

Manual

AER 5300

Air sampler for radioactive aerosols

Version 04/2026

Reference documents:

Software manual dVISION

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Operational controls

Exterior view

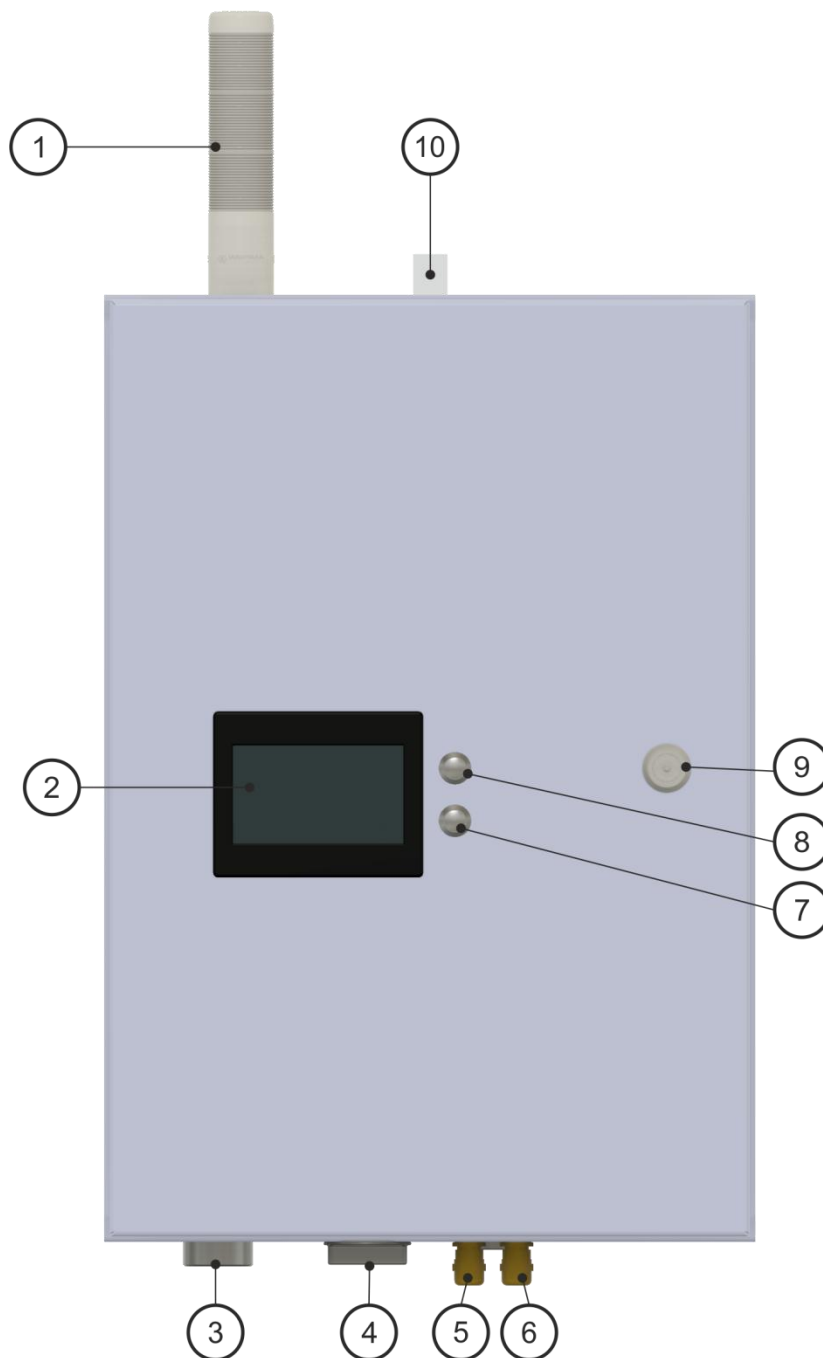


fig 1: basic equipment

- 1) Light tower red/yellow/green
- 2) Touch screen
- 3) Hose fitting for pump connection
- 4) Divisible cable gland for communication cables
- 5) Cable gland for signal cable to control frequency converter
- 6) Cable gland for mains power connection
- 7) Button "WAKE" with integrated light for alerts and warnings

- 8) Button "ON" with integrated light to indicate charging the internal battery
- 9) Door lock
- 10) Air inlet tube

Internal control panel

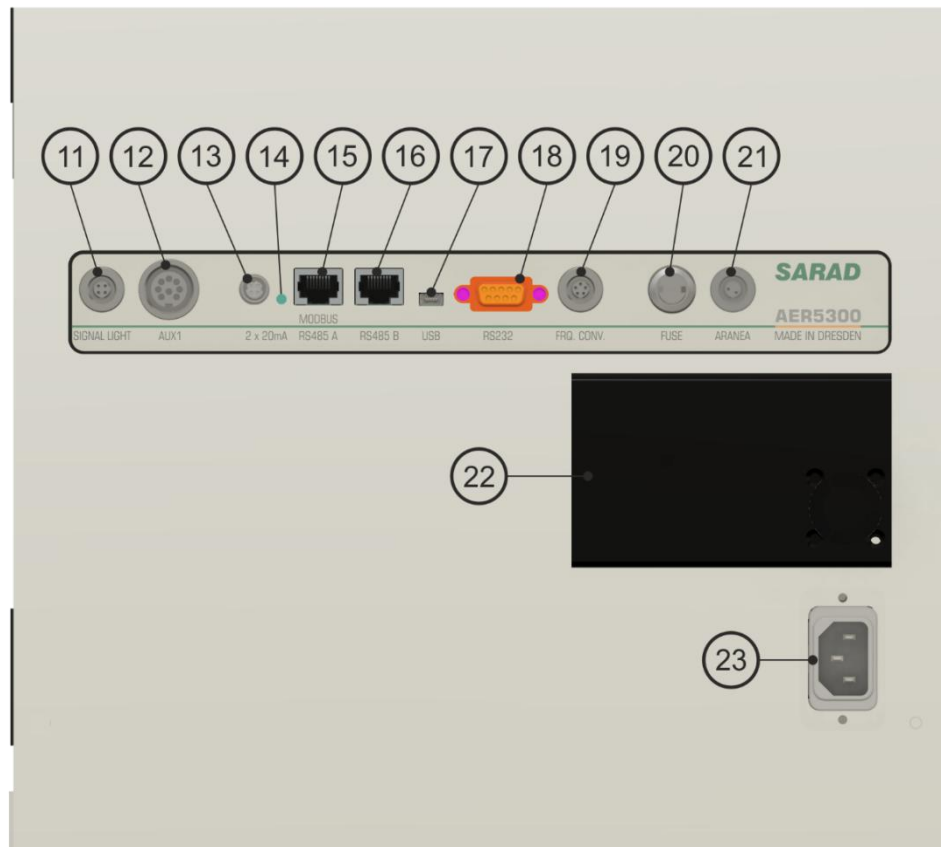


fig 2: Sampling head for progeny products

- 11) Connector for light tower ("Signal light")
- 12) Connector for accessory ("AUX1")
- 13) Connector for 2 x 20mA current loop
- 14) LED indicator for activated current loop
- 15) RJ45 connector for RS485 interface A and Modbus
- 16) RJ45 connector for RS485 interface B
- 17) Mini USB connector
- 18) SUB-D9 connector for RS232 interface
- 19) Connector for frequency converter control signals
- 20) Fuse for internal electronics
- 21) Power connector for ARANEA
- 22) ARANEA – universal MQTT server for communication via LAN/WLAN/GSM/Internet
- 23) Mains power connector

1. Overview

1.1. The DACM32 platform as basic monitor

The monitor is based on the DACM32 measurement platform developed by SARAD. This platform is based on a microcontroller with proprietary firmware. Since no operating system is used and communication also takes place via proprietary protocols, maximum protection against tampering is guaranteed.

The DACM32 platform is based on hardware with a number of universal interfaces to which a wide variety of sensors and actuators can be connected. Simple examples are an analogous input and a switching output. These interfaces are referred to as components in the DACM32, and the different types of interfaces are referred to as component types. Each component can be parameterized using configuration software to calculate the respective measured values in the desired physical unit from the sensor's electrical output signal. Each component is uniquely indexed in the DACM32 and has a unique name. This consists of an abbreviation for the component type followed by an index if multiple components of a type are present (example: AIN2 refers to analogous input no. 2). Each component is assigned an alias name via configuration that identifies the component in a user-friendly manner. Depending on requirements, the short names or alias names are used on the monitor display, in the configuration software, and in the operating software. The appendix contains a list of all component types with a brief functional description.

A specific measuring monitor is created by combining the DACM32 hardware with the required sensors and actuators, as well as the associated component and monitor configuration. Standard users do not need to worry about these aspects, as the monitors are fully configured for the respective measurement task upon delivery. However, familiarity with the platform concept will help you better understand this manual. Furthermore, both monitor manufacturers and experienced users can implement customized modifications quickly and easily.

1.2. Control of the measurement process- measuring cycles

A measurement cycle defines the time interval at the end of which the measured values acquired during this interval are stored in the data memory. Depending on the definition, the measurement cycle is repeated for a defined number of measurements or indefinitely, so that the measurement data is available as a time series. Up to 15 measurement cycles can be stored in the monitor, customized for the respective measurement task. The required measurement cycles for all standard applications are already included upon delivery. The measurement cycles are defined using configuration software, allowing experienced users to create their own cycles.

Within a measurement cycle, each component can be controlled individually. It is defined which components are included in a measurement – and when within a cycle a component should generate data or activate actuators.

1.3. Alarm-system

A maximum of 32 independent alarms can be freely defined. Any measurement value available in the monitor can be used as the data source for an alarm. A distinction is made between alarms for current sample values (measurement and verification every second) and interval alarms (verification of the integral values at the end of the interval). An alarm is acknowledged either via the touch panel, a communication interface, or (if provided in the monitor) via an input for connecting a button. The types of acknowledgements permitted can be determined via configuration. An on and off threshold can be defined for each alarm, allowing the implementation of a hysteresis. If the on threshold is

greater than the off threshold, an alarm is generated when the measured value increases; otherwise, an alarm is generated when the measured value decreases. Each alarm can be assigned several actions that are executed by the corresponding components (e.g., activating a signal light via a switching output). The alarm settings configured in the monitor are described in the "Predefined Warnings and Alarms" section.

