PERSONAL RADIATION DETECTOR

PM1401 GNA, PM1401 GNB

OPERATING MANUAL

CONTENTS

Thank you for purchasing the personal radiation detector of POLIMASTER production.

Before starting the operation with the personal radiation detector you should get acquainted with the present manual.

! During the search of radiation sources observe the existing rules of operation with radio active materials and sources, as well as the standards of radiation safety.

1 GENERAL INFORMATION [1)]

1.1 The personal radiation detector **PM1401 GNA, PM1401 GNB** (hereinafter referred to as the detector) is intended for searching (detection and localization) of radio active and nuclear materials by means of the analysis of a count rate of impulses coming from the detector outlet at registration of gamma and neutron radiation with indication on the LCD:

- gamma radiation ambient **Dose Equivalent Rate** ö*(10) for ^{137}Cs (hereinafter referred to as "DER");
- average gamma radiation count rate;
- average neutron radiation count rate.

The detector PM1401 GNB differs from the detector PM1401 GNA by a possibility of transfer of information to a Pocket PC (PPC) through radio channel and a possibility of identification of radionuclide composition of materials.

The detector can be operated both in premises and in the open air. The detector can be used by a wide circle of consumers, who are by their mode of activities related to detection and localization of sources of the ionizing emissions.

The history of detector operation is stored in the non-volatile memory and can be transferred to a personal computer (PC) through infra-red (IR) communication channel. The PM1401 GNB can transfer a history through radio channel additionally.

[1] In the process of detector manufacture amendments may be entered to the electric circuit, construction, external execution and software, which do not influence the technical and metrological specifications and, therefore, not reflected in the present manual.

2 Delivery kit

Delivery kit of the detector corresponds to the Table 2.1.

Table 2.1

Description, type	Quantity
Personal radiation detector **PM1401 GNA (PM1401 GNB)**	1
Battery cell Panasonic POWER LINE AA (LR6)[1)]	1
Vibration alarm device	1
Wrist band (for vibration alarm device)	1
IR communication adapter (ACT-IR220L or IR210B)[2)]	1
Telescopic tube[2)]	1
Housing [2)]	1
Moderator chamber [2)]	1
Software on CD	1
Secure Digital Card only for **PM1401 GNB**	1
Pocket PC only for **PM1401 GNB** [2)]	1
Operating manual	1
Package	1
[1)] **IT IS ADMITTED TO USE ANOTHER SIMILAR BATTERY** [2)] **IS SUPPLIED BY ORDER OF A CUSTOMER**	

3 Specifications

Table 3.1

3.1 Detector type: - gamma - neutron	 CsI(Tl) scintillator ^{3}He
3.2 Typical value of sensitivity of the detector to gamma radiation	2.0 cps/(μR/h) (200 cps/(μSv/h)) – for ^{241}Am; 1.0 cps/(μR/h) (100 cps/(μSv/h)) – for ^{137}Cs
3.3 Typical value of sensitivity of the detector to neutron radiation	0.1 (counts·cm^2)/neutron - for Pu- α -Be; 7.0 (counts·cm^2)/neutron - for heat neutrons; 1.0 (counts·cm^2)/neutron - for Pu- α -Be; at use of chamber-moderator or on phantom
3.4 Range of gamma radiation registration energy	from 0.033 to 3.0 MeV
3.5 Range of neutron radiation registration energy	from thermal to14.0 MeV
3.6 Range of indication of an average count rate of neutron radiation	 1.0 - 999 c^{-1}
3.7 Range of indication of DER of photon radiation	0.01 – 99.99 μSv/h (1 – 9999 μR/h)
3.8 Range of DER measurement of photon radiation (at ^{137}Cs)	 0.1 до 70 μSv/h (10 – 7000 μR/h)
3.9 Relative error of DER measurement (at ^{137}Cs) no more	 ± 30 %
3.10 At preset coefficient **n=4.5** (**number of mean-square deviation of current radiation background**) for gamma channel and gamma radiation background level is no more than 0.25 μSv/h, the detector should detect gamma radiation sources according to Table 3.2 below with the probability more than 0.5	 Correspond to III H_{Y20} P 51635-2000 II standard
3.11 At preset coefficient **n=4.0** (**number of mean-square deviation of current radiation background**) for neutron channel and gamma-radiation background level is no more than 0.25 μSv/h, the detector should detect neutron radiation sources ^{252}Cf generating flux density 2.5 s^{-1}·sm^{-2} in the reference point of the unit located on the phantom with the probability more than 0.5	 According to the P 51635 IY H_{n100} standard
3.12 Response time at fast increase of radiation background (gamma radiation) by 0.5 μSv/h (**at preset coefficient n=5.3 for gamma radiation channel**), no more	 2 s Correspond to ANSI N42.32
3.13 Response time at slow increase of radiation background (gamma radiation) by 0.5 μSv/h (**at preset coefficient n=5.3 for gamma radiation channel**), no more	 2 s Correspond to ANSI N42.32
3.14 Alarms at movement of a gamma source creating in a checkpoint of a detector the DER of 0.5 μSv/h (0.06 – 1.33 MeV) with the rate of 0.5 m/s (**at preset coefficient n=4.5 for gamma radiation channel**), no less	45 alarms For 50 passes for each from the recommended sources Correspond to IAEA Nuclear Security Series №1

3.15 Time for detection of a neutron source ^{252}**Cf** with the flux density 2.5 s^{-1} cm^{-2} in a reference point of the detector located on a phantom (**at preset coefficient n=5.0 for neutron radiation channel**), no more	2 s. Correspond to ANSI N42.32
3.16 Frequency of false alarms in gamma radiation registration mode at the radiation background of 0.2 μSv/h (20 μR/h) and at the preset coefficient for gamma radiation channel: - **n**=5.3	no more than one alarm for 10 hours of continuous operation
- **n**=4.5	no more than one alarm for 60 minutes of continuous operation
3.17 Frequency of false alarms in the neutron radiation registration mode at the radiation background at preset coefficient for neutron radiation channel: - **n**=5.0 - **n**=4.0	no more that one alarm per 10 hours of continuous operation no more than one alarm for 60 minutes of continuous operation
3.18 Background level calibration:	-**automatic** – at turning the detector ON, change of coefficients **n;** -**autocalibration** at change of a background level; **- forced** calibration upon pressing the button by a user
3.19 Type of alarm:	-audible; -vibration (external); -visual
3.20 Connection with PC through IR channel up to 0.3 m	- data reading from the memory; - setting of detector working parameters
3.21 Connection with PPC through radio channel (Bluetooth) up to 10 m:	- data reading from the memory; - setting of detector working parameters
3.22 Quantity of recorded events to the detector memory	up to 1000
3.23 Operation conditions: - temperature range of ambient temperatures - relative humidity	from minus 30 to 50 °C (-22 °F to 122 °F) (LCD from minus 15°C to plus 50 °C); up to 98 % at 35°C (+95° F)
3.24 The detector has resistance against impact of direct and alternate magnet fields having intensity	up to 400 A/m
3.25 The detector has resistance against impact of electrostatic discharges:	- 8 kV (air discharge); - 6 kV (contact discharge)
3.26 The detector has resistance against impact of radio frequency electro-magnetic fields	10 V/m in the range of frequencies from 80 to 1000 MHz (amplitude sinusoidal modulation having depth of 80 % and frequency of 1 kHz), 30 V/m in the range of frequencies from 800 to 960 kHz and from 1.4 to 2.0 GHz, (amplitude rectangular modulation having the depth of 100 % and frequency of 200 Hz)
3.27 Detector supply	1.5 (+ 0.1; -0.4) V (one cell XTREME POWER LINE AA (LR6))

