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TrackMaker61MK2



# Nav601

Version 1.00

*for Windows 10/7 Field Computer*

data acquisition & real time navigation software  
for the Bartington Grad601 and GPS/RTS receiver

# User's Manual

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# Introduction

# 1

The Geomar TrackMaker601 Data Logging System for Bartington Grad601 (models Grad601-1 and Grad601-2) consists of a data acquisition program Nav601 and associated PC computer data processing program TrackMaker601. There are several versions of NAV601 programs designed for various field computers. This manual describes the use of the Nav601 program used with the laptop or tablet field computer (operating under MS Windows 10 or 7) with display in landscape as well as portrait mode, Bartington Grad601 magnetometer, and Global Positioning System (GPS) receiver or selected Robotic Total Station (RTS).

The associated program TrackMaker601 is used to process data files recorded under the control of program Nav601. Main function of this program is to position the Grad601, one or two sensors based on the recorded GPS position and the configuration of the system. The TrackMaker601 also allows you to correct the collected GPS positions with post-processed GPS files. In case of grid based surveys (without GPS positioning) the program will layout the survey grid based on survey setup parameters and the system geometry.

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## 1.1 About the Nav601 Program

Program Nav601 acquires and records survey data from the Grad601 unit, under the control of the operator. It also records various field information such as survey line number (line name), starting station, increment, comments, etc. Readings are given in real time in nT. In addition, the program allows you to monitor the instrument output while data are not recorded. The Nav601 continuously monitors the GPS receiver signal quality, the Grad601 sensors measurements, as well as a performance of a connected GPS receiver.

During data collection the program can work in two display modes: navigation and profile mode. While in navigation mode, the main portion of the screen displays all logged GPS antenna positions marked by a swath bars or dots, and current position of the system denoted by cross mark based on GPS input. 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. The size of swath bar representing the Grad601 footprint is user selectable when one magnetic sensor is employed, it depends on intended survey resolution across the survey line direction. However when two sensors are used then the swath bar width is set by default to a size of double the Grad601 sensors separation. The swath bar is drawn to scale in the employed

map scale with correction for the GPS antenna offsets. The Nav601 does not require that survey has to be conducted along parallel straight lines. In Navigation mode the instrument output is also shown in windows containing profiles. The display can be switched to Profile mode at any time. In this mode Map window disappears and profile windows are extended in length. Navigation mode is available only when working GPS receiver (or RTS) is connected to the field computer.

In any display mode readings are additionally displayed in real time as numeric values in nT as well as in graphic mode, as profiles and moving graphic bars. The output of the instrument in one or two sensors mode (depending on the instrument settings) is represented by two bars, for Sensor 1 (located on the left while facing direction of movement) and Sensor 2 (located on the right while facing movement direction). This allows for very fast visual information about each sensor output. In addition, the program monitors the instrument output while data are not recorded.

The Nav601 can act as a standalone GPS logger if required. This feature can be useful while mapping topographical features (roads, fences, etc.) that are to be presented together with Grad601 data. These files have extension GXY and they can be used in Geomar data processing software for any other instrument (i.e. RTmap38MK2, TrackMaker31, MLgrad601, etc.).

When program operates in mapping or navigation mode the display is not limited to the current set of data. The user may also display positions from previously recorded Nav601 (or GXY) file, including last data file and continue data collection. This allows for the easy and fast location of the last recorded positions (i.e. from former day), as well as fill any gaps in the survey coverage. Up to 10 data files (selected versions of RTmap or TrackMaker data files) or user prepared text files (with coordinates) can be displayed as background files. This option is useful to show site outline, areas of special interest, any specific lines to follow, etc..

The Nav601 accepts NMEA-0183 compatible data from a GPS receiver directly connected to a field computer. GPS data which is embedded in the Nav601 data file and can be processed later in the Geomar TrackMaker601 program. The connected GPS must be able to stream NMEA-0183 compatible messages. The Nav601 uses one of the following types of NMEA messages: a pair GGA/GSA, GGA, POS, GLL, LLK, LLQ, GLL, and GGK, as well as positions given by Robotics Total Station streaming pseudo-GGA message (for example Leica TPS1100/TPS1200, some Trimble, and LiDAR SLAM models). Messages GGA, GGK, and pair GGA/GSA are preferred since they contain all necessary information. GPS readings Latitude and Longitude (or UTM meters or feet coordinates), as well as parameters indicating quality of GPS signal: status of differential corrections, number of satellites, and PDOP parameter, are displayed in real time.

If GPS data are not differentially corrected in real time and post processed GPS data will be used for positioning please log GPS data concurrently in Nav601 and in GPS logger. An option "Position Readings using External GPS file" in TrackMaker601 which uses satellite time recorded in both devices is much more accurate than any method that uses computer clock.

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

Data files can be saved in user specified directory. Data file names, which can be set by the program based on the computer clock or they are user specified, have extension names 601. The Nav601 data files cannot be appended. If traces of already collected lines or spatial data coverage are needed please use option Enter Background Files to display positions of previous files on the program map. Therefore already collected data is displayed on the screen map and survey can be continued to assure proper area coverage. One Grad601 record takes 27 bytes.

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

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

It is strongly advised that even if your GPS receiver supports faster rates the 1 Hz update for GPS positions is used. Nav601 will work with rates higher than 1 Hz, however operation may not be fast when re scaling display and data files will unnecessarily large in size. The data processing program TrackMaker601 will interpolate all Grad601 stations between GPS positions in the very similar way as GPS receiver in real time.

## 1.2 Program Requirements

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To successfully use this software, you will need :

### Computer

- PC field computer operating under Windows 10 or 7,
- USB port for memory module, or other mean to transfer files,

- minimum 800 x 600 pixel display resolution,
- serial ports:
  - one serial port for instrument and one serial port if directly connected
  - GPS receiver is to be used (USB to RS-232 ports adapters or wireless Bluetooth connection can be used for Grad601 and/or GPS),

#### **Bartington Grad601**

The Grad601-1 or Grad601-2 instrument with associated cables.

#### **GPS Receiver**

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

## **1.3 Contents of Nav601 disk**

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The program Nav601 is stored on TrackMaker601 USB drive or CD distribution disk. All necessary configuration files (with extension names .INI) are created in your computer after the program is run for the first time. Check that the file SetupNav601.exe that installs Nav601 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:

<b>SetupNav601.exe</b>	-	installs data acquisition program file Nav601
<b>SetupT601.exe</b>	-	for the data processing program TrackMaker601
<b>Nav601win.pdf</b>	-	manual for Nav601 program (Windows 10 version)
<b>TrackMaker601.pdf</b>	-	manual for TrackMaker601 program

## **1.4 Installing Nav601**

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Execute supplied or downloaded setup program **SetupNav601** (another setup program SetupT601 installs data processing program TrackMaker601). The Nav601 is a stand alone program and does not require any additional drivers nor run time libraries. The Nav601 data files contain extension name 601 and their base names should be limited to 8 characters.

## **1.5 Software Key**

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The data acquisition program Nav601 is licensed for one field computer. The program is secured with Software Key. Initialization of the program requires a software key that

is based on the computer unique ID number generated by the program. During the first run (after any 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. Please forward this number to Geomar Software and the Software Key will be provided.

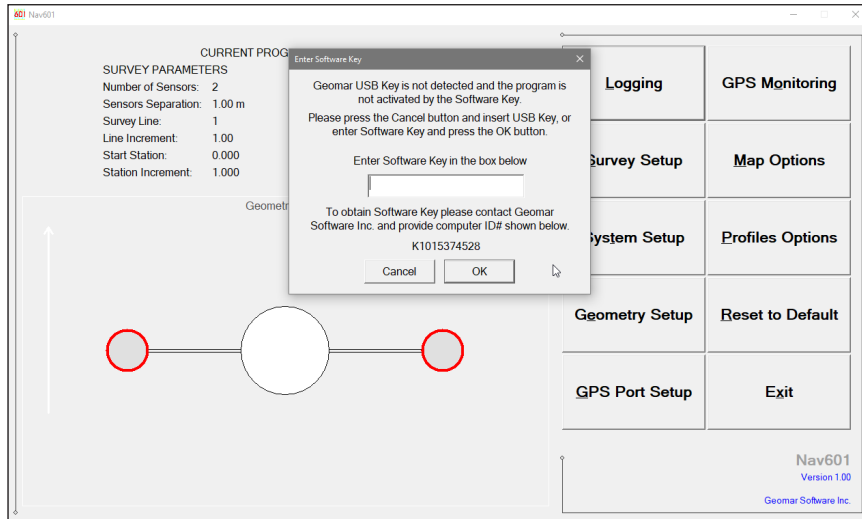


Figure 1.1: Enter Software Key dialog

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 program will be moved without key file to another folder or key file will be deleted. Any future updates of the program will not require entry of the software key.

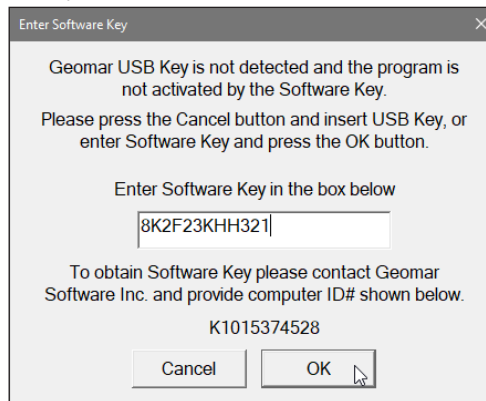


Figure 1.2: Entering the Software Key

## 1.6 Data Files

Data files are saved in the user specified folder with extension name 601. All Nav601 data files with extension 601 or GXY (standalone GPS files) are binary data files. These data files can be loaded to and processed in the TrackMaker601 program.

**Please do not open binary 601 files in a text editor. While it is possible to view these files in text editor, any accidental Save will damage data file. If any binary data file is to be viewed in text editor please make a copy of the file first.**

Also, if 601 files are sent by e-mail it is safer to zip them since some e-mail server treat attached binary files as text files and add Carriage Return or Line Feed characters. This action corrupts any binary file. In any case, please retain raw binary data files in the logging computer till end of the project.

## 1.7 Running Nav601 Program

Start Nav601 by double clicking the Nav601 icon in the Start | Programs menu, in Windows Explorer, or on the desktop shortcut created by the setup program. At the start, Nav601 displays the screen presented in Figure 1.3 if two sensors are used, or if the Grad601 with one sensor is used then Nav601 displays screen as shown in Figure 1.4.

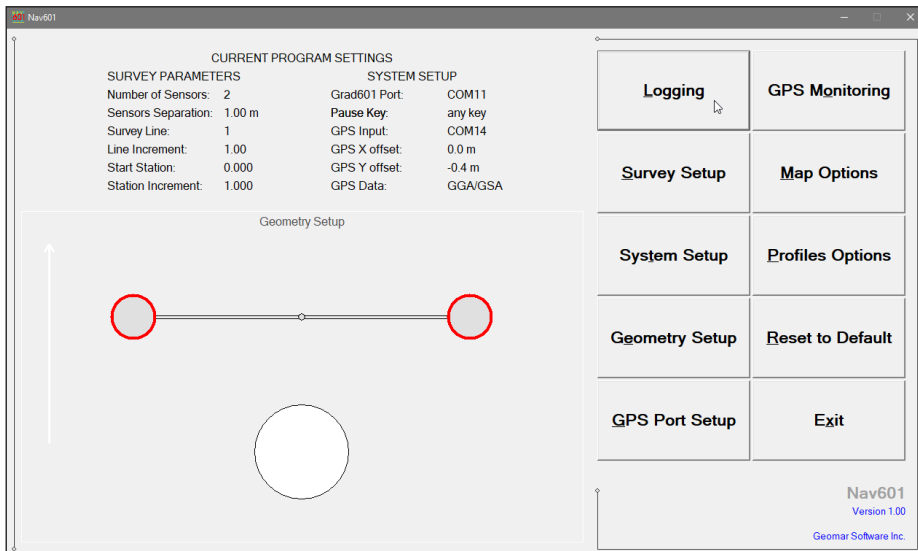


Figure 1.3: The Nav601 Main Screen, two sensors system selected

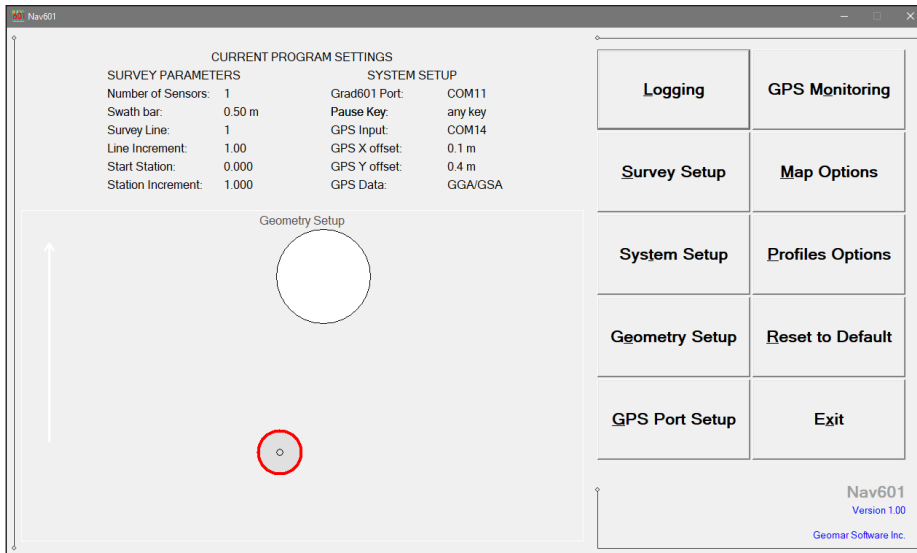


Figure 1.4: The Nav601 Main Screen, one sensor system selected

The Nav601 is a command button and dialog driven program. Command buttons can be executed by clicking with the left mouse button, or by tapping if touchscreen is available, or by pressing the indicated (underlined) character on the keyboard, or by using TAB or arrow keys to scroll through the buttons and ENTER to execute. In the Main Screen of the program Up and Down arrow keys can be also used to scroll through the buttons.

The Main Screen appears always as the first window after the program is started. It contains the name of the program, its version number (right bottom corner), and list of command buttons with available options on the right side. The major, left portion of the window contains information about current survey and system settings, and a graphic diagram illustrating current system geometry (Grad601 sensors and GPS antenna). The graphic diagram is updated in real time as soon as the system geometry parameters are changed in Array Geometry dialog. A description of the Main Screen functions and information is given in Chapter 3.

## 1.8 Nav601 Program Overview

The data acquisition program Nav601 was designed with field use in mind. This was the main thought while preparing the program flow. Once all necessary parameters are set in the program they are saved in initial files. Assuming that the survey set up is the same as in previous logging session: when the program is started, the instrument and GPS

receiver are turned on, output of the connected Grad601 console 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 1.5) which allows you to examine the Grad601 each channel output and GPS performance.

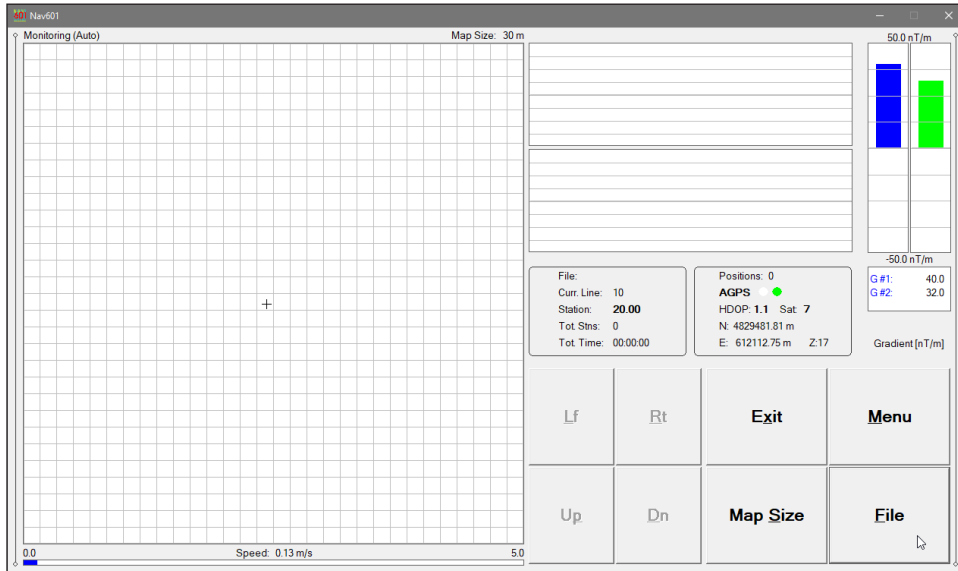


Figure 1.5: Nav601 logging screen in the Navigation (Monitoring) mode

To record data one has to specify the data file name. The program will not allow you to overwrite an existing file. Also, the program does not allow you to append data to an existing file but if needed coverage of the last or any other data file (up to 10 files simultaneously) can be displayed using option Enter Background Files. After the data file is created the program will switch to Stand By mode. The Stand By mode provides continuous data monitoring as well as use of 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.

The instruments output is shown in the form of numeric values for Grad601, one or two sensors in nT/m, as well as plotted in graphic mode (Figures 1.6 to 1.9). An equalizer type (graphic bars) displays data for Sensor #1 and Sensor #2 as bars in a bar window.

Left graphic bar is associated with Sensor #1 values, while the right bar represents Sensor #2 readings. If one sensor is used then only one graphic bar is displayed. In addition moving bars are displayed with different colours that correspond to profile curves colours specified in Profile Display Options dialog. Range of displayed components is common for moving bars window and profile windows. Readings range is labeled at the bottom and top of moving bars window and profile windows. This type of display allows for a legible and very quick estimation of the Grad601 performance. When more detailed monitoring is required each measured value is displayed in numeric form in nT as well.

The program displays windows with profile outputs (one or two profile windows depending on number of sensors connected). If longer and more detailed profiles are needed the program can be switched to Profile View mode at any time during the survey.

When working GPS receiver is connected to the field computer then program uses Navigation mode by default. The Nav601 screen in Navigation mode is shown in Figure 1.6 (Grad601 position and footprint represented by selected swath bar for one sensor system, or double sensors separation if two sensors system is used) and Figure 1.7 (Grad601 position is represented by a dots, dot represents one sensor). Each swath bar or dot shows position recorded at the moment the GPS station is recorded, positions of recorded Grad601 data sensors located between GPS points are not shown in Navigation mode in real time.

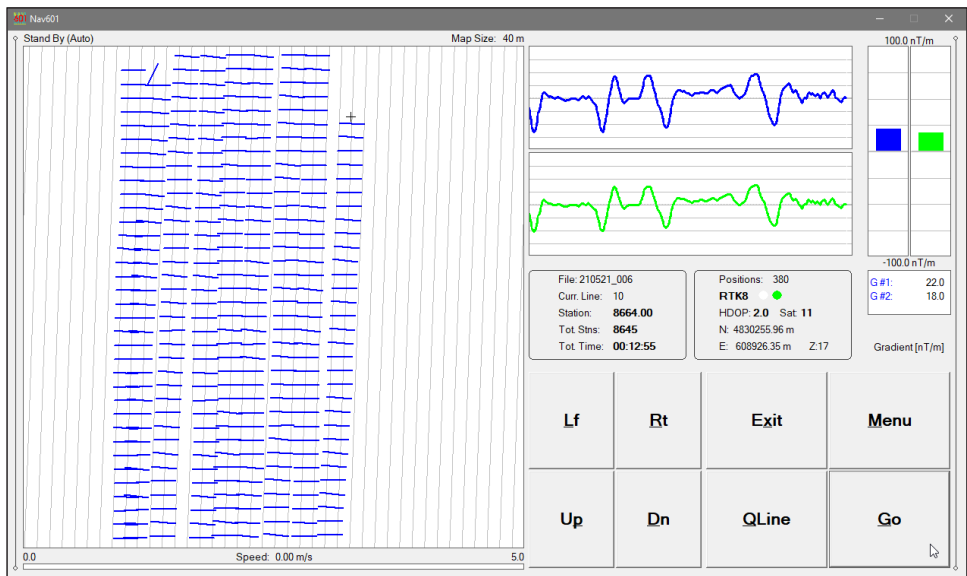


Figure 1.6 Nav601 screen in Navigation (Stand By) mode, Swath Bars represent selected footprint as 1 m on a 40 m map size with 1 m guiding lines separation.

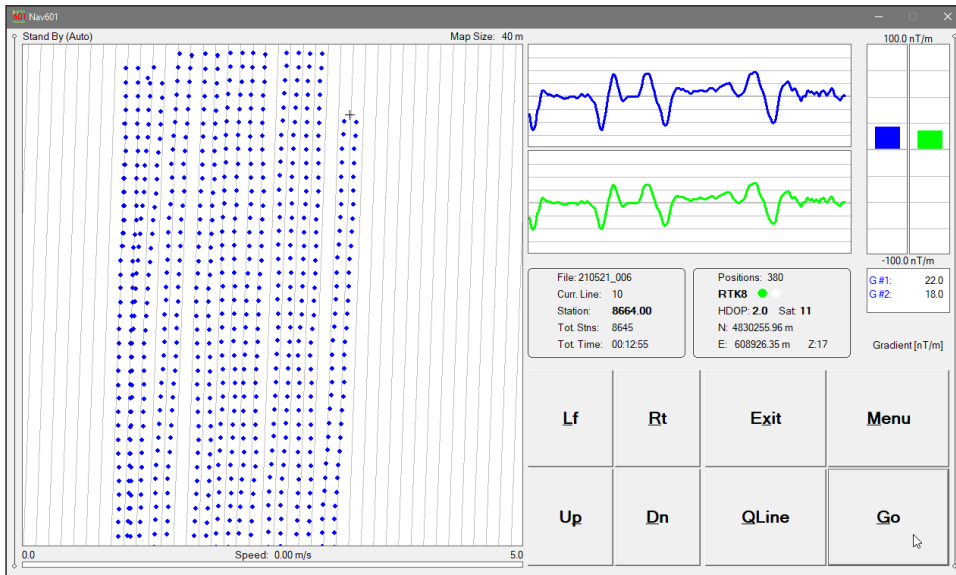


Figure 1.7 The Nav601 screen in Navigation (Stand By) mode, Grad601 positions are represented by dots (parameters as in Fig. 1.6).

Clicking or tapping on the Go button (or pressing key G or <ENTER> if it is default button) will change the program to Logging mode and Grad601 and GPS data will be recorded in the data file according to selected mode of operation. Updated map, profile windows as well as green background in numeric values window clearly indicate Logging mode and data recording, Figure 1.8.

Positions of sensors are calculated in real time in Navigation mode and calculations include and 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 Navigation mode is not accessible. Example of the Nav601 screen in Profile mode is given in Figure 1.9. When changing display from Profile to Navigation mode while large amount of data is collected, a message Wait is displayed and the program may take several seconds to select the needed coordinates while scanning the entire database of collected positions. There is no such delay during scrolling since the program keeps track of survey path while in navigation mode.

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

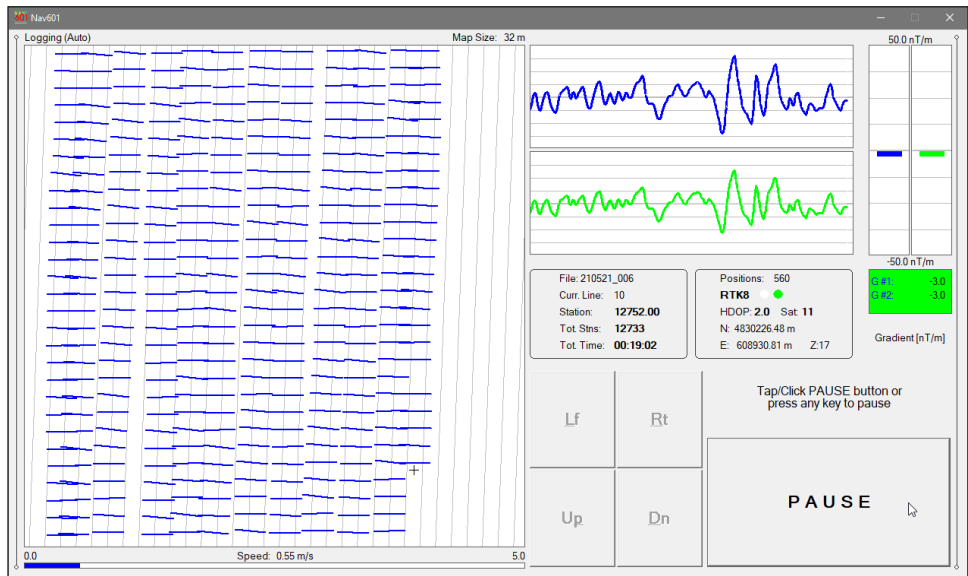


Figure 1.8: The Nav601 in the Mapping (Logging) mode, Swath Bars represent positions recorded, (cursor indicates instant position of the GPS antenna, and green background in numeric window indicates data recording)

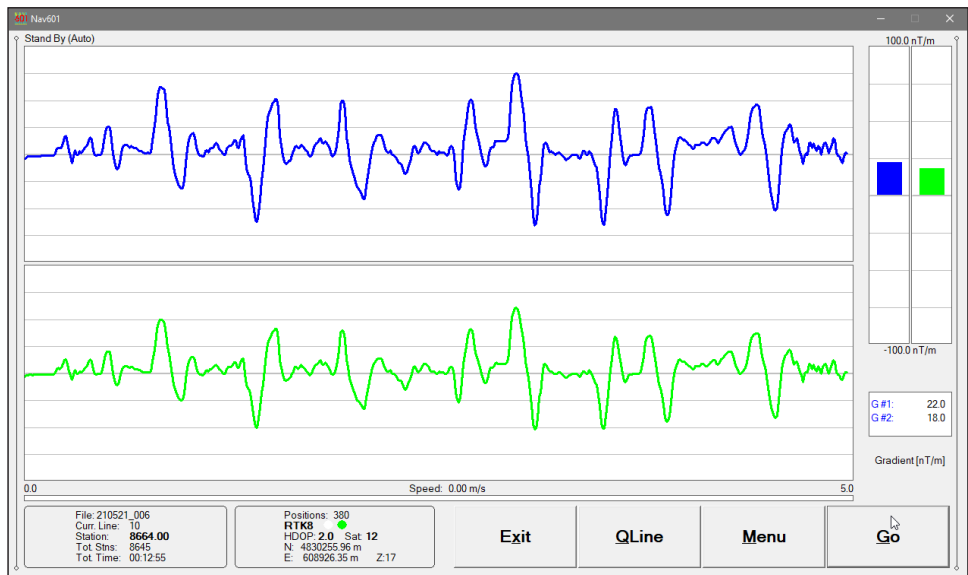


Figure 1.9: The Nav601 in the Profile (Stand By) mode, Sensor #1 data is displayed in a top window while Sensor #2 in a bottom window. One profile window is displayed if one sensor system is employed.

files for example to 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 used. In case of accidental computer lock up, data file will contain all readings till the Pause Key was used last time. Therefore, **it is good practice to pause data recording at any possible moment**, for example at the end of each survey line, at any obstruction, etc.

## 1.9 Surveys Carried Out With GPS Positioning

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Most of the stations positions for surveys positioned with GPS receiver will be calculated based on the GPS antenna position and instant heading of the array. The data processing program TrackMaker601 uses sophisticated calculations to apply GPS antenna offsets, however in order to achieve highest possible quality of data positioning the survey should be carried out along relatively smooth pathways, especially if GPS antenna is located not in the center of the instrument.

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

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

## 1.10 The Nav601 System Geometry

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When a survey is positioned by GPS system the program allows to specify the GPS antenna offset from a system reference point 0,0 (or sensors center). Two parameters, GPS X Offset and GPS Y offset describe location of GPS antenna. This location is represented by the distance which is measured from the center of the system to the center of the GPS antenna, while facing direction of the movement.

The reference point 0,0 (center of the system) varies depending on number of sensors used. In case of one sensor the system reference point is located in the center of the

sensor, see Figure 1.10. For two sensors setup the reference point 0,0 is located in the middle point between magnetic sensors, sensor #1 (left) and sensor #2 (right) as presented in Figure 1.11.

Whenever GPS antenna is placed left of reference point the GPS X Offset will be negative, similarly when GPS antenna follows magnetic sensor(s) then the GPS Y Offset is negative.

The GPS antenna can be placed anywhere in relation to the reference point 0,0. However to achieve higher accuracy of the calculated positions the GPS antenna must be placed as close to the center of the system as possible.

During the survey Nav601 applies GPS antenna offsets in real time, and calculates and displays the Grad601 real scaled positions in Mapping/Navigation mode.

In the case where a wrong value was entered in the field, GPS X Offset and GPS Y Offset parameters can be corrected later during data processing in the program TrackMaker601.

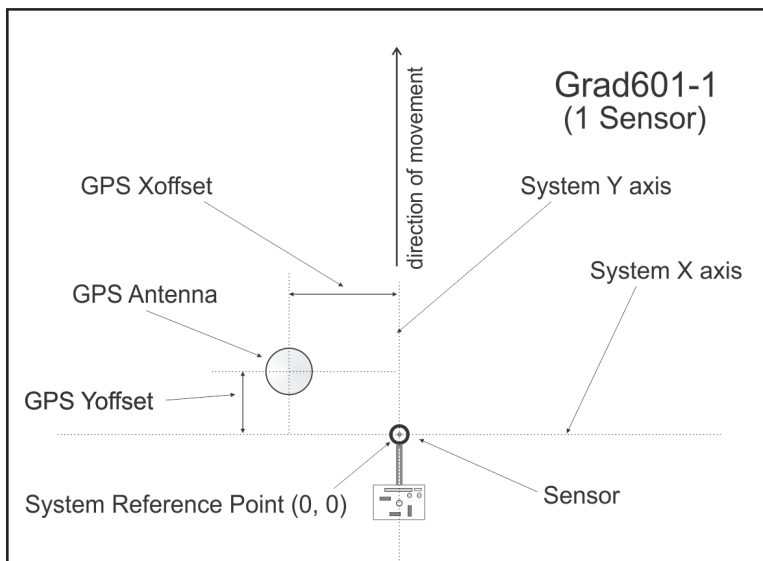


Figure 1.10: The Nav601 system geometry - One Sensor

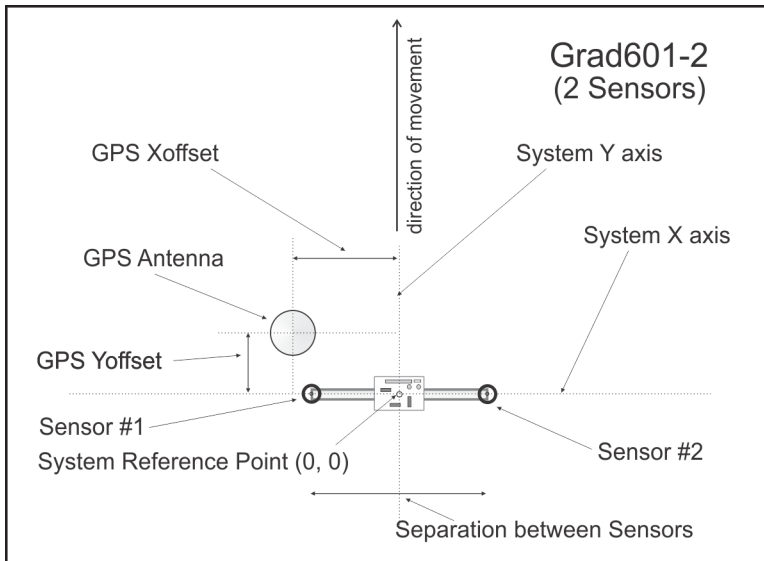


Figure 1.11: The Nav601 system geometry - Two Sensors

# Main Screen

# 2

The Main Screen appears always as the first window after the program is started. It contains the name of the program, its version number, and list of command buttons with available options on the right side. The major, left portion of the window contains information about current survey and system parameters settings, and graphic illustrating current system geometry (sensors number and GPS antenna location). The graphic diagram is updated in real time as soon as geometry parameters are changed in the Geometry Setup dialog. The Nav601 Main Screen is shown below in Figure 2.1 (portrait display orientation, the same screen in landscape display orientation is shown in Figure 1.3).

