GT-30/GT-32 Mk II

User's Guide

Rev. 1.2 – October 2024



NOTE:

User's Guide Rev. 1.2 covers all firmware versions of GT-30 Mk II launched before version 0.15 in all features.

There is required program Geomon of version 0.6.6 or higher for access to all functions and parameters of FW 0.15 via a PC

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1. GENERAL

The GT-30 Mk II is the second generation of popular handheld gamma ray spectrometer GT-30. Strengths of the first generation were copied in the new model. There has to be highlighted a strong alloy body sealed against dust and water, protective removable rubber boot, comfortable grip and low weight. The Mk II learned of the limitations of the first generation and features a large colored transreflectible sun readable display, improved user's interface with five operation buttons, removable but well-sealed battery pack and clear and loud audio.



1.1. Main Features

- **GT-30 MkII / GT-32 MkII – 2 x 2" (106 cm^3)** Sodium-Iodide detector provides High sensitivity performance due to the large crystal. Or **GT-32 MkII – 2 x 2" BGO** for higher peak absorption efficiency. Energy response from 15 keV - 3000 keV.
- Large Graphic Color LCD **Trans reflexive display** of size 360 x 240 dots ensures excellent readability in any outdoor conditions. The size is 3,5" diagonal. Automatic dimming.
- Simple operated with five-position **navigation joystick**. Positions of the joystick are illuminated.
- Memory able to store **8000 samples** what includes spectra or search profiles including gamma total, dose rate, neutrons and GPS coordinates optionally voice recordings.
- New designed state-of-the art electronics with advanced CPU capability.
- Special rugged mechanical design, robust aluminum construction. Rubber shock absorber and internal thermal isolation.
- Well balanced, easy to hold and designed for easy operation in field condition.
- **Full IP65 weatherproofing** – short term water immersion and fully dust protected.
- **Removable and rechargeable battery Li-ion** module.
- Typical **8+ hour** battery life at 20 ^{0}C.
- Size 290 mm length, 160 mm height and 100 mm width, Weight – 2,45 kg NaI or 3,2,kg BGO.
- Operational Temperature range **-10 to +50 ^{0}C** (limited by display readability).
- Sensitivities 2x2" NaI/Tl (1 MBq from 1 m): Cs-137 160 cps.
- Modern spectrometer design. Fully digital.
- Automatic energy calibration based on natural background radiation. **No external radioactive source required.**
- USB and Wi-Fi connection.
- Integrated GPS.
- Integrated microphone for voice recording

1.2. Description

The GT-30 MkII / GT-32 MkII is a portable handheld instrument. The design respects specifications for indoors as well as for outdoors applications in wide range of temperature and humidity conditions. The instrument is self-contending, there are no additional devices required for its full functionality.

The detector body is made of thin alloy, shaped to harbor internal shock absorbers and temperature isolation.



The bottom of the instrument is protected with rubber boot. The boot is removable and covers bottom lid closing access to removable battery pack.

There is USB-C connector on backside of the head assembly covered by a rubber lid. The USB-C standard takes care of data communication as well as battery charging.

A loudspeaker is hidden behind milled grid below handle grip.

Main panel consists of large display, buttons joystick, holes for microphone and light sensor. A WiFi antenna is located near display under bezzel sticker. The joystick is made of five separate buttons. Four of them are orbiting a central OK button. All buttons are protected with transparent rubber cover. Each of the buttons is illuminated.

The instrument can be cleaned or decontaminated any time using soap water or it can be also a cleaner based on ethyl alcohol or isopropyl alcohol used. All mechanical components were designed for highest possible robustness. The most fragile elements (detection crystal and photomultiplier) are bedded in shock absorbers regardless that fact user must pay attention to how the unit is used and prevent mechanical shocks.

A black circular lid made of plastic located on front wall of the instrument protects a GPS antenna.

2. SYSTEM OPERATION

2.1. Batteries

The GT-30MkII / GT-32 MkII is powered from Li-ion battery pack build in the unit. The pack is removable by user after opening 4 bolds and removing lid. It can be charged in as well as outside of the unit. USB-C connector for external charging is allocated on battery pack. To increase protection of any damage caused by batteries the manufacturer uses only batteries with build in protection. Full control of charging and discharging of batteries is arranged by battery pack control circuit.



The Li-ion battery is an excellent source of power for the unit but needs an extra care. Although the most critical conditions are watched by build in processor, user is requested to care of following:

- Never charge the unit when temperature of the batteries drops below 0 degree of Celsius. Preferable conditions are around 20 degrees of Celsius.
- Do not store the unit with fully discharged battery!
- Pay attention to warning messages of internal diagnostic.
- Do not replace single batterie in pack. The batteries have to be balanced.
- Only original spare battery pack can be used.
- Charge only using USB-C type of charger with minimum 45W

2.2. Charging (Low batteries)

The GT-30 MkII / GT-32 MkII has a full control of capacity of batteries. If the Battery icon shows very little capacity left (message **LOW**) the battery pack must be charged promptly. We recommend as prevention of any data loss by uncontrolled termination of measuring activities to switch unit off. This action ensures complete and correct data storage.

Battery charging controller is built in battery pack. Chargeing status is communicated with main control processor. This allows to recharge the unit while operating without removing the batteries. The embeded charging controller is active during charging regardless a working status of the instrument. The unit can be charged in power on as well as in power off status. Indication of charging progress is arranged by yellow LED light located on frontside light ramp. LED light on indicates charging process. Light off means no charging and flashing light announces any error.

To charge connect the unit's or battery pack's USB-C to a USB-C PD charger. Charging progress indicates an icon shown on right top corner of display. The icon has animated filling pattern to indicate charging progress. If a direct connection to the battery pack is used a green LED status light on the battery pack is used. Permanent light for charging, no light for no charging activity and flashing light for an error or overheating.

The Manufacturer will not be held responsible for damage to the unit caused by use of improper adaptor. Connecting a wrong type may lead to unpredictable damage on the unit and will invalidate the warranty.

The unit may operate on external power anytime. External power use is not time limited and suits for long term monitoring tasks (permanent monitoring stations).

2.3. Joystick

The GT-30 MkII / GT-32 MkII has five control buttons associated in a PUSH-BUTTON JOYSTICK. Each button is illuminated what is used for prompting expected actions. The Joystick has four buttons on sides creating an orbit around the fifth button in the center. The orbital buttons controls graphical cursor directions UP, LEFT, RIGHT and DOWN. The central button is used for confirmation of a selection and also for switching the unit ON and OFF.

Except switching ON and OFF all clicks of any button shall be performed as a short press of a finger on center of the button as long as mechanical feedback (click) occurs. Then the finger pulls back. Any button click must be followed with any action of graphic user interface. User must pay attention to a feedback. The feedback can be a move of graphic display to different position, change of a value in editable boxes, starting any action. To increase operability of some editable functions or spectrum browsers an auto repeat function on buttons is implemented. User shall push a button and hold as long as expected number or cursor position occurs on the screen.

2.4. Display

The Display is a backlit LCD trans reflective color display optimized for high contrast in outdoor conditions. Display backlighting is required in low light conditions to make the display readable. The Backlit is controlled automatically. Ambient light is measured by sensor under main panel. The Display is used for various functions and messages. The trans reflective feature ensures magnificent readability even on bright sunlight.

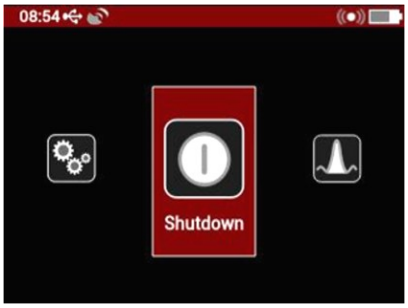
2.5. Switching ON

Press and hold the button OK as long as button's illumination lights appear or for maximum three seconds. Following actions will continue. There is a

message LOADING informing on progress of booting. Then the display is replaced with a welcome screen consisting of manufacturer's logo, name of the instrument, serial number and firmware version number. Follows the startup action and the unit switches after internal tests to a SURVEY mode.

2.6. Switching OFF

To switch the unit OFF, press and hold the **Button** OK until the unit switches OFF. The other way to switch OFF the unit is to choose switch OFF function from MAIN MENU and confirm SWITCH OFF action. Access to MAIN MENU is described in chapter 3. Shall it happen that the unit stops user interface function and there is no reaction on any key touch, hold the OK button pressed until the



unit powers OFF.

2.7. Connection to devices

Transfer of Recorded data from the unit as well as major parameters modification or remote operation can be provided via two different communication channels. There is one wire and one wireless standard to connect the unit with external devices.

USB-C standard wire connection cares of all tasks between PC devices. Via USB there are accessible all measured data logged information and access to all parameters. A remote operation is also possible. A connection procedure description is a part of this User's Guide in section Supporting PC programs. The USB connection can be operated also in ETHERNET mode. Default IP address is 192.168.137.101, port number 4444.

Wi-Fi connection is the most preferable way. It profits of worldwide use and presence of Wi-Fi devices and high speed. It is not only reserved for applications requiring direct LAN access. Beside Internet connection and far distance controlling mode this type of connection allows also creation of a network of GT-30 MkII / GT-32 MkII e.g. in environmental monitoring applications or fix monitoring stations.

