User Manual

Nubo Sphere sensor node & wind meter

Continuous methane emissions monitoring system

Version 1.1 from April 24, 2024

SENSIRION
connected solutions

IMPORTANT Safety Information

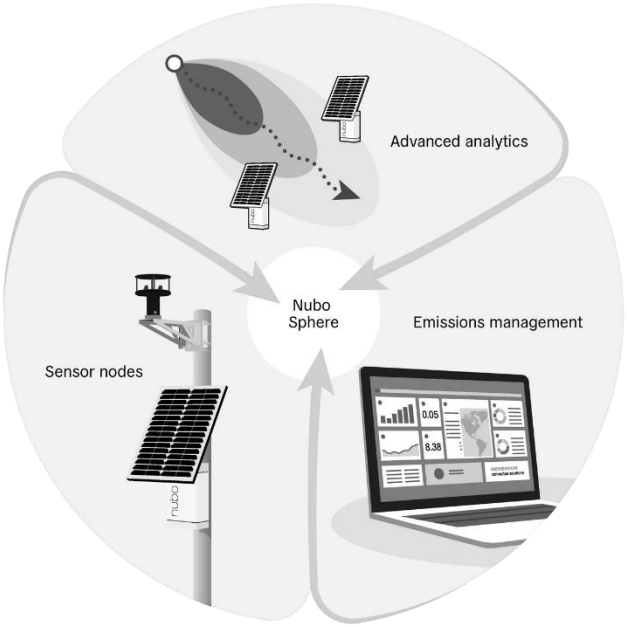
Throughout the manual, you will find caution and warning statements that require you to take cautionary measures when working with the device to avoid damage to the device or personal injury. Please read the manual carefully and follow the procedures of operation as prescribed.

Caution
Caution means that incorrect use might break the device. Failure to follow the procedures explained and prescribed in this manual might result in irreversible damage to the device.

Warning
Warning means that unsafe use of the device can result in personal injury or cause damage to the device or its surroundings. Follow the procedures prescribed.

Contents

Introduction



The Nubo Sphere methane (CH_4) emission monitoring system, based on the rugged and reliable Nubo sensor node, is an end-to-end solution for the real-time detection, localization and quantification of methane emissions. Combining Sensirion's market-leading environmental and air quality sensing expertise with our expertise in high-volume scaling solutions, the Nubo Sphere system offers high performance at a low total cost of ownership. The robust system design enables the acquisition of reliable and highly accurate data at any time. It is rapidly deployed and easy to use, and the two sensor cartridges ensure low maintenance expenses and provide a future-proof, sustainable setup.

Nubo Sphere changes the game when it comes to methane emissions monitoring. Detecting, locating and quantifying methane emissions have never been easier. The deployment of consistent ground-based methane data logging enables emission detection much earlier than was previously possible through human detection, ensuring fast, accurate and cost-saving damage control through rapid incident response actions for increased safety, reduced financial losses and regulatory compliance.

The forward-thinking system design, which features two exchangeable sensor cartridges, allows easy maintenance and sustainable upgrades to the latest sensor technology. In cases of customer-specific sensing needs or changing regulatory requirements, parameters can be added in a very flexible manner and on an as-needed basis without the need to exchange the entire system.

System description

System operation overview

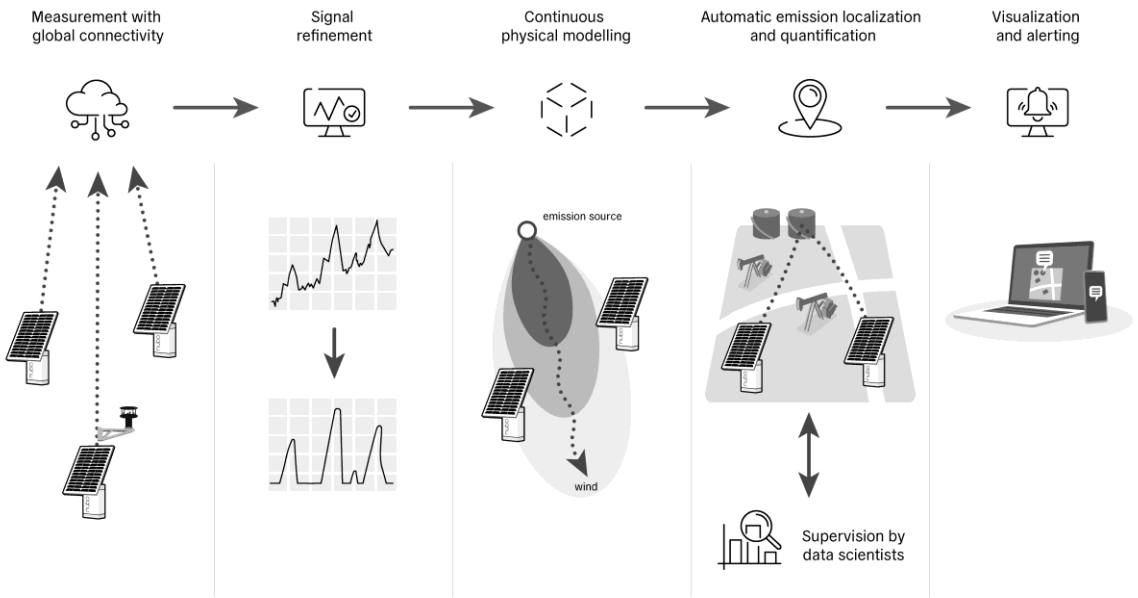
The Nubo Sphere monitoring system consists of multiple Nubo sensor nodes, a cloud-based data analytics system and a user- and smartphone-friendly web interface. The node has two slots for sensing cartridges. The cartridges can be easily exchanged for maintenance or upgrading. At the present moment, a methane (CH_4) sensing cartridge is available. The currently unused second cartridge slot could be used to extend the parameter space once other cartridges become available.

