Manual

Smart Radon Sensor

Radon monitor for building automation

Version march 2025

Referenced documents
Software-Manual Radon Vision

SARAD GmbH
Wiesbadener Straße 10
01159 Dresden
Deutschland

www.sarad.de
info@sarad.de

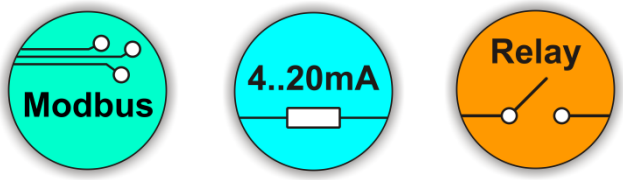


Table of content

Introduction /Application

The Smart Radon Sensor is an innovative Radon monitor, designed **for integration in building automatization systems**. Thanks to the broad spectrum of interfaces one can integrate the sensor with relative small effort within an existing infrastructure. The high sensitivity allows for quick and precise determination of Radon value, so the device is suitable **for controlling the ventilation systems**.

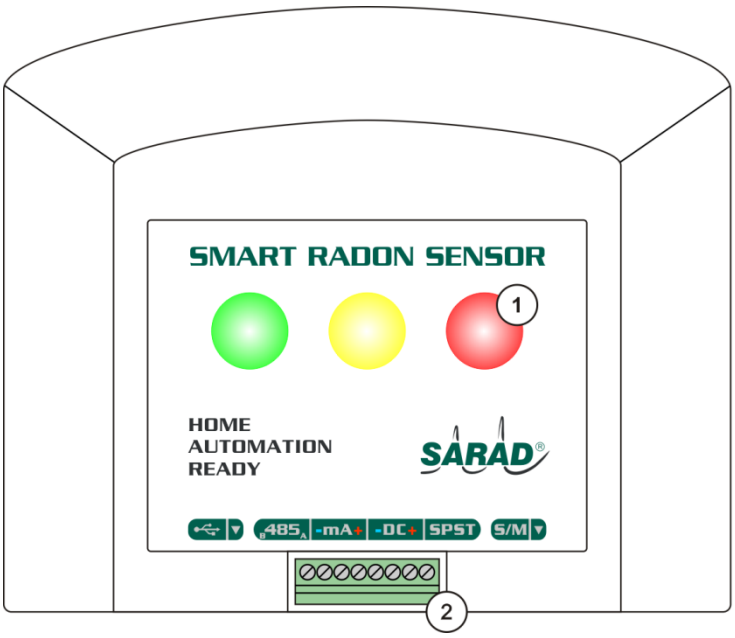
The Smart Radon Sensor is used for long-term monitoring of the legal reference value for the radon concentration in breathing air. The device was specially designed **for homeowners as well as tenants, lessors and housing companies**.

The Smart Radon Sensor records the transient behaviour of the radon concentration over many years reliably, meaning that influences on weather conditions and seasonal changes are safely recorded. Sensors for temperature and humidity provide information about a healthy indoor climate. The measurement data can be read out at any time for preservation of evidence.

The device should also be used to monitor the **success of radon remediation measures**.

The instrument

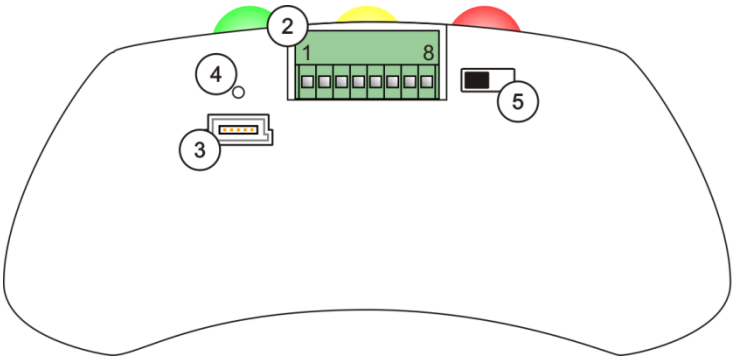
Controls



1 Alert /Status LEDs

2 Terminal block

Fig. 1. - Front panel controls



2 Terminal block

3 USB Port

4 Reset button

5 Protocol switch

Fig. 2. - Bottom panel controls

1	RS-485 port „D-“
2	RS-485 port „D+“
3	4..20mA current loop „-“ (GND)
4	4..20mA current loop „+“ (Iout)
5	DC external power supply „-“ (GND)
6	DC external power supply „+“ (12÷24 V)
7	Switch output port 1
8	Switch output port 2

Tab. 1. - Ports definition of terminal block.

