

automess

Automation und Messtechnik GmbH

Instructions for Use Dose Rate Meter 62AD



Meets the AmSeL specification.
(Automess Serial Link)

Optional accessories:
Radioactive source holder 761.50-01
Unlocking key 888.1.1
Connection cable EB84-0237

Status 7/2025

Contents

1	Safety information	1
2	Suitability and general features	1
3	Types	3
4	Mechanical design and instructions for use	4
4.1	Button positions	4
4.2	Battery replacement	5
4.3	62AD sealing	6
4.4	Detector position and preferred direction	7
4.5	LCD and backlighting	7
5	Functions and features	9
5.1	Software clock and sleep mode	9
5.2	Date of the next check and release of the sleep mode	13
5.3	Motion sensor	14
5.4	Dose rate measurement and single click detection	15
5.5	Alarm thresholds of dose rate and dose	18
5.5.1	Dose rate alarm	20
5.5.2	Dose measurement and dose alarm	22
5.6	Dose rate mean value	23
5.7	Dose rate maximum value	26
5.8	Dose	26
5.9	Battery Monitoring	26
5.10	Counter Tube Monitoring	27
5.11	Program memory monitoring	29
5.12	Measured values archive and archive use	29
5.13	Calibration	32
5.14	Probe operation and compliance bit	33
6	Coefficient of variation, response time and time constant	35
7	Detection limit and decision limit	41
8	Operation	44
8.1	Flowcharts	44
8.1.1	Use case without sleep mode (default setting)	44
8.1.2	Use case with sleep mode	46
8.1.3	Service functions unlocked	47
8.2	Arrow button and speaker button	48
8.3	Switching on and off	49
8.4	Display statuses	50
9	Test mode	52
10	Programming mode	56

10.1	Programming the sequence of display statuses	62
10.2	Programming the individual alarm thresholds	64
11	Service mode	64
12	Radiological examination and extension of the calibration period	66
12.1	Test function t1	66
12.2	Testing without check source	67
12.3	Testing with check source and source holder	68
12.4	Correction for the loss of activity of the source	69
12.5	Logging the check measurements	70
13	Energy response and anisotropy	71
13.1	62AD for $H^*(10)$, PTB type approval	72
13.2	62AD and the Roentgen measuring unit, no PTB type approval	73
13.3	Influence of Beta and Neutron Radiation	75
14	Serial interface	75
14.1	Interface socket and unlocking key (optional accessory)	76
14.2	Automatic transmission of the dose rate - AmSeL type number	77
15	Alarms and error messages	80
16	Declarations of compliance	81
17	Disposal advice	83
18	Technical specification	83
18.1	Accessories	85
19	Document history	86

1 Safety information

The device contains a counter tube used as a radiation detector. To operate the counter tube, the device generates an internal high voltage of approx. 500 volts. Therefore, do not attempt to open the device!

Caution!

Danger of electric shock! Inside the device, a high voltage of approx. 500 volts is live! For safety, never attempt to open or repair the device.

2 Suitability and general features

The dose rate meter 62AD is a portable, battery-operated radiation meter that measures photon radiation (gamma and X-ray radiation). The robust and waterproof aluminium housing accommodates a Geiger-Müller counter tube as the radiation detector.

The following table provides an overview of the tasks which the 62AD is suitable and/or unsuitable for:

Type of radiation to be measured	Is the 62AD suitable for this purpose?
Gamma radiation, i.e. photon radiation emitted by radionuclides	Yes, provided the photon energy of the gamma radiation is within the energy measuring range of the meter. If it is lower than the range, the value displayed at the 62AD may be too low. If it is higher than this range, the value displayed at the 62AD may be too high.
X-ray radiation	With reservations: Yes, if it is continuous X-ray radiation of low energy. No, if the X-rays are pulsed or relatively "soft" (low-energy) or both, as is usually the case in medical X-ray examinations.
Alpha and beta radiation	No. Due to its design, alpha radiation cannot reach the detector of the 62AD meter. Nearly the same applies to beta radiation. However, there is still a low sensitivity to beta radiation caused indirectly by the bremsstrahlung generated by beta particles decelerated by the 62AD housing. This indirect reaction to beta radiation is a general characteristic of all gamma radiation meters if the wall around the detector is thin.
Neutron radiation	No. The detector of the 62AD does not respond to neutron radiation.

As medical X-ray examinations mostly work with pulsed radiation, we would like to point out again that the 62AD is not suitable for this purpose:

Note

The 62AD is unsuitable for pulsed radiation! Radiation pulses with a duration well below 1 second, frequently used in X-ray examinations, are underestimated and, in extreme cases, not detected (i.e., very short and intense radiation pulses).

Please note that the 62AD supports external probes connected at its interface socket. External probes extend the range of applications possible with the 62AD. One example is an external contamination probe to detect alpha and beta radiations.

The 62AD includes a small transformer to generate the high voltage the counter tube needs. The transformer may no longer work as intended if you use the device near powerful magnetic fields, such as those common in particle accelerator-focusing magnets. Without high voltage, the counter tube is unable to supply pulses!

Note

In the vicinity of powerful magnetic fields, the device's high-voltage generation and, thus, measuring function may fail!

In particular, our focus was on versatility without compromising easy operation. The only function that you cannot switch off is the primary function, i.e. measuring the dose rate. As the letters "AD" in its name suggest, the 62AD displays the dose rate simultaneously in analog and digital form on an LCD, with automatic range selection. In addition, the 62AD supports many other functions, such as average and maximum dose rate, accumulated dose, selectable time constant, fixed and programmable alarm thresholds with visual (LCD and LED) and audible alarm, visual (LED) and audible single pulse detection, archiving of measured values and monitoring of the date of the next recurring test. As the user, you can decide which functions are helpful and use a programming mode to activate only these functions. Only the most essential functions are activated after delivery. All programming mode functions are also available as commands of the serial interface.

We also focussed on low power consumption (low current) while maintaining high comfort. A light sensor automatically controls the white backlight of the LCD based on the ambient lighting conditions. This control ensures the best readability in all environments, from complete darkness to direct sunlight. The 62AD uses a motion sensor to detect whether it is being moved. If the device has not been moved for a long time, it assumes it has lost its user's attention. Then, it reduces the brightness of the LCD backlight to save battery power, and if it has not been used for an extended period, it can also switch off automatically. If you move it again afterwards, it will switch on automatically. You can use the programming mode to specify whether it has to.

A power supply of 5 volts and a serial interface are available at the socket on the side. This socket has several possible uses (see also section 14):

- You can connect probes from the AmSeL family to this socket. AmSeL ("Automess Serial Link") is a procedure defined by Automess that describes how a basic device, an intelligent probe and a PC communicate with each other.

- If you connect a PC to this socket, the PC and 62AD can exchange data according to the proprietary AmSeL protocol. This exchange includes transferring actual and archived measured values to the PC, reading and writing programmable parameters from and to the 62AD, and much more. Thus, it is easy to adapt the 62AD to your requirements. We provide free PC software for this purpose.
- The unlocking key, which controls access to test and programming functions, is also plugged into this socket.
- Other external devices, such as Bluetooth adapters, can be developed to connect to this socket.

3 Types

There are two versions of the 62AD with different dose rate measuring ranges. The last two digits of the type designation indicate the upper end of the dose rate measuring range mSv/h:

1. **62AD25**, standard version with a measuring range up to 25 mSv/h.
2. **62AD50**, version with an extended measuring range up to 50 mSv/h. This model uses a different counter tube type with an extremely short dead time and allows the measurement of higher dose rates. This type of counter tube has a slightly better parameters, which makes the 62AD50 model more expensive than the 62AD25.

Both models are equivalent at low dose rates, which prevail in practical use, as both types of counter tubes have the same basic sensitivity. Therefore, most users prefer the 62AD25, mainly because it is typically held in one's hand, and device and user are exposed to the same radiation field. Under these conditions, the 25 mSv/h offered by the 62AD25 are quite high. The 62AD50 is reserved for applications where, for whatever reason, a more extensive measuring range is required. If you have applications where you expect higher dose rates, an external high-range probe can significantly increase the measuring range.

The only difference between both models is their dose rate measuring range. The electronics, software and operation of both models are identical. Therefore, if there are differences, we will differentiate between the 62AD25 and 62AD50 models. In all other cases, we use the basic designation 62AD as a generic term for both models. The 62AD50 received a type examination certificate issued by the Physikalisch-Technische Bundesanstalt (PTB). Therefore, it fulfils the requirements for a compliance assessment with subsequent official calibration under the German Weights and Measures Act (Mess- und Eichgesetz). International versions (with identical designs) have labels and operating instructions in languages other than German. This amendment is an external deviation only, but it is sufficient for international versions not to be considered certified.

The 62AD is only available for the ambient dose equivalent $H^*(10)$, which is measured in Sv = Sievert. This equivalent is an accepted measured variable in many parts of the world. However, some countries or institutions still work with the old measured variable standard ion dose J_s , which is measured in the unit R = Röntgen. For this purpose, we also offer the 62AD with the R unit. However, we want to pinpoint the fact that a 62AD R version internally is still a device for $H^*(10)$, although it displays its measurement values in R. Section 13.2 explains this in more detail. In these instructions for use, we will only provide specifications in the Sv unit. You can use

the equation $1 \text{ Sv} = 100 \text{ R}$ to convert this information to R. The corresponding specification in R is therefore always 100 times the specification in Sv. Example: An alarm threshold of $25 \mu\text{Sv/h}$ corresponds to the specification $2500 \mu\text{R/h} = 2.5 \text{ mR/h}$ for the R device.

4 Mechanical design and instructions for use

4.1 Button positions



- [1] Housing, anodised aluminium, waterproof.
- [2] Battery compartment cover (on the back of the device).
- [3] Piezo speaker emits short tones to guide the user, and alarm sounds in case of alarms.
- [4] Arrow button, symbol , for navigation, e.g. for setting different display statuses.
- [5] Speaker button, symbol , in connection with alarms and as an “OK” button.
- [6] Orange LED as an additional visual alarm.
- [7] Light sensor. Measures the ambient light to control the backlight of the LCD [8].
- [8] LCD with quasi-analog bar graph and digital display.
- [9] Socket with interface for computer cable [14], external probe [15] or unlocking key [16].
- [10] Electronics compartment cover with quick start guide (on the back of the device).
- [11] Eyelets for carrying strap [13].
- [12] Shows the position of the counter tube.
- [13] Carrying strap (included in the scope of delivery, article number MB12-0001).
- [14] Computer cable for connection to a PC (optional accessory, article number EB84-0237).
- [15] Probe of the AmSeL family.

- [16] Unlocking key used for locking and unlocking special functions (this is an interface connector with an internal jumper, an optional accessory with article number 888.1.1).
- [17] Probe cable for the AmSeL family.
- [18] Source holder 761.50-01, also available as wall mount.
- [19] Check source 6706 (333 kBq Cs-137).

In the following, we often use the numbers in square brackets [] to identify the individual elements. The piezo speaker [3] emits short tunes to guide the user, and alarm sounds in case of alarms. Alarm sounds are particularly intense siren-like tones.

The buttons [4] and [5] are made of temperature-resistant silicone rubber. They have a perceptible positive click action and are easy to operate even when wearing gloves.

The LED [6] visually reproduces the sounds that the speaker [3] can emit: Alarms and single pulse detection.

The light sensor [7] detects the intensity of the ambient light and switches on the LCD backlight if required. This approach eliminates the need for an extra button to switch on the backlight, making the device much more convenient.

4.2 Battery replacement

A standard 9-volt block battery serves as a power supply. To change the battery, loosen the screws [20] until you can remove the battery compartment cover [2]. To remove the old battery, hold the open battery compartment downwards and let the battery drop; if necessary, give it a pat in the palm of your hand.

Note

Do not dispose of the old battery in household waste. Dispose of used batteries in the waste battery collection containers at retailers or public waste disposal providers!



- [2] Battery compartment cover.

[20] Covers, standard M4 screws, with slotted head for screwdriver or coin.

[21] Battery.

Now insert the new Battery [21]. The battery compartment's mechanical design prevents the batteries' insertion with reversed polarity. In addition, an electronic reverse polarity protection protects the device against damage by a voltage with reverse polarity.

Note

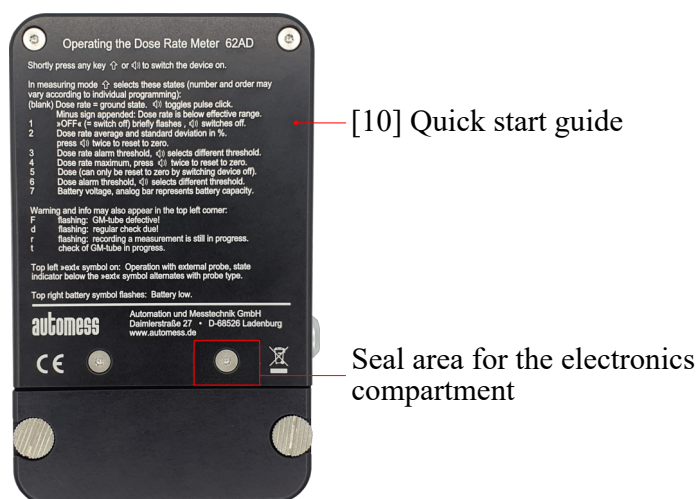
Pay attention to the use-by date of the battery, which is usually printed on the bottom! An expired battery may still appear useful at first attempt but can stop working quickly!

Now close the battery compartment. Install the cover [2] and tighten the screws [20] as far as they will go.

After inserting the battery, the 62AD is initially switched off. The 62AD switches on immediately if the service functions have been enabled.

4.3 62AD sealing

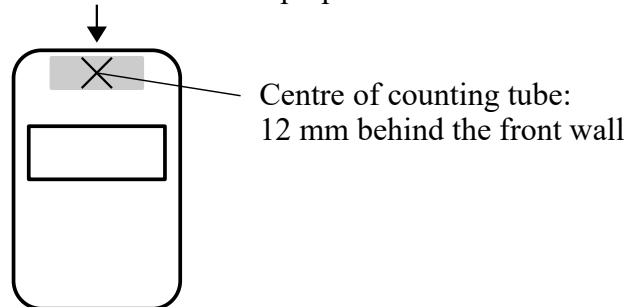
You may want to seal the 62AD to avoid tampering, or legal regulations may require you to do so. All components essential for the integrity of the measured values are located in the electronics compartment. Four screws attach the electronics compartment cover [10] on the back of the 62AD. If at least one of these screws is sealed, access to the inside of the device is only possible after breaking the seal. The two screws at the bottom are particularly suitable for attaching a seal in the form of a sticker. As shown in the illustration, we affix our Automess seal to one of the two screws at the bottom of new or repaired devices.



4.4 Detector position and preferred direction

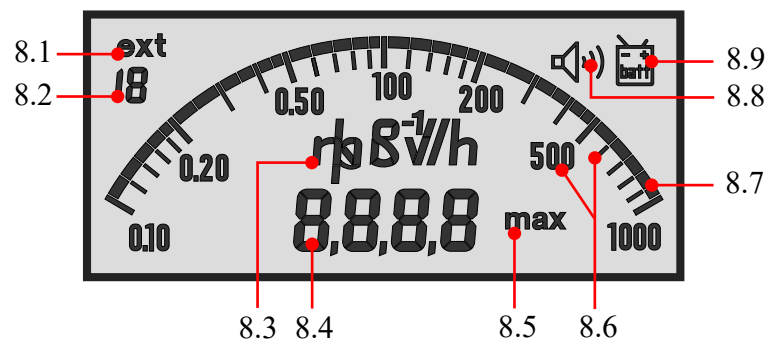
The preferred direction, i.e. the direction of beam incidence with the highest measuring accuracy, is perpendicular to the front face. A triangular arrow symbol on the front above the LCD indicates the preferred direction. The marking also indicates the position of the counter tube centre.

Preferential direction: perpendicular onto the marking on the front side



4.5 LCD and backlighting

The LCD [8] has a bright white LED backlight. If the ambient light sensor [7] reports insufficient ambient light, the backlight switches on automatically. The LCD [8] contains the following symbols:



[8.1] The "ext" symbol indicates that the 62AD is currently working with an external probe.

[8.2] The current operating status can assume the following values. If several values have to be displayed simultaneously, only the most important one is shown. The most important mode is displayed first. There are the following operating statuses:

- | | |
|---------------|---|
| "F" flashing | The "F" stands for "Failure" and indicates a counter tube failure. This error message appears both in sleep mode and in measuring mode. |
| "t" permanent | Sleep mode, "t" as in test, the counter tube is being tested. If this test ends successfully, the "t" disappears; If it fails, the flashing "F" will appear. |
| "d" flashing | The date for the next check of the 62AD (can be set via the test function "t3") is deemed to have been reached or exceeded. This display does not necessarily mean that the test date has expired; it may also be because the 62AD clock has not been set. The flashing "d" stands for "date". It appears |

both in sleep mode and in measuring mode. If “ext” [8.1] is displayed at the same time and the “d” alternates with a probe identifier, this warning refers to the connected probe.

- “r” flashing It only occurs in measuring mode. Indicates that recording (“r” = “recording”) has started, but the measurement has not yet lasted long enough to be saved in the archive. This message only appears if you use the programming function P13 to activate the display of the block number. This indication never appears with an external probe, as the probe may archive its measurements according to its proprietary rules.
- “1” to “7” It only occurs in measuring mode. Indicates the display status set with the arrow button [4] and serves as a reference to the explanation of the various display statuses in the quick reference guide [10]. If in operation with the probe (“ext” [8.1] is displayed), this number alternates with the probe identifier.
- (leer) In measuring state: The 62AD is in the default state, i.e., the dose rate display. In sleep mode: The 62AD sleeps without any strange behaviour to report.
- (Probe identifier) Only found in measuring mode with an external probe (“ext” [8.1] is displayed). The probe transmits the probe identifier. It can be a number from 0 to 19 or any other symbol composed of the LCD segments of “18”. Probes are switched off in sleep mode. Thus, neither “ext” nor the probe identifier is displayed in sleep mode.

If one of the special functions is active, this is displayed as follows in operating status:

- “t” ↔ x Test function No. x is active. A group of special functions, called “test functions”, provide unique information about the 62AD (e.g. the software version, date of next check, and date/time) and allow specific tests (e.g., radiological testing, test pattern for LCD, test of alarm tone). The test functions are numbered; see section 9. When a specific test function is running, “t” and the test function’s number x are displayed alternately. You may also use some of the test functions with external probes. Then, the “ext” [8.1] is also displayed.
- “P” ↔ x Programming function No. x is active. It is very similar to the test functions above; here, the “programming functions” are special functions that allow the 62AD to be adapted to individual requirements (e.g., programming of individual alarm thresholds). The programming functions are also numbered; see section 10. You may use some of the programming functions with external probes. Then, the “ext” [8.1] is also displayed.
- “C” ↔ x Service function No. x is active. It is very similar to the test and programming functions above; here, the “service functions” are special functions required for manufacture and maintenance (e.g., calibration of the 62AD). You can only unlock them by opening the 62AD; they will never appear in normal operation. If they do, there is something wrong with the 62AD. Section 11 briefly describes what the service functions are used for. You

may also use some of the service functions with external probes if the probe service functions have been enabled. Then, the “ext” [8.1] is also displayed.

- [8.3] Prefix (e.g. μ and m) and the units Sv/(h), R/(h), but also “v” such as “volts”.
- [8.4] Digital display, sometimes also used for simple text messages.
- [8.5] The “max” symbol for displaying maximum values.
- [8.6] Scale marks and scale labelling, logarithmic scale over two decades. The following three scale labels can be created from this:
0.1 – 0.2 – 0.5 – 1 – 2 – 5 – 10
1 – 2 – 5 – 10 – 20 – 50 – 100
10 – 20 – 50 – 100 – 200 – 500 – 1000
- [8.7] Analog bar display, including 32 bars.
- [8.8] Speaker symbol for displaying alarm thresholds and exceeded alarm thresholds. This symbol flashes when the alarm threshold is exceeded. It also shows if the audible single pulse detection is switched on.
- [8.9] Battery symbol displaying battery voltage and battery warning. This symbol flashes when there is a battery warning.

5 Functions and features

5.1 Software clock and sleep mode

There are two uses where it is advantageous if the 62AD has a system clock:

- When accessing the 62AD archive, it can be helpful if the archive records have a date and time stamp.
- The 62AD can monitor the date of its next test.

If you provide a device with a system clock, the question arises of where the device gets its date and time after the system has been switched off or after a new battery has been inserted. Either the device has a software clock, and you have to reset it manually every time the voltage is restored, or it is equipped with a hardware clock and an internal backup battery. Hence, the clock continues to run even without the 9V battery. Since most users will probably not need a clock, we opted for the more straightforward software clock. Thus, the device has fewer electronic components, lower production costs, and no backup battery maintenance (checking, replacement, risk of leakage).

The clock stores the year in two digits, with 17 being the earliest year 2017. This procedure provides a hundred-year calendar from 01.01.2017 to 31.12.2116. Incidentally, this also considers the year 2100, which will be the next exceptional year because it is not a leap year. Thus, the 62AD is already immune to a future “year 2100 problem”. If you want to set the clock manually, use the test function “t4” described in section 9. Alternatively, you may also use a command on the serial interface to set the clock.

The disadvantage of the software clock is that you have to set it every time the 62AD is switched on. We do not want users to do this, especially if the clock is not essential to them. We created the option for users who want to use the clock to keep the software clock running longer with a 9V battery. For this purpose, the 62AD has a sleep mode, which switches off most parts of the device, but not the clock, to conserve battery power.

You must enable the sleep mode locked in the default settings. As long as the sleep mode is locked, the 62AD behaves like a simple device without a clock: After being switched off, it is “dead”, and you can turn it on again by pressing a button. The clock is not used, and in that case, the user does not even notice the device has a clock.

If sleep mode is enabled and the 62AD is switched off, it goes into sleep mode instead of completely turning off. In sleep mode, the clock continues to run and, as helpful side effects, the date of the next test as well as counter tube and program memory are monitored (see section 5.2 as well as 5.10 and 5.11). Press the button to switch the device on again. To release the sleep mode, set a date for the next recurring check. Section 5.2 describes the effect of this test date in more detail.

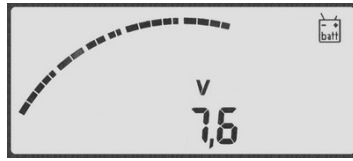
The sleep mode consists of a relatively short half-sleep mode followed by an extended deep-sleep mode (see the diagram below).

Activated are:	Active state	Optional sleep mode		Off
Counter tube high voltage, LCD backlight, speaker	Measuring mode / special function "tx", "Px", "Cx"			
LCD, 5 volts at the interface socket		Half-sleep		
Clock, serial interface, tube / memory monitoring		LCD active (5 minutes)	Deep-sleep, LCD blank (max. 8 months)	
Battery life	Max. 18 weeks	1 year	3.5 years	> 15 years

Let us now explain the statuses shown in the table in more detail:

- **Activated status.** This is the status during regular measuring operations and also during the execution of special functions (test, programming and service functions). All components are active: High voltage generation for counter tube, LCD, backlight, speaker, clock, serial interface, counter tube and program memory monitoring. In this state, the service life of an alkaline manganese battery depends heavily on the external conditions. It ranges from a remarkable 18 weeks (without significant radiation, LCD illumination, or alarm tone) to 30 hours (full dose rate, LCD illumination, and alarm tone permanently on). The active state ends either by manual switch-off or the sleep timer. Then, the sleep mode follows if enabled. Otherwise, the device will switch itself off.
- **Half sleep mode.** This mode follows after the active mode when the sleep mode is enabled. If there are no special conditions, the half-sleep mode lasts only five minutes and then moves into deep-sleep mode. The half-sleep mode allows you to check the battery status and device clock immediately after use. In half-sleep mode, various components are no longer active: The high voltage for the counter tube is switched off (i.e., radiation is not

measured anymore), the speaker is muted, and the backlight of the LCD is off. The 5 volts at the interface socket are still available. The LCD is still active and alternately displays the battery voltage and the clock.



The battery voltage is shown digitally, and as a bar (see illustration on the left). The bar displays the approximate battery capacity on an fictitious linear scale of 0 % to 100 %. If the voltage is below 6.0 volts (this is also the threshold for the battery alarm in measuring mode), the digits flash. The display shows

the battery voltage and clock alternately. To display the clock, the date first runs on the digital display as a banner message:

2019-01-14 Date in year-month-day format, in this example, the 14th. January 2019. Thereafter, the time is displayed for a few seconds:

15.38 Time in 24-hour format, in this example, 15.38, with the dot flashing. Then, the battery voltage is displayed again.

If you did not set the clock, the following banner message runs over the digital display:

“dAtE not Set”. “date not set” = “Date (and time) are not set”. The operating status [8.2] at the top left remains empty in half-sleep mode as long as none of the following special conditions are present:

- “F” (“Error”) flashes: The self-monitoring option has detected a failure of the counter tube. The device remains in half-sleep mode and waits for a pulse from the counter tube with the high voltage switched on. The device needs a repair.
- “t” (“Test”) is permanently on: A test of the counter tube is currently underway. This test is carried out automatically once a day. To this end, the device interrupts the deep-sleep mode and goes into half-sleep mode (it also switches on the high voltage of the counter tube, which is otherwise not the case in half-sleep mode). After a successful test, the device goes back into deep-sleep mode. If an error occurs, the “F” flashes as described above. Section 5.10 explains the counter tube monitoring in more detail.
- “d” (“Date”) flashes: The next test is due. This test may be due because of the due date and because the device clock is not set. To eliminate this condition, you must set the clock or, if you already have, do a radiological check of the device; if successful, you must code the new future due date into the device. Section 5.2 explains the effect of the date of the next check in more detail.

As long as one of these conditions is present, the device does not go into deep-sleep mode (the LCD is blank), so the user can recognise this special condition immediately. While the “t” test terminates on its own in one way or another, with “F” and “d”, you have to rectify the cause of the device going into deep-sleep mode. Note that “F” and “d” may also occur if the device has been in deep-sleep mode for months. The counter tube’s daily test “t” can result in an error “F” one day, so the date of the next test is reached, causing the “d” error. The device is then permanently in half-sleep mode until the cause of the error condition is rectified. In addition to the running clock, these automatic notifications are an advantage of the sleep mode. Half-sleep mode can also temporarily interrupt the deep-sleep mode due to dialogs on the serial interface. Note that the device listens for such dialogs even in deep-sleep mode. Suppose an external dialog partner, such as a PC, starts a sequence of dialogs, for example, to read archive records. In that case, the device temporarily goes from

deep to half-sleep mode because it needs the 5 volts of the serial interface. Then, the LCD also wakes up and displays the battery voltage and clock while dialogs are running. After a few seconds of rest on the interface, the device returns to deep-sleep mode. An alkaline manganese battery lasts about a year when used in half-sleep mode. However, this can only happen if one of the special conditions prevents the device from going into deep-sleep mode after a half-sleep mode of a few minutes.