3. Access to working modes and Main menu

The Main menu is a root of tree of action's direct calls and submenus. The direct actions are Shutdown, Survey and Assay. Shutdown call leads to





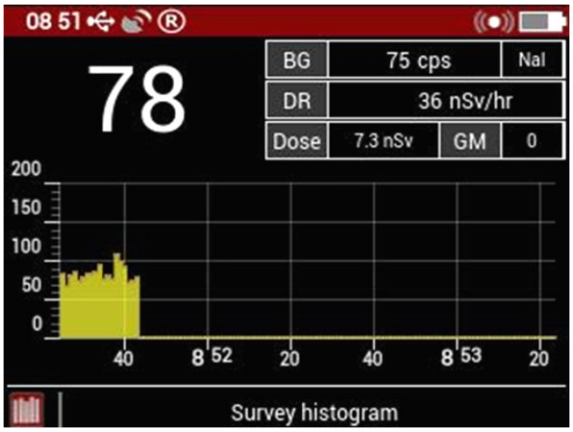
switching off the unit action. A confirmation of switching off process is required. Select YES button and press OK. Survey and Assay starts measurement procedure promptly. Activation of the two other items Storage and Settings leads to opening submenus for further access to Data Logs or Parameters. Return to Main menu off procedures or submenus is arranged through an Action menu where selection of the last item of this menu returns to Main menu. See appendix for detailed map of functions and menus.



After power on the GT-30/GT-32 starts immediately Survey process. A button OK pushed any time during surveying or assay calls a subordinate menu **Actions** from active working procedures. For example. To go to Main menu from Survey or to switch to any supported feature user needs to touch OK to popup Action menu then select **Main menu** or other requested feature following confirmation of choice with OK again. To reach Main menu from Assay through related **Actions** menu use the same way.

4. Survey

The GT-30/GT-32 unit associates two functions at a time. A sensitive gamma ray scintilometer accompanied with gamma spectrometer function working on backstage. The survey mode is rated for fast and easy sources targeting or as a stationary monitor of radioactivity. Survey is suitable for a sensitive gamma ray profile logging in terrain. Carrying unit as backpack or on any suitable moving device gives excellent gamma profile information. Each reading is completed with actual position of the unit in GPS coordinates and is stored on memory. Survey mode starts automatically



after power on or can be started from Main menu calling item Survey. Since the unit is on a gamma spectrum is continuously collected on backstage. It is used for a real time gain compensation of the unit's scintillator temperature drift.

Indication on display is partitioned into three fields – windows. The strip field in a top is status information bar. There are various pictograms displayed in this row. See the appendix for details about icons used. Actual time of the unit occupies the left corner. The middle of the row is used for icons. There are Gain stabilization, Recording, USB connection, Bluetooth® connection active, GPS status and important error warnings icons. Shall be more icons to be displayed then there is space available, Icons are animated and rotate from right to left like headlines. Battery status is on the right side of the bar.

The left side of second window is reserved for Total Counts. Up to five digits are reserved for showing every second readings of recorded gamma ray incidents within last second (cps). The total counter is connected with a graphical histogram what occupies lower two thirds of display area. The histogram - recorder is used for easy orientation while searching. The recorder indicates intensities of radiation recorded during last 120 seconds. It allows to user fast and simple compare of gamma-ray intensities in different positions of the unit while searching and easy determination of radioactive spots. The histogram's scale is auto ranging and the current amplitude is indicated with a little arrow left of the y scale. X scale of the histogram is marked with actual time marks.

The right side of the second window is a table of most important on fly results. There are written last updated background values and current dose rate together with accumulated dose.

For a detailed inspection of the histogram a user can **Pause recording**. This will happen after call of **Action menu** by pressing OK button followed with selection **Pause** and its confirmation with OK button again. In this mode the screen freezes and there is given time to user to inspect the recorded histogram. A user can use UP, RIGHT, DOWN and LEFT buttons to move position of the histogram on x as well as y scale to see time or amplitude details. Return to actual mode is performed after pressing OK button and selecting of **Resume** followed by OK confirmation. It is important that during the pause the unit keeps recording of actual data on backstage and no data of search profile are lost. The histogram is automatically updated and time synchronized.

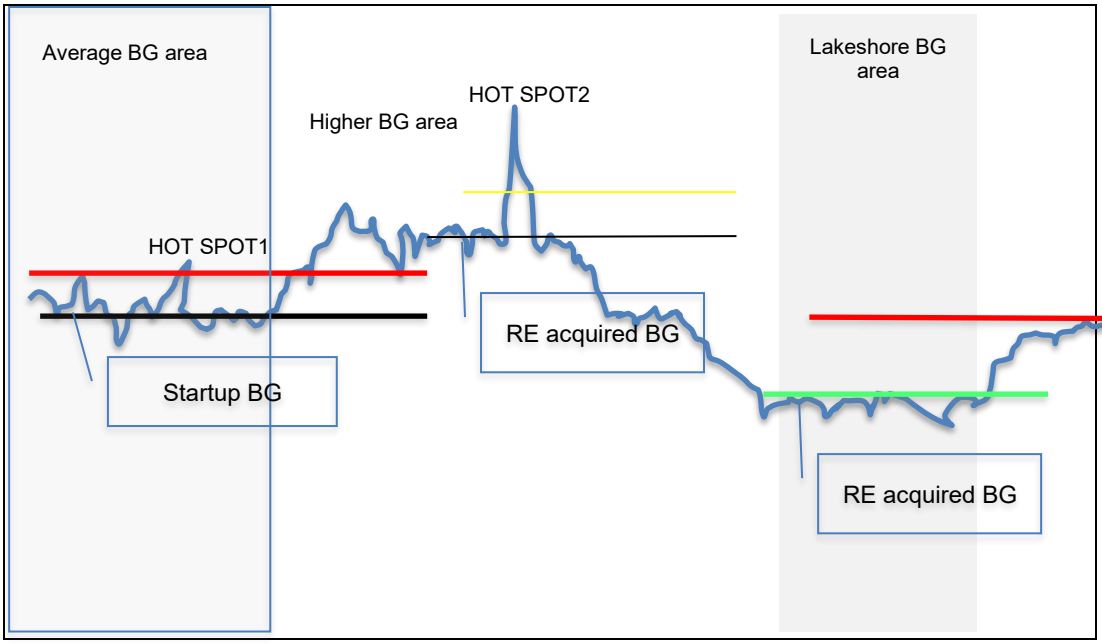
4.1. Audio and voice recording

The GT-30/GT-32 has an audio loudspeaker inside the unit. The audio system is used in various modes. In the search mode the audio system is activated when the radiation level gets above a certain internally computed Audio Threshold. Once the Audio Threshold is exceeded then the Audio frequency pitch will reflect the incoming count rate. The frequency pitch is proportional to count rate. Rules for audio threshold set up are in the next chapter.

Audio system is used for recording of spoken messages and comments of a user in **assay** mode. Important information about measurement can be spoken to a build in microphone in front panel and re played before saving. The voice in digital form is then attached to a spectrum. Voice notes are exported in wmf format and can be replayed on a PC. The voice notes are editable prior storing on memory.

4.1.1. Re-acquire Radiation Background

We use a following condition for demonstration how the audio in survey mode works. Let set the **AUDIO THRESHOLD** to one sigma. Immediately as the unit is powered on and starts Survey or the Survey is engaged from any menu, the first 10 readings of total counts in cps are averaged and the Audio Threshold is computed from this average. The threshold responds to a value of the average plus one standard deviation of the averaged data. Factorisation od standard deviations used is changeable in parameter's Settings service. If the count level exceeds this threshold the audio starts sound as described above. However in many areas and conditions the local background may vary and it may cause threshold problems, false alarms or sensitivity failure. It is important then to be able to accommodate the audio threshold to local conditions any time.



There is an example when the local background average level is 100 cps then at 1 Sigma the Audio Threshold = 110 cps (100 + 1 Sigma). See the red line in Average BG area what demonstrates the threshold. So if the count rate goes above 110 cps the audio will sound. Indication of a hot spot 1 is possible. However the local Background may increase substantially let say to 200 cps (user moved from an open space to a building e.g.) then the audio will be on continuously and the frequency pitch will not be sensitive enough to small local changes so the hot spot 2 will be missed due a false alarm. Re adjustment of the threshold is essential to accept higher background condition. The new threshold is 214 cps. It may happen an opposite case. If the local Background drops down e.g. to 50 cps (Lakeshore area) then a accidental radiation would have to increase very substantially (above 214 cps) before the audio sounds what means that even as high source of radiation as from hot spot 2 can be missed because it sits on a low background and total counts of the source will not reach the threshold. This effectively desensitizes the audio system. The new re adjustment on Lakeshore area sets the threshold to 57 and maintains high sensitivity to hot spots.

To overcome this “problem” AT ANY TIME the user can briefly touch the **Button OK** and choose the **Reacquire BG** from **action menu** list then the system will automatically return to the Survey display and the system will re-compute the Audio Threshold. A message **UPDATING BACKGROUND** will be kept on the display for the 10 seconds while the background update process is active.

This means the user can “re-tune” the Audio Threshold at any time thus keeping the audio threshold optimized. The actual background level is indicated in the table on search display.

