MODEL 23 AND 23-1
ELECTRONIC PERSONAL DOSIMETER

May 2024

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LUDLUM MEASUREMENTS, INC
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SWEETWATER, TEXAS 79556
325-235-5494, FAX: 325-235-4672

STATEMENT OF WARRANTY

Ludlum Measurements, Inc. warrants the products covered in this manual to be free of defects due to workmanship, material, and design for a period of twelve months from the date of delivery. The calibration of a product is warranted to be within its specified accuracy limits at the time of shipment. In the event of instrument failure, notify Ludlum Measurements to determine if repair, recalibration, or replacement is required.

This warranty excludes the replacement of photomultiplier tubes, G-M and proportional tubes, and scintillation crystals which are broken due to excessive physical abuse or used for purposes other than intended.

There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face there of. If the product does not perform as warranted herein, purchaser's sole remedy shall be repair or replacement, at the option of Ludlum Measurements. In no event will Ludlum Measurements be liable for damages, lost revenue, lost wages, or any other incidental or consequential damages, arising from the purchase, use, or inability to use product.

RETURN OF GOODS TO MANUFACTURER

If equipment needs to be returned to Ludlum Measurements, Inc. for repair or calibration, please send to the address below. All shipments should include documentation containing return shipping address, customer name, telephone number, description of service requested, and all other necessary information. Your cooperation will expedite the return of your equipment.

LUDLUM MEASUREMENTS, INC.
ATTN: REPAIR DEPARTMENT
501 OAK STREET
SWEETWATER, TX 79556

800-622-0828 325-235-5494
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Table of Contents

Section 1

Introduction

The Model 23 EPDi is an electronic personal dosimeter, which measures personal dose equivalent from external radiation sources. It is ideal for the measurement and general monitoring of gamma and X-ray radiation in medical and laboratory environments, as well as any controlled or restricted area where personal radiation monitoring is required or desired.

The Model 23-1 is identical to the Model 23, except that it measures in Sv/h instead of R/hr. (For the rest of the manual, the instrument will simply be referred to as the Model 23, which will include both versions.)

The compact and lightweight body of the instrument (55.9 g {2 oz}) makes it ideal for personal use. It can be compared to the size of an ink pen. The Model 23 is sensitive to a wide range of energies from 35 keV to 3 MeV. Dose, dose equivalent rate, and alarm values are easily seen on the four-digit LCD screen. Each preset alarm threshold is displayed on the Configuration Mode screen. When the dose or dose rate reaches the preset alarm thresholds, the alarm activates.

Users who have multiple EPDi units, there is an optional reader/software kit that can be used to quickly take data directly from the EPDi Dosimeter via infrared communication to the user's PC. The optional software also allows the user to set or change alarm set points quickly.

Since the Model 23 has energy characteristics corresponding to 1 cm dose equivalent, by placing it close to the body it is able to measure 1 cm dose equivalent.

Notice!

The Model 23 Dosimeter may not measure pulsed radiation accurately. Point the "body side" (noted on the dosimeter) or display side towards the body or area to be measured. A dot next to the gamma symbol on the instrument indicates the center point of the unit.

Section 2

Getting Started

Unpacking and Repacking

Remove the calibration certificate and place it in a secure location. Remove the instrument and ensure that all of the items listed on the packing list are in the carton. Check individual item serial numbers and ensure calibration certificates match between instruments.

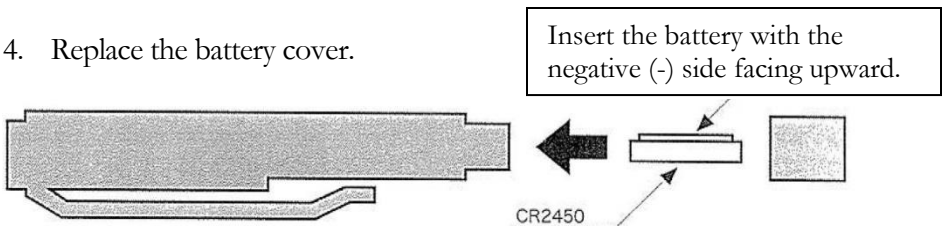
To return an instrument for repair or calibration, provide sufficient packing material to prevent damage during shipment and appropriate labeling.

