S.T.E.P.S.
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FOSSBot

# Instruction manual for the assembly and programming of S.T.E.P.S. educational robot

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## FOSSBot 2.0

April 2026

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# Information

| | |
|---|---|
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| Work Package / Project Result number | Work package n°2 - S.T.E.P.S. educational robot : Design and development of the open source educational robot/ PR4 |
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# Consortium

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# 1. Introduction

**FOSSBot** is an open-source and open design DIY educational robot[1] that has been designed to help students, educators, and STEM enthusiasts improve the educational process with the use of programmable robots.

In terms of the **S.T.E.P.S. project,** the FOSSBot has been redesigned and improved to cover the increasing needs of educators, offering an innovative STEM teaching tool focused on making robotics and STEM education accessible to a wider audience. With the current robot, the project aims to overcome barriers in STEM learning by providing affordable, hands-on tools and resources designed to support educators and engage students.

Through the redesigned FOSSBot the S.T.E.P.S. project attempts to democratize and enhance access to STEM education by leveraging affordable, open-source technology and digital learning resources.

## About the Manual

The manual for the S.T.E.P.S. project is designed for pre-service and in-service secondary school teachers and trainers who wish to incorporate STEM and robotics into their educational practice, even if they have little or no prior experience with these technologies.

Its structure includes detailed instructions on how to:

- download and print the plastic parts of the robot
- buy and assemble the list of electronics and other non-printable parts.
- connect and operate the robot
- program the robot

By offering accessible guidance, this resource aims to increase teachers' confidence and capacity to use the robot in practice.

[1] https://github.com/eellak/fossbot

# 2. Printing instructions

## 2.1 List of plastic parts and files downloading instructions

The first step in preparing the new robot is to download all the designs of the 3D printable plastic parts, which are freely available on GitHub:
https://github.com/chronis10/fossbot-hardware/tree/fossbot-v2

Make sure to download and print the following parts:

1. Bottom base - bbase.stl
2. Battery cover - battery_cover.stl
3. Left wheel spoiler - spoiler_l.stl
4. Right wheel - spoiler_r.stl
5. MIddle base - mbase.stl
6. Top base - tbase.stl
7. Top cover - tcover.stl
8. Pen holder - pen_holder.stl

**Download the files**

All the parts are stored as .stl files in the **stl** folder and are available for download. The .stl file represents geometric data of 3D object models as triangular meshes and contains information about the coordinates of each triangle and the direction of each surface.

**Changing the designs (optional)**

The .stl file is one of the most popular files for 3D printing objects and can be used in design and engineering programs such as AutoCAD, SolidWorks, Blender, Tinkercad. If you want to preview or modify any of the 3D printable parts of the robot, you can use any of the above software available for your OS and customize them.

**Slicing and preparing for printing**

The next step is to import the .stl files into a suitable program for slicing, such as the CURA software. The software takes the 3D model and converts it into G-code, which is the format needed to print with a 3D printer.

## 2.2. Preparing the printer

Before the printing of the plastic parts begins, the printing material (plastic thread) needs to be inserted into the 3D printer. We **recommend the use of PETG plastic** for printing because of each balance between low cost and durability, but any other suitable material can be chosen.

Next, you must warm up the printer. The temperature of the printing nozzle and the temperature of the bed, i.e. the surface on which the object is going to be printed, must be set. The temperatures differ for each printing material as well as for different types of printing surfaces.

| Material | Nozzle Temperature (°C) | Bed Temperature (°C) | Notes |
|---|---|---|---|
| **PLA** | 190–220 | 50–70 | Easy to print, low warping, no heated bed required (but recommended). |
| **PETG (Suggested)** | 230–250 | 70–90 | Strong and durable, requires good bed adhesion. |
| **ABS** | 230–250 | 90–110 | Prone to warping; enclosed printer recommended. |

**Table 1.** Recommended Printing Temperatures for Different Materials

Notes for PETG Printing:

- Nozzle Temperature: PETG typically prints best between 230–250°C. Too low, and it won't adhere well; too high, and it may string or ooze.
- Bed Temperature: A bed temperature of 70–90°C is ideal for PETG. It adheres well to surfaces like PEI, glass with glue stick, or blue painter's tape.
- Cooling Fan: Use partial fan speed (20–50%) to reduce warping and improve layer adhesion.
- Adhesion: PETG can stick too well to some surfaces, so consider using a release agent (e.g., glue stick) to prevent damage to the build plate.

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## 2.3 Plastic part visuals

The new designs and a brief description of them follows:

### 2.3.1. Bottom Base

The bottom base houses the motors, odometers, ultrasonic distance sensors, floor IR distance sensors, batteries, and the motor driving circuit.

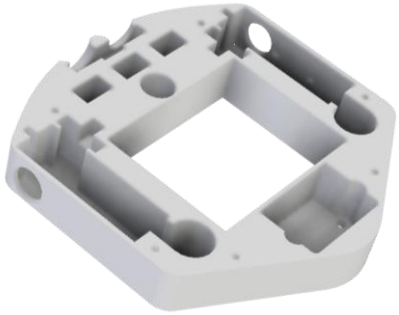

**Figure 1.** Bottom base of FOSSBot 2.0

### 2.3.2. Middle Base

The middle base houses IR distance sensors and also provides a surface for attaching the main PCB.

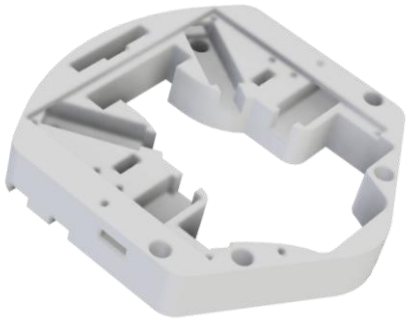

**Figure 2.** Middle base of FOSSBot 2.0

### 2.3.3. Top Base

The top base of the robot houses the speaker, light sensor, and LED. It also stabilizes the assembly of the robot, which is attached to the middle base.

**Figure 3.** Top base of FOSSBot 2.0

### 2.3.3. Top Cover

A magnetically attached top cover with a Lego-compatible surface. It allows easy access to the internal components of the robot and provides a convenient way to attach the pen holder component.

**Figure 4.** Top cover of FOSSBot 2.0

### 2.3.3. Battery Cover

The battery cover protects the battery from accidental removal. Additionally, this cover allows for easy access and replacement of the batteries when disposable batteries are used, accessible from the bottom of the robot.

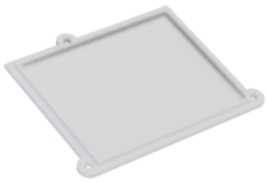

**Figure 5.** Battery cover of FOSSBot 2.0

### 2.3.3. Spoilers

Protective covers for the wheels to prevent detachment due to unexpected crashes.

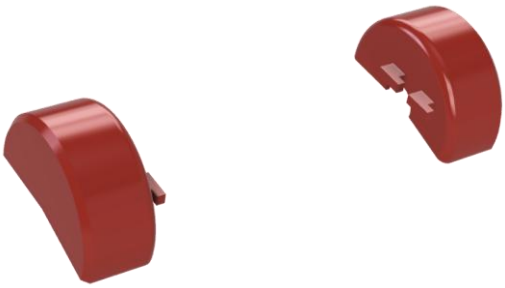

**Figure 6.** Spoilers of FOSSBot 2.0

### 2.3.3. Pen Holder

A special removable component is designed for attaching a pen to the robot. This component securely holds a pen and positions it at the bottom of the robot, enabling the robot to function as a plotter.

**Figure 7.** Pen holder of FOSSBot 2.0

## 2.4 Printing times

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Each plastic part needs to be printed separately. Please refer to the following table for the estimated printing time of each part. The printing time and material specifications are for reference only, based on the default Cura settings with 10% infill for the Ender 3 Pro. You should adjust the settings to suit your printer best. By modifying the printing speed and infill density, you may achieve a faster print time while using less material.

| Plastic robot part | Printing time (hours) | Material in grams | Support |
|---|---|---|---|
| Battery Cover | 1:53 | 15 | No |
| Bottom Base | 14:19 | 98 | Everywhere |
| Middle Base | 12:35 | 86 | Everywhere |
| Top Base | 8:40 | 59 | Everywhere |
| Left Spoiler | 3:50 | 25 | Touching build plate |
| Right Spoiler | 3:50 | 25 | Touching build plate |
| Lego top | 4:55 | 31 | Everywhere |
| Pen holder | 1:00 | 4 | No |

**Table 2.** Estimated Printing Times and Material Usage for Robot Parts

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# 3. Electronics and wiring

FOSSBot falls into the DIY (Do It Yourself) category, designed to be easily built by anyone beyond its original creators. Its assembly and disassembly can serve as an educational activity, making it an engaging learning tool in the classroom. This is possible since FOSSBot is made of electronic parts that are low cost and easily widely available while the plastic parts are printable. Therefore, they can be replaced easily in case a component is defective or it wears out.

## 3.1. List of electronic parts

The following list contains the electronic and non-printable parts that will be needed for the robot assembly:

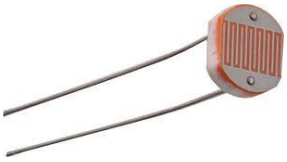
| Part Name | Photo | Quantity | Link |
|---|---|---|---|
| Rubber Wheel 66x26mm - Yellow |  | 2 | https://grobotronics.com/rubber-wheel-66x26mm-yellow.html?sl=en&srsltid=AfmBOopd5-3DW47tWfBmrnNKnbCVc0dmFRVubhED6B-bAPUGSDl1W6jq |
| DC Gear Motor TT - 120 RPM (Metal Dual Shaft) |  | 2 | https://botland.store/geared-dc-angle-motors/16016-dc-motor-with-148-gear-3-6v-with-double-sided-shaft-200rpm-5904422344078.html |
| Coded Disc Encoder |  | 2 | https://grobotronics.com/plastic-encoder-24mm.html |
| Dual Motor Driver Module L298N |  | 1 | https://botland.store/motor-drivers-modules/3164-l298n-two-channel-motor-controller-12v-2a-5904422359317.html |

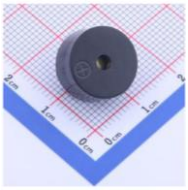
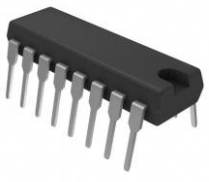
| Part Name | Photo | Quantity | Link |
|---|---|---|---|
| Photo Interrupter Sensor |  | 2 | https://botland.store/sensors-odbiciowe/8834-photo-interrupter-sensor-speed-measuring--5904422366292.html |
| MCP3008 - 10bit 8 channel ADC SPI |  | 1 | https://botland.store/converters/2358-converter-adc-mcp3008-10-bit-8-channel-dip-5904422362089.html |
| microSDHC 32GB |  | 1 | https://botland.store/microsd-sd-cards/17091-sandisk-memory-card-microsd-32gb-80mbs-class-10-raspberry-pi-os-5903351247771.html |
| DC-DC Step-Down 5.2V 5A |  | 1 | https://grobotronics.com/dc-dc-converter-step-down-9-36v-5a.html |
| DC-DC Converter Step-Down 5-35V 2A |  | 1 | https://grobotronics.com/dc-dc-step-down-1.3-35v-3a.html?sl=en&srsltid=AfmBOooySa2M_pm3gMnfCiPTf9evSP-bVhUgBf6OUDEJC7e1g8NO00lHX9w |
| Li-ion Battery Charger Protection Module 3S 10A |  | 1 | https://grobotronics.com/li-ion-battery-charger-protection-module-3s-10a.html |
| Battery Li-ion 18650 3.6V 3400mAh |  | 3 | https://grobotronics.com/battery-lithium-18650-3.6v-3400mah-8a-samsung-inr18650-35e.html |

| Part Name | Photo | Quantity | Link |
|---|---|---|---|
| Battery holder 18650 |  | 3 | https://botland.store/battery-holders/16516-cell-holder-for-1x-18650-battery-without-wires-5904422344597.html |
| Ultrasonic Distance Sensor HC-SR04 |  | 1 | https://botland.store/ultrasonic-distance-sensors/16257-ultrasonic-distance-sensor-hc-sr04-2-400cm-sparkfun-sleep-15569-5904422378097.html |
| IMU - MPU6050 (Accelerometer and Gyroscope) |  | 1 | https://grobotronics.com/gy-521-mpu6050-3-axis-gyroscope-and-accelerometer-imu.html |
| WAVESHARE IR proximity sensor with analog |  | 7 | https://grobotronics.com/waveshare-infrared-proximity-sensor.html?gad_source=1&gclid=CjwKCAiAt4C-BhBcEiwA8Kp0CRljuPmuZBYgBn4VrRwHzfNAGdLIiWcvREXeuI1YGBmSbw_Q06OxRBoCqzwQAvD_BwE |
| Ball Caster Metal 12mm |  | 1 | https://grobotronics.com/ball-caster-metal-12mm.html |
| Power supply 12V 5A - Output 5.5x2.1 SN-12D500 |  | 1 | https://grobotronics.com/power-supply-12v-5a-output-5.5x2.1-sn-12d500.html |
| DC Power Jack 5.5x2.1 - Plastic |  | 1 | https://grobotronics.com/dc-power-jack-5.5x2.1-plastic-el.html |

| Part Name | Photo | Quantity | Link |
|---|---|---|---|
| Transistor 2N2222A |  | 1 | https://botland.store/npn-transistors/18995-bipolar-transistor-npn-2n2222a-st-5pcs-5904422357931.html |
| JST 4-pin female-to-female jumper pins |  | 2 | https://grobotronics.com/jumper-wire-jst-xh-to-separate-dupont.html?variation_id=17936 |
| JST 3-pin female-to-female jumper pins |  | 21 | https://grobotronics.com/jumper-wire-jst-xh-to-separate-dupont.html?variation_id=17935 |
| JST 2-pin female-to-female jumper pins |  | 3 | https://grobotronics.com/jumper-wire-jst-xh-to-separate-dupont.html?variation_id=17934 |
| JST XH Conector 4-Pin Male 2.5mm |  | 2 | https://grobotronics.com/jst-xh-conector-4-pin-male-2.5mm.html |
| JST XH Conector 3-Pin Male 2.5mm |  | 21 | https://grobotronics.com/jst-xh-conector-3-pin-male-2.5mm.html |

