Erasmus+

Assembly and programming Micro:bit system

FISH
Farmers Innovaton Science Hub

AUTHORS OF THIS MANUAL:

IMAGINA, Educación y Ocio, S.L. – Rodrigo Carlos Rodríguez García y Álvaro Ruiz Hidalgo | **APS WE DO FABLAB** – Massimiliano Ferré, Alice Briola y Gabriele Sasso | **Associação Terra Maronesa** -Duarte Gomes Marques y Marco André de Almeida Fernandes-.

Con la colaboración de **Asociación Plantío Chinampa** -Pepe Lobillo Eguíbar y Juan Manuel Selma- y **Edintra Consulting S.L.** -Luis Miguel Sanabria Lucena-.

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INDEX

1. Erasmus+ FISH Project and the Present Manual

This document is an annex to the Aquaponics Manual and Other Sustainable Production Methods, framed within the ERASMUS+ KA210 FISH Project.

Its objective is to serve as a guide for assembling and programming a Micro:bit system to facilitate the collection of information and environmental monitoring of orchards and crops, using open-source and low-cost technology. This type of system allows for the realization of interactive projects with a very simple and accessible interface, even for absolute beginners, and can be used as an educational tool.

Throughout the following pages, we will see step by step, supported by images, the assembly and programming of a system of this type. Therefore, it functions as a complement to the information developed in the Aquaponics Manual or as an independent manual for those people who are only interested in this informatics and technical part of crops.

1.1. Erasmus+ FISH – Farmers Innovation Science Hub Project.

Farmers Innovation Science Hub (FISH) is an ERASMUS+ KA210 project whose main objective is to promote environmental sustainability and food security by improving resource efficiency—primarily water—through the implementation of new techniques that combine traditional methods with modern techniques and technologies (hydroponics, aquaponics, electronic sensors, etc.).

In this way, the project seeks to enhance plant production alongside fish cultivation through the following objectives:

- ✓ Promote learning opportunities and the development of knowledge and skills among adults.
- ✓ Provide practical tools to improve the cultivation of plants and fish.
- ✓ Contribute to environmental protection and conservation.
- ✓ Increase the resilience of people and communities by implementing sustainable production systems that improve food security.

Through a series of pedagogical resources and tools, the project aims to develop and strengthen a set of "green skills" to improve sustainable production of plants and fish while optimising resources.

Accordingly, the project strives for better adaptation and a stronger fight against climate change and drought, while also fostering community development thanks to the synergies and collaborations that are generated.

The project is aimed at adults residing in the European Union, with a preference for Spain, Portugal and Italy.

Two target groups are distinguished according to different adult profiles:

- **People with experience and knowledge** who are already developing production initiatives for educational, leisure and/or self-consumption purposes and who belong to a collective (such as an association of allotment growers or a socio-cultural association), an institution (such as schools or universities) or who carry out a professional activity (farmers and extensive livestock producers).
- **Individuals interested in a personal basis** and at a domestic scale. They are people with varying levels of knowledge and experience in self-consumption initiatives.

The priority group for the project is the first of the two above.

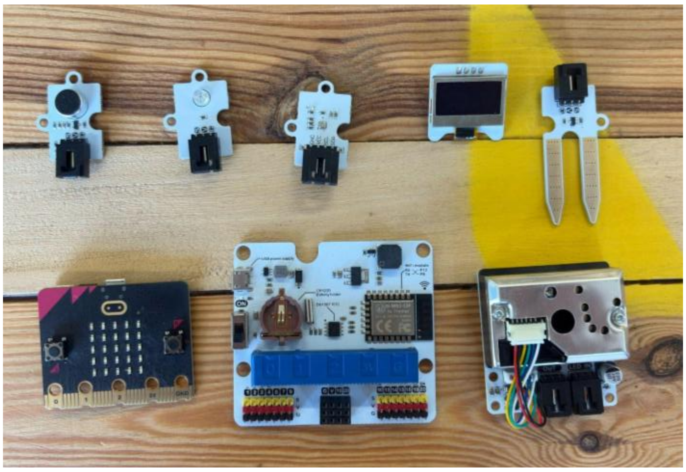
Using a participatory methodology, a series of training, research and knowledge-exchange activities have been carried out throughout 2025, of which this manual is the result.

As the project is planned to continue over time, readers are invited to visit its website (www.hidroedulab.eu) to keep up to date.

2. Step-by-Step Micro:bit Assembly

1. This is how the IoT Micro:bit kit + Micro:bit board is presented

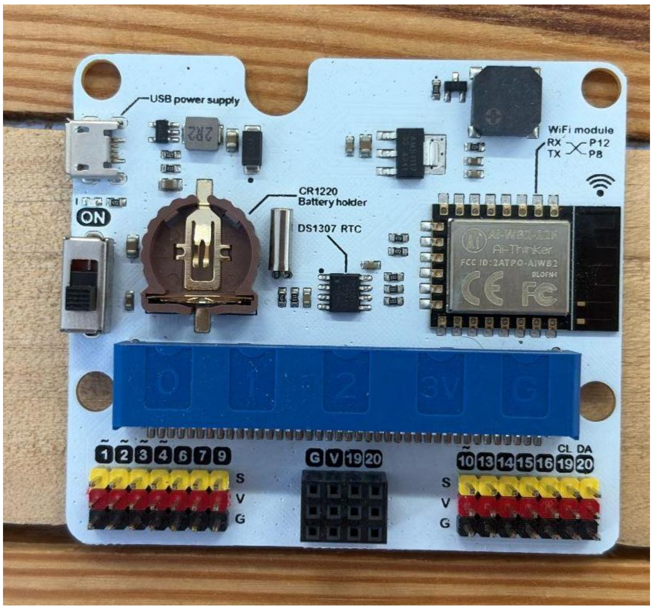
2. The components selected for the project are the following; from top left:
    a. Noise sensor [dB]
    b. Light sensor [0-100]
    c. Temperature sensor [°C], humidity [0-100] and atmospheric pressure [hPa]
    d. OLED screen 128 x 128 pixels for data visualization
    e. moisture sensor [0-100]
    f. Micro:bit
    g. "iot:bit" expansion board for Micro:bit
    h. Air quality sensor PM2.5 PM10 [µg/m³]



Within the framework of our project, the use of a weather station based on Micro:bit and environmental sensors allows for the collection of useful data to better understand and manage the agricultural ecosystems in which we operate. Thus, all the described elements have their function:

