

Zero2

INSTRUCTIONS FOR FABRICATION

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CREDITS:

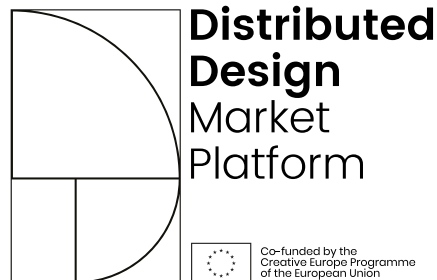
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1. Basic info

ZERO2 is a device for patients with respiratory deficiency. It is used to monitor their blood oxygen levels.



Fig. 1. ZERO2: the final object (photo credits: Gabriele Renna)

Zero2 is a digital device designed to solve the problem of oxygen wastage during oxygen therapy. It is conceived for the patients suffering from chronic respiratory failure, safeguarding the user from fatigue situations. Thanks to the possibility to control the fluctuations of hemoglobin in the blood, the pulse oximeter will be able to define if the quantity of oxygen supplied to the patient is correct, lower or higher. The indication will be provided through the use of LEDs.

BILL OF MATERIALS

The table below contains all the materials necessary for the reproduction of the product (consumables, electronics, components).

CONSUMABLES

Name and tipology	Link	Quantity	Price
Resin Invicta 907	https://www.google.it/search?q=xfab+invicta907&oq=xfab+invicta907&aqs=chrome..69i57.4960j0j7&sourceid=chrome&ie=UTF-8	1 cartridge	75,00 €
Textile for the wrist	n.a	300x100 mm	3,00 €
Automatic button	n.a.	2	2,00 €

ELECTRONICS COMPONENTS

Name and tipology	Link	Quantity	Price
ESP32-WROOM	https://www.digikey.it/products/it?keywords=1904-1025-1-ND	1	6,67€
MAX3010IEFD+ ND	https://www.digikey.it/products/it?keywords=MAX3010IEFD%2B-ND%20	1	4,28€
Led RGB 516-3908-1-ND	https://www.digikey.it/products/it?keywords=516-3908-1-ND	1	0,40 €
Micro USB B	https://www.digikey.it/products/it?keywords=609-4050-1-ND	1	0,66€
"Buzzer"	https://www.digikey.it/products/it?keywords=433-1087-1-ND	1	1,88€
Vibration motor	https://www.digikey.it/products/it?keywords=1670-1011-1-ND%20	1	2,98€
Switch	https://www.digikey.it/products/it?keywords=P16765CT-ND	1	0,27€
Capacitor 1uF 0805	https://www.digikey.it/products/it?keywords=1276-1246-1-ND	1	0,10€
Capacitor 10uF 080	https://www.digikey.it/products/it?keywords=1276-1052-1-ND	2	0,14€
Capacitor 0805	https://www.digikey.it/products/it?keywords=1276-1007-1-ND	1	0,09€
Capacitor 0805	https://www.digikey.it/products/it?keywords=1276-6460-1-ND	1	0,15€
Capacitor 0805	https://www.digikey.it/products/it?keywords=1276-1065-1-ND	2	0,12€
Diode Schottky SOD-123F 30V 2A	https://www.digikey.it/products/it?keywords=MBR230LSFTIGOSCT-ND	1	0,34€
Diode Schottky 20V 1A	https://www.digikey.it/products/it?keywords=478-7800-1-ND	2	0,36€
Inductor 22uH	https://www.digikey.it/products/it?keywords=587-2046-1-ND	1	0,09€
MOSFET n-channel	https://www.digikey.it/products/it?keywords=T2N7002BKLMCT-ND	2	0,17€
MOSFET p-channel	https://www.digikey.it/products/it?keywords=NTR3A052PZTIGOSCT-ND	2	0,46€

