

# GENERAL DESCRIPTION

*karaloop* P3



### *karaloop* – Prototype 3 (P3)

**P3** is a fully adjustable light-weight wireless headset that measures voluntary movements of the face and translates them into mouse/keyboard commands sent via Bluetooth Low Energy (BLE) to any PC, iOS or Android device.

**P3** consists of a padded headband (1) designed to provide extensive-use comfort; two hubs (2, 4) housing an Arduino-compatible Bluefruit nRF52 Feather board that is automatically recognized via BLE as a human-interface device (HID) by any PC, iOS or Android device, and a rechargeable built-in battery that delivers hours of wireless use in a single charge; and three probes (3, 4, 6) that detect voluntary movements of the face. Two mechanical contact probes (3, 4) capture orofacial movements bilaterally via magnetic-based sensing, and a contactless probe (6) captures forehead movements via optical sensing.

Designed for easy setup, **P3** is calibration-free and only requires an initial mechanical adjustment to ensure a stable and comfortable fit for all-day use of mainstream devices without hands.



**P3 components.** (1) Head band; (2) Left hub; (3) Left magnetic probe; (4) Right magnetic probe; (5) Right hub; (6) Optical probe.

# ASSEMBLY DESCRIPTION

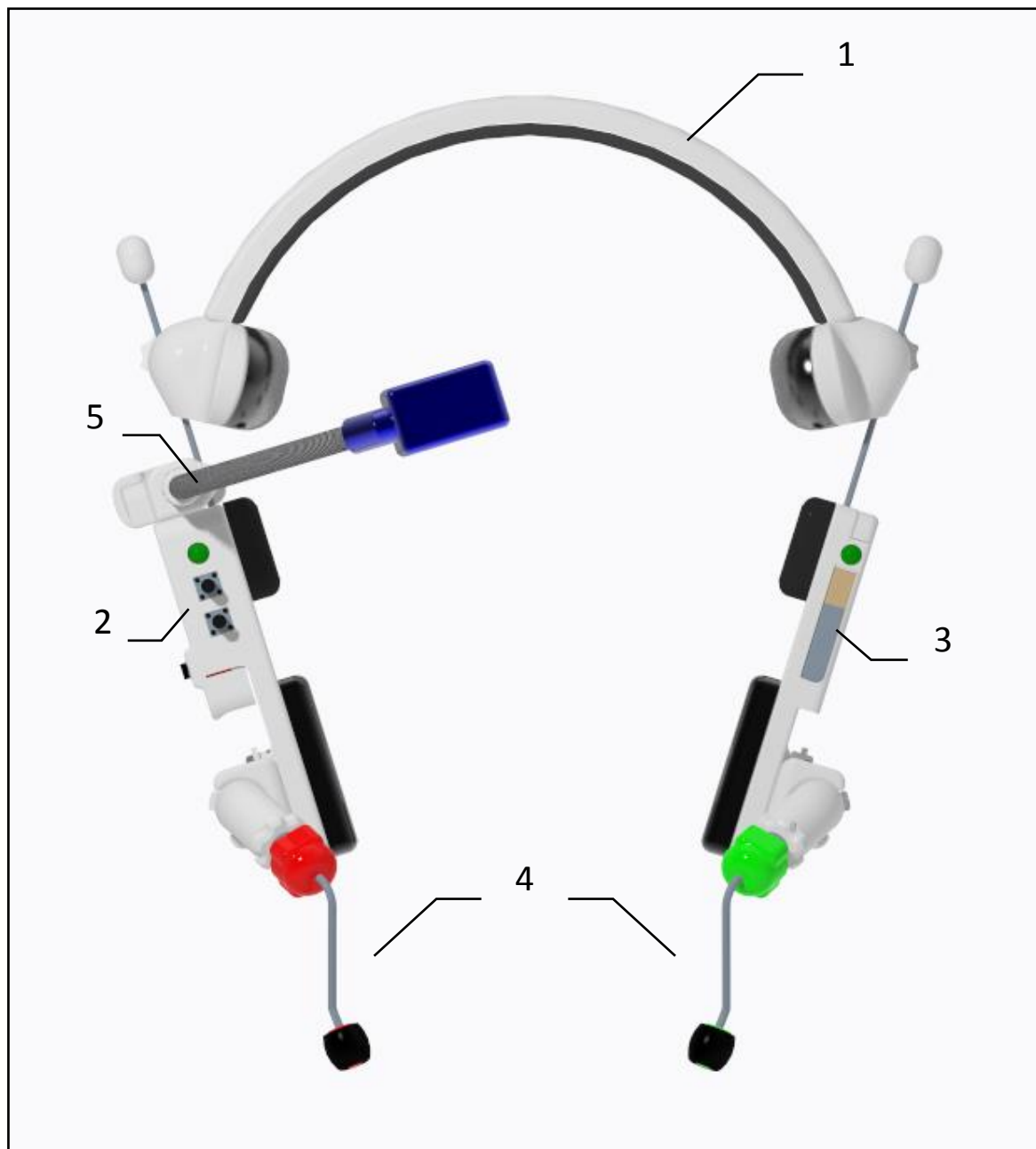
*karaloop P3*



# CONTENTS

<b><i>karaloop P3</i></b> .....	3
General assembly .....	5
1. Headset band sub-assembly.....	6
Fabrication process .....	7
2. Right Hub sub-assembly .....	8
Fabrication process .....	9
3. Left Hub sub-assembly.....	11
Fabrication process .....	12
4. Magnetic probe sub-assembly.....	13
Fabrication process .....	14
5. Optical probe sub-assembly .....	17
Fabrication process .....	18
Optical sensor circuit schematic.....	20
PCB optical sensor Layout .....	21
PCB optical sensor parts list (PCB-PL).....	21
Electronic parts list (EPL) .....	22
General circuit schematic.....	23
Mechanical parts list (MPL) .....	24
Printed parts list (PPL) .....	25

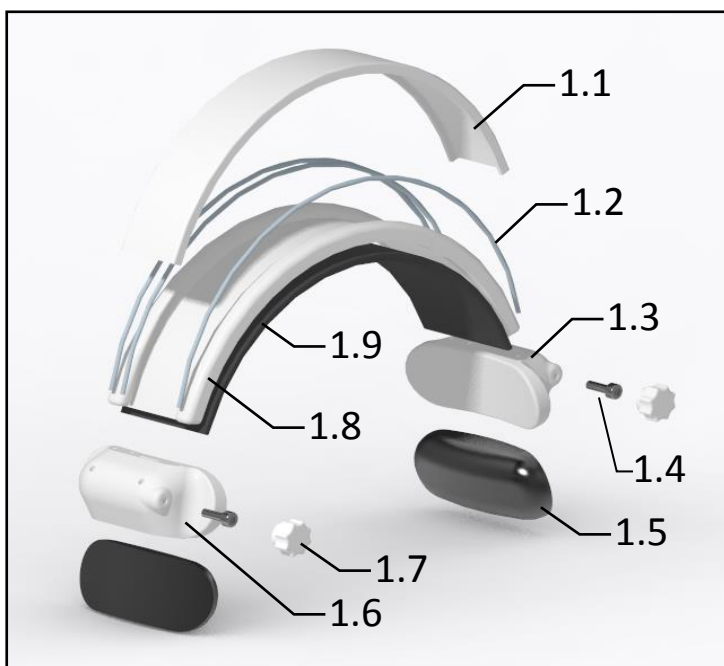
## General assembly



N°	Part description	Abbreviation	Quantity
1	<a href="#">Headset band sub-assembly</a>	HB	1
2	<a href="#">Right hub sub-assembly</a>	RH	1
3	<a href="#">Left hub sub-assembly</a>	LH	1
4	<a href="#">Magnetic probe sub-assembly</a>	MP	2
5	<a href="#">Optical probe sub-assembly</a>	OP	1

## 1. Headset band sub-assembly

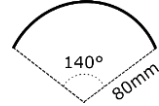
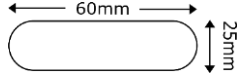
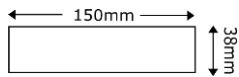
The padded headset band ensures stable yet adjustable (Right and Left hubs) functionality for all-day comfort.



