MLgrad 601

Version 2.14

for MS Windows 10/7

data acquisition program for
an array of Grad601 and GPS

User's Manual

GEOMAR SOFTWARE INC.
Tel: 905.306.9215

E-mail: geomar@geomar.com

Revision 2.14 — June, 2020

Geomar Software Inc.
899 Runningbrook Drive
Mississauga, Ontario, Canada L4Y 2S4
Tel: 905 306 9215
e-mail: geomar@geomar.com

Table of Contents

Introduction 1

The Geomar MLgrad601 Data Logging System consists of a data logging program MLgrad601 and associated PC computer program MultiGrad601. The program MLgrad601 is designed for the Windows 10 (or Windows 7) based field computer.

This manual describes the use of the MLgrad601 program used with the laptop field computer with screen resolution at least 800 x 600 pixels, equipped with necessary number of serial ports, maximum nine Bartington Grad601-1 or Grad601-2 instruments (or up to 18 probes), and Global Positioning System (GPS) receiver or supported model of Robotic Total Station (RTS).

The associated program MultiGrad601 is used to process data files recorded under control of the program MLgrad601. Main function of this program is to position each Grad601 sensor based on the recorded GPS position and the configuration of the system. The grid positioned data files are not supported by MultiGrad601, however they can be exported to ASCII file format.

1.1 About the MLgrad601 Program

Program MLgrad601 acquires and records survey data from the array of Grad601 probes, under the control of the operator. The array of instruments can contain one to a maximum of nine Grad601 gradiometers (each gradiometer may contain one or two probes) and one GPS receiver (or RTS).

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 amplitude variations for each connected probe. 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 array in the employed map scale with correction for the GPS antenna offset. 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. In addition 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 in continu-

ously resulting in pseudo-grid image. The MLgrad601 does not require that survey has to be conducted along parallel straight lines. In Mapping and Navigation modes the output of each sensor 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.

Readings are displayed in real time as values in nT as well as in graphic mode, as profiles and moving graphic bars. The output of each instrument is represented a windows containing profiles (updated only during logging mode) and by one or two bars, for one or two magnetic probes (depending on the instrument type). Moving bars display allows for very fast visual information about each instruments output. In addition, the program monitors the instrument output while data is not recorded.

The MLgrad601 accepts NMEA-0183 compatible data from a GPS receiver directly connected to a field computer. GPS data which is embedded in the MLgrad601 data file can be processed later in the Geomar MultiGrad601 program. The connected GPS must be able to stream NMEA-0183 compatible messages. The MLgrad601 can use following types of NMEA messages: a pair GGA/GSA, GGA, POS, GLL, LLK, LLQ, GLL, and GGK, as well as positions given by Leica Robotics Total Station TPS1100 and TPS1200, and Trimble RTS S3 model that supports pseudo-GGA message. Messages POS, GGK, and pair GGA/GSA are preferred since they contain all necessary information. GPS coordinates (geodetic or UTM format), as well as parameters indicating quality of GPS signal: status of real time differential corrections, number of used satellites, and PDOP parameter, are displayed in real time. A speed bar shows actual surveying velocity calculated from GPS data.

The program also records various field information such as survey line number (line name), starting station, increment, comments, etc.

The program records all readings streamed by the array of Grad601 gradiomenetrs. The program allows you to record data while using both types of gradiometers, Grad601-1 equipped with one probe as well as Grad601-2 with connected two magnetic sensors. Both types can be mixed in any configuration within the array setup.

System and survey setup parameters are saved in a 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 MGR. 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 the survey is Paused, therefore it is advised to pause data collection from time to time, especially during U-turns.

It is strongly advised that even if your GPS receiver supports faster rates the 1 Hz update for GPS positions is used. The MLgrad601 will work with rates higher than 1 Hz, however, depending on the field computer parameters, operation may not be smooth when scrolling display. In addition, created data files will have large size due to large size of each GPS record. The data processing program will interpolate all Grad601 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 7 or 10,
- Minimum 4Gb of 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 per instrument in array plus one serial port if directly connected GPS receiver is to be used (USB to multiple RS-232 ports, PCMCIA RS-232 , or other adapters suported by Windows can be used).

Bartington Grad601

The required number of Grad-601 consoles with associated cables.

1.3 Contents of MultiGrad601 disk

The program MLgrad601 is stored on USB drive or CD distribution disk, or it can be downloaded from the web site. All necessary configuration files (with extension names .INI and .TXT) are created in your computer after the program is run for the first time. Check that the file SetupMLgrad601.exe that installs MLgrad601 is included on the USB or CD disk. This file can be also downloaded from the Geomar web site. In general four files are needed for the MLgrad601 software package:

SetupMLgrad601.exe	-	installs data acquisition program file MLgrad601
SetupML601.exe	-	setup for the data processing program MultiGrad601
MLgrad601.pdf	-	manual for the MLgrad601 program
MultiGrad601.pdf	-	manual for the data processing MultiGrad601 progam

1.4 Installing MLgrad601

Execute supplied or downloaded setup program **SetupMLgrad601** (another setup program SetupML601 installs data processing program MultiGrad601). The MLgrad601 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 MLgrad601.ini which contains the program settings.

The MLgrad601 data files contain extension name MGR and their base names should be limited to 8 characters.

1.5 Software Key

The data acquisition program MLgrad601 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 the Logging button is pressed or tapped) the program will display the Enter Software Key window (Figure 1.1) and the ID number for this computer will be displayed at the bottom of the window as 11 character string (one letter followed by 10 digits). Please forward this number to Geomar Software and the Software Key will be provided.

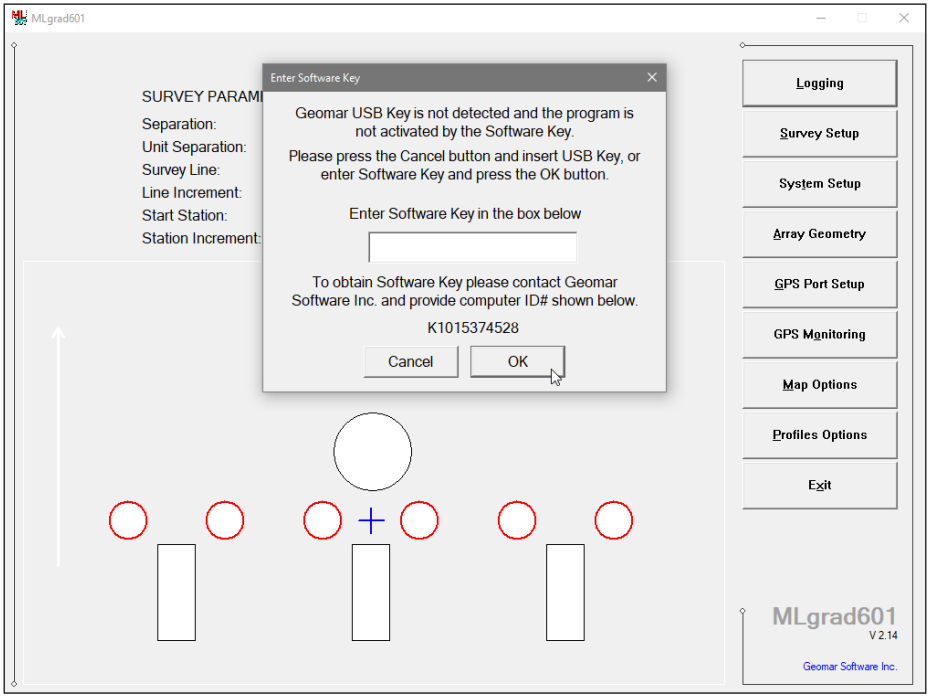


Figure 1.1: Enter Software Key dialog

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 the program key file will be deleted. Any future updates of the program will not require entry of the software key.

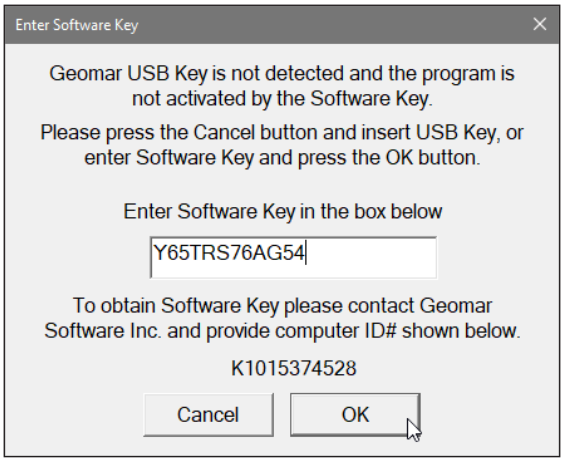


Figure 1.2: Entering the Software Key

1.6 Running MLgrad601 Program

Start MLgrad601 by double clicking the MLgrad601 icon in the Start|Programs menu, in Windows Explorer, or on the desktop if a shortcut was created. At the start, MLgrad601 displays the following screen (Figure 1.3):

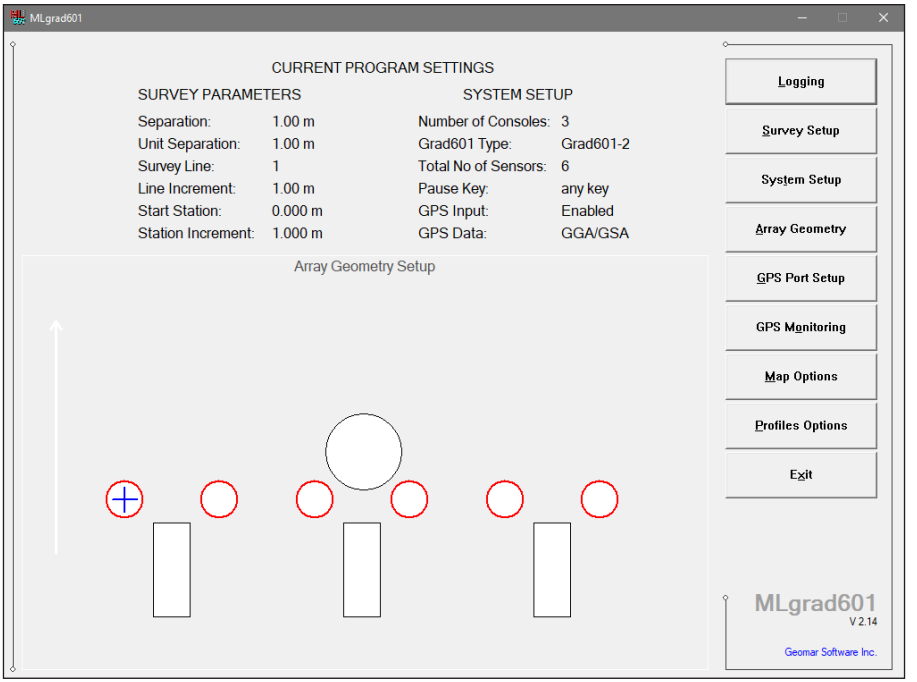


Figure 1.3 The MLgrad601 Main Screen

The MLgrad601 is a command button and dialog driven program. Command buttons can be executed by clicking with the left mouse button, tapping on the touch sensitive display, 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.

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 array geometry. The graphic diagram is updated in real time as soon as array geometry parameters are changed in the Array Geometry dialog. A description of the Main Screen functions and information is given in Chapter 3.

1.7 MLgrad601 Program Overview

The data acquisition program MLgrad601 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 configuration (initial) file. Assuming that the survey set up is the same, when the program is started, the instrument and logging computer are turned on, output of the connected array of Grad601s can be monitored after one key stroke. Obviously any parameters can be modified 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 Grad601 outputs and GPS performance. To record data one has to specify the data file name. 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 Grad601 and GPS data will be recorded in the data file according to selected mode of operation.

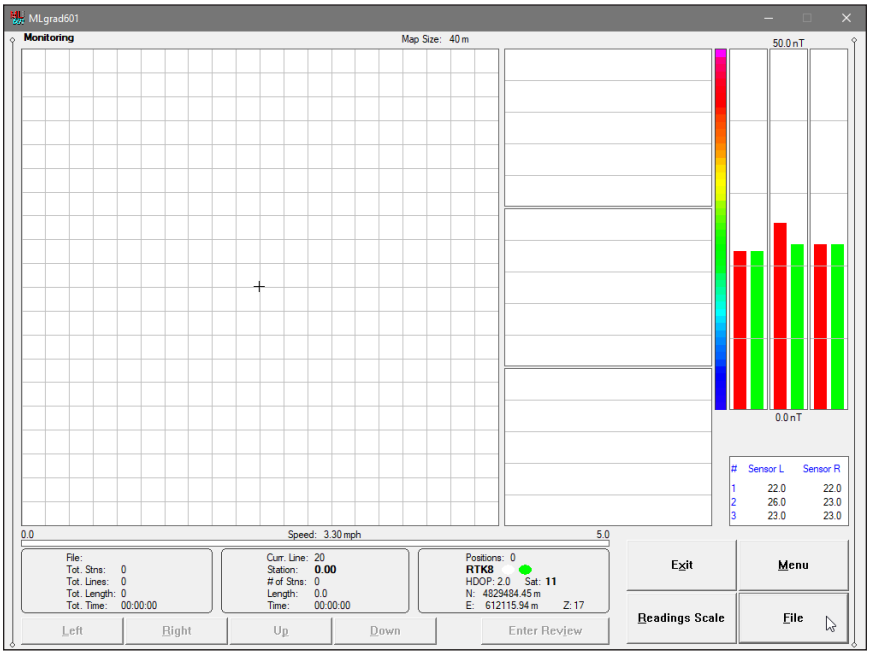


Figure 1.4 The MLgrad601 logging screen in Monitoring mode

The instruments output is shown in the form of numeric values for each connected probe (number depending on the instrument type and number of sensors) in nT, as well as plotted in graphic mode in moving bar windows. An equalizer type (graphic bars) displays data for Grad601 channels as one or two bars in each bar window. Left bar represents always probe #1 readings and second bar shows reading for probe #2 (if connected to given console). Number of bar windows corresponds to number of consoles in the array. The Grad601 #1 readings are displayed in the left most bar window, the Grad601 #2 in the second window, and so on. This type of display allows for a legible and very quick estimation of each Grad601 performance. When more detailed monitoring is required each measured channel is displayed in numeric form in nT as well. In addition the program displays windows with profile curves for each probe. 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.

Mapping mode provides navigation, survey coverage and data quality control at the same time is similar to Navigation mode, it shows positions of Grad-601 readings (not only at GPS points). Reading for each sensor are shown as coloured amplitude for each measurement. Due to screen resolution and specified map size readings points are decimated or filled in (expanded) to show coverage in continues mode. Mapping mode example is shown in Figure 1.5.

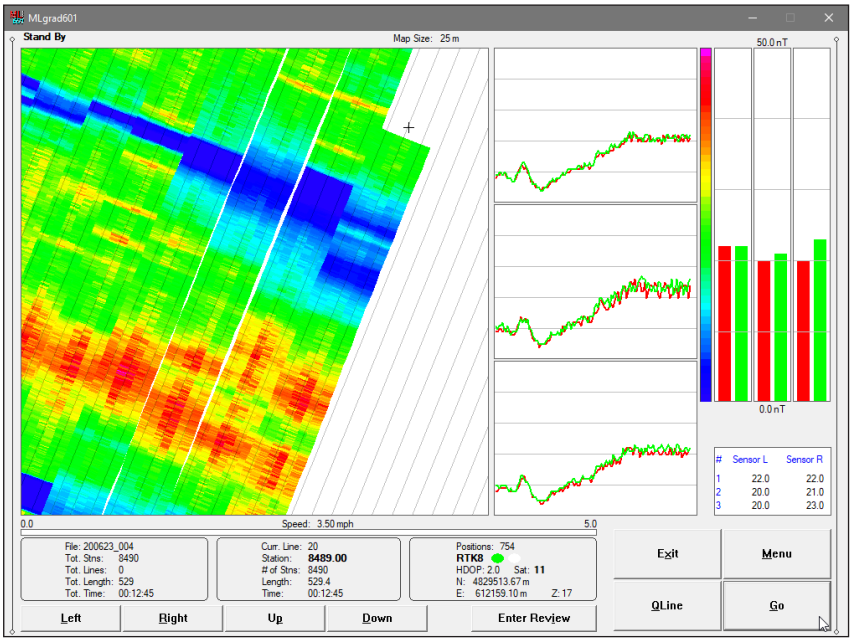


Figure 1.5 The MLgrad601 screen in Mapping mode, see array parameters in Fig 1.6

When working GPS receiver is connected to the field computer then program uses Navigation or Mapping (depending on settings) mode by default. The MLgrad601 screen in Navigation mode is shown in Figure 1.6 (array represented by swath bar) and Figure 1.7 (each sensor is represented by a separate dot). Each swath bar or dot shows position of recorded at the moment the GPS station is recorded, positions of recorded Grad-601 sensors (located between GPS points) are not shown in Navigation mode.

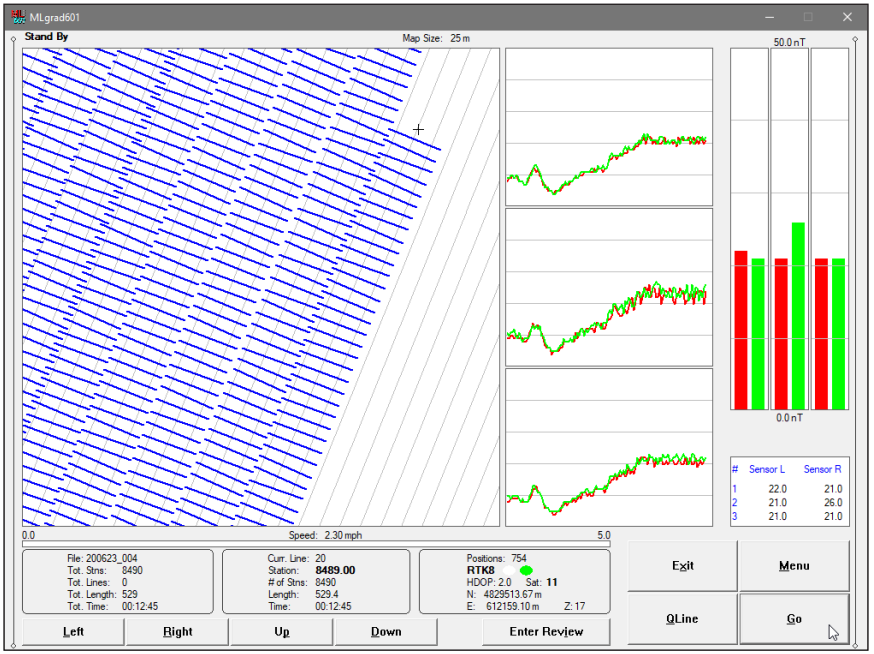


Figure 1.6 MLgrad601 screen in Navigation mode, blue Swath Bars represent positions of six sensors array, connected to 3 consoles (2.5 m array width, sensors 0.5 m apart) on a 40 m scale map.

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.

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 MLgrad601 screen in Profile mode is given in Figure 1.8. When changing display from Profile to Mapping or Navigation mode while large amount of data is collected, a message Please 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.

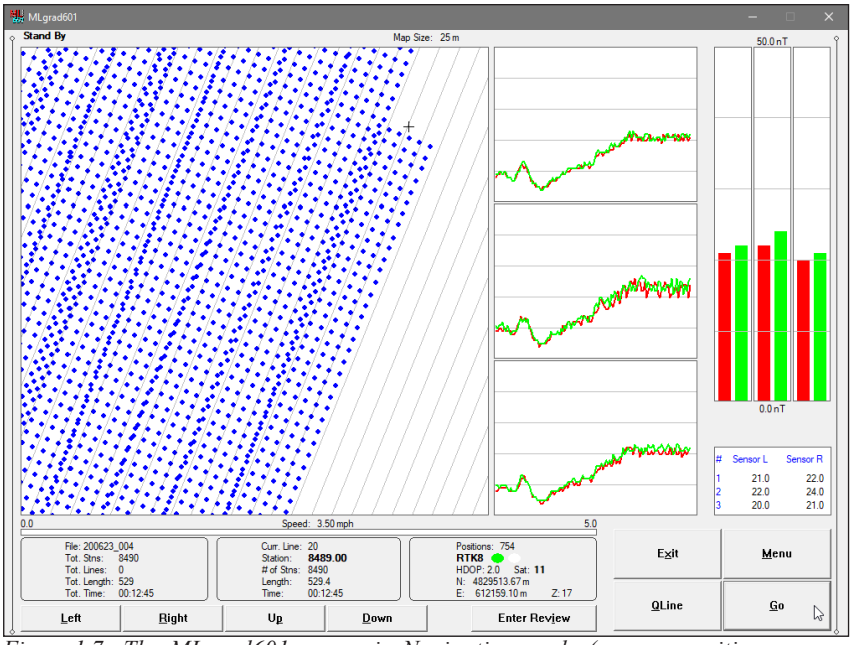


Figure 1.7 The MLgrad601 screen in Navigation mode (sensors positions are represented by dots.

Figure 1.8 The MLgrad601 Logging screen in Profile 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 to for example approximately 1 hour blocks, especially when using high frequency of Grad601 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 executed. Therefore, in case of accidental computer lock up, data file will contain all readings till last time Pause key was used.

Main Screen Window 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 array geometry parameters are changed in Array Geometry dialog. The MLgrad601 Main Screen window is shown below in Figure 2.1.

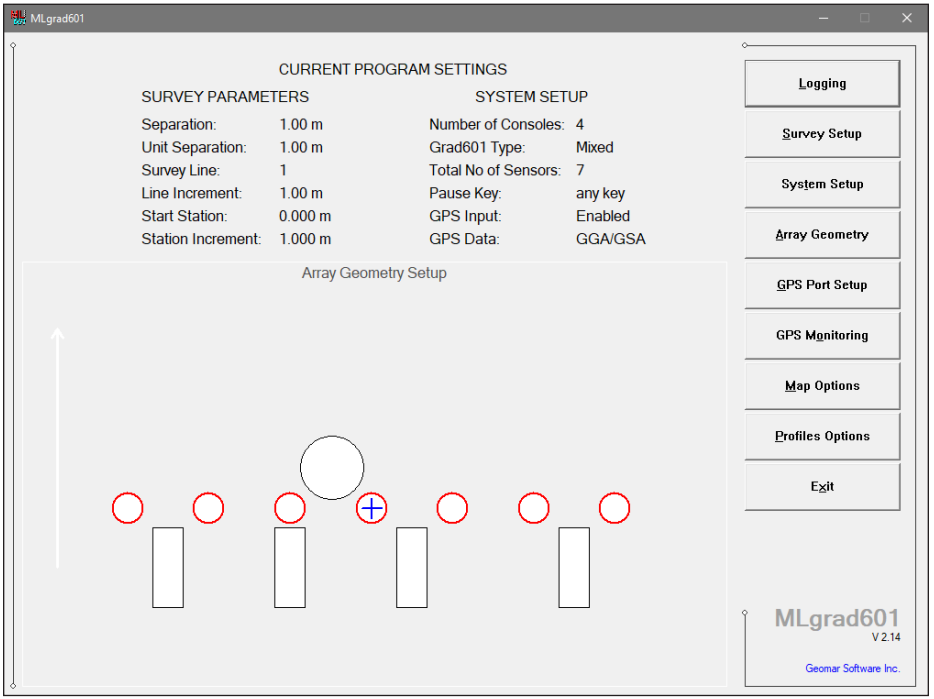


Figure 2.1: MLgrad601 Main Screen window

The MLgrad601 is a command button and dialog driven program. Command buttons can be executed by clicking with the left mouse button, tapping touch sensitive display, 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.

2.1 Short Description of Main Screen Options

Logging

This option allows to monitor output of all connected Grad601s and GPS receiver, and record data.

Survey Setup

Dialog window that is associated with this option is used to set survey line name, line and station increments, direction of survey lines, and sequence of survey lines during the survey (Figure 2.2).

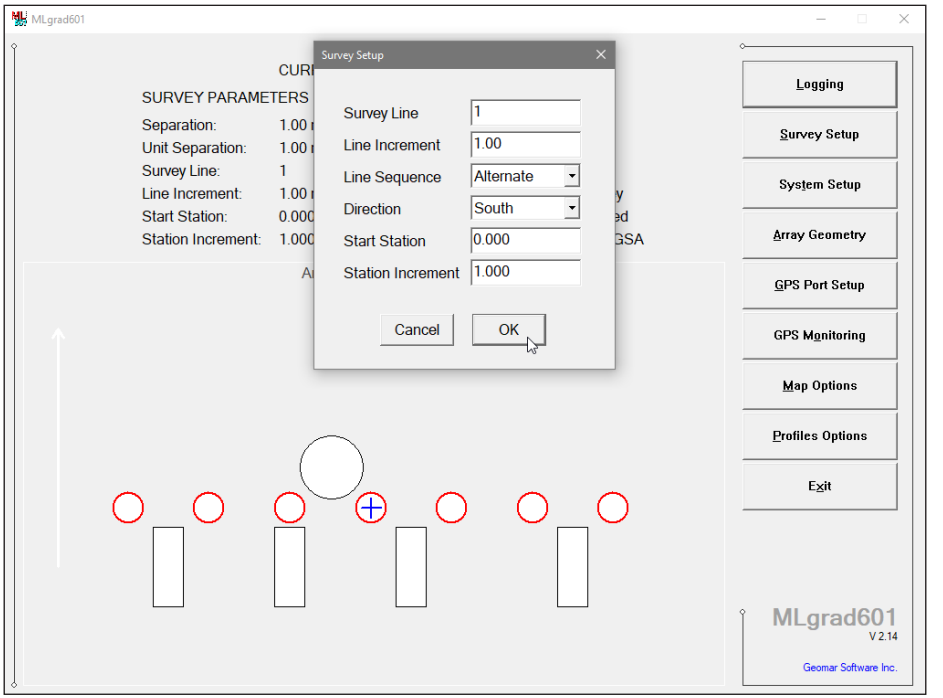


Figure 2.2: Survey Setup dialog

System Setup

The System Setup dialog (see Figure 2.3) allows user to select number and type of Grad601 instruments (consoles) connected to the field computer, specify Leading Point of the array (applicable only for if survey is performed without GPS positioning), and logging computer settings: type of pause key, audio tik associated with data collection, alarm ring for disconnection or any other prob-

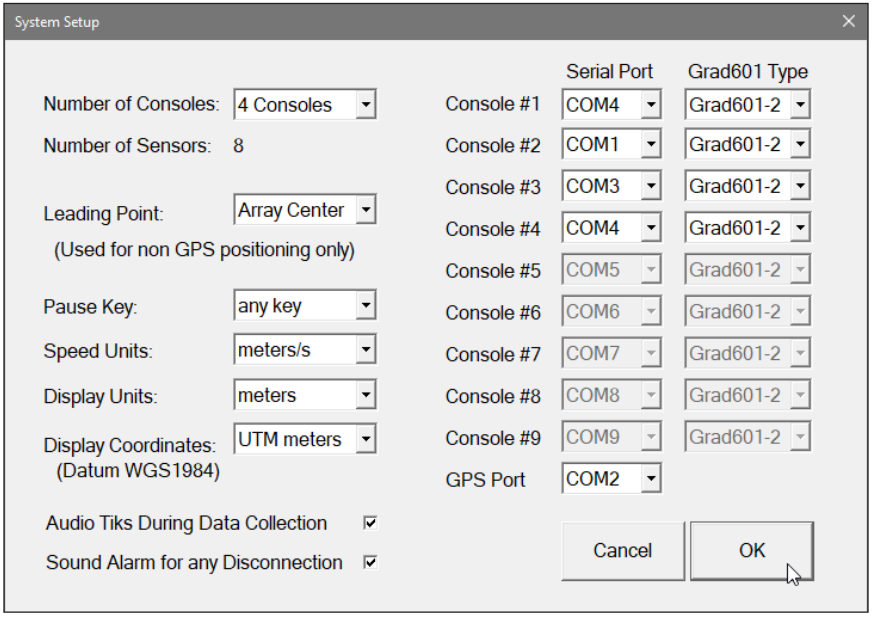


Figure 2.3: System Setup dialog

lem associated with lack of signal from interfaced sensor or GPS, display units, display coordinates type and units, and speed bar units. This dialog also is used to assign serial port numbers to each instrument console, as well as to specify type of the instrument console: Grad601-1 (1 sensor) or Grad601-2 (2 sensors) connected to each serial port.

Separations between senors are specified in Array Geometry dialog.

Array Geometry

The Array Geometry Setup dialog that is associated with this option is used to set all parameters that describe and determine array layout. These parameters are used during data acquisition session as well as later by data processing program to position each sensor while creating XYZ file output. 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 array).