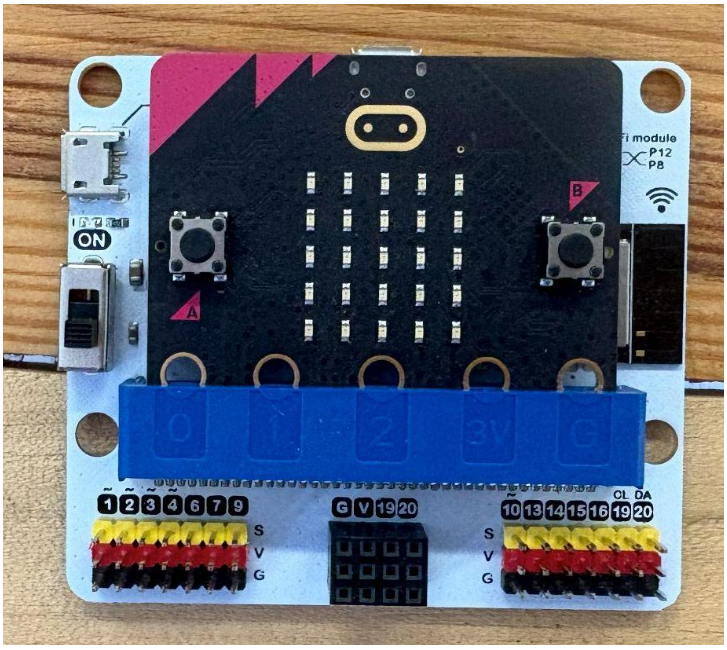
- The noise sensor can detect acoustic disturbances that affect wildlife or the school environment in which we work.
- The light sensor allows monitoring the light exposure of crops, useful in protected environments or to evaluate the optimal position of an installation.
- The temperature, humidity, and atmospheric pressure sensor provides fundamental climate data to observe the influence of the local microclimate.
- The soil moisture sensor is particularly relevant for optimizing irrigation in wicking beds and other low-water agricultural systems.
- Through the Micro:bit and the iot:bit expansion board, the collected data can be visualized, recorded, or sent online, fostering a didactic approach based on direct experimentation, critical reading of the environment, and open sharing of data.

3. En detalle, la placa de expansión integra In detail, the expansion board integrates:
    a. Switch for power on/off
    b. Compartment for CR1220 battery
    c. DS1307 RTC clock
    d. ESP12 WiFi module



This specific expansion board allows taking advantage of all the Micro:bit pins at 3V thanks to practical plug-in connections, facilitating the connection of sensors and external modules. Additionally, the presence of an RTC module (clock), integrated WiFi, and a battery enables creating a standalone system, connected to the Internet and capable of autonomously recording operation logs.

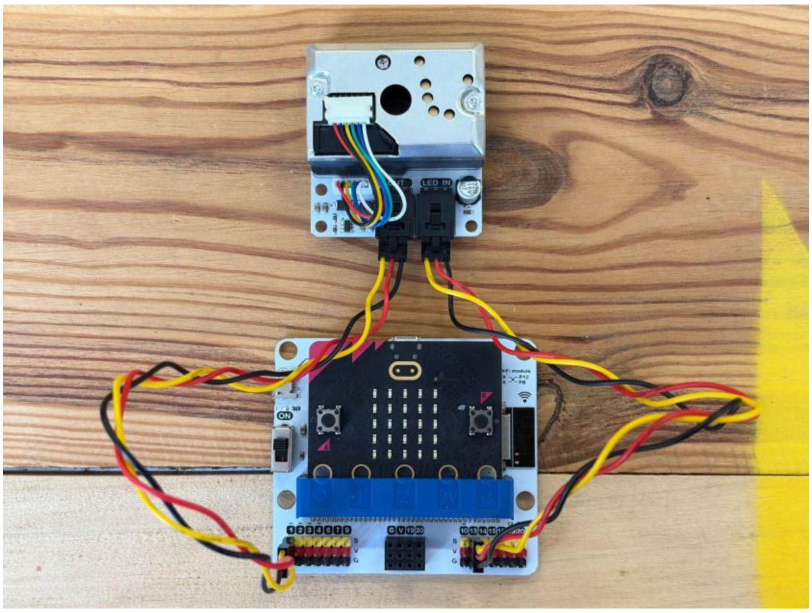
4. To allow Micro:bit to interface correctly with the expansion board, it is necessary that the assembly be done as illustrated in the image:



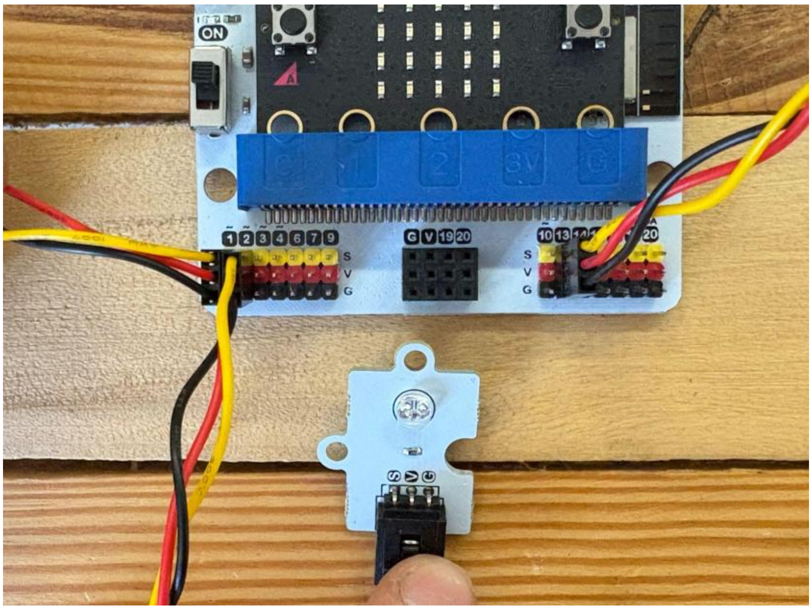
5. air quality sensor has two distinct circuits:
   a. LED (LED-IN):
      - to turn on the internal infrared LED of the sensor
      - Requires:
        - + (VCC) → power to the LED
        - – (GND) → ground
        - Signal (LED control) → a digital signal (often from Micro:bit) that activates the LED only when a reading is desired, to reduce consumption and interference.
   b. OUT (DATA-OUT):
      - It is the output of the analog or digital signal proportional to the amount of particulate matter detected.
      - Here too, the following are needed:
        - + (VCC) → power for the reading part
        - – (GND) → shared ground

- Signal (OUT) → sends the data to the Micro:bit (analog or digital, depending on the model).

