

THE ALARMING RATEMETER PM1703 M /PM1703 M-O
OPERATING MANUAL



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112, Bogdanovich str.,
220040 Minsk, Belarus

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**Alarming Ratemeter
PM1703M**

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Minsk, February, 2002



A. A. Antonovski
Managing Director

CONTENTS

1 APPLICATION and FEATURES	4
2 PRECAUTIONS	5
3 GENERAL DESCRIPTION	6
3.1 Introduction	6
3.2 Delivery kit	6
3.3 Overview of control buttons and display	7
3.4 Overview of the operation modes	8
4 SPECIFICATIONS	15
5 OPERATING INSTRUCTIONS TO THE USER.....	17
5.1 The instrument operation check up	17
5.2 Searching gamma radiation sources	17
6 ADDITIONAL OPERATING INSTRUCTIONS TO THE ADVANCED USER	20
6.1 Parameters setting	20
6.2 Communication with PC	20
7 DESIGN AND THEORY OF OPERATION	21
8 PERFORMANCE EVALUATION.....	27
8.1 The check-up of the dose rate range and accuracy of dose rate measurements	27
8.2 The check-up of the instrument sensitivity	28
9 MAINTENANCE	29
10 TROUBLESHOOTING	30
11 STORAGE AND SHIPPING.....	31
12 WARRANTY.....	32
ATTACHMENT A Energy response of the instrument.....	33

1 APPLICATION and FEATURES

- The alarming ratemeter PM1703 M/PM1703 M-O is designed to search, to detect and to locate gamma-emitting radioactive sources. It may be also used to measure dose rate of collimated Cs-137 gamma radiation.
- There are two instrument modifications:
 - PM1703 M;
 - PM1703 M-O, that is characterized by availability of additional modes in comparison with the PM1703 M: *count pulses accumulation* mode and mode of *average count rate for accumulation time*.
- The instrument operation history is stored in its non-volatile memory and may be transferred to a personal computer through an IR interface.
- The instrument may be used both indoor and outdoor by various users whose professional duties involve detection and location of radiation sources.

- | | |
|-------------------------------|---------------------------------|
| ➤ New pager- type design | ➤ Meets the ITRAP requirements |
| ➤ Easy to use | ➤ Configuration via PC |
| ➤ Dose rate indication | ➤ Shock-resistant plastic case |
| ➤ Reference to the background | ➤ Light weight |
| ➤ Two modifications | ➤ Additional modes availability |

2 PRECAUTIONS

Before using this instrument, please read this operating manual carefully. Take special care to follow the safety instructions listed below.

- The PM1703 M/PM1703 M-O is water resistant, but care should be taken to avoid an immersion into water.
- As with any sensitive electronic instrument, the PM1703 M/PM1703 M-O should not be subjected to severe mechanical shock.
- Clean the PM1703M /PM 1703M-O with a soft, lightly wetted cloth. Do not use benzene or any other strong chemicals.
- In searching for radiation sources your site regulations for work with radioactive materials and other radiation sources, as well as the Standards of radiation safety should be followed.

① *Some changes may be introduced in the instrument electrical scheme, construction, design and software that do not influence the specifications and, therefore, may be not specified in this manual.*

3 GENERAL DESCRIPTION

3.1 Introduction

The PM1703 M/PM1703M-O is an easy-to-use instrument with two buttons only.

To operate with PM1703M /PM 1703 M-O the user does not need to be an expert in nuclear physics or radiation protection. After been switched ON, the instrument works automatically and alarms when finds a radiation source (gamma emitting isotopes).

However, to make proper settings of the instrument parameters, to transmit data from the instrument memory to PC and, especially, to interpret the data obtained, the user should have some knowledge of radiation and a procedure of searching for radioactive sources.

Accordingly, the present manual has two sections: "Operating instructions to the user" and "Additional operating instructions to the advanced user".

3.2 Delivery kit

Item	Quantity per modification		Notes
	PM1703M	PM1703 M-O	
Alarming ratemeter PM 1703 M	1	-	-
Alarming ratemeter PM 1703M-O	-	1	-
Battery PANASONIC POWER LINE AA (LR6)	1	1	or similar
IR adapter ACT-IR220L	1	1	or similar; supplied by customer request
CD	1	1	-
Carrying Case	1	1	supplied by customer request
Operating manual	1	1	-
Package for shipping	1	1	-

3.3 Overview of control buttons and display

BUTTONS

The PM1703M (PM 1703M-O) has two control buttons that are located on the top panel of the instrument (see Fig. 3, 4).

These buttons perform different functions depending on the mode used. In general, the button main functions are:

1 - MODE button is used:

- to turn the unit ON;
- to select the operation mode (see further);
- to perform the background updating , by keeping pressed for more than 2 s;
- to enter the *set* mode of the coefficient **n** or to turn ON/OFF the audio and/or vibration alarm devices, by keeping pressed for more than 4 s;
- to select a set parameter in the *set* mode: coefficient **n** or turning ON/OFF the audio and/or vibration alarm devices, by short pressing for less than 1 s;
- to decrease the coefficient **n** value in steps of 0.1 in the *set* mode;
- to increase the coefficient **n** value in steps of 0.1 in the *set* mode (PM1703 M-O);
- to reset the accumulated value and start new accounting in the *count pulses accumulation* mode (for PM1703 M-O).

2 - LIGHT button is used:

- to turn the LCD (liquid crystal display) backlight ON;
- to initiate IR communication with PC;
- to activate changing the coefficient **n**;
- to decrease the coefficient **n** value in steps 0.1 in the *set* mode (for PM1703 M-O);
- to increase the coefficient **n** value in steps of 0.1 in the *set* mode;
- to change the status of audio and vibration alarm devices ON or OFF.

DISPLAY

4- the LCD upper scale indicates:

- count rate value in cps (counts per second);
- dose rate value;
- number of accumulated count pulses (for PM1703 M-O);
- average count rate for accumulation time (for PM1703 M-O);
- messages "test", "CAL", "-OL-", "ON", "OFF";
- coefficient **n** value in the *set* mode;
- turning ON/OFF the audio and/or vibration alarm devices.

5 - the analog scale of 19 segments indicates:

- time left until self-tests are completed; a number of segments *decreases* until they completely disappear;
- time left until the background updating is completed; a number of segments *increases* until the scale is completely filled;
- relative value of the count rate excess over the calculated threshold *in case of alarm*.

6 - battery discharge warning sign is indicated when the battery voltage drops below 1.1 V;

7 - RADIATION sign; it is indicated when the instrument *alarms* (for PM1703 M)

- “ γ ” sign indicating the gamma radiation parameters on the LCD upper scale (for PM1703 M-O);

8 – the LCD lower scale indicates:

- relative meansquare error of an average value of measurement result (hereinafter the *statistical error*) in percent at confidence probability of 0.95;
- count pulses accumulation time in hours (for PM1703 M-O);

9 – unit of measurement:

- “s⁻¹” (counts per second, cps), in the *search* mode; “ μ Sv/h” (or “ μ R/h” by customer request) in the *dose rate* mode (for PM1703 M);
- “s⁻¹” in the search mode or in the mode of *average count rate for accumulation time*; “ μ Sv/h” (or “ μ R/h” by customer request) in the *dose rate* mode (for PM1703 M-O).

