

Manual

RPM 2300

Spectroscopic Radon/Thoron Progeny Monitor

Version 08/2026

Reference documents:

Software manual dVISION

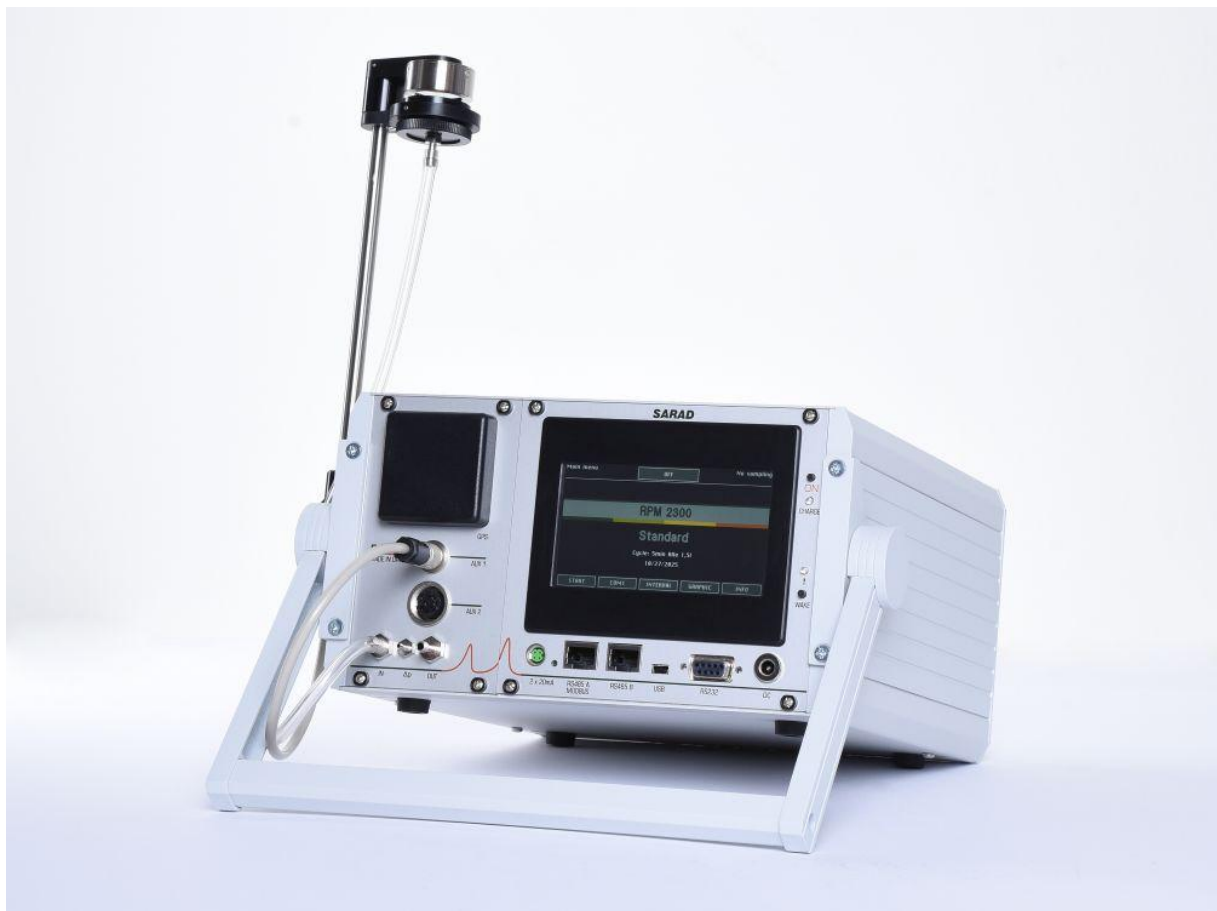
SARAD GmbH

Wiesbadener Straße 10

01159 Dresden

www.sarad.de

info@sarad.de



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Operational controls

Basic unit

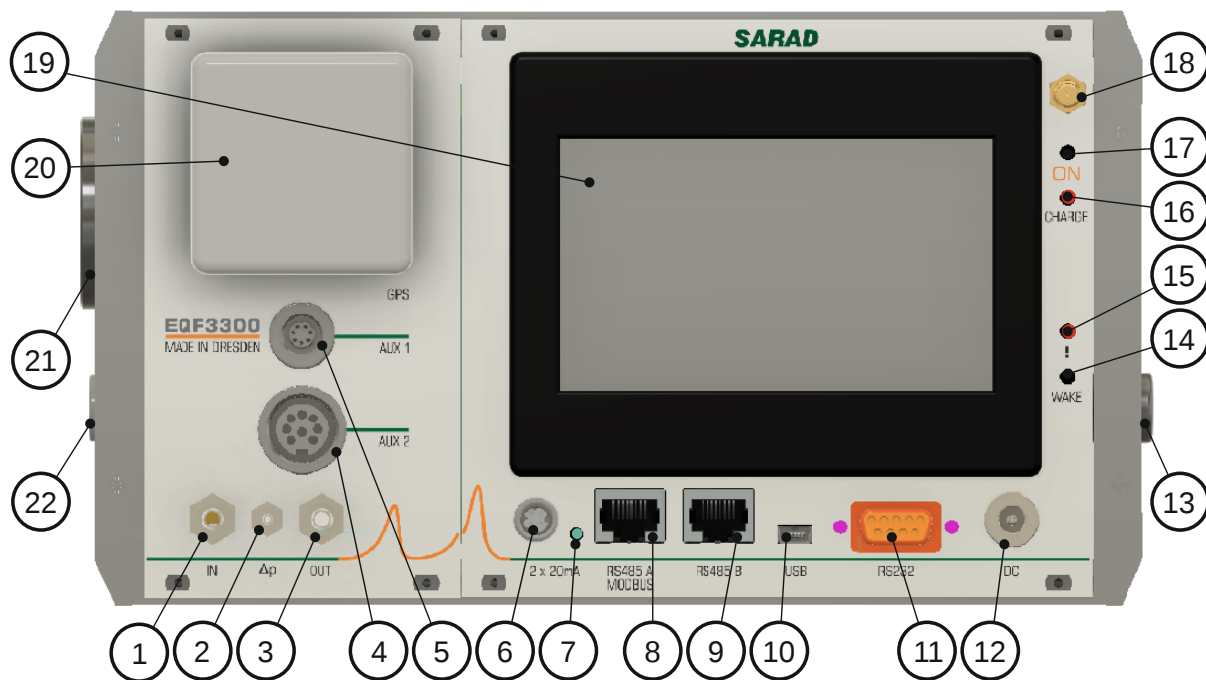


fig 1: basic equipment

- 1) Internal air circuit air inlet
- 2) Connection for differential pressure measurement
- 3) Internal air circuit air outlet
- 4) Accessory socket "AUX2" for connecting signal lights
- 5) Accessory socket "AUX1" for connecting the radon progeny measurement head
- 6) Connection socket for 2x 0-20 mA current loop outputs
- 7) LED indicator for activated current loop outputs
- 8) RS485A interface (configurable for MODBUS RTU protocol)
- 9) RS485B interface
- 10) USB Type B Mini interface
- 11) RS232 interface
- 12) Connection socket for power supply
- 13) Fuse
- 14) Button for activating the display
- 15) LED indicator for alarms / warnings
- 16) LED indicator for charging status
- 17) Power ON - button
- 18) WIFI antenna socket (option)
- 19) Coloured touchscreen display
- 20) GPS receiver
- 21) Accessory adapter (RP-head, water intake protection (optional))
- 22) Connection socket for water ingress protection (optional)