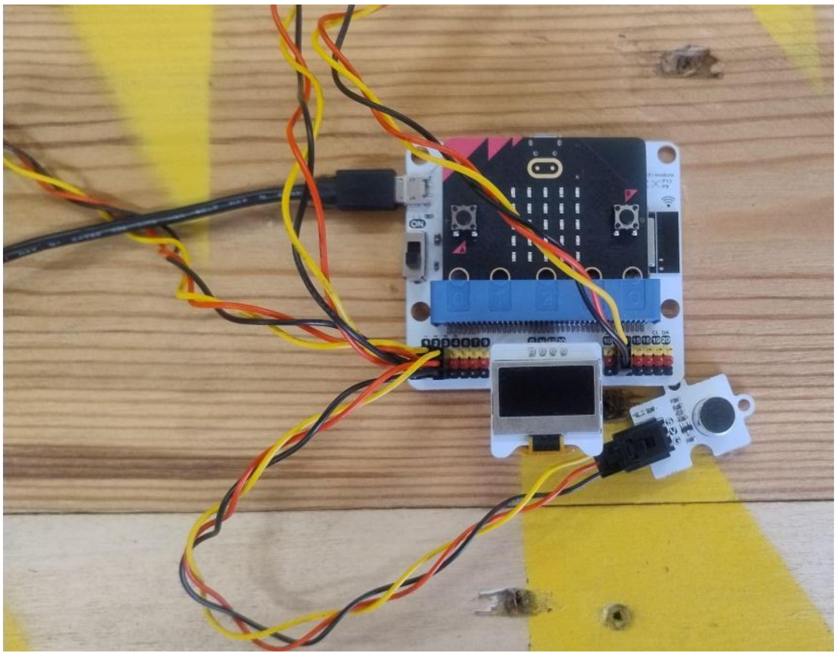
Respecting the polarity (and therefore the correspondence between the wire colors and the PIN colors on the expansion board), connect the sensor's LED IN to PIN 13 of the expansion board and the sensor's OUT to PIN 1 of the expansion board.



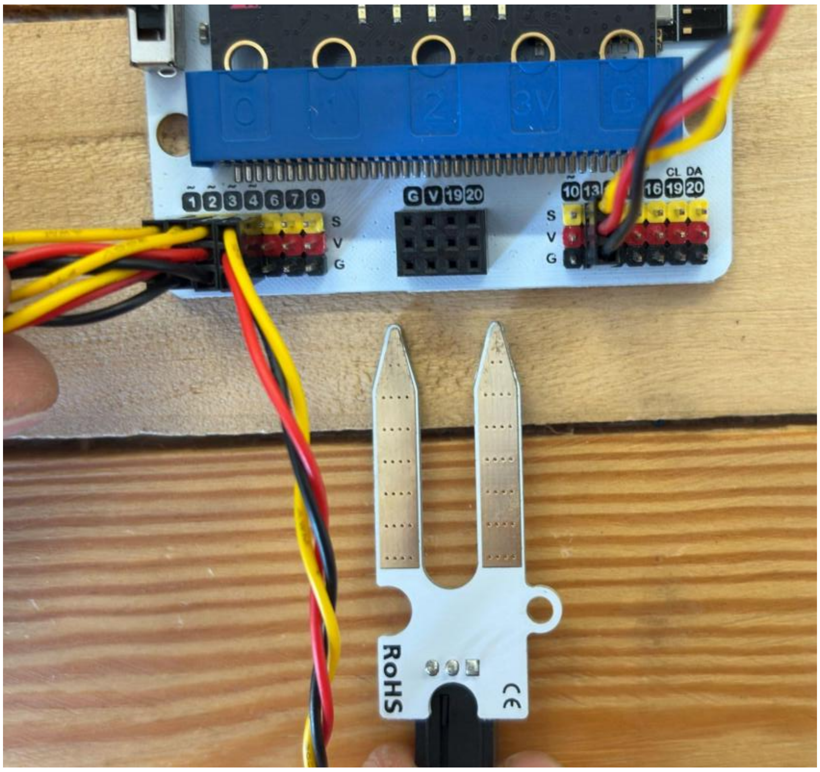
6. Connect the light sensor to PIN 2



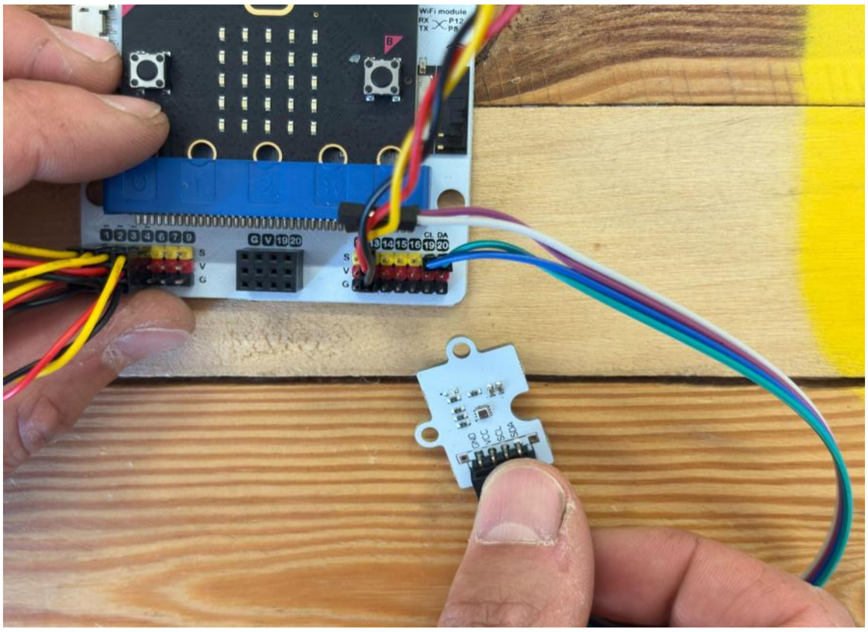
7. Connect the noise sensor to PIN 3



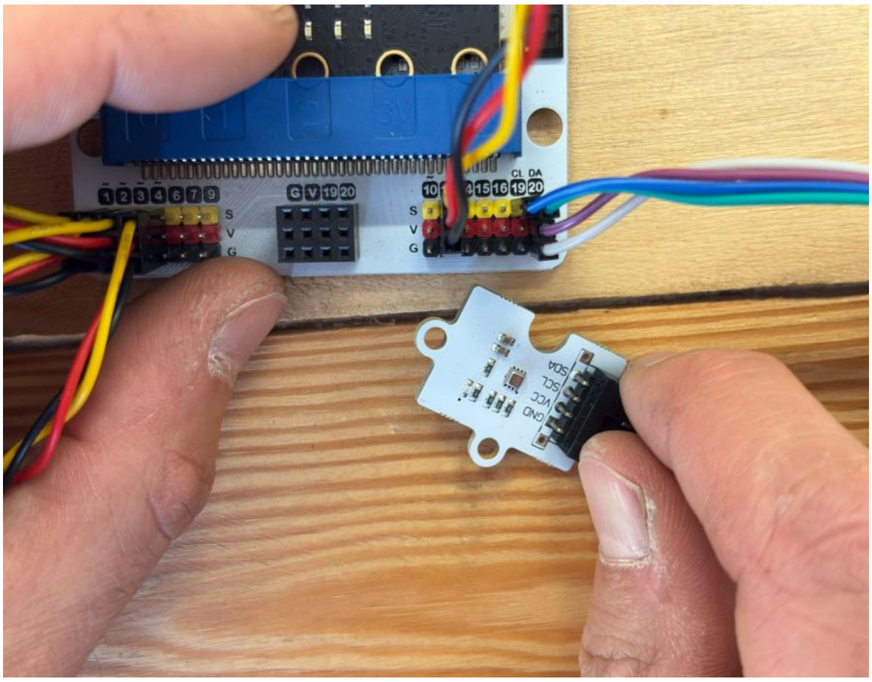
8. Connect the soil moisture sensor to PIN 4



9. The temperature, humidity, and air pressure sensor in question uses the I²C protocol, which is based on two lines: SDA for data and SCL for the clock. Therefore, connect the sensor's SCL to PIN 19 (CL signal) of the expansion board and SDA to PIN 20 (DA signal).

