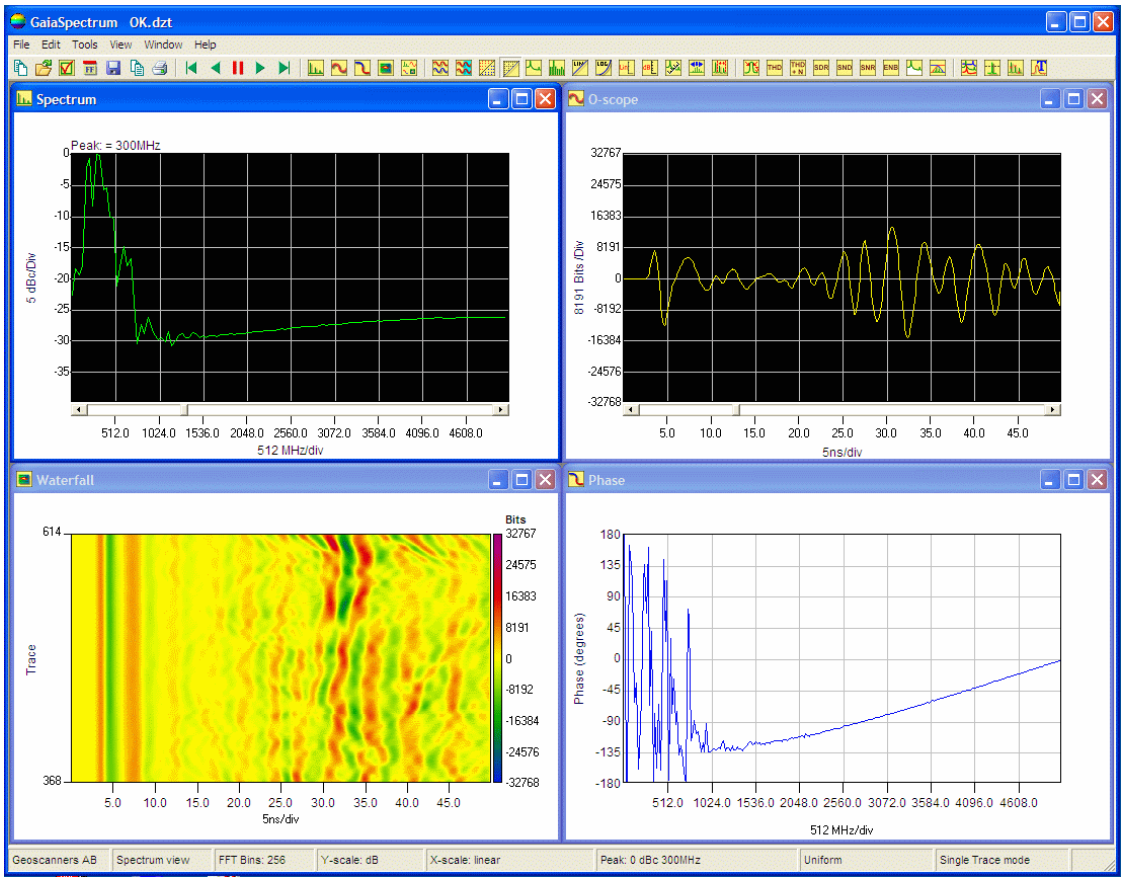
GaiaSpectrum®

User guide



Contents

GaiaSpectrum®

Overview

Many manufacturers, one tool for analyzing the data.
GaiaSpectrum® is a compact yet powerful set of tools for analyzing and comparing geophysical data collected from different instruments from the same or different manufacturers. It is designed to import all major GPR(Ground Penetrating Radar) file formats, geophysical data formats such as SEG-Y, SEG-2 and a wide variety of laboratory instruments. The data can be viewed in four different ways and there are several tools for automatic and semi-automatic analysis of the data sets.

Data integrity is a paramount.

The source data is imported into the software without making any modifications to the original file. The analysis results can be them stored as reference files or GaiaSpectrum® native files for further comparison with other data files. It is possible to export ground penetrating radar data files into a DZT compatible format for further viewing it in applications supporting DZT files.

Efficient and time saving viewing of the analyzed data.

GaiaSpectrum® has full support for viewing multiple traces without compression and playing them in a continuous manner. One can pause, play forward or in reverse the imported file without any restrictions of file size or type.

Installation

GaiaSpectrum® can be installed from the distribution CD or from the archive downloaded from the Internet. The installation procedure will create all the required short-cuts and setup necessary for the software to properly function.

GaiaSpectrum® has been tested in: Windows 98 SE, Windows ME, Windows 2000, Windows XP and Windows Vista Pro.

Minimum system requirements:

- Intel Pentium processor 200 MHz CPU clock, recommended 800 MHz or higher.
- 64 megabytes (MB) of RAM, recommended 512 MB or higher.
- 10 MB free disk space plus space enough to import the file.
- 256-color video display adapter.
- Screen area: 800x600, recommended 1024x768.

Follow these instructions to properly setup GaiaSpectrum® on your PC.

1. Extract the installation package from the archive. Use WinZip or any other ZIP software.

2. Run GaiaSpectra.msi and follow the instructions.

3. Run GaiaSpectrum® from the Start Panel or the shortcut placed on the desktop.

A window will open asking for the license details, follow the instructions for registering GaiaSpectrum®.

Check Geoscanners AB web site regularly for new versions or updates.

Support

Geoscanners AB provides 12 months free e-mail and telephone support for problems related to the operation of the software. The e-mail support can be obtained sending a request to support@geoscanners.com and the telephone support can be reached at +46 921 530 20 from 9.00 a.m. to 1.00 p.m. CET (Central European Time).

Problems importing files must include the file or a link to where it can be obtained. For registered users we can add new file formats as long as three or more sample files can be provided together with a working format documentation.

Geoscanners AB accepts additional requests for new tools or functionality not available at the present version. If the request is of a general matter or can be used by many different users then it will be provided at no cost. On the other hand if the request is of a very particular matter and narrow use then additional fees may apply.

Getting Started

GaiaSpectrum® is a very user-friendly software, there are multiple ways of achieving the same result. Despite of the simplicity of GaiaSpectrum® it is advised to read carefully through the basic steps for using the software. If any a question arise this help is your first stop for finding answer to your questions. If the question is not answered in the present help file send a support request to support@geoscanners.com.

File Import

GaiaSpectrum® works with temporary copies of the original files. The reason is that different manufacturers have very different ways of storing data files and we needed a common platform for all of them. Another important issue was to prevent corruption of the original files, which in many cases cannot be retrieved without substantial investments of time and money.
Importing a file into GaiaSpectrum® is as easy as opening a file in any application for Microsoft Windows®.The equipment manufacturer usually provides fixed values for the most important file parameters. GaiaSpectrum® recognizes all the required parameters on the supported files formats and sets up the options accordingly. After the import is completed the spectrum view opens showing the spectrum of the imported file.

Supported file formats:

· CSV Comma separated values format according to CSV format.

· DAT ASCII data (MATHCAD® or MATLAB®) file with inputs parameters specified in the options menu or dat header file.

· DT (S&S) Ground penetrating radar from Sensors & Software Inc., Canada.

· DZT Ground penetrating radar from Geophysical Survey Systems Inc., USA.

· RD3 Ground penetrating radar from Malå Geoscience AB, Sweden.

· SEG-Y Geophysical data exchange format rev 1, 2002.

· SEG-Y (Radsys) Ground penetrating radar from Radar Systems Inc., Latvia.

· SEG-2 Seismic/radar data file based on special report from SEGEGGC.

· SEG-2 (SPRScan) Ground penetrating radar from ERA Ltd, UK.

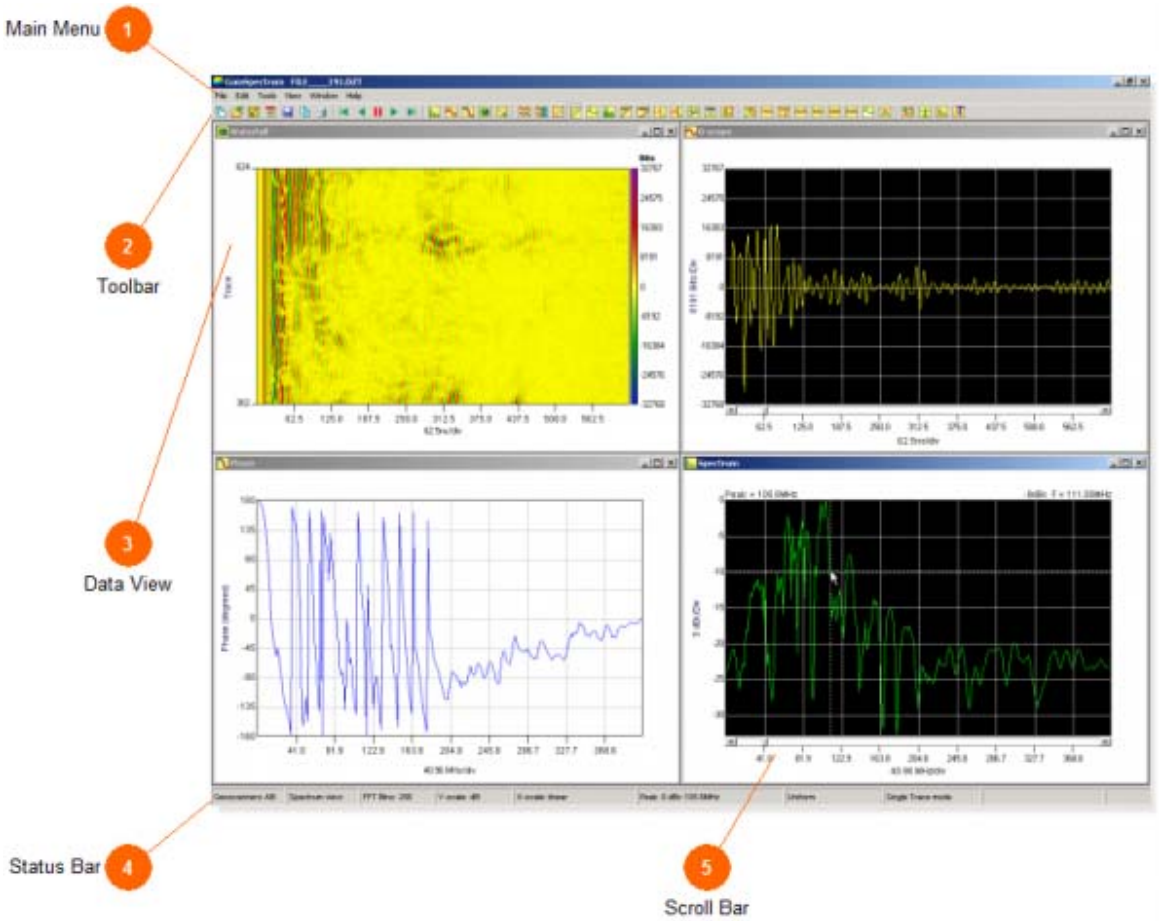
· SHT wavestar® Oscilloscope data files from Tektronix Inc., USA.

· WAV Microsoft and IBM audio file data format.

· ZON Ground penetrating radar from IDS GeoRadar Division, Italy.

The parameters for the file such as amount of samples per trace, sampling rate etcetera can be changed later on.

Main Window



The main window of GaiaSpectrum® has the main menu, the toolbar, the data view or views and the status bar.The spectrum and o-scope data views have both a scroll bar that allows for moving the data back or forward in order to find troublesome areas.

The main menu has all the major functions and displays the short cuts for fast access of the major functions via the keyboard.

2 Toolbar

This is the main toolbar. It is divided into sections that group a set of functions with similar properties.

The first section contains icons for all the operations related to files: import, options, print and file info.

The items in the second section are also always present, and are icons for controlling the playback and position within the imported file: skip to start, rewind, pause, forward and skip to end.

The items of the third section are always present as well and are icons for selecting the displayed data views: spectrum, o-scope, phase and waterfall. Upon importing the file the spectrum data view opens but it can be closed while any other window is open. The way GaiaSpectrum® opens is controlled via the options menu and can be customized to fit your needs.

The amount and type of items in the fourth section depend on the active data view and will be updated accordingly when switching between data views. These icons are the display options for each data view.

The fifth section may or may be not present at all depending on the active data view. These icons are the available utilities for the active data view.

The last section are the icons for the editing tools and again are depending on the active data view.

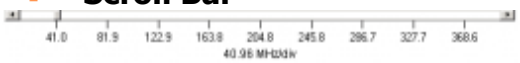
3 Data View

The Data View is one of the five different representations of the imported file, that can be viewed and analyzed with GaiaSpectrum®. Since there are only four available views at the time the waterfall view is shared between time-domain waterfall and frequency-domain waterfall. The type of waterfall view is controlled in the options menu.

4 Status Bar

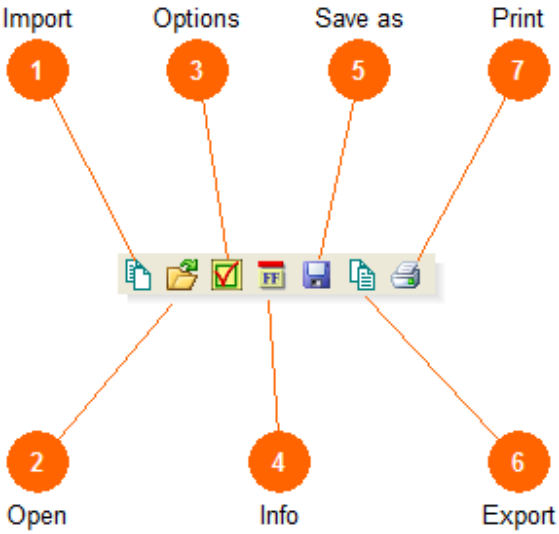
The status bar contains basic information on the loaded file and the active data view. The scales and main parameters are shown here for an easy and quick access.

5 Scroll Bar



The scroll bar allows for displaying continuously the data one trace at the time. This is very useful for finding specific areas within the data that are difficult to spot with the playback function.

File Toolbar



This is the main toolbar for handling files in GaiaSpectrum®. From this toolbar it is possible to do all the available file operations in a simple and intuitive way.

1 Import

This button invokes the familiar Windows® dialog box for windows explorer.Select the required file type from the drop down menu, locate the file to be imported and select it. Press the "open" button to import the file into GaiaSpectrum®.

2 Open

This button invokes the familiar Windows® dialog box for windows explorer. In this case only files previously exported as GaiaSpectrum® files (.gsp) are going to be available. Select the required file from a location in your PC or in the network and press open.

Options

This button opens the general options dialogue box . From there you can select settings for parameters such as default file type, amount of samples per trace etc.

Info

This button calls the file info window that display all the major parameters of the already imported file.

Save as

This button invokes the familiar Windows® dialog box for saving files. In this particular case the active data view can be saved as a bmp or a jpg image file.

Export

This button invokes the familiar Windows® dialog box for saving files. Here you can export the data currently in use as a GaiaSpectrum® or as a GSSI Inc. compatible data file with the extension DZT.

