

GR-100

PERSONAL RADIATION DETECTOR SYSTEM MANUAL

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PRELIMINARY DRAFT

EXPLORANIUM

RADIATION DETECTION SYSTEMS

GR-100

PERSONAL RADIATION DETECTOR

SYSTEM MANUAL

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EXPLORANIUM

RADIATION DETECTION SYSTEMS



GR-100
PERSONAL RADIATION DETECTOR

1.0 GENERAL

1.1 INTRODUCTION

Thank you for purchasing the Exploranium GR-100 Personal Radiation Detector. The GR-100 is one of the most advanced, yet simple to use, personal radiation detectors deployed in customs, security, military and emergency response applications. It has been designed to provide accurate and reliable measurement of gamma and neutron radiation, trigger visual and audio alarms to warn the operator, and accurately measure exposure dose rate over the full spectrum range. It also aids the operator in search and location of the source of the detected radiation. The unit is typically used as a belt-mounted monitor or a hand-held search detector. It automatically stores alarm events date and time and dose data in its memory for subsequent retrieval to a PC. Its simple one-button operation and user-friendly operator interface make it truly an ideal front-line tool for a variety of users involved in detection and interception of radioactive and nuclear materials.

1.2 SYSTEM DESCRIPTION

Standard GR-100 Personal Radiation Detector system consists of:

- GR-100 Personal Radiation Detector Unit
- Two "AA" Alkaline Batteries
- Earphone With Volume Control
- Belt Mounted Carrying pouch
- PC Interface Cable
- CD With GR-100 Monitor Software
- GR-100 User Manual
- Shipping Case

The following optional equipment is also available:

- Rechargeable Nickel-Cadmium Battery
- Rechargeable Nickel Metal Hydride Battery
- Battery Charger and Cable Assembly
- Battery Charger/PC Interface Cable Assembly
- 0.25 Micro-Curie Cesium 137 Test Source

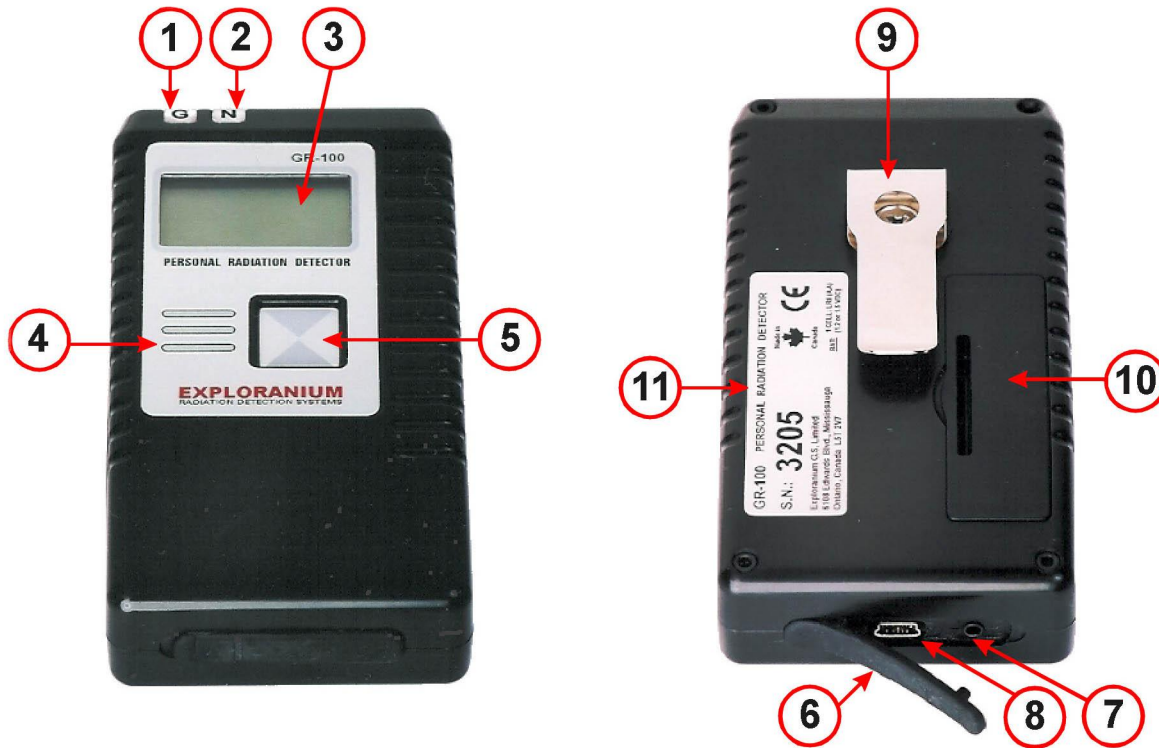
The GR-100 Personal Radiation Detector is supplied in two versions:

- GR-100 – equipped with CsI gamma detector
- GR-100N – equipped with both CsI gamma and LiI neutron detectors

The neutron detector option must be selected at the time of purchase.

Figure 1.1 shows the front and back views of the GR-100 unit. The unit is housed in a rugged ABS plastic case designed to withstand adverse weather conditions. It has a universal removable stainless steel clip for mounting on a variety of waist belts. Operator interface is facilitated by graphic liquid crystal display (LCD) and a single push button (MODE button). Radiation alarm is displayed via two Light Emitting Diode (LED) lamps on the top of the unit. These lamps are clearly visible when unit is worn on a belt. Alarm is also indicated with an audio beeper and a vibrator. An earphone with volume control is provided for operation in noisy environment. It connects to an audio jack located at the bottom of the unit under a rubber protection cap. This cap also conceals a USB connector for interfacing the unit to a PC. All functions and settings are controlled with the MODE button on the front panel. Battery compartment is accessible by lifting the removable cover plate on the back of the unit. For additional protection during operations, the unit can be inserted into a belt mounted leather pouch. The earphone can remain connected to the unit when in the pouch. The instrument parameters setup and stored data retrieval is accomplished by connecting the unit to any desktop or notebook computer that has the GR-100 Monitor software installed.

Figure 1.1 GR-100 Personal radiation Detector Features



- 1** Yellow LED lamp indicating gamma radiation alarm
- 2** Red LED lamp indicating neutron radiation alarm
- 3** Graphic LCD showing operating parameters and radiation measurements results
- 4** Audio transducer indicating radiation alarm and source intensity
- 5** MODE push button used to select operating parameters and functions
- 6** Connector protecting rubber cover
- 7** Earphone jack
- 8** PC interface connector
- 9** Belt clip
- 10** Battery compartment

Figure 1.2 GR-100 Personal radiation Detector Accessories



- 1** Belt Mounted Carrying Pouch
- 2** 0.25 μCi Cs 137 Test Source
- 3** Earphone with Volume control
- 4** PC interface Cable
- 5** CD With GR-100 Monitor Software

2.0 OPERATION

2.1 MODE BUTTON

The MODE push button is used as a function selection switch. There are 3 basic ways to use this button:

SHORT PRESS – Short depression of the button, lasting less than 1 sec.