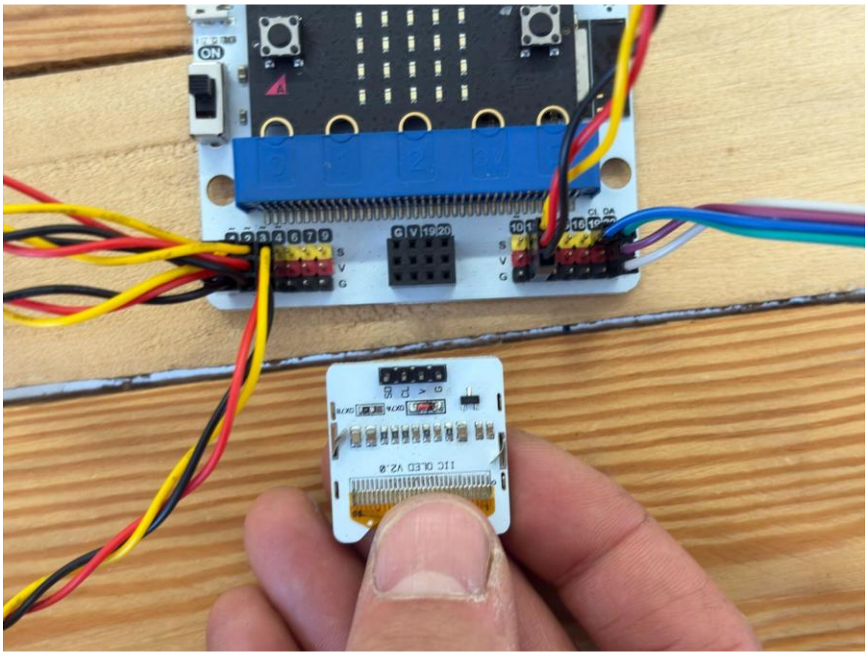


10. The sensor's VCC and GND are connected to two V and G PINs on the expansion board (for example, corresponding to PIN 20).

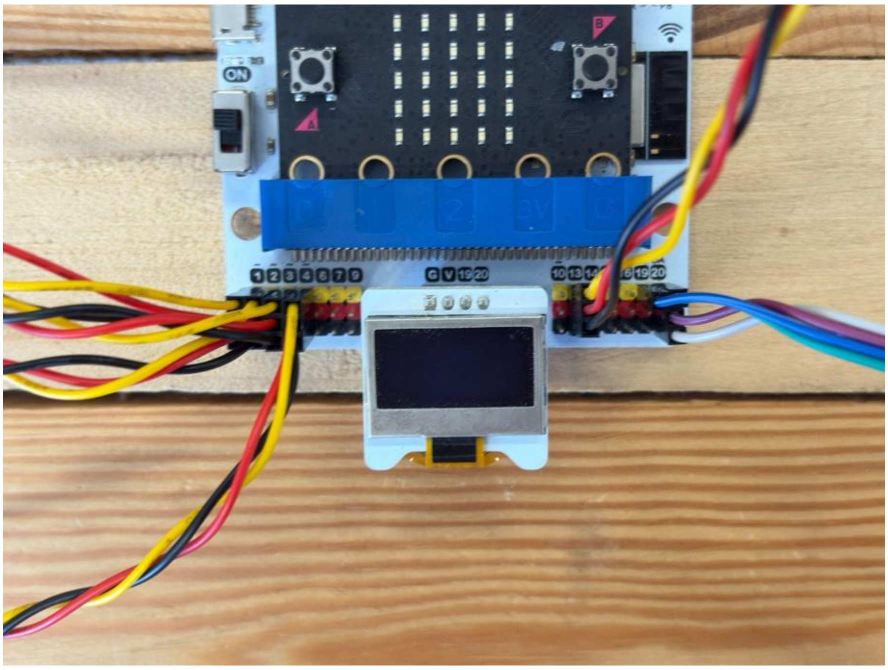


11. The OLED screen presents 4 PIN:

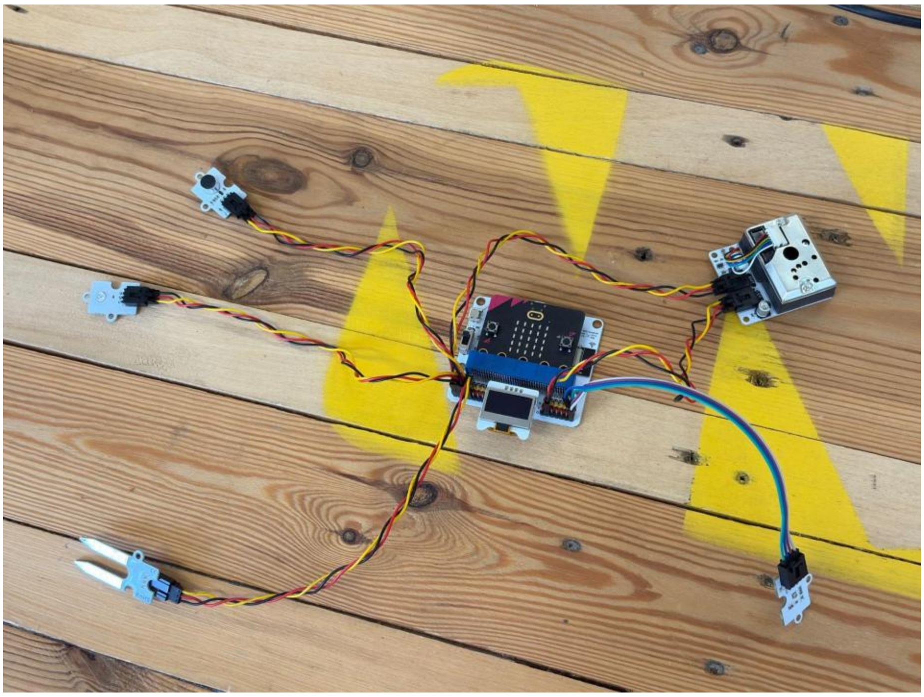
   a. G (-)
   b. V (+)
   c. CL (SCL) I^2C protocol
   d. SD (SDA) I^2C protocol



12. The screen can be easily connected to the female PINs located in the center of the expansion board and corresponding to G, V, 19, and 20.



