ML61MK2 xpn

Version 2.15

for MS Windows 10/7

data acquisition program for
an array of EM61-MK2s and GPS

User's Manual

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Introduction 1

The Geomar ML61MK2xpn Data Logging System consists of a data logging program ML61MK2xpn and associated PC computer program Multi61MK2. The program ML61MK2xpn is designed for the Windows 10 or 7 based field computer equipped with necessary number of serial ports.

This manual describes the use of the ML61MK2xpn program used with the laptop field computer with screen resolution of minimum 800 x 600 pixels, equipped with the USB to multi RS-232 ports, or Bluetooth connection, maximum nine Geonics EM61-MK2 instruments, and Global Positioning System (GPS) receiver.

The associated program Multi61MK2 is used to process data files recorded under control of the program ML61MK2xpn. Main function of this program is to position each EM61-MK2 sensor based on the recorded GPS position and the configuration of the system. Resulting XYZ files may be used as input files in most of mapping programs. The Multi61MK2 also allows to you correct the collected GPS positions with post-processed GPS files. The grid positioned data files can be also exported to Geonics DAT61MK2 (M61) format and data can be processed using the Geonics program DAT61MK2 that has advanced capabilities for editing grid based data.

1.1 About the ML61MK2xpn Program

Program ML61MK2xpn acquires and records survey data from the array of EM61MK2 units, under the control of the operator. The array of instruments can contain one to a maximum of nine EM61MK2 instruments and one GPS receiver.

During data collection the program can work in three display modes: mapping, navigation, and profile mode. Mapping mode is a special case of Navigation mode, while providing all functions of navigation mode, mapping mode displays colour image that represents amplitude variations for each connected probe. Therefore Navigation and Mapping mode labeling may be used interchangeably for both modes in this manual. While in navigation mode, the main portion of the screen displays all logged positions marked by a swath bars or dots, and current position of the system denoted by cross mark based on GPS input. A swath bar represents width of the array in the employed map scale with correction for the GPS antenna offset. This type of real time display allows the operator for real time control of the survey coverage and helps in avoiding unnecessary overlaps and skips without any on ground guidance hardware. Mapping mode

(real time colour imaging) helps in control quality during surveying since in any areas of anomalous response density of survey coverage can be increased instantly. There is no dot representation in mapping mode, all data points are drawn continuously as small bars separately for each sensor resulting in pseudo-grid colour image. The size of graphic bar representing each coil is of the same as width of sensor antenna in one row array while for two rows array setups that increase survey resolution across the survey line direction, each drawn bar corresponds to half of the antenna sensor. The ML61MK2xpn does not require that survey has to be conducted along parallel straight lines. In Mapping and Navigation modes the output of each sensor is also shown in windows containing profiles. The display can be switched to Profile mode at any time. In this mode Map window disappears and profile windows are extended in length. Mapping and Navigation modes are available only when working GPS receiver is connected to the field computer.

Readings are displayed in real time as values in mV as well as in graphic mode, as profiles and moving graphic bars. The output of each instrument is represented a windows containing profiles (updated only during logging mode) and by four bars, for Channels 1, 2, 3, and 4 or T (depending on the instrument mode). Moving bars display allows for very fast visual information about each instruments output. In addition, the program monitors the instrument output while data are not recorded. The ML61MK2xpn also continuously monitors the condition of the battery for each instrument, without leaving the program.

The ML61MK2xpn accepts NMEA-0183 compatible data from a GPS receiver directly connected to a field computer. GPS data which is embedded in the ML61MK2xpn data file can be processed later in the Geomar Multi61MK2 program. The connected GPS must be able to stream NMEA-0183 compatible messages. The ML61MK2 can use following types of NMEA messages: a pair GGA/GSA, GGA, POS, GLL, LLK, LLQ, GLL, and GGK, as well as positions given by Robotics Total Station streaming pseudo-GGA message (for example Leica TPS1100/TPS1200 and some Trimble models) and Trimble label messages. Messages POS, GGK, and pair GGA/GSA are preferred since they contain all necessary information. GPS readings Latitude and Longitude, as well as parameters indicating quality of GPS signal: status of real time differential corrections, number of used satellites, and PDOP parameter, are displayed in real time. A speed bar shows actual surveying velocity calculated from GPS data.

If GPS positions are not differentially corrected in real time and post processed GPS data will be used for positioning please log GPS data concurrently in ML61MK2xpn and in GPS logger. An option “Position Readings using External GPS file” in Multi61MK2 which uses satellite time recorded in both devices is much more accurate than any other method that uses computer clock.

The ML61MK2xpn provides the possibility of automatic nulling of instruments outputs. The program also records various field information such as survey line number (line name), starting station, increment, comments, logger battery, etc.

The program supports the array of EM61-MK2 set in AUTO mode. In AUTO mode readings can be automatically recorded in desired time intervals. The ML61MK2xpn V2.00 and later, does not support EM61-MK2 units operated in Wheel and Manual modes.

The program allows you to record data while using the standard EM61-MK2 antennas (1.0 x 0.5 m in two configurations, 1 x 1 m, or 0.5 x 0.5 m sensors) as well as Geonics EM61MK2 Hand Held sensor. The ML61MK2xpn supports two basic types of EM61-MK2, Standard and High Power. Additional instrument types Standard and High Power N.C.C. (no current correction) and Standard and High Power A.C.C (automatic current correction where program detects unit with connected Transmitter antenna) are provided for systems that employ only one transmitter antenna for several receiver antennas.

System and survey setup parameters are saved in a configuration file (with an extension name .INI), 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 N61. Data files can be appended, therefore already collected data is displayed on the screen map and survey can be continued to assure proper area coverage. When append data file is used, size of the entire data file (past and currently logged portions) is subject to limitation described in below paragraph.

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

Data files are permanently saved every time the survey is Paused, therefore it is advised to pause data collection from time to time, especially during U-turns.

It is strongly advised that even if your GPS receiver supports faster rates the 1 Hz update for GPS positions is used. The ML61MK2xpn will work with rates higher than 1 Hz, however operation will not be smooth when scrolling and re scaling display. The data processing program will interpolate all EM61-MK2 stations between GPS positions in the very similar way as GPS receiver in real time.

1.2 Program Requirements

To successfully use this software, you will need :

Computer

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

Geonics EM61-MK2

The required number EM61-MK2 instruments with associated cables.

1.3 Contents of Multi61MK2 disk

The program ML61MK2xpn is stored on ML61MK2xpn USB drive or CD distribution disk, or it can be downloaded from the web site. 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 SetupML61MK2xpn.exe that installs ML61MK2xpn 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:

SetupML61MK2xpn.exe	-	installs data acquisition program file ML61MK2xpn
SetupML61.exe	-	setup for the data processing program Multi61MK2
ML61MK2xpn.pdf	-	manual for the ML61MK2xpn program
Multi61MK2.pdf	-	manual for the data processing Multi61MK2 progam

1.4 Installing ML61MK2xpn

Execute supplied or downloaded setup program **SetupML61MK2xpn** (another setup program SetupML61 installs data processing program Multi61MK2). The ML61MK2xpn is a stand alone program and it does not require any additional drivers nor run time libraries.

After you run the program for the first time it will create permanent configuration file ML61MK2xpn.ini which contains the program settings.

The ML61MK2xpn data files contain extension name N61 and their base names should be limited to 8 characters.

1.5 Software Key

The data acquisition program ML61MK2xpn is licensed for one field computer. The program is secured with Software Key (some previous versions can be secured by USB security key - USB dongle). Initialization of the program requires a software key that is based on the computer unique ID number generated by the program. During the first run (after any 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.

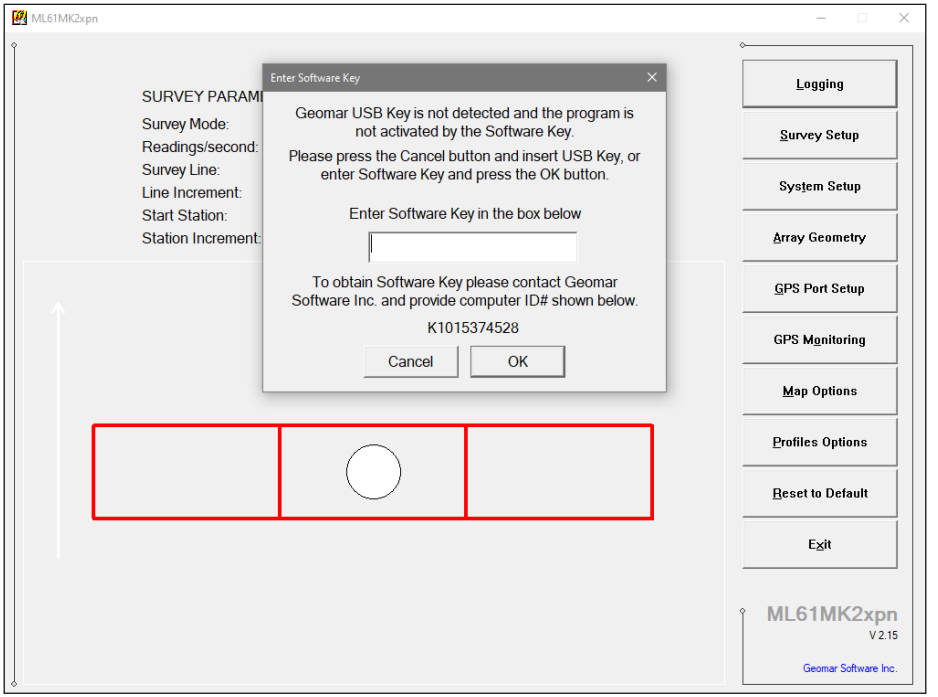

Figure 1.1: Enter Software Key dialog

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.

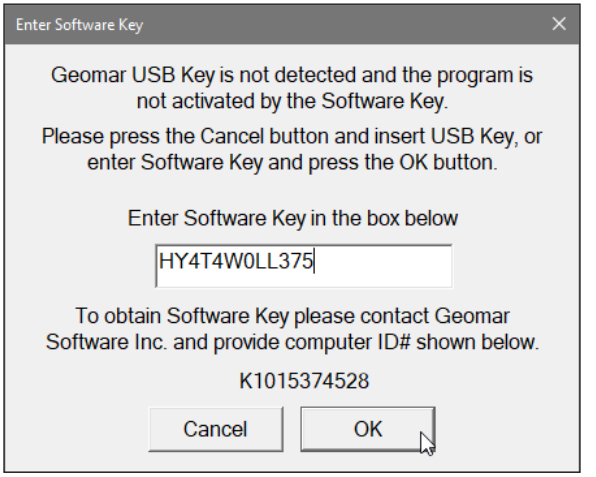

Figure 1.2: Entering the Software Key

1.6 Running ML61MK2xpn Program

Start ML61MK2xpn by double clicking the ML61MK2xpn icon in the Start|Programs menu, in Windows Explorer, or on the desktop if a shortcut was created. At the start, ML61MK2xpn displays the following screen (Figure 1.3):

The ML61MK2xpn is a command button and dialog driven program. Command buttons can be executed by clicking with the left mouse button, or by pressing the indicated (underlined) character on the keyboard, or by using TAB to scroll through the buttons and ENTER to execute. In the Main Screen of the program Up and Down arrow keys can be also used to scroll through the buttons.

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

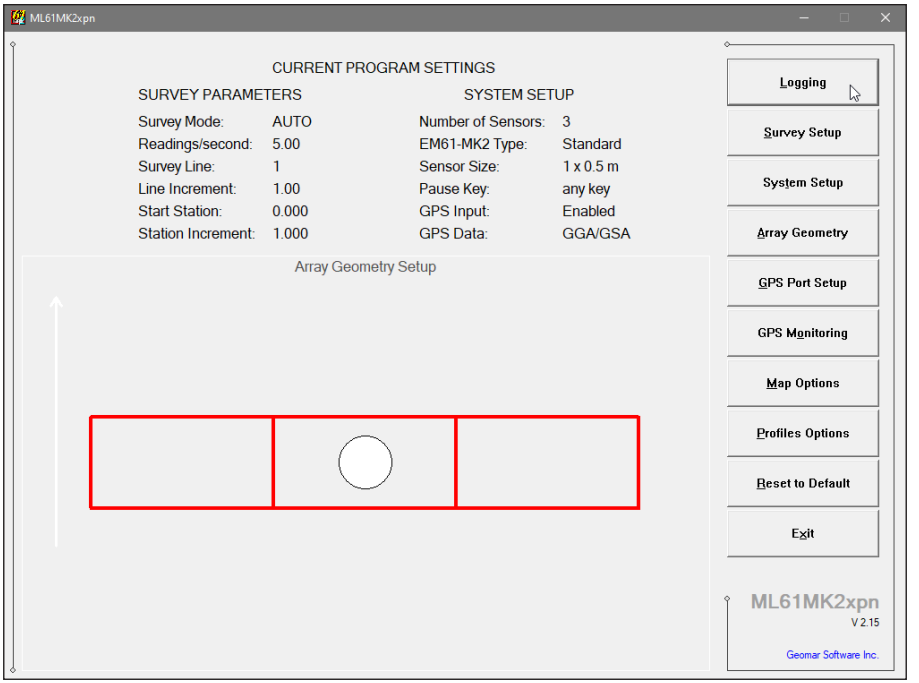

Figure 1.3 The ML61MK2xpn Main Screen

1.7 ML61MK2xpn Program Overview

The data acquisition program ML61MK2xpn 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, when the program is started, the instrument and logging computer are turned on, output of the connected array of EM61-MK2s can be monitored after one key stroke. Obviously any parameters can be modified any time, however as long as the field procedure remains the same the program needs very minor adjustments, especially when survey is conducted using GPS positioning.

When all settings for the system and survey (discussed in later sections) are specified, the user selects Logging option in Main menu of the program. This sets the program in Monitoring mode (Figure 1.4) which allows you to examine the EM61-MK2 outputs and GPS performance. To record data one has to specify the data file name. After the data file is created the program will switch to Stand By mode. The Stand By mode allows for continuous data monitoring as well as use available field options. Clicking on the **Go** but-

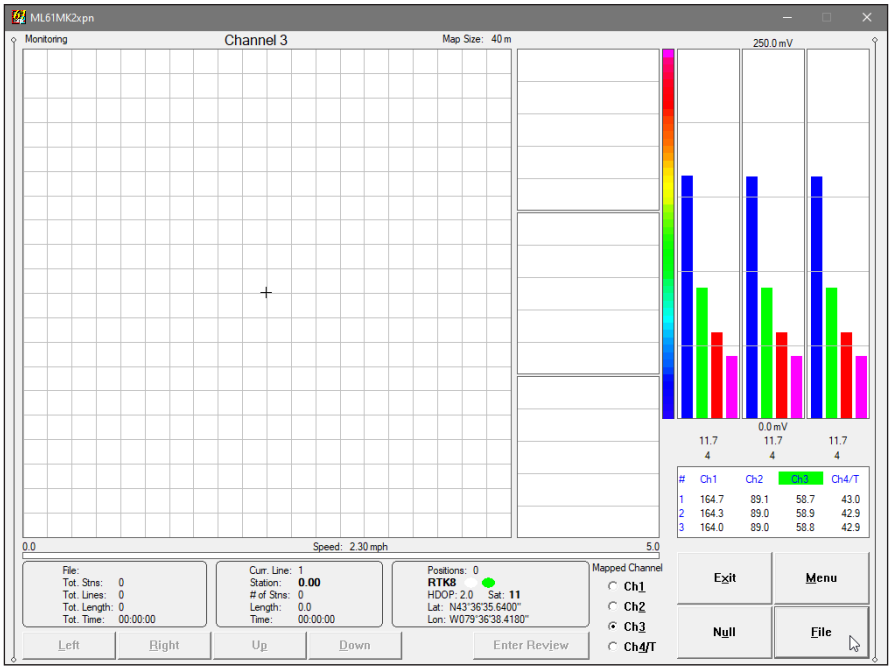

Figure 1.4 The ML61MK2xpn logging screen in the Monitoring mode

ton (or pressing key G or <ENTER> if it is default button) will change the program to Logging mode and EM61-MK2 and GPS data will be recorded in the data file according to selected mode of operation.

The instruments output is shown in the form of numeric values for channels 1, 2, 3 and 4 or T (depending on the instrument mode used) in mV, as well as plotted in graphic mode in bar windows. An equalizer type (graphic bars) displays data for EM61-MK2 channels as four bars in each bar window. Left bar represents always Channel 1 readings, second bar Channel 2 and so on. Number of bar windows corresponds to number of instruments in the array. The EM61-MK2 #1 readings are displayed in the left most bar window, the EM61-MK2 #2 in the second window, and the last instrument is shown in the right most bar window. This type of display allows for a legible and very quick estimation of each EM61-MK2 performance. When more detailed monitoring is required each measured channel is displayed in numeric form in mV as well. In addition the program displays windows with profile curves for each probe. If longer profile curves are needed the program can be switched to Profile mode at any time during the survey. Change of display type between Mapping/Navigation and Profile modes can be performed by pressing key **T** (toggle) in the Monitoring or Stand By mode.

When working GPS receiver is connected to the field computer then program uses Navigation or Mapping (depending on settings) mode by default. Mapping mode provides navigation, survey coverage and data quality control at the same time is similar to Navigation mode, however it shows positions of EM61-MK2 sensors (not only at GPS points). Reading for each sensor are shown as coloured amplitude for each measurement. Due to screen resolution and specified map size readings points may be decimated or filled in (expanded) to show coverage in continues mode. Mapping mode example is shown in Figure 1.5.

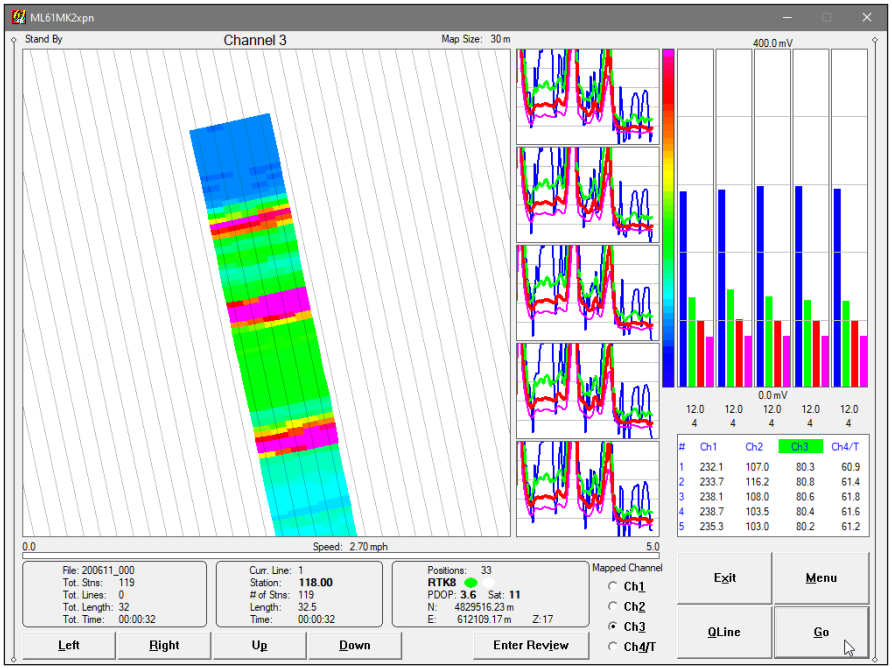

Figure 1.5 ML61MK2xpn screen in Mapping mode, Colour Swath represents positions of a five units array (5 m width) on a 30 m scale map with 1 m guide lines separation.

The ML61MK2xpn screen in Navigation mode is shown in Figure 1.6 (array represented by swath bar) and Figure 1.7 (each sensor is represented by a separate dot). Each swath bar or dot shows position of recorded at the moment the GPS station is recorded, positions of recorded EM61-MK2 sensors (located between GPS points) are not shown in Navigation mode. While dots presentation shows exact position of the center of each sensor including two rows arrays, the swath bar represents width of the entire array (the second row in two rows setup is not shown).

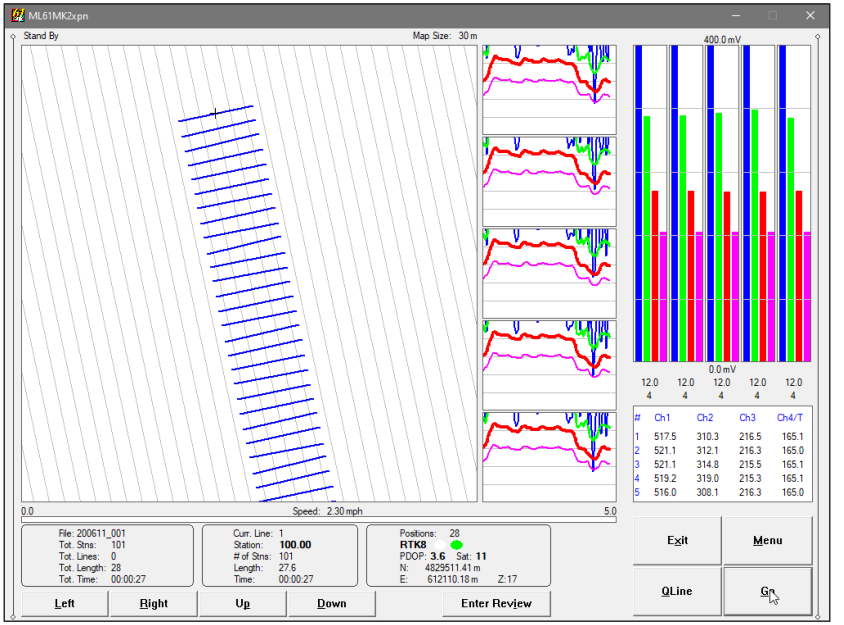

Figure 1.6 ML61MK2xpn screen in Navigation mode, Swath Bars represent positions and width of a five units array (5 m width)

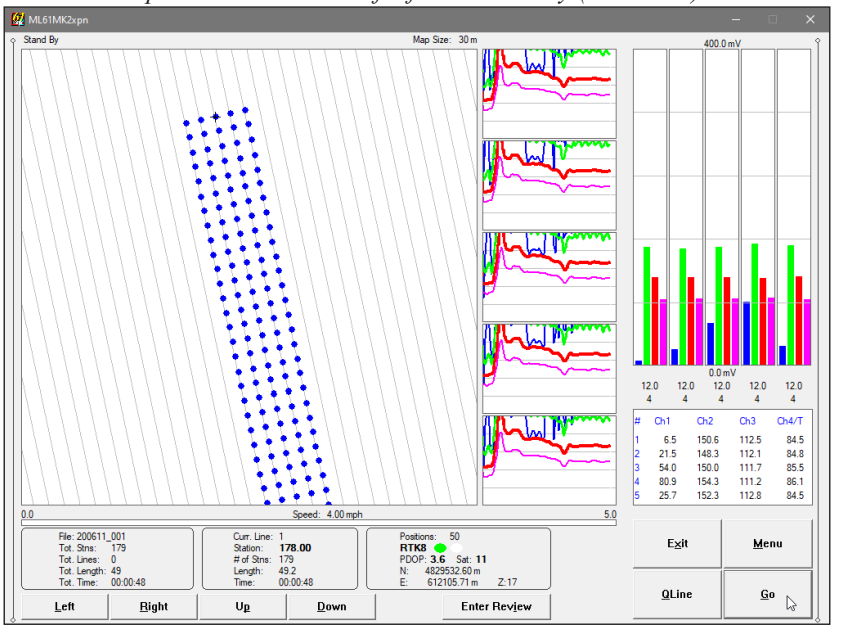

Figure 1.7 The ML61MK2xpn screen in Navigation mode where each sensor position is represented by a dot (parameters as in Fig. 1.6).

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

If GPS is not used during the survey the default type of display is Profile mode and Mapping and Navigation modes are not accessible. Example of the ML61MK2xpn screen in Profile mode is given in Figure 1.8. When changing display from Profile to Naviga-

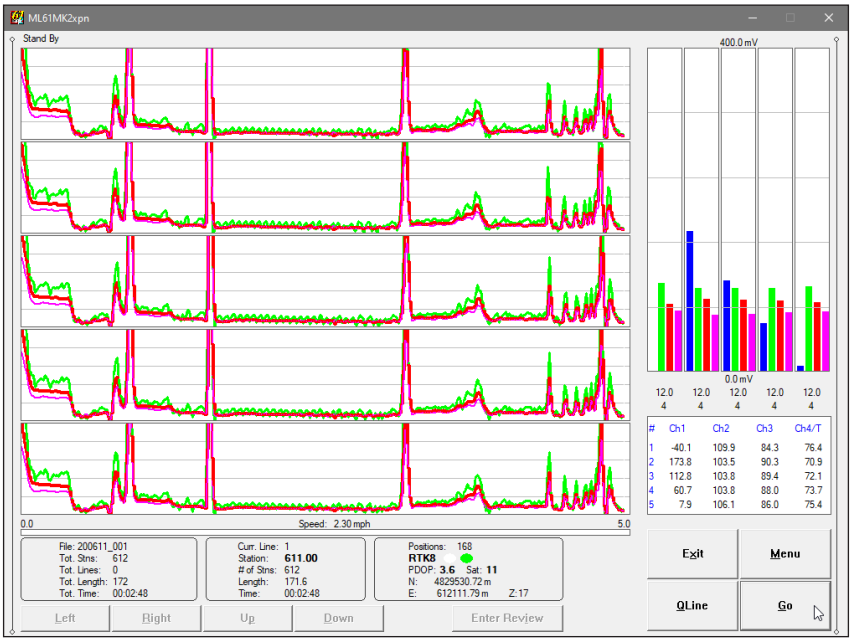

Figure 1.8 The ML61MK2xpn Logging screen in Profile mode

tion mode while large amount of data is collected, a message Wait is displayed and the program may take several seconds to select the needed coordinates while scanning the entire database of collected positions. There is no such delay during scrolling since the program keeps track of survey path while in navigation mode.

The maximum number of 28,800 GPS positions is allowed in one file. This corresponds to 8 hours of continuous data collection if GPS positions are collected every second, or 16 hours if GPS data is taken every 2 seconds. However, it is strongly advised to limit files to for example approximately 1 hour blocks, especially when using high frequency of EM61-MK2 data collection. In case of any possible error in data file it is much easier to correct smaller file. Data files are permanently saved every time Pause key is executed. Therefore, in case of accidental computer lock up, data file will contain all readings till last time Pause key was used.

Program and Survey Procedure 2

This chapter is provided for quick overview of the program, EM61-MK2 array setup and survey procedure.

2.1 ML61MK2xpn Program Overview

The data acquisition program ML61MK2xpn 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 number of EM61-MK2s in the array is the same, when the program is started, instruments in EM61-MK2 array and field computer are turned on, output of all connected EM61-MK2s 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.

The instruments output is shown in the form of profiles and numeric values for channels 1, 2, 3, and 4/T of each instrument, as well as plotted in graphic mode. An equalizer type (graphic bars) display is incorporated (in addition to profile view which is enabled only during data recording) for displaying data of up to 36 channels (1, 2, 3, and 4/T) for nine instruments. This type of display allows for a legible and very quick estimation of the EM61-MK2s performance. When more detailed monitoring is required each measured value is displayed in numeric form in mV as well.

The program can be tested, or parameters and settings can be prepared employing the single EM61-MK2 unit. This can be accomplished by selecting an array of i.e. five instruments, and then assigning the same port number to each instrument. The result will be five sets of data originated and acquired by the program separately from the same unit. This may be very helpful in survey preparation and testing the system.

When all settings for the system and survey (discussed in sections 4 to 8) are specified, the user selects Logging option in Main menu of the program. This sets the program in Monitoring mode which allows you to examine the EM61-MK2 outputs and GPS performance. To record data one has to specify the data file name. The program will not allow you to overwrite an existing file. After the data file is created the program will switch to Stand By mode. The Stand By mode allows for continuous data monitoring as well as use

available field options. Clicking on **Go** button or pressing **G** (or <ENTER> if button is highlighted) key will change the program to Logging mode and EM61-MK2 and GPS data will be recorded in the data file according to selected mode of operation.

Data files can be created in any directory. The program directory contains initial files. If the program is copied to another directory, and previous settings are needed all initial files (all files with INI extension name) must be copied to the same directory. Otherwise new INI files with default parameters will be created. All data files have extension name N61, and files that contain only GPS positions have extension names GXY (not available in Version 1.00).

2.2 The EM61-MK2 Array Geometry

The instrument array may consists from one to nine instruments organized in two rows. The reference point 0, 0 is located at the center of the left edge of Row 1 (see Figure 2.1). Instruments are numbered from the left of the first row while facing the direction of the array movement. This procedure of naming (numbering) is very important since positioning of specific sensors based on one GPS is based on this assumption. For surveys carried out along grid (without GPS receiver) this method of numbering particular EM61-MK2s will be used in specifying the position of the survey line for each sensor.

The main result of the described method of numbering EM61-MK2 instruments in the array is that the system can not change its orientation. The instrument furthest to the left (#1) must remain in this position (related to direction of moving) during collection of data to one data file. This means that the EM61-MK2 array can not be pushed toward the fence or building, and then towed away from an obstruction. If the survey is conducted along a grid, without GPS positioning, the above method can be omitted, however the operator has to keep track of sensor locations for each survey line.

The EM61-MK2 array geometry (Figure 2.1) is described by following parameters:

number of EM61-MK2 units and number of rows
sensor size
offset of Row 2 in both directions (Row2X and Row2Y)
separation between sensors in Row 1
separation between sensors in Row 2
offset of GPS antenna in both directions (GPSX and GPSY)
leading EM61-MK2 (only for surveys conducted without GPS)
array measurement units (m, cm, feet, or inches).

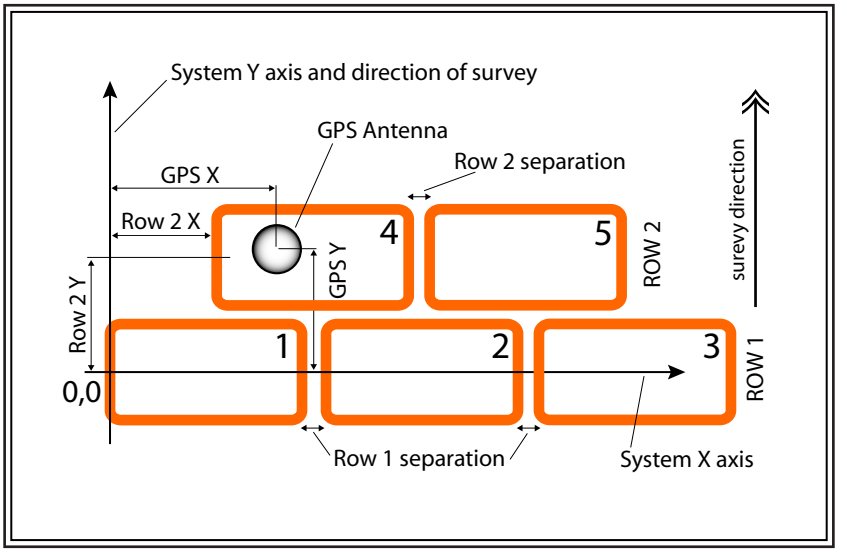

Figure 2.1: Array geometry with GPS Antenna X and Y offsets

Number of EM61-MK2 Units and Number of Rows

The ML61MK2xpn is designed to work with an array of up to nine EM61-MK2s systems (however it will work with one unit as well). Instruments can be organized in one or two rows (as shown in Figure 2.1). Reference point 0,0 is always assigned to Row 1, therefore Row 2 is optional. Row 2 is usually placed in front of Row 1 (in relation to the direction of movement), if for any reason Row 2 must follow Row 1 then please use negative Row 2 offset in Y direction.

Sensor Size

Program assumes that all EM61-MK2 sensors used in array are of the same size. The following sensor size can be selected in the program: 1.0 x 1.0 m, 1.0 x 0.5 m, 0.5 x 1.0 m, 0.5 x 0.5 m, and Hand Held. Attention should be paid when choosing antenna 1.0 x 0.5 m. These sensor can be used in two configurations 1.0 x 0.5 and 0.5 x 1.0 m as shown in Figure 2.2. The first dimension represents the side of the antenna oriented along the array axis, or perpendicular to the movement direction. If Hand Held sensor is used then layout of the array is specified only by sensor separation (distance between centres of neighboring coils), and GPS antenna location which is measured from the center of the left most sensor located in Row 1.

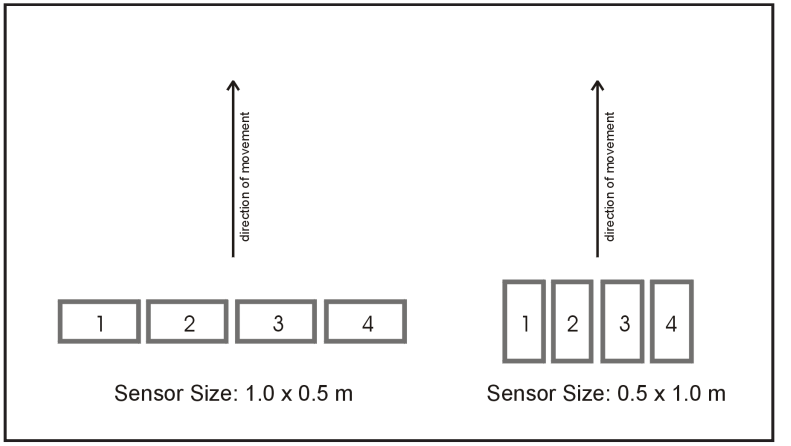

Figure 2.2: Two types of 1.0 x 0.5 m sensors layouts

Offsets of Row 2

Location of Row 2 is specified by offsets in X and Y directions (see Figure 2.1) in relation to reference point 0,0. Offset in X direction is calculated from reference point to the left side of the Row 2 left most antenna, while offset in Y direction is calculated from the reference point to the center axis of antenna. Positive offset for Row 2 places Row 2 in front of Row 1. Row 2 with negative Y offset follows Row 1. If Hand Held sensors are employed, offset to the second row is measured to the center of the left most coil.

Separation Between Sensors

The ML61MK2 program assumes that separation in each row between all sensors is the same. This parameter is taken to account during calculation positions of sensors for surveys conducted with GPS positioning, as well as for surveys carried out along grid. If Hand Held sensors are employed, the separation between antennas is measured between centers of coils.

Location of GPS Antenna

Location of GPS antenna is described by two parameters, offsets in X and Y directions (while facing direction of the movement) from the reference point 0,0 (see Figure 2.1). Offsets for GPS Antenna can be entered in Array Geometry dialog.

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

system as possible, and preferably in the center of the EM61-MK2 sensor. For example, if three instruments are used the optimal location of the GPS antenna would be in the center of the second instrument (assuming 1 x 1 m coils and Separation between coils 0, the GPS Antenna distance is 1.5 m). In the case of a two instrument array the GPS antenna can be placed in the center of the system, however locating the GPS antenna in the center of one of the coils is much easier and it is still close to the center of the system.

In the case wrong value was entered in the field, GPS Antenna parameter can be corrected later during data processing in the program Multi61MK2.

Leading EM61-MK2

This option, named Leading EM in System Setup menu, applies only when a survey is positioned using a laid out grid, and it is not used when the survey is positioned with GPS. The Leading EM indicates the sensor that follows the Survey Line name entered in the program during data collection. Survey lines coordinates for the remaining instruments will be calculated by the Multi61MK2 during data processing. The survey line coordinate for a particular sensor is determined based on the number of instruments in the array, sensor size, coil separation, direction of survey (positive or negative station Increment), and survey line name which is related to the Leading EM61 (instrument number). An example of the array setup and corresponding survey lines is given in Figure 2.3. In this example Leading EM61 is #2 (marked by circle),

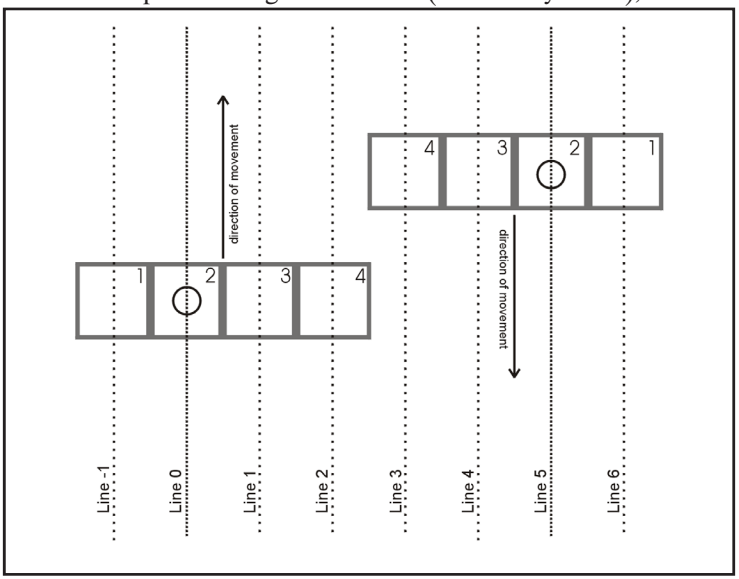

Figure 2.3: Example of survey lines layout for four EM61-MK2

Its survey lines are marked by finely spaced dotted line. When the array is heading North (positive Station Increment) and Survey Line name was specified 0, the Multi61MK2 assumes that the EM61-MK2 #1 will follow coordinate -1, and instruments located to the right of the Leading EM will follow survey lines 1 and 2. If the array heads towards South (negative Station Increment) and the Survey Line is selected as 5, the program will assume coordinate 6 for the EM61-MK2 #1, and correspondingly 4 and 3 for EM61-MK2 #3 and #4. Similar procedure is followed when the array is used along West -East direction. If any Survey Line name is entered wrong during the field work, it can be easily corrected easily during data processing. One Leading EM (number of the EM61-MK2 in an array) is selected for the entire data file.

2.3 Surveys Carried Out With GPS Positioning

Most of the stations positions for surveys positioned with GPS receiver will be calculated based on the GPS antenna position and instant heading of the array. In order to achieve higher quality of data positioning the survey should be carried out along relatively smooth pathways. Any sudden change of direction of the array causes large acceleration of sensors that are located at the edge of the array. This may result in the inaccurate calculation of the position of the outer sensors.

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. Additional important benefit of the frequent Pause button usage is permanent Save File action performed by the program every time the Pause button is clicked.

Similar approach applies to situations when the array 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 sensors positions. It may appear that the array 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.

Main Screen Window 3

The Main Screen appears always as the first window after the program is started. It contains the name of the program, its version number, and list of command buttons with available options on the right side. The major , left portion of the window contains information about current survey and system settings, and graphic illustrating current array geometry. The graphic diagram is updated in real time as soon as array geometry parameters are changed in Array Geometry dialog. The ML61MK2xpn Main Screen window is shown below in Figure 3.1.

