



# AirScout User Manual

ERASMUS+  
CHEN PENG

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# 1. Air Scout – 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 **two** final versions of the AirScout. This document describes the Version for more skilled persons, as it uses SMD-components (Surface Monted Device) resulting in a compact version of the AirScout.

**Bild einfügen** (no final product)

*Figure 1: SMD-component on a print*

This version of the AirScout enables following measurements:

- CO<sub>2</sub>
- NO<sub>x</sub>
- Fine Dust 1 µm
- Fine Dust 2,5 µm
- Fine Dust 10 µm
- Temperature
- Humidity

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

Beside these measurements a button is attached to mark a spot as especially dangerous for bike riders.

After taking the measurements the AirScout can be connected via WiFi to a server. When the 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.

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

## 3. Requirements

### 3.1. Requirements

Name	Price/ pcs	Price total	Link
ADXL345 Accelerometer	8.83€	8.83€	<a href="https://www.amazon.de/ADXL345-Accelerometer-Acceleration-Compatible-Raspberry/dp/B0987T1GS8/ref=sr_1_2_sspa?crid=3D7AQEYXAY5BH&amp;dib=eyJ2ljojMSJ9.XgMYGQBdKrz5XAeFEtBBG Cd_HW9YdNaMb8ce8yZCBn_jshkyqpldITHUWm8OzycDB SBgPfLM_KJjxaDEqw_nsN9tUKuoNFDJqjtOYvZz1Z1GJV0p3 1S1I9chBCYBr1f5BlfqK_1_6ZEklxTp9t2aZsloAlmnflnHtHvm clgWKyJsWwW0E1FGJvkmVcp5wJp3jXxal5og06WsNB8G3 8EZGNRSCvQ34mxvKw4thyK6IMgBAo22vklIPR3Cr3yR31 mGPoXYhAc- 182WNUeoPH4Y3jUkkvK60fxYaShAiKezEY.v0nRAWKRn2p ceD-aa4_VTzOY0gN- Uko4vhdZdN1ZYaA&amp;dib_tag=se&amp;keywords=adxl345&amp;qid=1728379053&amp;srefix=adx%2Caps%2C150&amp;sr=8-2-spons&amp;sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&amp;pssc=1">https://www.amazon.de/ADXL345-Accelerometer-Acceleration-Compatible-Raspberry/dp/B0987T1GS8/ref=sr_1_2_sspa?crid=3D7AQEYXAY5BH&amp;dib=eyJ2ljojMSJ9.XgMYGQBdKrz5XAeFEtBBG Cd_HW9YdNaMb8ce8yZCBn_jshkyqpldITHUWm8OzycDB SBgPfLM_KJjxaDEqw_nsN9tUKuoNFDJqjtOYvZz1Z1GJV0p3 1S1I9chBCYBr1f5BlfqK_1_6ZEklxTp9t2aZsloAlmnflnHtHvm clgWKyJsWwW0E1FGJvkmVcp5wJp3jXxal5og06WsNB8G3 8EZGNRSCvQ34mxvKw4thyK6IMgBAo22vklIPR3Cr3yR31 mGPoXYhAc- 182WNUeoPH4Y3jUkkvK60fxYaShAiKezEY.v0nRAWKRn2p ceD-aa4_VTzOY0gN- Uko4vhdZdN1ZYaA&amp;dib_tag=se&amp;keywords=adxl345&amp;qid=1728379053&amp;srefix=adx%2Caps%2C150&amp;sr=8-2-spons&amp;sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&amp;pssc=1</a>
RGB LED	2.95€	2.95€	<a href="https://www.mpja.com/Pack-of-10-PL9823-Programmable-RGB-5mm-LED/productinfo/35762%20OP/">https://www.mpja.com/Pack-of-10-PL9823-Programmable-RGB-5mm-LED/productinfo/35762%20OP/</a>
Jumper wire	5.94€	5.94€	<a href="https://www.amazon.de/-/en/EL-CP-004/dp/B01EV70C78/ref=sr_1_5?crid=3VFVAF49KXl68&amp;dib=eyJ2ljojMSJ9.C_WCU31FYAmzCGkwMcM1VxKsTuWPjYb H9qZ9OjTwmZz5RXxSjrpre2zV1ibuaqG5yvk1j5ZBZuClpTtK txvk2qTQbXcVcs72_5SrQDkP_jTsj4m6abcZlv9bpTwlsRVqi OTjxsP1tVrRnEPT-- V8g9XwvgeLB1IKM_t5E9P_W1yakRIkytj_IGAxug1O5lvqclv0 WrU19m82_mMcAD-69Jai4CdZF0E-jYZKLCI2-fPn_XcibDB7VTSKvAN4Lj42xIXPt4ADKRMioj4Ow55MCz6b OFmuQv7JPNtuFnTwQE.VQCa7m9rGz_bome0MdnmvK5u vkMucd08Cecy5CQccKw&amp;dib_tag=se&amp;keywords=jumper+ wire&amp;qid=1718012482&amp;srefix=jumper+w%2Caps%2C96 &amp;sr=8-5">https://www.amazon.de/-/en/EL-CP-004/dp/B01EV70C78/ref=sr_1_5?crid=3VFVAF49KXl68&amp;dib=eyJ2ljojMSJ9.C_WCU31FYAmzCGkwMcM1VxKsTuWPjYb H9qZ9OjTwmZz5RXxSjrpre2zV1ibuaqG5yvk1j5ZBZuClpTtK txvk2qTQbXcVcs72_5SrQDkP_jTsj4m6abcZlv9bpTwlsRVqi OTjxsP1tVrRnEPT-- V8g9XwvgeLB1IKM_t5E9P_W1yakRIkytj_IGAxug1O5lvqclv0 WrU19m82_mMcAD-69Jai4CdZF0E-jYZKLCI2-fPn_XcibDB7VTSKvAN4Lj42xIXPt4ADKRMioj4Ow55MCz6b OFmuQv7JPNtuFnTwQE.VQCa7m9rGz_bome0MdnmvK5u vkMucd08Cecy5CQccKw&amp;dib_tag=se&amp;keywords=jumper+ wire&amp;qid=1718012482&amp;srefix=jumper+w%2Caps%2C96 &amp;sr=8-5</a>