Sampling head for Radon/Thoron progeny

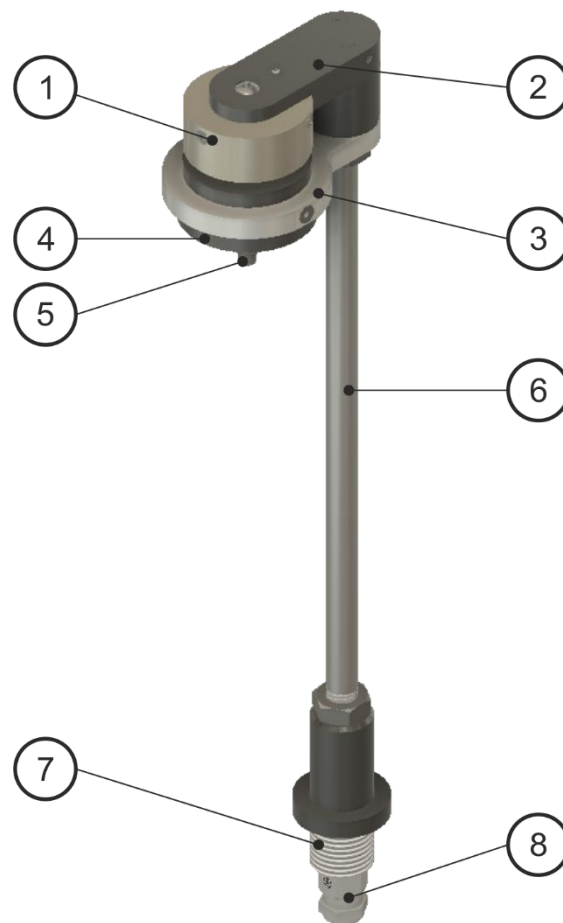


fig 2: Sampling head for progeny products

- 1) Detector
- 2) Detector Support
- 3) Filter Support
- 4) Filter nut
- 5) Tube connector for connecting air tube to air inlet of the basic unit
- 6) Stand
- 7) Mounting socket with thread M16x1
- 8) Cable gland for connection cable to basic unit

1. Overview

1.1. The DACM32 platform as monitor platform

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 16 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 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 instrument contains a NiMH battery with a nominal voltage of 13.6 V and a capacity of 7.6 Ah. Power consumption during measurement depends on the configuration and the components/sensors used in the measurement cycle. To maximize battery operating time, use only the components/sensors actually required.

The battery is charged using the included plug-in power adapter (18 V / 60 VA). The integrated charging circuit allows the battery to be fully charged within four hours. The DC connection socket for the power adapter is located at the bottom right of the front panel of the monitor. The red LED indicator to the right of the display lights up during charging. It switches off when the battery is fully charged.

The RTM 2300 can be operated continuously with the power supply. The charging control ensures cyclic charging to optimize battery life. During the charging process, heat is released, which causes the entire device to heat up. The integrated temperature sensor then displays significantly elevated values.

NOTE: To accurately measure the outside temperature, an additional external sensor should be used in the case of continuous mains operation.

If the battery voltage drops below 11.6 V during a measurement when the device is operating solely on battery power, the measurement is aborted. If the discharge continues below a threshold of 10.6 V, the deep discharge protection completely shuts down the device's electronics. When connected to the mains power supply, the device is ready for immediate operation. When powered exclusively by the battery, the device can only be switched on again once the battery voltage has reached the threshold of 11.8 V during charging.

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. Sockets for external accessories (AUX1, AUX2)

The two sockets provide additional components of the DACM32. They 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 and AUX2 Connectors." 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.

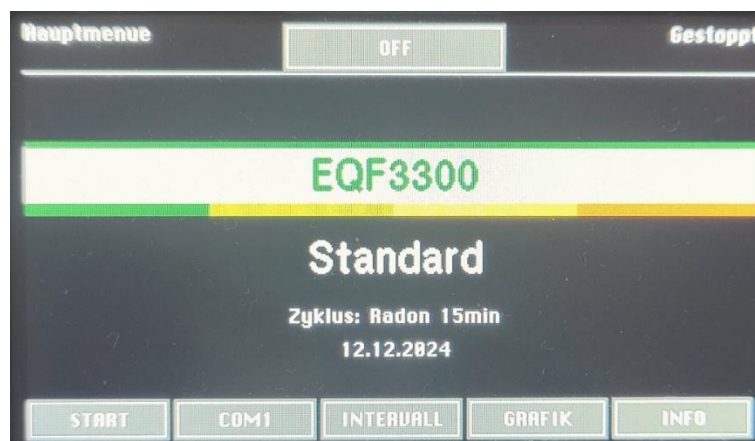


fig 3: Main menu if measurement stopped

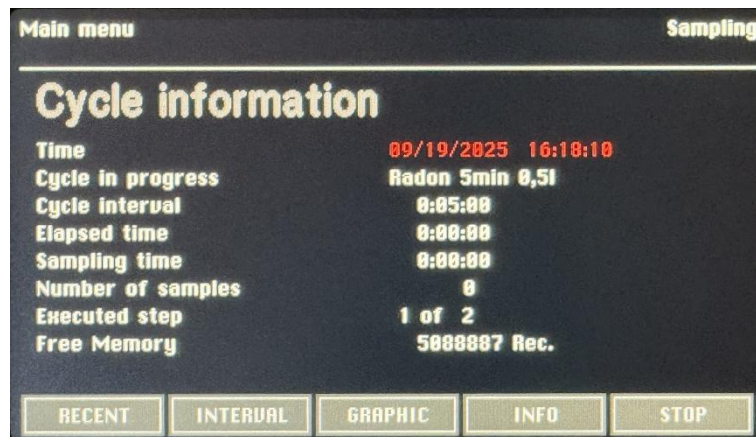


fig 4: Main menu during measurement

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 parameters of the RTM 2300. The display pages can be switched using the "TOGGLE" button.

Via the "INFO" menu and the "ALERTS" button the list of configured alarms is accessed (see Section 2.10. "Changing Alarm Thresholds").

