PM704
Portal Monitor
Operation and Service Manual

D00025 May 23, 2016 Rev. 3

Rapiscan® systems

An OSI Systems Company

Foreword

Thank You for choosing a Rapiscan Detection product. This manual is intended for the installation and normal daily use of the equipment. In addition to these instructions, local laws and regulations, and requirements by authorities shall be observed.

The user should read this manual and understand its contents before the installation or use of the equipment.

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Content of this Manual

We have made an effort to ensure that the information in this manual is accurate as of the date of publication. However, the product that you have purchased may contain options, upgrades or modifications not covered by this manual.

If you have any questions about the content of this manual or the product that you have purchased, please contact Rapiscan Systems Customer Service.

No Warranties

The provision of this manual to you creates no express or implied warranties of any kind, including, without limitation any warranties with respect to the accuracy, applicability, completeness or fitness of this manual for any particular purpose.

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Any modification or alteration made to the system after purchase by the customer or their agents without written authorization from Rapiscan Systems Service Department Management will void any warranty issued to the customer. Additionally, Rapiscan Systems is not liable for any damage that might be caused by any unapproved changes or modifications.

Revision History

Name of Document: Operations & Service Manual, PM704

Document Number: D00025, Revision 3

Rev.	ECN #	Date	Name	Comments
A		2014-08	CB	Initial draft.
B		2014-10	CB	Several additions
1		2014-10	CB	Changed to Rapiscan numbering system
2		2015-01	CB	Updated safety, liability, graphics, photos and more
3		2016-05	CB	Updated formatting

Table of Contents

CONFIGURATION TRACKING SHEET

RAPISCAN MODEL NUMBER: _____ SERIAL NUMBER: _____

SOFTWARE VERSION: _____ DATE RECEIVED: _____

OPTIONS AND ACCESSORIES: _____

SYSTEM MODIFICATIONS

MODIFICATION: _____
_____

INSTALLED BY: _____ DATE: _____

MODIFICATION: _____
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1 IMPORTANT INSTRUCTIONS

Read through this chapter carefully before operating the equipment. Keep this manual so that it is always readily available to the user.

The instructions in this manual shall be followed in all situations, when installing, using, or servicing the equipment. Rapiscan Systems cannot be held responsible for any personal or material damage caused by use contradicting the instructions given in this manual.

All safety regulations must be observed. A dangerous or unsafe manner of operation may be a health risk.

Installation may only be carried out by qualified persons.

Before installing, operating or servicing the equipment, make sure that it poses no risk of personal or material damage.

Be aware that although the PM704 system is heavy it may fall down if a heavy force collides with it. To minimize the risk of tilting, the PM704 base must have its footplate attached.

Do not operate the equipment unless you are fully trained to do so. The operator must know the use, service, and safety instructions of the equipment, and local safety regulations. Service of Rapiscan products shall be performed only by a Rapiscan Systems qualified service provider or authorized contractor qualified service provider. Make sure that there are no unauthorized persons in the working area when servicing and repairing the equipment.

It is forbidden to operate the equipment when ill, or under the influence of alcohol or drugs.

The equipment may not be connected to mains supply until all other connections necessary for the installation are completed.

The equipment shall always be connected to an earthed socket outlet.

The equipment shall be disconnected from mains supply and the battery pack removed before servicing, cleaning, or moving it. If the unit is to be stored for longer than a week the batteries should be removed from the battery holder and stored separately.

Original PM704 spare parts should be exclusively used.

Use a damp cloth for cleaning the equipment. Do not use any chemicals or liquid detergents.

The end user is responsible for the final calibration of the equipment for the intended application. It is also the end user's responsibility to regularly verify calibration to the desired sensitivity level by using a suitable test object or objects.

If there is any reason to suspect that the security level of the equipment may have deteriorated due to incorrect operation or external damage, the equipment should be removed from operation and an authorized service provider should be called in.

1.1 Types of Alert Messages

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or equipment damage or generally unsafe practices

NOTICE

Indicates an important notice to the reader that does not necessarily involve the possibility of personal injury or equipment damage

All warnings, cautions, notices and instructions presented in this manual should be read and followed by all personnel who will use or maintain this equipment

Failure to follow all such warnings, cautions, notices and instructions may result in damage to the equipment and/or injury or death to personnel. Such failure may also nullify any warranties provide by the manufacturer

1.2 Symbols used on Unit and in Manual

General Warning Sign

This sign is used to alert the user to potential hazards. All safety messages that follow this sign shall be obeyed to avoid possible harm.

Recycling Symbol

This symbol means that according to local laws and regulations this product should not be disposed of in the household waste but sent for recycling.

CE Symbol

CE marking on a product is a manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety and environmental protection legislation.

Symbol for Direct Current (DC)

2 INTRODUCTION

2.1 SCOPE AND PURPOSE OF MANUAL

This manual is designed to enable operating and service personnel to properly operate and care for the PM704. Since applications are necessarily site-specific, operation procedures are given in general terms. Service and repair are covered to the board level. Anything more complex than this requires that the instrument or assembly be returned to Rapiscan Systems.

2.2 GENERAL DESCRIPTION

The Portal Monitor, Model PM704, is a highly reliable system for the detection of radioactive isotopes. The PM704 is used to monitor personnel. It can be set up quickly with a minimum of training.

When the portal is not occupied, the system will automatically monitor background radiation and periodically update a visual display on the controller. When a person enters the portal, the system begins fast count monitoring and will alarm if the count exceeds a predetermined alarm level. The system will also alarm if the background radiation level exceeds or falls below preset limits.

The system consists of two vertical pillars, two footplates, and an overhead cross-piece which serves as an interconnect. The system electronics are mounted in the cross-piece. The pillar spacing is fixed at 32" to provide adequate clearance for wheelchairs. The PM704 may be powered by eight "D" sized alkaline cells which provide at least 10 hours of continuous operation; or from 100 - 240 Vac, 50 - 60 Hz power using the power supply included with the system.

Each pillar contains a radiation detector assembly and detector module. The system controller and occupancy detector are mounted on the cross-piece.

