GR-320

PORTABLE GAMMA RAY SPECTROMETER
USERS MANUAL

Part #92321 Rev 3.2
Software Version 3V03 (or later)
June 30, 2000

EXPLORANIUM

RADIATION DETECTION SYSTEMS

WARRANTY REGISTRATION

The GR-320 system software is regularly upgraded to add special new user features and to improve existing ones. In addition Exploranium regularly develops various software utility programs for system support. REGISTERED users of the GR-320 are notified of these new features by mail as they are released and they can contact Exploranium if they want to upgrade to utilize these features.

For this reason it is imperative that all end users register as detailed below.

PLEASE NOTE THAT IT IS COMPANY POLICY THAT EXPLORANIUM WILL PROVIDE THIS UPGRADE CAPABILITY TO END USERS ONLY SO IF THE UNIT HAS BEEN PURCHASED THROUGH AN AGENT PLEASE ENSURE THAT THE END-USER IS OFFICIALLY REGISTERED.

Please note that Exploranium also strongly encourages user feedback on system performance and any suggestions on how the product can be improved. This feedback should be sent by FAX to provide a written reference.

Please provide the following information and fax the response card to Exploranium at Fax # Canada (905)670-7072.

GR-320 Console Serial #: _____ Detector Serial #: _____

Customer Name : _____

Customer Address : _____
Customer Address : _____
Prov/State/Zone : _____
Zip/Code : _____ Country : _____
Customer Contact Name : _____
Tel # : _____ Fax # : _____

EXPLORANIUM

RADIATION DETECTION SYSTEMS

GR-320 Portable Gamma Ray Spectrometer

User Manual Rev. 3.2 Software Version 3V03

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GR-320 USERS' MANUAL

HISTORY OF CHANGES

Eco #	Date	Description	Rev From	To
B320	05/05/97	01-TN-97-150 SOFTWARE TECHNICAL APPLICATION NOTE ADDED.	2	3
B519	15/04/98	HOUSECLEANING TO REMOVE ERRORS	3	3.1
GR320/0123	27/06/00	FIRMWARE CHANGE FOR Y2K COMPLIANCE GPX-21 CHANGE TECHNICAL SPECIFICATIONS CHANGE FOR 0.25 Uc CESIUM SOURCE	3.1	3.2

EXPLORANIUM
RADIATION DETECTION SYSTEMS

GR-320 – "enviSPEC"

PORTABLE GAMMA-RAY SPECTROMETER

Version 3V02

1.0 GENERAL OVERVIEW

This manual has been written for the GR-320 software version 3.02. It has been written assuming single detector operation. Users with a dual detector system should refer to Appendix B.

The system is supplied with an internal 0.25uCi Cesium source installed in the base of the detector unit. For Geophysical users who have no interest in Cesium this is the correct mode of operation. For information regarding Environmental measurements where the lower spectrum is important refer to Section 2.4: MENU 4 - Stabilization.

1.1 QUICK START

The rear of the instrument has 3 connectors:

10 pin - for RS 232 serial input/output
3 pin - for external power
6 pin - for detector connection

Connect the detector to the instrument using the 6 pin coiled cable supplied. Refer to Appendix A.3: Connectors and Cables for more information.

When the instrument is received it should be charged overnight by connecting to the 3 pin external charger/power supply. Refer to Appendix D: Using Rechargeable Battery for more information.

On the front panel of the instrument there is a power ON/OFF switch, an LCD display and a 5 x 4 keyboard. Switch on the power by pressing the ON/OFF button. After a brief sign-on message when the Software Version is displayed, the Top Menu will appear as shown in Figure 1-1.

The user can select an item from this menu by pressing the appropriate menu number (e.g "5" selects ROIs/Calibration). Alternatively, use the arrow keys to scroll through the menu and select the desired menu item by press ENTER. Pressing STOP inside the selection will return to the Top Menu.

TOP MENU

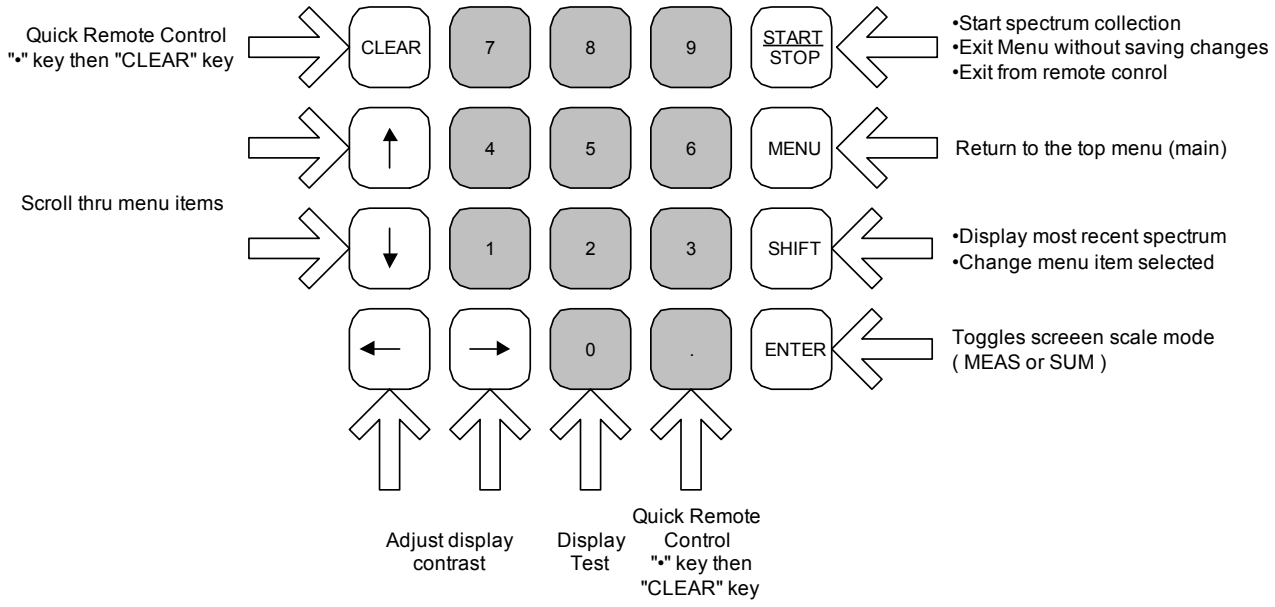
1 System Test
2 Detector config.
3 Operational mode
4 Stabilization
5 ROIs/Calibration
6 Data output
7 Line/Pos./Step
8 Data memory
9 Maintenance
START Measurement

Figure 1-2 shows the keyboard outlining some hidden key functions.

Figure 1-2

ON/ OFF - powers the system ON or OFF

GR320 Keypad Main Menu



CLEAR - is normally used to clear a data entry

^v<> - are the UP, DOWN, LEFT and RIGHT arrow keys.

When the Top Menu is displayed, the display contrast may be changed to suit the user by repeatedly pressing the ARROW LEFT or ARROW RIGHT keys. Once the contrast is set it is maintained by temperature correction in the case of a significant ambient temperature change.

The UP and DOWN arrows can be used to scroll through the Top Menu

START/STOP - used to Start or Stop a function. At any point in the selection menu, pressing STOP will return to the Top Menu with no changes made.

MENU - used to bring up the Top Menu for user selection. This key is disabled during sample accumulation.

SHIFT - used to change a function from within a menu item. From the Top Menu, the most recent spectrum can be re-displayed.

ENTER - used to store spectrum after a single measurement. Also used to accept any menu changes, and return to the Top Menu

"." & CLEAR - decimal point and clear - used to put GR320 in remote mode.

0 - If "0" is pressed while at the Top Menu, a procedure for testing the display will start. The screen will first display the "small fonts" used in the display. Pressing ENTER will display the Large Fonts used. Pressing ENTER again will display a full screen of alphanumeric data for 10 seconds then a display of diagonal lines for 10 secs etc.

Pressing ENTER again will display "WAIT" and after about 40 seconds a Lissajou figure display will show. All these routines test the display and any display related problems can be seen in one of these tests. These tests are intended for use only if the user feels there is a Display error of some kind.

Pressing STOP at any time will terminate the tests. If stop is pressed during the last test, some time will elapse before the screen is returned to the main menu as this test must be completed before termination is possible.

NOTE: In this manual, all key presses will be shown in BOLD. The key "CLEAR" will be shown as CLEAR and "UP ARROW" will be shown as UP-ARROW. The display will specify what additional action is required, for example by requesting the user to press ENTER to accept a set of parameters.

1.2 SYSTEM DEFAULT SETTINGS

The system is shipped from Exploranium with default settings for each menu item. These settings are outlined in the calibration sheet sent with the detector. A sample calibration sheet is shown in Figure 1-3 and explained below. Refer to the appropriate Menu item in Section 2.0 - Detailed Operation for information on changing these default settings.

SYSTEM CALIBRATION SHEET

Customer : _____ Tech : _____ Date: _____
Console Ser # : _____ Det # 1 Ser # : _____
Software Ver : _____

M1- System Test : Xtal resolution _____ Final Gain _____

M2 - DET.Config : Coarse Gain 0.5 1.0
Det #1 ON
Det #2 ON OFF
Mode Normal Add Coinc Anticoinc

M3 - Operational Mode :
Sampling time 60 (or as required)
Meas mode Single Repeat Base
Evaluation None Assay enviSPEC User#1
No channels 256 512
Control Keyboard Remote
Position None Keyboard GPS AUTO

M4 - Gain stabilization : Gain stab ON Off
Stab Cs K Th xx
Stab. channel 55 _____ _____
Count level 5000
Timeout 100

M5 - ROIs - 1 _____ _____ 5 _____ _____
6 _____ _____ 6 _____ _____
7 _____ _____ 7 _____ _____
8 _____ _____ 8 _____ _____

M5 - Calibration : TOT K U Th
B/G _____ _____ _____ _____
Cal TOT _____
K _____ _____ _____
U _____ _____ _____
Th _____ _____ _____

M6 - Data Output
Device OFF DATA MEMORY RS-232 SW HSH RS-232 SIMPLE
Bd 1200 2400 4800 9600 19200
Config DET#1 only
DET#1 ROIS only ROIS+SPECTRUM SPECTRUM only

M9 - Maintenance : Real Time Clock - set as required
ADC offset : _____
Low thresh : 2

FIGURE 1-3. SAMPLE CALIBRATION SHEET

MENU 1 System Test System Test Results
MENU 2 DET. Config Set for 1 detector operation

MENU 3	Sampling Time	Set for a 60 second sample
	Measurement Mode	Set for a SINGLE reading
	Evaluation	Data is displayed in the ASSAY format
	No. of Channels	256 channel operation/display
	Control	KEYBOARD - system controlled from front panel keyboard
MENU 4	Gain Stabilization	Set for Cesium
MENU 5	ROIs	Preset from factory calibration
	Calibration	Set from Factory Calibration
MENU 6	Data Output	Set for storing data in MEMORY as ROIs + Spectrum data
MENU 9	Maintenance	Real time clock set to Toronto time - should be set to local time by the user

You can check the default settings above by selecting the corresponding menu number from the top menu.

1.3 INITIAL SYSTEM TEST

It is necessary to first perform a system test to ensure that the system is OK and has not been damaged during shipment. This procedure should also be carried out once per day to ensure that the system is OK.
Select Menu 1: System Test.

The screen should appear as Figure 1-4.

If not, press START/STOP to return to main menu and then select Menu 4: Stabilization and use the shift and arrow keys to change the display so it shows as follows:

Gain Stabilizer	ON
Stab.	Cs 662 keV
Stab. Channel	55
Count Level	5000
Timeout	100 secs

SYSTEM TEST

Gain Stabilizer **ON**
Stab **Cs** 662 keV
Stab. channel **55**
Count level **5000**

Place Cs source
as specified
Press **ENTER**
to start test

Figure 1-4

Refer to Section 2.4: Stabilization for more information. Press ENTER to save this setup and return to the main menu, and then select Menu 1 : System Test.

When the system test screen has appeared, as in Figure 1-4, press ENTER. If all is OK after 10 seconds the screen should show "D1 active – wait" this shows that the system is working correctly.
After about 60 secs the message will change to numeric data:

"D1 55 6.9 180".

The system is working correctly if the second number (6.9 in the example) is less than 9% or within +/- 0.5% of the RESOLUTION specified on the System Calibration Sheet (M1) that accompanied the instrument. The third number "180" is the GAIN and should be between 100 and 400 - if these conditions are NOT met, please advise Exploranium as this indicates a serious problem.

If all is OK, press STOP twice to get back to the Top Menu. Refer to Section 2.1:
MENU 1 - System Test for more information.

1.4 STARTING FIRST MEASUREMENT

Before taking your first measurement, you must ensure that the data memory has been initialized, and is empty. Select Menu M8 by pressing 8 from the Top Menu. The display should be as in Figure 1-5 and show that the data memory is clear of all previous data. If the display shows that there IS data already in memory, the display will advise users to press CLEAR CLEAR CLEAR to erase the memory. If the data memory shows -1 measurements, then the memory needs initializing. Press CLEAR CLEAR CLEAR to initialize the memory.

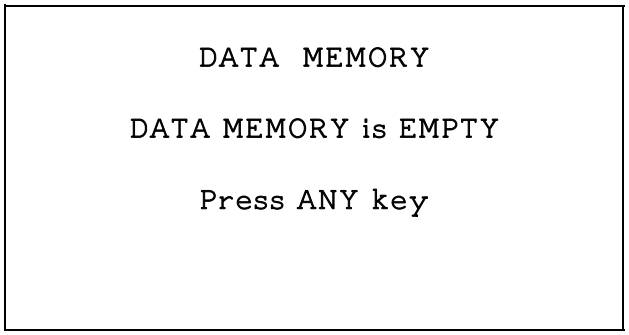


Figure 1-5

Press START to take a reading and follow the display prompts at the end of the data sample to store the data as required. Refer to Section 3.0 - Start Measurement for more information.

2.0 DETAILED OPERATION

When a menu item is selected, a new screen appears requiring user selection. The cursor starts at the first point of adjustment and the ARROW KEYS may be used to select the item to be adjusted. Once the parameter to be adjusted has been selected using the ARROW KEYS, then the selection between choices may be made by pressing SHIFT. If the input required is numeric then the NUMBER KEYS may be used. CLEAR can be used to clear a numeric entry.

2.1 MENU 1 - SYSTEM TEST

The GR-320 carries out Automatic Gain Stabilization. The system test is used as a check of basic system performance. Normally the system is set to stabilize on CESIUM (as a very small 0.25uCi Cesium test source is contained in the lower part of the detector) and Menu 4 is set for:

Cesium - 662 keV , Channel - 55 , Count Level - 5000, Timeout - 100 secs.

If Cesium stabilization is not selected, it is necessary to align the system each day on Cesium before another isotope stabilization is attempted. If this pre-stabilization on Cesium is not used then Automatic Gain Stabilization may give errors under certain conditions. Note that for normal operation when Cesium IS the selected Gain stabilization source, a system test is only necessary as a means of ensuring that the system is OK prior to the acquisition of survey data.

IT IS RECOMMENDED THAT YOU PERFORM A SYSTEM TEST AT THE START OF EACH SURVEY DAY.

When the system test is started, a preliminary gain is computed after a 10 second measurement and then the spectrum is reset and accumulation starts again. When the Cesium peak exceeds the 5000 Count Level threshold (typically 20 seconds), the system computes the correct gain using a Least-Squares fit of a Gaussian peak shape. This is referred to as the FINE GAIN. After the FINE GAIN has been computed the spectrum is reset and the cycle is repeated. The FINE GAIN is continuously updated every time the 5000 level) is exceeded (typically 40 seconds) until STOP is pressed. This ensures that System Gain is always correct.

Every time the FINE GAIN is computed and the spectrum is reset, a 5 minute timer is started and this time period is referred to as the STABILIZATION TIME. When the System Test procedure is terminated by pressing STOP, this timer is kept alive. For more information on automatic gain stabilization refer to Section 2.4 - STABILIZATION.

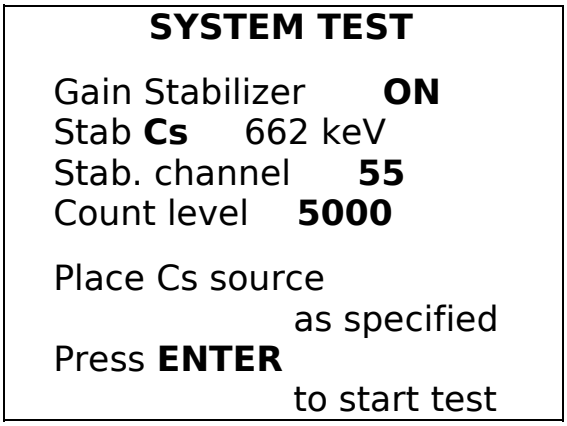


Figure 2-1

2.1.1 Cesium Stabilization

If this selection is made, Figure 2-1 appears. This display advises the user of the current settings.