Page 1 Module Information

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

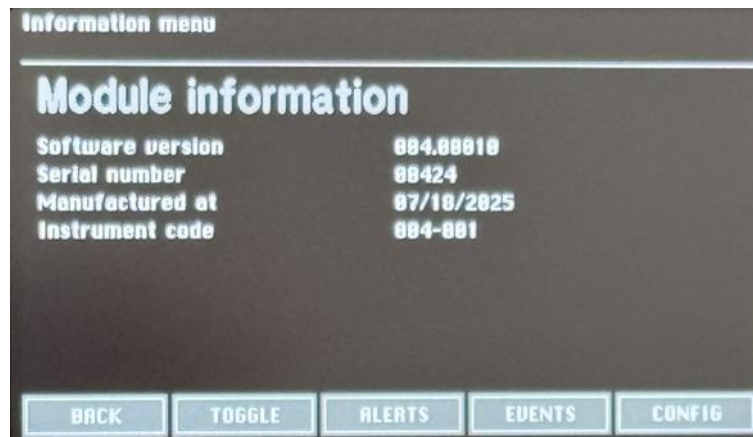


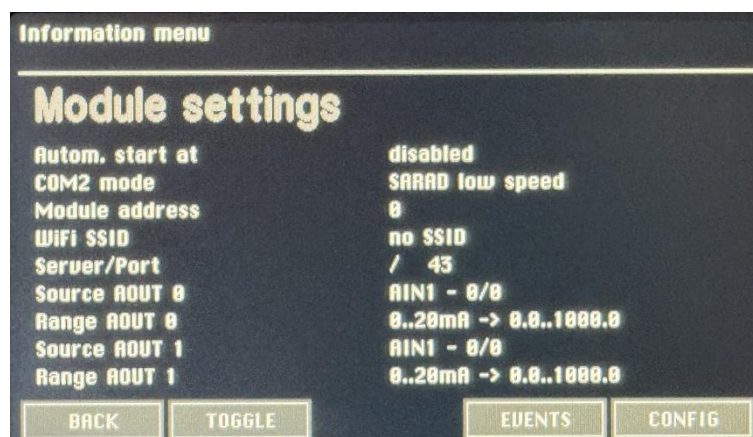
fig 5: Module information

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)



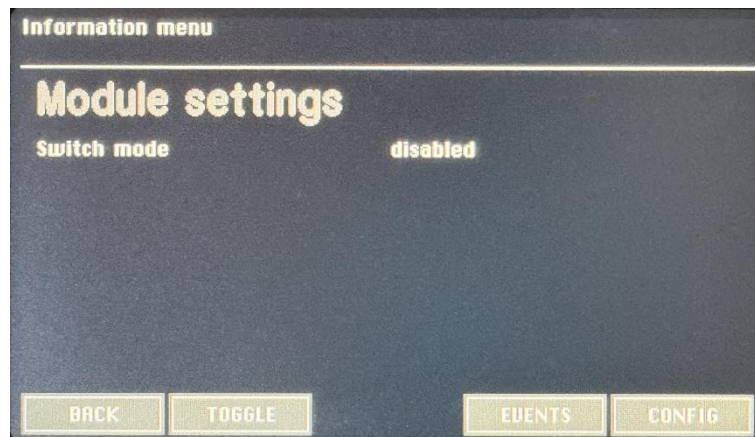


fig 6: Module settings

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.

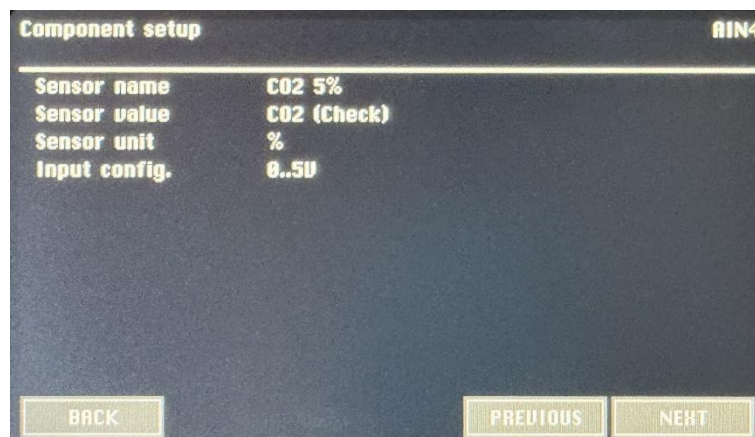


fig 7: Configuration of components

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 16 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.

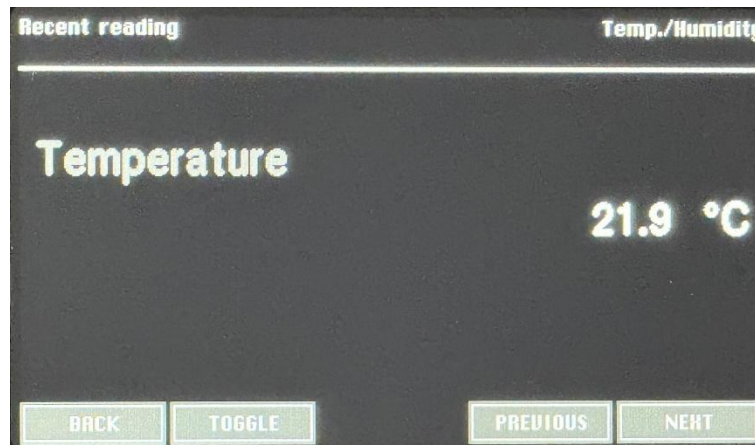


fig 8: Display of actual measured values

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.

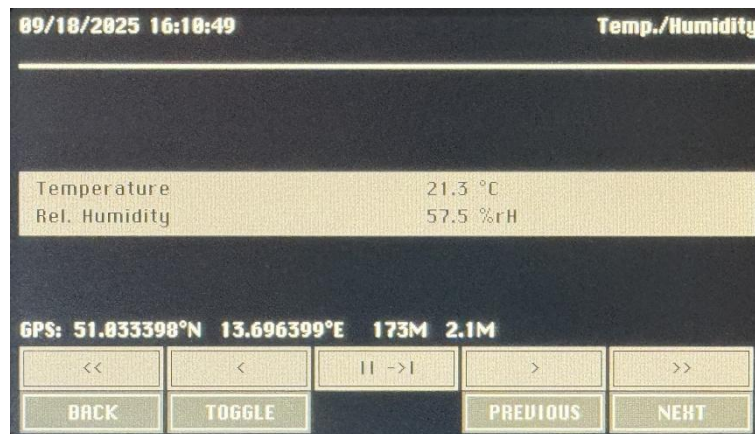


fig 9: First display page for interval measurement data for components with multiple measured values

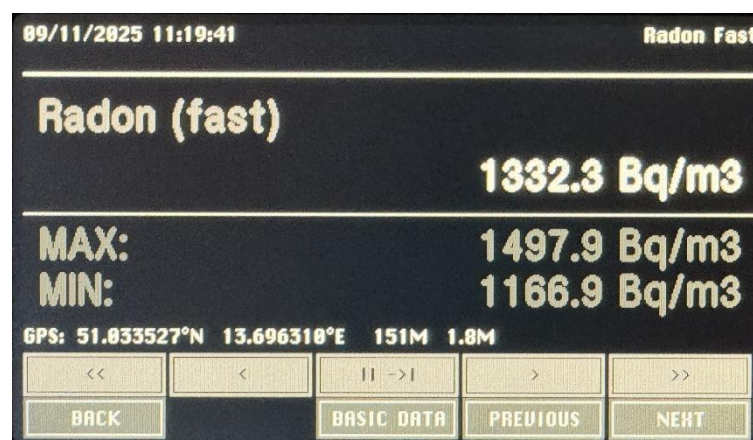


fig 10: Display of interval measurement data

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.

