RTmap31

Version 2.17

for MS Windows 10 and 7
based field laptops and tablets

data acquisition, navigation & real time imaging
software for the Geonics EM31-MK2 and GPS receiver

User's Manual

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Introduction 1

The Geomar RTmap31 Data Logging System for Geonics EM31-MK2 consists of a data acquisition program RTmap31 and associated PC computer data processing program RTM31. This manual describes the use of the RTmap31 program used with the laptop or tablet field computer (operating under operating system MS Windows 10 or 7) with display in landscape as well as portrait mode (however chosen computer screen orientation must be fixed for logging session, screen cannot rotate during measurements), Geonics EM31-MK2 (or EM31 with digital modification) instrument, and Global Positioning System (GPS) receiver or selected Robotic Total Station (RTS).

The associated program RTM31 is used to process data files recorded under the control of program RTmap31. Main function of this program is to position the EM31-MK2 sensor based on the recorded GPS position and the configuration of the system. The RTM31 also allows you to correct the collected GPS positions with post-processed GPS files. In case of grid based surveys (without GPS positioning) the program will layout the survey grid based on survey setup parameters and the system geometry. Alternatively, the grid based data files can be exported to Geonics DAT31W (G31) format and data can be processed using the Geonics program DAT31W.

1.1 About the RTmap31 Program

Program RTmap31 acquires and records survey data from the EM31-MK2 unit, under the control of the operator. It also records various field information such as survey line number (line name), starting station, increment, comments, etc. Readings are given in real time in mS/m or ppt. In addition, the program allows you to monitor the instrument output while data are not recorded. The RTmap31 continuously monitors the GPS receiver signal quality, the EM31-MK2 measured components (Conductivity and Inphase) and instrument dipole mode (Vertical or Horizontal), and state of fiducial marker without leaving the program.

During data collection the program can work in three display modes: mapping, navigation, and profile mode. Mapping mode is a special case of Navigation mode, while providing all functions of navigation mode, mapping mode displays colour image that represents measured amplitude variations. Therefore Navigation and Mapping mode labeling may be used interchangeably for both modes in this manual. While in navigation mode, the main portion of the screen displays all logged positions marked by a swath bars or dots, and current position of the system denoted by cross mark based on GPS

input. A swath bar represents width of the user selected width of footprint (depends on the survey requirements) in the employed map scale with correction for the GPS antenna offsets. This type of real time display allows the operator for real time control of the survey coverage and helps in avoiding unnecessary overlaps and skips without any on ground guidance hardware. Mapping mode (real time colour imaging) helps in control quality during surveying since in any areas of anomalous response density of survey coverage can be increased instantly. There is no dot representation in mapping mode, all data points are drawn continuously as small bars separately for each sensor resulting in pseudo-grid colour image. The size of graphic bar representing the EM31-MK2 footprint is user selectable, it depends on intended survey resolution across the survey line direction. The RTmap31 does not require that survey has to be conducted along parallel straight lines. In Mapping and Navigation modes the instrument output is also shown in windows containing profiles. The display can be switched to Profile mode at any time. In this mode Map window disappears and profile windows are extended in length. Mapping and Navigation modes are available only when working GPS receiver is connected to the field computer.

In any display mode readings are additionally displayed in real time as numeric values in mS/m and ppt as well as in graphic mode, as moving graphic bars. The output of the instrument is represented by four bars (two visible at any time depending on the dipole mode), for Conductivity and Inphase for Vertical or Horizontal dipole mode). This allows for very fast visual information about each channel.

The RTmap31 can act as a standalone GPS logger if required. This feature can be useful while mapping topographical features (roads, fences, etc.) that are to be presented together with EM31-MK2 data. These files have extension GXY and they can be used in Geomar data processing software for any other instrument (i.e. TrackMaker61MK2, RTmap38MK2, Multi61MK2, etc.).

The RTmap31 accepts NMEA-0183 compatible data from a GPS receiver directly connected to an Allegro field computer. GPS data which is embedded in the RTmap31 data file can be processed later in the Geomar RTM31 program. The connected GPS must be able to stream NMEA-0183 compatible messages. The RTmap31 uses one of the following types of NMEA messages: a pair GGA/GSA, GGA, POS, GLL, LLK, LLQ, GLL, and GGK, as well as positions given by Robotics Total Station streaming pseudo-GGA message (for example Leica TPS1100/TPS1200 and some Trimble models) and Trimble label messages. Messages POS, GGK, and pair GGA/GSA are preferred since they contain all necessary information. GPS readings Latitude and Longitude, as well as parameters indicating quality of GPS signal: status of differential corrections, number of satellites, and PDOP parameter, are displayed in real time.

The program RTmap31 is designed to work with GPS receiver. If for any reason the employed GPS cannot stream NMEA data and positions are logged separately in GPS dedicated computer please use Geonics standard data acquisition program EM31win. If data was collected with RTmap31 please convert files to Geonics G31 format using RTM31. Later an option "Combine EM31-MK2 and GPS files" of the program DAT31W can be used to position EM31-MK2 records.

If GPS data are not differentially corrected in real time and post processed GPS data will be used for positioning please log GPS data concurrently in RTmap31 and in GPS logger. An option "Position Readings using External GPS file" in RTM31 which uses satellite time recorded in both devices is much more accurate than any method that uses computer clock.

System and survey setup parameters are saved in the program configuration file, therefore they can be automatically used during subsequent data collection sessions.

Data files can be saved in user specified directory. Data file names, which can be set by the program based on the computer clock or they are user specified, have extension names T31. Data files can be appended, therefore already collected data is displayed on the screen map and survey can be continued to assure proper area coverage. When append data file is used, size of the entire data file (past and currently logged portions) is subject to limitation described in below paragraph.

The maximum number of 28,800 GPS positions is allowed in one file. This corresponds to 8 hours of continuous data collection if GPS positions are collected every second, or 16 hours if GPS data is taken every 2 seconds. However, it is strongly advised to limit files to for example approximately 1 to 2 hours blocks.

Data files are permanently saved every time a Pause button is used (whenever logging mode is changed from Logging to Stand By) during data logging. Therefore it is recommended to use Pause button as often as possible, at any turns between survey lines, breaks, etc.

It is strongly advised that even if your GPS receiver supports faster rates the 1 Hz update for GPS positions is used. The RTmap31 will work with rates higher than 1 Hz, however operation will not be smooth when scrolling and re scaling display. The data processing program will interpolate all EM31-MK2 stations between GPS positions in the very similar way as GPS receiver in real time.

1.2 Program Requirements

To successfully use this software, you will need :

Computer

- PC field computer operating under Windows 10 or 7,
- Minimum of 4 Gb RAM memory,
- CD drive, USB port for memory module, or other mean to transfer files,
- minimum 800 x 600 pixel display resolution,
- serial Ports:
  one serial port for the instrument plus one serial port if directly connected GPS receiver is to be used (also USB to multiple RS-232 ports adapters and wireless Bluetooth connections can be used).
- one USB port (if the Geomar USB security key is used).

Geonics EM31-MK2

EM31-MK2 (or EM31 model with digital output) instrument with associated cables.

Software Key (previous versions were supplied with Geomar USB security key)

GPS Receiver

The GPS receiver capable of streaming NMEA messages (GGA. POS, GLL, LLQ, LLK, GGK) or supported Robotics Total Station.

1.3 Contents of RTmap31 disk

The program RTmap31 is stored on RTmap31 USB drive or CD distribution disk. All necessary configuration files (with extension names .INI) are created in your computer after the program is run for the first time. Check that the file SetupRTmap31.exe that installs RTmap31 is included on the USB or CD disk. This file can be also downloaded from the Geomar web site. In general four following files are needed:

SetupRTmap31.exe	-	installs data acquisition program file RTmap31
Setup31R.exe	-	setup for the data processing program RTM31
RTmap31win.pdf	-	manual for RTmap31 progam
RTM31.pdf	-	manual for RTM31 program

1.4 Installing RTmap31

Execute supplied or downloaded setup program **SetupRTmap31** (another setup program Setup31R installs data processing program RTM31). The RTmap31 is a stand alone program and it does not require any additional drivers nor run time libraries.

After you run the program for the first time it will create permanent configuration file RTmap31.ini which contains the program settings.

The RTmap31 data files contain extension name T31 and their base names should be limited to 8 characters.

1.5 Software Key

The data acquisition program RTmap31 is licensed for one field computer. The program is secured with Software Key (some previous versions can be secured by USB security key - USB dongle). Initialization of the program requires a software key that is based on the computer unique ID number generated by the program. During the first run (after any key is pressed or a command button is tapped) the program will display the Enter Software Key window (Figure 1.1) and the ID number for this computer will be dis-

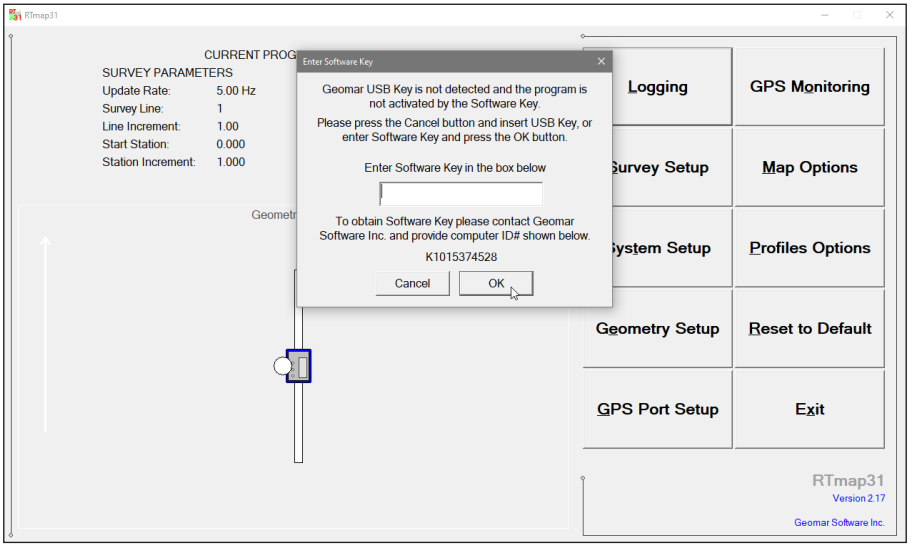


Figure 1.1: Enter Software Key window

played at the bottom of the window as 11 character string. Please forward this number to Geomar Software and the Software Key will be provided.

Please enter the software key in the appropriate box in the Enter Software Key window (Figure 1.2) and click the OK or press the Enter key. From now on the program will run without any interruption, unless program will be moved without key file to another folder or key file will be deleted. Any future updates of the program will not require entry of the software key.

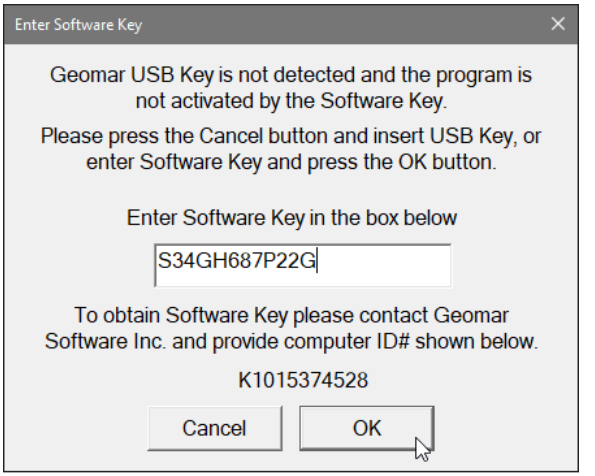


Figure 1.2: Entering the Software Key

1.6 Data Files

Data files are saved in the user specified folder with extension name T31. RTmap31 data files with extension T31 (or GXY if standalone GPS files are created) are binary data files. These files can be loaded and processed in the RTM31 program.

Please do not open binary T31 files in a text editor. While it is possible to view these files in text editor, any accidental Save will damage data file. If any binary data file is to be viewed in text editor please make a copy of the file first.

Also, if T31 files are sent by e-mail it is safer to zip them since some e-mail server treat attached binary files as text files and add Carriage Return or Line Feed characters. This action corrupts any binary file. In any case, please retain raw binary data files in the logging computer till end of the project.

1.7 Running RTmap31 Program

Start RTmap31 by double clicking the RTmap31 icon in the Start|Programs menu, in Windows Explorer, or on the desktop if a shortcut created by the setup procedure. At the start, RTmap31 displays the following screen (Figure 1.3).

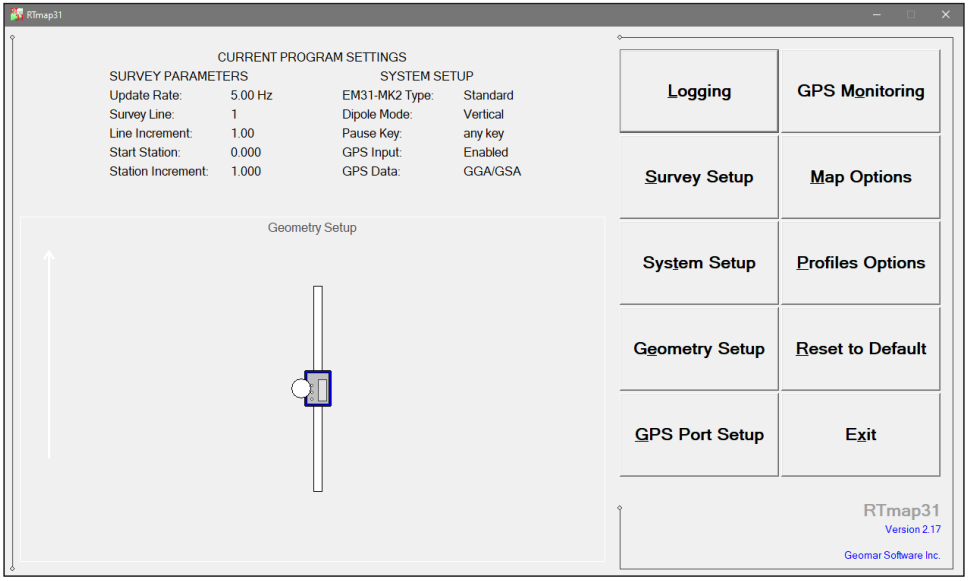


Figure 1.3: The RTmap31 main screen

The RTmap31 is a command button and dialog driven program. Command buttons can be executed by clicking with the left mouse button, or by tapping if touchscreen is available, or by pressing the indicated (underlined) character on the keyboard, or by using TAB or arrow keys to scroll through the buttons and ENTER to execute. In the Main Screen of the program Up and Down arrow keys can be also used to scroll through the buttons.

The Main Screen appears always as the first window after the program is started. It contains the name of the program, its version number (right bottom corner), and list of command buttons with available options on the right side. The major , left portion of the window contains information about current survey and system settings, and a graphic diagram illustrating current system (EM31-MK2 and GPS antenna) geometry. The graphic diagram is updated in real time as soon as the system geometry parameters are changed in System Geometry dialog. A description of the Main Screen functions and information is given in Chapter 3.

1.8 RTmap31 Program Overview

The data acquisition program RTmap31 was designed with field use in mind. This was the main thought while preparing the program flow. Once all necessary parameters are set in the program they are saved in initial files. Assuming that the survey set up is the same as in previous logging session: when the program is started, the instrument and GPS are turned on, output of the connected EM31-MK2 can be monitored after one key stroke. Obviously any parameters can be modified at any time, however as long as the field procedure remains the same the program needs very minor adjustments, especially when survey is conducted using GPS positioning.

When all settings for the system and survey (discussed in later sections) are specified, the user selects Logging option in Main menu of the program. This sets the program in Monitoring mode (Figure 1.4) which allows you to examine the EM31-MK2 output

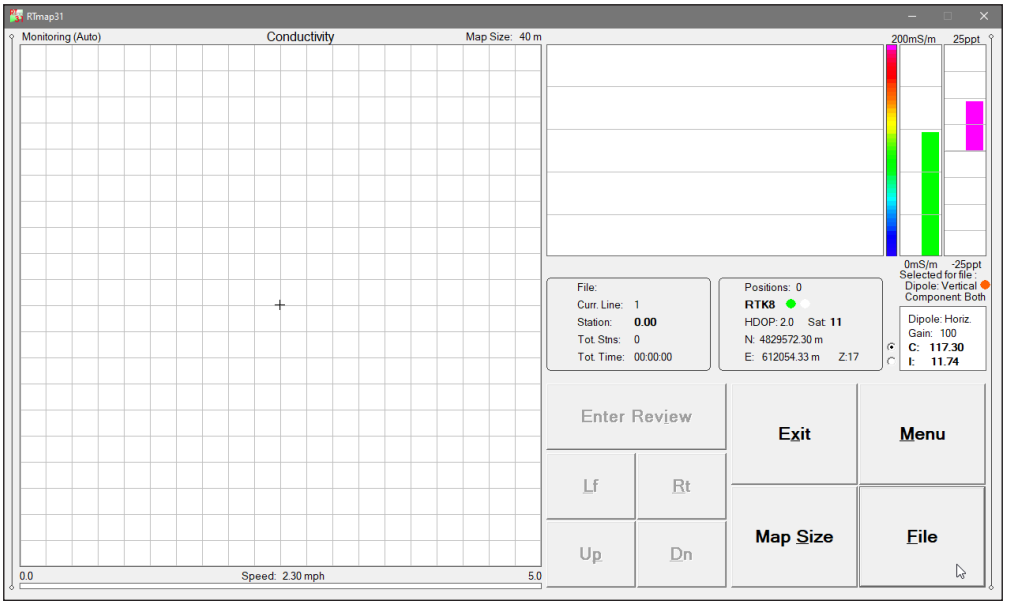


Figure 1.4: The RTmap31 in the Mapping (Monitoring) mode

and GPS performance. To record data one has to specify the data file name. The program will allow you to append data to an existing file (any file in T31 format created by RTmap31 version 2.00 or later), or recall the last file. After the data file is created the program will switch to Stand By mode. The Stand By mode allows for continuous data monitoring as well as use available field options. Clicking on the **Go** button (or pressing

key G or <ENTER> if it is default button) will change the program to Logging mode and EM31-MK2 and GPS data will be recorded in the data file according to selected mode of operation.

The instruments output is shown in the form of numeric values for Conductivity in mS/m and Inphase in ppt, as well as it is plotted in various graphic modes (Figures 1.4 to 1.8). Two characters labels in numeric window indicate component and dipole mode. C indicates conductivity and I indicates Inphase, while V and H correspond to Vertical and Horizontal dipole mode.

An equalizer type (graphic bars) displays data for Conductivity and Inphase as moving bars in two bar windows. Left bar window displays bars associated with Conductivity values, while right bar window displays Inphase readings. In each moving bar window, bar placed at the left edge of the window represents always readings for Conductivity in Vertical dipole mode. Bars are displayed for currently employed dipole mode, when the instrument dipole mode is changed from one to another dipole mode then a set of two bars is replaced by another set of bars with colors corresponding to the dipole mode. Current dipole mode (Vertical or Horizontal) is also indicated by the label in numeric display window (second character V or H). In addition moving bars are displayed with different colours that correspond to profile curves colours specified in Profile Display Options dialog. Range of displayed components is common for moving bars windows and profile window. Range of conductivity and Inphase separately is labeled at the bottom and top of corresponding moving bars windows. This type of display allows for a legible and very quick estimation of the EM31-MK2 performance. When more detailed monitoring is required each measured value is displayed in numeric form in mS/m and ppt as well. In addition the program displays windows with profile lines for each component. If longer profile curves are needed the program can be switched to Profile mode at any time during the survey. Change of display type between Mapping/Navigation and Profile modes can be performed by pressing key **T** (toggle) in the Monitoring or Stand By mode.

When working GPS receiver is connected to the field computer then program uses Navigation or Mapping (depending on settings) mode by default. The RTmap31 screen in Navigation mode is shown in Figure 1.5 (EM31-MK2 position and footprint represented by selected swath bar) and Figure 1.6 (EM31-MK2 position is represented by a dot). Each swath bar or dot shows position recorded at the moment the GPS station is recorded, positions of recorded EM31-MK2 data (located between GPS points) are not shown in Navigation mode.

Mapping mode that provides navigation, survey coverage and data quality control at the same time is similar to Navigation mode, however it shows positions of EM31-MK2 readings (not only at GPS points). Readings are shown as a coloured image of amplitude

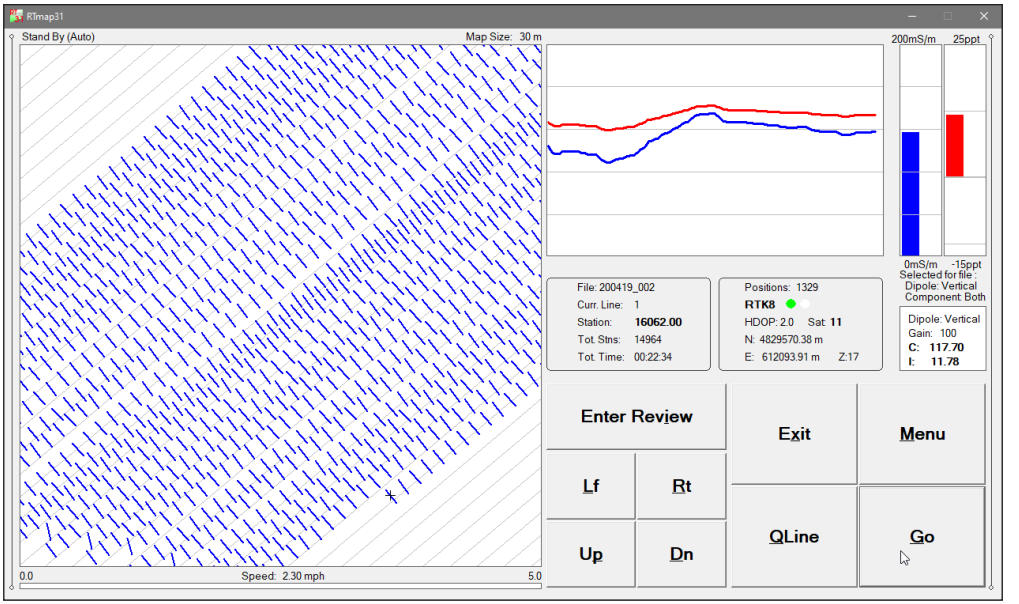


Figure 1.5 RTmap31 screen in Navigation (Stand By) mode, Swath Bars represent selected footprint as 1 m on a 30 m scale map with 1 m guiding parallel lines separation.

for each measurement. Due to screen resolution and specified map size readings points may be decimated or filled in (expanded) to show coverage in continues mode. The RTmap31 screen in Mapping mode example is shown in Figure 1.7.

When all settings for the system and survey (discussed in later sections) are specified, the user selects Logging option in Main menu of the program. This sets the program in Monitoring mode which allows you to examine the EM31-MK2 outputs and GPS performance. To record data one has to specify the data file name. The program will allow you to append data to an existing file (in T31 format), or recall the last file. After the data file is created the program will switch to Stand By mode. The Stand By mode allows for continuous data monitoring as well as use available field options. Clicking or tapping on the Go button (or pressing key G or <ENTER> if it is default button) will change the program to Logging mode and EM31-MK2 and GPS data will be recorded in the data file according to selected mode of operation. Updated map, profile windows as well as green background in numeric values window clearly indicate Logging mode and data recording, Figure 1.8.

Positions of sensors are calculated in real time in Navigation and in Mapping modes and properly reflect preset GPS antenna offsets. Actual position of GPS antenna is shown by "+" cursor.

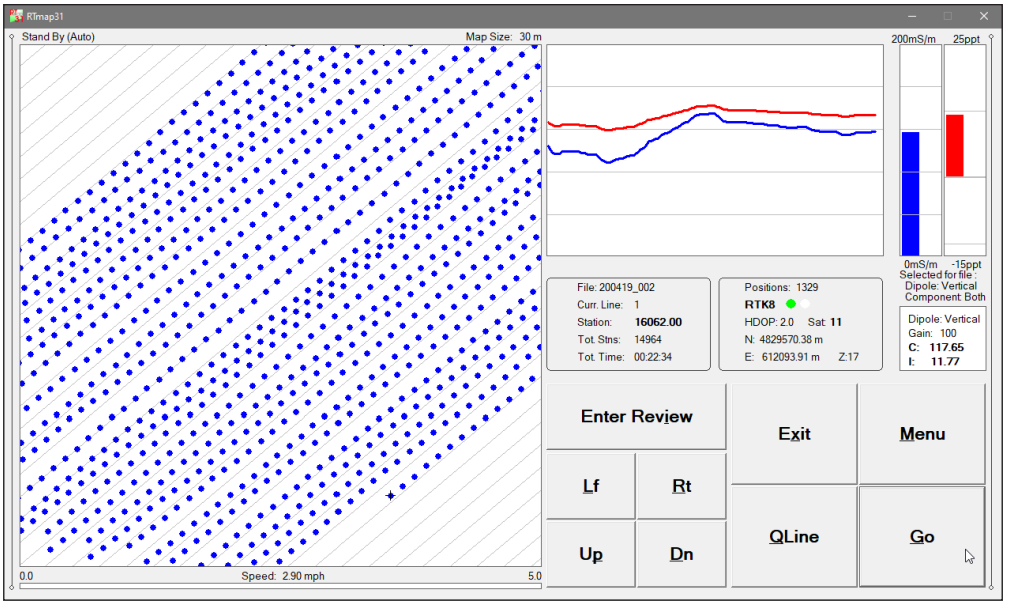


Figure 1.6 The RTmap31 screen in Navigation (Stand By) mode, EM31-MK2 positions are represented by dots (parameters as in Fig. 1.5).

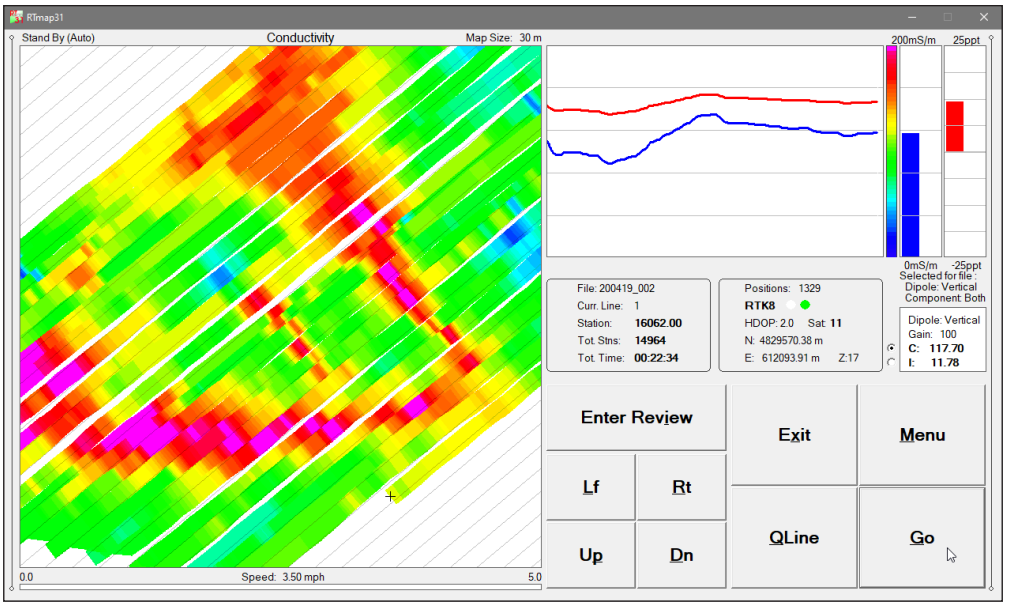


Figure 1.7: The RTmap31 in the Mapping (Stand By) mode, mapped is Conductivity, (parameters as in Figure 1.5)

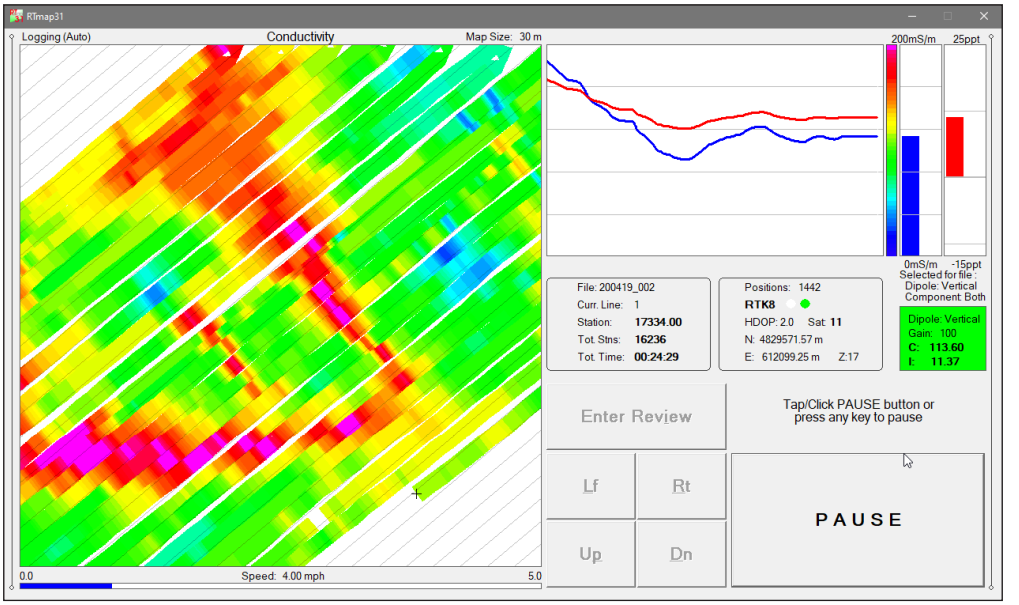


Figure 1.8: The RTmap31 in the Mapping (Logging) mode, mapped is Conductivity component, (cursor indicates instant position of GPS antenna, color traces instrument positions, and green background in numeric values window indicates data recording)

If GPS is not used during the survey the default type of display is Profile mode and Mapping and Navigation modes are not accessible. Example of the RTmap31 screen in Profile mode is given in Figure 1.9. When changing display from Profile to Navigation mode while large amount of data is collected, a message Wait is displayed and the program may take several seconds to select the needed coordinates while scanning the entire database of collected positions. There is no such delay during scrolling since the program keeps track of survey path while in navigation mode.

The maximum number of 28,800 GPS positions is allowed in one file. This corresponds to 8 hours of continuous data collection if GPS positions are collected every second, or 16 hours if GPS data is taken every 2 seconds. However, it is strongly advised to limit files for example to approximately 1 hour blocks, especially when using high frequency of EM31-MK2 data collection. In case of any possible error in data file it is much easier to correct smaller file. Data files are permanently saved every time PAUSE key is used. In case of accidental computer lock up, data file will contain all readings till the Pause Key was used last time. Therefore, it is good practice to pause data recording at any possible moment, for example at the end of each survey line, at any obstruction, etc.

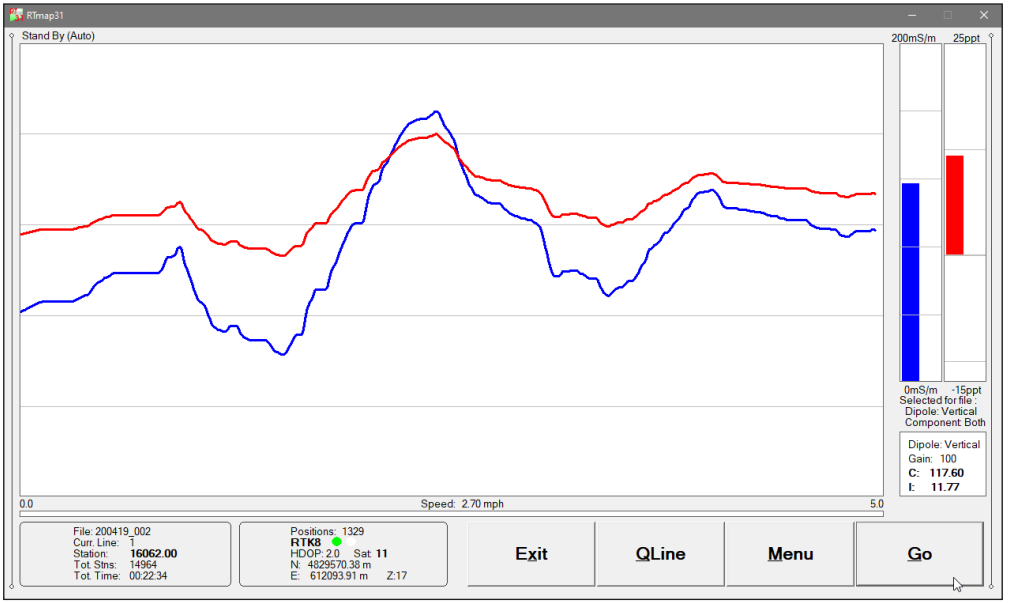


Figure 1.9: The RTmap31 in the Profile (Stand By) mode

1.9 Surveys Carried Out With GPS Positioning

Most of the stations positions for surveys positioned with GPS receiver will be calculated based on the GPS antenna position and instant heading of the array. The data processing program RTM31 uses sophisticated calculations to apply GPS antenna offsets, however in order to achieve highest possible quality of data positioning the survey should be carried out along relatively smooth pathways, especially if GPS antenna is located not in the center of the instrument.

When the direction of the survey line is changed it is advised to pause recording of data for the duration of U-turn. Toggling between Stand By mode (pause) and Log mode is relatively easy in the most difficult field conditions, it is done by one key stroke (Pause and Start keys), and it can save time during data processing.

Similar approach applies to situations when the system is stopped. In this case if readings are not paused, the random distribution of small GPS errors will likely result in unreliable locations of calculated sensor positions. If the offset of GPS antenna is used it may appear that the instrument is rotating since GPS errors occur in many directions. Pausing readings while the system is stopped will save time during data processing and will result in better data presentation.

1.10 The RTmap31 System Geometry

When a survey is positioned by GPS system the program allows to specify the GPS antenna offset from the EM31-MK2 center. Two parameters, GPS X Offset and GPS Y offset describe location of GPS antenna. This location is represented by the distance which is measured from the center of the conductivity meter to the center of the GPS antenna, while facing direction of the movement, see Figure 1.10.

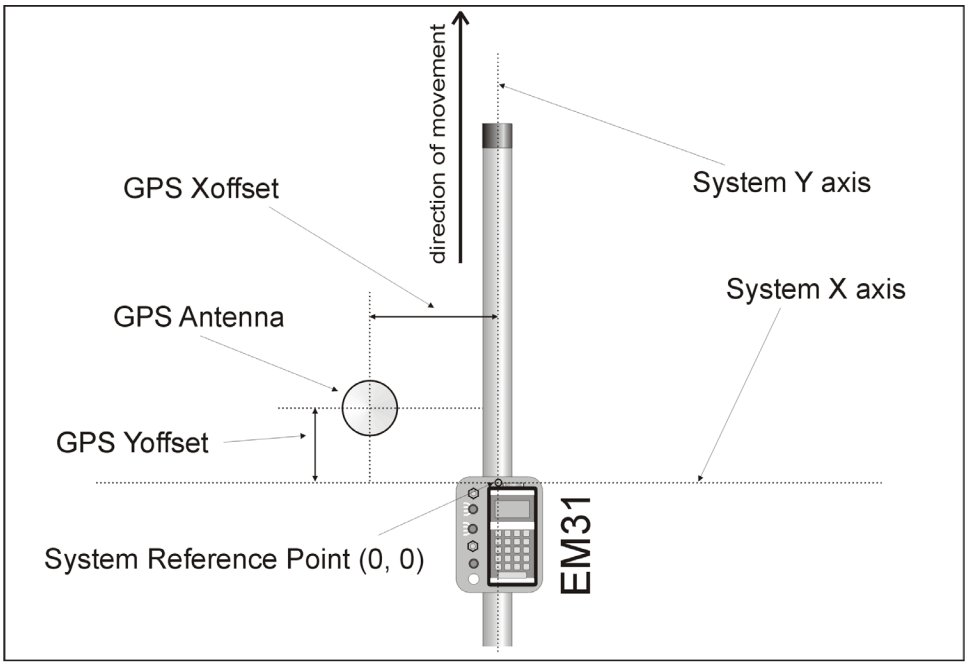


Figure 1.10: The RTmap31 system geometry

The antenna can be placed anywhere in relation to the instrument center. However to achieve higher accuracy of the calculated positions the GPS antenna must be placed as close to the center of the system as possible.

This option is provided mainly for common situations where the operator carries the EM31-MK2 on his right side, and GPS antenna (placed in backpack) is located above his left shoulder. In this case distance between GPS antenna and the instrument (GPS Xoffset) is negative.

An example of the system geometry employed during towing is shown in Figure 1.11. In this case GPS Y offset is positive and GPS X offset is zero.

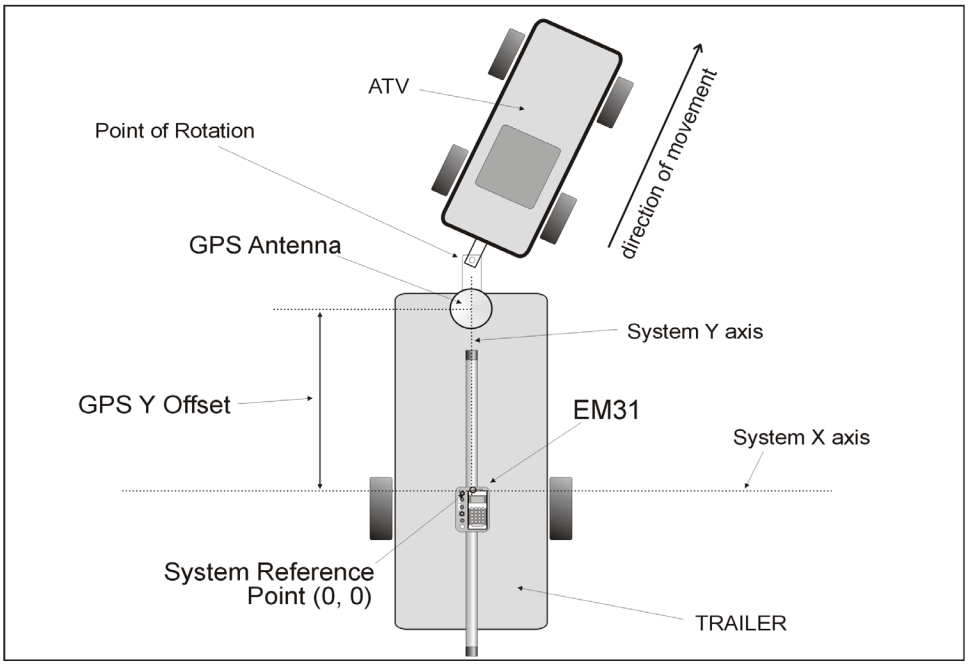


Figure 1.11: The RTmap31 towing setup example

During the survey RTmap31 applies GPS antenna offsets in real time, and calculates and displays the EM31-MK2 real scaled positions in Mapping/Navigation mode.

In the case where a wrong value was entered in the field, GPS X Offset and GPS Y Offset parameters can be corrected later during data processing in the program RTM31.

Main Screen

2

The Main Screen appears always as the first window after the program is started. It contains the name of the program, its version number, and list of command buttons with available options on the right side. The major , left portion of the window contains information about current survey and system settings, and graphic illustrating current array geometry. The graphic diagram is updated in real time as soon as system geometry parameters are changed in Geometry Setup dialog. The RTmap31 Main Screen window is shown below in Figure 2.1.