Because of the solar panel, the low-power electronics and the state-of-the-art lithium-ion batteries, the nodes operate fully autonomously, even under the most adverse conditions and without the need to deploy electric power cables. The compact size ensures easy deployment wherever needed. At least one of the nodes is equipped with a wind meter in addition to the methane sensor to enable measurement of the local wind speed and direction at any time.

The nodes constantly transmit the data to the cloud platform via LTE-M or 2G (GPRS). Every node has its own connectivity to ensure maximum redundancy, simple and rapid setup and flexibility. At the cloud level, the signals are refined to exclude artifacts and ensure maximal data fidelity. The algorithms have been developed on the basis of Sensirion's extensive specialist knowledge of the employed sensor technologies and their application in the field.

Our advanced analytics system continuously applies algorithms based on physical modeling to the refined data to detect any emissions as early as possible. The models allow for automatic and reliable localization and quantification of most emissions. The models and their output are continuously improved and supervised by our dedicated team of data scientists to improve accuracy and avoid false positives.

The status of all your sites can be easily monitored via the intuitive dashboard in any web browser or smartphone. Sites where action is most urgently required can be easily identified, and their status can be tracked during the repair process. The best mitigation action can be easily determined on the basis of the intuitive data visualization of the location and size of any emission event. If critical emission events are detected, you will receive notifications to enable your team to react rapidly.



Nubo Sphere system components and accessories

Each Nubo Sphere sensor node package contains:

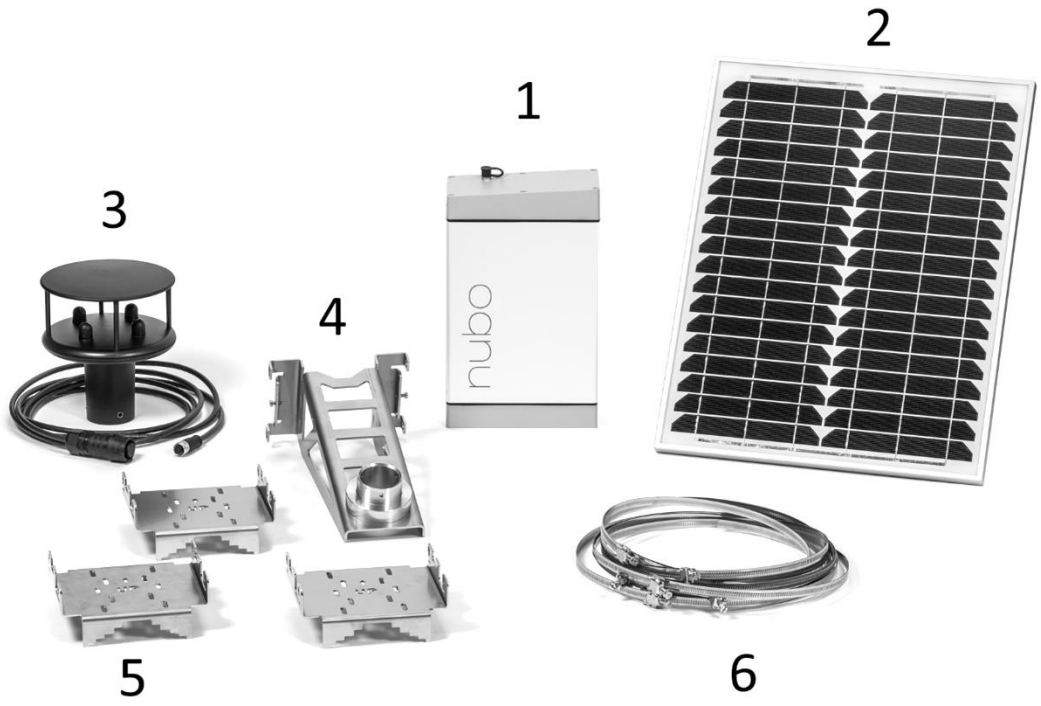
- 1 sensor node that includes a preinstalled methane sensing cartridge (see image 1 below)
- 1 solar panel with mount and cable (see image 2)
- 2 pole mounts (see image 5)
- 4 band ties for the pole mounts (see image 6)