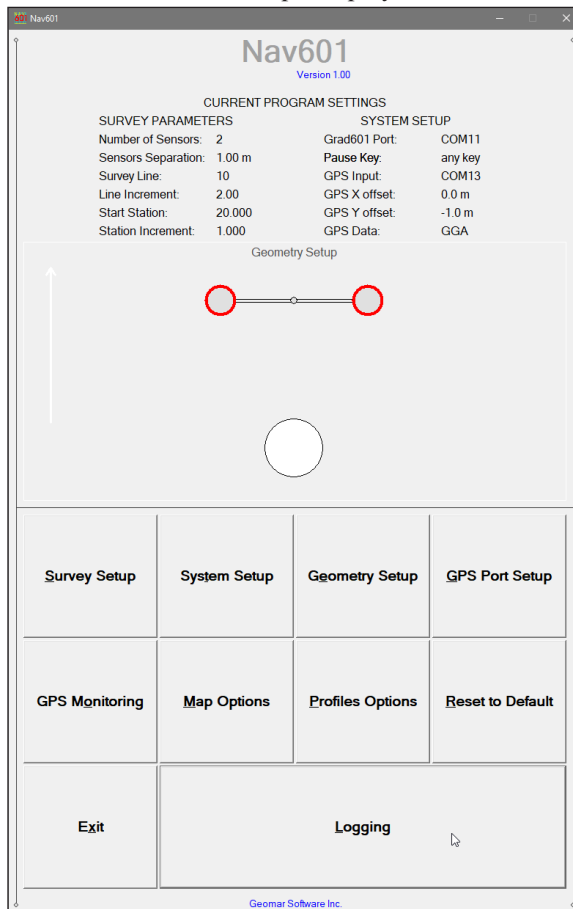


Figure 2.1: The Nav601 Main Screen window

The Nav601 is a command button and dialog driven program. Command buttons can be executed by tapping touch sensitive screen, clicking with the left mouse button, or by pressing the indicated (underlined) character on the keyboard, or by using TAB to scroll through the buttons and ENTER to execute. Up and Down (or Left and Right) arrow keys can be also used to scroll through buttons of the program Main Screen. Short description for each of the options follows.

## 2.1 Short Description of Main Screen Options

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### Logging

This option allows you to monitor and log the Grad601 output and GPS receiver positions. Logging screen starts always in Monitor mode, and then after a data file is created Logging mode is available. Monitor mode provides initial inspection of the range of the instrument readings at the particular site, and quick inspection of the instrument settings and GPS receiver performance.

### Survey Setup

Dialog window that is associated with this option is used to set survey line name, start station, line and station increments, and other parameters which are necessary to determine survey settings (Figure 2.2).

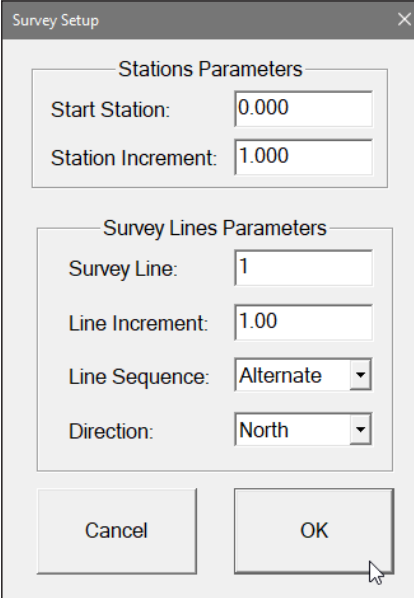


Figure 2.2: The Survey Setup dialog

## System Setup

This option (see Figure 2.3) allows user to enable and disable (if GXY file is to be collected) instrument connection, to select type of Grad601 sesors connected to the console, and to assign serial port number for the Grad601 and GPS. The Pause Key, Speed Bar units, Coordinates Display type (geodetic or UTM with units), Audio indicating recording as well as Audio Alarm for disconnection can be also selected in this dialog.

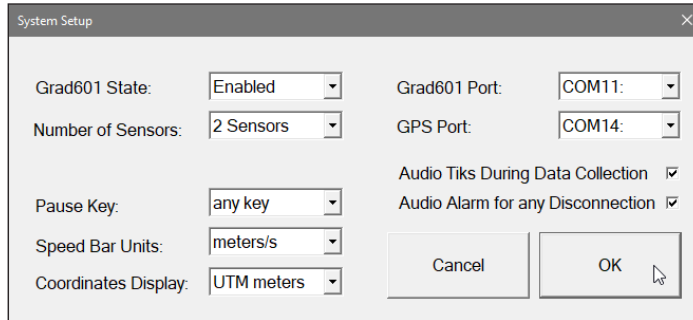


Figure 2.3: System Setup dialog

## Geometry Setup

This dialog allows you to specify GPS antenna offsets, and sensors separations for two sensors systems. The dialog is shown in Figure 2.4. Small graphic window illustrates meaning of geometry parameters for one sensor (top) as well as two sensors systems (bottom). This is reference graphic, the drawing is not

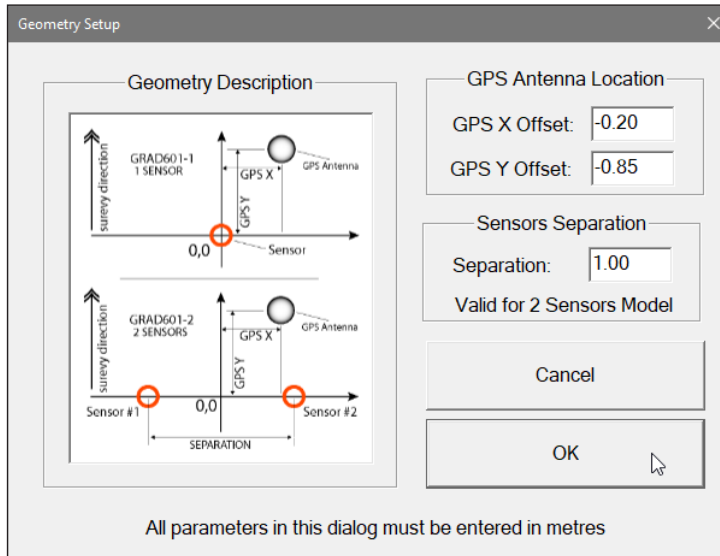


Figure 2.4: Geometry Setup dialog

updated as graphic diagram in Main Screen which represents actual layout of the system). After the button OK is clicked or tapped the dialog disappears and layout of the system configuration is updated in the Main Screen.

### 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.

GPS Parameters Setup		GPS Warning Mask	
GPS Input:	Enabled	Warning	Enabled
NMEA Data:	GGA/GSA	Quality	DGPS
Serial Port:	COM14:	PDOP	4.0
Baud Rate:	9600	Satellites	5
Parity:	No	Enable Audio Warning	<input checked="" type="checkbox"/>
Data Bits:	8	If any of above not met then GPS circle indicator will blink in red and audio warning sound if enabled	
Stop Bits:	1		
pseudo-GGA by SLAM RTS	<input type="checkbox"/>		
RTS Units:	meters or feet		
		Cancel	OK

Figure 2.5: GPS Port Setup dialog

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

### Monitor GPS

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

### Map Options

The Map Display Options dialog (Figure 2.6) allows you to specify size and colour of the cursor showing current GPS antenna position, as well as a size of dot or swath bar representing recorded position.

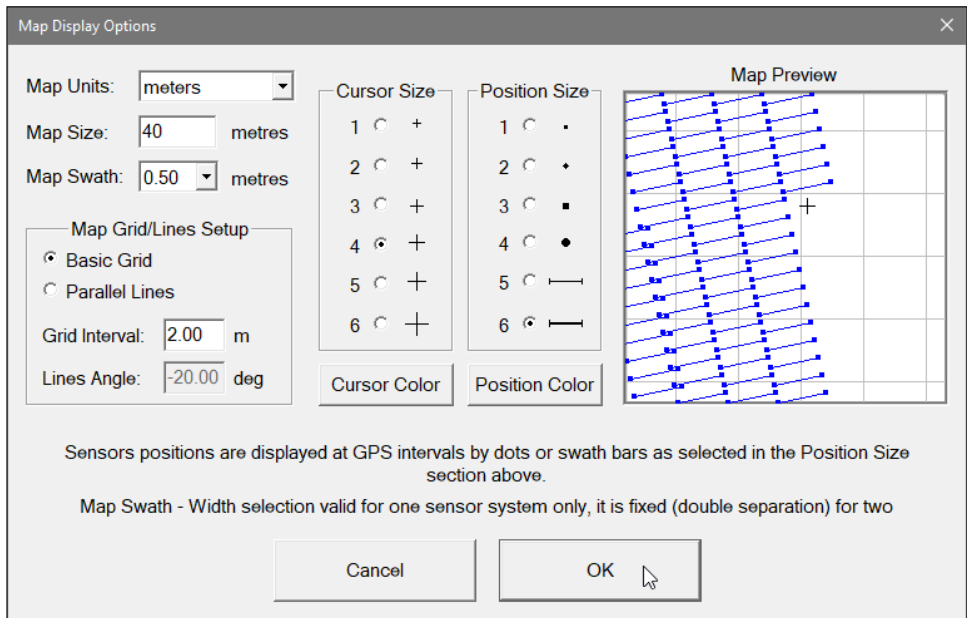


Figure 2.6: Map Display Options dialog

A value for the Map Swath can be specified only for the Grad601 single sensor layout. In this case Map Swath is optional and it can be selected in meters. It will represent width of the sensor footprint drawn and scaled to displayed map. The Map Swath bar width should be selected based on intended survey line spacing and lateral resolution of the survey.

The Map Swath bar width for two sensors system is fixed by default and it is equal to double size of sensors separation. Therefore, footprint of each sensor is equal to sensors separation specified in Geometry Setup dialog.

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

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

This option allows you to select profiles to be displayed, including colour as well as thickness of each profile separately.

### Profile Options

The Setup Display Options dialog (Figure 2.7) allows you to specify colour and thickness of profile line for each sensor.

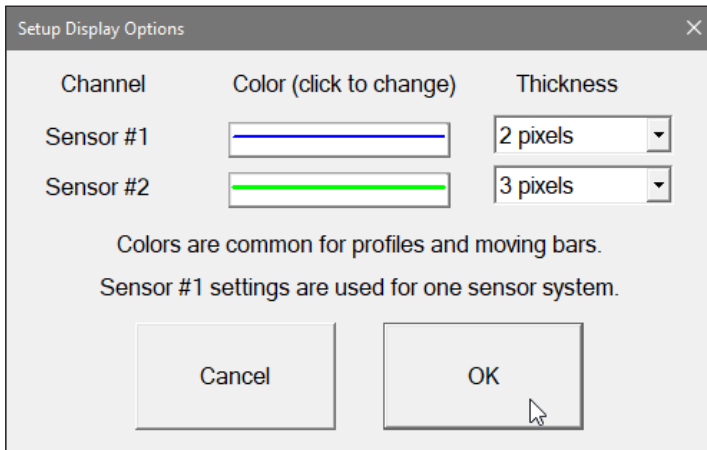


Figure 2.7: Setup Display Options dialog

### Reset to Default

A warning message will appear (Figure 2.8). The program reloads its default settings and it closes. When it will be run again a new fresh configuration file will be created.

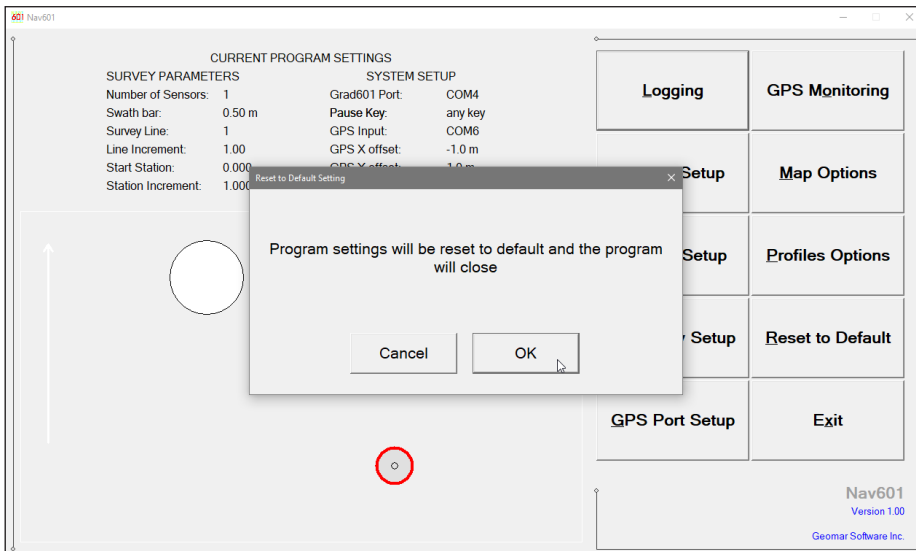


Figure 2.8: Reset parameters to default values procedure

### Exit

Selecting this option will terminate the program execution.

The Survey Setup dialog, presented below in Figure 3.1, contains several parameters which affect survey geometry layout (survey line names, line spacing, start station, station increment, and survey lines direction and sequence).

The image shows a 'Survey Setup' dialog box with the following parameters:

- Stations Parameters:**
  - Start Station: 0.000
  - Station Increment: 1.000
- Survey Lines Parameters:**
  - Survey Line: 1
  - Line Increment: 1.00
  - Line Sequence: Alternate (dropdown)
  - Direction: North (dropdown)

Buttons: Cancel, OK

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, touch screen input, 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.

**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.

Start Station value is used in conjunction with Station Increment to calculate the current station number for display purposes.

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

**Station Increment** (station or wheel increment)

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

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

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

**Survey Line** (survey line name)

Activate text box for this option by clicking with a mouse or using TAB key and then enter desired name (number) for the survey line.

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

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

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

### Line Increment

Activate text box 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. This setting will be used to determine number (name) of the next survey line and will provide automatic survey line name while executing option Quick Line. This parameter can be ignored if survey is positioned with GPS system.

### Sequence

Tapping on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box and then by using up or down arrow keys select one of two available items: Alternate and One Way (Figure 3.2).

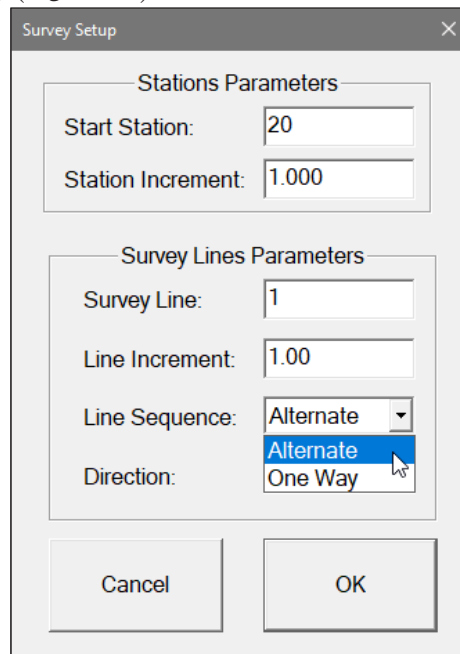


Figure 3.2: Survey Line Sequence options

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.

This parameter can be ignored if survey is positioned with GPS system.

## 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 and it can be ignored if survey is positioned with GPS system.

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

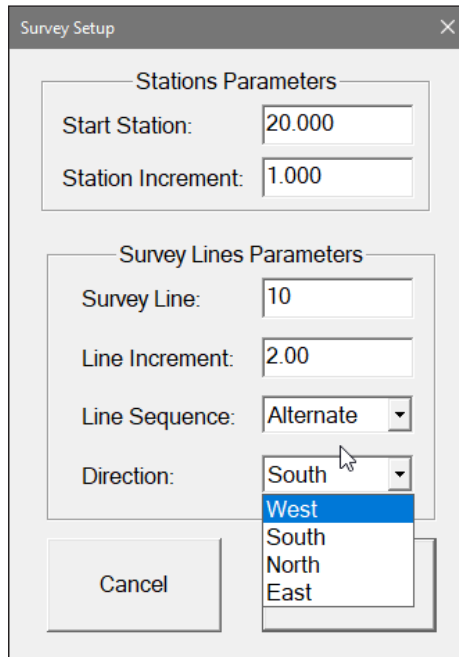


Figure 3.3: Survey Line Direction selection

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

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

# System Setup

# 4

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

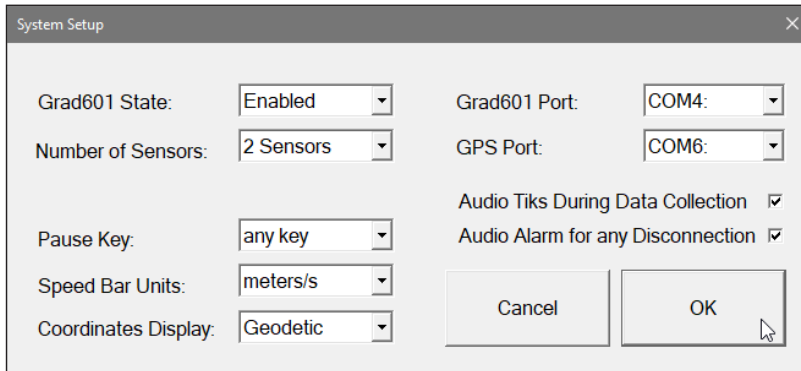


Figure 4.1: System Setup dialog

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

Description of the System Setup dialog options and parameters.

## Grad601 State (Enable/Disable)

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

Select Enable for normal operation when Grad601 are to be recorded.

When Disabled is selected the program will not record, nor will check for presence of the Grad601 instrument. This feature is used when only GPS positions are to be recorded. In this case created data file will have extension name GXY. These files can be used to survey roads, fences, buildings, or any other topographical features.

## Number of Sensors

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 two available Grad601 console options: 1 Sensor and 2 Sensors.

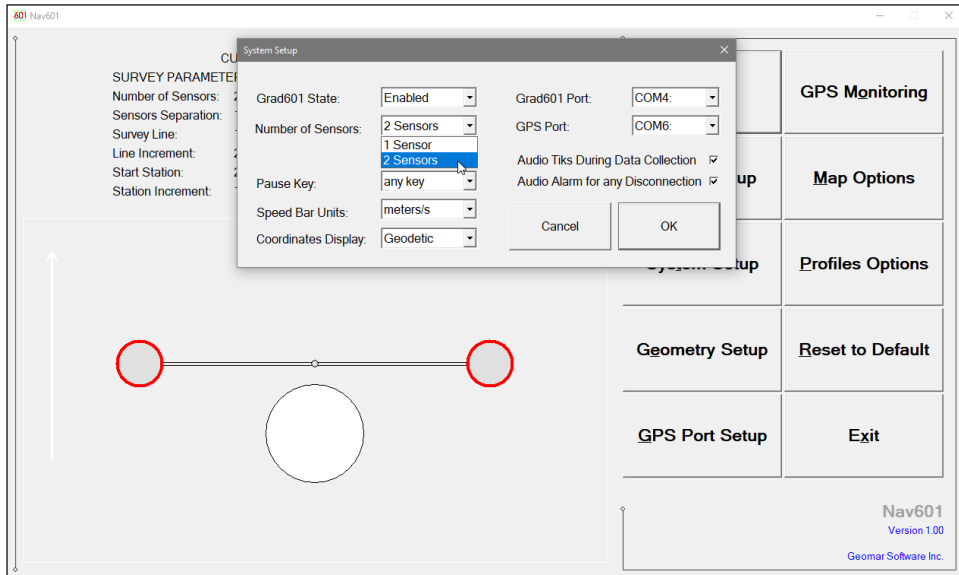


Figure 4.2: Selection of Number of Sensors

Main Screen graphic representing layout of the system (gradiometer sensors and GPS antenna) is always updated when number of sensors is changed.

## Pause Key

When this option is highlighted and drop-down box is expanded use mouse or use Down or Up cursor key to toggle between available options (Figure 4.3).

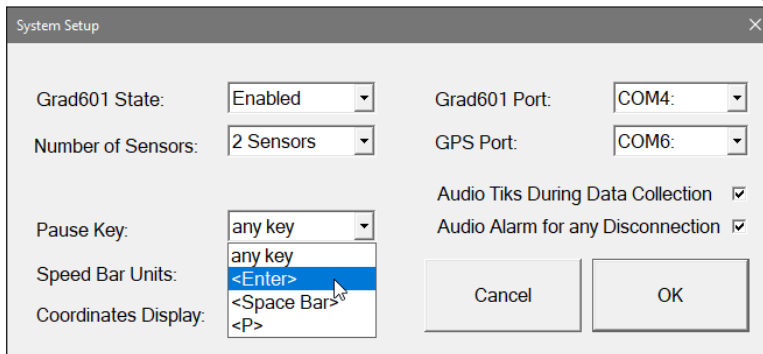


Figure 4.3: Selecting Pause Key in the System Setup dialog

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.

### Speed Bar Units

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

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

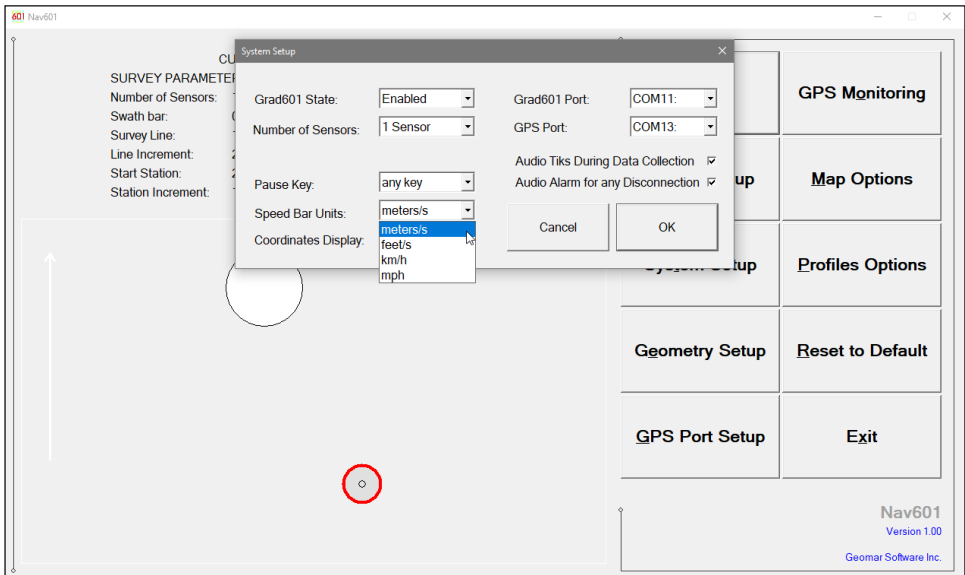


Figure 4.4: Selecting Speed Bar units

### Coordinates Display

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

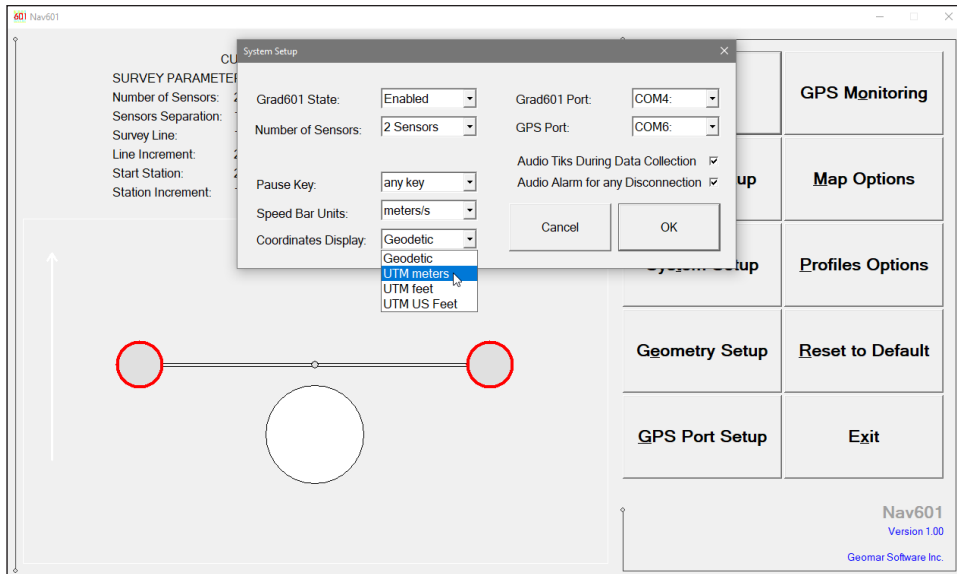


Figure 4.5: Selecting type of Coordinates display

This parameter can be changed later during data logging.

### Grad601 Port and GPS Port

Navigate with mouse or TAB key to each Sensor Port (Grad601 or GPS) and when the option is highlighted and drop-down box is expanded use mouse or use Down or Up cursor key to toggle between available settings. The program supports ports from COM1 to COM60 for the Grad601 and for GPS receiver, see Figure 4.6 and Figure 4.7.

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

The program supports Serial Ports 1 to 60. Any serial port can be assigned, however care should be taken that the Grad601 instrument and GPS receiver are connected to proper (indicated here) serial ports.

### Audio Ticks During Data Collection

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

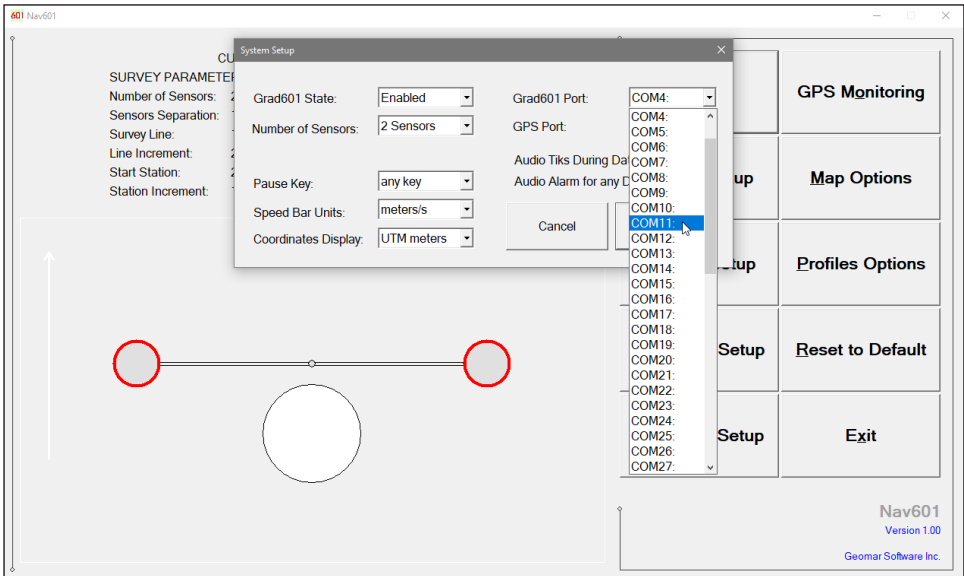


Figure 4.6: Selecting Serial Port in the System Setup dialog

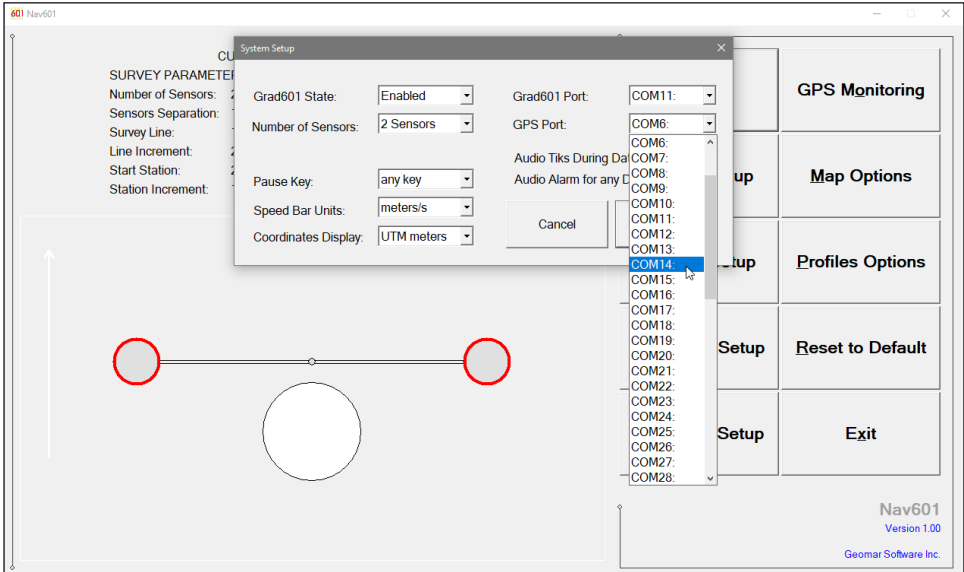


Figure 4.7: Selecting GPS Serial Port in the System Setup dialog

### Sound Alarm

The program will sound loud ring in case of any serial port disconnection, or in case any Grad601 unit or GPS receiver will stop streaming data. The audio

alarm function does not depend on the visual alarm that is always enabled regardless of audio alarm setting. The audio alarm function can be enabled or disabled by check button at the Sound Alarm for any Disconnection label as shown in Figure 4.5.

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

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

# Geometry Setup

# 5

The Geometry Setup dialog, presented below in Figure 5.1, contains parameters which describe the system configuration: location of GPS antenna and Separation between sensors (applies to two sensors systems only). The dialog contains a graphic window labeled Geometry Description which illustrates meaning of parameters used to specify geometry of a system. It is divided in to two parts. Top portion shows one sensor system. Important is that reference point 0,0 is located in the center of Grad601 gradiometer sensor. The bottom portion of drawing presents two sensors system. In this case reference point 0,0 is located in the middle point between sensors. Parameter Separation describes distance between sensors. In both cases positive Y coordinate is the same as surveying direction, while positive X coordinate is on the right while facing direction of the system movement. This graphic window is used only as a reference, it does not reflect actual system layout.

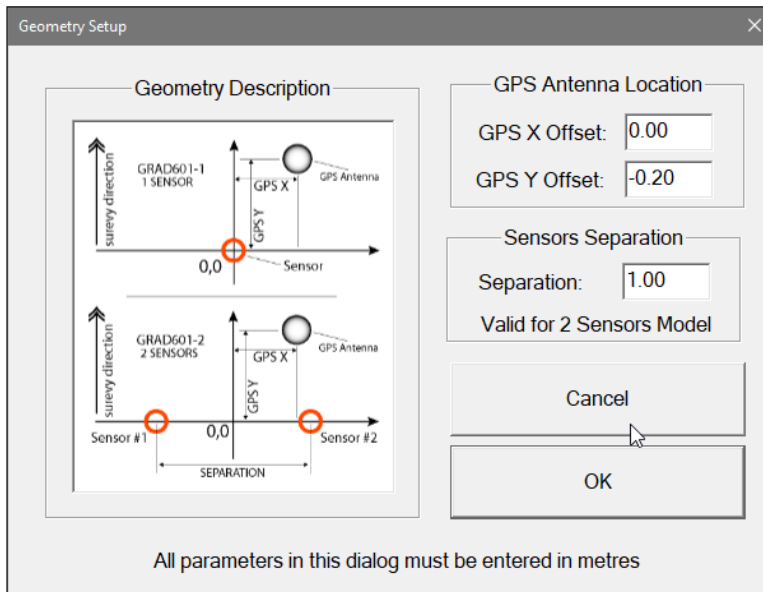


Figure 5.1: Geometry Setup dialog

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

Description of the Logger Setup dialog options and parameters.