| Part Name | Photo | Quantity | Link |
|---|---|---|---|
| JST XH Conector 2-Pin Male 2.5mm |  | 3 | https://grobotronics.com/jst-xh-conector-2-pin-male-2.5mm.html |
| On/Off Switch PCB 3pin SPDT Switch |  | 1 | https://ampere-electronics.com/product/on-off-switch-pcb-3pin-spdt-switch/?srsltid=AfmBOoqiCXJJJ-AAeio8zfw4rX5ipF6zHLDEUZYFuHeTMvZXiLmqZ0Wo |
| Raspberry Pi 2 Zero W |  | 1 | https://botland.store/rpi-zero-modules-and-kits/20347-raspberry-pi-zero-2-w-512mb-ram-wifi-bt-42-5056561800004.html |
| 10K Resistor |  | 1 | https://www.digikey.gr/en/products/detail/yageo/CFR-25JR-52-10K/11998 |
| 3K Resistor |  | 1 | https://www.digikey.gr/en/products/detail/stackpole-electronics-inc/CF14JT3K00/1741418 |
| 2.2K Resistor |  | 1 | https://www.digikey.gr/en/products/detail/stackpole-electronics-inc/CF14JT2K20/1741321 |

| Part Name | Photo | Quantity | Link |
|---|---|---|---|
| 1K Resistor |  | 2 | https://www.digikey.gr/en/products/detail/stackpole-electronics-inc/CF14JT1K00/1741314 |
| 270Ω Resistor |  | 3 | https://www.digikey.gr/en/products/detail/yageo/CFR-25JR-52-270R/11960 |
| Bolt M3- L14mm |  | 12 | https://www.digikey.gr/en/products/detail/apm-hexseal/RM3X12MM-2701/2063201 |
| Loudspeaker 2W 8Ω |  | 1 | https://www.digikey.gr/en/products/detail/same-sky-formerly-cui-devices/CLS0361-L152/1630878 |
| Mono 2.5W Class D Audio Amplifier - PAM8302 |  | 1 | https://botland.store/mp3-wav-ogg-midi-players/6381-mono-25w-class-d-audio-amplifier-pam8302-adafruit-2130-5904422348960.html |
| 4 Channels Bidirectional logic bit converter |  | 1 | https://botland.store/voltage-converters/6117-4-channel-logic-level-converter-5904422365189.html |
| Photoresistor (LDR) |  | 1 | https://www.digikey.gr/en/products/detail/advanced-photonix/PDV-P8103/480610 |

| Part Name | Photo | Quantity | Link |
|---|---|---|---|
| Electrolytic Capacitors - 1uF/50V |  | 1 | https://www.digikey.gr/en/products/detail/kemet/ESK105M050AC3AA/3083011 |
| Raspberry PI HEADER 44PINS |  | 1 | https://www.digikey.gr/en/products/detail/samtec-inc/SSW-122-02-S-D-LL/6694399 |
| Microphone capsule |  | 1 | https://www.digikey.gr/en/products/detail/same-sky-formerly-cui-devices/CMA-4544PF-W/1869981 |
| RGB LED Common Cathode |  | 1 | https://www.digikey.gr/en/products/detail/kingbright/WP154A4SUREQBFZGC/3084119 |
| Buzzer 12V |  | 1 | https://www.digikey.gr/en/products/detail/pui-audio-inc/AT-1224-TWT-12V-2-R/5011403 |
| Multiplexer TC74HC4051APF |  | 1 | https://www.digikey.gr/en/products/detail/toshiba-semiconductor-and-storage/TC74HC4051APF/870508 |

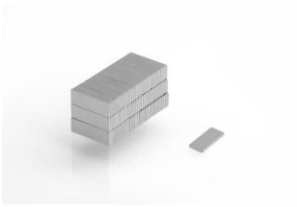
| Part Name | Photo | Quantity | Link |
|---|---|---|---|
| Neodymium block magnet 10x5x1 thick N38 |  | 6 | https://euromagnesy.com/en/ndfeb-neodymium-block-magnets-small-5-mm-10-mm/919-neodymium-block-magnet-10x5x1-thick-n38-5905072506274.html?srsltid=AfmBOoqG9WObDhvC93B4OMTdcfK_K4pLFdm5ndKFSaw0KmENt02GmwNh |

**Table 3.** Electronic and Non-Printable Parts for Robot Assembly

## 3.2. The PCB boards

In this section, the user must have basic soldering skills to assemble the PCB for the robot. The PCB already has printed markings on its surface indicating where the electronic components should be soldered.

### 3.2.1 Main PCB

The PCB designs can be downloaded from Github: https://github.com/chronis10/fossbot-hardware/blob/fossbot-v2/electronics_instructions/Schematic_FOSSBot.pdf

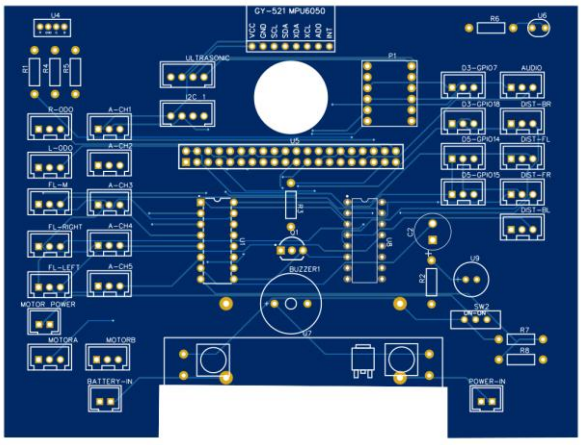



**Figure 8.** Front Side of PCB

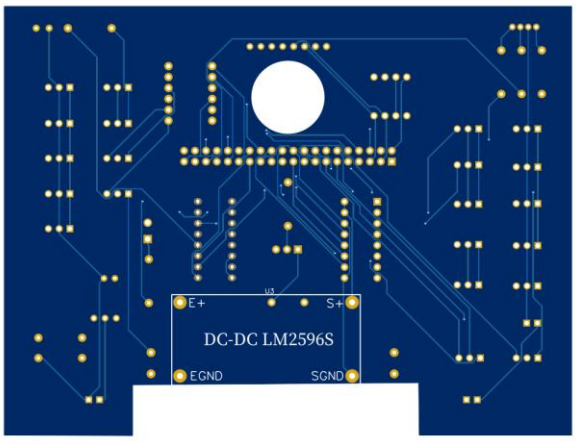



**Figure 9.** Back Side of PCB

Prepare the parts as shown in the following list, preheat your soldering tool, and start placing and soldering all the components.

| | | | |
|---|---|---|---|
| IMU - MPU6050 (Accelerometer and Gyroscope) |  | 1 | U2 |
| Transistor 2N2222A |  | 1 | Q1 |
| Electrolytic Capacitors - 1uF/50V |  | 1 | C2 |
| JST 4-pin male |  | 2 | I2C_1, ULTRASONIC |
| JST 3-pin male |  | 21 | A-CH1, A-CH2, A-CH3, A-CH4, A-CH5, AUDIO, D3-GPIO7, D3-GPIO18, D5-GPIO14, D5-GPIO15, DIST-BL, DIST-BR, DIST- |

| | | | |
|---|---|---|---|
| | | | FL, DIST-FR, FL-LEFT, FL-M, FL-RIGHT, L-ODO, MOTORA, MOTORB, R-ODO |
| JST 2-pin male |  | 3 | BATTERY-IN, MOTOR_POWER, POWER-IN |
| On/Off Switch PCB 3pin SPDT Switch |  | 1 | SW2 |
| 10K Resistor |  | 1 | R6 |
| 3K Resistor |  | 1 | R7 |
| 2.2K Resistor |  | 1 | R2 |
| 1K Resistor |  | 2 | R3, R8 |

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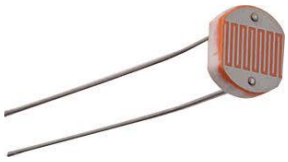
| | | | |
|---|---|---|---|
| 270Ω Resistor |  | 3 | R1, R2, R5 |
| 4 Channels Bidirectional logic bit converter |  | 1 | P1 |
| MCP3008 - 10bit 8 channel ADC SPI |  | 1 | U1 |
| Raspberry PI HEADER 44PINS |  | 1 | U6 |
| Photoresistor (LDR) |  | 1 | LDR - U6 |
| DC-DC Step-Down 5.2V 5A |  | 1 | U7 |
| DC-DC Converter Step-Down 5-35V 2A |  | 1 | U3 |

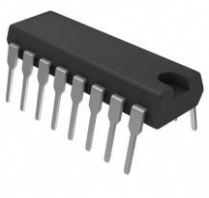
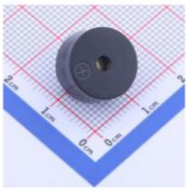
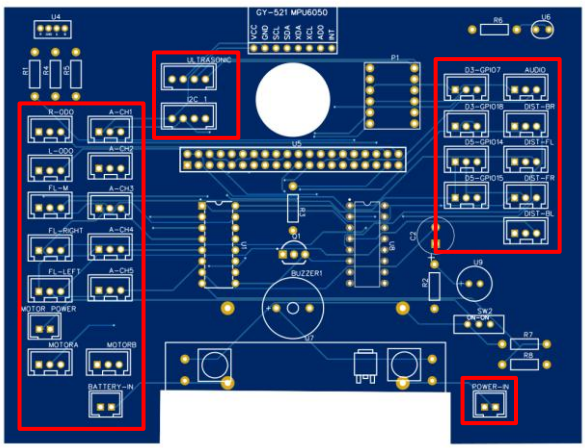
| | | | |
|---|---|---|---|
| Multiplexer TC74HC4051APF |  | 1 | U8 |
| Microphone capsule |  | 1 | U9 |
| RGB LED Common Cathode |  | 1 | U4 |
| Buzzer 12V |  | 1 | BUZZER1 |

**Table 4.** Electronic Components for PCB Assembly

The PCB has printing on both the top and bottom, indicating where each component should be placed. Using the previous table as a reference, start placing and soldering all the components. Some components, such as capacitors, must be placed with the correct orientation. The correct orientation can be determined by checking the length of the component's legs—the longer pin is positive, while the shorter pin is negative.

### JST Connectors

Place all the JST connectors in their corresponding places.