- **Deep sleep mode.** This state follows after half-sleep mode. The device switches the LCD and 5 volts off to save more power. The clock, the serial interface receiver, and thus the device's dialog capability, the daily counter tube monitoring, and the silent test of the program memory remain active. The LCD is now blank, but the Alarm LED [6] flashes briefly every few seconds from now on (one flash every second for one hour, then one flash every two seconds for one day, then one flash every four seconds for all later days). You may be familiar with this method of emitting a very economical sign of life from other devices that also need a minimum power consumption, e.g. smoke alarms. As mentioned above, two events interrupt the deep-sleep mode and temporarily enable the half-sleep mode with an active LCD. These events are the automatic daily test of the counter tube "t" and the dialog started by an external device on the serial interface. In deep-sleep mode, an alkaline manganese battery would last approximately 3.5 years (one year less if the motion sensor is activated for automatic switch-on). However, the device will never reach this end of service life because it switches off after eight months of deep-sleep mode. The clock stops running and is frozen. Why does the deep-sleep mode end after eight months? Deep-sleep mode is intended for applications where the device is used at least every six months, even if this six-month use only includes a periodic radiological examination. Professional users may proceed this way and be interested in a set clock and continuous monitoring of the counter tube. If the device has not been activated for a significantly more extended period than six months, it has obviously been forgotten. A longer deep-sleep mode operation only drains the battery, so the deep-sleep mode is terminated after eight months. The previous eight months of deep-sleep mode operation have only used up around 20 % of the battery capacity, so it still makes sense to conserve the battery.
- **Off.** All components of the 62AD are switched off. Please note that the device draws a very low current from the battery even in this state. However, this current is so low that it would take 30 years for an alkaline manganese battery to run out. This time is much longer than the battery's shelf life, so you can neglect this current. In addition, as with all electronic devices, you should remove the battery during more extended periods of non-use to prevent damage to the device caused by a leaking battery. Leaking batteries can cause considerable damage!

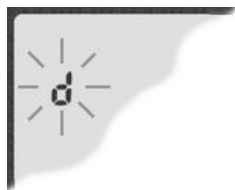
Finally, we would like to suggest whether and how to use the sleep mode of the 62AD:

- The sleep mode is an interesting option if you use the 62AD at least every six months. A periodic test, usually carried out every six months, is also considered a use. The sleep mode allows you (but does not force you) to have the device display the "d" message when a test is due. Thanks to the automatic daily test of the counter tube, you know that with every activation, the counter tube has given a sign of life within the last 24 hours. Finally, the running clock ensures the archive records receive a time stamp. You only need to set the clock once after inserting the battery, and this battery can last up to several years.

- If you use the 62AD less than every six months, we advise not to use the sleep mode. The sleep mode would hardly have any advantage but would drain the battery unnecessarily. You don't need a set clock if you use it so infrequently. The device is also not supposed to monitor the next test date. Otherwise, someone would have activated it at least every six months. The permanent test of the program memory is also unnecessary, as the device carries out this test within a second after being switched on. The only disadvantage is that the counter tube's monitoring will be less convenient when you do not use the sleep mode. Without sleep mode, this monitoring starts when you switch the device on. If the counter tube had a defect during the last operating pause, it will take a few to many minutes for the defect to be detected. Section 5.10 explains why this can take so long. In sleep mode, the error is immediately apparent, at least if it occurs before the end of the deep-sleep mode, which can last up to eight months.
- If you keep the 62AD as an emergency device, the sleep mode can also be an interesting option. In this scenario, the device is stored in a location from where it is only removed in an emergency. In such a situation, the staff member who uses the device has little time to remember how to operate it. In an emergency, he may even forget how to switch on the 62AD by simply pressing any of the two buttons. You can avoid this trouble by using the programming function P10 to activate the automatic switch-on by motion control. The device switches on automatically when removed from the standby storage. You must enable the sleep mode for this function to take effect. The daily monitoring of the counter tube is a welcome side effect. After inserting the battery, you only have to set the clock once, so the device goes into a particularly economical deep-sleep mode later. In addition, your organisation has to ensure that the device is activated every six months, typically for a recurring test. Otherwise, the device would switch off entirely after eight months in deep-sleep mode.

5.2 Date of the next check and release of the sleep mode

Checking measuring devices at certain intervals is standard as part of quality assurance. The measuring device should indicate when the next test is due, e.g., using a suitable sticker.



The 62AD offers a function that does not replace such a sticker but makes it easier to comply with the test deadline. To this end, the 62AD saves the date of the next test and decides whether it is due by comparing it with the current date. When the test is due, a “d” (“date”) flashes in the operating mode [8.2] as a warning; see the illustration on the left.

Enter a date for the next test using the test function “t3” to activate the test date monitoring. To turn off monitoring, you can delete the test date again using the same test function, “t3”. Alternatively, you may also use commands on the serial interface to set and delete the test date.

The test date is deleted in the default settings. As soon as you set a test date, this test date is monitored as follows:

- If the 62AD clock is not set, the test is considered due. This deadline may not be accurate, but as long as the actual date is unknown, the test date must be considered for safety.

- If the clock of the 62AD has reached or exceeded the test date, the test is also considered due. Thus, the test date is the first day, after which the 62AD should not be used anymore without first being tested.
- In other words, the next test is not yet due only if the 62AD clock is set and the current date is earlier than the test date.

The device can only monitor the test date if the clock is set. You can set the clock using the test function “t4” or a serial interface command.

The test date monitoring is intended as a helpful reminder, not as a tamper-proof procedure. An incorrect current date alone is enough to circumvent the monitoring. That is why the flashing “d” in the current operating status is the only result of a test due. We did not implement more exhaustive alarms or restrictions on the functions of the 62AD.

If the test date is set, the sleep mode is also enabled; see also the previous section 5.1. The sleep mode is required for the 62AD not to switch off completely after being switched off but to keep the clock running in sleep mode. This way, the device can constantly compare the test date with the current date.

Now, let us assume that you do not want to monitor the test date at all but want to enable the sleep mode for other reasons, e.g. because you want the 62AD’s clock to continue to run during breaks in operation or because you want to activate the automatic switch-on by motion feature. To do this, enter a fictitious test date so far in the future that it will not be reached in practice. The calendar of the 62AD offers 31.12.2116 as the latest future date. The test is only considered due if the 62AD clock is not set. Consequently, in this case, the flashing “d” in the operating status [8.2] only reminds you to set the clock. You should set the clock; otherwise, the device will not go into extremely economical deep-sleep mode later.

Note

If you want to enable the sleep mode without worrying about the date of the next test, enter a fictitious test date in the very distant future! In this case, the flashing “d” only reminds you to set your clock.

The following applies to operation with an external probe: If the probe can save its test date (see probe documentation) and if the 62AD’s test date is set, the test date of the external probe is also monitored. If the 62AD’s test date is not set, its clock is likely not set because there is no sleep mode. Therefore, a 62AD without its test date never attempts to monitor a test date, neither the own nor that of a probe, and the alarm “d” never appears.

5.3 Motion sensor

The motion sensor helps to keep the 62AD’s energy consumption as low as possible. It recognises both jerky motions and slow rotations, except rotations around the Earth’s gravitational field, i.e., rotations around the vertical axis. Pressing a button is also interpreted as a motion. If the 62AD is not moved, it is lying somewhere unnoticed. The 62AD reacts to this “neglection” as follows:

- Backlight of the LCD: If the 62AD has not been moved for a minute, it first reduces the brightness of the backlight. After another minute of inactivity, it switches the backlight off completely. As soon as the device is moved again, the backlight is switched on again at full intensity, provided the ambient lighting conditions are still insufficient.
- How to cancel special functions Special functions, such as programming a parameter, require user input. Suppose the 62AD has waited in vain for input during a minute of inactivity. In that case, it cancels the special function as a precaution without changing any data and switches itself off or returns to sleep mode.
- Switching off: If the 62AD has not been moved for a certain period, it switches off automatically. Use the programming function P11 to set this time to a value between 10 and 90 minutes (the default setting is 30 minutes). You may also completely deactivate the automatic switch-off.
- Switching on: The 62AD switches on automatically if it is moved while in sleep mode, for example, because you remove it from standby storage. This function does not save battery power; it is offered as a complement to automatic switch-off. This function is somewhat unusual but not activated in the default settings. If you want to use it, activate it using the programming function P10.

5.4 Dose rate measurement and single click detection

The dose rate is displayed both in analog and digital form. As mentioned, the letters “AD” in the designation “62AD” mean analog and digital display. The logarithmic arc-shaped analog bar display spans two decades. Two neighbouring areas always overlap by one decade. The digital display [8.4] is the main display. The analog display [8.7] is used as a trend display only and is not intended for official measurements because it does not provide the required resolution (reading accuracy).

It can be helpful to make the individual pulses of the counter tube “audible” and “visible” to recognise minor dose rate changes better. For this purpose, the 62AD has an audible and a visual single pulse detection, which we call “pulse click” and “pulse flash” for short. The pulse click is a short tone of the speaker [3], and the pulse flash is a brief flash of the LED [6]. The pulse flash is the visible equivalent to the audible pulse click. However, the pulse flash is always active in all 62AD display statuses, whereas the pulse click is only emitted while the dose rate is displayed. You can switch it off and on again using the speaker button [5]. Examples of the dose rate display:



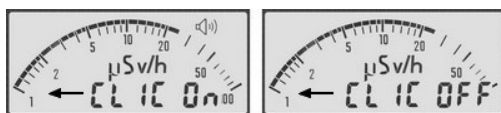
In this example, the speaker symbol [8.8] shows that the pulse click is switched on. The operating state [8.2] at the top left is empty and indicates that the 62AD is in the default state of its measuring mode, i.e. the dose rate display. If you access other displays, their number appears at this point.



In this example, the pulse click is switched off. Thus, the speaker symbol [8.8] is not displayed. Furthermore, the next test of the 62AD is due in this example; thus, a “d” flashes at the top left in the operating status [8.2]. This image also shows an example of the measuring unit “R” (Röntgen).



This example shows the operation with an external probe used to detect contamination. It displays values in the S^{-1} measuring unit (pulses per second). In the operating status [8.2] at the top left, the probe identifier appears under the “ext” symbol [8.1], which is 17 in this example. In other display statuses, “ext 17” alternates with the number of the display state.



If you switch on the pulse click, the banner text “CLIC On” runs on the digital display; if it is switched off, “CLIC OFF” runs on the digital display. This display also explains the function accessed when the user has pressed the speaker button.

Pulse click and pulse flash are limited to 16 events per second, so humans can still perceive them as a sequence of individual events. High dose rates, however, trigger far more than 16 counter tube pulses per second. The frequency of clicks or flashes does not reflect the entire measuring range; it is only an aid for minor dose rates.

You can adapt pulse click and pulse flash to your requirements. Use the programming function P7 to set the sound type for the pulse click (soft or aggressive tune) and the programming function P9 to switch the sound on or off with the 62AD (of course, you can still switch the pulse click on and off during operation). You can deactivate the pulse flash using the programming function P6. The soft pulse click is activated by default when you switch on the device, and the pulse flash is active.

Switching between the dose rate ranges is automatic and accompanied by a short tune to indicate the upshift $\uparrow$ or downshift $\downarrow$. The changeover point for upshifting is different from that one for downshifting (technical term: “hysteresis”). If there were only one switching point, the 62AD would constantly switch back and forth between the two ranges if dose rates were close to this single switching point, making it very difficult to read. The hysteresis avoids this phenomenon. The two switching points are like 10:3. If, for example, the system switches to the next higher range when 100 $\mu S v/h$ is exceeded, it switches back to the lower range only when the value falls below 30 $\mu S v/h$.

The 62AD indicates both an overshooting and an undershooting. If the measuring range is exceeded, the bar [8.7] flashes and “OFL” (overflow) appears in the digital display [8.4]. However, it is also possible that a value falls below the measuring range. This is because national and international standards define specific requirements on the measuring range. In particular, they

require that the dose rate display does not fluctuate too much within the measuring range. As the fluctuations increase with a decreasing dose rate, there is a minimum dose rate below which the requirement is no longer met. This minimum dose rate defines the lower limit of the dose rate measuring range. The 62AD dose rate measuring range starts either at $1 \mu\text{Sv/h}$ or $5 \mu\text{Sv/h}$, depending on the time constant set. The natural ambient radiation is, therefore, well below the measuring range. In practice, ambient radiation below the measuring range is more the rule than the exception. Section 6 describes in detail the relationship between measuring range and time constant.



The trailing minus sign on the digital display stands for “minor” or “tiny” and indicates that the dose rate measuring range has not been reached. This display does not mean that the mean value displayed is incorrect. It just means that the values fluctuate quite strongly around their mean value and do not meet certain requirements.

Of course, statistical fluctuations in the dose rate display are also unavoidable within the measuring range. Due to these fluctuations, the small digits change relatively frequently, but these changes are not very relevant. If you want to obtain a slower display, these almost meaningless digits should be ignored. On the other hand, standards also set requirements for reading accuracy (the PTB requires an accuracy of two percent or better). Therefore, the 62AD rounds the displayed value up or down as generously as possible so that the two neighbouring values do not differ by more than two percent. The following table explains how the 62AD rounds the three-digit dose rate value regardless of the position of the decimal separator:

The three highest digits of the dose rate	are displayed as follows:	
0 to 99	0 to 99	These values are displayed without rounding. Here, the increment is equal to 1 and, therefore, larger than 2 % for values below 50. Therefore, two-digit values below 50 are below the start of the measuring range.
100 to 250	100, 102, 104, ... , 246, 248, 250	These values are rounded to multiples of 2 (increment 2 % to 0.8 %).
250 to 500	250, 255, 260, ... , 490, 495, 500	These values are rounded to multiples of 5 (increment 2 % to 1 %).
500 to 999	500, 510, 520, ... , 980, 990, OFL	These values are rounded to multiples of 10 (increment 2 % to 1 %). “OFL” (overflow) is displayed in a range overflow and the bar flashes.

This method makes the display appear calmer and does not confuse the user because of meaningless information.

The dose rate is recalculated and displayed once per second. We have chosen this cycle for ergonomic reasons, as a faster display change, especially of the digital display, is not easy to read. You must consider this if changes in the dose rate are to be detected with the 62AD. The 62AD

will hardly recognise a short “wipe” over a radiation source. Here, you have to allow the 62AD at least a few pulses, i.e. a few seconds. Section 6 (“Coefficient of variation, response time and time constant”) contains more detailed information about the 62AD response time.

The range of the 62AD25 ends at 25 mSv/h, and the range of the 62AD50 at 50 mSv/h. In the event of an overflow, “OFL” (“Overflow”) appears in the digital display [8.4], and the flashing bar [8.7] gives a rough indication of how far the range has been exceeded. However, note that this reading of the bar can be unreliable because it is above the measuring range. If the measuring range ends at the end of a decade (i.e. at a power of ten), which may be the case with an external probe, the flashing bar extends over the full length of the entire scale. You can neither read the digital nor the analog values in this case.

5.5 Alarm thresholds of dose rate and dose

In case of a dose rate alarm, the device will issue a dose alarm if the dose has reached or exceeded a specific value. This limit is called the “dose rate alarm threshold”. Accordingly, there is a dose alarm threshold for the dose. These alarms are intended to draw the user’s attention to the device and prompt appropriate action. The alarms prevent increased radiation levels from being detected too late or not at all. The 62AD has visual and audible warning functions for both dose rate and dose.

However, what are meaningful values for the alarm thresholds? It makes sense to base them on the legal requirements. These specifications are usually not available as dose rate limits but as limits of the effective dose in a calendar year.

The following table lists many of these limit values. Most of these values are based on the “Directive 2013/59/EURATOM on basic safety standards for protection against the dangers arising from exposure to ionising radiation”, transposed into German law by the German Radiation Protection Act (Strahlenschutzgesetz) and the German Radiation Protection Ordinance (Strahlenschutzverordnung).

Limits of the effective dose:

1 mSv	Annual limit for the non-monitored population. This limit value separates the “monitoring range” from normal ranges.
6 mSv	Annual limit for occupationally exposed persons of category B, which also defines the “controlled area”.
20 mSv	Annual exposure limit for occupationally exposed persons of category A. For fire departments: Reference value per operation to protect material assets.
50 mSv	Annual exposure limit for occupationally exposed persons if approved by the competent authority on a case-by-case basis. This procedure was used to be the standard annual exposure limit for people of category A, and it may still be valid in some countries.
100 mSv	For fire departments: Reference value per operation to protect human life or health.
250 mSv	For fire departments: Reference value per operation to save human life.
500 mSv	For fire departments: Only in case of exceptions, if the value of 250 mSv is not sufficient.

Limits of the local dose rate. Where appropriate, the following list also contains dose rate limits derived from the dose limits mentioned above:

0.5 $\mu\text{Sv/h}$	= 1 mSv / 2000 h. This value is the limit value of the monitoring area if that area is only entered by professionals, i.e. for a maximum of 2000 hours per year.
1 $\mu\text{Sv/h}$	The regulations on some objects (e.g. devices with type approval and consumer goods containing radioactive substances) require that the dose rate measured at a distance of 10 cm from the touchable surface must not exceed 1 $\mu\text{Sv/h}$.
3 $\mu\text{Sv/h}$	= 6 mSv / 2000 h = Limit value of the controlled area, which is generally only entered by professionals, i.e. for a maximum of 2000 hours per year.
5 $\mu\text{Sv/h}$	Maximum dose rate at the surface of a free-standing package as required by the regulations on the transport of dangerous goods.
10 $\mu\text{Sv/h}$	= 20 mSv / 2000 h = Limit value for occupationally exposed people of category A.
25 $\mu\text{Sv/h}$	= 50 mSv / 2000 h = Limit for occupationally exposed people of category A in those countries where the annual limit of 50 mSv still applies.
3 mSv/h	Limit value of the restricted area. The restricted area is a part of the controlled area people should not enter.

From these limits, we compiled sets of alarm thresholds, also called “alarm categories”:

Category (0 = default setting)	Fixed alarm thresholds; you can select one in the 62AD measuring mode. In addition, a freely programmable alarm threshold is available for dose and dose rate each.
	Dose:
0	No fixed alarm threshold.
1	1 mSv. Annual limit for the non-monitored population.
2	1 / 20 / 100 / 250 / 500 mSv. Reference values for fire department operations. The smallest value of 1 mSv is reserved for training operations.
	Dose rate:
0	No fixed alarm threshold.
1	0.5 / 1 / 3 / 5 / 10 $\mu\text{Sv/h}$. This is a selection of small alarm thresholds for very high-sensitivity devices.
2	5 μ / 10 μ / 25 μ / 3m Sv/h. This is a selection of alarm thresholds for high-sensitivity devices.
3	25 μ / 3m Sv/h. This is a selection of alarm thresholds for medium-sensitivity devices.
4	3 mSv/h. This is for devices of low sensitivity (but high range).
5	0.5 μ / 1 μ / 3 μ / 5 μ / 10 μ / 25 μ / 3m Sv/h. All alarm thresholds for devices which have an extensive range.

The 62AD is factory-set to category 0 for dose and dose rate, so there are no fixed alarm thresholds. Only the individual alarm thresholds created using the programming functions P2 and P3 are available in this state. You can use the P4 programming function to select other categories and add a group of fixed alarm thresholds to this selection.

The alarm thresholds of external probes work the same way. The probe has its own programmable thresholds and alarm categories. To define them, use the programming functions P2, P3, and P4. Regarding the categories, the probe saves only the categories themselves (a number between 0 and 2 for the dose and between 0 and 5 for the dose rate) but not the associated alarm thresholds. The basic device, not the probe, determines what alarm thresholds belong to a category.

Confirm that the category matches the detector's range before assigning an alarm category to a device, whether a basic device or a probe.

The following two subsections describe how the 62AD displays dose and dose rate alarms.

5.5.1 Dose rate alarm

There is a display status (number 3, which you set by pressing the arrow button [4] multiple times), which allows the alarm threshold to be read and another threshold to be set. The dose rate warning itself consists of the standard dose rate display (basic status), to which the following alarms are added:

- Visual alarm: The speaker symbol [8.8] and the analog scale [8.6] flash on the LCD once per second. The LED [6] also flashes at a faster rate of twice per second (the same rate as the tone).
- Audible alarm: Intermittent siren-like tone two times per second.

You can mute the alarm tone by pressing the speaker button [5], but the symbols [8.6], [8.8] and the LED [6] will continue to flash. The LED flashes even if you press the arrow button [4] to set another status than the dose rate display. Hence, the LED warns in every display status.

If you do not like that LED flashing, use the programming function P6 to suppress it. The LED is activated in the delivery default settings.

As soon as the dose rate drops below the alarm threshold again, the alarm disappears automatically.

Whenever the dose rate exceeds the lower alarm threshold, i.e. as soon as a new dose rate alarm is emitted, the 62AD automatically switches to the dose rate display. Therefore, you cannot overlook a dose rate warning even if it occurs after a different display status has been set.

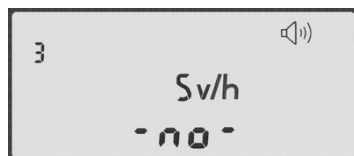
Any simultaneous dose alarm has priority over a dose rate warning.

You can decide how you want to use the dose rate alarm. The 62AD offers dose rate alarms in several extension levels; the first three of them are for less experienced users:

1. *The dose alarm is suppressed completely.*

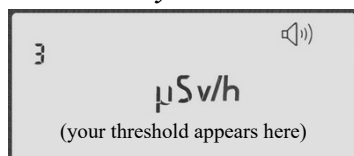
To do this, use the programming function P1 to remove display status 3 ("Display and select dose rate alarm threshold") from the list of display statuses. If the 62AD cannot display the alarm threshold, it will not issue an alarm either. The user does not even realise that the 62AD has something like a dose rate alarm.

2. *The dose rate alarm is switched off but visible.*



This setting is the default setting. Status 3 remains in the list of display statuses, the alarm category is 0 (programming function P4), and the individual alarm threshold is deleted (P2). If you access display status 3, the text “no” (“no alarm”) appears and pressing the speaker button [5] has no effect. The display only indicates that the alarm is switched off.

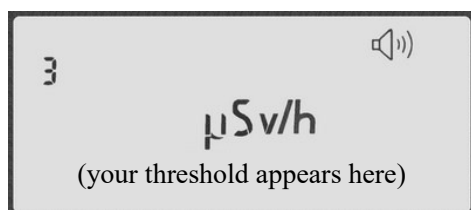
3. *There is only one dose alarm threshold, namely the programmed alarm threshold.*



You cannot change or switch off this alarm threshold during regular operation. As before, status 3 remains in the list of display statuses, and the alarm category is 0, but an individual alarm threshold is programmed (P2). If you access display status 3, this alarm threshold appears and pressing the speaker button [5] has no effect. The display is only used to indicate which alarm threshold is active.

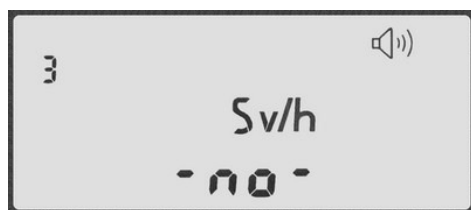
4. *There are multiple alarm thresholds the user may select.*

Again, include state 3 in the sequence of display statuses, but set the alarm category to a value other than zero. An individual alarm threshold may or may not be programmed. If it is programmed, it applies after switching on and is also part of the selection options. If it is not programmed, no alarm threshold is active after switching on, and the selection options only include the fixed thresholds of this alarm category. Press the speaker button [5] multiple times to select the following options available in display status 3:

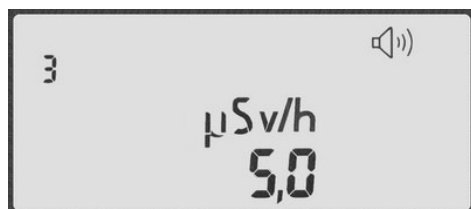


The individual alarm threshold is active. Press the speaker button to switch off the alarm threshold; see the next picture.

If an individual alarm threshold is programmed, this status is always active after you have switched the device on. Otherwise, this step is automatically ignored.



The dose rate warning is deactivated. Instead of a number, the text “-no-” (“no”) appears. If no individual alarm threshold is programmed, this status is always active after the device has been switched on. After you have pressed the speaker button, the first of the fixed alarm thresholds is available; see the next image.



You can set the fixed alarm thresholds of the current alarm category one after the other by pressing the speaker button. At the last threshold, pressing the speaker button takes you back to the beginning.

Would you prefer to automatically activate one of the fixed alarm thresholds after switching the device? This option is not available. However, you may program the individual alarm threshold to this value. This value then appears twice (as an individual value and as one of the fixed values).

5.5.2 Dose measurement and dose alarm

The dose is constantly cumulated (always, even if the dose display is not activated). The dose is deleted when you switch off the 62AD, so its value is always zero after the device has been switched on. Connecting or disconnecting an external probe deletes the dose as well.

The dose display and, more so, the dose alarm are functions rarely needed. These two functions are, therefore, not activated in the state of delivery. If you want to read the dose and to use a dose alarm, proceed as follows:

- Use the programming function P1 to add state 5 (“Dose display”) to the list of display statuses. Afterwards, you can access the dose as an additional display status when you press the arrow button [4].
- If you also need the dose alarm, use the programming function P1 to add state 6 (“Display and select the dose alarm threshold”) to the list of display statuses. From now on, you can use the arrow button [4] to access the dose alarm threshold as an additional display status. As with the dose rate alarm, the alarm thresholds available for selection via the speaker button [5] depend on the individual threshold and the alarm category. If the dose alarm category is zero, nothing can be selected, but either “-no-” or the individual dose alarm threshold (set via programming function P3) is displayed. If the dose alarm category is not zero, the individual alarm threshold, the deactivated alarm “-no-” and the fixed alarm thresholds of the dose alarm category are available for selection.

If a dose alarm threshold is active, the 62AD displays the dose digitally and quasi-analogously on the bar graph. This analog dose representation does not use a radiological unit, but an fictious linear scale of 0 % to 100 % of the set dose alarm threshold. This way, the user can easily recognise the percentage of the dose alarm threshold that has already been exhausted when the dose is displayed:



Pictures shows the dose value, in this example a dose of 2.21 µSv with a dose alarm threshold of 10 µSv. The alarm threshold is exhausted by 22.1 %, which corresponds to seven of the total 32 bars (without a dose alarm, the analog bar would remain completely blank). If a (perhaps only brief) dose rate overflow should have occurred while measuring the dose, the displayed dose may be incorrect (probably too small). The dose value then alternates with the alarm message **OFF** (Overflow).

While the dose reaches the dose alarm threshold for the first time, the 62AD gives a dose alarm by switching to state 5 “Dose display” combined with visual and audible alarms:

- Visual alarm: The speaker symbol [8.8] flashes on the LCD and the entire analog bar [8.7] flashes once per second. The LED [6] also flashes at a faster rate of four times per second (the same rate as the sound).
- Audible alarm: Intermittent siren sound of four tones per second (this is twice as fast as the dose rate alarm).

You can mute the alarm tone by pressing the speaker button [5]. Then, the 62AD simultaneously switches back to its default state, the dose rate display. The alarm LED [6] continues to flash in all display statuses. In contrast to the dose rate, the dose cannot decrease again. Therefore, the dose alarm, i.e., the flashing LED, cannot disappear independently; it can only disappear if you change or switch off the alarm threshold, connect or disconnect an external probe, or switch off the 62AD.

If you do not like that LED flashing, use the programming function P6 to suppress it. The LED is activated in the delivery default settings.

A dose alarm has priority over any simultaneous dose rate warning.