Each Nubo Sphere wind meter package contains:

- 1 wind meter, including cable (see image 3)
- 1 wind meter mounting adapter (see image 4)
- 1 pole mount (see image 5)
- 2 band ties for the pole mount (see image 6)

For a typical installation, multiple sensor nodes (4 to 12, depending on conditions and goals for a 150 x 150 m^2 (500 x 500 $ft.^2$) site) and at least one wind meter are required. The exact numbers depend on the specifics of the installation site (e.g. its size), the installed equipment and the performance requirements. For additional details, please contact our support team or your local sales representative. Our experts can help you determine the optimum number of devices for your project.

A package of one Nubo Sphere sensor node and one Nubo Sphere wind meter contains:



Handling and mounting instructions

General safety instructions

Warning

- The methane sensing cartridge is a class 1 laser product according to the international standard IEC 60825-1:2014.

Warning

- Do not open the device. Do not modify the device in any way, including, but not limited to, exchanging the included antenna, replacing the included modem and modifying the power supply or circuit board.
- Nubo sensor nodes are to be operated only with compatible sensor cartridges provided by Sensirion Connected Solutions AG. Do not modify the cartridge or install components not supplied by Sensirion Connected Solutions AG or components not explicitly marketed to be used with Nubo sensor nodes.
- The device is to be installed in a clean and dry environment. Do not install in rainy conditions.
- The device is to be operated with the supplied powering options only. Do not attach any other power supplies. Do not use the supplied powering options for any purpose other than powering the device.
- The device contains a lithium-ion battery. Do not store or operate the device or battery in temperature conditions outside the specified range. Do not crush the device or its battery. Do not dispose of the device or battery via a fire or hot oven. Do not expose the device or the battery to extremely low air pressures. Do not replace the battery with any other type.

Caution

- The device must be installed with the sensor cartridges facing toward the ground. Do not install or operate the system in any other orientation.
- The system is designed to be water resistant to rain or spray. It is not designed to be waterproof when immersed. Do not immerse the device in water.

Installation instructions

The device comes pre-assembled with a methane sensor cartridge and a blind cover to seal the second slot. No further configurations or steps are needed to prepare the Nubo sensor nodes. They can be

deployed directly in the field, as described below. A video tutorial showing the installation steps is available on our website.

Node placement

For the entire system to operate correctly, it is important to ensure that the Nubo Sphere sensor nodes are placed at the correct positions on your site. Please check with your sales representative before installation to determine exactly where the Nubo Sphere units and the wind meter should be placed and how the wind meter should be oriented.

No elements of the system must be placed within hazardous zones. Nubo Sphere sensor nodes should be placed approximately 20 to 60 m (66 to 197 ft.) downwind of potential emission sources.
The units can be installed either on new poles or on existing infrastructure. In the latter case, ensure that no other equipment that might influence the wind patterns is in close proximity (i.e. closer than 20 m (66 ft.)) to the units, especially those devices equipped with a wind meter. In any case, ensure that the pole is fixed properly and cannot be moved or rotated by wind or other external influences.

To avoid insufficient charging of the internal batteries, please also ensure that the solar panels are not shaded by buildings or trees at any time of the day.

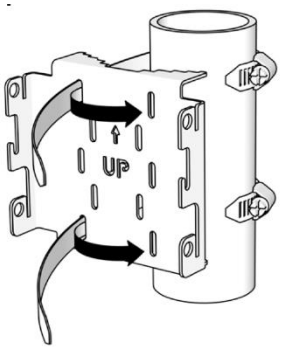
Warning

The Nubo Sphere sensor nodes are not rated for operation in hazardous zones. It is your responsibility to verify whether installation of the device is permissible by local laws or the owner of the infrastructure.