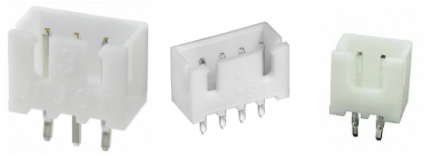


**Figure 10.** Placement of JST Connectors on PCB

### RGB LED and LED resistors

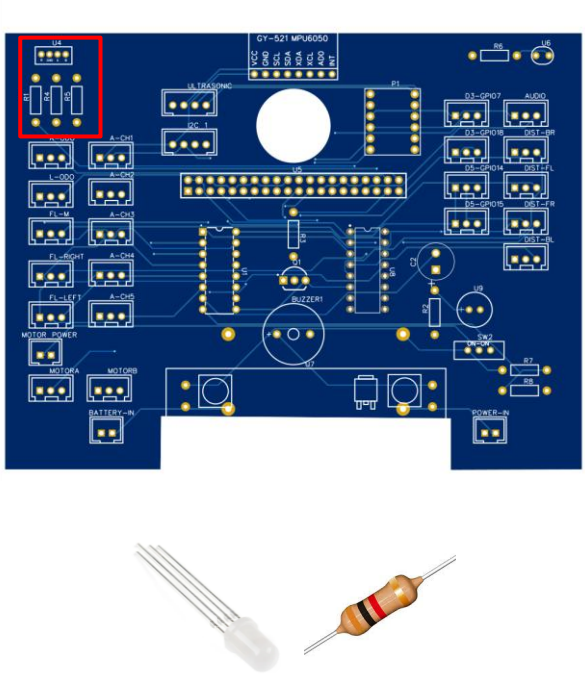


**Figure 11.** Placement of RGB LED and LED resistors on PCB

### Accelerometer and Gyroscope

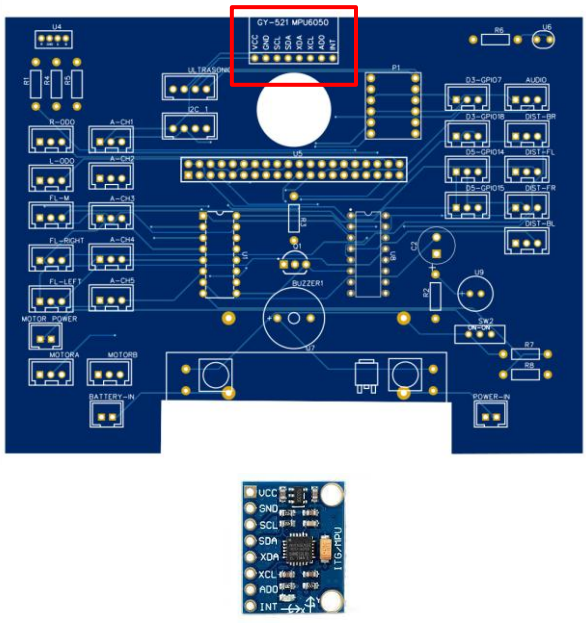



**Figure 12.** Placement of Accelerometer and Gyroscope on PCB

### Bidirectional logic bit converter

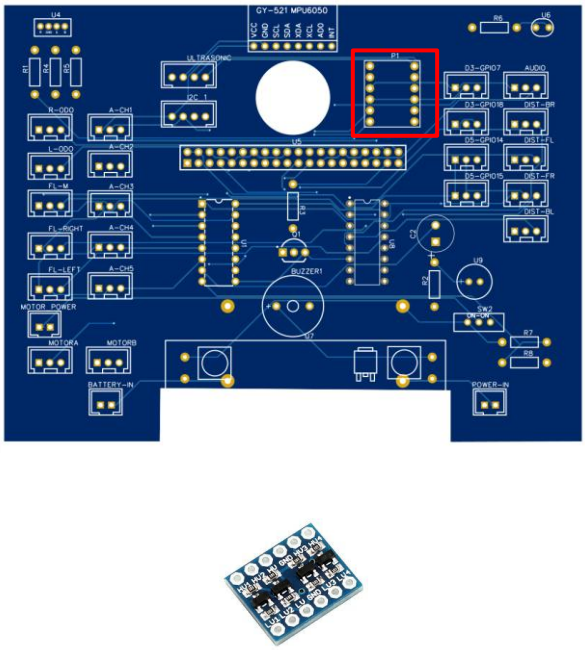


**Figure 13.** Placement of Bidirectional logic bit converter on PCB

### Photoresistor

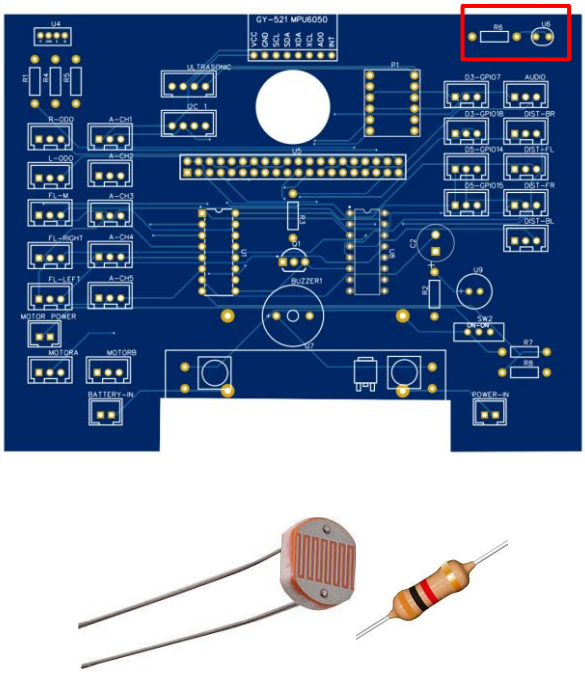


**Figure 14.** Placement of Photoresistor on PCB

### MCP3008 Analogue sensors reader

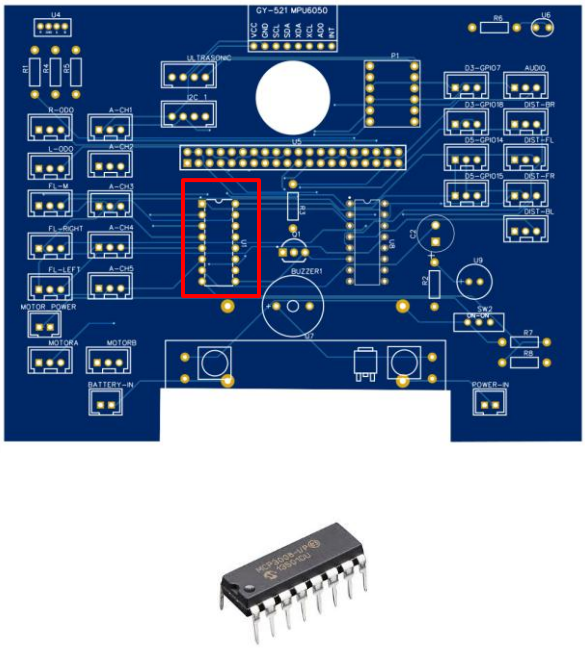


**Figure 15.** Placement of MCP3008 chip on PCB

### Multiplexer

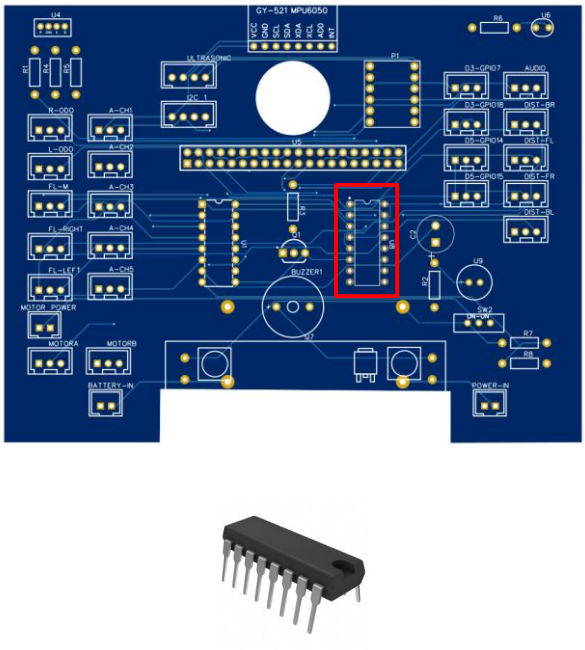


**Figure 16.** Placement of Multiplexer on PCB

### Noise sensor

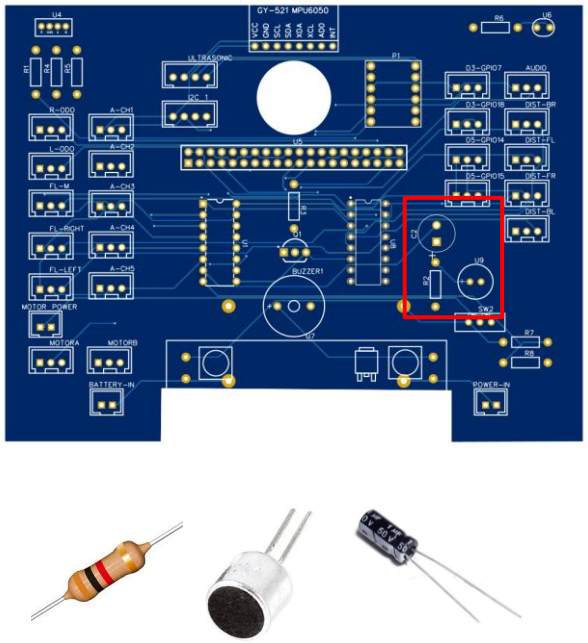


**Figure 17.** Placement of Noise Sensor on PCB

### On/Off Switch

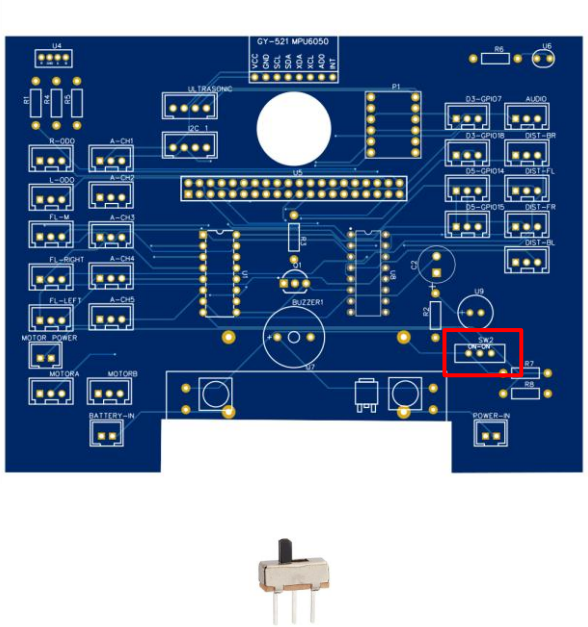


**Figure 18.** Placement of On/Off Switch on PCB

### Raspberry Pi header

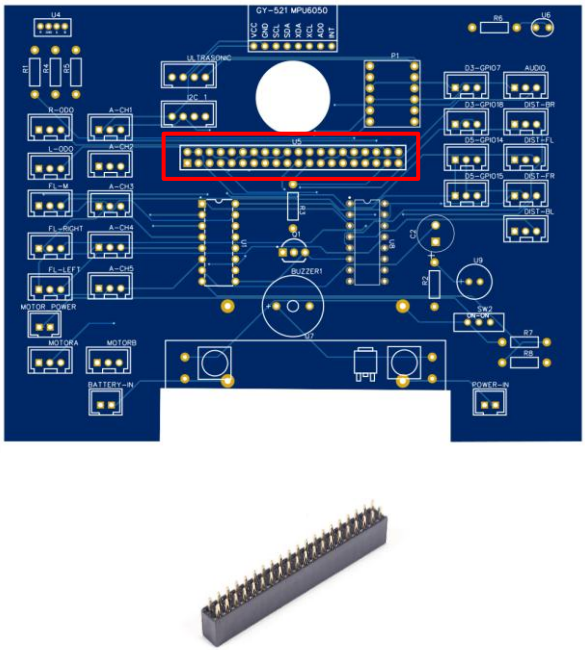


**Figure 19.** Placement of Raspberry Pi header on PCB

### Buzzer

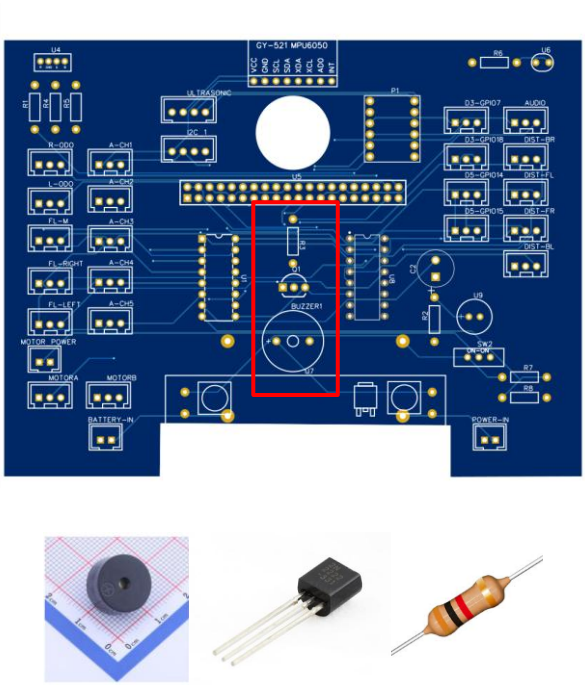


**Figure 20.** Placement of Buzzer on PCB

### 5V Step Down

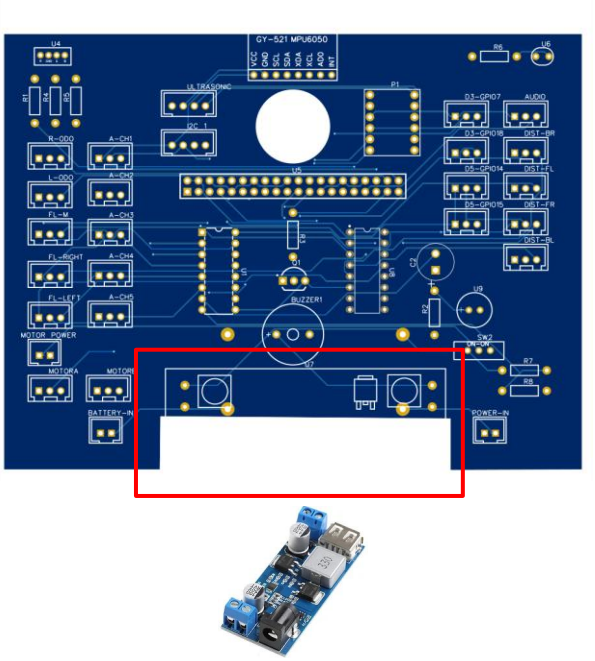


**Figure 21.** Placement of 5V Step Down on PCB

### Power Sensor

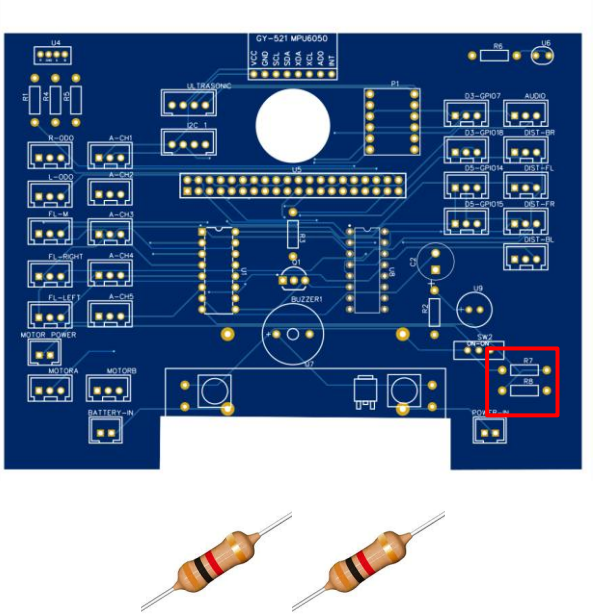


**Figure 22.** Placement of Power Sensor on PCB

### 3.3V Step Down (Back Side of the PCB)

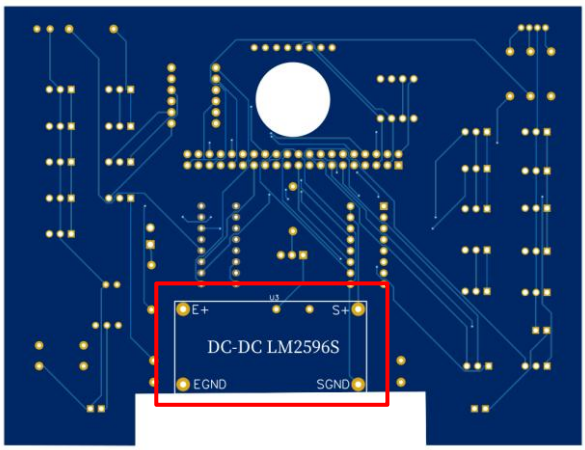



**Figure 23.** Placement of Step Down (Back Side of the PCB)

## 3.2.2 Battery pack PCB

The PCB designs can be downloaded from GitHub:
https://github.com/chronis10/fossbot-hardware/blob/fossbot-v2/electronics_instructions/Schematic_Battery.pdf

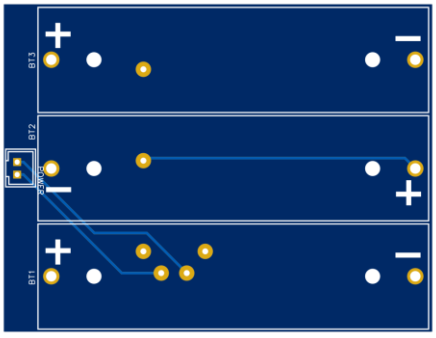


**Figure 24.** Battery Pack for the PCB (front side)

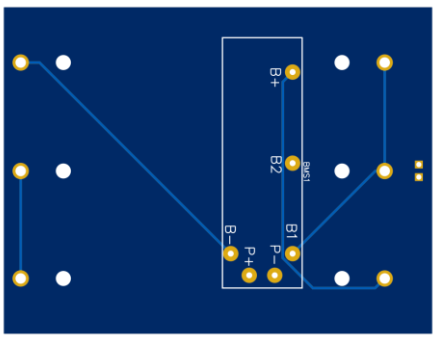



**Figure 25.** Battery Pack for the PCB (back side)

| | | | |
|---|---|---|---|
| JST 2-pin male |  | 1 | POWER |
| Battery holder 18650 |  | 3 | BT1, BT2, BT3 |
| Li-ion Battery Charger Protection Module 3S 10A |  | 1 | BMS1 |