This dialog provides information about number of sensors in the array, and it allows you to specify separations between sensors within console and between sensors of neighbouring consoles, GPS antenna offsets, and units used in this dialog. After button OK is clicked the dialog disappears and layout of the array is updated in the Main Screen.

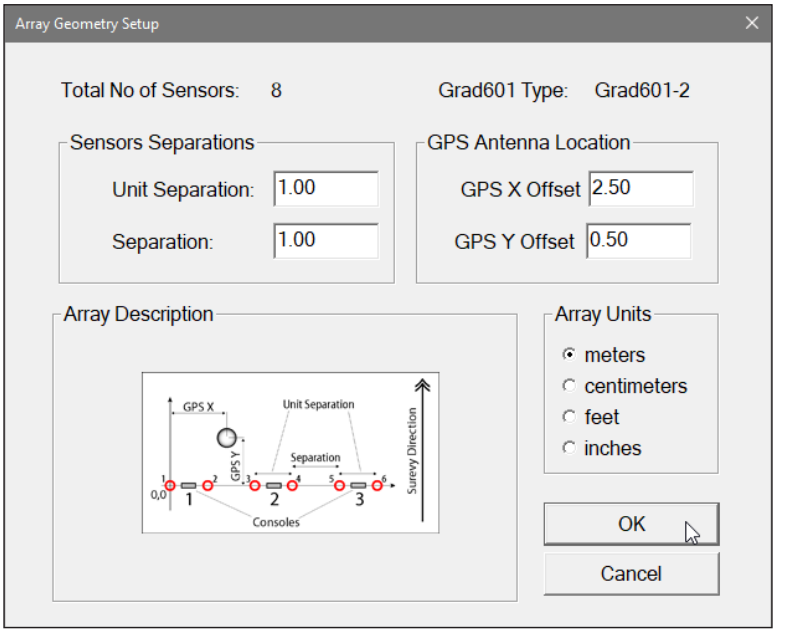


Figure 2.4: Array Geometry Setup dialog

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. The GPS Warning Mask parameters can be specified in this dialog.

GPS Monitoring

After the button is clicked 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 Display 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 in Navigation mode. The option labeled Colour Map View can be used to set Navigation mode (GPS Positions, No Color Amplitude) and Mapping mode (colour image of amplitude level). The size of Array Swath bar is 100% of the array span and on the map it will

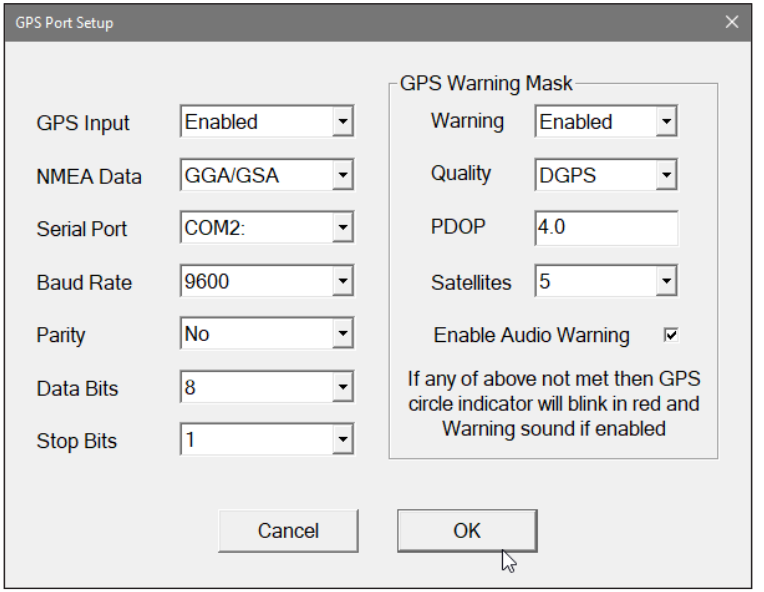


Figure 2.5: GPS Port Setup dialog

represent full width of the array scaled to displayed map. If Mapping mode is selected in Colour Map View option then the size of swath (colour represen-

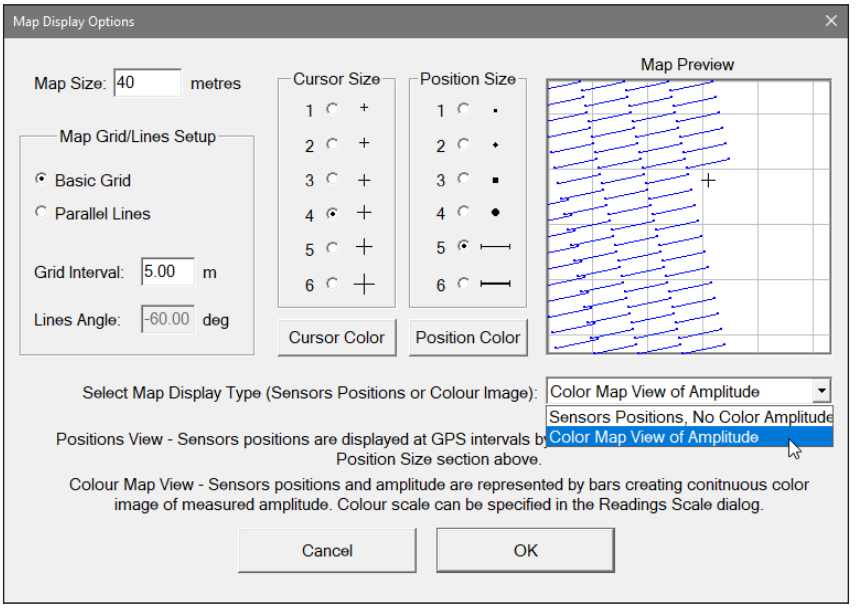


Figure 2.6: Map Display Options dialog

tation) will be expanded by half of the sensor interval, therefore each sensor shows colour section equal to the sensor interval length. In addition the Map Size, selection of Grid or Parallel Lines (together with Lines Tilt Angle) can be specified in this dialog.
This dialog can be also displayed, and all parameters can be adjusted at any time during data collection in Logging mode.

Setup Profiles Options

The Setup Display Options dialog (Figure 2.7) allows you to unable/dispable profile display for each channel, to specify colour and thickness of profile line for Probe #1 (Left Sensor) and Probe #2 (Right Sensor).

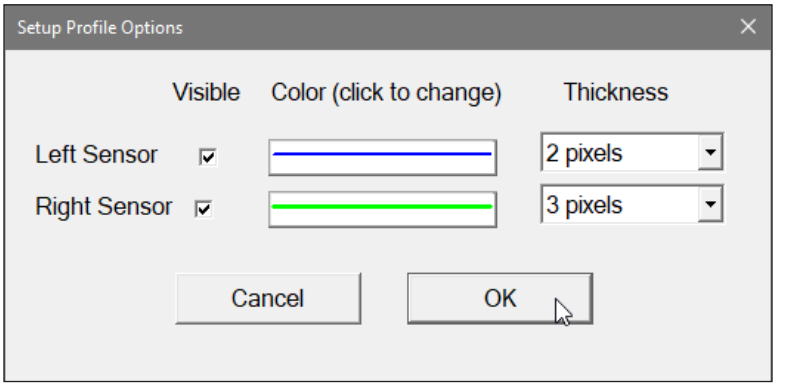


Figure 2.7: Setup Display Options dialog

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 procedure: survey geometry layout (survey line names, line spacing, start station, station increment, etc.).

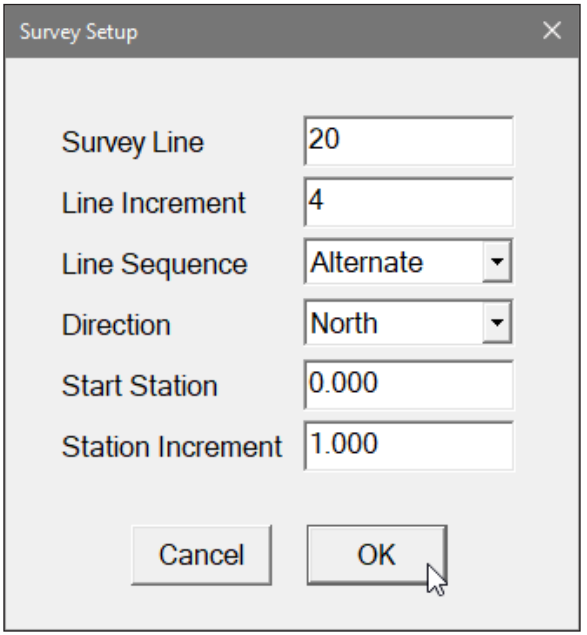


Figure 3.1: Survey Setup dialog

To select any option click on the corresponding drop-down list box or text box, or use TAB key to scroll to the option and then use mouse or the **Down** and **Up** keys in drop-down box (parameters that have only a few possible options), or keyboard for text box entry.

Description of the Survey Setup dialog options and parameters.

Survey Line (survey line name)

Activate text box for this option by clicking with a mouse or using TAB key and then enter desired value.

This is a user's tag number/name for the profile line. The length of the name can not exceed 8 characters. 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 MultiGrad601 program (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).
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.

Line Increment (separation between survey lines)

Activate text box for this option by clicking with a mouse or using TAB key and then enter desired value.
This parameter specifies the distance by which survey lines will be separated. When array of the instruments is used this parameter must be used for entire array. See also parameter **Leading Point** in the System Setup dialog.
This setting will be used to determine number (name) of the next survey line. In case of New Line command the survey line name can be overwritten, however if you use Quick Line button then Line Increment specified here will be used by the program to determine next Survey Line name.

Sequence

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between two available settings: Alternate and One Way (Figure 3.2).
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 the station increment, and line direction when parameters for the next survey lines is determined.
If Quick Line command (described later in will be used during the survey then this parameter will be used in determining the Start Station, signature of Station Increment and Direction of the next survey line.
This parameter can be ignored if survey is positioned with GPS system.

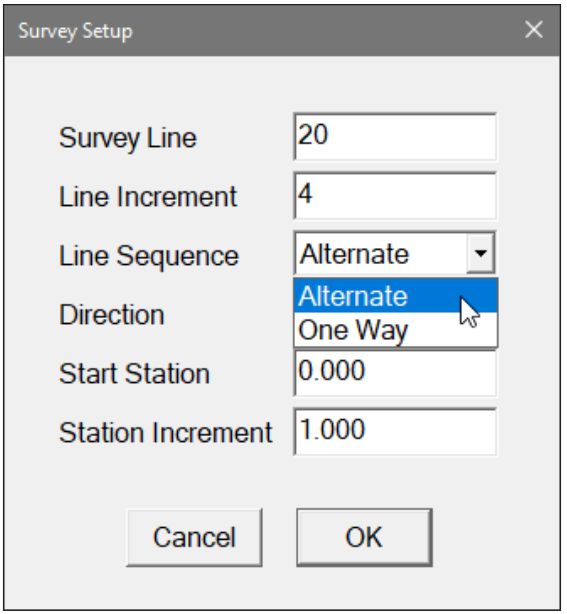


Figure 3.2: Line Sequence selection

Direction

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between four available settings: East, West, South, and North (Figure 3.3).
This parameter indicates the heading of the survey line. 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 for this option by clicking with a mouse or using TAB key and then enter desired value.
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 (if Station Increment is positive) the current station will indicate number of stations (readings for set of the instruments) taken since the start of the data file.

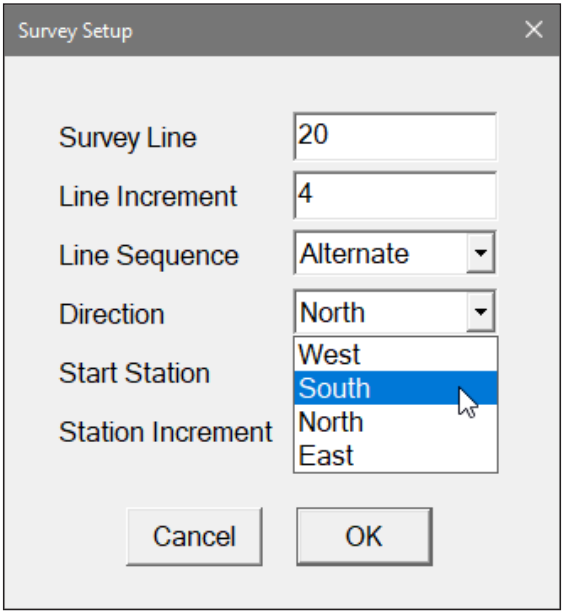


Figure 3.3: Line Direction selection

Station Increment

Activate text box for this option by clicking with a mouse or using TAB key and then enter desired value.
If Wheel mode was selected then this parameter will be labeled Wheel 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 Station Increment to Positive. The station displayed during data recording will indicate number of stations (readings for set of the instruments) 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 which describe the instrument array (Number of Grad601 consoles, Leading Instrument), logger settings (Pause Key, Speed and Display units, type of displayed Coordinates), assignment of serial ports, type of Grad601 type connected to each serial port, and two audio functions (Audio Tik and Sound Alarm). Number of sensors in the array is displayed as an information, it is calculated based on Number of Consoles and Grad601 type assigned to serial ports.

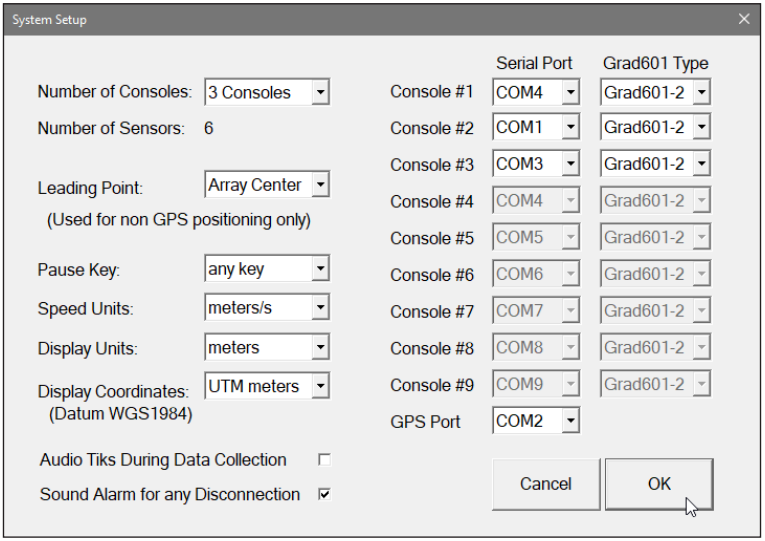


Figure 4.1: System Setup dialog for array of three Grad601 consoles (and six sensors)

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 or the **Down** and **Up** keys in drop-down box or radio buttons section.

Description of the System Setup dialog options and parameters.

Number of Consoles

When this option is highlighted and drop-down box is expanded (Figure 4.2) use mouse or use **Down** or **Up** cursor key to toggle between available items: between 1 and 9 Consoles. Please note that enabled combo boxes (labeled Serial Port and Grad601 Type) corresponds to selected Number of Consoles. Number of

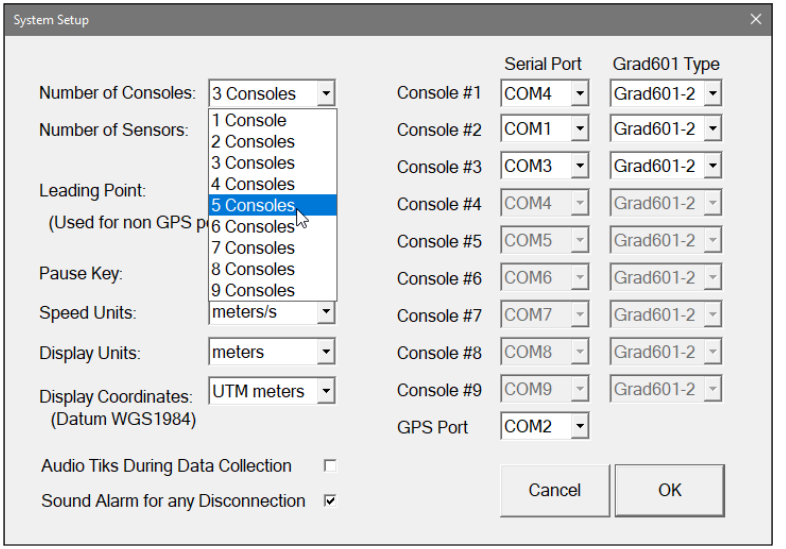


Figure 4.2: Selecting number of Grad601 consoles

Sensors value is calculated based on number of consoles and type of the instrument connected to each port (one sensor for Grad601-1, and two sensors for Grad601-2). Number of enabled Serial Port combo boxes and Number of Sensors is updated immediately after Number of Consoles is selected. Please compare the System Setup dialog with 5 consoles selected (Figure 4.3) with Figure 4.1 and 5.2.

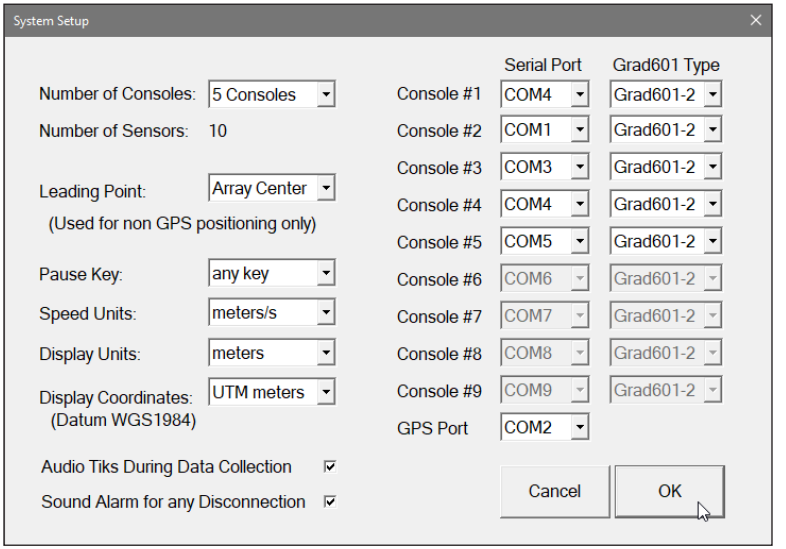


Figure 4.3: System Setup dialog with 5 consoles selected

Leading Point

This option applies only when a survey is positioned using a laid out grid (see Figure 4.4).

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between available Grad601 numbers or Center of Array. Number of options depends on and does not exceed number of Grad601 probes in the array selected in the System Setup dialog.

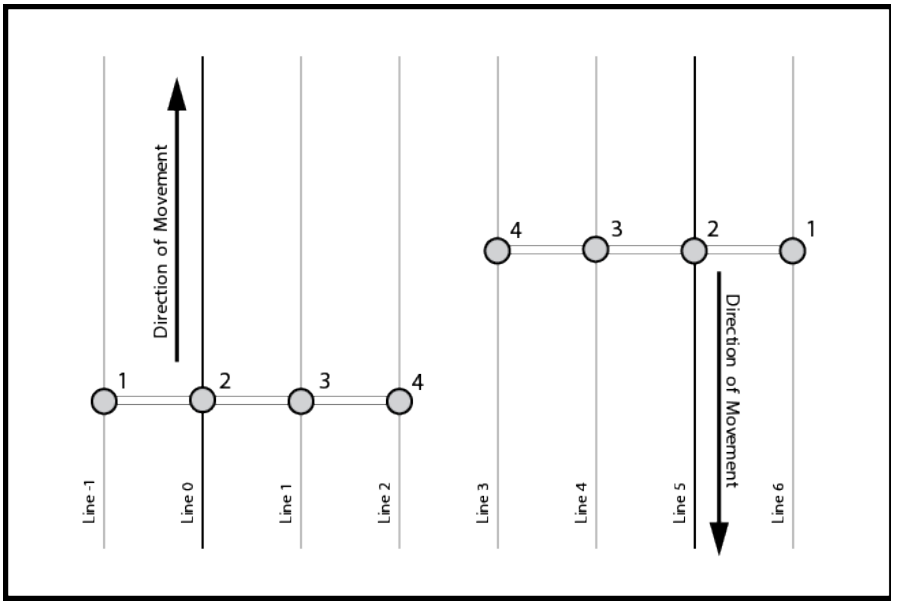


Figure 4.4: Example of survey lines layout for array of four Grad601 probes (two consoles system) organized in one row. Leading Point is Probe (Sensor) #2.

The Leading Point indicates the sensor that follows the Survey Line name entered in Survey Setup menu, or New Line name during data collection. Survey lines coordinates for the remaining instruments will be calculated by the MultiGrad601 during data processing. The survey line coordinate for particular sensor is determined based on the Sensor Size, array geometry parameters, direction of survey (positive or negative station Increment) and Line Name which is related to the Leading Grad601 (instrument number).

In the example in Figure 4.4 the Leading Point is Probe #2 and separation between probes is 1 m. Leading Point (Probe #2) survey lines are marked by thicker line. When the array is heading North (positive Station Increment) and Survey Line name was specified 0, the MultiGrad601 assumes that the probe #1 will follow coordinate -1, and instruments located to the right of the Leading Probes will follow survey lines 1 (Probe #3) and 2 (Probe #4). If the array will

head toward South (negative Station Increment) and the Survey Line selected is 5, the program will assume coordinate 6 for the Probe #1, and correspondingly 4 and 3 for Probes #3 and #4.
If any Survey Line name is entered wrong during the field work, it can be corrected easily during data processing. One Leading Point (number of the sensor in an array or center point of the array) must be select for the entire data file. It appears that the most optimal would be selection Array Center (or Probe that is located in the array center), then entire setup is symmetrical and Line Increment set in Survey Setup dialog can be used.

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 4.5). 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.

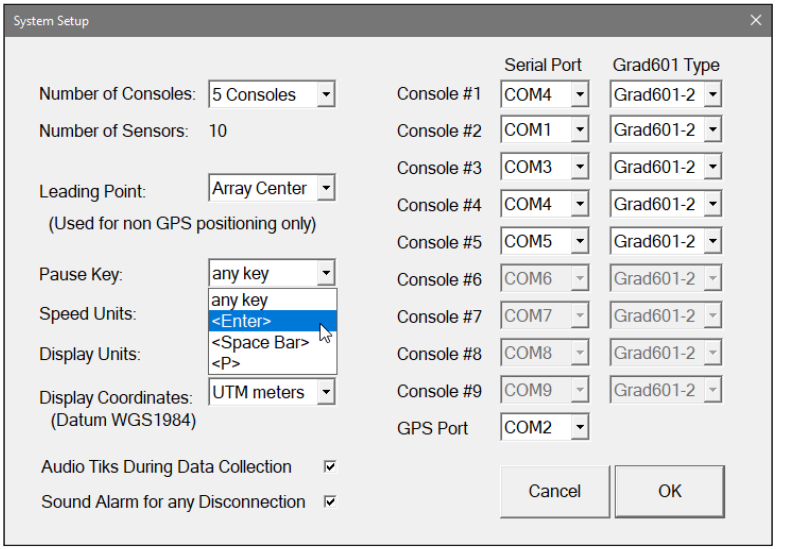


Figure 4.5: Selecting Pause Key in the System Setup dialog

Speed 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.
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.

Display Units

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between three available options: **Meters**, **Feet**, and **US Survey Feet**. These units will be used to calculate positions for sensors in program MultiGrad601.
In case wrong selection was entered, units or other parameters can be corrected later in the program MultiGrad601.
These units are not used in the geometry of the system description. Array Geometry Units can be entered in Array Geometry Setup dialog.

Display Coordinates

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between four available options: **Geodetic** (Longitude, Latitude)**, UTM meters**, **UTM feet**, and **UTM US Survey Feet** (Figure 4.6). These units will be used to display coordinates of GPS antenna.
Selection of Coordinates display has only informative function, it does not affect data file content.
This parameter can be changed later using Menu options during data logging.

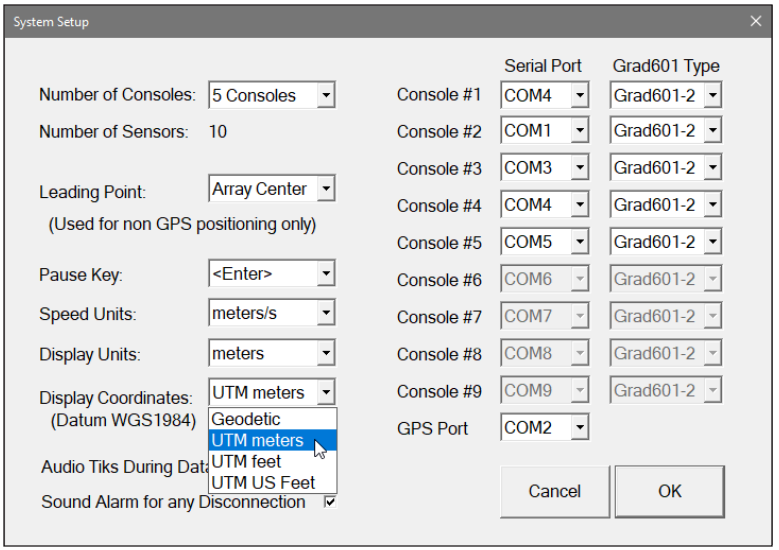


Figure 4.6: Selecting Speed Units in the System Setup dialog

Audio Tiks

The program will provide tik sound during data recording (in the Logging mode only). The tik 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 4.7.

Sound Alarm

The program will sound loud ring in case of any serial port disconnection, or in case any Grad601 console 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

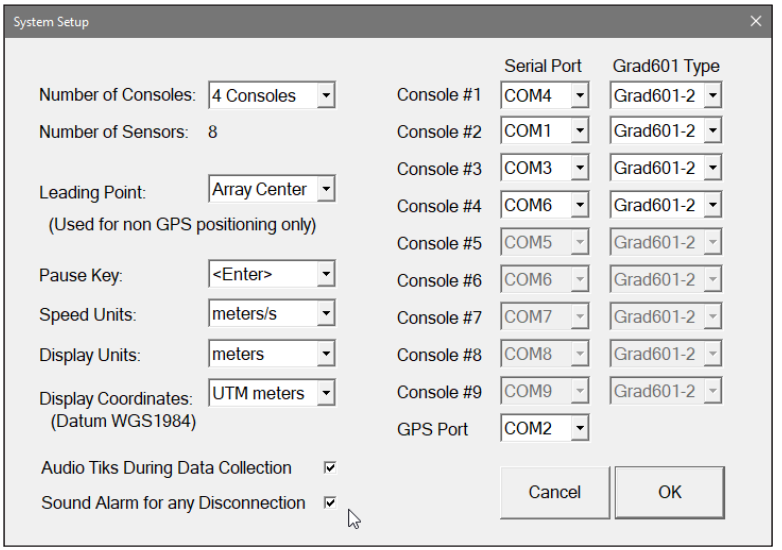


Figure 4.7: Selecting Serial Port for Consoles

disabled by check button at the Sound Alarm for any Disconnection label as shown in Figure 4.7.

Serail Port (Console #1 to #9 and GPS Ports)

Navigate with mouse or TAB key to each Sensor Port 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 COM48 for each sensor and for GPS receiver (see Figure 4.8).

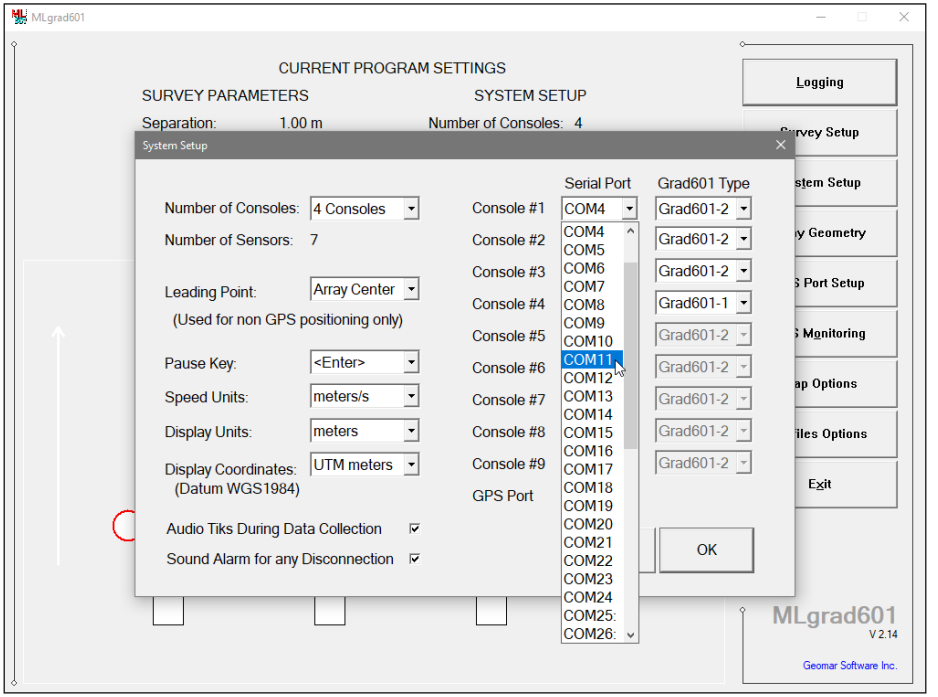


Figure 4.8: Selecting Serial Port for Consoles

Select proper serial port for each instrument and GPS receiver. Serial ports for all nine Grad601 consoles are listed however only ports corresponding to number of instruments in the array (Number of Consoles) are enabled and must be specified. Remaining ports are not checked by the program for assignment conflict.

