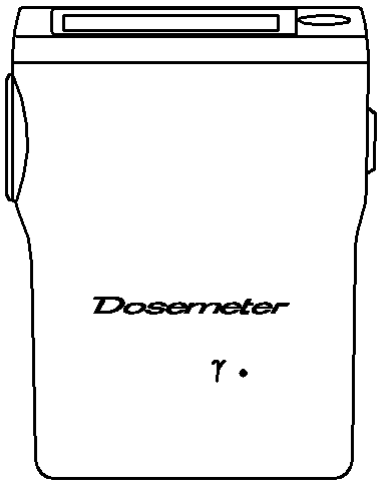
User's Manual

Electronic Personal Dosimeter (For Gamma(X)-ray)

NRF30



Introduction

Thank you for purchasing the Electronic Personal Dosimeter NRF30 (Hereinafter described as “the Dosimeter”) by FUJI ELECTRIC CO., LTD. The User’s Manual is organized to provide descriptions of parts, functions and operational instructions for optimal use. Please make sure that you read this manual carefully before operation.

In the event of product malfunction, contact your Fuji Electric authorized customer service representative. In order to ensure prompt service, please provide precise details of the problem and its evolution, along with the model and serial number. A photo or drawing would enhance understanding and would be greatly appreciated.

Do not repair or attempt to repair the Dosimeter through any unauthorized service providers. Such actions may void the warranty by Fuji Electric Co., Ltd.

HANDLING PRECAUTIONS

Please read the following handling precautions to ensure that you use the Product safely and avoid injury/ damages. Please read this User's Manual carefully to understand all the precautions before using the Product.

	Measures of Precaution
⚠ Attention	・ The Dosimeter is a precision instrument; do not drop it or subject it to impact. ・ Keep the Dosimeter in a plastic bag for protection when used in an environment where chemical fumes, splashes /steam, full of dust and wastes are present. ・ Handle the Dosimeter with clean, dry hands. If becomes tainted, clean it with dry cloth. ・ Do not place the Dosimeter and metal objects in the same pocket. It may cause the dosimeter breaking. ・ Avoid use where with high frequency noise. Pay attention when use near the following devices: 1. Mobile phone 2. Premises/local wireless phone such as <PHS> 3. High power transceiver, or like kind 4. Microwave oven 5. Radar 6. Welding machine 7. Any other spark discharging or high intensity radio wave emitting devices Especially keep the Dosimeter at least 5cm away from any mobile/ wireless phones ・ When the battery level is critically low, read the displayed value within 10 minutes. ・ Use CR123A battery only. During replacement, align the battery polarities correctly. ・ Prior to disposal of the used battery, protect exposed terminals with insulating tape to prevent shorting that may cause possible heating, rupture, or burning. Otherwise, injury or fire may result. ・ Do not throw the Dosimeter or battery into a fire. Do not disassemble them. ・ Keep distance between the buzzer and ears to avoid the injury. (Buzzer makes the sound over 85dB) ・ Do not use the Dosimeter as a survey meter. ・ If a hard impact operating on the dosimeter, it may have a crack to the dosimeter. In this case, it may deteriorate the capabilities in a waterproof and a resistance of radio wave. ・ Do not excessively open or pull the clip to avoid breakage.

Contents

1. Overview

The Electronic Personal Dosimeter NRF30 (hereinafter referred to as NRF30) is designed to provide measurement of personal dose equivalent of external exposure to radiations (hereinafter referred to as dose).
The Dosimeter NRF30 measures gamma dose, and indicates each preset dose threshold (alarm threshold) will be audibly alarmed if reached.

Using the Dosimeter Setting Device and a PC, you can write PC-edited values to / read measurement data trend from the Dosimeter NRF30 via communication with the device.
If worn tight to the body, energy characteristic of the NRF30 series enables direct reading of dose equivalent at the depth of 1cm (unit: Sv or rem, 1Sv is equivalent to 100 rem).

You can switch Sv and rem units through the Dosimeter Setting Device. Default setting of NRF30021-☐☐1YY and NRF30021-☐☐2YY are Sv and rem, respectively.

2. Product Overview

2.1 Product package

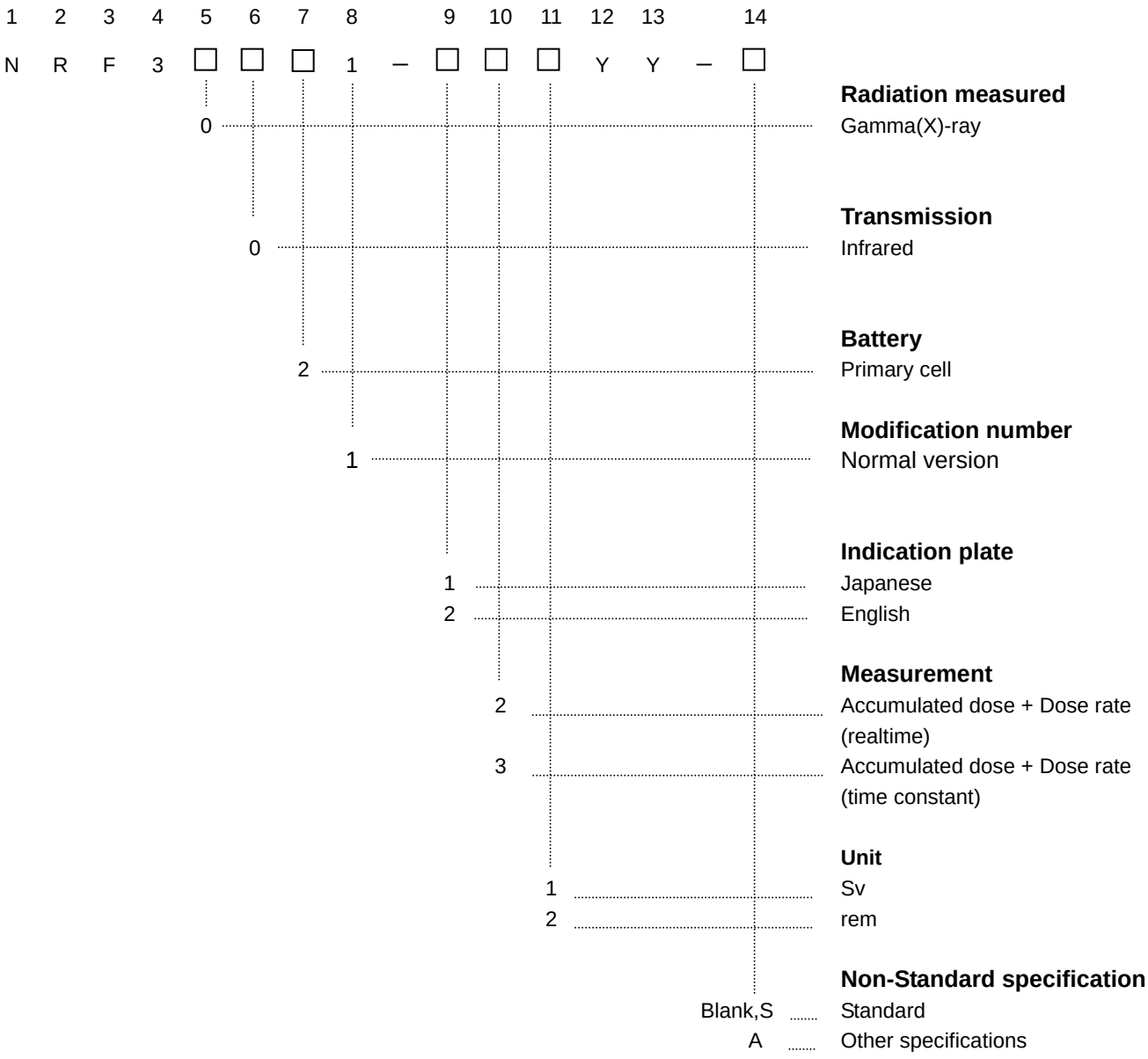
(1) The Dosimeter NRF30 1 (Clip included)

(2) Option

Battery (CR-123A) 1

Plug-pin 1

2.2 Product type code



3. Precautions

⚠ Attention

3.1 Operational conditions

Item	Condition
Temperature range	-20 ℃ to ＋50 ℃
Relative humidity	90 % or less (No condensation)
Storage temperature	-20 ℃ to +50 ℃
Reset of accumulated dose	Reset through the Dosimeter Setting Device
Alarm volume	Approximately 85 dB @20 cm
Battery life	Continuously 2880 hours (Using a new battery under normal temperature and no alarm activity)
Impact resistance	Impact from 150cm drop onto a hard wood surface
Dose thresholds by default	Alarm 0.5 mSv (50 mrem) Pre-Alarm 0.25 mSv (25 mrem)
Dose rate thresholds by default	Alarm 700 mSv/h (70000 mrem/h) Pre-Alarm 70 mSv/h (7000 mrem/h)
Overload indication	'OVER' is indicated

3.2 Other requirements

(1) See User's Manual "Dosimeter Setting Device" for information on parameter writing and data reading via the device and a PC.