13. The complete system is presented as shown in the following image:



At the output of the expansion board's pins, the Micro:bit supplies 3 volts, which correspond to the nominal operating voltage of the connected sensors. The current consumption required by the sensors, even if they are used simultaneously, is within the limits manageable by the microcontroller, which can supply up to 90 mA in total, with a maximum of 5 mA per pin.

3. Micro:bit Programming

Before discovering how to make the weather station autonomous, it is necessary to think about the microcontroller's programming; it is necessary to use a graphical block programming interface called MakeCode.

MakeCode is the official programming environment for BBC Micro:bit, developed by Microsoft. Available both in online version (in makecode.microbit.org) as in offline desktop version, it allows writing code in a simple and intuitive way.

The interface is designed for didactics: it is possible to program using graphical blocks (similar to Scratch): or switch to JavaScript or Python mode for more experienced users. MakeCode allows managing all the functionalities of the Micro:bit immediately, such as:

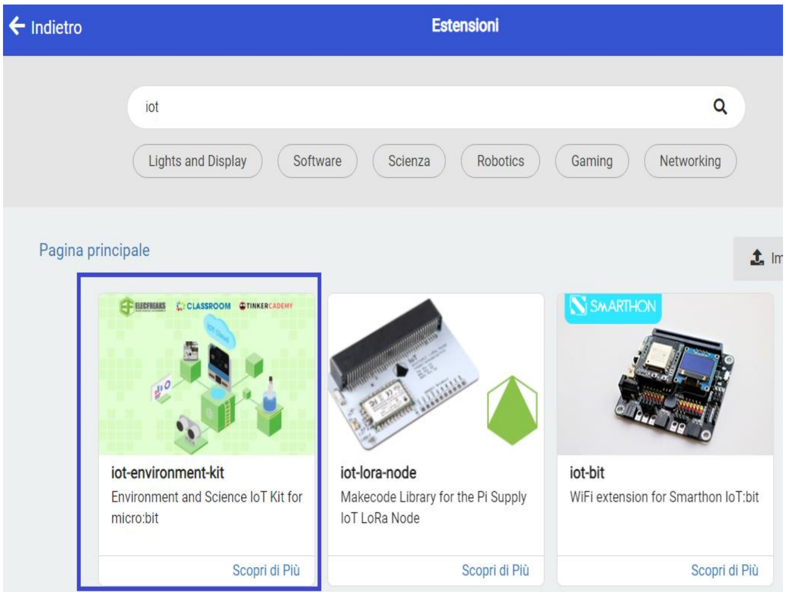
- LEDs and buttons,
- integrated sensors (temperature, accelerometer, compass),
- I/O ports to connect external sensors,
- radio and Bluetooth communication.

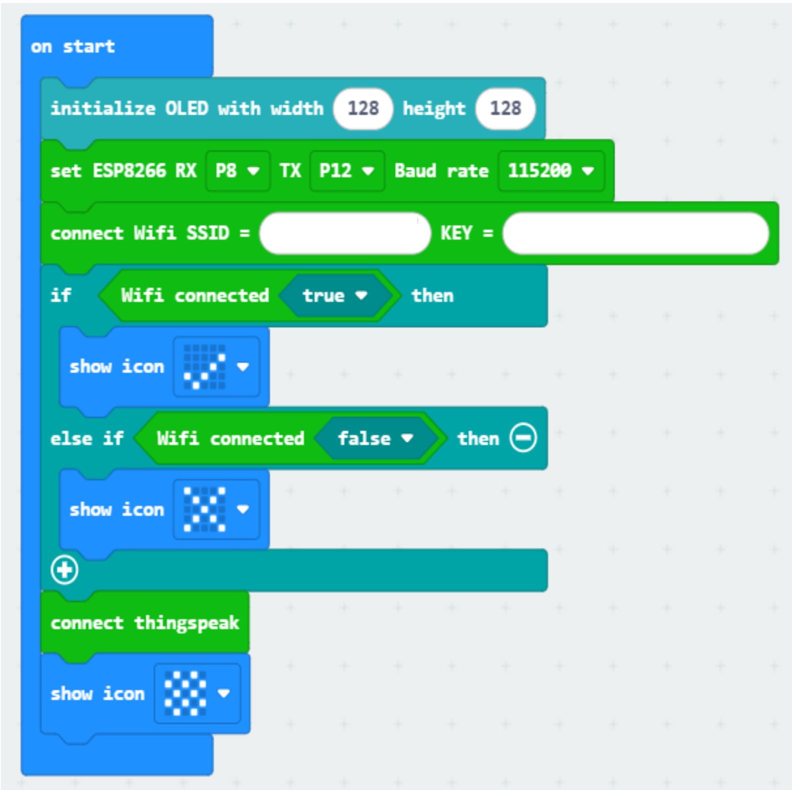
An integrated simulator allows testing the code even without having the Micro:bit physically connected immediately.

We will explain step by step how to program it:

1. At the start of Micro:bit, all initialization and configuration processes useful for the proper functioning of the system must be initialized:
    a. OLED screen initialization (for on-board data visualization)
    b. WiFi connection configuration (PIN and Baud rate)
    c. WiFi connection establishment (network name and password)
    d. Connection to the ThingSpeak platform (useful for data publication)

    To program the operation of the included sensors, it is necessary to use a specific library/extension: iot-environment-kit. The emoticons shown on the on-board screen can be useful to be certain of the connection to the Internet and ThingSpeak.

