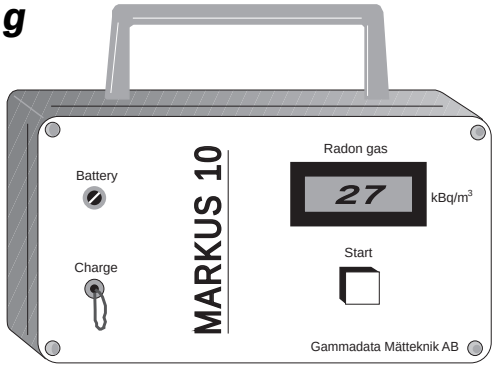
User's Guide

MARKUS 10

The instrument for determining the radon content in the soil



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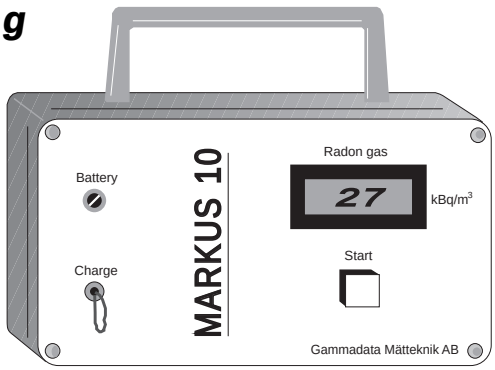

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Introduction

MARKUS 10 is a portable, battery-powered instrument for determining the radon content in the soil. It was designed to be as simple as possible to operate, without compromising its high precision. The instrument has been developed by Gammadata in Uppsala, Sweden.

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User's Guide MARKUS 10, version 1.4

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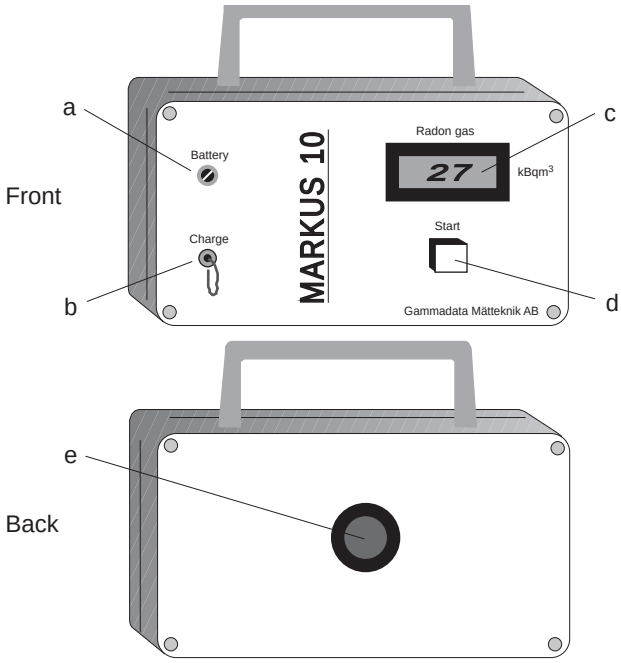
1

The instrument

The figure below shows the layout of the instrument.

- **a.** Battery indicator
- **b.** Connection for charger
- **c.** Display
- **d.** Starter
- **e.** Connection for waterseal and sounding tube



User's Guide MARKUS 10, version 1.4

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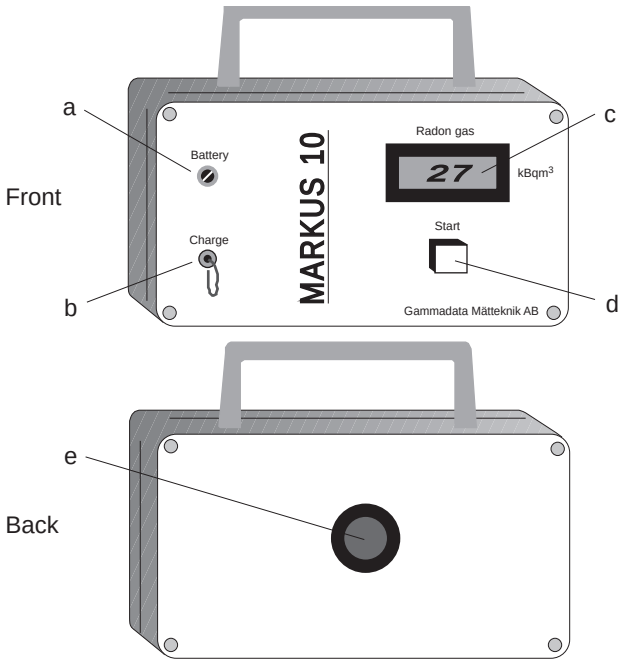