LONG PRESS – Long depression lasting, lasting more than 1 sec but less than 2.2 sec.

HOLD – Press and hold for more than 5 sec.

In the following text, this button activation will be described as SHORT-MODE, LONG-MODE and HOLD-MODE to clarify functionality. Activation shorter than 0.1 secs is called SPIKE and is ignored by the system. Activation longer than 2.2 secs starts the switch OFF procedure, but if activated for less than 5 seconds it changes to LONG-MODE.

2.2 BATTERY

The unit operates off a single AA battery. Three types of batteries can be used – alkaline battery and two types of rechargeable batteries: Nickel-Cadmium (NiCd) or Nickel Metal Hydride (NiMH). Charging of the rechargeable batteries is described in Section 2.13.

The battery is loaded by removing the battery cover – use a finger-nail or coin in the groove in front of the slot on the rear to lever the battery door open. Insert the battery in the battery compartment, being sure to place the bottom of the battery on the spring and the top to the brass terminal. Seat the battery firmly in place above the removal strap then clip the battery cover in place.

NOTE: All measured data are nonvolatile and they are stored in the memory regardless if the battery is installed or not. But the time/date information will be destroyed if the battery is not installed for 1 minute or more. Therefore it is recommended to replace battery within 1 minute to avoid the time and date reset. Prepare the new one at first and then remove the old one and new one load without any delay. In case of problems return the old battery back. The low voltage is not sufficient for operation of the equipment but enough for keeping the time and date.

2.3 POWER ON

The front panel push button switch is called the MODE switch. Press the LONG-MODE switch to power the unit ON and the STARTUP display is seen for approximately 5 seconds.

EXPLORANIUM
GR-100
1V3 #1601

1V3 = the current software version

#1601 = the unit serial number

During this time period the internal electronics are tested and various tests performed:

- RED light flashes as a lamp tests
- YELLOW light flashes as a lamp tests
- BUZZER beeps (if enabled)
- VIBRATOR vibrates (if enabled)

The electronics inside the equipment recognize the replacement of battery and after switching ON a set of tests is provided in addition to only switching the equipment ON. During those tests you have to select the battery type for proper operation.

NEW BATTERY
SELECT TYPE
ALKALINE ?

The SHORT-MODE causes change of the battery description to the next one. Up-to-date possibilities are ALKALINE, Ni-Cd and Ni-MH. The LONG-MODE confirms the actual type by message and

ALKALINE
SELECTED

continues the power ON sequence of operation.

The next warning will be displayed if the remaining capacity of the battery is less than about 5 – 10 %. It is possible to continue monitoring for a few hours, but it is recommended to change or charge battery soon. Also the backlighting cannot be activated in this case to save remaining battery live.

LOW BATTERY
PRESS MODE

The discharged battery is indicated on the display by the following message. The operation is cancelled.

BATTERY
DISCHARGED
SWITCH OFF

2.4 POWER OFF

To power the unit OFF press HOLD-MODE button for about 5 seconds until the following sequence of displays is seen from the Monitor display and the power will go OFF. Note that if you release the MODE button at any point before power OFF, the system will take it as LONG-MODE press, in this case it goes back to the PARAMETERS SETTING screen as shown in Section 2.10.1.

NOTE: From the Search display the first message will be MONITORING (compare Section 2.9), from Parameter Setting ACCEPTED will be seen at first (compare Section 2.10.1).

PARAMETERS
SETTING

SWITCH OFF
3

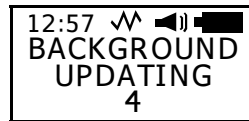
SWITCH OFF
2

SWITCH OFF
1

SWITCH OFF
0

2.5 BACKGROUND UPDATING SCREEN

After initial start up the system must accumulate a radiation background level to assess the local background. Be sure to do this while at a sufficient distance from possible radioactive sources. The display shows a 5 second countdown (5, 4, 3, 2, 1) during this process. At the end of this period the local background is stored in memory, which is updated regularly and used for Alarm Level calculations. During this period the display shows:




2.6 MONITOR SCREEN

After the STARTUP screen is displayed for a few seconds and BACKGROUND UPDATING goes through, the MONITOR screen is displayed



12:57 – real time clock showing the current time

 - this shows that the system alarm warning VIBRATOR is active

 - this shows that the system BUZZER audio device is active

 - this icon shows the battery status

MON – shows that the system is in the MONITOR mode

234 - this is the current Gamma count rate in counts per second units [cps]

44.4 μ R/h – is the current Dose Rate (Exposure) in selected units (see Section 2.7)

NOTE: In the standard condition (no radioactive sources) the count rate should be between 5 and 25 cps and the dose rate about 50 - 250 nGy/h, 50 - 250 nSv/h or 5 - 25 μ R/h.

The battery status icon is fully black in case of fully charged battery. As the battery capacity goes down the black filling decreases itself to the right-hand side. The icon is "empty" if the capacity drops down to about 10 %.

Moreover the YELLOW LED light flashes shortly every 3rd second to show the battery is OK and the system is operational. Low battery is indicated by the RED light flashing.

2.7 DOSE RATE

The GR-100 is an instrument that accurately displays the computed Dose-Rate over the full spectrum range. The unit is calibrated so that whether the source is Americium, Cesium, Cobalt or any other isotope - the Dose Rate computation is accurate. This is achieved by using an internal spectrometer analysis system that compensates spectral influence of the dose rate. Previous instruments in this range

measure the Dose Rate correctly ONLY FOR CESIUM thus making the Dose values extremely inaccurate at a different part of the spectrum such as Americium or Cobalt.

The dose rate is shown in Monitoring mode in the bottom part of the display. If the count rate exceeded 500 cps in Search mode the dose rate is showed too, replacing bar graph under the count rate. The user is now informed about the danger during searching.

Note that displayed dose rate is 10 seconds moving average. It means that the value is renewed every second and is calculate from the signal during the last 10 seconds. The maximal value is a little bit lower then in case of evaluating every second but it is more stable and gives better view to real radiation level.