4.2. Actions

The GT-30 Mk II/GT-32 Mk II has the joystick as noted above. To achieve the required system functions from running services (Survey or Assay) CLICK the OK button, the **Action Menu** appears. The user navigates up and down this menu using clicks on proper arrow buttons. To prompt a user to use only sensible buttons the expected are illuminated. Highlighted icons on display moves with the selection. Once the item is selected press OK and the selection is confirmed and the unit starts action.

a) **Assay** – starts a spectrum measurement and performs radio assay – see chapter ASSAY.
b) **Reacquire BG** – the unit starts new background measurement. This is announced with message **UPDATING BACKGROUND**. Then a new audio threshold is computed and set up. A new actual averaged background is indicated in the table on search display.
c) **Start recording** – activation will start the recording of the count rate measured (cps) and dose rate. Data are recorded every second with actual GPS coordinates. Once selected and the units is recording readings the item Start recording in action menu is replaced by **Stop recording**. This way a user can Start or Stop in flip flap mode.
d) **Pause** – leads to pausing survey histogram move. The values on display and histogram are not updated. A user can user left and right button to move cursor through survey histogram bars and can take readings of past scans. While the user browses the paused display the unit continues with scanning on backstage.
e) **Resume** – resume returns display to actual position of last scanned sample. The Pause function is left and histogram resumes to actual position from backstage buffer.
f) **Main Menu** – return to instrument's root menu.
g) **Continue** – activation will switch off the action menu and keeps all background values without change.

4.3. Recording to Memory

Gamma Ray intensities and dose rate accompanied with GPS coordinates can be recorded to memory. There is a huge space allocated for Survey in memory. Data are saved every second. Data stream is exportable via supporting PC programs. See section about PC tools.

Start recording is accessible from menu **Action** what appears immediately after OK button click while unit works in Mode – Survey. Next the user moves highlighted cursor bar to position **Start recording** (using up or down button clicks) and activates it with OK Button press. Unit switches back into Survey. Memory storage starts promptly. Icon R in the information bar indicates process of continuing data storage. To Stop recording user must revoke menu **Action.** Selecting and activating **Stop recording** user will interrupt data storage and the unit will return to basic Survey mode again.
User can read, browse recorded data and manage memory with PC support program GeoMon or browse profiles on units screen using functions from Survey log.

5. Spectrometer features

The GT-30 Mk II/GT-32 Mk II is a High Sensitive Handheld Gamma Ray Spectrometer. Build with large volume NaI/Tl detector with 1024 channel analyzer (MCA) gives a solid base for highly sophisticated algorithms for gamma spectra evaluation. A new powerful Microprocessor allows engaging complicated statistical method to be used in the unit. A unique evaluation algorithm allows determining concentration of natural radioactive elements as well as manmade radioisotopes in various applications. Beside most common application in geology the GT-30 Mk II/GT-32 Mk II is perfectly suitable for tasks in waste management, environment and general monitoring. The whole assay process is fully automated and does not require special user's effort. Information about concentrations and their confidence are printed in a result table.

5.1. Warming Up

As other devices based on NaI/Tl (or BGO) scintillation detector the GT-30 Mk II/GT-32 Mk II must compensate amount of light emited from the detector in relation to ambient temperature. Unlike other units the GT-30 Mk II/GT-32 Mk II profits of radiation of natural background where is enough information to provide gain correction precisely. There is no requirement to use any man made radionuclide for warming up process.

Warming up and hold on correct working parameters is automated process running continuously after power on. For all the time while the unit is ON there is spectrum measurement process active (all background process) and actual gain deviations are compensated. Exposition of the unit to other than natural sources (search for unknown source and identification of radionuclides) will temporally postpone any gain correction. Recovery of the self-compensation process starts immediately as the unit is back on natural background level. Method of self-compensation uses spectral patterns of K-40, Ra-226 and Th-232 with their library templates to be compared. Any shift from ideal position leads to gain adjustment. After switch-on the unit prompts to Survey. Warming up process starts immediately on backstage – system is collecting actual spectrum. Collected spectrum is evaluated every 30 seconds and unit's gain is tuned. Evaluation progress is indicated with flashing icon **((o))** located on the information bar. Once the unit sets the gain to the correct value the icon **((o))** holds in info bar on display and the unit is fully ready to work. The gain correction process is active all the time and access to any other functions of user's interface e.g. setup menus will not interrupt it.

Because sensitivity of NaI/Tl or BGO to temperature is relatively high and unit may compensate big differences in gain, to save time it is recommended to let unit running for all the time even when assay is not needed. The unit can be powered on external power. While in idle, the unit will proportionally compensate any temperature drift and hold unit ready to go any time. Should it happen that the unit was stabilized and finally switched off in very different ambient temperature then other day when is switched on again? The warm up process started next day will have to compensate a huge drift off previous last work gain setup what may take longer time but no longer than 15

minutes. Exposing the unit to higher radioactivity than natural background will work contra productive. In case there is no way to perform warm up process for any reason e.g. extremely low local background typically on glaciers or on a sea user can use maintenance function and re-stabilize the unit using external source of Cs-137. The radioactive source Cs-137 is not delivered with the instrument. All process of warming up is logged and can be reported via supporting programs. In case of gain stabilization troubles contact manufacturer for advice.

5.2. ASSAY

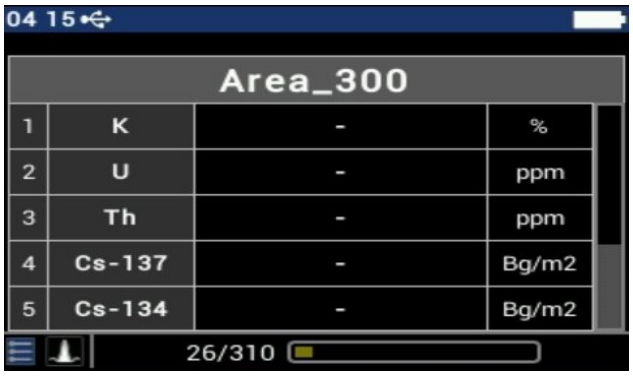
Routines for Radionuclide ASSAY feature the highest level of Gamma Ray Spectrum processing. Calculation of concentration of various elements is a unique method developed by Georadis. Result is a list of determined radionuclides and their concentrations.

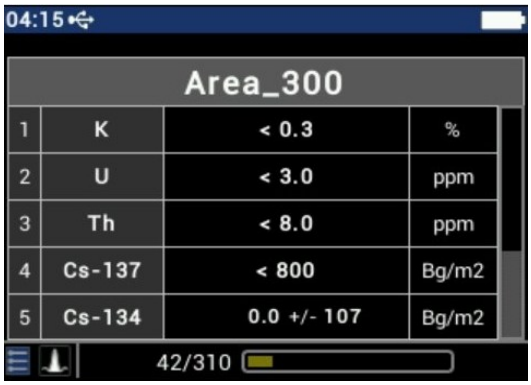


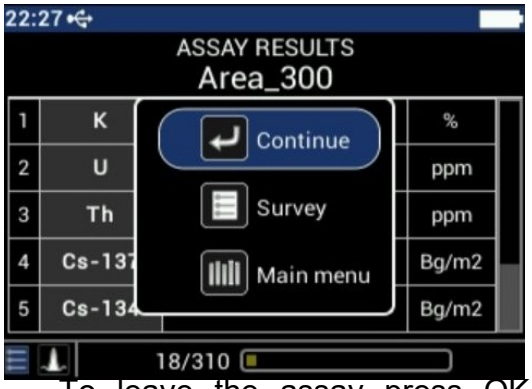
Let suppose that the unit has been switched on and the warming up process has been finished. There is the icon **((o))** present in info bar on all screens. The ASSAY process can start. From Survey touch OK **Button** to activate menu **Action**. Select and activate of vitual button **Assay**. Spectrum acquisition starts immediately and a new screen ASSAY appears on display. Two different screens can be engaged. User can easily switch between the screens anytime. Use left and right arrows.

5.2.1. Assay results screen

The picture below shows a screen with Assay results. An index number of each component assigned to the method is in the first column. There are maximum six components. Rows in the table can be scrolled up and down using UP and Down button. A name of a component is in the second column. The third column shows activities respective concentrations of components plus their errors, used units are printed in the fourth column. The first results of Assay are printed after 30 seconds after spectrum acquisition start and then every 30 seconds are updated. Information about time progress is in numeric as well as graphic form and is located down on the bottom of the screen.



