Sphensor™

User manual

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Revisions list

Issue	*Date*	*Description of changes*
Origin	10/11/2020	
1 (A)	31/05/2022	Update with new devices
2	21/12/2023	Update with new repeaters and gateways

Notes on this manual

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LSI LASTEM reserves the right to intervene on the product, without the obligation to promptly update this document.

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1 Introduction

Sphensor is the line of sensors produced by LSI LASTEM for monitoring environmental parameters and air quality control in indoor environments.

The sensors, either battery operated or powered by a USB socket, have low power consumption, transmit the measurements via radio to one or more devices called *Sphensor Gateway*.

Sphensor Gateway sends the received values to *LSI LASTEM Cloud Service* or to an *MQTT broker*, either within the company network or reachable from outside via the Internet. Sphensor Gateway communicates over the network via LAN network connection (Ethernet) or via Wi-Fi radio or 3G/4G mobile phone.

The Sphensor line is completed by repeaters, to be used where the sensor radio signal does not reach Sphensor Gateway due to obstacles or long distances between the devices.

In Fig. 1 a typical example of a Sphensor sensor network.

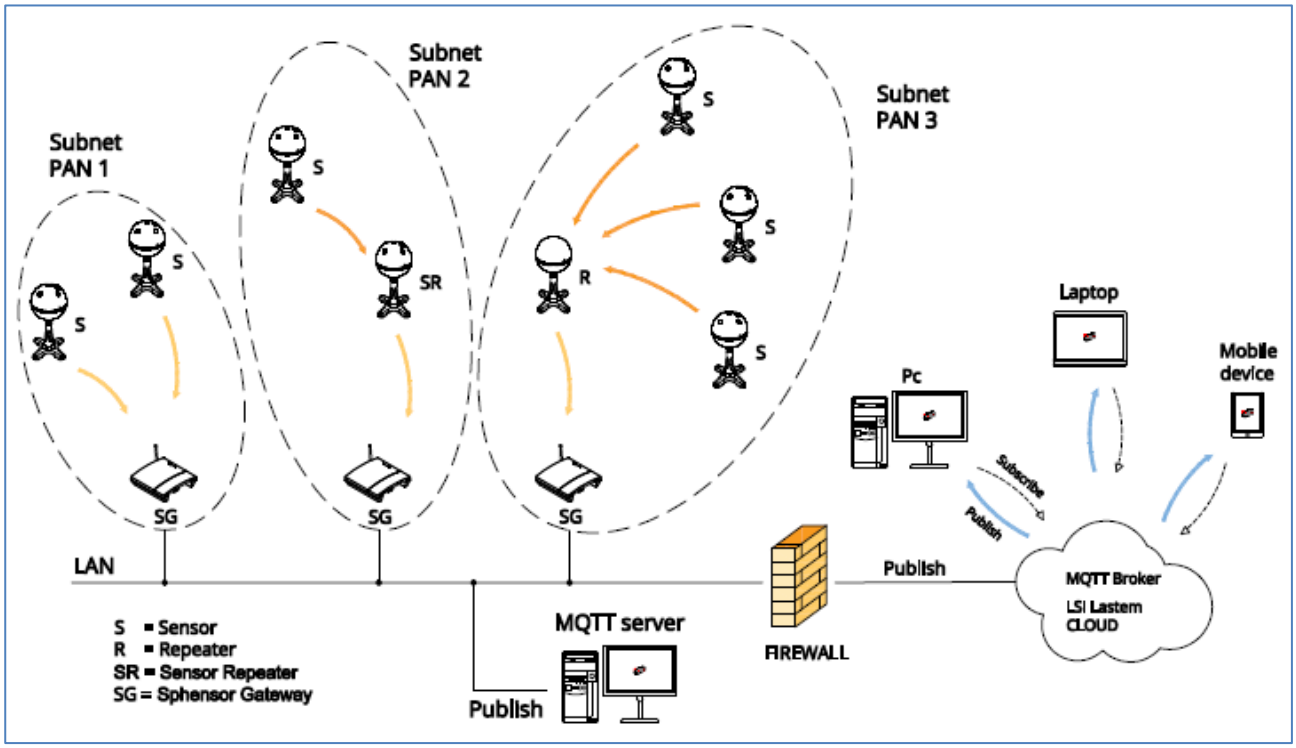


Fig. 1 – Sphensor network generic scheme.

The peculiar characteristics that characterize and distinguish Sphensor from other similar solutions are:

- **Quality of measurements** to the highest market standards.
- An entire family of multi-parameter sensors with an **innovative design** for the best placement in the environment.
- Integration of different sizes within a single **body of reduced size**.
- *Thread* protocol: allows the creation of an **interconnected network of sensors** with high extension and flexibility of geometry.
- Extension of radio range through the use of signal **repeaters**.
- **Flexible installation** thanks to a wide variety of mechanical supports.
- Measured data displayed directly on **cloud software**.
- **Local diagnostics** via multicolored led crown.

- High battery operating **autonomy**. Additional power supply via standard micro-USB socket.
- Three levels of **data recording**: locally to the sensor, in the Sphensor Gateway and in the server with "store and forward" function.
- **Additional inputs** available for connection to external sensors.
- Automatic calculation of **derived quantities**.

Sphensor Gateway is equipped with the following innovative features:

- Possibility of **connection** via Ethernet LAN and, via accessory, 3G/4G modem or Wi-Fi.
- **Power supply** via standard mini-USB socket and integrated back up battery.
- **Programming** functions via software on PC.
- **Open architecture** for easy integration into third-party systems, through data transmission in market format and standard protocols (MQTT, JSON).
- Additional Sphensor Gateways with **back-up** functions can be installed.

1.1 Models

In Tab. 1 are listed the available sizes in the various sensor models of the Sphensor line

Sensor code	Air temp.	Rel. Hu-mid.	Atm. press.	Illum.	UV-A	Out side temp.	Out side analog sig.	Air speed	Partic-ulate mat-ter	VOC	CO_2	CO
PRMPB0401	√	√	√									
PRMPB0402	√	√	√	√ (x5)								
PRMPB0403	√	√	√	√ (x5)	√							
PRMPB0404	√	√	√			√ (x2)						
PRMPB0405	√	√	√				√ (x2)					
PRMPB0406	√	√	√			√	√					
PRMPA0421									√			
PRMPA0422										√	√	
PRMPA0423	√*		√*						√	√	√	
PRMPA0424										√		√

Tab. 1 – Available measurements per sensor model.

* measurements related to the sensor cell.

The type of power supply is indicated in Tab. 2.

Sensor code	Rechargeable battery	Non-rechargeable battery (low power sensor**)	External power supply
PRMPB0401		√	
PRMPB0402		√	
PRMPB0403		√	
PRMPB0404		√	
PRMPB0405		√	
PRMPB0406		√	
PRMPA0421	√		√
PRMPA0422	√		√
PRMPA0423	√		√
PRMPA0424	√		√
PRMPA0441		√	√
PRMPA0442	√		√

Tab. 2 – Power supply available for sensor model.

** even low-power sensors, if powered by power supply, can operate in standard mode (not low-power), after appropriate configuration (see §5.1).

Other devices of the Sphensor line are the repeaters and Sphensor Gateways as per Tab. 3.

Code	Description
TXMRB1100	Indoor radio Thread repeater; power supply from 85÷250 V AC mains socket
TXRGB1001	Sphensor Gateway for Thread network Rev. B
TXRGB1101	Sphensor Gateway for Thread network (2.4 GHz) and CISS Network (868 MHz)
TXRGC1001	Sphensor Gateway for Thread network with RPI4

Tab. 3 – Repeaters and Sphensor Gateway.

1.2 Operating limitations

In the realization of the Sphensor sensor network it is necessary to keep in mind some limitations regarding sensors of the "low power" type (indicated in Tab. 2). In this case:

- Sphensor Gateway is able to accept direct connection up to 32 sensors. If there are multiple sensors, repeaters or sensors with a repetition function shall be used.
- The Repeater can accept up to 10 sensors. If there are multiple sensors, other repeaters or sensors with a repetition function shall be used.

2 Safety requirements

Read the following general safety rules to avoid personal injury and prevent damage to the product or any other products related to it. To avoid possible damage, use this product only in the way it is specified.

2.1 General requirements

Only qualified service staff shall be authorized to carry out installation and maintenance procedures.

Install the tool in a clean, dry and safe place. Humidity, dust and extreme temperatures tend to deteriorate or damage the instrument. In such environments it's recommended to install inside suitable containers.

Power the instrument appropriately. Respect the supply voltages indicated for the instrument model owned.

Make the connections appropriately. Carefully follow the connection schemes provided with the instrumentation.

Do not use the product if you suspect the presence of malfunctions. If a malfunction is suspected, do not power the instrument and ask for the intervention of qualified service staff.

Before any operation on electrical connections, power, sensors and communication equipment:

- Turn off the power.
- Discharge the accumulated electrostatic charges by touching a conductor or a grounded system.

Do not operate the product in presence of water or moisture.

Do not operate the product in an explosive atmosphere.

Lithium-ion battery inside. Replacing the battery with an incorrect type can cause risk of explosion.

For more information about safety regulations, please refer to manual INSTUM_05290.

3 Getting started

At the factory exit, all Sphensor line devices use a default configuration: they communicate on the same radio network (*Channel* = 17, *PanId* = 0xDEFA, *Key* = 0x751751. *NetworkId* = 0xDEFA0170) and the sensors transmit the measurement data to Sphensor Gateway every 3 minutes. Typically, in basic installations, where the system consists of a single Sphensor Gateway and some sensors, the default configurations are suitable for the proper functioning of the system. In more complex installations, consisting of multiple Sphensor Gateways and different sensors and repeaters, it is necessary to change the configurations.

Sphensor Manager is the software for configuring Sphensor equipment and verifying data reception. For its working it is necessary that the PC on which it is installed and the Sphensor Gateway are on the same network and that the DHCP service is active in the network.

3.1 Installing the Sphensor Manager software on the PC

The Sphensor Manager software is installed using the LSI WEB Installer program, which can be downloaded from the www.lsi-lastem.com.

To install LSI WEB Installer proceed as follows:

1. Download the ZIP file from the Download section of the website www.lsi-lastem.com.
2. Unzip the ZIP file into a temporary folder on your PC (eg c:\temp).
3. Go to the temporary folder and double-click the *Setup.xx.xx.xx.xx_en.exe* file to start the installation.
4. Follow the instructions indicated until the installation is complete.

For the installation of Sphensor Manager:

1. If not already started, start LSI WEB Installer.
2. Select Sphensor Manager and select [Install].
3. Follow the instructions indicated until the installation is complete.

On this topic watch the video tutorial

Sphensor #1 - Sphensor Manager Program Installation

3.2 Sphensor Gateway installation

The Sphensor Manager software needs to communicate with the Sphensor Gateway to display Sphensor sensor data. For commissioning proceed as follows:

1. Screw the 2.4 GHz stylus antenna into the SMA connector(6) at the front of the Sphensor Gateway and position it vertically relative to the device.
   The TXRGB1101 model has a second 869 MHz antenna identifiable by a red O-ring. Screw it into the SMA connector(7) and also position it vertically relative to the device.
2. Connect the supplied power supply to the USB-C port(5) and the power outlet.
3. Plug the LAN cable into the Ethernet port(2) and the network pin (or a modem/router port).
4. Turn on the Sphensor Gateway via the On/Off switch(4) and the switch on the cable, check that the *USB pwr* and *On* LEDs are switched on and, after about one minute, the Active LED is switched on.

The USB port(1) can be used to power a sensor installed close the Sphensor Gateway.

Wait for the Sphensor Gateway to be detected by the Sphensor Manager software.