Current Dose Rate can be measured in three different units. The Gy/ hr (Grays per hour) are used for radiation dose rate especially in Europe, the R/ hr (Roentgens per hour) are used for exposure especially in America and Sv/ hr (Sievert per hour) are used for equivalent dose rate when the man's health risk is assessed. The multiplication prefixes are displayed automatically:

n = nano = 0.000 000 001, μ = micro = 0.000 001, m = mili = 0.001.

The range of measurement is from natural background to 100 μ Gy/h. When the actual dose rate is higher the message OVERLOADED is displayed instead of the dose rate value. After returning to the place with lower dose rate appears again.

The calibration point for dose rate is defined to the center of the gamma detector. It is 3 cm from the top (in the mid of display), 1 cm from the right-hand side and 1.3 cm under the face side. The irradiation direction is from the opposite side to display.

The dose rate is accumulated in the GR-100 memory during the operation in monitoring or searching mode and stored at every exact hour or at the switching OFF procedure. The results can be loaded to the PC (see Section 3.5.2) and saved due to the staff health work purposes.

2.8 ALARMS

For normal operation the unit is set in the MONITOR screen and in this mode the alarm analysis system is analyzing the data every second.

Normally the GR-100 is belt mounted so the user would be alerted to the alarm by an audio and/or vibration action depending on system settings. When they glance down at the unit the LEDs are visible through the transparent window as a visual reinforcement that an alarm has occurred

If an alarm is detected various things occur:

- the AUDIO beeps in a warning mode of 3 triple-beeps approx. 2 secs apart
- the appropriate LED comes on (YELLOW=Gamma, RED=Neutron) in a flashing mode ones per second
- the VIBRATOR vibrates on a warning 3 times if it is enabled

When the unit is removed and inspected the display shows:

<p>GAMMA ALARM PRESS MODE 4.44 μR/h</p>
--

In this case the unit indicates that a GAMMA ALARM has occurred. The dose rate shows the maximum value measured during the alarm message is on display. Note that this value is 10 seconds moving average.

It means that the value is renewed every second and is calculate from the signal during the last 10 seconds. The maximal value is a little bit lower then in case of evaluating every second but it is more stable and gives better view to real radiation level.

The user now presses SHORT-MODE and SEARCH MODE display is seen:

<p>12:57 \checkmark \blacktriangleleft \blacksquare SRCH N 0 234 \blacksquare \square \square \square</p>

As noted above, in the SEARCH mode the numeric, bar graph and audio tone are used to accurately locate the source of radiation.

2.8.1 ALARM LEVEL SETTING

As noted above, after startup a 5 second average of the local radiation background is computed and stored in memory = START BACKGROUND

The system automatically updates this background every second using a special process that creates an accurate measure of the local background referred to as LOCAL BACKGROUND.

The Gamma BG Factor is a parameter in system memory set by the user (adjusted via a PC program by the expert user – see Section 3.4).

The unit automatically sets the ALARM THRESHOLD by applying the Gamma BG Factor to the background. As an example if the LOCAL BACKGROUND = 10 cps and the Gamma BG Factor = 5.0 then the ALARM THRESHOLD = 10 x 5.0 = 50 cps

Note that the local background is constantly updated UNLESS AN ALARM OCCURS – in which case the updating is suspended until the alarm is cancelled and Monitoring is restarted. It is strongly recommended the user make themselves sure by Search measurement that the background is truly reflective of only the local radiation levels.

Also note that, after using this technique, the ALARM THRESHOLD once set makes the unit usable in any local radiation setting WITHOUT FURTHER UNIT ADJUSTMENTS – so this alarm level automatically changes itself to adapt to local radiation conditions. So all units can be set to the same level of sensitivity, requiring NO FURTHER USER ADJUSTMENTS.

2.9 SEARCH SCREEN

If the user presses the SHORT-MODE the display changes to the SEARCH mode.

<p>12:57 \checkmark \blacktriangleleft \blacksquare SRCH N 0 234 \blacksquare \square \square \square</p>

ICONS – top row is the same as for MONITOR screen

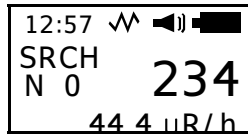
SRCH – this shows that the unit is in the SEARCH mode

234 – this is the count rate in counts/second and changes with radiation intensity

N 0 – this is the NEUTRON count rate in counts/second

BAR GRAPH – shows the Gamma intensity in counts/second (zero to the left – 500 cps to the right)

NOTE: If the count rate exceeded 500 cps the dose rate replace bar graph under the count rate. The user is now informed about any danger during searching.



Press the SHORT-MODE button at any time to return to the MONITOR display

2.9.1 SEARCH ACTIONS

With the unit in the SEARCH mode various actions occur:

- As the unit is moved near radioactive material the COUNT display (2345 above) will increase to show that the radiation intensity is increasing.
- If any NEUTRONS are detected during the scan process the N data will be displayed in counts/second.
- The BAR GRAPH at the bottom will increase (to the right) to show the radiation increasing. Note for simplicity this is a low count-rate scale so each "box" segment is approx. 100 counts/second. Thus the bar graph will change rapidly from the left edge (zero) but as the radiation intensity increases to 500 counts/second it will be full no matter the radiation changes. The audio signal works perfectly at this high level of radiation. Using this technique the user has high sensitivity at low count rates making it easier to detect small changes.
- As the radiation intensity increases, the AUDIO frequency will increase proportionally (if enabled), thus making it easy to locate the actual source in an "eyes-free" mode.

2.10 INTERNAL FUNCTION SETUP

There are 3 internal functions that the user can select:

- BUZZER – select ON or OFF – this determines whether the internal buzzer (or earphone) is active for alarms and search. It is highly recommended that this function be enabled.
- VIBRATOR – select ON or OFF – some users want a covert alarm capability so they want the vibrator ON. It is recommended placing the GR-100 into the breast pocket in this case. The vibrations can be easily passed by when GR-100 is situated on the belt. However since the vibrator uses a lot of battery, if this function is not really essential, it is recommended that the vibrator be set OFF to conserve battery life.
- BACKLITE – select ON or OFF – in low light conditions the backlight makes the display substantially more visible. If ON, the display is illuminated during switching ON procedure; in case of ALARM, during SEARCH mode operation and 10 seconds after any MODE button activation. During backlighting the battery drain is increased about 10 times. Normally it decreases the battery life 2 or 3 times according to the ratio between MONITOR and SEARCH mode. In the rare occasions that this feature is actually required it can be temporarily enabled as described below. So normally it is recommended that this function be OFF.

2.10.1 FUNCTION SELECTION

From the MONITOR (MON) display press LONG-MODE until you see

PARAMETERS
SETTING

then release the MODE button.

