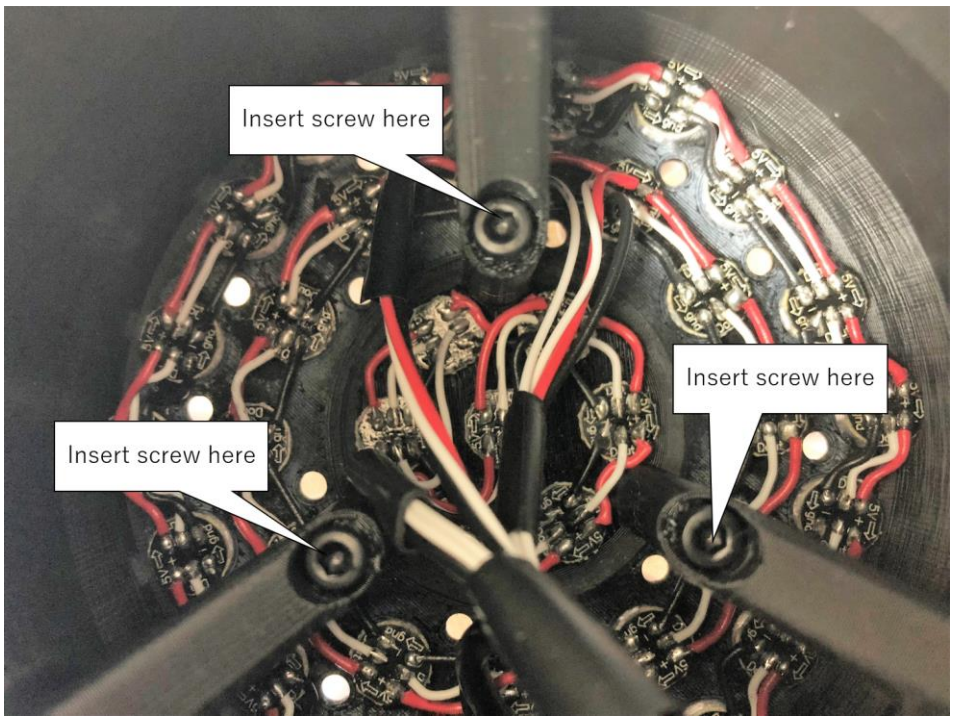
Insert the engine mount plate from the back of the segment. Drag the wire bundle of the engine pod out of the segment. Place the USB and DC adaptor cable in the notch of the engine pod, and align the notch with the matching part of the shade.

The LEDs of the 6 outermost engines extend slightly out of the mount plate. To get them inside the hull segment, gently pull on the fin to make room for the LED to go through, then push the mount plate inside the segment. Do this for the 6 fins one by one.

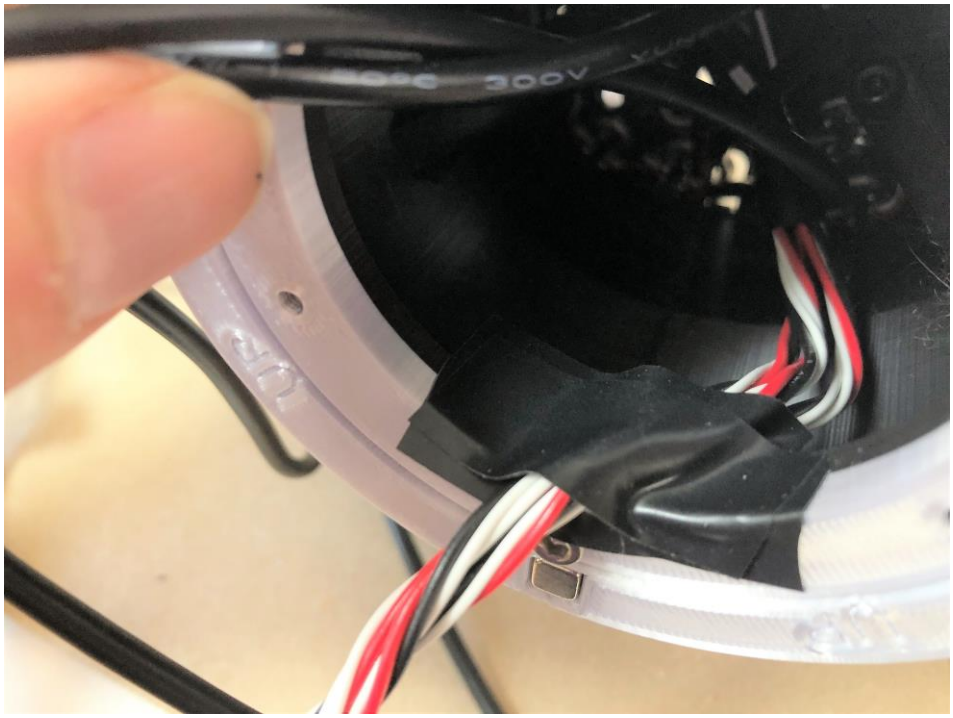


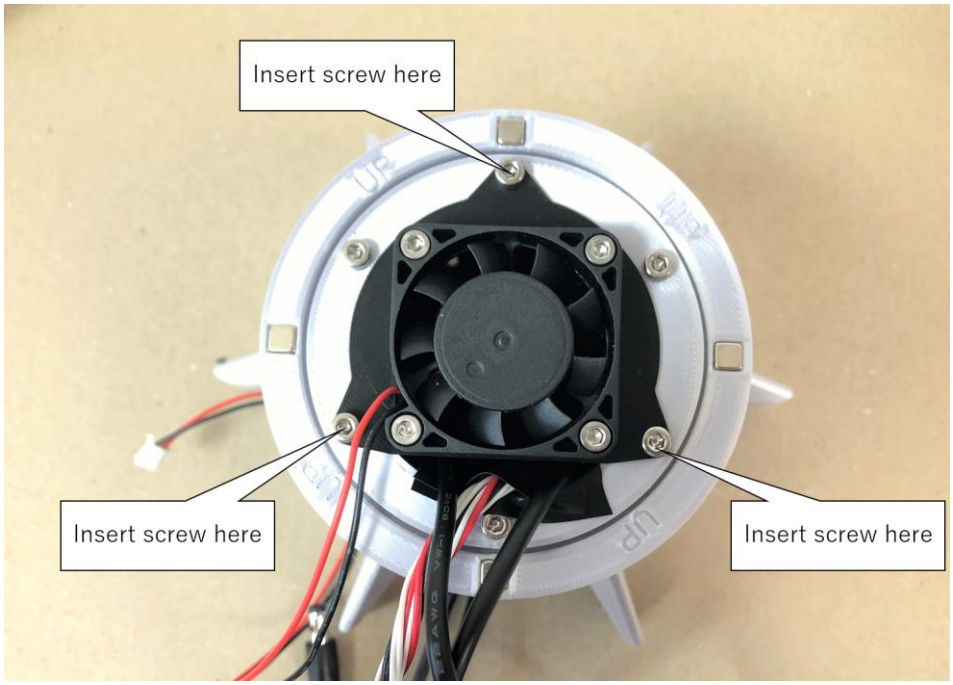

Place the 2 cables in the notch
Align the notch with the shade
Gently pull on the fin, then push the mount plate inside the segment

Using 3 M3x30mm screws, secure the engine mount plate to the shade. Make sure that no wire is pinched between the plastic parts.



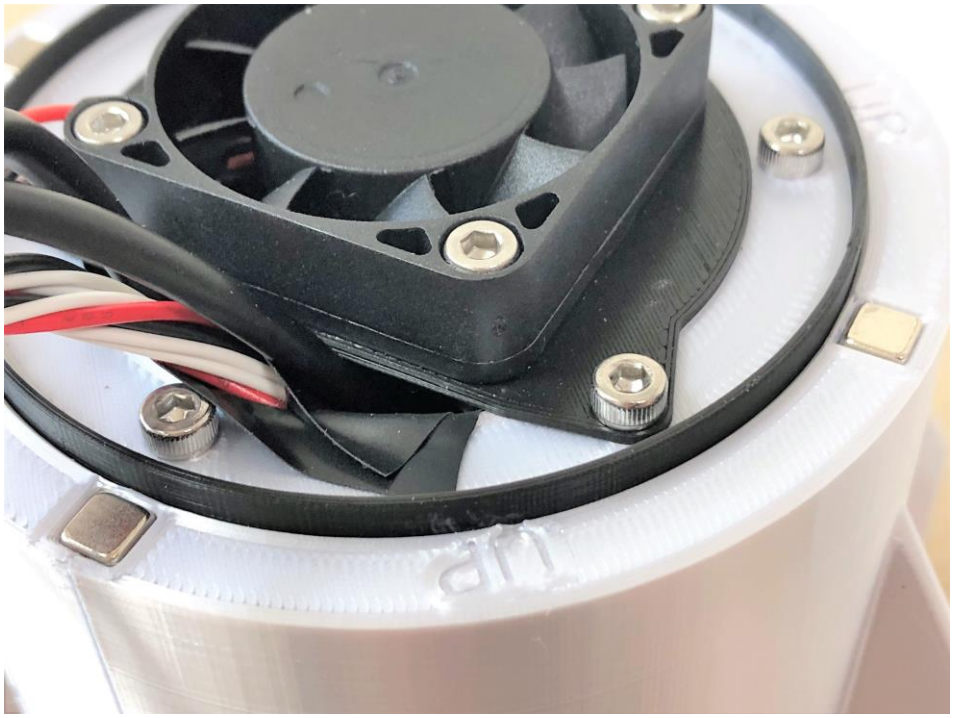
Adjust the length of the USB and DC power adaptor cables so that they have approximatively the same length as the cable bundle from the engine pod. Place the hull segment upward, with the seaming towards you. Use vinyl tape to attach the wire bundle of the LEDs to the segment ring. Using 3 M3x8mm screws, secure the fan mount on top of the hull segment. Place the USB cable and the DC adaptor cable on both sides of the LED wire bundle.



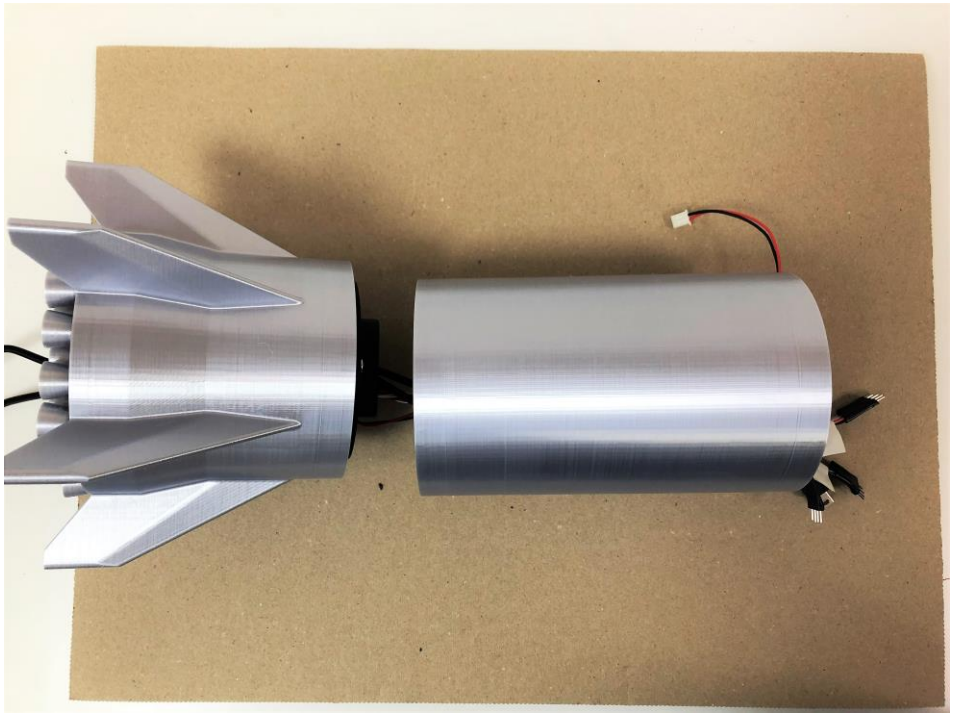


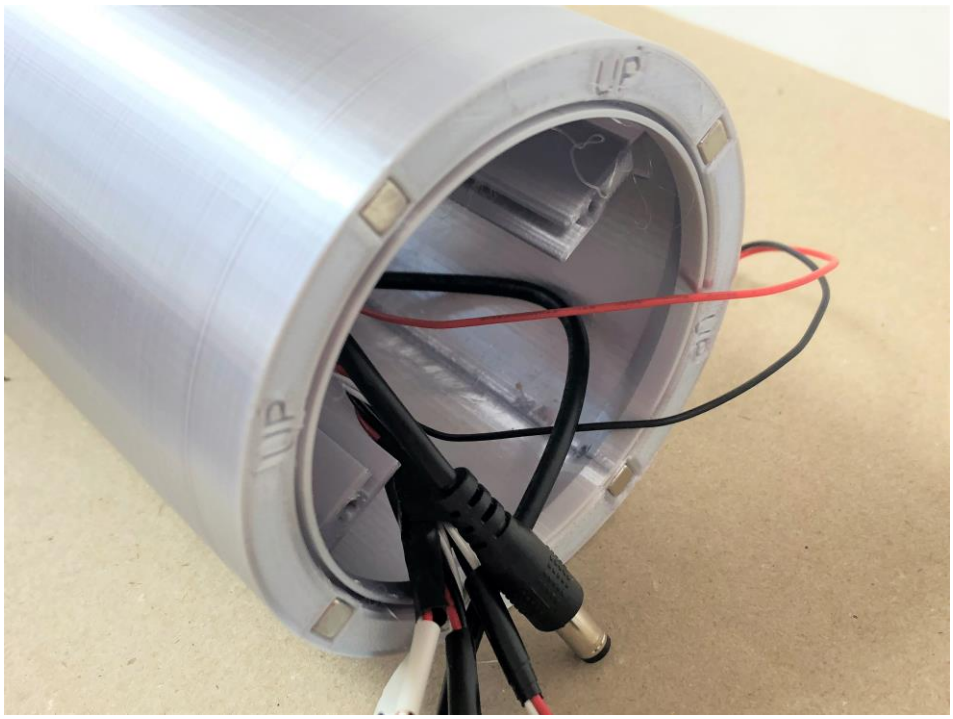
### 7.7.5 Engine block connection

Take one seal and insert it in the slit between the magnets of the engine block. Make sure that the seal is fully inserted in the slit. It should stick out about 3mm.