3.4 Overview of the operation modes

The PM1703M (PM1703 M-O) operates in the following modes:

self-test mode;

background updating mode;

search mode;

dose rate mode;

count pulses accumulation mode (for PM1703 M-O);

mode of average count rate for accumulation time (for PM1703 M-O);

set mode;

PC communication mode.

Mode of operation for PM1703 M-O see Fig.5

- The instrument will go into the *self-test* mode immediately after it is turned ON, and the LCD displays "test". Time left until the self-test completion is indicated in the relative units on the analog scale with a number of segments *decreasing*.

- After the self-tests are completed the audio and/or vibration alarms are activated for approximately 1 s, the instrument will automatically go into the *background updating* mode and the LCD will display "CAL" (calibration). In this mode the

instrument measures the background and calculates the threshold. A time since the background updating began is indicated in the relative units on the analog scale with a number of segments *increasing*. The user may update the background value whenever it is necessary. Press and fix the MODE button for approx. 2-3 s. The LCD will display "CAL", and the background updating will restart.

- The instrument automatically enter the *background updating* mode after it's activation or changing the coefficient **n** in the *set* mode.

- When the background accumulation and necessary calculations (including threshold) are completed the PM1703 M /PM1703 M-O will automatically go into the *search mode*. In this mode the instrument automatically compares the current pulse count to the threshold and alarms when the threshold value is exceeded. In the *search mode* the LCD displays the value of the statistical error in percent.

- While the PM1703 M /PM1703 M-O is in this mode, the user may search, detect and locate the radioactive sources. To evaluate the intensity of a radiation source (or background) press and release the MODE button and the instrument goes into the *dose rate mode*. The LCD will display dose rate of photon radiation $\dot{H} \cdot (10)$ at ^{137}Cs - on the upper scale. On the lower LCD scale the statistical error in percent is indicated.

- The PM1703 M-O is characterized by availability of two additional modes: *count pulses accumulation* mode and *mode of average count rate for accumulation time*

- While in the *count pulses accumulation* mode the LCD upper scale indicates the “ γ ” sign flashing (see Fig. 4) and a number of accumulated count pulses, the LCD lower scale indicates time (in hours) of count pulses accumulation.

- While in the *mode of average count rate for accumulation time*, the LCD upper scale indicates the “ γ ” sign flashing (see Fig.4) and an average count rate for accumulation time in counts per second (cps). And the LCD lower scale indicates statistical error value.

- The PM1703M /PM1703 M-O goes into the *set* mode by keeping pressed the MODE button for more than 4 s. While in the *set* mode the user may check the preset value of the coefficient **n**, or set a new value and may also check the current status (ON or OFF) of the audio and vibration alarm devices, or to change it. The instrument exits the *set* mode if no button is pressed for more than 4-6 s.

- The PM1703M /PM1703 M-O may be switched to the *PC communication* mode by pressing the LIGHT button (see section 2.3). While in this mode it is possible to make the necessary configuration of your PM1703M /PM1703 M-O and transfer the history of the instrument operation stored in its non-volatile memory to PC. For more details please refer to the section "Additional operating instructions to the advanced user".

The PM1703M /PM1703 M-O is equipped with an automatic low battery detection circuit. If the voltage drops below 1.1 V, the battery discharge warning sign will be displayed in the LCD lower left corner. In this case the battery needs to be replaced

(see section "Battery replacement").

The detector block operation is also checked. If the count rate is higher than the factory preset high limit, the LCD will display "-OL-" (OverLoad).

To turn the PM1703M /PM1703 M-O ON press the MODE button.

To turn the PM1703M OFF keep pressed the LIGHT button. While the backlight is ON keep pressed the MODE button for 2-3 s until the LCD displays "OFF".

The way of turning OFF the PM1703M-O can be chosen by the user in the *PC communication* mode.

If the "quick turning ON" option is activated the user should keep pressed the LIGHT button for 2-3 s until the LCD displays "OFF".

If the "quick turning OFF" option is not activated the user should keep pressed the LIGHT button for 2-3 s until the LCD displays flashing "OFF" message , then confirm the turning OFF by short press. The LCD will display not flashing "OFF" message.