Every returned instrument must be accompanied by an **Instrument Return Form**, which can be downloaded from the Ludlum website at www.ludlums.com. Find the form by clicking the "Support" tab and selecting "Service Center" from the drop-down menu. Then choose the appropriate Service Center division where you will find a link to the form.

Battery Installation

Replace the battery with the following procedure:

1. Press and hold the power switch (color: red) for approximately two seconds until the Model 23 turns off.
2. Remove the battery door.
3. Extract the used battery using miniature pliers or something similar and insert the new battery with the negative (-) side facing upward.
4. Replace the battery cover.



Caution:

Always turn off the Model 23 EPDi before replacing the battery. Be sure to observe proper polarity when replacing the battery. This product operates on the CR2450 battery (3.0 V) only (Part # 21-8639). Only use the battery specified.

Note:

When a low-battery indicator appears, take readings within one minute before replacing the battery. To save battery life, the power saving mode should be used. When storing the dosimeter for a longer period, remove the battery. When the alarm activates, the battery consumption will be higher, so turning off the dosimeter is recommended.

Warning:

Do not throw the dosimeter or batteries into a fire. This could result in personal injury.

Error Involving the Battery Installation

When the error message E12 appears after turning the instrument on:

1. The battery was removed and inserted before the power was turned on. This is not a malfunction. Turn off the power, and then turn it on again.

2. The battery was NOT removed and inserted before the power was turned on. There may be a data recording failure. Stop using the dosimeter.

Section 3

Specifications

Detector: silicon semiconductor

Measurement Range: 0.1 mrem to 99.9 rem; 0.1 mrem/h to 99.99 rem/h for Dose Rate; (0.001 mSv to 999.9 mSv; 0.001 mSv/h to 999.9 mSv/h)

Radiation Detected: gamma and X-Ray (35 keV to 3 MeV)

Display: 4-digit liquid crystal display, with dose rate, low battery, overflow

Accuracy: within 10% from 1.0 mrem to 99.99 rem (^{137}Cs)

Linearity: within 10% (to 100 mSv/h)

Alarm Output: low, medium, high user-settable volume, and OFF. When reaching or exceeding the present values – the alarm activates, red LED lamp flashes, and vibrator activates.

Alarm Settings: accumulated dose alarm threshold can be set in increments of 1 mrem. Dose rate alarm threshold can be set in increments of 10 mrem/h. *Note: Alarm setting values can be modified by configuration mode or configuration software, including infrared communication device.*

Alarm Volume: approximately 60 dB

Sensitivity: approximately 2 cpm per μSv/h (20cpm/mR/hr)

Data Logging: 600 records (optional IR reader required for data transmission to PC). When the Model 23 is turned off, the accumulative dose data is automatically deleted.

Data Reset: if Data Reset setting is effective, accumulated dose and operating time shall be reset at the time of startup automatically.

Overflow: The message "over" appears.

Temperature Range: -10 to 40 ˚C (14 to 104 ˚F)

Operating Humidity: ≤90% (non-condensing)

Shock Resistant: operates properly after a vertical drop test from 20 cm

Power: one each coin-type lithium battery (CR2450)

Battery Life: typically one month at 8 hours per day in non-alarm status

Size: 12 x 30 x 112.8 mm (0.5 x 1.2 x 4.4 in.) (H x W x D) without clip

Weight: 55.9 g (2 oz)

Environmental Rating: IEC60529 Waterproof Grade 1 – water resistant under normal conditions.

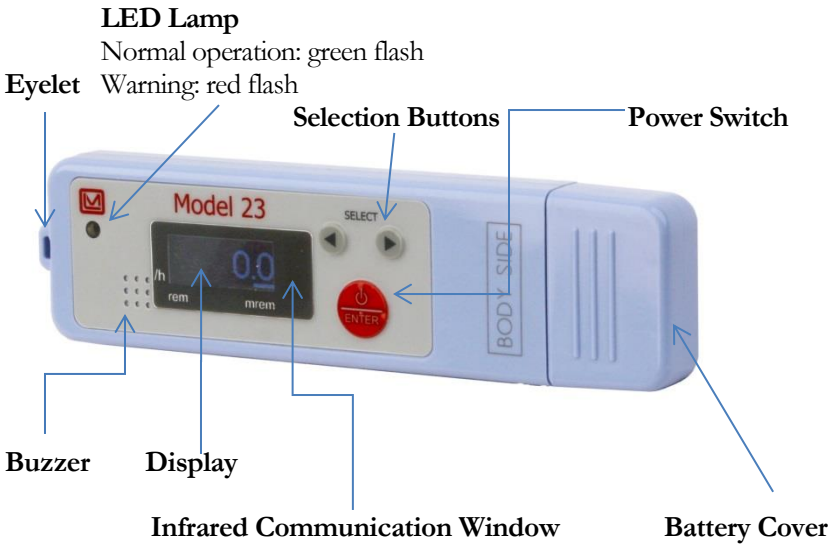
Default Settings:

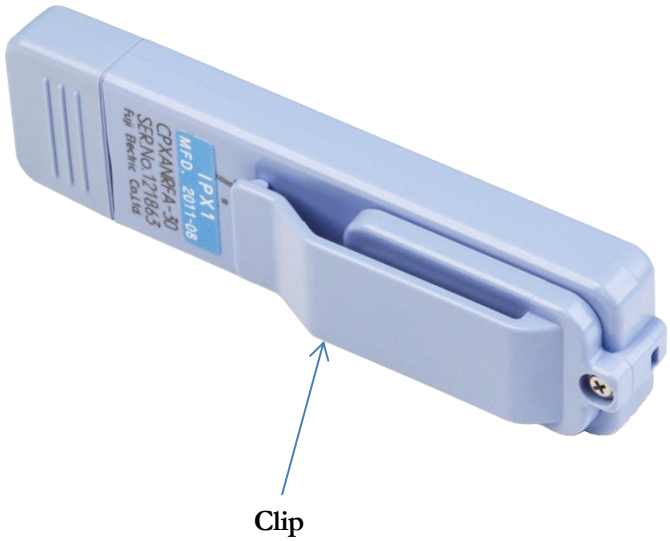
Default Settings		
	Model 23	**Model 23-1**
Dose Alarm	50 mrem	0.5 mSv
Dose Rate Alarm	400 mrem/h	4 mSv/h
Dose Pre-Alarm	30 mrem	0.3 mSv
Dose Rate Pre-Alarm	200 mrem/h	2 mSv/h
Time Alarm	OFF	OFF
Volume	3	3
Brightness	1	1
Power Save	10 sec	10 sec
Vibe	OFF	OFF

Section 4

Description of Controls and Functions

Parts and Features





Display

Note:

The display in this manual shows Organic EL display. On an LCD display, black and white are inverted and you cannot change brightness.

Display During Normal Operation

Display (Accumulated Dose)

Indicates that the Model 23 measures accumulated dose of gamma rays in Measurement Mode. When the indicated value exceeds the upper limit of the mrem unit, the bottom bar is moved to the left, and the value of the rem unit is displayed.

Display (Dose Rate)

When the indicated value exceeds the upper limit of the mrem unit, the bottom bar is moved to the left and the value of the rem unit id displayed.

Indicates that the Model 23 measures gamma ray dose rate in Measurement Mode.

Display During Abnormal Operation

Alarm indications:

- ALM DOSE (Accumulated Dose Alarm)
- ALM RATE (Dose Rate Alarm)
- ALM TIME (Operating Time Alarm)
- ALM BATT (Low Battery Alarm)
- ALM E06 (Counting Circuit Failed)
- ALM E11 (Setup Error)