PM704

2.3 ENVIRONMENTAL CONDITIONS

Normal Operation:
Temperature rating is 0°C to 40°C.
Ambient Relative Humidity: 5% - 95% (non-condensing)
Altitude: -200 to 14,000 ft. (-60 to 4,267m)

Storage and Transport:
Temperature: -40° to 185°F (-40°C to 85°C)
Ambient Relative Humidity: 5% - 95% (non-condensing)
Altitude: -200 to 50,000 ft. (-60 to 15,000m)

2.4 SPECIFICATIONS

Detectors:
One 3" x 72" x 1.5" (7.5 x 180 x 3.8cm) organic plastic scintillator in each pillar, for a total detector volume of 648in3 (10.6 liters) per system

Sensitivity:
1µCi of 137Cs

Power:
Battery: Eight "D" size alkaline cells provide >10 hours of continuous operation

Power Supply:
Mains input: 100-240V-/0.6A/50-60Hz

Passage Time:
Normally 0.5 seconds on a walk-through basis

Serviceability:
Self-checking routines and easily performed tests simplify board level trouble shooting. The modular design allows quick and easy repair and maintenance.

Weight:
Approximately 128 lb. (58kg) total

Dimensions:
Two, 11" x 4.5" diameter x 87.5" high pillars (28 x 11.43 x 222.25cm), with a crossover which provides 32" (81cm) pillar spacing

3 INSPECTION AND SET-UP

The following procedures should allow on-site personnel to correctly set up the PM704 for normal operation. Follow the procedures in the order given. A Checklist is included at the end of Section 3. It is recommended that a copy of this be filled out after initial installation and whenever the PM704 is put into service after prolonged storage.

3.1 INSPECTION

Immediately inspect the instrument for mechanical damage, scratches, dents or other defects. It should be examined for evidence of concealed as well as external damage.

3.1.1 DAMAGE CLAIMS

If the instrument is damaged in transit or fails to meet specifications upon receipt, notify the carrier and Rapiscan Systems immediately. Shipping cartons, packing materials, waybills and other such documentation should be preserved for the carrier's inspection. Rapiscan will assist in providing replacement or repair of the instrument if necessary.

3.1.2 STORAGE

If the instrument is to be stored for any length of time, disconnect power to the instrument, remove the battery pack, and remove the batteries from the battery holder. Care should always be taken to avoid subjecting the instrument to severe mechanical or environmental shock. The instrument should be stored in a dry, temperature controlled location.

3.1.3 SHIPPING

Before returning the instrument for any reason, notify Rapiscan Systems of the difficulty encountered, giving the model and serial numbers of the equipment. Rapiscan will furnish specific shipping instructions.

3.2 SITE SELECTION AND PREPARATION

Select a smooth, level site with enough space to accommodate the system and provide access for the personnel to be scanned.
Avoid positioning the equipment in a manner that makes disconnecting the unit difficult.

WARNING

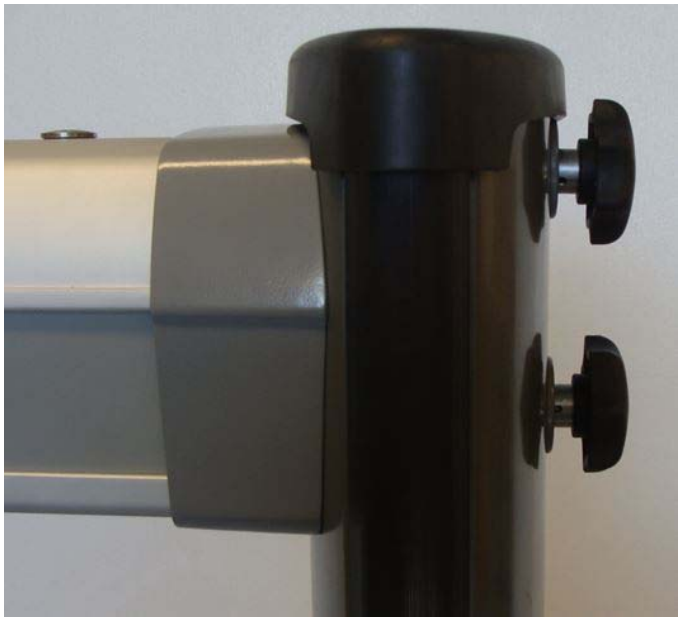
Operation of this unit in a manner not specified by the manufacturer may decrease or eliminate the unit's ability to detect radioactive materials.

3.3 ASSEMBLING THE SYSTEM TO SCAN PEDESTRIANS

1. Unzip the storage bag or unlatch the hard case and remove the pieces. There will be two vertical pillars, two foot plates, a cross-piece, a battery pack, and a power supply.

2. Attach the vertical pillars to the foot plates with the small hand screws, brackets, and Phillips head screws provided.

3. Attach the cross-pieces to the pillars using the four large hand screws provided.



4. Open the cover on the bottom of the cross-piece and plug in the Cat5 cable and the power cable for each of the pillars.

5. Stand the two vertical pillars upright, approximately 32" apart.

6. Verify that the power switch on the electronics box in the upper cross piece is in the "Off" position.

7. If the system is to be operated on batteries continue with step 8. If only operating on AC power then skip to step 12.

8. Install a fresh set of "D" cells in the battery pack and use the Velcro cinch strap to prevent the batteries from falling out during installation of the pack in the crosspiece.

9. Remove the wingnut from the battery pack mounting stud in the crosspiece.

CAUTION

Do not plug the battery pack into the electronics box until the battery pack has been secured to the crosspiece stud with the wingnut.

10. Slide the battery pack on the mounting stud until the pack has engaged the Velcro at the base of the mounting plate then install and tighten down the wingnut on the pack before releasing the pack.

11. Plug the battery pack into the electronics box.

CAUTION

The unit's detachable power supply cord must be rated for the input power being supplied for the unit.

12. Attach the properly rated power cable to the external power supply and plug the output connector from the power supply into the pillar. The connector on either pillar can be used to supply power to the unit.

