

AccuRad PRD

Personal Radiation Detector

**User's
Manual**



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Directive 2012/19/UE of the European parliament and of the council of 4th july, 2012 on waste electrical and electronic equipment (WEEE). At the end of the product's useful life, please dispose of it according to the local legislation. If necessary, please send an email to: environnement-iso14001@mirion.com



CAUTION:

The AccuRad PRD is not certified for explosive atmospheres!

Revision Log

Ind.	Date	Verified by	Approved by	Origin and description of revision	Revised pages
A	2019-11	D. LE BRAS	P. TALENT	Document creation	/
B	2020-11	P. TALENT	T. VIDAL	DEVN 40052 Applicable up to firmware V1.3 §3.2.1, Edited hardware overview §3.3, Edited detectors paragraph §3.4, Edited smart app overview §3.5, Added Management center §4.6, Added pairing with NFC §4.7, Added standby/wakeup §5.2.1, Edited Using Trend screen §5.3, Edited Using in alarm §5.4.3.1, Edited Using radar §6, Edited Settings chapter §6.1.2, Edited Behavior paragraph §6.2.5, Added Saturation paragraph §6.5, Edited Bluetooth paragraph §6.7.2, Edited Radar calibration §7, Added Management Center §8.2, Edited troubleshooting §9, Edited Specifications §10.1, Added Appendix 1 §10.2, Edited Appendix 2 §10.4, Added Appendix 4	 14 16 18 19 27 27 31 32-33 30 41-60 43 48 52-54 56 61-68 73-75 79-84 85-102 103-104 106



Ind.	Date	Verified by	Approved by	Origin and description of revision	Revised pages
C	2021-04	C. FOURCADE	P. TALENT	<p>DEVS 40705</p> <p>Applicable up to firmware V1.4</p> <p>§3.2.2, Added dark mode</p> <p>§4.1, Edited battery insertion</p> <p>§4.2, Edited first use procedure</p> <p>§4.4, Edited Use summary</p> <p>§4.5.3, Edited using earphones</p> <p>§4.8, Edited AccuRad power-off</p> <p>§5.2, Edited Detection mode</p> <p>§5.4.2, Edited Search mode use</p> <p>§5.4.2.1, Edited radar use</p> <p>§5.78, Edited Update background</p> <p>§6.1.2, Edited behavior settings</p> <p>§6.7.2, Edited Radar calibration</p> <p>§6.7.4, Edited change PIN</p> <p>§6.7.5, Added dose history</p> <p>§7, Edited AccuRad Management Center chapter</p> <p>§8.1, Added Recommendations</p> <p>§8.2, Edited Troubleshooting</p> <p>§9, Updated specifications</p> <p>§10.1, Edited Appendix 1</p> <p>§10.2, Edited Appendix 2</p> <p>Various screenshots updated</p>	<p>16</p> <p>21</p> <p>22</p> <p>24-25</p> <p>27</p> <p>29</p> <p>32</p> <p>36-37</p> <p>38-40</p> <p>43</p> <p>48</p> <p>62</p> <p>64</p> <p>65</p> <p>67-78</p> <p>79</p> <p>80-83</p> <p>85-90</p> <p>107</p> <p>109-111</p>
D	2022-02	<p>N.CANOLLE</p> 	<p>P.TALENT</p> 	<p>DEVN 41383</p> <p>Applicable up to firmware V1.5</p> <p>§7, added a firmware update procedure for AccuRad simulators + a calibration procedure</p> <p>§9, updated measurement specifications</p> <p>§10.4, updated calibration recommendations</p> <p>Various small corrections and screenshots updated</p>	<p>78-82</p> <p>91</p> <p>120</p>

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1. Introduction

The AccuRad PRD is a Personal Radiation Detector (PRD), packaged in a small, rugged and easy to use form factor. The AccuRad PRD is a high-performance measurement device for operations requiring detection, search and localization of radiation sources. AccuRad addresses all applications requiring efficient detection of radiological threats in civilian defense.

The AccuRad PRD combines one sensitive low range detector to quickly detect low gamma radioactivity levels and one high range detector for extended dose rate range and dose measurements.

The AccuRad PRD is a self-operating device that automatically detects gamma radioactive sources. A unique “on the move” localization algorithm enables intuitive source search by directional screen indicator.

When a source is detected, the AccuRad PRD triggers various sound and visual alarms and/or vibrations. The device has a built-in discreet mode that mutes alarm sound, thus making it convenient to use in crowded environments (airport, malls, metro stations, stadiums, streets, etc.).

The AccuRad PRD is compact sized for performing one-handed measurements, even when wearing gloves. The user-friendly interface utilizes two display screens; one large front case display; a smaller top display, and five buttons. The integrated belt clip affixes securely to a belt or pocket, allowing easy view of the top display without removing.

The AccuRad PRD is powered by two AA batteries (1.2V to 1.5V).

The AccuRad PRD is designed for pairing to a smartphone with the AccuRad App. The AccuRad App provides sharing features including data logging, batch processing, messaging (email, SMS), and reachback connectivity to common operational data platforms.

Optionally, the AccuRad PRD can also be remotely monitored by the **SpirVIEW** Supervision software or RadResponder for situational awareness along with the other SPIR family instruments.

The AccuRad PRD complies with the relevant current international standards (IEC, IAEA, ANSI).

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2. Advantages

- **Exceptional radiological performance**
- **Smooth user experience**
- **Radar indication for accurate source localization**
- **Discreet mode for covert operations**
- **Robust protection for resistance to water, dust and sand ingress**
- **More than 900 hours of continuous operation**
- **Simplified data transmission over the smartphone app via Bluetooth**

- **Exceptional radiological performance**

The AccuRad PRD measurement range is from background to 10 Sv/h (1000 rem/h) utilizing a combination of two energy compensated detectors. Dose measurements are in compliance with various industry dosimetry standards. The Varying Background Suppression (VBS) algorithm inhibits false alarms from normal background variations.

- **Smooth user experience**

The AccuRad PRD can operate in full autonomy, only alerting the operator when a source is detected and to assist in localizing and evaluating the threat. Effective alarm indicators are provided: loud audible, attentive vibrator, clear visual display information and bright LEDs.

The operator can acknowledge the alarm to silence the sound and vibration by pressing any button. The sound alarm indicators allow to easily distinguish weak alarms from dangerous ones. In addition, audible chirps and flashing LED help to locate the source.

The large front display helps the user clearly read alert messages during use.

Saving device data is automated, no operator action is required.

- **Radar indication for accurate source localization**

A built-in and intuitive radar screen display (localization indicator) helps the operator to find the detected source.

- **Discreet mode for covert operations**

The discreet mode silences alarms for stealth applications. For more discretion, the user can also connect headphones via the USB-C port.

- **Robust protection for resistance to water, dust and sand ingress**

The AccuRad PRD is resistant to dust, sand and moisture. The integrated rubber case protection improves shock resistance and handling.

The AccuRad can be used in temperatures as low as -4°F (-20°C) and as high as 140°F (60°C).

- **More than 900 hours of continuous operation**

The AccuRad PRD uses a “standby” mode for outstanding battery life. The AccuRad is powered by two commercially available AA batteries: non-rechargeable Alkaline or Lithium, and rechargeable NiMH (1.2V to 1.5V).

Rechargeable NiMH batteries can be recharged in the device when powered by USB.

- **Simplified data transmission over the smartphone application via Bluetooth**

The AccuRad integrates Bluetooth with Near Field Communication (NFC) for pairing and transmission of AccuRad data to a dedicated smartphone application.

For smartphone without NFC, manual pairing remains possible via Bluetooth Low Energy (BLE).

3. AccuRad PRD description

3.1 What's in the box

- One AccuRad PRD detection device with a belt clip
- Two AA alkaline batteries
- One spare belt clip
- One quick start guide



See §9.8.2 *Optional accessories and spare parts* for more information on accessories and spare parts.





The AccuRad Quick Start Guide and other documentation can be downloaded at <https://accurad.mirion.com/>

3.2 AccuRad PRD overview

3.2.1 Hardware overview



The AccuRad PRD device includes five buttons, two screens, two LED indicators and a connector:

- A large **front display screen**
- The **top display screen**
- The  **on/off button** is used to power on (short press); power off (long press) and turn on/turn off the front display screen (short press).
- The  **back button** allows to return to the previous selection or exit the search mode.
- The  **enter button** is used to access and select a settings parameter.
- The  **arrow buttons** allow to navigate through the menu.
- The **alarm LED indicator** colors are:
 - Red, slow blinking: low or high alarm (dose or dose rate)
 - Red, fast blinking: danger alarm (dose or dose rate)
 - Orange: information, low battery level (with battery gauge depleted), temperature out of range
 - Green, blinking: search mode enabled (the faster the blink, the closer to the source). Turns red in case of alarm.
 - Purple: a failure is reported. Refer to §8.2 *Troubleshooting*.
- **Battery Cover Tab**: quarter-turn counterclockwise to open or clockwise to close the battery cover.
- The **USB type C port** allows the user to plug the provided earphones, perform Service operations (setup, data collection update and calibration). It can also be used to charge the batteries.
- The **USB LED indicator** colors are:
 - Green, solid: battery full.
 - Red, solid: battery charging
 - Red/green, blinking: battery depleted, or inserted battery cannot be recharged

3.2.2 User interface overview



Note:

The user interface is displayed in light mode by default, however it can also be displayed in dark mode. For more information about dark mode, refer to §6.1.2 Behavior .

3.3 Detectors

The AccuRad PRD has two detectors to cover the whole detection range.

- The **low range detector**, made of CsI (TI) scintillator, is designed to detect weak gamma radiation activity from background to 160 kcps; refer to the table below for the equivalent dose rate.

The center of the low range detector is identified on the AccuRad PRD case by a round symbol.

	Sensitivity	Max range for 160 kcps
Am-241	2200 c/s/ μ Sv/h	73 μ Sv/h
Cs-137	160 c/s/ μ Sv/h	1000 μ Sv/h
Co-60	60 c/s/ μ Sv/h	2667 μ Sv/h

- The **high range detector** extends the dose rate capabilities of the device, up to 10 mSv/h (for Cs-137) when set to be compatible with ANSI 42-32. This limit can be set at 10 Sv/h, it impacts the recovering time if the device is exposed to a dose rate higher than ANSI 42-32 limits. For more information, refer to §6.2.5 *Saturation*.

The center of the high range detector is identified on the AccuRad PRD case by a cross symbol.

Refer to §10.3 *Appendix 3: AccuRad PRD drawings and reference point for dose rate measurement* and §10.4 *Appendix 4: Calibration recommendations* to identify the calibration points.

3.3.1 Wearing the AccuRad PRD

- **Worn on the belt**

To release it from the belt, just turn the device.

The AccuRad is designed to be worn on the belt with the integrated belt clip. The operator shall ensure the top display remains visible in order to check any detected threat without manipulating the device.

Clothes must not cover the loudspeaker. Otherwise the sound level may not be sufficient to be heard in case of alarm. When holding the device, the reference direction of the measurement is orthogonal to the front display. The device is calibrated in this direction.



*Reference direction:
Best accuracy for integrated
dose*



- **In Search Mode**

Source search is facilitated by the positioning of the low range detector, which is placed above the front display.

Please note that the high range detector is not ideally placed to provide accurate measurements while the device is in this position



*Reference direction for
search/survey.*



Note:

The Search Mode should only be used when a source is present (to localize) and not for search in low background environment.

3.4 AccuRad App overview

The AccuRad App is the companion interface of the AccuRad PRD system.

The AccuRad App is available on the Apple Store or Google Play download platform. It communicates with the AccuRad PRD device via Bluetooth. The AccuRad PRD device can be easily paired to the AccuRad App via NFC or manually. Refer to §4.6 *Pairing the AccuRad PRD to a smartphone with NFC*.

Use the AccuRad App to:

- Review the last alarms
- Review the history of the device (alarms, dose history, failures and information)
- Reachback (SMS, email, RadResponder)
- Stream data to a supervision system (SpirVIEW, RadResponder)
- Configure the AccuRad PRD
- Deploy the configuration very fast on a batch of AccuRad PRDs
- Get trained on the use of the device and take a skills test.



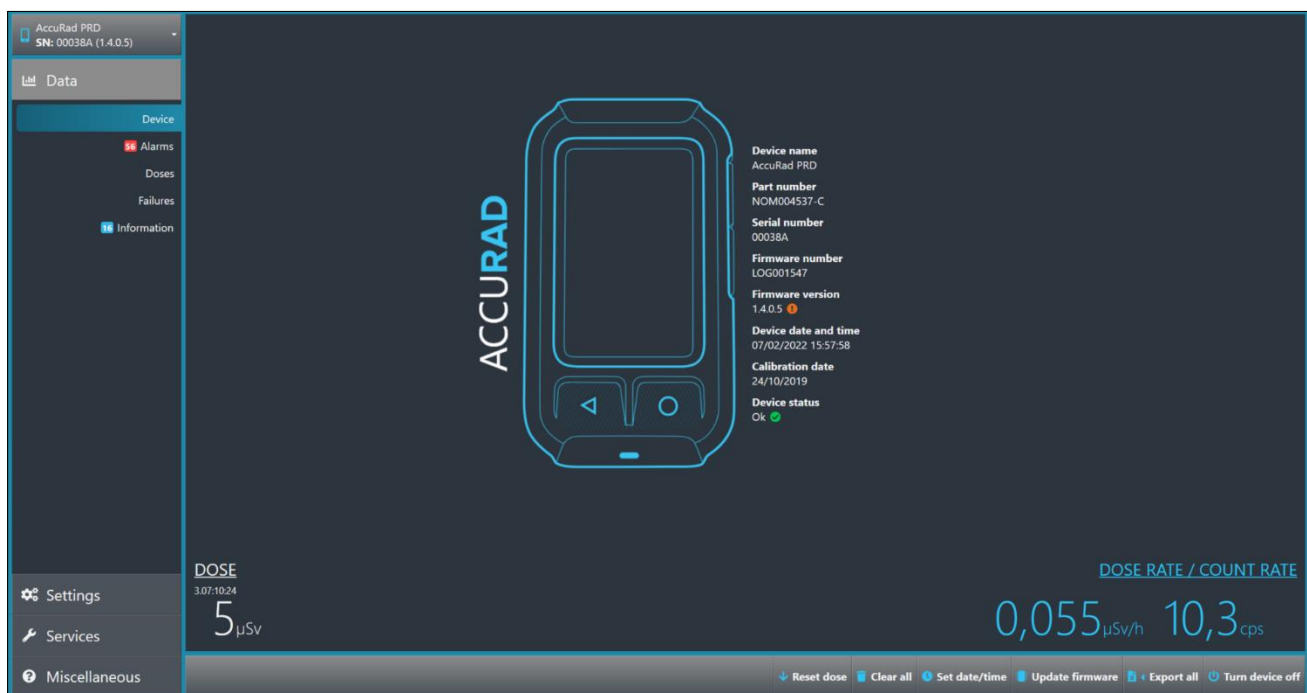
Learn more at <https://accurad.mirion.com/platform>.

3.5 AccuRad Management Center

The AccuRad Management Center requires a PC with Windows 10 64-bit, one USB 2.0 port (or newer), and a USB type C cord.

Launch the AccuRad Management Center and connect the AccuRad PRD. Once the AccuRad PRD is automatically detected, the operator can use the user-friendly interface to:

- Check the device status (presence of detector / system faults)
- Check the current measurement
- Set the device time
- Check and set up the calibration date
- Check, export (xlsx or N42 format) or delete:
 - Alarm history
 - Default history
 - Information history
 - Dose history
- Check and edit the device settings
- Save the settings
- Transfer the stored settings to other AccuRad PRD devices
- Update the firmware



4. Using AccuRad PRD

4.1 Battery insertion



Release the battery cover tab.



Turn counterclockwise the battery cover tab.



Lift the battery cover.



Insert two AA batteries into the AccuRad PRD.
Ensure the correct polarity position.



Reinstall the battery cover.
Turn the cover tab clockwise to lock it.

The AccuRad PRD can work with the following types of batteries:

- AA (LR6) 1.5V alkaline batteries (non-rechargeable),
- Lithium 1.5V batteries (non-rechargeable),
- NiMH 1.2V batteries (rechargeable).

Make sure to set the AccuRad PRD with the correct type of batteries. For more information refer to paragraph §6.6 *Battery*.



Caution:

- When inserting the batteries, make sure to position them to the correct polarity following the polarity marking present in the battery compartment.
- Always use batteries of the types listed above. Using non-compatible batteries may cause the AccuRad to explode!

4.1.1 Charging NiMH batteries

If using NiMH batteries, connect the AccuRad PRD to the mains via the USB-C port to charge it. The power adaptor automatically detects if the batteries can be charged and if they work properly. If that is not the case, the USB LED indicator blinks red and green.

The batteries may heat a little during charge, it is a normal reaction. However, if the temperature exceeds 50°C / 122°F, the build-in thermal security forbids the charge and a default message is displayed.

Charging time may vary depending on the NiMH batteries, for instance a complete charge of 2000 mAh NiMH batteries take about 5 hours.



Note:

When the AccuRad PRD is connected via USB, the screen does not turn off. It can be useful when using the AccuRad PRD on a car, for instance.

4.2 First use of the AccuRad PRD



Press the  on/off button.



Check the interface language, then select Save.



Check the unity to be displayed, then select Save.



Set the date, then select Save.



Set the time, then select Save.



Select a time fuse, then select Save.



The AccuRad PRD initiates a self-test sequence; wait a few seconds.



Follow the on-screen instructions to calibrate the radar.



After initialization, background update is triggered; wait a few seconds.



When a measurement is displayed, the AccuRad PRD is ready to use.

4.3 Start the AccuRad PRD

1 Press the on/off button.

2 The AccuRad PRD initiates a self-test sequence; wait a few seconds.

3 After initialization, background update is triggered; wait a few seconds.

4 When a measurement is displayed, the AccuRad PRD is ready to use.



Note:

At the end of the self-test sequence, the AccuRad PRD warns the user if the battery is low, if the date and time are not consistent, and if the calibration due date is expired.

4.3.1 Calibration expired

If the calibration date is expired, and if the function is enabled, the AccuRad PRD notifies it twice, during the startup then with a **CAL** pictogram on the main screen.



The calibration is performed with a high range calibrator/irradiator. For more information about calibrating the AccuRad PRD, refer to §7.3.4.2.1 *New Calibration*. When the calibration is done, enter the calibration date in the settings (refer to §6.7.1 *Calibration*).

4.4 Use Summary of the AccuRad PRD

The AccuRad is designed for comfortable one-handed or hands-free operation.

The front and side buttons are easily accessible for one-handed operation



4.4.1 Detection Mode Operation Summary

The operator is wearing or holding the AccuRad in Detection Mode. Dose Rate provided on both display screens



The AccuRad alarms when a source is detected. The operator presses any button to acknowledge the alarm and responds accordingly.

- DANGER** Move away!
- HIGH ALARM** Move away and investigate with caution
- LOW ALARM** Investigate with caution

Detection Mode Operation Summary (cont.)

Press the **enter** button twice to switch to Search mode and press **▲/▼** arrow buttons to choose trend or radar.

Press **◀** back button to exit Search mode.

In Search mode the device emits no alarm sound; only chirping (unit = cps recommended).

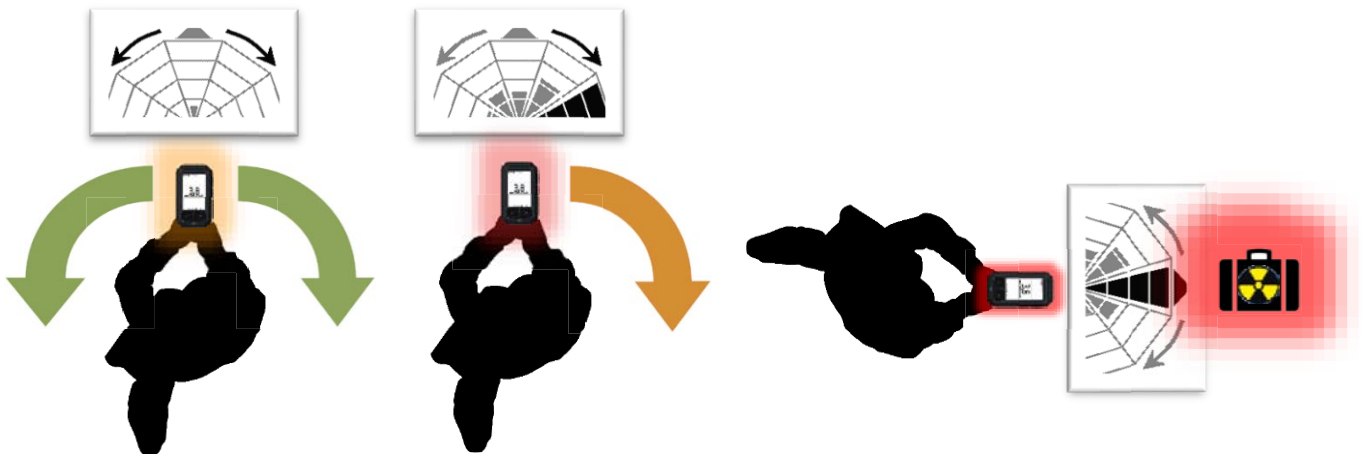


Note:

Neither the trend screen nor the radar screen can be used during background initialization.

4.4.2 Search with Radar Mode Operation Summary

In **Radar** mode, the operator turns with the AccuRad to build the radar sectors, then follows the black sectors and the arrows to find the source.



Note:

The radar must be calibrated to work properly. Refer to §6.7.2 Perform radar calibration.


4.5 Discreet mode overview

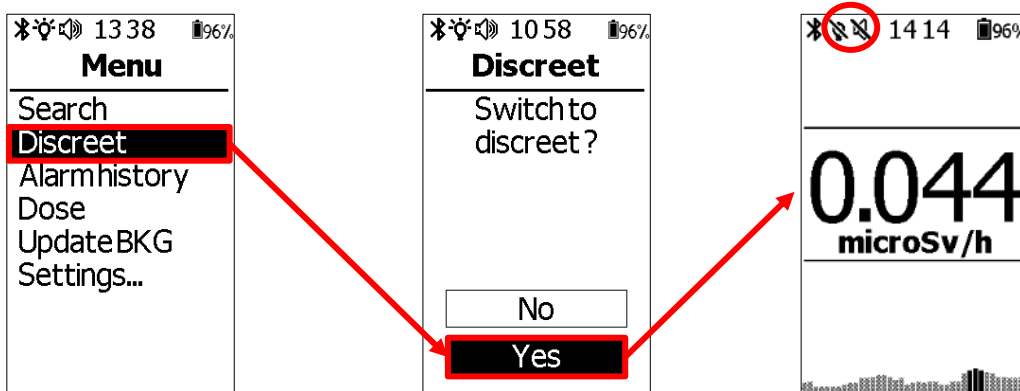
The discreet mode can be used when the operator does not want the alarms generated by the AccuRad PRD to be perceived by the environmental people.

By default, in this mode, the audible and visual alarms (LEDs) are deactivated. However, audible alarms can be heard if using earphones. The AccuRad PRD continues to alarm the operator through its vibrator and the warning messages are displayed.


Discreet mode behavior is configurable in the Settings menu.
For more information, refer to §6.3.1 *Discreet mode*.

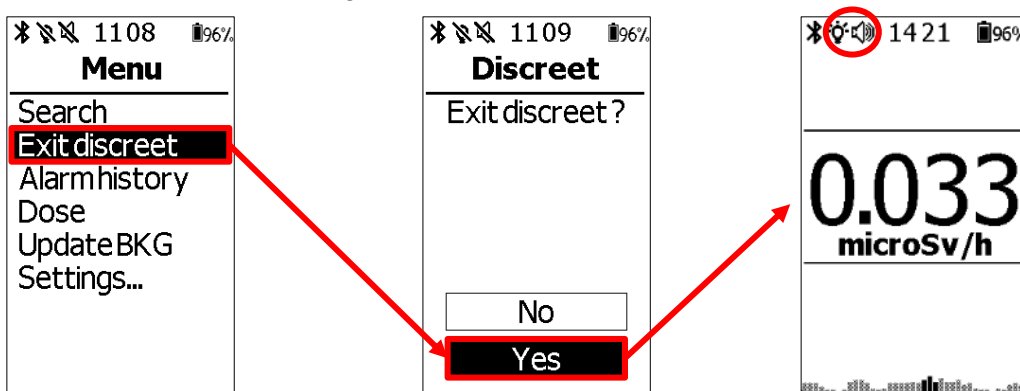
4.5.1 Switching to discreet mode

- Open the menu and select **Discreet**. The Discreet menu is prompted.
- Select **Yes** to switch to discreet mode and exit settings. Note the  icons at the top of the screen, meaning the alarm LED indicator is off and the sound is muted.



4.5.2 Disabling discreet mode


- Open the menu and select **Exit Discreet**. The Discreet menu is prompted.
- Select **Yes** to disable discreet mode and exit settings. Note the  icons at the top of the screen, meaning both the alarm LED indicator and sounds are enabled.

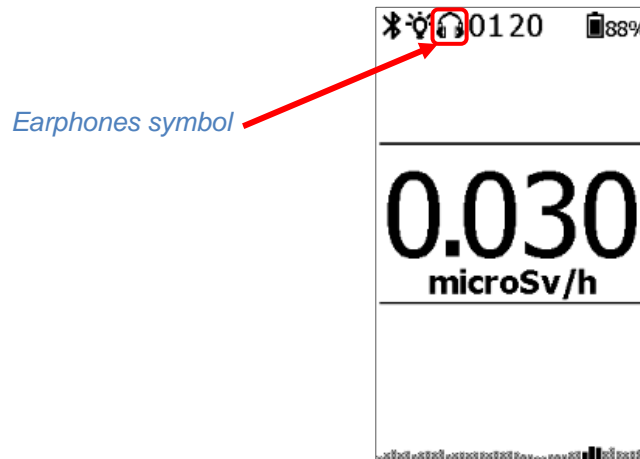


4.5.3 Using earphones

Connect the optional earphones to the USB-C port. The sound is automatically switched to the earphones, but the LEDs are still functioning.

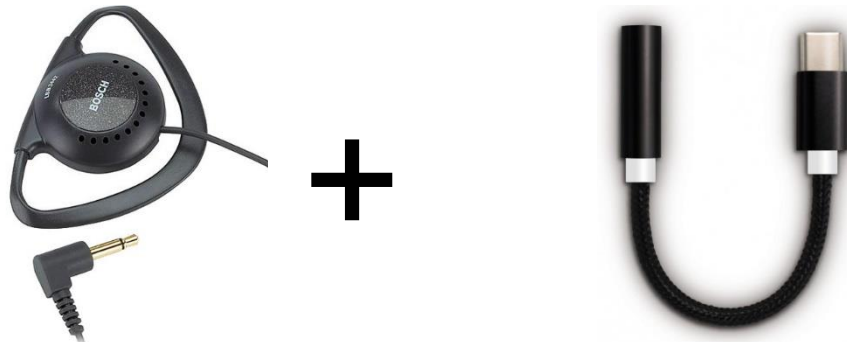
Use the earphones buttons to control the sound volume and acknowledge alarms.

When earphones are connected, a  symbol is displayed.



In discreet mode, connecting the earphones automatically redirects all the sounds (alarm + chirp) into the earphones.

3.5 mm jack earphones can be used through a 3.5 mm jack to USB-C adapter.



NOM005846 (pictures are not contractual)



Note about USB-C earphones:


- The AccuRad PRD is compatible with analog earphones only.
- Mirion can supply earphones tested for operability. Mirion cannot guarantee similar functionality in other brand models. It is recommended to test before using in the field. For more information contact your Mirion representative.



Caution !

Do not use at high volume during extended periods.
Risk of hearing impairment!

4.6 Pairing the AccuRad PRD to a smartphone with NFC

- Open the AccuRad App on the smartphone.
- Place the smartphone next to the AccuRad (see picture), with the two NFC logos  in contact.




Note :

The location of the NFC contact point may change depending on the smartphone model. For more information, refer to your smartphone user's manual.

4.7 Standby / Wakeup the AccuRad PRD

Do a short press on the  **on/off button** to put the AccuRad PRD on standby.

To wake it up:

- Press any button;
- Or, if the Lock key function is enabled, press the  **on/off button** and then press the **◀ back button** twice.





Note :

For more information about the Lock keys function, refer to §6.1.2 Behavior.

4.8 Powering off the AccuRad PRD

There are two methods to power off the AccuRad:


- Continuous press of the  **on/off button** for about 5 seconds and the AccuRad will automatically power off at the end of the countdown.
- Long press the  **on/off button** to display the Power OFF window, then select **OK** to power off the AccuRad.



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5. AccuRad PRD advanced usage

5.1 Main menu overview

To access the main menu, press  **enter button**:



The menu consists of the following features:

- **Search:** switch to search mode. For more information, please refer to §5.4 *Using AccuRad PRD in Search mode*.
- **Discreet:** switch to discreet mode. For more information, please refer to §4.5 *Discreet mode overview*.
- **Alarm history:** an internal log of the alarms triggered by the AccuRad PRD. For more information, please refer to §5.4.3 *Stopping the Search Mode*
- *To exit the Search Mode, press the ◀ back button.*
- Analyzing AccuRad PRD alarm history data.
- **Dose:** view the current dose information. For more information, please refer to §5.6 *Dose*.
- **Update BKG:** update the background value. For more information, please refer to §5.7 *Update background (BKG)*.
- **Settings:** Give access to advanced features. For more information, please refer to §6 *AccuRad PRD settings*.



Note:

Fields or menu selections that are **GREYED OUT** are either locked and require a PIN code to be unlocked or are not available in the current configuration.

5.2 Using AccuRad in Detection Mode

Detection mode is used when the AccuRad is worn for operation in background environments. In Detection mode, the large display is off and only the top display screen is active. The top display shows:

- The battery level.
- The current dose rate with measurement unit.
- During an alarm, its type is displayed (LOW ALARM, HIGH ALARM, DANGER (Rate) DOSE ALARM and DOSE DANGER).
- During a failure, specific messages are displayed.