1.4. Event -memory

The last 100 important events affecting the monitor are stored in the event log with a time stamp. This log cannot be deleted by the user, so errors, alarm situations, and tampering with the monitor can be traced later. The following events are recorded:

- Turning the monitor on and off
- Setting the monitor clock
- Changes to the component or monitor configuration
- Selecting a measurement cycle
- Starting and stopping the measurement
- Occurred alarms
- Confirmation of alarms

1.5. Communication with the host-system

All monitor settings, data transfer, and remote control of the monitor are performed independently of the communication channel using a proprietary protocol. This protocol is used by all SARAD software solutions. Additionally, current measurement data can be retrieved via the industry-standard "MODBUS RTU" protocol. Separate applications are available for monitor configuration (dCONFIG) and monitor operation (dVISION).

2. Operation

2. 1. Switching ON/OFF, standby-mode, fuse

For safety reasons, the monitor is shipped with the removed fuse. Before switching the monitor on, please open the fuse holder on the right side of the housing, insert the fuse, and then close the fuse holder again. Press the "ON" power button and hold it for a few seconds until the SARAD logo appears on the display. The monitor is switched off using the "OFF" touch button in the main menu (top centred).

After completing a measurement, the monitor goes into "standby" mode so that the monitor is not completely disconnected from the internal battery. The display is deactivated after a configurable time interval. The display is activated by pressing the "WAKE" button.

If the monitor is not used for an extended period of time, the internal battery should be fully charged and disconnected from the power supply by switching it off using the "OFF" touch button in the main menu on the display. The fuse must be removed for shipping or air transport.

2. 2. Power supply

The device has a mains connection cable that is permanently connected to the frequency converter box. The electronics are powered via the connection cable from the frequency converter box, which is connected to the device cabinet using an IEC connector. The device has a built-in NiMH battery with a nominal voltage of 12 V and a capacity of 2 Ah. This is used to supply power to the electronics and to continue measurement in the event of a power failure. The pump cannot be operated via the internal battery, i.e. it stops when there is no mains voltage.

The battery is charged automatically when necessary. During the charging process, the red LED indicator to the right of the display lights up. It goes out when the battery is fully charged.

If the battery voltage drops below 11.2 V during a measurement, the measurement is aborted. If the discharge continues below a threshold of 10.6 V, the deep discharge protection completely shuts down the monitor's electronics. The monitor can only be switched on again once the battery voltage has reached the threshold of 11.6 V during the charging process.

The battery should always be charged at temperatures between 10 °C and 30 °C. At ambient temperatures above 40 °C, charging is automatically interrupted to protect the battery. When not in use, the monitor should be turned off using the "OFF" touch button in the main menu.

2. 3. Operation panel (Touchscreen)

The monitor is operated via touchscreen. The display and backlight consume a relatively high amount of power, so they automatically shut off even during a measurement if no input is made. The time from the last touch to shutdown can be set to a maximum of 255 seconds via the monitor setup.

The display is activated as soon as the black "WAKE" push button is pressed. The last displayed page is always activated afterward. All other operating functions are controlled via the dynamic touch buttons shown on the display.

2. 4. Interfaces

2. 4. 1. Interfaces for communication (COM1, COM2)

The monitor has two independent communication channels (COM1, COM2) that can be used to communicate with the monitor simultaneously. Different physical interfaces are assigned to each channel, which are automatically switched between according to a priority scheme.

The following interfaces are assigned to the COM1 communication channel:

USB: active as soon as a USB connection is established
RS232: active when an RS232 signal is detected and no USB connection is present
RS485B: active when neither a USB nor an RS232 connection is present

The COM1 communication channel cannot be configured using configuration software. This ensures constant access to the monitor. The data transfer speed can be increased by pressing the "COM1" button in the main menu.

The following interfaces are assigned to the COM2 communication channel:

WLAN: active when WLAN has been activated by the user and the monitor is logged in
RS485A: active when the monitor is not logged in to the WLAN

The COM2 communication channel is configured using the setup functions of the configuration software. The following modes are available:

- SARAD 9600 bps no parity
- SARAD 115200 bps no parity
- MODBUS 9600 bps even parity
- MODBUS 19200 bps even parity
- SARAD wireless

The modes marked with "SARAD" use the proprietary SARAD protocol. This includes data transfer and complete monitor control.

The industry standard MODBUS RTU is also supported. This protocol only supports querying current measured values. Information on using the MODBUS RTU protocol can be found in the document "AN-009-sarad_modbus_rtu_protocol".

The "SARAD wireless" setting must be selected to activate the WLAN interface. If WLAN is not used, this mode should not be selected, as operating the wireless interface consumes a relatively high amount of power. Once this mode is enabled, the monitor will only switch to the WLAN connection once it is logged in. The WLAN access data (SSID, password, server, and port) must be entered in the setup function of the configuration software.

2. 4. 2. Analog output

The monitor has two freely configurable current loop outputs, which are available at the "2 x 20 mA" socket. The following output signal options are available:

- 0...20 mA
- 4...20 mA
- 0...24 mA

Each output can be assigned any measured value acquired in the monitor. The desired value range of the measured value must be assigned to the selected output range (e.g., for battery voltage: 4...20 mA corresponds to 0...15 V). All settings are made using the setup function within the configuration software.

2. 4. 3. Socket for external accessories (AUX1)

One socket provides additional components of the DACM32. It can be used to control external accessories or integrate external sensors into the system. In addition to the standard configuration, monitor- and user-specific modifications are possible. The standard configuration is documented in the section "AUX1 Connector." Customer-specific configurations are described in a separate document.

2. 5. Data storage of measurements

The measurement data is stored on an internal SD card. Several million data records can be stored. The generated measurement data is always saved as raw data, i.e., in the binary format generated by the components. This ensures absolute traceability of the measurement data for quality assurance purposes. A component can generate one or more measured variables from the raw data. To display the measured values on the monitor or to retrieve current measured values via the communication interface, they are calculated based on the raw data using the component configuration. When transferring the complete measurement data to the host system, however, only the compressed raw data is transferred along with the component configurations. The host system then generates the actual measurement results from this.

Please note that the monitor can collect very large amounts of measurement data, which later result in longer transmission times via the communication interfaces. Therefore, only activate the required sensors and select the length of the measurement intervals appropriate to your application.

The data of the memory card can be deleted using the corresponding function in the operating software.

2. 6. Menu navigation

2. 6. 1. Main page

After activating the display using the button below the display, the main navigation page appears.

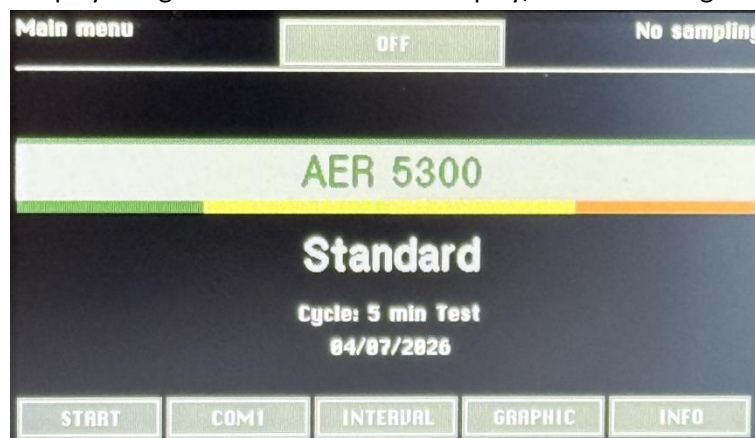


fig 3: Main menu if measurement stopped



fig 4: Main menu during measurement

In "Standby" mode, the monitor's name, the name of the current monitor configuration (including the date of the last change), and the selected measurement cycle are displayed. The measurement is started by touching the "START" button. While a measurement is running, the current cycle settings and system status are displayed:

- Time
- Name of the currently running measurement cycle
- Current measurement time of the current interval
- Total measurement time since the start of the measurement
- Number of the completed step and number of steps within the cycle
- Size of the free data memory (number of data records still available for storage)

From the main menu, you can also access the submenus for displaying the module and component configuration, the data stored on the memory card, and, if a measurement is running, the current measured values of the sensors.

To end a measurement in progress, touch the "STOP" button.

2.6.2. Display of module information and module settings

The display pages, accessible from the main menu via the "INFO" button, provide an overview of the module version and the current settings of various monitor parameters. The display pages can be switched using the "TOGGLE" key.

Page 1 Module Information

- Software Version
- Serial Number
- Manufacturing Date
- Date of Last Firmware Update

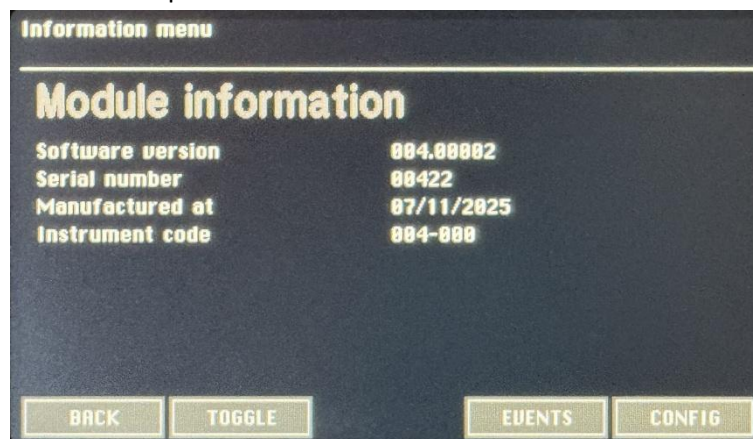


fig 5: Module information

Page 2 Module Settings

- Time of automatic start, if this function has been enabled. Otherwise, the text "disabled" appears instead of the time.
- Protocol set for the COM2 communication interface
- Information about the Wi-Fi connection stored in the monitor (SSID and server/port)
- Current loop output settings (data source, output signal range, and assigned value range). (The name of the data source corresponds to the unique component name. The value range refers to the physical unit of the selected measured value.)

