SPIRIT
Radon Detector

Spirit Radon detector

Version 1.0

radonova
The global leader in radon measurement

1.0   Getting started

1.1   Included parts

SPIRIT includes the following parts:

- SPIRIT radon device
- USB adapter & cable
- Quick start manual

1.2   Quick start guide

For detailed instructions, see section 3.0. This section is a quick start to easily get started with a measurement.

1. Place the device where you want to measure radon.

2. Power the device by pressing and holding down the power button for 3 seconds until the LED indicates blue.

3. Verify that the device is measuring by pressing the status button. See the section about LED indicators for more information.

4. To see your measurement, please visit https://spirit.radonova.com. Here you can create an account and add your device to your account.

5. When your measurement is complete, power down the device by pressing and holding the power button for 3 seconds until the LED indicates red. If you also want to power down the network connection, press and hold both status- and power button for 3 seconds.

2.0   Disclaimer

FCC Compliance Statement

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
CAUTION: The grantee is not responsible for any changes or modifications not expressly approved by the party responsible for compliance. Such modifications could void the user's authority to operate the equipment.

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, may 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 try to correct the interference by 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 circuit different from that to which the receiver is connected.
– Consult the dealer or an experienced radio/TV technician for help.

RF exposure statement

This equipment complies with the FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and any part of your body.

Canadian Compliance Statement

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada license-exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licencecontenudans le présentappareilestconformeaux CNRd'Innovation, Sciences et Développementéconomique Canada applicables aux appareils radio exempts de licence. L'exploitationestautorisée aux deux conditions suivantes :

1) L'appareil ne doit pas produire de brouillage;
2) L'appareildoitaccepter toutbrouillageradioélectriquesubi, mêmesi le brouillageest susceptible d'encompromettre le fonctionnement.

RF exposure statement

This equipment meets the exemption from the routine evaluation limits in section 2.5 of RSS-102. It should be installed and operated with a minimum distance of 20cm between the radiator and any part of your body.
Cetéquipementestconforme à l'exemption des limitesd'évaluationhabituelle de la section 2.5 de la norme RSS-102. Il doitêtreinstallé et utilisé à une distance minimale de 20 cm entre le radiateur et toutepartie de votre corps.

2.1   Environmental

The trash-symbol on the product or on its packaging indicates that this product must not be disposed of with your other household waste. Instead, it is your responsibility to dispose your waste by taking it to a collection point designated for the recycling of electrical and electronic appliances. Separate collection and recycling of your waste at the time of disposal will contribute to conserving natural resources and guarantee recycling that respects
the environment and human health.

For further information concerning your nearest recycling center, please contact your nearest local authority/town hall offices, your household waste collection company or the shop where you bought the product.

2.2   Safety

Warning!
Risk of explosion if the battery is replaced with an incorrect type of battery.

Warning!
Disposal of a battery into fire or a hot oven, or mechanically crushing or cutting of a battery can result in an explosion.

Warning!
Leaving a battery in an extremely high temperature surrounding environment can result in an explosion or the leakage of flammable liquid or gas.

3.0   Instrument operation

3.1   Start and stop of measurement

The instrument is started and stopped using the power-button on the device. The button must be pressed for three seconds until the measuring LED lights up in blue, then release. The instrument starts measuring immediately when it is started.

3.2   Measure series

Each time the device is started with the power button, a new measure serie is started. This can be used to distinguish between different measurement locations. When retrieving and analyzing the data, it will be grouped by measurement series.

3.3   LED-indicators

The device has three status-leds which will light up each time the status button is pressed.

3.3.1   Battery indicator

Indicates battery level. The LED is flashing when the battery of the device is charging.

● > 80%   ● 30 - 60%   ● < 30%   ◕ **Charging**

3.3.2   Network indicator

Indicates network status. It usually takes a few seconds for the device to connect to LoRa-network if it is available. **Note:** The LED indicates if a successful connection has ever been made to the network since the latest startup of the device, not the current network status.

Important Note: If the device is physically moved after it has been successfully connected, it might loose its reach from the current network. If this happens, the LED will still indicate as connected. It is always recommended to force a reconnection to the network once the device is moved. Hold and press power and status (Or only power if version >1.3) to power down the device. Start the device with power button.

Please visit https://spirit.radonova.com to see and monitor latest connection status for the device.

● **Connected**   ◔ **Connecting**

3.3.3   Measurement indicator

Indicates if a radon measurement is active or not.

● **Measuring**   ○ **Not measuring**

3.4   Buttons

3.4.1   Power button

Requires to be pressed for three seconds. Turn on and off the device.