3.28 Time of continuous operation of the detector	no less 1000 h*
3.29 Protection degree of the detector housing	IP65
3.30 The detector has resistance against dropping from a height to the concrete floor	0.7 m (2.3 ft)
3.31 Overall dimensions: PM1401 GNA PM1401 GNB	183 x 57 x 32 mm ($7^{3/16}$ x $2^{1/4}$ x $1^{1/4}$ in.) 195 x 57 x 32 mm ($72^{3\32}$ x $2^{1\4}$ x $1^{1\4}$ in.)
3.32 Mass, no more: PM1401 GNA PM1401 GNB	398 g (14 oz.) 420 g (14.82 oz.)
Time of continuous operation of the personal radiation detector PM1401GHB at the constantly turned ON the Pocket PC communication mode through the radio channel is no less 15 h.	

Table 3.2

Parameter	**Source type**		
	^{133}Ba	**^{137}Cs**	**^{60}Co**
Gamma source activity, kBq (μCi) ±30 %	55.0 (1.5)	100.0 (2.7)	50.0 (1.35)
Movement velocity (source/instrument), m/s	0.5±0.05	0.5±0,05	0.5±0.05
Distance between source and sensitive surface of detector , m	0.2±0.005	0.2±0.005	0.2±0.005

4 GENERAL DESCRIPTION

PM1401 detectors belong to Polimaster's new generation of extremely sensitive, small and power-saving gamma-neutron radiation detectors. When ON the detector continuously monitors the environment for radiation and alerts the user with an audio, visual, and/or vibrating alarm if a radiation source is detected.

The present section contains the information about the detector design necessary for a user.

4.1 Control buttons. Indication on LCD

4.4.1 Two control buttons for the instrument operation are located on the front panel of the detector: (MODE) and (LIGHT), a liquid crystal display (LCD), a window of the IR transmitter-receiver, figure 1.

4.2 Installation and replacement of battery cell

The detector is supplied without a battery cell installed.

For installation of the battery cell:

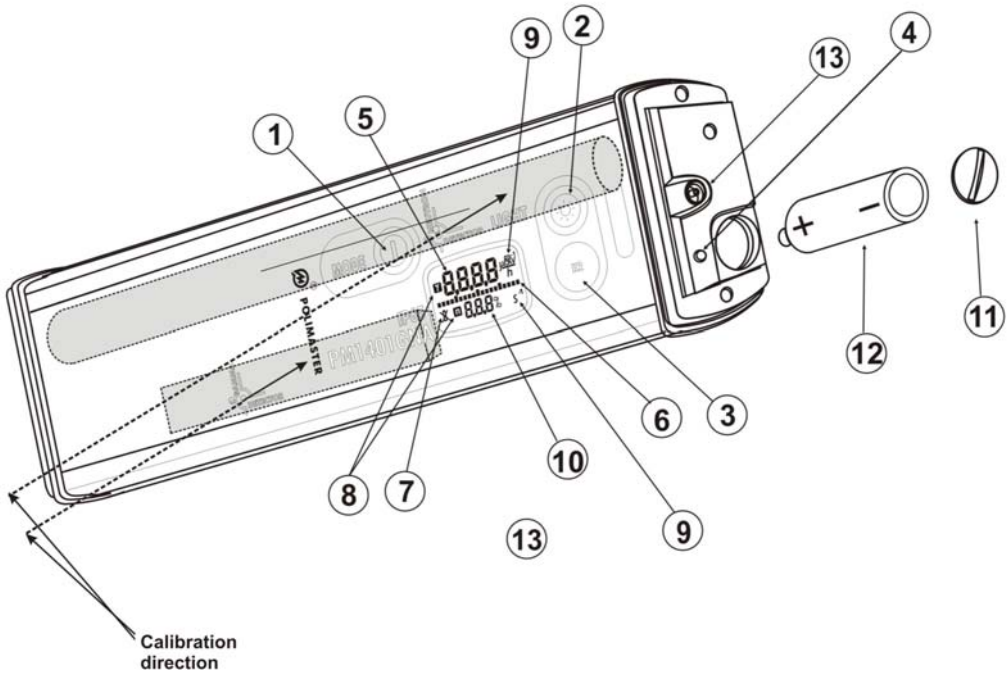
- to unscrew a cover of the battery section (11) (figure 1) with the help of a coin, a screw-driver, etc.;
- to install the battery cell by observing polarity (the cell electrode marked with "+" must be directed inside the detector) (figure 1);
- to place the cover of the battery section back.

When the battery cell is installed the detector is automatically turned on.

During turning on and during operation of the detector periodic control of the battery cell is performed. If the voltage becomes lower than 1,1 V, a mark "  " is indicated in the left lower part of the LCD, and a light and audio (and/or vibration) signal is given. **In this case the battery cell should be replaced.**

N o t e – After appearance of a discharge symbol "  " on the LCD the detector retains workability for at least 8 hours (at a normal background level).

The user may switch the indication of cell discharge off for approximately 30 min by a short pressing the MODE button. At this alarming by thresholds will be switched on.



1 (MODE) – the button is intended for:
- turning on the device;
- selection of operation modes;
- recalibration by the background level;
- change of parameters in the mode of settings.

2 (LIGHT) – the button is intended for:
- turning on the LCD backlighting;
- turning on the IR communication with PC;
- change of parameters in the mode of settings;
- turning off the device.

3 – the window of the IR transmitter-receiver.

4 – the LED.

5 – the upper LCD line is intended for display of:
- count speed, s^{-1} (in the search mode);
- DER values of gamma radiation, μSv/h (μR/h) (in the mode of DER measurement);
- information "test", "CAL", "OL", "OFF", "P-1.3" etc.;
- type of alarm (audio or vibration).