If ENTER is pressed the system automatically sets its Gain to mid-scale and takes a 10 second spectrum. The display shows Figure 2-2.

After the 10 second countdown (10,9,8...) the display changes to Figure 2-3.

Test in Progress
WAIT.....10 (9,8,7.., 1)

Figure 2-2

This shows that only one detector has been selected and all is OK

"active" means that the detector is active

"wait" means PLEASE WAIT.

After a short period the display changes (Figure 2-4)

SYSTEM TEST

peak fwhm gain
D1 active-wait
D2 not selected

Press ENTER to see Spectrum

Figure 2-3

The numeric data shows that the system is stabilizing correctly -

- peak should be 55.0 +/- 0.2 channels as Cesium was selected in Menu 4. If not wait a short period (usually about 30 seconds) and the next Gain adjustment should be within the specified limits.

- FWHM Resolution for Cesium was measured at 6.8% - the System CALIBRATION SHEET specifies the correct value for this system. It should be the value on the sheet +/- 0.5%

- Gain = 268 - for correct operation the Gain should be ideally between 200 and 300 but correct performance will occur between 100 and 400.

SYSTEM TEST

peakfwhm gain
D1 55.1 6.8 268
D2 not selected

Press ENTER to see Spectrum

Figure 2-4

If any of these parameters are significantly outside the recommended zone then the system may require adjustment - contact Exploranium.

If the user is interested in watching the automatic stabilization press ENTER to view the accumulating spectrum. Pressing ENTER again returns to the Data Display. The Spectrum Display is more fully described in Section 3.0 - Start Measurement, the only difference being the word TEST at the upper left corner of the screen.

If all the parameters are OK, press STOP to terminate this test (press twice to return to the Top Menu).

2.1.2 THORIUM STABILIZATION

The display appears as in Figure 2-5. Normally Cesium is ALWAYS used to stabilize the system first, so SHIFT must be pressed and the display will change to the "normal" Cesium display (as in Figure 2-1). After this, the operation is the same as if Cesium had been originally selected.

If SHIFT is NOT pressed and the user presses ENTER then the system FINE-GAIN is left at the previous setting and the 10 second countdown starts. At the completion of this countdown the data is checked to ensure that the detector is active but no gain change occurs. The spectra then begins to accumulate data and when the preset COUNT LEVEL is reached - Automatic Gain Stabilization occurs.

SYSTEM TEST

Gain Stabilizer **ON**
Stab **Th** 2615 keV
Stab. channel **206**
Count level **200**

If OK - press **ENTER** to start test
If you want Cs - press **SHIFT**

Figure 2-5 SYSTEM TEST – Thorium

The user can see that the only difference in this procedure between CESIUM and THORIUM selections is that if CESIUM is used it is assumed that a small source has been inserted close to the detector. In this case the Cesium peak will be relatively strong so the 10 second countdown spectra is good enough to carry out a PRELIMINARY GAIN. Whereas a 10 second spectra of THORIUM would be statistically unusable.

2.2 MENU 2 - DETECTOR CONFIGURATION

If this selection is made Figure 2-6 appears.

2.2.1 Coarse gain :

Selection is 1.0 or 0.5 (using SHIFT) and is used to permit the system to be used with a wide variety of detectors. Always set this to 1.0. Only very special detectors use the 0.5 setting. Refer to Appendix A: Technical Specifications for more information on detectors.

DET. CONFIGURATION

Coarse Gain **1.0**

Det #1 **ON** **274**
Det #2 **OFF** **312**

Mode **NORMAL**

Press **STOP** to CANCEL
Press **ENTER** to CONF.

Figure 2-6

2.2.2 Det #1

Since the system MUST have at least 1 detector for operation, Detector #1 is always selected. When the cursor is moved down it goes to the position marked as "274" in Figure 3.

This is the FINE GAIN of the system and may be set between 0 and 511 with "mid-gain" in the middle

at 255. These 512 steps are automatic gain steps and are used to adjust system Gain to position the peak precisely where required. This setting is normally for display and special test purposes only as any selection will be overridden by the Automatic Gain Stabilization. For normal use setting this parameter has no effect.

2.2.3 Det #2 :
The next "stop" of the cursor is here but for normal single detector users, no setting is required.

Note that in a single detector system - if Det # 2 is set to ON using the SHIFT button, then when the data is stored (by pressing ENTER at the end) - the message "Defective PIC#2" will be seen. When the user exits to the TOP MENU and re-enters Menu 2 again, the ON will have been automatically changed to OFF. Set to OFF for single detector systems. Refer to Appendix B - Dual Detector Operation for more information on operating two detectors.

2.2.4 Mode :
In the single detector version - MODE has no selection. With two detector systems there are 4 choices NORMAL, ADD, COINC and ANTICOINC. Refer to Appendix B - Dual Detector Operation for more information.

2.3 MENU 3 - OPERATIONAL MODE

If MENU 3 is selected, then Figure 2-7 appears.

OPERATIONAL MODE

Sampling time	**60**
Meas. mode	**SINGLE**
Evaluation	**NONE**
No. of channels	**256**
Control	**KEYBOARD**
Position	**NONE**

Press **STOP** to CANCEL
Press **ENTER** to CONF.

Figure 2-7
Figure 2-7

2.3.1 SAMPLING TIME

Sampling time may be set using numeric keys from 1 to 9999 seconds and is the actual sample time of the system, including live time and dead time.

2.3.2 MEAS. MODE

Measurement modes are selected using SHIFT and options are as follows:

2.3.2.1 SINGLE : (DEFAULT)

In this mode, when START is pressed, a single measurement is taken and the results displayed. This is the normal mode of measurement for ground applications.

2.3.2.2 REPEAT :

In this mode the system takes a continuous set of measurements at the selected sample rate, which now is actually the cycle rate. This is the normal mode of measurement for automatic recording in a

vehicle or aircraft application. Data is stored in the internal memory or output on the RS-232 serial port. An audio beep occurs whenever a reading is stored. This audio beep can be disabled by pressing CLEAR.
If the Sample Period set in Menu 3 is very short (e.g 1 sec) then in the REPEAT mode the display is only showing 1 second spectra and not much information can be gained . If ENTER is pressed the top right label changes to SUM and the display sums each spectrum so the user can see the accumulating spectrum on the display. The Vertical Scale is automatically set to the COUNT LEVEL set in Menu 4 but this may be overridden by the Arrow keys. In this mode the accumulating spectrum is reset when the stabilization peak reaches its limit and Gain Stabilization takes place - during this time the label is STAB. After correct stabilization the displayed spectrum is reset and the label changes to SUM and the sequence is repeated.

Some users are now selecting the REPEAT mode for normal "walking" surveys. For example, with the Sample Time set at 30 seconds - the user can walk slowly along the survey line and the data will be recorded at the 30 second interval and the data will be the actual average of the area covered during 30 seconds. If this is integrated with a GPS system (see below) a very fast method of surveying is possible.

2.3.2.3 BASE :

In this mode data can be stored at fixed time intervals and the Start/Stop times can be set. The system also has a special Power Conservation mode that shuts most system functions down between readings to conserve battery power.

Most users of the Base Station mode would normally be studying Environmental applications so the system would be set to stabilize on THORIUM and the internal Cesium source would be removed. In this application it is common for a long period to elapse between readings. Since during this time no stabilization will be occurring, 12 MINUTES prior to the start of the sample, the GR-320 automatically starts acquiring data for a 10 minute period of time. This data is then analysed, the Thorium peak position and correct Gain computed, the Gain is adjusted as required and a 20 minute Timer started. Since the Gain is now correct - the actual sample period can start with assurance that the system gain is correctly adjusted. This procedure is referred to as PRE-SAMPLE STABILIZATION.

During the Base-Station Sample Period the GR-320 will continue to carry out FINE GAIN adjustments every time the peak counts exceed the preset Count Level and each time this occurs the 20 minute timer is reset and starts again. Thus this timer is a measure of how much time has passed since a FINE GAIN adjustment was made.

If the start of the next Base Station sample occurs in LESS than the 20 minutes then the Gain can be assumed to be correct and the next sample starts at the time required.

If the start of the next Base Station sample occurs in more than this 20 minute time period then the Gain is assumed to be potentially in error so 12 minutes prior to the start of the Sample the PRE-SAMPLE STABILIZATION procedure is repeated.

This means that if the FIRST Base-Station sample is started LESS then 12 minutes from the time that the Base-Station mode was entered, then there is NO Gain Pre-Stabilization for this sample. In practice this is not a problem as sample periods are usually long and well spaced out.
To operate in BASE mode, follow these steps:

a. SET GR-320 CLOCK

Set Internal clock as described in Section 2.9: MENU 9 - Maintenance.

b. SET OTHER SYSTEM PARAMETERS

Ensure that Menu 4 Stabilization is set as required - see section 2.4: MENU 4 - Stabilization.

Ensure that Menu 6 - is set to record data in memory or output to a PC - see Section 2.6: MENU 6 - Data Output.

Ensure that the memory has been cleared. See Section 2.8: MENU 8 - Data Memory. Data in this mode may be added to data already in memory but it is normal to clear data memory before starting the Base Station mode.

c. START

In Menu 3 - select the appropriate Sample Time period.

set Meas mode = BASE

Set Position = none

Press ENTER and the display appears as in Figure 2-8. The user may then enter the Date/Time that they want to START recording data then press ENTER to store this data.

Set START of MEASUREMENT

D D M M Y Y
2 7 - 0 4 - 9 5

H H M M S S
1 6 - 4 3 - 0 0

Figure 2-8

d. SET REPETITION + # OF SAMPLES

After the Start Date and Time are set and ENTER is pressed, additional data appears on the display as in Figure 2-9.

Repetition - (2-999 mins) = the required sample repetition time in minutes (minimum 2 mins). If 10 is selected by numeric entry then samples will be taken at a 10 minute rate.

Nb measurements - (1-999 samples) - the number of successive measurements required. If 20 is entered then 20 successive measurements will be taken.

Power save mode -if this is enabled (YES) then the system will shut down between readings to conserve battery power. If NO is selected then the display shows Start Time and Current Time continuously and no power conservation is used.

Set START of MEASUREMENT

D D M M Y Y
2 7 - 0 4 - 9 5

H H M M S S
1 6 - 4 3 - 0 5

REPETITION [min] - 10
NB Measurements - 20
Power Save mode - ON

Figure 2-9

e. OPERATION

With the above parameters set as shown in Fig 2-9 - the system will have a blank display (Power Save mode) - then activate at 16:43:05 on 27 April 1995 and take a 60 second reading (set in Menu 3: Sampling Time=60) and store data in memory (or output as determined by MENU 6: Data Output) - then shut down for 9 minutes (Repetition Time of 10 minute minus the Sampling Time of 1 minute) - then take a new reading. This will repeat until the selected 20 samples have been taken then the

system will switch off.
At any time this mode may be terminated by pressing STOP.

2.3.3 EVALUATION : select using SHIFT as follows :

NONE : (DEFAULT) this selection means that after a measuring period and data storage, the counts/sample period of each ROI are displayed - position information may be displayed if selected.

ASSAY : this selection uses the Calibration Coefficients computed during Calibration on the Test Pads (and stored in Menu 5) to display data at the end of a Sample Period as :
ROI #1 =*TOTAL COUNT* in ppm eU and Counts/minute
ROI #2 = *POTASSIUM* in %K and Counts/minute
ROI #3 = *URANIUM* in ppm and Counts/minute
ROI #4 = *THORIUM* in ppm and Counts/minute
The cts/min values are background corrected and live time normalized to 1 minute.

enviSPEC: Indicates any peaks that were found, the radio-isotope most likely associated with those peaks and the total dose in Exposure [R], Absorbed Dose [Gy], or Equivalent Dose [Sv]. See Appendix E for more information.

USER #1 : no numeric data is displayed unless location data is selected. Future releases will permit speciality programs to be loaded for special applications or to customise the display to customers specifications.

2.3.4 NO. OF CHANNELS :

The number of channels may be selected as 256 (DEFAULT) or 512 channel data by using SHIFT. For normal Geophysical applications 256 channel operation is normally used.

For specialised applications where detailed analysis of the narrower peaks in the lower section of the spectrum is required, then 512 channel analysis is commonly used. As long as no data output or spectrum storage is required 512 channel data may be used in all applications but is not recommended for GEOPHYSICAL applications. 512 channel spectra have twice as much data as the 256 channel spectra so users with limited data storage/transfer requirements should use 256 channel analysis only. If this selection is set to 512 then :

Menu 5 ROIs are all multiplied by 2

Menu 4- Cs stabilization level is set to
- Channel=110
- Count Level = 5000

Data Output format changes - see section 5.0 - DATA OUTPUT FORMAT

NOTE : Calibration Constants and ROI channel limits are specified on the supplied Calibration sheet assuming 256 channel operation.

2.3.5 CONTROL :

KEYBOARD - (DEFAULT).

System actions are controlled from the front panel keyboard.

REMOTE -

When the system operation is under the control of an external PC/Data system. In 3V02 Parameters can be DOWNLOADED and UPLOADED as a data block to permit full REMOTE operation. Refer to Appendix C: Remote Control Operation for more information
Another way to enter the REMOTE mode directly from the Top Menu is by pressing "." and then CLEAR.

2.3.6 POSITION :

"GPS" - there are 2 ways to work with GPS data :

a) MANUALLY input Lat/Long data from any GPS system by selecting the KEYBOARD selection for POSITION in MENU 3.

b) AUTOMATICALLY add GPS data by connecting a GPS system to the RS-232 port. In Software Version 3V03 - THIS VERSION - the software currently supports the Garmin GPS 45 and the Magellan NAV 5000DX systems. Other systems that contain the RMC sentence may also be directly compatible.

NONE : (DEFAULT) - in this position NO location data is used.

KEYBOARD : With this selection, after a reading has been taken and the data stored (by pressing ENTER) the display will then prompt the user to input LOCATION data in a Latitude, Longitude format to suit a GPS system.

This selection is used with Menu 3 set to Meas Mode=SINGLE and Position=KEYBOARD. When the end of Sample Period is reached the display will appear as in Fig 2-10 (Note that in this example ASSAY mode was also selected).

The user can now enter in the LATITUDE data from their GPS system.
Normal format = XXXX.XXXN(S).
Note that UP ARROW=N and DOWN ARROW=S. Press ENTER.

The display will now show Longitude. Enter this data as required.
Normal format = XXXXX.XXXE(W).
Note that LEFT ARROW=W and RIGHT ARROW=E. Press ENTER.

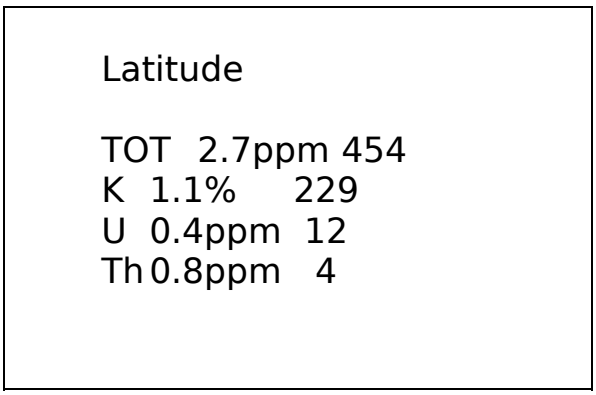


Figure 2-10

NOTE : In REPEAT (or Base-Station) mode, if Position=Keyboard is selected an Error MESSAGE:"INVALID Meas. mode/Position selected"will appear. If the user overrides this with ENTER, dummy data is stored as the Location data.

GPS : This selection requires that a GPS system is connected to the GR-320 Serial port and Menu 6 is

configured correctly. The following GPS systems are supported by the GR320:

Garmin GPS 45 - Using menu I/O SETUP select NEMA / NONE and NEMA 0183 2.0 4800 baud. Note that recent experience with the GARMIN has shown that some versions of the Garmin software have incorrect RS-232 data output - contact Exploranium if problems with a Garmin.

Magellan NAV 5000DX - press AUX, select 06 NEMA, and press ENTER then using RIGHT ARROW select 0183B output message format. Press POS to start the GPS tracking.

Both types of GPS devices will not send data to the serial port until they have a location fix.
Always start the GPS first and wait for a location fix before starting the GR-320, or you will get an error message saying that the RS-232 port of the GPS in not active.