Page 3: Additional module settings

- Timer operating mode (timer or periodic timer synchronized with the measurement cycle)
- Time points for switching the timer on and off, either as real time (timer mode) or as on, off, and delay intervals (periodic timer mode)

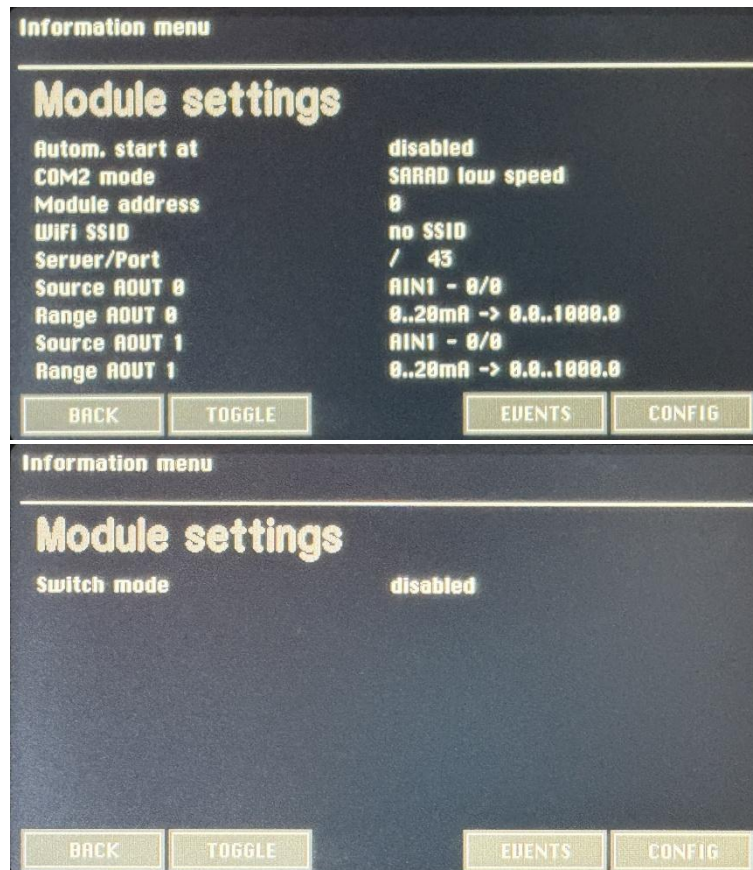


fig 6: Module settings

The "BACK" button returns to the main page. The "CONFIG" button allows you to switch to the display pages for the configured component parameters.

2. 6. 3. Display of component configuration

The current configuration parameter settings for each component can be viewed for review. To do so, click the "CONFIG" button in the information menu. Parameter changes cannot be made. The "NEXT" and "LAST" buttons can be used to select individual components.

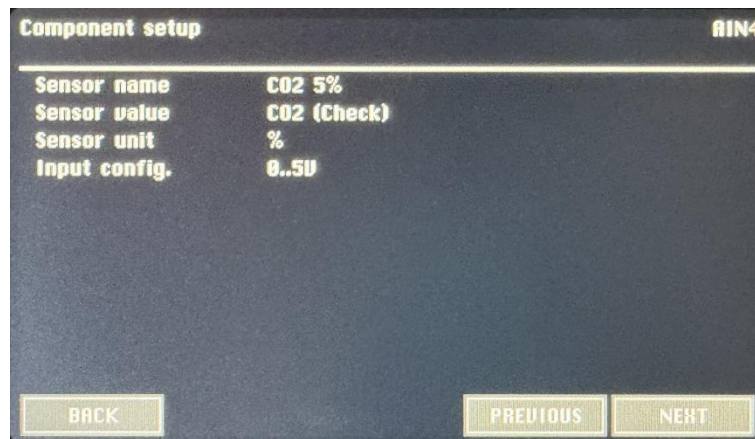


fig 7: Configuration of components

If one page isn't sufficient to display all parameters, you can access additional pages using the "TOGGLE" button. You can return to the main page using the "BACK" button. The unique component name is displayed in the upper right corner.

2. 6. 4. Selection of measurement cycle

Touching the cycle name displayed in the main menu opens a list for selecting one of the predefined measurement cycles. A maximum of 15 different measurement cycles can be stored in the monitor. If the number of stored cycles does not fit on one display page, the "MORE" button appears, which can be used to scroll through the list. The desired measurement cycle is selected by touching the list entry. In this case, the monitor automatically returns to the main page. If you do not want to select a new cycle, press the "BACK" button.

2. 6. 5. Display of actual measured values

This display page is only accessible when a measurement is in progress. You access this page by touching the "RECENT" button. The display is updated every second so that the current sample value of a component is always shown. This function corresponds to that of a direct reading measuring monitor. Only the data of those components that are actually included in the measurement cycle and are currently active are displayed. Switching between the available components is done using the "NEXT" and "LAST" buttons. The alias name of the component appears in the display header.

If a component delivers more than one result, the "TOGGLE" button for switching the measured values is activated. Return to the main page is done using the "BACK" button.

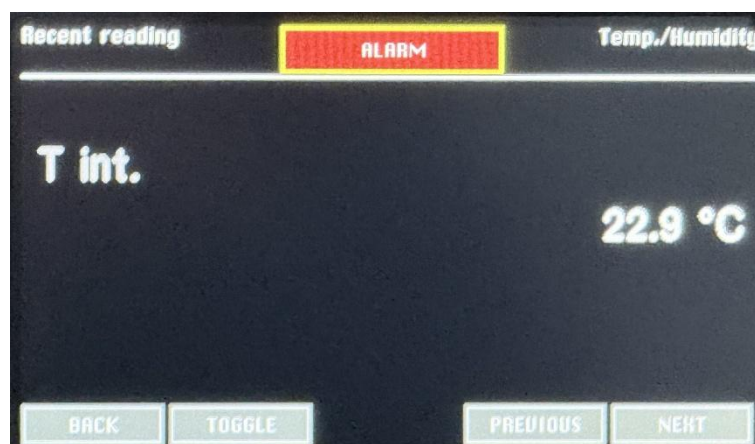


fig 8: Display of actual measured values

2. 6. 6. Display of the stored measurement values

If available, all measurement data stored on the memory card can be displayed. This function is accessible via the "INTERVAL" button during or stopped measurement. Switching between the individual components whose data is contained in the data set and selecting the desired measurement value is carried out in the same way as displaying the current values. For components that calculate multiple measured values, an additional overview page has been implemented for viewing all measurement results simultaneously.

A bar with navigation buttons appears for selecting data points within the measurement series. The middle button can be used to retrieve the most recent data set chronologically. The other buttons scroll forward or backward by one or ten data sets, respectively.

The header of the display shows the alias name of the component and the time at which the data set was saved. If the geographical position could be determined using the integrated GPS receiver, the coordinates appear in the footer. Return to the main page is achieved by pressing the "BACK" button. In addition to the highlighted mean value of the measurement for the current measurement interval, the minimum and maximum individual values within the interval are displayed below. For radiological measurements, these two values indicate the 1-sigma confidence interval determined from the counting statistics.

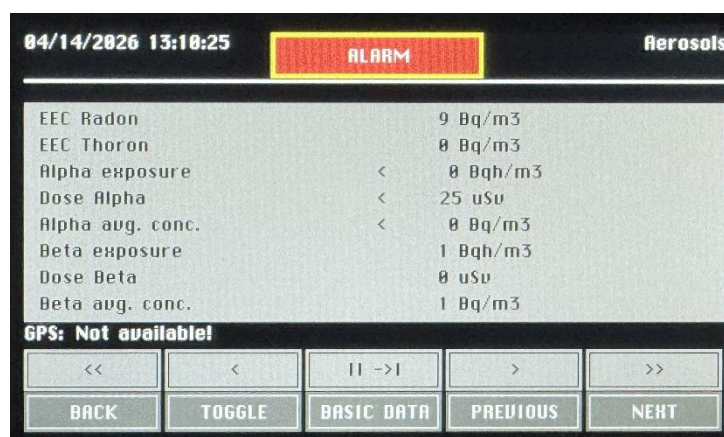


fig 9: First display page for interval measurement data for components with multiple measured values

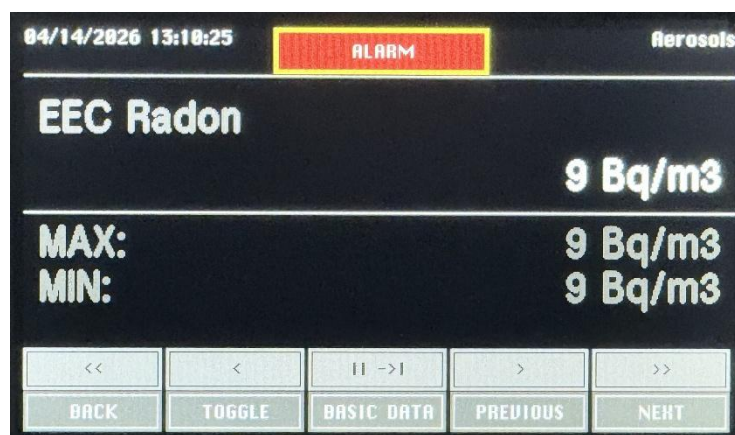
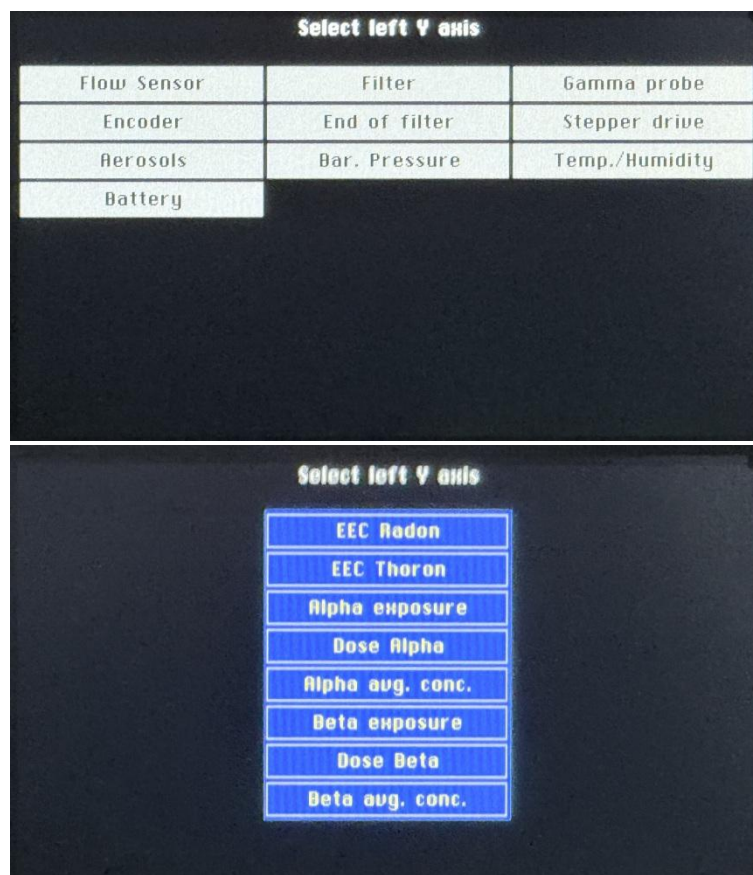


fig 10: Display of interval measurement data

2. 6. 7. Graphical display of the measurement data as a time series

All measured values available on the monitor can be displayed as a time series in a diagram. To do this, touch the "GRAPH" button in the main menu. The display is limited to the last 50 values of the current or most recently executed measurement cycle. The time axis is scaled accordingly until the limit of 50 measuring points is reached; after that, the oldest data is moved out of view with each new measured value during the measurement. Two measured variables can be displayed simultaneously. The Y-axis is always scaled automatically. Below the diagram view there are four navigation buttons with which the red cursor line can be moved by one or ten measured values. The timestamps and measured values associated with the cursor position appear above the cursor line. The desired measured variable is selected using the Select Y button. A table with the alias names of all available components appears. Now the desired component to be assigned to the left Y-axis can be selected. Since some components can generate multiple measured values, a list appears for selecting the desired value. The procedure for selecting the measurement value for the right Y-axis is then repeated. The "BACK" button returns to the main menu.