### GPS X Offset

### GPS Y Offset

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

These two options apply only when a survey is positioned by GPS system. The GPS X and Y offsets describes location of GPS antenna. This location is represented by the distance which is measured from the center of a system reference point 0,0 to the center of the GPS antenna, while facing direction of the movement.

Reference point is different for one and two sensors setups:

In case of one sensor system reference point 0,0 is located in the center of Grad601 sensor, see Figure 5.2.

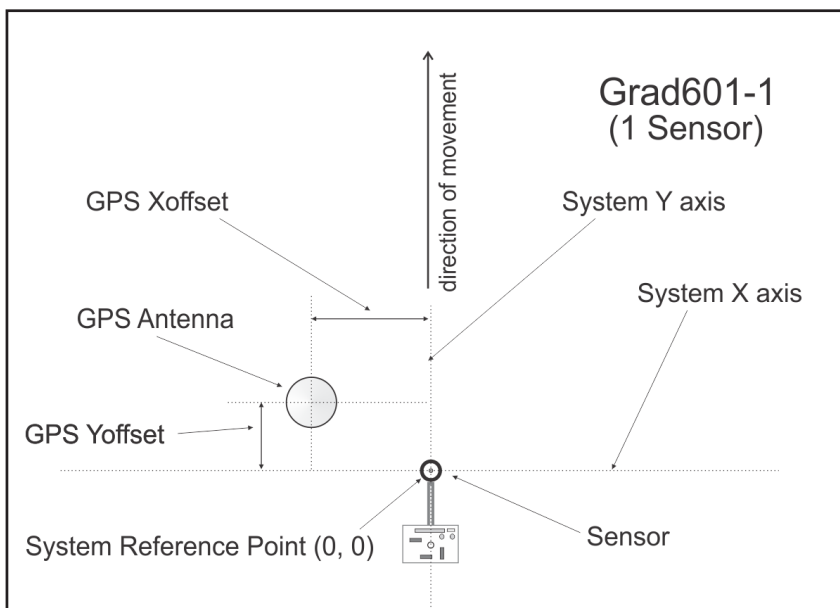


Figure 5.2: Geometry description for One Sensor setup

For two sensors systems reference point 0,0 is located in the middle point between sensors, see Figure 5.3.

The GPS Antenna offset distances must be given in meters.

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

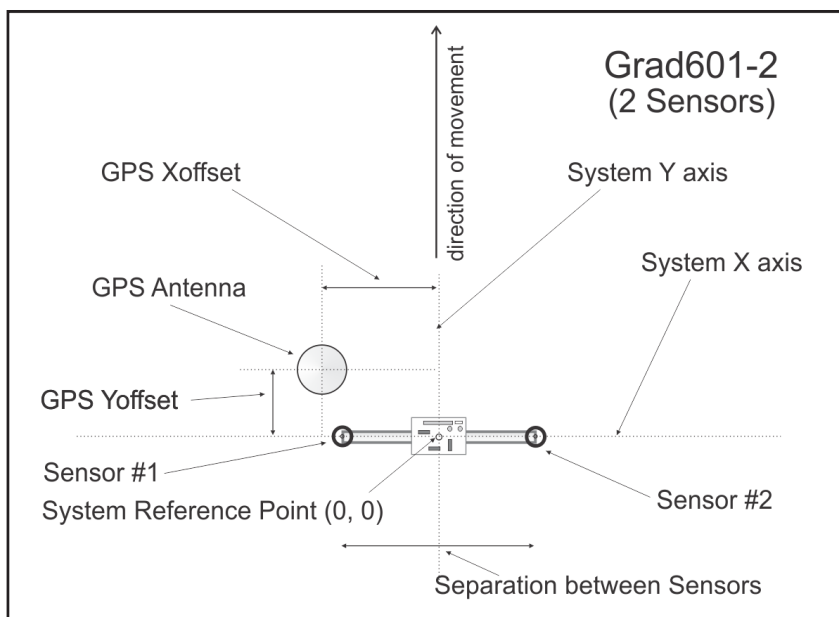


Figure 5.3: Geometry description for Two Sensors setup

#### Separation (Sensors Separation)

This parameter is applicable for two sensors setups only. If one sensor system is selected in the System Setup dialog, then the Separation parameter is ignored. The Separation must be specified in metres and must be greater than zero. In case wrong value is entered, separation can be corrected later in the program TrackMaker601.

After all the parameters in the Geometry Setup dialog are updated click or tap on the button OK or press O key (or ENTER if button OK is highlighted) to accept the displayed settings. The program will return to the Main Screen and diagram illustrating system layout will be updated immediately. An example of Geometry Setup is shown in Figures 5.4 and 5.5 below, it is typical layout if an operator tows sensors cart and has GPS antenna over its right shoulder. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent Geometry Setup dialog.

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

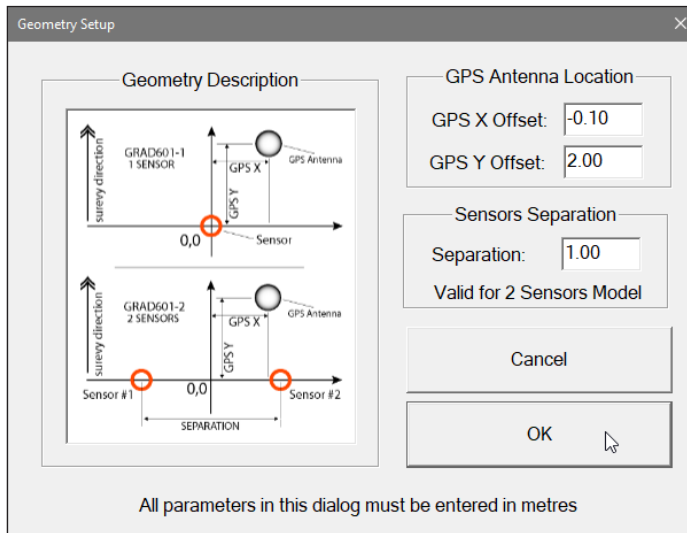


Figure 5.4: GPS Antenna Location:  
GPS X Offset -0.10 m, GPS Y Offset 2.00 m

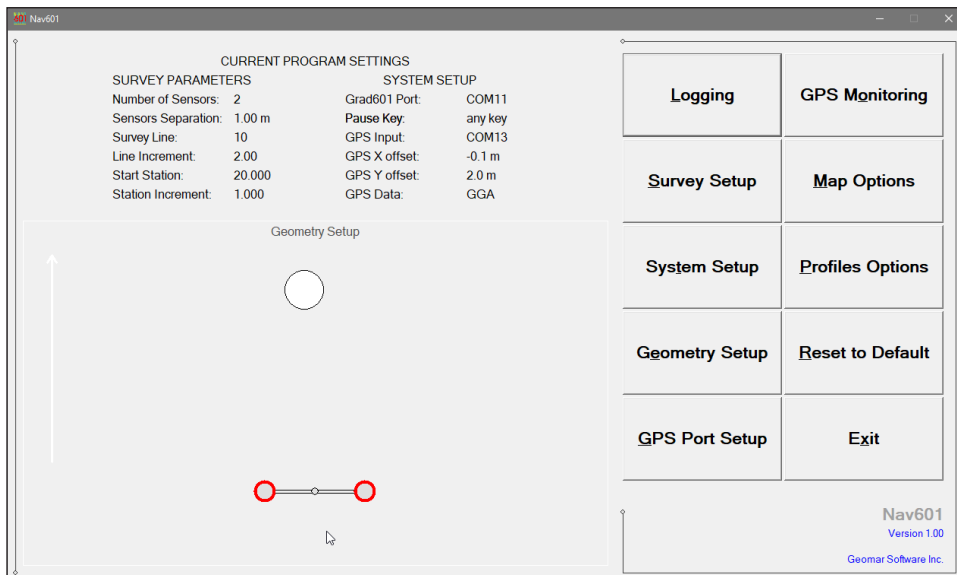


Figure 5.5: Layout representing settings in Figure 5.4

# GPS Port Setup & Monitoring

# 6

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

## 6.1 GPS Port Setup Dialog

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

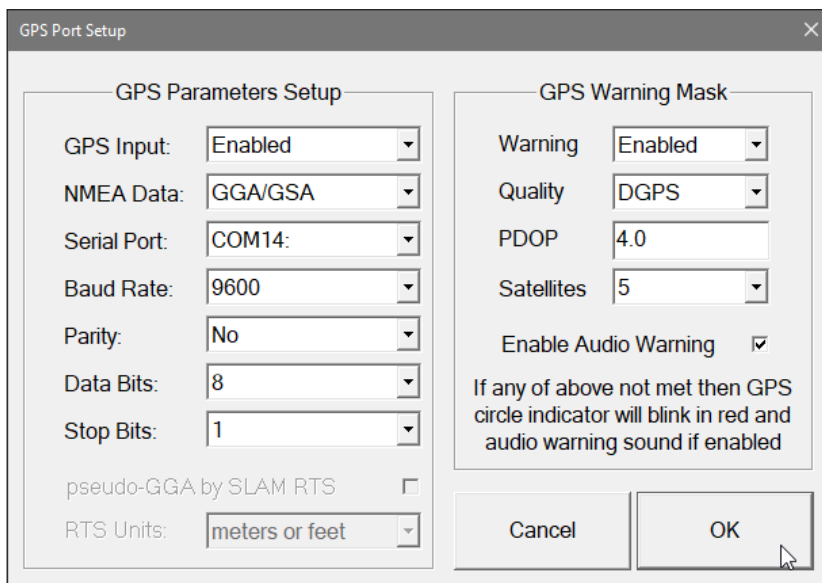


Figure 6.1: The GPS Port Setup dialog window

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

Description of the GPS Port Setup menu options and parameters.

## GPS Port Setup Parameters

### GPS Input

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

This option allows you to Enable/Disable a serial port for GPS input. When Disabled is chosen logging and monitoring screens will display message “GPS disabled” in place of GPS parameters. Also, when the Disabled item is selected the Nav601 will work only in Profile View mode, and Mapping nor Navigation modes will be unavailable.

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

### NMEA Data

This option allows you to choose NMEA message. The RTmap61M can make use of messages: GGA, GGA with associated GSA sentence, POS, GLL, LLK, LLQ, GLL, GGK, RTS pseudo-GGA (includes Leica TPS models, and several Trimble RTS models, and other RTS brands supporting pseudo-GGA stream), pseudo-GLL (used in some marine positioning systems), Figure 6.2.

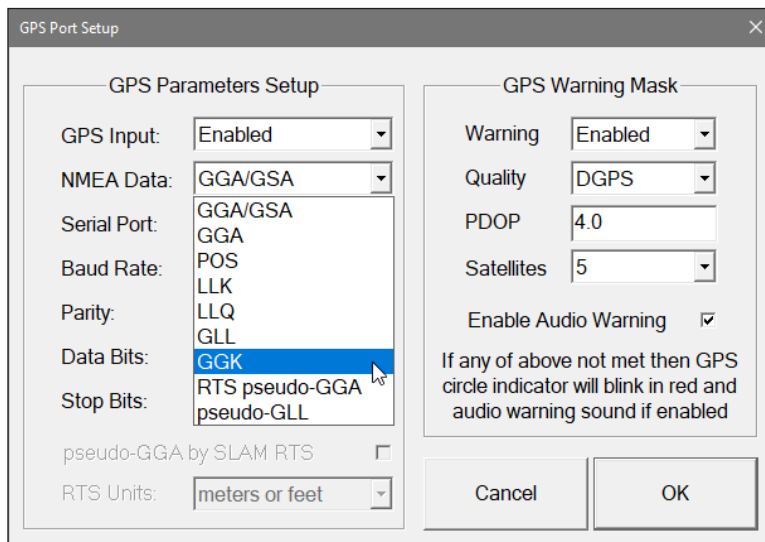


Figure 6.2: Selecting NMEA Data message

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

### **COM Port**

The number of serial port that is assigned to the GPS input. Available selections are from COM1 to COM 60. The program default is COM2. Communication parameters for the selected serial port can be determined in options described below.

This port must be different than a port specified in the Logger Setup menu for the Grad601 input, otherwise a warning message will be displayed and ports will have to be reassigned.

### **Baud Rate**

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

### **Parity**

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

## Data Bits

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

## Stop Bits

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

## pseudo-GGA by SLAM RTS

This parameters is enabled only when NMEA Data item RTS pseudo-GGA is selected (Figure 6.3). If an RTS (LiDar scanner) SLAM by KAARTA is connected and the enabled check box button is checked the program will use its custom formatted pseudo-GGA output and in addition to standard RTS info it will display SLAM Confidence, Roll, Pitch, and Yaw (see Figure 6.4). Similarly these parameters can be placed later in XYZ file created by TrackMaker601. The SLAM pseudo-GGA string contains SLAM Confidence in field 8, Roll in filed 9, Pitch in 12, and Yaw in field 14. In other words NMEA structure of SLAM custom GGA contains Confidence Indicator (as Number of SVs/Satel-lites), Roll (as HDOP), Pitch (as Geoid Separation), and Yaw (as Geoid Separation).

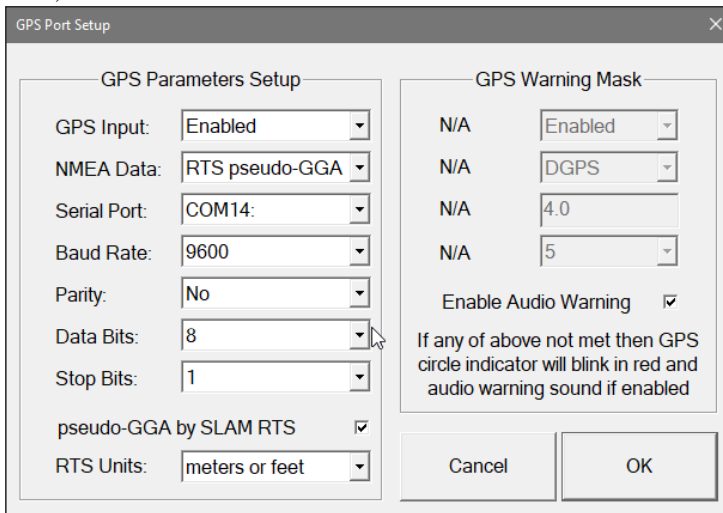


Figure 6.3: GPS Port Setup dialog with RTS pseudo-GGA item selected and enabled pseudo-GGA SLAM RTS and RTS Units options

In case this parameter will be checked by accident when standard RTS is connected, data will be good, simply program will show some invalid values for Roll, Pitch, and Yaw however positioning data will not be affected. Similarly if

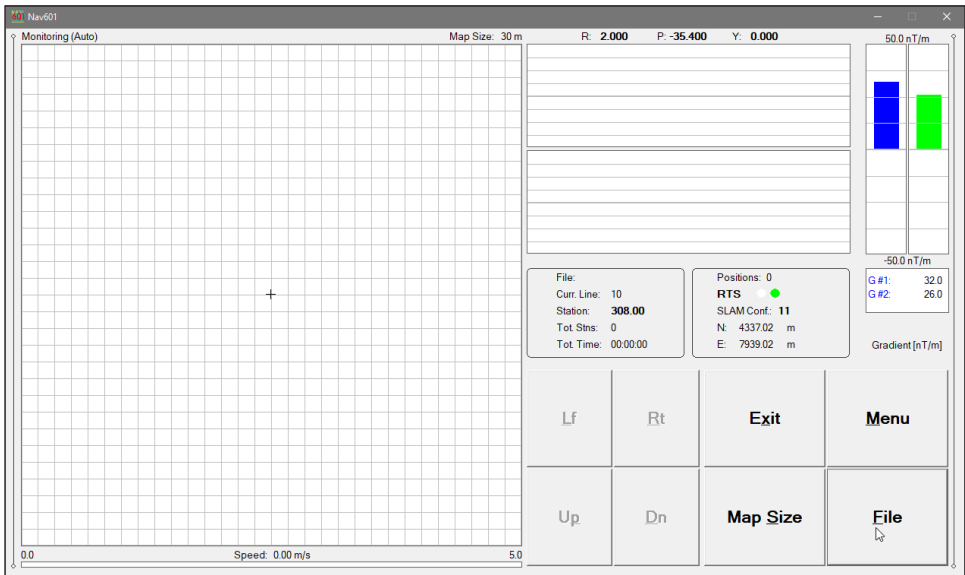


Figure 6.4: Monitoring mode while RTS SLAM is used, SLAM Confidence is shown in Position box while additional parameters Roll (R.), Pitch (P.), and Yaw (Y:) are displayed above profiles window during data collection

the check box remains unchecked when RTS SLAM is connected, still data file will have Roll, Pitch, and Yaw values recorded in file, just above values will not be displayed during data connection.

### RTS Units

The RTS Units is provided to eliminate problems with lack of information regarding type of feet (International Foot and US Survey Foot) used in pseudo GGA string (Leica and new Trimble units). This option is activated when pseudo-GGA item is selected (Figure 6.5). When pseudo-GGA is chosen (Leica and newer Trimble RTS supporting pseudo GGA messages) the item “US Survey Feet” must be selected if the positioning system is set to use these particular units, otherwise “meter or feet” must be selected.

## GPS Warning Mask Parameters

### Warning

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

This option allows you to Enable/Disable a GPS Warning Mask that contains three parameters: Quality Indicator (degree of differential corrections), Dilution Parameter (PDOP or other label depending on the selected NMEA message), and number of available satellites (Figure 6.5).

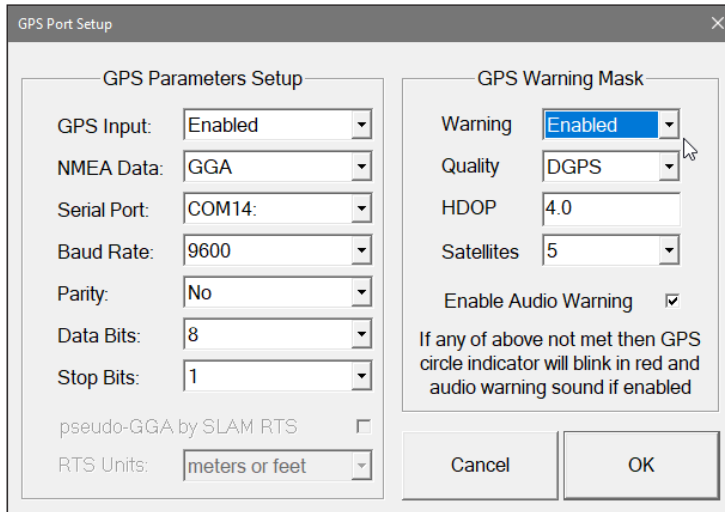


Figure 6.5: GPS Mask Warning Section enabled

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

### Quality

This parameter describes Quality Indicator (degree of differential corrections). Tapping on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: AGPS (Raw), DGPS, RTK3, RTK4, and RTK5, Figure 6.6. 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)

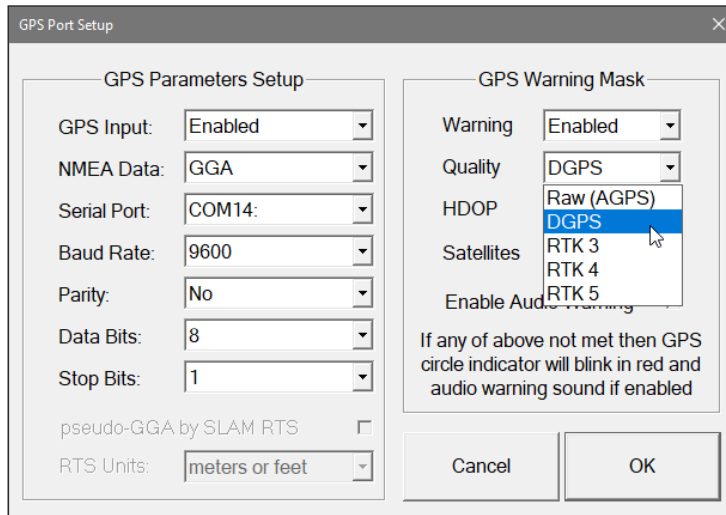


Figure 6.6: GPS Mask Warning Section, Quality selection

if LLQ was selected, or it is not available (labeled N/A) when messages GLL or pseudo-GGA are used.

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

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

### Satellites

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

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

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

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

## 6.2 Monitoring GPS Receiver Output

After the Main Screen command button GPS Monitoring is clicked or executed by the keyboard the program will display the GPS Monitoring window in terminal mode. In this mode the screen is divided into three parts. The terminal window in the top portion of the screen displays the GPS receiver output. The middle portion labeled NMEA Command is used to display entered NMEA commands previously sent to the GPS receiver, and at the bottom, command buttons with available options is displayed. The Nav601 screen in terminal mode is shown in Figure 6.7.

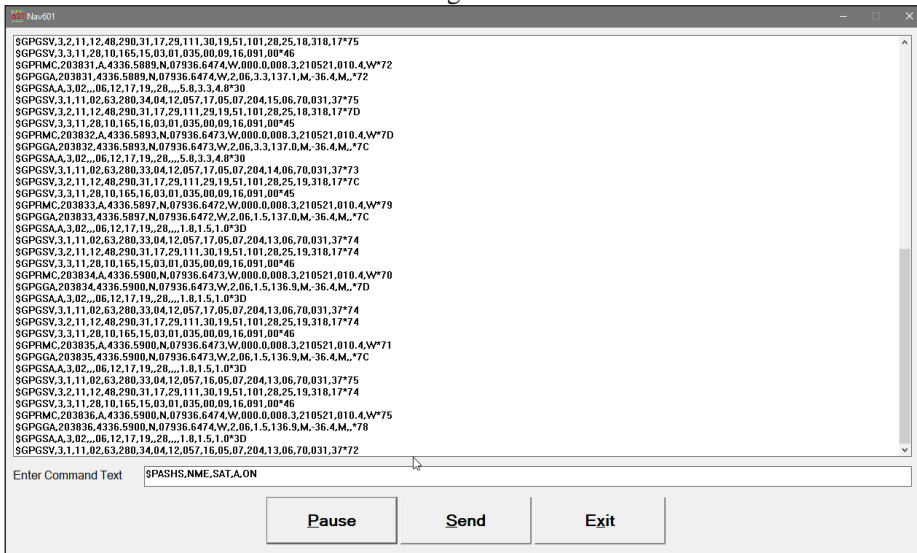


Figure 6.7: Monitoring GPS output in monitoring (terminal) mode

As soon as the Nav601 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 6.7 shows output of GPS receiver which sends three NMEA messages GGA and GSA updated every second. In cases where the GPS data is not received by the logger a message NO DATA and current time will appear in the top window of the display, as shown in Figure 6.8.

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

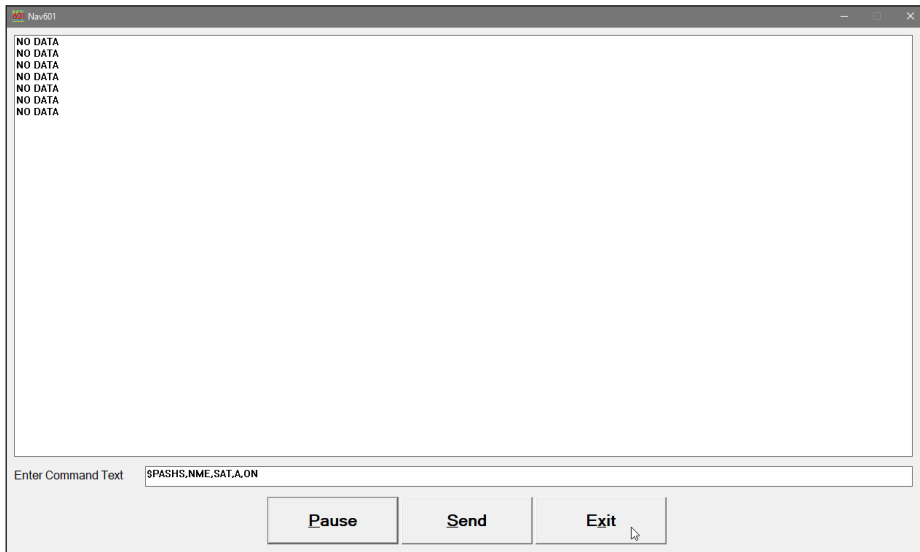


Figure 6.8: GPS Monitoring window when no GPS data is available

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

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

The NO DATA message may also appear if the GPS data are received correctly, but the GPS receiver was set to send data with a time interval longer than 6 seconds. In this case the NO DATA message will be displayed in between GPS messages. This indicates that the GPS is working correctly, however the operator should consider adjustment of the GPS receiver output update rate. Most high resolution geophysical surveys require positioning update of 1 or 2 seconds, and a 5 seconds interval can be used only when the survey is carried out at an even pace and along relatively straight survey lines.

The monitoring display can be paused any time by clicking on the button Pause or pressing the P key (or ENTER if the button is highlighted). At that time scrolling of the GPS output will be stopped, and the Pause button will be replaced by the button labeled Go (Figure 6.9). 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.

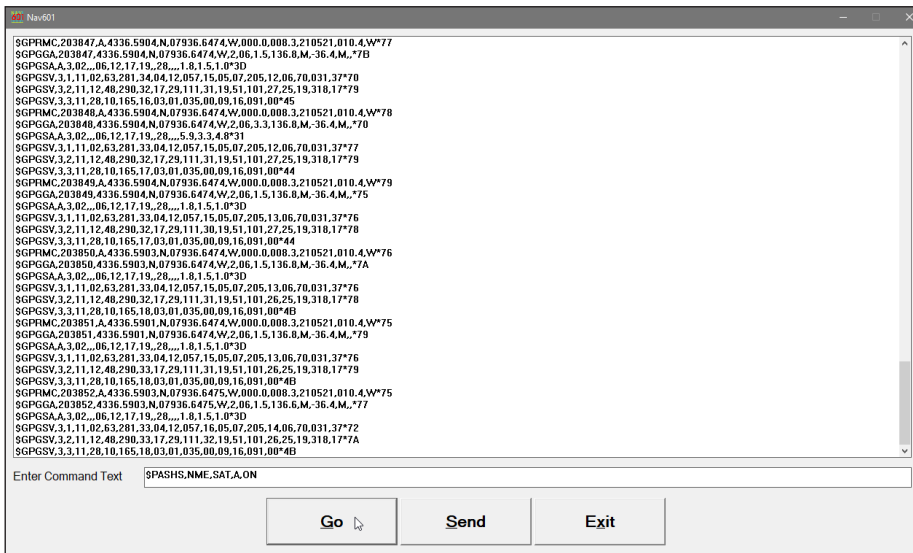


Figure 6.9: Paused GPS Monitoring window

## 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 Nav601 without using any other software.

After the button **Send** is tapped a dialog titled GPS Message is displayed and the beginning of the standard NMEA command, **\$PASHS**, or the last entered command is displayed (Figure 6.10). After the entire NMEA command is typed in, tap **OK** button or press the key <ENTER> to send the command to the GPS receiver. Tapping **Cancel** button or pressing the <Esc> key will cancel the command and hide the NMEA Message dialog. An example of a command that will enable the NMEA message SAT is given in the Figure 6.11 (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 not contain the message POS (**\$PASHR, POS,.....** ), as shown in Figure 6.12.

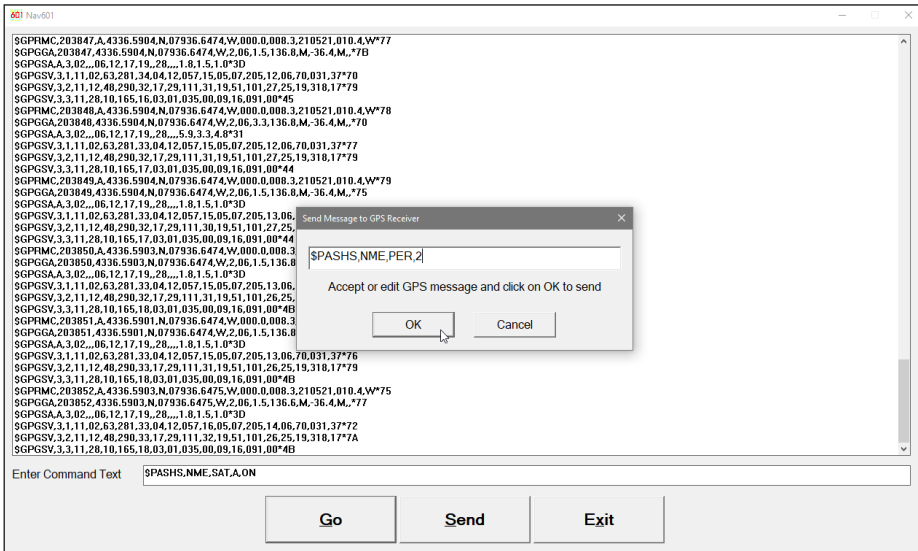


Figure 6.10: GPS Monitoring screen after button Send is executed

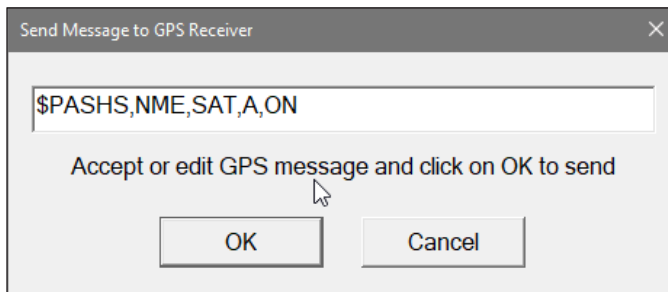


Figure 6.11: Example of the NMEA command entry

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

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

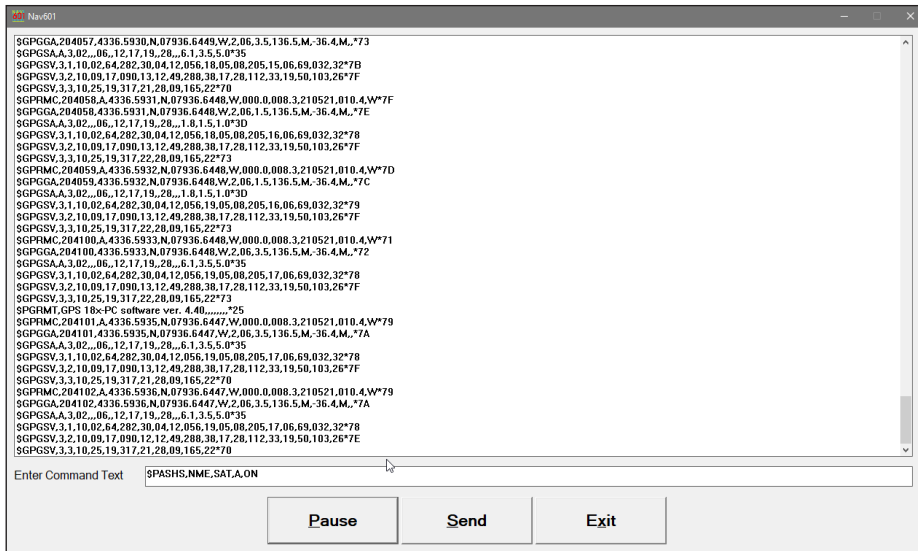


Figure 6.12: GPS Monitoring screen after NMEA command is sent

# Map & Profile Options

# 7

The Map Display Options dialog is used to specify plotting parameters for map display, colours and size of cursor and positions, and the displayed position type (navigation 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 the Navigation mode position of the sensor is displayed as a dot of specified size or as a bar that has Map Swath width, positions are plotted at GPS update rate in this mode. Samples of various map displays are provided in Chapter 1 of this manual.