13. Turn on the power switch to power up the PM704.

14. The unit may now be checked out and programmed.

4 SET-UP AND PROGRAMMING

4.1 START-UP AND SELF TEST

Turn on the power switch. The unit will reset and clear the system, then perform a Power On Self-Test (POST) which takes approximately ten seconds. The tests are displayed on the screen as they are run, if any test fails, the system will be halted. The problem must be corrected before operation can commence.

The alarm will be turned on for about four seconds. If all the tests have been completed successfully the system will go into the BACKGROUND Mode. The initial background acquisition takes twenty seconds.

When the background is complete, system status will be displayed. The status screen consists of four lines:

GAMMA = nnnn (background or COUNT, in CPS)
READY (system status, READY, TAMPER, OCCUPIED)
OCC: (number of occupancies)
mm/dd/yy hh:mm (date and time)

The system is now ready for programming and set-up.

4.2 SET-UP

The PM704 is fully calibrated at the factory. It is possible that these adjustments may be affected during shipment, so the calibration should be verified using the Field Calibration Procedures in Section 5.1.

The PM704 controller is a variation of the SC-770, a general purpose controller that is used in several different systems. It has many user programmable parameters that can be used to optimize it for a wide variety of applications. Refer to Section 3.4 for details on programming the controller.

4.3 PASSWORD CONTROL

The zero (0) key on the keypad is used to enter the set-up mode from the operating screen. Before the menus can be accessed, the password must be input, followed by the pound (#) key. If the password in not entered correctly, the system will return to the operating screen.

NOTICE

The password is set to "1234" and cannot be changed.

ENTER PASSWORD 0 NEW =	ENTER PASSWORD 0 NEW = 1234

4.4 PROGRAMMING THE SYSTEM

CAUTION

Once the password is entered and programming mode is enabled, all alarm functions are disabled. DO NOT leave the system in programming mode for normal operation!

CAUTION

Always verify the calibration of the system before attempting to program the system.

All of the system parameters are controlled from the system controller which is mounted in the cross-piece. In order to access the PM704, the cover must be opened on the cross-piece. The PM704 has a twelve-key keypad. Using this keypad, the operator can perform system set-up and diagnostic tests.

After the system has been powered up, and acquired its initial background, the set-up menu can be accessed. The parameters and diagnostic functions are protected by password access.

This section outlines the menus. A detailed description of the functions immediately follows. Pressing the number associated with the desired operation permits the operator to access that function. Pressing the zero key will display the next page of the current menu, where appropriate. Pressing the pound (#) key will return to the main menu from the sub menus, or return to normal operation if it is pressed at the main set-up menu.

When a parameter is with a "NEW =" prompt below it, a new value may be entered from the keypad. Pressing the asterisk (*) key clears the current operator entry, pressing the pound (#) key accepts the current value, or the new value that has been entered by the operator.

The set-up menu presents the operator with a choice of parameters or functions. Pressing the "one" key will present a menu of the available PARAMETERS. Pressing the "two" key will present a menu of the available FUNCTIONS.

```
1: GAMMA
0=MORE  #=EXIT
```

Selecting the desired menu choice will present the operator with another menu allowing the operator to access the appropriate parameters and or functions.

GAMMA

```
1: PARAMETERS
2: FUNCTIONS
0=MORE  #=EXIT
```

4.5 SC-770 Display Menu Options

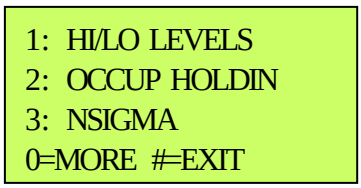
Factory Settings

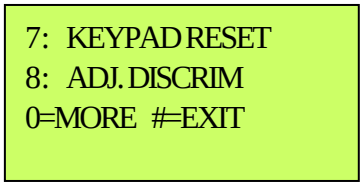
1:GAMMA	**1: PARAMETERS**	**1: HI/LO LEVELS**	½ Bkg of 1 det. (LO) / 3 x Bkg of 1 det. (HI)
		2: OCCP HOLDIN	Ensure scanning of departing object, 10 - Vehicle
		3: NSIGMA	4-10 (must enter leading zero)
		4: SET CLOCK	Military Time 24h, HH/MM/DD/YY
		5: DET. ONLINE	12
		6: BKG TIME	20 – (Use 1 & 7 to adjust)
		7: SHOW VERSION	SC1.10.1A – (Current Version)
		8: KEYPAD RESET	Normally not enables
		9: DISCRIM	0.068(LLD) & 0.455(ULD) Master & Slave
	2: FUNCTIONS	**1: SHOW COUNTS**	Both approximately the same
		2 VARIANCE	Must be below .150 after 5 passes
		3: CLEAR G-CNTS	Shows # of occ's & alarms since powered up
		4: F-ALARM TEST	Shows # of alarm comp made & # of alarms
		5: SYSTEM I.D.	1 (RS-232 only)
		6: PROFILING	ON (ASCII string via RS-232 & Ethernet)
		7: CALIBRATION	Starts the calibration routine
		8: RESET CAL	Restores the calibration to the factory default

4.5.1 PARAMETERS

To access PARAMETERS you will first have to press “0” followed by the password. The next screen gives you two options, 1. GAMMA and 2. COMM SET. Press 1 on the keypad. The next screen that comes up will give you 1. PARAMETERS and 2. FUNCTIONS. Press 1 to give you the following options:

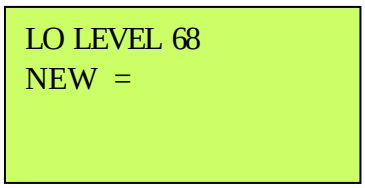
1. HI/LO LEVELS: Background alarm levels
2. OCCUP HOLDIN: Number of 200ms intervals to hold in after occupancy
3. NSIGMA: N*sigma radiation alarm level
4. SET CLOCK: Time and date
5. BKG TIME: Number and position of detectors in the system
6. SHOW VERSION: Displays the firmware version
7. KEYPAD RESET: Changes from auto reset to manual reset
8. ADJ. DISCRIM Discriminator adjustment