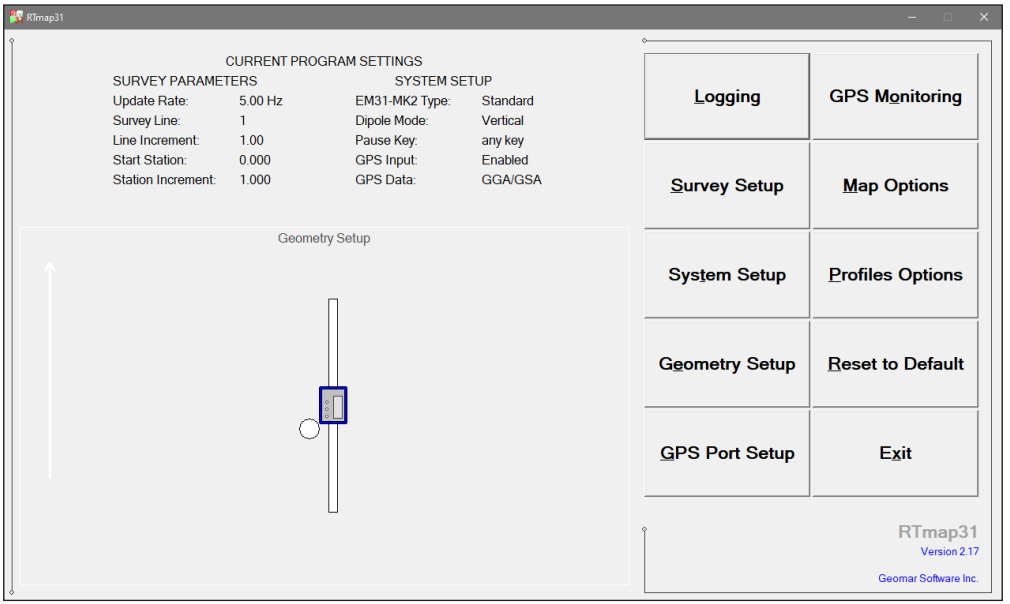


Figure 2.1: RTmap31 Main Screen window

The RTmap31 is a command button and dialog driven program. Command buttons can be executed by clicking with the left mouse button, or by pressing the indicated (underlined) character on the keyboard, or by using TAB to scroll through the buttons and ENTER to execute. In the Main Screen of the program Up and Down arrow keys can be also used to scroll through the buttons. Short description for each of the options follows.

Logging

This option allows you to monitor and log the EM31-MK2 output and GPS receiver positions. Logging screen starts always in Monitor mode, and then after a data file is created Logging mode is available. Monitor mode provides initial inspection of the range of the instrument readings at the particular site, and quick inspection of the instrument settings and GPS receiver performance.

Survey Setup

Dialog that is associated with this option is used to set data collection update rate, dipole mode, survey line name, line and station increments, and other parameters which are necessary to determine survey settings.
Dialog window that is associated with this option is used to set instrument update rate, dipole mode, component, survey line name, start station, line and station increments, and other parameters which are necessary to determine survey settings (Figure 2.2).

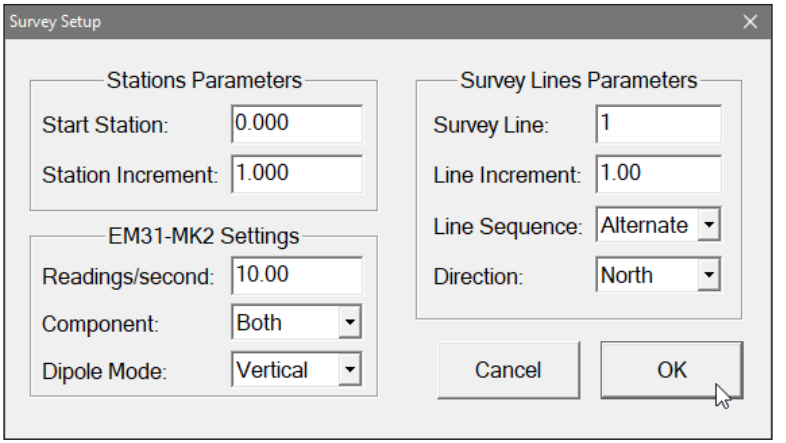


Figure 2.2: Survey Setup dialog

System Setup

This option (see Figure 2.3) allows user to enable and disable (if GXY file is to be collected) instrument connection, to select type of EM31-MK2 instruments connected to the field computer, and to assign serial port number for the EM31-MK2 and GPS. The Pause Key, Speed Bar units, Coordinates Display type (geodetic or UTM with units), Audio indicating recording as well as Audio Alarm for disconnection can be also selected in this dialog.

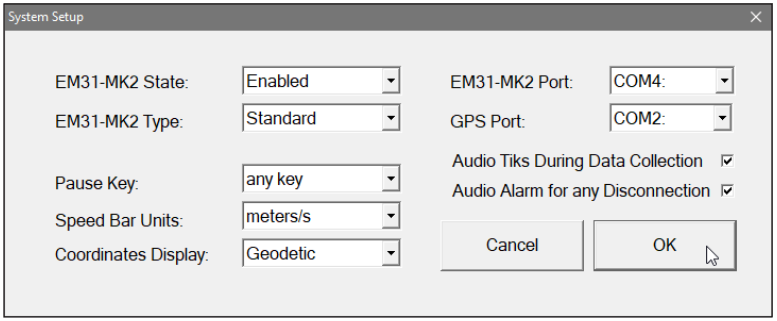


Figure 2.3: System Setup dialog

Geometry Setup

This dialog allows you to specify GPS antenna offsets, and units used in this dialog. The dialog is shown in Figure 2.4. Small graphic window illustrates meaning of geometry parameters (this is reference graphic, the drawing is not updated as graphic diagram in Main Screen which represents actual layout of the system). After the button OK is clicked the dialog disappears and layout of the system configuration is updated in the Main Screen.

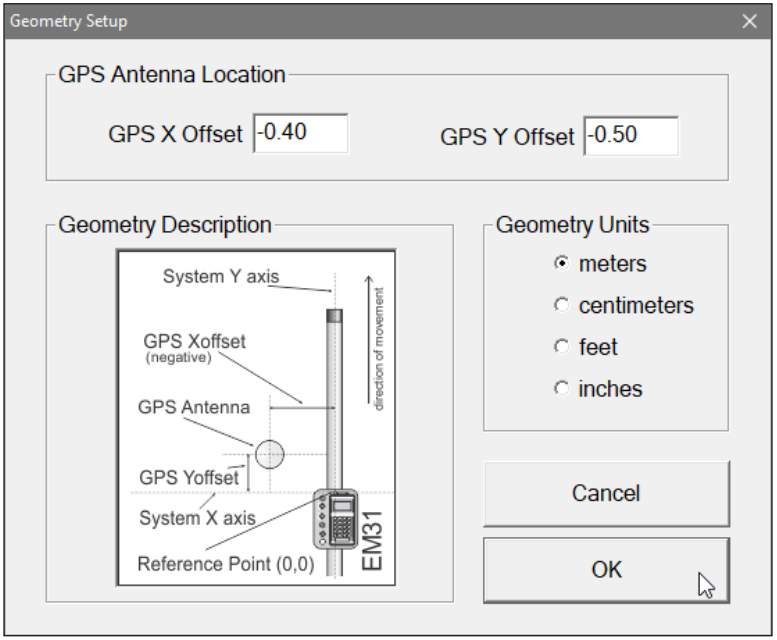


Figure 2.4: Array Geometry Setup dialog

GPS Port Setup

The GPS Port Setup dialog (Figure 2.5) allows you to disable and enable GPS data acquisition. It is also used to specify NMEA message that is streamed by GPS receiver or Robotic Total Station interface, set the serial port number used for GPS input (it can be also set in System Setup dialog), and to specify all necessary serial port communication settings.

This dialog provides also set of parameters that enable and determine GPS Warning Mask function.

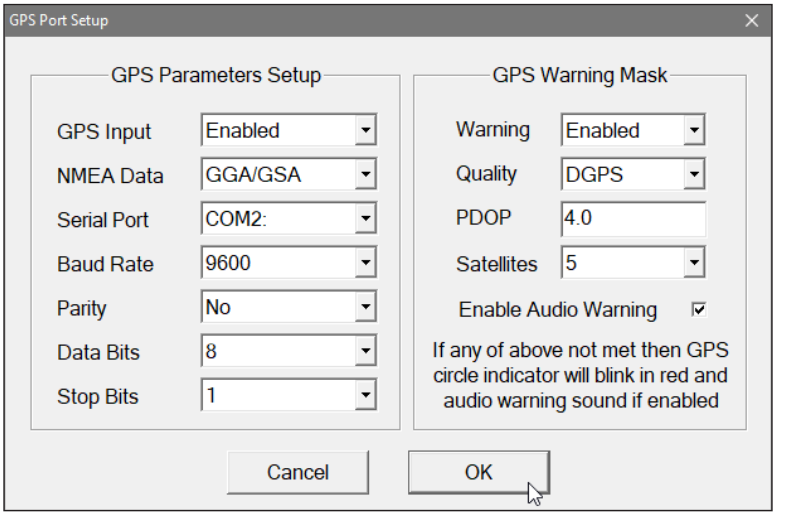


Figure 2.5: GPS Port Setup dialog

Monitor GPS

After the button labeled Monitor GPS is clicked or tapped on the GPS Monitoring will be displayed. Any string streamed by GPS receiver will be displayed in the monitoring window. In addition to monitoring GPS output, this window allows to send NMEA command to GPS receivers (if supported by connected GPS model).

Map Options

The Map Display Options dialog (Figure 2.6) allows you to specify size and colour of the cursor showing current GPS antenna position, as well as a size of dot or swath bar representing recorded position. The option labeled Colour Map View can be used to set Navigation mode (by selecting item: GPS Positions, No Color Amplitude) and Mapping mode (any other item in this combo box selection with choice of displaying colour map of one of channels - Conductivity for 1.0 m coils separation is selected in Figure 2.6).

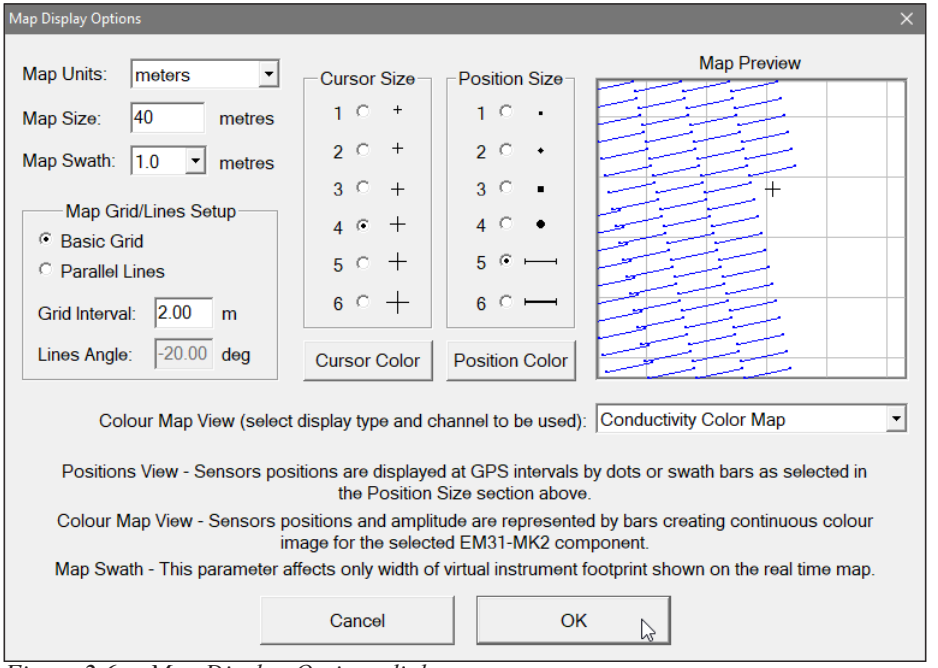


Figure 2.6: Map Display Options dialog

The size of Map Swath can be selected in meters. It will represent width of the instrument footprint drawn and scaled to displayed map. The Map Swath width should be selected based on intended survey line spacing and lateral resolution of the survey.

In addition the Map Size, selection of Grid or Parallel Lines (together with Lines Tilt Angle), as well as Grid (or Lines) interval can be specified in this dialog.

This dialog can be also displayed and all parameters with the exception of Map Swath and Map Units (both must be selected before Logging session) can be adjusted at any time during data collection in Logging mode.

Profile Options

The Setup Display Options dialog (Figure 2.7) allows you to specify colour and thickness of profile line for each channel (component, dipole mode, and coils separation).

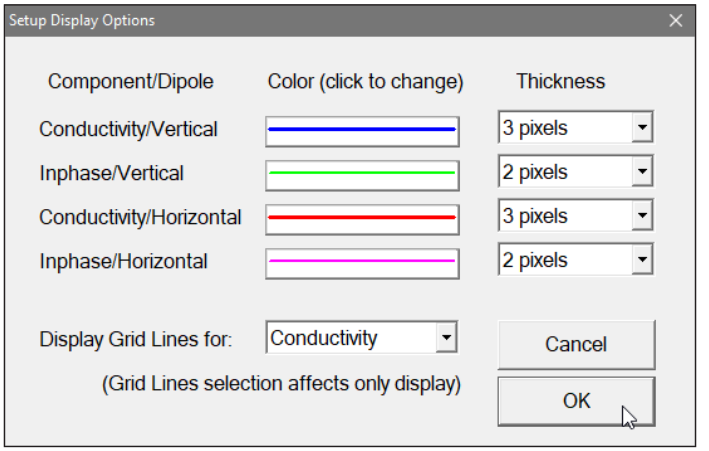


Figure 2.7: Setup Display Options dialog

Reset to Default

A warning message will appear. The program reloads its default settings and it closes. When it will be run again a new fresh configuration file will be created.

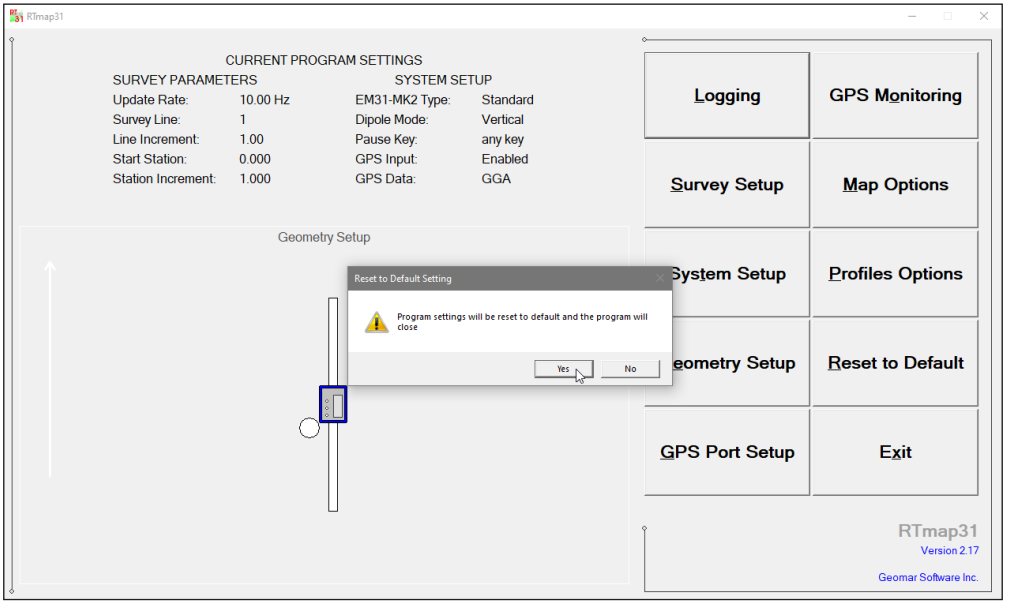


Figure 2.8: Reset parameters to default values procedure

Exit

Selecting this option will terminate the program execution.

Survey Setup 3

The Survey Setup dialog, presented below in Figure 3.1, contains several parameters which affect two important procedures: instrument settings (update rate, component, and dipole mode), and survey geometry layout (survey lines parameters and stations parameters).

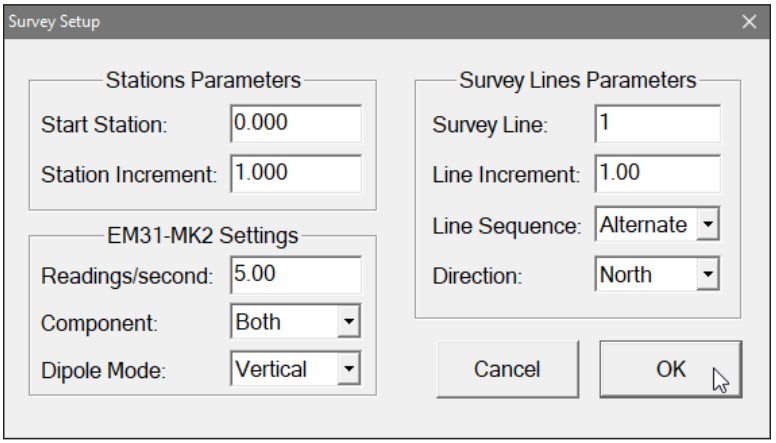


Figure 3.1: Survey Setup dialog

Description of the Survey Setup dialog options and parameters.

Readings/second (update rate)

Activate text box by left mouse click, tapping or using TAB key and then enter desired value. The edit box accepts only positive numerical values.
This parameter describes number of readings per second that will be taken. Any number larger than zero can be entered, however the EM38-MK2 fixed frequency of data output is approximately 11 readings per second. Therefore any entered value is rounded to the nearest possible base frequency of the instrument, i.e. user specified frequency of 10 readings/s will result in effective data acquisition rate of 11 readings/s (every reading is logged), 6 readings/s will cause program to log at a rate of 5.25 readings/s (every second reading from instrument output is logged), etc. At slower rates the difference between specified and effective frequencies is negligible.

Component

Tap on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box and then by

using up or down arrow keys select one of two available items: Both or Inphase (Figure 3.2). When switch on the EM31 console is set to OPER then use Both, Conductivity and Inphase is streamed by the instrument and both components will be recorded in data file. If the switch on the console indicates COMP mode then component Inphase must be selected. The Inphase component (no conductivity) is streamed by the EM31 in this mode.

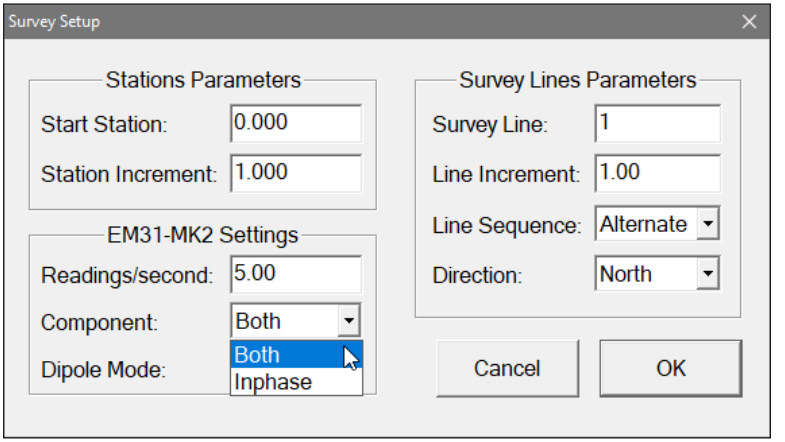


Figure 3.2: Selecting EM31 component

Dipole Mode

Tap on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box and then by using up or down arrow keys select one of two available items: Vertical or Horizontal (Figure 3.3).

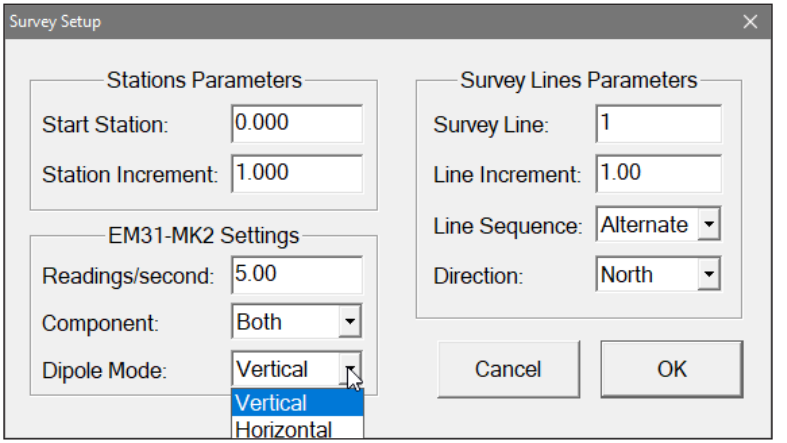


Figure 3.3: Selecting EM31 Dipole Mode

Survey Line (survey line name)

Activate text box by tapping or using TAB key and then enter desired name (number) for the survey line.

This is a user's tag number/name for the profile line. The length of the name can not exceed 8 characters.

In case the survey is positioned with GPS system, the Survey Line (and all following parameters described below) can be ignored. The Survey Line, however, can have informative meaning, it can be used to divide or to distinguish certain portions of the survey, without creating new file for each set of data.

During surveys conducted along grid (no GPS positioning) the line name is usually used as a coordinate perpendicular to the survey lines direction. For example, when survey lines are laid out along W-E direction stations describe W-E coordinate, while Line names may describe S-N (vertical on a map) coordinate.

If survey is conducted along grid (no GPS positioning) use negative numbers to indicate South and West direction. Letters associated with direction (S, N, W, E) can be used, however they must follow numbers and they will be ignored during creating XYZ file in the Geonics DAT31W program format (i.e. Line -20S, will be assigned to coordinate -20, South or West depending on the survey layout, while Line 20S will indicate coordinate 20, North or East depending on the survey layout). Letters used in Survey Line name have only informative meaning, they can be used also for naming the same lines, either portions of the same line or if a survey line is repeated (computer program will assign the same coordinate for lines 10, 10A, and so on).

Line Increment

Activate text box by clicking or tapping on or using TAB key and then enter desired for the survey line increment.

This parameter specifies the distance by which survey lines will be separated. This setting will be used to determine number (name) of the next survey line and will provide automatic survey line name while executing option Quick Line. This parameter can be ignored if survey is positioned with GPS system.

Sequence

Tapping on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box and then by using up or down arrow keys select one of two available items: Alternate and One Way (Figure 3.4).

Alternate is used when neighboring lines are surveyed in the opposite direction, which is the most common procedure during field surveys.

One Way is used when each survey line is traversed in the same direction.

The choice of this parameter will affect the default start station, a signature of

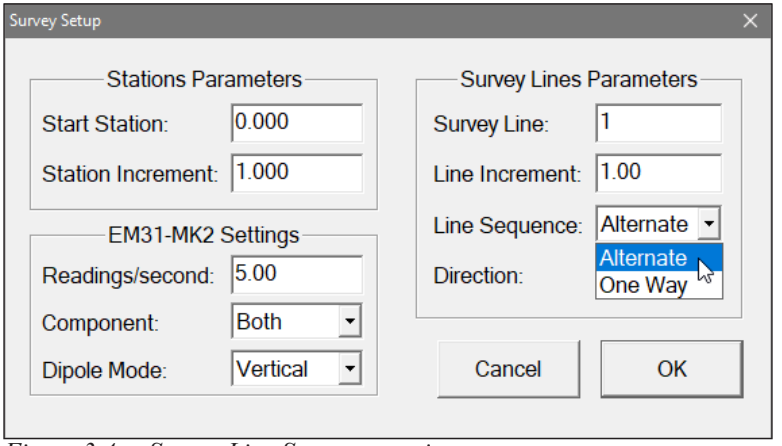


Figure 3.4: Survey Line Sequence options

the station increment, and line direction when parameters for the next survey lines is determined.
This parameter can be ignored if survey is positioned with GPS system.

Direction

Tap on the down arrow next to the text box and a drop-down box will open showing the available options, or when the keyboard is used activate the text box and then by using up or down arrow keys select one of four available settings: East, West, South, and North (Figure 3.5).

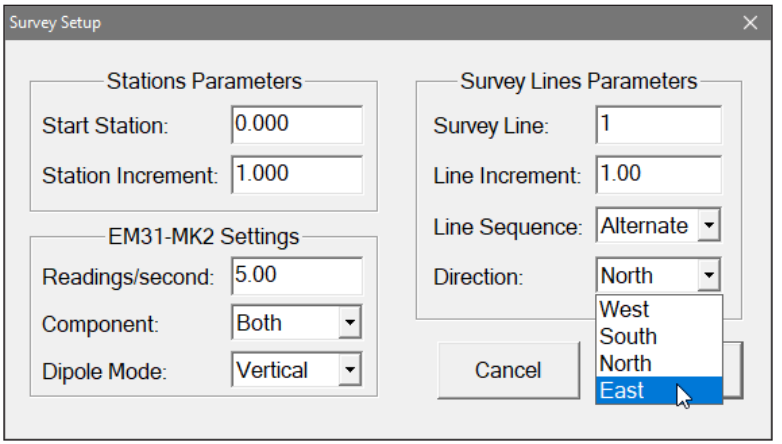


Figure 3.5: Selecting Direction of Survey Line

This parameter indicates the heading of the survey line and it can be ignored if survey is positioned with GPS system.

When survey is conducted along a grid, the Direction has only informative meaning. During generating XYZ file, only three parameters: Survey Line Name, Start Station and Station Increment, will be used to determine geometry of the survey layout.

Start Station (start station of a survey line)

Activate text box by tapping or using **TAB** key and then enter the desired value for the start station.

This parameter specifies the starting station number for the selected survey line. This value is used in conjunction with Station Increment to calculate the current station number for display purposes.

If GPS positioning is used, this parameter has only informative meaning. The most convenient is to set Start Station to 0, then Station Increment = 1 and the current station will indicate number of stations taken since the start of the data file.

Stn Increment (station or wheel increment)

Activate text box by tapping or using **TAB** key and then enter the desired value for the station increment.

This parameter specifies the station increment for the selected survey line. This value is used in conjunction with Start Station to calculate the current station number for display purposes.

If GPS positioning is used the most convenient is to set the Station Increment equal 1. The station displayed during data recording will indicate number of stations taken since the start of the data file.

After all the parameters in the Survey Setup dialog are updated tap the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent Survey Setup dialog.

To return to original settings (state before this dialog was selected) tap **Cancel** (X) button or press **Esc** key. All parameters will be reset to initial settings and the program will return to the Main Screen.

System Setup 4

The System Setup dialog, presented below in Figure 4.1, contains several parameters. It allows you to enable and disable instrument connection, select the instrument type, a pause key selection, speed bar units used during survey, coordinates display, serial ports assignment and audio options.

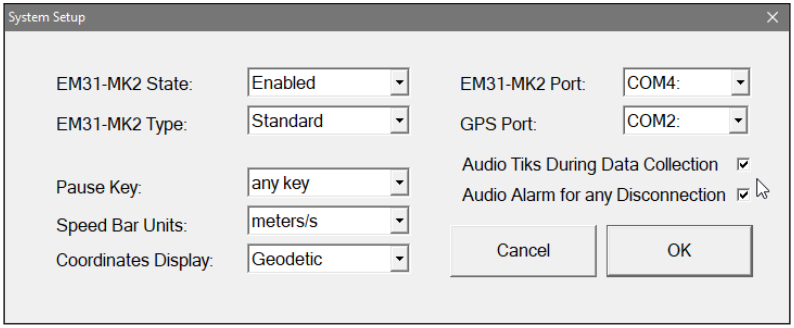


Figure 4.1: System Setup dialog

To select any option click on the corresponding drop-down list box or radio button, or use TAB key to scroll to the option and then use mouse, touch screen, or the Down and Up keys in drop-down box or radio buttons section.

Description of the System Setup dialog options and parameters.

EM31-MK2 (Enable/Disable)

Click with left mouse button or tap on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box and then by using up or down arrow keys select one of two available items: **Enabled** or **Disabled**.

Select Enable for normal operation when EM31-MK2 are to be recorded. When Disabled is selected the program will not record, nor will check for presence of the EM31-MK2 instrument. This feature is used when only GPS positions are to be recorded. In this case created data file will have extension name GXY. These files can be used to survey roads, fences, buildings, or any other topographical features.

EM31-MK2 Type

Tap on the down arrow next to the text box opens a drop-down box showing the available settings (Figure 4.2), or when the keyboard is used activate the text box and then by using up or down arrow keys select one of two available items:

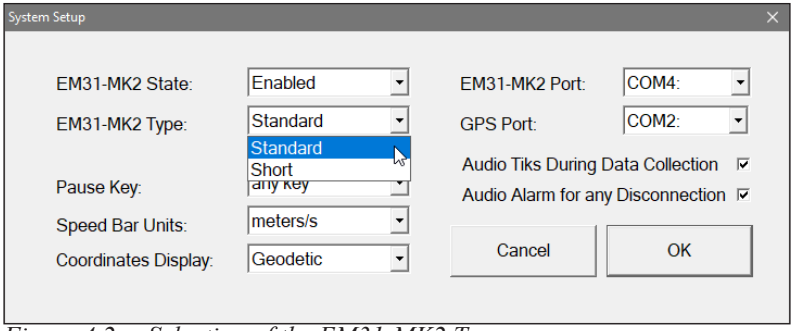


Figure 4.2: Selection of the EM31-MK2 Type

EM31 Standard (3.6 m boom) and EM31-SH (2 m boom). All data coming from the instrument are saved in original form in the data file, therefore in case of an error in selection all readings can be retrieved in the data processing program.

Pause Key

When this option is highlighted and drop-down box is expanded use mouse or use Down or Up cursor key to toggle between available options (Figure 4.3). Four selections are available: Any key, Enter, Space bar, and P key. This feature is used to pause data recording during logging session. Default setting **any key** can be changed to a single key for field conditions where a logger key can be accidentally pushed causing unwanted stop of data logging.

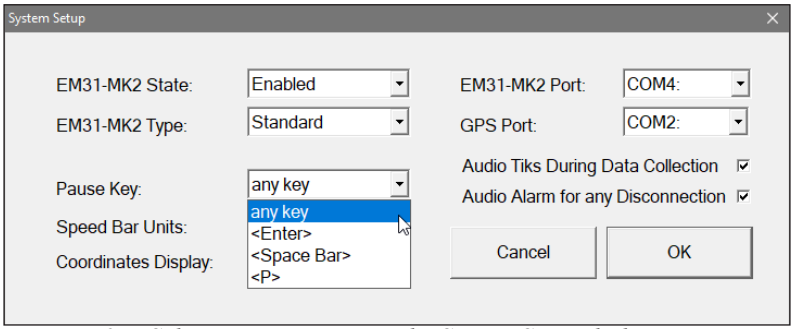


Figure 4.3: Selecting Pause Key in the System Setup dialog

Speed Bar Units

When this option is highlighted and drop-down box is expanded use mouse or use Down or Up cursor key to toggle between available options (Figure 4.4). Four selections are available: meters/s , feet/s, km/h, and mph. These units will be used to calculate the system speed based on the current and former GPS antenna position. Speed is displayed graphically as a speed bar and in numeric form while logging data during GPS based surveys.

This parameter can be changed later using Menu options during data logging.

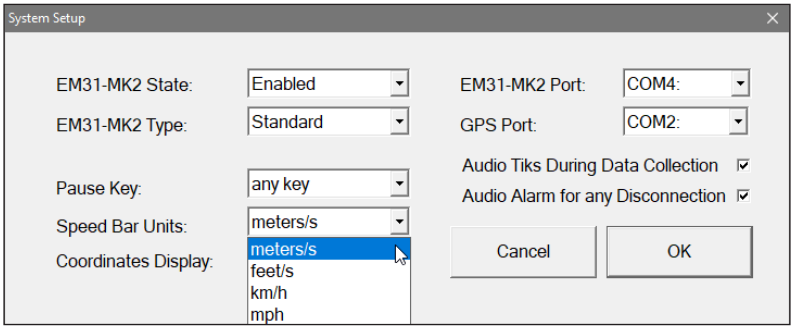


Figure 4.4: Selecting Speed Bar units

Coordinates Display

When this option is highlighted and drop-down box is expanded use mouse or use Down or Up cursor key to toggle between available options (Figure 4.5). Four selections are available: Geodetic, UTM meters, UTM feet, and UTM US Feet. A selected type of coordinates will be calculated and displayed in real time below map during data collection (please see numerous examples in Chapter 8). It affects only display (data file contains always original GPS readings). Regardless of the coordinates type selection positions are always displayed in datum WGS1984.

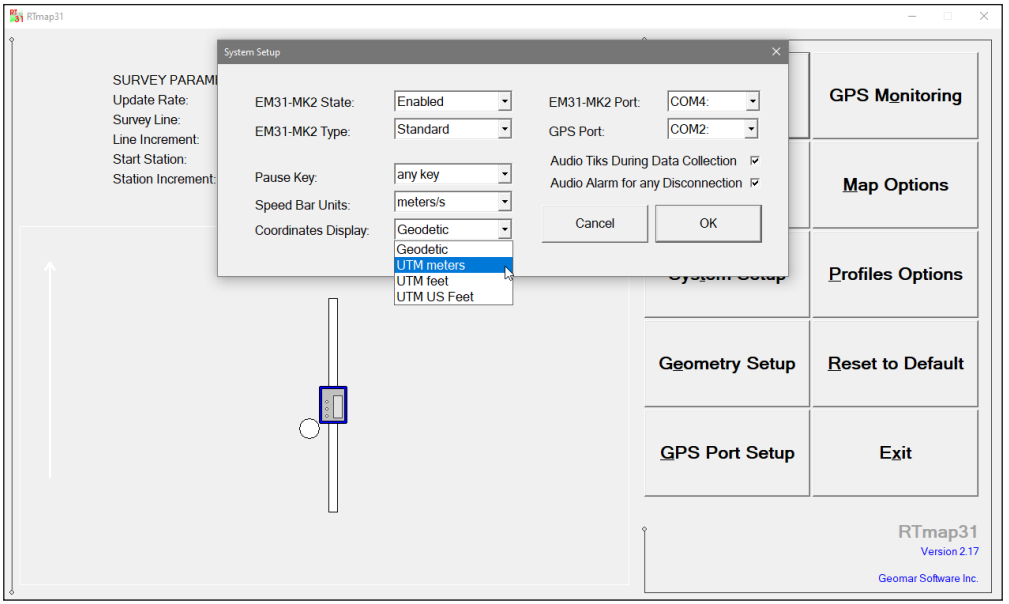


Figure 4.5: Selecting type of Coordinates for display

This parameter can be changed later during data logging.

EM31-MK2 Port and GPS Port

Navigate with mouse or TAB key to each Sensor Port (EM31-MK2 or GPS) and when the option is highlighted and drop-down box is expanded use mouse or use Down or Up cursor key to toggle between available settings. The program supports ports from COM1 to COM60 for the EM31-MK2 and for GPS receiver (see Figure 4.6).

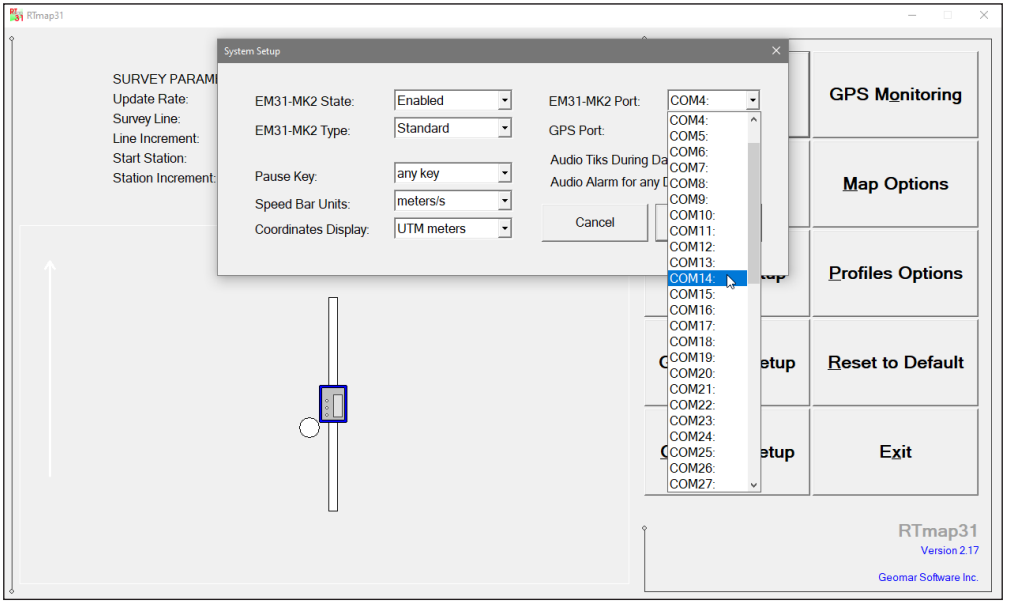


Figure 4.6: Selecting Serial Port in the System Setup dialog

Select proper serial port for the instrument and GPS receiver (GPS Port can be also modified in the GPS Port Setup dialog). Selected ports are checked by the program for assignment conflict at the time data logging starts.

The program supports Serial Ports 1 to 60. Any serial port can be assigned, however care should be taken that the EM31-MK2 instrument and GPS receiver are connected to proper (indicated here) serial ports.

Audio Tiks During Data Collection

The program will provide tik-tak sound during data recording (in the Logging mode only). The tick sounds with frequency approximately 3 Hz. This audio feature may be helpful as a confirmation that the button Go has been pressed (or tapped) and data is being collected and saved in data file. This audio function can be enabled or disabled by check button as shown in Figure 4.5.

Sound Alarm

The program will sound loud ring in case of any serial port disconnection, or in case any EM31-MK2 unit or GPS receiver will stop streaming data. The audio alarm function does not depend on the visual alarm that is always enabled regardless of audio alarm setting. The audio alarm function can be enabled or disabled by check button at the Sound Alarm for any Disconnection label as shown in Figure 4.5.

After all the parameters in the System Setup dialog are updated click by the mouse or tap the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent Survey Setup dialog.

To return to original settings (state before this dialog was selected) tap **Cancel** (X) button or press **Esc** key. All parameters will be reset to initial settings and the program will return to the Main Screen.

Geometry Setup 5

The Geometry Setup dialog, presented below in Figure 5.1, contains parameters which describe the system configuration: location of GPS antenna. The dialog contains a graphic window labeled Geometry Description which illustrates meaning of parameters used to specify geometry of a system. This graphic window is used only as a reference, it does not reflect actual system layout.

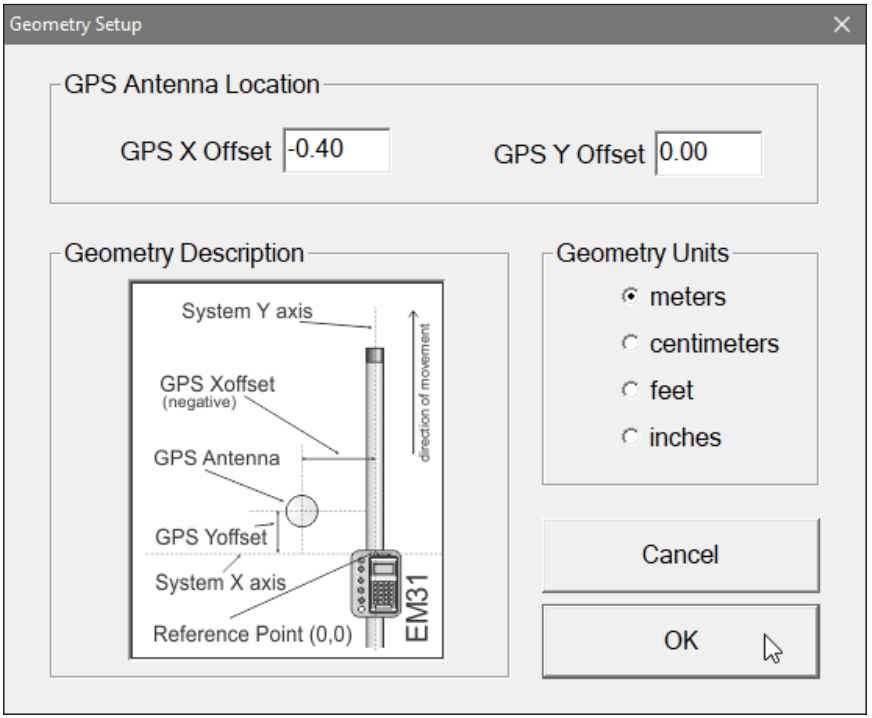


Figure 5.1: Geometry Setup dialog

The current layout of a system is displayed in graphic diagram located in Main Screen. As soon as the button OK in Geometry Setup dialog is clicked (or executed by keyboard) the dialog is closed, the program calculates positions of sensor and GPS antenna using new parameters and displays its layout in the Main Screen window. This visual approach helps to notice immediately a case when wrong parameters were entered.