During an alarm event, the AccuRad vibrates while also emitting a visual and/or sound alarm, depending on the selected alarm indicators. For more information about alarm indicators, refer to §6.3 *Indicators*.



Note:

The device may automatically switch to search mode, depending on the settings. For more info about this setting please refer to §6.1.2 *Behavior*.



Note:

To return to the detection mode, click on ◀ Back button or press the ○ Enter button to return to the detection screen and power off the front screen.

1



The operator is wearing or holding the AccuRad in Detection Mode. Dose Rate is provided on both display screens.

2



The AccuRad alarms when a source is detected. The operator presses any button to acknowledge the alarm and responds accordingly.

5.2.1 Using the Trend screen

The Trend Screen provides:

- The measurement value (dose rate or count rate in search mode).
- The graphical autoscale trend view corresponds to the real time measurement value. The trend view scales automatically and shows the last 10s of measurement, to help the operator locate the source. The vertical scale has no unit of measurement, and an algorithm sets the focus on the measurement fluctuations to help locate a source. Each bar represents 0.25s of measurement.
- The height and/or color of the trend peaks varies in real time and depend on the gamma dose rate. The maximum count rate is highlighted in **bold**.



5.3 Using AccuRad PRD in Alarm

The AccuRad PRD has three alarm levels for dose rate measurement and two alarm levels for dose measurement.

In dose rate, the low alarm level implies a weak but abnormal elevation of the radioactive background. The high alarm and danger levels mean the measured dose rate exceeds the high alarm / danger thresholds; these thresholds are absolute.

5.3.1 AccuRad PRD behavior

In case of alarm, the AccuRad PRD triggers various signals, in the following order:

- LED and display
- Sound
- Vibration

These signals are repeated until acknowledgment or if the threat is over.



Note:

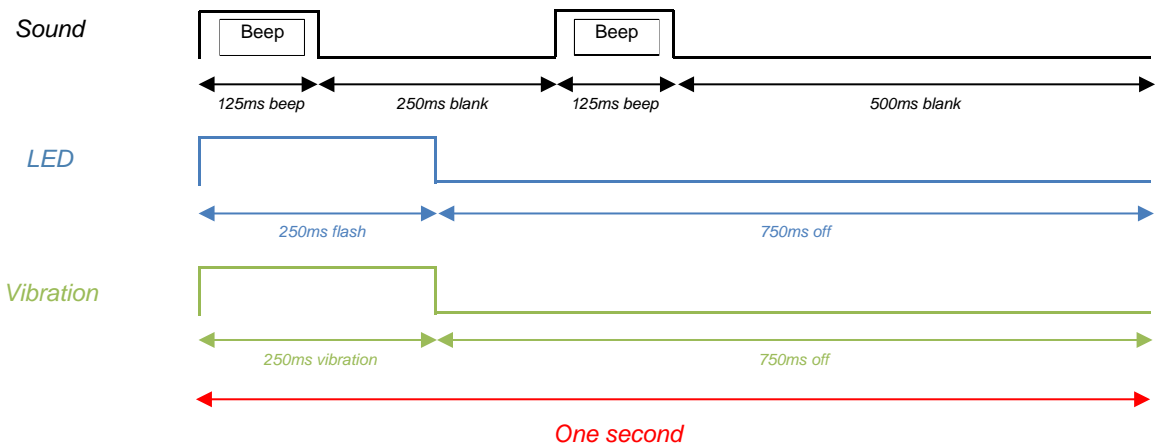
These signals are also triggered when the AccuRad PRD is in standby and even if the Lock Keys function is enabled. If the alarm appears during standby the backlight of the top display will automatically be enabled to ease the reading of the current dose rate.

5.3.2 Alarm Indication general behavior

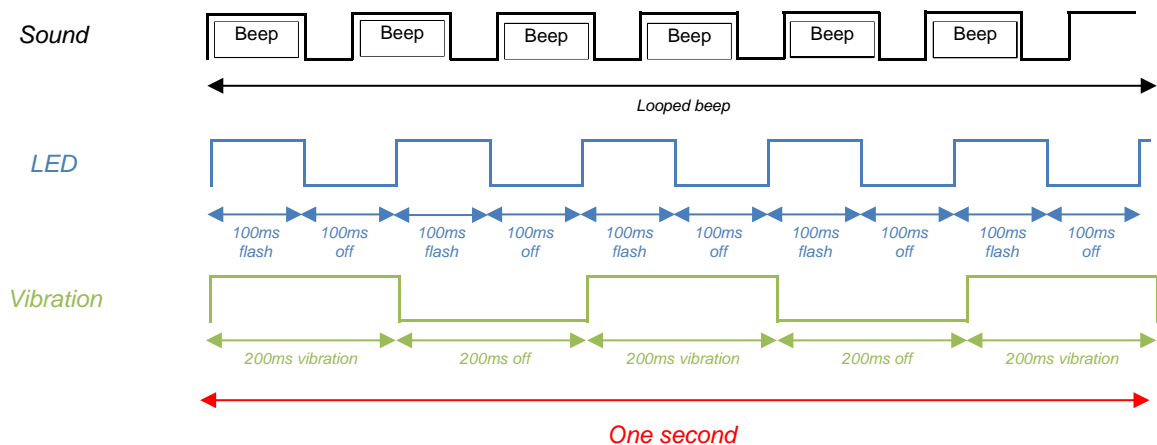
During an alarm, the **Alarm LED indicator** flashes in red.

An **alarm sound** is periodically (1s) generated in alarm until acknowledged, except in Discreet mode or if using earphones.

In case of Low / High alarm, the following pattern is repeated until alarm acknowledgment:



In case of Danger alarm (dose and dose rate alarms), the following pattern is repeated until alarm acknowledgment:



In Search mode, the Alarm LED indicator blinks to the rhythm of detected pulses. The LED color is green in normal mode, and red in alarm. In normal conditions, the Alarm LED indicator blinks in green then turns red if a threshold is reached.

5.3.3 Acknowledging visual and sound alarms

During an alarm, the AccuRad PRD vibrates with visual and/or sound alarms, depending on the configured alarm indicators.

- If the Lock keys function is disabled, press any button to acknowledge the alarm and suppress the sound and vibration. If the large display is off, press any button a second time to wake it up.
- If the Lock keys function is enabled, press any button to acknowledge the alarm and suppress the sound and vibration; then press the **on/off button** once and the **back button** twice to wake up the large display.

5.3.4 Recommended Alarm Actions

The following recommendations are for operator actions upon alarm activation. The top display screen notifies which alarm is triggered:

- LOW ALARM: Investigate.
- HIGH ALARM: Evacuate and investigate.
- DANGER: Evacuate.

These recommendations shall not replace operator training, procedures or CONOPS.

For more details about alarm levels, refer to paragraphs §6.1.1.1 *Setting up the Dose Rate or Count Rate Measurement Display* and §6.1.1.2 *Using the 0-9 Unitless Measurement Scale Display*.

5.3.5 High background alarm


The AccuRad PRD continuously calculates a background level which is used to calculate the low alarm level. If this calculated background level becomes excessive, the AccuRad PRD emits a sound and indicates "High background". If this happens in a place where background is known as normal, this "High background" indication means that the AccuRad PRD is probably close to a source. This can happen for very slowly approaching sources (typically less than 0.1 m/s) or very slowly increasing levels. In these conditions, take the same actions as for a "LOW ALARM".

5.4 Using AccuRad PRD in Search mode

When a low alarm or a high alarm is triggered, the operator activates the Search mode to investigate and find the cause of the alarm.

5.4.1 Activating the Search Mode


Search Mode becomes active:

- **Automatically** when a source is detected, if configured in settings. For more details, please refer to §6.1.2 *Behavior*.
- **Manually**, when the operator enables it. To activate it, press the  **enter button** to enable the Search mode.



Note:

*If the Display sleep function is enabled, the front display automatically turns idle after 30 seconds of inactivity (editable default value, see §6.1.2 *Behavior*). However, in Search mode, this automatic display sleep delay cannot be lower than 120s, even if the display sleep function is set on a lower delay.*

The device will not turn idle in alarm condition whereas the front display is active. However, it is still possible to manually turn it off by doing a short press on the  on/off button.

5.4.2 Using the Search mode

In search mode, both displays are active. The operator holds the AccuRad PRD in his/her hand and either observes the Trend screen to find where the radiation level is the highest (and at the same time avoid being in a dangerous situation) or uses the Radar screen to determine the direction of the radioactive source.

Two types of display are available:

- **Trend screen**, described at §5.2.1 *Using the Trend screen*.
- **Radar screen**, described at §5.4.2.1 *Using the Radar screen*.

In Search mode, the alarm LED indicator blinks at the same rhythm of the detected radiations, and as the operator moves closer to the source, the faster the blinks. It blinks green as long as any alarm threshold is not reached, otherwise it blinks red. If the AccuRad PRD is in alarm and in Search mode, the alarm LED indicator blinks red.

In addition, the audible chirp, when used, behaves like the alarm LED indicator - the AccuRad PRD chirps faster moving closer to the source.



Note:

To ease the search, alarm sounds are disabled in Search mode.

The LED switches from green to red if an alarm is triggered while searching.

There are two types of gamma measurement values for the Search mode:

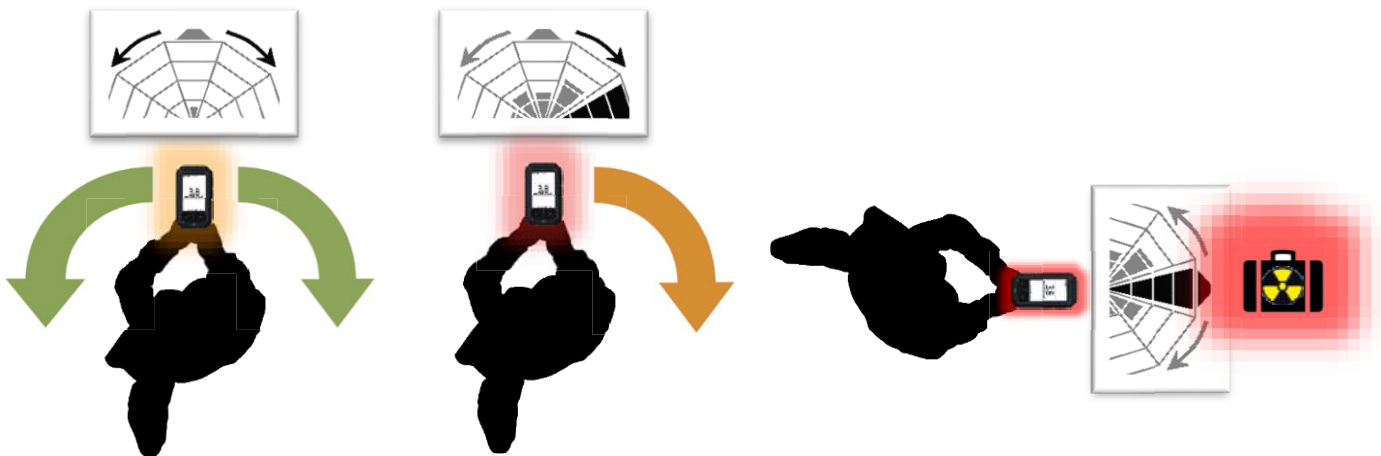
- **Dose rate / Count rate** (recommended) measurement display. For more information, please refer to §6.1.1.1 *Setting up the Dose Rate or Count Rate Measurement Display*.
- **0-9 Unitless Measurement Scale** display. For more information, please refer to §6.1.1.2 *Using the 0-9 Unitless Measurement Scale Display*.

Operator Actions:

- Press the **enter** button twice to switch to search mode and press the **▲/▼ arrow buttons** to choose trend or radar. Press the **back** button to exit Search mode.
- In **Search** mode: no alarm sound, chirping only (recommended unit = cps).
- In **Search Mode with Radar**, no alarm sound, chirp on/off (recommended unit = cps).



When using the **Radar**, the operator turns with the AccuRad to build out the radar sectors, then follows the black sectors and arrows to locate the source, as shown below:



The unit in search mode can set to count rate (cps) or dose rate unit. In order to maintain the safety information at all times, be consistent across displays, and avoid introducing an additional unit that is device-dependent (not physical), the AccuRad is set by default to display dose rates in all modes. The graphical information: trend or radar and chirp, are based on count rates, taking advantage of its better dynamics. Organizations used to search modes in cps may adapt the settings on each device as explained in paragraph §6.1.1 *Setting up the Dose Rate or Count Rate Measurement Display* or using the batch configuration mode of AccuRad Management Center

5.4.2.1 Using the Radar screen

The Radar display helps the operator locate the detected source by providing its direction. The Radar screen consists of ten sectors, each one represents a direction of measurement from the device axis, but only the five front sectors are displayed.

The radar must be calibrated prior to use. For more information refer to §6.7.2 *Perform radar calibration*.

The radar display is built out during the rotation of the AccuRad PRD as the operator attempts to locate the radioactive source by turning on the spot. The AccuRad PRD uses a magnetometer sensor to measure the rotation. The radar records the maximum count rate measured for each of ten sectors of 36°.

The information remains accurate only if the operator turns on the spot while holding in hand and in front of him/her the AccuRad PRD. The radar information will not remain accurate if the operator deviates from his original position. In this case, the radar will need to be reset by exiting to the trend screen using the **▲/▼ arrow buttons**, and then going back to the radar screen.

Sectors represent the geographical direction of potential radioactive sources. The detection of a radioactive source is represented by the number of the sector(s) that shows the direction of the source. When three sectors are completed (3 x 36°), the sector where the maximum count where detected is highlighted in bold black.

The radar information and calibration can be affected by magnetic environments, magnets, and iron (e.g. buildings, cars, trucks, etc.). If the current magnetic environment is different from the environment during which the AccuRad radar was calibrated, an “Interference” message is displayed; the radar works but its accuracy is affected.



Note:

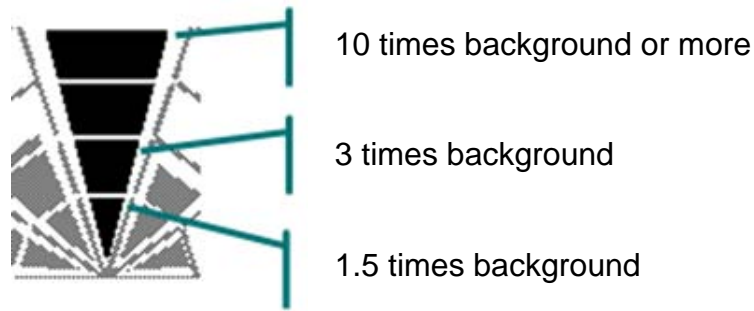
For more information about the Interference message, refer to §8.2 *Troubleshooting*.



Caution!

Using the AccuRad in a highly magnetic environment can magnetize some of its parts like the batteries and affect its calibration and accuracy.

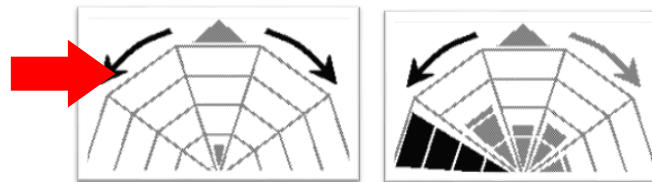
Sector scale:



Note:

All the sectors are progressive except the first one that is fully filled when the sector is scanned.

When the arrows are **bold black**, the AccuRad is prompting the operator to turn around.


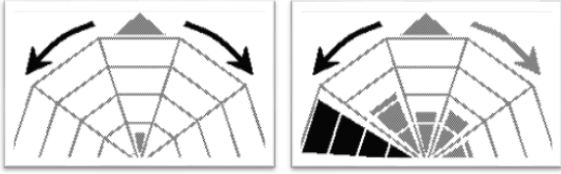




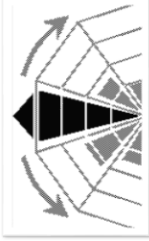

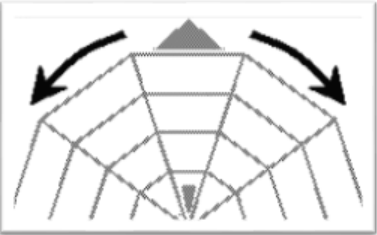


When three sectors or more are scanned, the arrows now show the rotation to perform in order to maximize the axis of the AccuRad, confirmed by the top arrow.



Pressing the **▲/▼** buttons resets the radar content, then the process restarts.

How to use the Radar:

	Operator action	On screen
1/	 <p>The operator moves around to find the direction of the source.</p> <p>Note:</p> <ul style="list-style-type: none"> - Keep the AccuRad PRD with the same angle against the body during the rotation. - It is recommended to perform one full turn to determine the real direction of the radioactive source. 	 <p>The radar adapts its position according to the user position, like a compass pointing the north. Sectors are progressively filled during the rotation. When at least three sectors have been partially filled, the sector with the highest count rate is highlighted in bold black.</p> <p>Arrows   show the rotation to do by the operator to put the maximum in the axis of the AccuRad PRD, confirmed by the top arrow .</p>
2/	 <p>When the direction of the source is found, the operator walks in its direction.</p> <p>Caution: be careful not to walk in a dangerous area, keep an eye on the alarm level.</p>	 <p>When the operator is getting closer to the source, the radar sectors widen. The wider they are, the closer the source is. The sectors numbers vary depending on the radiation level and the maximum count where recorded is highlighted in bold black.</p>
3/	 <p>After the search completes the operator presses the ▲/▼ arrow buttons to reset the radar and, if necessary, do a more precise search.</p>	 <p>The radar is ready for a new search, the first grey sector is scanned.</p>

5.4.3 Stopping the Search Mode

To exit the Search Mode, press the **◀ back button**.

5.5 Analyzing AccuRad PRD alarm history data

Alarm history is accessible from any measurement screen. This history provides the operator the alarm history from the newest to the oldest; it contains only the alarms.



Alarm history can also be viewed by opening the Alarm History from the menu.

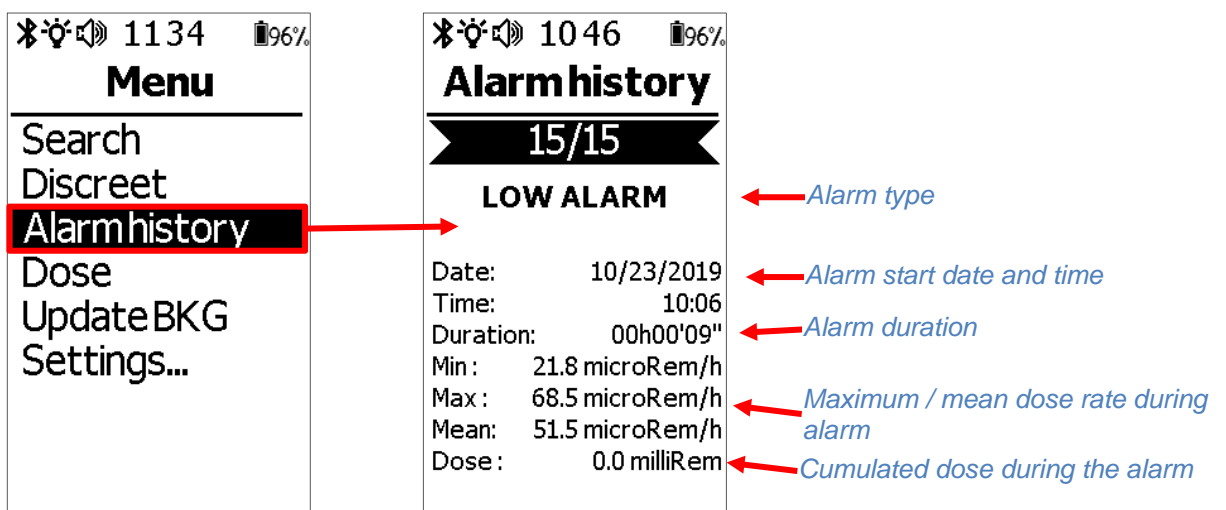
5.5.1 Accessing alarm history data

To access alarm history data:

- Press the **enter button** to open the menu.
- Use the **▲/▼ buttons** to select **Alarm History**; then press the **enter button** to open it.
- Use the **▲/▼ buttons** to display an alarm.

The alarm history provides the following information:

- Alarm type: LOW ALARM (significant count rate elevation), ALARM (absolute dose rate), DANGER (absolute dose rate), DOSE ALARM, DOSE DANGER.
- Alarm start date and time.
- Alarm duration.
- Minimum, maximum and mean dose rate during alarm.
- Cumulated dose during the alarm



Note:

Up to 400 alarms, 720 doses, 16 failures and 16 informations can be stored in the AccuRad memory. If the memory is full, the newest alarms replace the oldest.

5.5.2 Sending Alarm History Data to a Remote Monitoring Station

The operator can send an event report using the AccuRad App to a remote monitoring location.

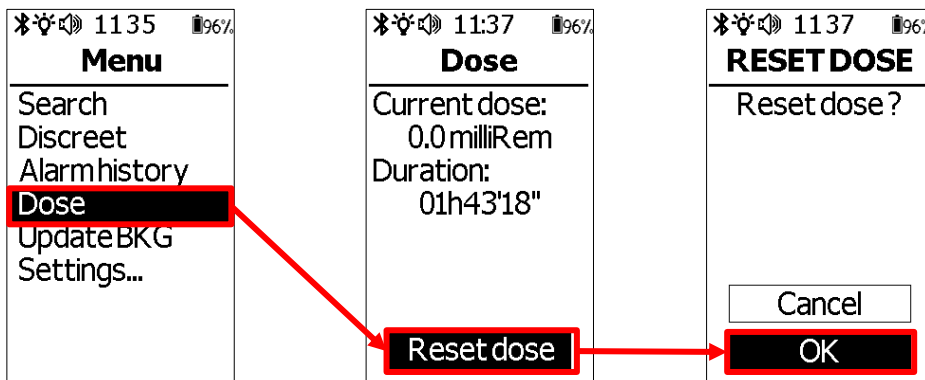
- The AccuRad App records the event data from the AccuRad PRD.
- The operator selects an event from history.
- The operator sends the event to a remote monitoring station using the AccuRad App. Smartphone location is added to AccuRad PRD measurements by the AccuRad App.

5.6 Dose

Dose mode gives the possibility to see the dose since the last startup of the AccuRad PRD or since the last dose reset (when the AccuRad PRD is all the time on or for a calibration).

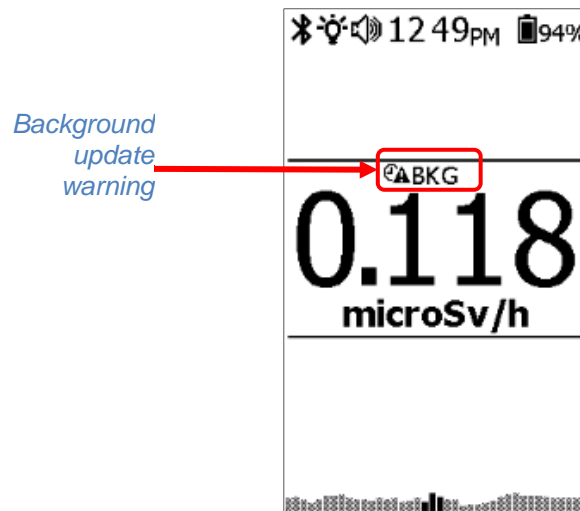
To reset the dose:

- Open the menu.
- Select **Dose**.
- Select **Reset dose**.
- Enter the PIN code.
- Select **OK**.



5.7 Update background (BKG)

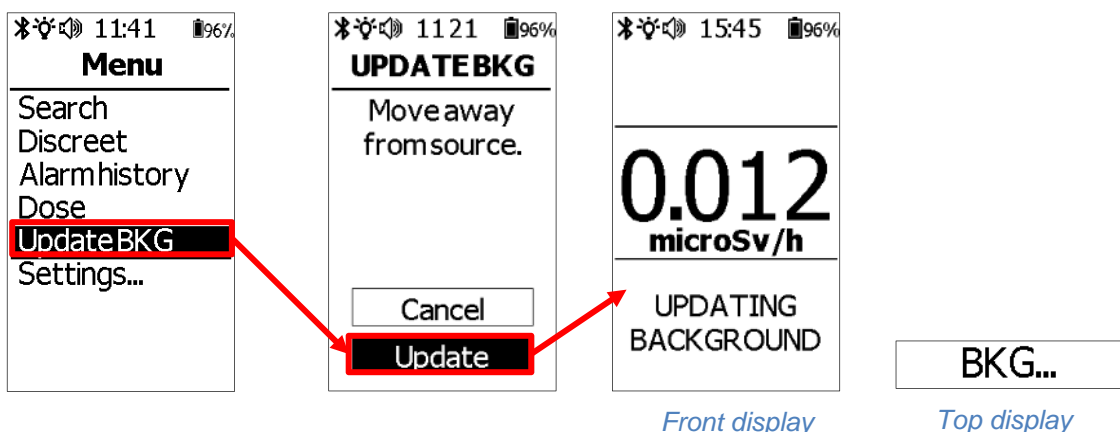
If the measured background has not been updated for more than two minutes without alarms, a background update warning is displayed.



This background update warning means that the background has evolved but not enough to trigger an alarm; the device still works but detection is not optimal and there is a growing risk of false alarms. In that case the operator should check if there is a source nearby; if there is no source then background must be manually updated.

In case of persistent low alarm in a known elevated background, updating the background will have the consequence to adapt the low alarm threshold to the current background. This situation is very unlikely to happen because the device constantly adjusts the background and the low alarm threshold; however it may be necessary to manually update the background value to low alarm accuracy (sigma).

- Open the menu.
- Select **Update BKG** and then **Update**. The background update starts immediately.



The AccuRad PRD is ready to be used when the background update is complete.



Note:

Neither the trend screen nor the radar screen can be used during background initialization, because those screens require the background value to operate.

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6. AccuRad PRD settings

The AccuRad PRD is delivered with a default set of parameters. These settings are stored in non-volatile memory. The settings of the AccuRad PRD can be edited:

- on the device itself,
- by the AccuRad Management Center PC software tool via an USB connection,
- or by the AccuRad App via Bluetooth.



Caution:

All alarms are disabled during the navigation in the menus of the device!

To access the Settings menu:

- Press the **○ Enter button** to open the menu.
- Press **▲/▼ buttons** to select **Settings**.
- Press the **○ Enter button** to open the **Settings** menu.



The **Settings Menu** consists of the following features/functions:

- **Display:** set the units, various behaviors and the language. For more information, refer to §6.1 *Display*.
- **Alarms:** set the alarm thresholds. For more information, refer to §6.2 *Alarms*.
- **Indicators:** set the visual and sound notifications, the vibrations of the discreet and search modes; and the volume of the headphones. For more information, refer to §6.3 *Indicators*.
- **Date/ Time:** check and adjust the AccuRad PRD date and time. For more information, refer to §6.4 *Date/Time*.
- **Bluetooth:** set the Bluetooth and the manual connection. For more information, refer to §6.5 *Bluetooth*.
- **Battery:** set the battery chemistry. Refer to paragraph §6.6 *Battery*.
- **Service....:** set the calibration date, the code PIN, perform a health test and manage the history. For more information, refer to §6.7 *Service*.
- **About:** get info about the AccuRad PRD. For more information, refer to §6.8 *About*.



Note:

Some settings can be protected by a PIN code.

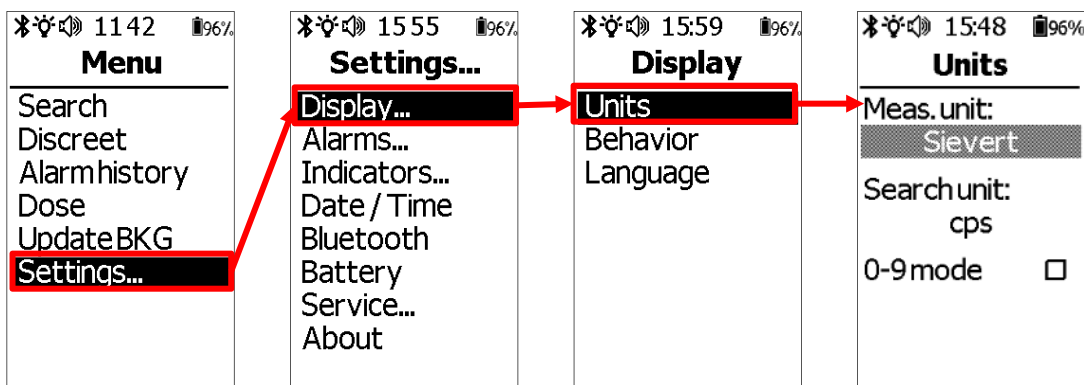
6.1 Display

6.1.1 Units

6.1.1.1 Setting up the Dose Rate or Count Rate Measurement Display

The **dose rate measurement display** shows the gamma dose rate or count rate of the detection. To set this type of display:

- Open the menu **Display**.
- In the **Units** menu, set the following items:
 - **Meas.unit**: select the measurement unit to be displayed on the device. Available choices are rem and Sievert.
 - **Search unit**: select the measurement unit to be displayed in Search mode. Available choices are cps or the selected measurement unit.
 - **0-9 mode**: check this option to switch to 0-9 Unitless measurement scale display. The 0-9 mode does not apply to Search mode.



A Trend display, which represents the current measured count in detection mode, can be added on the bottom of the front screen via the Trend option, in the Behavior settings. For more information, please refer to paragraph §6.1.2 *Behavior*.



6.1.1.2 Using the 0-9 Unitless Measurement Scale Display

The **0-9 Unitless Measurement Scale Display** corresponds to ten levels of radiation defined by default following this table (example of conversion values provided by default):

Unit-less value displayed	Equivalent exposure rate range (mRem/h)	Equivalent exposure rate range (μ Sv/h)	* Response Action
0	0 - 0.017	0 – 0.17	No response
1	0.017 - 0.028	0.17 – 0.28	Investigate
2	0.028 - 0.048	0.28 – 0.48	
3	0.048 - 0.087	0.48 – 0.87	
4	0.087 - 0.162	0.87 – 1.62	Evacuate & investigate
5	0.162 - 0.308	1.62 – 3.08	
6	0.308 - 0.590	3.08 – 5.90	
7	0.590 - 1.136	5.90 – 11.36	Evacuate
8	1.136 - 2.191	11.36 – 21.91	
9	2.191 – 1000 Rem/h	21.91 – 10 Sv/h	

* Response Actions are recommendations only and should not replace Standard Operating Procedures or CONOPS.