**Table 5.** Electronic Components for the Battery Pack of the PCB

### Battery holders

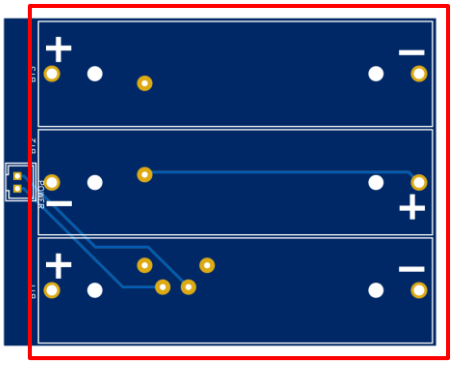



**Figure 26.** Placement of Battery holders on battery pack

### JST Connector

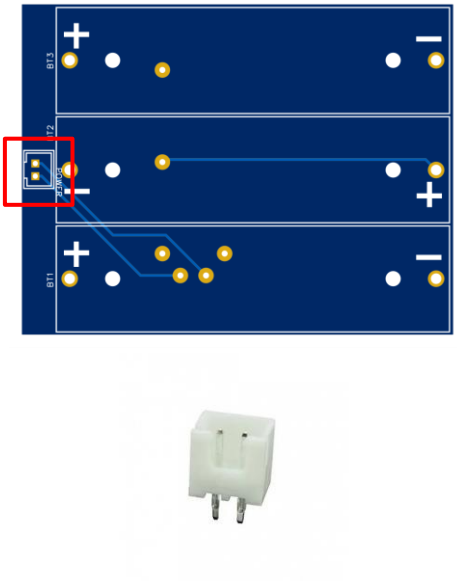


**Figure 27.** Placement of JST Connector on battery pack

### BMS (Back Side of the PCB)

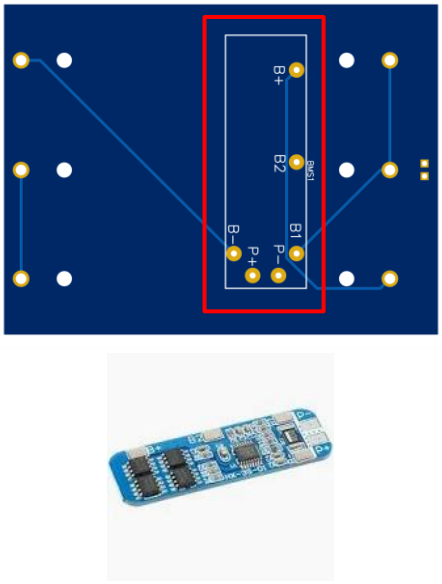



**Figure 28.** Placement of BMS Battery Protection Board on the back side of the battery pack

## 3.3 Wiring

An important step is the preparation of all sensors using the JST connector so that they can be easily attached to the main board later. The electronic components come with 3 or 4 male pin headers, and we need to convert these pins into JST connectors.

The following two images show examples of connecting an electronic component with a male pin header to a JST connector. One image illustrates a sensor with 3 pins, while the other shows a sensor with 4 pins. Similarly, you can connect any compatible sensor to the board, provided it is supported.

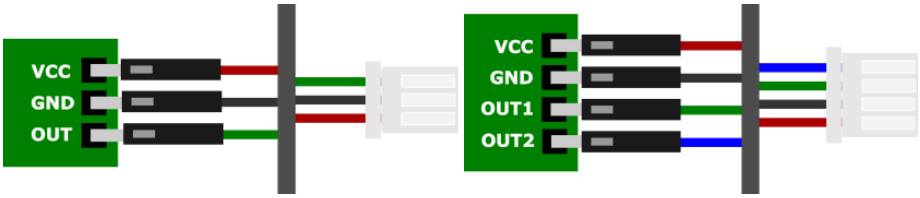
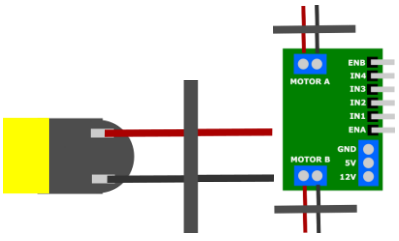
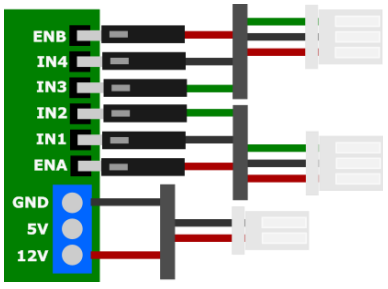



**Figure 29.** Connection of 3-pin and 4-pin sensors to JST connectors

The following images provide examples of these components and demonstrate how to connect them using the JST converter. You must repeat the same process for all components in the list below. The exact order of the connections may vary depending on how the component manufacturer assigns the outputs. Before starting the connection, please verify the corresponding pins and rearrange the connections if necessary.

Finally, some parts require soldering. These parts are indicated in the table below with a soldering requirement.

| | | |
|---|---|---|
| 2x Dc motors<br>(Soldering Required) |  |  |
| 1x Dual Motor Driver Module |  |  |

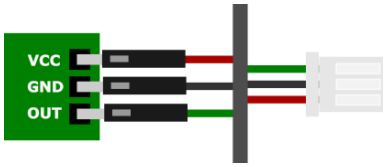
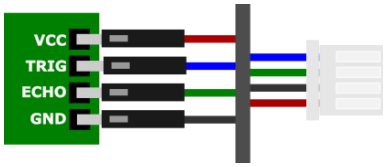
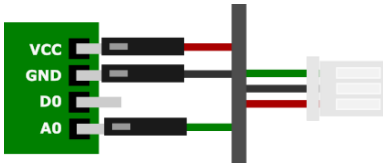
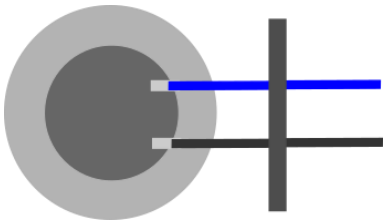
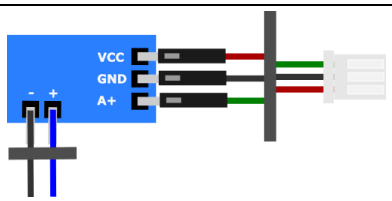
| | | |
|---|---|---|
| 2x Photo Interrupter Sensor (Odometer) |  |  |
| Ultrasonic Distance Sensor |  |  |
| IR distance sensor analog |  |  |
| DC Power Jack (Soldering Required) |  |  |
| Loudspeaker (Soldering Required) |  |  |
| Audio Amplifier (Soldering Required) |  |  |

**Table 6.** Electronic Components that require soldering

# 4. Assembly Instructions

After all the plastic parts have been printed, they need to be assembled. An important notice is to be take in mind that all the cables must be accessible from the top of the robot when complete the assembly in order to connect the JST connectors. During the limitation of the illustration is impossible to present the cabling so you must take care the proper cable management during the assembly using the internal grooves and slot in order to the end to drive all the cables on top of the PCB. The assembly instructions regarding the 3D-printed parts are the following :