These settings describe how each Grad601 in the array is connected to the field computer. Any serial port can be assigned to any instrument number, however care should be taken that each Grad601 instrument is connected to the proper (indicated here) serial port.

Grad601 Type

Type of Grad601 can be specified in series of combo boxes located in the column labeled Grad601 Type. Two selections are available: Grad601-1 (one probe) and Grad601-2 (two probes connected to the console), Figure 4.9. The selection must be specified for each Grad601 console in the array. Number of Sensors in the array depends on the Grad601 Type and will be updated after each selection.

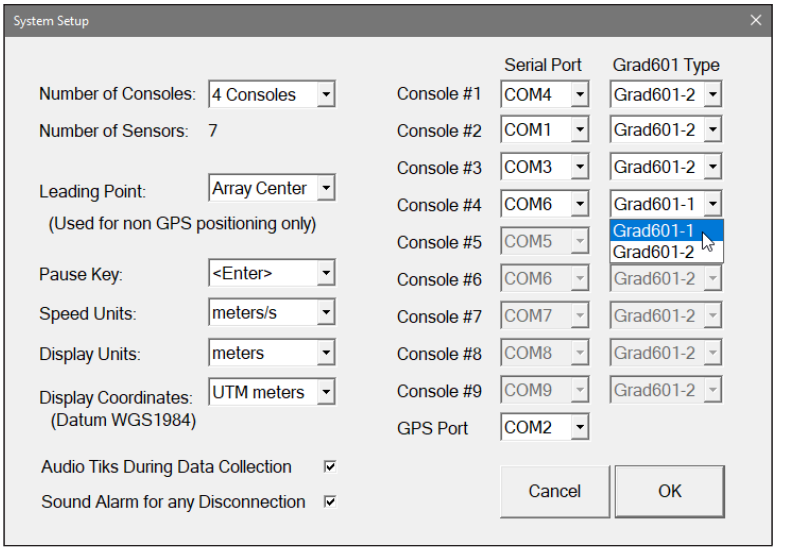


Figure 4.9: Selecting Grad601 Type (1 or 2 sensors setup) for each console in the array

After all the parameters in the Survey Setup dialog are updated click on the button **OK** or **O** key (or **ENTER** if button OK is highlighted) 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 **Cancel** button or press **C** key. All parameters will be reset to initial settings and the program will return to the Main Screen.

Array Geometry Setup 5

The Array Geometry Setup dialog, presented below in Figure 5.1, contains parameters which describe the instrument array: number of sensors in array (information only, number of sensors is specified in the System Setup dialog base on number of connected Grad601 consoles and type to Grad601), separations between sensors, and location of GPS antenna described by X and Y offsets from reference point 0,0. The dialog contains a graphic window labeled Array Description which illustrates meaning of parameters used to specify geometry of an array. This graphic window is used only as a reference, it does not reflect actual array layout.

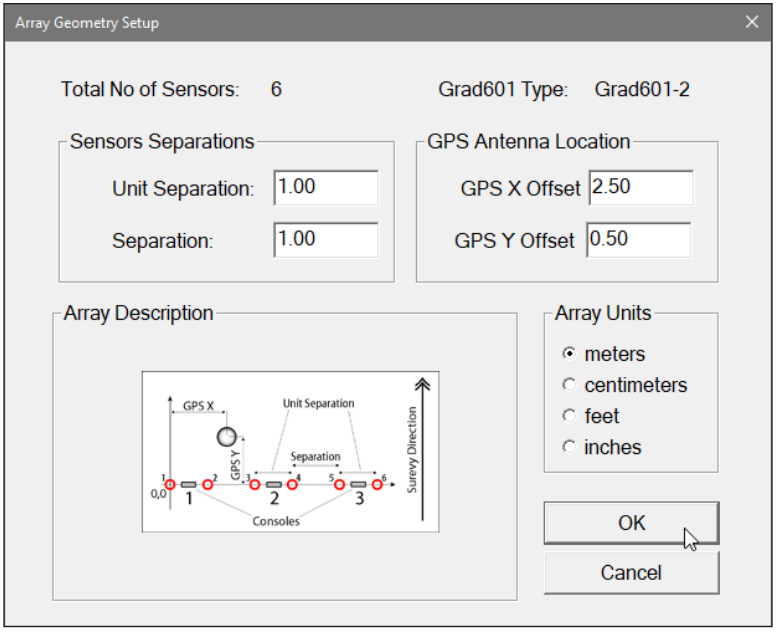


Figure 5.1: Array Geometry Setup dialog for array of six Grad601 sensors

The current layout of an array is displayed in graphic diagram located in Main Screen. As soon as the button **OK** in Array Geometry Setup dialog is clicked (or executed by keyboard) the dialog is closed, the program calculates layout of the array using new parameters and displays its layout in Main Screen window. This visual approach helps to notice immediately a case when wrong parameters were entered. The array layout that corresponds to Array Geometry Setup dialog parameters shown in Figure 5.1 is presented on diagram in Main Screen in Figure 5.2 below.

Two other examples of Array Geometry Setup dialog and corresponding Main Screen diagram are placed at the end of this chapter.

5.1 Description of Array Geometry

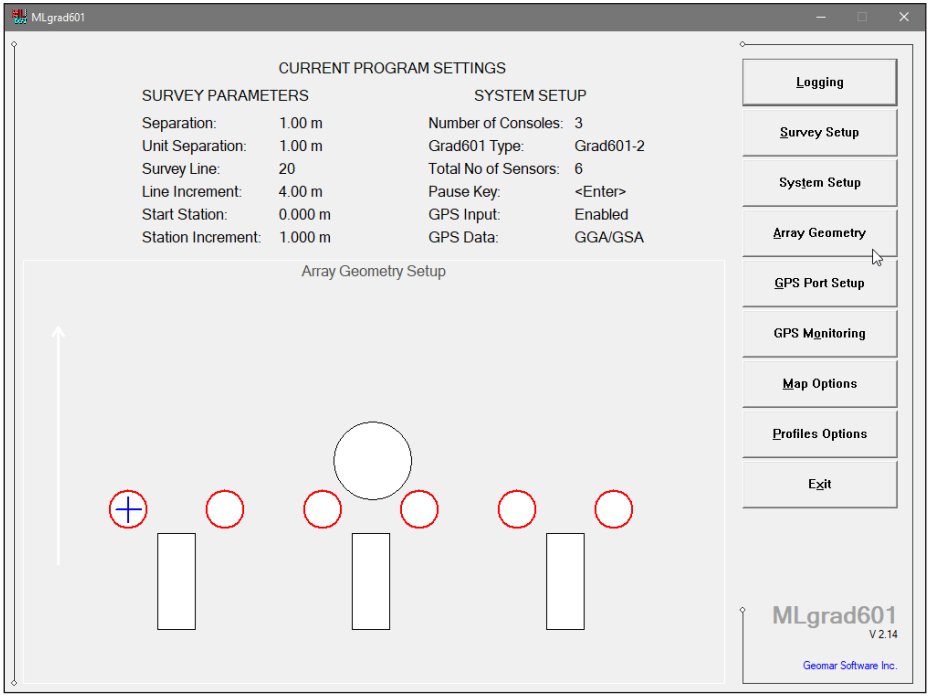


Figure 5.2: Main Screen with array layout corresponding to parameters specified in Figure 5.1

Array The reference point 0, 0 of the array is located at the center of the left most Grad601 sensor (see Figure 5.3). Sensors (as well as Grad601 consoles, however consoles are not taken to account while specifying system geometry) are numbered from the left edge of array row while facing the direction of the array movement. This procedure of naming (numbering) is very important since positioning of sensors calculated from one GPS antenna bases on this assumption. For surveys carried out along grid (without GPS receiver) this method of numbering particular Grad601 probes will be used in specifying the position of the survey line for each sensor.

The main result of the described method of numbering Grad601 instruments in the array is that the system can not change its orientation. The sensor furthest to the left (#1) must remain in this position (related to direction of moving) during collection of data to one data file. This means that the Grad601 array can not be pushed toward the fence or building, and then towed away from an obstruction; it must make U-turn. If the survey is conducted along a grid, without GPS positioning, the above method can be omitted, however in such case, the operator has to keep track of sensor locations for each survey line.

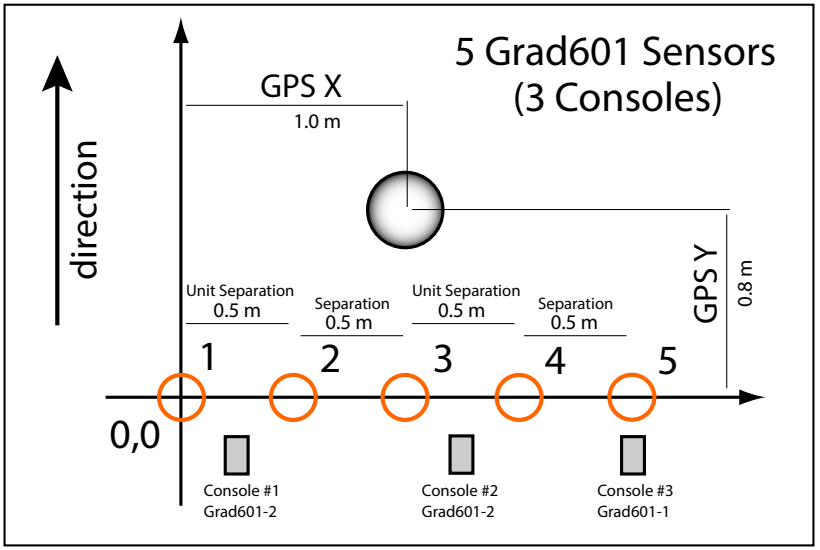


Figure 5.3: Array Geometry description

The MLgrad601 is designed to work with an array of up to 18 Grad601 sensors connected to maximum nine consoles (however it will work with one unit as well). Instruments can be organized in one row (as shown in Figure 5.3).

Separations between Grad601 probes are described by two parameters: Unit Separation and Separation. The Unit Separation reflects distance between two sensors connected to the same console (Grad601-2). The Separation is used to describe distance between neighbouring sensors that are connected to two different neighbouring consoles. In most practical applications both parameters, Unit Separation and Separation will have the same value.

GPS antenna can be placed anywhere, however to achieve higher accuracy for the calculated positions of each coil the GPS antenna must be placed as close to the center of the system as possible, and preferably in the center of the Grad601 sensor. For example, if three sensors are used the optimal location of the GPS antenna would be in the center of the second instrument. In the case of a two sensors array the GPS antenna can be placed in the center of the system, between two sensors. Location of GPS antenna is described by two parameters, offsets in X and Y directions (while facing direction of the movement) from the reference point 0,0 (see Figure 5.3).

Both separations as well as GPS antenna offsets are specified in measurement units as selected in the section labeled Array Units (meters, centimeters, feet, or inches).

In the case wrong value was entered in the field, GPS Antenna offset as well as any other Array Geometry Setup parameter can be corrected later during data processing in the program MultiGrad601.

In summary the Grad601 array geometry is described by following parameters:

number of Grad601 sensors
separation between sensors connected to the same console (Unit Separation)
separation between sensors connected to different consoles (Separation)
offset of GPS antenna in both directions (GPSX and GPSY)
array measurement units (m, cm, feet, or inches).

5.2 Array Geometry Setup Options and Parameters

To select any option click on the corresponding drop-down list box, radio button, or text box, or use TAB key to scroll to the option and then use mouse or the **Down** and **Up** keys in drop-down box (parameters that have only a few possible options), radio buttons section, or keyboard for text box entry.

Number of Sensors (number of Grad601 sensors in array)

Number of sensors is in fact specified in the System Setup dialog (Figure 5.4) as a combination of number of consoles and Grad601 Type (Grad601-1: 1 sensor and Grad601-2: 2 sensors). The Array Geometry displays number of sensors as

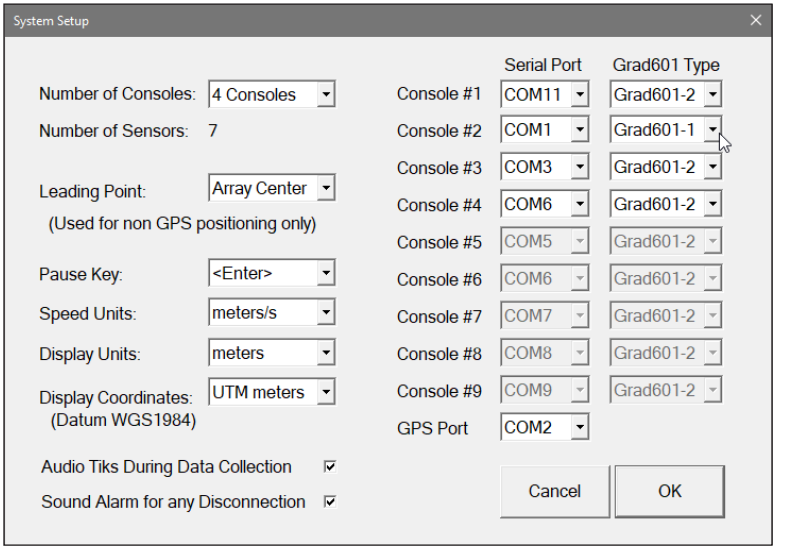


Figure 5.4: System Setup dialog with 4 consoles and 7 sensors selected

information only. Figure 5.4 shows selection of 4 consoles, with three consoles set as Grad601-2 (2 sensors) and one console (#2) as Grad601-1 (1 sensor). Assuming parameters in Array Setup dialog as in Figure 5.1 (both separations equal to 1 m, and GPS X offset 2.5 m and GPS Y offset 0.5 m) the corresponding layout of the array is displayed in Figure 5.5. Please note that optimal placement of GPS antenna would be above center, fourth sensor, which correspond to GPS X offset specified as 3.0 m in the Array Setup dialog.

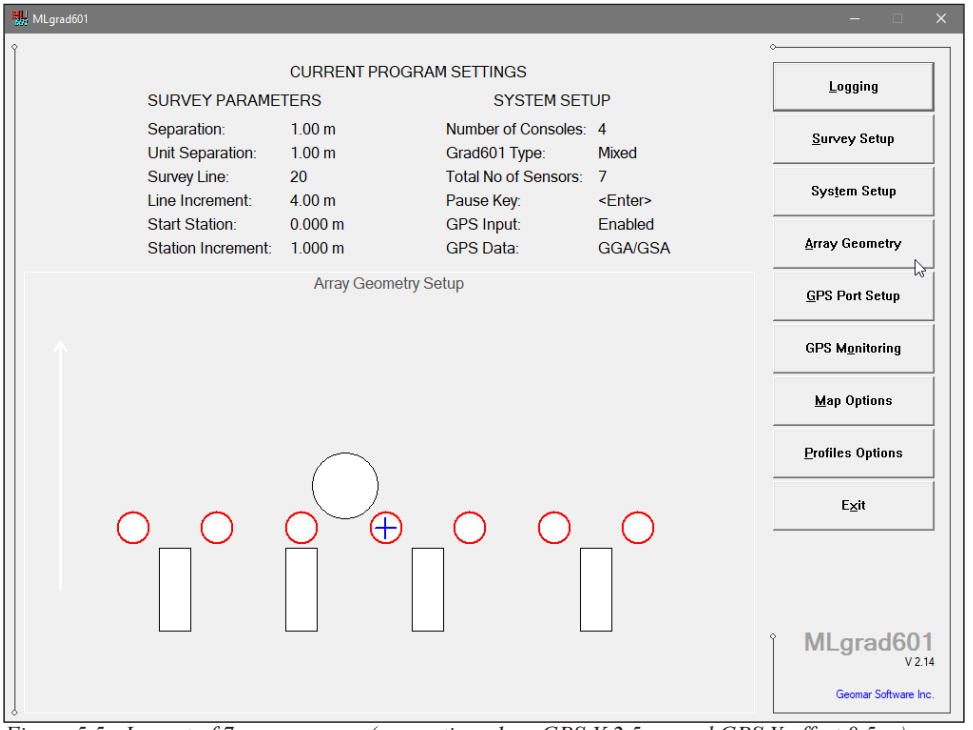


Figure 5.5: Layout of 7 sensor array (separations 1 m, GPS X 2.5 m, and GPS Y offset 0.5 m)

Unit Separation

Distance between sensors connected to the same Grad601-2 console. It has no meaning and it is ignored by the program if Grad601-1 console is specified.

Separation

Distance between two neighbouring sensors connected to two separate neighbouring consoles. This parameter is valid for both Grad601-1 and Grad601-2 console types.

GPS Antenna Location

Location of GPS antenna is described by two parameters, GPS X and GPS Y. These parameters are offsets in X and Y directions (while facing direction of the movement) from the reference point 0,0 (see Figure 5.3).

GPS antenna can be placed anywhere, however to achieve higher accuracy for the calculated positions of each coil the GPS antenna must be placed as close to the center of the system as possible.

In the case wrong values were entered in the field, GPS Antenna offsets can be corrected later during data processing in the program MultiGrad601.

Array Units

Four selections are available: **Meters**, **Centimeters**, **Feet**, and **Inches** (Figure 5.6). These units will be used to calculate positions for sensors in program MultiGrad601. All parameters that describe geometry of the system must be specified using units selected at this option.

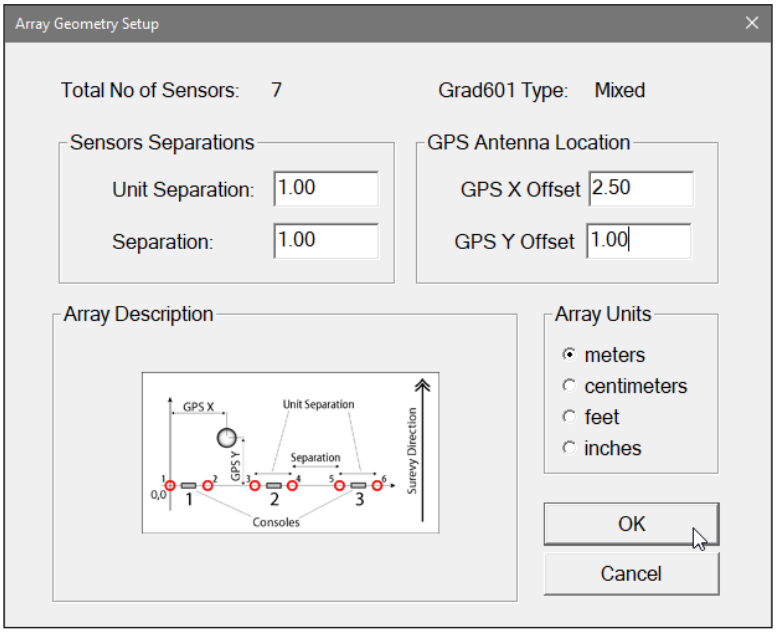


Figure 5.6: Array Geometry dialog

After all the parameters in the Array 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 array 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 Array Geometry Setup dialog.

In case of any wrong values describing array geometry (separations or GPS offsets) unnoticed in the field, adjustments can be performed later during data processing in the program MultiGrad601.

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.

5.3 Examples of Array Geometry Setup Dialog

Two examples for array of Grad601 sensors were given at the beginning of this chapter, see Figures 6.1 and 6.2, and 6.4 and 6.5. Following two figures contain two examples of the Array Geometry Setup dialog settings and corresponding array layouts shown in Main Screen. The first example is given for six sensors (three consoles) with non equal values of separations between sensors, Unit Separation 2 m and Separation 1 m. The first example has GPS X offset 2.5 m (Figure 5.7) while in the second example the GPS

Figure 5.7: Array Geometry Setup dialog parameters with corresponding layout of the array displayed on the Main Screen

antenna is located along the center of the six sensors array. In this case GPS X offset is specified as 4.0 m in the Array Geometry Setup dialog (Figure 5.8).

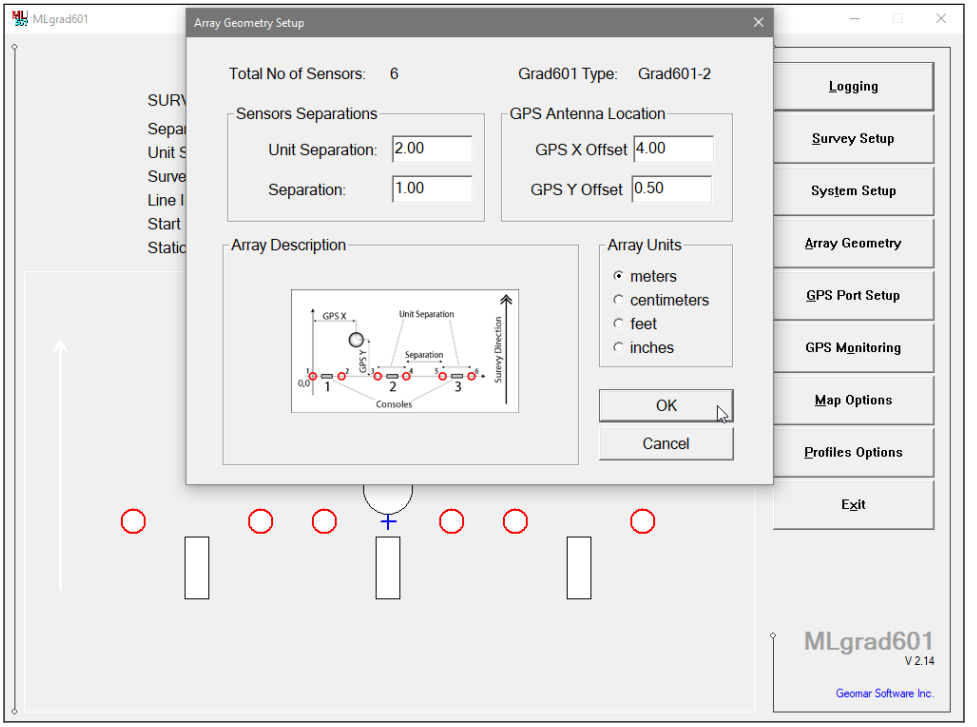


Figure 5.8: Array Geometry Setup dialog parameters with corresponding layout of the array displayed on the Main Screen

GPS Port Setup & Monitoring 6

The GPS Port Setup dialog allows for enabling GPS input, selection of NMEA data string, setting communication parameters for serial port associated with GPS or Robotic Total Station (RTS) input, and GPS Warning Mask parameters (not used for RTS positioning). GPS Monitoring window allows you monitoring the GPS output in terminal mode and to send NMEA commands to GPS receivers (if supported).

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, specifying GPS Warning Mask parameters, and Position Interpolation Limiting parameters (Figure 6.1).

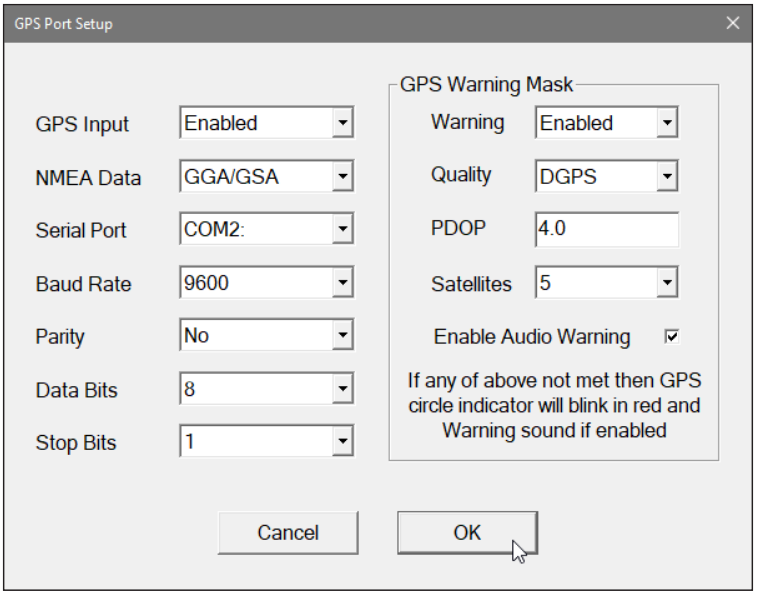


Figure 6.1: GPS Port Setup dialog

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 dialog options and parameters.

GPS Input

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.
The GPS Input can be **Enabled** even if there is no GPS system connected to the Allegro CX. In such case data file will contain proper sequence of Grad601 readings without any GPS input.

NMEA Data

This option allows you to select NMEA message. The MLgrad601 can make use of messages: GGA, GGA with associated GSA sentence, POS, GLL, LLK, LLQ, GLL, and GGK. Therefore NMEA Data option has nine selections: GGA/GSA, GGA, POS, GLL, LLK, LLQ, GLL, GGK, Leica TPS (includes Leica RTS 1100 and 1200 models, as well as newer Trimble RTS supporting pseudo-GGA message), and Pseudo GLL (used in some marine positioning systems), see Figure 6.2.

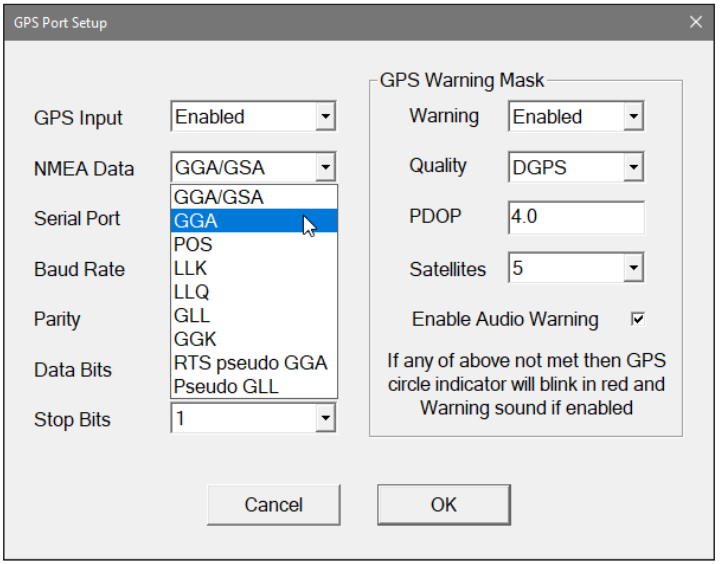


Figure 6.2: Selecting NMEA message

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 avail-

able). In such case user should monitor quality of GPS signal using GPS receiver panel display (if available) or can monitor number of available satellites. If GGA option is selected a parameter HDOP will be displayed on the screen. Messages GGK and POS which are supported by smaller number of manufacturers (however POS is available in all Ashtech receivers and GGK in some Trimble systems) are somehow preferable since they contain all necessary information, including the PDOP, in one sentence. If your GPS receiver supports POS, 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.

COM Port

The number of serial port that is assigned to the GPS input. Available selections are from COM1 to COM48 (Figure 6.3). This parameter can be also selected in the System Setup dialog. Communication parameters for the selected serial port can be determined in options described below.

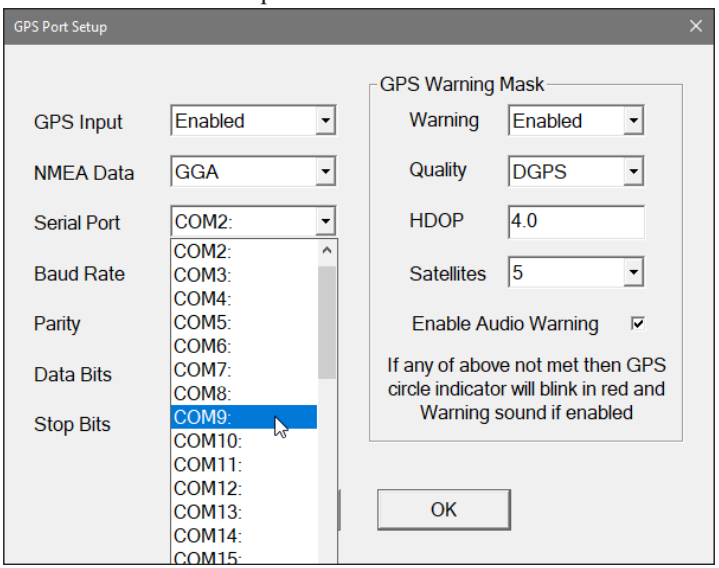


Figure 6.3: Selecting GPS serial port

This port must be different than any of ports specified in the System Setup dialog (for any selected Grad601), otherwise a warning message will be displayed and ports will have to be reassigned. Therefore it may be easier to select GPS port in System Setup dialog which lists all serial ports.