The display will then show the functions that are currently active. Pressing SHORT-MODE steps through these functions in the following sequence:

BUZZER ON

VIBRATOR ON

BACKLITE ON

< ALL OFF >

BUZZER ON
VIBRATOR ON
BACKLITE ON

BUZZER ON
VIBRATOR ON

BUZZER ON
BACKLITE ON

VIBRATOR ON
BACKLITE ON

Pressing SHORT-MODE steps through these sequences continuously until the required selection is made (BUZZER ON and everything else OFF is recommended for most applications).

Note that vibrator increases the current consumption 10 times at the time of its operation. It does not have a great influence on battery life because it operates only in case of alarm, but when battery has low capacity it can stop GR-100 operation much sooner than usual.

During backlighting the battery drain is increased about 10 times. Normally it decreases the battery life 2 or 3 times according to the ratio between MONITOR and SEARCH mode. In the rare occasions that this feature is actually required it can be temporarily enabled as described below.

Press LONG-MODE until ACCEPTED is seen, and then release it (note if you hold the MODE down longer than 5 seconds the unit will power off (see Section 2.4). However in this case the settings are stored in memory so the unit can be powered on again.

2.11 SETUP

The GR-100 is supplied with an external RS-232 cable that plugs into a connector on its base. The cable is connected to a PC running the supplied Monitor GR-100 software supplied by Exploranium.

Operating instructions for this software are in Section 3 of this manual.

2.12 EARPHONE

The earphone supplied with the unit can be used in noisy environment, or in covert operations. The earphone can be plugged into a special connector on the base of the unit after opening the rubber cover.

The earphone connector is located under the rubber cover on the left-hand side. The right-hand side is fixed to avoid the loss of the cover. When connected it automatically disables the internal AUDIO speaker.

NOTE: The BUZZER must be enabled for this function to work.

When the earphone is unplugged the unit automatically reverts to internal audio functions.



Figure 2.1 - Earphone Connection

If the GR-100 is used with the belt mounted leather carrying pouch, connect the right-angle earphone plug as shown in Figure 2.1. Hold the cable along the left side of the case and insert the unit into the leather pouch with the cable running along the side of the pouch as shown in Figure 2.2. There is space provided inside the pouch for the connector to fit. GR-100 can be taken out without disconnecting the earphone.



Figure 2.2 – Earphone Used in Belt Pouch

2.13 BATTERY CHARGING

The GR-100 is able to charge Ni-Cd or Ni-MH batteries without removing them from the unit. Exploranium supply the 110 VAC/12 VDC or 220 VAC/12 VDC adapters with the standard 2.5 mm power plug on its cable. Connect this with power cable adapter supplied as option.

CAUTION: Using any other cables can cause fatal damage to the instrument!

Open rubber cover located on the bottom of the GR-100 and insert power cable adapter to appropriate connector in the center. Handle the cover on its left hand side where the earphone connector is located.

The right-hand side is fixed to avoid the loss of the cover. The user must be sure that proper battery type is selected! If not, remove the battery, check its type and switch GR-100 ON. The request for battery type appears during start up procedure with new battery (see Section 2.3).

Connecting the power supply to main power begins the charging process, whether the equipment is ON or OFF.

NOTE that this function is disabled in the PARAMETERS SETTING.

IMPORTANT: Never connect external power to the GR-100 if the battery is not correctly placed in the battery compartment!

The yellow LED is shining continuously to indicate charging mode and the next screen is visible on the display.

CHARGING ON	
TIME	0 min
1.40V	221mA

The charging time in minutes is displayed in the middle row; the voltage on the batteries and actual current is in the bottom row. Normal battery charging from fully discharged to fully charged takes out about 8 hours for the rechargeable batteries specified in the Section 4.8 A. Exploranium suggests overnight charging.

When the battery is charged to about 95 % charging goes to the trickle mode and the yellow LED starts flashing once every 10 seconds. The display indicates end of charging but every ten seconds charging continues to conserve full battery capacity.

BAT. CHARGED	
TIME	468 min
1.40V	

After disconnecting the power adapter the GR-100 returns to previous point of operation. From MONITORING or SEARCH mode goes to BACKGROUND UPDATING and then to MONITORING mode. Being switched OFF before charging switches the unit OFF. If charging was started from the display BATTERY DISCHARGED SWITCH OFF or LOW BATTERY message, the Start up procedure checks the battery voltage.

Note that charging of the battery must be done in an area within temperature range 10°C - 30°C.

2.14 BELT MOUNTING

- The GR-100 box is equipped with a clip for breast pocket or belt mounting, and is also furnished with a leather carrying case, which can also be attached to the belt. If GR-100 is used with carrying case only, the clip should be unscrewed from the unit for smooth insertion into case.
- If the earphone is used for covert exploration with belt mounted leather carrying case, connect the plug and insert GR-100 into the leather case with the cable on the left-hand side of the equipment and close the case. There is space enough for the connector inside the case.

It is then easily possible to take out the GR-100 from the case and follow the display during SEARCHING without disconnecting the earphone.

2.15 GAMMA ALARM TEST

For fast and easy alarm test, use delivered reference source. Run GR-100 in the monitor mode and move the delivered reference source close to the backside of the instrument according to the arrow on the Figure 2.1. GR-100 must show GAMMA ALARM (see Section 2.8) within 2 seconds.

NOTE: Used reference source has very low activity ($0.25 \mu\text{Ci} = 9.25 \text{ kBq}$) of Cesium-137. It does not count as a radioactive source. Using this by operator for testing purpose is regular and safe.

3.0 MONITOR GR-100 SOFTWARE FOR PC

This software permits the user to setup correct operating parameters as well as retrieve internal data for analysis and record keeping.

3.1 SOFTWARE INSTALLATION

The software Monitor GR-100 is supplied on the CD ROM. Copy the directory "MonitorGR100" from the CD to your PC via Windows Explorer or similar software. Then made shortcut to Mon100.exe on the desktop for easier software launching.

NOTE: It is also possible to run the Mon100.exe from the CD directly.

3.2 START OF OPERATION

Open rubber cover on the bottom side of the GR-100. Handle the cover on the left hand side where the earphone connector is located. The right-hand side is fixed to avoid the loss of the cover. Connect the GR-100 equipment to the PC serial port via the serial cable supplied by Exploranium. Note the serial port number.

CAUTION: Use only communication cable supplied by Exploranium. Using any other USB cable can cause fatal damage to the GR-100 or PC.

The double click on the software icon on the desktop starts the software. The Main Menu appears on the screen (See Fig. 3.1). The operation is done via upper menu bar.