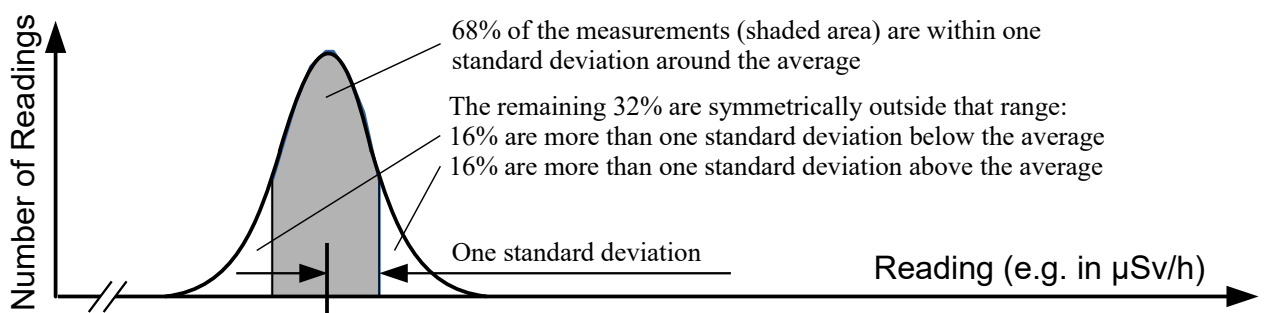
5.6 Dose rate mean value

The dose rate display (of each radiation meter) fluctuates more or less. This behaviour is not a fault of the device. Nobody can precisely predict the radioactive decay and the detection of the radiation inside the detector; they can only be expected as probable values. Section 6 (“Coefficient of variation, response time and time constant”) describes in more detail how these random fluctuations must be considered both in the design of a device and in its use.

If you need an extremely accurate dose rate, you may have to read the fluctuating display over a more extended period and calculate the mean value. The 62AD does this job for you by constantly measuring the dose rate’s mean value and calculating its statistical accuracy, the so-called coefficient of variation. The longer you measure, the more accurate the mean value becomes, i.e. the coefficient of variation of the mean value gets smaller.

Note: The term “coefficient of variation” is less common than the term “standard deviation”; nevertheless, both terms are very closely related: The coefficient of variation is equal to the relative standard deviation. In norms and standards, the term “coefficient of variation” is preferred, and we will follow suit.

We will not explain here how to calculate the coefficient of variation. However, we briefly describe the importance of the coefficient of variation. Suppose you repeat a statistically fluctuating measurement often and enter the frequency of the measured values in a diagram. In that case, you obtain (usually, but not always) a symmetrical bell-shaped distribution around the mean value, the *Gaussian distribution*, provided certain conditions are met:



The width of this bell curve, i.e., the extent of the fluctuations, is measured using the so-called *Standard deviation*. The smaller the fluctuations, the narrower the bell curve, i.e., the smaller the standard deviation. The standard deviation is measured in the same unit as the displayed value, e.g. in $\mu\text{Sv/h}$. The following applies to the Gaussian normal distribution:

The following data are within 1 standard deviation: approx. 68 %,

The following data are within 2 standard deviations: approx. 95 %,

The following data are within 3 standard deviations: approx. 99.7 % of all measured values.

If the standard deviation is related to the mean value, you obtain the *relative* standard deviation as a percentage. This *relative* standard deviation is the aforementioned *Coefficient of variation*.

If the coefficient of variation calculated by the 62AD is smaller than about 10 %, you can assume that the coefficient of variation belongs to a *Normal distribution*. We can then use the coefficient of variation to specify a range within which the real value is found with a certain probability. This probability is called *Confidence level*. Example: The 62AD shows a mean value of 10 $\mu\text{Sv/h}$ with a coefficient of variation of 3.0 %. Then, the three statements below (for one/two/three coefficients of variation) are all correct:

The mean value is 10 $\mu\text{Sv/h} \pm 3\%$ with a confidence level of 68 %,

the mean value is 10 $\mu\text{Sv/h} \pm 6\%$ with a confidence level of 95 %,

the mean value is 10 $\mu\text{Sv/h} \pm 9\%$ with a confidence level of 99.7 %.

What the confidence level lacks at 100 % (32/5/0.3 %) is the probability that the statement is false, the so-called *Significance level*. Standards and regulations often require a confidence level of 95 %, which corresponds to the doubled coefficient of variation (in our example, 2 times 3 % = 6 %). If you read the mean value and enter the doubled displayed coefficient of variation as the measurement uncertainty, you have determined the mean value with a confidence level of 95 %. However, do not forget that this confidence level only refers to the statistical reading accuracy, not to systematic deviations due to other influencing variables.

Caution: The coefficient of variation of the *Mean value* is different from the coefficient of variation of the *Dose rate display* from section 6! The coefficient of variation of the mean value becomes smaller with increasing measurement duration, i.e., the mean value becomes more accurate. The coefficient of variation of the dose rate value will not get smaller because even after a long time, the display fluctuates just as much as at the beginning. Still, its value becomes more accurate than before.

Let us explain in more detail why the mean value is essential. First, please note that the mean value is not simply the mean value of the dose rate display but an independent measured value calculated from a simultaneous measurement of dose and time. This way, the mean value is independent of the time constant with which the dose rate display is damped to reduce fluctuations.

Note: When you switch on the 62AD for the first time, it may be somewhat confusing to realize that the independently calculated mean value is higher than all dose rate values displayed so far, i.e., even higher than the previous “maximum” dose rate. This behaviour may happen because the initial dose rate display is too small, starting at zero and increasing slowly because of the time constant and because the initial mean value may be too high at random. However, these differences disappear with a longer measurement duration. Therefore, there will not be an error in the 62AD if the mean value displayed shortly after switching on is higher than the maximum value also displayed.

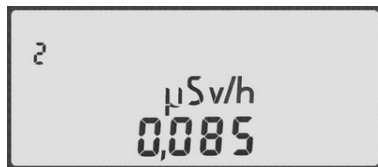
There are two things to bear in mind while interpreting the mean value:

- The mean value mainly intends to obtain a (statistically) more accurate result under constant conditions. If, for example, the mean value is to be used to measure a radiation field more accurately, it must be a radiation field constant over time, and the 62AD must remain in the same place during the measurement. The coefficient of variation (the statistical uncertainty) will decrease with increasing measurement duration only if these conditions are met. If

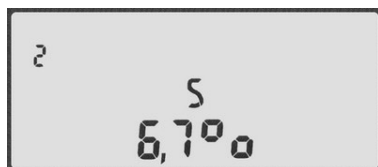
conditions change during the measurement, the coefficient of variation will increase again. The mean value is still correct, but it is unclear whether this temporal and spatial averaging of the variable radiation field can still be adequately interpreted.

- Do not overestimate the absolute accuracy of the mean value. A long measurement period can almost arbitrarily reduce the mean value's coefficient of variation. Still, you cannot exclude the influence of other variables (accuracy of calibration, ambient temperature, radiation energy, and direction of incidence). If, for example, the 62AD is left to its own for 24 hours with natural ambient radiation of 70 nSv/h, a coefficient of variation of around 1 % is achieved. However, this does not mean that the natural ambient radiation has been determined with this accuracy. The influencing variables just mentioned can add up to a high total percentage and have also influenced the measurement result, as they cause systematic deviations that do not disappear after a long measurement period. In the case of very low dose rates, the 62AD's device background radiation also influences the system as a systematic deviation. Although this device's background radiation is compensated, it varies slightly from device to device, leading to a systematic error at low dose rates.

Having made these theoretical preliminary remarks, we will now explain how the mean value and the coefficient of variation are displayed. Press the arrow button [4] to access display status 2:



Display of the dose rate mean value, range 0.000 mSv/h to 999.9 mSv/h. You can reach the upper end of this range only with external probes. Probes in the S^{-1} unit cover the range 0.000 S^{-1} to 999.9k S^{-1} . The mean value becomes more accurate with longer measurements, i.e., the coefficient of variation decreases. The digits on the digital display flash until the coefficient of variation is 5 % or less. This display alternates automatically with the display of the coefficient of variation:



Value of the coefficient of variation, displayed in %, range 0.1 % to 99 %, “0.1 % max” if smaller than 0.1 %. The “S” stands for the Greek letter “sigma”, which statistical theory uses to indicate the standard deviation. The coefficient of variation is nothing else than the relative standard deviation. If a (perhaps only brief) dose rate overflow should have occurred during the mean value measurement, the mean value may be incorrect (probably too small). The coefficient of variation is then replaced with the alarm **OFL** (overflow).

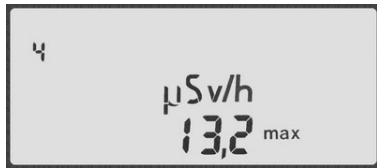
The mean value calculation begins when you switch the 62AD on and is not limited in time. Connect or disconnect an external probe to restart the mean value calculation. You can also restart the mean value at any time by pressing the speaker button [8.8] twice:



The first press on the speaker button [5] shows “SEt.0” = “set to zero”. The “SEt.0” flashes for about three seconds. If you press the speaker button again within this time, you delete the mean value and restart its calculation.

5.7 Dose rate maximum value

The 62AD memorizes the maximum value of the dose rate. Press the arrow button [4] to access display status 4:



As with the determination of the mean value, the determination of the maximum value also begins when you switch the 62AD on and/or connect or disconnect an external probe. You can delete the maximum value the same way as the mean value by pressing the speaker button [5] twice (“SEt.0” flashes).

The maximum value is not an independent measured value but simply the highest dose rate that the 62AD has ever determined and memorized as the maximum value. The maximum value can be helpful after an activity, such as measuring a radiation field.

5.8 Dose

Measuring the dose has already been detailed in section 5.5.2; see there.

5.9 Battery Monitoring

With radiation levels close to the natural ambient radiation, the 62AD achieves up to 3 000 operating hours in measuring mode with an alkaline manganese battery, which is approximately 18 weeks. At 100 µSv/h and simultaneous activation of alarm LED and speaker, it still lasts for 250 hours, i.e. 10 days. If the LCD is also permanently backlit, the operating time drops significantly to about 70 hours, which is still almost three days. If the dose rate is also set to full deflection, you have the state with the maximum current consumption conceivable. In this state, the battery lasts about 30 hours, which is still longer than a whole day. Although alkaline manganese batteries are recommended, zinc-carbon batteries can also be used. Operation with rechargeable batteries is also possible. However, the battery's voltage provides little information about its capacity, limiting its warning function.

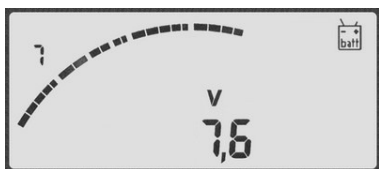
When you switch on the 62AD, the brief voltage display gives you immediate information on the battery status. If the battery condition is not too bad, the 62AD's low power consumption will make the battery sufficient for everyday use.

In idle mode, i.e., without load, a battery's voltage is higher than under load, especially if the battery is aged. The 62AD briefly switches a load to the battery before measuring the voltage to avoid overestimating the battery condition. If you measure the battery with a voltmeter without an artificial load, you will probably see a higher voltage than the 62AD indicates; now you know why this is the case.

Due to the load on the battery, the 62AD must not measure the voltage too frequently; otherwise, the device would use almost all the power for battery monitoring. Thus, the 62AD checks the battery frequently enough to detect a drop in battery voltage in good time. The interval between two measurements depends on the operating conditions. In measurement mode, the interval between two measurements is five minutes; at higher dose rates, it is only two minutes, and in sleep mode, it is one hour.

The 62AD assumes that it is powered by a 9-volt block battery, i.e. six cells connected in series, each with a nominal voltage of 1.5 volts. This combination results in a nominal voltage of $6 \times 1.5 = 9.0$ volts, which is achieved in practice (the open-circuit voltage of new batteries can be even higher, but the 62AD does not measure the open-circuit voltage).

In half-sleep mode, i.e. at the beginning of the sleep mode, the 62AD displays the battery voltage alternately with the clock. In measuring mode, press the arrow button [4] to access display status 7:



The 62AD assigns the battery a voltage range from 5.4 to 9.0 volts between “totally empty” and “totally full”. This range is converted into the analog bar when the battery voltage is displayed; herewith, the bar shows the approximate battery capacity on an fictious linear scale of 0 % to 100 %. The battery status is also divided into three categories based on the battery voltage:

- Higher than 6.5 volts: The battery is good (residual capacity higher than 30 %). All functions of the 62AD are available without restriction.
- 6.0 up to 6.5 volts: The battery is quite exhausted (residual capacity 15 % to 30 %), a battery replacement should be considered. To conserve battery power, the LCD backlight is operated with reduced brightness and for safety reasons, the programming mode is no longer available.
- Lower than 6.0 volts: The battery is low (residual capacity below 15 %), the battery needs to be replaced soon. A battery alarm is issued. The LCD backlight remains switched off, and the programming mode is no longer available.

The battery is monitored in half-sleep mode and active state. The battery alarm is the flashing battery symbol [8.9]. This silent alarm remains in half-sleep mode. When the insufficient battery condition is detected for the first time in measuring mode, an additional visual and audible alarm is triggered. Thus, if the battery voltage drops below 6.0 volts for the first time in measurement mode, or if the battery power is already low when you switch the 62AD on, the following visual and audible alarms are produced:



Display statuses in measuring mode:

The battery symbol [8.9] and the text “bAtt” flash in the digital display, and a continuous alarm tone is emitted. The LED [6] does not light to conserve the already low battery. Pressing either button mutes the alarm tone and restores the current display status.

The flashing battery symbol remains. Deleting the alarm tone is also advisable to save the battery that has already been exhausted. It should not have to supply power to the speaker if not needed.

5.10 Counter Tube Monitoring

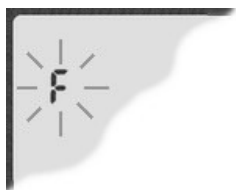
Even without external radiation, the counter tube generates a low pulse rate. Natural radioactive inclusions in the counter tube material and a certain number of spontaneous pulses cause this behaviour. These effects are collectively called “device background” or “device zero effect” because they generate a dose display that does not originate from external radiation but from the device itself and is always ubiquitous as background radiation.

The 62AD monitors its counter tube using background radiation, including the (almost) always present natural background radiation. The test is considered passed as soon as a pulse is detected. This test usually only takes a few seconds. If the 62AD does not detect a pulse for approximately three minutes, it assumes that the counter tube (or the associated electronics) is defective. Three minutes is long enough to make erroneous failure alarms so unlikely under typical environmental conditions that they do not occur in practice.

In active mode, the counter tube monitoring works permanently.



In sleep mode, the sleep mode is interrupted once a day for the counter tube test. Even if the 62AD was previously in deep-sleep mode, it goes now into half-sleep mode, i.e., with an active LCD and a “t” like “Test” in the operating status [8.2] (see figure on the left). If an error is detected, the 62AD remains in half-sleep mode, displays a flashing “F” (see next paragraph), and waits endlessly for a signal from the counter tube. Daily testing in sleep mode is frequent enough to be considered valid but so infrequent that it does not significantly increase battery power consumption in sleep mode. So, if you store the 62AD in sleep mode, it checks its counter tube once a day without any action from your side. Of course, you can also switch on the 62AD while the counter tube monitoring “t” is running. In measuring mode, the counter tube monitoring continues in the background.



The 62AD indicates a counter tube failure in sleep mode and normal measuring mode by a flashing “F” such as “Failure” in operating status [8.2] (see figure on the left). The respective “Tx”, “Px”, or “Cx” special function appear instead of the failure alarm only if a special function is active. The 62AD saves the fault diagnosis permanently after switching off or replacing the battery, so the failure alarm appears immediately after the device is switched on again.



Each time a 62AD with a defective counter tube is switched on, or the first time a counter tube failure occurs during measurement, additional visual and audible alarms are emitted: In addition to the flashing “F”, the text “**dEF.**” (= “defective”) flashes on the digital display. At the same time, a continuous alarm tone sounds, and the LED [6] is permanently on. Pressing either button switches off the alarm tone and the LED and restores the current display status. The flashing “F” in the operating status is retained because it has priority over the number of the display status. The dose rate display also retains the text “**dEF.**”, which flashes alternately with the dose rate zero.

Note: Given atypical conditions (counter tube with a particularly low zero effect, extremely low-radiation location), you cannot completely rule out that the alarm is not genuine but caused by statistical chance. If the 62AD has detected a counter tube failure under such special conditions, send it in for repair only if the “F” in the operating status [8.2] does not disappear on its own after some time under normal conditions!

When operating an external probe, the same alarms are issued if the probe can monitor its detector. For details, refer to the probe documentation.

5.11 Program memory monitoring

The microprocessor uses check numbers to check its program memory (flash memory) and the critical part of its data memory (RAM). The procedure used is a so-called CRC (Cyclic Redundancy Check). Every time data is written to the non-volatile flash memory, it is verified by a subsequent read-after-write check.

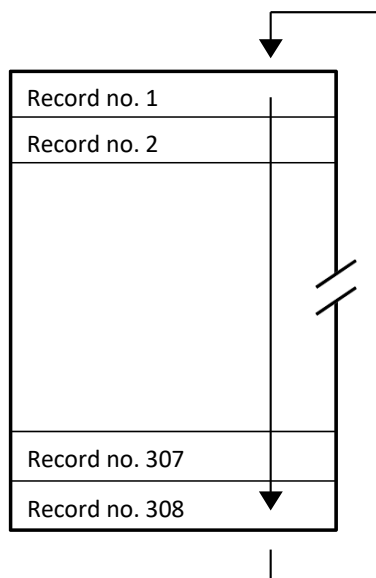
It takes just over a second to check all the data. The device always performs a complete check when the battery voltage is automatically displayed after switching it on. The test runs in the background in small steps to avoid overusing the microprocessor and battery. A complete background check takes several minutes in the active state and half-sleep mode, and two hours in deep-sleep mode. If the microprocessor detects an error, the device goes into half-sleep mode and displays the banner message “**FLASH Error**” (flash error) or “**FAtAL Error**” (RAM error) only. In this condition, you cannot activate the device.

In most cases, however, a memory error will result in the microprocessor no longer working correctly and the device displaying nothing or nonsense. On the other hand, if the device works, its memory is also intact, so no accidental or deliberate changes to the program code are present.

5.12 Measured values archive and archive use

Occasionally, you may need to reconstruct a process. Suppose a user reports that his 62AD displayed odd values or reacted strangely. However, the 62AD was switched off, and no abnormalities were observed during a subsequent check. Everything is still unclear, and nobody knows what happened. In such a case, the archive of the 62AD, which you can read via the serial interface [9], may be helpful.

However, you can also use the archive to record and evaluate measured values. The 62AD saves the data from the last 308 uses in the archive. Each use becomes an archive record. Imagine the archive as a list with records numbered from 1 to 308:



Ring buffer: You can save the records in the order indicated by the arrows. After the last record, no. 308, the first record, no. 1 is overwritten.

Conclusion: If you read the ring buffer backwards from the newest to the older records, you do this in the opposite direction to writing, i.e., decreasing record numbers down to record no. 1. The predecessor of record no. 1 is then record no. 308.

The first use is saved in record no. 1, the second use is saved in record no. 2, and so on up to the last record no. 308. Then, record no. 1 is overwritten, then record no. 2, and so on. This ring buffer procedure avoids cumbersome data transfer and maintains the assignment between content and number of a record. As you know its structure now, you can use the archive. Use the programming function P13 to have the 62AD display the record number under which the use just completed was archived each time it is switched off with “rec=xxx” (record, entry). You can later retrieve the data from this use by reading the duplicate record “rec=xxx” from the archive.

If the 62AD is relatively new, the archive will only contain a few records. At least, it contains those records that originate from the final radiological test during production. You recognize this by the high dose rates in at least some of these uses. These first records for a new device do not mean that someone already used it, but they prove that the device has been tested. If the archive has been filled to its maximum of 308 records, each new record overwrites the oldest one. Thereafter, only the number of the last record will change.

A “use” in this context is defined as follows: A use starts when you switch the 62AD on and ends when you switch it off, when an external probe is connected, when the power supply is interrupted (battery failure), or in case of a spontaneous memory error. To save storage capacity in the archive, the device does not save short and inconspicuous uses. A use is only saved if at least one of the following conditions is met:

1. The use took at least a minute,
2. The dose rate during use was at least 1 $\mu\text{Sv/h}$ at some time.
3. The use ended due to a spontaneous error of the permanent memory.

Archiving is entirely invisible to the user and, therefore, does not affect the manual operation (unless you used the programming function P13 to activate the “rec=xxx” display). If you don’t need the archiving function, you won’t even notice it and won’t have to worry about it.

However, anyone who wants to use the archiving function systematically to store measured values faces two problems due to the silent archiving of the 62AD:

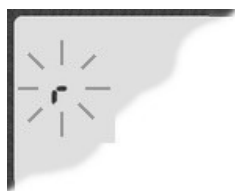
- When you evaluate the archive records, it can be helpful if they have a time stamp.
- Once you have archived a measurement by switching off the 62AD, you need to know the record number to assign it to this measurement later.

The 62AD offers the following solutions for these problems:

- The clock and the sleep mode of the 62AD were described in section 5.1. The archive records receive a time stamp only if this clock is set. If the sleep mode is disabled but the clock is still to be set during measurement mode, you have to use a command on the interface to set the clock each time you switch the 62AD on. This procedure is very inconvenient. You must enable the sleep mode to work systematically with the clock. The clock then continues to run in sleep mode, and you can use the test function “t4” to set the clock manually if required.

Please note, however, that even if you use the archive systematically, you can go without time stamps. For example, if you do a walking inspection on a day, carry out several measurements, and then evaluate these measurements shortly afterwards, you will know the time, and the measurements do not need a time stamp.

- Use the programming function P13 to tell the 62AD that you want to see the numbers of the archive records because you want to use the archive. This programming changes the behaviour of the 62AD as follows:



An “r” (“record”) flashes on the dose rate display in the operating state [8.2]. The “r” continues to flash until the conditions specified above for archiving the measurement are met. This will occur after one minute – or earlier, if the dose rate is significant. The “r” then disappears. If you switch off the 62AD now, it archives the use and displays the number of the archive record as banner text in the form “rEC=123” (“record” = recording). Note this number to find the measurement again later during the evaluation. Then press any button to have the display “rEC=123” disappear and switch off the 62AD. Then, you can switch it on again and archive the subsequent measurement using the same procedure.

If you switch off the 62AD too early, i.e., while the “r” is still flashing, the device will not save the measurement. The 62AD then displays “rEC=no” (no record).

What if you want to delete or repeat a measurement (a specific record)? This is neither possible nor necessary. Please start a new measurement and note the new record number.

The record display is switched off by default, so users who do not use the archive systematically are not confused with this additional information. Use the programming function P13 to activate the record display.

Uses with an external probe are not stored in the 62AD archive. The probe may archive its uses in the archive. For details, refer to the probe documentation.

Each archive record contains the following use data:

Parameters	Meaning
Start time	Date and time of the start of use (unknown if the clock of the 62AD was not set).
Duration	Duration of use.
Mean dose rate and unit	Dose rate averaged over the duration of use and its measuring unit (Sv/h, R/h, S ⁻¹).
Maximum dose rate and time of occurrence	The highest dose rate during use and the elapsed time between the start time and the time of the highest dose rate. If both values are zero, no significant dose rate was measured.
DR overflow identifier	“Yes”: There was a dose rate overflow during use.
Compliance identifier	“Yes”: In use, the compliance bit (see 5.14) was set.
Identifier for automatic start of use	“Yes”: The motion sensor switched on the 62AD. “No”: A button pressed switched on the 62AD.

Parameters	Meaning
End of use identifier	Used with one of the following four options: “Switching off”: Device is terminated and switched off by pressing a button or plugging in an external probe. “Auto”: Use terminated by sleep timer or after receipt of a command via the serial interface. “Battery”: Use terminated due to power supply failure. “Flash Error”: Use terminated due to a memory error.
Test mode identifier	“Yes”: This use is not a normal one but a measurement in test mode (test function “t1”). “No”: Use in normal measuring mode.
Identifier of a second detector involved	Always “No”. This identifier is reserved for devices which have a second detector (typically a high-range detector).
Counter tube failure identifier	“Yes”: The counter tube was defective during the use or part of the use. The defect may not have occurred during this use but may have been detected earlier. “No”: No counter tube failure was detected during this use.
Identifier of a second detector failure	Always “No”. This identifier is reserved for devices which have a second detector (typically a high-range detector).
CRC	Cyclic Redundancy Check. This check number detects memory errors when the record is read from the archive.

5.13 Calibration

The microprocessor counter converts tube pulses into digital dose and dose rate values. The microprocessor needs slightly different specifications for each counter tube to convert these pulses into measured values. We call these specifications “calibration parameters”. They are stored in the microprocessor’s permanent memory on the mainboard and are therefore immune to ageing, which ensures a very high measurement accuracy even in the long term.

During production, the manufacturer configures the 62AD motherboards with standard calibration parameters. These standard calibration parameters are typical values that may be sufficient for a good measurement of the 62AD. However, no one can guarantee compliance with certain error limits with these standard values. Therefore, all devices are calibrated in their default settings; i.e. each 62AD has its calibration parameters specified. This calibration is only possible in service mode, so you must open the 62AD. This feature prevents external tampering with the calibration parameters and subsequent changes in measuring accuracy.

Why use the standard calibration parameters first if individual calibration parameters later overwrite them? Technically speaking, you do not need the standard calibration parameters, but the motherboard has to be initialized with something. It will also be more convenient if the 62AD displays at least approximately correct values directly after installing a new mainboard.

Note: If a new mainboard is installed, the calibration parameters are lost and replaced with the standard ones. If the mainboard is replaced, the 62AD must be recalibrated. Calibration is an exacting process that requires rather intense radiation sources. Only a few institutions are equipped for such calibration. We mention this if you are considering replacing the motherboard on your own.

5.14 Probe operation and compliance bit

You can operate a probe of the AmSeL family at the interface socket [9], which supplies the voltage of the probe. Such a probe is an independent measuring device but without the ability to visualize its measured values. To visualize the measured values, connect the probe to a device that supports serial interface communication following the AmSeL protocol. This device can be a basic device of the AmSeL family or a PC with suitable software. The complete segregation of conversion and display of measured values allows new AmSeL basic devices or probes to be added to the AmSeL family at any time without affecting compatibility with existing devices. We developed the AmSeL protocol precisely with this flexibility in mind. Thanks to this flexibility, discussing available probe types and their characteristics in detail makes no sense today. New probes may be introduced to the market after these instructions for use are published. A probe's technical specifications should be taken from its documentation because the manufacturer is the only one who knows how the measured values are determined.

Remember the locking mechanism while inserting or removing a plug from the interface socket [9]. The locking mechanism prevents the plug from slipping out of the socket. Insert the plug fully into the socket until it clicks into place. The red dots on the plug and socket indicate the correct orientation. When you pull out the plug again, grasp it only in the area suitable for deactivating the lock recognizable by its textured surface. This step is not so tricky as the plug has no other convenient grip:



Note

Never pull out a cable [17] grabbing the cable instead of the plug! This approach will not release the locking mechanism of the plug and will, therefore, damage the cable!