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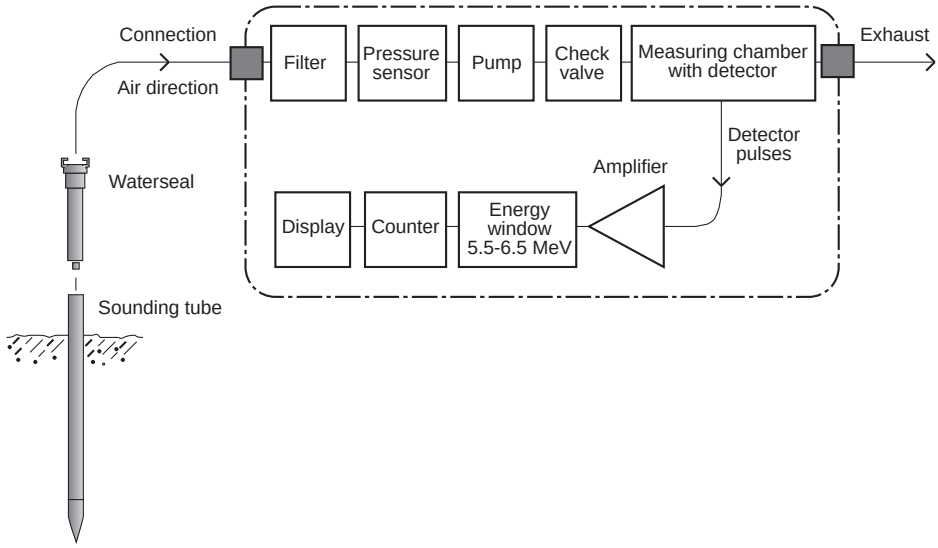
2

The figure below shows the operation principle of the instrument.



In the initial measuring phase, air from the soil is pumped up through the sounding tube into the measuring cell. The pumping time (about 30 sec) has been chosen to ensure that all fresh air in the system is pumped out.

A pressure sensor stops the pump if the pressure in the tube drops below a given value. When the pressure rises, the pump starts again. The pump's effective running time is always the same, which guarantees that a certain minimum volume of air will always be forced through the measuring cell before measurement begins. The pumping time without pauses is about 30 seconds. If the pumping phase is not finished after 2 to 3 minutes, the soil is very compact. One should then interrupt the measurement and try again at an adjacent spot.

User's Guide MARKUS 10, version 1.4

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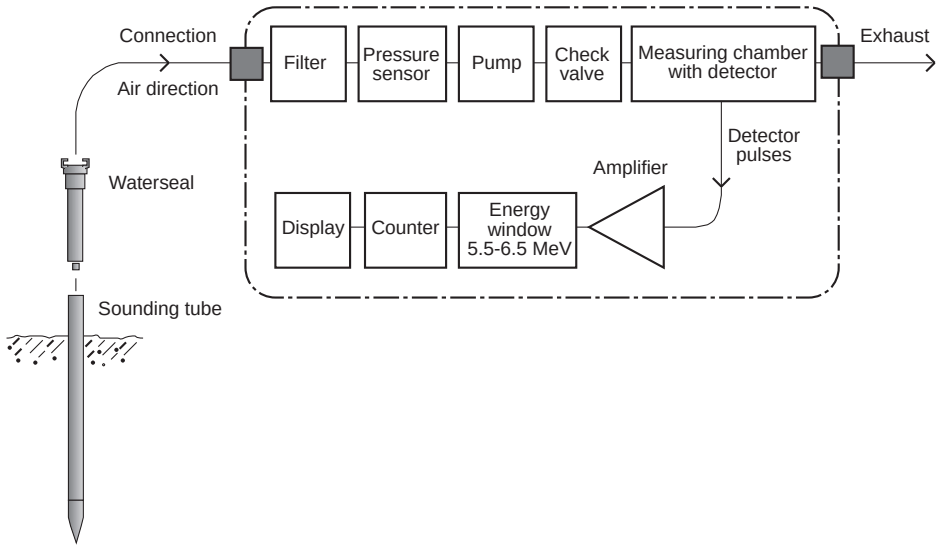

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3

After the pumping phase the measuring phase begins. The detector is activated and the voltage is switched on to the measuring chamber. The charged radon daughters, formed by the decaying radon gas, are driven towards the detector by an electric field in the chamber. The detector registers the alpha radiation originating from the radon daughters. The detector pulses are amplified and filtered in a so-called single-channel analyser that only lets through pulses from the short-lived radon daughter polonium 218 (with a half-life of about 3 minutes). This eliminates the slow variations in the background from polonium 214.

