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GMS312 Core Gamma Logger

User Guide

Issue: 1.1



Welcome to the GMS312 Core Analyser

This document contains all instructions for the use of the GMS312 Core Gamma Logger and is supported by the GMS Core Analyser Data Manager Software user guide.





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The GMS312 contains high voltages and must only be opened by a suitably qualified and experienced engineer.

Glossary

CPS	Counts Per Second
CD	Compact Disc
KeV	Kilo-Electron Volt (1000 electron Volts)
MCA	Multi-Channel Analyser
NiMH	Nickel Metal Hydride
OS	Operating System
PC	Personal Computer
ROI	Region of Interest
NaI (TI)	Sodium Iodide (Thallium Activated)
USB	Universal Serial Bus



1. Introduction

1.1 Scope

This document is a hardware user manual which describes the use of the GMS312 Core Gamma Logger. Please refer to the GMS Core Analyser Data Manager user manual for use of the supplied software.

1.2 Overview

The GMS312 Core Analyser is a rolling Gamma Spectrometer designed to detect naturally occurring gamma radiation emitted by core samples.

The Instrument is used to measure gamma radiation and display the results in seven predefined Regions of Interest (ROI). Four of the predefined ROIs are Uranium, Potassium, Thorium and a Spectrum gamma count, (gross gamma). There are also an additional three user ROIs available.

Survey results are saved manually or automatically to the internal memory of the instrument, so that they may be downloaded and analysed on a PC via the GMS Core Analyser Data Manager Application software.

1.3 Capability

The GMS312 is intended as a first look tool for analysis of a core. It is not intended to be used a laboratory standard instrument and does not provide definitive results. The Regions of Interest provide data that should give an experience core analyst the means to correlate the GMS312 data with that of wire line measurements. For the majority of measurement applications, the spectrum (gross) gamma counts are all that is required.

GMS312 also features API units with Uranium, Potassium and Thorium concentration function.



2. The GMS312 Features

2.1 Instrument Case and Features

The main physical features of the GMS312 core logger are;

- Display
- Instrument controls - Membrane keypad
- USB and power charger socket – on front panel
- Rear detachable handle
- Four angled wheels – designed to roll on cores from 2 5/8" to 6" with sleeve

The angle of the wheels, ensures that all four wheels maintain contact with the core. The measurement wheel, indicated below, determines the distance travelled.



The USB and charge sockets can be accessed under the cover on the front panel. The use of these sockets should be performed in a safe and dry environment.



2.2 Instrument Controls

There are 9 user keys on the instrument control panel that are used to:

- Power on/off
- Start and stop samples
- Step through menus
- Change settings
- Pause measurements

The GMS312 is switched on by momentarily pressing the  button once. To switch off again, press and hold the  button until **Powering Down** is indicated on the screen. The battery state is indicated on the display and as the battery voltage drops the battery symbol will empty.

2.3 Power

The GMS312 is powered by a NiMH rechargeable battery pack and can be charged in approximately 4 hours by using the external charger supplied. A full charge will provide around 12 hours of operation.

When the charger is connected a green LED is illuminated next the charger socket. The charge LED on the display decal is illuminated green when a fast charge is in progress. The LED extinguishes when the fast charge is complete followed by trickle charging.

Warning. NiMH rechargeable batteries have a relatively flat voltage/discharge curve followed by a sharp drop off. A battery pack with little charge may appear to be well charged at first but then drop quickly. It is recommended that the GMS312 is charged before each use.

2.4 Display

The GMS312 utilizes a 480 x 272-pixel colour Transflective LCD display that can be viewed in bright daylight, and at night the white LED backlight provides excellent illumination.

2.5 Detector

The detector is a custom designed 72mm x 72mm NaI(Tl) scintillator with a rugged photo multiplier tube.

To ensure optimum accuracy, it is recommended that the GMS312 is given at least 4 hours to stabilise to the local ambient temperature. To avoid thermal shock of the detector, which may result in damage to the crystal, leave the GMS312 in its case to stabilise.

2.6 Measurement Mode

The GMS312 has two main measurement modes of operation; either static mode, or dynamic mode. In the static mode, the GMS312 is placed into the required position on the core and a measurement is performed over a predefined sample time, between 10 and 900 seconds. In the dynamic mode, the



GMS312 is rolled at a constant speed and samples are taken once per second. In each mode the depth is displayed and is saved along with each measurement.

2.7 Regions of Interest

Six user adjustable regions of interest (ROI) and a fixed spectrum (gross) count are provided. The ROIs accumulate counts from naturally occurring uranium, thorium, potassium and the spectrum (gross) from a broad range of energies. The ROIs do not give definitive results but merely provide an approximation of the proportions of the naturally occurring materials.

