# STATIAL.b

## ADJUSTABLE MOUSE - BUILD INSTRUCTIONS

v01.00 - 09/06/2024

The Statial.b is an open source DIY mouse design. This concept has adjustable surfaces that can be moved and locked in position to create a wide range of new ergonomics for any grip style. Files for ambidextrous builds are included.

Knowledge of 3D printing, basic electronics & soldering skills as well as the ability to upload code to an Arduino are needed for this build. The design is based around a 16,000 DPI optical sensor in the PMW3389 and driven by an Arduino compatible PRO MICRO controller.

This is a fairly complex project. I tried to cover all the assembly details in the in this PDF and on YouTube, but some problem solving skills are still going to be required.

The finished design is a functioning prototype that requires a lot of adjusting to get it dialed in and is more fragile than a normal commercially produced product. It's also a heavy mouse weighing up to a hefty 130 grams (depending on components used).

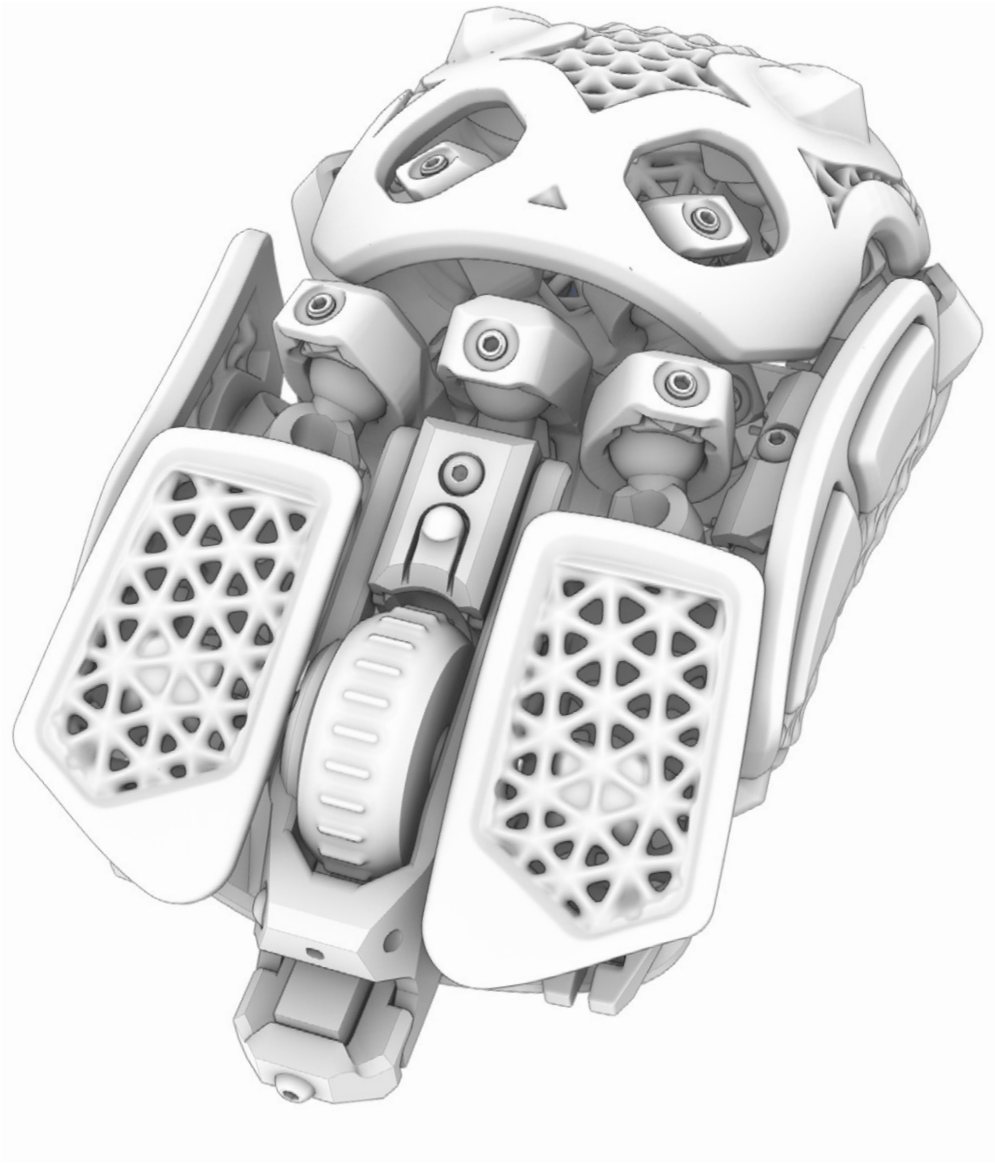
Not trying to put anyone off the build, just important to have realistic expectations about the end product. All that said, it works great and is super fun to use. There's really nothing else like it out there if you're looking to explore mouse ergonomics.

All 3D printed parts need to be made in a "Tough" or "ABS like" resin material. Resin print color is up to you. **This project requires resin printed parts.**
**It will not work if parts are 3D printed with the FDM process.**

Current (2024) project materials costs are around **$200** (not including tools). This is a rough guess so you have an idea of what you're getting into.

GitHub Project Repository
http://

YouTube Design and Assembly Walkthrough:
http://



# BOM - 3D PRINTS



All STL file units in MM. Slicer files for Preform & Lychee also available at GitHub repository. Requires ~170mL of resin for all parts.
Complete print sets fit within approx 220mm x 125mm build areas but can be broken up into multiple batches for smaller printers.

Best results in Formlabs Tough 2000. Had good (although more fragile) results with Anycubic ABS-Like Pro 2 line of resins.
Did not test but Sunlu ABS-Like and Siraya Tech lines would probably be fine as well.

STL Filename syntax: All matching “SBv##” files work together. The “A##” (letter/number) sections are individual component version IDs.
Qty-## are number of print copies needed for a single build. Preform & Lychee files in repo should be have most up to date versions of all files.

| ID | NAME | FILE NAME | QTY | MATERIAL | NOTE |
|---|---|---|---|---|---|
| 3DP.01 | BODY - LOWER | body-lower_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.02 | BODY - UPPER | body-upper_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.03 | ARM - STATIC | arm-static_SBv10A01_qty-03.stl | 3 | tough / abs like resin | Duplicate parts in slicer |
| 3DP.04 | ARM - ADJUSTABLE - A | arm-adj-A_SBv10A01_qty-04.stl | 4 | tough / abs like resin | Duplicate parts in slicer |
| 3DP.05 | ARM -ADJUSTABLE -B | arm-adj-B_SBv10A01_qty-04.stl | 4 | tough / abs like resin | Duplicate parts in slicer |
| 3DP.06 | MOUSE BUTTON - L | mb-L_SBv10A01_qty-01.stl | 1 | tough / abs like resin | Keep interior supports during post-cure to prevent warpage |
| 3DP.07 | MOUSE BUTTON - R | mb-R_SBv10A01_qty-01.stl | 1 | tough / abs like resin | Keep interior supports during post-cure to prevent warpage |
| 3DP.08 | MIDDLE - WHEEL | mid-wheel_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.09 | MIDDLE - CRADLE | mid-cradle_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.10 | MIDDLE - FLEX | mid-flex_SBv10A01_qty-01.stl | 1 | tough / abs like resin | Fragile part, careful when removing from supports |
| 3DP.11 | MIDDLE - ROTOR CAP | mid-rotor_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.12 | MIDDLE - DPI CAP | mid-dpi_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.13 | REAR SURFACE | mid-rotor_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.14 | SIDE SURFACE - SWITCH | side-switch_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.15 | LEFT SURFACE | side-L-std_SBv10A01_qty-01.stl | 1 | tough / abs like resin | Left/Right side surface parts skipped for left handed build |
| 3DP.16 | RIGHT SURFACE | side-R-std_SBv10A01_qty-01.stl | 1 | tough / abs like resin | - |
| 3DP.17 | ALT-L - LEFT SURFACE | side-L-flip_SBv10A01_qty-01.stl | 1 | tough / abs like resin | Optional prints for Left/Right handed build - found in "extras" folder |
| 3DP.18 | ALT-L - RIGHT SURFACE | side-R-flip_SBv10A01_qty-01.stl | 1 | tough / abs like resin | Optional prints for Left/Right handed build - found in “extras” folder |
| 3DP.19 | CUTTING JIG | cutting-jig_32mm | 1 | tough / abs like resin | Optional jig for cutting 1/8” tube stock to 32mm in "extras" folder |

| ID | PART | VENDOR | PART NO | QTY | PRICE (est) | LINK | NOTE |
|---|---|---|---|---|---|---|---|
| HW-01 | M2 NUT - STANDARD | MCMASTER | 91828A111 | 13 | $ 8.00 | AMAZON | Generic parts, McMaster Carr for reference |
| HW-02 | M2 X 4MM - BUTTON HEAD SCREW | MCMASTER | 91239A703 | 10 | $ 12.00 | AMAZON | Sets available - 1.3mm hex wrench |
| HW-03 | M2 X 8MM - BUTTON HEAD SCREW | MCMASTER | 97763A408 | 2 | - | - | - |
| HW-03 | M2 X 16MM - BUTTON HEAD SCREW | MCMASTER | 97763A411 | 3 | - | - | - |
| HW-04 | M2.5 NUT - STANDARD | MCMASTER | 90591A270 | 18 | $ 6.00 | AMAZON | - |
| HW-05 | M2.5 X 4MM - CUP HEAD SET SCREW | MCMASTER | 97763A412 | 16 | $ 7.00 | AMAZON | 1.3mm hex wrench |
| HW-06 | 1/8" ROD OR TUBE STOCK - CUT TO 32MM LENGTH | Misc | n/a | ~1' | $ 6.00 | AMAZON | Rec. aluminum tube. Available at most hardware stores. |
| HW-08 | MOUSE FEET FOR LOGITECH G-PRO | Misc | n/a | - | $ 7.00 | AMAZON | Any 3rd party glides for G-Pro are ok |
| EL-01 | ARDUINO PRO MICRO (5V/16MHz) - NO SOLDERED HEADERS | Misc | n/a | 1 | $ 14.00 | AMAZON | Any clone is fine, must be 5 volt ver. |
| EL-02 | PMW3389 MOTION SENSOR | TINDIE | n/a | 1 | $ 30.00 | TINDIE | Supplied by Joe's Sensors and Sundry |
| EL-03 | (A) PCB - CUSTOM BRIDGE BOARD / (B) MIDDLE BUTTONS | JLCPCB / PCBWAY | n/a | 1 | $ 14.00 | LINK | D/L Gerber file from Statial.b GitHub and order through PCB fab house (usually x5 min order) |
| EL-04 | 8, 8, 12 PIN - SURFACE MOUNT HEADER - GULL WING - 2.54MM | DIGIKEY | HDR100IMP40M-G-V-SM-ND | 1 | $ 1.00 | DIGIKEY | Come as 40 pin headers, cut to length |
| EL-05 | 5'-6' MICRO USB CABLE OR REPLACEMENT MOUSE CABLE & USB MICRO COMPONENT END | Misc | n/a | 1 | $ 10.00 | AMAZON | Any Micro USB will work OR order a mouse cable (AMAZON) + micro usb end (AMAZON) |
| EL-06 | MOUSE MICRO SWITCHES | Misc | n/a | 5 | $ 20.00 | AMAZON | can find cheaper but these look cool |
| EL-07 | PUSH BUTTON MOMENTARY SWITCH - 6mm x 6mm x 5mm | Misc | n/a | 1 | $ 6.00 | AMAZON | must be 4.5mm (5mm) high version |
| EL-08 | TTC ROTARY ENCODER - FOR GLADIUS III OR RAZER MAMBA | Misc | n/a | | $ 8.00 | AMAZON | 8mm x 8mm encoder only |
| EL-09 | NEOPIXEL 5050 RGB LED | ADAFRUIT | 1655 | 1 | $ 5.00 | ADAFRUIT | - |
| EL-10 | 2 PIN - JST PH - 2.0MM PITCH - THROUGH HOLE - RIGHT ANGLE | DIGIKEY | S2B-PH-K-S | 2 | $ 10.00 | AMAZON | Generic JST-PH sets available |
| EL-11 | 2 PIN - JST PH - 2.0MM PITCH - MALE CABLE PLUG | DIGIKEY | PHR-2 | 2 | $ 10.00 | AMAZON | PA-09 crimp required (see tools) |
| EL-12 | 3 PIN - JST PH - 2.0MM PITCH - THROUGH HOLE - RIGHT ANGLE | DIGIKEY | S3B-PH-K-S | 1 | - | - | - |
| EL-13 | 3 PIN - JST PH - 2.0MM PITCH - MALE CABLE PLUG | DIGIKEY | PHR-3 | 1 | - | - | - |
| EL-14 | 5 PIN - JST PH - 2.0MM PITCH - THROUGH HOLE - RIGHT ANGLE | DIGIKEY | S5B-PH-K-S | 1 | - | - | - |
| EL-15 | 5 PIN - JST PH - 2.0MM PITCH - MALE CABLE PLUG | DIGIKEY | PHR-5 | 1 | - | - | - |
| EL-16 | 28 GA WIRE - SILICONE | - | n/a | ~6' | $ 13.00 | AMAZON | Rec. 6 wire ribbon cable |

| NAME | NOTE | PRICE | LINK |
|---|---|---|---|
| RESIN BASED 3D PRINTER & TOUGH OR ABS LIKE RESIN | Resin print only. STL, Preform & Lychee Print files available via Github link. Req. ~170mL of resin | - | - |
| SOLDERING IRON & SOLDER | Attaching headers,  ProMicro, PMW sensor and PH ports to bridge board | - | - |
| WIRE CUTTERS | Used for clearing supports & wiring | - | - |
| NEEDLE NOSE PLIERS | Used for clearing supports | - | - |
| XACTO KNIFE | Used for clearing supports & cleanup | - | - |
| CRIMPING PLIERS FOR JST PH - PA09 | Needs to have 1.4mm and 1.6mm connector crimp slots - 4mm thick - PA-09 (or knock off) only. Annoyingly expensive! | $35.00 | AMAZON |
| LITHIUM GREASE | Highly recommend for lubricating axle of 3D printed scroll wheel | $8.00 | AMAZON |
| HAND HOBBY SAW | Used for cutting adjustable arm metal tube stock to length. Any metal hand saw or Dremel will work | $8.00 | AMAZON |
| HEAT SHRINK TUBE (MISC. SIZES) | Will be visible when build is complete so choose a color you like | $8.00 | AMAZON |
| HOT GLUE / HOT GLUE GUN | Optional for attaching Neopixel to board & securing nuts in slots for easier assembly. Can also use tape. | - | - |
| NEEDLE FILE SET | Optional - cleaning up prints | - | - |
| LOC TIGHT - BLUE | Optional - securing attachment screws in place to prevent loosening up over time | $9.00 | AMAZON |
| MULTIMETER | Multimeter or continuity tester for checking switches and trouble shooting. Doesn't need to be fancy. | | |
| HEX ALLEN WRENCH - 1.3MM | Hex L-key wrench for all screws. This can be stored in the bottom bracket on Statial.b after assembly is complete. | | |

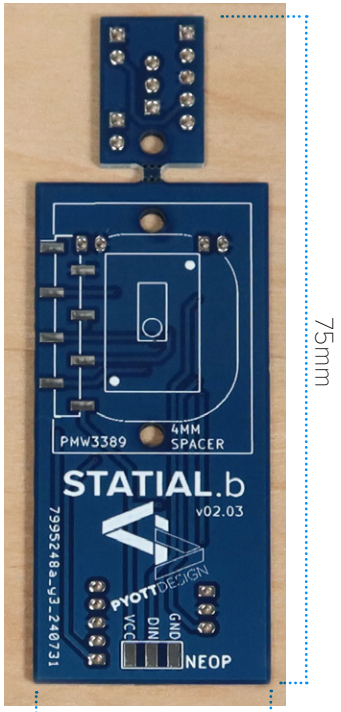
## CUSTOM PCB

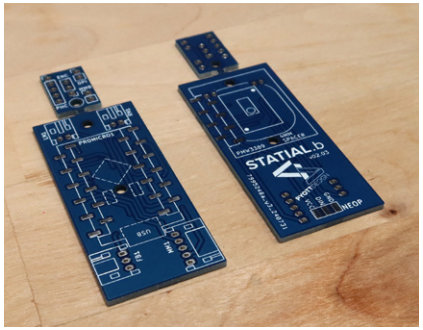
The Statial-b uses a custom printed circuit board (EL-03) to connect the Pro Micro (EL-01) and PMW3389 sensor (EL-02). The design has the main bridge board and a smaller middle mouse wire routing board connected by a snap off tab.