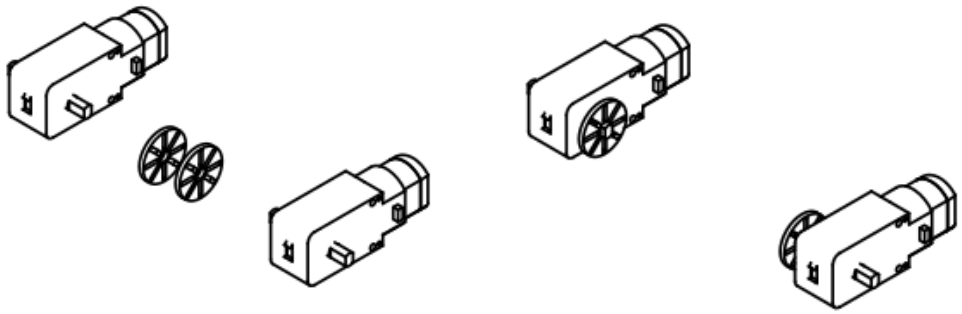


**Figure 30.** Odometer discs and motors

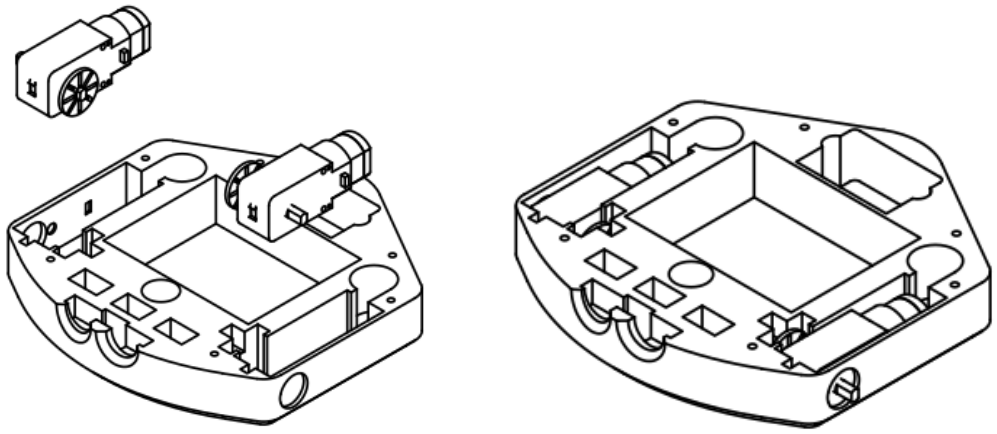


**Figure 31.** Place the motors on the bottom base

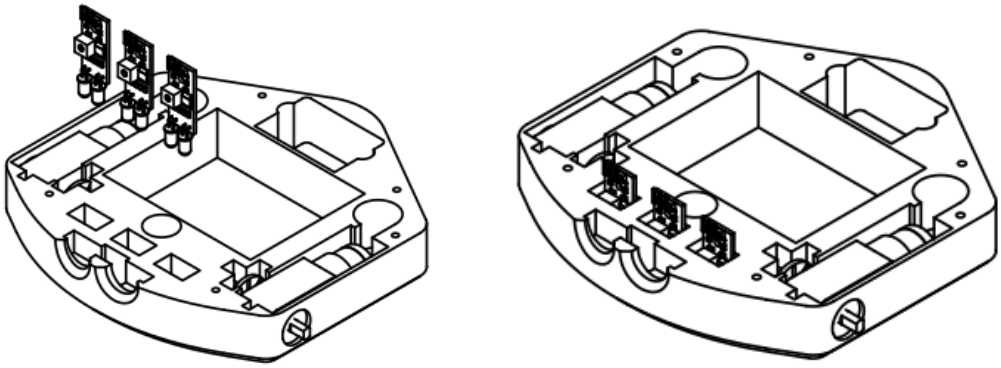


**Figure 32.** Place the IR distance sensors on the bottom base

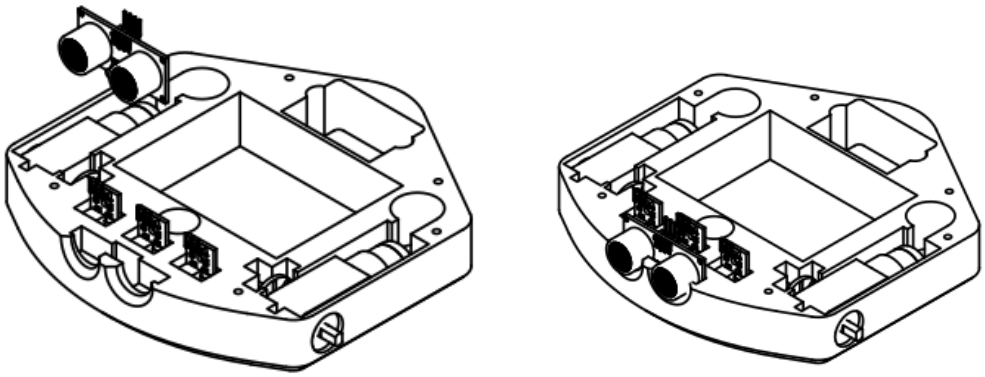


**Figure 33.** Place the ultrasonic sensor on the bottom base

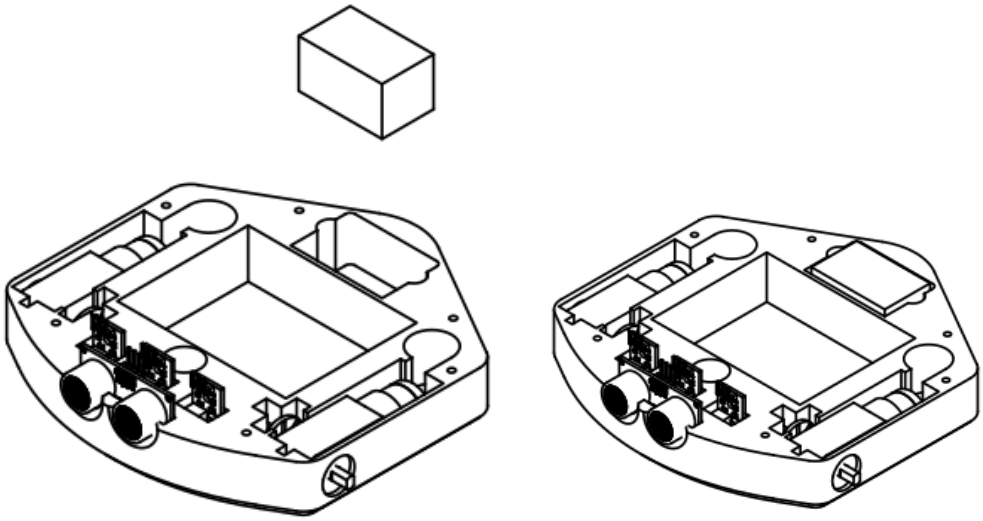


**Figure 34.** Place the motor driver on the bottom base

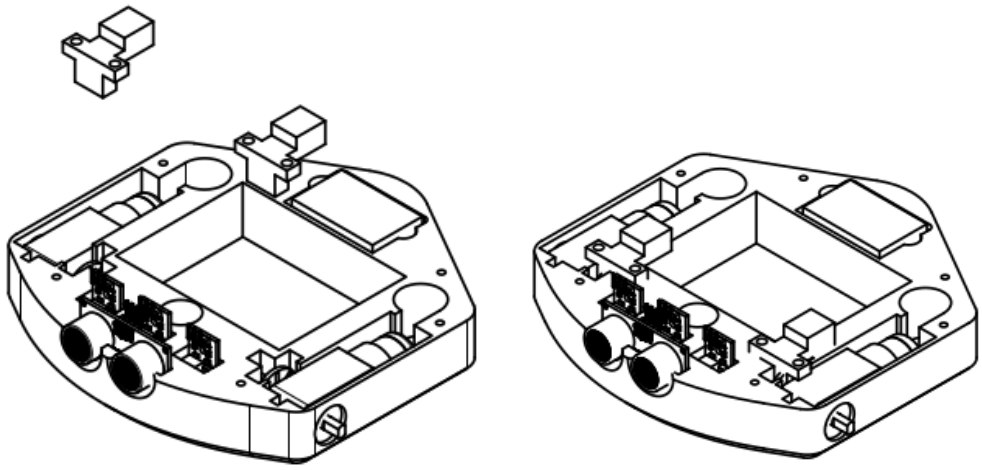


**Figure 35.** Odometers sensors

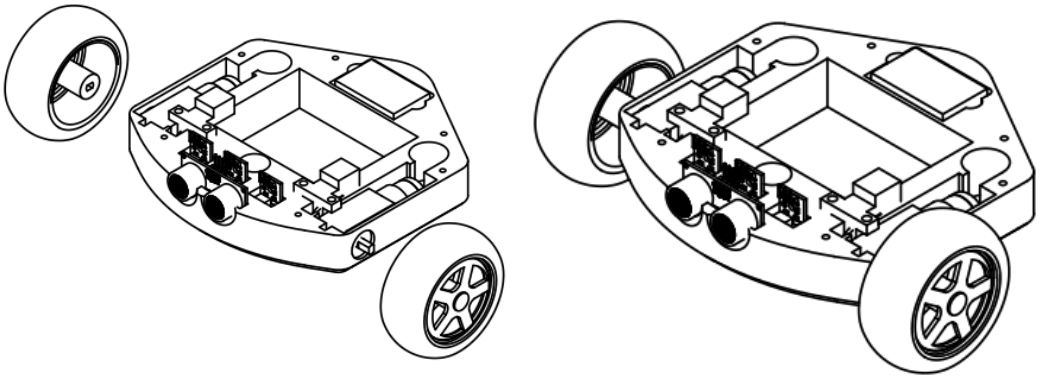


**Figure 36.** Attach the wheels

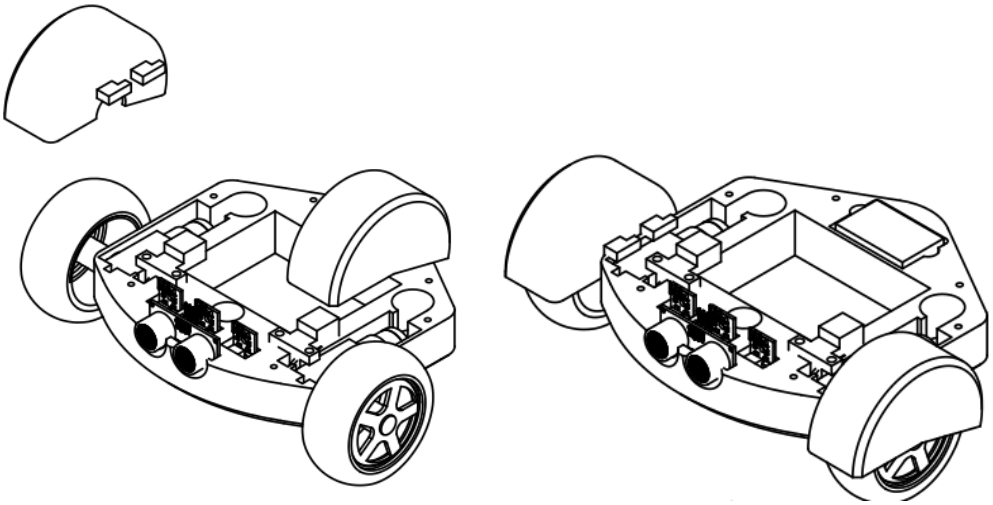


**Figure 37.** Attach the spoilers

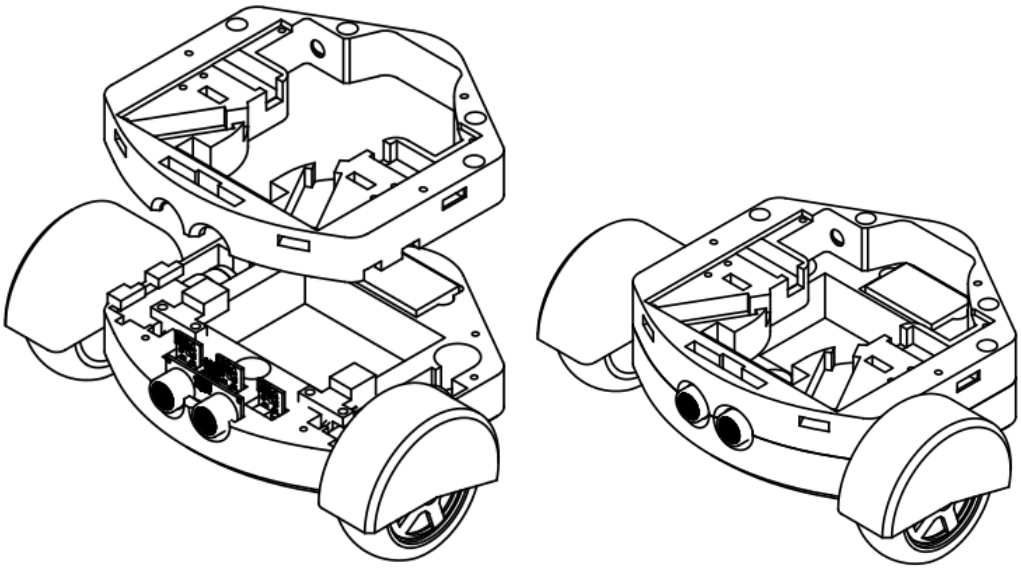


**Figure 38.** Place the middle base to stabilize all the components

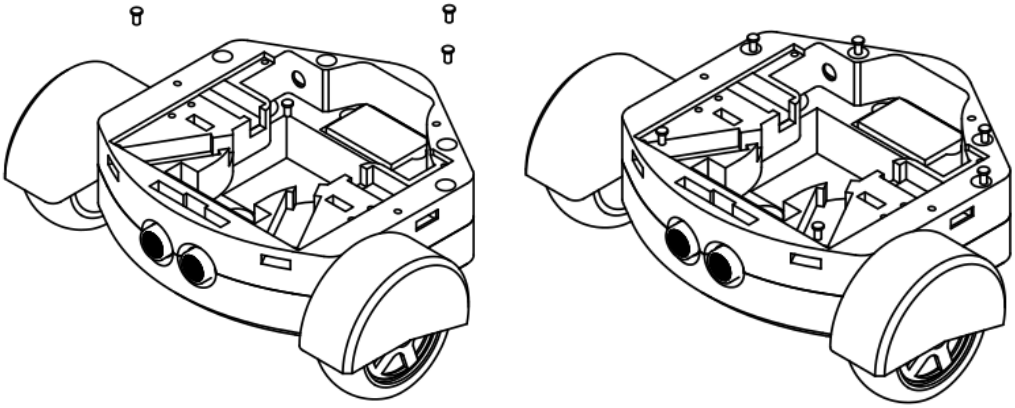


**Figure 39.** Screw the middle base to the bottom base

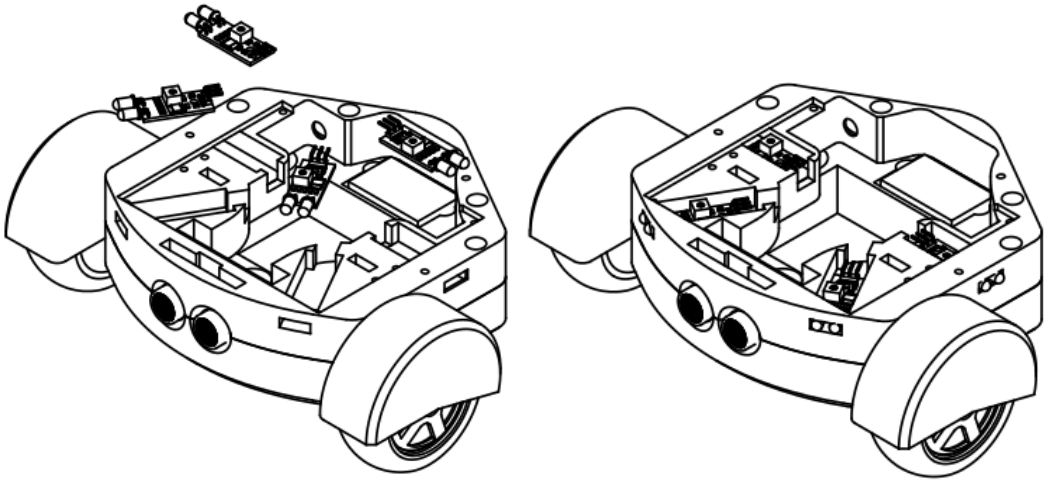


**Figure 40.** Place the perimeter IR distance sensors

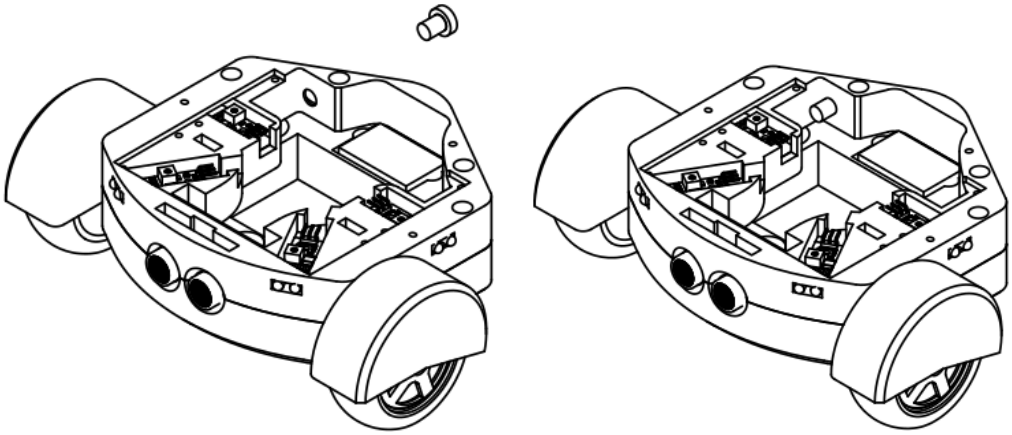


**Figure 41.** Place the DC charging port

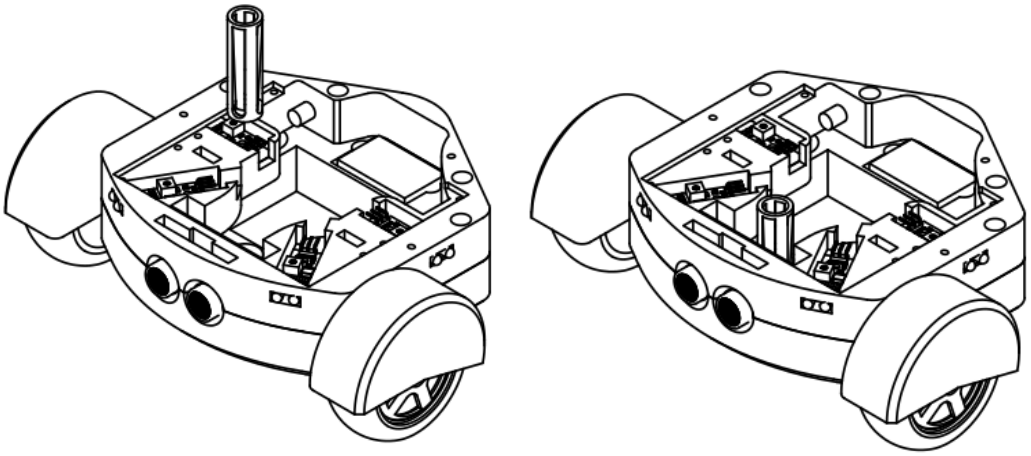


**Figure 42.** Place the pen holder

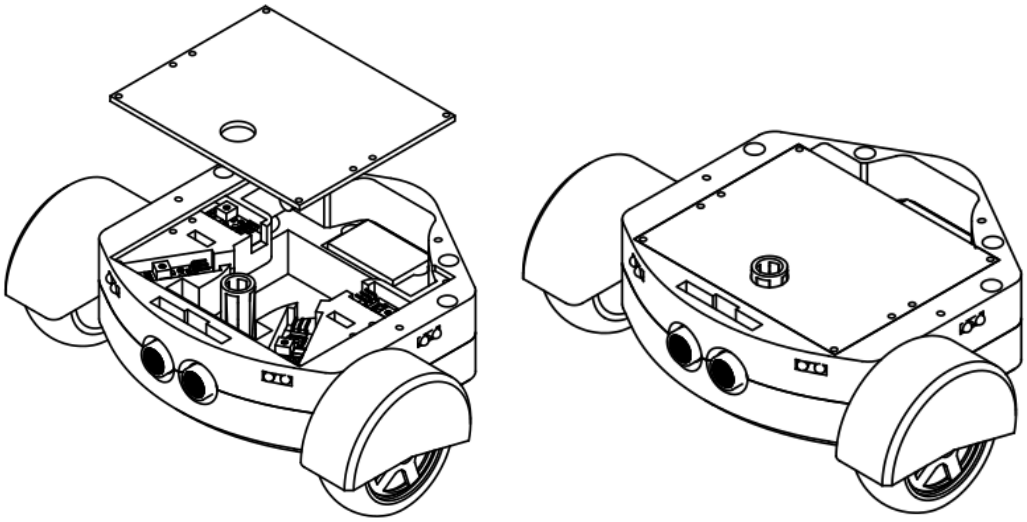


**Figure 43.** Place the main PCB

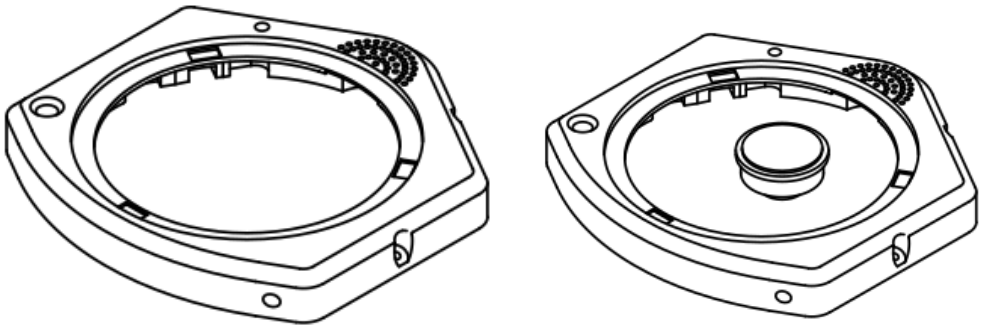


**Figure 44.** Place the speaker on the top base

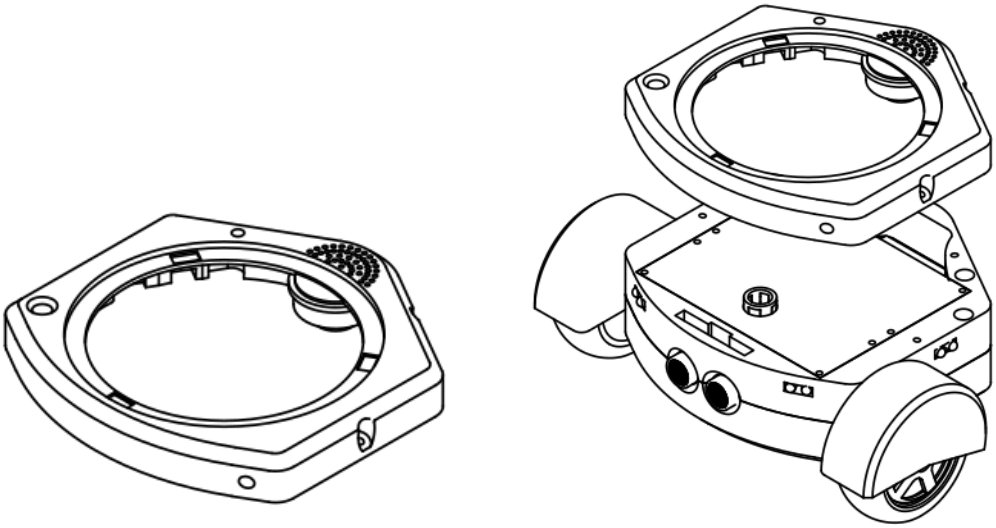


**Figure 45.** Place the top base on the middle base

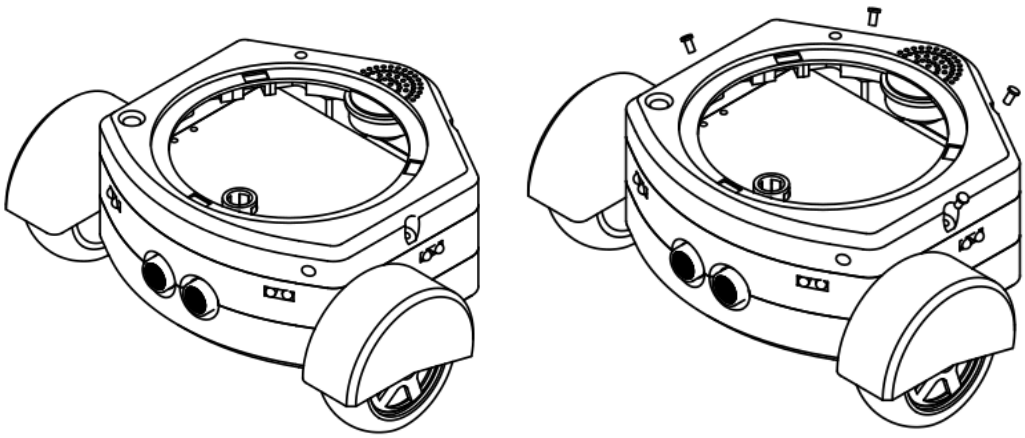


**Figure 46.** Screw the top base to the middle base

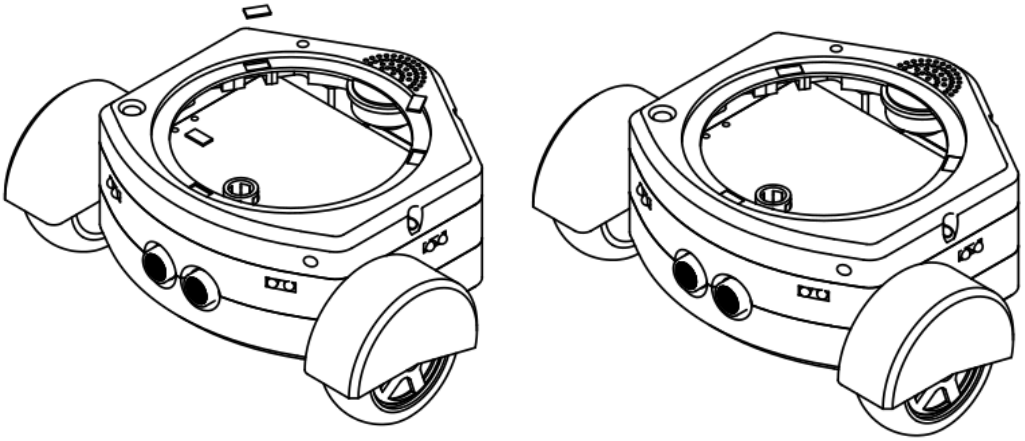


**Figure 47.** Place and glue the magnets to the top base

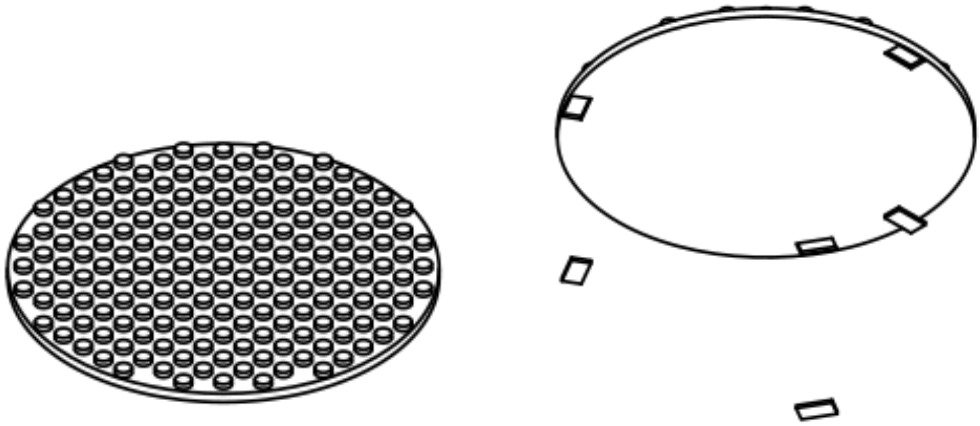


**Figure 48.** Place and glue the magnets to the top cover

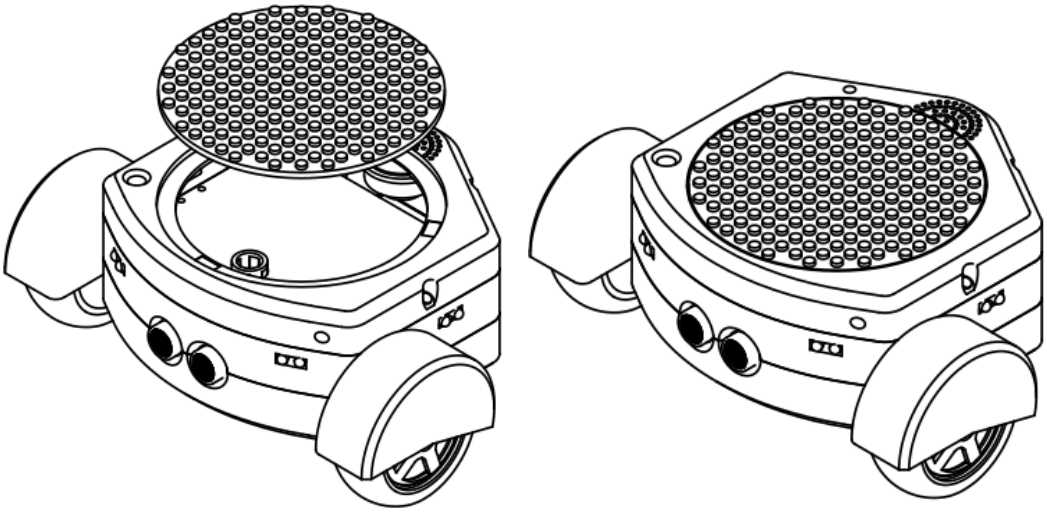


**Figure 49.** Place the top cover on the top base

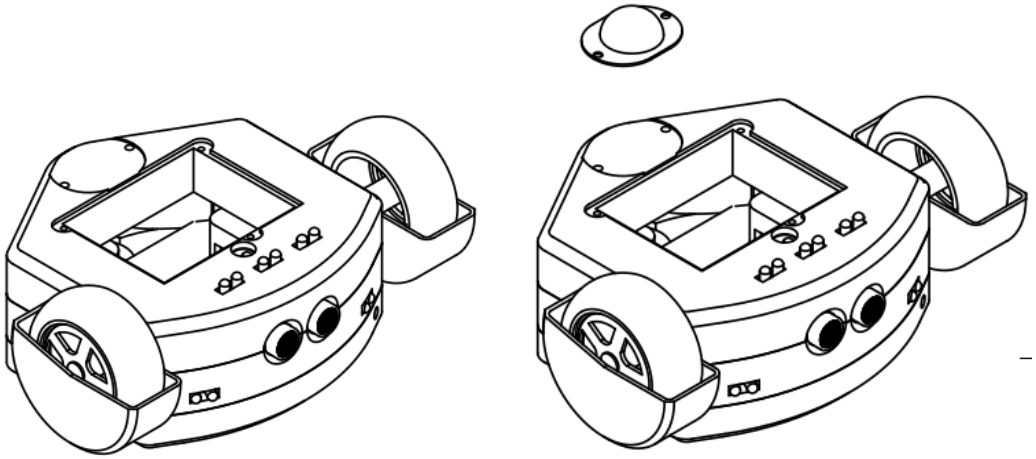


**Figure 50.** Place the ball caster at the bottom of the robot

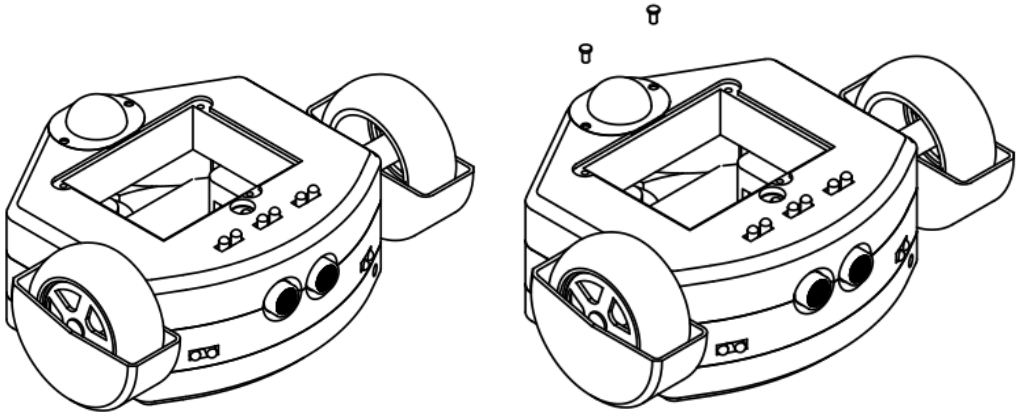


**Figure 51.** Screw the ball caster to the bottom

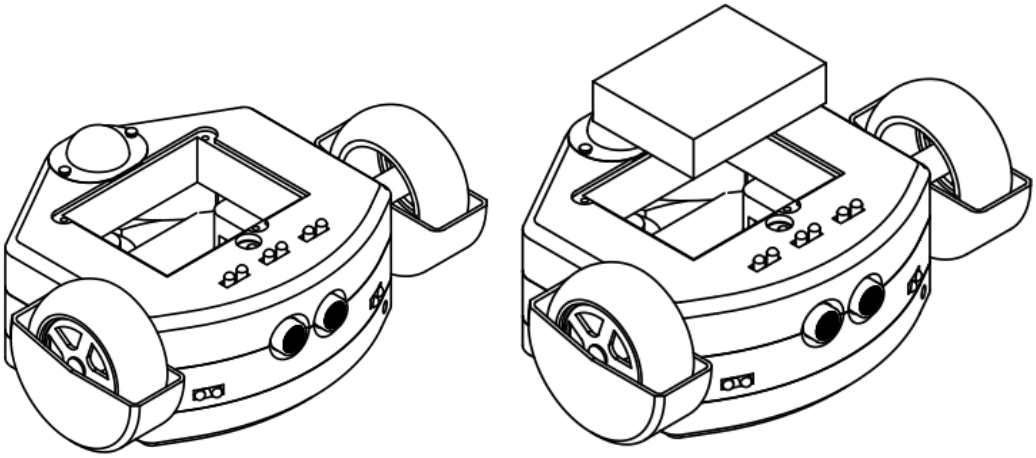


**Figure 52.** Place the battery pack

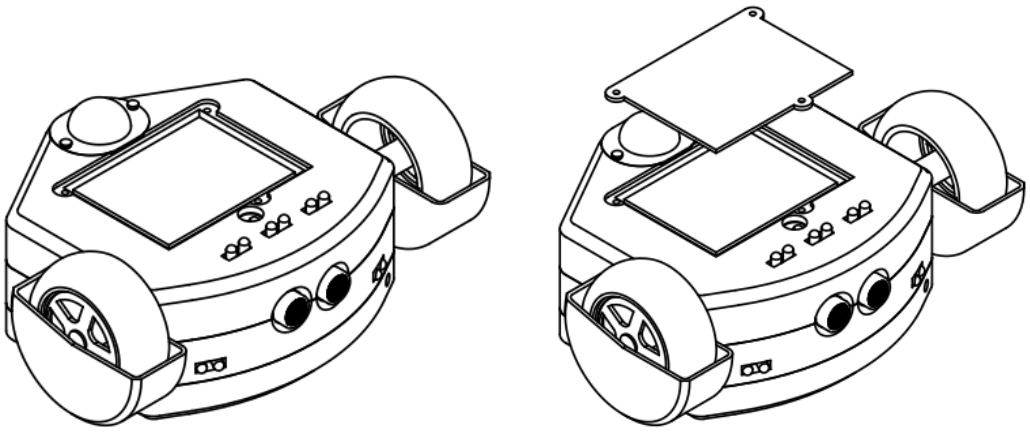


**Figure 53.** Place the battery cover

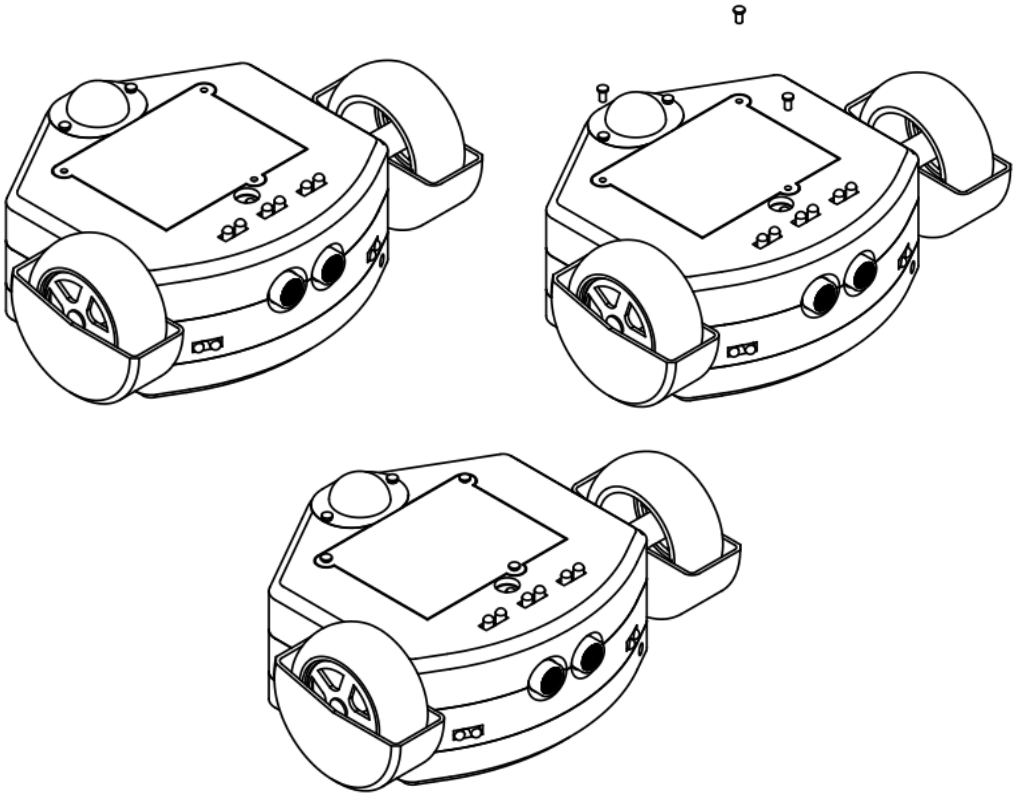