Power supply

Main power supply

The smart Radon Sensor requires an external power supply in range from 12 V up to 24 V. The maximal current consumption does not exceed 50 mA (including 20 mA of current loop's maximal signal and active LEDs, but without usage of the CO2 sensor).

The connection ports for a power supply are shown in figure 1 and defined in table 2. Two ports of the terminal block with the description „DC-„ and „DC+“, at the device`s front panel, are ground and positive potential respectively. It is recommended to use the power supply unit with a galvanic isolation for supplying the Smart Radon Sensor. The galvanic isolation is of importance in case the analogue output is utilized AND the 0..20mA inputs of the data log system are referenced to the ground potential (e.g.: the current signal is transformed into the voltage value through a defined resist).

Back-up batteries

The device is equipped with an internal backup power supply (UPS) consisting of two LR3 (AAA) batteries. This feature allows one to continue the measurement seamlessly if main power supply failure occurs.

Without DC connection the backup will supply the device for approximately two weeks. In such circumstances the current loop as well as (if present) CO2 sensor will be deactivated, and the LEDs functionality will be reduced. If the cell voltage drops below 1,0 V, then the current measurement will be interrupted and the instrument enters the standby mode. Once the main powers supply recovers or new batteries are placed, the stored measurement data will be accessible immediately.

The instrument accepts alkaline as well as NiCd or NiMH batteries. Attention! Do not use lithium-ion batteries because their cell voltage is 3 V or 3,6 V. For maximum operational period we recommend the usage of alkaline batteries which are optimized for low loads.

It is also recommended to insert the batteries prior to mounting the device and connecting the terminal block. The placement of the batteries is described more in detail in the next chapter.

Important: **The real time clock of the instrument must be set by software after inserting the batteries**.

The rechargeable batteries cannot be charged once placed in the instrument. For stationary operation alkaline batteries are recommended. In contrary to rechargeable batteries, the alkaline batteries do not suffer from excessive self-discharge process and therefore are able to keep their initial electrical capacity for over 10 years.

Batteries replacement

For battery replacement, the rear cover has to be removed. To do that, both screws (A in fig. 3) at the backside must be unscrewed at first. After that, the cover can be detached by tilting as shown in picture 4. Please, pay special attention to the correct polarity of the batteries when inserting them (fig. 5). Change both batteries at the same time because differing charging levels may lead to failures. Use always batteries of the same type.

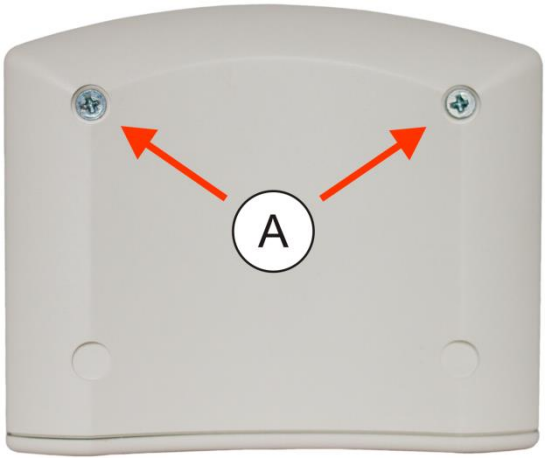


Fig. 3. - Remove both screws (A) at the rear panel.

Fig. 4. - Remove the rear cover. Tilt it at the round edge as shown.