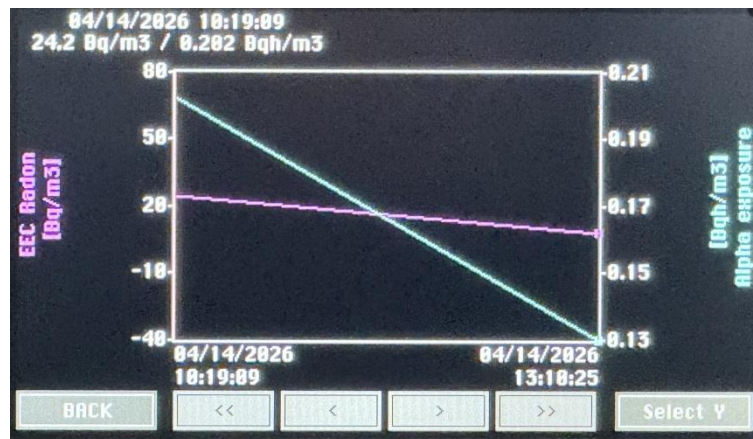


fig 11: Selection and display of series of measurements

2. 6. 8. Display of basic data

Some components support the display of the acquired base data used to calculate the displayed measured values. For such components, an additional button labelled "BASE DATA" appears on the interval data display page, which takes you to the corresponding display page.

2. 6. 8. 1. Display of the acquired spectrum

A spectrum can be displayed for all measured values that were calculated based on an acquired energy spectrum. The spectrum is shown in the form of a diagram. A control panel appears to the right of the diagram. The light grey buttons are used for cursor navigation, while the dark grey buttons are used to control the display. The upper button switches between cursor and ROI navigation. The navigation buttons can then be used to either move the cursor or switch between the energy regions (ROI) required for calculating the measured values. The "FIT Y" button scales the diagram to the maximum value of the spectrum. The "/10" and "x10" buttons can be used to increase or decrease the scaling of the Y-axis by a factor of 10. The lower button is used to switch the spectrum view between linear and logarithmic scaling.

When cursor navigation is selected, the counting channel, the associated energy, and the number of counting pulses contained in the counting channel appear above the white cursor line. When ROI navigation is selected, the energy range of the ROI is highlighted in colour. The energy range of the ROI and the counting pulses contained therein are displayed above it.

Depending on the number of counting channels in the energy spectrum, a correspondingly segmented bar appears below the diagram, allowing the spectrum to be scrolled left or right across the diagram area. The yellow bar below the scroll bar indicates the currently displayed spectrum range.

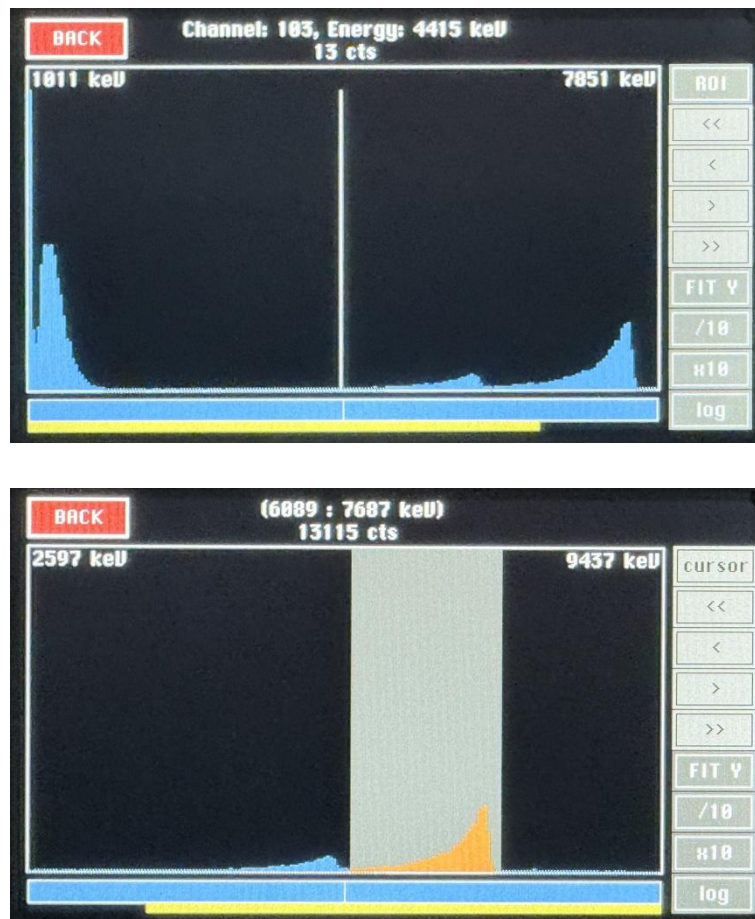


fig 12: Display of spectra (Cursor- and ROI-navigation)

2. 6. 9. Alarm-display

As soon as a new alarm occurs on the monitor, it automatically switches to the alarm display page. If the display was deactivated, it will be activated. The display contains a list of all existing alarms in the form of a text line. The current status of an alarm is indicated by the text colour, which is assigned as follows:

- Red: New alarms, only when the alarm menu is first accessed
- Yellow: Alarm situation still exists; alarm confirmation has not yet been received
- Green: Alarm situation still exists; alarm has already been confirmed
- White: Alarm situation no longer exists; alarm confirmation has not yet been received

The alarm is confirmed using the "CONFIRM" button in the bottom right corner of the display. The BACK button returns to the main menu. As long as alarm situations exist or there are unconfirmed alarms, a red button labelled "ALARM" appears at the top centre of the main menu. This button can be used to access the alarm display page at any time.

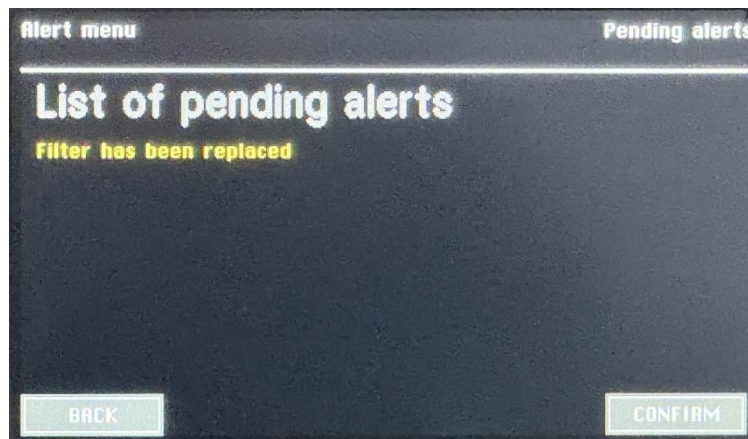


fig 13: Display of alerts (Cursor-navigation)

2. 6. 10. Display of event memory

The entries in the event log can be displayed from the main menu using the "EVENTS" button. The output is in reverse chronological order, i.e. the most recent event is at the top of the list. The "MORE" button scrolls to the end of the event list. The events are output as text messages. For some event types, the text contains additional information regarding the origin of the event, e.g. whether the event was triggered via the touch screen or via one of the communication interfaces. When selecting a cycle, the index of the selected cycle is specified. If alarms have occurred, a bit mask is displayed. The index of a component corresponds to its position within the bit mask. A set bit (a "1" is displayed) signals the origin of the alarm(s) that have occurred. The "BACK" button takes you back to the main menu.

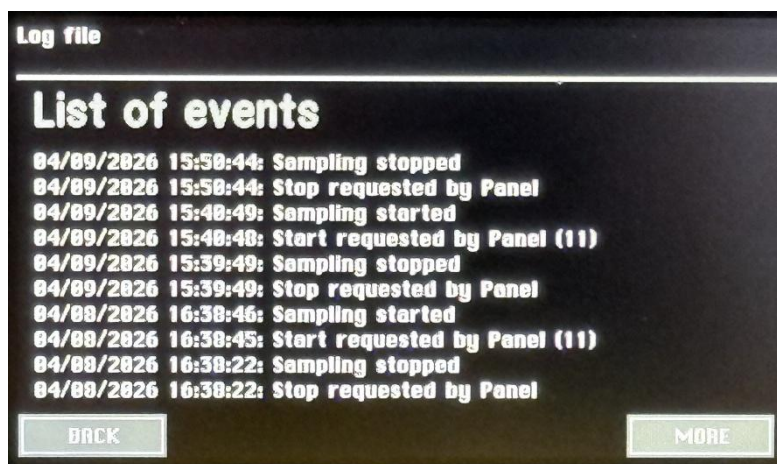


fig 14: Display of events

2. 7. Setup (timer, synchronous start, display switch off)

2. 7. 1. Timer

Using the integrated timer, the 12 V DC system voltage can be switched to an external load (e.g., relay, solenoid valve, modem, etc.) for a specific period of time. The maximum current must not exceed 400 mA.