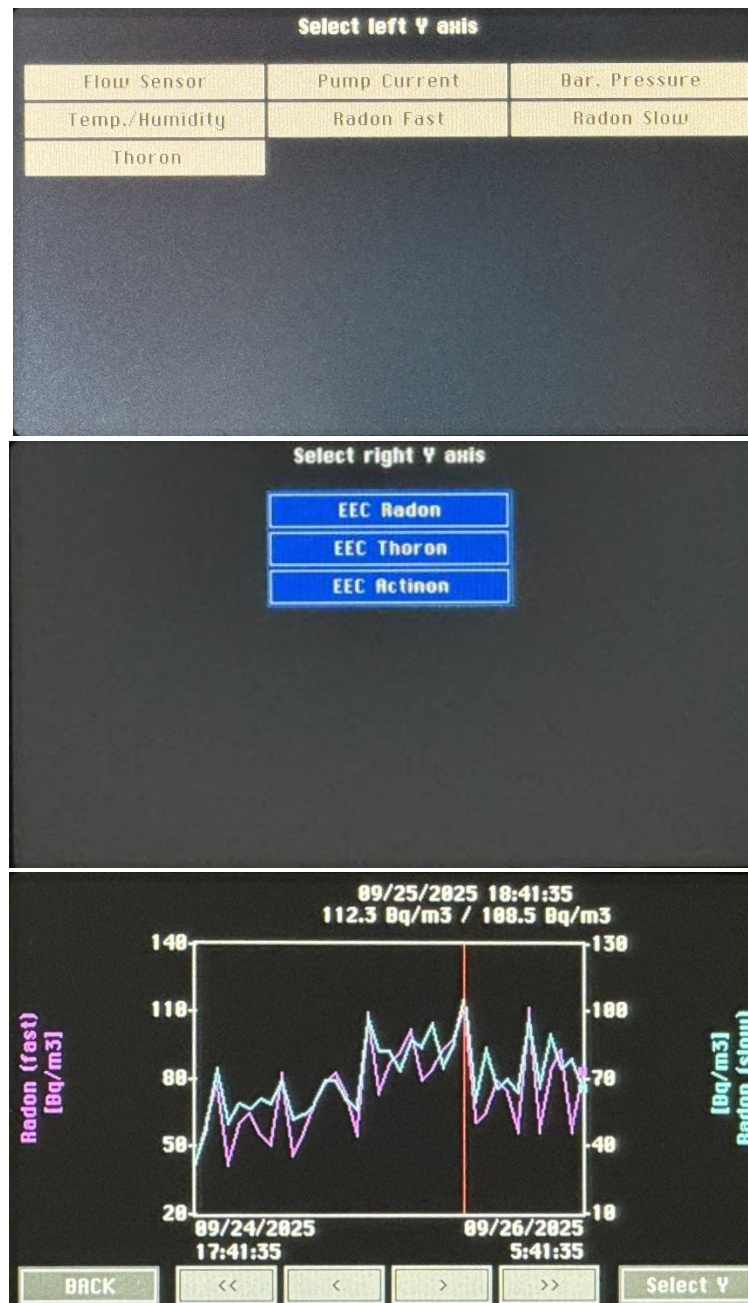


fig 11: Selection and display of series of measurements

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.

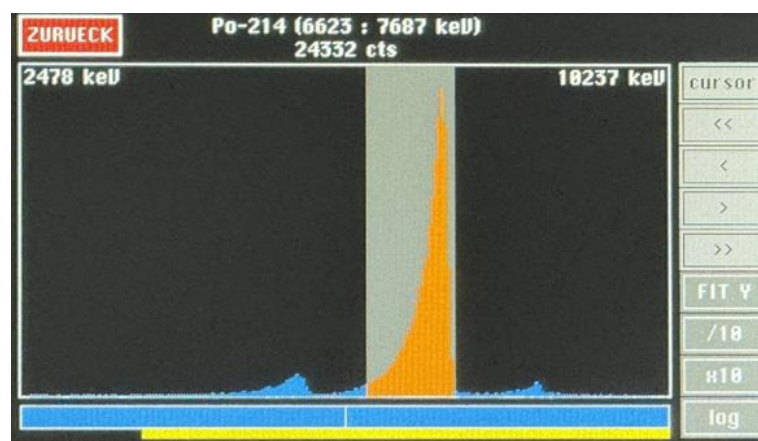


fig 12: Display of spectra (Cursor- and ROI-navigation)

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.

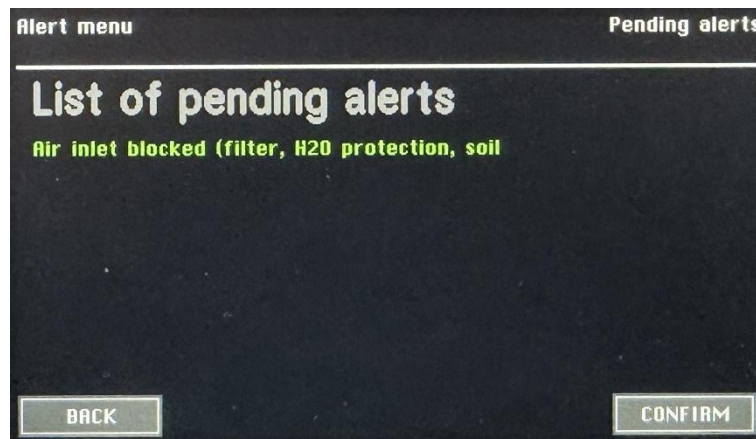


fig 13: Display of alerts (Cursor-navigation)

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.

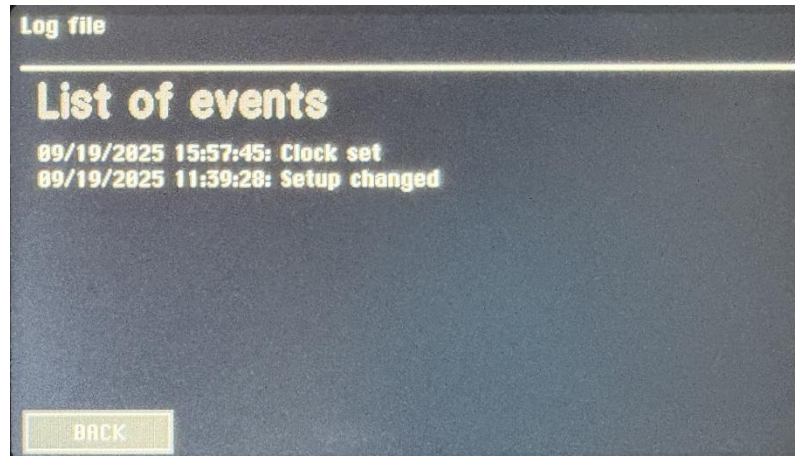


fig 14: Display of events

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.