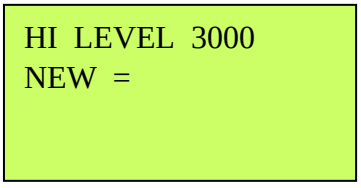




4.5.1.1 HI/LO LEVELS:

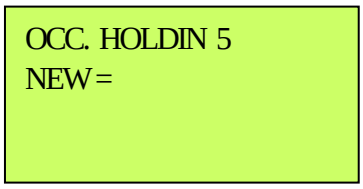
Sets the low and high background alarm levels, in CPS per detector. If the counts fall outside this window, the system will indicate a background fault, and not allow further operation until the problem is corrected. These levels should be set to alarm if the average background deviates too far from normal. These alarms are intended to flag a failure in the detector or electronics. The precise settings will vary with local conditions and requirements, but a good starting point is usually 50% of the average background (per detector) for the low and 150% of the average background (per detector) for the high.





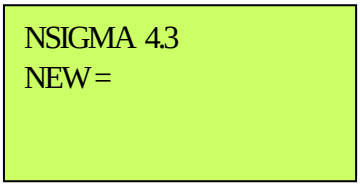
4.5.1.2 OCCUP HOLDIN

Number of 200ms intervals to hold in after the occupancy signal indicates the system is vacant. This prevents the person from attenuating the background. The factory setting is 5 intervals (1,000 milliseconds), but the optimum setting may vary with local conditions.



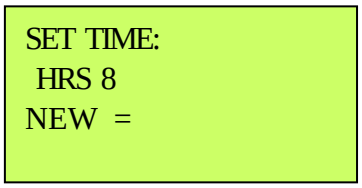
4.5.1.3 NSIGMA

Sets N*sigma radiation alarm level. Where N is the number entered and sigma = 1 background in CPS. This formula determines the number of counts, above background, that will trigger a radiation alarm.



4.5.1.4 SET CLOCK

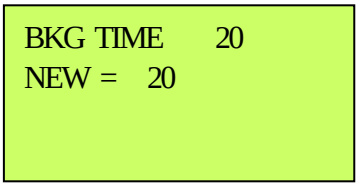
Sets the system time and date. The operator will be prompted to enter the hours (in 24-hour format), minutes, month, date, and year (last two digits only) from the keypad. When the pound (#) key is pressed after the last entry, the data are written to the internal clock/calendar.



4.5.1.5 BKG TIME

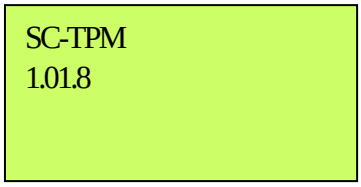
Sets the background counting time for the system. Press <1> to increment the time by 5 seconds, <7> to decrement the time by 5 seconds. Press <#> to accept the setting. Range is 20 - 120 seconds.

* If you have an area with large background fluctuations, you can increase the BKG Time to help average out those background spikes over a longer period of time (say ~1 minute).



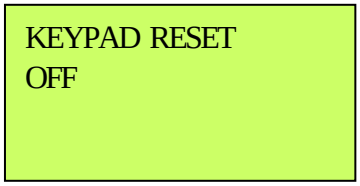
4.5.1.6 SHOW VERSION

Displays the software version number, press any key to return to the setup menu.



4.5.1.7 KEYPAD RESET

When enabled, requires any alarm to be silenced by using the keypad.



4.5.1.8 ADJ. DISCRIM

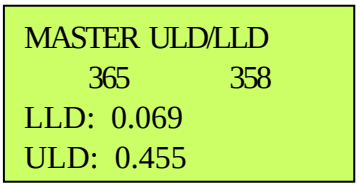
Opens the menu to adjust the LLD and ULD. The discriminators set the energy levels at which the system will be accept counts. If the isotopes are unknown, leaving the discriminators set at the factory defaults of 0.068 and 5.040 volts is normally acceptable. When the system is shipped from the factory, the discriminators are set to accept energy in the approximate range of 22 KeV to 1650 KeV. The settings are necessarily site specific, and may require adjustment to meet local requirements. The relationship of discriminator voltage to energy level, in KeV, is approximately 1 volt of discriminator level equals 330 KeV. Using this formula, the factory settings equal:

LLD 0.068 volts = 22.4 keV
ULD 5.040 volts = 1,650 keV

This relationship is an approximation. In practice, the actual values will vary slightly. Always test the system with the isotope(s) of interest to ensure maximum sensitivity. Refer to the formula for signal to background ratio in Appendix A for details on optimizing the discriminator settings for specific isotopes.

NOTICE

After changing the discriminator settings, always run a variance test to ensure that system noise is not affecting the count data.



Three methods of adjustment are provided:

1. **Direct entry**: Press the zero key from the "ADJUST ULD/LLD" menu. The operator will be prompted for a new LLD setting. Press the pound (#) key to accept the current setting. Three digits must be entered to change the value: volts, tenths of a volt and hundredths of a volt; press the pound (#) key to complete the operation.

NOTICE

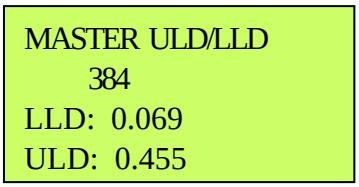
Since the Digital to Analog Converters (DACs) have limited resolution, manual entries will be rounded to nearest value the DACs can output.

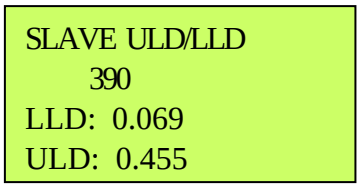
2. **Manual adjustment**: At the "ADJUST ULD/LLD" menu, the discriminators may be adjusted one step at a time while observing the count from both detectors.

The following keys are used:
1 increments the LLD by one step (approximately 0.0098 volts)
7 decrements the LLD by one step
3 increments the ULD by one step (approximately 0.0196 volts)
9 decrements the ULD by one step

When the settings are satisfactory, press the pound (#) key to accept the settings.