NOTE : The GR-320 will support the GARMIN-45 and the Magellan NAV 5000DX GPS systems. Other GPS units that output the RMC sentence may also work. Depending on user requirements, other types of GPS devices may be supported. If the GPS is configured correctly when data is stored the relevant location data will also be stored automatically using the format defined in Appendix B: Data Output/Storage Formats.

AUTO : This selection permits an "Automatic" location system to be used. Refer to Section 2.7: MENU 7 - Line/Pos./Step for more information on auto positioning.

2.4 MENU 4 - STABILIZATION

The GR-320 Automatic Gain Stabilization is designed to stabilize system gain under all system operational conditions. This is a crucial feature for Gamma-Ray-Spectrometers as small gain changes can have a very serious affect on data results. Under normal conditions with the standard parameters set correctly (supplied by the factory) correct system Gain control should be invisible to the user unless problems occur, in which case Error Messages will be generated to warn users of system performance problems.

AUTOMATIC GAIN STABILIZATION is crucial for correct spectrometer operation. If the Gain is automatically stabilized, then the spectrum is completely stable, and the selected ROI output data are correct. If the Gain is NOT controlled then spectrum drift will occur and the spectral display and the ROI data may be in error. Older systems required the user to set correct gain performance but this meant that semi-skilled users often recorded erroneous data but never knew it.

The GR-320 system carries out AUTOMATIC GAIN STABILIZATION during data sampling to ensure that no Gain drift occurs that could interfere with spectral accuracy. In Gamma-Ray Spectrometry an important fact to note is that the emitted gamma-rays absorbed in the detector all have a known position in the spectrum. As an example, Cesium-137 emits ONLY at 662 keV and this must occur at Channel 55 in the spectrum if the spectrometer is set correctly. Due to potential electronic and thermal error although the Cesium peak always emits at 662 keV it may occur at channel 59 or another nearby channel in the spectrum due to these errors.

In this case the system analyses the spectrum, determines the actual position of the Cesium peak and automatically changes the system Gain to ensure that the peak remains at channel 55 at all times. By using this technique any small errors are automatically corrected by the system and Gain errors are totally removed from the resulting spectra. The actual POSITION of all the isotopes can be predicted in advance so accurate analysis can be carried out.

The automatic gain stabilization system in the GR-320 has many special features. The following items explain these features in moderate detail as an aid to users.

STABILIZATION on CESIUM after pressing START

a) STABILIZATION TIME > 5 minutes

If a new Sample is begun by pressing START, and if the STABILIZATION TIME is MORE than 5 minutes (since last FINE GAIN adjustment) - it is assumed that so much time has passed since the last correct Stabilization, that the quality of this previous stabilization is incorrect.

The system sets the System Gain to mid-scale, starts a 4 SECOND Count time and sets the top right flag of the display to show STAB.
This 4 second spectrum is then analysed for Peak Position, a PRELIMINARY GAIN computed/set and then the actual SAMPLE TIME Count commences (flag at top right of the display changes to MEAS). During this Sample Time every time the Cesium peak exceeds the Count level (normally 10000 cts = 30 seconds) the FINE GAIN is computed and set. Each time this FINE GAIN is computed the 5 minute timer is reset and starts again.

If the Sample Time is so short that the Count Level is never reached DURING the Sample Time then the 4 seconds PRELIMINARY GAIN computation is repeated for each sample.

b) STABILIZATION TIME < 5 minutes

If a new Sample is begun by pressing START, and the STABILIZATION TIME is LESS than 5 minutes (from last FINE GAIN adjustment) - it is assumed that a very short time has passed since the last correct Stabilization, so that the quality of this previous stabilization is still correct.

When START is pressed to begin the new sample, the system immediately begins the sample period and the top right flag shows MEAS. During this sample period if the Cesium peak exceeds the Count Level (typically 30 seconds) then the FINE GAIN will be computed, and the top right flag will show STAB for about 7 secs), The system Gain will automatically be adjusted, and the 5 minute FINE GAIN timer is reset.

If the Sample Time is less than the FINE GAIN period (for example a 10 second Sample Period when the period between FINE GAIN's is about 30 seconds), the FINE GAIN will not be adjusted during the Sample Period and after the FINE GAIN TIMER exceeds 5 minutes each Sample Period will be preceded by the 4 second PRELIMINARY GAIN adjustment.

In the special case where the Sample Period is so short that during a Sample, the stabilization peak will NEVER exceed the Count level - a special procedure occurs. As an example - Menu 4 set = Thorium, Count Level = 50, Timeout = 2000 secs, the Thorium peak takes 9 minutes to reach the Count Level, Sample Period = 1 minute and Repetition Rate = 2 minutes. When the first sample is starts no stabilization occurs as at the end of the 1 minute sample the Count Level is not exceeded so no Gain control occurs. The accumulated spectrum is stored in a special part of memory and at the end of each sample with no Gain control, the spectrum is added to the spectrum in memory. When the stabilization peak in the accumulating spectrum in memory finally exceeds the Count level, Gain stabilization occurs, the accumulated spectrum is erased and the procedure repeated. In this way even very short sample periods get correct automatic gain control.

STABILIZATION DATA OUTPUT

If the RS-232 output port is NOT configured for data output (Menu 6 = DATA MEMORY or OFF) then the Gain Data is output on this port for Test purposes. A special Test program TEST_30.EXE can be used to record/display this data or a terminal program such as Windows Terminal can see this data output. The data is output in the format :

Det #	peak	Res%	Gain
#1	54.9	6.9	166

This is interpreted as Detector #1, Peak was found at Channel 54.9 (should be 55 for Cesium), Resolution was 6.9% for Cesium and Gain position was 166 Gain steps (total of 0-512 with 256 being mid-range). This data can be used to assess system performance. This Data is output during SYSTEM TEST or when START is pressed as long as the RS-232 port is NOT configured for data output.

GEOPHYSICS : For the majority of users "Cesium" is usually selected for Automatic Gain Stabilization and makes use of a small 0.25uCi Cesium-137 isotope mounted in the base of the detector. This gives more frequent analysis in the relatively short sample periods often used in Geophysical applications. Since Cesium does not intrude in the region of the spectrum of interest to Geophysics, it s presence in the lower portion of the spectrum is of no concern.

SPECIAL : In special applications for ENVIRONMENTAL MONITORING and/or airborne system monitoring, the presence of a small Cesium source may limit system performance. Stabilization on a "natural" (K/U/Th) peak is used (usually THORIUM). For these reasons the GR-320 may be selected to stabilize on ANY isotope as required, however only certain isotopes may be used reliably based on their local abundance and relative intensity.

When MENU 4 is selected the display is as in Figure 2-11 is shown.

2.4.1 GAIN STABILIZER :

ON : <u>normal mode for most applications</u>. In this mode the system will carry out AUTOMATIC Gain stabilization on the selected isotope without interfering with system operation.

OFF : should only be used for special experiments as without stabilization serious spectral drift will occur.

GAIN STABILIZATION

Gain stabilizer **ON**

Stab. **Cs** **662** keV
Stab. Channel **55**
Count level **5000**
Time out **100** sec

Press **STOP** to CANCEL
Press **ENTER** to CONF.

Figure 2-11

2.4.2 STAB :

Cs - this selects CESIUM stabilization using an internal source. This 0.25uCi Cesium source is enclosed in the bottom of the detector and may be accessed by removing the threaded cover with a coin. Note that for this Cs selection the label is shown as 662keV which is the energy level of Cesium. Note that a Cesium source smaller than 9.9uCi REQUIRES NO LICENCE in most countries, so the 0.25uCi source used in the GR-320 normally requires no special handling or licensing.

Select Cs for most applications

K - this selects K (POTASSIUM) as the stabilization source. Users wanting to use Potassium for stabilization would normally remove the internal Cesium source.

Note that the energy level for Potassium is shown in the label as 1460 keV.

Th - this selects Th (THORIUM) as the stabilization source. Users wanting to use Thorium for stabilization would normally remove the internal Cesium source. Note that the energy level for Thorium is shown in the label as 2615 keV.

xx - this selection permits the user to select ANY isotope

2.4.3 Stab Channel -

This sets the CHANNEL NUMBER in the spectrum that will be used to stabilize the Gain. Note that for Cs, K, Th the CHANNEL NUMBER is preset as this is computed and entered during initial system calibration, however this data can be overridden by the user.
NOTE : It is crucial for correct system performance that the selected STABILIZATION CHANNEL is correct as a wrong selection can seriously distort system performance. A special CALIBRATION SHEET is supplied with each system and the correct stabilization channels are defined there. Unless special experimentation is being carried out, these recommended channels should be used. See figure 1.3 in Section 1.1 Quick Start for a sample calibration sheet.

2.4.4 COUNT LEVEL :

This sets the count level that the spectrometer must achieve at the selected peak before Automatic Gain Stabilization occurs. This is a very important parameter and should only be changed from typical settings after discussions with Exploranium. Incorrect parameters can affect system performance.

TYPICAL SETTINGS : CESIUM - set to 5000
K - set to 1000
Th - set for 500

2.4.5 TIMEOUT

This sets the MAXIMUM TIME in seconds that the peak may take to reach the selected COUNT LEVEL. If not reached in this time the system gives an error message. See Section 4.2: Stabilization Timeout for more information on this error.

NOTE : In most small detectors the 0.25uCi source takes about 70 seconds to achieve the recommended 5000 counts peak threshold. Since many users set a 60 second Sample Period, setting the Timeout at 100 seconds will give warning of any Gain errors. The correct setting is usually 10 seconds more than the typical time taken for the peak to achieve the Count level. For CESIUM operation set to 100 seconds.

2.5 MENU 5 - ROIs/ CALIBRATION

2.5.1 ROIs

In the GR-320 the user may set up to 8 Regions of Interest (ROIs). These are "windows" in the spectrum and are used to select a portion of the spectrum centred around specific peaks for analysis. Since the Sodium-Iodide detector has a fairly poor resolution, even though an isotope is emitting at a specific energy level the detector will display this peak as a Gaussian shape spread over a few channels. To improve counting statistics and data quality the International Atomic Energy Agency (IAEA) has specified a spread of channels around each peak as the "range" of this peak.

If this selection is made, Figure 2-12 appears.

This screen permits the user to enter in the required range of channels as required to produce the ROI data. The correct channels are computed by Exploranium during system Calibration and are specified on the system CALIBRATION SHEET.

These numbers should not be changed unless the system is re-calibrated on Test pads.

Default Settings :

ROI#1 is TOTAL COUNT
ROI#2 is POTASSIUM
ROI#3 is URANIUM
ROI#4 is THORIUM

ROIs

ROI	(channel)
1	[70] - [228]
2	[103] - [134]
3	[126] - [157]
4	[183] - [228]
5	[0] - [0]
6	[0] - [0]
7	[0] - [0]
8	[0] - [0]

Press **STOP** to CANCEL
Press **ENTER** to CONF.

Figure 2-12 – ROIs Display

The ASSAY mode requires the first 4 ROIs to be set to these channels but the lower 4 ROIs can be set to whatever is desired. The display must be set in CHANNEL units but if the user is interested in what energy these channels represent, then press SHIFT and the ROIs will be displayed is keV.
The conversion uses an embedded function derived during system calibration. To avoid confusion, the system Calibration Sheet is specified in channel numbers only. The data in Figure 2-12 is a typical data set for 256 channel operation (512 channel operation is 2x the above data).

In STOP and SCAN modes the ROIs are high lighted on the display.

2.5.2 CALIBRATION

CALIBRATION

	TOT	K	U	Th
B/G	**120**	**48**	**18**	**6**

Cal TOT **151**

roi#	2	3	4
K	**457**	**-369**	**-76**
U	**-10**	**4057**	**-2960**
Th	**41**	**-281**	**12459**

Figure 2-13 - CALIBRATION

After the ROI data is entered as above, pressing ENTER brings up the CALIBRATION menu. The 14 Calibration constants are derived during calibration and permit the full matrix computation to be made convert the raw ROI data into Concentrations in % K, ppm eU and ppm eTh. This will be done automatically at the end of each reading if Evaluation=ASSAY in Menu 3.

The calibration constants should not be changed unless a full Test Pad calibration is carried out. Users who can compute a more representative background may update the first 4 settings as these are the background (B/G) values in counts/minute.

Backgrounds can be calculated by taking the instrument out on a deep lake and recording measurements
in the ASSAY mode.

2.6 MENU 6 - DATA OUTPUT

If this selection is made, Figure 2-14 appears.

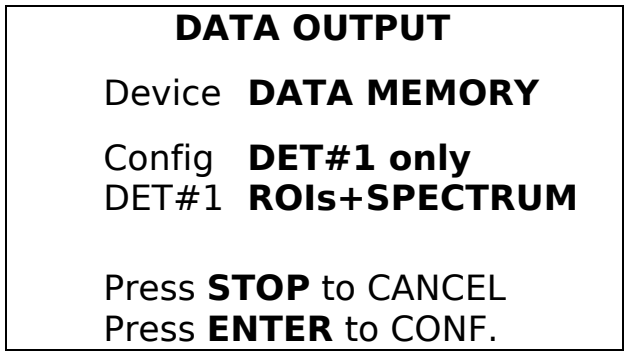


Figure 2-14

2.6.1 DEVICE :

DATA MEMORY : this is the selection for users who want to store the data in the internal memory of the GR320 for retrieval later.

RS-232 SW HSH: this is the selection when real-time output of the data through the RS-232 data port is required. This output mode enables SW HSH (Software Handshaking) format. This is the mode to use for DEDICATED data transfer.
The communicating PC uses the handshaking capability to ensure maximum data transfer quality.

RS-232 SIMPLE: this is the selection when real-time output of the data on the RS-232 data port is required but no handshaking is possible or desired. This is the preferred mode of data transfer for NON-DEDICATED data acquisition where the full handshaking protocol cannot be implemented due to other data system overheads. This is a reliable method of data transfer but places the onus of ensuring data is correct on the Data System itself.
If either of the RS-232 protocols are selected, then an additional selection of Baud Rate (Bd) must be made. Baud Rate may be set to 1200, 2400, 4800, 9600 or 19,200. The correct selection is required to communicate correctly with an external recording device/computers.

OFF : This selects NO data output of any kind.

Refer to Appendix C - REMOTE CONTROL for more information on Remote Control operation of the GR320 or RS-232 Interfacing.

2.6.2 CONFIG

Config : DET#1 only: this is the ONLY selection for 1 detector operation, see Appendix B: Dual Detector Operation for more information.
DET#1 : ROIs only : this outputs or stores the data for ROI data only
ROIS+SPECTRUM : this outputs/stores data for ROIs as well as the full spectrum (256 or 512 channels as selected).

SPECTRUM only : this outputs/stores only the full 256 or 512 channel spectrum
See Section 5.0 - Data Output/Storage Formats for more information on data output formats.

2.7 MENU 7 - LINE/POS/STEP

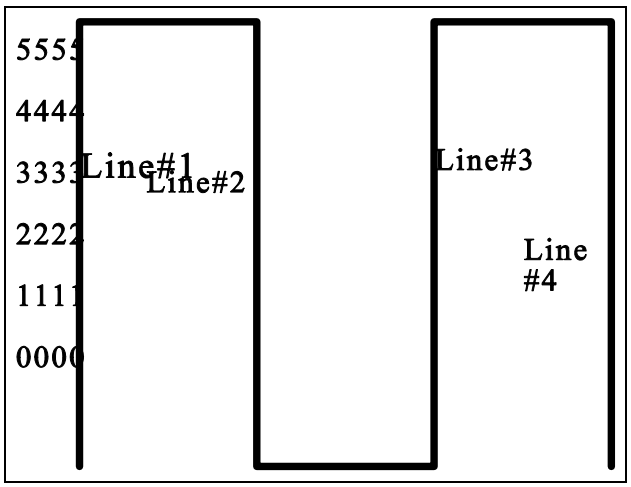


Figure 2-16

The manual positioning system has been designed to be used in the following basic manner but can be adapted to suit specific applications. Figure 2-16 shows a simple Survey Grid.

There are 4 lines numbered 1,2,3,4 and on each line readings must be taken at positions 0,1,2,3,4 and 5.

This survey can be carried out as follows :

a) Set MENU 3 as required for sample time etc. and set Position = AUTO and press ENTER.

b) Menu 7 is be used to change the Position data. When ENTER is pressed at Menu 7, Figure. 2-17 appears :

```
AUTO POSITION

Line          1
Line Point    0
Step-on-Line  1

Press STOP to CANCEL
Press ENTER to CONF.
```

Line : This is intended to be used as a LINE # with

entry up to 9999.

Line Point : Used to define the STARTING point on the Line.

Step-on-Line : Defines the spacing increment the along line

Figure 2-17

Set LINE # = 1, Line Point=0, Step-on-line=1 and press ENTER.