2.8. The integrated GPS receiver

The monitor is equipped with a GPS receiver. The coordinates (longitude, latitude), altitude, and the deviation underlying the positioning are saved for each data set. This information is shown on the monitor display (interval data menu).

If the monitor is moved within a measurement interval, the time-weighted geographic centre is saved. The current position is determined every 5 seconds, and the average values for longitude, latitude, and altitude are calculated for the entire measurement interval.

The specified deviation is an indicator of the navigation accuracy (satellite signal) underlying the positioning. The actual deviation may be greater.

Coordinates are displayed on the monitor in decimal degrees (max. 6 decimal places), each with the compass direction indicated.

If the reception quality is too poor, the message "No signal" appears on the display instead of the coordinates. After starting a measurement, the module needs a few minutes to acquire all satellites available for navigation.

2.9. Access Protection

Access protection can be enabled to prevent unauthorized operation or configuration of the monitor. Up to eight users can be created using dVISION Software. Each user is assigned a name, a four-digit PIN and one of three access levels: User, Administrator or Supervisor. The access level determines the available permissions. To disable access protection, all configured users must be deleted by dVISION. When access protection is enabled, the user selection screen (Fig. 15) appears whenever the display is activated. After selecting a user, the numeric keypad for entering the PIN is displayed (Fig. 16).

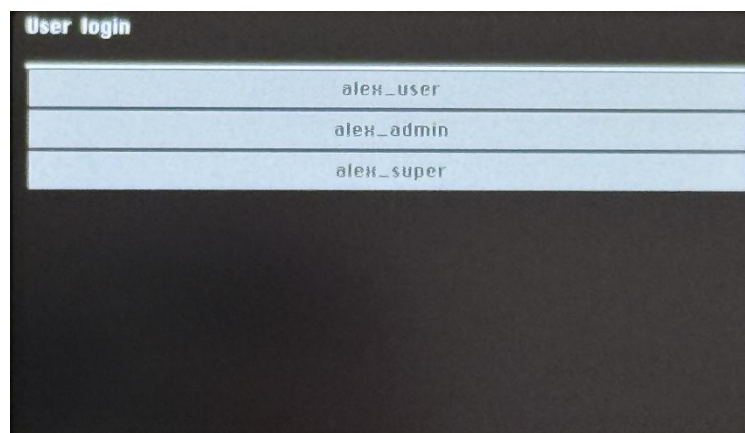


Figure 15: User selection screen

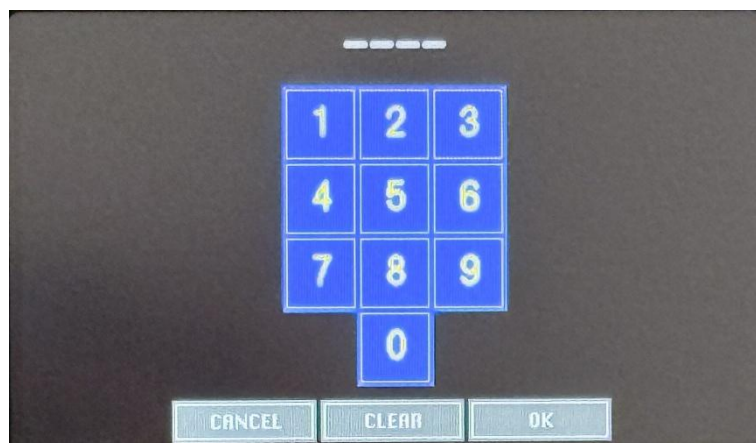


Figure 16: Numeric keypad for PIN entry

Incorrect entries can be deleted using the “CLEAR” button. Pressing “CANCEL” or entering an incorrect PIN switch the display off again. After the correct PIN has been entered, the user is logged in and can operate the monitor according to the permissions assigned to that user.

After three incorrect PIN entries, the user account is automatically deactivated. The user name then disappears from the selection list and the account must be created again by dVISION. If all configured users are deactivated, the message “All users deactivated” appears when the “WAKE” button is pressed.

NOTE: Only users with the Supervisor access level can create and delete user accounts. Therefore, a Supervisor account should be created first when access protection is enabled.

If no active Supervisor is available or all configured users have been deactivated, access can be restored using the instrument-specific service login. The service login is independent of the user accounts created in dVISION and is intended for authorized service and recovery purposes.

Access protection also applies when the monitor is operated or configured via software. Each control or configuration command is checked against the permissions of the currently logged-in user. Login is possible via the touch screen, dVISION or the configuration software; the most recent successful login is used by the monitor.

A User can operate the monitor but cannot change protected settings or the instrument configuration. Such changes require Administrator or Supervisor permissions, or authorized service access. The required permissions for the individual device functions are listed in the appendix.

2. 10. Changing Alarm Thresholds

Alarm thresholds can be changed via the monitor touch screen. Some alarms are used to detect malfunctions or unacceptable operating conditions. Incorrect threshold settings may prevent a fault from being detected or may result in improper operation. Alarm thresholds should therefore only be changed by authorized personnel.

Changes are only permitted when access protection is enabled and the active user has Administrator or Supervisor permissions.