Baud Rate

Specify Baud Rate for the output port, the entered value should match the Baud Rate of the GPS system, default is 9600 (Figure 6.4).

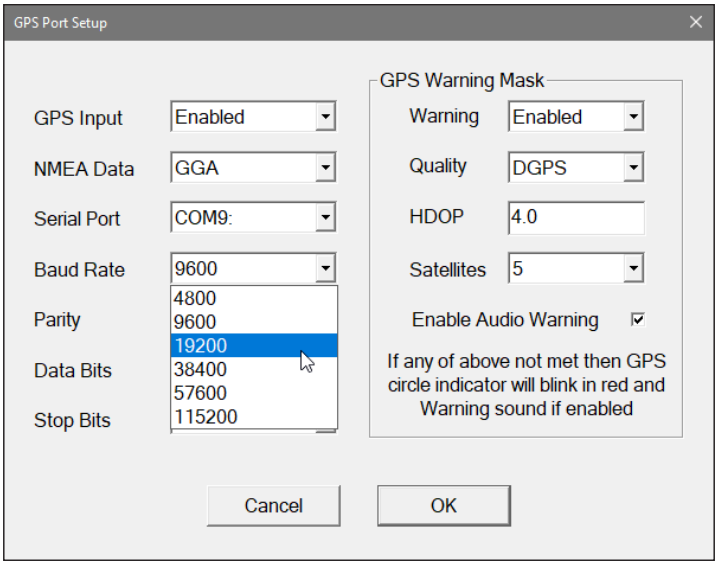


Figure 6.4: Selecting Baud Rate

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.

After all the parameters in the Survey Setup dialog are updated click on the button **OK** or **O** key (or **ENTER** if button **OK** is highlighted) 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 GPS Port 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.

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 6.5).

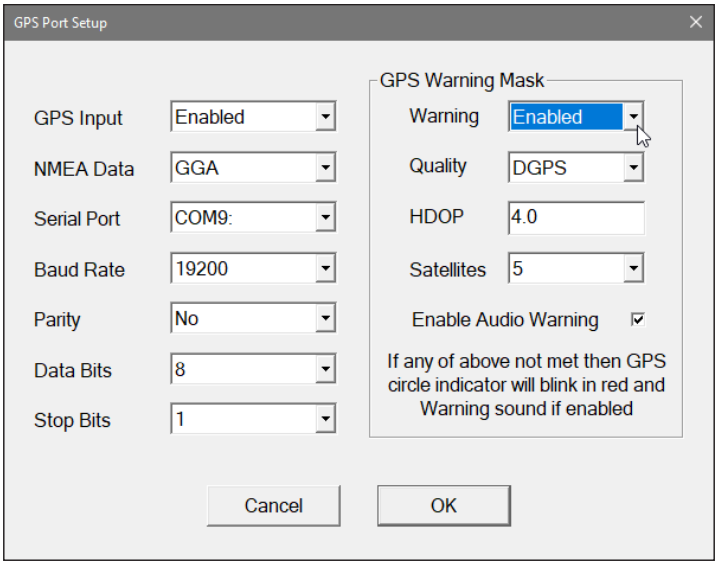


Figure 6.5: GPS Warning Mask setup

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 addition, if the Enable Audio Warning check button is checked then an audio warning will sound ("gentle bell"). 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). 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 Leica TPS are used.
Activate text box by pointing and clicking mouse left button or by 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.

Enable Audio Warning

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

After all the parameters in the GPS Port Setup dialog are updated click on the button **OK** or **O** key (or **ENTER** if button **OK** is highlighted) 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 GPS Port 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.

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 MLgrad601 screen in terminal mode is shown in Figure 6.6.

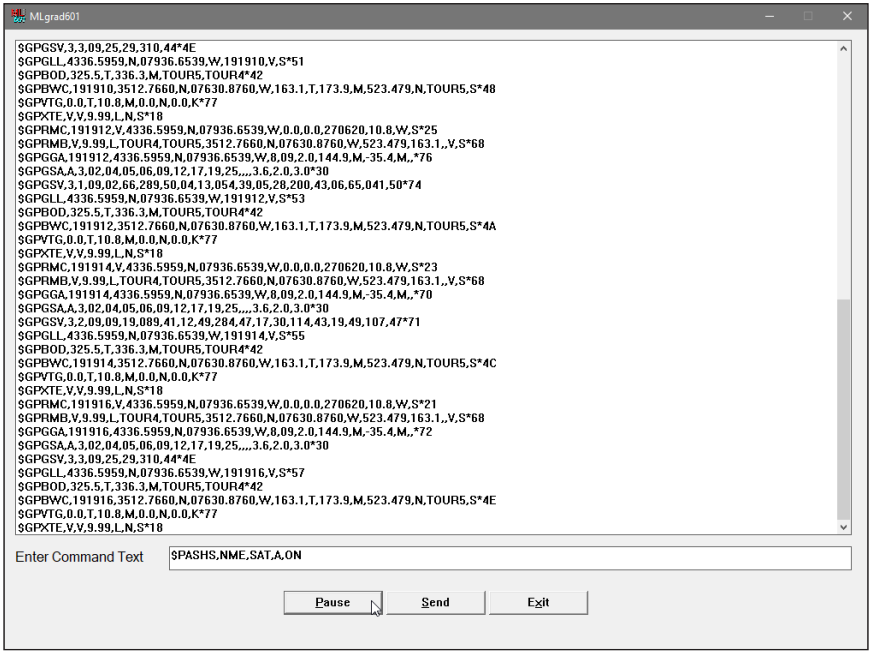


Figure 6.6: Monitoring GPS output in terminal mode

As soon as the MLgrad601 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 6.6 shows output of GPS receiver which sends three NMEA messages GGA and GSA updated every two seconds. 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 6.7.

Figure 6.7: 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 GPS Port Setup dialog,
- 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 in GPS Port Setup dialog.

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 6.8). 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 6.8: 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 MLgrad601 without using any other software.

After the command button labeled **Send** is clicked S key (or ENTER if the button is highlighted) is pressed the dialog Send Message to GPS Receiver is displayed. The previously used NMEA command or the beginning of the standard NMEA command, **$PASHS,** is displayed in the dialog's edit box (Figure 6.9). After the entire NMEA

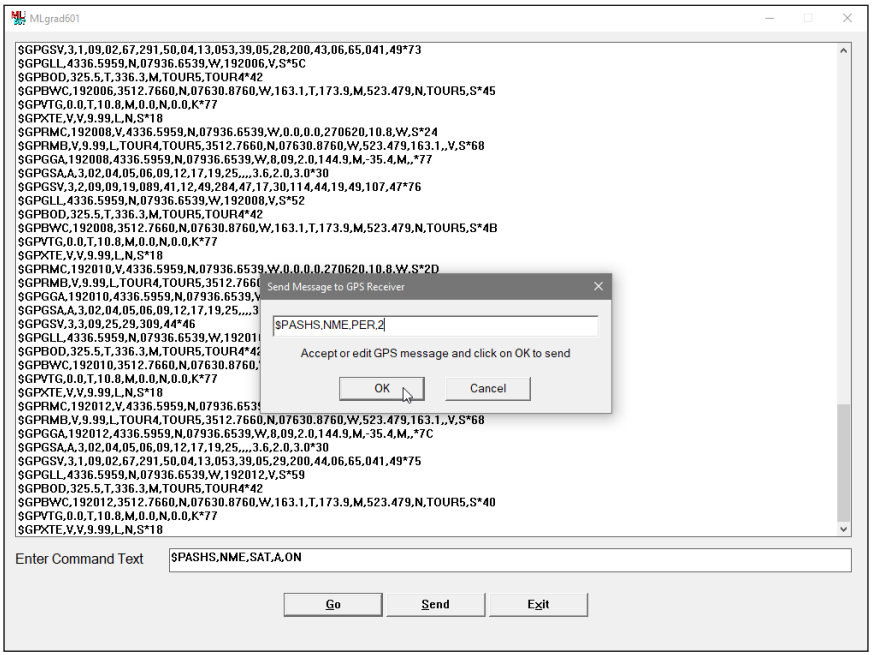


Figure 6.9: Send Message to GPS Receiver dialog with an example of command changing GPS update rate to 2 seconds

command is typed in, press the **OK** button or press O key (or ENTER if the button is highlighted) to send the command to the GPS receiver. Clicking on Cancel button or pressing the C key will cancel the command and the dialog disappear. An example of a command that will enable the NMEA message **SAT** is given in the Figure 6.10 (it is assumed that the GPS receiver output serial port is A).

After this command is received by the GPS receiver, the confirmation message will be send by the receiver ($PASHR, ACK*3D) and data stream will contain the message SAT ($PASHR, SAT,.....).

When the button **Send** is clicked next time, the text of the former NMEA command is displayed in Send Message to GPS Receiver dialog. This text can be edited and send to GPS receiver by clicking on the **OK** button or pressing the **<ENTER>** key.

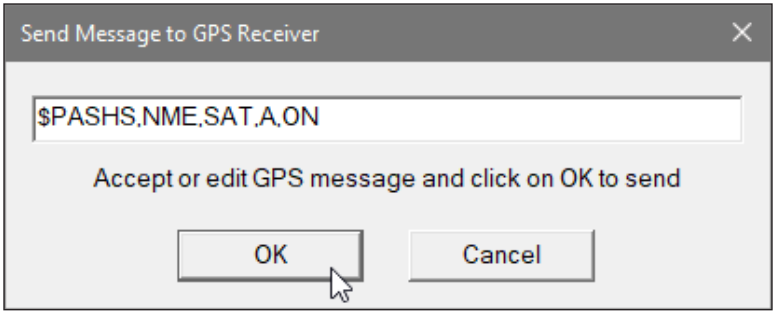


Figure 6.10: Send Message to GPS Receiver with command enabling NMEA message SAT

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. 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 Display 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 colour image of data (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 MLgrad13 can display navigation map in two modes: Navigation and Mapping. In the Navigation mode position of each sensor is displayed as a dot of specified size or as a bar that has width (swath) of the entire array, positions are plotted at GPS update rate. Mapping mode displays swath bar for instrument reading with colour reflecting amplitude value. Samples of various map displays are provided in Chapter 1 of this manual (Figures 1.4 to 1.6)

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

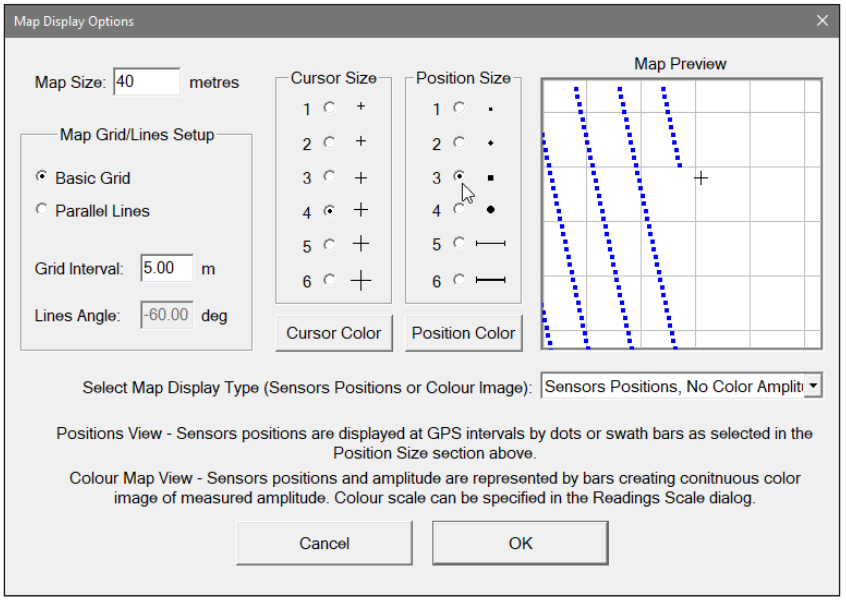


Figure 7.1: Map Display Options dialog

This window is divided into five main sections. The first section located at the left specifies map size 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 (sensors positions, no colour image) or Mapping (colour image representing acquired data).
All parameters selected in this dialog can be adjusted later during data collection.

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 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.
Grid lines can be plotted only in as perpendicular lines SN and WE drawn at specified interval (Figure 7.1), while selection Parallel Lines allows for Lines Interval as well as Lines Angle entries (Figure 7.2). Lines tilt angle is measured in degrees clockwise from North.

Cursor Size and Position Size

Cursor Size (+ symbol) represents position of GPS antenna while Position Size (dot or swath bar) represents position of each sensors (dot) or entire array (swath bar) in Navigation mode.
When Mapping mode (colour image) is selected then position of each sensor is represented by a swath bar by default. Each swath bar in Mapping mode consists of several (number of connected sensors) short bars drawn with colours corresponding to each sensor amplitude. Size of a bar for each sensor is equal to sensor interval (as specified in Array Geometry dialog) and the center of the bar is position of given sensor. Therefore array in Mapping mode is represented by one continues path of varying colour and its size is the array span plus overlapping half of sensor interval on each side (to have same weight of representation for each sensor). In special case when one sensor is selected in Mapping mode the sensor is represented by 0.5 m bar (or position of sensor +/-0.25 m on each side) by default.

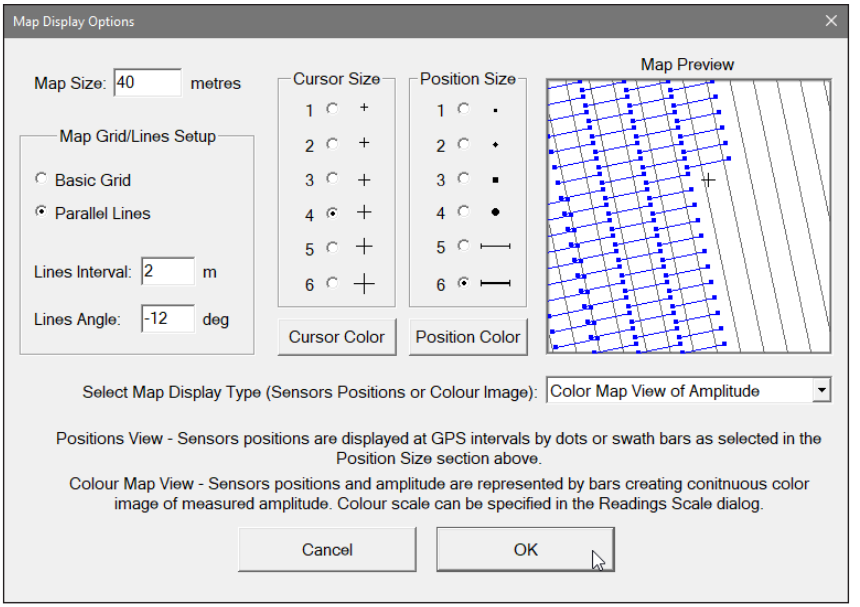


Figure 7.2: Selecting swath bar in Map Display Options dialog

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 7.2 (please compare with Figure 7.1).

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/Array Swath Color**. The Color dialog will appear (Figure 7.3).

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.

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.

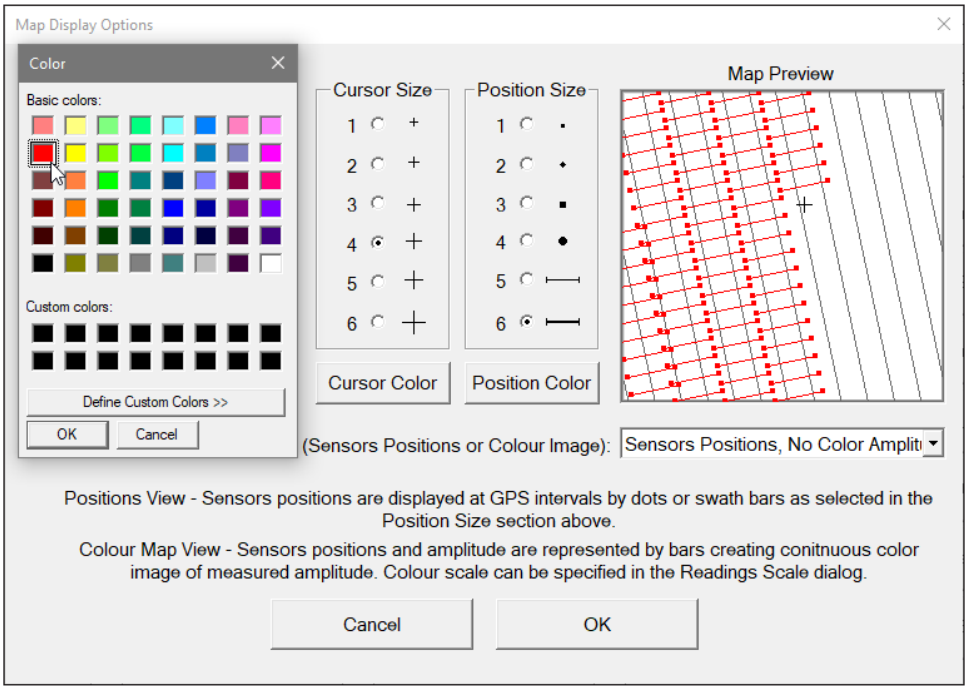


Figure 7.3: Selecting Color of Dot or Swath Bar in Map Display Options dialog

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.

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 7.4.

When the first item "GPS Positions, No Color Amplitude" is selected the program will display map in Navigation mode. Despite the label "GPS Positions..." positions drawn on map (dots or swath bar) indicate locations of Grad-601 sensors that include corrections for GPS antenna offsets, GPS Positions meaning is that sensors 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 item will set the program in Mapping mode. The map will show colour image of the amplitude values measured.

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

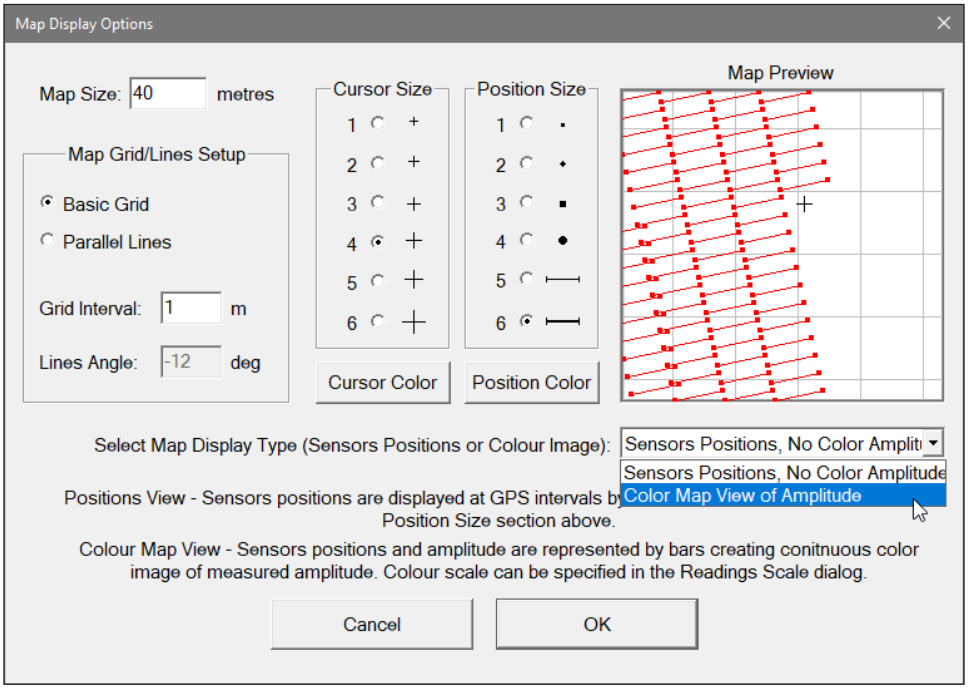


Figure 7.4: Selecting Navigation mode and any option of Mapping mode

After all the parameters in the Map Display Options window are updated click 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 initial 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) click on **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

The Profile Display Options dialog allows you to enable and disable the display of each sensor connected to the Grad601 cosole (left or right while facing direction of the array movement or following numbering in array), to specify color and thickness of profiles. If particular console is a type Grad601-1 (one probe connected) then the Left Sensor parameters apply. The dialog is presented in Figure 7.5.

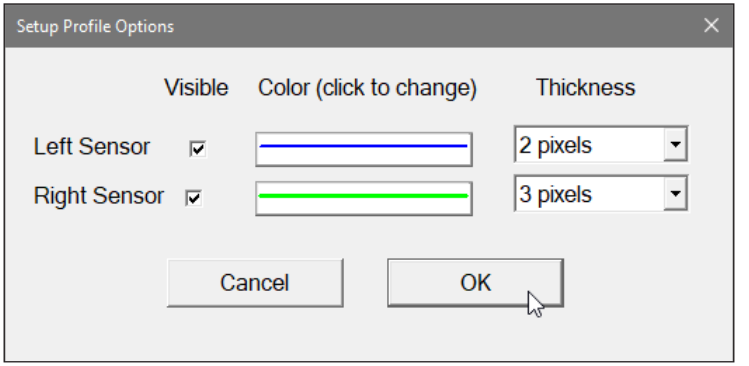


Figure 7.5: Display Setup Options dialog

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.

Description of the Survey Setup dialog options and parameters.

Visible

To enable or disable displaying of each channel profile click on the corresponding check box button labeled Visible. Profiles of sensors with checked buttons will be displayed for each Grad601 in the array during data logging. Regardless of which sensors are chosen to be displayed as profiles, data for all connected sensors will be displayed in numeric form for each instrument in the array.

Color

To change colour of each profile line and moving bar (for all sensors in the array) click on the corresponding button (with colour line) labeled Color (Figure 7.6). The Color dialog will appear (Figure 7.7).

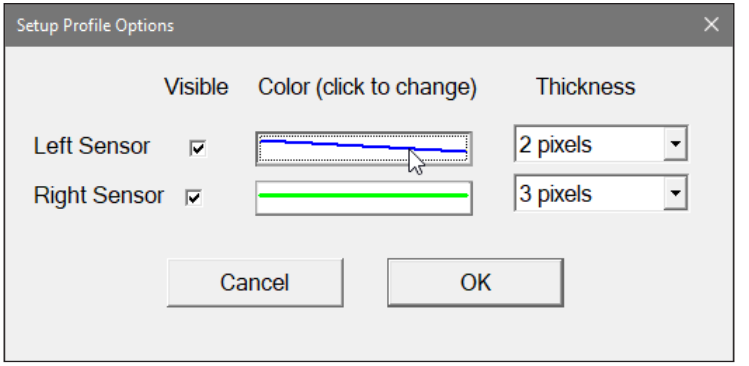


Figure 7.6: Selecting Profile and Moving Bar colour

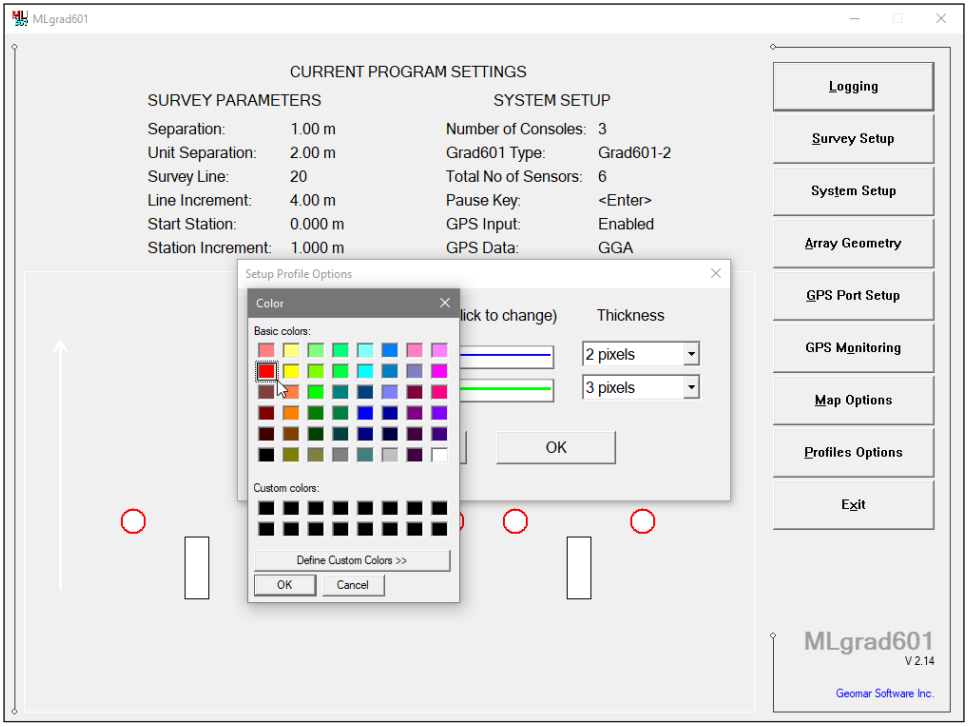


Figure 7.7: Selecting Profile Colour

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 Grad601 channel will be used to plot corresponding profile line and moving bar.

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 appropriate channel button will updated. To cancel colour selection click on the **Cancel** (or X button) button or press **Esc** key.

Thickness

Specify thickness of a profile for a Grad601 probe (applies to all Grad601 sensors in the array) 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 7.8). Select

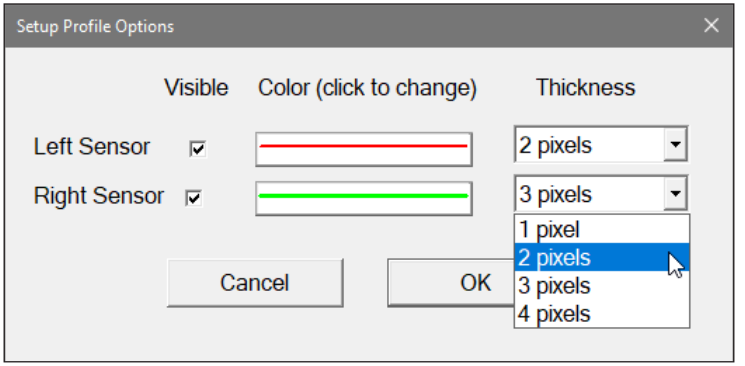


Figure 7.7: Selecting Profile Thickness

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.

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 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 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.

Logging Data

8

After the Logging button in Main Screen is clicked or executed by the keyboard the MLgrad601 starts to read data from connected Grad-601 sensors and GPS receiver. Data is displayed in three modes: Monitoring, Stand By and Logging. Further each of these modes can use Mapping/ Navigation or Profile display mode. Mapping and Navigation modes are used for GPS positioned surveys, and if the GPS Input is disabled then only the Profile mode is available. The navigation mode displays GPS positions in form of dots or a swath bar corresponding to the sensors array scaled width while mapping mode displays continuous colour image for recorded data set. Since Mapping mode is likely more useful as it shows real coverage of the surveyed area and amplitude distribution and otherwise Mapping and Navigation modes are similar, this manual will refer mostly to mapping mode unless describing specifically Navigation mode features.