Fig. 1

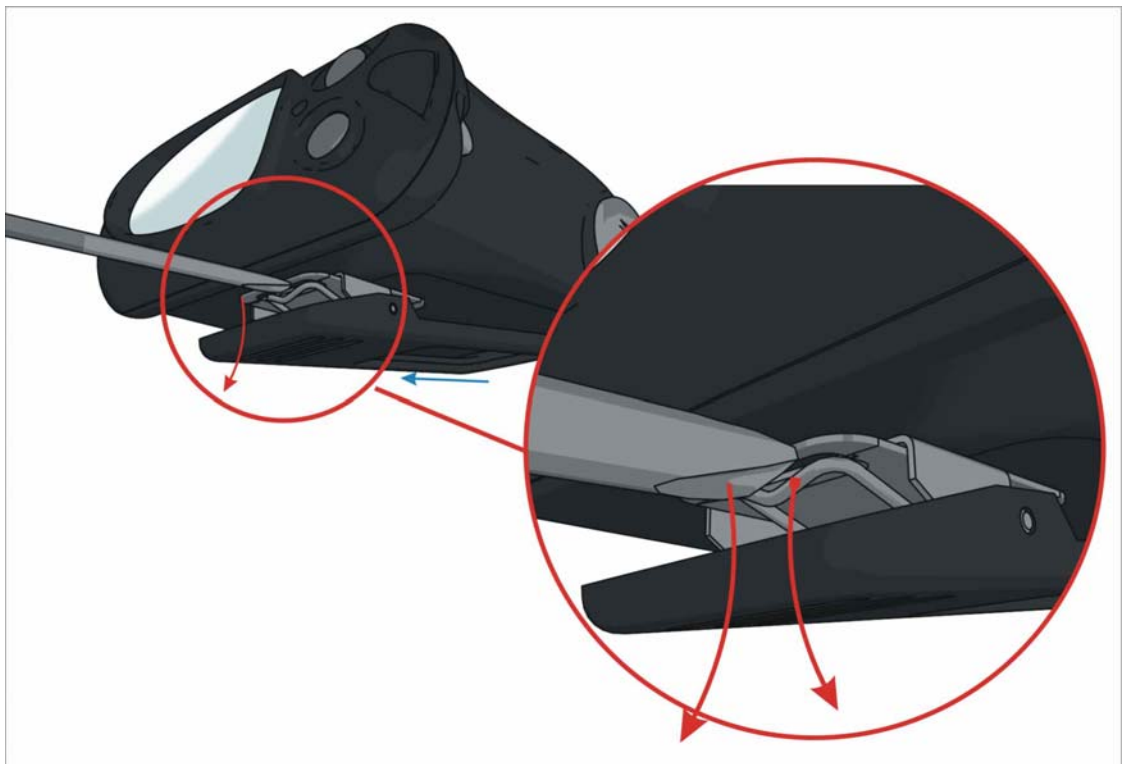
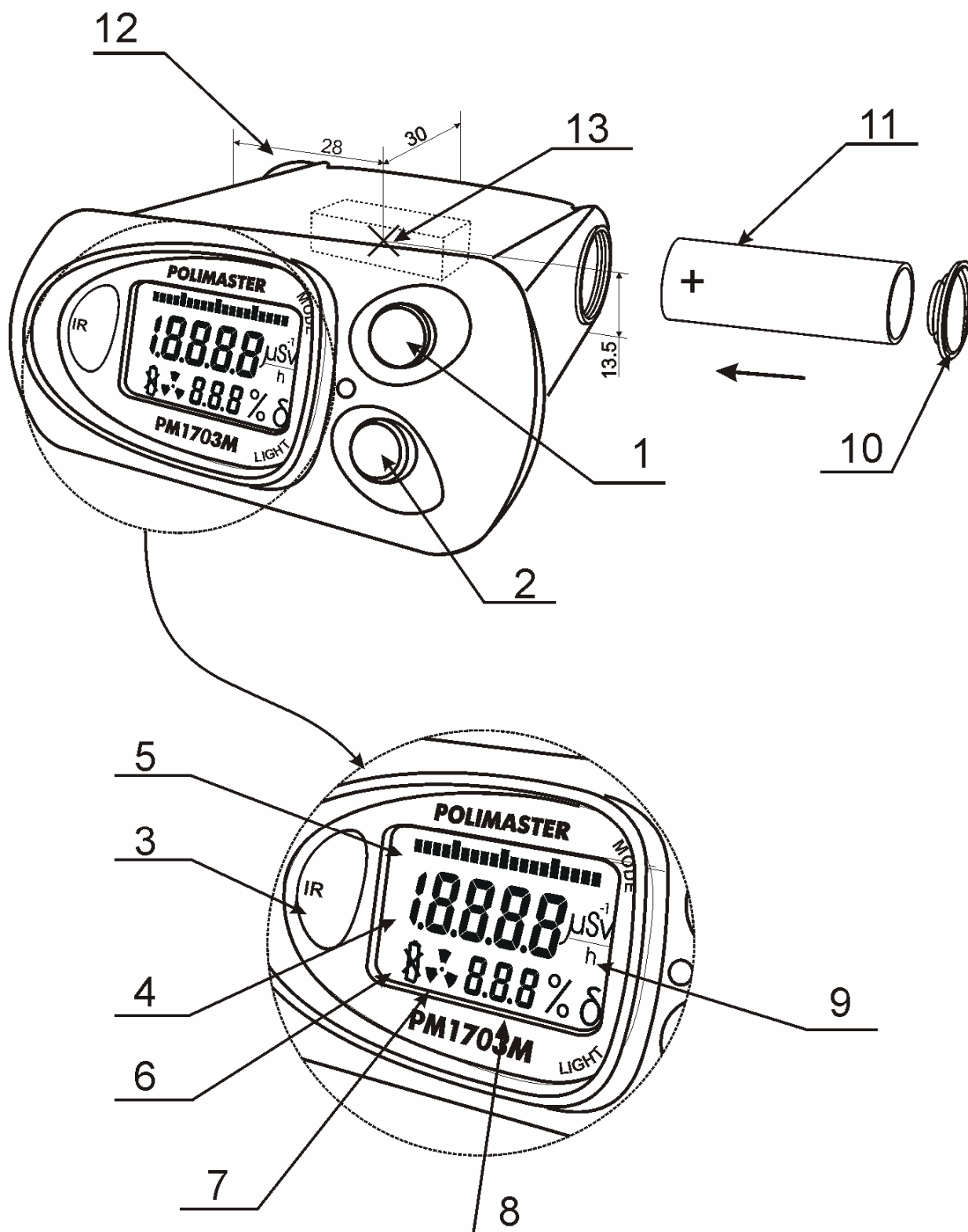
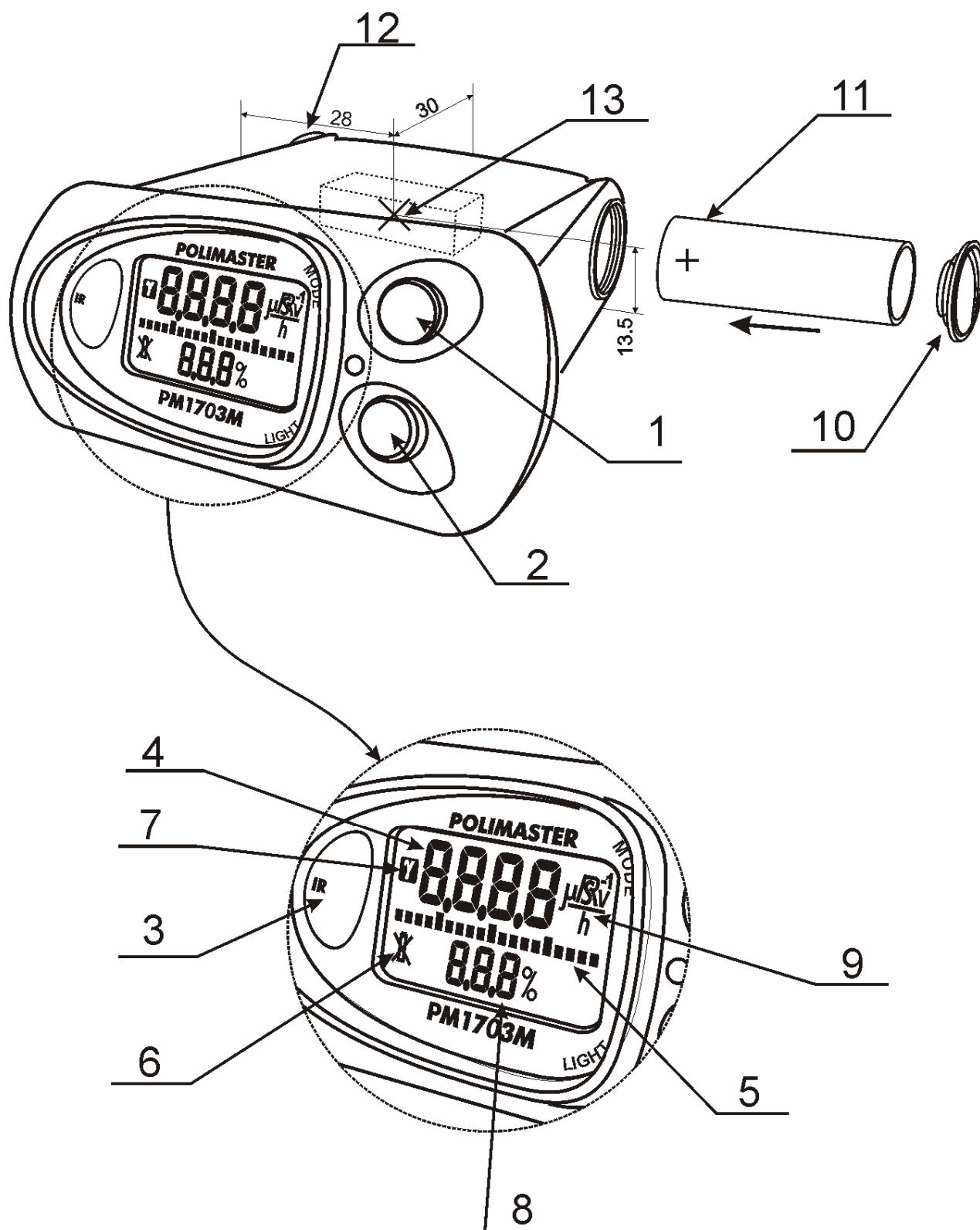