Once data has been entered and ENTER pressed to store it, the system returns to the Top Menu. At any time these parameters can be changed from the Top Menu by selecting Menu 7

c) Go to the Start of Line #1 and Position 0 and take a reading by pressing START. When the sample is complete and the Assay data displayed, on top of the screen will be seen :

Line #	1
Line pos	0
Step-on-line	1

When ENTER is pressed to store the data, this Location data is stored in memory as defined in Section 5.0: Data Output/Storage Formats.

d) In the GR-320 INTERNAL memory the Line Pos which was "0" for this first reading is AUTOMATICALLY incremented by the increment defined in Step-on-Line - in this case "1". Thus if the system is moved to position #1 on line#1 and a new reading taken, at the end of the sample period on the display will be shown :

Line #	1
Line pos	1
Step-on-line	1

e) If this data is stored, the instrument moved to Position #2 on Line #1 then if another sample is taken the display shows :

Line #	1
Line pos	2
Step-on-line	1

f) This procedure is repeated until Line #1, Position #5 is reached and this data stored

g) The system is then moved to Line#2, Position #5 and Menu 7 accessed. Since the memory was incremented automatically when the last reading was taken (at position #5) - the display will show :

Line #	1
Line pos	6
Step-on-line	1

Change the Line# to 2 (CLEAR then 2) then use ARROW DOWN to set the Line Pos=5 (the starting point). Then ARROW DOWN to set Step-on-Line to increment 1 again.

However this time we will be going DOWN the line so the Line Pos data should decrement so the Step-on-Line must be set to -1. This is achieved by setting "1" then pressing SHIFT to change it to -1. Press ENTER to store this data.

h) Take a reading at this location (Line#2, Position#5) and press ENTER to store.

j) Move to Line#2, Position #4 and take a new reading. At the end of the reading the display will show:

Line # 2
Line pos 4
Step-on-line -1

k) This procedure can be repeated as required to build up the required data set.

With this random positioning system, any sequence of survey points may be used. Some users use the Step-on-Line as a dimensional increment so if a 10m spacing is required - then by setting the Step-on-Line to 10 (or -10) the ground spacing is recorded. Since only the LINE # and POSITION are recorded in the data the user can change the Step-on-Line part way along the line from say 10 (m) to 2 (m) for a selected potion of the line.

It is much easier completing one line at a time the line as the parameters need only be changed at the start of a new line. If you carry out your survey across lines, then the Line # and Position parameters will need manual changing every measurement.

2.8 MENU 8 - DATA MEMORY

Menu 8 is selected to view the contents of the GR320 internal memory.
If there is NO data in memory then the display will appear as Figure 2-18.

DATA MEMORY

DATA MEMORY is EMPTY

Press ANY key

Figure 2-18

If there is any data in memory, the data is as shown similar to Figure 2-19.

DATA MEMORY
Stored 5 meas.

To SCAN data memory
press **1**

To DUMP data memory
to RS-232 press **2**

To ERASE data memory
press **CLEAR** 3 times

Press **STOP** to RETURN

Figure 2-19 DATA MEMORY

2.8.1 SCAN

This mode permits the user to review the data stored in the GR-320 Memory. If selected the data in memory is displayed on the screen in the format shown in Figure 2-20 :

REC = Record#
LEN = Record length in bytes
FMT = Data Format (e.g. R+S = ROIs+Spectrum)
DDHHMM = Day:Hour:Minute

SCAN DATA MEMORY

REC	LEN	FMT	DD	HHMM
1	311	R+S	24	1626
2	311	R+S	24	1626
3	311	R+S	24	1626

Figure 2-20

The user can SCAN the data by selecting a record with the cursor. The up and down arrows can be used to move through the data list. The left and right arrows can be used for paging up and down respectively. By pressing ENTER, the spectrum display of that data is shown. With the spectrum displayed the arrow keys can be used to inspect the spectrum. Pressing ENTER again gives the 8 ROI count rate data from that spectrum. STOP steps back through the previous menus to the TOP MENU. If only ROIs were stored, or only Spectrum, only that display will be shown on the screen.

2.8.2 DUMP

This mode is used to dump the Data Memory to an external recording device such as a PC. All the data stored in memory is transferred through the RS 232 data port by pressing 2.
Refer to Section 6.0: Support Software for more information on retrieving/processing stored data using the supplied software.

2.8.3 ERASE

If it is necessary to ERASE the data in memory, press CLEAR 3 times. Users should note that this process will completely erase all current data AND THIS DATA CANNOT BE RETRIEVED.

2.9 MENU 9 - MAINTENANCE

If this selection is made, Figure 2-21 appears:

This screen permits users to set/adjust various internal system parameters as follows (scroll through the menu with the Arrow keys and press ENTER to select) -

MAINTENANCE

Real Time Clock
ADC Offset, lower dis
Heating of display
Energy calibration
ADC1 test
ADC2 test
GPS maintenance
Load user option #1
Load user option #2

2.9.1 Real time clock

This permits setting of the DATE and TIME. Once set, the clock will continue to run even if the system is switched off.

2.9.2 ADC Offset/ Lower disc.

This permits adjustment of special spectrometer parameters - the ADC offset and Lower Threshold Discriminator. Figure 2-21

Figure 2-21 MAINTENANCE

ADC offset - this is a special setting used to adjust the system ADC. Normally it should NOT BE ADJUSTED as any changes here can affect system operation. The supplied CALIBRATION SHEET with the instrument will define this parameter setting for the supplied system. Changes are by numeric entry.

Unless specified elsewhere - set to 140

Lower disc.threshold - set in channel numbers as the lower limit of the spectrum. This parameter is defined on the CALIBRATION SHEET and should NOT BE ADJUSTED without discussion with Exploranium.

Unless specified otherwise - set to 2

2.9.3 Heating of the display : Disabled in this version

2.9.4 Energy Calibration

This is a special calibration method which requires the use of an external program (EXPLORE) to compute a math function to carry out the energy to channel conversion. The program output can be input by RS-232 or directly from the KEYBOARD. The display is shown in Figure 2-22 next page:

The current coefficients are shown as "Old a[0],a[1],a[2]".

The computed new coefficients can be input via the RS-232 port by selecting "2".

Alternatively the coefficients may be input manually by selecting "1". If this option is selected then the numeric data is set using the numeric keys. The Exponent "E" is set using the RIGHT ARROW, and the minus sign " – " is set by using the SHIFT key.

ENERGY CALIBRATION

Old a[0] = 1.468E+00
a[1] = 1.662E-01
a[2] = -3.350E-06

To enter calib. from KEYBOARD - press 1
RS-232 - press 2

Press STOP to CANCEL

Figure 2-22

2.9.5 ADC#1 test

This is useful for testing system performance.
If selected, Figure 2-23 appears after a few seconds.

This screen displays the results of a test of the system electronics and detector and is updating at a 1/sec rate. The data may be interpreted as follows :

ch 4 - 7 - the lowest 4 channels that have some count rate. This may be 1-4, 2-5 etc depending on 256/512 channel selection and Lower Threshold selection, but will always be the lowest channels. As long as these lower channels are displaying counts, the detector is operating.

maxp 55, cnt 157 - this displays the HIGHEST PEAK and the COUNTS in that peak in the 1 second spectrum just completed.

contr - shows the current setting of the front panel CONTRAST between 1 and 100. If this number is between 25 and 75 and the front panel contrast is OK then any number is fine. However, if for good contrast this number is between 0-25 or 75-100, the contrast control is running out of range. In this case contact Exploranium for advice how to adjust the hardware coarse adjustment to give adequate contrast range.

ch 4 cnt 13
ch 5 cnt 18
ch 6 cnt 24
ch 7 cnt 28
---
maxp 108 cnt 157
---
contr 31 heating 0
live 972 clk 997
cosm 3 cntr 3178
Ebat 11.9 temp 23.2
Tbat 57 gain 255

heating - shows if the display heating is ENABLED (1) or DISABLED (0). Currently this function is

disabled, as the GR-320 does not have a heated display at this time.

live - is the LIVETIME in mSec for the sample, since this data is the result of a 1 sec test = 1000 mSec thus the data normally is between 950 and 990 depending on source activity.

clk - is the actual clock rate in mSec - should be 997 mSec as it is the 1 sec (1000 mSec) actual sample rate MINUS the system overhead which is normally 3mSec.

cosm - is the value of the COSMIC channel - all pulses in the 1 second period ABOVE the 3MeV upper threshold of the system. This is normally less than 10.

cntr - is the TOTAL count rate of the 1 sec sample for all pulses ABOVE the Lower Threshold and BELOW the Upper Threshold. This number is typically 2000-3000 cts for a GPX-21 detector in a "normal"
field with the 0.25 Cesium source installed.

Ebat - Current voltage level -
If Rbat = the current battery voltage - should be above 5.5 for correct operation.

If Ebat = external power and should be 100% if the battery charger is functioning OK.

temp - the current TEMPERATURE of the console in degrees Celsius.

Tbat - a special parameter defining how much time in MINUTES has passed since the battery was last charged.

gain - the current setting of the system's automatic Gain system. It should be between 200-400 for correct operation.

2.9.6 ADC#2 Test - applicable only if a second detector is used, in which case a display the same as the one described for ADC#1 above is shown.

2.9.7 GPS Maintenance - tests the performance of an attached GPS system to ensure that communication is OK. Any errors are displayed on the screen. The GPS must have a location fix before it will communicate with the GR-320.

2.9.8 Load user option #1 - permits loading of DEFAULT parameters. If the instrument is acting erratically it is possible that power noise/transients have interrupted the micro-computer during writing to memory. If this occurs then a part of RAM is probably corrupted and since this can cause strange problems (depending on where the corruption occurs) invoking this option will ERASE RAM and load DEFAULT parameters from EPROM. If this occurs then the system CALIBRATION sheet must be used to reset all parameters to their correct calibrated values.

In MENU 8 - DATA MEMORY - Loading Default Parameters action is confirmed by "Stored -1 meas." The user must initialize the data memory (CLEAR CLEAR CLEAR) before new data can be stored.

2.9.9 Load user option #2 - permits the user to change the MATH function parameters that convert ENERGY LEVEL to CHANNEL NUMBER for display purposes only. These coefficients are normally set during system calibration but since their

adjustment only affects the Channel-keV conversion on the display, they are not crucial numbers.

3.0 START MEASUREMENT

NOTE : If this is the first reading of the day Exploranium recommends carrying out SYSTEM TEST prior to data accumulation - see Section 2.1: MENU 1 - SYSTEM TEST for more information.

To start a measurement press START. The following display appears -

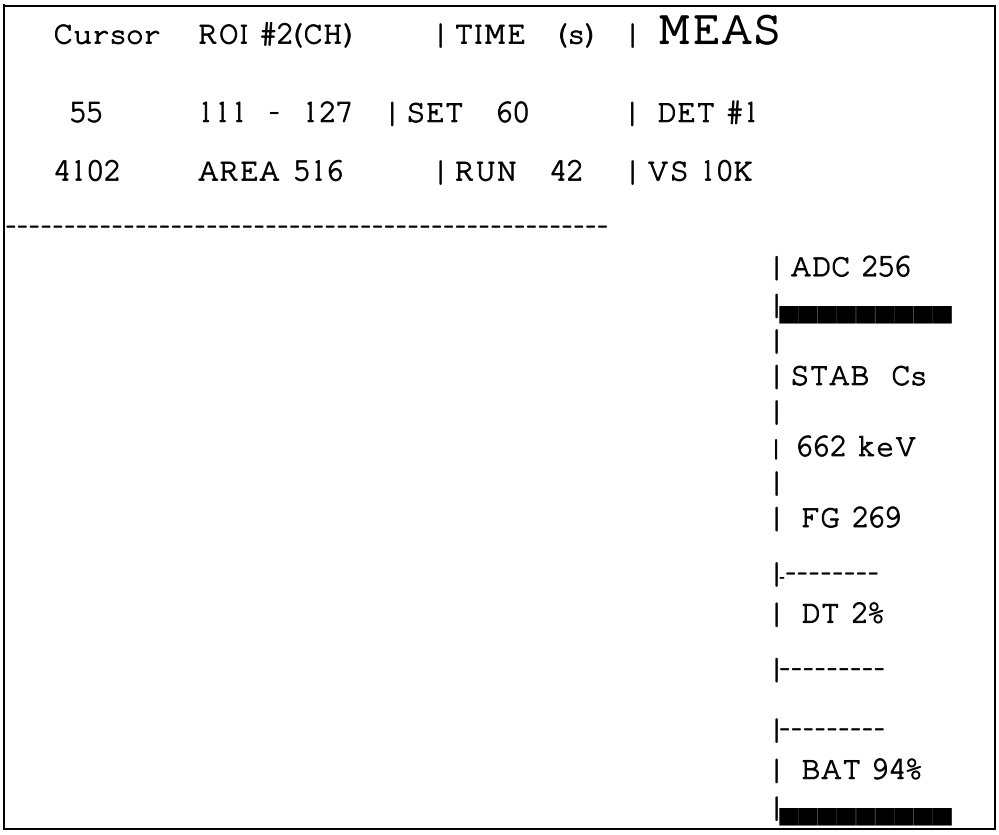


Figure 3-1 MAIN Display

The display is explained as follows :

Cursor 55 4102 - This means that the cursor has been set on channel 55 and this peak has reached a height of 4102 counts. The data is updated at 1 second intervals during the measurement period. At any time the cursor can be moved to a new position using the ARROW KEYS.

ROI#2 (CH) 111-127 AREA 516 - This is the data from ROI#2 (set to be Potassium in Menu 5 - Section 2.5). The data shows the ROI displayed (ROI#2), the current channel selections in Menu 5 (channels 111-127) and the current 1 sec count rate (AREA 516). These count rates are also updated every second.

The selection of ROI# depends on the current position of the cursor and is the first ROI to the right of the cursor. Thus moving the cursor to the right will change from ROI#2 to ROI#3 to ROI#4, etc. ROI#1 is NOT visible as this is the Total Count channel.

SET 60 This is the current SAMPLE TIME (set in Menu 3 as 60 seconds)

RUN 42 This is the current display i.e. 42 seconds of data is displayed. This number increases

until it reaches the SET 60 number after 60 seconds. If running in repeat mode, the sequence will start over in the next reading. If running a single measurement, then the ASSAY display is shown (see below) if running in ASSAY mode.

MEAS This is the label of the display. Note that when the display first starts this label shows STAB. The system starts in the Stabilization mode when a 4 second spectrum of Cesium is taken and Gain pre-stabilization carried out BEFORE the actual 60 second sample period starts. The user can see the STAB label and note that the RUN number starts at 0 then increments 1,2,3,4. At this point the 4 second spectrum is analysed, the correct Gain set and the label then changes to MEAS and the RUN data starts at 0 again and increments to 60 as normal. See Section 2.4: MENU 4 - Stabilization for more information.

DET #1 This is a single detector system so this is a permanent label indicating one detector operation. This label changes for 2 detector operation - see Appendix B: Dual Detector Operation for more information.

VS 10K This is the VERTICAL SCALE. It is automatically adjusted to a maximum of 65,000 counts within each sample period. The display starts at a Vertical Scale of 500 then increments to 1K (1000), then 5K, 10K, 20K etc to 65K. At the start of the next sample period the scale starts once again at 500. At any time the Vertical Scaling can be overridden by using the UP ARROW and DOWN ARROW which will step the display through the scales. Once a scale is selected this scale will be fixed until the start of the next sample period.

ADC 256 This shows that the system is operating with the 256 channel spectrum option (alternative is 512 channel - see Section 2.3: MENU 3 - Operational Mode for more information).

 This bar indicates the display selection. In 256 channel operation a fully shaded bar shows that all 256 channels are being displayed. Pressing "." will shade only half the bar. Repeated pressing of "." changes from 0-256, to 0-128, to 128-256, to 0-256. If the left-hand portion of the bar is shaded then the display is showing channels 1-128 -the lower portion of the spectrum. In addition the RIGHT ARROW key can be used to change this selection to middle 128 channels (shaded bar in the centre) or the upper 128 channels (shaded bar to the right). Most users will find that a "fully shaded bar" = all 256 channels displayed is easier to understand.

Stab Cs 662 Shows that CESIUM stabilization is enabled and set for 662 keV

FG 269 Shows that the FINE GAIN is set to 269 - remember a setting of 200-400 is normal. See Section 2.2: MENU 2 - Detector Configuration for more information.

DT 2% This means that system DEAD-TIME is approximately 2%. The bar below it is a horizontal display of DEAD TIME

BAT 94% This Shows the battery status as a % and as a horizontal shaded bar. This is useful to assess battery life for field operations. If operating on an external charger, it should show 100% at all times.