Description of the Logger Setup dialog options and parameters.

GPS X Offset
GPS Y Offset

Activate GPS X Offset or GPS Y Offset text box by tapping or using TAB key and then enter value for corresponding offset

These two options apply only when a survey is positioned by GPS system. The GPS X and Y offsets describes location of GPS antenna. This location is represented by the distance which is measured from the center of the EM31-MK2 coil to the center of the GPS antenna, while facing direction of the movement, see Figure 5.2.

The GPS Antenna offset distances can be given in meters or feet depending on the Geometry Units setting in this dialog.

GPS antenna can be placed anywhere in relation to the instrument center. However to achieve higher accuracy of the calculated positions the GPS antenna must be placed as close to the center of the system as possible.

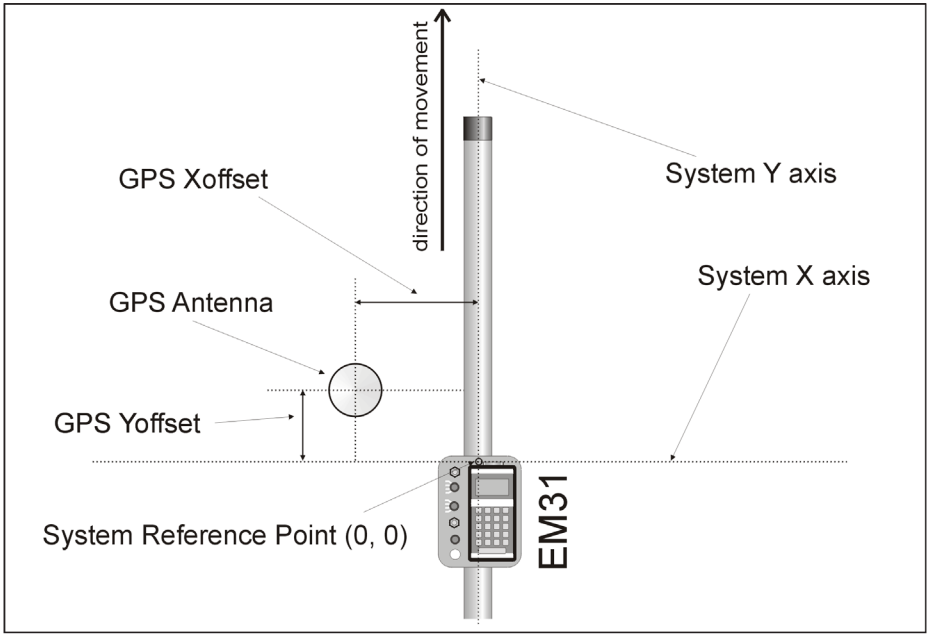


Figure 5.2: Geometry of the EM31-MK2 sensor and GPS receiver antenna

This option is provided mainly for common situations where the operator carries the EM31-MK2 on his right side, and GPS antenna (placed in backpack) is located above his left shoulder. In this case distance between GPS antenna and the instrument (GPS Xoffset) is negative.

The offset in other direction (GPS Yoffset) must be used if the instrument is towed on the trailer. If GPS antenna is located i.e. on vehicle and the EM31-MK2 is placed on the trailer (there is a point of rotation between them, see Figure 5.3) then the GPS antenna should be placed as close as possible to the point of rotation.
In the case where a wrong value was entered in the field, GPS X and Y offset parameters can be corrected later during data processing in the program RTM31.

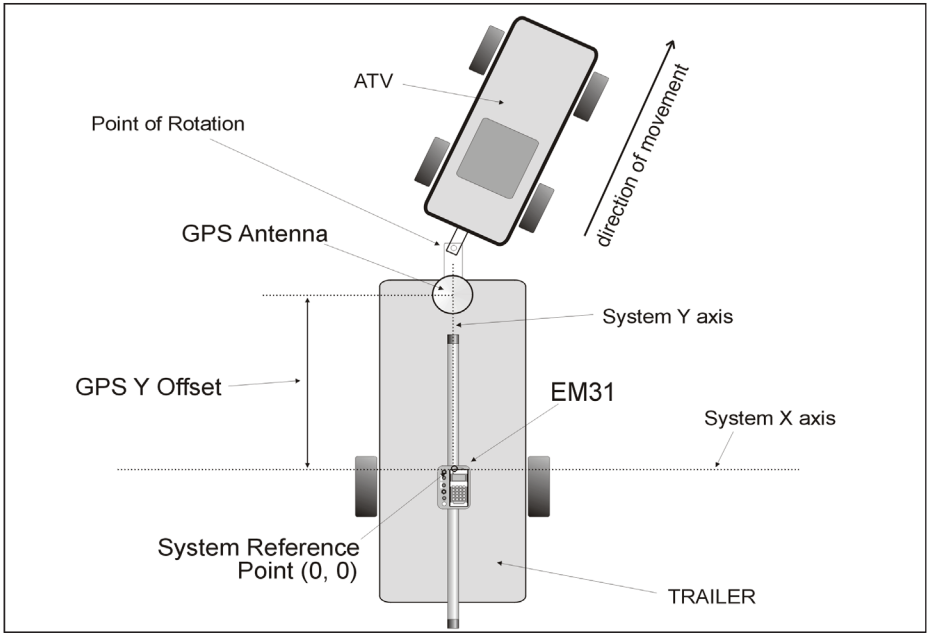


Figure 5.3: Geometry of the EM31-MK2 and GPS antenna during towing

Units

Four selections are available: Meters, Centimeters, Feet, and Inches (Figure 5.1). These units will be used to calculate positions for sensors in the program RTM31. All parameters that describe geometry of the system must be specified using units selected at this option.
Since EM31-MK2 sensors are described in meters, it is more natural and easier to use meters during specifying GPS antenna offsets parameters.
In case wrong selection was entered, units or other parameters can be corrected later in the program RTM31.

After all the parameters in the Geometry Setup dialog are updated click on the button OK or press O key (or ENTER if button OK is highlighted) to accept the displayed settings. The program will return to the Main Screen and diagram illustrating system layout will be updated immediately. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent Geometry Setup dialog.

To return to original settings (state before this dialog was selected) click Cancel button or press C key. All parameters will be reset to initial settings and the program will return to the Main Screen.

GPS Port Setup & Monitoring 6

The GPS Port Setup dialog, presented in Figure 6.1, allows for enabling or disabling GPS input, choice of NMEA data string, setting communication parameters for serial port associated with GPS input, and GPS Warning Mask parameters. The GPS Monitoring window allows you to monitor the GPS output in terminal mode as well as to change GPS receiver settings by sending a NMEA command.

6.1 GPS Port Setup Dialog

The GPS Port Setup dialog allows for enabling or disabling GPS input, choice of NMEA data string, setting communication parameters for serial port associated with GPS receiver input, as well as specifying GPS Warning Mask parameters (Figure 6.1).

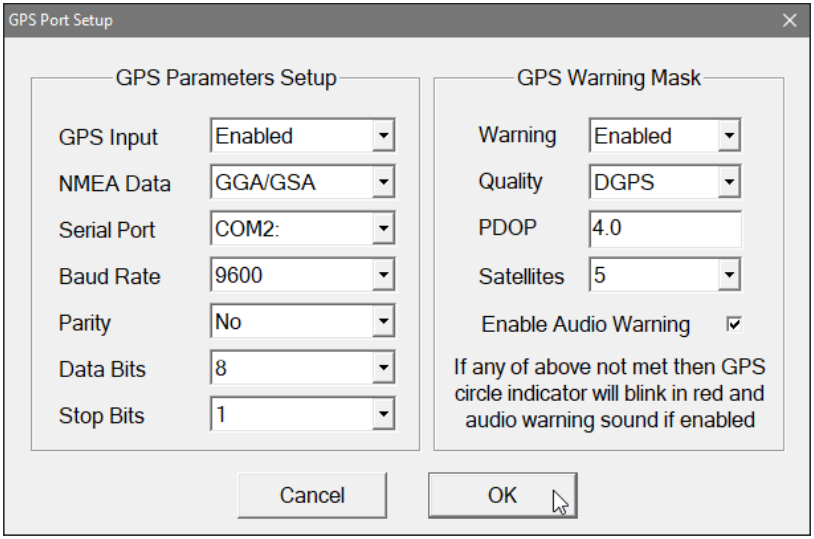


Figure 6.1: The GPS Port Setup dialog window

To select any option click on the corresponding drop-down list box or use TAB key to scroll to the option and then use mouse or the Down and Up keys to select option.

Description of the GPS Port Setup menu options and parameters.

GPS Port Setup Parameters

GPS Input

Tapping or clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: Enabled and Disabled.

This option allows you to Enable/Disable a serial port for GPS input. When Disabled is chosen logging and monitoring screens will display message "GPS disabled" in place of GPS parameters. Also, when the Disabled item is selected the RTmap31 will work only in Profile View mode, and Mapping nor Navigation modes will be unavailable.

The GPS Input can be Enabled even if there is no GPS system connected to the field computer. In such case data file will contain proper sequence of EM31-MK2 readings without any GPS input.

NMEA Data

This option allows you to choose NMEA message. The RTmap31 can make use of messages: GGA, GGA with associated GSA sentence, POS, GLL, LLK, LLQ, GLL, GGK, Leica TPS (includes Leica TPS 1100 and 1200 models, and several later Trimble RTS models supporting pseudo-GGA), Pseudo GLL (used in some marine positioning systems), Figure 6.2.

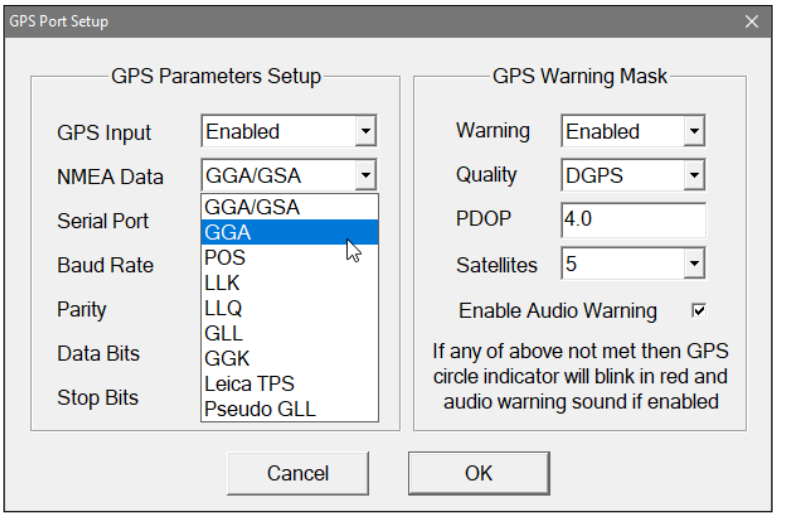


Figure 6.2: Selecting NMEA Data message

Therefore NMEA Data option has nine selections: GGA/GSA, GGA, POS, LLK, LLQ, GLL, GGK, Leica TPS (covers Leica TPS1100 and TPS1200 and several Trimble RTS), and pseudo-GLL devices.
Message GGA is supported by almost all GPS receivers. This string is used to record GPS position, while associated message GSA is used to display parameter PDOP which indicates quality of GPS signal. If a GPS receiver supports only GGA string and option GGA/GSA is selected, GPS positions will be recorded using GGA message and PDOP parameter will be displayed as N/A (not available). In such case user should monitor quality of GPS signal using GPS receiver display or can monitor number of available satellites. If GGA option is selected a parameter HDOP will be displayed on the screen.
Messages POS and GGK which are supported by a smaller number of manufacturers (however POS is available in all Ashtech receivers and GGK in some Trimble receivers) are preferable since they contain all necessary information, including the PDOP, in one sentence. If your GPS receiver supports POS or GGK and GGA messages, and PDOP parameter is required, select POS or GGK which provide faster operation for the field computer.
Messages LLK and LLQ are used in some Leica GPS systems and provide positions in meters in local coordinate system. When LLK is selected a parameter GDOP will be displayed on the screen. Message LLQ provides precision of positioning in meters and this parameter will be provided on the logger screen.
Various NMEA messages support different Dilution parameters therefore selected message will affect label of Dilution parameter in Warning Mask section of the dialog (compare Figure 6.1 and 6.3). Message GGA/GSA supports PDOP, GGA supports HDOP, GGK supports DOP, etc. (please refer to your GPS manual or Appendix B).

COM Port

The number of serial port that is assigned to the GPS input. Available selections are from COM1 to COM60. The program default is COM1. Communication parameters for the selected serial port can be determined in options described below.
This port must be different than a port specified in the Logger Setup menu for the EM31-MK2 input, otherwise a warning message will be displayed and ports will have to be reassigned.

Baud Rate

Specify Baud Rate for the output port, the entered value should much the Baud Rate of the GPS system, default is 9600.

Parity

Select Parity for the output port, the entered parameter should much the Parity set in the GPS serial port settings, default is N.

Data Bits

Specify Data Bits for the output port, the entered value should much settings in the GPS system, default is 8.

Stop Bits

Specify Stop Bits for the output port, the entered value should much settings in the GPS system, default is 1.

GPS Warning Mask Parameters

Warning

Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: Enabled and Disabled.
This option allows you to Enable/Disable a GPS Warning Mask that contains three parameters: Quality Indicator (degree of differential corrections), Dilution Parameter (PDOP or other label depending on the selected NMEA message), and number of available satellites (Figure 6.3).

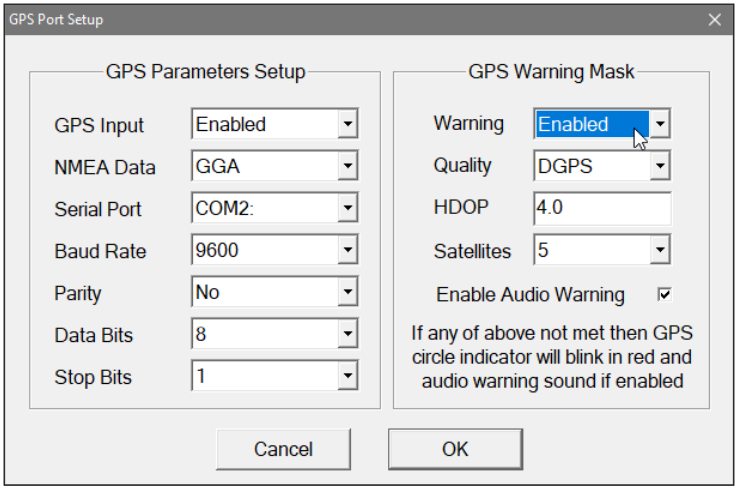


Figure 6.3: GPS Mask Warning Section enabled

When Enabled is chosen GPS two circle indicator will be alternating in green and white if conditions for specified parameters setting will be met. When any of the parameters is below set values then GPS indicators will alternate in red and white colours. In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours regardless of GPS signal quality.
All GPS data is logged, GPS Warning Mask affects only display.

Quality

This parameter describes Quality Indicator (degree of differential corrections). Tapping on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: AGPS (Raw), DGPS, RTK3, RTK4, and RTK5, Figure 6.4. If Quality Indicator received from GPS receiver will be worse than specified then GPS indicator will alternate in red and white colours.

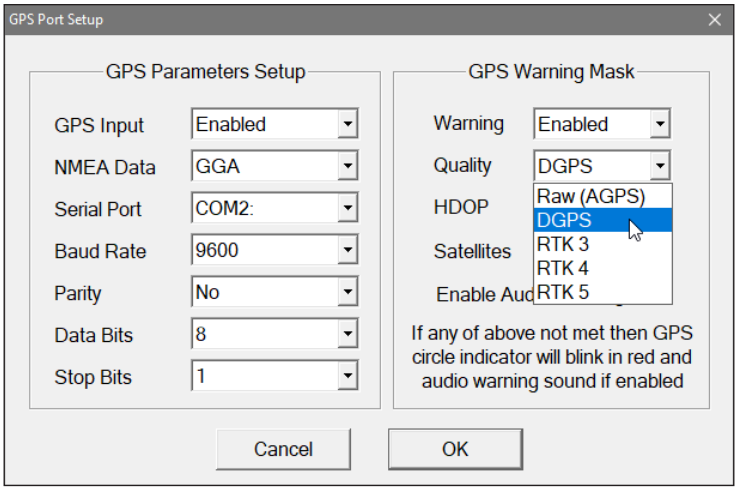


Figure 6.4: GPS Mask Warning Section, Quality selection

PDOP

This parameter can be labeled PDOP, HDOP, DOPG, DOP depending on the selected NMEA message. It can be also named Quality m (accuracy in meters) if LLQ was selected, or it is not available (labeled N/A) when messages GLL or Leica TPS are used.

Activate text box by a mouse click or using TAB key and then enter the chosen acceptable maximum value of Dilution parameter.

If PDOP (or other similar parameter) is larger than specified value then GPS indicator will alternate in red and white colours.

Satellites

Tapping on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: 3 to 12.

If number of available satellites will be smaller than specified then GPS indicator will alternate in red and white colours.

After all the parameters in the Survey Setup dialog are updated click on the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent Survey Setup dialog.

To return to original settings (state before this dialog was selected) click on the **Cancel** (X) button or press **Esc** key. All parameters will be reset to initial settings and the program will return to the Main Screen.

6.2 Monitoring GPS Receiver Output

After the Main Screen command button GPS Monitoring is clicked or executed by the keyboard the program will display the GPS Monitoring window in terminal mode. In this mode the screen is divided into three parts. The terminal window in the top portion of the screen displays the GPS receiver output. The middle portion labeled NMEA Command is used to display entered NMEA commands previously sent to the GPS receiver, and at the bottom, command buttons with available options is displayed. The RTmap31 screen in terminal mode is shown in Figure 6.5.

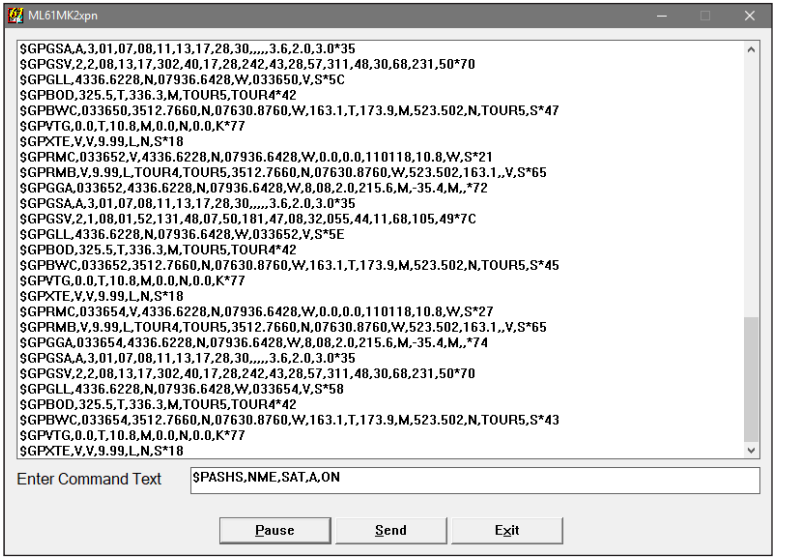


Figure 6.5: Monitoring GPS output in monitoring (terminal) mode

As soon as the RTmap31 GPS Monitoring window is displayed and the GPS receiver is streaming data, the contents of each message will appear in the top portion of the

display. The display is updated with the frequency the GPS receiver outputs data. This allows you to recognize the GPS update rate and type of messages being sent by the connected GPS.

Example in Figure 6.5 shows output of GPS receiver which sends three NMEA messages GGA and GSA updated every second. In cases where the GPS data is not received by the logger a message NO DATA and current time will appear in the top window of the display, as shown in Figure 6.6.

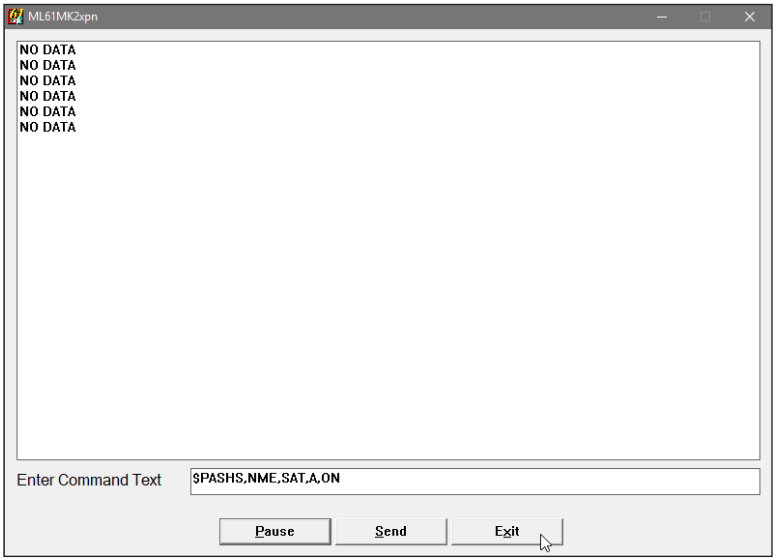


Figure 6.6: GPS Monitoring window when no GPS data is available

The message NO DATA is normally updated with a rate of 6 seconds. This indicates the following:

serial port number not correctly specified in Set Port for GPS menu,
the GPS receiver not sending any data,
not connected or not working GPS receiver.

If the message is updated more often than 6 seconds (i.e. every 1 or 2 seconds) or the display does not show legible characters, it is possible that the GPS is working correctly and is connected to the proper serial port, however communication parameters are not specified correctly. In most cases the Baud Rate or Parity must be adjusted.

The NO DATA message may also appear if the GPS data are received correctly, but the GPS receiver was set to send data with a time interval longer than 6 seconds. In this case the NO DATA message will be displayed in between GPS messages. This indicates that the GPS is working correctly, however the operator should consider adjustment of

the GPS receiver output update rate. Most high resolution geophysical surveys require positioning update of 1 or 2 seconds, and a 5 seconds interval can be used only when the survey is carried out at an even pace and along relatively straight survey lines.

The monitoring display can be paused any time by clicking on the button Pause or pressing the P key (or ENTER if the button is highlighted). At that time scrolling of the GPS output will be stopped, and the Pause button will be replaced by the button labeled Go (Figure 6.7). The next click on this button or pressing the G key (or ENTER if the button is highlighted) will activate receiving and display of GPS data.

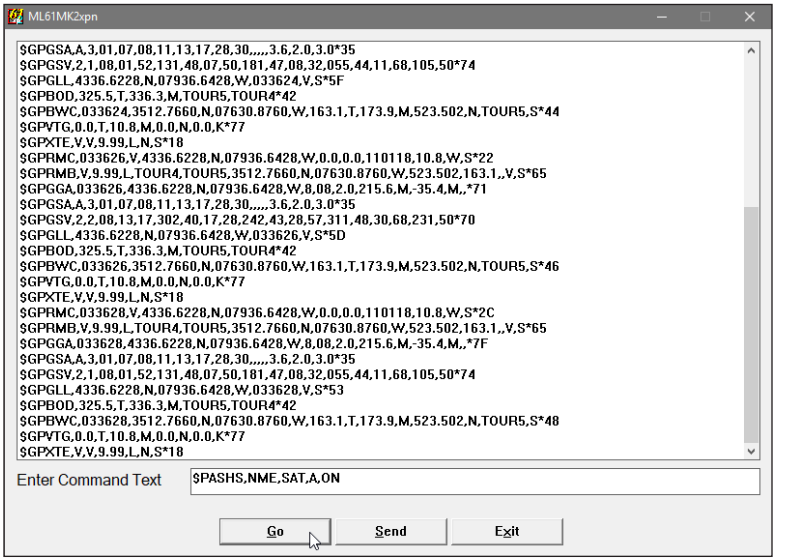


Figure 6.7: Paused GPS Monitoring window

6.3 Sending Command to GPS Receiver

The button labeled **Send** allows you to send a NMEA command to the GPS receiver. It is preferable if the GPS receiver parameters are set using the GPS manufacturer software or controller (GPS logger or panel keys). However, **when the operator is familiar with NMEA protocol and structure of commands for a given GPS system**, this function can be very convenient and useful when the update rate and enabling or disabling messages in the data stream is required. In this case resetting the GPS can be done from the RTmap31 without using any other software.

After the button **Send** is tapped a dialog titled GPS Message is displayed and the beginning of the standard NMEA command, **$PASHS,** or the last entered command is displayed (Figure 6.8). After the entire NMEA command is typed in, tap **OK** button

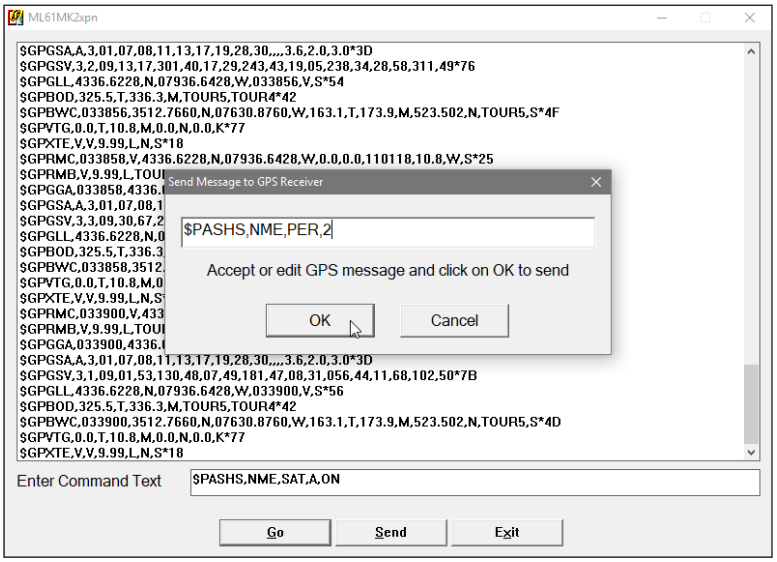


Figure 6.8: GPS Monitoring screen after button Send is executed

or press the key **<ENTER>** to send the command to the GPS receiver. Tapping **Cancel** button or pressing the **<Esc>** key will cancel the command and hide the NMEA Message dialog. An example of a command that will enable the NMEA message SAT is given in the Figure 6.9 (it is assumed that the GPS receiver output serial port is A).

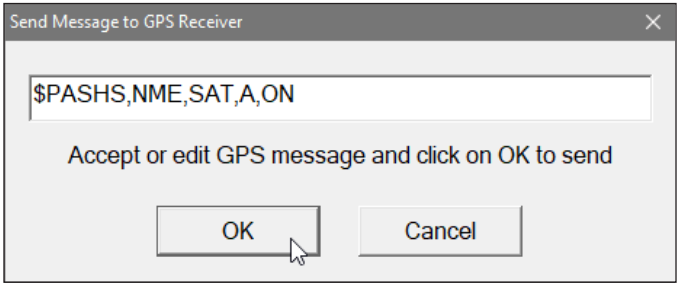


Figure 6.9: Example of the NMEA command entry

After this command is received by the GPS receiver, the confirmation message will be send by the receiver ($PASHR, ACK*3D) and data stream will not contain the message POS ($PASHR, POS,.....), as shown in Figure 6.10.

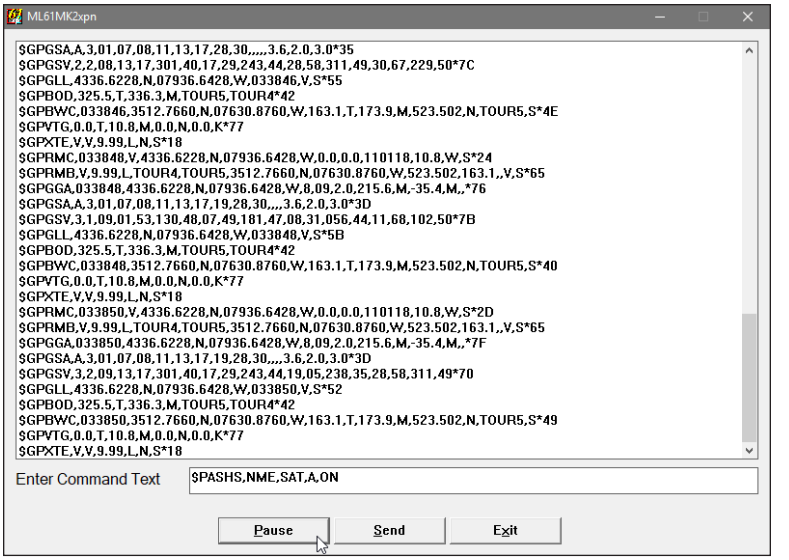


Figure 6.10: GPS Monitoring screen after NMEA command is sent

When the button **Send** is executed next time, the text of the former NMEA command is displayed in NMEA Command dialog. This text can be edited and send to GPS receiver by tapping the button **OK** in dialog window.

Please note, that not every GPS system accepts and uses the same standard set of NMEA commands and messages. In addition, some GPS systems do not accept commands sent by the serial port at all (i.e. Trimble ProXRS or ProXL). The configuration of these type of receivers can be updated only by the controlling device (usually GPS logger, controller, or the receiver panel keys). Please refer to the documentation of a given GPS system before using NMEA Command function.

Map & Profile Options 7

The Map Display Options dialog is used to specify plotting parameters for map display, colours and size of cursor and positions, the displayed position type (navigation mode), and displayed EM31-MK2 channel (mapping mode), while the Profile Options dialog allows you to select profiles to be displayed, including colour (applied also to moving graphic bars) as well as thickness of profiles.

7.1 Map Display Options

In general the RTmap31 can display map in two modes: Navigation and Mapping. In the Navigation mode position of the sensor is displayed as a dot of specified size or as a bar that has width Map Swath (selected instrument footprint), positions are plotted at GPS update rate. Mapping mode displays swath bar for each instrument reading with colour reflecting amplitude value. Samples of various map displays are provided in Chapter 1 of this manual.

After the **Map Options** button was tapped (or executed from the keyboard) in the Main Screen the Map Display Options window appears on the screen (Figure 7.1).

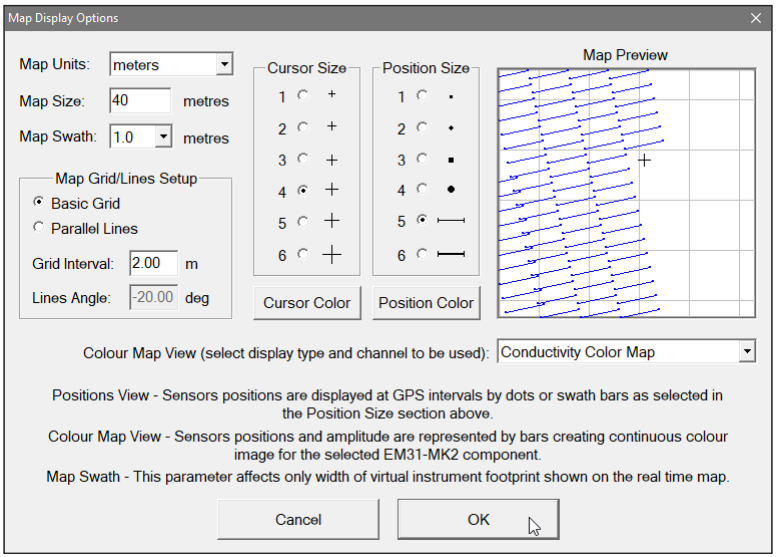


Figure 7.1: The Map Display Options window

This window is divided into five main sections. The first section located at the left specifies map units, map size, map swath, and grid lines options. The next section, second from the left, labeled Cursor Size is used to set size and colour of the cursor indicating current position of the GPS antenna. The third section, labeled Position Size allows you to specify size and colour of a dot or swath bar marking saved position on the Navigation map. The section on the right labeled Map Preview shows sample map with current settings (specified in the first three sections), it is updated in real time. The fifth section, combo box labeled Colour Map View is used to select Navigation mode or Mapping mode for a selected EM31-MK2 channel (component/dipole mode/coil separation) to be displayed as real time color image.

All parameters selected in this dialog can be adjusted later during data collection with the exception of Map Units and Map Swath.

Map Units

Three selections are available: **meters**, **feet**, or **US Survey Feet**. These units will be used to display positions and scale map in mapping and navigation modes, and to calculate positions for the instrument in program RTM31 if one of the offsets for GPS antenna is different than zero.

Map Size

Specify Map Size in units selected in the System Setup dialog. Map size describes length of each side of the map (map is always square regardless of the display size). This value can be also adjusted in Map Size option during data collection.

Map Swath

The size of Map Swath can be selected in meters, Figure 7.2. It will represent width of the instrument footprint drawn and scaled to map size. The Map Swath width should be selected based on intended survey line spacing and lateral resolution of the survey.

This parameter must be selected before Logging session starts, it cannot be adjusted at any time during data collection in Logging mode.

Map Grid/Lines Setup

Map can display gray grid or parallel lines at specified intervals as a background to help with navigation and survey coverage. When the radio button labeled Basic Grid is selected an interval between grid lines can be specified in below text box labeled Grid Interval. In case the Parallel Lines radio button is selected available parameters are Line Interval and Lines Angle.

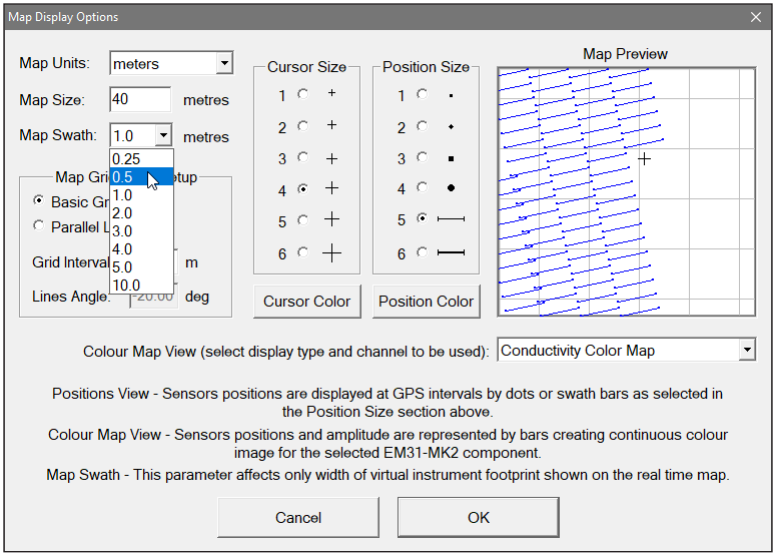


Figure 7.2: Selecting width of Map Swath bar in Map Display Options dialog

Grid lines can be plotted only in as perpendicular lines SN and WE drawn at specified interval (Figure 7.2), while selection Parallel Lines allows for Lines Interval as well as Lines Angle entries (Figure 7.3). Lines tilt angle is measured in degrees clockwise from North.

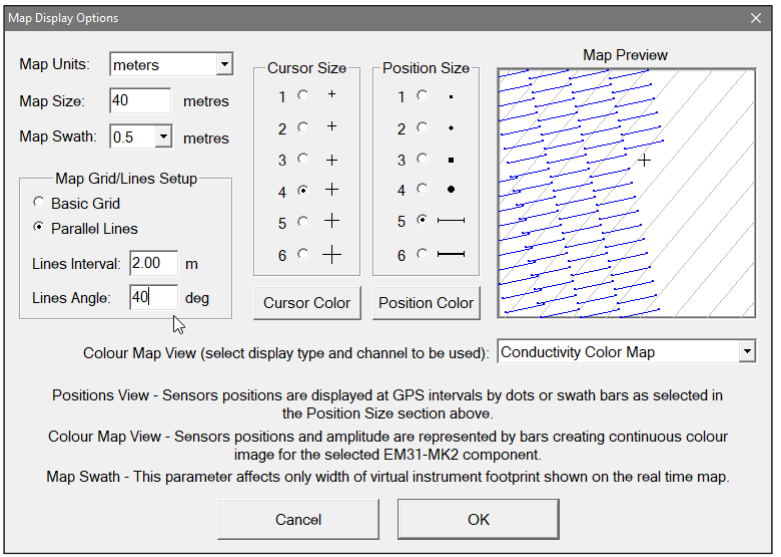


Figure 7.3: Specifying Parallel Lines and Lines Angle in Map Display Options dialog

Size of Cursor and Position

Tapping on a radio button in any of two sections will select a size of Cursor or Dot as shown by a graphic image placed next to the radio button. The selection will be immediately reflected in the Preview window, as shown in Figure 7.2 (please compare with Figure 7.1).
Size of Cursor and Position dots shown in the Preview window will be used in Mapping and Navigation modes during data collection. These parameters can be changed at any time during the survey.

Cursor Size (+ symbol) represents position of GPS antenna while Position Size (dot or swath bar) represents position of the sensor (dot) or selected instrument footprint (map swath bar) in Navigation mode.
When Mapping mode (colour image) is selected then position of the instrument is represented by a swath bar by default. Each swath bar in Mapping mode is drawn with colour corresponding to the reading amplitude at the corresponding location. Position of the instrument sensor is located in the center of swath bar. Therefore instrument trace in Mapping mode is represented by one continues bar of varying colour.
Clicking on a radio button in any of two sections will select a size of Cursor or Dot (or Swath Bar) as shown by a graphic image placed next to the radio button. The selection will be immediately reflected in the Preview window, as shown in Figure 7.4 (please compare with Figure 7.3).

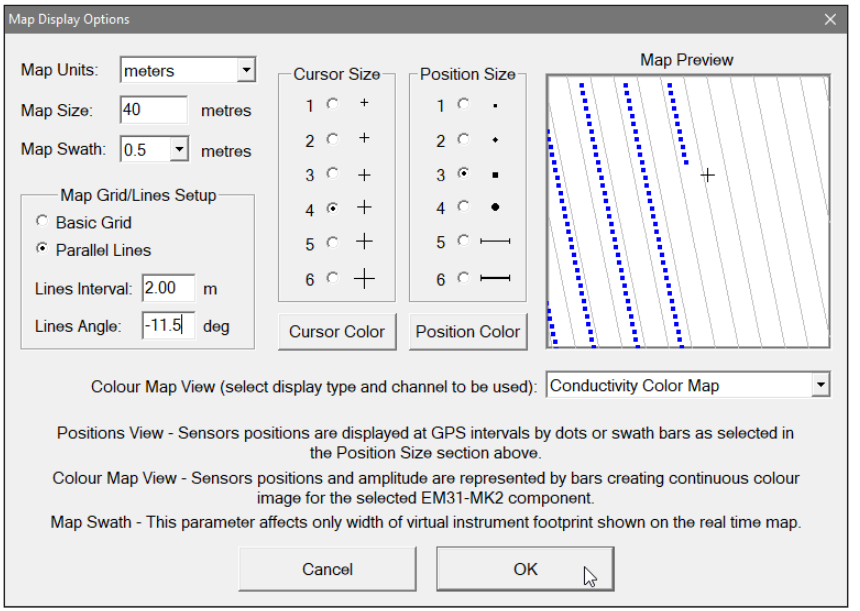


Figure 7.4: Selecting Displayed Position (Navigation mode)

Swath Bar can be selected in two thicknesses and it will be plotted to the real scale of the map.
Size of Cursor and Position dots shown in the Preview window will be used in Navigation mode during data collection. These parameters can be changed at any time during the survey.