N°	Part description
1.1	Flexible top cover
1.2	Curved spring wires (3x)
1.3	Right side node
1.4	Allen screw M3x10 (2x)
1.5	Side padding (2x)
1.6	Left side node
1.7	Locking wheel (2x)
1.8	Flexible headband
1.9	Top padding

## FABRICATION PROCESS

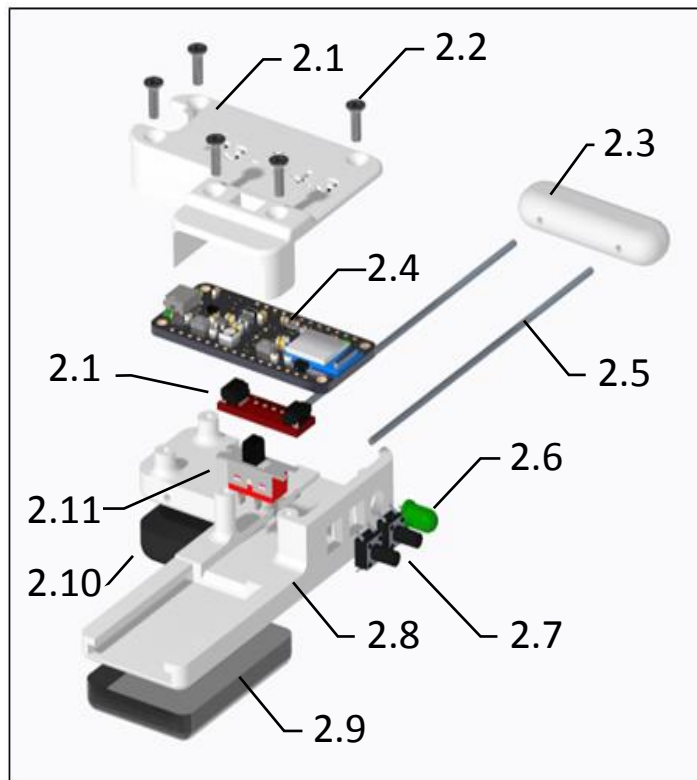
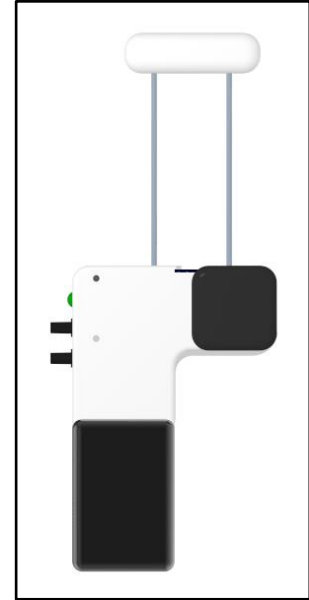
MATERIALS NEEDED can be found in Mechanical Part List (MPL, page 24), Printed Parts List (PPL, page 25) and Electrical part list (EPL, page 22)

Step	Description	Materials needed
1	<b>Curved spring wires (Part N°1.2)</b> Bend the three spring wires as illustrated with a bending radius of 80 mm and cut them to an angle of 140°.	<ul style="list-style-type: none"> <li>Spring wires of Ø1.6 mm (<a href="#">MPL N°2</a>)</li> <li>Pattern for each wire:                </li> </ul>
2	<b>Headband assembly (Parts N°1.1, 1.2, 1.3, 1.6, 1.8)</b> <ol style="list-style-type: none"> <li>Insert two of the three curved spring wires (Part N°1.2) into the flexible headband.</li> <li>Slide them into the two side nodes (right/left) (Parts N°1.3, 1.6) connecting the nodes with the flexible headband (Part N°1.7).</li> <li>Insert the third spring wire (Part N°1.2) into each side node (Parts N°1.3, 1.6) and cover up with the flexible top cover (Part N°1.1). A pair of pliers may be helpful.</li> </ol>	<ul style="list-style-type: none"> <li>Curved spring wires (3x) (<a href="#">Step 1.1</a>)</li> <li>Flexible headband (<a href="#">PPL N°5</a>)</li> <li>Flexible top cover (<a href="#">PPL N°1</a>)</li> <li>Right side node (<a href="#">PPL N°2</a>)</li> <li>Left side node (<a href="#">PPL N°3</a>)</li> <li>Flat pliers (Tool)</li> </ul>
3	<b>Padding (Parts N°1.5, 1.9)</b> <ol style="list-style-type: none"> <li><u>Side padding (Part N°1.5)</u>: Cut (2x) memory foam pieces of 12 mm thickness as illustrated.</li> <li><u>Top padding (Part N°1.9)</u>: Cut (1x) thin foam of 3 mm thickness with the pattern of the top foam as illustrated.</li> <li>Cover the foams from steps 1.3.1 and 1.3.2 with thin tissue using a sew machine.</li> <li>Attach the covered foams from step 1.3.3 to the side nodes (Parts N°1.3, 1.6) and the flexible headband (Part N°1.7) with double tape.</li> </ol>	<ul style="list-style-type: none"> <li>Memory foam (<a href="#">MPL N°3</a>)</li> <li>Side padding pattern:                </li> <li>Thin Foam (<a href="#">MPL N°4</a>)</li> <li>Top padding pattern:                </li> <li>Thin tissue for covering (<a href="#">MPL N°6</a>)</li> <li>Sew machine (Tool)</li> <li>Pair of scissors/cutter (Tool)</li> <li>Headband assembly (<a href="#">Step 1.2</a>)</li> <li>Double tape</li> </ul>
4	<b>Locking screws (Parts N°1.4, 1.7)</b> <ol style="list-style-type: none"> <li>Assemble the locking screws (2x) by fixing the locking wheel (Part N°1.7) on the head of the Allen screw (Part N°1.4).</li> <li>Screw them on each side node (Parts N°1.3, 1.6). When fully screwed, they will lock the sliding straight wires from the right/left hubs sub-assembly (Parts N°2, 3) into the desired position.</li> </ol>	<ul style="list-style-type: none"> <li>Allen screw M3x10 (<a href="#">MPL N°1</a>)</li> <li>Locking wheel (<a href="#">PPL N°4</a>)</li> <li>Headband assembly (<a href="#">Step 1.2</a>)</li> <li>Right hub (<a href="#">Part N°2</a>)</li> <li>Left hub (<a href="#">Part N°3</a>)</li> </ul>
5	<b>Electrical wiring</b> Insert and slide the flat cable through both side nodes (Parts N°1.3, 1.4) and the flexible headband (Part N°1.8). The flat cable will connect both hubs (Parts N°2, 3).	<ul style="list-style-type: none"> <li>6-contacts flat cable (<a href="#">EPL N°13</a>)</li> <li>Headband assembly (<a href="#">Step 1.2</a>)</li> </ul>



## 2. Right Hub sub-assembly

The right hub is topped with two straight spring wires (*Part N°2.5*) that slide within the corresponding right side node (*Part N°1.3*). The sliding range allows fine adjustment for stable and comfortable fit. The right hub houses a microcontroller Bluefruit nRF52832 feather (*Part N°2.4*), a sliding ON/OFF switch (*Part N°2.11*), two push-buttons (*Part N°2.7*), a green LED (*Part N°2.6*), a QWIIC I2C (*Part N°2.12*) adapter and wired connections.

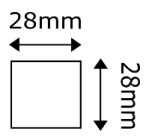
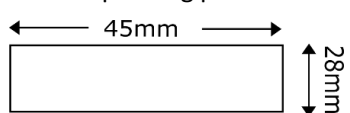
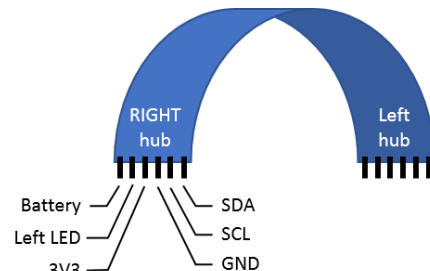


N°	Part description
2.1	Right hub cover
2.2	Flat head screw M2.5x8 (5x)
2.3	Hub end part
2.4	Bluefruit nRF52832 feather
2.5	Straight spring wire (2x)
2.6	Green LED
2.7	Push-button (2x)
2.8	Right hub holder
2.9	Bottom padding
2.10	Top padding
2.11	Slide switch ON/OFF
2.12	QWIIC I2C ADAPTER