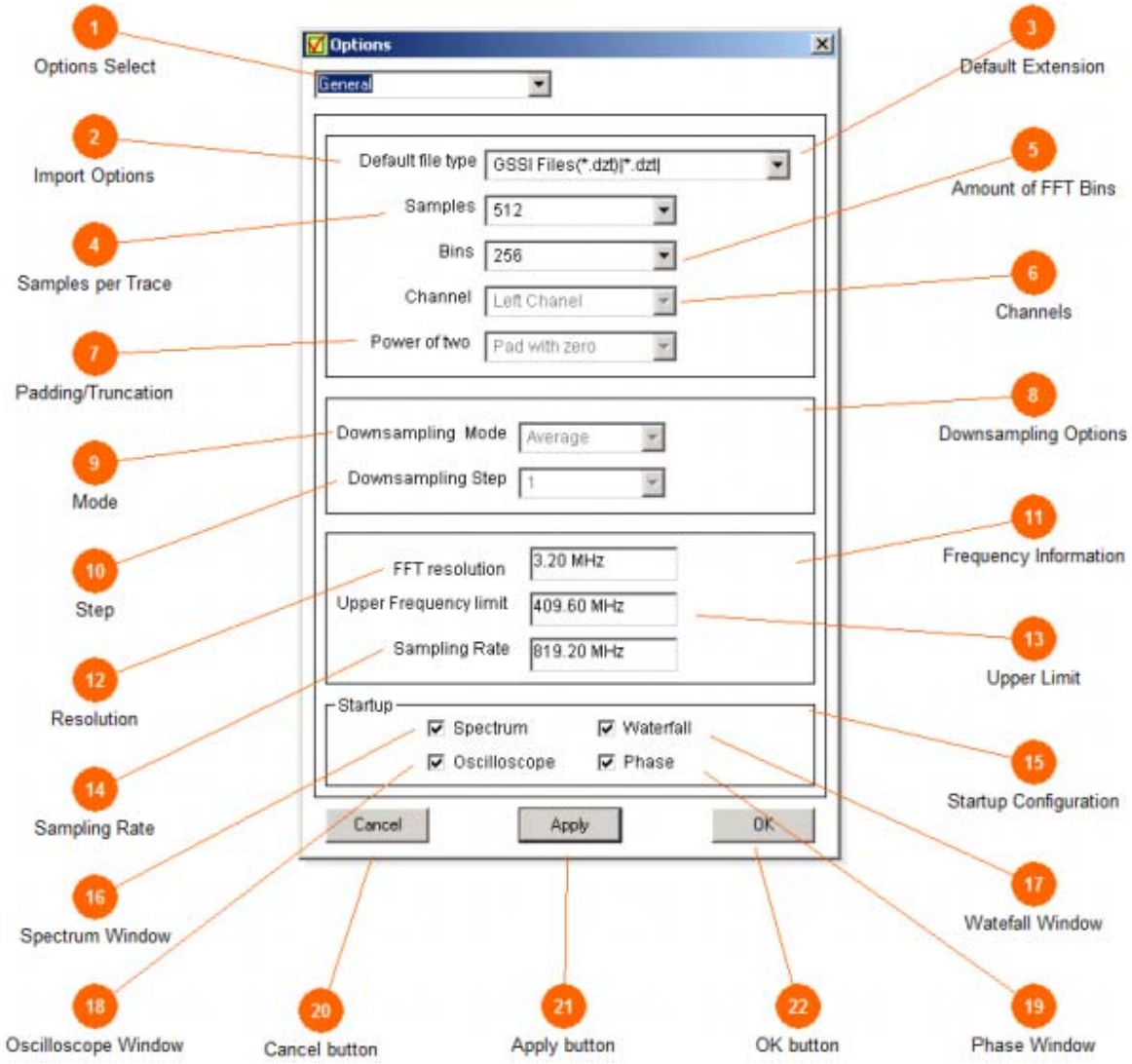
Exporting the data into a GSP file is useful for faster loading times when you work repeatedly with the same file. Opening a GaiaSpectrum® file is done directly without having to import the data.

Exporting the data into a GSSI Inc. compatible data file with the extension DZT is useful for viewing the data in software applications that accept GSSI Inc. files but have no support for the kind of data file you need. In some way it is possible to say that this feature works as a data file converter, however be aware that the resulting file is only compatible with readers of GSSI Inc data files but it is not a full formatted GSSI Inc. file.

Print

This button invokes the print dialogue box.

Options



The options menu allows you to control how the imported file are processed and accessed.

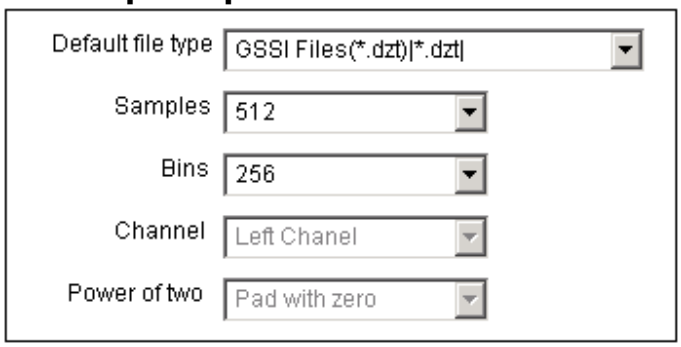
It also controls how the different data views look and process the data.

The options menu can be accessed from the main menu, the toolbar or using the keyboard short-cut F2.

1 Options Select

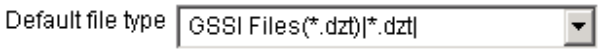
Select from the drop down menu the kind of options you want to set. The options set in this menu are the default ones when the files are imported.

2 Import Options



In this section it is possible to select the major parameters regulating the import of the data file.

3 Default Extension



The default file type is the default format extension in the import file dialogue menu. Any of the supported files can be set as the default. In this way the most frequent file format can be selected to avoid searching through the formats list.

4 Samples per Trace

The amount of samples in one trace is selected automatically from the information contained within the file, if there is such. However, after the import has been completed the amount of samples in one trace can be selected to be different of what it was specified

in the file info or header. The amount of samples has to be a power of two. It is worth noting that the selected amount of samples per traces directly affects the amount of frequency bins in the spectrum view and vice versa.

5 Amount of FFT Bins

The amount of frequency bins in one spectrum view is selected by GaiaSpectrum® while importing the data file. This value can be changed after the import has been successfully completed. The amount of frequency bins is always a power of two and it directly affects the amount of samples per traces displayed in the O-scope view. The opposite is also true.

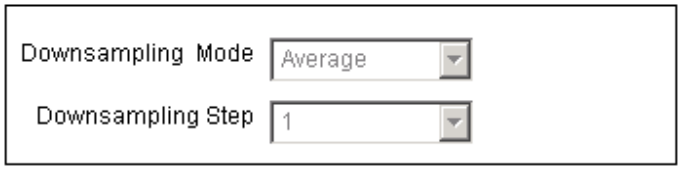
6 Channels

GaiaSpectra® supports only one data channel but there is a possibility to choose from left or right channels when importing audio files in WAV format.

7 Padding/Truncation

The amount of samples per trace accepted by GaiaSpectra® is always a power of two. This was done in order to use fast transform engines and avoid direct transform that are slow and heavy for large data files such as geophysical files. This leads to the need for adjusting the data accordingly to the closest power of two.
That can be done in two different ways: by padding the data with zeroes to the upper closest power of two or by truncating the data to the lower power of two. By default padding with zeroes is selected but it is not always the best way. Let's say the original file contains 278 samples per trace, then the logical way would be to truncate the data to 256 samples per trace. Exceptions of this may occur when applying windows to the data.

8 Downsampling Options

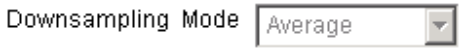


Down-sampling is use to artificially lower the sampling rate of the imported data. It is useful for obtaining greater frequency resolutions at lower frequencies than the original input data.
There are two ways of down-sampling the data: decimate and average. In the decimate mode data values are thrown away according to the down-sampling step. If for instance we set the down-sampling step equal to two then every second data value is discarded. In the average mode data values are average according to the down-sampling step. That is, if we set the down-sampling step equal to two then two samples are averaged and the result is taken as one data value. Neither mode corrupts or changes in any way the original file.

If low-pass filtering effect is desired then select average mode, otherwise select decimate mode.

It is important to note that down-sampling step equal to one does nothing to the imported data. Further more that is the default value when importing the file, if down-sampling is then needed the down-sampling step should be adjusted to fit the requirements.

9 Mode

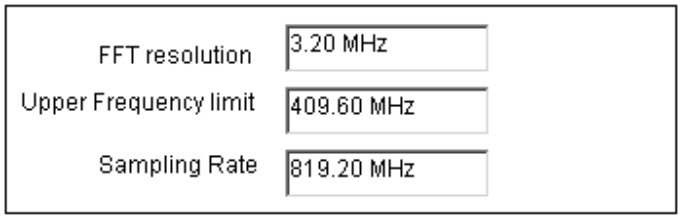


Select from the drop-down menu the preferred type of down-sampling mode from the two available.

10 Step

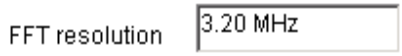
Selects the step for the selected down sampling mode. Down sampling mode step one means no down sampling at all is performed.

Frequency Information



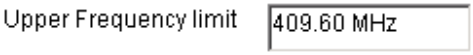
The boxes “FFT resolution”, “Upper Frequency Limit” and “Sampling rate” are informative only and do not accept changes. The FFT resolution shows the distance between two spectral lines in the spectrum view. The upper frequency limit is the product of the FFT resolution by the amount of frequency bins in the spectrum. The sampling rate is the frequency of acquisition of the data; this can be real or down-sampled.

Resolution



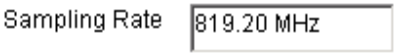
This is an informative box showing the FFT resolution in Hertz.

Upper Limit



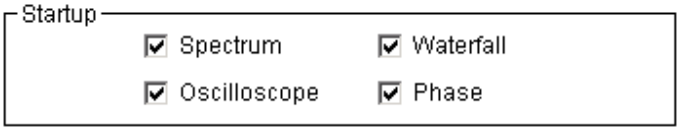
This is an informative box showing the available maximum frequency component from the imported file.

Sampling Rate



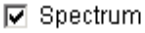
This is an informative box showing the sampling rate in Hertz. Please note that this sampling rate is read from the file.

15 Startup Configuration



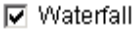
Use the check boxes in this section to select the data view windows you would like to open every time the application is launched.

16 Spectrum Window



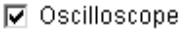
Set this check box to open the spectrum window every time the software starts. This is the default settings for GaiaSpectrum®

17 Watefall Window



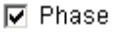
Set this check box to open the waterfall window every time the software starts. Please note that the selected type of waterfall window will be loaded, if other type of waterfall window is desired then change that setting in the spectrum options section.

18 Oscilloscope Window



Set this check box to open the oscilloscope window every time the software starts.

19 Phase Window



Set this check box to open the phase window every time the software starts.

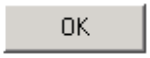
20 Cancel button

Close the Options window without applying any changes.

Apply button

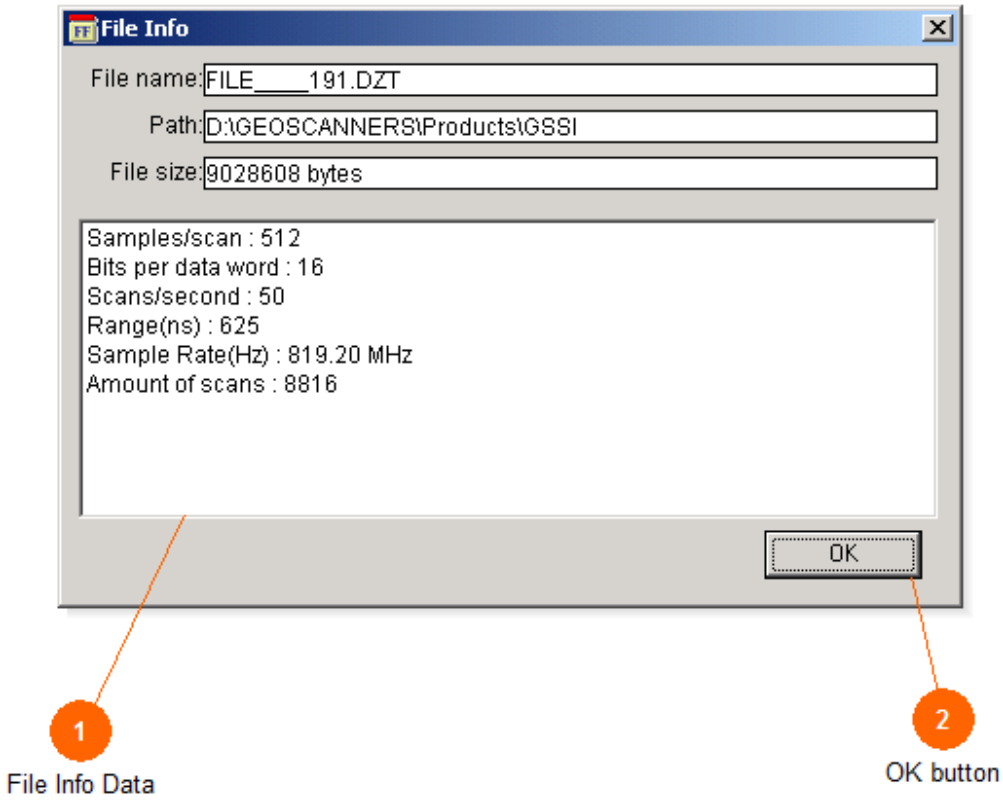
Apply the changes without closing the Options window.

OK button

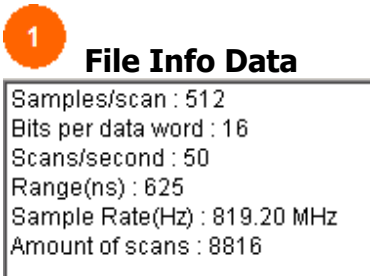


Apply the changes and close the Options window.

File Info



The file info window displays concise information about the imported file. Please note that different manufacturers use the same words but have different meanings. In general we tried to comply with the manufacturer's way of specifying the terms but be aware that some words may differ.
The file info window can be accessed from the main menu, from the toolbar or by pressing F2 on your keyboard.

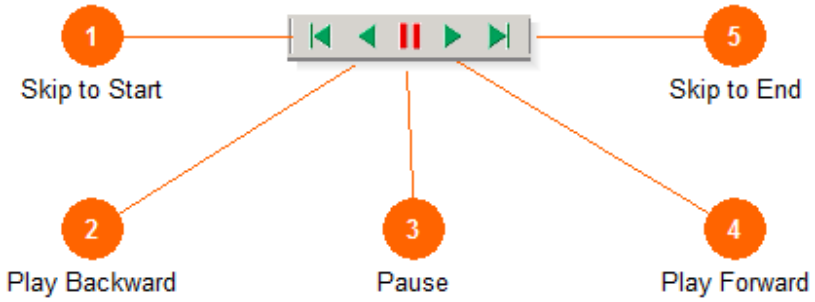


Info data gathered from the imported file.

OK button

Closes the file info.