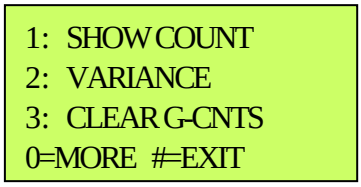
3. Factory Defaults: Pressing the asterisk <*> key at either the master or slave screen will load the default discriminator settings of LLD = 0.069 and ULD = 0.455 for the monitor.

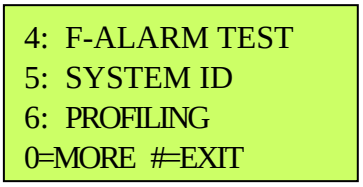




4.5.2 FUNCTIONS

1. SHOW COUNT: Displays detector counts
2. VARIANCE: Performs variance test on all detectors
3. CLEAR G-CNTS: Clears the counter of recorded gamma alarms
4. F-ALARM TEST: Displays the number of alarm comparisons vs. the number of alarms
5. SYSTEM ID: Assigns an identification number to the system
6. PROFILING: Turn ON or OFF an ASCII data string to the Ethernet and RS-232 outputs
7. CALIBRATION: Automatically adjusts each detector to achieve the proper CPS.
8. RESTORE CAL: Restores the factory calibration high voltage values.





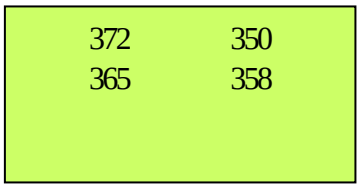
4.5.2.1 SHOW COUNT

Displays detector counts, in CPS, updated once per second.

NOTICE

All alarms are disabled in the Show Count mode.

Show Count Mode will display detector count rates on all operable detectors including those that are disabled in "DET. ONLINE". Press the pound <#> key to exit the Show Count mode.

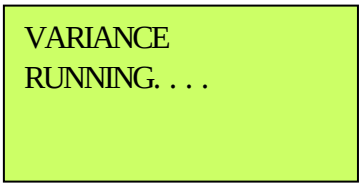


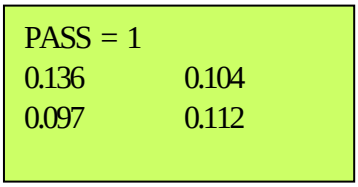
4.5.2.2 VARIANCE

Performs a variance test on all detectors. The system runs 15-second variance passes. In the PM704 system, Rapiscan recommends running five 15-second passes. After five passes all variance readings should be less than 0.10. Refer to Appendix A for further detail on the variance test and the formulas used. Press the pound (#) key to terminate the variance test. Perform a variance test and a walk-through test with a source (see Section 4) before the unit is put into operation. For more information and recommended settings for different SNM types call Rapiscan's engineering staff.

NOTICE

The variance for a detector that is disabled or disconnected will be 99.000





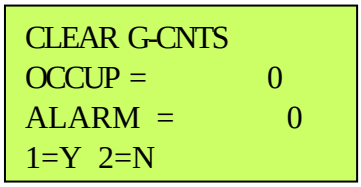
Variance mode performs a check to see that successive measurements produce the same amount of counts in each data run + 0.15%.

NOTICE

For a successful variance test to run, all movement in the immediate vicinity of the detectors must be ceased throughout the duration of the test. A vehicle, person, or object moving through, behind or around the monitors could cause a detector or detectors to fail the variance test. The shielding, due to an object's attenuation may change the count rate sufficiently to cause a test failure.

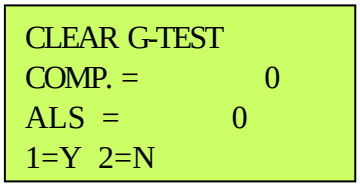
4.5.2.3 CLEAR G CNTS:

The SC-770 counts the number of occupancies and alarms since it was turned on. These numbers are displayed here. The counter may be cleared by pressing <1>; any other key exits this mode without clearing the counters.



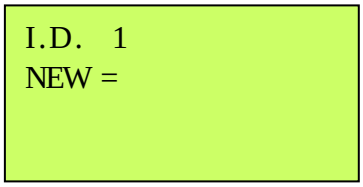
4.5.2.4 F-ALARM TEST:

Displays the number of alarm comparisons that have been made and the number of alarms that were detected. These values are cleared when the system is turned off. The primary use for this feature is to test the number of nuisance alarms in a controlled environment.



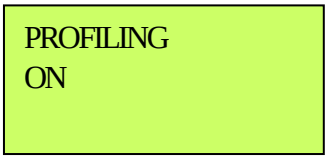
4.5.2.5 SYSTEM ID:

Assigns an identification number to the system. This number is used to uniquely identify the system to a PC. This number must be used by the PC to establish a communications link. This range of this number is 1 - 32,767. This number is set to 1 when the system is shipped.



4.5.2.6 PROFILING:

The controller can be set to continuously output an ASCII data string to the Ethernet and RS-232 outputs. The display will show "ON" or "OFF". Pressing any key other than the <#> key toggles the setting. The <#> key accepts the current setting.



The strings look like this:

GB,XXXXXX,XXXXXX,XXXXXX,XXXXXX CRLF
Gamma background sent every 5 seconds. Counts are a 20 second rolling average normalized to a one second count.

GH,XXXXXX,XXXXXX,XXXXXX,XXXXXX CRLF
Gamma high background fault sent every 5 seconds for the duration of the fault condition.

GL,XXXXXX,XXXXXX,XXXXXX,XXXXXX CRLF
Gamma low background fault sent every 5 seconds for the duration of the fault condition.

GS,XXXXXX,XXXXXX,XXXXXX,XXXXXX CRLF
TCP Ethernet output: Raw gamma count information sent every 200msec while the system is occupied and not in an alarm condition.
RS-232 Output: Sent every second while the system is occupied and not in an alarm condition. The counts are a one second count averaged from the 200msec rolling count buffer.