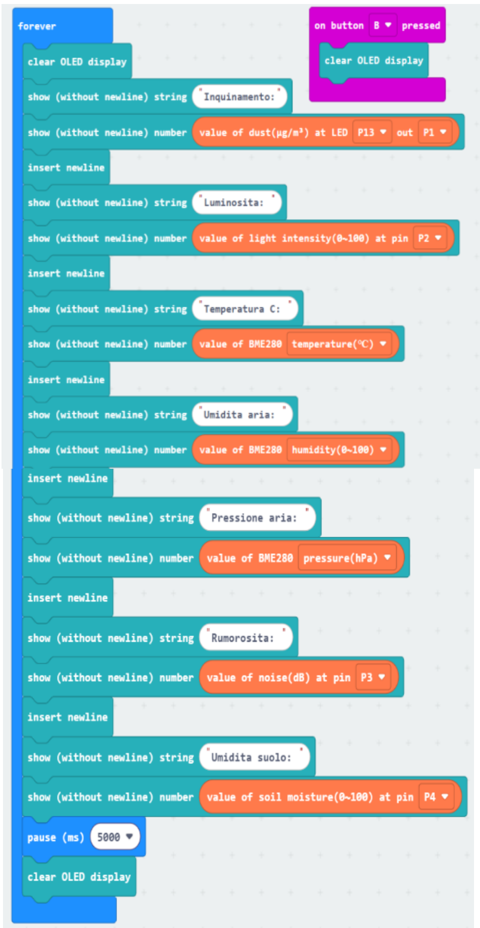




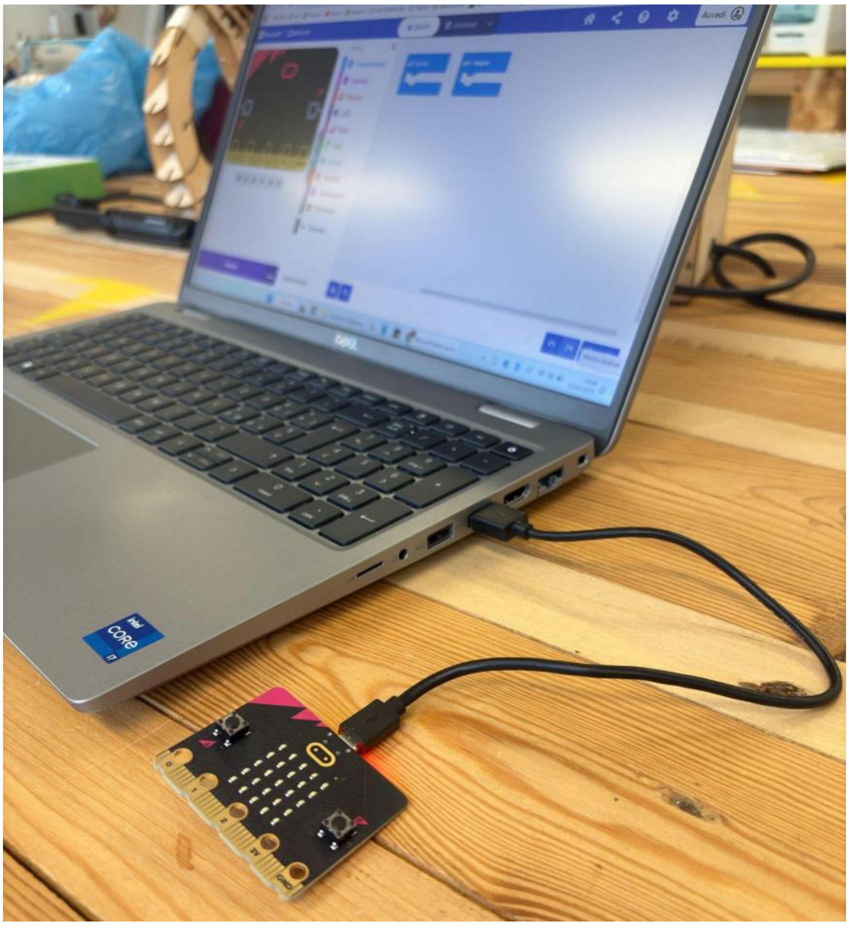
2. A first part of the program, in continuous execution, provides for the configuration of the data to be sent to the ThingSpeak platform and an emoticon to display on the on-board screen, to confirm the sending of the data detected by the sensors. The string related to the API key must be inserted in the corresponding field later.

   Note, the blocks related to the values detected by the sensors (orange color) must be correctly configured by selecting the corresponding PIN number.

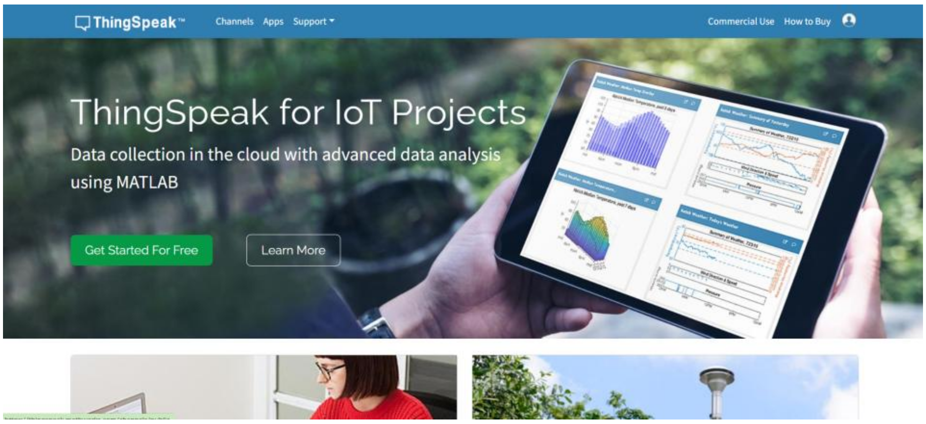
3. Parallelly, every 5 seconds, display on the OLED screen the values detected by the individual sensors



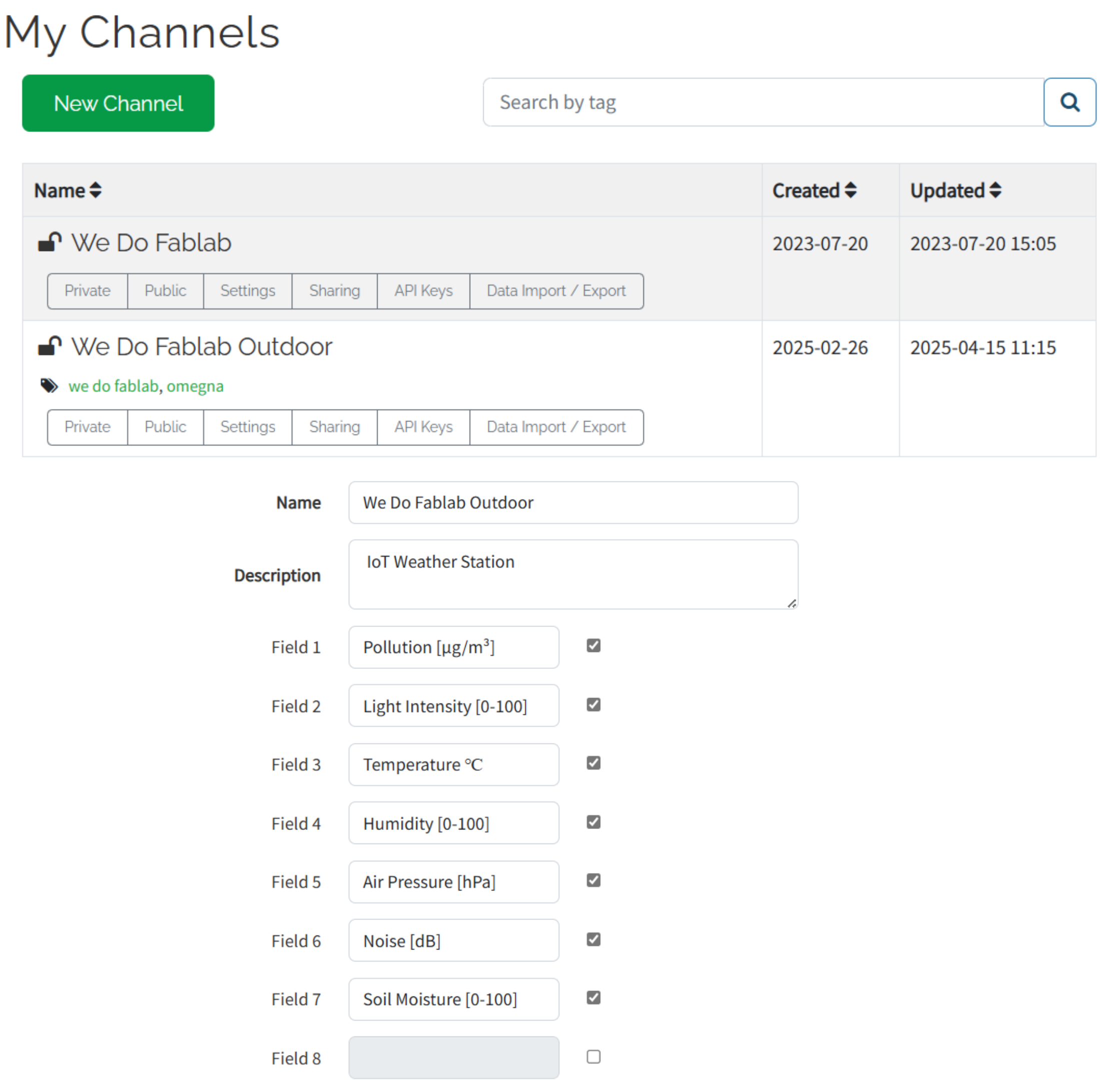
4. Transfer the created program to the Micro:bit memory