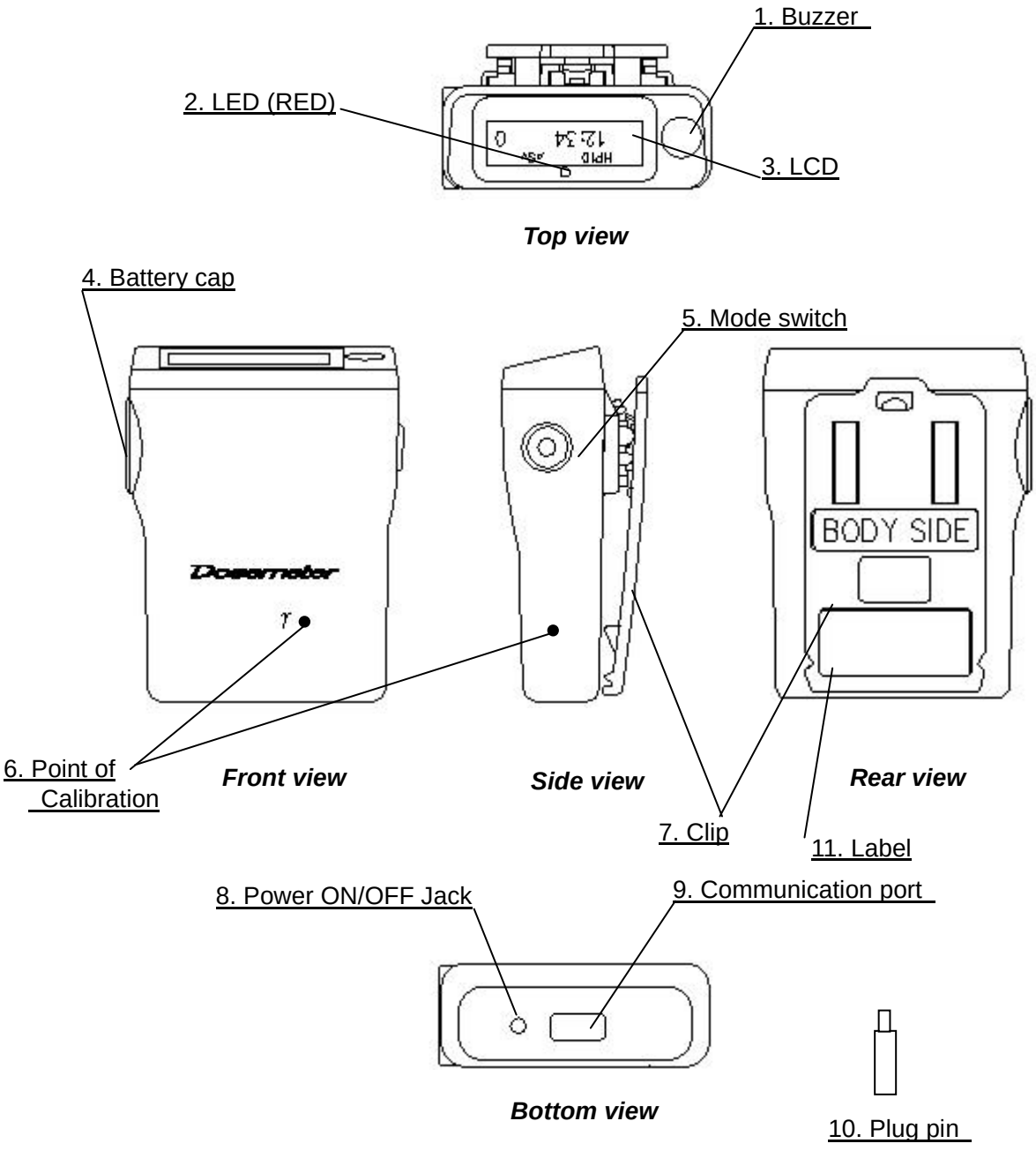
(2) If multiple dosimeters are used, dosimeter rack (*Option) is recommended. See Outline Drawing "Dosimeter Rack" for information on the rack for storage dosimeters.

(3) Try to turn OFF & ON the dosimeter if you encounter technical problems. See the "Troubleshooting Table" if not recovered.

(4) The dosimeter NRF30 cannot be reset by inserting the plug pin (*Option) if the reset-mode setting of dosimeter is "OFF". In this case, please reset the Dosimeter through the Dosimeter Setting Device.

4. Descriptions of Parts and Functions

4.1 Part names



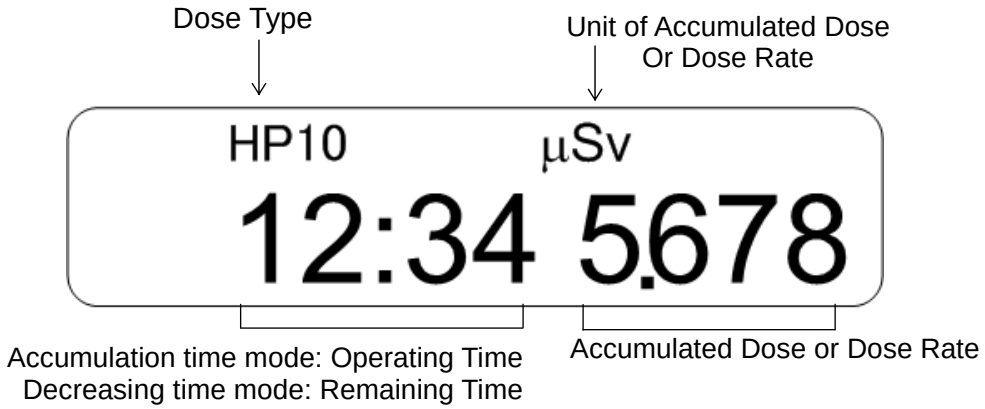
Functions

1. Buzzer: Sounds the alarm, buzzer sound check, low battery level.
2. LED: Red type Light Emitting Diode.
3. LCD: Liquid Crystal Display Indicator. Displays the dose, set dose value, operating time, etc. and can read directly as 1cm dose (unit: Sv or rem)
4. Battery Cap: Seals the battery compartment.
5. Mode Switch: Select desired display mode with this switch-- Accumulated Dose (mSv or mrem) or Dose Rate (mSv/h or mrem/h)
6. Point of Calibration: Shows location of calibration point. (Sensor position)
7. Clip: To fix the dosimeter on the pocket or on the band.
8. Power ON/OFF: Switches power ON and OFF.
   After 2 seconds from inserting a dosimeter to the dosimeter rack, power turns OFF. By pulling out, it turns ON.
9. Communication Port (IR): The communication port with the setting device of an exclusive use.
10. Plug pin: For power on or off of the dosimeter. If multiple dosimeters are used, dosimeter rack is recommended for storage.
11. Label: Type number, Serial number and the date of Manufacture are mentioned.
12. Maximum dose rate during use is transmitted to a dosimeter reader or a dosimeter setting device.
13. Stores maximum 600 records of trend data and maximum 500 records of access data.