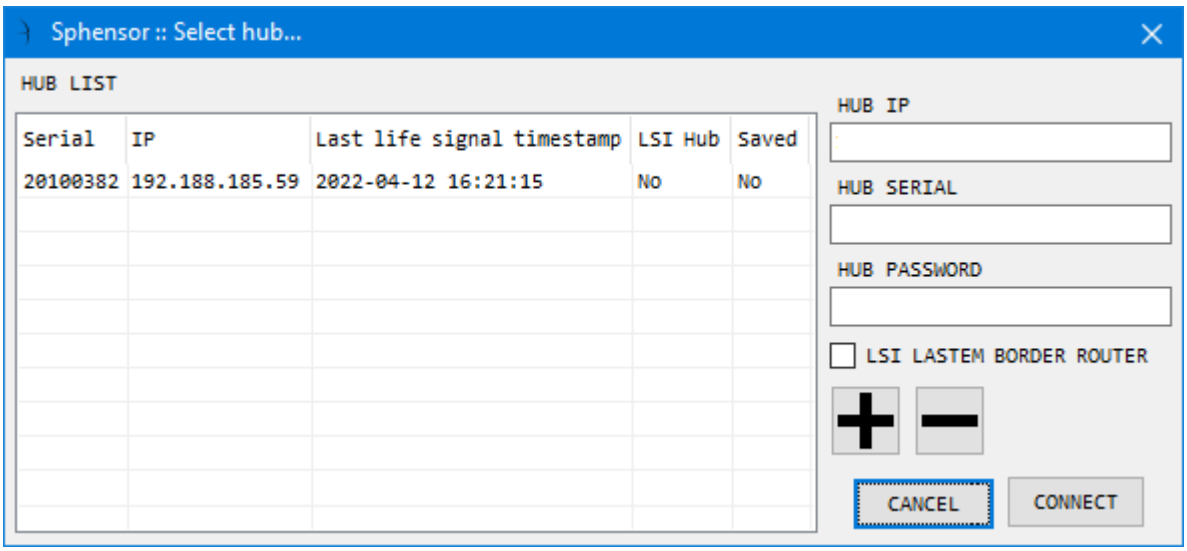
On this topic watch the video tutorial

Sphensor #2 - Unbox the Gateway

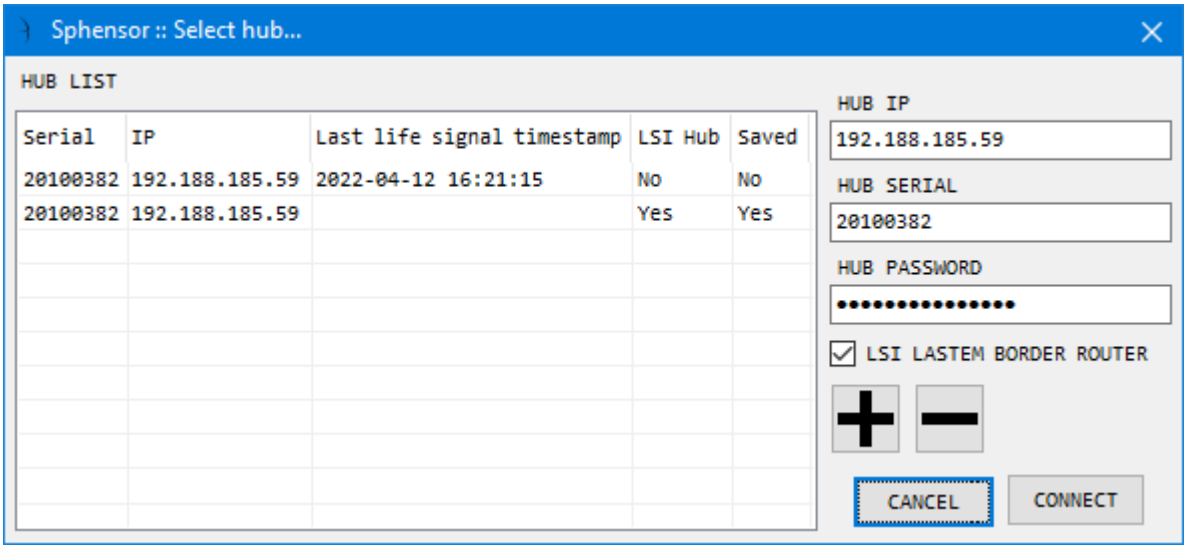
3.3 Connecting to Sphensor Gateway

To connect to the Sphensor Gateway proceed as follows:

1. From the Windows Start menu choose LSI-Lastem, then Sphensor Manager.
2. Wait for the program to recognize it (in the example are shown the information related to the recognized Sphensor Gateway with SN 20100382).

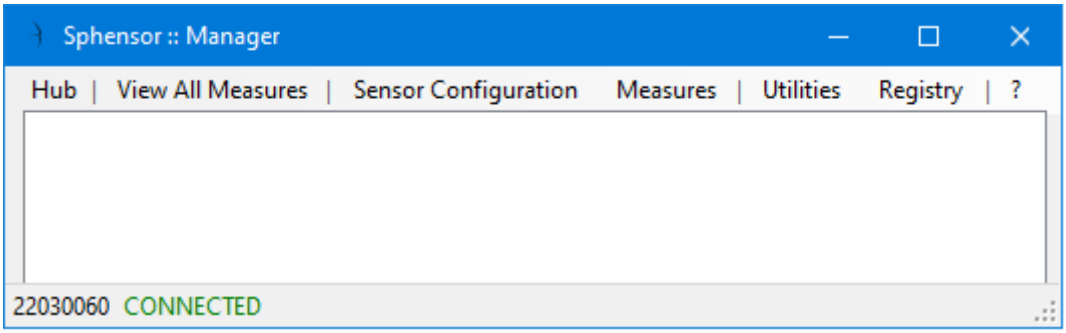


3. After double clicking on the line with the serial number of the Sphensor Gateway, enter in *HUB PASSWORD* the relative password indicated on the label placed on the bottom of the device.
4. If you want to save the Sphensor Gateway information related to your IP address, serial number and password, so that you do not have to enter it at each access and do not wait for the program to detect the device, press [+]. This will be added to the LIST HUB with the option *Saved* to *Yes*.



To remove a saved device from the list, press [-].

5. Press [CONNECT] to access to the main window of Sphensor Manager. The window shows the list of sensors that Sphensor Gateway receives via radio in real time. Initially there is no sensors in the list.



On this topic watch the video tutorial

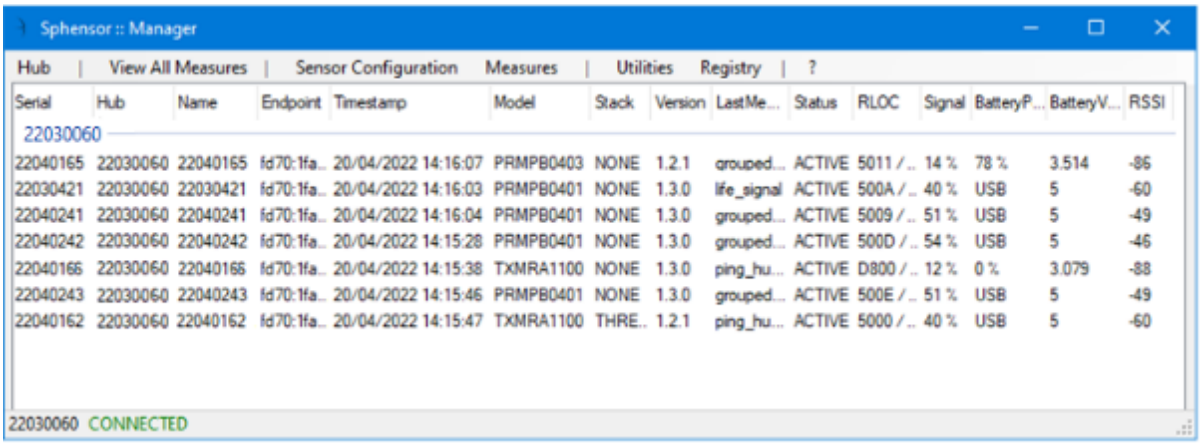
Sphensor #4 - Connection

3.4 Sensor reception

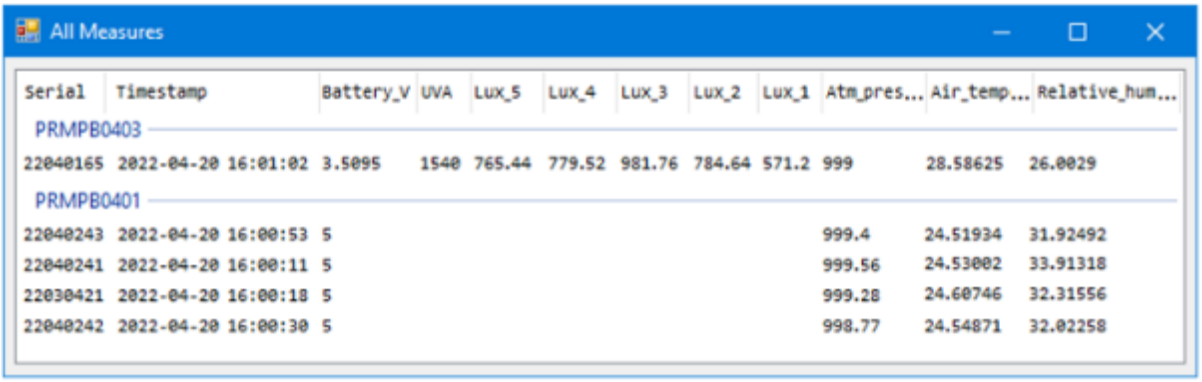
After connecting Sphensor Manager to Sphensor Gateway, turn all sensors on one by one and wait for the software to receive them by viewing them on the main window. Proceed as follows:

1. Power the sensors equipped with a USB power supply.
2. One by one, turn on the sensor by pressing with a pointed object the switch accessible from the hole on the upper half-sphere, verifying the blue LED.

3. Check the Sphensor Manager for information about each sensor (one line per sensor).



4. Choose the menu item *View All Measures* to view the measurements of all sensors received, considering that they are updated according to the transmission rate programmed in each sensor.



On this topic watch the video tutorials

Sphensor #3 - Unbox the Sphensor sensor

Sphensor #4 - Connection

4 Tips on building a Sphensor sensor network

Before proceeding to the modification of the configurations it is desirable to have in mind already how to realize the network of sensors Sphensor. To facilitate the implementation and to increase the reliability of the connections it is recommended to subdivide the network into sub-networks (Fig. 1 shows an example), where each sub-network has the following characteristics:

- A Sphensor Gateway
- Sensors located near the Sphensor Gateway
- Auxiliary repeaters or sensors, if any, with repetition function
- Same radio network for Sphensor Gateway, sensors and any repeaters and/or sensors with repetition function

Once the configuration of each individual apparatus has been completed, it is recommended to identify it so that it can be easily found. For this purpose it is supplied with a writable cable tie-cord.

You can, however, identify a sensor or repeater via software, via the *Find me* function of the *Utilities* menu of *Sphensor Manager*.

On this topic watch the video tutorials

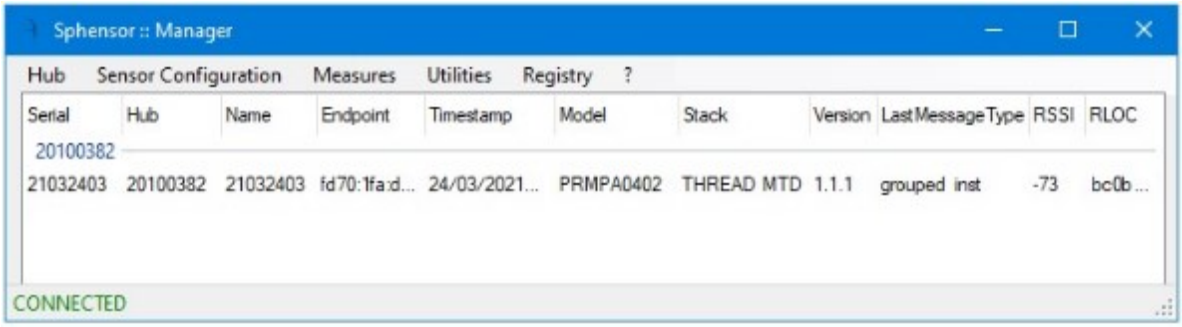
Sphensor #5 - Positioning inside the building

Sphensor #6 - Network setup

5 Configuration and identification

At the factory exit all Sphensor devices have a default configuration (§3). If it is necessary to modify some parameters

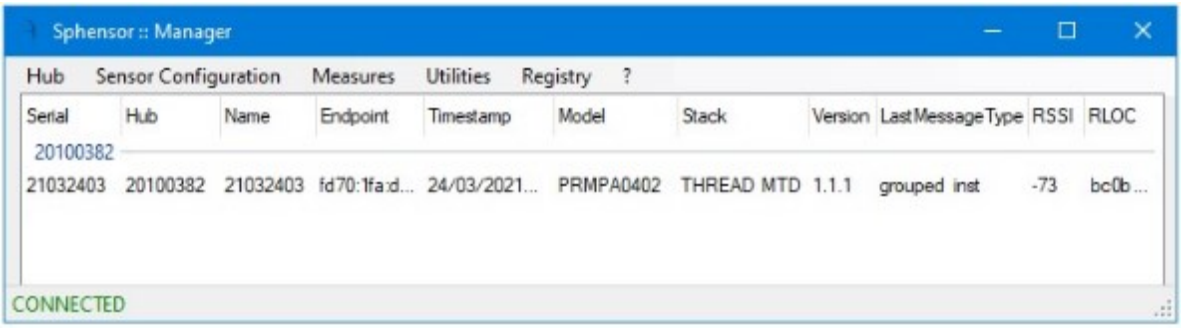
1. Turn on the sensor to be configured and wait for the program to recognize it.
2. One by one turn on the sensors, wait for Sphensor Gateway to receive them and for Sphensor Manager to display them on the main window.