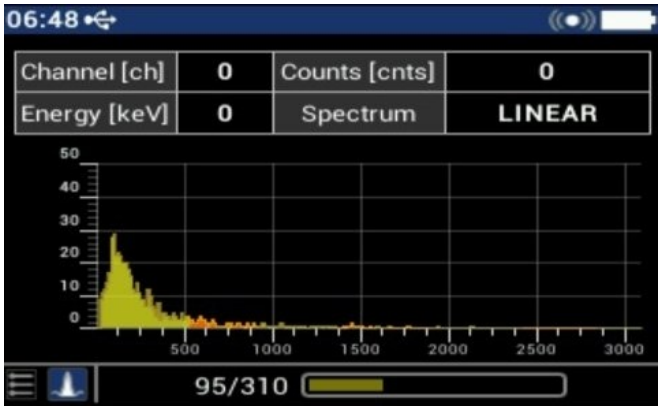


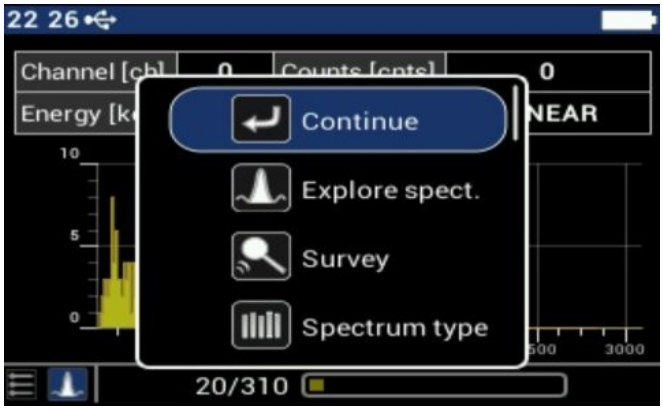


To leave the assay press OK button to activate **Actions** interface. Available services are: **Continue** - returns back to results table, **Survey** - jumps in survey or **Main menu** to return. Number of actions may vary with number of engaged services e.g. Save results etc.

5.2.2. Spectrum display.

To switch from results table to spectrum screen user must use right or left button. For indication of direction are used two icons in down left corner of both screens. The left icon indicates table of results and the right one spectrum. Actual selection is highlighted with red background. Beside the common objects like information bar and time progress area the spectrum screen shows table with cursor channel position, related energy, counts and plots a spectrum.





To leave the screen press OK button to activate **Actions** interface. Available services are: **Continue** leads to return back to spectrum. **Explore spect.** engages SPECTRUM **BROWSER**. Item **Survey** jumps in survey mode directly. Selection of **spectrum type** gives a choice to display either common LINEAR spectrum or compressed 256 channel nonlinear spectrum. Next is **Main menu** to return back.

An actual measured spectrum is animated on display. Once engaged **SPECTRUM BROWSER** mode there are active all direction buttons for x and y scaling, zooming of selected regions and spectral cursor move. While pushed the arrow button the cursor moves proportionally in direction of the arrow button. Its position over particular channel is displayed in a table above spectrum.

Channel position, related energy in keV and actual channel counts informs about spectrum details. There are additional services supporting the browser. After OK press a list of services pops on spectrum screen. Services are **Continue** to return back again without any change, next **Zoom** to enlarge x scale for details, **Auto Scale** to rearrange spectrum proportions, **Spectrum type** and Exit **exploring.**

5.3. Measuring Methods

Evaluation of concentrations of various samples in different geometries.

Determination of activity or concentration using gamma spectroscopy is based on comparing of spectrum of an unknown sample with spectral response of standards with known concentrations of elements in fixed geometry. The geometry factor is critical. There is no way to use one type of geometry for calibration and different one for samples. For example unit calibrated for response on a beaker of a small volume cannot give a correct result of soil contamination measurement in large area. Reference spectra, nominal values of standards and geometry proportions are build in table – called **Method**.

The method consists of a matrix of parameters and to them related spectra of known standards. All these parameters are essential and any improper change will lead to degradation of result's confidence. The method can be customized by manufacturer or advanced users can create a method themselves. Method can be stored on external PC and uploaded again if needed. Uploading a new method leads to complete recalibration of the unit.

The instrument is delivered with default calibration for determination of potassium, uranium, thorium in infinite area geometry. Default method is backuped on Flahdisk delivered and also at manufacturer’s server. Default method suits immediately in measurement of a topsoil contamination or rocks on large areas. For calibration were used PADs for K, U and Th plus background.

Dimensions of PADs: 1 x 1 x 0.3 m (K, U, Th) and 1 x 1 x 0.06 m (Cs isotopes)

Concentrations/Activities of PADs:

	K [%]	U[ppm]	Th[ppm]
Background	1.43	0.94	2.32
K PAD	7.57	1.22	1.40
U PAD	1.07	46.93	2.75
Th PAD	1.43	1.74	121.6

Numbers in the matrix above represent concentrations or activities of each radioisotope (component). The K, U and Th pads were made of natural

materials so there is a small contamination of each pad by other natural radioisotopes. Therefore there are also concentrations out of the main diagonal in the matrix.

Method creation can be done in proper PC supporting tool – Geomon, Geoview or RS Analyst. Contact any representative or manufacturer for navigation how to modify or create a new method.

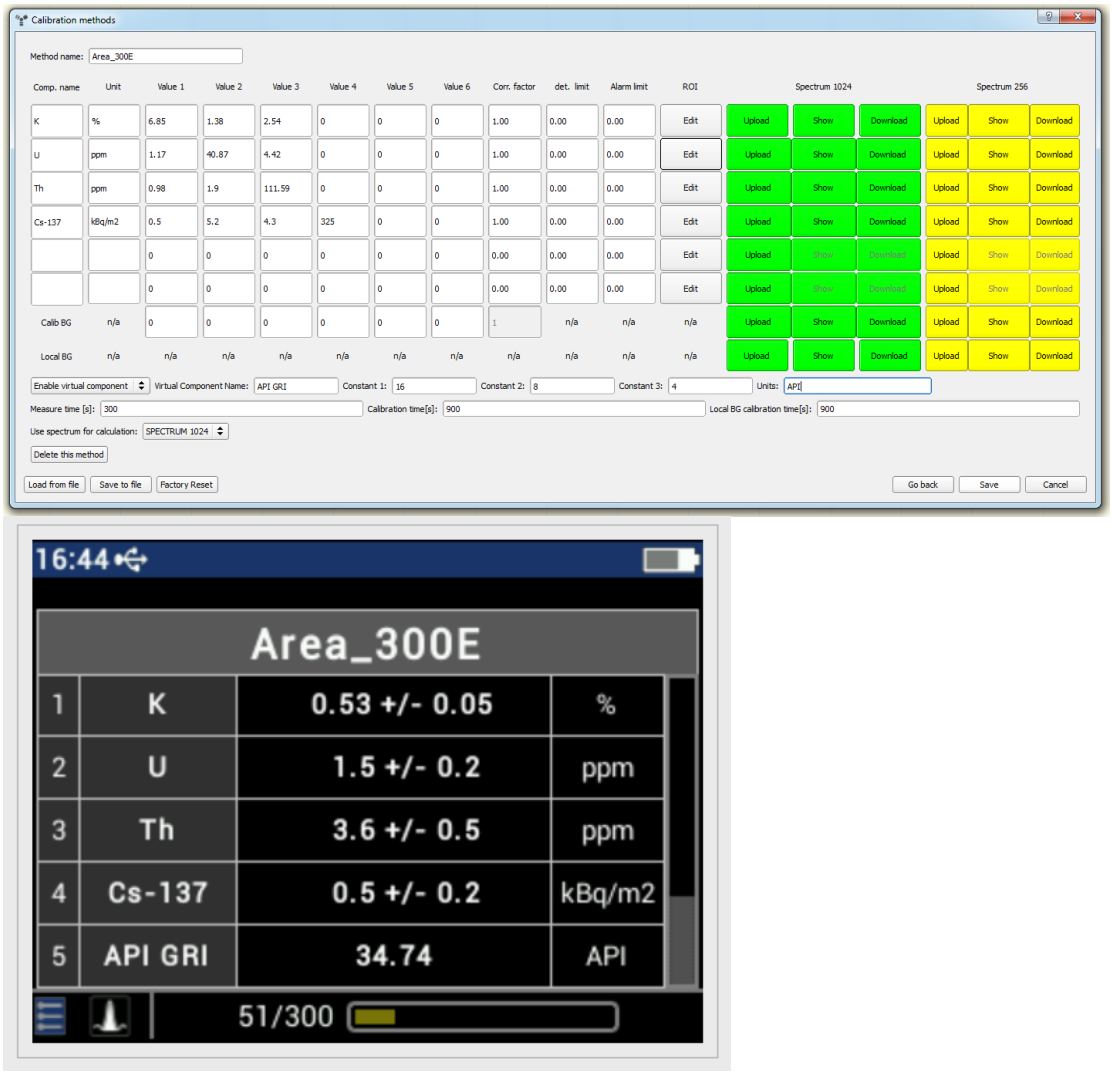
It is highly recommended to archive calibration spectra files for a future use.

5.3.1. Virtual components

Virtual components is a tool how to instruct the GT-30 Mk II/GT-32 Mk II to compute and display additional results from measured data. Typically there are required miscellaneous indexes describing properties of samples. For example there are API, Gamma Ray Index, Radium Index, Activity Index, Summary Activity, Uranium or Thorium Equivalent etc. All this indexes have a common structure. It is a sum of measured components weighted by factors. As an example there is calculation of API Gamma Ray from measured concentrations of K, U and Th.

$API = 16*K_c[\%] + 8*U_c[ppm] + 4*Th_c[ppm]$

User can activate virtual component evaluation in Method. Geomon's Method definition window is shown for this purpose.



Virtual component formula works with readings of the first three components. There is K, U, and Th in our example. User has to select Enable Virtual Component from a switch box. Then is necessary to input a string with name of the component. We used API GRI. Following there are three edit boxes for coefficients. The last edit box requires a string with name of the unit. The string edit boxes can be left empty. Calculated virtual component becomes a part of result data stream and is recorded together with other results.

