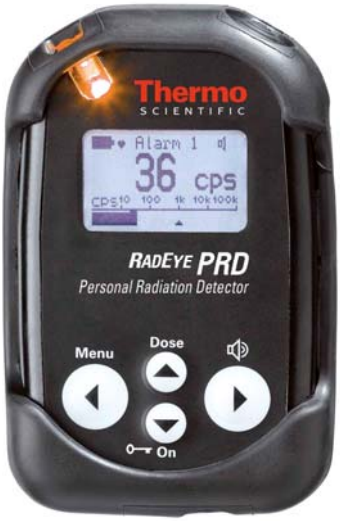
Thermo
SCIENTIFIC

Operating Instructions DB-057-050322 E

RadEye PRD

Alarming Personal Radiation Detector



REVISIONS SHEET:

Rev.	Rev. state	Dept. resp.	Name	Rev. page	Cat. *)	Explanation
	20.06.05	RM&P-E	Tr			
A	08.08.05	RM&P-M	Iw	cpl. 4-7 7-8	C I A	 Clarification about NBR Version **1.05**
B	28.09.05	RM&P-E	Tr	2-3, 2-5 5-2 7-9	A A A	RTC-Reset Error Codes, Watchdog **V 1.08**
C	08.12.05	RM&P-E	Tr	2-1, 2-5 7-9	C A	Scope of delivery Learning phase **V 1.10**
D	04.07.06	RM&P-EH	Pi	cpl.	A	New menu func-tions **V 1.16** date format acc. to ISO 8601 Acknowledgement sigma alarm
E	19.09.06	RM&P-EH	Pi	8-10	A	from **V 1.18**
F	18.01.07	RM&P-EH	Pi	cpl.	C	New menu Functions, bigger fonts from **V 1.31**
G	06.02.07	RM&P-EH	Pi	Cap. 6, 7 and 8	A	RadEye PRD-ER completed from **V 1.32**

Rev.	Rev. state	Dept. resp.	Name	Rev. page	Cat. *)	Explanation
H	29.03.07	RM&P-E	Tr	8-4	I	Diagram 8-3, 8-4
I	10.10.07	RM&P-E	Pi	1-2, 3-5	C	
J	18.10.07	RM&P-M	Iw	0-9, 3-5, 8-3 – 8-5	I	without PRD-ER
K	13.05.08	RM&P-E	Pi	3-4, 8-11	C	Set of date and time

*) Category C: editorial correction
I: clearing improvement
A: substantial amendment

Explanations must be given, at least with Category A.

CONTENTS:

TABLE OF FIGURES:

SAFETY INSTRUCTIONS

The RadEye PRD is not intended to be used as a personal dosimeter.
Due to the high detector sensitivity the dose rate measuring range of the RadEye PRD is limited.
Thus a reliable dose estimation is performed only, if the instrument was not exposed to higher radiation levels.
Otherwise an underestimation of the dose can be expected depending on the magnitude and duration of the overexposure.

Do not use the unit if error messages appear on the screen.

The earphone connector at the bottom side of the instrument must be exclusively used by equipment that is specified for use with RadEye PRD.

The instrument must not be used in explosive atmosphere.

WEEE Compliance:

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

Thermo Electron has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Electron's compliance with these Directives, the recyclers in your country, and information on Thermo Electron products which may assist the detection of substances subject to the RoHS Directive are available at **www.thermo.com/WEEERoHS**

1. Introduction

The Radiation Detection, Dose- and Dose Rate Monitor RadEye PRD is a highly sensitive and rugged measuring device to detect and localize radiation sources and to measure the dose rate of gamma radiation. The RadEye PRD is designed to meet the requirements in the ANSII standard 42.32 and 42.33 part 1 and IEC 62401. The characteristic feature of the RadEye PRD is the use of sophisticated low power technology components and microprocessor based, fully automatic self checks. No maintenance is required. The RadEye PRD incorporates a highly sensitive NaI(Tl) scintillation detector which is equipped with a miniature photo-multiplier allowing the detection of very low radiation levels. Thus, the RadEye PRD represents a high-performance measuring device for persons who are responsible for detecting and localizing radiation sources.

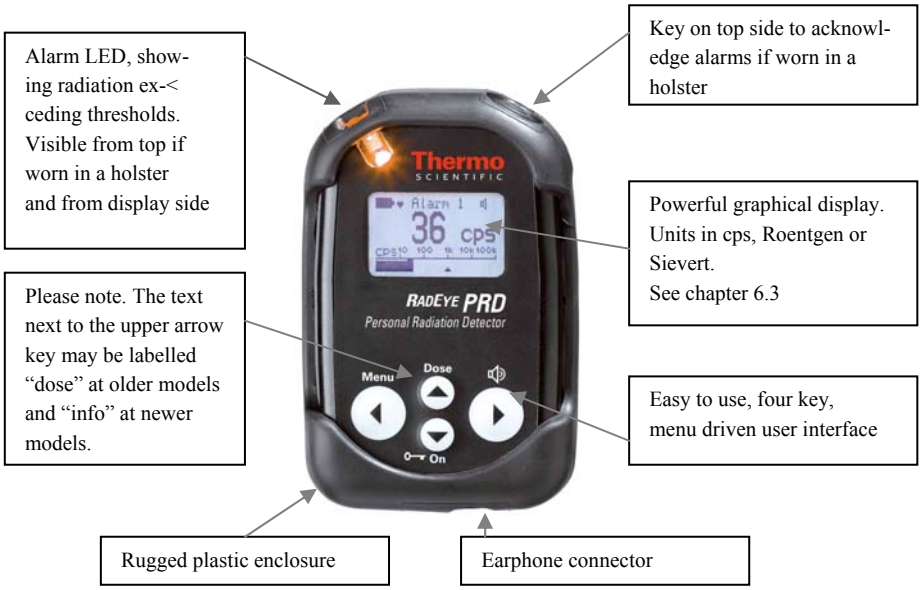
The last 1600 mean and maximum values of the dose rate and count rate are recorded internally and can be read out via serial interface.

Additionally the RadEye PRD logs the last 250 alarms, errors and changes of the configuration. All events can be read out via serial interface.

A real time clock is provided to add a time stamp to all buffer data.

The RadEye PRD enables measurement of detector pulse rates and energy compensated dose and dose rates.

All menu functions described in 3.1 can be configured to be invisible.
Thus the instrument can be configured to both, an extremely simple mode allowing just LCD-illumination and alarm acknowledgment to a very versatile mode for the more experienced user.



2. Installation and start-up

2.1 Scope of delivery

The RadEye PRD is delivered in a folding paper box together with two AAA cells, a rubber protection sleeve and an operating manual.

Ordering information for the accessories:

Holster	Part No.:	42506/7046
Earphone	Part No.:	42506/7037
Car holder	Part No.:	42506/7065
Desktop holder	Part No.:	42506/7060
Rubber sleeve Replacement	Part No.:	42506/7030-18

2.2 Inserting the battery

The two AAA-Alkaline cells as delivered with the instrument allow up to 600 h of normal operation.
AAA size rechargeable batteries can be used as well.

- Switch off the measuring instrument.
- Remove rubber boot.

- Open the cover of the battery compartment.
  Use of a coin is recommended.

- Exchange the batteries according to the shown polarity.
- Close the compartment cover, hooks first, care for the rubber seal being in it's groove.
- Switch on the unit again. (see chapter 2.4)

The instrument continues working in the operating mode set last (see chapter 3.2).
The measured values in the history memory remain stored.
The real time clock for time stamp of history values and logbook continue operation, if batteries are exchanged without

delays. If Real Time Clock is set, actual time and date is displayed for 3 s (see chapter 2.4).

If correct timing information of logbook and history is required, the Real Time Clock should be set by means of the PC-program.

To keep RTC running during battery exchange, batteries must be exchanged without delays.
History data and measurement parameters are stored permanently, even if batteries are removed.

RTC information is only required, if the instrument is switched off and on during operation and if correct timing information for history and logbook entries is needed.
For the last power on interval, the relative time information of logbook and history is corrected to actual PC clock time during read out. In these cases the setting of the clock is not required.

2.3 Mounting of the protection sleeve

The rubber protection sleeve improves ruggedness to mechanical shocks.

For mounting of the sleeve first put the instrument into the top of the sleeve. Then pull lower edges of the sleeve, one after the other into it's right position.

First step

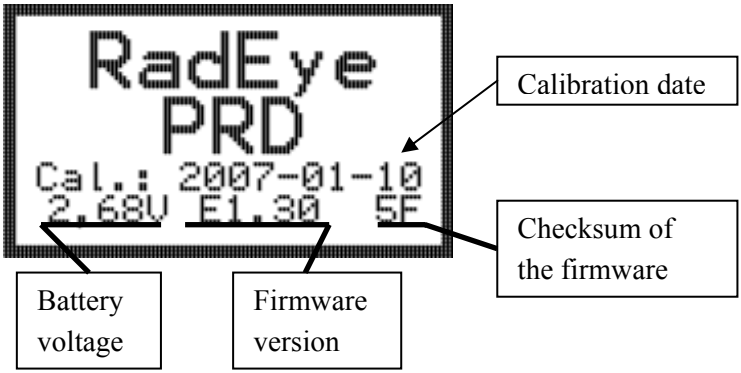
Second step

Front view

Rear view

2.4 Switching the unit on

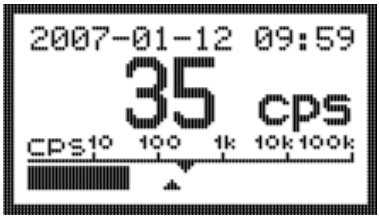
To switch on the RadEye PRD, keep the „ON“ button pressed for at least one second. The sound generator (beeper) is initiated.



