

**OPERATING INSTRUCTIONS**  
**EM61LX2 DATA LOGGING SYSTEM**  
**FOR FIELD COMPUTER MESA2 (MS Windows 10)**

# **EM61LX2**

Version 1.13

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## **Geonics Limited**

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# Table of Contents

1.	Introduction .....	1
1.1	Program Requirements .....	2
1.2	Installing EM61LX2 .....	2
1.3	Data Files Transfer .....	2
1.4	Running EM61LX2 Program .....	2
1.5	Main Menu .....	3
	Short description of Main Screen options .....	3
2.	Survey Setup .....	7
3.	Logger Setup.....	11
3.1	Description of Parameters.....	12
4.	Set Port for GPS.....	19
4.1	GPS Port Setup.....	19
4.2	Monitoring GPS Receiver Output .....	21
5.	Display Options .....	25
6.	Logging Data .....	29
6.1	Monitoring Mode .....	29
	Description of Monitoring Mode options.....	34
6.2	Stand By Mode.....	42
6.3	Logging Mode.....	44
6.4	Stand By Mode Field Options .....	45
6.5	Logging Screen Layout in the Portrait Display Orientation .....	52
Appendix A	.....	55
A.1	Description of Data File in EM61LX2 (L61) Format.....	55
A.2	Conversion Factors.....	58
A.3	Example of File in EM61LX2 Format .....	60



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# 1. Introduction

The Geonics EM61LX2 Data Logging System (DAS70-M2) consists of a field computer Mesa2 with MS Windows 10 operating system, data logging program EM61LX2, and wireless Bluetooth connection or associated cable to connect the Mesa2 computer to the Geonics EM61-LX2 instrument.

The program is prepared for the MS Windows 10 tablet Mesa2 (manufactured by Juniper Systems) operated in the landscape as well as in portrait display mode (landscape mode is used in this manual mainly). However the program can be used in other Windows 10( or 7) based field computers with vertical and horizontal oriented displays. The minimum supported display resolution is 800 x 600 pixels. In case high resolution display is employed, it is advised to set fonts to 125% or 150% to increase legibility of the screen. The maximum size of program main windows is 1024 x 762 pixels.

The EM61LX2 program acquires and records survey data from the EM61-LX2 system, under the control of the operator. It also records various field information such as survey line number (line name), starting station, increment, comments, etc. Data is displayed in graphic and text mode. Readings are displayed in real time in mV. In addition, the program allows you to monitor the instrument output while data is not recorded. Readings can be automatically recorded or displayed in Monitoring mode at user specified time intervals. The EM61LX2 program continuously monitors the condition of the instrument battery, without leaving the program. The EM61LX2 also provides the possibility of automatic nulling of the instrument output as well as calibrate Filter Channel factors at any time during the survey.

The program provides dual graphic display - modulated colour ribbon graphs and profiles. It can also display measured channels Early (ChE) and Late (ChL), or Filtered (ChF) for each sensor. Displayed set of channels (E and L, or F) can be toggled at any time during Monitoring instrument data. Furthermore, for two sensors channels are named for the left sensor: ChLE (Left-Early), ChLL (Left-Late), and similarly for the right sensor: ChRE (Right-Early) and ChRL (Right-Late). It is always assumed that the left sensor is on the left (and the right one on right) of center point while facing direction of a system movement. If one sensor is employed in the instrument then labeling for Left sensor applies. In case of GPS based positioning it is the only method to determine proper location of each coil.

The EM61LX2 will accept NMEA-0183 compatible data from the Mesa2 built in GPS receiver or external GPS directly connected to the field computer. GPS data which are embedded in the EM61LX2 data file can be processed later in the Geonics DAT61LX2 program. The connected GPS must be able to stream NMEA-0183 compatible messages. The EM61LX2 uses two NMEA messages GGA and GSA. While message GGA is mandatory, the GSA string is used only to provide information related to the GPS signal quality during data collection.

The EM61LX2 program records data together with a time stamp at each station. Data files created with this program can be used to position a survey according to locations recorded separately by a Global Positioning System (GPS). Survey setup parameters are saved in a configuration file, therefore they can be automatically used during subsequent data collection sessions.

Data files are saved to the user selected data directory. Data file names, which can be set by the program based on the computer clock or user specified, have extension names L61. Files can be converted to LX2 format and viewed in DAT61LX2 program. Number of readings in a data file is limited only by the hard drive capacity, however it is strongly recommended to avoid huge data files (i.e one to two hours long data files are adequate). The maximum speed of data collection is approximately 18 readings per second assuming 5 Hz (or less) GPS input.

## 1.1 Program Requirements

To successfully use this software, you will need :

### Computer

- Mesa2/Mesa3 field computer (or similar) operating under Windows 10,
- minimum 4 Gb of RAM memory,
- USB port or other mean to transfer files,
- minimum 800 x 600 pixel display resolution,
- serial Ports:
  - one serial port for instrument plus one serial port if directly connected GPS receiver is to be used (USB to multiple RS-232 ports adapters can be used) or available Bluetooth connection.

### Geonics EM61-LX2

The EM61-LX2 instrument with associated cables (or Bluetooth option).

The EM61LX2 program may be stored on DAT61LX2 CD disk, USB memory stick, or it is available for download from the Geonics web site. All necessary configuration files (with extension names .INI) are created in your field computer after the program is run for the first time.

## 1.2 Installing EM61LX2

The program consists of a standalone file EM61LX2.exe, no DDLs nor other libraries are required to run this program.

If the program file is included separately on the DAT61LX2 CD disk, or downloaded from the web site it can be installed by copying the SetupEM61LX2.exe file and executing standard installation procedure.

After you run the program for the first time it will create permanent configuration file (.INI) which contains all needed program settings. If the above file does not exist on the default drive it will be created with default parameters during the first execution of the program.

The EM61LX2 data files contain extension name L61 and their base names should be limited to 8 characters.

## 1.3 Data Files

Data files are saved in the field computer with extension L61. Data files with extension L61 are binary raw data files. These files have to be converted to DAT61LX2 format with extension LX2 (option "Convert Files" in DAT61LX2). Then they can be loaded and processed in the DAT61LX2 program.

## 1.4 Running EM61LX2 Program

Start EM61LX2win by double clicking the EM61LX2 icon in the Start|Programs menu, in Windows Explorer, or on the desktop if a shortcut was created. At the start, EM61LX2 displays the following screen.

The EM61LX2 is a command button and dialog driven program. Command buttons can be executed by tapping (if touch screen is used) or 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, 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. This section is updated in real time as soon as the program parameters are changed in dialogs.

## 1.5 Main Screen

The Main Screen always appears after the program is started. It contains the name of the program, its version number, and a list of buttons representing the available options. The EM61LX2 Main Screen for a computer sporting landscape display orientation is shown below while the same screen for the computer with portrait display mode is shown in Figure on the next page.



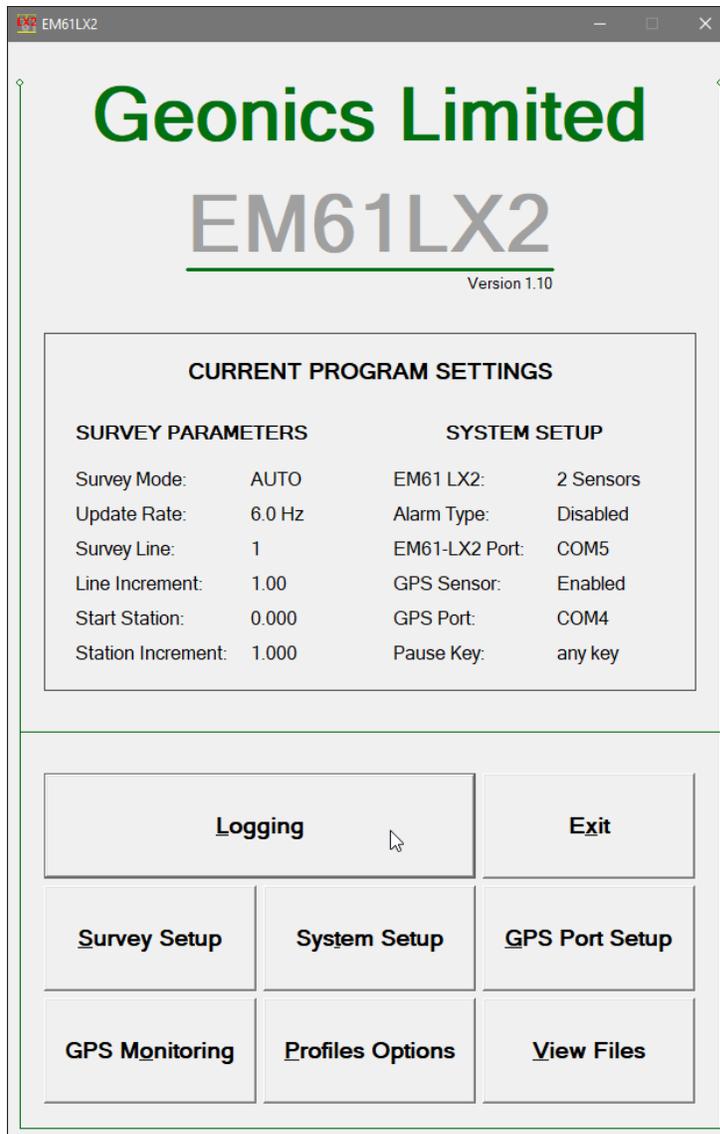
These options are selected by using tapping buttons, or from keyboard using TAB/ENTER or shortcuts indicated by underline label characters. In case of Main Screen buttons the **Down** and **Up** arrow keys and **<ENTER>** can be used as well.

Short description for each of the options follows.

### Short description of Main Screen options

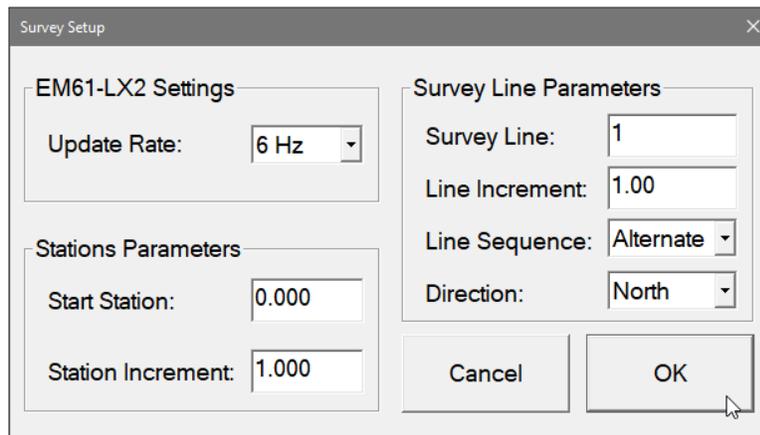
#### Monitor/Log

This option allows to monitor and log the EM61-LX2 output. Monitor/Log screen starts always in Monitor mode, and then after a data file is created Logging mode is available. Monitor mode provides several options: the instrument Offset Nulling, performing Filter Calibration, monitoring EM61-LX2 battery level, etc.



### Survey Setup

The Survey Setup dialog will be displayed. The EM61-LX2 update rate, and all survey settings (survey line name, increments, etc.) can be specified in this dialog.



## System Setup

Dialog window that is associated with this option is used to set number of sensors, filter values, serial ports numbers, specify type and parameters for Alarms.

The System Setup dialog box is divided into several sections:

- EM61-LX2 Setup:** EM61-LX2 Type: Standard, No of Sensors: 2 Sensors, Filter Factor Left: 310.0, Filter Factor Right: 310.0, Battery Warning: 10.50 [V].
- Alarms Setup:** Alarm: Disabled, Sound: Voice Indicatic.
- Simple Alarm:** Alarm Level: 100.0 mV.
- Enhanced Alarm Parameters:** Minimum: 50.0 mV, Maximum: 1000.0 mV, Med. Width: 3 Samples, Down: 1 Sample.
- Program Settings:** Metronome: Yes, Display Units: meters, Pause Key: any non arrow/numeric key, Soft Marker Key: any arrow or numeric key, Disable Pause Button:  for Touch Screen/Mouse.
- Serial Ports:** EM61-LX2: COM5, GPS Receiver: COM4.

Buttons: Cancel, OK.

## Set GPS Port

The GPS Port Setup dialog allows to disable and enable GPS data acquisition. This option is also used to set the serial port number used for GPS input and to specify necessary serial port communication settings. This dialog has also option for specifying GPS antenna offsets. GPS monitoring window can be accessed from this dialog as well.

The GPS Port Setup dialog box contains the following settings:

- GPS Receiver Parameters:** GPS Input: Disabled, Serial Port: COM4, Baud Rate: 9600, Parity: No, Data Bits: 8, Stop Bits: 1.
- GPS Antenna Offsets:** X Offset: 1.00 meters, Y Offset: 0.00 meters.

Note: Reference point 0,0 in the centre of sensors (or sensor).

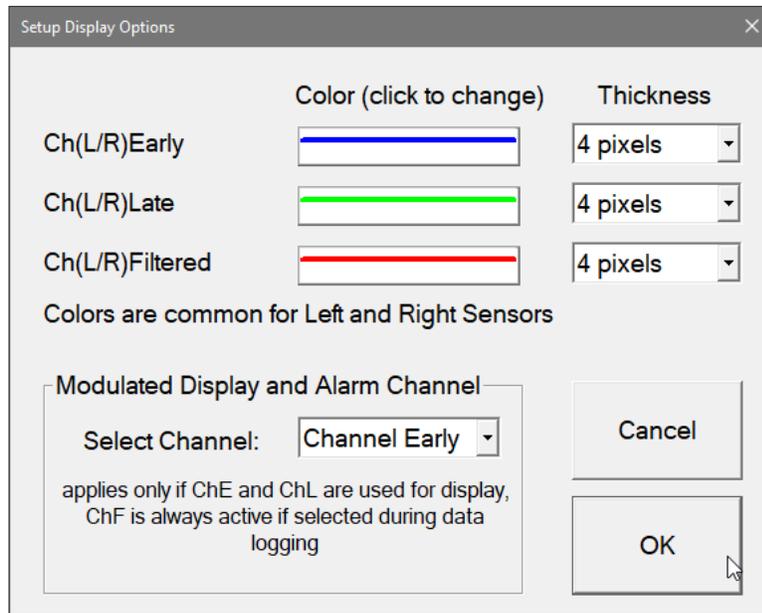
Buttons: Cancel, OK.

## GPS Monitoring

The program enters terminal mode and displays input from GPS. This function is very convenient to test communication with GPS receiver and examine GPS stream type..

## Display Options

The dialog which will allow you to specify colour and thickness of profile lines will appear. This dialog provides also choice of linear or compressed amplitude used for profile display.



**View Files**

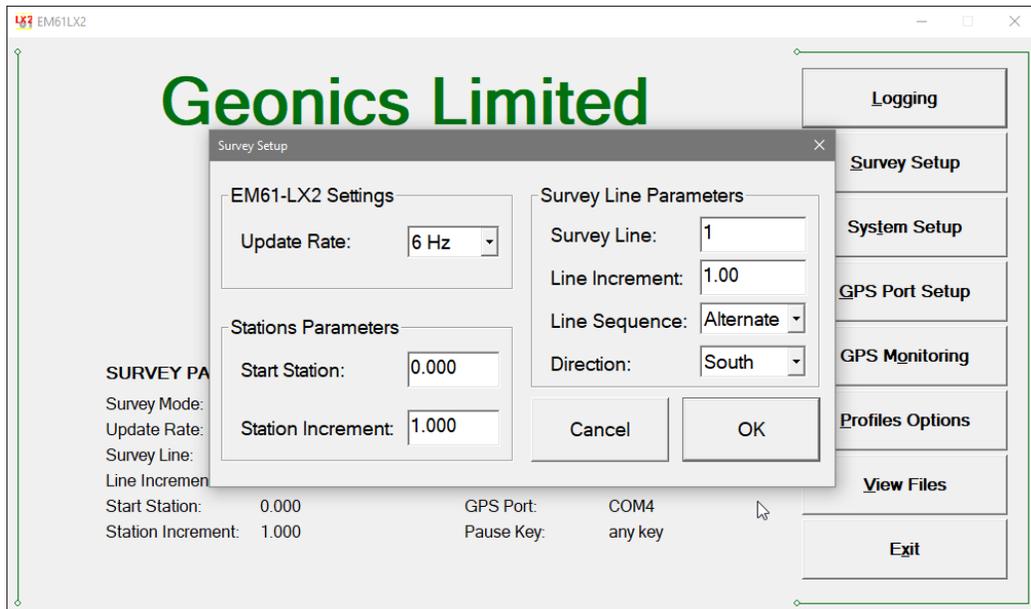
This option allows to review data files saved in the field computer.

**Exit**

This option will terminate the program execution.

## 2. Survey Setup

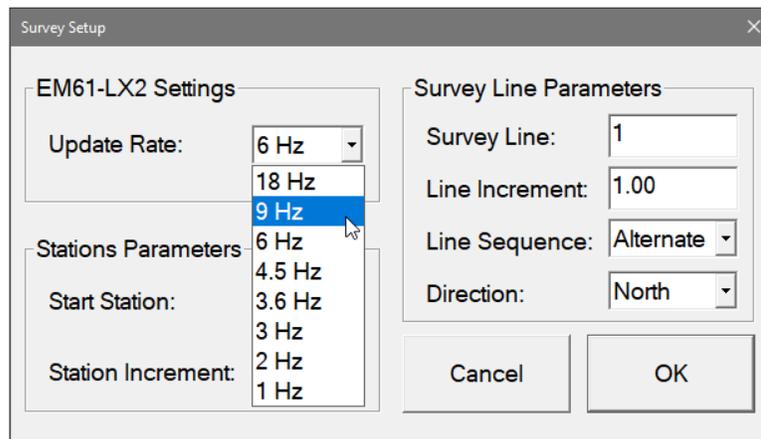
The Survey Setup dialog, presented below, contains several parameters which affect two important procedures: instrument settings (frequency of data collection) and survey geometry layout (survey line names, line spacing, start station, station increment, etc.).



Description of Options and Parameters:

### Update Rate

This parameter describes number of readings per second that will be taken. Clicking on the down arrow next to the text box labeled Update Rate opens a drop-down box showing available settings: 19 Hz, 9 Hz, 6 Hz, 4.5 Hz, 3.6 Hz, 3 Hz, 2 Hz, and 1 Hz.



This parameter describes number of readings per second that will be taken. The EM61-LX2 frequency is based on the base data output of approximately 18 readings per second. Therefore selections reflect the nearest possible base frequency of the instrument, i.e. at user selection of 18 Hz program will record every record, at selection 9 Hz the program will record every 2nd reading, selection 6 Hz will cause program to record every 3rd reading, and so on.

### Survey Line (survey line name)

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

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

### Line Incr. (survey line name)

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

This parameter specifies the distance by which survey lines will be separated. This setting will be used to determine number (name) of the next survey line.

### Sequence

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

The screenshot shows a 'Survey Setup' dialog box with the following fields and values:

- EM61-LX2 Settings:**
  - Update Rate: 9 Hz
- Stations Parameters:**
  - Start Station: 0.000
  - Station Increment: 1.000
- Survey Line Parameters:**
  - Survey Line: 1
  - Line Increment: 1.00
  - Line Sequence: Alternate
  - Direction: Alternate (highlighted)

Buttons: Cancel, OK

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.

### Direction

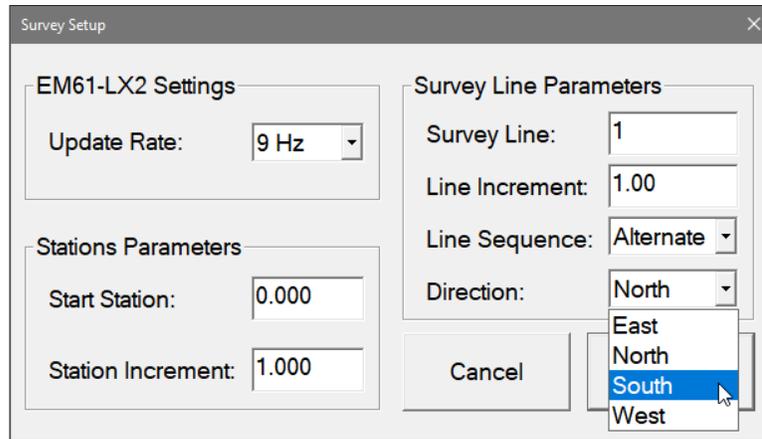
Tapping on the down arrow next to the text box opens a drop-down box showing the available options, or when the keyboard is used activate the text box and then by using up or down arrow keys select one of four available settings: East, West, South, and North.

This parameter indicates the heading of the survey line.