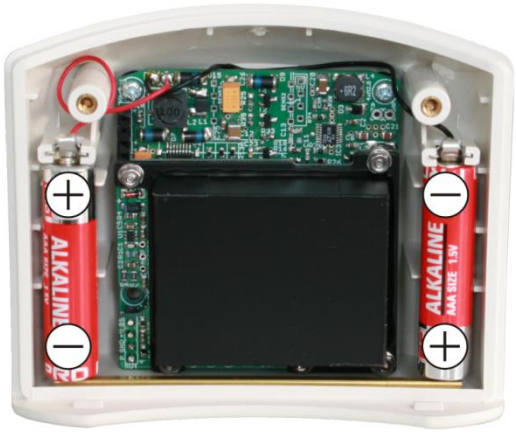


Fig. 5. - Insert batteries (AAA/LR3) left and right (take care for right polarity!).

Selection of the right location for exposure and installation

The instrument should be placed at a location which is representative for the indoor air quality of a room. The incidence of direct light and exposure to strong heat sources should be avoided. For permanent installation, the Smart Radon Sensor can be mounted on a wall using a wall mounting clip (accessory). Attention has to be paid because the wall itself could be the origin of the Radon inside a room. This would result in an increased concentration in the surrounding of the surface. Some comparison measurements at the preferred mounting position and in the middle of the room (each at least a few days under similar weather conditions) will show if this is the case or not.

When the mounting of the device is accomplished the terminal block can be wired. If the batteries were replaced before the installation had taken place, the internal clock has to be set with Radon Vision software over USB connection.

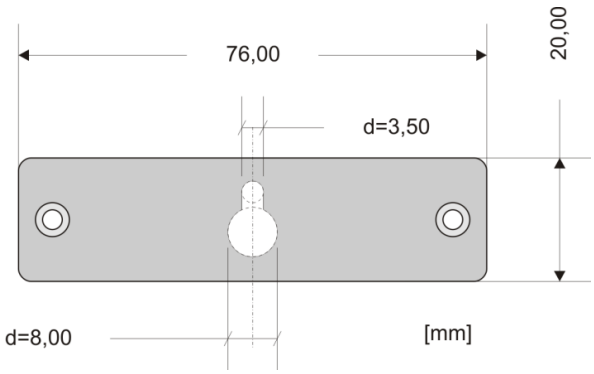


Fig. 6. – The wall mounting clip.

Fig. 7. - Smart Radon Sensor with the mounting clip.

Selection of the right integration interval

It is possible to adjust the sampling interval of the Smart Radon Sensor between 1 and 255 minutes. From the physical point of view, it makes no sense to choose intervals shorter than 30 minutes because the response time of the instrument is in that order. If the expected Radon concentrations are in the range or less than the statutory reference level of 300 Bq/m³, an interval of 60 minutes (default setting) should be used. Frequent zero readings for individual sampling intervals indicate that the chosen interval is too short.

Measurement

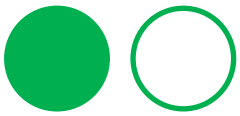
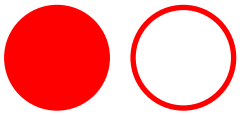
The measurement starts autonomously after replacing the batteries or connecting the main power supply. **The real time clock of the instrument must be set by software before starting the measurement.** The first measurement result will be available as soon as the first sampling interval is accomplished. Newly acquired values will be appended periodically to the previously stored results. The measurement cannot be stopped by the user.

Each year the voltage of the batteries should be checked. This can be done e.g.: by using Radon Vision software and USB connection. Older data in the memory, which are no more needed, can also be deleted by means of the software.

Radon activity above alarm threshold value (which is settable) will be indicated by LEDs at the front panel (fig. 1.). Simultaneously the alert switch will be activated. Please refer to the chapters: „LED indicators" and „Alert Switch".

LED indicators

The Smart Radon Sensor has three color LEDs at the front panel. Their purpose is to indicate the state of the instrument. The table below (tab. 2.) sums up all possible LED signals.

