

# User manual

# SwisensAtomizer



## Imprint

# SwisensAtomizer user manual

Swisens AG

English

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## 1. Introduction

This document provides information about using SwisensAtomizer.

SwisensAtomizer:

- simplifies the process of dispersing solid and dry particles in the air
- is able to produce particle concentration in a wide range
- is not bound to a fix air flow rate
- produces stable particle concentration over a long period of time
- can generate relatively low aerosol particle concentrations
- allows economical use of sample material
- can be operated locally using the keys and the display
- can be remotely controlled via PC using a cable connection

This is particularly important when working with airflow cytometers, as these typically have some limited range of concentrations over which they operate efficiently and for generating large measurement data sets.

### 1.1. Scope of Delivery

Qty	Item
1	Swisens Atomizer incl. cover assembly and HEPA-filter
1	Grounding cable
10	Metal cuvettes
10	Shaker beads
100	Plastic cuvettes

## 2. Safety information

### 2.1. General understanding of safety

SwisensAtomizer is designed to be safe and poses no hazard when used as intended. For proper operation of the SwisensAtomizer, the instructions should be read, understood and followed.



### 2.2. Intended usage

- ◆ The SwisensAtomizer is designed to disperse low volumes of solid particles (e.g. pollen, spores, dust) in a size range from  $1\mu\text{m}$  ..  $100\mu\text{m}$ , contained in standard macro cuvettes ( $12.5 \times 12.5 \times 45\text{mm}^3$ ) with a volume of 4.5ml.
- ◆ The unit is not weatherproof.
- ◆ **Dispersed particles may float in the air for a long time and may be transported over wide distances by wind or through building ventilation shafts. If working with potentially hazardous substances, appropriate containment measures **MUST** be taken to ensure that no particles are released uncontrolled.**
- ◆ The device contains a  $\text{LiFePO}_4$  battery. **DO NOT** allow the device temperature to exceed  $45^\circ\text{C}$  when charging and  $65^\circ\text{C}$  otherwise.
- ◆ **In case of misuse or manipulation of the measuring station, normal and safe operation cannot be guaranteed by the manufacturer.**



#### **WARNING**

**The device is not explosion-proof. Use in conjunction with explosive media is not permitted!**

- ◆ The pollen and spores are highly flammable. Keep any source of ignition away.
- ◆ The pollen and spores used can cause an allergic reaction. Consult a specialist to carry out an allergy test. If you notice allergic reactions in yourself or someone else, call an emergency doctor immediately.
- ◆ Clean the unit before taking a new measurement. Pay special attention to the membrane, where many particles accumulate. Old particles can falsify the measurement.

- ◆ The unit draws in ambient air and blows it into the unit. Make sure the ambient air is clean so that the measurements are not distorted. The speaker may produce resonance and may damage the unit.
- ◆ Make sure that the blade plug is always fully inserted. The LED can be damaged if the plug is not fully inserted.

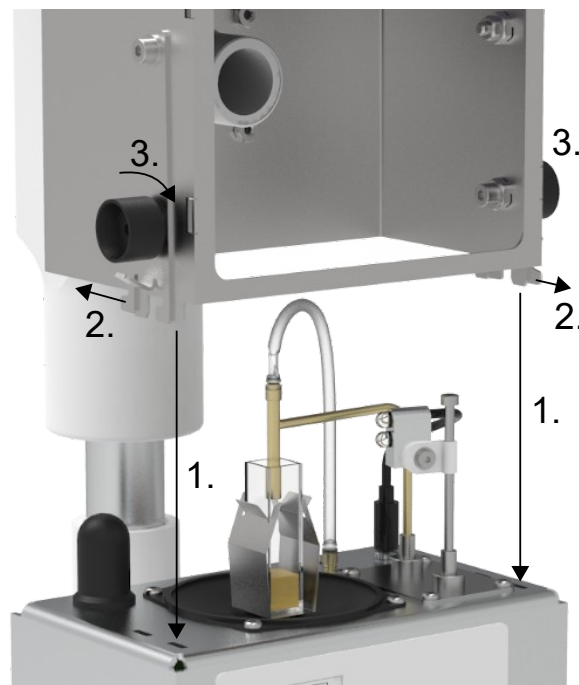
### 3. Quick start

This chapter contains a quick start introduction. Refer to chapter 4 for detailed device overview.