SPECTRUM The spectrum display shows the accumulation spectrum with the selected Automatic Gain Stabilization selection highlighted in reverse video. Under normal CESIUM operation, a visible highlighted peak should be seen easily.

At the completion of the sampling time (60 seconds in this example), Figure 3-2 appears (if running a single measurement in the ASSAY mode). This is the result of the matrix computation using the

sampling time data from the ROIs and applying the 14 calibration constants set in Menu 5. See Section 2.5: MENU 5 - ROIs/Calibration.

The data is displayed as:

TOT - Total Count - in eU and cts/min.
K - Potassium - in % and cts/min.
U - Uranium - in ppm and cts/min.
Th - Thorium - in ppm and cts/min.

The cts/min. values are background corrected and livetime normalized to 1 minute.

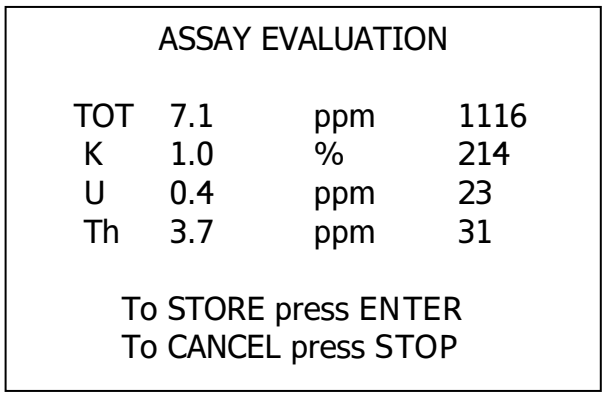


Figure 3-2 ASSAY Display

GR320 Keypad Reference

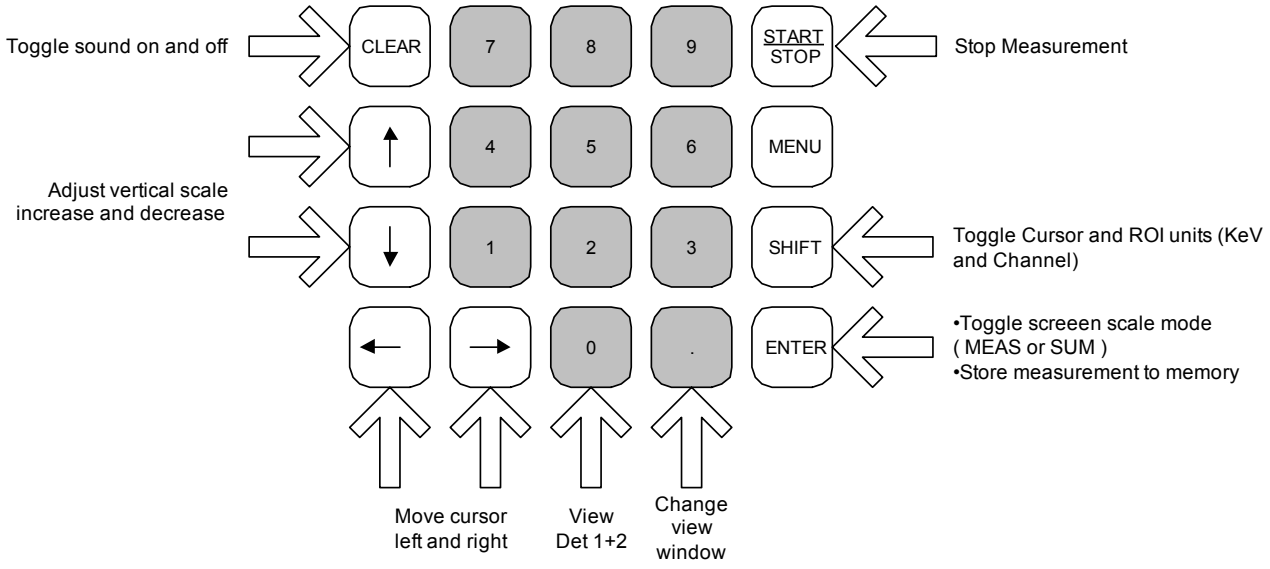


Figure 3-3

Figure 3-3 shows some hidden key functions that can be used during sampling:

ENTER — Press ENTER to store the data at the end of a single measurement. The program returns to the Top Menu.

Press ENTER to toggle the screen from MEAS to SUM during a sample.

STOP — Press STOP during a measurement and the measurement will stop. A screen will appear indicating that you press ENTER to store the data or press STOP to cancel. This is the same screen that will appear at the end of a single measurement.

Press STOP again and a message appears on the display "DATA NOT STORED".

If ENTER is now pressed data will be stored in memory and the system will return to the Top Menu.

If STOP is pressed, the data spectrum of the Sample Period is displayed and the top right label shows STOP.

In this STOP spectrum display mode the vertical ARROW KEYS can be used to increase the Vertical Gain to make the smaller peaks in the upper spectrum visible. The data cannot be stored.

4.0 ERROR MESSAGES

When the GR-320 detects an action that is interpreted as a problem, the error is brought to the users attention by an Error Message on the display. These error messages are discussed below :

4.1 RS-232 Device Error

MEANING : If an incorrect RS-232 setting is made (for example if GPS is enabled and the Data Output is set to RS-232) this error will be displayed.

ACTION : The display shows Use menu #6 to set correct output device. Stop the system, go to
MENU 6 and set the Data Output correctly (or disable GPS in MENU 3 as required).

4.2 Stabilization Timeout

MEANING : During stabilization the channel selected for Automatic Gain Stabilization did not reach the specified COUNT LEVEL before the TIMEOUT time selected was reached.

ACTION : Normally this error means that the COUNT LEVEL is set too high, the TIMEOUT is set too low, the stabilization source (if Cesium) is not in place or there is a fault with the detector. If levels are normal and this error occurs often consult with Exploranium. This Error Message is emphasised with an audio "beep".

The error can sometimes be removed by pressing CLEAR depending on the timing of the error.

4.3 No Data Recorded

MEANING : If a sample is started (by pressing START) in any mode (Single, Repeat, Base-Station) and Menu 6 - Device = OFF (no data storage or output) then this error message will be displayed on the screen. If the user is doing testing only this may be an acceptable but under most circumstances this is not normal operation.

ACTION : Set Menu 6 to the correct function

4.4 DEFECTIVE PIC#1 (or #2)

MEANING : This error means that one of the detectors selected has a communication error - PIC#1 refers to Detector #1 etc. This usually means that DETECTOR #2 has been selected as ON but there is no extra ADC board to support it.
In older 2 detector systems this error occurs when a Dual-detector system is operated on Battery power. In the latest GR-320 systems a redesign of the Power Supply board also permits dual-detector operation on battery.

ACTION : Check Menu 2 for correct settings
If old power supply, and 2 detectors, connect an external power supply

---

4.5 Data Memory not Initialized

MEANING : When DEFAULT PARAMETERS are loaded (see Section 2.9: MENU 9 - Maintenance) the data in memory in Menu 8 is set to -1. If this memory is NOT cleared prior to recording data this Error Message is given at the end of each sample and the GR-320 beeps to draw attention to it.

ACTION : Clear Data Memory in Menu 8. Refer to Section 2.8: MENU 8 - Data Memory for more information on initializing the data memory.

4.6 Detector #1 No Counts

MEANING : This means that the detector appears defective. During the Sample Period every second the total number of counts in the spectrum must exceed 100 counts. If not the system beeps and the above error message is displayed.

ACTION : Check cables/detector. Contact Exploranium if this problem continues.

4.7 Invalid Measurement Mode/Position

MEANING : In Menu 3, if MEAS. MODE is set to REPEAT or BASE and POSITION is set to KEYBOARD then this error message will occur. The user is requesting a manual keyboard entry of Location data but the system is in the REPEAT mode so it will not pause to permit this manual data entry. If ENTER is pressed to store this combination of parameters anyway, then dummy data "R" will be automatically be stored as the location data.

4.8 Data Not Stored

MEANING : This error means that at the end of a single measurement, the user has pressed STOP instead of ENTER. It is necessary to press ENTER at the end of a sample to store it in memory so this error message advises users that data has NOT been stored.

ACTION : Store the data as described in Section 3.0: Start Measurement.

4.9 Stabilization Error

MEANING : This error means that the Automatic Gain Stabilization is not functioning correctly. This is a FATAL Error as without correct Gain stabilization the spectrometers data may be seriously in error.

ACTION : Press STOP and check Menu 2 and 4 for correct settings, then run System Test to check system performance.

For special testing this error message can be bypassed by setting Menu 4 - to STABILIZATION = OFF.

5.0 DATA OUTPUT/ STORAGE FORMATS

5.1. DATA FORMAT AND STORAGE CAPACITY.

The GR-320 permits the user to select which data is to be stored in an internal memory or output to a RS-232 port. The internal memory capacity is 384K bytes. The data is organized into data blocks and the operator makes decisions about which of the data blocks are stored.

Refer to Appendix B: Dual Detector Operation for output and storage formats for dual detector operation.

Header: this data block is always stored and contains four "Z" characters to permit synchronization. In addition the header includes - total data block size, system configuration, date, time, temperature, battery voltage, # channels in the spectrum and sample time (See Section 5.2.1).

ROI Data Block Detector #1: this data block contains the live time of detector #1 and ROI (Region-of-Interest) data from detector #1 (or Detector 1+2 depending on selection (see Section 5.2.2).

GPS Data Block: this block contains latitude, longitude and altitude data from a GPS receiver (if the GR-320 is so equipped and configured) or manual keyboard entry location data (See Section 5.2.3).

Spectrum Data Block : contains spectrum data (256 or 512 channels as selected) for Detector #1 (See Section 5.2.4).

The data storage capacity depends on the selection of data for storage:

# chns	ROI det #1	Spectrum det #1	GPS	Data length in bytes(words)	Capacity [data set]
256	yes	no	no	110(55)	3574
256	no	yes	no	570(285)	690
256	yes	yes	no	622(311)	632
256	yes	yes	yes	682(341)	576
512	yes	no	no	110(55)	3574
512	no	yes	no	1082(541)	363
512	yes	yes	no	1134(567)	347
512	yes	yes	yes	1194(597)	329

5.2. DATA BUFFER ASSIGNMENTS

5.2.1 HEADER - always included (56 bytes):

Byte #	DATA	label	COMMENTS
1-4	character	"Z"	4 bytes "ZZZZ" for synchronization
5,6	integer		Length of data in words
7	character	confOUT	=0 detector#1 active only (=1 det #1,#2 active - see App.B)
8	character	c-mode	=0 normal (=1 ADD = Det#1+Det#2) (=2 COINCIDENCE) (=3 ANTI-COINCIDENCE)
9	character	det1	=0 ROI's only =1 ROI's and spectrum =2 spectrum only
10	character	det2	=0 ROI's only =1 ROI's and spectrum =2 spectrum only
11	character	config1	=0 detector #1 output only (=1 det #1 and #2 output -see App.B)
12	character	gpsFLAG	=0 no position data =1 keyboard entry of position data =2 GPS latitude, longitude, altitude =3 AUTO - line#,pos#,step
13,14	character	year	YY From internal Real Time Clock
15,16	character	month	MM
17,18	character	day	DD
19,20	character	hour	HH
21,22	character	minute	MM
23,24	character	second	SS
25,26	integer	temp	console temperature (*10) in deg C
27,28	integer	Volt	Battery Voltage (*100) in Volts
29,30	integer	nch	Number of Channels=256 or 512
31-34	long	clock time	Accumulation time [mSec]
35,36	integer	Ser#	Serial # 0 - 9999
37-40	character	Ver#	S/W Version # "V1.8"
41-56	character	Spare	16 characters = future assignments

5.2.2 ROI DATA BLOCK - (52 bytes)

For Detector #1 only - 52 bytes

1-4	long	Livetime	det#1 - 4 bytes - live time in [mSec]
5-8	long	ROI#1	det#1 - ROI #1 counts
9-12	long	ROI#2	det#1 - ROI #2 counts
13-16	long	ROI#3	det#1 - ROI #3 counts
17-20	long	ROI#4	det#1 - ROI #4 counts
21-24	long	ROI#5	det#1 - ROI #5 counts
25-28	long	ROI#6	det#1 - ROI #6 counts
29-32	long	ROI#7	det#1 - ROI #7 counts
33-36	long	ROI#8	det#1 - ROI #8 counts
37-40	long	Cosmic	det#1 - Cosmic channel - counts
41-44	long	totCOUNT	det#1 - TOTAL input count rate-cnts
45,46	integer	Gain	det#1 - gain (0 to 511)

47,48	integer	pp	det#1 - peak channel number (*10) of the isotope selected for stabilization
49,50	integer	fwhm	det#1 - energy Resolution*10 in [%]
51,52	integer	stab# 1	det#1 - number of Gain adjustments

5.2.3 GPS DATA BLOCK (60 bytes)

5.2.3.1 IF "POSITION=GPS" is selected (RMC string):

1	character	$	1 char = decode as GPS
2-9	character	latitude	8 char = 9999.999 lat.
10	character	N(or S)	1 char = N or S - lat.
11	character	","	1 char = separator
12-20	character	longitude	9 char = 99999.999 lon.
21	character	E (or W)	1 char = E or W - long.
22	character	","	1 char = separator
23-26	character	altitude	4 char = 9999 alt.
27	character	","	1 char = separator
28	character	A(or V)	1 char = A valid or V invalid
29	character	","	1 char = separator
30-35	character	UTC	6 char = UTC time
36	character	","	1 char = separator
37-42	character	date	6 char = date
43	character	"*"	1 char = end of string
44-60	character	"#"	17 char = ###..### (fillers)

5.2.3.2 IF "POSITION=KEYBOARD" is selected :

1	character	K	1 char = decode as Keyboard
2-9	character	latitude	8 char = 9999.999 lat. from keyboard
10	character	N(or S)	1 char = N or S - lat. From keyboard
11	character	","	1 char = separator
12-20	character	longitude	9 char = 99999.999 lon.from keyboard
21	character	E (or W)	1 char = E or W - long. From keyboard
12	character	"*"	1 char = end of string
23-60	character	"K"	38 char = KK...KK (fillers)

5.2.3.3 IF "POSITION=AUTO" is selected

1	character	A	1 char = decode as Auto
2-5	character	LINE #	4 char = 9999 Line #
6	character	","	1 char = separator
7-10	character	Pos	4 char = 9999 position on line
11	character	","	1 char = separator
12-15	character	STEP	4 char = 9999 Step-on-Line
16	Character	"*"	1 char = end of string
17-60	character	"A"	44 char = AA...AA (filler)

5.2.4 SPECTRUM DATA BLOCK #1

5.2.4.1 256 channel - Detector #1 only (512 bytes)

confOUT (see Header) = 0 so this data block = Det #1 ONLY

1-4	long	LT	LIVETIME in mSec
5,6	integer	chn 2	counts/sample period
7,8	integer	chn 3	counts/sample period
.....			
507,508	integer	chn 253	counts/sample period
509,510	integer	chn 254	counts/sample period
511,512	integer	Cosmic	Cosmic channel counts/sample period

5.2.4.2 512 channel - Detector #1 only (1024 bytes)

confOUT (see Header) = 0 so this data block = Det #1 ONLY

1-4	long	LT	LIVETIME in mSec
5,6	integer	chn 2	counts/sample period
7,8	integer	chn 3	counts/sample period
.....			
1019,1020	integer	chn 509	counts/sample period
1021,1022	integer	chn 510	counts/sample period
1023,1024	integer	Cosmic	Cosmic channel counts/sample period

5.2.5 CHECKSUM

1,2	integer	CKSUM	Checksum - negated sum of all data bytes EXCEPT Checksum – If C/Sum is added to the sum of all data = 0

5.2.6 DATA BLOCK summary (# bytes) - 2 bytes=1 word

Data Block	Det#1 only
Header	56
ROI block	52
GPS	60
256 spectrum	512
512 spectrum	1024
Checksum	2

EXAMPLE : Det #1 - 256 channel + ROI data + Spectrum
Format Header + ROI + Spectrum + Checksum
Bytes 56 + 52 + 512 + 2 = 622 bytes = 311 words

6.0 SOFTWARE PROGRAMS

6.1 EXPLORE software program (Windows 3.1, 95/98, NT)

Exploranium supplies a special WINDOWS based software package titled "EXPLORE" for use with the GR-320.

This software permits users to :

- Import data from the GR320
- View data in graphic or chart format
- Print data
- Average data sets
- Export data to a spreadsheet format

This software is supplied with a separate manual, which describes operation.

6.2 DOS Based Programs

Exploranium also has a wide range of speciality programs to permit various stand-alone applications. These utilities are intended to aid users in various applications, however if the user wants to integrate various 320 software capabilities inside their own user software, the full source code in "C" is available on request.