### Start Station (start station of a survey line)

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

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



### Stn Increment (station increment)

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

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

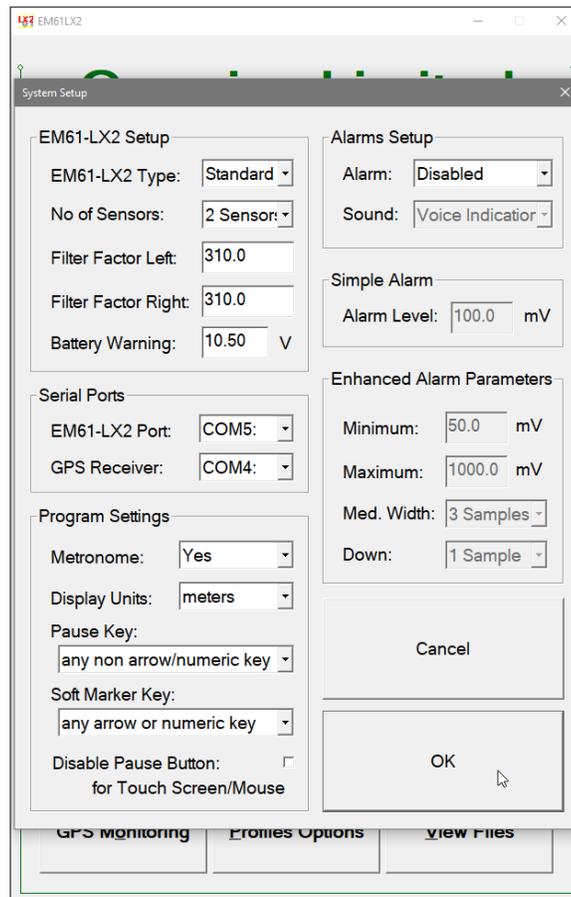
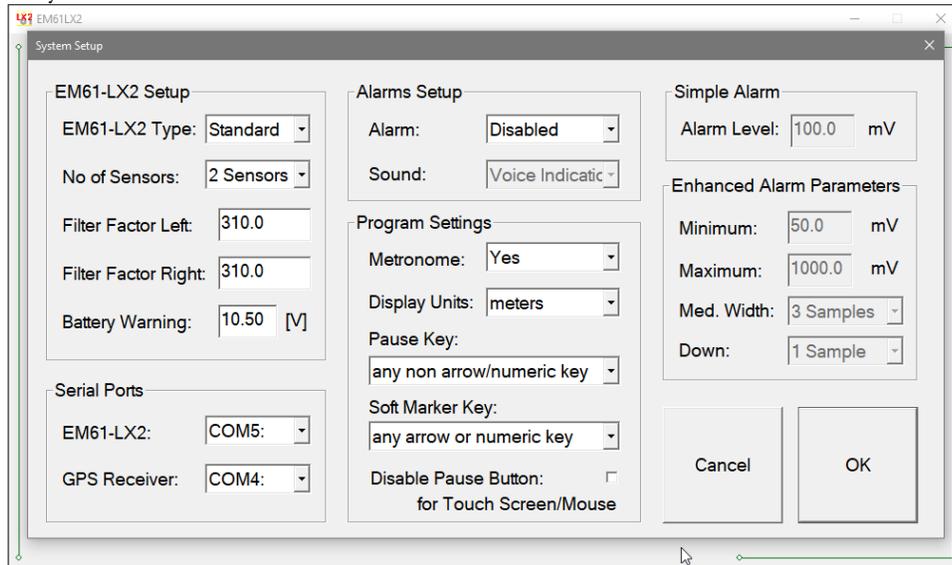
After all the parameters in the Survey Setup dialog are updated tap the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent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

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



### 3. System Setup

This option allows you to specify numerous important parameters as instrument setup, serial ports assignment, program setting and alarm type. A separate Alarm Setup dialog is also accessible during measurement session therefore alarm type and corresponding parameters can be adjusted later during data logging. The System Setup dialog is presented below in two Figures for program used at computer landscape and portrait display orientation. Despite different layout all parameters are exactly the same.



## 3.1 Description of Parameters

### EM61-LX2 Type

The EM61-LX2 can be used in a standard mode, meaning that readings include normalized for TX current, or in the N.C.C. (No Current Correction) mode where TX current normalization is not applied. Normalization factors are calculated dynamically during data collection (regardless of Monitoring or Logging mode) and correction is applied continuously. When N.C.C. type is selected then the program does not use transmitter current normalization to reduce EM61-LX2 readings to the same current level. It is mandatory for setups where external transmitter antenna is employed. Type N.C.C. can be also chosen when transmitter current normalization is not desired for any reason.

The screenshot shows the 'System Setup' dialog box with the following settings:

- EM61-LX2 Setup:**
  - EM61-LX2 Type: Standard (selected)
  - No of Sensors: N.C.C. (selected)
  - Filter Factor Left: 310.0
  - Filter Factor Right: 310.0
  - Battery Warning: 10.50 [V]
- Serial Ports:**
  - EM61-LX2: COM5
  - GPS Receiver: COM4
- Alarms Setup:**
  - Alarm: Disabled
  - Sound: Voice Indicatic
- Program Settings:**
  - Metronome: Yes
  - Display Units: meters
  - Pause Key: any non arrow/numeric key
  - Soft Marker Key: any arrow or numeric key
  - Disable Pause Button for Touch Screen/Mouse:
- Simple Alarm:**
  - Alarm Level: 100.0 mV
- Enhanced Alarm Parameters:**
  - Minimum: 50.0 mV
  - Maximum: 1000.0 mV
  - Med. Width: 3 Samples
  - Down: 1 Sample

### No of Sensors

The EM61-LX2 can be used with one or two sensors connected. Select number sensors (antennas) connected to the console. Selection is "1 Sensor" or "2 Sensors" (default).

If two sensors are selected, the sensor number 1 is the one located on the left and sensor number two is located on the right while facing both antennas in the direction of movement.

When one sensor is selected then it is considered by the program as the left sensor. Labels "sensor one" as well as left sensor are "synonymous", as for example during specifying Filter Factors below.

The screenshot shows the 'System Setup' dialog box with the following settings:

- EM61-LX2 Setup:**
  - EM61-LX2 Type: Standard
  - No of Sensors: 2 Sensors (selected)
  - Filter Factor Left: 2 Sensors (selected)
  - Filter Factor Right: 310.0
  - Battery Warning: 10.50 [V]
- Serial Ports:**
  - EM61-LX2: COM5
  - GPS Receiver: COM4
- Alarms Setup:**
  - Alarm: Disabled
  - Sound: Voice Indicatic
- Program Settings:**
  - Metronome: Yes
  - Display Units: meters
  - Pause Key: any non arrow/numeric key
  - Soft Marker Key: any arrow or numeric key
  - Disable Pause Button for Touch Screen/Mouse:
- Simple Alarm:**
  - Alarm Level: 100.0 mV
- Enhanced Alarm Parameters:**
  - Minimum: 50.0 mV
  - Maximum: 1000.0 mV
  - Med. Width: 3 Samples
  - Down: 1 Sample

## Filter Factor Left / Filter Factor Right

Filter Factors used to remove soil magnetic susceptibility in surveyed area must be specified separately for each antenna, Left Coil (number 1) and Right Coil (number 2). Filter Factors for each antenna can be determined automatically later during data acquisition stage. In case automatic filter determination won't be used, values entered here will be used during data collection and embedded in data file.

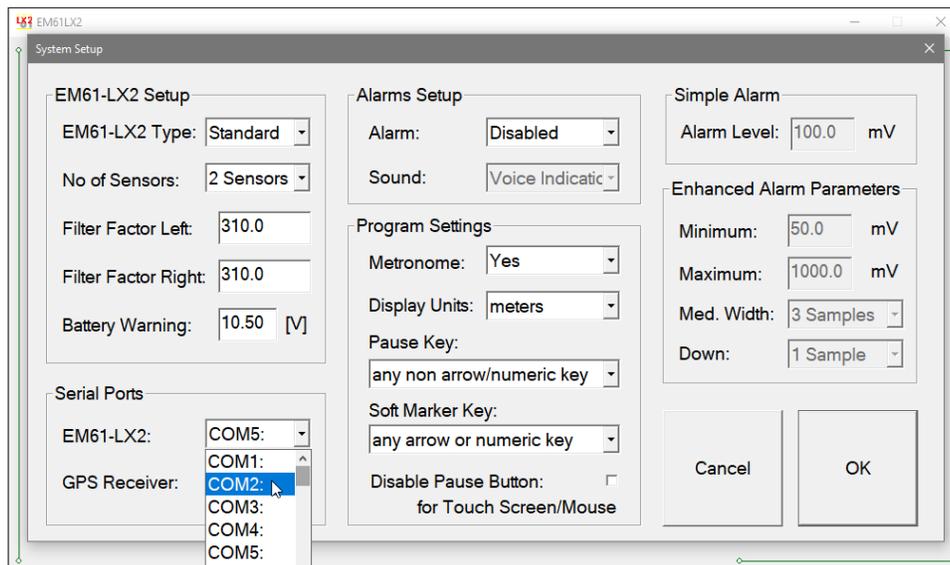
Default value for each filter factor is 310, and accepted range of filter is 100 to 900.

## Battery Warning

Specify instrument battery warning level. When the EM61-LX2 battery voltage will reach and drop below specified value the program will display battery voltage on the red background.

## EM61-LX2 Port

The number of serial port that is assigned to the EM61-LX2. Available selections: COM1 to COM60. The program default is COM1. Communication parameters for the selected serial port are set by the program, since the EM61-LX2 operates at fixed settings: Baud Rate (9600), Parity (N), Data Bits (8), and Bit Stop (1).



This port must be different than the port specified in the list box "GPS Port:" (see below) or in the GPS Port Setup dialog window (see chapter 4), otherwise a message will be displayed and ports will have to be reassigned.

Select port number in the drop-down list box.

## GPS Port

The number of serial port that is assigned to the GPS receiver. Available selections: COM1 to COM60. The program default is COM2. Communication parameters for the selected serial port can be set in GPS Port Setup dialog. The GPS port can be also assigned in the latter dialog.

This port must be different than the port specified as the EM61-LX2 serial port.

Select port number in the drop-down list box similarly to EM61-LX2 port assignment procedure.

The wireless Bluetooth connection (if available) between EM61-LX2 and Mesa2 (or similar field computer) must be set up only once (see Windows 10 Settings), then it works the exactly same way as physical cable connection assuming that proper serial port (COMx) is selected. To check which serial port (COM) is assigned for Bluetooth communication check Bluetooth settings in Windows 10. Both EM61-MK2 and GPS receiver can use wireless connection separately or concurrently.

### Metronome

Two selections are available: **Yes** or **No**. The audible click will be generated at uniform rate when this option is enabled. At fast rate (above 10 readings/s) the sound may appear not very uniform, however this does not affect quality of data acquisition.

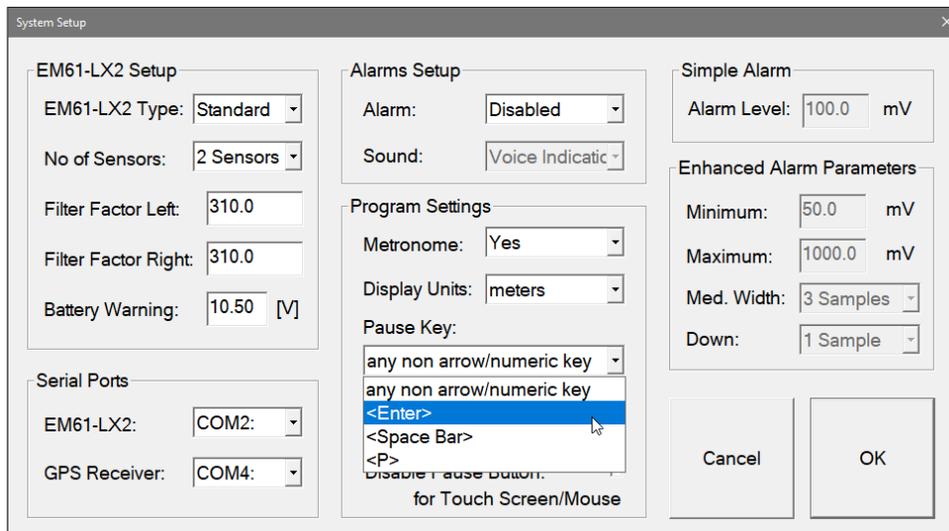
The Metronome mode is switched off automatically if any audio Alarm (see next section) is enabled.

### Display Units

Three selections are available: **Meters**, **Feet** or **US Survey Feet**.

### Pause key

Four selections are available: **any non arrow/numeric key**, **Enter**, **Space Bar**, and **P** This feature is used to pause data recording during logging session. Default setting **any key** can be changed to one of the three specific keys for field conditions where a logger key can be accidentally pushed causing unwanted stop of data logging. When Windows based tablet computer Mesa2 or Mesa3 is used the best setting is **<any non arrow/numeric keys>** or **<ENTER>** option. User specified keys P1, P2, and P3 may have various assignment, and arrow keys located on Mesa2 keyboard are reserved for Fiducial Marker.



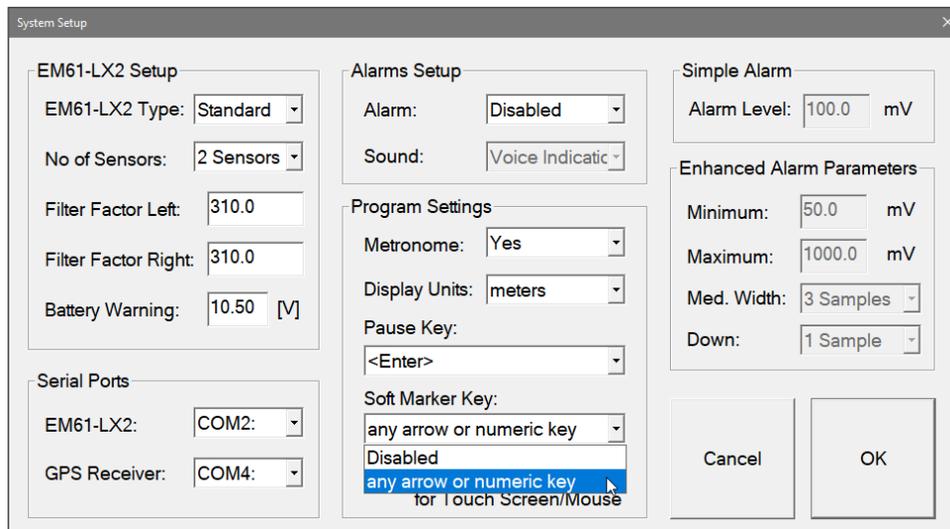
### Soft Marker Key

A software based fiducial marker is available in the EM61LX2 program. There are two available selections for the Soft Marker Key: **Disabled** and **any arrow or numeric key**.

When the latter option is selected pressing any arrow key on tablet (Mesa2 or Mesa3) or any numeric key (from 0 to 9) on any computer equipped with hard keyboard during logging session will tag current station as a station with fiducial marker. It acts exactly the same way as a standard hardware based marker in other instruments and marker is tagged at the moment reading is recorded. Therefore a marker key should be pressed while reading is

taken, and it is recommended to keep it depressed for next reading or two (data processing program recognizes only the first marker in sequence).

Enable the Soft Marker by selecting any arrow or numeric key or deactivate this option by selecting Disabled (see Figure below).



### Disable Pause Button for Touch Screen/Mouse

When desired a Pause button can be disabled. This may be desired in harsh terrain when accidental screen touch by operator, branches, or heavy rain drops may accidentally pause readings. When this option is checked the Pause action must be executed by the selected Pause key.

### Alarms Options

There are two types of alarms (not counting the third: Disabled) in the EM61LX2 program. The Simple Alarm is triggered whenever the indicated amplitude level is exceeded. The Enhanced Alarm contains four parameters that describe minimum and maximum levels, width of anomaly, and number of descending points. The enhanced alarm option can be used to design alarm settings for specific targets.

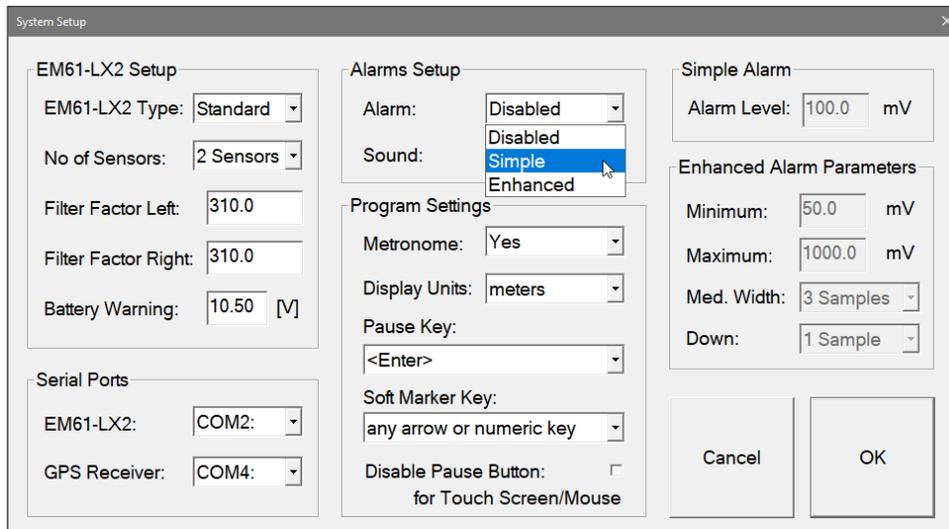
Alarm is shown visually as red squares displayed under corresponding sensor. There are also two types of audio alarms: Voice Indication and Ringing. When the Voice Indication is selected human voice indicates sensor that (coil) that triggers alarm (for example: **One** - left sensor, or **Two** - right sensor). The Ringing type provides ringing sound whenever one of sensors alarm is triggered.

Description of Options and Parameters:

#### Alarm

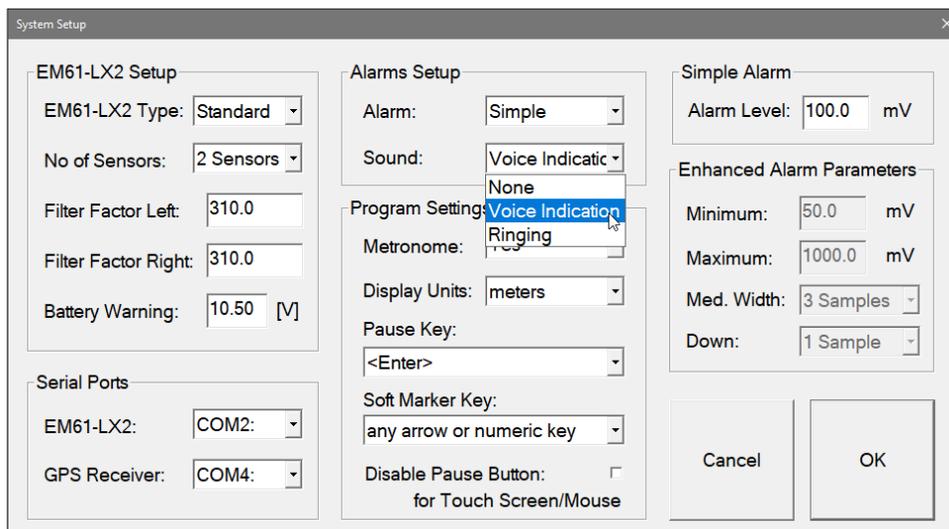
This option allows you to selected one of three settings for alarm: Disabled, Simple, and Enhanced.

Tapping on the down arrow next to the text box labeled Alarm Type opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by pressing TAB key and then by using up or down arrow keys select one of the three available items: Disabled, Simple, and Enhanced. Depending on the selection corresponding portions of the dialog are enabled. In the Figure above (this page), when the Disabled item is selected all alarm parameters are disabled.



## Sound

This option allows you to specify the sound type of alarm. Tapping on the down arrow next to the text box labeled Sound Type opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by pressing TAB key and then by using up or down arrow keys select one of the three available items: Disabled, Voice Indication, and Ringing.



When the Voice Indication is selected human voice indicates sensor (coil) that triggers alarm: **One** - left sensor, **Two** - right sensor, or **One And Two** if amplitude indicates target located between two sensors. The Ringing option provides ringing sound (minimum duration about 1 second) whenever alarm is triggered for any sensor.

## Alarm Level (Simple Alarm only)

Specify amplitude value that will trigger alarm. Whenever the target response will be larger than specified amplitude the alarm will be triggered. Visual alarm will be always displayed, while an audio alarm will sound depending on the Sound Type selection.

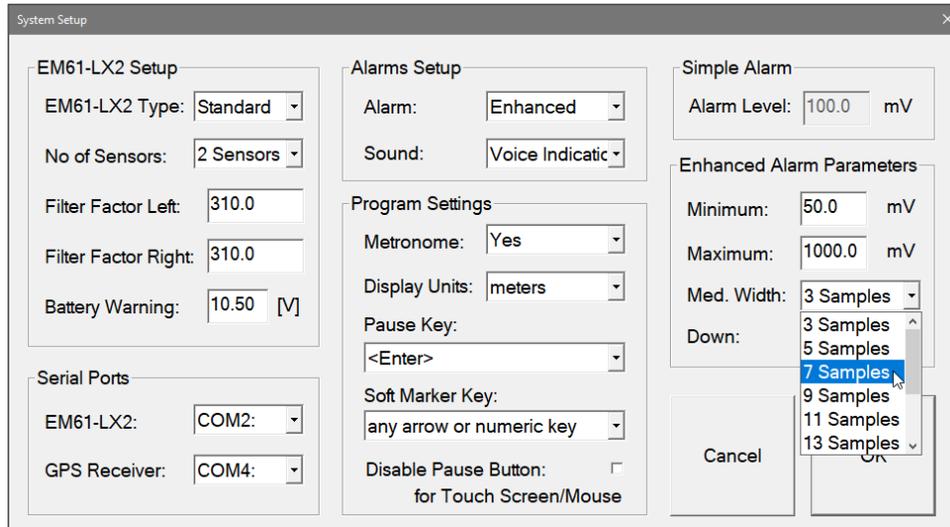
Parameters described below can be selected only when the Enhanced Alarm is selected. When Enhanced Alarm is selected conditions for all set parameters must be reached to trigger alarm.

## Minimum and Maximum

The target response amplitude must be between Minimum and Maximum specified levels to trigger alarm.

## Med. Width

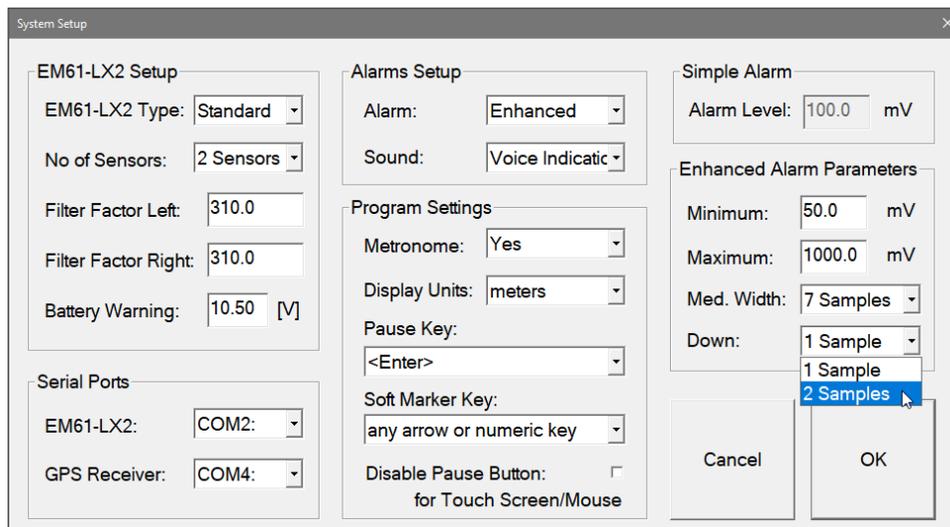
The width of alarm specified by number of samples (readings). This parameter depends on the selected update rate (Survey Setup dialog). The native update rate of the instrument is 18 Hz. Therefore at update rate at 18 Hz when 0.5 second width is to be used then 9 samples should be selected, the same width for update rate 9 Hz requires 5 samples.



Tapping on the down arrow next to the text box labeled Med. Width opens a drop-down box showing the available parameters, or when the keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items (minimum 5 samples and maximum 21 samples).