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

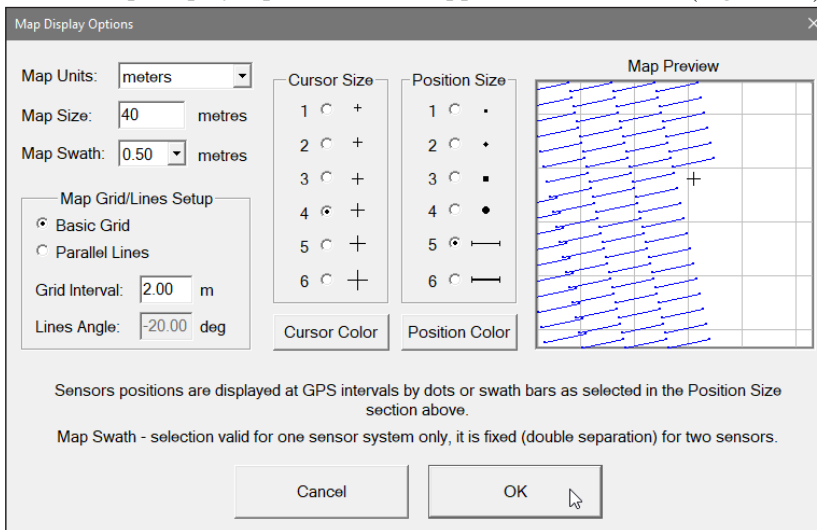


Figure 7.1: The Map Display Options dialog

This window is divided into four main sections. The first section located at the left specifies map units, map size, map swath, and grid lines options. The next section, second from the left, labeled Cursor Size is used to set size and colour of the cursor indicating current position of the GPS antenna. The third section, labeled Position Size allows you

to specify size and colour of a dot or swath bar marking saved position on the Navigation map. The section on the right labeled Map Preview shows sample map with current settings (specified in the first three sections), it is updated in real time.

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

### Map Units

Three selections are available: **meters**, **feet**, or **US Survey Feet**. These units will be used to display positions and scale map in mapping and navigation modes, and to calculate positions for the instrument in program TrackMaker601 if one of the offsets for GPS antenna is different than zero.

### Map Size

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

### Map Swath

The size of Map Swath option applies only to single Grad601 sensor system. It can be selected as an user specified value in metres, Figure 7.2. Map Swath bar will represent width of the instrument footprint drawn and scaled to map size. The default value is 0.50 m. The Map Swath width should be selected based on

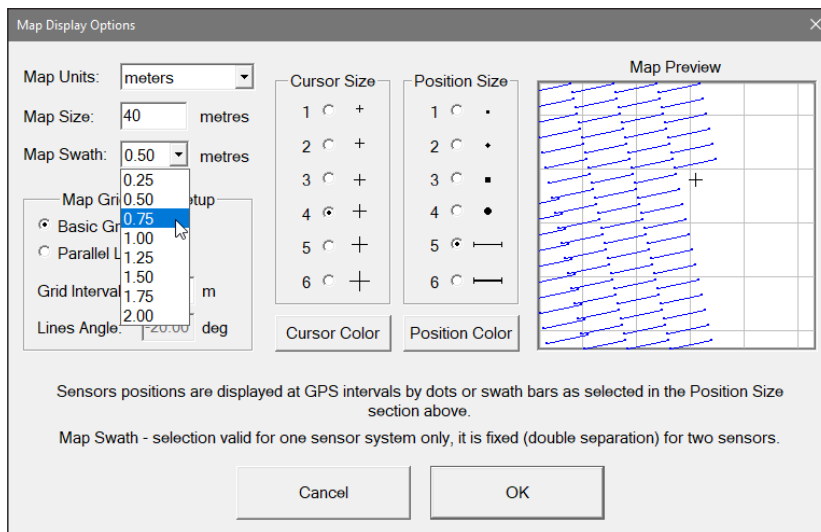


Figure 7.2: Selecting width of Map Swath bar (as a sensor footprint in metres) in Map Display Options dialog

intended survey line spacing and lateral resolution of the survey.

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

When two sensors system is employed this option is ignored, and the program will use a fixed value for Swath Bar that is equal to double value of Sensors Separation (specified in Geometry Setup). Therefore Swath Bar will cover area of 0.5 separation on both sides of each sensor centre.

This option will be also ignored if dot is used as presentation of positions. In case of one sensor setup a single dot will represent center of sensor, while in two sensors systems two dots will be drawn for every position, representing centers for each sensors.

GPS antenna offsets are applied in real time regardless Swath Bar of dots presentation is selected.

### 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 7.2), while selection Parallel Lines allows for Lines Interval as well as Lines Angle entries (Figure 7.3). Lines tilt angle is measured in degrees clockwise from North.

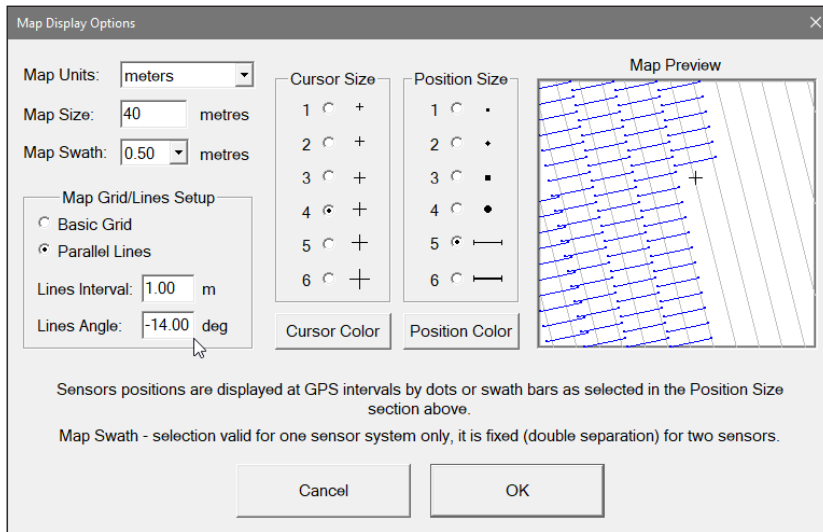


Figure 7.3: Specifying Parallel Lines and Lines Angle in Map Display Options dialog

## Size of Cursor and Position

Clicking or tapping on a radio button in any of two sections will select a size of Cursor or Dot as shown by a graphic image placed next to the radio button. The selection will be immediately reflected in the Preview window, as shown in Figure 7.2 (please compare with Figure 7.1).

Size of Cursor and Position dots shown in the Preview window will be used in Navigation modes during data collection. These parameters can be changed at any time during the survey.

Cursor Size (+ symbol) represents position of GPS antenna while Position Size (dot or swath bar) represents position of the sensor (dot) or selected instrument footprint (map swath bar with the position of the sensor in its center) in Navigation mode.

Clicking on a radio button in any of two sections will select a size of Cursor or Dot (or Swath Bar) as shown by a graphic image placed next to the radio button. The selection will be immediately reflected in the Preview window, as shown in Figure 7.4 (please compare with Figure 7.3).

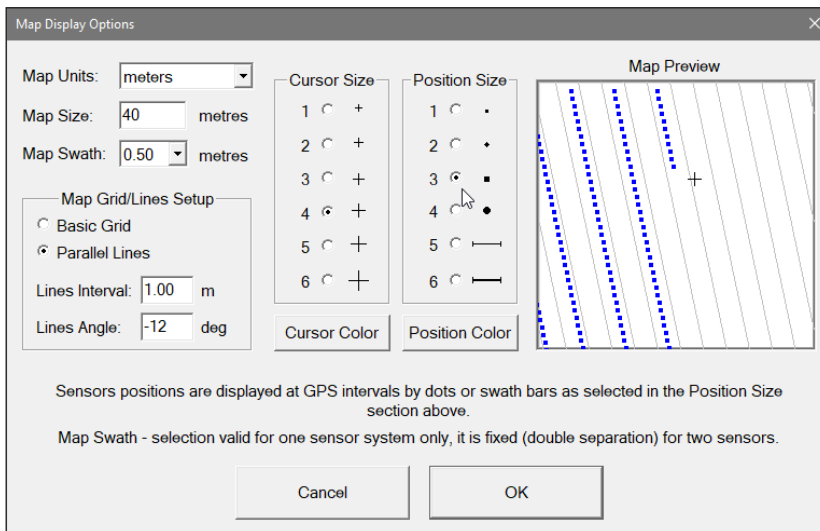


Figure 7.4: Selecting Displayed Position Type (Navigation mode)

Swath Bar in Navigation mode 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 Current Position Cursor or Position dot click on the corresponding button labeled Color. The Color dialog will appear (Figure 7.5). 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 **Custom** button. The selected color will be used to plot corresponding parameter.

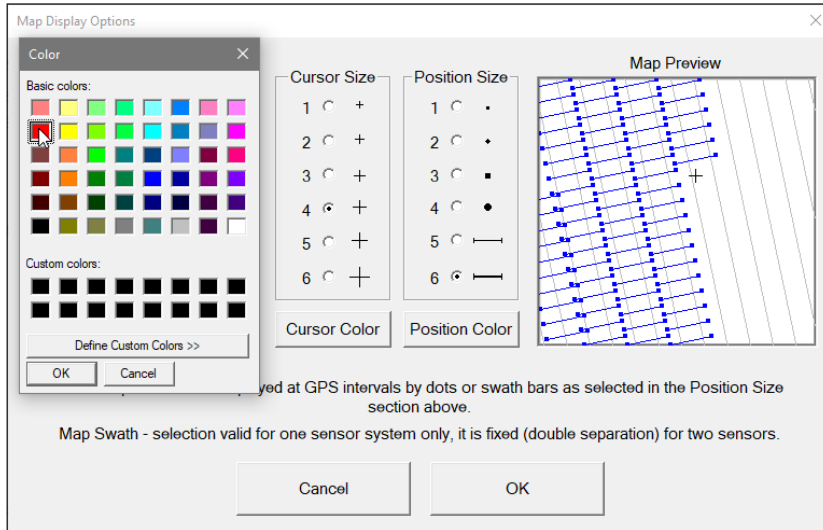


Figure 7.5: Selecting Color for Cursor or Dot and Swath Bar in Map Display Options dialog

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 selected parameter (Cursor or Position) will be updated in the Preview window. To cancel colour selection click on the **Cancel** (or X button) button or press **Esc** key. Selected colours of Cursor and Position dots shown in the Preview window will be used in Navigation mode during data collection. Colour for each parameter can be changed later at any time during the survey.

After all the parameters in the Map Display Options window are updated click on 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 the **Cancel** button or press **Esc** key. All parameters will be reset to initial settings and the program will return to the Main Screen.

## 7.2 Profile Display Options

After the **Profile Options** button was clicked (or executed from the keyboard) in the Main Screen the Setup Display Options dialog appears on the screen. This window is used to specify plotting parameters for Profile window as well as for the program Profile View mode. The window allows you to specify color and thickness of line representing each sensor profile: Sensor #1 (left) and Sensor #2 (right). If one sensor system is used then the sensor is represented by Sensor #1 settings. The Profile Display Options window is presented in Figure 7.6.

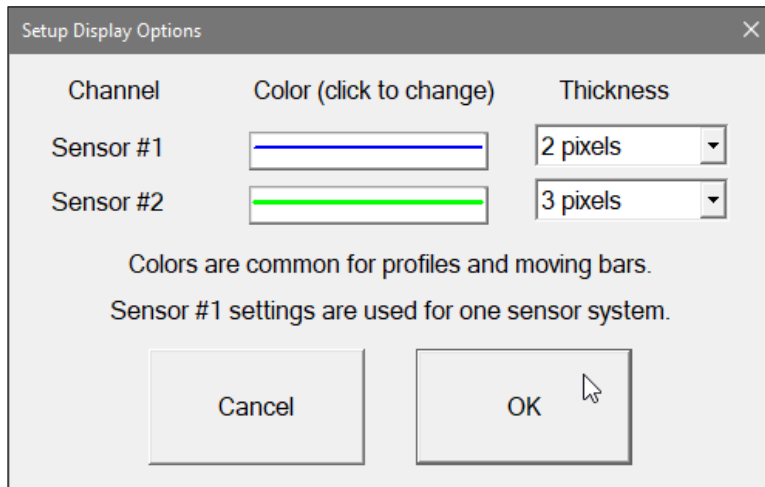


Figure 7.6: Profile Display Options dialog

Description of the Survey Setup dialog options and parameters.

### Color

To change color of the profile line and moving bar click on the corresponding button (with color line) labeled **Color (click to change)** as shown in Figure 7.7. The Color dialog will appear (Figure 7.8). 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 sensor 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 be updated. To cancel colour selection click on the **Cancel** button or press **Esc** key.

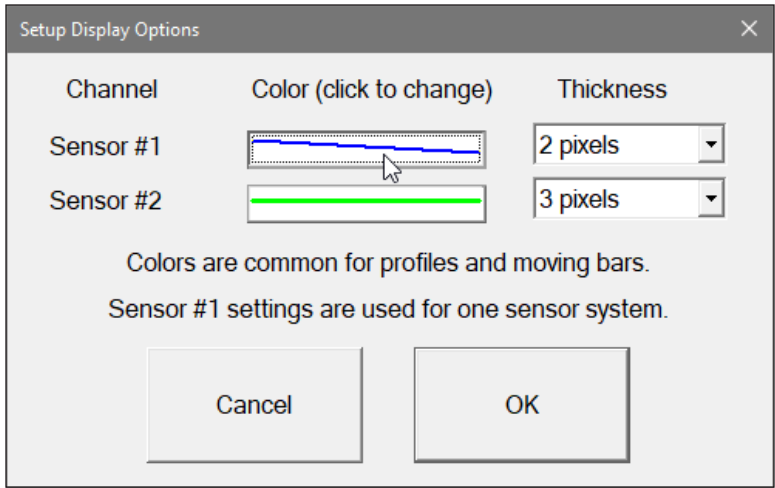


Figure 7.7: Clicking on the Color button

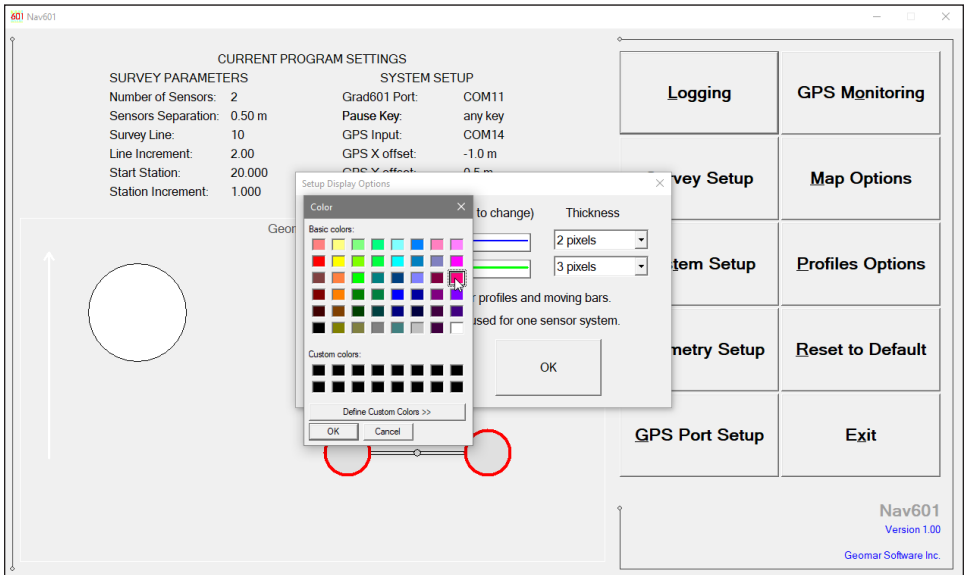


Figure 7.8: Selecting color of profile

**Thickness**

Specify thickness of a profile for a Grad601 sensor by using one of two 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 7.9). Select thickness by clicking on the desired selection. If keyboard is used activate text box by pressing TAB key (till the box is highlighted) and then by using **Up** or **Down** arrow keys select one of available items.

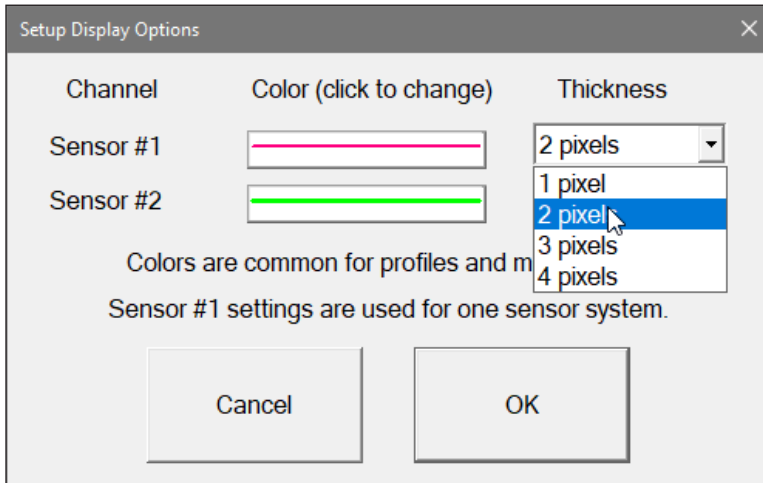


Figure 7.9: Selecting Thickness of Profile Line

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

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

# Logging

# 8

After the **Logging** button (in Main Screen) is clicked, or tapped, or executed by the keyboard, the program enters logging session and starts to read data from the connected Grad601 and GPS receiver. Logging session contains three modes: Monitoring, Stand By and Log. Further each of these modes can use Navigation or Profile mode of the display. If the GPS Input is disabled then only the Profile mode is available.

Program starts Logging session always in Monitoring mode and in Navigation display mode if GPS Input is enabled (Figure 8.1). In this mode Grad601 and GPS readings can be quickly examined. Stand By mode is similar to Monitoring mode, however different options are available. Recording of Grad601 and GPS data is allowed only in Logging mode, which is accessible from Stand By mode. In general, after the data file is created in the Monitoring mode, two modes Stand By and Logging are toggled by **Go** (Start) and **Pause** keys. In Stand By mode instrument outputs can be monitored and some survey parameters can be changed, and Logging mode is used only to record data.

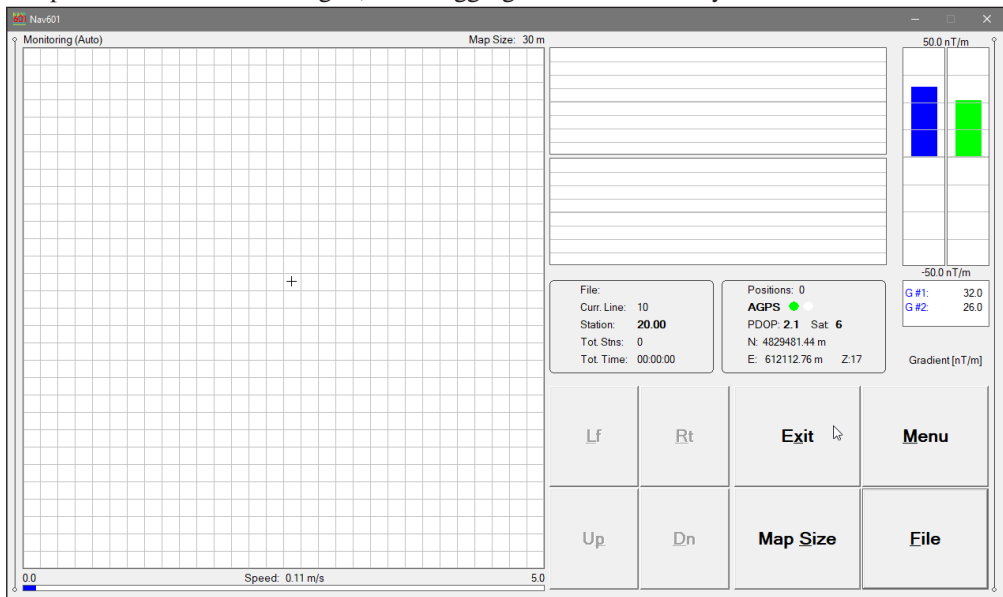


Figure 8.1: The Nav601 Monitoring screen in Navigation mode

It is assumed that all settings, especially assignment of serial ports, are correctly specified and instrument is turned ON prior to using this option. Navigation mode requires GPS input to register start of the map. In case GPS is not available for any reason a

message "Waiting for GPS..." will appear in the centre of the map. In case the instrument is OFF or it is not connected to the field computer numeric results window will be highlighted by red and label "Lost Connection.." will be displayed. If the program cannot open selected serial port (for Grad601 or GPS receiver) then a message shown in Figure 8.2 will appear. This message will not appear if option Grad601 in System Setup dialog is Disabled. Check program settings (System Setup), connection, or turn the instrument ON and select the Logging option again.

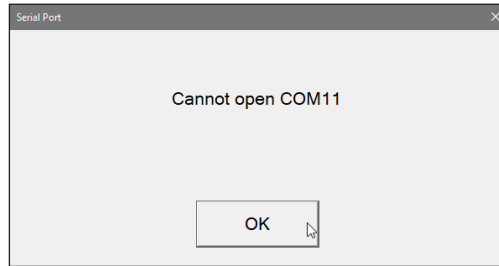


Figure 8.2: Cannot open port message

Assuming that instruments work properly the program will initialize connection with Grad601 and a screen in Monitoring mode will be displayed.

## 8.1 Logging Screen Layout in Monitoring Mode

---

The Nav601 Monitor mode allows initial inspection of the range of the instrument readings at the particular site, monitoring the instrument performance, monitoring number of available GPS satellites, GPS differential corrections, PDOP parameter status, and GPS coordinates (geodetic or UTM). Speed bar located at the bottom of the screen shows current instrument speed (over the ground) which is calculated based on GPS data.

The Grad601 readings in Monitoring and Stand By modes are updated approximately 14 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 Nav601 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 rate of Grad601 is used. The data processing program TrackMaker601 interpolates Grad601 position similarly to real time GPS interpolation.

## Navigation Mode

When the GPS Input is Enabled in GPS Port Setup menu then the program displays the screen in Navigation mode by default. The Nav601 Logging screen in Monitoring mode and Navigation display mode is shown below (Figure 8.3).

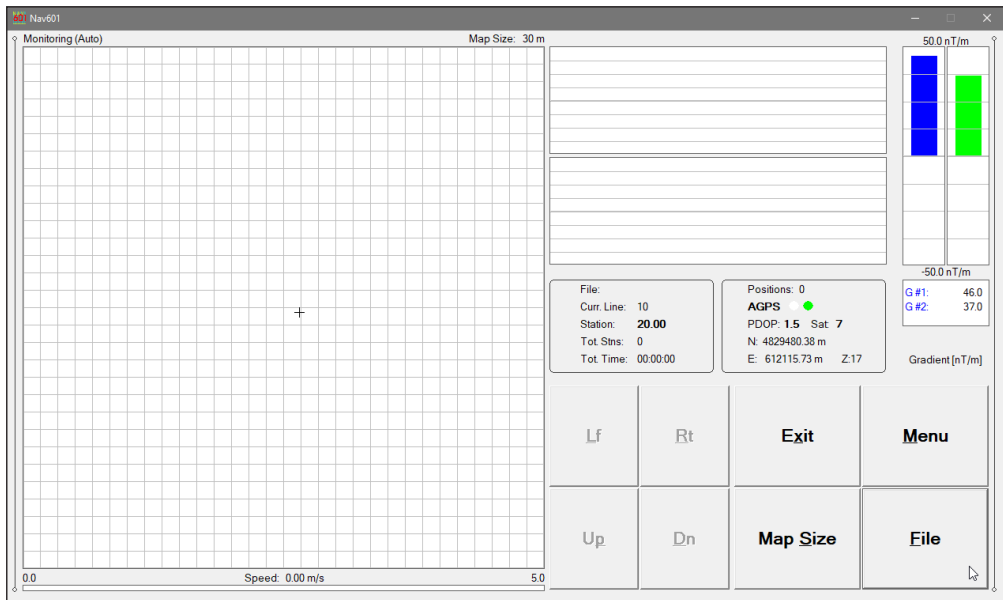


Figure 8.3: Logging screen in Monitoring (Navigation) mode

The left portion of the screen is occupied by the square plot area, a map, which presents current location of the system (based on GPS antenna position) in graphic form. This plot area will display all recorded positions during data recording. The side of the square corresponds to map size which is displayed at the top line of the screen, above the plot area. The size can be given in meters or feet depending on Units selection in the Map Options Setup dialog. Figure 8.3 shows map area that represents square 30 x 30 m. A cross mark indicating current position of the GPS antenna (or indicating position of the instrument if GPS offsets are zero) 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. Points or swath bars indicating sensors stations are plotted only in Log mode when Grad601 and GPS data are recorded in data file. The North direction always points to the top of the screen.

A window displaying profiles (drawn only during data logging) is located on the right side of the map and left of graphic moving bars. There are two sections (text boxes) be-

tween map and numeric display window, below profile window. The left box displays parameters associated with data file, and the right one is associated with GPS parameters.

The Monitoring screen will display GPS related information in five lines in the right text box below the profiles window.

The first parameter labeled Positions: indicates number of recorded positions in the data file. This number is increment only during data logging.

The second line displays label indicating actual corrections of GPS signal. 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. Other labels can be displayed: **RTK3** (Real Time Kinematic) when Quality Parameter is 3, and **RTK4**, **RTK5** (and so on for higher numbers associated with Quality parameter, for example 8 indicates WAAS correction in some receivers) for Quality parameters equal 4, 5 and above. On the right side of **DGPS**, **AGPS**, or **RTK** label two small circles are displayed. A colour of these circles should alternate between white and green with the frequency of GPS update rate (usually 1 second intervals), Figures 8.3. When GPS Warning Mask conditions are not met then circles will be displayed in red and white colours, Figure 8.4. 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). The PDOP is given when NMEA data messages GGA/GSA, GSK or POS were selected. If only message GGA is available, then index HDOP (labeled **HDOP**) will be displayed, and when LLK message was selected parameter GDOP (labeled **GDOP**) is displayed. The LLQ message will provide precision of positioning in meters and it is labeled by **X**. Refer to section 6 (Set Port for GPS), Appendix A, and to GPS manuals for more information about GPS parameters.

The label **Sat** and following number shows number of currently tracked satellites.

Coordinates are displayed in two bottom lines. Coordinates are always given in GPS native datum WGS1984 and they can be represented as geodetic (Latitude (N) and Longitude (W), values are given in degrees, minutes, and seconds with four decimal places), or UTM coordinates with units specified in the System Setup dialog.

The remaining portion of the monitoring screen display available options and parameters associated with the Grad601 output. The Grad601 output is represented by a small grid windows that includes one or two (depending on one or two sensors setup) moving vertical bars. The first (left) bar represents Sensor #1 (left) and the second corresponds to Sensor #2 (right). If one Grad601 sensor is used then only one moving graphic bar will be shown. Range of readings displayed in this grid can be adjusted (option Scale Readings), window with moving bars are labeled at the top and bottom (same range is

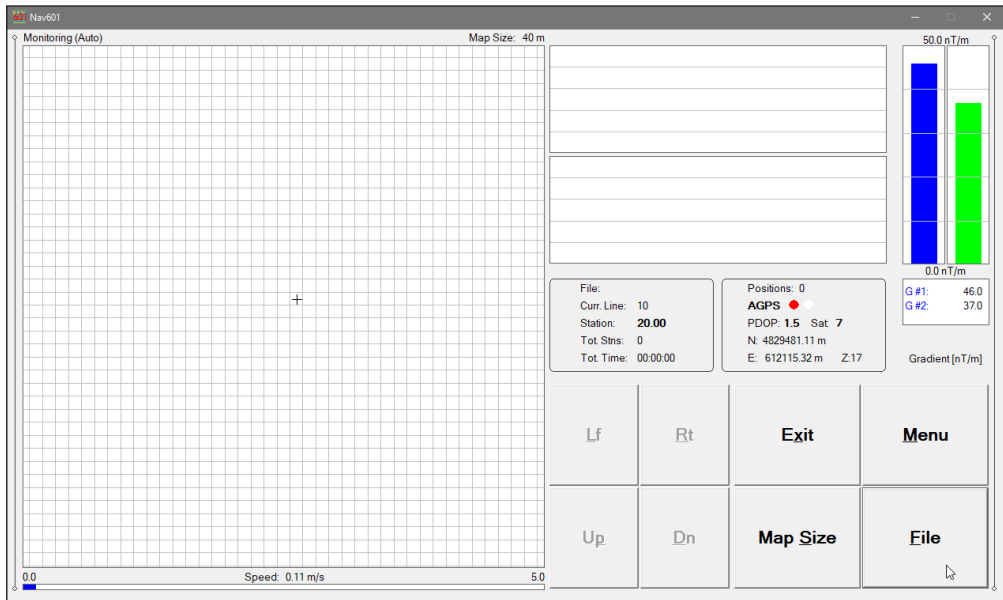


Figure 8.4: Logging screen in Monitoring (Navigation) mode - GPS Warning

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

Readings for one or two sensors are shown in numeric form in a window located below the grid with moving bars area. Data for sensors are labeled **G#1** and **G #2** correspondingly. Units of readings are in nT/m. Fiducial marker is represented by label **M**. Label **M** is displayed only when the marker is actually pressed by the operator.

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

Four command buttons panning buttons **Lf** (Left), **Rt** (Right), **Up**, and **Dn** (Down) are located next to the map. Panning buttons can be used to shift displayed map in four

directions. Above four command buttons are not enabled in Monitoring mode, they will be enabled and functional in Stand By mode after data file is created.

Four main and enabled command buttons (right bottom section of the screen) provide access to options available in Monitoring mode. These options are described below in the section 8.2.

## Profile Mode

When the GPS Input is Disabled in GPS Port Setup dialog then the program displays the screen in Profile mode. The same mode is displayed when GPS was Enabled and the operator used Toggle option to display program in Profile mode. The Nav601 Logging screen in Monitoring mode and Profile display mode is shown below (Figure 8.5).

The logging screen is essentially the same as described in Navigation Mode. The main difference is that the map is not displayed and profile plot area occupies most of the display. This area will contain profile curves for each recorded and selected (in Profile Options window) Grad601 sensor in graphic form. Scale is labeled at the top and bottom of the moving graphic bars window. Two text boxes are located on the left, below the profile view window. Four command buttons are placed along the display bottom and panning buttons are not shown.