READ_30 Reads the data directly or from the memory of the 320 and saves the data in one file in exactly the same form as it is output. This data file is compatible with the EXPLORE program.

DUMP_30 Dumps the data saved using read_30 to the screen or printer.

DRAW_30 Displays the spectrum data in a graphical form on the screen.

TEST_30 Reads data from the system test (gain, peak and resolution) and stores this information in a file.

ASC_30 Converts data saved using READ_30 to ASCII and saves individual files for each reading. There is an option to save the header information with the spectrum or just the spectrum data. The spectrum data without the header may be used in the EXPLORE program.

Please contact Exploranium for any special applications.

APPENDIX A: TECHNICAL SPECIFICATIONS

A.1 DETECTORS

DETECTORS:

1. GPX-21A: 3 x 3" NaI(Tl) - 21 cu.ins (0.35 l)volume hand carry detector
2. GR-320L: 3 x 3" NaI(Tl) - 21 cu.ins (0.35 l) volume laboratory detector with 2" lead shielding
3. GPX-256: 4 x 4 x 16" NaI(Tl) - 256 cu.ins (4 l) volume detector for vehicle applications
4. GPX-512: 2x[4 x 4 x 16 NaI(Tl)] - 512 cu.ins (8 l) volume detector for vehicle or airborne applications

A.1.1 GPX-21A

Crystal:	21 cu.ins (0.35 l) Sodium Iodide (Thallium) [NaI(Tl)] detector - 3" (75 mm) diameter by 3" (75 mm) long with an integral bi-alkali photo-multiplier tube(PMT).
Resolution:	Better than 9.0 % FWHM (resolution) for Cesium-137 (662keV)
High Voltage:	600 to 800 Volts supply used to power the PMT. Special electronics provide highly stable low-noise circuitry.
Gain setting:	Continuously adjustable by internal 10-turn pot from x 1 to x 10. Typically 0.4 V amplitude on the output for 662 keV
Output:	Positive pulses, rise time < 0.5 us, fall time approx. 50 us
Output impedance:	approx 100 ohms, DC coupling, short-circuit proof
Linear range:	max. + 6 V amplitude of output pulses
Reference source:	Cesium 137 - 9 kBq (approx. 0.25 uCi) mounted in the base of the detector housing
Housing :	Aluminium cylinder with water resistant seals and internal thermal protection and shock mounting
Connector:	6-pins male circular connector
Power used :	+5 VDC, +9 VDC, -9 VDC (from GR-320 console)
Dimensions:	4.5" (115 mm) diameter, 16" (406 mm) long
Weight:	2.3 lbs (5 kgs)
Temp. Operating :	- 10 to + 60 deg. C
Temp: Storage :	- 20 to + 70 deg. C

A.1.2 GR-320L

Detector:	3" (75 mm) diam x 3" (75 mm) NaI(Tl) detector
Electronics:	standard GPX-21A electronics
Shielding:	2" (50 mm) lead walls, bottom and sliding cover
Sample containers:	normally 3" (75 mm) diam x 1.1" (28 mm) high
Dimensions:	12" (30cms)W x 24"(60cms)D x 30"(0.8m)H
Shipping weight:	600 lbs (272 kgs)

A.1.3 GPX-256

Detector:	256 cubic inches (4 l) NaI(Tl) 4"x 4"x 16" (101 mm x 101 mm x 406 mm)
Electronics:	standard GPX-21A electronics
Housing:	rugged aluminium container
Dimensions:	H= 8" (200 mm) x W= 9" (230 mm) x D= 27" (690 mm)
Weight:	51 lbs (23 kgs)
Temp. Operating :	- 40 to + 50 deg. C (closed pack)
Temp. Storage :	- 40 to + 60 deg. C (closed pack)

A.1.4 GPX-512

Detector:	2 x 256 cubic inches (total 8 l) NaI(Tl)
Electronics:	dual GPX-21A electronics, with independent output from each crystal on the output connector
Housing:	Aluminum container
Dimensions:	H= 8" (200 mm) x W= 13" (330 mm) x D= 27" (690 mm)
Weight:	95 lbs (43 kgs)
Temp. Operating :	- 40 to + 50 deg. C (closed pack)
Temp. Storage :	- 40 to + 60 deg. C (closed pack)

A.2 CONSOLE

A.2.1 ANALOG PROCESSOR

Amplifier and Automatic Gain Control

Input signal: Positive, from preamplifier output, rise time max. 1 us, fall time 20 - 50 us, linear range up to 6 V pulse amplitude

Shaping: bipolar, 1 us time constant

Pole-zero : internally adjustable from 20 to 50 us pulse fall time

Coarse Gain: 1 x or 0.5 x, software selectable

Fine Gain: +/- 50 % in 512 steps, under software control

Analog to Digital Convertor

Type: Dual buffer, high speed, high linearity, two pass flash convertor

Resolution: 256 or 512 channel, software selectable

Conversion Time: 5 us per pulse (due to dual buffering this ADC does not add any dead time for 1 us time constant input pulses)

Int. non-linearity: max. 0.1 % full scale over top 99% of range

Diff. non-linearity: typ. 1 % (max. 1.5 %) full scale over top 99% of range

Lower threshold: digitally adjustable from channel 2-25 under software control in approx. 1 channel steps

Upper threshold (Cosmic channel): fixed to channel 255 (511 in 512 channel selection)

ADC Offset (Zero of ADC): software adjustable from 1 - 255 in special units.
Maximum Count per Channel: 65,535

Dead Time Correction: automatic, 0.25 % precision

Detector configuration

Number of analog inputs: 1 (standard), 2 (optional)

Acquisition Mode:

a) Det.#1 only (normal operation)

b) Det.#1 and Det. #2 - fully independent acquisition

c) Det.#1 + Det.#2 - summing

d) Coincidence - Det.#1 - normal
Det.#2 - only coincidence pulses

e) Anticoincidence - Det.#1 - normal
Det.#2 - only anticoincidence pulses

High Count Rate System Performance

Test Condition: The following data are the maximum measured differences between LOW input count rates (approx. 2K cps) and MAXIMUM input count rate 100K cps using Cesium 137 at 110 channel (662 keV)

Zero Drift: max. 0.5 channel

Gain Drift: max. 0.5 channel

FWHM (resolution) degradation: max. 5 %

A.2.2 DIGITAL PROCESSOR

Spectrum Analyzer

Sample Period: 1 to 9,999 seconds, Clock time or Live time

Mode of measurement:

Single - a single measurement

Repeat - next measurement starts immediately after the previous one finished

Base Station
- specified start of the first measurement
- specified repetition time 1 to 999 min
- specified number of meas. from 1 to 999
- specified power save mode (unit is automatically switched OFF between measurements)

Number of Energy Windows (ROI) : 8 - all but #1 can be highlighted on the display

ROI Setting Range: 1 to 511

Spectrum Evaluation:

ASSAY - using internal calibration constants computes concentration of Th [ppm], U [ppm] and K [%]

enviSPEC - using an energy calibrated matrix, dosimetry values are displayed in one of the following units: Exposure [R], Absorbed dose [Gy], or Equivalent Dose [Sv].

User #1 - special computation program can be prepared according to user's requirement

Peak Evaluation: Peak position computation - 0.1 channel precision
FWHM (resolution) computation - 0.1 % precision
Gross / Net area computation

Energy Calibration: precisely converts channels to keV using an internal math function

Digital Spectrum Stabilizer

Procedure: uses a spectral peak from natural or artificial isotopes to automatically change gain for complete spectrum stabilization

Stabilization peaks range: from 30 to 500 channel (512 channel)

Confidence Level: set by keyboard from 100 to 50,000 cps

Precision: +/- 0.1 channel for Cesium 137 at 662 keV

Clock - Calendar

Type: built in 24-hour clock, 4-year calendar (no leap year), fully battery backup, 10 year operation

Precision: +/- 3 s/day at 25 deg. C
+/- 30 s/day at full operating range

Data Storage

Type: 500 KB CMOS SRAM memory, with Li-battery back-up

Capacity: 20,000 sets of ROI, including time and location data

or 500 spectra (512 channel), including time and location data

or corresponding number of combination of ROI's and spectra

Data Retention Time: typically 10 years, limited by Li-battery life

Stored Data Retrieval: - on the console display
- via RS 232 serial cable to a computer

Data output

Type: Serial channel RS-232C
1 start bit, 8 data bits, no parity, 1 stop bit

Baud Rate: 1200, 2400, 4800, 9600 or 19200 Bd, selectable from the keyboard

Format: binary for spectra , all other ASCII. See Section 5.0: Data Output/Storage Formats

Data output: Date and time, livetime, dead time, detector configuration, stabilization information selectable: - ROI's only, Spectra only, ROI's + Spectra

A.2.3 GENERAL DATA

DISPLAY

Type: graphics LCD, 320 x 200 dots

Viewing area: 100 x 64 mm

Contrast: digitally adjustable by keyboard in 32 steps, automatic temperature compensation. See Section 1.1: Quick Start for more information on changing screen contrast.

KEYBOARD

Type: Membrane with tactile feedback, 21 pushbuttons, dust proof and water tight

POWER REQUIREMENTS

Battery voltage = 6 V

State	1 Det.+ Console	2 Det. + Console
Measurement:	2.6 W	4.6 W
Computation or Data Transfer:	0.7 W	0.8 W
Stand-by:	0.5 W	0.6 W

POWER SUPPLY OPTIONS

The power supply has a universal power input capability and can be connected to any AC power source 110/220V 50/60Hz. The AC connector should be changed to suit local conditions. The supplied external Battery Charger is primarily designed to be used to CHARGE the battery but AC operation is also supported.

The internal Power Supply in the GR-320 has been upgraded to permit special functions not available originally. The differences are as follows :

Ser # 2001-2030
- Dual detector operation ONLY on AC operation
- 28V operation using special power supply requires outboard cable.
- non-automatic switch over to Battery if AC power is removed and vice versa. Connecting power causes system operation to be disrupted.

Ser # 2031+
- Dual detector operation on Battery and AC operation
- 28V operation using special power supply which connects directly inside the power supply unit
- automatic switch over to Battery if AC power is removed and vice versa with no change in system operation

1. Internal Rechargeable Battery

Type: 6 V / 6.5 Ah Sealed Lead-Acid, maintenance free rechargeable battery

Operation time: typically 12 hours of true measurement at 25 deg.C for one detector system

Charging: overnight charging using external AC adapter and dual level float internal charger with

full charge indication by LED on the GR-320 back panel. For more details see Appendix D: Using Rechargeable Battery.

2. Internal Battery (Optional)

Type: 6 "D" cells - alkaline recommended

Battery Life: typically 15 hours of true measurement at 25 deg.C for one detector system

3. External 12 VDC

Type: any reasonably voltage stabilized DC power supply

Voltage Range: from 9 to 14VDC (0V input = Ground). Directly connected to the Power Connector of the GR-320 Console (12 V car battery)

4. External 28 VDC (Optional)

Type: Special power supply available. DC-DC converter (28 VDC - 12 VDC) assembly replaces the Battery Pack.

Voltage Range: 14 - 40 V

5. External AC Adapter

Type: Supplied with unit. Can be used simultaneously for charging and measurement

Voltage Range: 90 - 250 VAC, 47 - 440 Hz

Environment:
1. This adapter is for use in a normal office environment only.
2. Ambient temperature max. 40 deg.C, rel. humidity max. 85 %
3. The power cord is the main power disconnect.
4. This adapter requires an external safety ground.

PHYSICAL

Dimensions:
W = 9.5" (241 mm)
H = 4.0" (101 mm)
D = 9.8" (250 mm)

Weight:
3.6 kg (8 lbs) without battery
4.6 kg (10 lbs) including alkaline D-cells
4.8 kg (10.5 lbs) including rechargeable battery pack

ENVIRONMENTAL

Operating Temperature Range: - 10 to + 45 deg. C
(recommended external battery pack for operating in temperatures under 0 deg. C due to the extra power required for the internal display heater)

Storage Temperature Range: - 20 to + 60 deg. C

Protection: dust and splash water proof (excluding battery compartment

Non-condensing Relative Humidity: less than 90 % at 40 deg.C

Vibration: 0.5G max. (10 - 300 Hz, XYZ directions, 1 h)

Shock: 3G (10 ms, XYZ directions, 1 time each)

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

A.2.4 ACCESSORIES

STANDARD:

- GR-320C Console
- GPX-21A Detector assembly
- Detector to Console straight cable 4' (1.3 m)
- internal Rechargeable battery 6 V/6.5 VA (placed inside the battery compartment of the Console)
- 110/220 VAC - 12 VDC Adapter for battery charging
- Leather carrying case for the Console
- Harness assembly and shoulder strap for the Console
- Detachable carrying handle for the Console
- 4 x 3.5" disk with support software programs for IBM PC compatible computers
- RS-232 cable for connecting Console to the PC
- Reference Source 0.25 uCi Cesium 137 (in holder at bottom of detector)
- Operating Manual
- Padded, compartmentalized carrying case

OPTIONAL:

a) P/N 92337 - 6 D-cell battery holder

b) P/N 40-320-000 - Spare re-chargeable Battery

c) P/N 92352 - 28V Power option

d) P/N 60-320-OPT - European AC power cord

e) P/N 84245..m - Detector-Console cable - specify length "m"

f) P/N 92342 - spare ADC board required for 2 detector system

g) P/N 92347..m - 2 detector connection cable - specify length

h) P/N 92316..m - Ext. power cable for vehicles - specify length

I) P/N 92306SP - Console spares kit

j) P/N 92002SP - Detector Spares kit

k) P/N 92325 - Console extension PCB assembly

A.3 CONNECTORS AND CABLES

A.3.1 EXTERNAL POWER CONNECTOR

Type: 3-pin, male, circular connector, back panel
Mating connector: SOURIAU 851-06-AC-08-3S

PIN	DESCRIPTION	DIRECTION
A	GROUND FRAME	from ext. supply
B	GROUND	from ext. Supply
C	+ 12 VDC	from ext. supply

A.3.2 DETECTOR CONNECTOR

Type: 6-pin, female, circular connector, back panel
Mating connector: SOURIAU 851-08-AC-10-6P

PIN	DESCRIPTION	DIRECTION
A	+ 9 VDC	from GR-320
B	+ 5 VDC	from GR-320
C	- 9 VDC	from GR-320
D	Signal # 2	from DET # 2
E	GROUND	
F	Signal # 1	from DET # 1

A.3.3 INPUT - OUTPUT CONNECTOR

Type: 10-pin, female, circular connector, back panel
Mating connector: SOURIAU 851-06-AC-12-10P

PIN	DESCRIPTION	DIRECTION
A	DTR	from PC
B	TXD	from PC
C	RXD	from GR-320
D	RTS	from PC
E	CTS	from GR-320
F	DSR	from GR-320
G	GROUND	
H	GROUND	
J	+ 5 VDC	from GR-320
K	EXT. TRIG*	from ext. device

* - Optional hardware triggering from an external device.
TTL / CMOS levels, negative edge active

A.3.4 RS-232 CABLE

to GR-320	to PC	to PC
10p, Male	25p, Female (or)	9p, Female
A	20	4
B	2	3

C	3	2
D	4	7
E	5	8
F	6	6
G	7	5

APPENDIX B : DUAL DETECTOR OPERATION

If 2 detectors are connected to the GR-320 the unit must have 2 Analog boards installed at the factory. Cable the system up as required.

NOTE : GR-320 Serial #'s 2001-2030 require AC operation for 2 detector operation. Serial # s 2031+ can be operated on external AC or internal batteries

Note: battery life is halved with 2 detector battery operation.

1. In Menu 2 - set DET#2 to ON - see Section 2.2: MENU 2 - Detector Configuration for more information

   Set MODE selection as required :

   - NORMAL - (DEFAULT) - normal mode of operation, in this case the 2 detectors are configured as 2 independent detectors

   - ADD - Add the spectra

   - COINC - the output of the 2 detectors are ONLY pulses that are in COINCIDENCE - (arrive at the same time on both detectors) - this is a mode for special applications.

   - ANTICOIN - the output of the 2 detectors are ONLY pulses that are NOT in COINCIDENCE - (only pulses that do NOT arrive at the same time on both detectors) - this is a mode for special applications.

2. During measurement the default display condition is DET 1+2. If the individual detectors need to be inspected, press "1" and the label on the MEAS display will show DET #1. If "2" is pressed it will display DET #2. Pressing "0" will go back to the DET 1+2 label on the display.