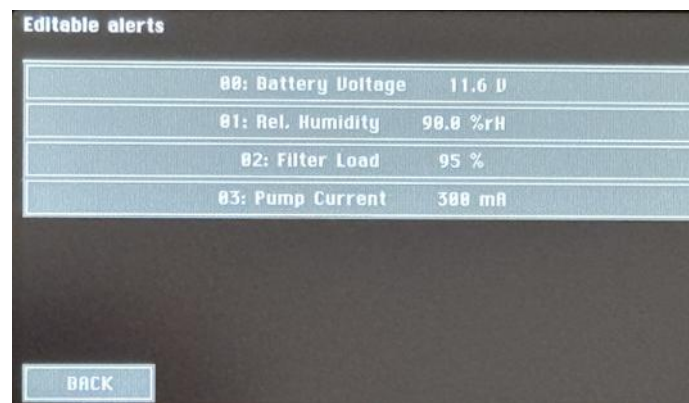


Figure 17: List of configured alarms

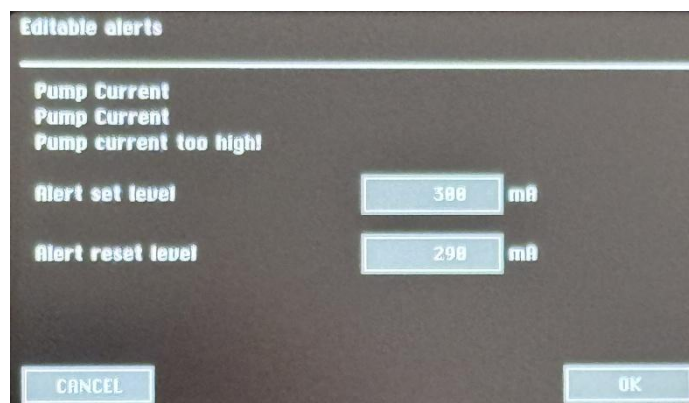


Figure 18: Alarm settings and threshold adjustment

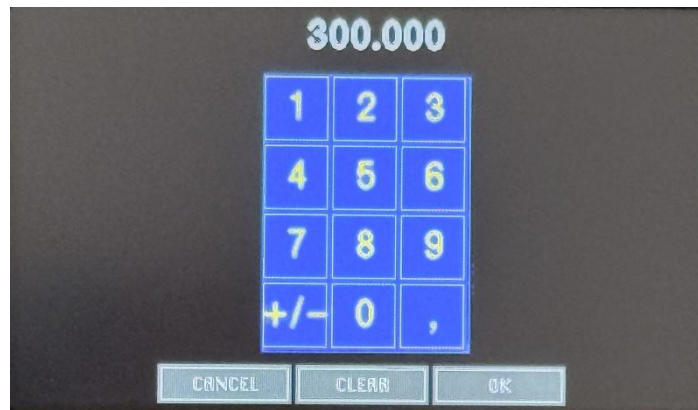


Figure 19 Numeric keypad for entering a new threshold value

The list of configured alarms is accessed from the “INFO” menu using the “ALERTS” button. Touch the required alarm to display its information and the two fields containing the current alert set level and alert reset level (Fig. 18).

Touch the threshold to be changed to open the numeric keypad (Fig. 19). Enter the new value and confirm with “OK”. The new threshold is then applied.

NOTE: Each alarm has an alert set level and an alert reset level. Their relative values determine whether the alarm is activated when the measured value rises above or falls below the defined limit (see Section 1.3 “Alarm System”).

3. Sensors and actuators in the RPM 2300

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. Radon/Thoron progeny measurement

The Radon/Thoron progeny measurement is carried out using a freely positionable measuring head, which is connected to the air circuit and electronics of the basic unit via a cable (connection to socket 'AUX1') and an air tube (connection to nipple 'IN').

For reproducible measurements of radon decay products and other radioactive aerosols, a constant flow rate 1.5 l/min 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.

3.1.1. Functional principle

The radon decay products contained in the sample air are separated on a filter. The detector above registers the activity collected on the filter. The activities of Po-218, Po-214, and Po-212 are spectroscopically separated, and the equilibrium equivalent concentration (EEC) for radon (Po-218 and Po-214) and thoron (Po-212) is calculated based on the count rates. To achieve practically usable response times for changes in the thoron decay product concentration, the calculation is performed by differentiating the time course of the detected Po-212 activities on the filter. Since in this case the difference between the count pulses from two consecutive measurement intervals must be calculated, the calculated value has a significantly larger statistical fluctuation range. Therefore, a correspondingly large measurement interval should always be selected. In practice, intervals of one to three hours have proven effective. These are sufficiently large to record daily cycles, for example, and are also within the response time range of the Rn-222 decay product measurement.

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

3.1.2. DACM32 components for Radon/Thoron progeny measurement

The output signal of the progeny sensor head is connected to the SPEC1 spectrometer module, which provides an alpha spectrum for each measurement interval to determine the count rates and calculate the progeny activity concentrations.

3.1.3. Display of Radon/Thoron progeny concentrations

The progeny concentrations for radon and thoron are displayed on a separate page (SPEC1), each as EEC (equilibrium equivalent concentration) and PAEC (potential alpha energy concentration). Using the TOGGLE button, the various measured values and the corresponding confidence interval (1-sigma) can be displayed.

3.2. 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.

3.2.1. 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 (setpoint). If the filter is too heavily contaminated, the pump reaches its maximum capacity, so that further contamination will prevent the nominal flow rate from being achieved. Therefore, the monitor's alarm system generates a warning signal at 80 % of the pump capacity.

Every pump is a mechanical component subject to wear. At the end of its service life or in the event of a defect, the pump's operating current can increase significantly, even leading to a short circuit. To protect the electronics, the instrument monitors the pump current and the alarm system stops the measurement if a limit value is exceeded.

3.2.2. DACM32 components for internal air circuit

The flow sensor output is connected to analog input AIN6, and the pump current and pump voltage signals are connected to analog inputs AIN6 and AIN7. The pump power is controlled by the controller component REG1. The controller component generates a control voltage that can be used to vary the pump power.

3.2.3. Display of the measured values of the air circuit

The current flow rate measurement (AIN6) and the pump current (AIN7) are displayed in the corresponding physical unit. The pump voltage (AIN8) serves as an indicator of the required pump power and thus the condition of the filter. The maximum possible pump voltage determines the maximum pump power and thus the control limit for the flow. The control limit is equated with a filter occupancy of 100 %. A new filter would theoretically correspond to a filter occupancy of 0 %. However, the lower value is factory-set to 15 %, as the required pump power can vary within certain limits depending on the ambient conditions and filter. Instead of the pump voltage, the monitor displays the filter occupancy in percent. Each measured value of the air circuit has its own display page.

3.3. Barometric pressure, differential pressure (option)

The monitor is equipped with a barometric pressure sensor as standard, and an optional differential pressure sensor for small differential pressures. In the standard monitor, the pressure sensor terminal is connected to the monitor's centre tube nipple labelled "p." If a differential pressure sensor is present, the vacuum sensor terminal is connected to the hose nipple. The unconnected terminals are open, i.e., they are subjected to ambient pressure. Note: The pressures applied to the "p" hose nipple must not exceed the maximum permissible pressure values specified in the data sheet. The I2C2 component is used for the barometric pressure sensor; for the optional differential pressure sensor, the analogous input AIN5 or the I2C3 component is used, depending on the configuration. The pressure values are each displayed on a separate display page.

3.4. Warning and alarm lights

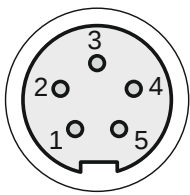
The basic unit has a signal LED labelled "!" directly above the "WAKE" button. This LED illuminates both in the event of warnings and alarms. The signal LED is connected to the DOUT8 switching output. Two

additional signal lights can be connected to the "AUX2" socket. A signal tower (yellow/red combination) is included upon request, or two separate signal lights (yellow and red) can be mounted on the lid of the measuring case. The yellow light indicates warnings regarding the operating status of the monitor (DOUT1), while the red light (DOUT2) is assigned to radiometric alarms.