Cursor Color/Position Color

To change colour of the Cursor or Position click the corresponding button labeled **Cursor Color** or **Position Color**. The Color dialog will appear (Figure 7.5). Select desired colour by clicking a colour box (the selected colour box will be highlighted). Other colours can be specified by tapping on the **Custom** button. The selected color will be used to plot corresponding parameter.

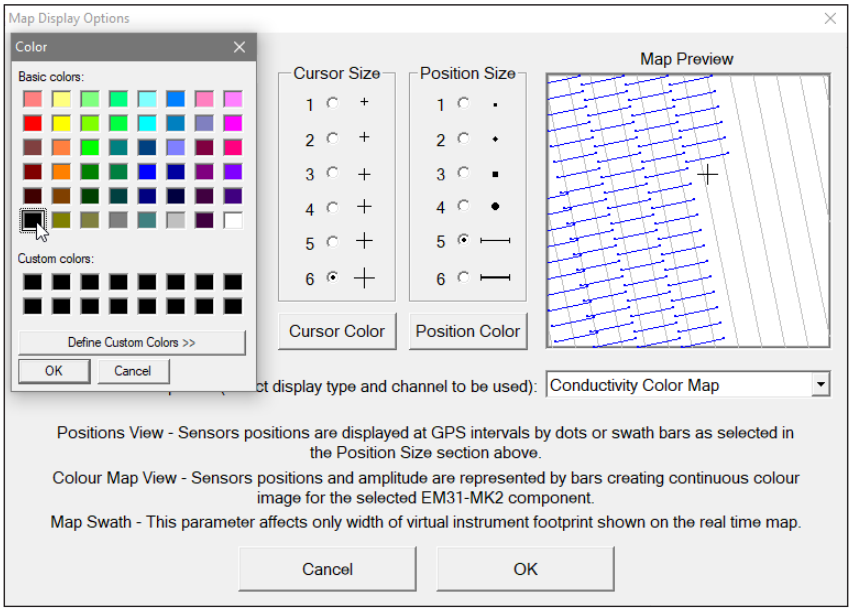


Figure 7.5: Selecting Color for Cursor or Dot and Swath Bar

Click the button **OK** or press **ENTER** key (if highlighted) to accept the highlighted colour. The Color dialog will disappear and the colour of the selected parameter (Cursor or Position) will be updated in the Preview window. To cancel colour selection click the **Cancel** (or X button) button or press **Esc** key.
Selected colours of Cursor and Position dots shown in the Preview window will be used in Navigation mode during data collection. Colour for each parameter can be changed later at any time during the survey.
When Mapping mode is selected the colour of Saved Position will be ignored since position will use colour that depends on the reading amplitude and assigned colour scale.

Colour Map View (select display type and component to be used)

Items available in this option are shown after clicking on and expanding the combo box labeled "Colour Map View", Figure 7.6.

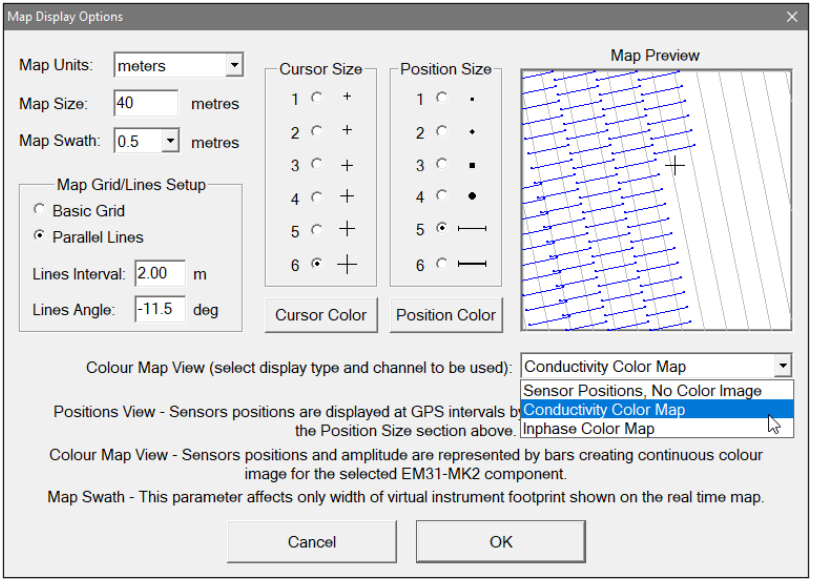


Figure 7.6: Selecting Navigation mode or Color Map View of selected channel in the Mapping mode

When the first item "Sensor Positions, No Color Amplitude" is selected the program will display map in Navigation mode. Positions drawn on map (dots or swath bar) indicate locations of EM31-MK2 sensor that include corrections for GPS antenna offsets. In Navigation mode instrument positions are drawn with the frequency of GPS update rate. GPS antenna positions is continuously updated and shown on the map by cursor "+ symbol".

Selecting remaining two items will set the program in Mapping mode. The map will show colour image of the selected EM31-MK2 component: Conductivity or Inphase measurements. Colour image of data collected for any EM31-MK2 channel (one at a time) can be selected during data collection session.

Two measured values are shown in profile view, moving graphic bars, and as numeric values, and all available data is recorded in data file regardless of the selected map display.

Scale of colour image amplitude can be specified and adjusted in the Profile Scale dialog accessible in menu in Logging mode.

After all the parameters in the Map Display Options window are updated tap the button **OK** or press **ENTER** key (if the button is highlighted) to accept the displayed settings.

The program will return to the Main Screen. Updated settings will be written to the configuration file and they will be given as default parameters in the subsequent Map Display Options windows.
To return to original settings (state before this window was displayed) tap **Cancel** button or press **Esc** key. All parameters will be reset to initial settings and the program will return to the Main Screen.

7.2 Profile Display Options

After the **Profile Options** button was clicked or tapped (or executed from the keyboard) in the Main Screen the Profile Display Options window appears on the screen. This window is used to specify plotting parameters for the program Profile View mode. The window allows you to specify color and thickness of line representing each profile, and to select Grid Lines for one of components: conductivity or Inphase. The Profile Display Options window is presented in Figure 7.7.

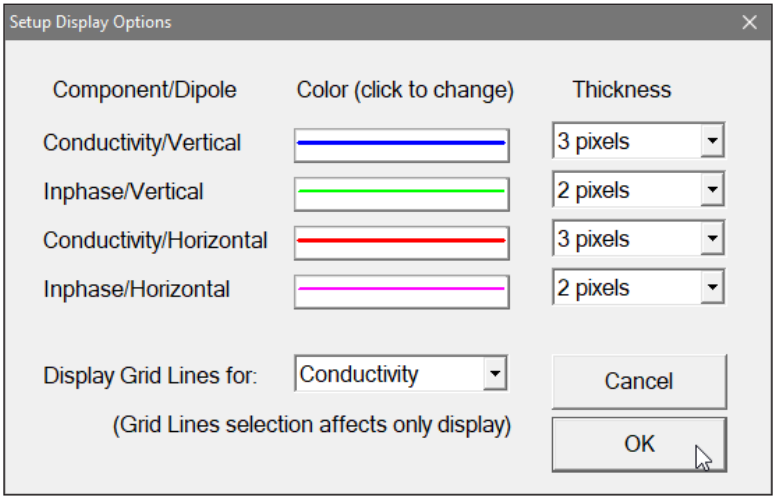


Figure 7.7: Setup Profile Display Options dialog

Description of the Survey Setup dialog options and parameters.

Color

To change colour of each profile line and moving bar click on the corresponding button (with colour line) labeled **Color (click to change)** as shown in Figure 7.8.

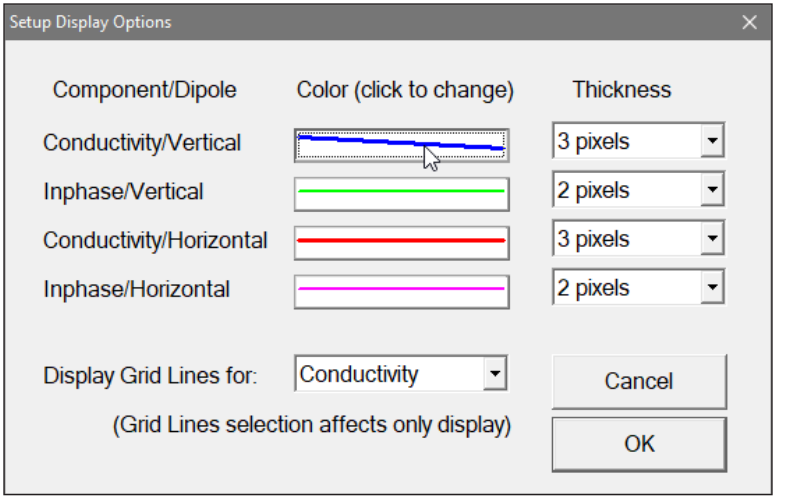


Figure 7.8: Clicking on the Color button

The Color dialog will appear (Figure 7.9). Select desired colour by clicking on a colour box (the selected colour box will be highlighted). Other colours can be specified by clicking on the **Define Custom Colors** button.
The selected color for the EM31-MK2 channel (component/dipole mode) will be used to plot corresponding profile line and moving bar.

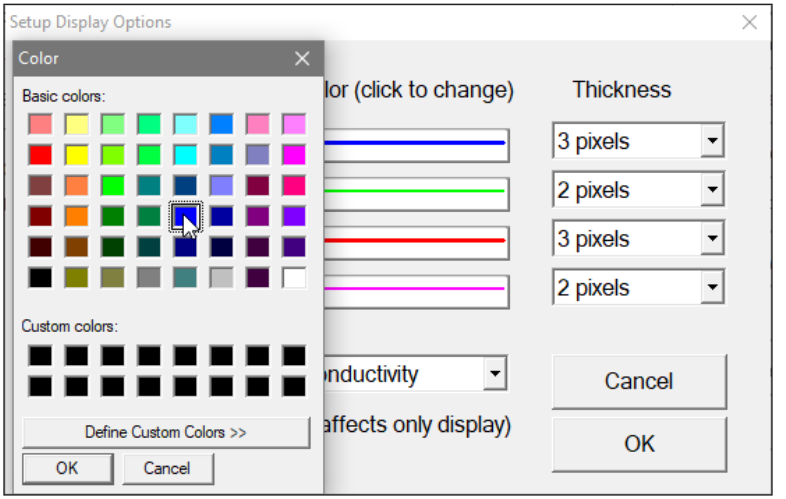


Figure 7.9: Selecting colours for profiles

Click on the button **OK** or press **ENTER** key (if highlighted) to accept the highlighted colour. The Color dialog will disappear and the colour of the appropri-

ate channel button will updated. To cancel colour selection click on the **Cancel** button or press **Esc** key.

Thickness

Specify thickness of a profile for an EM31-MK2 channel by using one of four drop-down boxes labeled Thickness. Thickness of a profile curve is specified in pixels. Available settings are: 1, 2, 3, or 4 pixels.

Clicking on the down arrow next to the text box (labeled by number of pixels) opens a drop-down box showing available selection (see Figure 7.10). Select thickness by clicking on the desired selection. If keyboard is used activate text box by pressing TAB key (till the box is highlighted) and then by using **Up** or **Down** arrow keys select one of available items.

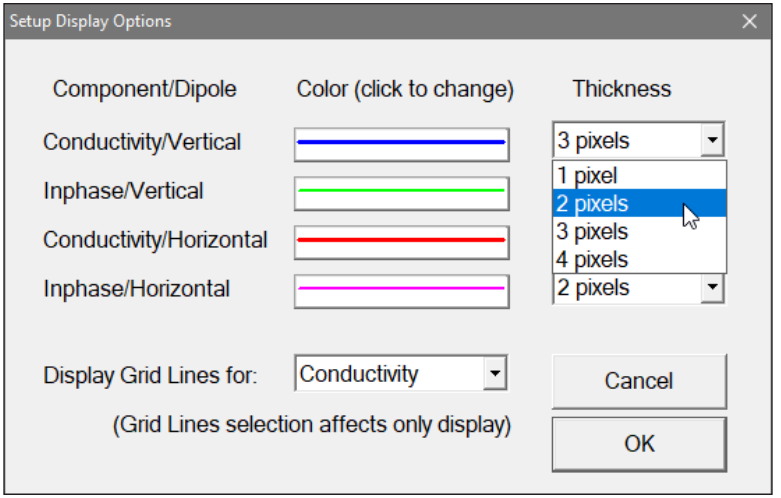


Figure 7.10: Selecting Thickness of Profile Lines

Grid Lines

Clicking or tapping on the down arrow next to the combo box labeled **Display Grid Lines** opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available two items (Figure 7.11). Profiles for both components share the same graphic window, however each component has its own scale. This option allows you to select grid lines to be displayed (as thin grey lines) for conductivity or Inphase scale. Minimum and maximum values are labeled on the right side of profile view window. Labels for the component with selected grid lines are displayed as bold numerals.

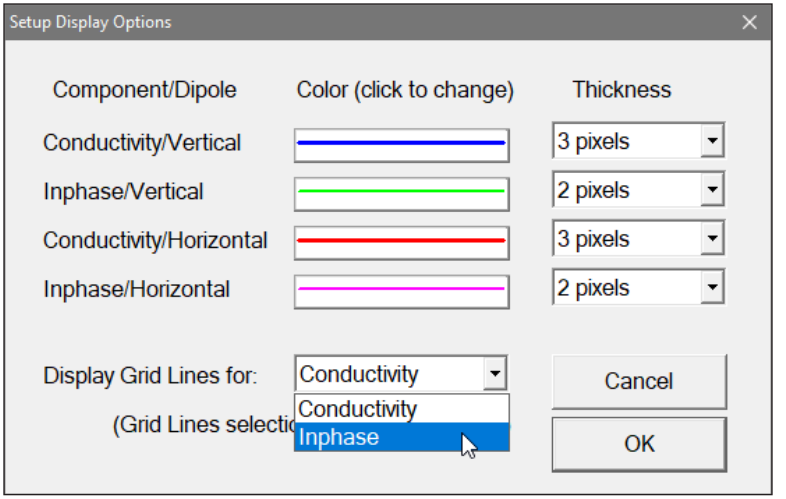


Figure 7.11: Selecting Grid Lines for Profiles

This option does not apply to moving bar windows where appropriate grid lines are always displayed for each component scale.

After all the parameters in the Profile Display Options window are updated tap button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent Profile Display Options.

To return to original settings (state before this dialog was selected) tap **Cancel** button or press **Esc** key. All parameters will be reset to initial settings and the window will disappear.

Logging

8

After the **Logging** button (in Main Screen) is clicked on, or tapped, or executed by the keyboard, the program enters logging session and starts to read data from the connected EM31-MK2 and GPS receiver. Logging session contains three modes: Monitoring, Stand By and Log. Further each of these modes can use Mapping or Navigation, or Profile mode of the display. Since the Navigation mode is a special case of Mapping mode (display of EM31-MK2 stations or GPS positions without colored image of component amplitude) the term Mapping mode will be used further to describe Mapping and Navigation modes. If the GPS Input is disabled then only the Profile mode is available.

Program starts Logging session always in Monitoring mode and in Mapping display mode if GPS Input is enabled (Figure 8.1). In this mode EM31-MK2 and GPS readings can be quickly examined, and EM31-MK2 parameters (signal level, instrument configuration) can be adjusted. The Stand By mode is similar to Monitoring mode, however different options are available. Recording of EM31-MK2 and GPS data is allowed only in Logging mode, which is accessible from Stand By mode. In general, after the data file is created in the Monitoring mode, two modes Stand By and Logging are toggled by Start

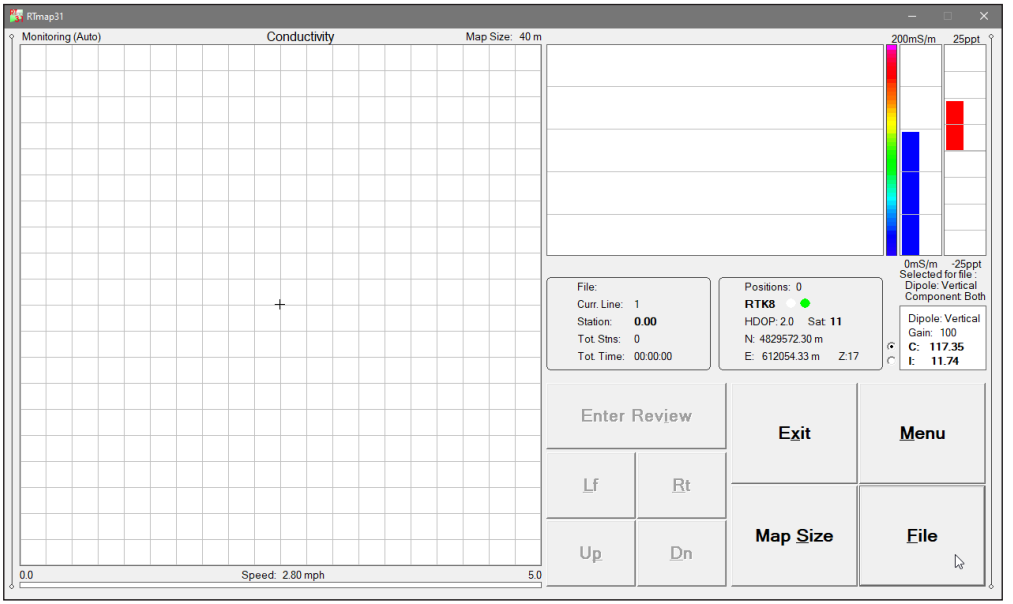


Figure 8.1: Initial RTmap31 Monitoring screen in Mapping mode

and Pause keys. In Stand By mode instrument output can be monitored and some survey parameters can be changed, and Logging mode is used only to record data.

It is assumed that all settings, especially assignment of serial ports, are correctly specified and instrument is turned ON prior to using this option. In case the instrument is OFF or it is not connected to the field computer the message shown in Figure 8.2 will appear. This message will not appear if option EM31-MK2 in System Setup dialog is Disabled. Check program settings (System Setup), connection, or turn the instrument ON and select the Logging option again.

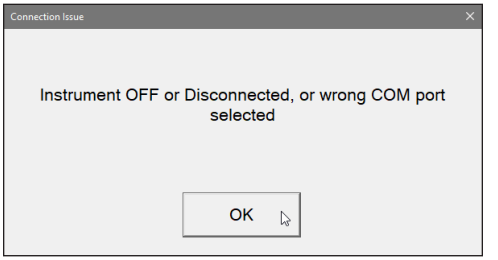


Figure 8.2: No Connection message

Assuming that instruments work properly the program will initialize connection with EM31-MK2 and a screen in Monitoring mode will be displayed.

8.1 Logging Screen Layout in Monitoring Mode

The RTmap31 Monitor mode allows initial inspection of the range of the instrument readings at the particular site, monitoring the instrument performance, dipole mode, selected channel for mapping, monitoring number of available GPS satellites, GPS differential corrections, PDOP parameter status, and Latitude and Longitude coordinates. Speed bar located at the bottom of the screen shows current instrument speed (over the ground) which is calculated from GPS data.

The EM31-MK2 readings in Monitoring and Stand By modes are updated approximately 10 times per second during monitoring session. GPS positions are updated at a rate specified in GPS receiver, usually 1 second interval.

Despite the fact that program will handle more than 1 Hz GPS update it is strongly recommended that GPS receiver is set to 1 Hz update, faster data stream may affect program performance especially when high rate of EM31-MK2 is used. The data processing program interpolates EM31-MK2 position similarly to real time GPS interpolation.

When the GPS Input is Enabled in GPS Port Setup menu then the program displays the screen in Mapping/Navigation mode by default. The RTmap31 Logging screen in Monitoring mode and Mapping display mode is shown below (Figure 8.3).

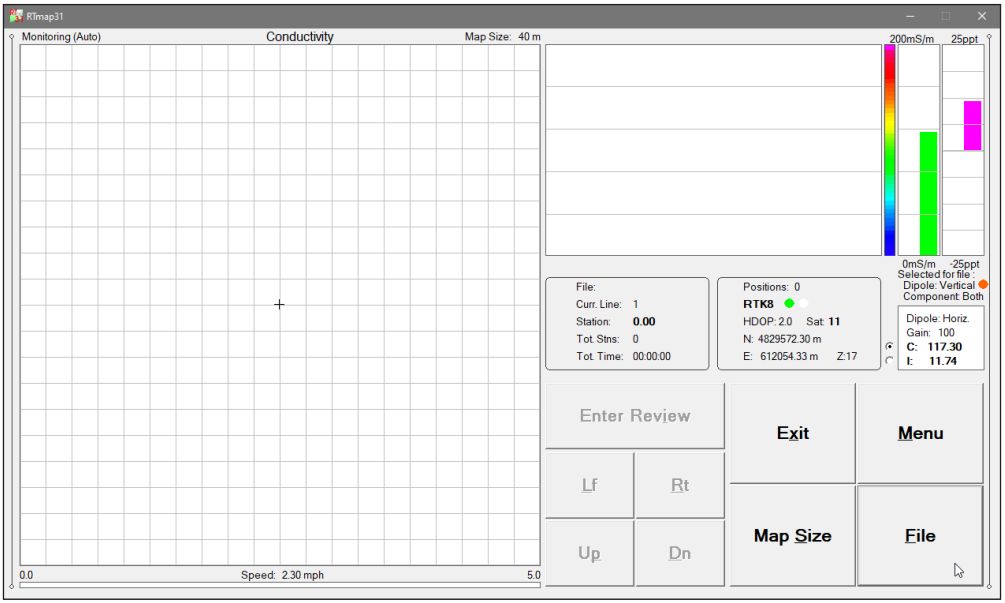


Figure 8.3: Logging screen in Monitoring (Mapping) mode

The left portion of the screen is occupied by the square plot area, a map, which presents current location of the system (based on GPS antenna position) in graphic form. This plot area will also display all recorded positions during data recording. The side of the square corresponds to scale which is displayed at the top line of the screen, right to the plot area. The size can be given in meters or feet depending on Units selection in the Map Options Setup dialog. Figure 8.3 shows map area that represents square 40 x 40 m. A label with component that is selected for colour image display is shown above map in the center and it is also marked by a checked radio button at numeric window label. A cross mark indicating current position of the GPS antenna (usually indicating position of the instrument) is always placed in the center of the map when logging session starts. After the operator will start moving the cross mark will move accordingly, however colour image or traces will not be plotted. Points indicating GPS stations are plotted only in Logging mode when EM31-MK2 and GPS data are recorded in data file. The North points to the top of the screen.

A window displaying profiles (drawn only during data logging) is located on the right side of the map. The most right section is associated with EM31-MK2 output. There are two sections (text boxes) at the right of the map, below profiles window. The left text box displays parameters associated with data file, and the right one is associated with GPS receiver parameters.

The Monitoring screen will display GPS related information in the right most frame box under the speed bar.
A label **DGPS** (Differential Global Positioning System) indicates that GPS readings are differentially corrected in real time, while label **AGPS** (Autonomous Global Positioning System) indicates lack of differential correction. Three other labels can be displayed: **RTK3** (Real Time Kinematic) when Quality Parameter is 3, and **RTK4** and **RTK5** for Quality parameters equal 4 or 5. On the right side of **DGPS**, **AGPS**, or **RTK** label two small circles are displayed. A colour of these circles should alternate between white and green with the frequency of GPS update rate (usually 1 second intervals), Figures 8.3 and 8.4. When GPS Warning Mask setting are not met then circles will be displayed in red and white colours. If the circle is displayed in one colour for long periods of time it means that the GPS system is not working or that it is not connected to the field computer.
The next label **P** with a value varying between 0 and 99.9 represents an index called Position Dilution of Precision (PDOP). PDOP is given when NMEA data messages GGA/ GSA, GGK or POS were selected. If only message GGA is available, then index HDOP (labeled **H**) will be displayed, and when LLK message was selected parameter GDOP (labeled **G**) is displayed. The LLQ message will provide precision of positioning in meters and it is labeled by **X**. Refer to section 6 (Set Port for GPS), Appendix A, and to GPS manuals for more information about GPS parameters.
The label **Sat** and following number shows number of currently tracked satellites. Latitude (N) and Longitude (W) are displayed in two bottom lines. These values are given in degrees, minutes, and seconds with four decimal places, or as linear UTM coordinates in meters, feet, or US Survey Feet depending on setting in the System Setup dialog.

The remaining portion of the monitoring screen display available options and parameters associated with the EM31-MK2 output. The EM31-MK2 output is represented by two small bar windows that include two moving vertical bars. The left bar window represents Conductivity readings, and the second bar window shows Inphase response. Displayed moving bars and their colors correspond to current dipole mode, when dipole mode changes then one set of bars will disappear and another set of moving bars will be displayed, with selection of colors corresponding to measured dipole mode. Bar colours correspond to selection of colours for profiles specified in Profile Options dialog. Range of readings displayed in this grid can be adjusted (option Reading Scale). Grid window with moving bars is labeled at the top and bottom (same range is applied for profile

window that is not labeled). The scale for graphic bars is divided by four or five grey grid lines. In the case where the amplitude scale starts with a negative value, then the grid line corresponding to zero is always plotted as a thicker grey line. This type of graphic presentation allows the operator for very easy and quick monitoring the response of the connected instrument.

Readings for all channels (components) are shown in numeric form below the grid with moving bars area. Data for displayed channels are labeled **C** and **I**. Dipole mode of the current reading is indicated by a label **Dipole** (Vertical or Horizontal mode). If Dipole Mode selected for the file (displayed above the numeric window) does not match reading dipole mode then a red dot is displayed as a warning above numeric window (Figure 8.3). Currently selected Range (10, 100, or 1000) on the console is also displayed in numeric window. A checked radio button at one of channel labels indicates the EM31-MK2 channel selected for colour scale in Mapping mode (option Colour Channel in Map Options dialog, see chapter 7). In addition label indicating selected Component for mapping is displayed above map window (Conductivity in Figure 8.3). Due to the small size of numeric window, units of readings are not labeled, they are given in mS/m (conductivity) and ppt (Inphase) - these are labeled above moving bars windows. Fiducial marker is represented by label **Marker**. Label **Marker** is displayed only when the marker is actually pressed by the operator.

Several other parameters are shown on the right side of map plot area. Label **Monitoring** indicates Monitoring mode. Labels **Stand By** and **Logging** will be displayed for Stand By and Log modes respectively. Labels in two left text boxes File (data file name), **Curr. Line** (line name), **Station** (current station) and corresponding parameters are not used in Monitoring mode.

Command buttons labeled Enter Review, and four panning buttons Lf (Left), Rt (Right), Up, and Dn (down) are located next to the map. Panning buttons can be used to shift displayed map in four directions. Above five command buttons are not enabled in Monitoring mode, they will be enabled and functional in Stand By mode after data file is created.

Four command buttons (on the right side of the grid containing moving bars) provide access to options available in Monitoring mode. These options are described below in the section 8.2.

Navigation Mode

The RTmap31 Monitoring screen in Navigation mode is almost identical to the described above Mapping mode. Main difference is that when no colour imaging is specified in the Map Display Options dialog the RTmap31 screen in Navigation mode will not show colour bar for readings, and there will be no indication provided by radio buttons (left to numeric window) in numeric display window, and there is no label indicating active channel in the center above the map window. Positions of recorded readings will be indicated by dots or monochromatic swath bar during Logging mode. All other parameters and functions are same as described above in the Mapping Mode section (see Figure 8.4).

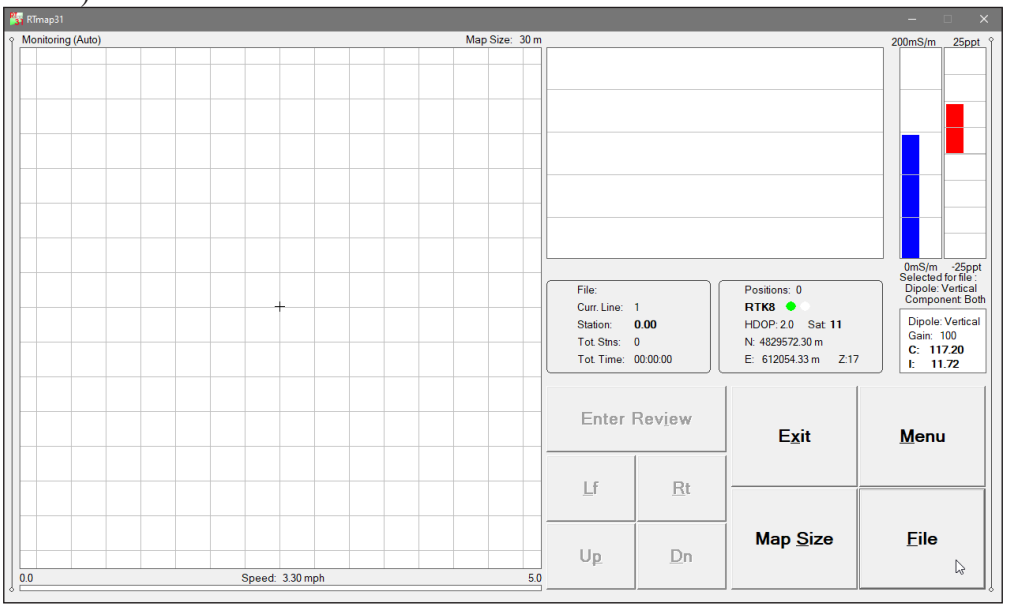


Figure 8.4: Logging screen in Monitoring (Navigation) mode

Profile Mode

When the GPS Input is Disabled in GPS Port Setup dialog then the program displays the screen in Profile mode. The same mode is displayed when GPS was Enabled and the operator used Toggle option to display program in Profile mode. The RTmap31 Logging screen in Monitoring mode and Profile display mode is shown below (Figure 8.5).

The logging screen is essentially the same as described in Mapping Mode profile (section above). The only difference is that the map is not displayed and profile plot area is extended to the left side of the screen. This area will contain profile curves for each

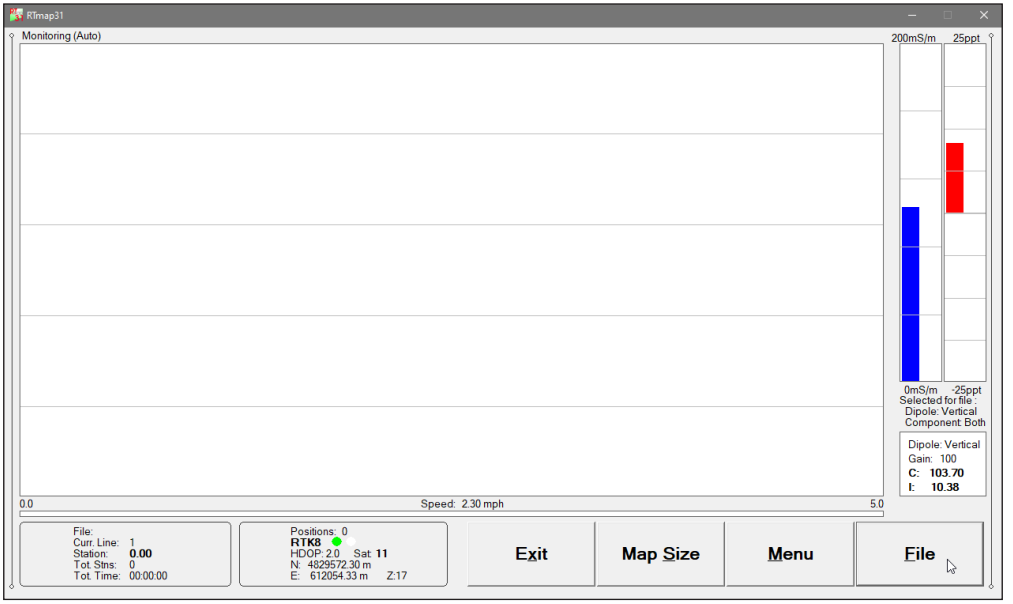


Figure 8.5: Logging screen in Monitoring (Profile) mode

recorded and selected (in Profile Options window) EM31-MK2 channels (component/dipole mode) in graphic form. Scale is labeled at the top and bottom of the moving graphic bars window.

8.2 Options Available in Monitoring Mode

Several options are available while the Logging window is in the Monitoring mode. Four more frequently used options can be accessed directly from command buttons and others can be used from pop up menu activated by button **Menu** (displayed in Figure 8.6). Command buttons can be used by clicking on the desired button, or from the keyboard by pressing one of the shortcut keys (underlined characters on button labels) or by navigating using **<TAB>** key (sets button as a default button - default button is highlighted) and pressing **<ENTER>** key.

Options listed in the menu can be accessed directly (without displaying pop up menu from Menu button) by using keyboard shortcuts, i.e. pressing key R will display Scale Reading dialog. While menu is displayed options can be selected by clicking on the appropriate proper option, or from the keyboard by pressing the shortcut keys or by navigating using **<Up>** and **<Down>** arrow keys and executing by **<ENTER>**.

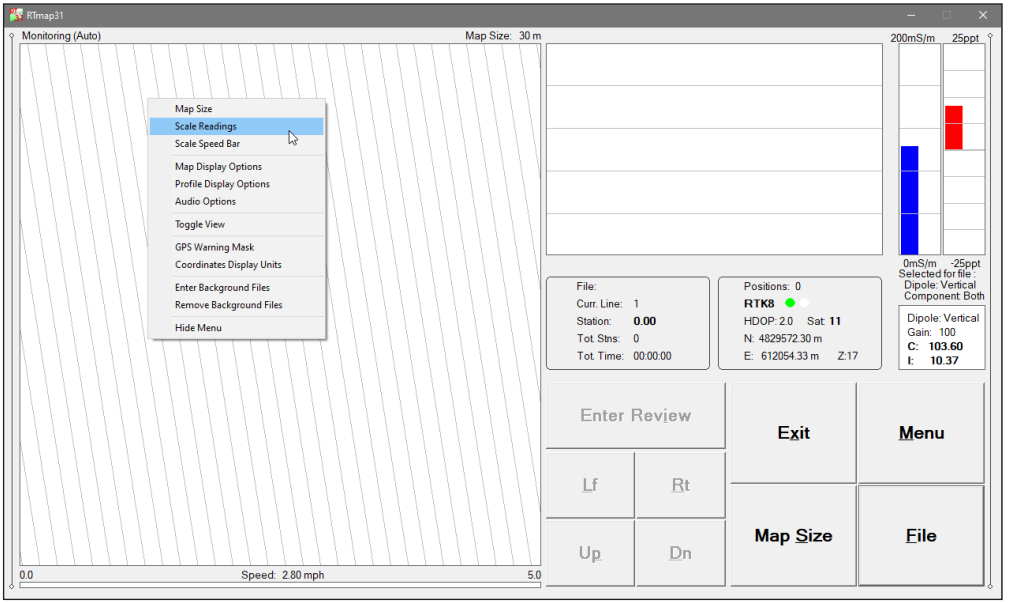


Figure 8.6: Monitoring mode with displayed pop up menu

File (create new and append to existing data file)
The RTmap31 data file can be created in any folder. The name of the file is given by the field computer clock and it consists of month (2 digits), day (2 digits), hour (2 digits), and underscore followed by sequential three digits number (001, 002 and so on). (If all 1000 names during one hour are used specify any other name). The extension name of RTmap31 data file is T31. The Create Data File dialog is presented in Figure 8.7.

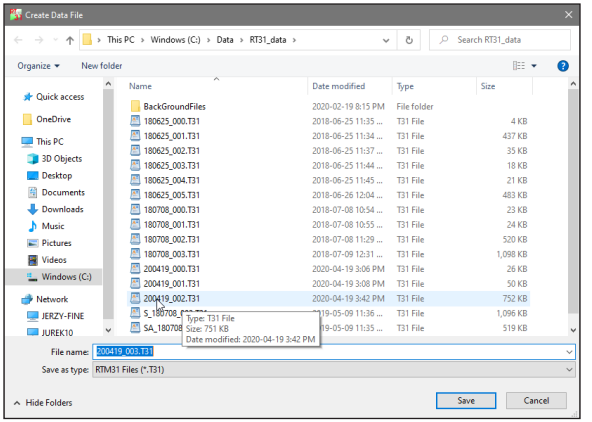


Figure 8.7: Create Data File dialog

The file name can be specified in the Create Data File dialog using the Windows standard interface procedure.
The RTmap31 data files can be appended (data files created with Version 2.00 or later) and after message informing about number of GPS positions already collected in the file (Figure 8.8) the previous data set will be plotted on the map (Figure 8.9). All data collected will be appended to the existing data set. The program run in Profile mode will not display the last survey line profile since the program assumes that a new survey line is to be surveyed (see New Line option). Maximum number of all positions in one data file cannot exceed 28,800 GPS positions and number of EM31-MK2 readings is unlimited.

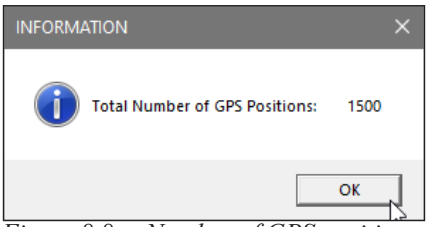


Figure 8.8: Number of GPS positions in the selected data file

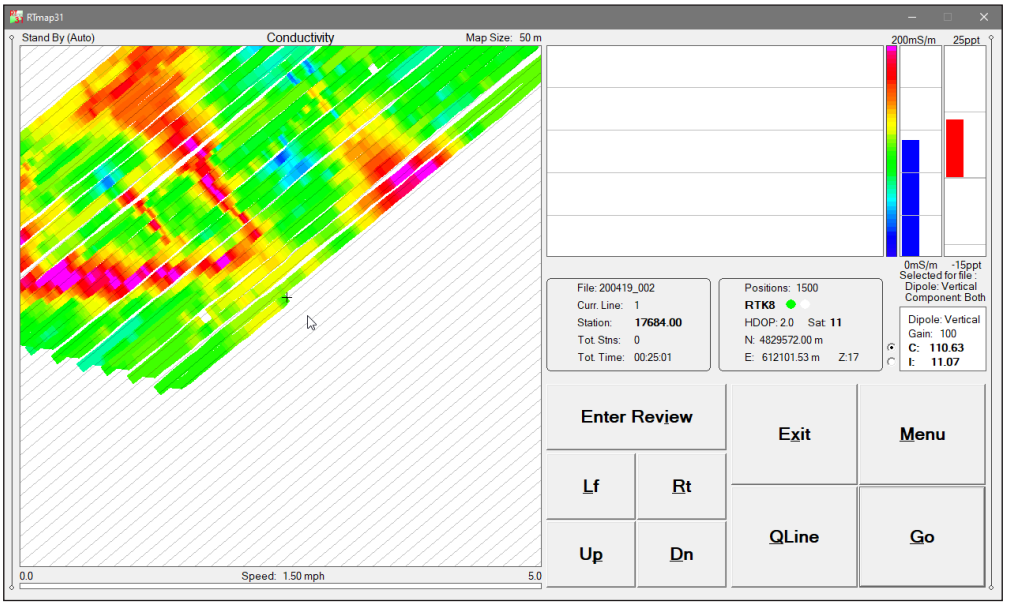


Figure 8.9: Logging display after existing file is selected for append

The data file in the field computer (binary raw data file) has an extension name T31 (unless it is GXY file created when EM31-MK2 was Disabled in the System Setup window) and it is created in the directory specified in Create Data File

dialog. All T31 files are created in the RTmap31 binary format. They can be processed and exported to XYZ file format using the RTM31 program. These files can be also converted to ASCII format, or to Geonics DAT31W format G31 and viewed in the Geonics program DAT31W.
After the file is specified click on the button **Save** or press the S key (or **ENTER** if the button is highlighted) to accept and create data file. The program will switch Monitor mode to Stand By mode and the data file will be displayed on the screen.
To cancel selection and return to Monitoring mode tap the **Cancel** (X) button or press **Esc** key.
After a data file is created the program will switch to Stand By mode automatically (see section 8.3).

Map Size (Adjust scale of map)

This option is available by clicking on (or selecting by arrow keys) the pop up menu item labeled **Map Size** or directly from keyboard by using shortcut key **S**. The Map Scale dialog will appear on the screen, Figure 8.10.