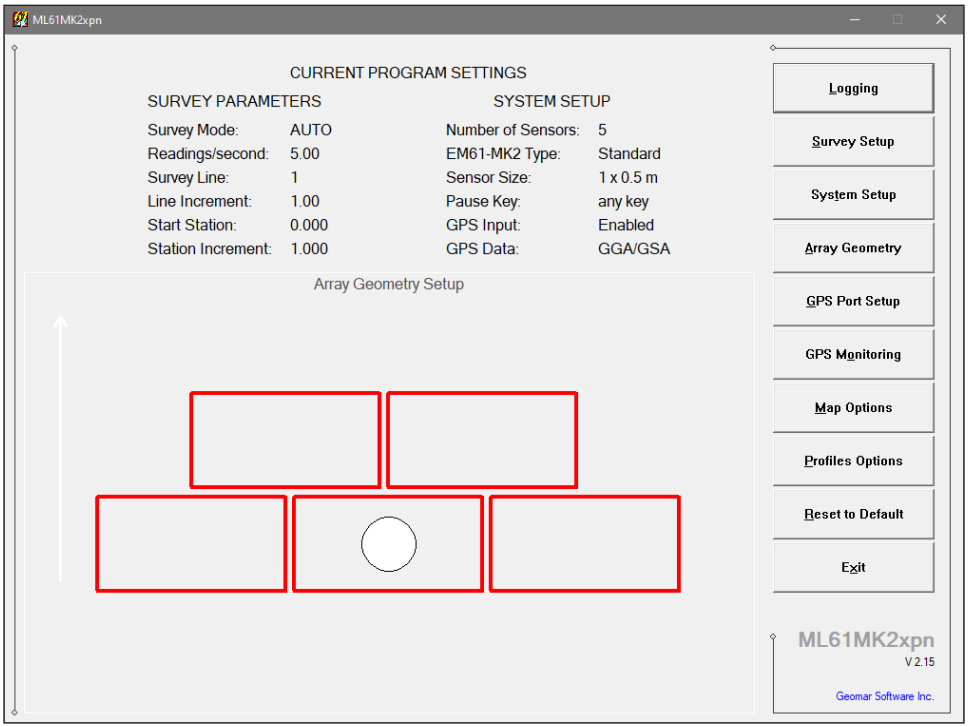

Figure 3.1: ML61MK2xpn Main Screen window

The ML61MK2xpn is a command button and dialog driven program. Command buttons can be executed by clicking with the left mouse button, or by pressing the indicated (underlined) character on the keyboard, or by using TAB to scroll through the buttons and ENTER to execute. In the Main Screen of the program Up and Down arrow keys can be also used to scroll through the buttons. Short description for each of the options follows.

3.1 Short Description of Main Screen Options

Logging

This option allows to monitor output of all connected EM61-MK2s, null each instrument, and record data.

Survey Setup

Dialog window that is associated with this option is used to set triggering mode (Auto is the fixed option in this version), survey line name, line and station increments, and other parameters which are necessary to determine survey settings (Figure 3.2). The Null Values parameter determines whether Nulling Factors from the last session are applied (Last Survey) or they are re-set to zero (None).

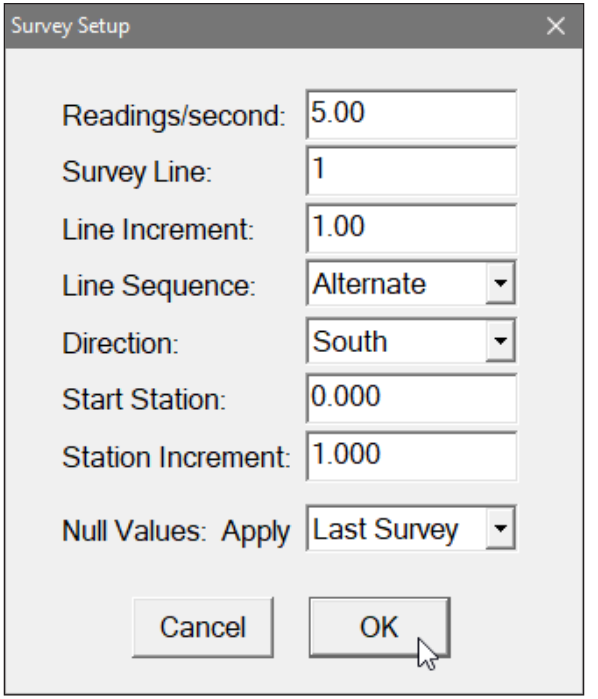

Figure 3.2: Survey Setup dialog

System Setup

This dialog (see Figure 3.3) allows user to select type of EM61-MK2 instruments connected to the logger, instrument output Baud Rate, specify Leading and Triggered instruments, and logger settings: type of pause key, audio click,

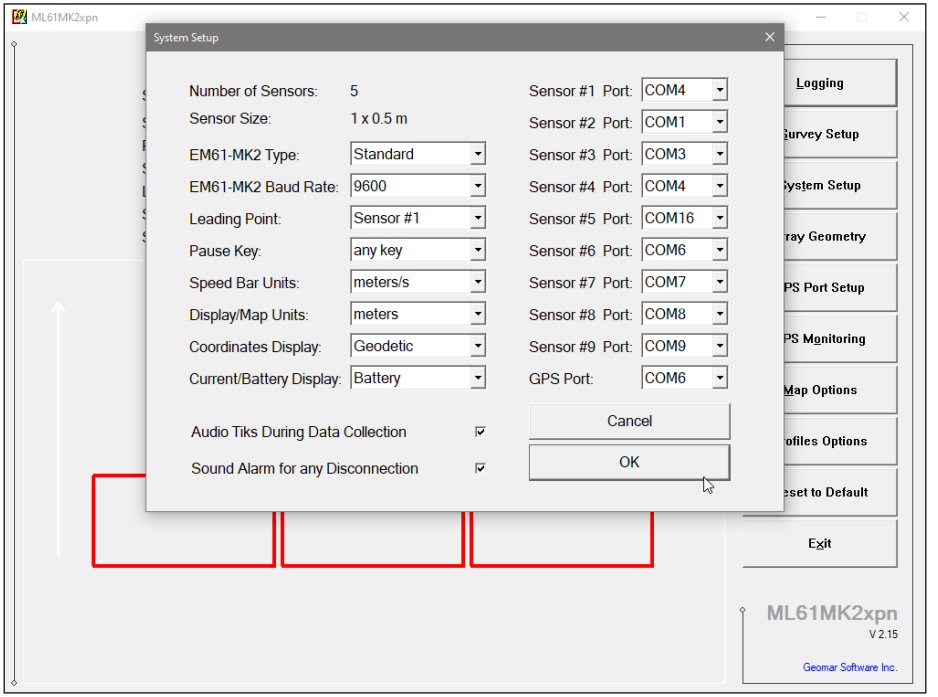

Figure 3.3: System Setup dialog with array of 5 sensors selected in the Array Geometry Setup dialog.

display units, and speed bar units. This dialog also is used to assign serial port numbers to each instrument and GPS receiver port.
Number of sensors in array as well as sensor size are specified in Array Geometry dialog.

Array Geometry

The Array Geometry Setup dialog that is associated with this option is used to set all parameters that describe and determine array layout. These parameters are used during data acquisition session as well as later by data processing program to position each sensor while creating XYZ file output. The dialog is shown in Figure 3.4. Small graphic window illustrates meaning of geometry parameters (this is reference graphic, the drawing is not updated as graphic diagram in Main Screen which represents actual layout of the array).
This dialog allows you to specify number of employed EM61-MK2s units, sensor size, number of rows in array, separations between sensors, offset of the optional second row, GPS antenna offsets, and units used in this dialog. After button OK is clicked the dialog disappears and layout of the array is updated in the Main Screen.

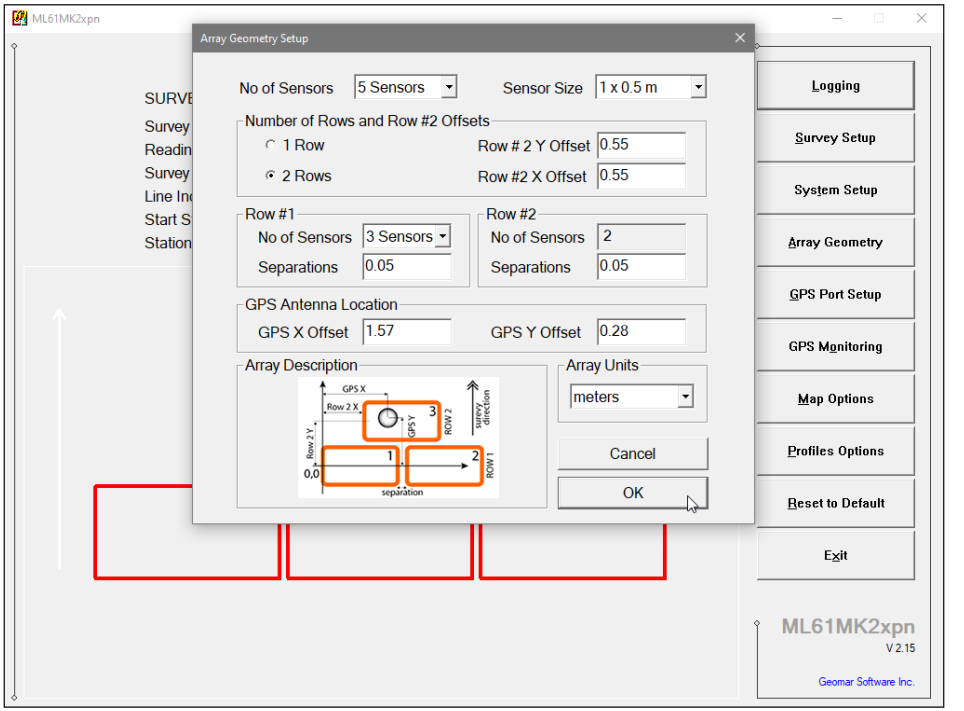

Figure 3.4: Array Geometry Setup dialog

GPS Port Setup

The GPS Port Setup dialog (Figure 3.5) allows you to disable and enable GPS data acquisition. It is also used to specify NMEA message that is streamed by GPS receiver or Robotic Total Station interface, set the serial port number used for GPS input (it can be also set in System Setup dialog), and to specify all necessary serial port communication settings. The GPS Warning Mask parameters can be specified in this dialog.

GPS Monitoring

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

Map Options

The Map Display Options dialog (Figure 3.6) allows you to specify size and colour of the cursor showing current GPS antenna position, as well as a size of dot or swath bar representing recorded position. The option labeled Colour Map View can be used to set Navigation mode (by selecting item: GPS Posi-

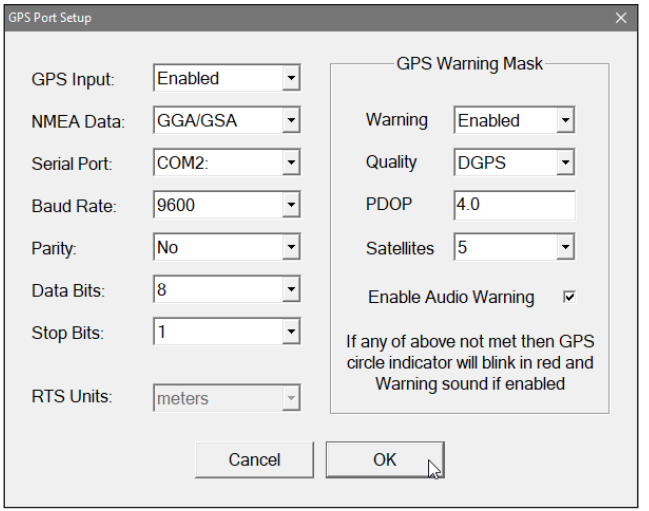

Figure 3.5: GPS Port Setup dialog

tions, No Color Amplitude) and Mapping mode (any other item in this combo box selection with choice of displaying colour map of one of channels - Channel 3 is selected in Figure 3.6).

The size of Array Swath bar is 100% of the array span and on the map it will represent full width of the array scaled to displayed map. If Mapping mode is selected in Colour Map View option then the size of swath for each sensor an-

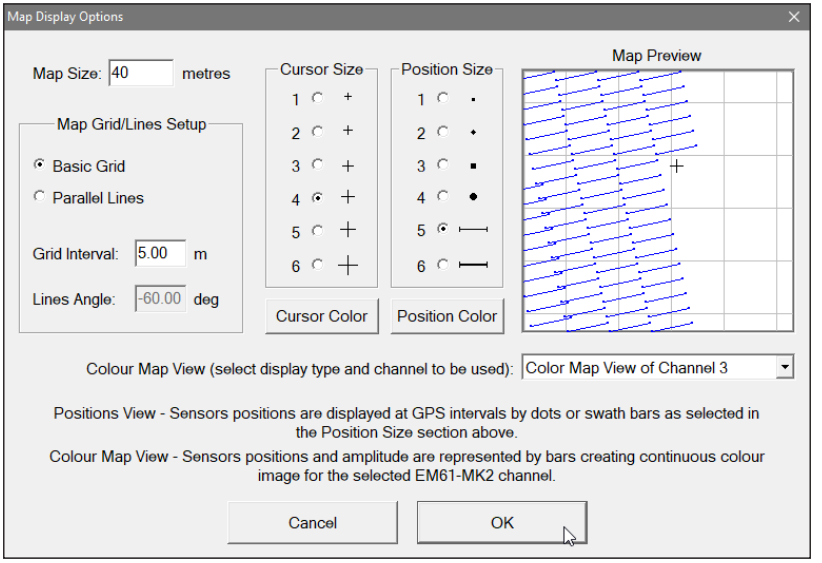

Figure 3.6: Map Display Options dialog

tenna equals to the width of coil in one row array setups and half of the sensor size when two row array of sensors is used. Therefore each sensor shows colour section equal to the sensor lateral length in one row array, and half of the sensor when two rows are selected for increased resolution of the survey.
In addition the Map Size, selection of Grid or Parallel Lines (together with Lines Tilt Angle) can be specified in this dialog.
This dialog can be also displayed, and all parameters can be adjusted at any time during data collection in Logging mode.

Profiles Options

The Setup Display Options dialog (Figure 3.7) allows you to unable/dispable profile display for each channel, to specify colour and thickness of profile line for each channel, and to select amplitude to be displayed in linear or compressed mode.

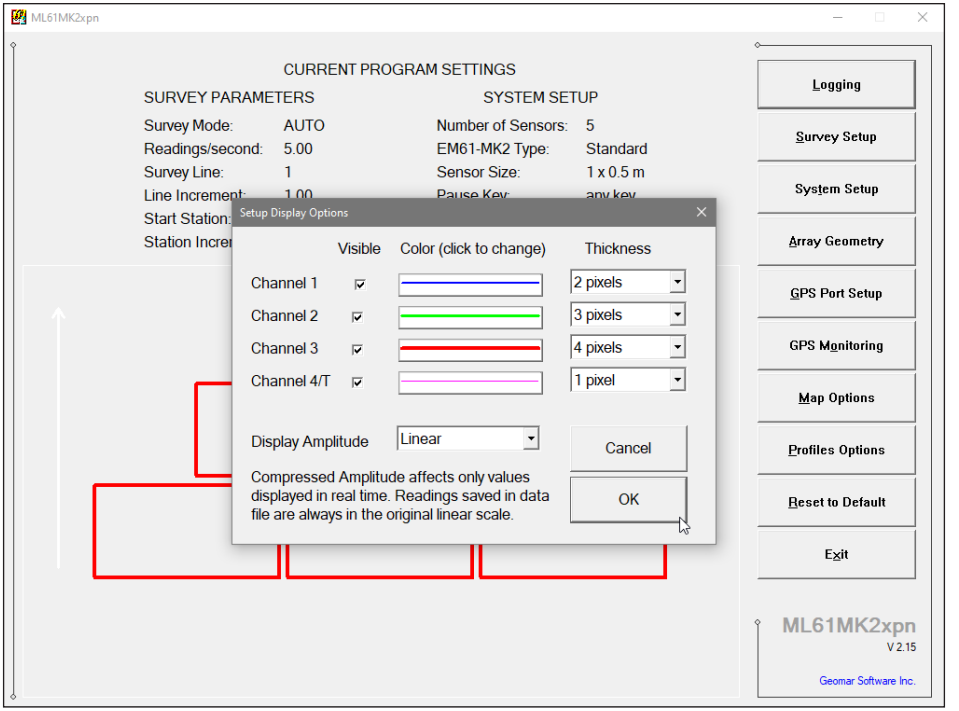

Figure 3.7: Setup Display Options dialog

Exit

Selecting this option will terminate the program execution.

Survey Setup 4

The Survey Setup dialog, presented below in Figure 4.1, contains several parameters which affect two important procedures: instrument settings (instrument mode, frequency of data collection, etc.) and survey geometry layout (survey line names, line spacing, start station, station increment, etc.).

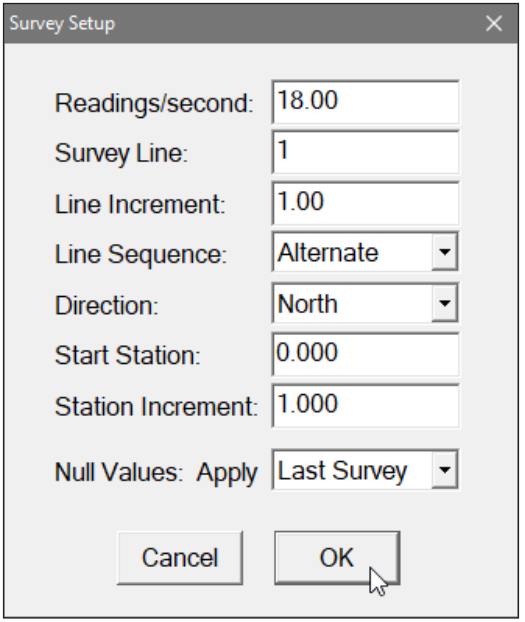

Figure 4.1: Survey Setup dialog

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

Description of the Survey Setup dialog options and parameters.

Readings/seconds

When this option is available (only in Auto mode) activate text box by clicking with a mouse or using TAB key and then enter desired value.
This parameter describes number of readings per second that will be taken. Any number larger than zero can be entered, however the EM61-MK2 maximum

frequency of data output is about 15 readings per second for older models of EM61-MK2, and 18 readings per second for models (named Bluetooth) with a new processor in the EM61-MK2 console.
The EM61-MK2 update rate does not depend on GPS update rate, the program will position instrument readings for each sensor based on neighbouring GPS positions, time, and array geometry parameters.

Survey Line (survey line name)

Activate text box for this option by clicking with a mouse or using TAB key and then enter desired value.
This is a user's tag number/name for the profile line. The length of the name can not exceed 8 characters. The line name is usually used as a coordinate perpendicular to the survey lines direction. For example, when survey lines are laid out along W-E direction stations describe W-E coordinate, while Line names may describe S-N (vertical on a map) coordinate.
If survey is conducted along grid (no GPS positioning) use negative numbers to indicate South and West direction. Letters associated with direction (S, N, W, E) can be used, however they must follow numbers and they will be ignored during creating XYZ file in the Multi61MK2 program (i.e. Line -20S, will be assigned to coordinate -20, South or West depending on the survey layout, while Line 20S will indicate coordinate 20, North or East depending on the survey layout). Letters used in Survey Line name have only informative meaning, they can be used also for naming the same lines, either portions of the same line or if a survey line is repeated (computer program will assign the same coordinate for lines 10, 10A, and so on).
In case the survey is positioned with GPS system, the Survey Line (and all following parameters described below) can be ignored. The Survey Line, however, can have informative meaning, it can be used to divide or to distinguish certain portions of the survey, without creating new file for each set of data.

Line Increment (separation between survey lines)

Activate text box for this option by clicking with a mouse or using TAB key and then enter desired value.
This parameter specifies the distance by which survey lines will be separated. When array of the instruments is used this parameter must be used for entire array. See also parameter **Main EM61** in the System Setup dialog.
This setting will be used to determine number (name) of the next survey line. In case of New Line command the survey line name can be overwritten, however if you use Quick Line button then Line Increment specified here will be used by the program to determine next Survey Line name.

Sequence

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between two available settings: Alternate and One Way (Figure 4.2).
Alternate is used when neighboring lines are surveyed in the opposite direction, which is the most common procedure during field surveys.
One Way is used when each survey line is traversed in the same direction.
The choice of this parameter will affect the default start station, a signature of the station increment, and line direction when parameters for the next survey lines is determined.

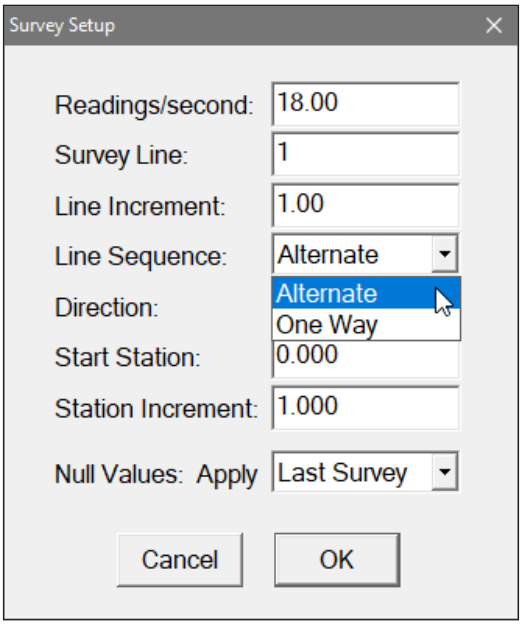

Figure 4.2: Line Sequence selection

If Quick Line command (described later in will be used during the survey then this parameter will be used in determining the Start Station, signature of Station Increment and Direction of the next survey line.
This parameter can be ignored if survey is positioned with GPS system.

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 4.3).

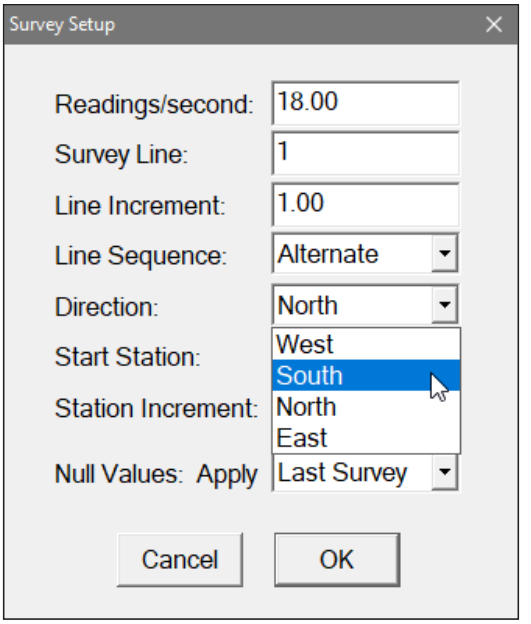

Figure 4.3: Line Direction selection

This parameter indicates the heading of the survey line. It can be ignored if survey is positioned with GPS system.
When survey is conducted along a grid, the Direction has only informative meaning. During generating XYZ file, only three parameters: Survey Line Name, Start Station and Station Increment, will be used to determine geometry of the survey layout.

Start Station (start station of a survey line)

Activate text box for this option by clicking with a mouse or using TAB key and then enter desired value.
This parameter specifies the starting station number for the selected survey line. This value is used in conjunction with Station Increment to calculate the current station number for display purposes.

If GPS positioning is used, this parameter has only informative meaning. The most convenient is to set Start Station to 0, then (if Auto mode is used and Station Increment is positive) the current station will indicate number of stations (readings for set of the instruments) taken since the start of the data file.

Station Increment

Activate text box for this option by clicking with a mouse or using TAB key and then enter desired value.
If Wheel mode was selected then this parameter will be labeled Wheel Increment.
This parameter specifies the station increment for the selected survey line. This value is used in conjunction with Start Station to calculate the current station number for display purposes.

If GPS positioning is used the most convenient is to set Station Increment to Positive. The station displayed during data recording will indicate number of stations (readings for set of the instruments) taken since the start of the data file.

Null Values

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between two available settings: None and Last Survey (Figure 4.4).

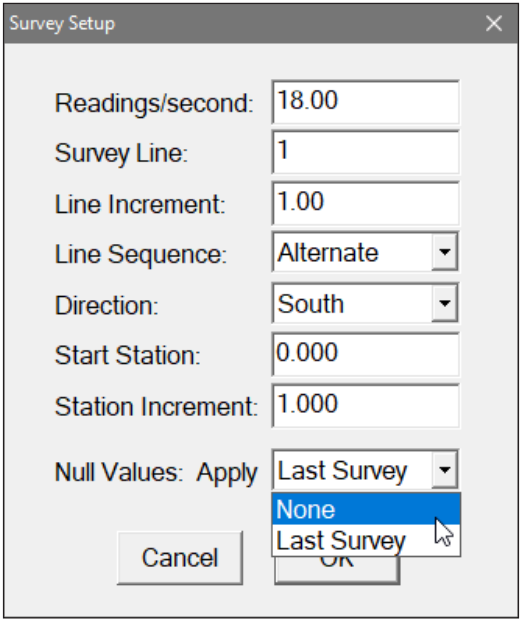

Figure 4.4: Null Values selection

This parameter indicates whether Nulling offsets (see Nulling in Monitoring section) are to be applied same as in the **Last Survey** (or file) or they are reset to zero. In the latter case select **None**.

If Nulling operation is to be performed later in this logging session then this parameter is not important, new Nulling factors will overwrite former values.

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

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

System Setup 5

The System Setup dialog, presented below in Figure 5.1, contains several parameters which describe the instrument array (EM61-MK2 type, Baud Rate, Leading Point), logger settings (Pause Key, Speed and Display units, Displayed Coordinates, Audio functions), and assignment of serial ports). Number of instruments in the array and sensor size are displayed as an information, these parameters can be specified in Array Geometry Setup dialog (discussed in the next chapter).

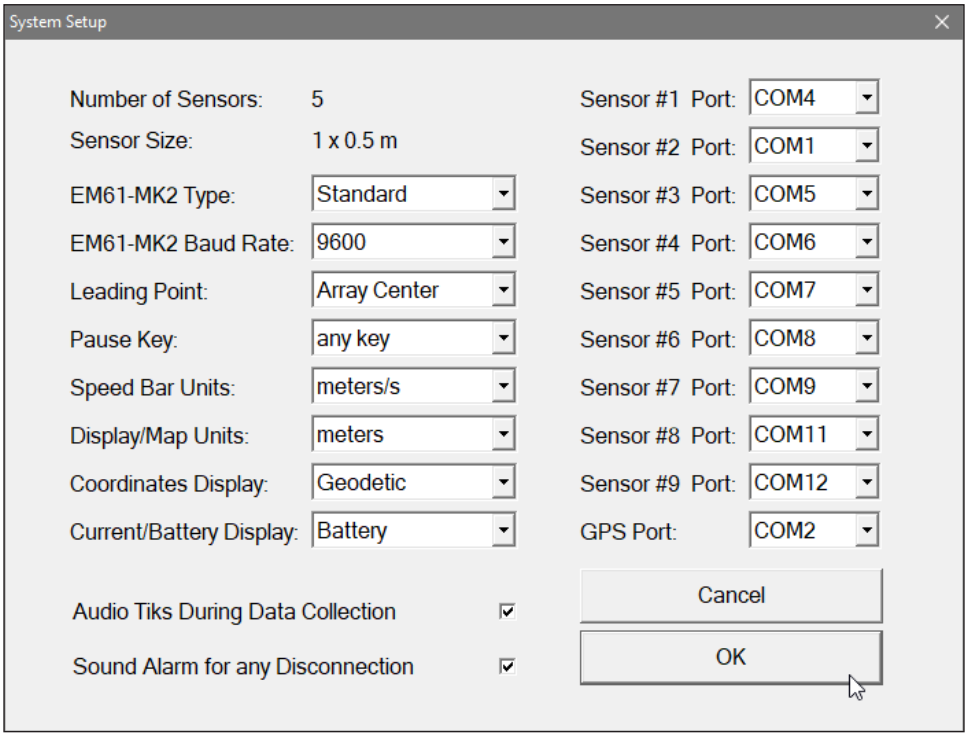

Figure 5.1: System Setup dialog for array of five EM61-MK2 units

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.

EM61-MK2 Type

When this option is highlighted and drop-down box is expanded (Figure 5.2) use mouse or use **Down** or **Up** cursor key to toggle between six available EM61-MK2 types: Standard, High Power, Standard N.C.C., High Power N.C.C., Standard A.C.C, and High Power A.C.C..

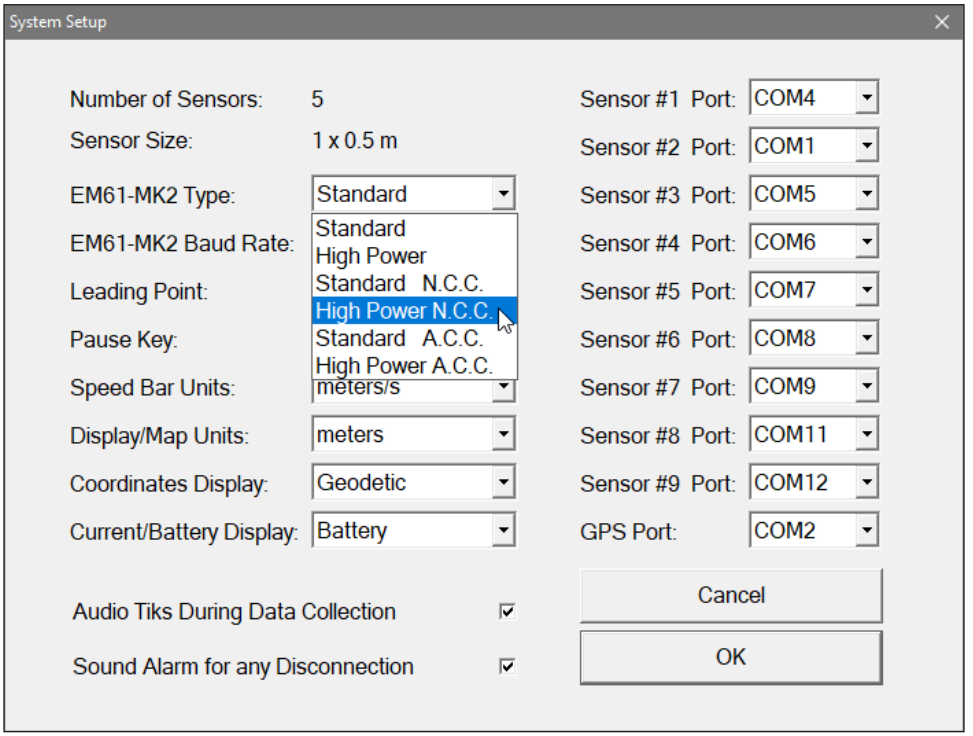

Figure 5.2: Selecting the EM61-MK2 Type

Standard and High Power items correspond to standard EM61-MK2 setups where each console is connected to a sensor that consists of Transmitter and receiver coils. The transmitter current is measured and applied during current normalization procedure to each unit individually.

Type N.C.C. (No Current Correction) is provided for setups with only one transmitter and several receivers. When N.C.C. type is selected then the program does not use transmitter current normalization to reduce EM61-MK2 readings to the same current level. Type N.C.C. can be also chosen when transmitter current normalization is not desired for any reason.

Type A.C.C. (Automatic Current Correction) is provided for setups when one of the instruments is connected to the transmitter and remaining units have only receivers. When A.C.C. type is selected then the program automatically detects the units that has the transmitter connected and applies the current measured by this unit to reduce EM61-MK2 readings to the same current level.

EM61-MK2 Baud Rate

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between available Baud Rates.
Majority of EM61-MK2 units have serial output at Baud Rate 9600. However there are few units that use Baud Rate 38,400 kb/s during serial connection.

Leading Point

This option applies only when a survey is positioned using a laid out grid (see Figure 5.3).
When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between available EM61-MK2 numbers. Number of options includes Array Center and depends on and does not exceed number of EM61-MK2s in the array selected in Array Geometry Setup dialog. The Leading Point indicates Array Center or the sensor that follows the Survey Line name entered in Survey Setup menu, or New Line name during data col-

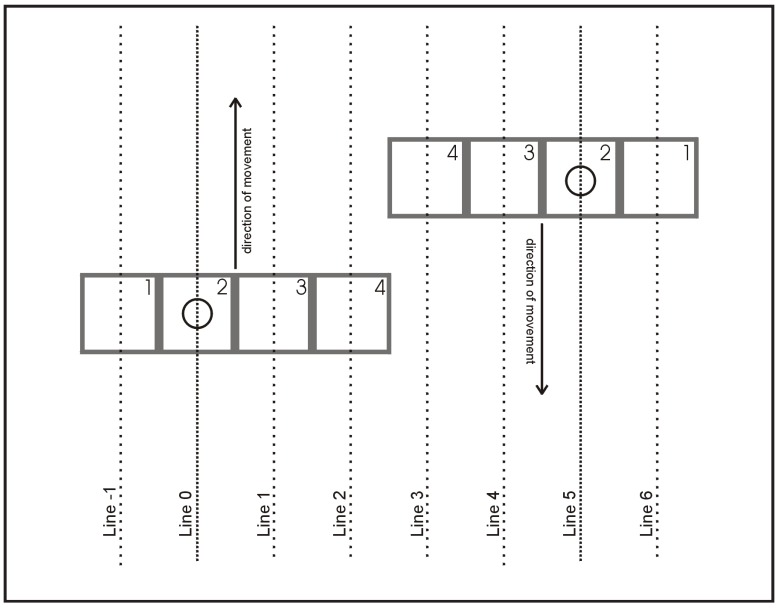

Figure 5.3: Example of survey lines layout for array of four EM61-MK2s organized in one row

lection. Survey lines coordinates for the remaining instruments will be calculated by the Multi61MK2 during data processing. The survey line coordinate for particular sensor is determined based on the Sensor Size, array geometry parameters, direction of survey (positive or negative station Increment) and Line Name which is related to the Leading Point (Array Center or instrument number). An example of the array setup and corresponding survey lines is given in Figure 5.3.

In the example in Figure 5.3 the Leading EM is 2. Its survey lines are marked by finely spaced dotted line. When the array is heading North (positive Station Increment) and Survey Line name was specified 0, the Multi61MK2 assumes that the EM61-MK2 #1 will follow coordinate -1, and instruments located to the right of the Leading EM will follow survey lines 1 and 2. If the array will head toward South (negative Station Increment) and the Survey Line selected is 5, the program will assume coordinate 6 for the EM61-MK2 #1, and correspondingly 4 and 3 for EM61-MK2 #3 and #4.

If any Survey Line name is entered wrong during the field work, it can be corrected easily during data processing. One Leading Point (number of the instrument in an array or its center) must be select for the entire data file.

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 5.4). 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 Units

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

Four selections are available: **meters/s** , **feet/s**, **km/h**, and **mph**. These units will be used to calculate the system speed based on the current and former GPS antenna position. Speed is displayed graphically as a speed bar and in numeric form while logging data during GPS based surveys.

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

Display Units

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between three available options: **Meters**, **Feet**, and **US Survey Feet**. These units will be used to calculate positions for sensors in program Multi61MK2.

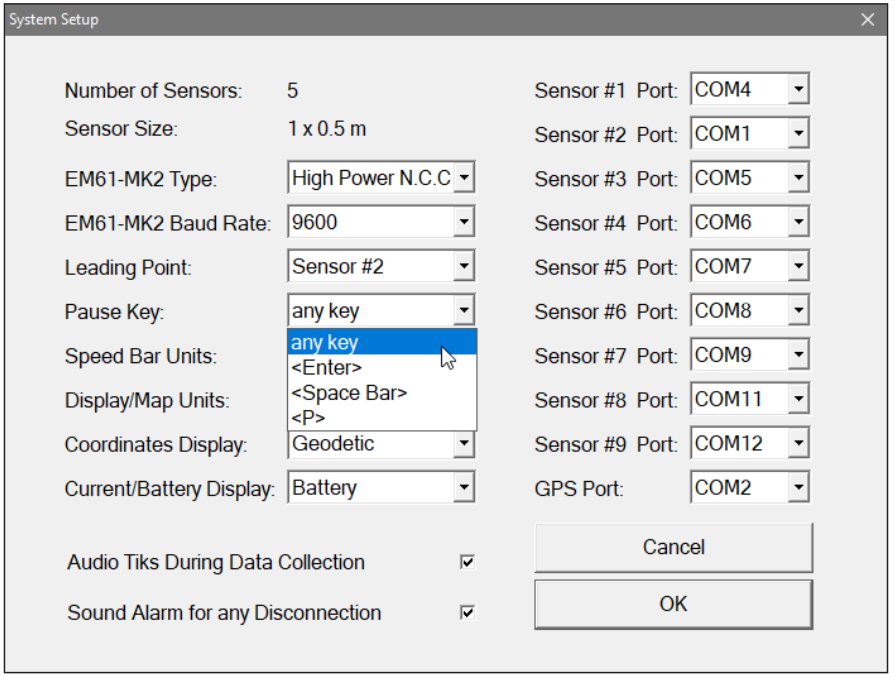

Figure 5.4: Selecting Pause Key in the System Setup dialog

In case wrong selection was entered, units or other parameters can be corrected later in the program Multi61MK2.
These units are not used in the geometry of the system description. Array Geometry Units can be entered in Array Geometry Setup dialog.

Display Coordinates

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between four available options: **Geodetic** (Longitude, Latitude)**, UTM meters**, **UTM feet**, and **UTM US Survey Feet** (Figure 5.5). These units will be used to display coordinates of GPS antenna. Selection of Coordinates display has only informative function, it does not affect data file content.
This parameter can be changed later using Menu options during data logging.

Current/Battery 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 5.6). Two selections are available: **TX Current** and **Battery**. The program will display the Battery voltage (in Volts) or transmitter current (in Ampers) for each EM61-MK2 unit during logging session depending on the selection.

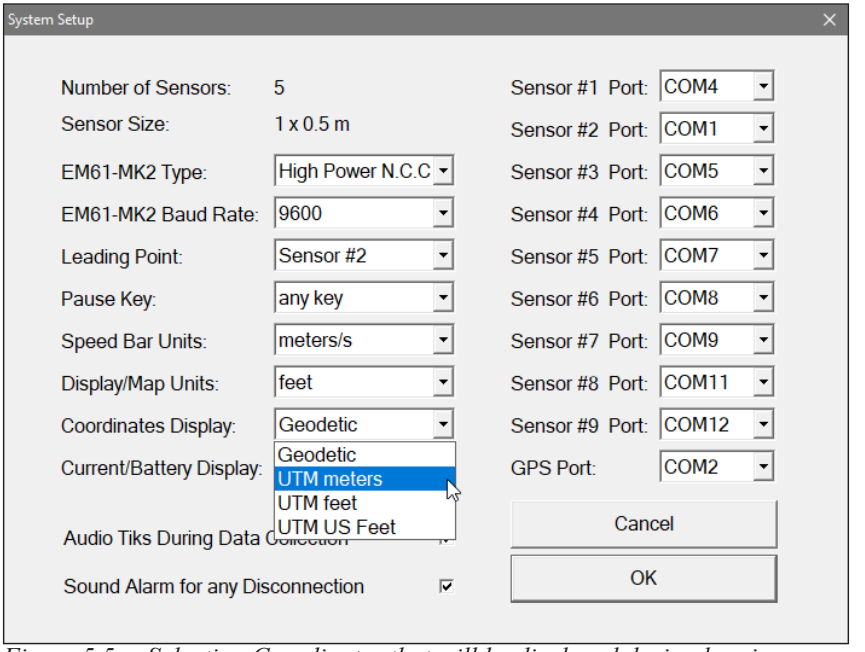

Figure 5.5: Selecting Coordinates that will be displayed during logging

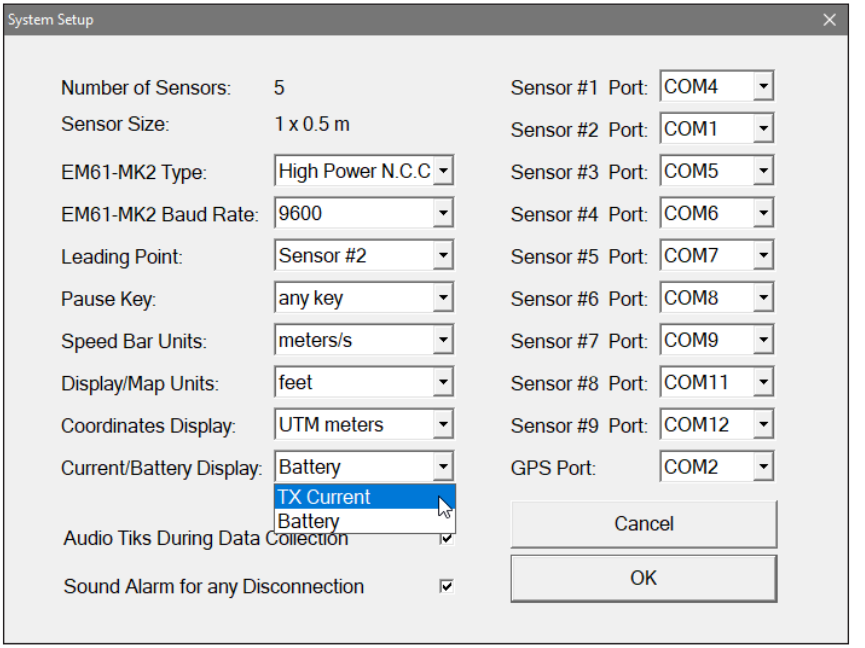

Figure 5.6: Selecting TX Current or Battery display

Audio Tiks

The program will provide tik sound during data recording (in the Logging mode only). The tik sounds with frequency approximately 3 Hz. This audio feature may be helpful as a confirmation that the button Go has been pressed (or tapped) and data is being collected and saved in data file. This audio function can be enabled or disabled by check button as shown in Figure 5.7.