The switched voltage is available at the "AUX2" jack. The timer can operate in two modes ("Clock Switch Mode"):

1. Timer

In this mode, two times of day are specified for switching on and off. The switching process then occurs daily at these times. The monitor's internal real-time clock serves as the time base.

2. Periodical timer

Here, a period for the on and off states, as well as an additional switch-on delay, can be defined. The timer function is synchronized with the start of a measurement. After the start, the monitor waits for the switch-on delay period (which can also be set to 0). The voltage is then switched on for the switch-on period and, after this period has elapsed, switched off for the switch-off period. This process is repeated periodically until the end of the measurement. If the timer is not to be used, it can be deactivated by selecting the operating modes.

2. 7. 2. Synchronous start at a set time of day

If multiple measuring monitors at different locations need to be synchronized, we recommend using the synchronous start function. A time of day can be set at which the currently selected measurement cycle will automatically start. The monitor's internal real-time clock serves as the time reference. The clocks of all monitors to be synchronized should be set to the same time beforehand.

2. 7. 3. Display shutdown interval

To reduce power consumption, the display is deactivated after a configurable period of time (starting from the last touchscreen operation). The time period can be set from 1 to 255 seconds.

3. Sensors and actuators in the AER 5300

The following describes the sensors available in the monitor, their assignment to the DACM32 components, and the measured values generated from the sensor signals. The configuration of the respective components is not explicitly discussed, as this was defined by the manufacturer for the monitor. The text provides the unique component names and, in parentheses, the alias names of the components. Both names are used as needed on the various display pages.

3. 1. Measurement of radioactive aerosols and Radon decay products

The measurement air enters the closed filter housing via the intake manifold on the top of the cabinet. For reproducible measurements of radon decay products and other radioactive aerosols, a constant flow rate (20–50 l/min – standard pre-set is 35 l/min) ensures both consistent sensitivity and constant air intake conditions. Constant intake conditions are necessary to avoid variable collection losses depending on particle size. Depending on the model, the air flow is generated by an internal pump or an externally provided vacuum connection.

3. 1. 1. Measuring principle

The radioactive aerosols contained in the measured air are collected on a filter by the air flow generated by the pump. The detector above registers the activity collected on the filter. The activities of the radon decay products and the long-lived isotopes (LLRD – Long Lived Radioactive Dust) are separated by alpha spectroscopy. The exposure, dose and average activity concentration for long-lived isotopes as well as the concentrations of radon and thoron decay products are determined on the basis of the obtained count rates. The influence of radon decay products on the LLRD measurement results is automatically compensated for on the basis of spectra.

Important if thoron daughter products are of particular interest: In order to achieve practically usable response times when the concentration of thoron daughter products changes, the calculation is performed by differentiating the time distribution of the detected activity of Po-212 on the filter. Since the difference between the counting pulses of two consecutive measurement intervals must be formed in this case, the calculated value results in a significantly larger statistical fluctuation. A correspondingly large measurement interval should therefore always be selected. In practice, intervals of one to three hours have proven to be effective. These are sufficiently large to record daily trends, for example, and are also within the response times of the Rn-222 daughter product measurement.

Single nuclide analysis with regard to LLRD is not possible because the emission energies of many isotopes are very close together and the energy resolution of a filter-air spectrum is too low. In practice this is not necessarily due to the very similar dose coefficients of the most common target nuclides. However, the spectrum analysis algorithm recognizes if only natural uranium is the origin for the LLRD activity. In this case, the device automatically applies the corresponding dose coefficient, which is approximately one order of magnitude lower than that of typical artificial isotopes.

Spectroscopic analysis is only possible for alpha emitters; for isotopes emitting beta radiation, the total activity is determined. A compensation for radon decay products is performed too. In contrast to alpha emitters, beta emitters have a continuous energy spectrum, which starts at an energy of 0keV. Due to the thermal noise of semiconductor detectors, decays with emission energies below the noise threshold cannot be detected and are therefore lost for activity determination. The amount of loss depends on the emission spectrum of the respective isotope and must be compensated for

individually. This is done within the device configuration. The default setting refers to strontium (Sr-90).

The various dose coefficients used to derive the dose from the measured exposure are part of the device configuration and can be adjusted individually. In the delivery state, these are defined for a worst-case scenario with plutonium (Pu-239 for alpha) and strontium (Sr-90/Y90 for beta).

Note: The sensitivity of the device, i.e. the amount of activity collected on the filter, is linearly dependent on the air flow through the filter. The device constants were determined during calibration for the nominal flow rate specified in the data sheet. Any change to the nominal flow rate by the customer therefore requires a change to the device constants as part of a recalibration.

3. 1. 2. DACM32-components for the measurement of radioactive aerosols

The output signal from the semiconductor detector is connected to the SPEC1 spectrometer module, which provides a spectrum for each measurement interval to determine the count rates and calculate the exposure, concentration and dose values.

3. 1. 3. Display of measuring values

The output of the daughter product activity concentrations for radon and thoron is displayed on the SPEC1 spectrometer display page as EEC (equilibrium equivalent concentration). For LLRD, the output is separated into alpha and beta, each with exposure, dose and mean activity concentration. The mean activity concentration refers to the measurement duration since the start of a measurement. The shift key can be used to display the various measured values and the associated confidence interval (assumption probability 1σ). The display menu for the current measurement shows the pulses accumulated for the current interval. Here, 'Pulses Hi-E' corresponds to the energy range for alpha emitters, whilst 'Pulses Lo-E' corresponds to that of beta emitters.

3. 1. 4. Calculated measurement results

3. 1. 4. 1. Alpha/beta exposure

Exposure forms the basis for all further calculations relating to long-lived alpha and beta emitters. The collected and measured net filter activity for long-lived nuclides (background corrected) is directly proportional to the exposure. Exposure is defined as the product of activity concentration and exposure period. Consequently, the exposure displayed by the device always corresponds to the exposure period since the last filter change.

3. 1. 4. 2. Alpha/beta dose

To calculate the dose, the exposure is multiplied by a dose coefficient. The dose coefficient quantifies the various nuclides in terms of their harmful effects on human tissue. For airborne radioactivity, the coefficients for inhalation are used, as the radiation energy is released in the lungs. Different dose coefficients apply to different nuclides. As a nuclide-specific analysis of a filter spectrum is not possible, the worst-case scenario must be assumed. This occurs in the presence of plutonium (alpha) and strontium (beta). It should be noted that only natural uranium has a significantly lower dose coefficient. As natural uranium can be separated by the device and the dose coefficient is automatically adjusted, a significant overestimation of the dose is highly unlikely.

3. 1. 4. 3. Average alpha/beta concentration

The average concentration is calculated by dividing the exposure by the elapsed exposure time. It therefore represents the average concentration since the last filter change, regardless of any fluctuations in the activity concentration over time. Unlike the exposure, this value can rise or fall

during the course of a measurement. The latter case occurs when an activity concentration was present in the measurement air only at the start of a measurement. The accumulated filter activity therefore remains constant as the measurement progresses, whilst the exposure time increases continuously.

A time-resolved measurement of the activity concentration is not meaningful without periodic filter changes, as the detection limit rises very rapidly with increasing filter activity due to the necessary differentiation of the activity curve. Changing the filter at the start of each measurement interval provides a solution. This mode delivers the lowest detection limits, as the background level from radon is not yet fully established for measurement intervals of up to one hour. The necessary settings for the filter change are described in Chapter 3.5.

3. 1. 4. 4. EEC Radon/Thoron

The activity concentration of radon decay products acts as a background signal for the measurement of long-lived nuclides. However, depending on the location, it can contribute significantly to the dose. As radon is present in virtually every environment, the measured values provide valuable information regarding the expected detection limits for long-lived nuclides and the correct functioning of the measuring instrument. A missing measured value or unexpectedly high concentrations usually indicate a fault in the detector system.

3. 2. Compensation of Gamma background – Local dose rate

3. 2. 1. Gamma compensation

When ambient gamma radiation interacts with the material surrounding the detector, conversion electrons are generated that are physically indistinguishable from electrons emitted by a beta emitter. These conversion electrons lead to an increase in the count rate for betas. At low ambient gamma radiation levels (<100 nSv/h), compensation is usually not necessary. At higher radiation levels, compensation can be either static or dynamic. Static compensation is useful if the ambient radiation at the measurement location is constant and known. In this case, a test measurement without a pump and with a fresh filter can be used to determine the beta count rate resulting from the ambient radiation. The result can be transferred into the instrument as a configuration parameter. For dynamic compensation, the device must be equipped with a double detector. The main detector detects the sum of actual filter activity and conversion electrons. The second detector (compensation detector) is shielded so that only the conversion electrons are detected. The actual filter activity is then determined by calculating the difference. The signal processing of the compensation detector is part of the SPEC1 spectrometer.

The display menu for the current measurement shows the pulses accumulated by the compensation detector for the current interval. The display can be switched between 'Pulses Lo-E', 'Pulses Hi-E' and 'Comp. Detector'.

3. 2. 2. Measurement of the local dose rate

For devices with a double detector, the local dose rate can be estimated based on the count rate of the compensation detector. It should be noted here that the angle and energy dependence is higher than the one of special ODL probes based on Geiger-Müller counting tubes. The device can be optionally equipped with an external ODL probe. This is connected to the 'AUX1' socket on the device. The probe is mounted on the cabinet for minimum shielding effect. The signals from both variants are connected to the comparator/counter combination input CMP1/CNT1. The measured values are shown on a separate display page. The counter is configured so that the current display

value is based on the time elapsed since the start of the current measurement interval. The value therefore becomes more and more accurate as time progresses.

3. 3. Flow measurement, flow control and pump current

For reproducible measurements of radon decay products and other radioactive aerosols, a constant flow rate ensures both consistent sensitivity and consistent airflow conditions. The latter is necessary to avoid variable particle size-dependent collection losses. The air flow is generated by an internal pump.

3. 3. 1. Functional principle

The flow rate is measured using a calorimetric mass flow sensor. This also serves as the actual value transmitter for flow control. A mass flow sensor always measures the air volume that would occupy the displayed volume under standard conditions. For example, if the ambient pressure is 10% lower, the flow rate must also be increased by 10% to achieve the same air flow rate. The measuring air flows through the flow sensor as part of the internal air circuit. The control loop gradually increases or decreases the pump flow if the sensor's measured value deviates upwards or downwards from the nominal flow (set point). The air flow is controlled differently depending on how it is generated. In standard devices with a three-phase pump, the pump speed is varied using a frequency converter. In devices connected to an external vacuum system, control is via a servo valve.