Display during switch on.

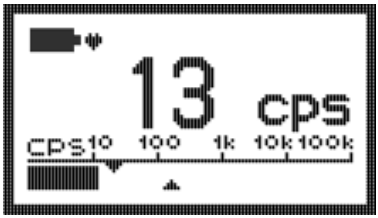
The RadEye PRD starts working with the parameters previously selected (operation mode, calibration factor, alarm threshold etc.)

If the real time clock is set, actual time and date is displayed for 3s.



In the operating mode „Sigma-Alarm“ (chapter 3.4), as well as for activated NBR-Alarm (chapter 4.7), the message “Learning” is displayed together with a progress bar for the first 30 s. During this time the sigma-alarm level is adapted more quickly to the current radiation level and the reference energy distribution is determined for the NBR evaluation.
During this time period the sigma alarm is active, however not yet with the full sensitivity. The NBR-Alarm is not yet active. In order to avoid erroneous initial parameters, the device should not be exposed to artificial gamma radiation during this phase.

Display during the learning phase.



The RadEye is set up

Unless otherwise specified by the customer when placing the order, the following values are set by the factory before delivery:

Operation mode	Count Rate
Sigma-Alarm	6
Alarm 1	Sigma-Alarm
Alarm 2	200 cps
Alarm-NBR	active
Artificial gamma indication (NBR)	normal sensitivity *)
Minimum count rate for NBR-Alarm	15 cps *)
Minimum count rate for Sigma alarm	30 cps *)
Alarm 1 and 2 for the dose	app. 16 Sv or 1600 R
Acoustic alarm (Sound)	active
LED alarm indication	active
Vibrator alarm indication	active
Acoustic count rate indication	Finder
Autosend	off
History recording interval	120 s *)
Safety Alarm	On *)
Safety Alarm	20 µSv/h or 2 mR/h

*) These parameters can only be changed through the serial interface by means of the configuration software.

Further parameters, used in other operation modes:

Alarm 1 for the Dose Rate mode	0.5 µSv/h or 50 µR/h
Alarm 2 for the Dose Rate mode	20 µSv/h or 2 mR/h
Alarm 1 for Count Rate mode, if sigma=off	50 cps
Alarm threshold 1 for the Level mode	2 (= 64 cps)
Alarm threshold 2 for the Level mode	3 (= 128 cps)

The alarm thresholds for dose rate and count rate are around 200 - 500 % above the typical normal background and allow sensitive, but false alarm free dose rate monitoring with a reasonable fast response time. The alarm thresholds for the dose are set to the maximum possible values, thus being deactivated. With the setting of the history recording interval of 120 s , the last 52 hours of operation will be stored in the history memory.

These default values can be changed by the user with the menu functions (chapter 3.1) or with the help of the optional PC-program „RadEye.EXE“ and the cable 42540/29. Furthermore, additional monitoring modes can be activated.

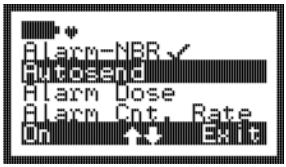
The calibration parameters can only be changed in the factory using special software tools.

3. Configuration

3.1 Menu functions

To enter the operating menu press the “Menu” key.
Scrolling through the single menu options is effected by the up / down arrow keys.
The display returns to its initial default setting in case no key has been activated for more than 10 seconds.
A j to be found behind some menu options means that the respective function is active.

The menu offers the following displays:



The above illustration depicts all menu options for the standard configuration.

Using the PC-Software and an interface adapter, the functions can be hidden. This allows the user to be given only the functions necessary to accomplish his measurement duties, thus simplifying the handling considerably.

The Up- and Down arrow key are used to scroll through the menu.

To select a menu option, release the left key as the respective menu option has been reached.

The meaning of the Menu key may change with the selected menu. The meaning is shown on the bottom of the display.
Change: Edit Alarm values
Off, **On**: Switching a function on and off
Select: Select a default display mode
Yes: Confirmation of an action
Exit: Exit menu
In Change menu the Up-/Down arrow keys are used to change a digit of an alarm value.

MENU DISPLAY	DESCRIPTION OF THE FUNCTION ACTIVATED BY THE LEFT KEY
Switch off	RadEye is switched off. Time and stored data are maintained.
Sound	Switching the acoustic alarm and the audible indication of keystrokes on/off
LED	Switching the optical alarm on/off
Vibrator	Switching the vibration alarm on/off
Count Rate	Select Count rate mode (cps)
Dose Rate	Select Dose rate mode (R/h or Sv/h): This function is disabeled in the default configuration.
Level	Select level mode (1 – 9): This function is disabeled in the default configuration.
Alarm Dose Rate	Allows setting of Alarm1 and 2 (R/h or Sv/h) for dose rate mode. This function is accessible only if the dose rate mode is active.
Alarm Cnt. Rate	Allows setting of Alarm1 and 2 (cps) and sigma for count rate mode. If sigma is set > 0, Alarm1 level is set automatically depending on learned background count rate.
Alarm Level	Allows setting the level alarm (1 – 9). This function is accessible only if the level mode is active.

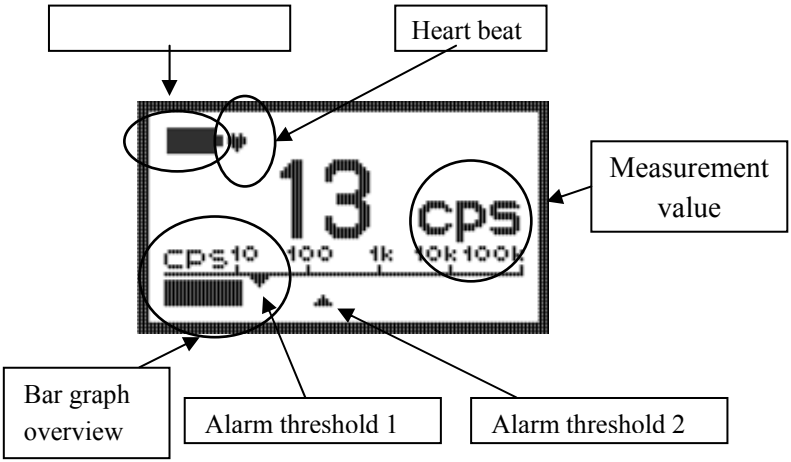
Alarm Dose	Allows setting of dose alarm 1 and 2 for all modes.
Alarm NBR	Activation or deactivation of NBR-Alarm.
Autosend	If activated, the instrument sends a data string periodically to the infrared port. This is used for radio transmission units.
Finder	Enabling and disabling of audible radiation intensity. Activation is done by audio keys (right button and top button).
Single Pulse	Enabling and disabling of single pulse indication. Activation is done by audio keys (right button and top button).
Backlight	Backlight always on/Backlight extinguish after 10 s.
Show Alarm	Display of alarms stored in alarm log.
Settings	- Switching between battery type Battery and Accu. It is used for the correct warning of low battery. - Set date and time of the real time clock.
Text Info	Displays the text info stored in the RadEye

3.2 Basic display

3.2.1 Count Rate Mode

3.2.1.1 Count Rate Mode with cps display (Recommended Mode)

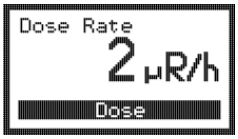
The standard display is indication of the actual count rate (cps). The **Alarm Cnt. Rate** thresholds are active.
This mode has the quickest display and alarm response.



Pressing the up arrow – key shows upon the
- 1st click: the current dose rate (µR/h or µSv/h),
- 2nd click: the accumulated dose (R or Sv)
  Additionally the remaining time until the dose alarm 1 is reached, assuming the current dose rate will persist.

- 3rd click: the mean value and max value of the measured count rate (cps), together with the time indicated since the last reset..

After 10 seconds or after 4th click standard display with count rate indication is activated again.



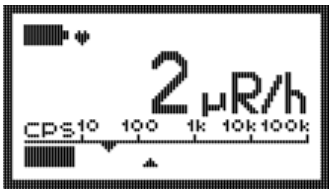
1st click

2nd click

3rd click

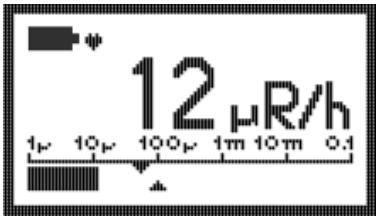
3.2.1.2 Count Rate Mode with Dose Rate Display

In this mode the measurement value of the dose rate is displayed together with the bar graph of the cps value. The count rate alarm thresholds are active. That is the alarming has a quick alarm response, while the calculating of the dose rate for low count rates takes place over a longer time. (see chapter 3.2.2).



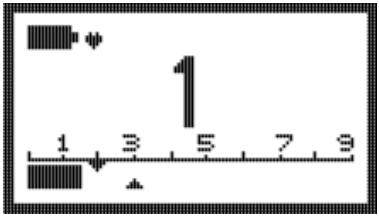
This mode is for rapid finding of radioactive sources while displaying true dose rate values. A press on the hot key (arrow up) results directly to the display of the accumulated dose respectively the mean- and max value.
This mode can be activated or deactivated alternatively to the Count Rate Mode (3.2.1) via PC-Software only.

3.2.2 Dose Rate Mode



This mode displays energy compensated dose rate. At background, a sliding window filter is used to smooth values. This filter reacts much slower to sudden radiation changes than count rate mode display. The **Alarm Dose Rate** thresholds are active

3.2.3 Level Mode



The level display shows count rate in steps from 1 to 9.
Level 0 means less than 16 cps, level 1 more than 16cps, level 2 more than 32 cps, up to level 9 more than 4096 cps. There is no variation in indication from 4096 cps.
Each subsequent level has twice as much cps as the preceding level. The **Alarm level** thresholds are active.
Overload indication is given at dose rates of more than 25mR/h as in the other modes.