5.4. Dose rate

Unique algorithms build in a firmware of GT-30 is used for real time gamma dose rate evaluation from gamma spectra of NaI/Tl detector. The instrument is not targeted as dose rate measuring device and this feature is only additive to help protect user of unexpected exposure. The measured dose rate is within range 0.1 nSv/hr - 80 microSv/hr and matches all requirements of IEC 60846 standard. The response is fully compensated in energy range 60 keV – 1,5 MeV. The maximum dose range is sufficient enough to give an early warning on dose rate levels allowed for public.

The angle response of the detector used is very uniform there is not much limitation which way the unit shall be oriented towards coming radiation to get correct values but please be reminded that a central reference point of

the unit is eight centimeters above bottom cover. The preferable direction of radiation is towards the bottom.

6. DATA MEMORY

The GT-30 Mk II/GT-32 Mk II files data in a huge Solid State Memory. There is enough room for measured data, voice comments, information about position of the unit and there are also logged all information about gain stabilization including spectra used as well as reports of internal system messages and events. Access to logs and basic browser operation is common for all types of logs.

The common access is from **Main menu – Storage**. Then selection of type of log. Once selected and activated there are three action items. To let read **All records** of selected type and put on a list or to use a date **Filter** to get only logs between chosen days. Result of loading procedure is a list of logs available. For details the user must select one item of the list and confirm with OK button. The last item of the list returns back to previous menu.

6.1. ASSAY results log

The Assay log consists of assay results and spectra. Spectra browsing is arranged the same way like in real assay function. Identical are two screens one for results, second one for spectra. All spectra browsing features are used for scaling and zooming. Return back is arranged via action menu with items Continue, Reload, Graph, Results and Back to Logs.

6.2. Survey profiles log

The survey log is organized as a stream of total counts in cps, dose rates, integrated dose values. Additionally there are linked On FLy Assay results. GPS coordinates are also recorded. To check profiles there is accessible graphical histogram. All browsing features are supported. See details of the profile on time as well as counts scale. For more about go back to section section Survey.

6.3. Stabilization log

The stabilization log offers a table of most important stabilization inputs and outputs. In columns: Index, Date, Time of stabilization event and stabilization result. The stabilization result is OK when unit’s gain is corrected or there is report about problems caused unsuccessful gain stabilization. An additional note is in the next column. The next six columns are used for detail information about peak differences of nominal peak position in channels, next is listed information about high voltage adjustment before and after stabilization event. The last columns show fine gain adjustment prior and after stabilization. All that information is rated for maintenance purposes and can be requested by authorized personal in case of any gain adjustment failures.

6.4. Calibration log

The calibration log is only list of spectra used for each method and date and time of their acquisition. This informs the user about validity of calibration of the method.

6.5. System log

The system log is used to file all important system announcements and is organized as a simple strings output. It is used by maintainer or manufacturer for any service events.

7. PARAMETER SETUP

Warning: Change or improper set up of some parameters may have a negative impact on function of the unit. Uncertain meanings of parameters shall be consulted with manufacturer.

7.1. Access to parameters

There is a structured menu user interface integrated in the unit to help to a user set up of selected basic working parameters. Access to all parameters is possible only via remote connection from the PC. Limited set of parameters accessible from unit's user interface are described in this section. Menus are organized into function groups. To browse in menus use short Button clicks for step by step move or button hold to engage an auto repeat function. The **Main menu** is accessible from **Survey** after short button click or from other menus redirecting to **Main menu**. Next go to **Settings** and and follow to requested partameter's group. For return from a group to previous level there is a service **Go Back** in each menu.

7.2. Date and time

Date and time setup is arranged in three items. One for date the other for time and the third for time zone. Year, month and day or hour, minute and second are kept in separate editable window. Only one window is active for edit at a time. Selection of nearby window is arranged by right and left button. Increase or decrease the value in the window by up and down buttons.

7.3. Display

Display setup consists only from one parameter for adjustment of contrast. Values are editable by right and left button.

7.4. Audio

Audio section arranges access to three parameters. Audio volume, audio mode and sweep threshold. Audio volume allows muting or adjusting loudspeakers volume. Audio mode defines signaling after exceeding of alarm threshold. It can be chosen **Silent, Frequency Sweep** or **Alarm**. Frequency sweep activates audio indication where frequency pitch is proportional to registered number of gamma ray incidents in last second. Alarm means activation of horn signal once the threshold is crossed. The horn is on as long as the alarm message is served and confirmed. Sweep threshold is a multiplicative factor of standard deviation of averaged background. See section Survey for details.

7.5. Measurement

Measuring method. Activation of a proper calibration for measurement of a sample is here. Measurement time can be re adjusted. Dose units - selection of dose measurement quantity. Background - parameters for different type of background evaluation in Survey mode. Floating background automatically copies slow changes of background radiation during a day. It is used for

permanent monitoring applications. Factory method reset for recovery of default calibration.

7.6. Calibration

Calibration section consists of many sensitive parameters. It is recommended not to change any prior contacting a maintainer and full understanding of meanings. Next are parameters important for fast preparation of the unit for measurement.

In some unpredictable circumstances may happen that rule for gain stabilization fails. Mainly it happens due lack of presence of natural radioisotopes in local background. There are known cases where the unit was used on vessel on a sea or thick layers of ice on glaciers where high shielding efficiency of the water almost suppressed any local radiation. To resume correct working set up there is accessible Cs calibration utility.

Cs calibration

It will perform basic gain setup. To use this item user needs weak source of Cs-137 (not delivered with the unit). The source can be ordered as an option.

7.7. Accessories

7.7.1. GPS logging

GPS receiver is an integral component of the GT-40/GT-40S. The GPS antenna is located on top of the head between handle supports. For a best performance the antenna shall stay clear of metal or high conductive materials what may shield a signal from satellites.

As soon as GPS service is enabled and a position is fixed following icon  appears on top bar of each screen. Up to date information about GPS status, number of satellites and actual position are accessible through **Settings – Maintenance – GPS status**.
Once available the GPS coordinates are automatically integrated in survey records as well as in assay or identification results. The GPS receiver can be disengaged also in **GPS Status** screen after pushing button OK and selecting **GPS Turn OFF** or from **Accessories** menu setting parameter **GPS to disable**.

7.7.2. USB port

The USB port can be used in three different modes. There are Direct, Ethernet and Serial mode. Each mode specifies its own communication protocol.
The Direct mode is used for cable connection between the GT-40/GT-40S and a PC via USB hub.
The Ethernet mode emulates a TCP/IP communication between the unit and any suitable access point via USB. Setting up in Ethernet mode is required in case of a connection to a local area networks.
The Serial mode is a simple serial communication level mainly used for hardware debugging or in special applications.

The USB Port setup goes through **Main menu – Settings – Connections – USB – USB mode**. Selection of the mode is done by using left or right button and then confirmation with **Save** button. Once the mode is changed the unit will reset automatically.
To setup the USB port in Ethernet mode there is required to define **TCP/IP properties**. It is arranged through **Main menu – Settings – Connections – USB – USB Ethernet**. This mode is used only optionally and details of parameters are not described in this manual.
See section appendix for How to connect the GT-40/GT-40S with a PC.

7.7.3. Wi-Fi connection

A build in Wi-Fi transmitter extends a communication range of the GT-30 Mk II/GT-32 Mk II to be capable to work within WLAN. This allows maintaining or operating the unit worldwide using internet or intranet networks. A discrete login information will be required for successful connection therefore any cooperation with a local IT personal is needed. For the communication is essential to connect the GT-30 Mk II/GT-32 Mk II Wi-Fi with a local Wi-Fi router or Wi-Fi wireless access point. There are utilities build in the GT-30 Mk II/GT-32 Mk II. Go through **Main menu – Settings – Connections – Wi-Fi**. Service
Wi-Fi scan is available. It starts the activity of Wi-Fi receiver and checks for Wi-Fi networks in range of the unit. List of available networks is displayed then. After selecting a network using up down buttons and confirmation of selection on the list the user is requested to enter a password. A graphic keyboard interface driven by UP, RIGH, DOWN, LEFT an OK key is used. This way can be typed all combinations in letters, numbers and special characters.

7.7.4. Bluetooth®

Bluetooth® technology is designed to establish a wireless connection between your GT-30 Mk II/GT-32 Mk II device and a Bluetooth® enabled device. You must pair your GT-30 Mk II/GT-32 Mk II device with a Bluetooth® enabled device before you can connect to it. For more information about preparing the Bluetooth® enabled device for pairing, see the documentation delivered with the Bluetooth® enabled device.

8. Maintenance

8.1. Hardware maintenance

The GT-30 Mk II/GT-32 Mk II is designed to be resistant of harsh outdoor condition. Regardless of it is important to remember it is a delicate measuring instrument calibrated for high sensitive and precise measurements. There are used very sensitive components – scintillation crystal and photomultiplier and any negative impact may change its performance and void calibration. All devices handling with low radiation levels **MUST BE** maintained with extra care of potential surface contamination by radioactive elements. Any extra protection using vinyl bags or similar is recommended.

In case of the units contamination there is recommended to use ethyl alcohol and soft towels for its decontamination.

