Radon sensors ÆR² / ÆR²+ / ÆR²C

USER GUIDE

www.algade.com

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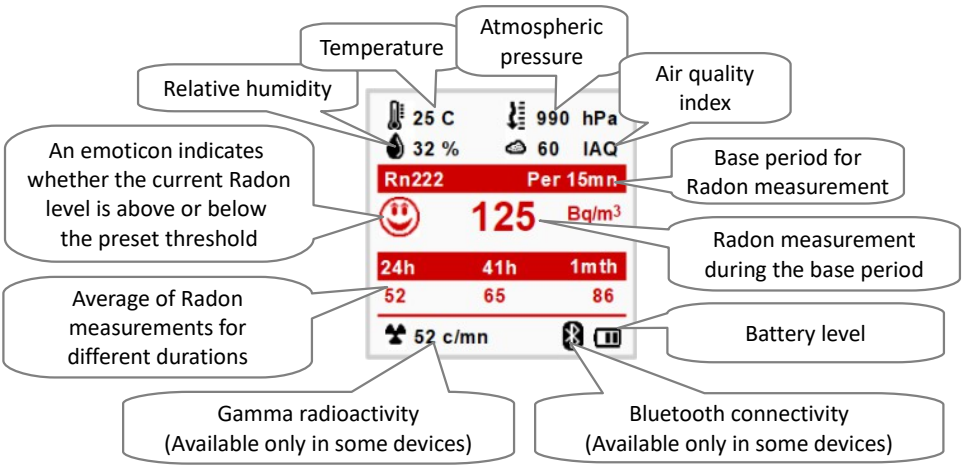
● DISPLAY DESCRIPTION



● HOW TO USE YOUR RADON SENSOR ?

1. Place your Radon monitor in the room to be analyzed. Ideally, position the Radon monitor at breathing height (Avoid placing it near the ground or on top of a piece of furniture).

2. Initialize the Radon monitor by **pressing the button until the LED lights red (Approximately 5 seconds)**. The screen displays “Measuring, please wait”.

3. After 60 minutes (or 15 minutes depending on the device model), a first value is displayed. The value is updated every 60 min (or 15 min depending on the device model).

4. Allow your Radon monitor to measure for a sufficient amount of time. The lower the Radon level measured, the longer it is necessary to let the device measure. Ideally, a **measurement of at least 24 hours is recommended**.

5. Whenever you want to put your Radon monitor in a different room, or perform a new measurement in the same room, go back to step 1. Do not forget to reset your device by pressing the button for 10 seconds to reset average values.

*Your Radon detector can remain on permanently without risk. However, **in order to turn it off during a long period of inactivity, press and hold the button until the LED turns green (approximately 10 seconds)**. To turn it back on, press and hold the button again for a few seconds.*