GA,XXXXXX,XXXXXX,XXXXXX,XXXXXX CRLF
TCP Ethernet output: Raw gamma count information sent every 200msec while the system is occupied and in an alarm condition.
RS-232 Output: Sent every second while the system is occupied and in an alarm condition. The counts are a one second count averaged from the 200msec rolling count buffer.

TT,000000, 000000, 000000, 000000 CRLF
Tamper or power fail condition detected. This is sent once when the following conditions occur; ac power loss, charger output failure, or when the pillar doors are open. Fields are padded to 32 bytes.

TC, 111111,111111,111111,111111 CRLF
Tamper or power fail condition cleared. This is sent once when the following conditions occur; ac power returned, or when the pillar doors are closed. Fields are padded to 32 bytes.

GX,XXXXXX,000000,000000,000000 CRLF
System occupancy count since midnight each day. xxxxxx = 1 – 99,9999 occupancies. This message is sent with an incremented count every time the pillar clears the occupancy. This variable is automatically cleared on a power cycle and at midnight each day. Fields are padded for 32 bytes.

NOTICE

PC Communications will not work (connect) when profiling is turned on.

4.5.2.7 CALIBRATION:

Required items: A Cs137 source with a depreciated value from 1uCi to 10uCi

The first thing the PM704 controller does is to ask for the depreciated Cs137 activity of the source that will be used for the calibration. If the user does not know the depreciated value of the calibration source but does know when the source was manufactured, then the user can go to the Rapiscan Systems web site (tsasystems.com) and look under archives/software/ SourceDepr to determine the depreciated value. When entering a value less than 10 remember to enter a zero as the first digit.
After the depreciated value has been entered the next screen is an information only screen that will list the target counts that the controller will be using to perform the calibration.
The next thing the PM704 controller does is take "roll call" to identify/verify the addresses of the DM-757's. If the addresses haven't changed since the last time the unit was calibrated, it will continue with the calibration. If it senses a conflict, the PM704 controller will instruct the pillars (DM-757's) to pick random addresses and will attempt to resolve the pillars. If communications fail after 3 attempts, the controller will tell the user which pillar failed and halt operation. If pillars are resolved successfully, calibration will continue.

After testing/resolving the pillars, the unit will flash both LED's and emit a short <beep>, then the user will be prompted:

PLACE SOURCE
ON PILLAR 1
PRESS ANY KEY

After user presses a key

CALIBRATING
PILLAR 1
COUNTS: X
HVDAC: X

COUNTS are one second count data from the pillar.

HVDAC is the DAC value being sent to the pillar to adjust the high voltage.

If the HVDAC value reaches 1000 and target counts haven’t been achieved, the calibration will fail because the HV is getting dangerously high (for the PMT). The unit will flash both LED’s, emit a short <beep> and the user will be presented with a message:

PILLAR 1
FAILED CALIBRATION
PRESS ANY KEY

After pressing any key, the user will be returned to the menu. (No sense in continuing with the calibration at this point).

If the calibration completes successfully, the user will be prompted to place the source on pillar 2 and repeat the process for that pillar.

At the end of a successful calibration, the unit will flash both LED's, emit a short <beep> and the user will be presented with a message:

CALIBRATION
COMPLETED
PRESS ANY KEY

After user presses key:

PILLAR 1
HVDAC: X
PRESS ANY KEY

After user presses key the same info will be presented for pillar 2

Pressing any key at this point returns to menu.

4.5.2.8 RESET CAL:

This routine restores the factory calibration HVDAC value. When pillar is calibrated at Rapiscan, the HVDAC value is stored in the DM-757 in the pillar. If a calibration fails, the user may attempt to recover by using the Reset Cal routine.

User is presented with:

RESET FACTORY
CALIBRATION
ON BOTH PILLARS
RESET: 1 ABORT: 3

If user presses 1:

The PM704 controller sends a command to both pillars instructing the DM-757's to use the factory calibration HVDAC value and presents the user with:

FACTORY
CALIBRATION
RESTORED
PRESS ANY KEY

Pressing key returns to the menu

If the user chose to abort by pressing 2, he/she is presented with:

RESET ABORTED
PRESS ANY KEY

Pressing key at this point returns to menu

4.6 HISTORY

When the system is operating, certain data are written to its internal, non-volatile RAM. These data include:

Date and time stamp each time the system is powered up

The background is written each hour of operation, including date and time

Date and time stamp of each radiation alarm, including the detector counts and the background used in the radiation alarm calculations

These data can be downloaded to a disk file in a PC by clicking on the "History" tab. The operator will be given the option of downloading all records, or input the number desired. The system can store up to 3,017 records.

The operator must provide a file name, and optionally, an extension. If no extension is given, the program will use .LOG.

The data file is in ASCII text format, and will look something like this:

06/09/05 17:20:51 Power-up 0 0 0 0 0

06/09/05 17:21:51 Avg. Bkg. 1710 861 849 0 0

06/09/05 17:22:51 Avg. Bkg. 1989 998 991 0 0

06/09/05 17:24:52 Background 1997 1001 996 0 0

06/09/05 17:24:52 Rad Alarm 1951 981 970 0 0

15/09/05 19:37:59 Low Alarm 0 1257 8 0 0

After the download is complete, the operator will be prompted for a file name, and given the option to view a file at this time.

4.7 INITIAL INSTALLATION CHECKLIST

___ Incoming inspection performed by:
_____

___ 90 - 250 Vac 47 - 63 Hz power supply available.
___ Pillars vertical and square to each other.
___ Pillars stabilized.
___ Cabling correctly installed.