Gerber files can be downloaded as a ZIP file from the GitHub repository and ordered through any PCB fabrication house. I would recommend JLCPCB or PCBWAY for low cost boards.

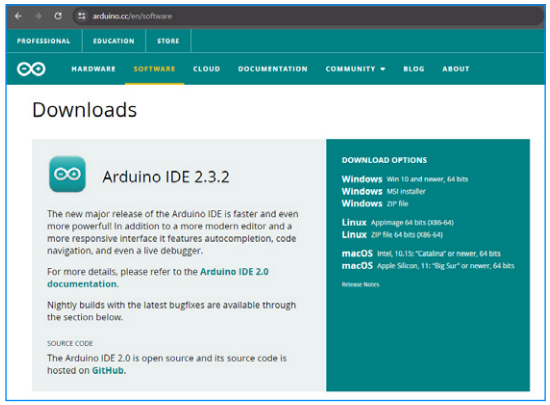
Upload the Statial-b Gerber ZIP file for instant quote order. **Make sure to specify "2 design board" when ordering.**

Select alternate PCB color if desired. The board is a simple dual layer design and all other settings can be left as default (cheapest) for ordering. Most fabrication houses will have a 5 piece minimum order.




Before starting build, load controller software onto Pro Micro (5v). This is to check that the control board is good before getting to far into assembly process (some of the clone Pro Micros can be a bit sketchy on the reliability front).

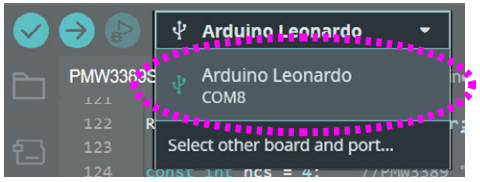



## A
## ARDUINO IDE

Download and install the Arduino IDE for your OS

## B
## STATIAL.B SKETCH

Download the STATIAL.b Arduino Sketch from GitHub and open in the Arduino IDE.



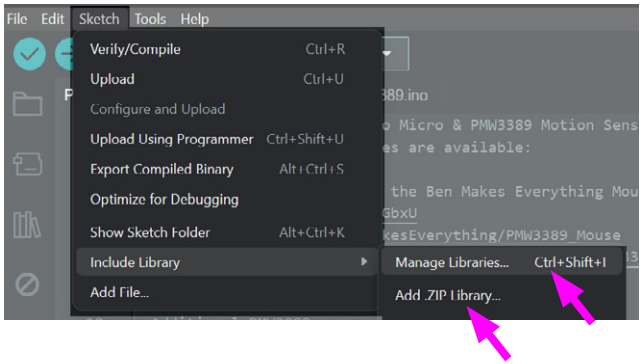

## C
## PRO MICRO

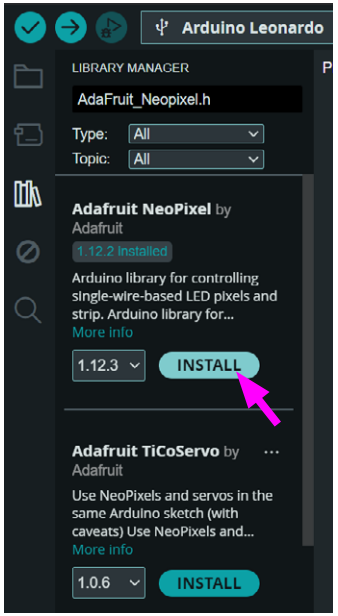
Plug in Pro Micro board using Micro USB cable. Device should appear as “Arduino Leonardo”.

## D
## LIBRARIES

Add required libraries: Mouse.h, Keyboard.h, Adafruit_Neopixel.h, RotaryEncoder.h, AdvMouse.h*

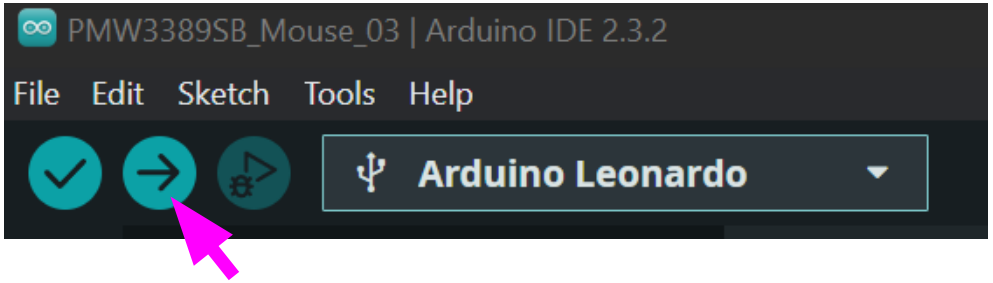
*AdvMouse.h can be downloaded from Ploopy’s GitHub repository and added manually as zip file: GITHUB.COM/PLOOPYCO

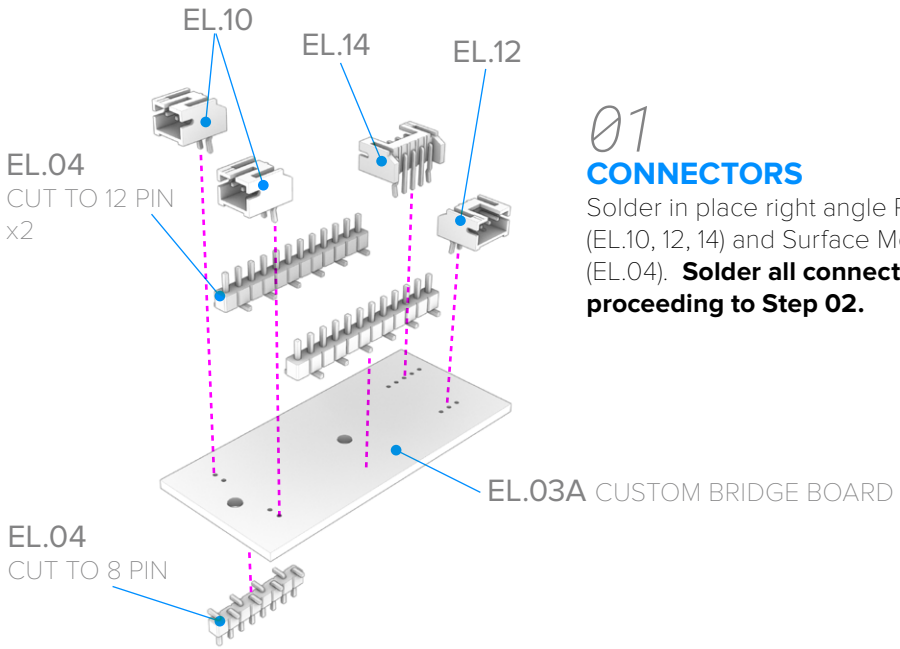



## E
## INSTALL

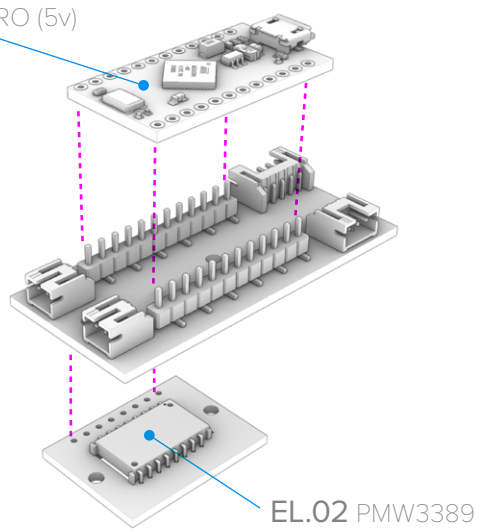
Upload sketch to Pro Micro & confirm the board is working. Mouse settings like LED brightness, DPI presets, button mapping, etc. can be adjusted once the Statial.b is fully assembled.






## 01 CONNECTORS

Solder in place right angle PH connectors (EL.10, 12, 14) and Surface Mount Headers (EL.04). **Solder all connectors before proceeding to Step 02.**

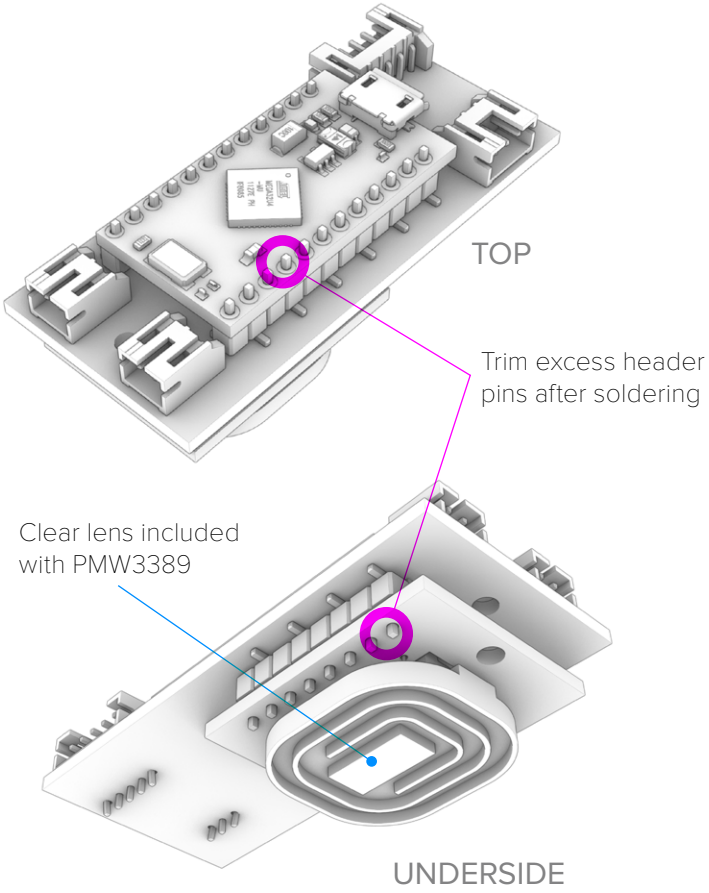



## 02 COMPONENTS

Solder in place ProMicro (5v) and PMW 3389. Trim excess header pins with wire cutters. **Ensure PMW optical senor is facing away from bridge board.**

Finished electronics, sensor should be working. Plug in the micro USB connector again to check that mouse tracking is working. Cursor should move when you move the electronics assembly on a surface.

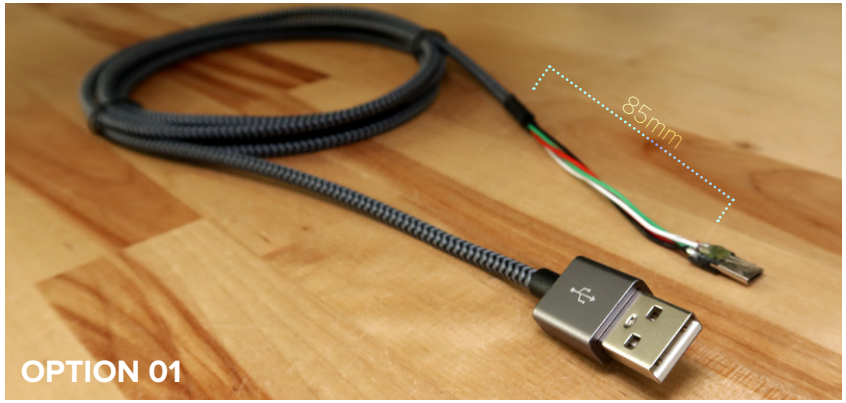
The focusing lens on PMW3389 is loose at this point so be careful while testing and keep it in safe place while continuing assembly.



## 03

### PREPARE MICRO USB CABLE

Carefully remove Micro USB connector cover & 85mm of sheathing from end of a common Micro USB to USB Type A cable using exacto knife. Cover Micro USB end of cable with heat shrink.




Alternatively, you can order a standard mouse replacement cable and Micro USB plug component & resolder. This will give you a thinner more flexible USB cable.

