



# Sniffer Bike-User Manual

# Content

<b>CONTENT .....</b>	<b>1</b>
<b>1. AIRSCOUT – MEASURING SYSTEM FOR ENVIRONMENTAL PARAMETERS .....</b>	<b>2</b>
<b>2. PROCEDURE OF RECEIVING AN OWN AIRSCOUT .....</b>	<b>2</b>
<b>3. REQUIREMENTS.....</b>	<b>3</b>
3.1. SKILLS.....	3
3.2. MATERIALS AND DEVICES.....	3
<b>4. SOFTWARE FOR THE PICO W .....</b>	<b>5</b>
<b>4.1. PREPARATION OF THE CODE FOR CONNECTING TO THE WEBSERVER .....</b>	<b>8</b>
4.2. SOFTWARE UPLOAD TO THE MICROCONTROLLER PICO W .....	FEHLER! TEXTMARKE NICHT DEFINIERT.
<b>5. ASSEMBLY OF THE PRINTED CIRCUIT BOARD (PCB) .....</b>	<b>22</b>
5.1. ORDERING .....	22
5.2. SOLDERING.....	23
5.2.1. Soldering SMD Components.....	23
5.2.2. Soldering Through Hole Components & Socket Headers .....	24
5.2.3. Soldering Pin headers & wires .....	25
5.2.4. Mounting the Display & Fine Dust Sensor.....	27
<b>6. CASE .....</b>	<b>28</b>
6.1. SLICING AND PRINTING .....	28
<b>7. ASSEMBLY .....</b>	<b>29</b>
<b>8. USE.....</b>	<b>34</b>
8.1. DISPLAY .....	34
8.2. TWO LED INDICATORS .....	34
8.3. BUTTONS .....	34
8.4. CONNECTING TO WIFI.....	35
8.5. USING THE WEBSITE .....	35
8.5.1. Uploading Data.....	35
8.5.2. Viewing Data.....	35
8.6. CHARGING THE DEVICE .....	37
<b>9. TROUBLESHOOTING .....</b>	<b>38</b>
9.1. NO GPS-VALUES ARE TAKEN.....	38
9.2. CAN'T CONNECT TO SERVER? .....	38
9.3. NO MEASUREMENTS? .....	38
9.4. NO LIGHTS .....	38

# 1. AirScout – Measuring system for environmental parameters

The AirScout is a measuring system cofounded by the Erasmus+ Programme of the European Union. The development was done from October 2023 until March 2025 in cooperation with three schools

- Gottlieb-Daimler-Schule 2 (Sindelfingen, Germany)
- HTBLuVA St. Pölten (St. Pölten, Austria)
- Lycée Technique d'Ettelbruck (Ettelbruck, Luxembourg)

Primary goal of the AirScout is to capture environmental measurements along a bike route by attaching a measuring box to a common bike.

The AirScout is a measuring system for environmental parameters. As the development was done by different schools with students having different skills, there are more final versions of the AirScout. This document describes the Version for more skilled persons, as it uses an PCB-Layout (Printed Circuit Board) containing also SMD-components (Surface Mounted Device) resulting in a compact version of the AirScout.

This version of the AirScout enables following measurements of environmental parameters:

- CO<sub>2</sub>
- Fine dust 2.5 µm
- Fine dust 5 µm
- Fine dust 10 µm
- VOC
- Temperature
- Humidity
- Air pressure

In addition to these parameters the GPS-coordinates are measured. This allows, that the measured values can be assigned to specific spots on a map.

After storing the measurements into the Raspberry Pico W, the AirScout can be connected via WiFi to a server. When data is uploaded, the measurements of this specific AirScout, of all AirScouts of a school or of all registered AirScouts can be displayed on a map.

## 2. Procedure of receiving an own AirScout

The AirScout was developed as a rebuildable kit for schools and interested persons. The development and documentation were done for technically interested students to rebuild their own AirScout.

In order to build an own AirScout you can use the following chapters to gather information on requirements and building steps.

## 3. Requirements

### 3.1. Skills

As this variant of the AirScout is a more advanced revision, the required skills contain also more advanced ones.

- SMD-soldering
- Working with advanced components, especially polarity
- Basic skills of working with microcontrollers (uploading programs)
- Working with a 3D-printer (slicing, printing)

### 3.2. Materials and Devices

Name	Price / pcs [€]	minimum quantity
Inductor 10 $\mu$ H	1.74	1
Step-up transformer 12V	0.98	1
Voltage converter 3,3V	0.92	1
Switch	1.62	1
BME688	26.72	1
Resistor 220 Ohm	0.26	2
Resistor 120 kOhm	0.08	2
Capacitor 47 $\mu$ F	0.56	1
Capacitor 4,7 $\mu$ F	0.22	7
LED green 3mm	0.07	1
LED red 3mm	0.08	1
Screw M3x6mm		7

Table 1: List of Components – RS-Components

Name	Price / pcs [€]	minimum quantity
GPS-Sensor	28,94	1
CO2 Sensor	30,56	1
Button 90°	0,28	2

Table 2: List of Components - DigiKey

Name	Price / pcs	minimum quantity
<b>Microcontroller</b>	8,47	1
<b>Fine Dust Sensor</b>	26,52	1
<b>Display</b>	18,96	1
<b>Charge Controller</b>	2,22	1
<b>Battery 18650</b>	10,59	1
<b>Battery holder</b>	5,34	1
<b>Capacitor 100nF</b>	0,06	2
<b>Capacitor 470pF</b>	0,07	1
<b>Pin Headers</b>		(required quantity in 5.2.3)
<b>Socket Headers (not required)</b>		(if needed, refer to 5.2.2)

Table 3: List of Components – Reichelt

The full component list with all the links, prices and exact component name is provided in the downloadable files for the AirScout, as well as the complete Schematic circuit.

Materials
<b>Tin Solder</b>
<b>Solder Paste</b>
<b>Thinn wires (Jumper wires)</b>
<b>heat shrink tube (not required)</b>

Table 2: List of Materials

Equipment
<b>Equipment for SMD-soldering (SMD-Soldering-Machine or/and soldering iron for SMD-soldering)</b>
<b>PC or Laptop</b>
<b>USB-Micro-cable</b>
<b>3D-Printer</b>
<b>Soldering Iron</b>
<b>Screwdrivers, Pliers, Tweezers</b>

Table 3: List of Devices

## 4. Software for the Pico W

### 4.1. Login to the Website and get the Token for your Device

- Navigate to [www.gm4s.eu](http://www.gm4s.eu) using a browser and click on Login.

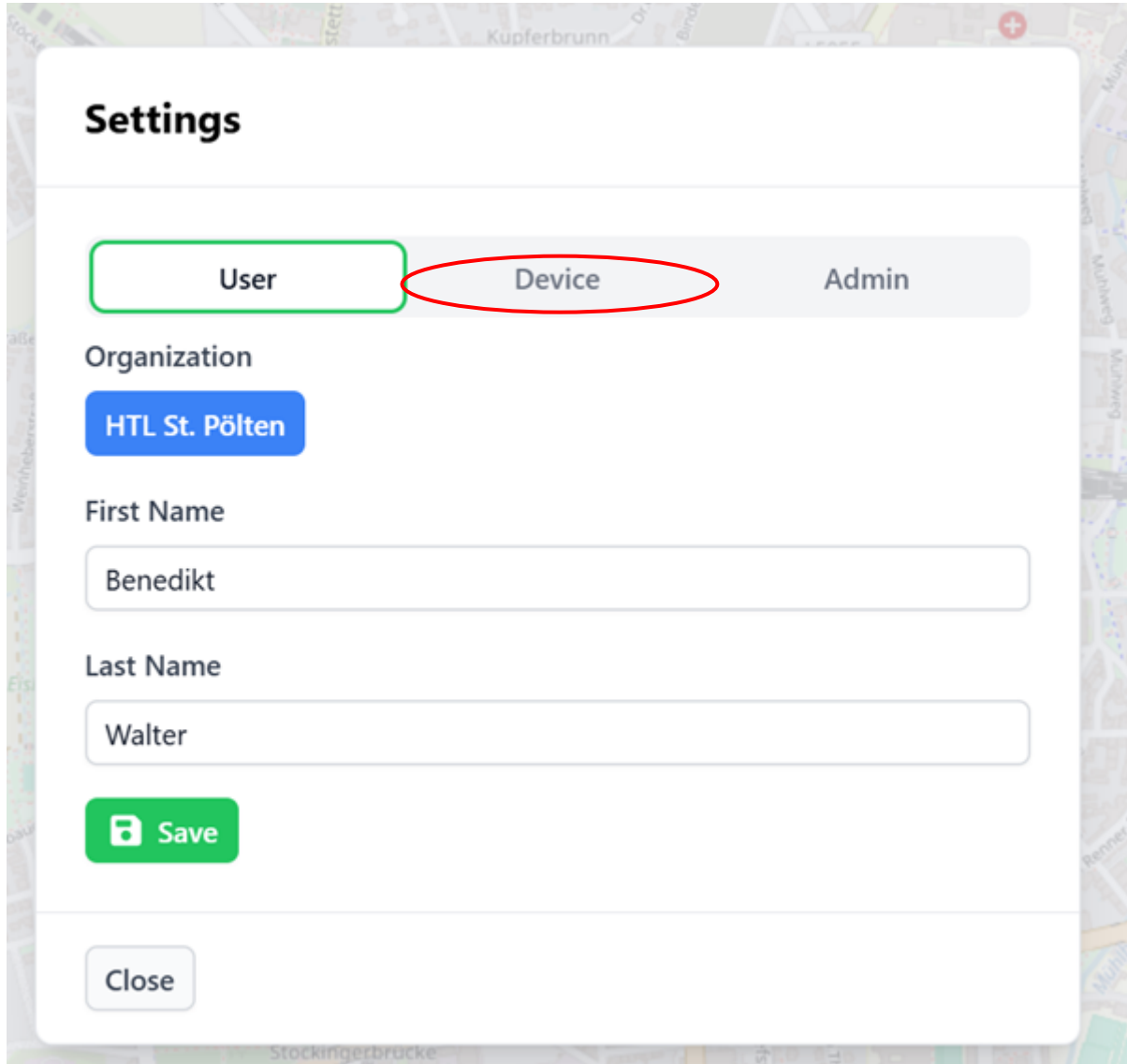


- Log in with your credentials.

- Go to the Settings Page



- In the Settings page click onto Device



## Settings

User Device Admin

Organization


HTL St. Pölten

First Name

Benedikt

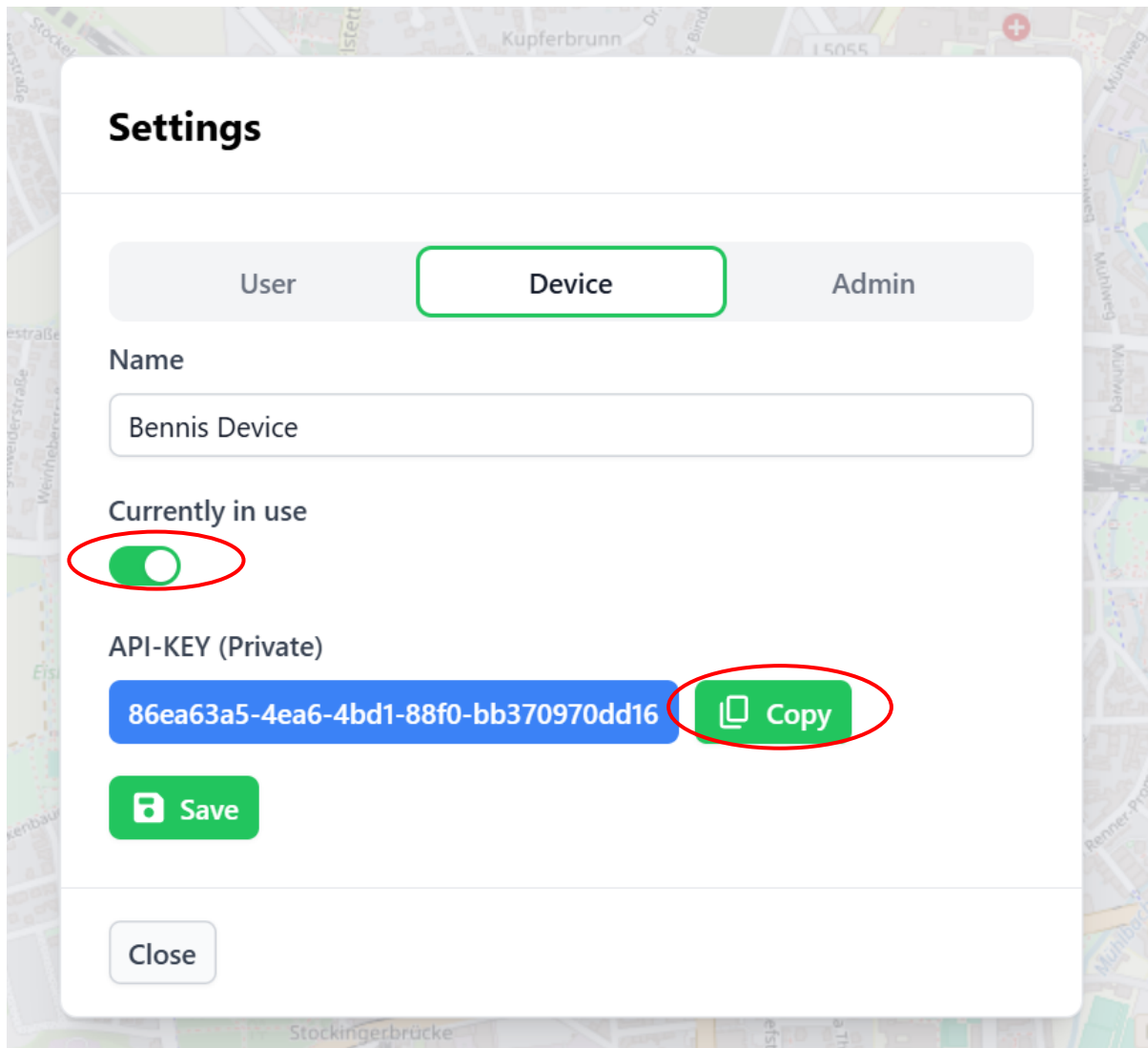
Last Name

Walter

 Save

Close

- In the Device Settings set the “Currently in use” to true (that the slider is green) now you can copy the token that will be used later.