## Down

Specify number of samples (1 or 2) that must be lower after the peak of anomaly. This option is used to avoid false alarm when the signal rises along the slope before reaching its maximum. Available selections are 1 or 2.



Tapping on the down arrow next to the text box labeled Down Samples opens a drop-down box showing the available parameters, or when the keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items.

After all the parameters in the Logger 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 Logger Setup dialog.

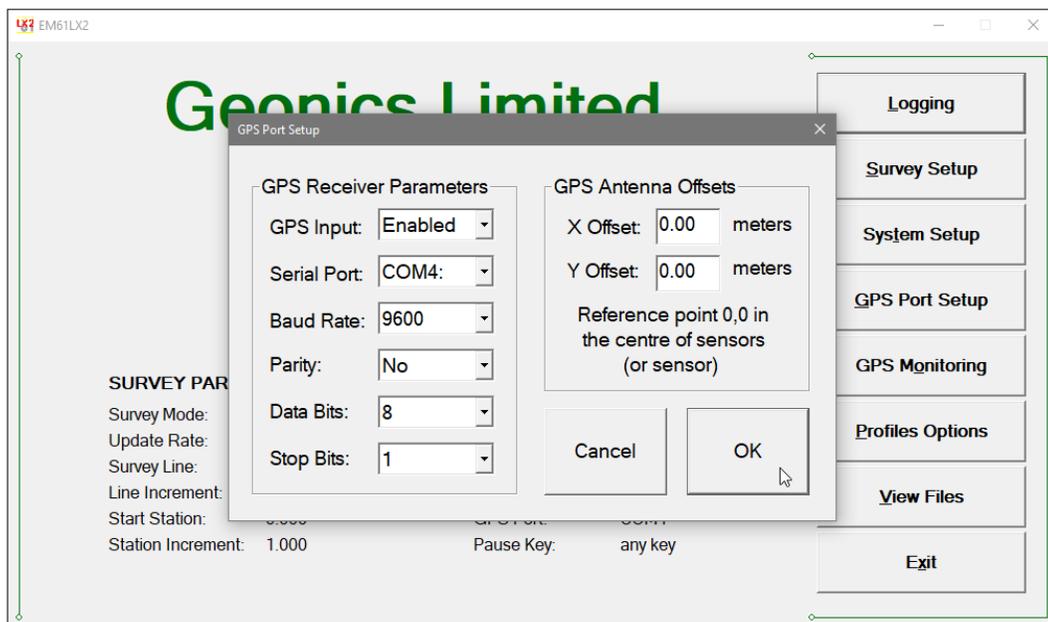
To return to original settings (state before this dialog was selected) tap or click on the **Cancel** button. All parameters will be reset to initial settings and the program will return to the Main Screen.

## 4. Set Port for GPS

The GPS Port Setup dialog allows for enabling GPS input, and setting communication parameters for serial port associated with GPS input. GPS Monitoring window allows you monitoring the GPS output in terminal mode and to send NMEA commands to GPS receivers.

### 4.1 GPS Port Setup

After the Set Port for GPS button was clicked on (or executed from the keyboard) in the Main Screen the Set Port for GPS dialog window appears on the screen. This dialog allows you to enable and disable the GPS input, select serial port for GPS input, and to specify serial communication parameters matching GPS receiver settings. The dialog is presented below.



Description of 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.

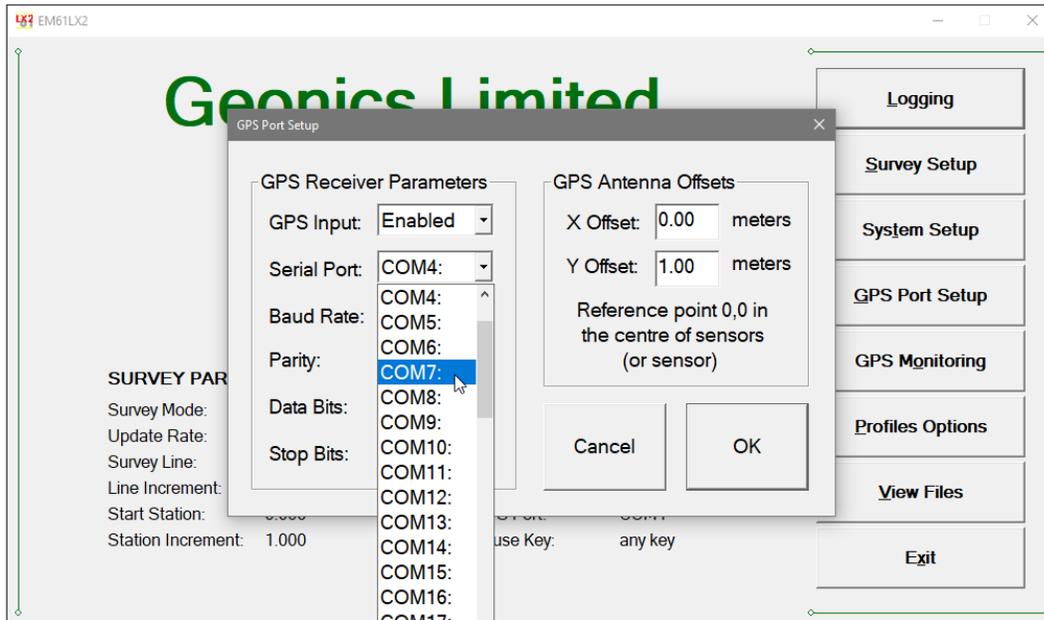
The GPS Input can be Enabled even if there is no GPS system connected to the computer. In such case data file will contain proper sequence of EM61-LX2 readings without any GPS input.

Clicking on the down arrow next to the text box labeled GPS Input opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by pressing TAB key and then by using up or down arrow keys select one of two available items: Enabled and Disabled.

#### Serial Port

The number of serial port that is assigned to the GPS input. Available selections: COM1 to COM60. The program default is COM2. Communication parameters for the selected serial port can be determined in options described below.

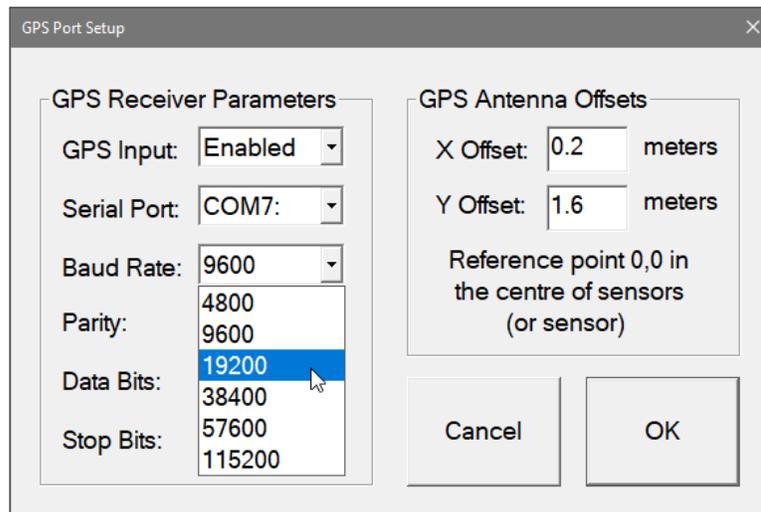
This port must be different than the port specified in the System Setup menu (for EM61-LX2), otherwise a message will be displayed and ports will have to be reassigned.



Clicking on the down arrow next to the text box labeled Serial Port opens a drop-down box showing the available ports, or when the keyboard is used activate the text box by pressing TAB key and then by using up or down arrow keys select one of available items.

### Baud Rate

Specify Baud Rate for the output port, the selected value should match the Baud Rate of the GPS system, default is 9600. Available settings are: 4800, 9600, 19200, 38400, 57600, and 115200.



Clicking on the down arrow next to the text box labeled Baud Rate opens a drop-down box showing the available parameters, or when the keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items.

### Parity

Select Parity for the output port, the parameter should match the Parity set in the GPS serial port settings. Available settings are None, Even, and Odd; default is N.

Clicking on the down arrow next to the text box labeled Parity opens a drop-down box showing the available parameters, or when the keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items.

#### Data Bits

Specify Data Bits for the output port, the selected value should much settings in the GPS receiver, default is 8. Other available selection is 7.

Clicking on the down arrow next to the text box labeled Data Bits opens a drop-down box showing the available parameters, or when the keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items.

#### Stop Bits

Specify Stop Bits for the output port, the selected value should much settings in the GPS receiver, default is 1. Available selections are 1 or 2.

Clicking on the down arrow next to the text box labeled Stop Bits opens a drop-down box showing the available parameters, or when the keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items.

#### GPS Antenna Offsets

These two parameters describe GPS antenna placement in reference to the center of the system while facing direction of movement. Therefore, if GPS antenna is placed in front of the system **Y Offset** is positive, and negative if GPS antenna follows EM61-LX2 sensors. Similarly, when GPS antenna is placed on the right of the system center (while facing direction of movement) then **X Offset** is positive, otherwise it is negative.

These two parameters are written in data file and later they are used for proper positioning of two EM61-LX2 sensors when XYZ file is created. It is important that described geometry is consistent during entire data file, therefore while surveying along alternating lines the system must use turns. It cannot be situation when the system is "pushed" along one survey line and "towed" along neighboring survey line.

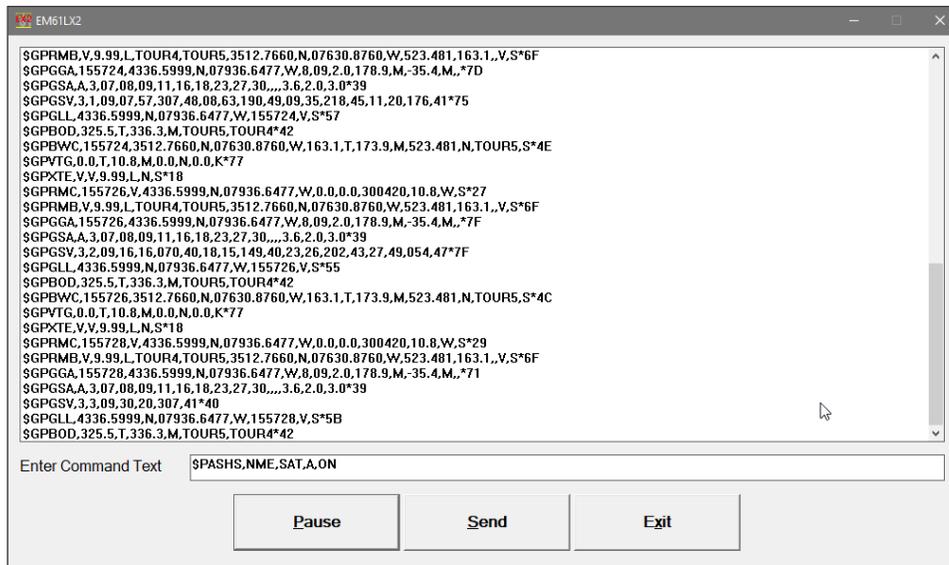
After all the parameters in the GPS Port Setup dialog are updated click on the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent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

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

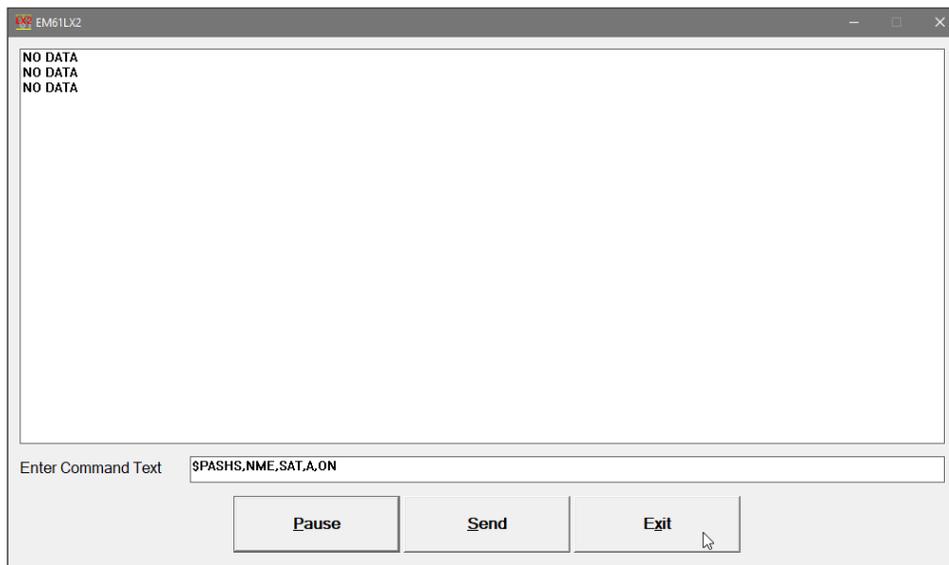
## 4.2 Monitoring GPS Receiver Output

After the button Monitor GPS Output is tapped or executed by the keyboard the program will display the screen in terminal mode. In this mode the screen is divided into three parts. The largest, top portion of the screen displays the GPS receiver output. The middle portion shows that last NMEA command sent to the GPS receiver (by default command shown in Figure below), and at the bottom three buttons representing available options: Pause/Go, Send, and Exit. These buttons can be tapped, executed by TAB key and ENTER keys, or by using shortcuts (pressing underlined letter keys). This screen is shown below.

As soon as the EM61LX2 screen is in terminal mode and the GPS is streaming data, each message transmitted by GPS receiver will appear in the top portion of the display (the end may be cut off



if an NMEA message is longer than screen). 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. 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 below.



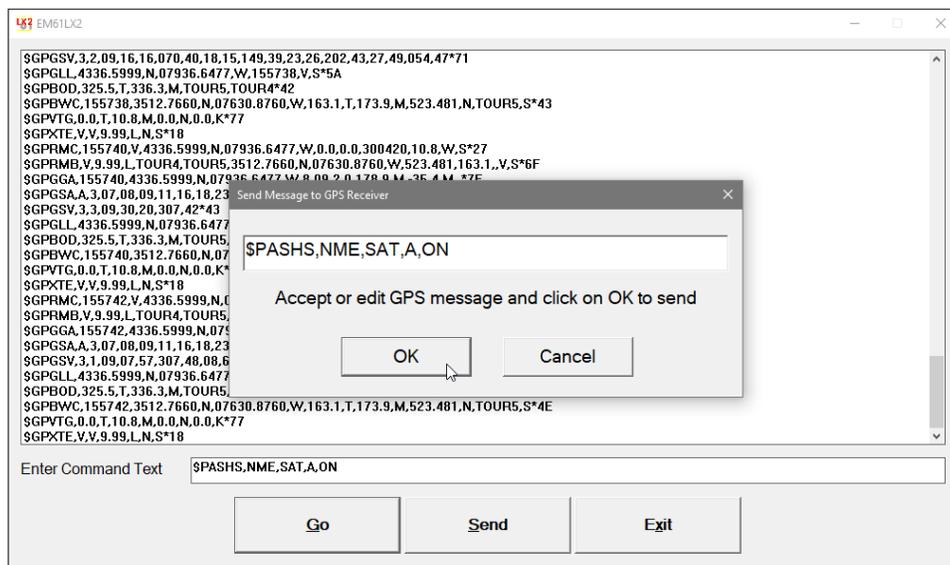
The message NO DATA is normally updated with a rate of 7 seconds. This may indicate the following: serial port number not correctly specified in Set Port for GPS dialog, GPS receiver not sending any data, and not working or not connected GPS receiver. If the message is updated more often than 7 seconds (i.e. every 1 or 2 seconds) or the display does not show legible characters, it is possible that the GPS is working correctly and is connected to the proper serial port, however communication parameters are not specified correctly. In most cases the Baud Rate or Parity must be adjusted.

The NO DATA message may also appear if the GPS data are received correctly, but the GPS receiver was set to send data with a time interval longer than 7 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 stopped any time by using button labeled **Pause**. At that time scrolling of the GPS output will be stopped, and the button will be labeled **Go**. The next tap (or keyboard action) on this button will activate receiving and display of GPS data.

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.

After the button **Send** is tapped a dialog titled GPS Message is displayed and the beginning of the standard NMEA command, **\$PASHS**, or the last entered command is displayed. After the entire NMEA command is typed in, tap **OK** button or press the key **<ENTER>** to send the command to the GPS receiver. Tapping **Cancel** button or pressing the **<Esc>** key will cancel the command and hide the NMEA Message dialog. An example of a command that will enable the NMEA message **SAT** is given in the below figure (it is assumed that the GPS receiver output serial port is A).



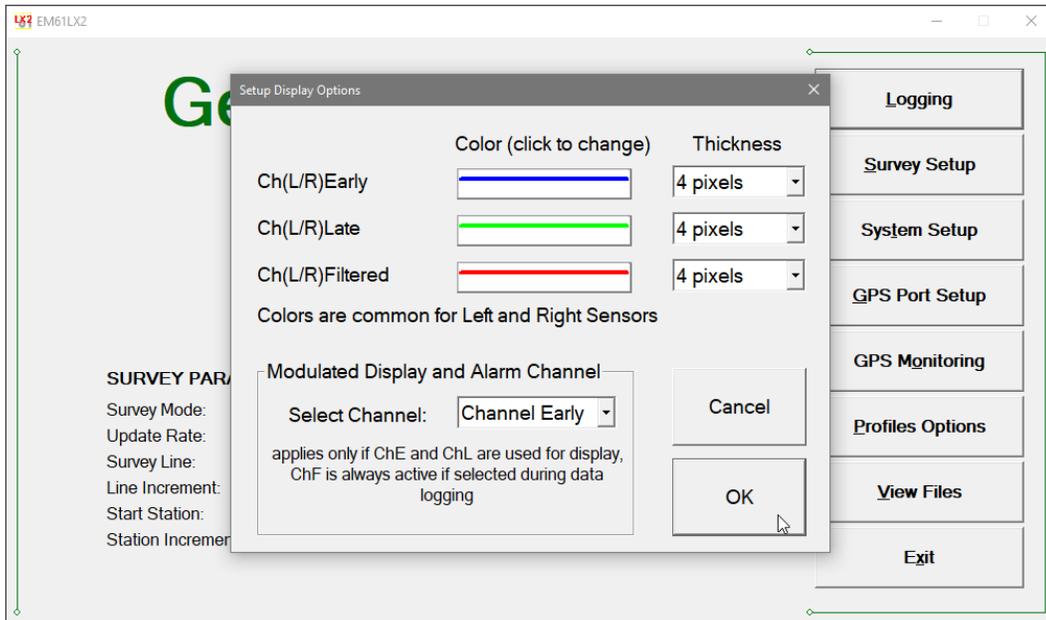
After this command is received by the GPS receiver, the confirmation message will be sent by the receiver (**\$PASHR, ACK\*3D**) and data stream will contain the message **SAT** (**\$PASHR, SAT,....** in the above figure).

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).



# 5. Display Options

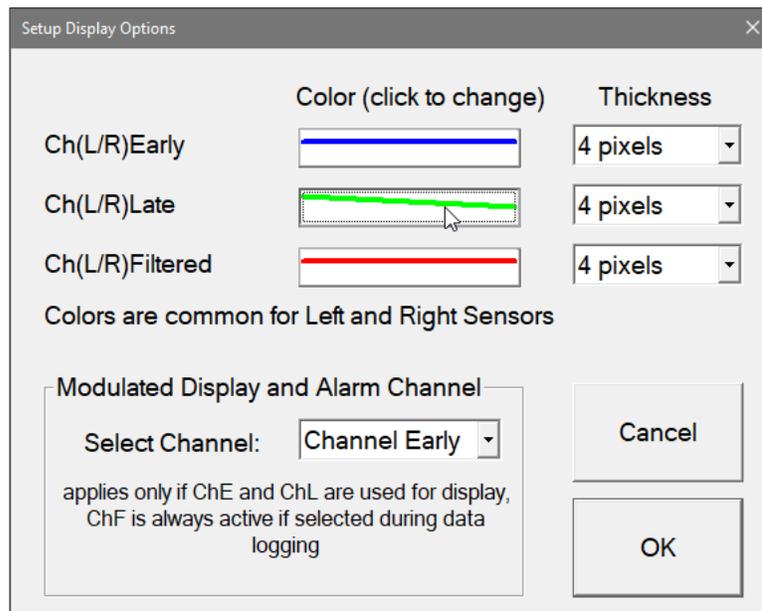
After the **Display Options** button was tapped (or executed from the keyboard) in the Main Screen the Display Options dialog window appears on the screen. This dialog allows you to set display of each channel profile, specify color and thickness of profiles, and select channel to be used in modulated ribbon display and alarm monitoring. Please note that profile attributes (colour and line thickness) are common for Left and Right sensors). Therefore, for example Early channel will be always shown with the same colour regardless of the sensor. The dialog is presented below.



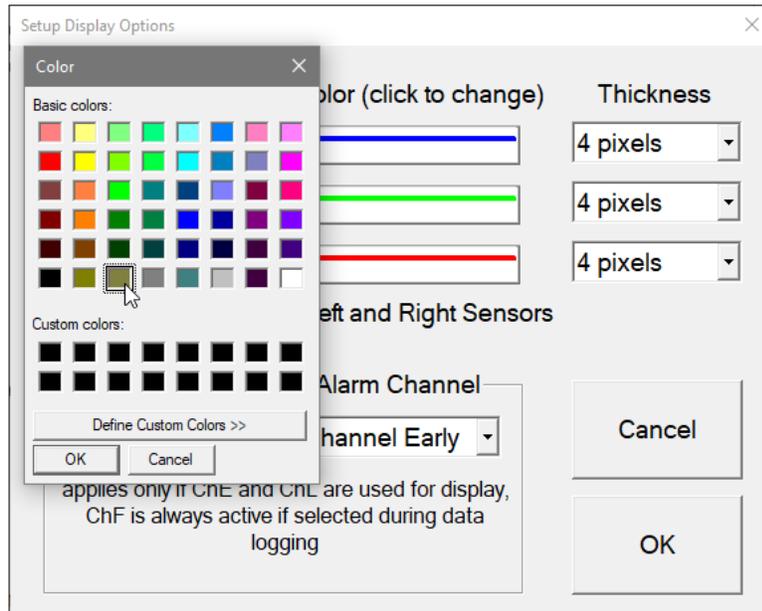
Description of Options and Parameters:

## Color

To change colour of each profile tap or click the corresponding button (with colour line) labeled Color at the top and a sample colour line on the button will tilt, see Figure below.



The standard dialog titled Color will appear. Select desired colour by tapping on a colour box (the selected colour box will be highlighted, see Figure below).

