Line guard – product manual

Sentrisense - Powering up a greener future

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Warranty and Assistance

Sentrisense AB warrants that the Sentrisense SENTRI will be free from defects in materials and workmanship under normal use and service for a period of five (5) years from the date of shipment, unless specified otherwise. Batteries are not covered under this warranty.

In the event of a defect, Sentrisense sole obligation under this warranty will be to repair or replace (at Sentrisense option) the defective product. The customer shall be responsible for all costs associated with removing, reinstalling, and shipping the defective product to Sentrisense. Sentrisense will return the repaired or replacement product by carrier, the cost of which will be covered by the customer.

This warranty will not apply to any Sentrisense product that has been modified, misused, neglected, damaged by natural disasters, or damaged during shipping. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. Sentrisense is not liable for any special, indirect, incidental, or consequential damages. Products may not be returned without prior authorization. The maximum liability of Sentrisense will be limited to the value of the SENTRI.

For international customers residing in countries served by Sentrisense directly, please contact info@sentrisense.com for a Returned Materials Authorization (RMA) number. For customers in other countries, please visit www.sentrisense.com/distributors to determine the Sentrisense affiliate company that serves your country.

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Revision history

Revision	Date	History
v1.0	08/10/2019	Release version
v1.1	11/06/2019	Update new company image
V1.2	23/06/2020	Update format and instruction for a new SENTRI type
v1.3	01/02/2022	Update with instructions for Sentrisense v2.0
v1.4	26/05/2022	Update with performance information
v1.5	23/09/2022	Changed logos on footer and header
v1.6	20/01/2023	Text improvement
v1.7	25/04/2023	Text fixes and some definitions added

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General and safety information

- Do not attempt to open the SENTRI unless instructed to do so by Sentrisense technical support.
- Avoid contact between electronic parts and steel elements to prevent injuries and burns.
- Never submerge the SENTRI in any liquid.
- Do not remove the battery unless instructed to do so by Sentrisense technical support.
- Refer to the product specifications section for the maximum allowed power voltage and current range, and only use power adapters and batteries that fall within that range. Sentrisense will not be responsible for any malfunctions caused by using the SENTRI with batteries, power supplies, or chargers other than those supplied by Sentrisense.
- Keep the SENTRI within the temperature range specified in the Appendix section.
- Do not connect or power the SENTRI with damaged cables or batteries.
- In case of an electrical failure, immediately disconnect the main switch and any other power supply that is being used.
- Ensure that the frequencies and power levels of the radio communication modules and integrated antennas are appropriate for the location in which the SENTRI will be used.
- Place the SENTRI in an area that is accessible only by maintenance personnel (restricted area).
- In case of any anomaly conditions or disturbances that may affect the SENTRI's performance, the SENTRI will automatically restart to initiate a recalibration and reconfiguration process.
- Keep children away from the SENTRI at all times.

Safety is important, so it's important to follow these instructions carefully to prevent any accidents or damage to the SENTRI. If you have any doubts or questions, please contact Sentrisense technical support.

Product description

Sentrisense is a comprehensive solution for monitoring power lines. It is made up of a cloud-based platform that processes data and uses various calculations and Artificial Intelligence algorithms, as well as a physical SENTRI that is installed on the power line conductors.

Our offering includes a suite of interconnected solutions to enhance the power grid in three key areas: real-time incident detection, predictive maintenance, and power grid optimization:

1. Real-time incident detection enables the maintenance team to quickly and accurately locate failures.

2. Predictive maintenance allows asset managers to schedule replacements for damaged power lines, improving early fault detection capabilities of power line maintenance teams.

3. Power grid optimization improves the capacity of the grid, enabling power line operators to increase energy transmission through the grid using existing infrastructure.

This manual covers all the technical details and operative instructions of the physical SENTRI.

Product Applications

Feature	Use case
Motion detection	• Cable theft detection • Broken or fallen cables detection • Fallen tower detection • Strong winds
Inclination and sag monitoring	• Fallen tree detection (even with or without cable cut). • Tower inclination detection • Bushfire alert
Oscillation frequency monitoring	• Aeolian vibration measurement • Galloping measurement • Corrosion fatigue and aging analysis

SENTRI description

The Sentrisense SENTRI is designed for both ease of installation and ease of use. Its durable metal casing features electromagnetic shielding and is equipped with an industrial-standard clamp for quick and secure mounting on hot power lines or using drones. Two solar panels, located on either side of the SENTRI, are strategically placed to optimize solar radiation in a variety of mounting positions and throughout the day.

The SENTRI is activated by pressing its single button, which also features a built-in LED indicator for displaying various status updates. Additionally, it has two antenna connectors for 4G communication, which must be installed at a 90-degree angle from each other to enhance signal quality.

Picture 1

Each of the elements listed in picture 1 are referred below:

1. Power button

   This is the SENTRI general power button. To turn on the SENTRI, you must press this button, and it will stay in the “pressed” position. To turn it off, you need to press it again.

2. Solar Panel

   The SENTRI uses two solar panels to charge the battery and extend the life of the SENTRI. The panels will constantly charge the battery as long as they have direct sunlight.

   Notes: make sure to remove the protective cover from the two solar panels before installation. keep in mind that the battery charges even with the SENTRI turned off.

3. Cover Screws

   The SENTRI has 4 screws on the cover, which keep the SENTRI closed and protect against the ingress of liquids and dust. DO NOT OPEN unless technical support gives you specific instructions.

4. Snap fast ® Clamp

   Clip This bracket or clamping clip is used to fasten the SENTRI to the power line.

5. Clamp rivets

   The clamp is fastened to the SENTRI by means of rivets that ensure correct fastening to the equipment casing.

6. Venting

   will keep the interior of the SENTRI free of moisture.

7. Antenna Connectors

   The SENTRI ships with two antennas disconnected. DO NOT use unauthorized antennas. DO NOT operate the SENTRI without antennas.

   Later in this manual, there is an explanation on How to connect the antennas.

Built-in Battery

The SENTRI has a cylindrical 18650 Lithium-Ion battery. Unless the manufacturer indicates otherwise, comply with the following indications:

- DO NOT remove the battery.
- DO NOT replace the battery.

In case of having to replace the battery by explicit indication, check the polarity of the battery before connecting.

