Manual

poCAMon

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Content

Common 2
Power supply 3
Filter replacement and flow control 3
Data storage 3
Instrument operation by menus 4
Command „Show results“ 4
Command „Select cycle“ 4
Start of a measurement 5
Alert functions 5
Gamma background 5
Operation conditions 6
Communication via USB and Net Monitors (ZigBee) 6
User specific settings 7
Changing the alert settings for radiometric measures 7
Changing the threshold level for count rate 7
Adjusting the gamma background compensation 8
Changing units (US/SI) and dose coefficients 8
Enabling the wireless interface in standby mode 8
Appendix 9

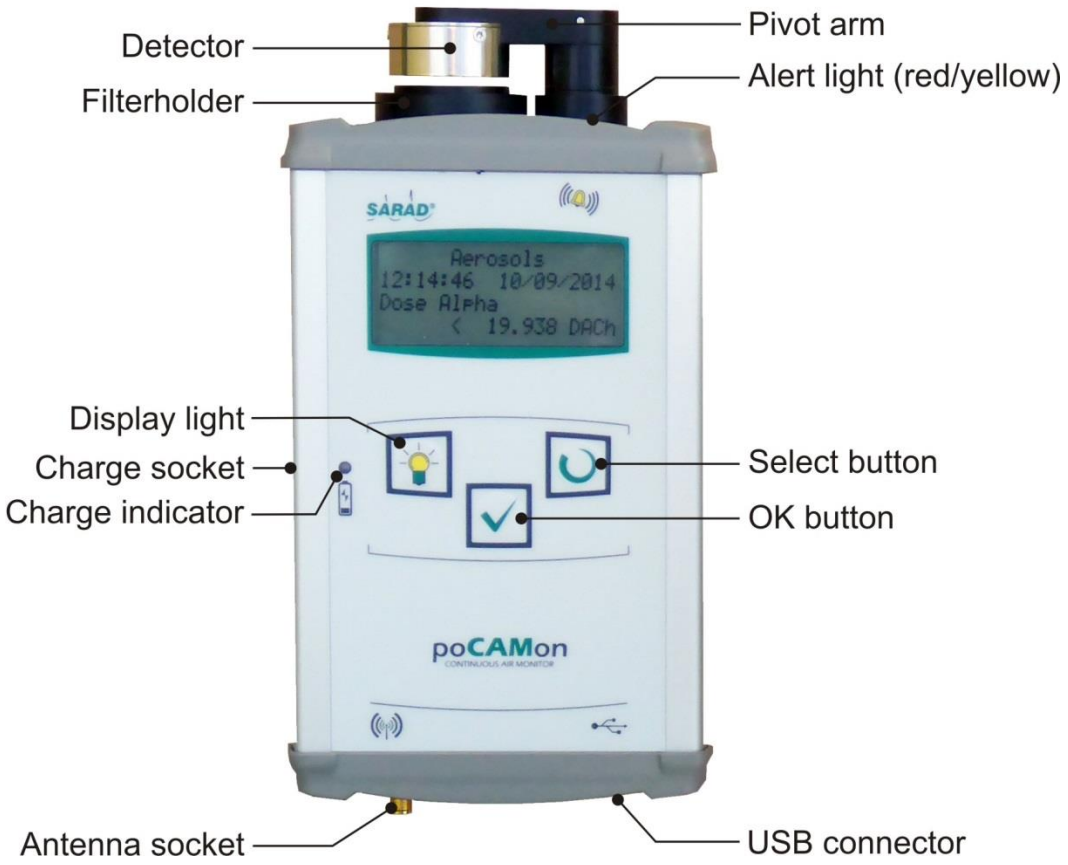
General information

The personal online continuous air sampler poCAMon allows the measurement of the exposure of workers and first responders with respect to radioactive aerosols. The unit measures long lived radioactive dust (LLRD) as well as natural occurring Radon daughter products. Both values are presented separately. The influence of Radon daughters is dynamically compensated for LLRD detection. Following results are achieved from the acquired energy spectrum

- Alpha exposure and dose for LLRD
- Beta exposure and dose for LLRD
- Equilibrium equivalent concentration for Radon (Rn-222) daughters
- Equilibrium equivalent concentration for Thoron (Rn-220) daughters

If any of the user-adjustable thresholds is exceeded, audible and optical alerts are generated. Special attention has been spent on quality assurance. Air flow and filter status are logged in parallel with the radiation results. A complete energy spectrum is saved for each single sampling interval. The instrument offers various measurement cycles to fit for several applications. The configuration and operation software package dCONFIG/dVISION will be delivered with the unit.