Sound Alarm

The program will sound loud ring in case of any serial port disconnection, or in case any EM61-MK2 unit or GPS receiver will stop streaming data. The audio alarm function does not depend on the visual alarm that is always enabled regardless of audio alarm setting. The audio alarm function can be enabled or disabled by check button at the Sound Alarm for any Disconnection label as shown in Figure 5.7.

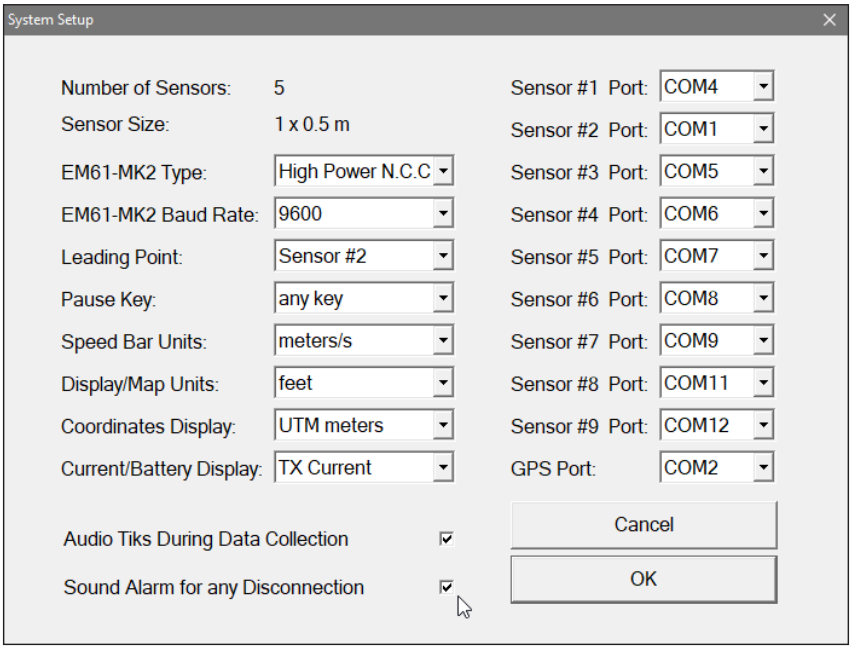

Figure 5.7: System Setup dialog with Audio options selected

Sensor #1 to #9 and GPS Ports

Navigate with mouse or TAB key to each Sensor Port and when the option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between available settings. The program supports ports from COM1 to COM60 for each sensor and for GPS receiver (see Figure 5.8).

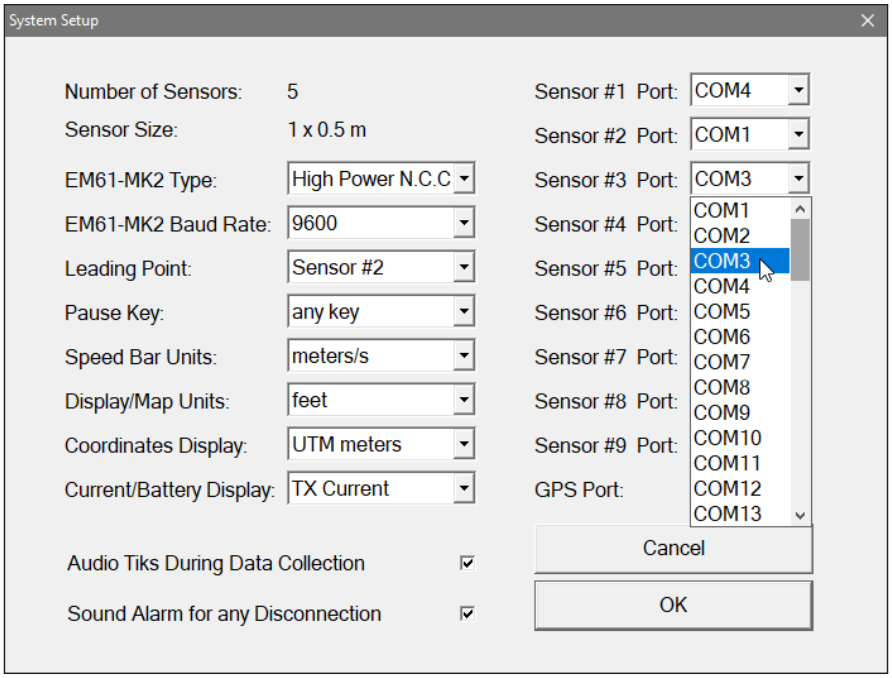

Figure 5.8: Selecting Serial Port in the System Setup dialog

Select proper serial port for each instrument and GPS receiver. Serial ports for all nine EM61-MK2 are listed however only ports corresponding to number of instruments in the array (Number of Sensors) have to be specified. Remaining ports are not checked by the program for assignment conflict.
These settings describe how each EM61-MK2 in the array is connected to the field computer. The program supports Serial Ports 1 to 60. Any serial port can be assigned to any instrument number, however care should be taken that each EM61-MK2 instrument is connected to the proper (indicated here) serial port.

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

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

Array Geometry Setup 6

The Array Geometry Setup dialog, presented below in Figure 6.1, contains parameters which describe the instrument array: number of sensors in array, size of antennas, number of rows, offsets for sensors, and location of GPS antenna. The dialog contains a graphic window labeled Array Description which illustrates meaning of parameters used to specify geometry of an array. This graphic window is used only as a reference, it does not reflect actual array layout.

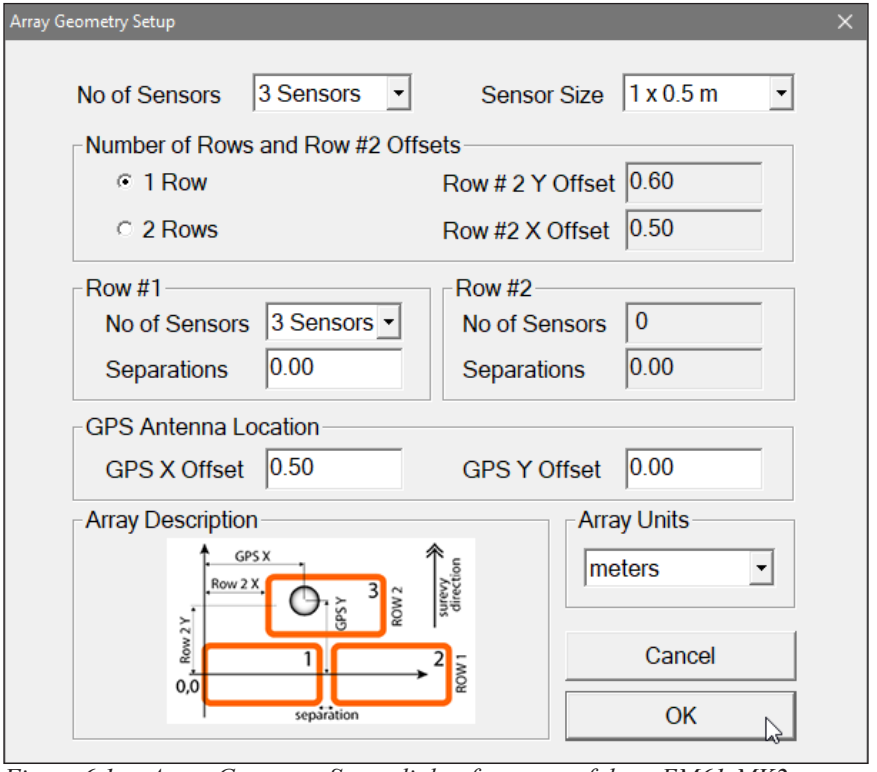

Figure 6.1: Array Geometry Setup dialog for array of three EM61-MK2

The current layout of an array is displayed in graphic diagram located in Main Screen. As soon as the button **OK** in Array Geometry Setup dialog is clicked (or executed by keyboard) the dialog is closed, the program calculates layout of the array using new parameters and displays its layout in Main Screen window. This visual approach helps to notice immediately a case when wrong parameters were entered. The array layout that corresponds to Array Geometry Setup dialog parameters shown in Figure 6.1 is presented on diagram in Main Screen in Figure 6.2 below.

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

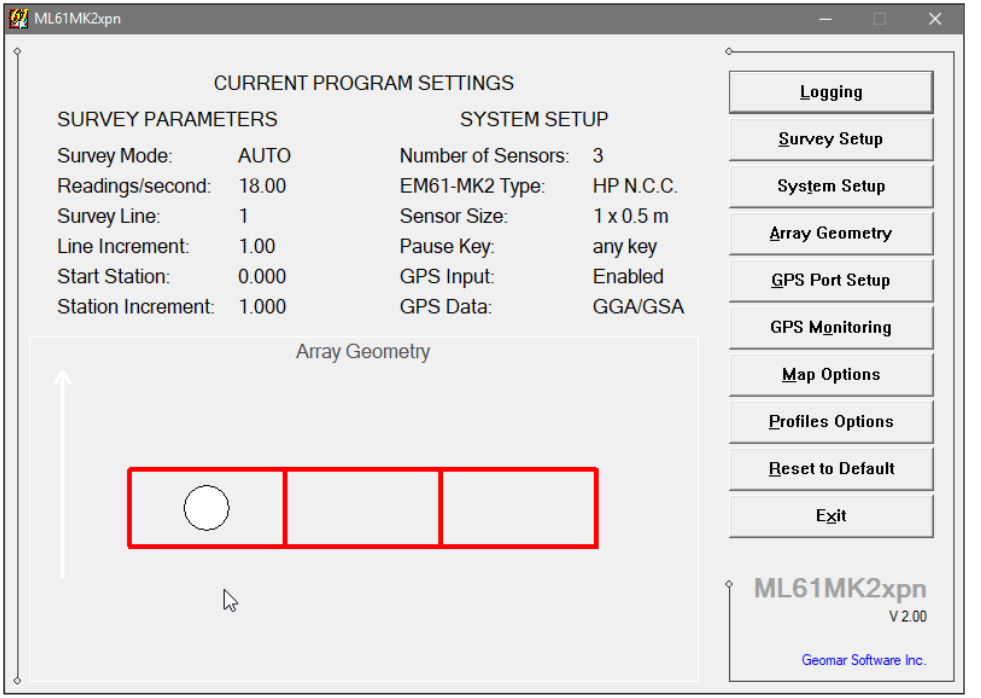

Figure 6.2: Main Screen with array layout corresponding to parameters specified in Figure 6.1

6.1 Short Description of Array Geometry

Array The reference point 0, 0 of the array is located at the center of the left edge of Row 1 (see Figure 6.3). Instruments are numbered from the left of the first row while facing the direction of the array movement. This procedure of naming (numbering) is very important since positioning of sensors calculated from one GPS antenna bases on this assumption. For surveys carried out along grid (without GPS receiver) this method of numbering particular EM61-MK2s will be used in specifying the position of the survey line for each sensor.

The main result of the described method of numbering EM61-MK2 instruments in the array is that the system can not change its orientation. The instrument furthest to the left

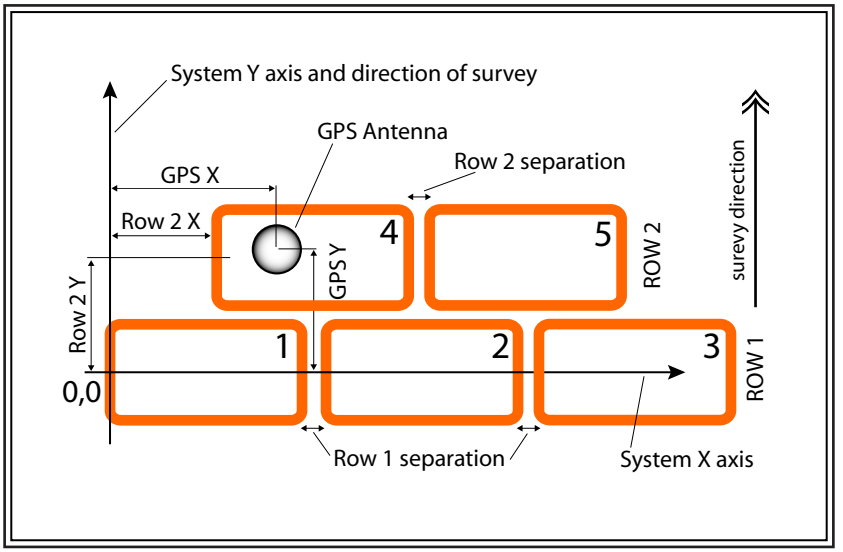

Figure 6.3: Array Geometry description

(#1) must remain in this position (related to direction of moving) during collection of data to one data file. This means that the EM61-MK2 array can not be pushed toward the fence or building, and then towed away from an obstruction. If the survey is conducted along a grid, without GPS positioning, the above method can be omitted, however the operator has to keep track of sensor locations for each survey line.

The ML61MK2xpn is designed to work with an array of up to nine EM61-MK2s systems (however it will work with one unit as well). Instruments can be organized in one or two rows (as shown in Figure 6.3). Since reference point 0,0 is always assigned to Row 1 (which always exists) presence of Row 2 is optional. Row 2 is usually placed in front of Row 1 (in relation to the direction of movement), if for any reason Row 2 must follow Row 1 then please use negative Row 2 offset in Y direction.

All EM61-MK2 sensors used in array must be of the same size. The following sensor size can be selected in the program: 1.0 x 0.5 m, 0.5 x 1.0 m, 1 x 1 m, 0.5 x 0.5 m. and Hand Held. Attention should be paid when choosing antenna size 1.0 x 0.5 m. These sensor can be used in two configurations 1.0 x 0.5 and 0.5 x 1.0 m as shown in Figure 6.4. The first dimension represents the side of the antenna oriented along the array axis, perpendicular to the movement direction. If Hand Held sensor is used then layout of the array is specified only by sensor separation (distance between centres of neighboring coils), and GPS antenna location which is measured from the center of the left most sensor located in Row 1.

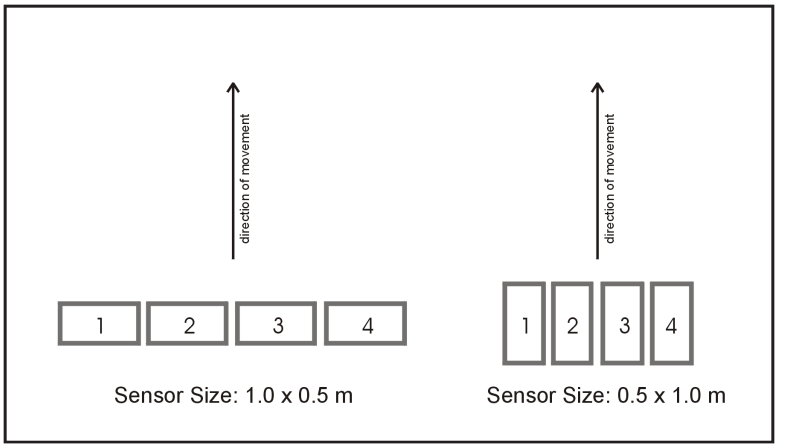

Figure 6.4: Difference in 1 x 0.5 m and 0.5 x 1 m sensor size

GPS antenna can be placed anywhere, however to achieve higher accuracy for the calculated positions of each coil the GPS antenna must be placed as close to the center of the system as possible, and preferably in the center of the EM61-MK2 sensor. For example, if three instruments are used the optimal location of the GPS antenna would be in the center of the second instrument (assuming 1 x 1 m coils and Separation between coils 0, the GPS Antenna distance is 1.5 m). In the case of a two instrument array the GPS antenna can be placed in the center of the system, however locating the GPS antenna in the center of one of the coils is much easier and it is still close to the center of the system.
Location of GPS antenna is described by two parameters, offsets in X and Y directions (while facing direction of the movement) from the reference point 0,0 (see Figure 6.3).

In the case wrong value was entered in the field, GPS Antenna offset as well as any other Array Geometry Setup parameter can be corrected later during data processing in the program Multi61MK2.

In summary the EM61-MK2 array geometry is described by following parameters:

number of EM61-MK2 units
number of rows in the array
sensor size
offset of Row 2 in both directions (Row2X and Row2Y)
separation between sensors in Row 1
separation between sensors in Row 2
offset of GPS antenna in both directions (GPSX and GPSY)
array measurement units (m, cm, feet, or inches).

6.2 Array Geometry Setup Options and Parameters

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

No of Sensors (number of EM61-MK2 sensors in array)

Select number of EM61-MK2 instruments used in the array. The ML61MK2xpn is designed to work with one to nine EM61-MK2 systems. However available selections are: None, 1, 2, 3, 4, 5, 6, 7, 8 and 9 (see Figure 6.5). Option **None** may be available in future versions of the program, in this version it will be automatically replaced by **1**.

A corresponding number of serial ports must be specified in System Setup dialog.

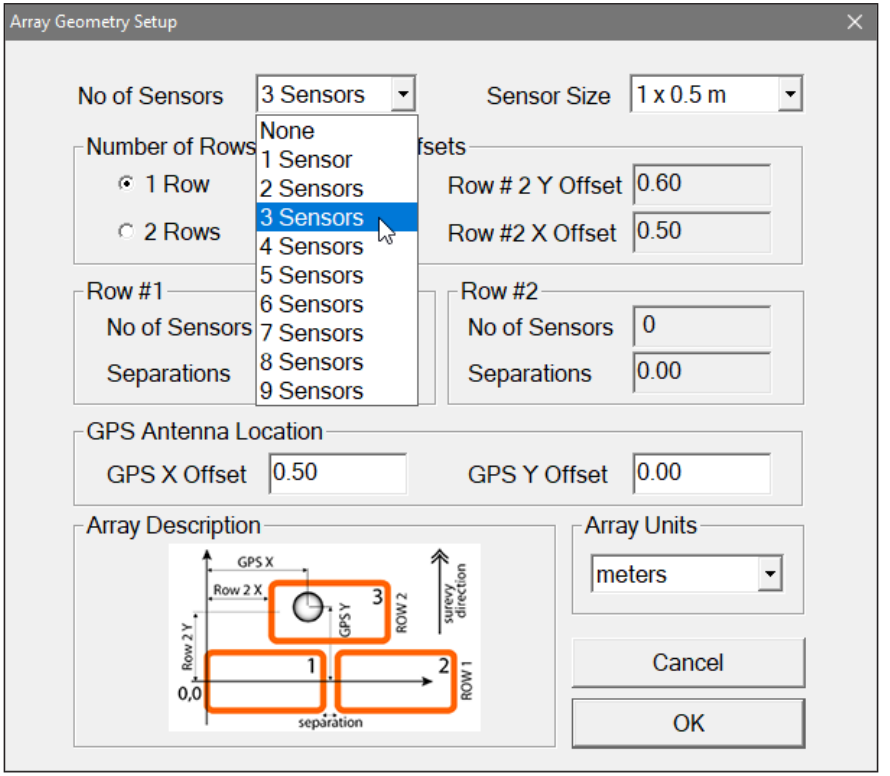

Figure 6.5: Selecting Number of Sensors

Sensor Size

The Sensor Size (antenna size) drop-down list box allows you to select the size of the EM61-MK2 sensor. The available options are: 1.0 x 0.5 m, 0.5 x 1.0 m, 1.0 x 1.0 m, 0.5 x 0.5 m, *(Hand Held sensor is automatically detected by EM61-MK2 and recorded in the ML61MK2xpn file).*

If the standard antennas are used (1 x 0.5 m, 1 x 1 m, or 05 x 0.5 m) the size of the sensor must be specified before monitoring the instrument output.

If antenna 1.0 x 0.5 m is selected, Sensor Size 1.0 x 0.5 or 0.5 x 1.0 m, the first dimension represents the side of the antenna oriented along the array axis (see section 6.1 and Figure 6.4).

Number of Rows and Row#2 Offsets

This section specifies number of rows in an array and if two rows option is selected it allows you to set offsets (in relation to reference point 0,0) for sensors in the second row. Edit boxes labeled Row#2 X Offset and Row#2 X Offset are disabled fir one row array and as soon as radio button labeled 2 Rows is clicked (selected) these edit boxes are enabled by the program (compare Figures 6.5 and 6.6). At the same time edit box labeled Separations in Row#2 (section below) is enabled as well.

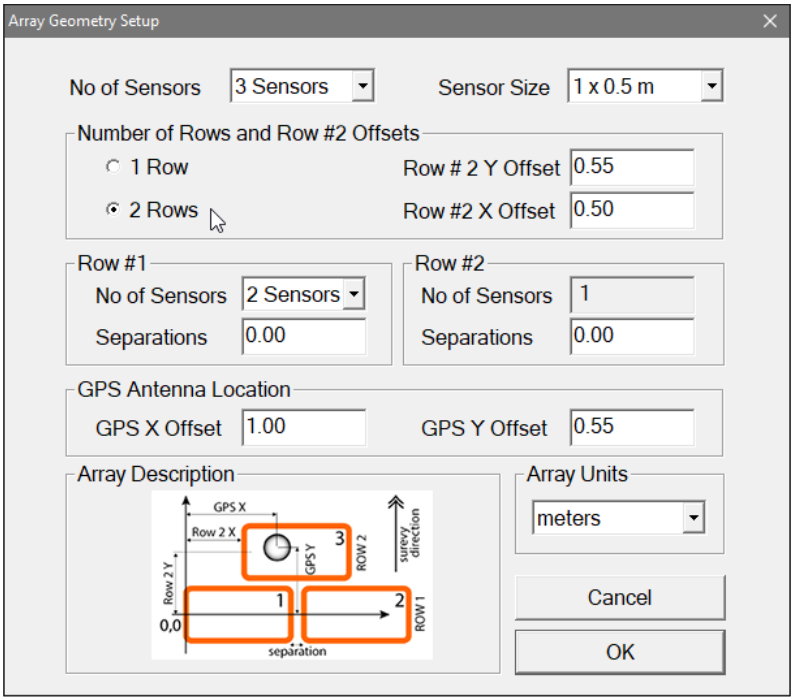

Figure 6.6: Array Geometry dialog for two rows array

If the two row array was selected specify values for Row#2 X and Row #2 Y offsets. Offsets are measured from the array reference point 0,0 in units selected in Array Units (described below), refer to Figure 6.3 in this chapter.

Row #1

This frame box contains two parameters: Number of Sensors and Separations. Number of options (visible when No of Sensors drop-down list box is expanded) is limited to number of sensors selected for the entire array. Obviously if one row was selected then number of sensors in Row #1 is equal to total number of sensors in the array. When two row array was selected then number of sensors selected for Row #1 specifies number of sensors (remaining sensors) in Row #2. In case of two row array program forces that at least one sensor is located in Row #2.

Separation (separation between sensors in Row #1, see Figure 6.3) can be entered in units selected in Array Units section. This parameter is taken to account during calculation positions of sensors for surveys conducted with GPS positioning, as well as for surveys carried out along grid.

The program assumes that Separation between all sensors in Row #1 is the same.

Row #2

This frame box contains two parameters: Number of Sensors and Separations. Number of Sensors edit box is disabled for entry. It has only informative meaning and it is updated according to number of sensors selected for Row #1.

Separation (separation between sensors in Row #2, see Figure 6.3) can be entered in units selected in Array Units section. This parameter is taken to account during calculation positions of sensors for surveys conducted with GPS positioning, as well as for surveys carried out along grid.

The program assumes that Separation between all sensors in Row #2 is the same.

GPS Antenna Location

Location of GPS antenna is described by two parameters, GPS X and GPS Y. These parameters are offsets in X and Y directions (while facing direction of the movement) from the reference point 0,0 (see Figure 6.3).

GPS antenna can be placed anywhere, however to achieve higher accuracy for the calculated positions of each coil the GPS antenna must be placed as close to the center of the system as possible, and preferably in the center of the EM61-MK2 sensor. For example, if three instruments are used the optimal location of the GPS antenna would be in the center of the second instrument (assuming 1 x 1 m coils and Separation between coils 0, the GPS Antenna distance is 1.5 m). In the case of a two instrument array the GPS antenna can be placed in the

center of the system, however locating the GPS antenna in the center of one of the coils is much easier and it is still close to the center of the system.
In the case wrong values were entered in the field, GPS Antenna offsets can be corrected later during data processing in the program Multi61MK2.

Array Units

Four selections are available: **Meters**, **Centimeters**, **Feet**, and **Inches**. These units will be used to calculate positions for sensors in program Multi61MK2. All parameters that describe geometry of the system must be specified using units selected at this option.
Since EM61-MK2 sensors are described in meters, it is more natural and easier to use meters during description of an array geometry (sensors, GPS antenna offsets, and Separation between coils).
In case wrong selection was entered, units or other parameters can be corrected later in the program Multi61MK2.

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

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

6.3 Examples of Array Geometry Setup Dialog

One example for one row array with three EM61-MK2s was given at the beginning of this chapter, see Figures 6.1 and 6.2. Following two pages contain two examples of the Array Geometry Setup dialog settings and corresponding array layouts shown in Main Screen. The first example is given for three instrument array organized in two rows (Figures 6.7 and 6.8), while the second example shows two rows and five instruments array (Figures 6.9 and 6.10).

In case of any wrong selection, units or any other parameter describing array geometry, corrections and any adjustments can be performed later during data processing in the program Multi61MK2.

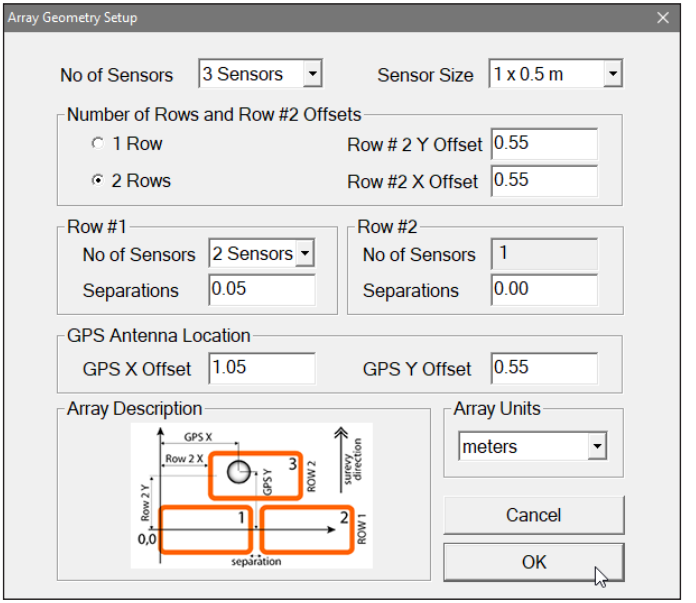

Figure 6.7: Array Geometry dialog with parameters for 2 rows, 3 sensors, and GPS antenna

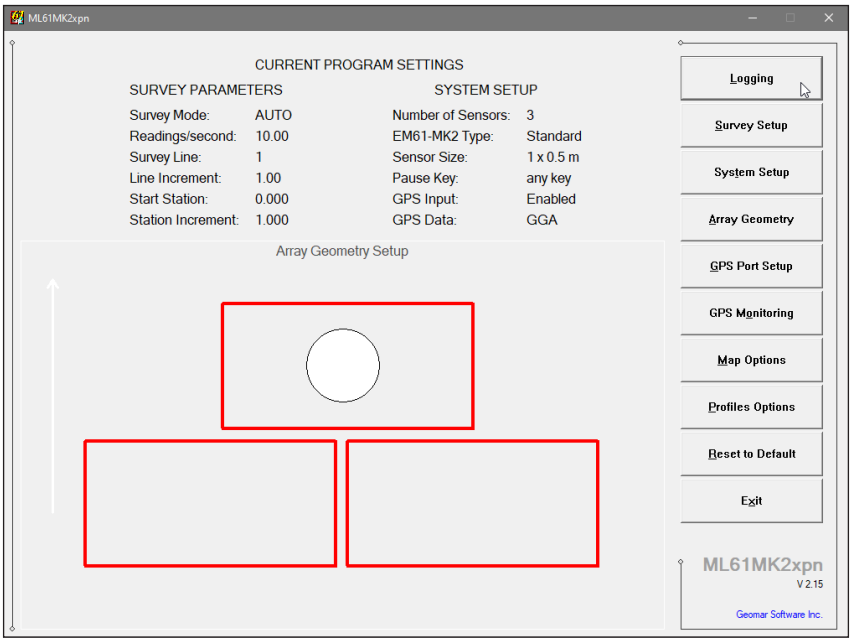

Figure 6.8: Main Screen with array layout corresponding to parameters specified in Figure 6.7

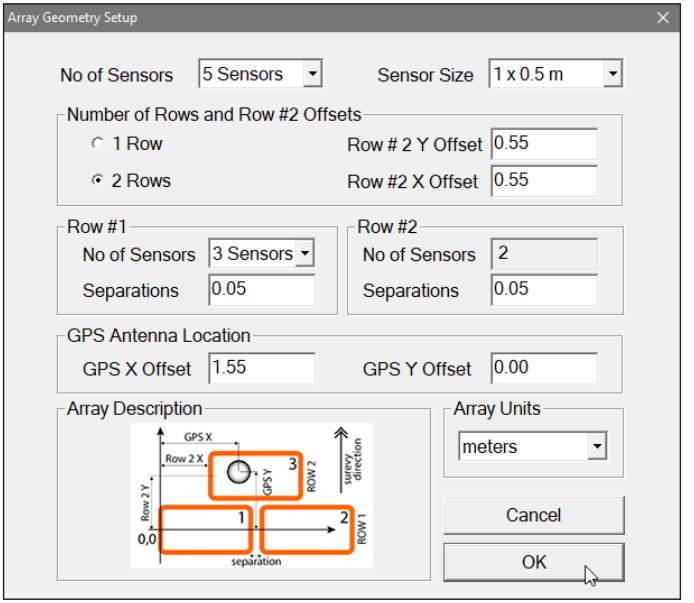

Figure 6.9: Array Geometry dialog with parameters for 2 rows, 5 sensors, and GPS antenna

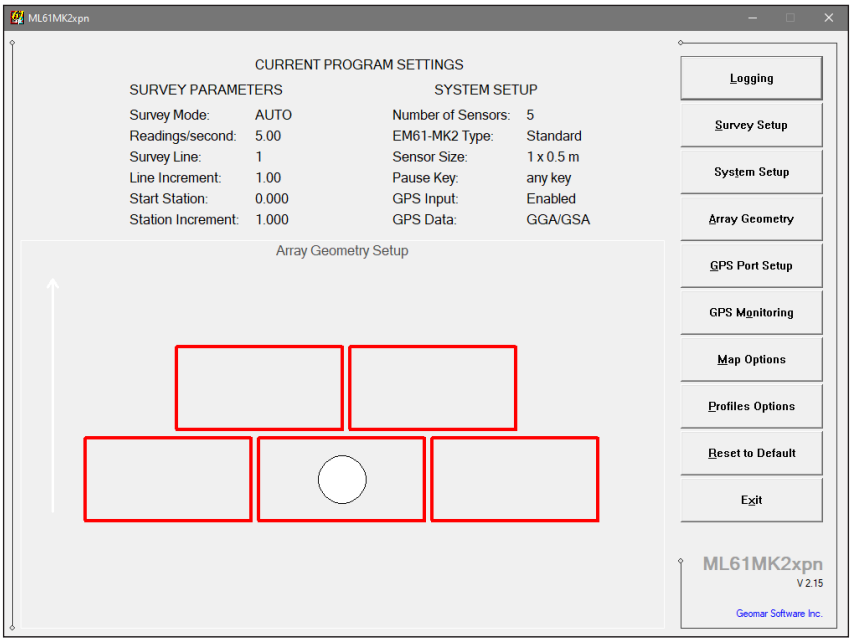

Figure 6.10: Main Screen with array layout corresponding to parameters specified in Figure 6.9

GPS Port Setup & Monitoring 7

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

7.1 GPS Port Setup Dialog

The GPS Port Setup dialog allows for enabling or disabling GPS input, choice of NMEA data string, and setting communication parameters for serial port associated with GPS receiver input, and specifying all available GPS Warning Mask parameters (Figure 7.1).

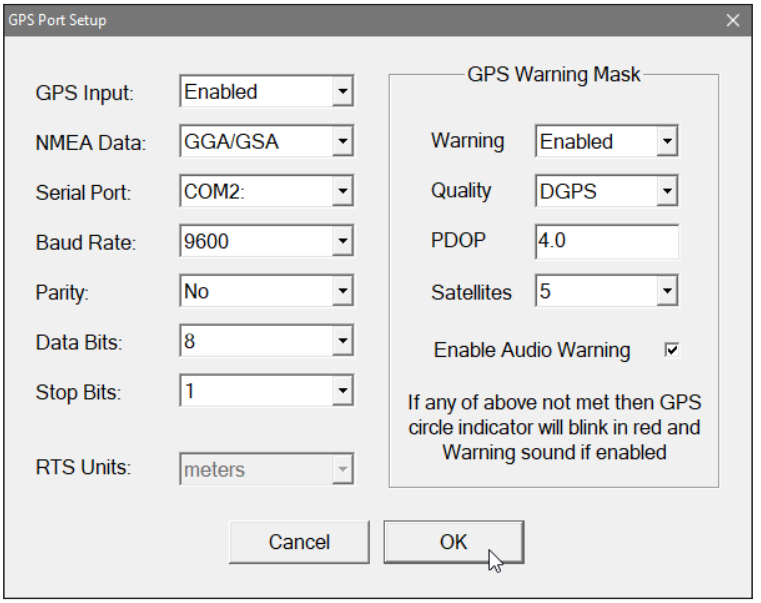

Figure 7.1: GPS Port Setup dialog

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

Description of the GPS Port Setup dialog options and parameters.

GPS Input

This option allows you to Enable/Disable a serial port for GPS input. When **Disabled** is chosen logging and monitoring screens will display message "GPS disabled" in place of GPS parameters.
The GPS Input can be **Enabled** even if there is no GPS system connected to the field computer. In such case data file will contain proper sequence of EM61-MK2 readings without any GPS input.

NMEA Data

This option allows you to select NMEA message. The ML61MK2xpn can make use of messages: GGA, GGA with associated GSA sentence, POS, GLL, LLK, LLQ, GLL, and GGK. Therefore NMEA Data option has ten selections: GGA/GSA, GGA, POS, GLL, LLK, LLQ, GLL, GGK, Psudo-GGA (includes Leica TPS 1100 and 1200 models, sever later Trimble RTS models), Pseudo GLL (used in some marine positioning systems), and Trimble RTS (Trimble protocol: labels 37, 38, 52, and optionally 39 if elevation is required), see Figure 7.2.

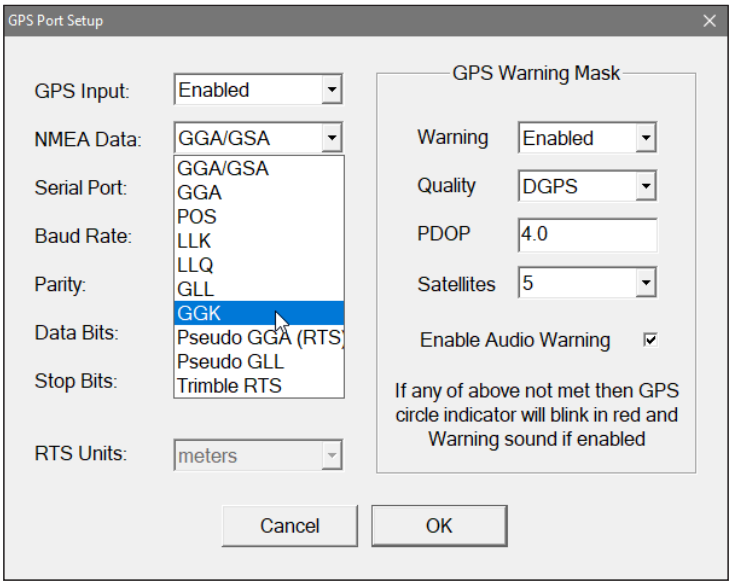

Figure 7.2: Selecting NMEA message

Message GGA is supported by almost all GPS receivers. This string is used to record GPS position, while associated message GSA is used to display parameter PDOP which indicates quality of GPS signal. If a GPS receiver supports only GGA string and option GGA/GSA is selected, GPS positions will be recorded

using GGA message and PDOP parameter will be displayed as N/A (not available). In such case user should monitor quality of GPS signal using GPS receiver panel display (if available) or can monitor number of available satellites. If GGA option is selected a parameter HDOP will be displayed on the screen.
Messages GGK and POS which are supported by smaller number of manufacturers (however POS is available in all Ashtech receivers and GGK in some Trimble systems) are somehow preferable since they contain all necessary information, including the PDOP, in one sentence. If your GPS receiver supports POS, GGK and GGA messages, and PDOP parameter is required, select POS or GGK which provide faster operation for the field computer.
Messages LLK and LLQ are used in some Leica GPS systems and provide positions in meters in local coordinate system. When LLK is selected a parameter GDOP will be displayed on the screen. Message LLQ provides precision of positioning in meters and this parameter will be provided on the logger screen.

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 or Trimble RTS item is selected (Figure 7.3). 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 using these

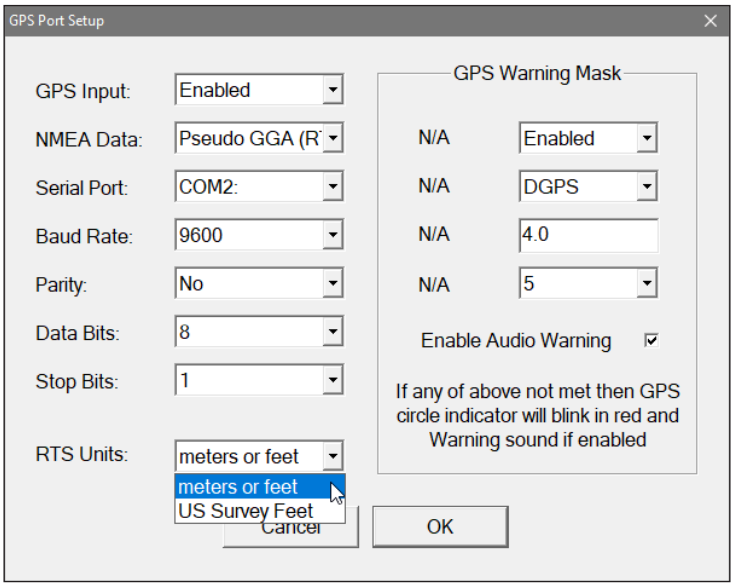

Figure 7.3: Selecting RTS Units (RTS interface only)

units, otherwise “meter or feet” must be selected. In case of Trimble RTS selection specify units (meters, feet, US Survey Feet) according to the RTS settings. The later allows to separate map units and units used by positioning system.

COM Port

The number of serial port that is assigned to the GPS input. Available selections are from COM1 to COM 60 (Figure 7.4). This parameter can be also selected in the System Setup dialog. Communication parameters for the selected serial port can be determined in options described below.