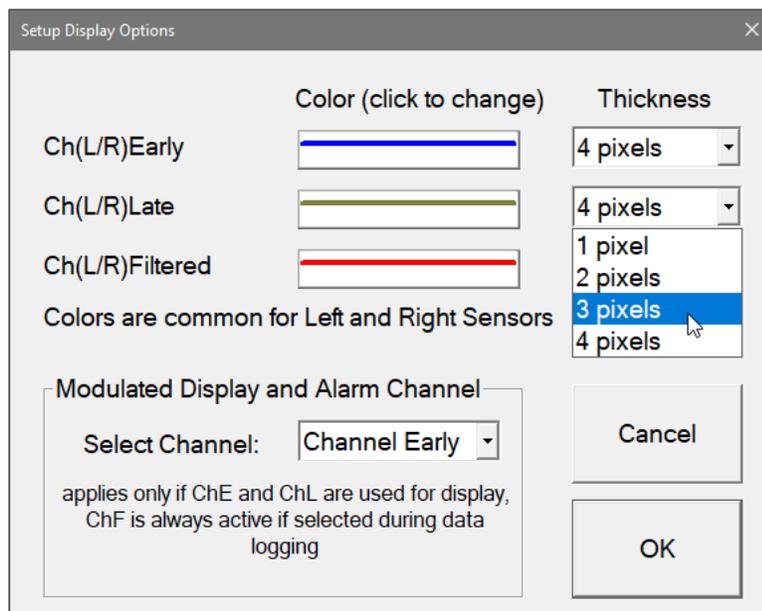


Tap the button **OK** or press **ENTER** key to accept the highlighted colour. The Color dialog will disappear and the colour of the appropriate channel button will updated. To cancel colour selection tap the **Cancel** button.

### Thickness

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

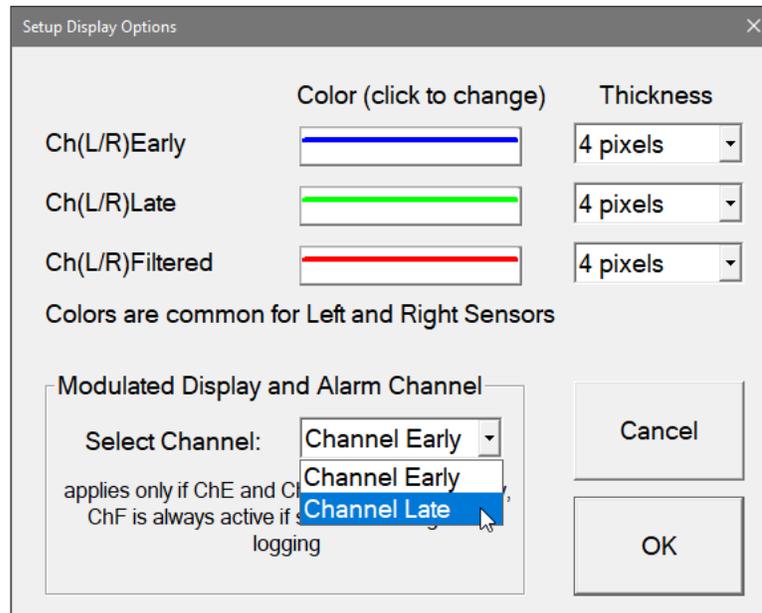
Tapping on the down arrow next to the text box (labeled by number of pixels) opens a drop-down box showing available selection (see Figure below). Select thickness by tapping on the desired selection. If keyboard is used activate text box by pressing TAB key (till the box is highlighted) and then by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



### Select Channel (for Modulated Display and Alarm Channel)

This option allows you to select channel Early or Late when both ChE and ChL are selected for profile display. This option can be disregarded if the Filtered Channel (ChF) is used all the time, since it is default setting if ChF is selected for profile display.

The above applies also to Alarm settings. If Alarm is enabled then in case of Channel Early and Channel Late are selected for profile display the selected here channel will be monitored by alarm functions. When ChF is selected for profile display then alarm always monitors ChF. Tapping on the down arrow next to the text box labeled Select Channel opens a drop-down box showing available parameters: Channel Early and Channel Late, or when keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items.



**Please note, that selection of graphic display does not affect readings saved in the data file. Data are always written to file in original form.**

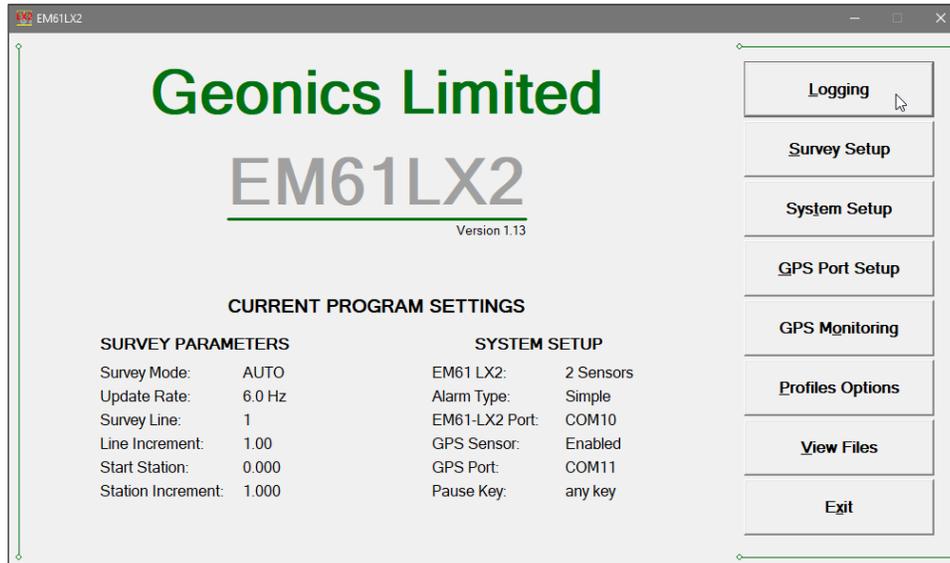
After all the parameters in the Display Options dialog are updated tap button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent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

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



## 6. Logging Data

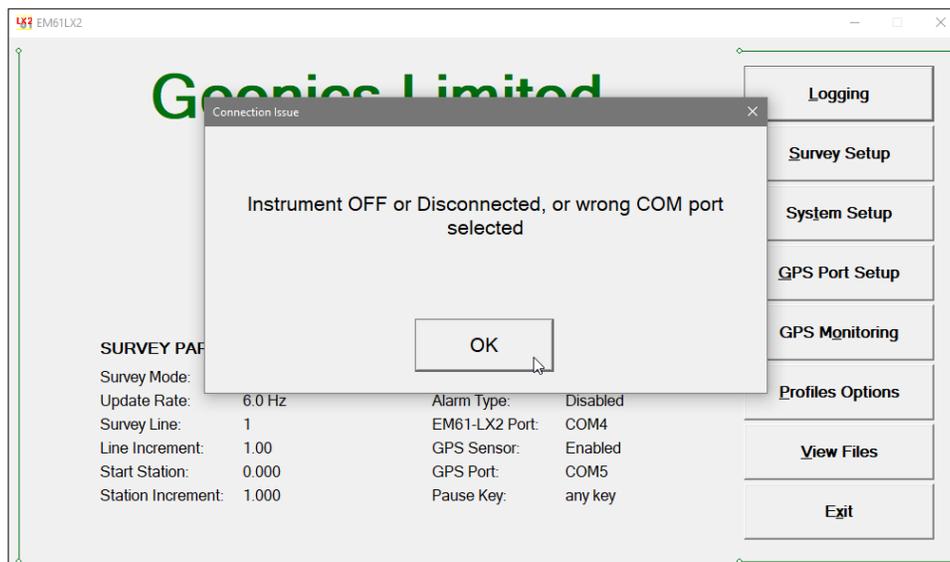
After the **Logging** button (in Main Screen) is tapped or executed by the keyboard, the program enters logging session which contains three modes: Monitoring, Stand By and Logging. Program starts logging session always in Monitoring mode. EM61-LX2 readings and GPS parameters can be quickly examined and some functions (creating data file, offset nulling) can be performed while program is in Monitoring mode. After a



data file is created in Monitoring mode, the program switches to Stand By mode and allows access to Logging mode. In Stand By mode instrument output can be monitored and some survey and logging parameters can be changed, and Logging mode is used only to record data. Two modes Stand By and Logging are toggled by **GO** and **Pause** buttons.

### 6.1 Monitoring Mode

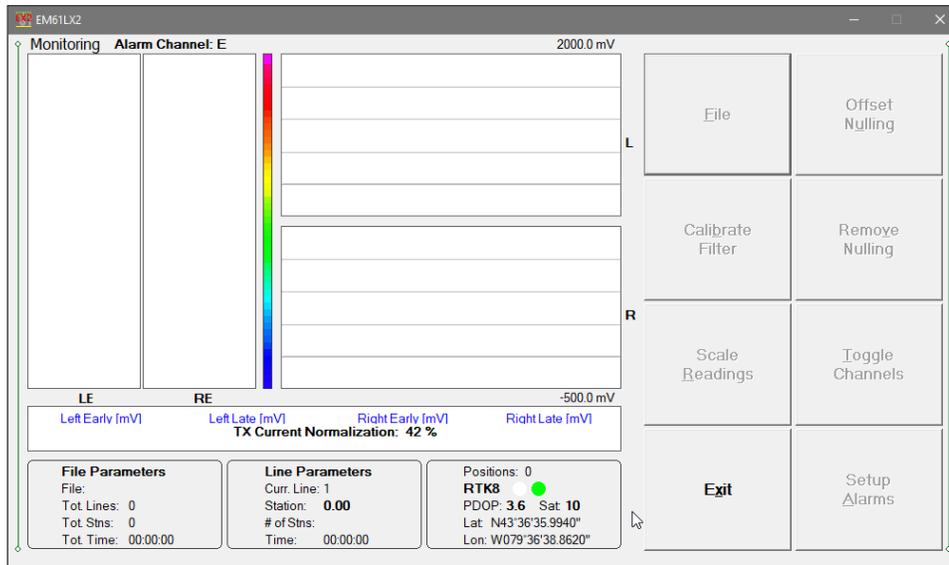
The Monitor mode allows initial inspection of the range of the instrument readings at a particular site, monitoring the instrument performance, quick inspection of the condition of the instrument battery, reading scale, display mode, and setting zero level of the instrument.



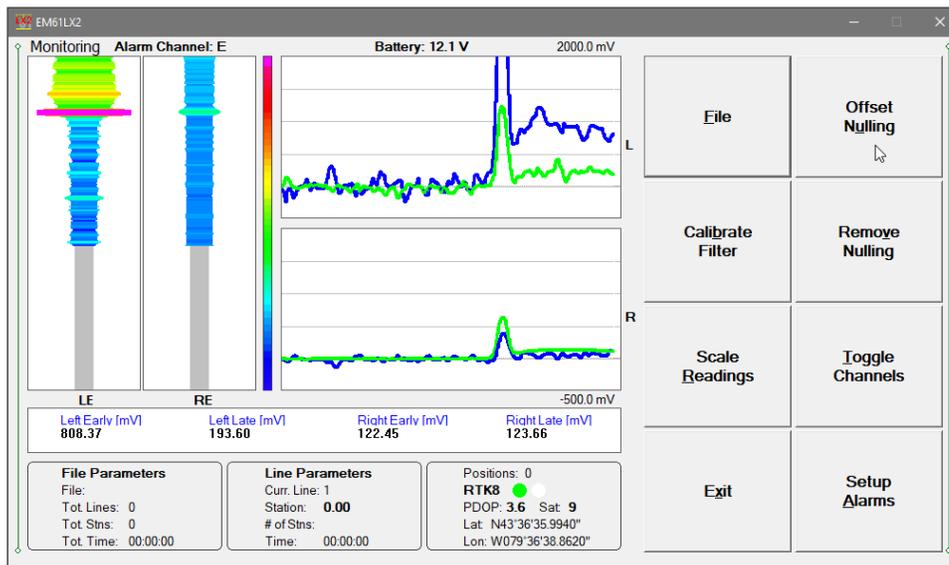
It is assumed that the instrument is turned ON prior to using this option. If the instrument is OFF or the instrument console is not connected to the computer the following message will appear (see Figure above).

Check the connection or turn the instrument ON and select the Monitor/Log option again.

Assuming that the instrument works properly the program will display the Monitor mode window and will start normalization session which lasts less than 10 seconds. At this stage the Monitor window will display the following message in numeric values window (this procedure takes place even when EM61-LX2 N.C.C. type was selected):



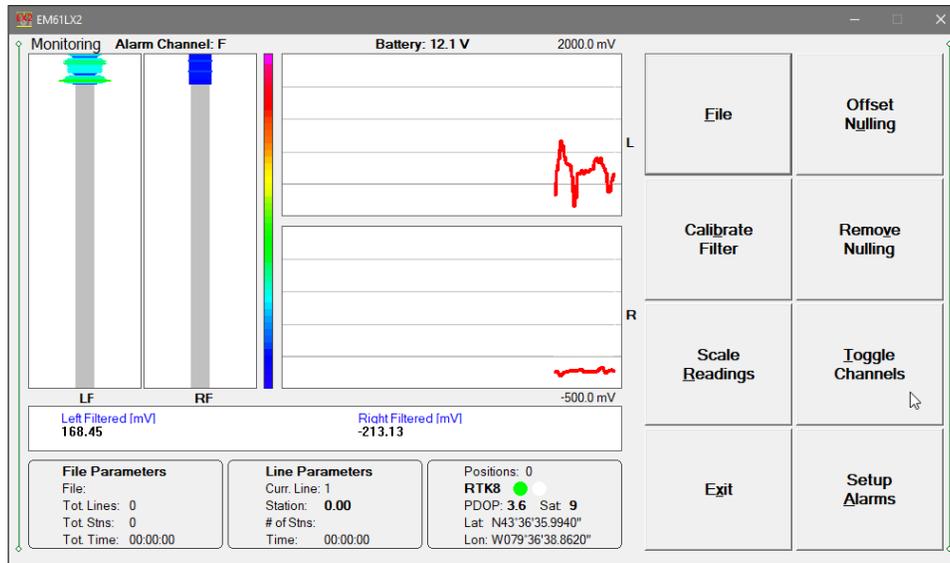
After the normalization is completed the layout of the Monitor window is displayed as follows:



The program screen layout shows two types of graphic windows (see Figure above). Windows located in the left part of the screen displays instrument response as Modulated Colour ribbon. In this presentation Left window corresponds to the Left sensor and Right sensor is displayed in the right graphic window. In case one Sensor is connected then there is only one windows with modulated colour ribbon. The center graphic windows display instrument response in Profile Mode. Panel for the Left sensor is shown at the top of the screen and panel corresponding to the right sensor is located below (both are labeled L and R). Readings display scale is shown as a colour bar in the

Modulated Ribbon display mode while in Profile mode the readings range is labeled at the top and bottom of each panel.

Numeric values for each sensor are shown under corresponding windows: LE and LL (Left Early and Left Late), and RE and RL (Right Early and Right Late). Alternatively when Filtered channel option is selected the program displays LF (Left Filtered) and RF (Right Filtered), see Figure below. The screen shown on the right displays instrument response in Profile Mode. Panel for the Left sensor is shown at the top of the screen and panel corresponding to the right sensor is located below (both are labeled L and R). Readings display scale is shown as a colour bar in the Modulated Ribbon display mode while in Profile mode the readings range is labeled at the top and bottom of each panel.



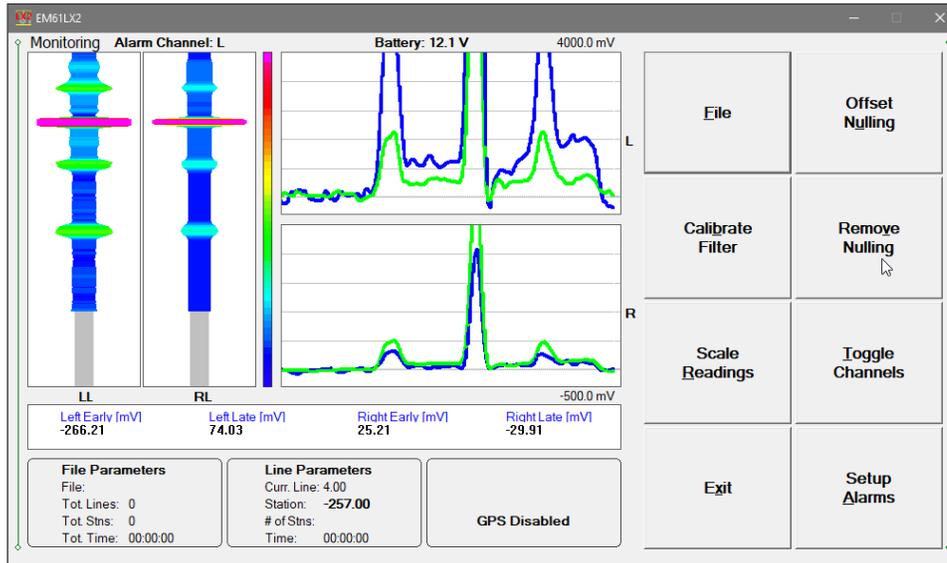
The Modulate Ribbon and Profile Display modes presentation of both channels (channels E and L) or channel F can be switched at any time by the **Toggle Channels** button. All three channels cannot be displayed concurrently. One channel only can be represented by the colour display in Modulated Ribbon windows when both channels E and L mode are enabled. In the latter case a channel selected in the Display Options dialog (available from main menu and popup menu during data logging) and labeled at the top of the modulated ribbon window.

The Monitor (as well as Stand by and Logging) window is divided into five sections in each graphic mode.

One line of text in the top section provides survey parameters (used in Stand By and Logging modes) and instrument information. In Monitor mode this section displays: current display mode (Monitor, Stand By or Logging), channel selected for Alarm and Colour Ribbon display, the EM61-LX2 battery level in Volts (following label **Battery**), and max range for EM61-LX2 readings. When fiducial marker is pressed then label **Marker** or **M** is displayed.

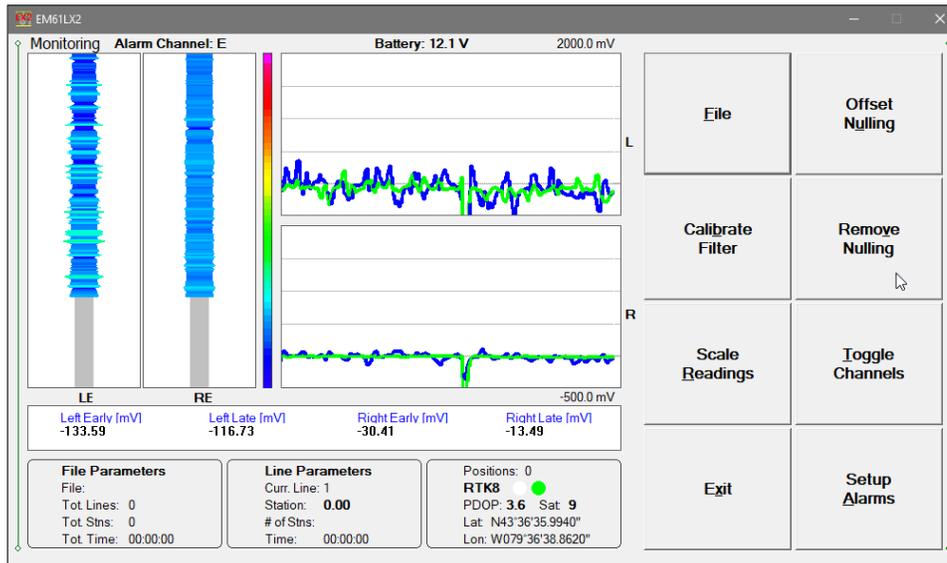
The second, largest graphic section will be used to display graphic modes: colour ribbon or profiles during logging data for channels L and E, or F depending on the selection. The second, largest graphic section will be used to display profiles (during actual data logging) and modulated colour ribbon. Numeric labels on the right side of profile window correspond to scale minimum (below the profile window) and maximum (above the profile window). Labels **L** and **R** indicate corresponding sensors. If instrument with one sensor is selected in the System Setup dialog then modulated ribbon and profiles will be displayed in single widows.

The remaining sections section contains a numeric window with current EM61-LX2 readings, three frames (File Parameters, Line Parameters, and GPS information), and command buttons located at the bottom (vertical screen) or on the right (horizontal screen mode) side of the screen.



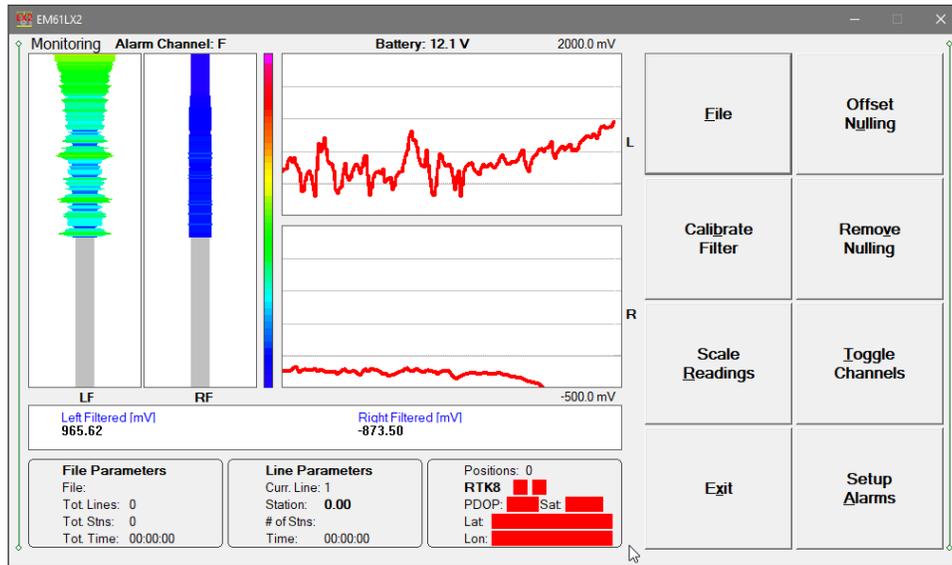
The third section, numeric window, displays data in numeric form in mV. Channels RE and RL that correspond to the right sensor are shown at the right side of the window. When the Filtered channel mode is selected then similarly program displays LF and RF (for left and right sensors). The EM61-LX2 readings are updated approximately 10 times per second during the monitoring session.

When GPS is Disabled in the Set GPS Port dialog a message **GPS Disabled** will be displayed (see Figure above). If the GPS port is Enabled and a working GPS receiver is connected to the field computer the Monitoring screen will display GPS parameters, as presented below.