## Settings

User Device Admin

Name

Bennis Device

Currently in use

☒

API-KEY (Private)

86ea63a5-4ea6-4bd1-88f0-bb370970dd16 Copy

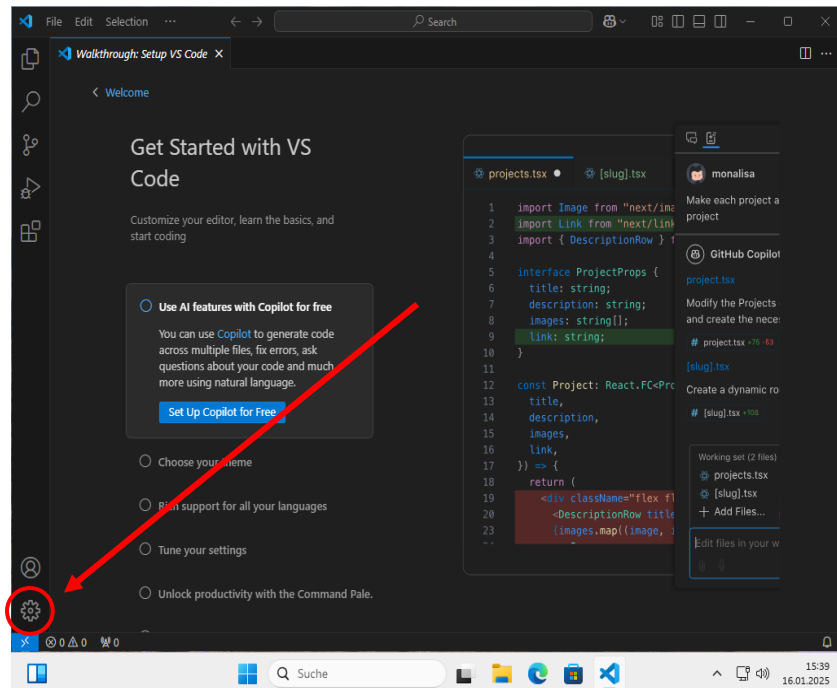
Save

Close

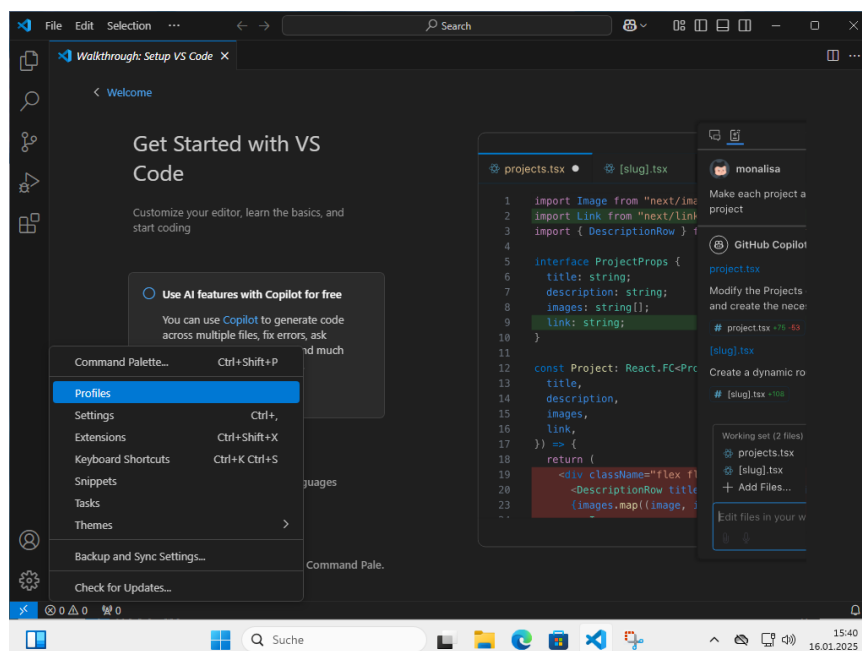


## 4.2. Preparation of the code for connecting to the webserver

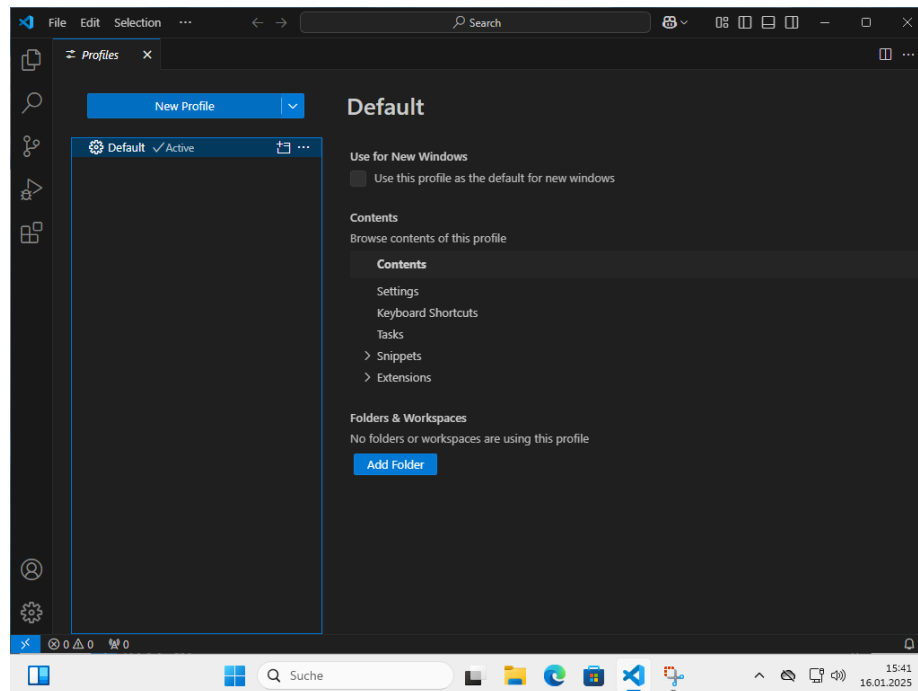
1. First of all, install python of this website <https://www.python.org/downloads/>
2. Just click onto the Download button
3. Open VSCode if you haven't installed it go onto this website: <https://code.visualstudio.com/download>
4. Click onto the gear icon in the bottom left corner



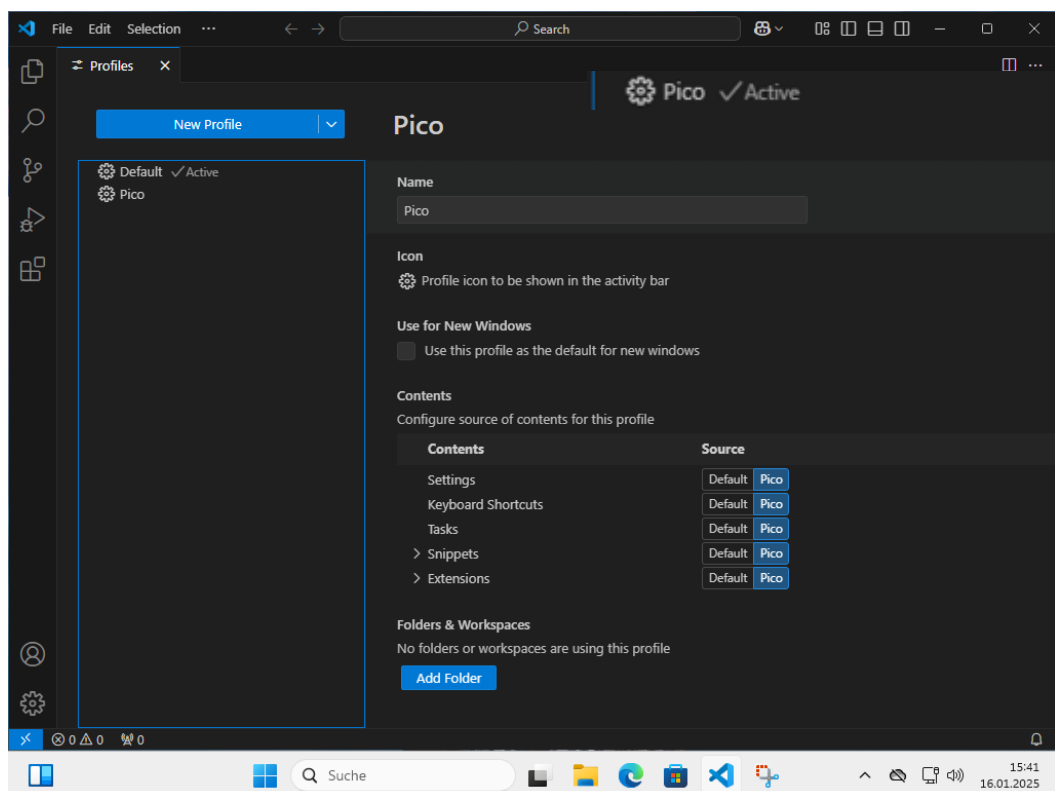
5. Go now onto Profiles



## 6. Now click onto new Profile

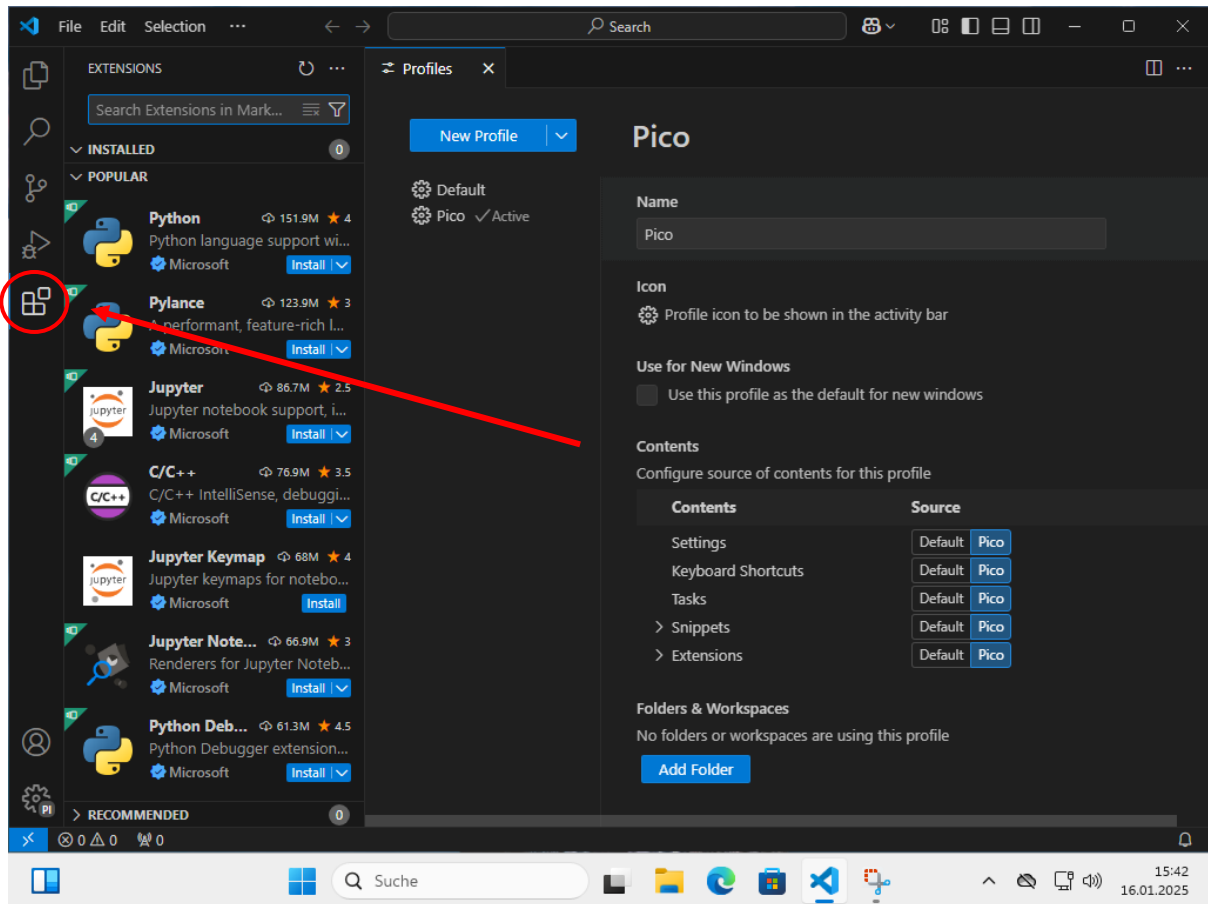


## 7. Now Type into the Name box "Pico" and click onto create

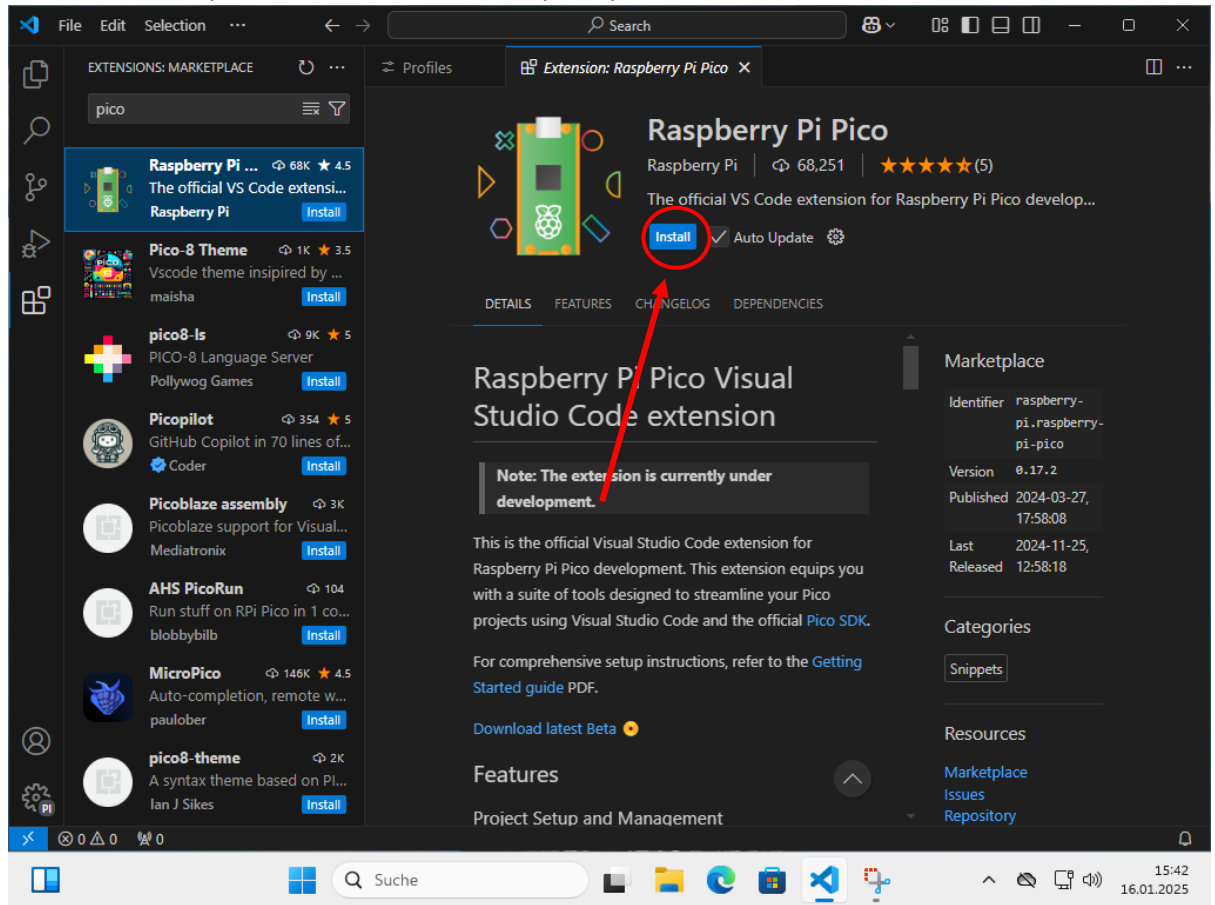


## 8. now click onto the PICOs ✓ and activate the Pico profile there should be a text in next to the Pico with ✓ Activate like that