The default ROIs are:

ROI Window	Name	Description	Lower Limit (keV)	Upper Limit (keV)
1	Uranium	Uranium Peak (1760keV)	1596keV	2024keV
2	Thorium	Thorium Peak	493keV	667keV
3	Potassium	Potassium Peak (1460keV)	1241keV	1596keV
4	ROI 4		90keV	90keV
5	ROI 5		90keV	90keV
6	ROI 6		90keV	90keV
7	Spectrum	Spectrum Total	90keV	2700keV

2.8 Depth and Speed

The GMS312 constantly updates the depth during the measurement process. The speed and depth units may be set to metric, imperial or US tenths. The speed during a dynamic measurement is indicated below the depth.

- Depth
 - Range and Resolution
 - 0.000 to 99999.999 m
 - 0 ft 0.00in to 99999ft 11.9in
 - 0ft 0.0th to 99999ft 9.9th
- Speed
 - Range and Resolution
 - 0 to 1000 mm/s
 - 0.0 to 36.0 in/s
 - 0.0 to 30.0 ths/s

The user may also set a **Target speed** for use in the dynamic mode. The speed indication LEDs under the display will illuminate as shown below;

Red	Too slow	=<70% of set speed
Red	Too slow	>70% <80% of set speed
Green	Correct speed	Within ±20% of set speed
Green		
Green		
Amber	Too fast	>120% <130% of set speed
Amber	Too fast	=>130% of set speed



2.9 API

The GMS312 can be switched between ROI counts and API display modes. The API mode indicates API units and the concentrations of uranium (ppm), thorium (ppm) and potassium (%). The API mode functions independently of the user ROI set values and uses fixed values not available to the user. It is important to have the correct core size set otherwise large inaccuracies will be incurred in the API function.

Important. When operating in the API mode, long sample times or slow speeds are required to obtain the best accuracy.

2.10 PC Connection

The saved data may be accessed via a PC with Microsoft™ OS Windows XP, 7, 8 or 10 and suitable USB type A to B cable. No device drivers are required as the PC will see the GMS312 as a mass storage device. Please refer to the GMS Core Analyser Data Manager Software user guide for details of extracting and managing saved data from the GMS312.

2.11 GPS

The GMS312 has a built-in GPS function. The satellite icon indicates the GPS status;

- White - locked on and operating correctly
- Yellow - not locked on to minimum number of satellites but operating correctly
- Red - faulty

2.12 Battery Indicator

The battery indicator in the top right of the screen will be green when fully charged. Approximately 4 hours is required for a full charge, but depending on the battery charge level it could be less. During use the battery icon will empty.

2.13 Saved Data

The measurement data is saved in two phases; first the individual measurements are stored in internal RAM memory, then finally, at the end of the measurement session the data is collated and saved to in internal SD card in a single file. The file is viewable when the GMS312 is connected to a PC via its USB port.

The data files are saved in an XML format, though viewable in a spreadsheet, the files should only be accessed utilising the GMS Core Analyser Data Manager Software.

All measurements are saved as non-background corrected data and background data. That is, even if background correction was used, the background corrected data is saved as two separated sets of data. This makes it possible to do more post-measurement analysis with the GMS Core Analyser Data Manager Software. This feature may be particularly useful where there is little difference between the background and core measurements, sometimes resulting in zero readings.



3. GMS312 Operation

3.1 Power On and Self-Test

When powered on the GMS310 will display the following screen for several seconds during which the instrument performs a self-test and starts up all circuitry. It is recommended that the GMS312 is charged before each use.

```
GMS310 Core Analyser
Serial Number: 998
Firmware: v3.23.5 v1.24.1

Self Test:      OK
Memory Test:   OK
GPS:           OK
```

After the self-test, a mini-menu is displayed showing the time and date along with a choice of whether to enter the main menu options or start the measurement process.

```
GMS310 Core Analyser

> Go to main menu
Continue with stored Job details
Continue without Job details
```

Before starting a measurement check the 'Set up instrument' page in the main menu. A full description of parameters and their settings is given in section 4.

3.2 Positioning the GMS312

Place the GMS312 on the core section with the direction arrows pointing forward. Rolling the GMS312 back and forth a few times will locate all four wheels on to the core. The front wheels must be firmly in contact with the core for the position/depth indicator to function. The detector is located half way along the length of the GMS312, as indicated by the labels on the side of the GMS312, and should be positioned over the starting point on the core section.