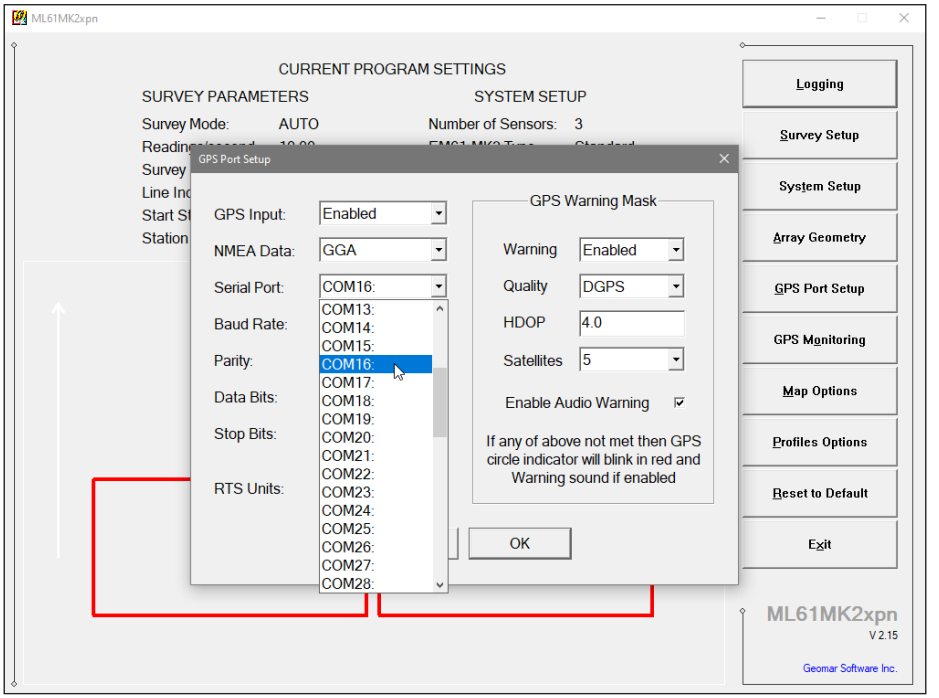

Figure 7.4: Selecting GPS serial port

This port must be different than any of ports specified in the System Setup dialog (for any selected EM61-MK2), otherwise a warning message will be displayed and ports will have to be reassigned. Therefore it may be easier to select GPS port in System Setup dialog which lists all serial ports.

Baud Rate

Specify Baud Rate for the output port, the entered value should match the Baud Rate of the GPS or RTS system, default is 9600 (Figure 7.5).

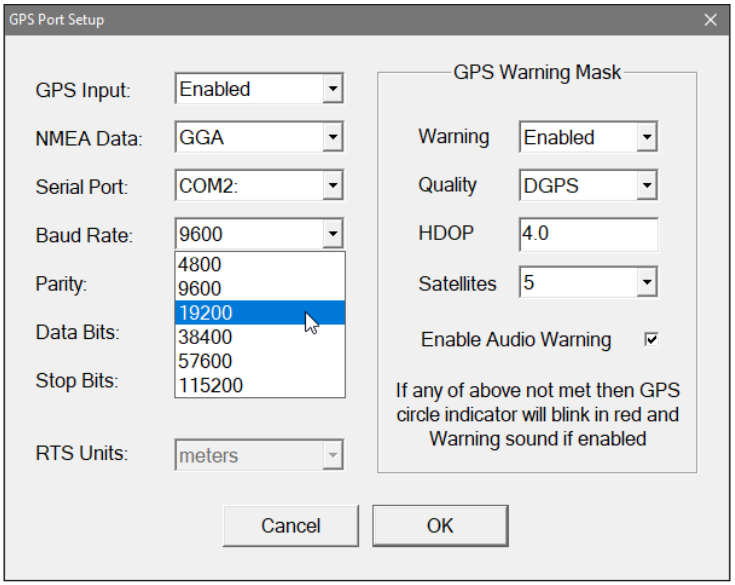

Figure 7.5: Selecting Baud Rate

Parity

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

Data Bits

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

Stop Bits

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

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

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

Warning

Clicking on the down arrow next to the text box opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: Enabled and Disabled.
This option allows you to Enable/Disable a GPS Warning Mask that contains three parameters: Quality Indicator (degree of differential corrections), Dilution Parameter (PDOP or other label depending on the selected NMEA message), and number of available satellites (Figure 7.6).

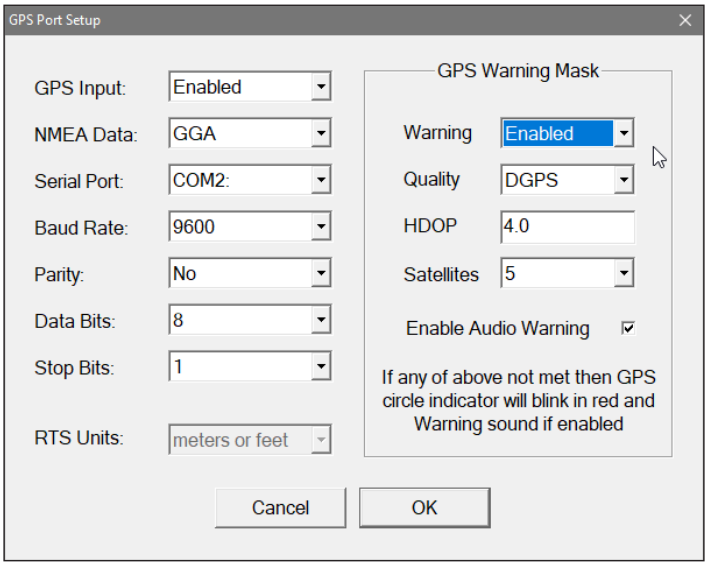

Figure 7.6: GPS Warning Mask setup

When Enabled is chosen GPS two circle indicator will be alternating in green and white if conditions for specified parameters setting will be met. When any of the parameters is below set values then GPS indicators will alternate in red and white colours. In addition, if the Enable Audio Warning check button is checked then an audio warning will sound ("gentle bell"). In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours regardless of GPS signal quality.

Quality

This parameter describes Quality Indicator (degree of differential corrections). Clicking on the down arrow next to the text box opens a drop-down box showing

the available settings, or when the keyboard is used activate the text box by navigating with Tab key and then by using Up or Down arrow keys select one of the available items: AGPS (Raw), DGPS, RTK3, RTK4, and RTK5 (higher degree of corrections, regardless of manufacturer labelling are not filtered during data collection however all are accepted and recorded in the data file to be used during data processing program Multi61MK2).
If Quality Indicator received from GPS receiver will be worse than specified then GPS indicator will alternate in red and white colours.

PDOP

This parameter can be labeled PDOP, HDOP, DOPG, DOP depending on the selected NMEA message. It can be also named Quality m (accuracy in meters) if LLQ was selected, or it is not available (labeled N/A) when messages GLL or Leica TPS are used.
Activate text box by pointing and clicking mouse left button or by using TAB key and then enter the chosen acceptable maximum value of Dilution parameter.
If PDOP (or other similar parameter) is larger than specified value then GPS indicator will alternate in red and white colours.

Satellites

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

Enable Audio Warning

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

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

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

7.2 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 ML61MK2xpn screen in terminal mode is shown in Figure 7.7.

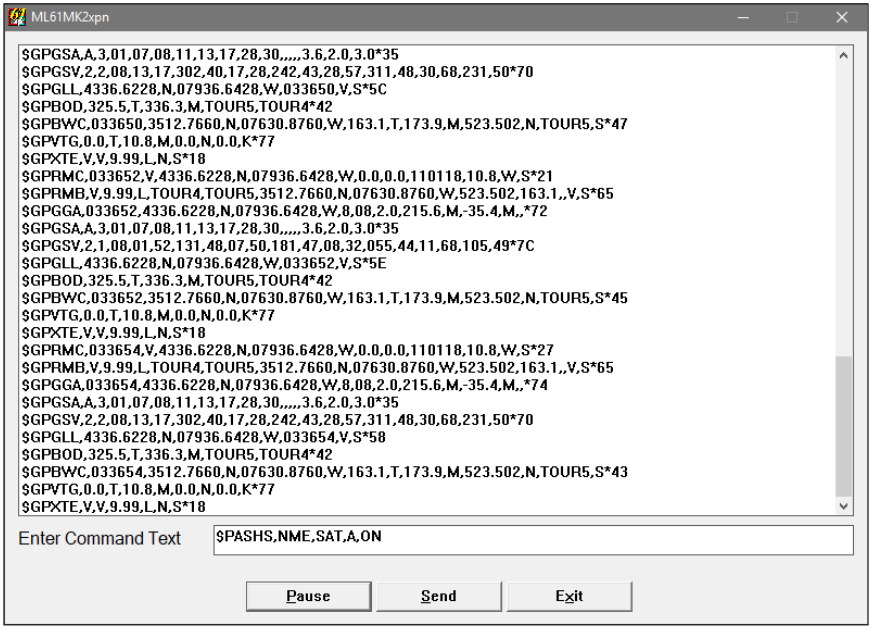

Figure 7.7: Monitoring GPS output in terminal mode

As soon as the ML61MK2xpn 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 7.7 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 7.8.

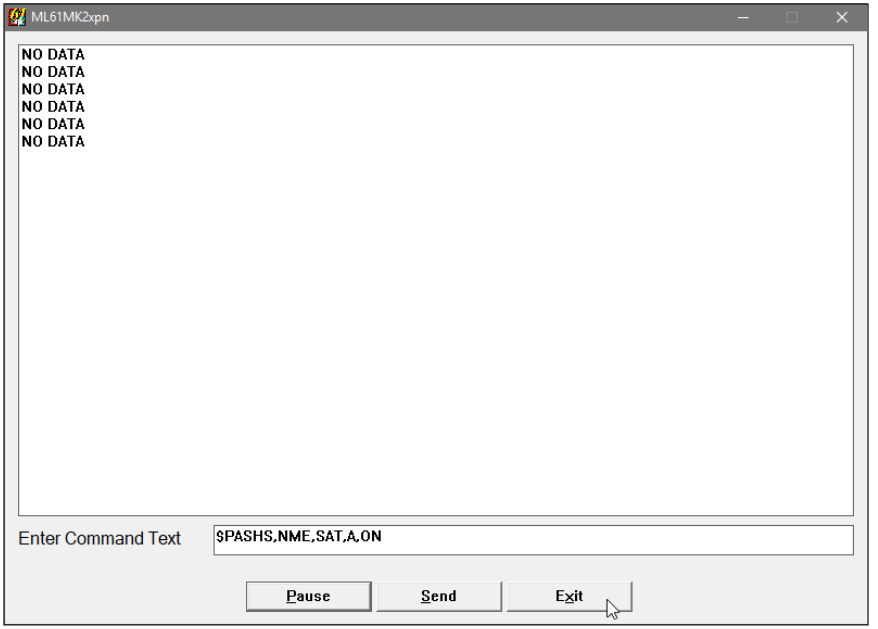

Figure 7.8: GPS Monitoring window when no GPS data is available

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

- serial port number not correctly specified in GPS Port Setup dialog,
- the GPS receiver not sending any data,
- not connected or not working GPS receiver.

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

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

The monitoring display can be paused any time by clicking on the button **Pause** or pressing the P key (or **ENTER** if the button is highlighted). At that time scrolling of the GPS output will be stopped, and the Pause button will be replaced by the button labeled **Go** (Figure 7.9). 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.

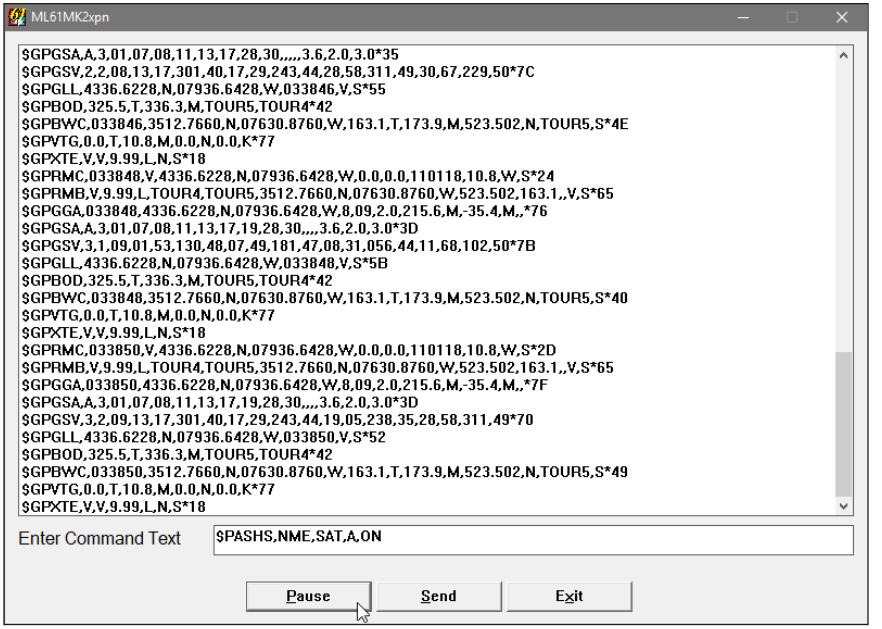

Figure 7.9: Paused GPS Monitoring window

7.3 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 ML61MK2xpn without using any other software.

After the command button labeled **Send** is clicked S key (or ENTER if the button is highlighted) is pressed the dialog Send Message to GPS Receiver is displayed. The previously used NMEA command or the beginning of the standard NMEA command, **$PASHS,** is displayed in the dialog's edit box (Figure 7.10). After the entire NMEA

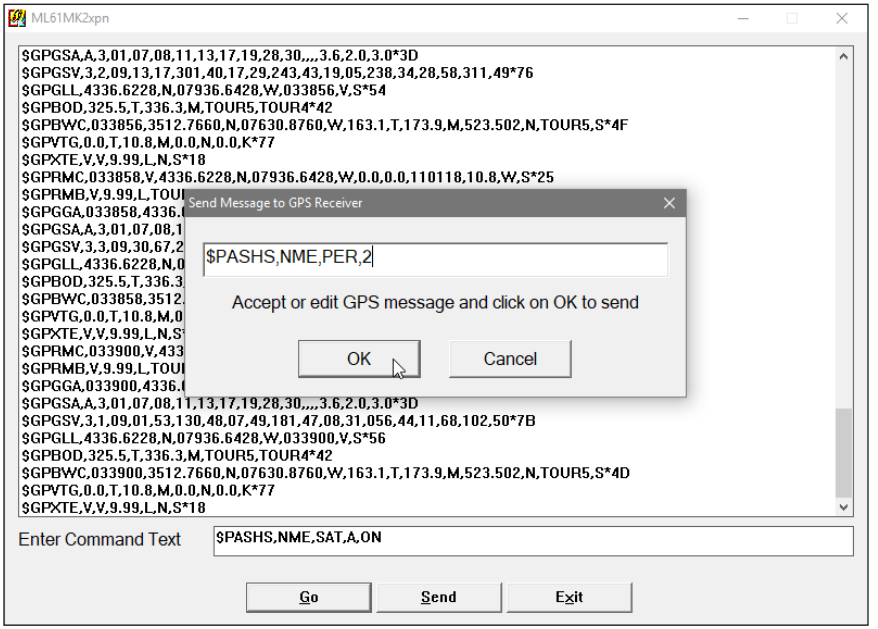

Figure 7.10: Send Message to GPS Receiver dialog with an example of command changing GPS update rate to 2 seconds

command is typed in, press the **OK** button or press O key (or ENTER if the button is highlighted) to send the command to the GPS receiver. Clicking on Cancel button or pressing the C key will cancel the command and the dialog disappear. An example of a command that will enable the NMEA message **SAT** is given in the Figure 7.11 (it is assumed that the GPS receiver output serial port is A).

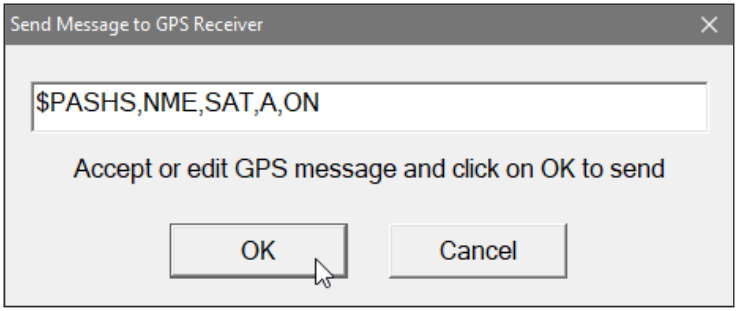

Figure 7.11: Send Message to GPS Receiver with command enabling NMEA message SAT

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

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

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

Map & Profile Display Options 8

The Map Display Options dialog is used to specify plotting parameters for map display, colours and size of cursor and positions, the displayed position type (navigation mode), and displayed EM61-MK2 channel (mapping mode), while the Profile Options dialog allows you to select profiles to be displayed, including colour (applied also to moving graphic bars) as well as thickness of profiles.

8.1 Map Display Options

In general the ML61MK2xpn can display navigation map in two modes: Navigation and Mapping. In the Navigation mode position of each sensor is displayed as a dot of specified size or as a bar that has width (swath) of the entire array, positions are plotted at GPS update rate. Mapping mode displays swath bar for each instrument reading with colour reflecting amplitude value. Samples of various map displays are provided in Chapter 1 of this manual (Figures 1.4 to 1.6)

After the **Map Options** button was clicked (or executed from the keyboard) in the Main Screen the Map Display Options dialog appears on the screen (Figure 8.1).

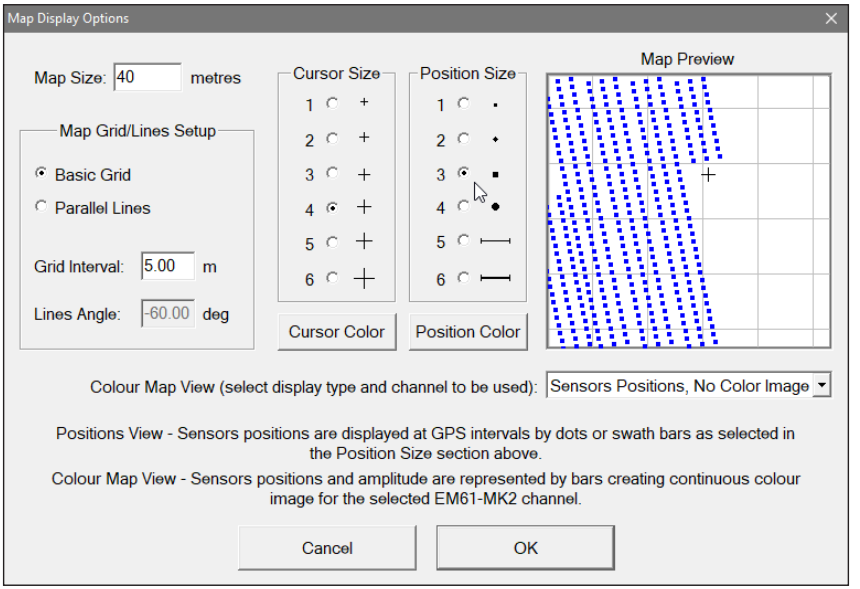

Figure 8.1: Map Display Options dialog

This window is divided into five main sections. The first section located at the left specifies map size and grid lines options. The next section, second from the left, labeled Cursor Size is used to set size and colour of the cursor indicating current position of the GPS antenna. The third section, labeled Position Size allows you to specify size and colour of a dot or swath bar marking saved position on the Navigation map. The section on the right labeled Map Preview shows sample map with current settings (specified in the first three sections), it is updated in real time. The fifth section, combo box labeled Colour Map View is used to select Navigation mode or Mapping mode for a selected EM61-MK2 channel (Ch1, Ch2, Ch3, or Ch4/T).

All parameters selected in this dialog can be adjusted later during data collection.

Map Size

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

Map Grid/Lines Setup

Map can display gray grid or parallel lines at specified intervals as a background to help with navigation and survey coverage. When the radio button labeled Basic Grid is selected an interval between grid lines can be specified in below text box labeled Grid Interval. In case the Parallel Lines radio button is selected available parameters are Line Interval and Lines Angle.
Grid lines can be plotted only in as perpendicular lines SN and WE drawn at specified interval (Figure 8.1), while selection Parallel Lines allows for Lines Interval as well as Lines Angle entries (Figure 8.2). Lines tilt angle is measured in degrees clockwise from North.

Cursor Size and **Position Size**

Cursor Size (+ symbol) represents position of GPS antenna while Position Size (dot or swath bar) represents position of each sensors (dot) or entire array (swath bar) in Navigation mode.
When Mapping mode (colour image) is selected then position of each sensor is represented by a swath bar by default. Each swath bar in Mapping mode consists of several (number of connected sensors) short bars drawn with colours corresponding to each sensor amplitude. Size of a bar for each sensor is equal to sensor width (as specified in Array Geometry dialog) for one row array and half of the sensor width when two array setup is used. The center of the bar is position of given sensor. Therefore array in Mapping mode is represented by one continues bar of varying colour if separation between sensors is set to zero.

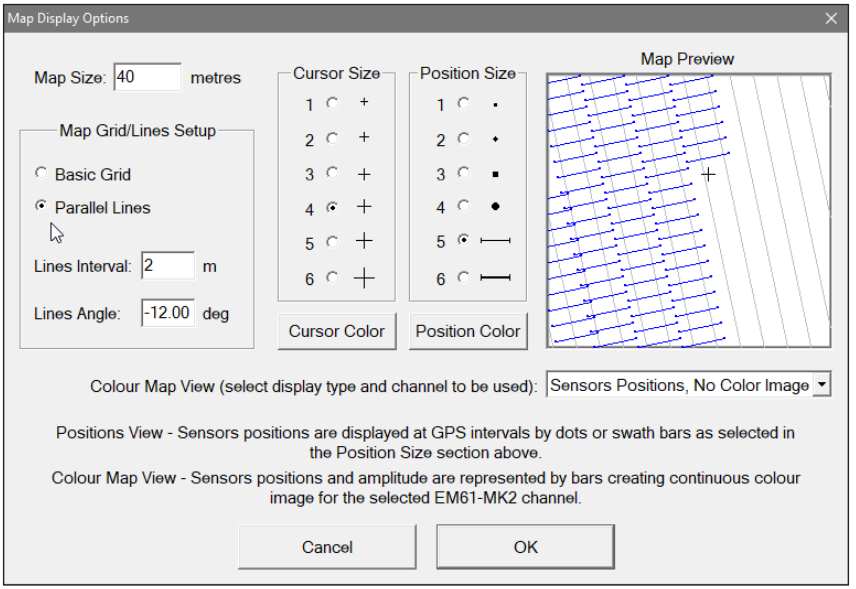

Figure 8.2: Selecting swath bar in Map Display Options dialog

Clicking on a radio button in any of two sections will select a size of Cursor or Dot (or Swath Bar) as shown by a graphic image placed next to the radio button. The selection will be immediately reflected in the Preview window, as shown in Figure 8.2 (please compare with Figure 8.1).
Swath Bar can be selected in two thicknesses and it will be plotted to the real scale of the map.
Size of Cursor and Position dots shown in the Preview window will be used in Navigation mode during data collection. These parameters can be changed at any time during the survey.

Cursor Color/Position Color

To change colour of the Cursor or Position click the corresponding button labeled **Cursor Color** or **Position Color**. The Color dialog will appear (Figure 8.3). Select desired colour by clicking a colour box (the selected colour box will be highlighted). Other colours can be specified by tapping on the **Custom** button. The selected color will be used to plot corresponding parameter.

Click the button **OK** or press **ENTER** key (if highlighted) to accept the highlighted colour. The Color dialog will disappear and the colour of the selected parameter (Cursor or Position) will be updated in the Preview window. To cancel colour selection click the **Cancel** (or X button) button or press **Esc** key.

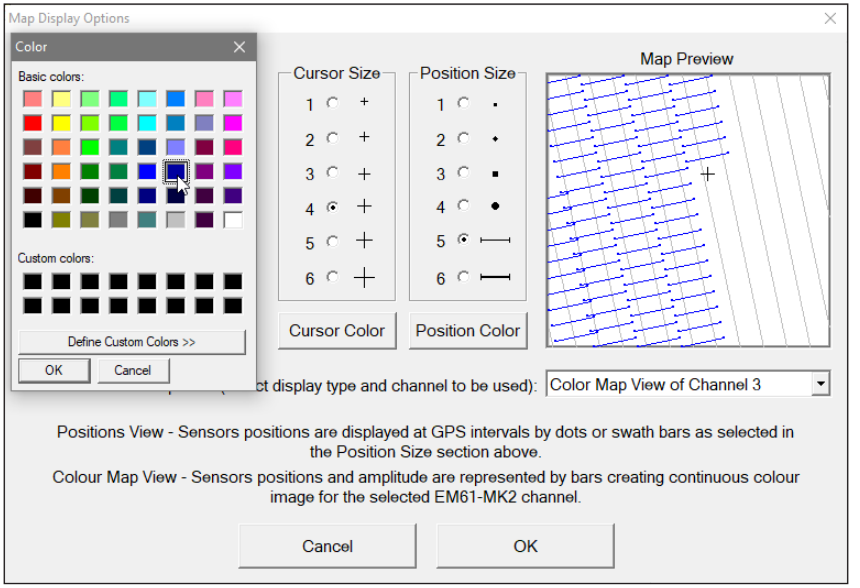

Figure 8.3: Selecting Color for Cursor or Dot and Swath Bar in Map Display Options dialog

Selected colours of Cursor and Position dots shown in the Preview window will be used in Navigation mode during data collection. Colour for each parameter can be changed later at any time during the survey.

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

Items available in this option are shown after clicking on and expanding the combo box labeled "Colour Map View", Figure 8.4.

When the first item "GPS Positions, No Color Amplitude" is selected the program will display map in Navigation mode. Despite the label "GPS Positions..." positions drawn on map (dots or swath bar) indicate locations of EM61-MK2 sensors that include corrections for GPS antenna offsets, GPS Positions meaning is that sensors positions are drawn with the frequency of GPS update rate. GPS antenna positions is continuously updated and shown on the map by cursor "+ symbol".

The exception is two rows array, when the swath bar is selected in Navigation mode then swath bar is drawn on the position corresponding to the first row (second row is not drawn). When dots are selected in Navigation mode then each dots (for one and two rows array) represents real position of the sensor center.

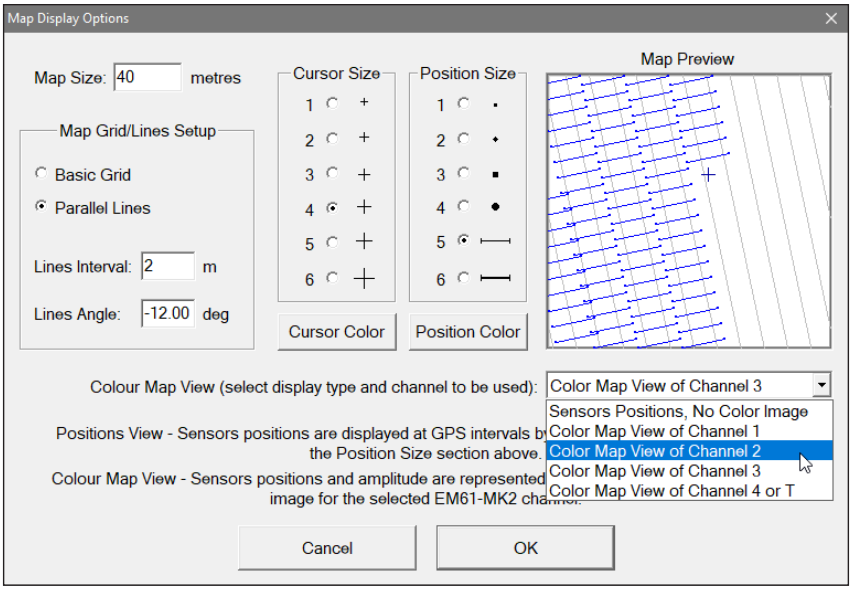

Figure 8.4: Selecting Navigation mode or Color Map View of selected channel in the Mapping mode

Selecting remaining four items will set the program in Mapping mode. The map will show colour image of the selected EM61-MK2 channel 1, 2, 3, or 4 (or T depending on the instrument mode) measurements. Colour image of data collected for any EM61-MK2 channel (one at a time) can be selected during data collection session.

All four measured values (Ch1, Ch2, Ch3, Ch4/T)are shown in profile view, moving graphic bars, and as numeric values, and all available data is recorded in data file regardless of the selected map display.

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

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

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

8.2 Profile Display Options

The Profile Display Options dialog allows you to enable and disable the display of each channel profile (for all instruments in the array), to specify color and thickness of profiles, and to select linear or compressed amplitude for profiles. The colour specified in this dialog is also applied for corresponding graphic bars. The dialog is presented in Figure 8.5.

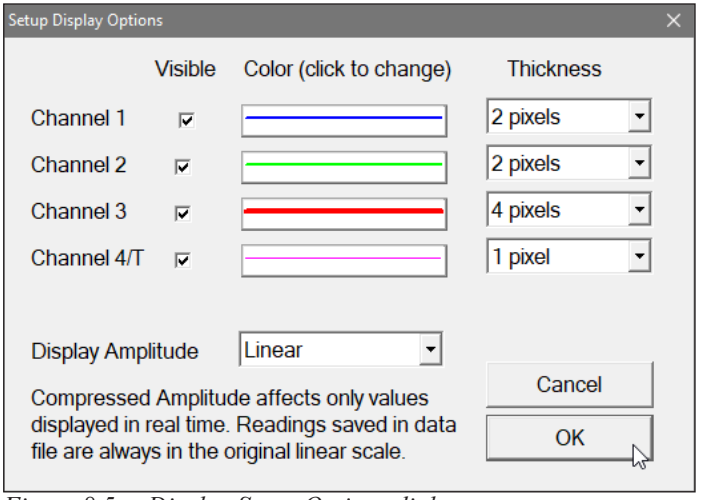

Figure 8.5: Display Setup Options dialog

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

Description of the Survey Setup dialog options and parameters.

Visible

To enable or disable displaying of each channel profile click on the corresponding check box button labeled Visible. Profiles of all channels with checked buttons will be displayed for each EM61-MK2 in the array during data logging. Regardless of which channels are chosen to be displayed as profiles, data for all four channels will be displayed in numeric form for each instrument in the array.

Color

To change colour of each profile line and moving bar (for all instruments in the array) click on the corresponding button (with colour line) labeled Color. The Color dialog will appear (Figure 8.6).

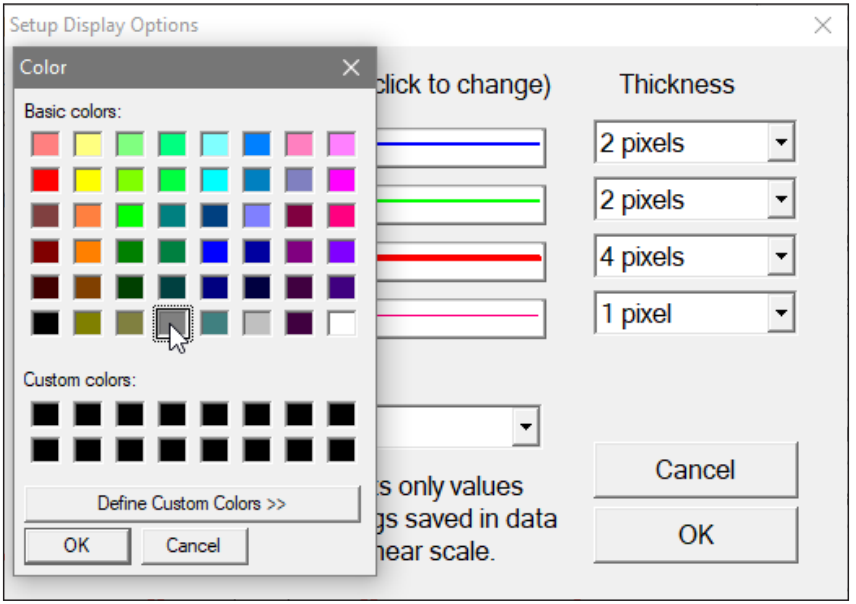

Figure 8.6: Selecting Profile Colour

Select desired colour by clicking on a colour box (the selected colour box will be highlighted). Other colours can be specified by clicking on the **Define Custom Colors** button.

The selected color for the EM61-MK2 channel will be used to plot corresponding profile line and moving bar.

Click on the button **OK** or press **ENTER** key (if highlighted) to accept the highlighted colour. The Color dialog will disappear and the colour of the appropriate channel button will updated. To cancel colour selection click on the **Cancel** (or X button) button or press **Esc** key.

Thickness

Specify thickness of a profile for an EM61-MK2 channel (applies to all EM61-MK2s in the array) by using one of four drop-down boxes labeled Thickness. Thickness of a profile curve is specified in pixels. Available settings are: 1, 2, 3, or 4 pixels.

Clicking on the down arrow next to the text box (labeled by number of pixels) opens a drop-down box showing available selection (see Figure 8.7). 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.

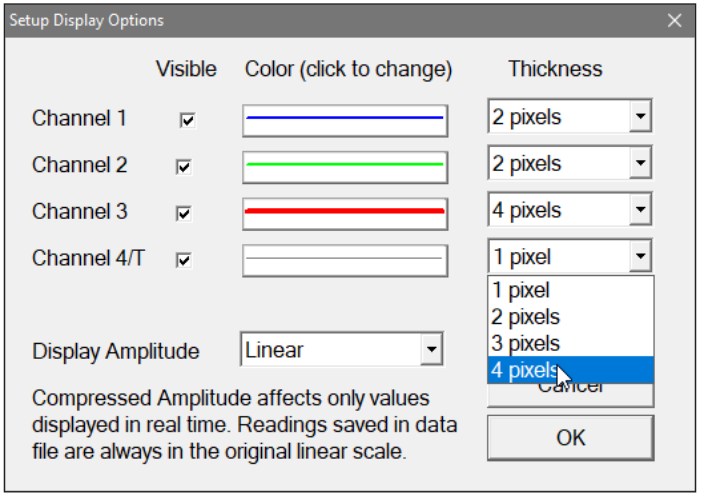

Figure 8.7: Selecting Profile Thickness

Display Amplitude

This option allows you to select Linear or Compressed amplitude scale for profiles and moving bars. The compressed amplitude (square root function) allows you to display the highly dynamic range of the EM61-MK2 data in a legible way (showing details in low range of response while compressing often less important high level of amplitude) and it is recommended.

Clicking on the down arrow next to the text box labeled Display Amplitude opens a drop-down box showing two available parameters (Linear and Compressed). Select item by using mouse. When keyboard is used activate this drop-down list box by pressing TAB key till it is highlighted and then by using **Up** or **Down** arrow keys select one of available items.

Please note, that readings in numeric form are always given in mV (linear scale) regardless of the Display Amplitude selection which applies only to profile and moving bars plots. Further, graphic display in the compressed scale does not affect readings saved in the data file. Data are always written to data file in original form.

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

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

Logging Data

9

After the Logging button in Main Screen is clicked or executed by the keyboard the ML61MK2xpn starts to read data from connected EM61-MK2 units and GPS receiver. Data is displayed in three modes: Monitoring, Stand By and Logging. Further each of these modes can use Mapping, Navigation or Profile display mode. The navigation mode is used for GPS positioned surveys, and if the GPS Input is disabled then only the Profile mode is available. The navigation mode displays GPS positions in form of dots or a swath bar corresponding to the sensors array scaled width while mapping mode displays continuous colour image for recorded data set. Since Mapping mode is likely more useful as it shows real coverage of the surveyed area and amplitude distribution and otherwise Mapping and Navigation modes are similar, this manual will refer mostly to mapping mode unless describing specifically Navigation mode features.

Program starts Logging session always in Monitoring mode (Figure 9.1). In this mode EM61-MK2s and GPS readings can be quickly examined, and data file can be created. The Stand By mode is similar to monitoring, however more field functions are available. Recording of EM61-MK2 and GPS data is allowed only in Logging mode, which is accessible from Stand By mode.

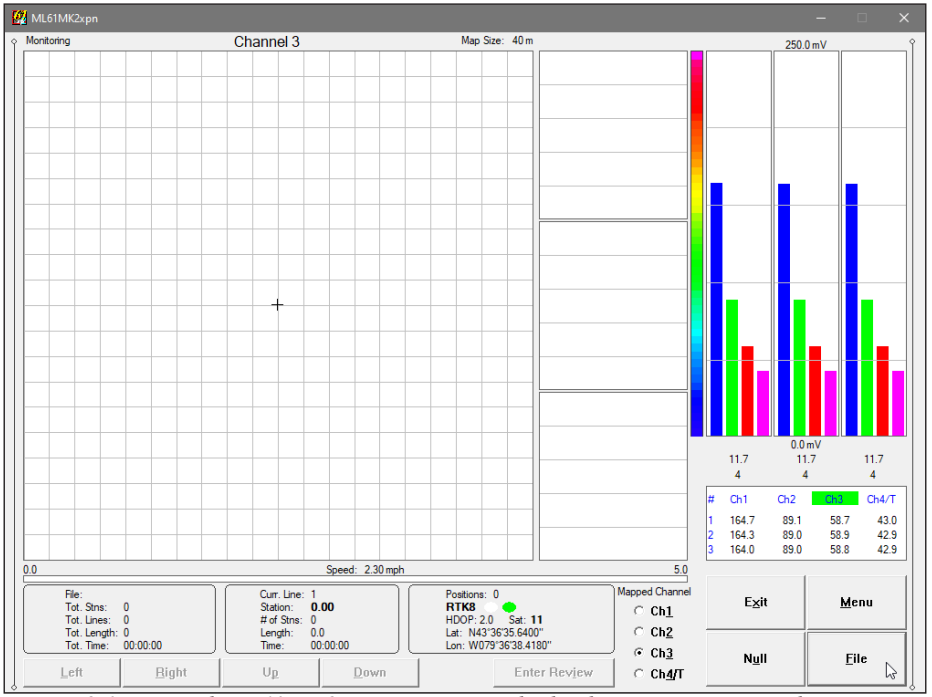

Figure 9.1: Initial ML61MK2xpn Monitor mode display in Mapping mode

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

It is assumed that all settings, especially assignment of serial ports, are correctly specified and instruments are turned ON prior to using this option. In case any of the instruments are OFF or any console is not connected to the field computer or connected to a wrong serial port the message shown in Figure 9.2 will appear.

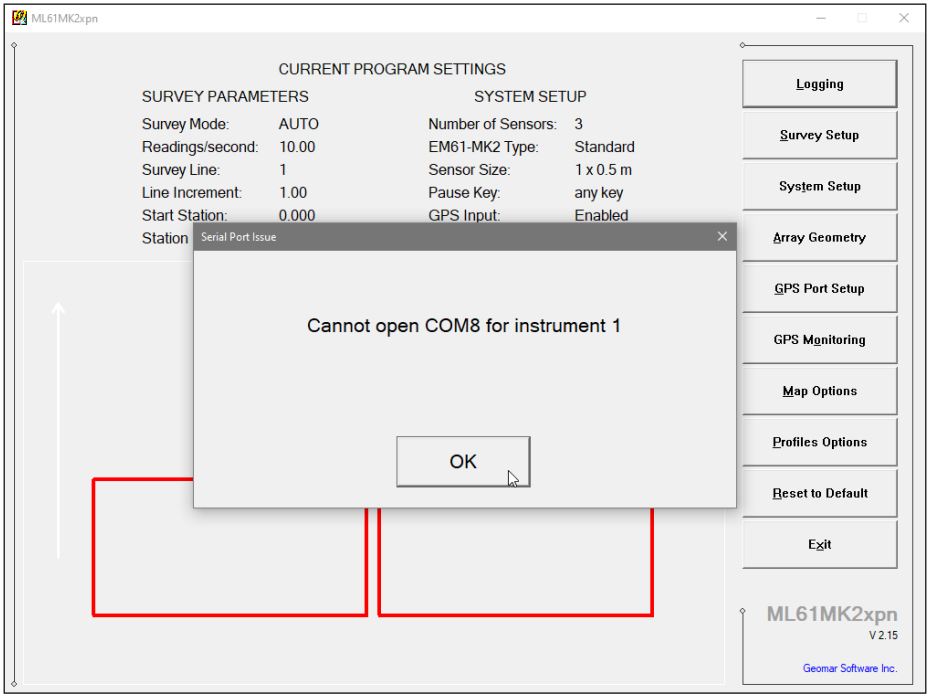

Figure 9.2: No Connection message or wrong serial port selection, number indicates disconnected instrument

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

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

Assuming that instruments work properly the program will initialize each connected EM61-MK2 and then Normalization for each instrument is started. Normalization process is performed simultaneously for all instruments. During this time the normalization progress for each instrument is displayed and all command buttons but the **Exit** are disabled, as shown in Figure 9.3.