Fig.2



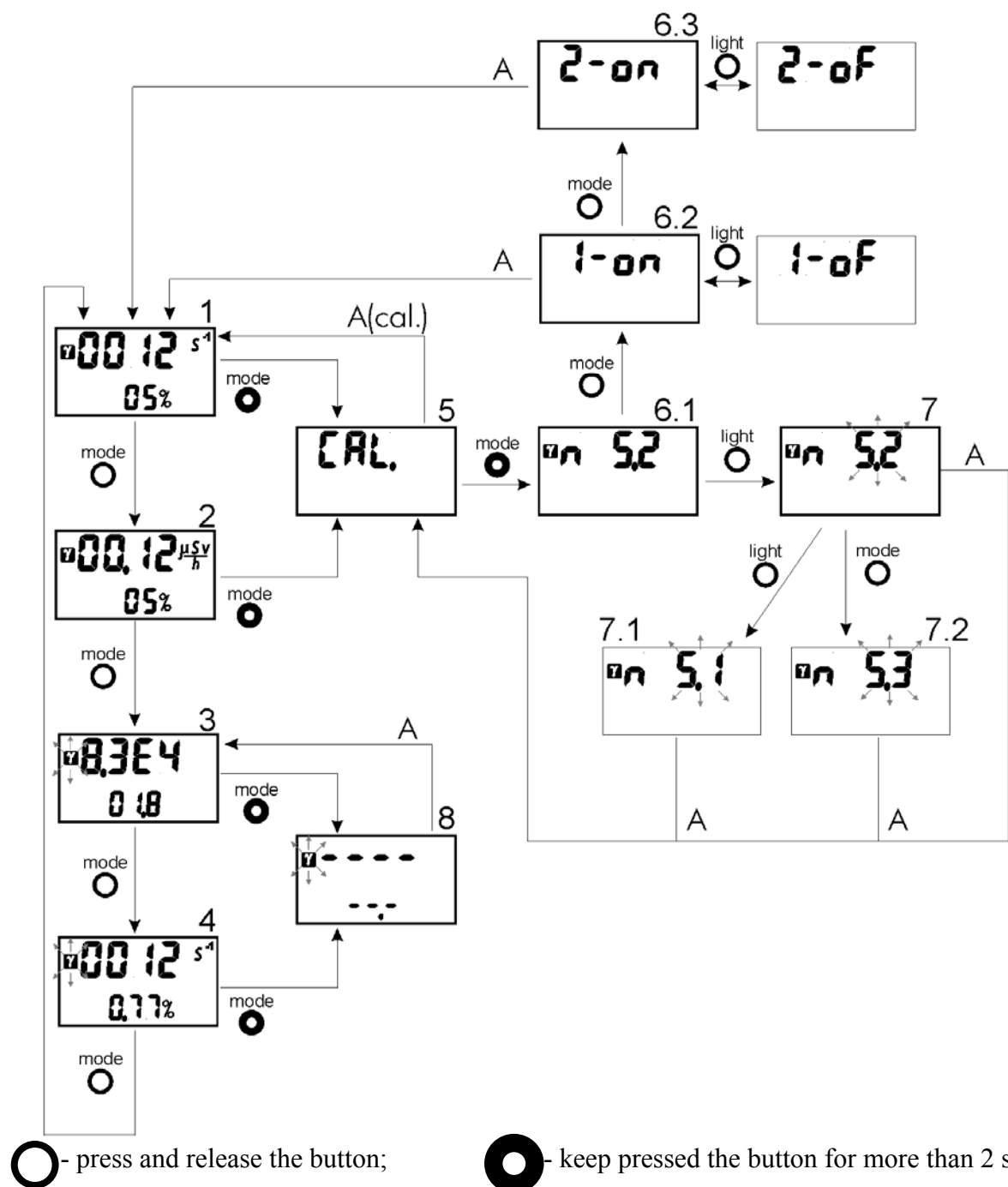
- | | |
|-------------------------------------|-----------------------------------|
| 1 – MODE button; | 7 – RADIATION sign; |
| 2 – LIGHT button; | 8 – the lower LCD scale; |
| 3 – window of IR- transceiver; | 9 – unit of measurement; |
| 4 – the upper LCD scale; | 10 – lid of battery compartment; |
| 5 – analog scale; | 11 – battery; |
| 6 – battery discharge warning sign; | 12 – outlet of audio alarm device |

Fig.3 - The alarming ratemeter PM1703 M. General view



- | | |
|-------------------------------------|--|
| 1 – MODE button; | 7 – sign indicating gamma radiation parameters on the upper LCD scale; |
| 2 – LIGHT button; | 8 – the lower LCD scale; |
| 3 – window of IR- transceiver; | 9 – unit of measurement; |
| 4 – the upper LCD scale; | 10 – lid of battery compartment; |
| 5 – analog scale; | 11 – battery; |
| 6 – battery discharge warning sign; | 12 – outlet of audio alarm device; |
| | 13 – geometrical center of the detector |

Fig.4 - The alarming ratemeter PM1703 M-O. General view



A – the instrument exits the *set* mode , if no buttons are pressed for 4-6 s;

A (CAL) – the instrument automatically enter the *search* mode after the calibration is completed;

1 – *search* mode;

2 – *dose rate* mode;

3 – *count pulses accumulation* mode;

4 - mode of *average count rate for accumulation time*;

5 – *background updating* mode;

6 – *set* mode

6.1– reference to the preset coefficient *n*;

6.2 – turning ON/OFF the audio alarm device;

6.3 – turning ON/OFF the vibration alarm device;

7 – initialization of changing the coefficient *n* value (coefficient *n* value is flashing);

7.1 - decrease (7.2 - increase) of the coefficient *n* value in steps of 0.1 (hold pressed the button to change the coefficient *n* value rapidly);

8 - reset of the accumulated value and starting a new one in the *count pulses accumulation* mode