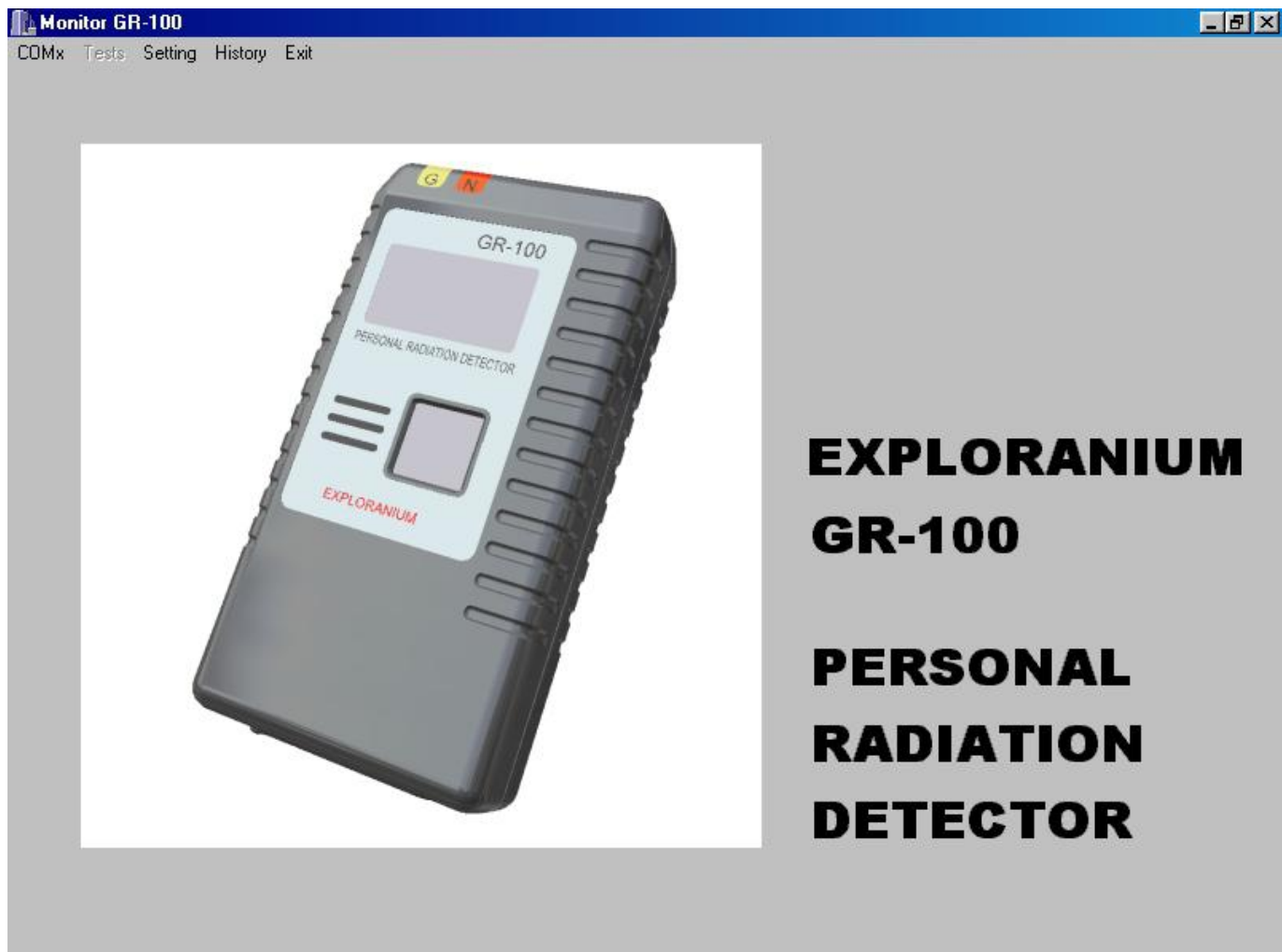


Figure 3.1

NOTE: If you start the Monitor GR-100 software sooner than the GR-100 is connected, communication problems between PC and the equipment can occur. In this case the software gives the error message and stops the operation. Start Monitor GR-100 again after proper connecting and continue your work.

First the communication port must be selected. Clicking on COMx button opens a window with a list of the serial ports (See Fig. 3.2). Select the appropriate one by mouse clicking to its point or name and return to the Main Menu. If the selected port does not exist, an error message appears on the screen.

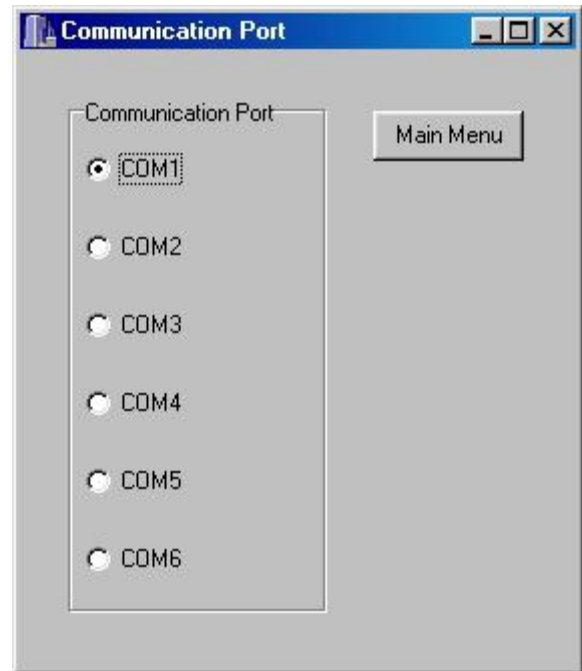


Figure 3.2

3.3 TESTS

The tests menu is useful only for service technicians so it is not available in the customer version of this software.

3.4 PARAMETER SETUP

Clicking on the Setting button opens a new window for parameter setup (See Fig. 3.4).

The right-hand side of the screen has some buttons for saving or renewing the parameters in the equipment. The GR-100 operates with "Customer" parameters that are set from the factory to the same values as "factory" parameters. If the customer desires he can change some of them and save them as "Customer" parameters. From this point the equipment will work with this set. During the operation it is possible to change some parameters in the equipment (see Section 2.10.1). In case of switching GR-100 OFF and ON the equipment goes to "Customer" set.

- The Get Factory button takes the factory set of parameters from the equipment and display them on this screen. Factory parameters are displayed in black text. Modification of any parameter causes changes the text to red.
- Modified parameters can be saved into the GR-100 via Save Customer button. The set of customer parameters can be load via Get Customer button.
- The Main Menu button quits this window and returns the software to Main Menu window.