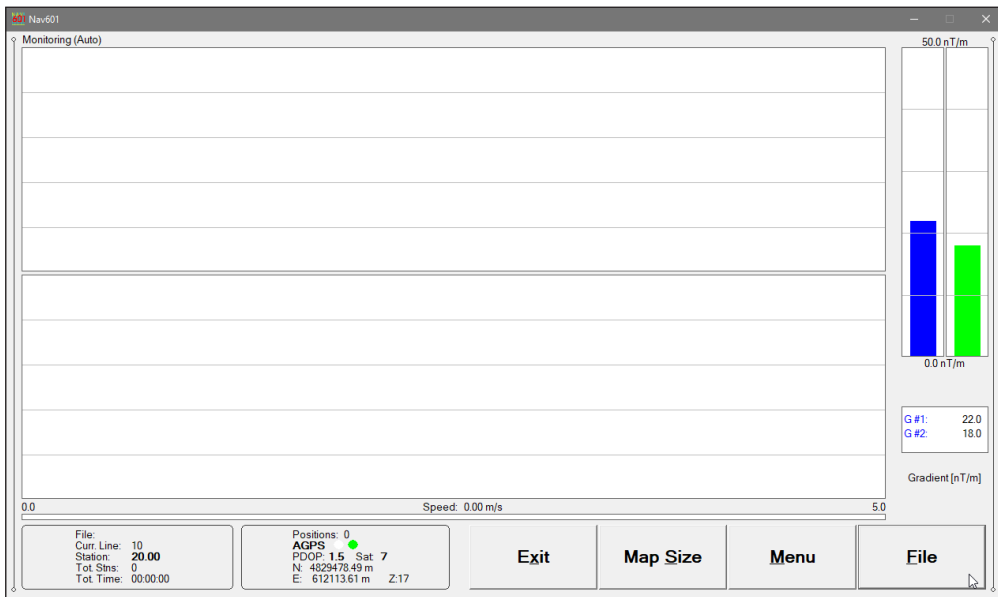


Figure 8.5: Logging screen in Monitoring (Profile) mode

## 8.2 Options Available in Monitoring Mode

Several options are available while the Logging window is in the Monitoring mode. Four frequently used options can be accessed directly from command buttons and others can be used from pop up menu activated by the button **Menu** (displayed in Figure 8.6). There are also four buttons associated with panning the map (Lf - shift Left, Rt - shift Right, etc.), however they are disabled in Monitoring mode. 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.

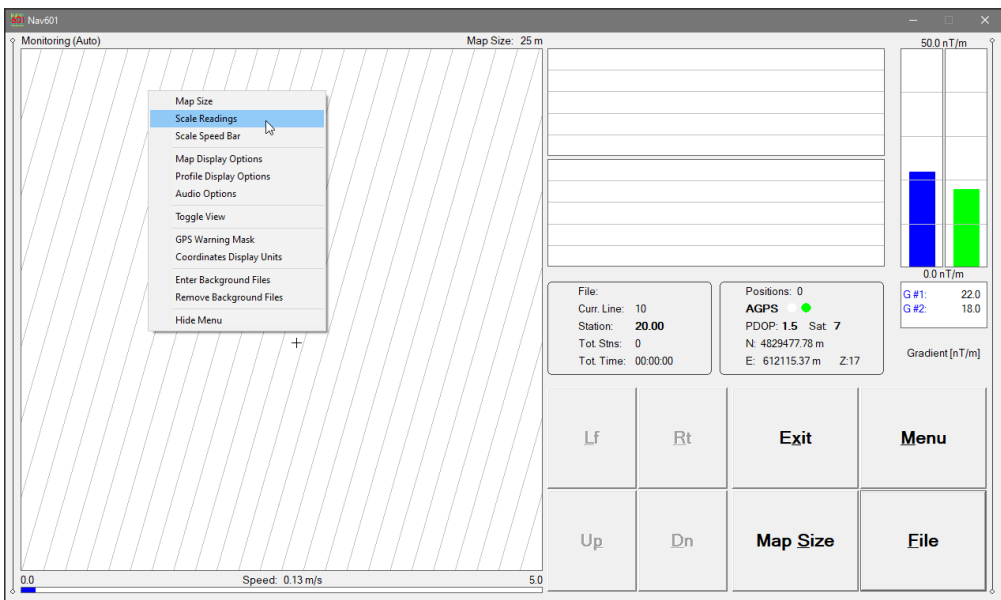


Figure 8.6: Logging screen in Monitoring mode with displayed pop up menu

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 **w** will display GPS Warning Mask dialog. While menu is displayed options can be selected by tapping on the appropriate item, or from the keyboard by pressing the shortcut keys or by navigating using **<Up>** and **<Down>** arrow keys and executing by **<ENTER>**.

**File** (create new data file)

The Nav601 data file can be created in any folder. The name of the file is given by the field computer clock and it consists of month (2 digits), day (2 digits),

hour (2 digits), and underscore followed by sequential three digits number (001, 002 and so on). (If all 1000 names during one hour are used specify any other name). The extension name of Nav601 data file is P61. The Create Data File dialog is presented in Figure 8.7.

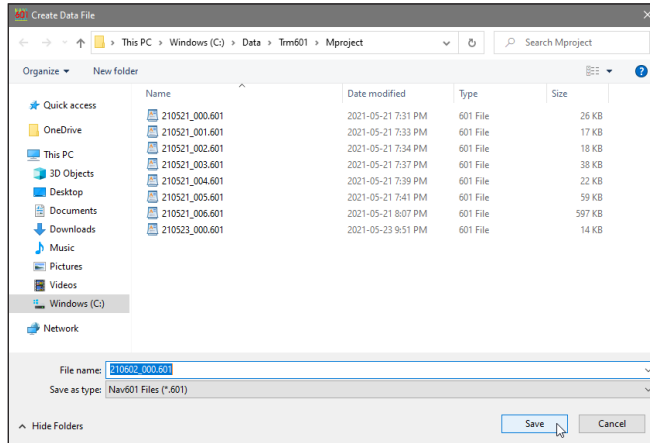


Figure 8.7: Create Data File dialog

The file name can be specified in the Create Data File dialog using the Windows standard interface procedure.

The Nav601 data files cannot be appended. In case specified data file name exists in the folder a proper message will be displayed (Figure 8.8), otherwise the screen will switch to Stand By mode (Figure 8.9) or Log mode (Figure 8.10). Maximum number of all positions in one data file cannot exceed 28,800 GPS positions while number of Grad601 readings is unlimited.

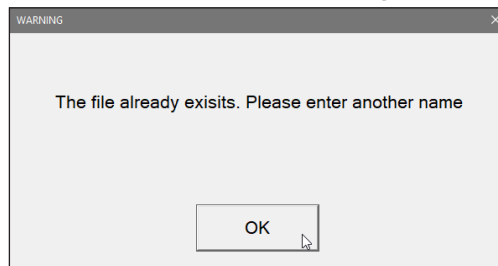


Figure 8.8: File name warning

Each data file in the field computer created by Nav601 has an extension name 601 (unless it is GXY file created when Grad601 was Disabled in the System Setup window). All 601 data files are created in the Nav601 binary format. They can be processed and exported to XYZ file format using the TrackMaker601 program. These files can be also exported to ASCII (text) format.

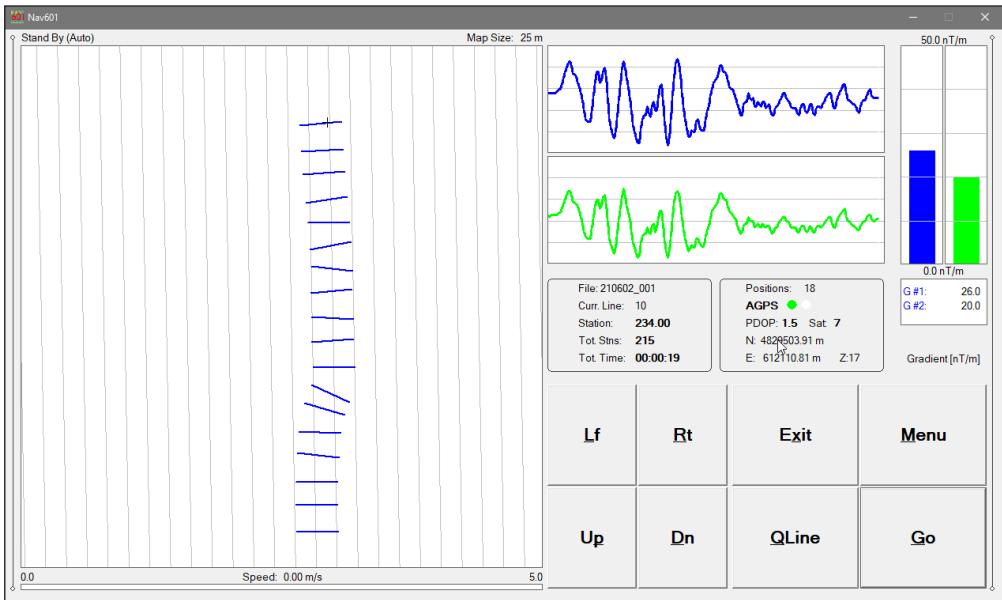


Figure 8.9: Stand By mode display after data file is selected and created in Monitor mode

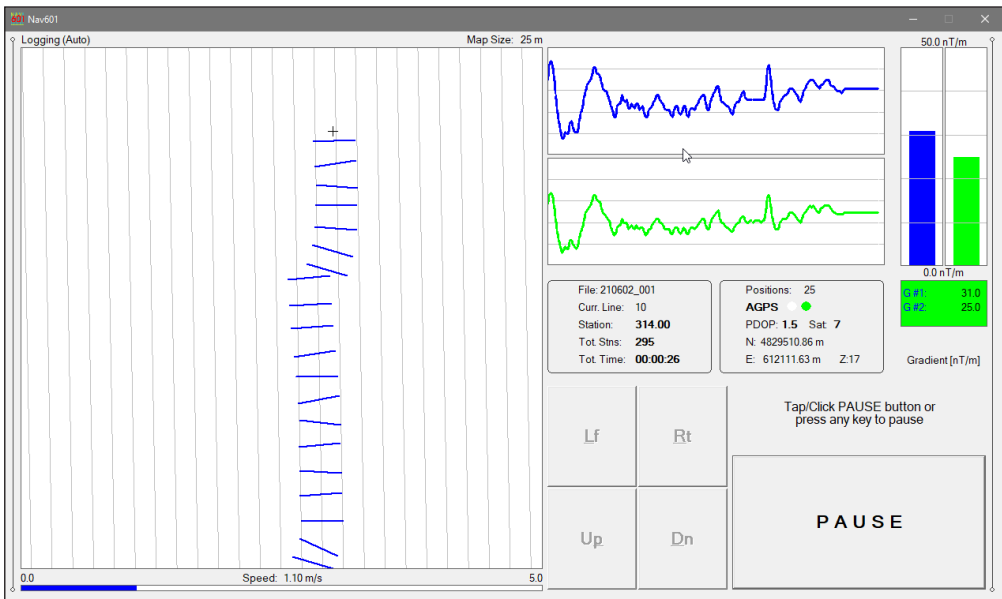


Figure 8.10: Log mode (data recording mode)

When a data file is created the program will switch to Stand By mode automatically (see section 8.3).

## Exit

The program immediately returns to Main Screen.

## Menu

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

### Map Size (Adjust scale of map)

This option is available by clicking on (or selecting by arrow keys) the pop up menu item labeled **Map Size** or directly from keyboard by using shortcut key **S**. The Map Scale dialog will appear on the screen, Figure 8.11.

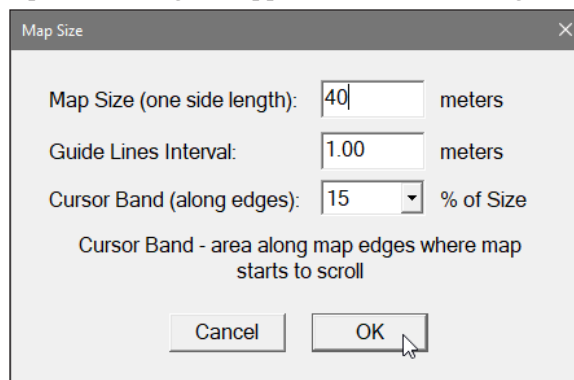


Figure 8.11: Map Scale dialog

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

Map scale value is entered either in meters or feet according to selected units in Logger Setup dialog and it represents side of the square map. Only positive integer values ranging between 1 and 99999 are allowed by the program.

The second parameter in the Map Size dialog is Grid Interval. These are grey grid lines in Mapping (and Navigation) mode which may be helpful in estimation of distance on the map displayed in Mapping mode. If Parallel Lines (with optional tilt angle) was selected in the Map Display Options dialog then the label for this option will be Line Interval and the entered value will be applied to distance between parallel lines (regardless of specified tilt angle). Setting Grid Interval to zero will not plot any grid lines on the screen.

The third parameter in the dialog is named Cursor Band. This parameter describes an inner band around the map perimeter that is always displayed. In other words, when cursor approaches and enters band area the map is scrolled. The band width is described by percentage of Map Scale. Six selections are

available in the combo box labeled **Cursor Band**: ranging from 10% to 40%. After parameters are specified click on the button **OK** or press **ENTER** key to accept new values and the map will be redrawn at a specified scale. To ignore an entry and return to Monitor mode click the button **Cancel** ( or X) or press **Esc** key, and the dialog window will disappear.

This option is available also in Stand By mode.

The map size and grid/line interval can be also set in the Map Display Options dialog by clicking on the corresponding item in the pop up menu.

### Scale Readings

This option is available by clicking on (selecting by arrow keys) the pop up menu item labeled **Readings Scale** or directly from keyboard by using shortcut key **R**. The Readings Scale dialog will appear on the screen, Figure 8.12.

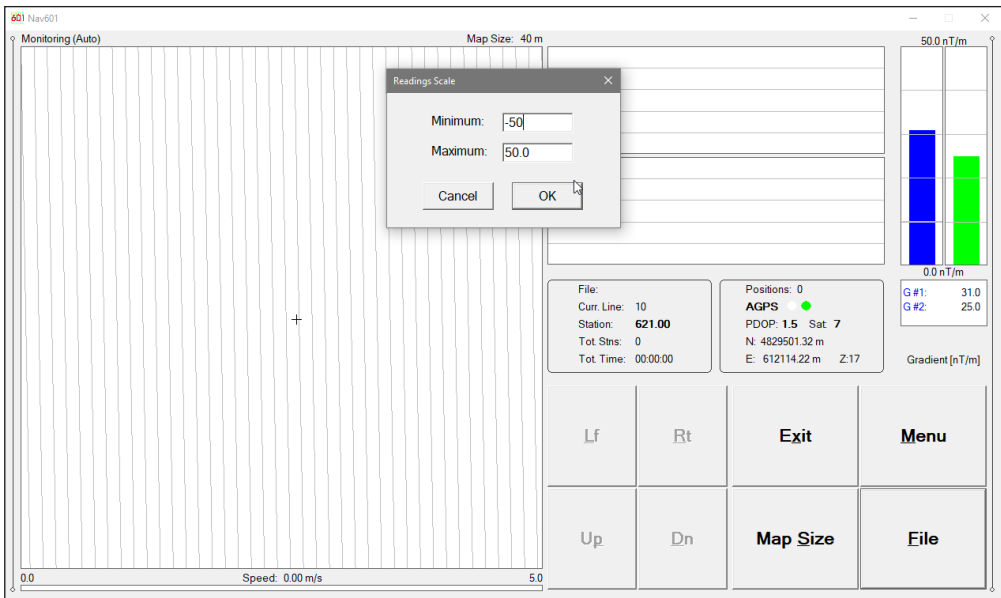


Figure 8.12: Reading Scale dialog

Two edit boxes labeled **Minimum** and **Maximum** allow you to set the amplitude range. Minimum and maximum values are specified for a pseudo-grid image in Mapping mode for the selected Grad601 channel, the plot range of all Grad601 channels in the window containing four moving bars as well as for the profile plot display. Therefore range of displayed data is the same for the Mapping mode, the profile display area and for the grid area with vertical bars. However only profile moving bars window is labeled at its top and bottom (Figure 8.12).

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

A colour bar representing colour distribution for mapping mode is provided on the left side of the screen. The colour bar is updated whenever Minimum or Maximum Response values are changed.

After the file is specified click on the button **OK** or press **ENTER** key to accept new values or cancel selection and by clicking on the **Cancel (X)** button.

### Scale Speed Bar

This option is available by clicking on (selecting by arrow keys) the pop up menu item labeled **Scale Speed Bar** or directly from keyboard by using shortcut key **B**. The Speed Bar Scale dialog will appear on the screen, Figure 8.13.

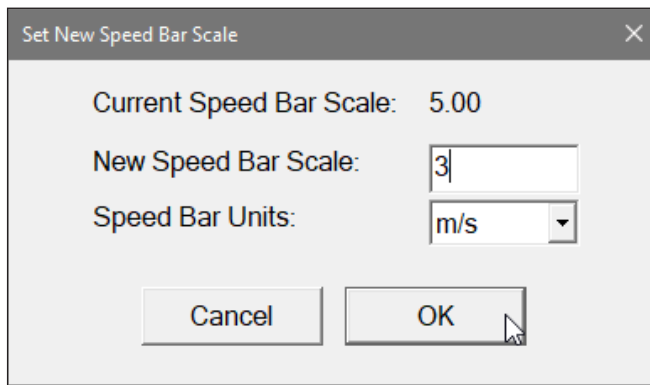


Figure 8.13: Set New Speed Bar Scale dialog

The minimum value for the Speed Bar is preset to 0, therefore this scale requires only entry for the maximum speed. 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 units can be selected in the combo box labeled Speed Bar Units.

After the maximum value for the speed bar is specified tap the button **OK** or press **ENTER** key to accept new values and the display will be redrawn. To cancel selection tap the **Cancel (X)** button or press **Esc** key.

### Map Display Options (Mapping and Navigation modes)

The Map Display Options dialog (Figure 8.14) is identical to a dialog described in detail in Chapter 7. If the program is in the Mapping or Navigation mode, please refer to section 7.1 of the manual.

Please note that two options: Map Units and Map Swath while available when this dialog while called from Main Screen (before Logging session) are not

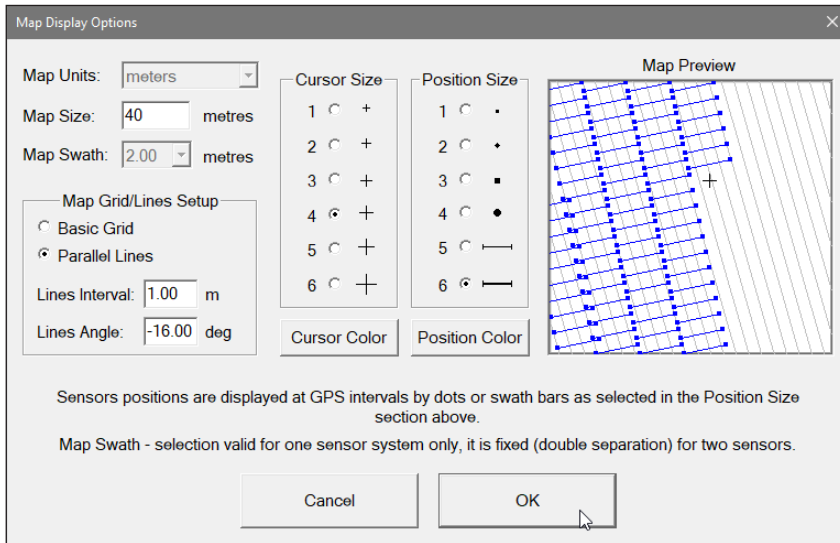


Figure 8.14: Map Display Options dialog

available in Monitor (and Stand By) mode. This option can be accessed from pop up menu or directly by the keyboard by pressing **D** key.

### Display Options (Profile display options)

The Setup Display Options dialog is described in detail in Chapter 7. This dialog allows you to specify color and thickness of profiles (same colours apply to moving bars). The dialog is presented in Figure 8.15.

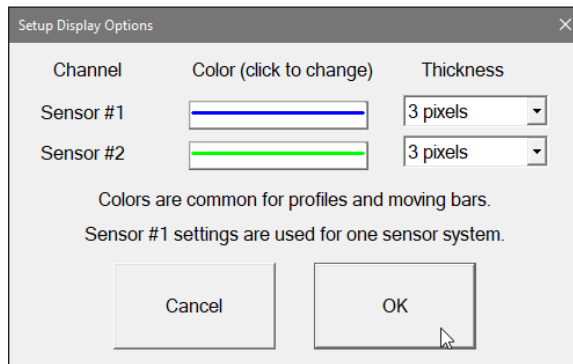


Figure 8.15: Setup Display Options dialog

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 configuration 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 8.16.

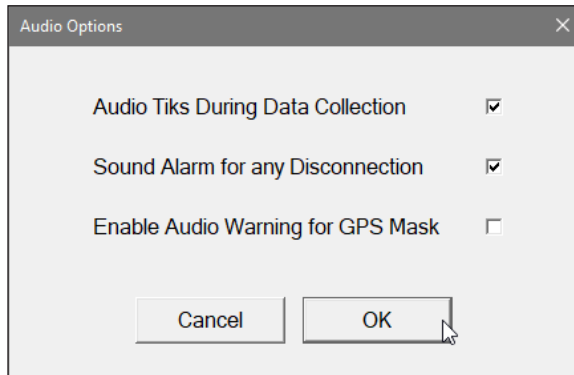


Figure 8.16: Audio Options dialog

Parameters in Audio Options dialog are described below.

#### Audio Tiks During Data Collection

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

#### Sound Alarm for any Disconnection

The program will sound loud ring when a disconnection in any serial port is detected by the program, or in case any Grad601 console or GPS receiver will stop streaming data for any reason. The audio alarm func-

tion 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 8.16.

### Enable Audio Warning for GPS Mask

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

### Toggle View (toggle between Mapping and Profile modes)

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

### GPS Warning Mask

This option is available by clicking on (selecting by arrow keys) the pop up menu item labeled **GPS Warning Mask** or directly from keyboard by using shortcut key **W**. The GPS Warning Mask Scale dialog will appear on the screen. 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 8.17. Parameters in GPS Warning Mask are described below.

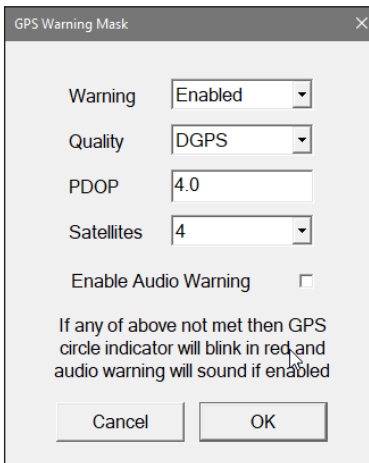


Figure 8.17: GPS Warning Mask dialog

## **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 (Figure 8.4). In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours (Figure 8.12) regardless of GPS signal quality.

All GPS data is logged, GPS Warning Mask affects only display.

## **Quality**

This parameter describes Quality Indicator (degree of differential corrections). Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: AGPS (Raw), DGPS, RTK3, RTK4, RTK5, and so on.

If Quality Indicator received from GPS receiver will be worse than specified then GPS indicator will alternate in red and white colours.

## **PDOP**

This parameter can be labeled PDOP, HDOP, DOPG, DOP depending on the selected NMEA message. It can be also named Quality m (accuracy in meters) if LLQ was selected, or it is not available (labeled N/A) when messages GLL or any RTS (including pseudo-GGA) are used. Activate text box by Clicking 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 on the **Cancel (X)** button or press **Esc** key. All parameters will be reset to initial settings.

### Coordinates Display Units

The Set Coordinates Display Units dialog will be displayed, Figure 8.18. There are four items after the combo box labeled Coordinates unit will be expanded: Geodetic Lat/Lon (coordinates in Degrees, Minutes, Seconds), UTM meters, UTM feet (International Feet), and UTM US Feet (US Survey Feet). Select one of items and coordinates of the GPS antenna will be displayed in the GPS section (bottom of the logging screen) in selected units.

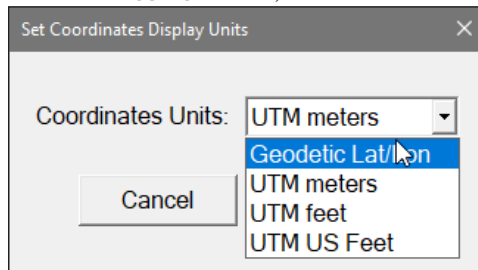


Figure 8.18: Set Coordinates Display Units

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

### Enter Background File

The Load Background File dialog is shown in Figure 8.19. 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, Figure 8.20. 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

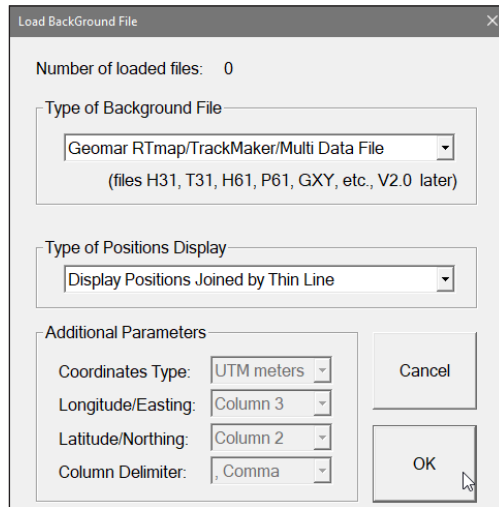


Figure 8.19: Load Background File dialog

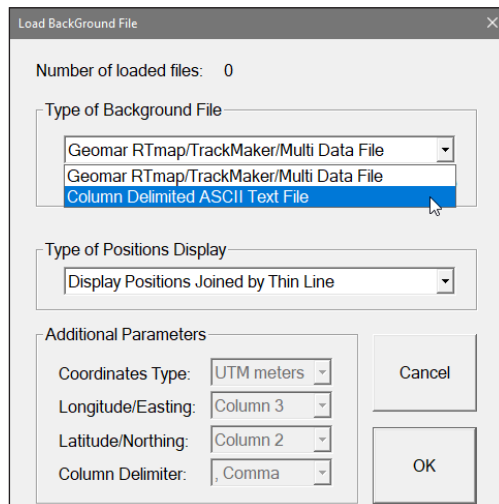


Figure 8.20: Select Type of Background File dialog

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 8.21. 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.

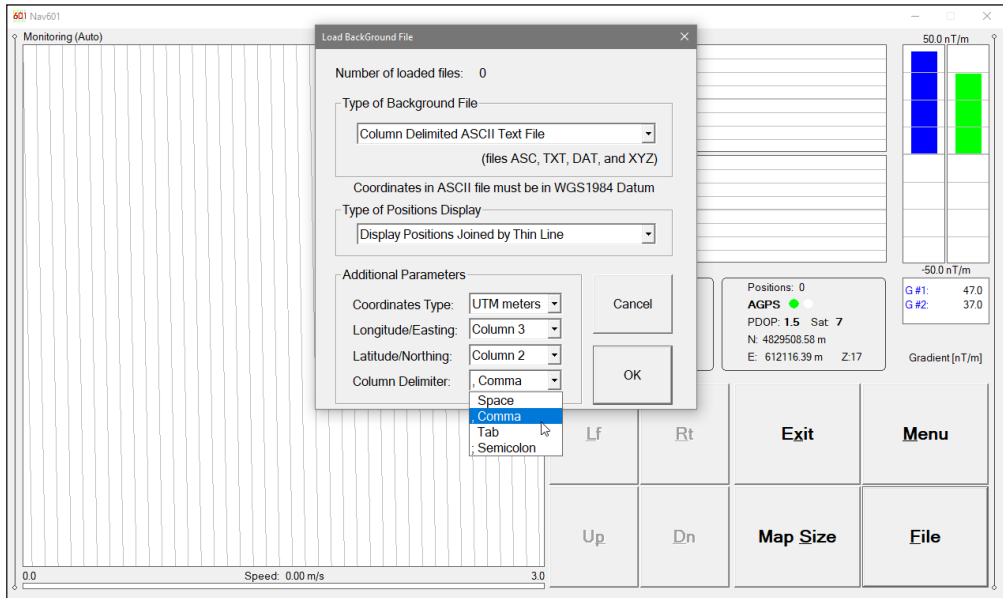


Figure 8.21: Selecting Column Delimiter in Column Delimited File to be loaded.

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 8.22.

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 Nav601 screen with two background files (both Column Delimited type) and one data file positions (from previous logging session) is shown in Figure 8.23.

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

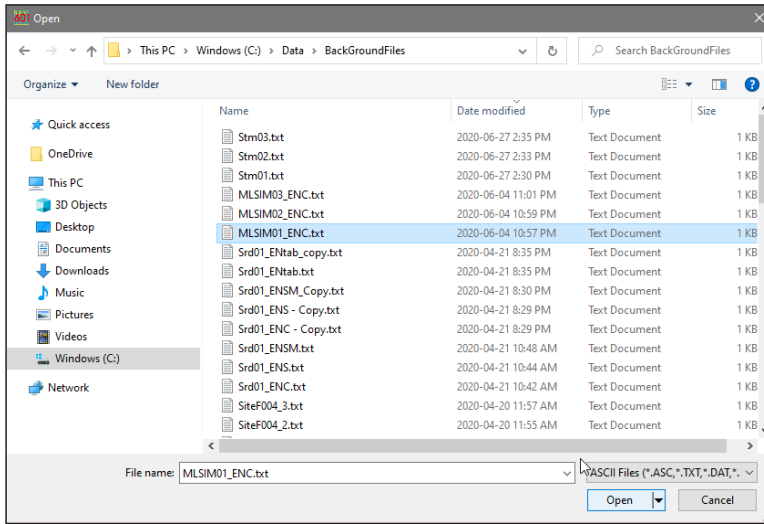


Figure 8.22: Selecting Background File

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.

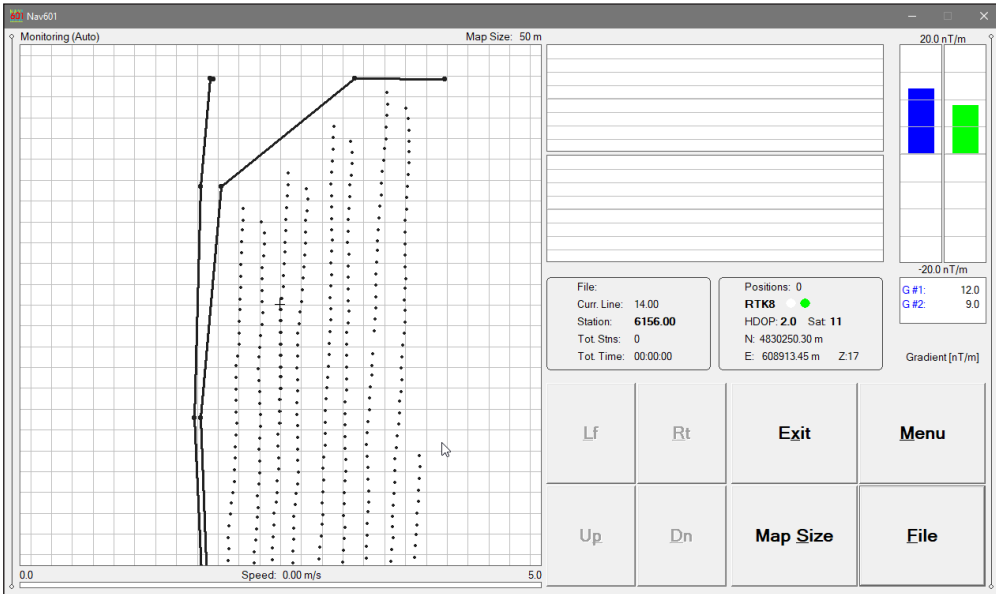


Figure 8.23: Three background files displayed in Nav601 Monitoring mode

## Remove Background Files

After this option is executed the Remove Background Files dialog appears, Figure 8.24. 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.