6 – the analogue scale consisting of 19 segments is intended for:
- time indication to completion of the internal processor tests – reduction of the number of segments up to their disappearance;
- time indication to completion of calibration by the background level – increase of the number of segments up to the full scale filling;
- indication of range of excess of gamma channel count rate over alarm threshold in the search mode.

7 – a mark of battery cell discharge "".

8 – marks indicating the parameters of gamma, neutron radiation.

9 – an detector of a size of the indicated value:
- «s^{-1}» – in the mode of searching the gamma radiation;
- «s^{-1}» – in the mode of searching the neutron radiation;
- «μSv/h» – in the DER indication mode (option "μR/h").

10 – the lower LCD line is intended for indication of an average count rate of neutron radiation, (s^{-1}).

11 – the cover of the battery section.

12 – the battery cell.

13 – the connector for connection of the vibration alarm device.

Figure 1

4.3 Clip Installation/Removal

The PM1401 detector comes with a clip which may be used to fasten the instrument to a waist belt or pocket. Optionally the detector may be supplied with a synthetic protective case.

The clip may be easily removed from the instrument by using a screwdriver or similar tool according to instructions depicted in the figure 2.

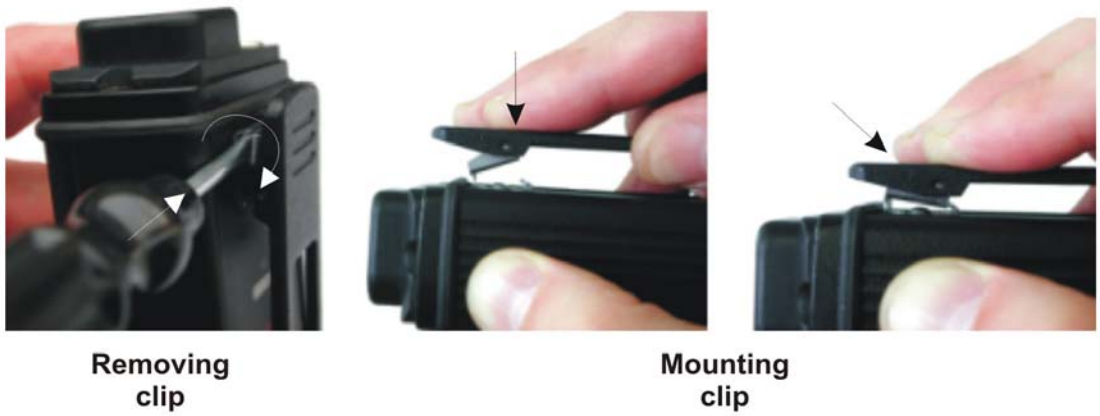


Figure 2 -Clip installation/removal

4.4 Telescopic tube.
External vibration alarm device.
Moderator chamber

4.4.1 The detector has the built-in audio and light alarm devices, besides it has an external ***vibration alarm device (6) (figures 3, 4)***, intended for producing signals that can be noted by a user as mechanical vibrations of the detector case when an exceed of *count threshold level* occurs.

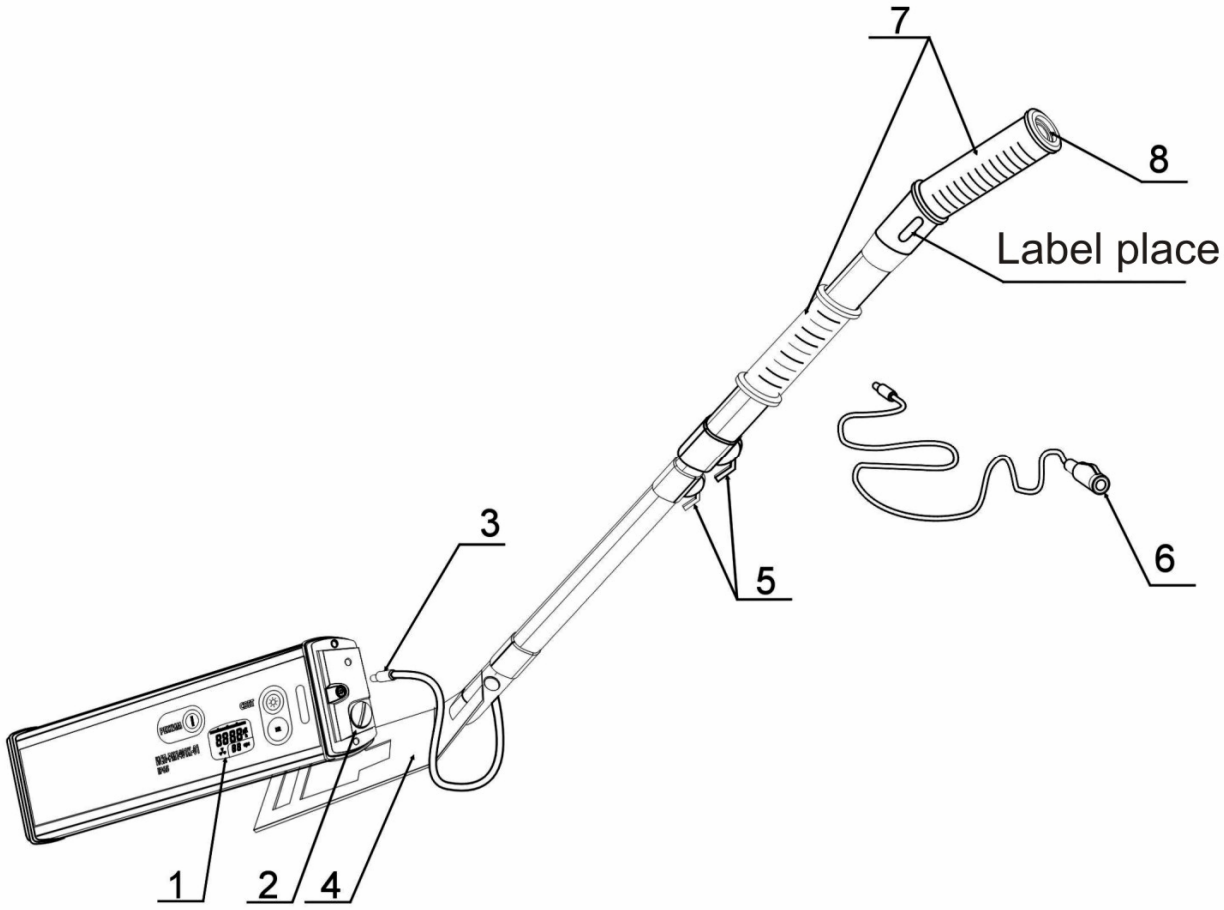
While in the search mode at approaching to a gamma radiation source the frequency of signals increases. It allows searching for gamma radiation sources secretly or at high levels of audio noise.

External vibration alarm device can be in a pocket or on a user arm when using a special wrist strap ***(figure 3)***.