Fig.5 – The PM1703 M-O operation modes and control

4 SPECIFICATIONS

Type of detector	CsI(Tl) scintillator
Energy range	0.033 – 3.0 MeV
Detection of sources	Meets the ITRAP requirements *
Gamma energy response differs from the typical one (see Attachment A)	no more than - 25 %
Frequency of false alarms at the radiation background 0.2 $\mu\text{Sv/h}$	no more than 1 for 12 hours **
Measurement time	0.25 s
Range of coefficient n (used to calculate threshold) step	from 1 to 9.9 0.1
Dose rate indication range of photon radiation $\dot{H}^*(10)$	0.01 – 70 $\mu\text{Sv/h}$ (indication in $\mu\text{R/h}$ by request)
Accuracy of dose rate measurements (at collimated Cs-137 radiation)	$\pm 30 \%$
Count time (by default): - in the <i>background updating</i> mode - in the <i>search mode</i>	36 s 2 s
The instrument produces the audible and/or vibration signal at DER threshold exceeding (for PM1703 M-O) - range of DER threshold setting - step	1 – 40 $\mu\text{Sv/h}$ 1.0
Alarm types	audio tone and/or vibration
Battery lifetime	800 hours
Communication with PC through the IR interface on the distance of	up to 0.2 m
Environmental: temperature range humidity	-30 °C to +50 °C (-15 °C to +50 °C for <i>LCD</i>) up to 98 % at 35 °C
Drop test	0.7 m on concrete surface
Water tightness	IP65
Power requirements	one PANASONIC POWER LINE AA (LR6) battery ***
Weight including the battery in package	0.18 kg 0.45 kg
Dimensions without clip with clip in package	87 x 72 x 35 mm 87 x 72 x 45 mm 180 x 135 x 71 mm

* more details about the ITRAP program are available in the ARCS web site at the address <http://www.arcs.ac.at/G> or in the POLIMASTER web site at the address <http://www.polimaster.com/en/support/docs>

** the manufacturer guarantees the validity of the technical features regarding false alarm frequency only in case the coefficients **n** have the factory preset meanings **5.3**

*** another non rechargeable battery or a rechargeable battery may be used (AA size, 1.1-1.6V). However, battery lifetime and/or range of operating temperatures may differ from the stated above.

5 OPERATING INSTRUCTIONS TO THE USER

5.1 The instrument operation check up

Turn the PM1703M /(PM1703 M-O ON by pressing and releasing the MODE button. If the instrument is operative and the battery voltage is normal, the instrument will go through a series of self-tests with all segments, signs and indicators displayed on the LCD. Then the LCD will display "test" and the analog scale with a number of segments decreasing in time.

After the self-tests are completed the alarm will be activated and the instrument will go into the *background updating* mode. The LCD will display "CAL." and the analog scale with a number of segments increasing in time.

After the analysis of the gamma radiation background has been completed, the LCD will display for one second a value of the count rate, and the instrument will go into the *search* mode. The PM1703M /PM1703 M-O is ready for operation.

If the battery voltage drops below 1.1 V, the LCD will indicate the battery discharge warning sign (see Fig.3). **The battery needs to be replaced!** (see section "Maintenance").

5.2 Searching for gamma radiation sources

Refer to you site regulations and Operating Procedures prior to search operation. The following may serve as a general guide.

- ① *The PM1703M /(PM1703M-O is intended firstly for efficient searching, detection and location of gamma radiation sources. It is not energy compensated and so it has a high sensitivity at low energies (33-300 keV, see Appendix), which allows efficient detection of nuclear materials.*
- ① *When the PM1703M /PM1703M-O operates at temperatures below -15 °C, the LCD normal operation can not be guaranteed. In this case the audio and/or vibration alarm devices only should be used to detect radiation sources. When the normal conditions with temperatures higher than -15 °C are restored, the LCD will resume its normal operation.*

The PM1703M /PM1703M-O is provided with a clip and may be fasten to the belt. The clip may be removed using a screwdriver (see Fig.2). A carrying case is also available by a separate order.

Detection of gamma sources

When detecting gamma radiation sources the instrument should be held so that the audio alarm device is directed onto the scanned object.

When detecting gamma radiation sources under conditions when the audible signals produced by the instrument are not heard (for example, are damped by noise) the vibration alarm device should be used.

The efficiency of detecting gamma radiation sources is the higher, the closer is the instrument to the scanned object (article, person, container, vehicle, etc) and the smaller is the velocity of its movement along the object.

It should be remembered that both a sensitivity of the instrument and a rate of false alarms depend not only on the preset coefficient **n** (for more details see section "Theory of Operation"), but also on the background value, which the instrument stored while in the *background updating* mode. As the changes of the natural background level may be significant, it is recommended to perform the background updating just before inspection. Press and fix the MODE button when the instrument is turned ON, and the instrument will automatically perform the background updating according to its new level.

It should be noted that false signals (sound or pulsation) are not regular and, therefore, may be easily distinguished from alarm signals produced by the existing gamma radiation source as far as their rate is constant or increases when the instrument moves closer to a gamma radiation source.

Locating gamma radiation sources

When the gamma radiation source is detected by the PM1703M /PM1703 M-O or a stationary system, the gamma radiation source is to be **located**.

To **locate** the gamma radiation source the instrument should be held at a distance no more than 10 cm from the scanned object. The velocity of movement along the scanned object should not be more than 10 cm per second. As the PM1703M/ PM1703 M-O moves closer to a gamma radiation source, the rate at which the audio tone or pulsation repeat will increase.

When the maximum rate is achieved a continuous audio alarm sounds, but the rate of pulsation (if the vibration alarm device is turned ON) will not change. In this case further locating of gamma radiation source is not possible without background updating. Press the MODE button **trying to keep a distance to the scanned object unchanged**. The instrument will automatically perform the background updating and then the gamma radiation source locating may be continued. If necessary this procedure may be repeated several times until a gamma radiation source is located.

Dose rate indication

Press and release the MODE button to go into the *dose rate* mode. The LCD will display a dose rate value in $\mu\text{Sv/h}$ (at ^{137}Cs) on the upper scale and statistical error in percent at the confidential probability of 0.95 on the lower scale. When the necessary value of statistical error is achieved the user may read the dose rate value.

If the background remains the same after calibration while the statistical data are accumulating, the statistical error decreases.

The PM1703 M-O produces audio and/or vibration signals if the DER threshold is exceeded, that, for example, can alert about nearby the source dangerous to user.

If during the device operation in the *dose rate* mode, a value of the dose rate exceeds approx. $70 \mu\text{Sv/h}$, the LCD will display “-OL-”.

- ① *While in the dose rate mode, the alarm signals are disabled. They are automatically enabled after returning to the search mode (for PM1703M).*
- ① *The PM1703M /PM1703 M-O is calibrated at collimated ^{137}Cs radiation only. Thus, its readings in the dose rate mode may differ from readings of energy compensated dosimeters; this is not considered to be due to the improper operation of the instrument.*

6 ADDITIONAL OPERATING INSTRUCTIONS TO THE ADVANCED USER

6.1 Parameters setting

Refer to you site regulations and Operating Procedures prior to search operation. The following may serve as a general guide.