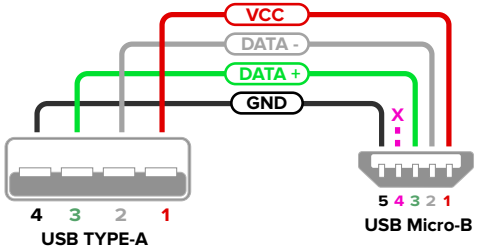
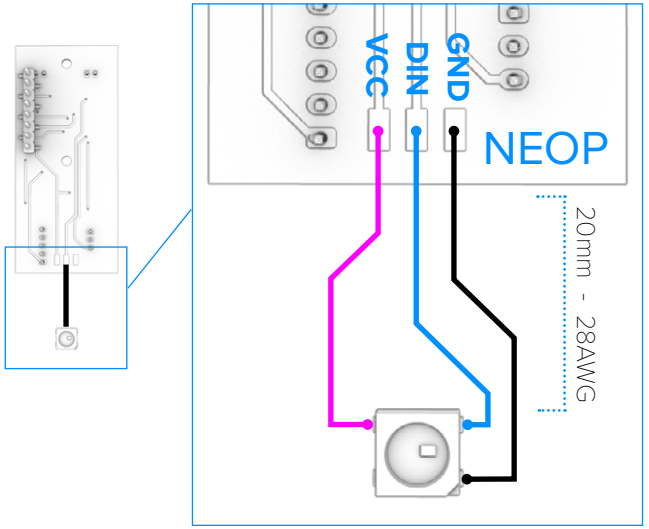


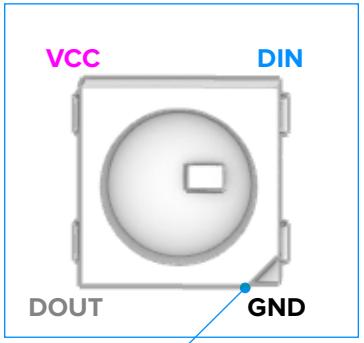

*DIAGRAM COLOR CODE MAY NOT MATCH WIRE COLORS!


## 04

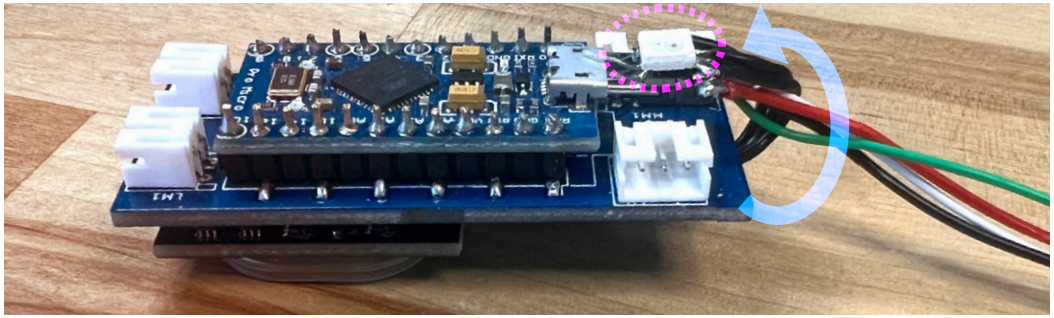
### WIRE NEO PIXEL

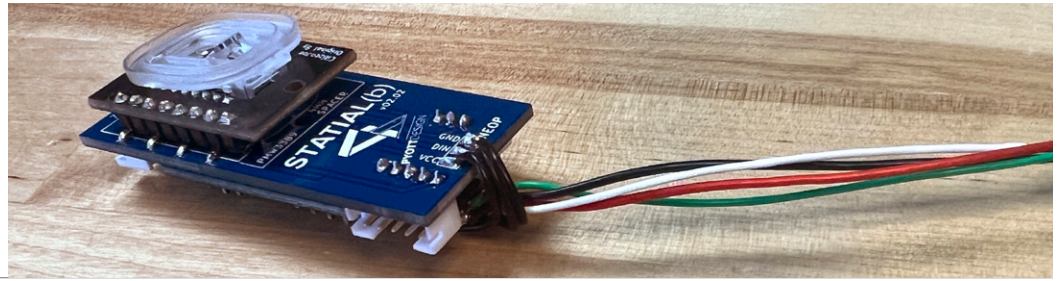
Solder NeoPixel to PCB using 28 gauge wire. Hot glue or double stick tape the LED to top of micro USB plug facing upwards.



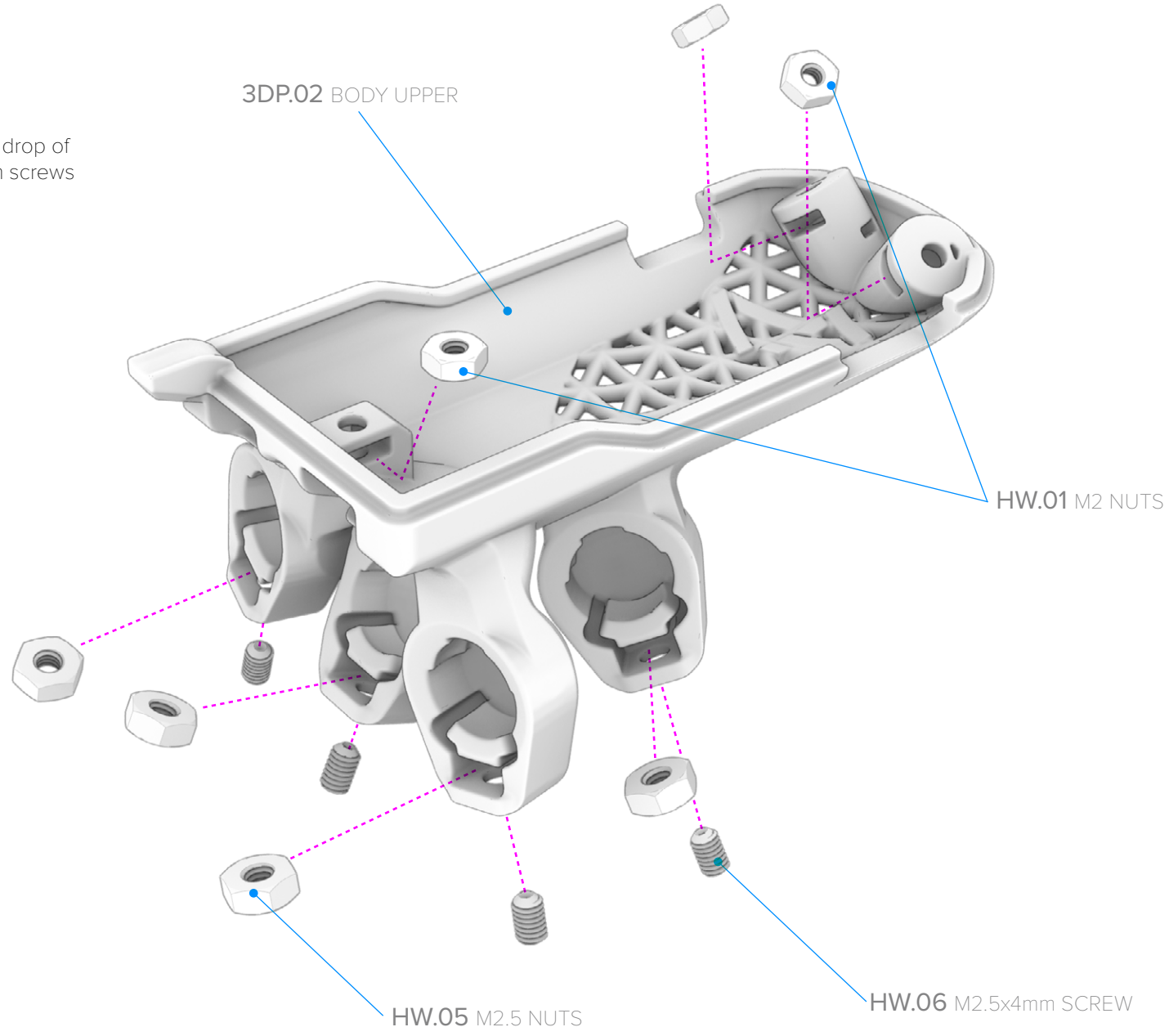

Triangle corner notch marks ground





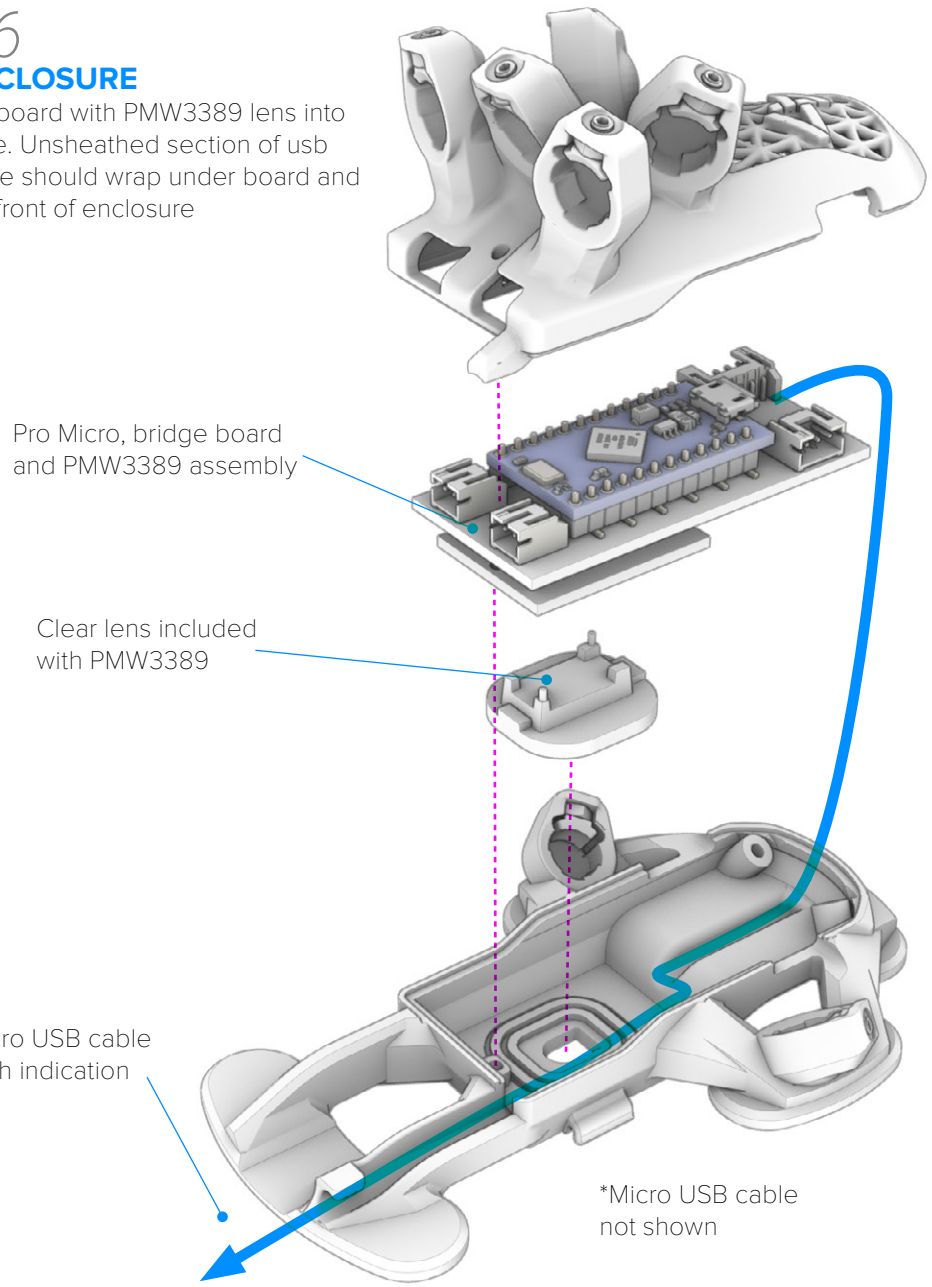
## 05
## NUTS

Seat nuts into holders. Secure with drop of hot glue if loose. Install m2.5 x 4mm screws into ball joint ends.



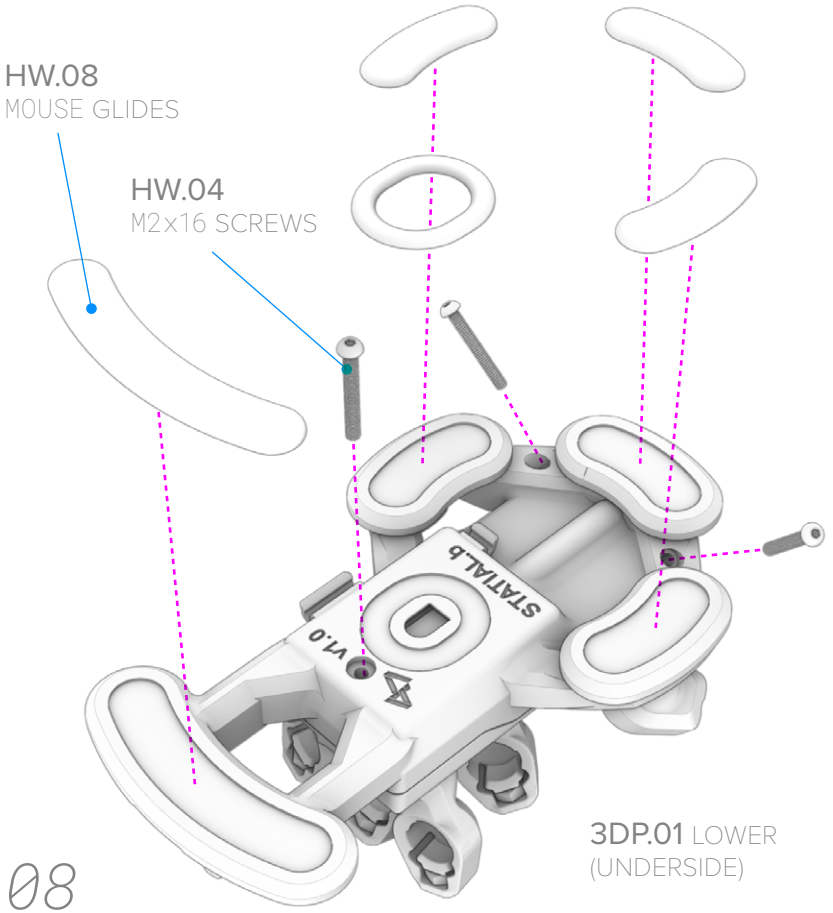
## 06
## ENCLOSURE

Set board with PMW3389 lens into base. Unsheathed section of usb cable should wrap under board and out front of enclosure