Picture 2

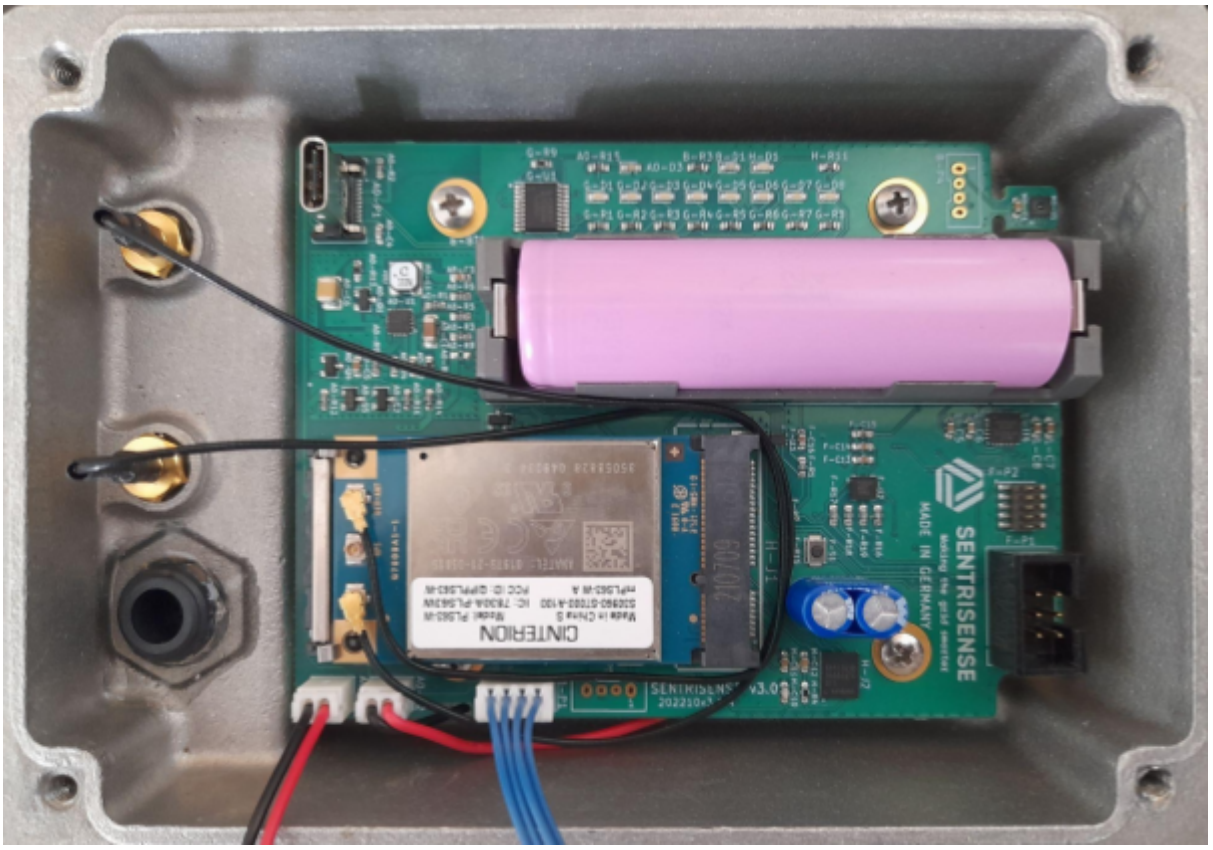
The picture is for illustrative purposes, and some physical characteristics of the battery may differ from those presented in the image. Some batteries do not have their polarity marked. In this case, it is always respected that, as in image 2, the positive corresponds to the side whose upper part is not completely flat. Instead, it has a better diameter girth than the battery body.

Sentrisense recommends a 18650 3.6V 3400mAh (flat top) lithium battery. Brands such as Panasonic, LG, Sony are good. The ideal battery is Panasonic NCR18650B 3.6V 3400mAh (flat top). Please avoid buying generic brands because it can affect the SENTRI's performance.

For freezing weather, we recommend Nitecore NL1829RLTP 2900mAh USB Rechargeable 18650 Battery, Low Temperature & High Performance.

Internal view

Internal view of the SENTRI and identification



Picture 3

Picture 3 shows the complete interior of the SENTRI, with the main board and its corresponding battery holder. As well as the antenna connectors and other elements of the SENTRI.

Unique SENTRI ID

Picture 4

Each SENTRI has a label that indicates its ID or unique identifier along with a code that redirects to a quick guide to use the SENTRI, on the outside and inside of it, as seen in the picture.

Picture 5

In the part indicated by the red box in picture 5, the type of SENTRI and its version can be identified, in this example SENTRISENSE v3.0

Technical specs

Electrical characteristics

Characteristics	Value or condition
Power supply	Powered by solar energy
Battery Type and shape	Lithium-Ion cylindrical 18650
Battery nominal voltage	3.7 V
Battery nominal capacity (recommended)	3500 mAh
Power consumption	The SENTRI can consume as low as 45 µA while in sleep mode. Note: Sleep mode time depends on the SENTRI configuration and the kind of measurements it is performing.
SENTRI autonomy	The SENTRI runs using solar energy from its solar panels. In the event of limited sunlight, the SENTRI also has a rechargeable battery as a backup power source. When fully charged, the battery can provide enough energy to operate the SENTRI for up to eight months. The estimated battery life (the overall lifespan of the battery) is more than 10 years.

Special SENTRI features

Feature	Value or condition
Upgrading capability (Firmware over the air)	The SENTRI is fully upgradeable remotely. Meaning it can receive software updates while installed in the line, for improving its capabilities.
Voltage rating	0 V to 330 kV
Vibration detection range	3 Hz - 150 Hz
Reporting alerts	Generated by SMS or email.
Certifications and lab tests	The SENTRI is tested under: • IEC 61284 Ed.2:1997, CISPR TR 18-2 Ed.3.0:2017. Measured value of the corona extinction voltage phase-to-earth corresponds to a phase-to-phase voltage of 284 kV • Windtunnel test according to FNN Standards • UV radiation test - Accelerated aging - according to PN-EN ISO 4892-2:2013-06 • Environmental test - Change of temperature - According to PN-EN 60068-2-14:2009 • Environmental test - Corrosion resistance - According to PN-EN ISO 9227:2017-06

	• Environmental test - Resistance to humidity - According to PN-EN ISO 3270-2:2018-02 • Environmental test - Cold resistance - According to PN-EN 60068-2-1:2009 • Environmental test - Heat cycle - According to PN-EN 60068-2-30:2008
System security	Encrypted communication at SENTRI level and SSL for the web platform and API interface.
Integration with existing 3rd systems	Yes, through an API (e.g. SCADA).
SENTRIs per conductor per kilometer	Depending on the line characteristics, generally one SENTRI per kilometer per line.
Hardware version	Sentrisense v3.0

Connectivity capabilities

Type of networks	Supported bands
4G	Twelve Bands FDD-LTE: 700, 800, 850, 900, 1700/2100 (AWS), 1800, 1900, 2100, 2600 MHz (bands 1, 2, 3, 4, 5, 7, 8, 12, 18, 19,20, 28)
3G	Seven Bands UMTS (WCDMA/FDD): 800, 850, 900, 1700/2100 (AWS), 1800, 1900 and 2100 MHz (bands 1, 2, 4, 5, 8, 9, 19)
2G	Quad Band GSM: 850, 900, 1800 and 1900 MHz
WiFi	IEEE 802.11 b/g/n-compliant

Sensing capabilities

Type	Function
Gyroscope	The SENTRI is able to perform various types of analysis by measuring the angular position of the SENTRI, such as detecting tilting alerts and identifying abnormal installation positions.
Accelerometer	The SENTRI uses the measurement of acceleration to detect various types of motion events, as well as to measure oscillation frequency which is crucial for analyzing the behavior of the power line.
Temperature sensor (for internal SENTRI use only)	The SENTRI monitors its internal temperature to protect the battery from overheating and maximizing its lifetime.