Place the hull segment 4 (the one with the rails inside) next to the engine block. Draw all the cables through the segment. Make sure that the cables are exiting the segment from the side that has the labels “UP” engraved.

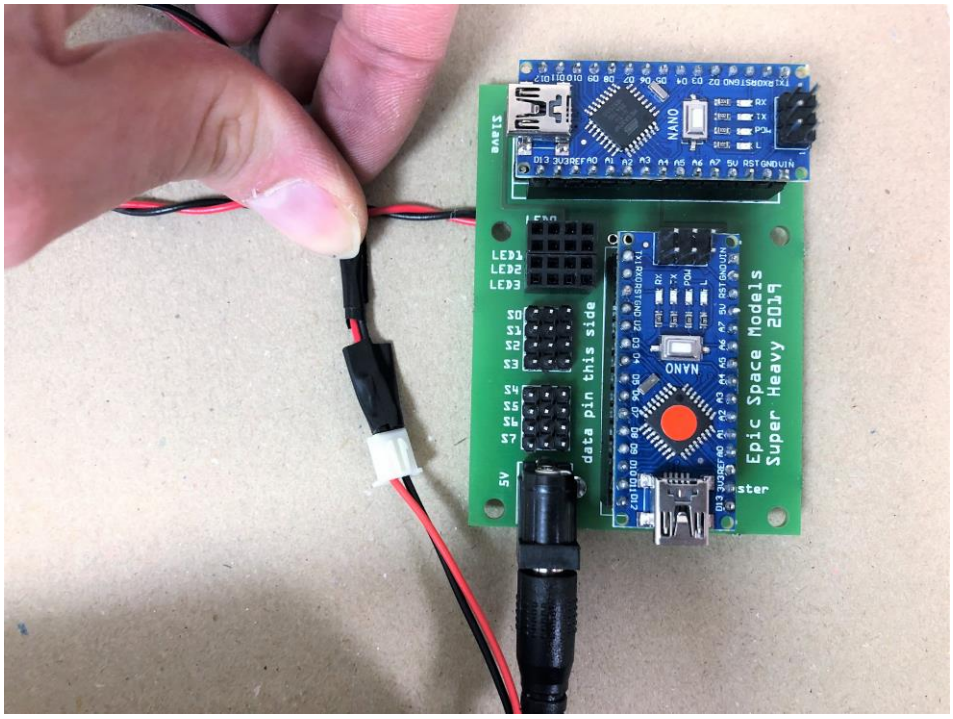




Take the control board. Connect the fan to the control board. Make sure to match the red and black wires. Connect the DC power adaptor cable to the control board. Connect the DC power adaptor to a wall outlet. After a few seconds, the fan should start rotating. Make sure that the fan is blowing air INSIDE the engine block. If this is not the case, check the orientation of the fan and the orientation of the connector.

The fan will periodically turn on and off. This is normal.

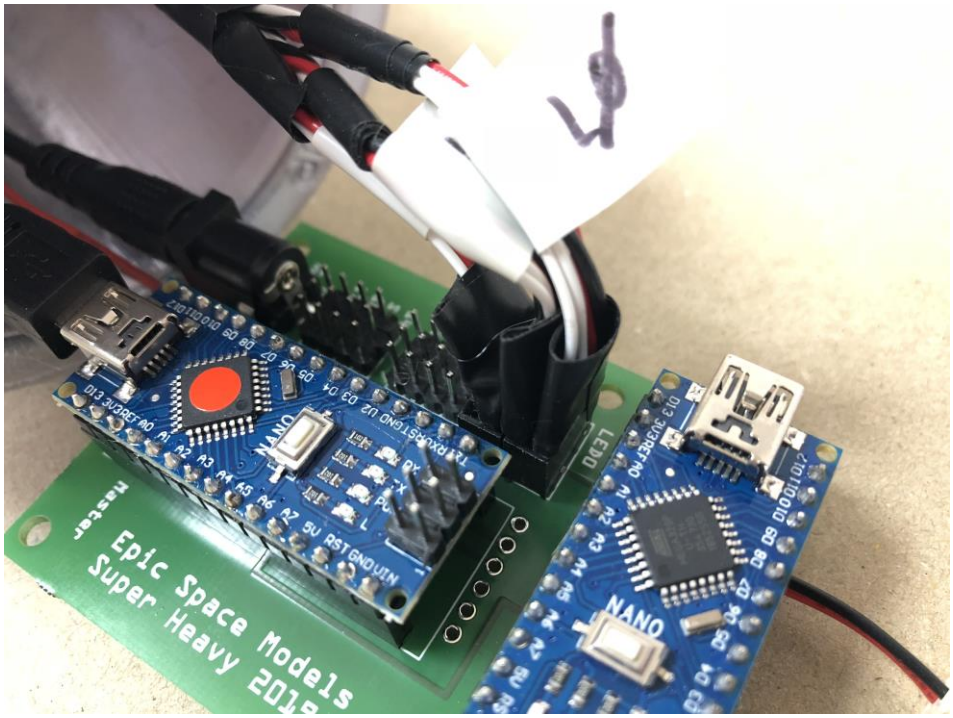
Once you have checked that the fan works, unplug the DC power adaptor from the wall outlet.

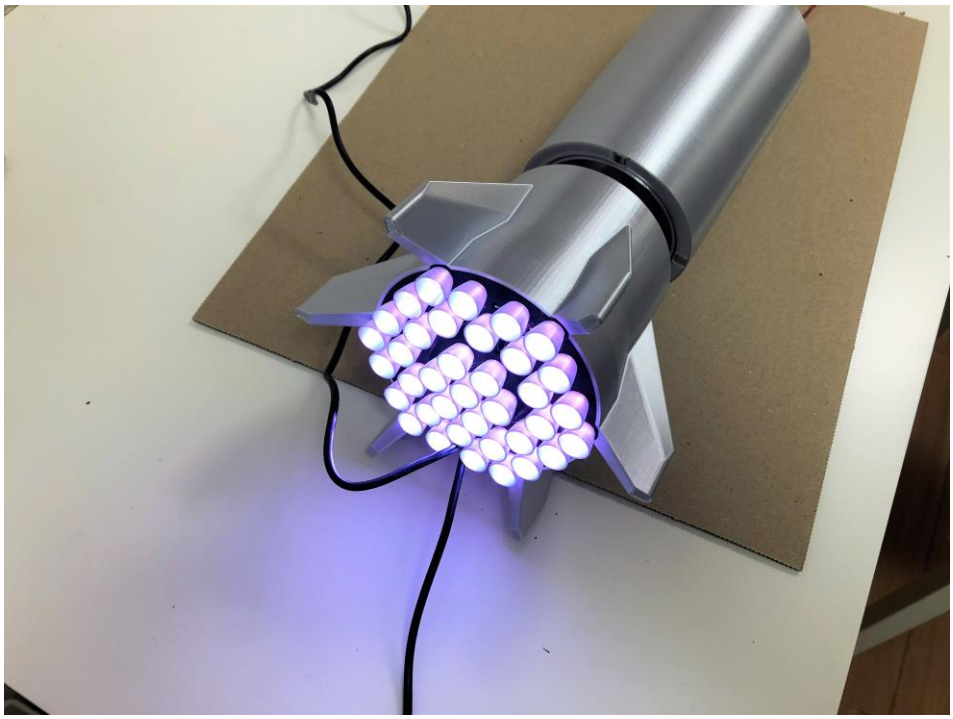


Connect the L0, L1 and L2 wire bundles to the LED0, LED1 and LED2 slots of the control board. The black cable must be towards the edge of the board. Connect the DC power adaptor cable to the control board, then connect the DC power adaptor to a wall outlet. Check that the engines light up.

The engines should light up in sequence: center cluster, ring 1, ring2.

When you are done, unplug the DC power adaptor from the wall outlet.

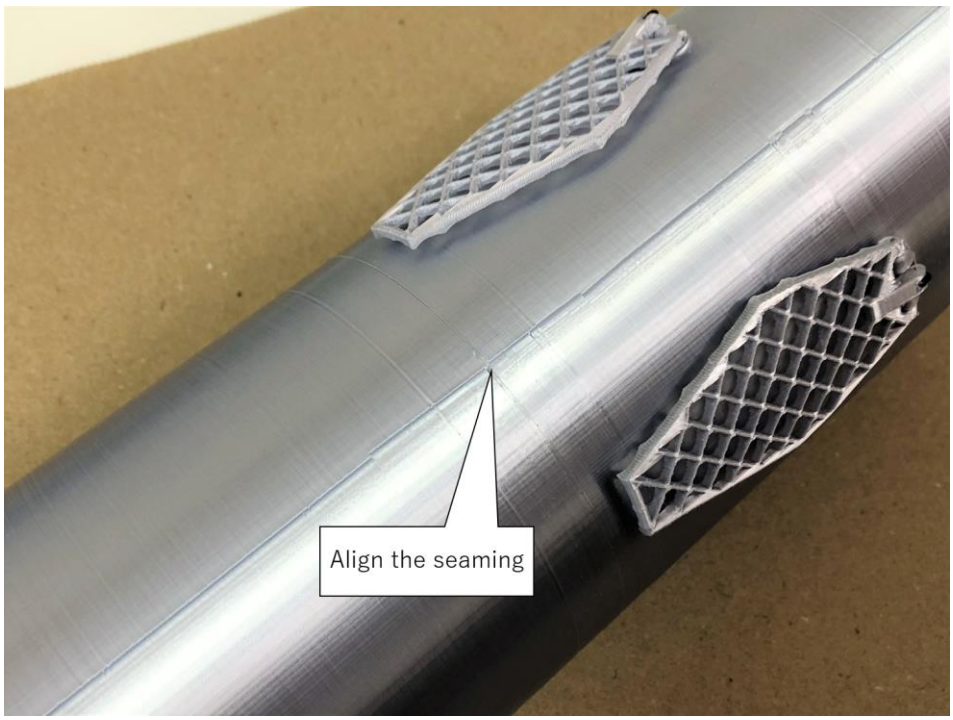


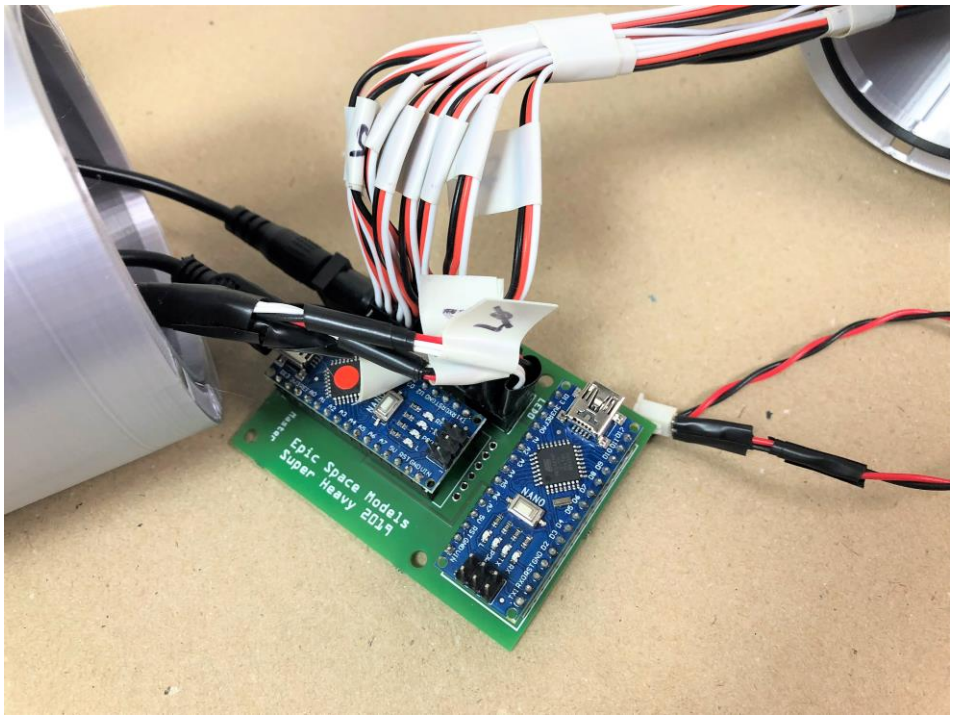
### 7.7.6 Interstage connection

Take the hull segments 2 and 3 (same shape). Insert a seal in each segment, on the side that has the label “UP”.