Caution

- All Nubo Sphere components need to be installed first before installing and orienting the wind sensor.
- All devices should stay within the designated areas, determined during siting with the sales representative or customer support team for optimal performance.
- After siting and installation have been completed, any reconfiguration of the Nubo Sphere positioning or changes to the site should be updated in the site configuration in the app. Failing to do so may yield incorrect results of the Nubo Sphere data analytics.
- The wind sensor needs to be oriented correctly, as indicated in the installation guide.
- The wind sensor orientation and installation height need to be correctly entered into the site configuration in the app.
- Changes to the position or orientation of the wind sensor need to be entered in the site configuration in the app. Failing to do so may yield incorrect results of the Nubo Sphere data analytics.
- Please make sure that all parameters asked during siting and installation have been stored in the Nubo Sphere system and are always up to date.

Installing pole mounts



All physical components of the Nubo Sphere system can be easily installed on a pole using the supplied pole-mount adapter. The Nubo sensor node, the solar panel and the wind meter all use the same pole-mount adapter (see image (5) in section 0). You can use any commercially available pole with a diameter between 50 and 80mm (1.95-3 in) for the one including the wind meter, and between 50 and 300mm (1.95-12 in) for the one not including the wind meter. The pole should have a height of approximately 2–3 m (6.5–10 ft.) and should be made of a suitable material that can withstand expected wind forces and support the system's weight (total approx. 6.5 kg; please compare specifications in the Nubo Sphere data sheet). The pole and attached system should not be able to rotate after installation.

Always use two band ties to fix a pole mount to the pole. Use the slits on the mount that best fit the actual pole diameter. Always tighten the band ties well. Verify that the bracket is mounted securely and cannot move or become loose. After tightening the band ties, carefully shorten protruding parts of the band ties using a strong wire cutter. Please be careful: the cut surfaces can have sharp edges. Wear protective gloves and smooth out the edge with a file.

Warning

- Using the pole-mount adapters may result in scratch marks or abrasion on the chosen pole. By installing and using this mounting kit, you accept that Sensirion Connected Solutions AG is not liable for any damage resulting from the installation and use of the pole-mount adapters.
- Plastic zip ties might age or break due to environmental influences. Only use metal bands or similarly reliable mounting bands.
- Cut surfaces can have sharp edges. Always wear gloves and safety glasses when cutting metal band ties and use a file to smooth the edges.

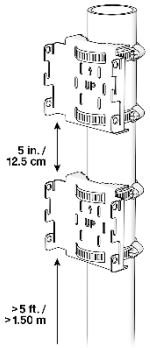
There are two installation variants to choose from, depending on the actual location. All sensor nodes are installed in conjunction with a solar panel. The necessary components are included in the Nubo Sphere sensor node package. In most situations, one node per site is equipped with an additional wind meter, which requires a Nubo Sphere wind meter package.

Two pole mounts are usually required: one for the sensor and one for the solar panel. Alternatively, a third pole mount is needed if a wind meter is to be connected to the node.

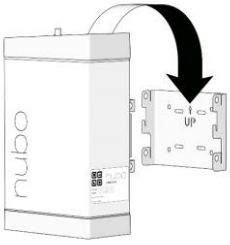
Node without wind meter

1. Fix two mounting plates to the pole with a 12.5 cm distance between the plates (12.5 cm is the height of a mounting plate). The lower plate should have at least 1.5 m (5 ft.) clearance from the ground. A higher clearance may be suggested by the sales representative during siting to accommodate local site settings. All sensor nodes on a site should have the same clearance to the ground, unless otherwise indicated.

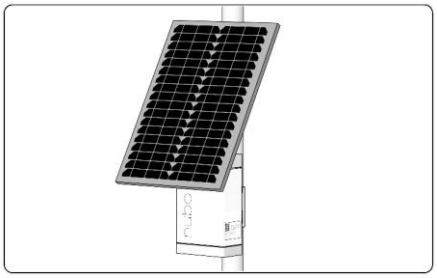
   All plates should face the orientation of the sun at noon. The plates should therefore face south in the Northern Hemisphere and north in the Southern Hemisphere.



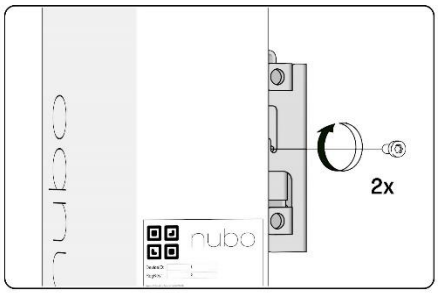
2. Once the mounting plates are installed, you can simply attach the sensor node and the solar panel by sliding the corresponding backplate onto the mounting plate.