5. To be able to publish data online, it is necessary to create an account through MathWorks, by connecting to the main ThingSpeak page and clicking on “Get Started For Free”.

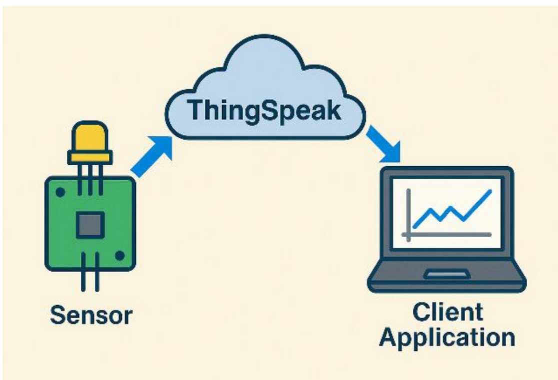


6. Create a CHANNEL and customize the labels of the data detected by the sensors, which in turn will be transformed into graphs



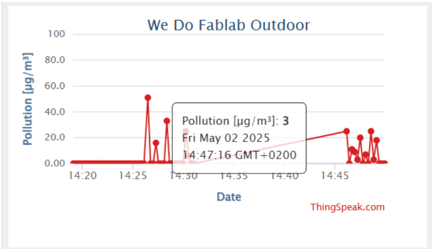
The names inserted in the fields must correspond to the number of Field used in MakeCode in point 2.

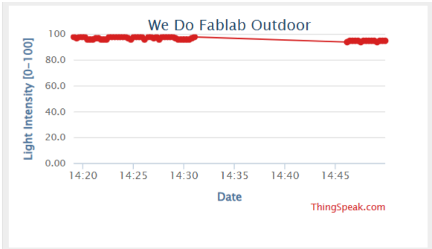
7. In the API Keys section of the own CHANNEL, it is possible to view or generate an API Key that must be transcribed in the "Write API Key" field in MakeCode, as illustrated in point 2. The API code allows creating a connection between the Micro:bit system, connected to the Internet, and the ThingSpeak page.

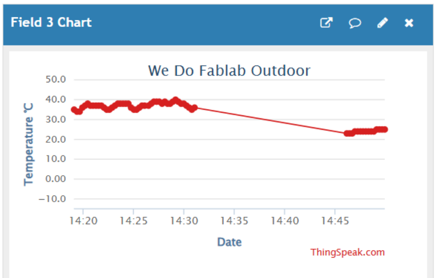


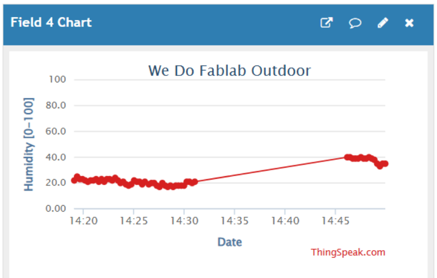
8. In the “Sharing” section of ThingSpeak, select “Share channel view with everyone” if you intend to make the data public through a link available from the browser's address bar, once the “Public View” section is selected. The public URL has a format

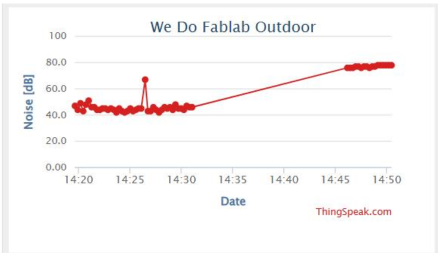
   “https://thingspeak.mathworks.com/channels/*******”.
   At this point, the CHANNEL is ready to receive the data detected by the sensor, transform them into customizable graphs based on the current time. In the CHANNEL SETTINGS, it is also possible to set the GPS data of where the weather station is located, to be able to view the geographic location within the public page.

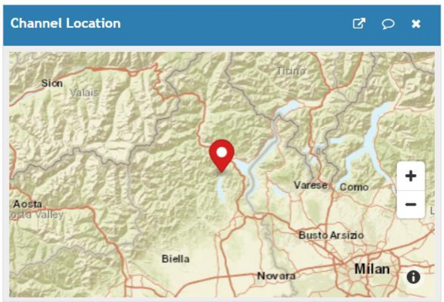












4. Electrical Connections Tutorial - System Power Supply

As anticipated, the weather station is designed to operate autonomously. To ensure the continuous transmission of the detected data, it is essential that the power supply is never interrupted. We have decided to use a photovoltaic solar panel to generate the energy necessary for the system's operation.

The essential components to create a stable and long-lasting power supply system are:

- Photovoltaic solar panel (min. 5 Watt) - *In our case, we have chosen a solar panel of 12V and 4.25 A nominal, reusing material already present in the laboratory.*
- solar Charge regulator with the same voltage as the solar panel
- Rechargeable lithium battery of 12V and 8Ah, capable of providing energy even when solar irradiation is not sufficient to generate enough current.