	Permanent ON	RADON < 50% • AlarmTH(*)
	Permanent ON	50% • AlarmTH =< RADON < 100% • AlarmTH
	Permanent ON	RADON >= 100% • AlarmTH
	Blinks	USB connection present
	Blinks	Internal sensor clock not set
	Blinks short	Main power supply failure (**)

Tab. 2. - LEDs signals.

(*) AlarmTH – Alarm threshold for Radon.

(**) The green and the yellow LED switched OFF, the analogue output deactivated.

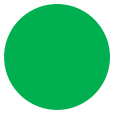
Example: AlarmTH = 300 Bq/m³.

The green LED will be active at Radon concentration below 150 Bq/m³.

The yellow LED will be active at Radon concentration between 150 Bq/m³ and 300 Bq/m³.

The red LED will be active at Radon concentration above 300 Bq/m³.

In case the instrument additionally encloses CO2 sensor the meaning of the LEDs signals changes as stated below, in the table 3.

	Permanent ON	RADON < 100% • AlarmTH CO2 < 1000 ppm
	Permanent ON	CO2 >= 1000 ppm

Tab. 3. - LEDs signals for Smart Radon Sensor with CO2 Sensor.

The meaning of all other signals stays unchanged.

Communication interfaces

For a communication between the Smart Radon Sensor and the data acquisition system two digital, wire interfaces are provided. The RS-485 standard serial interface allows user to integrate the instrument within corresponding network. The USB interface provides a quick way for sensors configuration and maintenance. Once the USB cable is attached to the device, the RS-485 interface will be automatically disabled. In such a situation only USB communication is possible. After removing the USB cable the RS-485 interface will be reactivated.

An integrated Wi-Fi Module can be chosen as an optional component for the Smart Radon Sensor. If the module is present and the jumper is placed on the PCB (top right in Fig.5), the RS-485 interface is disabled and communication is via the local Wi-Fi network. During the USB transfer the wireless connection is disabled.

RS-485

General

The communication over RS-485 interface can be realized with usage of two protocols: proprietary SARAD protocol or industrial standard MODBUS RTU. The MODBUS protocol supports only the transmission of the recent readings. For all other functions the SARAD standard protocol has to be used. The protocol frames are explained in detail by the document “SARAD_MODBUS_Protocol”. The complete MODBUS Documentation can be found in the internet under “modbus.org”.

Selection of the transfer protocol, addressing

To identify an instrument within a network, a unique address in the range of 1…250 must be assigned. This address and the bus speed for MODBUS protocol can be programmed into the instrument using the software Radon Vision 8.2.5.

Important: To work with ModBus protocol you have also to set up a Bus address and a Baud rate for the instrument in the menu below and confirm it. The desired address can be entered. The drop-down list labeled „Baud rate[bps]” contains two entries: „9600” and „19200”. Those are used to select MODBUS protocol speed.

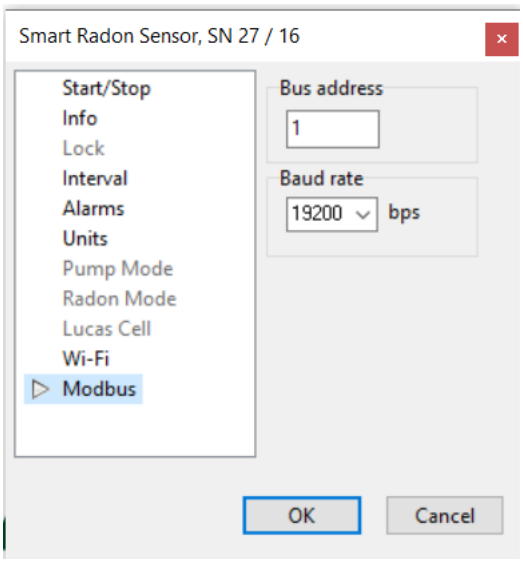


Fig. 8. - Program window for MODBUS configuration.

Selection of the desired operation protocol for RS-485 interface is performed with a „protocol switch“ placed at the bottom side of the instrument (fig. 2.). This slide switch in the „M“ position corresponds to the MODBUS protocol. The „S“ position of the slide switch activates the SARAD protocol.