Program starts Logging session always in Monitoring mode (Figure 8.1). In this mode Grad-601 sensors and GPS readings can be quickly examined, and data file can be created. Stand By mode is similar to monitoring, however more field functions are available. Recording of Grad601 and

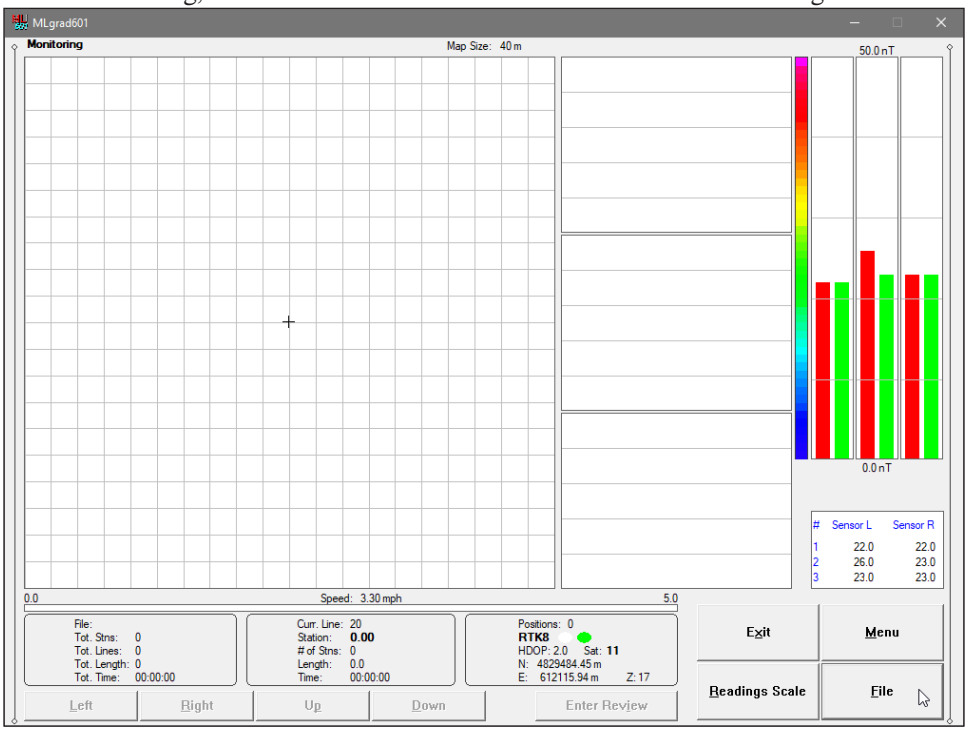


Figure 8.1: Initial MLgrad601 Monitor mode display in Mapping mode

GPS data is allowed only in Logging mode, which is accessible from Stand By mode. In general after data file is created in Monitoring mode, two modes Stand By and Logging are toggled by Start and Pause keys. In Stand By mode instrument outputs can be monitored and some survey parameters can be changed, and Log mode is used only to record data.

It is assumed that all settings, especially assignment of serial ports, are correctly specified and instruments are turned ON prior to using this option. In case any of the instruments are OFF or any console is not connected to the field computer or connected to wrong port the message shown in Figure 8.2 will appear.

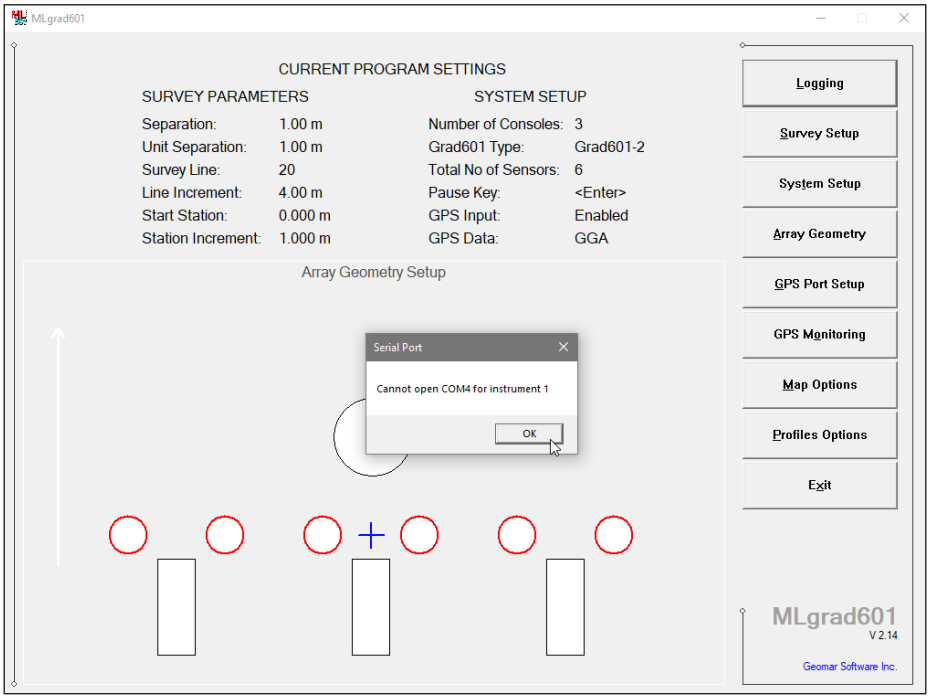


Figure 8.2: No Connection message or wrong port selection, number indicates disconnected instrument

Similarly, if a wrong conflicting port assignment is selected in the System Setup dialog a message informing that one port is specified to two or more consoles or GPS receiver will be displayed by the program (Figure 8.3).

Check program settings (System Setup and serial ports assignment), connections, or turn the instrument ON and select the Logging option again.

Assuming that instrument consoles work properly the program will start Monitoring Navigation mode, as shown in Figure 8.1, or if GPS input is disabled it will display Monitoring Profile mode (Figure 8.5).

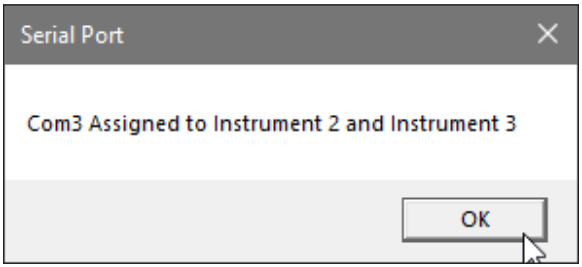


Figure 8.3: Conflict of serial ports assignment message

8.1 Logging Screen Layout and Monitoring Mode

The MLgrad601 Monitor mode allows initial inspection of the range of instruments readings at the particular site, monitoring the instrument performance, monitoring number of available GPS satellites, GPS differential corrections, PDOP parameter status, and GPS coordinates. Two MLgrad601 Logging screens in Monitoring mode are shown below, Figure 8.4 presents the program in Mapping mode (Navigation mode in Monitoring state is identical) and Figure 8.5 shows the program in Profile mode.

The Grad601s readings in Monitoring and Stand By modes are updated approximately 12 times per second during monitoring session. GPS positions are updated at a rate specified in GPS receiver, usually 1 second interval.

If GPS receiver streams data faster than at 1 Hz the MLgrad601 program will process and update display at 1 Hz in real time. However all GPS positions will be written to the data file and will be used later to position data in data processing program. 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 number of readings is displayed. The data processing program interpolates positions similarly to real time GPS interpolation.

Mapping Mode

When the GPS Input is Enabled in GPS Port Setup and Colour View was enabled in Map Display Options dialog then the program displays the screen in Mapping mode by default. The MLgrad601 Logging screen in Monitoring mode and Mapping display mode is shown below (Figure 8.4).

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 readings if form of colour image during data recording. The side of the square corresponds to scale which is displayed at the top line of the screen, in the centre of the plot area. The scale can be given in meters or feet depending on Units selection in the System Setup option. Figure 8.4 shows map area that represents square 40 x 40 m. A cross mark (cursor) indicating current position of the GPS antenna (usually indicating position of the array center) 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 traces will not be plotted in Monitoring mode. Colour image of Grad-601 sensors positions and amplitude is plotted only in Log mode when Grad-601 readings and GPS data are recorded in data file. The North points to the top of the screen.

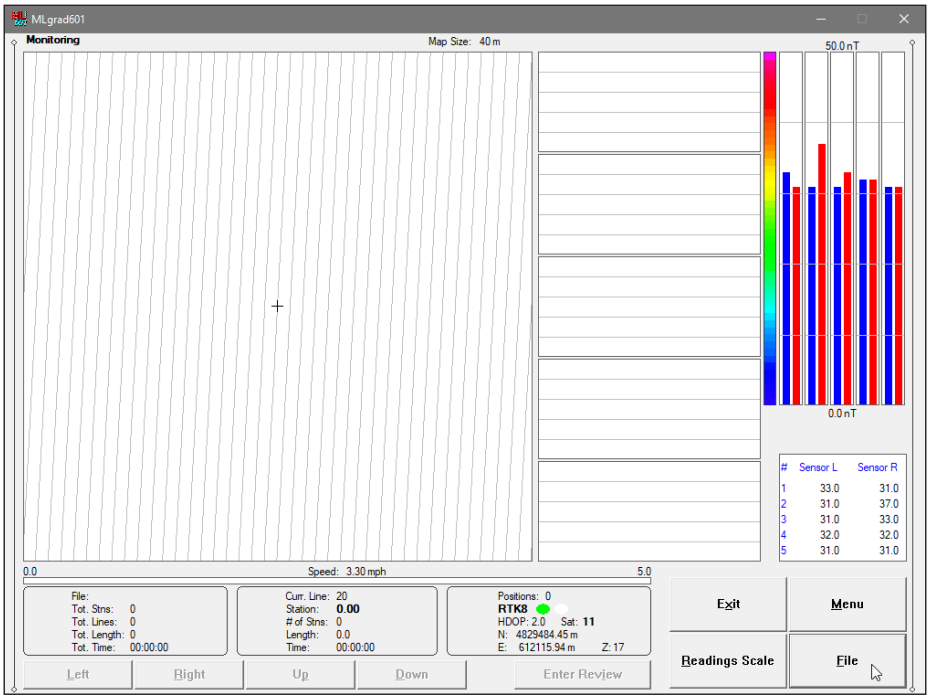


Figure 8.4: Logging Monitoring screen in Navigation mode

The Monitoring screen will display GPS related information in the right most frame box under the speed bar. Number of logged GPS position is displayed at the top of the box (in Monitoring mode it is zero). Below two lines display parameters describing quality of GPS positions. 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, and so on. 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), Figure 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 **PDOP** 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, POS, or GGK were selected. If only message GGA is available, then index **HDOP** will be displayed, and when LLK message was selected parameter **GDOP** is displayed. The LLQ message will provide precision of positioning in meters and it is labeled by **X**. The GLL statement does not provide PDOP information. The next label **Sat** and following number shows number of currently tracked satellites. Refer to section GPS Port Setup, Appendix B, and to GPS manuals for more information about GPS parameters. The bottom two lines of GPS section display current coordinates of GPS antenna. Coordinates are displayed as geodetic (Latitude/Longitude 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 portion to the right of the map plot area is occupied by panels which will be used to display profiles during data recording. Number of panels is equal to number of consoles in the array, and they are counted from the top (top panel corresponds to Grad601 console #1, the second to Sensor #2, and so on). Each panel displays one or two profiles corresponding to number of sensors connected to each console. The scale for profile panels is divided by four or five light 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 solid line. Profile scale of plot is the same as the scale for moving bars plots.

The top right portion of the window is occupied by the moving bars plot area, a grid, which presents Grad601 readings in graphic form. The grid is divided to portions equal to number of connected instrument consoles. Figure 8.4 presents screen for five Grad601 consoles, while Figure 8.1 shows the three console setup. Consoles and corresponding portions of the grid are counted from the left. The left most portion represents Grad601 #1, the next Grad601 #2, and so on. Each portion of the grid representing one Grad601 includes one or two moving vertical bars depending on Grad601 type. The first (left) bar corresponds to the Left Probe 1 and the following bar represents Right Probe while facing direction of the array movement. If particular Grad601 console is specified as Grad601-1 (one sensor) then only one bar (Left) will be displayed.

Range of readings displayed in the grid can be adjusted and it is the same as profile scale. Figures 9.4 and 9.5 show grid in linear scale from 0 to 150. Scale is labeled at the top and bottom of the moving bars plot area. The scale for graphic bars is divided by four or five light 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 solid line. The moving bars graphic presentation allows the operator for very easy and quick monitoring the response of all connected instruments. It is visible in all three Logging modes: Monitoring, Stand By, and Logging, as well as in Mapping, Navigation, and Profile display modes.

A colour bar representing colour distribution of amplitude to be plotted as a colour image in map area is located on the left of the graphic bar windows. Its scale and range corresponds to scale of graphic bar windows and can be adjusted by Readings Scale button or corresponding item in Menu. If this colour bar is not shown it means that the program is in Navigation mode.

Readings for all sensors in the array are shown in digital form in a window located below the moving bars plot area. Data for each instrument console occupies one line of the display. The Grad601 console #1 is displayed in the top line, the Grad601 console #2 occupies line below, etc. They are displayed in the following order (from the left): Left Probe (labeled **Sensor L**) and Right Probe (labeled **Sensor R**). Readings are given in nT as streamed by instruments.

A speed bar located under profile plot area indicates current speed of the system over the ground. It is calculated based on the current and previous GPS position and it is updated at the GPS output rate. Scale of the speed bar can be adjusted at any time during the survey. Speed Bar units must be selected in System Setup dialog prior to Logging session.

Several other parameters are shown in two frames under speed bar and profile plot area. These parameters (file name, line name, current station, etc.) are not used in Monitoring mode. Four command buttons (in the bottom right portion of the screen) provide access to options available in Monitoring mode. These options are described below in the section 9.2.

Navigation Mode

The MLgrad601 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 display in Navigation mode will not show colour bar for readings. All other parameters and functions are same as described above in Mapping Mode section.

When the GPS Input is Disabled in GPS Port Setup dialog then the program displays the screen in Profile mode and in the GPS text box a label "GPS Disabled" will be displayed. The MLgrad601 Logging screen in Monitoring mode and Profile display mode is shown below (Figure 8.5).

In general the screen layout in Profile mode is very similar to the Navigation mode, the main difference is that the profile section (profile panels) occupies most of the plot area (it is extended to the Map plot area).

Number of profile panels, bar windows, and numeric display depend on the number of Grad601 consoles in the array and display layout is identical as in the Navigation mode, please see the description in the previous section.

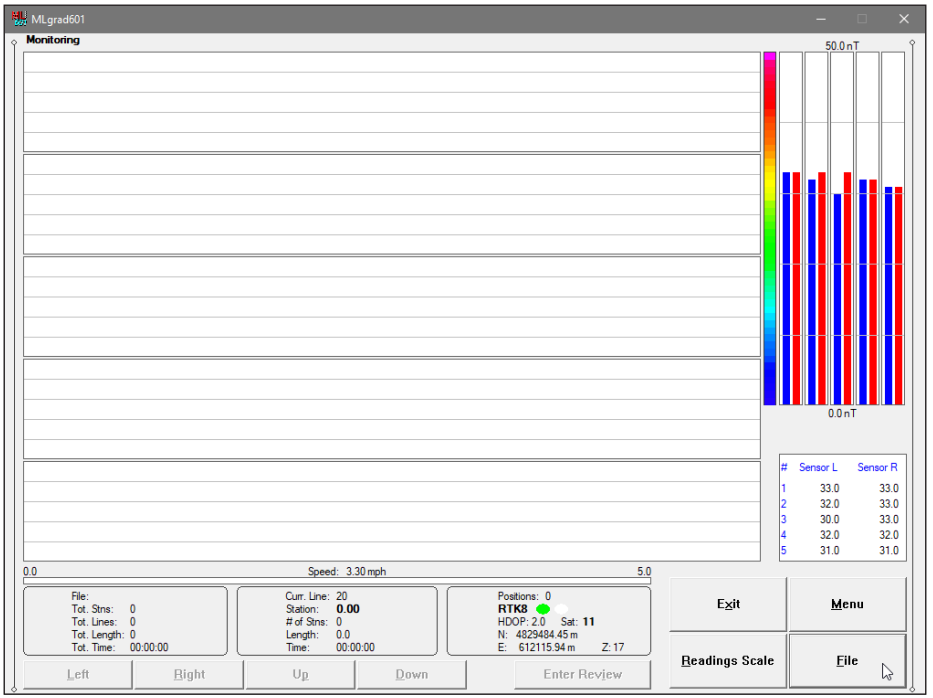


Figure 8.5: Logging Monitoring screen in Profile mode

A speed bar located under profile plot area is plotted however it is not active in Profile mode display if GPS is Disabled.

Several other parameters shown in two left bottom frames are not used in the Monitoring mode. Four command buttons (in the bottom right portion of the screen) provide access to options available in Monitoring mode. These options are described below.

8.2 Options Available in Monitoring Mode

Several options are available while the Logging window is in the Monitoring mode. Three 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 Profile Scale dialog. While menu is displayed options can be selected by clicking on the appro-

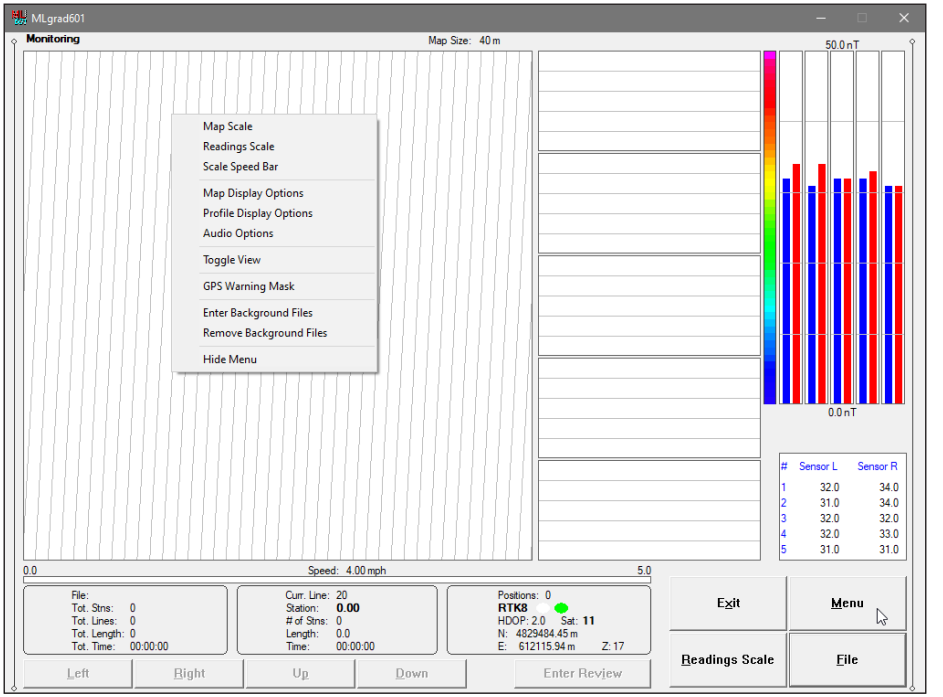


Figure 8.6: Monitoring mode with displayed pop up menu

priate proper option, or from the keyboard by pressing the shortcut keys or by navigating using **<Up>** and **<Down>** arrow keys and executing by **<ENTER>**.

File *(create data file)*

The log data file can be created in any directory. 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 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 MLgrad601 data file is MGR. The Create Data File dialog is presented in Figure 8.7.

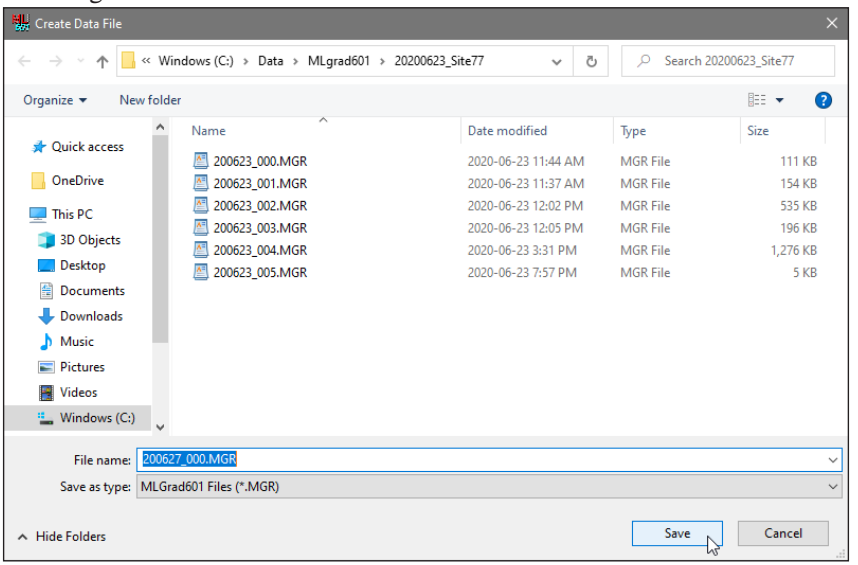


Figure 8.7: Create Data File dialog

The file name can be specified in the Create Data File dialog using the Windows standard interface procedure. The MLgrad601 data files can be appended (program version 1.11 or later), and after message informing about number of points already collected in the file the previous data set will be plotted on the map. Maximum number of positions in one data file cannot exceed 28,800 GPS positions (number of Grad-601 readings is unlimited).

Each data file in the field computer (binary raw data file) has an extension name MGR and it is created in the directory specified in Create Data File dialog. The MGR files are created in the MLgrad601 binary format. They can be processed using the MultiGrad601 program. These files can be also converted to ASCII format and viewed in any text editor program (for example Notepad).

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.

Exit

The program immediately returns to Main Screen.

Menu

The program will display pop up menu (Figure 8.8). Options available in menu are described below. These options can be executed by left mouse cick, tapping on a touch sensitive screen, or directly from the keyboard (without displaying menu) by pressing a shortcut key.

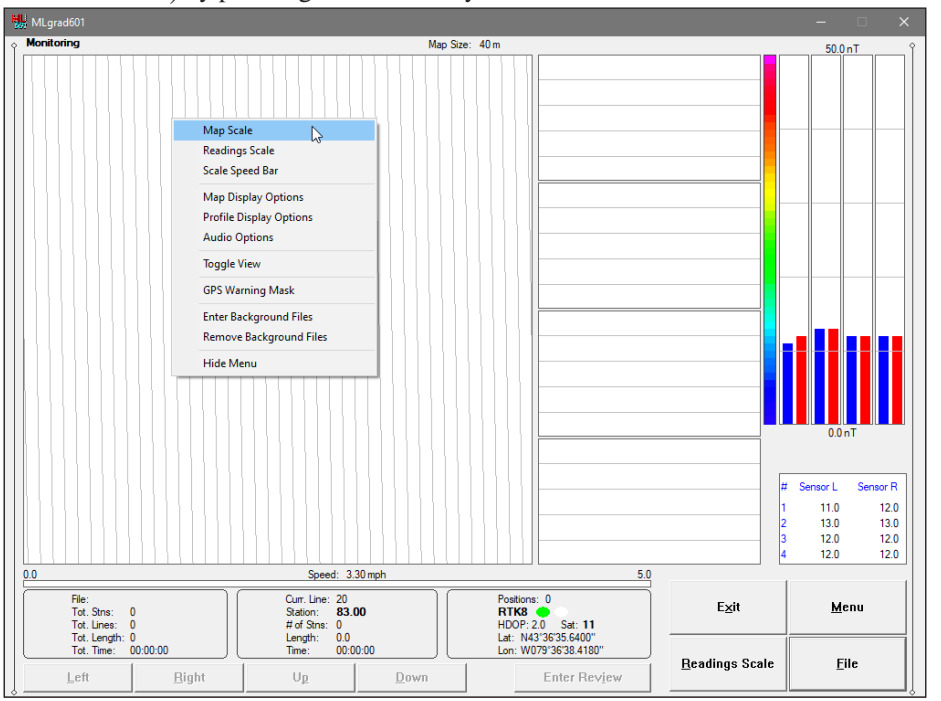


Figure 8.8: Options available from displayed pop up menu in Monitoring mode

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 Size dialog will appear on the screen, Figure 8.9.
This dialog allows the operator to enter new scale for the map displayed by the plot area, map grid interval, and cursor band.

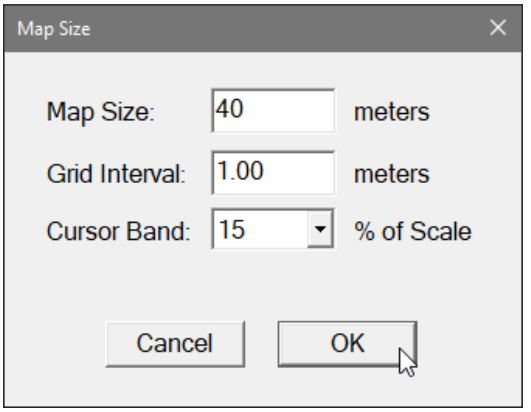


Figure 8.9: Map Size dialog

Map size 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 Scale 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. Five selections are available in the combo box labeled Cursor Nand: 10%, 15%, 20%, 25%, and 30%.
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.

Scale Readings (Adjust profile, moving bars, and map colour image range)
This option is available also in Stand By mode. Minimum and maximum values can be specified for the plot range. Selecting this option allows the operator

to enter new scale parameters for the amplitude display. Entered values are applied to profiles, moving bars plot, and colour imaging displayed in Mapping mode. A colour bar for the amplitude scale that show colour distribution is updated in real time. The Reading Scale dialog is given in Figure 8.10.

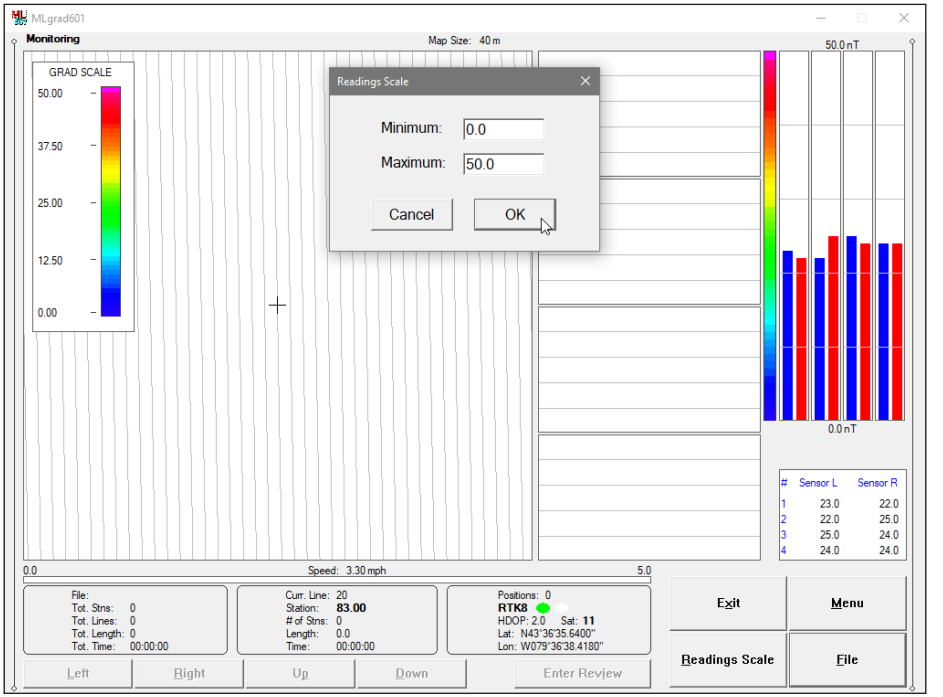


Figure 8.10: Reading Scale dialog

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

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 8.11.
After scale value and units are specified click on the button **OK** or press **ENTER** key to accept new parameters.

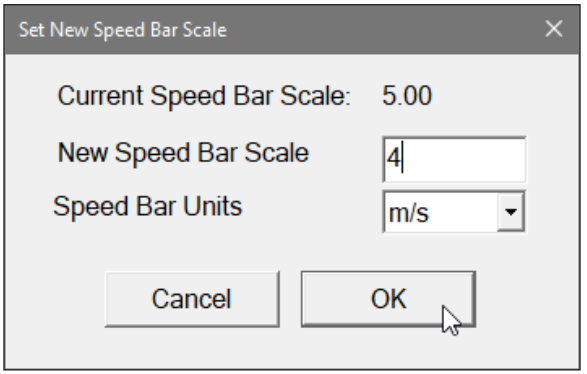


Figure 8.11: Set New Speed Bar Scale dialog

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 (Figure 8.12) is identical to a dialog described in detail in Chapter 8. If the program is in the Mapping/Navigation mode, please refer to section 7.1 of the manual.