6.2 Communication with PC

An application program should be used to configure your PM1703M /PM1703 M-O according to your requirements and site regulations.

An application program PM17XX supplied on the installation CD together with an IR adapter (supplied by request, in case there is no build-in IrDA).

Minimum requirements to a computer and its software:

P100;
32 Mb RAM;
Windows 98, 2000, XP (small font in Windows settings);
2 Mb free on the hard disk and an adequate space available to install the database;
800X600 resolution of a monitor;
IrDA.

To connect an IR adapter connect the cable of an adapter to a communication port of the personal computer.

To load the application program use the software disk included into the delivery kit. Run the SETUP.EXE program.

The help file and the attached text document that are supplied on the installation disk describe how to run the application program. To switch to the *PC communication* mode the user should place the instrument on the distance of 10-12 cm from the IR adapter window and press the LIGHT button.

7 DESIGN AND THEORY OF OPERATION

The **block diagram** of the PM1703M /PM1703 M-O is shown in Fig. 6.

The instrument consists of:

- detector block;
- processing block;
- audio alarm device;
- vibration alarm device;
- power supply block.

The **detector block** consists of a CsI(Tl) scintillator with a photodiode and amplifier. The scintillator-photodiode assembly transforms gamma-quanta to electric pulses that are amplified and come to the input of the processing block.

The main module of the **processing block** is a processor providing the instrument operation and output of the data processing results on the LCD.

The processing block includes a non-volatile memory that stores the instrument operation history:

- -current values of the count rate in data storage intervals;
- cases when the alarm threshold is exceeded;
- cases of background updating;
- time when the unit is turned ON/OFF.

The non-volatile memory of the unit stores the following parameters:

- the number of the instrument;
- information about the audio or vibration alarm devices turning ON/OFF;
- information about turning ON/OFF the auto background updating and indication of statistical error;
- the preset value of the coefficient n ;
- the current time and date;
- the preset successive intervals in that the current count rate values are stored in the non-volatile memory of the instrument;
- count time in the *background updating* mode;
- count time in the *search* mode;
- some other parameters according to the application program description.

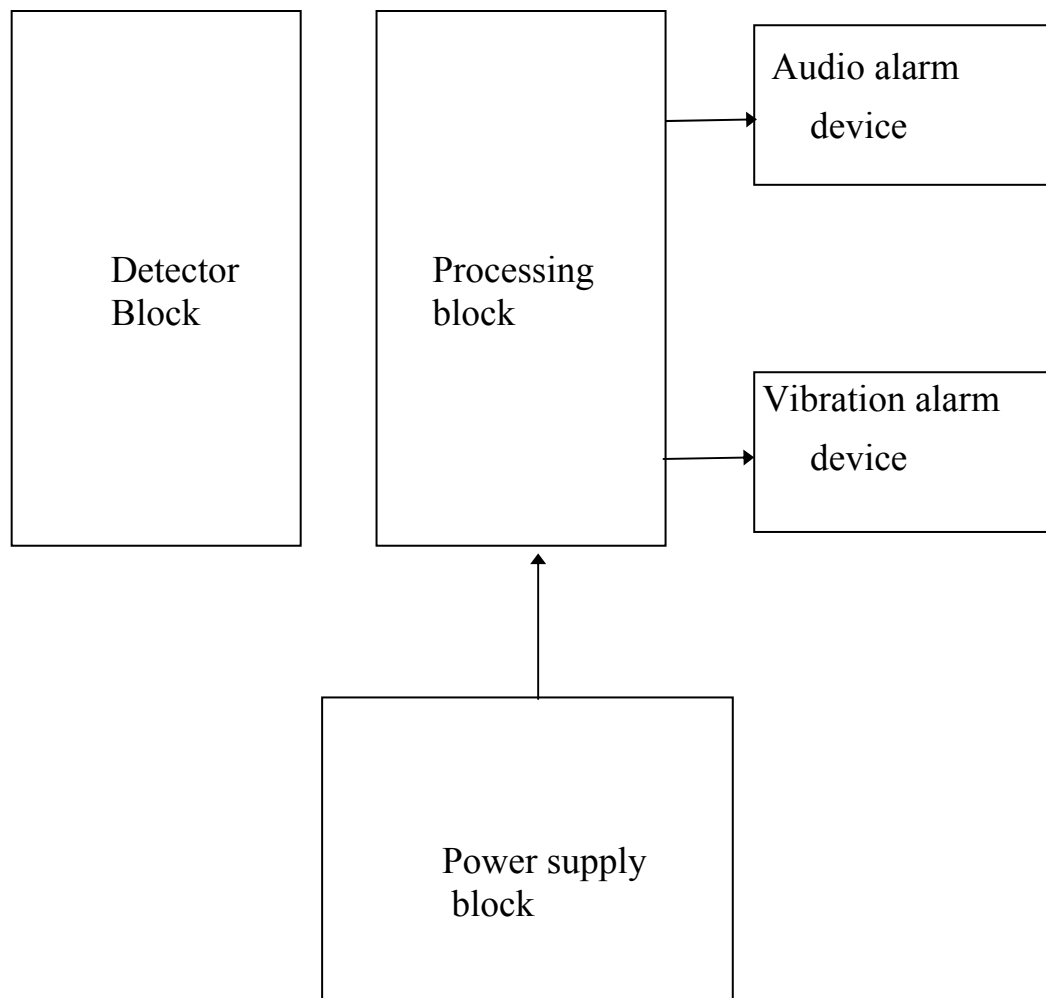


Fig. 6 - Block diagram of the instrument

The **audio alarm device** is designed to produce audible sound in the *self-test* and *search modes*. In the *search mode* a rate at which audible tone repeats will increase when the unit comes nearer to a gamma radiation source.

The **vibration alarm device** is designed to produce signals that the operator senses as vibrations inside the case of the unit when the *self-test mode* is completed, or when the alarm threshold is exceeded in the *search mode*. In the *search mode* a rate of pulsation will increase when the unit comes nearer to a gamma radiation source. It allows a secret search for gamma radiation sources and is good in situations when sound tones are damped by noise.

The audio or vibration alarm devices can be turned ON/OFF using software in the *PC communication mode* or manually using the buttons if this mode is enabled in the *PC communication mode*.

The **power supply block** is a built-in power source including a battery and voltage transformers providing the necessary voltage to the instrument.

The PM1703M /PM1703 M-O operates in the following modes:

- *self-test* mode;
- *search* mode;
- *background updating* mode;
- *dose rate* mode;
- *count pulses accumulation* mode (for PM1703 M-O);
- *mode of average count rate for accumulation time* (for the PM1703 M-O);
- *set* mode;
- *PC communication* mode.

Self-test mode

The PM1703M /PM1703 M-O will go into this mode immediately after it is turned ON, and the LCD will display the message "test". The following tests are performed:

LCD test;
detector block test;
processor test;
non-volatile memory test;
alarm device test.

The time left until the self-test completion is indicated in the relative units on the analog scale shown in decreasing a number of indicated segments.