There are legal reasons why a basic device has to reject certain probes. In Germany, these regulations are based on the German Measurement and Verification Act (Mess- und Eichgesetz, MessEG) and its subordinate ordinances (Mess- und Eichverordnung MessEV). As for probe use, the MessEG requires that the basic device's display clearly shows whether the measured value is compliant with a connected probe. We equipped our AmSeL devices (probes and basic devices such as the 62AD) with a *compliance bit* to meet this requirement. Each device recognizes whether it is compliant based on its compliance bit, and a basic device recognizes whether a connected probe is compliant. Compliance means that the device has the "DE-M" marking and has passed

a compliance assessment or calibration. The compliance bit can only be set via the interface in service mode. We do this while manufacturing the device. You can use the test function “t6” (see section 9) to check at any time whether the compliance bit was set. The compliance bit works as follows: If a basic device itself is compliant, it will only accept probes that are also compliant. However, what about, for example, a contamination detection probe that measures pulses per second (S^{-1})? Such a probe cannot be compliant because the German Measurement Act MessEG only refers to the measured dose (dose rate) caused by photons and measured in Sv(/h). Can we still display these non-compliant values in S^{-1} anyway? We are allowed to because we affix the following notice to the compliant basic unit: “Only measured values in Sv(/h) are compliant with the German MessEG.” Thus, the following rule applies to the compliant basic device: If an external probe measures in Sv(/h), this probe is accepted only if the probe is also compliant. If the probe measures something else than Sv(/h), I am allowed to accept this probe. Overall, a basic unit has to consider the following to accept a probe or not:

- The compliance bit must be checked, as explained above.
- The probe telegram must be signed. As the signature procedure is confidential, the probe must be an Automess probe or a guest probe, as explained below.
- We regard the AmSeL system an open system that should allow our customers to design their own probes for the AmSeL system. For this purpose, we have defined the AmSeL *Guest probe*, the only AmSeL type that does not have to send a correct signature. Of course, the German MessEG does not allow this, which means that compliant basic devices cannot accept guest probes.
- According to an earlier edition of the MessEG, it was also possible to deduce that a probe had to be assigned to a specific basic device only. The AmSeL family is also prepared to the case that this requirement should be reinstated. All members of the AmSeL family have a unique serial number, which is transmitted via the serial interface. This feature can be used for this purpose. AmSeL probes also transmit the *mandatory* serial number of the basic device. Any basic device may work with the probe if this *mandatory* serial number is zero. This use is the standard use. If the *mandatory* serial number is not zero, only a basic device with a serial number identical to the required serial number of the probe may work with that probe. This restriction to a specific basic device applies to regular use and all special functions except service mode. A probe’s service mode can be accessed on any basic device, if the probe requires a specific basic device.

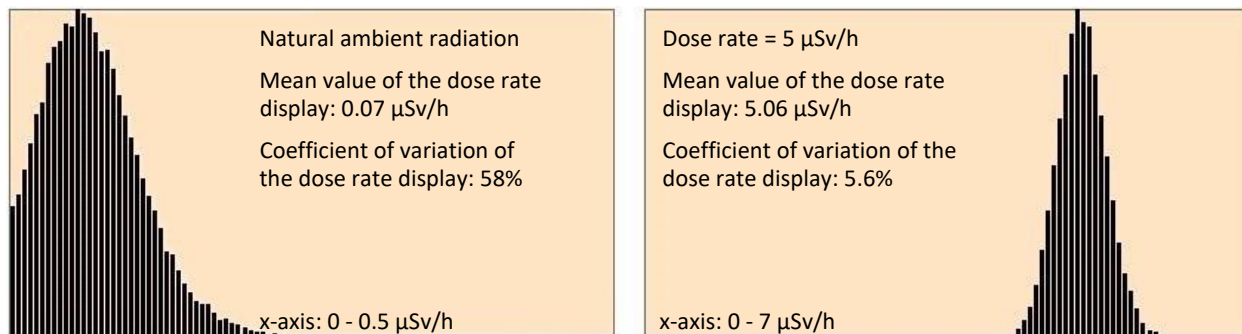
The following table summarises the compatibility of basic devices and probes. If the 62AD rejects the probe, it switches itself off and displays the banner text “**ProbE Error ...**” once (*probe* = English for *Sonde*).

	Basic device, compliance bit set (i.e. MessEG compliant)	Basic device, compliance bit <i>not</i> set (<i>not</i> MessEG compliant)
Probe (Sv), signed, Compliance bit set	Basic device accepts the probe (because it is also compliant)	Basic device accepts the probe (compliance bit of probe ignored)
Probe (Sv), signed, Compliance bit not set	Basic device rejects the probe: Probe Error CONF	Basic device accepts the probe (Compliance bit of the probe ignored)
Probe (no Sv), signed, Compliance bit never set	Basic device accepts the probe (because the measuring unit for the user identifies it as non-compliant)	Basic device accepts the probe (compliance bit of probe ignored)
Probe (any unit), <i>with wrong signature</i> signed, Compliance bit set or not set	Basic unit rejects the probe: Probe Error SIGN	Basic unit rejects the probe: Probe Error SIGN
Guest probe (any unit), correctly or incorrectly signed, compliance bit set or not set	Basic device rejects the probe: Probe Error GSt	Basic device accepts probe (because guest probes, and only these, do not have to be signed)
The probe would have been accepted, but it requests the basic device with serial number 654321.	Basic device (unless it has the serial number 654321) rejects the probe with this message: Probe Error SErno=654_321	

6 Coefficient of variation, response time and time constant

The inexperienced user of a radiation meter will inevitably have questions such as: The display is not stable but fluctuates back and forth. Is this a defect? The display was a bit higher for a moment; was that real? If something changes, how much time will the device take to adjust? This section explains the basic principles to answer such questions. In doing so, we need to look again at the basics of statistics, as we did in section 5.6 discussing the mean value. Such considerations are necessary to understand terms such as *lower dose rate measuring limit*, *confidence level*, *detection limit*, *decision limit* etc.

The following figure shows the frequency distribution of the dose rate values of a “slow” (IEC = 0) 62AD in two different conditions, i.e. with natural ambient radiation and with a dose rate of 5 µSv/h:



These bell curves clearly show to what extent the dose rate display fluctuates. The curves were determined experimentally by a PC reading the 1-second telegrams of the 62AD, sorting the dose rate values into the frequency distribution and calculating the mean value and the coefficient of variation based on these equations:

$$\text{Mean value} = \frac{\sum x}{n} \quad (6.1)$$

$$\text{Coefficient of variation} = \sqrt{\frac{n}{n-1} \cdot \left(n \cdot \frac{\sum x^2}{(\sum x)^2} - 1 \right)} \quad (6.2)$$

Here is: n the number of values (read from the 1-second interval telegrams,
 $\sum x$ the sum of the read values,
 $\sum x^2$ the sum of the squares of the read values.

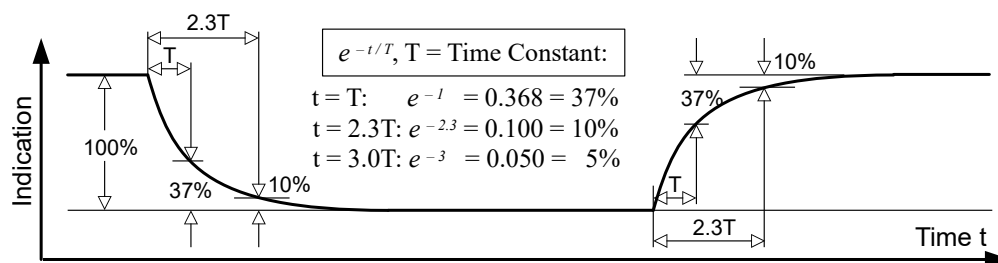
By the way: It takes many thousands of readings (1-second telegrams), i.e., several hours, for the bell curves to reach the smooth outline shown above! This long period makes not only the bell curves more beautiful but also the coefficient of variation more accurate (more accurate, but not smaller, which is the difference between the mean coefficient of variation and section 5.6).

A device should have the most minor possible fluctuations in the display, i.e., the smallest possible coefficient of variation. The longer you average the detector signal, the closer you reach this goal. However, averaging over longer periods has the disadvantage of the device's response time being longer. These two requirements of low fluctuations and fast response time are therefore contradictory. A measuring device must always find a compromise between these two requirements.

National and international standards require both the coefficient of variation and the response time not to exceed certain limits. Both requirements are met in the dose rate range, which is called the dose rate measuring range. Since both requirements are more challenging to fulfil the lower the dose rate is, they define the lower limit of the dose rate measurement range. This relation also clarifies the difference between the display and measuring ranges. In general, a measuring device still displays values below the measuring range. In this case, the lower limit of the display range is smaller than the lower measuring limit, while the upper limits of both ranges are usually identical. The display range is, therefore, usually higher than the measuring range.

These requirements affect the design of a measuring device as follows: The measuring device is initially set to the maximum possible response time to achieve the maximum possible measuring range. Then, you check at what dose rate the required coefficient of variation is met with this response time. This value is the lower limit of the dose rate measuring range, designated in the PTB requirements as $\dot{H}_L$, and in the international standard IEC 60846-1 as $\dot{H}_0$ (in case you want to look it up there). The more sensitive the detector is, the lower this lower limit. Above this limit, the requirement for the coefficient of variation is automatically met better with a higher dose rate since (given a constant response time) the coefficient of variation becomes smaller and smaller with a higher dose rate.

In addition to the response time, the term “time constant” is often used. The two terms are closely related but not equivalent. A time constant only exists if the display of the measuring device reacts to a stepped change of the dose rate acc. to the exponential function ($e^{-t/T}$, T = Time constant). The behaviour of such a measuring device is shown schematically in the following diagram (statistical fluctuations omitted):



This diagram shows some numerical examples to illustrate the significance of the time constant: If the dose rate changes in steps and the measuring device approaches the new value with a time constant, then there will be still 37 % left of the step after exactly 1 time constant, 2.3 time constants will be left after 10 %, and 5 % after three time constants. You can, therefore, consider this step “passed” after three time constants because the missing 5 % will no longer be noticeable due to the fluctuation of the display.

The measuring device feature to react with the exponential function dates from the old days of purely analog electronics. There, a capacitor smoothed out the fluctuation of the display (the oscillation of the pointer). This capacitor was charged or discharged if the display changed, almost inevitably following an exponential function. This time constant known from electrical engineering (RC , resistance multiplied by capacitance) may even have given its name to the time constant of a measuring device. Even with modern digital measuring devices, it may make sense to simulate this capacitor with software to smooth the display using a classic time constant as the response time.

A general standard must not define a requirement for the time constant because it must not require the measuring device to react to stepped changes in the dose rate with the exponential function. Therefore, a standard will use a general term such as “response time”, and the manufacturer must define this response time in its context.

The following table compares the PTB requirements and the requirements of the international standard IEC 60846-1 in simplified form:

	PTB requirements PTB-A 23.3 dated of Nov. 2013, supplemented in Nov. 2018	IEC 60846-1
Response time: In case of a change of Dose rate ...	... the display must have reached the final value $\pm 10\%$ at the latest after: 60 s (Final value below 60 $\mu\text{Sv/h}$) 10 s (Final value above 1 mSv/h) 60 s to 10 s for final values in between	... the remaining time for 10 % of the change (step) left, must not be longer than: 10 s (Final value below 10 mSv/h) 2 s (Final value above 10 mSv/h)
Maximum permissible coefficient of variation	Dose rate equal to the lower limit of DR measurement range: 15 % Dose rate 11 times the lower limit: 5 % 15 % to 5 % for values in between	

The requirements for the coefficient of variation are identical in both standards. The two response time requirements are not easy to compare because the two response times are defined differently (reaching the final value and/or reducing the difference between the initial and final values). However, the PTB requirements allow the measuring device a longer response time, especially at low dose rates.

A measuring device with a time constant that is to meet IEC 60846-1 must not have a time constant longer than 4.3 seconds. Why? In the diagram with the time constant above, we learnt that after 2.3 time constants, there are still 10 % of the change left ($e^{-2.3} = 0.1$). According to IEC 60846-1, this time must not exceed 10 seconds. However, if 2.3 time constants must not be longer than 10 seconds, then the time constant must not be longer than $10/2.3 = 4.3$ seconds.

Based on the PTB requirements, the counter tube of the 62AD can achieve a dose rate measuring range beyond 1 $\mu\text{Sv/h}$ with a time constant floating between 20 and 4 seconds, and according to the requirements of IEC 60846-1 a range beyond 5 $\mu\text{Sv/h}$ with a fixed time constant of 4 seconds. We decided to offer both options. The programming function P5 allows the "IEC" parameter to be set to 0 or 1. This setting has the following effects:

62AD-Parameter "IEC"	Time constant	DR-Display range from	DR-Measuring range from	Multiple-Range switching	PTB-compliant	IEC-compliant
IEC = 0	floating between 20 and 4 seconds	0.00 $\mu\text{Sv/h}$	1 $\mu\text{Sv/h}$	no	yes	no, as the response time is too long
IEC = 1	fixed 4 seconds	0.0 $\mu\text{Sv/h}$	5 $\mu\text{Sv/h}$	yes	yes	yes

So, the choice is yours: Select IEC = 1 if a dose rate measuring range above 5 $\mu\text{Sv/h}$ is sufficient for you and a fast response time is more important than a stable display, or if you require an IEC-compliant device. Otherwise, select IEC = 0. The lower limit of the display range (third column of the table) shows which setting is currently selected. In addition, the 62AD indicates that the dose rate measuring range has been undershot by displaying a trailing minus sign on the digital display; see section 5.4.

A “floating” time constant (second column of the table for IEC = 0) means that the value of the time constant changes with the dose rate so the time constant increases as the dose rate decreases. With a suitable floating time constant, the coefficient of variation does not increase with a decreasing dose rate but remains steady.

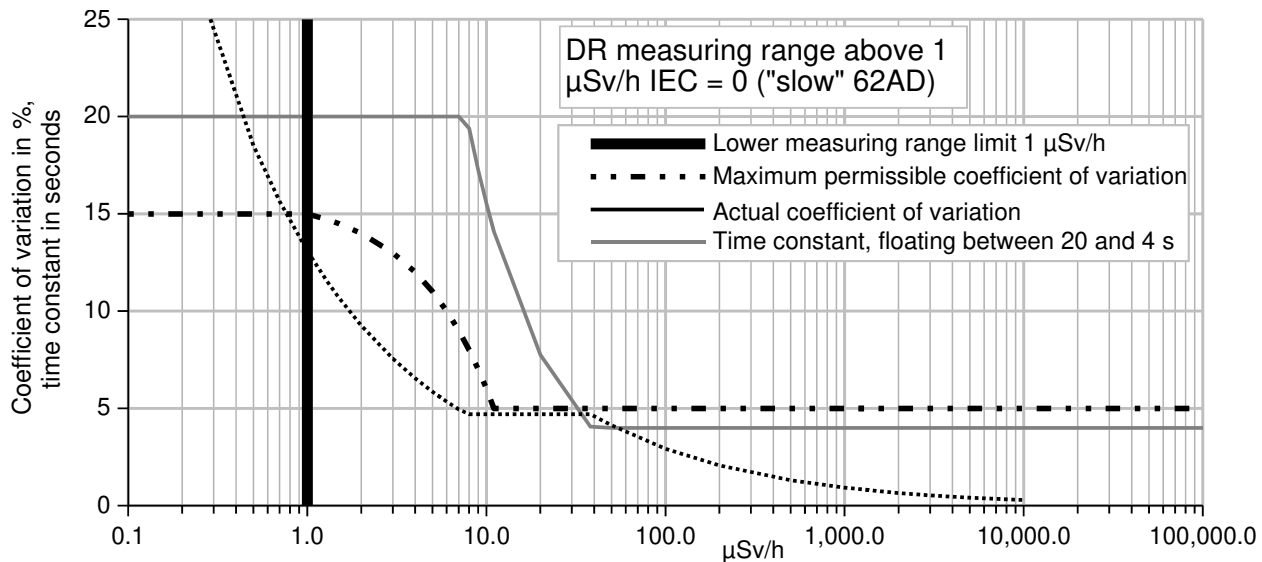
The “Multiple range switching” (fifth column of the table) indicates whether the 62AD switches several ranges at once if the dose rate suddenly changes by several ranges:

- With IEC = 0, the 62AD follows its predecessor, the 6150AD, switching only one range per second. These repeated range changes take several seconds and are combined with audible signals. They, therefore, draw particular attention to the drastic change in the dose rate.
- With IEC = 1, the 62AD immediately switches several ranges in one step. This method is not ideal because extremely big changes in dose rate can easily be overlooked. However, we have to choose this method to meet the IEC requirement of a fast response time (maximum two seconds with a final value above 10 mSv/h).

Like its predecessor, the 6150AD dose rate meter, the 62AD uses a sophisticated procedure with two response times:

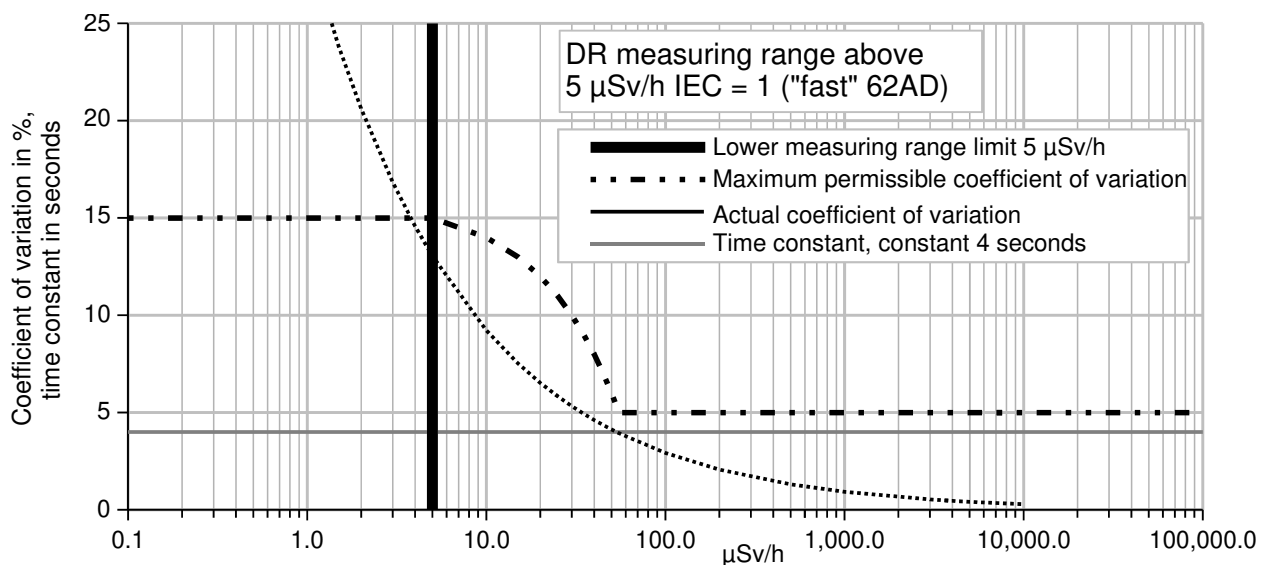
- If the dose rate changes slowly, the 62AD uses the time constant corresponding to the setting of the IEC parameter.
- The following applies regardless of the IEC parameter setting: If the dose rate suddenly changes significantly, the 62AD ignores the time constant and jumps to the new value within one to two seconds (range changes may also occur). This jump to the new value, or at least close to it, is much faster than an approximation with a time constant, even if this takes only a few seconds. A “big” change is a significant change in the dose rate that can hardly be explained as a random statistic outlier. This method is only possible with a microprocessor and drastically improves over the pure time constant.

The following diagrams show the time constant and the coefficient of variation for the “slow” (IEC = 0) and the “fast” (IEC = 1) 62AD. There are only differences below 55 $\mu\text{Sv/h}$. The “maximum permissible coefficient of variation” is the limit value required by the standards PTB-A 23.3 and IEC 60846-1. Note that the maximum permissible coefficient of variation is always 15 % for minor dose rates and 5 % for big dose rates. The range between these two limit values depends on the lower measuring limit used by the measuring device. This range is, therefore, different for IEC = 0 than for IEC = 1.



A floating time constant between 20 and 4 seconds within the range of 7 $\mu\text{Sv/h}$ to 40 $\mu\text{Sv/h}$ allows the "slow" 62AD (IEC = 0) to keep the coefficient of variation below 11 % above the range of 5 $\mu\text{Sv/h}$ (11 times the lower measuring range limit).

The time constant of the "fast" 62AD (IEC = 1) is always 4 seconds. Here, you have to raise the lower measuring limit to 5 $\mu\text{Sv/h}$ to keep the coefficient of variation below the maximum permissible coefficient of variation:



These diagrams only apply to the 62AD counter tube. When used with an external probe, that probe determines the time constant and the variation coefficient. During the dialog with the probe, the 62AD informs the probe whether it is set to "slow" or "fast" (IEC = 0 or 1). The probe may also be able to work "slowly" or "quickly" and adapt to the 62AD accordingly. For details, refer to the probe documentation.

7 Detection limit and decision limit

Detection limit and decision limit are terms closely related to statistical fluctuations; see the previous section “Coefficient of variation, response time and time constant”. Detection and decision limits are primarily used in connection with contamination measurement. However, even a dose rate meter such as the 62AD or an external probe has detection and decision limits. These are the lowest dose rates from artificial radiation sources that the device can still recognize and detect:

- **Decision limit:** During a measurement, a decision is made whether an artificial radiation source is present. A radiation source is considered present if the device’s display exceeds the zero-effect display by a certain value. This increase displayed is called the decision limit. In devices with an adjustable alarm threshold, the sum of the zero-effect display and decision limit can be used as the alarm threshold value.

Note: The decision limit should be as low as possible to detect artificial radiation sources as well as possible. On the other hand, the decision limit must not be so low that the fluctuating zero effect display often exceeds this limit and suggests detection of radiation sources that do not exist. When specifying the decision limit, you must always add the probability of error involved with this decision limit. The probability of error is the probability that the device’s fluctuating display accidentally exceeds the decision limit and thus misleads to the assumption that an artificial radiation source is present. In general, an error probability of 5 % is permitted, which is also referred to as a confidence level of 95 %. A confidence level of 100 %, i.e., absolute certainty, can never be achieved according to the laws of probability. Of course, there is also the opposite error, i.e., overlooking an artificial radiation source. This opposite probability of error determines the *Detection limit*; see the following paragraph.

- **Detection limit:** The detection limit is the lowest “artificial” dose rate the device can detect with a certain confidence level. The detection limit is always higher than the decision limit. If the same confidence level is required for the detection and decision limits, the detection limit is approximately twice the decision limit. The detection limit indicates whether a device is suitable for a specific purpose. If, for example, a regulation specifies that the “artificial” dose rate must not exceed a particular standard value, the detection limit of the measuring device must not exceed this standard value if the measuring device is to be suitable for demonstrating compliance with the standard value.

Note: As for the decision limit, a confidence level of 95 % is also generally required for the detection limit. Why is the detection limit about twice as high as the decision limit despite the same confidence level? The decision limit depends on the fluctuation of the zero effect values. This relation also applies to the detection limit. Still, the fluctuation of the gross effect values (the gross effect is the zero effect plus the “artificial” dose rate) which also has an influence. Since both fluctuations are very similar and thus double the uncertainty, the detection limit is twice as high as the decision limit.

The following measurement procedure demonstrates how the detection limit is used in practice to detect low “artificial” dose rates with the 62AD:

1. Read the zero effect, i.e. move the 62AD to a suitable long distance from the object in question and read the 62AD *after a waiting time of three time constants* (use three time constants, because then the display has approached the final value good enough, see previous section). A rest period, which may occur between two measurements for organizational reasons, is also considered a waiting period in the event of a zero effect.

2. Put the 62AD to the respective object, *wait for three time constants*, and then read the 62AD display again.
3. If the value of step 2 is at least the *Decision limit* above the zero effect value of step 1, you can assume an “artificial” dose rate. Otherwise, you cannot. To prepare the subsequent measurement, return to step 1.

The programmable dose rate alarm threshold can make this work much easier. If this alarm threshold is set to the value “zero effect plus decision limit”, the 62AD carries out step three on its own, emitting an alarm if an “artificial” dose rate is to be assumed. You need the zero effect and the decision limit to determine this alarm threshold. The zero effect can be measured more precisely once, preferably using the mean value display. Afterwards, the zero effect of the 62AD can only change if the ambient radiation has changed or if the 62AD has been contaminated. Then, you use the zero effect measured to calculate the decision limit and, thus, the dose rate alarm threshold. We will explain the equation and examples later.

What is the decision limit here? In any case, it depends on the fluctuation of the displayed values at zero effect because: The more the display fluctuates at zero effect, the higher the selected decision limit must be to achieve a certain confidence level. The previous section introduced the standard deviation, the measure of the display fluctuation, as the coefficient of variation. From now on, we will call the standard deviation of the zero effect display Sigma_0 :

Sigma_0 = standard deviation (absolute in $\mu\text{Sv/h}$, not relative in %) of the zero effect display

The decision limit and the detection limit are each a multiple of Sigma_0 :

$$\text{Decision limit} = 2.5 \times \text{Sigma}_0 \quad (7.1a)$$

$$\text{Detection limit} = 2 \times \text{Decision limit} = 5 \times \text{Sigma}_0 \quad (7.1b)$$

Having a confidence level of 95 %. These limits are rounded slightly upwards. Thus, the confidence level is somewhat higher than 95 %.

Where does this specification come from? Look at the probability distribution and standard deviation from the last section. However, we do not want to explain this in more detail here; please refer to the standard DIN ISO 11929 (formerly also DIN 25482) for more information. This standard deals much more extensively with determining “characteristic limits”, such as the detection and decision limits. Unfortunately, such standards are entirely unsuitable as practical guidelines. We prefer a somewhat simplified representation.

We now need the standard deviation Sigma_0 . An experimental method is used to determine the standard deviation. Although this procedure is laborious, it is straightforward as it does not require any knowledge of the measuring device. Observe the measuring device with natural ambient radiation as long as possible, read it at certain intervals and calculate the standard deviation from the readings using the following equation:

$$\text{Sigma}_0 = \sqrt{\frac{n \sum x^2 - (\sum x)^2}{n(n-1)}} \quad (7.2)$$

Here is: n the number of values read,
 $\sum x$ the sum of the read values,
 $\sum x^2$ the sum of the squares of the read values.

The equation (7.2) is sometimes integrated with scientific calculators. Common spreadsheet programs also support the standard deviation function. By the way: If you divide the equation (7.2) by the mean value $(\sum x)/n$, you get equation (6.2).

A faster but less accurate method for calculating the standard deviation is the equation $\text{Sigma} = \sqrt{N_0}$, where N_0 is the number of background events (counter tube pulses) counted. This equation is only an approximation, which is nearly correct for high N_0 , but it underestimates the standard deviation Sigma for small N_0 . Given a time constant T and a background pulse rate R_0 , the pulse number is $N_0 = 2 \times T \times R_0$. In our case, this N_0 may assume small values around 1, which means that equation $\text{Sigma} = \sqrt{N_0}$ is no longer correct. We help ourselves using a rule of thumb and increase our N_0 by 1 and thus define a corrected standard deviation $\text{SigmaKorr} = \sqrt{N_0 + 1}$. This equation provides the same result for high N_0 because the additional 1 hardly has an influence there, and for small N_0 , we obtain significantly better estimates for the standard deviation. This correction is sufficient for our purposes, as it is rounded upwards at the end. Using SigmaKorr and N_0 we can now calculate Sigma_0 , the standard deviation of the zero effect display:

$$\text{Sigma}_0 = \frac{\text{SigmaKorr}}{N_0} \times NA = \sqrt{\frac{N_0 + 1}{N_0^2}} \times NA^2 = \sqrt{\frac{NA \times KF}{2 \times T} + \left(\frac{KF}{2 \times T}\right)^2} \mu\text{Sv/h} \quad (7.3)$$

Here is: NA The zero effect display in $\mu\text{Sv/h}$, typically slightly smaller than $0.1 \mu\text{Sv/h}$.
 KF The calibration factor of the detector in $\mu\text{Sv/h}$ per pulse/s to convert a pulse rate into a dose rate, e.g. from the zero rate R_0 into the zero effect display NA according to $NA = KF \times R_0$. The typical value of counter tube 62AD, KF is $0.62 \mu\text{Sv/h}$ per pulse/s.
 T The time constant in seconds. We discussed the time constant in detail in the last section. The 62AD version's "slow" ($IEC = 0$) time is 20 seconds, and the "fast" ($IEC = 1$) time is four seconds.