The pulses are counted and the result is shown in plain text on the instrument's display (kBq/m^3 radon-gas activity). The display flashes during the measuring phase, and becomes steady when the measurement is completed. As the instrument only counts pulses from the short-lived nuclide polonium 218, a new measurement can be started after just 18 minutes. In that time, activity from the previous measurement will have decayed sufficiently.

NOTE: A measurement of radon concentrations above 40 - 50 kBq/m^3 should be immediately followed by a run with fresh air. Then one should wait for about 18 minutes before starting a new measurement.

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Measurement instructions

1. Insert the impact rod in the sounding tube.
2. Using a sledge hammer, drive the tube down to a depth of about 70 cm (indicated by a mark on the tube).
3. Remove the impact rod and screw the waterseal tightly into place.
4. Fasten the instrument onto the waterseal and press "START".
5. Check that water is not being sucked up into the instrument, and that the battery is sufficiently charged (the battery indicator needle should be in the green area when the instrument is operating). If water floods the waterseal, switch off the instrument and detach it from the waterseal. Pull up the sounding tube and make a new attempt somewhere else.
6. Wait until the pumping phase (about 30 seconds) and the measuring phase (about 10 minutes) are finished. During the measuring phase the display flashes, then becomes steady when measurement is completed. Note that the length of the pumping phase depends on the air permeability of the soil (see "The Instrument" above). If the pumping phase is not finished after about 2 to 3 minutes, this means the soil is very compact and a meaningful measurement cannot be made. In that case, stop the measurement and try again somewhere else.
7. When the measurement is completed, read the result in kBq/m^3 (thousands of Bq/m^3).
   Example: The number 27 on the display means a radon-gas activity of 27 000 Bq/m^3 in the soil.
8. Press "START" again to switch off the instrument.
9. Detach the instrument and the waterseal from the sounding tube.
10. Attach the handle to the sounding tube.
11. Rotate the tube by means of the spanner and pull it up.
12. The instrument can be used for a new measurement after about 18 minutes (6 half-lives). Fresh air should be pumped through the instrument if the radon-gas content exceeded 40 - 50 kBq/m^3 . It is important not to let the instrument stand with a high radon-gas concentration when not in use.

User's Guide MARKUS 10, version 1.4

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5

Battery
Use the accompanying charger to recharge the battery after every day's use. The battery can be checked by pressing "**START**", reading the battery indicator, then pressing "**START**" again to turn the instrument off. The needle should be in the green area when the pump is running.

Waterseal
The waterseal contains a float. If water is sucked up through the sounding tube, the float rises and blocks the flow of water to the instrument. If this happens, turn the instrument off and remove the water from the waterseal. When the tube is pulled up the water will run out, and a new measurement can be made somewhere else.

Maintenance and Inspection
Make sure that soil or other material does not endanger the tightness of the fittings connecting the tube, the waterseal and the instrument. Put them together, start pumping and plug the waterseal with your finger. If everything is tight, the pump will stop immediately. It should not start again until some air is let in.

Service
You can sign a service contract with Gammadata. The annual check-up includes service, calibration and any repairs. The instrument ought to be calibrated and checked regularly, once a year.

User's Guide MARKUS 10, version 1.4

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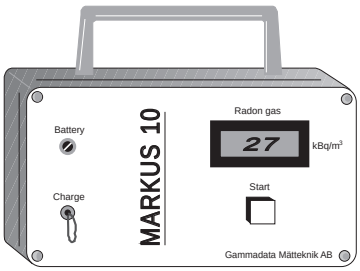
6

Technical specification

Pump capacity:	1.8 l/min
Effective pumping time:	30 sec
Lower pressure limit:	0.95 Atm
Type of detector:	Ortec Ultra Silicon detector
Area of detector:	100 mm^2
Window thickness:	200 µm
Energy resolution of the detector:	< 16 keV (α)
Battery capacity:	about 70 measurements
Recharging time:	8 hours
Accuracy of measurement:	about 10 % at 50 kBq/m^3
Measurement time:	typically 10 minutes
Dimensions L x H x D:	220 x 122 x 80 mm
Weight:	3 kg



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Battery
Charge
MARKUS 10
Radon gas
27
kBq/m3
Start
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7