The panel and battery chosen by us are oversized compared to the energy consumption necessary, but this allows us in the future to connect additional devices useful for the topic (e.g.: irrigation pump).

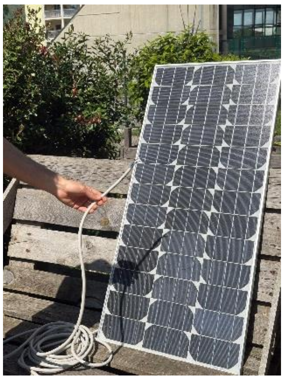
Let's see it step by step:

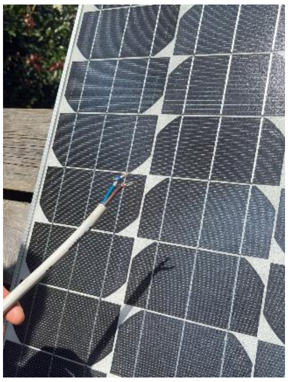
1. Connect the positive and negative pole of the battery to the + and - of the charge regulator's terminal block

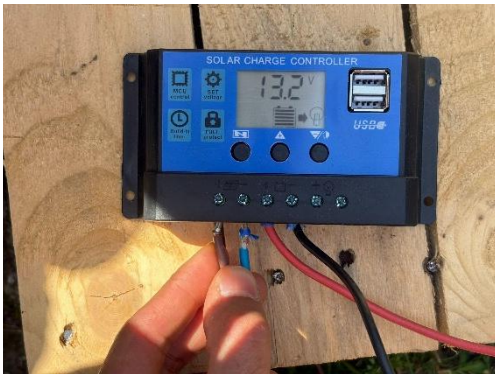
2. Connect the positive and negative pole of the solar panel to the + and - terminals corresponding to the INPUT of the charge regulator.

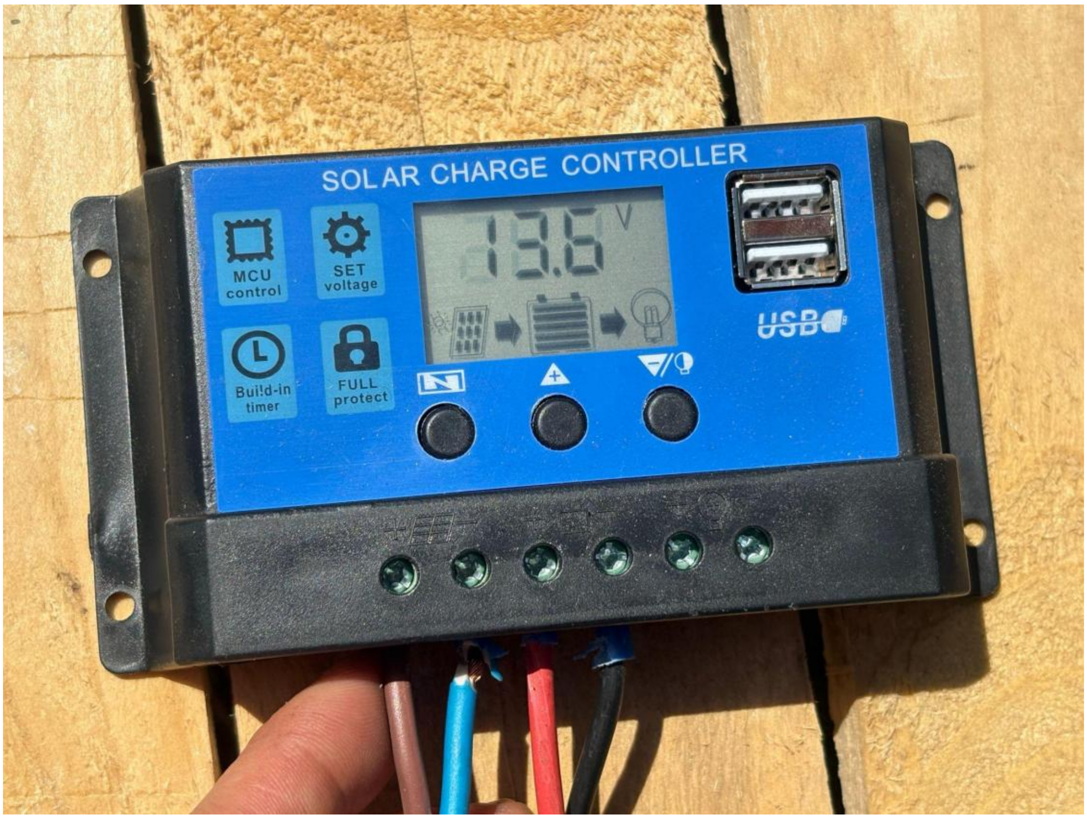
   On the charge regulator's screen, the voltage value detected through the solar panel appears.

   Additionally, icons are displayed that show if the panel and the battery are correctly connected.

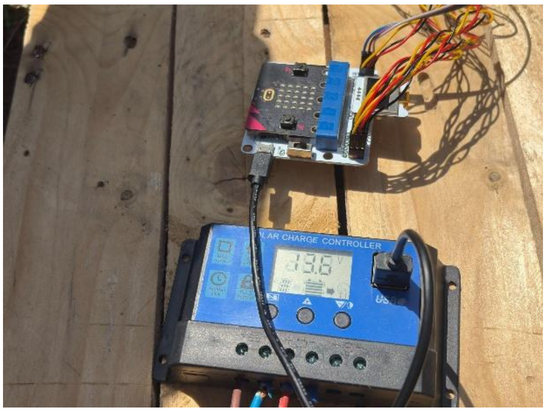


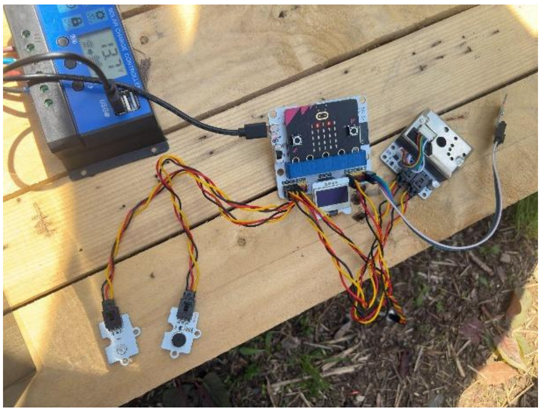






3. If the supplied charge regulator has an operating voltage of 5V, it is possible to connect the weather station directly to the OUTPUT terminal. Considering that the expansion board operates via USB cable (5V), it is preferable to have a charge regulator with a specific USB output (5V)





4. As soon as the switch present on the expansion board is moved to ON, Micro:bit will put the program into execution:
    a. Connection to Internet
    b. Connection to ThingSpeak
    c. Continuous detection of data through the sensors
    d. Visualization of the data on the screen
    e. Sending of the data to the ThingSpeak platform

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