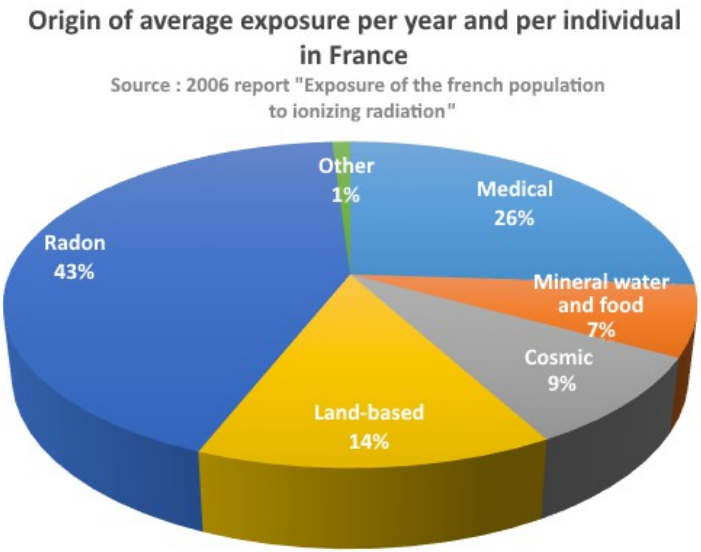
● RADIOACTIVITY, IN SHORT

Natural and artificial radioactivity

Source : www.irsn.fr

Radioactivity is a natural phenomenon that has existed since the origin of the Universe, billions of years ago, when atoms were formed. Although built on the same model, all atoms do not have the same properties : some are stable and remain unchanged indefinitely, while others are unstable. To acquire better stability, the latter, called **radionuclides**, expel a quantity of energy in the form of radiation and/or particles : this phenomenon is called "**radioactivity**".

In our daily lives, we are in constant exposure with radioactivity, in the proportions of the graph below. This may be of **natural** origin, from the Earth, the cosmos or in our food, but also of **artificial** origin, during examinations or medical therapies or even from discharges from nuclear installations or via ancient nuclear weapons tests in the atmosphere.

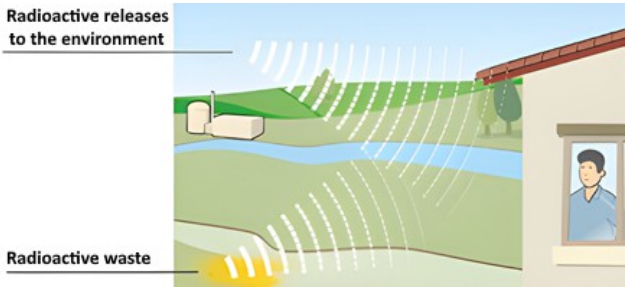


Contamination and radiation exposure

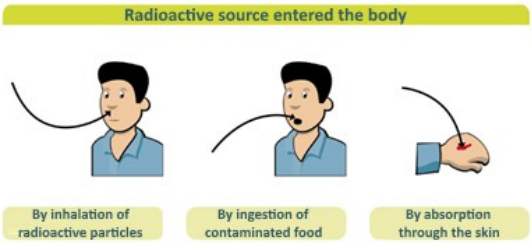
Source : www.irsn.fr

There are two types of exposure to radioactivity :

First of all, the term **irradiation** corresponds to **external** exposure. Indeed, radionuclides are naturally present in our environment. Therefore, each of us is more or less exposed to one or two of the ionizing radiation (particle or wave) that it emits. Naturally, this radiation comes from the cosmos, from Radon, or from human activity (mainly medicine but also nuclear industry). This external exposure ceases when the source of radioactivity is further from the person or if a screen (shielding) is interposed between the person and the source.



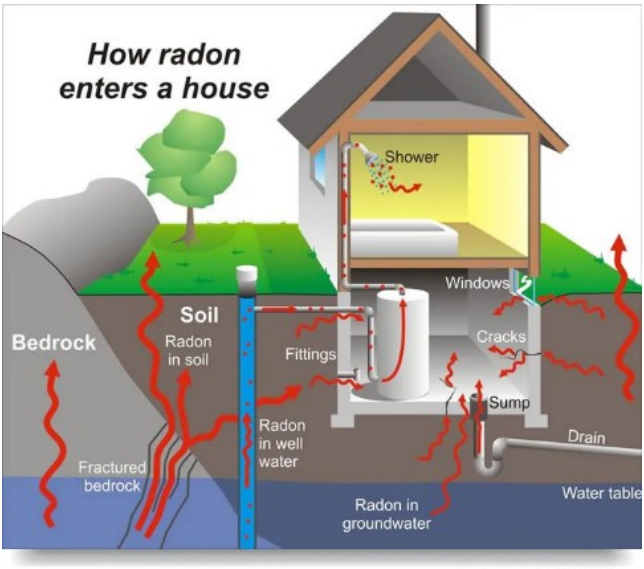
On the other hand, the term **contamination** corresponds to an **internal** exposure (the radioactive particles have penetrated into the body).
Three modes of internal exposure are possible (see diagram below): For example, Radon, a natural radioactive gas which emerges from the ground, generates various radioactive atoms which are present in the air and can therefore enter the lungs by inhalation and settle there. This internal exposure continues as long as the source is inside or in contact with the body.