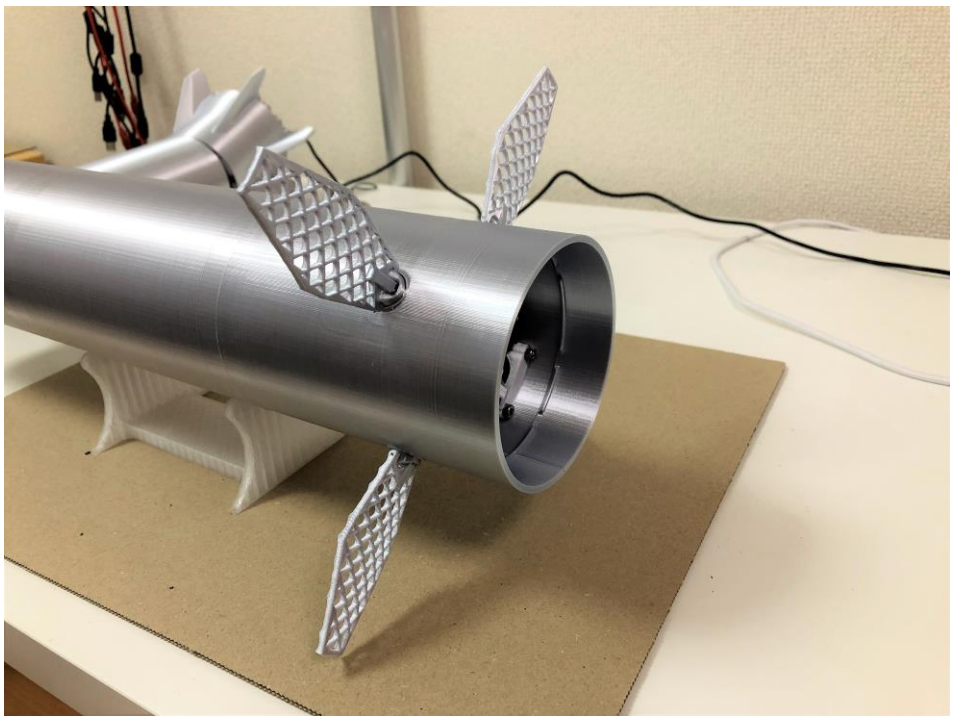
Take the hull segment 1 (the one with the fins). Draw the wire bundle through one of the other segments. The bundle must enter from the side with the labels “UP” and the seal. Verify that the flat surfaces of the segments are clean, especially the magnets, then mate the two segments. Make sure to align the seaming. Repeat this process so that the 3 segments are mated.



Take the last seal, and insert it at the back of the 3 segments tube. Connect the servomotors to the control board. Make sure to connect the servomotors in the correct order (match the cable labels with the board labels). The black wire of each servomotor must be closest to the edge of the board, while the white wire must be closest to the Arduino.

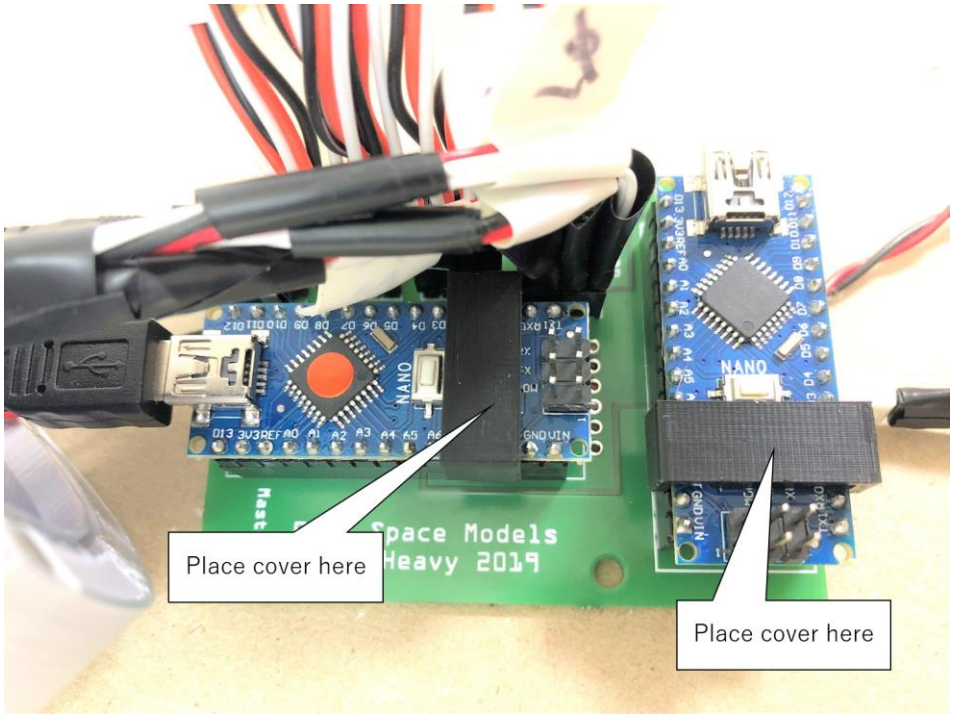


Place the 3 segments tube on one of the horizontal stands like in the photo below. Connect the DC power adaptor to a wall outlet, and check that the fins work correctly. Wait until the fins fold again, then unplug the DC adaptor from the wall outlet.

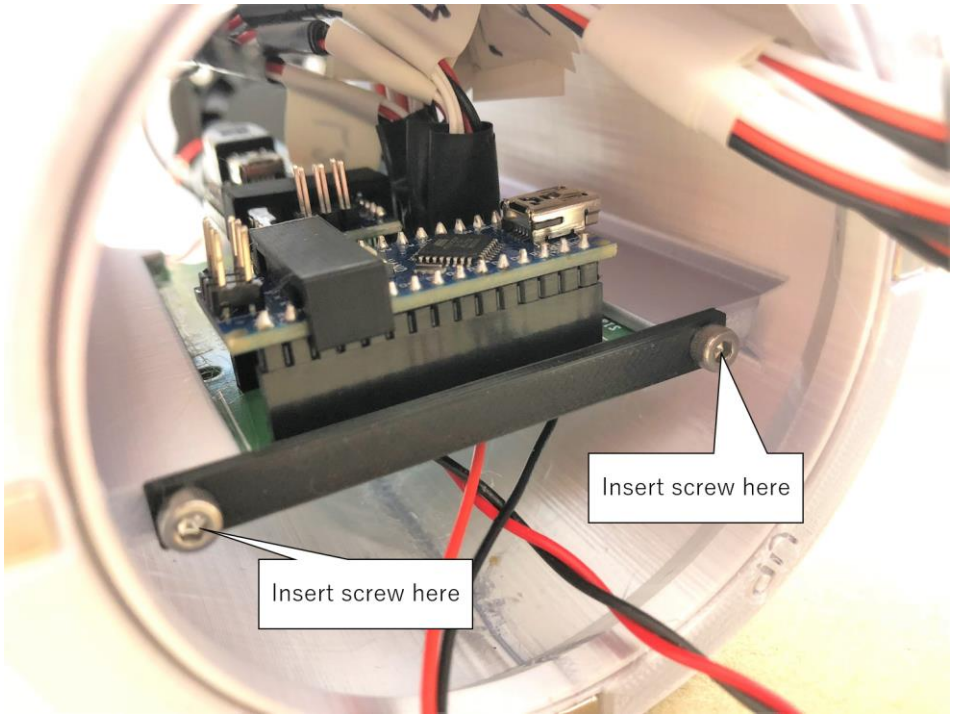


### 7.7.7 Control board installation and hull closure

Take the 2 Arduino LED covers, and place them across the Arduinos like in the photo below. This prevents the small LEDs from glowing through the hull.



Connect the USB cable to the control board. Insert the control board into the rails of the segment 4. While moving the control board, gently pulls on the USB and DC power adaptor cables from the outside of the engine block to reduce the cable slack.
Use the PCB lock and two M3x8 screws to secure the control board.



Verify that the flat surfaces between the segments are clean. Store the slack of the fan cables below the control board, then mate the segments. When mating the engine block, gently pull the USB cable and DC adaptor cables to reduce the slack inside the segments. Make sure to align the seaming on the outer side of the segments.

Place Superheavy on the horizontal stands like in the picture below.

# 8 Fins calibration

## 8.1 Installing Superheavy Control

Download Superheavy Control from the URL below
http://www.epicspacemodels.com/superheavy2019/

Unzip the archive, then run superheavy_control_installer.exe. Follow the instructions of the installer.

## 8.2 Connecting to Superheavy

Run SuperheavyControl.exe (the default location for the executable is C:¥Program Files¥Epic Space Models¥SuperheavyControl¥application).

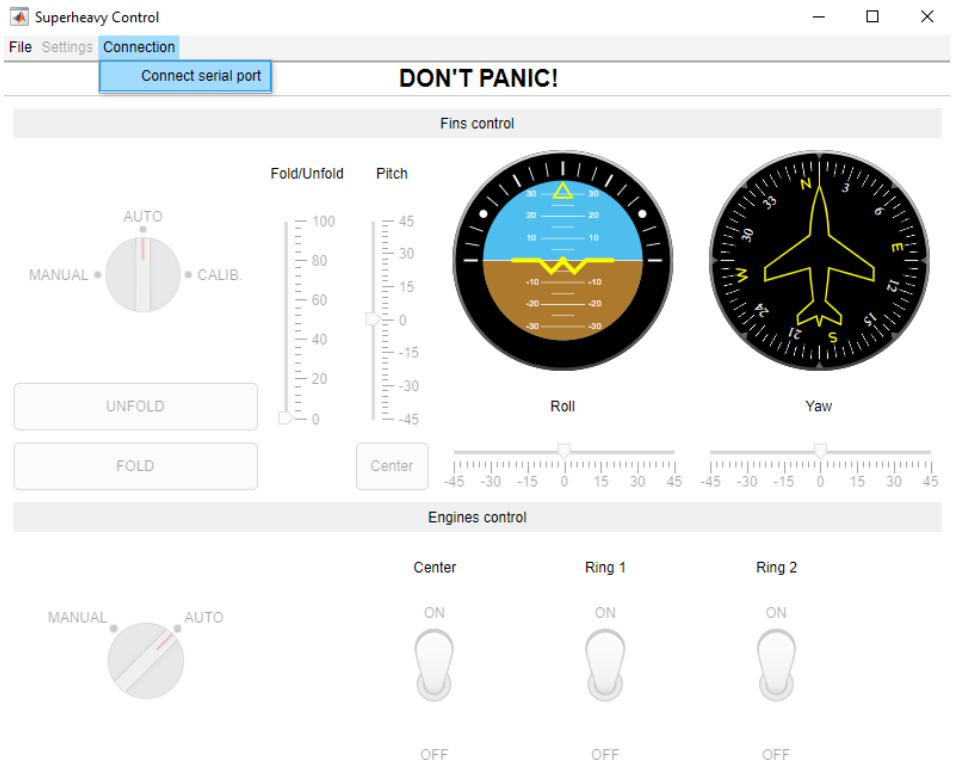
Connect the DC power adapter of Superheavy to a wall outlet, then connect the USB cable to your PC.

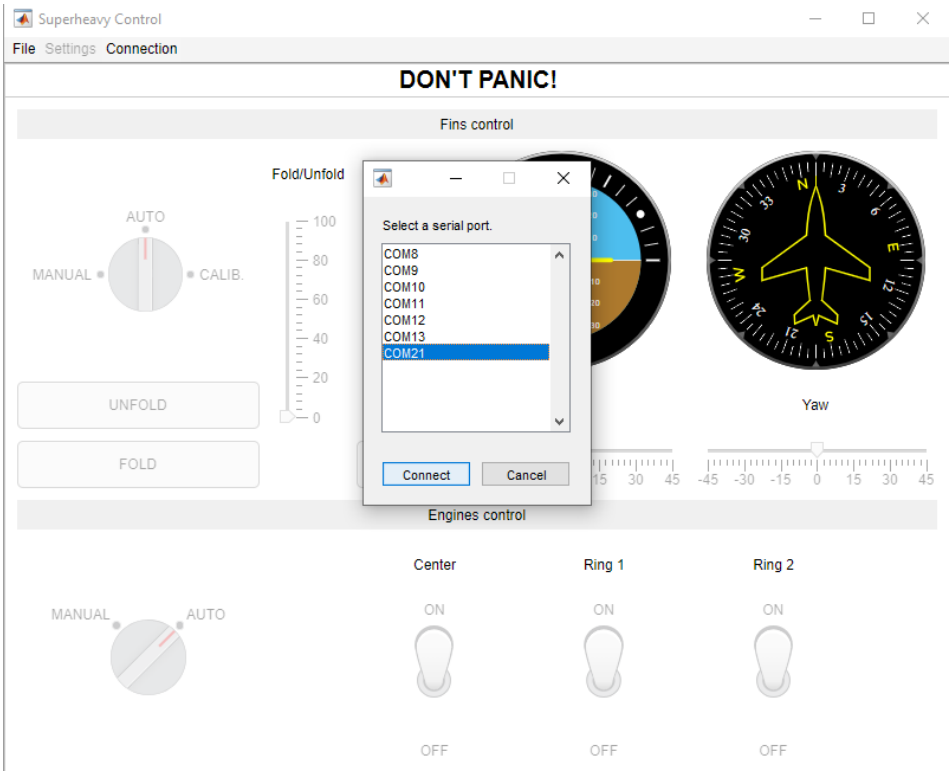
From the top menu, click Connection -> Connect serial port. Select the serial port corresponding to Starship and click Connect. After a few seconds you should get a message telling you that the connection was successful. The exact serial port will depend on your computer.