Figure 3

4.4.2 For operation in hard-to-reach places a telescopic tube to the detector can be supplied by an individual order.

When using the telescopic tube it is necessary to fasten on the telescopic tube with the help of a special clamp by inserting previously the cable (3) into the detector connector (figure 2). If it is supposed to work with the external vibration alarm device (6), it should be connected to the connector (8). Length of the telescopic tube is regulated with the help of two holders (5).



1 – the personal radiation detector PM1401 GNA (PM1401 GNB);
2 – the cover of battery section;
3 – the cable of the telescopic tube with the connector for connection to the detector;
4 – the fastening lug of the telescopic tube for fastening the detector with the help of the clamp;
5 – the telescopic tube holder;
6 – the vibration alarm device;
7 – the handles;
8 – the telescopic tube connector for connection of the vibration alarm device.

Figure 4

4.4.3 For higher sensitivity of the instrument to neutron radiation an optional moderator chamber may be supplied on requires. The moderator chamber is shown in Figure 5.

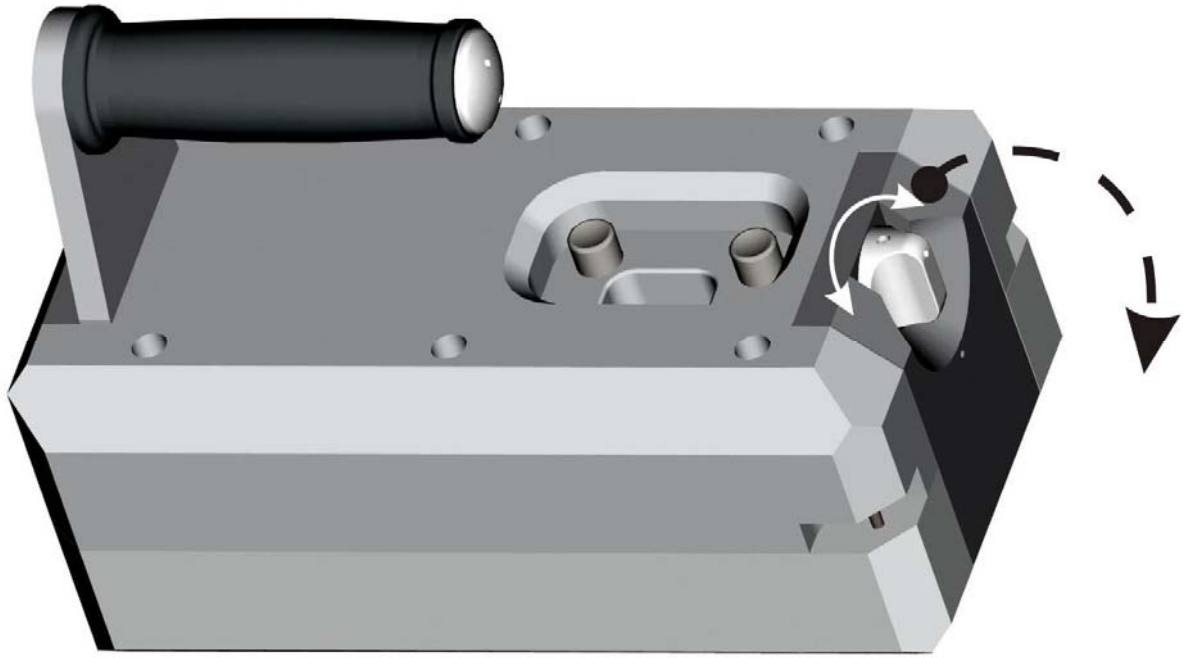


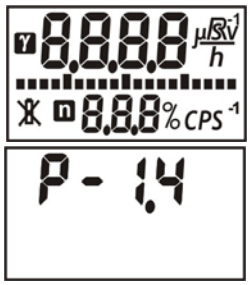
Figure 5

5 OPERATION

Attention! In case of the detector operation at temperature below minus 15 °C the normal operation of the LCD is not guaranteed. In this case only the audio or vibration alarm devices should be used as an detector for sources detection. When the detector returns to the conditions with the temperature above minus 15°C the normal operation of the LCD is restored.

5.1 Detector on/off

5.1.1 For switching the detector ON the MODE button should be pressed.



Immediately after that the LCD backlighting should be switched on and all LCD segments should be illuminated at the same time approximately for 1 s, alarm (audio and/or vibration) should be switched on, and the detector should enter the testing mode. In the testing mode a number of the software version (P-1.X[1]) is indicated on the LCD for several seconds.

After completion of the tests the detector should enter the background calibration mode, the analogue scale is indicated on LCD with the number of segments increased in time, as well as the "CAL" message.

After calibration completion the detector should enter the operation mode in accordance with the order chart (see Attachment A).

The detector is ready for operation.

5.1.2 For switching off the detector the LIGHT button should be pressed and kept for more than 5 s.

At this the "**OFF**" message appears.

Attention! The detector is automatically switched off ("OFF" is indicated on the LCD) after reading the detector operation history in the PC communication mode).

5.2 Operation modes

Operation modes included by the manufacturer in the given detector modification comply with the order chart (see attachment A).

The detector provides the following operation modes:

- the testing mode;
- the calibration mode by the background level;
- the search mode (indication of an average count rate, s^{-1});
- the mode of DER measurement;
- the mode of settings:
  - setting the coefficient **n** of gamma channel;
  - setting the coefficient **n** of neutron channel;
- the mode of the alarm devices settings:
  - selection of the audio and/or vibration alarm device;
- PC communication mode through IR channel;
- mode of accumulation of counts at registration of neutron radiation (by order);
- mode of indication of an average count rate of neutron radiation for the accumulation time (by order);
- Pocket PC communication mode through radio channel type Bluetooth (for PM1401 GNB).

Selection of the operation modes is to be performed with the help of the MODE button.

[1] Software version number is intended for manufacturer and it can differ from the one given herein.

5.2.1 Testing mode

The detector enters this mode just after being switched on.

Before the beginning of the *testing* process the alarm (audio and/or vibration) is switched on approximately by 1 s. All marks, segments and pointers must be indicated on the LCD. Then on the LCD a number of the software version (P-1.4) is indicated on the LCD for several seconds.

In the *testing mode* all the required tests are fulfilled. Initially, the battery discharge level is tested. The "bAtt" message is indicated on the LCD, as well as the quantity of segments of the analogue scale which corresponds to the battery discharge level.

Then the "test" message is indicated and the reducing analogue scale. The tests are performed. The time to completion of the test is displayed in relative units on the analogue scale in the form of the reducing number of the indicated segments.

Upon the test completion the detector enters the calibration mode by the background level. The analogue scale is indicated on the LCD with the number of segments increasing in time, as well as the "CAL" message.