9. Now click onto the Extention Tab



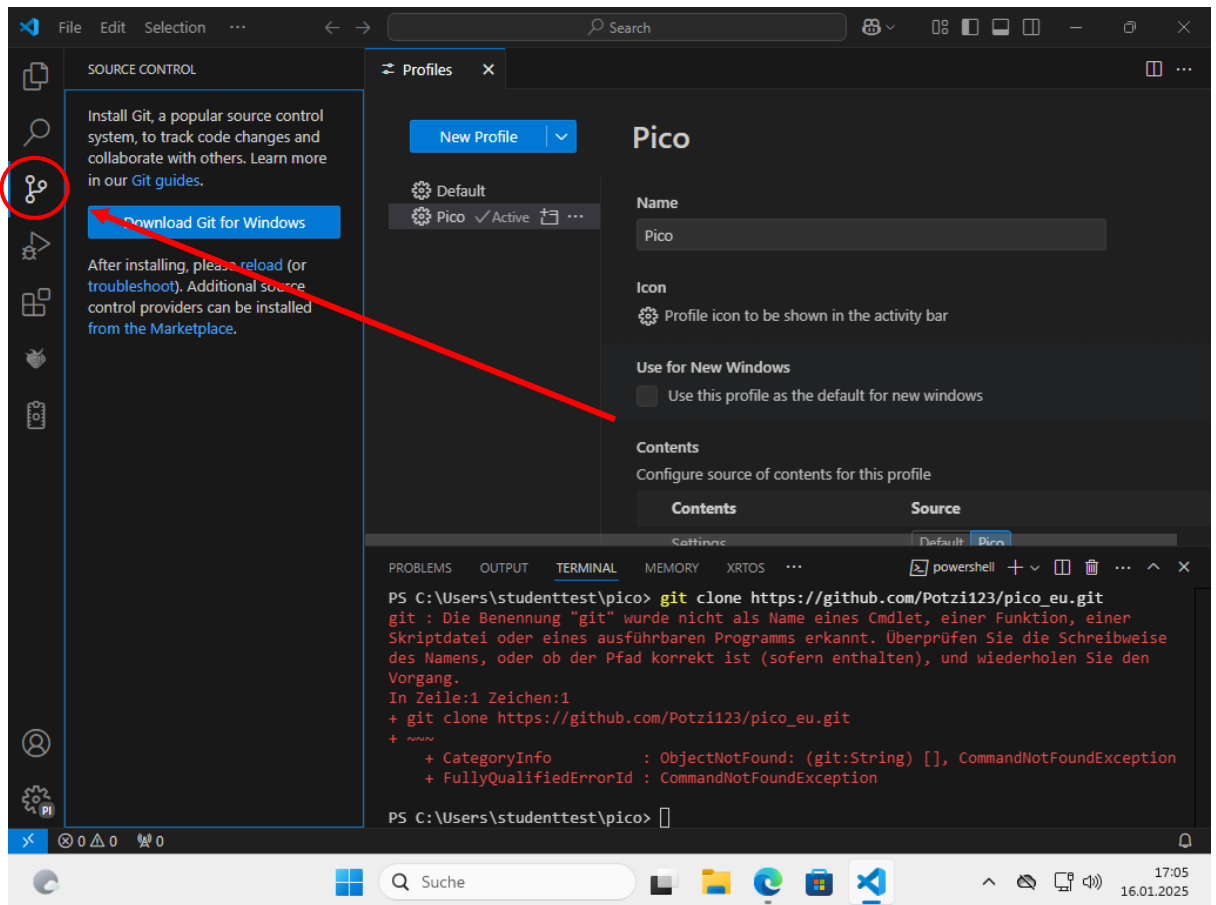
10. Now search for “pico” and Click onto the Raspberry Pi Pico extietntion and click onto Install



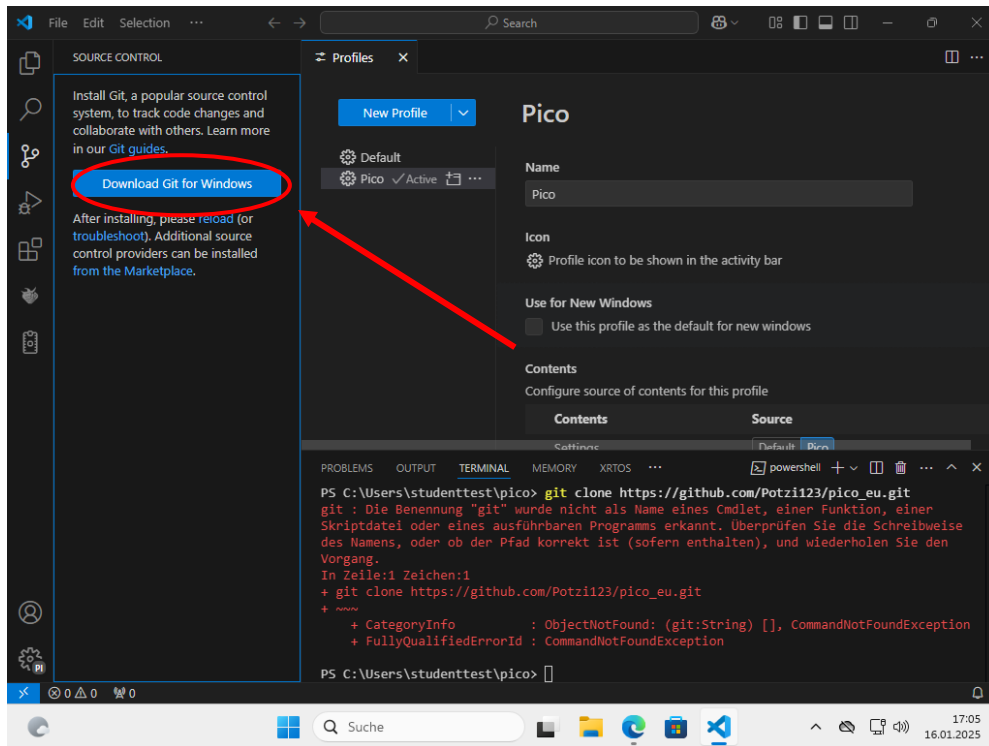
11. If it is installed, the page should look like this



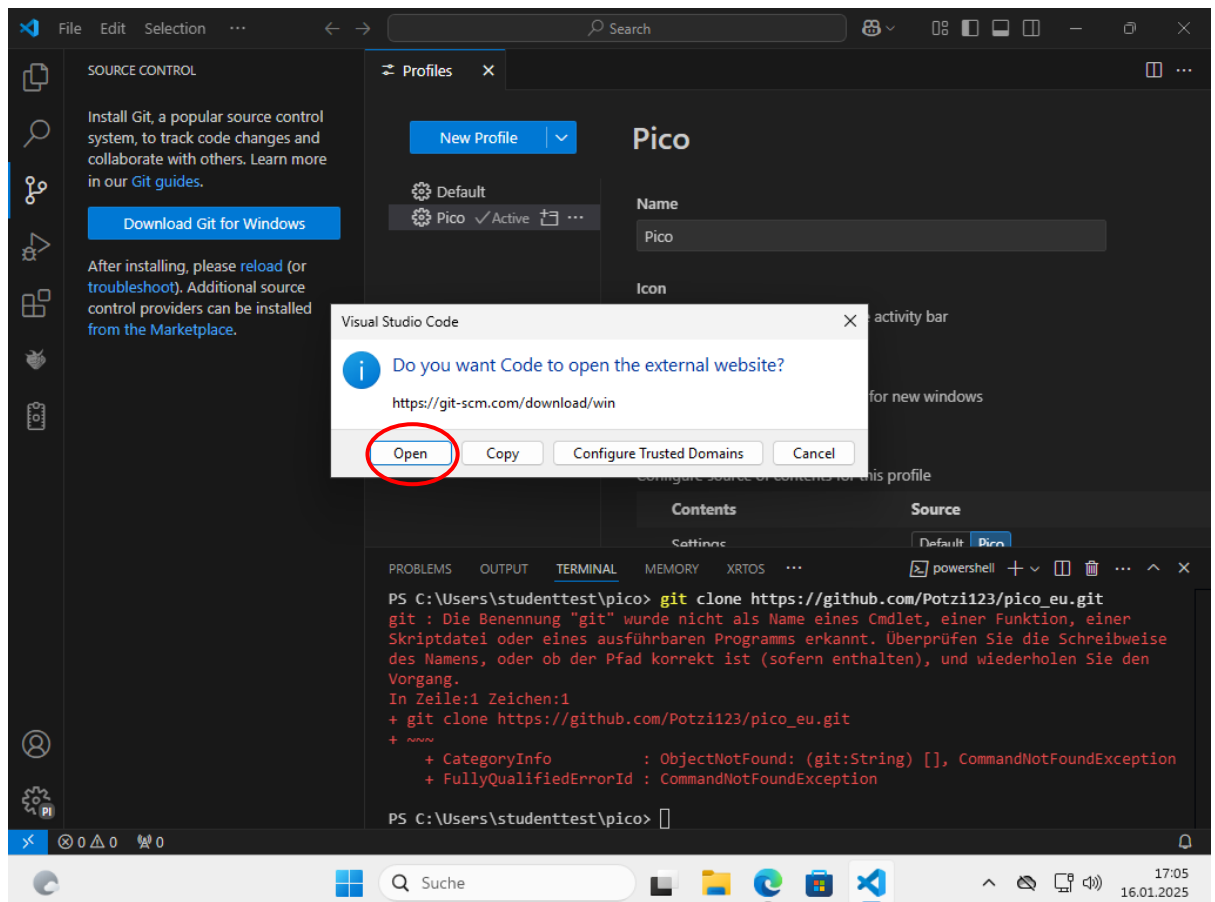
## 12. Now go onto the Source Control Tab



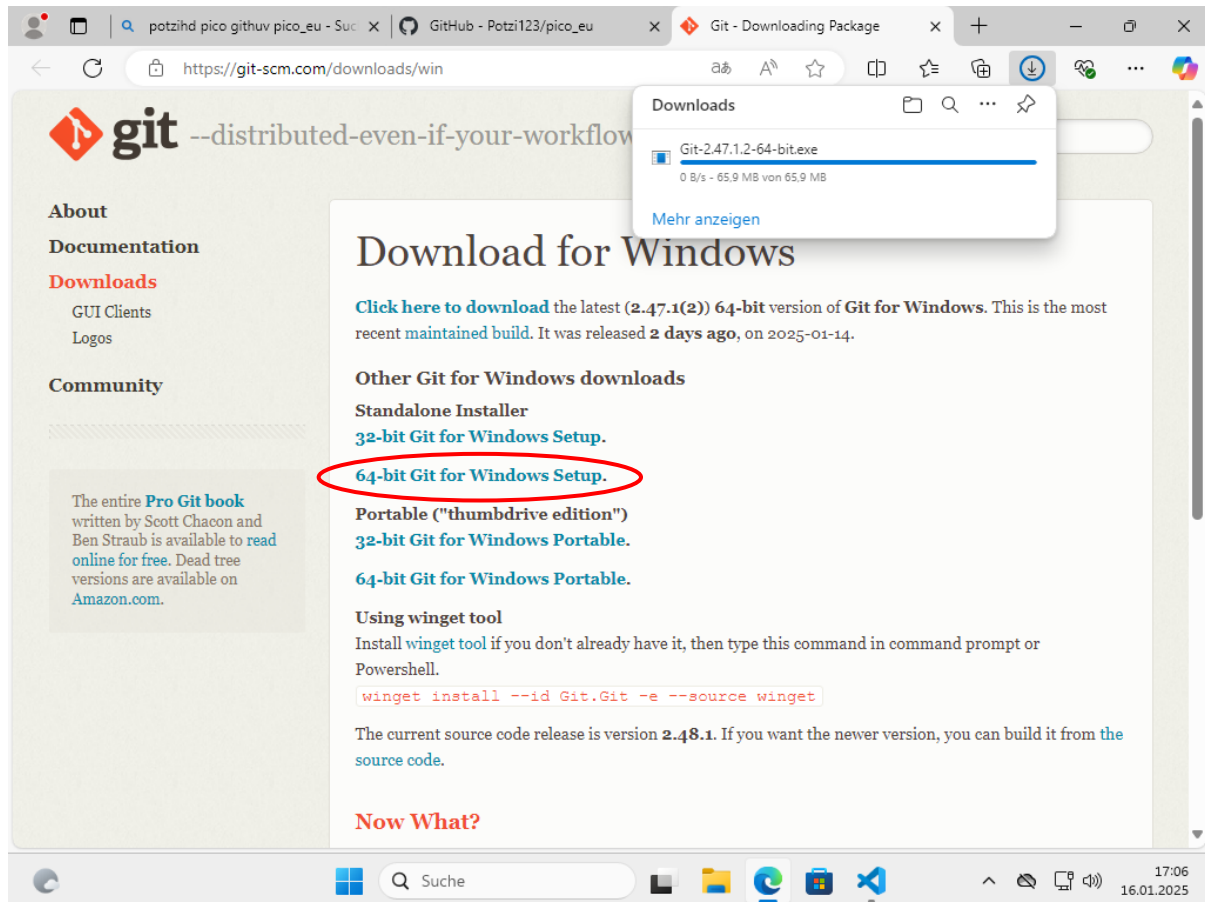
13. Go if there is a text that says “Download Git for Windows” click onto this button when not then go to Step XX