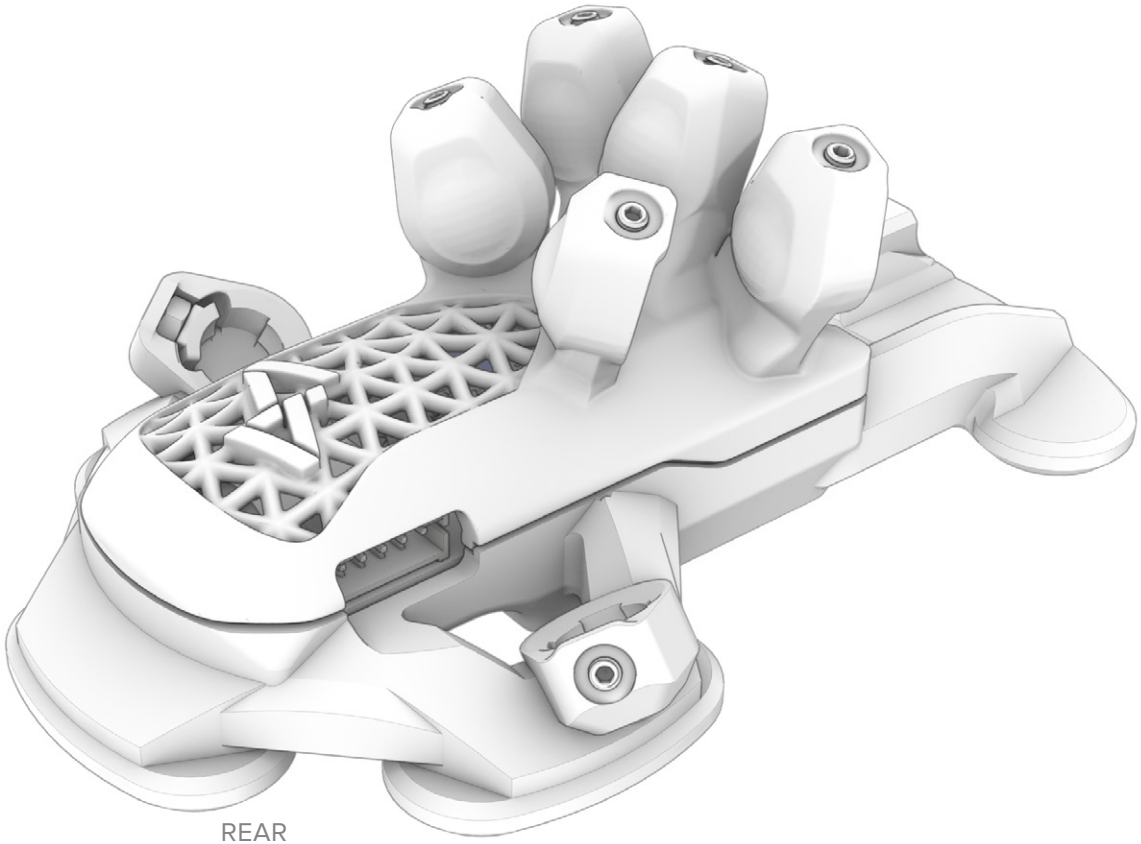

## 07
## GLIDES

Sand down any bumps in glide recesses and ensure surface is clean. Press adhesive backed mouse feet (HW.08) onto enclosure base. Glides must be for the newer generation Logitech G-Pro but can be from any 3rd party vendor.

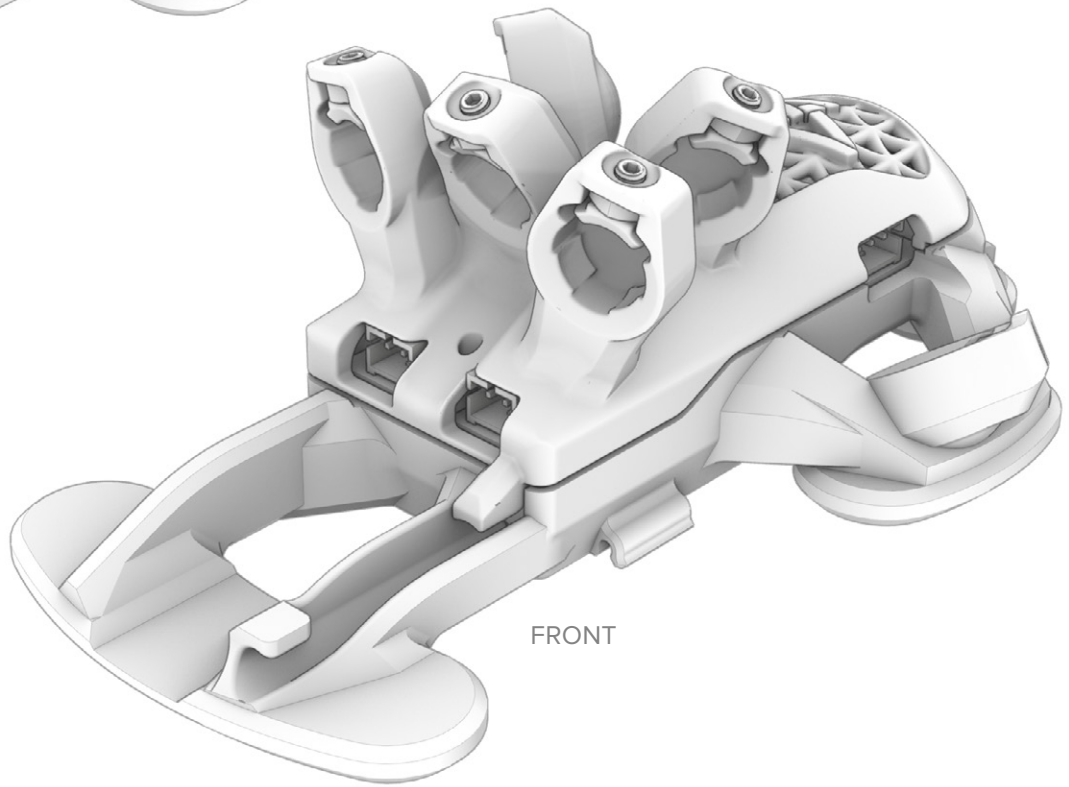



## 08
## SCREWS

Install m2 x 16mm screws (HW.04) to secure enclosure parts together.



REAR



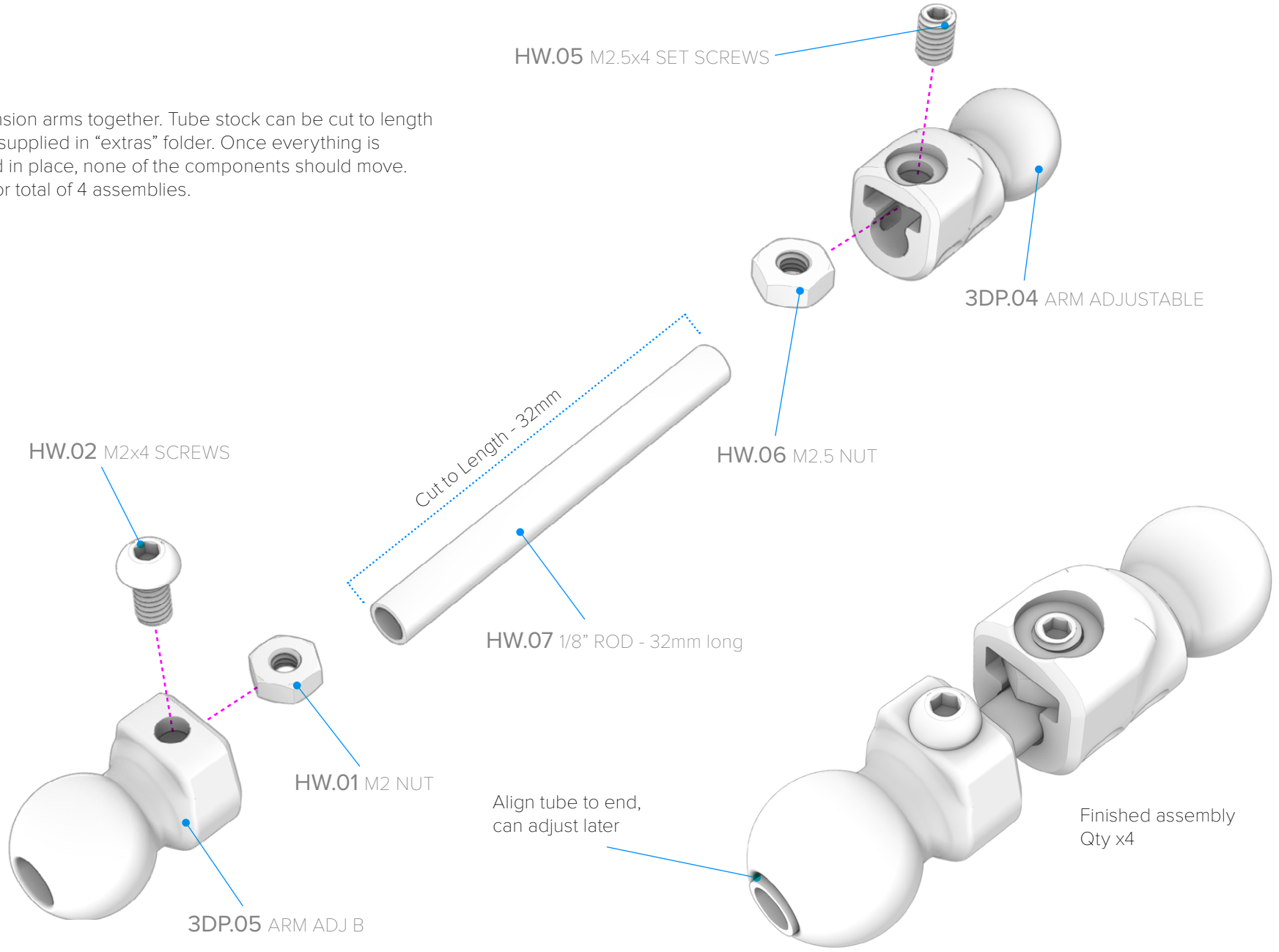
FRONT

*Micro USB connection
cable not shown

09

## ARMS

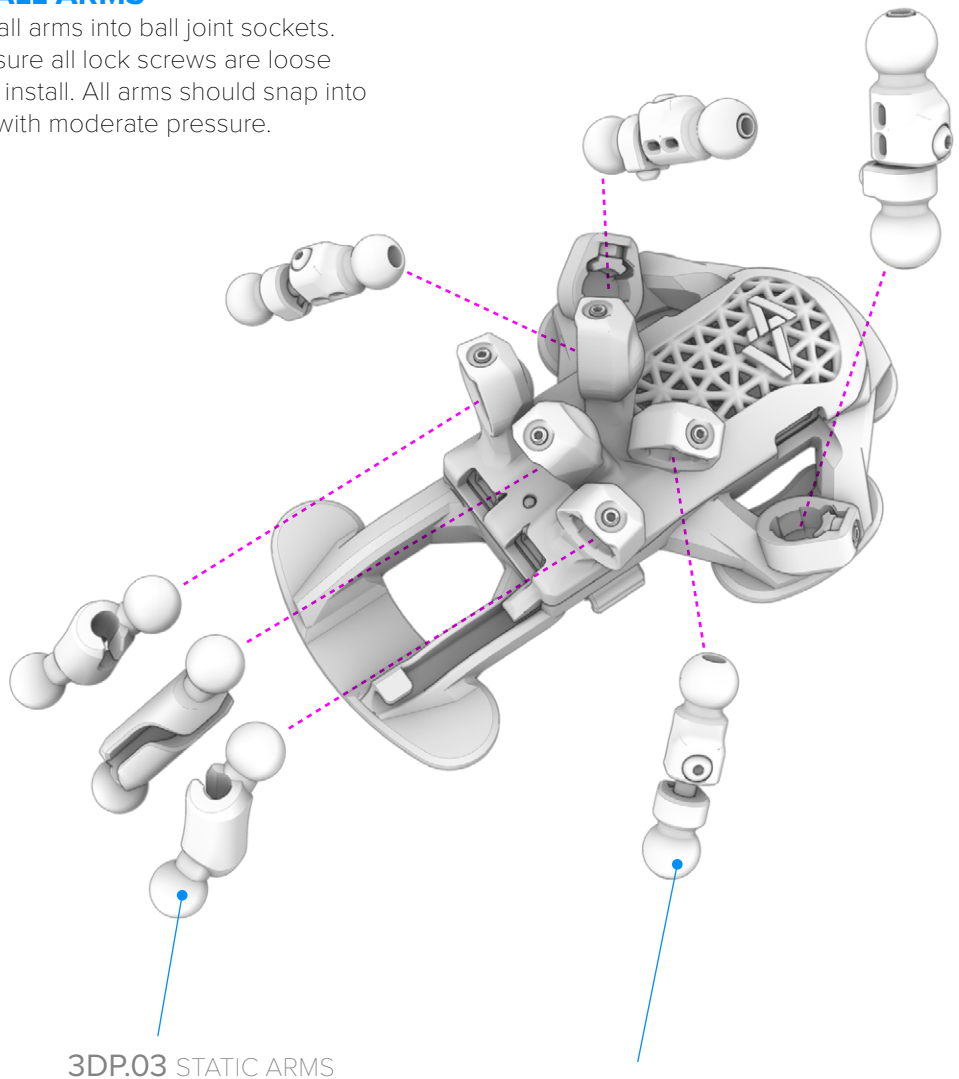
Put extension arms together. Tube stock can be cut to length using jig supplied in “extras” folder. Once everything is tightened in place, none of the components should move. Repeat for total of 4 assemblies.



*10*

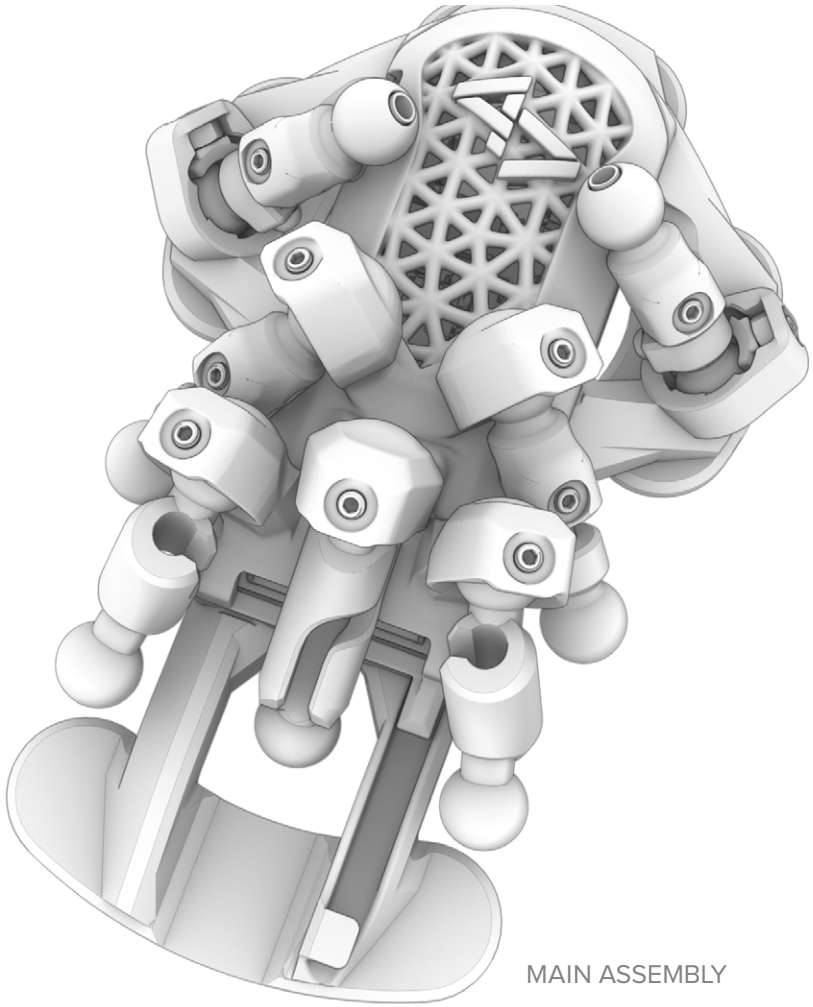
## INSTALL ARMS

Install all arms into ball joint sockets. Make sure all lock screws are loose during install. All arms should snap into place with moderate pressure.