The picture below shows the main part and controls of the poCAMon



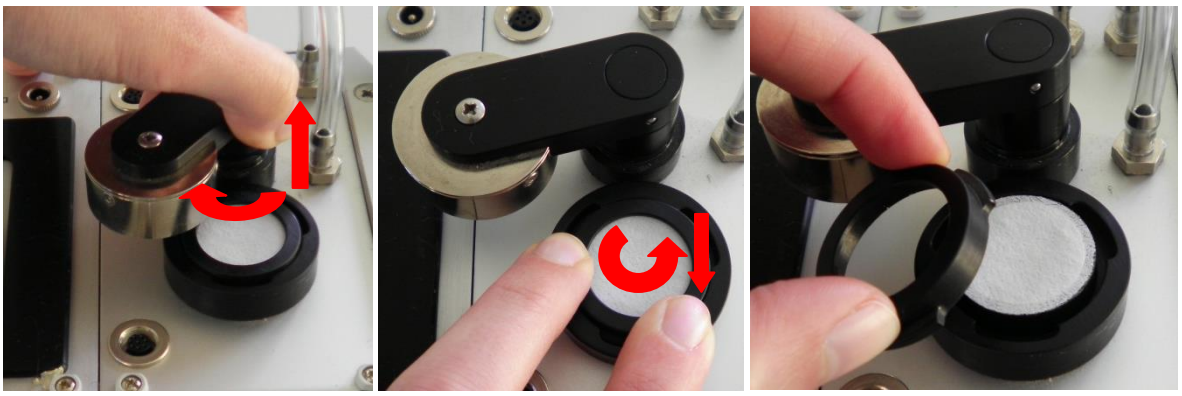
Power supply

The unit is powered by an internal 12V/3.8Ah rechargeable battery pack (standard cells). The battery allows more than 30 hours of autonomous operation. When the battery has been discharged, the instrument switches automatically to standby mode resulting in a very low power consumption. If the battery remains without recharging of longer periods, a deep discharge prevention circuit disconnects the whole electronics. Then, the display switches completely off. After connecting the power supply it takes a few minutes to reach the battery voltage threshold which is required to turn on the unit again. The charging process takes about two hours and is indicated by a red light left beside the buttons. If the charging has been completed, the light turns off. The instrument warms up during charging process therefore it should not be covered as long as the charger is connected. Only 18VDC power adapters with a minimum rate of 60VA can be connected.

The instrument can be permanently connected to the adapter. The integrated charge controller forces a cyclic charge/discharge process to maintain the battery.

Filter replacement and flow control

If the filter is heavily charged by particles and the pump cannot longer regulate the flow at the nominal rate, the yellow alarm light begins to blink. In this case the filter must be replaced. At first, the pivot mounted sampling head must be pulled out slightly and turned towards the display (pic. 1). After that, the filter cap (inner ring) must be pressed down and turned to lose the bayonet-catch (pic. 2). Now, the old filter can be removed and replaced by a new one. The smooth side of the filter must show in the direction of the sampling head. Only filters specified by SARAD should be used. This ensures a reliable sealing as well as the required spectroscopic performance.



The air flow rate determines mainly the calibration factor of any aerosol monitor. A constant flow rate ensures reliable results because not only the sampled volume but also the collection characteristics do not underlie variations. For this reason, the pump of the instrument is regulated to the nominal flow rate set-point even if the filter becomes loaded. As mentioned above, if the filter needs to be changed, the yellow signal starts to blink. This happens just before the contamination limit is reached. Thus, a running sampling can be finished before filter replacement. Flow rate as well as filter contamination are logged into the data file.