3. Note that in the DET 1+2 display, the Fine Gain (FG) data is not shown as it has no meaning.

DUAL-DETECTOR : DATA OUTPUT FORMATS

B.1DETECTOR #1, #2 (separately)

Byte #	DATA	label	COMMENTS
B.1.1 HEADER - always included (56 bytes):			
1-4	character	"Z"	4 bytes "ZZZZ" for synchronization
5,6	integer		Length of data in words
7	character	confOUT	=0 detector#1 active only (=1 det #1,#2 active - see App.B)
8	character	c-mode	=0 normal (=1 ADD = Det#1+Det#2) (=2 COINCIDENCE) (=3 ANTI-COINCIDENCE)
9	character	det1	=0 ROI's only =1 ROI's and spectrum =2 spectrum only
10	character	det2	=0 ROI's only =1 ROI's and spectrum =2 spectrum only
11	character	config1	=1 detector #1 and #2 output (=0 det #1 only)
12	character	gpsFLAG	=0 no position data =1 keyboard entry of position data =2 GPS latitude, longitude, altitude =3 AUTO - line#,pos#,step
13,14	character	year	YY From internal Real Time Clock
15,16	character	month	MM
17,18	character	day	DD
19,20	character	hour	HH
21,22	character	minute	MM
23,24	character	second	SS
25,26	integer	temp	console temperature (*10) in deg C
27,28	integer	Volt	Battery Voltage (*100) in Volts
29,30	integer	nch	Number of Channels=256 or 512
31-34	long	clock time	Accumulation time [mSec]
35,36	integer	Ser#	Serial # 0 - 9999
37-40	character	Ver#	S/W Version # "3V02"
41-56	character	Spare	16 characters = future assignments

B.1.2 ROI DATA BLOCK

For Detector #1,#2 (not summed) - 104 bytes

1-4	long	Livetime	det#1 - Live time in [mSec]
5-8	long	ROI#1	det#1 - ROI #1 counts
9-12	long	ROI#2	det#1 - ROI #2 counts
13-16	long	ROI#3	det#1 - ROI #3 counts
17-20	long	ROI#4	det#1 - ROI #4 counts
21-24	long	ROI#5	det#1 - ROI #5 counts
25-28	long	ROI#6	det#1 - ROI #6 counts
29-32	long	ROI#7	det#1 - ROI #7 counts
33-36	long	ROI#8	det#1 - ROI #8 counts
37-40	long	Cosmic	det#1 - Cosmic channel - counts
41-44	long	totCOUNT	det#1 - TOTAL input count rate-cts
45,46	integer	Gain	det#1 - gain (0 to 511)
47,48	integer	pp	det#1 - peak channel number (*10) of the isotope selected for stabilization
49,50	integer	fwhm	det#1 - energy Resolution*10 in [%]
51,52	integer	stab# 1	det#1 - number of Gain adjustments

53-56	long	Livetime	det#2 - Live time in [mSec]
57-60	long	ROI#1	det#2 - ROI #1 counts
61-64	long	ROI#2	det#2 - ROI #2 counts
65-68	long	ROI#3	det#2 - ROI #3 counts
69-72	long	ROI#4	det#2 - ROI #4 counts
73-76	long	ROI#5	det#2 - ROI #5 counts
77-80	long	ROI#6	det#2 - ROI #6 counts
81-84	long	ROI#7	det#2 - ROI #7 counts
85-88	long	ROI#8	det#2 - ROI #8 counts
89-92	long	Cosmic	det#2 - Cosmic channel - counts
93-96	long	totCOUNT	det#2 - TOTAL input count rate-cts
97,98	integer	Gain	det#2 - gain (0 to 511)
99,100	integer	pp	det#2 - peak channel number (*10) of the isotope selected for stabilization
101,102	integer	fwhm	det#2 - energy Resolution*10 in [%]
103,104	integer	stab# 1	det#2 - number of Gain adjustments

B.1.3 GPS DATA BLOCK (60 bytes)

Same as for 1 detector system, see Section 5.0 Data Storage Formats

B.1.4 SPECTRUM DATA BLOCK

B.1.4.1 256 channel - Detector #1, Det #2 (not summed) - (1024 bytes)

1-4	long	LT	det#1 - LIVETIME in mSec
5,6	integer	chn 2	det#1 - counts/sample period
7,8	integer	chn 3	det#1 - counts/sample period
.....			
507,508	integer	chn 253	det#1 - counts/sample period
509,510	integer	chn 254	det#1 - counts/sample period

511,512	integer	Cosmic	det#1 - Cosmic channel - counts
513-516	long	LT	det#2 - LIVETIME in mSec
517,518	integer	chn 2	det#2 - counts/sample period
519,520	integer	chn 3	det#2 - counts/sample period
.....			
1019,1020	integer	chn 253	det#2 - counts/sample period
1021,1022	integer	chn 254	det#2 - counts/sample period
1023,1024	integer	Cosmic	det#2 - Cosmic channel - counts

B.1.4.2 512 channel - Detector #1, Det #2 (not summed) - (2048 bytes)

1-4	long	LT	det#1 - LIVETIME in mSec
5,6	integer	chn 2	det#1 - counts/sample period
7,8	integer	chn 3	det#1 - counts/sample period
.....			
1019,1020	integer	chn 509	det#1 - counts/sample period
1021,1022	integer	chn 510	det#1 - counts/sample period
1023,1024	integer	Cosmic	det#1 - Cosmic channel - counts
1025,1026	long	LT	det#2 - LIVETIME in mSec
1027,1028	integer	chn 2	det#2 - counts/sample period
1029,1030	integer	chn 3	det#2 - counts/sample period
.....			
2043,2044	integer	chn 509	det#2 - counts/sample period
2045,2046	integer	chn 510	det#2 - counts/sample period
2047,2048	integer	Cosmic	det#2 - Cosmic channel - counts

B.1.5 CHECKSUM

1,2	integer	CKSUM	Checksum - negated sum of all data bytes EXCEPT Checksum - If C/Sum is added to the sum of all data = 0

B.2DETECTOR #1+#2 (summed)

BUFFER Byte #	DATA	label	COMMENTS

B.2.1 HEADER - always included (56 bytes):

1-4	character	"Z"	4 bytes "ZZZZ" for synchronization
5,6	integer		Length of data in words
7,8	integer	confOUT	=1 det#1 + det#2 active (=2 det #1,#2 active) (=0 det #1 active)
9	character	det1	=0 ROI's only =1 ROI's and spectrum =2 spectrum only
10	character	det2	=0 ROI's only =1 ROI's and spectrum =2 spectrum only
11	character	config1	=1 detector #1 and #2 output (=0 det #1 only)
12	character	gpsFLAG	=0 no position data =1 keyboard entry of position data

			=2 GPS latitude, longitude, altitude =3 AUTO - line#,pos#,step
13,14	character	year	YY From internal Real Time Clock
15,16	character	month	MM
17,18	character	day	DD
19,20	character	hour	HH
21,22	character	minute	MM
23,24	character	second	SS
25,26	integer	temp	console temperature (*10) in deg C
27,28	integer	Volt	Battery Voltage (*100) in Volts
29,30	integer	nch	Number of Channels=256 or 512
31-34	long	clock time	Accumulation time [mSec]
35,36	integer	Ser#	Serial # 0 - 9999
37-40	character	Ver#	S/W Version # "3V02"
41-56	character	Spare	16 characters = future assignments

B.2.2 ROI DATA BLOCK

For Detector #1,#2 (not summed) - 104 bytes

1-4	long	Livetime	det#1+det#2 - live time[mSec]
5-8	long	ROI#1	det#1+det#2 - ROI #1 counts
9-12	long	ROI#2	det#1+det#2 - ROI #2 counts
13-16	long	ROI#3	det#1+det#2 - ROI #3 counts
17-20	long	ROI#4	det#1+det#2 - ROI #4 counts
21-24	long	ROI#5	det#1+det#2 - ROI #5 counts
25-28	long	ROI#6	det#1+det#2 - ROI #6 counts
29-32	long	ROI#7	det#1+det#2 - ROI #7 counts
33-36	long	ROI#8	det#1+det#2 - ROI #8 counts
37-40	long	Cosmic	det#1+det#2 - Cosmic chn - counts
41-44	long	totCOUNT	det#1+det#2 - TOTAL input count rate
45,46	integer	Gain	det#1 - gain (0 to 511)
47,48	integer	pp	det#1 - peak channel number (*10) of the isotope selected for stabilization
49,50	integer	fwhm	det#1 - energy Resolution*10 in [%]
51,52	integer	stab# 1	det#1 - number of Gain adjustments
53-56	long	Livetime	det#2 - live time in [mSec]
57-60	long	ROI#1	det#2 - ROI #1 counts
61-64	long	ROI#2	det#2 - ROI #2 counts
65-68	long	ROI#3	det#2 - ROI #3 counts
69-72	long	ROI#4	det#2 - ROI #4 counts
73-76	long	ROI#5	det#2 - ROI #5 counts
77-80	long	ROI#6	det#2 - ROI #6 counts
81-84	long	ROI#7	det#2 - ROI #7 counts
85-88	long	ROI#8	det#2 - ROI #8 counts
89-92	long	Cosmic	det#2 - Cosmic channel - counts
93-96	long	totCOUNT	det#2 - TOTAL input count rate-cts
97,98	integer	Gain	det#2 - gain (0 to 511)
99,100	integer	pp	det#2 - peak channel number (*10) of the isotope selected for stabilization
101,102	integer	fwhm	det#2 - energy Resolution*10 in [%]
103,104	integer	stab# 1	det#2 - number of Gain adjustments

B.2.3 GPS DATA BLOCK (60 bytes)

Same as for 1 detector system, see Section 5.0 Data Storage Formats

B.2.4 SPECTRUM DATA BLOCK

B.2.4.1 256 channel - Det #1+Det #2 (summed) - (512 bytes)

1-4	long	LT	det#1+det#2 - LIVETIME in mSec
5,6	integer	chn 2	det#1+det#2 - counts/sample period
7,8	integer	chn 3	det#1+det#2 - counts/sample period
.....			
507,508	integer	chn 253	det#1+det#2 - counts/sample period
509,510	integer	chn 254	det#1+det#2 - counts/sample period
511,512	integer	Cosmic	det#1+det#2 - Cosmic channel - cts

B.2.4.2 512 channel - Det#1+Det #2 (summed) (1024 bytes)

1-4	long	LT	det#1+det#2 - LIVETIME in mSec
5,6	integer	chn 2	det#1+det#2 - counts/sample period
7,8	integer	chn 3	det#1+det#2 - counts/sample period
.....			
1019,1020	integer	chn 509	det#1+det#2 - counts/sample period
1021,1022	integer	chn 510	det#1+det#2 - counts/sample period
1023,1024	integer	Cosmic	det#1+det#2 - Cosmic channel - cts

B.2.5 CHECKSUM

1,2	integer	CKSUM	Checksum - negated sum of all data bytes EXCEPT Checksum - If C/Sum is added to the sum of all data = 0

B.3 DATA BLOCK SUMMARY (# bytes) - 2 bytes=1 word

Data Block	Det#1,Det#2	Det#1+Det#2
Header	56	56
ROI block	104	104
GPS	60	60
256 spectrum	1024	512
512 spectrum	2048	1024
Checksum	2	2

EXAMPLE : Det#1+Det#2 - 256 channel + ROI data + Spectrum
Format Header+ROI+Spectrum+Checksum
Bytes 56 + 104 + 512 + 2 = 674 bytes = 337 words

APPENDIX C : REMOTE CONTROL OPERATION

The GR-320 can be operated under control of an external PC system if required and a Data Parameter Data Block can be UPLOADED, modified and DOWNLOADED as required to provide full REMOTE control capability.

C.1RS-232 INTERFACING

Protocol

Baud 1200, 2400, 4800, 9600, 19200
Data bits 8
Stop bits 1
Parity none

General

The 320's RS-232 can be used to dump data from the 320's memory or send directly real time. The data block may contain a number of different sized blocks depending on the set-up in MENU 3 and MENU 6. Each block starts with a header that begins with four synchronization characters "Z", followed by a word that describes the length of data in words. An INTEGER checksum is contained at the end of each data block.

Special Characters

There are some special characters that the 320 uses for communication. Following is a list of these special characters.

Key Name	Dec.	Hex	Action
Status	85	55	Checks 320 s remote status (320 returns a status byte)
Arrow left	17	11	Controls cursor within menus
Arrow right	16	10	Controls cursor within menus
Arrow up	19	13	Controls cursor within menus
Arrow down	18	12	Controls cursor within menus
Enter	15	0F	Enter / Accept and save menu configuration
Clear	11	0B	Clear
Shift	14	0E	Change option
Start / Stop	12	0C	Start / Stop / Exit menu without saving
Menu	13	0D	Returns 320 to main menu
1	1	01	Menu 1
2	2	02	Menu 2
3	3	03	Menu 3
4	4	04	Menu 4
5	5	05	Menu 5
6	6	06	Menu 6
7	7	07	Menu 7
8	8	08	Menu 8
9	9	09	Menu 9

*	42	2A	Indicates key accepted
@	64	40	Indicates Main Menu
Z	90	5A	Header synchro character
T	84	54	RS-232 connection check from 320
t	116	74	RS-232 connection check answer from PC

RS-232 SW HSH

Before starting any transferring of data, the 320 checks that the connecting PC is alive by sending a "T". The expected response is a "T" from the PC indicating it is ready to receive. If after 3 tries the PC has not responded, the 320 considers the PC to be dead and terminates the transfer. This sequence is shown in Figure C-2.

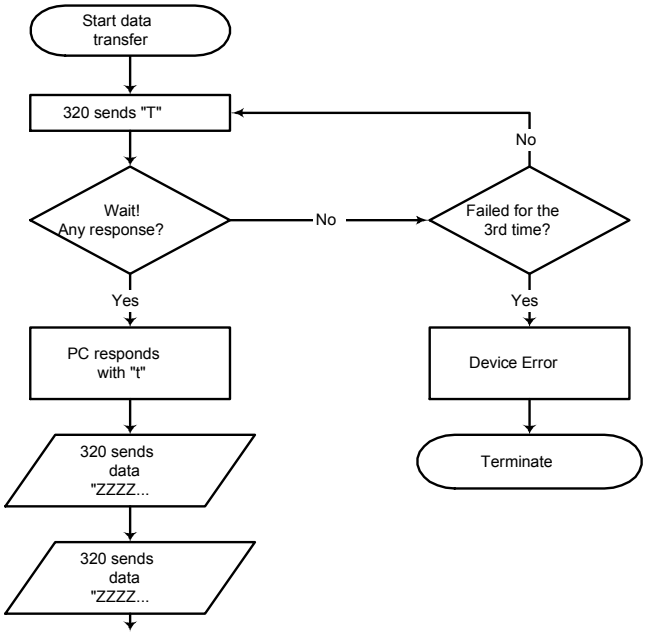
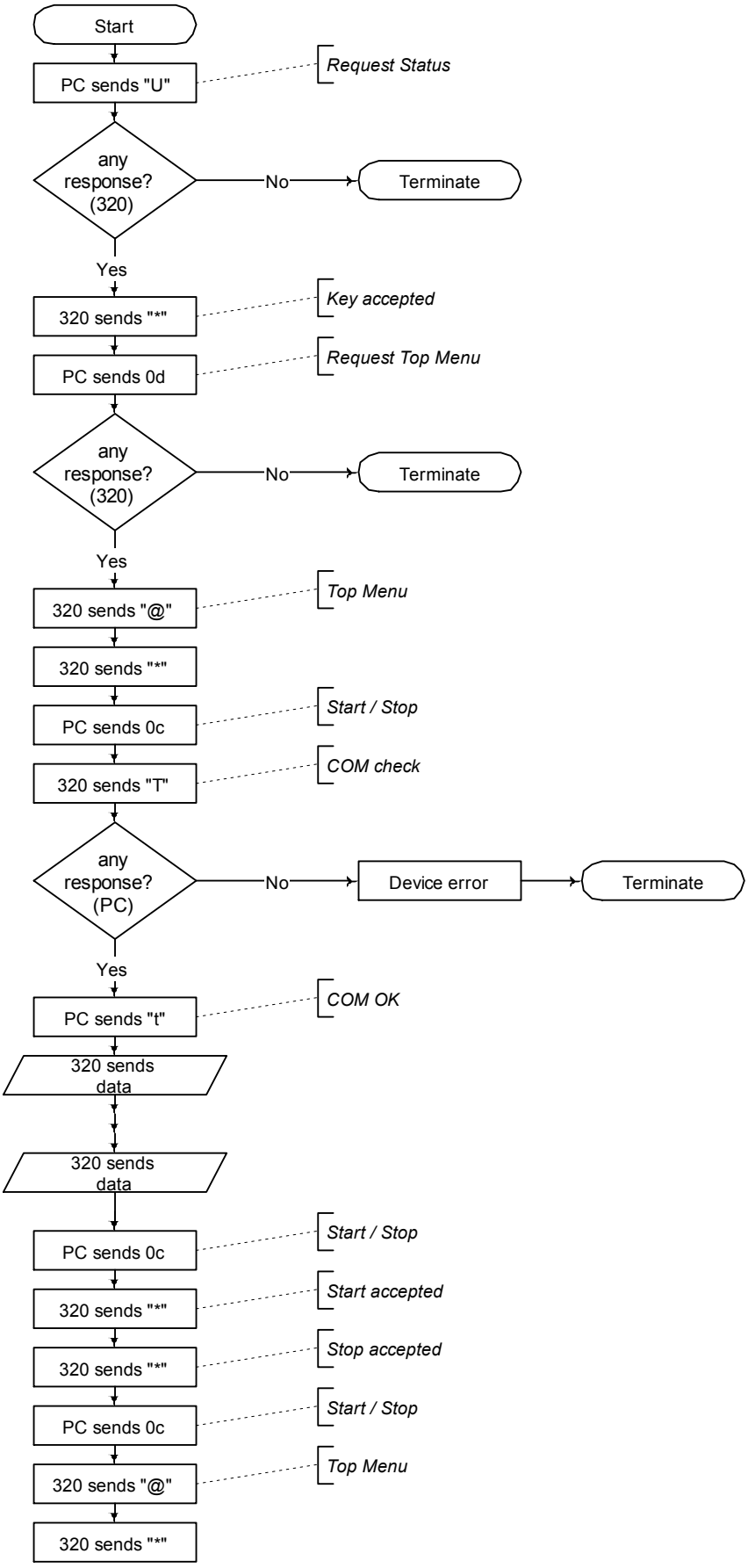


Figure C-1 Memory Dump Example

C.2 REMOTE CONTROL EXAMPLE



The GR-320 remote control was designed so that all keypad entries are available via RS-232 remote mode.