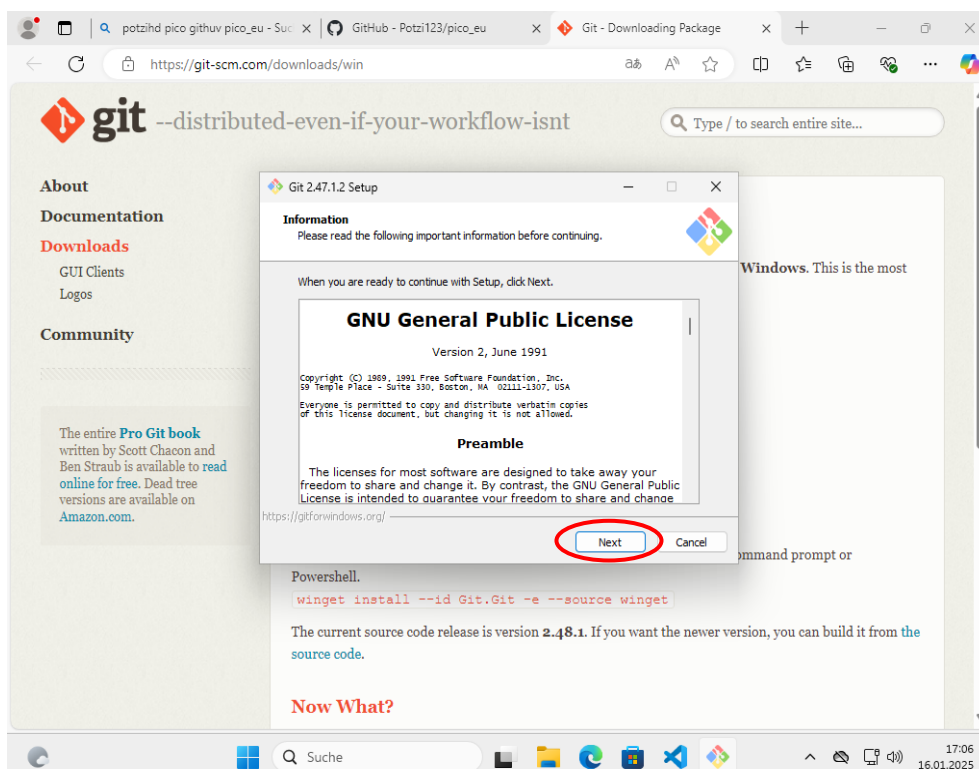
14. Click on open



## 15. Click on install

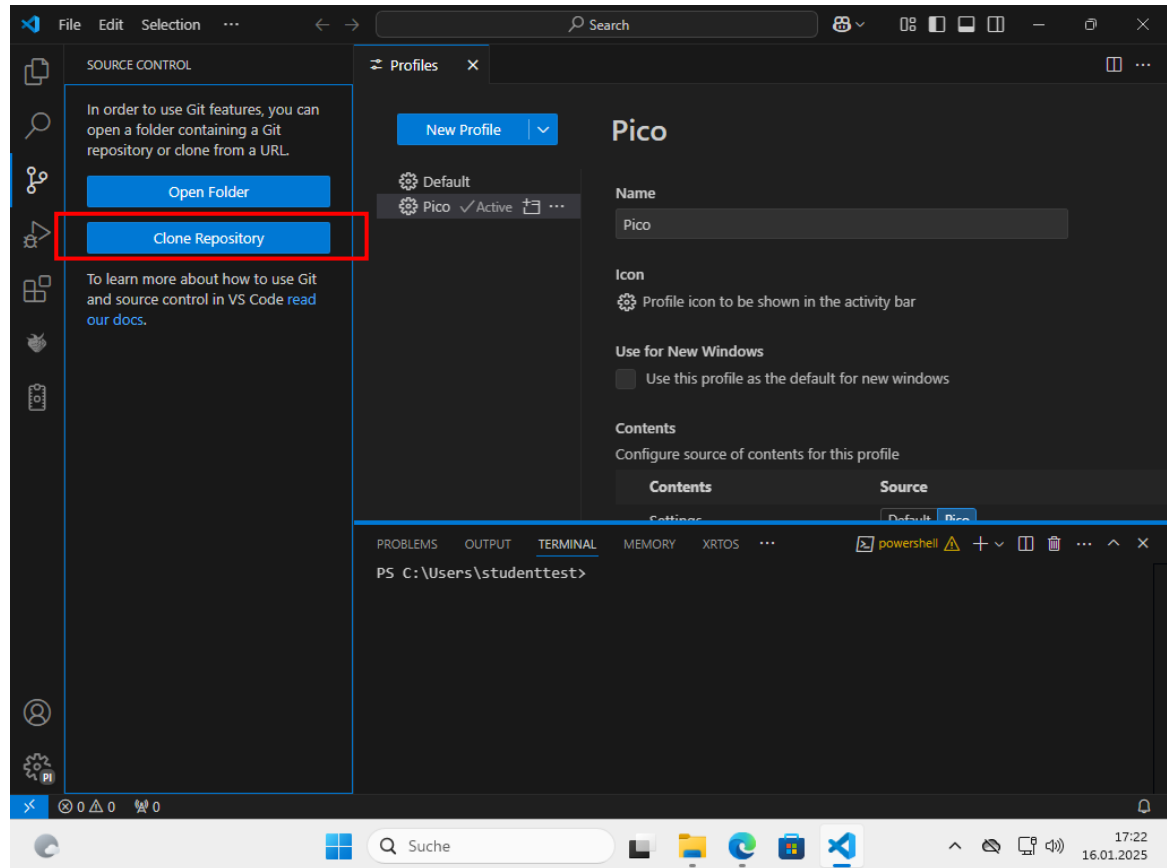


## 16. Open the installer of Git and just click onto next till you are finished with the setup

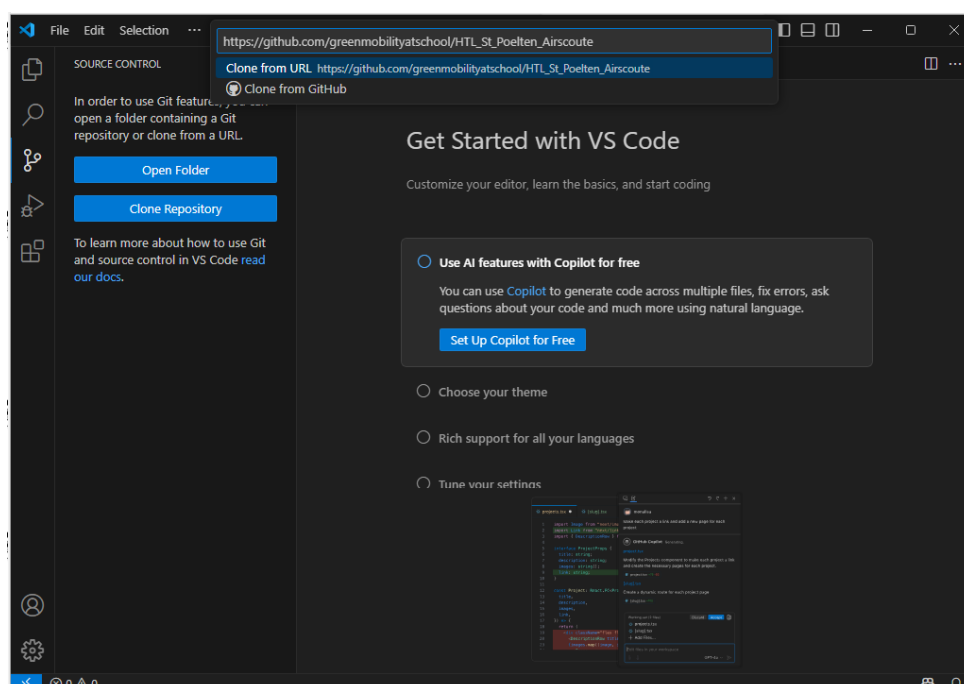


17. now close VS Code and start it again

18. now click on Clone Repository

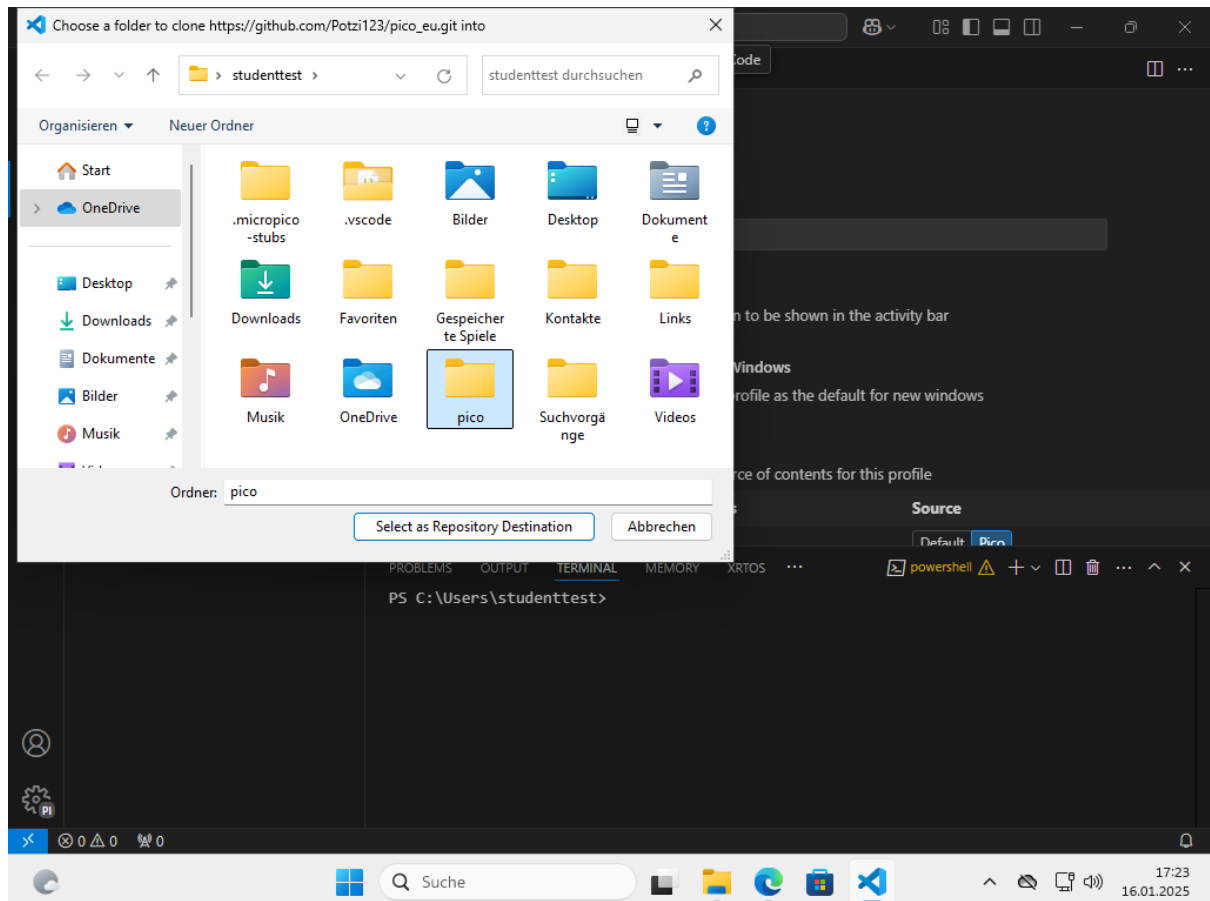


19. Now paste the url: [https://github.com/greenmobilityatschool/HTL\\_St\\_Poelten\\_Airscoute.git](https://github.com/greenmobilityatschool/HTL_St_Poelten_Airscoute.git) into the input and press enter

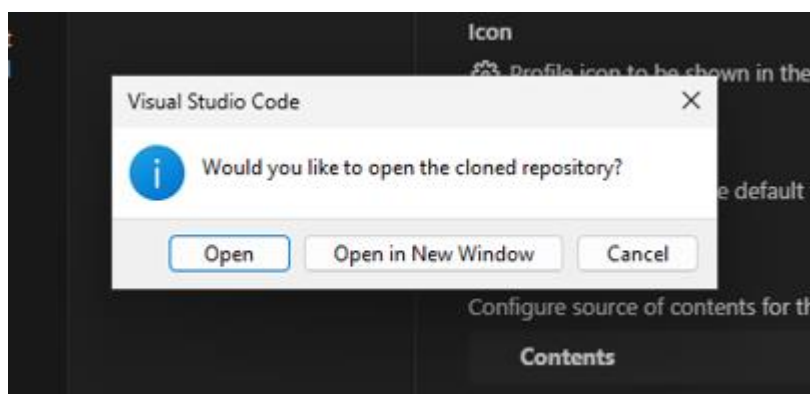




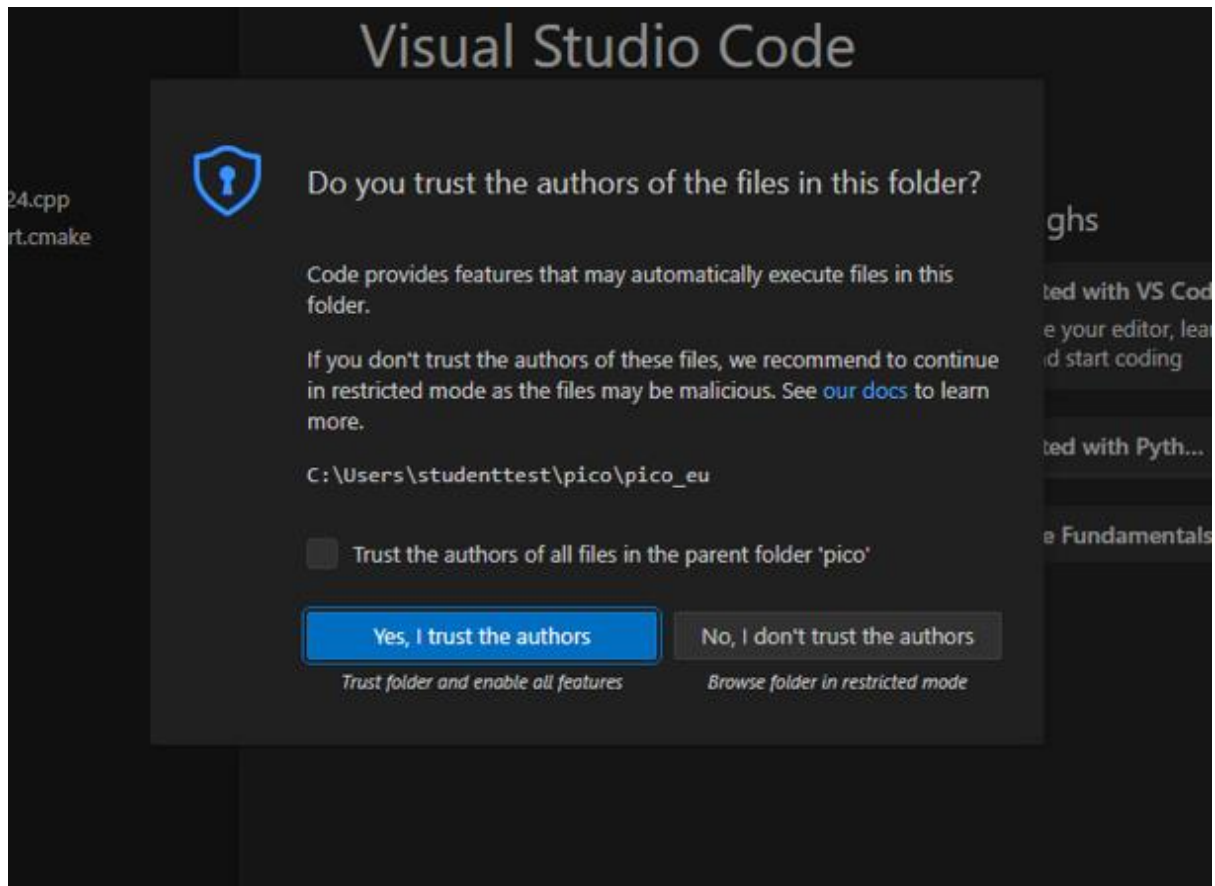
20. Create a new order with the name pico and select this folder