5.1 Sensor configuration

The sensors are configured via the Sphensor Manager software, accessing the sensor via Sphensor Gateway. Proceed as follows:

1. Start Sphensor Manager and connect to the Sphensor Gateway in use (§3.2 and §3.3).
2. Turn on the sensor that needs to be configured and wait for the program to recognize it.

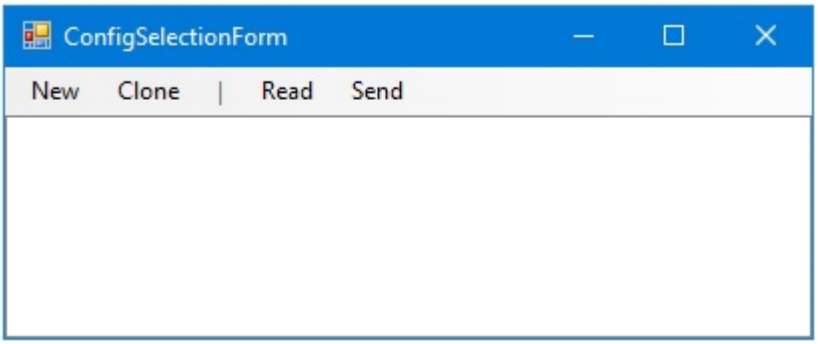


Once identified, it is displayed with the following information:

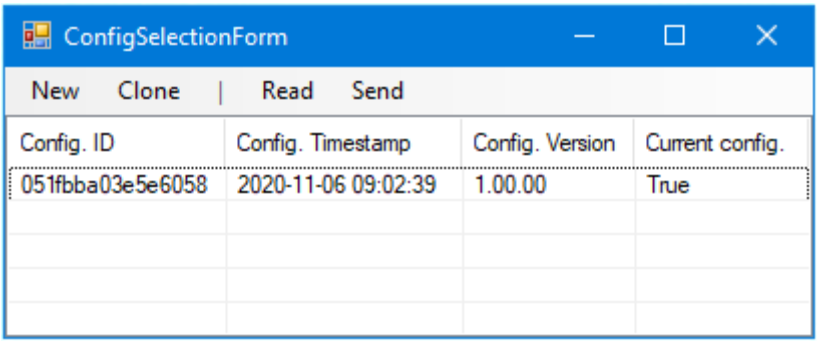
- *Serial*: is the serial number of the sensor.
- *Hub*: is the serial number of the Sphensor Gateway to which it is "hooked".
- *Name*: is the sensor name. By default it corresponds to the serial number. You can edit this text using the *Set alias* command of the *Utilities* menu in order to give the sensor a more representative indication (for example its progressive numbering or its location in the environment).
- *Endpoint*: the sensor's IPv6 address.
- *Timestamp*: is the date/time of the last message received from Sphensor Gateway.
- *Model*: is the model of the sensor.
- *Stack*: defines the type of sensor operation (*ftd*: the sensor can also act as a radio repeater; *mtd*: the sensor does not have a radio signal repetition function but, for this reason, it can operate at low power consumption).
- *Version*: is the firmware version of the sensor.
- *Last Message type*: is the type of message received.

- *Signal*: is the value based on RSSI but expressed in positive scale from 0 (absent signal) to 100 (maximum received signal strength). A good operating condition can be achieved with a received signal value greater than 20.
- *RSSI*: is the radio signal strength of the last message received. The indicated value moves within a scale from -100 to 0 (-100 = signal absent; 0 signal at maximum power). Normally the value is around -60...-70.
- *Battery percentage*: battery charge level expressed as a percentage.
- *BatteryVoltage*: battery voltage in volts.
- *Status*: sensor reception status according to the minimum RTM transmission rate:
    - ACTIVE: the sensor/repeater transmits with the expected RTM
    - MISSING: the sensor/repeater does not transmit from at least 2*RTM
    - LOST: the sensor/repeater does not transmit from at least 3*RTM
    - DEAD: the sensor/repeater does not transmit from at least 4*RTM
- *RLOC*: the pair of RLOC belonging to the sensor and to its parent; through these pairs it is possible to reconstruct the hierarchical structure of the devices connected to the PAN.
- *Parent*: the column indicates the serial, if available and known, of the parent device compared to the current device
- *MCU_ID*: indicates the unique hardware ID of the processor
- *Rx*: indicates the reception status of the device:
    - Always on: the sensor is always on active reception and should respond to requests immediately
    - Polling XX: the sensor goes into low power for XX seconds (default 60) and then should respond to requests after at most XX seconds
- *Config*: indicates the ID of the current configuration or Default if it is the factory configuration

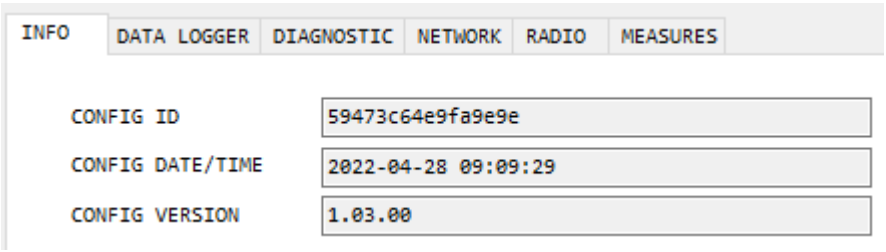
3. Select the line of the sensor to edit, then choose *Sensor Configuration*.



4. If the line with configuration information does not appear, choose Read to receive the default sensor configuration. This will be received as soon as the sensor communicates with Sphensor Gateway (see PARENT POLLING RATE sensor parameter).



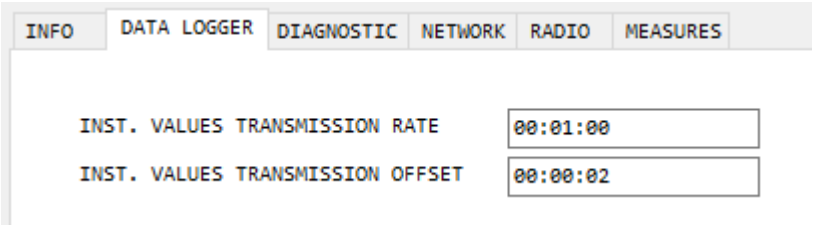
5. Select the received configuration line and choose *Clone* to create your own configuration from a copy of the factory configuration. Sphensor Manager will automatically open the sensor configuration dialog, logically divided by topic.
   The *INFO* tab displays information about the new configuration.



   In detail:

   - *CONFIG ID*: is an identifier, unmodifiable, automatically assigned. In case of use of a new configuration, the identifier is set completely with characters "0"; in case of use of derived configuration, the identifier is set with the corresponding value of the configuration from which it was cloned.
   - *CONFIG DATE/TIME*: is the configuration creation date/time.
   - *CONFIG VERSION*: is the version of the configuration.

6. The DATA LOGGER tab contains the parameters related to the measurement acquisition.

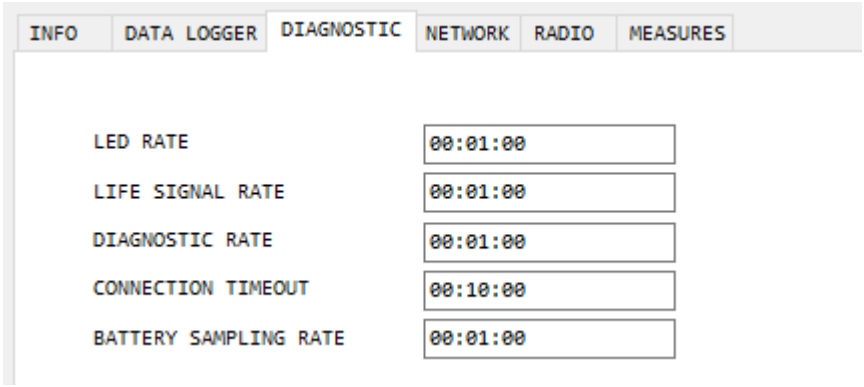


   In particular:

   - *INST. VALUES TRANSMISSION RATE*: is the rate of transmission (acquisition) of the measurements.
   - *INST. VALUES TRANSMISSION OFFSET*: is the time to be added to *INST. VALUES TRANSMISSION RATE* for the transmission (acquisition) of the measurements.
     It can be useful if there are sensors that need more time than expressed by *INST. VALUES TRANSMISSION RATE* to acquire all the measurements. For example, if the *INST. VALUES TRANSMISSION RATE* is set to 10 seconds and we have a sensor that needs 10 seconds to acquire all the measurements, to avoid risks and get measurements in error, set the *INST. VALUES TRANSMISSION OFFSET* parameter to a value greater than 0. for example 2 seconds,

to postpone the transmission of *INST. VALUES TRANSMISSION OFFSET*, giving the sensor the time it needs to acquire all the measurements.

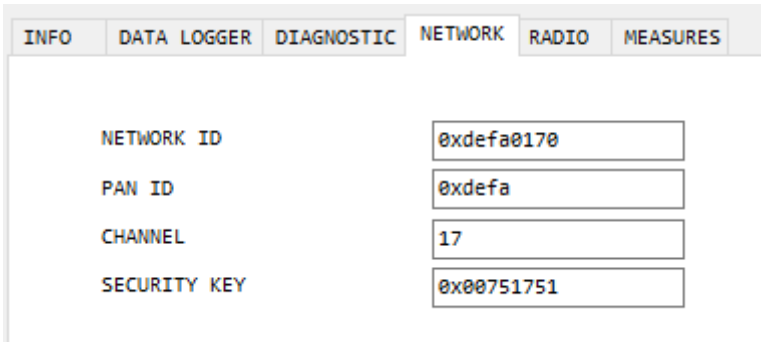
7. The *DIAGNOSTIC* tab contains the diagnostic parameters.



You can set:

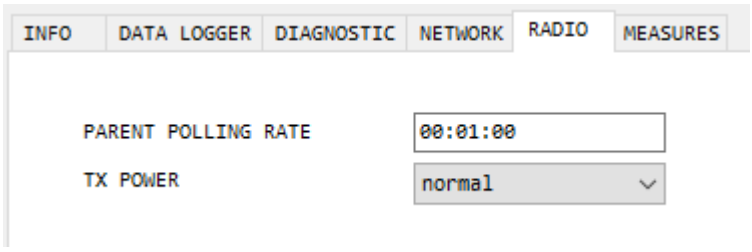
- *LED RATE*: the ignition rate of the LEDs. Set 00:00:00 to avoid ignition.
- *LIFE SIGNAL RATE*: the active sensor radio signaling rate. 00:00:00 disables this signal.
- *DIAGNOSTIC RATE*: the diagnostic data sending rate. Set 00:00:00 to disable sending.
- *CONNECTION TIMEOUT*: connection timeout, if this time is exceeded in case of no connection, the sensor will automatically restart. With 00:00:00. in case of no connection, the restart is disabled.
- *BATTERY SAMPLING RATE*: the sampling rate of the battery charge level.