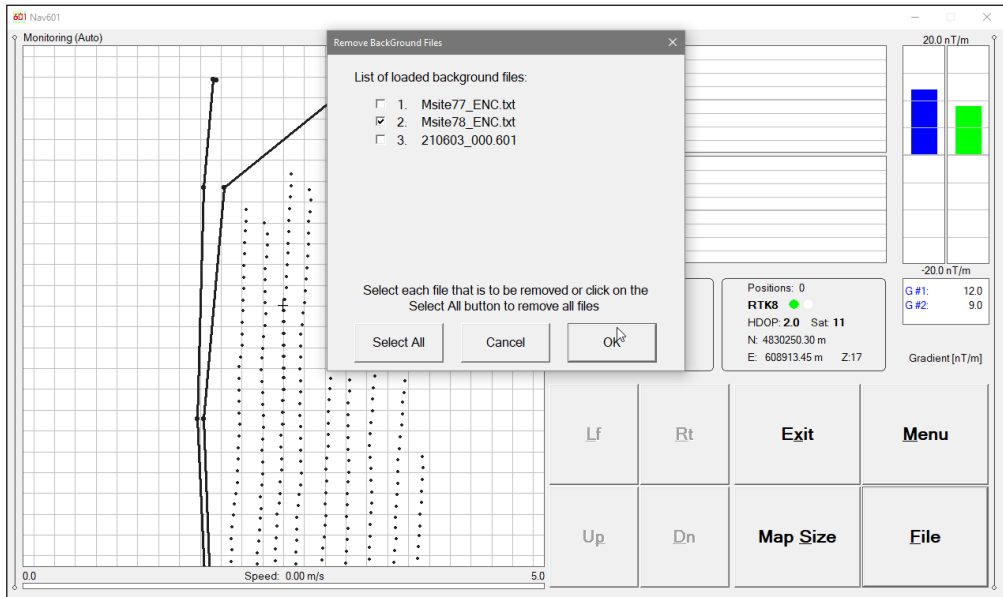


Figure 8.24: Remove Background Files dialog

## 8.3 Stand By Mode

The main difference between the Monitoring and Stand By modes is that from the Stand By mode the program can be directly switched to Log mode to record the data in the data file. The Nav601 screen in Stand By mode and Navigation mode is shown in Figure 8.25 and 8.26 (with swath bars and dots). When two sensors are used and positions are displayed as dots each position is represented by two dots, each dot is associated with location of corresponding sensor centre. When one sensor is used then single dot represents each position. The layout of the screen is almost identical to the layout described in section 8.1. Main differences are: label **Stand By (Auto)**, reminding the operator about current logging mode and survey mode (in this case Auto), different command but-

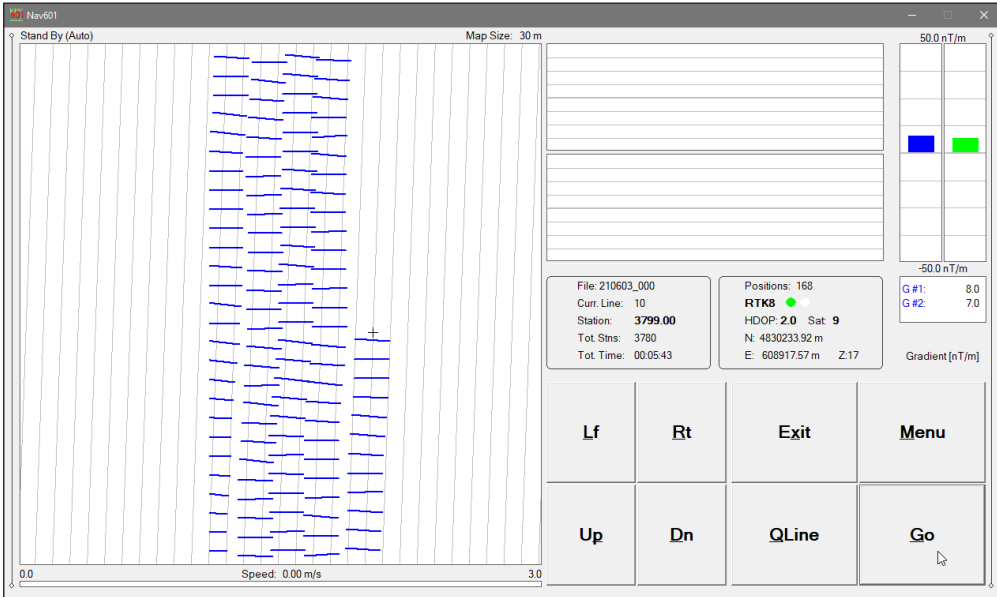


Figure 8.25: Nav601 in Stand By mode and Navigation display (swath bars - each bar has width of two sensors separations)

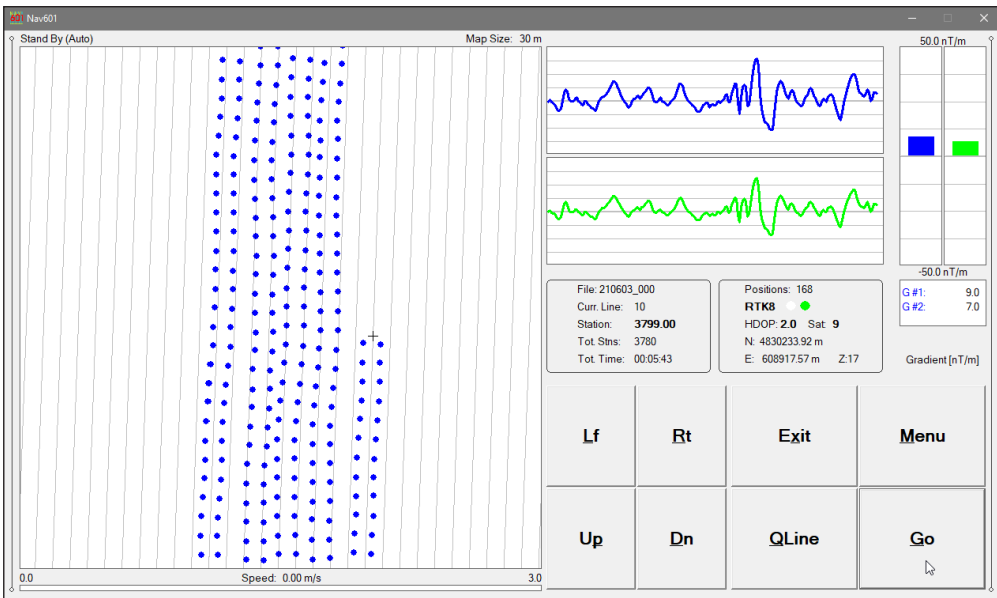


Figure 8.26: Nav601 in Stand By mode and Navigation display (dots showing each of two sensors)

tons, contents of two text frame boxes at the bottom of the profile window which display parameters specific to survey settings. The first frame box includes parameters related to file contents: File Name, Current Line Name, Station (current station number), Tot. Stns (total number of stations in file), Tot. Time (total elapsed time of recording). The second frame box described in section 8.1, contains parameters associated with GPS input.

Example shown in Figures 8.25 and 8.26 presents situation where the operator continues to walk in the N-S direction while logging data and then stopped logging data 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 GPS locations will not be plotted.

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

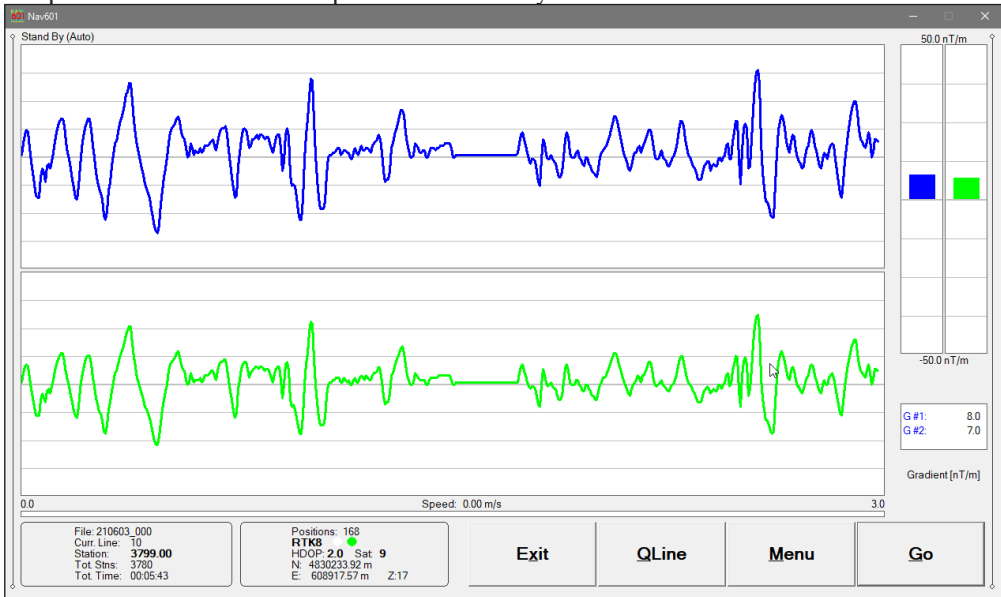


Figure 8.27: Nav601 in Stand By mode and Profile display mode

The Grad601 data displayed in the window with moving graphic bars and by numeric values will be displayed with the update rate approximately 12 readings per second, however data will not be saved in the log file in Stand By mode. If GPS input was enabled, GPS positions and parameters will be updated with a rate specified in GPS receiver. GPS data are not saved in file in Stand By mode as well.

Four command buttons available in Stand By mode include: **GO** (executed by clicking or tapping, or pressing key **G** or **ENTER** if the button is highlighted) 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). All command buttons are enlarged as compared to previous program versions to provide easier operation for field computers equipped with touch screen displays. The **Exit** button was moved away from display corner to avoid accidental touch of this button.

Options associated with command buttons are described in detail in Section 8.5 (Field options available in Stand By mode).

## 8.4 Logging Mode

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The Logging mode is enabled by clicking or tapping on the **GO** button or pressing the shortcut key **G** (or the **ENTER** key if the button **GO** is highlighted) in Stand By mode. After this button is executed the list of four buttons will be replaced by one large button labeled **Pause**, label **Stand By** will be replaced by label **Logging** (at the top of the display) and data will be logged in the mode corresponding to the selected Grad601 mode in the Survey Setup menu. 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 Nav601 screen in Logging mode and in Mapping display mode is presented in Figure 8.28. The cross mark corresponding to the system location will move while the operator is progressing along the survey line and recorded GPS positions will be plotted as swath bar or dots representing sensors on the screen. At the same time profiles will be plotted in panels located right to the map plot area.

The Enter Review button as well as all four panning buttons Left, Right, Up, and Down are not accessible and they are disabled while program is in Logging mode.

If the program's display was toggled in Stand By mode to Profile display mode or if GPS was disabled in GPS Input menu the Nav601 Profile display mode will be used as shown in Figure 8.27.

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

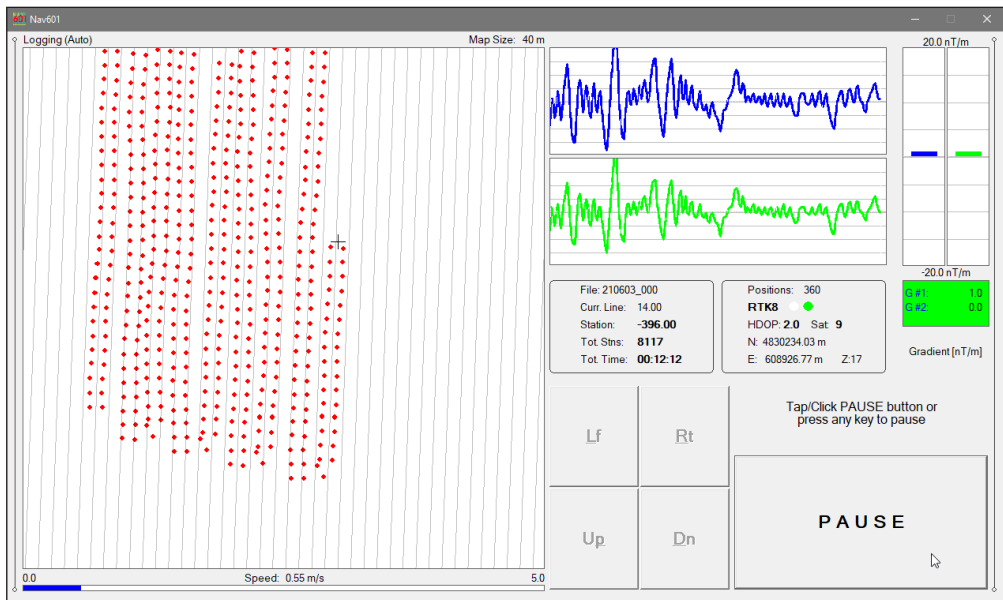


Figure 8.28: Nav601 in Logging mode and Navigation display mode

After the screen changes from Stand By mode to Logging mode survey parameters are updated according to the station interval. Similarly, if GPS input was enabled, total number of GPS positions in the data file is increment every time (usually once a second) GPS position is written to the file. Profile plots, amplitude of graphic bars in plot area and readings displayed in numeric form for each instrument are updated after each reading is written to the data file. In addition, background of numeric values window changes to green. The green background serves as a visual indicator that data is recorded, if it is white please check if the Pause button was not accidentally pressed during logging. The audible tik sounds at frequency approximately 3 Hz if Tik Sound option was enabled in the Logger Setup menu. The Map plot is updated with GPS input frequency and Profile display mode is updated at each Grad601 reading.

There is only one option available in the Logging mode - PAUSE logging. After the button labeled **PAUSE** is tapped or a Pause key selected in the Logger Setup dialog is pressed the recording is stopped and the Logging screen returns to the Stand By mode. In the Stand By mode the Grad601 data will be displayed with the update rate approximately 10 readings per second, however data will not be saved in the log file, profile plots will not be updated (in Profile mode). 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. Four frequently used options can be accessed directly from command buttons (Go, Qline, Exit, and Menu) and others can be used from pop up menu activated by button **Menu** (displayed in Figure 8.29). Command buttons can be used by clicking 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.

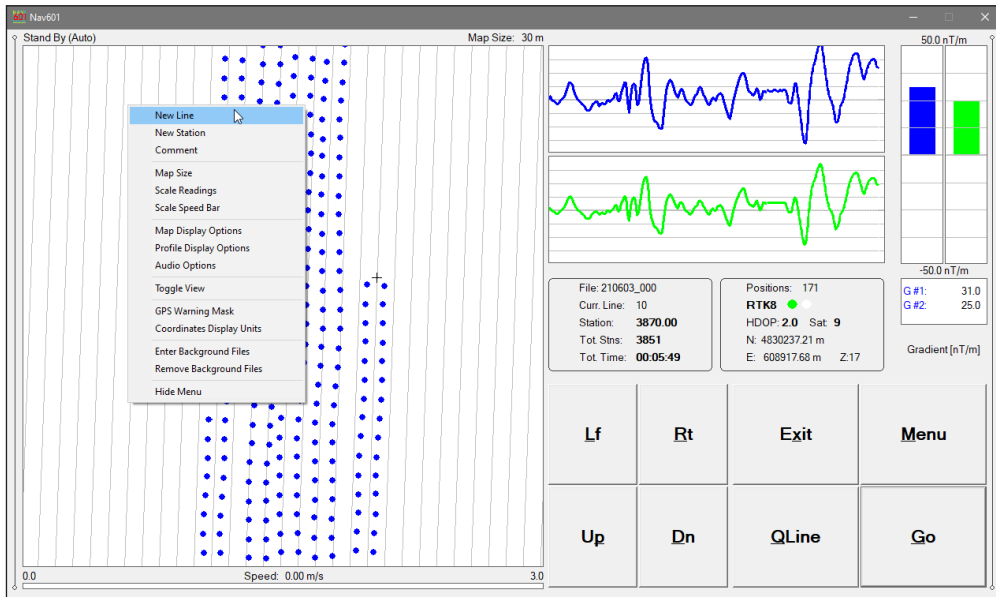


Figure 8.29: Nav601 in Stand By mode with pop up menu

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

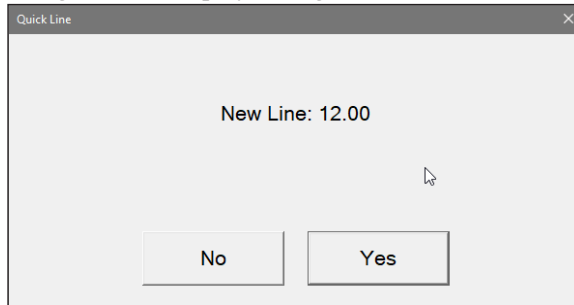
### **GO** (start data logging)

Click on the **GO** button, or while using the keyboard press shortcut key **G** or if the button is a default button (highlighted) press **ENTER** key. The logging

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

**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 8.30.



*Figure 8.30: Quick Line Confirmation message*

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.

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 clicked then the program will continue survey along existing survey line.

**New Line** (New Survey Line)

This option is available from pop up menu or from the keyboard by using short-cut key **L**. The New Line dialog is displayed, Figure 8.31. Selecting this option allows the operator to enter a new survey line number (name) and (as opposite to Quick Line described above) to change associated line parameters (Line Increment, Line Sequence, Direction, Start Station, and Station Increment). The new line number and associated parameters are prompted by the program based on parameters specified in the Survey Setup menu and the last survey line. At the top of the dialog the last survey line name and the last logged station are displayed. Default name for the new line is given based on the Line Increment

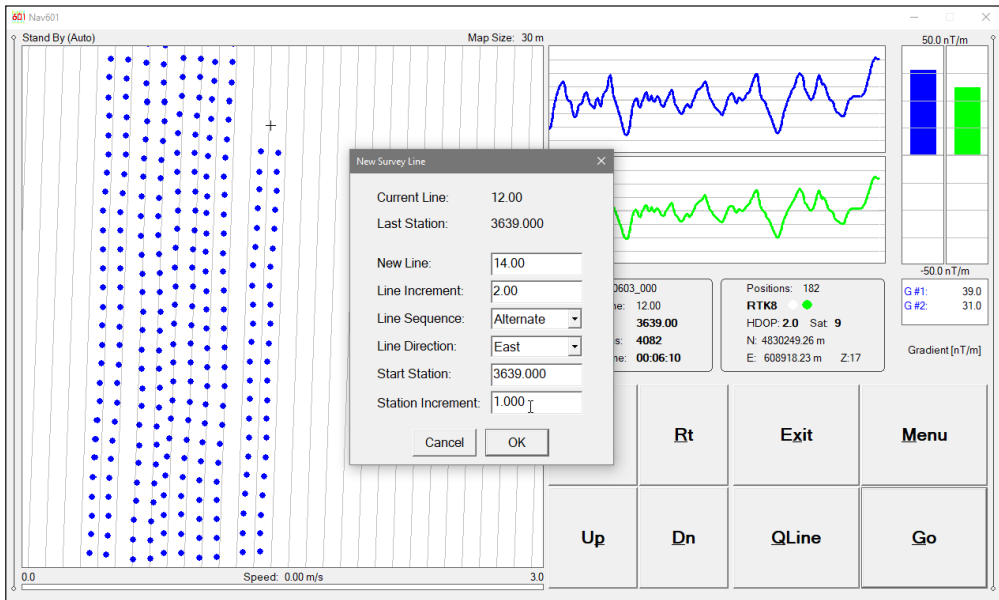


Figure 8.31: The New Survey Line dialog

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 (**Line:**) name and current station (**Station:**) value will be updated and if the program is in Profile mode then profile curves plot for former survey line will disappear.

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

### New Station

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

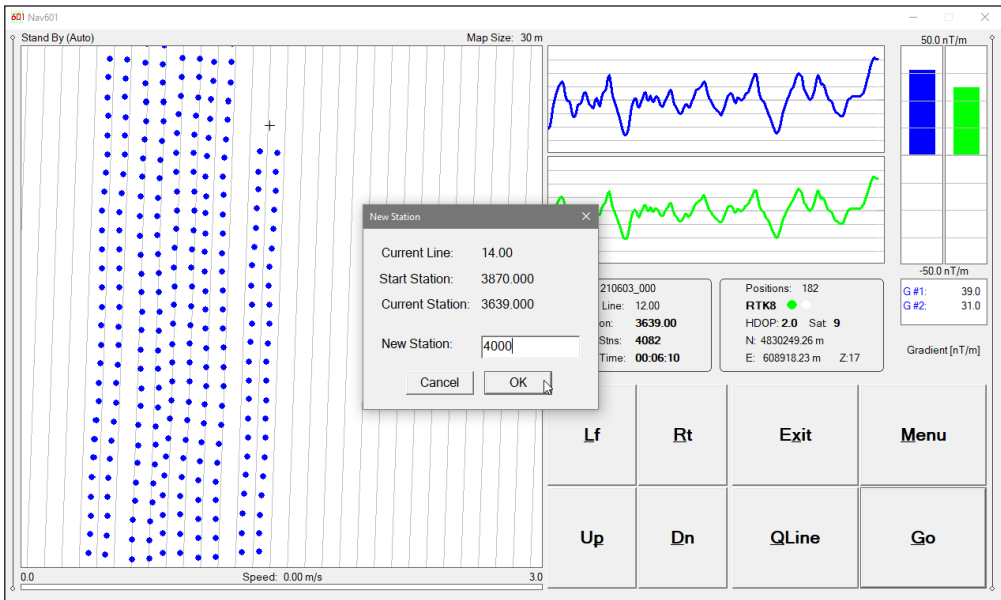


Figure 8.32: New Station dialog

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.

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

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

To return to Stand By mode and current survey line settings (state before this dialog was selected) click on the **Cancel** (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 8.33.

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.

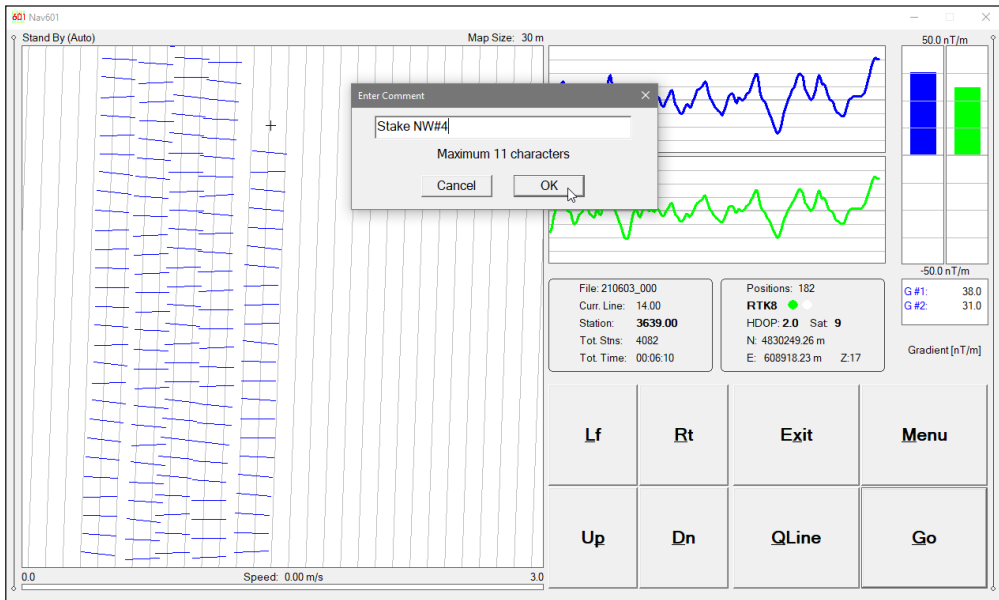


Figure 8.33: Enter Comment dialog

To ignore an entry and return to Stand By mode click on the **Cancel (X)** button or press **Esc** key, the dialog window will disappear and measurements can be continued.

### Map Size

This option is available by clicking on (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 8.34.

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

Map scale value is entered in the edit box labeled **Map Size** either in meters or feet according to selected units in System Setup dialog and it represents side of the square map. Only positive integer values ranging between 1 and 99999 are allowed by the program.

The second parameter in the Map Size dialog is **Grid Interval** or **Lines Intervals** depending on the selection (Grid or Guide Lines) in a Map Display Options dialog. These are grey grid lines in the map plot area that may be helpful in estimation of distance on the map displayed in Mapping or Navigation mode. Grid Interval equal zero will result in lack of grid lines.

The third parameter in the dialog is named Cursor Band. This parameter describes a band around map perimeter that is always displayed. In other words, when cursor approaches and enters band area the map is scrolled. The band

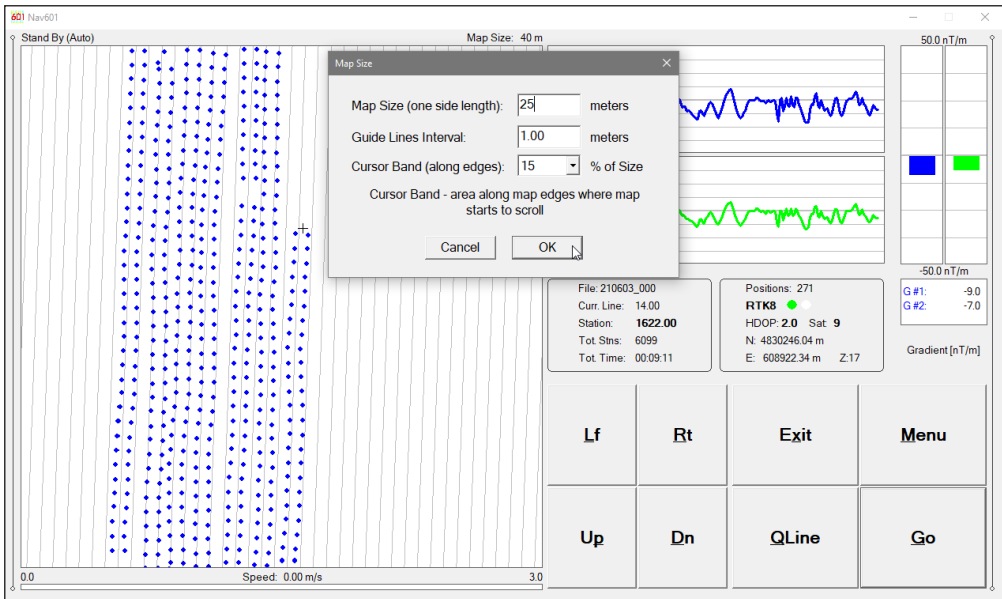


Figure 8.34: Map Size dialog, current Nav601 map at size of 40 m

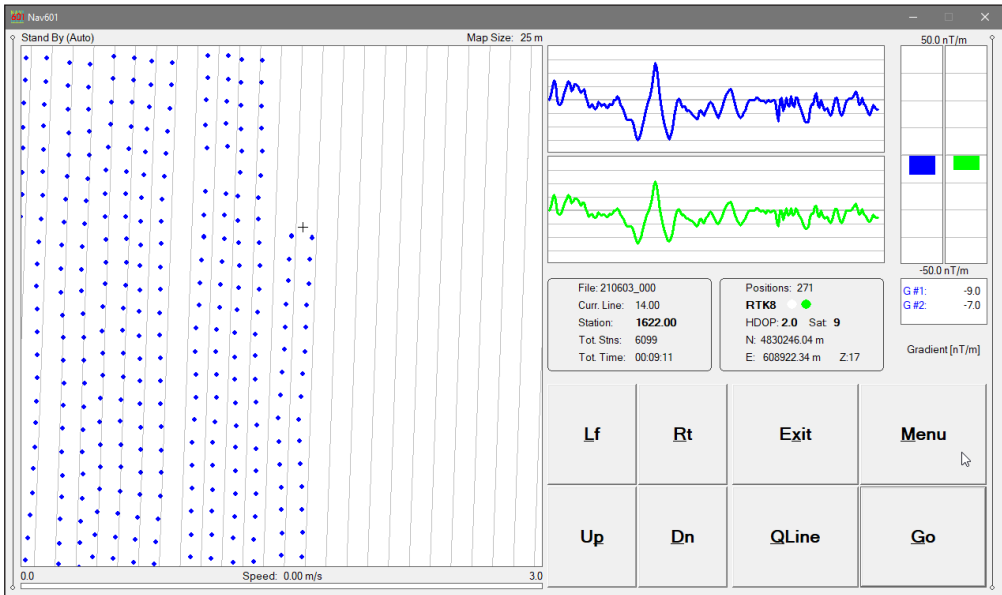


Figure 8.35: Nav601 in Stand By mode after re-scaling map to 25 m size

width is described by percentage of Map Scale. Five selections are available in the combo box labeled Cursor Nand: 10%, 15%, 20%, 25%, 30%, and 40%. At 40% cursor indicating GPS antenna is mostly in the center area of the map. After parameters in Map Scale dialog are changed click on the button **OK** or press **ENTER** key to accept new values and the screen with a new map scale will be redrawn at a specified scale, see Figure 8.34 (Map Size 40 m) and compare with Figure 8.35 (Map Size 25 m) and Figure 8.36 (Map Size 100 m). Re-drawing the map may take few seconds (prompt "Please Wait" is displayed), depending on parameters and number of data points collected in data file.

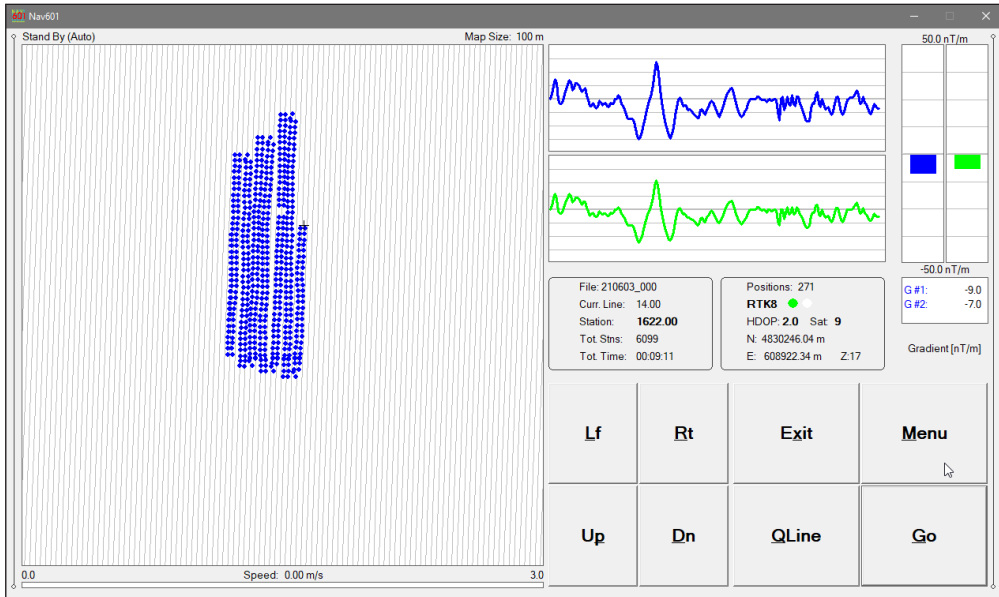


Figure 8.36: Nav601 in Stand By mode after re-scaling map to 100 m size

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

### Scale Readings (Adjust scale for profiles and moving bars)

This option is available by clicking on (selecting by arrow keys) the pop up menu item labeled **Readings Scale** or directly from keyboard by using shortcut key **R**. The Readings Scale dialog will appear on the screen, Figure 8.37.

Two edit boxes labeled **Minimum** and **Maximum** allow you to set the amplitude range for Grad601 sensors in windows containing moving bars as well as for the profile plot display. Range of amplitude is the same for moving bars and profiles however moving bars window is labeled only (Figure 8.37).