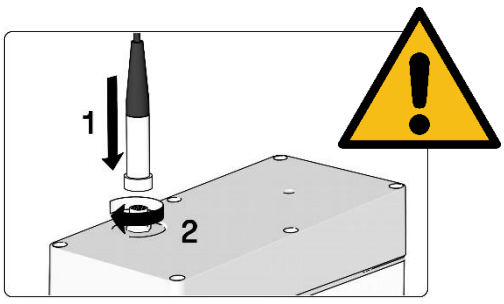
3. Mount the sensor node to the lower plate and the solar panel to the upper plate.



4. For ease of installation, the mounts are designed so that the node and the accessories remain in place without the screws being tightened. However, it is important to tighten both screws on each side of every mount to ensure safe and secure fixation of the system under all weather conditions. Do not overtighten the screws.

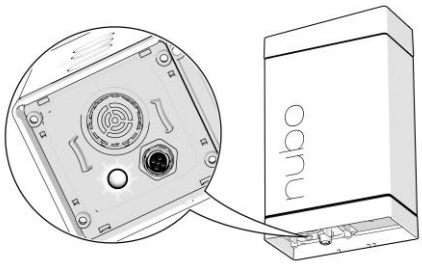


5. Connect the solar panel to the cable power plug on top of the sensor node. **Make sure to properly align the connector to the socket, and not to force the connection**. **A miss-plugged cable will prevent charging of the battery.**
   Always tighten the union nut to ensure proper protection from water ingress.



6. Once powered, the device will start up automatically, perform a self-test and then establish communication with the cloud. During this time, the LED will blink yellow.

   Once the device is working correctly, the LED will turn solid green for one minute. Afterwards, it will turn off to save power. If any error occurs, the LED will flash red.



Warning

- It is your responsibility to verify whether installation of the device is permissible by local laws or by the owner of the infrastructure.
- It is the responsibility of the person installing the device to ensure a secure and safe installation. Sensirion Connected Solutions AG cannot be held liable for damage or injuries due to improper placement or installation.
- Do not install or operate the device or any accessories without first tightening the lateral mounting screws. Always check that the device and accessories cannot be removed. Failing to do so may result in injury or damage to the device.

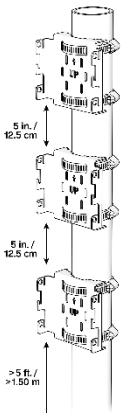
Caution

Do not install the power connector without tightening the union nut.

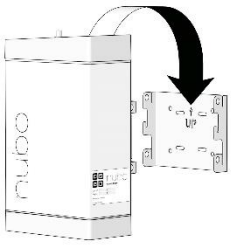
Node with wind meter

1. This node and the wind meter should be installed last. Fix three mounting plates to the pole with a 12.5 cm distance between all three plates (12.5 cm corresponds to the height of a mounting plate). The lowest plate should have at least 1.5 m (5 ft.) clearance from the ground. A higher clearance may be suggested during siting by the sales representative to accommodate local site settings. All sensor nodes on a site should have the same clearance to the ground, unless otherwise indicated.

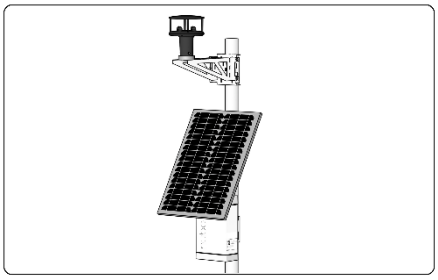
   All plates should face the orientation of the sun at noon. The plates should therefore face south in the Northern Hemisphere and north in the Southern Hemisphere.



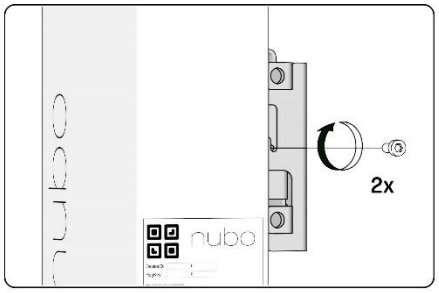
2. Once the mounting plates are installed, you can simply attach the sensor node and the solar panel by sliding the corresponding backplate into the mounting plate.