Section

5

Operation

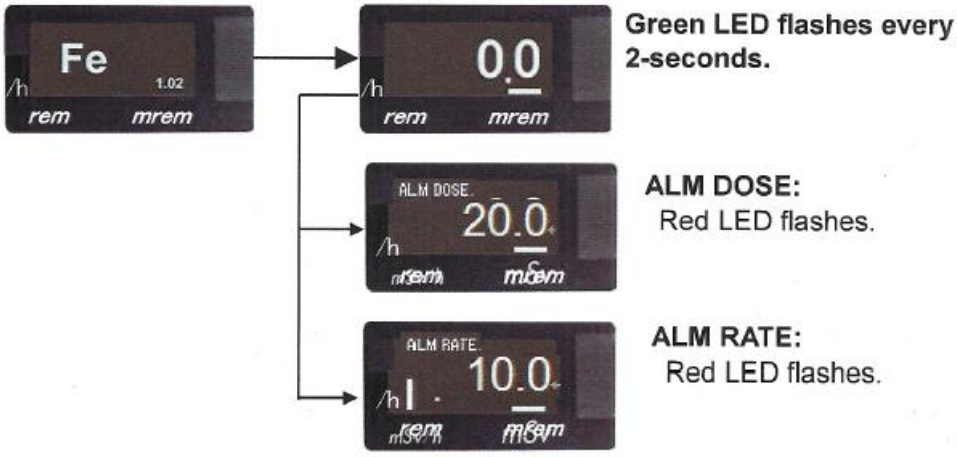
Preparing the Instrument for Use

To start the Model 23 EPDi, press and hold the power switch (color: red) for approximately two seconds.

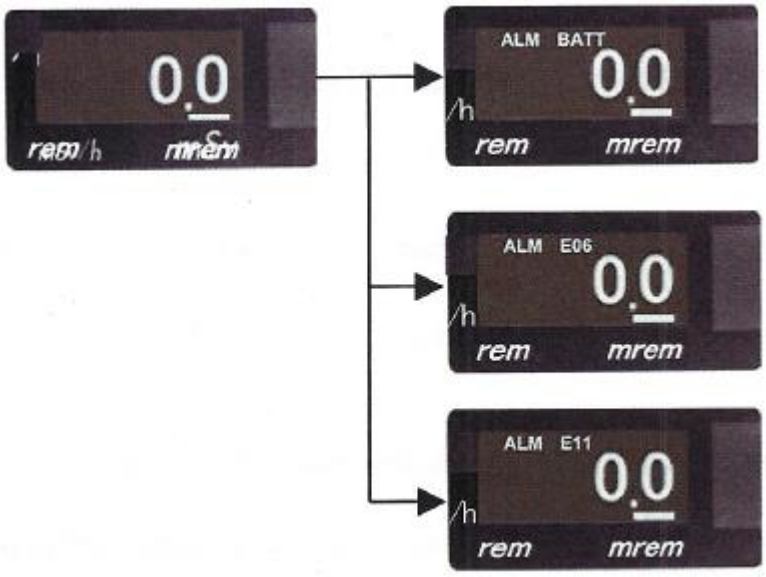
If data reset is effective, accumulated dose and operating time shall be reset at the time of startup automatically.

When the measurement screen appears, the red LED lamp lights for one second and one short beep sounds, indicating that the Model 23 is in the measurement mode.

Display During Normal Operation



Display During Abnormal Situation



ALM BATT:
Red LED flashes.
Replace the used battery with new one.

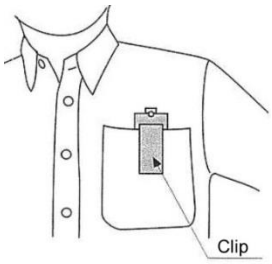
ALM E06:
Red LED flashes.
Contact Ludlum Measurements. Inc.

ALM E11:
Red LED flashes.
Restart the Model 23 by the following procedures:

1. Press and hold the power switch button for approximately 2 seconds until the Model 23 turns OFF.
2. Press and hold the power switch button for approximately 2 seconds until Model 23 turns ON.