Playback



The playback function is a unique feature of GaiaSpectrum® that allows continuous viewing and analysis of the data in an easy way. It is possible to scroll, skip to the beginning/end, play forward/backward the data at any point. This feature is very useful when looking into large files for infrequent anomalies. All data views are synchronized so moving the data forward or backward in one data view will cause all the other data views to update their contents accordingly.

1 Skip to Start

Returns to the beginning of the file.

2 Play Backward

Plays continuously the data in all data views backwards. It is worth noting that the spectrogram data view will play backwards only the data that has already been processed.

3 Pause

Pause the playback of the data while in forward or backward mode.

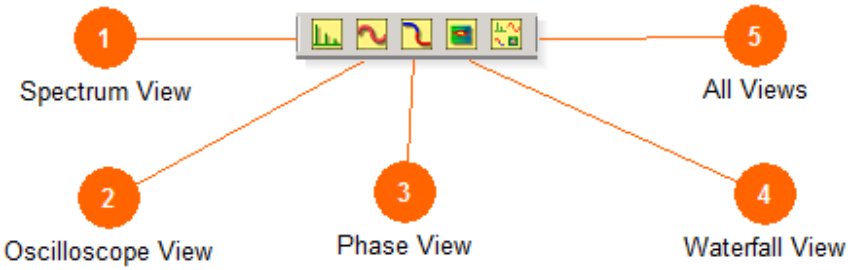
4 Play Forward

Plays continuously the data in the forward direction in all data views.

5 Skip to End

Goes to the end of the file.

Data Views



GaiaSpectrum® has 4 different ways of presenting the imported data:

· Spectrum view: Frequency domain representation of one trace.

· O-Scope view: Time domain representation of one trace.

· Phase view: Phase of the signal versus frequency.

· Spectrogram: Frequency domain representation of several traces.

Each view has a set of tools and viewing options that can be accessed while the data view is active. At least one data view must be open, otherwise the imported file is discarded and a new import must be done to continue working with the file.

1 Spectrum View

Frequency domain representation of one trace.

2 Oscilloscope View

Time domain representation of one trace.

Phase View

Phase of the signal versus frequency.

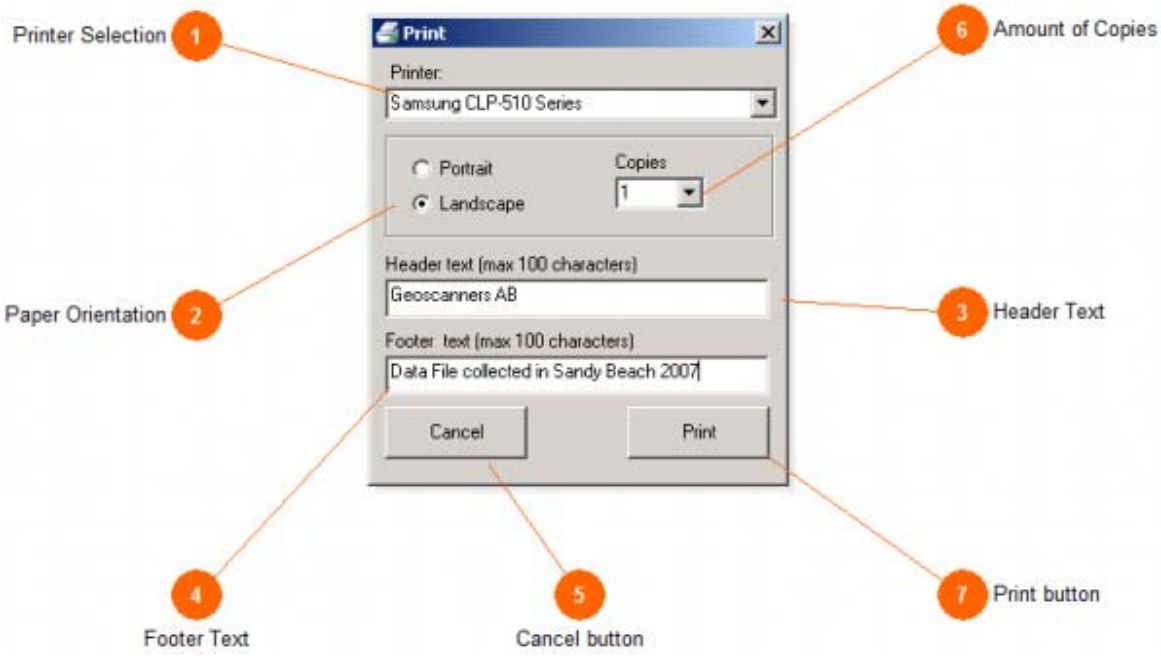
Waterfall View

Frequency or Time domain representation of several traces. The type of domain presented in the waterfall data view is depending on the one selected in the waterfall options.

All Views

By pressing this button all data views become available at once and they will be distributed equally in the available screen area for the application. Note that this button is not remembered, that is the configuration loaded at startup is the one saved in the options dialogue box.

Printing

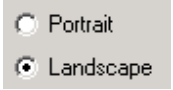


Setup the basic printing options for the active data view. When the printer dialogue box is invoked the active data view will be maximized automatically.

1 Printer Selection

Select from the drop down menu the printer for the job.

2 Paper Orientation

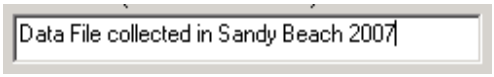


Select the paper orientation.

3 Header Text

Here you can type the header text. It should not exceed 100 characters.

4 Footer Text



Here you can type the header text. It should not exceed 100 characters.

5 Cancel button

Cancel printing job.

6 Amount of Copies

Choose the amount of copies.

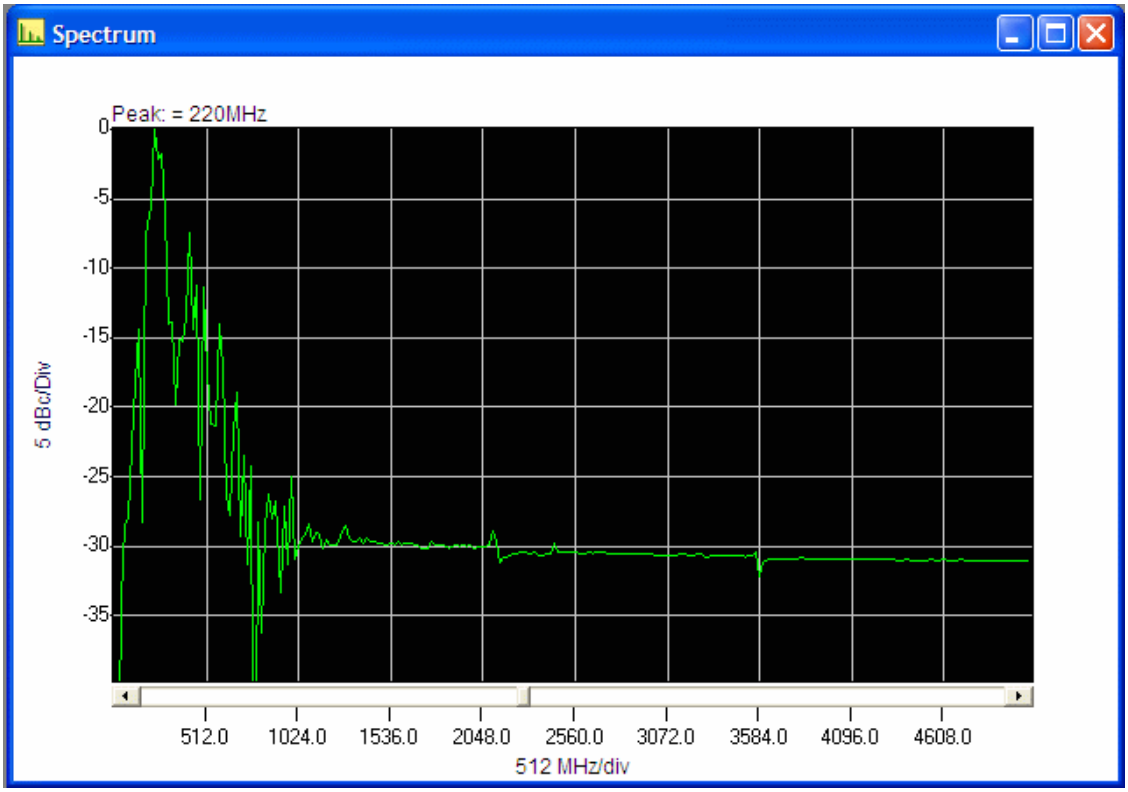
7 Print button

Send the job to the printer.

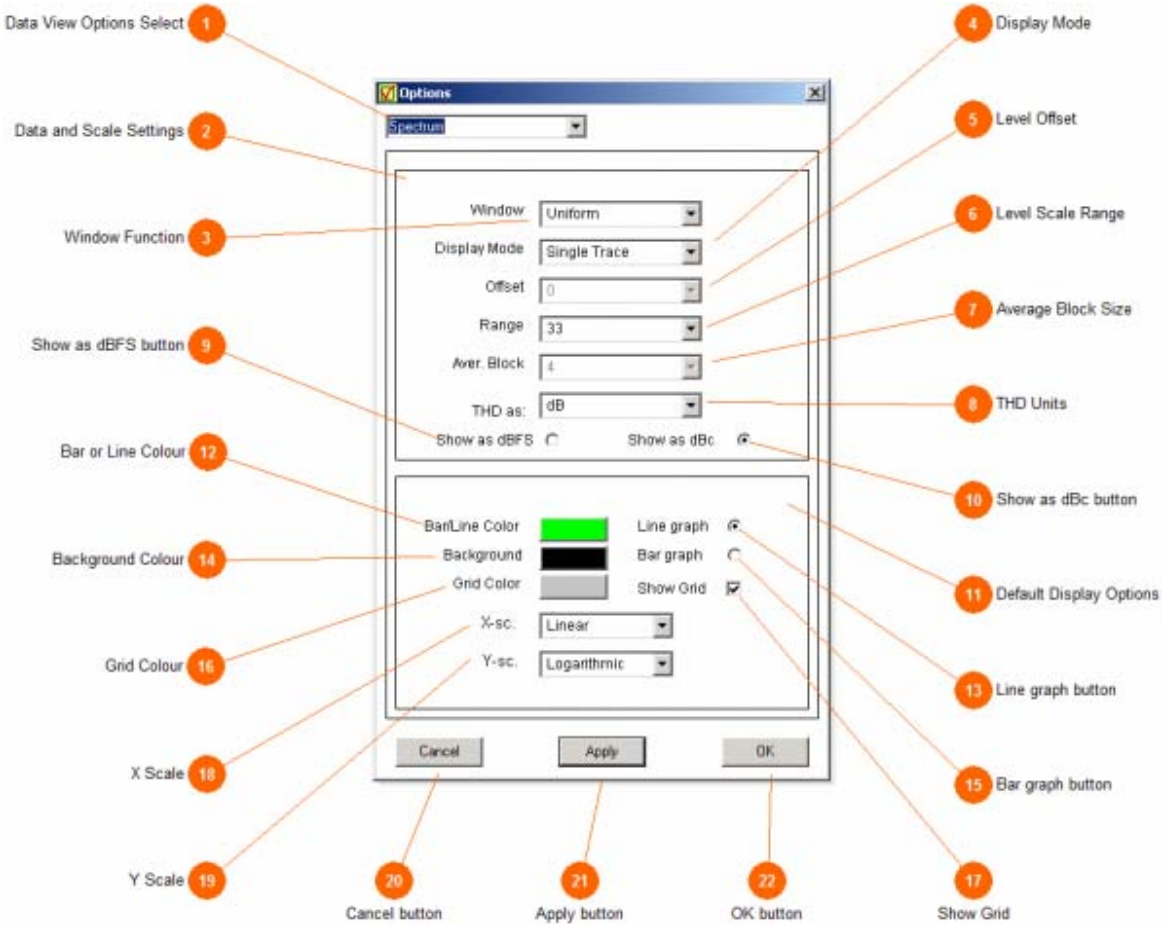
Spectrum View

The spectrum view is the main view of GaiaSpectrum® and it is a frequency domain representation of the trace or group of traces. The horizontal axis shows the frequency in Hertz and the vertical axis the magnitude corresponding to each spectral line. The total amount of available spectral lines always is half of the amount of samples in the data file. The spectrum view in GaiaSpectrum® always starts at zero Hertz but one can select a portion of the spectrum to be displayed with the aid of the span editing tool or using the auto tune function. Independently of the width of the displayed spectrum the whole spectrum is computed every time the software advances to the next trace.

It is worth noting that pressing down the left button of the mouse causes a cross hair line to appear and the corresponding frequency and magnitude values appear in the right upper corner.



Options



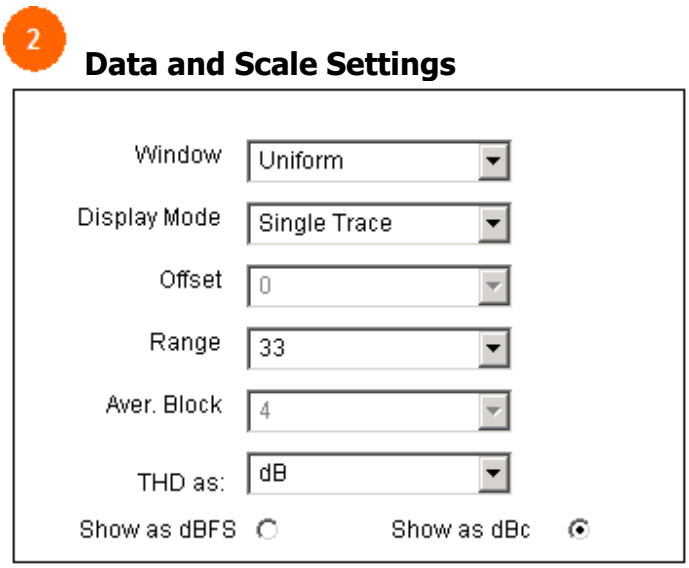
Spectrum View Options:

The spectrum view options control the way the data will be processed and presented in the Spectrum data view window. These options are very important because they have full impact in all the other data view windows and in the way the utilities work. The values selected here are the ones loaded by default every time the application imports a new file.

1 Data View Options Select

From this drop down menu it is possible to select the options that apply only to the

spectrum data view. Select Spectrum in order to access all the options related to it.



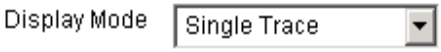
This box contains controls that affect the way the data is processed and displayed on the spectrum data view.

The drop down menu offers the possibility of selecting a window function from all the available at the moment.

Window functions are very useful in reducing spectral leakage when using the FFT for spectral analysis. However, they introduce distortion effects on their own in the way that they have an inherent coherent gain. GaiaSpectrum® does take that effect into consideration and applies the appropriate correction factors for each individual window. That allows maintaining a reasonable equality between different windows.

Each window has its own characteristic, that's why different windows should be used for different applications. As a very course rule of thumb one can try to use uniform window for broadband signals, Hann window for unknown signals and Flat top when amplitude accuracy is desired.

Display Mode



The display mode drop down menu allows to choose the way the data will be displayed or processed by the spectrum view.

It is possible to choose from:

1. Single Trace: The spectrum view displays the spectrum of a data set containing the amount of samples per trace specified in the general options menu. This is the most common type of display mode.