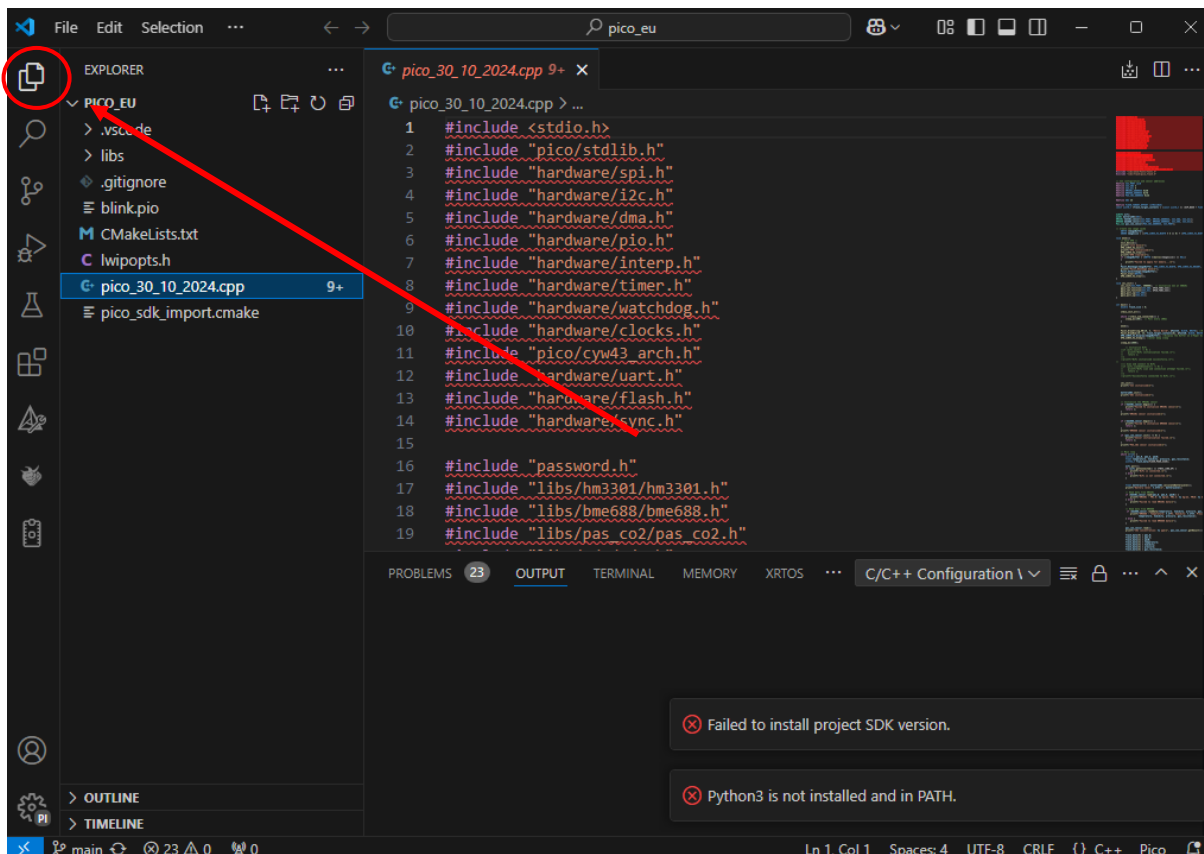
21. Now click on open



22. Now click on trust the author and select “yes I trust the authors”

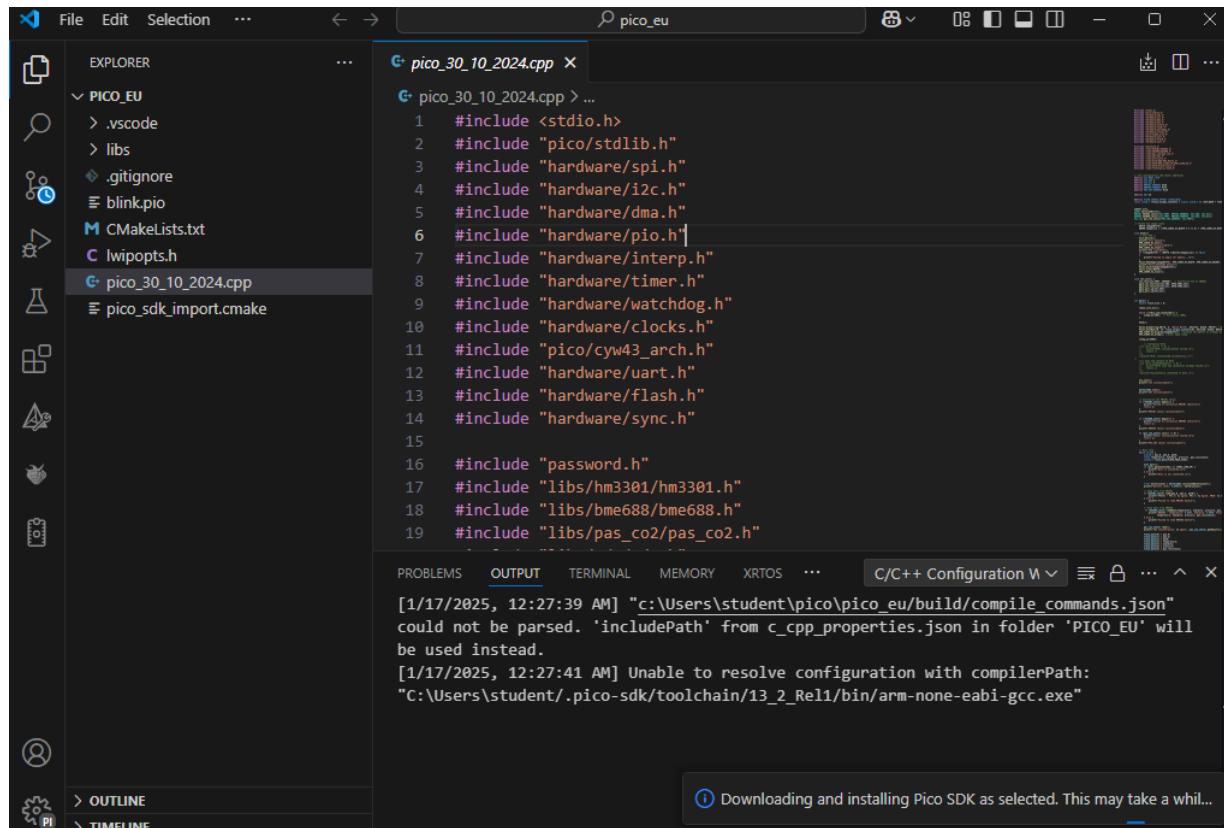


23. Now click onto the file tab and just wait if there are errors like in the picture bottom right

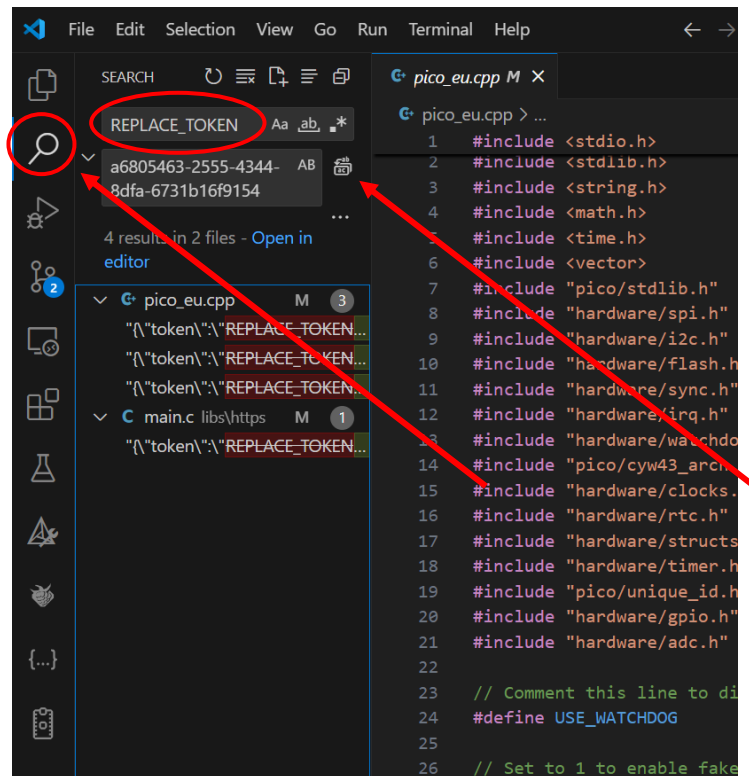


24. Now close vs code

25. Now there should be a install section in the right bottom with for it to finish



26. First, click on the magnifying glass and Type in “REPLACE\_TOKEN” in the underneath Input type in the token that you have copied before. Then click the Button on the right of the Input replace everything with your token.



27. Go to password.h and type in your password and Name of the Hotspot or WLAN you want to use.

This is an example of password.h:

password.h

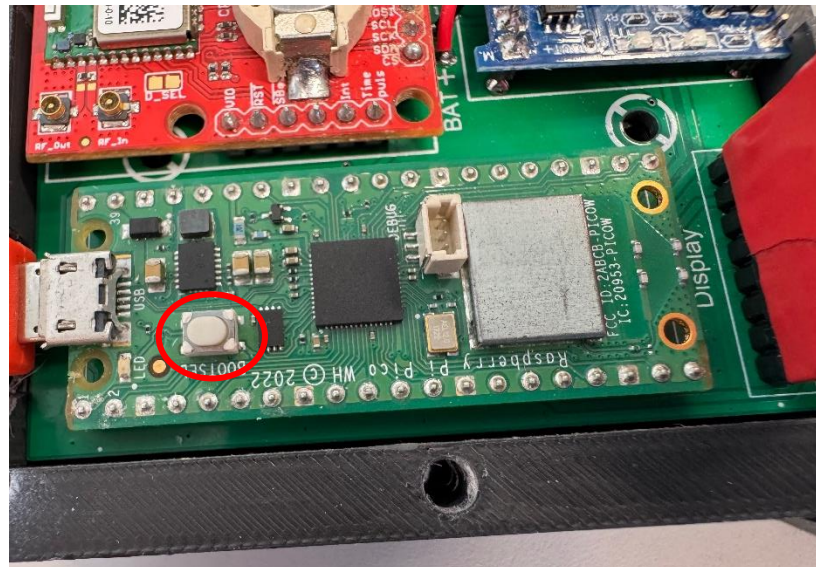
```
#ifndef PASSWORD_H
#define PASSWORD_H
```

```
#include <string>
#include <vector>
```

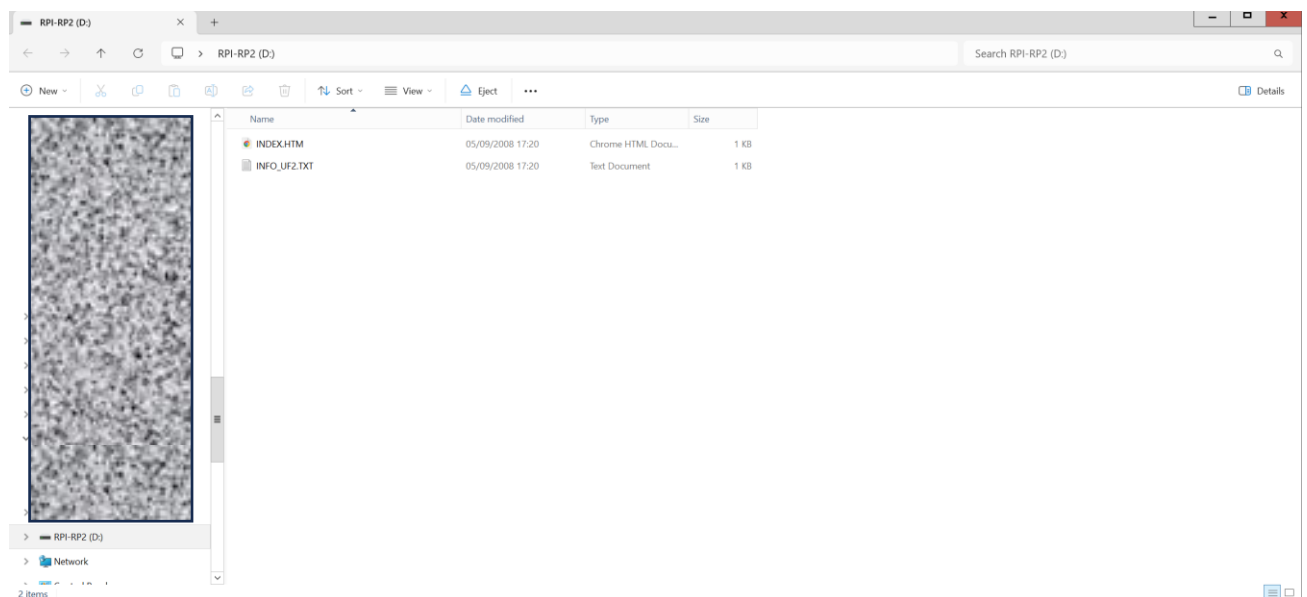
```
const std::vector<std::string> SSID = {"iPhone from Reiner", "Hotspotfrombemidafi"};
const std::vector<std::string> PASS = {"12345678", "987654321"};
```

```
#endif //PASSWORD_H
```

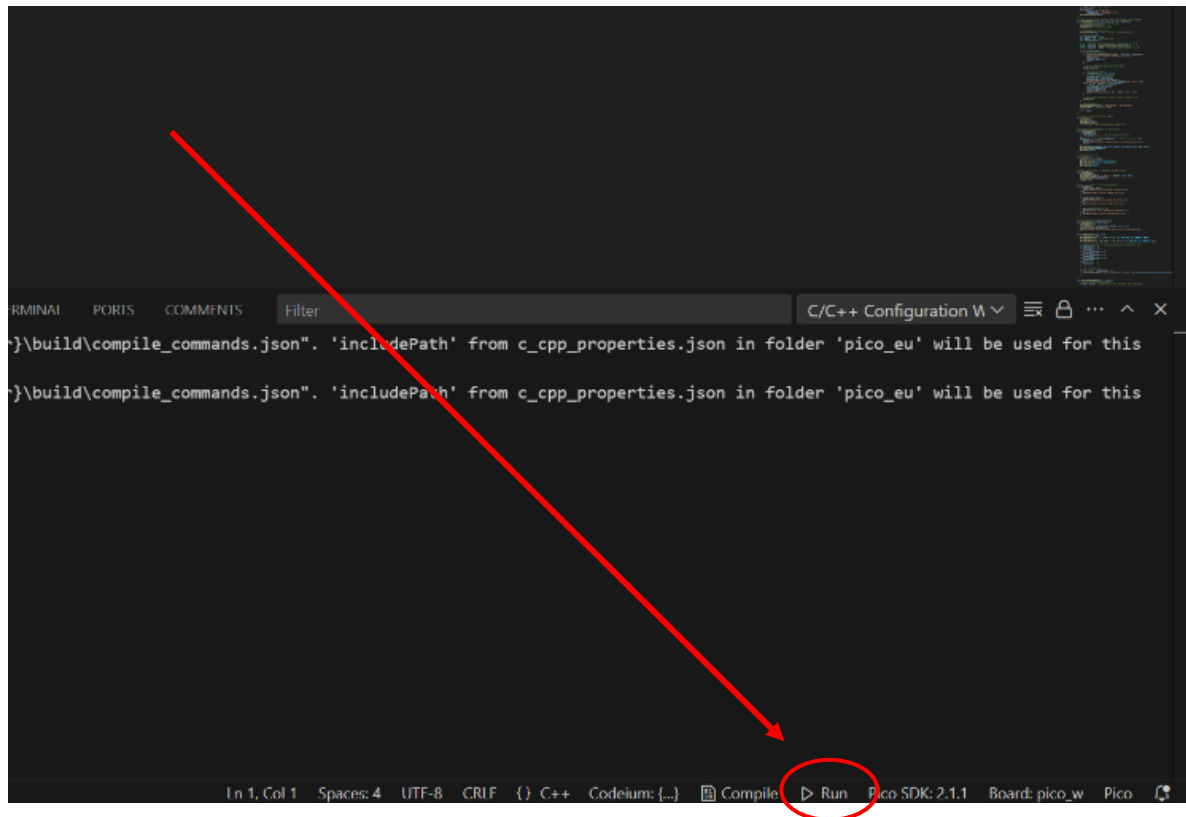
28. Now hold the button that is marked in the picture and at the same time connect the pico to your Laptop (PC)



29. If it worked, the the pico should appear like a usb stick in your explorer



30. Now you can upload the firmware to the pico with the run button



31. If the upload worked this should be displayed

```
uild/pico_eu.elf -fx
Loading into Flash:  [=====] 100%
The device was rebooted to start the application.
* Terminal will be reused by tasks, press any key to close it.
```

## 5. Assembly of the Printed Circuit Board (PCB)

The PCB is designed as a two-layer circuit. Due to very fine parts and connections, it is recommended to order it from a producer like JCL-PCB, Eurocircuits or PCB-Way.