Physical and environmental characteristics

Characteristic	Values and ranges
SENTRI dimensions	• 100 mm x 165 mm (3.9 in x 6.5 in) • 100 mm x 255 mm (3.9 in x 9.5 in) (with the clamp installed)
Weight	Aprox. 1 kg
Operating temperature	-20 to +60 °C Note 1: To avoid any damage to the battery or risk of explosion, if the internal temperature of the SENTRI goes above 45°C, the SENTRI will stop the battery charging process. Note 2: The SENTRI might work over 60°C but the nominal performance for the battery is not guaranteed
Operating wind condition	Up to 200 km/h
Environmental and electrical condition of operation	• Fully weatherproof • Corona-free operation through 284 kV rated voltage. Functional up to 330kV
Mounting method	• Energized (hot stick) • De-energized • Suitable for bundled conductor applications • Suitable for drone installation
Mounting time	Sentrisense can be install in up to 2 minutes
Cable diameter compatibility	• Cable size 4–70 mm (0.16–2.75 in.)
SENTRI material	• Metal (aluminum) case • Plastic clamp
SENTRI lifespan	At least 10 years
SENTRI warranty	5 years for manufacturing defects

Preparation and installation of the SENTRI

Connecting the antennas

The SENTRI uses two antennas, which are necessary for establishing communication with the cloud platform, to send data and receive settings.

Picture 6

Step 1: Place the antenna on the connector.

Step 2: Rotate the antenna clockwise.

The antennas are articulated, so they can be oriented after being adjusted. In any case, it is recommended that they be folded at 90°, as antenna “2” in picture 6 is positioned.

Turning on the SENTRI

Picture 7

Turn on sequence, calibration and expected behavior

a. Turn on the equipment by pressing the power button.

b. After 2 seconds, the button's LED will start blinking for 15 seconds, accompanied by the buzzer.

**Note: If you were prompted to open the SENTRI and press the internal button on the board during this sequence, the SENTRI would be factory reset.*

c. The button's LED will then start to flash rapidly, trying to connect to the network (this may take about 1 minute depending on the signal in your location).

   *Note: If the SENTRI is downloading a firmware update, the SENTRI will be with the led turned off while downloading (this may take from 5 to 10 minutes depending on the signal in your location), when the download is complete the SENTRI will automatically reboot, returning to the step b and continue with normal behavior.

d. The LED will start blinking again while the SENTRI configures itself automatically for approximately 2 minutes, once the configuration is complete, a sequence of 5 beeps will be heard (3 short beeps followed by 2 long beeps) if successful and a sequence of 3 long beeps if the configuration fails. If the configuration fails, it's recommended to reboot the SENTRI and check for any connectivity issues.

e. When the configuration is done the SENTRI will remain in stand by for 10 seconds before entering in IMU's Calibration mode (It is not recommended to enter calibration mode unless prompted). After these 10 seconds a sequence of 4 beeps will be heard and the SENTRI will wait 30 seconds to enter the calibration mode (to skip this mode, simply wait without moving the SENTRI). After that, a sequence of 9 beeps will be heard indicating that the SENTRI is ready to use.

f. Once all of the above has happened, you can confirm that the SENTRI is sending data to the dashboard.

In-line installation

Identify the SENTRI

Before installing the SENTRI, write down the SENTRI ID shown below and the coordinates of the place where it will be installed, this will be needed for the web platform.

Picture 8

Installation procedure

To install these SENTRIs a multi-installation tool is used as explained below:

Step 1: attach the multi-installation tool to the hotstick.

Picture 9

Step 2: Open the clamp.

Picture 10

Step 3: Attach the clamp to the multi-installation tool.

Picture 11

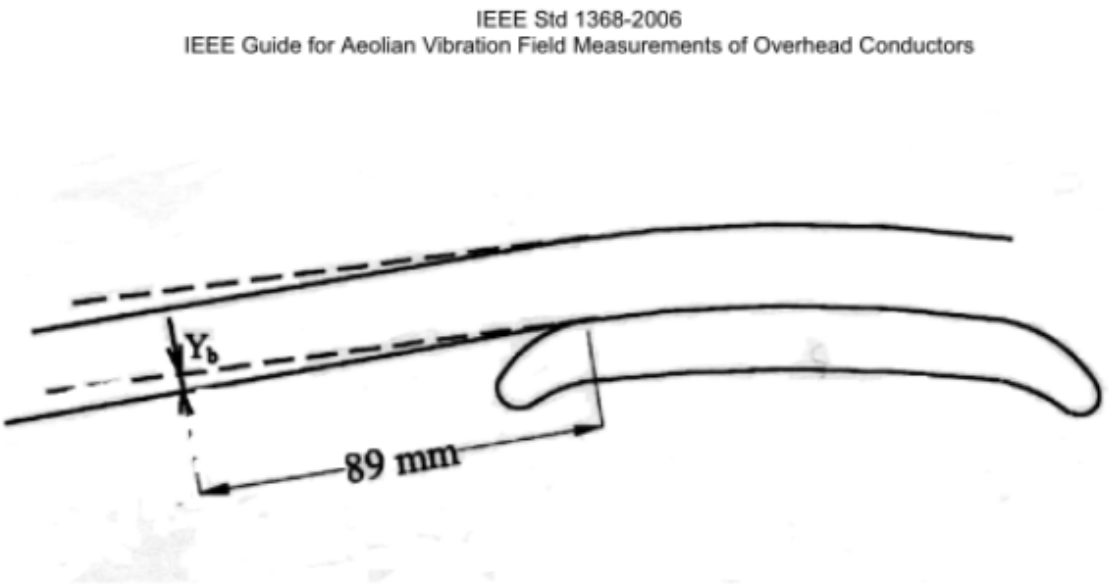
Paso 4: Lift the pole with the tool and press the clamp on the high voltage line, this will cause the clamp to close due to pressure against the conductor.

Picture 12

The installation process should look like this:

Picture 13

According to IEEE Guide for Aeolian Vibration Field Measurements of Overhead Conductors, standard 1368-2006, the distance from clamp and conductor contact to measurement point should be 89 mm (3.5 in).

