Radon Detector RA14 Application Notes

Measuring the Radon Concentration

Some level of radon will be found in all homes. Radon mostly enters a home directly from the soil through the lowest level in the home that is in contact with the ground.

Radon exposure in homes and offices may arise from certain subsurface rock formations, and also from certain building materials (e.g., some granites). The greatest risk of radon exposure arises in buildings that are airtight, insufficiently ventilated, and having foundation leaks that allow air from the soil into basements and dwelling rooms.

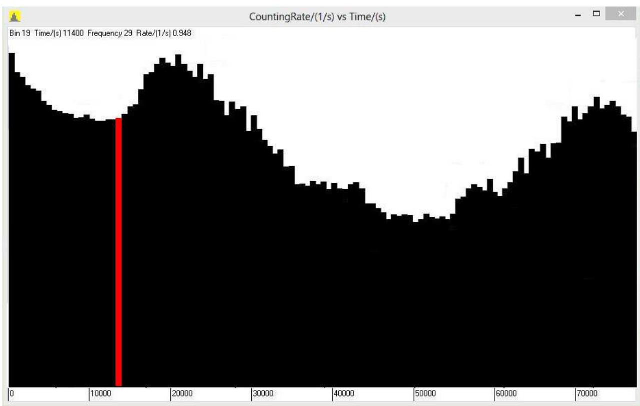
Radon concentrations in the same location may differ by a factor of two over a period of 1 hour. Also, the concentration in one room of a building may be significantly different from the concentration in an adjoining room.

Because radon concentrations can vary seasonally, it would be best to measure radon over the longest period of time possible. Ideally, this would be one full year because this allows you to determine the annual average radon concentration in your home.

The average annual radon concentration should not exceed 200 becquerels per cubic meter (200 Bq/m³) in the normal occupancy area.

Data Logger

For analyzing the collected samples the activities of Pb-214 and Bi-214 are of primary interest. Both Pb-214 and Bi-214 decay via beta decay followed by gamma emission. Electrostatic collection of the Rn-222 progeny Po-218 is a practical method to get a representative measure for the concentration of radon in the environment being monitored. Sampling times of at lest 3 hours are recommended. Consistent results over longer periods of time are available by using software displaying the detected radiation in a count rate vs. time graph.

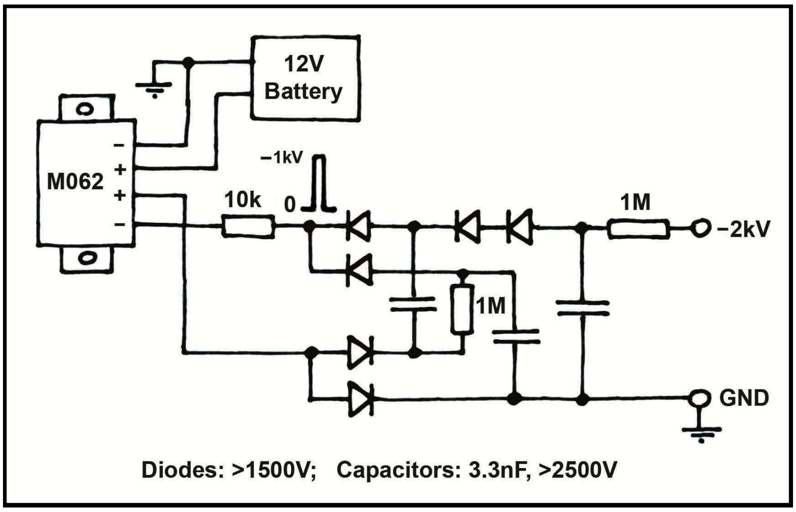


Radon concentration monitored over a period of 24 hours in a room in the basement of the building

Suggestions for high voltage supply

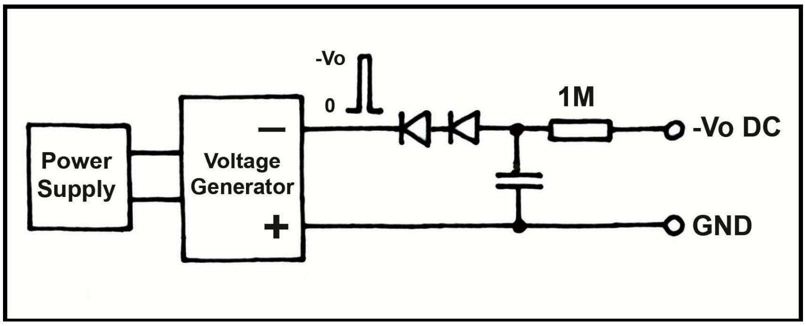
Using an electric fence voltage generator is a convenient way to get the required high voltage for the collector. Electric fence voltage generators produce pulses between 1000V and 10.000V which can be used to charge a capacitor to get the required DC high voltage supply.