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

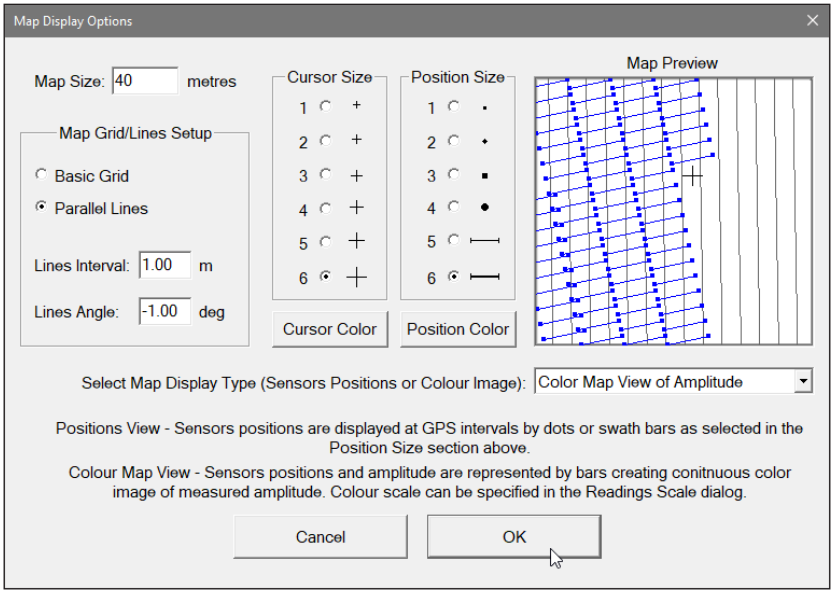


Figure 8.12: Map Display Options dialog

Profile Display Options

The Setup Display Options dialog is described in detail in Chapter 7. This dialog allows you to enable and disable the display of each sensor profile (for all instrument consoles in the array), to specify color and thickness of profiles (same colours apply to moving bars). The dialog is presented in Figure 8.13.

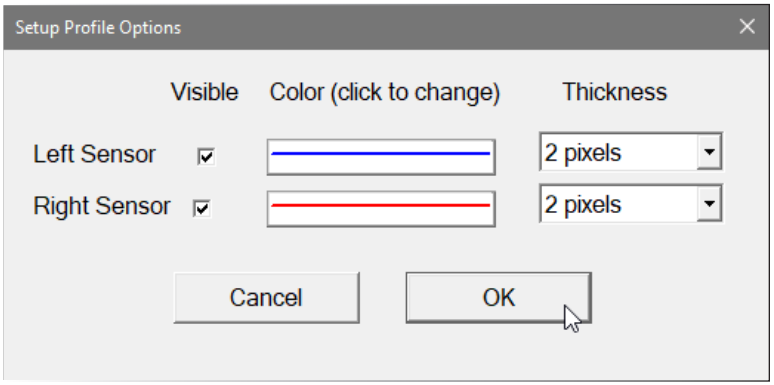


Figure 8.13: Setup Display Options dialog

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 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 8.14. 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.

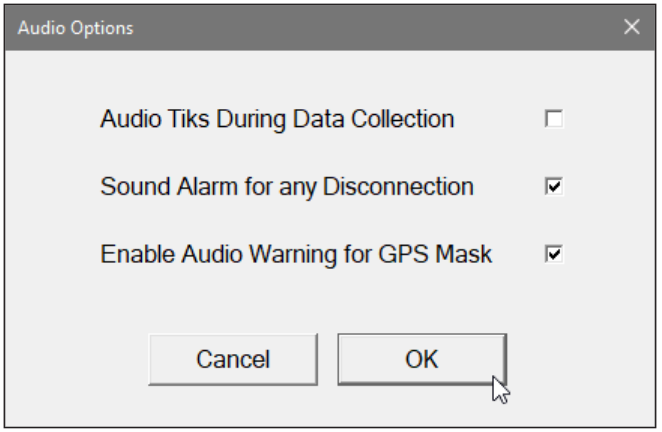


Figure 8.14: GPS Warning Mask dialog

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 Grad601 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 8.14.

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).

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 8.15. Parameters in GPS Warning Mask are described below.

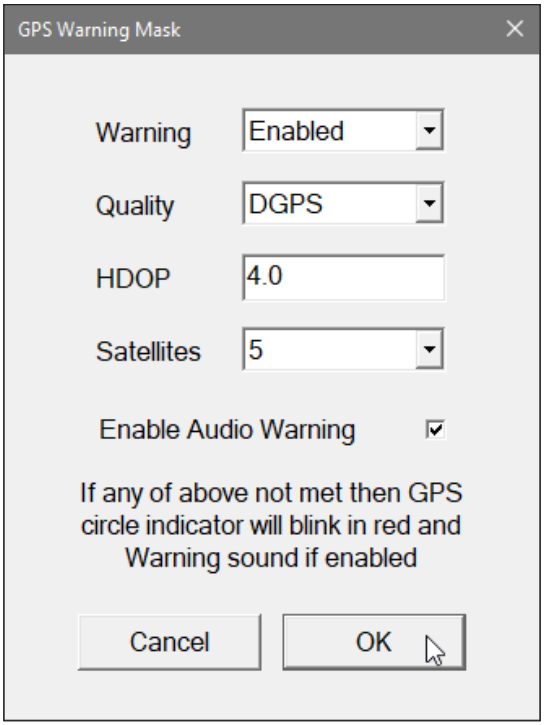


Figure 8.15: GPS Warning Mask dialog

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 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 8.8) 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, etc..

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 Leica TPS 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.

Enable Audio Warning

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).

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.

Enter Background File

The Load Background File dialog is shown in Figure 8.16. The program will display contents of entered files in the background of the map. Two types of

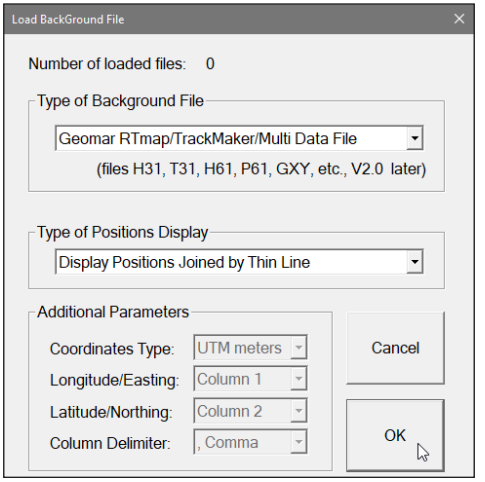


Figure 8.16: Load Background File dialog

files can be entered: any data file created with Geomar programs (MLgrad601, RTmap, or TrackMaker - all V2.00 or later) or user prepared column delimited text file (TXT format) containing coordinates representing site boundary, or any other feature, Figure 8.17. 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 measured coverage, or to repeat part of the survey. User prepared Column Delimited ASCII Text

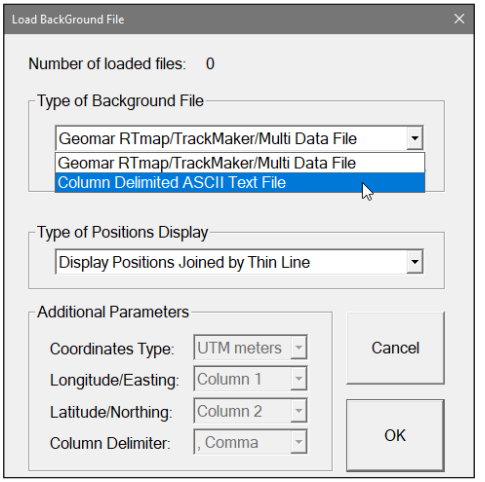


Figure 8.17: Load Background File dialog

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 8.18. 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.

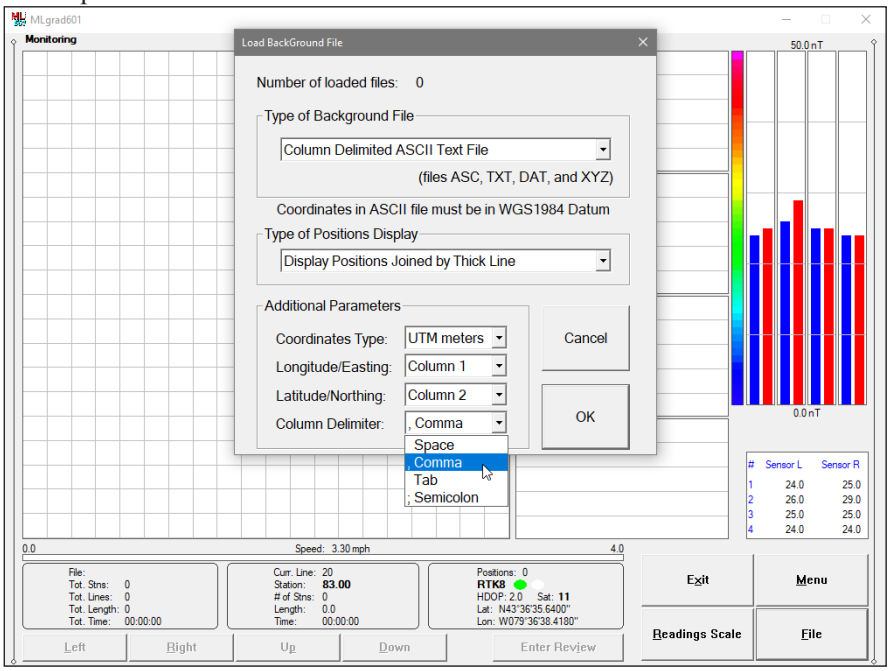


Figure 8.18: Selecting Column Delimiter in Column Delimited File to be loaded.

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 8.19.

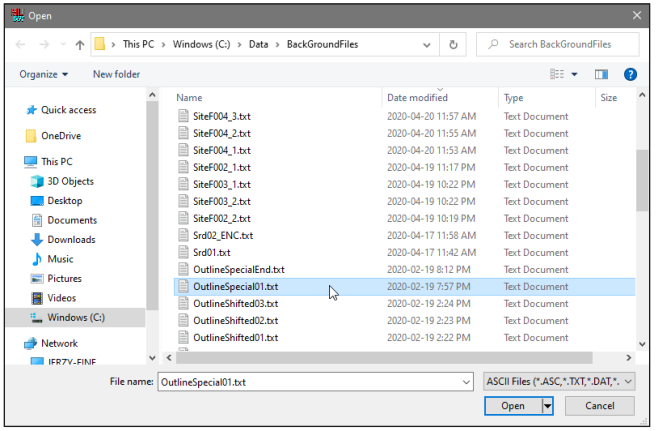


Figure 8.19: Load Background File dialog

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 MLgrad601 screen with two background files (both Column Delimited type) is shown in Figure 8.20.

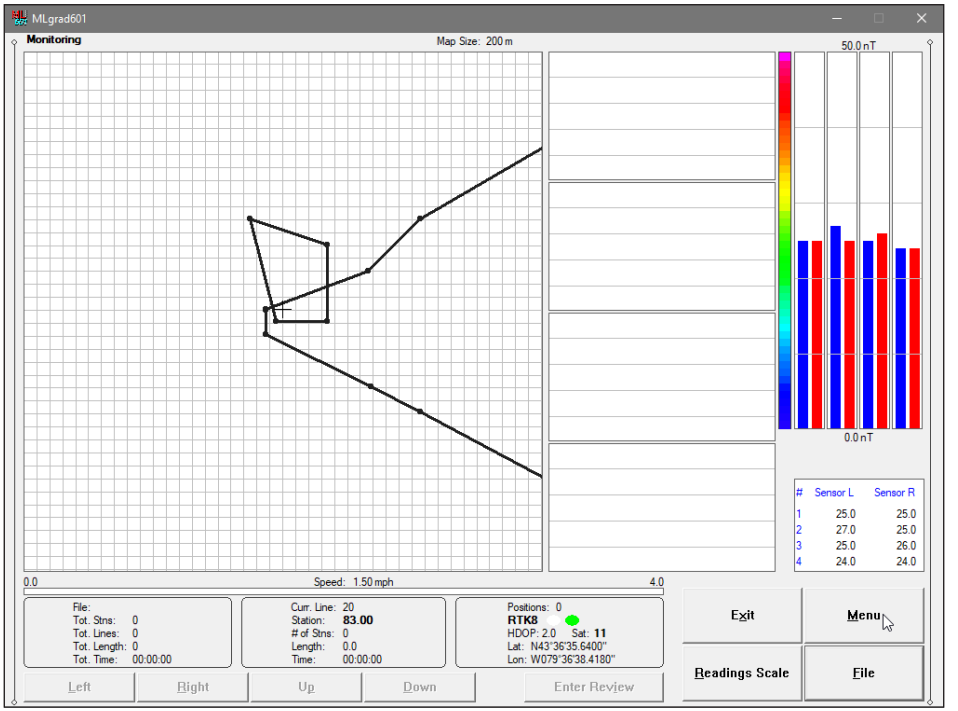


Figure 8.20: Load Background File dialog

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 8.21. 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.

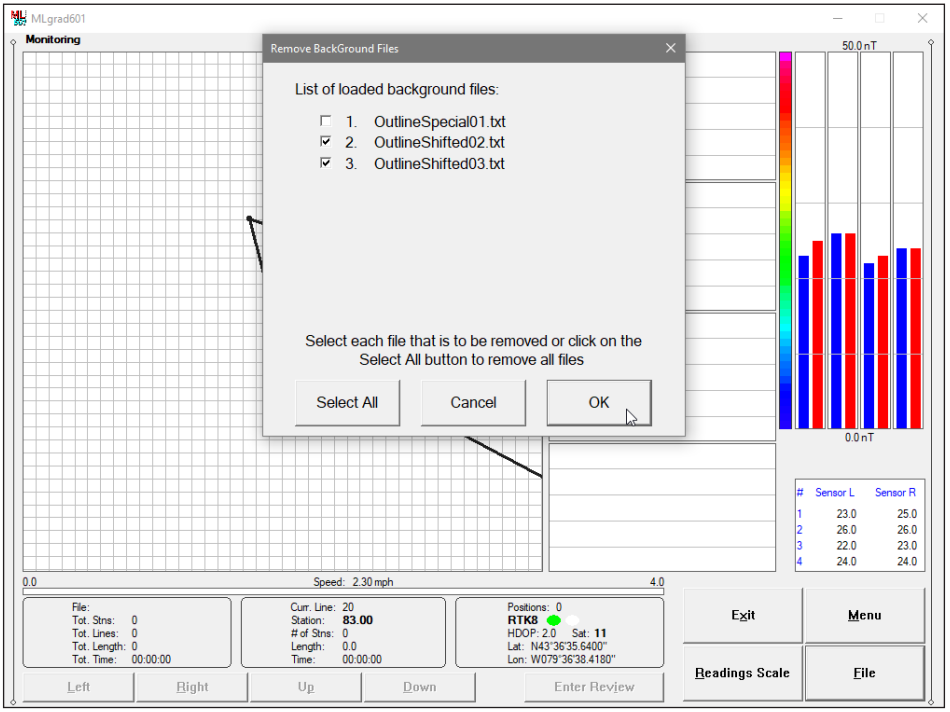


Figure 8.21: Remove Background Files dialog

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 file. The MLgrad601 window in Stand By mode is shown in Figure 8.22 (Mapping Mode) and in Figures 8.23 and 8.24 (latter two Navigation mode, swath bar 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 9.1, contains parameters associated with GPS input.

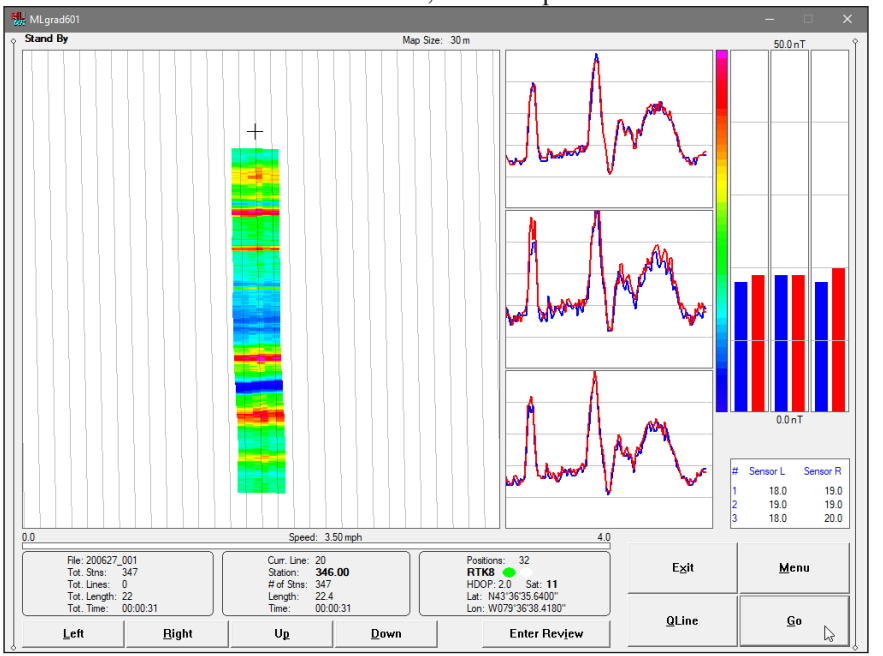


Figure 8.22: MLgrad601 in Stand By mode and displayed in Mapping mode

Examples shown in Figures 8.22, 8.23 and 8.24 presents situation where the operator started to walk in the North direction while logging data and then stopped logging data

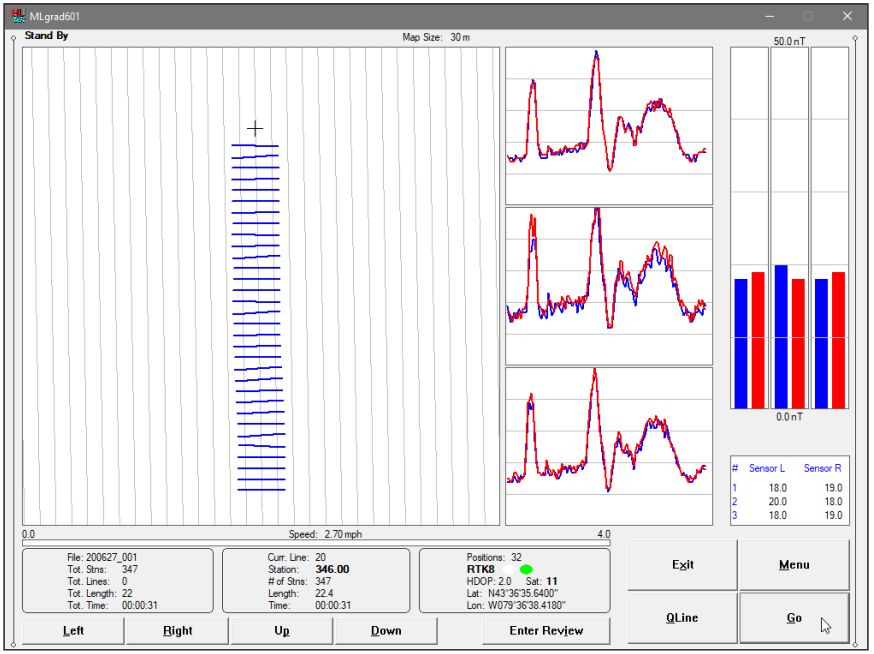


Figure 8.23: MLgrad601 in Stand By Navigation mode (positions shown by swath bars)

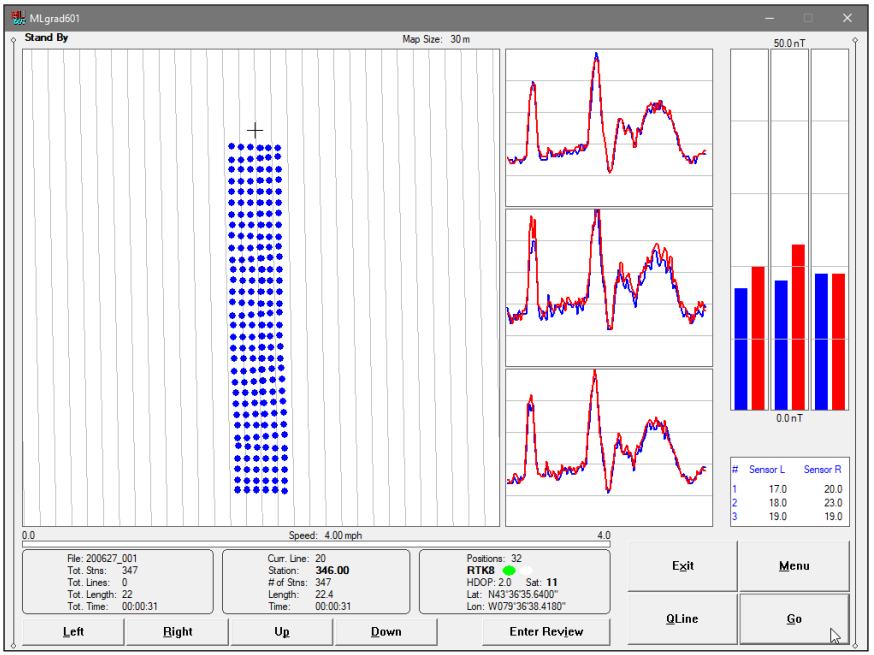


Figure 8.24: MLgrad601 in Stand By Navigation mode (positions represented by dots

by switching 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 8.25. 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.

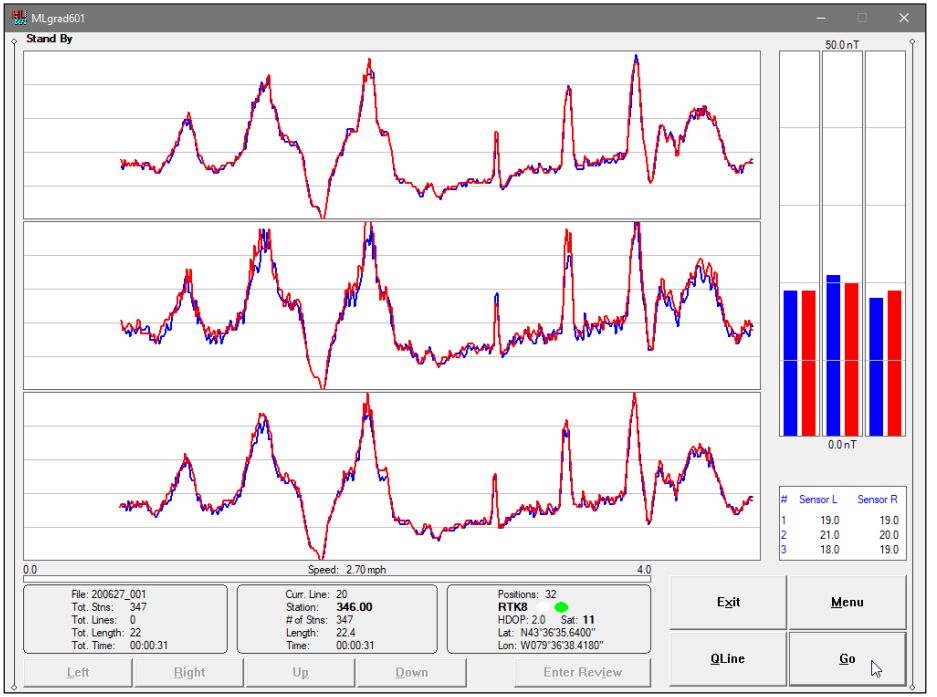


Figure 8.25: MLgrad601 in Stand By mode and Profile display mode

The Grad601 data will be displayed with the update rate approximately 12 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 Grad601 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 9.5 (Field options available in Stand By mode).

8.4 Logging Mode

The Logging mode is enabled by clicking 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. 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 MLgrad601 screen in Logging mode and in Mapping display mode is presented in Figure 8.26. The cross mark corresponding to the system location will move while the operator is progressing along the survey line and recorded array of Grad601 sensors positions will be plotted as coloured swath bars on the screen for each sensor. At the same time profiles will be plotted in panels located right to the map plot area.

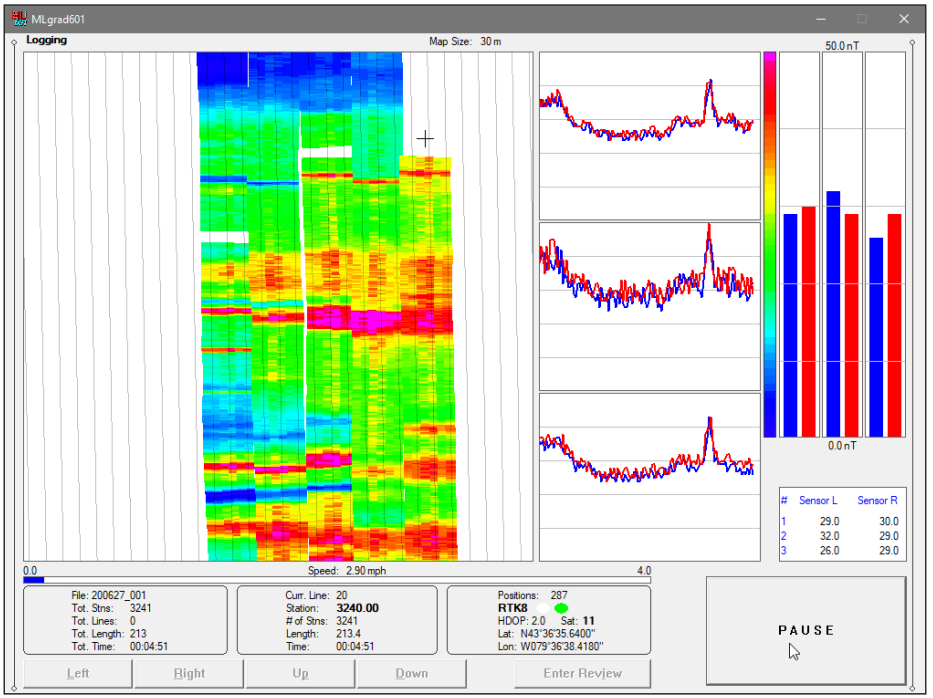


Figure 8.26: MLgrad601 in Logging mode and Mapping display mode

If the program is in Profile display mode (when GPS input is disabled in GPS Port Setup dialog) the MLgrad601 Profile display mode will be used as shown in Figure 8.25. When the Profile display mode is enabled profiles (or profile) curves are updated after each reading is written to the data file. The program displays profiles for readings with settings 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 sensor are updated after each reading is written to the data file. The audible click sounds at each reading if 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 Grad601 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 all Grad601 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 Navigation mode) will not be plotted as dots on the screen.

8.5 Field Options Available in Stand By Mode

Several options are available while the Logging window is in the Stand By mode. Three 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 8.27). 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 C will display Enter Comment 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>**.

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>**. The logging window in Stand By mode will change to Logging mode and data logging starts immediately.

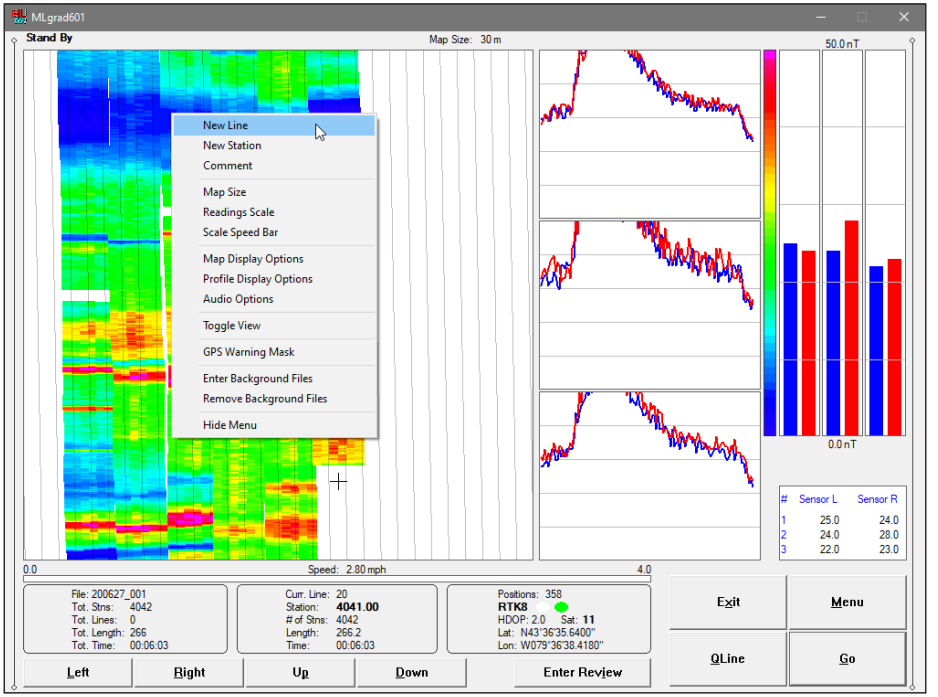


Figure 8.27: MLgrad601 in Stand By mode with pop up menu

QLine *(Quick Line change)*

Click 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 8.28.

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.

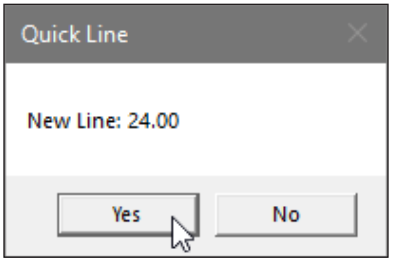


Figure 8.28: Quick Line confirmation message dialog

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 click 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)

The New Line dialog is displayed, Figure 8.29. 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.