The following table includes the standard deviation specifications Sigma_0 as well as the resulting decision and detection limits:

	Sigma_0 according to equation 7.3	Decision limit according to equation 7.1a	Detection limit according to equation 7.1b	Decision alarm threshold
With a normal zero effect display $NA = 0.07 \mu\text{Sv/h}$:				
"slow" 62AD ($T = 20$ s)	$0.037 \mu\text{Sv/h}$	$0.094 \mu\text{Sv/h}$	$0.187 \mu\text{Sv/h}$	$0.2 \mu\text{Sv/h}$
"fast" 62AD ($T = 4$ s)	$0.111 \mu\text{Sv/h}$	$0.277 \mu\text{Sv/h}$	$0.554 \mu\text{Sv/h}$	$0.4 \mu\text{Sv/h}$
With a normal zero effect display $NA = 1.0 \mu\text{Sv/h}$:				
"slow" 62AD ($T = 20$ s)	$0.129 \mu\text{Sv/h}$	$0.321 \mu\text{Sv/h}$	$0.643 \mu\text{Sv/h}$	$1.4 \mu\text{Sv/h}$
"fast" 62AD ($T = 4$ s)	$0.296 \mu\text{Sv/h}$	$0.741 \mu\text{Sv/h}$	$1.482 \mu\text{Sv/h}$	$1.8 \mu\text{Sv/h}$

The last column of the table includes the suggested detection alarm threshold that can be set as the measuring device's alarm threshold. The value of this alarm threshold is "zero effect display plus decision limit". It is always rounded to the next most considerable adjustable value ($0.1 \mu\text{Sv/h}$ is

the smallest increment when programming the alarm threshold). If this alarm threshold is reached or exceeded, you can assume an artificially increased dose rate with a maximum error probability of 5 %. Whether such an alarm threshold is helpful in practice is an entirely different question. An error probability of 5 % means that the measuring device erroneously emits a warning at 5 % of the time in case of a zero effect, i.e. without a suspicious object nearby. The inspector in charge will consider this behaviour annoying if enabled for a more extended period.

The lower part of the table clearly shows that the detection and decision limits increase steeply with the rising zero-effect value. For example, an increased zero effect value occurs if the 62AD is contaminated or the measurement location has a permanently increased dose rate for other reasons. This example also shows that the detection limit is not a simple number in the measuring device specifications but depends on the local operating conditions.

The above specifications refer to the 62AD counter tube. An external probe has a detector and, therefore, its decision and detection limits. You will find relevant information in the probe documentation.

The dose rates close to the decision limit or detection limit are so low that they are usually outside the measuring range. But that doesn't matter. The measuring range requirements differ from those for the detection limit. If you have *detected* low artificial dose rates below the measuring range, formulate this accordingly: use "*detected*" instead of "*measured*". Then, nobody can blame you for wrongdoing.

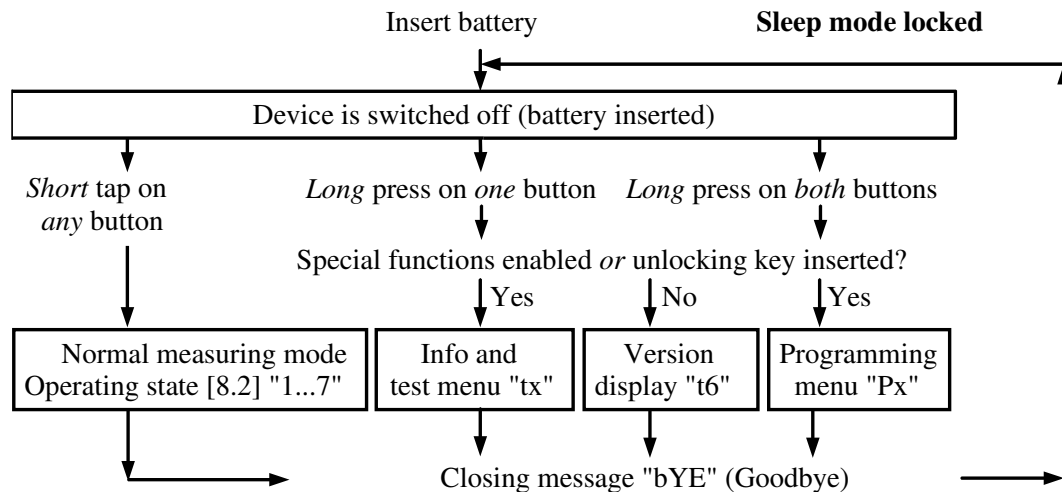
8 Operation

8.1 Flowcharts

The flowcharts in this section show the different statuses of the 62AD and how to get there. We differentiate between use cases with and without sleep status and use cases with the service functions enabled.

8.1.1 Use case without sleep mode (default setting)

The following flowchart applies to the simplest case in which the sleep mode is locked. Many users are likely to accept this default setting without making any modifications.



Operation is more straightforward than this flowchart might suggest at first glance. Pressing any button switches the 62AD on. If you press only *for a moment*, the 62AD goes into normal measuring mode. It doesn't matter which of the two buttons you tap. Switching on could hardly be easier.

To call up a special function, press and hold the button(s). Pressing *longer* on *any button* takes you to the "tx" info and test functions menu while pressing *longer* on *both buttons* takes you to the "Px" programming functions menu. You need the unlocking key [16] if the special functions are locked. The 62AD displays the special menus called up only if its battery is considered good. If the battery is low, the 62AD switches off again after a long button press and briefly flashes the "bAtt" message to give an indication.

The manual switch or a sleep timer terminates measurement mode and special functions in conjunction with the motion sensor. The 62AD then switches off again ("bYE").

The test function "t6" displays the software version and has the following unique feature: It cannot be locked. If all special functions, including "t6", are locked, "t6" can still be called up directly by a long button press (on one or both buttons). Thus, the 62AD complies with the German requirement that the software's legally relevant identifier be displayed without additional tools, i.e., without the unlocking key.

Notes on probe operation: The flowchart above applies if an external probe is connected when switching the device. Then, the measuring mode and the special functions refer to the probe. In measuring mode, the probe detection is displayed in the operating mode [8.2]. Furthermore, you can switch between the probe and the 62AD basic unit while in measuring mode by plugging or unplugging a probe. The 62AD switches itself off and then on again immediately. This way, switching to/from the probe mode is intuitive; simultaneously, it performs all the steps required to end the old operation and start the new use (archiving, initialization). Such a change takes about one second.

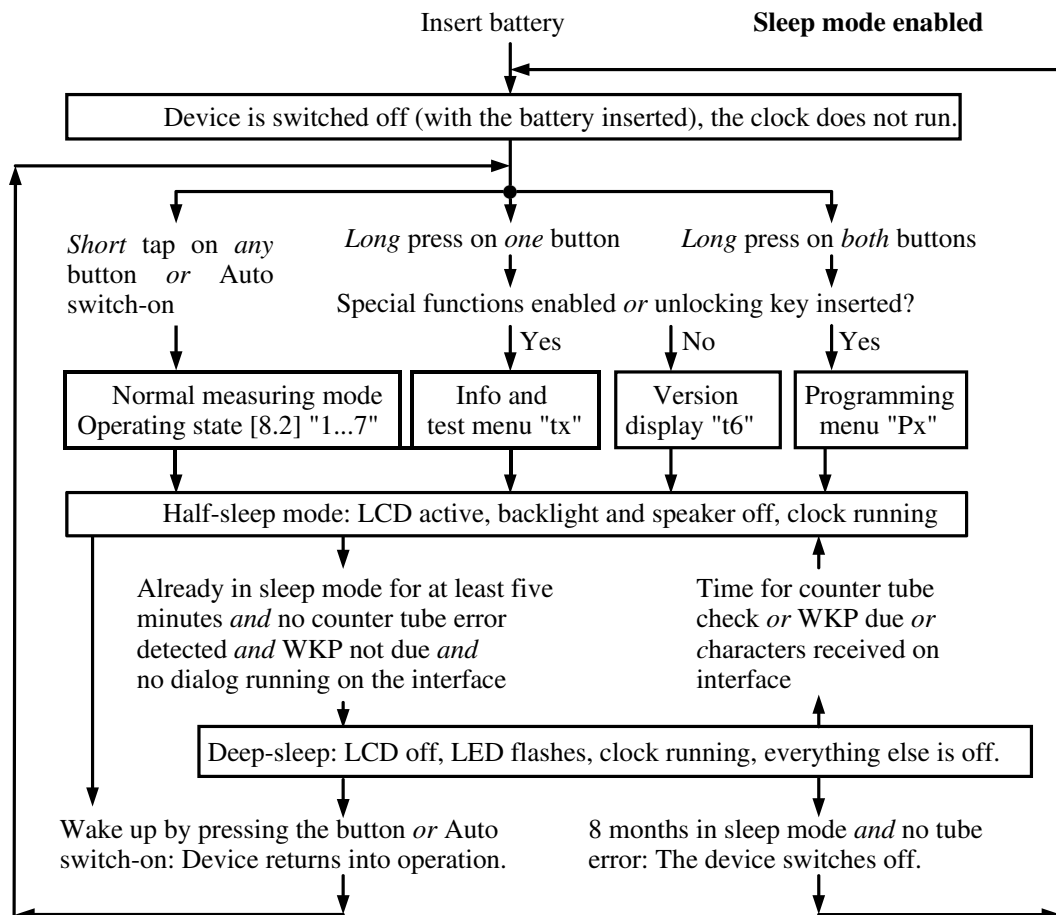
However, the special functions behave differently. If you connect or disconnect a probe while using a special function, you cancel this special function without saving any data. Only the two menus for selecting "tx" and "Px" are more tolerant of wrong operations (the menus, not the "tx" and "Px" functions themselves!). They allow you to switch from the 62AD to a probe (but not vice versa). You need this feature to call up a special probe function even though the special functions are locked. First, insert the unlocking key to access the "tx" or "Px" menus without the probe.

Then, remove the unlocking key and plug in the probe. The 62AD starts the selection again at the first menu option, "t1" or "P1", but this time for the probe. This return to the first menu option is required because the 62AD and probe have different selection options, "tx" and "Px."

The 62AD basic device turns on or off the special functions, not the attached probe. Therefore, a probe cannot call up a locked special function. The only exception is a probe whose service functions are unlocked. This exception may only occur while servicing a probe; the probe's special functions are accessible even if the special functions of the 62AD basic device are locked. This feature makes servicing the probe more convenient. We will show the workflow with unlocked service functions later in section 8.1.3.

8.1.2 Use case with sleep mode

The manual operation does not change; only the sleep mode is enabled. The main difference is that the 62AD goes into sleep mode (half and deep-sleep mode) but does not switch off after a terminated measuring mode or special function. You can reactivate the 62AD by pressing a button, just as without sleep mode, or, as a new option, by any motion if you have set this behaviour using the programming function P10. The 62AD never switches off entirely, except it has not been activated for eight months.



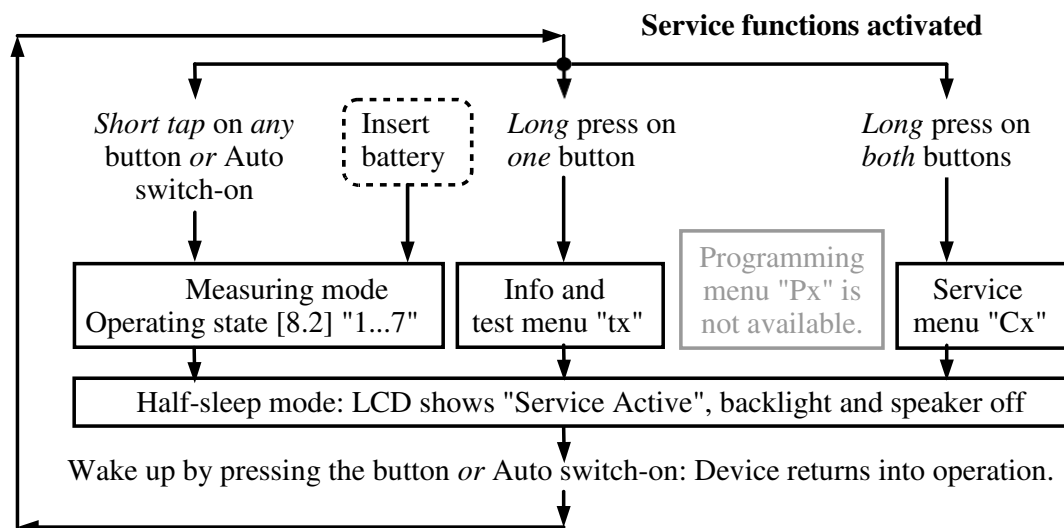
Probe operation is the same with and without sleep mode. However, what happens if you plug in a probe while the device is in sleep mode? This action does not affect the 62AD in deep-sleep mode because the probe cannot use the 5 volts supplied at the interface socket. With the 62AD in half-deep-sleep mode, the device recognizes the probe but immediately switches it off with a command. The probe identifier flashes briefly in the operating status display [8.2].

8.1.3 Service functions unlocked

As soon as the service functions are activated, a few things change:

- When you insert the battery, the 62AD switches on, and the sleep mode is considered unlocked. The 62AD is, therefore, either active (measuring mode or special function) or asleep. Still, it never goes into deep-sleep mode and always remains in half-sleep mode with the battery voltage and the message "Service Active" displayed. This permanent message draws attention to the rather unusual fact that the service functions are activated. There is also a technical reason for activating the sleep mode with the service functions enabled. There are a few service-related commands on the serial interface, which the 62AD cannot process in the activated state but can do so in sleep mode.
- The "Px" programming functions are not available. A long press on both buttons calls up the "Cx" service functions instead. The programming functions are still available as commands on the serial interface if required.
- You can access the special functions also while they are blocked for regular operation. Therefore, you never need an unlocking key to access the special functions "tx" and "Cx".

With the service functions activated, the workflow is as follows:



Notes on probe operation: Please note that the service functions of the 62AD and a probe are activated independently. The workflow above applies to the 62AD and an external probe if the service functions have been enabled. Implications: *Without a probe*, the procedure shown above applies to a 62AD whose *own service functions* have been enabled. *With probe*, the procedure

shown above applies to any 62AD if the *probe service functions* have been enabled. Because of this distinction, you can only access a probe's "Cx" service menu if you plug in the probe before you switch on the 62AD.

The service functions are required for repair and maintenance (e.g. calibration). Section 11 briefly describes what the service functions are used for. They should never be available during regular operation; hence, they need not be mentioned in these instructions for use. Nevertheless, we have explained them here so you may not be puzzled by the 62AD behaviour if you ever encounter a 62AD or a probe with activated service functions.

8.2 Arrow button and speaker button

The arrow button [4] and the speaker button [5] are used as follows:

- As indicated by the arrow symbol, the arrow button  is used for navigation. A short hit on the arrow button switches to a different 62AD state; a long button press always returns to the initial state:
 - In normal measuring mode, use the arrow button to set various display modes. If you keep the arrow button pressed, you always return to the initial mode, the dose rate display.
 - If you access the test, programming, and service mode menus, use the arrow button to scroll the menu items and the individual menu options of several special functions. If you cancel a special function, the 62AD switches off or goes into sleep mode. If you hold down the arrow button slightly longer, the active function is terminated without saving any data.
- The effect of the speaker button  depends on the current status of the 62AD. Press the speaker button if you can do anything at all in the current state. In normal measuring mode, you can switch off alarm tones, select alarm thresholds, and switch the pulse click. Since this involves alarms and sounds, we have chosen the speaker as the symbol for this button. You can also use the speaker button to confirm a change, such as turning off the 62AD and deleting the mean or maximum values. In the special functions mode, you use the speaker button to change digits when entering numbers.

Note

If you get stuck, the arrow button will always take you to a known state! In measuring mode, press the arrow button multiple times or press it for a few seconds to return to the dose rate display in the default state! If you keep the arrow button pressed for a few seconds in a special mode, the 62AD switches off without changing any data!

The 62AD also uses its resources to ensure it does not remain in a special mode. For example, if it waits in vain for an input in programming mode but is not used for a minute, it switches itself off without saving any data.

Buttons pressed that trigger a function are confirmed by a short tone  or a short tune . Buttons pressed that do not affect the current mode of the device are confirmed by another tune . This way, the 62AD always tells you that it has recognized your button activation and, by the tune, whether this activation has had any effect.

You can also use the ambient light sensor [7] controlling the backlight of the LCD as a control element. Cover the light sensor with your thumb if you want to switch on the backlight because the ambient light is not bright enough. The sensor then gets dark, and the backlight comes on.

8.3 Switching on and off

Switching on: Tap either of the two buttons to switch on the 62AD. The 62AD measures the battery voltage and displays it on a backlit LCD together with an alarm LED flashing for about one second. There is also a short welcome tune . The 62AD also checks its program memory integrity during this second. After that procedure, all the main controls, the battery and the program memory, were quickly but thoroughly tested. The 62AD then switches to the default state, the dose rate display. If there is a reason for an immediate alarm (counter tube failure or low battery), this alarm is issued immediately. You must clear this alarm by pressing either of the two buttons to return to the dose rate display.

When switched on, the 62AD establishes a well-defined initial status:

- If an individual dose rate alarm threshold is programmed, this is now active. Otherwise, no alarm threshold is active at all. It is, therefore, irrelevant whether you set a different alarm threshold in the previous measuring mode. If so, this does not apply any longer.
- The same applies to the dose alarm threshold.
- The dose is zero.
- The pulse click is as specified by the programming function P9.

There is also another way to switch on the 62AD: If you set the device accordingly using the P10 programming function, one motion is enough to wake up the 62AD from sleep mode. Grabbing the 62AD from its storage location is sufficient to switch it on.

Switching off: Use the arrow button to set various display statuses; see next section 8.4. One of these display statuses (no. 1) allows to switch off the device. In this state, the digital display flashes the text "OFF", and pressing the speaker button turns the 62AD off. If a probe is connected, the probe is also switched off. Therefore, the 62AD informs the probe that the measurement mode has ended, and the probe is to stop its activities. The behaviour of the probe depends on the probe specification, which can be found in the probe documentation.

If permitted by the programming function P11, the sleep timer switches the 62AD off automatically after a certain period of inactivity.

8.4 Display statuses

The table below lists the display statuses that you can set one after the other using the arrow button. After the last status, the default mode appears again, i.e. the dose rate display. If you hold down the arrow button longer, you can return to the default status from any status.

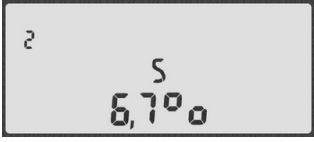
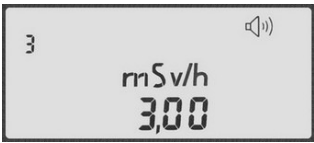
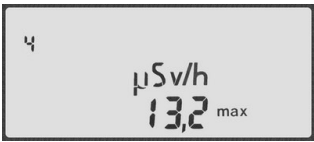
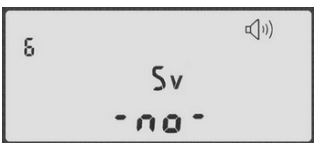
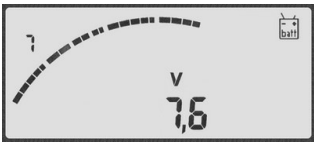
There is no need to worry that you might miss a warning when you access the various display statuses. The 62AD automatically switches to the corresponding display status when new alarms occur (dose rate display in the event of a dose rate alarm, dose display in the event of a dose alarm).

Some alarms are not assigned to a specific display status and are visible in all statuses. These are the flashing “F” or “d” in the operating mode [8.2] and the flashing battery symbol [8.9] due to low battery. When the counter tube alarm or battery alarm occur for the first time, you hear an alarm tone and are informed by a flashing text on the digital display (“dEF.” and/or “bAtt”). You can delete this additional initial warning by pressing either of the two buttons. After that, the current display status will appear again.

You can use the programming function P1 to determine which display statuses the 62AD offers and in which order. The only status you can neither remove nor move is the default state, i.e. the dose rate display, which is always the first in your sequence of display statuses. This basic status and the seven variable display statuses 1 to 7 are listed in the following table. This sequence corresponds precisely to the default setting of the 62AD. However, the default delivery configuration does not include the display statuses no. 5 and 6 because the dose display and dose alarm likely annoy most users.

The pictures below show the 62AD in operation with its counter tube. If an external probe is connected, the “ext” symbol [8.1] is also displayed, and the operating status [8.2] under the “ext” symbol shows the probe identifier. To prevent the probe identifier from hiding the display status number, it is permanently on in the default status (where the operating status without a probe is empty). It alternates with the display status number in all other display statuses.

No.	Symbol	Explanation and effect of the speaker button
-		Display of the dose rate (default status after switching on), digital range up to the end of the range of the current detector. <i>Speaker button function:</i> If a new alarm is pending: Deletes the alarm tone. Otherwise: Switches pulse click on/off. You recognize the current setting by the speaker symbol.
1		Option to switch off (“OFF” flashes). <i>Speaker button function:</i> Switches the 62AD off. If you do not press the speaker button within a few seconds, the 62AD returns to the default state (dose rate display). This feature prevents you from accidentally switching the device off.

No.	Symbol	Explanation and effect of the speaker button
2	 alternating with: 	Alternating display of the dose rate mean value (format 0.000 µSv/h to 999.9 mSv/h) and the respective coefficient of variation in % (symbol “S” = standard deviation, display range from 0.1 % to 99 %, “0.1 % max” if smaller than 0.1 %). The digital display flashes as long as the variation coefficient is higher than 5 %. <i>Speaker button function:</i> Deletes the mean value and restarts the calculation. To do this, press the button twice: After the first press, “SEt.0” (= set to zero) flashes in the digital display. You must confirm within a few seconds by pressing the button again.
3		Display and selection of the dose rate alarm threshold, text “-no-” if no alarm threshold is active. The speaker symbol indicates this is an alarm threshold, not a measured value. <i>Speaker button function:</i> Selects the next alarm threshold. This selection can trigger a new dose rate alarm!
4		Display of the maximum value (“max”) of the dose rate. <i>Speaker button function:</i> Deletes the maximum value and restarts the calculation. To do this, press the button twice: After the first press, “SEt.0” (= set to zero) flashes in the digital display. You must confirm within a few seconds by pressing the button again.
5		Dose display. The analog bar shows the dose relative to the alarm threshold if the alarm threshold has been set. <i>Speaker button function:</i> If a dose alarm is pending: Deletes the alarm tone and switches to the default status (dose rate display). Otherwise: none (dose deleted only by switching off).
6		Display and selection of the dose alarm threshold, text “-no-” if no alarm threshold is active. <i>Speaker button function:</i> Selects the next alarm threshold. This selection can trigger a new dose alarm!
7		Digital display of the battery voltage in volts and analog as an approximate battery capacity on an fictious linear scale of 0 % to 100 %. The digits flash below 6.0 volts (this is also the alarm threshold for the battery warning). After a few seconds, the 62AD returns to the default state (dose rate display) so this image cannot be confused with the sleep mode. <i>Speaker button function:</i> None.

9 Test mode

In test mode, you can test or check various components of the 62AD. You can also enter or delete the test date and read and set the clock on the 62AD. You cannot change other data in test mode.

The test functions are numbered. If a specific test function is running, the letter “t” and the number of the test function appear alternately in the operating status display [8.2]. This feature means you can check, at any time, which test function is currently active. The “ext” symbol [8.1] is also displayed if an external probe is connected. The user cannot read the probe identification in test mode because this would hide the test function number.

You can use the programming function P15 to lock test and programming modes. If you have done this, you must first insert the unlocking key [16]. Otherwise, you will be unable to enter the test mode. Then switch on the 62AD and keep the button pressed (either button, but not both buttons simultaneously!). If you insert the unlocking key [16], “ULoc” (unlock) appears on the digital display [8.4] while you press the button. After a few seconds, the 62AD plays a short tune to indicate it is now in the test function menu and offers the first test function, “t1”. Then, you can release the button. Next, remove the unlocking key [16]. If you want to test a probe, connect it now (if the test mode is not locked, you can connect it before switching the device on). In addition, the general operating principle of the two buttons also applies in test mode, i.e., the arrow button navigates to, and the speaker button executes an option:

- Arrow button: A short tap offers the next test function (t3, t4, etc.). The selection of functions is slightly different for probes than for the 62AD; see the explanations of the individual functions in the table. After completion of the last test function, the 62AD switches off. Keep the button pressed to skip all steps, i.e., it also switches the device off. If no one activates the 62AD (no motion or button press for one minute), the 62AD also switches itself off.
- Speaker button: A few test functions only display special information as banner text. Pressing the speaker button has no effect. You can start other test functions only when you press the speaker button. A long press on the speaker button has no particular effect.

These nine test functions are available:

No.	Explanation and effect of the speaker button
t1	“tEst” as banner text. Indicates that the radiological check of the counter tube can be started (62AD or external probe). In the rare case of an external probe with two detectors, “tEst Lo” (Lo = low) appears to indicate that you can test the first detector (for low range). <i>Speaker button function:</i> The detector test is started. The test mode is described in section 12.1. It always terminates when the 62AD is switched off.
t2	“tEst Hi” (Hi = high) as banner text. The behaviour is the same as with “t1”, but for an external probe’s second detector (for the high range). It is only possible with an external probe with two detectors. Otherwise, the test function “t2” is automatically skipped. <i>Speaker button function:</i> The detector test is started. The test mode is described in section 12.1. It always terminates when the 62AD is switched off.

No.	Explanation and effect of the speaker button
t3	“CHEC-dAtE=2019-02-28” banner message. Displays the date (62AD or external probe) the next radiological check is due, or: “CHEC-dAtE not SEt” if this date has been deleted. Entering a test date also releases the sleep mode. The effects of the test date are explained in detail in section 5.2. In short, the test is due if • the check date is set <i>and</i> • the clock of the 62AD is not set, or • the clock of the 62AD is set and has reached or passed the test date. When the test is due, “d” flashes in the current operating mode [8.2] as a warning. <i>Speaker button function:</i> Start with the entry of the test date. Enter the year, month and day of the next test date in succession: xx.99 max xx flashing = two digits for the year, range 00 to 99 xx.12 max xx flashing = month, range 00 to 12 xx.31 max xx flashing = day, range 00 to last day of the month (28 to 31) This input is similar to setting the clock (see the following test function “t4”). However, there is one clear difference: It is also possible to enter the invalid zero value for the month and day of the test date. Entering an invalid date deletes the test date (“CHECdAtE not SEt”), which deactivates both its monitoring and the sleep mode. After you have entered the test date, the 62AD switches off. If a probe is connected, the test date just entered refers to the probe but not to the 62AD.