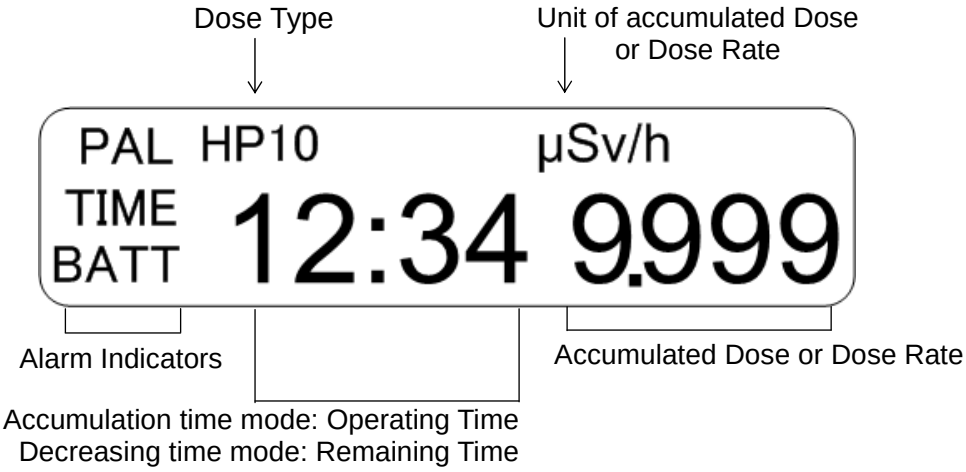
4.2 Display function

LCD Indications

Normal mode



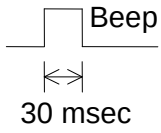
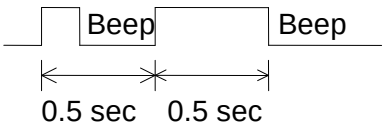
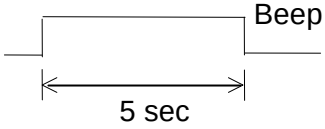
Alarm mode



4.3 Buzzer function

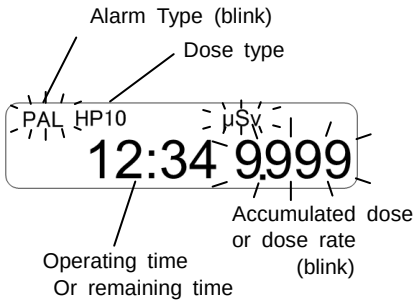
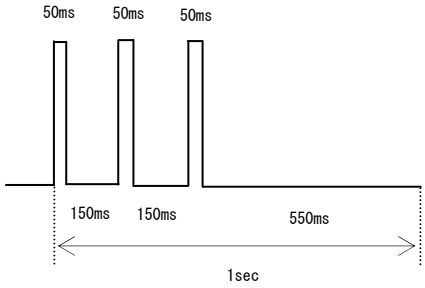
4.3.1 Audible signal

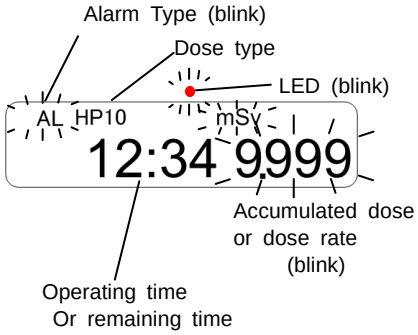
Audible signals sound under the following circumstances:

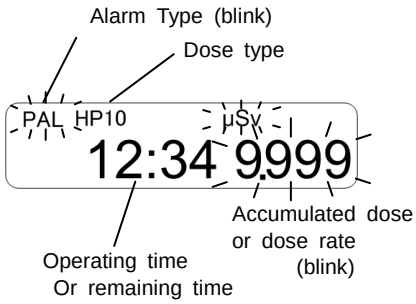
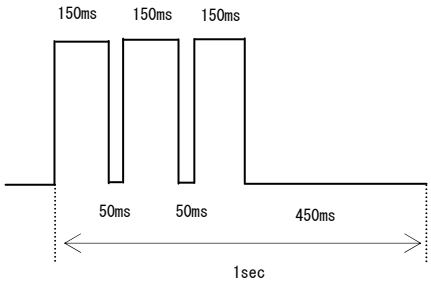
Signal beep	Starts when:	Beep pattern
ON/OFF	The dosimeter is turned on.	
	The dosimeter is turned off.	No sound
Contact to external device	The dosimeter is set at the setting device or a rack.	No sound
Data transmission	Successful completion of data transmission	No sound
	Setting value In the dosimeter are changed Using a setting device.	
	Data transmission failed	No sound
Buzzer test	Buzzer test (See Sec.6.2 During use)	

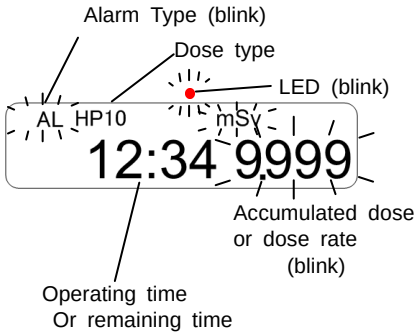
4.3.2 Audible alarms

Alarm activations and beep patterns are as follows:

<table>
<tr><th>Alarm activation</th><th>Alarm cause</th><th>Beep pattern</th></tr>
<tr><td rowspan="2">Preset accumulated dose threshold is reached</td><td>Accumulated dose has reached the preset dose threshold.
(Pre-ALarm)
 
</td><td rowspan="2">Alarm sound generates 50-ms beeps at intervals of 150 ms for 3 times in one second.*1
This repeats until exit operation by communicating with external devices or turning the power off. *2
 

Note: In case of pre-alarm, LED does not light on/blink.</td></tr>
<tr><td>Accumulated dose has reached the preset dose threshold.
(ALarm)
 
</td></tr>
</table>

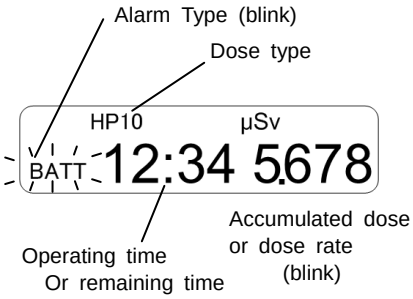
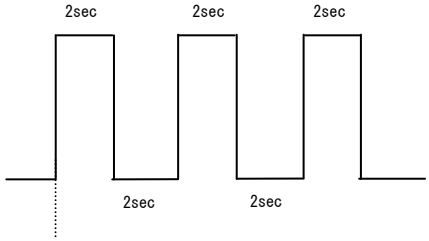
<table>
<tr>
<td rowspan="2">Preset dose rate threshold is reached</td>
<td>Dose rate has reached the preset dose threshold.
(Pre-ALarm)
 
</td>
<td rowspan="2">Alarm sound generates 150-ms beeps at intervals of 50 ms for 3 times in one second.*1
This repeats until decreasing to 50 % of preset dose rate, exit operation by communicating with external devices or turning the power off. *2
 

Note: In case of pre-alarm, LED does not light on/blink.</td>
</tr>
<tr>
<td>Dose rate has reached the preset dose threshold.
(ALarm)
 
</td>
</tr>
</table>

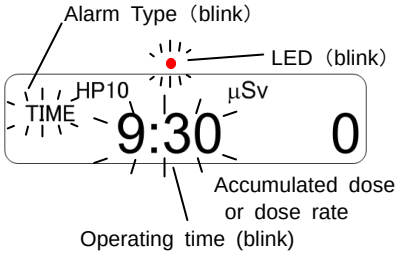
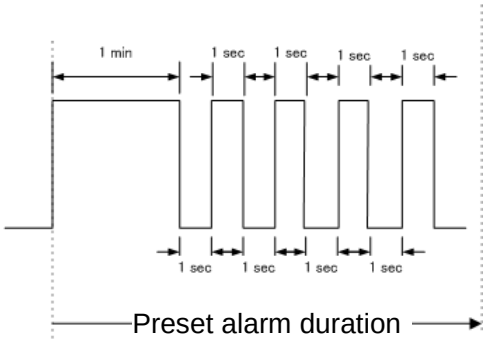
*1 If the preset dose and dose rate thresholds are simultaneously reached, the alarm sound pattern is switched and repeated at intervals of one second.

*2 If the mode-switch is pressed in 3 seconds during preset alarm duration, the buzzer and LED are inactivated. (This Alarm-Stop-Function can switch ON and OFF using a setting device. Default setting is ON.)