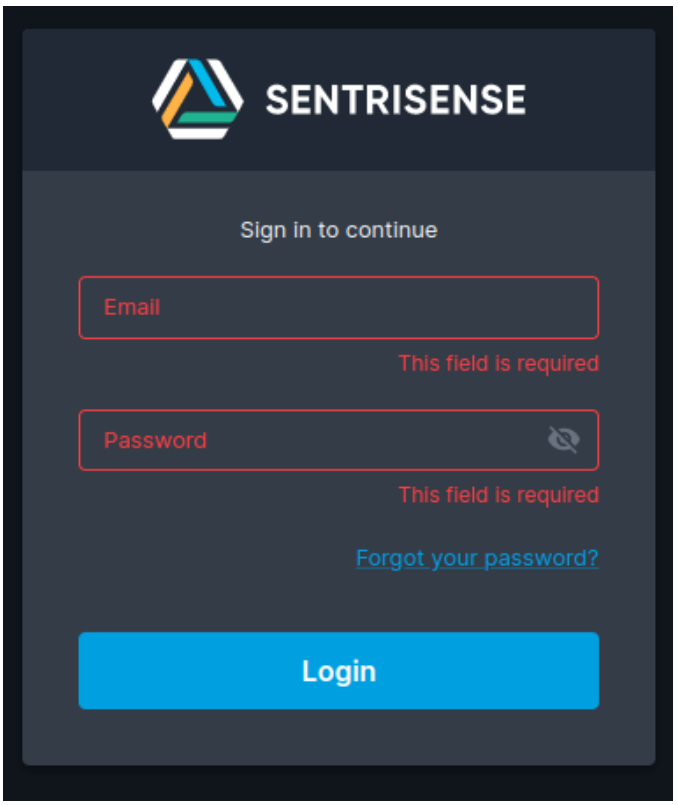


Picture 14: Distance from clamp and conductor contact to Yb measurement point

Dashboard

Web Platform

1. The link to the platform is Sentrisense - Dashboard
2. Login



Picture 15

The login page is made up of the following:

1. Email Field:
   In this field you have to enter the registered email to be used on the platform.

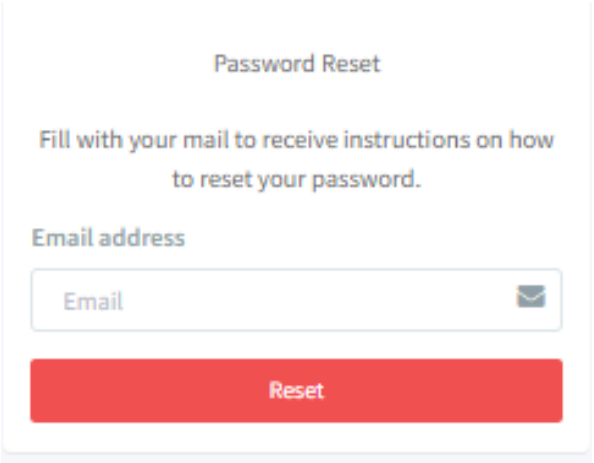
2. Password field:
   Enter the password to login.

3. “Forgot your password?”
   This button instructs you to reset your password if you forget it.

4. “Login”
   Once the required fields have been completed, sign in.

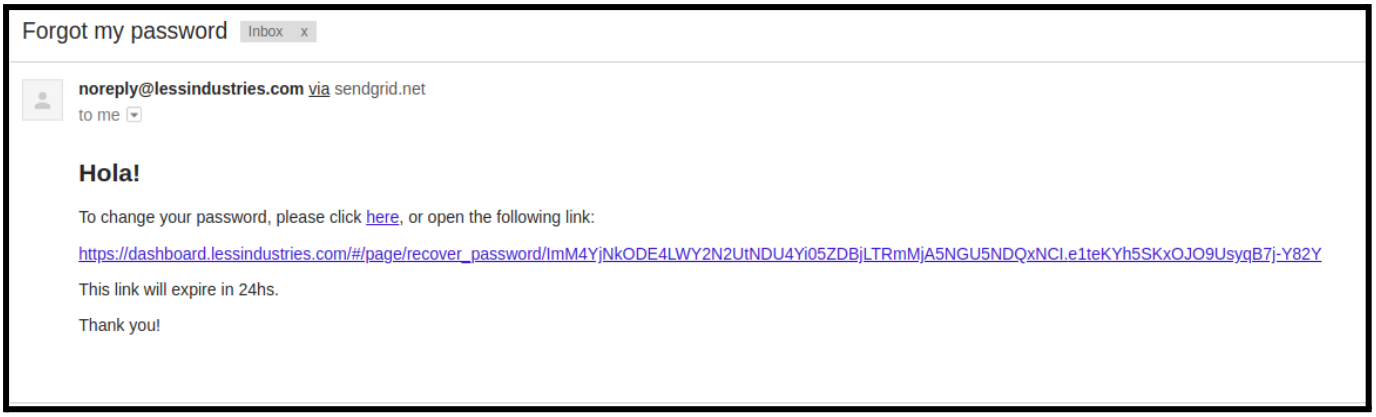
Reset password

If you forget your password, you can reset it using the “Forgot your password?” button.



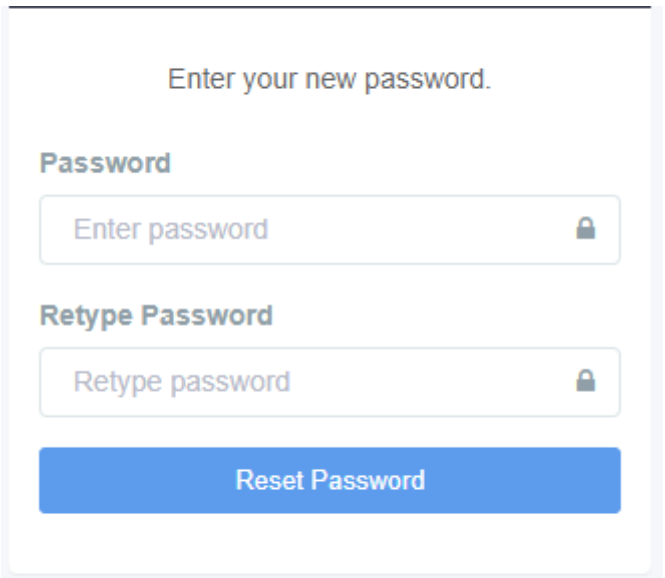
Picture 16

By filling the email field, you will receive an email with a link to reset your password.



Picture 17

By entering the link in the email, you must choose a new password and enter it in the following fields.