What is Radon ?

Source : www.irsn.fr

Radon, a radioactive gas of natural origin, represents a major part of the average exposure of the populations to ionizing radiation. It is present everywhere on the surface of the Earth in varying concentrations depending on the region. It is odorless and colorless and diffuses through the floor or walls in homes.
When your indoor air is not sufficiently renewed, it can accumulate and in the long term become a significant risk factor for the development of lung cancer.
ÆR² measures Radon gas and lets you know if your air is of good quality or if you need to ventilate your living space.



● HOW ÆR² RADON SENSOR WORKS ?

Ambient air enters the device by diffusion. A photodiode detects the Alpha particles emitted by radioactive decay and corresponding to Radon and converts them to electrical pulses. These electrical pulses are counted by an electronic board during a time range called the “measurement period”.

At the end of each measurement period, the electronic board calculates the Radon concentration according to the number of electrical pulses, the measurement period and the calibration coefficients of the device.

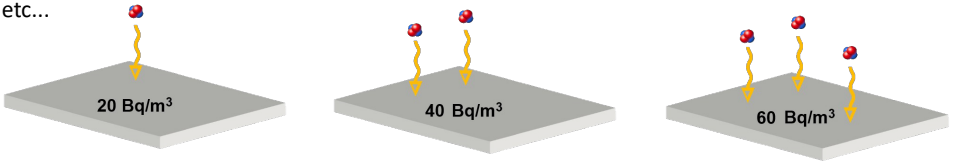
Radon measurement is expressed in a unit called “Becquerel per cubic meter” (Bq/m³) and is called “Radon activity concentration”.

● FREQUENTLY ASKED QUESTIONS

Why my Radon sensor always displays the same values ?

The calibration coefficient is a value determined with a Radon source by placing the Radon monitor ÆR² in a Radon enclosure and comparing it to a reference Radon measuring instrument (connected to the primary standard). It is expressed in Becquerel per cubic meter per count per hour (Bq/m³ / c/h).

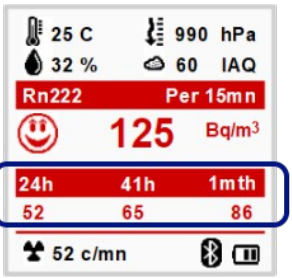
Suppose your device has a calibration coefficient of 20 Bq/m³ / c/h and its base measurement period is 1 hour. This value means that over a period of 1 hour, when the electronic detector "sees" 1 electrical pulse caused by Radon, it considers this to be equivalent to a Radon activity of 20 Bq/m³. If it "sees" 2 electrical pulses caused by Radon, it considers that to be a Radon activity of 2 x 20 Bq/m³, etc...



This is why the value displayed over a measurement period of 1 hour is always a multiple of the calibration coefficient. Only a cumulative average over several hours provides a more accurate measurement.

How to get a more accurate measurement ?

The main measurement is displayed in large characters and corresponds to the shortest measurement period (1 hour or 15 min depending on the device model). Since this value is a multiple of the calibration coefficient, it is not always accurate enough for your measurements.