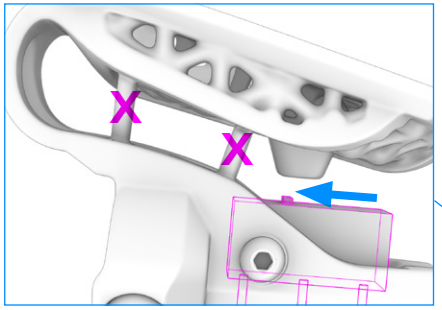


3DP.03 STATIC ARMS

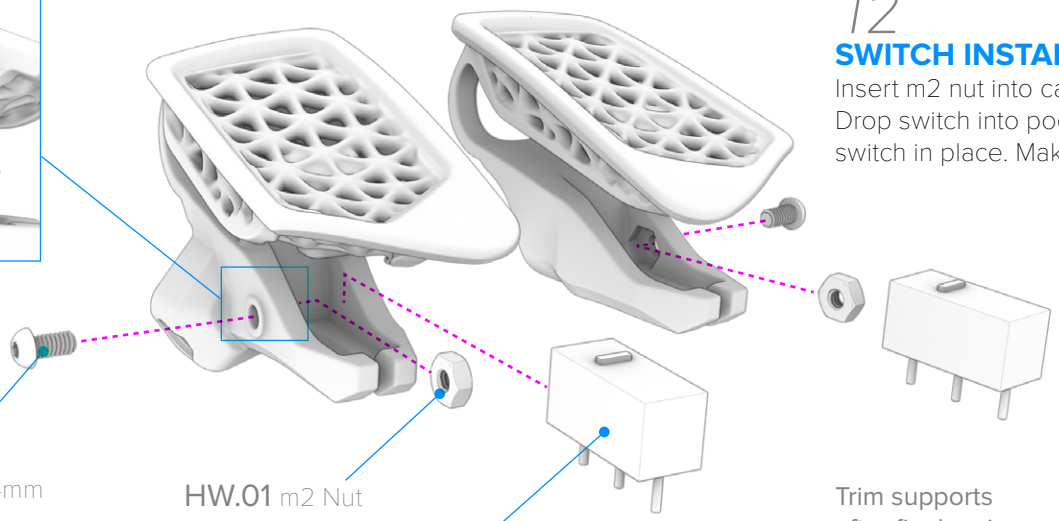
ADJ ARM ASSEMBLIES



MAIN ASSEMBLY

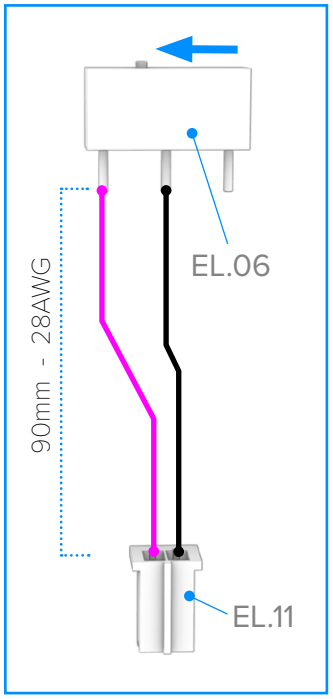


TRIM SUPPORTS AFTER CURE,
MOUSE SWITCH FACES BACK



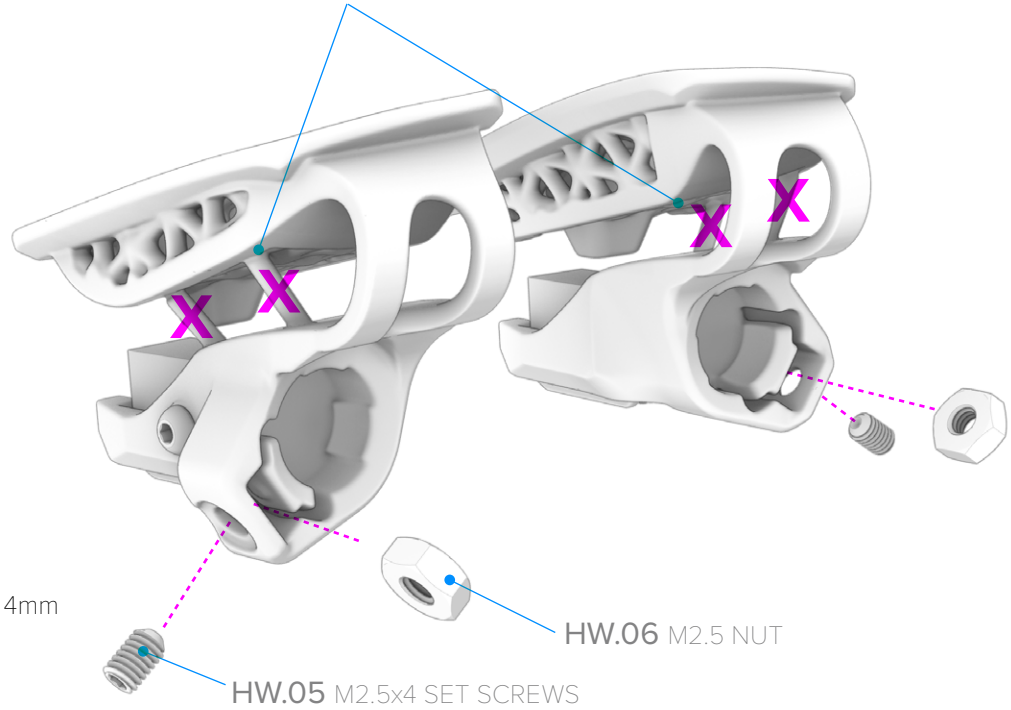

## 12
## SWITCH INSTALL

Insert m2 nut into capture pocket on inside of switch holder. Drop switch into pocket holder, screw in m2x4mm to secure switch in place. Make sure button is triggering when pressed.




## 11
## WIRE SWITCH

Solder leads to middle and switch-side posts. Crimp other wire ends and install into JST PH 2 pin plug. Which leads go into which plug post doesn't matter on this set.

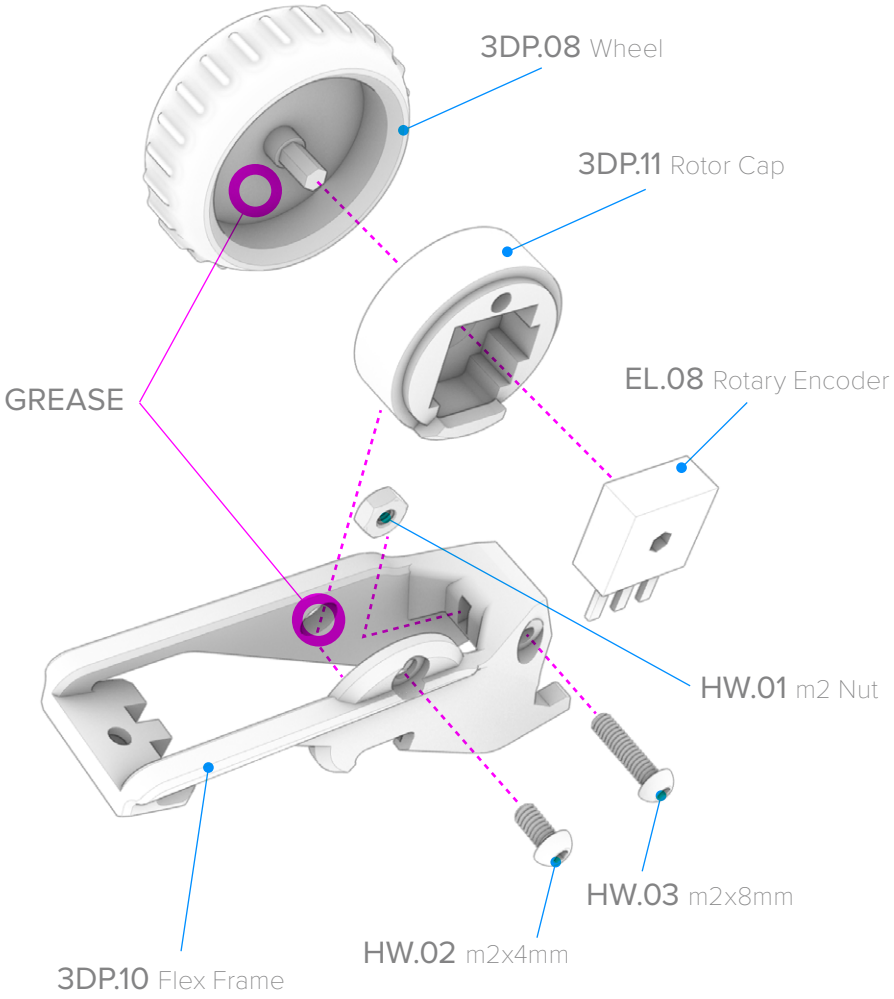


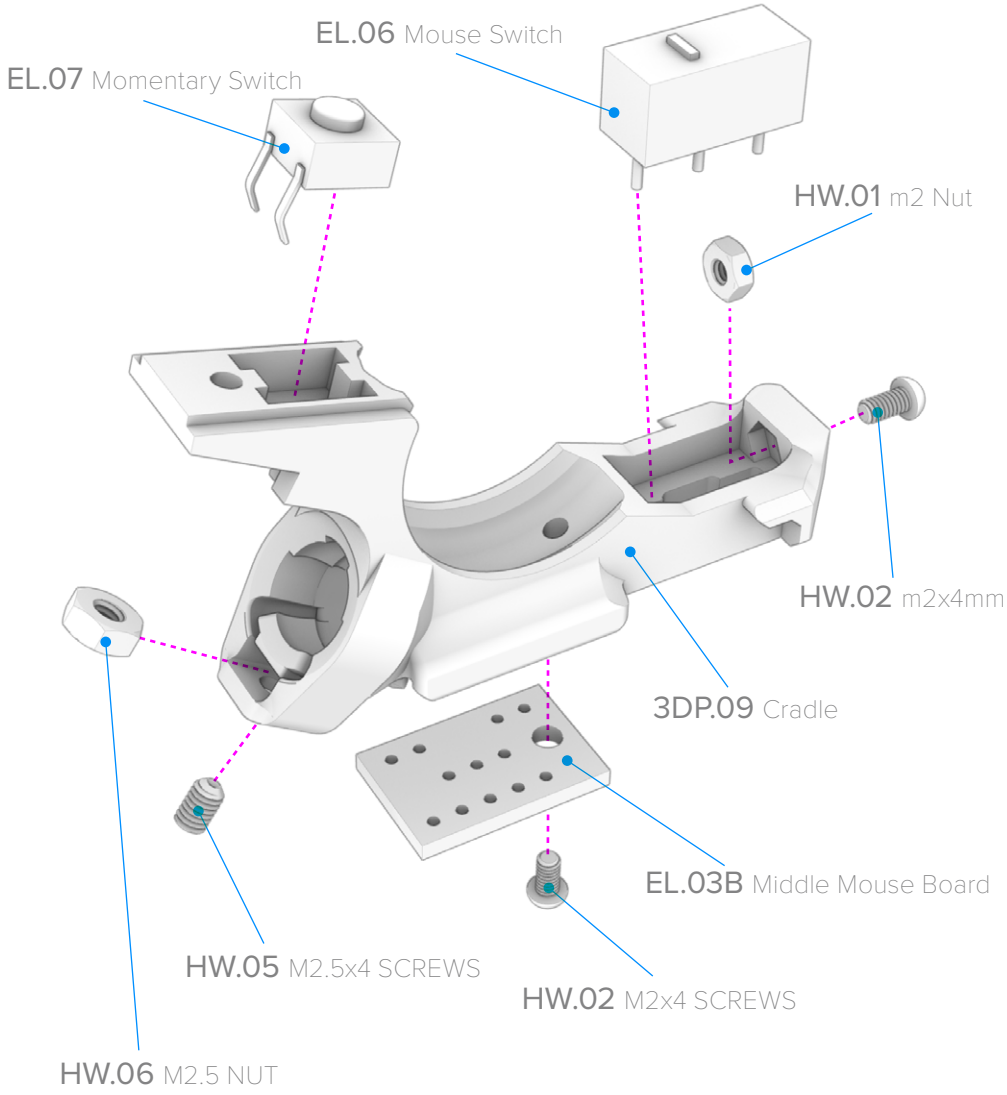

## 13
## BALL JOINT

Install m2.5 nuts and m2.5 x 4mm screws into ball joint ends.