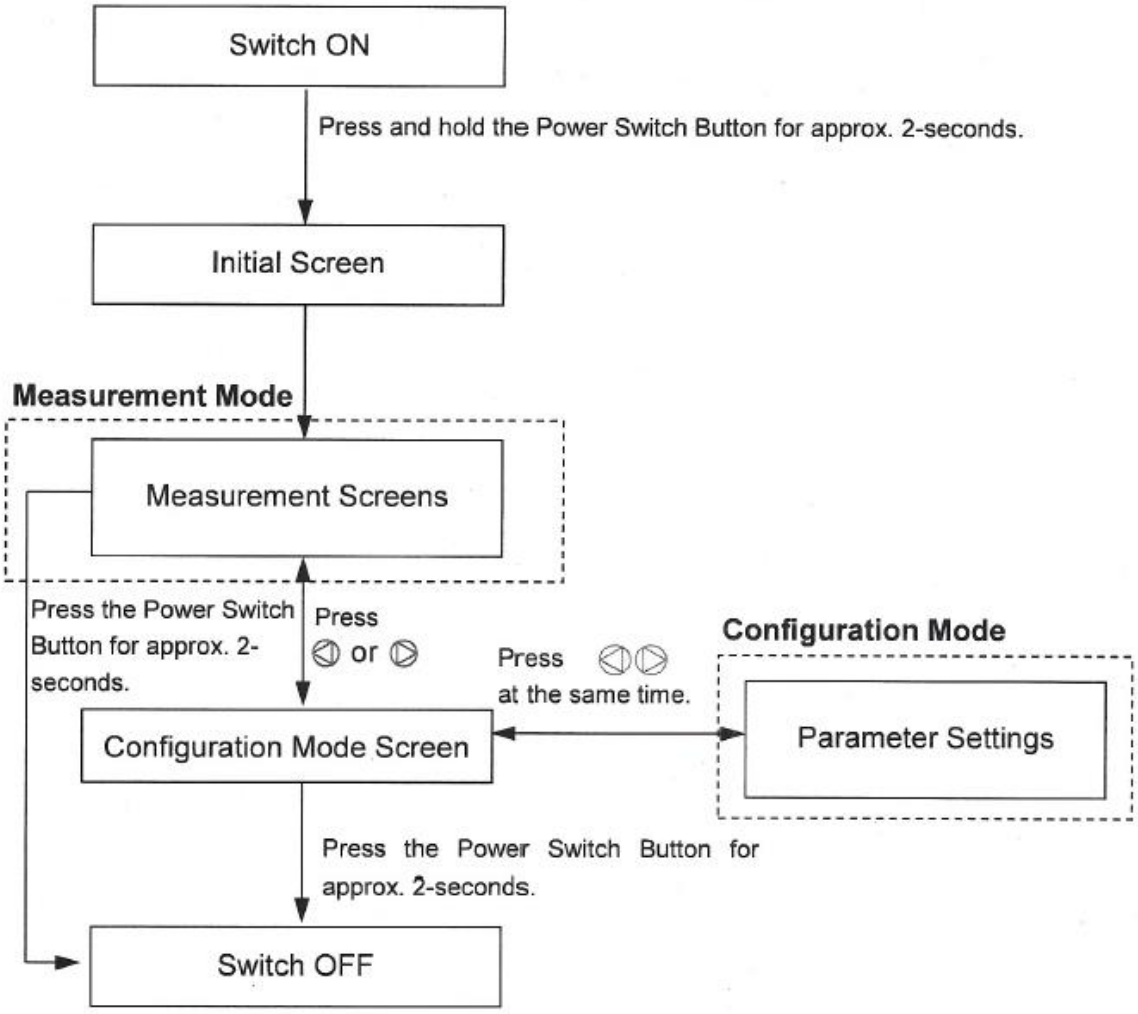
Operating Procedure

Point the "body side" (display side) of the Model 23 towards your body and insert the Model 23 into your pocket, securing it with the clip as shown below.



To turn off the Model 23, press and hold the power switch for approximately two seconds.

The operational flow of the Model 23 is as follows:

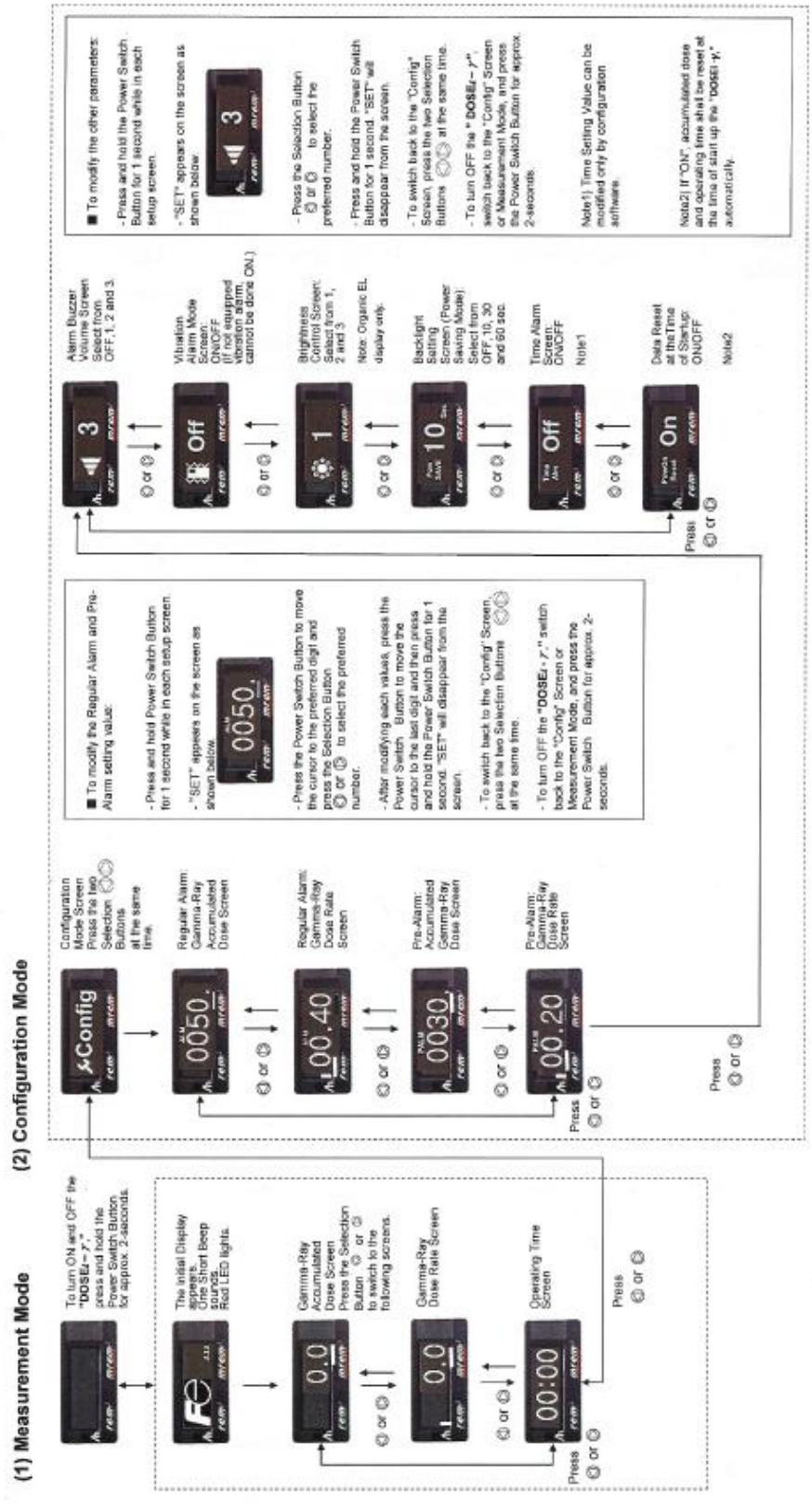


The Model 23 operates in two modes – Measurement Mode and Configuration Mode.

Measurement Mode: The Model 23 continuously measures gamma ray accumulated dose and gamma ray dose rate.

Configuration Mode: The parameters , including the Alarm Setting Values (excluding Time Setting Value), the Alarm Buzzer Volume, and the Backlight Setting can be changed in this mode.

The graphic on the following page shows the details on the operational flow and the operation procedures both modes.