2. Stacked: The spectrum view displays an overlay of all the spectrums of individual data sets each containing the amount of samples specified in the general options menu. This is useful when one wants to display single occurrences that do not repeat very often in the file.

3. Peak Hold: The spectrum view displays the result of the maximum peaks of all the individual data sets in the file. Each data set contains the amount of samples specified in the general options menu. This mode is very useful for finding out bandwidth of very broad banded systems.

4. Average: The spectrum view displays the average of the amount of spectrums specified in the average block drop down menu. This mode improves the video bandwidth of the spectrum and it is therefore well suited for wide band signals.

Level Offset

In the level offset drop down menu it is possible to select or type the offset in dB of the top of the spectrum view magnitude scale. This is only active when the Show as dBFS radio button is selected. In the Show as dBc mode zero dB offset is governed by the maximum peak.

6 **Level Scale Range**

The level range drop down menu control the amount of dBs the spectrum view displays. It is possible to select from the fixed values or type your own. This is available in both modes and it is particularly useful for focusing in some part of the magnitude scale.

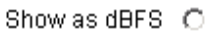
7 **Average Block Size**

The average block size specifies how many spectrums are going to be averaged while in the average display mode.

8 **THD Units**

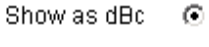
Select from the drop down menu the units for the total harmonic distortion measurement.

9 **Show as dBFS button**



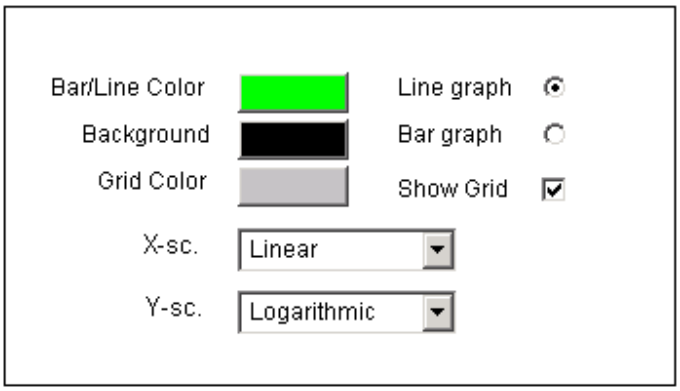
When this radio button is selected the magnitude is compare against the maximum possible value of the imported data. The dBFS means: decibel to full scale.

10 **Show as dBc button**



When this radio button is selected the magnitude is compare against the maximum value of the imported data, that is to the peak frequency. The dBc means: decibel to carrier.

11 Default Display Options

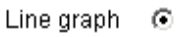


This box contains controls that affect the way the spectrum data view presents the data. The options selected here are the default ones. Any other changes done using the main menu or the icons in the toolbar will be ignored next time the application is started.

12 Bar or Line Colour

This button calls a menu for selecting the color of the bar or line of the spectrum.

13 Line graph button

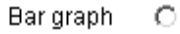


This radio button selects to present the spectrum function as a line.

14 Background Colour

This button calls a menu for selecting the color of the background of the spectrum data view.

15 **Bar graph button**



This radio button selects to present the spectrum function as a series of vertical bars.

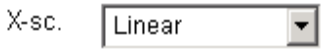
16 **Grid Colour**

This button calls a menu for selecting the color of the grid in the spectrum data view.

17 **Show Grid**

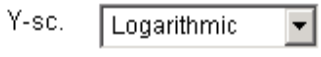
This check box allows to turn the grid on and off in the spectrum data view.

18 **X Scale**



This drop down menu makes possible to choose between linear or logarithmic frequency scale.

19 **Y Scale**



This drop down menu makes possible to choose between linear or logarithmic magnitude scale.

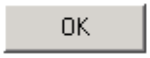
20 Cancel button

Exit the spectrum menu without making any changes.

21 Apply button

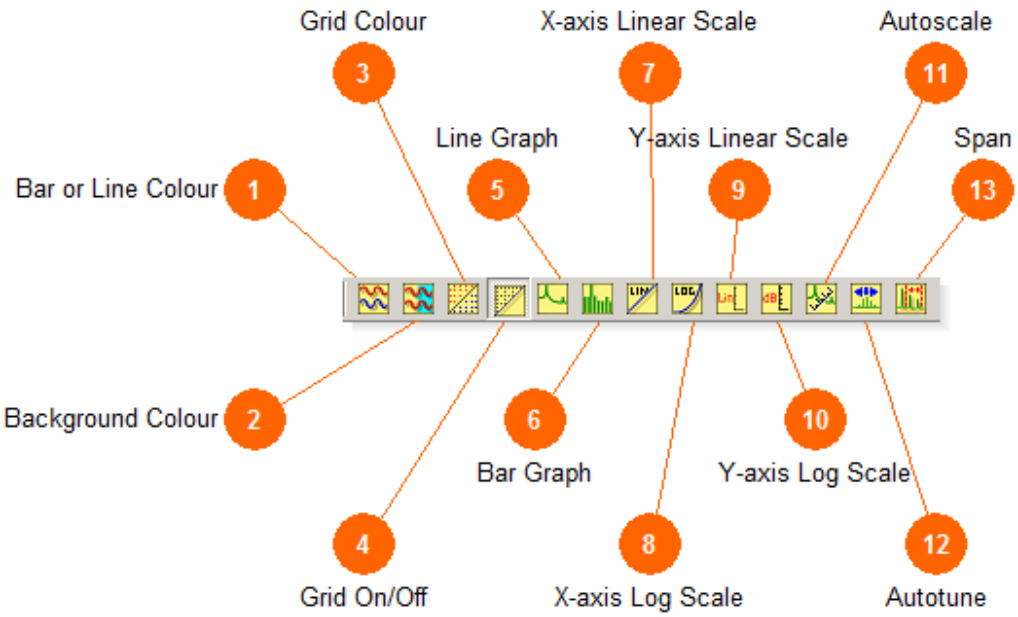
Apply the changes without closing the spectrum option menu.

22 OK button



Apply the changes and exit the spectrum option menu.

Display Options



This toolbar contains controls that affect the way the spectrum data view presents the data. The options selected here are valid only during the processing and viewing of the imported file. The default values will be restored after importing another file.

1 Bar or Line Colour

This button calls a menu for selecting the color of the bar or line of the spectrum.

2 Background Colour

This button calls a menu for selecting the color of the background of the Spectrum data view.

3 Grid Colour

This button calls a menu for selecting the color of the grid in the spectrum data view.

4 Grid On/Off

This button turns the grid on and off in the spectrum data view.

5 Line Graph

This button selects to present the spectrum function as a line.

6 Bar Graph

This button selects to present the spectrum function as a series of vertical bars.

7 X-axis Linear Scale

This button selects the frequency scale axis to be linear.

8 X-axis Log Scale

This button selects the frequency scale axis to be logarithmic.

9 Y-axis Linear Scale

This button selects the magnitude scale axis to be linear.

10 Y-axis Log Scale

This button selects the magnitude scale axis to be logarithmic.

11 Autoscale

By pressing this button the magnitude scale and the scale range will be automatically adjusted so the entire spectrum line is visible within the available area for the spectrum view.

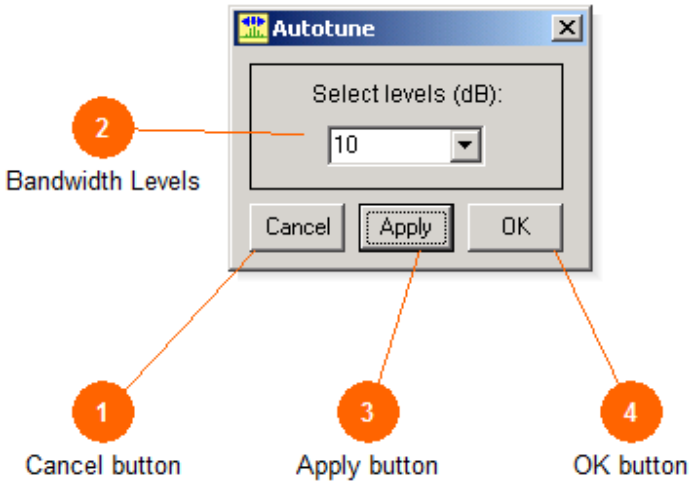
12 Autotune

This button invokes the autotune dialogue box.

Span

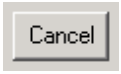
This button invokes the span setup dialogue box.

Autotune



This dialogue box allows to select the levels for the autotune function. Depending on the level selected here the spectrum view will show only those frequencies which have magnitudes higher than the selected level. This gives effectively the opportunity to observe only the frequencies within a selected bandwidth.

1 Cancel button

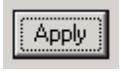


Close the Autotune window without applying any changes.

2 Bandwidth Levels

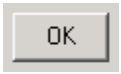
Select from the drop down menu the desired bandwidth to tune the spectrum view. There are three different levels to choose from: -3dB, -10dB and -20dB.

3 Apply button



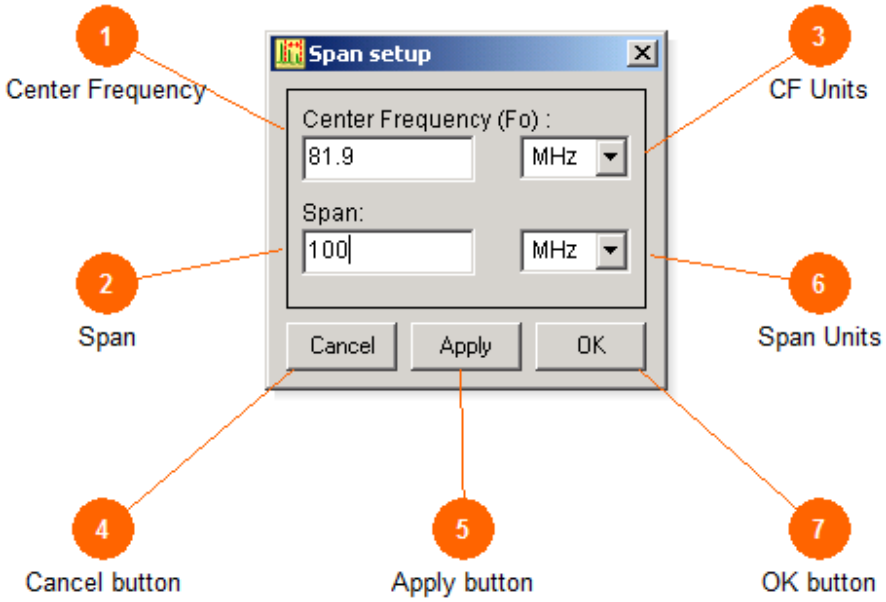
Apply the changes without closing the Autotune window

OK button



Apply the changes and close the Autotune window.

Span setup



The span setup button invokes a new window that allows for selecting a portion of the spectrum function in the spectrum data view. In such a way it is easy to observe and measure a specific portion of the spectrum in a greater detail. If the span setup button is depressed then the spectrum data view shows the entire frequency span from zero to the maximum available frequency component.
It is worth noting that the units for the center frequency and the frequency span are automatically selected depending on the imported file; however these can be changed to accommodate the needs of the user.

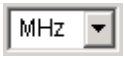
1 Center Frequency

Enter in this box the required center frequency and update the units accordingly in the center frequency units drop down menu.

2 **Span**

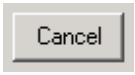
Enter in this box the required span and update the units accordingly to your needs in the span units drop down menu. Note that the span must fit in the available data area otherwise a window asking to decrease the span will appear. Another way of keeping a wider span within the available data area is to increase the center frequency.

3 **CF Units**



Select from the drop down menu the correct units for the center frequency, GaiaSpectrum® automatically recognizes the proper units. That means a file with a highest spectral line in kilo Hertz will never show mega Hertz in the center frequency units.

4 **Cancel button**

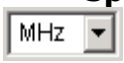


Close the Span setup window without applying any changes.

5 **Apply button**

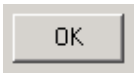
Apply the changes without closing the Span setup window

6 **Span Units**



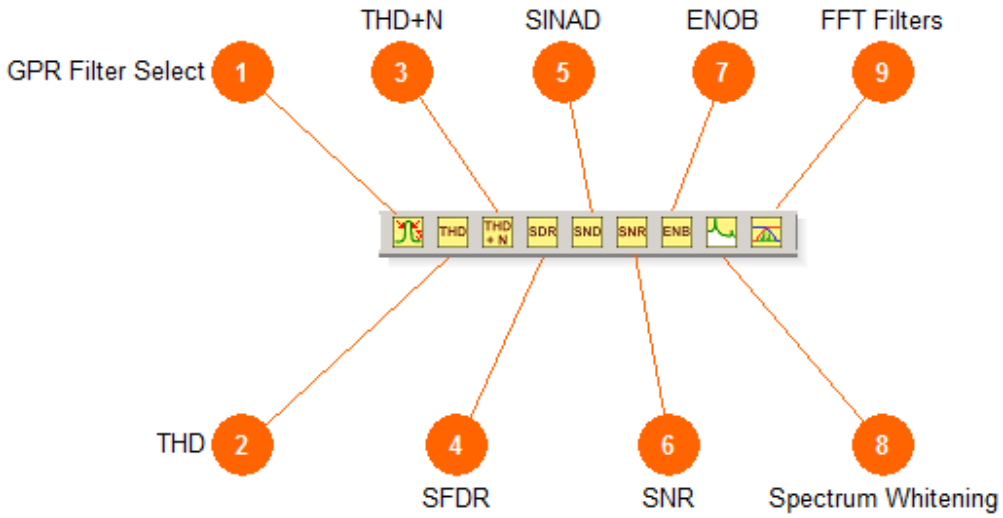
Select from the drop down menu the correct units for the center frequency. Please note that after the units for the center frequency have changed the units for the span automatically change as well. It is still possible to select some other units if desired and if the available data allows it.

7 OK button



Apply the changes and close the Span setup window.

Utilities



These are a set of automatic and semiautomatic measurement tools based upon the spectrum loaded in the spectrum data view.

1 GPR Filter Select

This utility first tries to find the -10dB bandwidth of the spectrum loaded in the spectrum data view. Then from the obtained data it makes an estimate of the higher and lower useful frequency components and displays them together with the center frequency in a new window. The suggested high pass and low pass filter values can be used while collecting the data if the hardware allows or in post processing mode. Please note that these are recommended values and in no case they should replace the common sense and experience of the professional in the field. However, in our experience they provide an excellent starting point for acquiring or processing GPR data files.
Press this button to display the GPR filter select window.

THD

Total harmonic distortion measurement is the ratio of the harmonic power to the fundamental power. This value is expressed in percentage and it takes in GaiaSpectrum® the first six harmonics if all are available.

THD+N

Total harmonic distortion plus noise measurement is the ratio of the harmonic power plus the noise power to the fundamental power. This value is expressed in percentage and it takes in GaiaSpectrum® the first six harmonics if all are available plus the noise power and excludes the DC component.

SFDR

Spurious Free Dynamic Range is the ratio between the fundamental signal and the highest spurious in the spectrum. This value is sometimes called simply dynamic range. This value is expressed in decibels.

SINAD

Signal to Noise And Distortion is the combination of the SNR and THD values and it is expressed in decibels.