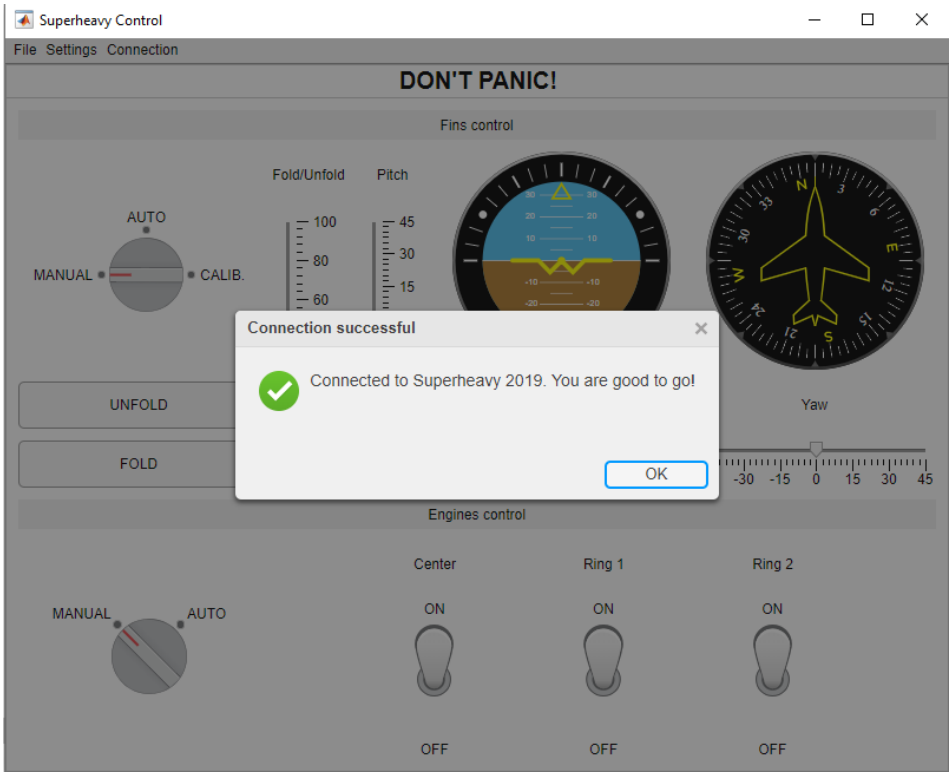
If you are not sure which serial port to use, use the following procedure

Click cancel to close the list of ports.

1. Disconnect the USB cable.
2. Click Connection -> Connect serial port.
3. Note the number of the ports displayed in the selection list.
4. Click cancel.
5. Reconnect the USB cable.
6. Click Connection -> Connect serial port.
7. The list should display one more port than in 3. Use this port to connect to Superheavy.

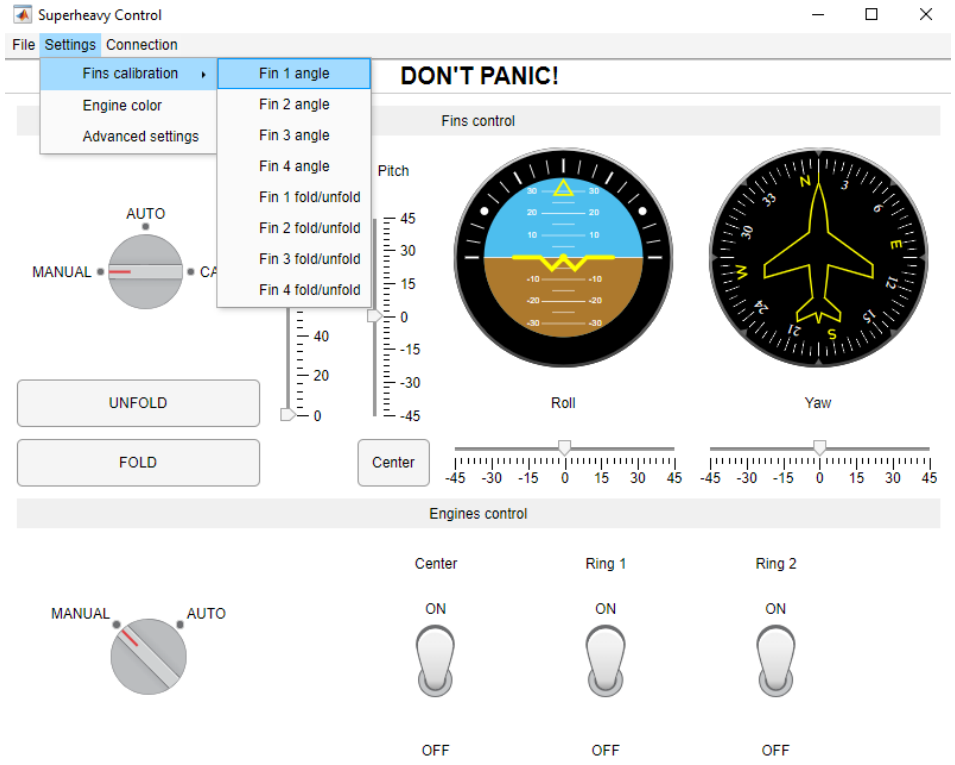

Superheavy Control
File Settings Connection
Connect serial port
DON'T PANIC!
Fins control
Fold/Unfold
Pitch
AUTO
MANUAL
CALIB.
UNFOLD
FOLD
Center
Roll
Yaw
Engines control
Center
Ring 1
Ring 2
MANUAL
AUTO
ON
OFF

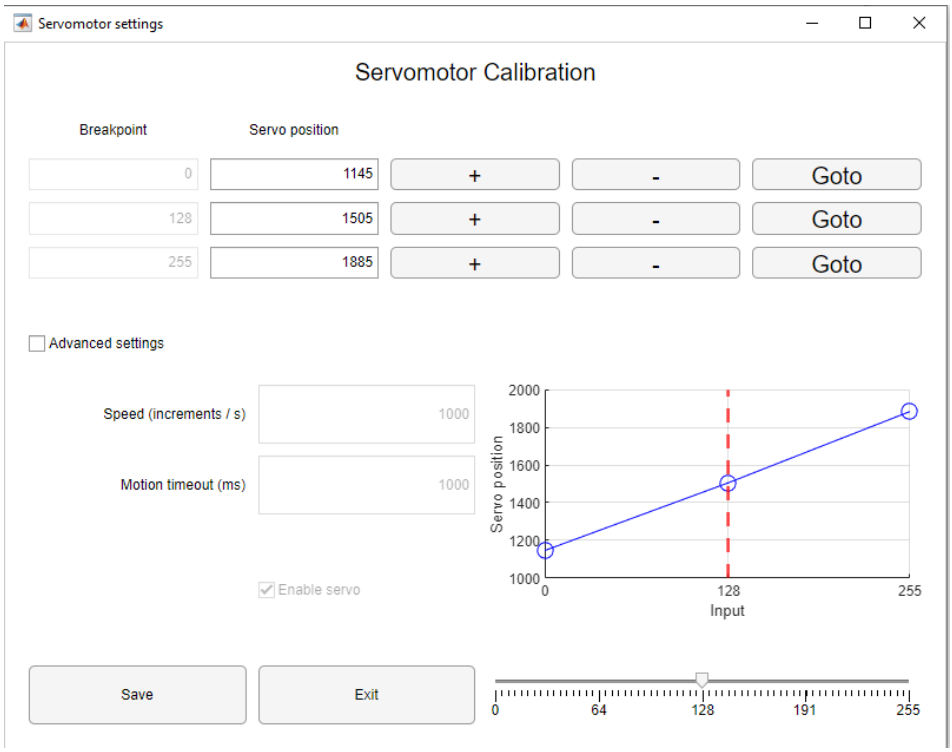

Superheavy Control
File Settings Connection
DON'T PANIC!
Fins control
Fold/Unfold
AUTO
MANUAL
CALIB.
UNFOLD
FOLD
Select a serial port.
COM8
COM9
COM10
COM11
COM12
COM13
COM21
Connect
Cancel
Yaw
Engines control
Center
Ring 1
Ring 2
MANUAL
AUTO
ON
OFF


Superheavy Control
File Settings Connection
DON'T PANIC!
Fins control
Fold/Unfold
Pitch
AUTO
MANUAL
CALIB.
100
80
60
45
30
15
Connection successful
Connected to Superheavy 2019. You are good to go!
OK
UNFOLD
FOLD
Yaw
-30 -15 0 15 30 45
Engines control
Center
Ring 1
Ring 2
MANUAL
AUTO
ON
ON
ON
OFF
OFF
OFF

## 8.3 Fin angle

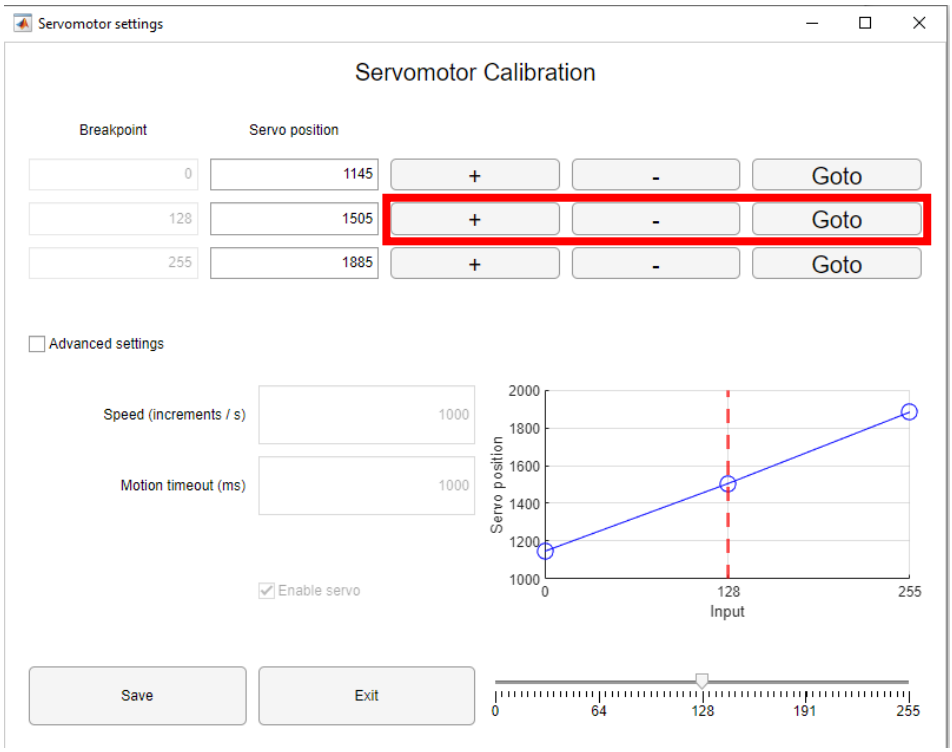
From the top menu, click Settings->Fins calibration->Fin 1 angle. This open a new window. Grab the slider at the bottom right of the window and move it a little left and right to identify the selected fin.