3.3 Alarm thresholds

There are two alarm thresholds each allocated to dose, dose rate, count rate and level.

Two rate alarm thresholds corresponding to the chosen basic display mode are active. The two active rate alarm thresholds are marked at the bar graph.

Additionally the two dose thresholds are active.
In order to avoid dose alarms while using the instrument exclusively as a rate meter, the dose alarms can be set to the maximum level.

For Count Rate or Level mode it is possible to configure via the PC-program RadEye.exe the alarm threshold 2 for dose rate as a safety alarm.

Configuration of the alarms is possible via infrared interface (chapter 6.3) or via the menu.
As to the alarm activation, please also read chapter 4.2.

3.4 Alarm threshold based on the relative standard deviation (sigma threshold)

In general, the alarm thresholds refer to the basic display set. Exception: In case the basic display is the **Count Rate** operating mode and the sigma value set ranges between 2 and 9, the first alarm threshold is calculated every second from the

count rate of the background ratemeter according to the following empirical equation:

$$As1 = Cnt + n \cdot \sqrt{Cnt \cdot T + 80} / T$$

where As1: Alarm threshold 1
Cnt: Count rate of the background ratemeter
T: 4 s, Time of measurement sliding window
n: sigma value set between 2 and 9

Thus the actual alarm threshold adjusts itself automatically to the existing background radiation level. The actual setting of the alarm threshold 1 can be observed at the bar graph threshold mark. At power on of the instrument, the background ratemeter starts with its maximum value of 100cps, reaching its final value after 30 seconds.
Using the menu option **Alarm Cnt. Rate**, the exact value of the alarm threshold currently valid at the respective background can be displayed.

After acknowledgement of a sigma-alarm, the background ratemeter is set to the actual count rate. Accordingly the alarm threshold is increased and is fine adjusted during the next 15 seconds after acknowledgment. For this time the message „Learning“ together with a progress bar is displayed.

Alarm 2 is always referring to the total count rate without consideration of any learned background.

Sigma	Threshold at 10 cps background	Mean time to false alarm in seconds	Mean number of false alarms per working day (8h)
2	15	22	1310
3	18	370	77
4	21	16000	1.7
5	24	1000000	0.03
6	26	In practice, there are almost no false alarms at a constant irradiation	
7	29		
8	32		
9	35		

Table 1: Interrelationship between false alarm probability and sigma value

Recommended Sigma values:

Sigma = 6 enables almost false alarm free searching in areas with a fairly constant radiation background.

For general use, especially in an urban environment the setting of a minimum count rate in the range of typically 20cps – 60cps for the Alarm 1 via the PC-configuration program is recommended to avoid false alarms from certain natural materials. Frequently paving stone and plates made from granite contain substantial traces of Uranium and Thorium.

3.5 Setting alarm thresholds

The menu options **Alarm Cnt. Rate** , **Alarm Dose Rate**, **Alarm Dose** and **Alarm level** allow the alarm thresholds to be modified. For this setting, the user has 255 seconds time. Changing the value is effected by pressing the left (Change) button if the corresponding "Alarm" is selected:

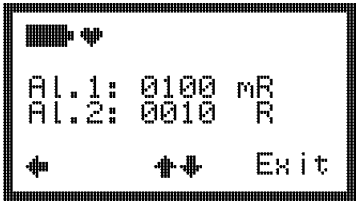
To increment the number, press the up/down arrow keys. To go on to the next digit or to quit the edit mode, menu use right/left arrow keys.
Once the last number has been set, quit the editing mode by pressing the "Exit"-key. Then, the value set is saved and the unit returns to the basic display.

Example:
The dose alarm threshold must be changed.

Press "Menu" key, and up/down arrow keys until
Alarm Dose is selected

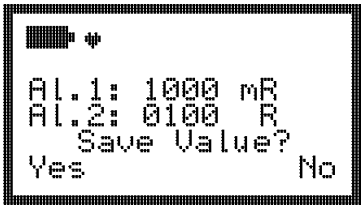
Then enter change menu by pressing "Change" key.

Edit value by pressing up / down keys
select digit by left / right keys
Pre unit "µ", "m" may be chosen as well.



Leaving the last digit with the right arrow key:

Confirm storage of edited value pressing “Yes”



Example:

The sigma value for the count rate alarm threshold must be changed.

Press “Menu” key, and up/down arrow keys until **Alarm Cnt. Rate** is selected

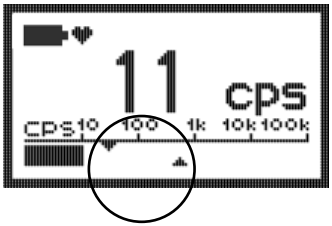
Then enter change menu by pressing “Change” key.

Edit value by pressing up / down keys

Sigma-Alarm: 0: off: Al.1 can be set as a constant threshold.

Sigma-Alarm 2....9: Al.1 is calculated from the actual background. Actual value is displayed.

Saving settings on leaving menu.



The set points of the actual alarm thresholds is seen at the marks on the intensity bar scale. The upper mark shows alarm threshold 1, the lower mark shows alarm threshold 2

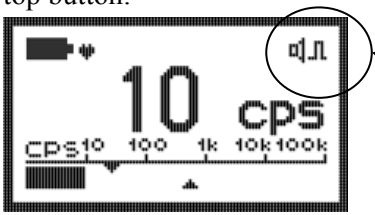
4. Operation

4.1 Audible single pulse indication and finder mode

With the single pulse indication being selected, each pulse of the detector generates a short audible signal emitted by the beeper.

An audible alarm signal caused by exceeding the alarm threshold is not given while single pulse indication is active.

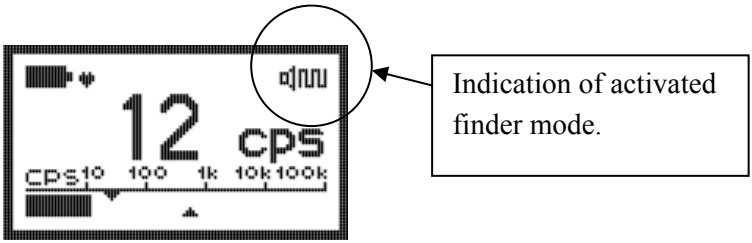
The single pulse indication must be enabled in the menu.
It is activated and deactivaded by two times pressing the right or top button:



Indication of activated single pulse indication.

Finder mode:
In the Finder mode, the sound frequency depends on the pulse rate of the detector. The more detector pulses above the count rate that is present at the moment of the activation of the finder mode are captured by the detector, the higher the tone.

The finder mode must be enabled in the menu.
It is activated and deactivated by two times pressing the right or top button:



4.2 Alarm indication

Each time the first alarm threshold is exceeded, the alarm devices beeper, LED and the vibrator become active, if they are enabled.

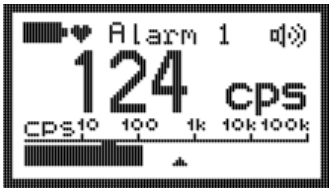
Alarm 1: LED slowly blinking, two frequency alarm tone

Alarm 2: LED quick blinking, continuous alarm tone

NBR-Alarm: LED quick blinking, two frequency alarm tone

Dose Alarm: LED constantly on, continuous alarm tone, vibrator slow.

The alarm tone and vibrator are acknowledged by a short key depression, the LED remains pulsing. The alarm is extinguished, when the first alarm threshold is remained under.



With the PC-program “RadEye.exe” the alarm threshold 2 of the dose rate can be configured as a safety alarm.

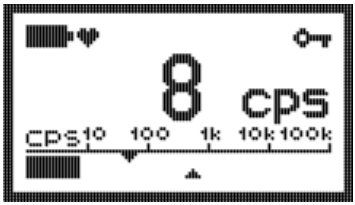
4.3 Additional information

In addition to the basic display, using the menu options, requests for further information can be started such as e.g. the setting of the operation mode and the enabling and disabling of the various alarm indicators.

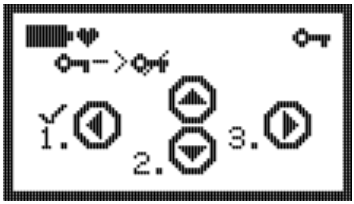
Using the upper arrow key, additional measuring values are displayed (see chapter 3.2.1).

4.4 Key Lock

Pressing the “on/arrow down” key for at least 5 seconds, locks the key pad:

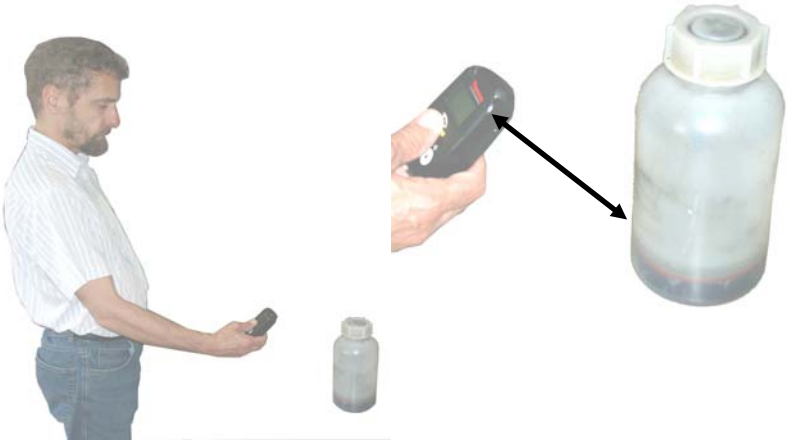


Unlocking is performed according to the LCD instructions upon pressing any key:



Press left key first, then lower key and then right key.