The GMS312 should roll freely over the core section, its weight is enough to ensure good contact with minimal slipping.



3.3 Making a Measurement in Dynamic Mode

Job details such as operator name, location, job number etc can be entered via the GMS Core Analyser Data Manager Software. These details are stored along with the measurement data when a session is complete. The Dynamic mode parameters maybe setup either in the Instrument Setup menu or via the Data Manager software.

The Dynamic measurement has a fixed 1 second sampling time for both the background and core measurement. Other user settings are;

- Units
- Speed
- Core size
- Start depth
- Number of averages

It is recommended that the slowest speed is used for the Dynamic mode, since this will produce the best results. Note that the core size is unimportant if API measurements are not required.

Using the navigation buttons select either;

- **Continue with stored Job details**
- **Continue without Job details**

followed by the  button.

3.3.1 Background Measurement in Dynamic Mode

If either of the continue options is selected the GMS312 will enter the background measurement mode and the following will be displayed;

- **Use background correction?**

Measurements may or may not be background corrected. Where possible, the background measurement should be performed on a blank core sleeve to give the best background corrected results. Pressing the  button will put the GMS312 in to the background measurement mode. To skip the background measurement, press the  button.

If a background measurement has already been made, then a further option will be offered;

- **Use stored background data?**

Provided that no settings have been changed and GMS312 has not been powered down, the background data will be stored for future measurements.

```
GMS310 Core Analyser
Dynamic Mode      Samples
Uranium           Depth      0.000 m
Thorium           Speed      0 mm/s
Potassium
ROI 4             GPS      54.123065N
ROI 5             3.19475W
ROI 6             Background measurement
Spectrum          Start measurement?
```



When the background measurement has started, the depth is reset to zero. The display readings will be update once per second. When sufficient points have been measured or the whole blank core has been measured, stop the measurement with the  button.

```
GMS310 Core Analyser
Dynamic Mode      Samples    19
Uranium           20        Depth     1.647 m
Thorium           74        Speed     26 mm/s
Potassium         28
ROI 4             0        GPS      54.123065N
ROI 5             0                 3.19475W
ROI 6             0        Background measurement
Spectrum          532      Running..
                  Stop measurement?
```

When the measurement has stopped the data is automatically stored and **Exiting background** will be display. The GMS312 will then enter the core measurement mode, and a **B** will be displayed to show that background correction will be performed.

3.3.2 Core Measurement in Dynamic Mode

The GMS312 will now be in the core measurement mode.

```
GMS310 Core Analyser
Dynamic Mode      Samples
Uranium           Depth     100.00 m
Thorium           Speed     0 mm/s
Potassium         Core Section 1
ROI 4             GPS      54.123065N
ROI 5             3.19475W   B
ROI 6             Core measurement
Spectrum          Start measurement?
```

Whilst in the idle state, that is, still waiting to make a measurement, the speed and depth readings update. This makes it possible to position GMS312 before starting a measurement. Other parameters though will remain static. When the measurement is started, the depth will be reset to the start depth value stored in the instrument set up.

Pressing the  button will start the measurement and the display will update once per second.

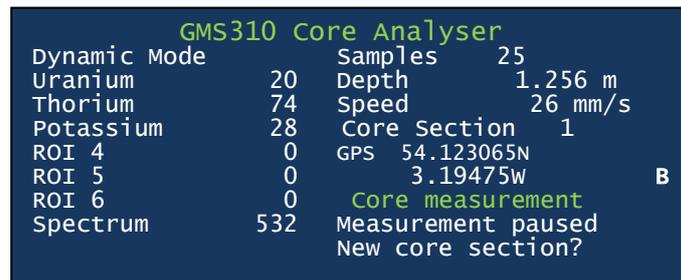
```
GMS310 Core Analyser
Dynamic Mode      Samples    25
Uranium           20        Depth     1.256 m
Thorium           74        Speed     26 mm/s
Potassium         28        Core Section 1
ROI 4             0        GPS      54.123065N
ROI 5             0                 3.19475W   B
ROI 6             0        Core measurement
Spectrum          532      Running..
                  Stop measurement?
```



Push the GMS312 along the core and maintaining a constant speed. The speed is indicated both on the display digitally and as a series of LEDs under the display. The 3 central green LEDs indicate that the GMS312 is travelling at the pre-set target speed. If the GMS312 is being pushed too slowly then red LEDs will be illuminated and if too fast, then amber.