## FABRICATION PROCESS

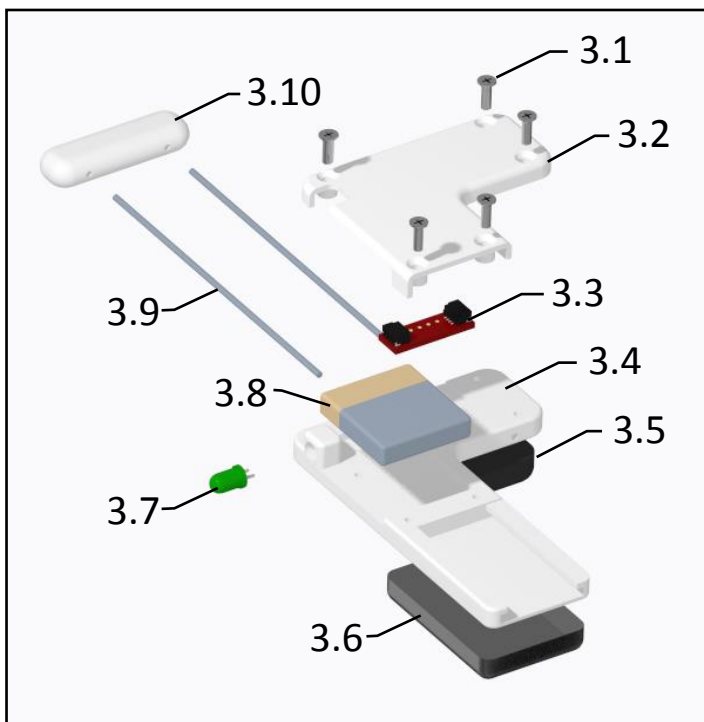
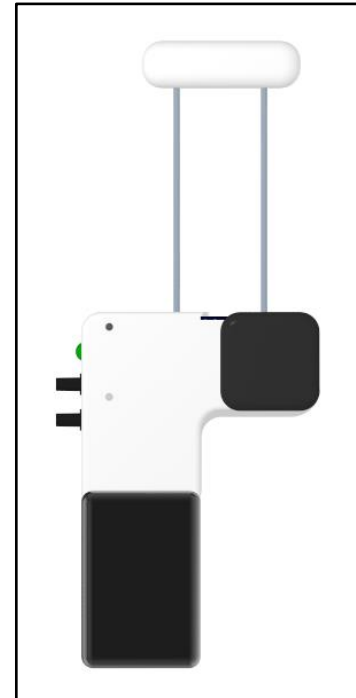
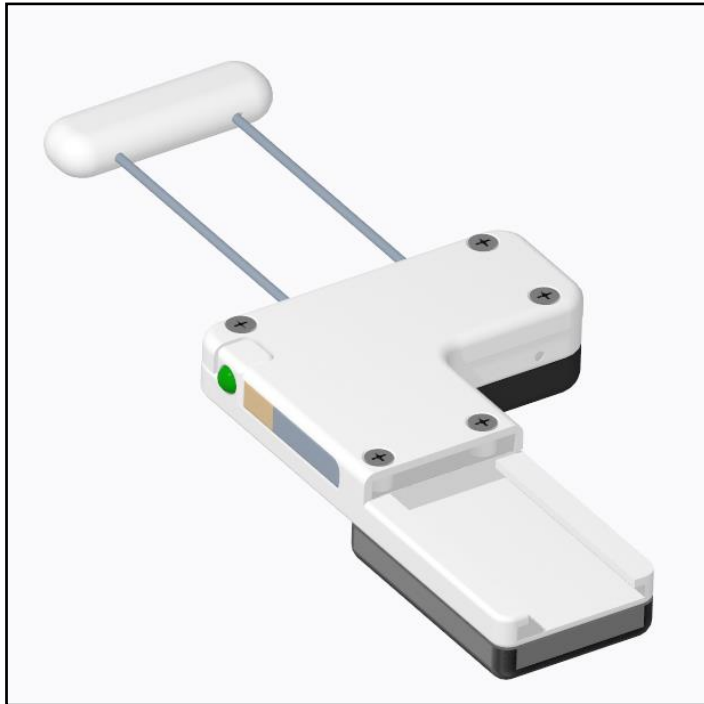
MATERIALS NEEDED can be found in Mechanical Part List (MPL, page 24), Printed Parts List (PPL, page 25) and Electronical part list (EPL, page 22)

Step	Description	Materials needed
1	<b>Straight spring wires (Part N°2.5)</b> <ol style="list-style-type: none"> <li>Cut (4x) 90 mm long straight spring wires (Another pair for the left hub).</li> <li>Insert (2x) the bottom end of the straight spring wires (Part N°2.5) into the right hub holder (Part N°2.8).</li> </ol> <p>A pair of pliers may be helpful.</p>	<ul style="list-style-type: none"> <li>Spring wire of <math>\varnothing 1.6</math> mm (<a href="#">MPL N°2</a>)</li> <li>Right hub holder (<a href="#">PPL N°6</a>)</li> <li>Flat pliers (Tool)</li> </ul>
2	<b>Padding (Parts N°2.9, 2.10)</b> <ol style="list-style-type: none"> <li><b>Top padding (Part N°2.10):</b> Cut (2x) memory foam of 12 mm thickness as illustrated (one for the Left hub).</li> <li><b>Bottom padding (Part N°2.9):</b> Cut (2x) memory foam of 12 mm thickness as illustrated aside (one for the Left hub).</li> <li>Cover the foams from step 2.2.1 and 2.2.2 with thin tissue using a sew machine.</li> <li>Attach one pair of the covered foams from step 2.2.3 to the back side of the right hub holder (Part N°2.8) with double tape within the specified areas.</li> </ol>	<ul style="list-style-type: none"> <li>Memory foam (<a href="#">MPL N°3</a>)</li> <li>Top padding pattern: <div style="text-align: center;">  </div> </li> <li>Bottom padding pattern: <div style="text-align: center;">  </div> </li> <li>Thin tissue for covering (<a href="#">MPL N°6</a>)</li> <li>Sew machine (Tool)</li> <li>Pair of scissors or cutter (Tool)</li> <li>Double tape</li> </ul>
3	<b>Electrical wiring (Parts N°1, 2.4, 2.6, 2.7, 2.11, 2.12)</b> <ol style="list-style-type: none"> <li>Connect the Green LED (Part N°2.6), the two Push-button (Part N°2.7), the ON/OFF switch (Part N°2.11) and the QWIIC I2C ADAPTER (Part N°2.12) with the Bluefruit nRF52832 feather (Part N°2.4) following the <a href="#">electrical schematic (Pag. 23)</a>.</li> <li>Connect the right hub (Part N°2) with the headband's flat cable (Part N°1) following the flat cable's pinout.</li> </ol>	<ul style="list-style-type: none"> <li>Green LED (<a href="#">EPL N°8</a>)</li> <li>Push-button (<a href="#">EPL N°6</a>)</li> <li>QWIIC I2C ADAPTER (<a href="#">EPL N°9</a>)</li> <li>Slide Switch ON/OFF (<a href="#">EPL N°5</a>)</li> <li>Bluefruit nRF52832 feather (<a href="#">EPL N°1</a>)</li> <li>Headset band (<a href="#">Part N°1</a>)</li> <li>Flat cable pinout (right side):</li> </ul> <div style="text-align: center;">  </div>

<p><b>4      Assembly with the Right hub cover (<i>Part N°2.1, 2.2 – Step 2.3</i>)</b></p> <p>Attach the right hub cover (<i>Part N°2.1</i>) to the assembly from step 2.3 by adding (5x) Flat head screw M2.5x8 (<i>Part N°2.2</i>).</p>	<ul style="list-style-type: none"> <li>○ Flat head screw M2.5x8 (<a href="#">MPL N°5</a>)</li> <li>○ Right hub cover (<a href="#">PPL N°6</a>)</li> </ul>
<p><b>5      Assembly with headset band (<i>Parts N°1, 2</i>)</b></p> <ol style="list-style-type: none"> <li>1. Slide the top end of the straight spring wires (<i>Part N°2.5</i>) through the right node (<i>Part N°1.3</i>).</li> <li>2. Insert the top end of the straight spring wires (<i>Part N°2.5</i>) into the hub end-part (<i>Part N°2.3</i>).</li> <li>3. Use the locking screw (<i>Step 1.4</i>) to lock both together into the desired sliding position.</li> </ol>	<ul style="list-style-type: none"> <li>○ Straight spring wires (<a href="#">Step 2.1</a>)</li> <li>○ Headset band (<a href="#">Part N°1</a>)</li> <li>○ Hub end-part (<a href="#">PPL N°7</a>)</li> </ul>

### 3. Left Hub sub-assembly

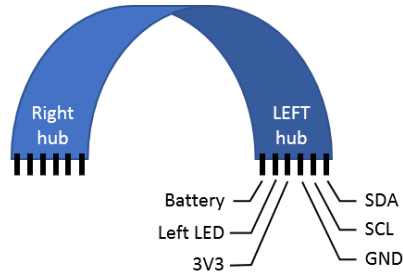
Like the right hub, the left hub is topped with two straight spring wires that slide within the corresponding (left) side node (*Part N°1.3*). The sliding range allows fine adjustment for stable and comfortable fit. The left hub houses a QWIIC I2C adapter (*Part N°3.3*), a green LED (*Part N°3.7*), a battery (*Part N°3.8*) and wired connections.