Resistor 100k 0805	https://www.digikey.it/products/it?keywords=541-3978-1-ND	1	0,09€
Resistor 330k 0805	https://www.digikey.it/products/it?keywords=1276-5426-1-ND	1	0,09€
Resistor 22k 0805	https://www.digikey.it/products/it?keywords=1276-5356-1-ND	1	0,09€
Resistor 33k 0805	https://www.digikey.it/products/it?keywords=1276-5370-1-ND%20	1	0,09€
Resistor 10k 0805	https://www.digikey.it/products/it?keywords=RMCF0805FT10K0CT-ND%20	5	0,09€
Resistor 330 0805	https://www.digikey.it/products/it?keywords=1276-5246-1-ND	3	0,09€
Resistor 2k 0805	https://www.digikey.it/products/it?keywords=1276-5287-1-ND	1	0,09€
Resistor 100 0805	https://www.digikey.it/products/it?keywords=1276-5224-1-ND%20	1	0,09€
Resistor 3,3k 0805	https://www.digikey.it/products/it?keywords=1276-5298-1-ND	1	0,09€
Loader IC	https://www.digikey.it/products/it?keywords=296-47315-1-ND%20	1	0,97€
Voltage monitor	https://www.digikey.it/products/it?keywords=296-35470-1-ND	1	0,60€
Voltage regulator	https://www.digikey.it/products/it?keywords=296-19643-1-ND	1	1,92€
LED driver	https://www.digikey.it/products/it?keywords=296-41920-5-ND	1	3,08€
Linear voltage regulator	https://www.digikey.it/products/it?keywords=296-40964-1-ND	1	0,70€
Resistor 10k 0805	https://www.digikey.it/products/it?keywords=RMCF0805FT10K0CT-ND%20	4	0,08€
MOSFET n-channel	https://www.digikey.it/products/it?keywords=2N7002NCT-ND	2	0,28€
Capacitor 1uF 0805	https://www.digikey.it/products/it?keywords=1276-1246-1-ND	1	0,10€
Capacitor 2.2uF 0805	https://www.digikey.it/products/it?keywords=1276-2902-1-ND	1	0,16€
3.7V 500mAh Li-Po Battery	https://www.ebay.it/itm/2pcs-4pcs-3-7V-500mAh-Li-po-Battery-4in1-Charger-for-JJRC-H37-BAYANGtoys-X20/401569276675?hash=item5d7f64e303:m:mZXRkX3zi4DNEltdezLixUg	1	4,36€

TECHNOLOGY AND TOOLS USED

- SLA 3D printing machine to print the body (work plan: 70x36x20 mm)
- Laser cutting machine to cut the wrist (work plan: 280x80 mm)
- Desktop CNC milling machine for the PCB (work plan: 65x25 mm)
- Electronics bench for soldering and debug the PCB

2. Step-by-step materialization

Step 01 – Mill the electronic board (PCB) and weld the components

Extract the folder **esp32_smartband_prototyping_board** from the **Zero2_digitalfiles.zip** that includes all the files related to the electronics board and the pulsoxymeter.

Use the files and follow the instructions to mill the electronic board using a Desktop CNC Milling Machine, then remove the excess material.