3.3.3 Pausing the Measurement

The **Pause** button may be pressed any time during the measurement with result that no further measurements are made. Pressing the **Pause** button again will restart the measurement. Should the GMS312 need to be located on another core section, then pressing  will restart the measurement and the **Core section** value will be incremented by one.



3.3.4 Stopping and Saving the Measurement

Whilst the GMS312 indicates **Running..**, pressing  will stop the measurement and the data will be saved automatically. The GMS312 will then return to the mini-menu.

As the number of samples increases the memory stick icon in the lower right of the display will fill up. If the maximum number of samples is reached, 3800, then the measurement will be stopped automatically and the data saved.

3.4 Making a Measurement in Static Mode

Job details such as operator name, location, job number etc can be entered via the GMS Core Analyser Data Manager Software. These details are stored along with the measurement data when a session is complete. The Static mode parameters may be setup either in the Instrument Setup menu or via the Data Manager software.

The Static measurement has the following user settings;

- Units
- Interval
- Core size
- Core measurement sample time
- Background sample time
- Start depth

It is recommended that the longest sample time possible is used for the Static mode, since this will produce the best results. 100 seconds is recommended as a minimum. Note that the core size is unimportant if API measurements are not required.



Using the navigation buttons select either:

- Continue with stored Job details
- Continue without Job details

3.4.1 Background Measurement in Static Mode

If either of the continue options is selected the GMS312 will enter the background measurement mode and the following will be displayed;

- Use background correction?

Measurements may or may not be background corrected. Where possible, the background measurement should be performed on a blank core sleeve to give the best background corrected results. Pressing the  button will put the GMS312 in to the background measurement mode. To skip the background measurement, press the  button.

If a background measurement has already been made, then a further option will be offered;

- Use stored background data?

Provided that no settings have been changed and GMS312 has not been powered down, the background data will be stored for future measurements.

```
GMS310 Core Analyser
Dynamic Mode      Samples      0
Uranium           Depth        0.000 m
Thorium           Interval     + 0 mm
Potassium
ROI 4             GPS 54.123065N
ROI 5             3.19475W
ROI 6             Background measurement
Spectrum
Start measurement?
```

When the background measurement is started, the depth is reset to zero. The display readings will be updated once per second until the sample time has counted down to zero. The interval value will go blank.

```
GMS310 Core Analyser
Dynamic Mode      Samples      0
Uranium           20          Depth        0.000 m
Thorium           74          Interval     mm
Potassium         28
ROI 4             0          GPS 54.123065N
ROI 5             0          3.19475W
ROI 6             0          Background measurement
Spectrum         532        Running..
Remaining:       89s       Stop measurement?
```



When the measurement is complete, if in the auto save mode, the measurement data will be saved automatically. But, if in manual save mode, the **Save measurement?** message will be displayed.

```

GMS310 Core Analyser
Dynamic Mode      Samples      0
Uranium           20          Depth       0.000 m
Thorium           74          Interval    mm
Potassium         28
ROI 4             0          GPS 54.123065N
ROI 5             0          3.19475W
ROI 6             0          Background measurement
Spectrum          532        Measurement complete
Remaining:        0s          Save measurement?
  
```

Pressing the  button will save the data or pressing the  button will cancel data for that measurement. When the measurement is saved the number of **Samples** will increment and the **Interval** will now indicate the distance to the next measurement point.

```

GMS310 Core Analyser
Dynamic Mode      Samples      1
Uranium           20          Depth       0.000 m
Thorium           74          Interval    -100 mm
Potassium         28
ROI 4             0          GPS 54.123065N
ROI 5             0          3.19475W
ROI 6             0          Background measurement
Spectrum          532        ✓Start Measurement?
Remaining:        0s          ✗Exit and save data?
  
```

When the GMS312 is rolled forwards, the **Interval** value will decrease; the GMS312 will be in the correction position when **Interval** value is zero.

When the background measurements are complete, pressing the  button will save the data and **Exiting background** will be displayed. The GMS312 will then enter the core measurement mode, and a **B** will be displayed to show that background correction will be performed.

3.4.2 Core Measurement in Static Mode

The GMS312 will now be in the core measurement mode. Whilst in the idle state, that is, when a measurement is not in progress, the **Depth** and **Interval** readings still update. This makes it possible to position GMS312 before starting a measurement. Other parameters though will remain static.

```

GMS310 Core Analyser
Dynamic Mode      Samples      0
Uranium           20          Depth       0.000 m
Thorium           74          Interval    + 0 mm
Potassium         28          Core Section 1
ROI 4             0          GPS 54.123065N
ROI 5             0          3.19475W
ROI 6             0          Core measurement
Spectrum          532        Start measurement?
  