3. 3. 2. DACM32-components for internal air circuit

The output of the flow sensor is connected to analogue input AIN6 and its signal serves as the actual value for controller REG1. The output signal from controller REG1 is used to control the frequency converter or servo valve. This signal is also used to evaluate the current filter load. The filter is exhausted when the control signal reaches its maximum value, i.e. the nominal flow rate can no longer be guaranteed due to a heavily contaminated filter. The control signal is connected to analogue input AIN8 in order to observe the current filter status. For timely detection, the device's alarm system generates a warning signal at approx. 80% of the maximum control voltage.

3. 3. 3. Display of the measured values of the air circuit

The current flow rate and filter status are displayed on separate display pages. The control limit is set to 100% filter exhaustion. A new filter would theoretically correspond to a filter load of 0%. However, the lower value is factory set to 15% because the required pump capacity can vary within certain limits depending on the ambient conditions and filter. The filter load is displayed on the device as a percentage instead of the control voltage.

3. 4. Measurement of ambient conditions

The device is equipped as standard with sensors for measuring barometric pressure, temperature and humidity in the cabinet. Component I2C1 is used for the barometric pressure sensor, and component I2C2 for the combined temperature and humidity sensor. There is a display page available for barometric pressure and temperature/humidity respectively. It is possible to connect external sensors for temperature and humidity, available as accessories, to the 'AUX1' accessory socket.

3. 5. Filter stepper

3. 5. 1. Filter feed control

The filter can be moved due to various situations, but it must always be done at the beginning of a new measurement interval. Control is carried out by the switching outputs DOUT1 and DOUT2 as well as the device's clock switch. DOUT2 acts as a synchronisation pulse and is set for one second at the start of each measurement interval. To move the filter, either the switching output DOUT1 (Step) OR the switching contact of the timer must also be activated simultaneously. This results in the following control options:

Stepping at start of a new measurement	Control by clock switch: Select the 'Periodic timer' mode for the clock switch. Set the delay time to zero seconds. Select one second as the switch-on duration and a period longer than the total duration of the measurement as the switch-off duration.
Stepping at the begin of each interval	Control by DOUT1: DOUT1 (step) is set for one second in the cycle in addition to DOUT2 (sync).
Periodical stepping	Control by clock switch: Select the 'Periodic timer' mode for the timer. The delay time must correspond to the measurement interval used. Select one second as the switch-on time and the measurement interval minus one second as the switch-off time. This setting also applies to all measurement cycles whose duration is a whole multiple of the originally defined measurement interval.
Stepping at defined day time	Control by clock switch: Select the clock switch mode. Set the switch-on and switch-off times so that the time difference corresponds exactly to the measurement interval used. This ensures that the synchronisation pulse occurs precisely within this time period. If the filter step should take place at an exact time of day, the synchronous start function of the device must be used. If, for example, the change should take place daily at midnight, the switch-on time is set to 23:59:58 and the switch-off time to 0:00:02. The synchronous start function must be activated and the next full hour set as the start time. The measurement then starts automatically at this time. The filter feed also takes place for all measurement cycles whose whole multiples of the measurement interval amount to one hour.
Stepping when filter is exhausted	Control by DOUT1: In this case, DOUT1 must be configured as an alarm output with the alarm source DOUT8 (filter exhaustion). If the alarm threshold is exceeded at the time of the synchronisation pulse, the filter is transported.
Stepping if filter activity is detected	Control by DOUT1: In this case, DOUT1 must be defined as an alarm output. The SPEC1 spectrometer, which provides several activity values, is selected as the alarm source. Several alarms for different activity values (e.g. alpha and beta) can be defined simultaneously. If the set alarm threshold(s) are exceeded at the time of the synchronisation pulse, the filter is transported.

Note: time dependent and alert caused filter stepping may be used simultaneously. It should be noted that the exposure, average activity concentration and dose are always calculated for the period since the last filter change.

3. 5. 2. Control and safety devices

To detect the end of the filter belt, there is a reflex light gate before of and after the sampling unit. The output of the light gate before the sampling unit is connected to the status input DIN1. If no filter belt is detected for a period of five seconds, the yellow warning light is activated via DIN1 as the alarm source.

The status input DIN2 is used to detect a possible filter blockage. If the feed motor remains activated for longer than is necessary for the filter feed, the measurement is interrupted by a corresponding alarm with DIN2 as the alarm source.

The feed length of the filter is controlled by a rotary encoder. The output of the encoder is connected to the input of the CNT4 counter. The measured pulse count is converted into a feed length and stored as part of the data record.

3. 6. Warning and alarm lights

The basic unit has a signal LED integrated into the 'WAKE' button. The LED lights up in the event of an alarm. The signal LED is connected to the DOUT8 switching output. The light column is connected to the 'Signal Light' socket. The signal colours red, yellow and green are controlled via the switching outputs DOUT8, DOUT7 and DOUT6. The yellow light signals warnings regarding the operating status of the device, while the red light is assigned to radiometric alarms. The green light signals an ongoing measurement.

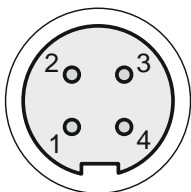
3. 7. The connectors „Signal light“ and „AUX1“

The two accessory connectors allow the connection of external sensors and actuators as well as accessories for special measuring tasks. Caution: Only components supplied by SARAD may be connected to the two sockets. Incorrect use may damage parts of the device electronics.

The 'Signal Light' socket is primarily intended for connecting the light tower, but can also be used for other purposes if the light tower is not required. The 'AUX1' socket allows the access to the terminals of various DACM32 components for different purposes.

Caution: The switching outputs are not potential-free, but are supplied with a system voltage of +12VDC when activated.

The following table shows the pin assignment and the use of the signals in the Aer 5300.



Socket "Signal light" (Binder Series 712, 5-pin), front view of the socket

Pin	Signal	Use
1	PGND	Ground potential for +12VDC system voltage
2	DOUT6	Switch output +12VDC, green signal light
3	DOUT7	Switch output +12VDC, yellow signal light
4	DOUT8	Switch output +12VDC, red signal light



Socket „AUX1“ (Binder Series 680 – DIN 8-pin), front view of the socket

Pin	Signal	Use
1	+5VDC	+5V system voltage; power supply for dose rate probe, turned on during running measurement
2	AIN1	Analog input , no special use in AER; option for external temperature sensor etc.
3	AGND	Reference potential for AIN1, AIN2, and CMP1
4	ALM_CONF	Switching output for optional accessories, controlled by the alarm system. A voltage of +12 VDC is applied when activated.
5	AIN2	Analog input, no special use in AER 5300; option for external humidity sensor etc.
6	DOUT5	Switching output for +12 VDC system voltage, no special use in AER 5300; May be used for power supply of external sensors or additional alert signal
7	PGND	Reference potential for +12 VDC
8	CMP1/CNT1	Input for comparator/counter combination; signal input for dose rate probe

4. AER 5300 configuration

4.1. Predefined measuring cycles

The following measuring cycles are stored in the delivered monitor:

Name of cycle	Description
1min	Measurement with a sampling interval of 1 minute
5min	Measurement with a sampling interval of 5 minutes
15min	Measurement with a sampling interval of 15 minutes
30min	Measurement with a sampling interval of 30 minutes
60min	Measurement with a sampling interval of 60 minutes
Alarm test	Test of signal lights and acoustic alert
Stepper test	Forces a filter step
Detector test	Sampling without pump to check the detector signal chain using a radiation source

4.2. Predefined warnings and alarms

In the DACM32 system, alarms are used to signal when limit values are exceeded and to indicate operating states, as well as to control measurement sequences. Users can add alarms and modify alarm settings (threshold values, type of acknowledgement, etc.). The alarms defined in the factory settings are explained below. Some alarms, which are necessary for a correct measurement sequence, must under no circumstances be deleted or modified. These are marked in red in the table. It is recommended that the current alarm settings be downloaded from the device and saved before making any changes. These can be transferred back to the device later if required.

No.	Signal (component)	Threshold	Action	Note
0	Flow rate (AIN5)	34 lpm	Yellow signal light	Flow rate too low
1	Flow rate (AIN5)	36 lpm	Yellow signal light	Flow rate too high
2	Filter belt (DIN1)	5 seconds	Yellow signal light	Indicates the end of filter belt
3	Motor (DIN2)	3 seconds	Sampling STOP	Measurement is stopped if the motor is running longer than 3 seconds. This may occur at the end of filter belt or when the drive becomes blocked.
4	Filter exhaustion (AIN8)	80 %	Filter stepping	The filter belt is moved at the begin of the next sampling interval (present alert plus synchronisation pulse)
5	Encoder (CNT4)	1 cm	Spectrometer	Indicates that the filter was replaced at the start of the current interval (display only). The filter service life is reset. This is used to calculate the

				average activity concentration for the period following the last filter change.
6	Dose rate (CMP1/CNT1)	3 $\mu\text{Sv/h}$	Red signal light	Only for optional dose rate probe (ELSE Nuclear).
7	Dose alpha (SPEC1)	2000 μSv	Red signal light	Based on the pre-set dose coefficients for alpha emitters.
8	Dose beta (SPEC1)	2000 μSv	Red signal light	Based on the pre-set dose coefficients for beta emitters.

4.2.1. Guidance on the use of alarms

4.2.1.1. Setting alarm thresholds

Alarm thresholds for radiometric measurands should always be set to values above the detection limit. As the detection limit depends on the selected measurement interval and the local background radiation (radon, ambient radiation), the alarm thresholds must be adjusted accordingly. The detection limits for typical conditions can be found in the AER5300 data sheet. If no information is available regarding the expected conditions, the thresholds should be set as low as necessary and as high as is still acceptable.

For the optional dose rate probe: Upon delivery, the dose rate is calculated on a per-second basis to detect changes as quickly as possible. Depending on the probe's sensitivity, no decay may be registered within a second in the presence of low ambient radiation, meaning that zero readings may frequently occur. On the other hand, for a probe with low sensitivity, a single registered decay per second corresponds to a relatively high dose rate. The alarm threshold should therefore be adjusted in accordance with the sensitivity of the dose rate probe.

4.2.1.2. Enabling of alert sources within the measurement cycles

The alarm check is only applied if the component that provides the measured value is activated in the measurement cycle. When defining custom measurement cycles, ensure that all components listed in the table are activated.