Implemented functions

Function code 0x03 (read holding register)

Valid register addresses are:

Register address	Register content	Number of registers	Format
0x0000	Radon concentration [Bq/m^3]	2	Float
0x0002	Statistical error of Radon concentration [%]	2	Float
0x0004	Average Radon concentration since last start [Bq/m^3]	2	Float
0x0006	Battery voltage [V]	2	Float
0x0008	Temperature [°C]	2	Float
0x000A	Relative humidity [%]	2	Float
0x000C	Barometric pressure [mbar] / CO2 concentration [ppm]	2	Float

Tab. 4. - MODBUS RTU register addresses.

IEEE 745 float values (4 Byte) are transmitted as two sequential 16 bit registers. The number of registers to be read must be two. That means, only one value can be transmitted per frame. Other values and not stated register addresses will cause an exception response.

USB

The additional communication interface, conform to USB standard, allows user to read out the measurement data and to adjust the operating parameters of the Smart Radon Sensor. The interface requires a software driver which can be downloaded from the SARAD company website. Within the Radon Vision software the USB communication path appears as a new COM port. During USB communication with the instrument the RS-485 terminal of the device is disabled. On the other hand the analogue output (current loop) and the alert switch are still available and active.

Warning: In case of the USB transmission only SARAD protocol will be supported independent from „protocol switch". After detaching the USB cable from the instrument the RS-485 interface will be reactivated with protocol selection according to the position of the slide switch.
The device cannot be powered via the USB port.

Wi-Fi

General

The Smart Radon Sensor can be equipped with the optional Wi-Fi module. The radio module can only operate if an external power supply is available. In order to establish the connection with the local wireless network, it is necessary to configure the Wi-Fi module by means of the USB and the Radon Vision software.

In addition to the above, there has to be a Windows based PC with the SARAD Registration Server Service installed, **or** a device from the Aranea family - both with the appropriate configuration. Details of configuration can be found in the Aranea manual or in the SARAD Registration Server Service manual.

Configuration

The following set of parameters is required for the configuration of the Wi-Fi module:

- **SSID** – "Service Set Identifier" for the WLAN network (typically available in the WLAN router)
- **Passwort** – Password for SSID
- **IP-Adresse** – static IP address of the computer with SARAD Registration Server Service.
- **Port** – Port for communication. Default set to: 50002

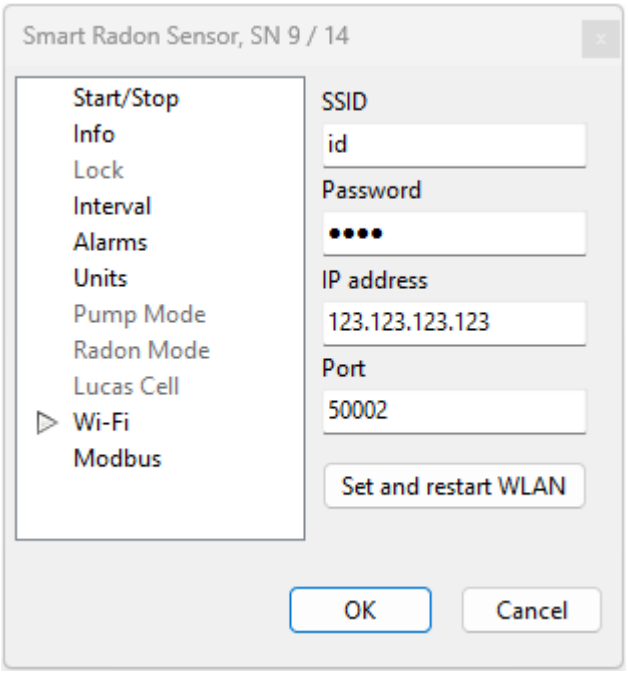


Fig. 9 - Program window for Wi-Fi configuration.

Once the parameters have been set, press the „Set and restart WLAN“ button. If the configuration is successful, the device will appear in the Radon Vision software device list after a few seconds.