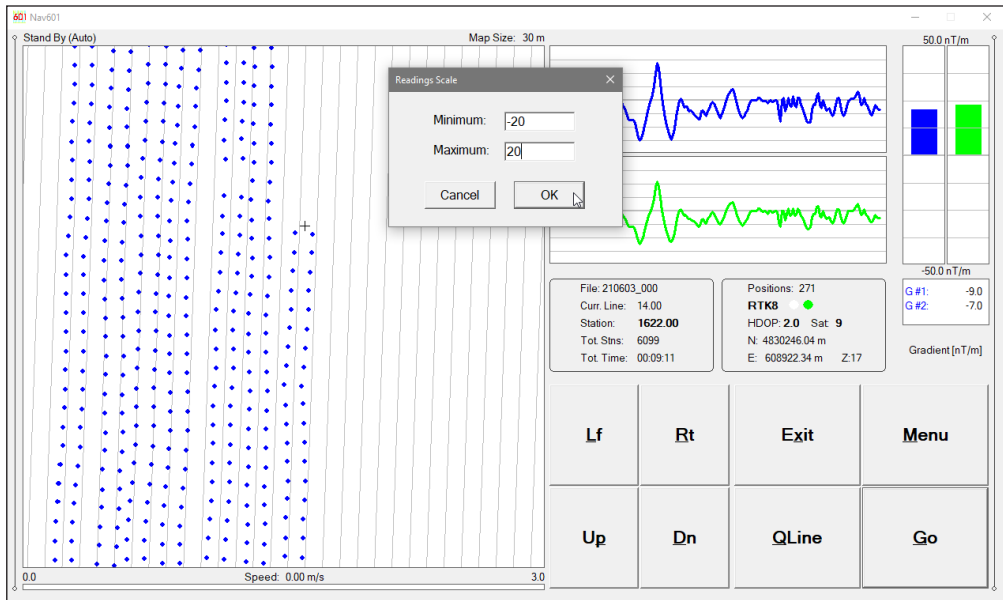


Figure 8.37: Readings Scale dialog, in the background the current Grad601 amplitude range from -50 nT/m to 50 nT/m

After minimum and maximum response values are specified and dialog changes are accepted by clicking on the button **OK** or pressing **ENTER** key the display will be redrawn.

To cancel selection click on the **Cancel (X)** button or press **Esc** key.

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

This option is available by clicking on (selecting by arrow keys) the pop up menu item labeled **Scale Speed Bar** or directly from keyboard by using shortcut key **B**.

The Speed Bar Scale dialog will appear on the screen, Figure 8.38.

Minimum value for the Speed Bar Scale is preset to 0, therefore this scale requires only one entry for maximum speed. Speed units (selection contains: m/s, ft/s, km/h, and mph) can be also changed in this dialog.

The entered scale applies only to graphic representation of the speed (graphic bar), speed in numeric form is always displayed above the bar.

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 (X)** or press **Esc** key, and the dialog window will disappear.

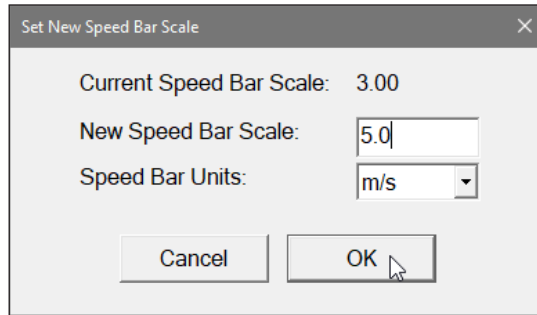


Figure 8.38: Set New Speed Bar Scale dialog

### Map Display Options (Mapping and Navigation modes)

The Map Display Options dialog is identical to dialog described in detail in Chapter 7 (please refer to section 7.1 of the manual) when measurements are conducted with GPS positioning and the program works in Mapping or Navigation mode.

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

The Map Display Options dialog is shown in Figure 8.39. Figures 8.40 and 8.41 below present various setups for Navigation mode. Please compare Figures 8.40 (where dots represent Grad601 positions) and Figure 8.41 (Navigation mode with swath bar presentation).

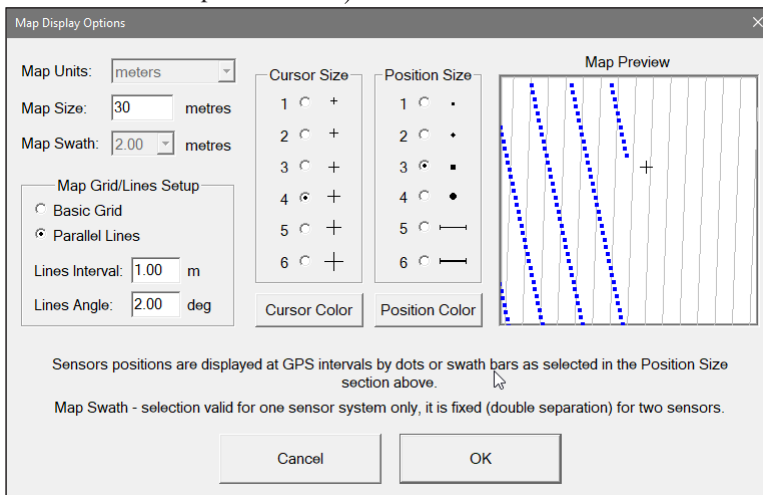


Figure 8.39: Map Display Options dialog

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

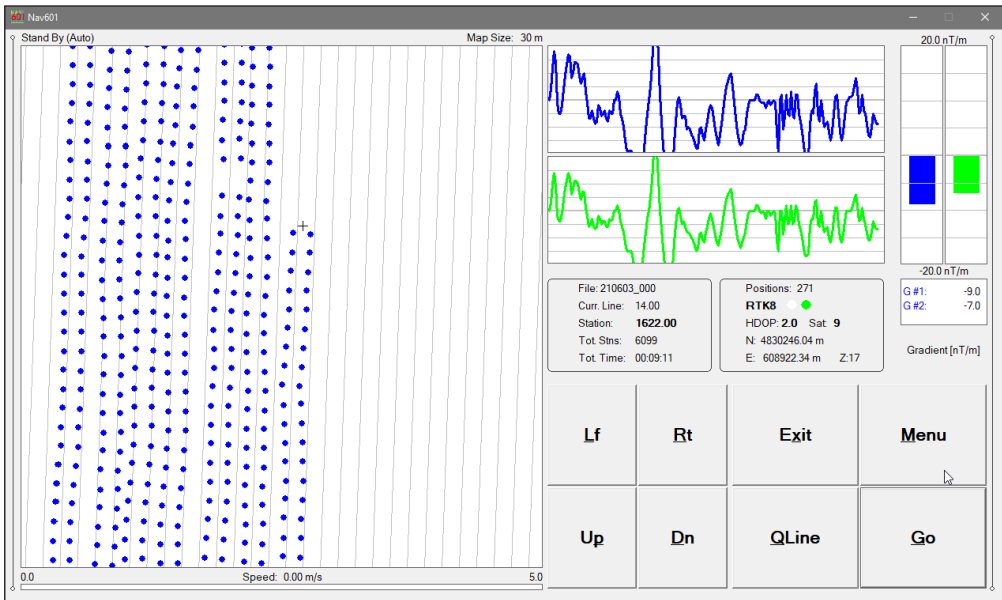


Figure 8.40: Nav601 Logging Navigation mode with dots representing sensor positions

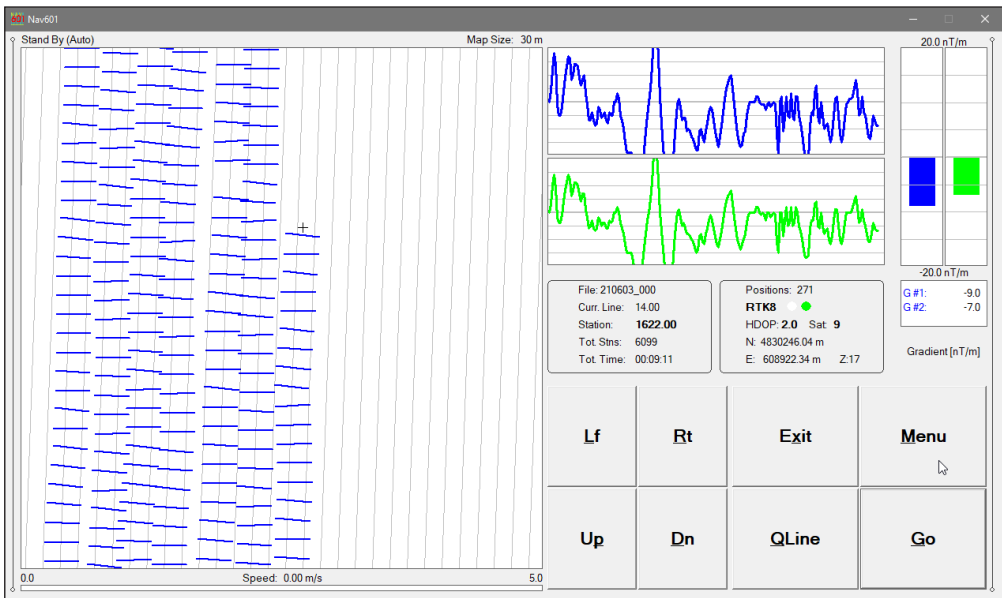


Figure 8.41: Nav601 Logging Navigation mode with swath bars representing Grad601 sensor positions at GPS update rate

## Profile Display Options

The Setup Display Options dialog is described in detail in Chapter 7. This dialog allows you to specify color and thickness of profiles (same colours apply to moving bars), and to select grid lines for specific component in profiles window. The dialog is presented in Figure 8.42.

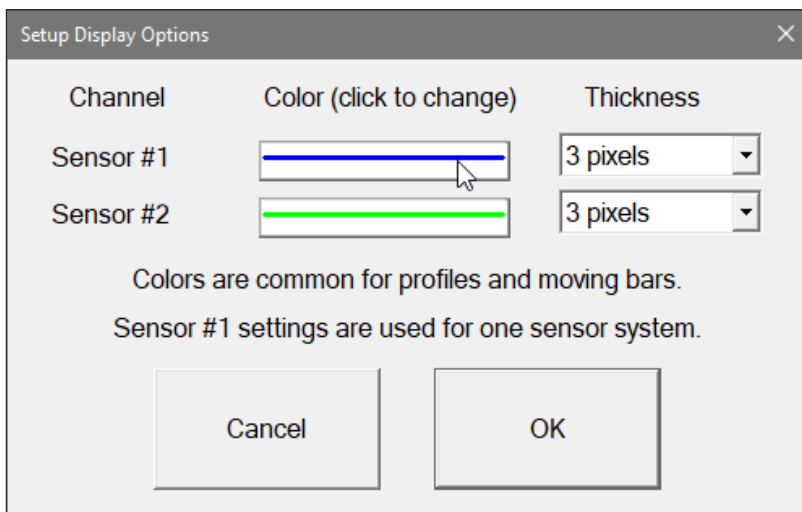


Figure 8.42: Profile Display Options dialog

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

After all the parameters in the Display Setup dialog are updated click on the button **OK** or press **ENTER** key (assuming it is highlighted) to accept the displayed settings. The dialog will disappear and the program will return to the Monitoring mode window. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent program executions. To return to original settings (state before this dialog was selected) click on the button labeled **Cancel** (or X button) or press **Esc** key. All parameters will be reset to initial settings and the dialog window will disappear.

## Audio Options

This dialog allows to enable and disable three audio functions. Two of these options can be specified in the System Setup dialog (see chapter 3), and the one associated with GPS Warning Mask can be set in GPS Port Setup dialog (see chapter 5). The Audio Options dialog is presented below in Figure 8.43. Parameters in Audio Options dialog are described below.

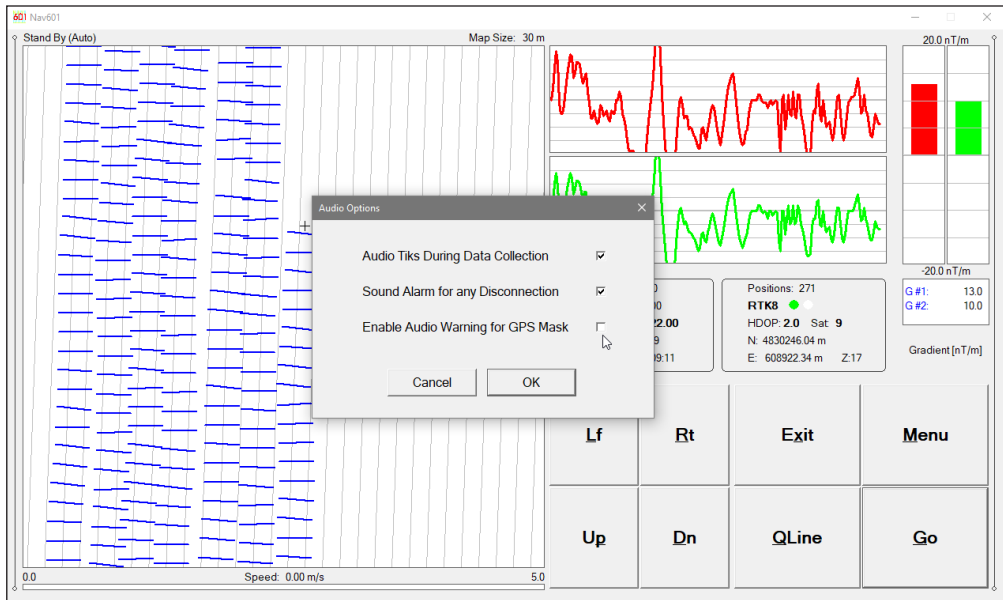


Figure 8.43: Audio Options dialog

### Audio Tiks During Data Collection

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

### Sound Alarm for any Disconnection

The program will sound loud ring when a disconnection in any serial port is detected by the program, or in case any 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 Figures 8.58 and 8.59.

### Enable Audio Warning for GPS Mask

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

## Toggle View (toggle between Mapping and Profile modes)

Selecting this item from pop up menu or simply pressing the key **T** will switch Monitoring or Stand By screens between Profile and Navigation modes. Changing the display from Profile to Navigation mode may take few seconds (depending on number of positions displayed and map scale).

## GPS Warning Mask

This option is available by clicking on (selecting by arrow keys) the pop up menu item labeled **GPS Warning Mask** or directly from keyboard by using shortcut key **W**. The GPS Warning Mask Scale dialog will appear on the screen. 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 8.44. Parameters in GPS Warning Mask are described below.

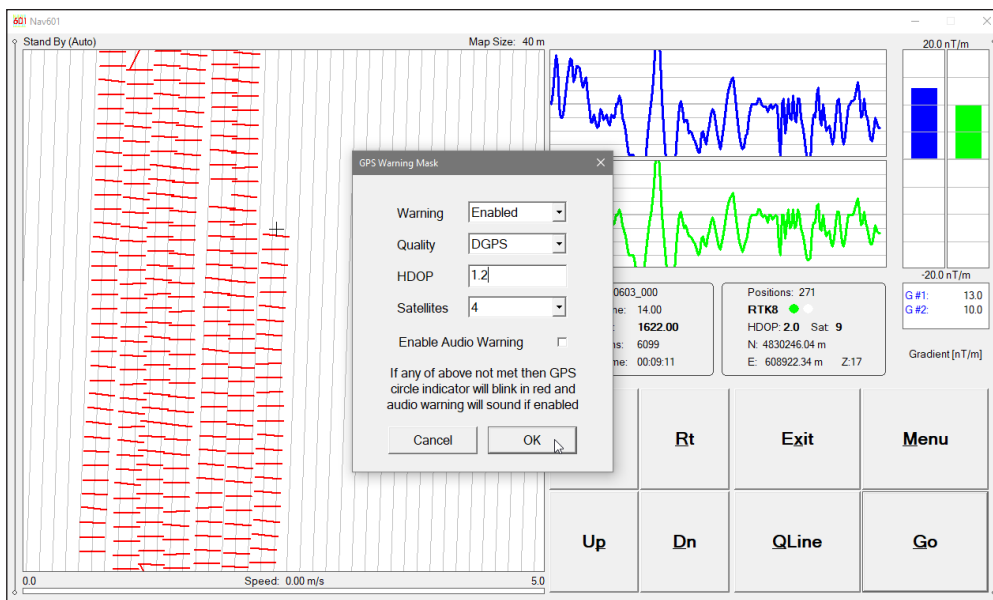


Figure 8.44: GPS Warning Mask dialog

### 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 cor-

rections), 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 8.45). In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours (see Figure 8.44) regardless of GPS signal quality.

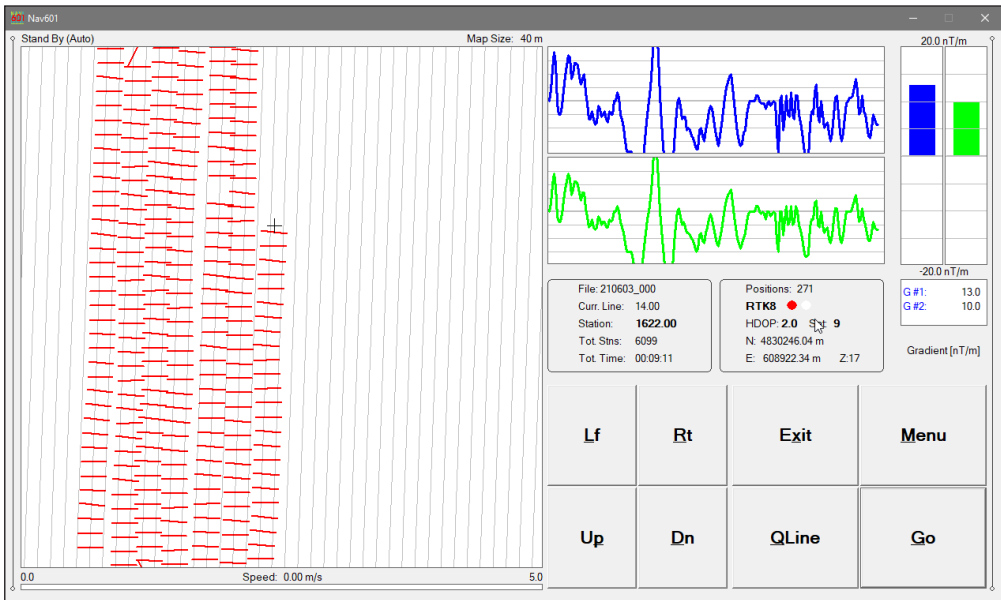


Figure 8.45: Nav601 screen with GPS Warning indication

All GPS data is logged, GPS Warning Mask affects only display.

### Quality

This parameter describes Quality Indicator (degree of differential corrections). Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: AGPS (Raw), DGPS, RTK3, RTK4, RTK5, and so on.

If Quality Indicator received from GPS receiver will be worse than specified then GPS indicator will alternate in red and white colours.

## PDOP

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

Activate text box by Clicking 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 on the **Cancel (X)** button or press **Esc** key. All parameters will be reset to initial settings.

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

## Coordinates Display Units

The Set Coordinates Display Units dialog will be displayed, Figure 8.46. There are four items after the combo box labeled Coordinates unit will be expanded: Geodetic Lat/Lon (coordinates in Degrees, Minutes, Seconds), UTM meters, UTM feet (International Feet), and UTM US Feet (US Survey Feet). Select one of items and coordinates of the GPS antenna will be displayed in the GPS section (bottom of the logging screen) in selected units. Please compare Figure 8.45 (Coordinates in UTM meters) and Figure 8.46 (Geodetic Coordinates in degrees).

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

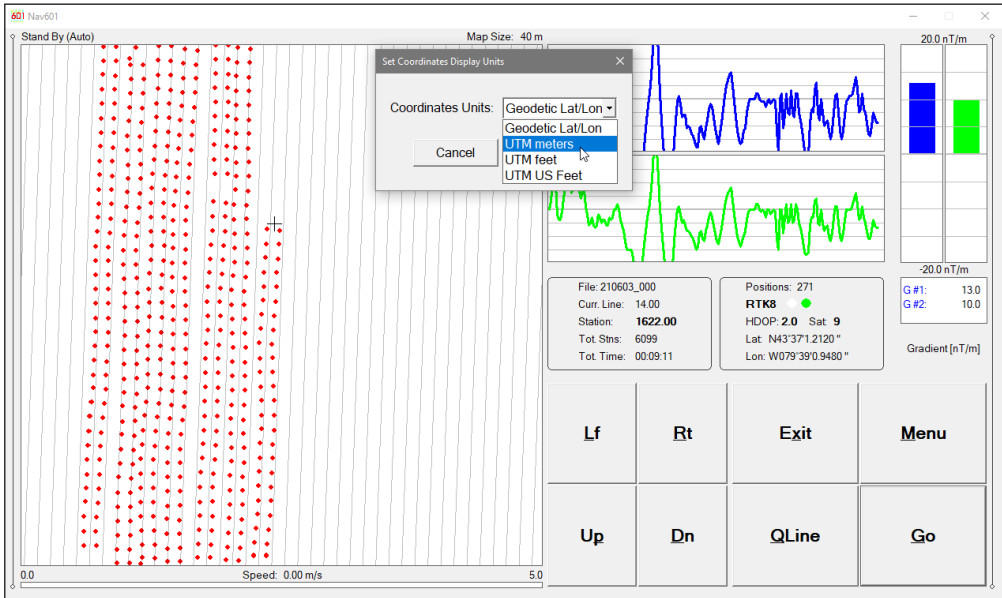


Figure 8.46: Nav601 Set Coordinates Display Units dialog

### Enter Background File

The Load Background File dialog is shown in Figure 8.47. This option is also described in section 8.2, in this section examples with background files and collected data will be shown. The program will display contents of entered files in the background of the map. Two types of files can be entered: any data file

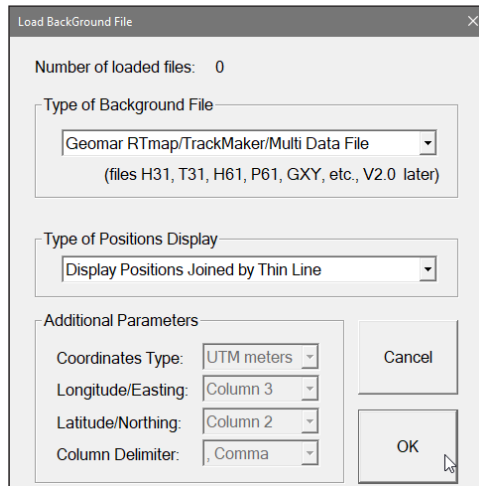


Figure 8.47: Load Background File dialog

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 8.48.

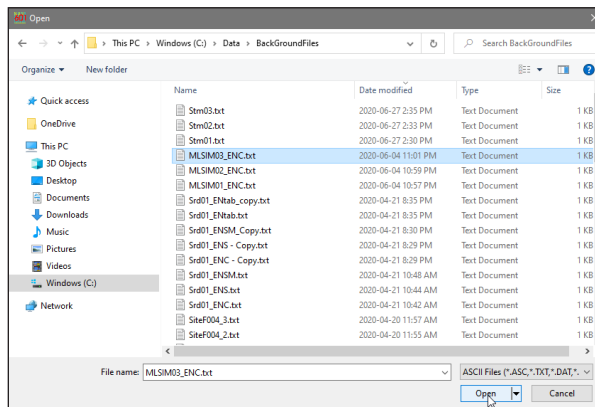


Figure 8.48: Selection of Background File

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 Nav601 screen with two loaded background files (both Column Delimited type) and start of actual data logging is shown in Figure 8.49.

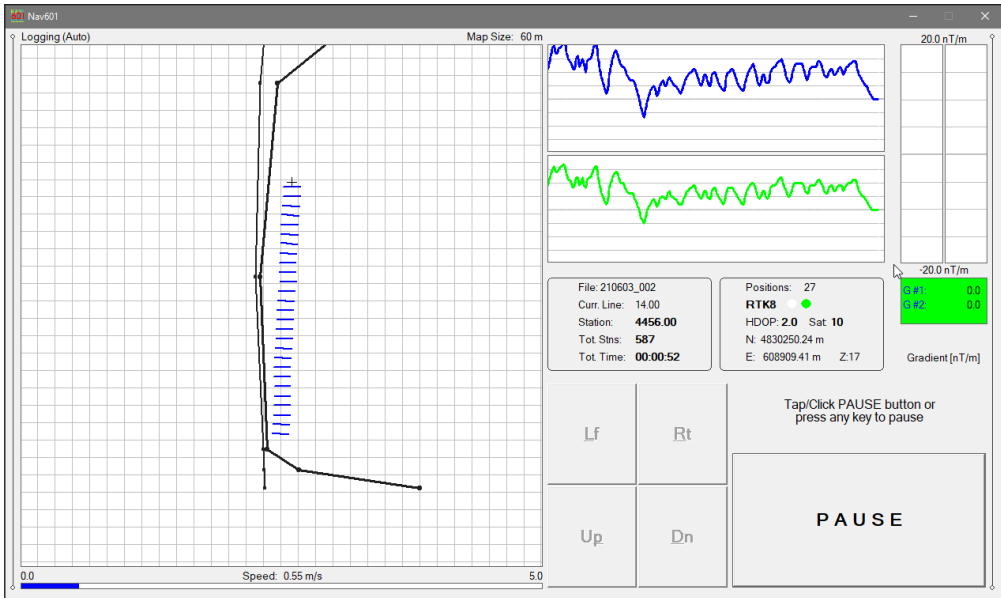


Figure 8.49: Nav601 with two background files after logging is started

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 8.50 and 8.51 (it is same logging session at later stage as shown in Figure 8.49). When Enter Background File option is executed, the dialog that appear indicates number of already loaded files (Figure 8.50). 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 8.51.

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.

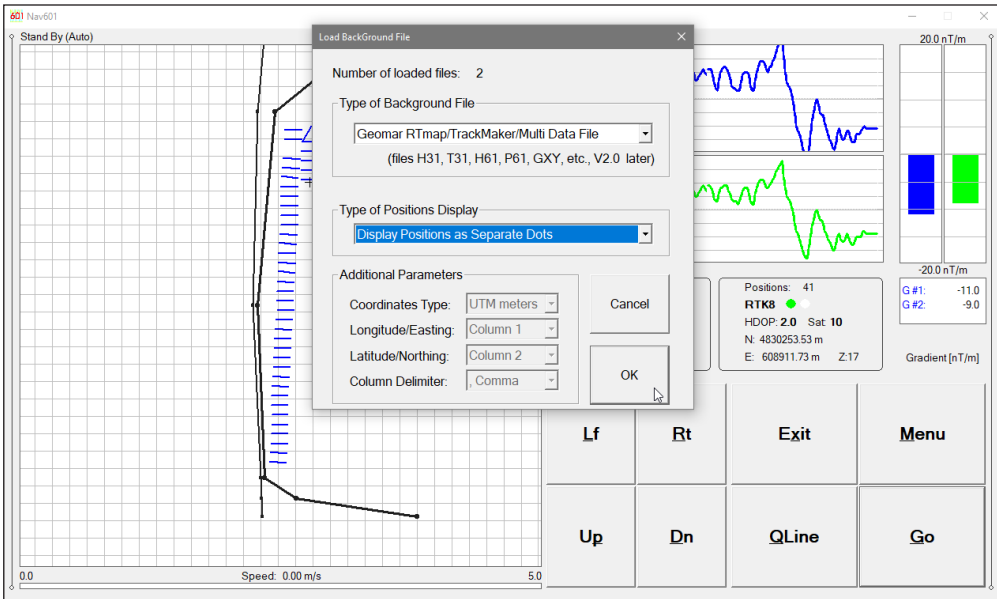


Figure 8.50: Nav601, loading third background file (former TrackMaker data file)

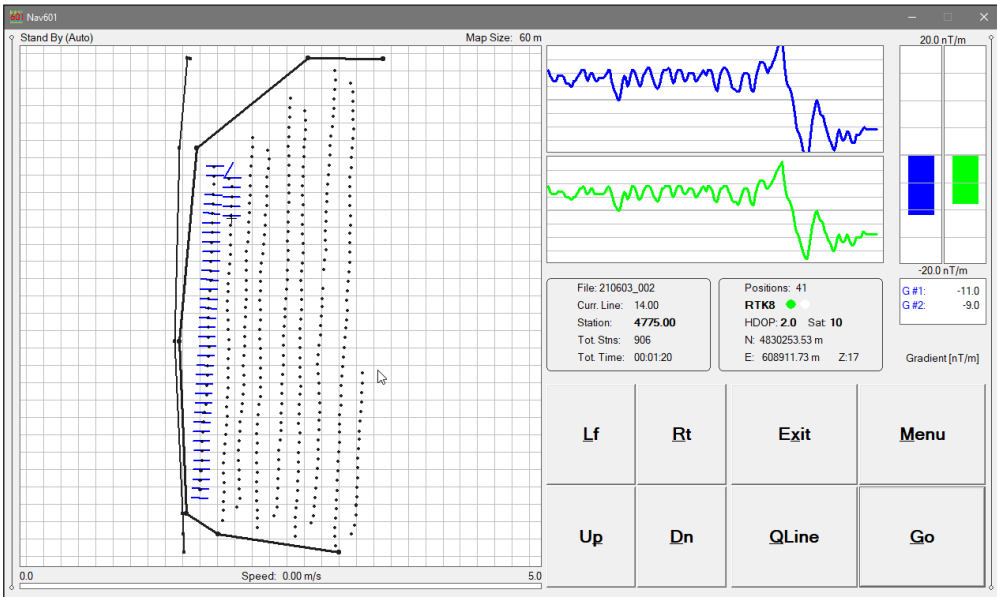


Figure 8.51: Three background files displayed on the map, compare with Figure 8.50

## Remove Background Files

After this option is executed the Remove Background Files dialog appears, Figure 8.52. In this example the dialog contains list of three loaded background files. Click on any check box located on the left of corresponding file name (in 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.

Click on the Select All button and then OK button to remove all entered files with one click.

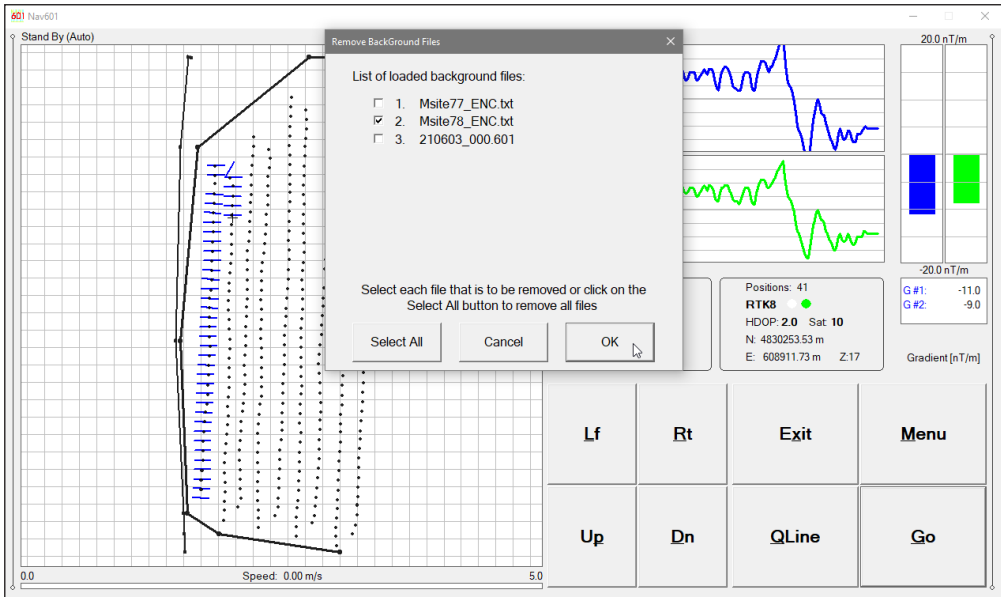


Figure 8.52: Remove Background Files dialog

### 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 8.53.

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 logging mode and data collection can be continued.