No.	Explanation and effect of the speaker button
t4	“dAtE=2019-01-28 17.03” as banner text. Displays date and time of the 62AD, or: “dAtE not SET” when the clock is not set. This function is only available if the sleep mode is enabled, i.e., if the date of the next radiological check is set (see the previous Test function t3). <i>Speaker button function:</i> The setting of the clock is started. To do this, you must enter five two-digit numbers for the year, month, day, hour and minute one after the other: xx.99 max xx flashing = two digits for the year, range 00 to 99 xx.12 max xx flashing = month, range 00 to 12 xx.31 max xx flashing = day, range 00 to last day of the month (28 to 31) xx.23 max xx flashing = hour, range 00 to 23 xx.59 max xx flashing = minute, range 00 to 59. The maximum value in the two rightmost digits of the digital display reminds you of the number you are entering. A short tap on the speaker button increases xx by 1; a long press accelerates the increase. You can only reduce a number by increasing it until it exceeds the maximum value and then restart with the minimum value. Use the arrow button to switch to the following number. Finally, after entering the minutes, the seconds are set to zero, and the 62AD goes into sleep mode. A long press of the arrow button or one minute of inactivity puts the 62AD into sleep mode without changing the clock. If the clock is set via a command on the serial interface during your entry, the entry mode is automatically terminated, and the 62AD goes into sleep mode. The 62AD displays its current clock for overwriting. If it has been without power for a long time, the clock will slow down accordingly. You may only need to update the minutes if it has been without power for a short time. You cannot return to an earlier number while entering the five numbers one after the other. If you made a mistake with an entry, you must exit the test function “t4” and re-access it. The test function “t4” is not offered with a probe because probes automatically retrieve the date and time from the basic device. If you connect a probe during input, your input will still refer to the clock of the 62AD.
t5	“Lcd tEst” as banner text (applicable only with 62AD, skipped with probe). Indicates that the LCD test of the 62AD can now be called up. <i>Speaker button function:</i> The LCD test has started. The LCD test includes many steps, which we cannot explain here, but we will describe them directly after this table. The LCD test always terminates when the 62AD is switched off. Plugging in or unplugging a probe during the LCD test is possible but not helpful. During the first ten seconds of this menu option, the 62AD switches on an internal resistor as an artificial load of the battery. You can check the function of the load resistor at this point. During the first ten seconds, the current drawn by the 62AD must increase by about 12 mA.

No.	Explanation and effect of the speaker button
t6	“SoFt=h-ccccccc-n.x” as banner text, e.g. “SoFt=0-F4F180A0-2.0”. If the compliance bit is set (see section 5.14 for an explanation), the two characters “co” are appended: “SoFt=0-F4F180A0-2.0co”. If a probe is connected, the banner message refers to the probe, otherwise to the 62AD. “h” is the output status of the hardware. “ccccccc” is the CRC (Cyclic Redundancy Check) of the program memory, which serves both as a check number and an identifier for the output status of the flash memory. The last section of this document (Document history) lists the CRCs created to date. This list will also tell you whether the software output of your 62AD and the output of these instructions for use match. While h and ccccccc cannot be changed for a specific device, a device can offer several program versions “n.x”, one of which you can set using the service function C7. When reading hexadecimal values, please note the format 0 123456789ABCDEF (digits 0 to 9 and letters A to F), so in particular, do not confuse 6 and b! The test function “t6” is called up directly if the special functions are locked and the unlocking key is not inserted. Thus, the user can identify the software anytime without additional tools. If you press the arrow button to exit the test function “t6”, the 62AD does not access test function “t7” but switches off. <i>Speaker button function:</i> The text runs more slowly as long as you press this button.
t7	“SErno=xxx_xxx” as banner text. This way, you can check the serial number of the 62AD or the connected probe. The serial number may include up to nine digits. For better readability, an underscore separates every three digits. The saved serial number may be helpful if the printed serial number is no longer legible. You need the serial number of the 62AD only for comparison with the serial number that an external probe may wait for from its basic device. <i>Speaker button function:</i> The text runs more slowly as long as you press this button.
t8	“d-SErno=xxx_xxx” as banner text. This is the serial number that a probe requires from its basic device. It is also displayed in groups of three digits. Since probes can request a specific basic device, test function “t8” is automatically skipped with basic devices such as the 62AD. This serial number is either zero (in which case every basic device can work with the probe) or has the same serial number as the 62AD. Otherwise, the 62AD would have rejected the probe. <i>Speaker button function:</i> The text runs more slowly as long as you press this button.
t9	“Sound tESt” as banner text (applicable with 62AD only, skipped with probe). Alarm sound and LED [6] are activated. Here, you can familiarize yourself with both alarms or check both. In this situation, the LED [6] is also on if the programming function P6 had deactivated the LED for the measuring mode. <i>Speaker button function:</i> none.
	If you press the arrow button again, the 62AD switches off. The 62AD also switches off if you keep the arrow button pressed, regardless of the option in the test menu.

Let us now describe the details of the LCD test just mentioned in the table as test function “t5”. The LCD test includes eight images, each covering a specific area of the LCD. Each image is a tiny animation that runs in an endless loop. You can use the speaker button to switch back and

forth between a still image and playback to check individual segments in more detail. Use the arrow button to switch to the next animation. The 62AD switches off after the last animation. The following eight animations appear one after the other:

1. Analog bar display [8.7]: The bar extends evenly from zero to the entire length of 32 segments and then starts again at zero. A scale labelled 1 - 2 - 5 - 10 - 20 - 50 - 100 is also visible as a guide. All other segments must be invisible.
2. Digital display [8.4]: The hexadecimal characters “0123456789AbCdEF” move through the four digits as banner text. Each of the four digits of the digital display must show each hexadecimal character correctly. All other segments must be invisible.
3. The three decimal points on the digital display [8.4] and the “max” symbol [8.5]: The three decimal points and the “max” symbol appear one after the other from right to left. Only one of these four symbols should be visible at any time. All other segments must be invisible.
4. The “ext” symbol [8.1] and the operating status [8.2]: The upper digit “1” of the operating status and the “ext” symbol appear alternately in a slow cycle. All hexadecimal characters from 0 to F appear in the lower digit of the operating status at a faster rate. All other segments must be invisible.
5. Speaker symbol [8.8] and battery symbol [8.9]: The speaker symbol and the battery symbol appear alternately. All other segments must be invisible.
6. Scale marks and scale labelling [8.6]: The scale marks are always visible; the following three scale labels appear one after the other:
 0.1 – 0.2 – 0.5 – 1 – 2 – 5 – 10
 1 – 2 – 5 – 10 – 20 – 50 – 100
 10 – 20 – 50 – 100 – 200 – 500 – 1000
 All other segments must be invisible.
7. Prefixes [8.3]: The following six symbols (unit prefixes) appear one after the other:
 p / n / μ / m / h / k (stands for: piko / nano / mikro / milli / hekto / kilo). All other segments must be invisible.
8. Units [8.3]: The following seven symbols (units) appear one after the other:
 S / Sv / Sv/h / R / R/h / S^{-1} / v (stands for: standard deviation / sieverts / sieverts per hour / röntgen / röntgen per hour / events per second / volts). All other segments must be invisible.

10 Programming mode

In programming mode, you can code a series of features to adapt the 62AD to your requirements. This programming is not a task for the daily user but part of your work planning; it is a relatively rare task that you should prepare carefully. When done, you may never need the programming mode again because all settings are saved permanently. To protect the settings further, you can use the programming function P15 to lock the test and programming modes.

Please note that you can also store all programmed data in the 62AD via the serial interface! This feature is a significant benefit if you have several 62ADs and want to program them all similarly.

- Example of an extremely simple 62AD: Remove all display statuses (use the programming function P1), including the “OFF” status for switching off. Thus, only the dose rate display status will be available, the alarm thresholds will be inactive, and you can no longer switch the 62AD off. Therefore, set the sleep timer (P11) to ten minutes. Activate sleep mode (test function t3) and automatic switch-on by motion (P10). You now have a 62AD that automatically switches on whenever it is moved (used). After use, store the 62AD in a quiet place. It will automatically turn off after ten minutes of inactivity. As soon as you pick it up again, it switches on again. Thus, the user does not have to know how to switch it on and off. The only thing the user can do by pressing a button is switch the pulse click on and off using the speaker button. The arrow button has no effect because all display statuses are hidden. The operation couldn't be more straightforward. The only alarms that this 62AD can produce are “low battery” and “counter tube failure”. You only need to press any of the two buttons to delete these alarms.
- Example of another simple 62AD configuration: The 62AD should work as described above but with an extra dose rate alarm threshold, which the user cannot change nor switch off. To this end, program a dose rate alarm threshold (P2), set the display state 3 as the only state in the display sequence (P1) and set the alarm category for the dose rate to zero (P4). The arrow button now has a new function: it displays the dose rate alarm threshold without allowing you to change it or switch it off. If you want to offer the user a selection of additional fixed dose rate alarm thresholds, set the alarm category for the dose rate to a suitable value other than zero (P4).
- We will not provide any further examples here. Please study the programming functions described below. Then, plan what functions you want to use and how you want to use them to customize your 62AD.

Now, let us explain the practical implementation of the programming functions. Similar to the test functions, the programming functions are also numbered. If a specific programming function is running, the letter “P” and the number of the programming function are displayed alternately in the operating status [8.2]. Thus, you can easily see which programming function is currently active. The “ext” symbol [8.1] is also displayed if an external probe is connected. You cannot read the probe identification in programming mode because this would hide the number of the programming function.

You can use the programming function P15 to lock test and programming modes. If you have done this, you must first insert the unlocking key [16]. Otherwise, you will not be able to enter the programming mode. Then, switch on the 62AD by pressing and holding the *two* buttons. If you insert the unlocking key [16], “ULoc” (unlock) appears on the digital display [8.4] while you press the button. After a few seconds, the 62AD plays a short tune to indicate that it is now in the programming function menu and offers the first programming function, “P1”. You can now release the buttons again. Next, remove the unlocking key [16]. If you want to program a probe, connect it now (if the programming mode is not locked, you can connect it before switching on the 62AD). Otherwise, the general operating principle of the two buttons applies here too, i.e., the arrow button navigates to, and the speaker button executes an option:

- Arrow button: A short button press offers the following programming function. Some of these functions are not useful for probes and are, therefore, skipped with them; see the explanations in the table below. After the last programming function has been reached, the

62AD switches off. Keep the button pressed to skip all steps, i.e., it also switches the device off. If no one activates the 62AD (no motion or button pressed for one minute), the 62AD also switches off without saving any data. Any entries already made are discarded.

- **Speaker button:** The first three programming functions, P1 to P3, require a slightly longer sequence of digits to be entered. If you press the speaker button from P1 to P3, the actual programming function starts, and you can use it to enter digit sequences. The remaining programming functions from P4 onwards include only the display of tiny numbers that can only take on a few values and which you can change directly using the speaker button. A long press on the speaker button has no particular effect.

The following table shows all programming functions:

No.	Explanation and setting options
P1	Display statuses, also for probes: A banner message similar to “dISPLAY=12347” appears. This option defines which display statuses appear in which order in normal measuring mode when you press the arrow button multiple times. Pressing the speaker button starts the programming of the display sequence. Section 10.1 describes how this programming works and what you need to consider. The 62AD then switches off. The display sequence of a probe applies to probe use, but only if it has priority using P10. Otherwise, the display sequence of the 62AD in probe mode is the same. The default setting of 62AD: “dISPLAY=12347”. The default setting of the probe: depends on the probe, but usually it is “dISPLAY=0”.
P2	Individual dose rate alarm threshold, also applicable for probes: The currently programmed alarm threshold is displayed as in normal measuring mode (“-no-” if not available). In addition, the text “ProG” appears alternately in the digital display to indicate that the individual alarm threshold can now be programmed. Pressing the speaker button starts the programming of the alarm threshold as described in section 10.2. The 62AD then switches off. The default setting of 62AD: no alarm threshold (“-no-”). The default setting of the probe: depends on the probe, but usually also “-no-”.
P3	Individual dose alarm threshold, also applicable for probes: Just like the P2 programming function, but now for the dose alarm threshold.
P4	“AC.xy” shows the current alarm categories for dose and dose rate, also applicable for probes: section 5.5 explains the alarm categories. “by” in “AC.xy” can assume these values: x = 0 to 5 = alarm category for dose rate, y = 0 to 2 = alarm category for dose. First, the “x” flashes and can be changed with the speaker button. Tap the arrow button to go to “y” and set the alarm category for the dose similarly. The default setting of 62AD: both categories xy = 00. The default setting of the probe: depends on the probe, but usually also xy = 00.

No.	Explanation and setting options
P5	“IEC.x” indicates whether the device (62AD or probe) is operating with a fast response time by IEC 60846-1. Section 6 describes its effects on the 62AD. Press the speaker button to set the flashing “x” to the following values: 0 = not compliant with IEC 60846-1 (slow response time, default setting of the 62AD) 1 = compliant to IEC 60846-1 (fast response time, see section 6). The default setting of the probe: It depends on the probe, but it is usually also 0. For a probe, this setting applies to stand-alone operation. When used on a basic device such as the 62AD, the probe usually adopts this setting from the basic device.
P6	“LED.x” defines the behaviour of the alarm LED [6]; it is skipped for probes as not applicable. Press the speaker button to set the flashing “x” to the following values: 0 = LED is always off, 1 = LED on for dose and dose rate alarms, pulse flash is always off, 2 = LED on for dose and dose rate alarms, pulse flash is active (default setting). In case of alarms, the LED flashes and blinks at the same rate as the audible alarm of the piezo speaker [3]. Unlike the speaker, however, the LED does this in all display statuses of the normal 62AD measuring mode. If there are several causes for the LED to light at the same time, the 62AD must prioritize on the most important cause: Priority has the dose alarm, the dose rate alarm, and the pulse flash.
P7	“Snd.x” (Sound) defines the pulse click tone and is skipped for probes as not applicable. Press the speaker button to set the flashing “x” to the following values: 0 = melodic tone of 440 Hz (default setting), 1 = melodic tone of 698 Hz, 2 = melodic tone of 1047 Hz, 3 = aggressive alarm tone, approx. 2100 Hz. During this programming function, mocked pulse clicks are emitted with the currently selected tone. Choose the tone that you think is most suitable.
P8	“Vol.x” (Volume) defines the volume of the speaker and is skipped for probes as not applicable. Press the speaker button to set the flashing “x” to the following values: 1 = moderate volume (default setting), 2 = high volume, 3 = full volume. Test tones are emitted at the currently selected volume during this programming function. Select the volume that best suits your background noise.
P9	“Clc.x” (Click) defines whether the pulse click is enabled after you switch on the device or after you plug in a probe (nevertheless, you can switch on and off the pulse click in measuring mode). Press the speaker button to set the flashing “x” to the following values. This “x” has the following meaning on the 62AD: 0 = Pulse click is off after switching the device on, 1 = Pulse click is on after switching the device on (default setting of the 62AD). The meaning is slightly different with probes: 0 = after plugging in the probe, the setting of the 62AD determines whether the pulse click is on (usually, this is the default setting of the probe), 1 = Pulse click is always on after the probe is plugged in. The usual button tone does not confirm any press of the speaker button, but the tone previously set under P7 as a reminder.

No.	Explanation and setting options
P10	“Aon.x” (Auto-On) defines whether the 62AD should automatically switch from sleep mode to measuring mode when moved (nevertheless, you can also switch the 62AD on by pressing a button). Please note that the Auto-On feature only works if the sleep mode is enabled. Press the speaker button to set the flashing “x” to the following values: 0 = no automatic switch-on (default setting), 1 = automatic switch-on. Please note that the automatic switch-on should not be activated if the 62AD is to be worn or transported in sleep mode. If used with an external probe, this function has an entirely different meaning and, therefore, also a different name: “dsp.x” (display) defines whether the probe display sequence (see programming function P1) has priority over the 62AD display sequence. Press the speaker button to set the flashing “x” to the following values: 0 = no priority, the 62AD display sequence applies (default setting), 1 = priority; when used with the probe, the 62AD uses the probe display sequence.
P11	“SLP.x” (sleep) shows the value of the sleep timer in multiples of ten minutes; this display is skipped for probes as not applicable. Press the speaker button to set the flashing “x” to the following values: 0 = no automatic switch-off of the 62AD, 1 to 9 = 62AD switch off after 10 to 90 minutes of rest. “Idle” means that you have not moved the 62AD and did not press a button. The default setting is 3, corresponding to 30 minutes. A probe also influences the sleep mode behaviour if it has a motion sensor. In that case, a probe motion also prevents the 62AD from switching off. The effect of this parameter is different with special version 62ADxx-Perm for permanent operation from a power supply unit: 0 = backlight of the 62ADxx-Perm never “switches to sleep mode” (default setting), 1 to 9 = backlight works as with the standard 62AD device, i.e. the backlight goes out if the device has not been moved over a long time. For details, see the operating instructions 62AD-Perm.
P12	This function determines whether a set clock is mandatory. It is intended for devices that cannot be switched off entirely but are at least in sleep mode (such as the Teletector 6112AD). The 62AD does not need this function and, therefore, skips it.
P13	“rEC.x” (record) defines whether the 62AD should inform that its uses are saved; this option is skipped for probes as not applicable. This option is recommended if you want to use the 62AD archive systematically. Press the speaker button to set the flashing “x” to the following values: 0 = no display of information on saved uses (default setting), 1 = display of information on saved uses The real saving of data is independent of this setting. This setting only determines whether the 62AD displays a message that the measurement is ready to be saved and the number under which you can later find it in the archive. Section 5.12 explains the use of the archive in more detail. The special version 62ADxx-Perm for permanent operation with a power supply ignores the value of this parameter. It always operates as if this value were zero. For details, see the operating instructions 62AD-Perm.

No.	Explanation and setting options
P14	“bLt.x” (Backlight) displays the threshold for switching on the backlight of the LCD; this option is skipped for probes as not applicable. Press the speaker button to set the flashing “x” to the following values: 0 = backlight always off (regardless of ambient light), 1 = backlight almost always off (comes on only in very dark environment), 2 to 7 = ambient brightness threshold continues to increase, 8 = backlight almost always on (goes out only in very bright environment), 9 = backlight always on (regardless of ambient light). The default setting is 4, which provides sufficient lighting with low battery consumption. Changes to the threshold have an immediate effect, so you can assess them immediately. However, you have to save the new threshold permanently using the programming function P16. Please note that this does not affect the function of the motion sensor. After some time of rest, the lighting is reduced and finally switched off completely, even at setting 9 (“always on”).
P15	“Loc.x” (“Lock” = locked) defines whether the test and programming modes are locked; this option is skipped for probes as not applicable. The “x” can have the following values: 0 = unlocked (default setting), 1 = test and programming modes locked. The “x” flashes and can be changed if you insert the unlocking key [16]. Thus, you need that key to lock and unlock the device. You need it for unlocking, of course, because this is the intended purpose. You need this locking key to ensure it will be available for unlocking later.
P16	“Stor” (Storage) flashes to indicate that you can now save your entries, even if you use an external probe: • Now, if you press the speaker button, all entries previously made in the programming functions P4 to P15 are saved with a tune (in the probe). After saving (inside the probe), the 62AD switches off. • If you press the arrow button instead of the speaker button, all entries previously made under P4 to P15 will be lost! Instead, you should choose the next and last programming function, P17, to reset all settings to their default state.
P17	“rSEt” (Reset) flashes to indicate that you can reset the device (62AD or probe) to the default setting: • If you press the speaker button now, all parameters are reset to the default settings listed above for each parameter. After resetting, the 62AD switches off. • If you press the arrow button instead of the speaker button, the entire programming mode is exited without changing data. The 62AD switches off. If you want to cancel the programming mode earlier, you do not have to use the arrow button to get to the end of the menu; you can also cancel the programming mode if you keep the arrow button pressed.

10.1 Programming the sequence of display statuses

“Display statuses” in this context refers to the statuses you can set in normal measuring mode by repeatedly pressing the arrow button. You can code which display statuses should appear in which order. We already introduced the display statuses and their numbers in section 8.4 and summarize them again briefly in the following table:

No.	Display status
-	Dose rate display This is the default state, which is always present and cannot be removed or moved to another position from the beginning.
1	“OFF” display with the option to switch off the 62AD. If the 62AD is not switched off, it returns to the default state after a few seconds. CAUTION: If this display status is missing, the 62AD cannot be switched off!
2	To display the dose rate mean value and the coefficient of variation mean value.
3	To display and select the dose rate alarm threshold. Do not use this display status if you want the 62AD to work completely without a dose rate alarm.
4	To display the maximum dose rate value.
5	Dose display
6	To display and select the dose alarm threshold. CAUTION: The dose alarm switches to display state 5, i.e. the dose display. For this reason, display status 6 only makes sense if you also use display status 5!
7	Battery voltage display. After a few seconds, the 62AD automatically returns from this state to the basic state.

In the default setting, the 62AD has the display statuses 1, 2, 3, 4, 7. The programming function P1 shows this default setting with the banner text “dISPLAY=12347”. These are all statuses except the dose and dose alarm threshold.

If you do not like the default setting, consider a different sequence of display statuses. Example: Your first press on the arrow button will display the battery voltage (display status 7), and your second press of the button will show the option “OFF” to switch off (display status 1). All other display statuses should not exist. You must then define the display statuses using the syntax “dISPLAY=71”. In general, please note the following when you plan your sequence of display statuses:

Note

If you omit display status 3 (dose rate alarm threshold), the dose rate alarm is switched off completely, even if an alarm threshold is programmed!

Note

If you omit display state 6 (dose alarm threshold), the dose alarm is switched off completely, even if an alarm threshold is programmed!

Note

If you omit display status 1, the 62AD cannot be switched off by pressing a button! This feature may be unusual, but it may make sense for some applications that users cannot switch off the 62AD, especially not by mistake. After use, the 62AD can switch off via its sleep timer (programming function P11). If the sleep timer is also deactivated, you can switch off the 62AD only by removing the battery.

The seven selection options 1 to 7 allow the compilation of seven display statuses. Thus, the “DISPLAY=xxxxxxx” list has seven items, but not all must be filled. For example, in the default setting “DISPLAY=12347”, only five of the seven items are filled. You could even leave all items empty (this would be displayed as “DISPLAY=0”); in that case, the arrow button would not function in normal measuring mode.

We designate the seven items as d1 to d7. Access the programming function P1 and program the seven items d1 to d7 as follows:

- First, “d1=0” appears in the digital display. When you press the speaker button multiple times, the “0” flashes to indicate that you can set this digit to a value between 0 and 7. Set d1 to the digit of the display status you want to appear first after the default status. “0” means that the item remains empty, and 1 to 7 indicate the display status that should appear in this item. A longer press on the speaker button has no special effect and does not accelerate the digit change.
- Then, press the arrow button to go to d2. Please note that the arrow button only takes you to the next item but never back. This way, all items are set up to d7 to the desired values. Leave the items at zero that you do not need.
- As soon as you have pressed the arrow button, you leave the last item, d7 and can save the sequence of display statuses. The digital display now flashes “**Stor**” (Storage). Press the speaker button to save the display statuses. The 62AD confirms your entry with a short tune and then switches off. If you press the arrow button instead of the speaker button, the 62AD switches off without saving the display statuses. You can cancel programming anytime by pressing and holding the arrow button.

Before the 62AD saves the sequence of display statuses, it corrects them as follows if necessary:

- Display statuses that occur more than once are removed.
- Gaps (zeros between two display statuses) are removed.
- If display status 6 (dose alarm threshold) is present but display status 5 (dose) is not, display status 6 is removed.

Example: “3202160” Was entered for the seven display statuses d1 to d7. Here, the 2 is doubled, with a gap in between, and the 6 is not accompanied by digit 5. This display sequence is corrected to “3210000”, displayed as “DISPLAY=321”.

10.2 Programming the individual alarm thresholds

The steps for programming the dose rate alarm threshold (programming function P2) and the dose alarm threshold (programming function P3) are very similar. As soon as you have accessed one of these functions, the digital display shows a three-digit section of the total alarm threshold range:

Dose rate: total 0 000 000.0 $\mu\text{Sv/h}$ divided into sections from 0.00 Sv/h to 00.0 $\mu\text{Sv/h}$

Dose: total 0 000 000 μSv divided into sections from 0.00 Sv to 000 μSv

The device will use the highest section with the digits 0.00 Sv(h) with a high-range probe only. At the end of its respective ranges, the 62AD starts with “00.0 mSv/h” for the dose rate and “000 mSv” for the dose as the first section. The highest of the three digits is the current digit. It flashes to indicate that you can change it by pressing the speaker button. Code your alarm threshold as follows:

- Speaker button: The current digit flashes. You can set the digit to a value between 0 and 9 if you press the speaker button multiple times. A longer press on the speaker button has no special effect and does not accelerate the digit change.
- Arrow button: Use the arrow button to select the desired digit. Please note that you can only move to a smaller digit by pressing the arrow button to the right. There is no chance of returning to the left to a higher digit. As long as you leave the highest digit of the current section at zero, you will move to the highest digit in the next lower section each time you press the arrow button. Note how the 62AD shifts the decimal point and adjusts the prefix (μ , m) while keeping the leftmost digit active. If the highest digit is not equal to zero, or if you are already in the minor section, you can use the arrow button to move to the right within that section. You can save the alarm threshold after leaving the smallest digit with the arrow button. Now, “**Stor**” (Storage) flashes in the digital display. Press the speaker button to save the alarm threshold. The 62AD confirms your entry with a short tune and then switches off. If you press the arrow button instead of the speaker button, the 62AD switches off without saving the alarm threshold. You can cancel programming anytime by pressing and holding the arrow button.

If you want to delete the individual alarm threshold, enter zero (000 or 0.00 or 00.0) as the alarm threshold and save this zero. As zero is not a meaningful alarm threshold, this entry is regarded as “no individual alarm threshold present”, which is displayed as “-no-” in normal measuring mode. If you try to code an alarm threshold above the upper end of the measuring range, the device sets the end of the measuring range automatically as the alarm threshold.

11 Service mode

In the last two sections, we explained the test functions “tx” and the programming functions “Px”. A third group of special functions includes the “Cx” service functions. The “C” stands for ServiCe (“S” would have been a much better abbreviation, but the “S” is unfortunately unsuitable because it looks exactly like the digit “5” on the 7-segment display).

The service functions modify important features such as measurement accuracy. They must, therefore, not be accessible without breaking the seals of the 62AD. You must open the 62AD and set a jumper on its mainboard to enable the service functions. If you ever experience the service functions being enabled without such an intervention, there is an error. In such a case, please return the 62AD for repair.