(1) Measurement Mode
(2) Configuration Mode
To turn ON and OFF the "DOSE/ – γ," press and hold the Power Switch Button for approx. 2-seconds.
The initial Display appears. One Short Beep sounds. Red LED lights.
Gamma-Ray Accumulated Dose Screen
Press the Selection Button ⊙ or ⊙ to switch to the following screens.
Gamma-Ray Dose Rate Screen
Operating Time Screen
Press ⊙ or ⊙
Configuration Mode Screen Press the two Selection Buttons ⊙⊙ at the same time.
Regular Alarm: Gamma-Ray Accumulated Dose Screen
Regular Alarm: Gamma-Ray Dose Rate Screen
Pre-Alarm: Accumulated Gamma-Ray Dose Screen
Pre-Alarm: Gamma-Ray Dose Rate Screen
■ To modify the Regular Alarm and Pre-Alarm setting value:
- Press and hold Power Switch Button for 1 second while in each setup screen.
- "SET" appears on the screen as shown below.
- Press the Power Switch Button to move the cursor to the preferred digit and press the Selection Button ⊙ or ⊙ to select the preferred number.
- After modifying each values, press the Power Switch Button to move the cursor to the last digit and then press and hold the Power Switch Button for 1 second. "SET" will disappear from the screen.
- To switch back to the "Config" Screen, press the two Selection Buttons ⊙⊙ at the same time.
- To turn OFF the "DOSE/ – γ," switch back to the "Config" Screen or Measurement Mode, and press the Power Switch Button for approx. 2-seconds.
Alarm Buzzer Volume Screen Select from OFF, 1, 2 and 3.
Vibration Alarm Mode Screen: ON/OFF (If not equipped vibration alarm, cannot be done ON.)
Brightness Control Screen: Select from 1, 2 and 3
Note: Organic EL display only.
Backlight Setting Screen (Power Saving Mode) Select from OFF, 10, 30 and 60 sec.
Time Alarm Screen: ON/OFF
Note1
Data Reset at the Time of Startup: ON/OFF
Note2
■ To modify the other parameters:
- Press and hold the Power Switch Button for 1 second while in each setup screen.
- "SET" appears on the screen as shown below.
- Press the Selection Button ⊙ or ⊙ to select the preferred number.
- Press and hold the Power Switch Button for 1 second. "SET" will disappear from the screen.
- To switch back to the "Config" Screen, press the two Selection Buttons ⊙⊙ at the same time.
- To turn OFF the "DOSE/ – γ," switch back to the "Config" Screen or Measurement Mode, and press the Power Switch Button for approx. 2-seconds.
Note1) Time Setting Value can be modified only by configuration software.
Note2) If "ON", accumulated dose and operating time shall be reset at the time of start up the "DOSE/ – γ," automatically.
Press ⊙ or ⊙

Alarm

Alarm Indicator	Conditions	Alarm Buzzer	LED
ALM DOSE **ALM RATE**	When Accumulated Dose or the Dose Rate of gamma rays reaches the preset values, the pre-alarm activates.	The short-pitched beep (0.1 second) sounds every second five times.	
	When Accumulated Dose or the Dose Rate of gamma rays reaches the preset values, the regular alarm activates.	A 1-minute beep, and then a 1-second beep followed by a 1-second pause. This operation repeats for the previously time set.	Red flashes every two seconds.
ALM BATT	Activates when battery level is LOW	Alarm for "ALM BATT" is prioritized over "ALM DOSE" or ALM RATE." A 2-second beep and a 2-second pause. This operation repeats three times.	
ALM TIME	Activates when the operating time exceeds the set time.	A 1-minute beep, and then a 1-second beep followed by a 1-second pause. This operation repeats for the time previously set.	Red flashes every two seconds.
ALM E06	Activates when the counting circuit shorts out due to disconnection, condensation, or etc.	A 1-minute beep, and then a 1-second beep followed by a 1-second pause. This operation repeats for the time previously set.	Red flashes every two seconds.

Alarm Indicator	Conditions	Alarm Buzzer	LED
over (Overflow)	Activates when the Accumulated Dose has reached 100 rem or when the Dose Rate is equal to or greater than 100 rem/h.	(No Alarm Buzzer)	Red flashes every two seconds
ALM E11	Activates when the measurement circuit is abnormal.	A 2-second beep and a 2-second pause. This operation repeats three times.	
ALM E12	Activates when the data recording is abnormal.	A 2-second beep and a 2-secomnd pause. This operation repeats three times.	Red flashes every two seconds.

Section 6

Safety Considerations

Environmental Conditions for Normal Use

No maximum altitude

Temperature range of -10 to 40 ˚C (14 to 104 ˚C)

Maximum relative humidity of less than 90% (non-condensing)

Pollution Degree 2 (as defined by IEC 664)

JIS Waterproof Grade 1: water resistant under normal living conditions

Notice!

The Model 23 Dosimeter may not measure pulsed radiation accurately. Also, do not use it as a survey meter.

Warning:

To prevent short-outs, protect exposed terminals with insulating tape prior to disposal. Failure to do so may cause excessive heat generation, rupturing, or combustion, leading to personal injury or fire. Do not throw the dosimeter or batteries into a fire. Do not disassemble the dosimeter.

Preacautions

Do not drop or subject to impact. Shock resistant after a vertical drop test from 20 cm.

Keep the dosimeter in a plastic bag for protection against organic solvents, water droplets, moisture, dust, and contamination.

Dosimeter should always be handled with clean, dry hands.

Do not place the dosimeter with metallic items in pocket.

Do not use the dosimeter in an environment with high-frequency noise and magnetic flux density equal to or greater than 200 gauss.