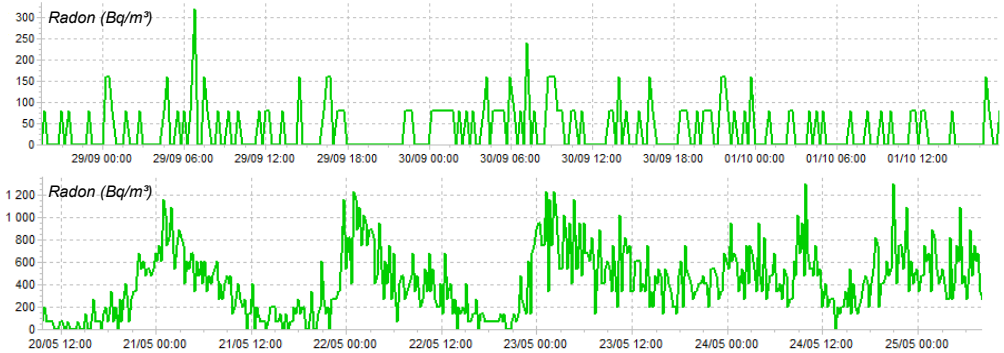


This is why it is strongly advised to observe the measurement over a longer period to have a more accurate value.
The display shows the measurement over different time periods:
- 24 hours (If at least 24 hours of measurements are available)
- 1 month (If at least 1 month of measurements is available)
- Duration since latest reset (performed by pressing the button for 5 seconds)

To fully understand the importance of the duration of the measurement, imagine a survey carried out on a random sample of people : A survey carried out on 1000 people is necessarily much more accurate than a survey carried out on only 10 people. Similarly, a Radon measurement taken over 24 hours is much more accurate than a Radon measurement taken over 1 hour.

Is it normal that the measurement varies widely ?

Radon, by its radioactive nature, is a random phenomenon. Therefore, the lower the Radon activity, the greater the measurement uncertainty. Measuring Radon is not the same as measuring temperature, for example.
A temperature sensor always displays a measurement that fluctuates very little from one moment to the next. On the other hand, a Radon sensor with a sensitivity similar to that of the ÆR² range, over a short measurement period (1 hour for example) displays a measurement highly dependent on the random nature of the Radon phenomenon. It is only by increasing the measurement time and displaying the average value over a sufficiently long time that the accuracy of the measurement increases.
Here are typical examples of Radon recordings performed with an ÆR²+, for a low Radon level, then a higher Radon level (Note the “noisy” aspect of the curve and the significant changes of values when the activity is weak)



Should I be concerned about the measurement displayed by my Radon sensor ?

The W.H.O. (World Health Organization) recommends not to exceed a threshold of 300 Bq/m³ inside homes, but be careful to interpret this recommendation correctly !

⚠ **This is an average value !** If your device sometimes displays several hundred Bq/m³, do not panic ! Take a good look at the average over a long period of time (1 month or more, for example). It is very common to observe significant rises in Radon, from time to time, while the long-term average level remains relatively low.

⚠ **What purpose serves the room where the device is measuring ?** Always try to relate the Radon value to the time you spend in the room. High values in a cellar or garage are not necessarily worrying because you usually spend very little time in these rooms. In contrast, high readings in a bedroom are more alarming.

⚠ **What season is it ?** During the autumn / winter period, rooms are generally much less ventilated, consequently, higher Radon levels are measured. If, for example, you measure an average value of 350 Bq/m³ during the winter and an average value of 50 Bq/m³ during the summer, the annual average is ultimately 200 Bq/m³!

● ABOUT AIR QUALITY AND VOLATILE ORGANIC COMPOUNDS (VOC)

The ÆR² Radon monitor is equipped with a sensor which can detect the presence of VOCs in the air and thus to estimate an index of the quality of the air you breathe (IAQ).

This air quality index comes in the form of a measured value ranging from 0 to 500. **Unlike Radon measurement, the lower the IAQ value, the better the air quality.**

The following table gives an indication of the estimated air quality according to the VOC value measured by ÆR².

IAQ index	Air quality
0-50	Very good
51-100	Good
101-150	Medium
151-200	Poor
201-300	Bad
301-500	Very bad

VOCs (volatile organic compounds) include a multitude of substances, which can be of natural or human origin. The best known are butane, ethanol (90% alcohol), acetone and benzene, which are found, for example, in paints or inks.