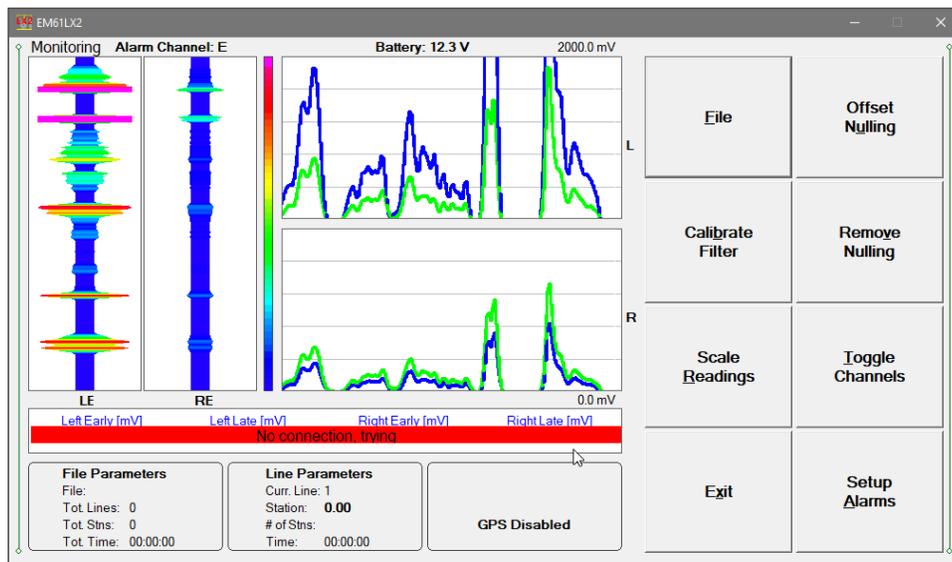


In the above Figure one line of the display is dedicated to show the GPS status. A label **Positions** will be used during data acquisition, it will provide the number of GPS positions saved in the data file. Below, two lines display the parameters describing the quality of GPS positions. A label **DGPS** (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. On the right side of **DGPS** or **AGPS** label two green and white circles alternate. These

two circles should alternate colours with the frequency of GPS update rate (usually 1 second intervals). If the circles do not change colours 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**). This value is available only when messages both, GGA and GSA are received from GPS. The last label **Sat** and following number shows number of currently tracked satellites. Refer to section 4 (Set Port for GPS), Appendix B, and to GPS manuals for more information about GPS parameters. Two bottom lines of the frame give current Latitude and Longitude of the instrument position (datum WGS1984). Position is updated with frequency of GPS receiver stream. If GPS signal is not received by the computer for any reason (disconnected or accidentally turned off receiver) then all GPS parameters are displayed as red sections to alarm operator (see Figure below).



Eight command buttons located in the right bottom corner of the Monitor window lists the program functions available in the Monitor mode. Options are as follows: **File** (create data file), **Calibrate Filter** (calculate filter factors in the measured area), **Scale Readings** (change scale for EM61-LX2 readings in profile window and for colour scale used by for modulated ribbon), **Exit** (exits the Monitor mode and returns the program to Main Screen), **Offset Nulling** (perform nulling function and calculates offsets), **Remove Nulling** (removes offsets), **Toggle Channels** (toggle displayed channels selection), **Setup Alarms** (opens dialog where alarm type and parameters can be selected).



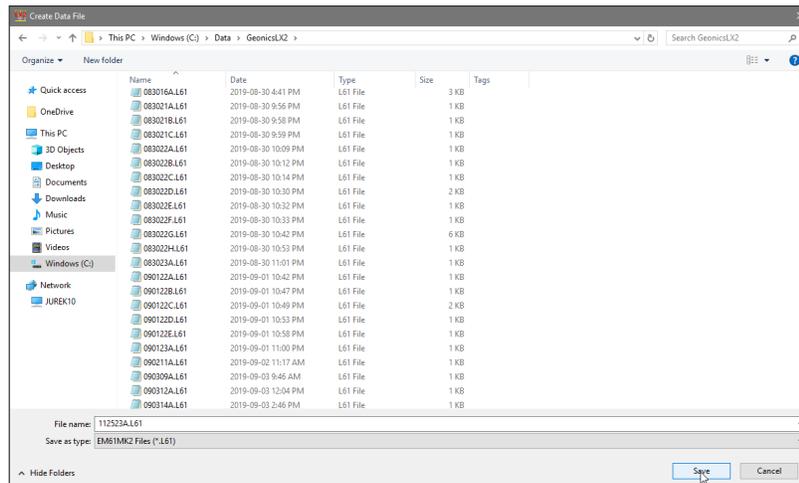
In case of any problems with instrument connection, battery failure, or accidental instrument Turn Off a message "No Communication, trying" will be displayed in numeric values window. The message is highlighted by red background to alert operator as fast as possible. The EM61LX2 will try to re-establish communication and after the problem is corrected the program will start communication automatically. Alternatively, the Monitor mode can be stopped by clicking on the Exit button or executing this function by a keyboard. The Monitoring window with alerting message is shown above (previous page).

## Description of Monitoring Mode Options

Several field options are available while the Monitoring mode. Options can be accessed directly from eight command buttons. Command buttons can be used by tapping on the desired button, or from the keyboard by pressing one of the shortcut keys (underlined characters on button labels) or by navigating using <TAB> key (sets button as a default button - default button is highlighted) and pressing <ENTER> key.

**File (create data file)** When a data file is created the program will switch to Stand By mode automatically. The data file can be created in the user selected 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 one alphabetic character A, B, C, etc. (If all letters during one hour are used use the Overwrite option). The Create Data File dialog is presented below. The file name can be specified in the Create Data File dialog using the Windows standard



interface procedure. The EM61-LX2 data files cannot be appended.

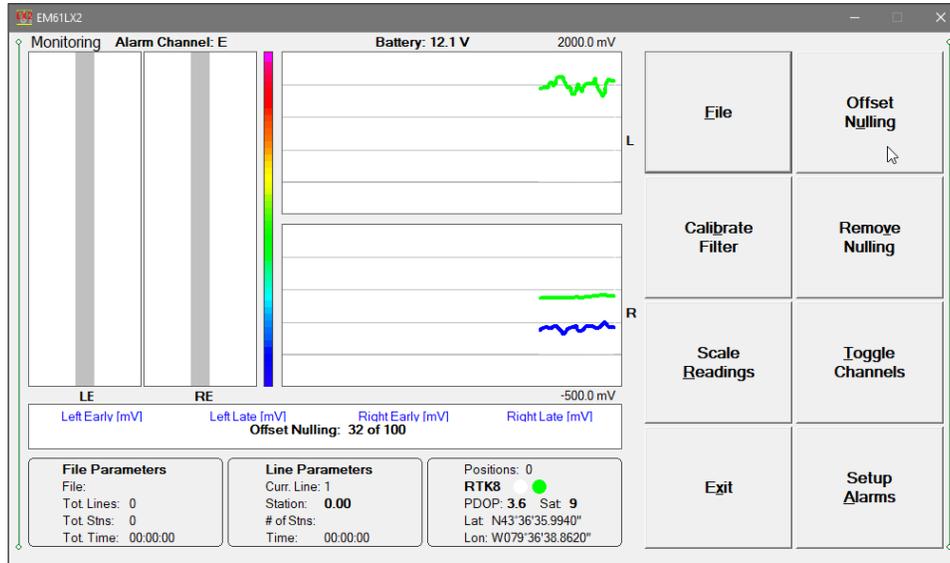
Each data file in the field computer (raw data file) has an extension name LX2 and it is created in the directory specified in Create Data File dialog. The LX2 files are created in the instrument binary format. They can be viewed using the Main Screen option "View Files". These files can be also converted to ASCII format and processed in the Geonics DAT61LX2 program.

After the file is specified tap the button **OK** or press **ENTER** key 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.

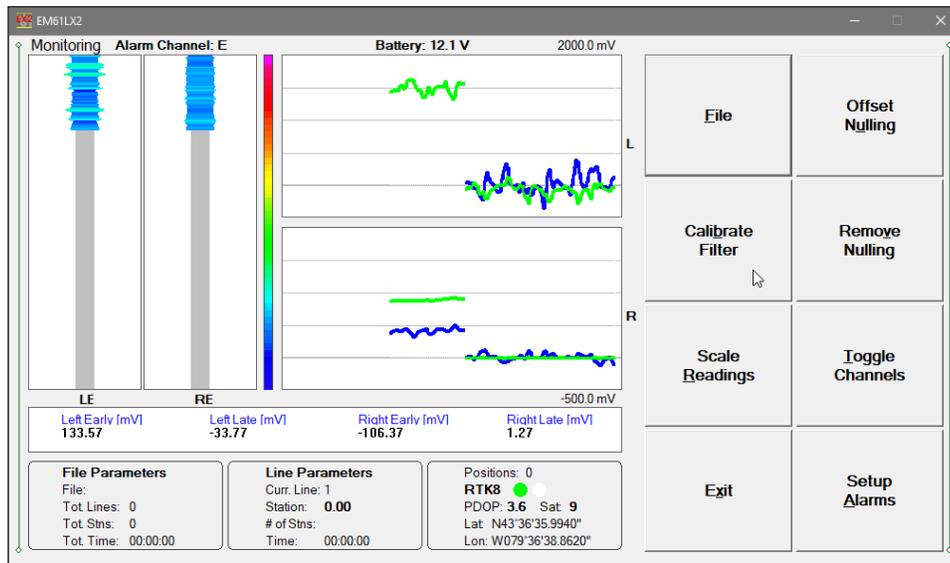
To cancel selection and return to Monitoring mode tap the **Cancel** button.

## Offset Null

To perform a null of the instrument tap the button labeled **Offset Nulling** or execute this option using the keyboard (navigate to the button by pressing **TAB** key and when highlighted press **ENTER** key, or use shortcut - press key **U**). At this moment the computer takes 100 readings and calculates the instrument offset.



The calculated offset is applied to all the readings that follow this operation. If needed, this procedure can be repeated several times until satisfactory results are obtained.



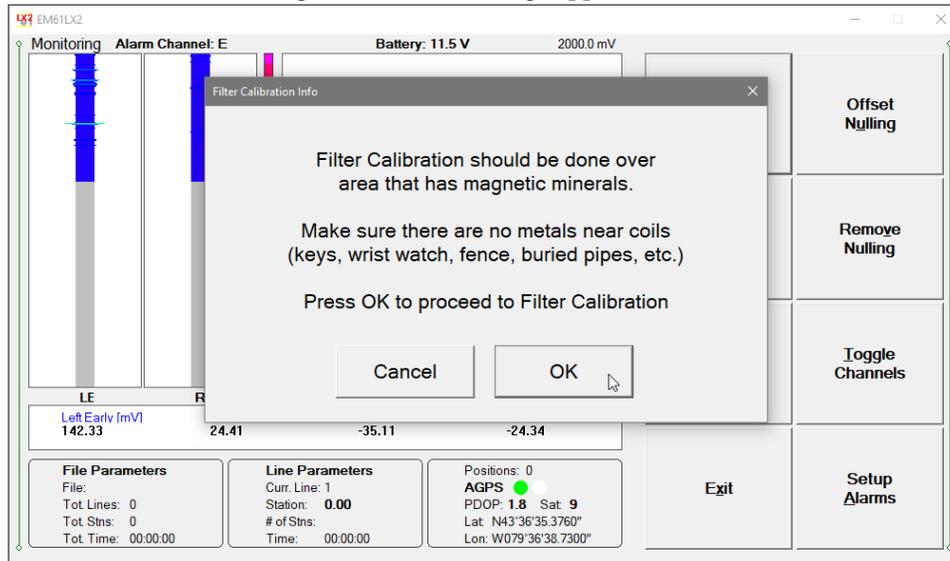
This option is available from command button as well as from the menu.

## Remove Nulling

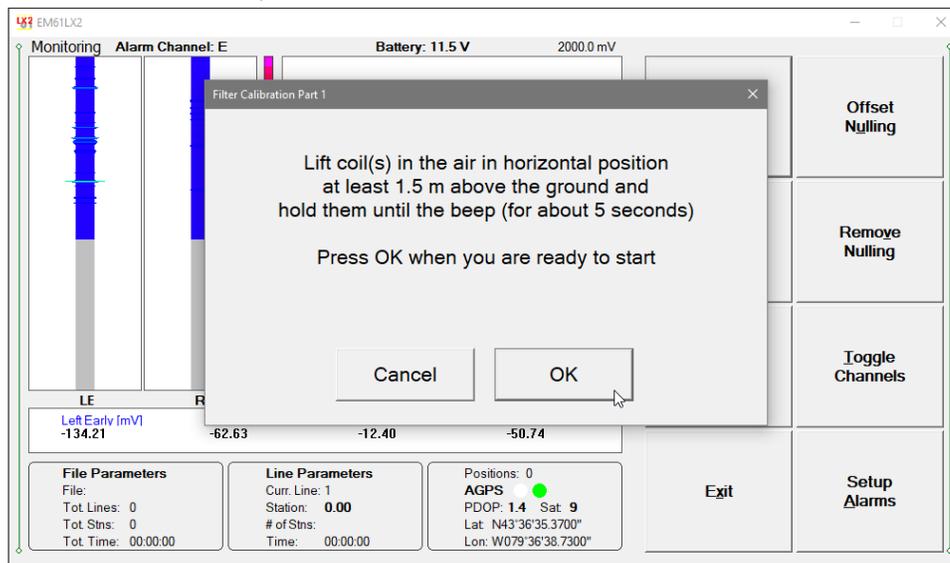
It is "Undo" function for above Nulling procedure. After the option will be executed all calculated Null Offsets (for each channel and sensor) will be reset to zero. In order to avoid accidental touch on the button a confirmation dialog is displayed before the Remove Null procedure.

## Calibrate Filter

Filter Factors are used to remove soil magnetic susceptibility in surveyed area. These can be entered manually in System Setup dialog (see Chapter 3). Here in Monitoring mode these factors can be determined by using automatic procedure. The procedure is exactly the same regardless one or two sensors are connected. After the Calibrate Filter button is tapped or clicked on following information message appears:

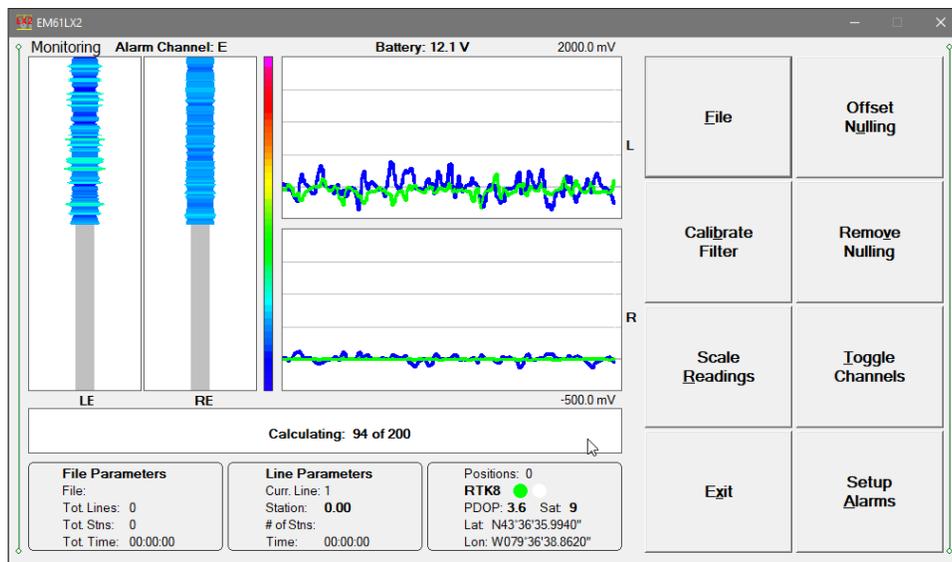
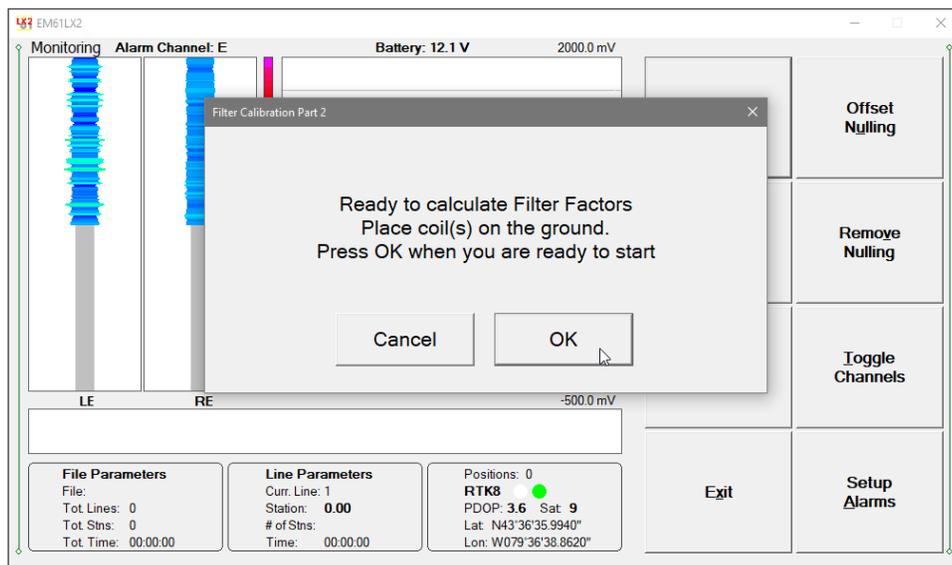
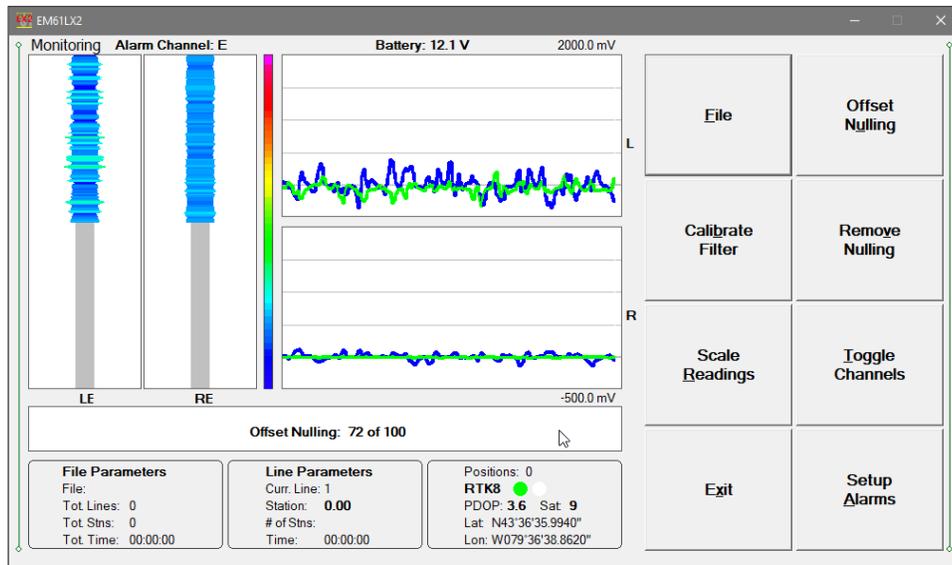


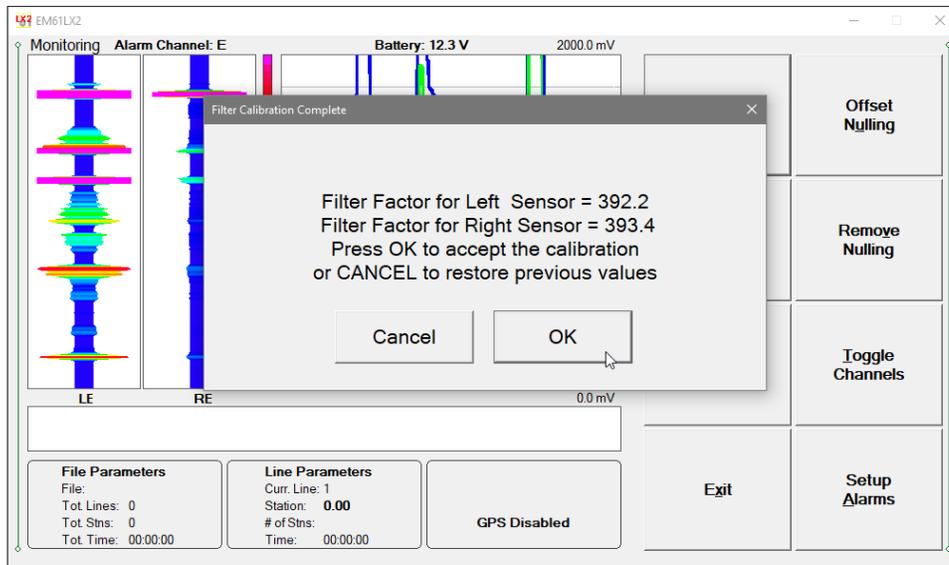
When the above message is confirmed by the clicking on the OK button the Filter Calibration - Part 1 appears (Figure below). The first stage of Calibrate Factors consists of Offset Nulling calculations (previous Nulling Factors will be lost unless the Calibrate Filter function is cancelled).



Offset Nulling procedure starts as soon as the OK button is pressed (figure below). Keep coils in the air till computer will beep (about 5 seconds) or if sound is not enabled till Message dialog will change and it will prompt to place coils on the ground.

When coils are placed on the ground then press OK to start next stage of Calibrating Filter. A message in numeric window will display Calculating, this stage lasts about 10 to 12 seconds. When done a message displaying calculated Filter Factors for Left and Right sensors will be displayed (4th Figure below). New values can be accepted or previous factors can be restored by pressing the Cancel button.