### Map Panning Buttons: Lf, Rt, Up, Dn (panning functions: Left, Right, Up, and Down)

Four panning buttons **Lf** (Left), **Rt** (Right), **Up**, and **Dn** (Down) are enabled and available at any time in the Stand By mode. Panning functions move screen in four directions. They can be used to shift colour image in any direction, as long

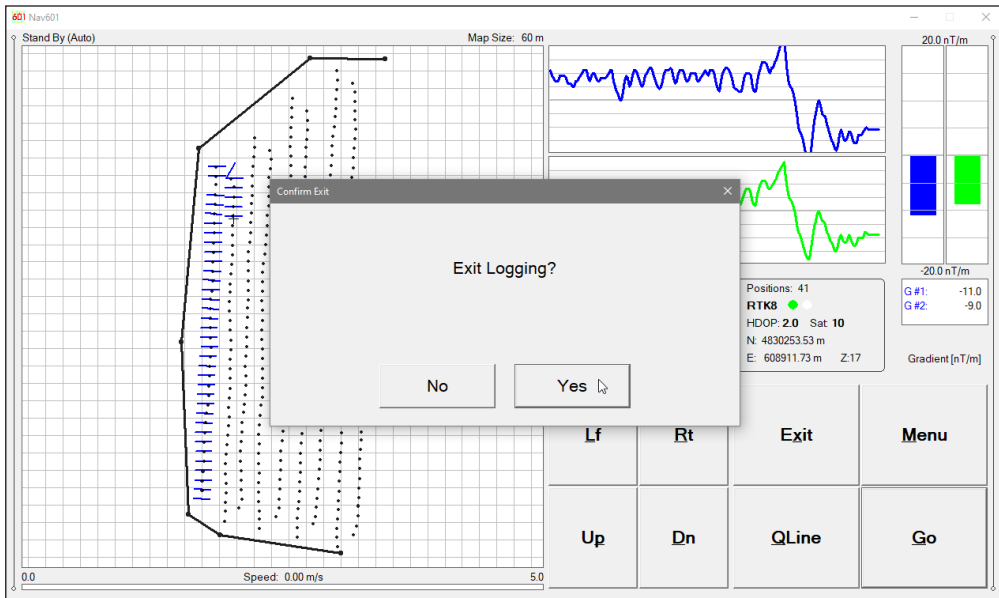


Figure 8.53: Nav601 - Exit Logging session confirmation message

as current position (cursor position) is located within the map. 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%.

Action of shifting the map image is shown in Figures 8.54 and 8.55, compare them also with Figure 8.53.

## 8.6 No Connection Message

A message **No Connection** may appear during any Nav601 logging mode (Monitoring, Stand By, or Log modes). The message **Lost Connection, trying** (Figure 8.56) is displayed in the numeric values window and replaces displayed values. The message is highlighted by red to alert operator, and audio alarm sounds if enabled.

This message indicates lack of communication between the Grad601 console and the field computer. In most cases the message **Lost 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 dis-

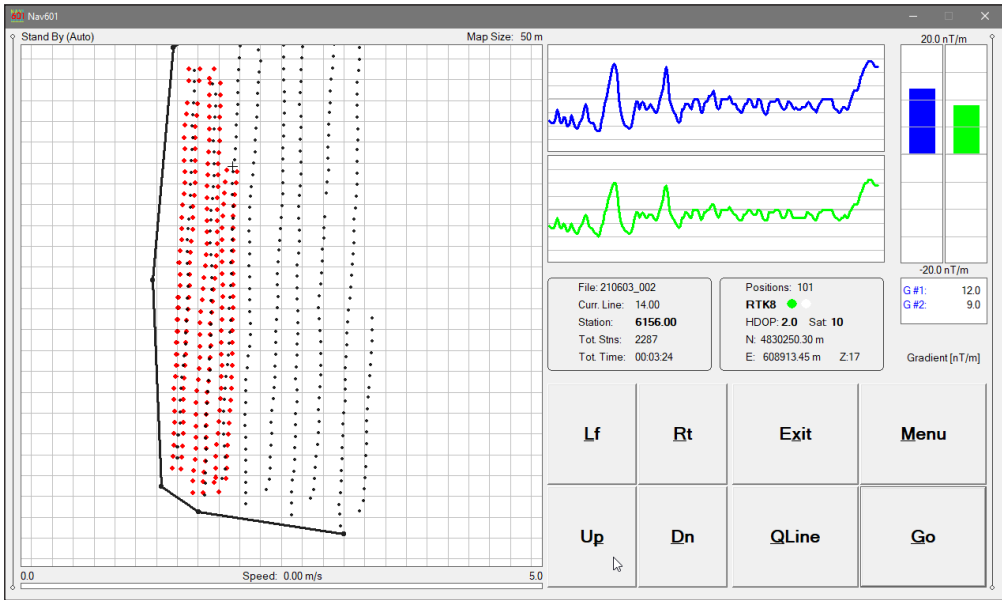


Figure 8.54: Nav601 - Panning buttons available in Stand By mode

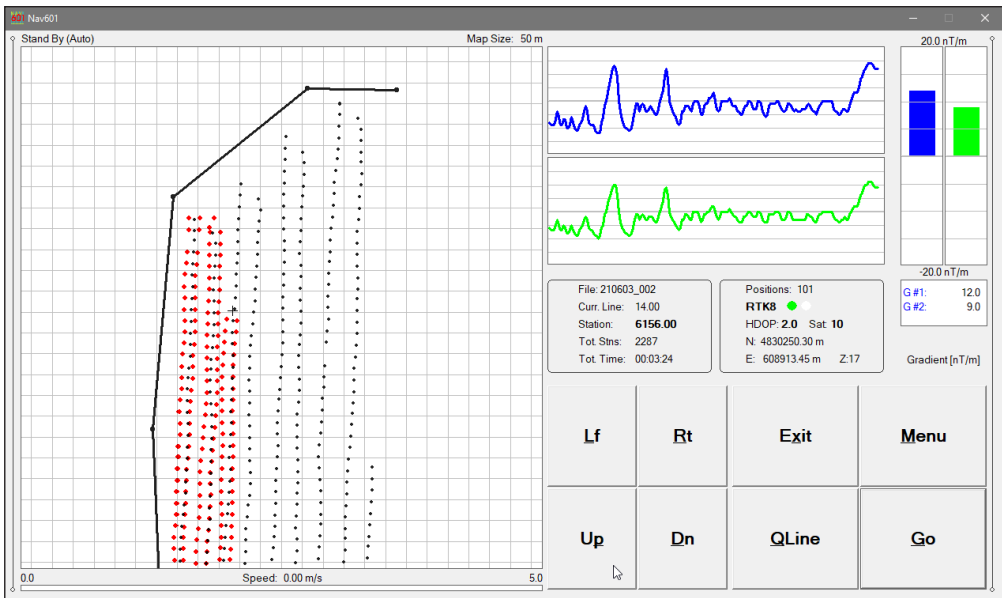


Figure 8.55: Nav601 - Panning buttons available in Stand By mode

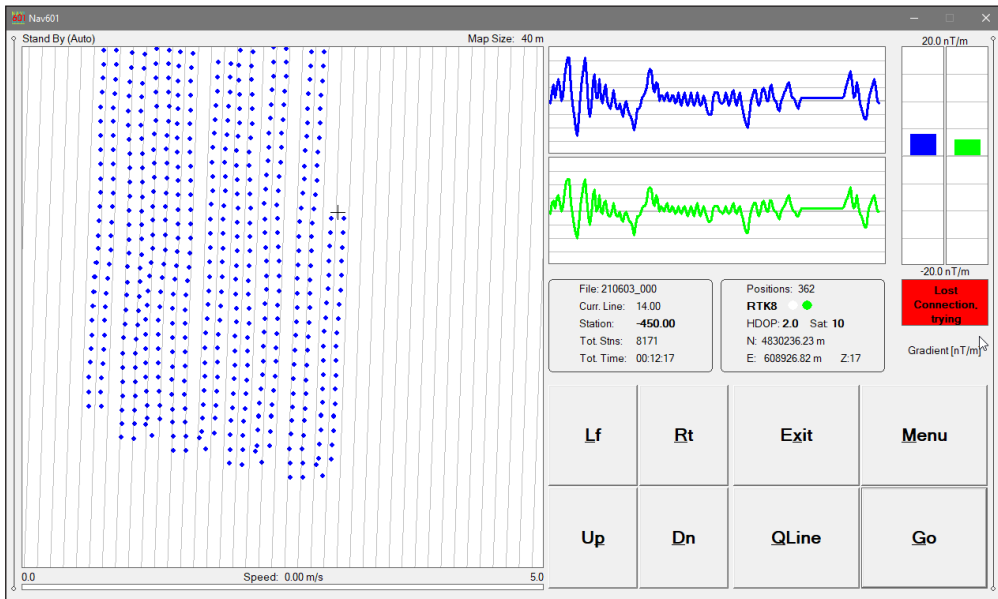


Figure 8.56: Message No Connection for the Grad601 unit

played. After correcting the source of a problem the program automatically connects to the Grad601, checks performance, and 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. If data is monitored or logged (in Monitoring, Stand By, or Logging modes) a message **Lost Connection** may appear in the centre of the screen when connection with the Grad601 is lost permanently.

## 8.7 No Connection for GPS Receiver

The alert that indicates lack of communication between the GPS receiver and the field computer is shown as red highlight of all GPS parameters displayed in the Nav601 screen (Figure 8.57). In most cases this message is caused by disconnected connector in the cable, turning the GPS receiver OFF, or low battery in the receiver. The program tries to re-establish communication while the message is displayed. After correcting the

source of a problem the program automatically connects to the GPS receiver, checks performance, and then the program returns to normal operation.

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.

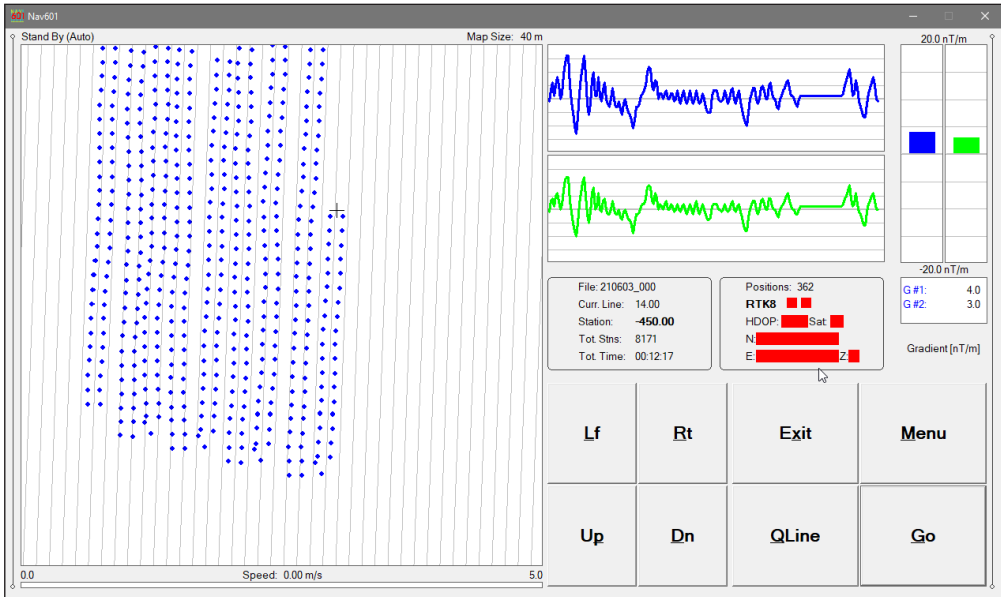


Figure 8.57: The Nav601 screen indicating lack of connection between GPS receiver and the computer

## 8.8 Program Layout for Display in Portrait Orientation

Almost all figures shown in the manual for practical layout reason present program screen shots of program used in landscape screen orientation. Figures 8.58, 8.59, and 8.60 depict logging screen layout for computers that use portrait display orientation. Program provides exactly the same info and parameters regardless of the screen orientation, the only difference is layout. The program detects the computer display orientation and adjusts its layout automatically. However, **it is very important to fix display orientation** (in Windows Settings) to either mode. The program cannot trace and rotate screen during data collection.

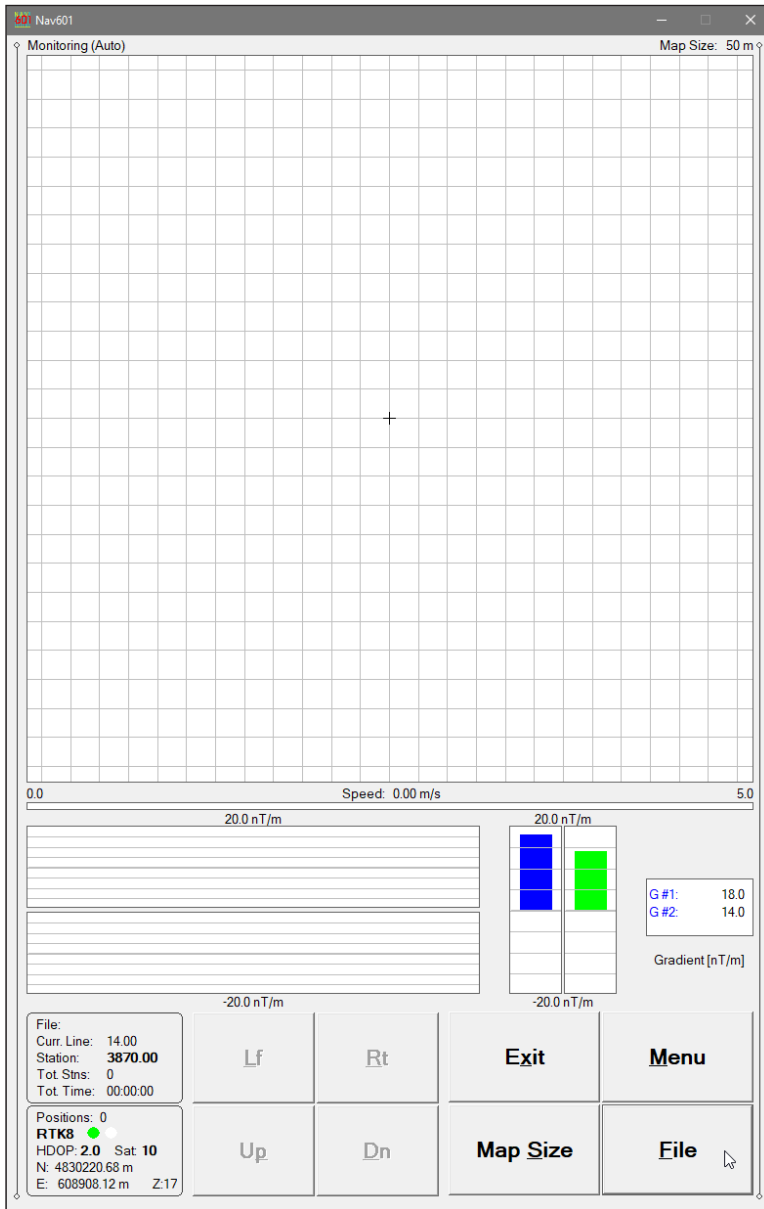


Figure 8.58: Nav601 portrait orientation - Monitoring mode



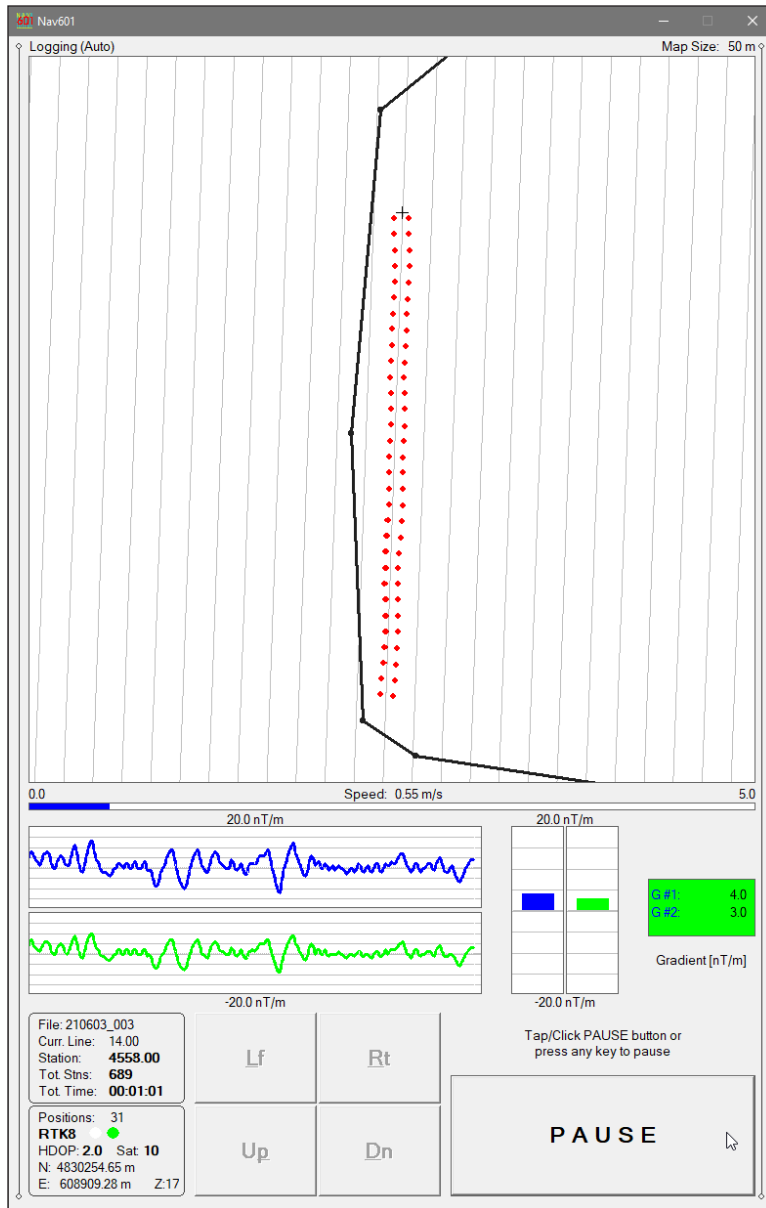


Figure 8.60: Nav601 portrait mode - Logging mode, one user file displayed.

# NAV601 Data File Format



## A.1 Description of NAV601 Data File Format (601) - Windows 10 Version

Each file record contains 27 characters including line feed at the end of each record.

**Header of the file contains 3 records starting with characters N, H, and 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
N	A	V	6	0	1		A	W	1	0	0	Survey Type	UT		IM		IS	SM	SP					svid	10	
H	Data File Name							Separation (F5.2)						TG										svid	10	
G	GPS X Offset (F7.2)				GPS Y Offset (F7.2)						CI	RU	SL	GP	GS									svid	10	

- NAV601 - identification of program file
- W100 - version number V1.00
- Survey Type - GPS (if GPS Input Enabled) or GRD (grid)
- UT - unit type (0 = meters, 1 = feet)
- IM - not used (=0, fixed)
- IS - number of sensors (0 = 1 sensor, 1 = 2 sensors)
- SM - not used (= 0, fixed)
- IS - Grad601 State (0 = disabled/GXY File, 1 = enabled)
- File Name - file name, maximum 8 characters
- Separation - Sensors Separation [m], applicable for 2 sensors only
- TG - File tag (space= original, 1= Saved As or/and edited)
- GPS X Offset - Offset of GPS antenna in X direction
- GPS Y Offset - Offset of GPS antenna in Y direction
- CI - program type (=7, fixed for Windows 10/7)
- RU - RTS units (0 = metres or feet, 1 = US Survey Feet)
- SL - RTS SLAM option (=0 not used, =1 enabled)
- GP - type of GPS NMEA message  
(0 = GGA/GSA, 1= GGA, 2 = POS, 3 = LLK, 4=LLQ, 5=GLL, 6 = GGK, 7 = pseudo-GGA (RTS), 8=pseudo-GLL)
- GS - GPS state (0 = disabled, 1 = enabled)
- svid - logger/software type id (not used)
- 10 - Line Feed character

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

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	
<b>L</b>	Line Name - 8 characters																								<b>10</b>		
<b>B</b>	Start Station (Format F11.2)																										<b>10</b>
<b>A</b>	Dir							Station Increment (Format F11.3)																<b>10</b>			
<b>Z</b>	D	D	M	M	Y	Y	Y	Y			H	H	:	M	M	:	S	S	.	h	h						<b>10</b>

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

**Timer Reset**

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
<b>*</b>	Computer Time (Format HH:MM:SS.hh)										Time Stamp in ms (10 digits)										<b>10</b>					

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.

**Reading**

Each instrument record consists of one line that starts with **T**.

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
<b>T</b>	ID	,	Reading 1			,	Reading 2			Time Stamp in ms (10 digits)										<b>10</b>						

- T** - indicates the first line of instrument record
- ID** - indicator, \$P (fixed string)
- ,** - comma character
- Reading 1** - five character field containing Sensor #1 output in nT/m
- Reading 2** - five character field containing Sensor #2 output in nT/m, if one sensor is used then this field contains spaces
- Time Stamp**- time stamp of the reading in milliseconds, this is time elapsed from the last timer reset. The time in milliseconds can be linked with the computer local time by using Times in line started by \* (see Timer Reset).
- 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
<b>C</b>	Comment (maximum 15 characters)															Time Stamp in ms (10 digits)										<b>10</b>

### 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
<b>S</b>	New Station (Format 11.2)										Time Stamp in ms (10 digits)										<b>10</b>					

### 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
<b>{ a</b>	Internal Position of an Element (Format 14.3)															Time Stamp in ms (10 digits)										<b>10</b>

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

### Records starting with X

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

### GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 25 characters strings and placed in the NAV601 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 NAV601 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	<b>10</b>
#	m	m	,	s	,	d	d	d	m	m	.	m	m	m	m	m	,	s	,	n	,	q	q	,	p	<b>10</b>
#	p	.	p	,	s	a	a	a	a	a	.	a	a	,	u	,	±	x	x	x	x	.	x	,	M	<b>10</b>
#	,	s	s	s	,	a	a	a	*	c	c	CR	LF											<b>10</b>		
!	0	0	4	3	5											Time Stamp in ms (10 digits)										<b>10</b>

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.

In case not selected NMEA messages are streamed by connected GPS receiver then such not needed positions are tagged by X and only first few elements are recorded in the file together with time stamp. It is just to trace and document GPS receiver activity.

## A.2 Example of NAV601 Data File (Windows 10 version)

---

```

NAV601 AW100GPS0 0 111
H210603_002 1.00      0
G 0.000 0.400 70011 01B
L14.00
B 3870.00
AE 1.000
Z03062021 21:30:47
*21:30:47.221 1470603109
X$STARTED 1470622781
T$P, 8.3, 6 1470622828
T$P, 8.7, 7 1470622906
@$GPGGA,014058,4337.0207,N
#,07939.0158,W,8,10,2.0,17
#5.5,M,-35.4,M,*70
!000001p 1470622812
{0 0.000
T$P, 8.4, 6 1470623000
X$GPGSA,A,3,05,10,13,15,18
T$P, 8, 7 1470623109
T$P, 8, 7 1470623187
X$GPGSV,3,2,10,18,80,250,5
T$P, 8, 7 1470623281
X$GPGLL,4337.0202,N,07939.
T$P, 8, 7 1470623359
X$GPBOD,325.5,T,336.2,M,TO
T$P, 8, 7 1470623453
T$P, 8, 6 1470623546
X$GPBWC,014058,3512.7660,N
T$P, 8, 7 1470623625

```

```

X$GFVTG,0.0,T,10.8,M,0.0,N
X$GFXTE,V,V,9.99,L,N,S*18
T$P, 8, 7 1470623734
T$P, 8, 7 1470623812
T$P, 8, 7 1470623906
T$P, 8, 5 1470624000
T$P, 8, 6.6 1470624078
T$P, 8, 7 1470624171
T$P, 8, 7 1470624250
T$P, 8, 7 1470624343
T$P, 8, 6 1470624453
T$P, 8, 7 1470624531
T$P, 8, 7 1470624625
X$GPRMC,014100,V,4337.0202
T$P, 8, 7 1470624703
T$P, 8, 7 1470624796
X$GPRMB,V,9.99,L,TOUR4,TOU
T$P, 8, 6 1470624890
@$GPGGA,014100,4337.0213,N
#,07939.0157,W,8,10,2.0,17
#5.5,M,-35.4,M,,*7C
!000002p 1470624812
{a 608907.054
{b 4830221.450
{c 608909.048
{d 4830221.302
{e 608907.135
{f 4830222.544
{g 608909.129
{h 4830222.396
T$P, 8, 7 1470624968
T$P, 8, 7 1470625078
X$GPGSA,A,3,05,10,13,15,18
T$P, 8, 7 1470625156
X$GPGSV,3,3,10,27,16,317,4
T$P, 8, 7 1470625250
X$GPGLL,4337.0202,N,07939.
T$P, 8, 7 1470625343
X$GPBOD,325.5,T,336.2,M,TO
T$P, 8, 7 1470625421
X$GPBWC,014100,3512.7660,N
T$P, 8, 6 1470625515
X$GFVTG,0.0,T,10.8,M,0.0,N
T$P, 8, 7 1470625593
X$GFXTE,V,V,9.99,L,N,S*18
T$P, 8, 7 1470625687
T$P, 8, 7 1470625796
T$P, 8, 6 1470625875
T$P, 8, 6 1470625968
T$P, 8, 7 1470626046
T$P, 8, 7 1470626140
.....

```

## A.3 Format of GXY Data File

---

The NAV601 data file with extension GXY contains GPS records. The structure of this file is identical to the standard NAV601 (601) file. The difference is that it does not contain any Grad601 records. This file is created by NAV601 when Grad601 is Disabled in the System Setup menu. In this case the program acts as a GPS logging program.

It should be noted that any NAV601 data file, as well as GXY and data files created by other Geomar data acquisition programs (NAV38, NAV61, ML61, ML31, etc.) can be used as an GXY file in the data processing programs TrackMaker601 and TrackMaker for any other supported Geonics instrument (TrackMaker38, 61, etc.). The extension name GXY indicates that the file does not contain magnetic data.

## A.4 Background File Format

---

The Nav601 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
```

---

# Nav601 and GPS Input

# B

---

## B.1 Using the Nav601 with a GPS System

---

The Nav601 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 Nav601 provides also interface to selected Robotics Total Stations (RTS) for areas where GPS signal is not accessible. To use Total Robotics device select option "RTS pseudo-GGA" in NMEA Data of the GPS Port Setup menu. The program writes entire message (that was selected in GPS Input menu) to the Nav601 data file. If the pair GGA/GSA is selected, both GGA and GSA messages are written to the Nav601 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 TrackMaker601.

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 Nav601.** 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 and unnecessarily large size of data file.

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 high frequency of GPS data (over 10 Hz) the program will be occupied by GPS activity and may delay some Grad601 data. In optimal settings the Nav601 records all readings streamed by the Grad601 console and one GPS position per second. When RTS is used then update rate of positioning stream is fixed, it is about 2.5 Hz. Data processing program TrackMaker601 will interpolate Grad601 stations between neighbouring GPS positions based on recorded time stamp.

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 Nav601 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 Nav601 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) indicates lack of differential correction. There are more labels **RTK3**, **RTK4**, and **RTK5** and they correspond to GPS Quality Indicator 3, 4, and so on. Correction AGPS corresponds to Quality Indicator 1, and DGPS represents Quality Indicator 2. Corrections described by RTK3 and above 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 between green and white with the frequency of GPS update rate (usually 1 second intervals). If circle are still 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 small green/white circles. This number is updated only in logging mode, when the data are recorded (in Stand By mode or during Monitoring alternating circles, updated GPS positions, index PDOP, and number of tracked satellites, indicate presence of GPS input).

Two more GPS parameters are displayed on the logger screen. These are index PDOP shown by label **PDOP** and number of tracked satellites represented by label **Sat**. 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:

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

<b>c1</b>	Mode, M = manual, A = automatic
<b>d1</b>	Mode, 2 = 2D, 3 = 3D
<b>d2-d13</b>	Satellites used in position computation (range 0 to 32)
<b>f1</b>	PDOP (range 0 to 99.9)
<b>f2</b>	HDOP (range 0 to 99.9)
<b>f3</b>	VDOP (range 0 to 99.9)
<b>*cc</b>	Checksum
<b>&lt;CR&gt;&lt;LF&gt;</b>	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:

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

<b>ttt</b>	True track/true course over ground in degree
<b>ggg</b>	Speed over ground (knots)
<b>svvv</b>	Vertical velocity (decimeters per second)
<b>pp</b>	PDOP - position dilution of precision (00 to 99)
<b>hh</b>	HDOP - horizontal dilution of precision (00 to 99)
<b>vv</b>	VDOP - vertical dilution of precision (00 to 99)
<b>tt</b>	TDOP - time dilution of precision (00 to 99)
<b>vvvv</b>	firmware version ID
<b>*cc</b>	Checksum
<b>&lt;CR&gt;&lt;LF&gt;</b>	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:

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

Definition of LLK message components:

<b>hhmmss.ss</b>	UTC time in hours, minutes, seconds of the GPS position
<b>ddmmyy</b>	UTC date (day, month, year)
<b>xxxx.xxxx</b>	Grid Easting, meters
<b>M</b>	Meters (fixed text "M")
<b>xxxx.xxxx</b>	Grid Northing, meters
<b>M</b>	Meters (fixed text "M")
<b>x</b>	Quality indicator, 0 = not valid, 1 = GPS Nav Fix (no differentially corrected position), 2 = DGPS Fix (differentially corrected position), 3 = RTK Fix
<b>x</b>	Number of satellites used in computation,
<b>xx.xx</b>	GDOP
<b>xxxx.xxxx</b>	Height, meters
<b>M</b>	Meters (fixed text "M")
<b>*cc</b>	Checksum
<b>&lt;CR&gt;&lt;LF&gt;</b>	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 LLQ message components:

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

**dddmm.mmmmm** Latitude in degrees, minutes, and decimal minutes  
**s** s=N or s=S, for North and South latitude

<b>dddmm.mmmmm</b>	Longitude in degrees, minutes, and decimal minutes
<b>s</b>	s=E or s=W, for East and West longitude
<b>hhmmss.ss</b>	UTC time in hours, minutes, seconds of the GPS position
<b>s</b>	Status, A = valid, V = invalid
<b>*cc</b>	Checksum
<b>&lt;CR&gt;&lt;LF&gt;</b>	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.mmmmmmmmm,s,dddmm.mmmmmmmmm,s,n,qq,p,p,EHT-aa.aaa,M\*cc<CR><LF>**

Definition of GGK message component:

<b>hhmmss.ss</b>	UTC time in hours, minutes, seconds of the GPS position
<b>ddmmyy</b>	Date
<b>ddmm.mmmmmmmmm</b>	Latitude in degrees, minutes, and decimal minutes
<b>s</b>	s=N or s=S, for North and South latitude
<b>dddmm.mmmmmmmmm</b>	Longitude in degrees, minutes, and decimal minutes
<b>s</b>	s=E or s=W, for East and West longitude
<b>n</b>	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)
<b>qq</b>	Number of satellites used in fix
<b>p.p</b>	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

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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 details 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 parameter set to **NMEA**, the Pathfinder GPS receiver begins to stream selected NMEA-0183 messages at the specified Output interval.