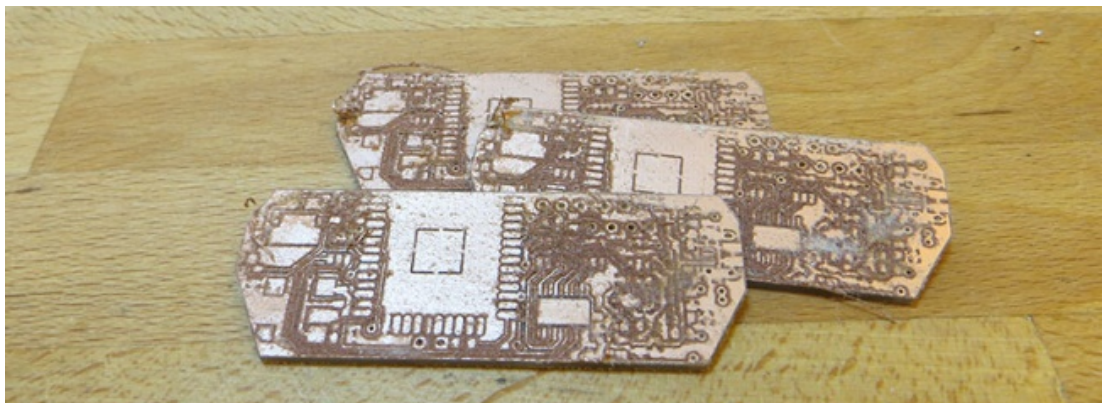


Fig. 2 and 3. The CNC milling machine in action and the final PCBs.

Extract from **Zero2_digitalfiles.zip** the schematics file to install all the electronic components on the PCB. Then, proceed with the welding of the components on the board.

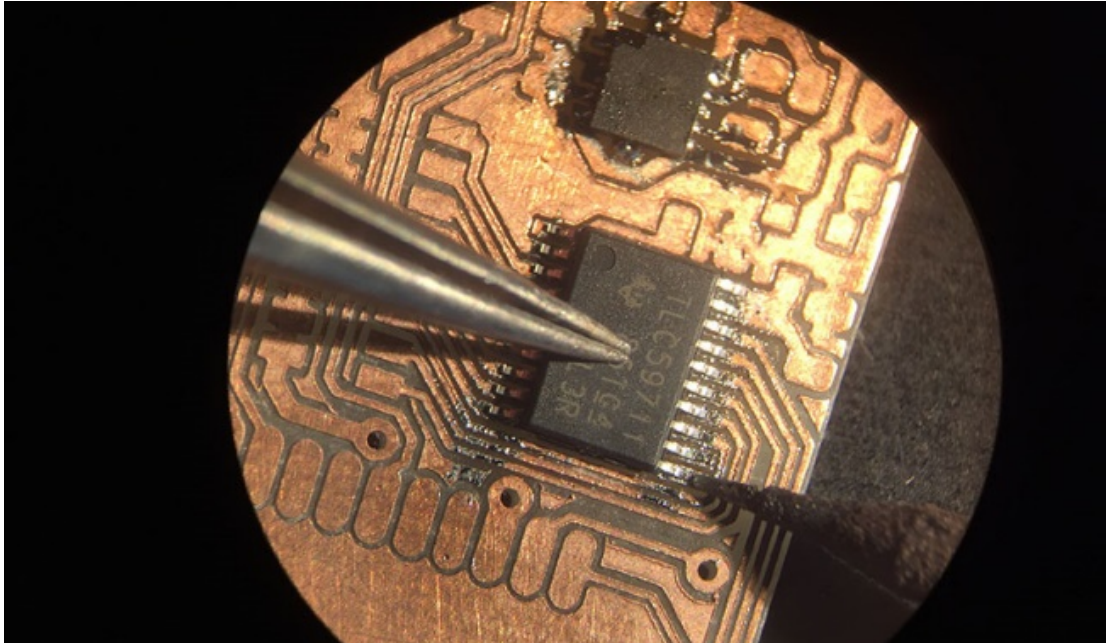


Fig. 4.. The welding of the microprocessors.

Step 02 - Board programming

Extract from Zero2_Digitalfiles.zip the file **Zero2_code.txt** which includes the code to be loaded on the electronic board. Use a programmer and an integrated development environment to load the code (in this case Arduino IDE). Then, verify the proper functioning of the board opening the serial monitor.