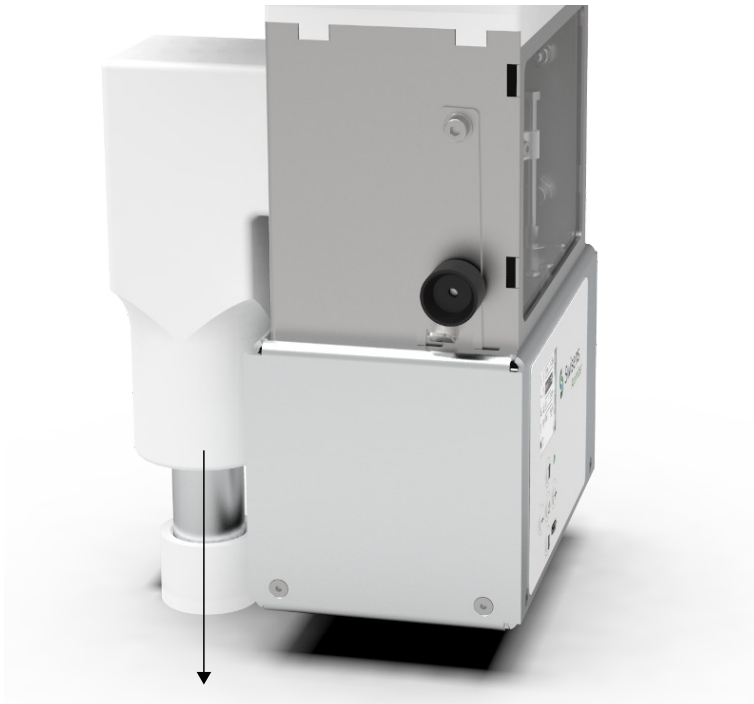
1. Fill the particle sample into a macro cuvette (12.5 x 12.5 x 45mm<sup>3</sup>) and insert the cuvette into the clamp. Make sure that the cuvette touches the bottom of the clamp. Align the magnetic holder of the air nozzle so that the nozzle is at the enter of the cuvette. Ensure that both ends of the silicone tube are firmly attached. Align the illumination LEDs to the top end of the cuvette.



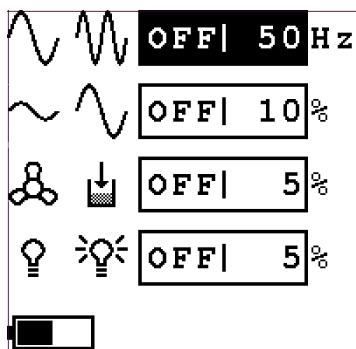
2. Put the cover assembly onto the Atomizer (1). Make sure that the four protruding tabs of the cover are fully inserted in the slots in the Atomizer shell. Move the latches to the close position (2) and tighten the locking screws (3).









3. Grip the assembly at the pipe adapter on the backside and mount it on a vertical pipe with an outer diameter of 40mm and an inner diameter of 35mm.