Note:

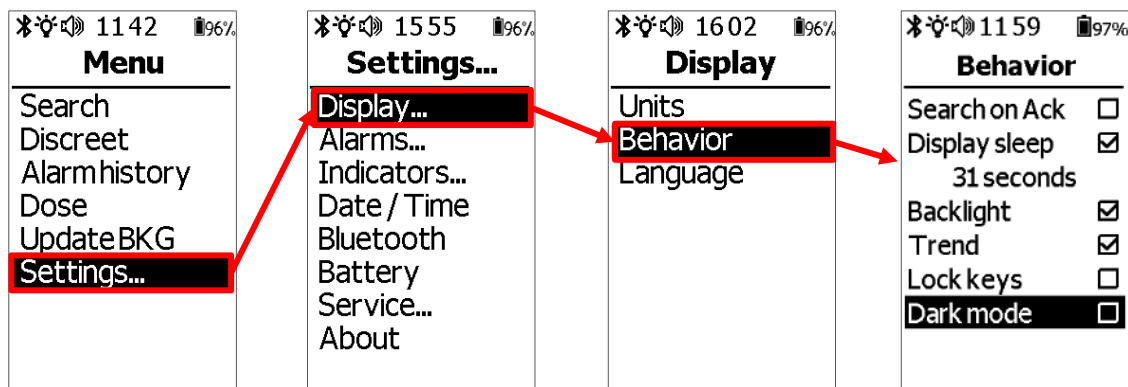
This table can not be directly edited on the device but only using the AccuRad Manager Center PC software tool or the smartphone app. The alarm levels can be selected on the device from 1 (transition from 0 to 1 trigger the alarm) to 9 (transition from 8 to 9).

For more information about the edition of the 0-9 levels in AccuRad Management Center, refer to §7.3.3.2 Settings overview.

6.1.2 Behavior

In the Behavior submenu, the operator can configure the automatic activation of the Search mode, Display sleep and Backlight of the screen device, in addition to the Trend display and Dark mode.

- Open the menu, select **Settings**, **Display**, and then **Behavior**.
- In the **Behavior** menu, set the following items:
 - **Search on Ack**: when enabled, the AccuRad PRD automatically switches to Search mode after the operator acknowledges a new alarm.
 - **Display sleep**: set the period after which the front display is turned off without operator action.
 - **Backlight**: when enabled, the front display backlight is automatically turned on.
 - **Trend**: in detection mode, enable/disable the display of a trend curve representing the current count. The trend curve is displayed at the bottom of the screen, in gamma measurement display.
 - **Lock keys**: enable key lock. When enabled, only the **on/off button** followed by two presses on the **◀ back** button awake the AccuRad PRD from standby (more information on §4.7 Standby / Wakeup the AccuRad PRD).
 - **Dark mode**: enable/disable dark mode. When dark mode is enabled, a dark theme is used on both displays.



Note:

If the Display sleep function is enabled, the front display automatically turns idle after 30 seconds of inactivity (editable default value, see §6.1.2 Behavior). However, in Search mode, this automatic display sleep delay cannot be lower than 120s, even if the display sleep function is set on a lower delay.

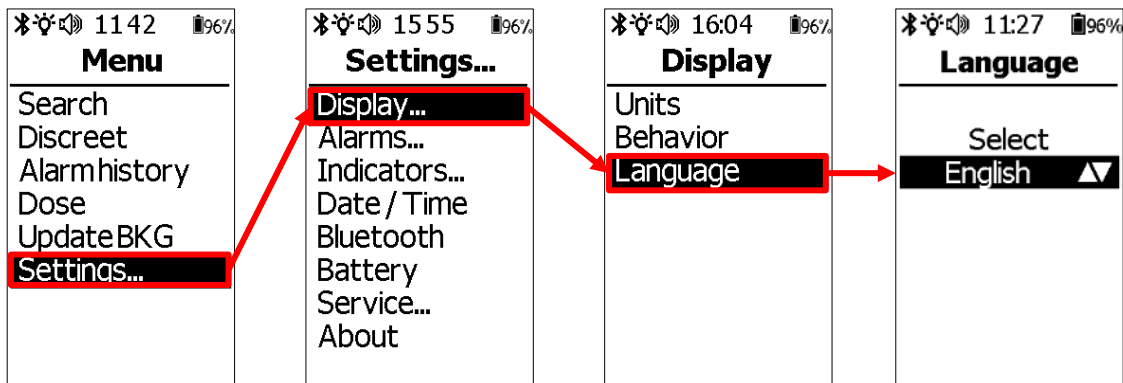


The device will not turn idle in alarm condition whereas the front display is active. However, it is still possible to manually turn it off by doing a short press on the **on/off button**.

6.1.3 Language

The Language submenu allows to select the desired language of the AccuRad PRD.

- Open the menu, select **Settings**, **Display**, and then **Language**.
- Press the **enter** button and enter the PIN code to edit this setting. The **▲▼** symbols are displayed.
- Use the **▲/▼** buttons to select a language, press the **enter** button to confirm. Available choices are English, French, Spanish, Chinese, Korean, Japanese, Polish, Arabic and German.



6.2 Alarms

Use the Alarms menu to set various alarm thresholds to warn the operator of a radiation level increase:

- **Low alarms** are triggered when a source, sufficient enough to generate a significant increase of the measurement above the background, is detected. It is a background relative threshold.
- **High alarms and Danger alarms** are alarms corresponding absolute dose rate used to inform the operator of a risk of personal dose rate exposure.
- **Dose alarm and dose danger** are alarms corresponding to levels of integrated dose to inform the operator about the level of dose integrated since the device was powered on. Dose alarm can be inhibited, danger alarm cannot because they are considered as personal protection alarms.



Note:

The dose is relevant only when the device is worn on the person.



Caution:

Thresholds are different in 0-9 Unitless Measurement Scale display and in Dose rate measurement display!

If the low range detector saturates, the AccuRad PRD automatically switches to the high range detector to measure the dose rates and protect the operator and the low range detector.

In Discreet mode, a dose alarm does not generate any sound or flashes of the LED but the vibrator remains enabled and cannot be disabled.

6.2.1 Alarms Thresholds for Dose Rate & Count Rate

There are three rate alarm thresholds:

- **Low Alarm:** Based on sigma threshold calculated using averaged count rate of the background and dose rate elevation. The VBS algorithm can inhibit some false alarms due to an ordinary background variation. A high background threshold can warn the operator in case of abnormal current background level.
- **High Alarm:** Absolute dose rate threshold, can be disabled.
- **Danger:** Absolute dose rate threshold. Personal protection alarm, cannot be disabled.

And two dose alarm thresholds, according to the dose integrated since the last startup of the device or to the last reboot of the dose:

- **Dose Alarm:** dose alarm, can be disabled.
- **Dose Danger:** absolute dose threshold. Personal protection alarm, cannot be disabled.

6.2.2 High background alarm

The AccuRad PRD continuously measures a background level which is used to calculate the low alarm threshold. If this measured background level becomes excessive, the AccuRad PRD emits a sound and indicates “High background”. The “High background” message is accompanied with a brief orange flash and a brief sound, both are repeated every minute. The message automatically disappears when the background level becomes lower than 30 $\mu\text{rem/h}$ (default value).

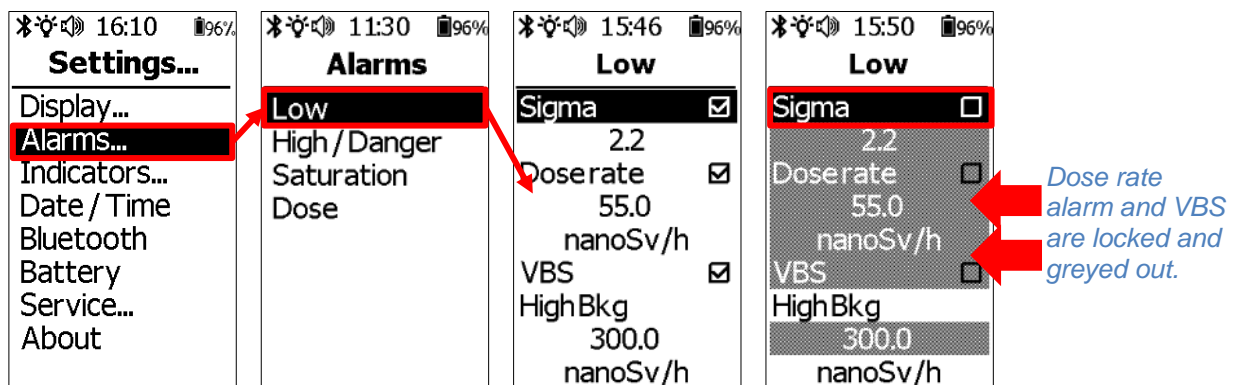
If this happens in a place where background is known as normal, this “High background” indication means that the AccuRad is probably close to a source. This can happen in case of very slowly approaching sources (typically less than 0.1 m/s) or very gradually increasing levels. In these conditions, take the same actions as for a “LOW ALARM”.

6.2.3 Low

This menu is used to enable and adjust the low alarm threshold.

- Open the **Settings** menu, select **Alarms**, then select **Low**.
- **Sigma**: threshold in number of standard deviations of the regular background level. Use a higher number to reduce the sensitivity and the false alarm rate. A value of 2.2 is recommended.
- **Dose rate**: used to limit the number of false alarms. If activated, low alarm is triggered only if the sigma threshold is reached and if the dose rate increase is higher than the set value. A value of 55 nSv/h is recommended.
- **VBS**: Varying Background Suppression inhibits low alarms due to sudden and normal variation of background noise radiation. For example, a sudden change can occur when the operator moves from a location with low background radiation, such as indoors, to another location with a higher background radiation levels, such as a city street or underground rail station. It is recommended to keep VBS enabled to avoid false alarms due to background variations.
- **High Bkg**: defines the high background alarm threshold. The default value is 300 nSv/h (0.30 μ rem/h). This value must be adjusted if the AccuRad PRD is used in an environment where background is naturally high.

When the sigma function (detection on relative variation of the measurement) is disabled, all the associated settings are no longer accessible and are greyed out.



CAUTION:



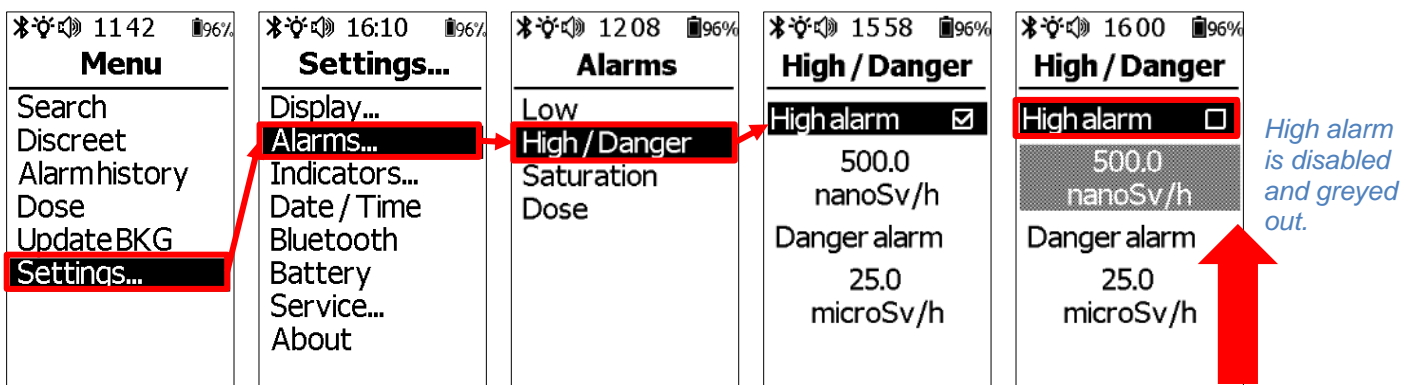
The device is delivered with a set of parameters adjusted to be compliant with the different standards. These parameters can be adjusted to cover the need of other applications, but this may compromise compliance to standards surrounding false alarm rates, time to alarm, and gradual changes to measurement.

6.2.4 High/Danger

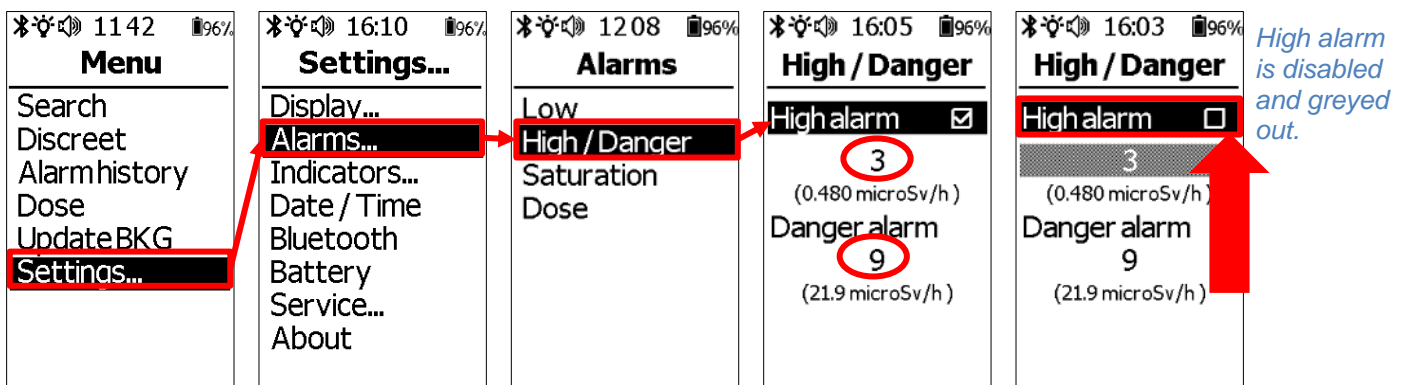
This menu is used to adjust the absolute dose rate High Alarm & Danger thresholds.

- Open the menu, select **Settings, Alarms**, and then **High/Danger**.
- In the **High/Danger** menu, set the following items:
 - **High alarm**: First level of absolute dose rate alarm. The unit can be set in dose rate unit only. This threshold can be disabled, in that case the line is greyed out.
 - **Danger alarm**: Second level of absolute dose rate alarm. The unit can be set in dose rate unit only.
The Danger threshold cannot be disabled; it is always higher than the High alarm threshold.

- Display of thresholds in dose rate units:



- Display with the 0-9 unitless measurement scale display:



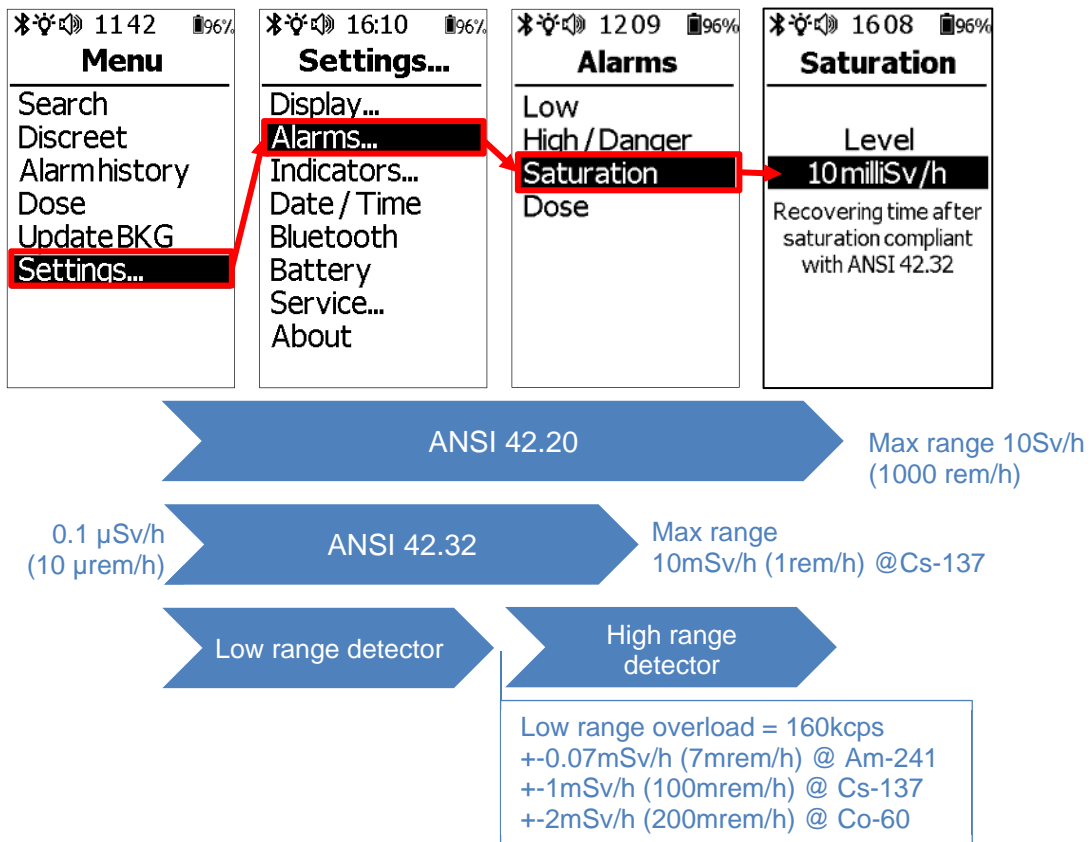
Note:

In 0-9 unitless measurement scale display, the alarm level is set, at least, to the closest value of the threshold defined in dose rate.

6.2.5 Saturation

This menu is used to set the device saturation level.

- Open the menu **Alarms / Saturation**.



If the saturation level is set to 10 mSv/h (1 Rem/h), and if the dose equivalent rate exceeds this value, the device continues to measure and integrate the dose up to the max range, but the display will be locked to 10 mSv/h, as required by ANSI N42.32.

If the device is exposed to a dose rate superior to 10 mSv/h, the background recovering time may be longer than 1 minute. In that case the AccuRad PRD may display the message **Low Range Overload**. During the display of this message the device keeps measuring using the high range detector. The device recovers automatically, and the message disappears once the measurement is stabilized.

Note:



- Turning off the device during the recovery period will not speed up the recovery.
- During the recovery period, the detection threshold is inhibited and the displayed dose rate comes from the high range detector. The device accuracy and response time are not ensured during this period. The detector cooldown period depends on the exposed dose rate ; it may last for a few seconds to several minutes.

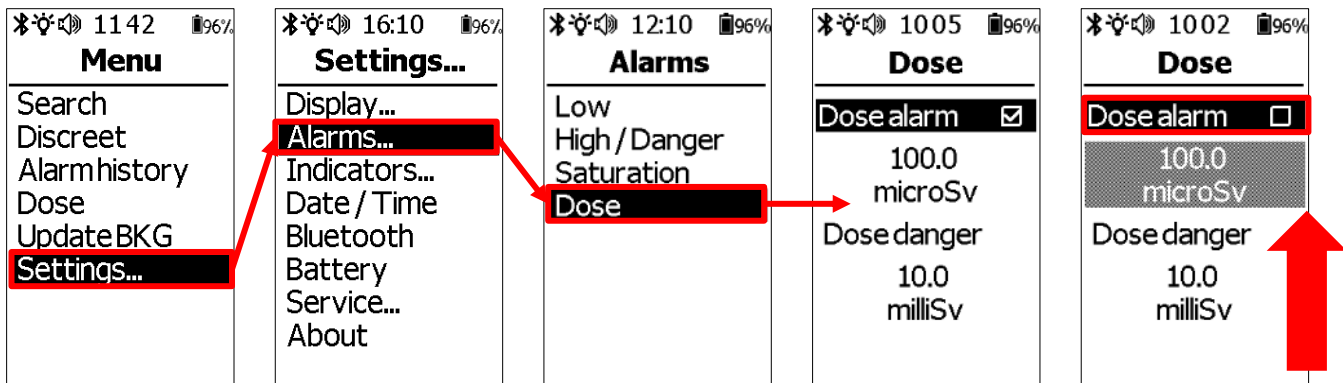
If the saturation level is set to 10 Sv/h (1000 rem/h), if the device is exposed to a dose rate superior to 10 Sv/h, the measurement is locked to 10 Sv/h.

6.2.6 Dose

This menu is used to adjust the dose alarm and the dose danger thresholds.

- Open the menu **Alarms / Dose**.
- In the **Dose** menu, set the following items:
 - **Dose alarm**: first level of dose alarm. The unit can be set in dose unit only. This threshold can be disabled, in that case the line is greyed out.
 - **Dose danger**: second level of dose alarm. The unit can be set in dose unit only. The Danger threshold cannot be disabled; it is always higher than the alarm threshold.

When the dose alarm and dose danger thresholds are reached, alarms are triggered.



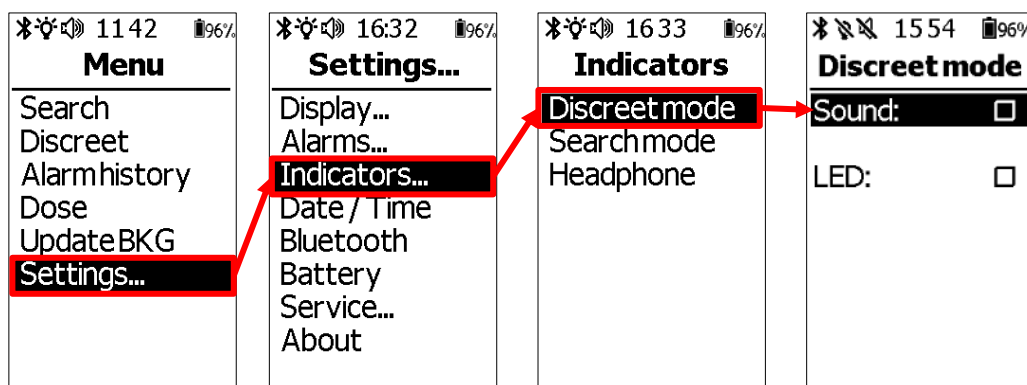
High alarm is disabled and greyed out.

6.3 Indicators

This menu is used to set the visual and sound notifications, the vibrations of the discreet and search modes, and the volume of the headphones.

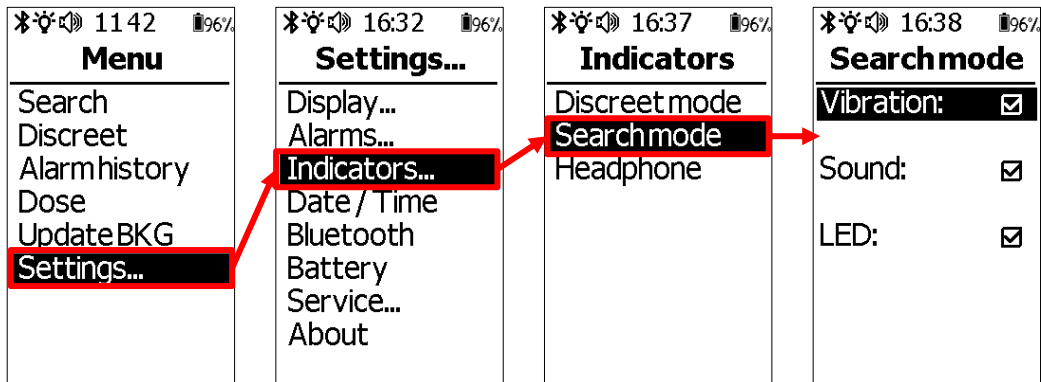
6.3.1 Discreet mode

- Open **Settings, Indicators, Discreet Mode** and set the following:
 - **Sound** (disabled by default): enable/disable all the sounds (alarm, chirp, and notifications) when the discreet mode is enabled.
 - **LED** (disabled by default): enable/disable all the blinks of the alarm LED indicator (alarm, chirp, and notifications) when the discreet mode is enabled.



6.3.2 Search Mode

- Open **Settings**, **Indicators**, **Search Mode** and set the following:
 - **Vibration** (recommended): enable/disable vibration which will vibrate in the rhythm of the count rate in search mode.
 - **Sound** (recommended): enable/disable the AccuRad PRD to generate the chirp sound in search mode and in alarm.
 - **LED** (recommended): enable/disable the alarm LED indicator in search mode. If enabled, the alarm LED indicator flashes to the rhythm of the measured count rate in Search mode.



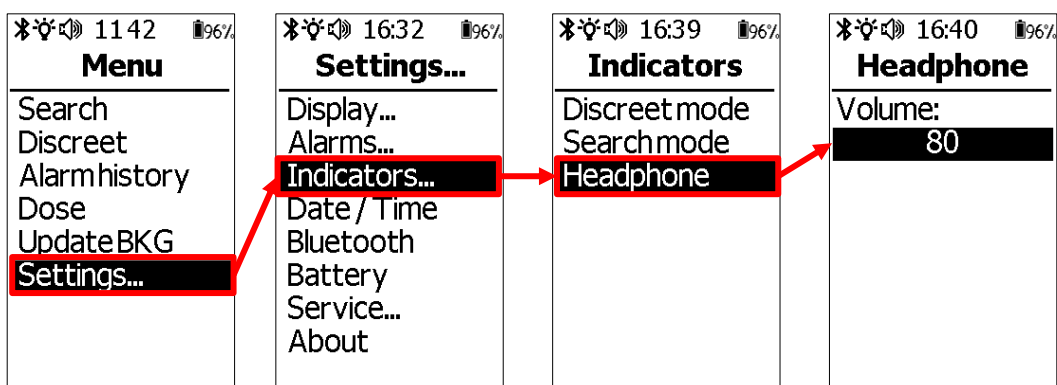
6.3.3 Headphone

- Open **Settings**, **Indicators**, **Headphone** and configure the following:
 - **Volume**: controls the volume of the headphone/earphone. The volume can also be controlled using the integrated control buttons (if available). The chirp is enabled when this menu is activated for adjusting the headphone volume.



Note:

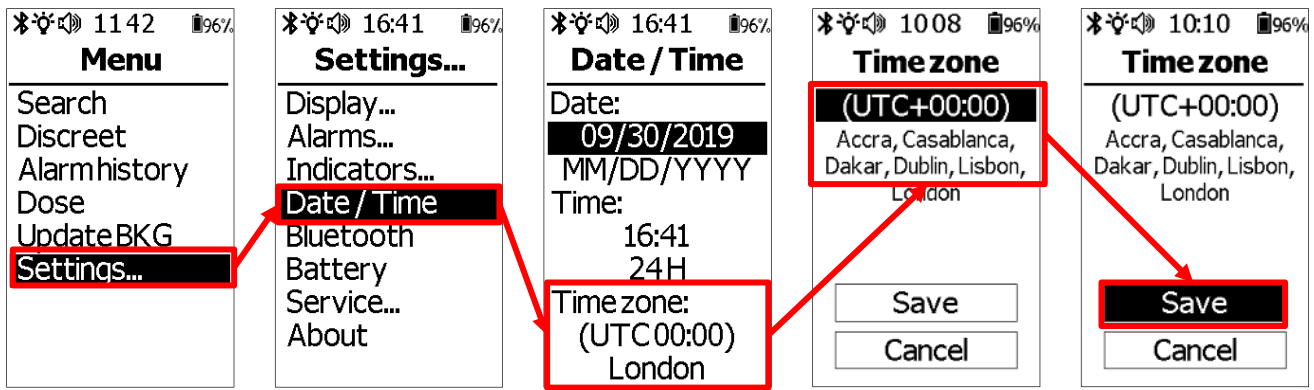
In order to ensure the sound level required by various standards, the internal loudspeaker volume can not be adjusted in the menus.



6.4 Date/Time

This menu is used to check and adjust the AccuRad PRD date and time.

- Open the menu, select **Date/Time** and set the following items:
- **Date:**
 - **Date:** press the **▲/▼ arrow buttons** and the **○ enter button** to select the date. Modify the year, month and day.
 - **Format:** press the **▲/▼ arrow buttons** and the **○ enter button** to select the format.
- **Time:**
 - **Hour, Min:** press the **▲/▼ buttons** and the **○ enter button** to select the time.
 - **Format AM/PM:** press the **▲/▼ buttons** and the **○ enter button** to select the format.
 - **Time zone:** press the **▲/▼ buttons** and the **○ enter button** to select the time zone. Select the value and **Save** the selection.



Note:

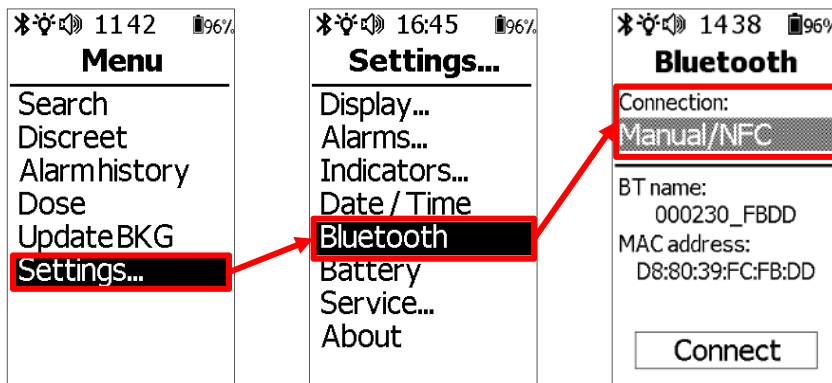
The internal clock of the AccuRad PRD remains active during at least one month if the AccuRad PRD is stored without batteries. After one month, the AccuRad PRD will ask to set the date and time at the next startup.

6.5 Bluetooth

This option is used to manage Bluetooth connection, for instance to pair the AccuRad PRD to a Smartphone without using NFC. Bluetooth can also be disabled here to forbid any connection.

AccuRad PRD uses Bluetooth 4.2 protocol; communication is encrypted using the AES 128 cryptography engine. Bluetooth connectivity helps the application to access to all measurements and settings of the AccuRad PRD.