SNR

Signal to noise ratio is the ratio of the fundamental signal to the noise power. The noise power includes all non-fundamental spectral components in the Nyquist frequency range without the DC component, the fundamental itself and the harmonics.

ENOB

Effective Number Of Bits shows how close the A/D converter approaches the theoretical mathematical model. The ENOB in GaiaSpectrum® is calculated from the SINAD. The units of measure for SINAD are decibels, and the units of measure for effective number of bits are bits. Be aware that effective number of bits and effective resolution are not the same thing.

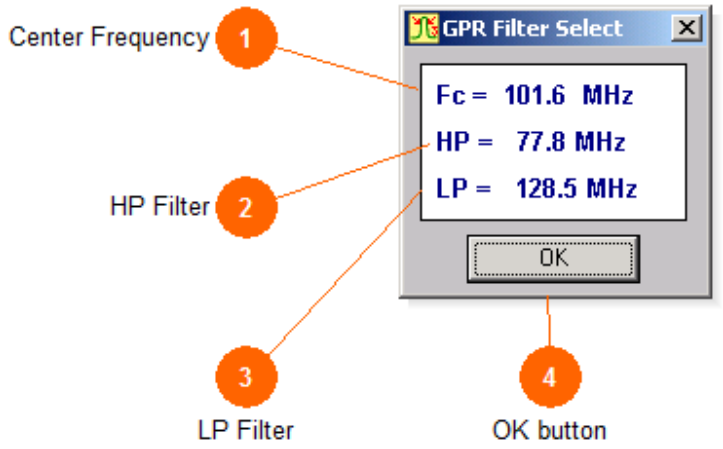
Spectrum Whitening

Spectrum whitening is a DSP tool for making all the magnitudes of the spectral lines equal within a specific bandwidth. In some situations it can be useful for obtaining higher resolution on collected time domain data. This button will call the whitening setup dialogue box.

FFT Filters

FFT filters are a very effective way of cleaning the data set at a reasonable speed. They are very steep filters and may come useful in many situations. This button invokes the setup window for them

GPR Filter Select



This window presents information on the recommended settings for the digital filters in ground penetrating radar systems.

1 Center Frequency

Fc = 101.6 MHz

Center frequency of the calculated pass-band is displayed here.

2 HP Filter

HP = 77.8 MHz

This is the recommended setting for the high pass filter cut-off frequency.

3 LP Filter

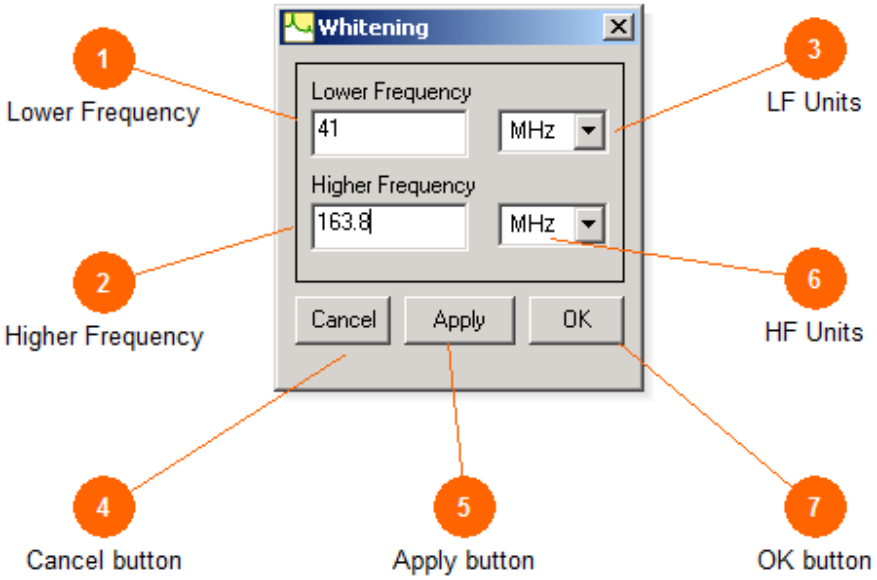
LP = 128.5 MHz

The recommended setting for the low pass filter cut-off frequency.

4 **OK button**

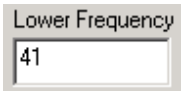
Exit this window.

Whitening



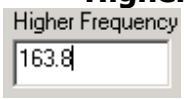
Enter in this dialogue box the values for the lower and upper frequencies of the desired pass-band to apply whitening.

1 Lower Frequency



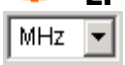
Low frequency of the pass-band to apply whitening.

2 Higher Frequency



Upper frequency of the pass-band to apply whitening.

3 LF Units

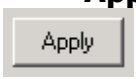


Units for the lower frequency of the pass-band.

4 Cancel button

Close the Whitening window without applying any changes.

5 Apply button

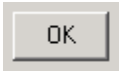


Apply the changes without closing the Whitening window

6 HF Units

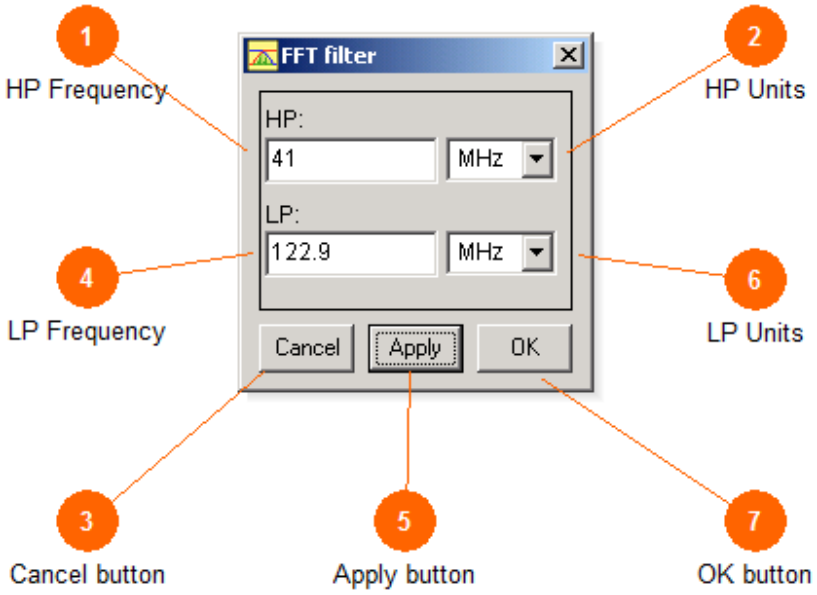
Units for the upper limit of the pass-band. Observe that this units always have to be equal or higher than the LF units.

7 OK button



Apply the changes and close the Whitening window.

FFT filter

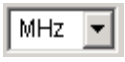


Enter in this dialogue box the low and high cut-off frequencies for the FFT filter. By combining these settings any kind of filter response can be achieved.

1 HP Frequency

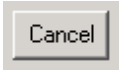
High Pass Cut-off frequency

2 HP Units



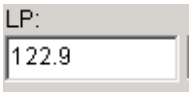
High Pass Cut-off frequency units.

3 Cancel button



Close the FFT filter window without applying any changes.

4 LP Frequency



Low Pass Cut-off frequency.

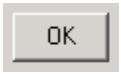
5 Apply button

Apply the changes without closing the FFT filter window

6 LP Units

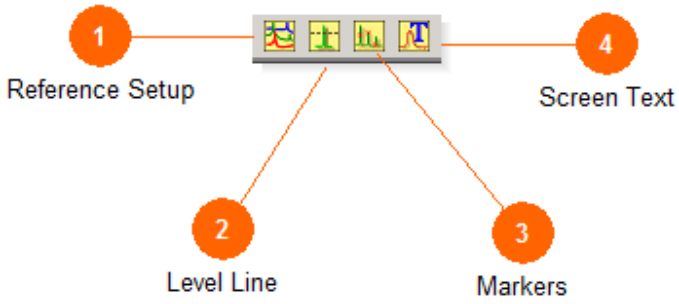
Low Pass Cut-off frequency units.

7 OK button



Apply the changes and close the FFT filter window.

Editing



The editing tools provide an easy and fast way to add level lines, text, markers and reference spectrum lines to the existing spectrum plot.

1 Reference Setup

The reference setup button invokes a new window with all the options for setting reference waveforms. This is a useful editing tool when two or three different spectrum most be compared against each other.

2 Level Line

The level line button calls a new window that asks for a level in dBs. After entering the desired value and pressing "Apply" a horizontal line appears in the spectrum data view plot indicating where the entered value lies.

3 Markers

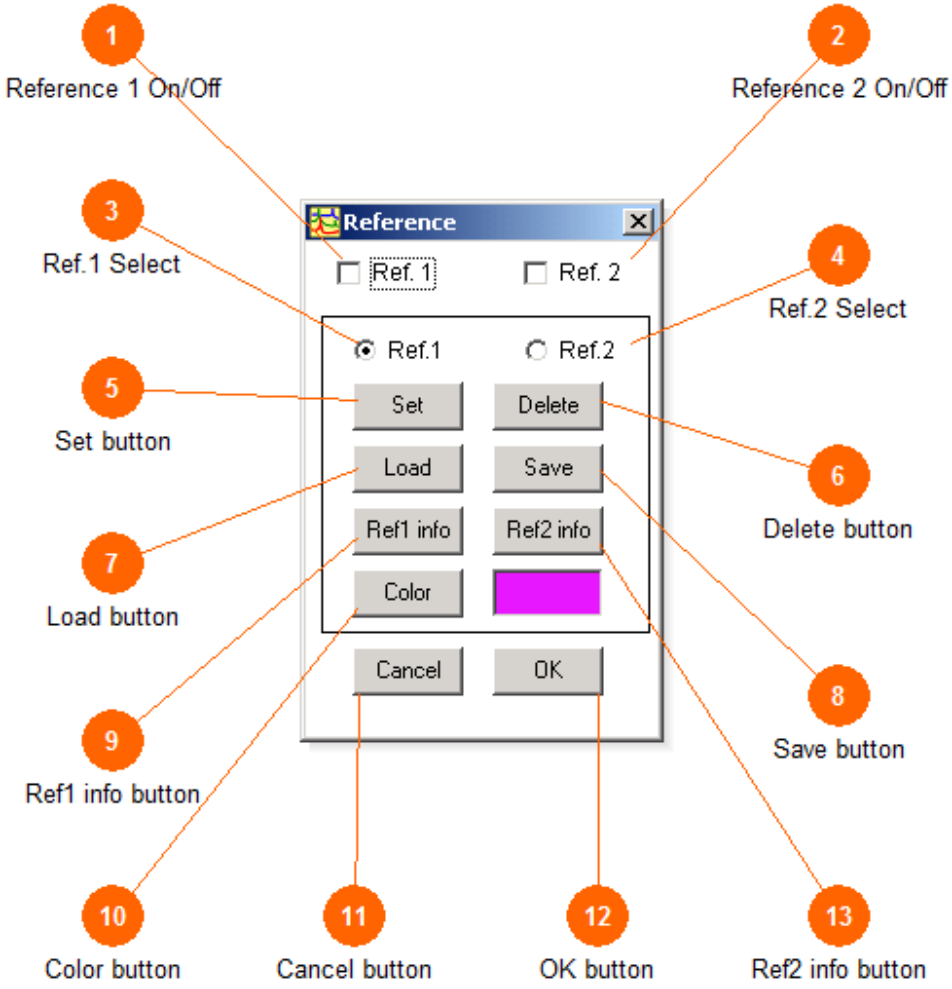
The markers button invokes a window and a cross with a number on it above the spectrum function in the spectrum data view. Move with the mouse the cross to the desired point and press the left button on the mouse to set a marker. Note that in data files

with low amount of frequency bins it can be difficult to set the marker in a specific place. That is not a bug but a result of too few points in the file. After setting a marker the number over the cross increments and you can set the next marker and so on. Every time a marker is place the frequency and magnitude appear in the markers window together with the difference in frequency between two consecutive markers. In order to exit the marker mode press the right button on the mouse and select “Exit marker button”. The markers and the markers window remain on the spectrum data view. Depress the markers button or close the markers window to clear the spectrum data view of markers.

Screen Text

The Screen text button invokes a window that allows for adding text to the spectrum data view. Up to four labels with a maximum of sixty four characters can be written in the spectrum data view. Each label can have its own color, size and font.

Reference



The reference setup button invokes a new window with all the options for setting reference spectrum lines. This is a useful editing tool when two or three different spectrum most be compared to each another.

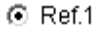
1 Reference 1 On/Off

This check box makes the reference number one visible on the spectrum data view when it is checked.

2 Reference 2 On/Off

This check box makes the reference number one visible on the spectrum data view when it is checked.

3 Ref.1 Select



This radio button selects the buttons: Set, Delete, Load, Save and Color for the reference number one.

4 Ref.2 Select

This radio button selects the buttons: Set, Delete, Load, Save and Color for the reference number two.

5 Set button

The current spectrums function is stored into the selected reference number.

6 Delete button

The contents of the selected reference number are cleared.

Load button

The selected reference number is loaded from a reference file stored anywhere in any media or network.

Save button

The contents of the spectrum data view are saved into a file with an arbitrary file name. This can be loaded later into a reference by pressing the load button.

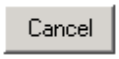
Ref1 info button

When this button is pressed a new window appears with the amount of frequency bins and the maximum frequency of the reference file stored in reference one. This is useful to know if the reference file and the current spectrum differ too much in frequencies. For instance, it is of no use to compare a spectrum with a maximum frequency of 10 kHz with one stored in the reference file and having a maximum frequency of 100 MHz.

Color button

This button invokes the window to change the color for the selected reference.

11 Cancel button

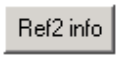


Exits without applying any changes to the spectrum data view.

12 OK button

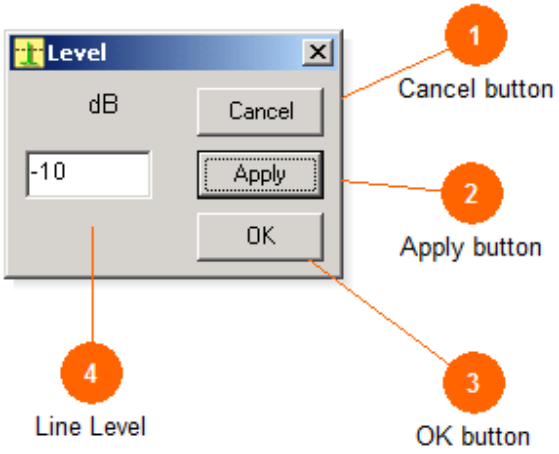
Apply the changes and closes the reference setup window.

13 Ref2 info button



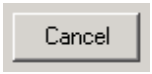
When this button is pressed a new window appears with the amount of frequency bins and the maximum frequency of the reference file stored in reference two. This is useful to know if the reference file and the current spectrum differ too much in frequencies. For instance, it is of no use to compare a spectrum with a maximum frequency of 10 kHz with one stored in the reference file and having a maximum frequency of 100 MHz.

Level



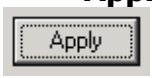
Use this dialogue box to select the level for the reference line on the spectrum data view.

1 Cancel button



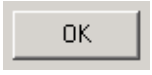
Exits without applying any changes to the spectrum data view.