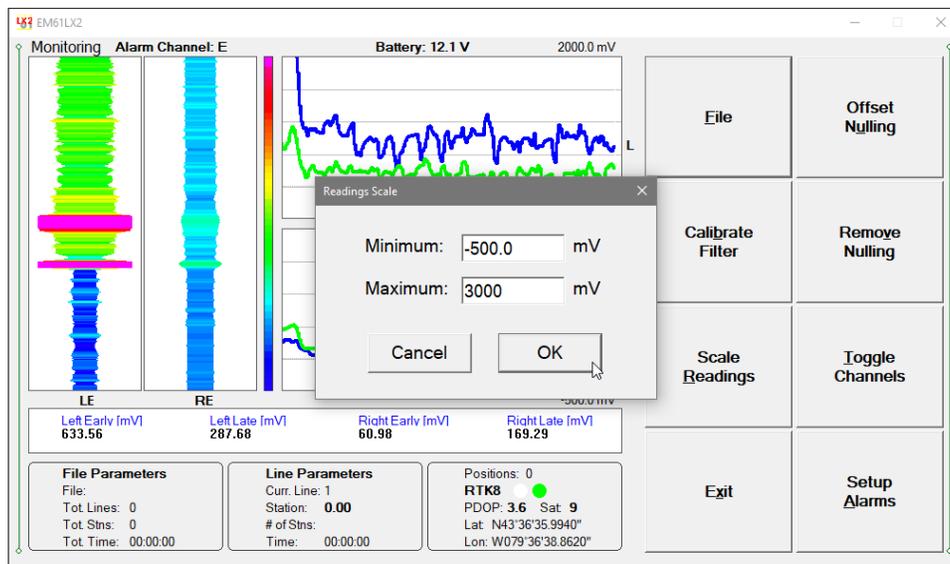




### Scale Readings *(New Scale for Readings Range)*

Selecting the Scale option allows the operator to enter new scale parameters for the instrument readings shown in corresponding graphic mode.

The Reading Scale dialog will be displayed. It contains two text boxes for Minimum and Maximum values of a new scale for profile plot. Current settings (minimum and maximum values) for the scale are displayed in the bottom right and top right corners of the plot area. After minimum and maximum values are specified tap the button **OK** or press **ENTER** key to accept to accept new values and the profile plot area will be redrawn (see Figure below).



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

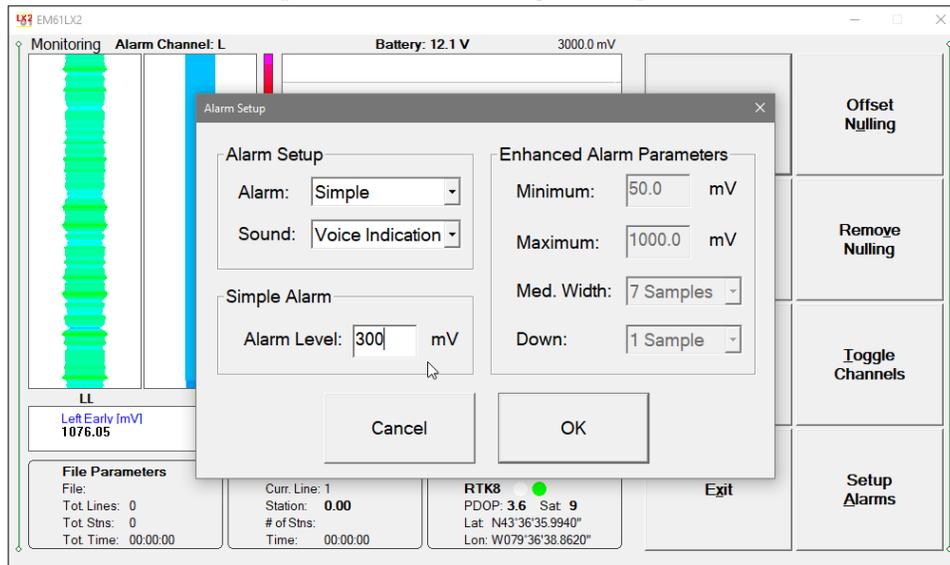
### Toggle Channels

Toggles between Channels E (Early) and L (Late), and Channel F (Filtered Channel) display modes.

## Setup Alarms

After the **Alarm Setup** item was selected in the pop up menu the Alarm Setup dialog window appears on the screen. The dialog is presented below.

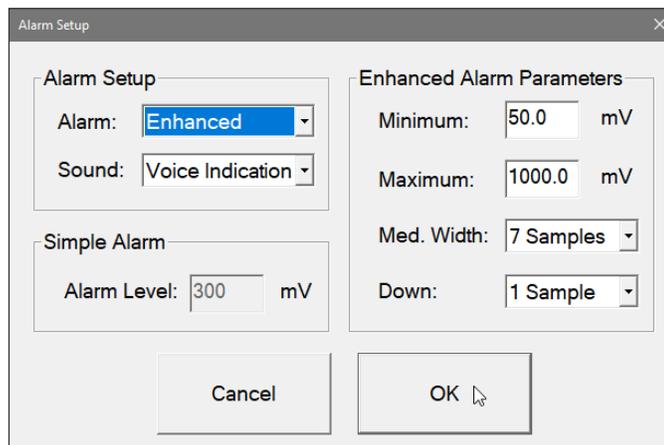
Please refer to chapter 3 where this dialog and its parameters are described in detail.



### Alarm

This option allows you to selected one of three settings for alarm: Disabled, Simple, and Enhanced.

Tapping on the down arrow next to the text box labeled Alarm Type opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by pressing TAB key and then by using up or down arrow keys select one of the three available items: Disabled, Simple, and Enhanced. Depending on the selection corresponding portions of the dialog are enabled. In the Figure above (this page), when the Simple item is selected the Simple Alarm section is enabled while all Enhanced Alarm Parameters are disabled. Compare above with Figure below where the Enhanced alarm is selected.



### Sound

This option allows you to specify the sound type of alarm. Tapping on the down arrow next to the text box labeled Sound Type opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by pressing TAB key and then by using up or down arrow keys select one of the three available items: Disabled, Voice Indication, and Ringing.

When the Voice Indication is selected human voice indicates sensor (coil) that triggers alarm: **One** - left sensor, **Two** - right sensor, or **One And Two** if amplitude indicates target located between two sensors. The Ringing option provides ringing sound (minimum duration about 1 second) whenever alarm is triggered for any sensor.

#### Alarm Level (Simple Alarm only)

Specify amplitude value that will trigger alarm. Whenever the target response will be larger than specified amplitude the alarm will be triggered. Visual alarm will be always displayed, while an audio alarm will sound depending on the Sound Type selection.

Following parameters described are available when the **Enhanced Alarm** is selected. Conditions for all parameters that belong to Enhanced Alarm set must be reached to trigger alarm.

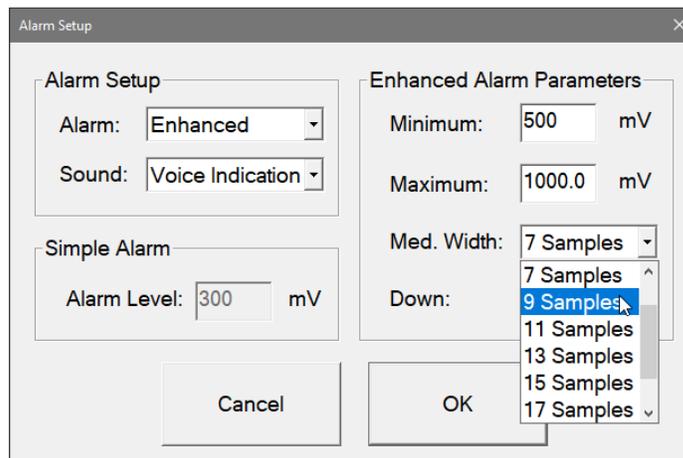
#### Minimum and Maximum

The target response amplitude must be between Minimum and Maximum specified levels in mV to trigger alarm.

#### Med. Width

The width of alarm specified by number of samples (readings). This parameter depends on the selected update rate (Survey Setup dialog). The native update rate of the instrument is 18 Hz. Therefore at update rate at 18 Hz when 0.5 second width is to be used then 9 samples should be selected, the same width for update rate 9 Hz requires 5 samples.

Tapping on the down arrow next to the text box labeled Med. Width opens a drop-down box showing the available parameters, or when the keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items (minimum 5 samples and maximum 21 samples).



#### Down

Select number of samples (1 or 2) that must be lower after the peak of anomaly. This option is used to avoid false alarm when the signal rises along the slope before reaching its maximum. Available selections are 1 or 2.

After all the parameters in the Alarm Setup dialog are updated tap the button **OK** to accept the displayed settings. The program will disappear. Updated settings will be now used to trigger alarms, new settings will be also written to the configuration file for subsequent program use. To return to original settings (state before this dialog was selected) tap the **Cancel** button. All parameters will not be updated.

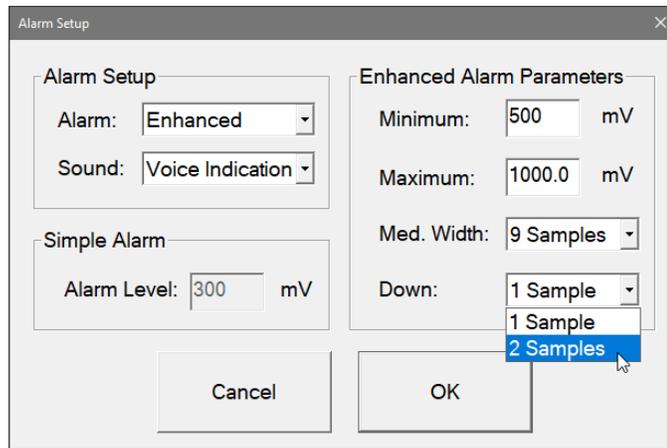
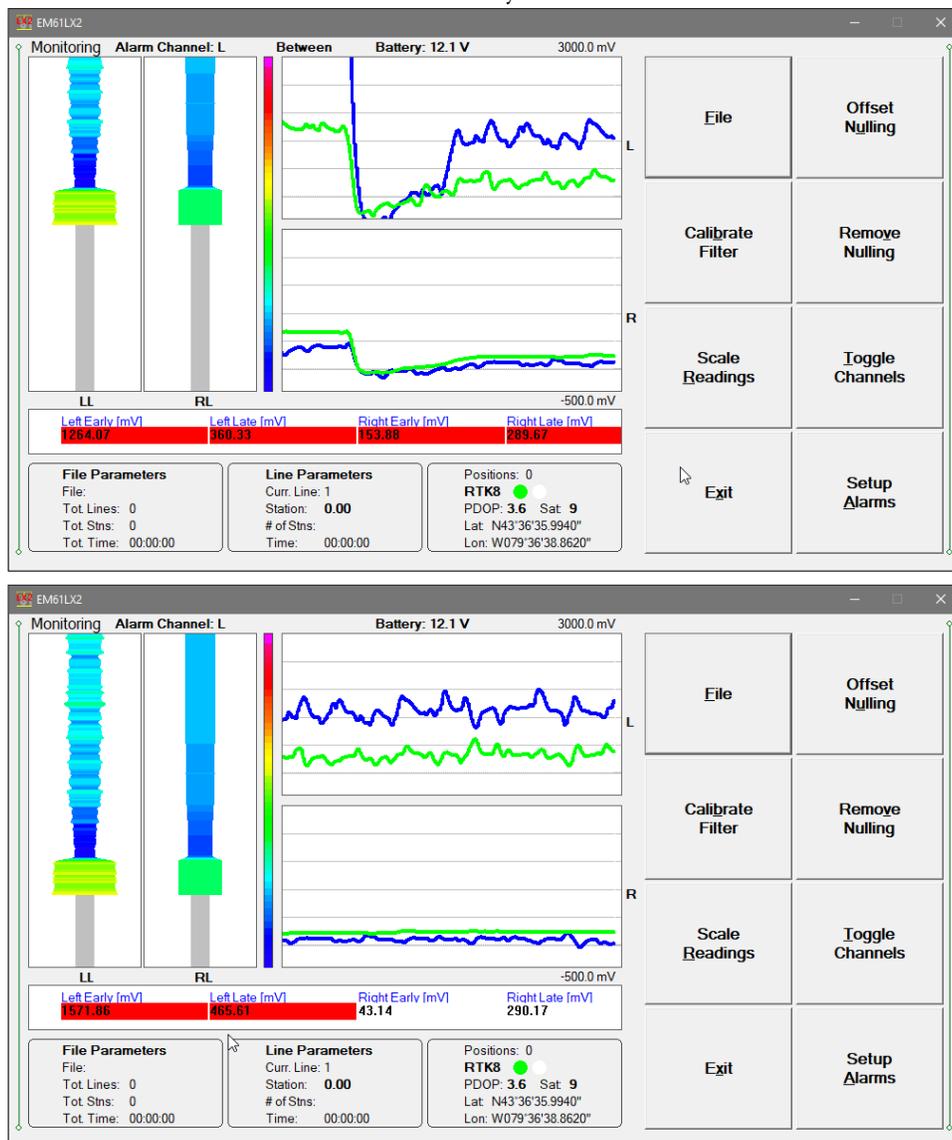


Figure below presents visual alarm for both Left and Right coils, and figure that follows show visual alarm for the Left coil only.

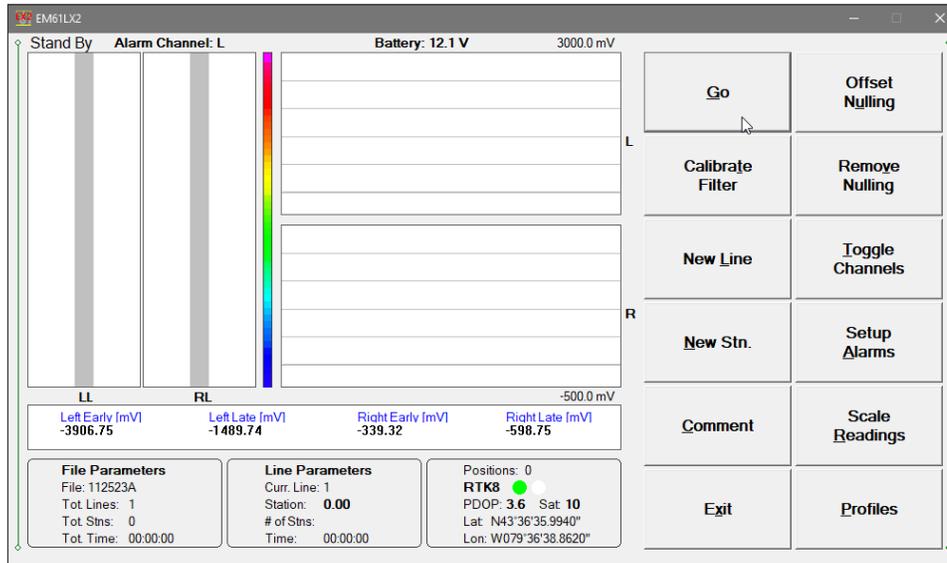


**Exit** (exit Monitor mode)

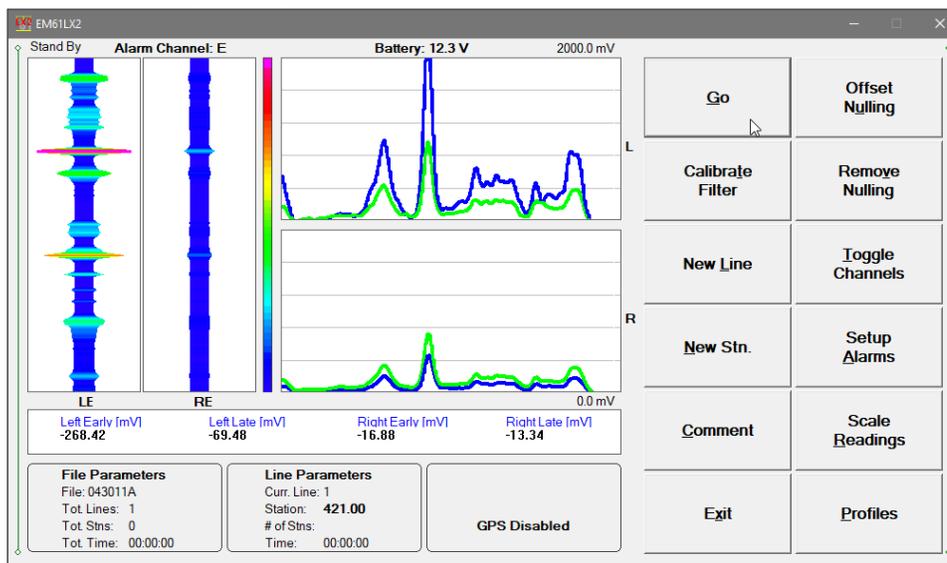
After tapping Exit button (or executing this option using keyboard) the program immediately returns to Main Screen.

## 6.2 Stand By Mode

After data file is created in Monitoring mode the program automatically switches logging window to Stand By mode. This window is similar to Monitor mode however it contains survey parameters (file name, survey line name, etc.), expanded set of options accessible by twelve command buttons. The logging window in Stand By mode in initial state (before any data is recorded) is presented below.



The main portion of the screen is occupied by the plot area which displays modulated ribbon response and profiles. The amplitude scale is divided by four or five grey grid lines in the profile mode graphic presentation. Two profile windows are labeled L (top one) and R (bottom window) indicating response of Left and Right coils. Each window contains two channels (Early and Late) for corresponding sensor. 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 line.



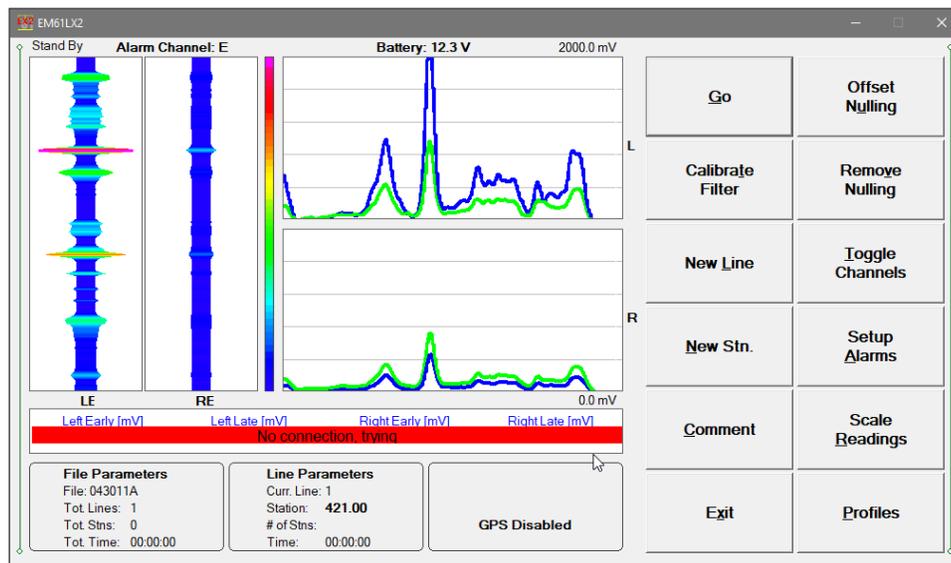
Readings for channels Left Early, Left Late, Right Early, Right Late are shown in numeric form below the plot area as in the monitoring mode. EM61-LX2 readings (in numeric form) are updated in Stand By mode approximately 10 times per second. Data shown in the plot area (modulated ribbon and profiles) are updated only during Logging mode when data are actually saved in the data file.

A section of the window at the top of the screen contains one line of text displaying survey and instrument related parameters. These are (from top left): logging mode **Stand By** or **Logging**, Alarm Channel Early or Late selected for both: the alarm info and for modulated ribbon display, EM61-LX2 battery level in Volts (labeled **Battery:**), and label for Maximum amplitude scale. When fiducial marker is active a label **Marker** is displayed in this line.

File and Survey Line parameters, and GPS information are displayed in three framed boxes at the bottom of the Stand By window. File Parameters frame displays: name of the data file, total number of survey lines, total number of stations collected in the file, and total time of surveying. The Line Parameters frame contains: name of current survey line, current station, number of stations in the current survey line, and time of surveying current line. In the Stand By mode the station number will not change. Stations in the EM61LX2 program are incremented by station increment value after each reading is written to the data file.

The third frame is dedicated to showing the GPS status. A number following the label **Position** provides the number of GPS positions saved in the current data file. In Stand By mode the number of positions is not incremented (it is updated only when GPS position is written to the file). Next two lines in this frame 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. On the right side of **DGPS** or **AGPS** label two green and white circles alternate. These two circles should alternate colours with the frequency of GPS update rate (usually 1 second intervals). If the circles do not change colours 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**). This value is available only when messages both, GGA and GSA are received from GPS. The last label **Sat** and following number shows the number of currently tracked satellites. Two bottom lines of the frame give current Latitude and Longitude of the instrument position (datum WGS1984). Position is updated with frequency of GPS receiver stream.

In case of any problems with instrument connection, battery failure, or accidental instrument Turn Off a message "No Communication, trying" will be displayed in numeric values window. The program window in Stand By mode and the alert message is shown below. The message is highlighted by red background to alert operator as fast as possible. The EM61LX2 will try to re-establish com-

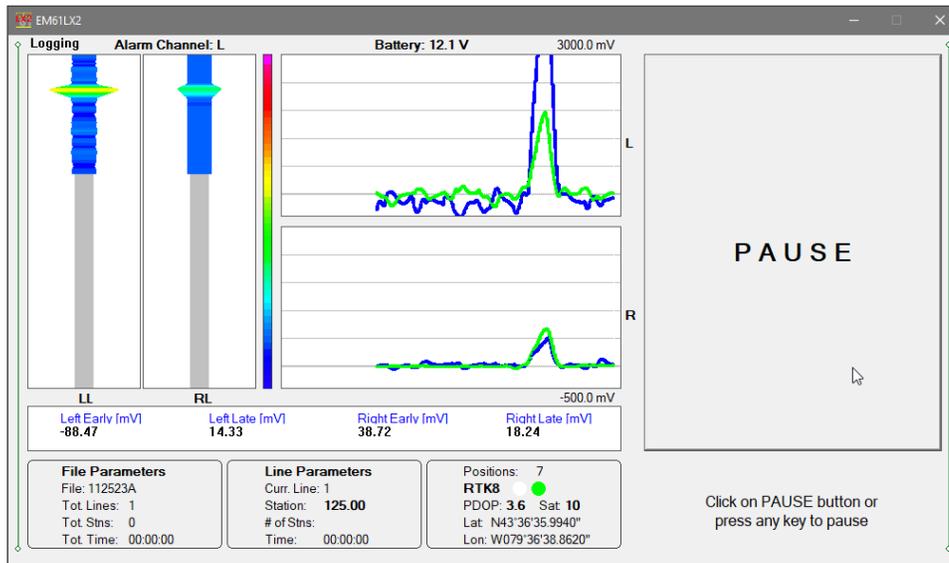


munication and after the problem is corrected the program will start communication automatically. Alternatively, click on the Exit button or execute this command from a keyboard.

Several available field options (in form of command buttons) are listed at the right side of the Stand By mode window. They will be described in the following section 6.4.