**Figure 54.** Screw the battery cover

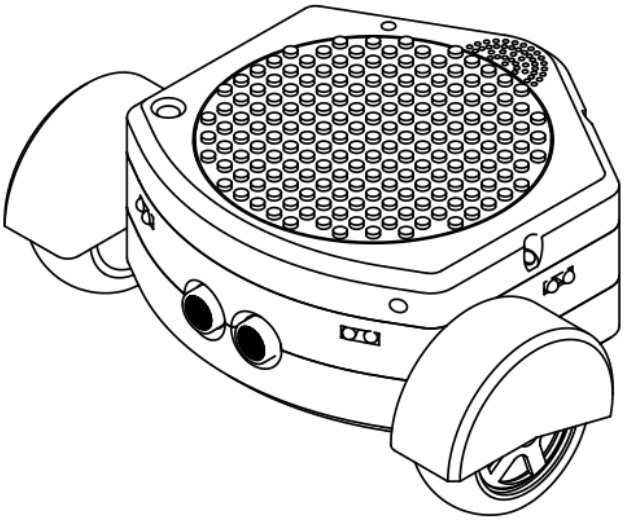
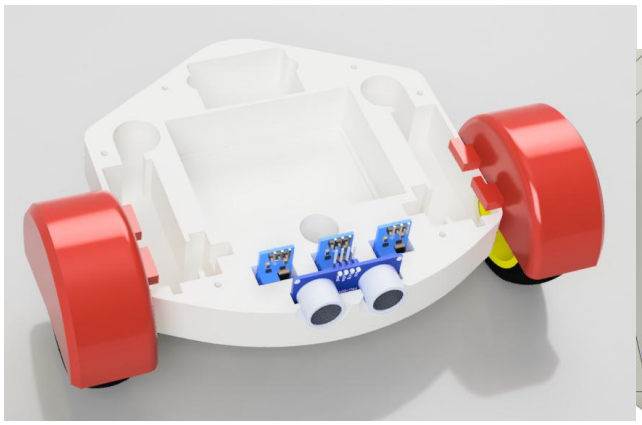


**Figure 55.** The robot is ready



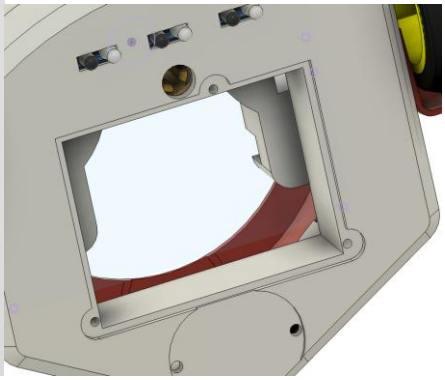


**Figure 56.** Images for the robot assembly

Finally remove the top cover and connect all the JST connectors to the main PCB.

# 5. Setting up and running

## Download the image file

- Download the newest version of the FOSSBot Image from the following link: ISO Images
- Click on the first option (**fossbot-app-v0.6-armv6-native.zip**)
- **Extract** the downloaded zip. This will produce an **iso .img** file
- Download the **Raspberry Pi imager** from the following link: https://www.raspberrypi.com/software/

## Install the image

- Connect the microSD card from FOSSBot to your pc via a **microSD adapter**
- **Open** the **Raspberry Pi imager** program

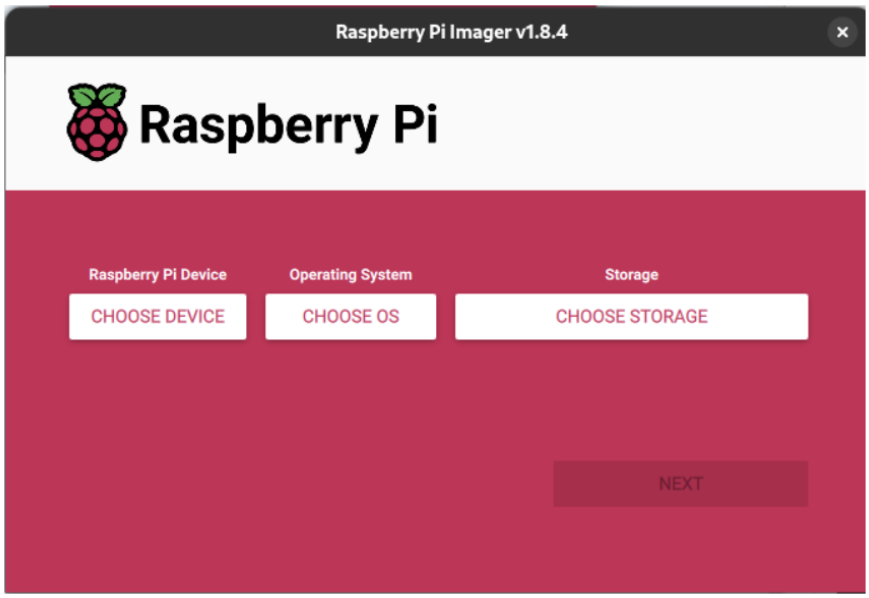



**Figure 57.** Raspberry Pi imager

- Fill in the three fields:
  - **Raspberry Pi Device: Raspberry Pi Zero**
  - **Operating System: Use custom**(last option) / Choose the previously **downloaded image**
  - **Storage:** Choose the **microSD card**
- Press **Next** (you may need to format the card first)

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# Configure the WIFI credentials

- After the successful installation, open in the boot partition of the microSD card and the **wifi_config.txt** file in your preferred editor
- Change the values **ssid**, **psk** and **region** according to your **WiFi credentials**

```
ssid="Your WiFi network name"
psk="Your WiFi Password"        # Use None for Open AP
key_mgmt="WPA-PSK"              # Change as needed (e.g. WPA-PSK (Almost always), None (Open AP))
region="GR"                     # Set your country code (e.g. GR, FR, TR, ES, RO, US, GB)
```

**Figure 58.** Wifi credentials in wifi_conig.txt file

- **Save** the file
- Safely **detach** the microSD card from your computer

# Attach microSD card to FOSSBot

- Now you are ready to use the microSD card you configured to FOSSBot
- **Attach** the **microSD** card to Raspberry Pi Zero and **power up** the robot
- In a few seconds, you will see the **LED sensor** blinking **red** 🔴. This means that FOSSBot hasn't detected your WiFi network yet