The manufacturer recommends to establish a simple measuring – verification point. It may be a fixed point in building, backyards or solid sample what may be used from time to time for re measuring purposes. In case of loosing long term stability manufacturer shall be contacted for advice.

An extra attention shall be paid to battery charging. See chapter System Operation for details.

8.2. Software maintenance

A core of the GT-30 Mk II/GT-32 Mk II is made on powerful multicore microprocessor in embedded PC like environment. To eliminate any trouble caused by unauthorized access there is only limited set of parameters accessible and user can control only selected databases. The GT-30 Mk II/GT-32 Mk II performance and features are permanently improved and any owner of the instrument may upgrade current firmware free of charge. In case of trouble related to functions or firmware updates there is a maintenance hot line established and user is encouraged to contact manufacturer. Majority of problems can be resolved remotely and due high efficient communication channels a solution is fast and effective. The manufacturer also files all important data of the instrument from production setup period for system recovery.

9. APPENDIX A: CALIBRATION

Default calibration is made for infinite area measurement. There were used calibration PADs traced to IAEA standards for K-40, natural Uranium and Thorium 232.

Dimensions of PADs: 1 x 1 x 0.3 m (K, U, Th)

Concentrations/Activities of PADs:

	K [%]	U[ppm]	Th[ppm]
Background	1.43	0.94	2.32
K PAD	7.57	1.22	1.40
U PAD	1.07	46.93	2.75
Th PAD	1.43	1.74	121.6

Correction for transition from PAD area 1x1m to an infinite response was used 85% of PAD readings.

10. APPENDIX B: TECHNICAL DATA

Detectors

Standard option

NaI/(Tl), Φ51 x 51 mm (2“ x 2“), 104 cm3 (6.3 in3), GT-30 MkII models
BGO, Φ51 x 51 mm (2“ x 2“), 104 cm3 (6.3 in3), GT-32 Mk II model
Photomultiplier diameter 2”, bialkali

Special option

CsI/(Tl), CsI/Eu, LaH, SrI, GAGG, YAP , Φ51 x max 120 mm (2“ x max 5“), SiPM array

Spectrometer

1024 channel, 40 MHz DSP, Linear Energy corrected
Pile-up Rejector, 200 ns Resolution
Energy range 20keV - 3,0 MeV

Scintillometer
Sampling period 20/second
Acoustic and video alarm, 4 LED indicators
Moving average and integration

Dose Meter
Energy corrected dose rate for NaI detector, H*10
Range 10 nGy/hr – 80 000 nGy/hr (Cs 137)

Gamma ray sensitivity at 1m (NaI/Tl 2x2”)
160 cps/1MBq for Cs-137
75 cps/1MBq for Am-241
270 cps/1MBq for Co-60

Display
Colour LCD, 360 x 240 dots, 72 x 54 mm (3.5”), Sun readable
Automatic Backlight

Acoustic indication
audio frequency is proportional to measured count rate
Speaker, dia. 28 mm + Built-in Microphone

Control
Illuminated Navigation Joystick, 5 positions

Data Storage and Transfer
32 GB memory for spectra, search profiles and dose, min. 8000 Samples with full Spectra, Data Position and Voice Message
USB-C, direct and Ethernet mode, Bluetooth® 1.2 Class 2 and Wi-Fi

GPS Support
Internal - GNSS engine for GPS/QZSS, GLONASS, 56-channels
NMEA 0183
External GPS connectable

Power
Rechargeable Li-ion 7.2 V / 6600 mAh (Panasonic CGR18650CG/2S3P) – min. 8 hours of operation at 20ºC in replaceable battery pack.
Battery pack individually chareable.
External AC adapter USB-C 60W for charging or measurement

Environmental
IP-65 Dust and Water resistant
Operating temperature range -10°C to +50°C
RFI/EMF Shielding complies with FCC(47 CFR part 15) for
Class A CE Certification

Size and weight
Size L x W x H 29 cm x 10 cm x 16 cm
Weight 2,45 kg (GT-30MkII)

Standard accessories:
Carrying Durable Suitcase
Battery charger
GeoView Software
USB cable
User's guide
Calibration protocols

Optional accessories:
Shoulder Carrying Harness
Spare Battery Pack

11. APPENDIX C: IMPORTANT ICONS and MEANINGS



Alarm message. Check alarm list for pended alarms



Battery status.