2 Apply button



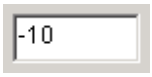
Apply the changes without closing the Level window

3 OK button



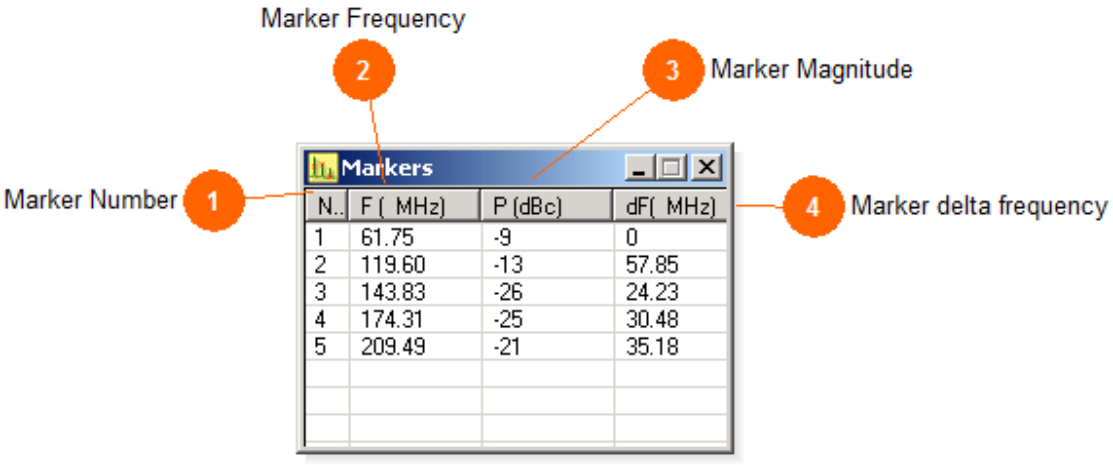
Apply the changes and closes the Level window.

Line Level



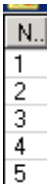
Enter here the level where the line should appear.

Markers



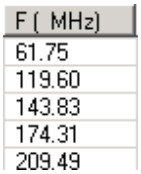
This window displays all the relevant information on the markers the users has set up in the spectrum data view.

Marker Number



The number of the marker in the spectrum plot.

Marker Frequency



Frequency corresponding to the marker number on the left.

Marker Magnitude

P (dBc)
-9
-13
-26
-25
-21

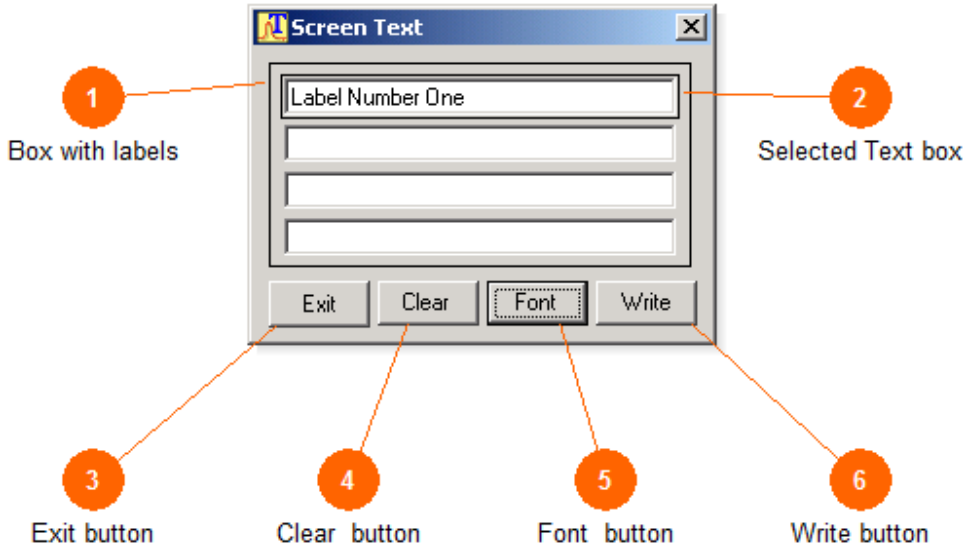
Magnitude in dBc or dBFS depending on the selected scale.

Marker delta frequency

dF(MHz)
0
57.85
24.23
30.48
35.18

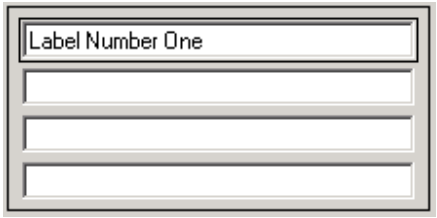
Difference in frequency between two adjacent markers.

Screen Text



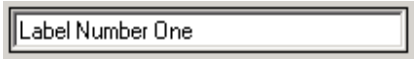
Dialogue box for entering and formatting labels to be displayed on the spectrum, o-scope, phase or waterfall data view.

1 Box with labels



This box contains four labels that can be edited. The text box with a frame around is selected. All the changes done with the clear, font and write buttons will affect only the label contained within the selected text box. To select a text box point at it with the mouse and press the left button.

2 Selected Text box



The text box that will be affected by the clear, font and write buttons.

3 Exit button

It closes the screen text window.

4 Clear button

This button deletes the contents of the text box from the box and from the screen as well.

5 Font button

This button invokes the Windows® standard font selection window.

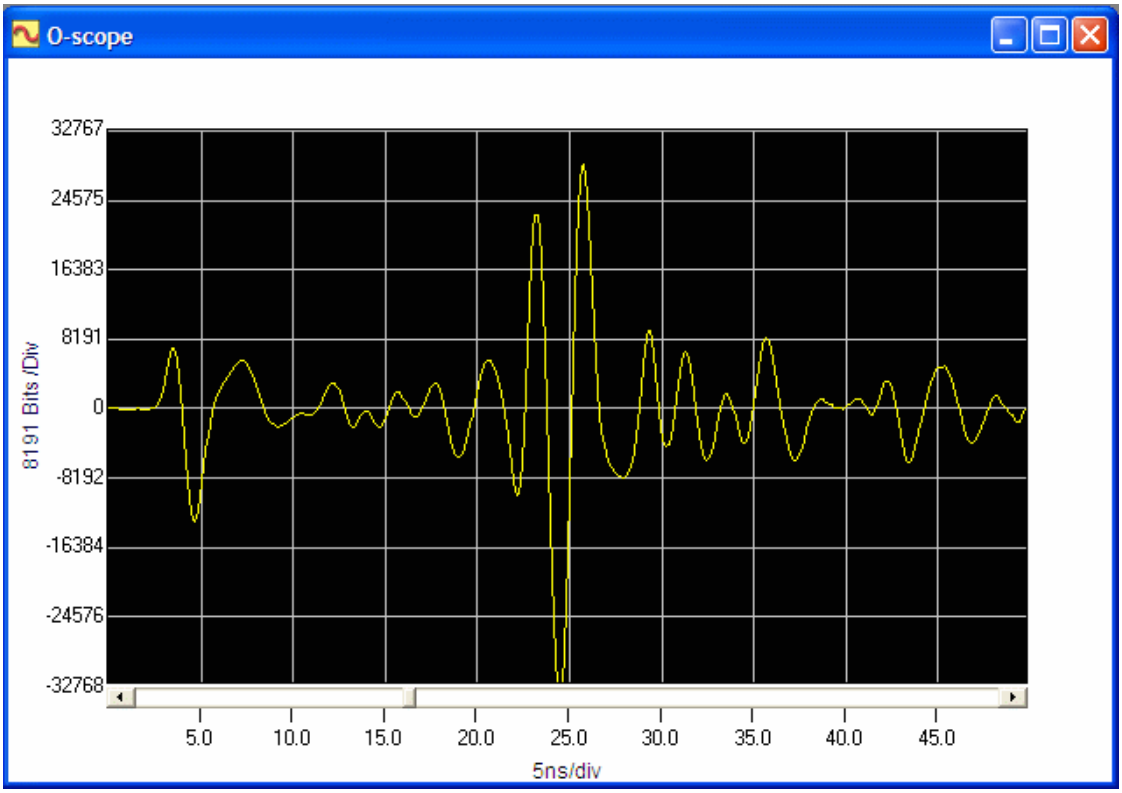
6 Write button

This button writes the contents of the text box to the selected data view. After that the label can be dragged with the mouse to any place in the selected data view. Point to the label with the mouse pointer, press the left button and drag the label to the desired position.

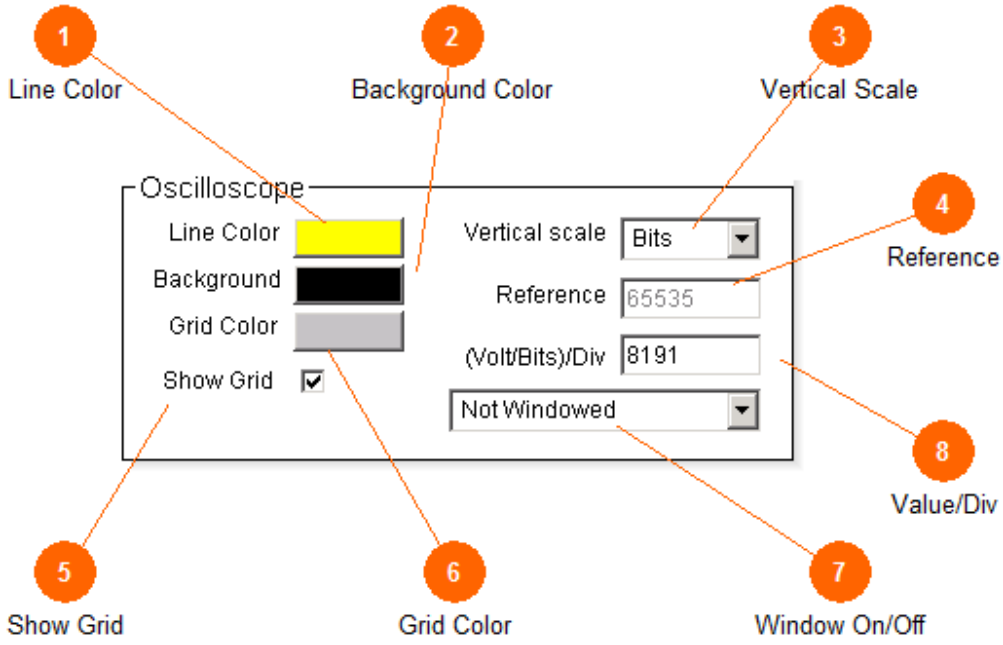
O-scope View

The o-scope view is a time domain representation of the trace or group of traces. The horizontal axis shows the time in Seconds and the vertical axis the amplitude in volts or bits. The total time of the o-scope data view plot is a function of the amount of samples per trace and the sampling interval. The o-scope view in GaiaSpectrum® always starts at time zero but it is possible to zoom in in any portion of the displayed waveform.

It is worth noting that pressing down the left button of the mouse causes a cross hair line to appear and the corresponding amplitude and time values appear in the right upper corner.



Options



O-scope Options:
This dialogue box is accessed via the options label in the main menu, through the icon in the file toolbar or by pressing F2. Here all the parameters concerning the display of the O-Scope data view can be accessed and modified.The values selected here are the ones loaded by default every time the application imports a new file.

Line Color

Invokes a new window to select the color of the line in the oscilloscope data view.

Background Color

Invokes a new window to select the color of the background in the oscilloscope data view.

3 Vertical Scale

Select from the drop down menu the units for the vertical scale.

4 Reference

Enter here the maximum amplitude of the acquired file in Volts or Bits.

5 Show Grid

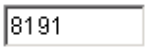
Selects the grid to be On or Off.

6 Grid Color

7 Window On/Off

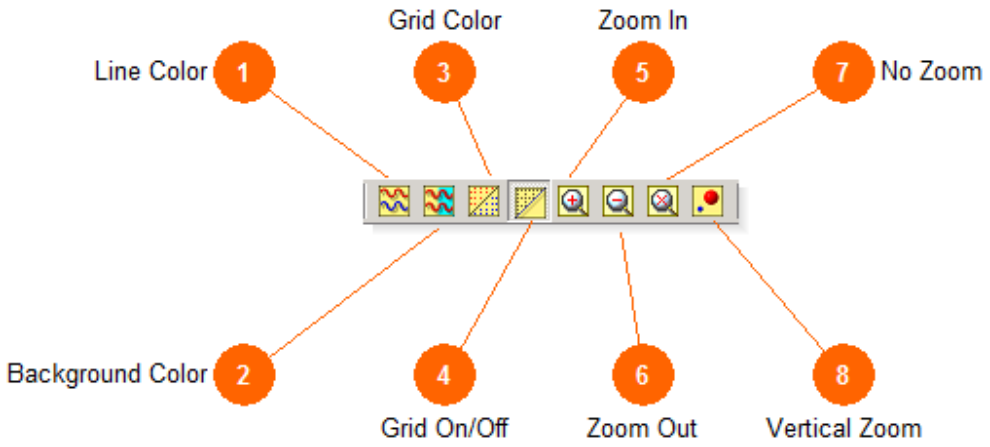
Select from the drop down menu whether the spectrum window function should be displayed or not in the O-Scope data view.

Value/Div



Shows the amount of volts/bits per division in the O-Scope data view.

Display Options



This toolbar contains controls that affect the way the o-scope data view presents the data. The options selected here are valid only during the viewing of the imported file. The default values will be restored after importing another file.

1 Line Color

This button calls a menu for selecting the color of the line of the oscilloscope.

2 Background Color

This button calls a menu for selecting the color of the background of the O-Scope data

3 Grid Color

This button calls a menu for selecting the color of the grid in the O-Scope data view.

4 Grid On/Off

This button turns the grid on and off in the O-Scope data view.

5 Zoom In

This button enables the zoom in mode. When pressed an icon indicating you are in zoom in mode appears in the upper left corner of the o-scope data view. Press down the right button on the mouse and drag to highlight the area you want to zoom. Release the mouse button to see the zoomed picture. While in zoom in mode one can continue zooming as long as there's data to zoom in. Press the no zoom button to exit this mode.

6 Zoom Out

This button enables the zoom out mode. Pressing this button will reverse one step back at the time the zoom in function. Let's say one zoomed in three times to focus certain part of the signal but the third time went too far. Then pressing zoom out once will return to the last zoom in position.

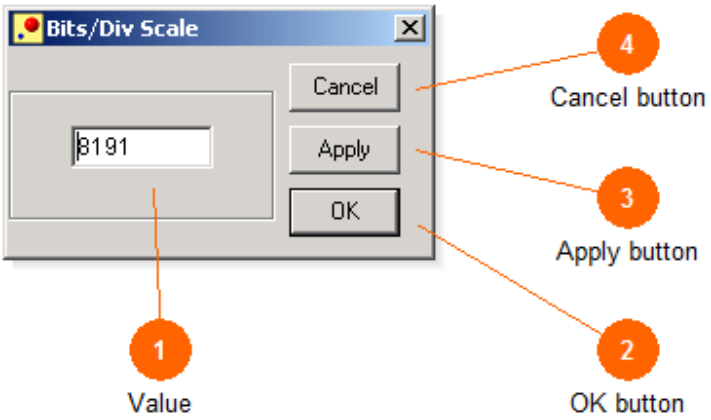
7 No Zoom

Pressing this button eliminates all possible zoom in steps restoring the o-scope data view into its original form.