5.2.2 Background calibration mode

The detector enters this mode automatically after completion of the testing mode, at this the "CAL" message is indicated on the LCD

In the calibration mode the analysis of the background level of gamma (and neutron) radiation is carried out.

Attention! Below the principles of operation of the detector's gamma channel are given. Functioning of the neutron channel follows the more complicated operation algorithm and is not shown in details in the present manual.

The processor counts the number of pulses coming from the detection block for the preset calibration time, and the time is indicated on the analogue scale in relative units from the calibration beginning in the form of increasing number of the indicated segments. Completion of the scale with segments means the calibration completion. In case of recalibration of the detector by a user during operation the recalibration time may automatically be reduced along with growth of the background level, at what the calibration is fulfilled.

The processor counts the value of **the alarm threshold of gamma channel, see 5.2.3 (2)**

$$\textbf{alarm threshold} = \mathbf{2N + n \cdot \sqrt{2N}}, \qquad (1)$$

where **N** – an average count rate for a calibration time, s^{-1};

n – number of mean square deviations (coefficient **n** of gamma channel).

Coefficient **n** changes the value of **the alarm threshold** (the minimum detection level), the less the coefficient **n,** the less threshold value is and the higher detector sensitivity is. Buy at this a probability of false alarms of the detector increases. Coefficient **n** is set by the user in the *settings mode*, if this is permitted in the communication mode with PC by the user-administrator (the manufacturer sets the value of coefficient **n** accordance with the attachment A). The range of the coefficient setting is from 1 to 9.9 with discreteness of 0.1.

For calibration of the detector by the background level the **MODE** button should be pressed (to be kept pressed for more than 2 s), until the "CAL" message is indicated on the LCD, then the push button should be released. The analogue scale with the number of segments increasing in time will also be indicated on the LCD.

The background auto calibration may be switched on in the PC communication mode. Auto background makes it possible to automatically retain the high sensitivity at reduction of the background level and avoid false alarms with its slow increase.

The detector is highly sensitive to the change of radiation level. The alarm may be produced, e.g. the detector being moved from the open air (street) to the premises with materials containing natural radioactive isotopes (potassium, thorium, radium, uranium) producing heightened natural radiation level. Such materials are mainly concrete and similar construction materials containing sand, natural stone (especially facet), ceramic tile, glass, etc. In this case, the detector auto calibration will be not switched on, that is why it is recommended to re-calibrate it manually to adjust it to the modified background. Also, the coefficient **n** may be altered to change the sensitivity threshold.

After background calibration is completed the detector is automatically enters the *operating mode* in accordance with the chart of order (see attachment A).

5.2.3 Search mode. Detection and localization of gamma and neutron radiations sources

5.2.3.1 Being in the *search mode* the detector shows the count rate of gamma channel in the LCD upper line, s^{-1}.

The following is indicated in the lower line:

	• an average count rate of neutron radiation in s^{-1}
	• If at the detector operation in the *search mode* an average count rate of gamma channel exceeds the upper limit of indication, **"OL"** is indicated on the LCD
	• If at the detector operation in the *search mode* an average count rate of neutron channel exceeds the upper limit of indication, the "999" blinking message is indicated on the LCD.

In this mode the detector operation is performed by the following thresholds:

1) The fixed **DER threshold** (safety threshold) set up in the PC communication mode by the user-administrator.

When the preset threshold is exceeded by DER the detector produces light, audio and/or vibration signals. At this single-tone periodical signals are sent with the constant interval and duration of 1 s that allows the user to distinguish alarms at exceed of DER threshold from the alarm threshold;

2) Alarm threshold of gamma channel (the minimum detection level) calculated in the calibration mode and taking into account the changes in the background level. When the gamma channel alarm threshold is exceeded the detector produces light, audio and/or vibration signals. At this, the frequency of coming signals is constant or increases along with the increase of **alarm threshold of gamma channel.**

The whole range of energies of the detector gamma radiations is divided into four energy channels. Three channels correspond to areas of interest for low, middle and high energies, and the 4^{th} one – to the whole range of energies of the gamma radiation. **The alarm threshold** is calculated for every channel.

The processor counts impulses every 0.25 s by each channel from the detection block, and it keeps the amount of impulses for the count time. At this every 0.25 s the number of impulses over the last (new) interval is added to the current amount, and the number of impulses during the first (the oldest) interval is deducted from the sum of impulses (the current average). So, the number of impulses stored in the processor by each channel is renewed every 0.25 s.

The current average number of impulses is compared every 0.25 s with alarm **thresholds** for each channel, **which are calculated in the calibration mode.** If the current average value of the number of impulses by any channel exceeds the threshold value, the alarm device (light, audio and/or vibration) is switched on.

3) Alarm threshold of neutron channel (the minimum detection level), calculated in the calibration mode and taking into account the changes in the background level. If the alarm threshold is exceeded the

detector produces light, sound and/or vibration signals. At this double signals are coming with the permanent interval and duration, that allows the user to distinguish the alarm at exceed of the alarm threshold of gamma channel from the alarm by neutron channel.

In the *search mode* the detector resolves problems of detection and localization of sources of gamma and neutron radiation.

In the following modes the analogue detector scale displays the count overriding over the calculated gamma channel threshold: search mode, DER measurement combined with search mode, count pulse accumulation, mean neutron count rate indication. The more the overriding, the more segments are displayed on the scale.

5.2.3.2 Detection of gamma and neutron radiation sources

When detecting a radiation source the instrument should be held so that the rear side (where the clamp is attached) is directed onto the scanned object. The efficiency of detecting 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.

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

One should remember that detector sensitivity and frequency of false alarms depend on:

- the preset value of coefficient n by gamma channel**;**
- the preset value of coefficient n by neutron channel**;**
- the background level calculated by the detector in the calibration mode by the background level.

In case when auto background is switched on in the PC communication mode, the detector will automatically take into account slow changes of the background level and calibrate by a new background level approximately in every ten minutes with the reduction of the background level or in a bit larger intervals during increase of the background level. However, auto calibration will be performed under conditions of absence of detector alarms or cardinal changes of the background level over certain intervals defined by the algorithm.

It should be noted that signals (light, audio and/or vibration) being produced at false alarms are not regular and, therefore, may be easily distinguished from alarm signals produced by the existing radiation source as far as their rate is constant or increases when the instrument moves closer to the radiation source.

When the radiation source is detected by the instrument or by a stationary system, the radiation source is to be **located.**

5.2.3.3 Localization of gamma and neutron radiation sources

To **locate** a 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 instrument moves closer to a gamma radiation source, the rate of the signals will increase.

With the switched on audio alarm the audio signals are heard accompanied with blinking of the red LED. With the switched on the external vibration alarm device the mechanical vibrations are felt accompanied with a red LED.