4.5 Process description for detection of radiation sources



Direction of maximum response

To detect hidden radiation sources, it is necessarily to use the count rate mode. Thus the instrument reacts much more quickly to suddenly changing pulse rates than the dose rate mode.
The value set for the alarm threshold is either a fixed alarm threshold being slightly higher than the occurring display values observed over a longer period of time or a sigma threshold, amounting to 5 to 6 sigma according to the false alarm frequency desired. Subsequently, the operator passes the object while keeping thereby the distance between the monitor and the object to be checked as small as possible.
With an alarm occurring, the operator should move the instrument while observing the display in order to localize the

position of the source. Please note, that the alarm can occur up to one or two seconds after passing the nearest distance to the source.
If the function “NBR” is activated and the display shows “low energy” after a few seconds, a low energy radiation source has been found. Typical examples are radiation from medical treatment, special nuclear materials as U-235 and shielded industrial sources.
In case a radiation source has been detected, the radiation intensity is indicated by means of the dose rate display (see chapter 3.2).

4.6 Background

During operation in count rate mode with sigma ≥ 2 the background radiation is always monitored and a smoothed, RC-filtered value is computed. This value, limited to 200cps, is used for the calculation of Alarm 1 if the sigma alarm activated. During sigma alarm the monitoring of background is suspended.
On acknowledgement of an alarm 1, the background ratemeter is set the actual count rate and continues learning.

4.7 NBR (natural background rejection)

For this additional feature the ratio between the detected gamma rays and the corresponding dose rate is used to indicate unusual radiation conditions. Low and high energy radiation changes the ratio between count rate and dose rate, which is essentially stable for background radiation from **N**atural **O**ccurring **R**adioactive **M**aterial (NORM). If the ratio exceeds the adjustable (via PC-program) threshold, an alarm is released and it appears a message "low energy" for low energy radiation, respectively "high energy" for high energy radiation, in the top line of the normal display. The alarm tone and vibrator can be acknowledged by a short key depression. The NBR-indicator can be activated by the menu function or the PC-program RadEye.exe.

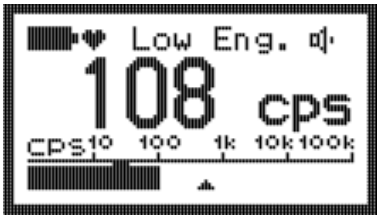
The purpose of this additional alarming algorithm is to allow the setting of a significantly lower detection level (compared the gross count rate alarm) for a vast number of artificial gamma isotopes: Especially in an urban environment the background count rate varies from a few cps up to 60-100cps (~20 µR/h natural gamma background). Thus operating on a Alarm 1 level of less than 60cps, natural background variations can cause a lot of annoying false alarms. Using the NBR feature however, radiation fields with a energy distribution that is sufficiently different from the natural environment can trigger a alarm at 30cps or even below.

A typical detection limit for a background of 5 µR/h is about 0.4 µR/h for Am-241 and 0.8 µR/h for Co-57.

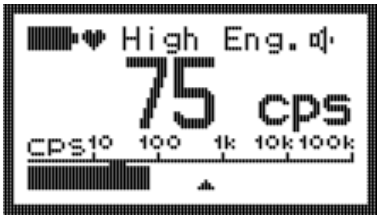
Fast initial alarm indication is achieved by the automatic adjustment of the Alarm 1 gross counting level according to the 5 – 6 sigma setting (if the set minimum value is exceeded).

Attention: Some artificial radioactive sources or combinations of different isotpes can exhibit a ration between count rate and dose rate that is similar to NORM. In that case message "balanced" will appear once a count rate alarm is triggered.

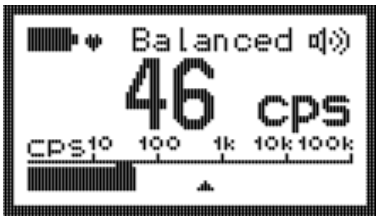
Alarm displays with activated NBR alarm:



Medical isotopes or heavily shielded radioactive material



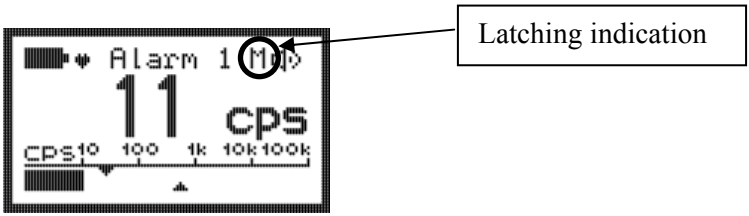
Radiation with energies above 600keV
e.g.: Industrial sources as Cs-137, Co-60



Typical for NORM and background radiation

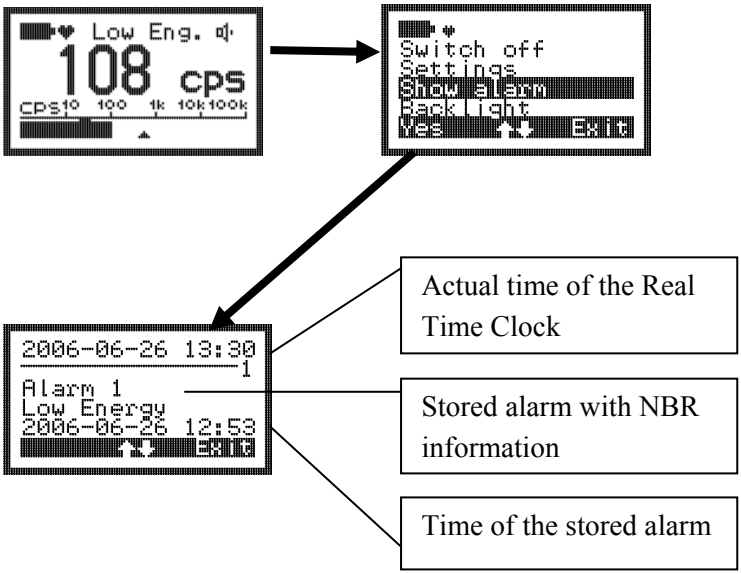
4.8 Alarm latching

Via PC-program it is possible to configure a alarm latching. Alarm latching means the alarm is stored for the configured time from 0 s (= off) to 9999 s.
A latched alarm is indicated by a “M” near by the alarm indicator. When the alarm is acknowledged the RadEye returns to normal operations.



4.9 Show alarm

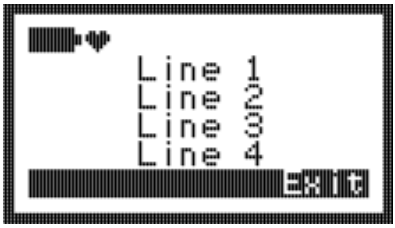
By selecting the menu point “show alarm” the alarms stored in the alarm log are displayed together with the time of alarm and the actual time.



By pressing the up and down arrow keys you can scroll through the alarm log. By pressing the right button the display returns to the menu.

4.10 Text Info

Via PC program „RadEye.exe“ it is possible to place a text information in the RadEye PRD. This text information can be displayed with the menu function „Text Info“.



4.11 Display rotation

If enabled, a short press on the lower centre key (arrow down) flips the display. If the lower centre key is pressed again or if the menu button is pressed, the screen flips into the normal orientation.

5. Functional test

The radiation meter performs continuous self-check routines. A complete failure of the detector will be detected in 20 s and will be indicated on the LCD and be announced by the beeper. The same applies to the battery voltage.

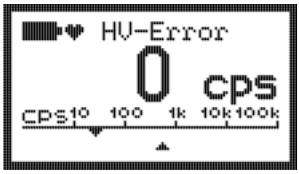
5.1 Functional test

To carry out a simple test, shortly press any key. A short audible pulse has to be released (if not disabled via PC configuration) and the LC display is illuminated for some seconds.

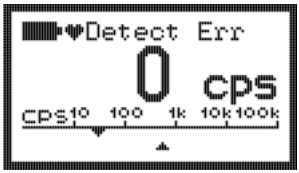
The heart symbol next to the battery indicator must be “beating”. This indicates that the cyclic tasks as calculating measurement values, and checking for alarm thresholds are active.

5.2 Failure indication

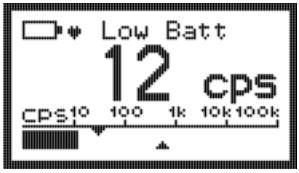
In case of a failure or if the battery voltage is low, the beeper generates a sharp single pulse every 32 s.
The corresponding failure message is displayed in the LCD:



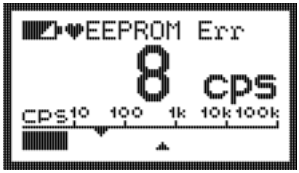
Error high voltage generation



No detector pulse within 20 seconds



Battery voltage below 2. 1V
The battery needs to be changed. However, the RadEye PRD can still be operated for several hours.

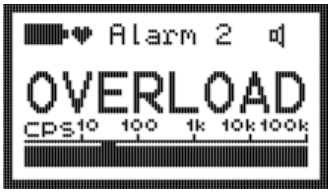


EEPROM with calibration data shows EEPROM Read and EEPROM Write error.

A Watchdog Error indicates, that the micro controller has problems to work on it's tasks in a given timeframe. Reasons are strong electromagnetic pulses, firmware errors or hardware issues.