The main part of the Parameter area, named CUSTOMER Parameters, involves setting of the parameters to the GR-100. The most important fields are Dose Units, Alarm Threshold and Date/ Time in the Info menu. The Vibrator, Buzzer and LCD can be selected in the PARAMETERS SETTING in GR-100 (see Section 2.10.1), the Discriminator values are only for service technicians and the rest of Info informs customer about various other system parameters.

- The units for dose rate measurement can be selected in the area labeled Dose Units. The Gy/ hr (Grays per hour) are used for radiation dose rate especially in Europe, the R/ hr (Roentgens per hour) are used for exposure especially in America and Sv/ hr (Sievert per hour) are used for equivalent dose rate when health risk to humans is assessed.

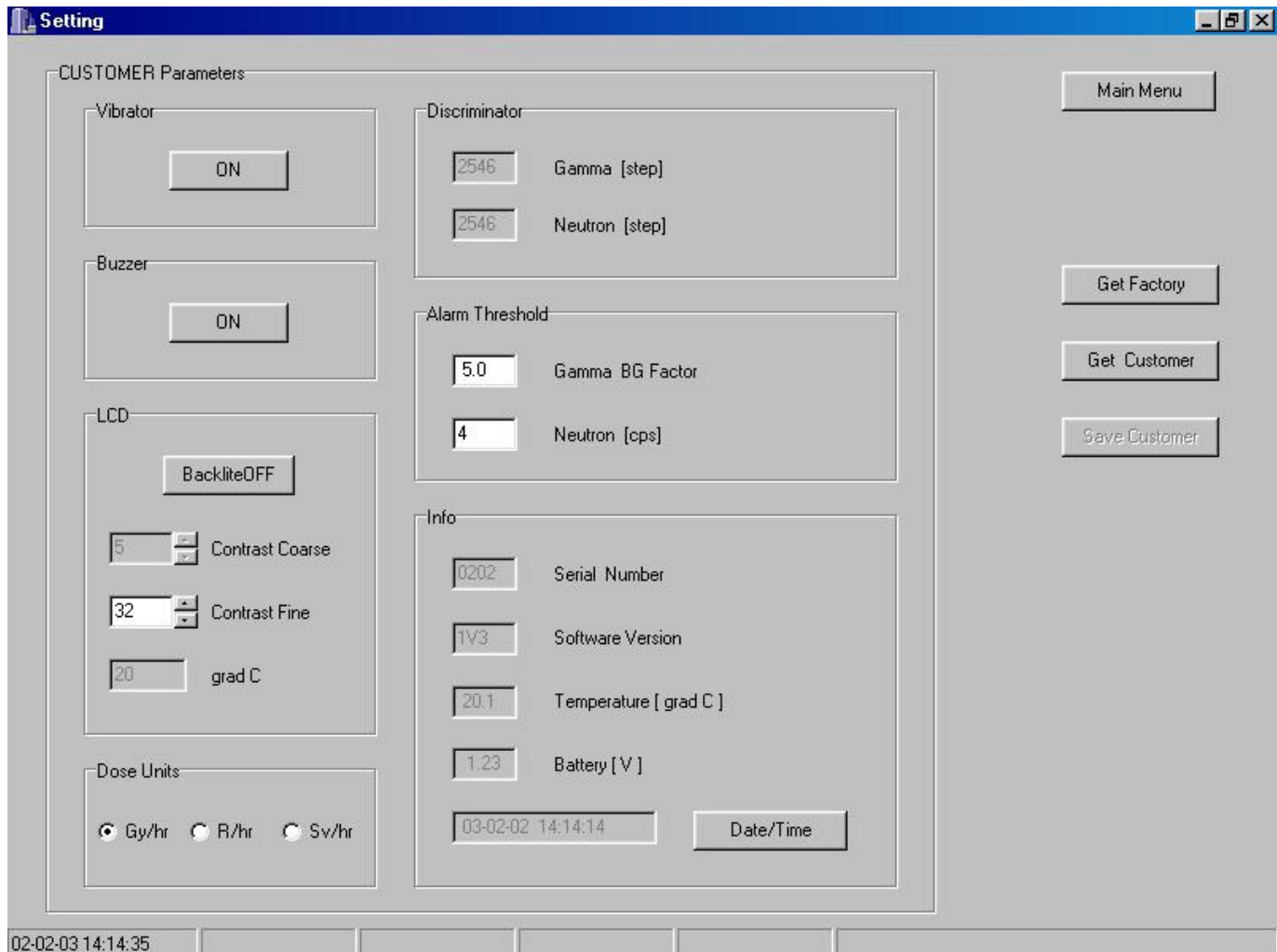


Figure 3.4

- The Alarm Thresholds area allows setting of the sensitivity of the GR-100 for gamma and neutron alarms for monitoring mode of operation. The Gamma BG Factor set the multiplication factor of gamma background that gives the count rate, which causes the alarm. For example, if gamma background is 10 cps, Gamma BG Factor is set to 5.0; that means $10 \times 5.0 = 50$ cps is the threshold for gamma alarm. The neutron setting is simpler since background is nearly zero. The value in the field Neutron [cps] directly gives the threshold for neutron alarm. The Factory values 5.0 for Gamma and 4 for Neutrons are the lowest values, which do not gives false alarms for the background about $40 \mu\text{Gy/hr}$.
- The Info area allows setting of the date and time after initialization of the GR-100. The customer is informed here about the Serial Number, Software Version, latest Temperature [grad C] used for automatic LCD contrast correction, Battery [V] voltage and equipment Date/ Time. Pressing the Date/ Time takes date and time running in the computer.
- The Vibrator area has a button for enabling = ON or disabling = OFF the vibrator warning in case of alarm in monitoring mode. Note that vibrator increases the current consumption 10 times at the time of its operation. It has not a great influence to battery life because of it operates only in case of alarm, but when battery has low capacity it can stop GR-100 operation much sooner than usually.
- The Buzzer area has a button for enabling = ON or disabling = OFF the buzzer warning in case of alarm in monitoring mode.
- The LCD area allows enabling = BackliteON or disabling = BackliteOFF light of the display and to set Contrast Fine to the optimal value. The Contrast Coarse and the temperature (grad C) in the next fields are only for information. Note that backlighting increases the current consumption 10

times, which has a great influence to battery life! The Contrast Coarse is set in the factory usually to 5. The Contrast Fine could be set in the range from 0 to 64, while the standard value is 32. Changing this value by 1 step is a practically invisible change in the display contrast, but from the totally white to totally black is about 35 steps. The displayed temperature is the reference temperature for automatic display contrast correction.