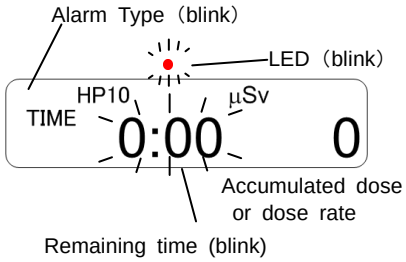
⚠ Attention	If you press and hold the button until the audible/LCD alarm stops, any other alarm is not available except for dose rate alarm. As for accumulated dose alarm in this case, audible alarm does not activate and only “AL” and “OVER” are blinking. * One-second interval alarm sound does not activate in this case.

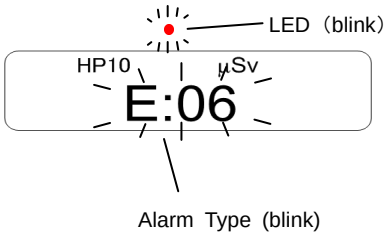
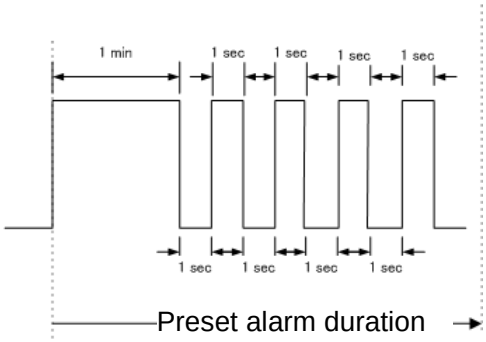
<table>
<tr><th>Alarm activation</th><th>Alarm cause</th><th>Beep pattern</th></tr>
<tr><td>Low battery level</td><td>When the battery voltage became lower than 2.2 V.
 
</td><td>If this alarm and one of the above-mentioned alarms activate simultaneously, the alarm sound for low battery voltage activates first. The low battery voltage alarm sounds 3 times with 2 seconds interval.
 

LED is NOT activated.</td></tr>
<tr><td rowspan="2">Exceed the
Operating time</td><td>Accumulated time

When the operating time reaches the preset time
(In case of the setting is 9:30)
 
</td><td rowspan="2">The alarm begins with a 1 min-long beep, followed by a 1 sec mute. After that, a 1 sec beep and a 1 sec mute are repeated. All beeps go on for preset alarm duration. *2
 

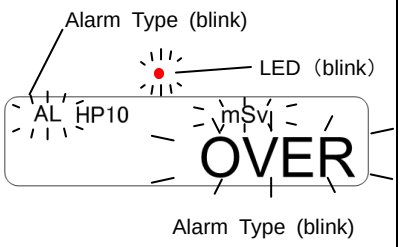
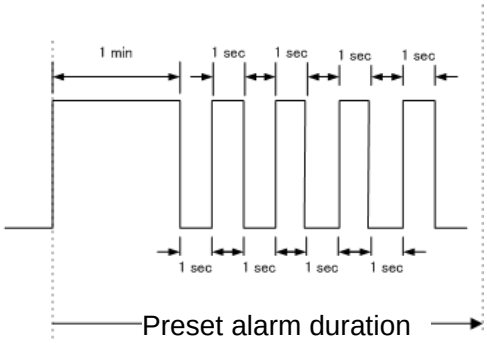
LED is activated in 1 sec. interval.</td></tr>
<tr><td>Decrease time

When the remaining-time reaches to zero.
 
</td></tr>
</table>

Detector function error	E :06” will start blinking if an error occurred with detection circuit (e.g. an open circuit or short –circuit with condensing).  	The alarm begins with a 1 min-long beep, followed by a 1 sec mute. After that, a 1 sec beep and a 1 sec mute are repeated. All beeps go on for preset alarm duration. *2  LED is activated in 1 sec. interval.

*2 If the mode-switch is pressed in 3 seconds during preset alarm duration, the buzzer and LED are inactivated. (This Alarm-Stop-Function can switch ON and OFF using a setting device. Default setting is ON.)

⚠ Attention	If you press and hold the button until the audible/LCD alarm stops, Operating time alarm activates without audible alarm. * One-second interval alarm sound does not activate in this case.

Alarm activation	Alarm cause	Beep pattern
Overflow	Accumulate dose reaches a 10 Sv or Dose rate reaches a 10 Sv/h.  	・Accumulate dose and dose rate (common) The alarm begins with a 1 min-long beep, followed by a 1 sec mute. After that, a 1 sec beep and a 1 sec mute are repeated. All beeps go on for preset alarm duration. ***3**  LED is activated in 1 sec. interval.

***3** If the mode-switch is pressed in 3 seconds during preset alarm duration, the buzzer and LED are inactivated. (This Alarm-Stop-Function can switch ON and OFF using a setting device. Default setting is ON.)

⚠ Attention	If you press and hold the button until the audible/LCD alarm stops and then dose rate alarm occurs, audible/LCD alarm for dose rate activates only when the dose rate exceeds 10 Sv/h. As for accumulated dose alarm in this case, audible alarm does not activate and only “AL” and “OVER” are blinking. * One-second interval alarm sound does not activate in this case.

5. Battery Replacement

5.1 Battery replacement

Follow these steps to replace the battery :

(1) Insert the plug pin (*Option) to turn the dosimeter off.

(2) Unscrew the battery cap using a coin.

(3) Replace the battery.

Insert a new battery in the compartment correctly.

(4) Close the battery cap using a coin till the O-ring is disappeared.

An O-ring is consumables, please change the O-ring every 2 years or the when of battery replacement (recommend). The information of the O-ring purchase, please contact our agency.

⚠ Attention	1. When replacing battery, make sure to turn off the dosimeter by inserting the Plug pin. 2. During replacement, align the battery polarity correctly. 3. Use only CR123A battery in 3.0 V. *4

*4 The battery voltage is checked on electrodes of CR123A by using a ordinary voltmeter.

Becase of a load resistance in the dosimeter, in some cases, the measured voltage is higher than the voltage during the operation.

5.2 Attaching and removing a clip

Follow these steps to replace the battery;

・Removing a clip

Pull up a clip as shown fig.2 with pushing the hook arrow pointing toward as shown fig.1

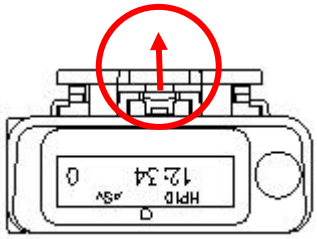


Fig.1

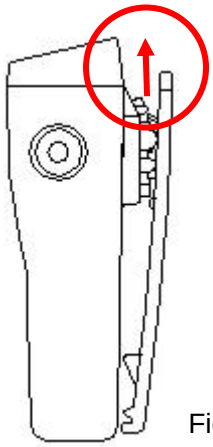


Fig.2

・Attaching a clip

Attach the circled area of a clip as shown below to the rear side of a dosimeter. Make sure to insert a clip perfectly. When inserting incompletely, a clip comes away and a dosimeter might fall.

6. Operational Instructions

6.1 When start to use

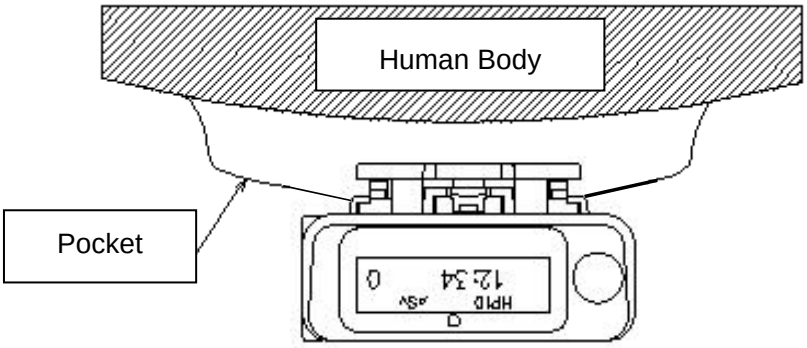
(1) Unscrew and remove the Plug pin (*Option). Confirm the power is ON (one beep) and LCD.