## 14
## ROTOR ASSEMBLY

Press fit rotary encoder into rotor cap. Slide scroll wheel onto encoder and cap. Affix to flex frame using m2x8mm screw. Apply small dab of lithium grease on wheel axle/pivot area. **The Flex Frame is very fragile before being fully assembled. Be careful with it when removing print supports.**




## 15
## SWITCH INSTALL

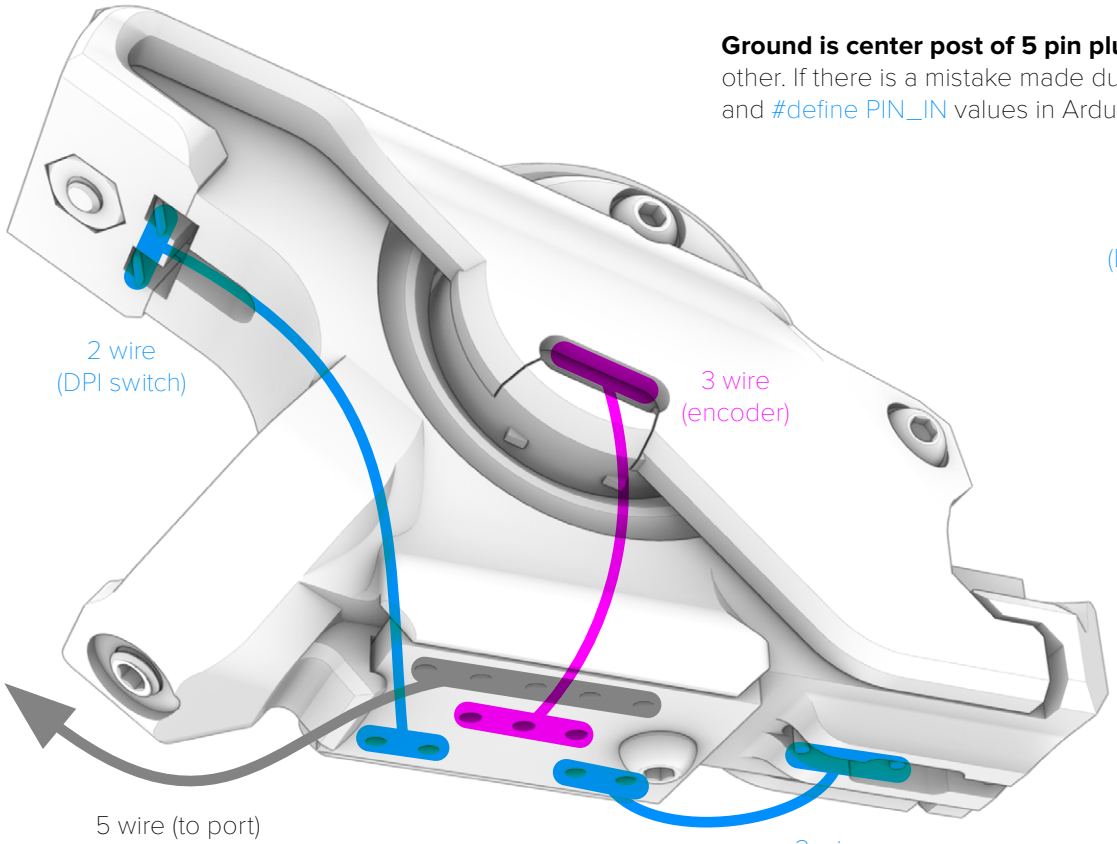
Trim unused posts on on side of DPI switch and seat into wheel frame. Install mouse switch retention screw and ball joint retention screw & nut.

16

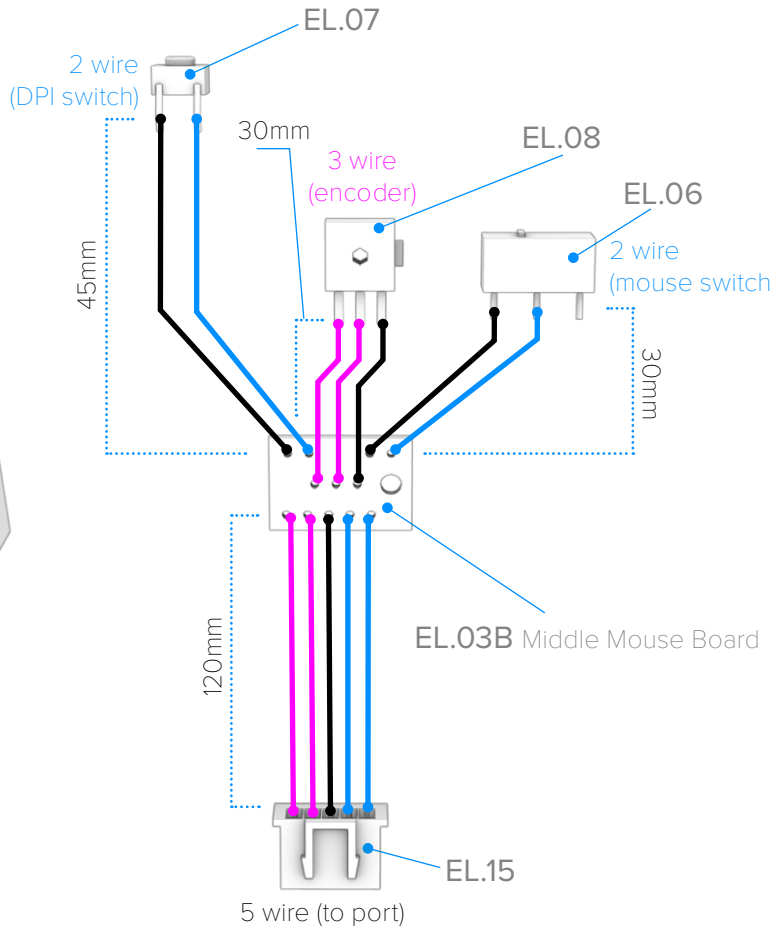
## WIRE MIDDLE

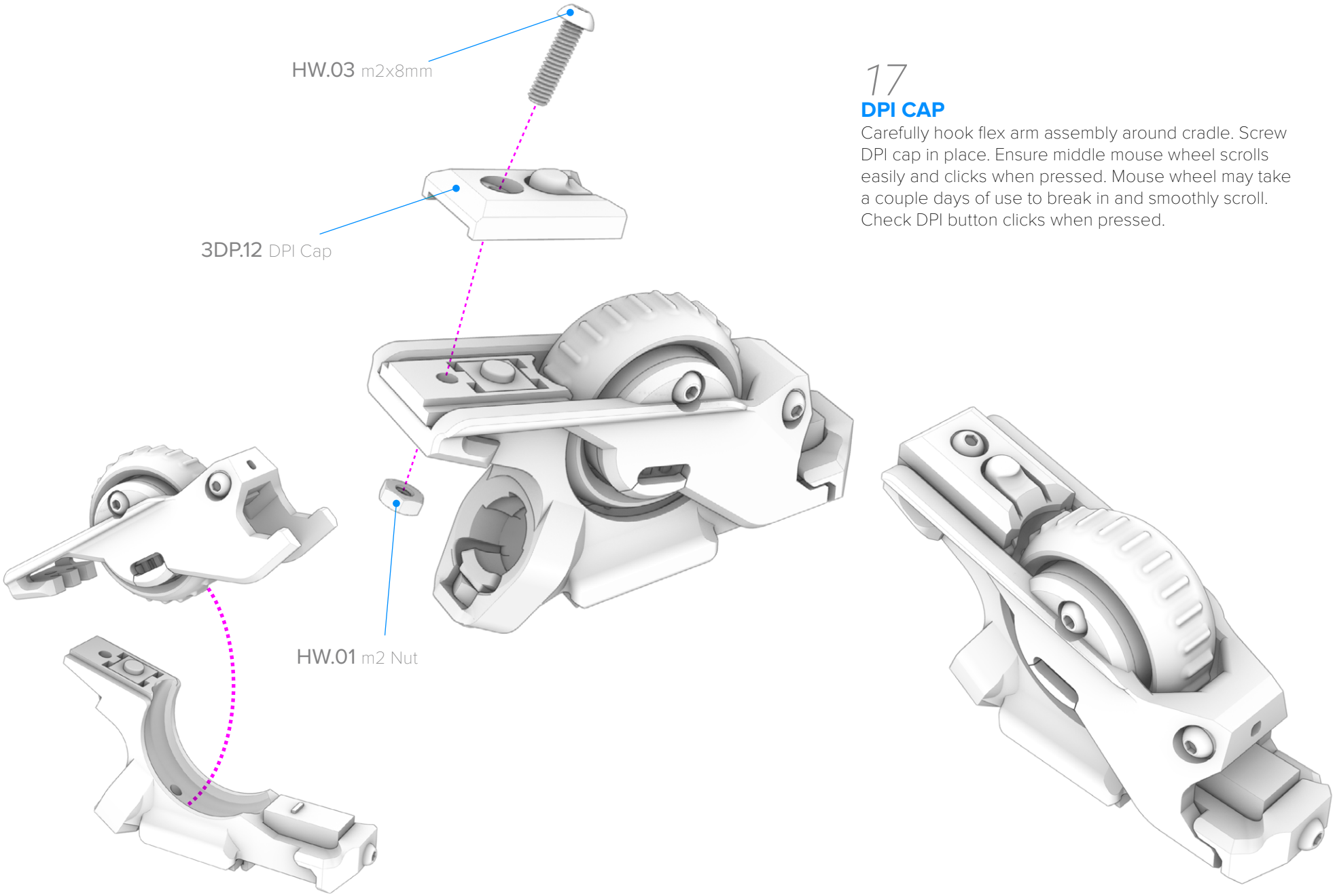
This is the most complicated area to wire on the whole build. Rotary encoder, DPI button and Mouse Switch all route into mini PCB. Please note recommended wire lengths connecting each component. **DPI switch and front mouse button wires must be fed through wheel cradle before final soldering.**

**Ground is center post of 5 pin plug.** Rotary encoder set is on one side, switches are on the other. If there is a mistake made during wiring it can be fixed by changing software #define Btn and #define PIN_IN values in Arduino IDE.




WIRE ROUTING

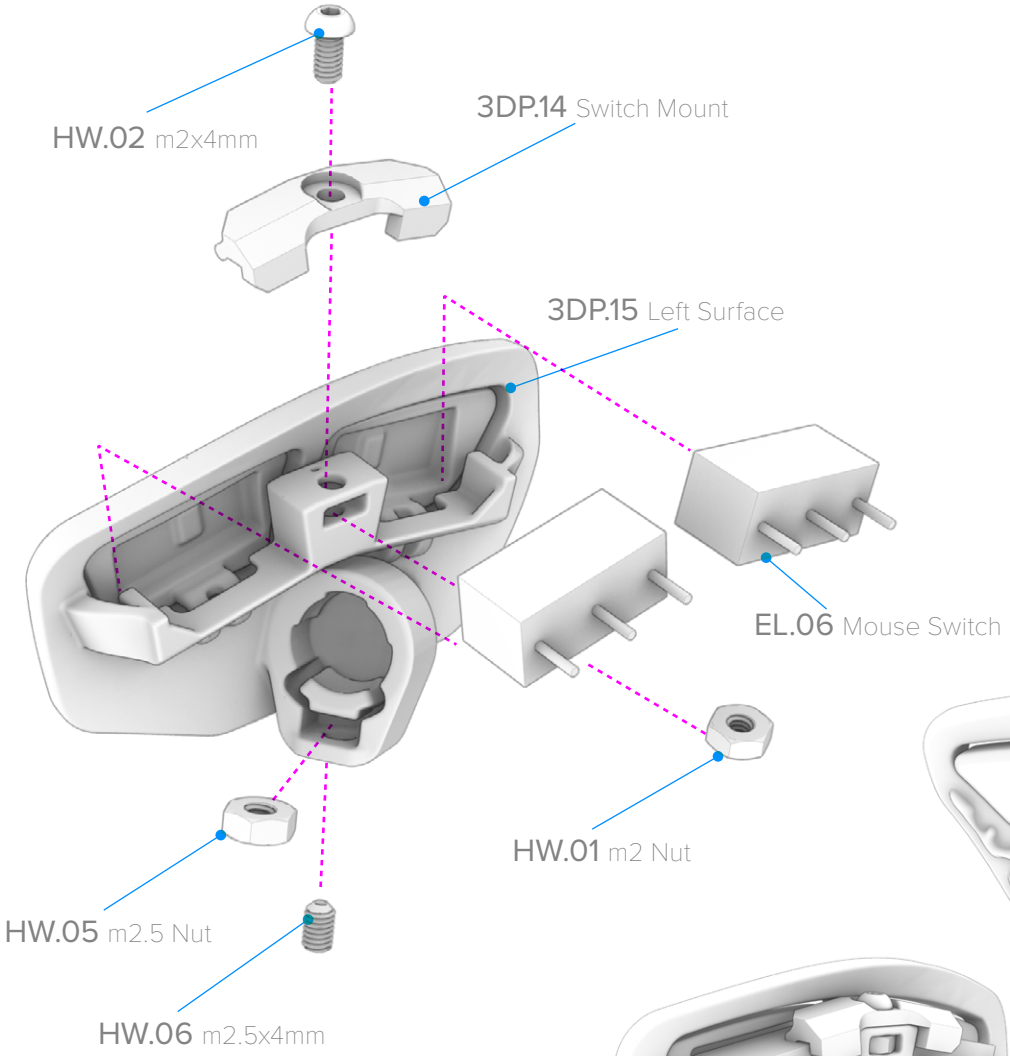


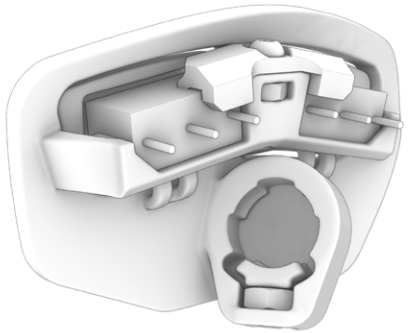



17

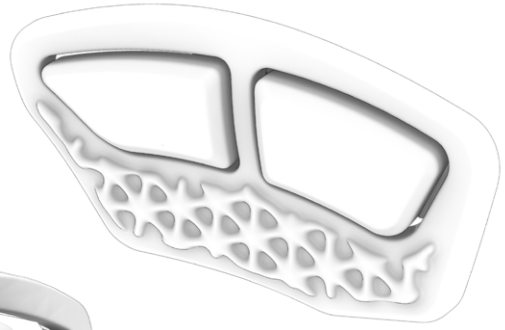
## DPI CAP

Carefully hook flex arm assembly around cradle. Screw DPI cap in place. Ensure middle mouse wheel scrolls easily and clicks when pressed. Mouse wheel may take a couple days of use to break in and smoothly scroll. Check DPI button clicks when pressed.