___ System calibration: ___ unchanged ___ new values:
Pillar #1: LLD set to: _____ ULD set to: _____
Pillar #2: LLD set to: _____ ULD set to: _____
Parameter settings:
Number of Detectors set to: _____
Low Alarm level set to: _____
High Alarm level set to: _____
Occupancy hold-in set to: _____
Alarm Comparison Intervals set to: _____
Alarm level (N*Sigma) set to: _____
Algorithm: Sum____ Horizontal____ Vertical____ Single____

Background level (N*Sigma) set to: _____
Background Time: _____

___ Electronic calibration required - ___ SC-771 ___ GHA-472
___ System starts up and runs initial self-test without errors.
___ All modes operational
___ Background mode in operation area; count = _____

___ Variance test; variance detector 1: _____ 2: _____

___Test; list sources and sizes used: _____
_____

Performed by: _____ Date: _____

COMMENTS: _____
_____
_____
_____
_____
_____

5 THEORY OF OPERATION

5.1 OVERVIEW

The portal monitor makes its decisions for radiation alarms in the following manner. A level for N*sigma is selected using the keypad. Whenever the occupancy detector senses that the monitor is occupied, the monitor starts making alarm comparisons based on the parameters that have been stored in the controller's NVRAM (FAST COUNT mode).

When unoccupied, the portal monitor constantly updates the background count to reflect changes in the environment. The background is accumulated in 5-second increments, with the current background reading equal to the one-second average of the last four 5 second intervals. This updates the background completely every 20 seconds. When the unit is occupied, it ignores the current 5-second background interval, and goes into FAST COUNT mode.

The monitor collects its counts in 200 millisecond (0.2 sec.) intervals. For example, if the number of intervals is set to 5, the alarm comparison will be based on 1.0 second counts. This sum of counts is then compared to an alarm level which is normalized to that number of intervals.

The number of intervals should be selected based on an average walk speed of 1.5 meters/second while passing through the monitor. The summed count of the chosen number of intervals should reflect total occupancy time, and thus offer the maximum probability of detecting an alarm condition.

While the monitor is occupied, it makes an alarm comparison every 200 milliseconds, based on adding together the most recent n 200 millisecond intervals. The intervals are stored continuously, so that as soon as the monitor is occupied, it waits for the current interval to end, then adds up the selected number of intervals and makes an alarm comparison. This means that if the monitor is set to five intervals, it is effectively starting to monitor the passage 1 second before the monitor has been occupied. This is called "look back." The monitor will continue to make comparisons until the "occupancy hold-in" time has expired after the end of the occupancy. This is called "look after."

The "occupancy hold-in" forces the unit to continue to make alarm comparisons after the occupancy detector has cleared (look after). The amount of time selected for this parameter is based on the estimated speed of passage and pillar spacing.

5.2 MODES

5.2.1 SELF-TEST MODE

When the instrument is turned on, it performs a Power-On Self-Test (POST). The POST performs the following tests:

RAM: Tests conventional memory, primarily the area used for the processor's stack
NVRAM: Tests the battery-backed, non-volatile memory used to store parameters
LAMPS: The audio annunciator and both LEDs are turned on for approximately 4 seconds.

If any of these tests fails, the controller will display a "FAIL" message. The system cannot be put into service until the problem is corrected.

After completing the POST, the system will enter the BACKGROUND mode and be ready to operate after the initial 20-second background is obtained.

5.2.2 BACKGROUND MODE

BACKGROUND mode is the default mode for routine operation. The system will automatically go to this mode after the initial self-test series. The display counts down from 19 to 0 during the first background collection period. During this initial countdown, no other functions are available, and occupancies are ignored. The unit then continuously takes 5-second background counts and adds the most recent 4 together to display the most recent 20-second average (20-second sliding background).

After the initial countdown, system status is displayed, and the system starts monitoring for occupancy. The background display will update every five seconds to show the current background being used for alarm calculations. While collecting background counts, the controller compares the latest count with the high and low background alarm levels once a second. If the background count is outside these limits, the unit will display DET X:LO/HI NNNN, where X is the detector number and NNNN is the current background for that detector.

5.2.3 FAST COUNT MODE

Upon occupancy, the system automatically goes into fast count mode. While this mode does not take counts any faster, it does update the display more often - every second instead of every five seconds - and begins testing for alarm conditions every 0.2 seconds. The controller also stores a number of 0.2 second count intervals in RAM, so that it can "anticipate" occupancy and start alarm comparisons before the subject actually enters the pillar.

The system may be forced into the fast count mode by pressing the asterisk (*) key on the keypad. Pressing the pound (#) key returns the system to background mode.

Upon entering the fast count mode, the unit waits for the current interval to go to completion (0.2 seconds maximum), discards the oldest interval, adds the latest one, tests for alarm conditions, and begins another 0.2 second collection interval. This cycle continues during manual FAST COUNT, or during occupation and the "occupancy hold-in" period, which starts when the unit goes out of occupancy. If an alarm condition occurs, the PM704 will hold the alarm on until 5 seconds after the alarm condition is cleared.

CAUTION

Do not leave unit in this forced state for normal operation.

5.2.4 VARIANCE ANALYZER MODE

In this mode, the unit takes 75 0.2 second background counts and performs a variance calculation on the data.

5.3 COMPONENTS

1. The PM Controller is installed in the cross-piece. It is made up of the following components:

1.1. The SC-771 board is the computer board for the system, and uses program software to run the unit and perform all functions. The SC-771 receives 12VDC from a dc to dc converter and uses another dc-dc converter to supply the ±5 Vdc required by its on-board circuitry.

The SC-771 board uses highly integrated components. If a failure occurs in the digital portion of the board, it must be replaced.

1.2. The GHA-472 board provides regulated dc high voltage to the voltage divider networks which are attached to the photo-multiplier tube on the detectors.

2. The DA372 Detector Assembly consists of a plastic scintillation detector coupled to a photo-multiplier tube through a plastic light pipe, plug-on base with voltage divider network and mounting hardware. The gamma ray is converted to photons (scintillation), which are then converted into a voltage pulse on the GHA-472 board.

3. The battery module consists of a battery holder that holds a total of eight "D" size alkaline cells. The system can also be operated from a 100 - 240 volt, 50 - 60Hz ac outlet.

4. The Infrared detector is a passive type occupancy detector.

5. Alarm LED and buzzer - A red LED and piezo-electric buzzer are used to indicate a Radiation Alarm.

6. Ready LED - A green ready LED indicates the monitor is on and ready to scan.

6 MAINTENANCE

Once initial installation has been completed, little maintenance is required. Periodic inspection is recommended to insure proper functioning. This should include (but is not limited to):

-visual inspection for loose wires, etc
-field calibration
-checking the settings of the control module
-running a variance test
-performing a walk-through test

A Performance Verification Checklist is included at the end of this section. It is recommended that a copy of this be filled out whenever the PM704 is put into service after tuning and recalibration.