5.3 Overload indication

On dose rates of more than 25mR/h (250µSv/h) an overload indication is given:



Overload indication in
count rate, dose rate and level display

The dose value is marked with an overload indication, if a dose rate overload occurred since the last dose reset.

Overload indication in dose display

6. PC configuration

RadEye desktop holder: 42506/60

6.1 Connection to a PC

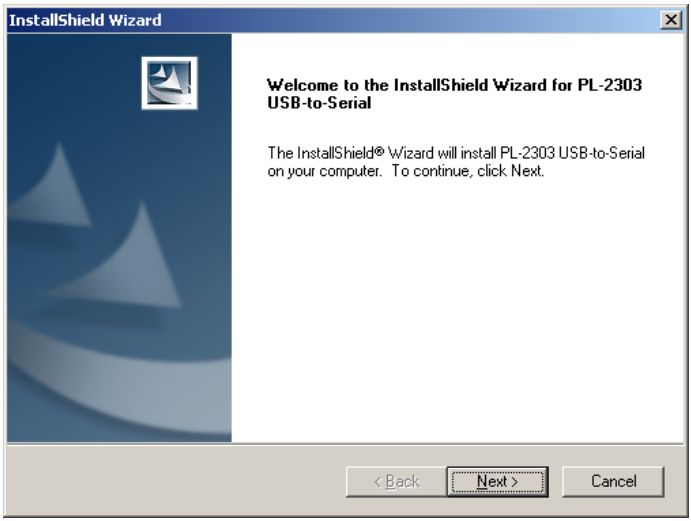
The connection of the RadEye to a PC requires an adapter cable.
Adapter cable Order No. 42540/29 is used to connect to a RS232 port of a PC.
Adapter cable Order No. 42540/26 is used to connect to an USB port. Using the USB port requires installation of driver software first.

Using the hardware provided and without exerting too much force, attach the connections of the adapter cable to the PC and to the RadEye desktop holder.

The following steps will show how to install the USB-driver under Windows XP.

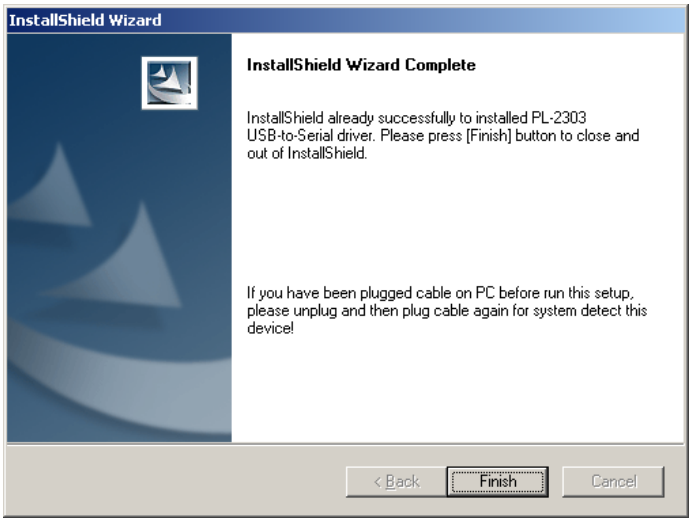
Power on your computer and boot to Windows.

Run the driver setup program “RadEye-USB.exe”. Click **Next** to continue and start the installation.

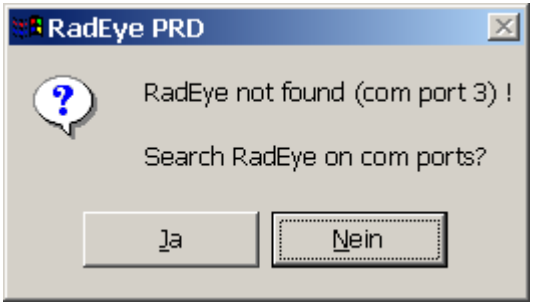


Wait until the InstallShield Wizard informs you that driver installation is successfully installed. Click the **Finish** button to close the InstallShield program. If you have plugged the adapter into the PC while running the setup installation, please unplug and replug the adapter for the system to detect the device.

RadEye.exe software will access the USB port via the next unused COM port.



If there is a faulty connection between the unit and the computer, the program shows the error message:



If there is a faulty connection between the unit and the computer, the program shows the error message “Data transfer to instrument fails”
In this case, you must check whether:

- the unit has been connected;
- the unit has been switched on;
- the infrared transmission window at the unit and at the transmission unit are clean;
- the correct serial interface has been selected.

Select the required interface, press OK to acknowledge the error message. In the window that is displayed now, select the **Configuration / Com settings...** menu.

6.2 Main menu

Once the RadEye.EXE program has been started, device parameters are displayed on the screen.

6.2.1 RadEye PRD Device Parameters

The Frame "RadEye PRD" contains the unit's serial number and version number of the software. Click on the Read button, the Parameters of RadEye PRD will be read out from device and shown in the Frame.

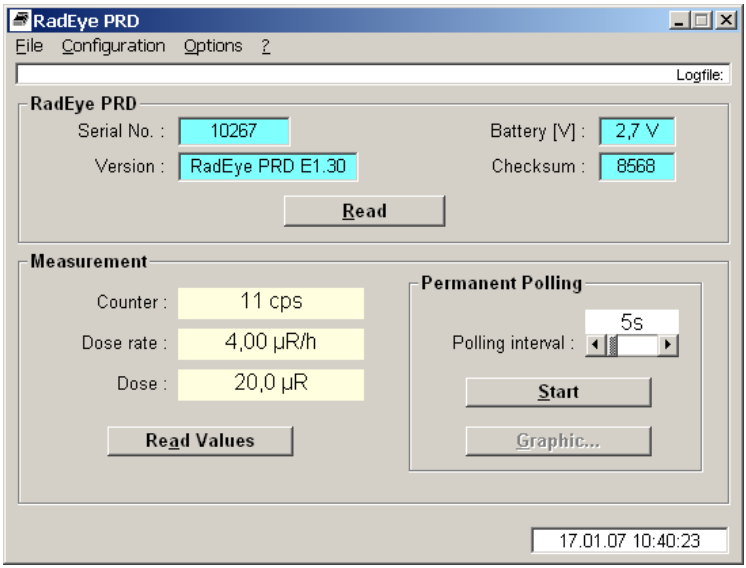


Figure 6-1: Main Window

6.2.2 Measurements

After pressing the button Read Values the current Count rate, dose rate and dose are displayed in this frame.
With button Start the measured value is read from the unit at a certain polling interval. Use the scroll bar or the buttons beneath the "polling interval" field to define the polling interval. You can select a value between 1 and 3600 seconds.

The counter and the dose rate can be displayed numerically and graphically. Click on the Graphics…. A diagram is displayed that gives a representation of the counter and dose rate values versus the time.
The current measured value is added at the right-hand side, and the diagram is shifted to the left. Up to 100 measured values can be represented. The graduation of the ordinate is automatically adjusted to the measured values supplied by the unit.

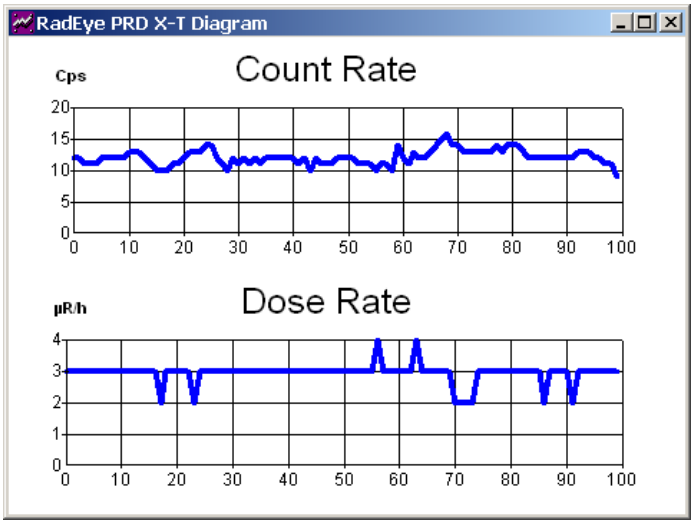


Figure 6-2: Measurement graphics

6.2.3 Creating a Measurement File

The actual measured values Count rate and Dose rate that are shown in the "Measurement" display field can be stored in a measurement file.

To do this, open the File menu, click on **Open Logfile...**, and enter path and name. The file is stored with the file name extension ".log".

If another file of the same name exists, the system asks whether that file shall be overwritten or the new measured data shall be appended to the existing data.

Once you have pressed OK to confirm the entries, the measurement logfile is created and the polling measured data is stored in the scan interval you have defined. An open measurement file is indicated by the name and the path of the measurement logfile that appears in the top right-hand corner of the window.

To terminate data storage, open the File menu and select the **Close Logfile** menu item. No further data is recorded.

Open the **File / View Logfile...** menu to view the measurement logfile.

For training and demonstration a prior recorded logfile can be replayed by opening **Replay logfile**.
With the buttons Start and Stop together with the polling interval the replay can be controlled.

Close Replay switches back to accessing measurement values via infrared interface.

The measurement logfile is an ANSI text file with columns that are separated by <TAB>. This enables this file to be read easily into other programs (such as Excel) where the data can be processed.

The first line of the measurement logfile contains the unit name, the file name, and the path. Serial number and Device identification are specified on the second line.

Date and time of the measurement are specified in the columns under the field names "mm.dd.yy" and "hh:mm:ss". The time setting corresponds to the PC system time.

The "Counter" column contains the numerical value of the counter measurement. The "Unit" column informs about the unit. The "Dose Rate" column contains the numerical value of the dose rate measurement. The "Unit" column informs about the unit (Sv/h or R/h).