Bluetooth® active



Warning or error message. See Status Log for details



GPS active and location fixed



GPS active and searching for satellites to get fixed



Survey recording in progress



Data are being written on Solid Disc



Unit stabilized

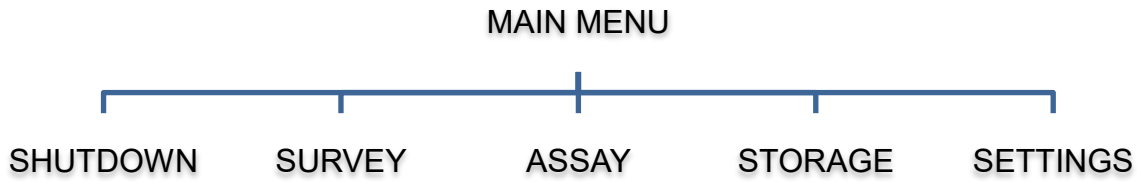


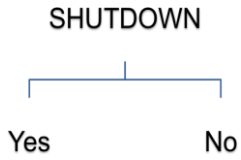
USB active

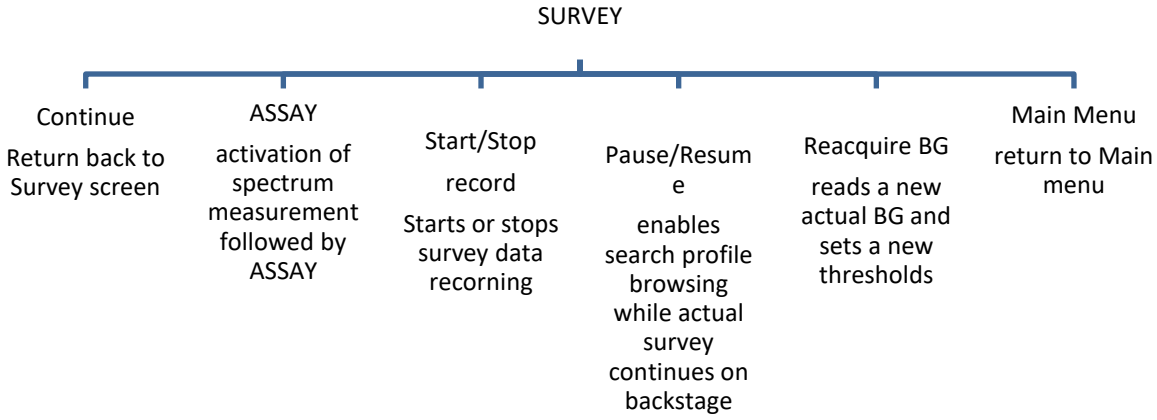


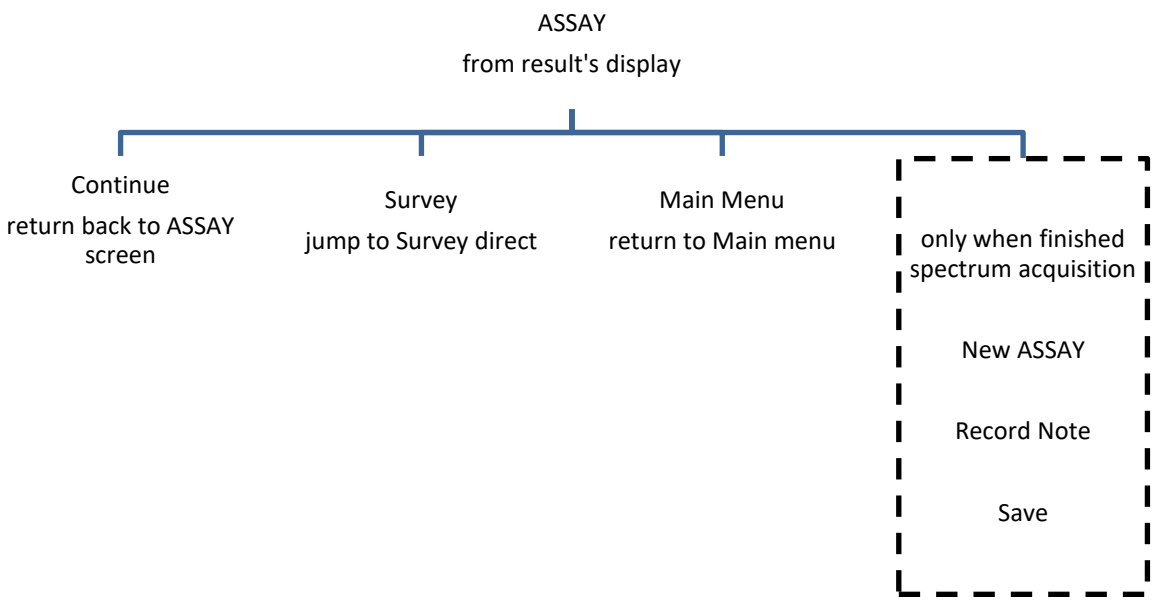
Wi-Fi active and connected

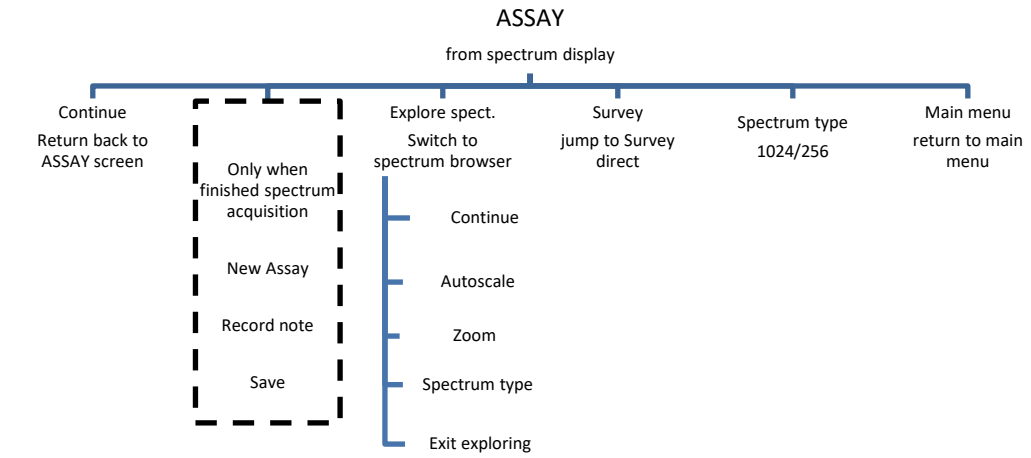
12. APPENDIX D: MAP OF ACTIONS

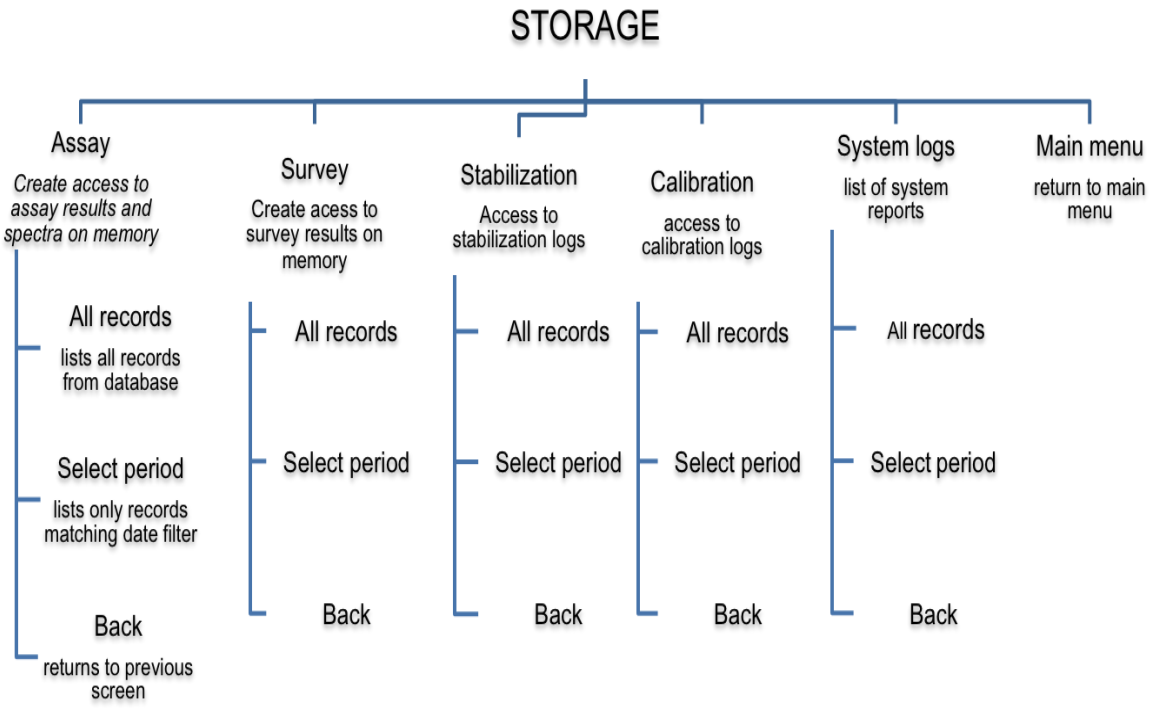


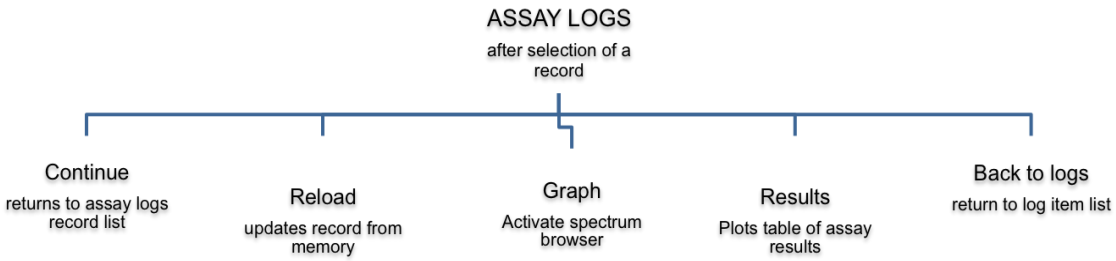


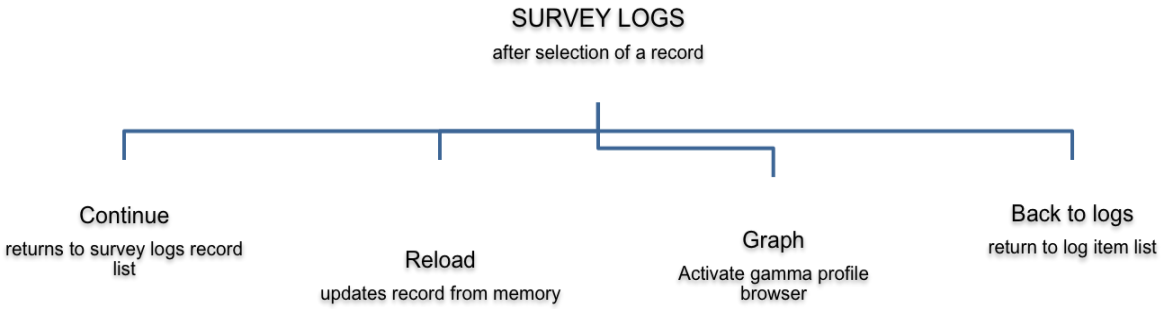


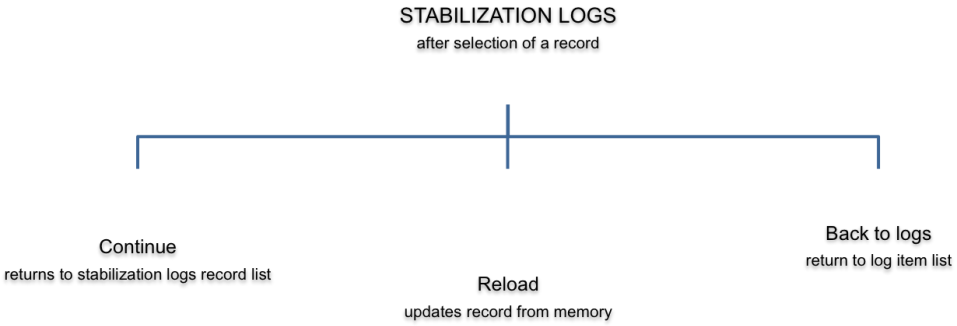

ASSAY
from result's display
Continue
return back to ASSAY screen
Survey
jump to Survey direct
Main Menu
return to Main menu
only when finished spectrum acquisition
New ASSAY
Record Note
Save

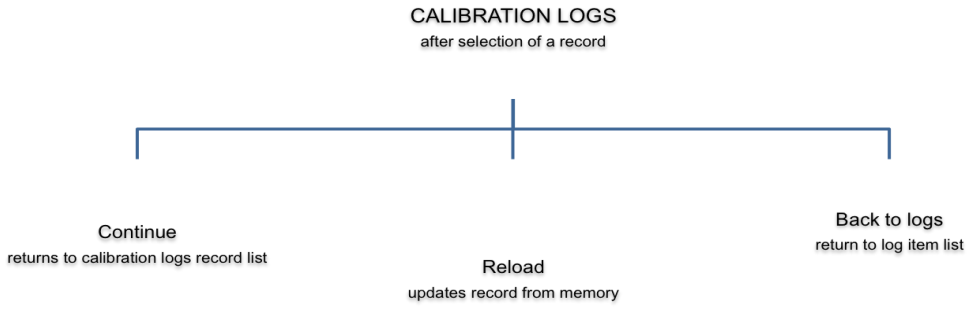

ASSAY
from spectrum display
Continue
Return back to ASSAY screen
Only when finished spectrum acquisition
New Assay
Record note
Save
Explore spect.
Switch to spectrum browser
Continue
Autoscale
Zoom
Spectrum type
Exit exploring
Survey
jump to Survey direct
Spectrum type
1024/256
Main menu
return to main menu