Note: Depending on the structure of the building between the Smart Radon Sensor and the Wi-Fi router, as well as the number of wireless devices transmitting in close proximity to the measurement device, there may be differences in the quality of the connection.

Analogue output

4..20 mA current loop

The Smart Radon Sensor provides an analogue output with current signal from 4 up to 20 mA (so called „current loop"). This feature offers a reliable way for transmitting the measurement signal over long distances. The terminal ports for the current loop are designated in figure 2 and table 1.

At the end of each integration interval, current value will be calculated according to the Radon activity and the chosen measurement range. The output signal therefore will be updated periodically.
From the beginning of the measurement till the end of the first measurement interval the output current value equals 4 mA.

The maximal current value of 20 mA corresponds to the value of ten times the Radon alarm threshold. In the case of threshold value of 300 Bq/m^3 (default setting) the 20mA output current represents the Radon value of 3000 Bq/m^3. For Radon activity below detection limit the 4mA current value will be held. The output signal of the current loop is realized with 12-bit digital/analog converter. As a result the resolution of the output signal is equal to 0,0039 mA.

Example:
The current output value will be set according to a following calculation with a Radon threshold of 300 Bq/m³ and the Radon measurement equal to 1125 Bq/m³:

$$I_{OUT} = \{ 1125\ Bq/m^3 \bullet (20mA - 4mA) \} / \{ 10 \bullet 300\ Bq/m^3 \} + 4\ mA = 10\ mA.$$

20mA output signal will be present for all measurement results above Radon range defined for the current loop (10 • Radon alarm threshold). The relationship between Radon alarm threshold and the output range of the analogue signal allows for easy adjustment to the input range of the data acquisition system.

Warning: If Smart Radon Sensor is being integrated in existing network or measurement system, first an apparent resistance has to be considered. The entire apparent ohmic resistance ought not to be greater than 475 Ohm for 12 V supply voltage. For 24 V supply voltage the apparent resistance must not excide 1075 Ohm.

Alert switch

The Smart Radon Sensor is equipped with a switch output which can be used for ventilation control or alert indication. The potential-free contacts of the switch will be short-circuited at the end of the sampling interval if the measured Radon concentration exceeds the alarm threshold. The output will be deactivated one minute before the subsequent interval ends. Therefore, the sampling interval must be set at least to two minutes. The alarm threshold is factory-set to 300 Bq/m³ (statutory reference value of the Radiation Protection Act) and may be changed by the user with respect to local regulations (instrument setup in Radon Vision). Warning: at the same time the alarm threshold defines the Radon range for the maximal output signal of the current loop. Please refer to the previous chapter: „Analogue output".

The terminal ports for the alert switch are designated in figure 2 and table 1.

As an accessory, we offer a wireless power switch which can be used for direct ventilation control. The switch includes a transmitter unit to be connected to the alert switch output of the instrument, and a plug adaptor (receiver) which can be placed between the wall outlet and the power cable of the ventilation unit. Optionally, a flush-mounting power switch is also available. The plug adaptor offers an additional timer function to define the duration of the ventilation period independent from the sampling interval of the instrument (for example 15 minutes ventilation while the sampling interval is 60 minutes long). The wireless switch is coded - that means, several transmission lines can be established within one building. The assignment between transmitter and receiver is easily done by a push button.

The sampling interval should be set to a value between 60 or 120 minutes for an alarm threshold lower than 300 Bq/m³.

Supplementary equipment

According to the needs of the customer the Smart Radon Sensor can be equipped with additional sensors for example: pressure or CO2 sensor.

Pressure sensor

The barometric pressure can be measured in a range from 800 mbar to 1200 mbar. The sensor unit is fully calibrated and features temperature compensation.

CO_2 gas sensor

The integrated CO2 sensor uses the non-dispersive infrared (NDIR) operational principle. This requires an infrared source which cannot be supplied by the internal batteries due to the increased power consumption. Therefore CO2 sensor works only if external power supply is present.

Continuous operation

The automatic calibration procedure of the sensor uses the CO2 concentration of fresh air (400 ppm) as reference. The instrument must be exposed to this “fresh air concentration” at least once during the last 24 hours. This can be achieved by short ventilation of the room. If there are no persons inside a room for a while (for example overnight), the concentration goes back to 400 ppm.