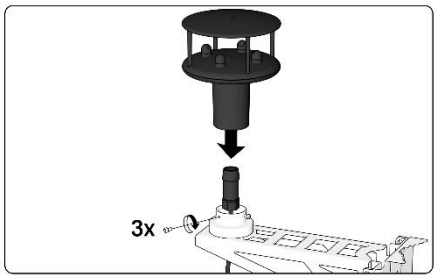
3. Mount the sensor node to the bottom plate, the solar panel to the middle plate and the wind meter arm to the upper plate.



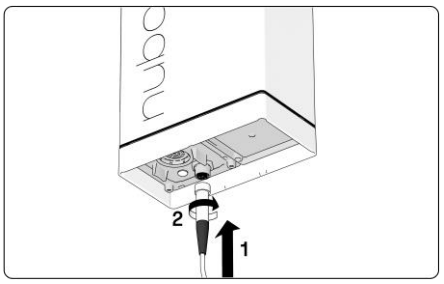
4. For ease of installation, the mounts are designed so that the node and the accessories remain in place without the screws being tightened. However, it is important to tighten the screws on the side to ensure safe and secure fixation of the system under all weather conditions. Do not overtighten the screws.



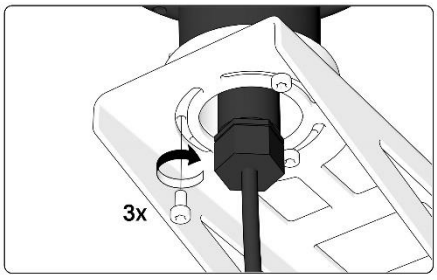
5. Connect the wind meter cable to the wind meter. Ensure that you hear a “click”, then thread the cable through the hole at the wind meter mount.
   Place the wind meter on the adapter and orient it approximately to another sensor node: the red mark on the wind meter should point toward another sensor node **at least 20 m (66 ft.) away and in direct line of sight**. If there is no line of sight, alternatively orient the wind meter to a landmark that you can precisely describe or north (not recommended). Fix the wind meter with the two supplied screws.



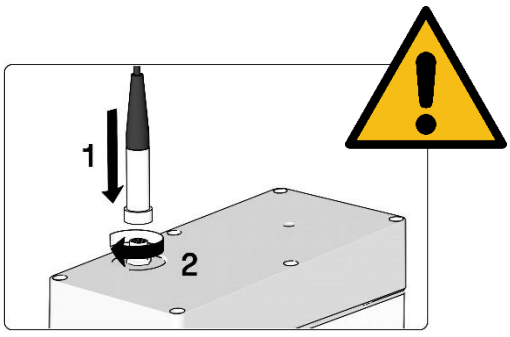
6. Connect the other end of the wind meter cable to the connector on the cartridge at the bottom of the Nubo Sphere sensor node.



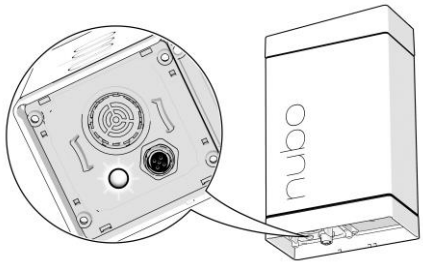
7. Carefully align the wind meter. For correct alignment, **the arrow and the red mark on the wind meter must point exactly toward another sensor node on the site, that is at least 20 m (66 ft.) away and in direct line of sight**. Secure its orientation by tightening the three screws on the bottom of the mounting adapter.
   In the web application, please either directly enter the IDs of the unit on which the wind meter is mounted and the ID of the unit toward which the wind meter is oriented (or the landmark or the angle to the north). Alternatively, note down for later configuration.



8. Connect the solar panel to the cable power plug on top of the sensor node. **Make sure to properly align the connector to the socket, and not to force the connection**. **A miss-plugged cable will prevent charging of the battery.**
   Always tighten the union nut to ensure proper protection from water ingress.



9. Connecting the cable turns the device on automatically, resulting in the device emitting a sound sequence. It will then perform a self-test and establish communication with the cloud. During this time, the LED will blink yellow.
   Once the device is correctly working, the LED will turn solid green for one minute. Afterwards, it turns off to save power. If any error occurs, the LED will flash red.



Warning
• It is your responsibility to verify whether installation of the device is permissible by local laws or the owner of the infrastructure. • It is the responsibility of the person installing the device to ensure secure and safe installation. Sensirion Connected Solutions AG cannot be held liable for damage or injuries due to improper placement or installation. • Do not install or operate the device or any accessories without first tightening the lateral mounting screws. Always check that the device and accessories cannot be removed. Failing to do so may result in injury or damage to the device.

Caution
Do not install the power connector without tightening the union nut.