Data storage

All acquired data is saved on an internal SD memory card (2GB). Data stored on the card can be read via PC either completely or for a selectable period (manual dVISION). If necessary, the SD card can be

replaced by removing the bottom cap of the instrument's enclosure (picture). After inserting a new card, the card needs to be initialized using the "RESET" button in the dVISIOn software.

Instrument operation by menus

If no measurement is in progress, the unit remains in a low power modus. The display shows the main menu containing the instrument name and configuration, the chosen sampling cycle and the selected menu command in the bottom line. The select button toggles between the following available commands:

- Start the chosen sampling cycle (Start cycle)
- Show the data of the last finished sampling interval after stopping the measurement (Show results)
- Select a pre-defined sampling cycle (Select cycle)

Command „Show results"

After selection of this menu command by the OK button, a list of available measurements appears on the display:

- "Filter check" contamination status of the filter
- "Battery" current battery voltage
- "Counter" Detector gross count rate (all detected disintegrations)
- "Aerosols" Activity and dose values derived from the energy spectrum
- "Pump" Flow rate

To select one of these items, the select button must be pressed several times until the arrow points to the desired measure. After pushing the OK button, the results including the time stamp are shown on the display. Because the "Aerosols" menu contains more than one result, the select button must be used to toggle between them. Press the OK button to return to main menu.

Command „Select cycle"

The selected sampling cycle determines the duration of a sampling interval as well as the kind of measurement. Up to 15 various cycles can be defined by the user. After delivery, six pre-defined cycles are available:

„Hazard alert": Sampling with one minute interval time to detect dangerous exposures quickly as needed for first responders.

„Hazard alert ZB": Same as cycle one but with enabled wireless interface (Net Monitors).

„Staff monitoring": Sampling with 30 minutes interval time resulting in a low detection limit. This cycle is used to get the time dependent increase of exposure over the whole exposure period of a worker.

„Staff monit. ZB" Same as cycle one but with enabled wireless interface (Net Monitors).

„Dose assessment": Spectroscopic analysis of the filter after exposure period (for example once per month). The sample interval is eight hours and the pump is not working (spectrometer mode). The filter analysis starts three hours after starting the

cycle. Possibly remaining activity of Radon daughters decays during that period. This procedure reduces the detection limit to a minimum which allows the exact determination of the exposure and related inhalation dose.

„Alert test“: Test of all available alert signals.

Start of a measurement

A new measurement (using the previously selected cycle) can be started by the menu command "Start sampling". Then, the display shows the name of the cycle, interval time and the elapsed sampling time. The bottom line shows various menu commands which can be toggled by the Select button. The output of the results is implemented in the same manner as in standby mode. In addition to the interval values, the display shows also the recent reading of the selected measure. A blinking bar indicates recent readings while the time stamp indicates the interval results (time stamp is related to the end of the interval).

One more display command („GPS position“) informs of the remaining data memory and, if the unit is equipped with GPS receiver, of the geographic position.

Alert functions

Several types of alerts can arise while the unit is in operation. In parallel to the radiometric measures, battery voltage, flow rate and filter contamination are monitored continuously. All alert thresholds are adjustable by the user. It is also possible to disable one or more alerts. These settings can be done with the PC configuration software dCONFIG.

The instrument offers two different alert signals, a yellow blinking light on the one hand and a red light combined with a buzzer on the other hand. Additionally to the optical and acoustic signals, the display shows a list of all pending alerts. The alert has to be confirmed by pressing the OK button. After delivery, following alerts are pre-defined:

Alert source	**Signal/check period**	**Preset threshold**	**Displayed phrase**
Alpha dose	Red/Interval	> 10DACh	Aerosols
Beta dose	Red/Interval	> 10DACh	Aerosols
EEC Radon	Red/Interval	> 1000Bq/m³	Aerosols
EEC Thoron	Red/Interval	> 1000Bq/m³	Aerosols
Gros count ate	Red/Second	> 20 cpm	Count rate
Low battery	Yellow/Second	11,8 V	Battery
No filter inserted	Yellow/Second	< 0%	Filter check
Filter contaminated	Yellow/Second	> 90%	Filter check

The configuration procedure for alerts will be explained in the chapter „user specific settings“.