4. Switch the Atomizer on by pressing  for 4 seconds. The main menu is shown.



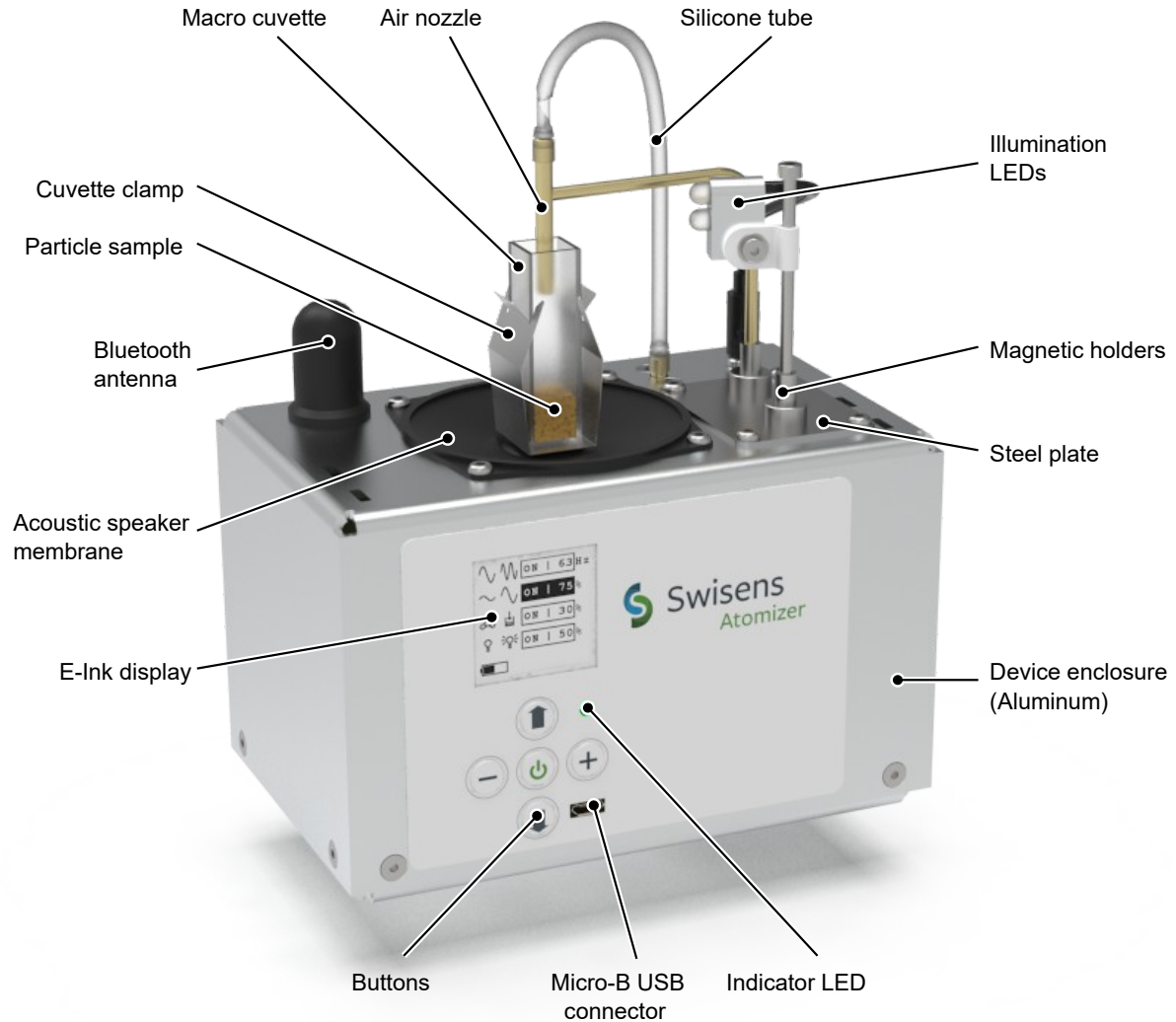
5. Use  and  to select the desired option. The value can be changed using  and  while a short press on  turns the selected function on and off. Adjust the values until the connected measurement device gets a suitable particle concentration. The illumination may be enabled so that the particle flow out of the cuvette can be seen.
6. When finished, turn off the Atomizer by pressing  for 4 seconds. Alternatively, it will turn off automatically when all functions are disabled for the defined inactivity period (by default 5 minutes) when no USB connection is present.