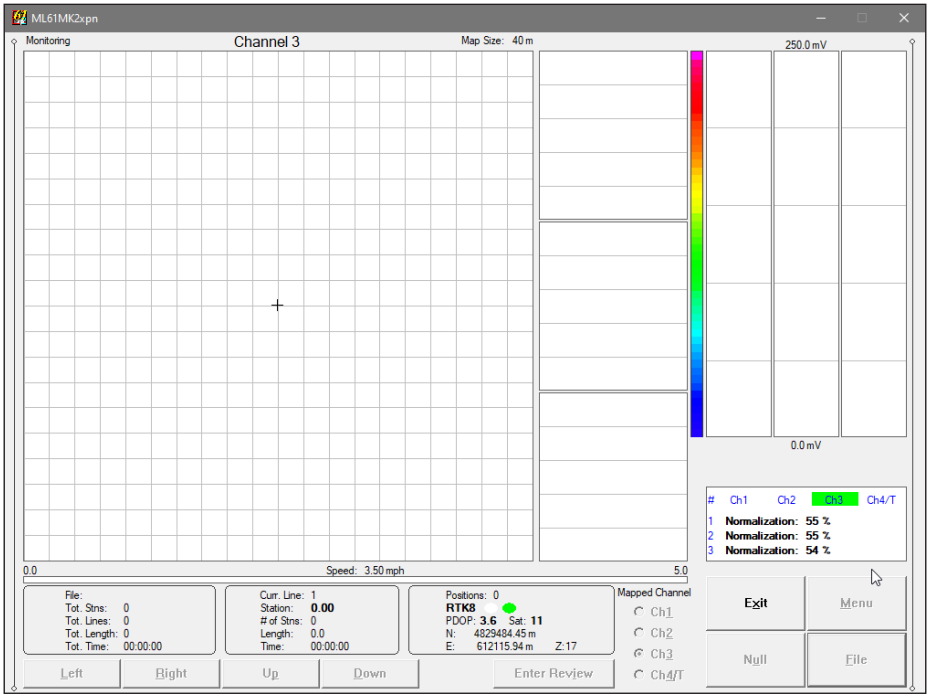

Figure 9.3: Logging window during current normalization

Normalization of each EM61-MK2 is performed every time the program starts receiving data from the array of instruments, or every time data is not received for more than 5 minutes (i.e. when a comment or new line screen are entered too long). After normalization for all connected EM61-MK2s is finished the Logging screen in Monitoring mode will be displayed (Figure 9.1).

9.1 Logging Screen Layout and Monitoring Mode

The ML61MK2xpn Monitor mode allows initial inspection of the range of instruments readings at the particular site, monitoring the instrument performance, monitoring number of available GPS satellites, GPS differential corrections, PDOP parameter status, quick inspection of the condition of the instrument battery, and setting zero level of the instrument. Two ML61MK2xpn Logging screens in Monitoring mode are shown below, Figure 9.4 presents the program in Mapping mode, Figure 9.5 presents the program in Navigation mode and Figure 9.6 shows the program in Profile mode.

The EM61-MK2s readings in Monitoring and Stand By modes are updated approximately 10 times per second during monitoring session. GPS positions are updated at a rate specified in GPS receiver, usually 1 second interval.

If GPS receiver streams data faster than at 1 Hz the ML61MK2xpn program will process and update display at 1 Hz in real time. However all GPS positions will be written to the data file and will be used later to position data in data processing program. Despite the fact that program will handle more than 1 Hz GPS update it is strongly recommended that GPS receiver is set to 1 Hz update, faster data stream may affect program performance especially when high number of readings is displayed. The data processing program interpolates positions similarly to real time GPS interpolation.

Mapping Mode

When the GPS Input is Enabled in GPS Port Setup and Colour View was enabled in Map Display Options dialog then the program displays the screen in Mapping mode by default. The ML61MK2xpn Logging screen in Monitoring mode and Mapping display mode is shown below (Figure 9.4).

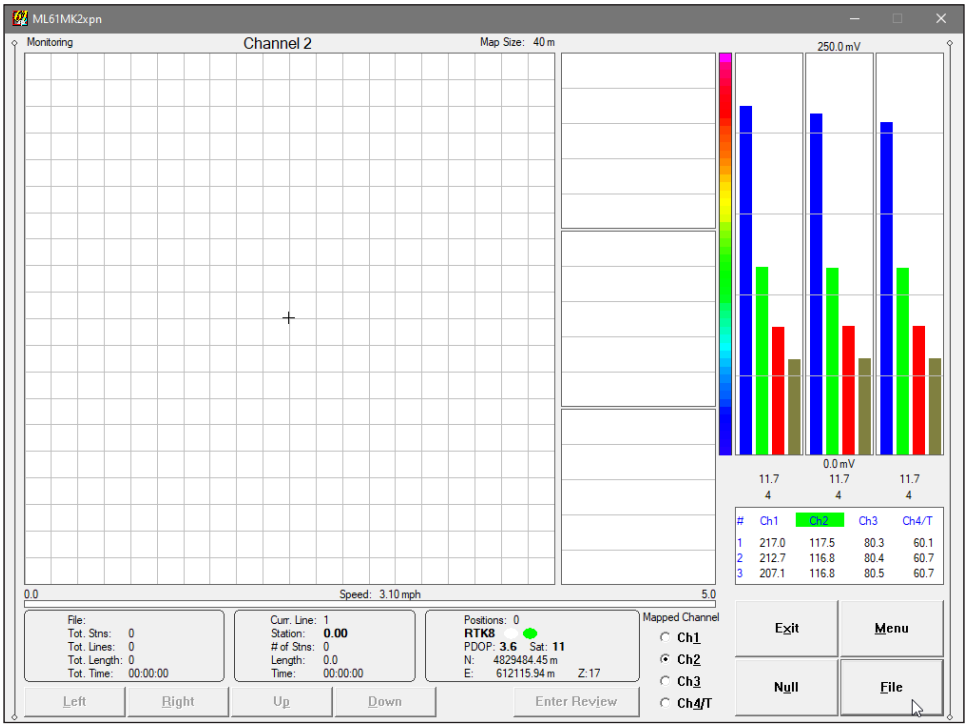

Figure 9.4: Logging Monitoring screen in Mapping mode

The left portion of the screen is occupied by the square plot area, a map, which presents current location of the system (based on GPS antenna position) in graphic form. This plot area will also display all recorded positions during data recording. The side of the square corresponds to scale (Map Size) which is displayed at the top line of the screen, at the right edge of the plot area. The scale (size of the square) can be given in meters or feet depending on Units selection in the Logger Setup menu. Figure 9.4 shows map area that represents square 40 x 40 m. A label with channel number that is selected for colour image display is shown above map in the center. A cross mark (cursor) indicating current position of the GPS antenna (usually indicating position of the array center) is always placed in the center of the map when logging session starts. After the operator will start moving the cross mark will move accordingly, however traces will not be plotted. Colour image of amplitude and EM61-MK2 sensors positions are plotted only in Log mode when EM61-MK2 readings and GPS data are recorded in data file. The North points to the top of the screen.

The Monitoring screen will display GPS related information in the right most frame box under the speed bar. Number of logged GPS position is displayed at the top of the box (in Monitoring mode it is zero). Below two lines display parameters describing quality of GPS positions. A label **DGPS** (Differential Global Positioning System) indicates that GPS readings are differentially corrected in real time, while label **AGPS** (Autonomous Global Positioning System) indicates lack of differential correction. Three other labels can be displayed: **RTK3** (Real Time Kinematic) when Quality Parameter is 3, and **RTK4** and **RTK5** for Quality parameters equal 4 or 5. 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 9.4. When GPS Warning Mask setting are not met then circles will be displayed in red and white colours. If the circle is displayed in one colour for long periods of time it means that the GPS system is not working or that it is not connected to the field computer.

The next label **PDOP** with a value varying between 0 and 99.9 represents an index called Position Dilution of Precision (**PDOP**). PDOP is given when NMEA data messages GGA/GSA, POS, or GGK were selected. If only message GGA is available, then index **HDOP** will be displayed, and when LLK message was selected parameter **GDOP** is displayed. The LLQ message will provide precision of positioning in meters and it is labeled by **X**. The GLL statement does not provide PDOP information. The next label **Sat** and following number shows number of currently tracked satellites. Refer to section GPS Port Setup, Appendix B, and to GPS manuals for more information about GPS parameters. The bottom two lines of GPS section display Latitude (N) and Longitude (W). These values are given in degrees, minutes, and seconds with four decimal places, or as linear UTM coordinates in meters, feet, or US Survey Feet depending on setting in the System Setup dialog.

The section to the right of the map plot area is occupied by panels which will be used to display profiles during data recording. Number of panels is equal to number of sensors in the array, and they are counted from the top (top panel corresponds to instrument #1, the second to Sensor #2, and so on). Each profile panel displays up to four profiles: Ch1, Ch2, Ch3, and Ch4 or T (depending on the selection in Profile options dialog as well as console setting) measurements. The scale for profile panels is divided by four or five light grey grid lines. In the case where the amplitude scale starts with a negative value, then the grid line corresponding to zero is always plotted as a thicker solid line. Profile scale of plot is the same as the scale for moving bars plots.

The top right portion of the window is occupied by the moving bars plot area, a grid, which presents EM61-MK2 readings in graphic form. The grid is divided to portions equal to number of connected instruments. Figure 9.4 presents screen for three EM61-MK2s and Figure 9.5 shows the three instruments setup as well. Instrument and corresponding portions of the grid are counted from the left. The left most portion represents EM61-MK2 #1, the next EM61-MK2 #2, and so on. Each portion of the grid representing one EM61-MK2 includes four moving vertical bars, the first (left) bar corresponds to the Channel 1 and the following bars represent Channels 2, 3 , and 4 or T (depending on the instrument mode). Range of readings displayed in the grid can be adjusted and it is the same as profile scale. Figures 9.4 and 9.5 show grid in linear scale from 0 to 500. Scale is labeled at the top and bottom of the moving bars plot area. Plotting data in compressed amplitude allows to show details in the low range of amplitude, as well as relatively good resolution in the high range of data on the small screen. **Please note, that data displayed in the numeric form are always given in the standard, linear scale.** The scale for graphic bars is divided by four or five light grey grid lines. In the case where the amplitude scale starts with a negative value, then the grid line corresponding to zero is always plotted as a thicker solid line. The moving bars graphic presentation allows the operator for very easy and quick monitoring the response of all connected instruments. It is visible in all three Logging modes: Monitoring, Stand By, and Logging, as well as in both Navigation and Profile display modes.

A colour bar representing colour distribution of amplitude to be plotted as a colour image in map area is located on the left of the graphic bar windows (between profiles panel and graphic bars windows). Its scale and range corresponds to scale of graphic bar windows and can be adjusted by Readings Scale button or corresponding item in a pop up menu (the button Menu).

Two labels are plotted under each grid in moving bars plot area. The first (top) label it is a value that represents instrument battery voltage (in Volts) for each connected EM61-MK2, while the second label (below) represents mode, 4 (mode 4) or D (differential mode), of each EM61-MK2. Levels of instruments batteries and modes are continuously updated.

Readings for channels **1**, **2**, **3**, and **4** (or **T**) are shown in numeric form in a window located below the moving bars plot area. Data for each instrument occupies one line of the display. The EM61-MK2 #1 is displayed in the top line, the EM61-MK2 #2 occupies line below, etc. Readings for each instrument are labeled and displayed in the following order (from the left): Channel 1, Channel 2, Channel 3, Channel 4/T. Readings are given in mV. **Data displayed in the numeric form are always given and recorded in the standard linear scale,** regardless of plot (profiles and graphic bars) scale. One of labels that is shown on green background indicates the component that is plotted on the map as colour image. Lack of radio buttons selecting mapped channel as well as the lack of the green background indicates Navigation mode.

A sequence of four radio buttons located below numeric display window and labeled **Mapped Channel** can be used to switch between active channels displayed as colour image in the Map window in the Stand By modes. Current selection is shown by the selected radio button, label of selected channel highlighted by green background in numeric window, as well as large label with channel number above the map (Figure 9.4).

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

Several other parameters are shown in two frames under speed bar and profile plot area. These parameters (file name, line name, current station, etc.) are not used in Monitoring mode.

Five command buttons labeled Enter Review, and four panning buttons Left, Right, Up, and Down are located below map and text frames. Panning buttons can be used to shift displayed map in four directions. Above five command buttons are not enabled in Monitoring mode, they will be enabled and functional in Stand By mode after data file is created.

Four command buttons (in the bottom right portion of the screen) provide access to options available in Monitoring mode. These options are described below in the section 9.2.

Navigation Mode

The ML61MK2xpn Monitoring screen in Navigation mode is almost identical to the described above Mapping mode. Main difference is that when no colour imaging is specified in the Map Display Options dialog the ML61MK2xpn screen in Navigation mode

will not show colour bar for readings, and there will be no indication (green background of one of channel labels) in numeric display window, and there is no label indicating active channel in the center above the map window. Positions of recorded readings will be indicated by dots or monochromatic swath bar during Logging mode. All other parameters and functions are same as described above in the Mapping Mode section (see Figure 9,5).

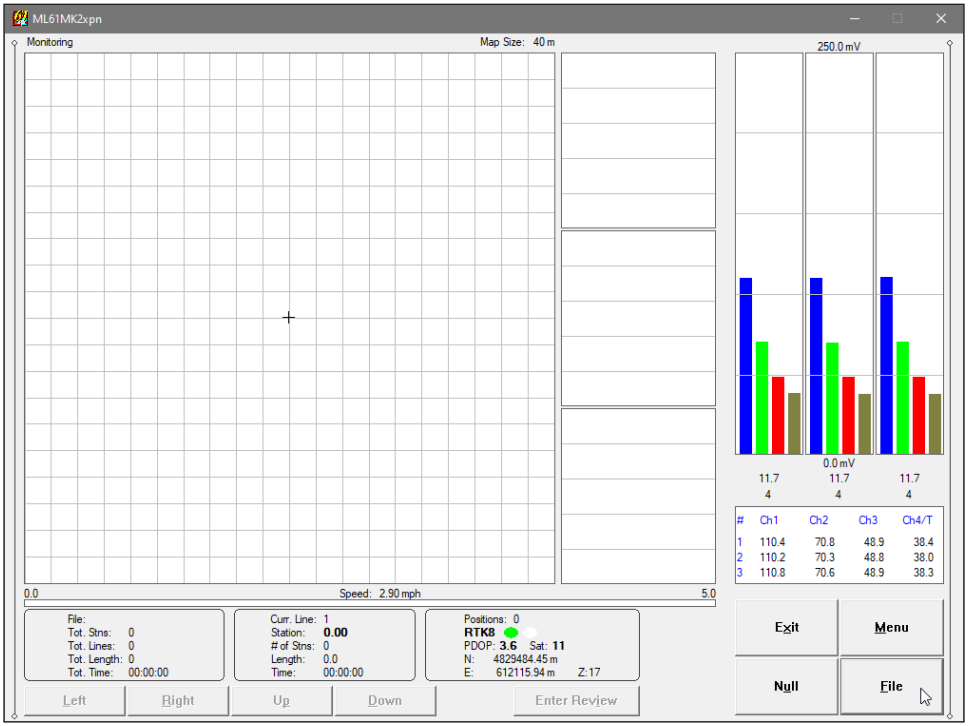

Figure 9.5: Logging Monitoring screen in the Navigation mode

Profile Mode

When the GPS Input is Disabled in GPS Port Setup dialog then the program displays the screen in Profile mode. The ML61MK2xpn Logging screen in Monitoring mode and Profile display mode is shown below (Figure 9.6).

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

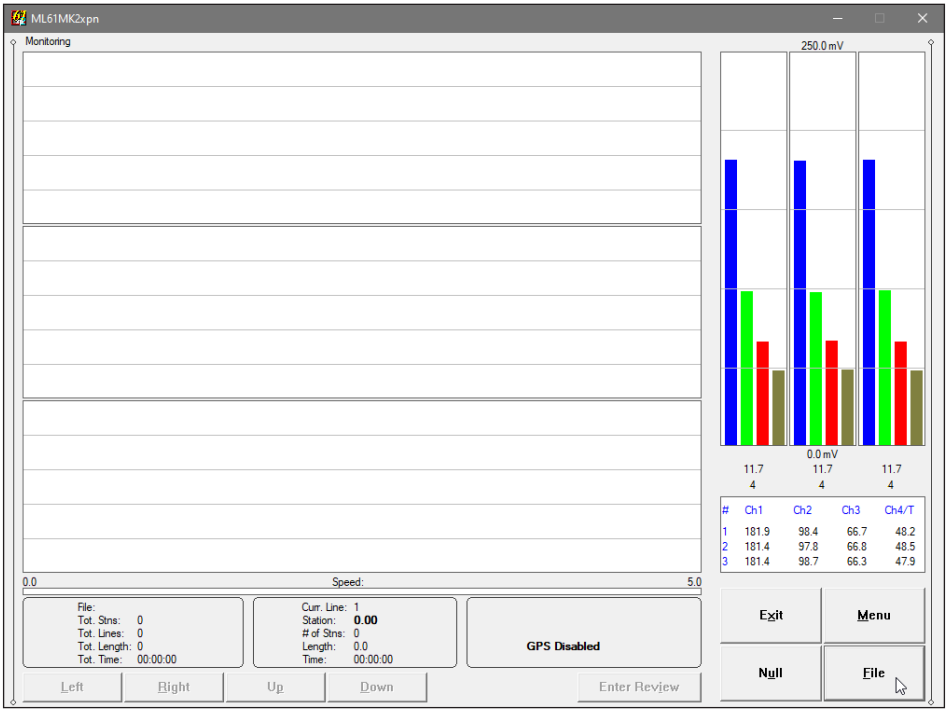

Figure 9.6: Logging Monitoring screen in the Profile mode

Number of profile panels, bar windows, and numeric display depend on the number of EM61-MK2 units in the array and display layout is identical as in the Navigation mode, please see the description in the previous section.

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

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

9.2 Options Available in Monitoring Mode

Several options are available while the Logging window is in the Monitoring mode. Three more frequently used options can be accessed directly from command buttons and others can be used from pop up menu activated by button **Menu** (displayed in Figure 9.7). Command buttons can be used by clicking on the desired button, or from the

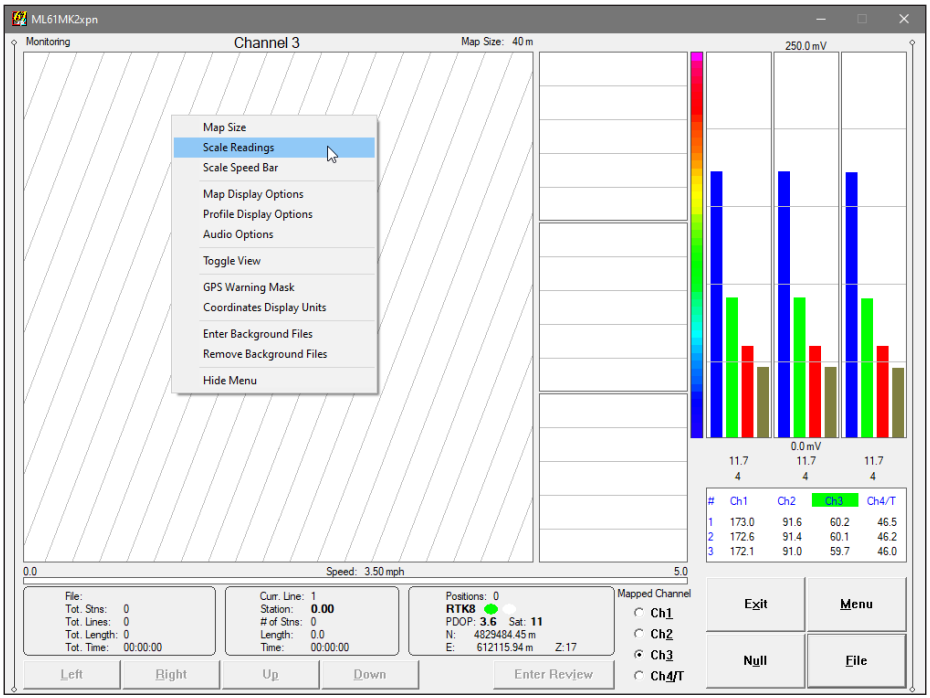

Figure 9.7: Monitoring mode with displayed pop up menu

keyboard by pressing one of the shortcut keys (underlined characters on button labels) or by navigating using **<TAB>** key (sets button as a default button - default button is highlighted) and pressing **<ENTER>** key.

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

File *(create data file)*

The log 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 ML61MK2xpn data file is N61. The Create Data File dialog is presented in Figure 9.8

The file name can be specified in the Create Data File dialog using the Windows standard interface procedure. The ML61MK2xpn data files can be appended (Version 2.00 or later) and after message informing about number of points

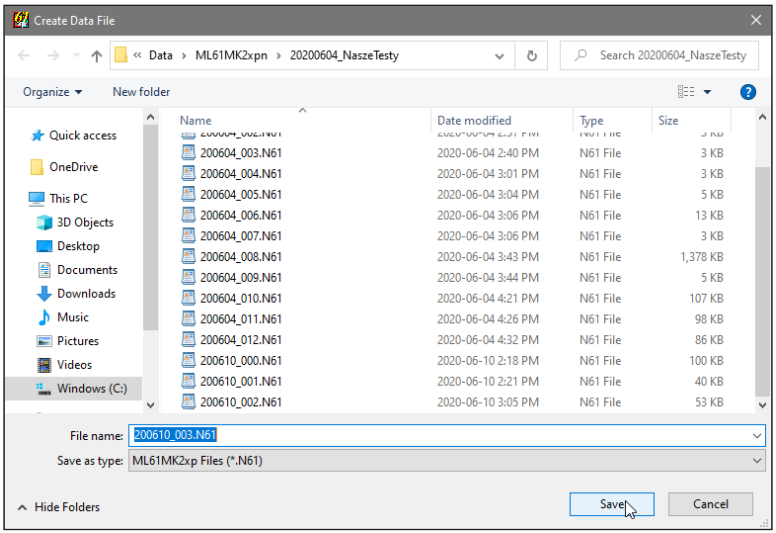

Figure 9.8: Create Data File dialog

already collected in the file the previous data set will be plotted on the map. Maximum number of all positions in one data file cannot exceed 28,800 GPS positions (number of EM61-MK2 readings is unlimited).

Each data file in the field computer (binary raw data file) has an extension name N61 and it is created in the directory specified in Create Data File dialog. The N61 files are created in the ML61MK2xpn binary format. They can be processed and exported to XYZ file format using the Multi61MK2 program. These files can be also converted to ASCII format, or to Geonics DAT61MK2 format and viewed in the Geonics program DAT61MK2.

After the file is specified click on the button **Save** or press the S key (or **ENTER** if the button is highlighted) to accept and create data file. The program will switch Monitor mode to Stand By mode and the data file will be displayed on the screen.

To cancel selection and return to Monitoring mode tap the **Cancel** (X) button or press **Esc** key.

Null (Nulling)

To perform null of instruments click on the button labeled **Null** or execute this function by the keyboard. At this moment the computer takes 50 readings for each instrument (Figure 9.9) and calculates offsets for connected EM61-MK2s. Calculated offsets are applied to all the readings that follow this operation. If needed, this procedure can be repeated several times until satisfactory results are obtained. However, there is no associated “Undo” function. If original values (without calculated offsets) of EM61-MK2 readings are needed, exit the

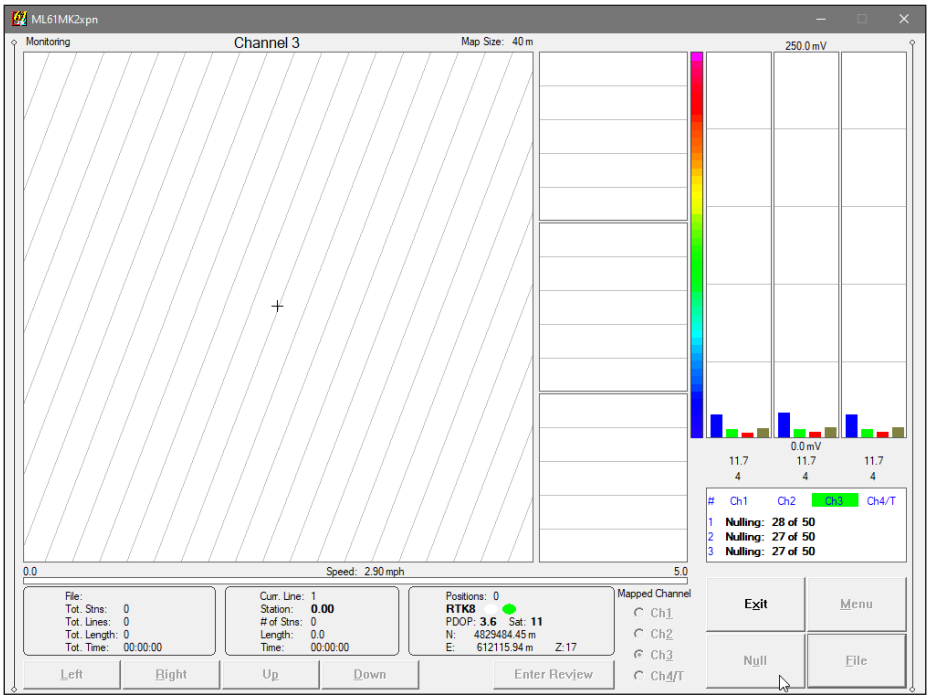

Figure 9.9: Nulling operation in Monitoring mode

ML61MK2xpn program and run it again. EM61-MK2 instruments do not have to be turned OFF.

Exit

The program immediately returns to Main Screen.

Menu

The program will display pop up menu (Figure 9.7). 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 9.10.

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.

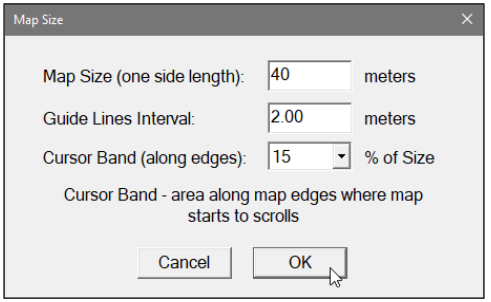

Figure 9.10: Map Size dialog

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

This option is available also in Stand By mode. Minimum and maximum values can be specified for the plot range. However, amplitude type (Compressed or Linear) can be selected only in Display Options dialog.

Selecting this option allows the operator to enter new scale range (minimum and maximum) parameters for the amplitude display. Entered values are applied to profiles, moving bars plot, and colour imaging displayed in Mapping mode. A colour bar for the amplitude scale that show colour distribution is updated in real time. The Reading Scale dialog is given in Figure 9.11.

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

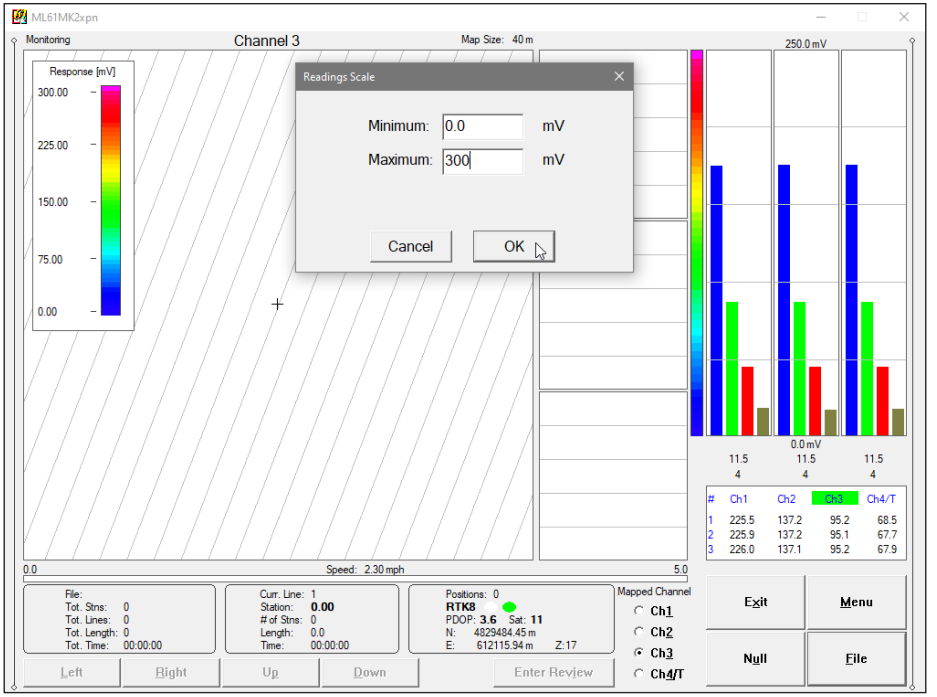

Figure 9.11: Reading Scale dialog

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

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

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

Minimum for the Speed Bar Scale is preset to 0, therefore this scale requires only one entry for maximum speed. In addition speed units can be changed in Set New Speed Bar Scale dialog, which is given in Figure 9.12.

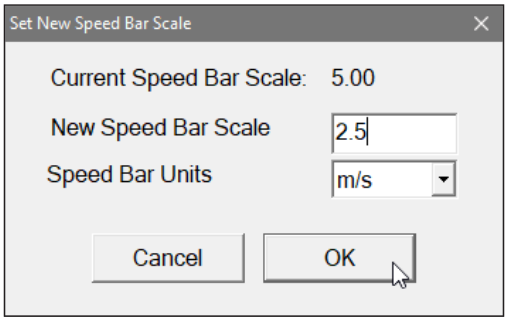

Figure 9.12: Set New Speed Bar Scale dialog

After scale value and units are specified click on the button **OK** or press **ENTER** key to accept new parameters.
To ignore an entry and return to Monitor mode click the button **Cancel** (or X) or press **Esc** key, and the dialog window will disappear. This option is available also in Stand By mode.

Map Display Options (Mapping and Navigation modes)

The Map Display Options dialog (Figure 9.13) is identical to a dialog described in detail in Chapter 8. If the program is in the Mapping or Navigation mode, please refer to section 8.1 of the manual.

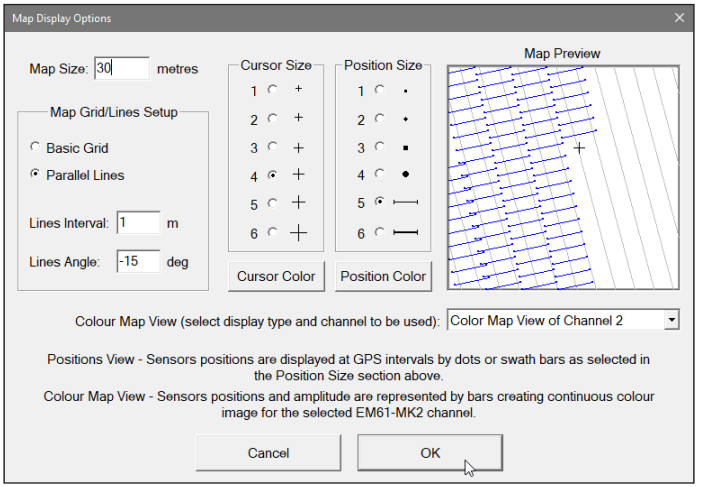

Figure 9.13: Map Display Options dialog

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

Display Options (Profile display options)

The Setup Display Options dialog is described in detail in Chapter 8. This dialog allows you to enable and disable the display of each channel profile (for all instruments in the array), to specify color and thickness of profiles (same colours apply to moving bars), and to select linear or compressed amplitude for profiles and moving bars. The dialog is presented in Figure 9.14.
To select any option click on the corresponding drop-down list box or check box, or use TAB key to scroll to the option and then use mouse or keyboard to select parameter.
After all the parameters in the Display Setup dialog are updated click on the button **OK** or press **ENTER** key (assuming it is highlighted) to accept the displayed settings. The dialog will disappear and the program will return to the Monitoring mode window. Updated settings will be written to the initial file and

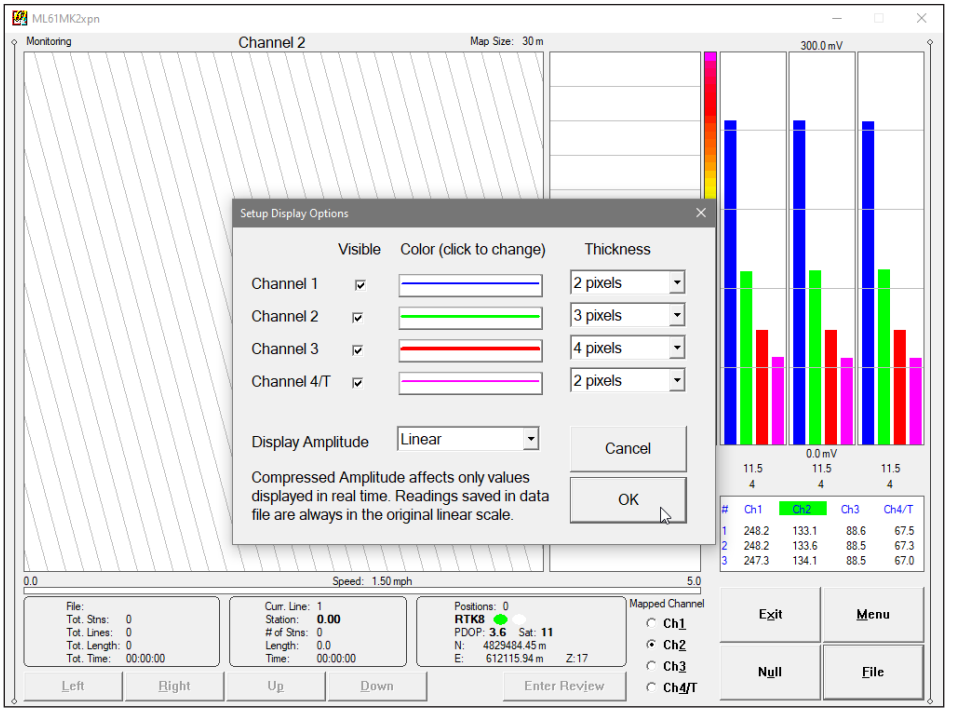

Figure 9.14: Setup Display Options dialog

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 5), and the one associated with GPS Warning Mask can be set in GPS Port Setup dialog (see chapter 7). The Audio Options dialog is presented below in Figure 9.15. 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.

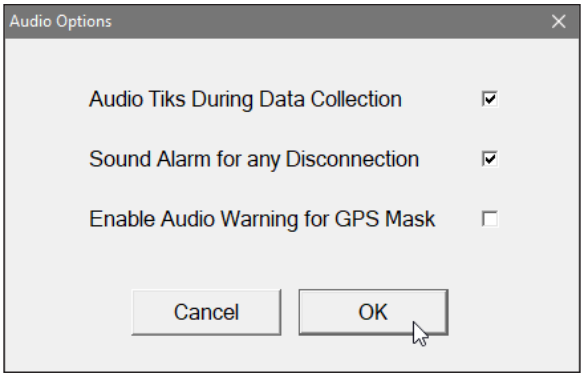

Figure 9.15: Audio Options dialog

Sound Alarm for any Disconnection

The program will sound loud ring when a disconnection in any serial port is detected by the program, or in case any EM61-MK2 console or GPS receiver will stop streaming data for any reason. The audio alarm function does not depend on the visual alarm that is always enabled regardless of audio alarm setting. The audio alarm function can be enabled or disabled by check button at the Sound Alarm for any Disconnection label as shown in Figure 9.15.

Enable Audio Warning for GPS Mask

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

GPS Warning Mask

This dialog allows to set or change GPS Warning Mask parameters during logging session. The same parameters can be set in GPS Port Setup dialog (see chapter 7). The GPS Warning Mask dialog is presented below in Figure 9.16. Parameters in GPS Warning Mask are described below.

Warning

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

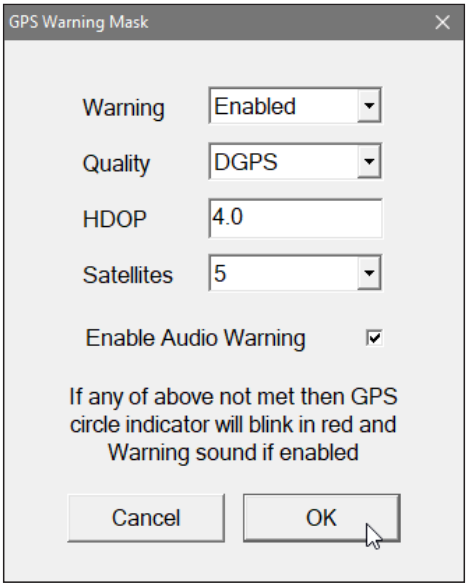

Figure 9.16: GPS Warning Mask dialog

When Enabled is chosen GPS two circle indicator will be alternating in green and white if conditions for specified parameters setting will be met. When any of the parameters is below set values then GPS indicators will alternate in red and white colours). In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours (see Figure 9.14) regardless of GPS signal quality.
All GPS data is logged, GPS Warning Mask affects only display.

Quality

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

PDOP

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

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

Satellites

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

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

Coordinates Display Units

The Set Coordinates Display Units dialog will be displayed, Figure 9.17. There are four items after the combo box labeled Coordinates unit will be expanded: Geodetic Lat/Lon (coordinates in Degrees, Minutes, Seconds), UTM meters, UTM feet (International Feet), and UTM US Feet (US Survey Feet). Select one of items and coordinates of the GPS antenna will be displayed in the GPS section (bottom of the logging screen) in selected units.
Select the OK button to accept selection or the Cancel button to exit dialog.