Gamma background

Increased background radiation results in an increased count rate for betas. The reason is the generation of conversion electrons by interaction of gamma quants with matter (e.g. detector housing). These conversion electrons cannot be separated from the electrons emitted by the collected aerosols. Thus, the instrument would show a beta exposer even if no air-born aerosols are

present. This “virtual” exposure disappears as soon as the instrument leaves the gamma radiation field while the real collect filter activity cannot decrease.

The instrument offers the possibility of static background compensation if the gamma radiation field on site is known (work place). The best way is to measure the background count rate directly with the instrument (sampling without pump). Then, the achieved value can be set as one configuration parameter using the configuration software dCONFIG. The background count rate can also be estimated if the local dose on site is known. For a natural radiation field, the following formula may be used:

Background count rate = 55cpm/(µSv/h) * Dose rate (µSv/h)

The preset background count rate will be subtracted from the beta gross count rate, taking the statistical fluctuations in consideration. If the unit with preset background is operated in areas without gamma radiation, the configuration needs to be changed again. Otherwise, the detection limit would be increased.

To set the background count rate see chapter „user specific settings“.

Operation conditions

The instrument has been designed as a robust unit for portable use in nuclear facilities and mining facilities. Because of the sampling method, the detector head is directly exposed to the ambient conditions. Therefore, the user should mind a few limitations.

- The temperature range from 0°C to 5°C should not be exceeded. An extended range can be provided on request.
- Condensation of water must be avoided. After strong temperature changes (moving a cold unit in warm environment) the instrument should be tempered for a while before using.
- Avoid beats onto the enclosure or detector head. The microphonic (piezo-electric) effect generates electronic signals similar to decay events. The instrument is equipped with dynamic shock suppression (electronic pulse shape analyses). Frequently shocks or permanent vibration must still be avoided. The unit should be worn on the body using the holster. The holster and the position close to the breathing tract offer a perfect shock protection as well as a good sampling procedure.
- Do not use any strong source of electro-magnetic fields in the immediate surroundings of the instrument (e.g. mobile phones, Wi-Fi adapter/router).
- The internal battery warms up during charging process. Therefore, the instrument must not be covered or operated in a box while the power supply is connected.
- The instrument should never be operated without filter. Particles in the air loop resulting in an increased abrasion of the pump.

Communication via USB and Net Monitors (ZigBee)

The instrument is equipped with both, a standard USB and a wireless interface. The USB interface has always the highest priority. That means, if the unit is connected to PC by the USB cable, the wireless connection will be interrupted. The USB port appears in the PC software as a virtual COM port. A driver must be installed before the communication can be established (see manual dVISION). After

delivery, the wireless interface is only activated if one of the cycles “Hazard alert ZB” or “Staff monit. ZB” is in progress. If the wireless communication shall also be provided also in standby mode, the configuration needs to be changed (see chapter “user specific settings”). It should be taken in account that in this case the wireless interface draws still current from the battery, resulting in a faster discharge. It takes about 60 seconds after switching on the wireless interface (start of the cycle) until the connection has been established. Please mind the correct baud rate setting (9600) at the Net Monitors coordinator. If the connection will be interrupted, the instrument automatically re-connects as soon as it is back in the range of the coordinator.

User specific settings

The instrument is based on the DACM platform, which provides flexible tools for custom specific configurations. Each of the functional blocks, the so-called components, can be configured and controlled separately using the PC software dCONFIG. Changing the configuration requires caution and should be carried out by skilled persons only (administrator). Erroneous settings may result in a male function of the instrument. Before changing anything, the operator should read the recent configuration from the unit and save it on PC as configuration file. If necessary, this file can be written back to the unit in case of trouble. Each component offers a specific configuration window in dCONFIG for all available configuration parameter. The dCONFIG software manual informs of the procedures to access the various configuration windows.