## 4. System description

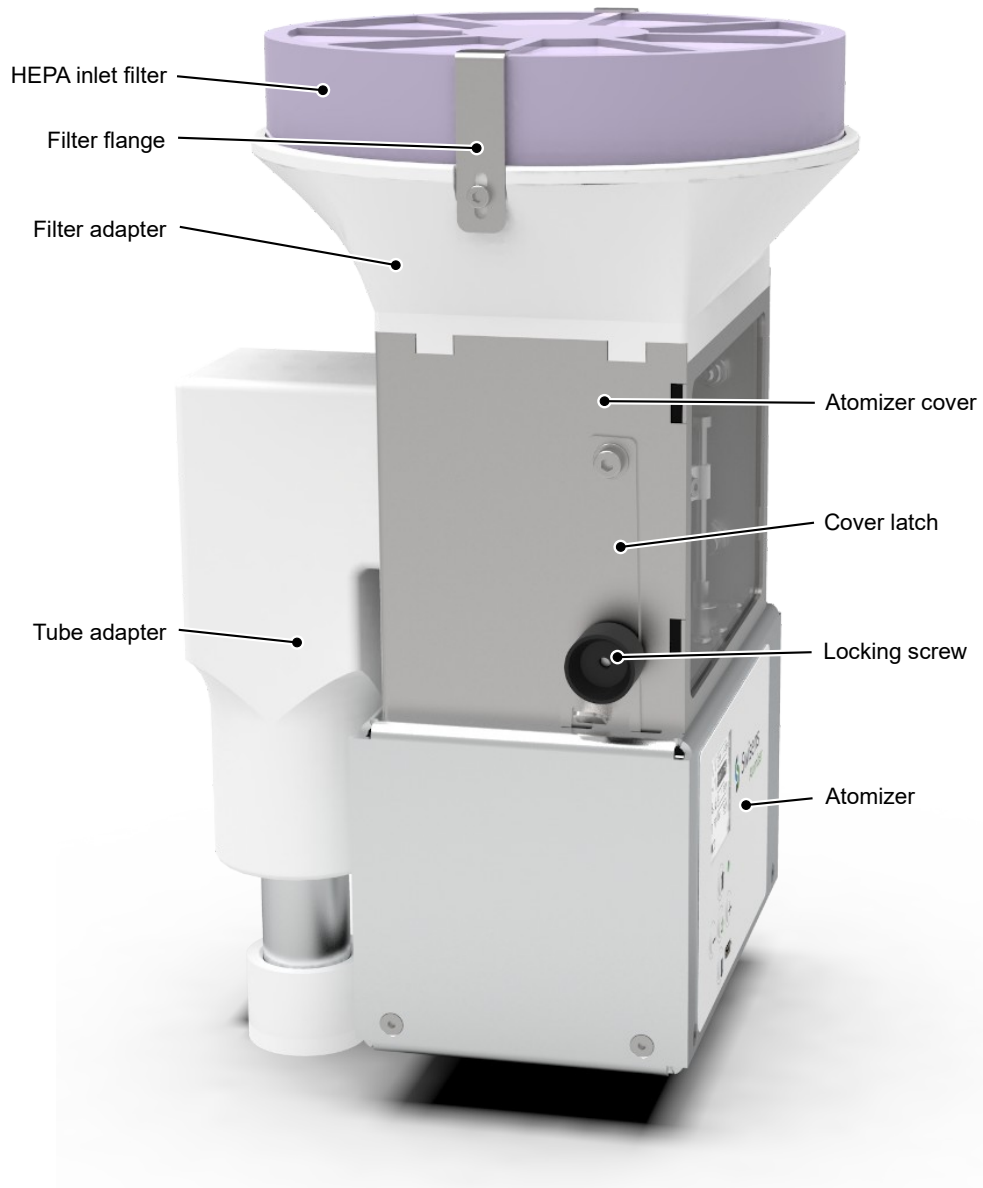
### 4.1. Device overview

#### 4.1.1. Atomizer device



Button	Function
	Standby / Function on, off
	Up, to select desired function
	Down, to select desired function
	Plus, to increase value of selected function
	Minus, to decrease value of selected function

4.1.2. Atomizer with cover assembly



## 4.2. Principle of operation

Whenever particles are stored in the form of a compact powder, the individual particles tend to stick together, forming agglomerates. This makes it difficult to aerosolize them, which is a requirement when analyzing particles using airflow cytometers. One possibility to disperse these agglomerates back into individual particles is to apply mechanical vibration, which breaks the adhesive links as a result of the acceleration forces.

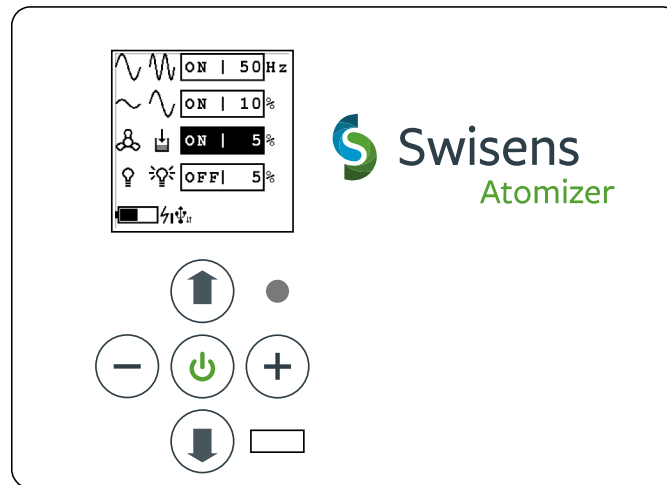
The described approach forms the basis of the SwisensAtomizer. A cuvette to hold some volume of a powder is mounted on an acoustic speaker, which when turned on shakes the cuvette in vertical direction, causing the top layer of particles to become aerosolized inside the cuvette. An integrated blower pumps a faint airflow into the cuvette, which then picks up the airborne particles and transports them out of the cuvette and into the airflow induced by a connected measurement device.