Pay careful attention when using it near the following devices:

- Cell phones
- PHS handsets
- High-power transceivers (or similar devices)
- Microwave ovens
- Radars
- Welding machinges
- Any other spark-discharging or high-intensity, radio-wave emitting devices.

Caution!

Keep at least 5 cm away from PHS handsets and cell phones. Failure to do this may result in false operation.

Caution!

Do not force open the clip, as it may be damaged.

Cleaning Instructions

The Model 23 Dosimeter may be cleaned externally with a dry cloth if contaminated with dirt.

Caution!

The operator or responsible body is cautioned that the protection provided by the equipment may be impaired if the equipment is used in a manner not specified by Ludlum Measurements, Inc.

Section

7

Recycling

Ludlum Measurements, Inc. supports the recycling of the electronics products it produces for the purpose of protecting the environment and to comply with all regional, national, and international agencies that promote economically and environmentally sustainable recycling systems. To this end, Ludlum Measurements, Inc. strives to supply the consumer of its goods with information regarding reuse and recycling of the many different types of materials used in its products. With many different agencies - public and private - involved in this pursuit, it becomes evident that a myriad of methods can be used in the process of recycling. Therefore, Ludlum Measurements, Inc. does not suggest one particular method over another, but simply desires to inform its consumers of the range of recyclable materials present in its products, so that the user will have flexibility in following all local and federal laws.

The following types of recyclable materials are present in Ludlum Measurements, Inc. electronics products, and should be recycled separately. The list is not all-inclusive, nor does it suggest that all materials are present in each piece of equipment:

- **Batteries**
- **Glass**
- **Aluminum and Stainless Steel**
- **Circuit Boards**
- **Plastics**
- **Liquid Crystal Display (LCD)**

8 Calibration Procedure

This section describes the calibration procedure for the Model 23.

Expose the Model 23 to a gamma ray source such as ^{137}Cs and ^{60}Co. A dose rate should be measured by placing the source at the distance from the reference point of the Model 23, and it should be traceable to the National Standard.

1. Determine a reference dose rate value (R_0):

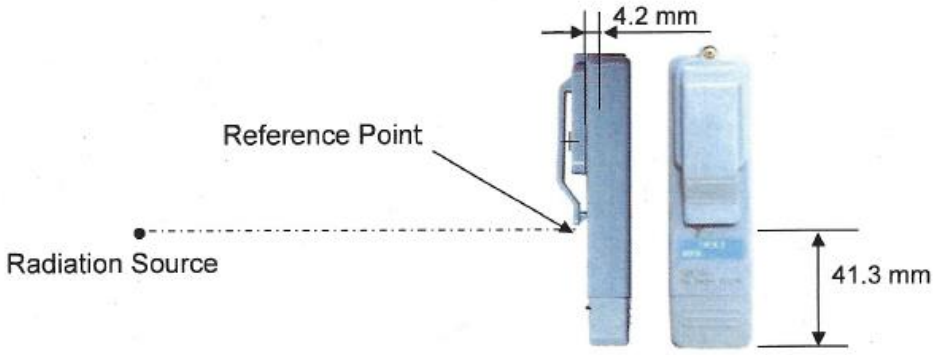
    a. Calculate R_0 from the distance between the reference source and reference point of the Model 23.

    b. The dose rate value at the reference point (R_0) may be simply well-known by field calibration/characterization.

2. For a dose rate value (R_1) measurement:

    a. Place the source such as ^{137}Cs or ^{60}Co at the distance from the reference point of the Model 23.

    b. Take the dose rate reading (R_1).



3. Calculate the calibration factor. Compare the reference dose rate (R_0) and the dose rate reading (R_1). If there is an unacceptable difference between them, change the calibration factor.

In general, the calibration factor (C_1) is calculated by the following formula:

$C_1 = C_0 \times R_0/R_1$

C_0: Original Calibration Factor

4. Set up the calibration factor. To change the calibration factor, perform the following procedures:

    a. After the irradiation, start the Configuration Software.

    b. Click on "Manual Calibration" on the Menu screen.

    c. Enter the calculated calibration factor (C_1) to "Gamma calib. Const." of Setting area on "Manual Calibration" screen.

    d. Press the "Write" button.

    e. Confirm "Gamma calib. Const." of View area is set to the new value.