We will not describe how to turn service functions on and off or explain them in more detail here. We will explain these functions in a separate technical manual. We only mention the service functions for completeness and explain the 62AD behaviour if the service functions have been enabled for whatever reason. If the service functions have been enabled, the 62AD changes its behaviour in three sections:

- The sleep mode is always enabled. In sleep mode, the banner message “**Service Active**” appears alternately with the battery voltage. Thus, even if the 62AD is inactive, it is immediately clear that the service functions have been enabled.
- The dose rate display’s analog bar always shows a dashed line stretching along the scale’s entire length. Thus, it will be immediately apparent that the 62AD in this condition is unsuitable for everyone because critical service functions have been enabled. The digital dose rate display and all other functions of the 62AD work normally. An external probe can also be in service mode. With such a probe, the dashed analog bar also appears (regardless of whether the 62AD service functions have been enabled).
- The programming mode is replaced with the service mode (the programming mode becomes accessible again only if the service functions are disabled again). Implications: If you press and hold both buttons in sleep mode, the device will not take you to the programming mode after a few seconds but to the service mode, and the service functions are offered:



No.	Service function
C1	“ SEt bGround=x.xx ”: (set background) To enter the device background.
C2	“ CAL=xx ” or “ CAL Lo=xx ”: To calibrate the 62AD counter tube or the first detector of a probe with two detectors.
C3	“ CAL Hi=xx ” To calibrate the second detector of a probe with two detectors.
C4	“ CCFAct=x.xx ” or “ CCFAct Lo=x.xx ”: To enter the calibration correction factor of the 62AD counter tube or the first detector of a probe with two detectors.
C5	“ CCFAct Hi=x.xx ”: To enter the calibration correction factor of the second detector of a probe with two detectors.
C6	“ Sound SEtUP=xxxx ”: To define the alarm tone frequency (62AD only, not with a probe).
C7	“ SoFt SEtUP=n.x ”: To select the unit (Sv or R, 62AD and probe) and the program version (62AD only).
C8	“ Edit SErno=xxx_xxx ”: To enter the serial number.
C9	“ Edit d-SErno=xxx_xxx ”: To enter the serial number a probe requires from its basic device (use with a probe only).
C10	“ Lcd SEtUP ”: To select the LCD type (Sv+R or Sv+Gy) (only 62AD, not with a probe).

No.	Service function
C11	“tco=x” or “tco Lo=x” : To enter the 62AD temperature coefficient or the first detector of a probe with two detectors.
C12	“tco Hi=x” : To enter the temperature coefficient of the second detector of a probe with two detectors.
C13	“End” : Locks the service functions again.

C9 is only offered for probes, as it is only relevant to a probe. C6 and C10 are only offered for the 62AD, as they are only relevant to the 62AD. C7 has a different scope for 62AD and probe. C3, C5 and C12 are only available for probes with two detectors.

12 Radiological examination and extension of the calibration period

There are three ways to test the 62AD response to radiation:

1. Without any artificial radiation source and with natural ambient radiation. This is a straightforward test of low significance. You cannot determine the measurement accuracy with this test, but you can at least test the basic functionality.
2. With check source [19] and source holder [18]. This test delivers a measured value, but it is only a low estimated value in the low range.
3. Using “intense” radiation sources. This test can be a comprehensive check over the entire range.

Anyone can carry out the test by point 1. According to point 2, the test requires handling radioactive substances, which are subject to certain conditions and unsuitable for everyone. According to point 3, the “major” test requires radiation equipment that only a few institutions have available.

We recommend observing a two-year interval between “major” tests or a six-year interval with tests according to point 2 in between. You can return the device to us for a “major” test performed by the manufacturer. As the manufacturer, we certify the successful test with a calibration report, as we do for all new and repaired devices.

Let us explain why the 62AD includes the test function “t1” for the radiological test. We will also describe how you carry out the two minor tests.

12.1 Test function t1

The test function “t1” is very similar to the mean value measurement in regular operation. The differences listed below make the check measurement a bit more convenient:

- The 62AD does not switch off automatically, even if the sleep timer is activated. Otherwise, the device might abort a check measurement before achieving the desired accuracy. For example, the check measurement of a high-range probe may take an hour.

- To ensure that the 62AD works silently in the background, the dose and dose rate alarms are switched off. The device does not emit alarm tones, pulse clicks, or pulse flashes.
- The operating status [8.2] is displayed as “t1” (the “t” and the digit 1 appear alternately at the top left of the LCD).
- The mean value stops flashing when a variation coefficient of *two* percent is reached (instead of *five* percent as in normal operation). This value of two percent is based on the PTB requirements for a test device, which specify, among other things, that the check measurement must be repeatable with a maximum variation coefficient of five percent. As these five per cent also include mechanical tolerances, the coefficient of variation caused by the measurement time must be significantly less than five per cent. Two percent is a good choice for sufficient accuracy and practical measurement time.
- The 62AD regularly emits a short tune after reaching a variation coefficient of two percent . This reminds you of the end of the check measurement, and you need not constantly monitor the 62AD.
- The analog bar [8.7] shows the measurement duration to date on an fictious scale of 0 % to 100 %. Here, 100 % is the estimated measurement duration needed to achieve the target coefficient of variation of two percent. The analog bar indicates to what extent the measurement has already been completed. The more pulses the counter tube delivers, the faster the desired coefficient of variation is achieved, and a new check source will need less time than an old check source, which has already lost some of its activity.
- The check measurement is saved in the archive using the “Test mode” identifier.

The test function “t1” also works with external probes. For a probe with two detectors, the test function “t2” is also offered for the second detector, so you can use “t1” and “t2” to address these detectors specifically. Connect the probe before calling up “t1” or “t2”, i.e. before switching on the dosimeter or accessing the test menu.

12.2 Testing without check source

A Geiger-Müller counter tube is inherently a digital component whose sensitivity hardly tends to change, not even in the long term. If such a counter tube is damaged, it typically results in a complete failure because it no longer sends pulses. The 62AD detects such a total failure by counter tube monitoring; see section 5.10. Please note the following: If the sleep mode is enabled and no failure warning is displayed, the 62AD received a sign of life from its counter tube 24 hours ago or later. Thus, the 62AD automatically carries out the test without a check source once a day without your interference.

Occasionally, an opposite error can occur, i.e., a counter tube without radiation will deliver elevated background radiation on its own and, therefore, show too high radiation. To avoid such false positives, ensure a more accurate measurement of the counter tube in natural ambient radiation. The test function “t1” is ideally suited for this purpose. Use the test function “t1” to measure the mean value of ambient radiation for approximately one hour. The mean value should be about 0.10 µSv/h, or whatever the typical ambient radiation is at your location. The test function “t2” can be used to test the second detector of a probe with two detectors in the same way.

Note: Of course, you need not perform this measurement under natural ambient radiation until the coefficient of variation of two percent targeted by the test function “t1” (and “t2”) is reached. This procedure would take too long, i.e. several hours in the case of the 62AD counter tube.

If the 62AD passes this test, it will probably still work properly. However, this is no proof and is not an official test either. The same applies if you test an external probe using this procedure.

12.3 Testing with check source and source holder

Testing with a check source is also referred to as a “check measurement”, and the measured value is called a “check value”. The components required for a check measurement (check source [19], source holder [18]) are called a test device.

Carry out the check measurement as follows:

1. Switch the 62AD off (completely off or in sleep mode, if enabled).
2. Attach the check source to the 62AD as follows: Insert the 62AD into the 761.50-01 source holder and screw the check source 6706 into the source holder as far as it will go.

If you want to test a probe, attach the check source to the probe instead. If the test mode is not locked, you can connect the probe to the 62AD now.

3. If the test mode is locked, insert the unlocking key [16]. Press and hold *either* of the two buttons to switch on the 62AD. After a few seconds, you will enter the test menu, and test function “t1” is offered first (“tEst”). You can now remove the unlocking key (and connect a probe instead if you want to test the probe). Press the speaker button to start the test function “t1”.

If you want to test a probe, you must connect the probe in the test menu or earlier because as soon as test function “t1” is running, you cannot switch to the probe anymore. A probe with two detectors offers two corresponding test functions, “t1” and “t2”, and you must select one of them.

4. The check measurement is now running. Put the check source already in position before you start the measurement. Otherwise, you must restart the check measurement exactly as you restart the mean value calculation in regular operation. Press the speaker button (“SEt.0” appears) and press the speaker button again within the next few seconds. The check measurement starts all over again. If you want to cancel or terminate the check measurement, press the arrow button. The 62AD then switches off.
5. The analog bar [8.7] indicates how much of the required measuring time has already elapsed. When you have reached the end of the check measurement, read off the mean value as the check value. The 62AD signals the end of the measurement as follows: The mean value does not flash any longer, the short tune ♪ sounds regularly, and the coefficient of variation has reached the target value of two percent. This time is the earliest time you can take a reading. However, you are welcome to take your readings later. The longer the check measurement takes, the more accurate the check value will be.
6. Correct the check value to the date of the reference measurement as explained in section 12.4.
7. Record the check measurement, e.g., according to the suggestion in section 12.5.

8. After you have successfully tested the 62AD or the probe (both detectors, if available), enter the date of the following test using the test function "t3" if your devices are to monitor the test date (see section 5.2). This date is when the device (62AD or probe) should first indicate that a test is pending.

Does a check measurement also make sense if no reference measurement exists for comparison? Such a measurement will be good enough as a rough estimate of the measurement accuracy. Correct the check value acc. to the age of the check source and compare the value obtained with this typical value:

62AD check value with a new check source 6706: $95 \mu\text{Sv/h} \pm 30 \%$

This value applies to a new Cs-137 check source with the full nominal activity of 333 kBq and is subject to considerable uncertainties. The activity tolerance of the check source alone is already $\pm 10 \%$, and due to the small distance between the check source and the counter tube, even tiny mechanical tolerances may have a significant effect. We have, therefore, generously, but not unrealistically, allowed an uncertainty of $\pm 30 \%$ for the value given above.

Note

The check value (corrected for the age of the check source) compared with the value given above only allows a relatively rough check of the 62AD measuring accuracy.

The following section will explain why and how to correct a check value to an earlier date.

12.4 Correction for the loss of activity of the source

The check source decays with a specific half-life like any other radioactive substance. The decrease in activity follows an exponential function $2^{-t/T}$, where t is the time since an initial point in time, and T is the half-life. At the end of a half-life, i.e. at the time $t = T$, the activity is still $2^{-1} = 0.5 = 50 \%$ = the half. The initial point in time is completely irrelevant! You can also calculate the loss of activity for any other period. Let's take the Cs-137 radionuclide of the 6706 check source, which has a half-life of 30 years, as an example. Given a period of, e.g., half a year, the activity of a Cs-137 source decreases to $2^{-0.5/30} = 0.9885 = 98.85 \%$ = 100% - 1.15 %. So a Cs-137 source activity drops by 1.15 % within half a year. This statement is accurate today, as it was in the past and will be accurate in the distant future. You may extend these examples as desired, and the following will always apply: The activity decreases by the same percentage at equal intervals. The age of the check source does not matter at all!

Why have we discussed this at such length? In radiological testing, it is often necessary to compare two check measurements performed on the same device with the same test device but at different times. You must consider the check source's activity loss between the two measurements in such a comparison. As we have just seen, this activity loss can be calculated from the check source's half-life, even if its age is unknown. You can correct the loss of activity if you multiply the t check value M_k measured later by a correction factor k_z , which is just the reciprocal of the loss of activity:

Correction factor: $2^{\frac{t}{T}}$ (this value is always larger than 1)
 Check value: Mk
 Corrected check value: $Mk' = kz \times Mk$

The corrected check value Mk' is the value you would have obtained if the source had still had its activity from the time $t = 0$. Mk' can be compared with the previous reference measurement. If the device has not changed, both values must match within the statistical uncertainty. We have adopted the terms kz , Mk and Mk' from official usage.

To save the use of equation $kz = 2^{t/T}$, we have tabulated kz for Cs-137 below in intervals of $t = 3$ months. We did not specify the half-life of Cs-137 in $T = 30$ years but used the more precise value of 11000 days, which is equal to 361.4 months.

Correction factor kz for Cs-137 for different periods t in months: $kz = 2^{t/361.4}$. Half-life $T = 11000$ days = $(11000/365.24) \times 12$ months = 361.4 months. If your t is not listed, take the value closest to your t									
t Months	kz	t Months	kz	t Months	kz	t Months	kz	t Months	kz
0	1.000								
3	1.006	27	1.053	51	1.103	75	1.155	99	1.209
6	1.012	30	1.059	54	1.109	78	1.161	102	1.216
9	1.017	33	1.065	57	1.116	81	1.168	105	1.223
12	1.023	36	1.071	60	1.122	84	1.175	108	1.230
15	1.029	39	1.078	63	1.128	87	1.182	111	1.237
18	1.035	42	1.084	66	1.135	90	1.188	114	1.244
21	1.041	45	1.090	69	1.141	93	1.195	117	1.252
24	1.047	48	1.096	72	1.148	96	1.202	120	1.259

This table covers a period of 120 months, i.e. 10 years.

12.5 Logging the check measurements

The following suggestion for a log structure contains all the data the log should include. The records of this log are examples of your log records. Although these examples are fictitious, they correctly determine the correction factor kz . In this respect, consider the examples from the previous section as exercises on how to use the table.

In principle, recording only the date and corrected display Mk' for the individual check measurements would be sufficient. However, we recommend that you also include the “raw” value Mk and the correction factor kz . This way, you can still track the calculation of Mk' at a later date.

In this example, we deliberately used a check source that is several years old (dated from 2002; the year of manufacture is appended to the serial number of the 6706 check source). As you can see, this age does not affect the correction factors kz . The only effect of this check source age is the lower check values. If you correct the check values from the example to the age of the check source, which you should do as an exercise, you will get approximately the typical value of 95 $\mu\text{Sv/h}$ mentioned in section 12.3.

(Name/company/institution of the user)				
Check measurements Radiation meter type Automess 62AD25		S/N 123456		
Check source type Automess 6706, Cs-137, 333 kBq		S/N 123457 / 2002		
Source holder type Automess 761.50-01		S/N 123458		
Date of the reference measurement		21.03.2019		
Check value: $Mk'_{\min} = 51.2 \mu\text{Sv/h}$ $Mk'_{\max} = 76.8 \mu\text{Sv/h}$				
Check measurements:				
Date	kz	Mk in $\mu\text{Sv/h}$	Mk' in $\mu\text{Sv/h}$	Comments
29th Aug. 2019	1.012	63.4	64.2	o.k. (Signature)
...	...	...	...	...
...	...	...	...	...
11th Nov. 2022	1.090	58.5	63.8	o.k. (Signature)
...	...	...	...	...
...	...	...	...	...
Oct. 2025	Device and test device sent in for calibration			

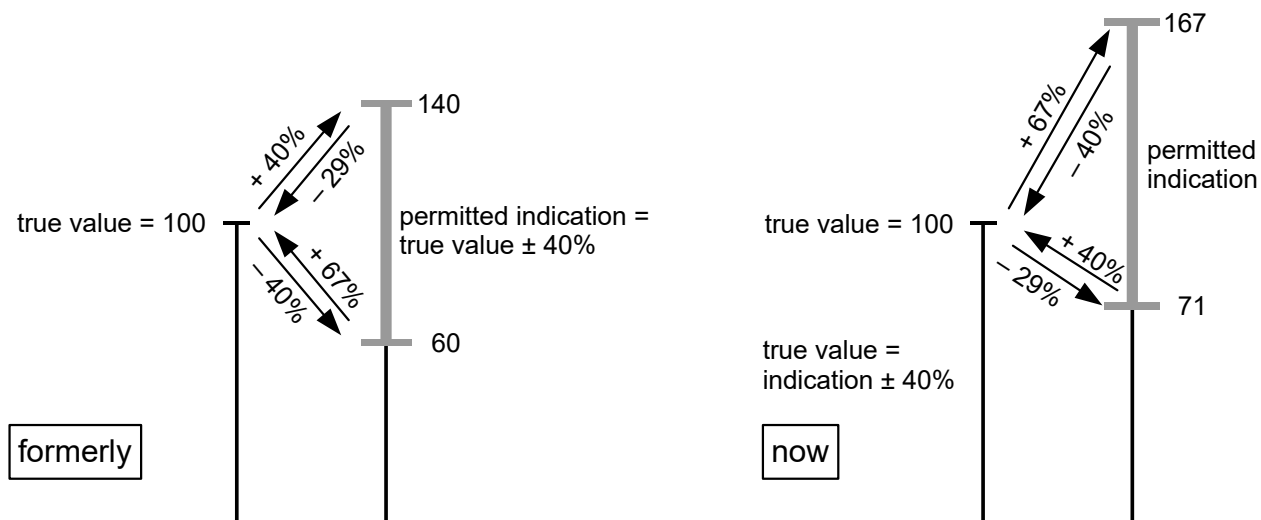
13 Energy response and anisotropy

The data listed in this section were determined using the following radiation sources:

- Cs-137 (662 keV),
- Co-60 (average energy 1250 keV),
- X-rays filtered according to the ISO 4037-1 “X-ray narrow-spectrum” (N-series).

The diagrams show typical characteristics; slight deviations are standard and cannot be avoided.

There are so-called nominal operating ranges for both the energy and the angle of incidence of the photon radiation (see technical specifications). A device must not exceed certain deviations within these nominal operating ranges. Internationally standard requirements allow a device to have an error of 40 %. However, there are different approaches to what this 40 % refers to. In the past, institutions specified that the displayed value at the device should not deviate from the actual value by more than 40 %. Today, the user’s point of view is accepted, who does not know the actual value, and requires the actual value shall not deviate more than 40 % from the value displayed at the device. This consideration results in an asymmetrical error tolerance of -29 % to +67 %. The following diagram illustrates both situations:



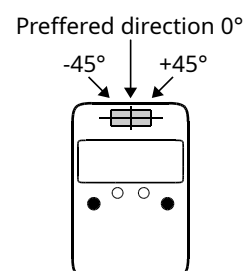
It is neither easier nor more difficult for a device to fulfil the new requirement than the old one. The maximum to minimum responsivity ratio is $140/60 = 167/71 = 2.3$ in both cases.

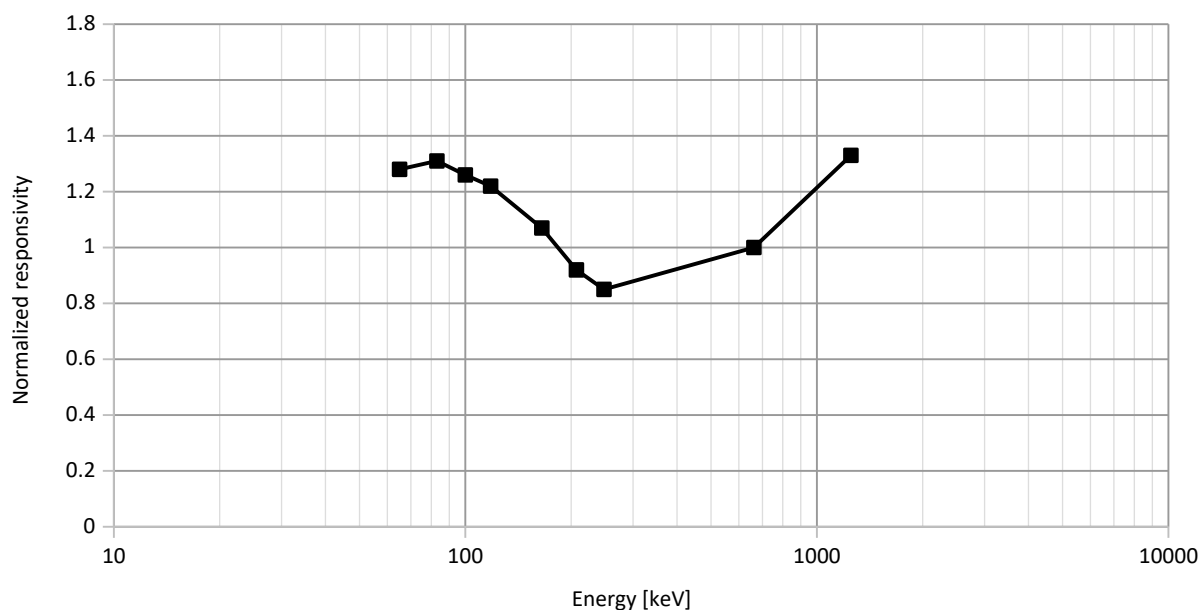
Due to the energy dependency, information about the radiation field is helpful when using the 62AD:

- If the radiation energy is well below the nominal operating range, the sensitivity of the 62AD decreases significantly up to “blindness”. In this case, the radiation field is significantly underestimated. This risk exists particularly with soft X-rays.
- If the radiation energy is significantly higher than the nominal operating range, such as the 6 MeV radiation of N-16 found in nuclear facilities, energy-compensated Geiger-Müller counter tubes such as the 62AD always indicate too high values (up to about three times the actual value). The 62AD is not suitable for the correct measurement of such high-energy radiation. Still, because the risk is overestimated, you are “on the safe side” regarding radiation protection.

13.1 62AD for $H^*(10)$, PTB type approval

Responsivity A concerning the ambient dose equivalent rate $\dot{H}^*(10)$ as a function of the photon energy, normalized to the responsivity A_0 of Cs-137 (662 keV) in the preferred direction of 0° . The deviation is calculated as $f = A/A_0 - 1$.



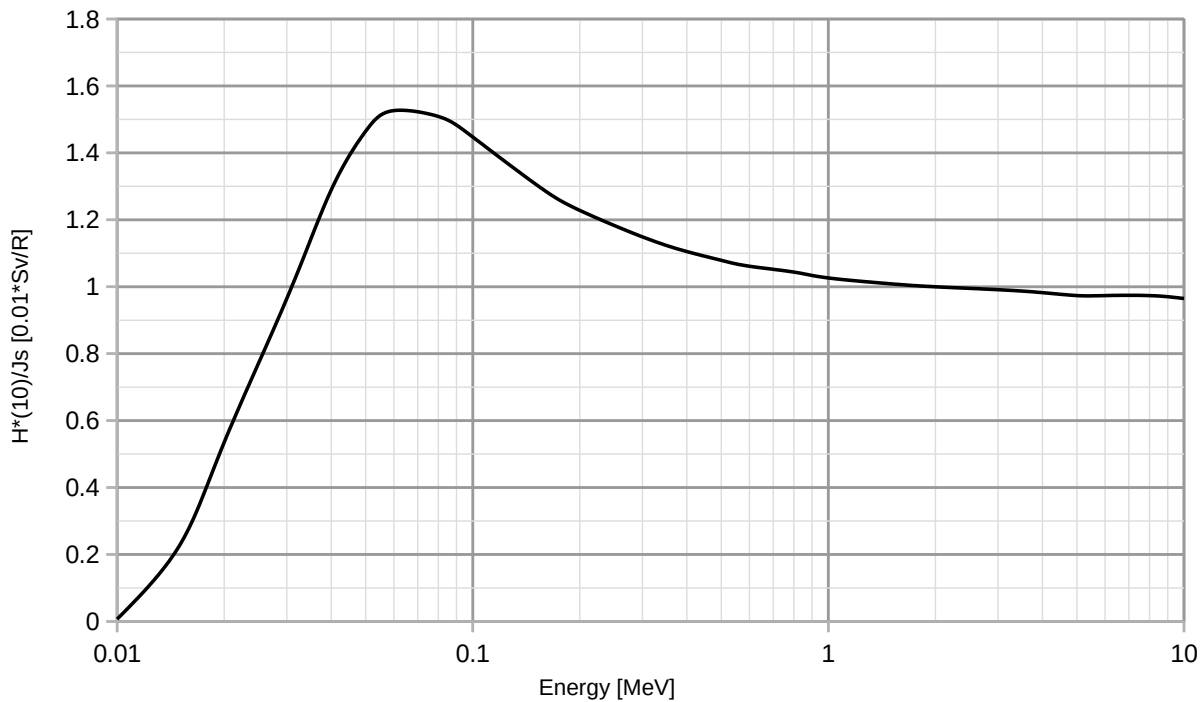


Radiation quality	Mean photon energy [keV]	Angle	Deviation	
			0°	$\pm 45^\circ$ ¹⁾
N-80	65	$f = A/A_0 - 1$	0.28	-0.40 ± 0.10
N-100	83		0.31	0.36 ± 0.10
N-120	100		0.26	0.23 ± 0.05
N-150	118		0.22	0.11 ± 0.08
N-200	165		0.07	-0.03 ± 0.05
N-250	207		-0.08	-0.15 ± 0.05
N-300	248		-0.15	-0.19 ± 0.05
Cs-137	662		0.00	
Co-60	1250		0.33	

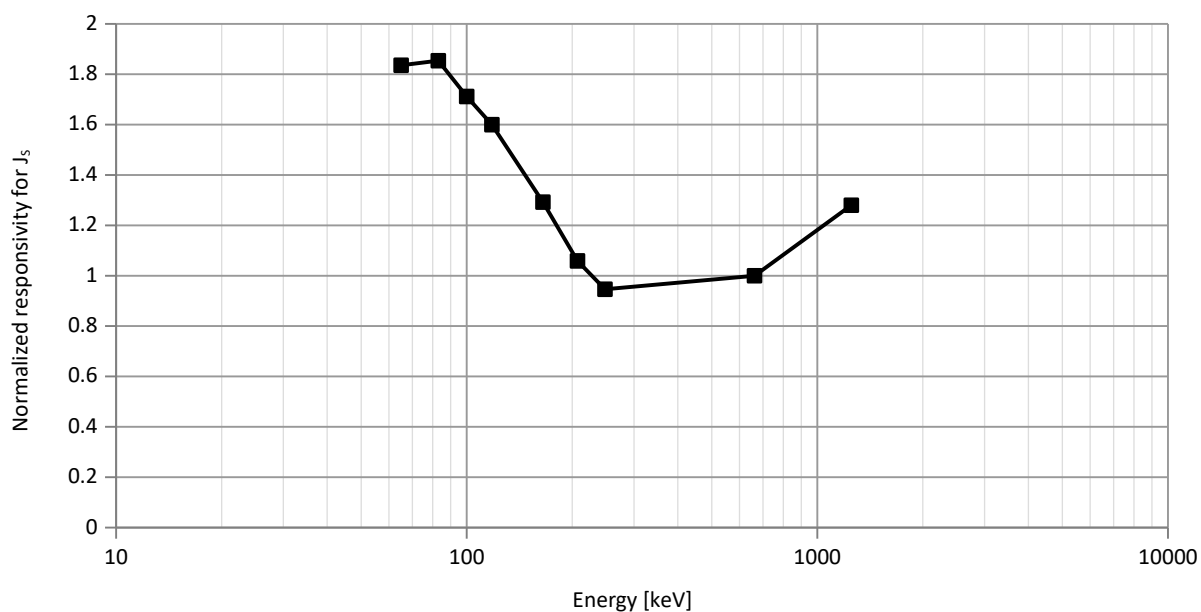
¹⁾ averaged across all orientations

13.2 62AD and the Roentgen measuring unit, no PTB type approval

The measured variable J_s in the Roentgen measuring unit is rarely required today, and is no longer required at all in Europe. We therefore decided not to develop a 62AD detector for J_s , but to offer an 62AD R-version instead, that still measures $H^*(10)$, but displays the R unit after the simple conversion $1 \text{ Sv} = 100 \text{ R}$. Scientifically speaking, this is wrong because $H^*(10)$ cannot be converted into J_s independently of the energy. However, we accept this error here because this way, we create a “modernized” R-device that imitates the $H^*(10)$ characteristic effect of the ICRU phantom. Experts have calculated this effect over many years as part of the definition of the measurement variable $H^*(10)$. It is illustrated in the diagram below:



If you multiply the above characteristic by the energy dependence of the $H^*(10)$ version from the previous section 13.1, and then normalize again to the responsivity of Cs-137 (662 keV), you get the responsivity related to the standard ion dose rate $\dot{J}_s$ as a function of the photon energy:



The high responsivity around 80 keV looks terrible at first glance but is ultimately a deliberate simulation of the ICRU phantom effect. As far as the anisotropy is concerned, we refer to the $H^*(10)$ version from the previous section 13.1; the responsivity of Cs-137 is the same and the responsivity at 65 keV is now about 1.5-fold.