When the maximum rate of light, audio and/or vibration signals have been reached the further localization becomes impossible without calibration by a new background level. For this purpose, if possible, a MODE button should be pressed **without changing the distance to the object**, and keep pressed until the “CAL” message appears on the LCD. The instrument will automatically perform the background calibration and then the gamma radiation source localization may be continued. If necessary this procedure may be repeated several times until the gamma radiation source is located.

If necessary to locate a neutron radiation source or a combined gamma and neutron radiation source it is not allowed to use audio and vibration alarm, as the instrument will produce the signals characterizing exceed of neutron count rate threshold, without a reaction to the source approach or removal. In this case it is recommended to perform source localization by observing the count rate change (or DER) on the LCD upper scale (gamma radiation channel) or the count rate change on the LCD lower scale (neutron channel).

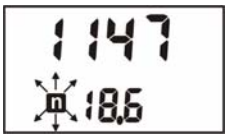
5.2.4 Mode of DER measurement

When in the DER indication mode, the upper line of the LCD screen indicates the dose equivalent rate of the photon radiation $\dot{H}$*(10), in μSv/h, while the lower line indicates the average neutron count rate in s^{-1}. If DER value exceeds the upper limit of the indication range more than 1.3 times, the LCD will display an overload message (OL).

Note - Search function may be available in this mode (upon the customer's request, agreed while delivery).

5.2.5 Mode of neutrons registration (by order)

In this mode the number of accumulated count impulses is indicated in the LCD upper line:

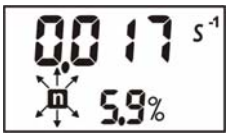


XXXX – in case of indication by the value of 9999 impulses;

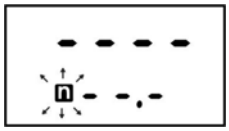
X.XEX – in case of indication above 9999 impulses, wherein X – any figure from 0 to 9, EX is 10^x.

In the lower line of the LCD the **n** mark is blinking and the time of impulses accumulation is indicated in hours.

5.2.6 Mode of indication of an average count rate of neutrons accumulated for accumulation time (by order)



In this mode an average count rate in s^{-1} for the accumulation time is indicated in the LCD upper line. In the lower line of the LCD the **n** mark is blinking and the value of statistical error of an average count rate in percents is indicated.



For reset of the current value of impulse counting and accumulation renewal a MODE button should firstly be pressed and retained by staying in this mode.

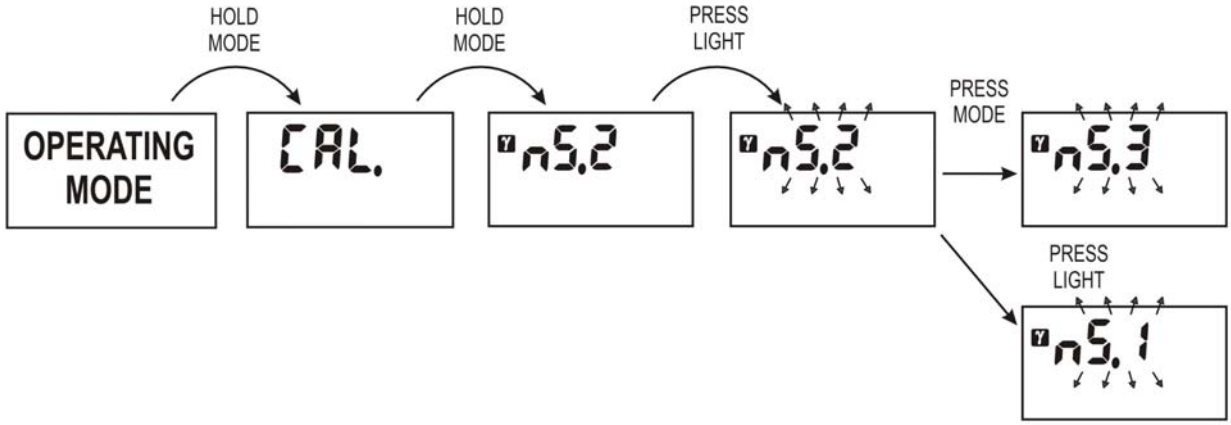
5.2.7 Set mode

The detector enters the setting mode at long pressing (for more than 5 s) the MODE button. By a short pressing of MODE button the user selects the preset parameter:

- to check the preset value of coefficient n (a number of mean square deviations) or to set a new one for gamma radiation channel registration (the range of the coefficient n setting is from 1 to 9.9 with discreteness 0.1);
- to check the preset value of coefficient n or to set a new one for neutron radiation channel registration;
- to check the preset status of audio and/or vibration alarm devices or to change them (on/off).

5.2.7.1 Setting the coefficient n of gamma channel

For setting the coefficient **n** it is necessary to enter the set mode, for what to press the MODE button and keep pressed for more than 5 s. The "CAL." message will appear on the LCD, and then the installed value of **coefficient n of the gamma channel**.

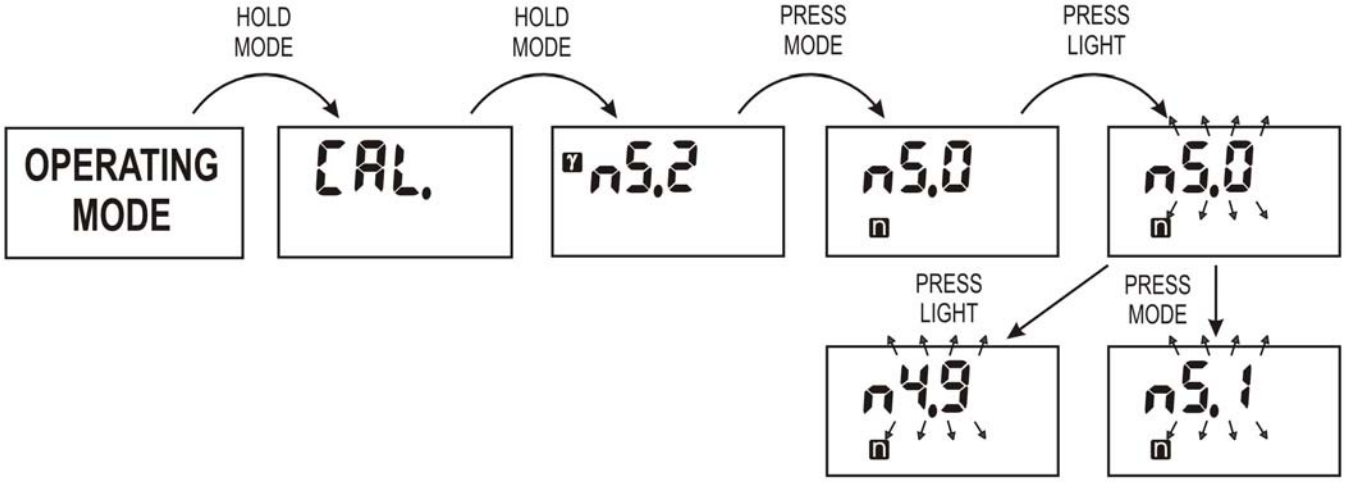


For changing the value of the coefficient **n** to press shortly the LIGHT button during subsequent four seconds. The preset value of the coefficient **n** will blink by indicating its possible change. If the LIGHT button was not pressed during the said time interval, the detector automatically returns to the operation mode. Subsequent pressings the LIGHT button increases the preset value of the coefficient **n** with the step 0.1. Subsequent pressings the MODE button increases the preset value of the coefficient **n** with the step 0.1. If the buttons are kept pressed the values are reduced or increased accelerated with the same step. After setting the required coefficient **n** of the gamma channel after expiry of approximately 6 s after the last pressing the button the detector will automatically enter the *calibration mode*.