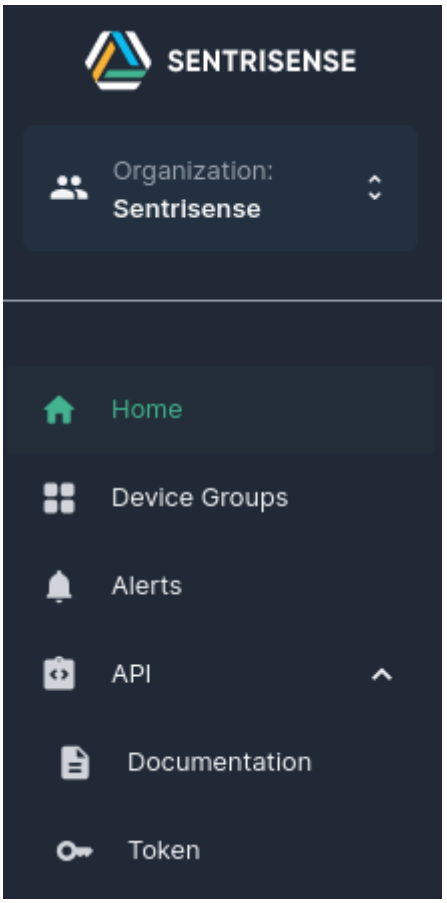


Picture 18

Create new user

To create a user that has access to the organization, follow these steps:

1. Go to the organization section on the left sidebar of the page.

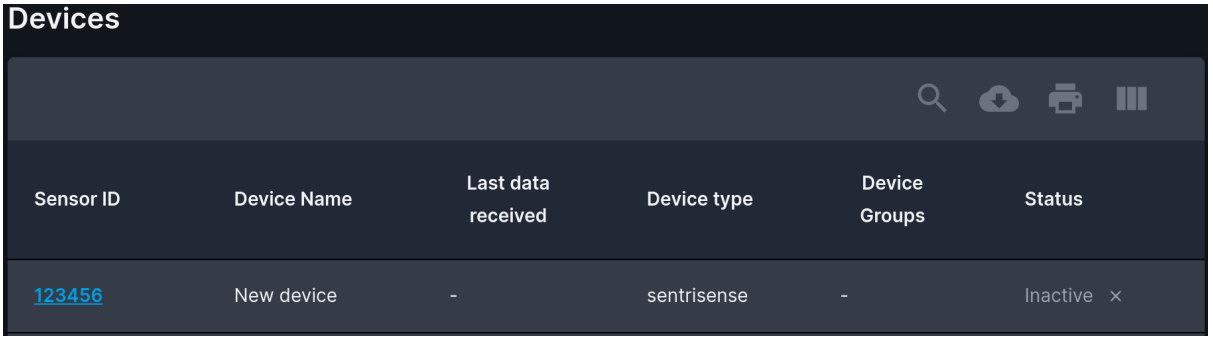


Picture 19

2. Select the organization.
3. Click on “Create new user”
4. Type the new user email address

Add GPS location

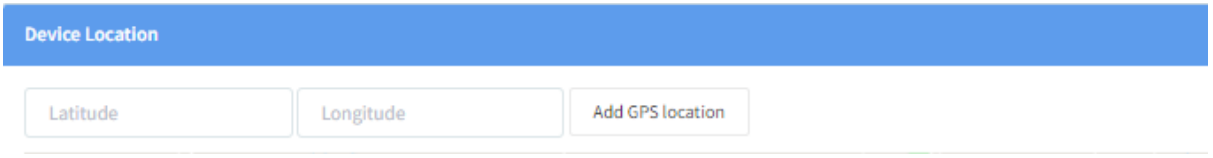
With in the organization, select the SENTRI you wanted to update location data and click on the id.



Picture 20

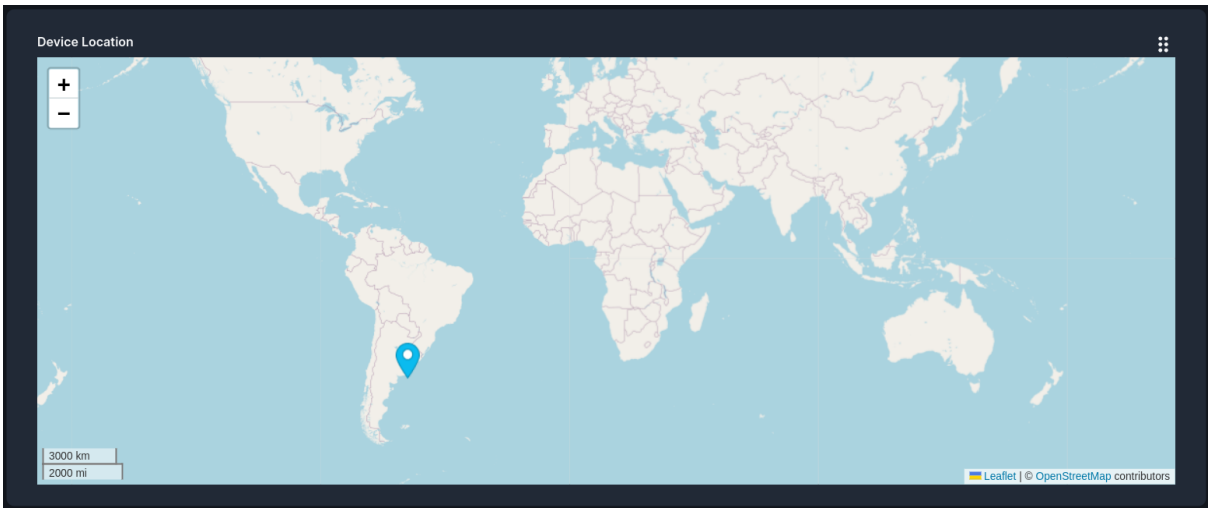
Fill the GPS coordinates fields

Find the location you want on google maps and copy the coordinates to paste them in the necessary fields indicated in the image, when the coordinates are loaded click on "add GPS location".



Picture 21

If you did it correctly, you should be able to see the location on the dashboard



Picture 22

How to read data on the dashboard

Data tables will appear on the web platform with the data sent by the SENTRI:

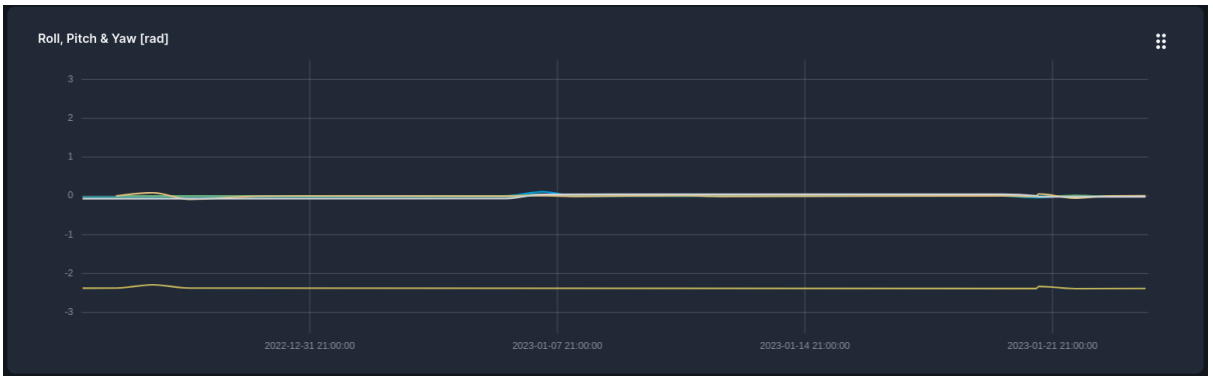
Note: in the board the tables can be dragged and moved around the page for convenience to the user to see the most important data first with the drag icon in the top-right corner of each table, clicking this icon and dragging the table will move the table to wherever the user wants.