## 6.3 Logging Mode

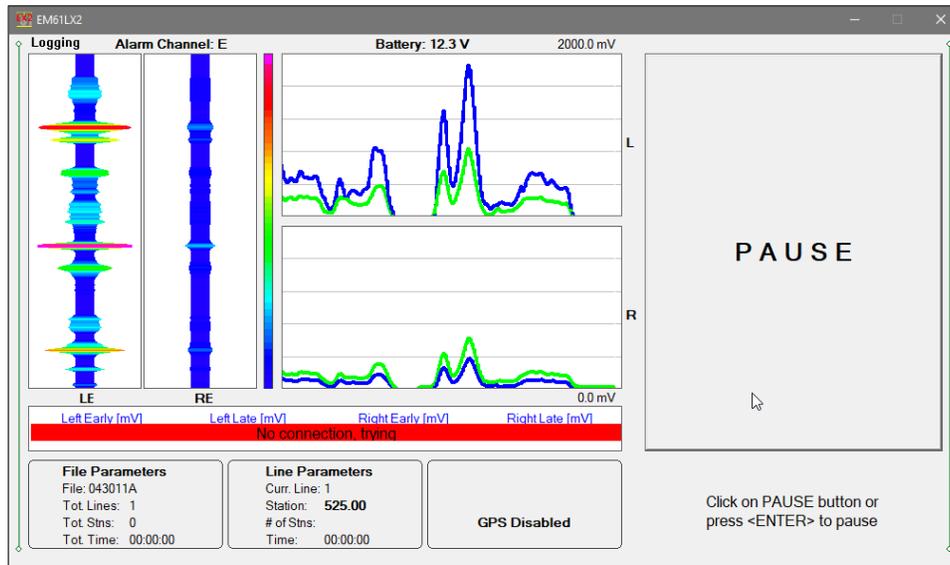
The Logging mode is enabled by clicking on the button labeled **GO (log data)** or pressing the shortcut key **G** (or the <ENTER> key if button **GO** is highlighted) in Stand By mode. After this button is pressed the list of buttons at bottom of the screen will be replaced by one **PAUSE** button, label Stand By will be replaced by label **Logging** (at the top of the display) and data will be logged at the update rate selected in the Survey Setup menu. All labels and parameters (with the exception of buttons representing Stand By mode options) are the same as in Stand By mode and they are described in the preceding section 6.2. The screen in Logging mode is presented below.



After the screen changes to Logging mode the current station (labeled **Station:**) is updated according to the station interval. Similarly, if GPS Input was enabled, total number of GPS positions (label **Positions**) in the data file is incremented every time (usually once a second) GPS position is written to the file. Profile curves and modulated ribbon graphic windows (for selected channels) are updated after each reading is written to the data file.

In case of any problems with instrument connection, battery failure, or accidental instrument Turn Off a message "No Communication, trying" will be displayed in numeric values window. The message is highlighted by red background to alert operator as fast as possible. The EM61LX2 will stop collecting data and will try to re-establish communication. After the problem is corrected the program will re-start communication automatically. Alternatively, click on the Pause button to return to Stand By mode. The program window in the Logging mode and the alert message is shown below.

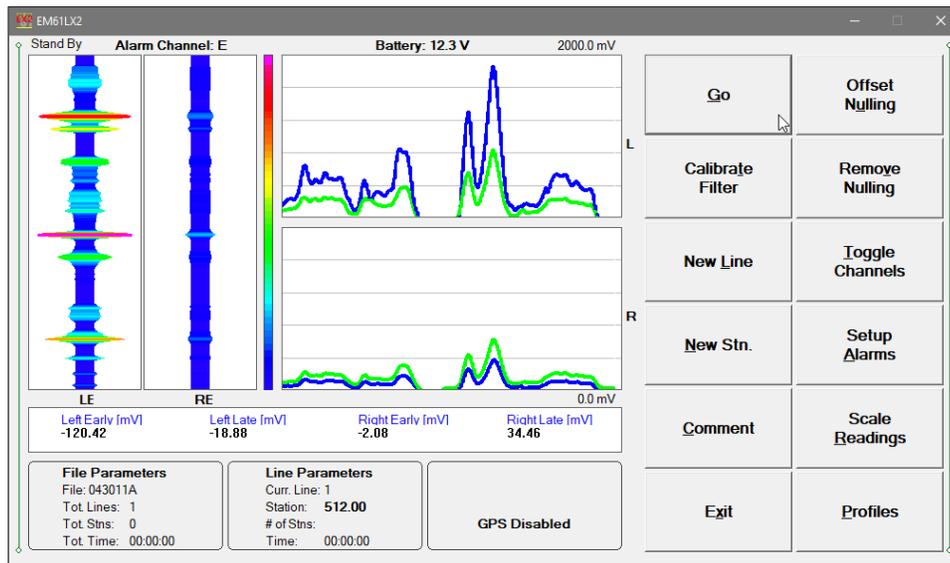
There is only one option available in the Logging mode - pause logging. After the Pause button is clicked or Pause key (any key or other Pause Key selected in Logger Setup window) is pressed the recording is stopped and the Logging mode returns to the Stand By mode. In Stand By mode the EM61-LX2 data will be displayed with the update rate approximately 10 readings per second, however data will not be saved in the log file and profile curves will be not updated.



Exit from the logging session and access to field options are available only from the logging window in Stand By mode.

## 6.4 Stand By Mode Field Options

Several field options are available while the Logging window is in the Stand By mode. Options can be accessed directly from command buttons, see Figure below. 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.

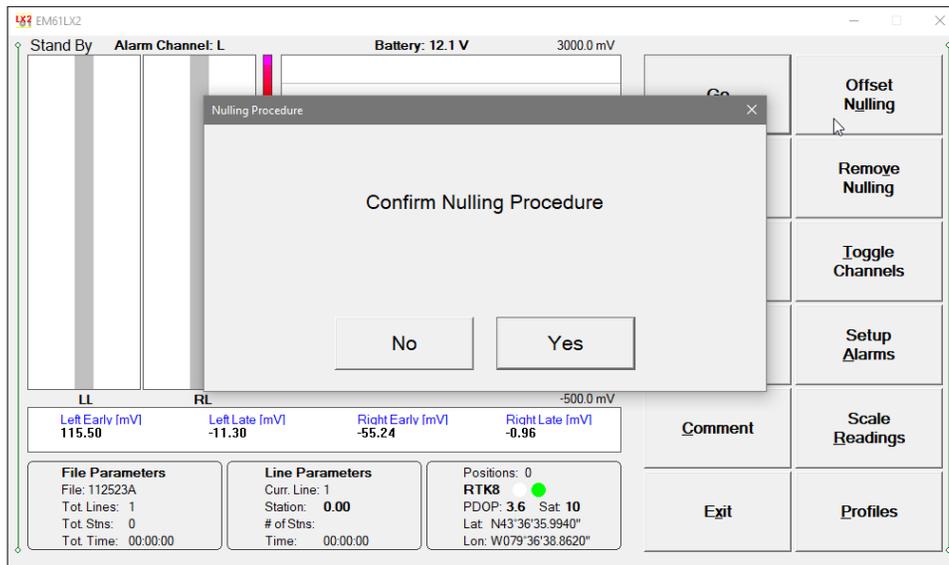


### **GO** (*start data logging*)

Click on the **GO** button, or while using the keyboard press shortcut key **<G>** or if the button is a default button (highlighted) press **<ENTER>**. The logging window in Stand By mode will change to Logging mode and logging data starts immediately.

## Offset Nulling

During data collection (in Stand By mode) a confirmation message will be displayed (there is no such message if Nulling is performed in Monitoring mode) before actual operation is applied (see Figure below).

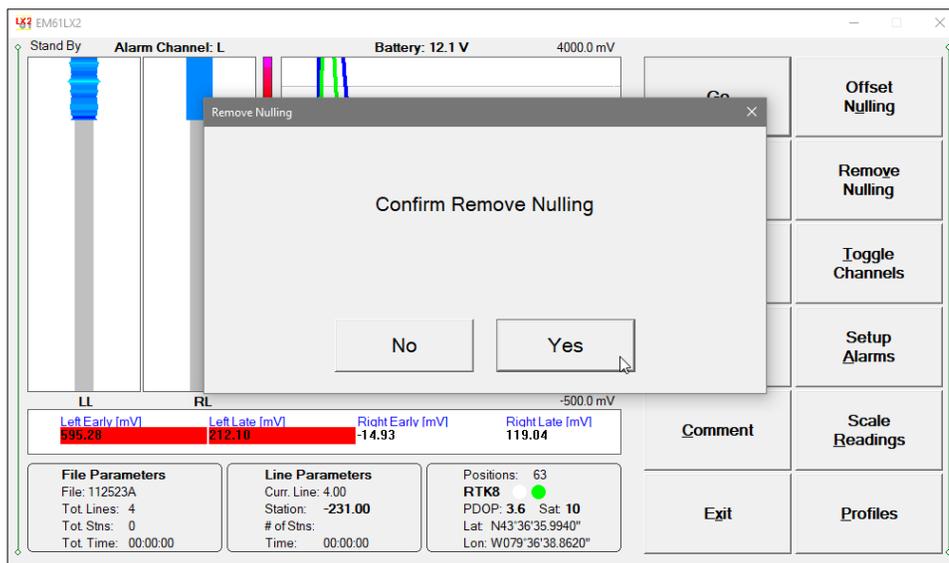


After above message is confirmed the program collects 100 readings and calculates the instrument offset.

The calculated offset is applied immediately to all the readings that follow this operation. If needed, this procedure can be repeated several times until satisfactory results are obtained. If original values (without calculated offsets) of the EM61-LX2 readings are needed use the Remove Nulling described below.

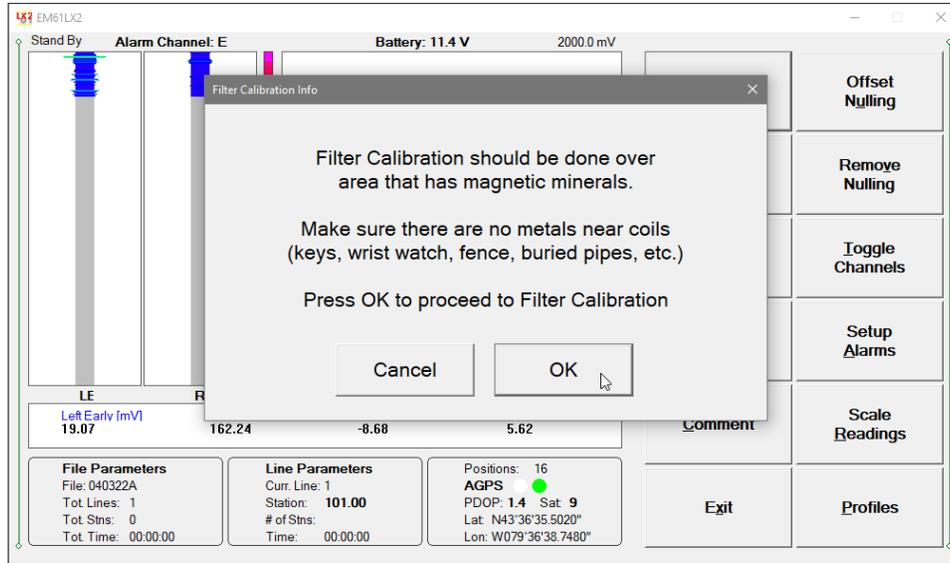
## Remove Nulling

It is "Undo" function for above Offset Nulling procedure. After the option will be executed all calculated Null Offsets (for each channel and sensor) will be reset to zero. In order to avoid accidental touch on the button a confirmation dialog is displayed before the Remove Null procedure (Figure below).



## Calibrate Filter

Filter Factors are used to remove soil magnetic susceptibility in surveyed area. These can be entered manually in System Setup dialog (see Chapter 3). Here in Stand By mode these factors can be determined by using automatic procedure. After the Calibrate Filter button is tapped or clicked on following message appears:

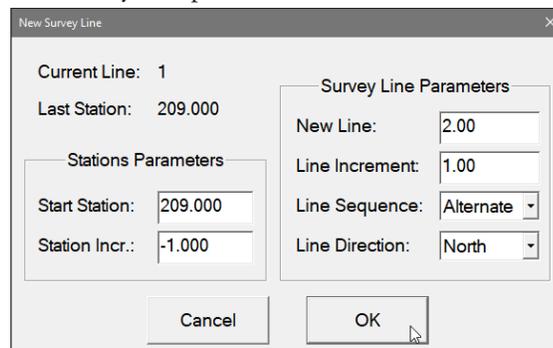


The procedure is exactly the same as described in the Section 6.1 (Monitoring mode options), please refer to that section where numerous figures present entire procedure in more detail. The first stage of Calibrate Factors consists of Offset Nulling calculations (previous Nulling Factors will be lost unless the Calibrate Filter function is cancelled). Offset Nulling procedure starts as soon as the OK button is pressed. Keep coils in the air till computer will beep (about 5 seconds) or if sound is not enabled till Message dialog will change and it will prompt to place coils on the ground.

When coils are placed on the ground then press OK to start next stage of Calibrating Filter. A message in numeric window will display Calculating, this stage lasts about 10 to 12 seconds. When done a message displaying calculated Filter Factors for Left and Right sensors will be displayed. New values can be accepted or previous factors can be restored by pressing the Cancel button.

## New Line (New Survey Line)

The New Survey Line dialog is displayed (see Figure below). Selecting this option allows the operator to enter a new survey line number (name) and 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.



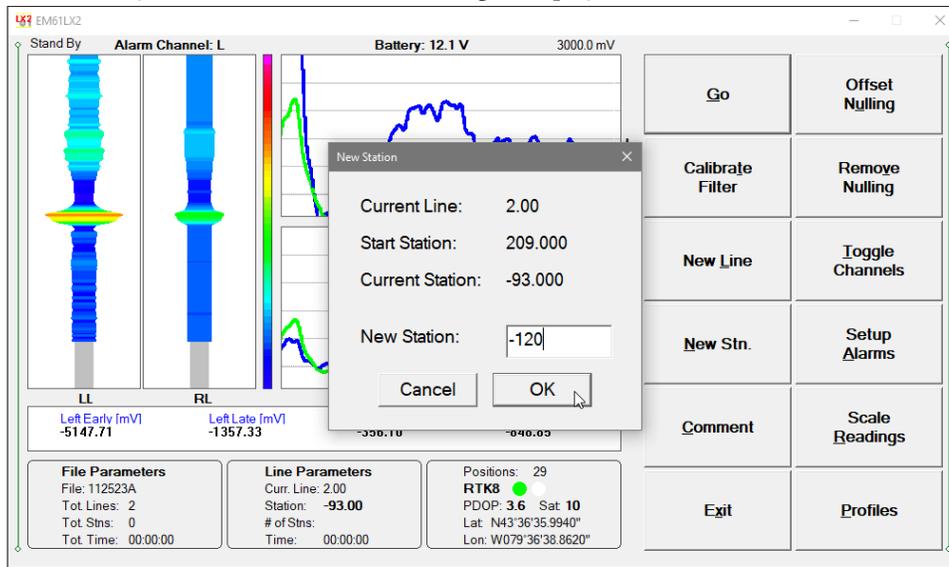
At the top of the dialog the last survey line name and the last logged station are displayed. Default name for the new line is given based on the Line Increment parameter. The default Start Station, direction of the Station Increment, and Direction are determined based on Sequence selection. All these parameters can be overwritten by the user as described in the Survey Setup menu description (chapter 2).

After all the parameters in the New Line dialog are updated tap the **OK** button or press **ENTER** key to accept the displayed settings. The program will return to the Logging window in Stand By mode. Survey line (**Ln:**) name and current station (**Stn:**) value will be updated and profile curves plot for former survey line will disappear.

To return to Stand By mode and current survey line settings (state before this dialog was selected) tap the **Cancel** button, the dialog window will disappear.

### New Stn. (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.



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

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

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

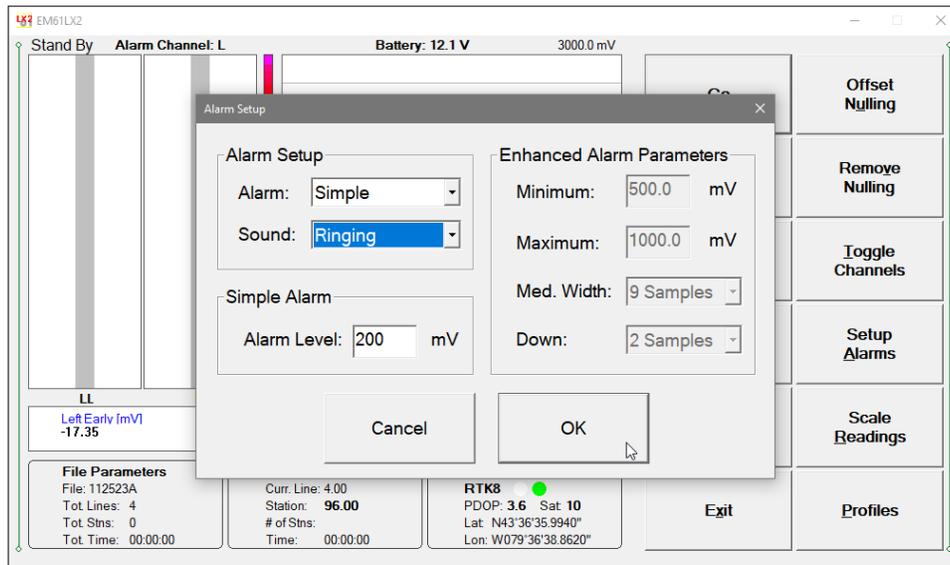
### Toggle Channels

Toggles between Channels E (Early) and L (Late) and Channel F (Filtered) display modes.

### Setup Alarms

After the **Alarm Setup** item was selected in the pop up menu the Alarm Setup dialog window appears on the screen. The dialog is presented below.

Please refer to chapter 3 and section 6.1 (above, in this chapter) where this dialog and its parameters are described in detail and more figures are provided.



## Alarm

This option allows you to selected one of three settings for alarm: Disabled, Simple, and Enhanced.

Tapping on the down arrow next to the text box labeled Alarm Type opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by pressing TAB key and then by using up or down arrow keys select one of the three available items: Disabled, Simple, and Enhanced. Depending on the selection corresponding portions of the dialog are enabled. In the Figure above, when the Simple item is selected the Simple Alarm section is enabled only while all Enhanced Alarm Parameters are disabled.

## Sound

This option allows you to specify the sound type of alarm. Tapping on the down arrow next to the text box labeled Sound Type opens a drop-down box showing the available settings, or when the keyboard is used activate the text box by pressing TAB key and then by using up or down arrow keys select one of the three available items: Disabled, Voice Indication, and Ringing.

When the Voice Indication is selected human voice indicates sensor (coil) that triggers alarm: **One** - left sensor, **Two** - right sensor, or **One And Two** if amplitude indicates target located between two sensors. The Ringing option provides ringing sound (minimum duration about 1 second) whenever alarm is triggered for any sensor.

## Alarm Level (Simple Alarm only)

Specify amplitude value that will trigger alarm. Whenever the target response will be larger than specified amplitude the alarm will be triggered. Visual alarm will be always displayed, while an audio alarm will sound depending on the Sound Type selection.

Following parameters described are available when the **Enhanced Alarm** is selected. Specified conditions for all parameters that belong to Enhanced Alarm set must be reached together to trigger alarm.

## Minimum and Maximum

The target response amplitude must be between Minimum and Maximum specified levels in mV to trigger alarm.

### Med. Width

The width of alarm specified by number of samples (readings). This parameter depends on the selected update rate (Survey Setup dialog). The native update rate of the instrument is 18 Hz. Therefore at update rate at 18 Hz when 0.5 second width is to be used then 9 samples should be selected, the same width for update rate 9 Hz requires 5 samples.

Tapping on the down arrow next to the text box labeled Med. Width opens a drop-down box showing the available parameters, or when the keyboard is used activate this text box by pressing TAB key and then by using up or down arrow keys select one of available items (minimum 5 samples and maximum 21 samples).

### Down

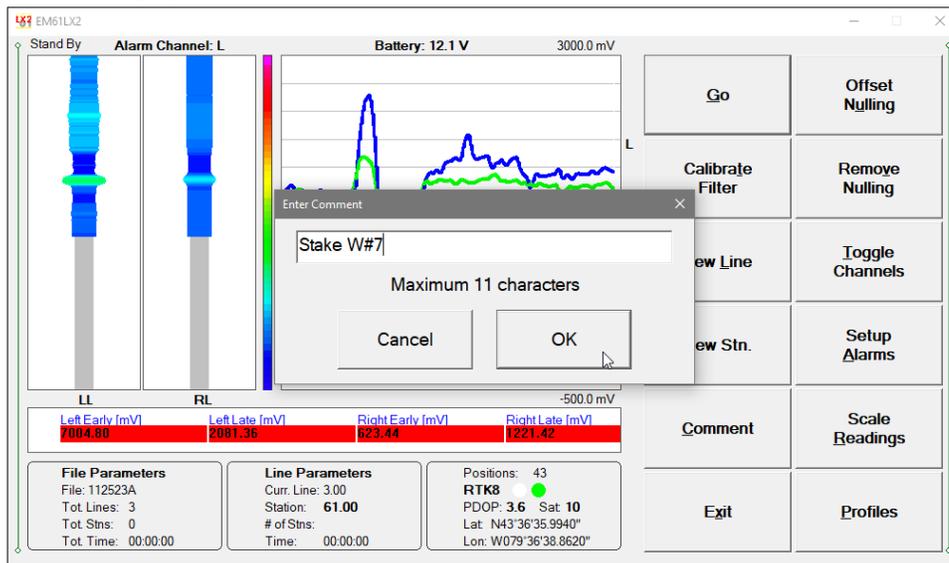
Select number of samples (1 or 2) that must be lower after the peak of anomaly. This option is used to avoid false alarm when the signal rises along the slope before reaching its maximum. Available selections are 1 or 2.

After all the parameters in the Alarm Setup dialog are updated tap the button **OK** to accept the displayed settings. The program will disappear. Updated settings will be now used to trigger alarms, new settings will be also written to the configuration file for subsequent program use. To return to original settings (state before this dialog was selected) tap the **Cancel** button. All parameters will not be updated.

See figures in section 6.1 that present visual alarm for both Left and Right coils and alarm for the Left coil only.