The battery voltage is monitored independently of the alarm system. At a voltage of 11.2 V, the measurement is automatically stopped without additional signalling. A corresponding entry is made in the event log.

4.3. Dose coefficients

The following table shows the dose coefficients currently used in the device for alpha emitters (Pu-239, natural uranium) and beta emitters (SR-90). These differ depending on the standard applied. In the delivery state, the values are set according to the selected unit scheme:

US-units: 10CRF20

SI-units: StrlSchV §§63 u. 63a Anlage 3

Coefficient for	iDACH/(Bqh/m ³)		$\mu\text{Sv}/(\text{Bqh}/\text{m}^3)$
	10CRF20	10CRF835	StrlSchV §§63 u. 63a Anlage 3
Plutonium	9,01	5,4	192
Natural Uranium	1,35	0,34	76,8
Strontium	0,014	0,0039	0,84

The dose coefficients are part of the device configuration and can be adjusted to the user's specifications. To do this, a corresponding configuration file must be loaded onto the device.

5. Important hints on operating the monitor

5.1. Vibrations and strong electromagnetic fields

Continuous strong mechanical shocks and vibrations can affect the detector signal due to the piezoelectric effect and must be avoided. The monitor should not be operated in close proximity to strong and high-frequency electromagnetic fields (e.g., placing the monitor on high-voltage switchgear or placing mobile phones on the monitor).

5.2. Aggressive Gases

Due to the operating principle, all sensors, semiconductor detectors, and mechanical components come into contact with the measuring air. Aggressive gases can damage or destroy the sensitive surfaces of the sensors/detectors or contact systems. This can lead to measurement errors or malfunction. Avoid using the monitor in the presence of aggressive gases.

5.3. Environmental conditions

The ambient conditions specified in the data sheet must be observed. Operating outside the specified limits may result in incorrect measured values or limit the functionality of the monitor. If the monitor must be used under such conditions, please consult the manufacturer.

5.4. Check of the alpha spectra

Recording and displaying alpha spectra is the most powerful tool for quality assurance measurement. Since radon is present in small quantities in the air practically everywhere, the alpha spectrum contains the characteristic emission lines of radon decay products, whose shape and position users can reliably evaluate after only a short time. Less experienced users should save the first measurement results after delivery of the device so that 'reference spectra' are available for comparison later. A quick glance at the acquired alpha spectra should always be part of good measurement practice.

5.5. Avoiding condensation

Condensation inside the instrument must be prevented. Condensation can occur if the temperature of the instrument is lower than the temperature of the sampled air and the dew point is exceeded during cooling down the air in the instrument. A typical scenario is immediate measurement in humid, warm rooms after transport at low temperatures. In such cases, the device must be allowed to warm up sufficiently before use. Damage to the device is not to be expected, but the measurement may be impaired. Even if temperature changes are to be expected in very humid ambient conditions during stationary installation, precautions must be taken against condensation. Depending on the device type, rotary vane pumps are used to generate the air flow. The surfaces of the compressors can corrode if surface moisture is present, which can lead to reduced pump performance or malfunction. After measurements in humid conditions, a fifteen-minute measurement should be carried out in a dry environment to remove any moisture from the internal air circuit.

5.6. Air sampling and particle collection

5.6.1. Air intake

The sampled air enters the device via a short intake pipe on the top of the cabinet. The pipe is connected inside the cabinet to a small KF16 flange with a pipe bend, which is permanently mounted

on the filter housing. If necessary, longer pipes, reducers or hose adapters can be connected to the KF16 flange. The suction pipe is sealed to the cabinet with a rubber ring for IP protection. Always ensure that the seal is placed correctly. It may need to be fitted when using alternative suction options.

Caution: The air inlet of the device must not be blocked and then suddenly released again. Due to the powerful pump, high pressure differences can quickly appear in the internal air circuit, which can displace the front contacts of the detector. In the event of a blockage, first stop the measurement and then wait a few minutes for the pressure to equalise. After that can be the blockage removed and the measurement restarted.

5. 6. 2. Filter material and filter sealing

The quality of the filter material is of fundamental importance for measurement in terms of:

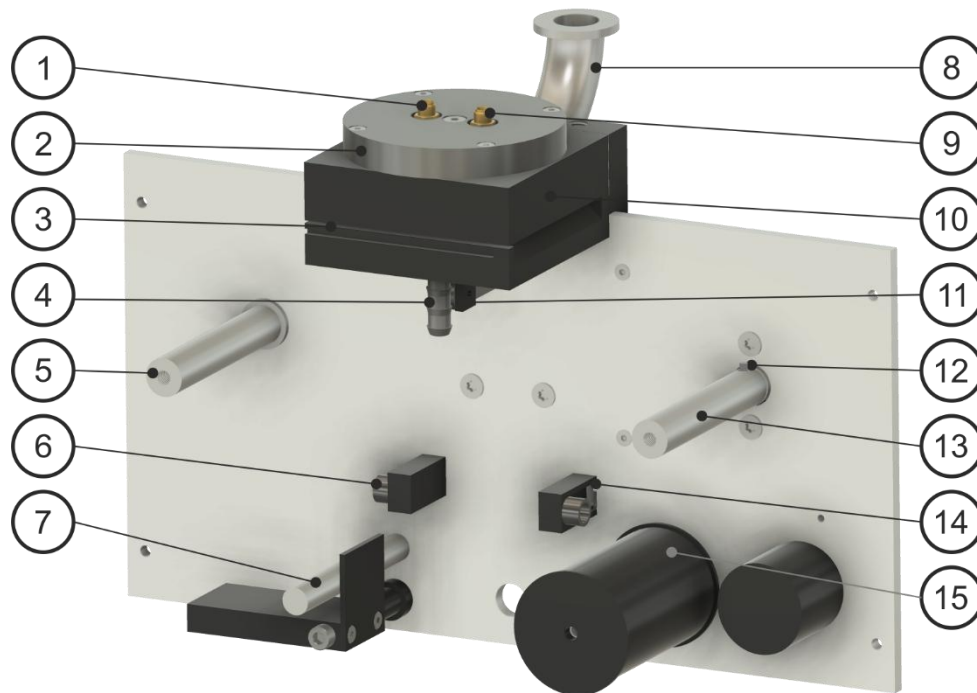
- High collection efficiency for particles across the entire size range
- High spectrometric resolution
- High air permeability
- High mechanical strength
- Smooth surface for optimum filter sealing

For this reason, only filter materials tested and approved by SARAD may be used. The use of other materials may lead to malfunctions.

To prevent partial air flow around the filter belt, the filter belt is pressed against the filter housing (10) by the filter seal mechanism (11). The filter is released as soon as the pump switches off (e.g. during automatic filter change). A soft rubber O-ring seal is placed on the impression plate of the filter seal mechanism to provide maximum tightness. When changing the filter belt or an individual filter, ensure that the O-ring is correctly positioned in the groove of the filter holder (the filter can be easily inserted into the slot of the filter housing). The filter impression plate must always be able to move up and down smoothly in the filter housing.

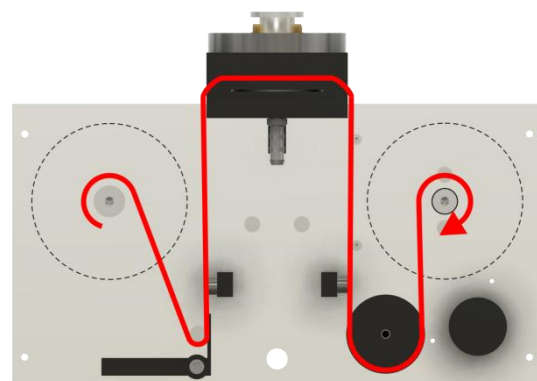
5. 6. 3. Filter belt drive

The belt filter drive is located in the cabinet and can be accessed by opening the door of the cabinet.



- 1) Coaxial connector for main detector
- 2) Detector cap
- 3) Slot for filter belt
- 4) Hose connector
- 5) Shaft for storage spool (new filter)
- 6) Light gate do detect end of filter
- 7) Tensioning device for stretched filter
- 8) Air intake – pipe bend with KF16 flange
- 9) Coaxial connector for compensation detector
- 10) Filter housing
- 11) Filter seal mechanism
- 12) Drive pin for take-up spool
- 13) Drive shaft for take-up spool
- 14) Light gate for missing filter
- 15) Encoder shaft

To change the filter belt, first remove the two spool locking screws from the two shafts (5 and 13). Both filter spools can now be pulled out towards the front. The empty spool serves as a take-up spool for the new belt filter. When inserting the empty coil, ensure that the drive shaft (12) is correctly inserted into the corresponding slot of the take-up coil. Once the spool with the new filter has been inserted, both spools can be secured by the coil

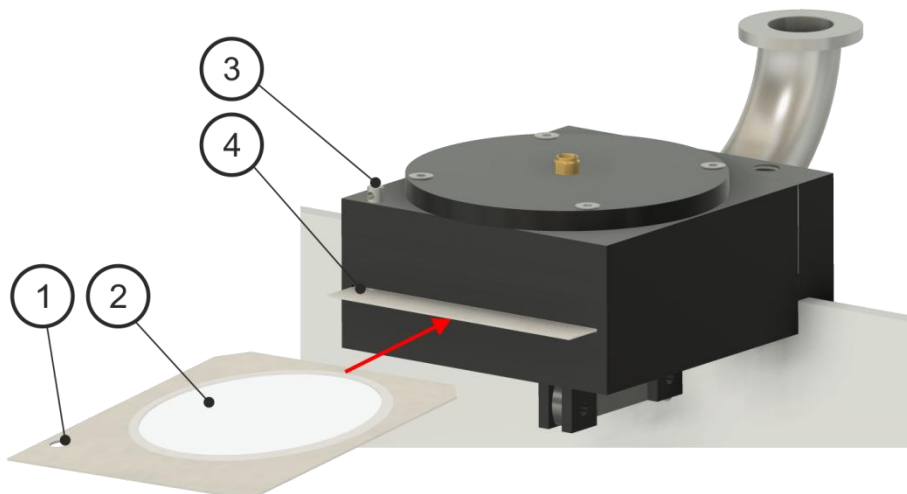


securing screws. The coils must not be clamped in place.