The following charts will appear in the “information” tab of the SENTRI.

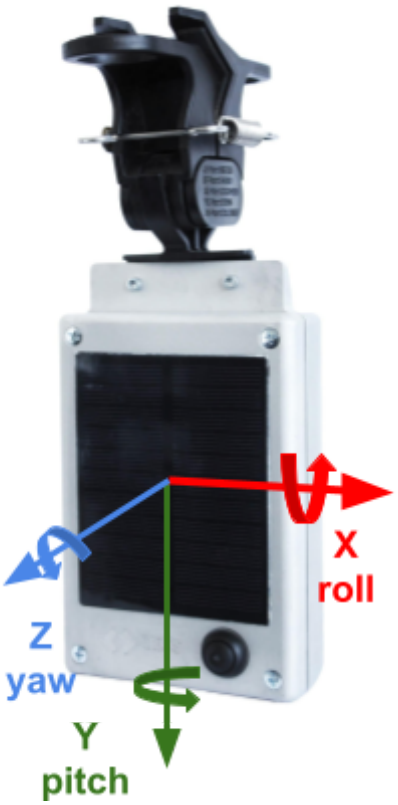
Data entries: Number of times the SENTRI has sent data.
First message: Date of the first message sent by the SENTRI.
Last message: Date of the last message sent by the SENTRI.
Count: Number of resets of the SENTRI.

Picture 23

Roll, Pitch and Yaw: the 3 axis of rotation of the SENTRI.

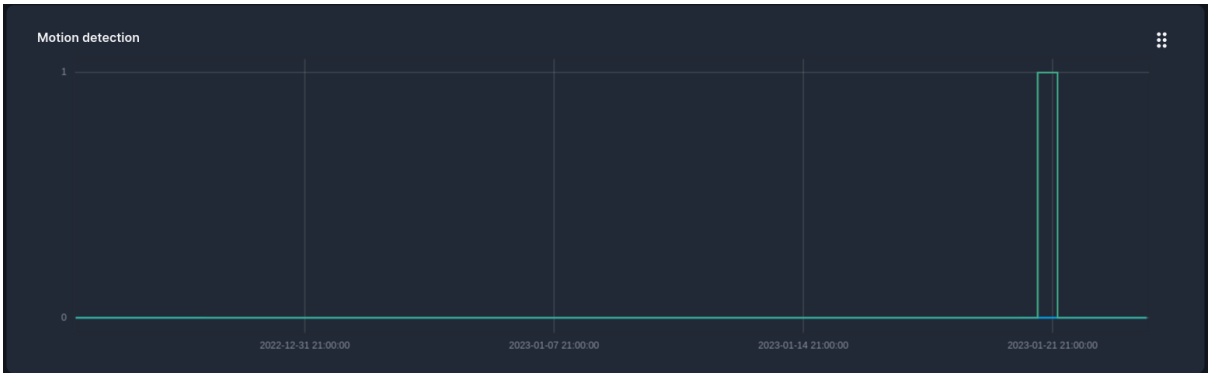


Picture 24



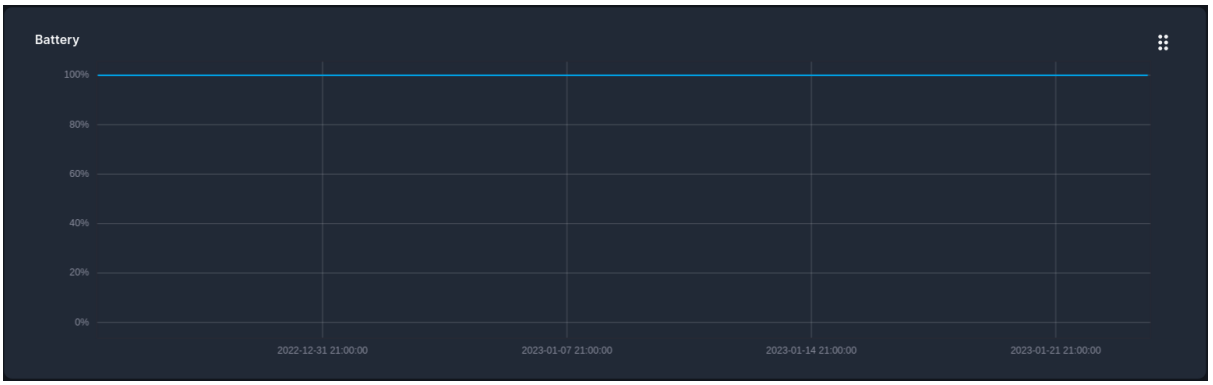
Picture 25

Motion detection: Shows if there has been any movement over the time.



Picture 26

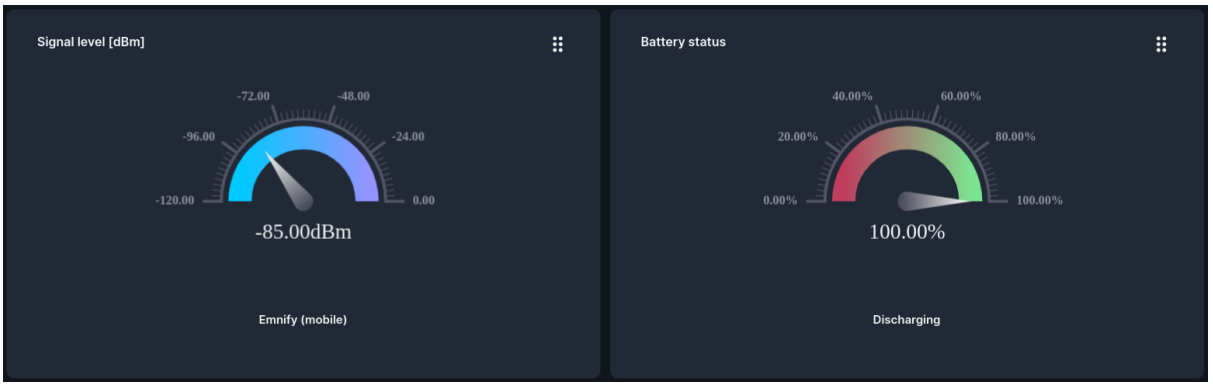
Battery: Battery over time.