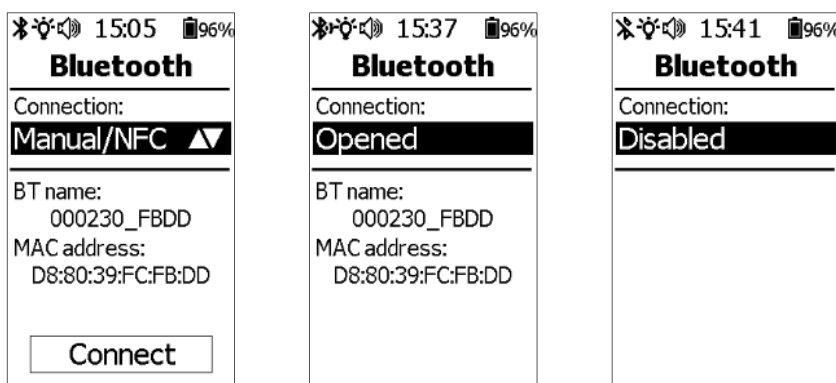
To access Bluetooth parameters, open **Settings** and then **Bluetooth**. On the screen, the Bluetooth connection, name and the MAC address are indicated.



6.5.1 About Bluetooth connection modes

On the **Bluetooth** menu, press the **enter** button and then press the **▲/▼** buttons to select the type of Bluetooth connection. There are three types of Bluetooth connections:

- **Manual/NFC:** in this mode, the AccuRad PRD can be manually connected via Bluetooth by pressing the Connect button, or via NFC for more convenience. For more information, refer to paragraph §6.5.2 *Using the Manual/NFC connection mode*.
- **Opened:** in this mode, the Bluetooth connection is always on, so the app can reconnect to the AccuRad PRD without user action, from startup to shut down; however the autonomy of the AccuRad PRD is limited in this mode. For more information, refer to paragraph §6.5.3 *Using the Opened connection mode*.
- **Disabled:** in this mode, the Bluetooth connection is disabled, hence the AccuRad PRD is neither detectable nor connectable. When Bluetooth is disabled, no pairing is possible, even with NFC. For more information, refer to paragraph §6.5.5 *Using Disabled mode*.

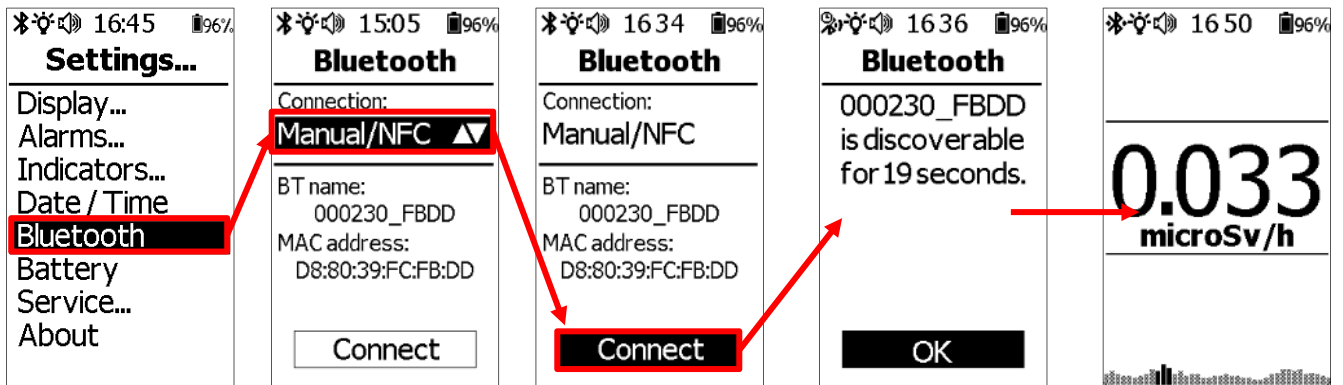


6.5.2 Using the Manual/NFC connection mode

This mode is recommended to ease Bluetooth connection and optimize the battery life or for cybersecurity reasons, manual action or very close NFC communications being required to set the connection with the device.

- Open **Settings, Bluetooth**.
- Press the **○ enter button** and then the **▲/▼ arrow buttons** to select **Manual/NFC**, then press the **○ enter button** to confirm.
- Select **Connect**: the AccuRad PRD is available for 30 seconds and can be connected to the smartphone via NFC; the Bluetooth icon turns **📶**. When a device is connected, the Bluetooth icon turns **📶**.

If NFC is not available on the Smartphone, the operator can use this command to perform a manual connection via Bluetooth. After 30 seconds, the Bluetooth is not discoverable.



Note :


When the connection is lost (device out of range, RF cluttered area), the device keeps the Bluetooth connection open (with the **📶** icon displayed) for 60 seconds to give the time to the smartphone app to recover the connection. After this delay, the device shuts down the Bluetooth connection to save the batteries and manual or NFC pairing are required to make a new connection. This delay does not exist if the connection is closed by a voluntary action on the smartphone.

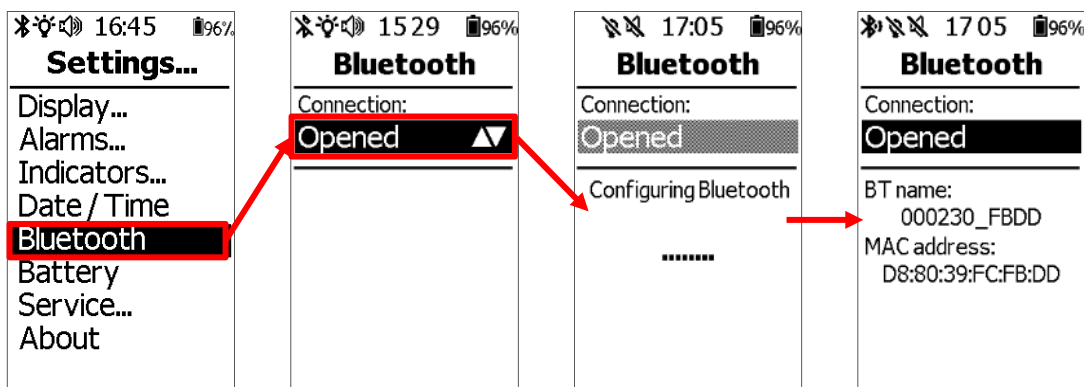


6.5.3 Using the Opened connection mode

In this mode, the smartphone can be reconnected at any time to the AccuRad PRD with which it was connected the last time, so the user does not have to worry about pairing the AccuRad PRD to the smartphone after turning it on. Note that the smartphone must be turned on too, the AccuRad PRD device must be the last paired one, and the connection must not have been manually shut.

The connection mode is also useful if the AccuRad PRD and the smartphone are out of range for one minute during regular use.

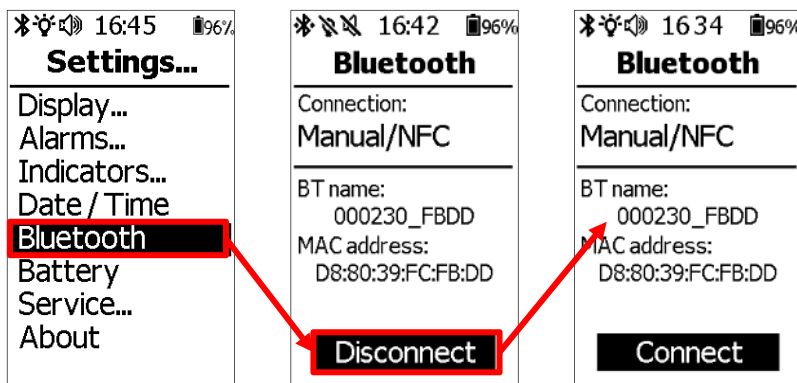
- Open **Settings, Bluetooth**.
- Press the **○ enter button**, enter the PIN code and then use the **▲/▼** buttons to select **Opened**, then press the **○ enter button** to confirm.
- Wait for Bluetooth configuration.
- When done, the BT name and MAC address are displayed; the Bluetooth icon turns to .



6.5.4 Disconnect a Bluetooth connected device

Use this function to force disconnection with the smartphone.

- Open **Settings, Bluetooth**.
- Select **Disconnect** to disconnect the AccuRad PRD.




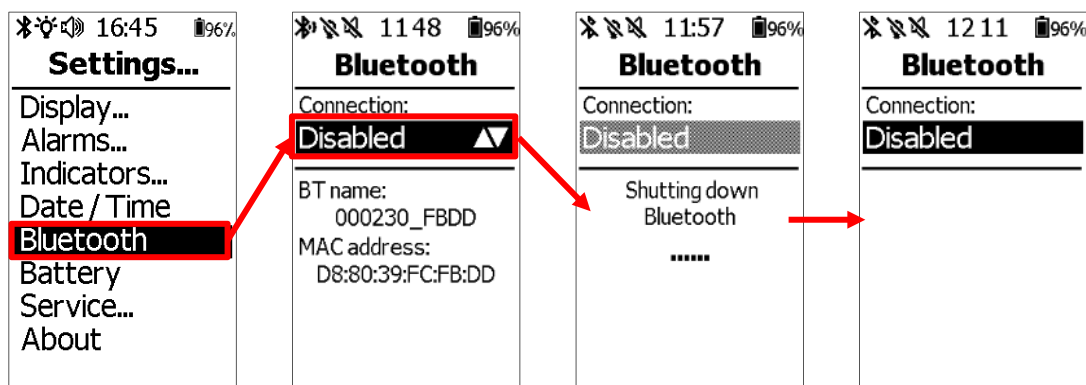
Note :

Bluetooth disconnection can also be performed on the smartphone via the AccuRad App.

6.5.5 Using Disabled mode

Use this mode to disable Bluetooth on the AccuRad PRD, so any connection is made impossible.

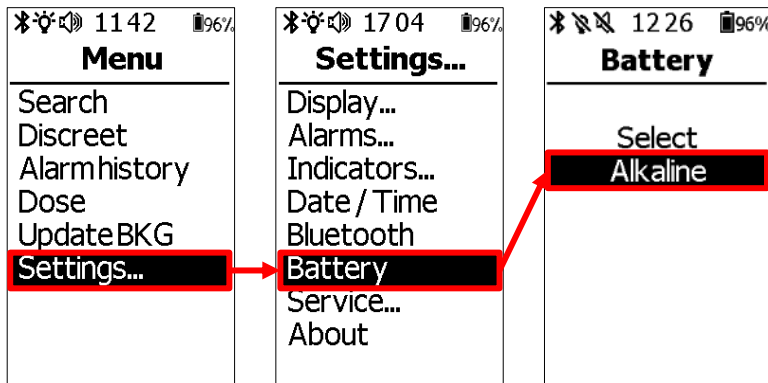
- Open **Settings, Bluetooth**: on the screen, the Bluetooth name and the MAC Address are indicated.
- Press the **enter button**, enter the PIN code and then use the **▲/▼** buttons to select **Disabled**, then press the **enter button** to confirm.
- Wait for Bluetooth shutdown.
- When done, Bluetooth is disabled, and the Bluetooth icon changes to . In Disabled mode, all Bluetooth connection are disabled, hence the AccuRad PRD is neither detectable nor connectable. When Bluetooth is disabled, no pairing is possible, even with NFC.



6.6 Battery

Change the type of battery to adapt the battery gauge with the battery chemistry.

- Open **Settings** and select **Battery**.
- Select the type of battery in the AccuRad. Available choices are Alkaline, Lithium and NiMH.



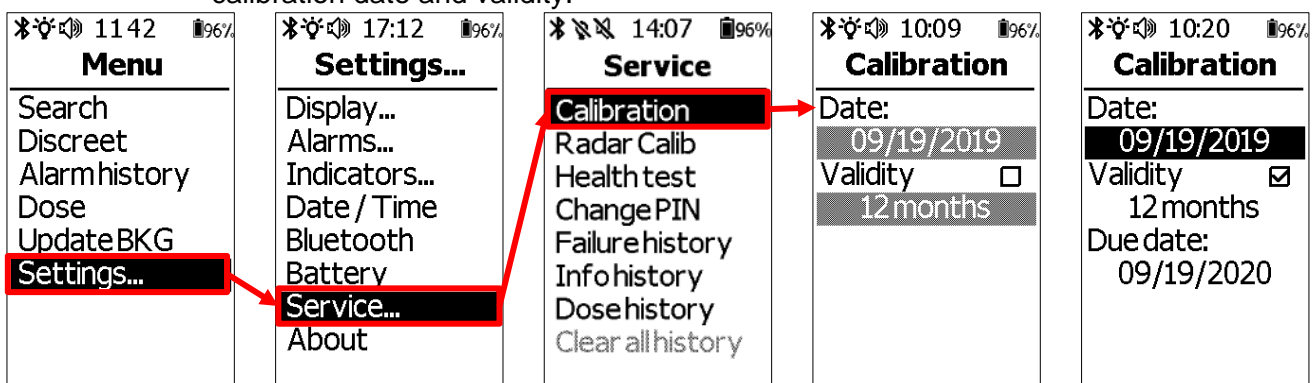
6.7 Service

6.7.1 Calibration

View and edit the calibration service date, validity period and if the validity is still good.

The calibration is performed with a high range calibrator/irradiator. For more information about calibration the AccuRad PRD, refer to § 7.3.4.2.1.

- Open **Settings, Service, Calibration**.
- In the Calibration menu, set the following items:
 - **Date:** Set the calibration date.
 - **Validity:** Set the calibration validity duration (from one to twelve months).
 - **Due date:** Appears if the Validity option has been checked. Date of the next calibration. The due date cannot be edited manually and is automatically according to calibration date and validity.



Note:

The calibration date settings should only be modified at the time of calibration and in accordance with procedures and/or CONOPS.

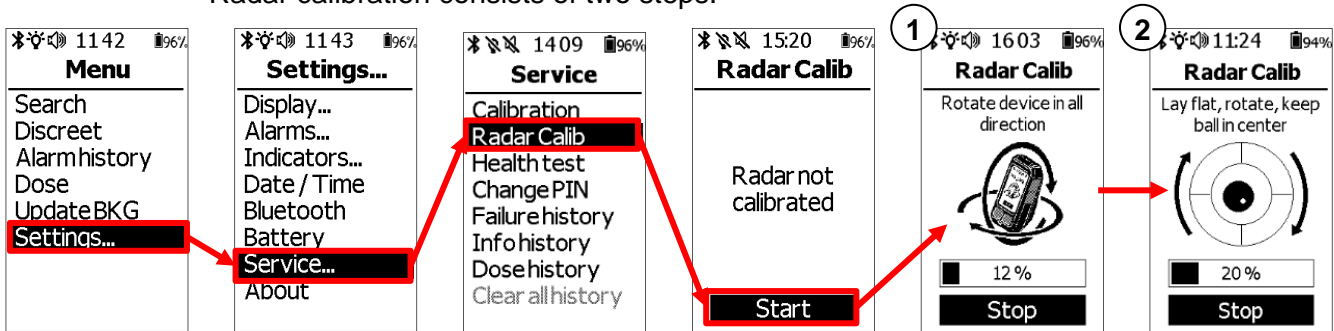
6.7.2 Perform radar calibration



Note:

Before starting the radar calibration, be sure to be in a magnetic free environment. Best accuracy will be reached outdoor far away from heavy iron parts and magnets.

- Open the menu, select **Service...**, select **Radar Calib** and then **Start**. Radar calibration consists of two steps:



- Step 1:** Slowly rotate the AccuRad PRD on each of the rotation axes (X, Y and Z) until the progress bar is filled. When done, the AccuRad PRD will vibrate. If this step fails (progress bar depleted), make sure that you are in a magnetic-free environment, then repeat step 1.



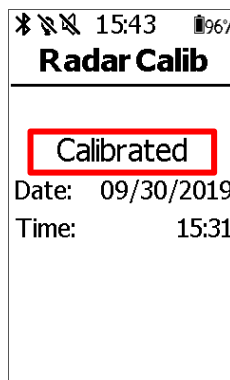
- Step 2:** Place the AccuRad PRD on a magnetic-free flat surface (a table for instance) and rotate it clockwise/anticlockwise until the progress bar is filled. Progression will perform only if the ball remains in the center circle during the horizontal plane calibration. When done, the AccuRad PRD will emit a sound.



Note:

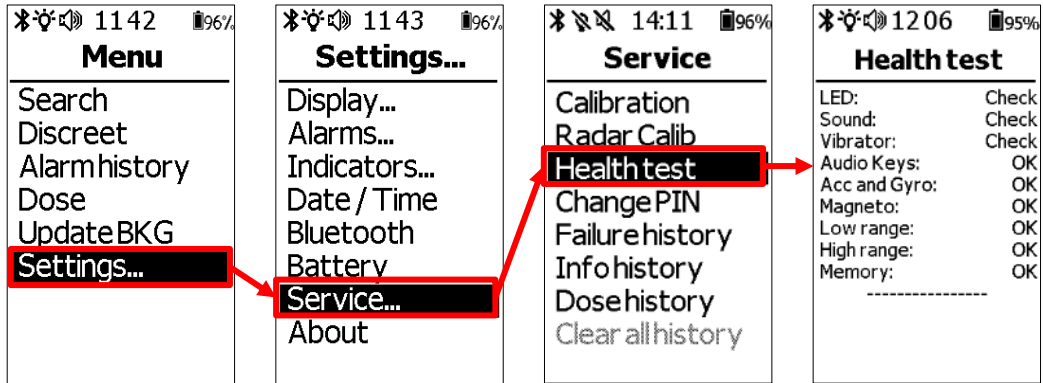
At any time, you can stop the calibration by selecting the Stop button.

- When the calibration is complete, the AccuRad PRD will display the “**Calibrated**” message.



6.7.3 Health test

The device will restart the same sequence as for the AccuRad initialization.
 During the test, the LEDs, sound and vibrator should be checked by the user.
 For more details, please refer to §4.3 Start the AccuRad PRD.



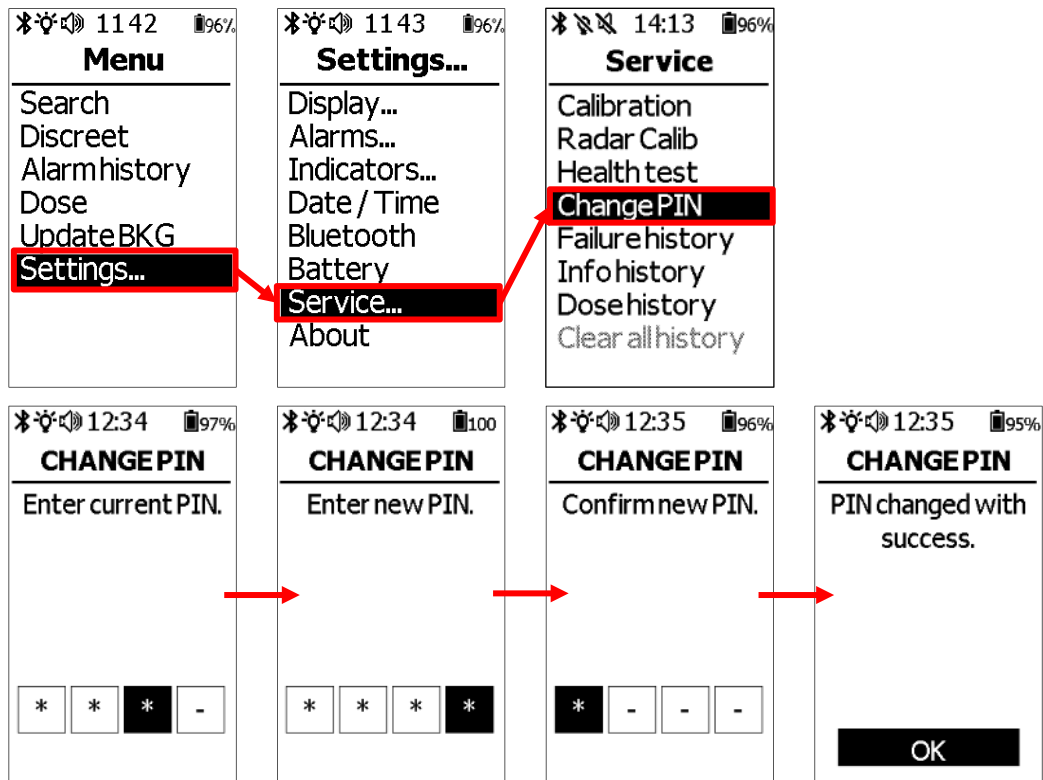
Note :
 If any of the Health Test items show FAIL, refer to paragraph §8.2 Troubleshooting or contact your Mirion Technologies representative.

6.7.4 Change PIN

The PIN code is used to protect all the critical settings and features of the AccuRad PRD that are greyed. A programmed PIN code is required to change the PIN code.

- Open **Settings, Service, Change PIN**.
- Enter the current PIN code.
- The **Enter New PIN** window appears:
 - Press the **enter button** to select the field
 - Use the **▲/▼ arrow buttons** to increase or decrease the number in the field
 - Press the **enter button** to validate each field.
- Confirm the new PIN code when prompted.

If the PIN code is correct, the modification is complete. A message will appear for an incorrectly entered PIN code, try again.



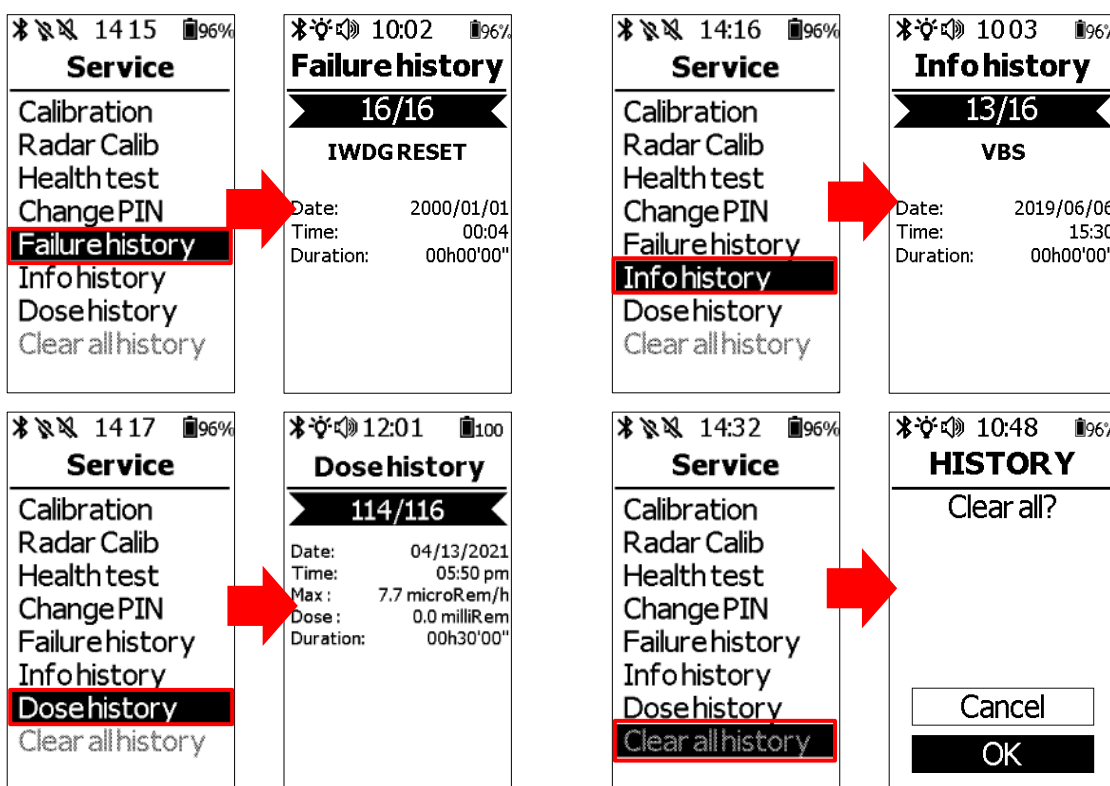
Note:

Note the PIN code it on a separate piece of paper.
The PIN code cannot be changed if lost!

6.7.5 Failure, Info, Dose and Clear all History

View and erase the failure and info history data.

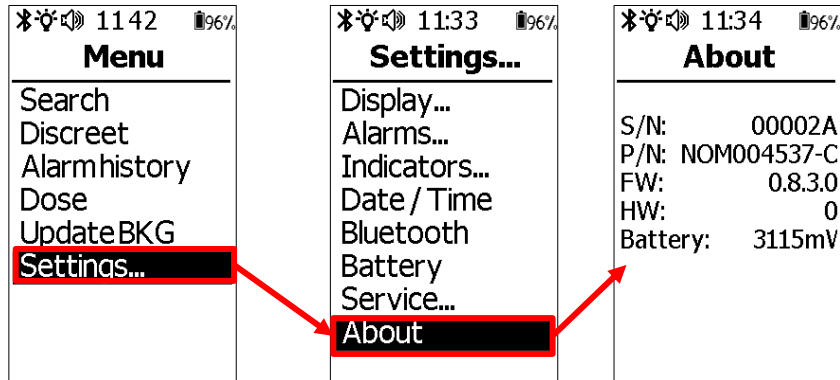
- **Failure history:** the operator can review the list of AccuRad PRD failures. For more information, refer to §8.2 *Troubleshooting*.
- **Info history:** the operator can review historical events such as high background.
- **Dose history:** the operator can review dose events. The displayed date and time correspond to the date and hour of recording after the integration duration, max corresponds to the highest dose rate measured during the duration of the recording, dose is the average measured dose for the duration of the recording. For more information, refer to paragraph §10.2.3 *Example of use of dose history and alarm history*.
- **Clear all history:** allows to erase all the histories, alarms, failures, info and doses. Access restricted by a PIN code.



6.8 About

This menu displays miscellaneous device information:

- Serial number
- Part number
- Firmware version
- Hardware version
- Battery voltage (not available if connected on USB)



7. AccuRad Management Center

The AccuRad Management Center is the companion program for the AccuRad PRD. It requires a PC with Windows 10 64-bit or more recent.

It communicates with one or several AccuRad PRD via USB.

Use the AccuRad Management Center to:

- Review the last alarms
- Review the history of the device (alarms, dose history)
- Setup Reachback functions (sending data via SMS, email, RadResponder)
- Update the AccuRad PRD firmware. Note that the AccuRad Management Center cannot install older firmwares, only the latest.



Note:

An administrator profile is required to install the AccuRad Management Center.

7.1 Compatibility

The AccuRad Management Center is compatible with AccuRad PRD devices with the same version number. For instance:

- if the AccuRad Management Center version is V1.3, then it is compatible with the AccuRad devices with a V1.3 firmware version (or older); however it is not compatible with V1.4 (or more recent) AccuRads devices.
- If the AccuRad Management Center version is V1.4 and the Accurad device version is V1.3 or older, the AccuRad Management Center will suggest to update the device firmware to V1.4.

To ensure proper compatibility, make sure the AccuRad Management Center version number matches the AccuRad PRD device version number.

If necessary, contact your Mirion representative.

7.2 Launching the AccuRad Management Center

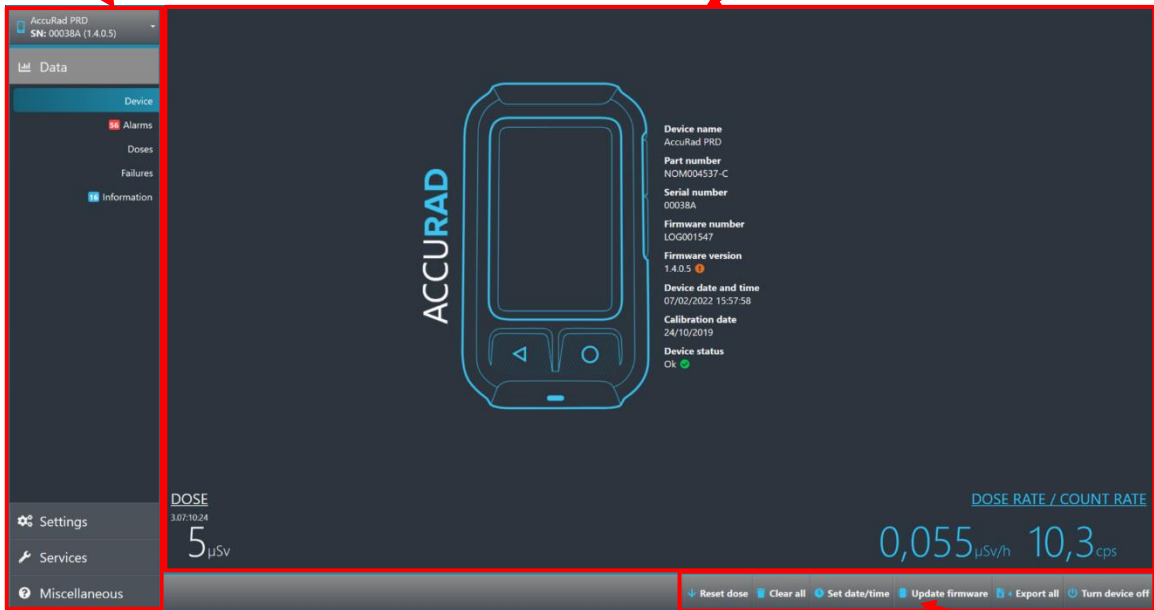
On the Windows desktop, double-click on the AccuRad Management Center icon to launch the program:



7.3 AccuRad Management Center overview

Main tabs

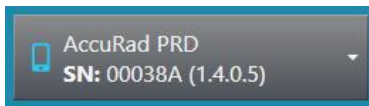
Viewing area



Viewing area buttons

7.3.1 Device

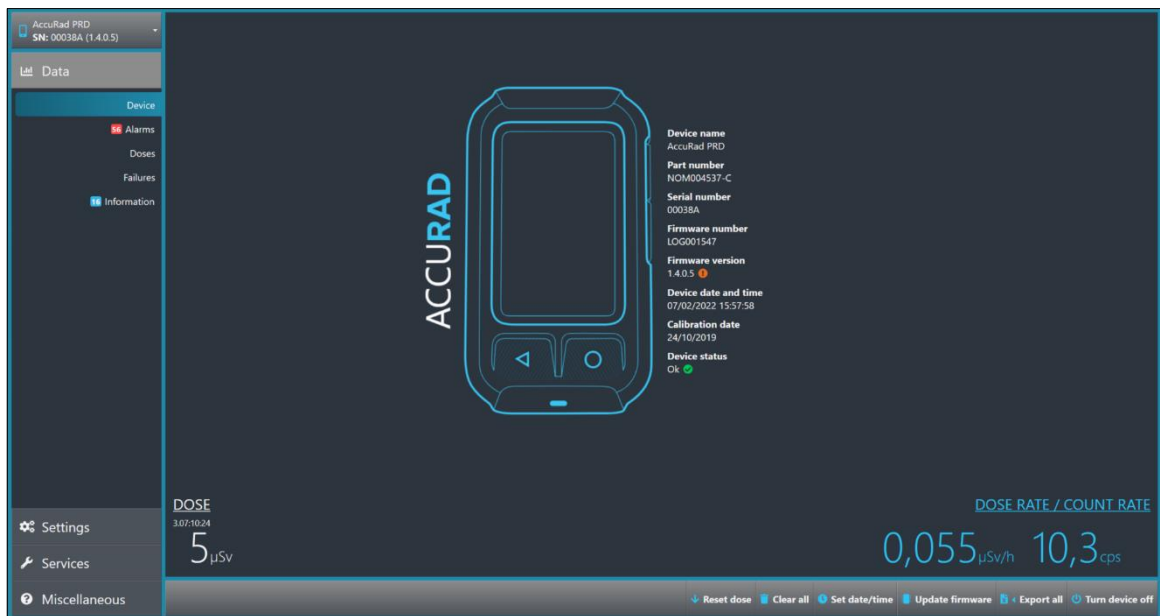
Click on the Device tab to select an AccuRad PRD to set. Any AccuRad PRD connected to the PC with a USB cable is listed here.