13.3 Influence of Beta and Neutron Radiation

Since the 62AD is suitable for use in mixed fields, the influence of beta and neutron radiation is shown below. In both tables, the displayed value contains twice the standard deviation.

Given the influence of beta radiation, a maximum $\dot{H}^*(10)$ value of 10 % of the correct value for $\dot{H}'(0, 07)$ is allowed. This results in the following values:

Radiation quality	Mean energy [MeV]	Beta dose rate $\dot{H}'(0, 07)$ [mSv/h]	Displayed photon dose rate $\dot{H}^*(10)$ [μSv/h]	Responsivity [%]
$^{90}\text{Sr}/^{90}\text{Y}$	0.8	$20 \pm 4 \%$	$6 \pm 12 \%$	$0.03 \pm 16 \%$
^{106}Ru	1.2	$2 \pm 4 \%$	$31 \pm 8 \%$	$1.55 \pm 12 \%$

Under the influence of neutron radiation, the results will be:

Radiation quality	Neutron dose rate [μSv/h]	$H^*(10)$ displayed dose rate [μSv/h]	Responsivity [%]
^{252}Cf	$533 \pm 3 \%$	$29 \pm 5 \%$	$5.4 \pm 8 \%$
^{252}Cf (D ₂ O-mod.)	$135 \pm 7 \%$	$22 \pm 5 \%$	$16.3 \pm 12 \%$

14 Serial interface

The serial interface serves two purposes:

1. Operation of external probes of the AmSeL family.
2. Connector to a PC for data transfer.

Automess offers free PC software for AmSeL-compatible devices for the latter purpose. We want to remain flexible in our choice of distribution channels used to make this software available (e.g. as part of the scope of delivery of the device, at request only, or for anyone to download from the Internet), so we do not specify a distribution channel here. This software enables you to use the following functions of the device's serial interface:

- Display and average the dose rate transmitted by the device every second,
- Read and write the date of the next recurring test,
- Evaluate the archive,
- Read, write and manage all programmable data,
- Support the service functions (only intended for service personnel, can only be used if the service functions of the device have been enabled).

The serial interface is an RS232, known in the PC world as a COM interface. Although this type of interface is no longer significant in the private sector, it is still widely used in the industrial sector as a simple, anonymous interface which has no viable alternative. Modern PCs without RS232 connectors can be retrofitted with an RS232 using USB-to-RS232 adapters.

The transmit signal TxD of the 62AD can get the levels zero and +5 V. The zero level instead of a negative voltage of -5 V to -15 V is not compliant with the RS232 standard but is accepted by all PCs in practice. Apart from infrequent exceptions, this deviation from the RS232 standard will not cause any trouble. The RxD input of the 62AD can handle the full voltage range of the RS232 standard of -15 V to $+15\text{ V}$.

The RS232 interface has the following settings:

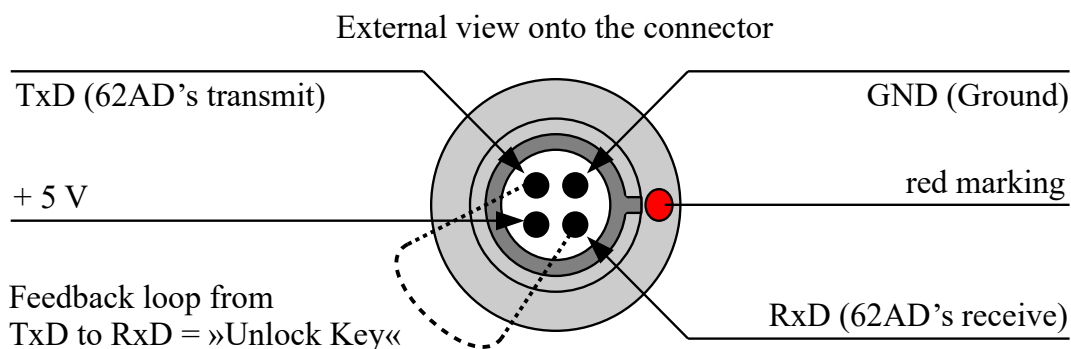
9600 Baud, 7 data bits, even parity, 1 start bit, 1 stop bit.

Bit width and parity cannot be changed. There are no handshake signals. The command to use the interface for fast data transfer (reading out the archive) can temporarily increase the baud rate to 38400 bps. We describe the command set of the AmSeL interface in a separate document.

14.1 Interface socket and unlocking key (optional accessory)

In addition to the serial interface, 5 volts are available at the interface connector. This voltage can power external devices, particularly probes of the AmSeL family. Other applications are also possible, e.g. a Bluetooth adapter that converts the serial interface data into radio signals. The voltage of 5 volts can supply a maximum current of 100 mA. The 62AD switches off these 5 volts in deep-sleep mode (the LCD is blank).

For smaller dimensions, the four connection pins are not numbered. Their assignment results from their arrangement relative to the red marking.



We repeatedly mentioned the unlocking key [16] for locking and unlocking the test and programming functions. The unlocking key is a plug inside which the TxD and RxD signals are connected. This connection between TxD and RxD creates a feedback loop that allows the 62AD to receive its messages. This way, the 62AD recognizes an inserted unlocking key.

The unlocking key has no effect in sleep mode. While in sleep mode, the 62AD does not transmit anything spontaneously. Therefore, there is no echo via the feedback loop, and the 62AD cannot recognize the unlocking key. This behaviour doesn't matter because you will never use the unlocking key during sleep mode.

You do not need the unlocking key if you have a computer cable [14]. Use the software we provide free of charge to access all special functions via the PC.

14.2 Automatic transmission of the dose rate - AmSeL type number

Let us explain how to send the dose rate automatically; we will do this in detail so you can code your PC software to record the messages from the 62AD if required. However, we will not discuss all the other required commands, such as evaluating the archive or saving the programmable parameters. Please refer to the complete command set of the AmSeL interface specified in a separate document.

If the 62AD is not in sleep mode, it calculates the dose rate every second and outputs it to the serial interface with the same rate.

Note: The 6150AD model has no clock pulse with an exact second cycle; the cycle is slightly longer, having 1.049 seconds. However, AmSeL devices such as the 62AD have an exact 1-second cycle. Consider this to determine the exact duration by counting the bars. If you connect an external probe to the 62AD, this probe determines the transmission clock. However, this cycle should also be an exact second cycle unless it is a special probe.

The telegram sent every second consists of 7-bit ASCII characters only and has the structure below. Lower-case letters are placeholders for variable data, but upper-case letters and other characters are fixed parts of the telegram:

```
CYC=a_bb_cccccccc_dd_eeeeeee_ffffffff_gggggggg_hhhh_iii_kkkk
      _Sssssssss_Xxxxx<CR><LF>
```

CYC=	“CYC=” indicates the cyclic telegram. It contains the actual measured value, which can also come from an external probe. The data fields have the following meaning:
a	Cycle counter. It runs cyclically from decimal 0 to 9 and then restart at 0. The cycle counter tells the receiver whether it has missed a telegram.
bb	AmSeL type number of the transmitter, 2-digit hexadecimal integer. The 62AD25 has the number bb = 02, the 62AD50 the number bb = 03.
ccccccc	Serial number of the transmitter (62AD), 8-digit hexadecimal integer.
dd	AmSeL type number of the connected probe, 2-digit hexadecimal integer, zero if no probe is connected.
eeeeeee	Serial number of the probe, 8-digit hexadecimal integer, zero if no probe is connected.
fffffff	Dose rate, 8-digit hexadecimal floating point number, measuring unit according to status identifiers hhhh bit 0 and 1. This is the current display of the 62AD. If a probe is connected, this value is taken from the probe.
	“8-digit hexadecimal floating point number” means that a floating point number of 32 bits is regarded as an integer of 32 bits, according to IEEE754, and is represented by eight hexadecimal characters. Example: The floating point number 5.0 is represented as 40A00000 in this notation. This notation is difficult to read for humans, but computers can convert it quickly and without losing accuracy.

- gggggggg** Dose increase during the last cycle, i.e. within the last second, 8-digit hexadecimal floating point number, measuring unit according to the status identifiers **hhhh** bit 0 and 1. If a probe is connected, this value is taken from the probe.
Calibration factor and dead time correction influence this value; that's why integer values such as "pulses" can now actually be fractional numbers. You can use these dose increments to calculate the dose rate according to a separate procedure (e.g., with a different time constant), calculate mean values over certain intervals, or calculate dose sums.
- hhhh** Status identifiers (part 1) of the transmitter (62AD), 4-digit hexadecimal integer. The 16 bits have the following meaning:
- Bit 0: 0 = unit is radiological (Sv/R/Gy), 1 = pulses (per second, S^{-1}), bit is always 0 here, as the 62AD always uses a radiological unit for its own detector.
 - Bit 1: only if bit 0 = 0: 0 = Unit is Sv, 1 = unit is R/Gy depending on LCD type (bit 13)
 - Bit 2: 0 = (main) detector ok, 1 = defective
 - Bit 3: 0 = long response time, 1 = short response time (IEC)
 - Bit 4: 0 = service functions not enabled, 1 = enabled
 - Bit 5: 0 = device has one detector, 1 = two detectors, bit is always 0 here
 - Bit 6: 0 = second detector inactive, 1 = active, bit is always 0 here
 - Bit 7: 0 = second detector ok, 1 = defective, bit is always 0 here
 - Bit 8: 0 = clock not set, 1 = clock set
 - Bit 9&10: 0/1/2 for good/limited/aged batteries
 - Bit 11: 0 = no dose rate alarm, 1 = dose rate alarm
 - Bit 12: 0 = no dose alarm, 1 = dose alarm
 - Bit 13: 0 = LCD type is Sv/R, 1 = LCD type is Sv/Gy
 - Bit 14: 0 = transmitter (62AD) is not MessEG-compliant, 1 = MessEG-compliant
 - Bit 15: reserve, always 0
- iiii** Status identifiers (part 2) of the transmitter (62AD), 4-digit hexadecimal integer. The 16 bits have the following meaning:
- Bit 0-2: 0 to 4 for current status: 0 = sleep mode, 1 = normal measuring mode, 2 = test mode, 3 = programming mode, 4 = service mode
 - Bit 3-7: Number of the current special function if the special mode (test, programming, service mode) is active, 0 if no special mode is active
 - Bit 8: 0 = no dose rate underflow, 1 = underflow
 - Bit 9: 0 = no dose rate overflow, 1 = overflow
 - Bit 10-15: Reserve, always 0

kkkk	Status identifiers of the probe (if connected), 4-digit hexadecimal integer. The 16 bits have the following meaning: Bit 0: 0 = unit is radiological (Sv/R/Gy), 1 = pulses (per second, S⁻¹), bit is always 0 here, as the 62AD always uses a radiological unit for its own detector. Bit 1: only if bit 0 = 0: 0 = Unit is Sv, 1 = unit is R or Gy Bit 2: 0 = main detector ok, 1 = defective Bit 3: 0 = long response time, 1 = short response time (IEC) Bit 4: 0 = service functions not enabled, 1 = enabled Bit 5: 0 = probe has one detector, 1 = two detectors Bit 6: 0 = second detector (if present) inactive, 1 = active Bit 7: 0 = second detector (if present) ok, 1 = defective Bit 8: 0 = clock not set, 1 = clock set Bit 9: 0 = no flash error detected, 1 = flash error detected Bit 10: 0 = no RAM error detected, 1 = RAM error detected Bit 11: 0 = no dose rate underflow, 1 = underflow Bit 12: 0 = no dose rate overflow, 1 = overflow Bit 13: 0 = probe at rest, 1 = probe recently moved Bit 14: 0 = probe not MessEG-compliant, 1 = probe MessEG-compliant Bit 15: reserve, bit is always 0 If no probe is connected, all 16 bits are zero.
ssssssss	Electronic signature of the telegram, 8-digit hexadecimal integer. A certified receiver has to check this signature to see if it displays or processes the measured values in a legally relevant manner. Recipients which are not legally responsible recipients can ignore the signature.
xxxx	CRC check sum, 4-digit hexadecimal integer. The CRC (cyclic redundancy check) is a number calculated from the characters of the telegram. The receiver also calculates the telegram CRC and compares it with xxxx . If the two values are not identical, there is a transmission error. If they are identical, you can assume with a high probability that the telegram was received unaltered. The CRC extends from the first character of the telegram to and includes the two characters “_X”, which mark the CRC. The algorithm used is the 16-bit wide “CRC-CCITT” with the generator polynomial vector 0x1021 and the start vector 0xFFFF. This algorithm returns the CRC 0x29B1 for the usual test string “123456789”.
<CR>	Carriage return (0x0D) as end character.
<LF>	Line feed (0x0A) as second end character. A single end character would have been sufficient in principle, but two end characters offer more redundancy and, therefore, more protection against transmission errors.

Earlier, we described how the 62AD rounds the digitally displayed dose rate values to achieve the smoothest display possible. This rule does *not* apply to the dose rate values output on the serial interface. The values are output there without the “cosmetic correction” of rounding. Why this slight difference? The data on the serial interface are processed on a computer. You can still round these values on the computer if you wish, but you cannot undo the already carried out rounding. Therefore, transferring the data on the interface in its original form makes more sense.

Note

The dose rate transmitted on the serial interface differs slightly from the dose rate displayed on the LCD of the 62AD because the value transmitted via the interface is not rounded!

15 Alarms and error messages

62AD behaviour	Cause
The dose rate display shows a minus sign after the digits.	This is not a warning and definitely not a mistake. It indicates that the displayed dose rate is below the measuring range and fluctuates considerably. Section 5.4 explains the dose rate display in more detail.
The speaker symbol [8.8] and the analog scale [8.6] flash on the dose rate display.	Dose rate alarm, i.e., the dose rate has reached or exceeded the alarm threshold. Section 5.5.1 explains the dose rate alarm in more detail.
The speaker symbol [8.8] and the entire analog bar [8.7] flash on the dose display.	Dose alarm, i.e. the dose has reached or exceeded the alarm threshold. Section 5.5.2 explains dose display and dose alarm in more detail.
The LED [6] flashes in all display statuses.	Two flashes per second: Dose rate alarm. Four flashes per second: Dose alarm.
The battery symbol [8.9] flashes.	The battery is low and needs to be replaced soon. Section 5.9 explains the battery warning in more detail.
A “d” flashes in the operating status [8.2].	The next regular test is due (date reached or exceeded). Section 5.2 explains the test date in more detail.
An “F” flashes in the operating status [8.2].	Counter tube failure, the 62AD must be repaired! Section 5.10 explains the counter tube monitoring in more detail.
“ProbE Error ...” runs once over the digital display.	An incompatible probe has been connected, see section 5.14 for details.
If you keep the button pressed longer when switching on the device, “Errx” appears in the digital display [8.4].	The 62AD has detected an error of its sensors: x = 1 means that the ambient light sensor [7] is not working, x = 2 means the motion sensor is not working, x = 3 means both sensors are not working. This failure does not affect the reliability of the measured values.
The analog bar [8.7] always shows a dashed line which extends over the full length in the dose rate display.	The service functions are activated. This behaviour is an error if this occurs spontaneously and no one has opened the 62AD. In such a case, please return the 62AD for repair! Section 11 explains the service functions in more detail. If this effect occurs with a probe, it affects the probe but not the 62AD. Please return the probe for repair!
“ErrS” (Error Service) is shown in the digital display [8.4].	There is a jumper inside the 62AD to activate the service functions. During the last service, the technician probably forgot this jumper and did not return it to its default position.

62AD behaviour	Cause
The text “FLASH Error” or “FAtAL Error” runs over the digital display, and the 62AD does not respond to anything.	The auto-diagnosis has detected an error in the program memory (flash memory) or the data memory (RAM). This error is a serious fault; the mainboard must be replaced. If this effect occurs with a probe, the cause is the probe.

16 Declarations of compliance

Products introduced on the European market must be “compliant” to the European regulations applicable to the product. The product manufacturer must confirm this compliance through an EU declaration of compliance and the CE marking. This marking is less important to the product’s user but to the trade and market surveillance authorities. For this reason, and because we do not want to amend these instructions for use every time the declaration of compliance is amended, we would like to omit the exact wording of the compliance declarations here.

However, we would like to briefly mention and explain the most essential regulations relevant to the 62AD (in the version applicable at the time of preparation or revision of this document):

- The EMC Directive (EMC = electromagnetic compatibility) requires the highest possible immunity to interferences and the lowest possible interference emissions. This guideline applies to the 62AD, and the 62AD fulfils these requirements. By the way, EMC requirements were already part of the PTB requirements for radiation measuring devices in the 1970s, long before there was a CE marking. Here, PTB-approved radiation measuring devices were far ahead of their time.
- The RoHS Directive (RoHS = “Restriction of the use of certain Hazardous Substances in electrical and electronic equipment”) bans hazardous substances such as lead, cadmium and mercury. The first RoHS Directive 2002/95/EC does *not* apply to “monitoring and check instruments” such as the 62AD. The second RoHS Directive 2011/65/EU applies to the 62AD, but “*industrial* monitoring and check instruments” such as the 62AD had to comply with it only by 22nd July 2017. Since we switched our production to lead-free soldering in June 2013, the 62AD has complied with this directive from the very beginning. As far as lead is concerned, Annex IV(1) of the second RoHS Directive 2011/65/EU expressly permits the use of lead in our specific case: “*Lead, cadmium and mercury used in detectors of ionising radiation*”. Nevertheless, we did not use lead in the energy compensation of the 62AD counter tube, although the use of lead would have improved the energy dependency.
- Regulation (EC) 1907/2006 (REACH = Registration, Evaluation, Authorization and Restriction of Chemicals) has the same goal as the RoHS Directive just mentioned, i.e. the avoidance of hazardous substances. However, REACH is not limited to electrical and electronic equipment but applies to all substances, with REACH defining the term *Substance* as follows: “*Chemical element and its compounds, in natural form or extracted in a production process, including the additives necessary to maintain its stability and the contaminations inherent to the used production process, but except solvents which can be extracted from the substance without affecting its stability and without modification of its composition*”. According to this very general definition, all physical products consist of substances. The 62AD complies with the

substance restrictions and is therefore REACH-compliant. What does REACH say about lead in ionizing radiation detectors? There are restrictions on the use of lead (e.g., in jewellery and products children can put in their mouths). However, these restrictions do not apply to products that fall within the scope of RoHS, i.e. not to electrical and electronic equipment such as the 62AD. Therefore, regarding the lead, we refer to our RoHS statement above. Note, by the way, that REACH does not require CE marking of REACH-compliant substances because it is impossible to mark *all substances* this way.

- The Measuring Instruments Directive (MID) 2004/22/EC, later replaced with 2014/32/EU, nevertheless does *not* apply to the 62AD, although there is no doubt that the 62AD is a measuring instrument. The Measuring Instruments Directive mainly regulates measuring instruments used for consumer protection when “purchasing measurable goods” (electricity, gas, heat, water meters, scales, etc.). Europe was unable or unwilling to reach an agreement for niche areas such as radiation measuring devices. Therefore, the 62AD *cannot* and must not bear a CE marking issued according to the Measuring Instruments Directive! Instead, the 62AD is subject to national regulation as a radiation measuring device; in Germany, the German Measurement and Verification Act (Mess- und Eichgesetz, MessEG) applies. To be MessEG-compliant, a radiation measuring device must first pass a type examination by the PTB (formerly known as “PTB approval”). In addition, the individual devices are subjected to a particular compliance assessment (metrological test) under the manufacturer’s responsibility (if necessary, also with the involvement of a verification office) before delivery. This compliance assessment includes a declaration of compliance to be issued by the manufacturer (without the prefix “EC” or “EU”!). If you need MessEG compliance with the 62AD, order it from us with a compliance assessment and notify the competent authority by § 32 MessEG not later than six weeks after commissioning. You can then have the 62AD legally calibrated on your responsibility.

Summary: There are two different declarations of compliance for the 62AD, which have little to do with each other:

- The **EU Declaration of Compliance** (formerly EC Declaration of Compliance) confirms compliance with all applicable European regulations. This declaration of compliance is intended for trade and authorities. As the device user, you do not need this declaration in principle.
- The **Declaration of Compliance** (without “EU” or “EC” prefix!) by the German Measurement and Verification Ordinance. You need this declaration of compliance if you use the 62AD for measurements as defined by the MessEG. The declaration of compliance may refer to other required documents, such as an official certificate of compliance related to the result of an official product test. All these documents then constitute a compliance assessment document that qualifies the 62AD for official measurements within the meaning of the German MessEG. As the user of the device, you must keep these documents.

As a manufacturer, we must keep any declaration of compliance for at least ten years after the market introduction of a device.

17 Disposal advice



The robust construction allows a long service life. Nevertheless, also this device will have to be disposed of at some day. A European regulation for this is the WEEE Directive (WEEE = “Waste Electrical and Electronic Equipment”) related to electric scrap. Like any other electronic device, the 62AD must be disposed of properly, i.e. it must not be disposed of with “unsorted municipal waste” (residual waste). As a commercial user, you must dispose of the device properly at your own expense, just like any other electrical waste. In particular, we ask that you do not “dispose” of our devices by handing them over to private individuals. If you are planning to dispose of our devices, please get in touch with us. We are prepared to take back old devices and will tell you how to dispose of them. We ask our foreign customers to contact the local dealer from whom they purchased the device.

Note

Please dispose of the 62AD like an electrical appliance, i.e., do not dispose of it in the residual waste. Please contact us or our office abroad if you want to dispose of the device.

18 Technical specification

Note: Specifications marked with ^(PTB) are confirmed by PTB as part of the model 62AD50 type examination. “Permissible” deviations comply with PTB requirements and IEC 60846-1. Only compliance with these permissible deviations shall be deemed guaranteed. If you are wondering about asymmetric error tolerances, you can find an explanation at section 13 (“Energy response and anisotropy”).

Detector	62AD25: Gamma counter tube LND7121 or equivalent type, 62AD50: Gamma counter tube ZP1200 or equivalent type, Both types: Effective length 40 mm, sensitivity at Cs-137 approx. 5800 pulses per μSv , lead-free energy compensation
Measured variable	Ambient dose equivalent (rate) $H^*(10)$ resp. $\dot{H}^*(10)$
Nominal energy consumption range	65 keV to 1.3 MeV ^(PTB)
Nominal operating range of the beam incidence direction	$\pm 45^\circ$ ^(PTB)
Energy and anisotropy, deviation at any energies and directions within their nominal ranges of use related to Cs-137 in the preferred direction	62AD25: $-25\% \dots +50\%$ 62AD50: $-24\% \dots +48\%$ ^(PTB) (permissible: $-29\% \dots +67\%$) related to 662 keV (Cs-137)

Preferred direction and reference location	See picture in section 4.4
Analog dose rate display range Digital dose rate display range	0.1 $\mu\text{Sv/h}$ to 100 mSv/h 0.00 $\mu\text{Sv/h}$ to 25.0/50.0 mSv/h (62AD25/62AD50)
Dose rate measuring range Response time Coefficient of variation	“fast” 62AD (conforms to IEC 60846-1): 5 $\mu\text{Sv/h}$ to 25/50 mSv/h ^(PTB) (62AD25/62AD50), Time constant 4 s, Coefficient of variation < 5 % at $\geq 55 \mu\text{Sv/h}$
Dose rate measuring range Response time Coefficient of variation	“slow” 62AD: 1 $\mu\text{Sv/h}$ to 25/50 mSv/h ^(PTB) (62AD25/62AD50), Time constant floating 20 s to 4 s, Coefficient of variation < 5 % at $\geq 11 \mu\text{Sv/h}$
Apparative zero effect	< 50 nSv/h
Linearity of the dose and dose rate measurement	-12 %...+14 % ^(PTB) (permissible: -13 %...+18 %) related to 1 mSv resp. 10 mSv/h
Overload	An exceedence by a factor of 50 beyond the measuring range limit is detected (i.e. by up to 1250/2500 mSv/h (62AD25/62AD50)), Device is still functional after overload ^(PTB)
Dose measuring range	0.1 μSv to 999 mSv ^(PTB)
Maximum possible measurement time for dose measurement	0.1 $\mu\text{Sv}/50 \text{ nSv/h} = 2 \text{ h}$ if you want to utilize the lower limit of the dose-measuring range of 0.1 μSv with an instrument zero effect of 50 nSv/h .
Detection of individual pulses	Audible and visual (LED) configurable
Freely programmable alarm thresholds	One alarm threshold each for dose rate and dose
Fixed alarm thresholds	There are several alarm categories (sets of fixed alarm thresholds) to choose from; see section 5.5
Climate (nominal operating ranges of ambient temperature and relative humidity)	-20 °C to +60 °C and 0 % to 95 % relative humidity, deviation -1 %...+2 % ^(PTB) (permissible: -13 %...+18 %) related to display at +20 °C and 65 % relative humidity (below -10 °C the LCD reaction will get slower.)
Atmospheric pressure	Nominal operating range 60 kPa to 130 kPa (600 mbar to 1300 mbar)
Dependency on position	None, any operating orientation permissible
Speaker	Melodic tone for operator guidance, aggressive Alarm tone of approx. 2.1 kHz, min. 85 dB(A) at 30 cm distance.

Monitoring of radiological operation	Automatic detector monitoring, audible and visual alarms in the event of failure.
Permanent memory	Flash memory (data retention 100 years) including: calibration parameters that cannot be changed, programmable parameters, Archive (data of the last 308 uses)
Display backlight	Backlight with bright white LEDs
Serial interface, external probes	RS232, suitable for AmSeL compatible probes
Housing	Aluminium anodized
Protection class	IP 67 by standard DIN EN 60529 (IEC 529)
Operating voltage range and power supply	5.0 up to 10.0 Volt e.g. 9 Volt battery block (IEC 6LR61)
Operating time with an alkaline manganese battery (IEC 6LR61)	Sleep mode (deep-sleep mode): Three and a half years, Measuring operation under the following reference conditions (0.1 mSv/h, pulse clicks (speaker) off, LCD backlight off, pulse LED on): Approx. 300 hours, otherwise, depending on dose rate, LCD backlight, speaker and alarm LED: 30 to 3000 hours
Dimensions	130 × 80 × 22 mm ³
Weight	Approx. 350 g including battery
Carrying strap	PES included in the scope of delivery

18.1 Accessories

Connection cable EB84-0237	Enables the 62AD to be connected to a PC
Length	1.8 m
Connection on the computer side	USB type A for connection with a USB socket of a computer
Connection 62AD side	4-pin plug for connection with the interface socket of the 62AD

Unlocking key 888.1.1	Allows the test and programming modes to be locked and unlocked again
Connection 62AD	4-pin plug for connection to the interface socket of the 62AD

Holder 761.50-01	Allows the 6706 check source to be attached to the 62AD (also to extend the calibration validity)
Dimensions	$164.2 \times 90.0 \times 38 \text{ mm}^3$
Weight	approx. 270 g without check source
Material	POM black

19 Document history

Date	Remarks
2025-07-24	Editorial changes.
2025-06-05	CRC changed to 1b9445C2.
2025-04-01	Added data from PTB.
2024-09-18	CRC changed to F4F180A0.
2022-12-01	Created for the first time. The CRC of the flash is bbc3023e, can be displayed using the test function "t6".