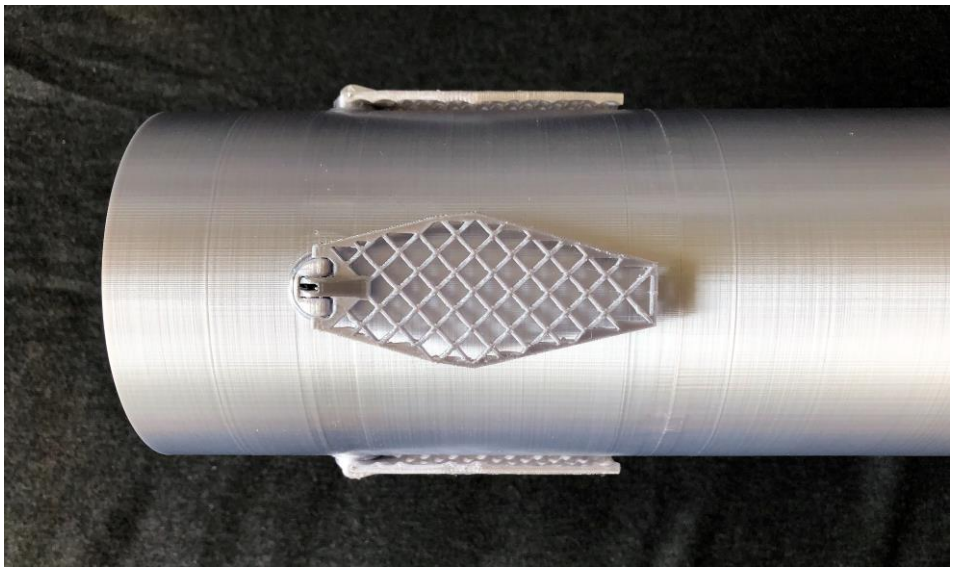


Centering the fin

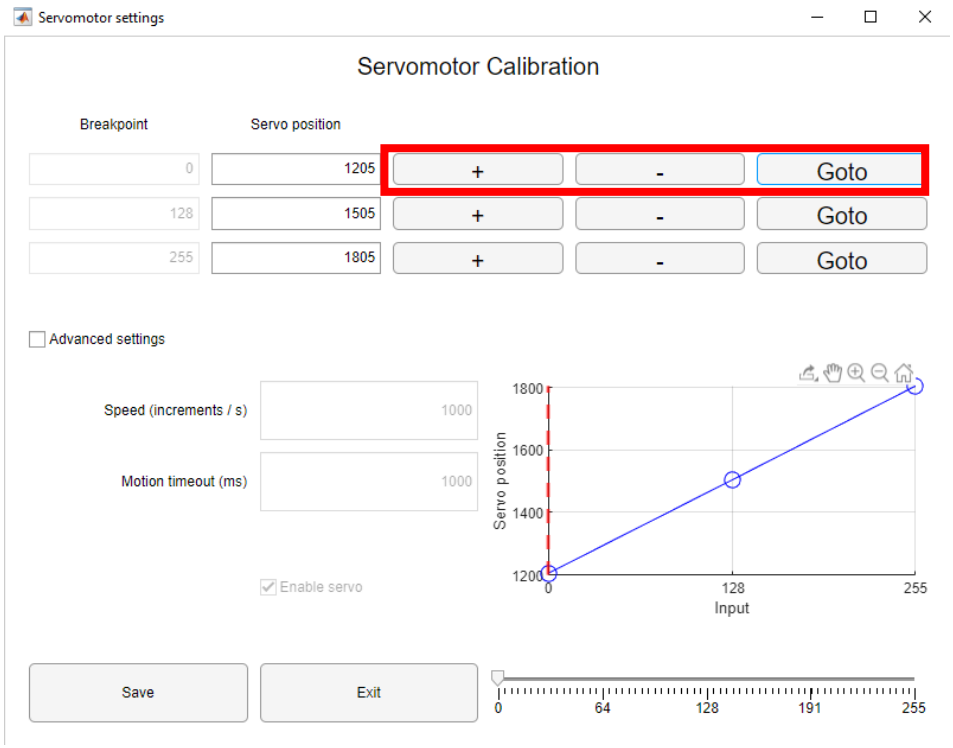
Click the middle Goto button. On the left side of the Goto button, you will see a + and - button. Each time you click on + or - the fin moves a bit left or right. Click on these buttons until the fin is centered (parallel to the rocket tube).

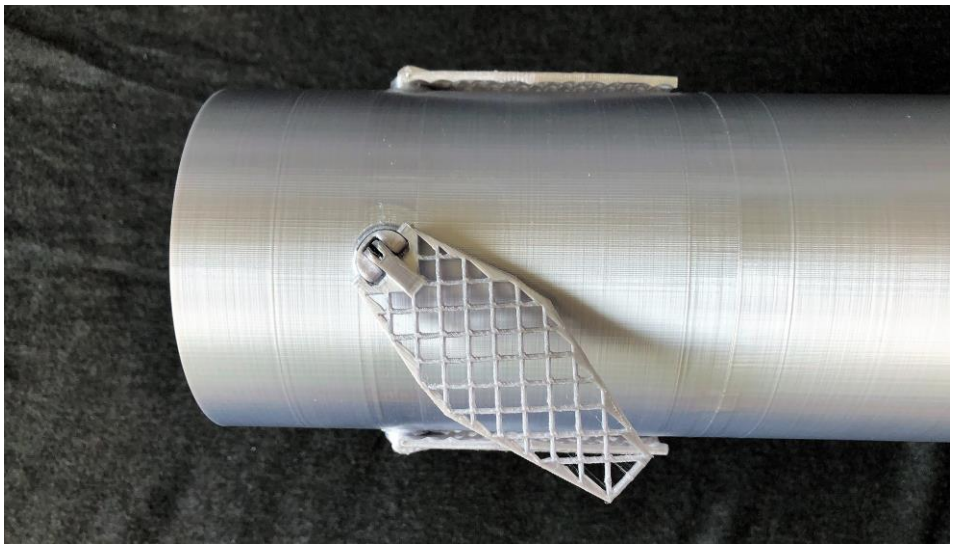


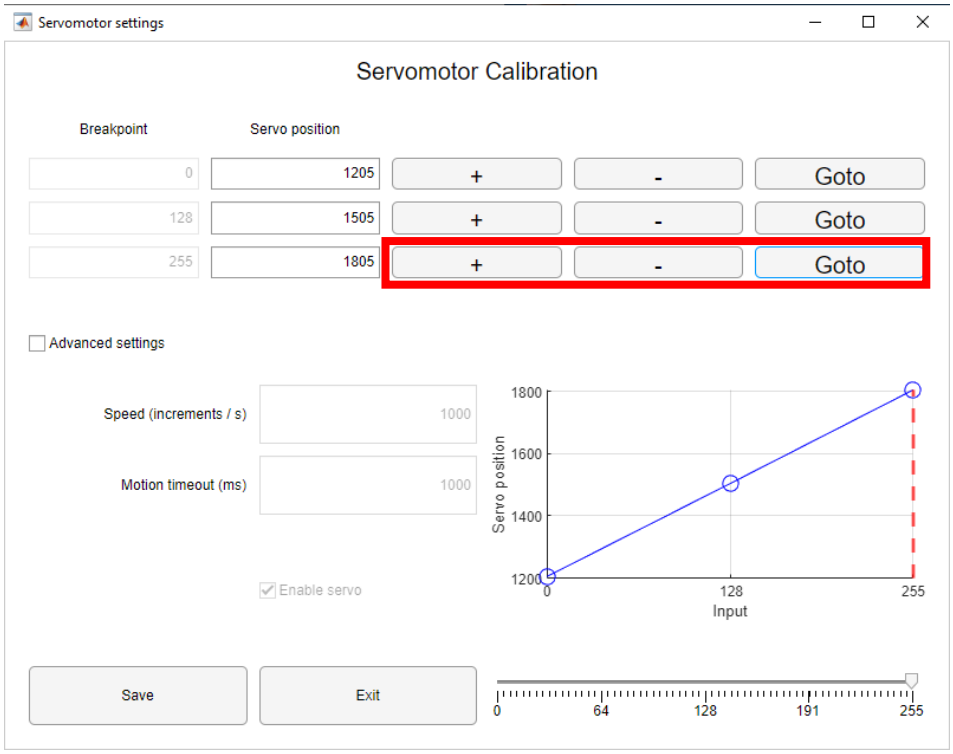
Adjusting the motion range

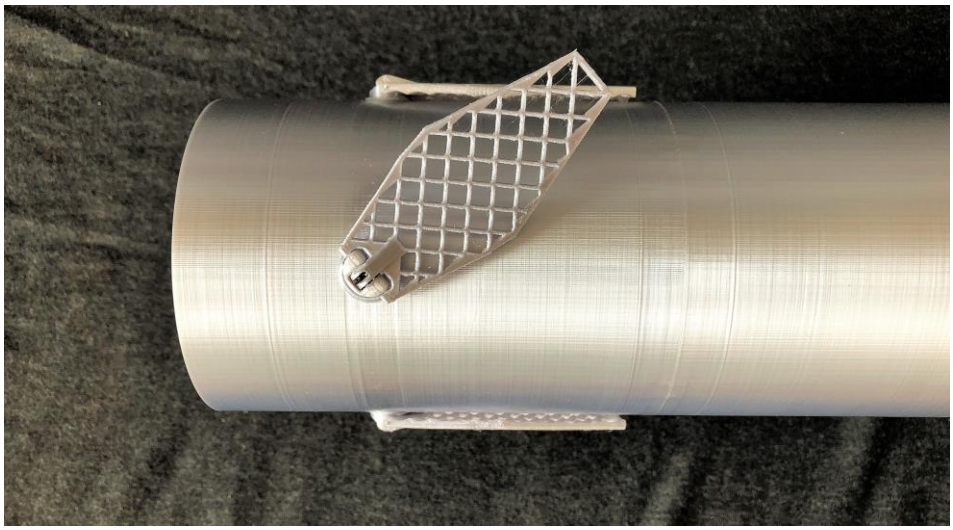
Click on the top Goto button. By clicking on the + and - buttons, adjust the angle of the fin so that it is approximatively 45 degrees.



Click on the bottom Goto button. Adjust the angle of the fin so that it is approximatively 45 degrees in the other direction.

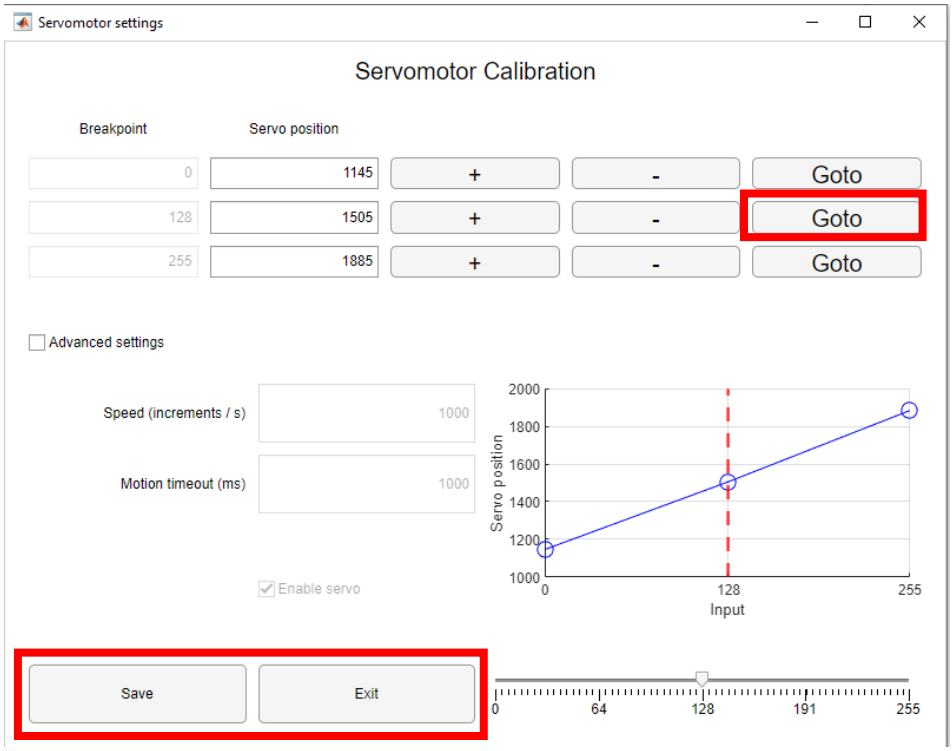


Saving the settings

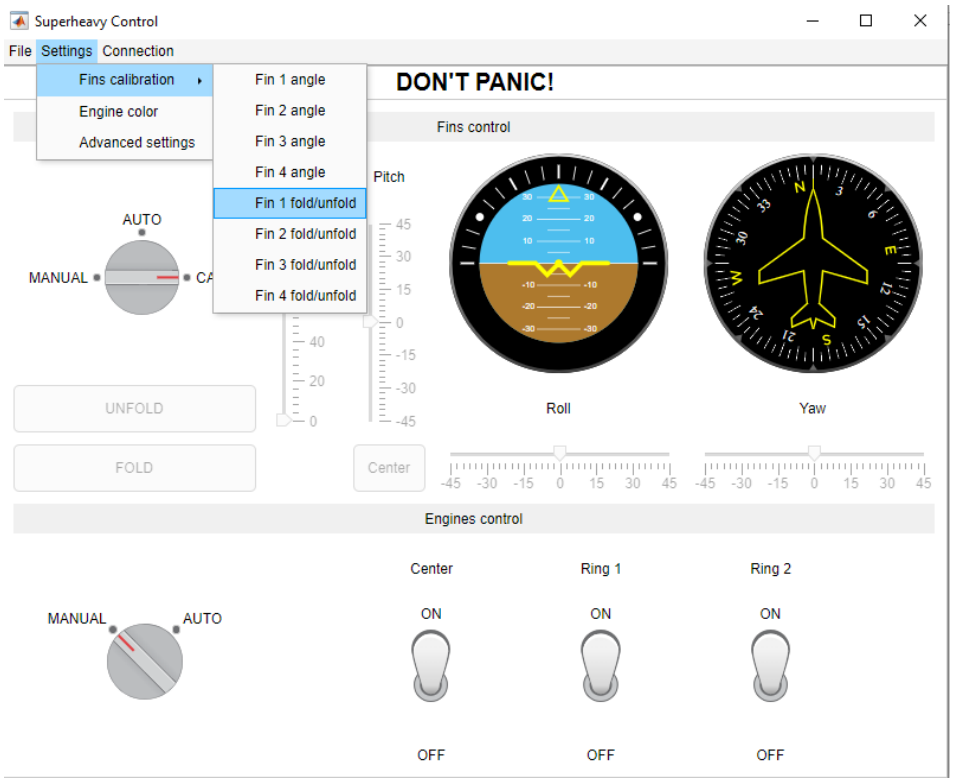
Click on the middle Goto button to center the fin.
Click the “Save” button, then click “Exit”.