The aerosolization performance can be controlled by three parameters selectable using the controls on the device front:

- **Vibration frequency:** This is the number of shaking cycles per second and measured in Hertz (Hz). A lower frequency typically aerosolizes larger particles, while a higher frequency is used for smaller particles. Values in the order of 50Hz have been found to perform well for particles with a size of a few 10 $\mu$ m, such as pollen. By leveraging resonance effects, it may be possible to aerosolize even badly agglutinated samples.
- **Vibration amplitude:** This is a relative value determining how far the cuvette travels in each vibration cycle. Larger values typically cause more particles to be dispersed, thereby increasing the particle concentration. It is usually a good idea to start with a low value of e.g. 10% and increase it until the desired concentration is reached.
- **Blower speed:** The amount of air blown into the cuvette and in turn picking up particles is determined by the selected blower speed. This value should usually be kept rather low (below 10%), to be able to control the concentration using the vibration amplitude. However, if the sample contains heavy particles, some more airflow may be required to transport them out of the cuvette.

## 4.3. Display and buttons

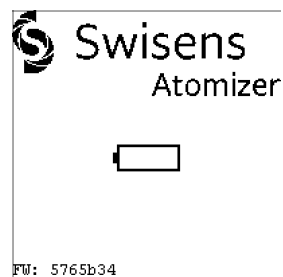
### 4.3.1. Overview




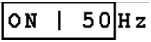

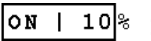





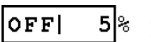
### 4.3.2. Description of indications

Local control of the Atomizer device is provided using a graphical E-Ink display, which provides good readability even in direct sunlight, an LED indicator (green/yellow/red) and five buttons.






When the device is off, the display shows the Swisens logo. In case it turned off automatically due to insufficient battery charge, a battery symbol is also displayed. At the lower border of the display, the revision code of the installed firmware is displayed:



When the device is turned on, the display shows the main process parameters as virtual controls:

-   : Vibration frequency in Hz
-   : Vibration amplitude in %
-    : Blower speed in %, this parameter is currently selected
-    : Cuvette illumination brightness in %

Below these parameters, there is an indicator showing the estimated remaining battery charge, if the device is currently being charged and if it is connected to a USB host. The flash symbol indicates that the battery is currently charging. The length of the vertical bar adjacent to it shows the USB host current limit, which is dependent on the type of port to which the device is connected. The current limit determines the amount of time it takes to recharge the battery. The USB symbol is on if the device is connected to a USB host and the two arrows indicate that a data connection is open. The following codes are available:






-  : Current limit 100mA, recharge time approx. 70h; this only happens if the device is plugged into an unsupported charger or to a USB port of insufficient current capability. It is recommended to use another port or a dedicated charger instead.
-  : Current limit 500mA, recharge time approx. 14h; this is the default for normal USB ports on computers and hubs.
-  : Current limit 1000mA, recharge time approx. 7h; this current is available from dedicated USB chargers and special battery charging ports on some computers.
-  : The device is connected to a USB host, but no data connection (virtual COM port) is currently open.
-  : The device is connected to a USB host and a data connection (virtual COM port) is open.

The LED indicator shows the basic operating status of the device:

- Off: The device is turned off.
- Green: The device is turned on.
- Yellow: The battery is being charged.
- Red: The battery is low and should be recharged.

#### 4.3.3. Description of controls

The device is operated by means of five push buttons:

- : Press to turn the selected function on or off. Keep pressed for 4 seconds to turn the whole device on or off. Keep pressed for at least 10 seconds to perform a reset of the device, in case it becomes unresponsive. When restarting the device this way, all settings are reset to their default values.
-  and : Press to move the selection to the previous or next function, respectively. The currently selected function is highlighted by a black background of the value field.
-  and : Press to change the value of the selected parameter by a single increment. Keep pressed to quickly scroll through the value range.