8. The *NETWORK* tab contains the specific parameters of the radio network.



All displayed parameters identify the network and can be modified. CHANNEL accepts integer values from 11 to 26 while the remaining parameters are hexadecimal. These must respect the length shown in the figure. In case of transmission disturbance it is possible to modify the frequency channel by modifying the *CHANNEL* parameter.

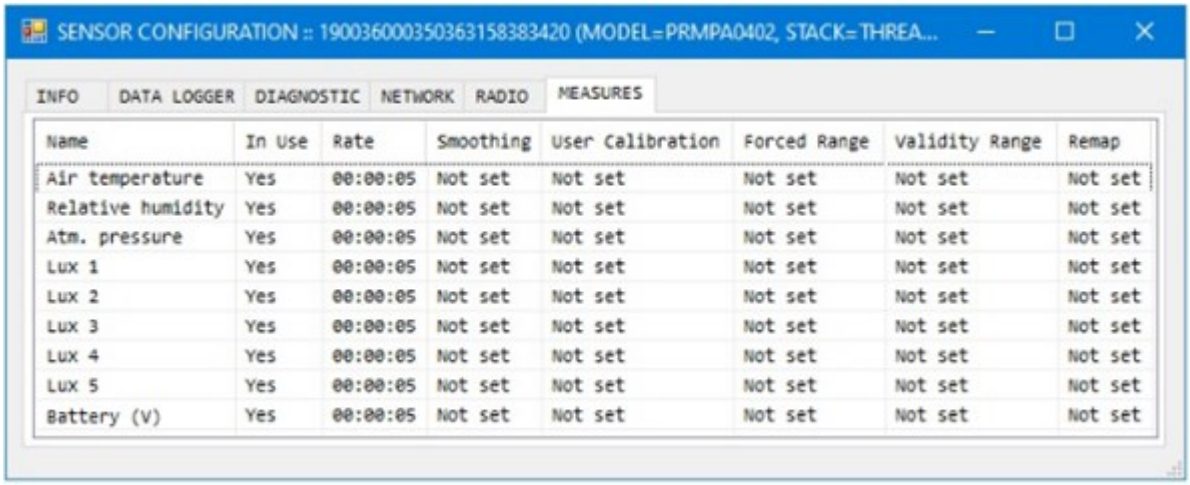
9. The *RADIO* tab specifies the radio operating parameters.



In particular:

- *PARENT POLLING RATE*: is the data transmission rate. In battery-powered sensors this parameter is set by default to 3 minutes. The sensor's radio is switched on only for the time it takes to transmit the data, then it turns off and the sensor switches to low power mode. In this mode the sensor is not accessible from Sphensor Gateway.
  If the sensor is externally powered by USB, it is recommended to set this parameter to 00:00:00.
- *TX POWER*: specifies the power of the radio signal. It is advisable to leave this parameter unchanged.

10. The *MEASURES* tab displays the list of measurements generated by the sensor.

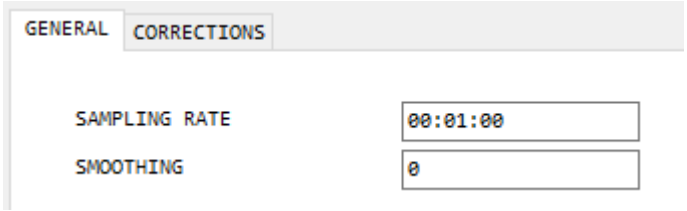


Name	In Use	Rate	Smoothing	User Calibration	Forced Range	Validity Range	Remap
Air temperature	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set
Relative humidity	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set
Atm. pressure	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set
Lux 1	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set
Lux 2	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set
Lux 3	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set
Lux 4	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set
Lux 5	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set
Battery (V)	Yes	00:00:05	Not set	Not set	Not set	Not set	Not set

For each measure is displayed:

- *Name*: is the name of the measure.
- *In Use*: specifies whether or not the measurement is acquired by the sensor (Yes = acquired; No = not acquired).
- *Rate*: is the acquisition rate of the measure.
- *Smoothing*: specifies if a sliding average has been set (if set: number of values used to compute the running average).
- *User Calibration*, *Forced range*, *Validity range*, *Remap*: these parameters are currently reserved for use by LSI LASTEM technicians.

To access the window with the measurement parameters, *double-click* on the measurement.

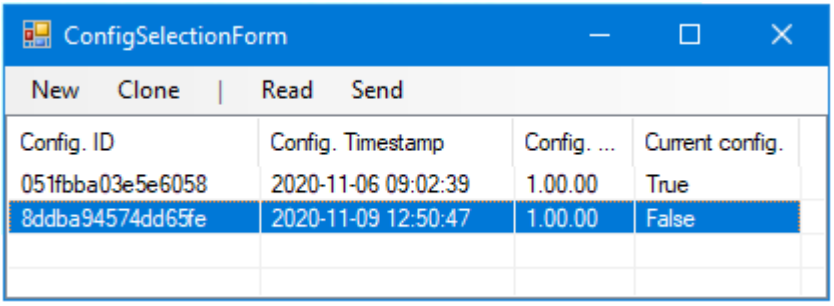


The displayed parameters are the following:

- *SAMPLING RATE*: is the update rate of the measure.

- *SMOOTHING*: is the number of samples constituting the measure. If it is 0 or 1. the transmitted value corresponds to the acquired value. If greater than 1. the transmitted value corresponds to the average of the latest *SMOOTHING* acquisitions. For example, if *SAMPLING RATE* is equal to 5 and *SMOOTHING* is equal to 12, the sensor will transmit the value, every 5 seconds, corresponding to the (sliding) average of the last minute.

11. Press [SAVE] to save the configuration. The sensor configuration dialog updates with the new configuration.



12. Select the new configuration and choose *Send* to send it to the sensor. This will be sent as soon as the sensor communicates with Sphensor Gateway (see PARENT POLLING RATE sensor parameter).
13. Wait for the sensor reboot light to verify the success of the operation, then turn off the sensor and proceed with the next one.

Please note that changing the PAN and/or the radio channel will cause the sensor to fail to connect to the Sphensor Gateway until the latter assumes the same network parameters; when the sensor is switched on, it tries to connect to a Sphensor Gateway that works with the same network parameters; as long as the search does not conclude, the sensor's power consumption is significant; for this reason it is recommended, in order to preserve the battery power of the sensor, to turn off the sensor after it has been programmed until even the Sphensor Gateway is not aligned to the new network parameters.

5.2 Repeater configuration

The configuration of the repeaters is done in the same way as the sensors:

- Device start-up and wait for the recognition by *Sphensor Manager*.
- *Double-click* the device and configuration reading.
- Cloning of the configuration.
- Changes in radio network parameters, the only ones that can be modified.
- Configuration saving and transmission to the device.
- Device shut down.

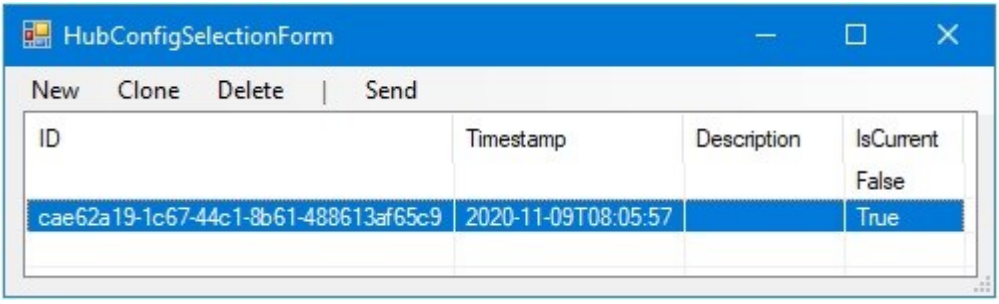
Being equipped with only the radio communication part, the setting of the repeaters operation is done by modifying a subset of the parameters available for the sensor configuration.

5.3 Sphensor Gateway configuration

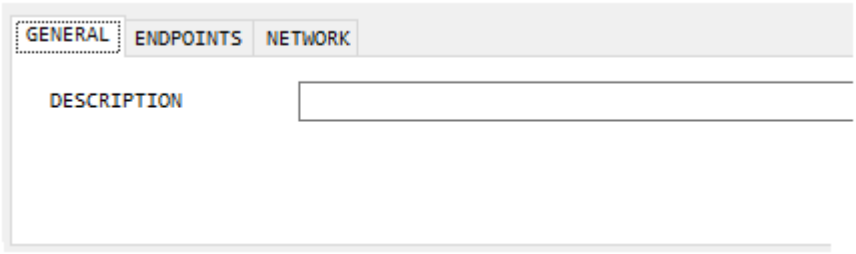
Once the sensors and any repeaters have been configured, proceed to the configuration of Sphensor Gateway.

From the Sphensor Manager main window:

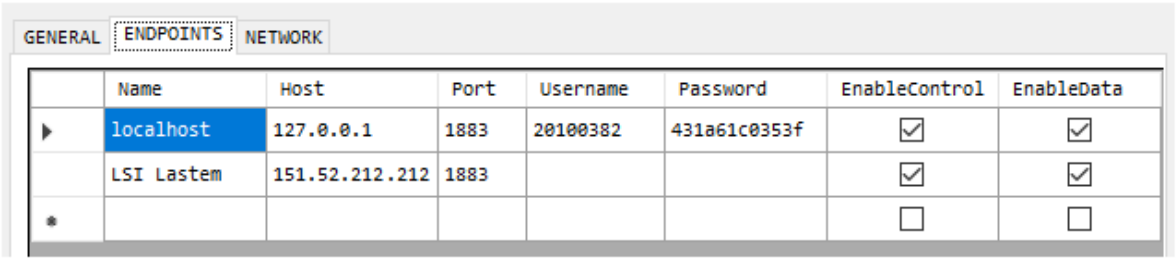
1. Choose *Config* from the *Hub* menu to open the Sphensor Gateway configuration dialog.



2. Select the current configuration (*IsCurrent* = True) and choose *Clone*.
3. In the *GENERAL* tab you can assign a description to the configuration.



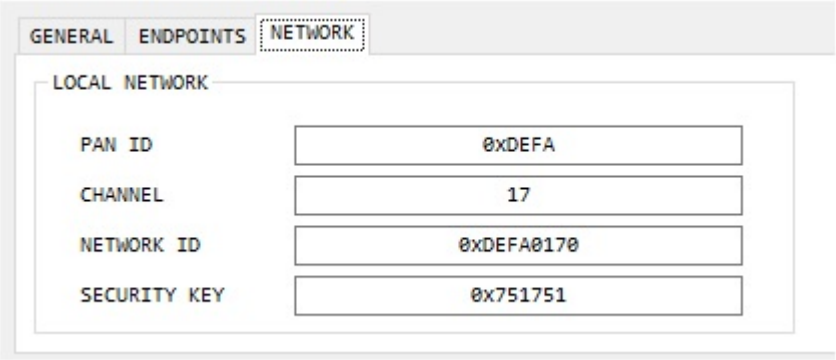
4. The *ENDPOINTS* tab displays the MQTT servers configured in the device. In the figure are represented two servers, one local (*localhost*) and one called *LSI Lastem*, both configured to receive the data unencrypted and to have control of Sphensor Gateway.



For each server you can configure:

- *EnableControl*: if checked, enables Sphensor Gateway control and then its reconfiguration by the software on PC. If the option is not enabled, you cannot send reconfiguration commands to Sphensor Gateway via the specified broker.
- *EnableData*: if checked, enable the sending to the MQTT broker of the sensors data (measurements, diagnostics, etc.) in JSON format as well as binary.

5. The *NETWORK* tab contains the specific parameters of the radio network.



The parameters have the same meanings as those set in sensors and repeaters. The communication between all the apparatuses happens only if these parameters have been configured with the same values.

6. Press [SAVE] to save the configuration. The command causes a restart of Sphensor Gateway.

5.4 Verification of pre-installation operation

Before installing all Sphensor equipment, it is recommended to check its correct functioning. If the network has been subdivided into sub-areas, it is advisable to proceed by sub-area.