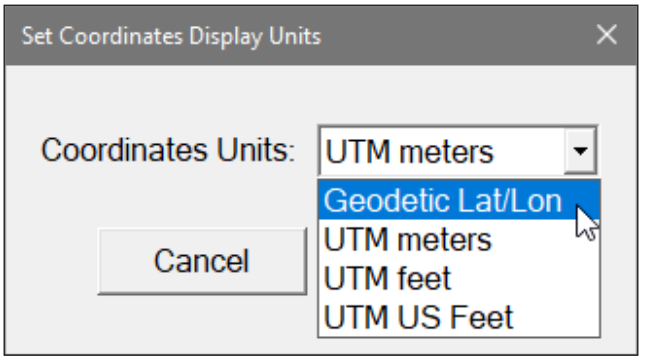

Figure 9.17: Set Coordinates Display Units dialog

Enter Background File

The Load Background File dialog is shown in Figure 9.18. The program will display contents of entered files in the background of the map. Two types of files

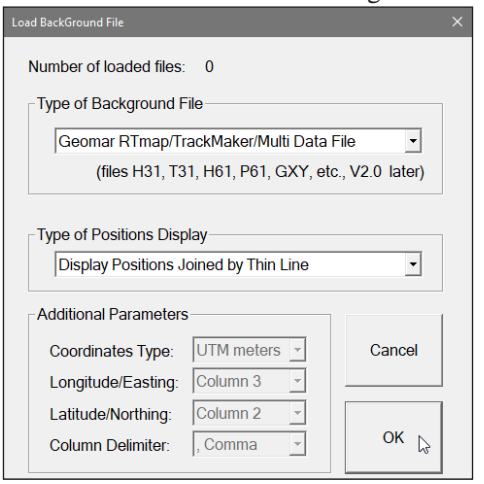

Figure 9.18: Load Background File dialog

can be entered: any data file created with Geomar programs (ML61MK2xpn, RTmap, or TrackMaker - all V2.00 or later) or user prepared column delimited text file (TXT format) containing coordinates representing site boundary, or any other feature, Figure 9.19. If Geomar data file is entered its content will be displayed as traces of collected survey lines. This option can be used to follow measurements with another instrument, to display already measured coverage, or to repeat part of the survey. User prepared Column Delimited ASCII Text

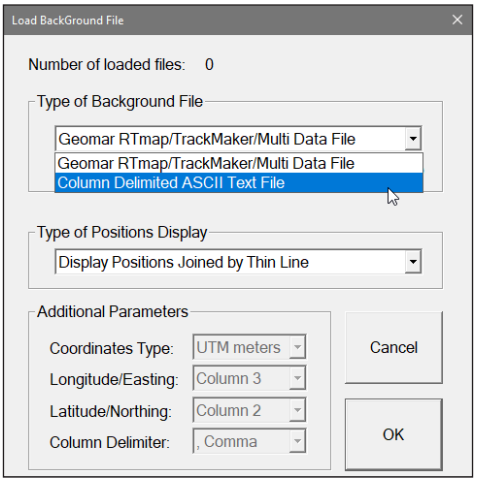

Figure 9.19: Load Background File dialog

File can be used to display a site outline, delineated area of special interest to be surveyed with finer line spacing etc. The latter file must contain coordinates in WGS 1984 datum. Geomar data files are in WGS 1984 datum by default. Up to 10 files (mixture of either type) can be entered and displayed.
Type of Positions Display describes how positions are displayed, they can be plotted as separate points, or lines joined by thin, medium, or thick lines depending on the selection in the corresponding combo box. Lines can have breaks if a tag "Break" (lower or upper case) is inserted in the file. Sample of Column Delimited file is shown in Appendix A.
When a Column Delimited file is selected a section labeled Additional Parameters is activated as shown in Figure 9.20. Parameters describing file structure must be specified, these are: Coordinates Type (Geodetic, UTM meters, feet, or US Survey Fee), column numbers for Longitude and Latitude or Easting and Northing, and finally Column Delimiter (Space, Comma, Tab, or Semicolon). For practical simplicity, if UTM coordinates are used it is assumed that the operator is located within the same UTM zone.

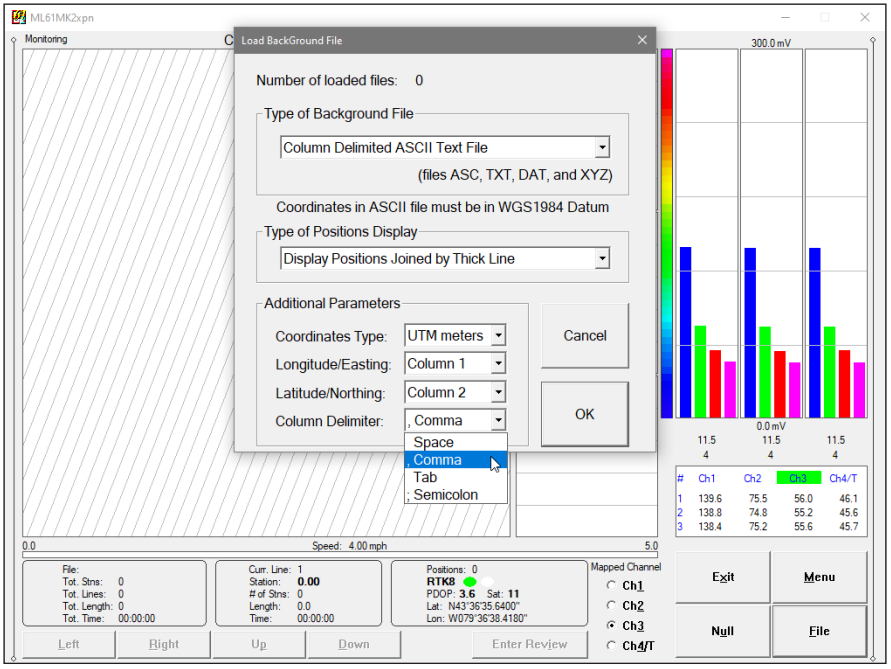

Figure 9.20: Selecting Column Delimiter in Column Delimited File to be loaded.

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 9.21.

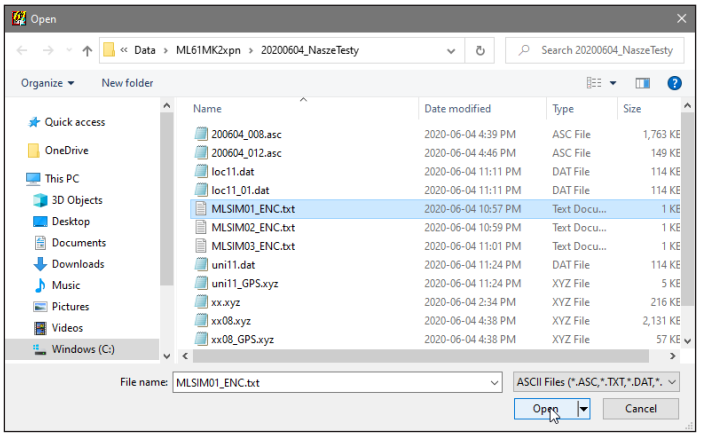

Figure 9.21: Selecting Background File

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

The RTmap61MK2 screen with two background files (both Column Delimited type) is shown in Figure 9.22.

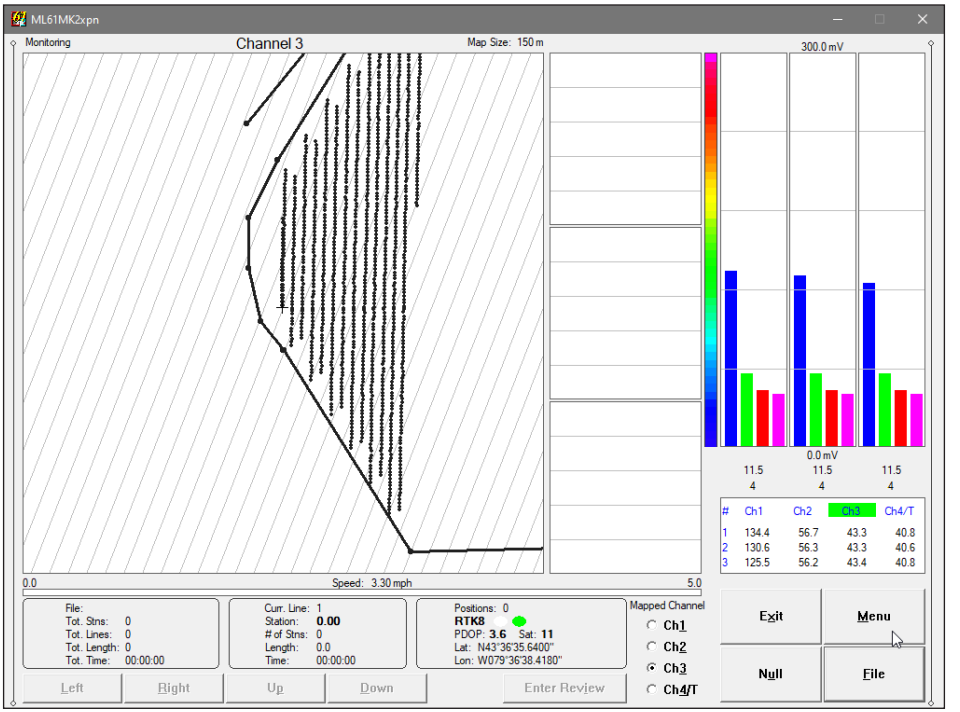

Figure 9.22: Two background files displayed in RTmap61MK2 Monitoring mode

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

Remove Background Files

After this option is executed the Remove Background Files dialog appears, Figure 9.23. It contains list of loaded background Files. Click on any check box located on the left of corresponding file name and when the OK button is clicked on or tapped the map will be re-drawn and checked files will be removed from the program map. Click on the Select All button and then OK button to remove all entered files at once.

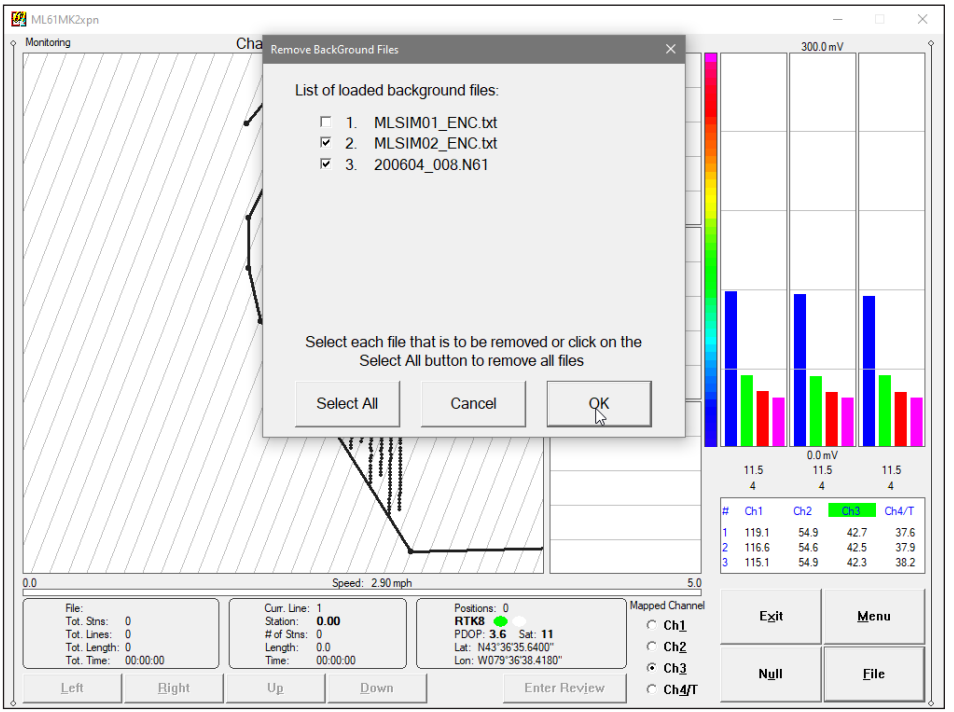

Figure 9.23: Remove Background Files dialog

9.3 Stand By Mode

The main difference between the Monitoring and Stand By modes is that from the Stand By mode program can be directly switched to Logging mode to record the data in the file. The ML61MK2xpn window in Stand By mode and Mapping mode is shown in Figure 9.24 and Figures 9.25 and 9.26 present Navigation mode (with swath bars and dots). The layout of the screen is almost identical to the layout described in section 9.1. Main differences are: label **Stand By**, reminding the operator about current mode, different command buttons, contents of two left frame boxes at the bottom of the window

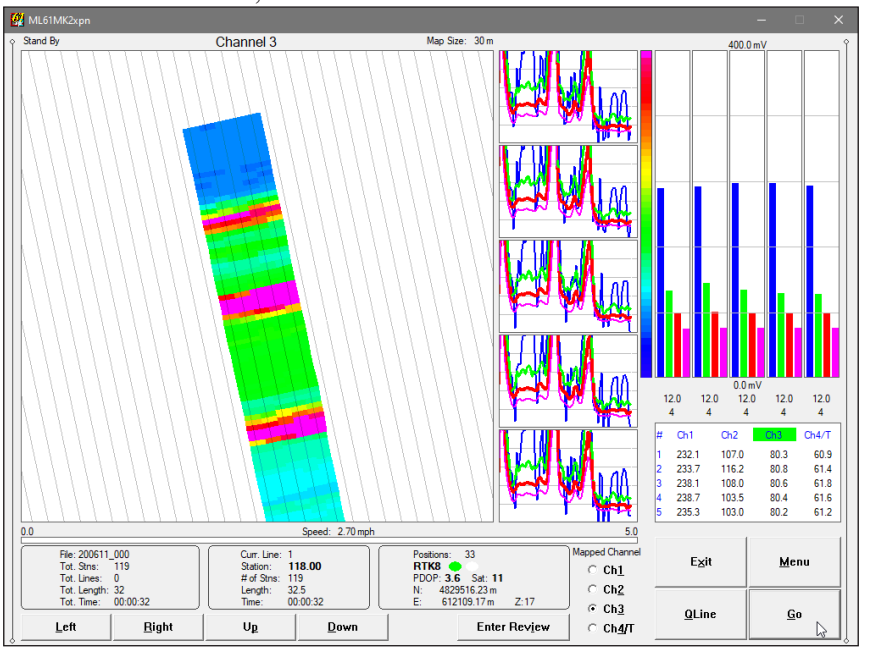

Figure 9.24: ML61MK2xpn in Stand By mode and Mapping display mode

which display parameters specific to survey settings. The first frame box includes parameters related to file contents: File Name, Tot. Stns. (total number of stations in file), Tot. Lines (total number of survey lines), Tot. Length (total length of survey lines in the file), Tot. Time (total elapsed time of recording). The second frame box contains parameters related to current survey line: Curr. Line (name of the current survey line), Station (current station), # of Stns. (number of stations in the current line), Length (length of the current line), Time (elapsed time of recording from the start of the current line). The third frame box described in section 9.1, contains parameters associated with GPS input.

Example shown in Figures 9.24 to 9.26 presents situation where the operator started to walk in the N-W direction while logging data and then stopped logging data by switching

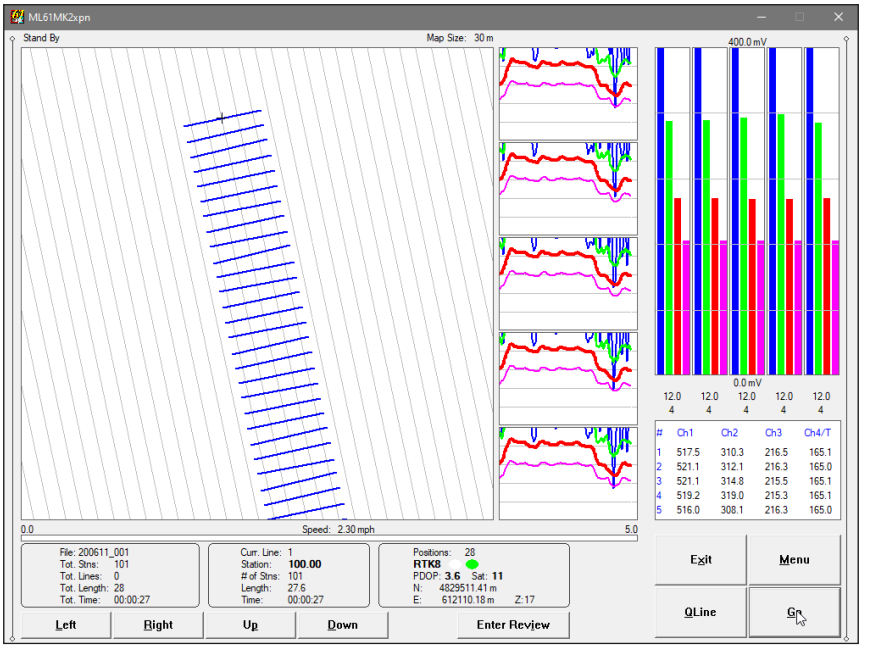

Figure 9.25: ML61MK2xpn in Stand By Navigation modedisplay (swath bars)

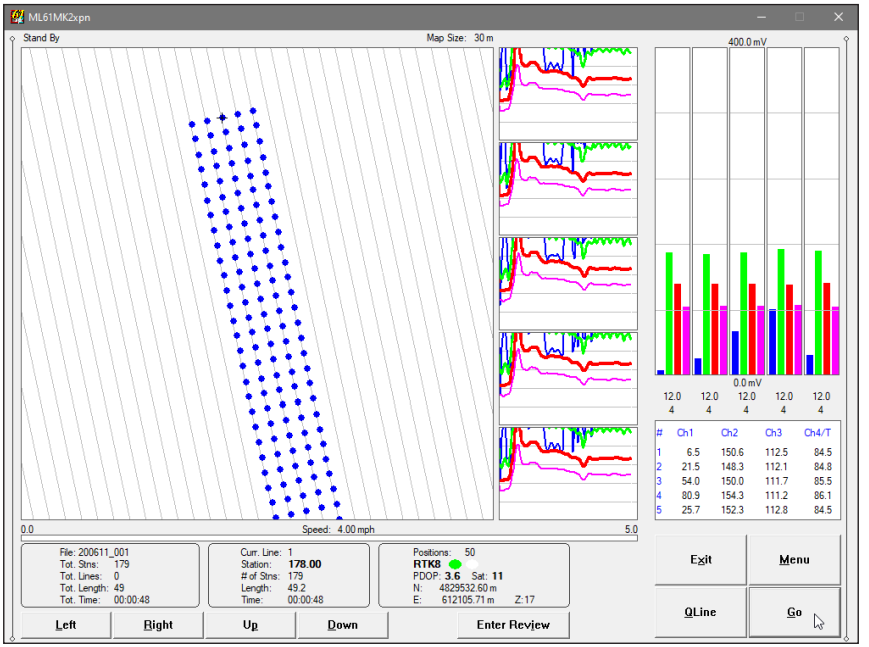

Figure 9.26: ML61MK2xpn in Stand By Navigation mode display (dots)

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

In case the program is run in the Profile display mode, data recorded previously in Log mode will be shown as profiles in the plotting area, as shown in Figure 9.27. Similarly to Navigation mode where GPS locations are not plotted on the screen, data plotted in profile form will not be updated in Stand By mode.

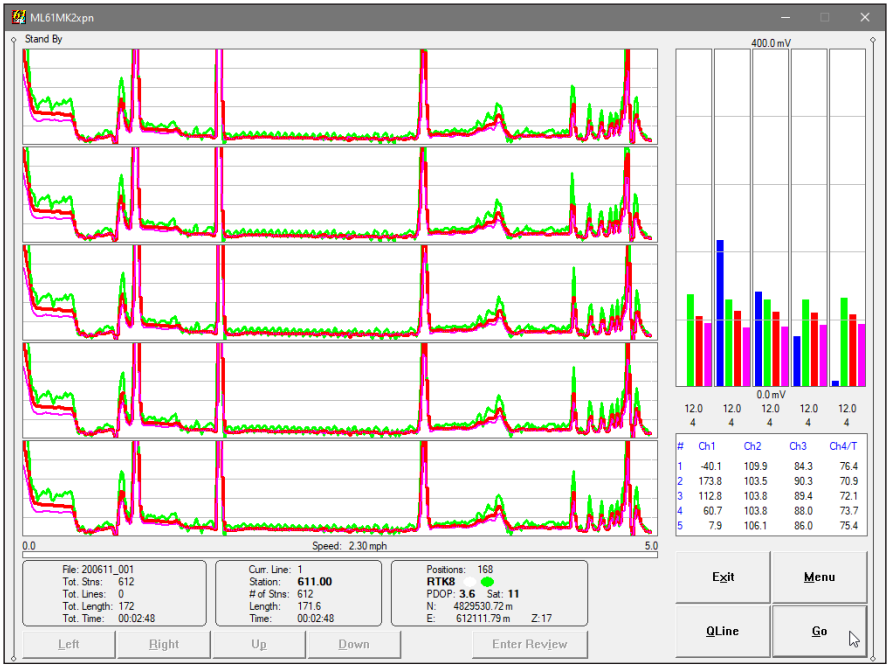

Figure 9.27: ML61MK2xpn in Stand By mode and Profile display mode

The EM61-MK2 data will be displayed with the update rate approximately 10 readings per second, however data will not be saved in the log file. If GPS input was enabled, GPS positions will be updated with a rate specified in GPS receiver. GPS data are not saved in file in Stand By mode.

Four command buttons available in Stand By mode include: **GO** (executed by mouse click, pressing key **G** or **<ENTER>**) which directs the program to Logging mode and recording EM61-MK2 and GPS data, **QLine** (Quick Line), **Exit**, and Menu (which contains more options than pop up menu in Monitoring mode). These options are described in detail in Section 9.5 (Field options available in Stand By mode).

9.4 Logging Mode

The Logging mode is enabled by clicking on the **Go** button or pressing the key **G** (or **<ENTER>** key if the button Go is highlighted). After this button is executed the list of four buttons will be replaced by one button labeled **Pause**, label Stand By will be replaced by label **Logging** (at the top of the display) and data will be recorded. All labels and parameters (with the exception of buttons representing Stand By mode options) are the same as in Stand By mode and they are described in the preceding section 9.2. The ML61FLEX4 screen in Logging mode and in Mapping display mode is presented in Figure 9.28. The cross mark corresponding to the system location will move while the operator is progressing along the survey line and recorded amplitude of EM61-MK2 readings will be plotted as colored image at sensors positions on the screen. At the same time profiles will be plotted in panels located right to the map plot area.

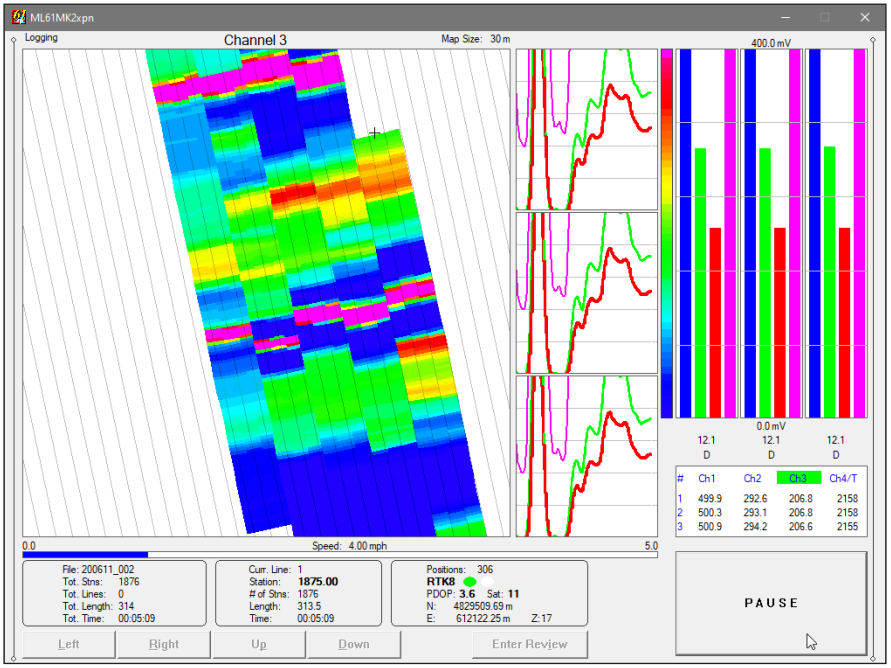

Figure 9.28: ML61MK2xpn in Logging mode and Mapping display mode

If the program is in Profile display mode (when GPS input is disabled in GPS Port Setup dialog) the ML61MK2xpn Profile display mode will be used as shown in Figure 9.27.

When the Profile display mode is enabled profiles (or profile) curves are updated after each reading is written to the data file. The program displays profiles for readings with settings selected in the Profile Display Options dialog.

After the screen changes from Stand By mode to Logging mode survey parameters are updated according to the station interval. Similarly, if GPS input was enabled, total number of GPS positions in the data file is increment every time (usually once a second) GPS position is written to the file. Profile plots, amplitude of graphic bars in plot area and readings displayed in numeric form for each instrument are updated after each reading is written to the data file. 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 EM61-MK2 reading.

There is only one option available in the Logging mode - PAUSE logging. After the button labeled **PAUSE** or a Pause key selected in the System Setup dialog is pressed the recording is stopped and the Logging screen returns to the Stand By mode. In the Stand By mode all EM61-MK2 data will be displayed in numeric form and graphically by moving bars with the update rate of the instrument, however data will not be saved in the log file, a map nor profile plots will not be updated. The cross mark corresponding to the system location will move according to the operator movement, however sensors positions (or GPS positions in Mapping/Navigation mode) will not be plotted as dots on the screen.

9.5 Field Options Available in Stand By Mode

Several options are available while the Logging window is in the Stand By mode. Three more frequently used options can be accessed directly from command buttons and others can be used from pop up menu activated by button **Menu** (displayed in Figure 9.29). 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.

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

GO *(start data logging)*

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

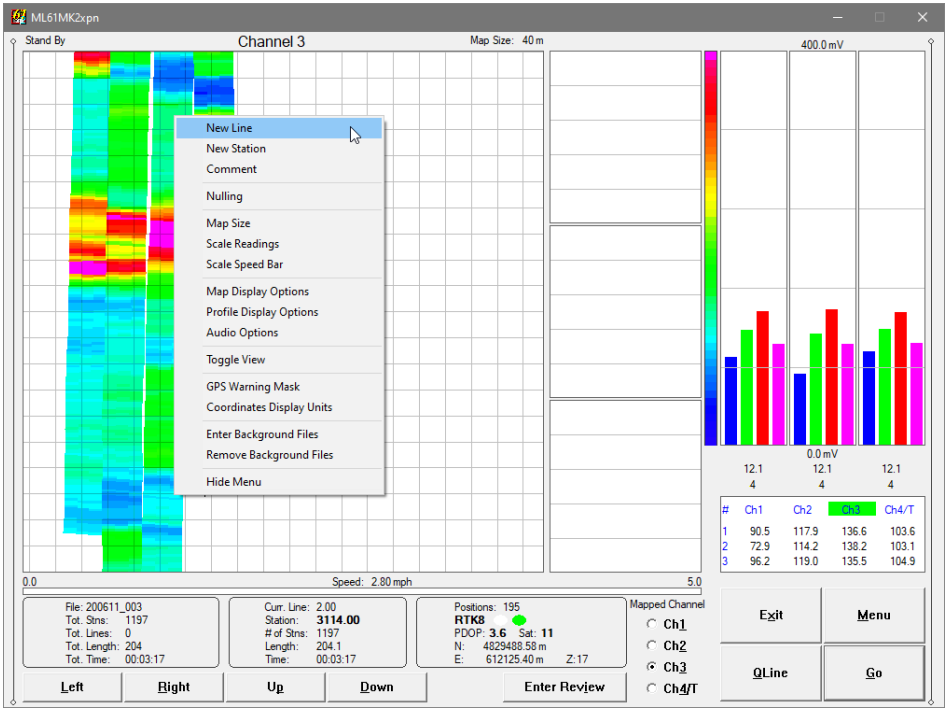

Figure 9.29: ML61MK2xpn in Stand By mode with pop up menu

QLine *(Quick Line change)*

Click on the **QLine** button, or while using the keyboard press shortcut key **Q** or if the button is a default button (highlighted) press **ENTER** key. The confirmation message will be displayed, Figure 9.30.

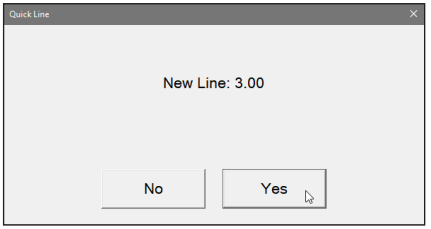

Figure 9.30: Quick Line confirmation message dialog

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

New Line (New Survey Line)

The New Line dialog is displayed, Figure 9.31. Selecting this option allows the operator to enter a new survey line number (name) and (as opposite to Quick Line described above) to change associated line parameters (Line Increment, Line Sequence, Direction, Start Station, and Station Increment). The new line number and associated parameters are prompted by the program based on parameters specified in the Survey Setup menu and the last survey line.
At the top of the dialog the last survey line name and the last logged station are displayed. Default name for the new line is given based on the Line Increment parameter. The default Start Station, direction of the Station Increment, and

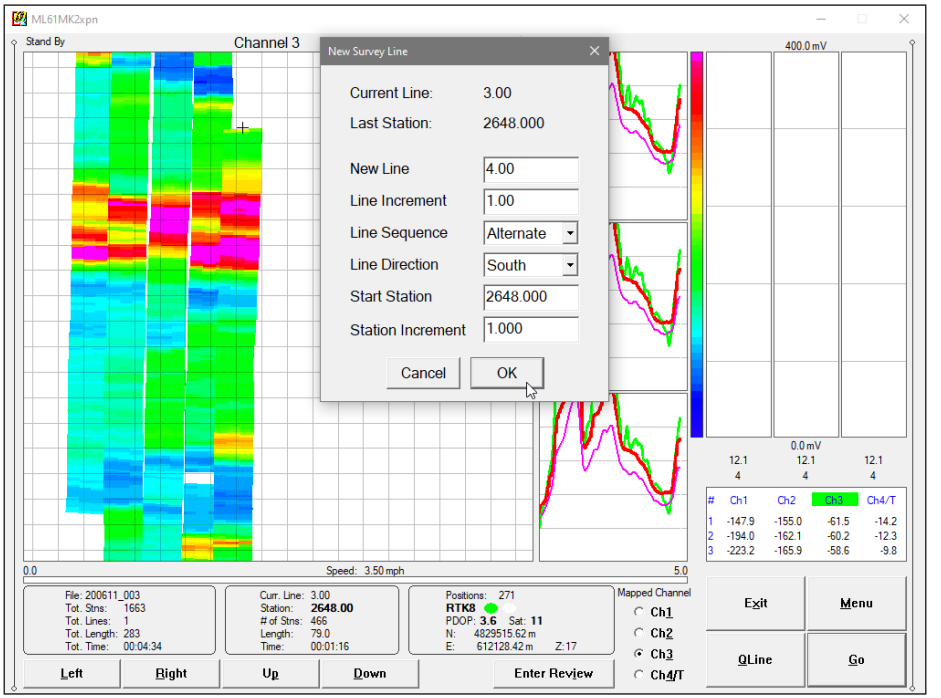

Figure 9.31: New Survey Line dialog

Direction are determined based on Sequence selection. All these parameters can be overwritten by the user as described in the Survey Setup dialog description (chapter 3).
After all the parameters in the New Line dialog are updated click on the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Logging window in Stand By mode. Survey line (**Curr. Line:**) name and current station (**Station:**) value and other associated parameters will be updated. Profile curves plot for former survey line will disappear.
To return to Stand By mode and current survey line settings (state before this dialog was selected) click on the **Cancel** (or X) button or press **Esc** key, the dialog window will disappear.

New Station

Selecting this option allows the operator to enter a new station number (within the same survey line). The New Station dialog is displayed and it is shown in Figure 9.32. 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.

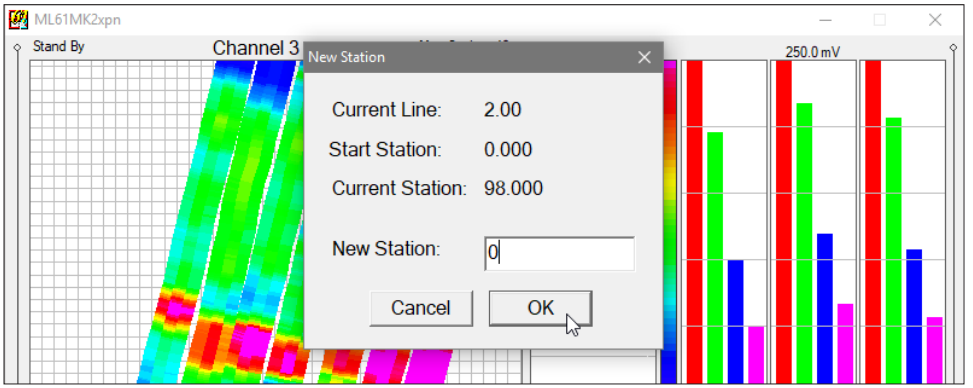

Figure 9.32: New Station dialog

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.
Click on the button **OK** or press **ENTER** key to accept the new value. The program will return to the Logging window in Stand By mode. Current station (**Station:**) value will be updated and after data logging is activated the profile curves will have a small gap (and possible amplitude discontinuity) showing the new station entry.
To return to Stand By mode and current survey line settings (state before this dialog was selected) click on the **Cancel** (or X) button or press **Esc** key, the dialog window will disappear and measurements can be continued.

Comment

The Comment option allows the operator to enter a comment at any point of the survey. A maximum of 11 characters can be entered as a comment. The Enter Comment dialog is displayed in Figure 9.33.

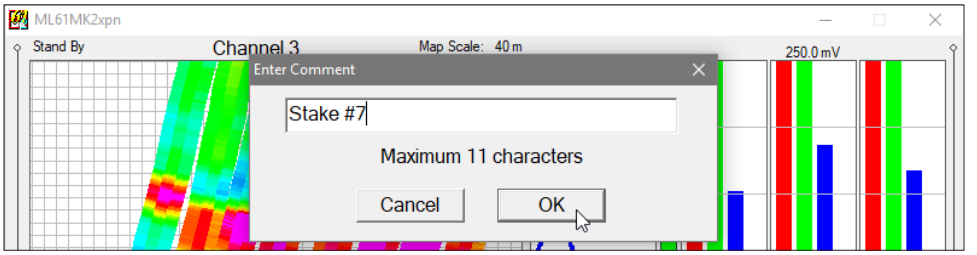

Figure 9.33: Enter Comment dialog

Click on the button **OK** or press **ENTER** key to accept the comment entered in a text box of the dialog. The text of the comment is saved in the file with a corresponding time stamp and the program will return to the Logging window in Stand By mode.

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

Nulling

To perform null of instruments click on the menu item labeled **Nulling** or execute this function by the keyboard. Since this operation is performed during data logging and will affect collected readings a confirmation message dialog is displayed, Figure 9.34. If the action was accidental click on the button No and the program will return to the logging screen in Stand By mode.

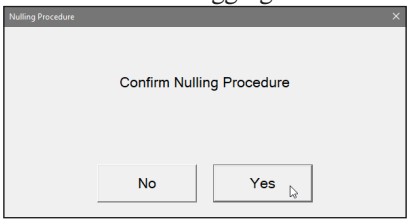

Figure 9.34: Confirmation dialog before nulling data procedure

Click on the **Yes** button to proceed. At this moment the computer takes 50 readings for each instrument (Figure 9.35) and calculates channel offsets for connected EM61-MK2s.

Calculated offsets are applied to all the readings that follow this operation. If needed, this procedure can be repeated several times until satisfactory results are obtained. However, there is no associated “Undo” function. If original values (without calculated offsets) of EM61-MK2 readings are needed, exit the

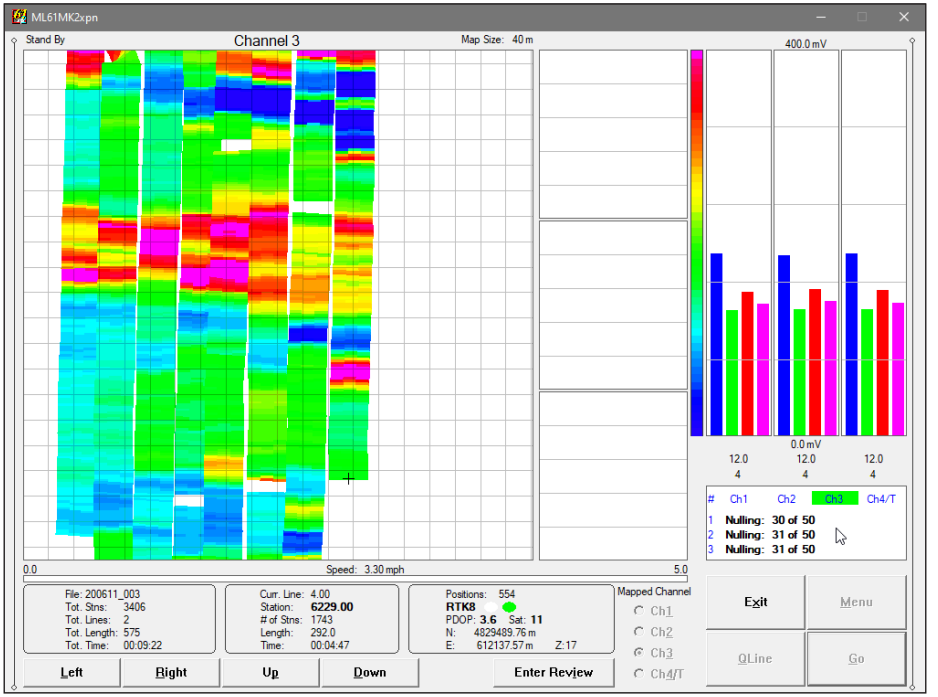

Figure 9.35: Logging Screen in Stand By mode during nulling operation

ML61MK2xpn program and run it again. EM61-MK2 instruments do not have to be turned OFF.

Map Size

This option is available from the pop up menu (accessible by clicking on the **Menu** button), or directly from keyboard by using shortcut key **S**. The Map Size dialog will appear on the screen, Figure 9.36.

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

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

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

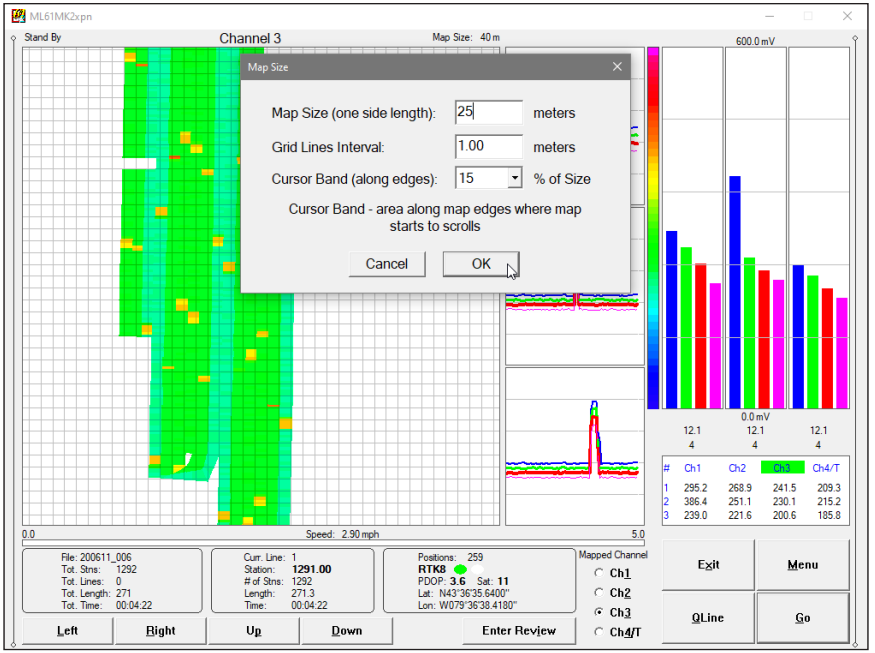

Figure 9.36: Map Size dialog, current ML61MK2xpn map at size of 40 m

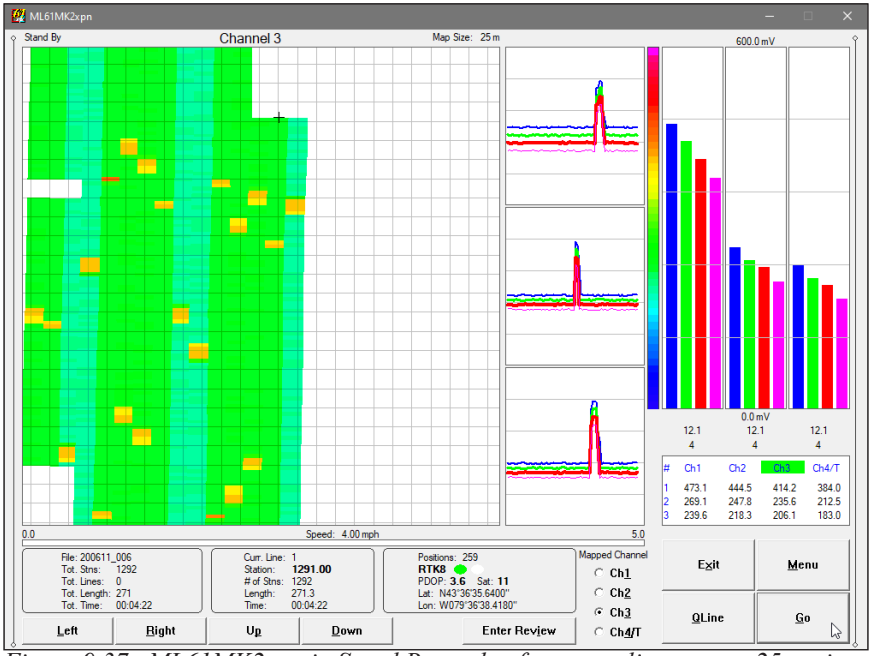

Figure 9.37: ML61MK2xpn in Stand By mode after re-scaling map to 25 m size

The third parameter in the dialog is named Cursor Band. This parameter describes a band around map perimeter that is always displayed. In other words, when cursor approaches and enters band area the map is scrolled. The band width is described by percentage of Map Scale. Five selections are available in the combo box labeled Cursor Nand: 10%, 15%, 20%, 25%, 30%, and 40%. At 40% cursor indicating GPS antenna is mostly in the center area of the map. After parameters in Map Scale dialog are changed click on the button **OK** or press **ENTER** key to accept new values and the screen with a new map scale will be redrawn at a specified scale (see Figure 9.37 and compare with Figure 9.36). Re-drawing the map may take several seconds (prompt "Please Wait" is displayed), depending on parameters and number of data points collected in data file.