BOROCO Passive Keramikantenne NEO-6M	8.99€	8.99€	<a href="https://www.amazon.de/dp/B09YD6MP4T?psc=1&amp;ref=ppx_yo2ov_dt_b_product_details">https://www.amazon.de/dp/B09YD6MP4T?psc=1&amp;ref=ppx_yo2ov_dt_b_product_details</a>
Adafruit	3.26€	3.26€	<a href="https://www.mouser.de/ProductDetail/Adafruit/4682?qs=hWgE7mdlu5TtwzYJhYD8g%3D%3D&amp;_gl=1*85r4wn*_ga*OTc1ODc2OTc2LjE3MTgwMDkwNzg.*_ga_15W4STQT4T*M TcxODAxMTc4Ni4yLjAuMTcxODAxMTc4Ny41OS4wLjA">https://www.mouser.de/ProductDetail/Adafruit/4682?qs=hWgE7mdlu5TtwzYJhYD8g%3D%3D&amp;_gl=1*85r4wn*_ga*OTc1ODc2OTc2LjE3MTgwMDkwNzg.*_ga_15W4STQT4T*M TcxODAxMTc4Ni4yLjAuMTcxODAxMTc4Ny41OS4wLjA</a>
Intenso Powerbank S5000	10.99€	10.99€	<a href="https://starmobile.de/ladezubehoer/intenso/powerbank-slim-s5000">https://starmobile.de/ladezubehoer/intenso/powerbank-slim-s5000</a>
Senserion SEN55-SDN-T	30.83€	30.83€	<a href="https://sensirion.com/products/catalog/SEN55">https://sensirion.com/products/catalog/SEN55</a>
OLED-Display	8.99€	8.99€	<a href="https://www.amazon.de/-/en/1-3-Inch-OLED-Display-Parent/dp/B078J78R45/ref=sr_1_3?crid=1FQK7BR6MU7B1&amp;dib=eyJ2ljojMSJ9.nt_BDwgLNtoLyPYKEW7WL2Zh6gWpVWYo47PmKkUaSDLIWydP5hTeRHj8VP_yJIU_iBjLuqDm9mwDCBvFe0ujmdIF8ljvdoPmf4phDut6q4pqVwcC7FMBC8lxZSFBocr9lNi9yv7thWSNevFBBWKytFzehFW-RwPDMSSuw8tlLmaFPfKrwZzMfhKuNuLROHY0haGfQ1Yps3Cz88_Pv8KqFaJ5R7C_s1iK0ugeLsoFROU.5RsHTixTp_9xH9SDHNIrGH1v3ROhpDiwNdMk8ChI7jA&amp;dib_tag=se&amp;keywords=oled%2Bdisplay&amp;qid=1718010169&amp;sprefix=oled%2Bdisplay%2Caps%2C105&amp;sr=8-3&amp;th=1">https://www.amazon.de/-/en/1-3-Inch-OLED-Display-Parent/dp/B078J78R45/ref