- Place the Sphensor apparatuses on a table.
- Turn on Sphensor Gateway. Consider what is indicated at §1.2.
- Turn on, one by one, any sensors with repetition function verifying the ignition of the blue LED.
- Turn on, one by one, any repeaters available, verifying the lighting of the blue LED.
- Turn on, one by one, the sensors verifying that after a few moments the blue LED is switched on, testifying that the sensor is properly connected to the network composed by Sphensor Gateway. Through the Sphensor Manager software, verify the reception of data from all sensors, taking into account the scheduled transmission rate.

5.5 Factory reset

The factory configuration of Sphensor sensors and repeaters can be restored to the factory state by acting on some keys of the electronic board inside the sphere. To access the board it is necessary to remove one of the two half-spheres that make up the sensor. This must be done with the utmost care so as not to disconnect any components mounted on the half-spheres.

5.5.1 PRMPv040x sensors factory reset

The following procedure applies to PRMPv040x sensors and TXMRv1100 repeaters, keeping in mind that the letter "v" indicates the sensor/repeater version (A, B, etc.) while the letter "x" indicates the model (1, 2, 3, etc.)

Proceed as follows:

1. Switch off the sensor via the On/Off button accessible from the hole on the hemisphere.
2. If the model in question is equipped with a power supply, remove the USB power cable from the sensor.
3. Remove the lower half-sphere, taking care not to disconnect the internal cables.

4. Turn on the sensor via the On/Off button. If the button is not visible on the board, turn it on through the hole on the hemisphere.
5. Holding down the DFLT key (§Fig. 2), press the RESET button; then release the RESET button and then the DFLT button.

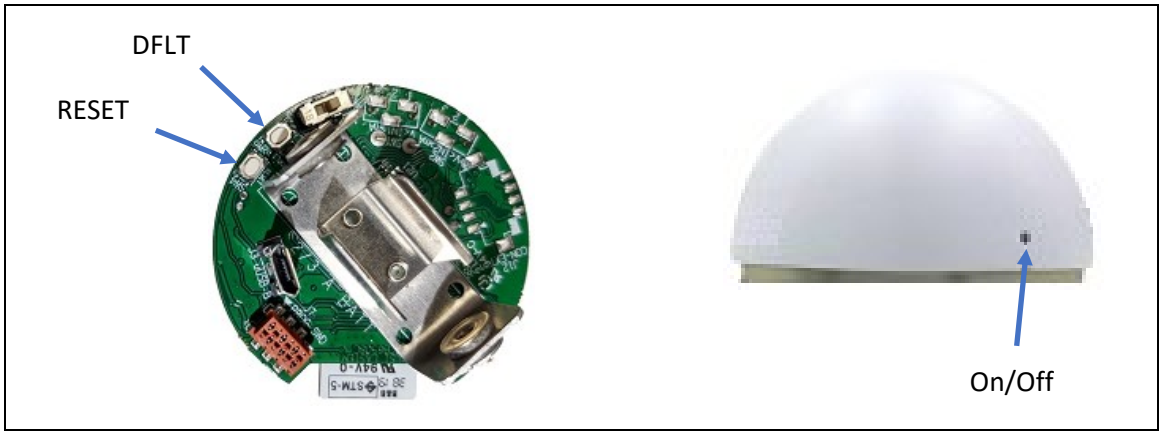


Fig. 2 – Positioning keys on board type sensors PRMPv040x.

6. Switch off the sensor via the On/Off button.
7. Apply the lower hemisphere to the sensor.

5.5.2 PRMPv042x sensors configuration restore

The following procedure applies to PRMPv042x sensors where the letter "v" indicates the sensor version (A, B, etc.) while the letter "x" indicates the model (1, 2, 3, etc.)

Proceed as follows:

1. Switch off the sensor via the On/Off button accessible from the hole on the hemisphere.
2. If the model in question is equipped with a power supply, remove the USB power cable from the sensor.
3. Remove the upper hemisphere taking care not to disconnect the internal cables.
4. Turn on the sensor via the On/Off button. If the button is not visible on the board, turn it on through the hole on the hemisphere.
5. Holding down the DFLT key (§Fig. 3), press the RESET button; then release the RESET button and then the DFLT button.

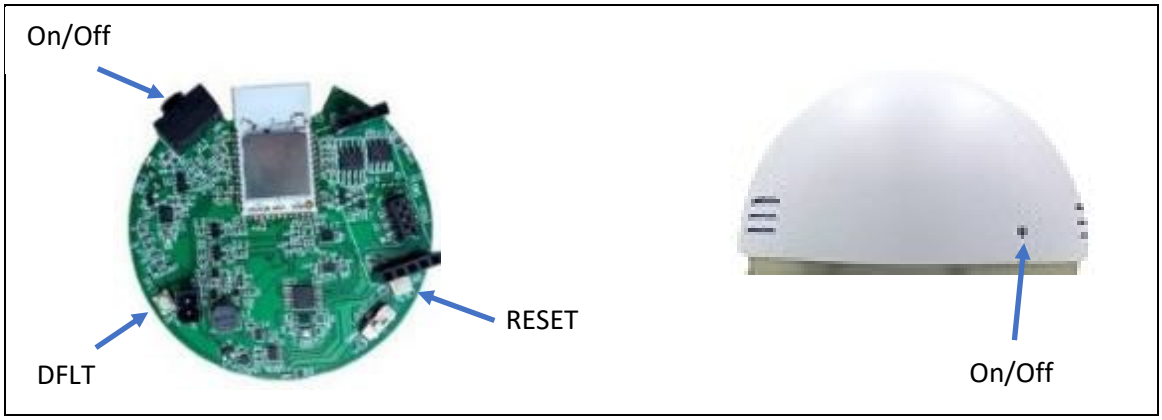


Fig. 3 – Positioning keys on board type sensors PRMPv042x.

6. Switch off the sensor via the On/Off button.

7. Apply the upper hemisphere to the sensor.

5.5.3 Repeater factory reset

Proceed as follows:

1. Remove the repeater from the wall outlet.
2. Remove the repeater cover by unscrewing the three fixing screws.
3. Holding down the DFLT key (§Fig. 3), press the RESET button; then release the RESET button and then the DFLT button.
4. Fix the cover to the repeater.
5. Plug the repeater into the wall outlet.

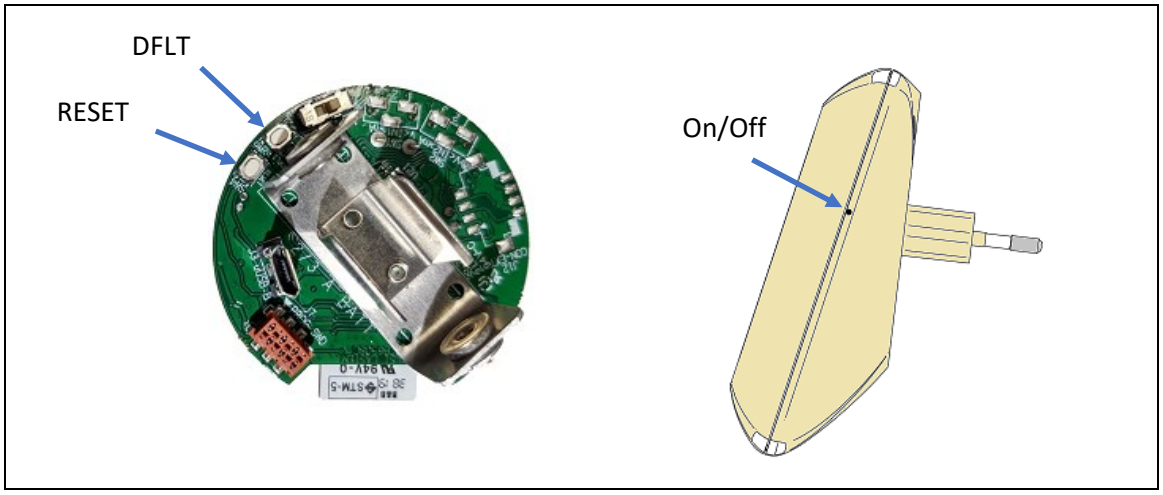


Fig. 4 – Repeater.

6 Installation of Sphensor equipment

On this topic watch the video tutorial

Sphensor #5 - Positioning inside the building

6.1 Guidelines for placement

The Sphensor line devices communicate with each other via radio. Before proceeding to their placement and installation consider the following:

- Radio devices are subject to possible interference. Sphensor devices operate on the 2.4 Ghz frequency, the same used by common equipment such as Wi-Fi networks on PCs, Bluetooth, cordless phones, presence and alarm detection systems, video surveillance systems.
- The presence of special materials blocks the diffusion of the signal, absorbing or reflecting radio waves. Elements in metal, cement, plaster and bulletproof glass, for example, represent highly absorbing obstacles.
- The location of Sphensor devices that require the use of an external power supply is constrained by the availability in the immediate vicinity of a socket.
- For greater accuracy of the measurements of the environment, it is recommended not to place the spheres in contact with the wall or other surfaces but at a distance of a few centimeters from them.
- Sphensor sensors with relative humidity measurement must not come into close contact with volatile chemicals such as solvents or other organic compounds such as acetone, isopropyl alcohol, ketenes, ethanol, toluene, HCl, H_2SO_4, HNO_3, NH_3, H2O2 and ozone at high concentration, since they could lead to an irreversible drift of the moisture reading and, in the most serious cases, to damage to the sensor. Avoid the application of detergents.
- The location of Sphensor Gateway is constrained by the current socket and RJ45 socket for LAN connection.
- The radio range of the sensor is also affected by environmental conditions that may vary over time, such as the presence of many people in the monitored environment.
- The radio range of Sphensor can be improved just by rotating the sensor so that its antenna is directed towards the nearest repeater or towards Sphensor Gateway. The antenna is positioned opposite the hole where the On/Off switch is inserted.

If it is possible, install the Sphensor Gateway in a central location relative to the sensors, in sufficiently large rooms and free of major barriers and obstacles. The antenna shall be positioned perpendicular to the plane of support of the device.

Install the sensors in the most representative location of the area and environmental parameter to be monitored. The models with battery operation offer a high flexibility of placement, not needing cables for power supply.

Install Sphensor repeaters if the distance between sensors and Sphensor Gateway is excessive or in the presence of obstacles that are difficult to overcome by radio transmissions and, above all, to allow the Thread

communication network to operate with multiple communication paths; this increases the overall reliability of the communication system.

If the area to be monitored is composed of several environments, where important obstacles are present, it may be useful to subdivide the entire area into sub-areas (see Fig. 1).

In Fig. 5 is represented the arrangement of the various Sphensor apparatuses in the plan of a building. Sensors identified with letters “a”, “b” and “c” are acquired directly from Sphensor Gateway, while the sensors "d" and "e", due to the low radio signal, are acquired by Sphensor Gateway through the use of the repeater "f".

Note that the sensor "d", the repeater "f" and Sphensor Gateway need a 230 Vac socket for the connection of the power supply and, for Sphensor Gateway, the network stud for the connection to the Internet.