After the self-tests are completed, the audio or vibration alarms will be activated for approximately 1 s, and the instrument will go into the *background updating* mode.

Background updating mode

The instrument will automatically go into this mode when the *self-test mode* is completed and the LCD will display the message "CAL" (calibration). In the *background updating mode* the analysis of the gamma radiation background value is performed. The processor counts pulses coming from the detector block, and the analog scale indicates in the relative units the time since the beginning of the *background updating mode* shown in increasing a number of indicated segments. The scale completely filled with segments indicates that the background updating is completed.

The processor calculates the average count rate N_b during the background count time and the threshold value P

$$P = N_b \cdot T_c + n \cdot \sigma, \quad (1)$$

with

$$\sigma = \sqrt{N_b \cdot T_c} \quad (2)$$

where:

T_c - count time in the *search mode*;

σ - meansquare deviation of the value calculated using the equation (2) for Poisson distribution of pulses;

n - number of meansquare deviations (coefficient n).

The coefficient n changes the threshold value according to equation (1).

Later on when the user makes the instrument to update the background, the background count time will automatically decrease with increasing the background level.

To perform the background updating, the user should keep pressed MODE button for more than 2 s (see Fig. 3). The LCD will display "CAL", and the background accumulation will restart.

Search mode

In the *search mode* the LCD indicates the current value of an average count rate in cps. The instrument compares the current value of number of pulses to the alarm threshold. If the current value of the average count rate exceeds the threshold value (in any mode except for the *self-test mode*, *background updating mode*, *set mode* and *PC communication mode*), then the audio and/or vibration alarm will be produced. The LCD will display the radiation danger sign (an average count rate value or dose rate value for PM1703 M-O is flashing), and the analog scale will indicate the number of segments increasing. The scale is filled up with segments when an average count rate value exceeds the alarm threshold approximately in 20 times.

The coefficient n changes the threshold value. It is obvious that the *lower* is the coefficient n , the *lower* is the threshold value, the *higher* is the instrument sensitivity in the *search mode*. However, in this case a probability of false alarms will increase.

In the *search mode* the LCD will indicate in the lower scale the value of statistical error in percent. If while the instrument in this mode, the value of average count rate exceeds the upper limit (more than 7000 s⁻¹) the LCD indicates "OL" message.

Dose rate mode

While in the *dose rate mode* the PM1703M indicates the dose equivalent rate (DER) of photon radiation H*(10) at ¹³⁷Cs in collimated radiation. While indicating the DER, the statistical error in percent is displayed on the LCD lower scale.

The PM1703 M-O produces audio and/or vibration signals if the DER threshold, preset in the *PC communication* mode, is exceeded.

Count pulses accumulation mode (for PM1703M-O)

While in the *count pulses accumulation* mode the “ γ ” sign is flashing on the LCD upper scale and a number of accumulated count pulses is displayed as:

9999 – up to 10000 pulses;

6.5E4 - over 10000 pulses, where E4 is 10^4 .

The time (in hours) of count pulses accumulation is displayed on the LCD lower scale.

Mode of average count rate for accumulation time (for PM1703M-O)

While in this mode the “ γ ” sign is flashing on the LCD upper scale (see Fig.4) and an average count rate for accumulation time is displayed in counts per second (cps). A statistical error value is indicated on the LCD lower scale.

Set mode

While in the *set mode* the user may perform the following operations:

- to check the preset value of the coefficient **n** (a number of meansquare deviations) or to set a new one; a range of the coefficient **n** settings is from 1 to 9.9 in a step of 0.1;
- to check the current status of the audio and vibration alarm devices or to change it (to turn ON or OFF) if changing is enabled in the *PC communication mode*.

The instrument will go into this mode after the MODE button is pressed and fixed for more than 4 s.

Note - The user can OFF the *set mode* and/or *dose rate* mode for PM1703M using the application program installed.

PC communication mode

The PM1703M (PM1703 M-O) may be switched to the *PC communication* mode by pressing the LIGHT button (see section 2.3). While in this mode it is possible to make the following operations:

- to register the instrument to the user;
- to store the time when the instrument was given out or taken away;
- to read the instrument history;
- to check or set the instrument parameters;
- to turn ON/OFF the audio and/or vibration alarm devices; to enable/disable changing the status of alarm devices using the buttons;
- to check preset or set a new value of coefficient **n**;

- to check or correct current date and time;
- to set a value of successive time intervals in which the current value of count rate is stored in the non-volatile memory of the instrument;
- to set a password **for entering the parameters menu**;
- to check a preset or set a new value of count time;
- to turn ON/OFF the auto background updating; the auto background updating allows to keep high sensitivity of the instrument at slow decreasing the background and avoid the false alarms at slow increasing the background;
- to turn ON/OFF the indication of statistical error in percent;
- to turn ON/OFF the *count pulses accumulation* mode and the mode *of average count rate for accumulation time*(PM1703 M-O);
- to select the way of turning the instrument OFF (PM1703 M-O);
- to set DER threshold, at which the instrument produces the audio and/or alarm signals(PM1703 M-O).

Also see the section "Additional operating instruction to the advanced user".

8 PERFORMANCE EVALUATION

The evaluation of the instrument performance includes checking (at collimated ^{137}Cs -radiation):

- the dose rate range and accuracy of dose rate measurements,
- the instrument sensitivity in the *search* mode.

This evaluation is performed under the normal conditions stated below.

Influenced quantity	Range of values
Temperature	20 °C (± 5 °C)
Atmospheric pressure	101.3 kPa (+5.5 kPa; -15.3 kPa)
Relative humidity	60 % (+20 %;-30 %)
Gamma radiation background	no more than 20 $\mu\text{Sv/h}$

❶ *In process of evaluation your site regulations for work with radioactive materials and other radiation sources, as well as the Standards of radiation safety should be followed.*

The dosimetric verification unit with the source of ^{137}Cs is to be used for checking. The equipment should be verified and the source should be certified.

8.1 The checking-up of the dose rate range and accuracy of dose rate measurements

Place the instrument into the dosimetric verification unit so that the instrument side with the audio alarm device is directed to a source and the conventional true value of the dose rate at the geometrical center of the detector $H_t = 0.8\mu\text{Sv/h}$, but do not irradiate the instrument. Turn the instrument ON, turn the audio and vibration alarm devices OFF (section 6.1).

Press and release the MODE button to switch to the *dose rate* mode. When the value of a statistical error becomes less than 5 %, read three background values H_{bi} in (5-10) s. Calculate the average background value H_b

$$H_b = (H_{b1} + H_{b2} + H_{b3}) / 3.$$

Irradiate the instrument. When the value of a statistical error becomes less than 5 %, read three dose rate values in (5-10) s and calculate the average dose rate value H_{av} .

Calculate the relative error of indication

$$I = (H_{av} - H_b - H_t) \times 100\% / H_t.$$

Repeat the above procedures for the conventional true of the dose rate of 12.0 $\mu\text{Sv/h}$ and 40.0 $\mu\text{Sv/h}$.