```

When the first measurement is started, the depth will be reset to the start depth value stored in the instrument set up. The display readings will be updated once per second until the sample time has counted down to zero. During the measurement the interval value will go blank.



```
GMS310 Core Analyser
Dynamic Mode      Samples      0
Uranium           20          Depth      0.000 m
Thorium           74          Interval   + 0 mm
Potassium         28          Core Section 1
ROI 4             0          GPS 54.123065N
ROI 5             0          3.19475W
ROI 6             0          Core measurement
Spectrum          532         Measurement complete
Remaining:        0s          Save measurement?
```

Pressing the  button will save the data or pressing the  button will cancel data for that measurement. When the measurement is saved the number of **Samples** will increment and the **Interval** will now indicate the distance to the next measurement point.

```
GMS310 Core Analyser
Dynamic Mode      Samples      1
Uranium           20          Depth      0.000 m
Thorium           74          Interval   -100 mm
Potassium         28          Core section 1
ROI 4             0          GPS 54.123065N
ROI 5             0          3.19475W
ROI 6             0          Core measurement
Spectrum          532         ✓Start Measurement?
Remaining:        0s         ✗Exit and save data?
```

At this point in the measurement process the GMS312 can moved onto another core section. Pressing the **Pause** button displays the message **New core section?**. Pressing the  button increments the core section number.

When the GMS312 is rolled forwards, the **Interval** value will decrease; the GMS312 will be in the correction position when **Interval** value is zero.

```
GMS310 Core Analyser
Dynamic Mode      Samples      1
Uranium           20          Depth      0.100 m
Thorium           74          Interval   + 0 mm
Potassium         28          Core section 1
ROI 4             0          GPS 54.123065N
ROI 5             0          3.19475W
ROI 6             0          Core measurement
Spectrum          532         ✓Start Measurement?
Remaining:        0s         ✗Exit and save data?
```

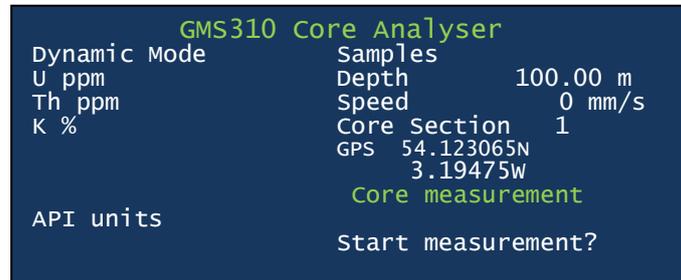
When all measurements have been performed; the core measurement mode is exited and the data saved by pressing the  button. The GMS312 will then return to the mini-menu.

```
GMS310 Core Analyser
Dynamic Mode      Samples      1
Uranium           20          Depth      100.000 m
Thorium           74          Interval   -100 mm
Potassium         28          Core Section 1
ROI 4             0          GPS 54.123065N
ROI 5             0          3.19475W
ROI 6             0          Background measurement
Spectrum          532         ✓Start Measurement?
Remaining:        0s         ✗Exit and save data?
```



3.5 API

While the GMS312 displays **Start measurement?** pressing  or  will toggle between the ROI and API displays.



It is important have the correct core size set or large inaccuracies will be incurred in the API function.

3.6 Plot Function

To use the plot function, it must first be enabled from the **Plot** setup in the main menu before starting a measurement. The plot function is only available in the Dynamic mode. When the Plot function is enabled, a graph of the of either the ROIs or API values against depth is shown. The scales may be set to suit the radiation levels on the core. It may be necessary to perform a measurement test run to set all the scales.

The plot screen is only available once a measurement has started.

3.7 Setup from Core Analyser Data Manager

The GMS312 may be set up using the Core Analyser Data Manager software by selecting Create **Setup File** in the PC application.

In the main menu of the GMS312 select **USB connection** and connect to the PC. Add job details such as operator name, country, oil field etc, the required mode and parameter values. Click **Create** to save details to the GMS312. When the **USB connection** function is exited the details are then set within the GMS312.



4. Menus

4.1 Menu Options

The main menu options may be accessed by selecting;

- Go to main menu

There are a number of options on two pages which can be highlighted by pressing the  and  buttons. Use the  button to enter the selected function.

```
GMS310 Core Analyser
>Job details
  Set up instrument
  Manage Regions of Interest
  Calibration
  Set time and date
  USB Connection
  Default settings
  Plot settings
```

```
GMS310 Core Analyser
>ESAM: Off
  Averages: 3
  Update firmware
```

4.2 Job Details

The job details are entered via the GMS Core Analyser Data Manager Software. Details if entered may only be viewed on GMS312 with no edit facility. Job details are;

- Job number
- Operator
- Oil field
- Well ID
- Country
- Core

Press  button to exit.