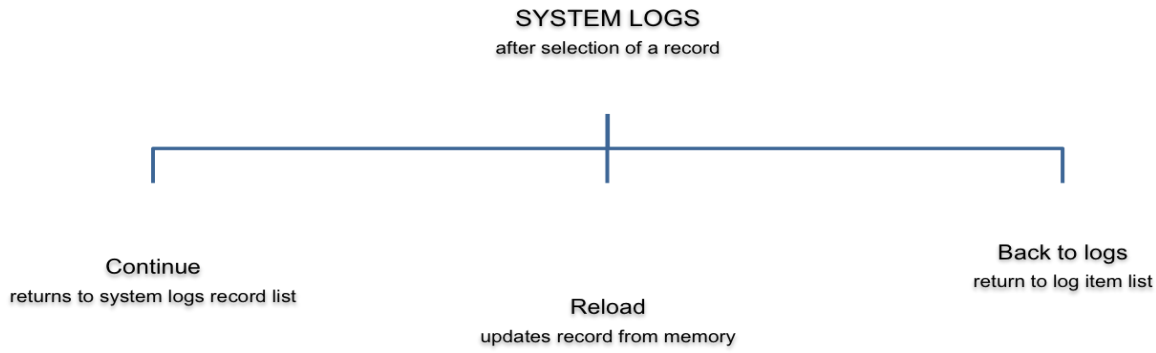

STORAGE
Assay
Create access to assay results and spectra on memory
All records
lists all records from database
Select period
lists only records matching date filter
Back
returns to previous screen
Survey
Create acess to survey results on memory
All records
Select period
Back
Stabilization
Access to stabilization logs
All records
Select period
Back
Calibration
access to calibration logs
All records
Select period
Back
System logs
list of system reports
All records
Select period
Back
Main menu
return to main menu

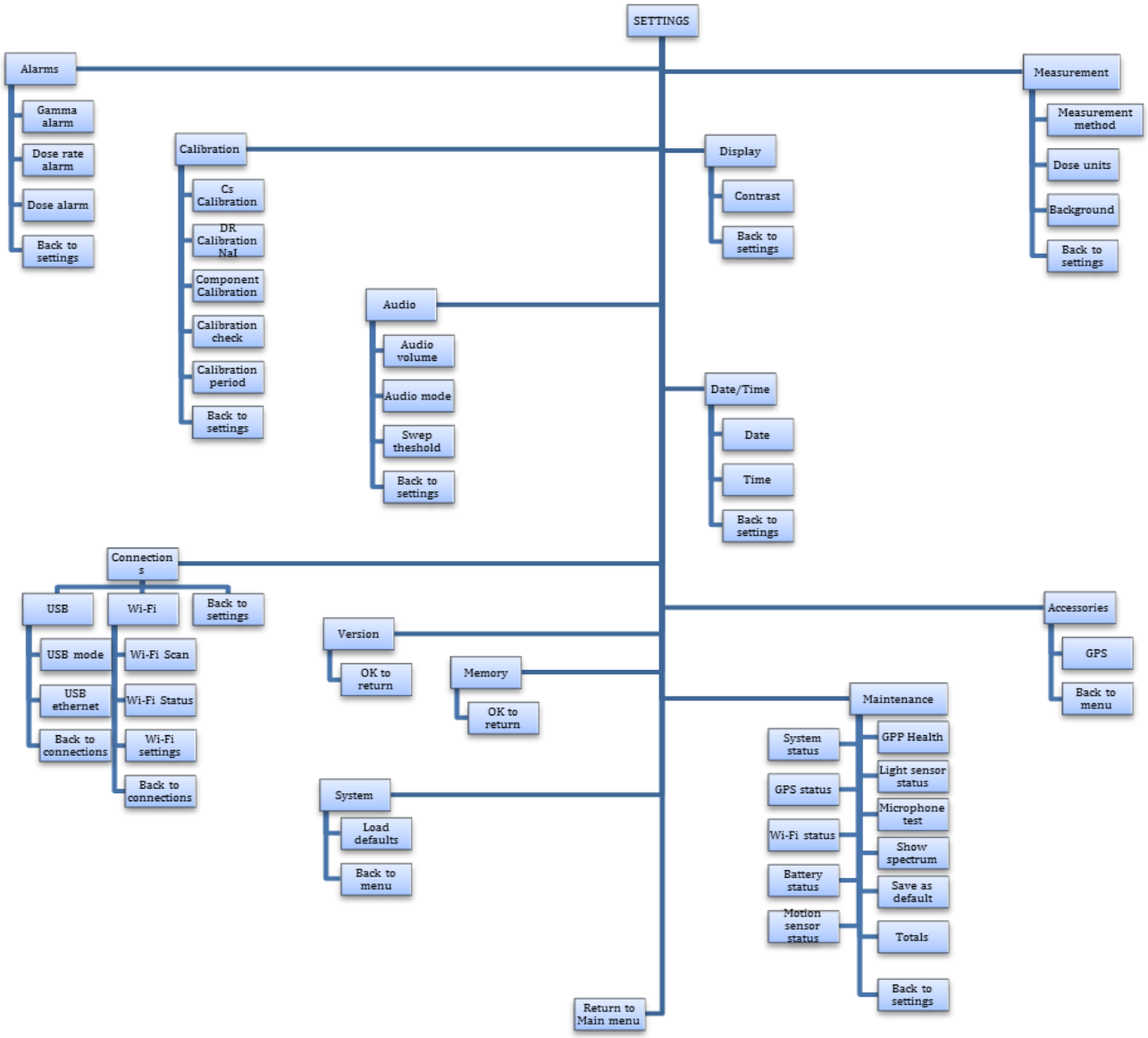

ASSAY LOGS
after selection of a record
Continue
returns to assay logs record list
Reload
updates record from memory
Graph
Activate spectrum browser
Results
Plots table of assay results
Back to logs
return to log item list


SURVEY LOGS
after selection of a record
Continue
returns to survey logs record list
Reload
updates record from memory
Graph
Activate gamma profile browser
Back to logs
return to log item list


STABILIZATION LOGS
after selection of a record
Continue
returns to stabilization logs record list
Reload
updates record from memory
Back to logs
return to log item list


CALIBRATION LOGS
after selection of a record
Continue
returns to calibration logs record list
Reload
updates record from memory
Back to logs
return to log item list


SYSTEM LOGS
after selection of a record
Continue
returns to system logs record list
Reload
updates record from memory
Back to logs
return to log item list


SETTINGS
Alarms
Gamma alarm
Dose rate alarm
Dose alarm
Back to settings
Calibration
Cs Calibration
DR Calibration NaI
Component Calibration
Calibration check
Calibration period
Back to settings
Audio
Audio volume
Audio mode
Swep theshold
Back to settings
Connections
USB
USB mode
USB ethernet
Back to connections
Wi-Fi
Wi-Fi Scan
Wi-Fi Status
Wi-Fi settings
Back to connections
Back to settings
Version
OK to return
Memory
OK to return
System
Load defaults
Back to menu
Return to Main menu
Display
Contrast
Back to settings
Date/Time
Date
Time
Back to settings
Measurement
Measurement method
Dose units
Background
Back to settings
Accessories
GPS
Back to menu
Maintenance
System status
GPS status
Wi-Fi status
Battery status
Motion sensor status
GPP Health
Light sensor status
Microphone test
Show spectrum
Save as default
Totals
Back to settings

13. NOTES and WARNINGS

The GT-30 Mk II/GT-32 Mk II is a delicate instrument and contains components (Crystal, Photomultiplier) very shock sensitive. **The detector assembly is not covered under warranty.**

Warranty:

Manufacturer warrants to the original purchaser of Equipment that for the Warranty period, the Equipment will be free from material defects in material and workmanship.

a) The “Warranty Period” begins on the date the Equipment is delivered and continues for 24 months.
b) Any repairs under this warranty must be conducted by an authorized Company service representative.
c) Excluded from the warranty are problems due to accidents, misuse, misapplication, storage damage, negligence, or modification to the Equipment or its components.

WARNING: Li-ion battery

Lithium-ion cells and battery packs may get hot, explode or ignite and cause serious injury if exposed to abuse conditions. Be sure to follow the safety warnings listed below:

- Do not connect the positive terminal and negative terminal of the battery to each other with any metal object (such as wire).
- Do not carry or store battery together with necklaces, hairpins or other metal objects.
- Do not pierce the battery with nails, strike the battery with a hammer, step on the battery or otherwise subject it to strong impacts or shocks.
- Do not expose battery to water or salt water, or allow the battery to get wet.
- Do not place the battery in or near fire or other high temperature locations.
- Do not place the battery in direct sunlight, or use or store the battery inside cars in hot weather.
- Do not disassemble or modify the battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode or ignite.

This is a Wi-Fi® enabled device subject to restrictions of use in some member states of the European Community.

Certificate of Origin

This is to certify that GEORADIS s.r.o., Novomoravanska 41 is only manufacturer of Radiation Detectors series GT-30 Mk II/GT-32 Mk II. All instruments are designed, manufactured and assembled in Czech Republic.

Manufacturer:

GEORADIS s.r.o.
Novomoravanska 41
619 00 Brno
Phone: +420 541 422 231
e-mail: info@georadis.com