N°	Part description
3.1	Flat head screw M2.5x8 (5x)
3.2	Left hub cover
3.3	QWIIC I2C ADAPTER
3.4	Left hub holder
3.5	Top padding
3.6	Bottom padding
3.7	Green LED
3.8	Battery Li-Po 3.7V – 350mA
3.9	Straight spring wire (2x)
3.10	Hub end-part

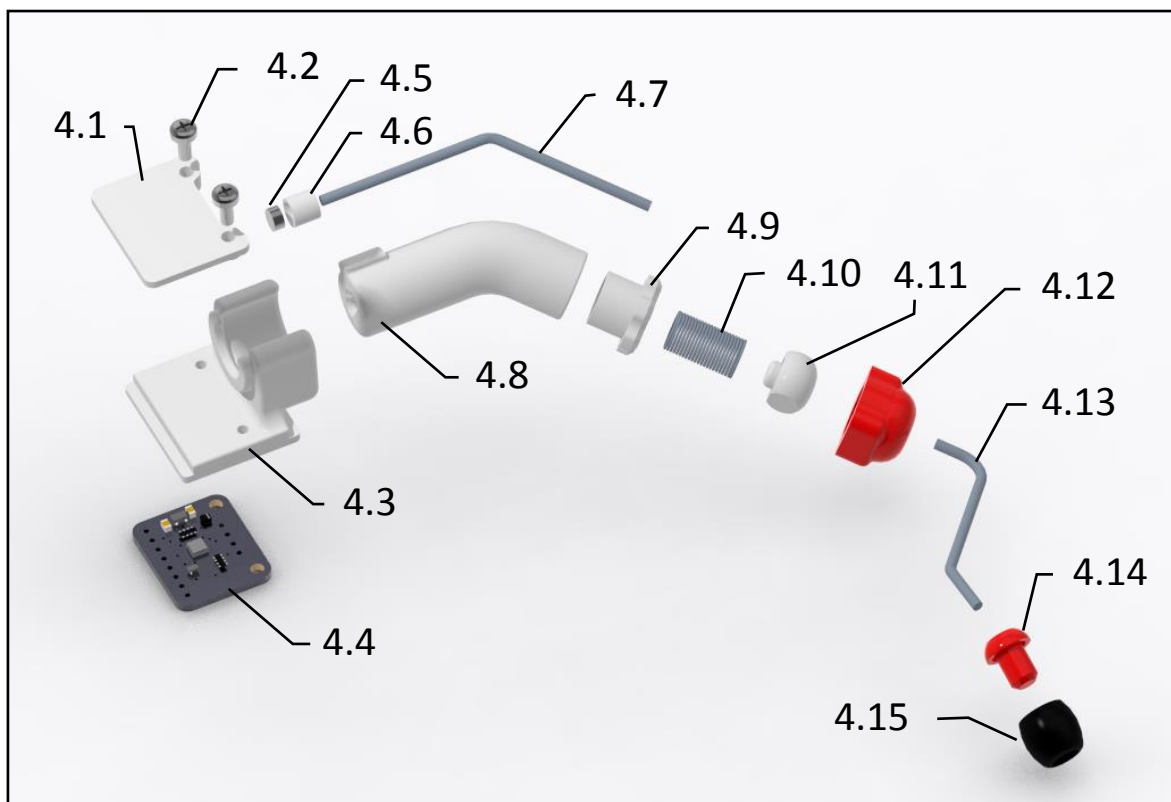
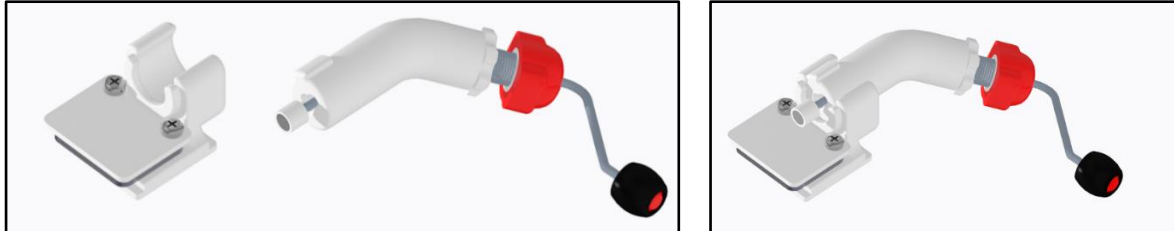
## FABRICATION PROCESS

MATERIALS NEEDED can be found in Mechanical Part List (MPL, page 24), Printed Parts List (PPL, page 25) and Electronical part list (EPL, page 22)

Step	Description	Materials needed
1	<b>Straight spring wires (Part N°3.9)</b> Insert (2x) the bottom end of the straight spring wires (Step 2.1) into the left hub holder (Part N°3.4).  A pair of pliers may be helpful.	<ul style="list-style-type: none"> <li>○ Straight spring wires (<a href="#">Step 2.1</a>)</li> <li>○ Left hub holder (<a href="#">PPL N°9</a>)</li> <li>○ Flat pliers (Tool)</li> </ul>
2	<b>Padding (Parts N°3.5, 3-6)</b> Attach the top and bottom padding (Step 2.2) covered foams to the back side of the left hub holder (Part N°3.4) with double tape within the specified areas.	<ul style="list-style-type: none"> <li>○ Top padding (1x) (<a href="#">Step 2.2</a>)</li> <li>○ Bottom padding (1x) (<a href="#">Step 2.2</a>)</li> <li>○ Double tape</li> </ul>
3	<b>Electrical wiring (Parts N°1, 3.3, 3.7, 3.8)</b> Connect the battery (Part N°3.8), the Green LED (Part N°3.7) and the QWIIC I2C ADAPTER (Part N°3.3) with the headband's flat cable (Part N°1) following the flat cable's pinout and the <a href="#">electrical schematic (Pag. 23)</a> .	<ul style="list-style-type: none"> <li>○ Green LED (<a href="#">EPL N°8</a>)</li> <li>○ Battery Li-Po 3.7V – 350mA (<a href="#">EPL N°2</a>)</li> <li>○ QWIIC I2C ADAPTER (<a href="#">EPL N°9</a>)</li> <li>○ Headset band (<a href="#">Part N°1</a>)</li> <li>○ Flat cable pinout (left side):</li> </ul> 
4	<b>Assembly with the Left hub cover (Part N°3.1, 3.2 – Step 3.3)</b> Attach the left hub cover (Part N°3.2) to the assembly from step 2.3 by adding (5x) Flat head screw M2.5x8 (Part N°3.1).	<ul style="list-style-type: none"> <li>○ Flat head screw M2.5x8 (<a href="#">MPL N°5</a>)</li> <li>○ Left hub cover (<a href="#">PPL N°10</a>)</li> </ul>
5	<b>Assembly with headset band (Parts N°1, 3)</b> <ol style="list-style-type: none"> <li>1. Slide the top end of the straight spring wires (Part N°3.9) through the left node (Part N°1.6).</li> <li>2. Insert the top end of the straight spring wires (Part N°3.9) into the hub end-part (Part N°3.10).</li> <li>3. Use the locking screw (Step 1.4) to lock both together into the desired sliding position.</li> </ol>	<ul style="list-style-type: none"> <li>○ Straight spring wires (<a href="#">Step 2.1</a>)</li> <li>○ Headset band (<a href="#">Part N°1</a>)</li> <li>○ Hub end-part (<a href="#">PPL N°7</a>)</li> </ul>

## 4. Magnetic probe sub-assembly

Both magnetic probes (*Part N°4*) consist of a mechanical unit that translates orofacial movements into a moving magnet (mobile unit), and a magnetometer Adafruit MLX90393 (*Part N°4.4*) sensing unit that measures the magnet's magnetic field (fixed unit). The probes slide vertically through the corresponding (right/left) hub (*Parts N° 2, 3*) to fit the contour of any face.