#### 4.4. USB connection, control software

When the Atomizer is connected to a computer, it registers itself as a virtual serial port (USB CDC ACM), which does not typically require the installation of device driver on the computer. On Windows operating systems, a new serial port (COMx) is created. On Linux operating systems, a device node like `/dev/ttyACMx` is created.

**Note: Do not unplug the Atomizer while the port is opened in some software, as this may cause the device and/or the software to crash.**

#### 4.4.1. Command line interface (CLI)

The virtual serial port provides remote control functionality for the Atomizer. The simplest case is to directly access the provided command line interface (CLI) using terminal software such as Microsoft HyperTerminal or the PuTTY terminal emulator (<https://putty.org/>). Commands are executed when pressing ENTER and a list of all available commands with short usage information can be obtained using the `help` command:

```
> help
Known commands:
atomizer [<param> [<val>] ...]: Gets/sets Atomizer parameters.
help                               : Prints a list of all known commands with
                                   : short usage information.
max17260 <reg> [<val>]           : Gets/sets a MAX17260 register.
msdelay <ms>                     : Busy-waits for <ms> milliseconds.
quit                               :
scriptmode <en>                   : Enables/disables UART script mode.
version                            : Prints firmware version information.
>
```

The most important command is **atomizer**, which provides access to the controls on the Atomizer:

```
> atomizer
spk_en: 1
spk_freq: 50 Hz
spk_amp: 10 %
fan_down_en: 0
fan_down_perc: 5 %
illumination_en: 1
illumination_perc: 5 %
batt_charging: 0
batt_low: 0
batt_perc: 60 %
batt_voltage: 3.3134 V
batt_current: +31.8 mA
inactivity_timeout: 300 s
usb_suspend_en: 1
usb_charging_en: 1
> atomizer illumination_en 0
>
```

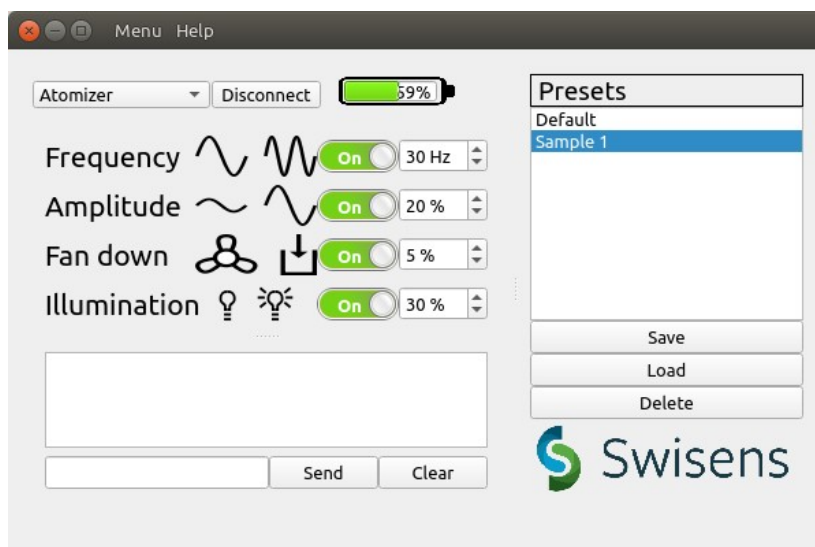
The current settings can be printed by issuing the **atomizer** command without arguments as shown above, or with the name of a setting to print only a single value. Settings can be changed by writing the desired new value (without unit) after the name of the setting as shown above. The following settings are currently available:

Name	Description
spk_en	Speaker (vibration) enable, either 0 (off) or 1 (on).
spk_freq	Speaker (vibration) frequency in Hertz.
spk_amp	Speaker (vibration) amplitude as percentage.
fan_down_en	Cuvette blower enable, either 0 (off) or 1 (on).
fan_down_perc	Cuvette blower speed as percentage.
illumination_en	Cuvette illumination enable, either 0 (off) or 1 (on).
illumination_perc	Cuvette illumination intensity as percentage.
batt_charging	Charging state of the battery, 0 (no charging), 1 (100mA), 2

	(500mA) or 3 (1000mA).
batt_low	1 if the battery is low, 0 otherwise.
batt_perc	Estimated remaining battery charge as percentage.
batt_voltage	Measured battery cell voltage in Volts.
batt_current	Measured battery current in Milliampères; positive values when discharging, negative values when charging.
inactivity_timeout	Time in seconds until the Atomizer turns off when not in use.
usb_suspend_en	USB suspend function enable, either 0 (disabled) or 1 (enabled). This should usually be left at the default 1 for USB compliance.
usb_charging_en	USB charging enable, either 0 (no charging) or 1 (charging possible). This should be left at the default 1 to allow the device to be charged via USB.