7.3.2 Data

7.3.2.1 Device

The Device subtab provides various info about the selected device: name, part number, serial number, firmware version, device date and time and calibration date. It also shows the dose rate and count rate currently measured by the AccuRad PRD.



The following buttons are available here:

- **Reset dose:** reset the device measured dose
- **Clear all:** clear all data from the AccuRad PRD
- **Set date/time:** set the device date and time to match the date / time used on the PC
- **Update firmware:** update AccuRad firmware. Available only if the AccuRad Management Center detects that the connected device has an older firmware than the one included with the AccuRad Management Center
- **Export all:** export all history
- **Turn device off:** turn off the device

7.3.2.2 Alarms

The Alarms subtab shows the alarm history stored in the AccuRad PRD.

Device: AccuRad PRD SN: 000017 (1.4.0.0)		Ack.	Type	Date	Duration	Min. dose rate (μ Sv/h)	Mean dose rate (μ Sv/h)	Max. dose rate (μ Sv/h)	Dose (mSv)
			High alarm	20/04/2021 15:57:06		--	--	--	--
			High alarm	20/04/2021 15:56:58	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:56:35	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:56:11	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:55:48	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:55:25	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:55:01	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:54:38	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:54:15	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:53:52	00:00:08	0,436	0,885	1,159	0,000
			High alarm	20/04/2021 15:53:28	00:00:08	0,436	0,886	1,162	0,000
			High alarm	20/04/2021 15:53:05	00:00:08	0,433	0,865	1,127	0,000
			High alarm	20/04/2021 15:52:01	00:00:53	0,411	0,693	0,990	0,000
			High alarm	20/04/2021 14:54:17	00:00:18	0,210	0,686	0,827	0,000
			High alarm	20/04/2021 14:49:54	00:00:18	0,210	0,685	0,817	0,000
			High alarm	20/04/2021 14:49:32		--	--	--	--
			High alarm	20/04/2021 14:46:52	00:00:18	0,386	0,682	0,757	0,000

The following buttons are available here:

- **Refresh:** update the alarm history
- **Acknowledge all:** acknowledge all the alarms that require acknowledgment
- **Export:** export alarm history as .n42 or .xlsx files
- **Clear all:** clear alarm history from the AccuRad PRD.

7.3.2.3 Doses

The Doses subtab shows the dose history stored in the AccuRad.

Device: AccuRad PRD SN: 000017 (1.4.0.0)	Start date	End date	Duration	Max. dose rate (µSv/h)	Mean dose rate (µSv/h)	Dose (mSv)
	26/04/2021 11:51:03	26/04/2021 12:21:03	00:30:00	0,068	0,054	0,000
Data	26/04/2021 11:21:03	26/04/2021 11:51:03	00:30:00	0,082	0,054	0,000
	26/04/2021 10:45:42	26/04/2021 11:15:43	00:30:00	0,075	0,054	0,000
Device	26/04/2021 10:15:42	26/04/2021 10:45:42	00:30:00	0,099	0,054	0,000
Alarms	26/04/2021 09:45:42	26/04/2021 10:15:42	00:30:00	0,068	0,054	0,000
Doses	26/04/2021 09:15:42	26/04/2021 09:45:42	00:30:00	0,071	0,054	0,000
Failures	26/04/2021 08:45:41	26/04/2021 09:15:41	00:30:00	0,068	0,053	0,000
Information	26/04/2021 08:15:41	26/04/2021 08:45:41	00:30:00	0,078	0,053	0,000
	21/04/2021 10:01:08	21/04/2021 10:04:41	00:03:33	0,058	0,049	0,000
	20/04/2021 18:06:55	20/04/2021 18:36:55	00:30:00	0,074	0,053	0,000
	20/04/2021 17:36:55	20/04/2021 18:06:55	00:30:00	0,070	0,054	0,000
	20/04/2021 17:06:54	20/04/2021 17:36:54	00:30:00	0,068	0,053	0,000
	20/04/2021 16:36:54	20/04/2021 17:06:54	00:30:00	0,064	0,052	0,000
	20/04/2021 14:54:33	20/04/2021 15:24:34	00:30:00	0,827	NaN	0,000
Settings	20/04/2021 13:19:43	20/04/2021 13:49:43	00:30:00	0,205	0,081	0,000
	20/04/2021 12:11:18	20/04/2021 12:41:18	00:30:00	0,000	NaN	0,000
Services	20/04/2021 11:41:18	20/04/2021 12:11:18	00:30:00	0,000	NaN	0,000
Miscellaneous	20/04/2021 11:11:17	20/04/2021 11:41:17	00:30:00	0,000	NaN	0,000

The following buttons are available here:

- **Refresh:** update the dose history
- **Export:** export dose history as .xlsx files
- **Clear all:** clear dose history from the AccuRad PRD

7.3.2.4 Failures

The Failures subtab shows the failure history stored in the AccuRad PRD. Each failure type is identified by a pictogram.

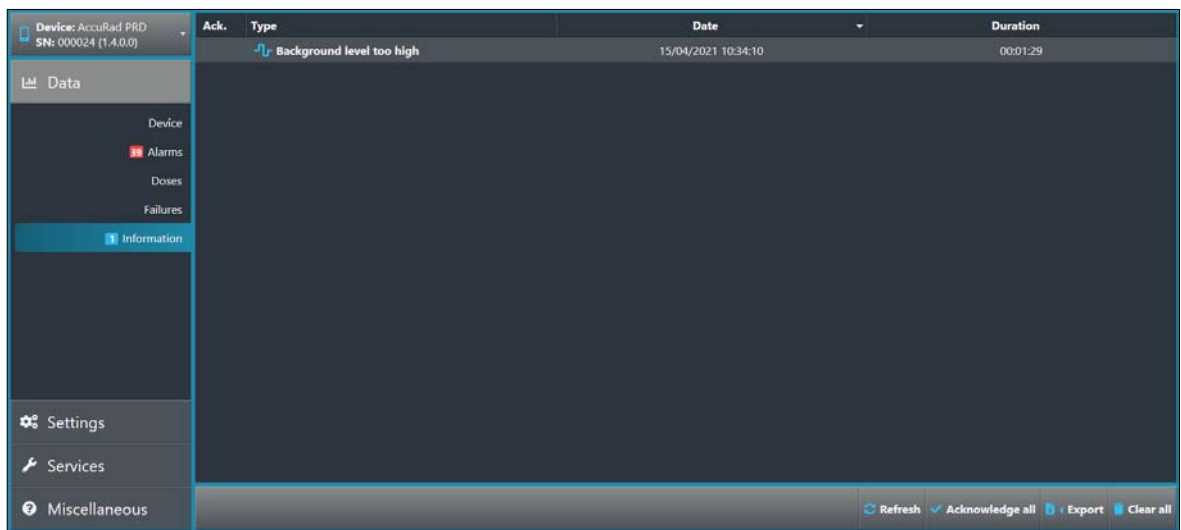
Ack.	Type	Date	Duration
	Polarization failure	15/04/2021 10:46:11	00:00:11

The following buttons are available here:

- **Refresh**: update the failures history
- **Acknowledge all**: acknowledge all the failures that require acknowledgment
- **Export**: export failure history as .xlsx files
- **Clear all**: clear failure history from the AccuRad PRD.

7.3.2.5 Information

The Information subtab shows the information history stored in the AccuRad PRD. Each information type is identified by a pictogram.



The following buttons are available here:

- **Refresh**: update the information history
- **Acknowledge all**: acknowledge all the info that require acknowledgment
- **Export**: export info history as .xlsx files
- **Clear all**: clear info history from the AccuRad PRD

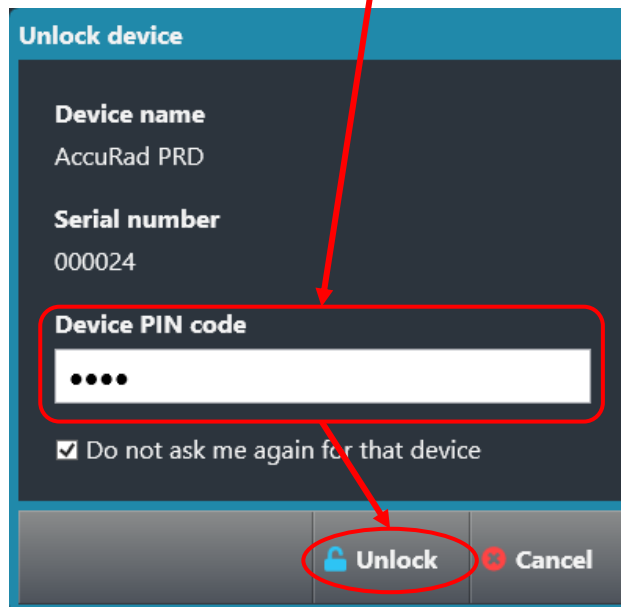
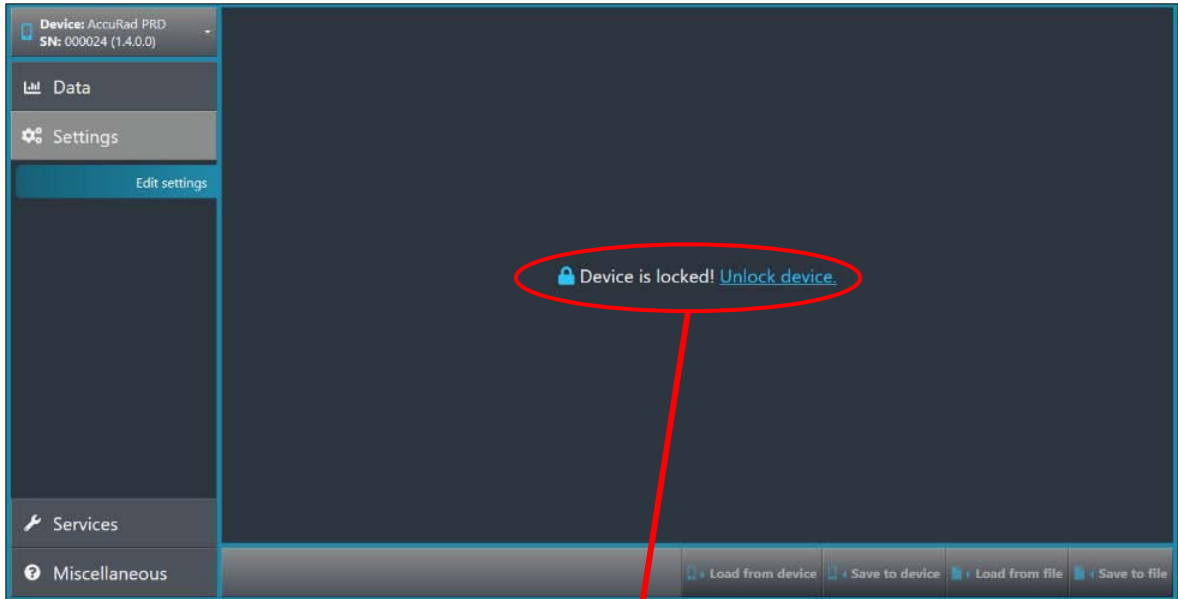
7.3.3 Settings

Use the Settings tab to easily edit the AccuRad PRD settings, create a settings file to update the settings of various devices.

7.3.3.1 Unlocking the AccuRad PRD device

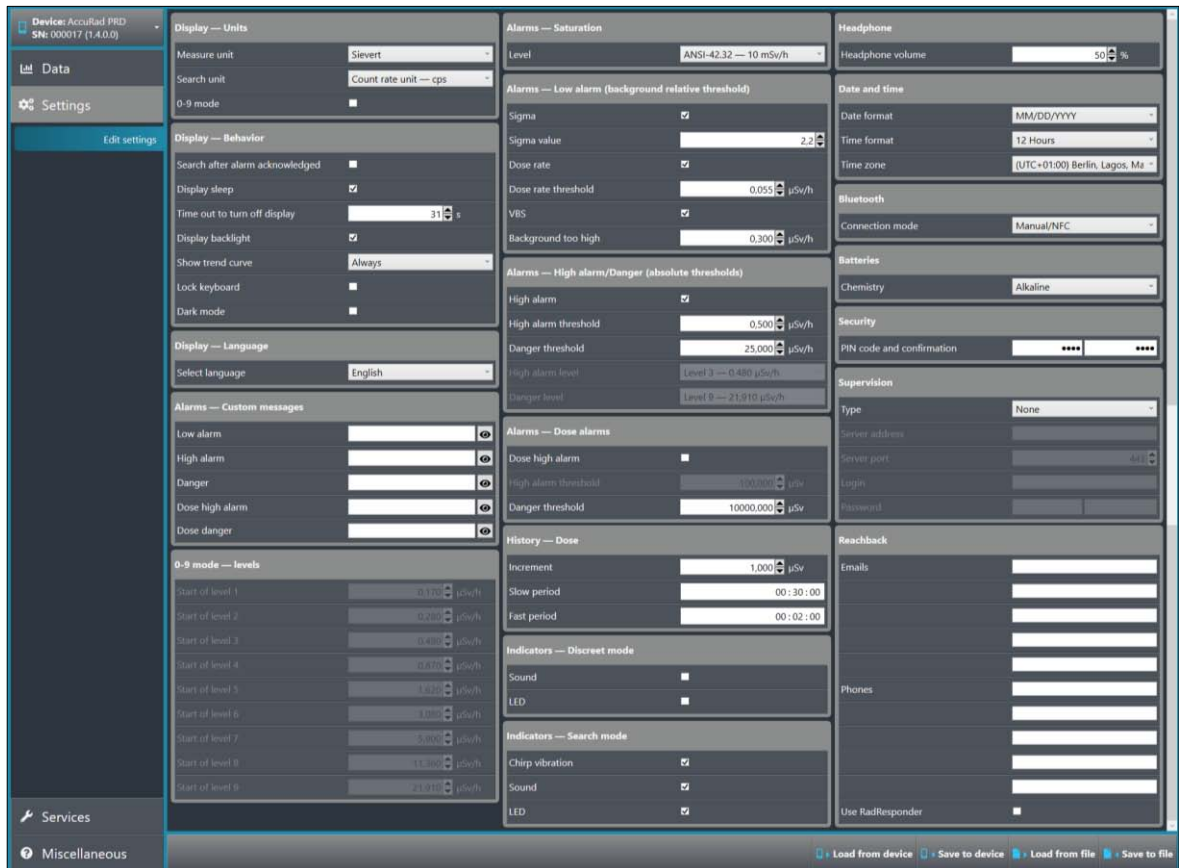
The Settings tab is unavailable if the AccuRad device is locked. If that is the case:

- Click on **Unlock device**.
- The Unlock device window is displayed. Enter the device PIN code then press the **Unlock** button.



7.3.3.2 Settings overview

The settings are available once the AccuRad PRD is unlocked:



The Settings tab is made of the same components described in §6 *AccuRad PRD settings*, with the following additions:

- **Alarm – custom messages:** use this part to set custom messages for the various alarms. Use the corresponding button to view the message on the AccuRad PRD device.
- **0-9 mode – levels:** set the thresholds of each of the levels of 0-9 mode.
- **History – dose:** set the increment. Use the slow period and fast period frames to set the duration between two recordings; the slow period frame corresponds to the AccuRad PRD in detection mode and the fast period frame corresponds to the AccuRad PRD in alarm.
- **Supervision:** select a supervision type in the drop-down list. If a supervision type is selected, enter the server address and port and set a login and a password.
- **Reachback:** enter email addresses and phone numbers to set a reachback system.

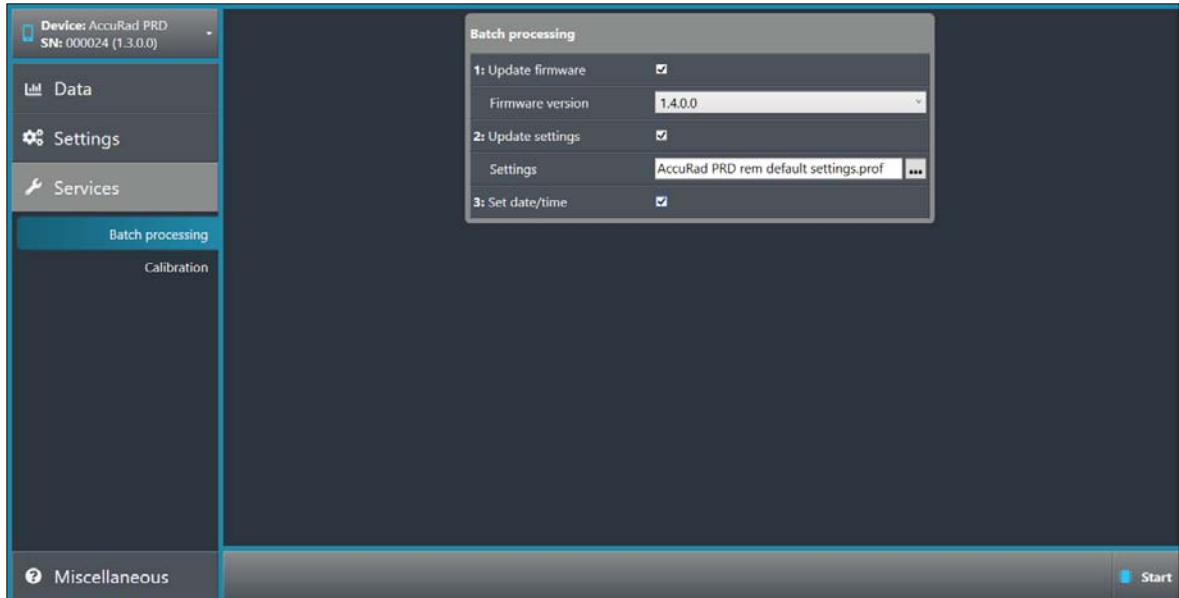
The following buttons are available here:

- **Load from device:** load the settings from a connected AccuRad PRD
- **Save to device:** save the settings to a connected AccuRad PRD
- **Load from file:** load the settings from an external file (default file format: .profile)
- **Save to file:** save the settings to an external file (default file format: .profile). This file can be used for batch processing.

7.3.4 Services

7.3.4.1 Batch processing

The Batch processing tab is used to update the AccuRad firmware, load a settings file and automatically set the date and time of a batch of AccuRads.



This tab is made of the following items:

- **Update firmware:** check the option, then select the firmware version in the drop-down list.
- **Update settings:** check the option, then use the [...] button to select the settings file. Note that the files corresponding to the default configuration are available.
- **Set date/time:** check this option to set the AccuRad PRD date and time.

When the desired items are set, press the **Start** button to start batch processing.

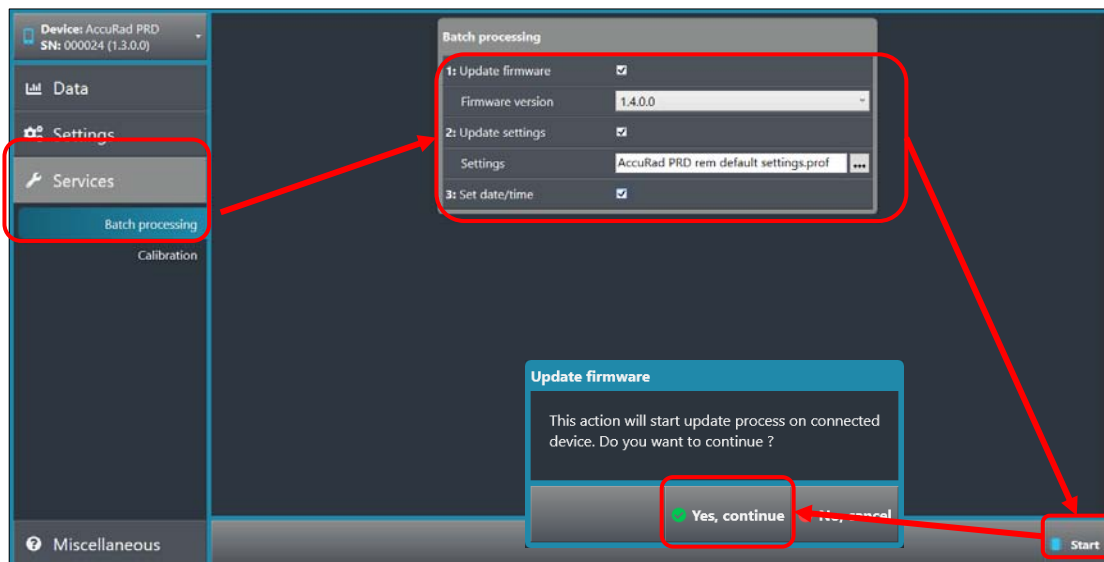
7.3.4.1.1 Updating the AccuRad PRD firmware and settings



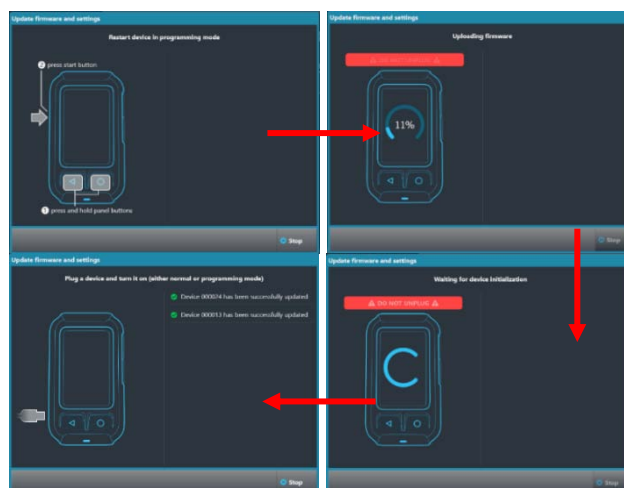
Note:

The most recent version of AccuRad Management Center is necessary to install the most recent firmware.

- Launch AccuRad Management Center, then connect the AccuRad PRD to the computer.
- On the AccuRad Management Center, go to **Services**, then **Batch processing**.
- Check the **Update firmware** option, then select the firmware version in the drop-down list.
- Check the **Update settings** option, then press the [...] button to select the settings profile file.
- Press the **Start** button.
- The update firmware window is displayed. Press the **Yes, continue** button to proceed with the firmware update.



- Follow the instructions on screen to restart the device in programming mode.
- Wait for firmware update; the device will be reinitialized after that. Do not unplug the AccuRad PRD during the whole procedure! When the process is over, the device is turned off.

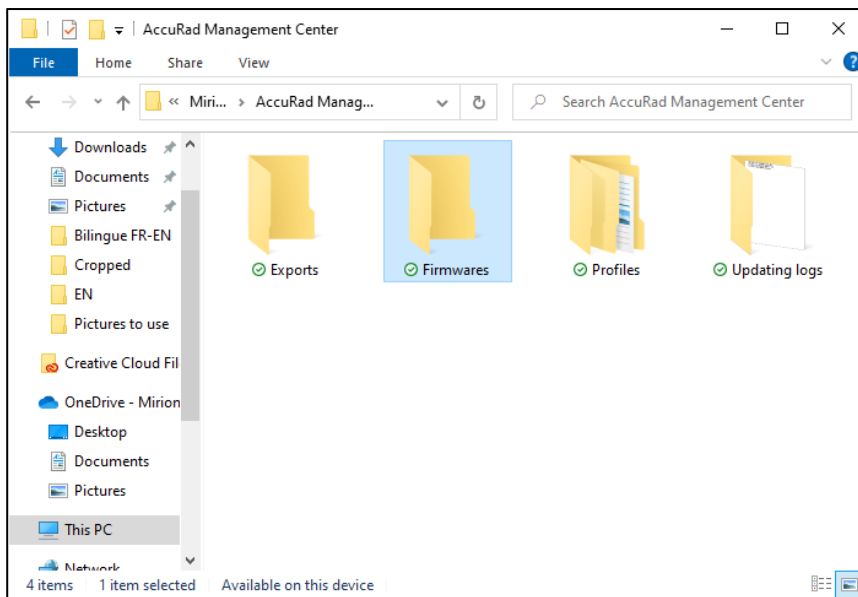


7.3.4.1.2 AccuRad PRD simulator firmware

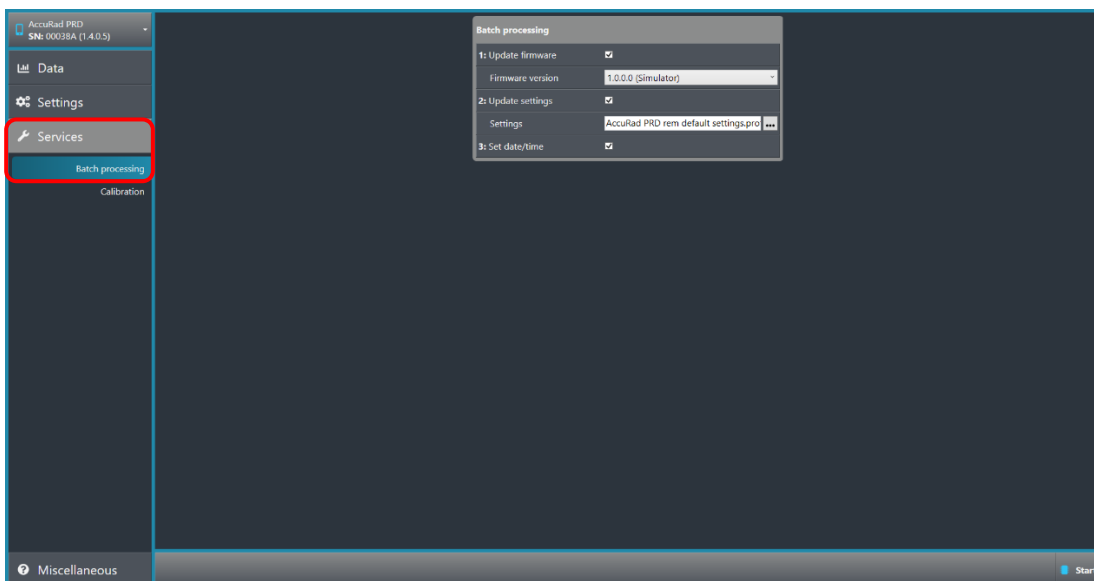
- Some clients may receive a simulator version of the AccuRad firmware, compatible with a simulator AccuRad as per the picture.



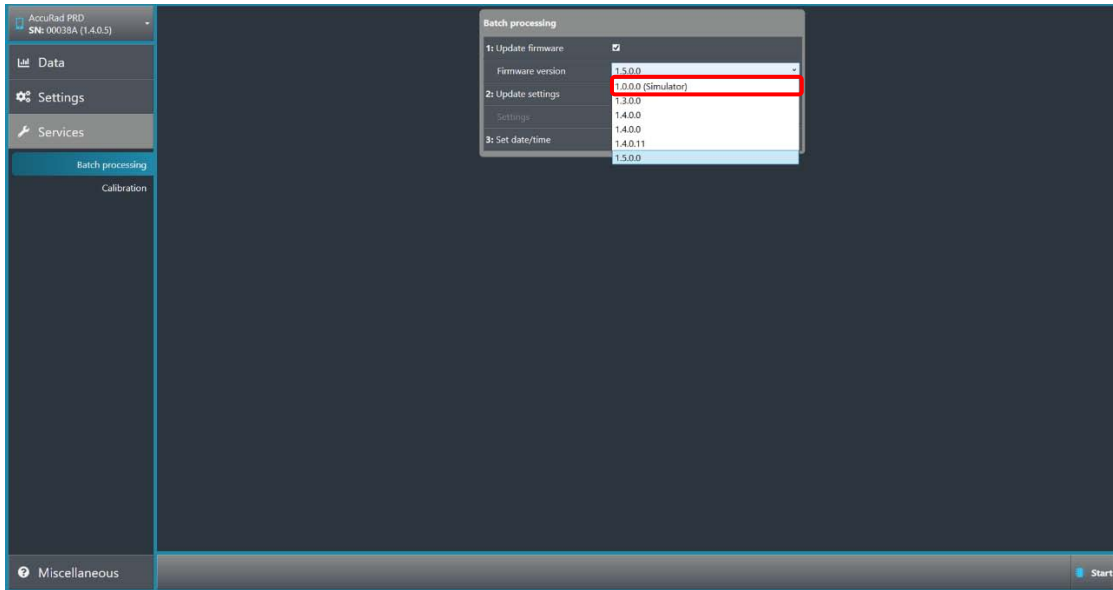
- To update or install a simulator firmware, go to **Documents\Mirion Technologies\AccuRad Management Center\Firmwares**.
- Place the firmware file **X.X.X.X_sim.hex** from Mirion Technologies.