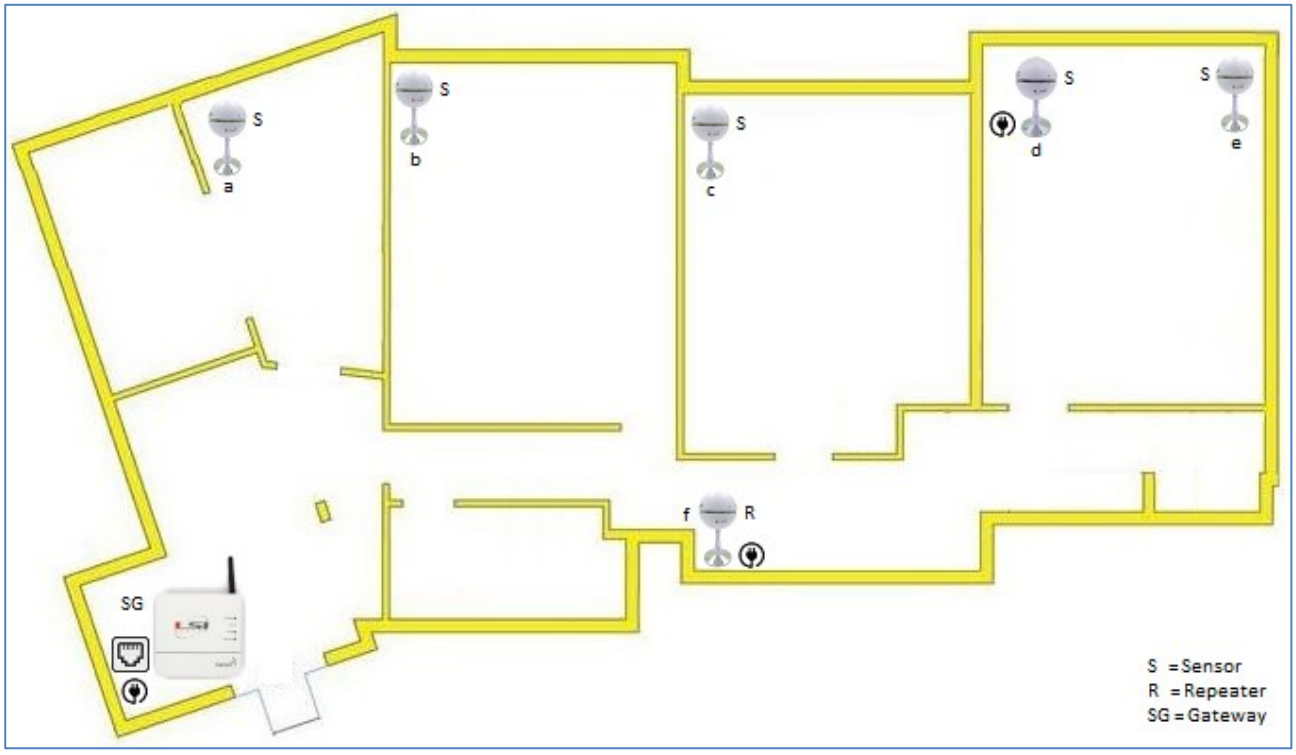


Fig. 5 – Placement of Sphensor devices in the building example.

6.2 Installation

If the Sphensor sensor network has been subdivided into sub-areas, we recommend proceeding by sub-area.

- Place the Sphensor Gateway in the predetermined location. Connect the power and network cables. Connect the antenna and place it perpendicularly to Sphensor Gateway. Turn on the device and check the power of LED *USB pwr* and *On*.
- Place the remaining devices in the predetermined place by connecting them to the external power supply, if the model allows it, and turn them on by pressing the switch accessible from the hole on the upper hemisphere. Before any wall mounting, check the correct data transmission.
- Place the sensors in the preset locations, checking their reception again on the software. In case of wall mounting, it is recommended to first check the radio signal strength.

- Disconnections and signal instability are generally attributable to the sensors' excessive distance to Sphensor Gateway or the presence of obstacles. In this case, use one or more Sphensor repeaters.

Also consider that low-power sensors need to refer, in their immediate vicinity (radio range), to a repeating apparatus or directly to Sphensor Gateway. Please note that Sphensor Gateway can serve as a reference for up to 32 low-power sensors at its immediate radio range, while repeaters can serve as a reference for up to 10 low-power sensors. In the event of temporary radio communication losses, which can be verified by the unjustified absence of measured data in the system, carefully evaluate this characteristic of operation of the radio communication network. If necessary, proceed with the introduction of additional repeating devices (including sensors with this function) to further improve the reliability of the radio communication system.

6.3 Sensors installation

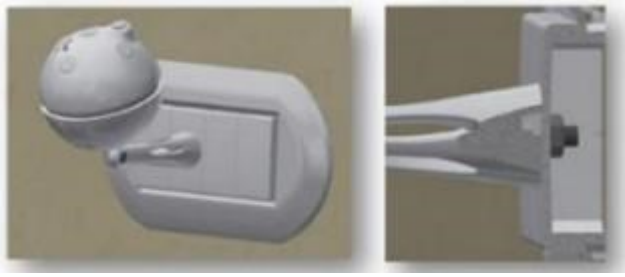
Sphensor line sensors offer different types of installation: resting on a shelf, fixed to the wall, hung by wire. The following chapters illustrate the various possibilities.

6.3.1 Via screw stud

The MC8111 shank is equipped with an M4 stud screw that allows it to be mounted on a rod/plate with a threaded hole or to a wall by means of the previous positioning of a dowel with a brass metric thread or a self-piercing dowel (in case of plasterboard wall).

6.3.2 On electric plate

A method similar to wall fixing via dowel is fixing on a false pole in the electrical outlet. It must be drilled to allow the passage of the M4 stud and at the rear it is fixed in position by means of an M4 nut. In case the sensor requires external power, the remaining plate positions can be used to provide power to the *wall* power supply.



6.3.3 Hung

If you need to have the sensor hanging, it must be installed with the appropriate component MK5351. The attachment to the ball is the same as that of the stem. Remove from these the M3 nut and place it in the special quarry, then tighten the component with the M3x10 screw supplied.

6.3.4 Via stainless steel base

Using the stainless steel base is the most convenient solution if you want to place the sensor on a surface, a desk or a table. The weight of the component allows unlimited tilt of the sensor without compromising its stability. The rubber ring below prevents sliding on particularly smooth surfaces and protects any glass surfaces or other delicate surfaces.

6.3.5 Via easel

As an alternative to the previous systems, one can consider the installation on tripods or mini-tripods on the market. This choice involves the replacement of the stem supplied with a specially designed one (supplied on request) which presents on the inside a hexagonal nut with thread W 1/4'', instead of the M4 stud. This thread allows positioning also on various photographic media on the market (tripods, pliers, articulated arms, etc.)

6.4 Repeater installation

The TXMRB1110 repeater is equipped with a 2-pole S10 type plug, so it can be inserted into a suitable wall socket.

7 Diagnostics

7.1 Functional status LEDs

Each sensor has blue and red LEDs; the two colors can be switched on independently or at the same time to provide the possibility of a third color.
The sensor can individually manage each of the following light signals:

LED	Flashing	Meaning	Priority
Blue	1 fast	Power on/network connected/reboot	
Red	1 fast	Missing/disconnected network	3
	3 fast	Local alarm	1 (highest)
	2 slow	Low battery level	2

Tab. 4 – Functional satus LEDs.

Reports shall be repeated cyclically over time according to the parameters configured with the Sphensor Manager software (§ 5.1).

At each signaling cycle, the priority to display the state of the network is as follows (starting from the highest priority one): local alarm, battery, connected/disconnected status (individually manageable but mutually exclusive).

Signalling of an abnormal functional condition shall be indicated by red staining and shall be defined as follows:

- No detected functional abnormalities: no signalling.
- Critical battery level, measurement operation and radio transmission suspended: a short flash.
- Low battery level, normal operation anyway: two short flashes.
- Signals concerning the condition of the measurement system (only sensors): a slow flashing followed by one or more short flashes depending on the type of condition:
    - One or more measurements in error: one flash.
    - Recalibration need (factory configurable relatively to operating time and type of measurement cells): two flashes.
- Signals regarding radio communication condition: two slow flashes followed by one or more short flashes depending on the type of condition:
    - No radio connectivity: one flash.
    - Connectivity present, being networked: two flashes
- System operating status alerts: three slow flashes followed by one or more short flashes depending on the type of condition:
    - No detected functional abnormalities: no signalling.
    - Data memory depleted due to persistent lack of connectivity: one flash.
    - Incorrect configuration: two flashes.
    - Internal anomaly not defined: three flashes.

The alarm condition signalling is indicated by red+blue coloration and is defined as follows:

- No detected functional abnormalities: no signalling.
- Alarm detected: a short blink followed by one or more flashes depending on the alarm logic index configured in the sensor.

7.2 Sphensor Gateway functional status LEDs

Sphensor Gateway has 4 LEDs that determine the state of operation.

Function	LED	Status
USB pwr	Green	On: power supply connected and battery charged
	Orange	On: power supply connected and battery charging
On	Green	On: device started
Active	Blue	On: device in operation mode
Alarm/Err	Red	On: presence of alarms/configuration error

In case of alarm or error signal, restart Sphensor Gateway using the On/Off switch on the device or via the Sphensor Manager software.

8 Technical specifications

8.1 PRMPB0401. PRMPB0402, PRMPB0403, PRMPB0404, PRMPB0405, PRMPB0406 sensors

Air temperature	Measuring range	-30 ÷ 60 °C
	Resolution	0.015 °C
	Accuracy	• Typ. ±0.1 °C, Max ±0.3 °C (@20 ÷ 60 °C) • Typ. ±0.2 °C, Max ±0.3 °C (@-40 ÷ 20 °C, 60 ÷ 80 °C)
Relative humidity	Measuring range	0 ÷ 100 %RH
	Resolution	0.01 %RH
	Accuracy	• Typ. ±1.5 %RH, Max ±2 %RH (@25 °C, 0 ÷ 80 %RH) • Typ. ±2 %RH, Max ±3 %RH (@25 °C, 80 ÷ 100 %RH)
Atmospheric pressure	Measuring range	600 ÷ 1100 hPa
	Resolution	0.1 hPa
	Accuracy	0.18 hPa (@ 25 °C), ±1.2 hPa (@ -30 ÷ 60 °C)
Illumination (only PRMPB0402 andPRMPB0403)	Measures type	Measurement of 4 axes in directions 0°, 90°, 180°, 270°, each with an elevation of 45° relative to the sensor plane; 1 additional measure on the normal of the same plane
	Measuring range	0.1 ÷ 90 klx
	Resolution	1 lx
	Accuracy	±5% MV ± 5 lx
	Sensitivity	3 lx
	Response to cosine	2% (by angle of incidence < 50°)
Radiation UV-A (only PRMPB0403)	Measure type	Measurement performed on the normal of the sensor plane
	Response curve	0.3 ÷ 0.4 µm
	Measuring range	0 ÷ 200 µW/cm^2
	Resolution	0.05 µW/cm^2
	Accuracy	±5% VM
	Response to cosine	ND
Outside temperature (only PRMPB0405 and PRMPB0406)	Measures type	No. 2 external temperatures, digital type sensor (1 for PRMPB0406), compatible with LSI LASTEM sensors
	Measuring range	-40 ÷ 125 °C
	Resolution	0.01 °C
	Accuracy	±0.1 °C
External analogue signal (only PRMPB0405 and PRMPB0406)	Measures type	No. 2 external voltage signals (1 for PRMPB0406), compatible with LSI LASTEM sensors
	Measuring range	±30 mV
	Resolution	< 1 µV
	Accuracy	±5 µV (TBD) @ 25 °C

Common features

Power supply	Battery	Non-rechargeable
	Type	⅔ A Li 3.6 V, dim. Ø17x33.5 mm, 2.1 Ah or greater
Radio	Type	2.4 GHz
	Protocol	Thread/IPv6
Sampling rate	Settable	Depending on the type of measures (unique for all configured measures). Default=3 minutes
Transmission rate	Settable	On the basis of the sampling rate or only on the basis of minimum variation in the measured size.
Data recording	Local	Automatic in absence of radio connectivity (linear storage until the end of the available space with data dating)
Diagnostics	Sent data	• Battery charge status • Radio signal level • Measures correctness • End of memory
	LEDs	If enabled report: • Normal operation • Local alarm • Operation critical issues
Ignition	Button	Accessible through a hole using a pointed object
General information	Level of protection	IP40
	Operating temperature	-30 ÷ 60 °C

Estimated non-rechargeable battery life

Sampling Rate	PRMPB0401	PRMPB0402	PRMPB0403	PRMPB0404
30''	2 year and 6 months			
1'	4 years			
2'	5 years			
5'	6 years			
10'	7 years			