- The Discriminators area informs user about the discrimination levels for gamma and neutron measurement.

3.5 DATA RETRIEVAL

Clicking on the History button opens the new window for loading the data from the equipment (See Fig. 3.5).

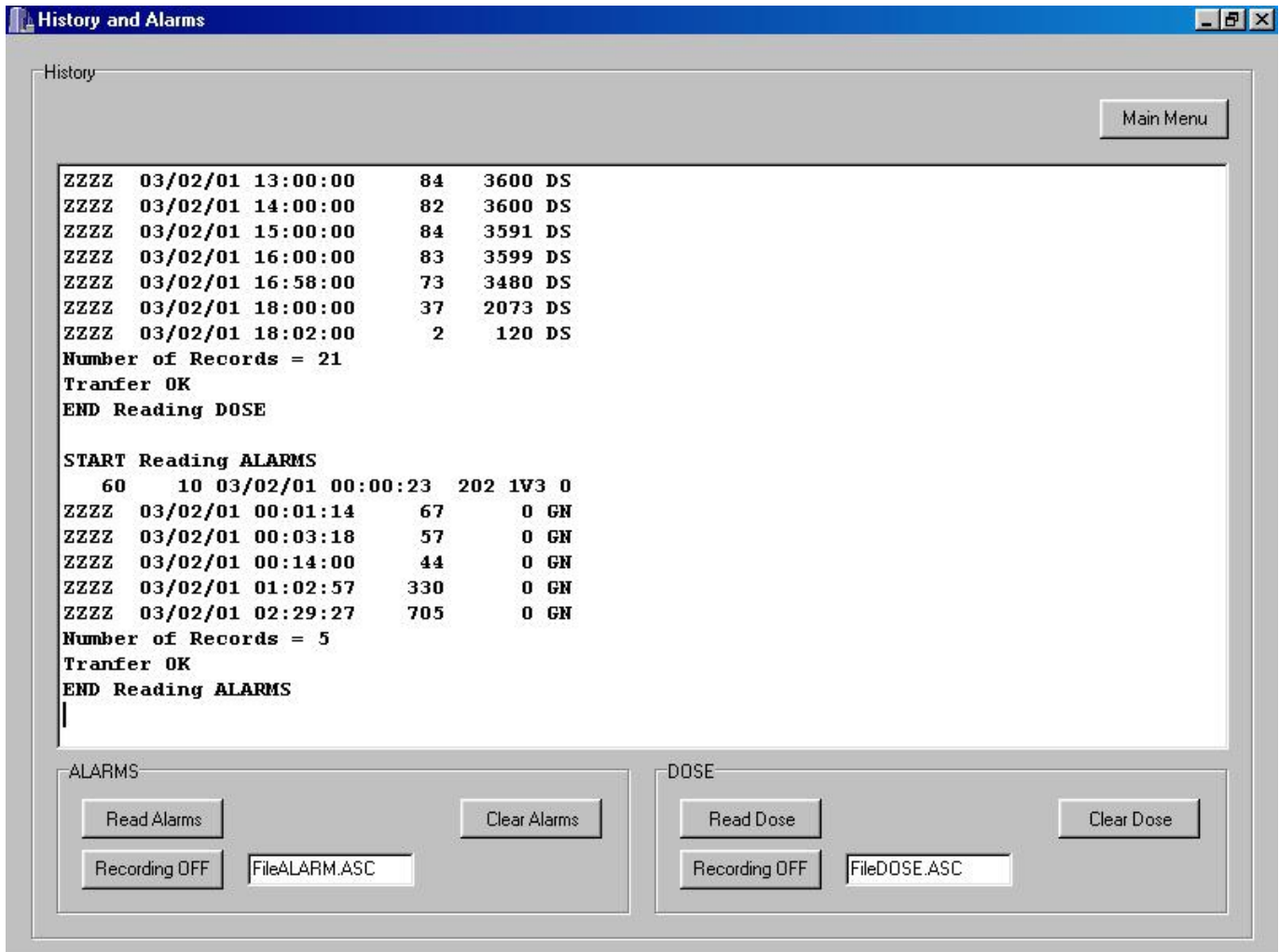


Figure 3.5

3.5.1 ALARM DATA RETRIEVAL

The Read Alarms button in area labeled ALARMS is used for retrieving the alarm data. The data are automatically stored into the file named in the field next to Recording ON button. The default name is FileName.ALA. For the future, it is strongly recommended to save it into the file with different name since the next retrieved alarm data will replace the file with the newer one. Using the ".ALA" suffix is useful for next orientation in files. The messages about provided actions, stored data, possible warning or error messages are displayed in the large white field. Switching the Recording ON button to

Recording OFF alternate causes the data to not be stored.

The data is stored in a file with header following by the data. File with an alarm looks like:

```
20 10 03/01/15 08:04:16 2801 1V3 0
ZZZZ 03/01/21 10:04:42 128 0 GN
```

The header contains write (20), read (10) and additional (0) pointer in memory, date (03/01/15) and time (08:04:16) of this file initialization, serial number (2801) of GR-100 and SW (1V3) version. One alarm is stored on one row with synchronization label (ZZZZ), date (03/01/21), time (10:04:42), total gamma count rate (128), neutron count rate (0) and label of event ("GN" = alarm, "WD" = watch dog reset of the equipment).

Clicking on the Clear Alarms button deletes the records from the GR-100 memory to enable it for the next operation. The user should check to ensure data is correctly stored.

3.5.2 ACCUMULATED DOSE RETRIEVAL

Retrieving the dose data is provided in the History window (See Fig. 3.5); similar to Alarms retrieving but from the screen area labeled DOSE. The READ Dose button selection begins reading the dose data from the equipment. The dose data is automatically stored into the file specified in the field next to Recording ON button. The default name is FileName.DOS. For the future, it is strongly recommended to save it into a file with a different name, since the next retrieved dose data will replace the file with the newer one. Using the ".DOS" suffix is useful for orientation of files. The message about provided actions, possible warning or error messages are displayed in the big white field. Switching the Recording ON button to Recording OFF alternate causes the data to not be stored.

The data is stored in a file with header following by the data. A file with dose data looks like:

```
1040 1030 03/01/15 08:04:16 2801 1V3 1
ZZZZ 03/01/21 10:04:42 47 2700 DS
```

The header contains write (1040), read (1030) and additional (1) pointer in memory, date (03/01/15) and time (08:04:16) of this file initialization, serial number (2801) of GR-100 and SW version (1V3). One dose record is stored on one row with synchronization label (ZZZZ), date (03/01/21), time (10:04:42), total gamma dose (accumulated during the latest period) in nGy, nSv or nR according to the selected unit (47), total time in seconds the dose were accumulated (2700) and label of event ("DS" = dose data).