The filter belt can now be inserted as shown in the illustration on the right. Ensure that it is guided correctly. The filter belt must pass outside the two light gates (6 and 14), otherwise the pump will not start. The new filter belt is wound onto the spool so that the filter side faces outwards and the carrier fabric faces inwards. The filter side must face upwards in the filter housing. If the supply spool is inserted incorrectly, the filter will be flowed through in the wrong direction, causing the particles to penetrate the carrier fabric. The alpha spectrum will then be unsuitable for measurement. The filter belt must be tightened by the tensioning device (7) after the storage spool. The easiest way to fix the beginning of the new filter belt is to attach a piece of adhesive tape to the supply spool. To be on the safe side, the filter can be wound onto the spool in two steps using the 'Stepper test' measurement cycle. This also serves to check that the belt is running smoothly.

5. 6. 4. Instruments sampling unit for single filters

The instrument is also available with a sampling unit for use with single filters. In this case all mechanical parts for filter feed are skipped. The filter housing is closed on both sides, so that the filter must be inserted from the front. The filter is sealed in the same way as the belt filter drive by means of the filter pressure mechanism.



There is a hole in the front left corner of the filter housing to accommodate the positioning pin (3). To insert the filter, the pin is removed and the filter is inserted into the slot in the filter housing with the positioning hole (1). The filter is then secured in the filter housing with the pin. The hole/pin arrangement ensures the correct flow direction of the filter.

5. 6. 5. Detector cleaning and detector protection

In very dusty environments, the detector surface becomes contaminated because a small portion of the aerosols are always deposited and accumulate on it. Cleaning must be carried out with extreme caution, as even small scratches on the detector surface can destroy the light protection and make the detector unusable. Any dust should be removed with a very soft optician's brush. The surface must not be wiped or liquids used for cleaning.

In dusty environments the optionally available detector protection should be used. This consists of a thin film stretched over the detector's entry window. The film can be replaced if necessary. To do this, the detector must be removed from the sealed filter housing. This may be done by authorised service personnel or by the user after receiving appropriate instruction from SARAD. Note: Only films specified by SARAD may be used, as the film influences the spectroscopic properties of the measuring arrangement.

5. 7. Connections at the bottom of the cabinet

5. 7. 1. Inserting communication and accessory cables

To achieve optimal protection against dust and moisture, all connection sockets are positioned inside the cabinet. The cables are fed through cable glands in the base of the cabinet. In addition to the cables that are permanently connected at the factory, the user can also feed additional cables into the cabinet. For this purpose, a separable cable gland (4) is mounted in the base of the cabinet. This allows cables that are already fitted with plugs to be inserted while maintaining the degree of protection. Sealing is achieved by means of replaceable rubber plugs, which are available for different cable diameters. To insert the cables, the gland must first be completely removed and the two half-shells separated. The cable can now be placed in the slotted rubber plugs and these can be pushed into the gland. It is essential to ensure that the correct plug size is used in order to guarantee the degree of protection. The two half-shells are then clicked back together and the screw connection is mounted in the base. Ensure that the flat seal between the screw connection and the cabinet is seated correctly.

5. 7. 2. Connection of the air hose

The air hose is connected to the cabinet with a plug-in fitting. To disconnect it, first unscrew the cap of the seal (3) and push it down onto the air hose. The clamping ring of the fitting, which is now accessible, must be pressed towards the cabinet with a suitable tool (e.g. pointed pliers) while simultaneously pulling the hose downwards. The hose can be inserted without tools. If the seal cap has been removed from the hose, ensure that the O-ring between the cap and the hose is placed correctly.

5. 8. Beta background compensation

The radon decay chain includes two beta emitters - Pb-214 and Bi-214 - which are present in the sampled air and generate a natural background signal. The activity levels of both nuclides collected on the filter cannot be spectroscopically separated from those of long-lived beta emitters. An estimate of the natural background is only possible using the two alpha emitters Po-218 and Po-214 as basis. Whilst every Po-218 decay on the filter is always followed by two beta decays, a Po-214 decay may be preceded by one or two beta decays, depending on the ratio of Pb-214 and Bi-214 in the air sample. This ratio cannot be determined by the measurement. Consequently, certain assumptions must be made resulting in an over- or underestimation of the natural background under different conditions.

Underestimation: In this case, the calculated reading for long-lived beta emitters is too high. Even if there is no activity from long-lived beta emitters, readings above the detection limit may occur.

Overestimation: Measurement values for long-lived beta emitters are calculated to be too low. A threshold for long-lived beta emitters becomes present, i.e. a certain level of activity must be collected on the filter to exceed the detection limit.

The deviation of the estimated natural background from the actual natural background is a maximum of $\pm 5\%$ for typical atmospheres. For radon concentrations in conditioned rooms (radon concentration less than 50 Bq/m^3 and equilibrium factors < 0.3), the over- or underestimation results in exposure deviations in the range of mBq/h/m^3 . For radon concentrations in the range of a few kBq/m^3 and high equilibrium factors of over 0.6, the deviations are in the range of a few Bq/h/m^3 .

In terms of dose, using the 'worst-case' nuclide Sr-90, this translates to a deviation of a few nSv to a few μSv .

If the conditions on site are relatively constant, the compensation can be optimally adjusted by the instrument configuration.

5. 9. Maintenance

The device is designed to require minimal maintenance. Each time the filter belt is replaced, the correct fit and integrity of the air hoses on the filter drive and to the pump should be checked. The filter pressure plate must be able to move up and down in the filter housing without resistance. Maintenance of the pump must be carried out after 8,000 operating hours for devices with a frequency converter and after 3,000 operating hours for devices with a servo valve. The carbon shifter and the inlet filter must be replaced. These tasks can also be easily carried out by the user. A corresponding spare parts kit can be obtained from SARAD or directly from the pump manufacturer. Instructions from the pump manufacturer are included with the device upon delivery.

The neoprene sealing ring on the filter pressure plate must be replaced after the filter belt has been changed five more times, or after five years at the latest.

The AER 5300 is mains-powered. The correct connection of all cabinet and chassis components to the protective earth must be checked annually in accordance with the applicable standards.

Attachment

A) DACM32 components

A1 - Type of components of DACM32

Type	Name	Description
Analog input	AIN	Connects sensors with analogous output signals (0...1 V, 0...2 V, 0...5 V, 0...10 V, 0/4...20 mA).
Status input	DIN	Detects states (e.g., switch contacts), recording the on and off duration and the number of changes.
Comparator-input	CMP	Detects pulse signals that are greater than an adjustable threshold; used in conjunction with a counter input.
Counter input	CNT	Detects a total number of pulses, a pulse rate, or an average pulse rate. Will be used with sensors with a pulse output.
Spectrometer	SPEC	Spectrometer module for recording pulse height spectra.
Universal digital sensor interface	I2C	Connects sensors with a digital interface according to the I2C standard.
Controller	REG	Provides a PID control loop. All available measurement results from existing sensors serve as the setpoint, and a control voltage is output at the controller output.
Switching output	DOUT	Potential-free switching contacts (opto-MOS switch or relay changeover switch)
Frequency generator	PWM	Applies a square-wave signal with variable pulse width to the output.
Calculator	CALC	Calculates complex measurement results from the measured values of the available sensors using functional prototypes.

A2 - Overview of the used components in AER 5300

Name	Alias-Name	Function
AIN1	AUX1-Pin2	Signal at "AUX1" connector
AIN2	AUX1-Pin5	Signal at "AUX1" connector
AIN6	Air-flow	Flow measurement and setpoint for flow control
AIN8	Filter exhaustion	Measurement of filter exhaustion based on the flow control voltage
CMP1	AUX1-Pin8	Signal at „AUX1“ connector, internal connection to CNT1
CNT1	AUX-CMP1	Internally connected to the output of CMP1, used for dose rate probe
DIN1	End of filter	Signal of light gate "end of filter"
DIN2	Stepper motor	Signal for running stepper motor
SPEC1	Aerosols	Used for pulse signals of main and compensation detector, generates energy spectrum as base for all activity measurements
I2C1	AMS5812	Measurement of barometric pressure
I2C2	SHT21	Combined temperature and humidity measurement in the cabinet

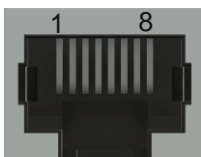
I2C3	Delta p	Optional Differential pressure sensor for filter control
REG1	Pump controller	Controls the flow via frequency converter or servo-valve
DOU1	Stepper ALM	Control signal for stepper drive
DOU2	Stepper SYNC	Control signal for stepper drive
DOU3	Flow PWR	Power supply for pump regulator
DOU4	Pump ON	Pump start/stop
DOU5	AUX1-Pin6	Supply for accessory, additional alarm etc.
DOU6	Signal green	Green signal light
DOU7	Signal yellow	Yellow signal light
DOU8	Signal red	Red signal light

B) Connector pin assignment



2 x 4-20mA (M8-PCB-THT-2PC-4P-DCOD-F-ANG-SHLD, Harting, part no. 21420000019)

Pin	Signal	Description
1	AOUT1+	Current Loop 1 Output
2	GND	Common reference potential (-) for AOUT1 and AOUT2
3	AOUT2+	Current Loop 2 Output
4	GND	Common reference potential (-) for AOUT1 and AOUT2



RS485A/RS485B (RJ45 Buchse, 8-pin)

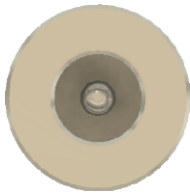
Pin	Signal	Description
4	B/B'	Transceiver terminal 1, V1 voltage (V1 > V0 for binary 1 [OFF] state)
5	A/A'	Transceiver terminal 0, V0 voltage (V0 > V1 for binary 0 [ON] state)
8	GND	Reference potential
1, 2, 3, 6, 7	N.C.	Not used



RS232 (SUB-D Buchse, 9-pin)

Pin	Signal	Description
2	TX	Monitor's transmit line (output)
3	RX	Monitor's receive line (input)

5	GND	Reference potential
1, 4, 6, 7, 8, 9	N.C.	Not used



DC (2,5mm jack socket)

Pin	Signal	Description
Inside	20 VDC	Power supply and charging voltage
Housing	GND	Reference potential

C) Disposal instructions

Batteries and accumulators must not be disposed of in the trash, but must be disposed of at local collection points!

At the end of their service life, the measuring monitors must be disposed of as electronic waste or returned to the manufacturer for proper disposal! If necessary, decontamination must be carried out before disposal.