Picture 27

Signal level: Shows the actual signal level of the SENTRI.

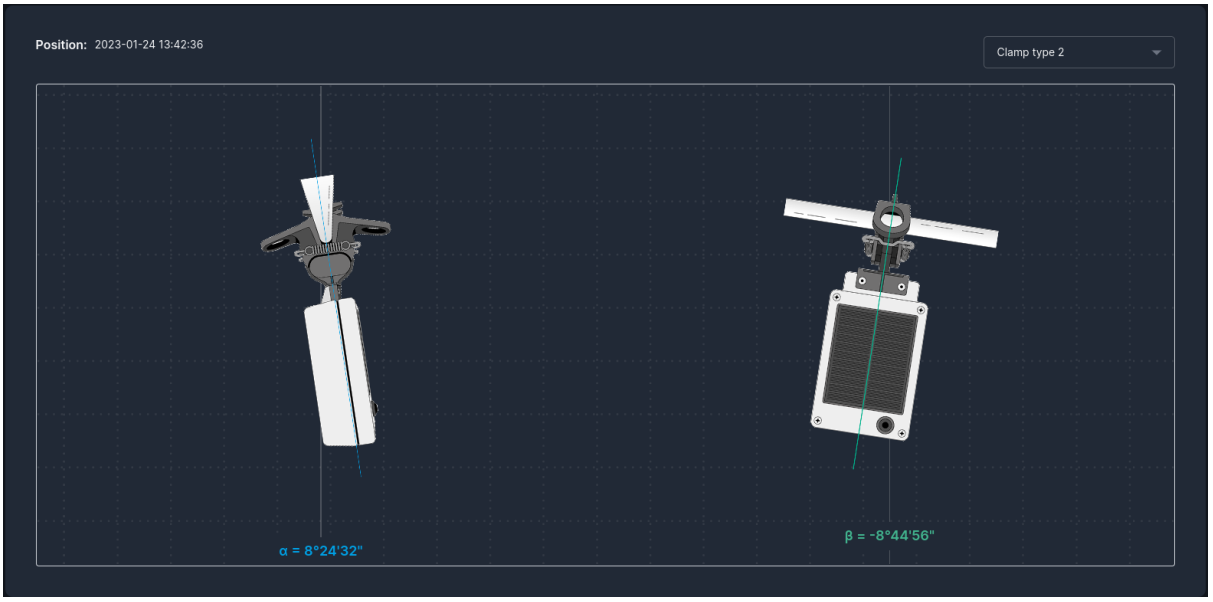
Battery status: Shows the actual battery status of the SENTRI.



Picture 28

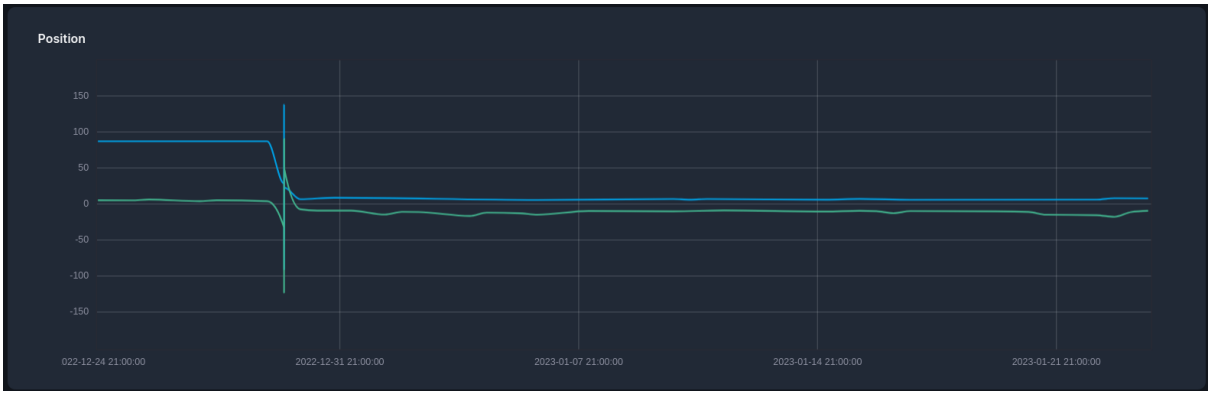
The following illustration and chart will appear in the “position” tab of the SENTRI.

Position: This table will show the position of the SENTRI at the moment of the last message



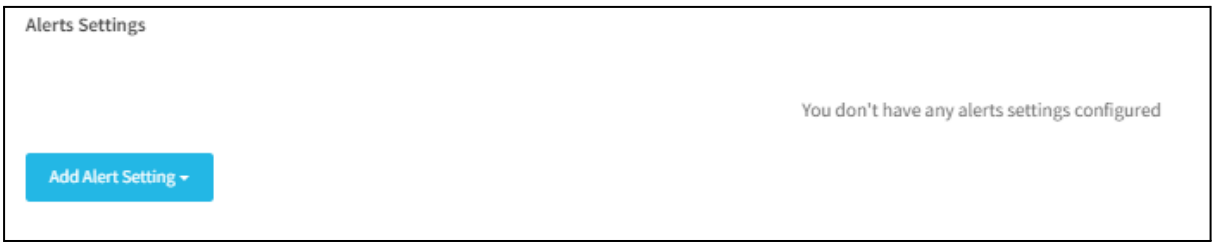
Picture 29

Position graph: Shows the alpha and beta angles over the time.



Picture 30

Alerts configuration



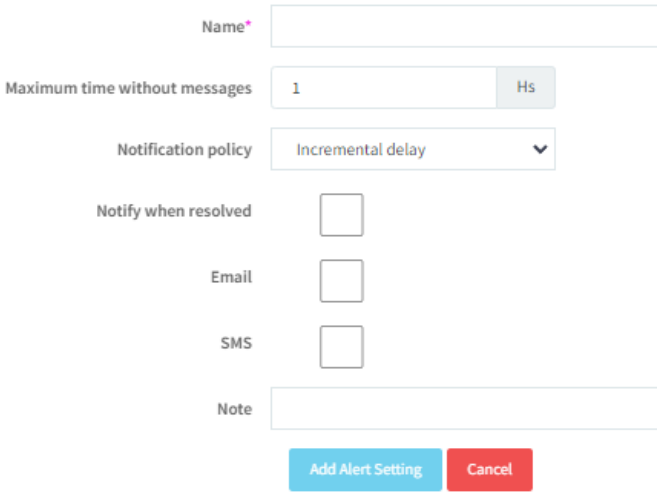
Picture 31

You can add an alert by clicking the “add alert setting” button and a menu will open