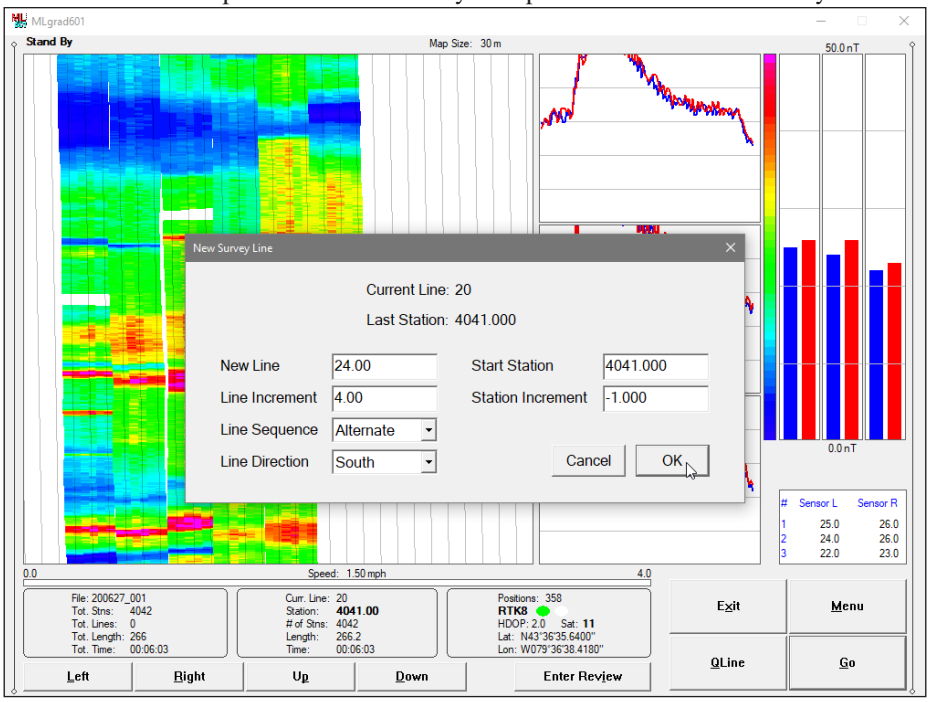


Figure 8.29: New Survey Line dialog

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 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 and other associated parameters will be updated. 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) click on the **Cancel** (or X) button or press **Esc** key, the dialog window will disappear.

New Station

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 8.30. 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.

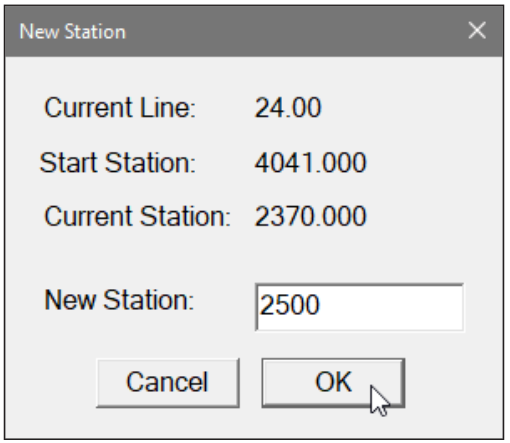


Figure 8.30: New Station dialog

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.
The profile display will reflect new station entry by a small gap in displayed profiles to mark new station entry (Figure 8.31).
Click on 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 will have a small gap (and possible amplitude discontinuity) showing the new station entry.
To return to Stand By mode and current survey line settings (state before this dialog was selected) click on the **Cancel** (or X) button or press **Esc** key, the dialog window will disappear and measurements can be continued.

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 8.31

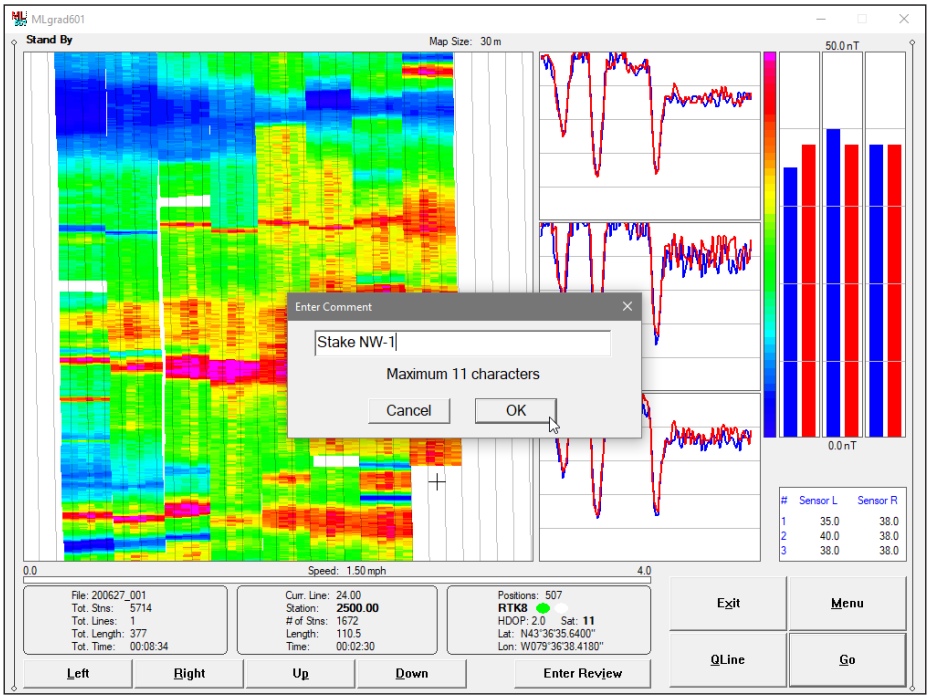


Figure 8.31: Enter Comment dialog

Click 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 click on the **Cancel** (or X) button or press **Esc** key, and the Enter Comment dialog will disappear.

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 8.32.

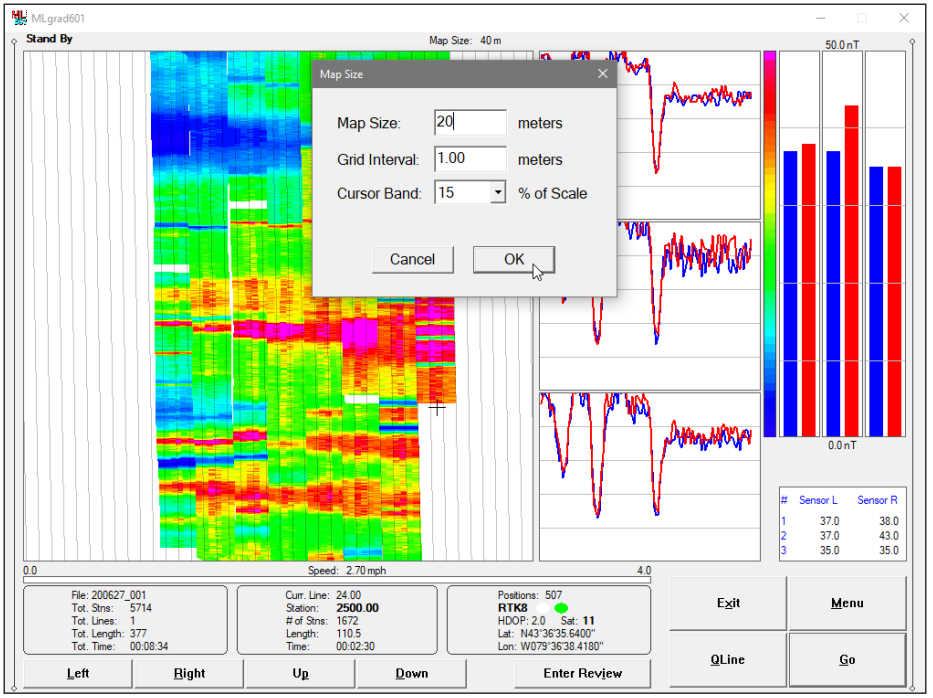


Figure 8.26: Map Scale dialog, current MLgrad601 map at scale of 40 m

This dialog allows the operator to enter new scale for the map displayed by the plot area, map grid interval, and cursor band.

Map size 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 Interval** depending on the selection in 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%, and 30%.
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 (see Figure 8.33 and compare with Figure 8.32).

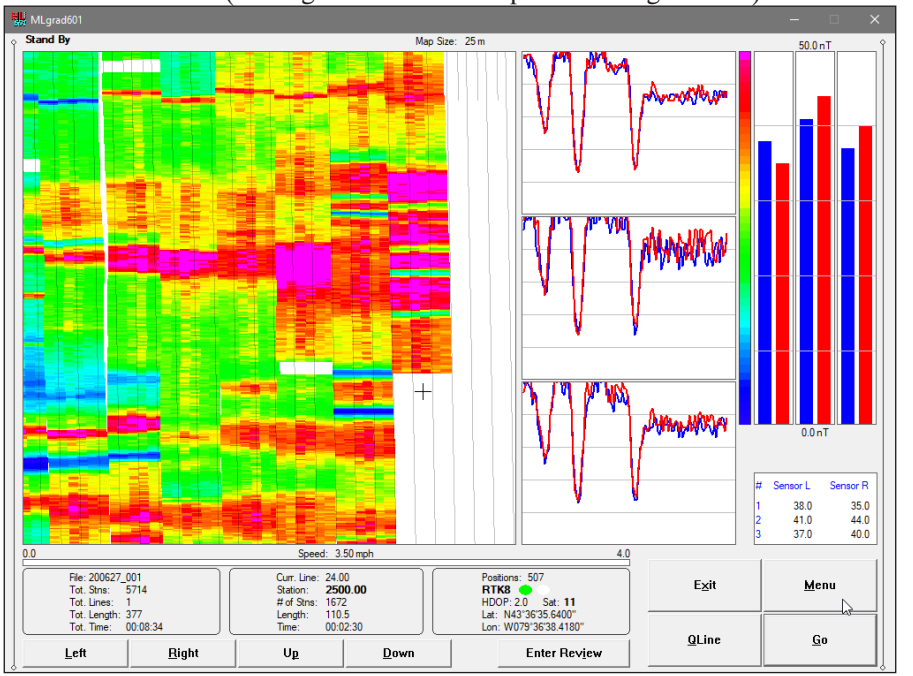


Figure 8.33: MLgrad601 in Stand By mode after re-scaling map to 25 m square

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.

Scale Readings (Adjust profile, moving bars, and Mapping mode colour image range)
Minimum and maximum values can be specified for the plot and moving bars range. Selecting this option allows the operator to enter new scale parameters for the amplitude display which applies to profiles as well as to moving bars plot. The Reading Scale dialog is given in Figure 8.34.
A colour bar labeled Amplitude represents colour distribution for colour image displayed in Mapping mode. Labels for amplitude are updated in real time.
After minimum and maximum values are specified click on the button **OK** or press **ENTER** key to accept new values and the profile plot, moving bars, colour map areas will be redrawn (see Figure 8.35 and compare with Figure 8.33).

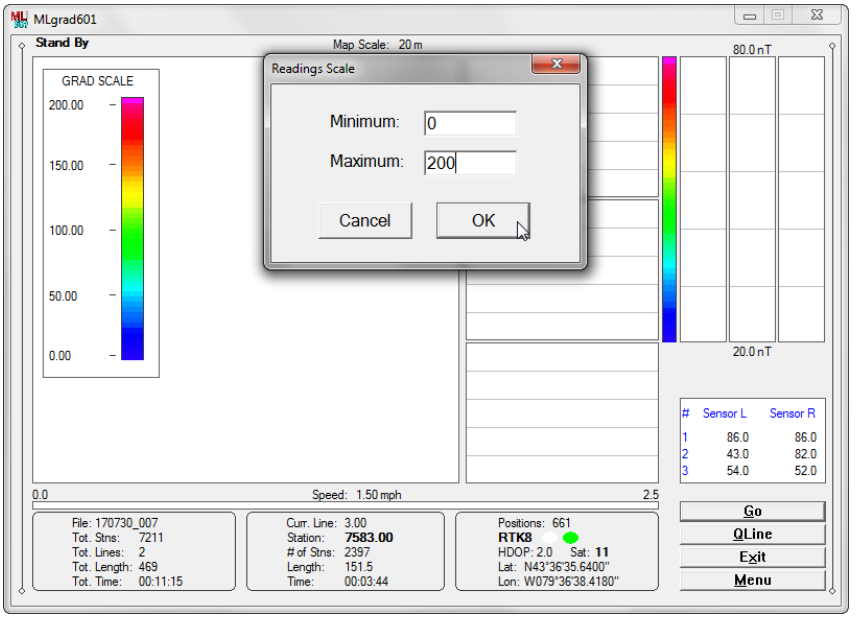


Figure 8.34: Readings Scale dialog, in the background the current MLgrad601 reading scale from 20 to 80 nT (see amplitude image in Figure 8.33)

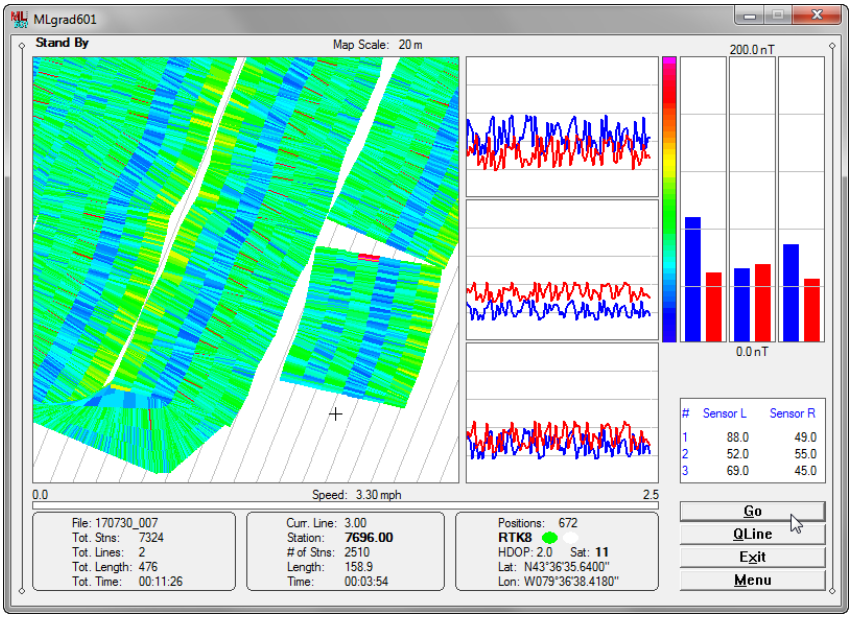


Figure 8.35: MLgrad601 Screen in Stand By mode after Readings Scale change, compare with Figure 8.33

When large number of readings was taken in the current logging session a message "Please Wait" may appear for duration of map re-drawing.
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.
In case where minimum or maximum values are wrong, the program will assume minimum scale (0 to 10 nT).

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 8.36.

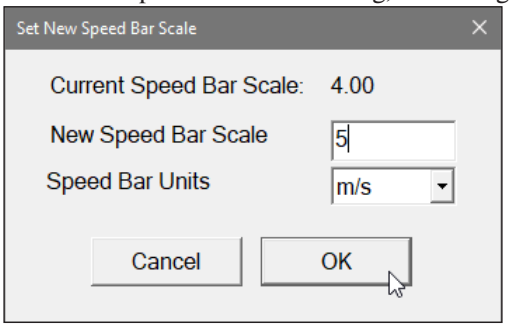


Figure 8.36: Set New Speed Bar Scale dialog

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 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 (Mapping and 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).
This option can be accessed from pop up menu or directly by the keyboard by pressing **D** key.
The Map Display Options is shown in Figure 8.37. Figures 8.38, 8.39, and 8.40 below present various setups for Navigation and Mapping modes. Please compare Figures 8.38 (Mapping mode with colour image of readings amplitude) , Figure 8.39 (Navigation mode where dots represent sensors positions), Figure 8.40 (Navigation mode with swath bar array presentation).

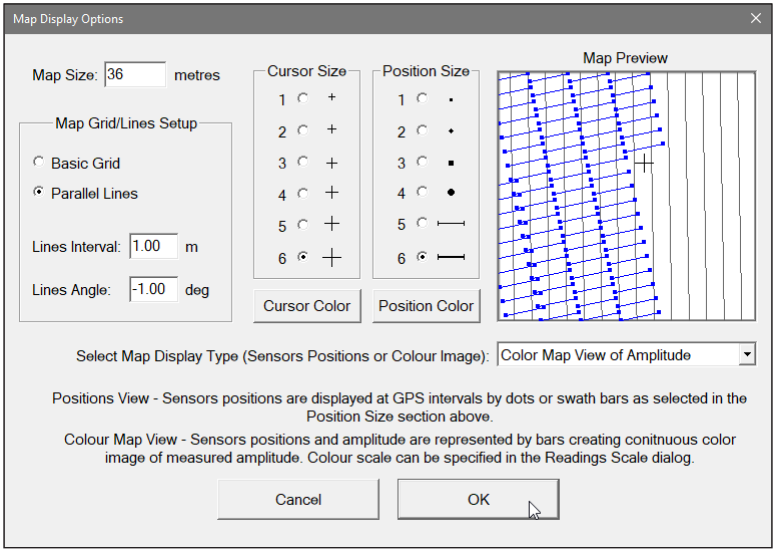


Figure 8.37: Map Display Options dialog

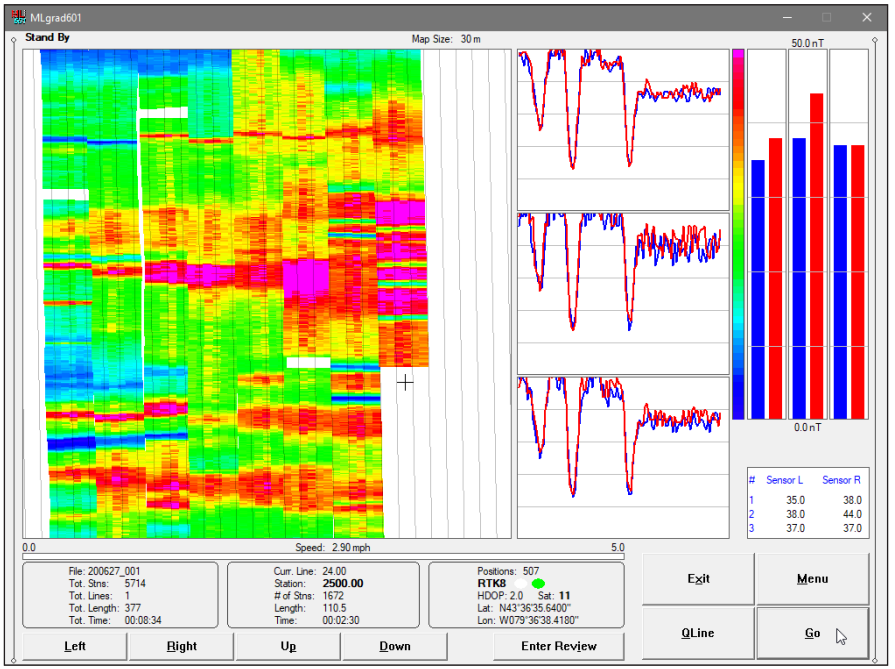


Figure 8.38: MLgrad601 Logging screen in Mapping mode with colour image

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

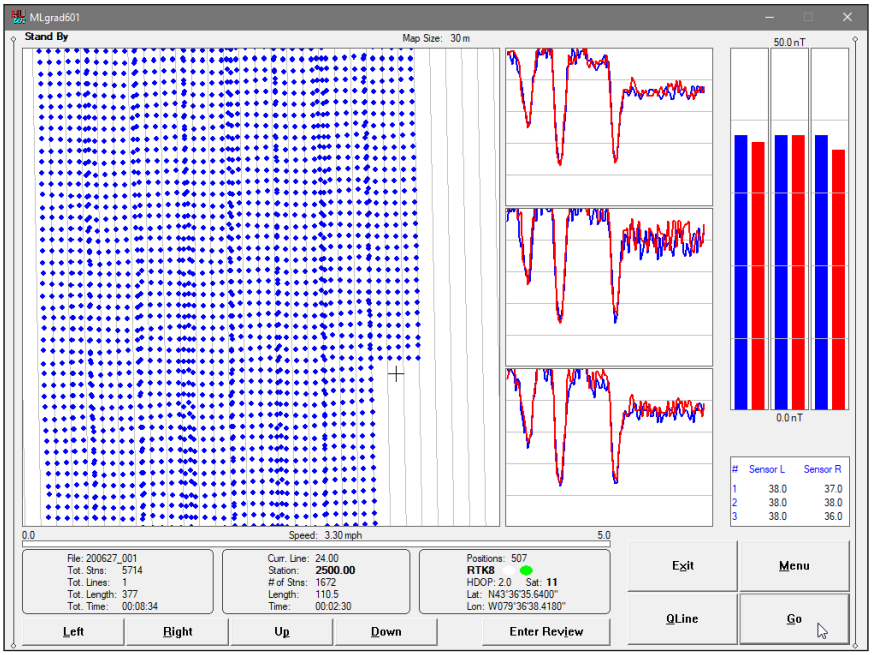


Figure 8.39: MLgrad601 Logging Navigation mode with dots representing sensors positions

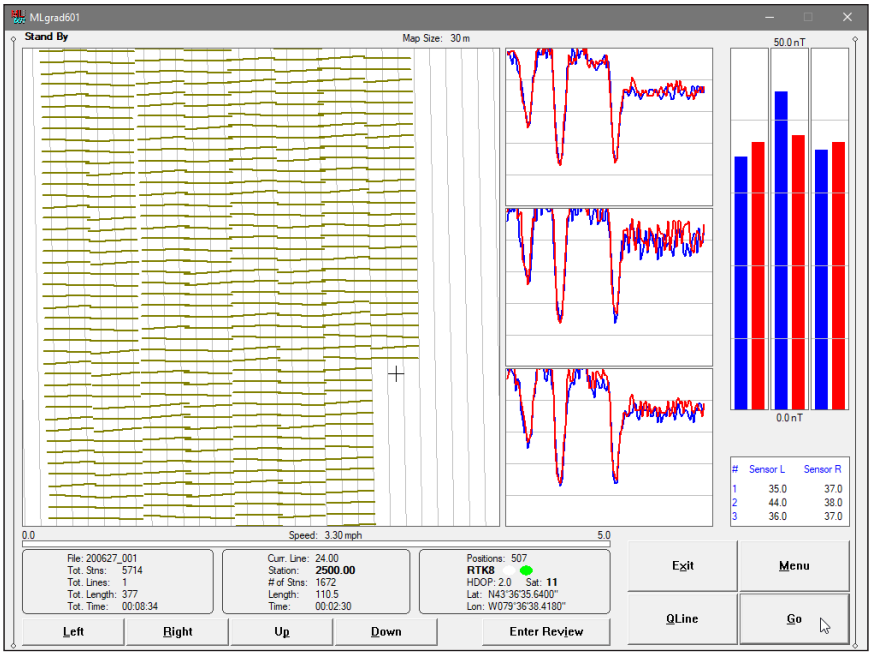


Figure 8.40: MLgrad601 Logging Navigation mode with bars representing array positions

Profile Display Options

The Setup Profile Options dialog is described in detail in Chapter 7. This dialog allows you to enable and disable the display of each sensor profile (for all instruments in the array), and to specify color and thickness of profiles (same colours apply to moving bars). The dialog is presented in Figure 8.41.

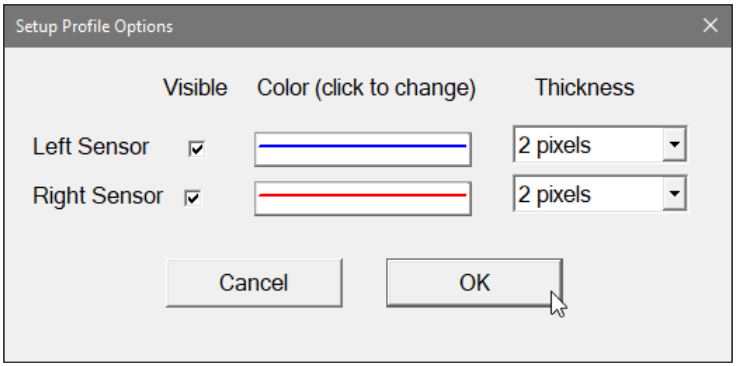


Figure 8.41: Setup Profile Options dialog

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 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 8.42. 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

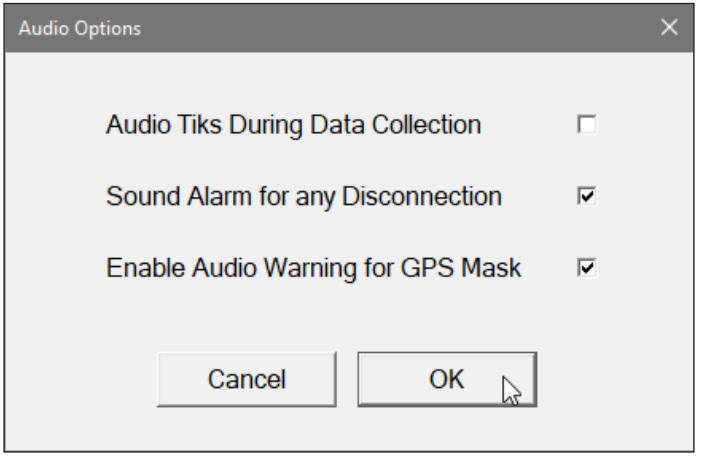


Figure 8.42: Audio Option dialog

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 Grad601 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 8.42.

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).

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 8.43. 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

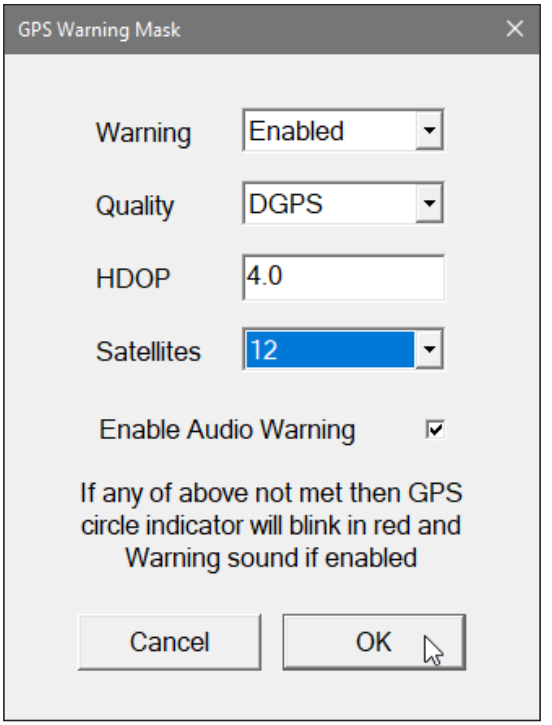


Figure 8.43: GPS Warning Mask

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 met. When any of the parameters is below set values then GPS indicators will alternate in red and white colours (see Figure 8.44). In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours (see Figure 8.40) 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

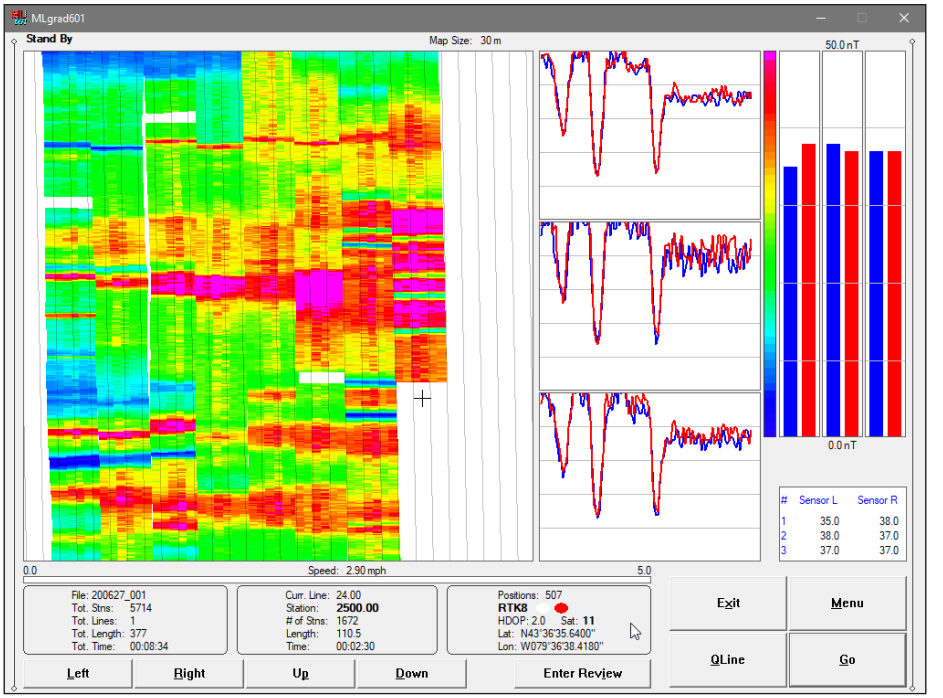


Figure 8.44: MLgrad601 screen with GPS Warning indication

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, etc..
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 Leica TPS 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.