NOTE: The data is stored every hour on the hour and during the switching OFF procedure. So the period of accumulation is maximally 1 hour (3600 seconds). The data from the last hour before connection to PC are also loaded without saving in the GR-100 memory. If the memory is not cleared this data will be stored together with the rest of this hour data.

Selecting the Clear Dose button deletes the records from the GR-100 memory to enable it for next operation. The user should check to ensure data is correctly stored.

4.0 GR-100 TECHNICAL SPECIFICATIONS

4.1 GAMMA DETECTOR AND ANALOG PROCESSOR

Detector:	Cesium-Iodide (Thallium) [CsI(Tl)] 0.3 cu ins (5 cm ³) volume detector, 0.5" diam * 1.5" long (13 mm dia x 38 mm long) with an integral bi-alkali PMT
Energy Range:	from 40 keV
Sensitivity:	15 cps per 1 MBq at 1 m distance using Cs-137.
Number of channels:	3 channels (Ch# 1, 2, 3)
Maximum count rate:	9 999 cps
Modes of measurement:	Monitoring, Searching

4.2 NEUTRON DETECTOR AND ANALOG PROCESSOR

Detector:	Lithium-Iodide solid state detector
Sensitivity:	1 cps per 0.01 µg 252 Cf (about 20 000n/s) at 0.25 m distance average background 0.05 cps
Number of channels:	1 channel (Ch#4)
Modes of measurement:	Monitoring, Searching

4.3 MONITORING

Sample time:	1 s
Gamma alarm level:	selectable 3.0 – 10.0 times background automatic background correction
Neutron alarm level:	selectable 3 – 10 cps
Audio Alert :	Buzzer: OFF, ON.
Visual Alert :	Red LED for Neutron Alarm Yellow LED for Gamma Alarm
Vibrator:	ON, OFF

4.4 SEARCHING

Response:	Variable tone buzzer LCD Bargraph up to 500 cps Count rate on LCD Dose rate (if count rate > 500 cps)
Audio meter:	0.5 second response Variable tone, linear from 200 to 4000 Hz Automatic background correction

4.5 DOSEMETER

Sample time:	1 s
Response:	10 s time constant
Energy range :	60 keV - 1.5 MeV
Meas. units:	Selectable R, Sv, Gy
Meas. range:	10 μ R/h - 10 mR/h (100 nSv/h – 100 μ Sv/h)
Dose accuracy:	+/- 50%
Output:	PC

4.6 CLOCK – CALENDAR

Type:	Built in 24-hour clock, 4-year calendar (including leap year) 1 minute battery backup, then reset to zero
Precision:	+/- 3 s/day at 25 deg. C +/- 30 s/day over full operating temperature range

4.7 DATA STORAGE

Type:	8 kB CMOS nonvolatile memory
Capacity:	256 alarm events, including time/date (SEARCH and DOSE mode) and 256 dose records data
Stored Data Retrieval:	Via serial channel to a computer.

4.7.1 DATA OUTPUT

Type:	Serial channel RS-232C, 1 start bit, 8 data bits, no parity, 1 stop bit.
Baud Rate:	2400 Bd.
Format:	Binary

4.8 DISPLAY

Type:	WTSTN (Wide Temperature Super Twist Nematic) graphics LCD, 106 x 56 pixels, LED backlight
Viewing area:	30 x 16 mm.
Contrast:	Automatic Temperature Correction

4.9 POWER SUPPLY OPTION

A. Rechargeable Battery

Type:	1 "AA" cell, 1.2 V Ni-MH (Nickel Metal Hydride) or 1.2 V Ni-Cd (Nickel Cadmium)
Operation time:	Typically 200 hours of monitoring at 25 °C, no backlight, with 2.0 Ah Ni-MH 120 hours of monitoring at 25 °C, no backlight, with 1.1 Ah Ni-Cd
Charging:	Inside GR-100 by external 12 VDC, constant current float charger, overnight charging, charging status and full charge indicated on display External power adapter 12 VDC (from 9 to 15 VDC)

B. Primary Battery

Type:	1 "AA" cells, alkaline 1.5 V
Battery Life:	Typically 280 hours of monitoring at 25 °C, no backlight, with Alkaline VARTA #4006 (2.8 Ah)

4.10 CONNECTORS

Serial Channel and Ext. Power Supply:	USB mini "B" jack
Mating connector:	only via Exploranium special cables
Earphone:	2.5 mm mono jack
Mating connector:	2.5 mm mono plug
Charger:	2.5 mm circular jack, +12 V on the center pin

4.11 PHYSICAL

Dimensions: L = 4.7" (120 mm)
 W = 2.5" (63 mm)
 H = 1.0" (25 mm)

Weight: 0.19 kg (0.42 lbs) including battery

4.12 ENVIRONMENTAL

Operating Temperature Range: - 15 to + 50 °C

Storage Temperature Range: - 20 to + 60 °C

Protection: Weather proof, dust and water sealed (no immersing).

Non-condensing Relative Humidity: Less than 90% at 35°C.

RFI/EMI Emission: Complies with FCC rules (47 CFR Part 15) for class A.

4.13 ACCESSORIES

Standard:

- GR-100 Unit
- Two AA Alkaline Batteries
- CD ROM with Monitor GR-100 Windows software
- RS-232 data cable for PC connection
- User's Manual
- Belt mounted leather carrying pouch
- Earphone with volume control
- Shipping Case

Optional:

- 110 VAC/12 VDC Power Adapter for battery charging (220 VAC optional) with cable
 - Reference Source Cesium-137 (0.25 µCi)
 - Rechargeable Nickel-Cadmium Battery
 - Rechargeable Nickel-Metal Hydride Battery
-

APPENDIX A – ERROR MESSAGES

DISPLAY MESSAGE	PROBLEM	ACTION
NO COUNTS	Gamma channel isn't working	Sent to repair to the nearest service center
LOW COUNTS	Unit is situated in a very low background area (caves) Gamma channel has a low gain	Continue with the measurement Sent to repair to the nearest service center
HIGH COUNTS	Unit is in the radioactive area when the background is updating Gamma channel is noisy	Go to the clean area without any radioactive sources Sent to repair to the nearest service center
BATTERY OVERLOADED	Wrong battery Short circuit in the unit	Change battery Sent to repair to the nearest service center