3.4.2   Status button

A simple press turns on the status led indicators.

3.4.3   Combinations

By holding both status- and power button for three seconds when turning off the device, the device will also disconnect from the LoRa-network. Can be used to save power when storing the device, or to force a reconnect to the LoRa network.

3.5   Network

The device uses the IoT network LoRaWAN (Long Range Wide Area Network) to transfer data wirelessly. Data is transferred every 10 minutes. For more information, see section 5.0.

3.6   Access of data

Data can be accessed through Radonovas online portal where it can be visualized and downloaded. Data can also be accessed through Radonovas REST-API which enables automatic export to any preferred system.

The online portal can be found at https://spirit.radonova.com.

3.7   Radon reports

Reports can be created using Radonovas online portal. The report creator includes powerful tools to create customized reports based on the post-processed data.

Features in the report creator tools:

- Add graphs and tables with data from the device. Climate parameters, tampering detector, and radon values (Including measurement uncertainty)

- Set a start and stop value for the measurement

- Compare working hours to non-working hours. Create a factor between the result.

- Add comments, data about the building and person responsible for measurement

- Data about latest calibration for device

Note: The radon reports are only available for the Spirit *Logger*.

3.8   Battery and charging

The battery can be charged using Micro-USB. It is recommended to charge the battery when the battery indicator is red.

If required, the device can also be supplied with 10-28V AC/DC. See section 4.4.3.

4.0   Instrument installation

4.1   Wall mount

The instrument may come with or without a wall mount. If a wall mount is supplied with the device, it can easily be installed with a snap on mount to the wall. Use the supplied snap on bracket and mount it to the wall using four screws sutiable for your type of wall.

4.2   Without wall mount

Simply place the device where you want to start measure.

4.3   Lock the device

The device can be locked using a standard locking cable.

### 4.4   Powering the device

4.4.1   Battery

The device has an built-in battery (3.7V Li-ion) which is used to power the device. When the battery status indicator is red, it is time to charge the device.

4.4.2 Micro-USB

The device can be charged using the supplied Micro-USB cable. The device is fully charged when the battery status led is green and is no longer flashing.

4.4.3 10-28V AC/DC

If a more permanent solution is required, the device can be supplied with 10-28V AC/DC. To do this installation, the encapsulation lid first needs to be removed. Remove the four screws on the back of the device and install the power cable in the socket on the circuit board. See figure to the right.
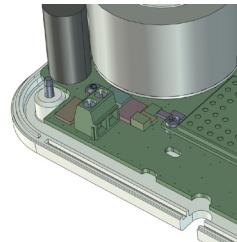
5.0 Instrument technical details

5.1 Technical specification

Measurement principle	Semiconductor detector with alpha spectroscopy
Measurement range	0 – 100.000 Bq/m^3
Measurement uncertainty	< 15% after 6h at 200 Bq/m^3
Minimum detectable activity	25 Bq/m^3 at 1 hour integration time
Connectivity	Wireless data transfer LoRaWAN
Temperature range	-10°C – 50°C
Humidity range	0-90% (Non condensing)
Usage height above sea level	0 – 2000m
Power connection	5V Micro USB or 10-28V AC/DC
Battery time	>60 days
Weight	360g

5.2 Radon detector technology

SPIRIT uses a semiconductor detector to detect energy from alpha particle which decays from radon particles. The detector is capsulated in a high voltage chamber which forces the charged radon daughter particles upon the semiconductor area in the bottom of the decay chamber.

The decay energy is measured when an alpha particle hits the detector surface. The number of detected decayed particles for a set time period is stored internally in the device as an energy spectrum. This makes it possible to distinguish between different decay types, since all alpha particles has a different decay energy. SPIRIT detects alpha decay from Rn-222, Po-214, Po-218 and Po-210.

5.3 Other sensors

SPIRIT is equipped with a temperature-, humidity- and pressure sensor. It also has an accelerometer to detect movement of the device. The data from the sensors is stored along with the decay spectrum from the radon detector.

5.4 Transfer of data

SPIRIT transfers data wirelessly using the IoT protocol LoRaWAN. This is the only way to transfer data from the device. When the device is connected to a LoRa-network, the device will transfer data every 10-minutes. The data is transmitted to Radonovas server for post-processing and further access through multiple options.