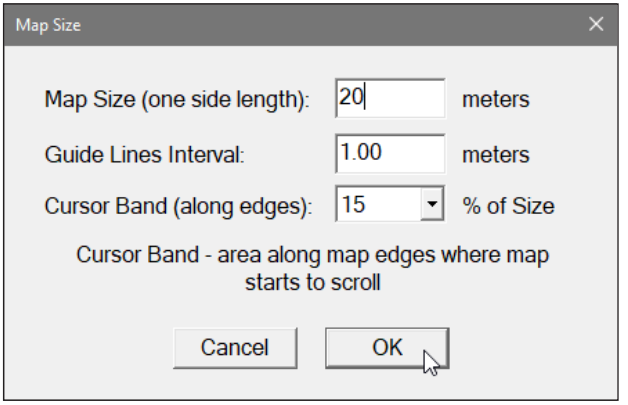


Figure 8.10: Map Size dialog

This dialog allows the operator to enter new scale for the map displayed by the plot area, map grid interval, and cursor band.
Map scale value is entered either in meters or feet according to selected units in Logger Setup dialog and it represents side of the square map. Only positive integer values ranging between 1 and 99999 are allowed by the program.
The second parameter in the Map Size dialog is Grid Interval. These are grey grid lines in Mapping (and Navigation) mode which may be helpful in estimation of distance on the map displayed in Mapping mode. If Parallel Lines (with optional tilt angle) was selected in the Map Display Options dialog then the label for this option will be Line Interval and the entered value will be applied to

distance between parallel lines (regardless of specified tilt angle). Setting Grid Interval to zero will not plot any grid lines on the screen.
The third parameter in the dialog is named Cursor Band. This parameter describes an inner band around the map perimeter that is always displayed. In other words, when cursor approaches and enters band area the map is scrolled. The band width is described by percentage of Map Scale. Six selections are available in the combo box labeled Cursor Band: ranging from 10% to 40%.
After parameters are specified click on the button **OK** or press **ENTER** key to accept new values and the map will be redrawn at a specified scale. To ignore an entry and return to Monitor mode click the button **Cancel** (or X) or press **Esc** key, and the dialog window will disappear.
This option is available also in Stand By mode.
The map size and grid/line interval can be also set in the Map Display Options dialog by clicking on the corresponding item in the pop up menu.

Exit

The program immediately returns to Main Screen.

Menu

The program will display pop up menu (Figure 8.6 above). Options available in menu are described below. These options can be executed directly from the keyboard (without displaying menu) by pressing a shortcut key.

Scale Readings (Adjust scale for profile, moving bars, and map colour image range)

This option is available also in Stand By mode. Minimum and maximum values for Conductivity and Inphase components can be specified for the plot range. Entered values are applied to profiles, moving bars plot, and colour imaging displayed in Mapping mode. Two colour bars for amplitude scale of Conductivity and Inphase that show colour distributions for each component are updated in real time. The Reading Scale dialog is given in Figure 8.11.
In case where minimum or maximum values are wrong, the program will assume minimum scale (0 to 10).
A colour bar representing colour distribution for mapping mode is provided on the left side of moving bars window. The colour bar is updated whenever Minimum or Maximum for active component (selected to be mapped) values are changed or active component is changed in the Map Display Options dialog.
After minimum and maximum values are specified click on the button **OK** or press **ENTER** key to accept new values and the profile plot and moving bars areas will be redrawn.
To ignore an entry and return to Monitor mode click the button **Cancel** (or X) or press **Esc** key, and the dialog window will disappear.

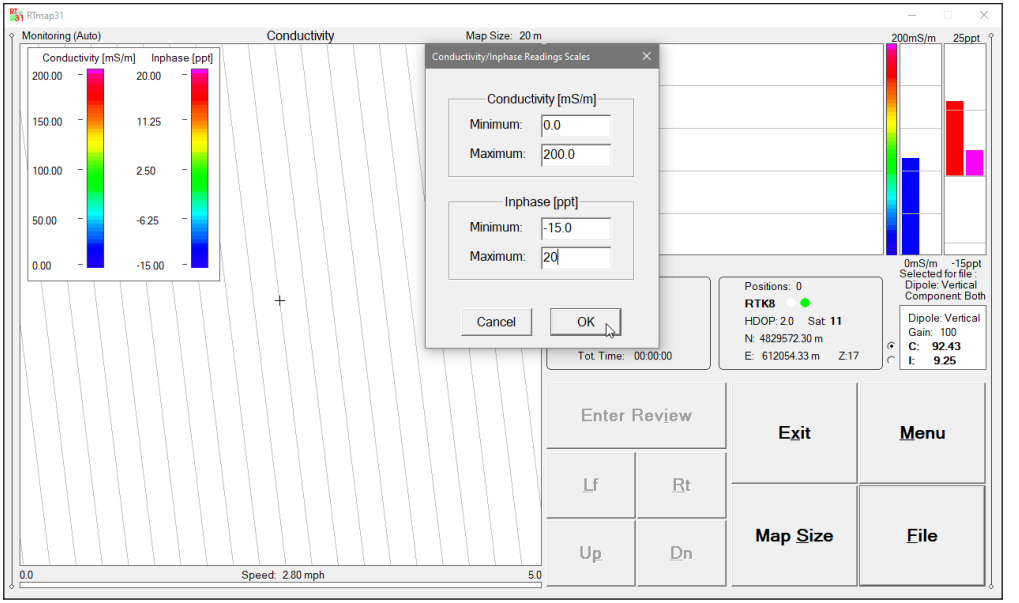


Figure 8.11: Conductivity/Inphase Readings Scale dialog

Scale Speed Bar (change units and adjust scale for speed bar)

This option is available also in Stand By mode. Minimum for the Speed Bar Scale is preset to 0, therefore this scale requires only one entry for maximum speed. In addition speed units can be changed in Set New Speed Bar Scale dialog, which is given in Figure 8.12.

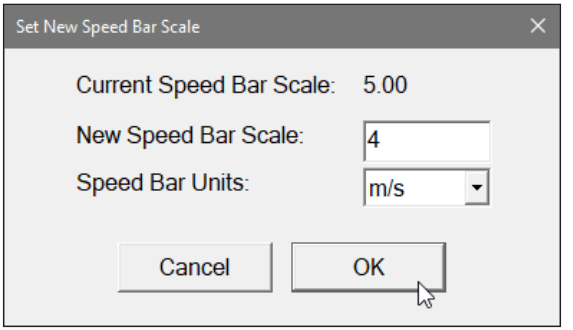


Figure 8.12: Speed Bar Scale dialog

After scale value and units are specified click on the button **OK** or press **ENTER** key to accept new parameters.

To ignore an entry and return to Monitor mode click the button **Cancel** (or X) or press **Esc** key, and the dialog window will disappear.

Map Display Options (Mapping and Navigation modes)

The Map Display Options dialog (Figure 8.13) is identical to a dialog described in detail in Chapter 7. If the program is in the Mapping or Navigation mode, please refer to section 7.1 of the manual.

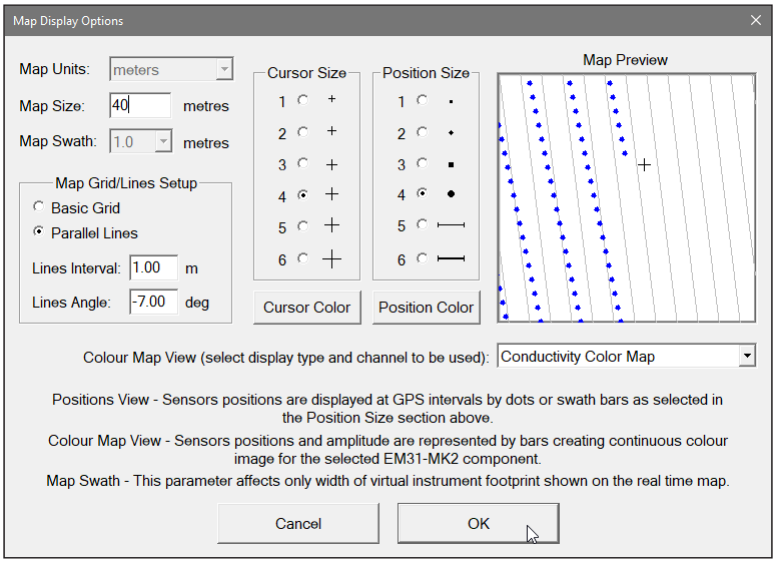


Figure 8.13: Map Display Options dialog

This option can be accessed from pop up menu or directly by the keyboard by pressing **D** key.

Display Options (Profile display options)

The Setup Display Options dialog is described in detail in Chapter 7. This dialog allows you to specify color and thickness of profiles (same colours apply to moving bars), and to select Grid Lines to conductivity or Inphase reading scale. The dialog is presented in Figure 8.14.

To select any option click on the corresponding drop-down list box or check box, or use TAB key to scroll to the option and then use mouse or keyboard to select parameter.

After all the parameters in the Display Setup dialog are updated click on the button **OK** or press **ENTER** key (assuming it is highlighted) to accept the displayed settings. The dialog will disappear and the program will return to the Monitoring mode window. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent program executions.

To return to original settings (state before this dialog was selected) click on the button labeled **Cancel** (or X button) or press **Esc** key. All parameters will be reset to initial settings and the dialog window will disappear.

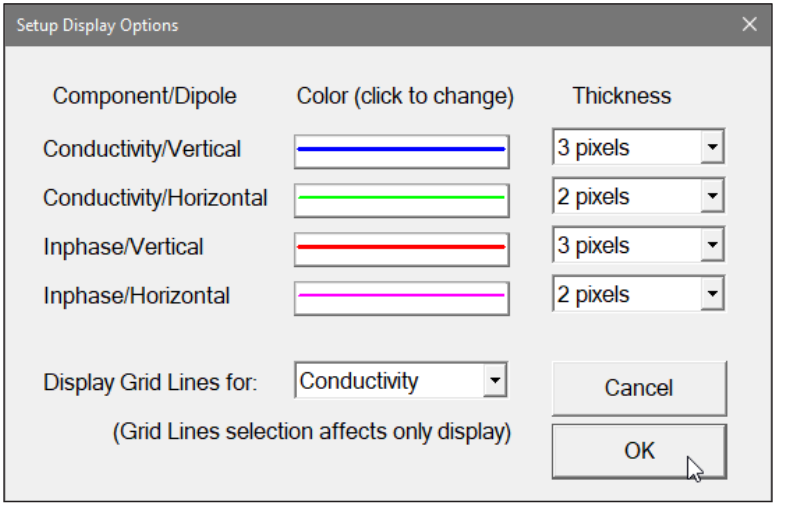


Figure 8.14: Setup Display Options dialog

Audio Options

This dialog allows to enable and disable three audio functions. Two of these options can be specified in the System Setup dialog (see chapter 4), and the one associated with GPS Warning Mask can be set in GPS Port Setup dialog (see chapter 6). The Audio Options dialog is presented below in Figure 8.15.

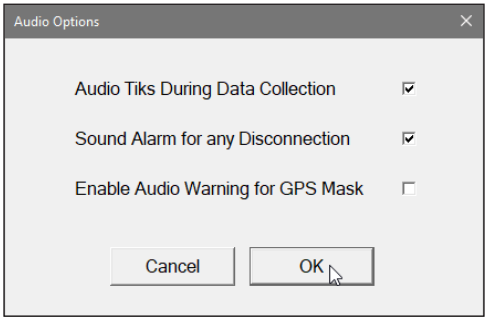


Figure 8.15: Audio Options dialog

Parameters in Audio Options dialog are described below.

Audio Tiks During Data Collection

The program will provide tik sound during data recording (in the Logging mode only). The tik sounds with frequency of approximately 3 Hz. This audio feature may be helpful as an additional confirmation that the button Go has been pressed (or tapped) and data is being collected

and saved in data file. This audio function can be enabled or disabled by check button located at the label naming this option.

Sound Alarm for any Disconnection

The program will sound loud ring when a disconnection in any serial port is detected by the program, or in case any EM31-MK2 console or GPS receiver will stop streaming data for any reason. The audio alarm function does not depend on the visual alarm that is always enabled regardless of audio alarm setting. The audio alarm function can be enabled or disabled by check button at the Sound Alarm for any Disconnection label as shown in Figure 8.15.

Enable Audio Warning for GPS Mask

When this option is enabled then in addition to visual warning (alternating red and white circles) an audio warning will sound (it is more gentle "bell" sound than loud audio alarm ring associated with disconnection of any sensor).

Toggle View (toggle between Mapping and Profile modes)

Selecting this item from pop up menu or simply pressing the key **T** will switch Monitoring or Stand By screens between Profile and Navigation modes. Changing the display from Profile to Navigation mode (when data were collected or external file was entered) may take several seconds (depending on number of positions displayed and map scale). The program will display message WAIT till all positions are plotted in current map area and it will beep at the end of this process.

GPS Warning Mask

This dialog allows to set or change GPS Warning Mask parameters during logging session. The same parameters can be set in GPS Port Setup dialog (see chapter 6). The GPS Warning Mask dialog is presented below in Figure 8.16. Parameters in GPS Warning Mask are described below.

Warning

Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: Enabled and Disabled. This option allows you to Enable/Disable a GPS Warning Mask that contains three parameters: Quality Indicator (degree of differential corrections), Dilution Parameter (PDOP or other label depending on the selected NMEA message), and number of available satellites.
When Enabled is chosen GPS two circle indicator will be alternating in green and white if conditions for specified parameters setting will be

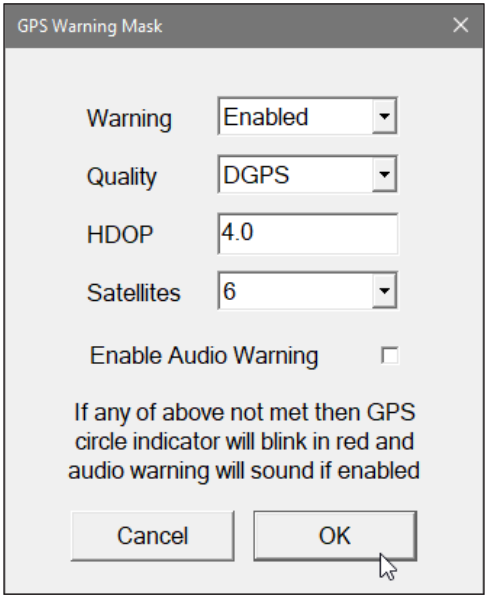


Figure 8.16: GPS Warning Mask dialog

met. When any of the parameters is below set values then GPS indicators will alternate in red and white colours). In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours (see Figure 8.22) regardless of GPS signal quality.
All GPS data is logged, GPS Warning Mask affects only display.

Quality

This parameter describes Quality Indicator (degree of differential corrections). Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: AGPS (Raw), DGPS, RTK3, RTK4, and RTK5.
If Quality Indicator received from GPS receiver will be worse than specified then GPS indicator will alternate in red and white colours.

PDOP

This parameter can be labeled PDOP, HDOP, DOPG, DOP depending on the selected NMEA message. It can be also named Quality m (accuracy in meters) if LLQ was selected, or it is not available (labeled N/A) when messages GLL or any RTS (pseudo GGA) are used.

Activate text box by clicking on the edit box or using TAB key and then enter the chosen acceptable maximum value of Dilution parameter. If PDOP (or other similar parameter) is larger than specified value then GPS indicator will alternate in red and white colours.

Satellites

Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: 3 to 12.
If number of available satellites will be smaller than specified then GPS indicator will alternate in red and white colours.

After all the parameters in the GPS Warning Mask dialog are updated click on the button **OK** or press **ENTER** key to accept the displayed settings. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent GPS Warning Mask and GPS Port Setup dialogs.
To return to original settings (state before this dialog was selected) click **Cancel** (X) button or press **Esc** key. All parameters will be reset to initial settings.

Coordinates Display Units

The Set Coordinates Display Units dialog will be displayed, Figure 8.17. There are four items after the combo box labeled Coordinates unit will be expanded: Geodetic Lat/Lon (coordinates in Degrees, Minutes, Seconds), UTM meters, UTM feet (International Feet), and UTM US Feet (US Survey Feet). Select one of items and coordinates of the GPS antenna will be displayed in the GPS section (bottom of the logging screen) in selected units.

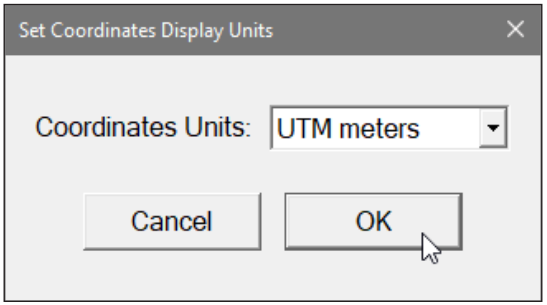


Figure 8.17: Set Coordinates Display Units

Select the OK button to accept selection or the Cancel button to exit dialog.

Enter Background File

The Load Background File dialog is shown in Figure 8.18. The program will display contents of entered files in the background of the map. Two types of

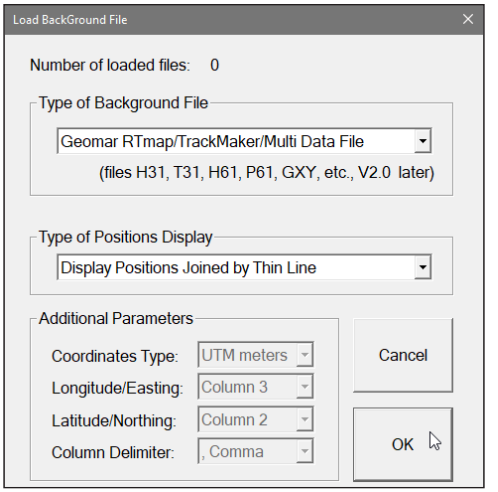


Figure 8.18: Load Background File dialog

files can be entered: any data file created with Geomar programs (RTmap, TrackMaker, or Multi - all V2.00 or later) or user prepared column delimited text file (TXT format) containing coordinates representing site boundary, or any other feature, Figure 8.19. If Geomar data file is entered its content will be displayed as traces of collected survey lines. This option can be used to follow

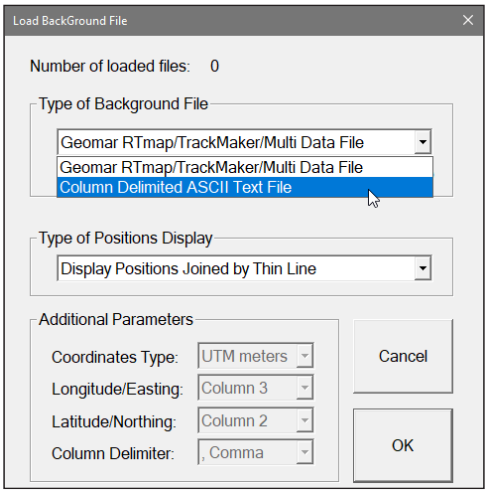


Figure 8.19: Selecting Type of File to Load

measurements with another instrument, to display already performed coverage, or to repeat part of the survey. User prepared Column Delimited ASCII Text File can be used to display a site outline, delineated area of special interest to be surveyed with finer line spacing etc. The latter file must contain coordinates in WGS 1984 datum. Geomar data files are in WGS 1984 datum by default. Up to 10 files (mixture of either type) can be entered and displayed.

Type of Positions Display describes how positions are displayed, they can be plotted as separate points, or lines joined by thin, medium, or thick lines depending on the selection in the corresponding combo box. Lines can have breaks if a tag "Break" (lower or upper case) is inserted in the file. Sample of Column Delimited file is shown in Appendix A.

When a Column Delimited file is selected a section labeled Additional Parameters is activated as shown in Figure 8.20. Parameters describing file structure must be specified, these are: Coordinates Type (Geodetic, UTM meters, feet, or US Survey Fee), column numbers for Longitude and Latitude or Easting and Northing, and finally Column Delimiter (Space, Comma, Tab, or Semicolon). For practical simplicity, if UTM coordinates are used it is assumed that the operator is located within the same UTM zone.

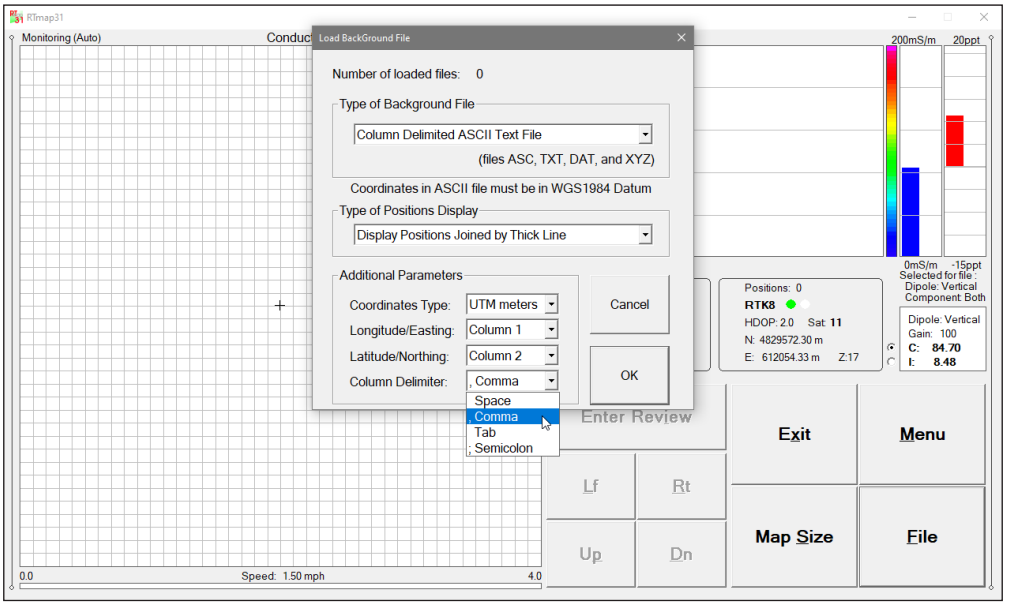


Figure 8.20: Selecting Column Delimiter for Column Delimited File to be Loaded

Type of the file and all parameters must be specified prior to selecting file name, therefore it is necessary to know structure of background files that are to be loaded. After the OK button is clicked on or tapped an Open File dialog will appear, Figure 8.21.

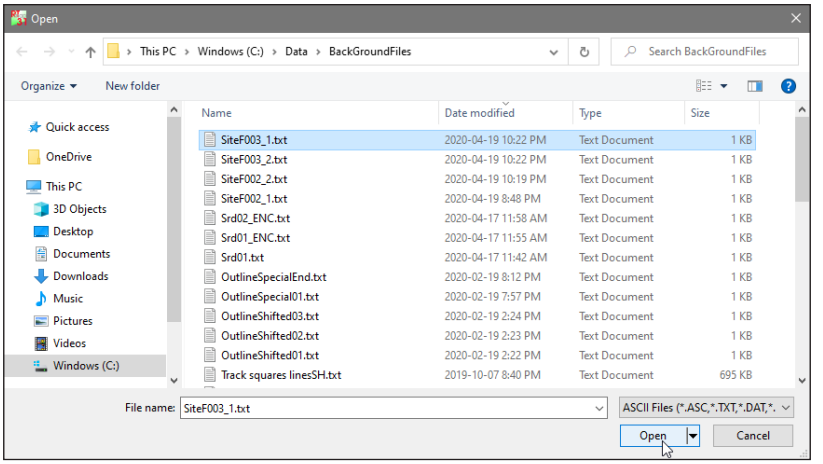


Figure 8.21: Selecting Background File

After file is opened in above dialog program will draw it immediately in the map window and another file can be entered if needed.
The RTmap31 screen with three background files (two Column Delimited type and one data file) is shown in Figure 8.22.

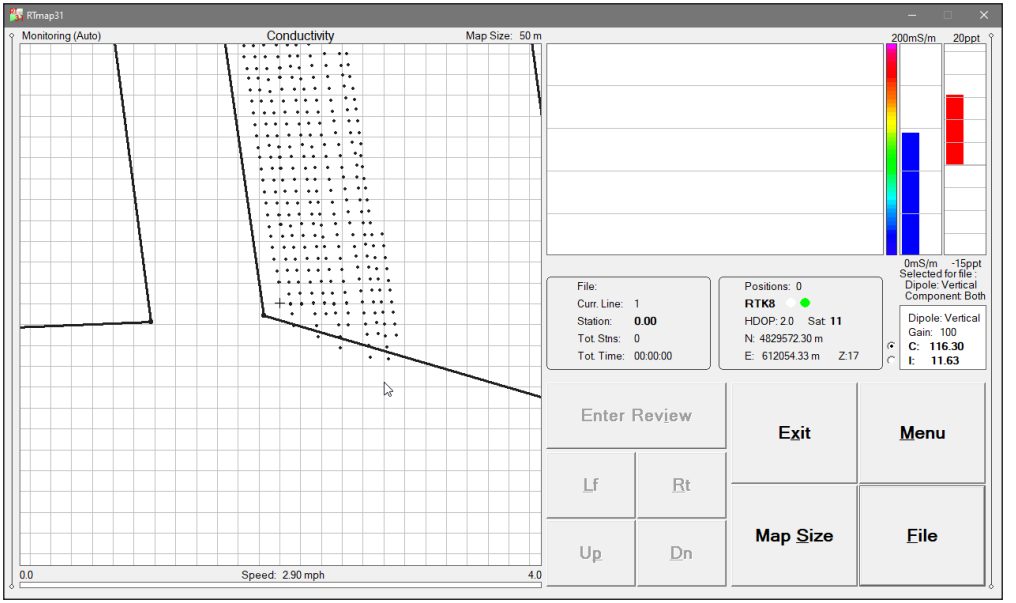


Figure 8.22: Two Background Files ASCII Type and Positions of Data Type File displayed in RTmap31 Monitoring mode

Please note that background files are displayed using real coordinates. Program registers its position as soon as the first GPS position is detected (it is cross cursor displayed in the center of the map). It is the reason that background files cannot be entered prior to the first GPS position obtained by the program. Therefore, loaded background files can be displayed only if operator is in the same area and map size covers coordinates listed in data file or Column Delimited file. If the entered file is not displayed then it may be visible after changing map to larger size.

Remove Background Files

After this option is executed the Remove Background Files dialog appears, Figure 8.23. It contains list of loaded background Files. Click on any check box located on the left of corresponding file name and when the OK button is clicked on or tapped the map will be re-drawn and checked files will be removed from the program map. Click on the Select All button and then OK button to remove all entered files at once.

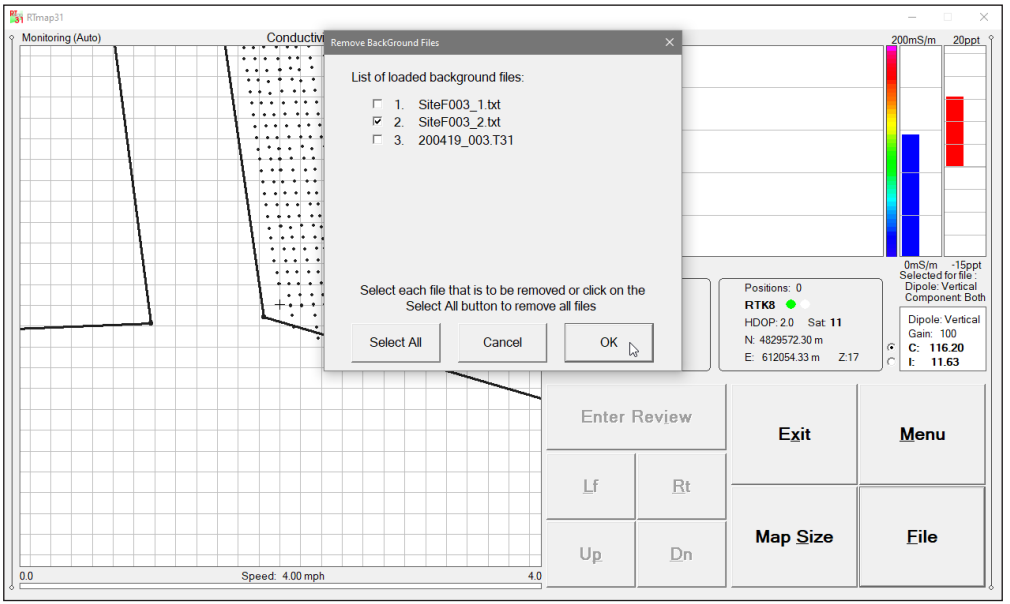


Figure 8.23: Remove Background Files dialog

8.3 Stand By Mode

The main difference between the Monitoring and Stand By modes is that from the Stand By mode program can be directly switched to Logging mode to record the data in the data file. The RTmap31 screen in Stand By mode and Mapping mode is shown in Figures 8.24, 8.25 and 8.26 present Navigation mode (with swath bars and dots). The layout of the screen is almost identical to the layout described in section 8.1. Main differences are: label **Stand By**, reminding the operator about current mode, different command buttons, contents of two left frame boxes at the bottom of the window which display parameters specific to survey settings. The first frame box includes parameters related to file contents: File Name, Tot. Stns. (total number of stations in file), Tot. Lines (total number of survey lines), Tot. Length (total length of survey lines in the file), Tot. Time (total elapsed time of recording). The second frame box contains parameters related to current survey line: Curr. Line (name of the current survey line), Station (current station), # of Stns. (number of stations in the current line), Length (length of the current line), Time (elapsed time of recording from the start of the current line). The third frame box described in section 8.1, contains parameters associated with GPS input.

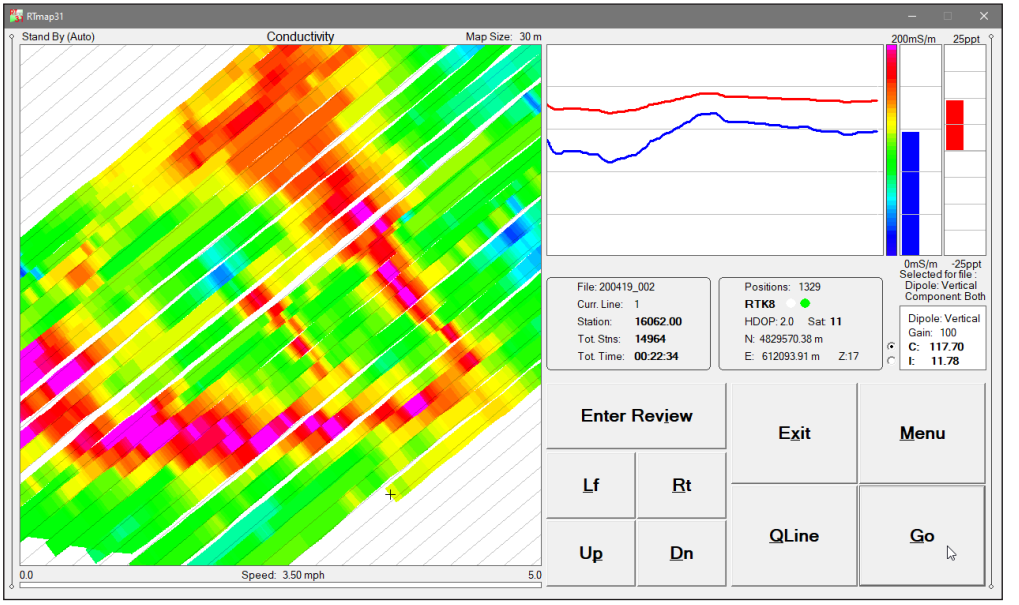


Figure 8.24: RTmap31 in Stand By mode and Mapping display mode

Example shown in Figures 8.24 to 8.26 presents situation where the operator continues to walk in the S-W direction while logging data and then stopped logging data by switch-

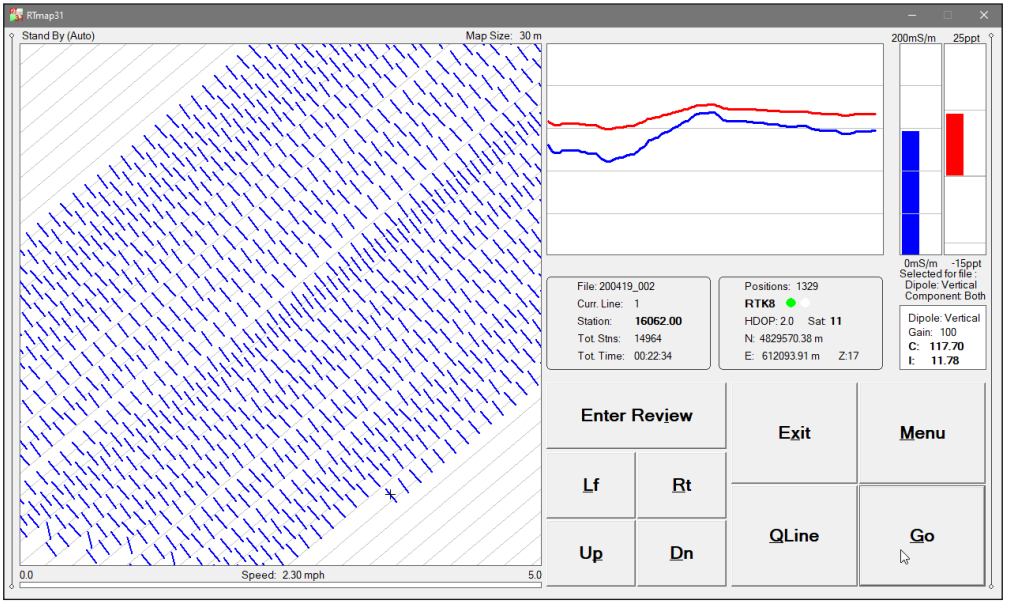


Figure 8.25: RTmap31 in Stand By mode and Navigation display (swath bars)

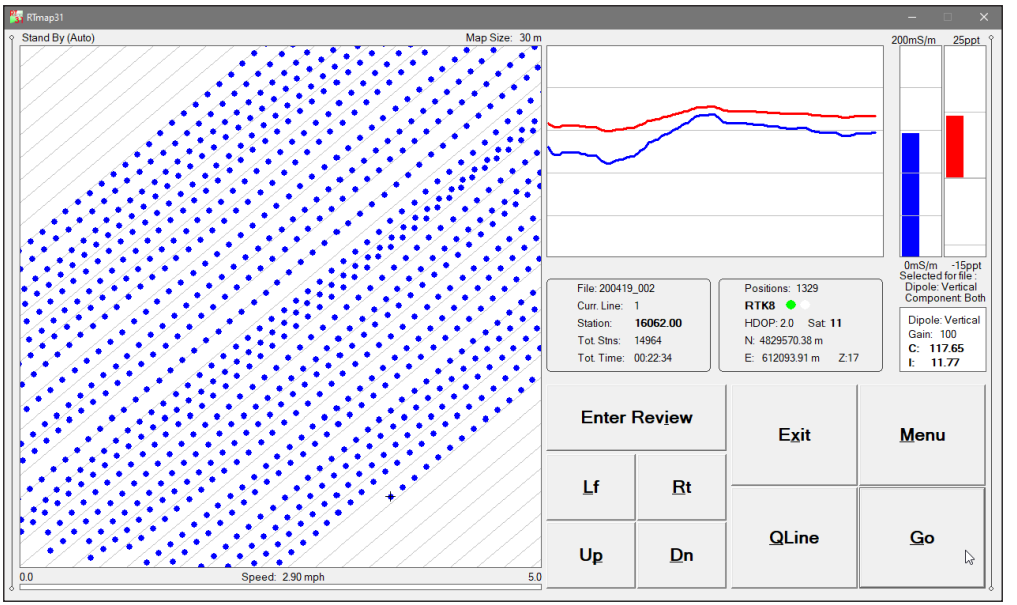


Figure 8.26: RTmap31 in Stand By mode and Navigation display (dots)

ing from Log to Stand By mode. In the Stand By mode the cross mark which represents position of the operator (GPS antenna) will move if the operator will change his location, however points corresponding to reading amplitude and locations will not be plotted.

In case the program is run in the Profile display mode, data recorded previously in Log mode will be shown as profiles in the plotting area, as shown in Figure 8.27. Similarly to Navigation mode where GPS locations are not plotted on the screen, data plotted in profile form will not be updated in Stand By mode.

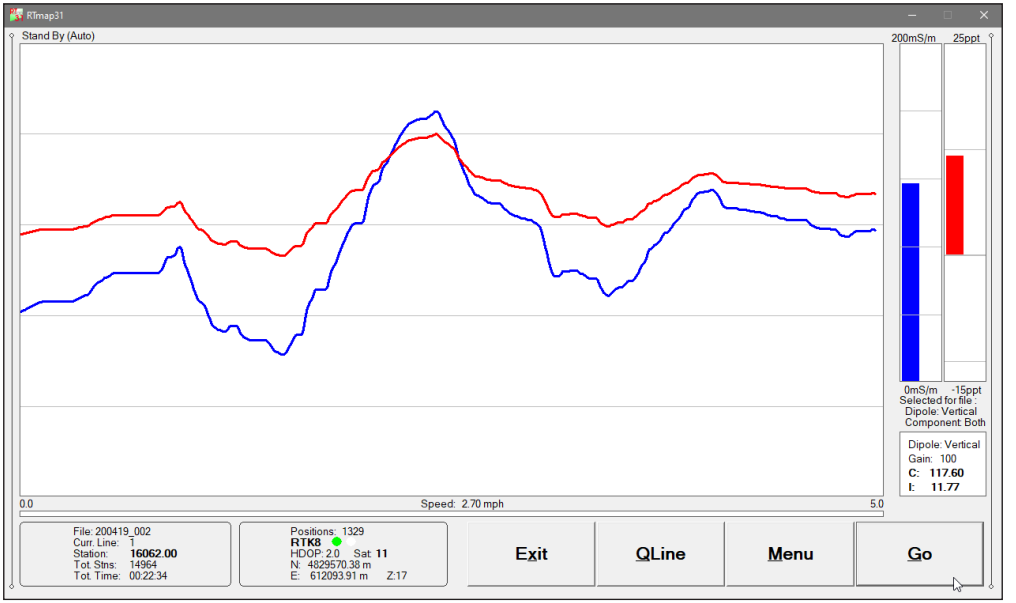


Figure 8.27: RTmap31 in Stand By mode and Profile display mode

The EM31-MK2 data will be displayed with the update rate approximately 20 readings per second, however data will not be saved in the log file. If GPS input was enabled, GPS positions will be updated with a rate specified in GPS receiver. GPS data are not saved in file in Stand By mode.

Four command buttons available in Stand By mode include: **GO** (executed by mouse click, pressing key **G** or **<ENTER>**) which directs the program to Logging mode and recording EM31-MK2 and GPS data, **QLine** (Quick Line), **Exit**, and Menu (which contains more options than pop up menu in Monitoring mode). These options are described in detail in Section 8.5 (Field options available in Stand By mode).

8.4 Logging Mode

The Logging mode is enabled by clicking or tapping on the **GO** button or pressing the key **G** (or **<ENTER>** key if the button Go is highlighted). After this button is executed the list of four buttons will be replaced by one button labeled **Pause**, label Stand By will be replaced by label **Logging** (at the top of the display) and data will be recorded. A green background in the numeric display window serves as visual confirmation that data is recorded (whenever it is not green please check that the button GO was pressed). All labels and parameters (with the exception of buttons representing Stand By mode options) are the same as in Stand By mode and they are described in the preceding section 8.2. The RTmap31 screen in Logging mode and in Mapping display mode is presented in Figure 8.28. The cross mark corresponding to the system location will move while the operator is progressing along the survey line and recorded amplitude of EM31 readings will be plotted as colored image on the screen. At the same time profiles will be plotted in panels located right to the map plot area.