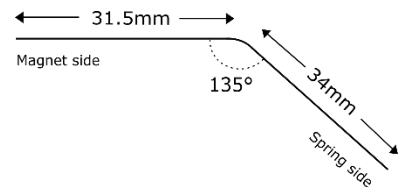
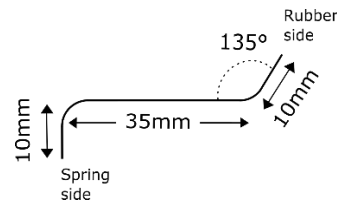


N°	Mechanical part description
4.1	Magnetometer top cover
4.2	Cylindrical head screw M2.5x6 (2x)
4.3	Magnetometer support
4.4	Adafruit MLX90393
4.5	Axial disc magnet
4.6	Magnet holder
4.7	Top beam
4.8	Right or Left tube
4.9	Spring holder part 1
4.10	Traction spring of 13 mm long
4.11	Spring holder part 2
4.12	Spherical socket
4.13	Bottom beam
4.14	End part holder
4.15	Rubber end part

## FABRICATION PROCESS

Both (left/right) probes share the same process except step 4.5 which involve different (left/right) tubes (*Part N°4.8*).

MATERIALS NEEDED can be found in Mechanical Part List (MPL, page 24), Printed Parts List (PPL, page 25) and Electronical part list (EPL, page 22)

Step	Description	Materials needed
1	<b>Top and bottom Beams (<i>Parts N°4.7, 4.13</i>)</b> Make the top ( <i>Part N°4.7</i> ) and bottom ( <i>Part N°4.13</i> ) beams as illustrated with a steel wire of $\varnothing 2$ mm.	<ul style="list-style-type: none"> <li>Steel wire of <math>\varnothing 2</math> mm (<a href="#">MPL N°10</a>)</li> <li>Pattern for the top beam:                </li> <li>Pattern for the bottom beam:                </li> </ul>

<p><b>2 Elastic coupling assembly (Parts N°4.9, 4.10, 4.11)</b></p> <ol style="list-style-type: none"> <li>1. Cut the traction spring of 1m long to have (2x) a 13 mm piece (Part N°4.10).</li> <li>2. Apply metal glue inside of each spring holder (Part N°4.9, 4.11) and fix them to each side of the 13mm long traction spring (Part N°4.10).</li> <li>3. Let the glue dry during 2 hours before continuing.</li> </ol>	<ul style="list-style-type: none"> <li>○ Traction spring of 1m long (<a href="#">MPL N°11</a>)</li> <li>○ Spring holder part 1 (<a href="#">PPL N°18</a>)</li> <li>○ Spring holder part 2 (<a href="#">PPL N°19</a>)</li> <li>○ Metal glue: CYANOACRYLATE INSTANT ADHESIVES such as Ergo®5011 or Ergo®5901</li> </ul>
<p><b>3 Top beam and elastic coupling assembly (Part N°4.7 – Step 4.2)</b></p> <ol style="list-style-type: none"> <li>1. Fill the central hole in the spring holder part 2 (Part N°4.11) with metal glue.</li> <li>2. Insert the spring side of the top beam (Part N°4.7) into the elastic coupling (Step 4.2) and guide it through the glued central hole (step 4.3.1) in the spring holder part.</li> </ol>	<ul style="list-style-type: none"> <li>○ Top beam (<a href="#">Step 4.1</a>)</li> <li>○ Elastic coupling (<a href="#">Step 4.2</a>)</li> <li>○ Metal glue: CYANOACRYLATE INSTANT ADHESIVES such as Ergo®5011 or Ergo®5901</li> </ul>
<p><b>4 Bottom beam assembly (Parts N°4.13, 4.12, 4.14, 4.15)</b></p> <ol style="list-style-type: none"> <li>1. Apply metal glue on both ends of the bottom beam (Part N°4.13).</li> <li>2. Insert the spring side of the bottom beam (step 4.1.2) through the spherical socket central hole (Part N°4.12).</li> <li>3. Insert the rubber side of the bottom beam (step 4.1.2) through the end-part holder (Part N°4.14) central hole.</li> <li>4. Insert the end-part holder (Part N°4.14) into the rubber end-part (Part N°4.15).</li> <li>5. Let the glue dry before continuing.</li> </ol>	<ul style="list-style-type: none"> <li>○ Bottom beam (<a href="#">Step 4.1</a>)</li> <li>○ Spherical socket (<a href="#">PPL N°20</a>)</li> <li>○ End-part holder (<a href="#">PPL N°21</a>)</li> <li>○ Rubber end-part (<a href="#">MPL N°13</a>)</li> <li>○ Metal glue: CYANOACRYLATE INSTANT ADHESIVES such as Ergo®5011 or Ergo®5901</li> </ul>
<p><b>5 Mobile unit assembly (Parts N°4.5, 4.6 – Step 4.3, 4.4)</b></p> <ol style="list-style-type: none"> <li>1. Assemble the resulting parts from steps 4.3 and 4.4 by inserting the spring holder part 2 (Part N°4.11) into the spherical socket (Part N°4.12).</li> <li>2. Insert the resulting part from step 4.5.1 through the tube (left/right) (Part N°4.8).</li> <li>3. Insert the magnet side of the top beam (step 4.1.1) into the magnet holder.</li> <li>4. Place the axial disc magnet into the magnet holder (Part N°4.6).</li> </ol>	<ul style="list-style-type: none"> <li>○ Top beam and elastic coupling assembly (<a href="#">Step 4.3</a>)</li> <li>○ Bottom beam assembly (<a href="#">Step 4.4</a>)</li> <li>○ Magnet holder (<a href="#">PPL N°15</a>)</li> <li>○ Axial disc magnet (<a href="#">MPL N°12</a>)</li> <li>○ Right/left tube (<a href="#">PPL N°16, 17</a>)</li> </ul>



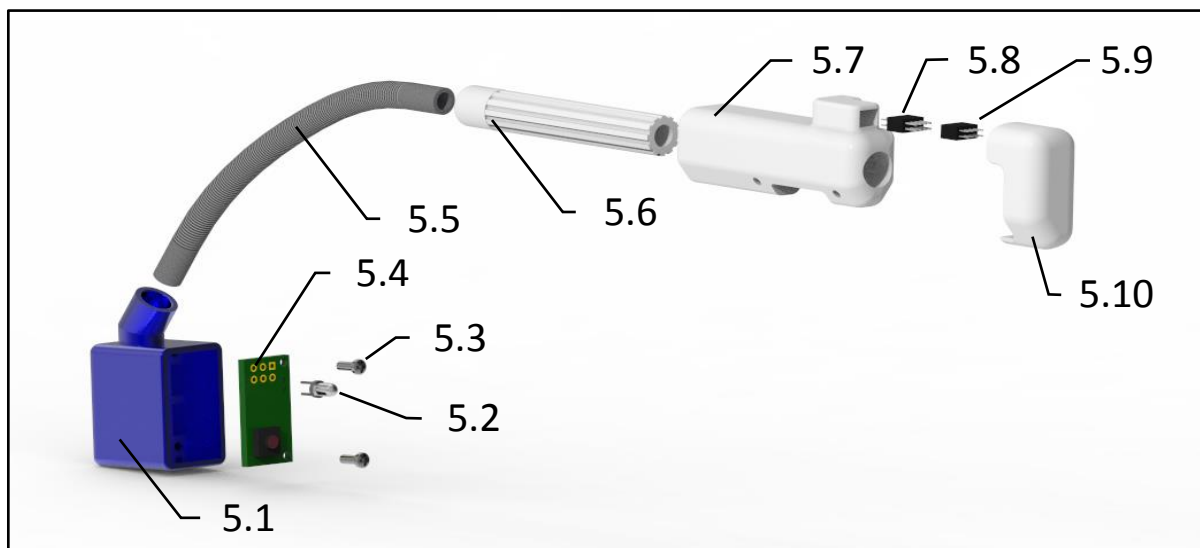
<p><b>6 Fixed and mobile unit assembly (Parts N°4.1, 4.2, 4.3, 4.4 – Step 4.5)</b></p> <ol style="list-style-type: none"> <li>1. Fix the Adafruit MLX90393 (Part N°4.4) between the magnetometer support (Part N°4.3) and the magnetometer top cover (Part N°4.1) using (2x) cylindrical head screws M2.5x6 (Part N°4.2).</li> <li>2. Slide the mobile unit (Step 4.5) into the magnetometer support (Part N°4.3).</li> </ol>	<ul style="list-style-type: none"> <li>○ Adafruit MLX90393 (<a href="#">EPL N°3</a>)</li> <li>○ Magnetometer support (<a href="#">PPL N°14</a>)</li> <li>○ Magnetometer top cover (<a href="#">PPL N°13</a>)</li> <li>○ Cylindrical head screw M2.5x6 (<a href="#">MPL N°9</a>)</li> <li>○ Mobile unit assembly (<a href="#">Step 4.5</a>)</li> </ul>
<p><b>7 Electrical wiring (Parts N°2, 3, 4.4)</b></p> <ol style="list-style-type: none"> <li>1. Insert the JST SH 4-PIN cable (connector side) in the right side of the QWIIC I2C ADAPTER (Part N°2.12, 3.3).</li> <li>2. Connect the JST SH 4-PIN cable (wires side) to the Adafruit MLX90393 (Part N°4.1) following the <a href="#">electrical schematic (Pag. 23)</a>.</li> </ol>	<ul style="list-style-type: none"> <li>○ Adafruit MLX90393 (<a href="#">EPL N°3</a>)</li> <li>○ JST SH 4-PIN cable (<a href="#">EPL N°12</a>)</li> <li>○ QWIIC I2C ADAPTER (<a href="#">EPL N°9</a>)</li> </ul>
<p><b>8 Assembly with the right or left hub (Parts N° 2, 3 – Step 4.7)</b></p> <p>Slide the assembly from step 4.7 into the bottom part of the right/left hub following the <a href="#">general assembly (Pag. 5)</a>.</p>	<ul style="list-style-type: none"> <li>○ Right hub (<a href="#">Part N°2</a>)</li> <li>○ Left hub (<a href="#">Part N°3</a>)</li> </ul>