Before beginning remote control the GR-320 must be set to remote mode by pressing "." and CLEAR at from the main menu.

Figure C-2 shows the sequence of steps that can be followed between the PC and the GR320 to initiate a measurement and get it output to the PC.

APPENDIX D : USING THE RECHARGEABLE BATTERY

D.1 General

The GR-320 uses a maintenance free lead-dioxide battery with a gelled electrolyte which exhibits high capacity and a long life.

For GR-320 we recommend using Dryfit batteries from SONNENSCHEIN, type A 200-6V-6.5Ah-, which have a 6 V nominal voltage and a capacity of 6.5 Ah. It may be possible to use a battery from another manufacturer, but specified nominal voltage and capacity should be adhered to for correct operation. Available volume for battery is 152.2 mm (L) x 65 mm (W) x 98.4 mm (H including contacts).

Dryfit batteries have many advantages comparing with other types of rechargeable batteries, so they are generally preferred for portable applications:

- high current capability
- wide operating temperature range
- immunity to catastrophic failure due to deep discharge
- absence of memory characteristics.
- low self-discharge

D.2 Operation

There is no restriction for using Dryfit batteries in the GR-320. It is possible to operate in the specified temperature range and in any position. The batteries are fully sealed so there are no possibilities of any leakage even if the battery is fully discharged or left discharged for a long time.

The real battery capacity is continuously monitored by the GR-320 and on the display in the measuring mode you can see the remaining capacity in percent. Real capacity of the battery can be different from rated nominal capacity under the following conditions:

- A new battery has an initial capacity of 80 - 90 % of its nominal rating. The rated nominal capacity will be reached after about 25 complete charge cycles.
- After 200 fully discharged cycles the rated capacity slowly falls. For partial discharge the number of repetitive cycles increases but the total sum of its capacity is the same (130 Ah).
- Nominal battery capacity is rated at room temperature. At low temperatures the real capacity is decreased.
-

D.3 Charging

For user's convenience charging is possible without removing the battery from GR-320 console.

A special charger for Dryfit batteries is built into the GR-320. It is a dual level float charger (see specifications below) which only needs the connection of +12 VDC from an external AC adapter.

WARNING: use the supplied GR-320 charger or 9-12V 2A D/C adapter only! The unloaded maximum output voltage of the charger can NOT exceed +15V*!*

Charging procedure:

1. Put the GR-320 console and AC adapter in a suitable place in an inside room environment. The recommended position for the GR-320 console is with the front panel vertical. Text can be read easily in this position.
2. Connect the output power cable of the AC adapter to the External Power connector of the GR-320.
3. Connect the adapter to AC power. The LED on the back panel of GR-320 console should be ON. This means the presence of external power and operational charging circuit. The LED is YELLOW when charging the battery. Charging time of a fully discharged battery is about 7 hours. End of charging is indicated by GREEN LED.
5. When charging is complete, disconnect the AC power and the cable from the GR-320 console if required.

Notes:

1. Overnight charging is recommended. Even if the battery is only partially discharged it can be charged without any decrease of nominal capacity.
2. It is not necessary to immediately disconnect the AC adapter when charging is over
3. (LED is GREEN). The charger operates in the float mode so system operation of the adapter continues and the battery is trickle charged at the same time.
3. It is possible to use the GR-320 and charge the battery at the same time. In this case the charge display in the measuring mode will always show BATT 100%.
4. It is preferable to keep the battery charged, when the system is not in use (winter season).

Troubleshooting:

1. When connecting the AC adapter the LED does not light.
   Check cables, AC power, test +12 V on the adapter cable [pin C (+) and B (-)].
2. When connecting the AC adapter the LED is RED.
   In this case the rechargeable battery is not properly connected or the battery is defective. Deeply discharged battery also turns the LED RED at the beginning of charge, but it will recover within 2 hours. If not, replace battery.

D.4 Charger Specifications

Input supply voltage :	9.0 to 15 VDC
Operating temperature range :	0 to 40 deg.C
Start-up trickle current :	20 mA
Bulk charge rate:	1.0 A
Bulk to overcharge transition voltage:	7.1 V
Overcharge voltage:	7.5 V
Overcharge terminate current :	100 mA
Float voltage :	7.0 V
Temperature coefficient on voltage levels :	- 12 mV / deg.C
Reverse current at charger output without input power supply:	max. 10 uA

APPENDIX E : EXPOSURE RATE+ISOTOPE ANALYSIS

For HEALTH PHYSICS applications the GR-320 has two special features :

- EXPOSURE RATE - the system can compute isotope corrected Exposure Rate data from the acquired spectrum

- ISOTOPE ANALYSIS - the system can analyze a recorded spectrum and identify all isotopes present in the data using a sophisticated search routine and a built in isotope identification library.

These advanced features permit the GR-320 to act as a highly sensitive site-investigation tool as well as many other Health Physics applications including :

- Site Analysis
- Sample, identification
- Lab spectroscopy
- Remote monitoring systems

To use these features note the following.

E.1. STABILIZATION CONSIDERATIONS

Most users of the Dose-Rate/Isotope Analysis feature want to carry out detailed analysis of the lower end of the spectrum as that is where the primary isotopes of interest emit. The presence of the 0.25uCi Cesium-137 source that emits at 662keV can mask low level emitters. For this reason it is recommended that the 0.25uCi Cesium-137 source is REMOVED from the base of the detector prior to activation of this feature.

This is simply accomplished by using a coin or BROAD screwdriver to remove the source container using the slot on the cover. Turn the detector upside down to identify this broad slot then insert something of the right size and unscrew the cover. (NOTE : use of a narrow screwdriver can damage this cover). Once the cover is off, remove the small source (1" plastic disk) and carefully replace the source cover.

The optimum method of gain stabilization depends on user requirements. There are typically 2 types of usage :

A. SHORT sample times (1-5mins) and RELATIVELY FREQUENT samples (e.g. 2 min samples every 3 minutes). In this case the system may be set to STABILIZE on the natural THORIUM in the local environment.

B. SHORT sample times and LONG PERIODS of time when the instrument is in standby (nor sampling) or switched OFF. In this case STABILIZATION OFF may be the best method.

E.2 SYSTEM USE - THORIUM STABILIZATION

1. REMOVE CESIUM SOURCE

Carefully open the base of the detector and remove the Cesium test source then carefully screw the holder back in place.

2. SET PARAMETERS

Menu 4 - Gain stabilizer = ON
Stab = Th
Stab. channel = 206 (use channel defined on system Calibration Sheet)
Count Level = 500
Timeout = 2000 secs

Menu 3 - Sample Time = 60 (or as required)
Meas. mode = SINGLE (or as required)
Evaluation = enviSPEC
other parameters as required

Other menus - set as required (Data Storage etc).

3. PRE-STABILIZATION

To ensure that the GR-320 is functioning correctly, place the CESIUM test source (removed above) under the detector centered on the black source container - and start SYSTEM TEST (1 - SHIFT(to temporarily switch to Cesium) - ENTER). Let the system stabilize at least twice (2-3 minutes) and verify that the display shows :

D1 55.0 6.6 232

Check - Channel data (55.0 above) is between 54.9 and 55.1
Resolution (6.6 above) is within 0.3% of the value on the Calibration sheet
Gain (232 above) is between 100 and 400

If all is OK - press STOP to go to the Top Menu

4. TAKE A SAMPLE

Press START to start a sample

5. DISPLAY AT END OF SAMPLE

At the end of sample the display shows :

enviSPEC
wait.....

Then the display of Fig. E-1 is seen.

Cs-137 - 662 - Cesium at 662keV

Co-60-1173,1332 Cobalt at 1173 and 1332 keV

K-40 - 1461 Potassium at 1461 keV

Exposure = 0.51 uR

Isotopes detected
Cs-137 662
Co-60 1173 1332
K-40 1461

Exposure 0.51 uR
rate 6.1 uR/h
SHIFT - units, ANY - cont

Figure E-1

Exposure Rate = 6.1uR/h

SHIFT - changes the Exposure and Exposure Rate units to R/Gy or Sv as required

ANY key goes to the next display (E-2)

In this display :

keV = the identified peak in keV

fwhm = the computed Resolution of this peak

area = the sum of all counts in the area of the peak - this is an indication of peak intensity

nucl = the identified nuclide

To STORE data press ENTER. The display then changes to display the recorded spectrum with all peaks highlighted. STOP goes to Top Menu.

TABLE OF PEAKS

keV	fwhm	area	nucl.
76	77	27k	N.I.
662	6.6	6009	Cs-137
911	10	371	N.I.
1162	5.3	1381	Co-60
1314	4.8	1007	Co-60
1314	4.9	282	K-40

To STORE press ENTER
To CANCEL press STOP

E.3 SYSTEM USE - STABILIZATION OFF

6. REMOVE CESIUM SOURCE

Carefully open the base of the detector and remove the Cesium test source then carefully screw the holder back in place.

7. SET PARAMETERS

Menu 4 - Gain stabilizer = ON
Stab = Cs
Stab. channel = 55
Count Level = 5000
Timeout = 100 secs

Menu 3 - Sample Time = 60 (or as required)
Meas. mode = SINGLE (or as required)
Evaluation = enviSPEC
other parameters as required

Other menus - set as required (Data Storage etc).

8. PRE-STABILIZATION

To ensure that the GR-320 is functioning correctly, place the CESIUM test source (removed

above) under the detector centered on the black source container - and start SYSTEM TEST (1 - ENTER). Let the system stabilize at least twice (2-3 minutes) and verify that the display shows:

D1 55.0 6.6 232

Check - Channel data (55.0 above) is between 54.9 and 55.1
Resolution (6.6 above) is within 0.3% of the value on the Calibration sheet
Gain (232 above) is between 100 and 400

If all is OK - press STOP to go to the Top Menu

9. CANCEL STABILIZATION

Menu 4 - set Stabilization = OFF

10. TAKE A SAMPLE

Press START to start a sample - then as per (2.e) above.

APPENDIX Z : CHANGES WITH FIRMWARE 3v02

The following are changes made in Software Version 3V02 with reference to the appropriate Section where further details can be found.

1. A new feature in Menu 3 - Operational Mode - Evaluation=enviSPEC does an automatic peak search and identifies radionuclide elements as well as providing energy accurate dose / dose rate measurements for each sample. See Section 2.3 MENU 3 - OPERATIONAL MODE and Appendix E for more information.

2. Display last spectrum is available by pressing the shift key while in the Top Menu. See Section 1.1 - Quick Start.

3. Quick remote mode, remote may be enabled by pressing "." followed by the "CLEAR" key. See Section 1.1 - Quick Start.

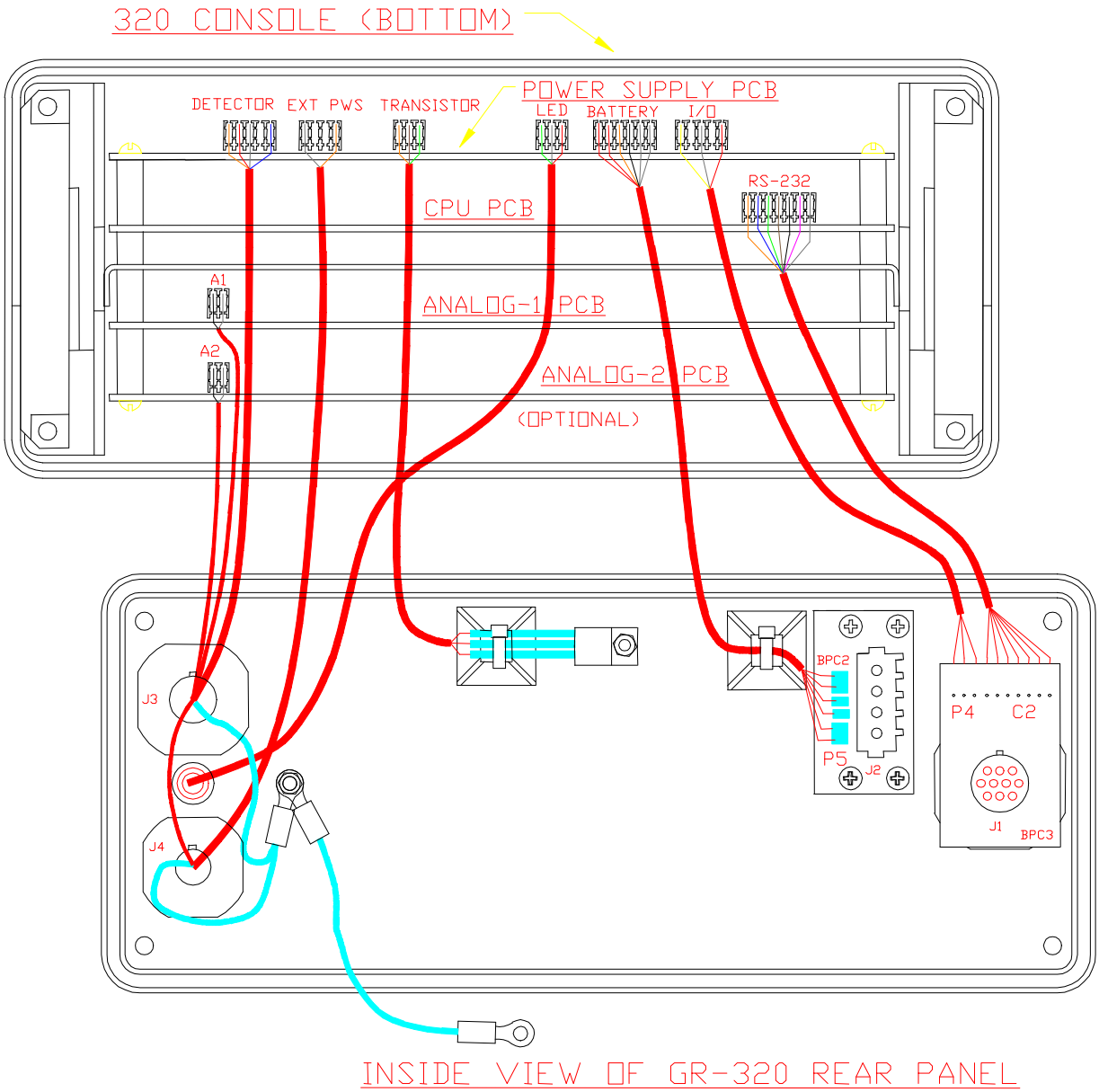
4. Output formats for GPS, Auto and Keyboard have been changed slightly. See Section 3.0 - Data Output/Storage Formats.

5. Full zoom of spectrum enabled with 512 channel operation. See Section 3.0 - Start Measurement.

APPENDIX Z : CHANGES FROM PREVIOUS VERSION

1. Firmware has been changed from 3v02 to 3v03 for Y2K compliance.

GR-320 INDEX



INSIDE VIEW OF GR-320 REAR PANEL