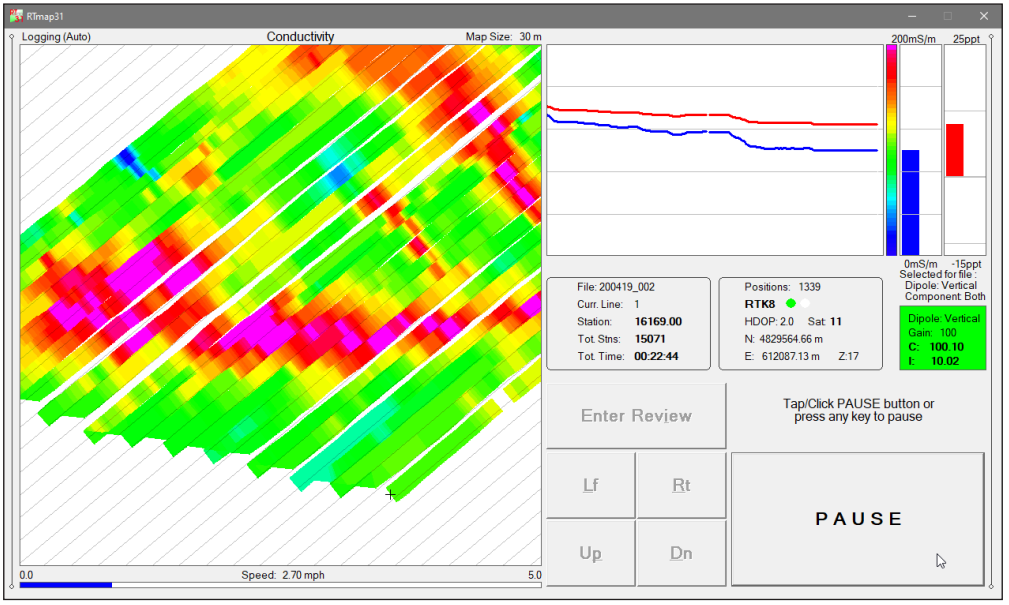


Figure 8.28: RTmap31 in Logging mode and Mapping display mode

If the program's display was toggled in Stand By mode to Profile display mode or if GPS was disabled in GPS Input menu the RTmap31 Profile display mode will be used as shown in Figure 8.27.

Profiles are updated after each reading is written to the data file. The program displays profiles for readings with settings (profile line colour and thickness) selected in the Profile Display Options dialog.

After the screen changes from Stand By mode to Logging mode survey parameters are updated according to the station interval. Similarly, if GPS input was enabled, total number of GPS positions in the data file is increment every time (usually once a second) GPS position is written to the file. Profile plots, amplitude of graphic bars in plot area and readings displayed in numeric form for each instrument are updated after each reading is written to the data file. In addition background of numeric values window changes to green. The green background serves as a visual indicator that data is recorded, if it is white please check if the Pause button was not accidentally pressed during logging. The audible tik sounds at frequency approximately 3 Hz if Tik Sound option was enabled in the Logger Setup menu. The Map plot is updated with GPS input frequency and Profile display mode is updated at each EM31-MK2 reading.

There is only one option available in the Logging mode - PAUSE logging. After the button labeled **PAUSE** or a Pause key selected in the System Setup dialog is pressed the recording is stopped and the Logging screen returns to the Stand By mode. In the Stand By mode EM31-MK2 data will be displayed in numeric form and graphically by moving bars with the update rate of the instrument, however data will not be saved in the log file, a map nor profile plots will not be updated. The cross mark corresponding to the system location will move according to the operator movement, however sensors positions (or GPS positions in Mapping/Navigation mode) will not be plotted as dots on the screen.

8.5 Options Available in Stand By Mode

Several options are available while the Logging window is in the Stand By mode. Four frequently used options can be accessed directly from command buttons (Go, Qline, Exit, and Menu) and others can be used from pop up menu activated by button **Menu** (displayed in Figure 8.29). Command buttons can be used by clicking or tapping on the desired button, or from the keyboard by pressing one of the shortcut keys (underlined characters on button labels) or by navigating using **TAB** key (sets button as a default button - default button is highlighted) and pressing **ENTER** key.

Options listed in the menu can be accessed directly (without displaying pop up menu from the **Menu** button) by using keyboard shortcuts (underlined characters in menu items), i.e. pressing key C will display Enter Comment dialog. While the pop up menu is

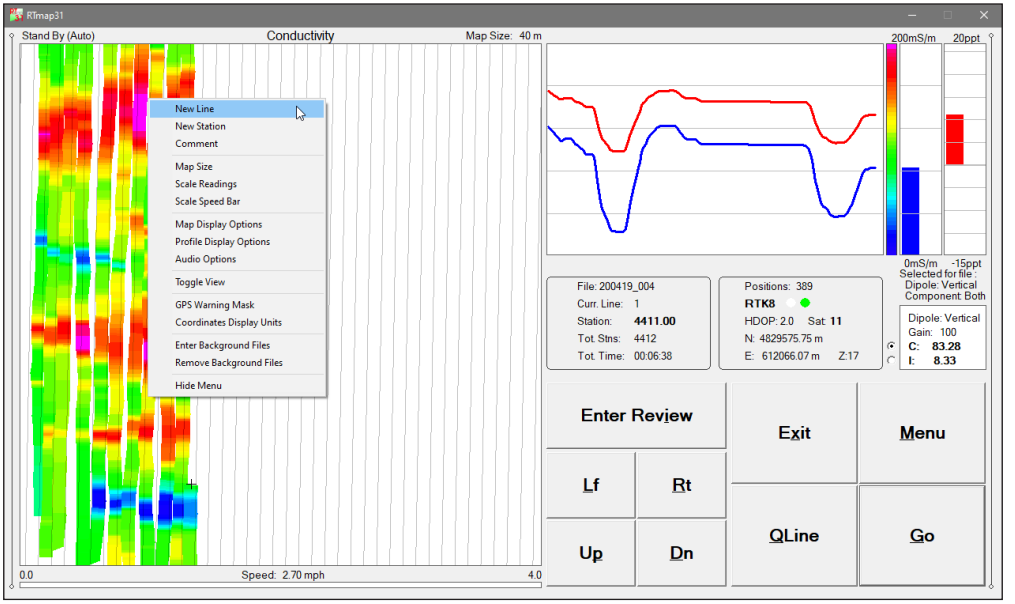


Figure 8.29: RTmap31 in Stand By mode with pop up menu

displayed options can be selected by clicking on the appropriate proper option, or from the keyboard by pressing the shortcut keys or by navigating using **Up** and **Down** arrow keys and then executing by the **ENTER** key.

GO *(start data logging)*

Tap on the **GO** button, or while using the keyboard press shortcut key **G** or if the button is a default button (highlighted) press **ENTER** key. The logging window in Stand By mode will change to Logging mode and logging data starts immediately (as described in detail in above section 8.4).

QLine *(Quick Line change)*

Click or tap on the **QLine** button, or while using the keyboard press shortcut key **Q** or if the button is a default button (highlighted) press **ENTER** key. The confirmation message will be displayed, Figure 8.30.

This option allows the operator for fast and convenient change of the survey line, assuming that formerly specified parameters describing survey procedure can be accepted. In case of GPS based survey, this option provides very convenient and fast (two key strokes) procedure of dividing large data sets to several survey lines, without displaying the New Line dialog.

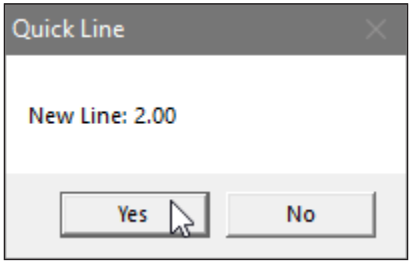


Figure 8.30: Quick Line message

The name of the new line is given by the program based on the former line name and Line Increment (see Survey Setup dialog or the New Line option). Start station and Station Increment of the new survey line is calculated by the program base on the Sequence parameter and former line Start Station and Increment (see Survey Setup dialog or option New Line that follows).
To accept proposed Survey Line name tap on the **Yes** button or press **ENTER** key. If the button **No** is tapped then the program will continue survey along existing survey line.

New Line (New Survey Line)

This option is available from pop up menu or from the keyboard by using short-cut key **L**. The New Line dialog is displayed, Figure 8.31. Selecting this option allows the operator to enter a new survey line number (name) and (as opposite to Quick Line described above) to change associated line parameters (Line Increment, Line Sequence, Direction, Start Station, and Station Increment). The new line number and associated parameters are prompted by the program based on parameters specified in the Survey Setup menu and the last survey line.
At the top of the dialog the last survey line name and the last logged station are displayed. Default name for the new line is given based on the Line Increment parameter. The default Start Station, direction of the Station Increment, and Direction are determined based on Sequence selection. All these parameters can be overwritten by the user as described in the Survey Setup dialog description (chapter 3).
After all the parameters in the New Line dialog are updated click or tap on the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Logging window in Stand By mode. Survey line (**Curr. Line:**) name and current station (**Station:**) value will be updated and if the program is in Profile mode then profile curves plot for former survey line will disappear.
To return to Stand By mode and current survey line settings (state before this dialog was selected) tap **Cancel** (X) button or press **Esc** key, the dialog window will disappear.

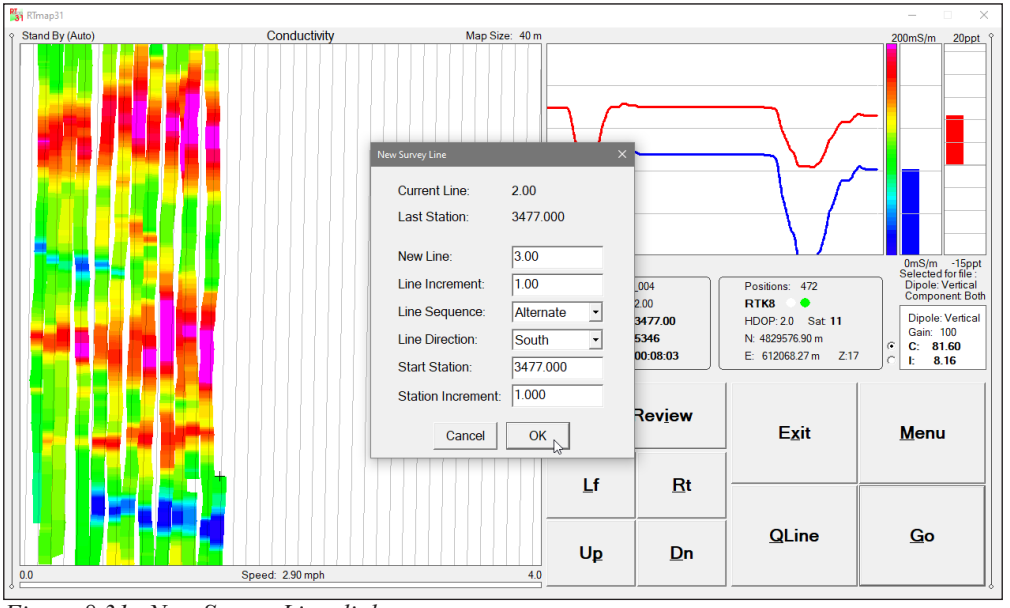


Figure 8.31: New Survey Line dialog

New Station

The New Station option can be selected from pop up menu or from the keyboard by pressing shortcut key **N**. Selecting this option allows the operator to enter a new station number (within the same survey line). The New Station dialog is displayed and it is shown in Figure 8.32. New station can be used in situation when an obstruction does not allow for continuation of the survey line. A new station can be entered and survey line can be continued. An alternative option in this case would be to use a new line with the same name and affix i.e. 11A, 11B, and so on.

Start and Current station are displayed at the top of the dialog. The New Station can be entered in the provided edit box labeled New Station.

Tap the button **OK** or press **ENTER** key to accept the new value. The program will return to the Logging window in Stand By mode. Current station (**Station:**) value will be updated and after data logging is activated the profile curves (if the program is in Profile mode) will have a small gap (and possible amplitude discontinuity) showing the new station entry.

This option does not provide any visual effect while the program is used in Mapping mode.

To return to Stand By mode and current survey line settings (state before this dialog was selected) tap **Cancel** (X) button or press **Esc** key, the dialog window will disappear and measurements can be continued.

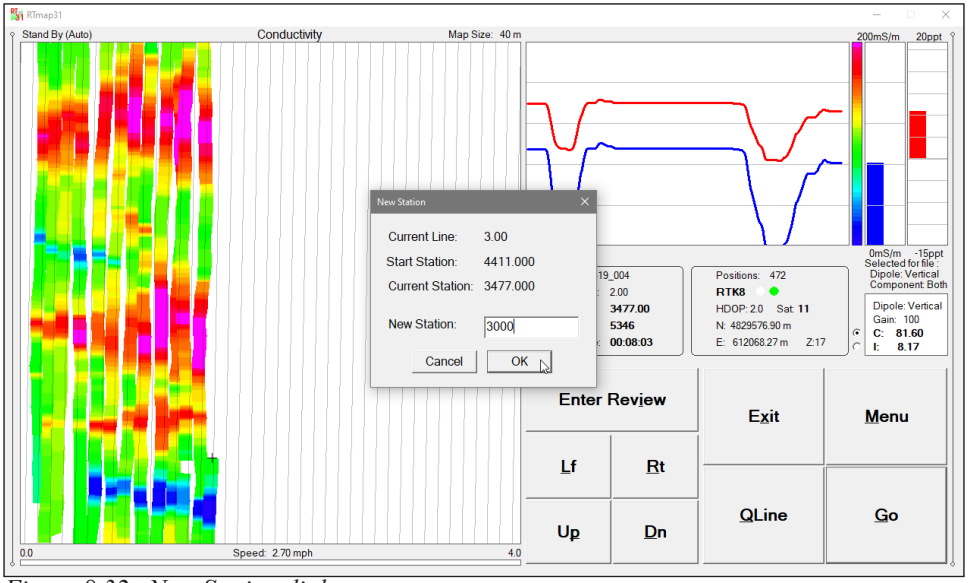


Figure 8.32: New Station dialog

Comment

The Comment option allows the operator to enter a comment at any point of the survey. A maximum of 11 characters can be entered as a comment. The Enter Comment dialog is displayed in Figure 8.33.

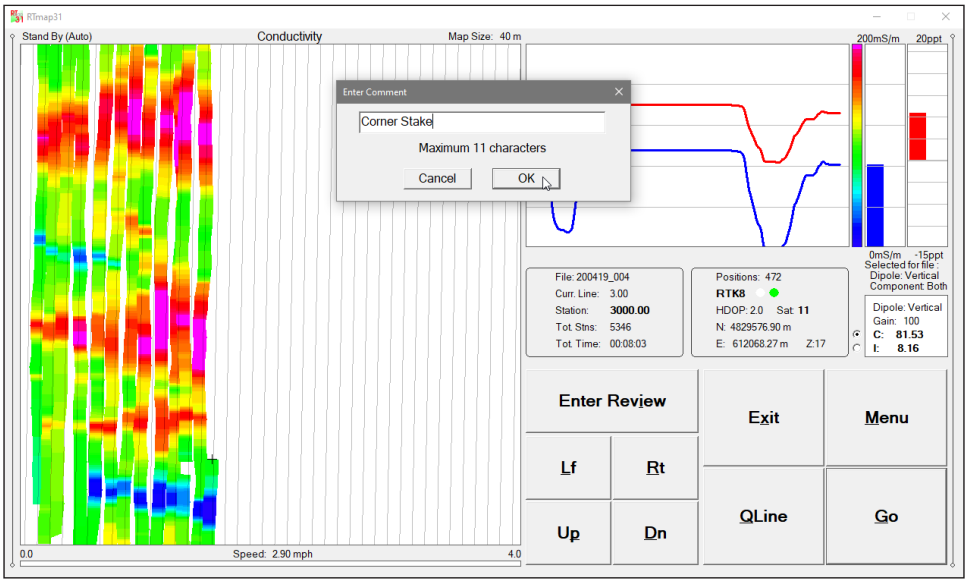


Figure 8.33: Enter Comment dialog

Click or tap on the button **OK** or press **ENTER** key to accept the comment entered in a text box of the dialog. The text of the comment is saved in the file with a corresponding time stamp and the program will return to the Logging window in Stand By mode.
To ignore an entry and return to Stand By mode tap the **Cancel** button, the dialog window will disappear and measurements can be continued.

Map Size

This option is available from the pop up menu (accessible by clicking on the **Menu** button), or directly from keyboard by using shortcut key **S**. The Map Size dialog will appear on the screen, Figure 8.34.

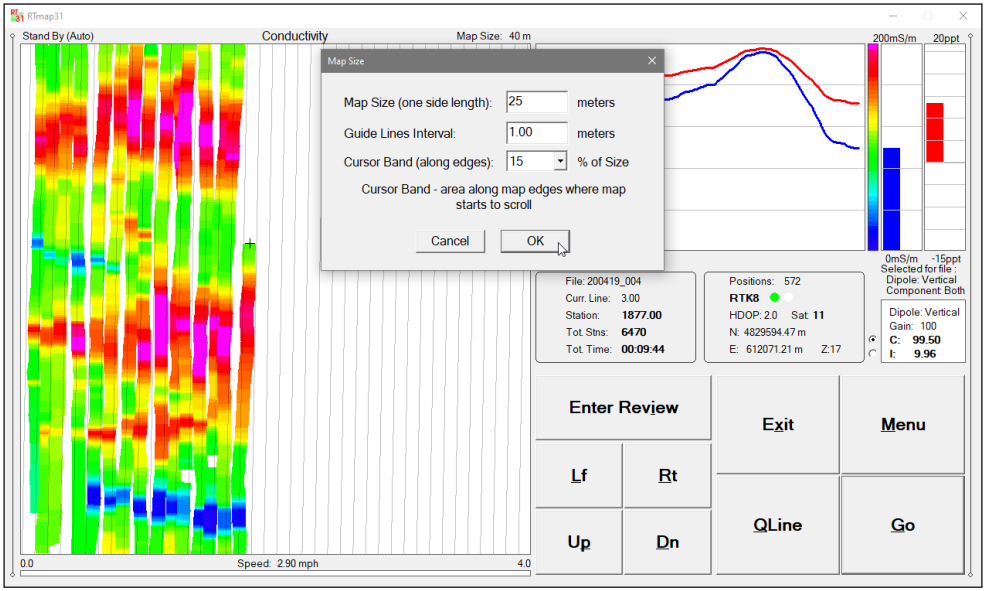


Figure 8.34: Map Size dialog, current RTmap31 map at size of 40 m

This dialog allows the operator to enter new scale for the map displayed by the plot area, map grid interval, and cursor band.
Map scale value is entered in the edit box labeled **Map Size** either in meters or feet according to selected units in System Setup dialog and it represents side of the square map. Only positive integer values ranging between 1 and 99999 are allowed by the program.
The second parameter in the Map Size dialog is **Grid Interval** or **Lines Intervals** depending on the selection (Grid or Guide Lines) in a Map Display Options dialog. These are grey grid lines in the map plot area that may be helpful in estimation of distance on the map displayed in Mapping or Navigation mode. Grid Interval equal zero will result in lack of grid lines.

The third parameter in the dialog is named Cursor Band. This parameter describes a band around map perimeter that is always displayed. In other words, when cursor approaches and enters band area the map is scrolled. The band width is described by percentage of Map Scale. Five selections are available in the combo box labeled Cursor Nand: 10%, 15%, 20%, 25%, 30%, and 40%. At 40% cursor indicating GPS antenna is mostly in the center area of the map. After parameters in Map Scale dialog are changed click on the button **OK** or press **ENTER** key to accept new values and the screen with a new map scale will be redrawn at a specified scale (see Figure 8.35 and compare with Figure 8.34). Re-drawing the map may take several seconds (prompt "Please Wait" is displayed), depending on parameters and number of data points collected in data file.

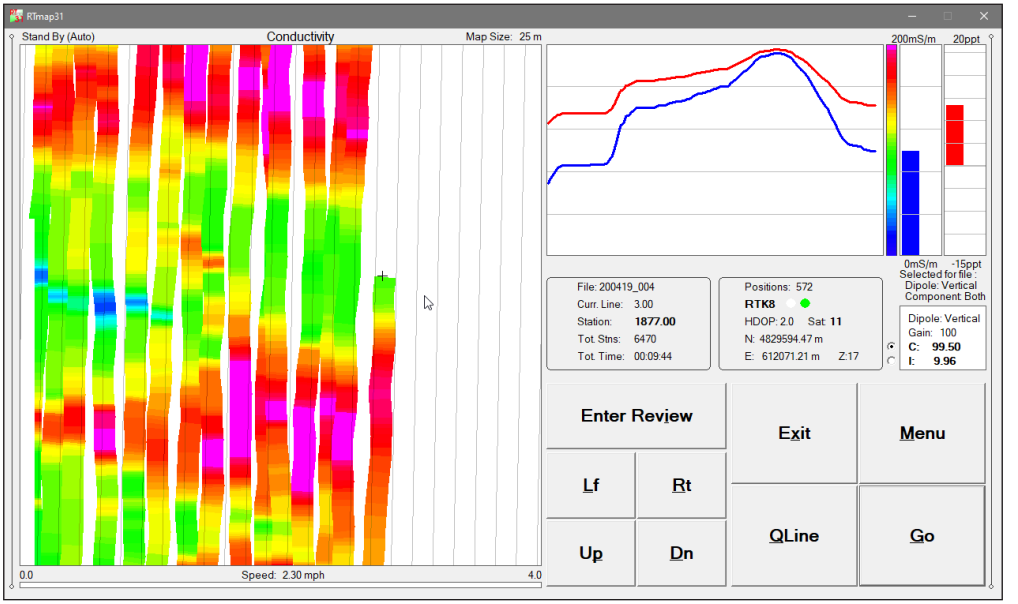


Figure 8.35: RTmap31 in Stand By mode after re-scaling map to 25 m size

To ignore an entry and return to Monitor mode click the button **Cancel** (or X) or press **Esc** key, and the dialog window will disappear.

Scale Readings (Adjust scale for profile, moving bars, and map colour image range) Minimum and maximum values for Conductivity and Inphase components can be specified in this dialog. Entered values are applied to profiles, moving bars plot, and colour imaging displayed in Mapping mode. Two colour bars for

amplitude scale of Conductivity and Inphase that represent colour distributions for colour image are updated in real time. The Reading Scale dialog is given in Figure 8.36.

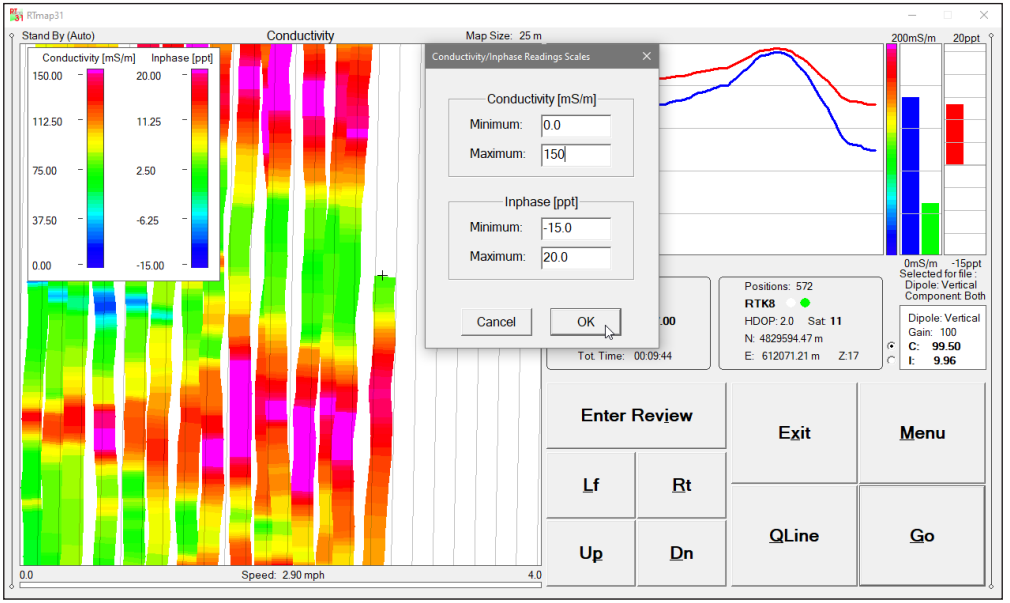


Figure 8.36: Readings Scale dialog, in the background the current EM31-MK2 conductivity readings range from 200 mS/m to 150 mS/m

After minimum and maximum values are specified click on the button **OK** or press **ENTER** key to accept new values and the profile plot and moving bars areas will be redrawn (see Figure 8.37 and compare with Figure 8.35 and 8.36, please note change in colours on the map that corresponds to change in conductivity from 0 to 200 mS/m to 0 to 150 mS/m). When large number of readings was taken in the current logging session a message "Please Wait" may appear for duration of map re-drawing.

In case minimum or maximum values entry is wrong, the program will assume minimum scale (0 to 10).

After minimum and maximum values are specified click on the button **OK** or press **ENTER** key to accept new values and the profile plot and moving bars areas will be redrawn.

To ignore an entry and return to Monitor mode click the button **Cancel** (or X) or press **Esc** key, and the dialog window will disappear.

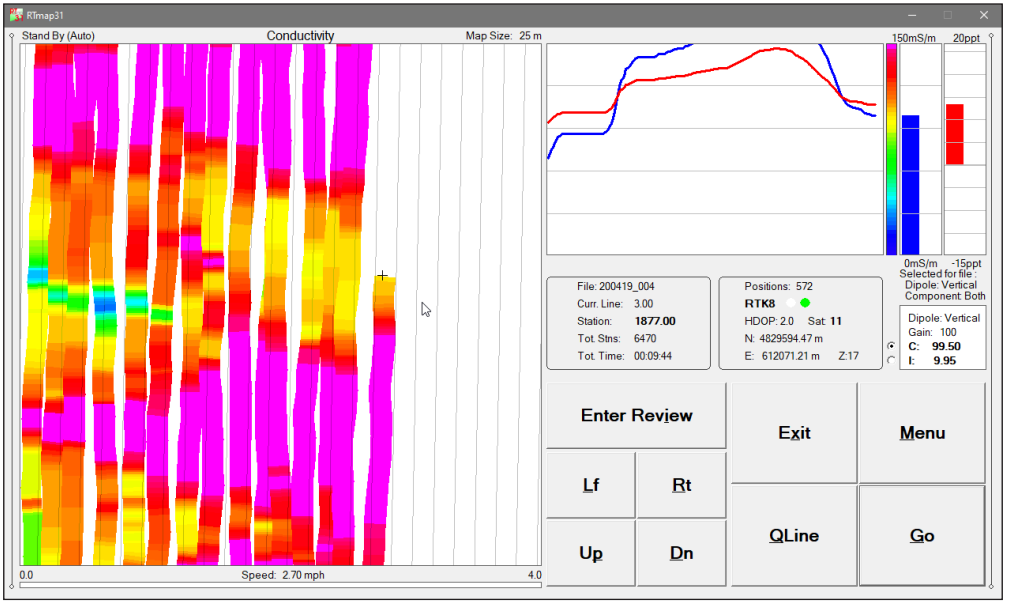


Figure 8.37: RTmap31 Screen in Stand By mode after Readings Scale change, compare with Figure 8.36 or Figure 8.35

Scale Speed Bar (change units and adjust scale for speed bar)

Minimum value for the Speed Bar Scale is preset to 0, therefore this scale requires only one entry for maximum speed. In addition speed units can be changed in Set New Speed Bar Scale dialog, which is given in Figure 8.38. The entered scale applies only to graphic representation of the speed (graphic bar), speed in numeric form is always displayed above the bar, even if the real

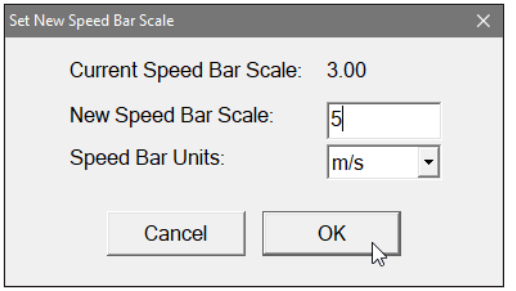


Figure 8.38: Set New Speed Bar Scale dialog

value exceeded maximum specified for the speed bar.
Speed Bar units selection contains: m/s, ft.s, km/h, and mph.

After maximum speed bar value and units are specified click on the button **OK** or press **ENTER** key to accept new parameters.
To ignore an entry and return to Monitor mode click the button **Cancel** (or X) or press **Esc** key, and the dialog window will disappear.

Map Display Options (Navigation mode)

The Map Display Options dialog is identical to dialog described in detail in Chapter 7 (please refer to section 7.1 of the manual) when measurements are conducted with GPS positioning and the program works in Mapping or Navigation mode.
This option can be accessed from pop up menu or directly by the keyboard by pressing **D** key.
The Map Display Options dialog is shown in Figure 8.39. Figures 8.40, 8.41, and 8.42 below present various setups for Navigation and Mapping modes. Please compare Figures 8.40 (Navigation mode where dots represent EM31-MK2 positions), Figure 8.41 (Navigation mode with swath bar presentation), Figure 8.42 (Mapping mode with colour image of readings amplitude - Inphase component selected).

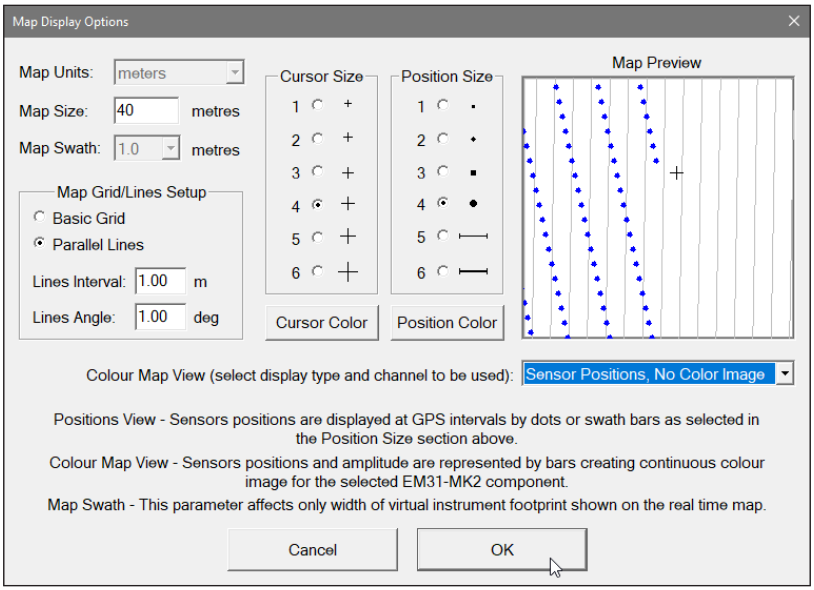


Figure 8.39: Map Display Options dialog

When large number of readings was taken a message "Please Wait" may appear for duration of map re-drawing.

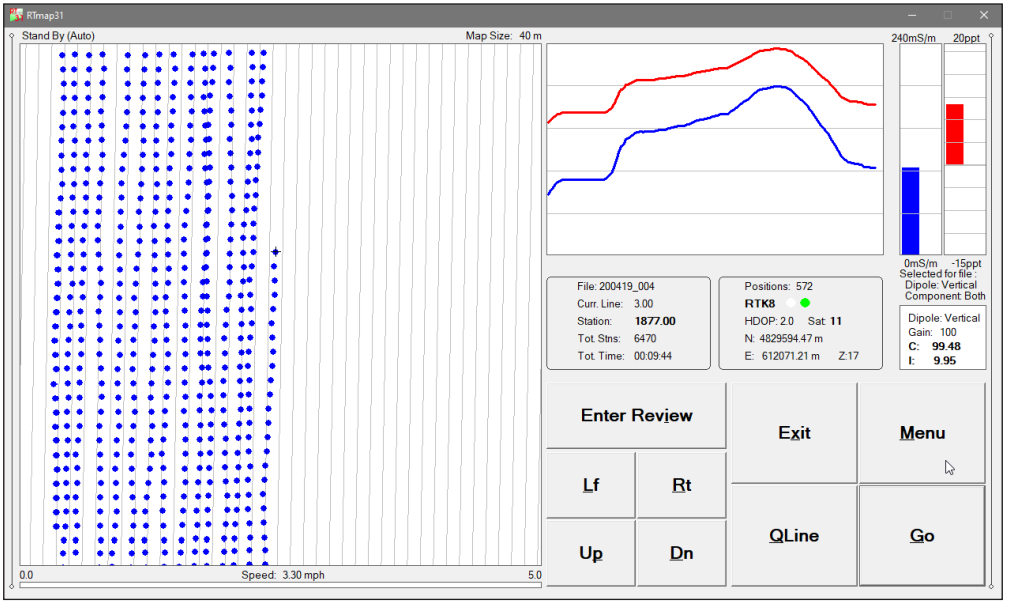


Figure 8.40: RTmap31 Logging Navigation mode with dots representing sensor positions

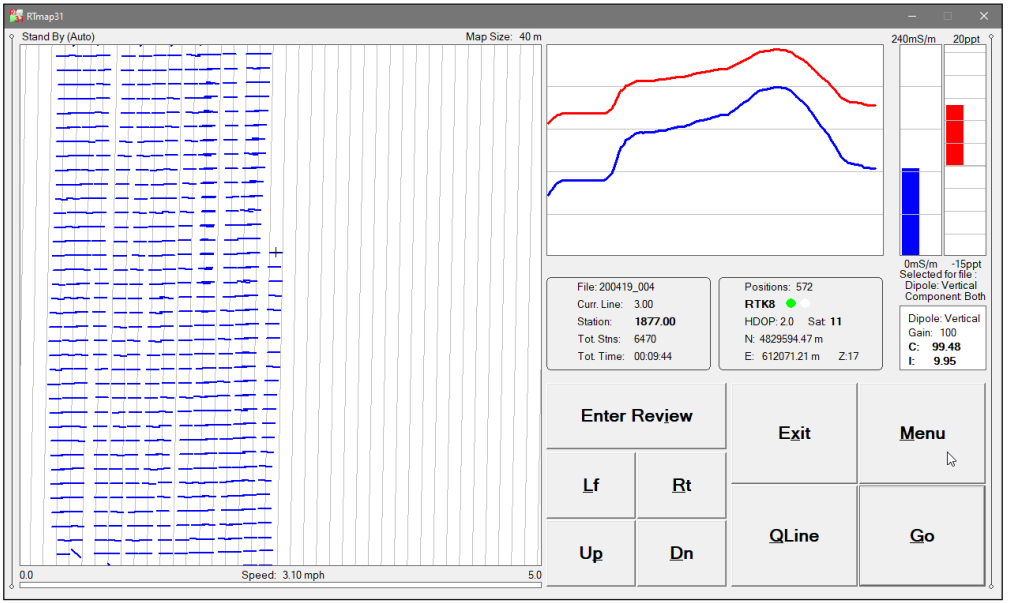


Figure 8.41: RTmap31 Logging Navigation mode with swath bars representing EM31-MK2 positions

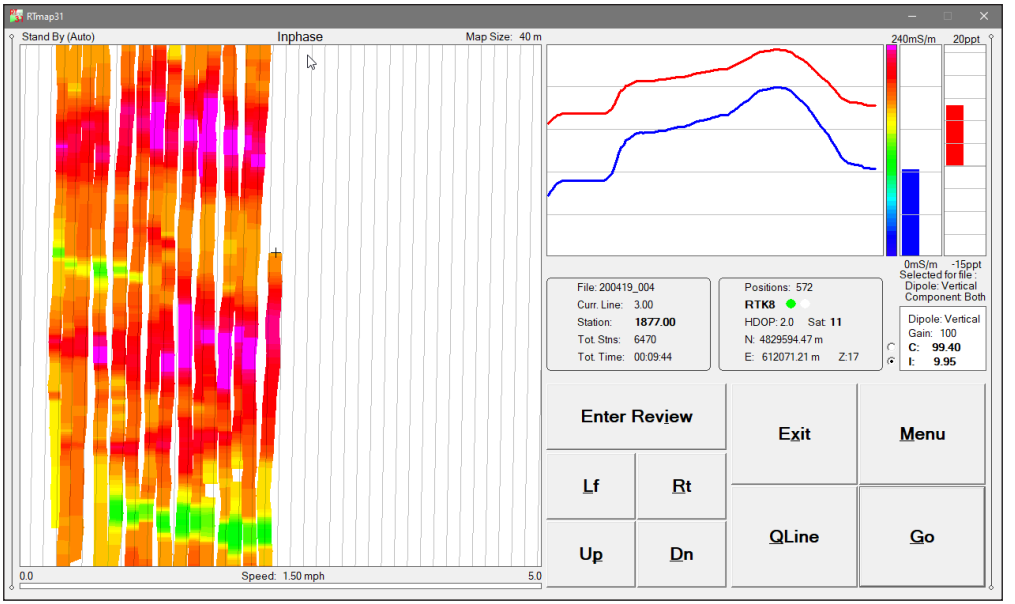


Figure 8.42: RTmap31 Logging screen in Mapping mode with colour image for the selected Inphase component

Profile Display Options

The Setup Display Options dialog is described in detail in Chapter 7. This dialog allows you to specify color and thickness of profiles (same colours apply to moving bars), and to select grid lines for specific component in profiles window. The dialog is presented in Figure 8.43.

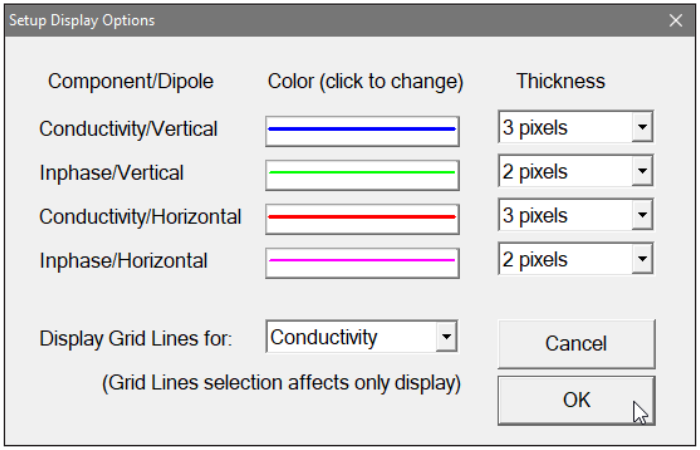


Figure 8.43: Profile Display Options dialog

To select any option click on the corresponding drop down list box or check box, or use TAB key to scroll to the option and then use mouse or keyboard to select parameter.
After all the parameters in the Display Setup dialog are updated click on the button **OK** or press **ENTER** key (assuming it is highlighted) to accept the displayed settings. The dialog will disappear and the program will return to the Monitoring mode window. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent program executions. To return to original settings (state before this dialog was selected) click on the button labeled **Cancel** (or X button) or press **Esc** key. All parameters will be reset to initial settings and the dialog window will disappear.

Audio Options

This dialog allows to enable and disable three audio functions. Two of these options can be specified in the System Setup dialog (see chapter 3), and the one associated with GPS Warning Mask can be set in GPS Port Setup dialog (see chapter 5). The Audio Options dialog is presented below in Figure 8.44. Parameters in Audio Options dialog are described below.