Repeat this procedure for the 3 other fins.



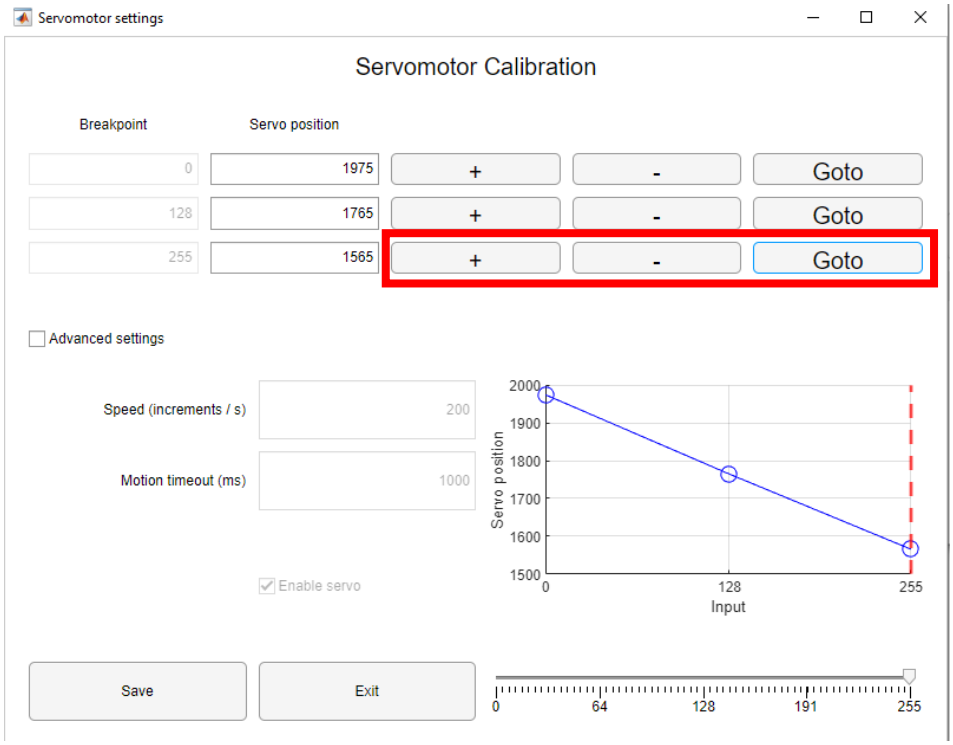
## 8.4 Fin folding

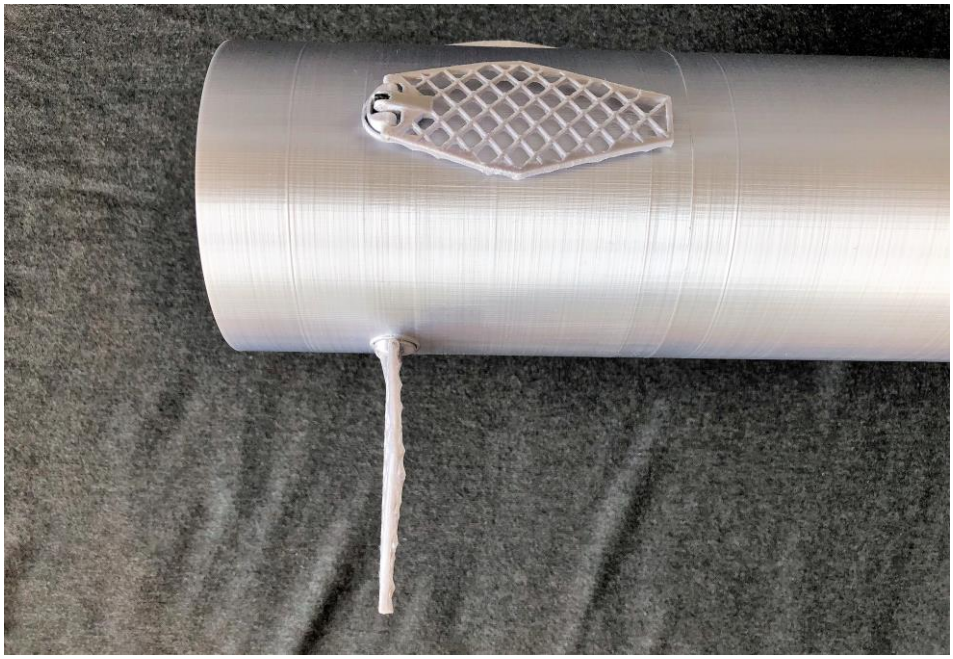
Select Settings->Calibration->Fin1 fold/unfold. Grab the slider at the bottom right of the window, and move it a bit left and right to identify the selected fin.



Unfolded position

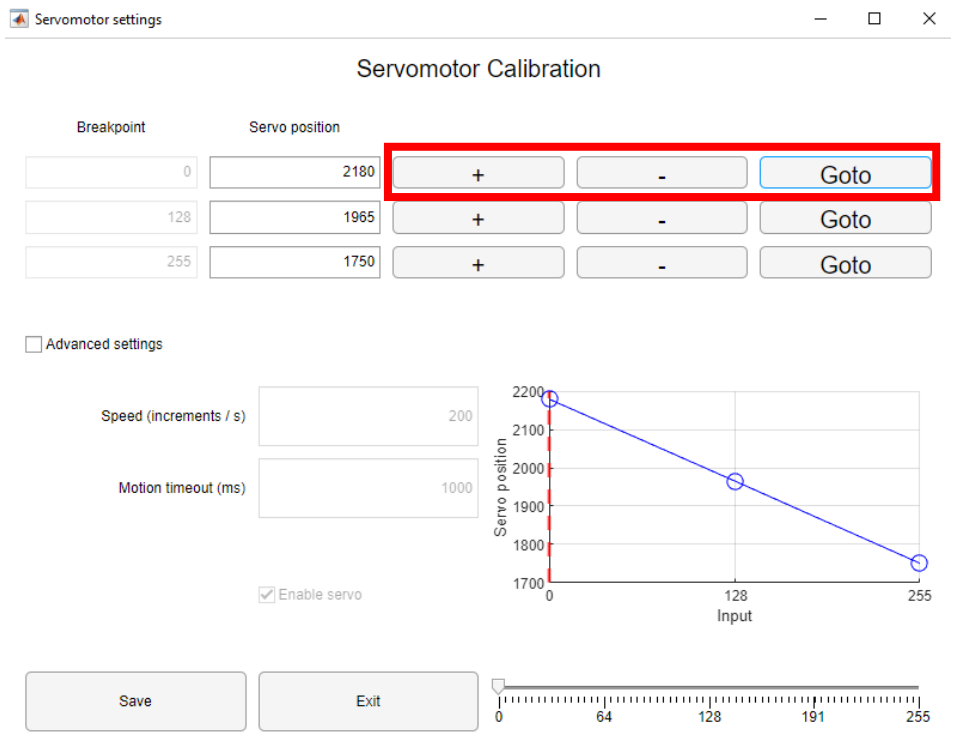
Click on the bottom Goto button. Click on the + and – buttons until the fin is horizontal.

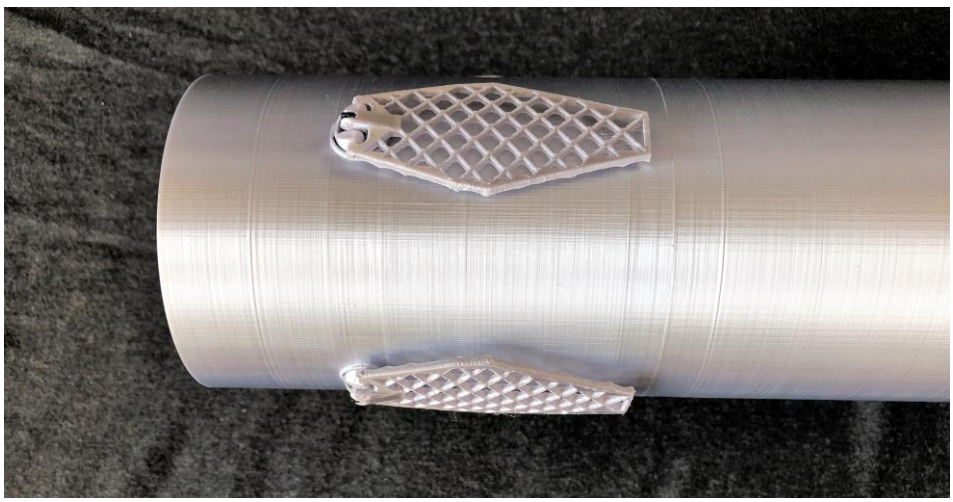


Folded position

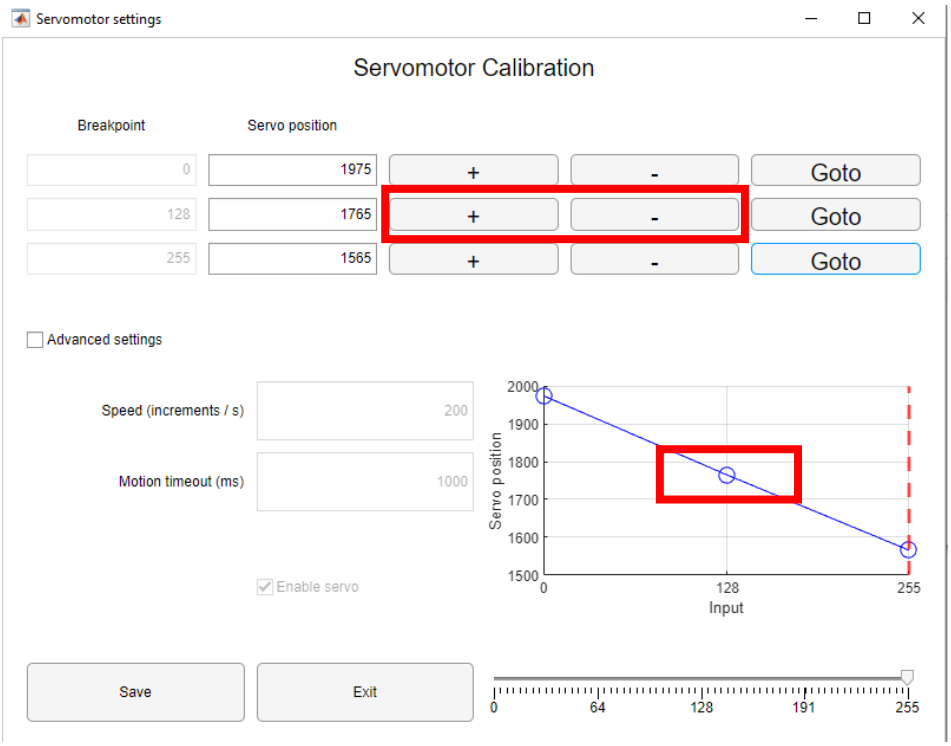
Click on the top Goto button. Click on the + and – buttons until the fin is parallel to the booster.

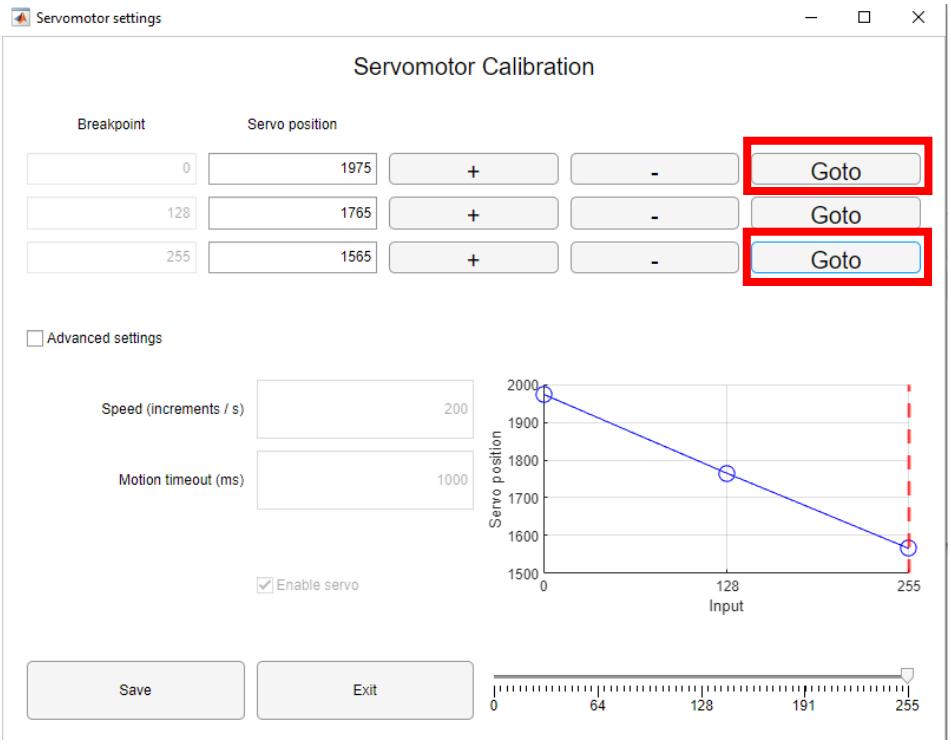


Fine tuning

Click the + and – button on the center line until the graph on the bottom right is almost a straight line. Click a few times on the top and bottom Goto buttons to check the motion of the fin. Click a last time on the top Goto button to fold the fin.