5.2.7.2 Setting the coefficient n of neutron channel

For setting the coefficient **n** it is necessary to enter the *set mode*, for what the MODE button should be pressed and kept pressed for more than 5 s. The "CAL.» message will appear on the LCD, and then the installed value of the coefficient **n** of the gamma channel. To press the MODE button once and the preset value of the coefficient **n** of neutron channel will be indicated on the LCD.

For changing the value of the coefficient **n** to press shortly the LIGHT button during subsequent four seconds. The preset value of the coefficient **n** will blink by indicating its possible change. If the LIGHT button was not pressed during the said time interval, the detector automatically returns to the working mode.



Subsequent pressing the LIGHT button reduces the preset value of the coefficient **n** with the step 0.1. Subsequent pressings the MODE button increases the preset value of the coefficient **n** with the step 0.1. If the buttons are kept pressed the values are reduced or increased accelerated with the same step. After setting the required coefficient **n** of gamma channel after expiry of approximately 6 s after the last pressing the button the detector will automatically enter the calibration mode.

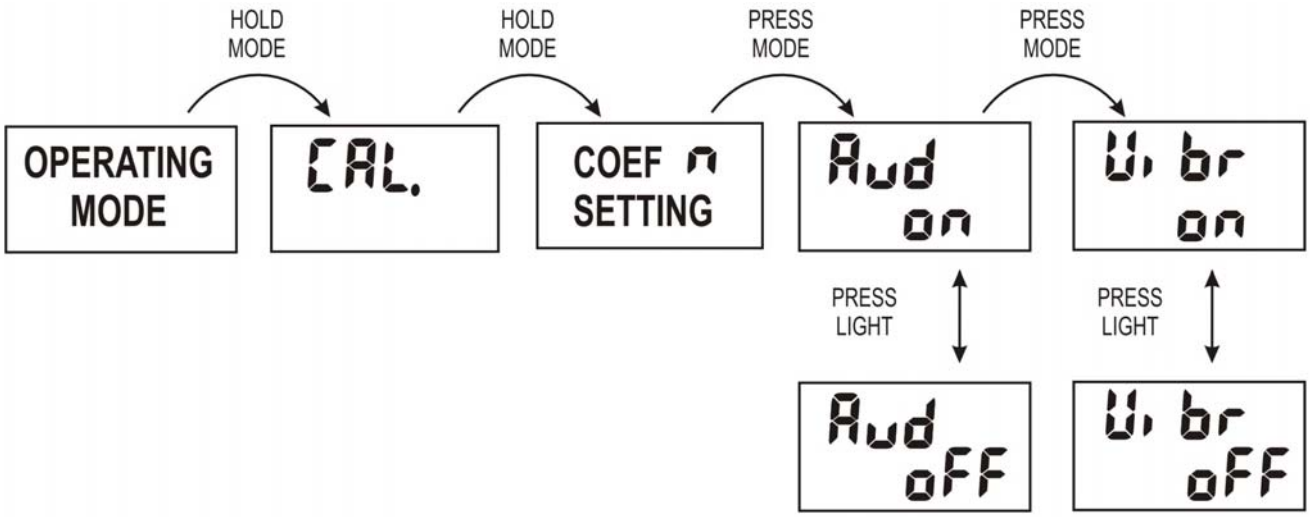
5.2.7.3 Mode of setting the alarms

Turning the audio and/or vibration alarm devices On/Off

Selection of status (on/off) of audio and vibration alarm from the front detector's panel is possible if this mode is allowed at setting the parameters set up in the PC communication. If this mode is allowed then the turning the audio or vibration alarm should be performed in the following way:

the set mode is to be switched on, for what the MODE button should be pressed and kept for more than 5 s. The "CAL." message will appear on the LCD, and then the installed value of the coefficient **n;**

to press the MODE button shortly (1 or 2 times, depending on the modification), until "Aud-oFF" or "Aud-on" message appears.



The abbreviated note "Aud" indicates the audio alarm, "oFF" ("on") marks for the off (on) status of the audio alarm.

For changing the status of the audio alarm it is necessary, when this note appears, select the required status of the audio alarm by means of the LIGHT button. This status is left by either automatically, if during approximately 6 s the button was not pressed, or at short pressing the MODE button, at this "Vibr-oFF" or "Vibr-on" message will appear on the LCD. The abbreviated note "Vibr" indicates the vibration alarm, notes "oFF" ("on") – the off (on) status of the vibration alarm. Setting of and removal from this mode is performed by actions similar to the aforesaid ones.

5.2.8 PC communication mode. Detector parameters

ATTENTION! Operation in the PC communication mode is intended for a trained user or the user-administrator.

Access to the PC communication mode for an ordinary user is protected with the password.

5.2.8.1 PC communication mode through IR communication channel

For detector operation in this mode a PC with IrDA should be used or an adapter of the IR communication channel supplied along with the detector by an individual order (see the delivery kit) and the user's program (UP) PM17XX_14XX, supplied on CD.

Minimum requirements for the computer and its software:

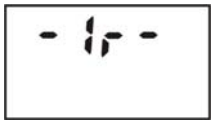
- P100;
- 32 Mbyte ROM;
- Windows 98, 2000, XP (small print in Windows set);
- 20 Mbyte of free space on HD plus the free space for the formed data base;
- monitor resolution 800x600;
- IrDA.

If the built-in IrDA is unavailable in the computer, the IR communication channel should be used which is to be supplied as per individual order. For connection of IR communication channel adapter the adapter's cable should be linked with the PC communication port.

For installing the User Program the CD with the software should be used that is included into the delivery kit.

The **SETUP.EXE** program should be started on the computer by using the installation instruction - **install.doc**. (the automatic start-up is supported).

Operation with the User Program is described in Help file in the attached text document which is installed along with the user program.