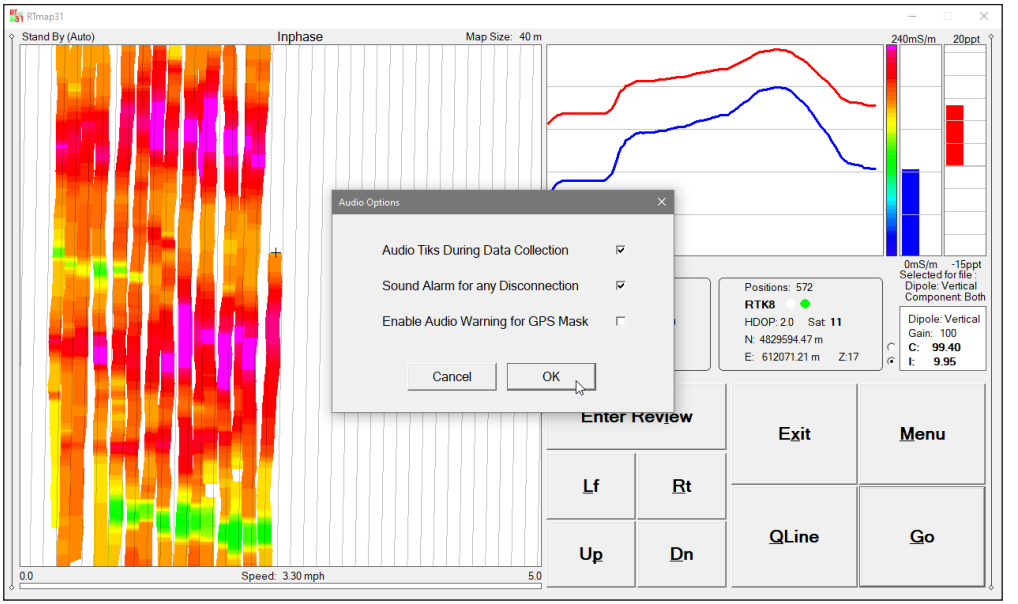


Figure 8.44: Audio Option dialog

Audio Tiks During Data Collection

The program will provide tik sound during data recording (in the Logging mode only). The tik sounds with frequency of approximately 3 Hz. This audio feature may be helpful as an additional confirmation that the button Go has been pressed (or tapped) and data is being collected and saved in data file. This audio function can be enabled or disabled by check button located at the label naming this option.

Sound Alarm for any Disconnection

The program will sound loud ring when a disconnection in any serial port is detected by the program, or in case any EM61-MK2 console or GPS receiver will stop streaming data for any reason. The audio alarm function does not depend on the visual alarm that is always enabled regardless of audio alarm setting. The audio alarm function can be enabled or disabled by check button at the Sound Alarm for any Disconnection label as shown in Figures 8.47 and 8.48.

Enable Audio Warning for GPS Mask

When this option is enabled then in addition to visual warning (alternating red and white circles) an audio warning will sound (it is more gentle "bell" sound than loud audio alarm ring associated with disconnection of any sensor).

Toggle View (toggle between Mapping and Profile modes)

Selecting this item from pop up menu or simply pressing the key **T** will switch Stand By mode display between Profile and Mapping/Navigation modes. Changing the display from Profile to Mapping mode (when data were collected or external file was entered) may take several seconds depending on number of positions displayed and map scale. The program will display message WAIT till all positions are plotted in current map area and it will beep at the end of this process.

GPS Warning Mask

This dialog allows to set or change GPS Warning Mask parameters during logging session. The same parameters can be set in GPS Port Setup dialog (see chapter 7). The GPS Warning Mask dialog is presented below in Figure 8.45. Parameters in GPS Warning Mask are described below.

Warning

Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: Enabled and Disabled.

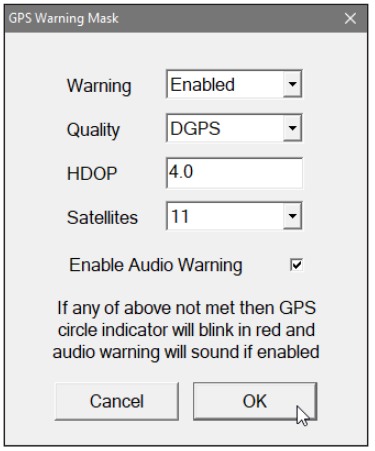


Figure 8.45: GPS Warning Mask

This option allows you to Enable/Disable a GPS Warning Mask that contains three parameters: Quality Indicator (degree of differential corrections), Dilution Parameter (PDOP or other label depending on the selected NMEA message), and number of available satellites.
When Enabled is chosen GPS two circle indicator will be alternating in green and white if conditions for specified parameters setting will be met. When any of the parameters is below set values then GPS indicators will alternate in red and white colours (see Figure 8.46). In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours (see Figure 8.44) regardless of GPS signal quality.
All GPS data is logged, GPS Warning Mask affects only display.

Quality

This parameter describes Quality Indicator (degree of differential corrections). Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: AGPS (Raw), DGPS, RTK3, RTK4, RTK5, and so on.
If Quality Indicator received from GPS receiver will be worse than specified then GPS indicator will alternate in red and white colours.

PDOP

This parameter can be labeled PDOP, HDOP, DOPG, DOP depending on the selected NMEA message. It can be also named Quality m (accuracy in meters) if LLQ was selected, or it is not available (labeled N/A) when messages GLL, pseudo-GGA or Trimble RTS are used.

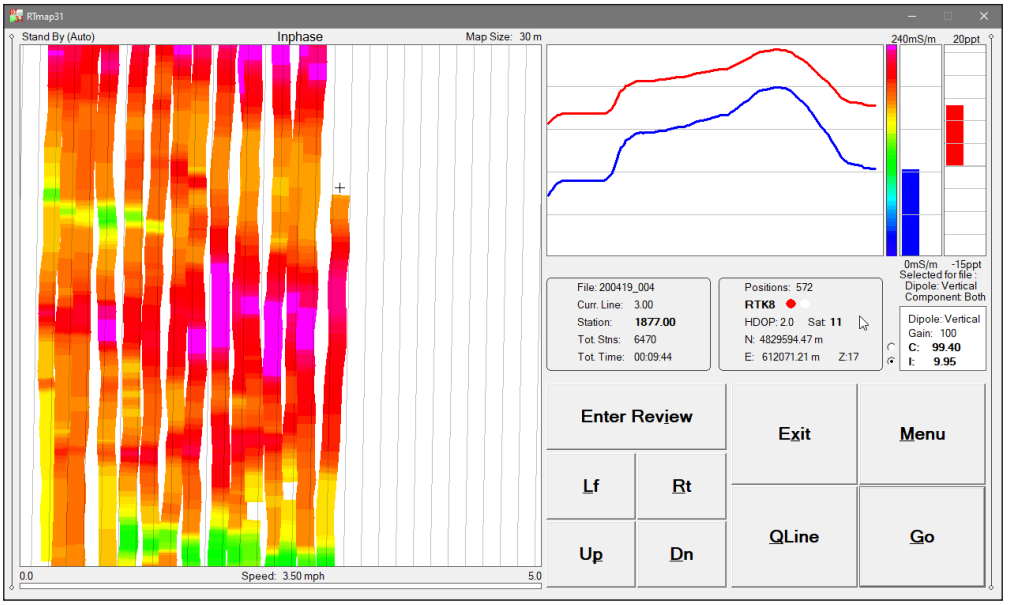


Figure 8.46: RTmap31 screen with GPS Warning indication

Activate text box by clicking on the edit box or using TAB key and then enter the chosen acceptable maximum value of Dilution parameter. If PDOP (or other similar parameter) is larger than specified value then GPS indicator will alternate in red and white colours.

Satellites

Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: 3 to 12.
If number of available satellites will be smaller than specified then GPS indicator will alternate in red and white colours.

After all the parameters in the GPS Warning Mask dialog are updated click on the button **OK** or press **ENTER** key to accept the displayed settings. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent GPS Warning Mask and GPS Port Setup dialogs.
To return to original settings (state before this dialog was selected) click **Cancel** (X) button or press **Esc** key. All parameters will be reset to initial settings.

GPS Warning Mask settings affect only display information. All GPS positions are written to data file in original form regardless of specified values in GPS Warning Mask dialog.

Coordinates Display Units

The Set Coordinates Display Units dialog will be displayed, Figure 8.47. There are four items after the combo box labeled Coordinates unit will be expanded: Geodetic Lat/Lon (coordinates in Degrees, Minutes, Seconds), UTM meters, UTM feet (International Feet), and UTM US Feet (US Survey Feet). Select one of items and coordinates of the GPS antenna will be displayed in the GPS section (bottom of the logging screen) in selected units. Please compare Figure 8.47 (Coordinates in UTM meters) and Figure 8.55 (Geodetic Coordinates in degrees).

Select the OK button to accept selection or the Cancel button to exit dialog.

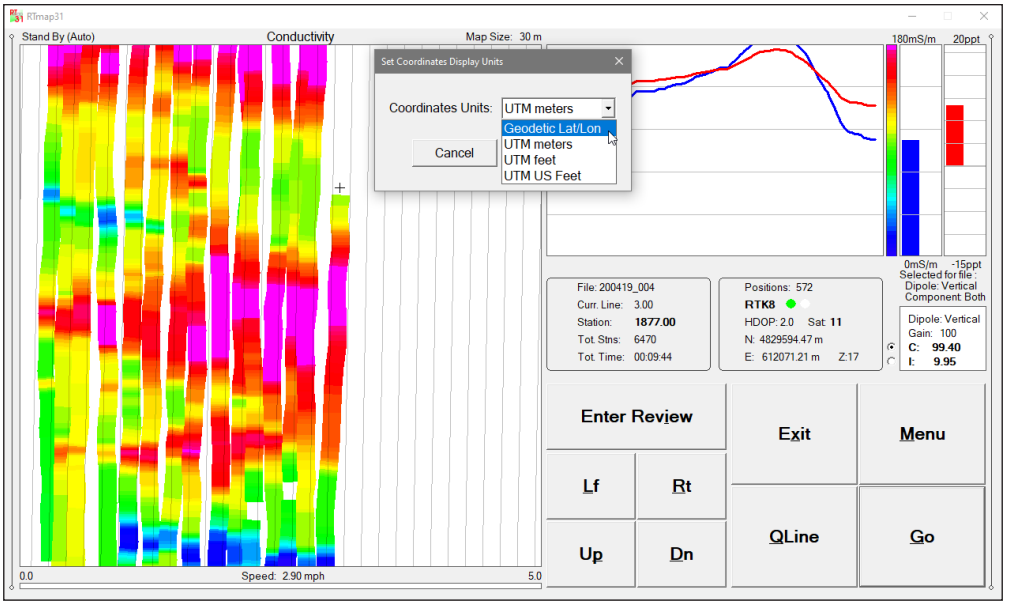


Figure 8.47: RTmap31 Set Coordinates Display Units dialog

Enter Background File

The Load Background File dialog is shown in Figure 8.48. This option is also described in section 8.2, in this section examples with background files and collected data will be shown The program will display contents of entered files in the background of the map. Two types of files can be entered: any data file created with Geomar programs (RTmap, TrackMaker, or Multi - all V2.00 or later) or user prepared column delimited text file (TXT format) containing coordinates representing site boundary, or any other feature. If Geomar data file is entered its content will be displayed as traces of collected survey lines. This option can be used to follow measurements with another instrument, to display already performed coverage, or to repeat part of the survey. User prepared Column Delimited ASCII Text File can be used to display a site outline, delineated

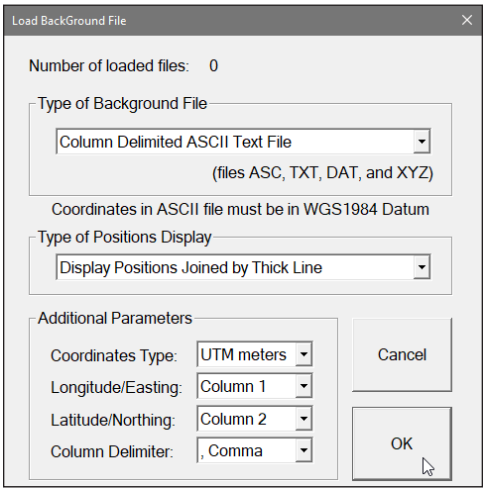


Figure 8.48: Load Background File dialog

area of special interest to be surveyed with finer line spacing etc. The latter file must contain coordinates in WGS 1984 datum. Geomar data files are in WGS 1984 datum by default. Up to 10 files (mixture of either type) can be entered and displayed.

Type of Positions Display describes how positions are displayed, they can be plotted as separate points, or lines joined by thin, medium, or thick lines depending on the selection in the corresponding combo box. Lines can have breaks if a tag "Break" (lower or upper case) is inserted in the file. Sample of Column Delimited file is show in Appendix A.

When a Column Delimited file is selected a section labeled Additional Parameters is activated. Parameters describing file structure must be specified, these are: Coordinates Type (Geodetic, UTM meters, feet, or US Survey Fee), column numbers for Longitude and Latitude or Easting and Northing, and finally Column Delimiter (Space, Comma, Tab, or Semicolon). For practical simplicity, if UTM coordinates are used it is assumed that the operator is located within the same UTM zone.

Type of the file and all parameters must be specified prior to selecting file name, therefore it is necessary to know structure of background files that are to be loaded. After the OK button is clicked on or tapped an Open File dialog will appear, Figure 8.49

After file is opened in above dialog program will draw it immediately in the map window and another file can be entered if needed.

The RTmap31 screen with one loaded background files (Column Delimited type) and start of actual data logging is shown in Figure 8.50.

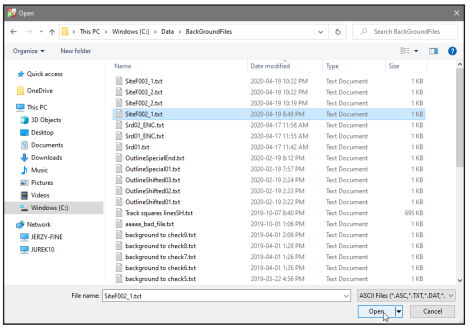


Figure 8.49: Selection of Background File

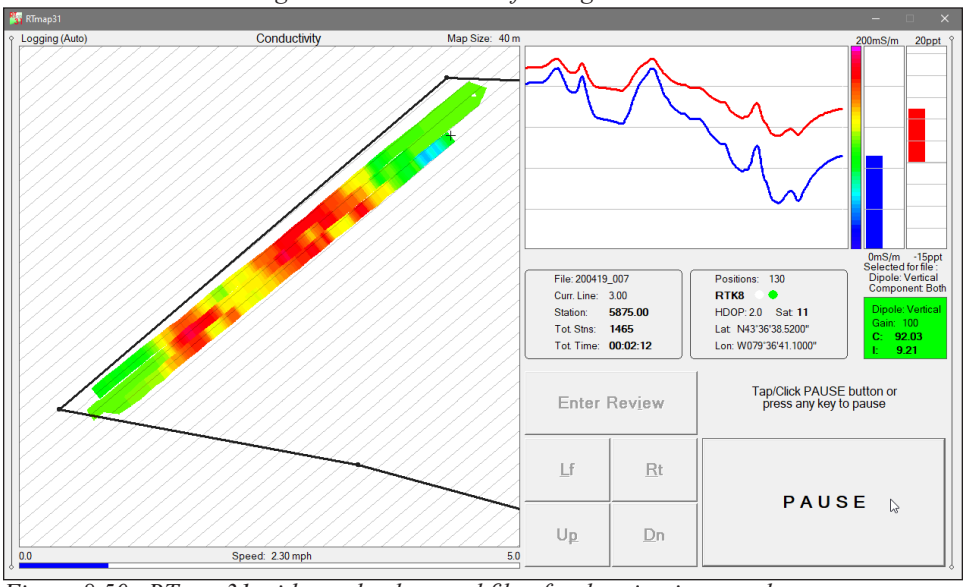


Figure 8.50: RTmap31 with one background file after logging is started

As long as there are less than 10 background files loaded into the program next file can be entered or removed at any time during logging data. Example of loading new file is shown in Figures 8.51 and 8.52 (it is same logging session at later stage as shown in Figure 8.50). When Enter Background File option is executed, the dialog that appear indicates number of already loaded files (Figure 8.51). After all parameters are specified and file is selected in Open File dialog the program displays newly entered background file on the map as shown in Figure 8.52.

Please note that background files are displayed using real coordinates. Program registers its position as soon as the first GPS position is detected (it is cross cursor displayed in the center of the map). It is the reason that background files cannot be entered prior to the first GPS position obtained by the program.

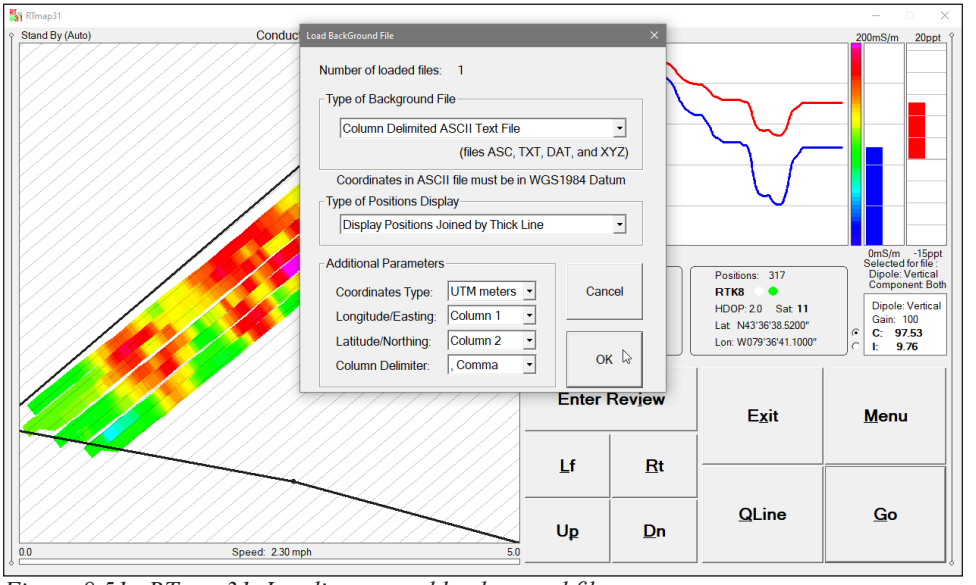


Figure 8.51: RTmap31, Loading second background file

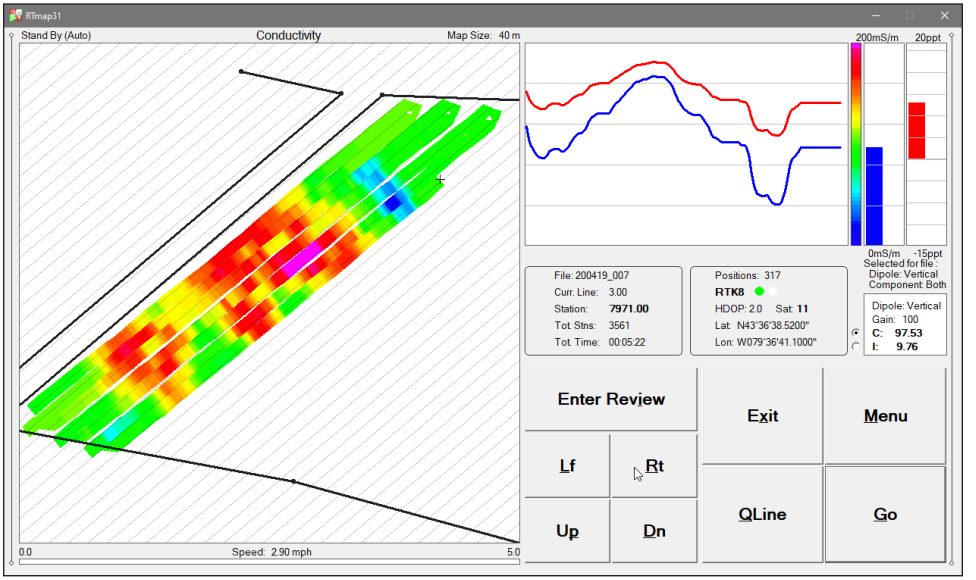


Figure 8.52:Two background files displayed on the map, compare with Figure 8.51

Therefore, loaded background files can be displayed only if operator is in the same area and map size covers coordinates listed in data file or Column Delimited file. If the entered file is not displayed then it may be visible after changing map to larger size.

Remove Background Files

After this option is executed the Remove Background Files dialog appears, Figure 8.53. In this example the dialog contains list of three loaded background files. Click on any check box located on the left of corresponding file name (in

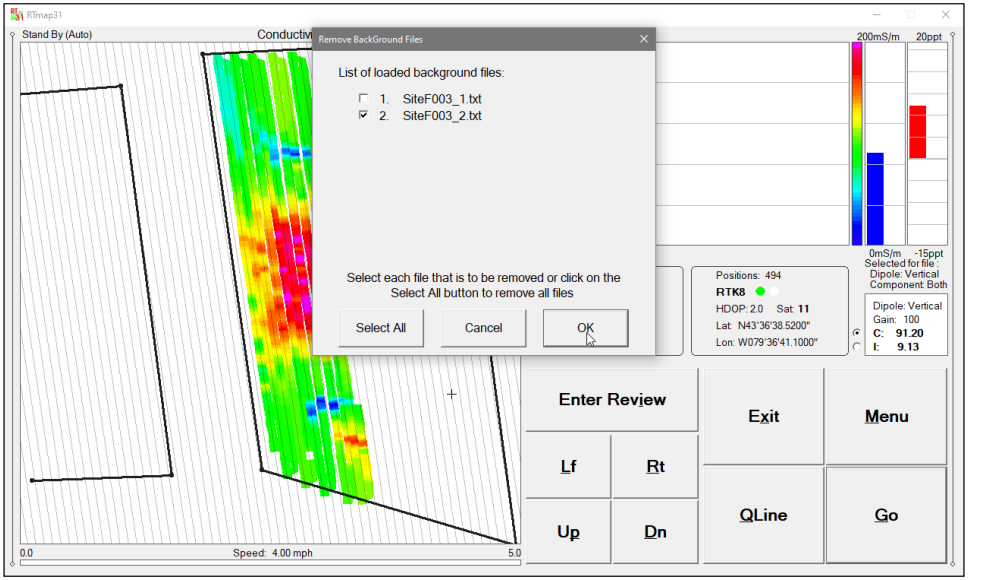


Figure 8.53: Remove Background Files dialog

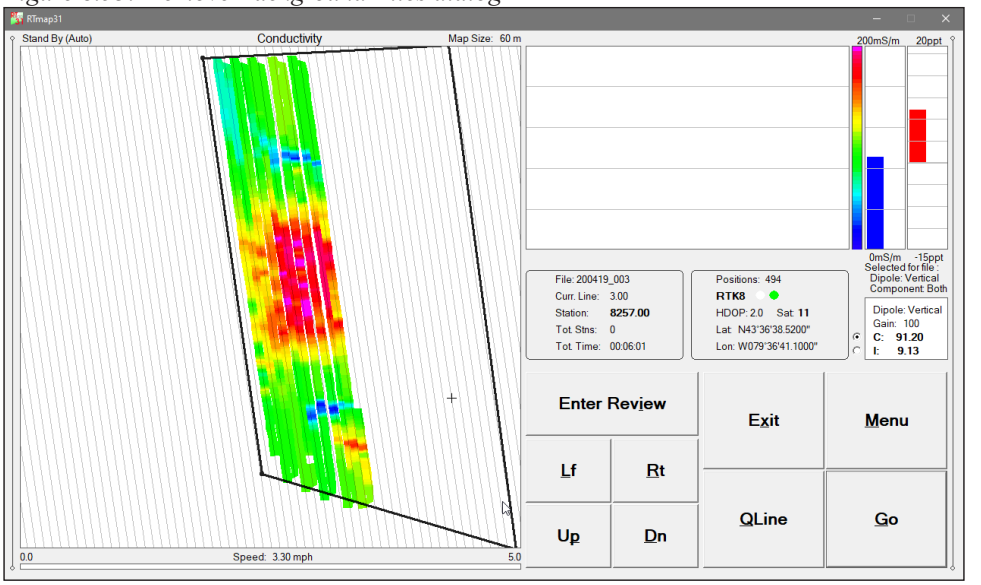


Figure 8.54: RTmap31 map with one removed file, compare with Figure 8.53

this example only one second file is to be removed) and when the OK button is clicked on or tapped the map will be re-drawn and checked files will be removed from the program map. Result is shown in Figure 8.54 where map does not contain outline located above main survey area.
Click on the Select All button and then OK button to remove all entered files at once.

Exit (exit data logging)
During data collection (in Stand By mode) a confirmation message dialog will be displayed (there is no such message if **Exit** is performed in Monitoring mode) before program exits logging window, Figure 8.55.

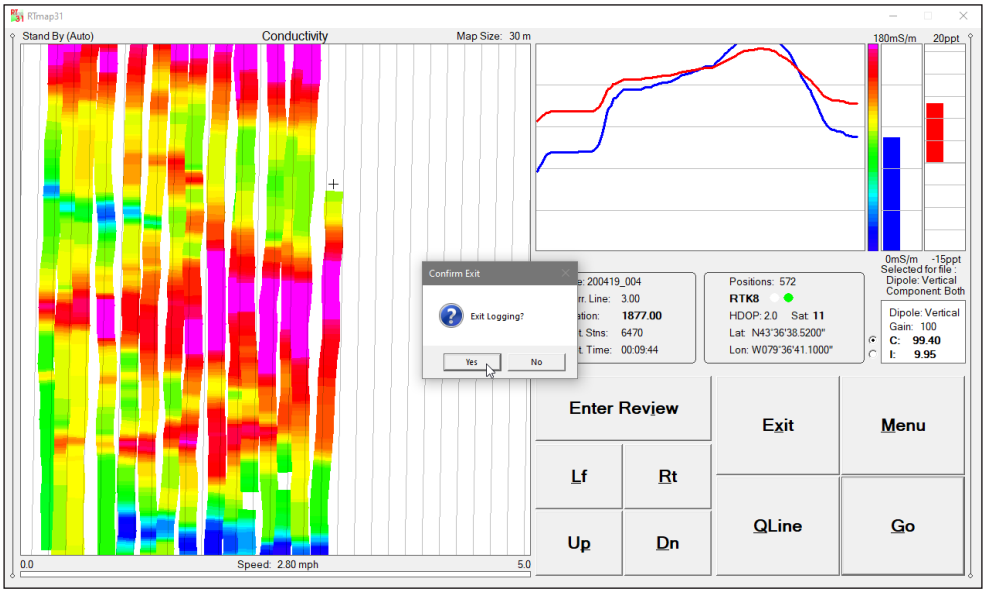


Figure 8.55: RTmap31 - Exit Logging session confirmation message

After above message is confirmed (click on the **Yes** button) the program stops logging, closes data file and returns to Main Screen. If the button **No** is tapped the program returns to current logging mode and data collection can be continued.

Map Navigation (seven command buttons below speed bar) and **Review**
Seven above command buttons are displayed below the label Panning and the button labeled **Enter Review** (Figure 8.56). Four panning buttons **Lf** (Left), **Rt**(Right), **Up**, and **Dn** (Down) are enabled and available at any time in the Stand By mode, without executing Review mode. They can be used to shift

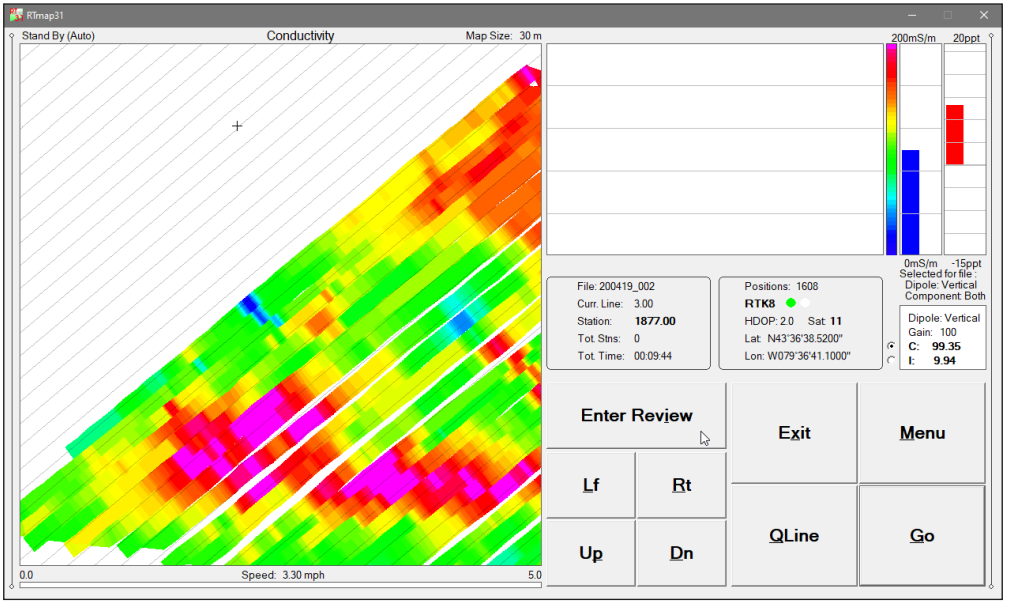


Figure 8.56: RTmap31 - Panning buttons available in Stand By mode

colour image in any direction, as long as current position (cursor position) is located within the map.

Three remaining buttons **Zm+**, **Zm-**, and **FitAll** are enabled as soon as the button **Enter Review** is clicked or tapped on. At this moment the displayed map is not updated (cursor indicating current position is disabled), label Panning is replaced by label Navigation, and button **Enter Review** is replaced by the button **Exit Review** (Figure 8.57). When Review is active top row of buttons is used to pan the displayed map while second row of buttons can be used to change scale of the map.

Description of panning and navigation buttons is given below and various zooming and panning action is show in Figures 8.57 and 8.58. Please compare Figures 8.56, 8.57, 8.58, and 8.59 that represent the same data set at various scales.

Lf, **Rt, Up, Dn** (panning functions: Left, Right, Up, and Down)

Panning functions move screen in four directions. The procedure can be accomplished by clicking or tapping on corresponding command buttons or by pressing cursor keys or **P**, **D**, **L**, and **R** keys correspondingly. The step of pan (percentage of the screen being moved) can be specified in the Map Scale dialog, the program default is 20%.

Zm+, **Zm-, FitAll** (zoom functions: Zoom In, Zoom Out, and Fit All)

These options can be used by clicking on corresponding command buttons or from keyboard by pressing keys **+** , **-**, or **F**. The step of zoom

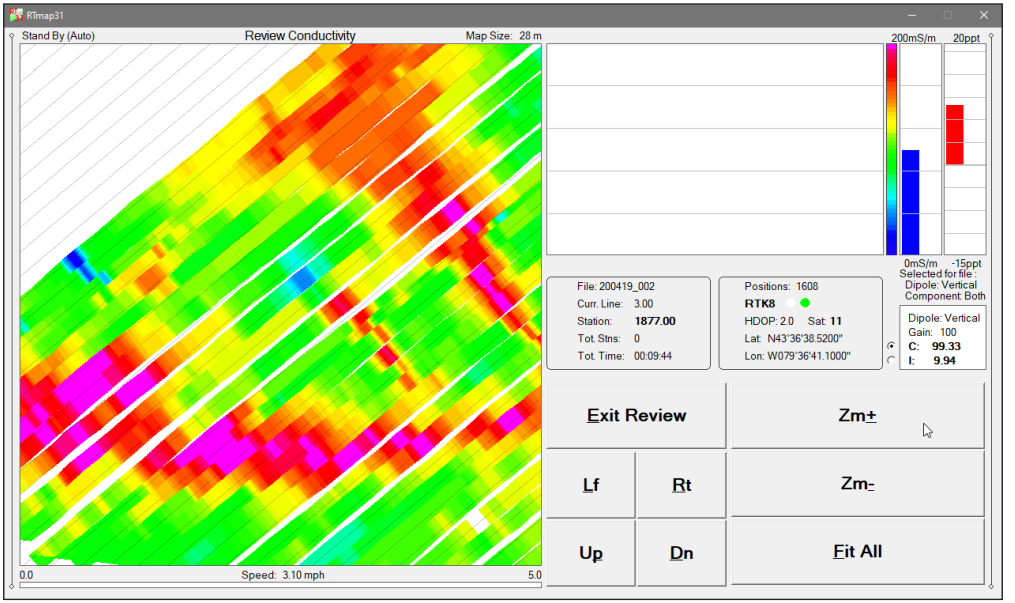


Figure 8.57: RTmap31 - Navigation buttons available in Review mode

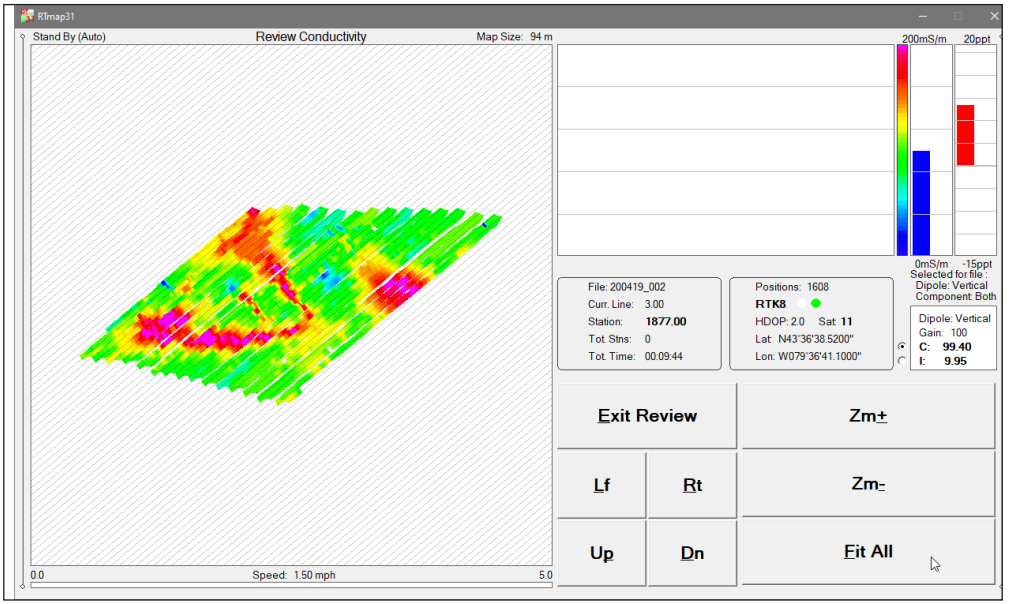


Figure 8.58: RTmap31 - Executing the Fit All option in Review mode

(percentage of the current map scale) is the same as a Band Cursor in Map Scale dialog.

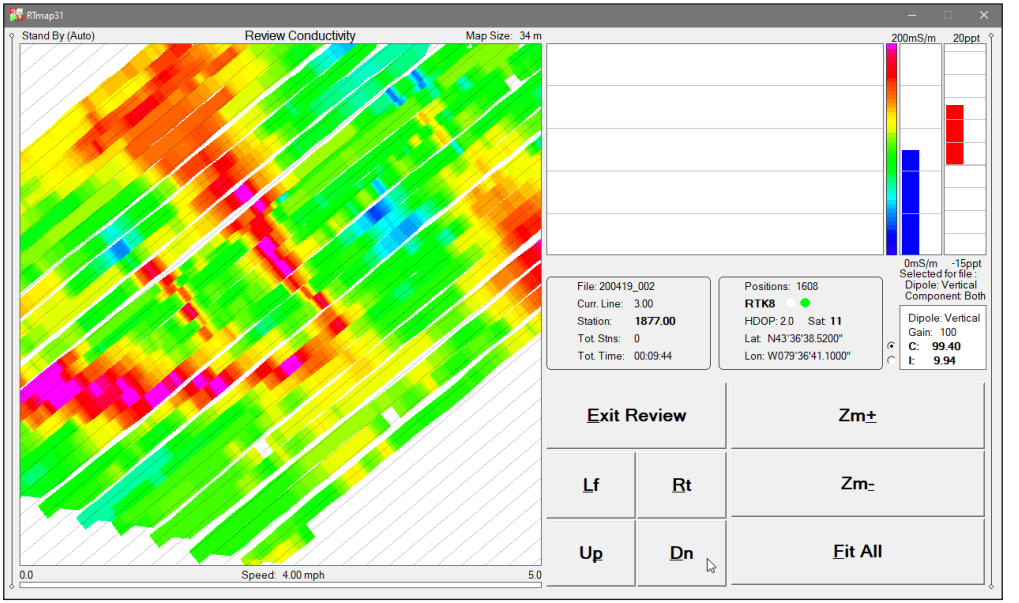


Figure 8.59: A map after multiple Zoom+ and Pan actions

To exit Review mode and return to Stand By mode tap or click on the button **Exit Review**. The label **Navigate** will be replaced by label **Panning**, zooming buttons will be disabled, map will return to the former size (scale), and cursor (cross) indicating current position of the system will appear.

8.6 No Connection Message

A message **No Connection** may appear during any RTmap31 logging mode (Monitoring, Stand By, or Log modes). The message **No Connection** (Figure 8.60) is displayed in the numeric values window and replaces displayed values. The message is highlighted by red to alert operator, and audio alarm if enabled.

This message indicates lack of communication between the indicated EM31-MK2 console and the field computer. In most cases the message **No Connection** is caused by disconnected connector in the instrument cable, turning the instrument OFF, or low battery in the EM31-MK2. The program tries to re-establish communication while the message is displayed. After correcting the source of a problem the program automatically connects to the EM31-MK2, checks performance, and then the program returns to normal operation.

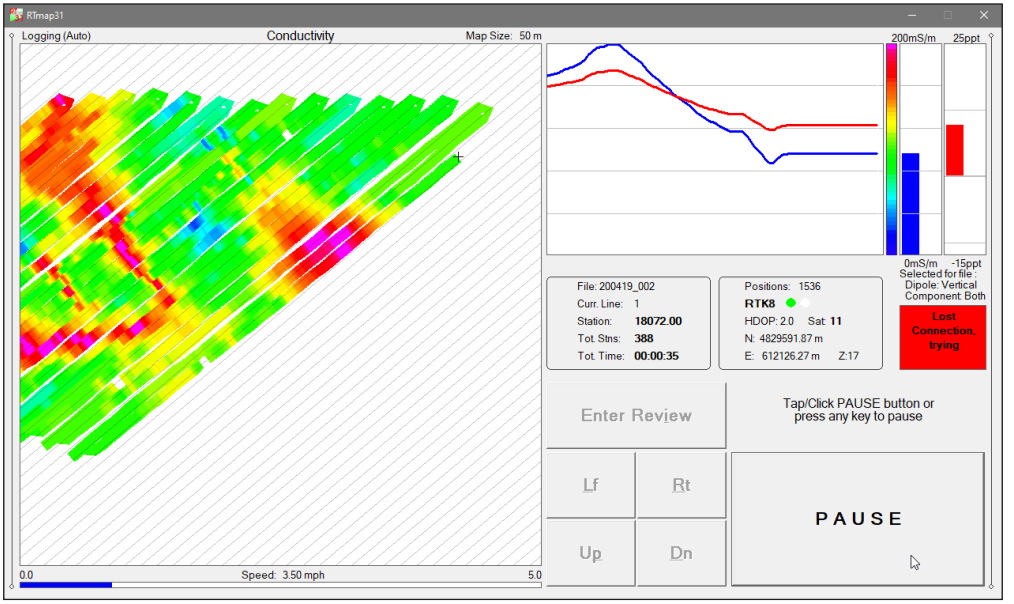


Figure 8.60: Message No Connection for the EM31-MK2 unit

When the source of the problem cannot be corrected please return program to Stand By mode (if in Log mode) and then use the **Exit** button (few clicks on the button may be required, pressing keyboard key **X** provides faster response in this case), the program will properly close open data file (if Logging session is not in Stand By) and the program will exit logging session. If data is monitored or logged (in Monitoring, Stand By, or Logging modes) a message **NO CONNECTION** may appear in the centre of the screen when connection with the EM31-MK2 is lost permanently.

8.7 No Connection for GPS Receiver

The alert that indicates lack of communication between the GPS receiver and the field computer is shown as red highlight of all GPS parameters displayed in the RTmap31 screen (Figure 8.61). In most cases this message is caused by disconnected connector in the cable, turning the GPS receiver OFF, or low battery in the receiver. The program tries to re-establish communication while the message is displayed. After correcting the source of a problem the program automatically connects to the GPS receiver, checks performance, and then the program returns to normal operation.