Before leaving the site

Please take the following steps before leaving the site:

Physically check the devices

1. Make sure that the pole is fixed properly (so that it cannot rotate or move).
2. Check that the Torx screws are tightened, and the mounting plates cannot move.
3. Make sure the wind sensor orientation is correct – check physically that it cannot move.
4. Make sure that the solar panel is connected properly to the sensor node.
5. Make sure that the wind sensor is connected properly to the sensor cartridge.

Note down or input important information to update the application

6. Note down and keep safe the installation height of devices (sensor nodes + wind sensor): input the data in the app or note down the clearance from the bottom of the device to the ground as well as the distance between the bottom of the wind sensor and the ground.
7. Make sure that the wind sensor node and the node to which the wind sensor is oriented are at least 66 ft. / 20 m apart.
8. Store or note down the type and the height of the equipment on site.

Check the application

9. Check that all devices have been registered correctly: Make sure that in the installation app, all devices are visible on the device list and all checkmarks are green.

Maintenance

General

The device requires minimal maintenance. The currently provided MOx sensor technology does, however, have a limited lifetime. When required to exchange the cartridge with a new factory-calibrated spare, please follow the steps below. Otherwise, the system does not require regular maintenance.

Cartridge replacement

Turn off the device before removing any cartridge. Ensure that the power source cable at the device side is disconnected.

Using a Torx T7 screwdriver, unscrew the four screws securing the cartridge. Then, working in clean and dry conditions, remove the cartridge by pulling on the small plastic handles on the cartridge. **If a cartridge is stuck, do not force it. Remove the other cartridge first and try to separate the stuck cartridge from the device using a flathead screwdriver.** When removing the cartridge, ensure that the internal elements of the device remain clean and dry. Loosen all four cartridge screws before attempting to remove the cartridge. Then grip the external parts of the cartridge and pull the cartridge in the direction opposite the direction of installation.

Insert the replacement cartridge into the now-empty slot. Insert the cartridge until you hear and feel it snap into place. Fix the cartridge inside the device by tightening the integrated screws. These screws are intended to prevent unwanted removal of the cartridge and to secure it in place.

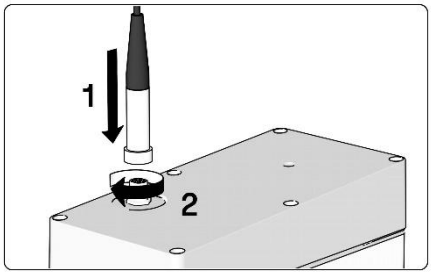
Note: new cartridges do not require any extra calibration or configuration. The device or system will configure the new cartridge automatically.

Caution
• Always use the supplied blind cover to protect unused cartridge slots from environmental influences. • Always disconnect the device from its power source before removing or installing a cartridge to avoid damage to the device. It is important to disconnect the cable from the device to power down the device correctly. • Do not tighten the screws of the cartridge forcefully. Only tighten them by hand and without excessive force to avoid wearing of the threads. • When removing the cartridge, only pull on the plastic parts. Never pull on the connector as doing so might adversely influence the water ingress protection.

General handling

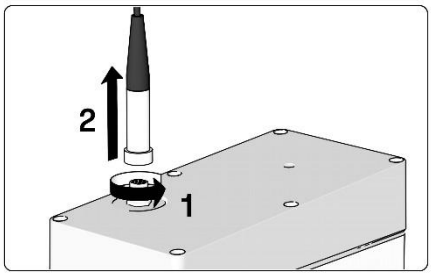
Powering up the device

The power connector of the device functions as an on/off switch. To power up the device, simply connect the power cord to your power source. Please always tighten the union nut to ensure proper protection from water ingress.

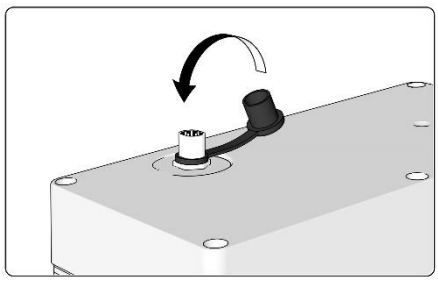


Powering down the device

To power down the device, unscrew the nut and unplug the cable at the device side.



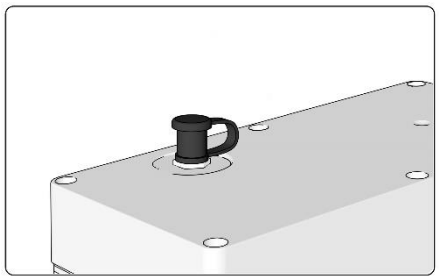
Unplugging the cable will turn off the device and disconnect the battery for transport. After the device has been powered down, be certain to correctly install the protective cap to protect the pin's connector and avoid corrosion or dirt build-up.