Changing the alert settings for radiometric measures

Configuration window of component SPEC1

It is possible to define two independent alert levels. The threshold values must be entered into the edit fields “Alarm 1 threshold” and “Alarm 2 threshold”. Several measures can be assigned to each of the alert levels. These measures must be selected by marking the items within the list boxes “Alarm 1 source” and “Alarm 2 source”. The threshold level is always related to the physical unit of the selected measure. For example, one could use the first threshold for the dose value and the other one for Radon and Thoron concentration. The instrument offers two alert signals, which are controlled by the components DOUT3 (red light and buzzer) and DOUT4 (yellow light). After delivery, the component DOUT3 is chosen for radiometric alerts. To disable the alert function, select the item “inactive” from the list “Alarm output”.

Changing the threshold level for the count rate

Configuration window of components CMP1 and CNT1

Two components, a voltage comparator (CMP1) and a counter input (CNT1) are used for gross count rate measurements. The comparator output is internally connected to the counter input. A digital pulse appears at the counter input if the detector signal exceeds the threshold level of the comparator. Because the height of the detector signal is related to the emission energy of the decay event, the count rate contains only events above the energy corresponding with the threshold. This allows the configuration of the counter either as gross alpha or total event counter. The threshold level can be adjusted in the component window of CMP1, edit field “Threshold voltage”. To count alpha and beta decays, enter 100mV, for alphas only, enter 350mV.

The alert threshold for the count rate can be configured in the configuration window of component CNT1 (“Alarm if count rate becomes higher than”). The alert can be disabled in the same manner as

described for the radiometric measures if the item “inactive” will be selected from the list box “Alarm index higher than”. After delivery, the red light and the buzzer (DOUT3) are activated in case of a pending alert. If only the yellow light shall signalize high count rates, select DOUT4 instead of DOUT3.

Adjusting the gamma background compensation

Configuration window of component SPEC1

To enter the background count rate, the parameter „Fixed Background Count Rate“ is available in the table “Calibration constants”. The unit is cpm (counts per minute).

Changing units (US/SI) and dose coefficients

Configuration window of component SPEC1

The activity and dose results can be presented either in traditional US units or in international SI units, depending on the selection in the list box “Unit scheme”. Changing the unit scheme requires always the changing of the dose coefficients. Dose coefficients must be stated in relation to the selected dose unit. That means for US unit scheme, the unit of dose coefficients is DACh/(Bqh/m³). The dose coefficient unit in case of SI unit scheme is µSv/(Bqh/m³). The values can be entered into the table “Calibration constants”. There, the parameters "Dose Coefficient Alpha" and "Dose Coefficient Beta" are available. After delivery, the values are 5 and 0.005 DACh/(Bqh/m³) for alphas and betas.

Enabling of the wireless interface in standby mode

Configuration window of component SPEC1

The power supply for the wireless interface can be switched on/off with the status of the switch output DOUT2. The output can be controlled during the measurement by the cycle definition chart (see dCONFIG). The configuration window offers the possibility to define the status of the output during standby. Use the list box “Reset status” either to turn on („active“) or turn off (“inactive”) the interface. After delivery, the reset status is set to „inactive“.

Appendix

Assignment of components in dCONFIG

Name	Function	Component type
DOUT1	Power supply for flow regulator	Switch outputs
DOUT2	Power supply for wireless interface (Net Monitors)	Switch outputs
DOUT3	Red Alert signal/buzzer	Switch outputs
DOUT4	Yellow alert signal	Switch outputs
CNT1	Gross count rate	16 bit counters
AIN8	Filter check (Pump voltage)	12 bit configurable analogous inputs
BATT	Battery voltage measurement	Internal sensors
SPEC1	Spectrometer for filter activity	Spectrometer
REG2	Flow rate regulator (set-point)	P-Regulator/analogous output
CMP1	Threshold for detector pulse signal	Voltage comparator input