## 5. Optical probe sub-assembly

The optical probe (*Part N°5*) measures voluntary forehead movements. A flexible metal conduit (*Part N°5.5*) and a sliding joint (*Parts N°5.6, 5.7*) allow to finely adjusting the position and orientation of the optical sensing unit (*Parts N°5.1, 5.4*) respect the forehead.

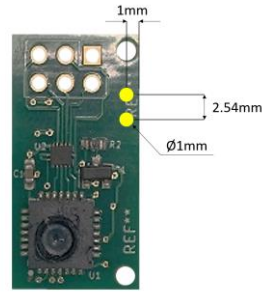


N°	Mechanical part description
5.1	Optical sensor case
5.2	White LED L3-W36N-BVW
5.3	Phillips screw M2x6 (2x)
5.4	Optical sensor PCB
5.5	Flexible metal conduit
5.6	Sliding joint male
5.7	Sliding joint female
5.8	8pos 1.27mm male connector
5.9	8pos 1.27mm female connector
5.10	Wires cover



## FABRICATION PROCESS

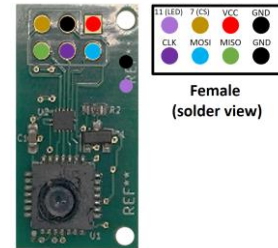
MATERIALS NEEDED can be found in Mechanical Part List (MPL, page 24), Printed Parts List (PPL, page 25) and Electrical part list (EPL, page 22)

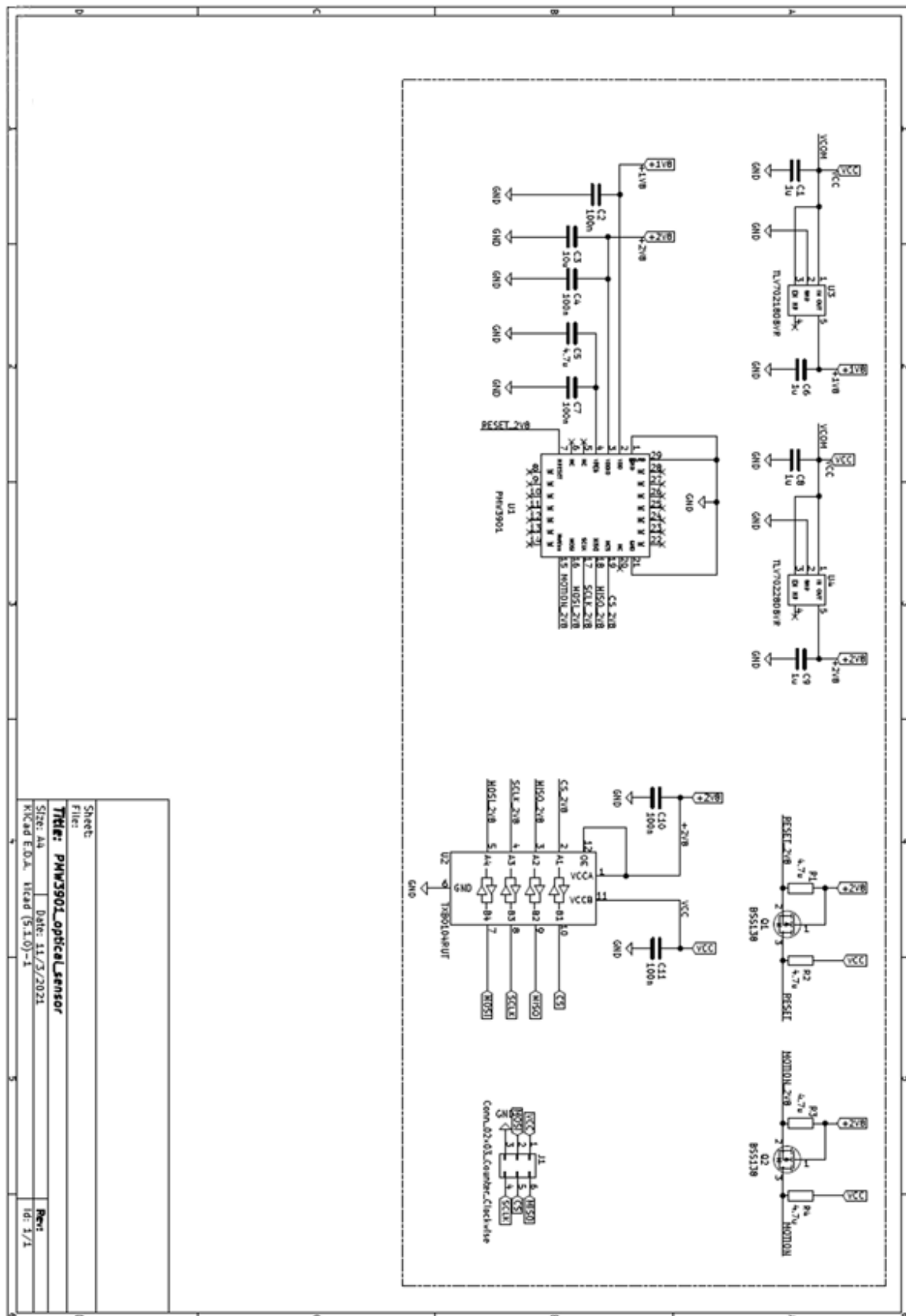
Step	Description	Materials needed
1	<b>Flexible metal conduit (Part N°5.5)</b> Cut a piece 136mm long of Interlock Type-C Conduit.	<ul style="list-style-type: none"> <li>Flexible metal Conduit of 10m (<a href="#">MPL N°8</a>)</li> </ul>
2	<b>Housing assembly (Parts N°5.1, 5.5, 5.6)</b> <ol style="list-style-type: none"> <li>1. Insert one end of the flexible metal conduit (Part N°5.5) into the optical sensor case (Part N°5.1) side opening.</li> <li>2. Insert the other end of the flexible metal conduit (Part N°5.5) into the sliding join male (Part N°5.6).</li> <li>3. Secure the assembly applying metal glue at around the contours interfacing the flexible metal conduit (Part N°5.5) with the optical sensor case (Part N°5.1) and the sliding join male (Part N°5.6).</li> <li>4. Let the glue dry before continuing.</li> </ol>	<ul style="list-style-type: none"> <li>Optical sensor case (<a href="#">PPL N°9</a>)</li> <li>Flexible metal conduit (<a href="#">Step 5.1</a>)</li> <li>Sliding join male (<a href="#">PPL N°10</a>)</li> <li>Metal glue: CYANOACRYLATE INSTANT ADHESIVES such as Ergo®5011 or Ergo®5901</li> </ul>
3	<b>Sensing unit assembly (Parts N°5.2, 5.4)</b> <ol style="list-style-type: none"> <li>1. Drill the optical sensor PCB (Part N°5.4) with 2x 1mm diameter holes as indicated in the figure in yellow.</li> <li>2. Insert the white LED (Part N°5.2) pins through the drilled holes in step 5.3.1.</li> <li>3. Secure the white LED (Part N°5.2) on the optical sensor PCB (Part N°5.4) with hot glue.</li> </ol>	<ul style="list-style-type: none"> <li>White LED (<a href="#">EPL N°7</a>)</li> <li>Optical sensor PCB (<a href="#">PCB-PL P.21</a>, <a href="#">EPL N°4</a>)</li> <li>Driller (tool)</li> <li>Silicone hot gun (tool)</li> </ul> 