VOCs have a double effect on health:

- An indirect effect by acting on ozone, as precursors of this gas in the air. Depending on the level of exposure, the volume of inhaled air and the duration of exposure, several manifestations are possible: cough, chest discomfort, shortness of breath, nasal, eye and throat irritation. These effects differ depending on the individual and the state of health;
- A direct effect as a toxic substance. The most harmful VOCs, such as benzene, are classified as CMR (carcinogenic, mutagenic and reprotoxic).

The risk associated with VOCs also affects the environment:

In the atmosphere, volatile organic compounds degrade and contribute to disturbing chemical balances with the consequent formation or accumulation of ozone. VOCs are direct pollutants for humans and plants, and also contribute to odor pollution. They are also precursors of ozone in the air by causing numerous chemical reactions. This overproduction of ozone has a detrimental effect on vegetation (altering the resistance of plants, for example) and also causes an additional greenhouse effect, by capturing the infrared reflected by the surface of the Earth at the level of the troposphere.

(Source: www.ademe.fr, 01/2022)

● GOOD TO KNOW !

The response time of the ÆR² Radon monitor is not instantaneous, in particular during a drop in the Radon value : If the monitor has been measuring a high Radon value for several hours, then, when it is moved into an healthy environment (a well-ventilated room, for example), the next measurement will not immediately be representative. It is necessary to allow time for the air stored in the detection volume of the device to renew itself. It sometimes takes several hours for the measured value to drop to the actual ambiant value !

The ÆR² Radon monitor is sensitive to humidity : A very high humidity level (for example, in a cellar or in a bathroom), or on the contrary a very low humidity level, leads to a measurement error up to 15%. Please refer to the technical characteristics on the last page of this manual to check the standard conditions of use.

If your Radon monitor display seems to be stuck (no value change for more than 24 hours) or if it is stuck for several hours on the “Measuring, please wait” screen, then the battery is probably too low and should be recharged.

● RECHARGING THE BATTERY OF YOUR RADON SENSOR

A battery icon indicates the remaining battery level on the device screen. When it becomes too low, simply use the USB socket on the top of the device to recharge it.

ÆR² is compatible with standard USB cables and chargers for mobile phones equipped with a micro-USB plug.

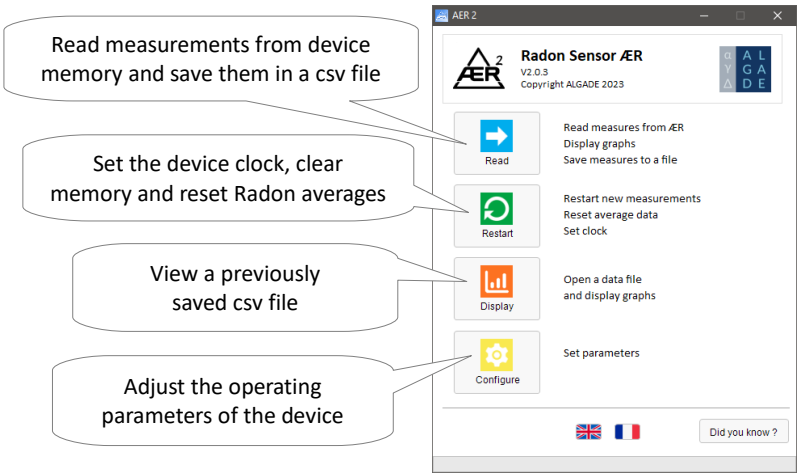
● YOUR MEASUREMENTS ON YOUR COMPUTER (ÆR²+ AND ÆR²C)

ÆR²+ and ÆR²C record their measurements in memory.
By connecting it to a computer, you can :

- Download all recorded measurements and observe the evolution of Radon and various data according to the time and place where you have put your device.
- Reset Radon averages and set device date and time
- Modify some of the operating parameters of the device.

How to use your device with your computer ?

- Install the ÆRsoft2 software (supplied with your device or downloaded on www.algade.com)
- Connect your device to your computer using the micro USB cable supplied with the device.
- Wait while your computer detects and installs the USB drivers.
- Launch the ÆRsoft2 software and follow the instructions displayed on the computer screen.