#### 4.4.2. Graphical control software

In addition to the built-in command line interface, a graphical control software is also available on request. This software provides the same controls as the Atomizer itself, plus the option to save and restore settings to/from files on the computer. The software is currently at an early stage of development and runs on Linux with Python 3 and the PyQt framework:



The combo box in the upper left corner lists connected Atomizer devices. A connection can be opened using the button adjacent. Next to the button is a display of the remaining Atomizer battery charge.

The main Atomizer settings are shown in the central part of the window, similar to how they are displayed on the integrated display of the Atomizer.

Below the settings is a terminal box, which provides direct access to the Atomizer's CLI (see above). The right part shows the available presets, to save and restore settings for different types of particles. The right and lower parts of the window are separated by splitter controls, which allow their width to be selected or to completely hide them, so that the window only needs little space on the screen.



## 5. Measurement setups

SwisensAtomizer including cover assembly in use with Swisens Poleno airflow cytometer for indoor (left) and outdoor (right) operation.



### **WARNING**

**Outdoor operation only for intermittent use during dry conditions. Swisens Atomizer is not weather-proof.**



## 6. Technical data











### 6.1. Mechanical properties


Dimensions including cover and filter:	155 mm x 265 mm x 145 mm (WxHxD)
Weight including cover and filter:	Approx. -- kg
Temperature range (operational):	0 °C .. 45 °C
Temperature range (storage):	-20 °C .. 45 °C
Vibration frequency range:	10 Hz .. 200 Hz
Pipe compatibility:	OD 40 mm, ID 35mm
Enclosure material:	Aluminium, stainless steel, plastic
Maximum sample volume (cuvette size):	4.5 ml
Contains volatile materials (empty cuvette):	No
Contains liquids:	No

### 6.2. Battery information

Chemistry:	LiFePO <sub>4</sub>
Total voltage:	3.2 V (single cell)
Stored energy (when fully charged):	19.2 Wh
Typical run time on battery:	20 h (depends on settings)
Typical full recharge time:	7 h (using fast charger 1000 mA)