8.2 PRMPA0423 sensors

Volatile Organic Compound (VOC)	Measuring range	0 ÷ 1000 ppm
	Resolution	0.2%
	Accuracy	15% ethanol
	Thermal drift	1.3%
Particulate matter PM1. PM2.5, PM4 and PM10	Measuring range	0 ÷ 1000 µg/m^3
	Precision	• PM1 and PM2.5: ○ 0 ÷ 100 µg/m^3 ±10 µg/m^3 ○ 100 ÷ 1000 µg/m^3 ±10% of the measured value • PM4 and PM10: ○ 0 ÷ 100 µg/m^3 ±25 µg/m^3 ○ 100 ÷ 1000 µg/m^3 ±25% of the measured value
	Thermal drift	• 0 ÷ 100 µg/m^3 ±1.25 µg/m^3/year • 100 ÷ 1000 µg/m^3 ±1.25% of the measured value /year
	Lifetime	24h/g > 10 years
	Noise emission level	25 dB
	Noise emission level drift	+0.5 dB
CO_2	Measuring range	0 ÷ 5000 ppm
	t_{63} response time	• 140 s with the measured average • 75 s with no average
	Accuracy	<± (50 ppm + 3% of the measured value)
	Typical temperature influence	± (1+CO_2 [ppm]/1000) ppm/°C (-20 ± 45 °C)
	Calibration	Every 5 years

Other features

Power supply	Battery	Rechargeable
	Type	GEI103450 Li 3.7 V, format 10.3x34x50 mm, 2 Ah
	Autonomy	About 2 days
	External	Via Micro USB port
Radio	Type	2.4 GHz
	Protocol	Thread/IPV6
Sampling rate	Settable	From 1 to 600 s depending on the type of measures (unique for all configured measures). Default=1 minute
Transmission rate	Settable	On the basis of the sampling rate or only on the basis of minimum variation in the measured size.
General information	Level of protection	IP40
	Operating temperature	-30 ÷ 60 °C

8.3 TXMRB1110 repeater

Power Supply	From wall socket	85÷250 V AC
	Connector	2-pole S10 type plug (standard Italy)
	Backup battery	Rechargeable type ⅔ A Li 3.7 V, dim. Ø17x33.5 mm, 750 mAh
	Power consumption	1 W
	Autonomy	About 2 days
	Charging time	5 hours
Thread Radio	Module	Minew
	Antenna	Internal
Dimensions and weight	Dimensions (HxLxW)	110x110x61 mm (with plug inserted)
	Weight	175 g (battery included)
	Material	Plastic

8.4 Sphensor Gateway TXRGB1001-TXRGB1101

Power Supply	Connector	USB-C
	Max voltage USB-C	5.4 V
	Max current USB-C	5 A
	Switch	External switch
	Backup batteries	Rechargeable with Li-Ion or Li-Po, 3.7 V, 11,6 Ah
	Power consumption	• During the battery rechearge: max 1 A • With charged battery: max 400 mA
	Autonomy	1 day
	Charging time	15 h
Diagnostic LED	Green LED *USB pwr*	Presence of 5 Vdc power supply from USB-C cable, full backup battery
	Orange LED *USB pwr*	Presence of 5 Vdc power supply from USB-C cable, backup battery on charge
	Green LED *On*	Power on state
	Blue LED *Active*	Activity state
	Red LED *Alarm/Err*	Alarm status according to pre-set or error logics
Thread Radio (TXRGB1001 and TXRGB1101)	Module	Minew
	Antenna connector	SMA tilt
	Antenna	External
	Antenna gain	2.4 GHz - 2 dBi
Radio Thread (TXRGB1101)	Antenna connector	ERE
	Antenna	SMA tilt
	Antenna gain	External
	Antenna connector	868 MHz - 2 dBi
Network connection	Connection 1	Ethernet RJ45
	Connection 2	USB for external Internet key
Actuators	Relays number	4
	Type	SPDT (Normal Open e Normal Close). Imax= 2.8 A-Vmax= 260 Vac
General information	Protection grade	IP20
	Operative temperature	-20 ÷ 60 °C
	Dimensions (HxLxW)	285x180x94 mm
	Weight	500 g

8.5 Sphensor Gateway TXRGC1001

Power Supply	Connector	USB-C, 5 Vdc, min 3 A
	Backup batteries	Rechargeable with Li-Ion or Li-Po, 11.6 Ah
	Power consumption max	About 1.2 A @5 V (with radio) while charging battery
	Autonomy	About 10 h with 3.6 V battery Li-Po
	Charging time	58 h
Diagnostic LEDs	LED *USB pwr*	- Green ON: power supply connected from USB-C cable and battery charged - Orange ON: power supply connected from USB-C cable and battery charging
	Green LED *On*	Device started
	Blu LED *Active*	Device in operation mode
	Red LED *Alarm/Err*	Alarm status according to pre-set or error logics
Thread Radio	Module	Minew
	Antenna connector	SMA
	Antenna	External
Network connection	Connection 1	Ethernet RJ45
	Connection 2	- 2 x USB 3.1 for external Internet key - 2 x USB 2.0
Alarm/Actuator	Relay	4 (NO or NC operation), max 230 Vac @ 3 A

9 Maintenance

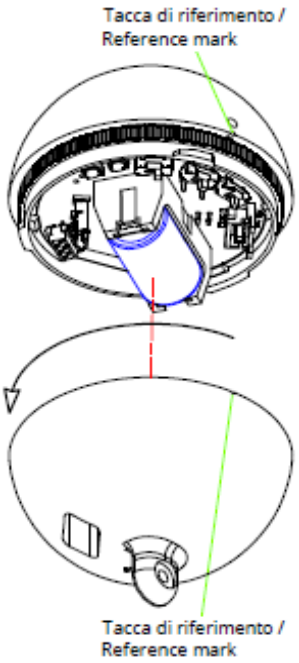
9.1 Replacement of non-rechargeable battery for PRMPv040x sensors

The following procedure applies to PRMPv040x sensors where the letter "v" indicates the sensor version (A, B, etc.) while the letter "x" indicates the model (1, 2, 3, etc.)

PRMPv040x are sensors powered by a non-rechargeable battery, therefore it will have to be replaced once reached the end of life.

The battery is placed on the bottom of the card inside the sensor. To replace proceed as follows:

1. With one hand, hold the upper half-sphere and the diffuser ring steady and with the other hand unscrew the lower half-sphere by turning it counter-clockwise.
2. Remove the lower half-sphere.
3. With a finger of the hand holding the half-sphere hold the battery holder and with the other hand pull out the battery discharge taking it to the sides in the central position; during the operation, avoid touching the electronic components welded on the board.
4. Insert the new battery in the battery port respecting the polarity indicated in the internal part of the battery port.
5. Screw the lower half-sphere to the ring by turning it clockwise until the lower half-sphere is aligned with the upper half-sphere.



Attention! The sensors have precision electronic components, very delicate, placed in the upper hemisphere and, in certain models, connected to the main board by electric cables. If the upper half-sphere is unscrewed during the operation, do not separate it from the diffuser ring to avoid damage, but try to screw it back in the original position as indicated by the instructions above.

10 Application protocol

Sensors communicate with Sphensor Gateway via binary protocol to save on transmission and hence on battery. Sphensor Gateway is now able to deserialize some of these messages and forward them to one or more MQTT brokers as per configuration. These messages are converted from binary format to JSON format to allow modern integration systems to read and interpret them simplifying the development phase.

The MQTT topics used in publish and subscribe by Sphensor Gateway are composed by the following preamble: *sphensor/<serial>/<subject>/<action>*

where:

- *sphensor*: distinguishes the message related to the Sphensor system.
- *serial*: is the Sphensor Gateway serial that radio sent/received the message to/from the sensor and received/sent it via MQTT. The same serial can be found on the Sphensor Gateway label.
- *subject*: the value of this parameter can be *hub* if the message is generated or intended for Sphensor Gateway otherwise it is the native sensor serial that is the generator or recipient of the message.
- *action:* the rest of the MQTT topic represents the action taken by the target or sent to it.

10.1 Instantaneous data snapshots

One of the most important messages sent by Sphensor Gateway is the message of the grouped snapshots: in this message, the values of all the measurements configured in the sensor are sent with the updated value at the most recent sampling.

The topic of the message is as follows:

sphensor/<sphensor_gateway_serial>/<sensor_serial>/grouped_inst

The format of this message is an array of JSON objects, such as the following:

```
[
 {
 "timestamp": "2020-01-03 06:03:27",
 "sensor_type": "lux4",
 "value": 2.2177724838256836,
 "result": "ok",
 "channel_index": 0
 },
 ….....
]
```

where:

- The *timestamp* field contains the data recording time, in UTC, stored in the sensor. If the sensor has not yet obtained the current time from Sphensor Gateway then the transmitted time will be equal to the sensor's turn on time from the date 2020-01-01 00:00:00. NOTE: Sensors are currently not enabled to receive time from Sphensor Gateway.
- The *sensor_type* field contains the name of the measurement cell that produced the measurement and its index when there is more than one measurement cell of that type.
- The *channel_index* field contains the zero-based index of the channel of the measurement cell that generated the measurement.

- The *result* field contains the status of the measure:
  - *ok*: correctly read measure
  - *timeout*: the item did not reply within the time allowed
  - *error*: the sensor responded with an error message
- The *value* field contains the floating-point value of the corresponding measure. In case the result field is different from ok, the value of this field should not be considered.

The following table summarizes the *sensor_type/channel_index* pairs that can be received from the sensor:

sensor_type	channel_index	name	unit
battery	0	Battery (V)	V
uva	1	UVA	W/m^2
press	0	Cell temperature	°C
press	1	Atm. pressure	hPa
t_rh	0	Air temperature	°C
t_rh	1	Relative humidity	%
lux1	0	Lux 1	lx
lux2	0	Lux 2	lx
lux3	0	Lux 3	lx
lux4	0	Lux 4	lx
lux5	0	Lux 5	lx
t_ext_1	0	Ext. temperature 1	°C
t_ext_1	0	Ext. temperature 1	°C
co2	1	CO2	ppm
tvoc	1	TVOC	ppb
pm	0	PM 1 (MASS)	ug/m^3
pm	1	PM 2.5 (MASS)	ug/m^3
pm	2	PM 4 (MASS)	ug/m^3
pm	3	PM 10 (MASS)	ug/m^3

10.2 Diagnostics snapshots

For diagnostic purposes you can use the topic:

sphensor/<sphensor_gateway_serial>/<sensor_serial>/diagnostic

Here is an example of a message received:


```
{
      "error_rate": 0.
      "uptime": "3:28:59",
      "memory_used": 0.
      "radio":
      {
            "rloc": "016C",
            "parent_rloc": "006C",
            "in_rssi": -50.
            "tx_power": 0.
            "in_quality": 3,
            "out_quality": 3,
```

```
            "out_rssi": -50
        },
        "battery": 255
}
```


Where:

- The *rloc* field is the local id of the sensor in the mesh network.
- The *parent_rloc* field is the id of its parent, the device (BR/sensor) that is responsible for delivering messages to the child device.

10.3 Status snapshots

To get the status of the sensor use the topic:

sphensor/<sphensor_gateway_serial>/<sensor_serial>/status

Here is an example of a message received:


```
{
        "link_quality_in": 3,
        "rssi": -67,
        "link_quality_out": 3,
        "battery": 255
}
```


Where:

- The *rssi* field is the power of the radio signal; the range is -100÷0 (-100 when the signal is bad, 0 when it is good).
- The *battery* field is the battery level; the value 255 indicates that the measurement is not available.

11 Video tutorials

#	Title	YouTube link	QR Code
1	Sphensor Manager: Installation from the LSI LASTEM web site	Sphensor #1 - Sphensor Manager Program Installation	
2	Unbox the Sphensor Gateway	Sphensor #2 - Unbox the Gateway	
3	Unbox the Sphensor Sensor	Sphensor #3 - Unbox the Sphensor sensor	
4	Test the connection between the Sphensor Sensors and the Gate-way	Sphensor #4 - Connection	
5	Installation of Sphensor devices in a building	Sphensor #5 - Positioning inside the building	
6	Setup of an alternative network	Sphensor #6 - Network setup	

12 Disposal

This product is a high electronic content device. In accordance with environmental protection and recovery regulations, LSI LASTEM recommends treating the product as a waste of electrical and electronic equipment (RAEE). Its collection at the end of its life must be separated from other waste.

LSI LASTEM is responsible for the conformity of the production, sale and disposal chain of the product, ensuring the rights of the user. Improper disposal of this product will result in law penalties.