Please entry a new battery (CR123A) into the dosimeter for the first time use. (To see Sec. 5.1 battery replacement)

Check items	Method of confirmation	
Audible signal (1 beep)	Confirm one beep after removing the plug pin.	
Indicated dose value	0 μSv (0.0 mrem) or 0 μSv/h (0.0 mrem/h)	
Display of operating time	Operating time or remaining time [hour : min] or [hour.] HP10 μSv 99:59 0 0 min. to 99 hr 59 min HP10 μSv 9999. 0 100 hr to 9999 hr 59 min	
LCD	〔Normal display〕 HP10 μSv 0:02 0 If Hp(10) is 0 μSv (0.0mrem). Operating time is 2 min.	〔Abnormal display〕 HP10 μSv BATT 0:02 0 Replace the battery if battery level is low.

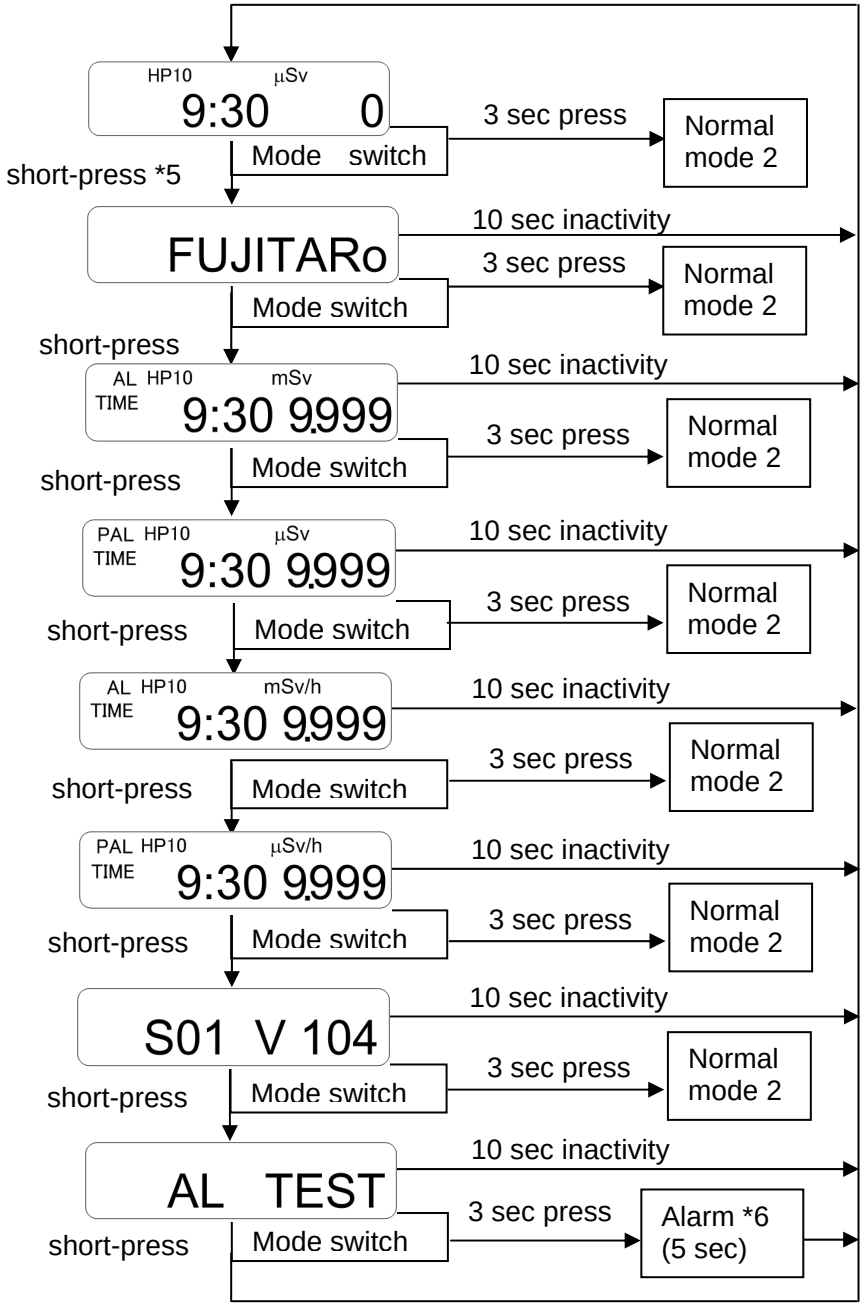
(2) Select desired display mode with this switch--Accumulated Dose (Sv or rem) or Dose Rate (Sv/h or rem/h). Display mode may be changed at any time by using the mode switch.

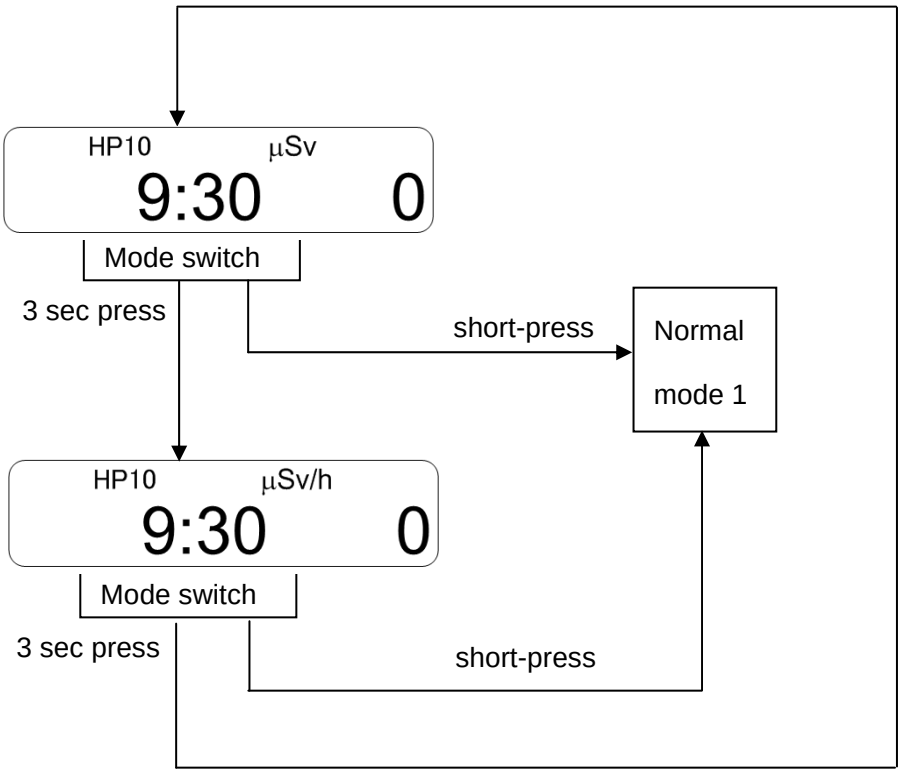
(3) Clip the dosimeter onto the chest pocket as shown below.

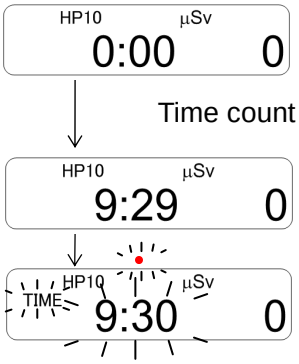
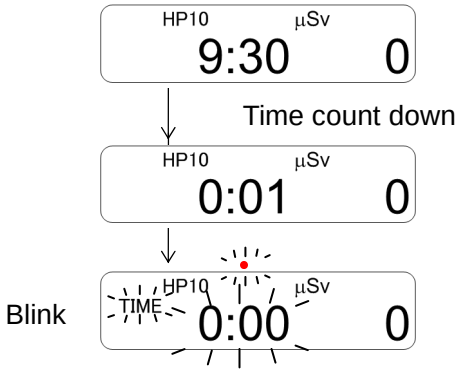
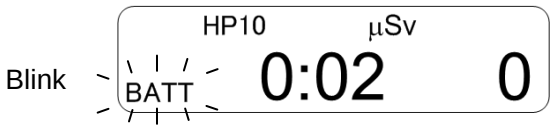
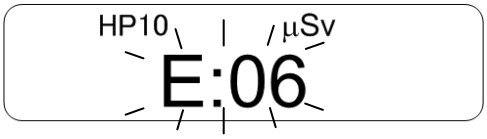


6.2 During use

To switch modes for LCD display:

No.	Display	Remarks
1	**Normal mode 1**  ***5** Short-press : press in 3 seconds ***6** LED is also activated.	Accumulated dose User's name Hp(10) Alarm threshold (Cumulative dose) Hp(10) Pre-alarm threshold (Cumulative dose) Hp(10) Alarm threshold (dose rate) Hp(10) Pre-alarm threshold (dose rate) Dosimeter's software version Alarm test (Buzzer test)

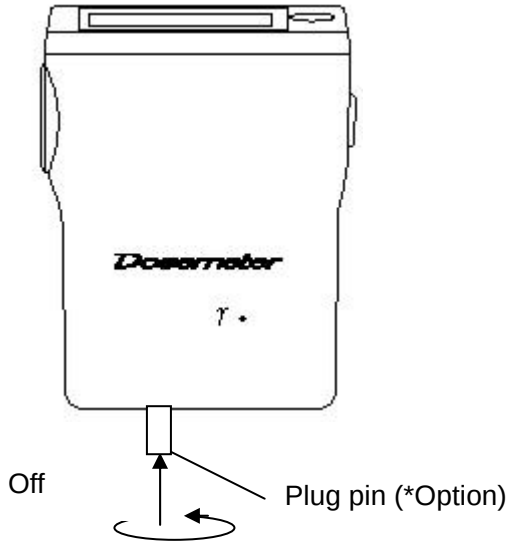
No	Display	Remarks
2	**Normal mode 2**  	Hp(10) Accumulated dose Hp(10) dose rate

No	Item	Display	Remarks
3	Operating time display	Accumulated time (In case of the setting is 9:30)  **TIME**, **Operating Time** and **LED** are blinking.	The time alarm will be activated when the operating time reaches the preset time value.
	Remaining time display	Decrease time (In case of the setting is 9:30)  **TIME**, **Remaining-time** and **LED** are blinking.	The time alarm is activated, when the remaining-time reaches to zero.
4	Low battery display	[BATT] will start blinking if the battery level is low.  (LED is NOT blinking) Note: During this alarm activation, the beep sound of dose and dose rate alarm will stop. After low battery voltage alarm (BATT blinking), available for about 10 hours without alarm and backlight.	The low battery alarm will beep 5 times only. LED is NOT blinking. In this case, please replace to a new battery as soon as possible.
5	Detector function error display	"E :06" will start blinking if an error occurred with detection circuit (e.g. an open circuit or short –circuit with condensing).  	DO NOT use the dosimeter after this error.

6.3 After use

Insert the dosimeter in the rack, or insert and screw the plug pin to turn off.

(2 seconds is needed to turn off the dosimeter)



⚠ Attention	Do not insert the plug pin again to dosimeter in 5 seconds after pulling out the plug pin.

7. Care and Maintenance

Check the Dosimeter as specified below to ensure quality performance.

7.1 Check procedures

No.	Check items	Procedures	Check point
1	Joint line of the battery cap.	Visually check the joint line. When to check: Before use and after battery replacement. Check purpose: To avoid contamination of the Dosimeter by moisture or dust.	The cases should be tightened and fixed together. No sign of gap should be found.
2	Crack to the dosimeter.	Visually check the joint line. When to check: Before use and after battery replacement. Check purpose: To avoid contamination of the Dosimeter by moisture or dust. To avoid deteriorations of the capabilities in a waterproof and a resistance of radio wave.	No sign of crack should be found.
3	The surface is clean	Wipe the dosimeter surface with dry cloth or soft brush. Also wipe the communication port. When to check: After use in environment where dust, chemical fumes and etc. are present. Check purpose: To prevent operation mistake.	The dosimeter surface should be clean. If dirt cannot be removed, please contact us.
4	Battery cap (With O-ring)	Recommend a replacement periodically When to replace: Every 2 years or when replaces a battery. Replacement purpose: To keep waterproofing.	Battery cap has elasticity.
5	Indication error / calibration	To confirm the indication error within 10% to the reference dose equivalent using Cs-137. When to check: 1 year or less Check purpose: To optimize the dose equivalent management and to avoid exposure accidents.	If indication error is over 10%, please contact us for calibration.

7.2 Consumable supplies

Please contact our agency.

1. Battery CR123A : Order from 1 unit.
2. Battery cap with O-ring : Order from 1 unit.

8. Specification

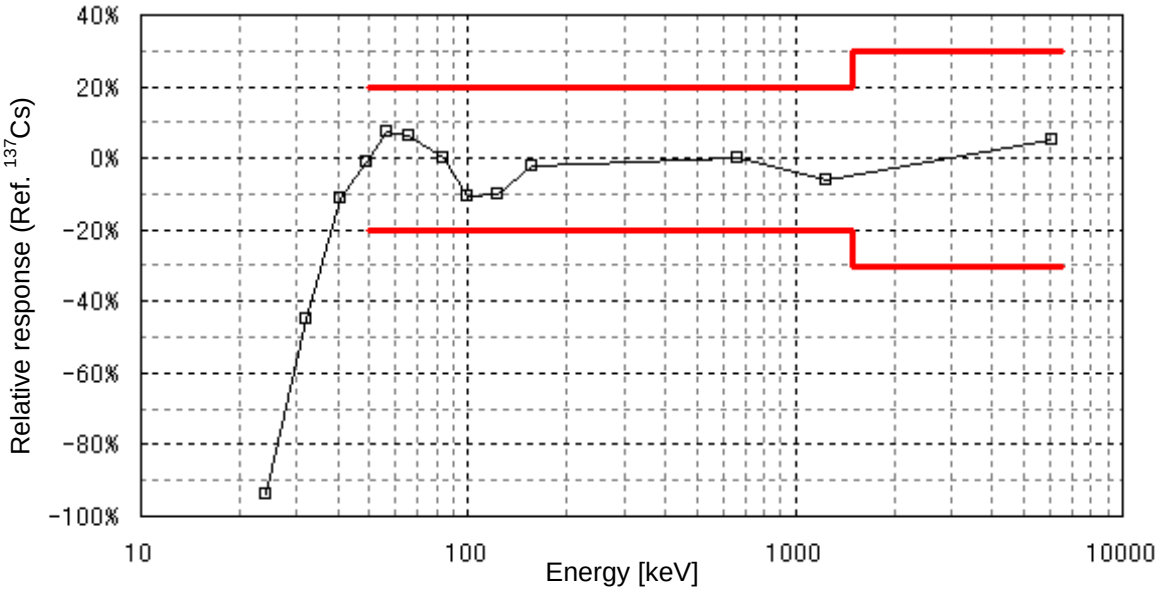
8.1 General specification

Type	NRF30021-☐☐1YY , NRF30021-☐☐2YY	
Radiation type	Gamma (X)-ray (35 keV to 6.0 MeV)	
Detector	Silicon semi-conductor	
Dose display range	0 μSv to 9.999 Sv	
	0 μSv/h to 9.999 Sv/h	
Display	LCD	
Calibration	±10 %	^{137}Cs, 1 mSv (10 mSv/h)
Energy response	50 keV to 1.5 MeV	< ±20 % (Ref. ^{137}Cs)
	1.5 MeV to 6 MeV	< ±30 % (Ref. ^{137}Cs)
Dose accuracy	±10 %	(0.1 mSv to 9.999 Sv) (^{137}Cs)
Dose rate accuracy	±20 %	(2 mSv/h to 9.999 Sv/h)
Linearity	±10 %	(0.1 mSv/h to 9.999 Sv/h) (^{137}Cs)
Angular of incidence	±20 %	(0 deg. - 60 deg.)(^{137}Cs, Ref. 0 deg.)
	±50 %	(0 deg. - 60 deg.)
		(^{241}Am or equivalent of 60 keV X-ray, Ref. 0 deg.)
Ambient temperature	±20 %	(-10 ℃ to +40 ℃) (Ref. 20 ℃)
Response time	5 s or less	(5 mSv/h to 9.999 Sv/h)
Battery	Li-ion battery	x1 (CR123A)
Battery life	2880 hours	(new battery, normal temperature, no alarms)
Operating temperature	-20 ℃ to +50 ℃ (90 % or less, no condensation)	
Dimensions	Approx. 60 mm x 78 mm x 33 mm (including clip)	
Weight	Approx. 100 g	(including clip, rubber cover and battery)