Vertical Zoom

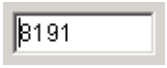
This button functions like the vertical amplifier button in a real o-scope. It will call a new window where the user can enter the required value for the volts or bits per division in the o-scope data view.

Bits/Div Scale



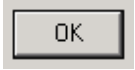
Enter in this dialogue box the desired amount of volts or bits per division.

1 Value



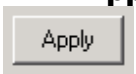
Enter here the value in Volts or bits depending on the selected unit for the vertical scale.

2 OK button



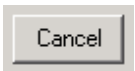
Apply the changes and close the Bits/Div Scale window.

3 Apply button



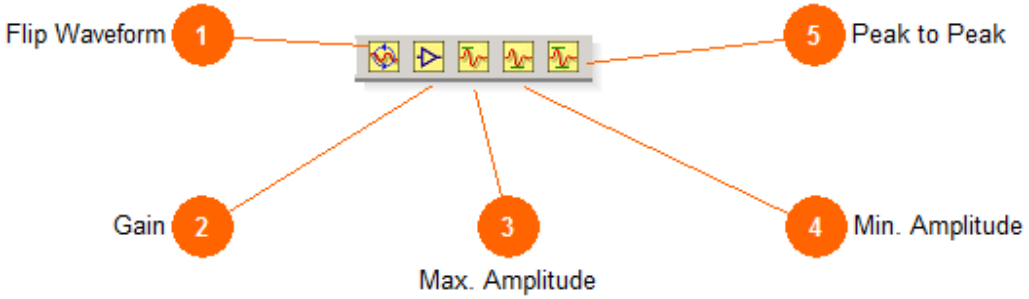
Apply the changes without closing the Options window

4 Cancel button



Close the Bits/Div Scale window without applying any changes.

Utilities



These are a set of automatic and semiautomatic measurement and editing tools based upon the waveform loaded in the o-scope data view.

1 Flip Waveform

Pressing this button flips the waveform vertically. This is useful for correcting the original data file to a more familiar polarity of the excitation impulse in ground penetrating radar applications.

2 Gain

This button will call a gain setup dialogue box where it is possible to apply gain to the current data set.

3 Max. Amplitude

The amplitude maximum value is displayed when this button is pressed.

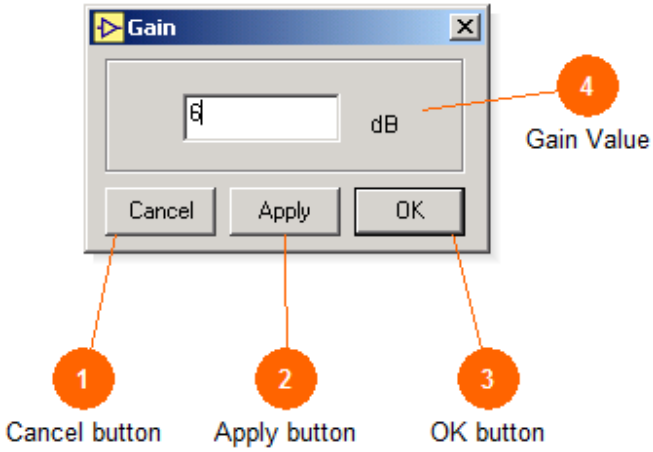
Min. Amplitude

The amplitude minimum value is displayed when this button is pressed.

Peak to Peak

The peak to peak value is displayed while this button is pressed.

Gain



This dialogue box is used to enter the desired amount of amplification to apply to the current data set.

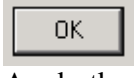
1 Cancel button

Close the Gain window without applying any changes.

2 Apply button

Apply the changes without closing the Gain window

3 OK button

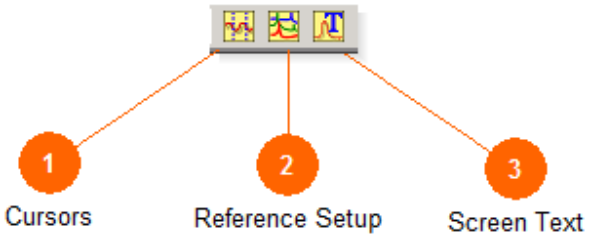


Apply the changes and close the Gain window.

Gain Value

Enter here the desired amount of amplification in decibels. This value can be positive for amplification or negative to attenuate the displayed signal.

Editing



The editing toolbar gives access to features such as cursors, reference waveforms and screen labels.

1 Cursors

This buttons add two cursors to the o-scope data view. The amplitude and time values of each cursor together with their difference appear in the upper right corner of the o-scope data view. To move the cursors in the data view point to the blue cursor handle until a hand appears, press then the left mouse button and grab the cursor to move it. Release the left mouse button to set the cursor in the new position.

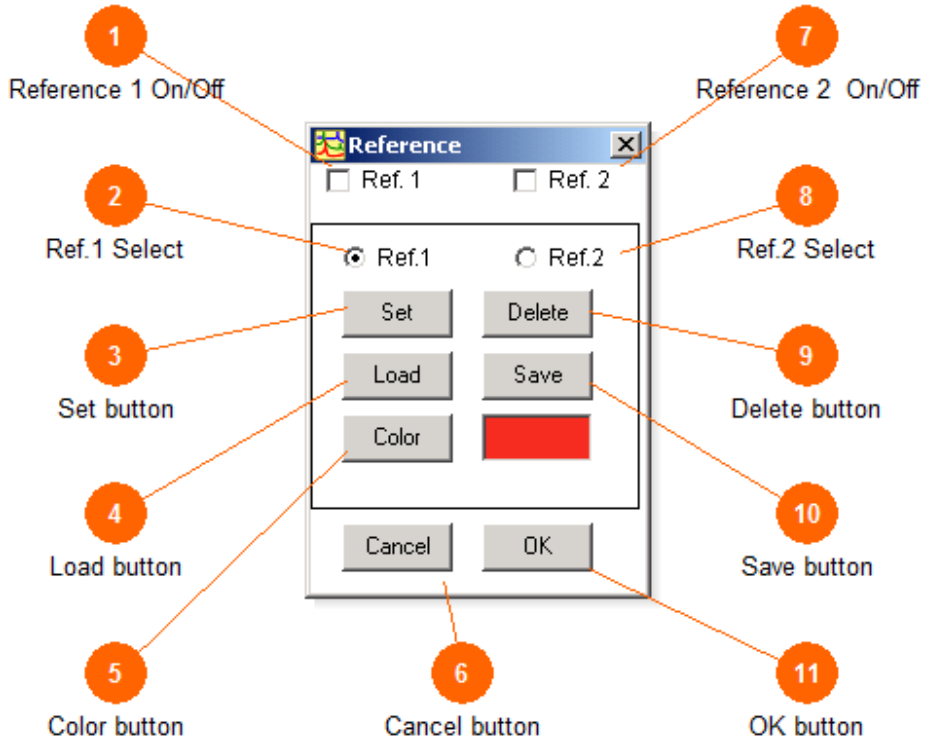
2 Reference Setup

The reference setup button invokes a new window with all the options for setting reference waveforms. This is a useful editing tool when two or three different waveforms most be compared against each other.

3 Screen Text

The Screen text button invokes a window that allows for adding text to the o-scope data view. Up to four labels with a maximum of sixty four characters can be written in the spectrum data view. Each label can have its own color and font.

Reference



The reference setup button invokes a new window with all the options for setting reference waveforms. This is a useful editing tool when two or three different traces most be compared to each another.

1 Reference 1 On/Off

Ref. 1

This check box makes the reference number one visible on the o-scope data view when it is checked

2 Ref.1 Select

Ref.1

This radio button selects the buttons: Set, Delete, Load, Save and Color for the reference number one.

3 Set button

The current waveform is stored into the selected reference number.

4 Load button

The selected reference number is loaded from a reference file stored anywhere in any media or network.

5 Color button

This button invokes the window to change the color for the selected reference.

6 Cancel button

Exits without applying any changes to the O-scope data view.

7 Reference 2 On/Off

This check box makes the reference number two visible on the o-scope data view when it is checked

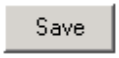
Ref.2 Select

This radio button selects the buttons: Set, Delete, Load, Save and Color for the reference number two.

Delete button

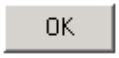
The contents of the selected reference number are cleared.

Save button



The contents of the o-scope data view are saved into a file with an arbitrary file name. This can be loaded later into a reference by pressing the load button.

OK button

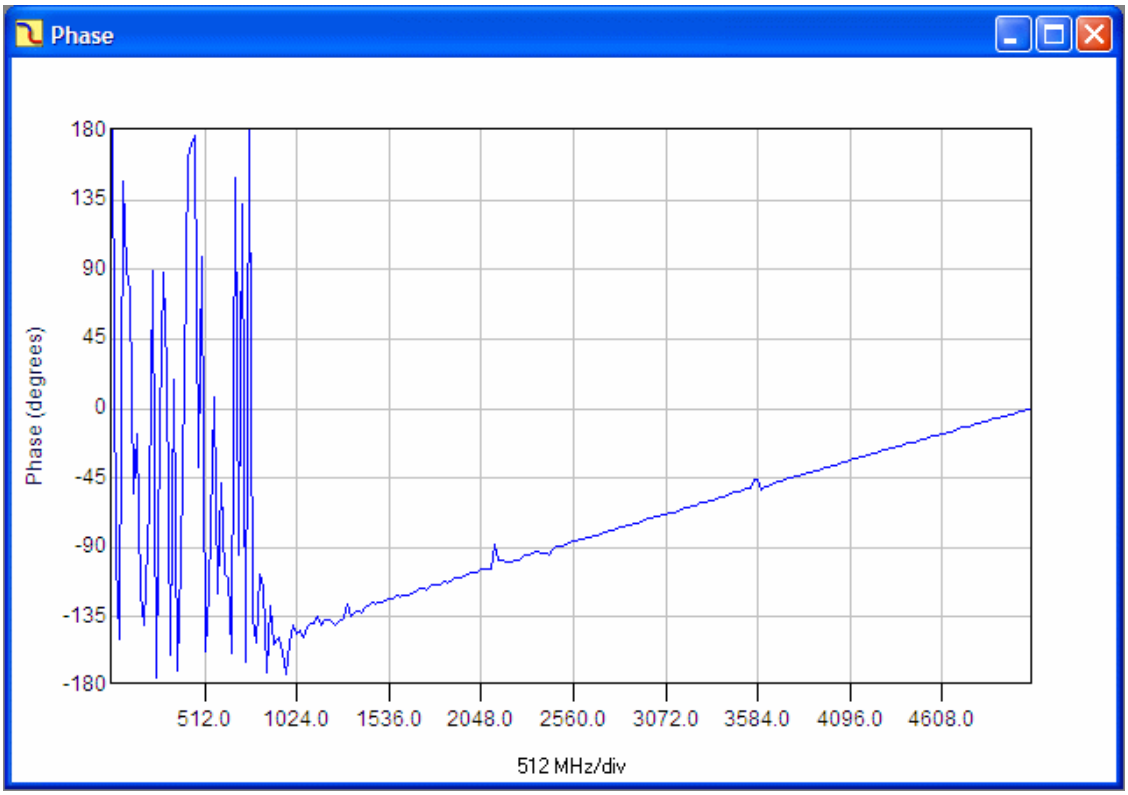


Apply the changes and closes the reference setup window.

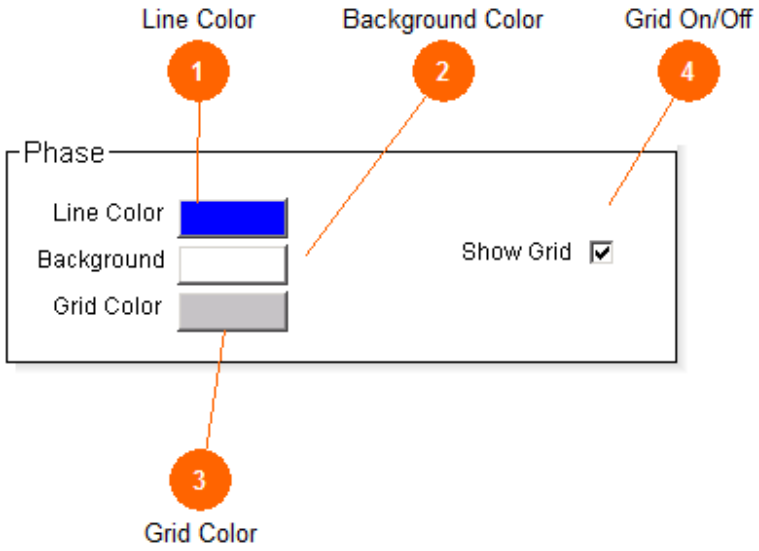
Phase View

The phase view is the representation of the phase of the signal versus each frequency component. The horizontal axis shows the frequency in Hertz and the vertical axis the phase in degrees. The total amount of available frequency lines always is half of the amount of samples.

It is worth noting that pressing down the left button of the mouse causes a cross hair line to appear and the corresponding phase in degrees and frequency in Hertz appear in the right upper corner.



Options



Phase Options:
This dialogue box is accessed via the options label in the main menu, through the icon in the file toolbar or by pressing F2. The phase view options control the way the data will be presented in the phase data view window. The values selected here are the ones loaded by default every time the application imports a new file.

Invokes a new window to select the color of the line in the phase data view.

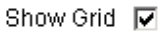
Background Color

Invokes a new window to select the color of the background in the phase data view.

3 Grid Color

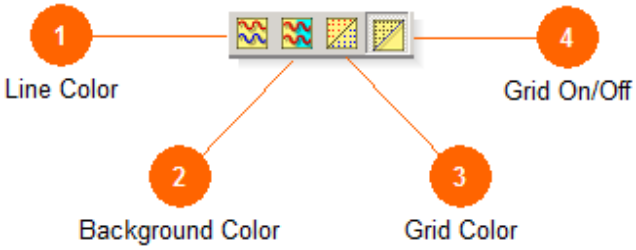
Invokes a new window to select the color of the grid in the phase data view.

4 Grid On/Off



Selects the grid to be On or Off.

Display Options



This toolbar contains controls that affect how the phase data view presents the data. The options selected here are valid only during the viewing of the imported file. The default values will be restored after importing another file.

1 Line Color

This button calls a menu for selecting the color of the line of the phase function in the Phase data view plot.

2 Background Color

This button calls a menu for selecting the color of the background of the Phase data view.

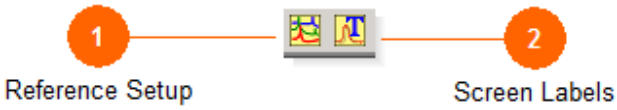
3 Grid Color

This button calls a menu for selecting the color of the grid in the Phase data view.

Grid On/Off

This button turns the grid on and off in the phase data view.

Editing



There are two tools for editing the contents of the Phase data view, reference functions and screen labels.