A low-cost voltage generator is the Kemo Model M062 (www.kemo-electronic.de). This device draws very low current which makes it ideal for battery driven operation. Eight 1.5V alkaline batteries size AA can run this generator for approx. 300 hours. In order to achieve 2000V, the pulses of 1000V must be doubled with the circuit described below.



- The 1MΩ resistor at the output reduces possible electric shocks to a harmless level.

Electric fence voltage generators with higher voltage pulses require only one diode and one capacitor:



Examples of electric fence voltage generators with voltage pulses higher than 1000V:

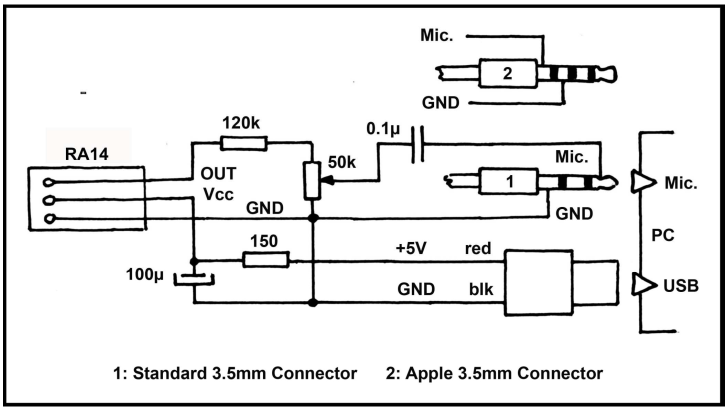
- Kemo Model FG025 (www.kemo-electronic.de)
- Patriot Model PE2 (www.patriotchargers.com)
- Zareba Model A15 (www.zarebasystems.com)
- Suregard Model M2 (http://www.sureguard.com.au/cattle_electric_fence.html)

Data Logger

It is the activities of Pb-214 and Bi-214 that are of primary interest. Both Pb-214 and Bi-214 decay via beta decay followed by gamma emission.

In order to display the activity of the collected data, the PRA logging software is used. PRA is available for free (http://www.physics.usyd.edu.au/~marek/pra/index.html).

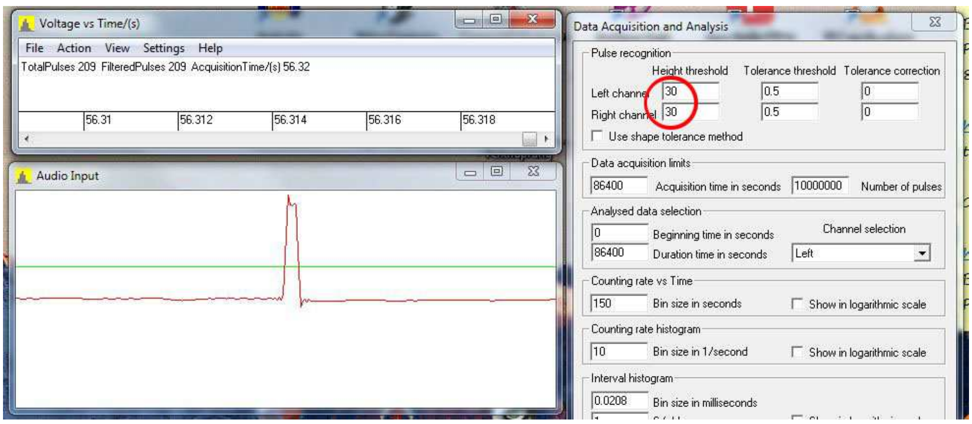
For analyzing the collected samples the output from the sensor is connected to a PC via microphone input and USB, which is used as a DC power source for the sensor.



After installation of PRA the pulse amplitude and the threshold need to be adjusted.

a) *Settings >> Data Acquisition and Analysis*
b) Set *Height threshold* to 30
c) *View >> Audio Input*
d) *Action >> Start Data Acquisition*

Position the PB40 Sensor Tester on top of the RA14. Adjust the potentiometer until the pulse amplitude is approx. double the threshold level (30). Check for proper counting of the pulses (*Total Pulses* xxx).