6.2.4 Select serial interface

Via **Configuration / Com settings**... menu another window is opened from which you may select the corresponding interface. An error message is displayed if the interface is not available.

6.3 Configuration

On the **Configuration** / **RadEye PRD…** menu, the following parameters can be modified:

- Operating mode
- Unit
- Basic display
- Time interval of the history
- Acoustic indication
- Alarm level for all basic displays
- Signalling types
- Additional surveillances
- active menu functions

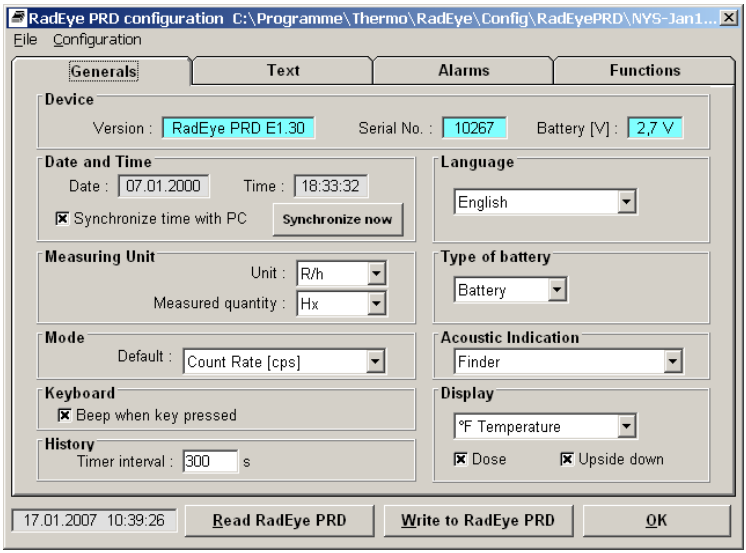


Figure 6-3: General configuration

On the „Generals“ tab, the user may set the physical unit (Roentgen or Sievert), the measured variable ($\dot{H}_X$ or $\dot{H}^*(10)$), the default mode, the time interval for the history memory (1...43200s), the basic display, the acoustic rate indication (single pulse, finder, 4.2) and temperature.

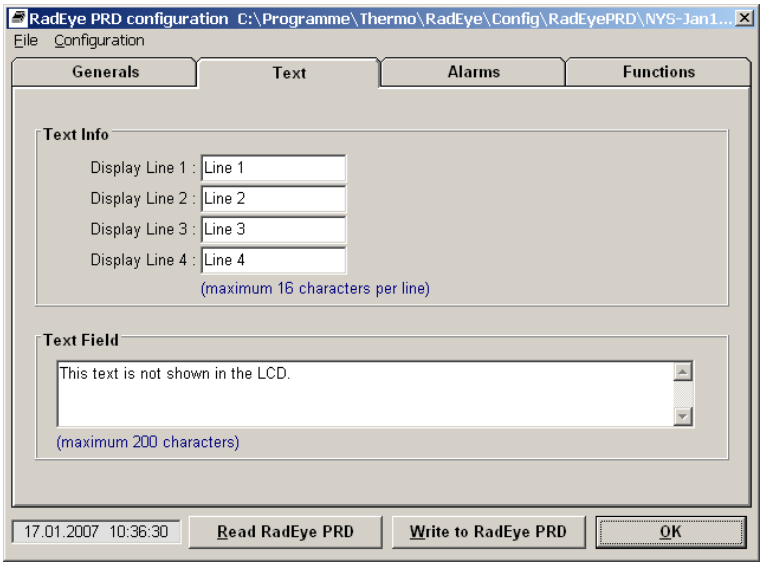


Figure 6-4: User defined text

On the tab „Text“ ist is possible to store a text in the RadEye. In the field „Text Info“ the user can define 4 lines text, which can be displayed on the LCD by the RadEye (see 4.10).
In the „Text Field“ it is possible store a text with up to 200 characters in the RadEye. This text can not be displayed by the RadEye.

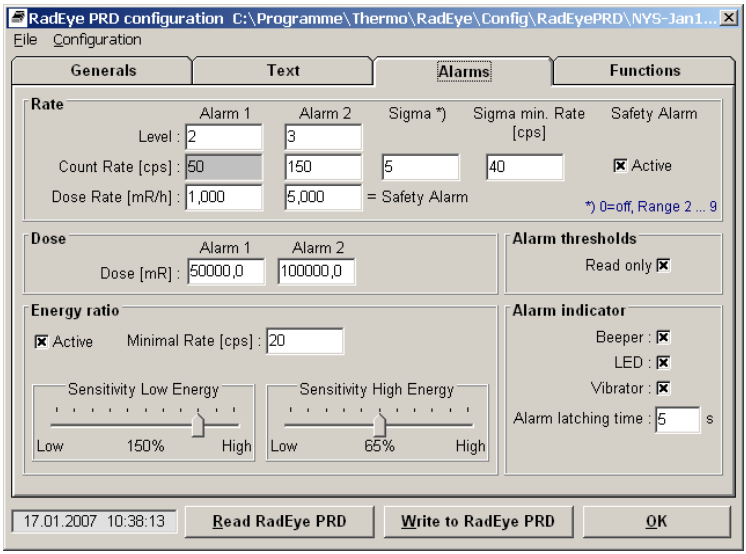


Figure 6-5: Alarm setting

The „Alarm“ tab offers the user the possibility of making the alarm settings for the single basic displays. Furthermore, the options on this tab allow beeper and additional alarm monitoring processes to be configured.

If the RadEye PRD is mainly used as an alarm device wearing at the belt, it is recommended to set an alarm latching time of 10s. This is useful to notice short exposure events.

The software control of the energy ratio sensitivity allows a fine tuning of the NBR-alarm (see chapter 4.7). E.g. selection of a high sensitivity for high energy radiation can be used to distinguish between material containing predominantly Thorium (high energy- indication) or natural Uranium (balanced indication).

In most cases both sliders can be set to high sensitivity without false alarms in a natural environment.

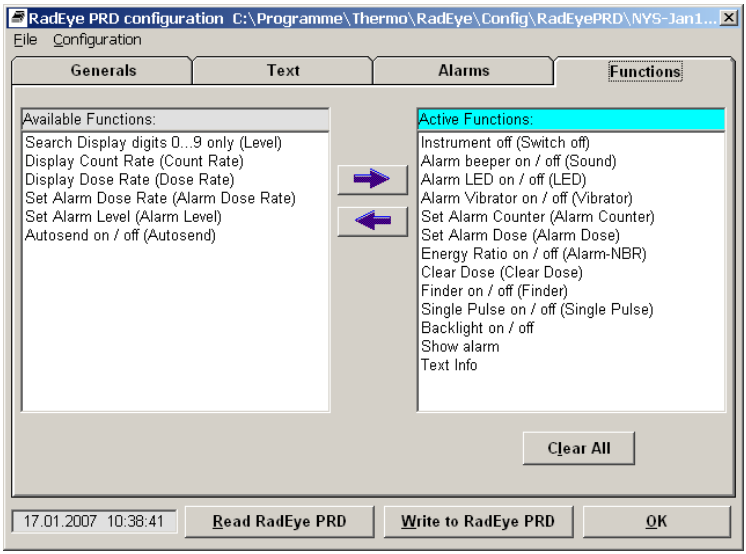


Figure 6-6: Menu selection

On the „Functions“ tab, the functions available to the user can be selected to speed up access to frequently needed functions. For example, if LED alarm is always active and rate level indication is never used, these functions can be hidden for the user.

Once the setting of the parameters is finished, these parameters have to be sent to the RadEye PRD by clicking on the Write to RadEye PRD button.

Parameters including the selected menu configuration can be saved with **File / Save as…** as parameter file (*.cfg). A saved

configuration can be reloaded using the menu **File / Open…** and sent to RadEye PRD.

6.4 History

Via the **Options** / **History** menu, the values stored in the RadEye PRD data memory can be read out, represented in a x/t diagram and saved to the hard disk of the computer. These data subsequently can be read in and further processed in a spreadsheet program.

Time interval of History storing can be set from 1s to 43200 s (12 hours). 1600 measurement values can be stored.

The following figure depicts for example the curve of the dose rate over the last two days at a time resolution of 120 s. Clearly various levels resulting from different locations and points with high peaks can be recognized.

The blue line shows the mean values, the red line the maximum value within the time interval.
If batteries are removed, the time reference is lost. In the diagram time information is only provided for history values with valid timing entries.

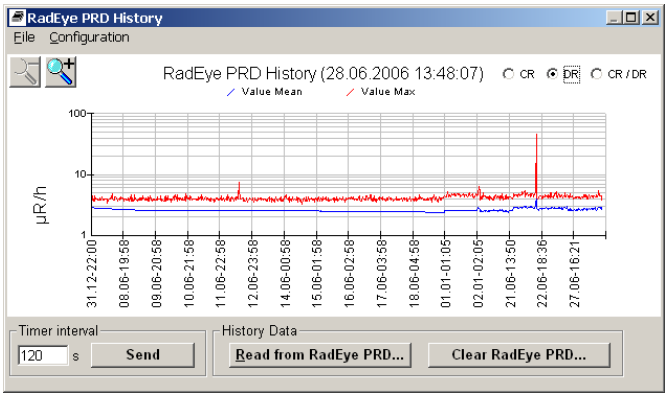


Figure 6-7: History read out

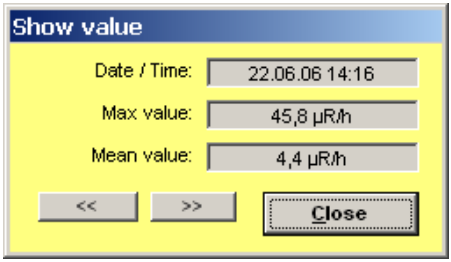


Figure 6-8: Single history value indication

Clicking at the graph, each individual, stored measured value can be displayed:

6.5 Logbook

Changes in configuration, occurring alarms and errors are logged in a buffer.
These saved events can be read out via **Options / Logbook…** .
The logbook is shown as a table, and can be saved to PC hard disc or printed.