### 5.1. Ordering

The following ordering description is made with JCL-PCB:

- 1) First, the Gerber files (1 ZIP-File called "AirScout – Gerber") must be downloaded from the provided Files for the Air Scout
- 2) Open the Website from JCL-PCB <https://jlcpcb.com>
- 3) Create an Account and go back to the ordering page
- 4) Click on "Add Gerber file" and upload the ZIP-File

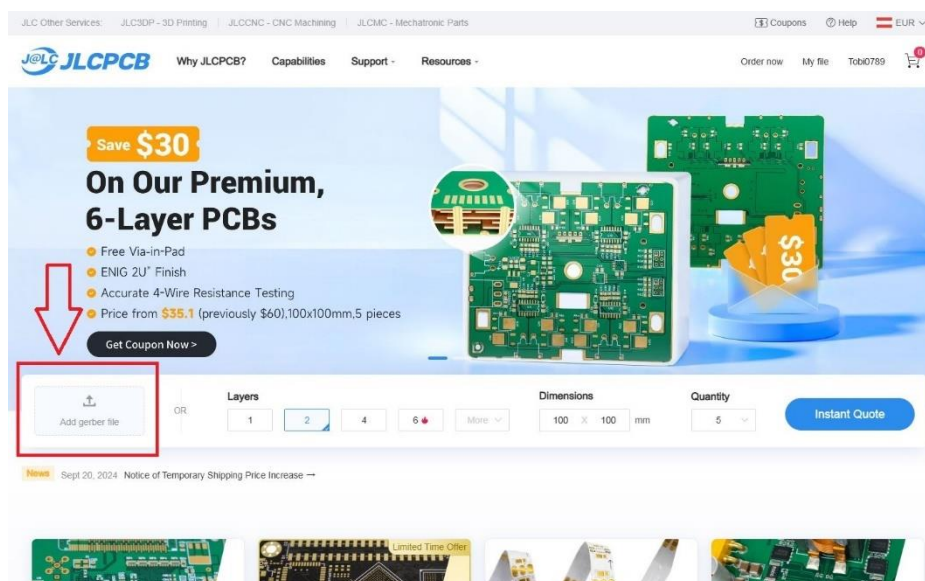


Figure 1: Ordering PCB

- 5) After uploading the files (might take a moment), a preview of the PCB should be displayed and the dimensions should automatically be filled out
- 6) Leave all the remaining specifications at default
- 7) Now the PCB can be ordered (set the delivery options to your liking)

The minimum order quantity is 5 pieces.



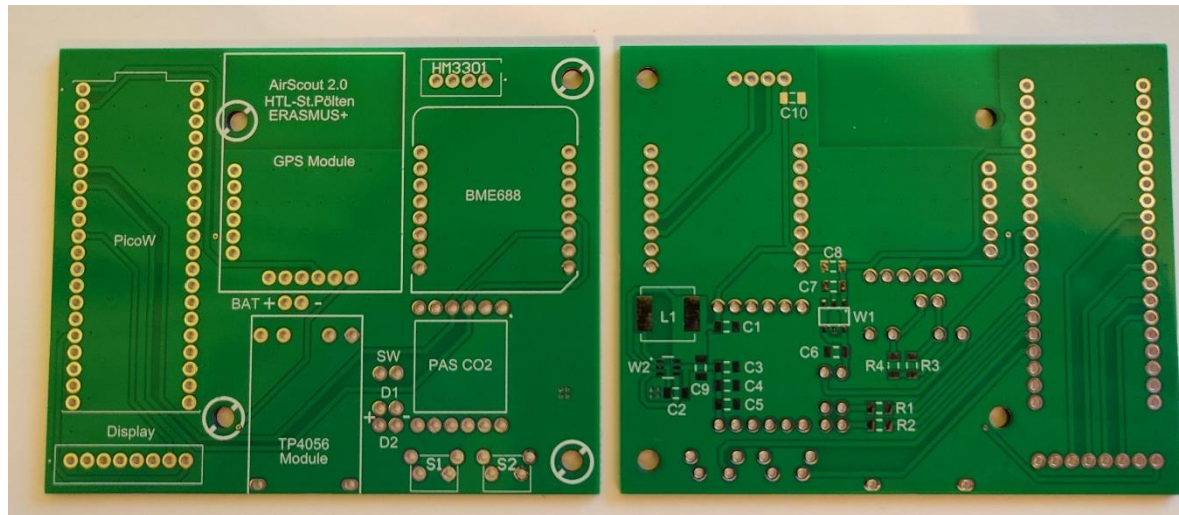


Figure 2: empty PCB - Top & Bottom

## 5.2. Soldering

The SMD components should be soldered before the wired parts, for easier assembly.

SMD - Soldering can be done either by SMD-Soldering-Machines (Heating plate, hot air soldering, Soldering-Oven) or by hand with a soldering iron, which requires more advanced soldering skills. When SMD-Soldering is done with any of the named machines, Solder Paste is required.

### 5.2.1. Soldering SMD Components

Component	Name	Value
Capacitor	C1, C2, C6, C7, C9, C10	4.7F
Capacitor	C3	47uF
Capacitor	C4	470pF
Capacitor	C5, C8	100nF
Resistor	R1, R2	220Ω
Resistor	R3, R4	120Ω
Inductor	L1	10uH
Voltage Boost Converter (12V)	TLV61046A	
Voltage Regulator (3,3V)	NJM12856	

Table 4: List of SMD-Components



Be careful with SMD components! It's best to lay them out on paper or store them in small boxes to avoid mixing them up during the assembly.

The polarity of the resistors, capacitors and the inductor, doesn't matter.

Proper alignment is important when working with the voltage converters. A small dot marks the top right pin of the component when it is oriented so that the labelling is readable. To better read the labelling, as it is very small, a smartphone camera with zoom can be useful.

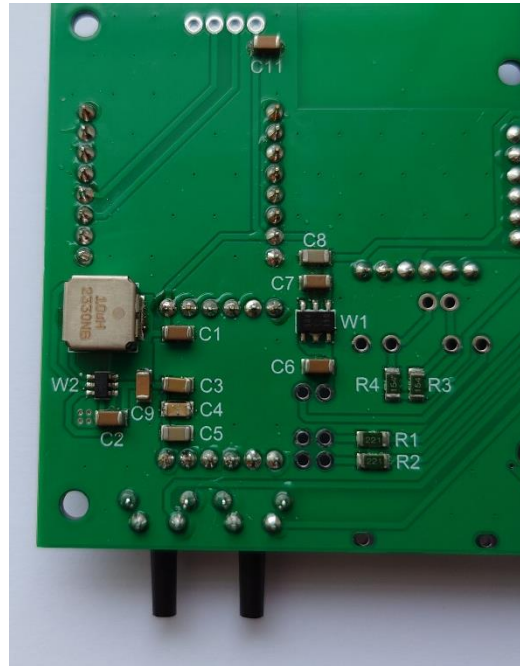


Figure 3: soldered SMD-Components

If you are working with solder paste, do not put too much on every pad. A small drop is just enough. Use tweezers for accurate placement of the SMD components.

### 5.2.2. Soldering Through Hole Components & Socket Headers

The through hole components can either be soldered directly into the PCB or socket headers can be used for the microcontroller and the sensors, if you want to make them removable. If your socket headers have too many pins, they can easily be cut with pliers to the right pin number. To ensure the correct spacing, it is helpful to solder the socket headers with the components already inserted. The two buttons must be directly soldered into the PCB.

Component	Name	(Socket header)
Microcontroller	Pico W	2 x 20 pin
GPS-Module	CAM-M8Q	2 x 6 pin
CO2 Sensor	PAS CO2	2 x 6 pin
Temp, Hum, VOC, - Sensor	BME688	2 x 8 pin
Buttons	S1, S2	



Figure 4: Socket header

Table 5: List of through hole Components

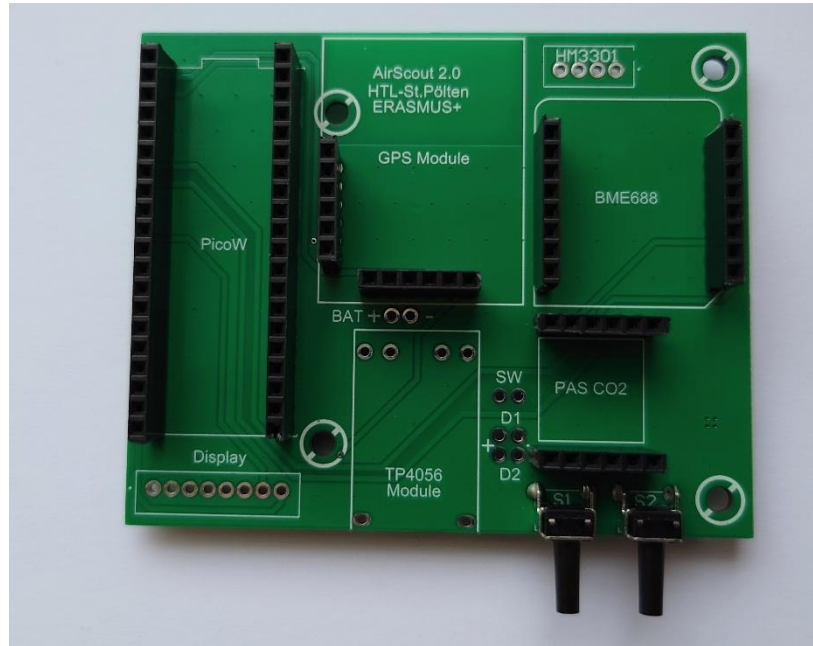


Figure 5: soldered Socket Headers & Buttons

### 5.2.3. Soldering Pin headers & wires

Since pin headers are already attached to the breakout board of the fine dust sensor, the easiest way to connect it to the PCB is by using four female-to-female jumper wires. The display also comes with a cable that already has connectors attached. Since the charge controller is only supplied with pads, it will also require pin headers for connection to the PCB. The best way is to turn the pin headers for the charging controller upside down and cut them at the bottom. Therefore, they don't stick out so much above and you get a better look (seen in Figure 7).

Component	Name	Pin header
Display	ePaper	1 x 8 pin
Fine Dust Sensor	HM3301	1 x 4 pin
Charging controller	TP4056 Module	6 x 1 pin

Table 6: List of Pin Header Components



Figure 6: Pin header

Since some components are not soldered directly onto the PCB but instead are mounted to the housing, it is necessary to solder wires to the components. The following wire lengths are needed for each of those components:

Component	Name	Wires	min. length	(Pin header)
LEDs	D1, D2	4	8 cm	2 x 2 pin
Swich	SW	2	8 cm	1 x 2 pin
Battery Holder	BAT	2	7 cm	1 x 2 pin

Table 7: List of external Components

The wires that connect these external components to the PCB, can either be directly soldered to the PCB, or made pluggable with a socket header on each wire and a pin header on the designated pad. The easiest way is to use a cut female jumper cable for the plugging. Logically female jumper wires and more pin headers are needed if the wires are made pluggable (amount not listed).

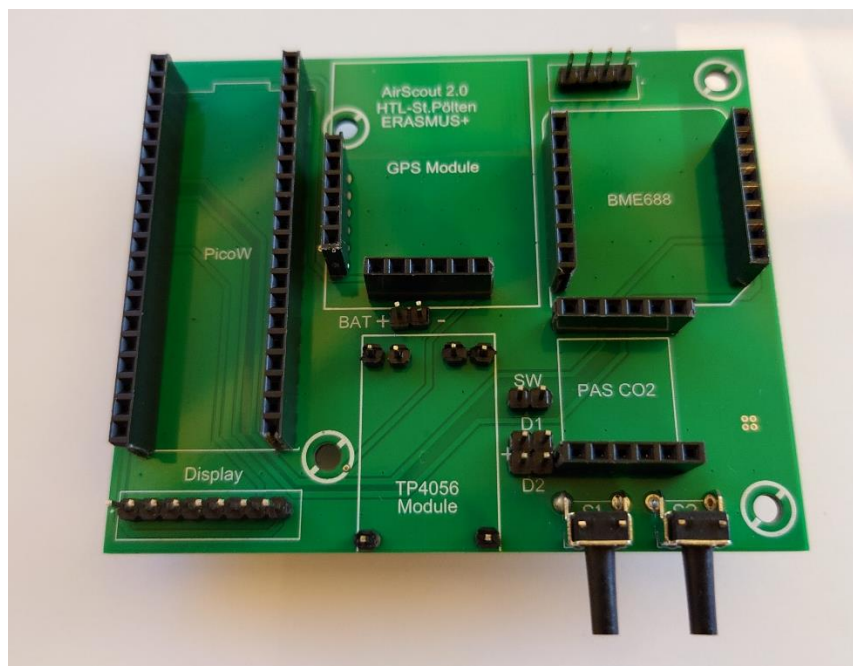


Figure 7: soldered Pin Headers, Socket Headers & Buttons

The Power Switch needs two wires. One at the middle pin and one at one of the outer pins.

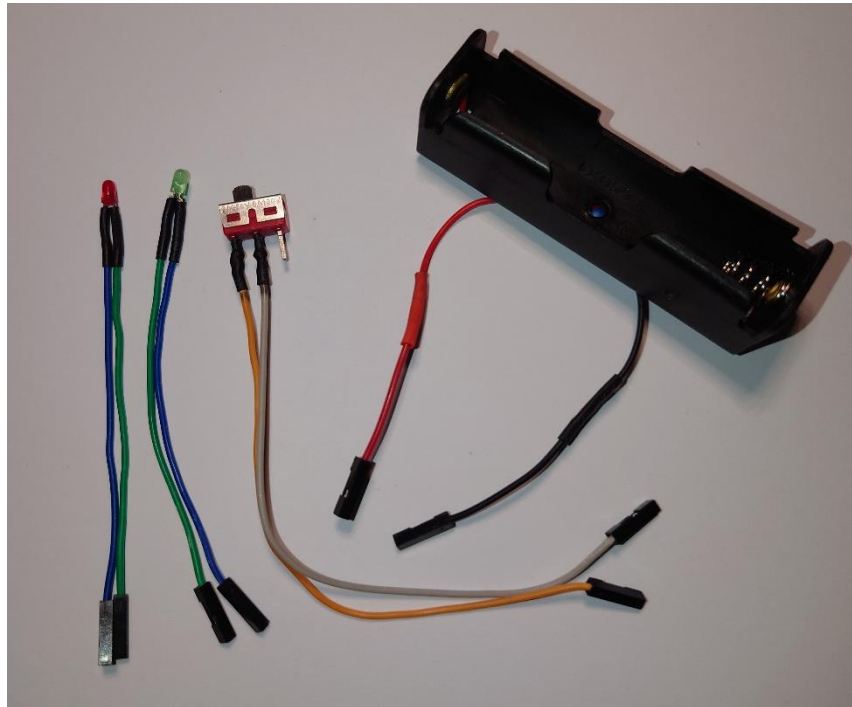


Figure 8: external Components with attached Wires

To ensure proper insulation of the solder joint between the component and the wire, using heat shrink tubing or electrical tape is recommended.