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

Scale Readings (Adjust profile and moving bars range)

Minimum and maximum values can be specified for the plot and moving bars range. The Reading Scale dialog is given in Figure 9.38.

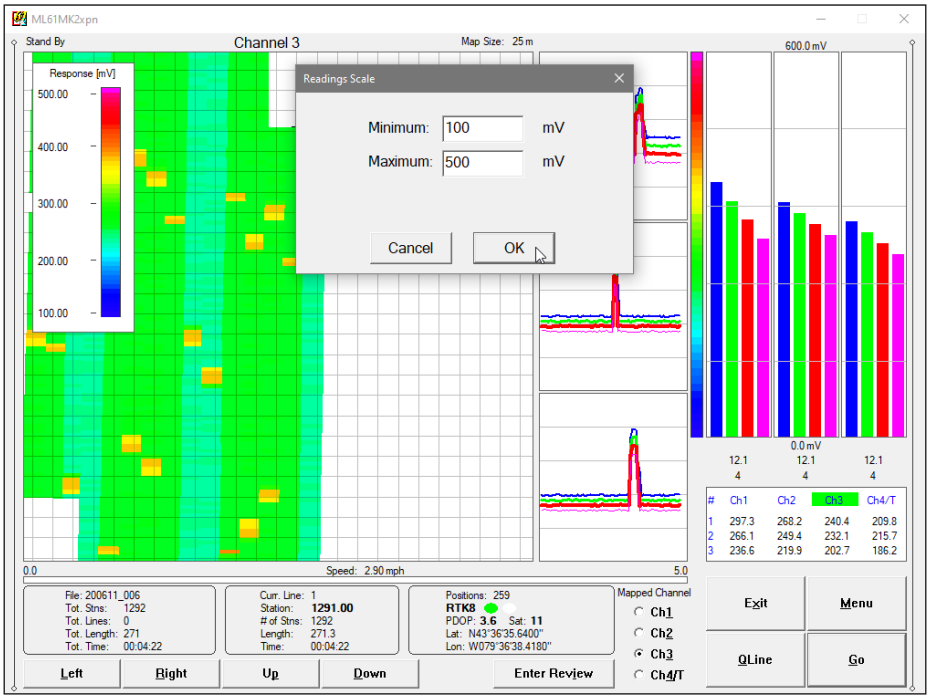

Figure 9.38: Readings Scale dialog, in the background the current ML61MK2xpn reading maximum range from 0 mV to 500 mV

Selecting this option allows the operator to enter new scale parameters for the amplitude display which applies to plotted colour map, profiles as well as to moving bars plot.
A colour bar labeled "Response [mV]" represents colour distribution for colour image displayed in Mapping mode. Labels for amplitude are updated in real time.
After minimum and maximum values are specified click on the button **OK** or press **ENTER** key to accept new values and the profile plot and moving bars areas will be redrawn (see Figure 9.39 and compare with Figure 9.38, please not change in colours on the map). When large number of readings was taken in the current logging session a message "Please Wait" may appear for duration of map re-drawing.

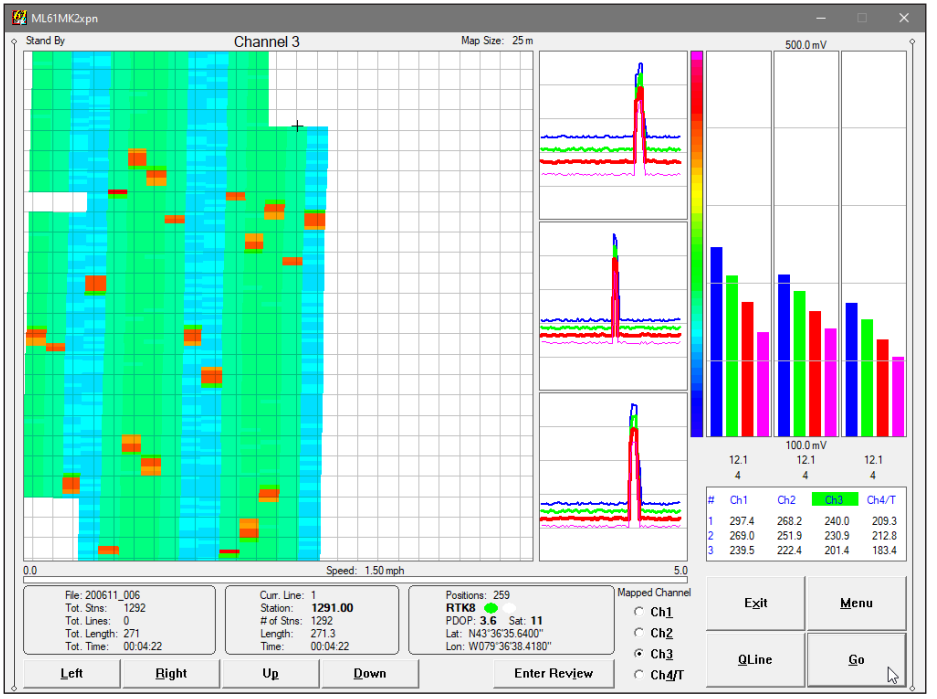

Figure 9.39: ML61MK2xpn Screen in Stand By mode after Readings Scale change, compare with Figure 9.38

To ignore an entry and return to Monitor mode click the button **Cancel** (or X) or press **Esc** key, and the dialog window will disappear.
In case where minimum or maximum values are wrong, the program will assume minimum scale (0 to 10).
Amplitude scale (Compressed or Linear) can be selected only in Display Options dialog.

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

Minimum value for the Speed Bar Scale is preset to 0, therefore this scale requires only one entry for maximum speed. In addition speed units can be changed in Set New Speed Bar Scale dialog, which is given in Figure 9.40.

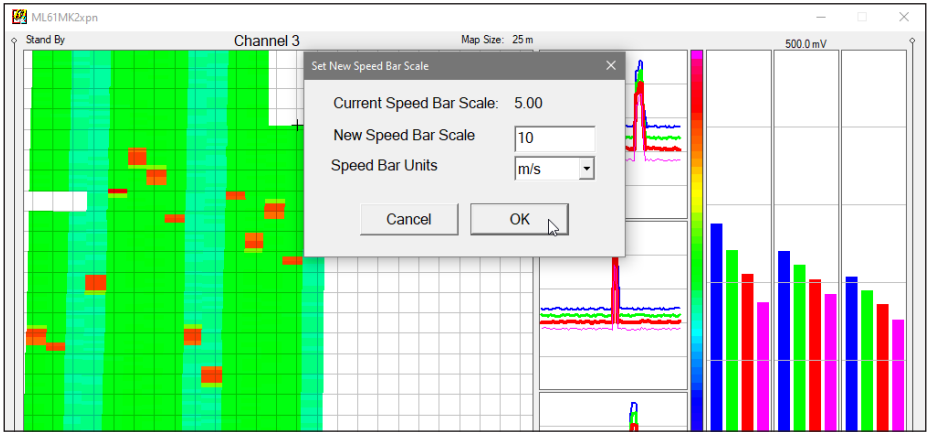

Figure 9.40: Set New Speed Bar Scale dialog

The entered scale applies only to graphic representation of the speed (graphic bar), speed in numeric form is always displayed above the bar, even if the real value exceeded maximum specified for the speed bar.

Speed Bar units selection contains: m/s, ft.s, km/h, and mph.

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

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

Map Display Options (Navigation mode)

The Map Display Options dialog is identical to dialog described in detail in Chapter 8 (please refer to section 8.1 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 is shown in Figure 9.41. Figures 9.42, 9.43, and 9.44 below present various setups for Navigation and Mapping modes. Please compare Figures 9.42 (Navigation mode where dots represent sensors positions), Figure 9.43 (Navigation mode with swath bar array presentation), Figure 9.44 (Mapping mode with colour image of readings amplitude).

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

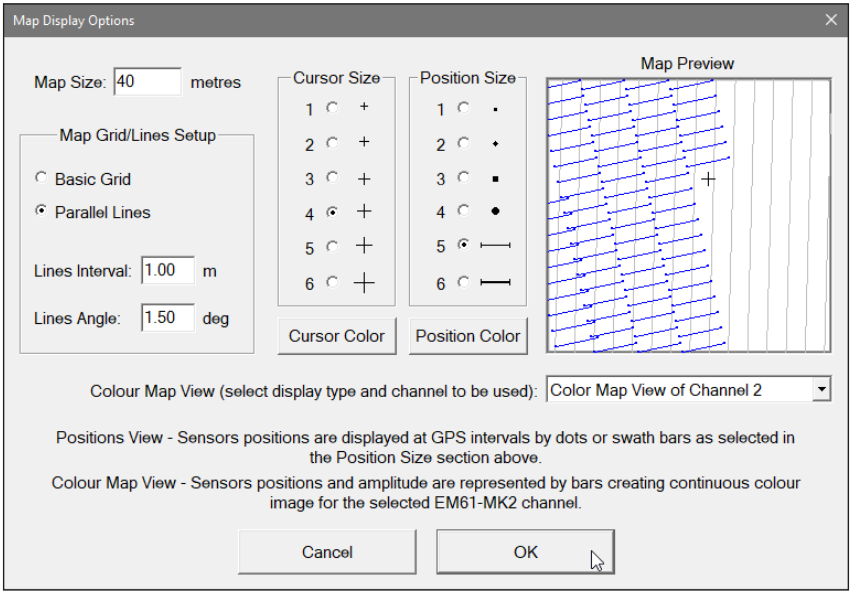

Figure 8.41: Map Display Options dialog

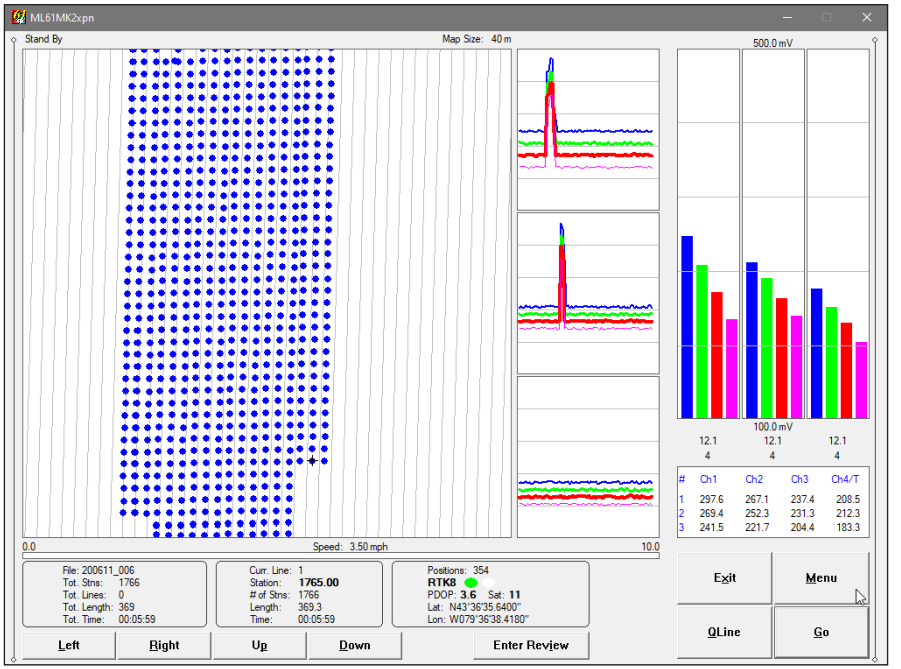

Figure 8.42: ML61MK2xpn Logging Navigation mode with dots representing sensors positions

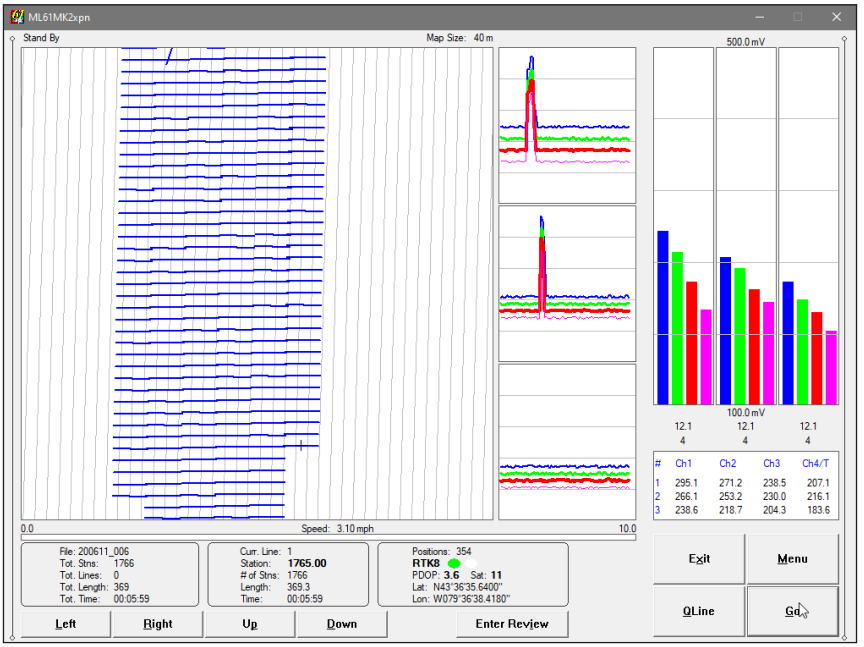

Figure 8.43: ML61MK2xpn Logging Navigation mode with swath bars representing array positions

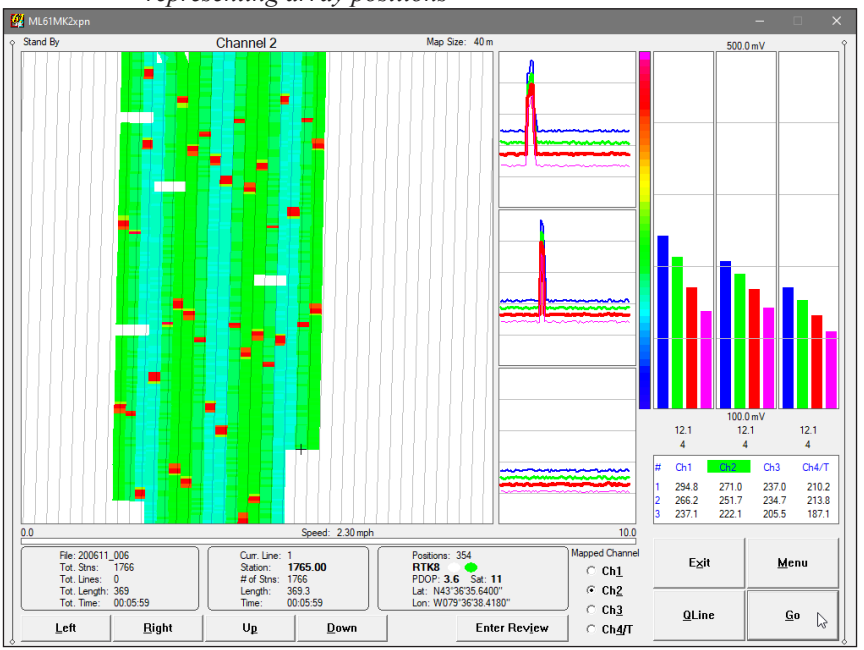

Figure 8.44: ML61MK2xpn Logging screen in Mapping mode with colour image

Display Options (change units and adjust scale for speed bar)

The Setup Display Options dialog is described in detail in Chapter 8. This dialog allows you to enable and disable the display of each channel profile (for all instruments in the array), to specify color and thickness of profiles (same colours apply to moving bars), and to select linear or compressed amplitude for profiles and moving bars. The dialog is presented in Figure 9.45.

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.

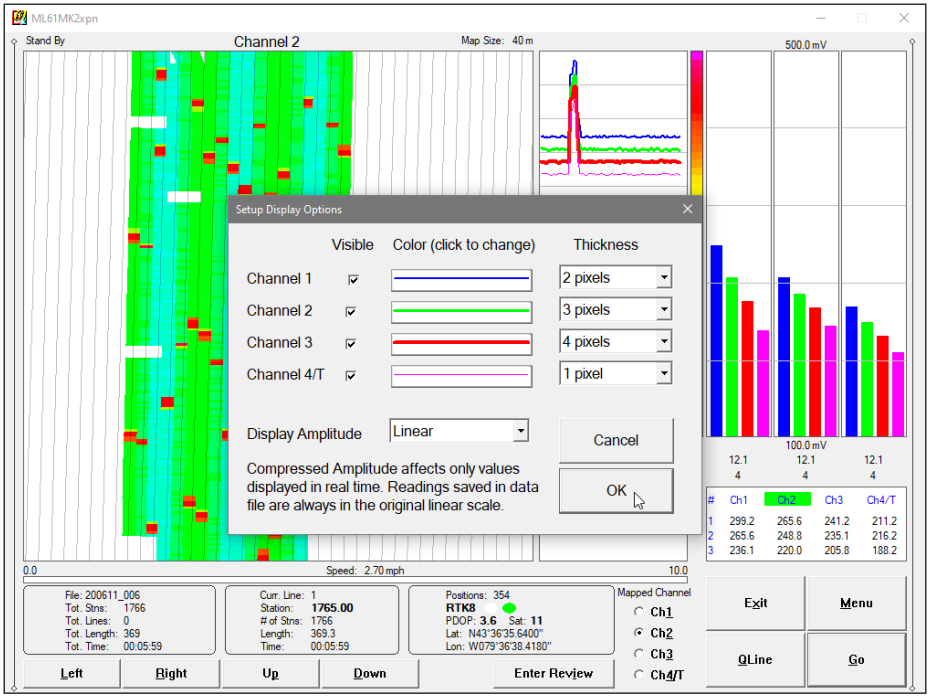

Figure 9.45: Setup Display Options dialog

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

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

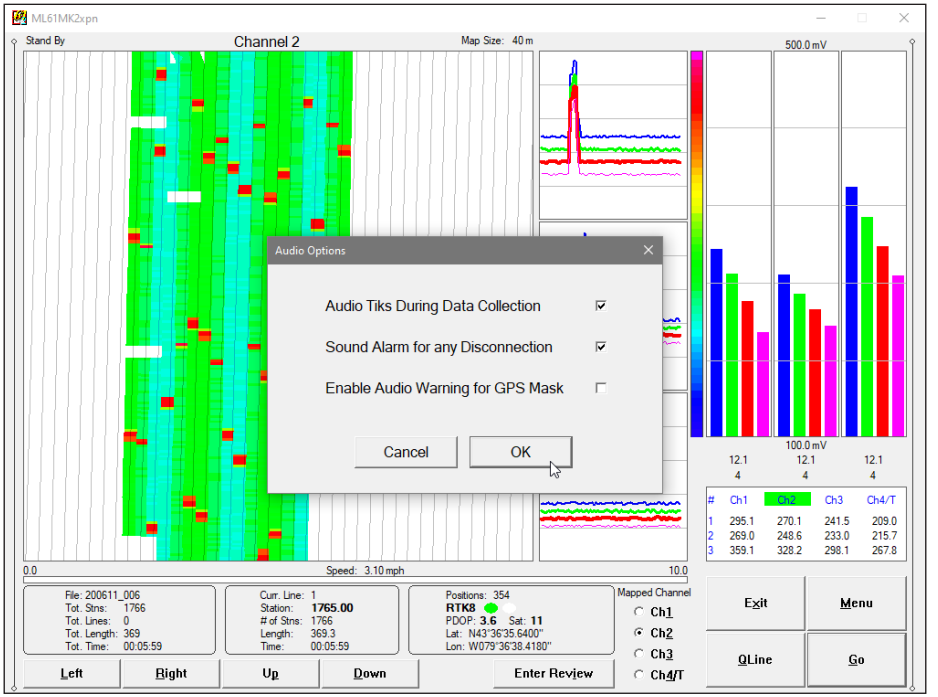

Figure 9.46: Audio Option dialog

Audio Options

This dialog allows to enable and disable three audio functions. Two of these options can be specified in the System Setup dialog (see chapter 4), and the one associated with GPS Warning Mask can be set in GPS Port Setup dialog (see chapter 6). The Audio Options dialog is presented below in Figure 9.46. 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 EM61-MK2 console or GPS receiver will stop streaming data for any reason. The audio alarm

function does not depend on the visual alarm that is always enabled regardless of audio alarm setting. The audio alarm function can be enabled or disabled by check button at the Sound Alarm for any Disconnection label as shown in Figures 9.51 and 9.52.

Enable Audio Warning for GPS Mask

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

GPS Warning Mask

This dialog allows to set or change GPS Warning Mask parameters during logging session. The same parameters can be set in GPS Port Setup dialog (see chapter 7). The GPS Warning Mask dialog is presented below in Figure 9.47. Parameters in GPS Warning Mask are described below.

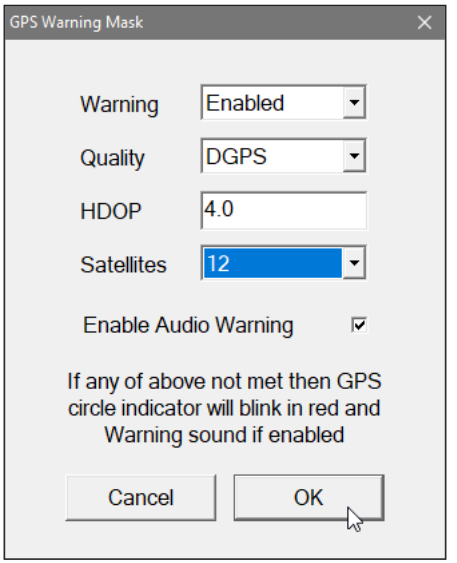

Figure 9.47: GPS Warning Mask

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 (see Figure 9.48). In case Warning parameter is disabled then GPS indicator will be displayed in green and white colours (see Figure 9.46) regardless of GPS signal quality.
All GPS data is logged, GPS Warning Mask affects only display.

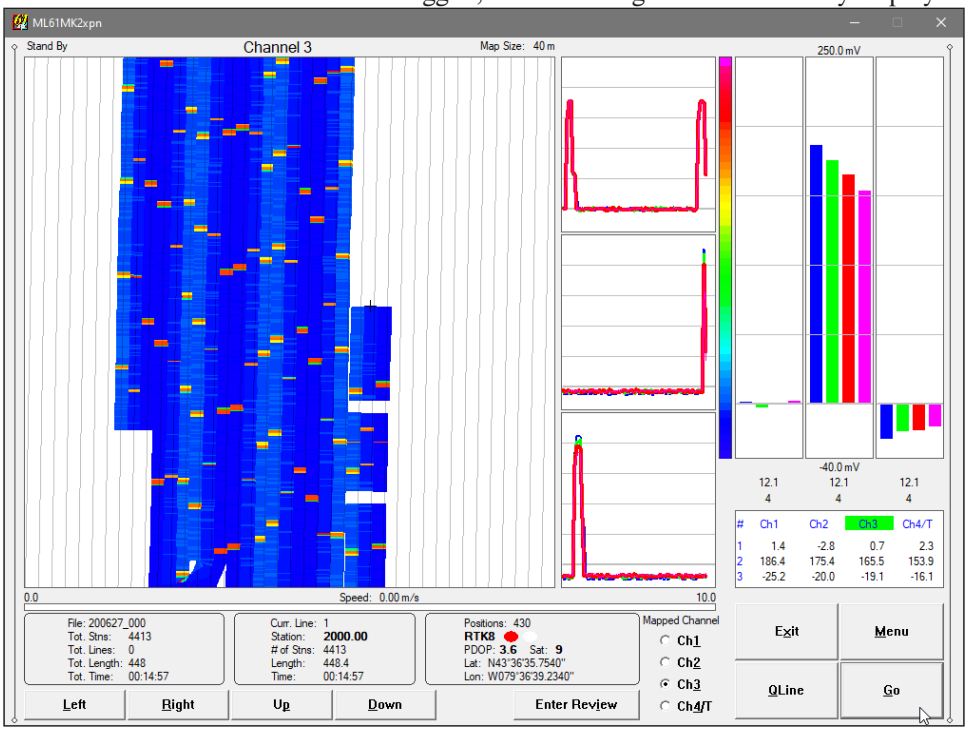

Figure 9.48: ML61MK2xpn screen with GPS Warning indication

Quality

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

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

PDOP

This parameter can be labeled PDOP, HDOP, DOPG, DOP depending on the selected NMEA message. It can be also named Quality m (accuracy in meters) if LLQ was selected, or it is not available (labeled N/A) when messages GLL, pseudo-GGA or Trimble RTS are used.
Activate text box by clicking on the edit box or using TAB key and then enter the chosen acceptable maximum value of Dilution parameter.
If PDOP (or other similar parameter) is larger than specified value then GPS indicator will alternate in red and white colours.

Satellites

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

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

Coordinates Display Units

The Set Coordinates Display Units dialog will be displayed, Figure 9.49. 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 9.49 (Geodetic coordinates) and Figure 9.50 (Coordinates in UTM meters). Select the OK button to accept selection or the Cancel button to exit dialog.

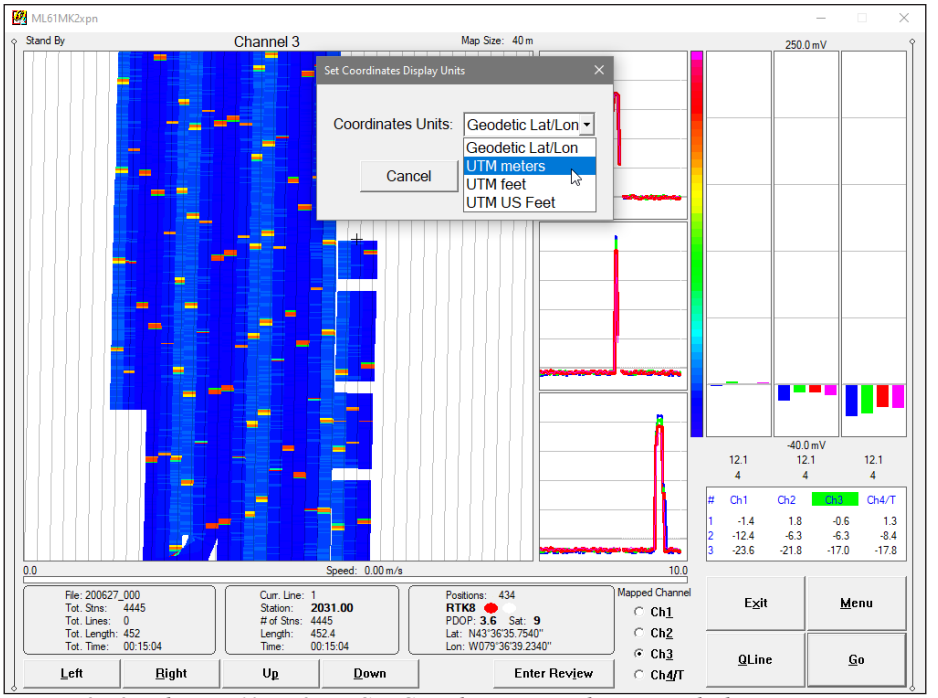

Figure 9.49: The ML61MK2xpn Set Coordinates Display Units dialog

Enter Background File

The Load Background File dialog is shown in Figure 8.50. This option is also described in section 8.2, in this section examples with background files and

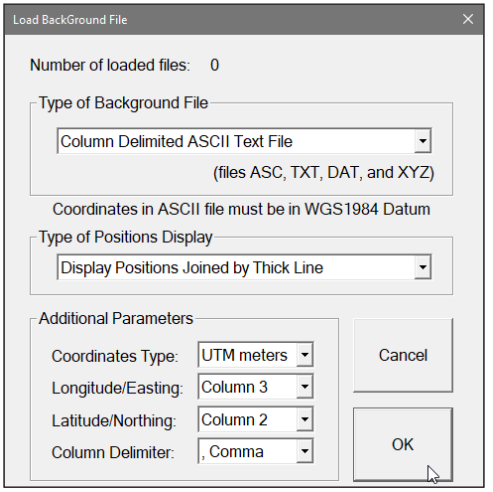

Figure 9.50: Load Background File dialog

collected data will be shown The program will display contents of entered files in the background of the map. Two types of files can be entered: any data file created with Geomar programs (RTmap, TrackMaker, or Multi - all V2.00 or later) or user prepared column delimited text file (TXT format) containing coordinates representing site boundary, or any other feature. If Geomar data file is entered its content will be displayed as traces of collected survey lines. This option can be used to follow measurements with another instrument, to display already performed coverage, or to repeat part of the survey. User prepared Column Delimited ASCII Text File can be used to display a site outline, delineated area of special interest to be surveyed with finer line spacing etc. The latter file must contain coordinates in WGS 1984 datum. Geomar data files are in WGS 1984 datum by default. Up to 10 files (mixture of either type) can be entered and displayed.

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

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

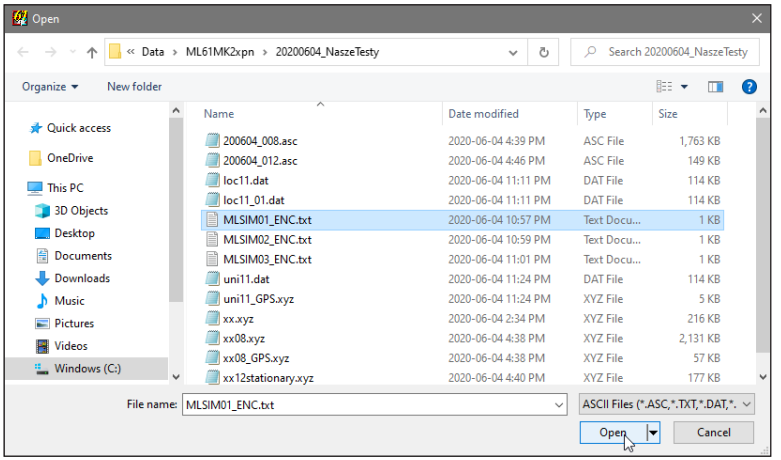

Figure 9.51: Selection of Background File

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 8.51.
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 ML61MK2xpn screen with two loaded background files (both Column Delimited type) and start of actual data logging is shown in Figure 8.52.

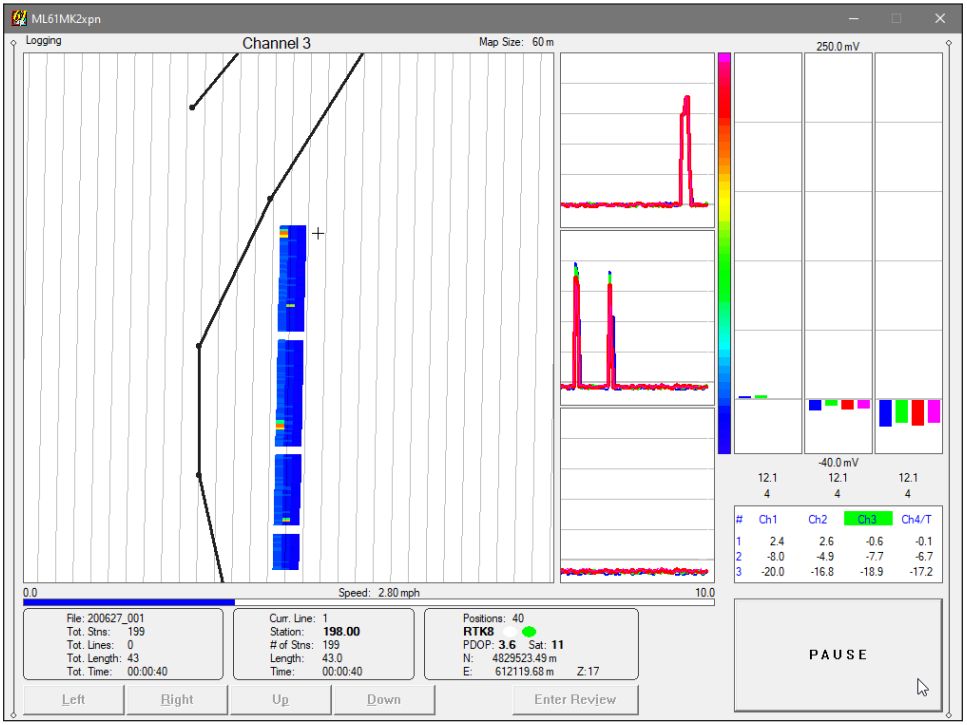

Figure 9.52: ML61MK2xpn with two background files after logging is started

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 8.53 and 8.54 (it is same logging session at later stage as shown in Figure 8.52). When Enter Background File option is executed, the dialog that appear indicates number of already loaded files (Figure 8.53). 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 8.54.

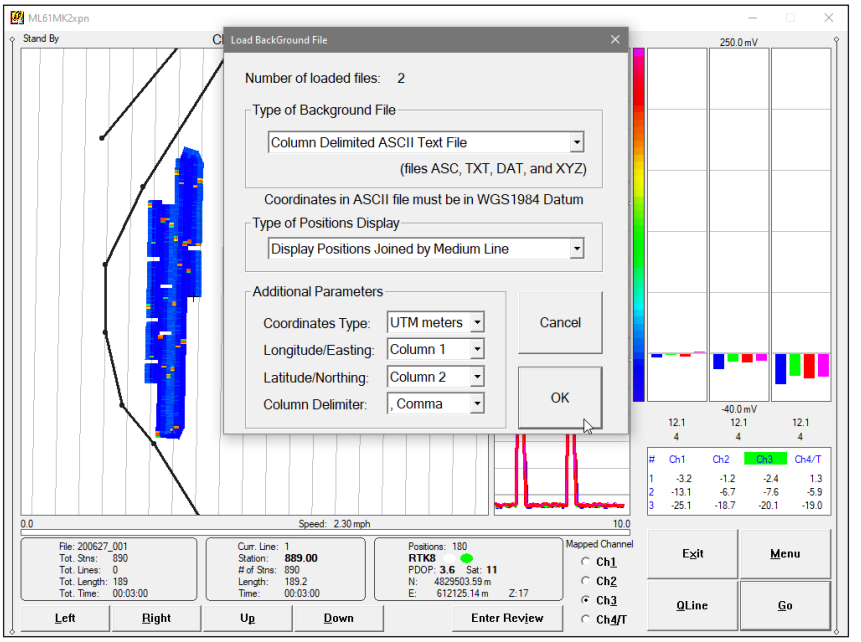

Figure 9.53: ML61MK2xpn, loading third background file

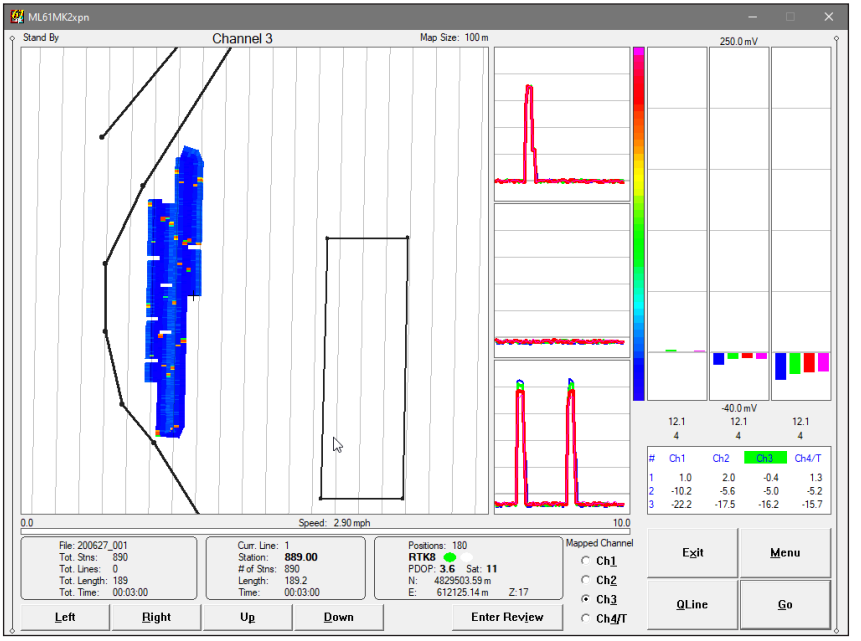

Figure 9.54: Three background files displayed on the map, compare with Figure 8.53

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

Remove Background Files

After this option is executed the Remove Background Files dialog appears, Figure 8.55. 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

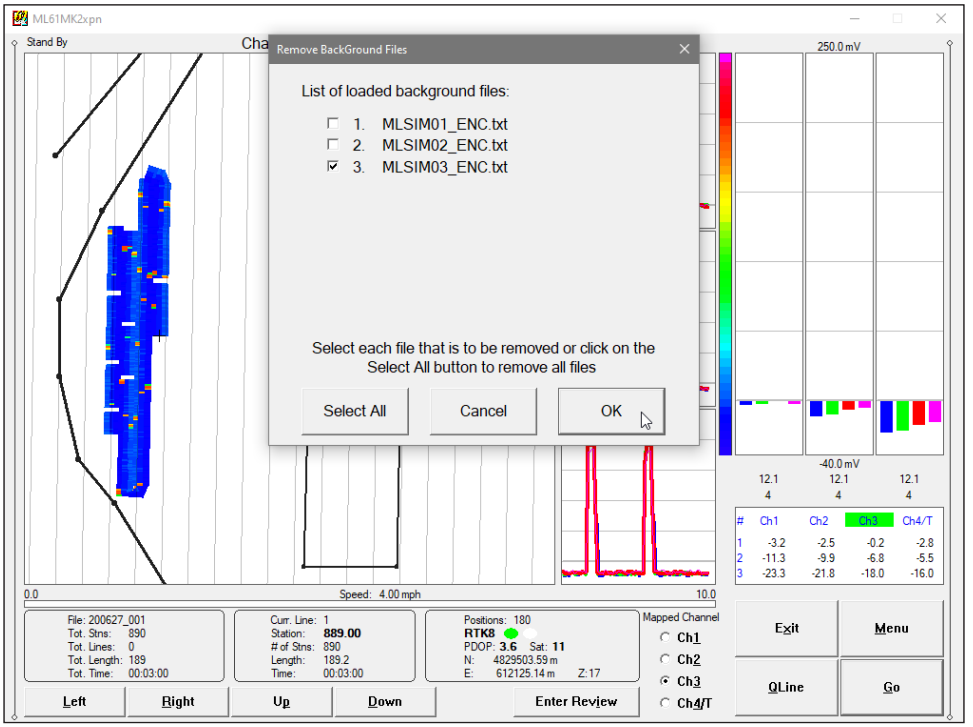

Figure 9.55: Remove Background Files dialog

clicked on or tapped the map will be re-drawn and checked files will be removed from the program map. Result is shown in Figure 8.56 where map does not contain outline located above main survey area.