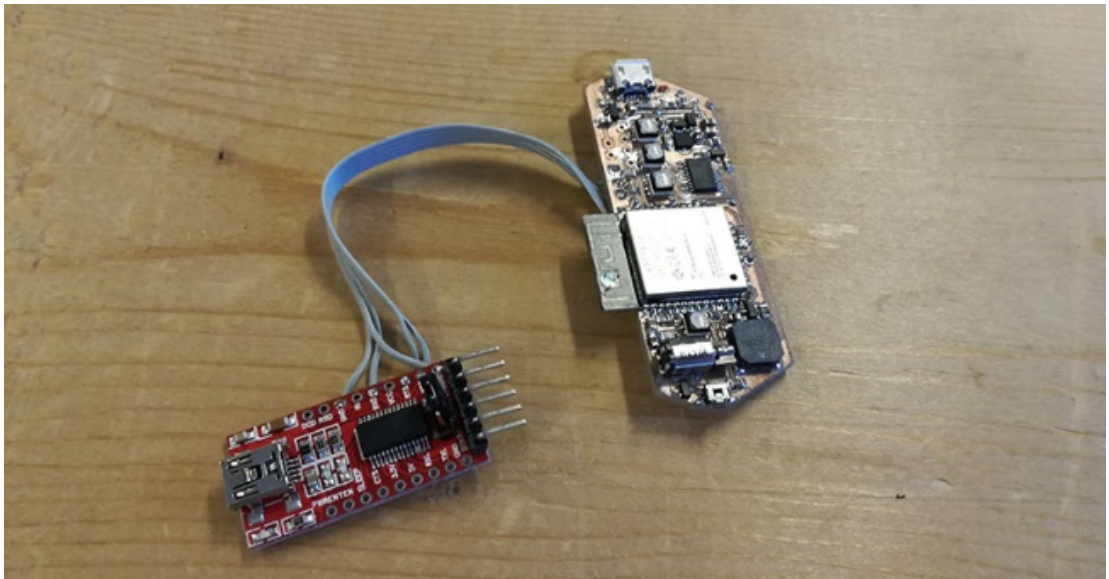


Fig. 5. The board with the programmer.

Step 03 – Zero2 shells 3D printing (SLA)

Download from Zero2_Digitalfiles.zip both the two .stl files named **Zero2_InferiorShell.stl** and **Zero2_SuperiorShell.stl**. These files include the geometry to be opened through a 3D printing software. Verify the printing settings, according to the printer used (SLA and/or FDM), and then proceed with the 3D printing operations.



Fig. 5. 3D printing the Zero2 shells using a SLA printer.

Step 04 – Wristband cutting and metal buttons insertion

Download from zip Zero2_Digitalfiles.zip the files named **Zero2_Wristband_bottom.svg** and **Zero2_Wristband_top.svg**.

These files include the outline drawings of the wristband to be cut with a laser cut machine. Check on software of the laser cut that colours and thickness of the drawing lines are correctly set-up (the red lines are for the internal cuts, the black one is for the external cut).

Step 05 – Final assembly

Assemble the device starting from inferior shell: insert the blood saturation sensor into the slot, then arrange the battery. After continue with the placement of the board, which must be connected with the battery.

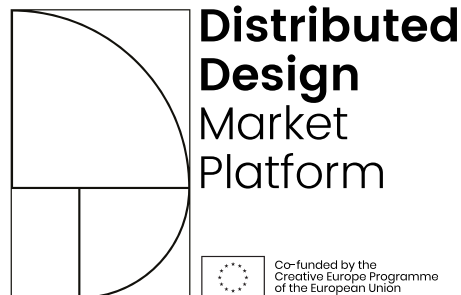
Lastly, close the device with the superior shell and Zero2 is finally assembled and ready to be used.

3. Credits

ZERO2 is a project publicly released and made available in open source mode according to the **Creative Common License (CC-BY)** and promoted by Distributed Design Market Platform with the related documentation.

The authors of ZERO2 are **Tommaso Brioschi**, **Lorenzo Lanzoni**, and **Giovanni Luca Fidone**.

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* POLIFACTORY and DDMP logos have to be inserted (a .svg file with the two logos is included in the .zip folder named Dermap_digitalfiles.zip)

4. Downloadable files

ZERO2 files can be download at:

www.polifactory.polimi.it/polifactory_progetti/ddmp-fabcare?lang=en

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