FINISHED LEFT SURFACE

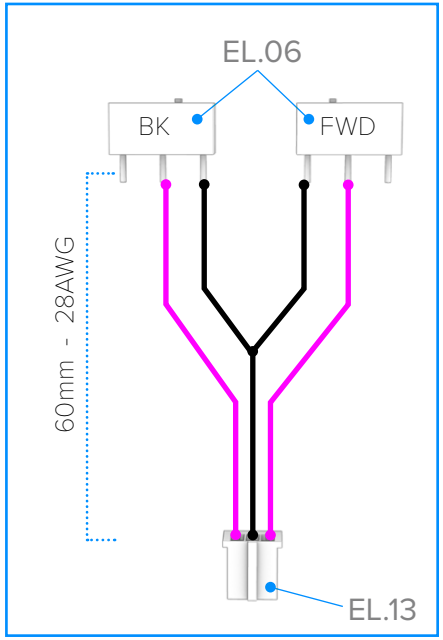


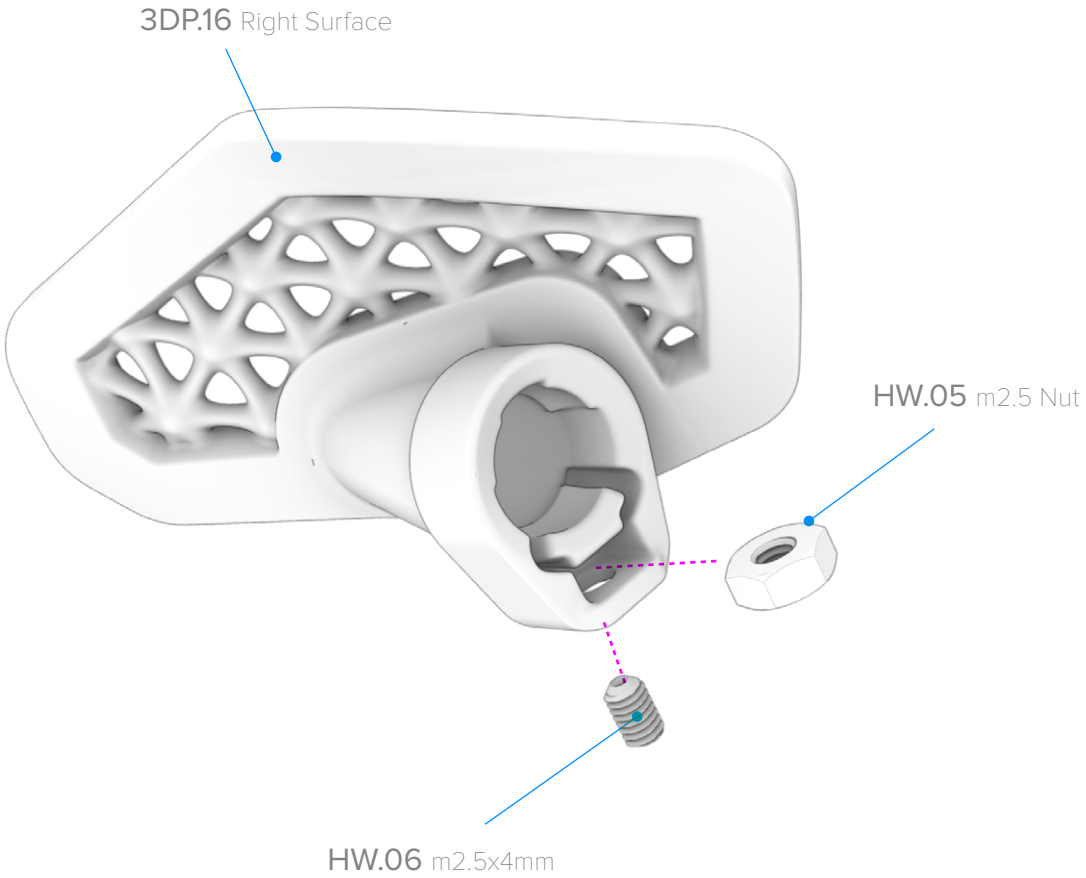
## 18
## LEFT SURFACE

Seat switches into holders and m2 nut into slot. Attach Switch Mount to secure components in place. Assemble ball joint clamp.

Switches are wired with shared ground going into center pin of plug. Forward and back buttons are on either side. If button pins are wired backwards, remove switch mount and swap switch locations (no need to re-solder).

If you are building this for left handed use, the alternate mirrored version of this file should be used (found in the extras folder).



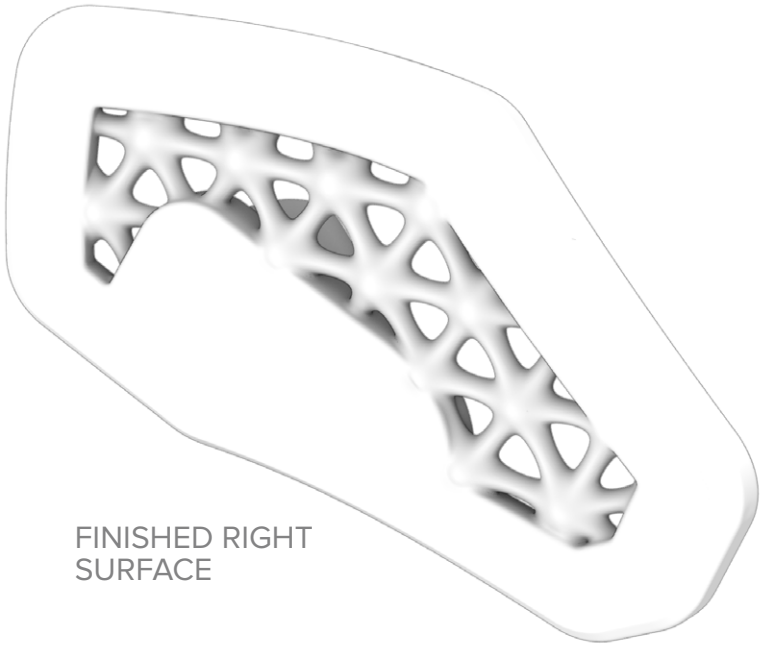



19

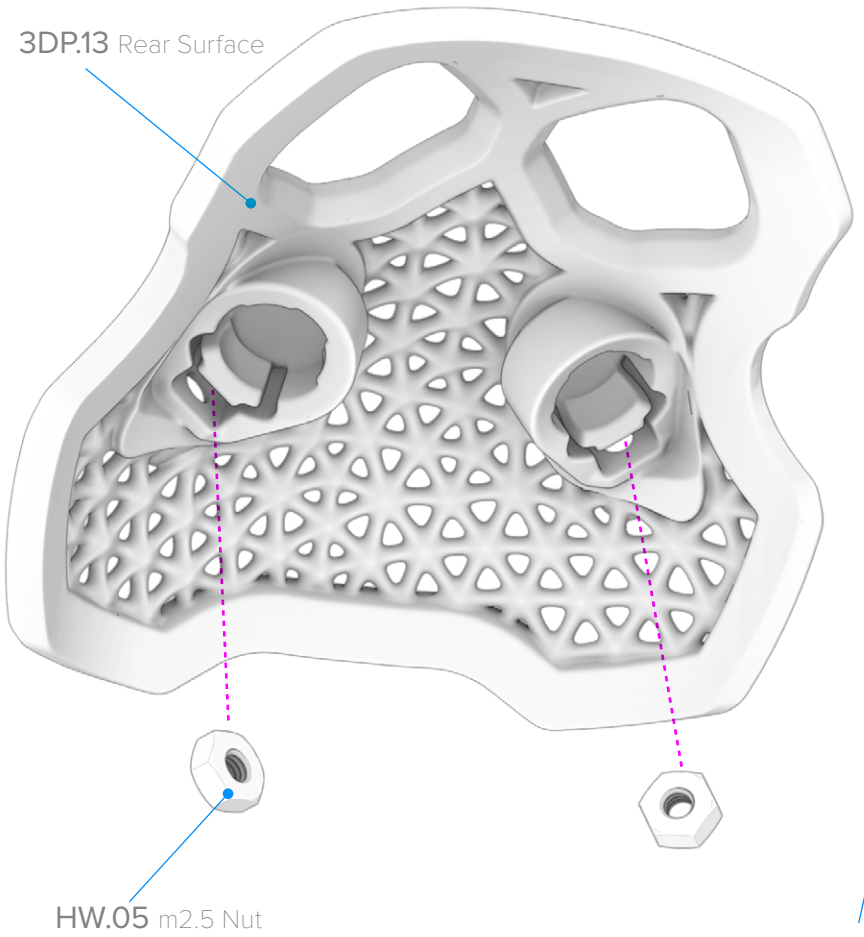
## RIGHT SURFACE

Assemble ball joint clamp with normal screw/nut combo.

If you are building this for left handed use, the alternate mirrored version of this file should be used (found in the extras folder).



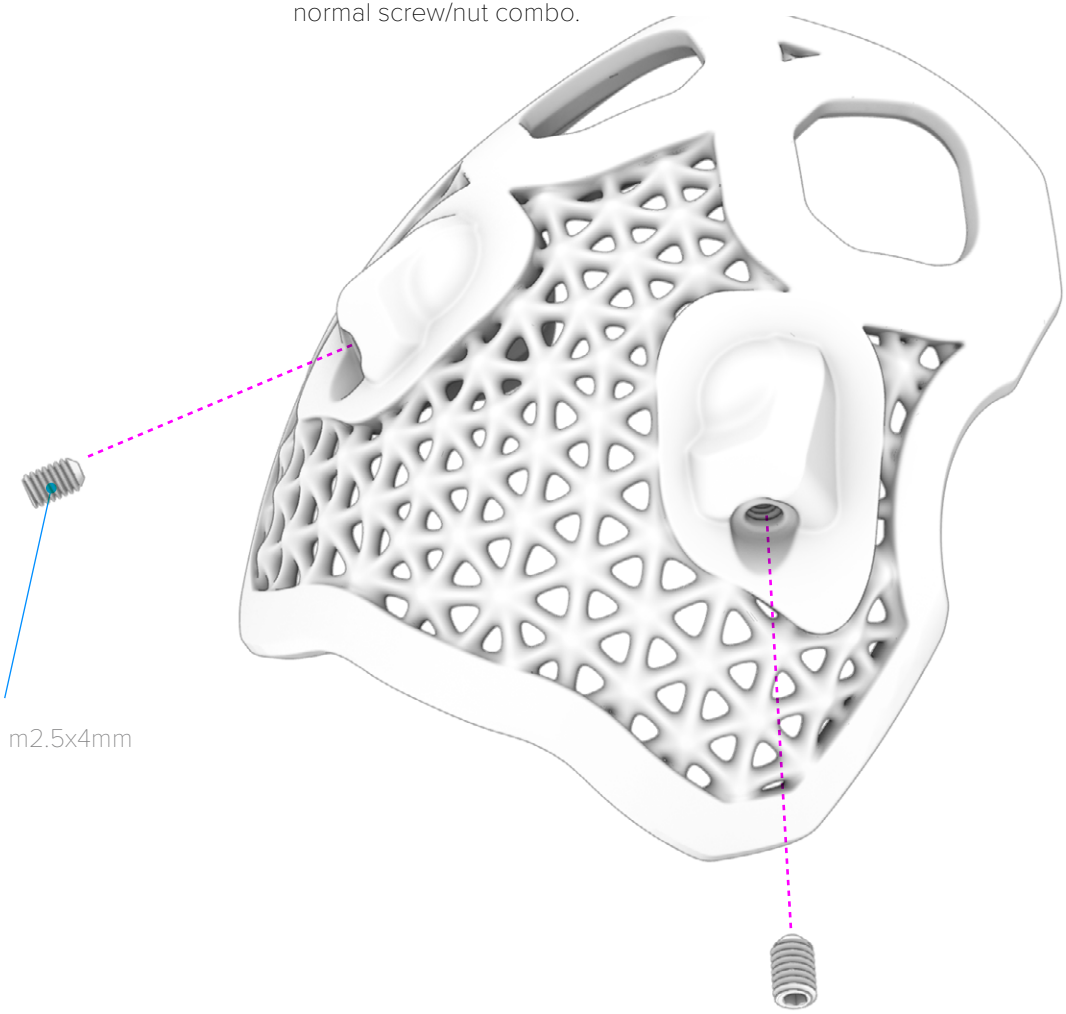
FINISHED RIGHT SURFACE

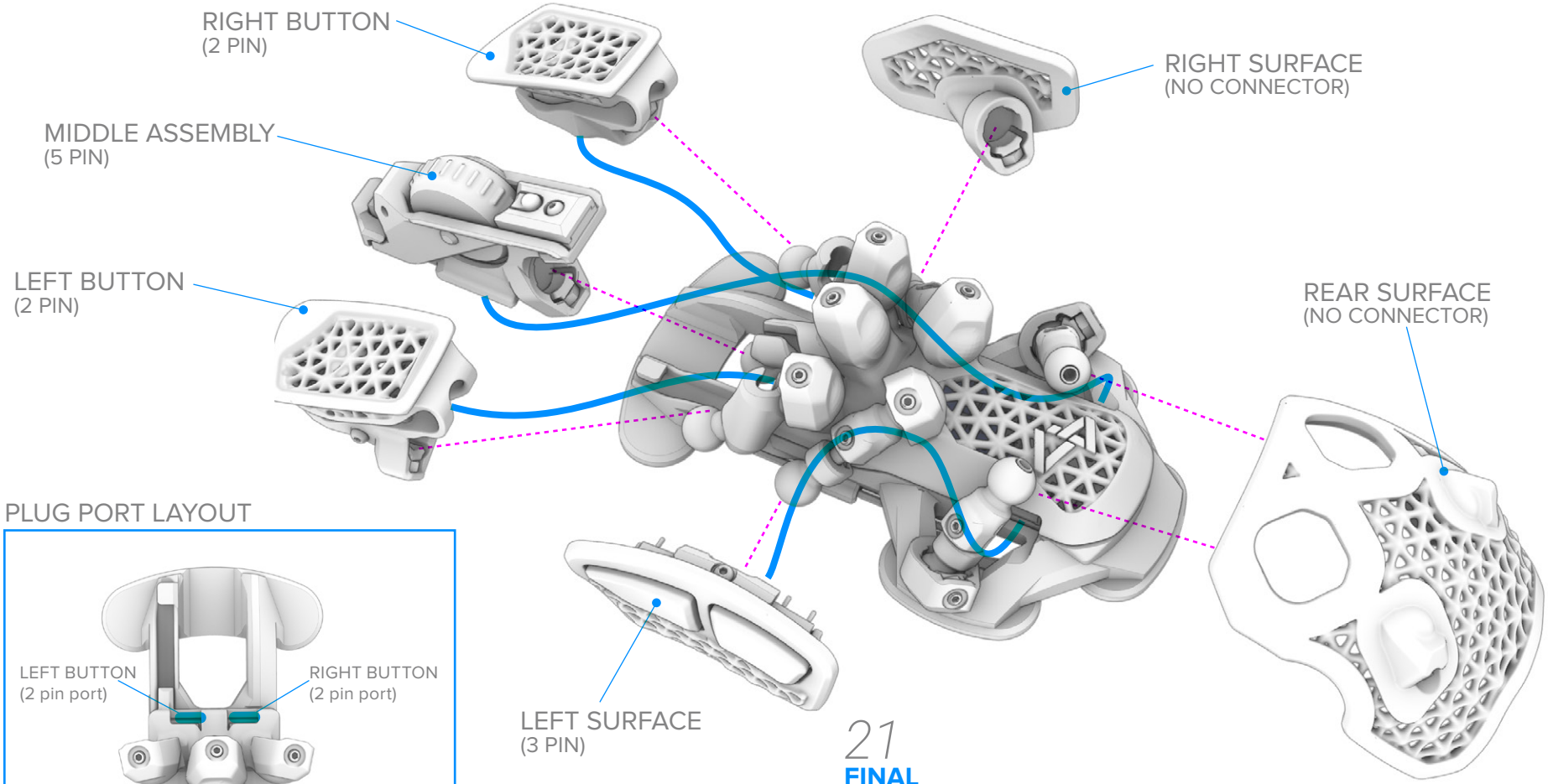



20

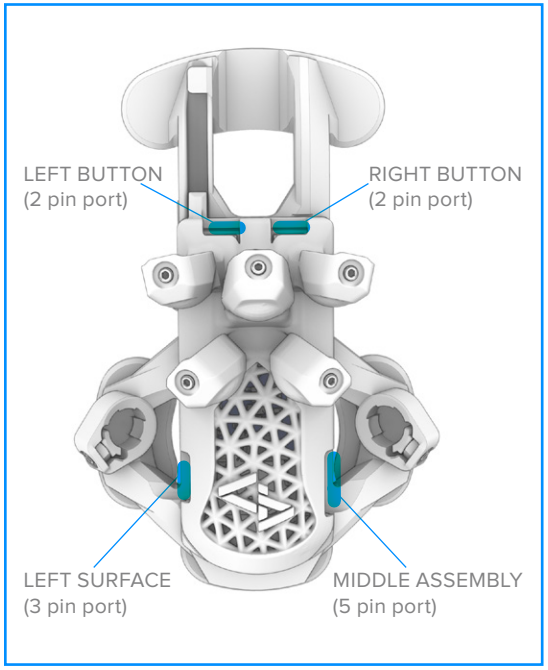
## REAR

Assemble ball joint clamp with normal screw/nut combo.