#### 5.2.4. Mounting the Display & Fine Dust Sensor

The display is delivered with its own connector, with the various wires. The pin labels are visible on the display itself and can also be found on the PCB.

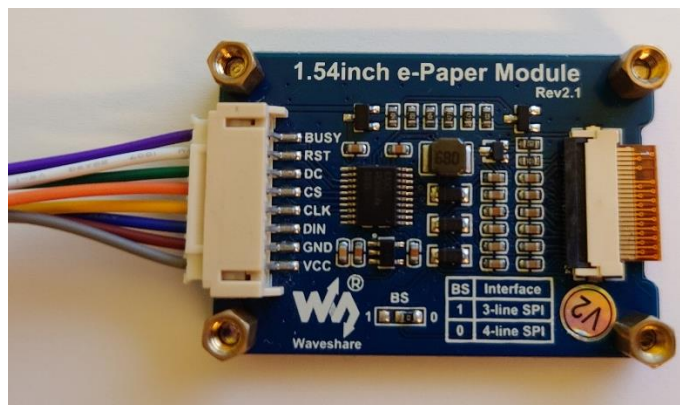


Figure 10: Display Pinout

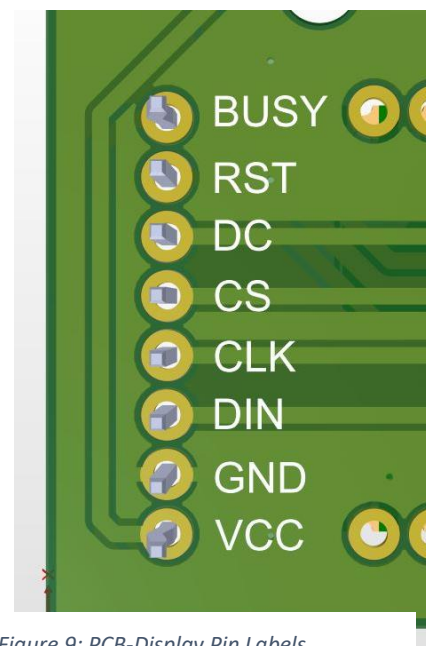
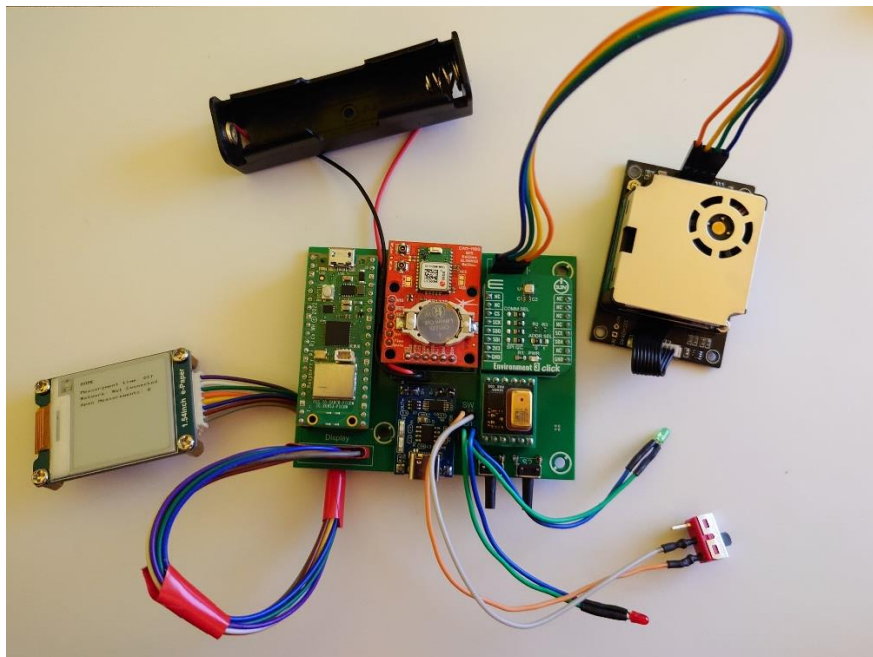


Figure 9: PCB-Display Pin Labels

The Fine Dust sensor (HM3301) has four pin headers that are already soldered to the sensor. These Pins have a 90° angle, which doesn't fit in the housing. For that these pins can either be straightened out with pliers (recommended) or soldered out and replaced with straight pin headers.



*Figure 11: PCB with all connected Components*

## 6. Case

### 6.1. Slicing and Printing

To print the case for the AirScout, an STL file is provided. This file can be sliced according to the specific requirements of the 3D printer being used. There are no particular restrictions regarding the choice of 3D printing material, except for TPE and TPU, which should not be used as they may not provide the required rigidity for the case.

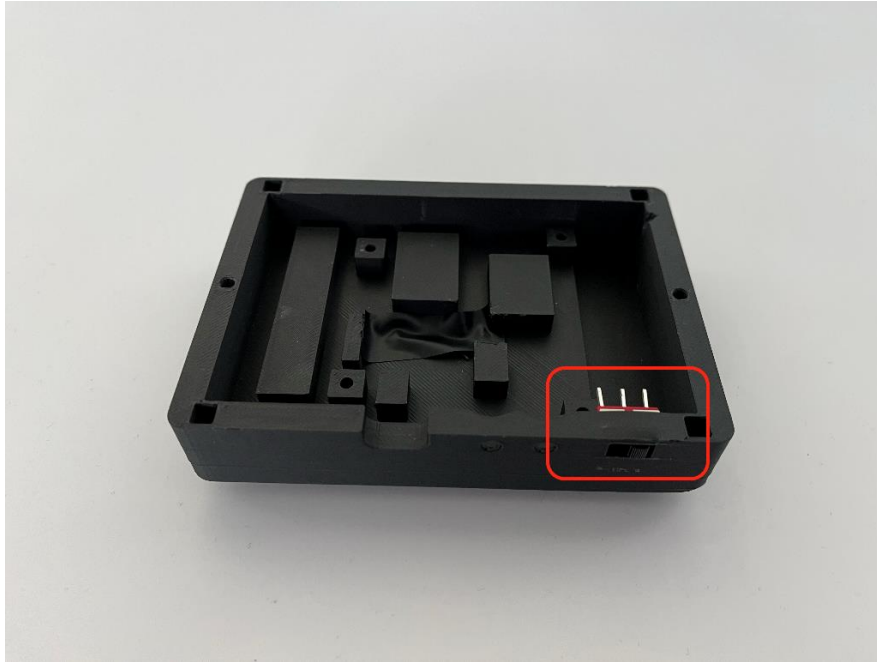
If you do not have access to a suitable 3D printer or are unfamiliar with the slicing process, it is recommended to consult the teacher responsible for 3D printing at your school. They can assist you in slicing and printing the case, ensuring that it meets the required specifications for assembly.



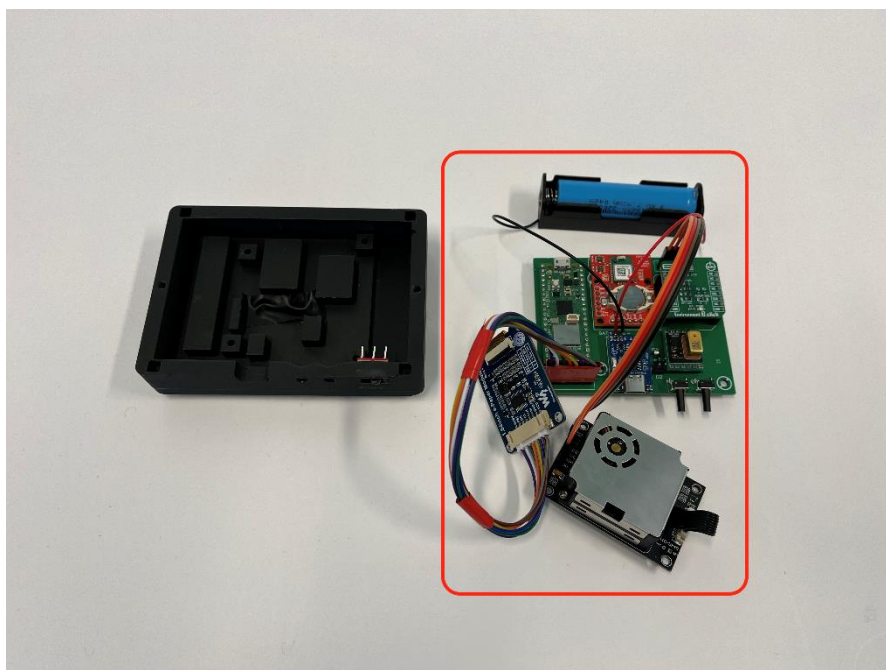
## 7. Assembly

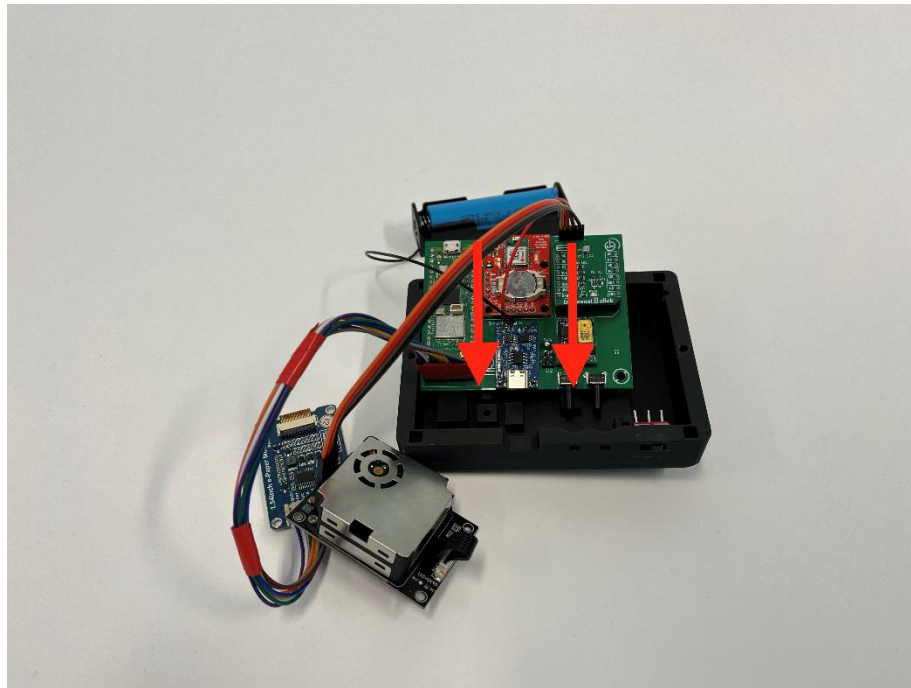
Before the assembly it is recommended to insert the battery and check the correct function of the measuring system. If everything is working fine the finished PCB can be mounted in the case.

### Step 1: Inserting the switch in the bottom part of the case



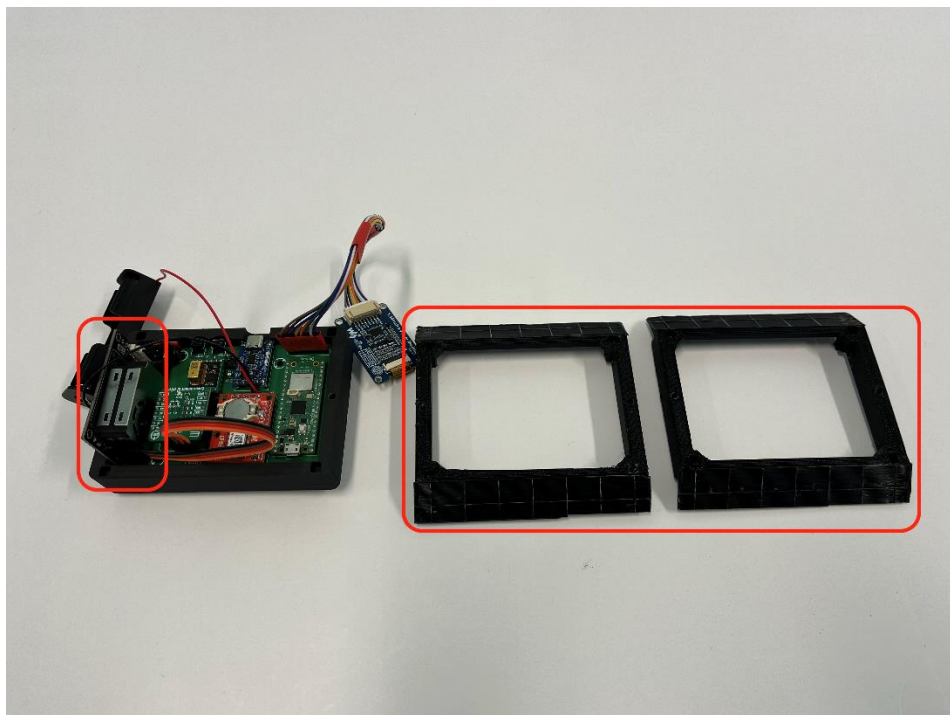
### Step 2: Putting the electronics in the case





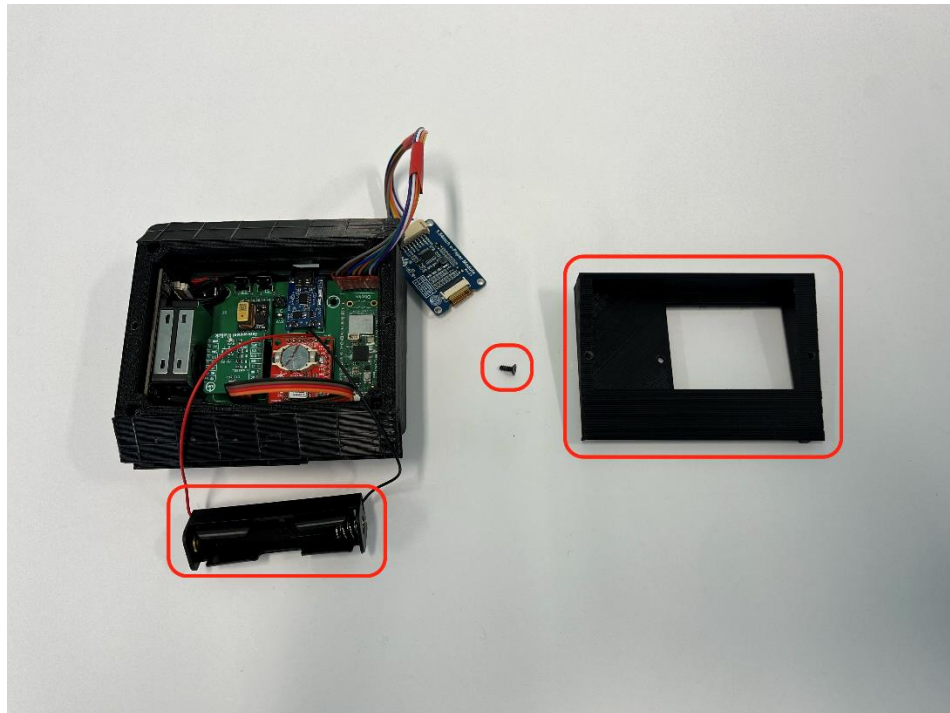
After putting the circuit board in the case, screw it tight.