4.3 Setup Instrument

Using only the  button, advanced through the menu in one direction. Use the  and  buttons to toggle through the pre-set values for each function. As each function is set to the desired value, use the  button to move to the next function. At any time, the  button will exit the **Setup instrument** menu.



```
GMS310 Core Analyser
>Dynamic mode
Units                m-mm
Measurement speed    25      mm/s
Core size             89      mm
Sample time          1       s
Background time       1       s
Start depth           00100.000 m
```

4.3.1 Measurement Mode

There are three main modes of operation;

- Dynamic mode
- Static mode with manual save
- Static mode with auto save

The GMS312 has been designed primarily to be used in the dynamic mode. The GMS312 is rolled along a core section at a constant speed and the radiation data is automatically saved. The sample time is fixed at 1 second, meaning that, whatever speed the GMS312 is rolled, 1 second of data is measured and stored along with the distance.

The Static modes of operation are for measurements where the GMS312 is left in a stationary position whilst a measurement is being made. The sample times in this mode are typically much longer than for the dynamic mode and this results more accurate data.

In the static mode each measurement is started by pressing the  button. But saving the data differs in that; manual save data requires the operator to accept the measurement or reject it, and for auto saved data there is no choice.

4.3.2 Units

The GMS310 has three sets of units;

- Metric in metres and mm
- Imperial feet and inches
- US feet and tenths

4.3.3 Measurement Interval

In the **Static** mode a depth interval is required to correctly position the GMS312. The interval can have the following values;

- Metric - 25 to 1000mm in 25mm steps



- Imperial – 1 to 36 inches in 1 inch steps
- US – 1 to 30 tenths in 1 tenth steps

4.3.4 Measurement Speed

In the **Dynamic** mode a target speed is required to roll the GMS312 at the correct speed. The target speed has the following values;

- Metric - 25 to 1000mm/s in 25mm/s steps
- Imperial – 1 to 36 inches/s in 1 inch/s steps
- US – 1 to 30 tenths/s in 1 tenth/s steps

It should be noted that the slower the speed, the better the quality of data and resolution. Since the detector will be passing more slowly over the core, more counts from the naturally occurring radioactive materials in the core section will be measured in a relatively shorter distance.

4.3.5 Core Size

Having the correct core size is essential for determining the concentrations of uranium, thorium and potassium. From the core size, the GMS312 calculates the mass core that is being measured and hence determine how much radioactive material is in the core.

Core sizes supported by the GMS312 are;

- 2½, 3, 3¼, 3½, 4, 4¾, 5¼, 6 (in) Imperial and US units
- 67, 76, 83, 89,102, 121, 133, 152 (mm) metric

There are three other settings; FL for a flat surface, NK is not known and NG is not given. All assume a flat surface is being measured and calculations of API values are made accordingly.

4.3.6 Sample Time

In the **Dynamic** mode the sample time is fixed at 1 second and the operator cannot change this value. For the **Static** mode the time may be set as;

- 10, 20, 30, 60, 100, 120, 180, 240, 300, 600, 900 seconds

For best results the sample time should be set as long as possible. The default sample time is set 30s.

4.3.7 Background Time

In the **Dynamic** mode the sample time is fixed at 1 second and the operator cannot change this value. For the **Static** mode the time may be set as;

- 10, 20, 30, 60, 100, 120, 180, 240, 300, 600, 900 seconds

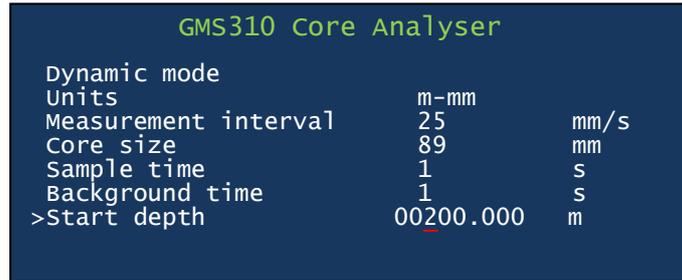
For best results the sample time should be set as long as possible. The default background time is 100s.



4.3.8 Start Depth

The start depth can be entered by moving the cursor under one of the digits with the and buttons. The digit can then be changed with the and buttons. The maximum values that can be entered are;

- 99999.999m
- 99999ft 11in - imperial
- 99999ft 9tenths – US



4.4 Manage Regions of Interest ROIs

There are 7 ROIs of which 6 may be edited by the user.