=sr_1_3?crid=1FQK7BR6MU7B1&amp;dib=eyJ2ljojMSJ9.nt_BDwgLNtoLyPYKEW7WL2Zh6gWpVWYo47PmKkUaSDLIWydP5hTeRHj8VP_yJIU_iBjLuqDm9mwDCBvFe0ujmdIF8ljvdoPmf4phDut6q4pqVwcC7FMBC8lxZSFBocr9lNi9yv7thWSNevFBBWKytFzehFW-RwPDMSSuw8tlLmaFPfKrwZzMfhKuNuLROHY0haGfQ1Yps3Cz88_Pv8KqFaJ5R7C_s1iK0ugeLsoFROU.5RsHTixTp_9xH9SDHNIrGH1v3ROhpDiwNdMk8ChI7jA&amp;dib_tag=se&amp;keywords=oled%2Bdisplay&amp;qid=1718010169&amp;sprefix=oled%2Bdisplay%2Caps%2C105&amp;sr=8-3&amp;th=1</a>
Raspberry pi PICO W	16.99€	16.99€	<a href="https://www.amazon.de/-/en/Pre-soldered-Raspberry-Pi-Pico-microcontroller/dp/B0BM3LCC7D/ref=sr_1_3?crid=OD3TG1UJ84IQ&amp;dib=eyJ2ljojMSJ9.EMwiDWyZ1EO1JUCNP48X8f4yzStTQNFblwx1SZW-P-AT51-Wl84xhDRdWEORnRu62Ueqrnv1-ShojBeX1L4-UenO-RW5xzAlmor90eQxctui8ia9x7mySdFKr2JVgSgpFVclMPSXikGWp0p83Lh6e0UmKGBjCUf8MYWqfAhTlvdfttdZKcCAy_mjNdGalW_U5I9L_IsK9gTlx6b5NuMt7-uNg6tx_X2raE8a7M8OWQ.JYqS9E45bUOYC--G0PR1SZC58bfmQi8rN6xPZ1vGyJw&amp;dib_tag=se&amp;keywords=Raspberry+pi+pico+w&amp;qid=1718010514&amp;sprefix=raspberrypi+pico+w%2Caps%2C120&amp;sr=8-3">https://www.amazon.de/-/en/Pre-soldered-Raspberry-Pi-Pico-microcontroller/dp/B0BM3LCC7D/ref=sr_1_3?crid=OD3TG1UJ84IQ&amp;dib=eyJ2ljojMSJ9.EMwiDWyZ1EO1JUCNP48X8f4yzStTQNFblwx1SZW-P-AT51-Wl84xhDRdWEORnRu62Ueqrnv1-ShojBeX1L4-UenO-RW5xzAlmor90eQxctui8ia9x7mySdFKr2JVgSgpFVclMPSXikGWp0p83Lh6e0UmKGBjCUf8MYWqfAhTlvdfttdZKcCAy_mjNdGalW_U5I9L_IsK9gTlx6b5NuMt7-uNg6tx_X2raE8a7M8OWQ.JYqS9E45bUOYC--G0PR1SZC58bfmQi8rN6xPZ1vGyJw&amp;dib_tag=se&amp;keywords=Raspberry+pi+pico+w&amp;qid=1718010514&amp;sprefix=raspberrypi+pico+w%2Caps%2C120&amp;sr=8-3</a>
Total Price			