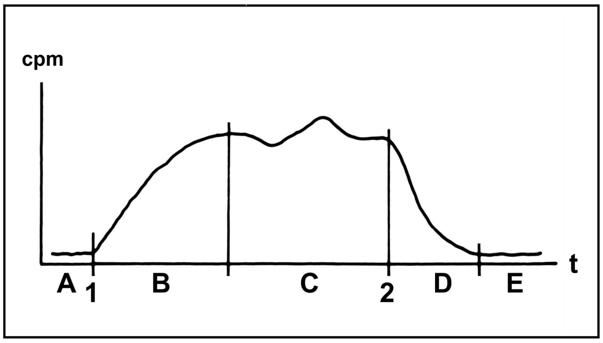


- On some audio boards the audio signal is inverted. In such a case the threshold of the channel being used is set to -30.

Analyzing the Collected Samples

PRA settings:
a) *View >> Counting Rate vs Time*
b) Set Bin size of *Counting Rate vs Time* to 600 seconds
c) *Action >> Start Data Acquisition*

The count in successive 600 s intervals is recorded by PRA and displayed in a *count rate vs. time* graph. Counting should be continued for at least three hours to show the full progeny collecting phase.



1 Collector Voltage ON
2 Collector Voltage OFF
A Background Radiation
B Progeny Collecting Phase (approx. 3h)
C Logging Phase
D Progeny Decay Phase (approx. 3h)
E Background Radiation

ANNEX

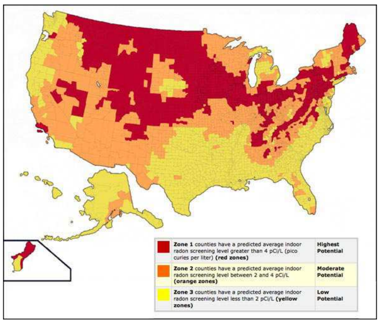
Radon

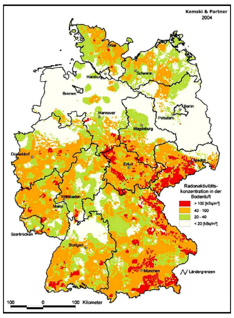
Radon (Rn-222) is a colorless, odorless and tasteless gas that is radioactive. Radon has been considered the second leading cause of lung cancer and leading environmental cause of cancer mortality. It can only be detected with special instruments that measure its radioactivity.

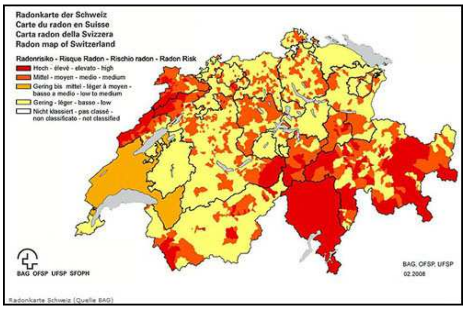
Rn-222 belongs to the radium and uranium-238 decay chain, and has a half-life of 3.82 days. Its four first decay products (excluding marginal decay schemes) are very short-lived, meaning that the corresponding disintegrations are indicative of the initial radon distribution. Its decay goes through the following sequence:

- Rn-222, 3.8 days, alpha decaying to...
- Po-218, 3.10 minutes, alpha decaying to...
- Pb-214, 26.8 minutes, beta decaying to...
- Bi-214, 19.9 minutes, beta decaying to...
- Po-214, 0.1643 ms, alpha decaying to...
- Pb-210, which has a much longer half-life of 22.3 years, beta decaying to...
- Bi-210, 5.013 days, beta decaying to...
- Po-210, 138.376 days, alpha decaying to...
- Pb-206, stable.

Rn-222 is produced by the radioactive decay of radium-226, which is found worldwide in uranium ores, phosphate rock, shale, metamorphic rocks such as granite, gneiss.







Radon is a major contributor to the natural radioactivity of the atmosphere near the earth's surface. With its half-life of 3.82 days it has plenty of time to diffuse through microcracks in rocks and through the soil and to enter the atmosphere. Radon concentration varies greatly with season and atmospheric conditions. For instance, it has been shown to accumulate in the air if there is a meteorological inversion and little wind.