For switching on the *PC communication mode* the detector should be placed at the distance of 10-12 cm from the adapter window of the (IrDA) communication channel, and the LIGHT button should be pressed. As soon as the detector enters the mode of information exchange, "Ir" message will be indicated on the LCD.

N o t e – The detector is automatically switched off ("OFF" note is indicated on the LCD) after reading the detector operation history in the PC communication mode.

5.2.8.2 Detector parameters

Detector parameters are set up in the PC communication mode by a user-administrator (the access is protected with a password).

The manufacturer sets up the access password – 1.

The detector is supplied to user along with the initial settings which comply with the chart of orders (see attachment A).

During operation in the PC communication mode the user-administrator may fulfill the following actions:

In the information system

- to register belonging of the detector to a specific user;
- to remember the time of detector sending and returning;
- to read information from the detector storage, including the history of its operation:

1) the detector number;

2) time of detector on/off;

3) current DER value by the gamma channel in the consecutive time interval set up by the user;

4) time and detector readings in case of exceeding the **alarm threshold of the gamma channel;**

5) time and detector readings in case of exceeding the **alarm threshold of the neutron channel;**.

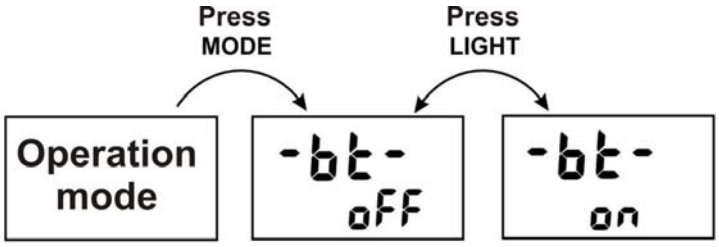
In settings of detector/program

- to check and/or set up working parameters of the detector:
- to switch on the audio and/or vibration alarm devices;
- to synchronize the time and the date of the detector with the current time and the PC date at the moment of information exchange – automatically at each communication of the detector with the PC;
- to set up the values of consecutive time intervals for storing the current values of DER in the non-volatile detector memory;
- to change the password for entrance to the file of parameters (default password - 1);
- to check and set up the fixed threshold by DER, if exceeded, the detector provides a light, audio and/or vibration signals;
- to check the preset or set up new values of the coefficient n by each channel determining the alarm thresholds (minimal levels of gamma and neutron radiation detection);
- to turn on/off the auto background updating.

5.2.9 Pocket PC communication mode through radio channel

In the Pocket PC (PPC) communication channel through the radio channel type Bluetooth, the personal radiation detector **PM1401 GNB** allows identifying a radionuclide composition of materials.

To set the connection between the detector and the PPC through the radio channel it is necessary to switch on the "Bluetooth" mode in the detector. For this press shortly the MODE button for several times until [–bt–off] is indicated on the LCD. Using the LIGHT button to switch the "Bluetooth" on [–bt–on]. Then run the user program "PoliIdentify" on the PPC.



The detector operation in this mode is described in Help file and is supplied on CD.

Attention!

1 At operation of the detector in the PPC communication mode the access to the mode of the detector's settings with the help of the buttons on the front panel of the detector is IMPOSSIBLE. All settings should be performed with the help of PPC.

2 Also it is necessary to take into account that at the "Bluetooth" mode switched ON the power consumption increases greatly.

At the "Bluetooth" switched on the detector in approximately 1 minute enters the power standby mode, at this the LCD will look in the following way:

-bt-	radio channel is switched on, no connection with PPC
-bt- ---	radio channel is switched on, connection with PPC is set

To switch the "Bluetooth" mode off, it is necessary to press shortly the MODE button for several times until the [–bt–on] in indicated on the LCD. Using the LIGHT button to switch the "Bluetooth" status in [–bt–off].

6 MAINTENANCE

Maintenance of the detector involves:

- performance of preventive works (external inspection, dust removal and deactivation, check of detector workability (see detector on/off). Deactivation is performed by wiping with clothes moisten in ethyl spirit. Deactivation of the case is done with a tissue impregnated with ethyl alcohol;
- battery replacement.

In case of visible mechanical damages of the casing and protection glass of the LCD detector (dents, burrs, cracks) operation of the detector is prohibited.

7 TROUBLESHOOTING

The list of possible problems and their solutions are specified in Table 7.1.

Table 7.1

Problem	Possible cause	Solution
The detector can not be switched on	Wrong installation of the battery	Replace the battery
The LCD displays the battery discharge warning sign	Exhausted battery	Replace the battery

Other malfunctions shall be eliminated by the manufacturer.

8 STORAGE AND SHIPPING

8.1 Storage

Detectors are to be stored in the manufacture's package without battery cells 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.

Detectors 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 without battery cells.

The storage place should be free of dust, vapors of strong chemicals, aggressive gases and other substances that may cause corrosion.

8.2 Shipping

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

Detectors 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.

9 LIMITED WARRANTY

Polimaster warrants to the purchaser (the "Purchaser") that the Product, including component parts, is free from material defects in material and workmanship, under normal use and service for a period of 18 months (the "Warranty Period") *provided, however*, that the foregoing warranties are expressly contingent (and shall otherwise be void) upon use of the Products in accordance with specifications and without misuse, abuse, or abnormal use, accident, damage, alteration, or modification thereto or improper or unauthorized repairs or improper maintenance. Non-substantial variations of performance from the documentation do not establish a warranty right.

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Applicability. The limitations and exclusions contained herein shall apply notwithstanding any failure of essential purpose of any limited remedy.

Appendix A
(for reference)
Chart of ordering the operation modes and functions of the detector

Table A.1

Modes and functions	**Enabled - (V)** **Disabled - (-)** **----------** **Value**	**Note**
1	2	3
Search mode (indication "s^{-1}")	**V**	Can be ON autonomous or combined with modes 2 or 3
Measurement mode (indication μSv/h)	**V**	Can be ON autonomous or combined with mode 1
Measurement mode (indication μR/h)		Can be ON autonomous or combined with modes 1
Auto calibration	**V**	
Installation of DER threshold for modes 1-3 - DER threshold (safety threshold)		limit- 1 – 7000 μR/h (0.01 – 70 μSv/h) advisable- 3 mR/h (30 μSv/h)
Neutrons registration mode: - modes of counts accumulations (neutrons, indication S^{-1}) and an average count rate for accumulation time		
Additional settings		
Interval of history record, min	60	
Permission to change the coefficient **n**	**V**	
Coefficient n (gamma)	4.5	Advisable 5.3; 4.5, see Table 3.
Coefficient n (neutron)	4.0	Advisable 5.0, 4.0, see Table 3
Permission to change alarm device	**V**	
Audio alarm device	**V**	
Vibration alarm device	**V**	