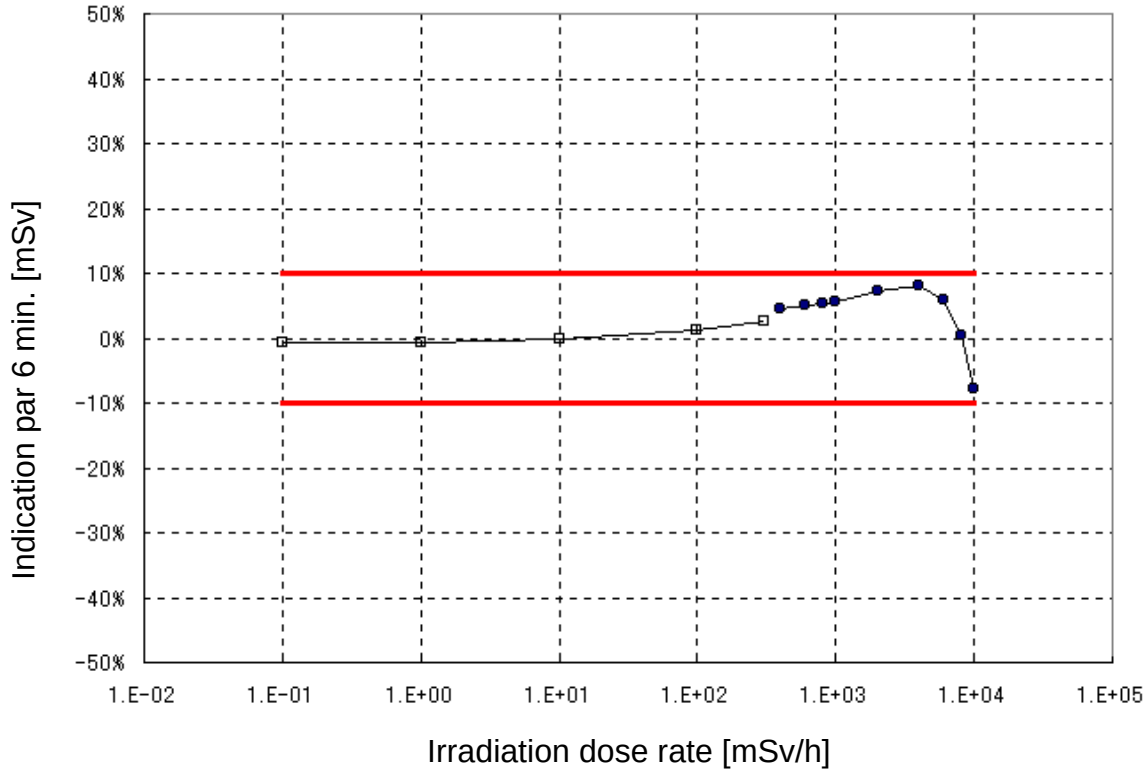
Tests on the dosimeter comply with the IEC Standard IEC 61525 (1998), and IEC 61526 (1998)、and JIS Standard JIS Z 4312 (2002). Indications on the dosimeter may be interfered by certain factors such as mobile phones, vibrations, and impacts.

If a hard impact operating on the dosimeter, it may have a crack to the dosimeter. In this case, it may deteriorate the capabilities in a waterproof and a resistance of radio wave.

8.2 Photon energy response



8.3 Dose equivalent rate dependence

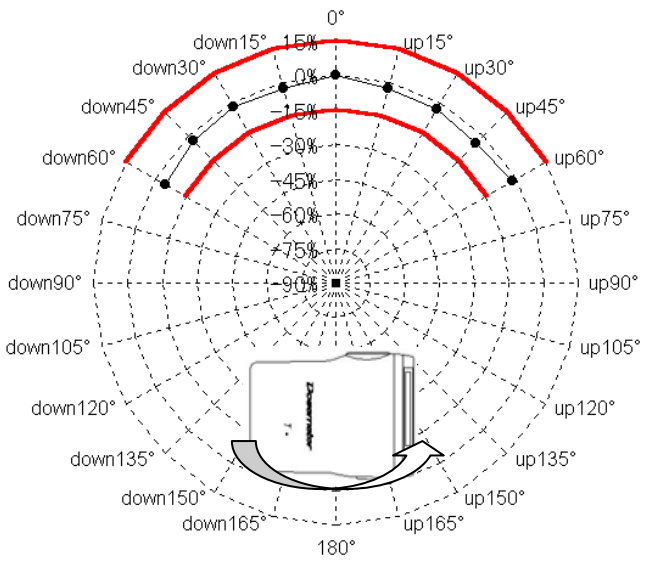


Open square is experimental data, black circle is simulated data using electric pulses.

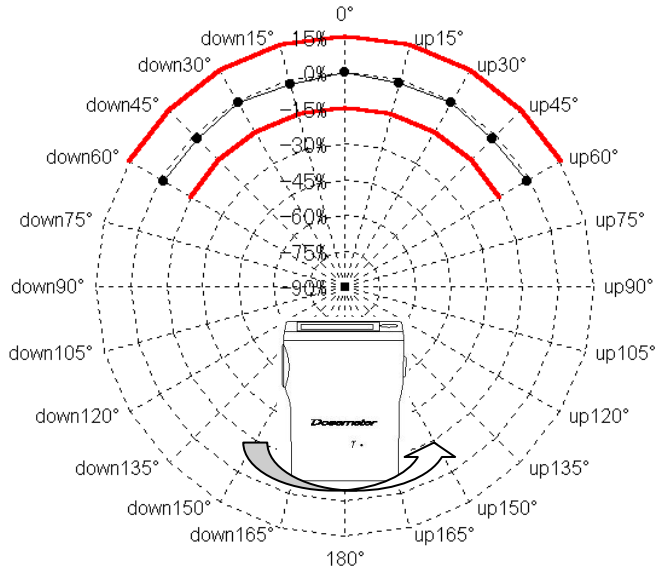
8.4 Angular of incidence

8.4.1 For ^{137}Cs on phantom

Anglar of incidence (^{137}Cs up, down)

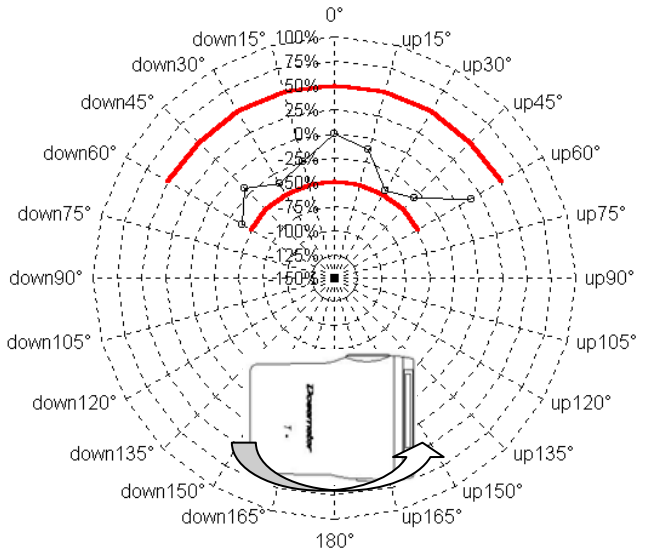


Anglar of incidence (^{137}Cs left, right)

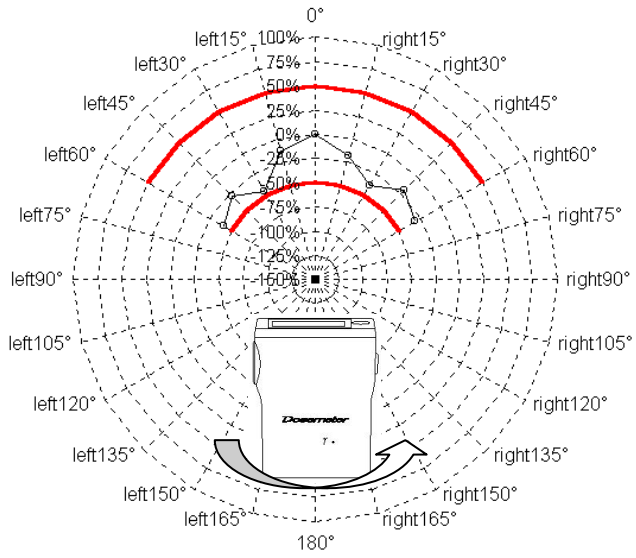


8.4.2 For ^{241}Am (X-ray 56.2 keV) on phantom

Angle of incidence (X-ray : 56.2keV up,down)