Saving the settings

Click the “Save” button, then click “Exit”.

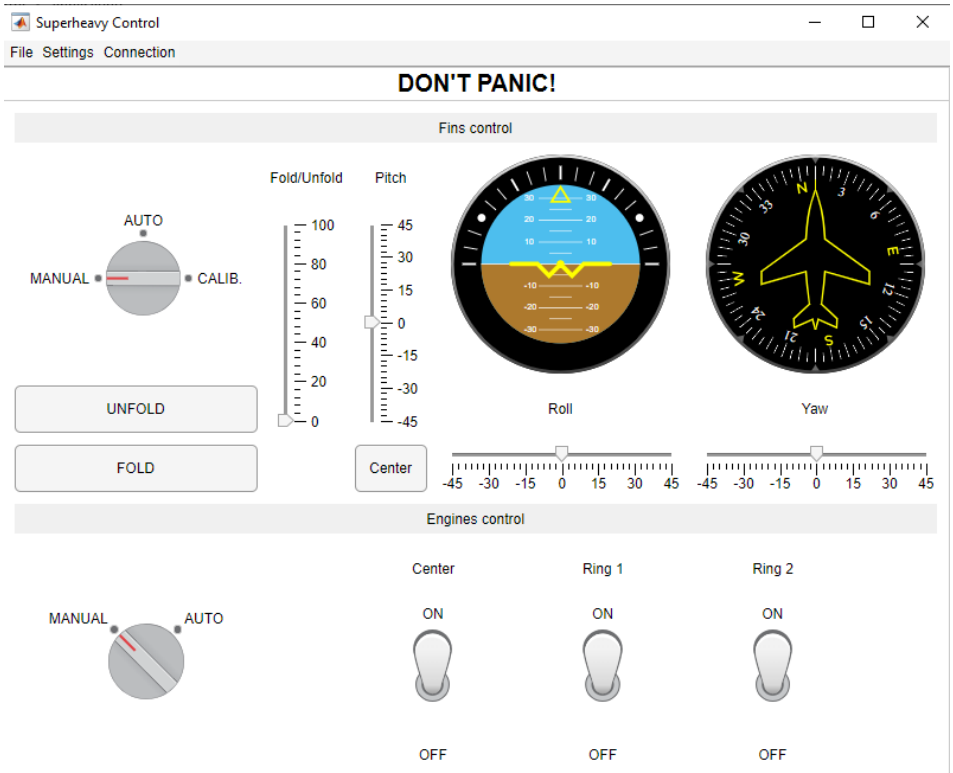
Repeat this procedure for the 3 other fins.

## 8.5 Switching back to manual/auto mode

Opening the calibration menu of one of the servomotors automatically switches the fins control mode to “CALIB.”. In this mode, each servomotor is controlled independently and directly from the calibration window.

Once the calibration is done, you need to switch the control mode to either MANUAL or AUTO.

- In MANUAL mode, the fins are controlled from the buttons and sliders on the main window of Superheavy Control.
- In AUTO mode, the fins move automatically following a preprogrammed sequence (similarly as when Superheavy is not connected to Superheavy Control). The duration and period of repetition of the sequence can be adjusted from the advanced settings menu.



## 9 Congratulations!

Congratulations for putting together Superheavy! This was a difficult model.
Reward yourself appropriately.

Don' forget to download Starship Control to control Superheavy from your computer.
http://www.epicspacemodels.com/superheavy2019/

## 10 What's next?

Although I did my best to provide you with the best experience, there is probably still room for improvement.

And I am always open to feedback.

Other Epic Models will follow…

# 11 Troubleshooting

## 11.1 One or more engines do not work

### 11.1.1 Symptoms

After connecting the engines to the control board and powering on the board, one or several engines do not work.

### 11.1.2 Possible causes

One LED is dead or not properly soldered.

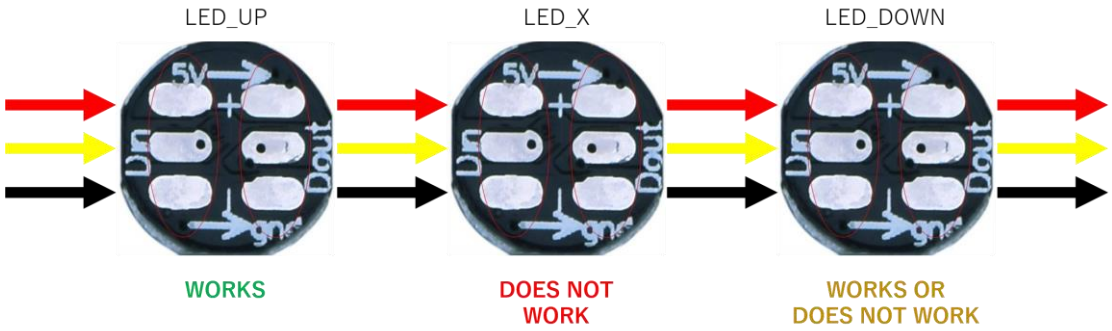
Because all LEDs are connected in series along a common data line, if one of the LEDs stops working all the LEDs downstream also stop working. They are not damaged; they are just not getting the required signal to operate.

### 11.1.3 Solution

#### 11.1.3.1 Identify the first LED not working

Identify which LED is not working. In case several LEDs are not working, identify the most upstream LED not working (the one that was soldered first). From now, we will refer to this LED as LED_X. The LED connected upstream (on its Din side) will be referred as LED_UP, while the LED connected downstream (on its Dout side) will be referred as LED_DOWN.

For example, in the above photo the engines 5 and 6 are not working. Therefore
LED_UP = 4
LED_X = 5
LED_DOWN = 6



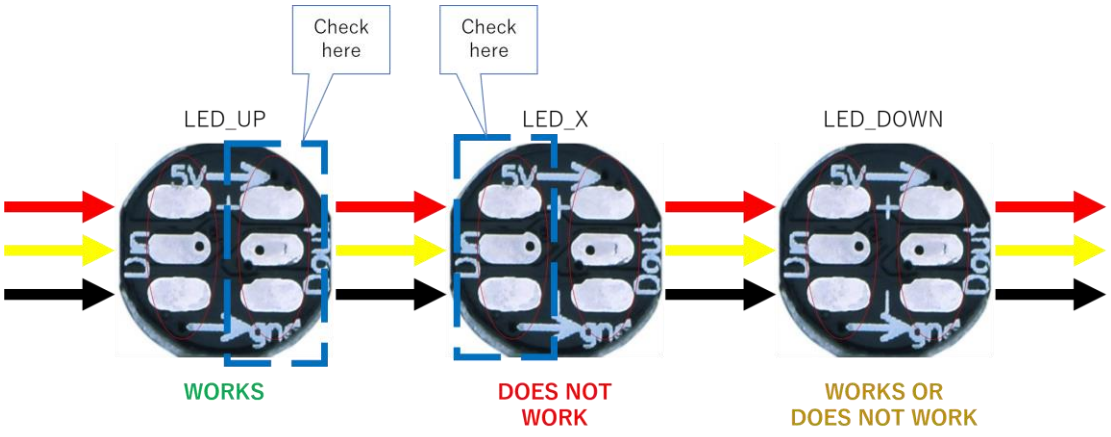

For the following step, leave the engine pod connected to the control board, but power up the control board only when instructed to do so.

#### 11.1.3.2 Check inbound connections

Check the following connections

- The 3 pads on the Din side of LED_X.
- The 3 pads on the Dout side of LED_UP. If LED_X = 1, check the solders on the connector instead.

Especially, check that the central pad is not shorted with one of the other pads (red / black). Most problems with the LEDs come from one bad solder.




If you see a suspicious solder, desolder the wire then solder it again. Power up the control board.

Dis this solve the problem?

Yes

End of troubleshooting.

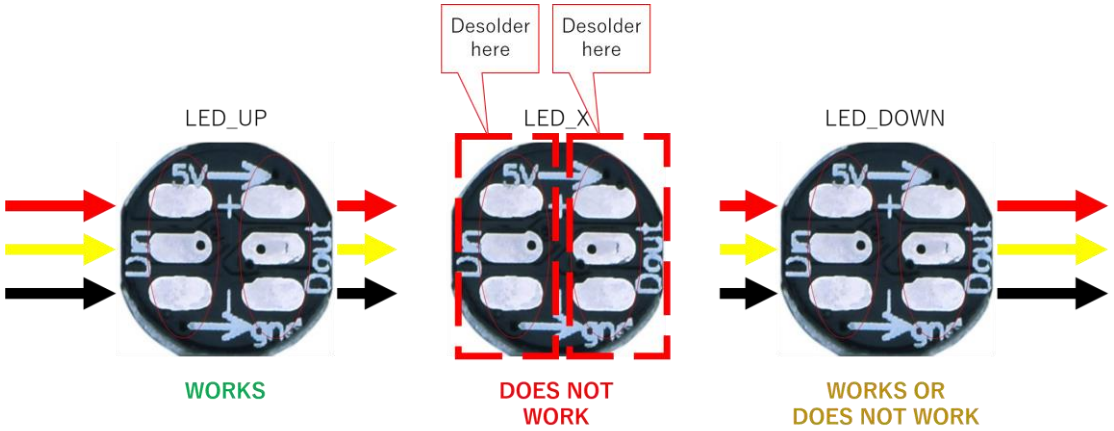
No

If this did not solve the problem, or if you are not sure what a suspicious solder looks like, proceed to the next step.

#### 11.1.3.3 Disconnect LED_X

Desolder all the pads of LED_X and put it aside. Do not throw it away! It might still be good.

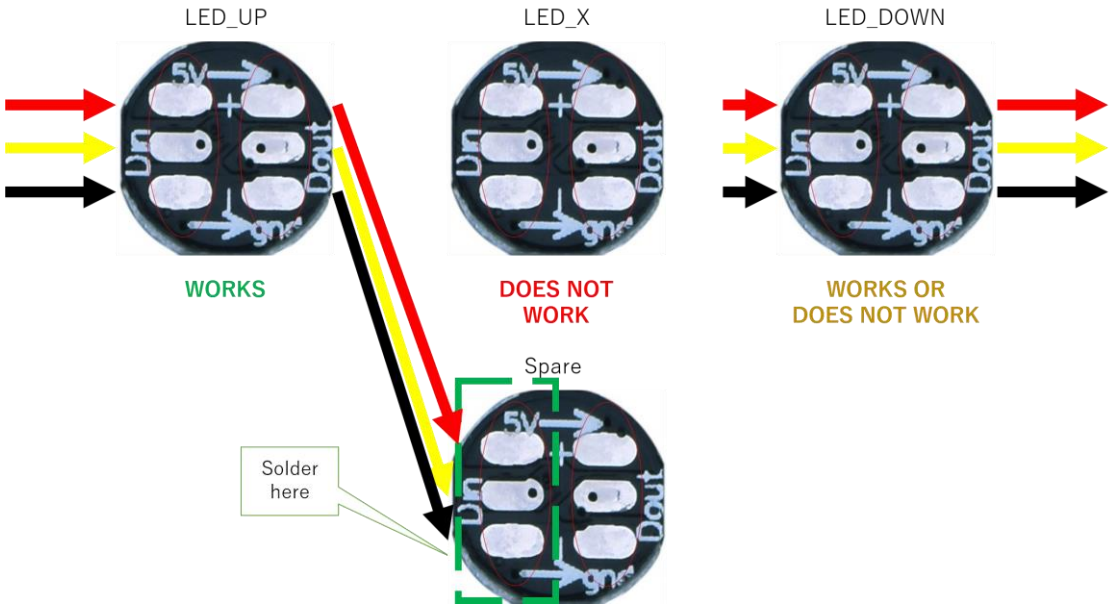
If LED_X = 1 (no upstream LED) proceed to step 11.1.3.5. Otherwise, proceed to step 11.1.3.4.



#### 11.1.3.4 Check the inbound data stream

In this step, we check that the upstream LED is correctly transmitting data through its Dout port.