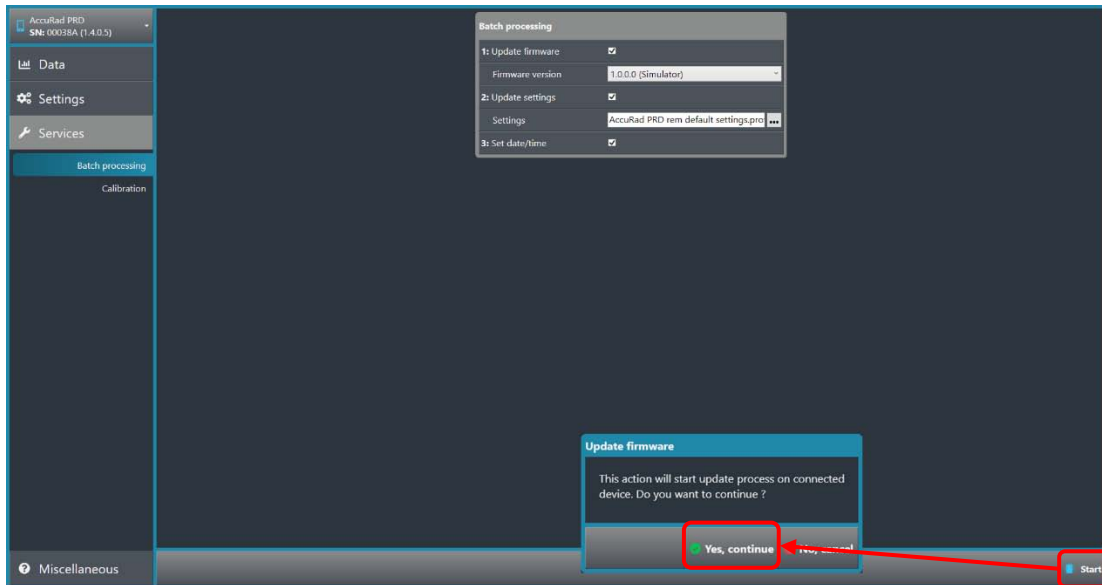
- Launch AccuRad Management Center, then connect the AccuRad PRD to the computer. On the AccuRad Management Center, go to **Services**, then **Batch processing**.



- Check the **Update firmware** option, then open the drop-down list. Simulator firmware will be indicated by the mention **(Simulator)** next to the firmware version. Select the simulator firmware

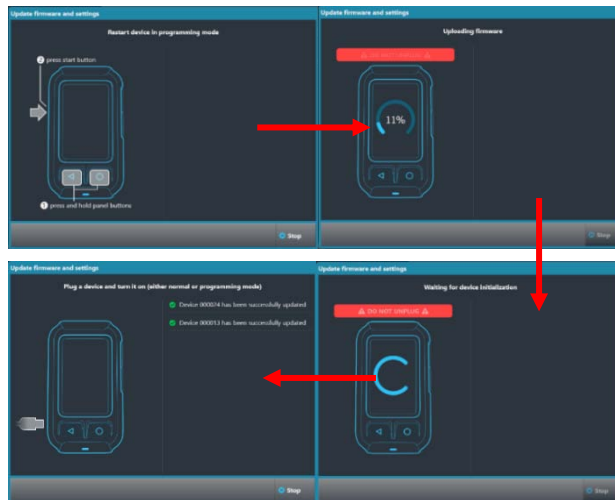


- Press the **Start** button.
- The **Update firmware** window is displayed. Press the **Yes, continue** button to proceed with the firmware update.



- Follow the instruction on the screen to restart the device in programming mode.

- Wait for firmware update; the device will be reinitialized after that. Do not unplug the AccuRad PRD during the whole procedure. When the process is over, the device is turned off.

**Caution:**

Do not install a simulator firmware on a regular AccuRad. Similarly, do not install a regular firmware on a simulator AccuRad.

7.3.4.2 Calibration

Use the **Calibration** tab to set the AccuRad PRD calibration date, use the calibration validity, and set up a new calibration.

The Calibration tab is made of the following items:

- In the **Last calibration** window: value currently in the AccuRad:
 - Date:** date of the last calibration
 - Low range coefficient:** low range coefficient of the last Calibration
 - High range coefficient:** high range coefficient of the last Calibration
- In the **New calibration** window: value to be updated:
 - Date:** after a calibration of the device, type here the date of calibration.
 - Use calibration validity:** check this option, then set the validity duration (in months).
 - Low range coefficient:** coefficient of the low range detection. Change in case of calibration. Mirion recommend that they should not be higher than 1.2, or lower than 0.8.
 - High range coefficient:** coefficient of the high range detection. Change in case of calibration. Mirion recommend that they should not be higher than 1.2, or lower than 0.8.



Note:

The calibration date settings should only be modified at the time of calibration and in accordance with procedures and/or CONOPS.

7.3.4.2.1 New Calibration

- To set up a new calibration, first follow the steps of §10.4.
- Once the average dose rate for the low range and high range detector have been obtained, compare the result to the dose rate of the source. If there's a disparity, follow this procedure:



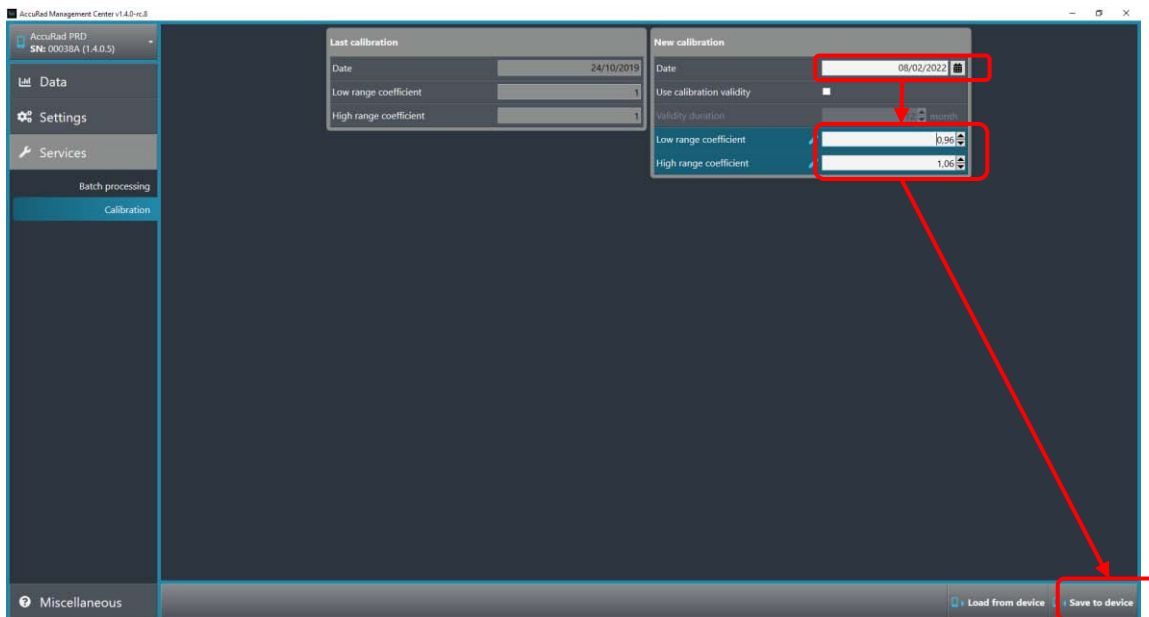
Note:

The calibration calculations must be done for both low and high range coefficient together, because the calibration date is common to both coefficients. By default, at the factory, the last calibration coefficients are equal to 1, and there is no calibration validity period. So to restore the factory defaults at any time, just set the coefficients to 1

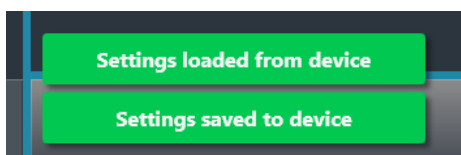
- In the **Services tab**, go to **Calibration**.
- In the **New Calibration** window, adjust both the high and low range coefficient following this formula:

$$\frac{\textit{Theoretical source dose rate}}{(\textit{Measured dose rate} / \textit{Current coefficient})} = \textit{New coefficient}$$

- Once the new coefficient is obtained, enter it in the appropriate field.
- Verify that the **Date** is correct. It should automatically fill to the current date.
- Click on **Save to device**.



- Let the AccuRad update for a moment. Notifications will appear at the bottom left of the application.



- Follow the steps of §10.4 once again. If the disparity persists, start the calibration again.



Note:

If the calculation results in the coefficients are beyond the limits, below 0.8 or above 1.2, do the calculations again. If the problem persists, contact your Mirion representative.

7.3.5 Miscellaneous

The Miscellaneous tab provides info about the AccuRad Management Center.



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8. Recommendations, troubleshooting and maintenance

8.1 Recommendations

8.1.1 Routine checkup

Before a mission:

- Visually inspect the AccuRad PRD for cracks, deformities or any other visible damage that may preclude operation.
- Check the belt clip.
- Power on the AccuRad PRD and verify correct configuration (mode, alert indicators, etc.).
- Check the batteries, replace them if necessary.
- If using a Smartphone:
 - Check the battery charge.
 - Check the communication with the AccuRad PRD.

Care should be taken to ensure the AccuRad PRD is always 'mission ready'. Mirion Technologies recommends a routine checkup when the following occurs:

- Excessive physical shock.
- Excessive thermal shock.
- After some uncontrolled transportation (for inst. in an aircraft hold).
- Extended storage greater than six months.

8.1.2 Storage

Prior to a storage of more than a month:

- Remove the batteries.
- Store the equipment in a dry, cool location with a temperature between -22°F and 158°F (-30°C and +70°C).

During storage periods:

- Perform a visual inspection, ensure the device is intact and stored in accordance with the prescribed conditions. These actions should be performed every six months.



Note:

*After an extended storage period, it may be necessary to reset the date and time of the AccuRad PRD
Contact a Mirion Technologies representative for service and calibration of the AccuRad PRD.*

8.2 Troubleshooting



Note:
Always follow the recommendations provided in the previous chapters.

The AccuRad PRD periodically performs self-testing and diagnostics to ensure it is mission ready. In the event of a test failure, the AccuRad PRD:


- displays a failure message on both display screens,
- has a purple flash from its alarm LED,
- emits an audible failure tone.

In that case, the AccuRad PRD should be removed from service.





Note:
A low battery is not considered a failure.

8.2.1 Troubleshooting Table

Problem (Symptom), Message	Cause	Actions
The radar “Interference” message remains displayed on the radar	Magnetic environment (car, truck, metallic building, etc.).	Move away from the current environment. If the problem persists, perform a radar calibration (see §6.7.2).
	No apparent cause, or the batteries have been replaced since the last calibration.	Perform a radar calibration (see §6.7.2). If the problem persists, contact your Mirion representative.
High background	Background becomes too high to ensure a good detection >0.3µSv/h (30µRem/h) (see §6.2.2).	Perform a background acquisition (see §5.7 <i>Update background (BKG)</i>). Move away to a radiation-free area. If the problem persists, contact your Mirion representative.
	The calculated background level is excessive. This may be because of an undetected source (slowly approaching source wrongly considered as a background elevation).	In that case “High background” should be considered as an alarm.
The background update warning  BKG is displayed	Background has not been updated for more than two minutes.	Apply the actions listed below.
	There is a radioactive source nearby.	Move away from the source.
	The device has detected a background variation that differs from the known background.	Check if there is a source nearby; if there is no source then perform a background acquisition (see §5.7 <i>Update background (BKG)</i>).

Problem (Symptom), Message	Cause	Actions
Low Range Overload	The AccuRad PRD is exposed to a dose rate superior than 1 mSv/h (Cs-137).	This symptom is not considered as a default, the device keeps measuring with the high range detector; however the trend curve and the radar are disabled. For more information, refer to §6.2.5 <i>Saturation</i> .
Overload	The AccuRad PRD is exposed to a dose rate superior than the saturation. The high range detector needs time to recover.	Return to a lower dose rate. For more information, refer to §6.2.5 <i>Saturation</i> .
Recovering from high exposure	The AccuRad PRD has been exposed to a very high dose rate higher than 2 mSv/h (Cs-137). The low range detector needs time to recover.	Return to a lower dose rate. Wait for the low range detector to recover and the message will disappear automatically. It can take several minutes depending on the radiation exposure level.
Detector failure	Issue with the low range detector polarization voltage, or no count.	This failure is latched and cannot be manually acknowledged. Auto-acknowledged if the status becomes good. Checked every 250ms cycle for counting fault, few seconds for polarization, at power up for electronic. The failure is cleared by powering off the AccuRad PRD. If the problem persists, contact your Mirion representative.
	Wrong firmware installed.	This failure can be cleared by checking which firmware is installed on the AccuRad, simulator or regular. For more information refer to § 7.3.4.1.2.
Temperature too low / too high	Temperature out of range.	Correct behavior of the AccuRad PRD is not ensured. Move the AccuRad PRD to a place with compliant temperatures. Auto-acknowledged if the read value becomes good and checked every 10s. If the problem persists, contact your Mirion representative.
Temperature failure	No communication with temperature sensor.	Reboot the AccuRad PRD. If the problem persists, contact your Mirion representative.

Problem (Symptom), Message	Cause	Actions
Bluetooth failure	No communication with Bluetooth component.	Reboot the AccuRad PRD. If the problem persists, contact your Mirion representative.
Audio failure	No communication with Audio component.	Reboot the AccuRad PRD. If the problem persists, contact your Mirion representative.
Flash failure	No communication with Flash memory (log storage).	Reboot the AccuRad PRD. If the problem persists, contact your Mirion representative.
Accelerometer failure	No communication with accelerometer and gyroscope components.	Reboot the AccuRad PRD. If the problem persists, contact your Mirion representative.
Magneto failure	No communication with Magnetometer component.	Reboot the AccuRad PRD. If the problem persists, contact your Mirion representative.
NFC failure	No communication with NFC component.	Reboot the AccuRad PRD. If the problem persists, contact your Mirion representative.
E2P failure	No communication with EEPROM component (settings storage).	Reboot the AccuRad PRD. If the problem persists, contact your Mirion representative.
IDWG Reset	The AccuRad PRD has unexpectedly rebooted.	No action required. If the problem persists, contact your Mirion representative.
User parameter error (menu name)	The user parameter area has been restored with the default parameters.	Go to the menu indicated by the message, check and edit the parameters.
User parameter error 00000010	Default low alarm configuration is loaded.	Validate the error message. Go to Settings -> Alarms -> Low. Disable VBS (PIN code is required). Re-enable VBS to update the low alarm configuration. Go back to the main screen, the error message should be cleared.
Factory parameter error	The factory parameter area has been restored with the default parameters.	This failure is latched and cannot be acknowledged. Contact your Mirion representative.
User and factory parameters error	The user and factory parameter area has been restored with the default parameters.	This failure is latched and cannot be acknowledged. Contact your Mirion representative.
Calibration Date Expired	Calibration date is too old.	The AccuRad PRD requires a calibration. Check the calibration and setup a new calibration date or contact your Mirion representative.

Problem (Symptom), Message	Cause	Actions
VBS	VBS has detected a change in background type.	No action required.
The Battery low message is prompted on the top display. The battery icon blinks on both screens with a cross in the middle. Every 30 minutes, a sound is emitted and the alarm LED indicator blinks orange	Batteries are too low.	Charge or change the batteries.
The device is powered off and does not start.	Batteries depleted.	Change the batteries and press the  on/off button. If the problem persists, contact your Mirion representative.
Sounds are not redirected to the connected earphones.	Earphones are not detected by the device.	Use the earphones supplied by Mirion. Check that the  symbol is displayed. If the problem persists, contact your Mirion representative.

8.3 Maintenance

The AccuRad PRD does not require preventive maintenance. However, if poor performance is observed, Mirion Technologies recommends some periodic verifications. Moreover, Mirion Technologies recommends a calibration once a year.

8.3.1 Periodic Verifications

- Built-in health test

The AccuRad PRD is designed with a built-in health test, which is automatically performed when the device is powered ON and periodically when the AccuRad PRD is turned on except for sound, vibration and LED. Refer to paragraph §6.7.3 *Health test*.

- Measurement Capability Verification

If performance seems subpar, Mirion Technologies recommends checking the device measurement capabilities using a reference gamma radiation source.

8.3.2 Calibration

Calibration with adjustment can be performed by Mirion Technologies. Please contact your Mirion Technologies representative for more information.

Simple calibration check can be performed by the user (see Appendix 4: Calibration recommendations). Refer to §6.7.1 *Calibration* and §7.3.4.2 *Calibration*.

8.3.3 Cleaning

- Frequency: after use; weekly.

8.3.3.1 Materials Required

- Lint-free soft cloths,
- Warm water, mild soap. Do not use abrasive cleaners or chemicals.
- Isopropyl alcohol

8.3.3.2 Procedure

- Power off.
- Remove batteries.
- Clean the screen with a clean cloth dampened with soapy water.
- Clean the battery compartment and internal battery cover with a dry cloth only.
- Carefully check the battery connector contacts. If they show signs of oxidation, clean with a lint-free cloth and isopropyl alcohol.

**CAUTION:**

Do not touch the other parts of the device with isopropyl alcohol. If necessary, contact your Mirion Technologies representative.

8.3.4 Decontamination

Decontamination consists of removing unwanted dust or fluids. When performing decontamination, personnel should wear the appropriate personal protective equipment (PPE) to the level of the hazard and training (radiological, chemical, etc.) or as prescribed in operating procedures.

All external parts are resistant to the decontamination agents listed below:

- Alkaline (pH > 12) solution (up to 3%, anionic or non-ionic) with a contact time of the liquid film with the device of less than 10 mins.
- Aqueous hypochlorite solution (5%) with contact time of the Liquid film with the device of less than 10 minutes.
- Aqueous peracetic acid solution (2%) with contact time of the Liquid film with the device of less than 10 minutes.

8.3.4.1 Decontamination recommendations

The following decontamination material methods can be used:

- Lint free cloths
- Warm water, mild soap
- Compressed dried air (<1 bar and only if determined non-hazardous)

**CAUTION:**

Watch out for screen surfaces. Abrasive element should not be used at the risk of frosting them and damaging the readability of screens.

9. Specifications

9.1 Measurements

9.1.1 ANSI N42.32 and IEC 62401

- Type of instrument PRD (Personal Alarming Radiation Detector)
- Type of radiation Photons (Gamma, X)
- Dose & dose rate equivalent quantity Hp(10)
- Unit for dose equivalent rate Sv/h or rem/h
- Unit for dose equivalent Sv or rem
- Unit-less mode 0-9, see table on paragraph §6.1.1.2.
- Unit for gross count rate (for search) cps (counts per second)
- Units spelling / scaling For readability, μ rem and mrem are displayed microRem and millirem

9.1.2 IEC 60846-1:2009 and IEC 60846-2:2015

- Measured quantity ambient dose equivalent rate $H^*(10)$
ambient dose equivalent $H^*(10)$
- Measurement range 0.1 μ Sv/h up to 10 Sv/h
(10 μ rem/h up to 1000 rem/h)
- Effective measurement range 0.1 μ Sv/h up to 10 Sv/h
(10 μ rem/h up to 1000 rem/h)
- Detectors CsI(Tl) scintillation detector and silicon diode
- Energy range 25 keV up to 3 MeV
- Effective energy and angular range 80 keV up to 1.3 MeV
- Operating temperature range -20°C u to +60°C

9.2 Detectors

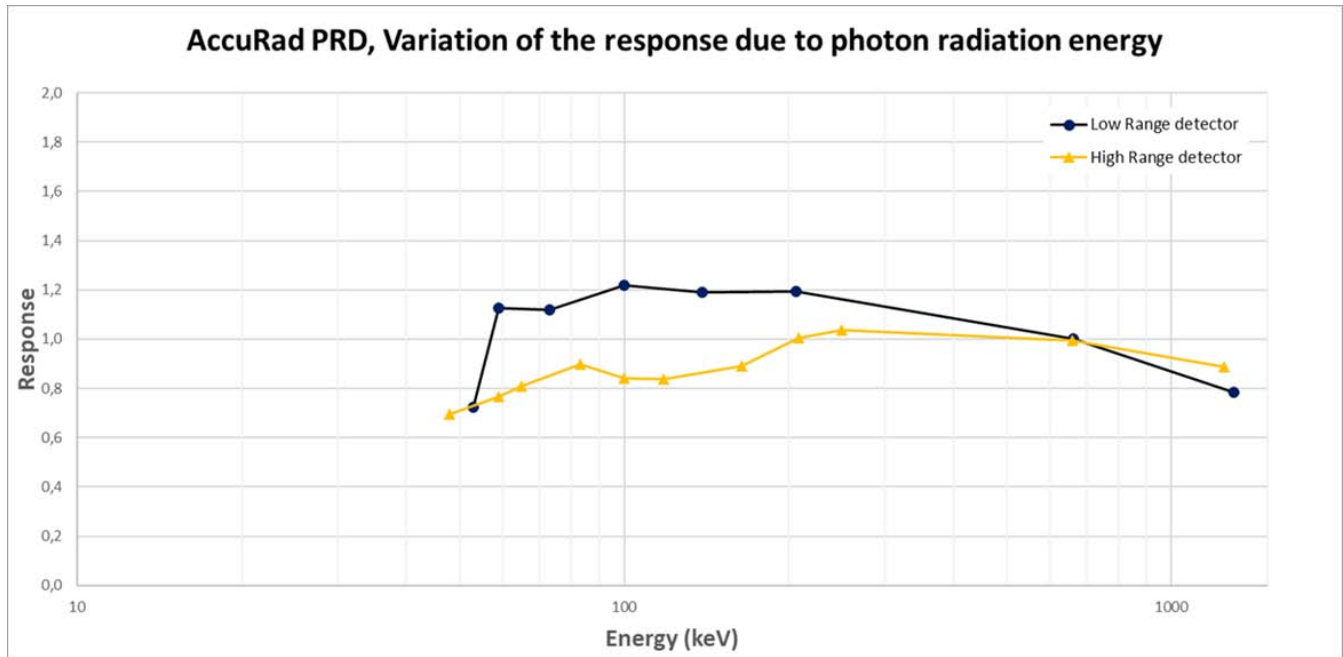
- Low range detector detection & dose equivalent rate measurement
- Sensitivity and max range (160 kcps) Am-241: 2200 c/s/ μ Sv/h, 73 μ Sv/h
(20 c/s/ μ rem/h, 7.3 mrem/h)
Cs-137: 160 c/s/ μ Sv/h, 1000 μ Sv/h
(0.16 c/s/ μ rem/h, 100 mrem/h)
Co-60: 60 c/s/ μ Sv/h, 2667 μ Sv/h
(0.6 c/s/ μ rem/h, 266.7 mrem/h)
- Detector type CsI(Tl) scintillator detector, energy-compensated, 10mm dia. x 35mm length
- High dose rate detector dose rate and integrated dose measurement
- Detector type Energy-compensated Silicon diode

9.3 Dose equivalent and dose equivalent rate

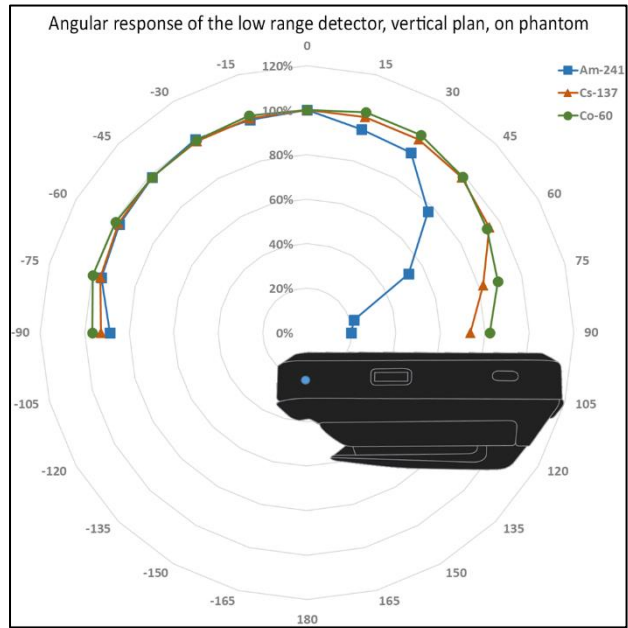
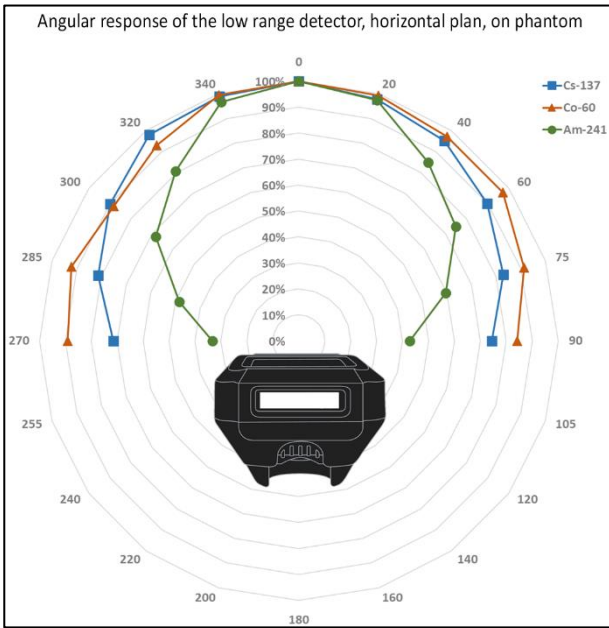
- Standard**
ANSI N42.20 section 5.3 (radiological requirement) for a type 1 device (accuracy, energy, angular, over-range)

- Range**
- According to ANSI N42.32 section 6.6 Up to 10 mSv/h (1rem/h)
- Extreme ⁽¹⁾ Up to 10 Sv/h (1000 rem/h)

- Accuracy (dose equivalent rate)**
+/-20 %
- Accuracy (dose equivalent)**
+/-20%
- Energy range:**
50 keV to 1.3 MeV

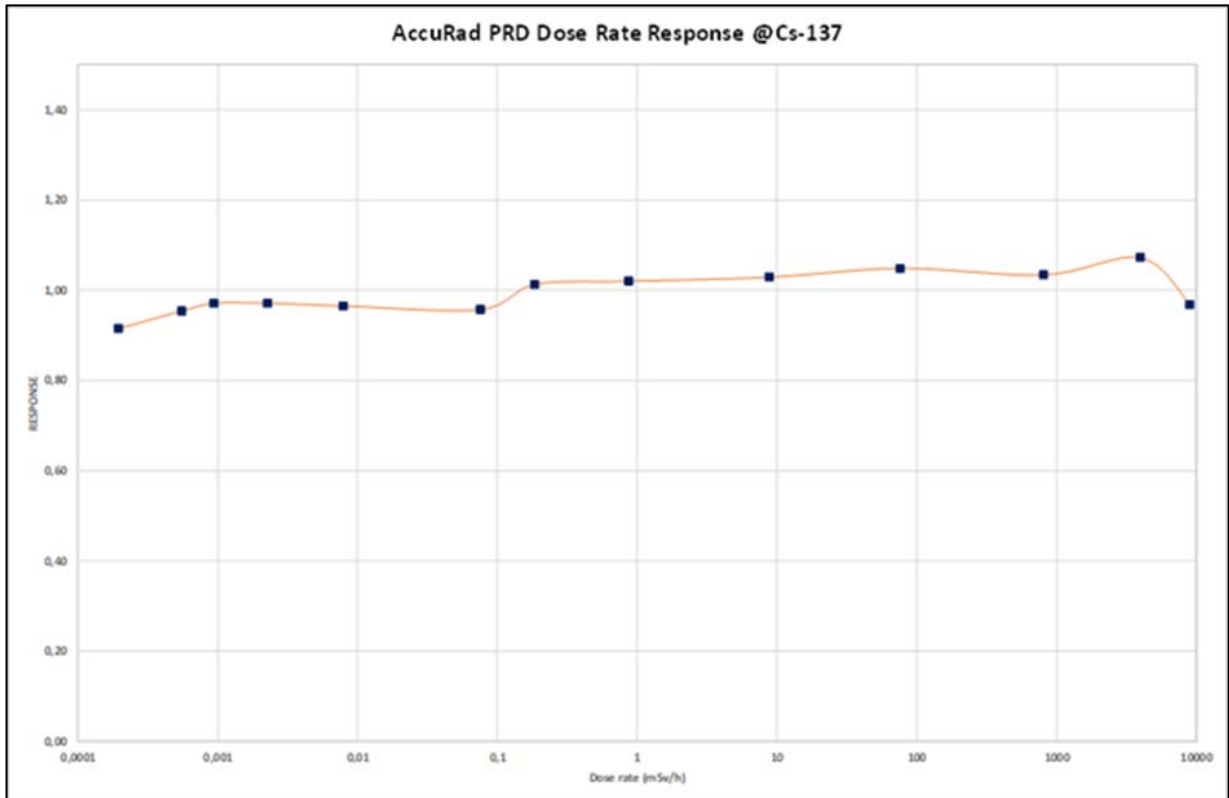


■ Angular response of the low range detector:



(1) The device is able to measure dose rates up to 1000 rem/h accurately. However, above 10 rem/h, the recovery time is longer than required in the ANSI N42.34. To enable this function, refer to §6.2.5 Saturation.