The logbook has a maximum of 250 data sets. Several events at the same time are saved as one record. At the display every event is shown in one line for better overview. The date and time of the PC is used for time relation.

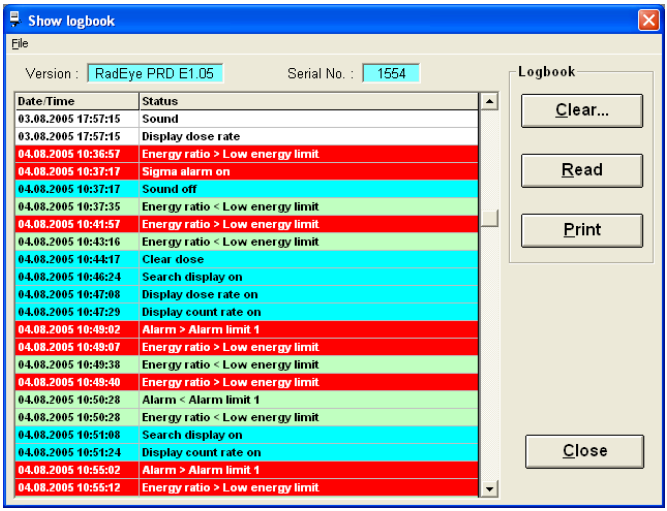


Figure 6-9: Logbook

7. RadEye car- and wall holder with accumulator charging circuit

Safety instructions

1. Only use NiMH – accumulators, no primary batteries (Alkaline –manganese, zinc – carbon ...)
2. Only use two accumulators of the same type (manufacturer, rated capacity ...)
3. Only charge accumulators having the same discharging state
4. Never use defective accumulators (penetrating/emerging electrolyte, damaged housing...)

RadEye car holder : 42506/7065

The RadEye car holder 42506/7065 serves as supporting device and power supply unit for the operation of a RadEye instrument in a vehicle. For convenient mounting to the dashboard one of the mechanical adaptors 42506/7061 ... 64 is required.

Together with a power supply unit 42506/7066, this support is also suitable for a cost attractive stationary ambient monitoring.
Via the alarm contact, power consuming external alarm indicator can be operated.

The RadEye car- and wall holder combines several functions.

(1) Mechanical holding device for instruments of the Rad-Eye-family
(2) Accumulator charger unit with temperature controlled charging of NiMH accumulators in the device
(3) Infrared interface for direct connection to the serial interface of computers
(4) Alarm contact for connecting alarm indicators up to a power of 24W (at 24V, see RadEye area monitor 42506/80)

7.1 Accessories for dash board mounting of
- car holder 42506/7065 (including charging function)
- holder 42506/7060 (mechanical holder only)

Goose neck adaptor kit 42506/7061


Pivot arm adaptor kit 42506/7062


Knuckle joint adaptor kit 42506/7063


Goose neck adaptor kit with suction cup 42506/7064

7.2 Accessories for data transmission using the car adaptor

RS232 connecting cable 2m:
SM1685 35223

USB 1.1 to RS232 adapter cable:
SM1685 35251

USB 2.0 to RS232 adapter cable:
SM1685 35255

7.3 Accessories for AC – operation of the car adaptor

Power supply with cigarette lighter socket 42506/7066
for mains operation of the car holder 42506/7065

7.4 RadEye holder with alarm contacts (including the car adaptor 42506/7065)

RadEye area monitor 42506/80

RadEye area monitor 42506/80 with external alarm unit 42506/8010

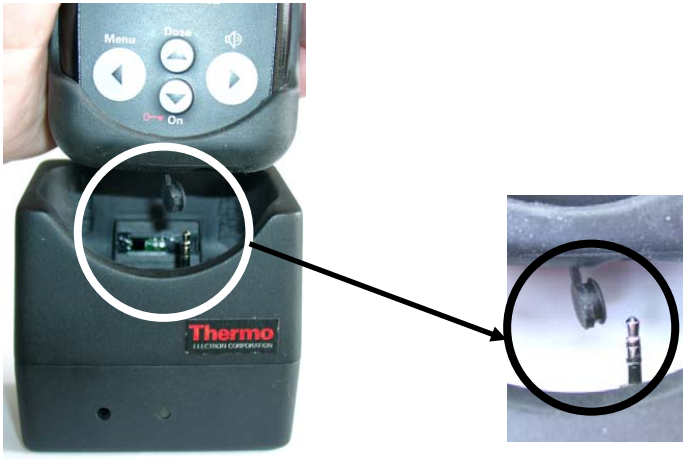
7.5 Installing the RadEye into the car holder

Before plugging the RadEye into the Car holder the rubber protection plug at the phone jack has to be opened:

- Carefully remove the protection sleeve and open the phone jack

- Remount the protection sleeve (see chapter 2.3). A small screw driver for the protection plug might be helpful. The phone jack must left be open, and the protection plug must be perpendicular to the protection sleeve.

- Then insert the RadEye into the car holder. Make sure that the protection plug is not mechanically interfering with the charging pin of the car holder.



7.6 LED indicators

Status	**LED**
No RadEye in the support	Green
RadEye plugged in, battery discharged	Orange
RadEye plugged in, battery almost fully charged	Yellow
RadEye plugged in, battery fully charged	Green
No voltage supply at the car holder	Off
Voltage supply on and temperature 0° < T < 40° Celsius T < 0° or T > 40° Celsius	Battery fully charged: green, off

8. Technical data

8.1 RadEye PRD

Radiation type:	Photon radiation
Measured variables:	Gross count rate[cps] Photon equivalent dose rate : $\dot{H}_X$ [R/h] or ambient equivalent dose rate : $\dot{H}^*(10)$ [Sv/h] Photon equivalent dose : H_X [R] or ambient equivalent dose: $H^*(10)$[Sv]
Measuring range:	25 mR/h or 250 µSv/h count display up to 800kcps, depending on calibration and photon energy
Overload display:	more than 25 mR/h or 250 µSv/h overload indication up to 10 Sv/h
Linearity error:	max. ± 10 % in the measuring range
Sensitivity:	around 1.5 cps/µR/h or 150 s^{-1}/µSv/h for photon radiation 660 keV (Cs-137) around 30 cps/µR/h or 3000 s^{-1}/µSv/h (60 keV)

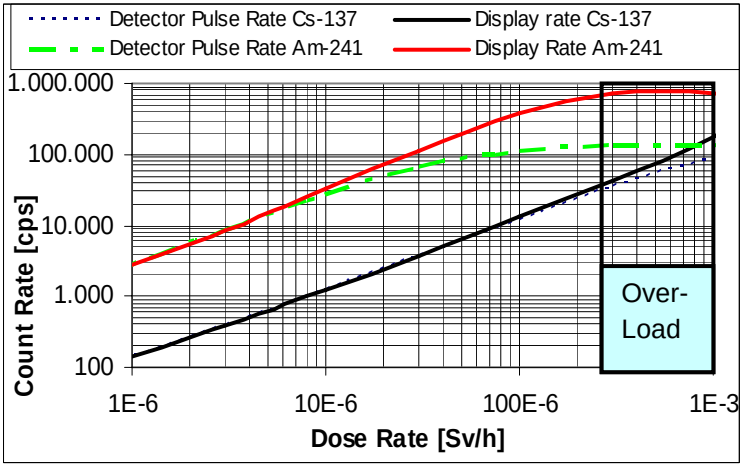


Diagram 8-1: Count rate depending on dose rate
RadEye PRD

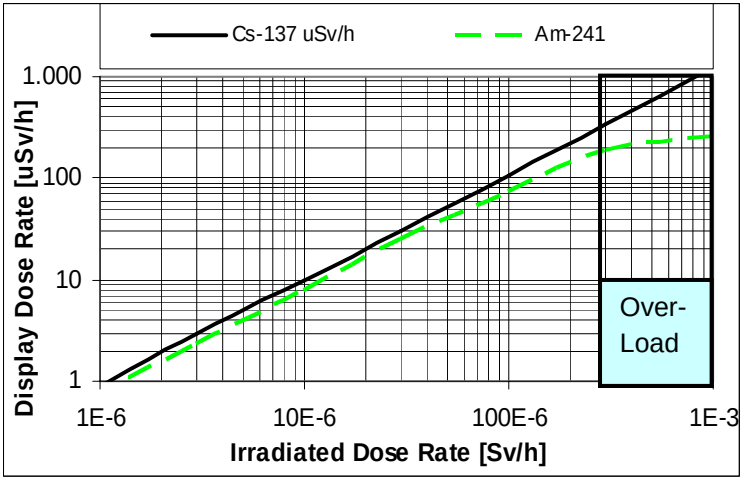


Diagram 8-2: Dose rate display depending on dose rate
RadEye PRD

Alarm threshold:	Independent alarm thresholds for all operating modes. Default setting: see chapter 2.4
Audible alarm intensity:	85 dB at a distance of 30 cm
Time to alarm:	typ.: 1s for count rate alarm ANSII N42.32, chapter 5.4.2
Energy range:	starting from 30 keV 60 keV – 1.3 MeV: error less than ±30% for dose and dose rate measurement
Energy dependence:	see Diagram 8-3
Direction of max. response:	perpendicular to the device's longitudinal axis, on the reference mark on the back side of the unit
Reference point:	on the axis of the direction of max. response, 14 mm behind reference mark.
Angular dependence:	see Diagram 8-4 and Diagram 8-5

Working temperature:	-20°C ... + 50°C
Relative humidity:	10 ... 95 %
Operating voltage:	1,8 ... 4 V, Battery low voltage starting from 2.1 V
Degree of protection:	IP 65 according to EN 60 529
EMC:	Disturbance emission : EN 50081 – 1 Immunity : EN 61000-6-2
Mechanical shock:	Drop onto a concrete surface 0,5m without protection sleeve 1,5m with protection sleeve
Size:	96 mm x 61 mm x 31 mm Without rubber protection
Weight:	around 160 g including two Alkali Manganese AAA cells LR 3
Internal memory:	The last 1600 measured values are saved and can be read out via PC program. Max- and mean value of count rate and dose rate. The time interval is factory preset to 120s by default. Logbook with 250 entries for changes of configuration, occurring alarms and errors.