6.1 PM704 CONTROLLER

The display contrast may change slightly with outside temperature variations. If the display is difficult to read, adjust the “R1” potentiometer on the SC-771 board. Refer to Drawings 6 and 10 for component locations.

6.2 VARIANCE ANALYZER MODE

After calibration is complete, a variance test should be performed. The variance analyzer will identify many problems such as noise or light leaks with both the detectors and associated electronics. Be sure to restrict all movement in the area while performing a variance test.

In the PM704 system after five updates all variance readings should be less than 0.10. Refer to the Appendix for further detail on the variance test and the formulas used. Press the pound (#) key to terminate the variance test.

6.3 WALK THROUGH TEST

Due to the many different environments and materials being monitored, the walk through test will vary from site to site, although several general principles apply in all cases. Select an appropriate source, and instruct the test subject to walk at the normal speed for testing personnel, carrying the source alternately at belt level, at head level (under a hat), and at shoe or ankle level. Repeat the test several times and record the sources and sizes used.

6.4 PERFORMANCE VERIFICATION CHECKLIST

___ Repairs made (if any): list component and type of repair:

___ System calibration: _____ unchanged _____ new values:

LLD set to: _____ ULD set to: _____

Parameter settings:
Low Alarm set to: _____

High Alarm set to: _____

Occupancy hold-in set to: _____

Alarm Comparison Interval set to: _____

Sigma set to: _____

___ Electronic calibration:

SC-771: _____ GHA-472: _____
___ System starts up and runs initial self-test without errors.
___ All modes operational
___ Background mode in operation area: count = _____
___ Variance test; variance = 1: _____ 2: _____
___ Walk-through test; list test source serial number and activity:

Performed by: _____ Date: _____

COMMENTS: _____
_____
_____
_____
_____
_____
_____
_____
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_____

7 TROUBLESHOOTING

This guide is designed so that on-site personnel can service the PM704 and effect necessary minor repairs. It covers procedures and parts down to the board level. Any other problems should be referred to Rapiscan's technical staff.

When a problem occurs, it is important to isolate the cause as much as possible. This is accomplished by a step by step procedure which checks each of the assemblies for proper function and works upwards through the system.

Begin with a physical inspection of the unit then check the power supply and cabling. Examine the exterior of the enclosure for physical damage, or loose connections. Open the enclosure and do the same inside, checking all wiring. If the physical inspection shows no obvious cause for the problem, proceed by checking the detectors, controllers, and other individual assemblies, as outlined in the following steps.

After repairs have been made, a field calibration must be performed (Section 3.4.2.7. Calibration)

7.1 COMPONENT ACCESS

The PM704 Controller is mounted in the cross-piece.

The pillars contain the detector assemblies, the detector module, and the high voltage module. Verify problems by substituting the detectors. Return the defective pillar to Rapiscan for repair.

7.2 COMPONENT TROUBLESHOOTING

7.2.1 PM704 CONTROLLER

The controller's function is to receive the detectors digital pulses for counting and processing which are amplified and discriminated by the detector module.

Physically inspect the unit for harness wiring or connector problems. This procedure does not cover the replacement of wires or connectors. Such replacement should only be done by qualified service personnel. Questions concerning parts or wire type and availability may be addressed to Rapiscan's technical staff.

If a problem is suspected in the controller, replace it with a known good assembly, either from spare parts or from another unit.

7.2.2 DETECTOR ASSEMBLIES

The detector assemblies have a detector module, high voltage module, and plastic scintillator detector mounted inside. This assembly is difficult to remove and then get reinserted into the frame without damaging any of the parts. It is recommended that if a detector assembly is defective that it be returned to Rapiscan for repair.

7.2.3 INFRARED DETECTOR

A green LED located on the front of the IR detector will flash on and off when first powered up. Once the flashing LED stops the occupancy detector is ready to use.

8 GLOSSARY

CPS: Counts Per Second

High Background Alarm/Fault: The condition that occurs if the counts exceed the programmed high background level. This condition prevents further operation until the problem is corrected. Normally set in CPS.

LED: Light Emitting Diode

LLD: The Lower Level Discriminator provides an adjustable threshold that determines the lowest signal level that will be accepted as a nuclear pulse by the system's electronics. Some systems have both upper and lower level discriminators that can be used to set a discriminator window. The discriminator window can be used to effectively reduce the background counts, and increase system sensitivity to certain isotopes.

Low Background Alarm or Low Background Fault: The condition that occurs if the counts fall below the programmed low background level. This condition prevents further operation until the problem is corrected. Usually set in CPS.

POST: Power On Self-Test

Rolling Background: This is the background accumulation method used in most of Rapiscan's instruments. Background accumulation is done in ten separate buffers, each buffer representing 1/10 of the total background time. As each buffer is filled, the background is updated. This results in a background update at background time/10. Initial background accumulation requires the full background time.

Standard Background: Standard background requires the full background time for the initial background and updates.

ULD: The Upper Level Discriminator provides an adjustable threshold that determines the highest signal level that will be accepted as a nuclear pulse by the system's electronics. Some systems do not have an ULD. Also see LLD.

9 PARTS LISTS

To facilitate the processing of spare parts orders the following information is required:

Product Number
Product Serial Number
Rapiscan Stock number
Part description (from parts list)

NOTICE

Model number suffixes are generally not included in the text of the manual. However, the suffixes in the parts lists must be included on orders for spare parts.

FOR ASSISTANCE CALL:

Rapiscan Systems
14000 Mead Street
Longmont, Colorado 80504 USA
Phone: +1.970.535.9949
Fax: +1.970.535.3285
Email: RapiscanTSASales@osi-systems.com

10 LIST OF DRAWINGS

*Schematic drawings available on request from Rapiscan Systems