#### 4 Electrical wiring

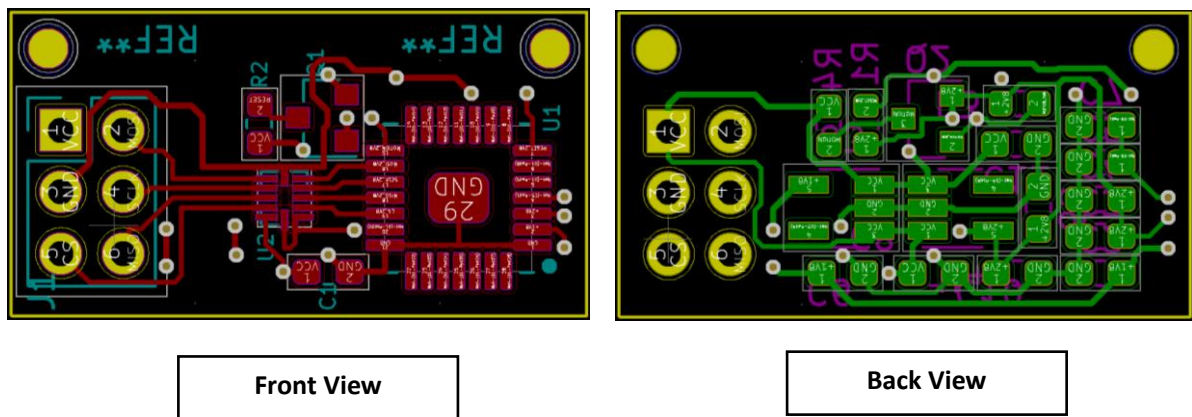
1. Cut 8 wires with a length of 150 mm and solder them with the pins of the optical sensor.
2. Twist the wires and pass them through the probe created at the step 2 by the side of the optical sensor case (*Part N°5.1*).
3. Solder the wires coming out of the sliding join male (*Part N°5.6*) with the female connector (*Part N°5.9*) according to the figure beside.
4. Cut 8 electric wires and solder them on the Male connector (*Part N°5.8*).
5. Insert the Male connector (*Part N° 5.8*) with the soldered wires inside the housing located on the Sliding join female (*Part N°5.7*).
6. Secure the Male connector (*Part N°5.8*) on the Sliding join female (*Part N°5.7*) with hot glue.
7. Assemble the Sliding join female (*Part N°5.7*) above the right hub.
8. Solder the wires coming out of the Sliding join female (*Part N°5.7*) with the Bluefruit NRF52 Feather (*Part N°2.4*) according to the [electrical schematic \(Pag. 23\)](#).

- 28AWG wires or 30AWG wires
- Silicone hot gun (tool)
- Sliding join female ([PPL N°11](#))


















## PCB optical sensor Layout

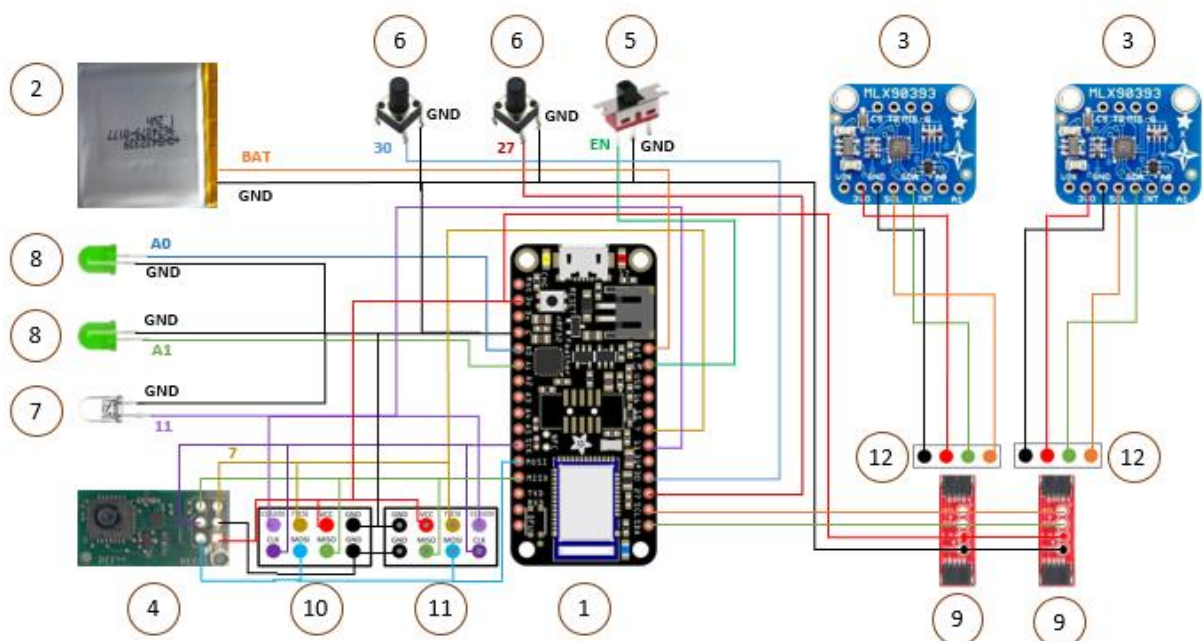


## PCB optical sensor parts list (PCB-PL)

N°	PCB part description	Quantity	Datasheet	Supplier link
1	Motion tracking sensor PMW3901	1		<a href="#">PMW3901MB-TXQT</a>
2	Translation Bidirectional 4- channel voltage levels	1		<a href="#">TXB0104RUTR</a>
3	MOSFET SOT-23 N-CH LOGIC BSS138	2		<a href="#">BSS138</a>
4	SMD resistors 0603 4.7KΩ 5%	4		<a href="#">SFR03EZPJ472</a>
5	TLV70218 Voltage regulators 1.8V, LDO, 300mA	1		<a href="#">TLV70218DBVR</a>
6	TLV70228 Voltage regulators 2.8V, LDO, 300mA	1		<a href="#">TLV70228DBVR</a>
7	Ceramic Capacitors SMD 6.3V 0.1uF 0603 10%	3		<a href="#">0603C104K5RECAUTO7411</a>
8	Ceramic Capacitors SMD 6.3V 1uF 0603 10%	4		<a href="#">C0603C105K9RAC7411</a>
9	Ceramic Capacitors SMD 6.3V 4.7uF 0603 10%	1		<a href="#">GMK107BBJ475KA-T</a>
10	Ceramic Capacitors SMD 6.3V 10uF 0603 10%	1		<a href="#">C0603C106M8PACTU</a>