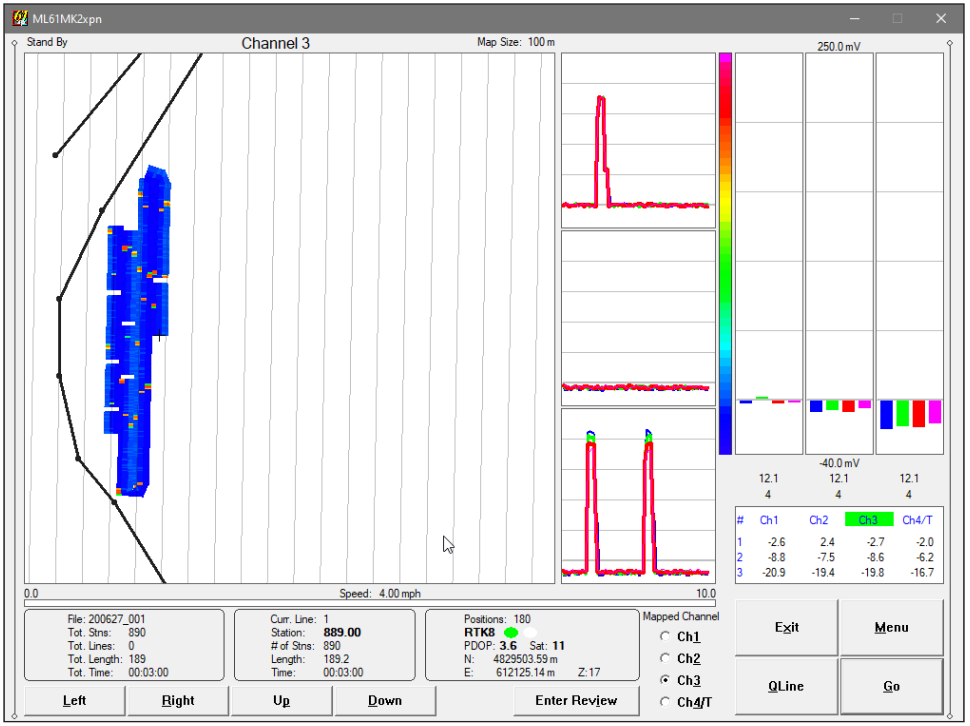

Figure 9.56: RTmap61MK2 map with one removed file, compare with Figure 8.55

Click on the Select All button and then OK button to remove all entered files at once.

Exit (exit data logging)

During data collection (in Stand By mode) a confirmation message dialog will be displayed (there is no such message if **Exit** is performed in Monitoring mode) before program exits logging window, Figure 9.57.

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

Map Panning and **Review**(five command along screen bottom)

Four command panning buttons are displayed below the map along the screen bottom Panning together with a button labeled **Enter Review** (Figure 9.58).

Four panning buttons **Left**, **Right**, **Up**, and **Down** are enabled and available at

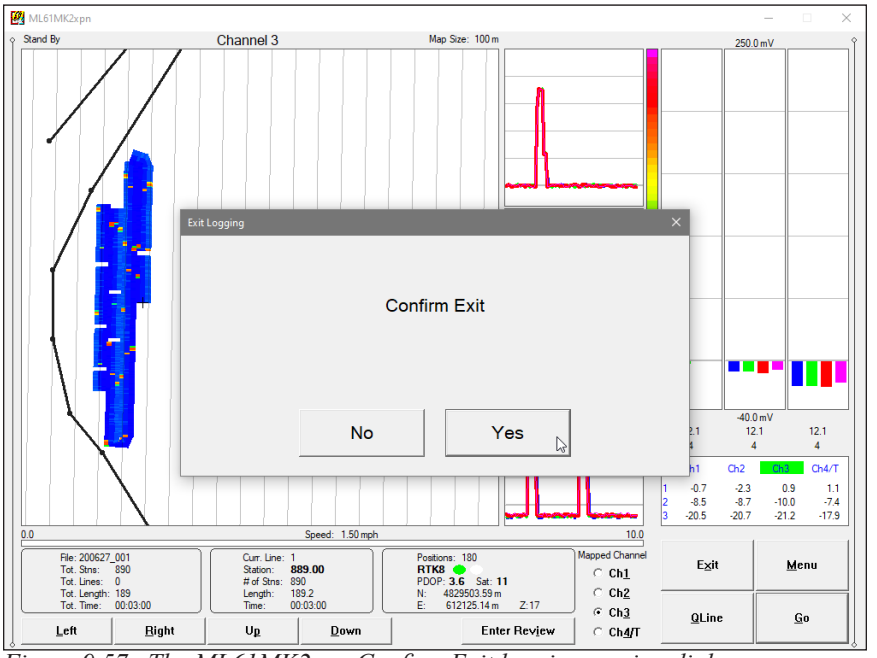

Figure 9.57: The ML61MK2xpn Confirm Exit logging session dialog

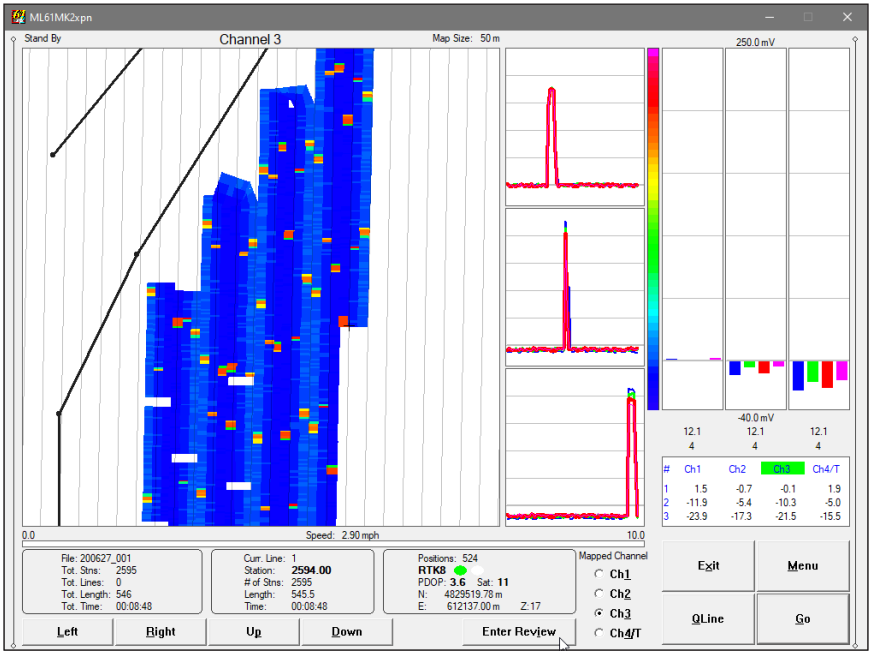

Figure 9.58: Panning and Enter Review buttons available in Stand By mode

any time in the Stand By mode, without executing Review mode. They can be used to shift colour image in any direction, as long as current position (cursor position) is located within the map.

Three remaining buttons **Zoom+**, **Zoom-**, and **FitAll** are replacing four command buttons in the right bottom corner of the screen as soon as the button **Enter Review** is clicked or tapped on. At this moment the displayed map is not updated (cursor indicating current position is disabled), and button **Enter Review** is replaced by the button **Exit Review** (Figure 9.59). When Review is active four buttons are used to pan the displayed map while the column of three Zoom buttons can be used to change size of the map.

Description of panning and scaling buttons is given below and various zooming and panning actions are shown in Figures 9.59. 9.60, and 9.61. Please compare Figures 9.58, 9.59, 9.60, and 9.61 that represent the same data set at various positions and scales.

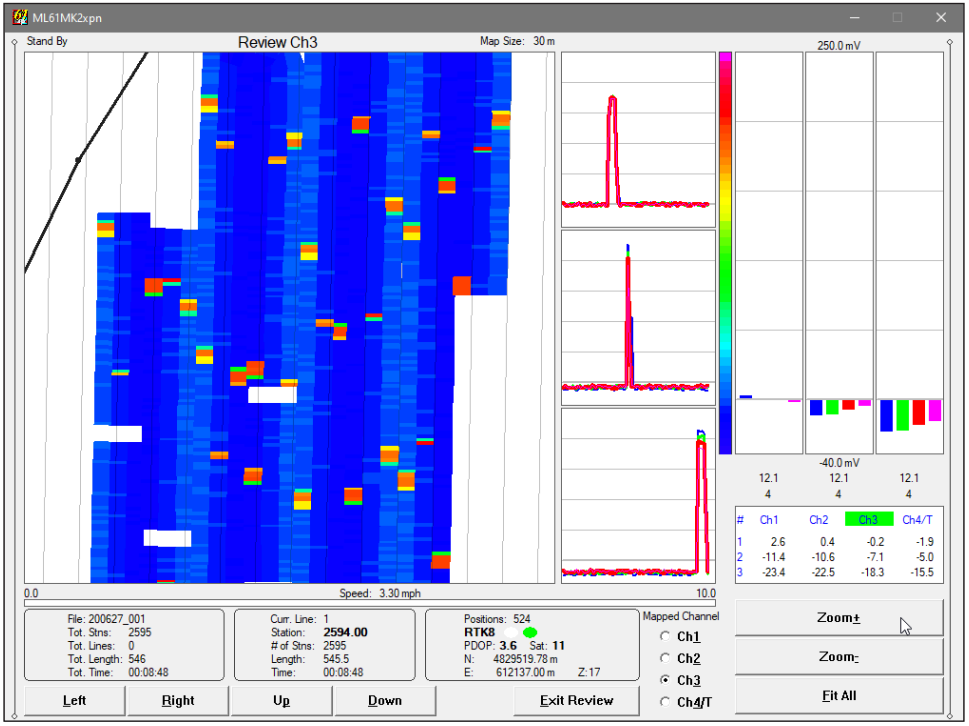

Figure 9.59: Panning and Zooming buttons available in Review mode

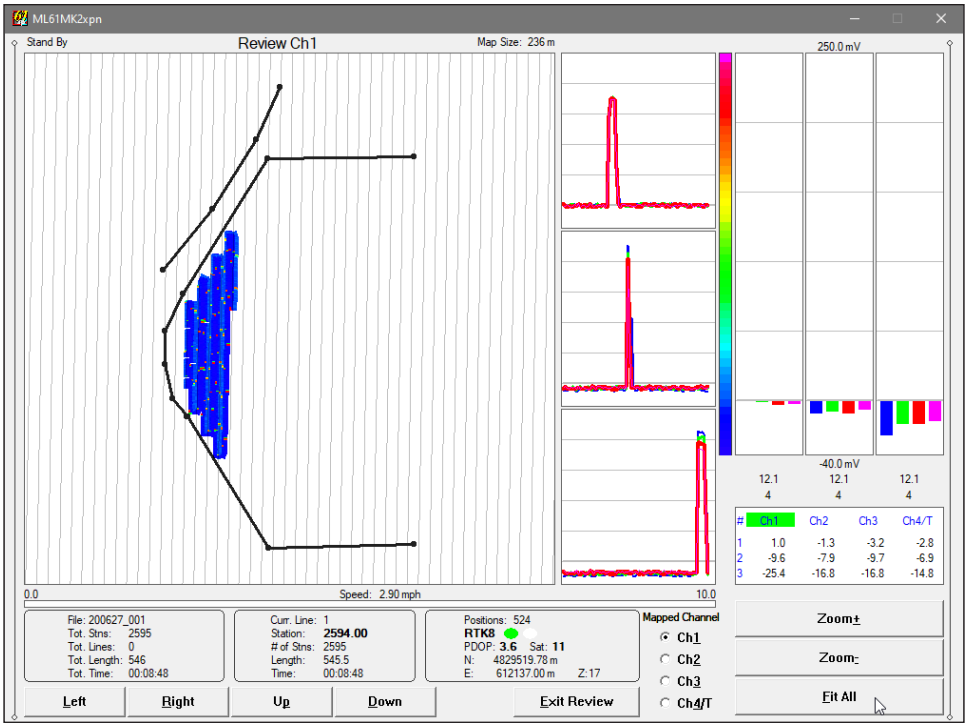

Figure 9.60: Executing the Fit All option in Review mode

Left, **Right, Up, Down** (panning functions)

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

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

These options can be used by clicking on corresponding command buttons or from keyboard by pressing keys **+** , **-**, or **F**. The step of zoom (percentage of the current map scale) is the same as a Band Cursor in Map Size dialog.

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

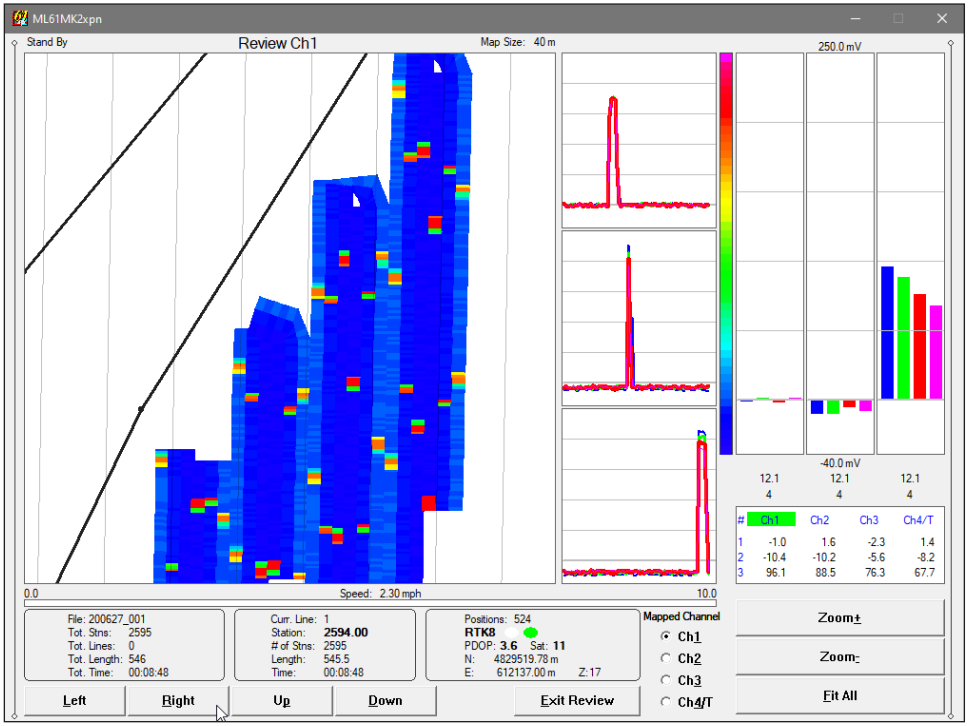

Figure 9.61: A map after multiple Zoom+ and Pan actions

9.6 No Connection Message

A message **No Connection** may appear during any ML61MK2xpn logging mode (Monitoring, Stand By, or Log modes). The message **No Connection** (Figure 9.58) is displayed in the numeric values window and replaces displayed values. The message is highlighted by red to alert operator.

This message indicates lack of communication between the indicated EM61-MK2 console and the field computer. In most cases the message **No Connection** is caused by disconnected connector in the instrument cable, turning the instrument OFF, or low battery in the EM61-MK2. The program tries to re-establish communication while the message is displayed. After correcting the source of a problem the program automatically connects to the EM61-MK2 and checks performance. This operation takes about 1 second. 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

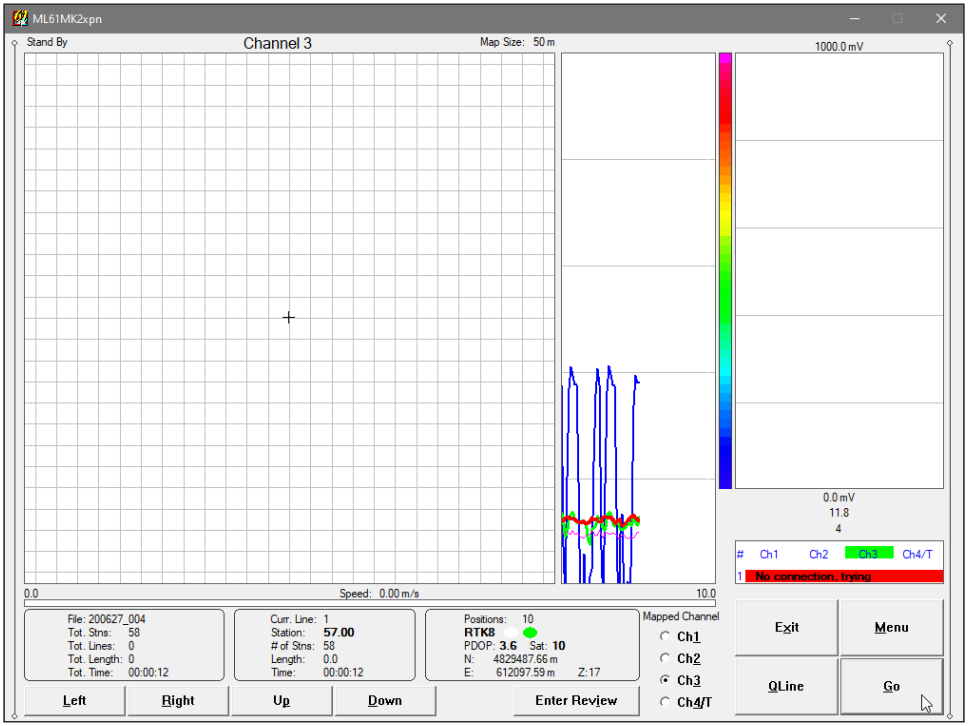

Figure 9.62: Message No Connection for the EM61-MK2 unit #1

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.

9.7 No Connection with GPS Receiver

The alert that indicates lack of communication between the GPS receiver and the field computer is shown as red highlight of all GPS parameters displayed in the ML61MK2xpn screen (Figure 9.63). 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 and checks performance. Then the program returns to normal operation.

When the source of the problem cannot be corrected please return program to Stand By mode (if in Log mode) and then use the **Exit** button (few clicks on the button may

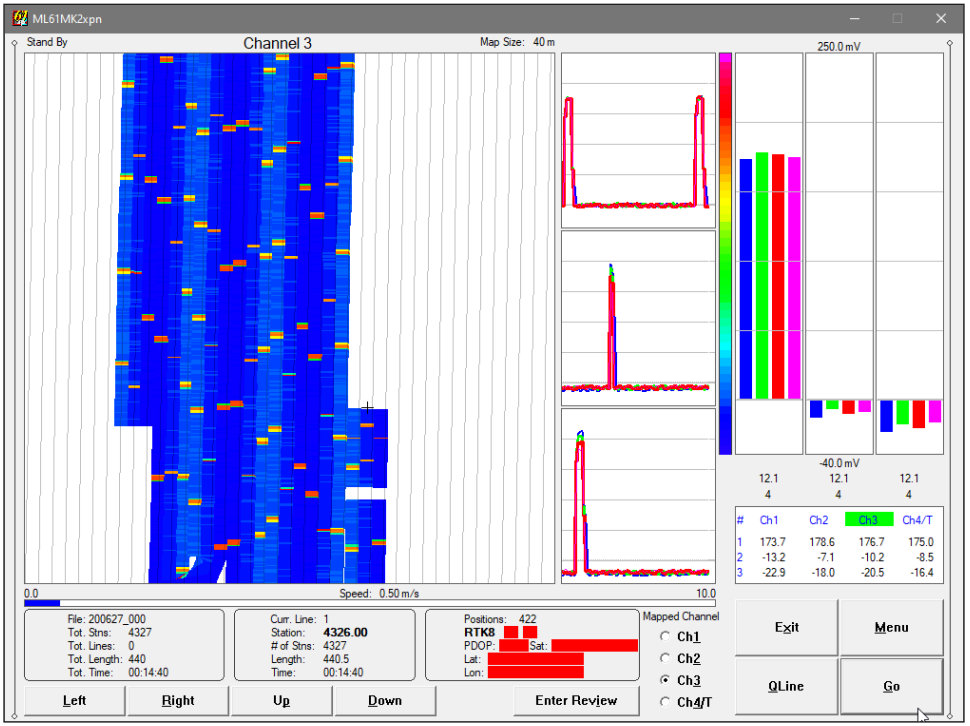

Figure 9.63: The ML61MK2xpn screen indicating lack of connection with GPS receiver

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.

ML61MK2xpn Data File

A

A.1 Description of ML61MK2xpn Data File Format (N61)

Each record created by the ML61MK2xpn program for MS Windows 10/7 contains 27 characters, including line feed at the end of each record.

Header of the file contains 8 records starting with characters R, H, six records starting with G, and then records starting with O. Number of records starting with O is four times larger than number of EM61-MK2 consoles employed in the array.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
M	L	6	1	M	K	2	H	W	2	0	0	Survey Type			UT	IT	IM	ST	IS	AU	EL	RQ			DM	10
H				File Name								Time Inc. (F7.3)							TG								10
G	GPS X Offset (F7.3)							GPS Y Offset (F7.3)							NC	MN	GP	TC	CO	NG	RI						10
G	not used							not used																			10
G	Row#2 - X (F7.3)							Row#2 - Y (F7.3)																			10
G	Separation Row#1 (F7.3)							Separation Row#2 (F7.3)																			10
G	UTM E (F14.3)														ZN												10
G	UTM N (F14.3)																										10
O	Offset for Channel 1 (F9.2)																								SN		10
O	Offset for Channel 2 (F9.2)																								SN		10
O	Offset for Channel 3 (F9.2)																								SN		10
O	Offset for Channel 4 (F9.2)																								SN		10
O	Offset for Channel 1 (F9.2)																								SN		10
O	and similar for remaining units																								SN		10

ML61MK2	-	identification of program file and EM61MK2xpn
H	-	instrument type " " (space) - Standard H - High Power s - Standard N.C.C h - High Power N.C.C A - Standard A.C.C a - High Power A.C.C
W103	-	version number (V1.03)
Survey Type	-	GPS (if GPS Input Enabled) or GRD (grid)
UT	-	unit type (0 = meters, 1 = ft, 2 = US Survey ft)
IT	-	sensor size (0 = 1 x 0.5 m, 1 = 0.5 x 1 m, 2 = 1.0 x 1.0 m, 3 = 0.5 x 0.5 m, 4 = HH)
IM	-	instrument type (see above parameter H)
ST	-	number of rows in array (1 or 2)
IS	-	number of sensors in a row #1 (1 to 8)
AU	-	array units (0=m, 1=cm, 2=feet, 3=inch)
EL	-	number of console with TX current (for A.C.C. only)
RQ	-	console processor type (space -Request, 1 - streaming)
DM	-	demo indicator (space - standard, 1 - demo mode)
File Name	-	file name, maximum 8 characters
Time Inc.	-	time increment in seconds
TG	-	File tag (space=original, 1=Saved As / edited)
GPS X Offset	-	Offset of GPS antenna in X direction
GPS Y Offset	-	Offset of GPS antenna in Y direction
NC	-	total number of sensors in the array (1 to 9)
MN	-	leading unit (1 to 9)
GP	-	type of GPS NMEA message (0 = GGA/GSA, 1= GGA, 2 = POS, 3 = LLK, 4=LLQ, 5=GLL, 6 = GGK, 7 = pseudo GGA, A = pseudo GLL, 9=Trimble RTS)
TC	-	(not used)
CO	-	RTS units (for GP=7: 0 - as in GGA, 1-USfeet; for GP=9: 0-m, 1-ft, 2-USfeet)
NG	-	number of GPS receivers (not used in this version)
RI	-	console processor type (the same as RQ above)
Row#2 - X	-	offset for Row#2 in X direction
Row#2 - Y	-	offset for Row#2 in Y direction
Separation Row#1	-	separation between sensors in row #1
Separation Row#2	-	separation between sensors in row #2
UTM E	-	first position UTM Easting m (used only internally)
ZN	-	first UTM Zone (used only internally)
UTM N	-	first position UTM Northing m (used only internally)
EM61-MK2 Offset	-	nulling factor for a specified channel, number of corresponding sensor is given by number SN
SN	-	sensor number corresponding to nulling value
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
L	Line Name - 8 characters																									10
B	Start Station (Format F11.2)																									10
A	Dir								Increment (Format F11.3)																	10
Z	D	D	M	M	Y	Y	Y	Y		H	H	:	M	M	:	S	S	.	h	h						10

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

Timer Reset

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

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

Reading

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

I - indicator of reading start, one ASCII character. Number of the ASCII character represents the EM61-MK2 number in array, type of reading (Standard or Hand Held and Instrument Mode 4 or D), and presence of fiducial marker (in Auto and Wheel modes).

84	-	Standard,	Mode 4,	channels 1, 2, 3, 4
68	-	Standard,	Mode D,	channels 1, 2, 3, T
69	-	Hand Held,	Mode 4,	channels 1, 2, 3, 4

70	-	Hand Held,	Mode D,	channels 1, 2, 3, T	
77	-	Standard,	Mode 4,	channels 1, 2, 3, 4	Marker
78	-	Standard,	Mode D,	channels 1, 2, 3, T	Marker
80	-	Hand Held,	Mode 4,	channels 1, 2, 3, 4	Marker
81	-	Hand Held,	Mode D,	channels 1, 2, 3, T	Marker

Above ASCII numbers are valid for EM61-MK2 #1. Following constants are added to each of these numbers to indicate other instruments in the array:

EM61-MK2 #1	**0**
EM61-MK2 #2	**+32**
EM61-MK2 #3	**+128**
EM61-MK2 #4	**+160**
EM61-MK2 #5	**-64**
EM61-MK2 #6	**+67**
EM61-MK2 #7	**+84**
EM61-MK2 #8	**+101**
EM61-MK2 #9	**-24**

Gn - one character parameter (Hex format), contains Gain, see table of ranges at the end of this section.

1h - higher byte of the 2's complement Hex number of Channel 1
1l - lower byte of Channel 1

2h - higher byte of the 2's complement Hex number of Channel 2
2l - lower byte of Channel 2

3h - higher byte of the 2's complement Hex number of Channel 3
3l - lower byte of Channel 3

4h - higher byte of the 2's complement Hex number of Channel 4
4l - lower byte of Channel 4

5h - higher byte of the 2's complement Hex number of TX averaged current
5l - lower byte of TX averaged current

6 - fraction of averaged current (5h 5l), Hex number

7h - higher byte of the 2's complement Hex number of TX current (original)
7l - lower byte of TX current (original)

8 - instrument battery voltage, Hex number - not used in this version

Time - time stamp of the reading in milliseconds, this is time elapsed from the start (creation) of the current data. The time in milliseconds can be linked with the computer local time by using Times in lines B and Z of Line Header.

10 - Line Feed character

Nulling

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
O	Offset for Channel 1 (F9.2)										Previous Offset Channel 1 (F9.2)														SN	10
O	Offset for Channel 2 (F9.2)										Previous Offset Channel 2 (F9.2)														SN	10
O	Offset for Channel 3 (F9.2)										Previous Offset Channel 3 (F9.2)														SN	10
O	Offset for Channel 4/T (F9.2)										Previous Offset Channel 4 (F9.2)														SN	10

Nulling can be performed anytime during survey, it is always written in two lines. Number SN indicates EM61-MK2 unit corresponding to the value. Nulling sequence also follows each Line Header. This sequence of 4 lines is repeated for each EM61-MK2 unit in the array.

Offset for Channel x - nulling value for channel corresponding to SN number
SN - instrument number corresponding to nulling value (=1 EM61-MK2 #1, =2 EM61-MK2 #2, etc.)
10 - Line Feed character

Comment

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

New Station

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

Internal Readings

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

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

Records starting with X
Several informative records, for example X$STARTED indicates start of Logging mode, X$PAUSED indicates Pause (activated by Pause key stroke), not used NMEA, etc.

GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 25 characters strings and placed in the ML61MK2xpn 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 ML61MK2xpn format is given below.

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

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

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

Table of Ranges Determined by the EM61MK2xpn Microprocessor

HEX	ChL	ChR
0	1	1
1	1	10
3	1	100
4	10	1
5	10	10
7	10	100
C	100	1
D	100	10
F	100	100
10	1	1
11	1	10
13	1	100
14	10	1
15	10	10
17	10	100
1C	100	1
1D	100	10
1F	100	100
30	1	1
31	1	10
33	1	100
34	10	1
35	10	10
37	10	100
3C	100	1
3D	100	10
3F	100	100

HEX	ChL	ChR
40	1	1
41	1	10
43	1	100
44	10	1
45	10	10
47	10	100
4C	100	1
4D	100	10
4F	100	100
50	1	1
51	1	10
53	1	100
54	10	1
55	10	10
57	10	100
5C	100	1
5D	100	10
5F	100	100
70	1	1
71	1	10
73	1	100
74	10	1
75	10	10
77	10	100
7C	100	1
7D	100	10
7F	100	100

HEX	ChL	ChR
C0	1	1
C1	1	10
C3	1	100
C4	10	1
C5	10	10
C7	10	100
CC	100	1
CD	100	10
CF	100	100
D0	1	1
D1	1	10
D3	1	100
D4	10	1
D5	10	10
D7	10	100
DC	100	1
DD	100	10
DF	100	100
F0	1	1
F1	1	10
F3	1	100
F4	10	1
F5	10	10
F7	10	100
FC	100	1
FD	100	10
FF	100	100

A.2 Conversion Factors

EM61-MK2 has four channels. Channels 1, 2, and 3 are common for Mode 4 and Mode D. Channel 4 in Mode D is named Channel T (it corresponds to Top coil).
The instrument response is converted to output voltage in mV for each sampling channel as given below.

Channel 1 to 4 - converted data
DATA1 (to 4) - instrument output for each channel as recorded in the data file
RANGE - range is controlled by the EM61-MK2, it can be 1, 10, 100

Standard Unit - Mode 4 (One Sensor 1 x 0.5 m or 1 x 1 m)

Channel 1=(DATA1 x 4.8333 x 2)/RANGE
Channel 2=(DATA2 x 4.8333 x 2)/RANGE
Channel 3=(DATA3 x 4.8333 x 2)/RANGE
Channel 4=(DATA4 x 4.8333 x 2)/RANGE

Standard Unit - Mode D (Two Sensors 1 x 0.5 m or 1 x 1 m, Top and Bottom coils)

Channel 1=(DATA1 x 4.8333 x 2)/RANGE
Channel 2=(DATA2 x 4.8333 x 2)/RANGE
Channel 3=(DATA3 x 4.8333 x 2)/RANGE
Channel T=(DATA4 x 4.8333 x 4)/RANGE
if coil is 1 x 0.5 m Channel T is further multiplied by a factor 1.114.

Hand Held Unit - Mode 4 (One Sensor)

Channel 1 = 0.902500 x (DATA1 x 4.8333)/RANGE
Channel 2 = 1.363000 x (DATA2 x 4.8333)/RANGE
Channel 3 = 2.026795 x (DATA3 x 4.8333)/RANGE
Channel 4 = 3.018856 x (DATA4 x 4.8333)/RANGE

Hand Held Unit - Mode D (Two Sensors, Top and Bottom coils)

Channel 1 = 0.9025 x (DATA1 x 4.8333)/RANGE
Channel 2 = 1.3630 x (DATA2 x 4.8333)/RANGE
Channel 3 = 2.0430 x (DATA3 x 4.8333)/RANGE
Channel T = 12.152 x (DATA4 x 4.8333)/RANGE

High Power Unit - Mode 4 and **Mode D** (One Sensor 1 x 0.5 m or 1 x 1 m)

Channel 1=(DATA1 x 4.8333 x 1.71644)/RANGE
Channel 2=(DATA2 x 4.8333 x 2.5398)/RANGE
Channel 3=(DATA3 x 4.8333 x 3.735)/RANGE
Channel 4=(DATA4 x 4.8333 x 6.0756)/RANGE
if coil is 1 x 0.5 m Channel T is further multiplied by a factor 1.114.

Further (with the exception of N.C.C. instrument type) each channel is normalized by current following formula:

Standard Unit Channel = Channel x 3000/Current
Hand Held Unit Channel = Channel x 1800/Current
High Power Unit if current is larger than 1350 (program units)
Channel = Channel x 1840/Current
otherwise
Channel = Channel x 920/Current
where, current is a value represented by **5h**, **5l**, and **6** in reading record of ML61MK2xpn data file (see section A.1)

A.3 Example of ML61MK2xpn Data File

The ML61MK2xpn data file records are written in binary format, therefore characters may have a different shape when displayed or printed, depending on particular video or printer settings.

```
ML61MK2 W200GPS000130 1
H 180123 00  0.200
G  1.700  1.000310  11
G
G  1.000  0.700
G  0.200  1.000
G    612115.936 17
G   4829484.452
O     0.00                1
O     0.00                1
O     0.00                1
O     0.00                1
O     0.00                2
O     0.00                2
O     0.00                2
O     0.00                2
O     0.00                3
O     0.00                3
O     0.00                3
O     0.00                3
L1
B       0.00
AS             1.000
Z23012018 15:30:12
O     0.00       0.00     1
O     0.00       0.00     1
O     0.00       0.00     1
O     0.00       0.00     1
O     0.00       0.00     2
O     0.00       0.00     2
O     0.00       0.00     2
O     0.00       0.00     2
O     0.00       0.00     3
O     0.00       0.00     3
O     0.00       0.00     3
O     0.00       0.00     3
*15:30:12.086      20587623
X$STARTED          20759801
Ôÿ(F%Ô"  U10 10Q  20759942
Tÿ2F-Ô( #U10 10Q  20759942
tÿ-F*Ô' $U10 10Q  20759942
tÿ--*µ' $I10 10Q  20760145
Oÿ(-%µ"  I10 10Q  20760145
Tÿ2--µ( #I10 10Q  20760145
@$GPGGA,173524,4336.5967,N
#,07936.6403,W,8,11,2.0,14
#2.5,M,-35.4,M,,*70
!           Ô    20760160
{0        0.000  20760160
tÿ-«*'û$ 10 10Q  20760347
Oÿ(«%"û  10 10Q  20760347
Tÿ2«-(û# 10 10Q  20760347
Oÿ( %µ"N .10 10Q  20760550
Tÿ2 -µ(N#.10 10Q  20760550
tÿ- *µ'N$.10 10Q  20760550
Oÿ(&%î"U v10 10Q  20760753
Tÿ2&-î(U#v10 10Q  20760753
tÿ-&*î'U$v10 10Q  20760753
Oÿ(î%¢"U þ10 10Q  20760956
Tÿ2î-¢(U#þ10 10Q  20760956
```

```
tÿ-î*¢'Ü$þ10_10Q  20760956
Ïÿ2q-d(_#_10¯10Q  20761159
Oÿ(q%d"¯_¯10¯10Q  20761159
tÿ-q*d'¯_$_10¯10Q  20761159
@$GPGGA,173524,4336.5994,N
#,07936.6403,W,8,11,2.0,14
#2.5,M,-35.4,M,,*70
!              0'  20761174
{a    612114.169  20761174
{b   4829488.426  20761174
{c    612117.568  20761174
{d   4829488.483  20761174
Ïÿ2º-Ï(_#ç10_10Q  20761361
Oÿ(º%Ï"¯_ç10¯10Q  20761361
tÿ-º*Ï'¯_$ç10¯10Q  20761361
Ïÿ2□-"()#ê10¯10Q  20761564
Oÿ(□%")_ê10¯10Q  20761564
tÿ-□*"')$ê10¯10Q  20761564
Ïÿ2…-_(p#³10¯10Q  20761767
Oÿ(…%_"p_³10¯10Q  20761767
tÿ-…*_'p$³10¯10Q  20761767
Ïÿ2Ù-‹(˜# 10¯10Q  20761970
Oÿ(Ù%‹"˜_ 10¯10Q  20761970
tÿ-Ù*‹'˜$ 10_10Q  20761970
.........................
```

A.4 Background File Format

The ML61MK2xpn 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
```

ML61MK2xpn and GPS Input B

B.1 Using the ML61MK2xpn with a GPS System

The ML61MK2xpn 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 ML61MK2xpn provides also interface to Leica Robotics Total Station TPS1100 and TPS1200 for areas were GPS signal is not accessible. To use Leica Robotics device select option "Leica TPS" in NMEA Data of the GPS Port Setup menu. The program writes entire message (that was selected in GPS Input menu) to the ML61MK2xpn data file. If the pair GGA/GSA is selected, both GGA and GSA messages are written to the ML61MK2xpn 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 ML61MK2xpn.

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 ML61MK2xpn.** The program will accept any GPS string sent by the GPS receiver, however it uses time to process GPS data that is not being used. Therefore, selecting a larger number of NMEA messages for GPS output will result in slower data acquisition of data. Normally, the ML61MK2xpn uses less than 100 ms to process and record GPS data from the two NMEA messages, GGA and GSA.

If the particular GPS receiver is capable of sending data more than once a second, limit its output frequency to a maximum 1 Hz. At higher frequency of GPS data the program will be occupied by GPS activity and may not record all required EM61-MK2 data. The ML61MK2xpn can record all EM61-MK2 readings and one GPS position per second, number may be lower depending on number of GPS statements and type of computer employed. Data processing program Multi61MK2xpn will interpolate EM61MK2xpn stations between GPS positions.

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

If the pair GGA/GSA is selected, only message GGA is necessary to position EM61-MK2 data. If message GSA is not available in a particular system, the ML61MK2xpn 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 ML61MK2xpn displays several parameters related to GPS status. A label **DGPS** (Differential Global Positioning System) in the program indicates that GPS readings are differentially corrected in real time. Label **AGPS** (Autonomous Global Positioning System) in ML61MK2xpn logging screen indicates lack of differential correction. There are three more labels **RTK3**, **RTK4**, and **RTK5** (RTK - Real Time Kinematic) and they correspond to GPS Quality Indicator 3, 4, and 5. Correction AGPS corresponds to Quality Indicator 1, and DGPS represents Quality Indicator 2. Corrections described by RTK1 to RTK5 (and higher) correspond to Quality Indicator 3, 4, and 5 (they have often different names for different brands of GPS receivers). See next section B.2 and GPS receiver documentation for detailed description and availability of this parameter.

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

Two more GPS parameters are displayed. These are index PDOP shown by label **P** (or **PDOP**) and number of tracked satellites represented by label **S**. The index called PDOP (Position Dilution of Precision) measures the strength of satellite coverage for a given area. PDOP is affected by the number of satellites visible and their relative positions in the sky. The smaller the number of PDOP the stronger the satellite coverage is. When there are more than 5 satellites widely spaced visible, the PDOP is 4 or less. However, when there are less satellites visible, or they are unevenly spaced in the sky, PDOP values can be 6 or higher. In most cases, the PDOP in open sky is less than 3, and most accuracies given for many GPS systems are given for this norm. The index called HDOP is related only to horizontal position fix. It is used when message GGA was selected. If a message GGL was selected the index PDOP nor HDOP are not available.

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

B.2 Description of Selected NMEA Data Messages

GGA Data Message

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

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

Definition of GGA message component:

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

GSA Data Message

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

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

Definition of GSA message components:

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

POS Data Message

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

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

Definition of POS message components:

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

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

LLK Data Message

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

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

Definition of LLK message components:

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

LLQ Data Message

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

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

Definition of LLK message components:

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

GLL Data Message

The GLL message takes the following form:

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

Definition of GLL message component:

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

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

GGK Data Message

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

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

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

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

Definition of GGK message component:

hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
ddmmyy	Date
ddmm.mmmmmmmm	Latitude in degrees, minutes, and decimal minutes
s	s=N or s=S, for North and South latitude
dddmm.mmmmmmm	Longitude in degrees, minutes, and decimal minutes
s	s=E or s=W, for East and West longitude
n	GPS Quality indicator, 0 = fix not valid or not available, 1 = Autonomous GPS fix, no differentially corrected position, 2 = differential, floating carrier phase integer based solution (FLOAT), 3 = differential, fixed carrier phase integer-based solution (FIXED), 4 = differential, code phase only solution (DGPS)
qq	Number of satellites used in fix
p.p	DOP of fix

EHT-aa.aaa	Ellipsoidal height of fix
M	unit of measure for ellipsoidal height in meters
***cc**	Checksum
<CR><LF>	Carriage return and Line feed

B.3 Configuring Trimble GPS Pathfinder ProXRS System

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

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

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