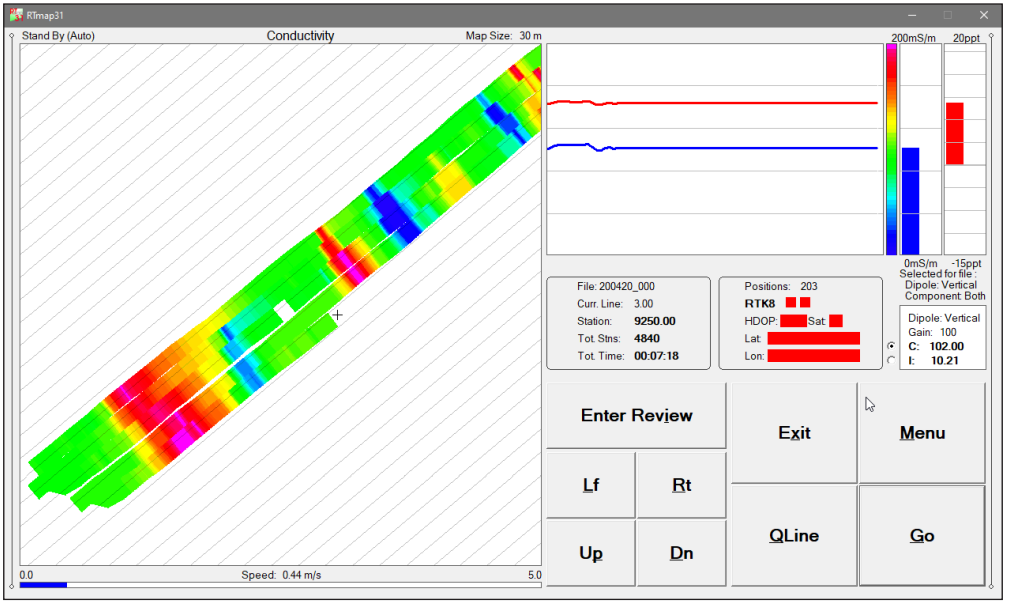


Figure 8.61: The RTmap31 screen indicating lack of connection for GPS receiver

When the source of the problem cannot be corrected please return program to Stand By mode (if in Log mode) and then use the **Exit** button (few clicks on the button may be required, pressing keyboard key **X** provides faster response in this case), the program will properly close open data file (if Logging session is not in Stand By) and the program will exit logging session.

8.8 Program Layout for Display in Portrait Orientation

Almost all figures shown in the manual for practical layout reason present program screen shots of program used in landscape screen orientation. Figures 8.62, 8.63, 8.64, and 8.65 depict logging screen layout for computers that use portrait display orientation. Program provides exactly the same info and parameters regardless of the screen orientation, the only difference is layout. The program detects computer display orientation and adjusts its layout automatically at the program start. However, it is very important to fix display orientation to Landscape or Portrait mode in Windows Settings. The RTmap31 program cannot trace and rotate screen during data collection.

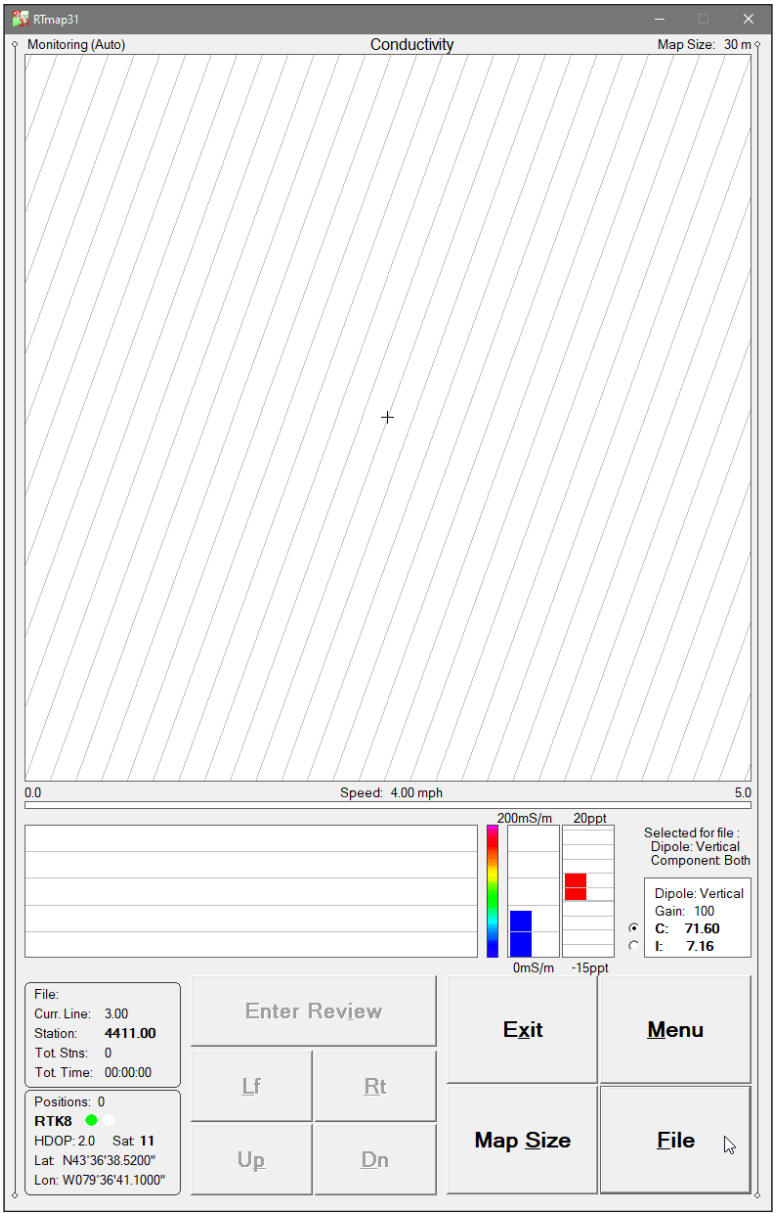


Figure 8.62: RTmap31 portrait orientation - Monitoring mode

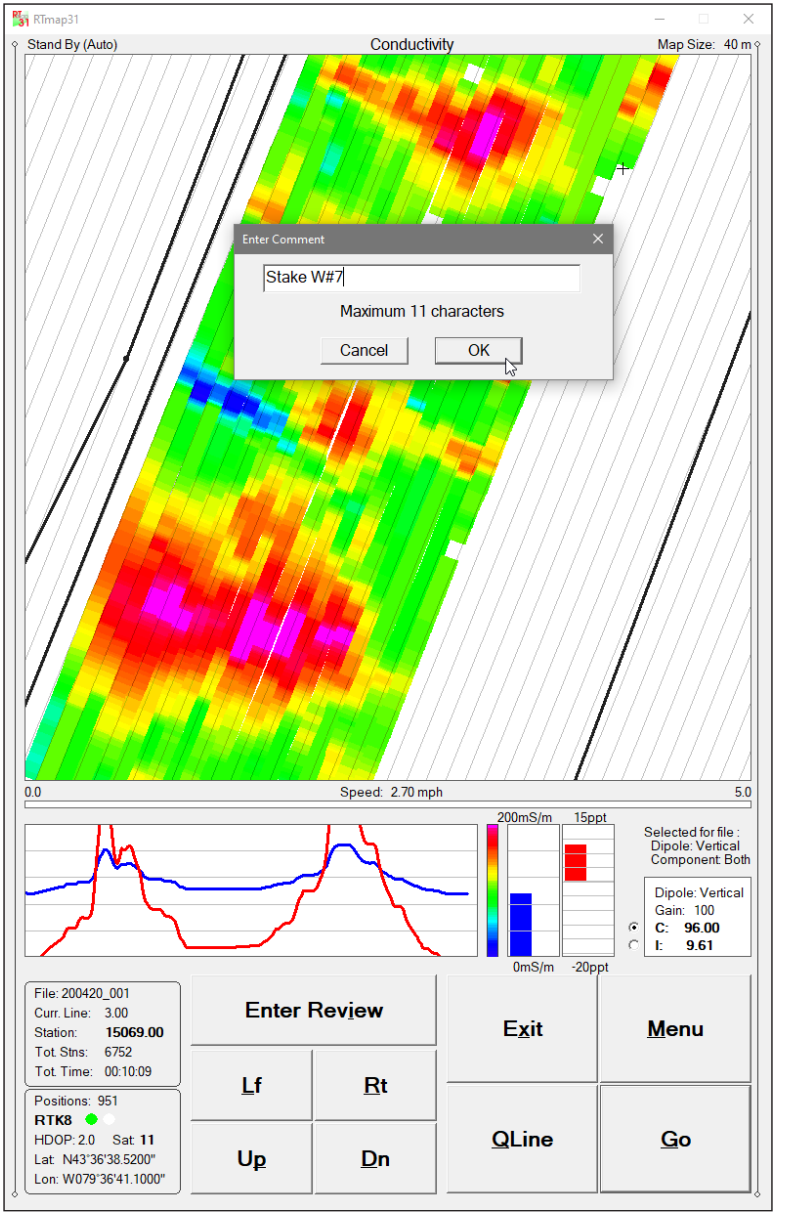


Figure 8.63: RTmap31 portrait orientation - Stand By mode, two background user files displayed, Conductivity map and Enter Comment dialog.

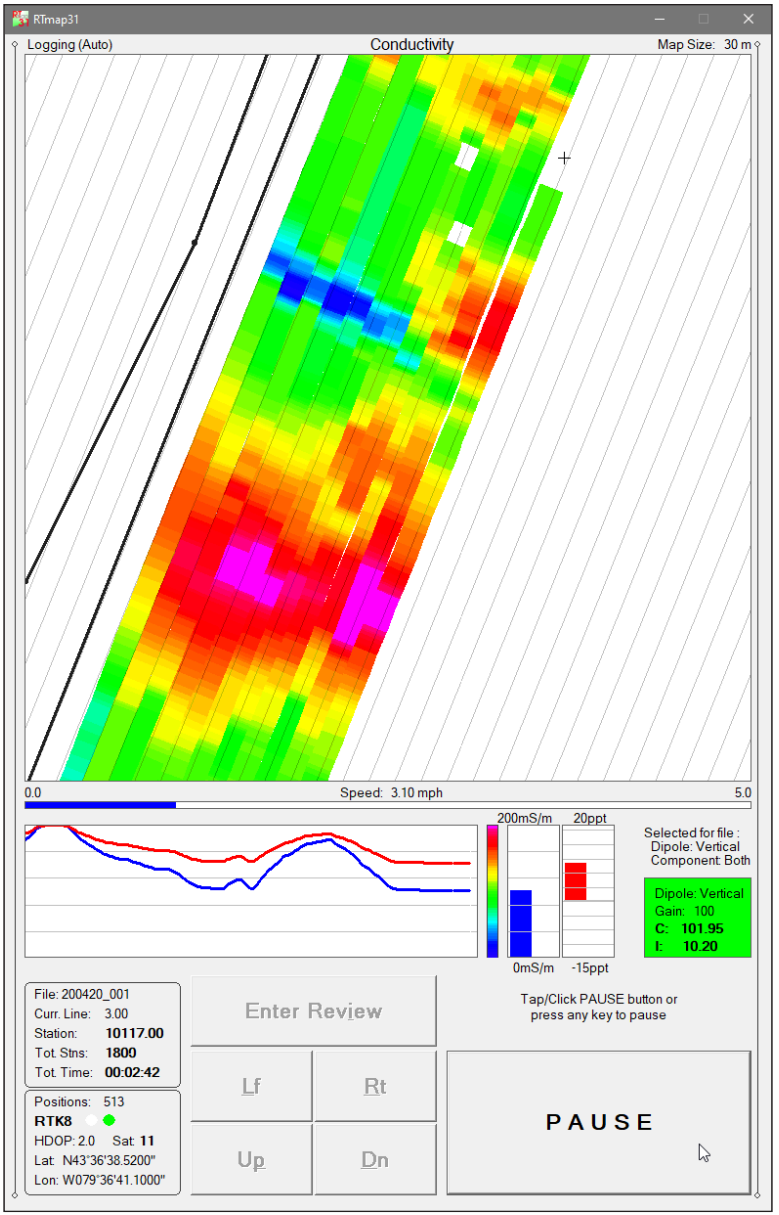


Figure 8.64: RTmap31 portrait orientation - Logging mode, two background user files displayed, Conductivity amplitude shown on colour map.

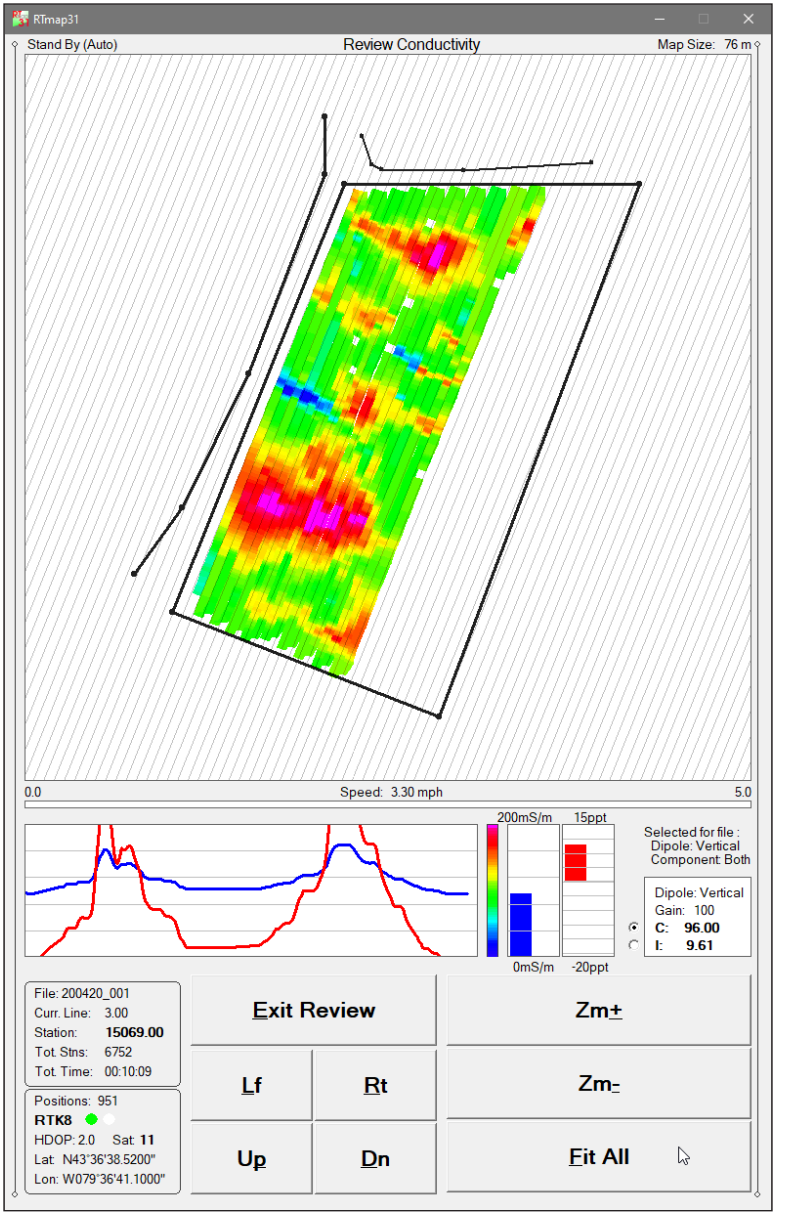


Figure 8.65: RTmap31 portrait orientation - Review mode, three background user files displayed, map size after the Fit All button pressed.

RTmap31 Data File

A

A.1 Description of RTmap31 Data File Format (T31)

Each record created by the RTmap31 for MS Windows 10/7 program contains 27 characters, including line feed at the end of each record.

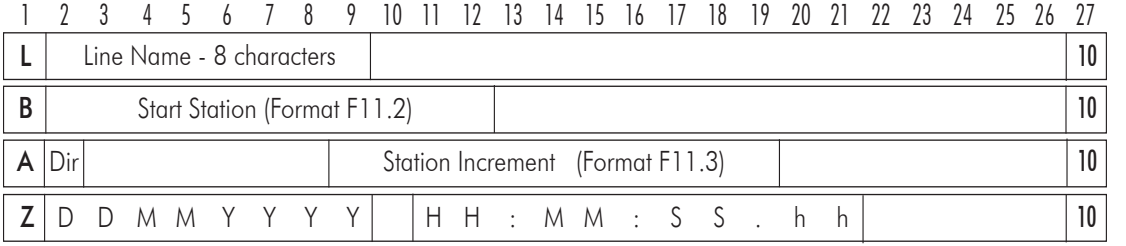
Header of the file contains 5 records starting with characters R, H, and then three records starting with G.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R	T	M	3	1				W	2	0	0	Survey Type			UT	ID	IM	IC	ST		LT			svid		10
H	Data File Name											Time Inc./Samples							TG					svid		10
G	GPS X Offset (F7.2)							GPS Y Offset (F7.2)											GP	GS	GR			svid		10
G	Initial Easting (F14.3)															ZN										10
G	Initial Northing (F14.3)																									10

RTM31	-	identification of program file, if rTM31 (lower case r) is present later in the file, it indicates start of appended file header
W200	-	version number (V2.00)
Survey Type	-	GPS (if GPS Input Enabled) or GRD (grid)
UT	-	unit type (0 = meters, 1 = ft, 2 = US Survey ft)
ID	-	EM31 Dipole Mode (selected by operator) (0 = Vertical, 1 = Horizontal, 2 = Both)
IM	-	EM31 survey mode (0 = Auto, 2 = Manual)
IC	-	EM31 component (=0 Both, =1 Inphase)
ST	-	EM31 type (0 = Standard 3.66 m, 1 = Short 2 m)
LT	-	computer type (fixed =1 MS Windows)
svid	-	logger/software type id (not used)
Data File Name	-	file name, maximum 10 characters
Time/Samples	-	this field depends on EM31 survey mode Auto Mode - Time Increment in seconds Manual Mode - Samples/Reading

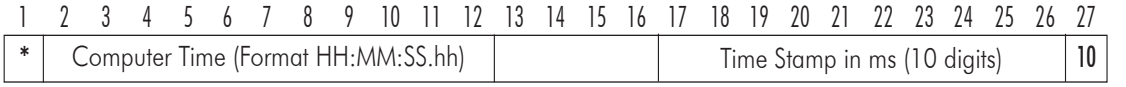
TG	-	File tag (space=original, 1=Saved As / edited)
GPS X Offset	-	Offset of GPS antenna in X direction
GPS Y Offset	-	Offset of GPS antenna in Y direction
GP	-	type of GPS NMEA message (0 = GGA/GSA, 1= GGA, 2 = POS, 3 = LLK, 4=LLQ, 5=GLL, 6 = GGK, 7 = RTS pseudo-GGA)
GS	-	GPS state (0=disabled, 1=Enabled, >1 indicates averaging number for GXY files)
GR	-	GPS update rate (= 0, fixed, not used)
Initial Easting	-	survey start coordinate (program internal use only)
ZN	-	UTM Zone (program internal use only)
Initial Northing	-	survey start coordinate (program internal use only)
10	-	Line Feed character

Header at the start of survey line (contains four records starting with L, B, A, and Z)



Line Name	-	Line Name, maximum 8 characters
Start Station	-	Start Station for the Line, format F11.2
Dir	-	Direction of the Line (E, W, N, or S)
Station Inc.	-	Station Increment, format F11.3
Date	-	Date when Line was created, format DD-MM-YYYY
Time	-	Time when Line was created, format HH:MM:SS.hh
10	-	Line Feed character

Timer Reset



Indicates reset time of the program timer. This record links timer in milliseconds and computer time (local time) in format HH:MM:SS.hh. This record is written to the file each time after the program switches from the Stand By to Log mode. In case when data are taken continuously the timer is automatically reset every hour.

Reading

1	2	3 4 5 6 7	8 9 10 11 12	13 14 15 16	17 18 19 20 21 22 23 24 25 26	27
I	Gn	Reading 1	Reading 2		Time Stamp in ms (10 digits)	10

I - indicator T or 2
T - first reading at the EM31 station (default for Auto mode)
2 - second reading at station (possible only in Manual mode)
Gn - information byte, one character parameter,
the ASCII number of this character indicates following:

Bit	Decimal		Value and Meaning
7	128	1	*not used*
6	64	Marker	= 1 *trigger pressed*
			= 0 *otherwise*
5	32	Mode	= 1 *Vertical*
			Horizontal
4	16	0	*not used*
3	8	0	*not used*
2	4	Range 3	
1	2	Range 2	
0	1	0	*not used*

Range 3 and Range 2 represent sensitivity (gain) as follows

Both Components (OPER mode)

Sensitivity	Range 2	Range 3	Multiplication Factors	
1000	1	1	Conductivity	-0.25
100	0	1	Conductivity	-0.025
10	1	0	Conductivity	-0.0025

Multiplication factor for Inphase is the same for all ranges: =0.025

Both Components (COMP mode)

Sensitivity	Range 2	Range 3	Multiplication Factors	
1000	1	1	Inphase	-0.0625
100	0	1	Inphase	-0.00625
10	1	0	Inphase	-0.000625

Conductivity is not recorded in COMP mode.

Multiply Reading by above factors to obtain reasult in mS/m or ppt.

Reading 1 - five character field containing instrument output. Conductivity if Both components, Inphase if Inphase was selected includes sign (+ or -) and four digits

Reading 2 - five character field containing instrument output. Inphase if Both components, not used if Inphase was selected includes sign (+ or -) and four digits

Time Stamp - time in ms from the Windows start (resets every 49.7 days). The time in milliseconds can be linked with the computer local time by using Times in line started by * (see Timer Relation).

10 - Line Feed character

Comment

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
C	Comment (maximum 15 characters)															Time Stamp in ms (10 digits)										10

New Station

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
S	New Station (Format 11.2)															Time Stamp in ms (10 digits)										10

Internal Readings

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
{	a	Internal Position of an Element (Format 14.3)														Time Stamp in ms (10 digits)										10

These records (curly brackets) are used only internally during data collection to speed up map re-drawing in real time.

Records starting with X

Several informative records, for example X$STARTED indicates start of Logging mode, X$PAUSED indicates Pause (activated by Pause key stroke), etc.

GPS Data Message Records

Each GPS record (GGA or other NMEA message) is broken in to several 25 characters strings and placed in the RTmap31 data file which contains 27 characters records, including one character indicator and line feed at the end of each record. The GPS sequence starts at the line which contains the character @ as the first character, then records that contain a continuation of the same message start with the character **#**. The GPS

sequence ends with a line starting with the character **!**. The last line contains sequential number of GPS recorded position and a logger time stamp for the given GPS reading. A sample of the GPS message (GGA example) written in RTmap31 format is given below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
@	$	G	P	G	G	A	,	h	h	m	m	s	s	.	s	s	,	d	d	m	m	.	m	m	m	10
#	m	m	,	s	,	d	d	d	m	m	.	m	m	m	m	m	,	s	,	n	,	q	q	,	p	10
#	p	.	p	,	s	a	a	a	a	a	.	a	a	,	u	,	±	x	x	x	x	.	x	,	M	10
#	,	s	s	s	,	a	a	a	*	c	c	CR	LF													10
!	0	0	4	3	5											Time Stamp in ms (10 digits)										10

The GPS sequence may contain 4 to 7 records. The components of the GGA message may differ in length, however they are placed in the same number of columns. Refer to Appendix B (section B.2) for the definition of each component of the GGA data message. Other available GPS messages in NMEA format, GSA, POS, LLK, LLQ, GLL, and GGK, are recorded similarly. The structure of these NMEA sentences is given in section B.2 of Appendix B.

If the Checksum in NMEA message is invalid then starting character @ is replaced by **?**, and **#** is replaced by " (ASCII character code 34). The starting character of Time Stamp record **!** remains the same.

A.2 Example of RTmap31 Data File

The RTmap31 data file records are written in binary format, therefore characters may have a different shape when displayed or printed, depending on particular video or printer settings.

```
RTM31   W200GPS00000 1
H180625 002  0.200     0
G  0.00U  0.500 7  11  101
G    610730.497 17     B2E
G   4829891.531
L1
B       0.00
AE           1.000
Z25062018 23:36:14
*23:36:14.004   1073216906
X$STARTED       1073218531
@$GPGGA,035214,4336.8268,N
#,07937.6649,W,8,08,2.0,19
#0.0,M,-35.4,M,,*7
!000001p        1073219453
{0         0.0001073219453
@$GPGSA,A,3,10,13,15,20,21
#,24,27,32,,,,,3.6,2.0,3.0
#*3
!000001         1073219609
T¤-2108-2112    1073221000
T¤-2108-2112    1073221375
@$GPGGA,035216,4336.8274,N
#,07937.6647,W,8,08,2.0,19
#0.0,M,-35.4,M,,*7
!000002p        1073221453
{a    610730.1091073221453
{b   4829892.1911073221453
{c    610731.0931073221453
{d   4829892.0171073221453
{e    610730.2971073221453
{f   4829893.2581073221453
{g    610731.2821073221453
{h   4829893.0841073221453
@$GPGSA,A,3,10,13,15,20,21
#,24,27,32,,,,,3.6,2.0,3.0
#*3
!000002         1073221609
T¤-2109-2112    1073221734
T¤-2108-2112    1073222093
T¤-2108-2112    1073222453
T¤-2109-2112    1073222812
T¤-2108-2112    1073223187
T¤-2108-2112    1073223546
@$GPGGA,035218,4336.8280,N
#,07937.6646,W,8,08,2.0,19
#0.0,M,-35.4,M,,*7
!000003p        1073223453
{e    610730.4841073223453
{f   4829894.3241073223453
{g    610731.4701073223453
{h   4829894.1531073223453
@$GPGSA,A,3,10,13,15,20,21
#,24,27,32,,,,,3.6,2.0,3.0
#*3
!000003         1073223609
T¤-2108-2112    1073223906
T¤-2108-2112    1073224265
T¤-2108-2112    1073224625
T¤-2108-2112    1073224984
.........................
```

A.3 Format of GXY Data File

The RTmap31 data file with extension GXY contains GPS records. The structure of this file is identical to the standard RTmap31 (T31) file. The difference is that it does not contain any EM31-MK2 records. This file is created by RTmap31 when the EM31-MK2 option is Disabled in the System Setup menu. In this case the program acts as a GPS logging program.

It should be noted that any RTmap31 data file, as well as GXY and data files created by other Geomar data acquisition programs (RTmap38MK2, NAV31, NAV61MK2, ML61MK2xpn, etc.) can be used as an GXY file in the data processing programs RTM and TrackMaker for any other supported Geonics instrument (RTM31, TrackMaker31, TrackMaker61MK2, etc.). The extension name GXY indicates that the file does not contain electromagnetic data.

A.4 Background File Format

The RTmap31 program can display user prepared column delimited ASCII (text) format. It is assumed file contains columns of coordinates (columns order needs to be reflected in the program dialog) and use one of 4 column delimiter: Space, Comma, Tab, or Semicolon. Any row started with slash "/" is recognized as comment and a row started by word "Break" (upper or lower case) is treated as a tag to break the continuity of line (assuming line connecting coordinates is selected in the dialog).

Sample #1 of background file format:

```
/UTM meters, Easting Col#1, Northing Col#2, delimiter comma
612228.933,4829559.632
612168.933,4829524.632
612148.933,4829504.632
612108.933,4829489.602
612108.933,4829479.602
break
612149.933,4829459.602
612168.933,4829449.602
612228.933,4829417.602
```

Sample #2 of background file format:

```
/UTM meters, Easting Col#2, Northing Col#1, delimiter Space
4829530 612080
4829530 612020
4829580 612020
4829580 612075
```

RTmap31 and GPS Input B

B.1 Using the RTmap31 with a GPS System

The RTmap31 program accepts input from GPS systems that stream NMEA-0183 compatible data. through their output port. The program can use the following NMEA messages: pair GGA and GSA, GGA, POS, GLL, LLK, LLQ. and GGK. In addition to GPS NMEA statements RTmap31 provides also interface to Leica Robotics Total Station TPS1100 and TPS1200 for areas were GPS signal is not accessible. To use Leica Robotics device select option "pseudo-GGA" or "Leica TPS" in NMEA Data of the GPS Port Setup menu. The program writes entire message (that was selected in GPS Input menu) to the RTmap31 data file. If the pair GGA/GSA is selected, both GGA and GSA messages are written to the RTmap31 data file. The GSA message is used to display index PDOP (Position Dilution of Precision) on the logger screen and to determine quality of GPS position while processing data in the program RTM31.

The GPS system means (control device, receiver panel, or manufacturer software) must be used to set GPS receiver communication parameters, to specify frequency of GPS output, and number and type of NMEA messages sent by the GPS system output port. Any GPS system can send various NMEA messages. **It is important to select only messages (GGA, POS, GLL, LLK, LLQ, GGK, or GGA and GSA) that are actually used by RTmap38MK2.** The program will accept any GPS string sent by the GPS receiver, however it uses time to process GPS data that is not being used. Therefore, selecting a larger number of NMEA messages for GPS output will result in slower data acquisition of data. Normally, the RTmap31 uses less than 100 ms to process and record GPS data from the two NMEA messages, GGA and GSA.

If the particular GPS receiver is capable of sending data more than once a second, limit its output frequency to a maximum 1 or 2 Hz. At higher frequency of GPS data the program will be occupied by GPS activity and may slightly delay some EM31-MK2 data. Data processing program RTM31 will interpolate EM31-MK2 stations between GPS positions.

To achieve higher speed of data acquisition it is also recommended to use single NMEA message (i.e. POS, LLK, GGK, or just GGA). In addition, if it is possible set faster Baud Rate for GPS, i.e. 19200 or 38400 instead of default value of 9600.

If the pair GGA/GSA is selected, only message GGA is necessary to position EM31-MK2 data. If message GSA is not available in a particular system, the RTmap31 will function and record position data based on GGA message. Lack of GSA message will result in PDOP index displayed as Not Available (N/A) on the logger display. In this case it is better to select the message GGA which will provide display of index HDOP (Horizontal Position Dilution of Precision).

The RTmap31 displays several parameters related to GPS status. A label **DGPS** (Differential Global Positioning System) in the program indicates that GPS readings are differentially corrected in real time. Label **AGPS** (Autonomous Global Positioning System) in NAV61 indicates lack of differential correction. There are three more labels **RTK3**, **RTK4**, and **RTK5** (RTK - Real Time Kinematic) and they correspond to GPS Quality Indicator 3, 4, and 5. Correction AGPS corresponds to Quality Indicator 1, and DGPS represents Quality Indicator 2. Corrections described by RTK1 to RTK5 correspond to Quality Indicator 3, 4, and 5 (they have often different names for different brands of GPS receivers). See next section B.2 and GPS receiver documentation for detailed description and availability of this parameter.

On the right side of labels **DGPS**, **AGPS**, or **RTK** a small circle is displayed. This circle should change colour between green and white with the frequency of GPS update rate (usually 1 second intervals). If the circle has one colour for a long period of time it means that the GPS system is not working or that it is not connected to the field computer. The number of recorded GPS positions are displayed on the right side of the small green/white circle. This number is updated only in logging mode, when the data are recorded (in Stand By mode or during Monitoring the moving square, updated GPS positions, index PDOP, and number of tracked satellites, indicate presence of GPS input).

Two more GPS parameters are displayed on the logger screen. These are index PDOP shown by label **P** (or **PDOP**) and number of tracked satellites represented by label **S**. The index called PDOP (Position Dilution of Precision) measures the strength of satellite coverage for a given area. PDOP is affected by the number of satellites visible and their relative positions in the sky. The smaller the number of PDOP the stronger the satellite coverage is. When there are more than 5 satellites widely spaced visible, the PDOP is 4 or less. However, when there are less satellites visible, or they are unevenly spaced in the sky, PDOP values can be 6 or higher. In most cases, the PDOP in open sky is less than 3, and most accuracies given for many GPS systems are given for this norm. The index called HDOP is related only to horizontal position fix. It is used when mes-

sage GGA was selected. If a message GGL was selected the index PDOP nor HDOP are not available.

Refer to GPS documentation and literature for more information related to error sources of GPS positioning.

B.2 Description of Selected NMEA Data Messages

GGA Data Message

The GGA message contains the GPS position information and it is the most widely used NMEA data message. This message takes the following form:

$GPGGA,hhmmss.ss,ddmm.mmmmm,s,dddmm.mmmmm,s,n,qq,pp.p,saaaaa.aa,u,±xxxx.x,M,sss,aaaa*cc<CR><LF>

Definition of GGA message component:

hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
ddmm.mmmmm	Latitude in degrees, minutes, and decimal minutes
s	s=N or s=S, for North and South latitude
dddmm.mmmmm	Longitude in degrees, minutes, and decimal minutes
s	s=E or s=W, for East and West longitude
n	Quality indicator, 0 = no position, 1 = raw, no differentially corrected position, 2 = differentially corrected position, 9 = position computed using almanac information
qq	Number of satellites used in position computation
pp.p	HDOP = 0.0 to 99.9
saaaaa.aa	Antenna altitude
u	Altitude units, M=meters
±xxxx.x	Geoidal separation (requires geoidal height option)
M	Geoidal separation units, M = meters
sss	Age of differential corrections in seconds
aaaa	Base station identification
***cc**	Checksum
<CR><LF>	Carriage return and Line feed

GSA Data Message

The GSA message contains active satellites and PDOP value. The GSA message is given in the following form:

$GPGSA,c1,d1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,d12,d13,f1,f2,f3*cc<CR><LF>

Definition of GSA message components:

c1	Mode, M = manual, A = automatic
d1	Mode, 2 = 2D, 3 = 3D
d2-d13	Satellites used in position computation (range 0 to 32)
f1	PDOP (range 0 to 99.9)
f2	HDOP (range 0 to 99.9)
f3	VDOP (range 0 to 99.9)
***cc**	Checksum
<CR><LF>	Carriage return and Line Feed

POS Data Message

The POS message contains the GPS position information and PDOP value. The POS message is given in the following form:

$PASHR,POS,n,qq,hhmmss:ss,ddmm.mmmmm,s,dddmm.mmmmm,s,saaaaa.aa,seeeee, ttt,ggg,svvv,pp,hh,vv,tt,vvvv*cc<CR><LF>

Definition of POS message components:

n	Quality indicator, 0 = no differentially corrected position, 1 = differentially corrected position
qq	Number of satellites used in position computation
hhmmss:ss	UTC time in hours, minutes, seconds of the GPS position
ddmm.mmmmm	Latitude in degrees, minutes, and decimal minutes
s	s=N or s=S, for North and South latitude
dddmm.mmmmm	Longitude in degrees, minutes, and decimal minutes
s	s=E or s=W, for East and West longitude

saaaaa.aa	sensor computed altitude
seeeee	reserved
ttt	True track/true course over ground in degree
ggg	Speed over ground (knots)
svvv	Vertical velocity (decimeters per second)
pp	PDOP - position dilution of precision (00 to 99)
hh	HDOP - horizontal dilution of precision (00 to 99)
vv	VDOP - vertical dilution of precision (00 to 99)
tt	TDOP - time dilution of precision (00 to 99)
vvvv	firmware version ID
***cc**	Checksum
<CR><LF>	Carriage return and Line feed

LLK Data Message

The LLK (Leica Local Position and GDOP) message provides position in local coordinates in meters and GDOP value. The LLK message is given in the following form:

$GPLLK,hhmmss.ss,ddmmyy,xxxx.xxxx,M,xxxx.xxxx,M,x,x,xx.xx,xxxx.xxxx,M,
***cc<CR><LF>**

Definition of LLK message components:

hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
ddmmyy	UTC date (day, month, year)
xxxx.xxxx	Grid Easting, meters
M	Meters (fixed text “M”)
xxxx.xxxx	Grid Northing, meters
M	Meters (fixed text “M”)
x	Quality indicator, 0 = not valid, 1 = GPS Nav Fix (no differentially corrected position), 2 = DGPS Fix (differentially corrected position), 3 = RTK Fix
x	Number of satellites used in computation,
xx.xx	GDOP
xxxx.xxxx	Height, meters
M	Meters (fixed text “M”)
***cc**	Checksum
<CR><LF>	Carriage return and Line feed

LLQ Data Message

The LLQ (Leica Local Position and Quality) message provides position in local coordinates in meters and position quality in meters. The LLQ message is given in the following form:

$GPLLQ,hhmmss.ss,ddmmyy,xxxx.xxxx,M,xxxx.xxxx,M,x,x,xx.xx,xxxx.xxxx,M, *cc<CR><LF>

Definition of LLK message components:

hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
ddmmyy	UTC date (day, month, year)
xxxx.xxxx	Grid Easting, meters
M	Meters (fixed text "M")
xxxx.xxxx	Grid Northing, meters
M	Meters (fixed text "M")
x	Quality indicator, 0 = not valid, 1 = GPS Nav Fix (no differentially corrected position), 2 = DGPS Fix (differentially corrected position), 3 = RTK Fix
x	Number of satellites used in computation,
xx.xx	Position quality, meters
xxxx.xxxx	Height, meters
M	Meters (fixed text "M")
***cc**	Checksum
<CR><LF>	Carriage return and Line feed

GLL Data Message

The GLL message takes the following form:

$GPGLL,ddmm.mmmmm,s,dddmm.mmmmm,s,hhmmss.ss,s*cc<CR><LF>

Definition of GLL message component:

ddmm.mmmmm	Latitude in degrees, minutes, and decimal minutes
s	s=N or s=S, for North and South latitude
dddmm.mmmmm	Longitude in degrees, minutes, and decimal minutes
s	s=E or s=W, for East and West longitude
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
s	Status, A = valid, V = invalid
***cc**	Checksum
<CR><LF>	Carriage return and Line feed

GGK Data Message

The GGK message contains the GPS position, Time, Date, Position Type, and DOP information. The GGK shown below is not a standard NMEA data message and it is used in several Trimble GPS receivers. If this message is used as a standard NMEA statement by a given GPS receiver it starts with $GPGGK and contains GDOP instead of DOP.

TrackMaker software automatically recognizes which type of GGK message is used.

The Trimble proprietary type of GGK message takes the following form:

$PTNL,GGK,hhmmss.ss,ddmmyy,ddmm.mmmmmmmm,s,dddmm.mmmmmmmm,s,n,qq,p.p,EHT-aa.aaa,M*cc<CR><LF>

Definition of GGK message component:

hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
ddmmyy	Date
ddmm.mmmmmmmm	Latitude in degrees, minutes, and decimal minutes
s	s=N or s=S, for North and South latitude
dddmm.mmmmmmmm	Longitude in degrees, minutes, and decimal minutes
s	s=E or s=W, for East and West longitude

n	GPS Quality indicator, 0 = fix not valid or not available, 1 = Autonomous GPS fix, no differentially corrected position, 2 = differential, floating carrier phase integer based solution (FLOAT), 3 = differential, fixed carrier phase integer-based solution (FIXED), 4 = differential, code phase only solution (DGPS)
qq	Number of satellites used in fix
p.p	DOP of fix
EHT-aa.aaa	Ellipsoidal height of fix
M	unit of measure for ellipsoidal height in meters
***cc**	Checksum
<CR><LF>	Carriage return and Line feed

B.3 Configuring Trimble GPS Pathfinder ProXRS System

The data output in the Trimble Pathfinder ProXRS receiver can be configured in Asset Surveyor software in Trimble field computer (TSC1, TDC1, or TDC2). The Asset Surveyor Operation Manual provides detailes of the NMEA output format.

While running Asset Surveyor software select NMEA/TSIP output options from the Communication options menu. In the NMEA/TSIP output options form for Output select **NMEA**. After the NMEA option is selected Asset Surveyor extends the NMEA/TSIP form. Select Baud Rate: **9600** and Output interval: **1s** (or larger if required). Below these parameters a list of available NMEA-0183 messages will be displayed. Enable only required messages: GGA and GSA, or only GGA.

After you save the contents of the NMEA/TSIP output options form with the Output patameter set to **NMEA**, the Pathfinder GPS receiver begins to stream selected NMEA-0183 messages at the specified Output interval.