■ Dose rate response:



9.4 Alarming (with factory setup)

- False alarm rate (stable background) Less than 2 alarms per 24 hours and < at 150 nSv/h (15 µrem/h)
- False alarm rate (varying background) VBS technology minimizes alarms due to background variations
- Response time < 2s for a 0.5µSv/h (50 µrem/h) increment in accordance with ANSI42.32-2016 & CEI62401-2017 standards
- Energy range 25 keV to 3 MeV (gamma)
- Alarm types (rate)
 - Low Detection of a low level of radiation, background relative threshold. Settable in background-related sigma in dose rate over background.
 - High Detection of a higher level of radiation. Settable in dose rate (absolute)
 - Danger Possibly harmful radiation, step back. Settable in dose rate (absolute)

9.5 Display, storage, controls and interface

- Top display
 - Resolution 38 x 184
 - Size 6 mm x 29 mm
- Front display
 - Resolution 240 x 400
 - Size 36 mm x 60 mm
- LEDs Multicolor, Alarms, Gamma pulse, failures & info, charge and external power supply indicator
- Sound Loudspeaker for alarm, chirp signal in source search, failure and info
- Sound level More than 85 dB (A) and less than 100 dB (A) at 30 cm
- Vibration For alarms and search, mutable
- Buttons Four buttons for operations plus one button for ON/OFF (separate and protected)
- Earphones Passive USB type-C, optional
- Available languages English, French, Spanish, Chinese, Korean, Japanese, Polish, Arabic, German
- History storage capacity Up to 400 alarms, 720 doses, 16 failures, 16 information files

9.6 Connectivity

- NFC For Bluetooth pairing without PIN code
- Bluetooth To connect to the smartphone application
- Bluetooth encryption BLE 4.2, AES 128
- USB For maintenance (firmware update), calibration, charge and external power

9.7 Environmental, electrical, physical characteristics

9.7.1 Environmental characteristics

- Climatic
 - Operating temperature -20°C to 60°C (-4°F to 140°F)
 - Storage temperature -30°C to +70°C (-22°F to 158°F)
 - Thermal shocks According to ANSI N42.32-2016 section 7.2
 - Humidity 93% RH at 35°C according to ANSI N42.32-2016 section 7.3
 - Water and dust ingress IP67 according to IEC 60529
 - Extreme temperature startup According to ANSI N42.32-2016 section 7.5

Note : *In case of long-term storage (more than one month), the battery has to be stored separately, in a controlled environment.*

- Electromagnetic
 - ESD +/- 6 kV, contact discharge According to ANSI N42.32-2016 section 8.1
 - Radiated immunity 50 V/m (80 MHz – 2.5 GHz) according to ANSI N42.32-2016 section 8.2
 - Magnetic fields 100 A/m (3 gauss) 60 Hz AC according to ANSI N42.32-2016 section 8.3
 - Radiated emissions FCC/CFR15.109, class A, according to ANSI N42.32-2016 section 8.4
- Mechanical
 - Vibration 0.01 g²/Hz (5 Hz – 500 Hz) according to ANSI N42.32-2016 section 9.1
 - Drop 1.5 m on concrete floor according to ANSI N42.32-2016 section 9.2
 - Impact 0.2 J impact according to ANSI N42.32-2016 section 9.3

9.7.2 Electrical characteristics

- Batteries Two AA (1.2V to 1.5V), alkaline, lithium (non-rechargeable) or NiMH (rechargeable)
- Battery lifetime (20°, non-alarming) 900 hours in continuous operation, with alkaline batteries

9.7.3 Physical characteristics

- Dimensions 108 x 61 x 36 mm without clip
- Weight with batteries ~ 200 g (7 oz)

9.8 Accessories, options

9.8.1 Regular packaging content

- Carton box
- AccuRad PRD
- 2 AA alkaline batteries
- Quick start guide
- Spare clip

Note : *Delivery with other packaging/case or in trays on request.*

9.8.2 Optional accessories and spare parts

- Earphones USB-C kit NOM005846
- Battery cover + clip NOM004540
- Battery tabs x10 NOM006778
- AccuRad App available on Google Play Store and Apple App Store
- AccuRad Management Center PC software tool available from Mirion Technologies website

Note : *For more information about the optional accessories and spare parts, contact your Mirion Technologies representative.*

10. Appendix

10.1 Appendix 1: Communication protocol

10.1.1 Transmission mode

AccuRad PRD supports two types of link:

- **USB virtual COM PORT:** on host side a port COM is created to emulate a serial COM Port link. The configuration of this port is only limited by host driver since the real communication uses USB and the driver emulate a serial port COM with its settings (speed, data length...).
- **Bluetooth virtual COM port service:** as for USB a COM Port is emulated on host ends. The AccuRad PRD sends data at 230400 bps. The reception can be configured regardless this speed since the host driver will emulate a link according to its own settings.

10.1.2 Protocol definition

Data sent in binary format.

Word sent low significant **byte** first:

- Example: $4660_{\text{decimal}} = 1234_{\text{hexadecimal}}$ bytes are transmitted in this order: $34_{\text{hexadecimal}}, 12_{\text{hexadecimal}}$

Byte sent most significant **bit** first.

- Example: $100_{\text{decimal}} = 64_{\text{hexadecimal}} = 01100100_{\text{binary}}$ is transmitted in this order: 0, 1, 1, 0, 0, 1, 0, 0

Bytes are place side-by-side with no alignment byte (packed data).

Each frame starts with #!AccuRad!# pattern

Data integrity is guaranteed by 2 bytes CRC

10.1.2.1 Frame format

A frame contains five parts:

#!AccuRad!# LEN ID XXXXX CRC

- #!AccuRad!# : frame start marker
- LEN: frame length (length of XXXXX + CRC in bytes). Frame length is a 2-byte word (max 65535 bytes)
- Frame ID: number that allow to identify the reply at a low level.
- XXXXX: N bytes of data (payload)
- CRC: CRC (computed on XXXXX). CRC is a 2-byte word.

Example:

Data to send from AccuRad PRD to host:

0xAA	0xE7	0xBB	0x11	0x7E
------	------	------	------	------

Frame:

Start											Length		ID		Payload (XXXXXX)					CRC	
#	!	A	c	c	u	R	a	d	!	#	0x08	0x00	XX	XX	0xAA	0xE7	0xBB	0x11	0x7E	XX	XX

10.1.2.2 CRC₁₆ calculation

```
#define POLYNOM16 0xAC5E // 1.X15 + 0.X14 + 1.X13 + 0.X12      1010 A
//+ 1.X11 + 1.X10 + 0.X09 + 0.X08      1100 C
//+ 0.X07 + 1.X06 + 0.X05 + 1.X04      0101 5
//+ 1.X03 + 1.X02 + 1.X01 + 0.X00      1110 E
```

```
U16 Crc16(const void* data, S16 sizeofData)
```

```
{
    U16 Crc = 0xFFFF;
    U16 ByteCnt = 0;
    U8 BitCnt = 0;
    U16 Parity = 0;
    if (sizeofData <= 0 || data == NULL) return 0;
    U8* ptr = (U8*)data;
    for ( ByteCnt = 0 ; ByteCnt < sizeofData ; ByteCnt ++ )
    {
        Crc ^= *( ptr + ByteCnt );
        if( Crc == 0 ) Crc = 1;
        for ( BitCnt = 0; BitCnt <= 7 ; BitCnt ++ )
        {
            Parity = Crc;
            Crc >>= 1;
            if ((Parity & 1) != 0 ) Crc ^= POLYNOM16;
        }
    }
    return(Crc);
}
```

10.1.3 Exchange between host and device

This section describes frame payload (previously noted XXXXX). Each frame type has an ID that allow determining payload content.

10.1.3.1 Data description

10.1.3.1.1 Date and time

	Type	Size (byte)	Description
1	10.1.3.1.3	10.1.3.1.3	Time
2	10.1.3.1.2	10.1.3.1.2	Date

```
typedef struct _DateTime_t
{
    Time_t Time;
    Date_t Date;
}DateTime_t;
```

10.1.3.1.2 Date

Date is coded inside a 4-byte word sent in little endian convention. Bits field's description:

Bit	Size	Description
0-2	3 bits	Day of week
3-7	5 bits	Day
8-11	4 bits	Month
12-31	20 bits	Year

```
typedef union _Date_t_
{
    uint32_t All;
    struct
    {
        uint32_t DayOfWeek : 3; /* 00 – 02*/
        uint32_t Day : 5; /*03 – 07*/
        uint32_t Month : 4; /*08 – 22*/
        uint32_t Year : 20; /*12 – 31*/
    }d;
}Date_t;
```

10.1.3.1.3 Time

Hour is coded inside a 4-byte word sent in little endian convention. Bits field's description:

Bit	Size	Description
0-4	5 bits	Hours
5-10	6 bits	Minutes
11-16	6 bits	Seconds
17-29	13 bits	Milliseconds
30-31	2 bits	Daylight saving time : 0 = none, 1 = add 1 hour, 2 = subtract 1 hour

```
typedef union _Time_t_
{
    uint32_t All;
    struct
    {
        uint32_t Hours      : 5;          /*00 – 04*/
        uint32_t Minutes    : 6;          /*05 – 10*/
        uint32_t Seconds     : 6;          /*11 – 16*/
        uint32_t MilliSeconds : 13;       /*17 – 29*/
        uint32_t DayLight    : 2;          /*30 – 31*/
    };
}Time_t;
```

10.1.3.1.4 Data

10.1.3.1.4.1 System state

The system state is a synthesis of the device state. It is composed by a 4-byte word sent in little endian convention.

Bit	Nom	Description
0	CountingFault	Counting fault on SED PRD and/or SED 15 keV subassembly
1	TempSensorFault	Temperature sensor failure
2	TempOutOfRange	Current device temperature is out of working range
3	CheckDateTime	Date/Time not up to date (date time lost)
4	AccumulationEnabled	Spectrum accumulation activated
5	AccumulationInProgress	Spectra accumulation in progress
6	Acknowledged	Device is in acknowledged state
7	Low alarm	Low alarm activated
8	High alarm	High alarm activated
9	Danger	Danger alarm activated
10	Dose alarm	Dose alarm activated
11	Dose danger	Dose danger activated
12	Low Power	Device is actually in low power mode
13	SearchMode	Device is in search mode
14	Not used	Not used
15	CalibrationExpired	Device calibration need to be checked
16	VBS	VBS is triggered (background variation)
17	MagnetometerFailure	Magnetometer is out of order or reports an error
18	AccGyrometerFailure	Accelerometer/Gyroscope are out of order or reports an error
19	E2PFailure	E2PROM memory failure
20	FlashFailure	Flash memory failure
21	AudioFailure	Audio failure
22	BLEFailure	Bluetooth communication failure
23	Discreet	Discreet mode activated
24	AlarmThresholdsNotConsistent	Current thresholds are not compliant with the rule "Dose rate High alarm" < "Dose rate Danger" < "Saturation"
25	Reserved	Reserved
26	Reserved	Reserved
27	Reserved	Reserved
28	Reserved	Reserved
29	Reserved	Reserved
30	Initialized	Initialization sequence is over
31	RemoteCtrl	Remote control is activated

```

typedef union _SystemState_t_
{
    uint32_t All;
    struct
    {
        uint32_t CountingFault : 1; /* 00 */
        uint32_t TempSensorFault : 1; /* 01 */
        uint32_t TempOutOfRange : 1; /* 02 */
        uint32_t CheckDateTime : 1; /* 03 */
        uint32_t AccumulationEnabled : 1; /* 04 */
        uint32_t AccumulationInProgress : 1; /* 05 */
        uint32_t Acknowledged : 1; /* 06 */
        uint32_t LowAlarm : 1; /* 07 */
        uint32_t HighAlarm : 1; /* 08 */
        uint32_t Danger : 1; /* 09 */
        uint32_t DoseAlarm : 1; /* 10 */
        uint32_t DoseDanger : 1; /* 11 */
        uint32_t LowPower : 1; /* 12 */
        uint32_t SearchMode : 1; /* 13 */
        uint32_t NotUsed_14 : 1; /* 14 */
        uint32_t CalibrationExpired : 1; /* 15 */
        uint32_t VBS : 1; /* 16 */
        uint32_t MagnetometerFault : 1; /* 17 */
        uint32_t AccGyrometerFault : 1; /* 18 */
        uint32_t E2PFault : 1; /* 19 */
        uint32_t FlashFault : 1; /* 20 */
        uint32_t AudioFault : 1; /* 21 */
        uint32_t BLEFault : 1; /* 22 */
        uint32_t Discreet : 1; /* 23 */
        uint32_t AlarmThresholdsNotConsistent : 1; /* 24 */
        uint32_t NotUsed_25 : 1; /* 25 */
        uint32_t NotUsed_26 : 1; /* 26 */
        uint32_t NotUsed_27 : 1; /* 27 */
        uint32_t NotUsed_28 : 1; /* 28 */
        uint32_t NotUsed_29 : 1; /* 29 */
        uint32_t Initialized : 1; /* 30 */
        uint32_t RemoteCtrl : 1; /* 31 */
    };
}SystemState_t;

```

10.1.3.1.4.2 Merged

10.1.3.1.4.2.1 State

1 byte word

Bit	Name	Description
0-1	Origin	Measurement origin: 0: Unknown 1: From low range (SED PRD/CsI(Tl)) 2: From high range (SED 15 keV/Pin diode) 3: Both (SED PRD/CsI(Tl) and SED 15 keV/Pin diode)
2	PRD_15keV_Incoherence	Measurement from low and high range are not consistent. It is an indication of geometric issue (detectors axes) on measurement
3	Reserved	Reserved
4	Reserved	Reserved
5	Reserved	Reserved
6	Overload	Device is in overload state
7	Initialized	Initialization is over

```
typedef enum _Measurement_Origin_t_
{
    MEASUREMENT_FROM_UNKNOWN,
    MEASUREMENT_FROM_SED_PRD, //data from CsI(Tl) = low range = SED PRD
    MEASUREMENT_FROM_SED_15KEV, //data from Pin diode = high range = SED 15 keV
    MEASUREMENT_FROM_BOTH, //data from CsI(Tl) + Pin diode = Low & high range = SED
    PRD+ SED 15 keV
}Measurement_Origin_t;
```

```
typedef union _MergedMeas_State_t_
{
    uint8_t All;
    struct
    {
        uint8_t Origin : 2; /*00-01*/ //Measurement_Origin_t values
        uint8_t PRD_15keV_Incoherence : 1; /*02*/
        uint8_t Reserved_03 : 1; /*03*/
        uint8_t Reserved_04 : 1; /*04*/
        uint8_t Reserved_05 : 1; /*05*/
        uint8_t Overload : 1; /*06*/
        uint8_t Initialized : 1; /*07*/
    };
}MergedMeas_State_t;
```

10.1.3.1.4.2.2 Measurement

	Type	Size (byte)	Description
1	Real	4	Dose rate ($\mu\text{Sv/h}$)
2	Real	4	Count rate (cps)
3	Real	4	Background dose rate ($\mu\text{Sv/h}$)
4	Real	4	Background count rate (cps)
5	Real	4	Level (0-9 display)

10.1.3.1.4.2.3 Data

	Type	Size (byte)	Description
1	10.1.3.1.4.2.1	10.1.3.1.4.2.1	State
2	10.1.3.1.4.2.2	10.1.3.1.4.2.2	Measurement

```
typedef struct _Merged_NuclearData_t_
{
    float DoseRate_uSv_h;
    float CountRateFiltered_cps;
}Merged_NuclearData_t;
```

```
typedef struct _Merged_Measurement_t_
{
    MergedMeas_State_t State;
    Merged_NuclearData_t Meas;
    Merged_NuclearData_t Bkg;
    float Level;
}Merged_Measurement_t;
```


10.1.3.1.4.3 Dose (SED 15keV/Silicon diode)

10.1.3.1.4.3.1 State

None

10.1.3.1.4.3.2 Measurement

Send the dose integrated since the Accurad startup or the last reset.

	Type	Size (byte)	Description
1	Real	4	Dose measurement (μSv) from SED 15keV/Pin diode
2	Real	4	Duration associated with dose measurement = integration duration (s)

```
typedef struct _Dose_Measurement_t_
{
    float Dose_uSv;
    float Duration_s;
} Dose_Measurement_t;
```

10.1.3.1.4.3.3 Data

	Type	Size (byte)	Description
1	10.1.3.1.1	10.1.3.1.1	Date/time
2	10.1.3.1.4.3.2	10.1.3.1.4.3.2	Measurement

```
typedef struct _Dose_Data_t_
{
    DateTime_t      DateTime;
    Dose_Measurement_t Values;
} Dose_Data_t;
```

10.1.3.1.4.4 Battery

10.1.3.1.4.4.1 State

1 byte word

Bit	Name	Description
0	LevelTooLow	Battery level low
1	LevelCritical	Battery level reach critical level (shutdown)
2	USB_Connected	USB is connected
3	Reserved	Reserved
4	Reserved	Reserved
5	Reserved	Reserved
6	Failure	Failure on battery
7	Initialized	Battery management phase terminated

```

typedef union _Battery_State_t_
{
    uint8_t All;
    struct
    {
        uint8_t LevelTooLow      : 1;    /*00*/
        uint8_t LevelCritical    : 1;    /*01*/
        uint8_t USB_Connected   : 1;    /*02*/
        uint8_t Reserved_03     : 1;    /*03*/
        uint8_t Reserved_04     : 1;    /*04*/
        uint8_t Reserved_05     : 1;    /*05*/
        uint8_t Failure         : 1;    /*06*/
        uint8_t Initialized     : 1;    /*07*/
    };
}Battery_State_t;

```

10.1.3.1.4.4.2 Measurement

	Type	Size (byte)	Description
1	UINT	1	Battery level (%): if USB is connected, this value should be ignored

10.1.3.1.4.4.3 Data

	Type	Size (byte)	Description
1	10.1.3.1.4.4.1	10.1.3.1.4.4.1	State
2	0	0	Measurement

```

typedef struct _Battery_Data_t_
{
    Battery_State_t State;
    uint8_t Level_perc;
}Battery_Data_t;

```

10.1.3.2 Request description

10.1.3.2.1 Device information access (ID = 0)

To get device information, the following bytes sequence need to be sent "as is":

0x7E	0x04	0x00	0x10	0xA7	0x07	0x46	0xE7
------	------	------	------	------	------	------	------

Reply payload. **Frame ID = 0**

	Type	Size (byte)	Description
1	byte[15+1]	16	Device manufacturer string (zero terminated string)
2	byte[15+1]	16	Device part number string (zero terminated string)
3	byte[15+1]	16	Device serial number string (zero terminated string)
4	UINT	4	Firmware number
5	UINT	4	Firmware version : 0xAABBCCDD => AA.BB.CC.DD
6	10.1.3.1.1	10.1.3.1.1	Current date and time
7	Byte	1	Time zone index : 00 : (UTC-12:00) Universal line -12 01 : (UTC-11:00) Universal line -11 02 : (UTC-10:00) Papeete, Honolulu 03 : (UTC-09:30) Marquesas Islands 04 : (UTC-09:00) Anchorage 05 : (UTC-08:00) Los Angeles, Vancouver, Tijuana 06 : (UTC-07:00) Phoenix, Calgary, Ciudad Juárez 07 : (UTC-06:00) Chicago, Guatemala City, Mexico City, San José, San Salvador, Winnipeg 08 : (UTC-05:00) New York, Lima, Toronto, Bogotá, Havana, Kingston 09 : (UTC-04:00) Caracas, Santiago, La Paz, Manaus, Halifax, Santo Domingo 10 : (UTC-03:30) St. John's 11 : (UTC-03:00) Buenos Aires, Montevideo, São Paulo 12 : (UTC-02:00) Fernando de Noronha 13 : (UTC-01:00) Cape Verde, Greenland, Portugal 14 : (UTC+00:00) Accra, Casablanca, Dakar, Dublin, Lisbon, London 15 : (UTC+01:00) Berlin, Lagos, Madrid, Paris, Rome, Tunis, Vienna, Warsaw 16 : (UTC+02:00) Athens, Bucharest, Cairo, Helsinki, Jerusalem, Johannesburg, Kiev 17 : (UTC+03:00) Istanbul, Moscow, Nairobi, Baghdad, Doha, Khartoum, Minsk, Riyadh 18 : (UTC+03:30) Tehran 19 : (UTC+04:00) Baku, Dubai, Samara 20 : (UTC+04:30) Kabul 21 : (UTC+05:00) Karachi, Tashkent, Yekaterinburg 22 : (UTC+05:30) Delhi, Colombo 23 : (UTC+05:45) Kathmandu 24 : (UTC+06:00) Almaty, Dhaka, Omsk 25 : (UTC+06:30) Yangon 26 : (UTC+07:00) Jakarta, Bangkok, Krasnoyarsk, Ho Chi Minh City 27 : (UTC+08:00) Beijing, Taipei, Singapore, Kuala Lumpur, Perth, Manila, Denpasar 28 : (UTC+08:45) Eucla 29 : (UTC+09:00) Seoul, Tokyo, Ambon, Yakutsk, Pyongyang 30 : (UTC+09:30) Adelaide 31 : (UTC+10:00) Port Moresby, Sydney, Vladivostok 32 : (UTC+10:30) New South Wales 33 : (UTC+11:00) Noumea 34 : (UTC+12:00) Auckland, Suva 35 : (UTC+12:45) Chatham Islands 36 : (UTC+13:00) Apia, Nuku'alofa 37 : (UTC+14:00) Kiribati

```
typedef struct _Device_Information_t_
{
    char        Manufacturer[15+1];
    char        PN[15+1];
    char        SN[15+1];
    uint32_t    FirmwareNumber;
    uint32_t    FirmwareVersion;
    DateTime_t  DateTime;
    uint8_t     TimeZone;
}Device_Information_t;
```

10.1.3.2.2 Device measurement access (ID = 1)

To get device information, the following bytes sequence need to be sent “as is”:

0x7E	0x04	0x00	0x11	0xA7	0x1E	0x43	0xE7
------	------	------	------	------	------	------	------

Reply payload. **Frame ID = 1**

	Type	Size (byte)	Description
1	10.1.3.1.4.2	10.1.3.1.4.2	Merged data
2	10.1.3.1.4.3	10.1.3.1.4.3	Dose data
3	10.1.3.1.4.4	10.1.3.1.4.4	Battery data
4	10.1.3.1.4.1	10.1.3.1.4.1	System state
5	UINT	4	Measurement ID: counter incremented every internal cycle (250 ms)

```
typedef struct _Device_Data_t_
{
    Merged_Measurement_t    Merged;
    Dose_Data_t             Dose;
    Battery_Data_t          Battery;
    SystemState_t           SystemState;
    uint32_t                 Id;
}Device_Data_t;
```

10.1.3.3 Appendix

Example using terminal:

The easiest way for decoding, if host memory uses little endian convention, is to declare a kind of structure and do a memory copy from received buffer to this structure.

10.1.3.3.1 Device information

Request: 7E 04 00 10 A7 07 46 E7

Answer : 0x23 0x21 0x41 0x63 0x63 0x75 0x52 0x61 0x64 0x21 0x23 0x45 0x00^{Length} 0x00 0x00^{Id}
 0x4D 0x41 0x4E 0x55 0x46 0x41 0x43 0x54 0x55 0x52 0x45 0x52 0x00 0x00 0x00 0x00 0x4E 0x4F
 0x4D 0x30 0x30 0x34 0x35 0x33 0x37 0x2D 0x43 0x00 0x00 0x00 0x00 0x00 0x30 0x30 0x30 0x30
 0x32 0x34 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x0B 0x06 0x00 0x00 0x00 0x00
 0x01 0x01 0xEE 0x41 0x68 0x06 0xC1 0x42 0x7E 0x00 0x0E 0x02 0x5B^{CRC}

Below table: "index inside whole frame" / "index in payload"

Start marker pattern

#	!	A	c	c	u	R	a	d	!	#
0x23	0x21	0x41	0x63	0x63	0x75	0x52	0x61	0x64	0x21	0x23
00 / --	01 / --	02 / --	03 / --	04 / --	05 / --	06 / --	07 / --	08 / --	09 / --	10 / --

Length	
0x45	0x00
11 / --	12 / --



Length
0x0045 = 69

ID	
0x00	0x00
13 / --	14 / --



ID
0x0000 = 0

Manufacturer

M	A	N	U	F	A	C	T	U	R	E	R				
0x4D	0x41	0x4E	0x55	0x46	0x41	0x43	0x54	0x55	0x52	0x45	0x52	0x00	0x00	0x00	0x00
15 / 00	16 / 01	17 / 02	18 / 03	19 / 04	20 / 05	21 / 06	22 / 07	23 / 08	24 / 09	25 / 10	26 / 11	27 / 12	28 / 13	29 / 14	30 / 15

Part Number

N	O	M	0	0	4	5	3	7	-	C					
0x4E	0x4F	0x4D	0x30	0x30	0x34	0x35	0x33	0x37	0x2D	0x43	0x00	0x00	0x00	0x00	0x00
31 / 16	32 / 17	33 / 18	34 / 19	35 / 20	36 / 21	37 / 22	38 / 23	39 / 24	40 / 25	41 / 26	42 / 27	43 / 28	44 / 29	45 / 30	46 / 31

Serial number

0	0	0	0	2	4										
0x30	0x30	0x30	0x30	0x32	0x34	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
47 / 32	48 / 33	49 / 34	50 / 35	51 / 36	52 / 37	53 / 38	54 / 39	55 / 40	56 / 41	57 / 42	58 / 43	59 / 44	60 / 45	61 / 46	62 / 47

Firmware #			
0x0B	0x06	0x00	0x00
63 / 48	64 / 49	65 / 50	66 / 51



Firmware #
0x0000060B = 1547

Firmware version			
0x00	0x00	0x01	0x01
67 / 52	68 / 53	69 / 54	70 / 55



Firmware version
0x01010000 = 1.1.0.0

Time			
0xEE	0x41	0x68	0x06
<small>71 / 56</small>	<small>72 / 57</small>	<small>73 / 58</small>	<small>74 / 59</small>



Time			
0x066841EE = 14:15:08.820			
06	68	41	EE
0000 0110	0110 1000	0100 0001	1110 1110
5 bits "Hours" = 0 1110 = 0x0E = 14 H 6 bits "Minutes" = 00 1111 = 0x0F = 15 min 6 bits "Seconds" = 00 1000 = 0x08 = 8 s 13 bits "Milliseconds" = 0 0011 0011 0100 = 0x0334 = 820 ms 2 bits "Daylight" = 00 = 0x0 = 0			

Date			
0xC1	0x42	0x7E	0x00
<small>75 / 60</small>	<small>76 / 61</small>	<small>77 / 62</small>	<small>78 / 63</small>



Date			
0x007E42C1 = 2020/02/24			
00	7E	42	C1
0000 0000	0111 1110	0100 0010	1100 0001
3 bits "Day of week" = 001 = 0x01 = Monday 5 bits "Day" = 1 1000 = 0x18 = 24 4 bits "Month" = 0010 = 0x02 = 2 = February 20 bits "Year" = 0000 0000 0111 1110 0100 = 0x007E4 = 2020			

Time zone index
0x0E
<small>79 / 64</small>



Time zone index
0x0E = 14 = UTC+0 (London)

CRC	
0x02	0x5B
<small>80 / --</small>	<small>81 / --</small>



CRC
0x5B02 = 23298

Information	
Manufacturer	MANUFACTURER
Part number	NOM004537-C
Serial number	000024
Firmware #	LOG001547
Firmware version	1.1.0.0
Date/Time	2020/02/24 14:15:08.820
Time zone	[UTC 00:00] London Accra,Casablanca ▾

10.1.3.3.2 Device data

Request: 0x7E 0x04 0x00 0x11 0xA7 0x1E 0x43 0xE7

Answer : 0x23 0x21 0x41 0x63 0x63 0x75 0x52 0x61 0x64 0x21 0x23 0x33 0x00^{Length} 0x01 0x00^{Id} 0x81 0xD7 0x86 0x4E 0x3D 0xE8 0x0A 0xE5 0x40 0x13 0x39 0x13 0x3D 0x4F 0x69 0xE8 0x40 0xFE 0xD9 0x61 0x3E 0x2B 0xCD 0x27 0x00 0xC1 0x42 0x7E 0x00 0xF6 0xBE 0xFA 0x3D 0x00 0x34 0x12 0x46 0xA4 0x60 0x00 0x00 0x00 0x40 0x32 0x92 0x00 0x00 0x4F 0xA9^{CRC}

Start marker pattern

#	!	A	c	c	u	R	a	d	!	#
0x23	0x21	0x41	0x63	0x63	0x75	0x52	0x61	0x64	0x21	0x23
00 / --	01 / --	02 / --	03 / --	04 / --	05 / --	06 / --	07 / --	08 / --	09 / --	10 / --

Length	
0x33	0x00
11 / --	12 / --



Length
0x0033 = 51

ID	
0x01	0x00
13 / --	14 / --



ID
0x0001 = 1

Merged data

State
0x81
15 / 00



State
0x81
1000 0001
[0-1] = 1 = from low range (SED PRD/CsI(Tl))
[2] = 0 = measurement is consistent
[3-5] = 0 = reserved
[6] = 0 = device not in overload state
[7] = 1 = device initialized

Dose rate (µSv/h)			
0xD7	0x86	0x4E	0x3D
16 / 01	17 / 02	18 / 03	19 / 04



Dose rate (µSv/h)
0x3D4E86D7 = 0.050421562

Count rate (cps)			
0xE8	0x0A	0xE5	0x40
20 / 05	21 / 06	22 / 07	23 / 08



Count rate (cps)
0x40E50AE8 = 7.15758133

Background dose rate (µSv/h)			
0x13	0x39	0x13	0x3D
24 / 09	25 / 10	26 / 11	27 / 12



Background dose rate (µSv/h)
0x3D133913 = 0.0359431021

Background count rate (cps)			
0x4F	0x69	0xE8	0x40
<small>28 / 13</small>	<small>29 / 14</small>	<small>30 / 15</small>	<small>31 / 16</small>



Background count rate (cps)
0x40E8694F = 7.262855

Level			
0xFE	0xD9	0x61	0x3E
<small>32 / 17</small>	<small>33 / 18</small>	<small>34 / 19</small>	<small>35 / 20</small>



Level
0x3E61D9FE = 0.220558137

Time			
0x2B	0xCD	0x27	0x00
<small>36 / 21</small>	<small>37 / 22</small>	<small>38 / 23</small>	<small>39 / 24</small>



Dose

Time			
0x0027CD2B = 11:41:57.019			
00	27	CD	2B
0000 0000	0010 0111	1100 1101	0010 1011

5 bits "Hours" = 0 1011 = 0x0B = 11 H
 6 bits "Minutes" = 10 1001 = 0x29 = 41 min
 6 bits "Seconds" = 11 1001 = 0x39 = 57 s
 13 bits "Milliseconds" = 0 0000 0001 0011 = 0x0013 = 19 ms
 2 bits "Daylight" = 00 = 0x0 = 0

Date			
0xC1	0x42	0x7E	0x00
<small>40 / 25</small>	<small>41 / 26</small>	<small>42 / 27</small>	<small>43 / 28</small>