- In a few more seconds you will see the **LED sensor** blinking **green** 🟢. This means that FOSSBot has connected to your WiFi network but hasn't established a connection to the internet yet
- Almost instantly the **LED sensor** will turn to blue and stay **blue** 🔵. This means that the connection to the internet is established
- **Now you are ready to connect to the robot's interface and start building projects! Just hit the link below to your browser: [http://fossbot-000.local:8081](http://fossbot-000.local:8081)**
- This is what we must see:

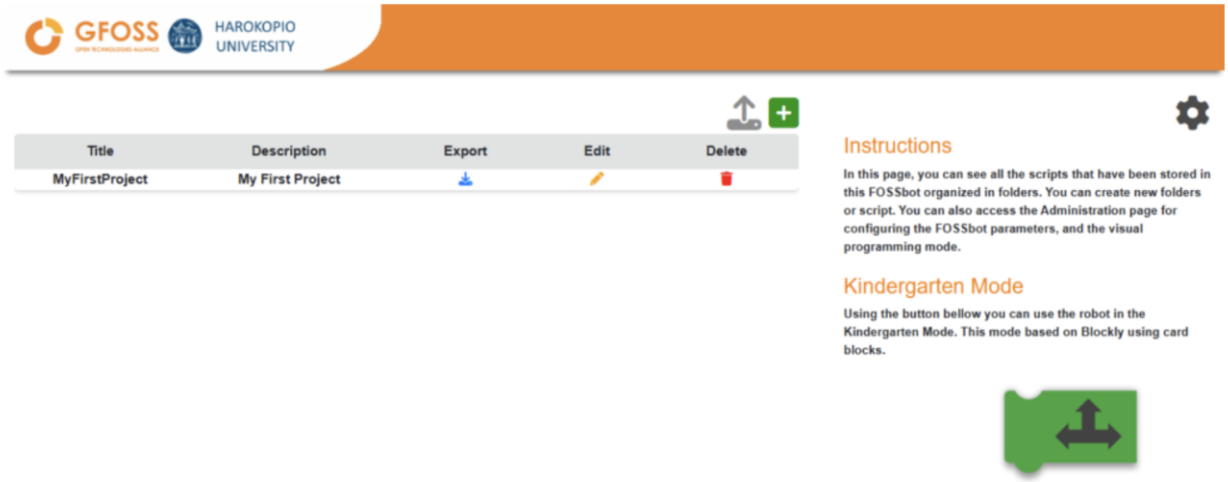



**Figure 59.** FOSSBot Programming Interface Home Page

Happy coding!

# 6. Basic programming

Programming takes place in a visual programming environment called **Blockly**.

**Blockly is a visual, block-based programming language developed by Google** that allows users to create code by **connecting puzzle-like blocks.** Each block represents **a code element**, such as variables, loops, or functions, making it easy to learn and understand programming logic without needing to write traditional code. Designed for beginners, **Blockly is often used in educational environments**, like schools, to teach basic programming concepts. It supports various languages, including **JavaScript** and **Python**, enabling seamless transition to more advanced coding.

After activating FOSSBot you can enter either **Kindergarten Mode** or the **Blockly customized workspace** tailored specifically for robotics functions.

The simplest way to use and control FOSSBot is by selecting the **Kindergarten Mode** (under Instructions).

The view for younger ages is a very simple one. It contains cards with basic movements that the robot can execute, like moving back and forth. The logic is that the cards need to get dragged and dropped into the Blockly workspace. When the program is ready, by clicking the play button, the robot executes the movements on the cards one after the other. If the program needs to be stopped, the stop button needs to be clicked.

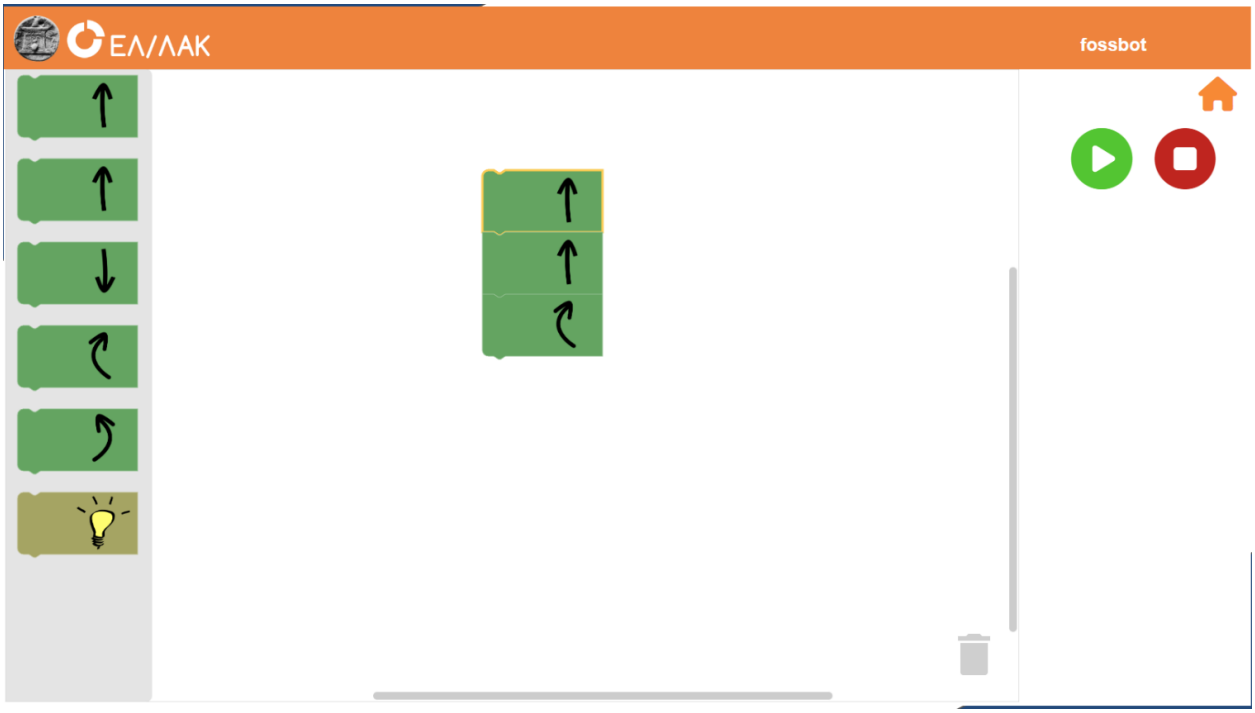



**Figure 60.** Kindergarten Mode

The second way to use and control FOSSBot is by using the **Blockly page**.