Storage

The system operates whenever a power source is connected to it. Therefore, when storing the device, please always disconnect the cable of the power source from the device as described in section 0. This procedure ensures that the system is turned off, avoiding deep discharge of the battery. Only store the device when you are confident that the battery was well charged.

When storing the device, please always ensure that the protective cap is securely placed on the power connector to protect the pins and avoid corrosion.



Warning
The device contains batteries. Store the device within the specified temperature range: **–20 to 60°C**. Store in a noncondensing environment. When the device is stored for an extended period, be certain to reconnect it to an external power source every **six months** to prevent battery damage.

Caution
Always place the protective cap on the power socket of the device whenever no plug is connected to avoid corrosion of the contacts.

Shipment

Note that the device includes a large buffer battery and will continue to run unless the device-side connector of the power cord is disconnected. Before transporting or shipping the device, powering down the device as described in section 0 is critical. The device contains batteries; please ensure correct handling and labeling when shipping the device.

Warning
• The device contains batteries. Store the device within the specified temperature range: **–20 to 60°C**. Store in a noncondensing environment. • When the device stored for an extended period, be certain to reconnect it to an external power source every **six months** to prevent battery damage. • Do not ship if damage to the battery is suspected. Ensure that the box is properly labeled to comply with international law.

Conformity information

European conformity information

Hereby, Sensirion Connected Solutions AG declares that this radio equipment is compliant with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at https://cloud.nubo-sphere.com/docs/eu-doc.

FCC notice

Warning
Do not open the device. Do not modify the device in any way, including, but not limited to, exchanging the included antenna, replacing the included modem and modifying the power supply or circuit board.

Contains FCC IDs: XMR201707BG96

NOTE: this equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio-frequency energy and, if not installed and used in accordance with the instructions, can cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to attempt to correct the interference using one or more of the following measures:

- Reorient or relocate the receiving antenna;
- Increase the separation between the equipment and receiver;
- Connect the equipment into an outlet on a different circuit to that which the receiver is connected to;
- Consult the sales representative or an experienced radio/TV technician for assistance.

Frequency band(s) and maximum radio-frequency power transmitted

This product includes the following features and characteristics:

- BDS
  - Operating frequency range: 1559–1610 MHz
- GLONASS receiver
  - Operating frequency range: 1559–1610 MHz
- GPS receiver
  - Operating frequency range: 1559–1610 MHz
- GSM 900
  - Operating frequency range: 880–915, 925–960 MHz
  - Maximum output power: 33 dBm rated
- GSM 1800
  - Operating frequency range: 1710–1785, 1805–1880 MHz
  - Maximum output power: 30 dBm rated
- LTE FDD Band 1
  - Operating frequency range: 1920–1980, 2110–2170 MHz
  - Maximum output power: 23 dBm rated
- LTE FDD Band 3
  - Operating frequency range: 1710–1785, 1805–1880 MHz
  - Maximum output power: 23 dBm rated
- LTE FDD Band 8
  - Operating frequency range: 880–915, 925–960 MHz
  - Maximum output power: 23 dBm rated
- LTE FDD Band 20
  - Operating frequency range: 832–862, 791–821 MHz
  - Maximum output power: 23 dBm rated
- LTE FDD Band 28
  - Operating frequency range: 758–803, 703–748 MHz
  - Maximum output power: 23 dBm rated

Important legal notices

Warning: personal injury
Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. Do not use this product for applications other than its intended and authorized use. Before installing, handling, using or servicing this product, please consult the manual and data sheet. Failure to comply with these instructions could result in death or serious injury. Please also consult local laws and regulations, in particular with regard to the radio frequencies used by this product.
If the buyer purchases or uses SENSIRION CONNECTED SOLUTIONS (SCS) products for any unintended or unauthorized application, the buyer shall defend, indemnify and hold harmless SCS and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages, expenses and reasonable attorney fees arising from, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if SCS is allegedly negligent with respect to the design or the manufacture of the product.

Ancillary services required
This product is part of the SCS continuous methane emission monitoring solution "Nubo Sphere" and requires the "Environmental Monitoring as a Service" (EMaaS) subscription available from SCS for proper functioning. SCS reserves the right, without further notice, (i) to change the product specifications or the information in this document, (ii) to improve the reliability, functions and design of this product and (iii) to modify the cloud service and data analytics algorithms.

Revision history

Date	Revision	Page(s)	Changes
2023-03-23	1.0	All	Initial release

Contact

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