Table 1: List of Components

Tin Solder
------------

Table 2: List of Materials

Soldering Iron
PC or Laptop
USB-Micro-cable
3D-Printer
Screwdrivers, Pliers
Equipment for SMD-soldering

Table 3: List of Devices

## 3.2. Skills

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

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

Am PCB eine allfällige Polarität klar kennzeichnen

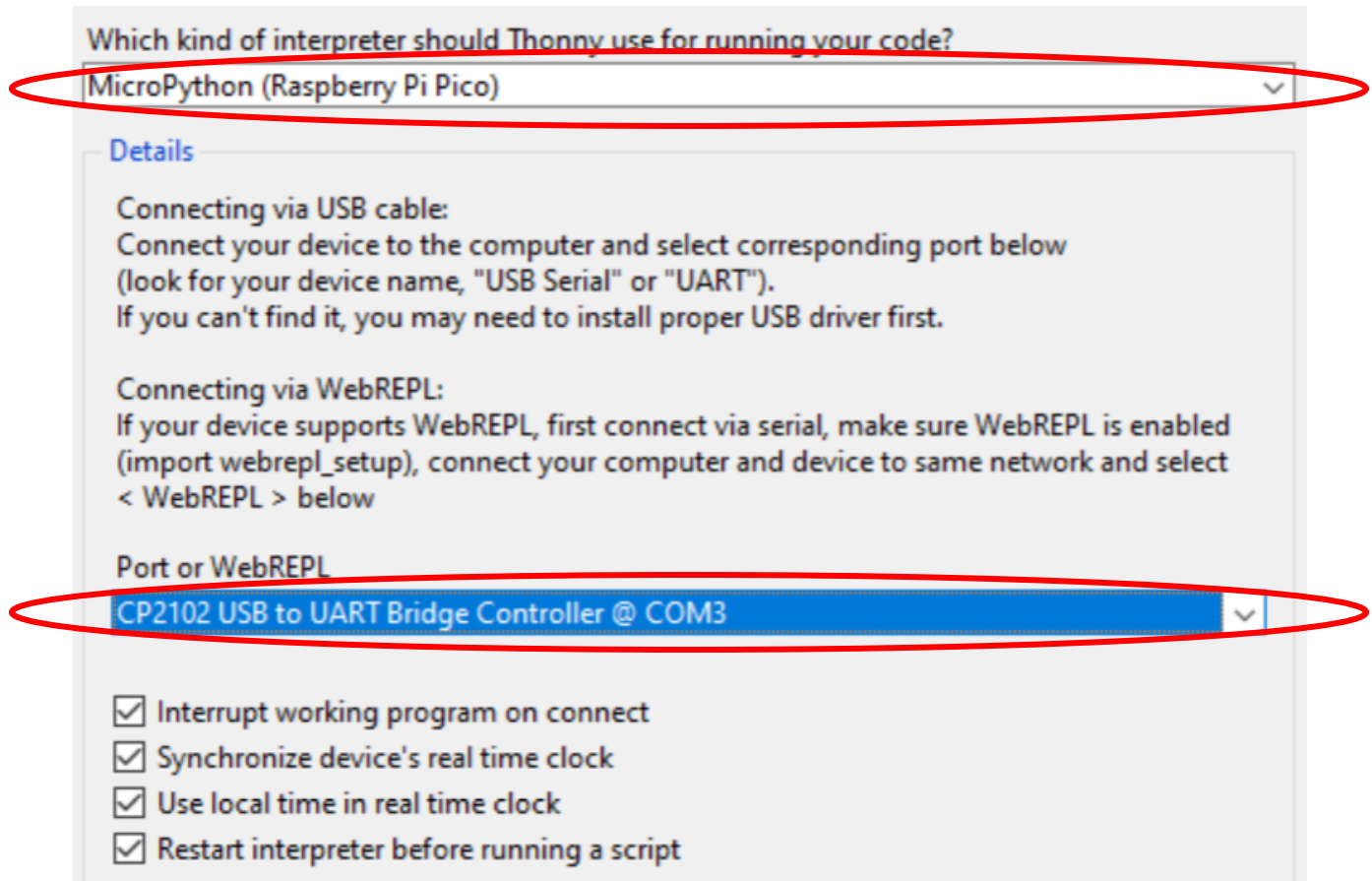
## 4. Software Upload to the microcontroller PicoW

### Step 1 (download & installation)

Download and install the “Thonny” app via [www.thonny.org](http://www.thonny.org) (the recommended version for your device)

### Step 2 (configuration)

Run → Configure interpreter



Make sure the interpreter is set to **MicroPython (Raspberry Pi Pico)**

Connect your Raspberry Pi Pico to your computer using an USB cable and select your **UART Bridge Controller @ (your port)**