3.5. The connectors „AUX1“ and „AUX2“

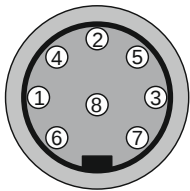
The two accessory connectors allow the connection of external sensors and actuators, as well as accessories for special measurement tasks. Caution: Only components supplied by SARAD may be connected to these two sockets. Improper use may damage the monitor's electronics.

The "AUX1" socket is primarily intended for connecting radiation sensors, while the "AUX2" socket provides external connections for various DACM32 components. The following tables show the socket assignments and signal usage in the RPM 2300.



Socket "AUX1" (Binder Series 712, 5-pin), front view of the socket

Pin	Signal	Use
1	SPEC1	Pulse input for spectrometer component, detector signal of the progeny product measuring head
2	V+	supply voltage for progeny product measuring head
3	CMP1/CNT1	Comparator/counter combination, not used in RPM 2300
4	BIAS	Bias voltage for progeny measuring head
5	GND	Reference potential



Socket „AUX2“ (Binder Series 680 – DIN 8-pin), front view of the socket

Pin	Signal	Use
1	DOUT1	Switching output for optional accessories, controlled by the alarm system. A voltage of +12 VDC is applied when activated.
2	AIN1	Analog input, no use in RPM 2300
3	AGND	Reference potential for AIN1, AIN2, and CMP1, no use in RPM 2300
4	DOUT2	Switching output for optional accessories, controlled by the alarm system. A voltage of +12 VDC is applied when activated.
5	AIN2	Analog input, no use in RPM 2300
6	Clock-Switch	Switching output of the timer. A voltage of +12 VDC is applied when activated, no use in RPM 2300
7	PGND	Reference potential for +12 VDC, Ground wire for red and yellow signal lights
8	DIN1	Digital status input for optional accessories

4. RPM 2300 monitor configuration

4.1. Predefined measuring cycles

The following measuring cycles are stored in the delivered monitor:

Name of cycle	Description
FP 15 min	Continuous Radon/Thoron progeny measurement with 15-minutes measurement intervals
FP 30 min	Continuous Radon/Thoron progeny measurement with 30-minutes measurement intervals
FP 1 h	Continuous Radon/Thoron progeny measurement with 1-hour measurement intervals
FP 2 h	Continuous Radon/Thoron progeny measurement with 2-hours measurement intervals
Markov PAEC	Fast procedure (15 minutes) for grab sampling of Radon daughter products. Requires filter replacement before sampling
Signal-Test	Test the "!" signal LED and, if present, the external signal lights (flashing)

4.2. Predefined warnings and alarms

The DACM32 platform offers a highly flexible alarm system that allows any user-specific alarms and warnings to be generated. The following alarms are configured by default:

Measuring value (Alarm-source)	Hint	Signal	Alarm message
Pump controller (AIN8)	Pump capacity >80 %	LED front plate, ext. Yellow lamp	"Air inlet blocked or water inlet protection!"
Battery voltage (BATT)	Battery voltage less than 11.6 V	LED front plate, ext. Yellow lamp	"Battery discharged, please charge!"
Pump current (AIN7)	Pump current >300 mA	Measurement will be stopped immediately	Alarm can be read in the event log
Optional: Differential pressure (AIN5 or I2C4)	Differential pressure too low (e.g., if no filter was inserted or hose is not connected)	LED front plate, ext. Yellow lamp	"No pressure drop, check filter!"
Radon progeny product concentration EEC (SPEC1)	Check at the end of the measuring cycle	LED front plate, ext. red lamp	„EEC limit exceeded“

Humidity sensor (I2C2)	Humidity in the internal air circuit >96 %	LED front plate, ext. red lamp	"Risk of condensation!"
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Hint: The alarm check is only possible 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 11.6 V, the measurement is automatically stopped without additional signalling. A corresponding entry is made in the event log.

The alarm signalling with yellow and red external lights is only activated if the monitor is supplied with a measuring case or a light column (accessory).

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 up of the alpha spectra

Recording and displaying alpha spectra is the most powerful tool for quality assurance of Radon/Thoron progeny measurements. The progeny sensor head provides characteristic energy spectra that the user can reliably evaluate after a short period of time. All radon and thoron progeny generate characteristic peaks in the spectrum, the shape and position of which indicate the proper functioning of the monitor. Less experienced users should save the initial measurement results after delivery of the monitor so that "reference spectra" are available for later comparison. A quick look at the acquired alpha spectra should always be part of good measurement practice.

5.5. Avoiding condensation

The formation of condensation in the monitor must be avoided. Condensation can occur if the monitor temperature is below the temperature of the measuring air and the dew point is exceeded upon cooling. Typical scenarios are soil air measurements in winter or immediate measurements in humid, warm rooms after transport at low temperatures. In such cases, the monitor must be sufficiently warmed before use. Damage to the monitor is not expected, but it may impair the measurement. If, for example, constant temperature changes are expected in a stationary installation under humid ambient conditions, a cooling and condensation monitor must be installed upstream or the monitor must be placed in a heated measuring cabinet. Depending on the monitor type, rotary vane pumps are used to generate the airflow. The surfaces of the compressors can corrode if surface moisture is present, which can lead to reduced pumping performance or even inoperability. After measurements under humid conditions, a fifteen-minute measurement should be performed in a dry environment to remove any moisture present from the internal air circuit.

5.6. Rechargeable battery

The lifespan of the built-in battery is reduced if it is deeply discharged or stored in a discharged state for extended periods. Even a fully charged battery will reduce its lifespan. For this reason, the battery should be subjected to a charge and discharge cycle every three months. This also applies if the monitor is not used for an extended period of time (the battery is subject to slight self-discharge, i.e.,

it loses capacity even when no power is drawn). Before the monitor is not used for an extended period of time, the battery should be charged to approximately 13V, the monitor turned off, and the fuse removed. Note: Deep discharge of the battery usually leads to a defect. This is detected by the charger, so the charging process will not begin.

5. 7. Hints for the sampling head for progeny

5. 7. 1. Connection and placing

The sampling head is a separate unit that can be placed either on the accessory adapter of the device, on the measuring case or freely in the room. It is mounted using an M16x1 thread and knurled nut on the mounting foot (7). The stand (6) should be positioned vertically. The mounting bracket can be adjusted on the accessory adapter according to the device positioning. The air flow through the filter is generated by the basic device, so the hose connection of the measuring head (5) must be connected to the air inlet of the basic device (1) with a hose. In addition, the electrical connection to the device must be established by connecting the connection cable to the 'AUX1' socket on the front panel of the device. The plugs must be locked with the screw sleeve and the hose connection must be checked for leaks.

Depending on their size distribution, aerosols accumulate on surfaces solely due to thermal movements, resulting in a depletion of aerosols and radon daughter products in their vicinity. For this reason, the daughter product measuring head should not be placed near surfaces if possible.

5. 7. 2. Replacing the filter

The filter must be replaced at the latest when a corresponding warning appears on the device. It is advisable to replace the filter earlier, as the energy consumption of the pump increases with increasing contamination and the battery life of the device is reduced.