Picture 32

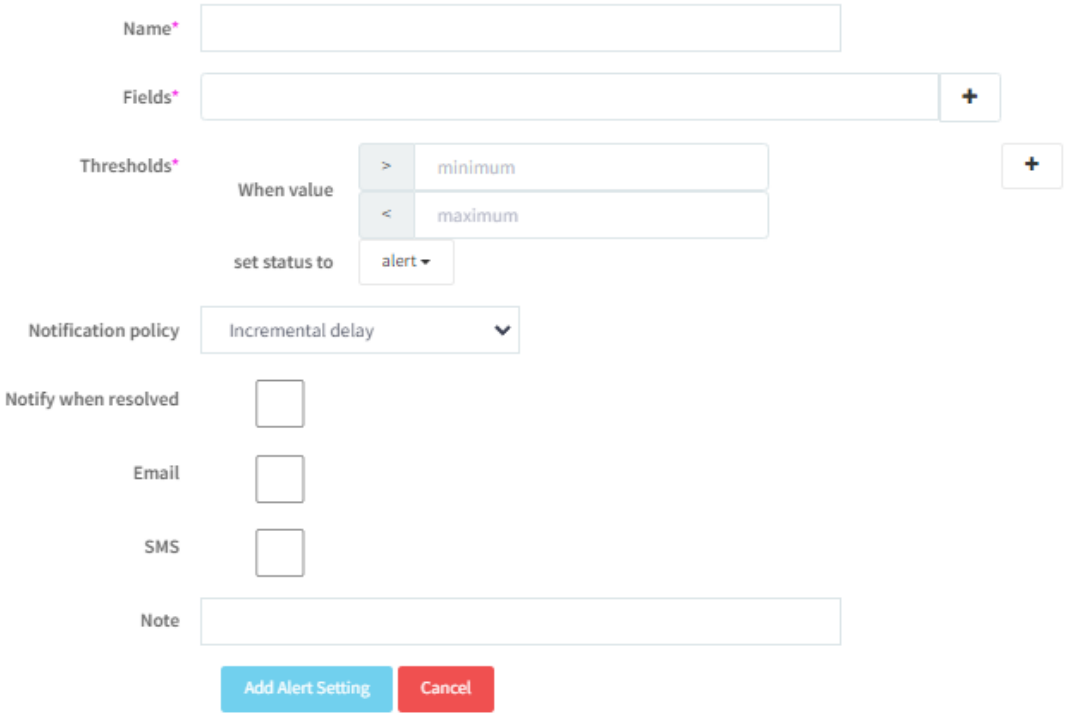
Each alert has its own set of options and can be received by email, also these have a custom name and a “note” field for custom annotations. Also every alert has the option to select the notification policy, which allows to select the delay and behavior between alert and alert.

- Silence: this alert can be used when the user wants to know when a SENTRI has been inactive for a certain time.



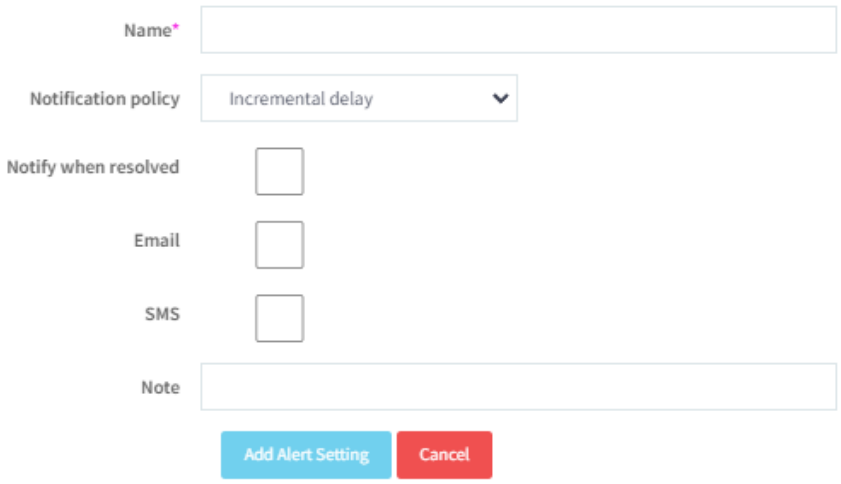
Picture 33

- Threshold: This alert can be used to determinate the parameters of any data that the SENTRI sends, for example in the field “fields” if you want to have a battery status alert you can fill it with “power.battery.level” and define the minimum and the maximum values to receive an alert when the battery level exceeds the parameters.



Picture 34

Sentrisense movement: this will send the user an alert when the SENTRI detects unusual movement



Picture 35

Appendix

Specifications and operating ranges

Battery Characteristics

- 18650 Li-Ion cell, 3.7 V, 2200mAh or larger (recommended 3000mAh)
- Operating temperature range: -10°C to 60°C
- Charging temperature range: 0°C to 45°C

Note: Do not remove or replace the battery unless directed by the manufacturer. Do not use batteries other than those recommended.

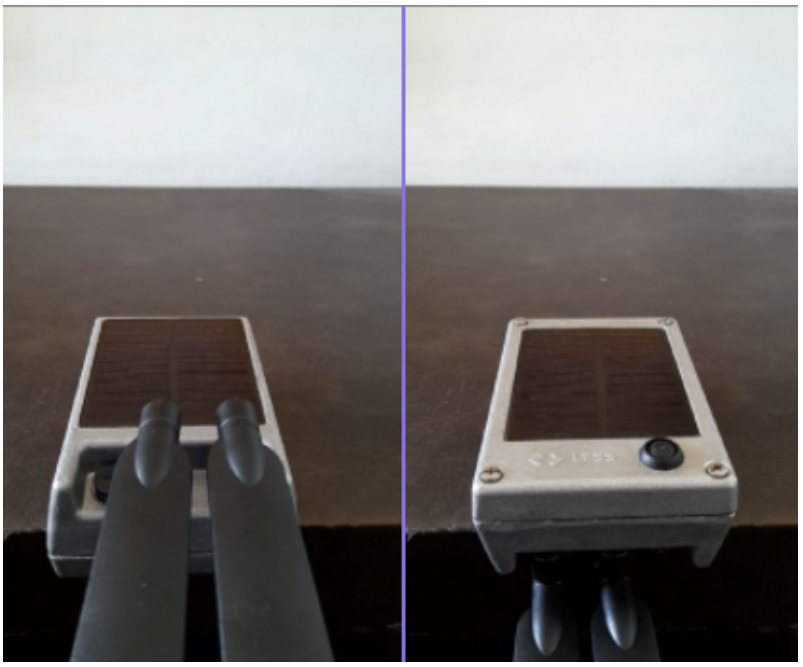
Charging voltage

- SENTRI charging voltage range: 5 V

In case you need to charge the SENTRI battery through an external charger, you must use a standard market's charger with a USB-C interface, as it is used for charging cell phones and other mobile SENTRIs.

Calibration mode

To enter the calibration mode, the SENTRI must be flipped 180° as shown in the image below and wait a few seconds. If the calibration was successful a final sequence of 9 beeps will be heard.



Picture 36