Recycle or dispose of the packaging material according to local regulations.

13 Contacting LSI LASTEM

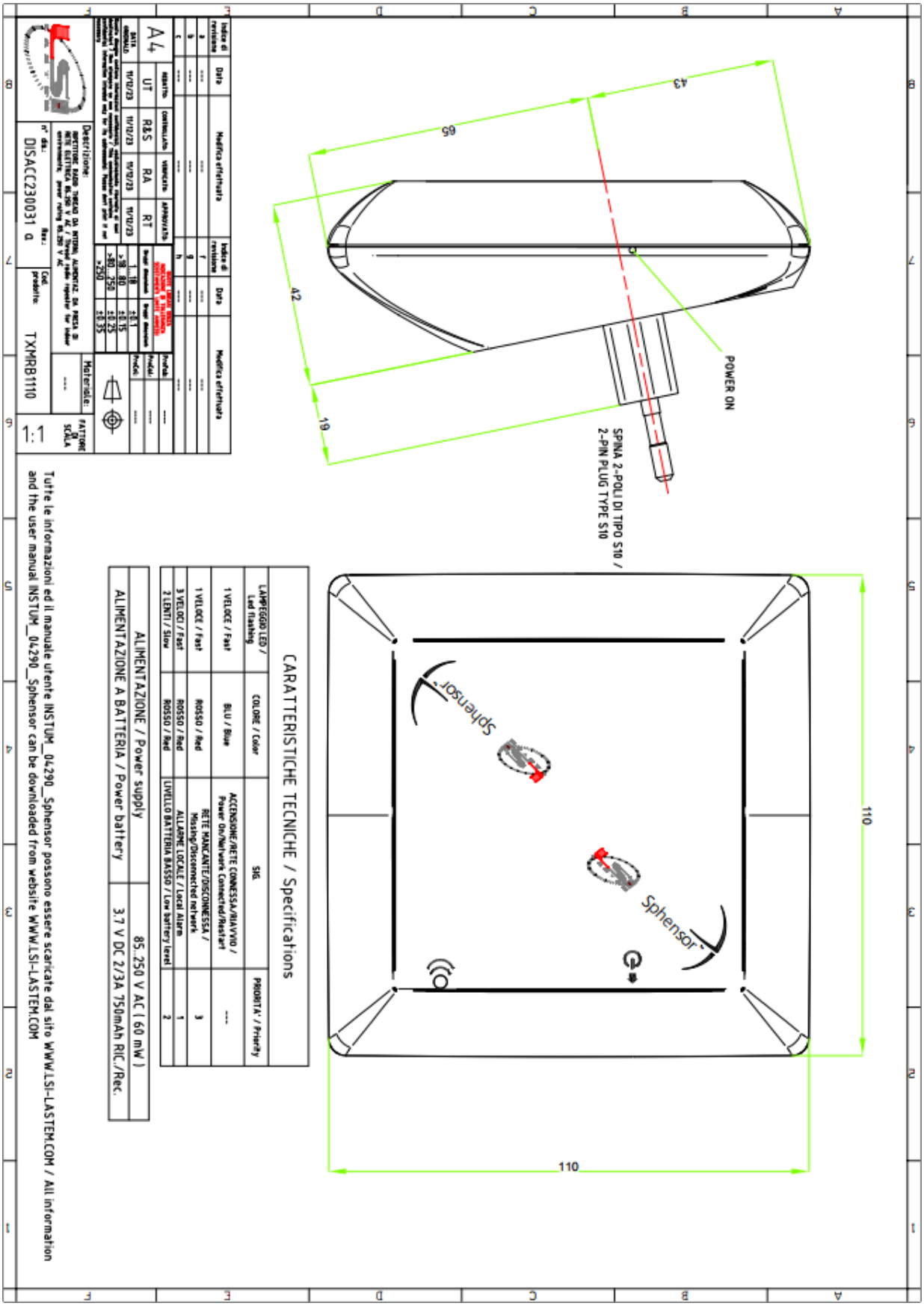
LSI LASTEM offers its assistance service at support@lsi-lastem.com, or filling out the Request for technical assistance module, downloadable from www.lsi-lastem.com.

See the following addresses for more information:

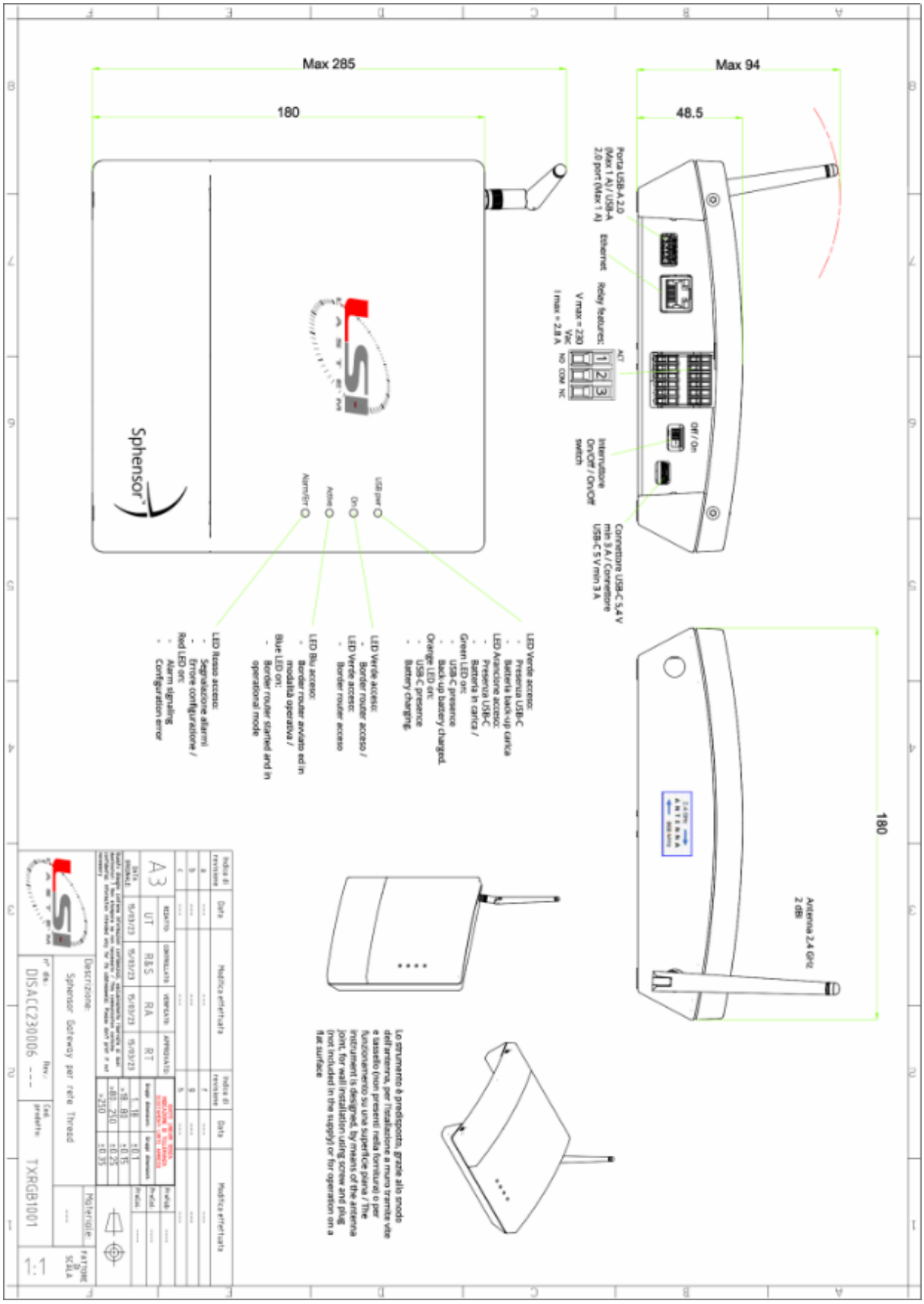
- Telephone number: +39 02 95.414.1 (switchboard)
- Address: Via ex S.P. 161 Dosso n. 9 - 20049 Settala, Milano
- Website: www.lsi-lastem.com
- Post-sale service: support@lsi-lastem.com, Repairs: riparazioni@lsi-lastem.com

Appendix

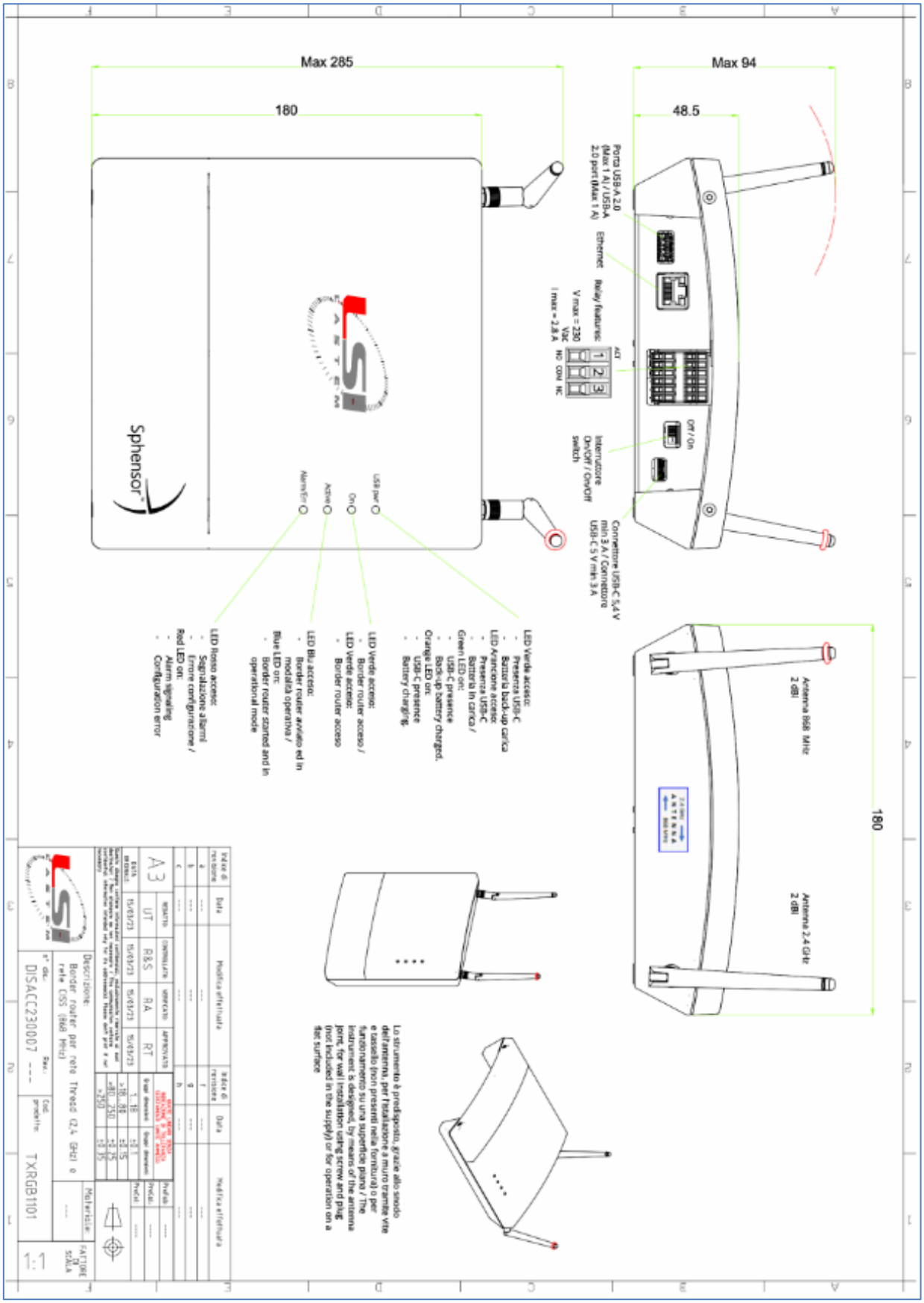
Repeater TXMRB1110



Sphensor gateway TXRGB1001



Sphensor gateway TXRGB1101



Sphensor gateway TXRGC1001