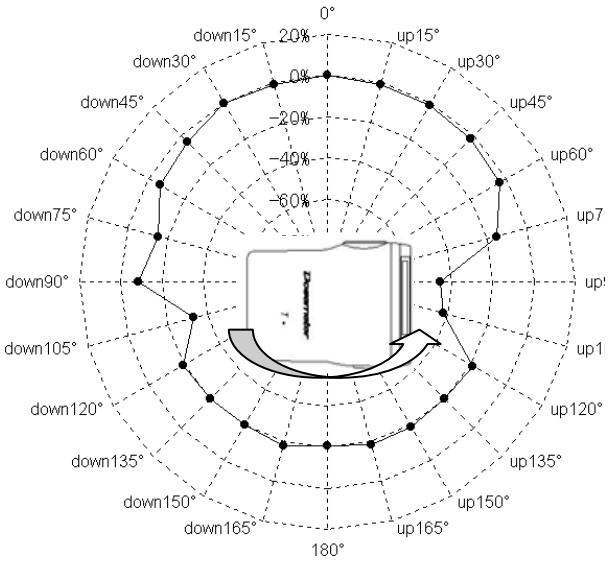


Angle of incidence (X-ray : 56.2keV left,right)

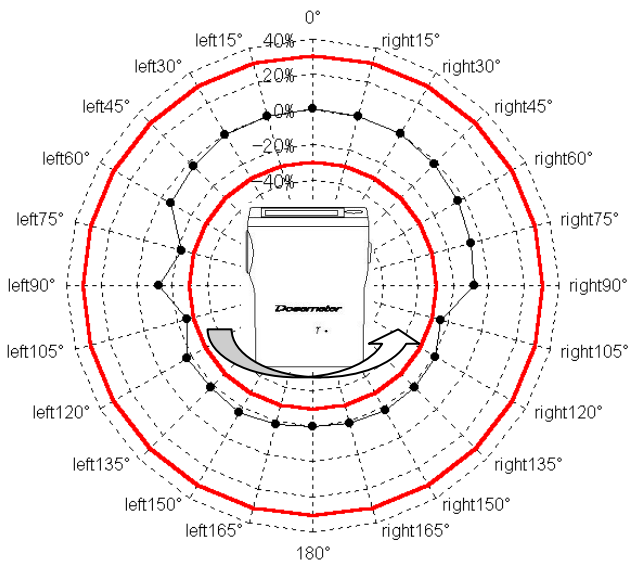


8.4.3 Angle of incidence for ^{137}Cs in Free air

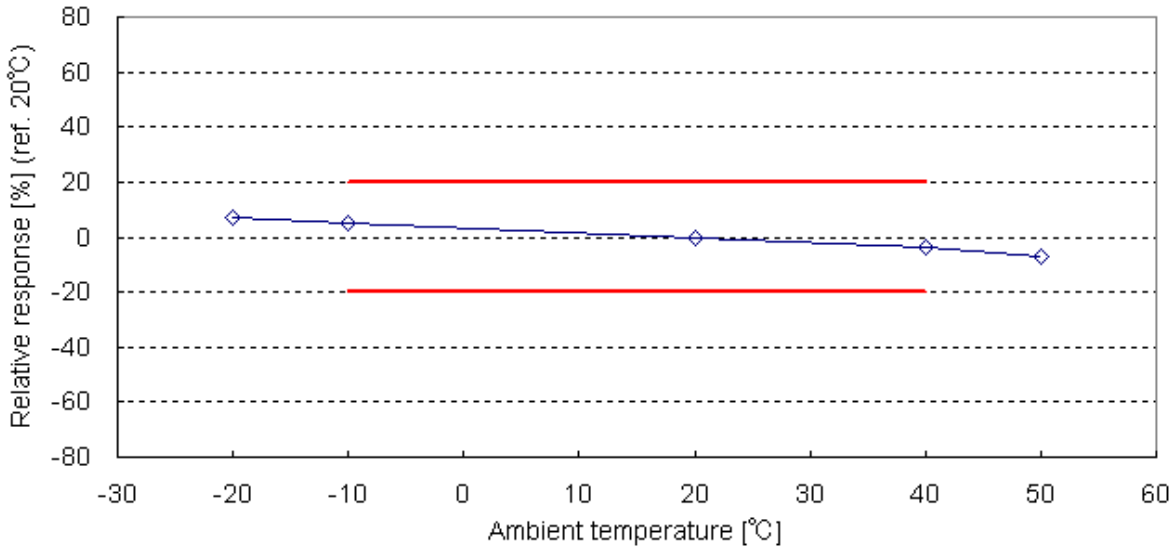
Anglar of incidence (^{137}Cs in free air up, down)



Anglar of incidence (^{137}Cs in free air left, right)



8.5 Ambient temperature



9. Appendix

9.1 Troubleshooting Table

Error No.	POSSIBLE CAUSE	SUGGESTED SOLUTION
E04 Communication error	(1) Communication distance is too far (2) Communication port is dirty. (3) IC circuit parts malfunction	(1) Set the distance between Communication port of the Dosimeter and the Setting Device within 5 cm. Also note that these windows are face to face. (2) Clean IR communication window with soft cloth. (3) Contact our agency.
E06 Detector function error	(1) IC malfunction	(1) Contact our agency.
E81 E82 E83 E89 etc.error	(1) RF Module malfunction (2) Additional Device malfunction (3)Communication Error	(1) Contact our agency. (2) Contact our agency. (3) Set the distance between Communication port of the Dosimeter and the Setting Device within 5 cm. Also note that these windows are face to face. Clean IR communication window with soft cloth.

When contact our agency, please provide precise details of the problem.

Note: *This Troubleshooting Table is to help you locate only the Dosimeter's malfunctions that occurred during use.*

SYMPTOM	POSSIBLE CAUSE	SUGGESTED SOLUTION
No Indications on LCD	(1) Defective battery connection (2) Power switch malfunction or IC malfunction	(1) Check the proper contacts in the battery compartment and there is no exogenous material in the battery case. (2) Contact our agency.
Characters on LCD is garbled	(1) Defective battery connection (2) Power switch malfunction or IC malfunction	(1) Check the proper contacts in the battery compartment and there is no exogenous material in the battery case. (2) Contact our agency.
Backlight does not light when pushing the mode switch	(1) Power switch malfunction or IC malfunction	(1) Contact our agency.

Dose error ・Dose accumulation doesn't work ・Displayed dose is high ・Displayed dose is low	(1) LCD malfunction (2) IC malfunction (3) Calibration constant trouble	(1) and (2) Contact our agency. (3) Confirm calibration constant. Please ask us how to check the calibration constant.
Audible signal doesn't work	(Assuming the indication display is normal) (1) Waterproof mesh is dirty (2) Frequency setting trouble (3) Buzzer lead wire is broken (4) Buzzer unit IC malfunction	(1) Clean up the mesh with soft brush. Do not use alcohol for cleaning. If trouble continues after this procedure, contact our agency. (2) (3) and (4), Contact our agency.
Time indication does not reach an intended value. Low battery indicator appears prematurely.	(1) Near the end of the battery's life. (2) Increase the current consumption (3) The change of the voltage decline detection level by IC malfunction.	(1) Replace with a new battery. (See 5.1) (2) Check the proper contacts in the battery compartment and there is no exogenous material in the battery case. If trouble continues, Contact our agency. (3) Contact our agency.
IR communication is unable.	(1) Communication distance is too far (2) Communication port is dirty. (3) IC circuit parts malfunction	(1) Set the distance between Communication port of the Dosimeter and the Setting device within 5cm. Also note that these windows are face to face. (2) Clean IR communication window with soft cloth. (3) Contact our agency.
Crack to the dosimeter	(1) A hard impact operating on the dosimeter by dropped or crushed.	(1) Contact our agency.

9.2 Disposal

Regarding disposal of this product, please follow the rule of your country.