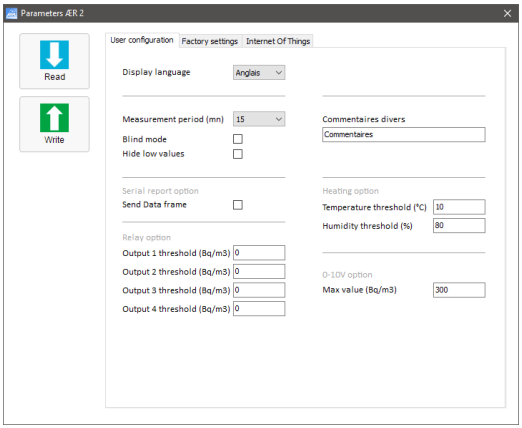
Sometimes, the installation of USB drivers is not automatic.
Are you facing difficulties to use your device with your computer ? Contact us ! We will assist you with the installation and configuration of your device :

ALGADE Instrumentation
algade@algade.com

Reading the measurements from the Radon sensor memory

Click on the “Read” button, then select a location and a file name.

Operating parameters

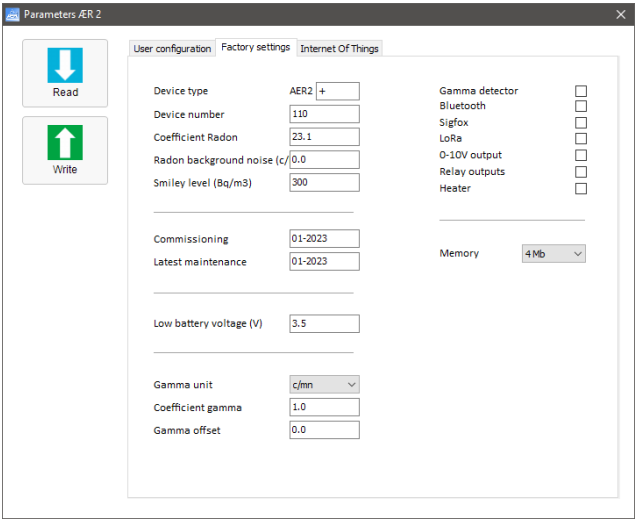


Click on the “Configure” button on the main screen, then, once on the settings screen:

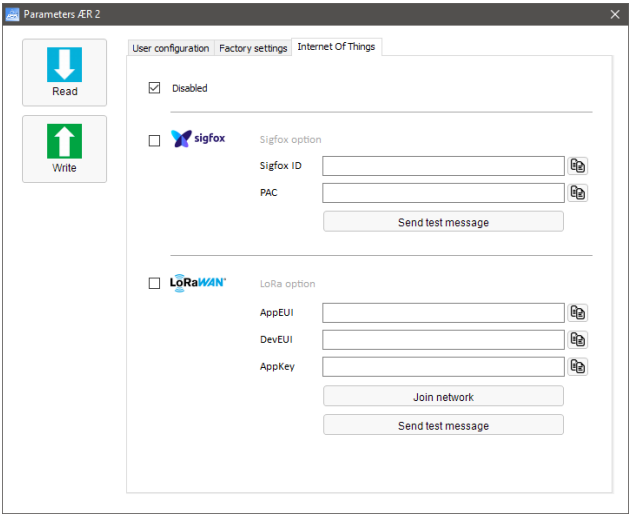
- Click on the “Read” button
- Change desired settings
- Click on the “Write” button

The “**User Configuration**” tab contains the modifiable parameters (The modifiable parameters depend on the device model and its options). The main parameters are:

Measurement Period : Base period at which measurements are updated and recorded
Blind mode : Do not display the Radon value but only a “Measurement in progress” message
Hide low values : The device displays a message “< 300 Bq/m³” instead of displaying the actual value if it is below the threshold of 300 Bq/m³



The "**Factory settings**" tab contains the non-modifiable parameters determined in the factory, such as the device number, its Radon calibration coefficients or the various options available.