SPIRIT   **LoRaWAN Gateway**   **Radonova application server**   **My pages / API**
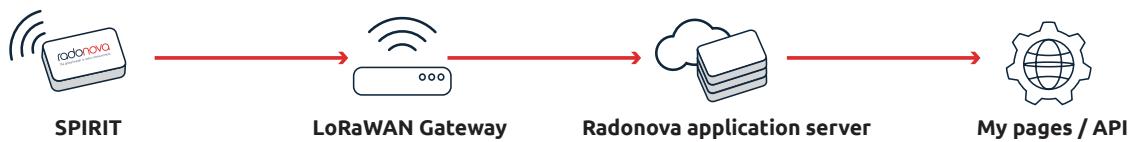
A LoRaWAN-gateway is required to transfer data, however, the gateway can be of different types. Some larger cities have full coverage with existing permanent gateways. If no coverage exists, one can use a portable (Wifi-router sized) gateway which utilizes the 4G mobile network to transfer data. This can be ordered along with the device. The gateway can also connect to Internet via Ethernet.

If a measurement is done when the device doesn't have reception, the data will automatically be transferred as soon as the device gets coverage again, see section 5.5.

5.5　Resending of "lost" data packages

Data packages sent from the device can be lost in the transmission. This can be due to multiple reasons, but the most common one is that the device is too far away from a gateway, or that the device has been moved to a new location and the network signal strength modulation (See 5.6) has not adjusted the signal strength yet.

For data packages that are lost, Spirit features automatic resending of them. Each time a data packet is succesfully received to the server, a check is performed if all previous data packages have been received correctly (Each data packet have a sequence number). If not, a request queue is initiated. The request queue will prioritize the most "important and recent" packages first. If a queue exists, this can be visualized at https://spirit.radonova.com.

Note: Resending of packages might take some time due to the limiations of LoRa-network. Approximately 8 data packages can be resent every 10 minutes.

Second note: Not all packages are resent. The time resolution between presented radon level points will be limited to 1 hour for requested packages, instead of 10 minutes as for "real-time" streamed data packages. Because a minimum intregration period of 1 hour is always used, this strategy will not affect the calculations and result of the radon level.

Important! In order for the device to be able to transfer "lost" data packages, the device needs to be in measuring mode and not turned off.

5.6　LoRaWAN modulation of signal strength

The LoRa-network uses modular signal strength to keep collision of data packages at a minimum. This technique enables the network to tell the devices which signal strength they are allowed to send at. For example, a device closer to a gateway is not required to send with as strong signal as a device further away. This can cause issues for devices that are moved between different locations, because it takes time for the device and network to re-adjust the signal strength to the new location. This could lead to potential loss of packages.

Our recommendation is to force a re-connection of the device to the network if the device has been moved a significantly distance from the previous location. This is done by pressing and holding both power- and status button down for 3 seconds, and then start it again with the power button only (See 3.4).

5.7　Processing of data

Post-processing of the raw sensor data is done on Radonovas application server. It converts the raw sensor data to an actual radon level value presented in Bq/m^3. Radonovas unique 'smart'-algorithm switches between different integration periods by analyzing the energy decay spectra. For example, if the radon level is analyzed as stable, a longer integration period is used in order to get a more accurate radon value with lower error. If rapid changes in the radon level is detected (For example due to start of ventilation system), a shorter integration period is used. The intregration period varies from 1h-3h.

Factory calibration is always carried out for each device. The calibration data is stored on Radonovas server and is compensated for in the post-processing of the data.

Compensation for climate data from the sensors on the device is also done in the post-processing.

Post-processing is always done in real time. As soon as new sensor data is sent from the device, post processing is carried out.

6.0   Calibration

Radonova recommends the device to be calibrated each year. However, requirements of calibrations might differ between authorities in different countries.

7.0   Troubleshooting & FAQ

The device is not connecting to a network, the LED indication flashes
Make sure that you are within range of a LoRa-network. If you are using a portable LoRaWAN-gateway, make sure that it is turned on.

Try to reconnect to the network by pressing and holding both power- and status button down for 3 seconds, and then start it again with the power button only (See 3.4).

Where can I see the measurement data?
Please visit https://spirit.radonova.com (Section 3.6)

How often is the device required to be calibrated?
Radonova recommends calibration every year. (Section 6.0)

The device indicates that it is connected to a network, but on the online portal no data is shown.
(See section 3.3.2 and 5.6) It might be because the gateway/device has been moved, and the device haven't been able to adjust the signal yet.

Try to reconnect to the network by pressing and holding both power- and status button down for 3 seconds, and then start it again with the power button only (See 3.4).

6.0   Contact

6.1   Company

Radonova Laboratories AB

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6.2   Service and support

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