### Step 3 (Install the libraries)

### Step 4 (Open & run the code)

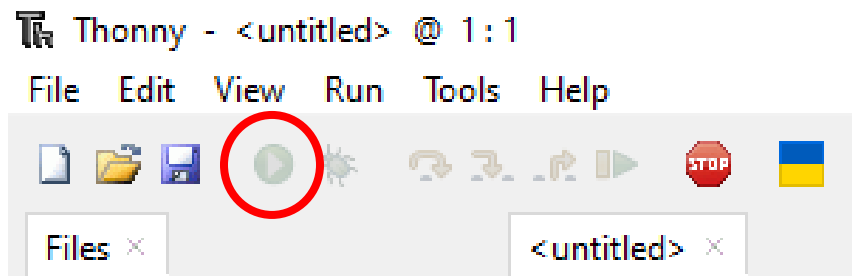
Download the program file (**NorbertSenserion.py**). Open the file in Thonny by:

**File → open → select NorbertSenserion.py**

Save the code on the Raspberry Pi Pico by:

File → Save as → Raspberry Pi Pico

Then run the code by clicking the green play button



Finally, the micro-USB-cable can be disconnected.



## 5. Circuit

### 5.1. Producing the Circuit

Download the “AirScout Gerber-File”

The PCB is designed as a two-layer-circuit. It must be ordered at producers such as PCBWay.com

Go to <https://www.pcbway.com/orderonline.aspx>

Click on Quick -order PCB

**PCB Specification Selection** [How it works \(3 steps\)](#) [Quick-order PCB >>](#)

Board type: ☒ Single pieces ☐ Panel by Customer ☐ Panel by PCBWay

Different design in panel: ☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6  e.g.

\* Size (single):  X

\* Quantity (single):  pcs

Layers: ☐ 1 Layer ☒ 2 Layers ☐ 4 Layers ☐ 6 Layers ☐ 8 Layers ☐ 10 Layers ☐ 12 Layers ☐ 14 Layers

Material: ☒ FR-4 ☐ Aluminum ☐ Rogers ☐ HDI(Buried/blind vias) ☐ Copper Base

\*Material model can be remarked below. HDI is available for 4-layer or more.

Upload the “AirScout Gerber-File”

**PCB Specification Selection** [Simple tutorial \(suitable for beginners\)](#) [Online Gerber Viewer](#)

PCB file (optional): ☒ [+ Add Gerber File](#)

Automatically sets the board size, hole, track/spacing. only accept .rar, .zip or .7z & Maximum 50M.

Add it to your cart, register on the website, fill in your information for shipping, and place the order.

## 5.2. Soldering

Soldering can be done either by a SMD-Soldering-Machine or by hand which requires advanced soldering skills.

The wired parts should be soldered after the SMD-soldering process.

Finally, the cables must be soldered into the correct pads.

**Insert Pictures of the steps** (no final product)

## 6. Case

### 6.1. Slicing and Printing

For printing the case a STL-File is provided.

The STL-File must be sliced according to the used 3D-printer.

There are no special requirements for the used 3D-Material.

## 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 is mounted into the case.

## 8. Use

### 8.1. Display

Following parameters can be displayed

The measured data will be saved on an SD card and can be displayed later on [GPSVisualizer.com](https://gpsvisualizer.com).

Red: lights, when any measured value, exceeds recommended values

Green: lights, when the device is running and measuring

### 8.2. Buttons

Button A (Pushbutton)

By pressing Button A the displayed measured value will change in following sequence

**Sequence einfügen** (no final product)

### 8.3. Connecting to WiFi

### 8.4. Using the Website

Open your internet browser and enter this link:

[https://www.gpsvisualizer.com/map\\_input?form=google](https://www.gpsvisualizer.com/map_input?form=google)

Configure track options like this:

Track options		hide advanced track options [-]	
Track opacity:	<input type="text" value="90%"/>	Line width:	<input type="text" value="3"/>
Colorize by:	<input type="text" value="custom field"/>	Default color:	<input type="text" value="Red"/>
Custom colorization field:		<input type="text" value="Data"/>	
Colorize min.:	<input type="text" value="20"/>	Colorize max.:	<input type="text" value="80"/>
Lightness:	<input type="text" value="90%"/>	Saturation:	<input type="text" value="100%"/>
Spectrum direction:	<input type="text" value="up"/>	Hue 1:	<input type="text" value="0°"/>
		Hue 2:	<input type="text" value="300°"/>
Custom spectrum file (URL):	<input type="text"/>		
Color of values beyond min. or max.:	<input type="text" value="Gray"/>		
Colorization legend:	<input type="text" value="Yes"/>	Steps:	<input type="text" value="10"/>
Color blocks:	<input type="text" value="Yes"/>		
Preserve track styles in input files (e.g., from KML or Garmin GPX):	<input type="text" value="Yes"/>		
Track list:	<input type="text" value="Names and descriptions"/>	Tickmark interval:	<input type="text"/>
Trackpoint distance threshold:	<input type="text"/>	Max. points per track:	<input type="text"/>
Draw tracks as waypoints:	<input type="text" value="No"/>		
Remove all tracks:	<input type="text" value="No"/>	Reverse tracks:	<input type="text" value="No"/>
Connect segments:	<input type="text" value="No, leave gap"/>	Merge all tracks:	<input type="text" value="No"/>
Segment break threshold for plain-text track data:	<input type="text"/> seconds		
Re-order coterminous tracks:	<input type="text" value="No"/>		
Outline behind/around tracks:	<input type="text" value="No"/>	Geodesic drawing:	<input type="text" value="No"/>
Make tracks clickable:	<input type="text" value="Yes"/>	Make tracks mouseover-able:	<input type="text" value="No"/>
Default polygon opacity ("filled" tracks only):	<input type="text" value="--"/>		
Moving average range for estimated fields (speed, slope, etc.):	<input type="text" value="1"/> point(s)		
GPX/CSV routepoints:	<input type="text" value="Convert to tracks, but include named pts. as waypoints"/>		
Show track statistics (distance, time, elevation):	<input type="text" value="No"/>		
Calculate elevation gain:	<input type="text" value="No"/>	Elevation threshold:	<input type="text"/>

Configure way points like this:

**Waypoint options**
hide advanced waypoint options [-]

Show waypoints: All ?

Default icon: cross ? + Color: white ?

Waypoint labels: Mouse-over "tooltips" only ?

Opacity: 100% ? Scale: 1 ? Shadows: Yes ? Vector: Yes ?

Preserve waypoint colors and symbols (e.g., from KML or Garmin): Yes ?

Colorize waypoints using this field: custom field ?

Custom colorization field: "Data"

Synthesize name: (field names in {curly} brackets) ?

Synthesize description: (fields in {curly} brackets) ?

Synthesize label: (fields in {curly} brackets) ?

Synthesize folders: (fields in {curly} brackets) ?

Initial state of folders in marker list: Open ?

Generate list of markers: No ? Width: 160 px ?

Interactively filter out-of-range points: No ? Max. # visible: ?

Discard outliers: No, show all points ?

Show only points whose 'name' matches this pattern: ?

Garmin waypoint icons: small, colorful (16x16) ?

Add "driving directions" form to each point's info window: No ?

Geotag points with times but no positions: Yes, interpolate points ?

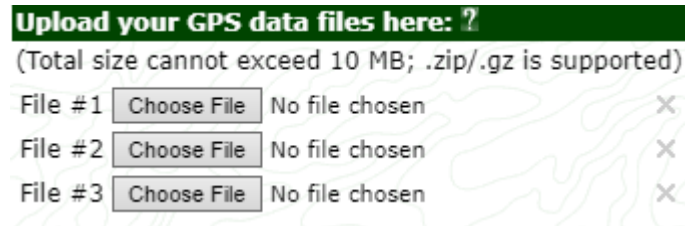
Geotagging offset: hours (positionless points vs. GPS data) ?

If you want to change the displayed data, just change the name that you used for the different data in the "custom colorization field."

### 8.4.1. Uploading Data

Make sure your data is a “.csv” data.

Upload the data here:

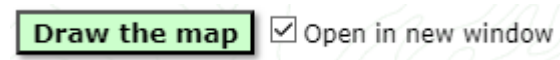


**Upload your GPS data files here: ?**  
(Total size cannot exceed 10 MB; .zip/.gz is supported)

File #1	<input type="button" value="Choose File"/>	No file chosen	<input type="button" value="X"/>
File #2	<input type="button" value="Choose File"/>	No file chosen	<input type="button" value="X"/>
File #3	<input type="button" value="Choose File"/>	No file chosen	<input type="button" value="X"/>

### 8.4.2. Viewing Data

To view your data, click on “draw the map”



☒ Open in new window

## 8.5. Charging the Device

The device will be charged via an USB-C-cable. So, the battery can be kept in the AirScout.

While measuring and storing data, the device will work for 1 hour.

## 9. Troubleshooting

### 9.1. No GPS-values are taken

Antenna Broken?

### 9.2. No measurements?

### 9.3. No lights

Is the battery placed correctly?

## Missing parts

Software upload thonny (Norbert / Louis)

Gehäuse (Max)

Point 8&9 of their document (All)