Enter Background File

The Load Background File dialog is shown in Figure 8.45. This option is also described in section 8.2, in this section examples with background files and

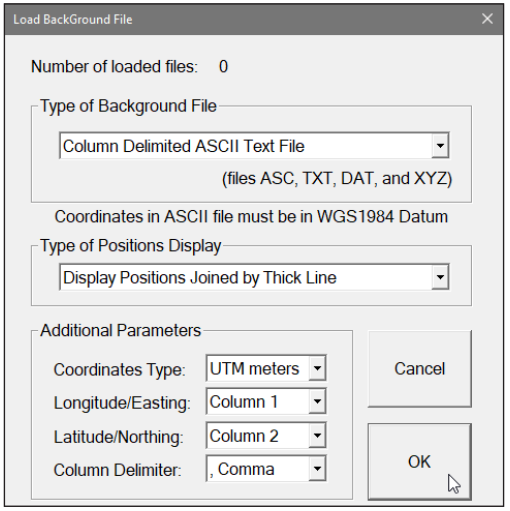


Figure 8.45: Load Background File dialog

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 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 8.46.

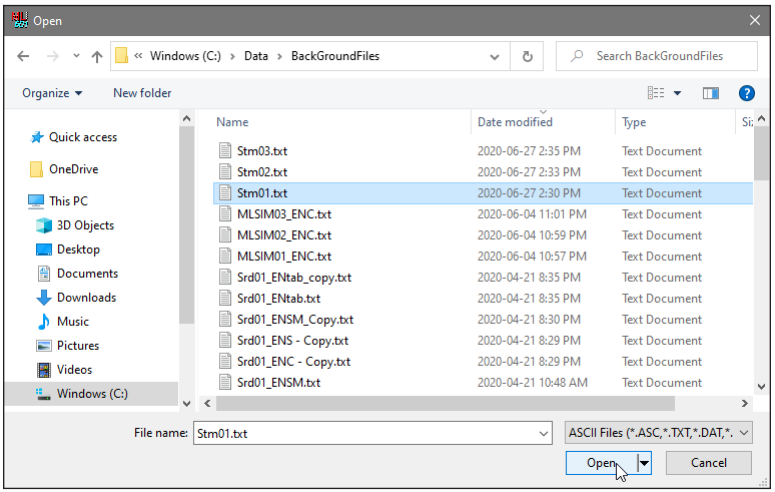


Figure 8.46: Selection of Background File

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 MLgrad601 screen with two loaded background files (both Column Delimited type) and start of actual data logging is shown in Figure 8.47.

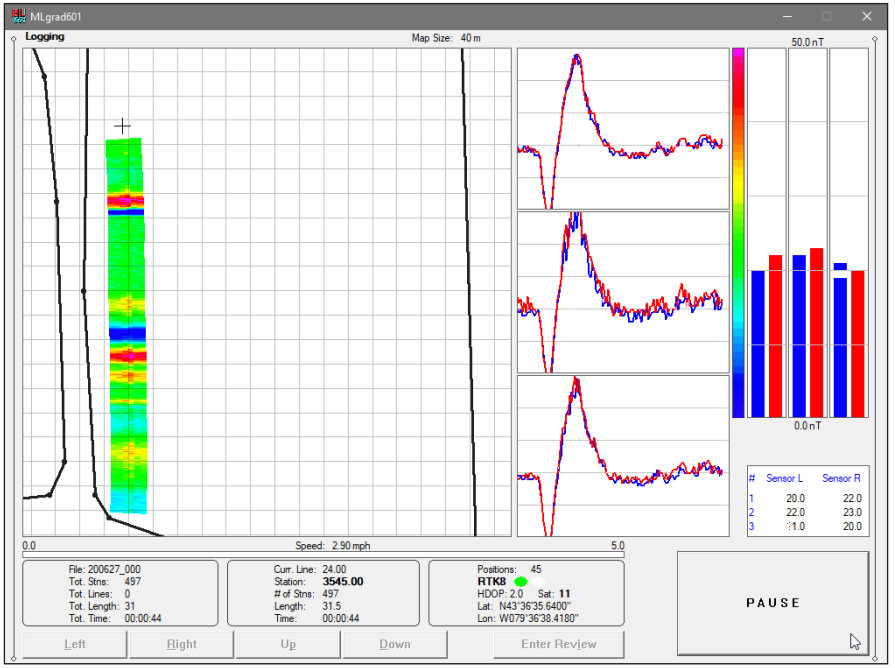


Figure 8.47: MLgrad601 with two background files after logging is started

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 8.48 and 8.49 (it is same logging session at later stage as shown in Figure 8.47). When Enter Background File option is executed, the dialog that appear indicates number of already loaded files (Figure 8.48). 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 8.49.

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.

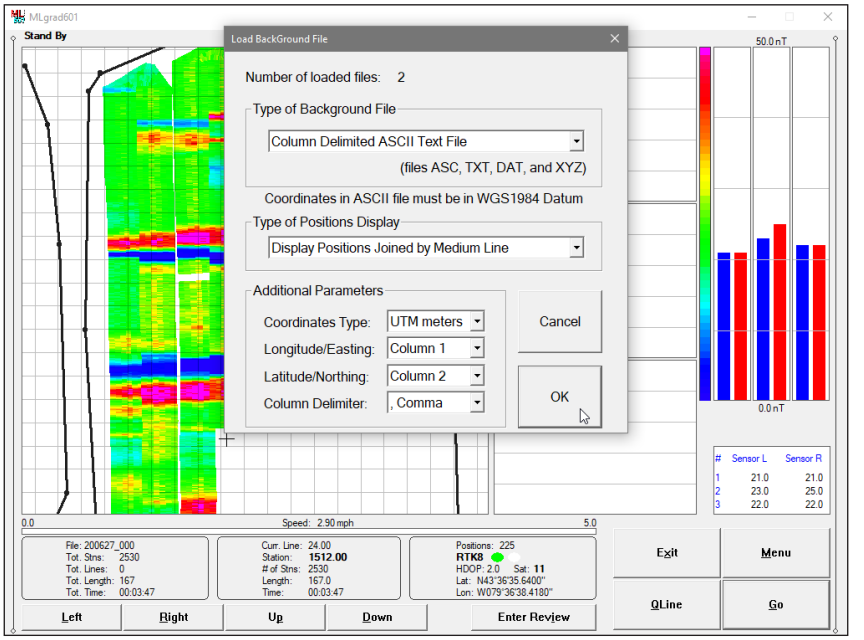


Figure 8.48: MLgrad601, loading third background file

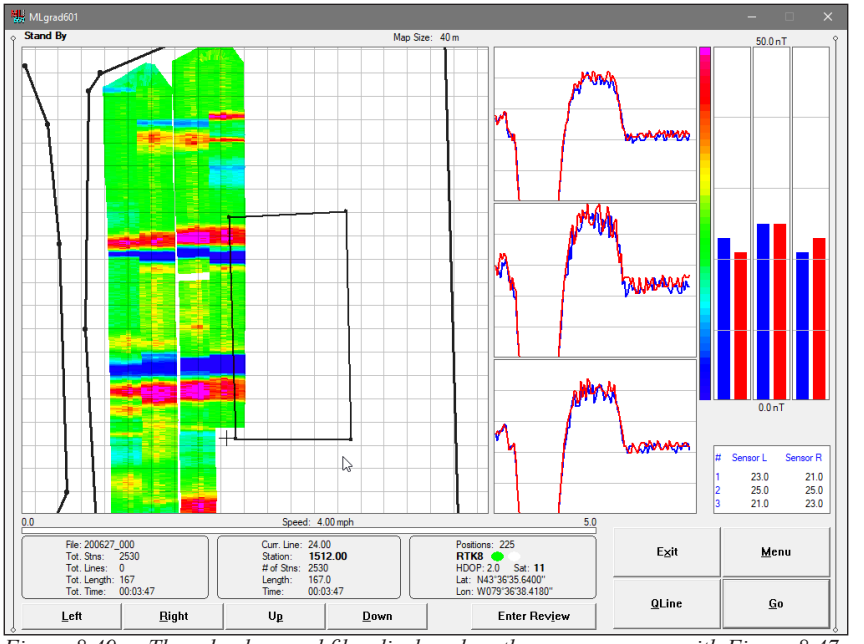


Figure 8.49: Three background files displayed on the map, compare with Figure 8.47

Remove Background Files

After this option is executed the Remove Background Files dialog appears, Figure 8.50. In this example the dialog contains list of three loaded background

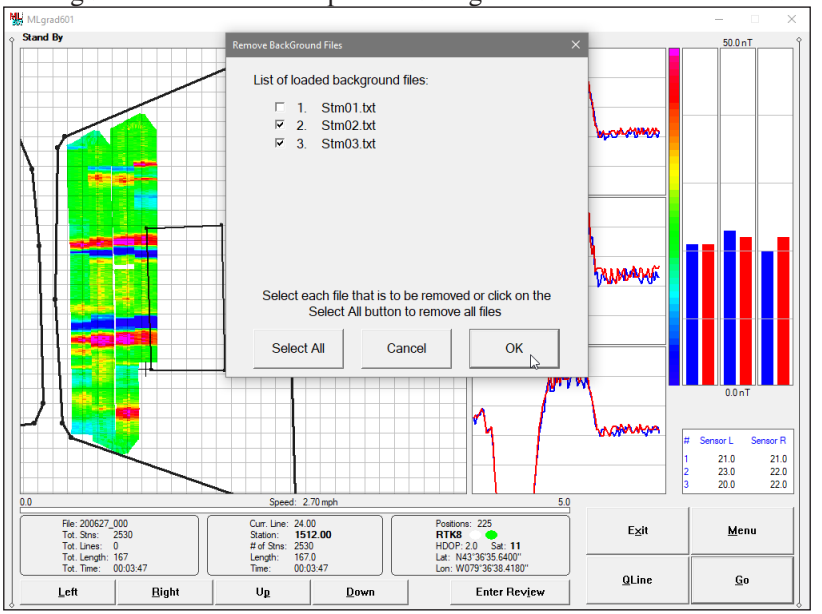


Figure 8.50: Remove Background Files dialog

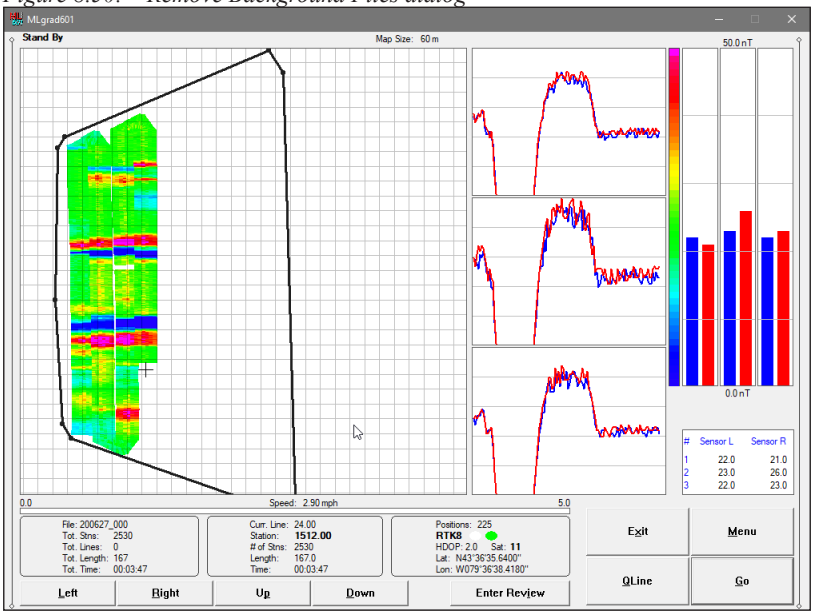


Figure 8.51: MLgrad601 map with two removed files, compare with Figure 8.50

files. Click on any check box located on the left of corresponding file name (in 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 8.51 where map does not contain outline located on the left and inside of the 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 8.52.

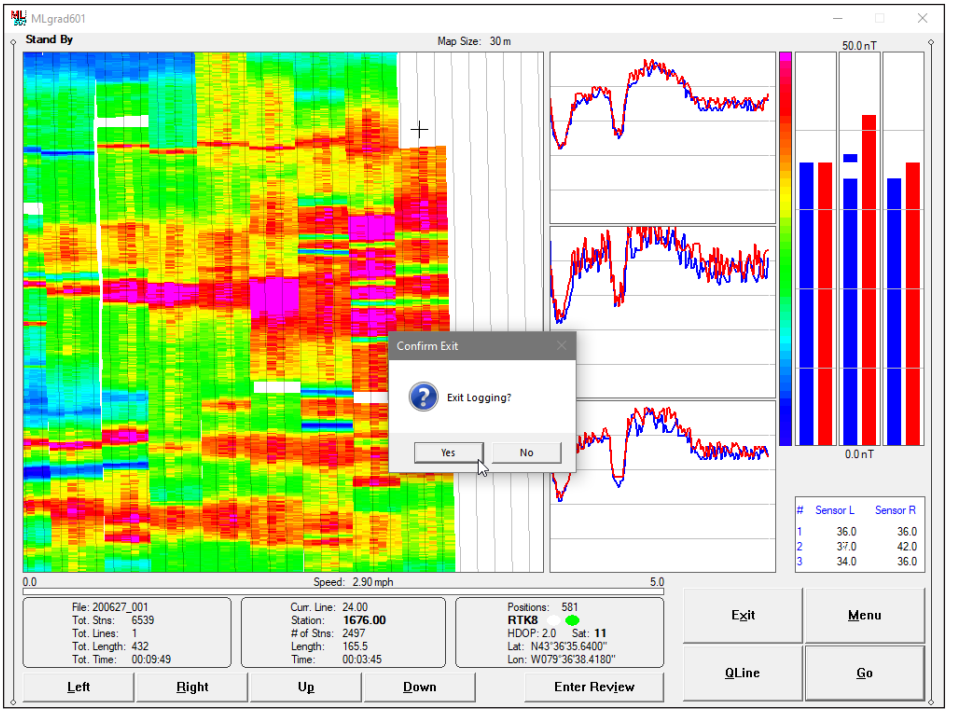


Figure 8.52: The MLgrad601 Confirm Exit logging session dialog

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 and **Review** (command buttons along the screen bottom)

Four Panning command buttons are displayed at the screen bottom together with the button labeled **Enter Review**. 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 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**. 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.

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

To exit Review mode and return to Stand By mode tap or click on the button **Exit Review**. Three zoom buttons will be replaced by four command buttons **Go**, **Menu**, **QLine**, and **Exit** and the program map will return to 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 MLgrad601 logging mode (Monitoring, Stand By, or Log modes). The message **No Connection** is displayed in the numeric values window and replaces displayed values (Figure 8.53). The message is highlighted by red to alert operator and the alarm sounds if it was selected.

This message indicates lack of communication between the indicated Grad601 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 Grad601. 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 Grad601 and checks performance. This operation takes about 1 second. Then the program returns to normal operation.

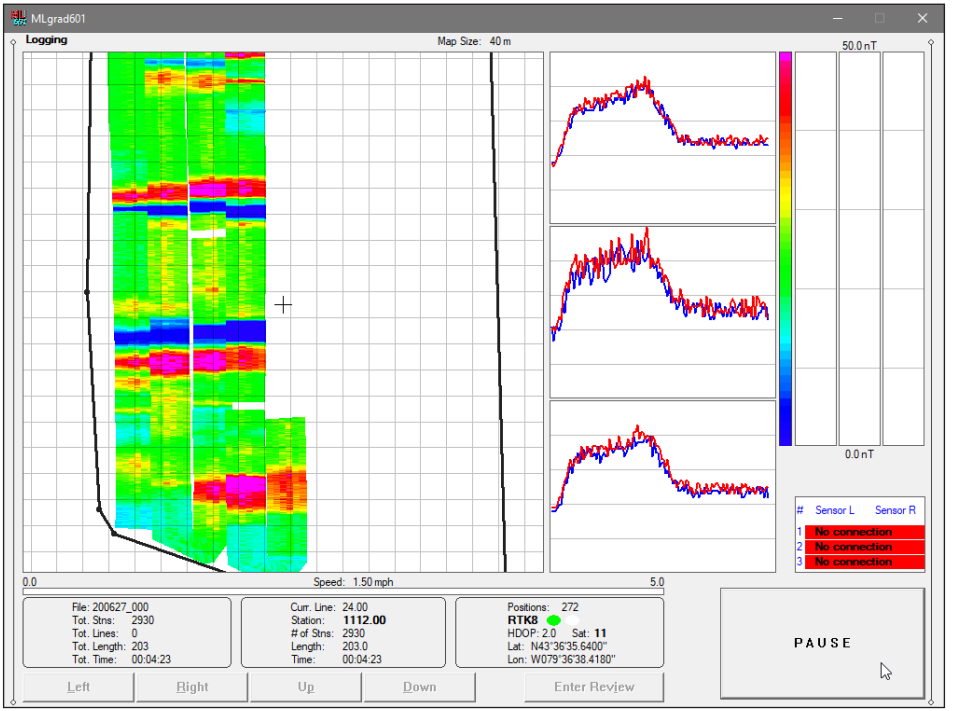


Figure 8.53: The MLgrad601 screen indicating lack of connection with Grad-601 consoles

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.

8.7 No Connection with 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 MLgrad601 screen (Figure 8.54). At the same time the alarm ring sounds if it was selected. In most cases this message is caused by disconnected connector in the cable, turning the GPS

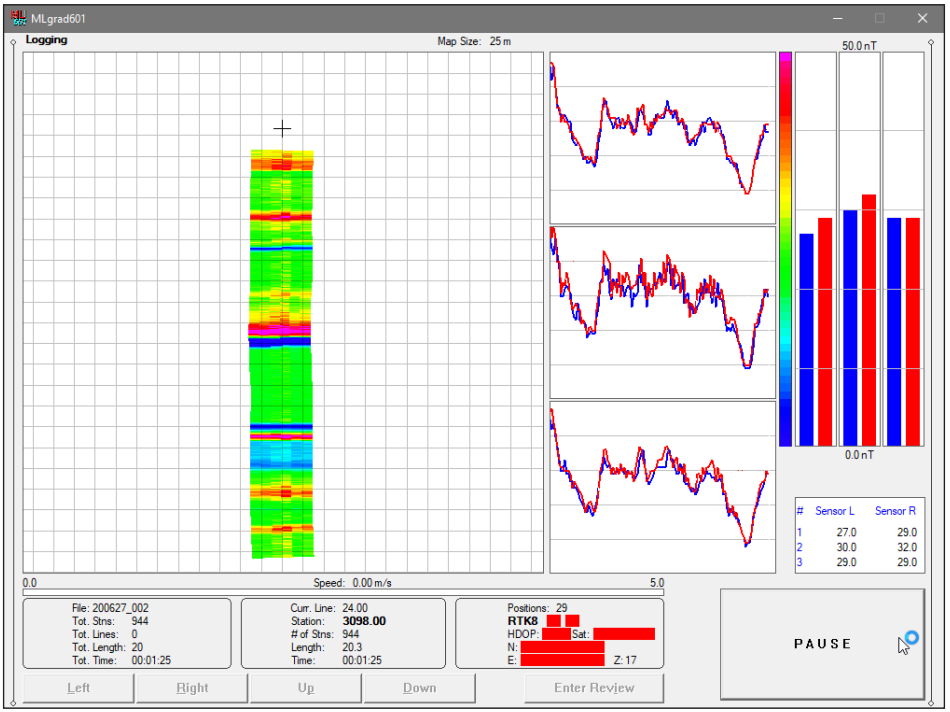


Figure 8.54: The MLgrad601 screen indicating lack of connection with GPS receiver

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 and checks performance. Then the program returns to normal operation.

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.

MLgrad601 Data File

A

A.1 Description of MLgrad601 Data File Format (MGR)

Each record created by the MLgrad601 program for Windows 10/7 contains 27 characters, including line feed at the end of each record.

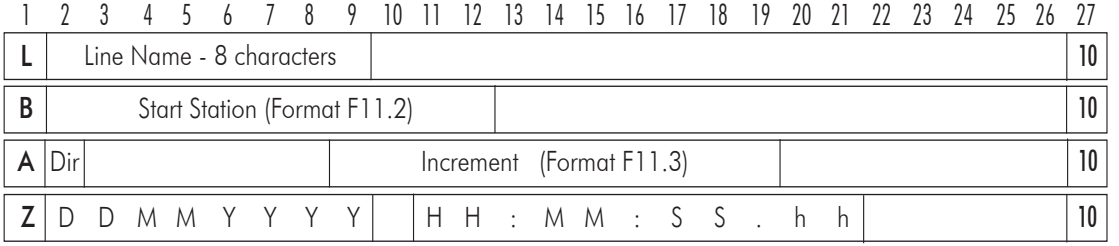
Header of the file contains 6 records starting with characters M, H, and four records starting with G.

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
M	L	G	6	0	1			W	2	1	4	Survey Type			UT		IM		IS	AU						10
H		File Name										C1	C2	C3	C4	C5	C6		TG		C7	C8	C9				10
G	GPS X Offset (F7.3)							GPS Y Offset (F7.3)							NC	MN	GP		CO	NG						10
G	not used							not used																		10
G	not used							not used																		10
G	Unit Separation (F7.3)							Separation (F7.3)																		10

ML601	-	identification of program file (rL601 if append part)
W214	-	version number (V2.14)
Survey Type	-	GPS (if GPS Input Enabled) or GRD (grid)
UT	-	unit type (0 = meters, 1 = ft, 2 = US Survey ft)
IM	-	survey mode (fixed 0 = Auto)
IS	-	not used (fixed =2)
AU	-	array units (0=m, 1=cm, 2=feet, 3=inch)
File Name	-	file name, maximum 8 characters
C1 to C9	-	type of Grad601 for each console (=1 Grad601-1, =2 Grad601-2)
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
NC	-	total number of consoles in the array (1 to 9)
MN	-	leading unit (1 to 9 sensor, 0 for center)

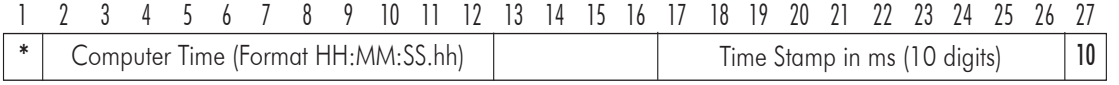
GP	-	type of GPS NMEA message (0 = GGA/GSA, 1= GGA, 2 = POS, 3 = LLK, 4=LLQ, 5=GLL, 6 = GGK, 7 = Leica TPS, 8 = pseudo GGA)
CO	-	coordinates (not used in this version)
NG	-	number of GPS receivers (not used in this version)
Unit Separation	-	separation between sensors of the same console
Separation	-	separation between sensors of neighbouring consoles
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
Time	-	Time when Line was created in milliseconds
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	$	P	B	A	R	,	Left Sensor				,	Right Sensor				Time Stamp in ms (10 digits)										10

I - indicator of reading start, one ASCII character. Number of the ASCII character represents the Grad601 console number in array. Console #1 is indicated by character T (ASCII number 84). Following constants are added to each of this number (84) to indicate other instruments in the array:

Grad601 Console #1	**0**
Grad601 Console #2	**+32**
Grad601 Console #3	**+128**
Grad601 Console #4	**+160**
Grad601 Console #5	**-64**
Grad601 Console #6	**+67**
Grad601 Console #7	**+84**
Grad601 Console #8	**+101**
Grad601 Console #9	**-24**

$PBAR - original indicator of Grad601 string (not used)
, - comma separator
Left Sensor - 4 digits, reading of the Left Sensor connected to console
Right Sensor - 4 digits, reading of the Right Sensor connected to console (spaces if Grad601-1 with one sensor is used)
Time - time stamp of the reading in milliseconds, this is time elapsed from the start (creation) of the current data. The time in milliseconds can be linked with the computer local time by using Times in lines B and Z of Line Header.
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 11 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

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), not used NMEA, etc.

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)																								10

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

Line starting with r

The tag **rL601** indicates location where file was appended. File header is repeated (see the first page of this chapter). The only difference is that instead of tag **ML601** the line starts with **rL601**.

GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 25 characters strings and placed in the MLgrad601 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 written in MLgrad601 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 MLgrad601 Data File

The MLgrad601 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.

```
MLG601  W211GPS0 0 20
H 082212A   222200   000
G  1.610  0.500410 01
G
G
G  0.460  0.460
L3.00
B    -137.00
AS            1.000
Z22082014 12:17:03
*12:17:03.078       4576351
t$PBAR,  44,  66    4579580
ô$PBAR,  74,  28    4579580
I$PBAR,  89,  58    4579580
O$PBAR,  57,  80    4579596
t$PBAR,  44,  78    4579674
ô$PBAR,  74,  49    4579674
I$PBAR,  89,  79    4579674
O$PBAR,  57,  62    4579705
t$PBAR,  45,  66    4579768
ô$PBAR,  75,  29    4579768
I$PBAR,  90,  59    4579768
O$PBAR,  65,  68    4579799
t$PBAR,  50,  70    4579861
ô$PBAR,  78,  36    4579861
I$PBAR, 101,  66    4579877
O$PBAR,  62,  62    4579892
ô$PBAR,  77,  29    4579955
t$PBAR,  48,  66    4579955
I$PBAR,  96,  59    4579970
O$PBAR,  35,  76    4579986
ô$PBAR,  65,  45    4580064
t$PBAR,  30,  76    4580064
I$PBAR,  60,  75    4580064
O$PBAR,  39,  73    4580080
@$GPGGA,162406,4336.8685,N
#,07937.7241,W,8,12,2.0,20
#1.2,M,-35.4,M,,*7C
!             0     4579986
ô$PBAR,  67,  41    4580158
t$PBAR,  33,  73    4580158
I$PBAR,  66,  71    4580158
O$PBAR,  73,  67    4580173
ô$PBAR,  82,  34    4580251
t$PBAR,  55,  69    4580251
I$PBAR, 111,  64    4580251
O$PBAR,  68,  67    4580267
ô$PBAR,  79,  34    4580345
t$PBAR,  52,  69    4580345
I$PBAR, 104,  64    4580345
O$PBAR,  52,  80    4580376
ô$PBAR,  72,  49    4580438
t$PBAR,  41,  78    4580438
I$PBAR,  82,  79    4580454
O$PBAR,  59,  61    4580470
t$PBAR,  46,  65    4580532
ô$PBAR,  76,  27    4580532
I$PBAR,  93,  57    4580548
O$PBAR,  78,  73    4580563
t$PBAR,  58,  73    4580641
.................
```

A.3 Background File Format

The MLgrad601 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 backslash "\" 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
```

MLgrad601 and GPS Input B

B.1 Using the MLgrad601 with a GPS System

The MLgrad601 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 MLgrad601 provides also interface to Leica Robotics Total Station TPS1100 and TPS1200, or Trimble RTS supporting pseudo-GGA statement for areas were GPS signal is not accessible. To use above RTS select option "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 MLgrad601 data file. If the pair GGA/GSA is selected, both GGA and GSA messages are written to the MLgrad601 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.

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 MLgrad601.** 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 MLgrad601 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 Hz. At higher frequency of GPS data the program will be occupied by GPS activity and may not record all required Grad601 data. The MLgrad601 can record all Grad601 readings and one GPS position per second, number may be lower depending on number of GPS statements and type of computer employed. Data processing program MultiGrad601 will interpolate magnetic sensor 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 Grad601 data. If message GSA is not available in a particular system, the MLgrad601 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 MLgrad601 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 MLgrad601 logging screen 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 (and higher) correspond to Quality Indicator 3, 4, and so on (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** two small circles are displayed. These circles should alternate colour between green (or red if below specified GPS Warning Mask) and white with the frequency of GPS update rate (usually 1 second intervals). If circles do not alternate 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 is 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. 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 message 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.mmmmmmm	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.