The default ROIs are:

- ROI 1 Uranium 1596 to 2024KeV
- ROI 2 Thorium 493 to 667keV
- ROI 3 Potassium 1241 to 1596KeV

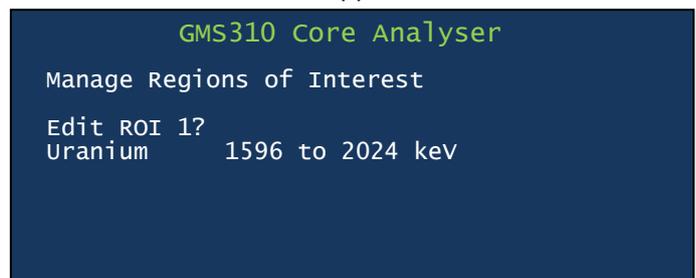
ROIs 4 to 6 are blank.

ROI 7 shows the whole spectrum of counts from 90keV to 2700keV and cannot be edited.

Select and Manage ROIs from the menu by using the and buttons then the button. Each of the 7 ROIs may be viewed by pressing the BACK-NO button. ROIs 1 to 6 may be edited for the user preference.

To change the ROI name press the button then using and buttons select either upper or lower case letters, numbers, a space or a '-' symbol. After 10 characters have been selected the cursor will move directly onto the lower threshold value of the ROI and then onto the upper threshold value as each digit is selected. Values between 90keV and 2700keV will only be accepted.

Press the button to move to the next ROI without editing. The changes are saved after each ROI is completed. The changes may also be rejected by the operator.





4.5 Calibration

As standard, the GMS312 will be calibrated as test before use procedure.

We recommend that the GMS312 is calibrated at least once a year to ensure optimal performance of the detector for ROI measurements. For API measurements regular field calibrations are required. The GMS312 has smart calibration function which requires the operator to have knowledge of handling a radionuclide¹.

Calibration is performed with a Cs-137 gamma source, ideally with an activity in the range 18.5kBq to 370kBq. The calibration process is automatic, but some user interaction is required at the beginning to ensure the source is placed in the optimum position. The calibration process is split into 5 steps that initially determine the source activity and then a series of detector bias voltage adjustments to set the Cs-137 full energy peak at 662keV.

When starting the calibration place the source in front of the detector ensuring there is no shielding between the source and detector. The distance between the source and detector face will be dependent on the source activity. An 18.5kBq source at the detector face will give a count rate of approximately 1500 counts per second and a 370kBq source at 100mm should give approximately the same result. If the source is placed too close to or too far away from the detector the user will be prompted to move the source accordingly.

Depending on the count rate, the calibration should take from just a few minutes up to 10 minutes. Once the calibration is complete the new settings can be saved.

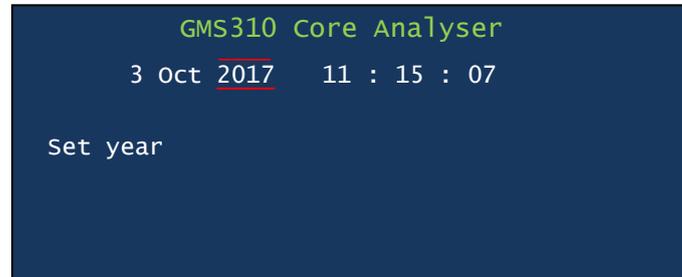
If not saved the GMS312 settings will revert to the original factory settings.

¹ Please contact John Caunt Scientific Ltd. for further information.



4.6 Set Time and Date

The current time and date is displayed.



Press the button to edit the time and date, note that the clock stops updating. Use the and buttons to change the year, month, day, hours, minutes and seconds. Pressing the button will advance to the next field.

The time will be set when the button is pressed when requested to exit.

4.7 USB

4.7.1 USB Connection

Select the USB Connection option in the main menu and open the GMS Core Analyser Data Manager. Connect and USB lead between the PC and GMS312. On the application select;

- Download data
- Connect to instrument
- Select required files
- Download to PC

Refer to the GMS Core Analyser Data Manager manual for further instruction on using the software.

When data has been downloaded to or from the application, remove the GMS312 from the PC safely using the PC's 'Safely Remove Hardware and Eject Media' facility. Corruption of the internal microSD card may result if GMS312 is not ejected safely.

Note that only one GMS312 should be connected to a PC at any one time.