Attention! If the reference concentration cannot be reached within the past 24 hours, the sensor interprets the lowest measured result as 400 ppm. This results in a systematically increasing measurement error.

If the CO2 concentration exceeds the recommended threshold of 1000 ppm, the yellow LED turns on. It will turn off as soon as the concentration drops below 1000 ppm.

Occasional operation

If the CO_2 sensor is used for sampling periods less than 24 hours no calibration procedure as described above is carried out. Therefore it is recommended to operate the sensor at least once per week for a period longer than 24 hours to force a calibration. Of course, the instrument must be exposed to the fresh air concentration of 400 ppm during that time.

Disposal instructions

Batteries and accumulators must not be disposed of in the garbage, but you are legally obligated to return them to the appropriate waste collection centers. The measuring instruments must be disposed of in the electronic waste or handed to the manufacturer at the end of their service life for proper disposal. If necessary, they have to be decontaminated before.

Technical data

Smart Radon Sensor

Radon measurement		
Operational principal	Lucas cell with gross alpha counting	
Sampling method	Diffusion	
Accuracy	<=6%	
Sensitivity	3,7 cpm/(kBq/m³)	
Range	1 ... 1 000 000 Bq/m³	
Uncertainty (1σ)	1 hour @ 300 Bq/m³	15%
	1 day @ 300 Bq/m³	3%
	1 day @ 50 Bq/m³	8%
Ambient	-10 °C ... 50 °C, 0 %rF ... 100 %rF non condensing	
Humidity		
Range	0 %rH … 100 %rH	
Accuracy	< 4,5 %rH (3% typ.) for 20 %rH … 80 %rH	
Temperature		
Range	-40 °C … 120 °C	
Accuracy	< 0,4 °C (0,3 °C typ.) for 5 °C … 60 °C	
Pressure [1])		
Range	760 mbar ... 1200 mbar	
Accuracy	< 0,5 % FSO	
CO_2 Sensor[1])		
Principle of operation	Non dispersive infrared (NDIR)	
Range	400 ppm … 5000 ppm	
Accuracy	< 5 % ± 50 ppm	
Response time	10 min	
Remark	Automatic calibration with respect to outdoor CO2 level	

Device	
Power supply	12 to 24 VDC at max. 50 mA current consumption 2 x AAA/ LR03 batteries for power backup
Switch output	Optical relay with potential-free contacts; max. switch current 0.2 A; max. switch voltage 40 V; 2 pin contact
Memory	16383 data records (approx. 2 years at 60min interval) Measurement interval settable from1 to 255 minutes
Interface	RS-485 (MODBUS RTU and SARAD protocol) 4 … 20 mA analogous output (range configurable) Alert switch (potential free contacts) All interfaces with screw terminals
Wi-Fi[1)]	Wi-Fi protocols 802.11 b/g/n Frequency range 2.4 GHz ~ 2.5 GHz Security WPA/WPA2
Alert indicators	Red, yellow and green LED indicators for alert and state of operation
Controls	Automatic start after powering up
Software	Radon Vision
Dimensions	96 mm x 82 mm x 44 mm
Weight	approx. 150 g including batteries
Accessories	Bracket for wall mounting USB data cable, batteries type AAA User manual& Software (electronic version) Factory calibration with certificate Wireless switch (option)

1) Available as an option

Wireless switch

Device		
Transmitter	2 inputs	*E.g. additional input for manual switch*
Frequency	433 MHz	*With coding for safe transmission*
Range	ca. 30 m	
Power supply	Battery CR2032	*Good for 20,000 switching cycles*
Load switch (plug adapter)	220 V/50 Hz	*6 programmable groups (e.g. to connect more than one Radon monitors)*
Max. switching load	3500 VA	
Adjustable timer	7 s, 5 min, 30 min, 1 h, 2 h, 4 h, 8 h	*If the timer function is not used, the power switch follows the state of the switch contact at the instrument*