Averaging filters:

ADF (Advanced Digital Filter)
cycle time: 0,5s

Dose Rate filter type: sliding window
counting rate < 150 cps: 16s
counting rate 151...400 cps: 4s
counting rate > 400 cps: 1s
cycle time: 1s

Background filter type: digital RC-filter
limited to 200 cps: 64s
cycle time: 1s
For determination of sigma thresholds

NBR-ratio filter type: RC: 30s
cycle time: 1s

Power consumption:

≈ 2 mA: normal operation without alarm signals and LCD illumination
≈ 57 mA with illuminated LC display
≈ 16 mA LED alarm
≈ 80 mA acoustic alarm
≈ 30 mA vibrator alarm

Battery service life:

≈ 600h using two alkaline AAA cells
≈ 300h using 800mAh NiMH accu

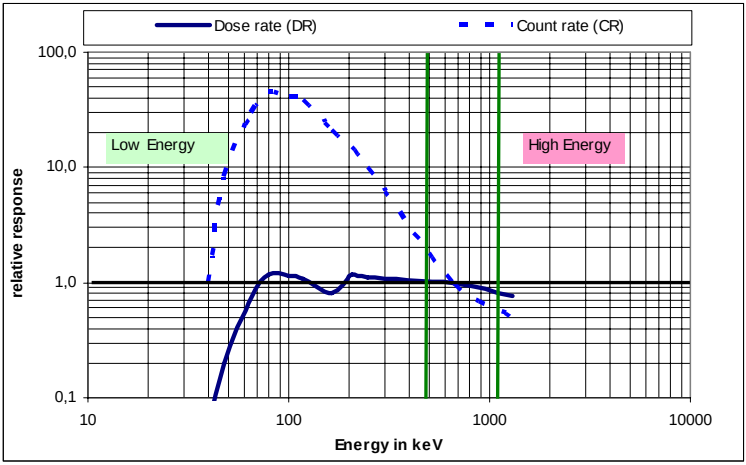


Diagram 8-3: Energy dependence in direction of max. response, perpendicular to ref. mark

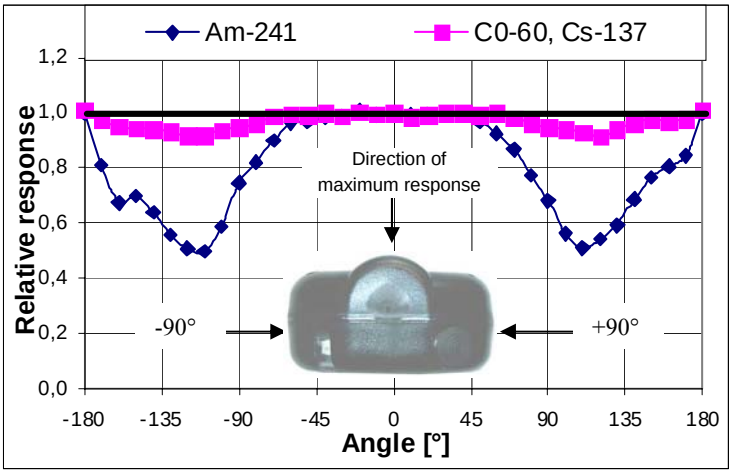


Diagram 8-4: Angular response, horizontal plane

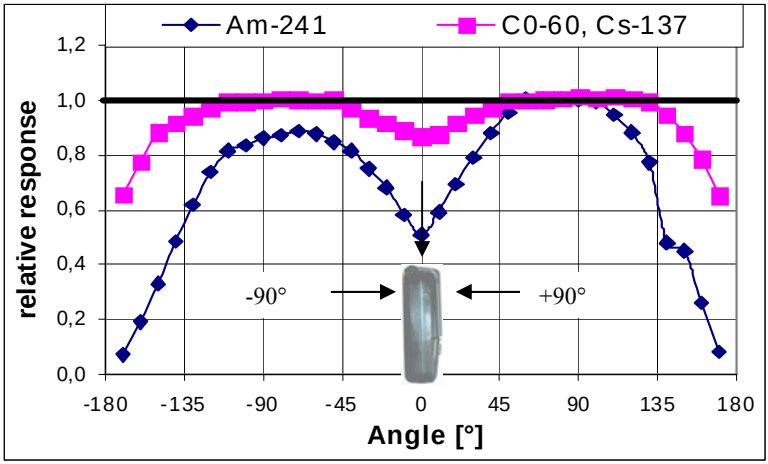


Diagram 8-5: Angular response, vertical plane A

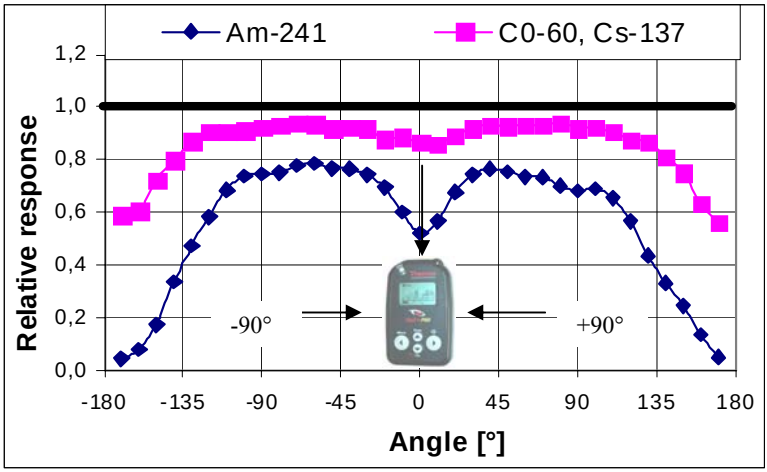


Diagram 8-6: Angular response, vertical plane B

8.2 RadEye car holder

Operating voltage:	8 … 35 V_{DC}
Current consumption:	52 mA from 14 V, RadEye charging
Accumulator charging current:	90 mA
Maintenance charge current:	15 mA
Alarm relay switching current:	1 A, fused
Alarm relay switching voltage:	38 V with overvoltage protection
Alarm relay On resistance:	0.22 … 0.33 Ω
Ambient temperature:	-30 … +60°C Operation -40 … +70°C Storage 0 … +40°C Accumulator charge
Degree of protection:	IP50 according to EN 60 529
Size:	80 x 78 x 50 mm
Weight:	140 g

8.3 Firmware versions RadEye PRD

V1.01

1) Improved NBR

V1.02

1) Frequency of alarm buzzer adjustable via infrared interface for optimal sound intensity.
2) Save of accumulated dose to EEPROM every 32s and every 5% increment.

V1.03

1) No influence to single pulse indication, if alarm threshold is exceeded.
2) Finder mode at frequencies above 255cps,
   Finder mode range always one decade of count rate variation

V1.04

1) Menu with less than two functions possible
2) Clear of dose overload flag in EEPROM

V1.05

1) Reduction of power consumption

V1.08

- Alarm setting of dose and dose rate
- Rounding error eliminated
- Improved behavior of switch off

V1.10

- Indication of learning phase

V1.16

- Battery voltage supervision adapted to RadEye car holder.
- Menu functions in German and French.
- New function „Alarm latching“ added
- New menu function „Show alarm“ added
- New menu function „Settings“ for type of battery added. It is used for "Batt low"-warning
- New menu function „Backlight“ added.
- Date format according to ISO8601: JJJJ-MM-DD hh:mm
- Acknowledge of sigma alarms: background is set to the actual count rate. Then the background is learned accelerated for 15 s.

V1.18

- Error eliminated: the battery symbol in the display was not indicated correctly, if the RadEye were charged in the car holder.

V1.31

1) Threshold „Low Batt“ for battery type akkumulator changed from 2.45V to 2.35V.
2) Bigger font set
3) New menu function "Text Info" added.
4) Additional text field with 200 characters can be stored in EEPROM.
5) New function „Display rotation“ added.
6) Display of an 16-Bit checksum of the flash area.

V1.32

1) New dimensions rem/h.
2) Set of date and time via menu function “Settings”

V1.33

Error eliminated: the range from
1.0 to 9.9 mR/h was shown as 1.0 to 9.9 µR/h.

Environmental Instruments Division
Radiation Measurement & Security

www.thermo.com
info.rmp.erlangen@thermofisher.com

Thermo Electron (Erlangen) GmbH
Frauenauracher Straße 96
D-91056 Erlangen, Germany
+49 (0)9131 909-0
+49 (0)9131 909 475 fax

Postfach/P.O. Box 16 60
D-91051 Erlangen, Germany