4.7.2 First Time Connection

Before Installing the GMS312 software:

1. Switch on the GMS312 and select the USB Connection option in the main menu.
2. Connect the USB lead between the PC and the GMS312.
3. The PC will indicate that it has found new hardware and automatically find a driver.
4. The GMS312 will be identified as a Mass Storage Device and a generic Windows driver will be used.
5. The PC will then indicate that the hardware is ready to use.
6. The GMS312 will appear as an additional external drive e.g. E: GMS312

Should the PC not find new hardware or no drives appear, disconnect the USB lead, switch off the GMS312 and repeat the above procedures.

4.8 Default Settings

The GMS310 can be reset the default factory settings.

Default values:

- ROI 1 Uranium 1596 to 2024KeV
- ROI 2 Thorium 493 to 667keV
- ROI 3 Potassium 1241 to 1596KeV
- ROIs 4 to 6 are blank.
- ROI 7 shows the total counts from 90keV to 2700keV spectrum and cannot be edited.
- Sample time 30s **Static** mode
- Background sample time 100s **Dynamic** mode
- Speed 25mm/s
- Interval 100mm/s

4.9 Plot Function

To use the plot function, it must first be enabled before starting a measurement.

```
GMS310 Core Analyser
Plot functions and scales
Plot on
Gross-Spectrum 500 cnts
ROI 100 cnts
API 200 API
Concentrations 20 ppm/%
>Depth 1 m
```

The Gross, ROI, API and concentration values refer the maximum scale value, where as, the maximum depth is five times value displayed.

Note that the plot function is only available in the **Dynamic** mode.



4.10 Enhanced Spectral Analysis Mode (ESAM)

API concentrations of uranium, thorium and potassium are determined from counts that accumulate within specific energy ranges or Regions of Interest (ROI). However, since the detector has a degree of Compton scatter, counts that should accumulate in a particular ROI may actually appear in another ROI. The scatter is predictable and provided a reasonable number of counts are accumulated in each of the ROIs, the effects of scatter can be compensated for.

In the **Dynamic** mode however, there may be insufficient counts and large statistical fluctuations can occur in the data. It is recommended that only the **Static** mode is selected for the use of ESAM and API concentrations.

The API units value has sufficient counts in the **Dynamic** mode and therefore there are restrictions on its validity.

4.11 Averaging

In the **Dynamic** mode, the 1 second samples may be averaged as a rolling mean of up to 5 samples. That is, each of the last five samples are averaged, where the oldest sample is discarded and replaced by the latest sample, then the mean value is calculated.

4.12 Update firmware

The GMS312 can be updated by using the GMS312 Updater application.



5. Care

5.1 The Detector

The custom-built detector is a Sodium Iodide (Thallium Activated) (NaI/Tl) crystal. The detector will operate reliably between -5°C and 45°C , provided the rate of temperature change does not exceed $5^{\circ}\text{C} / \text{hour}$. NaI/Tl is susceptible to thermal shock

It is recommended to store the GMS312 in its transit case to help provide thermal protection during transit. Should the instrument be subject to changes in temperature greater than $5^{\circ}\text{C} / \text{hour}$, it is recommended that it is left in its transit case for a precautionary period of 4 hours to prior to operation.

Moving the GMS312 from one temperature to another, i.e. from normal room temperature to hot or very cold conditions, causes inaccuracies in the measurement process. The gain of the detector and electronics changes with temperature. Without sufficient time to stabilise, the readings from the GMS312 will change over time, until stabilisation has occurred.

5.2 Cleaning

The GMS312 should be cleaned with a mild detergent and a damp cloth only.

5.3 Storage

The GMS312 should be stored in its transit case in room temperature conditions.



6. Specification

Display	480 x 272 pixel Colour Transflective LCD with white LED backlight
User controls	9 buttons: POWER ON-OFF PAUSE BACK-NO ACCEPT-YES 4 navigation buttons
User connections	Charger input USB type B for connection to a PC
Detector	72 x 72mm NaI(Tl)
Energy range	90keV to 2700keV
Power	Internal NiMH 7.2V 8000mA battery pack
Charger	Output: 12V 3.75A. Input: 100 to 240Vac 50/60Hz, supplied with world-wide power leads
Environmental	
Temperature	Operating range -10°C to 50°C
IP Rating	IP54 electronics and detector compartments
GMS312 Dimensions	300mm long, 320mm high, 150mm wide (530mm high with detachable handle)
GMS312 Weight	10.0kg
Transport case	(transport case details may vary)
Dimensions	520mm long, 230mm high, 440mm wide
Weight	6.5kg with GMS312 and accessories

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