To replace the filter, the filter nut (4) must be removed. The filter pressure plate can then be removed. The filter may stick to the filter support (3) due to the sealing material.

In this case, the filter must be removed with tweezers or similar. CAUTION: Behind the filter is the semiconductor detector, which must not be touched under any circumstances. The new filter should be positioned centrally with the seal on the filter pressure plate. The pressure plate can then be inserted into the filter support and secured with the filter nut. The filter support has two pins on the inside that must engage in the side grooves of the pressure plate to prevent the filter from twisting when the filter nut is tightened.

5. 7. 3. Detector cleaning and protection

In very dusty environments, the detector surface becomes contaminated, as a small portion of the aerosols is always deposited and accumulated on it. Cleaning must be carried out with extreme caution, as even small scratches on the detector surface can destroy the light shield and render the detector unusable. Any dust should be removed with a very soft optician's brush. Under no circumstances should the surface be wiped or liquids used for cleaning. If use in a dusty environment is necessary, the optionally available detector protection should be used. This consists of a thin film that is stretched over the radiation entrance window of the detector using a tensioning frame. A bracket positioned above the pivoting arm holds the tensioning frame in position using two screws. The film can be easily replaced by the user. To do this, the tensioning frame and the old film must be removed before a new film is carefully placed centred over the radiation entrance window of the detector. Placing the tensioning frame in place smooths the film. The bracket can now be attached and the tensioning frame secured with the two screws.

Note: Only films specified by SARAD may be used, as the film influences the spectroscopic properties of the measuring setup.

6. Use of accessories

6.1. Accessory adapter

For some external components (e.g. the progeny sampling head), it is necessary or advisable to connect them permanently to the monitor. For this purpose, there is an accessory adapter on the left side panel of the housing. This has a central threaded M6 hole for fastening and a series of opposite holes for positioning the accessories. The attachment is made using the counterpart that matches the respective accessory, which has two tabs for the positioning holes and a central hole for fastening with an M6 screw. The positioning holes are arranged in such a way that vertical positioning is guaranteed when the monitor is lying down (rack), standing up (case) and when using the stand bracket (table). The user must make the appropriate adjustment depending on the position of the monitor.

6.2. Case for harsh environmental conditions

If the monitor is to be used in harsh environmental conditions, the use of the optionally available measuring case is recommended. This is dust- and waterproof and features tube connections for transporting the measuring air to and from the monitor. The power supply socket on the case allows continuous operation of the monitor with the case closed (the cable extension in the case must be plugged into the "DC" socket). Depending on the model, one or two signal lights are mounted on the top of the case lid to indicate warnings and alarms. The connection cable for the signal lights is connected to the "AUX2" socket on the front of the monitor. When closing the case lid, care must be taken to ensure that no air tubes or cables are kinked. The measuring case for the RPM 2300 has an additional hole for the connection cable and the installation of the downstream product measuring head. The connection cable must be connected to the "AUX1" socket accordingly.

Note: The Rn/Th progeny sampling head itself is not protected against water ingress. If there is a risk of dripping water occurring at the measuring location, appropriate protective equipment must be provided.

6.3. Light tower

The light tower is used to signal warning and alarm conditions. The bright 360° signal lights ensure good visibility even from greater distances. The light column is connected to the monitor's "AUX2" socket. It is controlled via the "DOUT1" (yellow) and "DOUT2" (red) switching outputs. The light column can be freely positioned in the room using either a mounting bracket on the monitor's accessory adapter or a suitable cable extension.

6.4. Gamma dose rate probe

The RPM 2300 offers the option of connecting a probe for measuring the gamma local dose rate to the 'AUX2' accessory socket. The probe's pulse signal is connected to the 'CMP1/CNT1' comparator-counter combination via the plug. Power is supplied via the 'DOUT1' switching output. The probe is integrated into the measurement by activating the components (CNT1, CMP1, DOUT1) in the measurement cycles and entering their configuration parameters. This is done by the manufacturer when the probe is ordered together with the device. When the probe is reordered, configuration and measurement cycle files are supplied and can be transferred to the device by the user. The measured values of the local dose rate will appear automatically in the display and the measurement data files. SARAD offers two different gamma probes with measuring ranges of 1 mSv/h and 100 mSv/h. A mounting clip for attachment to the accessory adapter is included in the scope of delivery.

6. 5. External temperature and humidity sensor

The ambient temperature and humidity must be measured outside the device, as its power consumption distorts the readings of the internal sensor. The sensor is connected to the 'AUX2' sockets on the device. The required components and measurement cycles are already configured for this sensor when the device is delivered.

Attachment

A) DACM32 components

A1 – Type of components of DACM32

Type	Name	Description
Analog input	AIN	Connects sensors with analog 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 components used in RPM 2300

Name	Alias-Name	Function
AIN1	AUX2-Pin2	Signal at "AUX2" jack Temperature of external temperature/humidity sensor
AIN2	AUX2-Pin5	Signal at "AUX2" jack Rel. humidity of external temperature/humidity sensor
AIN5	Delta-p	Differential pressure, depending on the measuring range AIN5 or I2C3 (only with the "differential pressure sensor" option)
AIN6	Air-flow	Flow measurement and setpoint for flow control
AIN7	Pump current	Measurement of the internal pump current
AIN8	Filter assignment	Measurement of filter occupancy based on the pump voltage
CMP1	AUX1-Pin3	Unused, Signal at „AUX1“ socket, internal connection to CNT1
CNT1	AUX-CMP1	Internally connected to the output of CMP1, unused
DIN 1	AUX2-PIN8	Unused, at socket AUX2
SPEC1	Progeny products	Connected to the progeny sampling head, generates alpha spectrum and calculates EEC/PAEC
I2C1	AMS5812	Measurement of barometric pressure

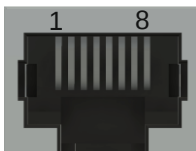
I2C2	SHT21	Combined temperature and humidity measurement in the internal air circuit
I2C3	Delta p	Optional Differential pressure sensor for filter control
REG1	Pump controller	Controls the flow via the pump power
DOUT1	AUX2-Pin1 or Signal yellow	Signal to socket "AUX2", either unused or: Power supply for external temperature/humidity sensor Connection of the yellow signal light on the measuring case
DOUT2	AUX2-Pin1 or Signal red	Signal to socket "AUX2", either unused or connection of the red signal light on the measuring case
DOUT7	Pump voltage	Switches on the supply voltage for pump and pump control

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)

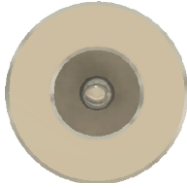
Pin	Signal	Description
4	B/B'	Transceiver terminal 1, V1 voltage (V1 > V0 for binary 1 [OFF] state)
5	A/A'	Transceiver terminal 0, V0 voltage (V0 > V1 for binary 0 [ON] state)
8	GND	Reference potential
1, 2, 3, 6, 7	N.C.	Not used



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.