Date			
0x007E42C1 = 2020/02/24			
00	7E	42	C1
0000 0000	0111 1110	0100 0010	1100 0001

3 bits "Day of week" = 001 = 0x01 = Monday
 5 bits "Day" = 1 1000 = 0x18 = 24
 4 bits "Month" = 0010 = 0x02 = 2 = February
 20 bits "Year" = 0000 0000 0111 1110 0100 = 0x007E4 = 2020

Dose (µSv)			
0xF6	0xBE	0xFA	0x3D
<small>44 / 29</small>	<small>45 / 30</small>	<small>46 / 31</small>	<small>47 / 32</small>



Dose (µSv)
0x3DFABEF6 = 0.122434542

Duration (s)			
0x00	0x34	0x12	0x46
<small>48 / 33</small>	<small>49 / 34</small>	<small>50 / 35</small>	<small>51 / 36</small>



Duration (s)
0x46123400 = 9357

Battery

State
0xA4
<small>52 / 37</small>



State
0xA4 1010 0100
[0] = 0 = battery level is not low [1] = 0 = Battery level is not critical [2] = 1 = USB is connected (charging is battery present) [3-5] = reserved [6] = 0 no failure detected [7] = 0 Battery measurement initialized

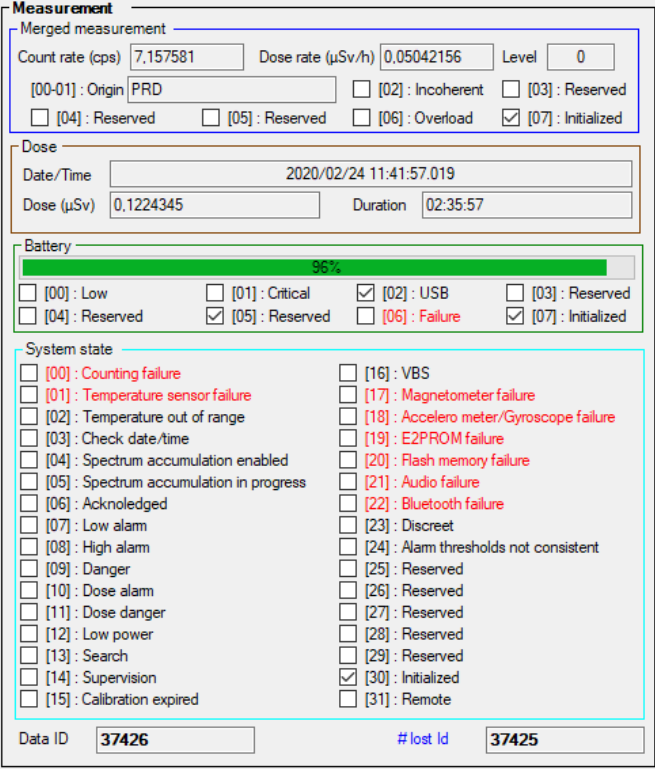
Level %
0x60
<small>53 / 38</small>



Level %
0x60 = 96%

System state

State				▶	State
0x00 <small>54 / 39</small>	0x00 <small>55 / 40</small>	0x00 <small>56 / 41</small>	0x40 <small>57 / 42</small>		0x40000000



Measurement

Merged measurement

Count rate (cps) 7,157581 Dose rate (µSv/h) 0,05042156 Level 0

[00-01] : Origin PRD [02] : Incoherent [03] : Reserved

[04] : Reserved [05] : Reserved [06] : Overload [07] : Initialized

Dose

Date/Time 2020/02/24 11:41:57.019

Dose (µSv) 0,1224345 Duration 02:35:57

Battery

96%

[00] : Low [01] : Critical [02] : USB [03] : Reserved

[04] : Reserved [05] : Reserved [06] : Failure [07] : Initialized

System state

<input type="checkbox"/> [00] : Counting failure	<input type="checkbox"/> [16] : VBS
<input type="checkbox"/> [01] : Temperature sensor failure	<input type="checkbox"/> [17] : Magnetometer failure
<input type="checkbox"/> [02] : Temperature out of range	<input type="checkbox"/> [18] : Accelerometer/Gyroscope failure
<input type="checkbox"/> [03] : Check date/time	<input type="checkbox"/> [19] : E2PROM failure
<input type="checkbox"/> [04] : Spectrum accumulation enabled	<input type="checkbox"/> [20] : Flash memory failure
<input type="checkbox"/> [05] : Spectrum accumulation in progress	<input type="checkbox"/> [21] : Audio failure
<input type="checkbox"/> [06] : Acknowledged	<input type="checkbox"/> [22] : Bluetooth failure
<input type="checkbox"/> [07] : Low alarm	<input type="checkbox"/> [23] : Discreet
<input type="checkbox"/> [08] : High alarm	<input type="checkbox"/> [24] : Alarm thresholds not consistent
<input type="checkbox"/> [09] : Danger	<input type="checkbox"/> [25] : Reserved
<input type="checkbox"/> [10] : Dose alarm	<input type="checkbox"/> [26] : Reserved
<input type="checkbox"/> [11] : Dose danger	<input type="checkbox"/> [27] : Reserved
<input type="checkbox"/> [12] : Low power	<input type="checkbox"/> [28] : Reserved
<input type="checkbox"/> [13] : Search	<input type="checkbox"/> [29] : Reserved
<input type="checkbox"/> [14] : Supervision	<input checked="" type="checkbox"/> [30] : Initialized
<input type="checkbox"/> [15] : Calibration expired	<input type="checkbox"/> [31] : Remote

Data ID 37426 #lost Id 37425

[00] = 0 = counting OK

[01] = 0 = Temperature sensor OK

[02] = 0 = Temperature OK

[03] = 0 = Date/time OK

[04] = 0 = Accumulation disabled

[05] = 0 = No accumulation

[06] = 0 = device not in acknowledged state

[07] = 0 = no low alarm in progress

[08] = 0 = no high alarm in progress

[09] = 0 = no danger alarm in progress

[10] = 0 = no dose alarm in progress

[11] = 0 = no dose danger in progress

[12] = 0 = device not in low power state

[13] = 0 = "normal mode" in progress

[14] = 0 = reserved

[15] = 0 = Calibration expired

[16] = 0 = VBS triggered

[17] = 0 = Magnetometer OK

[18] = 0 = Accelerometer/Gyroscope OK

[19] = 0 = E2Prom memory OK

[20] = 0 = Flash memory OK

[21] = 0 = Audio OK

[22] = 0 = Bluetooth OK

[23] = 0 = Not in discreet mode

[24] = 0 = Alarm thresholds OK

[25] = 0 = Reserved

[26] = 0 = Reserved

[27] = 0 = Reserved

[28] = 0 = Reserved

[29] = 0 = Reserved

[30] = 1 = Initialized

[31] = 0 = no remote control

Measurement ID				▶	Measurement ID
0x32 <small>58 / 43</small>	0x92 <small>59 / 44</small>	0x00 <small>60 / 45</small>	0x00 <small>61 / 46</small>		0x00009232 = 37426

CRC		▶	CRC	
0x4F <small>62 / --</small>	0xA9 <small>63 / --</small>		0x5B02 = 23298	

10.1.3.3.3 Bluetooth Connection

The Transparent UART Service is instantiated as a Primary Service. Its UUID is 49535343-FE7D-4AE5-8FA9-9FAFD205E455. The Transparent UART Service contains the following data characteristics:

transparent UART Transmit (TX) Characteristic

The Transparent UART TX Characteristic is used for data transmission by the Server or the Client. Once the Client Characteristic Configuration Descriptor (CCCD) of Transparent UART TX Characteristic is enabled, the Server sends data to the Client using the Notify property. The Client can also send data to the Server using the “Write”/ “Write without response” properties.

The transparent UART TX UUID is: 49535343-1E4D-4BD9-BA61-23C647249616 (properties: Notify, Write, Write without response).

When the Bluetooth connection with the AccuRad PRD is established, it is recommended to wait 1s before sending any request to the device else, the communication can fail.

For safety reasons, the Bluetooth connection is using the following timeout:

- Discoverable duration: AccuRad is discoverable during a period of 60s after a scan NFC or a connection lost. If no valid communication occurs during this period, AccuRad will turn off his Bluetooth connection. No effect if Bluetooth is set to opened mode.
- Connection lost timeout: When the connection is established, AccuRad must receive a valid communication message at least every 2.5s. If it is not the case, it will switch to discoverable mode.

For more information about the various Bluetooth modes, refer to §6.5 *Bluetooth*.

10.2 Appendix 2: Data Export Examples

Data stored in the database can be exported in two different formats: .n42 or .xlsx files.

The ANSI N42.42 2012 files contain measurement data plus spectra data, xlsx files contain measurement data only. Both file types are generated by the AccuRad App and the AccuRad Management Center PC software tool.

10.2.1 .n42 file example

```
<?xml version="1.0" encoding="utf-8"?>
<RadInstrumentData xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://physics.nist.gov/N42/2011/N42
http://physics.nist.gov/N42/2011/n42.xsd" xmlns="http://physics.nist.gov/N42/2011/N42">
  <RadInstrumentInformation id="RadInstrumentInformation-1">
    <RadInstrumentManufacturerName>Mirion Technologies</RadInstrumentManufacturerName>
    <RadInstrumentIdentifier>000014</RadInstrumentIdentifier>
    <RadInstrumentModelName>AccuRad PRD</RadInstrumentModelName>
    <RadInstrumentClassCode>Personal Radiation Detector</RadInstrumentClassCode>
    <RadInstrumentVersion>
      <RadInstrumentComponentName>Firmware</RadInstrumentComponentName>
      <RadInstrumentComponentVersion>1.4.0.0</RadInstrumentComponentVersion>
    </RadInstrumentVersion>
    <RadInstrumentVersion>
      <RadInstrumentComponentName>Hardware</RadInstrumentComponentName>
      <RadInstrumentComponentVersion>0</RadInstrumentComponentVersion>
    </RadInstrumentVersion>
    <RadInstrumentQualityControl>
      <InspectionDateTime>2019-01-01T00:00:00Z</InspectionDateTime>
      <InCalibrationIndicator>true</InCalibrationIndicator>
    </RadInstrumentQualityControl>
  </RadInstrumentInformation>
  <RadDetectorInformation id="RadDetectorInformation-1">
    <RadDetectorCategoryCode>Gamma</RadDetectorCategoryCode>
    <RadDetectorKindCode>Csi</RadDetectorKindCode>
    <RadDetectorVolumeValue>2.8</RadDetectorVolumeValue>
  </RadDetectorInformation>
  <RadDetectorInformation id="RadDetectorInformation-2">
    <RadDetectorCategoryCode>Gamma</RadDetectorCategoryCode>
    <RadDetectorKindCode>Other</RadDetectorKindCode>
    <RadDetectorDescription>PIN diode</RadDetectorDescription>
  </RadDetectorInformation>
  <AnalysisResults id="AnalysisResults-5">
    <AnalysisStartDateTime>2021-04-28T14:32:52.242Z</AnalysisStartDateTime>
    <AnalysisComputationDuration>PT6.2425</AnalysisComputationDuration>
    <RadAlarm radDetectorInformationReferences="RadDetectorInformation-1">
      <RadAlarmDateTime>2021-04-28T14:32:52.242Z</RadAlarmDateTime>
      <RadAlarmCategoryCode>Gamma</RadAlarmCategoryCode>
      <RadAlarmDescription>Danger</RadAlarmDescription>
    </RadAlarm>
    <DoseAnalysisResults>
      <AverageDoseRateValue>10.5425425</AverageDoseRateValue>
      <MaximumDoseRateValue>15.9321518</MaximumDoseRateValue>
      <MinimumDoseRateValue>0.0900926441</MinimumDoseRateValue>
      <TotalDoseValue id="TotalDoseValue-5">0</TotalDoseValue>
    </DoseAnalysisResults>
  </AnalysisResults>
</RadInstrumentData>
```



Note:

.n42 files are not directly generated by the AccuRad PRD.

Use the AccuRad PRD App or AccuRad Management Center PC software tool to generate .n42 files.

10.2.2 .xlsx files description

Excel-compatible datafiles. Their contents vary depending on the type of export.

Designation	Description	Alarm history	Dose history	Failure history	Info history
Device part number	-	X	X	X	X
Device serial number	-	X	X	X	X
Device calibration date	Date of the last calibration of the device	X			
Id	Auto-incremental measurement Id	X	X	X	X
Index	Event memory index	X	X		X
Type	Type of recorded event: alarm, high alarm, danger	X		X	X
Date	Event start date & time	X		X	X
Operational duration	Moment when the event occurred after starting the device	X	X		X
Duration	Event duration	X	X	X	X
Saturated	If this item is set on "True", it means that the detector has been saturated during the alarm; the measurement can be affected by the saturation	X	X		
Min. dose rate	Minimum dose rate recorded during the event	X	X		
Min. dose rate origin	Indicate from which detector the measurement has been done	X	X		
Max. dose rate	Maximum dose rate recorded during the event	X	X		
Max. dose rate origin	Indicate from which detector the measurement has been done	X	X		
Mean dose rate	Average of the dose rate over the event period	X			
Mean dose rate origin	Indicate from which detector the measurement has been done	X			
Dose	Dose measured by the high range detector over the event period	X	X		
Start date	Event start date and hour		X		
End date	Event end date and hour		X		

10.2.2.1 Alarm history file example

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Device part number	Device serial number	Device calibration date	Id	Index	Type	Date	Operational duration	Duration	Saturated	Min. dose rate	Min. dose rate origin	Max. dose rate	Max. dose rate origin	Mean dose rate	Mean dose rate origin	Dose			
2	NOM004537-C	000014	01/01/2019	1	0	High alarm	28/04/2021 10:25:44.3360000	00:00:11	False	0,16204907 µSv/h	Low range detector	1,4155426 µSv/h	Low range detector	0,90001607 µSv/h	Low range detector	0,12741373 µSv/h	Low range detector	0	mSv	
3	NOM004537-C	000014	01/01/2019	2	1	Low alarm	28/04/2021 10:25:59.6160000	00:00:02	False	0,02936359 µSv/h	Low range detector	0,26028097 µSv/h	Low range detector	0,09541515 µSv/h	Low range detector	5,13390827 µSv/h	Low range detector	0	mSv	
4	NOM004537-C	000014	01/01/2019	3	2	Low alarm	28/04/2021 10:26:07.8820000	00:00:03	False	0,05815175 µSv/h	Low range detector	0,20036016 µSv/h	Low range detector	0,09541515 µSv/h	Low range detector	5,13390827 µSv/h	Low range detector	0	mSv	
5	NOM004537-C	000014	01/01/2019	4	3	High alarm	28/04/2021 10:26:22.9120000	00:00:06	False	0,20688999 µSv/h	Low range detector	9,91823387 µSv/h	Low range detector	10,5425425 µSv/h	Low range detector	0,004828468 µSv/h	Low range detector	0	mSv	
6	NOM004537-C	000014	01/01/2019	5	4	Danger	28/04/2021 10:26:49.9630000	00:00:06	False	0,09009264 µSv/h	Low range detector	15,9321518 µSv/h	Low range detector	0,005155851 mSv						

10.2.2.2 Dose history file example

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Device part number	Device serial number	Id	Index	Operational duration	Start date	End date	Duration	Saturation	Max. dose rate	Max. dose rate origin	Mean dose rate	Mean dose rate origin	Dose		
2	NOM004537-C	000014	2640	479	1.17:21:25.0470000	26/03/2021 11:19:34	26/03/2021 11:21:34	00:02:00	None	209,5927124 µSv/h	High range detector	158,142868 µSv/h	High range detector	0,004850197 mSv		
3	NOM004537-C	000014	2641	480	1.17:23:25.2970000	26/03/2021 11:21:34	26/03/2021 11:23:34	00:02:00	None	186,082077 µSv/h	High range detector	146,5434418 µSv/h	High range detector	0,005131674 mSv		
4	NOM004537-C	000014	2642	481	1.17:25:25.5470000	26/03/2021 11:23:35	26/03/2021 11:25:35	00:02:00	None	198,0353241 µSv/h	High range detector	158,5639496 µSv/h	High range detector	0,005626137 mSv		
5	NOM004537-C	000014	2643	482	1.17:27:25.7970000	26/03/2021 11:25:35	26/03/2021 11:27:35	00:02:00	None	240,8490448 µSv/h	High range detector	170,370636 µSv/h	High range detector	0,005471561 mSv		
6	NOM004537-C	000014	2644	483	1.17:29:26.0470000	26/03/2021 11:27:35	26/03/2021 11:29:36	00:02:00	None	237,5287476 µSv/h	High range detector	165,2097626 µSv/h	High range detector	0,005652424 mSv		
7	NOM004537-C	000014	2645	484	1.17:31:26.2970000	26/03/2021 11:29:36	26/03/2021 11:31:36	00:02:00	None	242,4992981 µSv/h	High range detector	174,6073761 µSv/h	High range detector	0,004828468 mSv		
8	NOM004537-C	000014	2646	485	1.17:33:26.5470000	26/03/2021 11:31:36	26/03/2021 11:33:37	00:02:00	None	203,714386 µSv/h	High range detector	144,3028717 µSv/h	High range detector	0,005195972 mSv		
9	NOM004537-C	000014	2647	486	1.17:35:26.7970000	26/03/2021 11:33:37	26/03/2021 11:35:37	00:02:00	None	225,9923096 µSv/h	High range detector	160,1825409 µSv/h	High range detector			

10.2.2.3 Failure history file example

A	B	C	D	E	F	
1	Device part number	Device serial number	Id	Type	Date	Duration
2	NOM004537-C	0000C5	10	Bluetooth failure	14/05/2020 13:21:00	00:00:10
3	NOM004537-C	0000C5	11	Counting fault	19/05/2020 08:49:14	00:00:10
4	NOM004537-C	0000C5	12	Counting fault	25/05/2020 08:51:18	00:00:10
5	NOM004537-C	0000C5	13	Bluetooth failure	25/05/2020 12:21:47	00:00:10

10.2.2.4 Information history file example

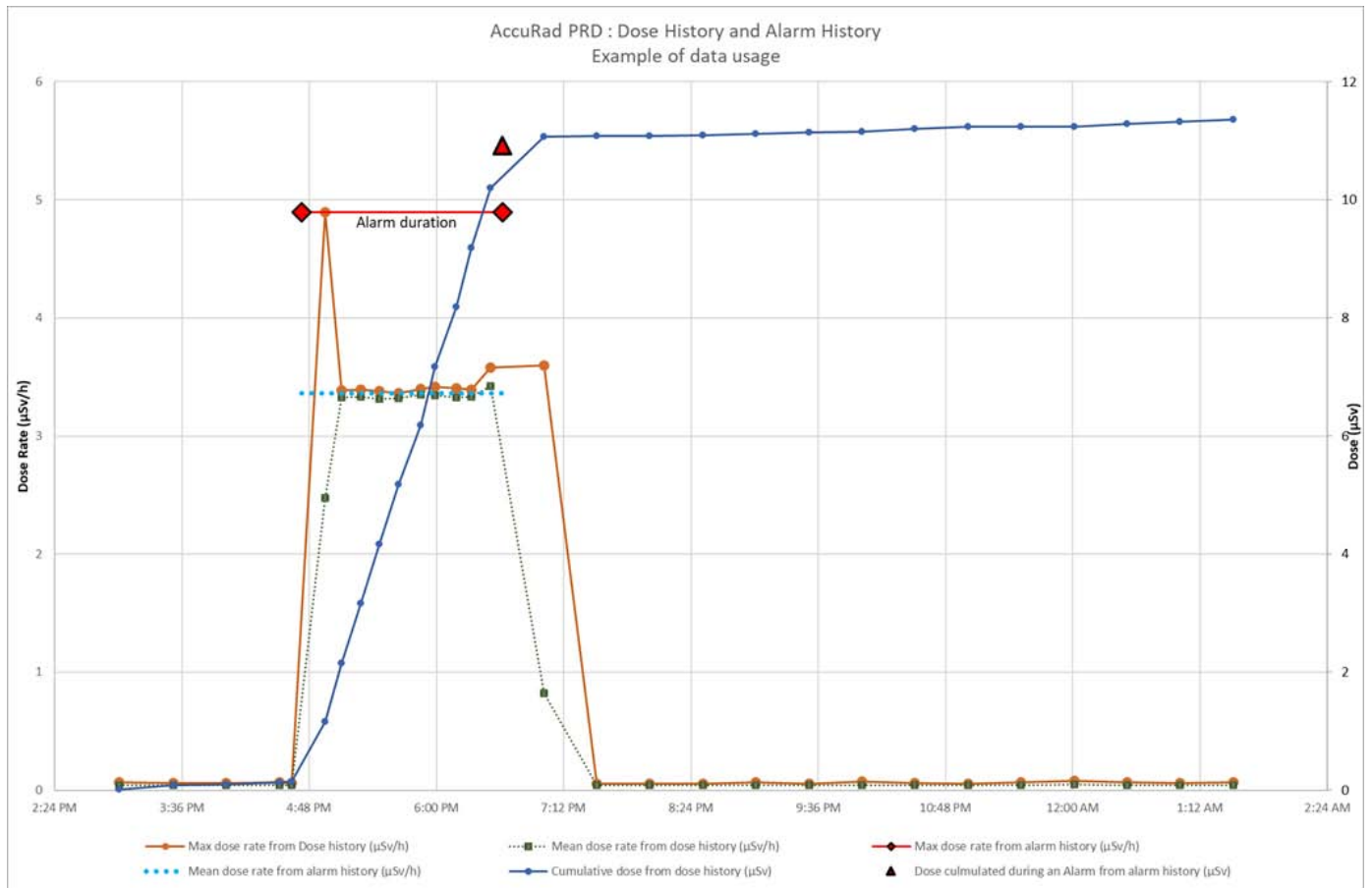
A	B	C	D	E	F	G	H	
1	Device part number	Device serial number	Id	Index	Type	Date	Operational duration	Duration
2	NOM004537-C	000014	28	11	Background level too high	08/04/2021 14:31:26	7.23:50:23.6250000	00:00:01
3	NOM004537-C	000014	29	12	Background level too high	08/04/2021 14:33:42	7.23:52:39.3750000	00:00:42
4	NOM004537-C	000014	30	13	Background level too high	08/04/2021 14:46:54	8.00:05:50.1250000	00:00:16
5	NOM004537-C	000014	31	14	Background level too high	08/04/2021 14:47:10	8.00:06:06.1250000	00:00:20
6	NOM004537-C	000014	32	15	Background level too high	08/04/2021 14:47:31	8.00:06:26.6250000	00:00:06
7	NOM004537-C	000014	33	0	Background level too high	08/04/2021 14:47:37	8.00:06:33.1250000	00:00:02

10.2.3 Example of use of dose history and alarm history

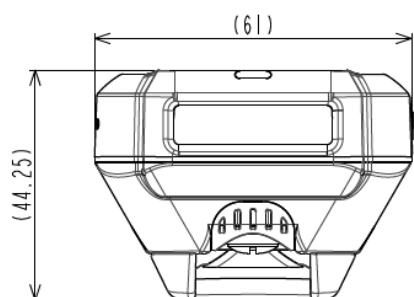
The AccuRad PRD is set to record dose, average and maximum dose rate (dose history) every 30 minutes if the dose increment is less than 1 μSv or every 1 μSv .

Moreover, it records the beginning and the end of the alarms, the maximum and average dose rate and the dose integrated during the alarm.

Both recordings are superimposed on the graph below. One can notice that the record frequency of the dose history increases when the source was present in order to get a more accurate analysis of the post-event.

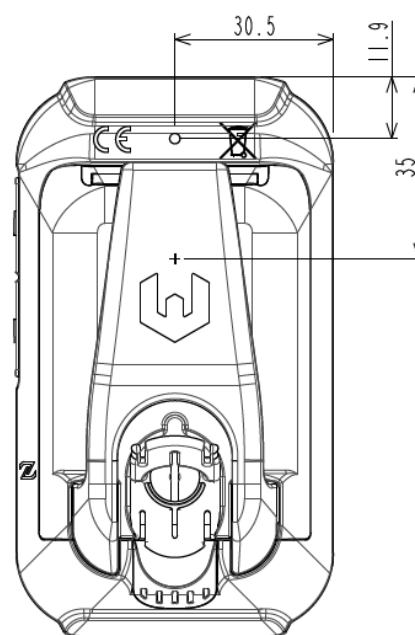
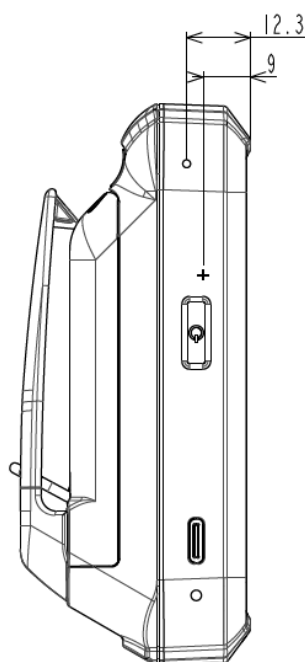
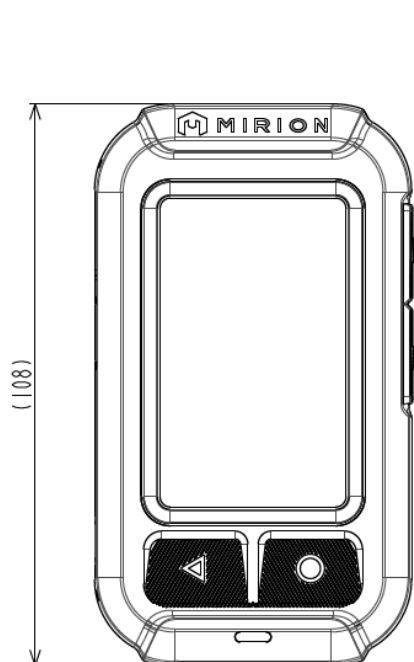


10.3 Appendix 3: AccuRad PRD drawings and reference point for dose rate measurement

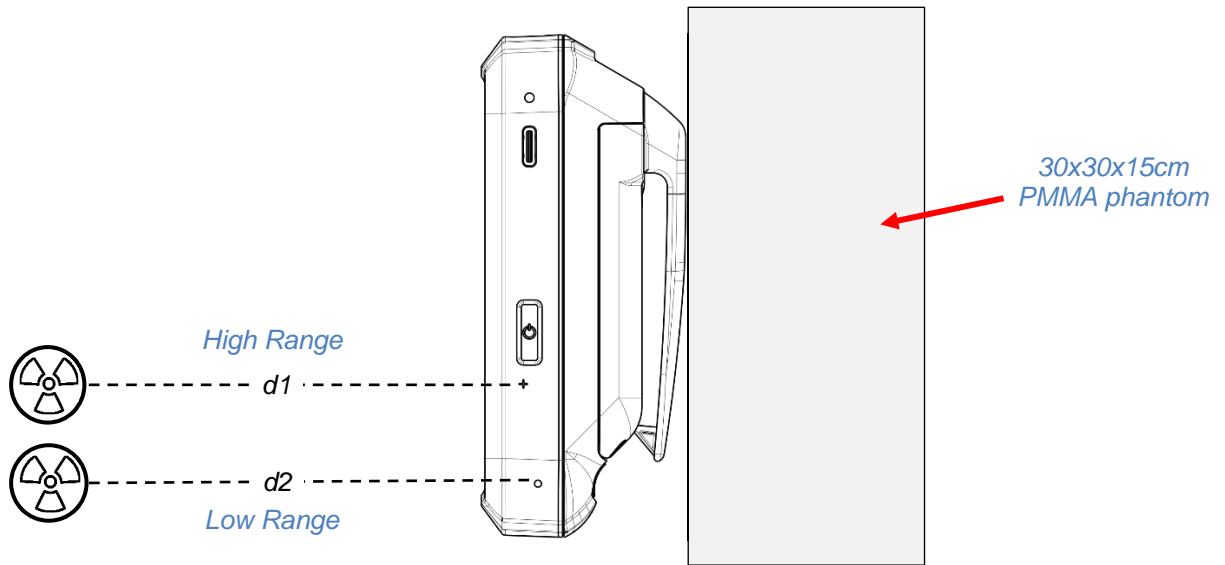


○ LOW RANGE DETECTOR

+ HIGH RANGE DETECTOR



10.4 Appendix 4: Calibration recommendations



The low range detector has a background measurement range of 1mSv/h (100 mrem/h) (Cs-137). To verify its dose equivalent rate response, expose it at an equivalent dose rate between 10% and 80% of the measurement range. Please refer to sensitivity detector (refer to §9.2 Detectors).

Example for Cs-137: between 8 μ Sv/h (800 μ rem/h) and 0.8mSv/h (80 mrem/h).

The average dose rate of the low range detector can be obtained by doing the average of ten successive readings on the display.

The high range detector has an extended measurement range up to 10Sv/h (1000 rem/h). To verify its dose equivalent rate response, expose it at an equivalent dose rate comprised between 0.005% and 50% of the measurement range. Please refer to sensitivity detector (refer to §9.2 Detectors).

Example for Cs-137: between 50mSv/h (5 rem/h) to 5Sv/h (500 rem/h).

The average dose rate of the high range detector can be obtained by doing the average of ten successive readings on the display, using a dose rate higher than 50 mSv/h (5 rem/h). If your source is not strong enough, you can use dose integration to determine the average dose rate. In this case, reset the dose using the PDR menu or the AMC 'reset dose' button on the Device screen (refer to §7.3.2.1 Device), expose the device for a time higher than 100 seconds, and a minimum dose rate of 600 μ Sv/h (60mrem/h). Then calculate the average dose rate dividing the integrated dose (in current dose unit) by the time (in hour).



Note:

The integrated dose is always measured by the high range detector.

If the equivalent dose rate used for the calibration of the high range detector is lower than 0.01Sv/h (1 rem/h), it is recommended to use the integrated dose value with a time-controlled irradiation using an exposure duration of more than three minutes. Direct reading can be used if the equivalent dose rate used for calibration of the high range detector is higher than 0.01Sv/h (1 rem/h).




Note:

d1 and d2 distances can be considered as equal if the source is far enough; but not if the source is close.

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- ⇒ Chapter, paragraph and page concerned.