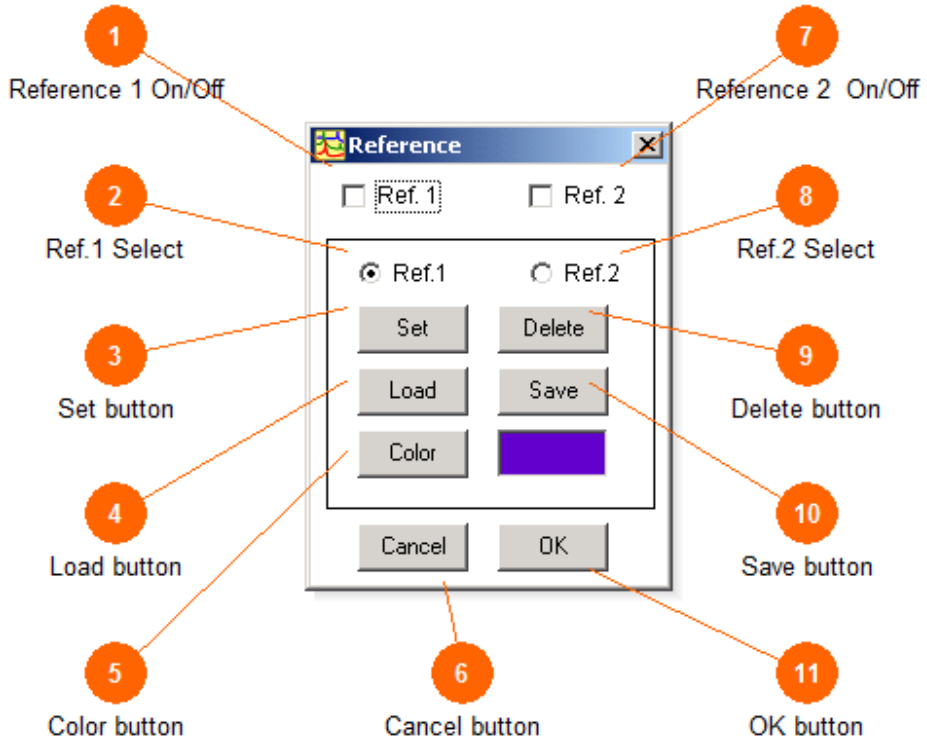
1 Reference Setup

The reference setup button invokes a new window with all the options for setting reference waveforms. This is a useful editing tool when two or three different phase functions most be compared to each another.

2 Screen Labels

The Screen text button invokes a window that allows for adding text to the phase data view. Up to four labels with a maximum of sixty four characters can be written in the spectrum data view. Each label can have its own color, size and font.

Reference



The reference setup button invokes a new window with all the options for setting reference functions. This is a useful editing tool when two or three different phase responses most be compared to each another.

1 Reference 1 On/Off

Ref. 1

This check box makes the reference number one visible on the phase data view when it is checked

2 Ref.1 Select

Ref.1

This radio button selects the buttons: Set, Delete, Load, Save and Color for the reference number one.

3 Set button

The current waveform is stored into the selected reference number.

4 Load button

The selected reference number is loaded from a reference file stored anywhere in any media or network.

5 Color button

This button invokes the window to change the color for the selected reference.

6 Cancel button

Exits without applying any changes to the phase data view.

7 Reference 2 On/Off

This check box makes the reference number two visible on the phase data view when it is checked

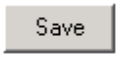
8 Ref.2 Select

This radio button selects the buttons: Set, Delete, Load, Save and Color for the reference number two.

9 Delete button

The contents of the selected reference number are cleared.

10 Save button



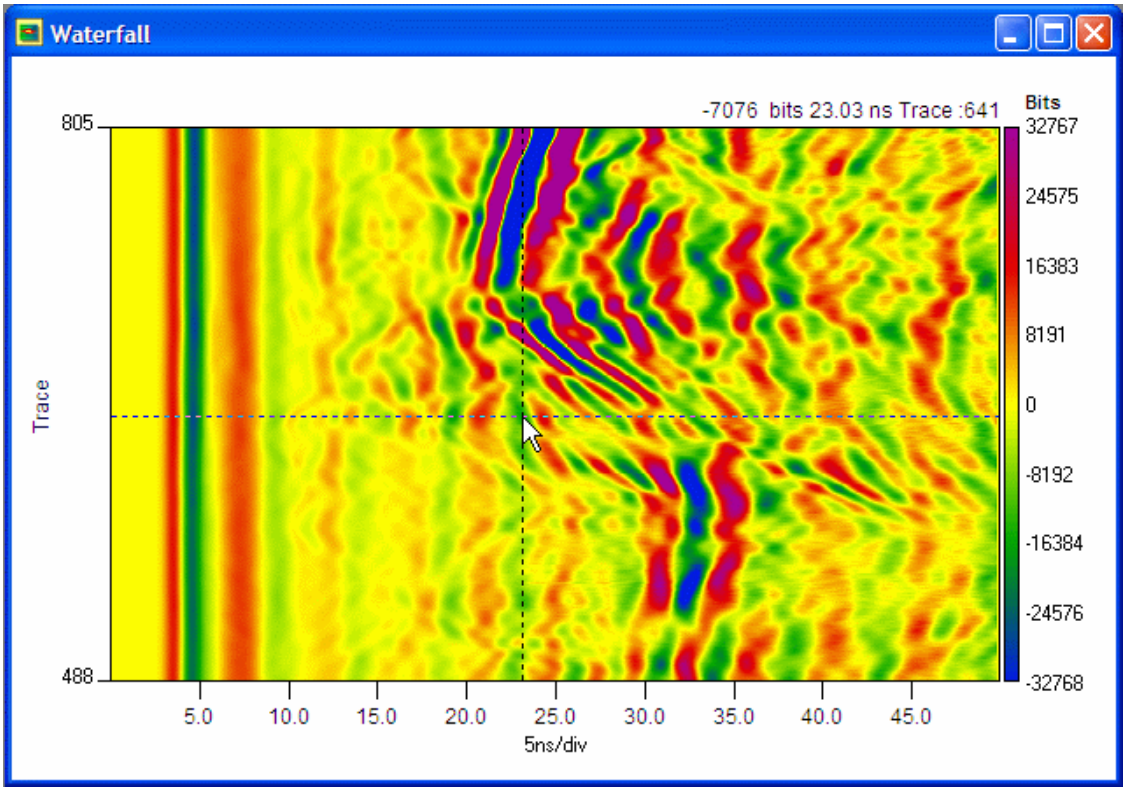
The contents of the phase data view are saved into a file with an arbitrary file name. This can be loaded later into a reference by pressing the load button.

11 OK button

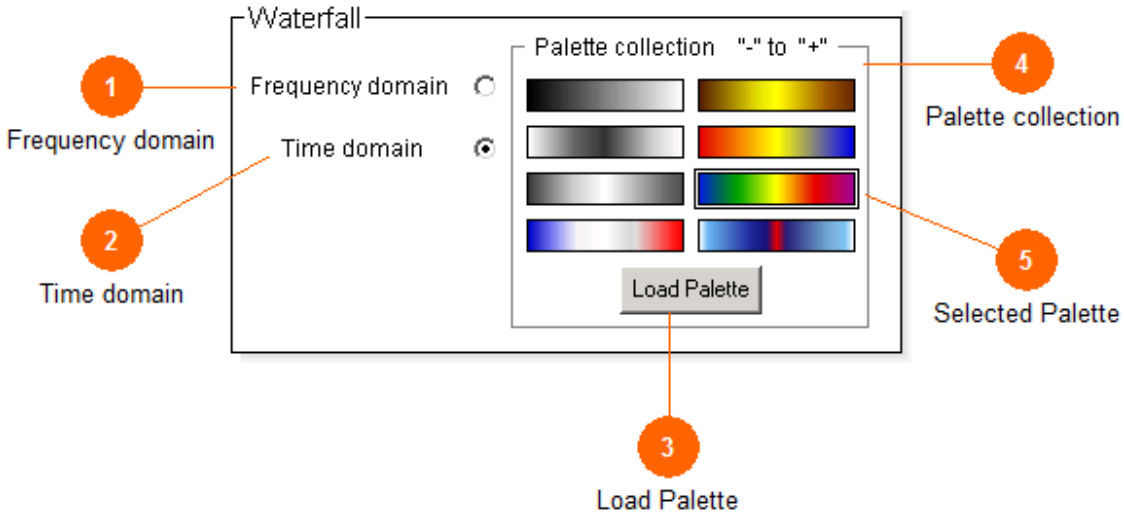
Apply the changes and closes the reference setup window.

Waterfall View

The waterfall view is the representation of several traces in the frequency or time domains. The frequency domain waterfall view is useful when searching for anomalies in modulation schemes or for infrequent behavior of the bandwidth of antennas or other frequency dependent devices.
In the frequency domain waterfall view the horizontal axis shows the frequency in Hertz and the vertical axis the trace number. The total amount of available frequency lines always is half of the amount of samples.
The time domain waterfall view or otherwise known as B-scan or just scan for people dealing with ground penetrating radar is useful for finding anomalies in the amplitude of the signal or instabilities in time, like jitter for instance.
In the time domain waterfall view the horizontal axis shows the time in seconds and the vertical axis the amplitude of the signal in bits or volts depending on what was chosen in the options menu. The full length of the signal is shown.
It is worth noting that pressing down the left button of the mouse causes a cross hair line to appear and the corresponding frequency in Hertz and the trace number appear in the upper right corner of the data view.

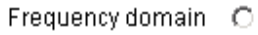


Options



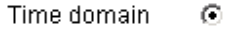
Waterfall Options:
This dialogue box is accessed via the options label in the main menu, through the icon in the file toolbar or by pressing F2. Here all the parameters concerning the display of the Waterfall data view can be accessed and modified.The values selected here are the ones loaded by default every time the application imports a new file.

1 Frequency domain



Select the waterfall data view to present the plot of the frequency domain as a function of time.

2 Time domain

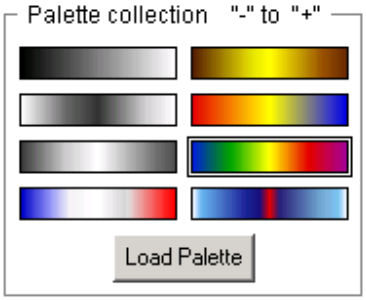


Selects the waterfall data view to present the plot of the time domain data versus time. This is known in ground penetrating radar as B-scan.

3 Load Palette

This button invokes a standard open file Windows® dialogue box, search the required file and loaded into GaiaSpectrum®. Please note that the selected palette will be replaced by the one loaded from your PC.

4 Palette collection



In this window the set of available palettes are displayed and is possible to select existing palettes or to load new ones. GaiaSpectrum® uses standard Windows® palettes with extension PAL. It is important though that all colors are present and no cells are skipped.

5 Selected Palette

This is the selected palette. When a palette is selected by clicking on it with the left button of your mouse a frame appears around it. The selected palette is the one active when the software starts up and is the one replaced by the <load palette> dialogue box.

Display & Editing

The waterfall data view has two ways of modifying the presentation of the data, the palettes and the screen labels.

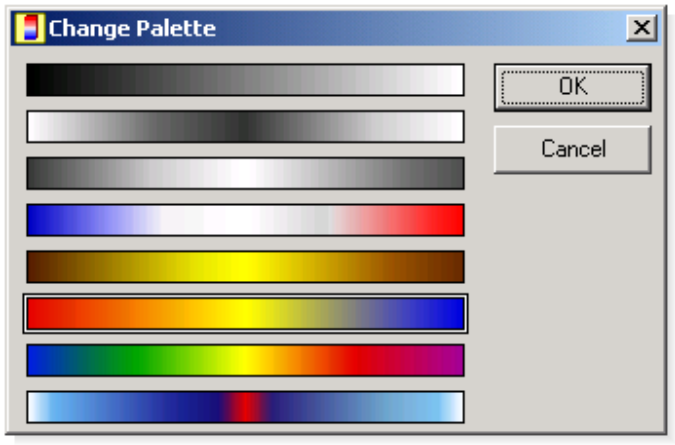
Palettes

This button invokes the palette selection window.

Screen Text

This button invokes the screen label setup window.

Palette Selection



Select the required palette from the available ones by clicking it with the left button of your mouse. Press OK to effect the change or cancel to exit. Pay attention that the selected palette is surrounded by a frame. The palette selected via this window is not the default palette when the software starts up. If you want to change the startup palette then do it in the <options> dialogue box.

Miscellaneous

Short-cuts

Main Menu	
File	Alt + F
Edit	Alt + E
Tools	Alt + T
View	Alt + V
Windows	Alt + W
Help	Alt + H

File Menu	
Import	Ctrl + I
Open File	Ctrl + O
Export to	Ctrl + E
Save Window as	Ctrl + S
Print	Ctrl + P
Exit	Ctrl + X

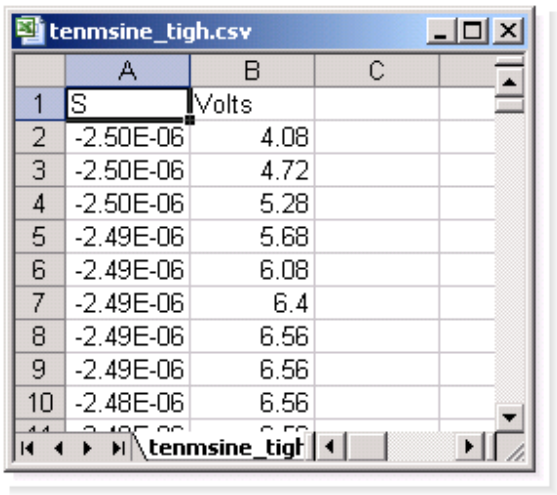
Edit Menu	
Reference	Ctrl + R
Markers	Ctrl + M
Text	Ctrl + T

Tools Menu	
Options	F2
File Info	F3
FFT Filter	Ctrl + B
Flip	Ctrl + F

View Menu	
Spectrum	F5
O-scope	F6
Phase	F7
Waterfall	F8
All Open	F9
Span	Ctrl + N

Help Menu	
Help	F1
About	Ctrl + U

CSV Format



CSV Format:

The CSV file must be correctly formatted in order for GaiaSpectrum® to load it properly. The first row contains the units for each column. The first column is the time expressed in seconds and the second column is the value in volts. GaiaSpectrum® will try to take all samples within the file in order to achieve higher resolutions; but it is possible to change that by entering a different amount of samples per trace in the Spectrum view options menu.

Header File

DAT Header File:

The header file is necessary for automatic loading the .DAT files into GaiaSpectrum®. The header file must have the same name as the data file and the .HDR extension.Tektronix® Inc instruments generate the HDR file upon request of exporting the data as MATHCAD® or MATLAB®. In general it is not difficult to write your own header file if the input parameters are known.Use Notepad or any ASCII editor in order to write the amount of samples per trace in the DAT file and in the second line the sampling interval in seconds.

References

1. On the use of windows for harmonic analysis with the discrete Fourier transform. By Fredric J. Harris. Proceedings of the IEEE Vol. 66. No. 1 January 1978.

2. The fundamentals of FFT based signal analysis and measurement in LabVIEW and LabWindows. By Audrey F. Harvey and Michael Cerna. National Instruments application note 041. November 1993.

3. The Scientist and Engineer's Guide to Digital Signal Processing. By Steven W. Smith. California Technical Pub 1997.
4. Spectral Analysis and Filter Theory in Applied Geophysics. Burkhard Buttkus. Springer 2000