On the left side, the categories are shown. Each category contains a list of blocks. The blocks were split into categories to make it easier to look for them. Blocks can be dragged and dropped into the Blockly workspace to create programs that control FOSSBot.

On the right side of the screen, there is a black area where the results of the code are displayed in real-time.

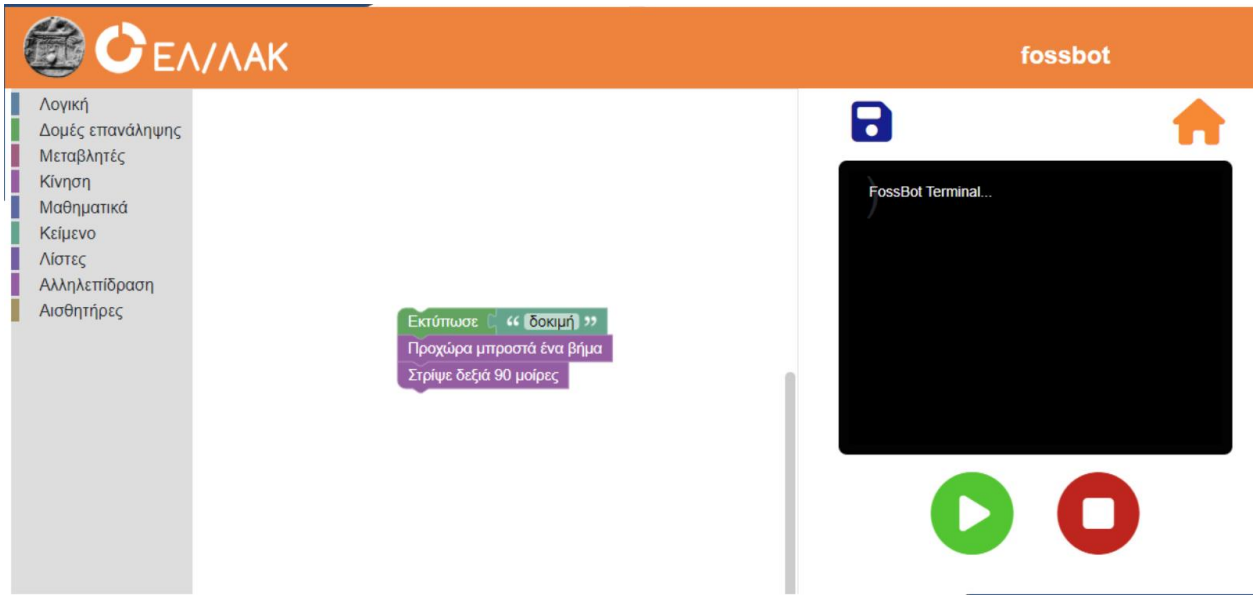
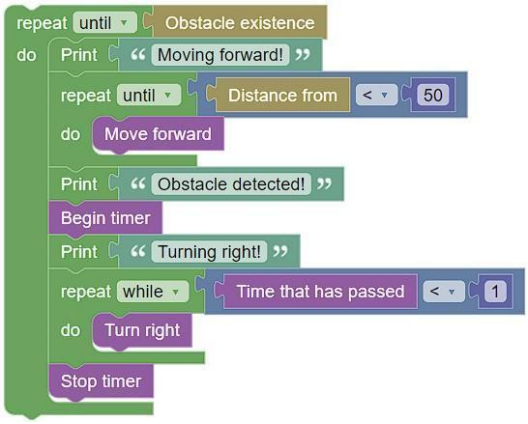



**Figure 61.** Blockly Page

# Examples

## Example 1 : Obstacle avoidance

In this example, the robot uses its ultrasonic distance sensor to avoid obstacles. When the ultrasonic distance sensor locates an object, then it checks the distance between the robot and the object found. In case the distance is less than 50 cm, the robot continues to move forward. Otherwise, it turns right. In Figure 5, the code for the obstacle avoidance example is presented. In Figure 6, the scene used for obstacle avoidance is where the robot moves between the cones without falling on them.



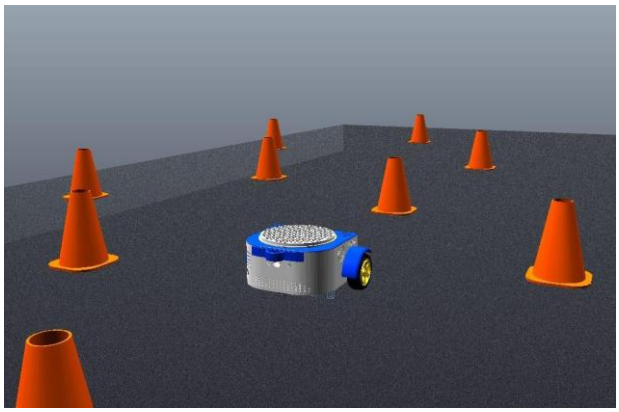



**Figure 62.** Code for obstacle avoidance **Figure 63.** Obstacle avoidance scene

## Example 2 : Line following

In this example, the robot uses its IR obstacle sensor for line following and the ultrasonic distance sensor for obstacle avoidance. While there is no obstacle in front of the robot, the code checks if any of the IR sensors on the bottom of the robot are above the black line. This ensures that the robot moves in the right direction. Figure 7 shows an example code that can be used for line following. Figure 8 shows the scene where the robot moves by following a single continuous line.

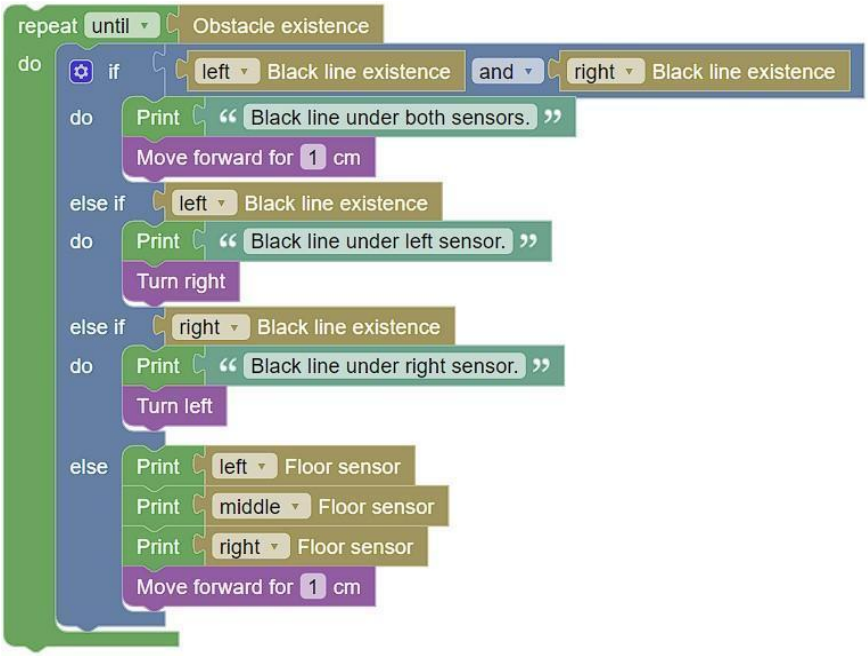



**Figure 64.** Code for line following

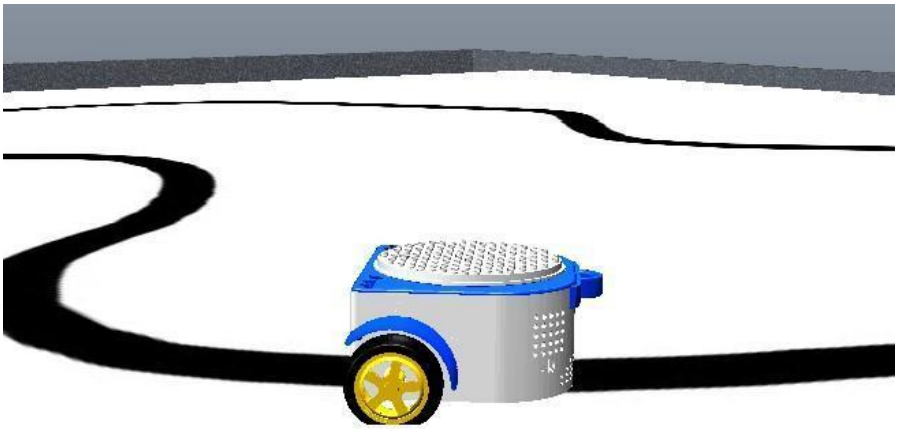


**Figure 65.** Line following scene

## Example 3 : Light detection

In this example, the robot uses its light detection sensor for the detection of a bright or dark source. Based on the detection of a bright or dark source, the robot turns right or left. The RGB color light changes accordingly. In Figure 9, the code for detecting a bright source is presented. Figure 10 shows the scene used for light detection, where a bright source is included.


**Figure 66.** Light detection scene

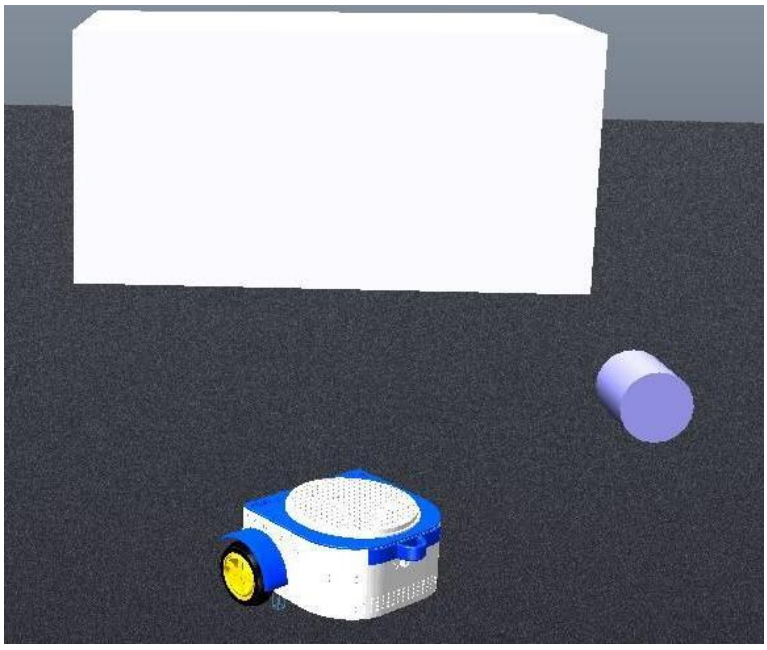


**Figure 67.** Light detection scene

# 7. Troubleshooting tips

1. Power off before soldering.

### ASSEMBLY ISSUES

2. If plastic parts do not fit because of the edges, they can get sanded with fine-grit sandpaper.
3. Make sure the .stl files used for printing are correct.
4. In case plastic parts were falsely printed, reprint them.

### BATTERY ISSUES

5. If you press the ON/ OFF button and the robot does not start, make sure the batteries are inserted correctly and the wiring is correct. Power should be able to run through the whole circuit.
6. If you press the ON/ OFF button and the robot does not start, maybe the batteries are not charged. Please charge the robot.
7. Robot turns off randomly, batteries may be empty. Please charge the robot.

### WI-FI CONNECTION PROBLEMS

8. Check wiifi_config.txt, please check if credentials are correct.
9. Please check if there is a Wi-Fi connection.
10. If there is a Wi-Fi connection but no good signal, please place the robot closer to the Wi-Fi router.

### PROGRAMMING ISSUES

11. If you press play in the Blockly page and the robot does not execute some of the blocks, ensure that blocks are snapped together correctly.
12. If you continue having issues with the execution, you can use debug prints.
13. If you press play in the Blockly page and the robot does not execute the blocks, check the connection.
14. No blue light? Recheck the commands for set up in Section 5.
15. Before running a “Follow the line” example, make sure the light detection sensors on the bottom of the robot are correctly configured. Configure the sensors in the Setting’s page.

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# 8. Glossary

| Term | Description |
|---|---|
| 3D printed part | The part was printed using a 3D printer using the material provided to the printer. |
| Blockly | Visual, block-based programming language developed by Google that allows users to create code by connecting puzzle-like blocks. |
| Blockly workspace | The area that contains all the blocks connected to each other. |
| Github | GitHub is a developer platform that allows developers to create, store, manage, and share their code. |
| IR distance sensor analog | Device that uses infrared light to measure distance, and its output is a continuously varying voltage that corresponds to the distance. |
| JST Connectors | It is a vernacular term for a range of different type of wire to board connectors. |
| Li-ion Battery Charger Protection Module | It is an electronic circuit to ensure safe operations within the lithium-ion batteries. |
| Battery Li-ion | Type of rechargeable battery. |
| microSD | A type of very small memory card typically used in mobile phones and other portable devices. |
| microSD adapter | Together with the microSD card, comes the adapter so that the micro sd card can be used in regular sd card slot on a computer, laptop, camera, or whatever might have a regular sd card slot. |
| Odometer | Instrument used for measuring the distance traveled by a vehicle. |
| PCB Board | It is an electronic assembly that uses |

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| | |
|---|---|
| | copper conductors to create electrical connections between components. PCBs also provide mechanical support for electronic components so that a device can be mounted in an enclosure. |
| Photoresistor | Type of resistor that changes its resistance based on the intensity of light shining on it. |
| Photo Interrupter Sensor | It is a sensor with a light-emitting component and light-receiving component packaged face to face. It applies the principle that light is interrupted when an object passes through the sensor. |
| Raspberry PI | Series of low-cost, small single board computers created by teh Raspberry Pi Foundation in collaboration with Broadcom. |
| Raspberry Pi Imager | A tool for writing an OS (Operating System) to an SD card |
| Resistor | Device having resistance to the passage of an electric current. |
| RGB LED | It is a LED module that can produce almost any color using these three primary additive colors: Red, Green and Blue. |
| stl file | It is a common file format for 3D printing and computer-aided design (CAD). It stores the surface geometry of a 3D object using a series of triangular facets, effectively creating a "mesh" of the object's outer shape. |
| WAVESHARE IR proximity sensor with analog | The sensor uses infrared transmitter and receiver tubes for obstacle detection. |