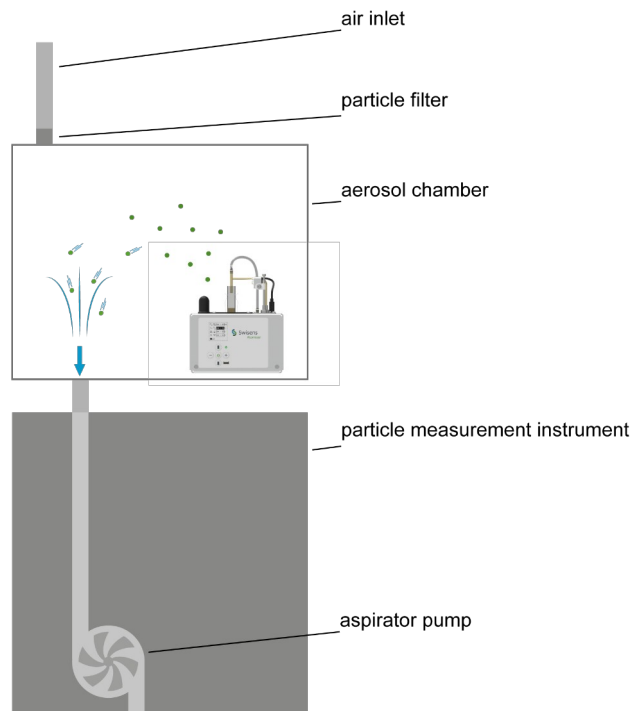
## 7. Troubleshooting

Symptom	Cause(s)	Countermeasure(s)
The device does not turn on when holding the  button.	The battery is low.	Connect the device to a powered USB port. Either leave the Atomizer charging or use it while connected.
The device does not react to any button presses.	The microcontroller software crashed.	Press and hold the  button for at least 10s to reset the microcontroller.
The vibration function can be turned on and off on the display, but no actual vibration occurs on the cuvette.	The vibration amplitude (  <b>ON   10%</b> ) is set too low.	Increase the vibration amplitude (20% or more).
	The Atomizer device is faulty.	Contact Swisens for repair.
The device is very noisy when the vibration is turned on.	The vibration amplitude (  <b>ON   10%</b> ) is set too high.	Decrease the vibration amplitude.
	The vibration frequency (  <b>ON   50Hz</b> ) excites a mechanical resonance of the system.	Change the vibration frequency (lower or higher).
Particles are transported out of the cuvette even if the vibration is turned off.	The air blower speed (  <b>ON   5%</b> ) is set too high.	Decrease the blower speed.
The air blower function can be turned on and off on the display, but no air is blown into the cuvette.	The air blower speed (  <b>ON   5%</b> ) is set too low.	Increase the blower speed (20% or more).
	The silicone tube from the enclosure to the nozzle is not properly connected or broken.	Fix or replace the silicone tube.
	The Atomizer device is faulty.	Contact Swisens for repair.
The illumination function can be turned on and off on the display, but the LED is never lit.	The illumination setting (  <b>OFF   5%</b> ) is too low.	Increase the illumination setting (20% or more).
	The LED cable plug is not properly seated in the jack on the Atomizer enclosure.	Fully insert the plug.
	The Atomizer device is faulty.	Contact Swisens for repair.
The device is plugged to a USB port but does not charge (no yellow LED, no  symbol).	The battery is already fully charged.	No action required.
	The USB port is not powered or the USB cable is bad.	Use another USB port and/or another USB cable.
	The setting <code>usb_charging_en</code> is 0.	Change the setting using the command line interface or reset the device.
The device is plugged to a USB port, but charges only very slowly (symbol  .	The USB port provides insufficient current or a non-compliant charger is used.	Use a self-powered USB hub or a compliant charger.

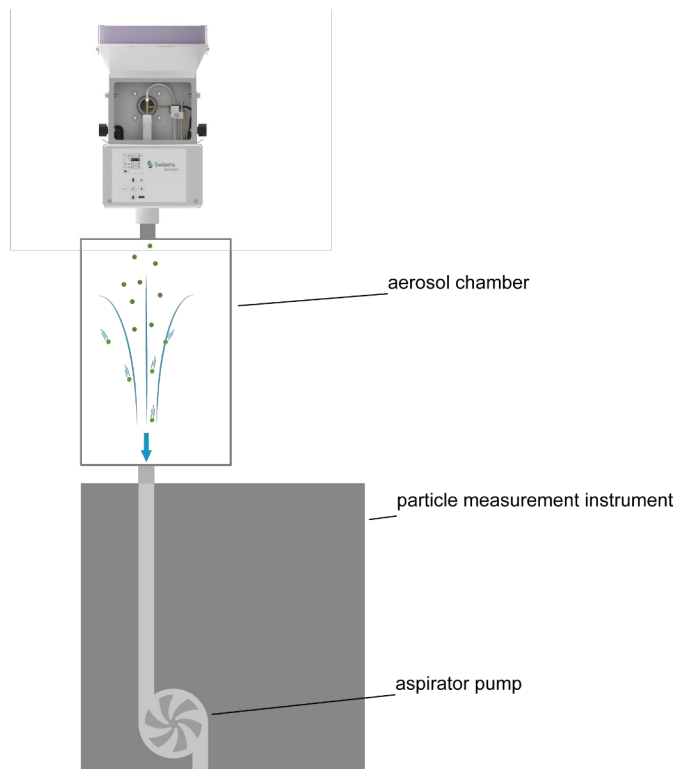
<b>Symptom</b>	<b>Cause(s)</b>	<b>Countermeasure(s)</b>
The device is plugged to a USB port and charges, but no USB connection is established (no  symbol).	The connected USB hub has no upstream connection to a running computer.	Plug the device directly to a running computer or fix the connection to the hub.
	A charger-only type USB cable is used or the cable is bad. <b>NOTE:</b> There are some USB cables around which can be used only for charging, as they do not electrically connect the USB data lines.	Use another cable.

### 8. Appendix

Example of alternatively use



Example of alternatively use



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