### Step 3: Putting in the HM3301 and the middle parts of the case

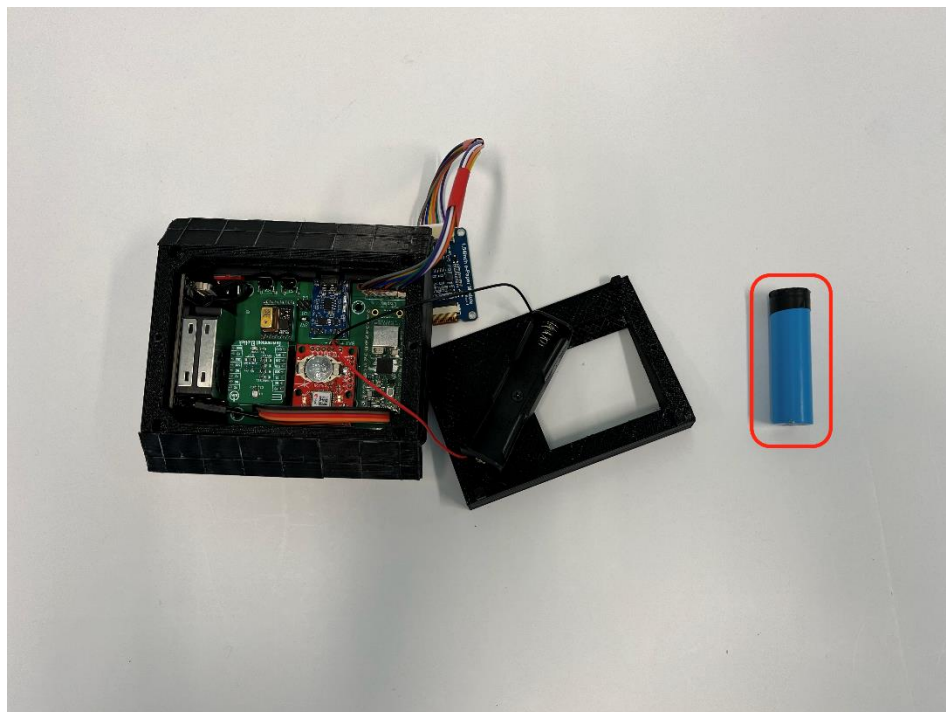


Make sure to connect the HM3301 with the right pins on the circuit board

#### Step 4: Mounting the battery holder to the top part of the case



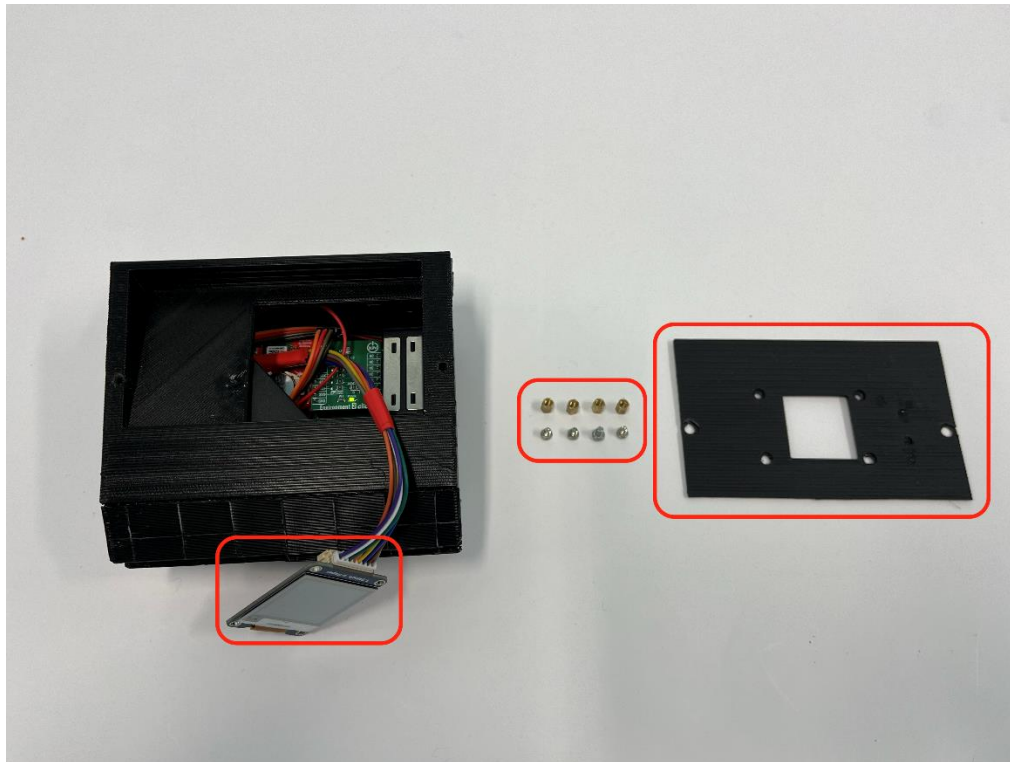
#### Step 5: Putting the battery in the battery holder



Make sure you get the polarity of the battery right. After that, the top part of the case can be put on the bottom part.

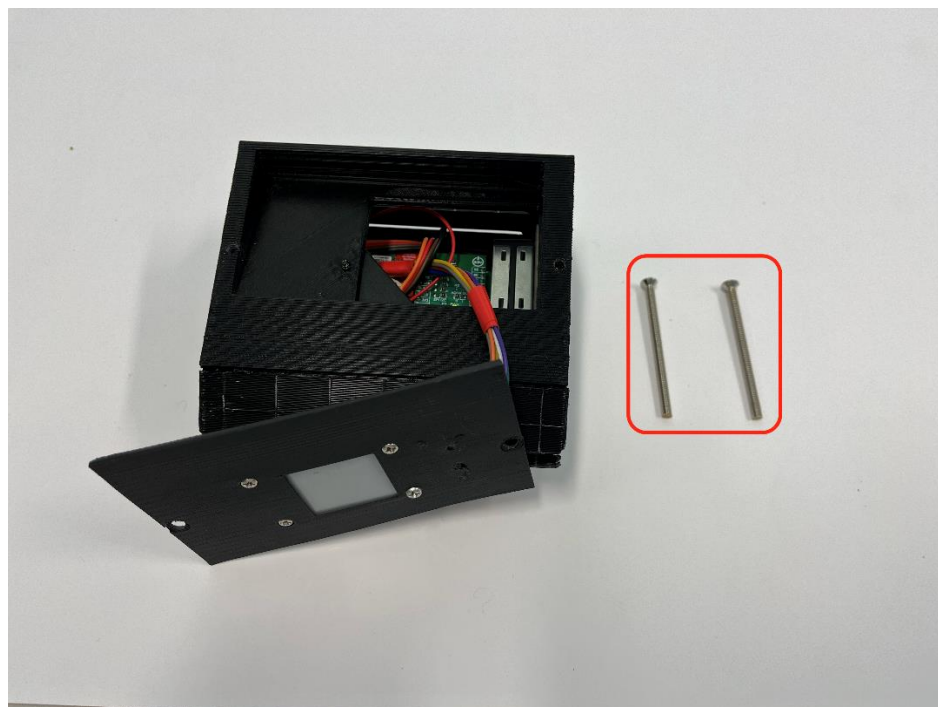


### Step 6: Connecting the display and mounting it to the lid



Make sure you connect the pins of the display in the right order.

### Step 7: Screwing the lid and the case together



After putting all the electronic parts in the case, the 2 big screws can be screwed in from above.  
Make sure no cables are sticking out of the case.




**Now you finally built up the AirScout and its time to test it.**



## 8. Use



### 8.1. Display

The AirScout provides real-time updates and alerts through its display:

-  **Battery Status**
  - Permanently shown in the top-right corner for easy monitoring.
-  **Measurement Values**
  - Displays selected environmental data. Switch between measurements by pressing **Button A**.
-  **Upload Status**
  - Indicates activity during data transfer to the server.









### 8.2. Two LED Indicators

The LEDs provide instant status feedback:



-  **Red LED:** Lights up when any measured value exceeds safe limits.
-  **Green LED:** Lights up when the device is operational and actively measuring.

### 8.3. Buttons






#### Button A (Right Button)

- Short Press **Button A** to switch between measurement values and settings in the following sequence:
  1.  **Temperature** /  **Humidity**
  2.  **Air Pressure** /  **CO<sub>2</sub> Levels** /  **VOC Levels**
  3.  **Fine Dust** (PM2.5, PM5, PM10)
  4.  **Refresh Display Settings**
-  Press and Hold **Button A** to initiate a WiFi scan.

#### Button B (Left Button)




-  **Mark Position:** Saves the current GPS position with a short press to mark a specific location which is problematic for bike riders.
-  **Refresh Display:** Refreshes the display with a long press to ensure the most up-to-date information is shown.

## 8.4. Connecting to WiFi

-  Ensure the WiFi module is properly initialized on the AirScout this can be seen on the E-Ink display.
-  Press and hold Button A to initiate a WiFi scan.
-  The device will automatically attempt to connect to a known WiFi network.
-  If successful, a 'WiFi Connected' icon (  ) will appear on the eInk display.

## 8.5. Using the Website

### 8.5.1. Uploading Data

-  Once the WiFi is connected, the device uploads stored measurement data to the server automatically.
-  The uploading process is indicated by an "Uploading Status" icon on the display.
-  After the data upload is complete, a confirmation message will be displayed.

### 8.5.2. Viewing Data

-  Navigate to [www.gm4s.eu](http://www.gm4s.eu) using a browser and click on Login.



- Log in with your credentials.

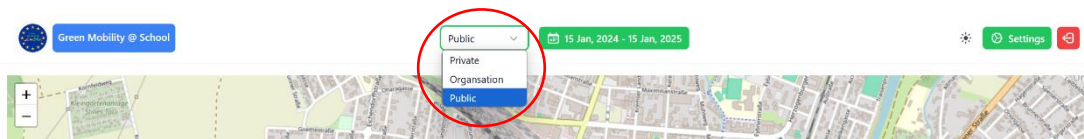
## Login

E-Mail

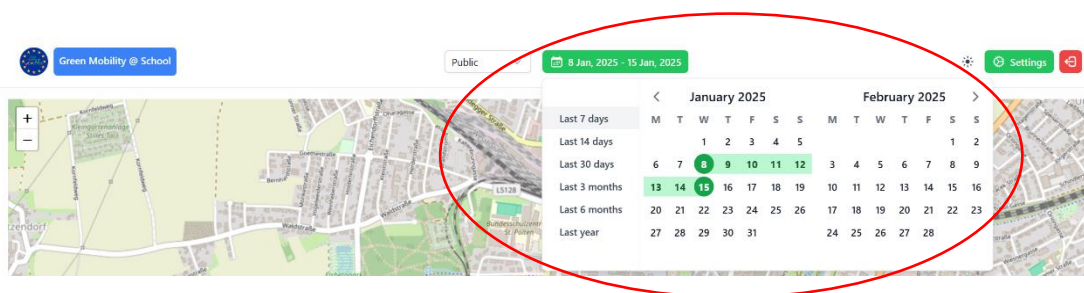
Password [Reset Password here](#)

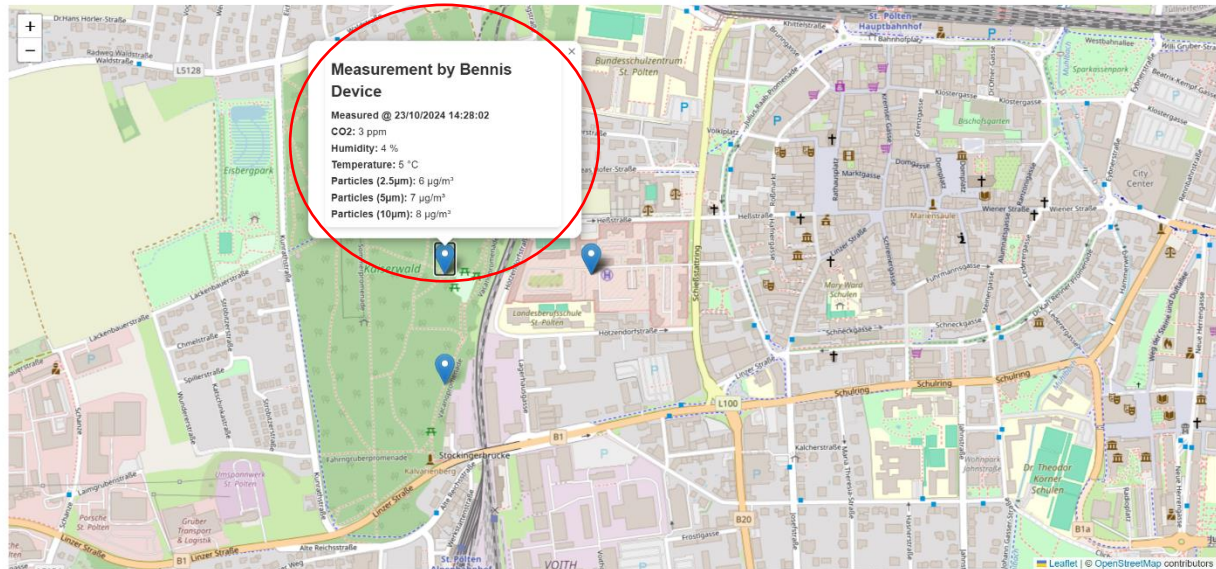
Login

- Access your AirScout's data to view measurements on a map or as a report.



Using the date selector, we can filter the map to display only the data created within a specific time frame.





On the map, you can click on the pins, which are color-coded to represent air quality—ranging from green for good to red for poor. Clicking a pin displays detailed measurement data.



## 8.6. Charging the Device

- IMPORTANT – DO NOT CHARGE THE DEVICE WHILE IT IS ON (POWER SWITCH IS ON)**  
 (Battery failures could occur due to the poorly designed charge controller module)
- Use a USB-C cable to charge the device.
- The battery remains inside the AirScout while charging.
- While actively measuring and storing data, the device can operate for **XXX** hours (value depends on the battery capacity and usage).






## 9. Troubleshooting




### 9.1. No GPS-values are taken

-  Check the GPS antenna for damage or incorrect connections.
-  Ensure the GPS module is powered and properly soldered.




### 9.2. Can't connect to server?

-  Verify WiFi credentials and ensure the network is available.
-  Check the server URL and ensure it is reachable.
-  Confirm that the device has an active internet connection.

### 9.3. No measurements?

-  Confirm that all sensors are properly connected and initialized.
-  Check for loose wires or soldering errors.
-  Ensure the firmware is correctly uploaded and the device is powered.

### 9.4. No lights

-  Verify the battery is properly inserted and charged.
-  Check the LED connections for faults or misalignment.
-  Test the power switch to confirm it is functional