Some devices are equipped with a modem to transmit measurements remotely (IoT = Internet of Things functionality). The "**Internet of Things**" tab contains identification information relative to the device IoT modem.

● CONTRACTUAL INFORMATION

SAFETY AND USAGE RECOMMENDATIONS

- This device has been designed for indoor use. Do not use outdoor. Do not submerge nor expose to liquid projections. Do not use when humidity exceeds 80%.
- Handle with care. Shocks on the device may cause abnormally high measurements, non-representative of the actual radon level in the room. If the device has been exposed to this situation, reset it as previously described in this manual.
- Do not place near a mobile phone, wifi access point (internet box), microwave or any other device generating electromagnetic interferences. Failure to follow these recommendations may cause abnormally high measurements, non-representative of the actual radon level in the room. If the device has been exposed to this situation, reset it as previously described in this manual.
- Do not expose to extreme temperatures (below 0°C or above 40°C)
- Do not cover the meshed aperture located on the front of the device
- Do not disassemble the device
- Do not insert any objects in the vents and apertures of the device.
- Do not drop the device.
- Do not place the device next to a heater, a stove or any other heat source.
- Do not place the device next to a flame or any source of ignition.
- This product is not intended for children.

WARRANTY

The manufacturer warrants that its hardware product is free from defects in materials and workmanship for a period of two years from the date of original purchase. In the event of a breach of warranty, the manufacturer will be liable, according to the general terms of sales, to repair or replace the equipment, or to refund the purchase price, provided that the product is returned to the manufacturer, proof of purchase included. The protection offered by this guarantee is in addition to the rights conferred by local consumer law and may vary with countries.
This warranty may only apply in connection with the use of the physical product under the conditions provided by the manufacturer. The manufacturer can not be held responsible for malfunctions, breakdowns and degradations of the material product resulting from a use lacking the respect of the safety and use instructions described in this manual. The manufacturer can not be held responsible for malfunctions, breakdowns and deterioration of the material product in any event of force majeure, including climatic and environmental events (floods, fires, etc ...).

● TECHNICAL SPECIFICATIONS

Dimensions : 14.4 cm x 9.2 cm x 5.1 cm
Weight : 310 g
Polycarbonate casing
Low current e-paper display
Li-Ion battery operation
Charge via USB
Battery autonomy : 1 month
Full charge time : < 4 h at 1 A

Radon detection by photodiode
Cumulated average over 24 h/ 1 month/ long duration
Temperature, humidity, atmospheric pressure and VOC measurement
Gamma radioactivity measurement by Geiger-Müller tube
Memory space : 6 months for 15 mn measurement period

	ÆR²	ÆR²+	ÆR²C
Measurement period	60 mn (Fixed)	15 mn (Adjustable)	15 mn (Adjustable)
Data recording	✗	✓	✓
Download and reset via USB	✗	✓	✓
Bluetooth	✗	✓	✓
Gamma radioactivity sensor	✗	✓	✓
Connection to Sigfox/LoRa for remote access to data	✗	✗	✓
Typical sensivity	40-60 Bq.m^{-3}/c/h	15-20 Bq.m^{-3}/c/h	15-20 Bq.m^{-3}/c/h
Uncertainty (24h at 300 Bq.m^{-3})	± 32 Bq.m^{-3}	± 18 Bq.m^{-3}	± 18 Bq.m^{-3}
Measurement range	0 – 99,9 kBq.m^{-3}	0 – 99,9 kBq.m^{-3}	0 – 99,9 kBq.m^{-3}

✗ Not available
✓ Available
✓ Available on request

Warning : Warranty applies only under conditions of normal use (Humidity range 40% to 80%, and temperature range 0°C to 40°C)

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