## PLUG PORT LAYOUT



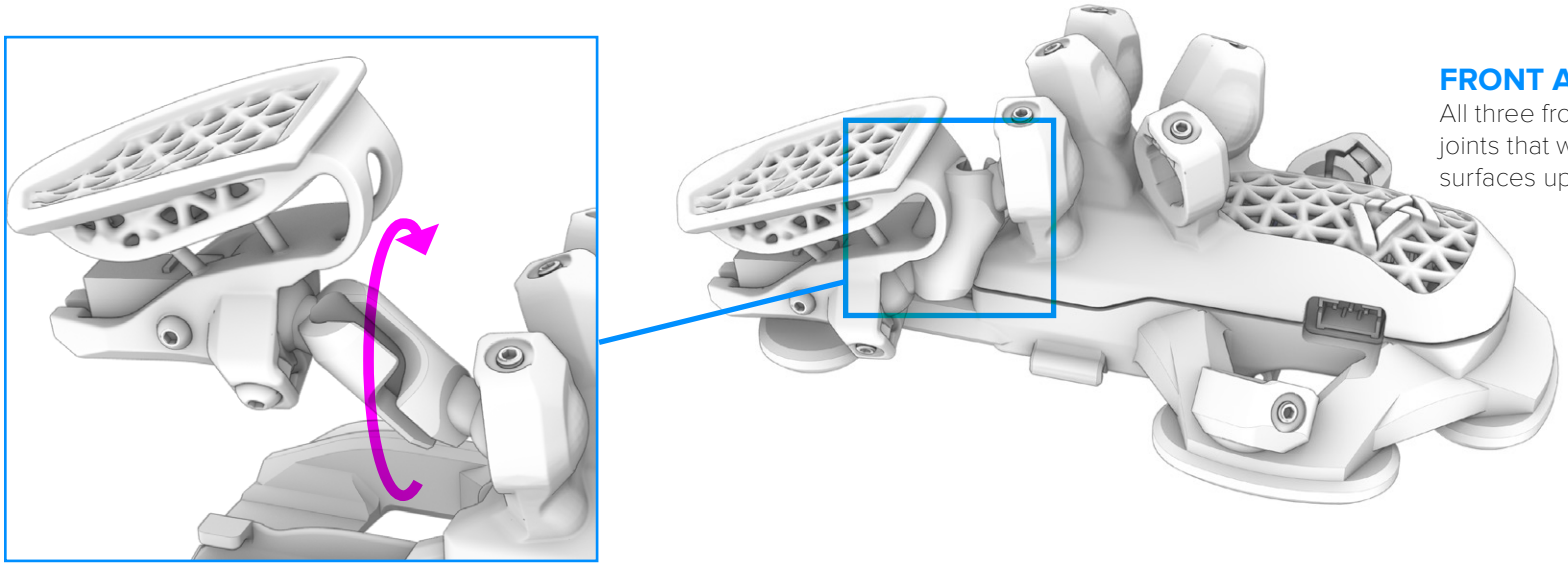

21

## FINAL

Plug in the Front Left, Front Right, Middle and Left Side electronics connectors into their matching ports. All cables should have noticeable slack when in position. **Be careful not to over tension connector wires when moving surfaces!**

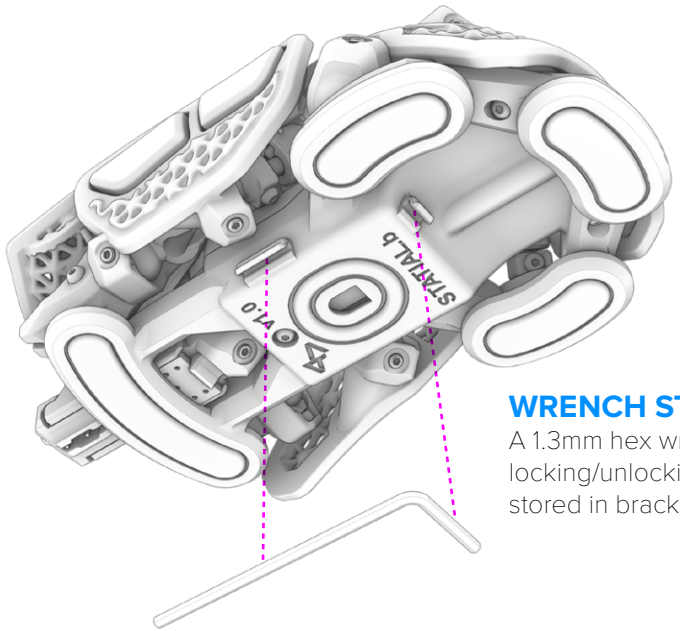
Snap all assemblies onto their matching ball joints. Parts should snap on with firm pressure. If not seating correctly ensure ball joint locking screws are backed out.

Plug in the mouse and check that everything is working. Assembly complete!



## FRONT ARMS

All three front arms have asymmetrical joints that will shift the connected surfaces up when rotated.

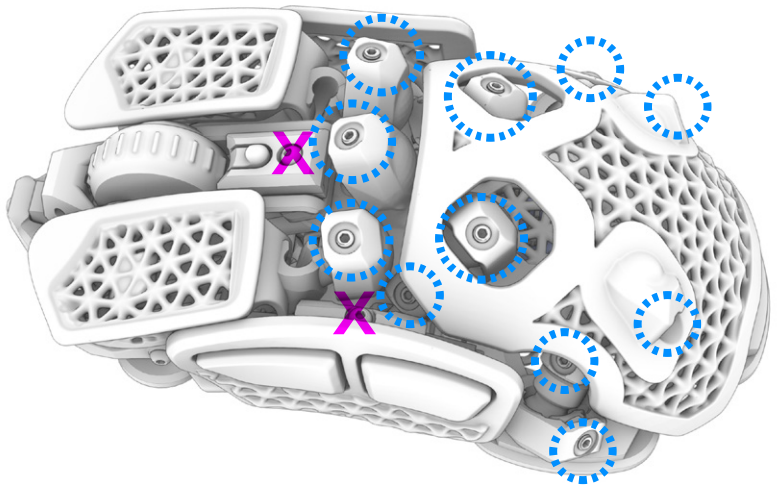


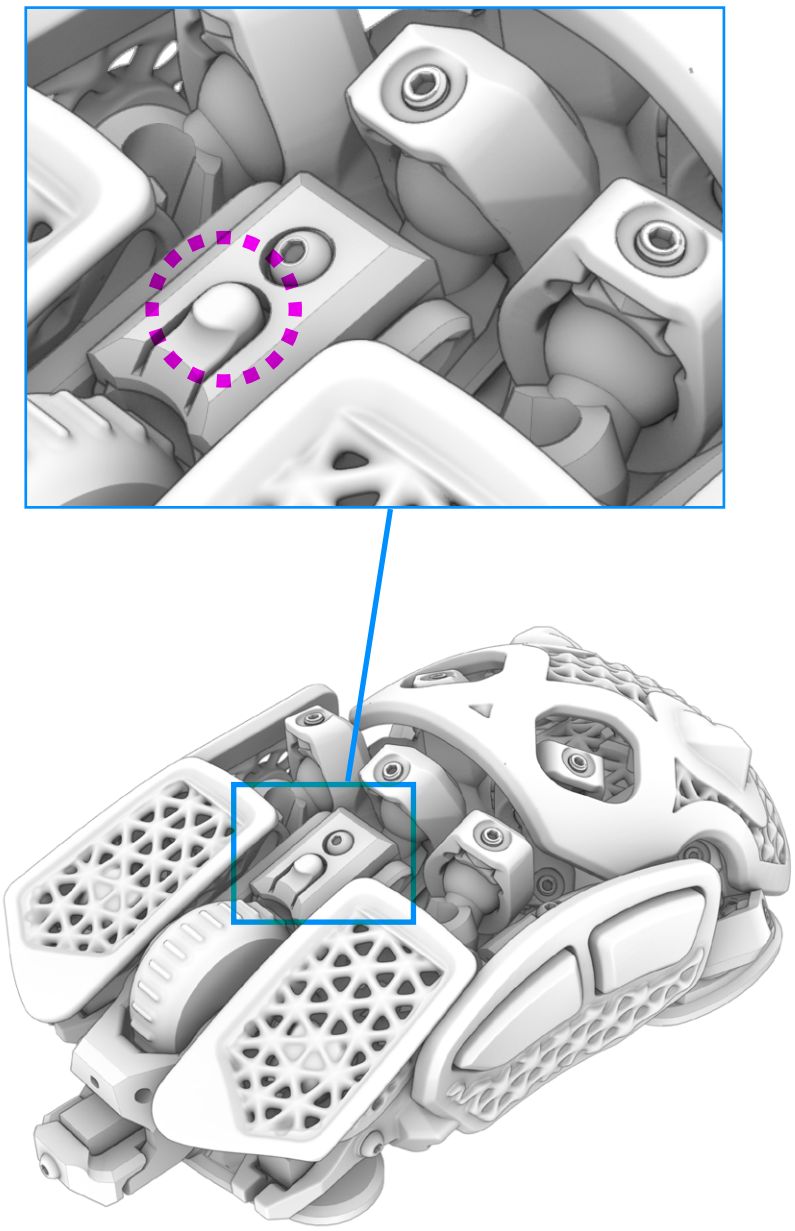

## WRENCH STORAGE

A 1.3mm hex wrench used for locking/unlocking surfaces can be stored in bracket under Statial.b

## 1.3MM WRENCH

It takes some practice to get familiar with which screws release which surfaces for adjustment. Both the 2mm button head screws and 2.5mm set screws use the same size 1.3mm hex wrench. The set screws are always used for adjustable surfaces, the 2mm button head screws are always for “permanent” parts.





## DPI TOGGLE

The button above the wheel toggles DPI with matching LED color switching. Default startup setting is 2,000 DPI / Purple. Pressing button switches between:

- 400 /Yellow
- 800 / Green
- 1,600 / Teal
- 2,000 / Blue
- 2,300 / Purple (default)
- 2,600 / Red
- 3,600 / Orange

Key assignments, DPI Presets and LED behavior can be all be altered via the Arduino IDE.

```
127  int Btn_pins[NUMBTN] = {Btn1_Pin, Btn2_Pin, Btn3_Pin, Btn4_Pin, Btn5_Pin};
128  bool Btns[NUMBTN] = {false, false, false, false, false};       // button state indicator
129  uint8_t Btn_buffers[NUMBTN] = {0xFF, 0xFF, 0xFF, 0xFF, 0xFF};  // button debounce buffer
130  char Btn_keys[NUMBTN] = { MOUSE_LEFT, MOUSE_RIGHT, MOUSE_MIDDLE, MOUSE_FORWARD, MOUSE_BACK };
131
132  int Key_pins[NUMBTN] = { Btn6_Pin };
133  bool Keys[NUMBTN] = { false };           // button state indicator
134  uint8_t Key_buffers[NUMBTN] = { 0xFF };  // button debounce buffer
135  char Key_keys[NUMBTN] /*= {240}*/;
136
137  //Colors·that·represent·the·CPI/DPI·setting:·Yellow=0,·Green=1,·Teal=2,·Blue=3,·Purple=4,·Red=
138  int·DpiColor[NUMCPI][6]·=·{··{·140,·115,·0,·0·},·{·0,·255,·0,·0·},·{·0,·155,·100,·0·},·{·0,·55
139
140  unsigned·long·Cpis[NUMCPI]·=·{·400,·800,·1200,·1600,·2000,·2600,·3600·};
141  struct CpiUpdater {
142    bool target_set;
143    bool updated;
144    uint8_t target_cpi_index;
145  };
146
147  CpiUpdater CpiUpdate = { false, false, 4 };  // Default Dpi = Cpis[2]
148
149  byte initComplete = 0;
150  bool inBurst = false;   // in busrt mode
151  bool reportSQ = false;  // report surface quality
152  int16_t dx, dy;
153
154  unsigned long lastTS;
155  unsigned long lastButtonCheck = 0;
156  unsigned long curTime;
```

Modern mouse grip styles have grown out of players adapting to the shape of a mouse. The Statial.b creates the opportunity for new mouse shapes to grow out of grip styles. Below are some common grip type configurations for the Statial.b as starting points for further adjustment.

## PALM

When fully collapsed the Statial.b is slightly smaller than a normal high performance mouse. Surfaces can be moved out significantly for XL hands.

## STUBNOSE CLAW

Unlike a normal mouse, the buttons on the Statial.b can pitch forward for different grip types. This allows claw grip users to position buttons perpendicular to pressing motion.

## VERTICAL

Surfaces can be configured to +50° angle to mimic the fit of a vertical mouse. Fixed ends of rear surface arms can be extended or longer sections of tube can be cut for even steeper angles.

## BACKLESS FINGER

Surfaces can be configured to experiment with alternate grip methods. Finger grip users can remove back surface entirely.