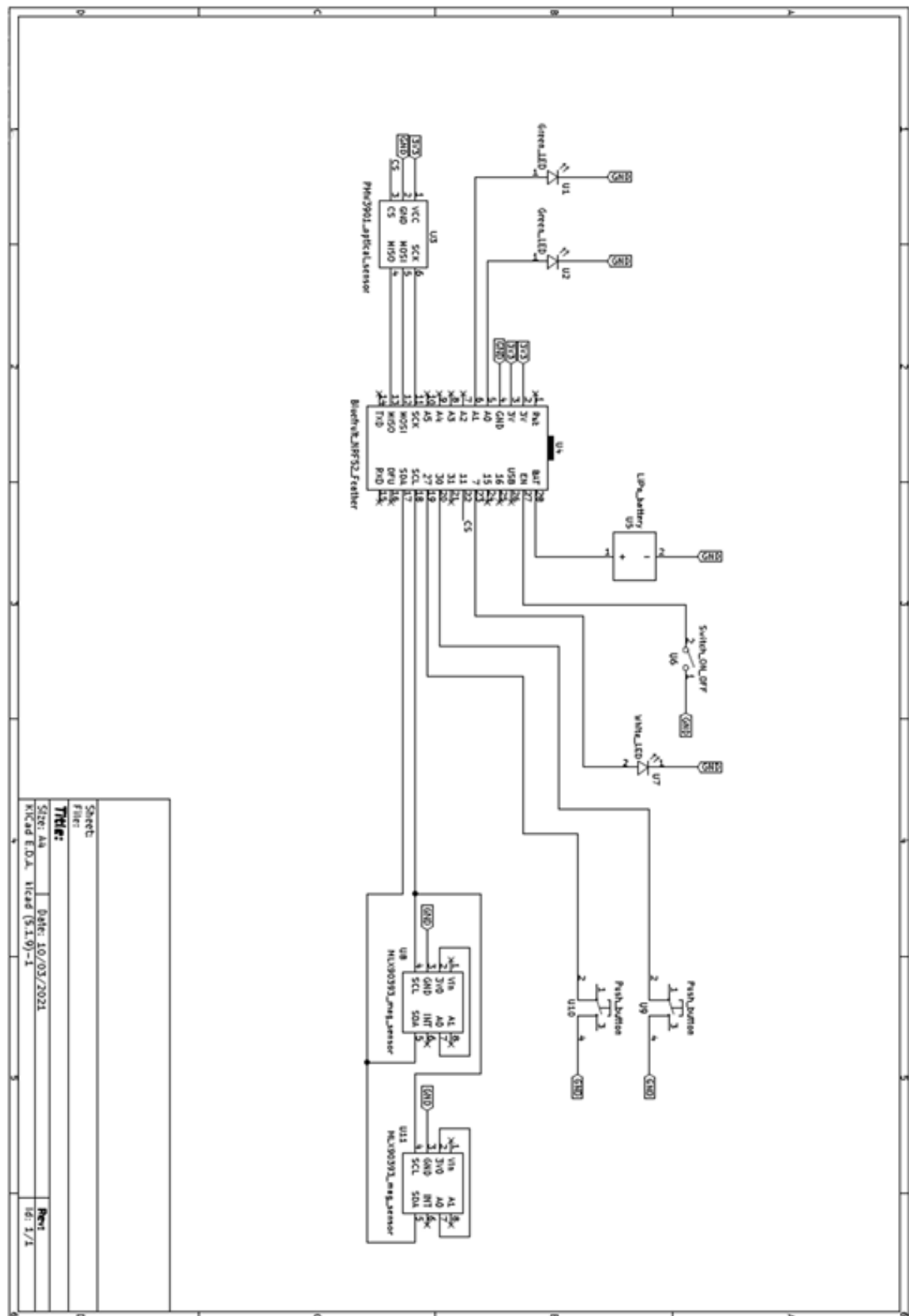
## Electronic parts list (EPL)

N°	Part description	Quantity	Datasheet	Supplier Link
1	Bluefruit nRF52 Feather	1		<a href="#">Nrf52</a>
2	Rechargeable battery Li-Po 3.7V 350mAh	1		<a href="#">ICP602823PA</a>
3	Triple-axis Magnetic sensor	2		<a href="#">MLX90393</a>
4	Motion tracking optical sensor	1		<a href="#">PMW3901</a>
5	Slide Switch ON/OFF	1		<a href="#">RND 210-00581</a>
6	Push button	2		<a href="#">PTS647SK70</a>
7	White LED	1		<a href="#">L3-W36N-BVW</a>
8	Green LED	2		<a href="#">WP7113LGD</a>
9	QWIIC I2C ADAPTER	2		<a href="#">DEV-14495</a>
10	8pos 1.27mm female connector	1		<a href="#">200213</a>
11	8pos 1.27mm male connector	1		<a href="#">20021111</a>
12	JST SH 4-PIN cable	2		<a href="#">4209</a>
13	6-contacts flat cable	300 mm		<a href="#">flat cable</a>





# General circuit schematic



# Mechanical parts list (MPL)

ASSEMBLY: Headset band (HB), Right hub (RH), Left hub (LH), Magnetic probe (MP), Optical probe (OP)

N°	Part description	Assembly	Quantity	Link
1	Allen screw M3x10	HB	2	<a href="#">[M3x10]</a>
2	Spring wire of Ø1.6 mm	HB, RH, LH	1 (m)	<a href="#">[Spring wire]</a>
3	Memory foam of 12mm thickness	HB, RH	A4 (210 x 297 mm)	<a href="#">[Foam 1]</a>
4	Thin foam of 3 mm thickness	HB	A4 (210 x 297 mm)	<a href="#">[Foam 2]</a>
5	Flat head screw M2.5x8	RH, RL	10	<a href="#">[M2.5x8]</a>
6	Thin tissue for covering	RH, RL	500 mm <sup>2</sup>	<a href="#">[tissue]</a>
7	Philipps screw M2x6	OP	2	<a href="#">[M2x6]</a>
8	Flexible metal Conduit of 10m	OP	10 m	<a href="#">[S-4N]</a>
9	Cylindrical head screw M2.5x6	MP	4	<a href="#">[M2.5x6]</a>
10	Steel wire of Ø2mm	MP	500 mm	<a href="#">[Steel wire]</a>
11	Traction spring of 1m long	MP	1 m	<a href="#">[Spring]</a>
12	Axial disc magnet	MP	2	<a href="#">[Magnet]</a>
13	Rubber end-part	MP	2	<a href="#">[Rubber]</a>

# Printed parts list (PPL)

ASSEMBLY: Headset band (HB), Right hub (RH), Left hub (LH), Magnetic probe (MP), Optical probe (OP)

N°	Part description	Assembly	Quantity	Part name	Printing material
1	Flexible top cover	HB	1	<a href="#">flexible_top_cover.stl</a>	TPU
2	Right side node	HB	1	<a href="#">right_side_node.stl</a>	Tough PLA or ABS
3	Left side node	HB	1	<a href="#">left_side_node.stl</a>	Tough PLA or ABS
4	Locking wheel	HB	2	<a href="#">locking_wheel.stl</a>	TPU
5	Flexible headband	HB	1	<a href="#">flexible_headband.stl</a>	TPU
6	Right hub cover	RH	1	<a href="#">right_hub_cover.stl</a>	Tough PLA or ABS
7	Hub end part	RH, LH	2	<a href="#">hub_end_part.stl</a>	Tough PLA or ABS
8	Right hub holder	RH	1	<a href="#">right_hub_holder.stl</a>	Tough PLA or ABS
9	Left hub holder	LH	1	<a href="#">left_hub_holder.stl</a>	Tough PLA or ABS
10	Left hub cover	LH	1	<a href="#">left_hub_cover.stl</a>	Tough PLA or ABS
9	Optical sensor case	OP	1	<a href="#">optical_sensor_case.stl</a>	Tough PLA or ABS
10	Sliding join male	OP	1	<a href="#">sliding_join_male.stl</a>	Tough PLA or ABS
11	Sliding join female	OP	1	<a href="#">sliding_join_female.stl</a>	Tough PLA or ABS
12	Wires cover	OP	1	<a href="#">wires_cover.stl</a>	Tough PLA or ABS
13	Magnetometer top cover	MP	2	<a href="#">magnetometer_top_cover.stl</a>	Tough PLA or ABS
14	Magnetometer support	MP	2	<a href="#">magnetometer_support.stl</a>	Tough PLA or ABS
15	Magnet holder	MP	2	<a href="#">magnet_holder.stl</a>	Tough PLA or ABS
16	Right tube	MP	1	<a href="#">right_tube.stl</a>	Tough PLA or ABS
17	Left tube	MP	1	<a href="#">left_tube.stl</a>	Tough PLA or ABS
18	Spring holder part 1	MP	2	<a href="#">spring_holder_part1.stl</a>	Tough PLA or ABS
19	Spring holder part 2	MP	2	<a href="#">spring_holder_part1.stl</a>	Tough PLA or ABS
20	Spherical socket	MP	2	<a href="#">spherical_socket.stl</a>	TPU
21	End-part holder	MP	2	<a href="#">end_part_holder.stl</a>	Tough PLA or ABS