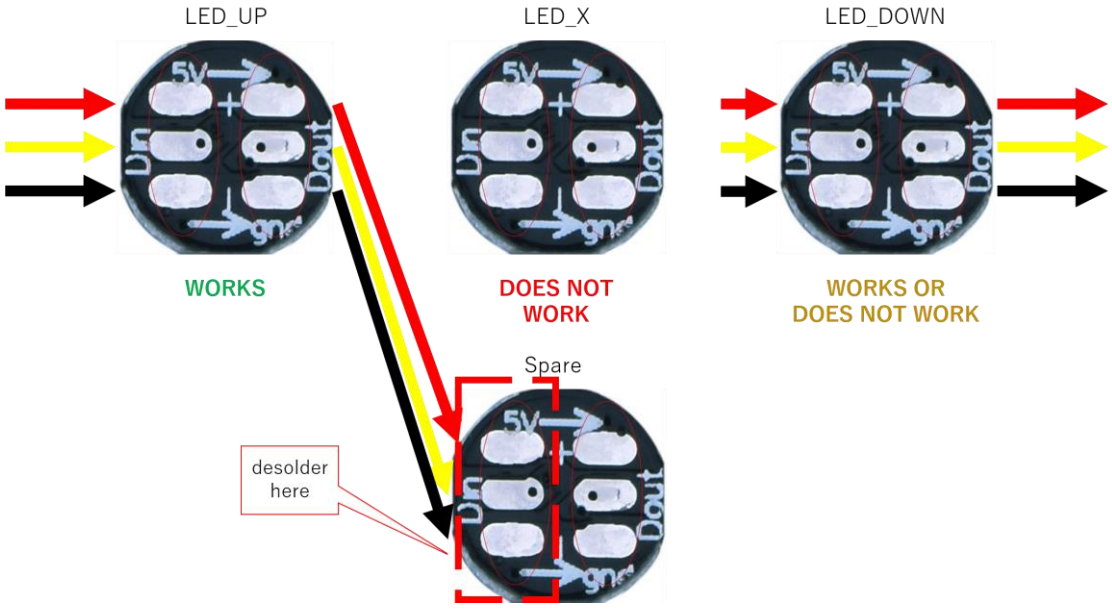
Take a spare LED from the bag. Connect its 3 pads on the Din side to the 3 pads on the Dout side of LED_UP. Power up the control board.




Does the spare LED light up?

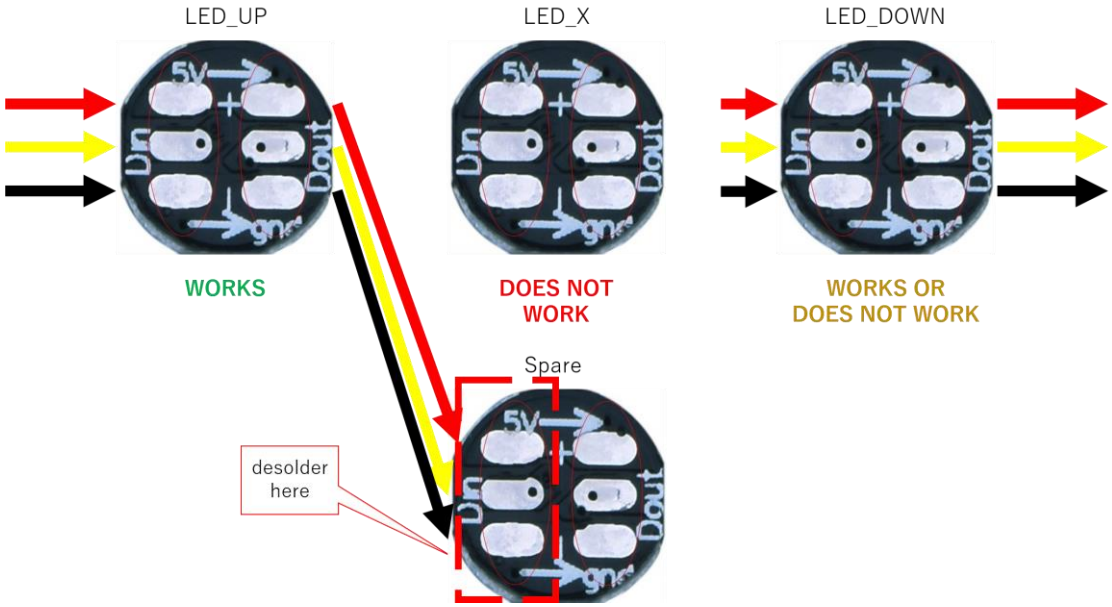
Yes

We can rule out a problem with LED_UP. Desolder the spare LED and keep it in a safe place. Proceed to step 11.1.3.5.



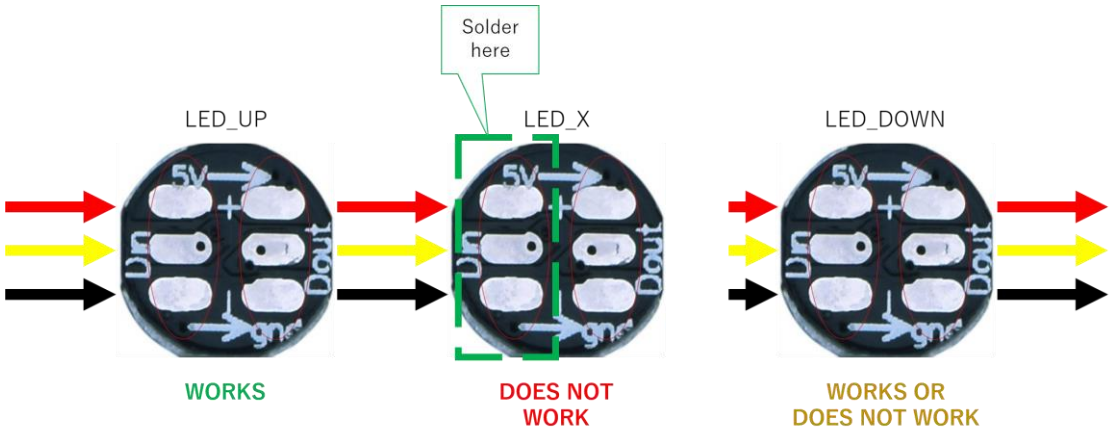

No.

There is a problem with LED_UP. The LED lights up but it is not correctly forwarding data downstream. Desolder the spare LED and keep it in a safe place. Proceed to step 11.1.3.6.



### 11.1.3.5 Check LED_X

Solder the 3 pads on the Din side of LED_X to the 3 pads on the Dout side of LED_UP. Power up the control board



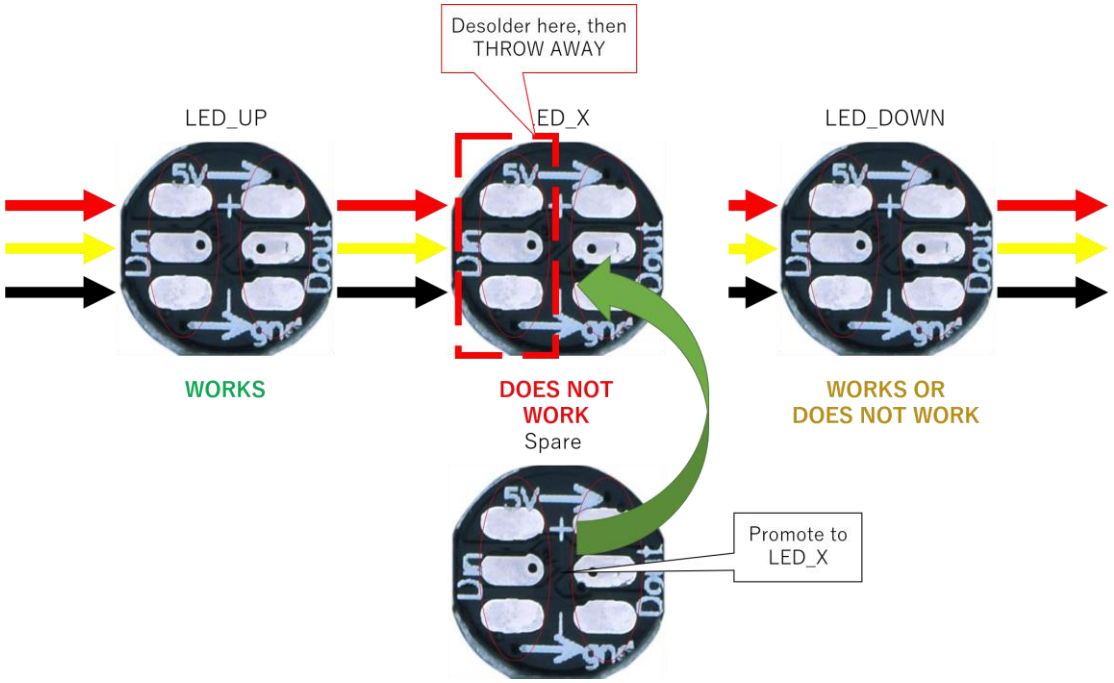

Does LED_X light up?

Yes

Problem with LED_X is fixed. Proceed to step 11.1.3.7.

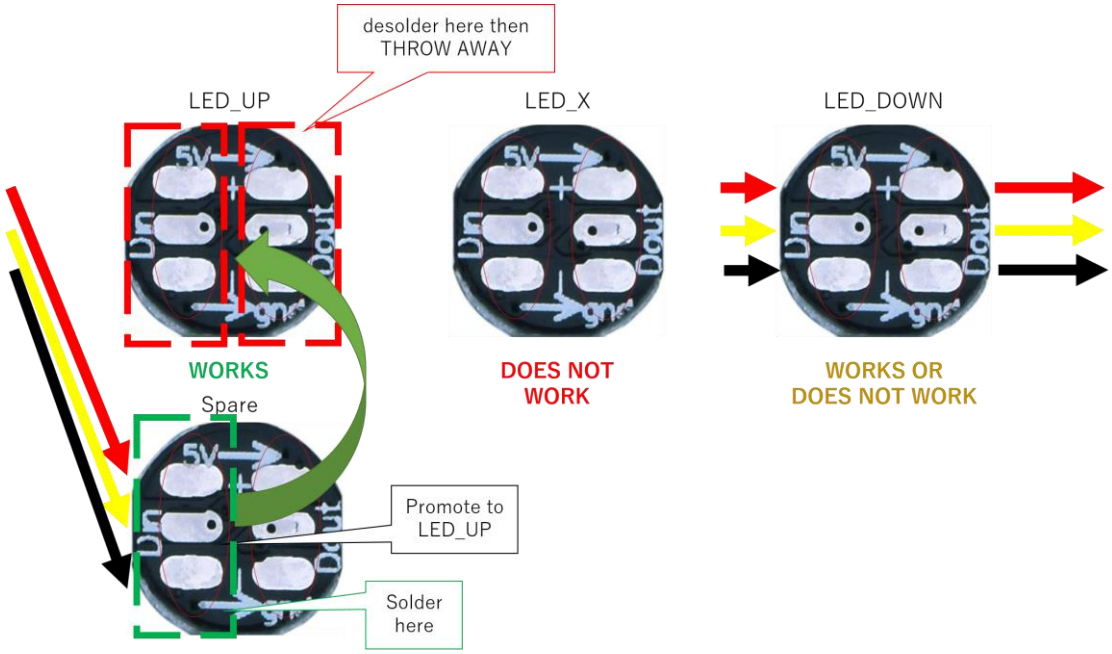
No

LED_X is dead. Desolder the 3 pads on the Din side and THROW AWAY this LED. Take a spare LED. This new LED will now officially become LED_X. Repeat step 11.1.3.5



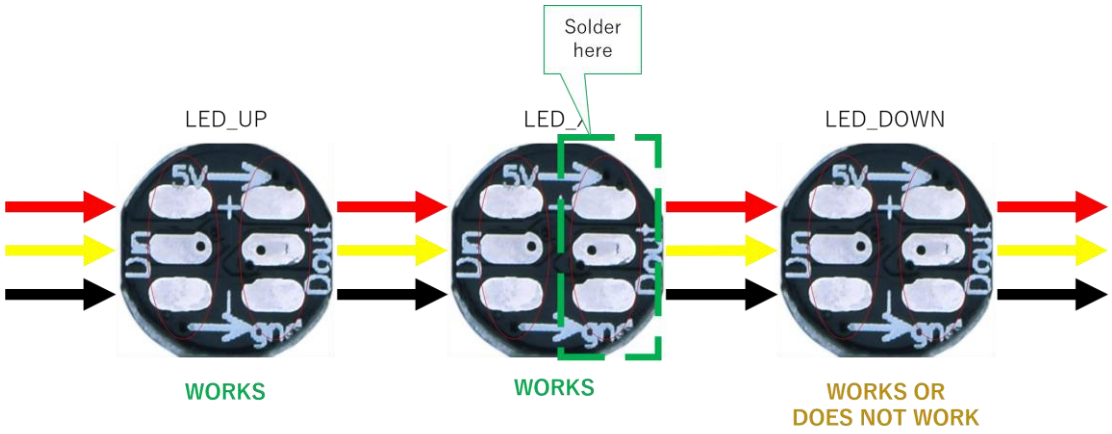
#### 11.1.3.6 Problem with upstream LED

Desolder LED_UP and THROW IT AWAY. Take a spare LED and solder it in place of LED_UP. This LED now officially becomes LED_UP. Go back to step 11.1.3.4.



#### 11.1.3.7 Reconnect downstream of LED_X

Solder the 3 pads on the Dout side of LED_X to the 3 pads on the Din side of LED_DOWN. Power up the control board.




Do the all the engines light up?

Yes

Troubleshooting is finished!

No

There are problems with other LEDs. Go back to step 11.1.3.1.

# 12 Change log