The results of checking are considered to be satisfactory if the relative error of indication is in the range from -30 % to +30 %.

8.2 The check-up of the instrument sensitivity

Turn the instrument ON, turn the audio and vibration alarm devices OFF (section 6.1).

When the instrument is in the *search* mode and the value of a statistical error becomes less than 5 %, read three count rate values of the background (in cps) N_{bi} in (5-10) s. Calculate the average background value N_b .

Place the instrument into the dosimetric verification unit so that the instrument side without the clip is directed to a source and the conventional true value of the dose rate at the geometrical center of the detector $H_t = 0.8 \mu\text{Sv/h}$, and irradiate the instrument.

When the value of a statistical error becomes less than 5 %, read three count rate values (in cps) in (5-10) s and calculate the average value N_{av} .

Calculate the instrument sensitivity

$$S = (N_{av} - N_b) / H_t .$$

Repeat the above procedures for the conventional true of the dose rate of 3.0 $\mu\text{Sv/h}$ and 12.0 $\mu\text{Sv/h}$.

The results of checking are considered to be satisfactory if the sensitivity is no less than 75 cps / ($\mu\text{Sv/h}$).

Note - At a higher temperate the instrument sensitivity may be by 40 % less than the sensitivity at normal conditions.

9 MAINTENANCE

Maintenance of the instrument involves preventive treatment, battery replacement and regular check up of the instrument operation (as described in the section 5.1).

The preventive treatment involves external examination of the instrument, dust removing and deactivation in the case of the radioactive contamination

Deactivation of the case is done with a tissue impregnated with ethyl alcohol.

To replace a battery:

- turn the instrument OFF;
- remove a lid 10 (Fig. 3, 4) of the battery compartment using a screwdriver, or coin;
- remove an exhausted battery and insert the new one into the compartment observing the polarity symbols (“+” of the battery should be faced inwards of the unit);
- close the battery compartment with the lid.

When the battery is replaced, the LCD will display all segments and the instrument will go into the *self-test mode*.

10 TROUBLESHOOTING

Problem	Possible cause	Solution
In any mode the LCD displays 00	1 Detector block failure. 2 Processing block failure	Send the instrument to the manufacturer
In any mode the LCD displays "-OL-"	1 Detector block failure. 2 Processing block failure. 3 A gamma radiation source close to the unit	1, 2 - Send the instrument to the manufacturer. 3 - Remove the source
The audio and/or vibration alarm devices are not operating	1 Alarming devices are turned OFF. 2 The device (devices) are not operative	1 Turn the devices ON. 2 Send the instrument to the manufacturer
The LCD displays the battery discharge warning sign	Exhausted battery	Replace the battery (section 9.3)

11 STORAGE AND SHIPPING

11.1 Storage

Instruments are to be stored in the manufacture's package at the air temperature from - 15 °C to +50 °C and humidity up to 95 % at a temperature of +35 °C. The storage time should not exceed the lifetime of the instrument, that is 8 years.

Instruments without package are to be stored at the air temperature from 10°C to 35°C and humidity of 80 % at a temperature of 25 °C.

The storage place should be free of dust, vapors of strong chemicals that may cause corrosion.

11.2 Shipping

Switched OFF instruments in package may be shipped by any kinds of transport at the air temperature from - 50 °C to +50 °C.

Instruments in package should be fastened in a vehicle. They must be arranged and fastened in transport so as to ensure their stable position and to avoid possibility of shocks against each other and the walls of a vehicle as well.

When carried by sea, instruments in package should be placed in hermetic plastic bags with silicagel.

When carried by air, the instruments in package should be placed in hermetic compartments.

12 WARRANTY

The manufacturer warrants this instrument to meet specifications provided that the user observes the guidelines of the instrument operation, shipping and storage described in the operating manual.

The warranty period is 18 months since the date of the beginning of usage.

The warranty storage period is 6 months since the date of the instrument acceptance by the quality control department officer.

Warranty and after-warranty repairs are carried out by the manufacturer or by a company authorized by the manufacturer.

Warranty does not cover instruments:

- which warranty period is expired if the instrument was purchased by the user within the limits of the warranty storage period;
- which were subjected to the user's service (the evidence of opening the device);
- with mechanical damages, if the requirements of operation and storage were not satisfied;
- without an operating manual.

The warranty period is prolonged for a period of warranty repair.

Warranty does not cover batteries. The battery replacement is not considered as the warranty repair.

ATTACHMENT A

Energy response of the instrument

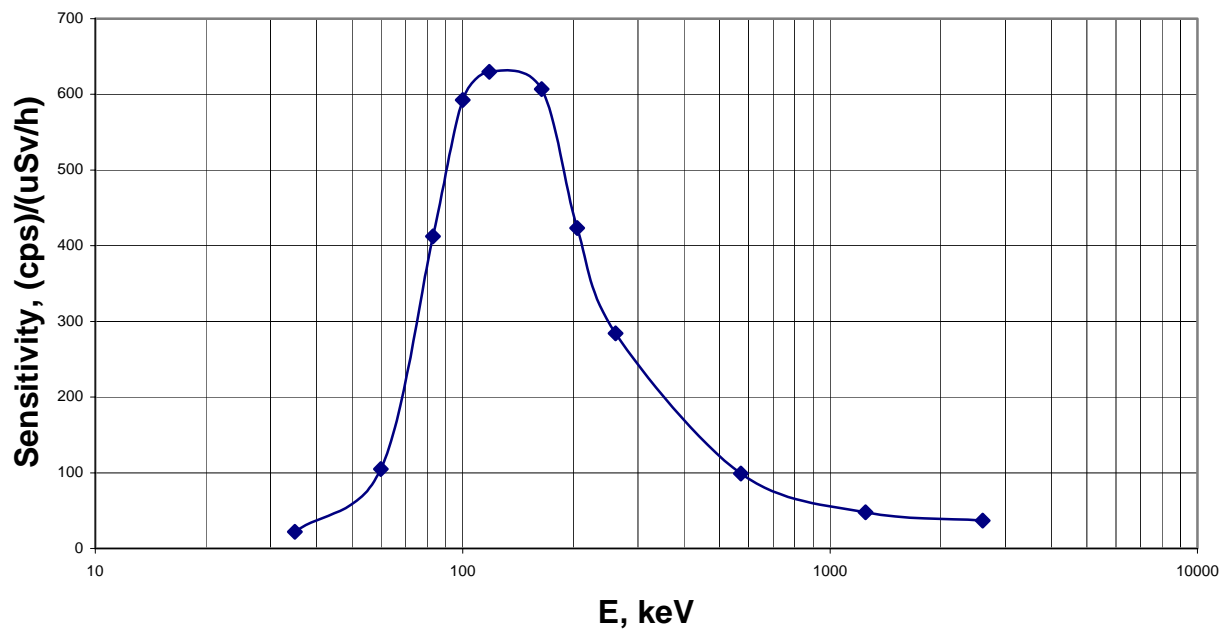


Fig. A.1 - Typical energy response of the PM1703M (PM1703M-O)