### Comment

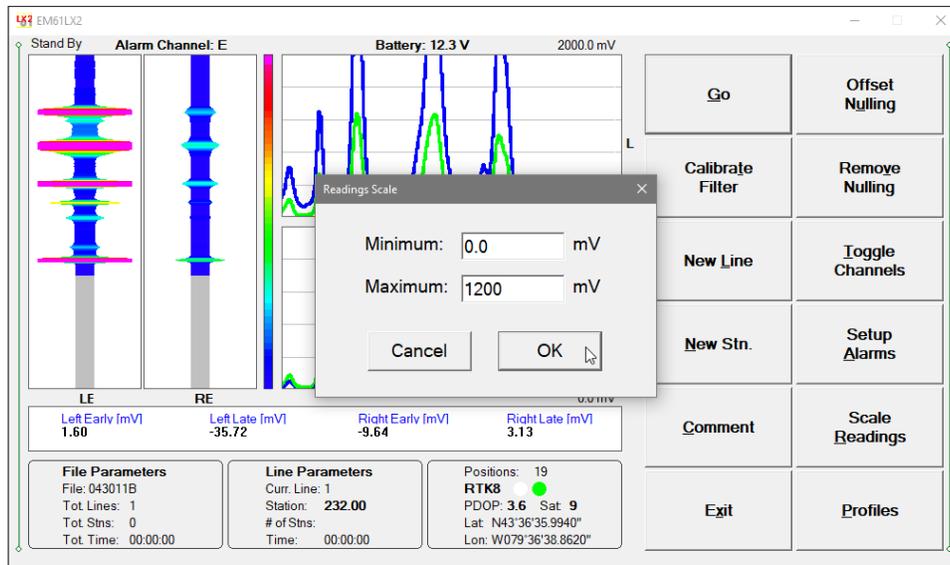
Selecting this option allows the operator to enter a comment at any point of the survey. A maximum of 11 characters can be entered as a comment. The Enter Comment dialog is displayed.



### Scale Readings *(New Scale for Readings Range)*

Selecting the Scale option allows the operator to enter new scale parameters for the instrument readings shown in corresponding graphic mode.

The Reading Scale dialog will be displayed. It contains two text boxes for Minimum and Maximum values of a new scale for profile plot. Current settings (minimum and maximum values) for the scale are displayed in the bottom right and top right corners of the plot area.



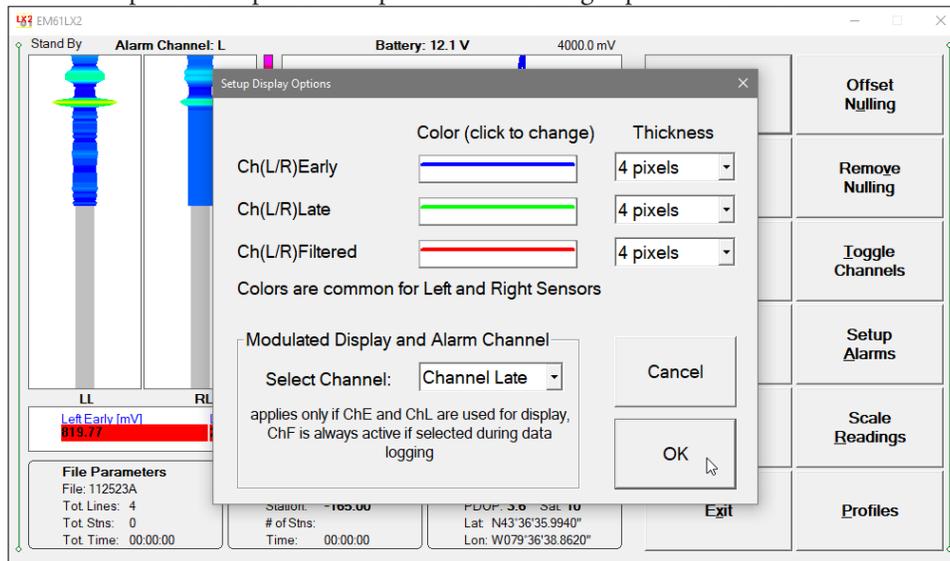
The same range of amplitude applies to colour distribution shown in modulated ribbon graphic display.

After minimum and maximum values are specified tap the **OK** button or press **ENTER** key to accept to accept new values and the profile plot area will be redrawn.

To ignore an entry and return to Stand By mode tap the **Cancel** button, the dialog window will disappear and measurements can be continued.

### Profiles *(options for profile plot display)*

After the **Display Options** item was selected in the pop up menu the Display Options dialog window appears on the screen. This dialog allows you to enable and disable the display of each channel profile, specify color and thickness of profiles, and select linear or compressed amplitude for profiles. The dialog is presented below.



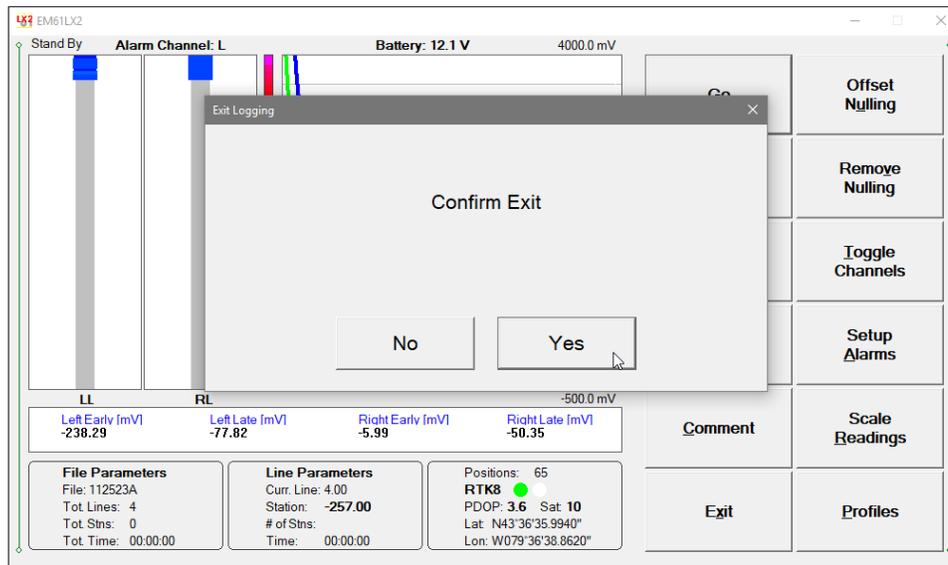
Please refer to chapter 5 where this dialog and its parameters are described in detail.

Tap the button **OK** or press **ENTER** key to accept updated display parameters. The dialog will disappear and profile plot area will be redrawn in Stand By mode.

To return to Stand By mode and current display options (state before this dialog was selected) tap the **Cancel** button and the dialog window will disappear.

## Exit (exit data logging)

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

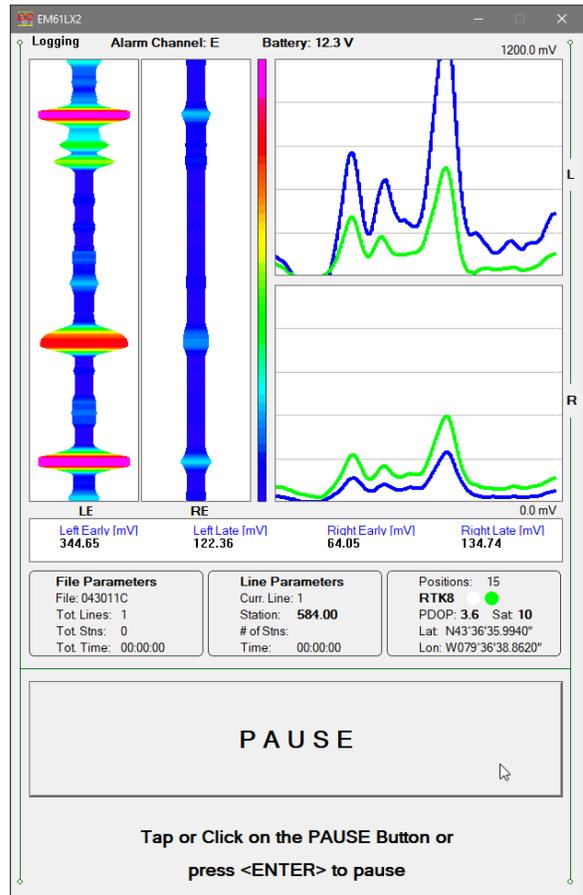
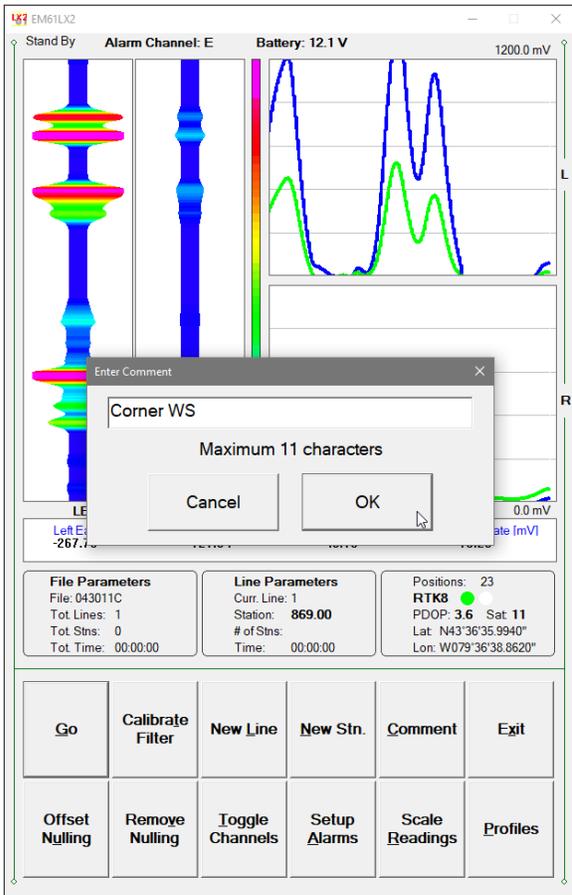
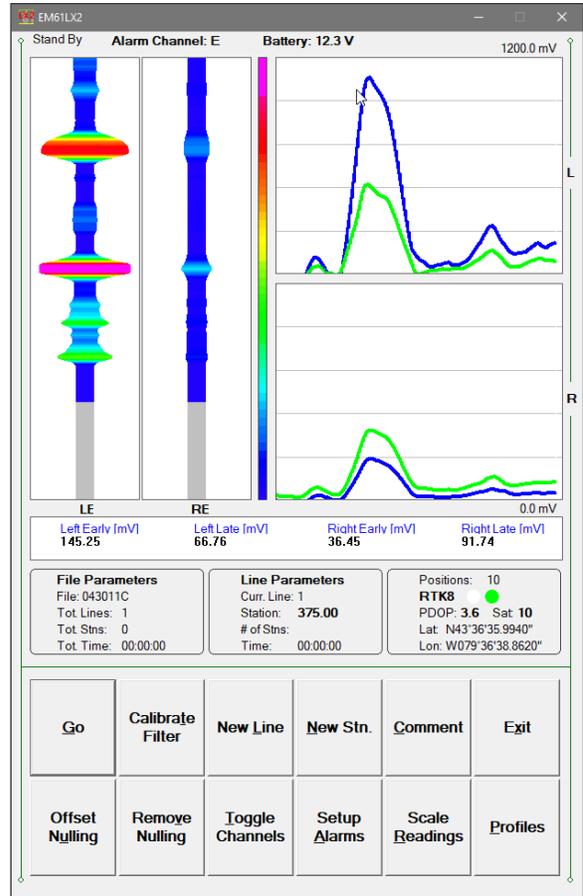
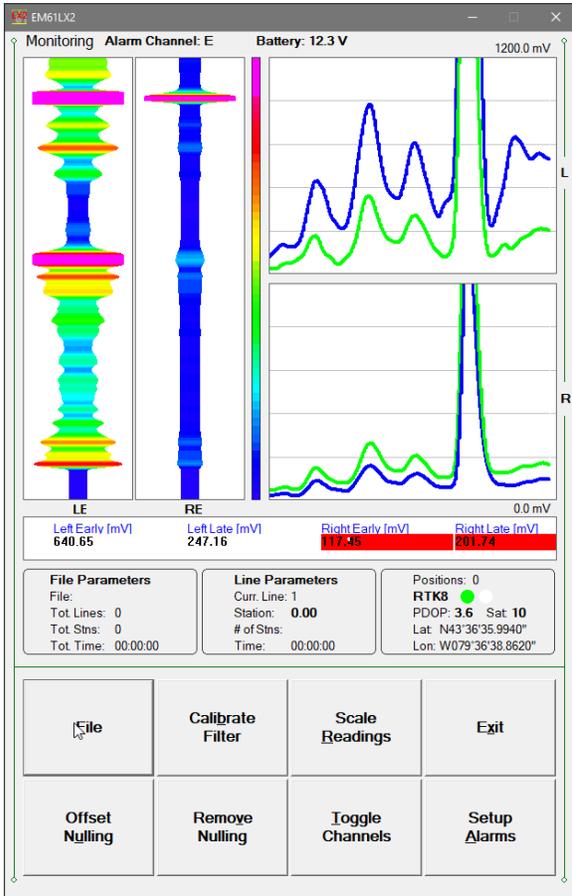


After above message is confirmed the program stops logging, closes data file and returns to Main Screen.

## 6.5 Logging Screen Layout in the Portrait Display Mode

Almost all figures shown in the manual for practical layout reason present program screen shots of program used in landscape screen orientation. Four figures shown in the following pages depict logging screen layout for computers that use portrait display orientation.

Program provides exactly the same info and parameters regardless of the screen orientation, the only difference is layout. The program detects the computer display orientation and adjusts its layout automatically. However, it is very important to fix the display orientation (in Windows Settings) to either mode. The program cannot trace screen rotation and adjust its layout during data collection.





# Appendix A

## A.1 Description of Data File in EM61LX2 (L61) Format

Each record contains 24 characters, including line feed at the end of each record.

**Header of the file (contains 9 records starting with characters E, H, G, O, O, O, O, I, I)**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
E	M	6	1	L	X	2		V	1	1	0	Survey Type	UT	IT	IM		IA	IB	IP	10			
H																							10
G																							10
O																							10
O																							10
O																							10
O																							10
I																						IN	10
I																						IN	10

EM61LX2(or LX1)	-	identification: LX2 - 2 sensors, LX1 - one sensor
V110	-	version number (1.10)
Survey Type	-	GPS (if GPS Input Enabled) or GRD (grid)
UT	-	unit type (0 = meters, 1 = feet)
IT	-	instrument type (0 = Standard, 1 = N.C.C.)
IM, IA, IB, IP, IN	-	not used in this version (fixed values 0, 8, 1, 3, 1)
File Name	-	file name, maximum 8 characters
Time Increment	-	time increment (Auto Mode) in seconds
GPS X/Y Offset	-	GPS antenna offsets from coils center (x and y)
Offset	-	offset for indicated channels in mV
Filter Factor	-	entered Filter Factor (separate for Left and Right coil)
10	-	Line Feed character

**Header at the start of survey line (10 records starting with L, B, A, Z, O, O, O, O, I, I)**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
L																							10
B																							10
A	Dir																						10
Z	D	D	M	M	Y	Y	Y	Y		H	H	:	M	M	:	S	S						10
O																						IN	10
O																						IN	10
O																						IN	10
O																						IN	10
I																						IN	10
I																						IN	10

Line Name	-	Line Name, maximum 8 characters
Start Station	-	Start Station for the Line, format F11.2
Dir	-	Direction of the Line (E, W, N, or S)
Station Inc.	-	Station Increment, format F11.3
Date	-	Date when Line was created, format DD-MM-YYYY
Time	-	Real Time when Line was created, format HH:MM:SS
Offset	-	Offset for indicated channels in mV at the start of Line
Previous Offset	-	Previous offset for indicated channels in mV
Filter Factor	-	Filter Factor value for indicated coil the start of Line
Previous Filter	-	Previous Filter Factor value for indicated coil
IN	-	Not used in this version (=1 fixed )
10	-	Line Feed character

### Timer Relation

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
*	Computer Time (Format HH:MM:SS.sss)											Time Stamp in milliseconds										10	

Indicates relation between computer clock and the program timer. This record links timer in milliseconds and computer time (local time) in format HH:MM:SS.sss. This record is written to the file each time a new new line is entered.

### 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
I	Gn	1h	1l	2h	2l	3h	3l	4h	4l	5h	5l	6	Time Stamp in ms (10 digits)										10

I	-	indicator
<b>D</b>	-	Standard reading
<b>N</b>	-	Standard reading +Marker
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 LE
1l	-	lower byte of Channel LE
2h	-	higher byte of the 2's complement Hex number of Channel LL
2l	-	lower byte of Channel LL
3h	-	higher byte of the 2's complement Hex number of Channel RE
3l	-	lower byte of Channel RE
4h	-	higher byte of the 2's complement Hex number of Channel RL
4l	-	lower byte of Channel RL
5h	-	higher byte of the 2's complement Hex number of TX current
5l	-	lower byte of TX current
6	-	fraction of current (5h 5l), Hex number
Time Stamp	-	time in ms from the Windows start (resets every 49.7 days)
10	-	Line Feed character

(when one coil is used then all bytes for channels RE and RL must be ignored, single coil bytes are written in fields designated for Left Coil - ChLE and ChLL)

### 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
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
S	New Station (Format 11.2)											Time Stamp in ms (10 digits)											10

### 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
O	Offset for ChLE (F9.2)											Former Offset for ChLE (F9.2)											10
O	Offset for ChLL (F9.2)											Former Offset for ChLL (F9.2)											10
O	Offset for ChRE (F9.2)											Former Offset for ChRE (F9.2)											10
O	Offset for ChRL (F9.2)											Former Offset for ChRL (F9.2)											10

### New Filter Factors

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
I	Filter Factor - Left Coil (F9.2)											Previous Filter Factor - Left (F9.2)											IN	10
I	Filter Factor - Right Coil (F9.2)											Previous Filter Factor - Right (F9.2)											IN	10

Filter Factor - indicates New Filter Factor value for indicated Coil,  
 Previous Filter Factor - indicates previous Filter Factor value for indicated Coil.

### GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 22 characters strings and placed in the EM61LX2 data file which contains 24 characters records, including one character indicator and line feed at the end of each record. The GPS sequence starts at the line which contains character @ as the first character, then records that contain continuation of the same message start with character #. The GPS sequence ends with a line starting with the character !. The last line contains logger time stamp in milliseconds for given GPS reading. A sample of the GPS message written in EM61LX2 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
@	\$	G	P	G	G	A	,	h	h	m	m	s	s	.	s	s	,	d	d	m	m	.	10
#	m	m	m	m	m	,	s	,	d	d	d	m	m	.	m	m	m	m	m	,	s	,	10
#	n	,	q	q	,	p	p	.	p	,	s	a	a	a	a	a	.	a	a	,	u	,	10
#	±	x	x	x	x	.	x	,	M	,	s	s	s	,	a	a	a	*	c	c	CR	LF	10
!	Time Stamp in milliseconds																					10	

The GPS sequence may contain 4 to 6 records. Component 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 definition of each component of GGA data message.

Any record started by sequence X\$, for example X\$STARTED are placed for information and diagnostic purpose.

## A.2 Conversion Factors

EM61LX2 has four channels. Channels LE and LL (Left Early and Left Late) for the Left Coil and channels RE and RL (Right Early and Right Late) for the Right Coil. If one coil is used then data is placed in fields for the Left Coil and data for the Right Coil are to be ignored.

The instrument response is converted to output voltage in mV for each sampling channel as given below.

Channel LE, LL, RE, RL-	converted data
DATA_LE (to RL)	- instrument output for each channel as recorded in logger
RANGE	- range is controlled by the EM61LX2 console, it can be 1, 10, 100

$$\text{Channel LE} = (\text{DATA\_LE} \times 20.0) / \text{RANGE}$$

$$\text{Channel LL} = (\text{DATA\_LL} \times 20.0) / \text{RANGE}$$

$$\text{Channel RE} = (\text{DATA\_RE} \times 20.0) / \text{RANGE}$$

$$\text{Channel RL} = (\text{DATA\_RL} \times 20.0) / \text{RANGE}$$

If EM61-LX2 type N.C.C. was selected then skip below paragraph describing TX current normalization.

Assuming EM61-LX2 type Standard was selected each channel is normalized by current following formula:

$$\text{Channel} = \text{Channel} \times 1585.6 / \text{Current}$$

if Current is larger or equal to 2212.00 then

$$\text{Channel} = \text{Channel} \times (2 \times 1585.6) / \text{Current}$$

where, Current is a value represented by **5h**, **5l**, and **6** in EM61LX2 data file (see section A.1)

When Nulling procedure was performed (Nulling offsets are not equal 0.00) in records started with character O then channel values are further corrected for each channel according to formula:

$$\text{Channel} = \text{Channel} - \text{Offset}$$

Table of Ranges Determined by the EM61-LX2 Microprocessor

HEX	Ch1	Ch2	Ch3	Ch4	HEX	Ch1	Ch2	Ch3	Ch4	HEX	Ch1	Ch2	Ch3	Ch4
0	1	1	1	1	40	10	1	1	1	C0	100	1	1	1
1	1	1	1	10	41	10	1	1	10	C1	100	1	1	10
3	1	1	1	100	43	10	1	1	100	C3	100	1	1	100
4	1	1	10	1	44	10	1	10	1	C4	100	1	10	1
5	1	1	10	10	45	10	1	10	10	C5	100	1	10	10
7	1	1	10	100	47	10	1	10	100	C7	100	1	10	100
C	1	1	100	1	4C	10	1	100	1	CC	100	1	100	1
D	1	1	100	10	4D	10	1	100	10	CD	100	1	100	10
F	1	1	100	100	4F	10	1	100	100	CF	100	1	100	100
10	1	10	1	1	50	10	10	1	1	D0	100	10	1	1
11	1	10	1	10	51	10	10	1	10	D1	100	10	1	10
13	1	10	1	100	53	10	10	1	100	D3	100	10	1	100
14	1	10	10	1	54	10	10	10	1	D4	100	10	10	1
15	1	10	10	10	55	10	10	10	10	D5	100	10	10	10
17	1	10	10	100	57	10	10	10	100	D7	100	10	10	100
1C	1	10	100	1	5C	10	10	100	1	DC	100	10	100	1
1D	1	10	100	10	5D	10	10	100	10	DD	100	10	100	10
1F	1	10	100	100	5F	10	10	100	100	DF	100	10	100	100
30	1	100	1	1	70	10	100	1	1	F0	100	100	1	1
31	1	100	1	10	71	10	100	1	10	F1	100	100	1	10
33	1	100	1	100	73	10	100	1	100	F3	100	100	1	100
34	1	100	10	1	74	10	100	10	1	F4	100	100	10	1
35	1	100	10	10	75	10	100	10	10	F5	100	100	10	10
37	1	100	10	100	77	10	100	10	100	F7	100	100	10	100
3C	1	100	100	1	7C	10	100	100	1	FC	100	100	100	1
3D	1	100	100	10	7D	10	100	100	10	FD	100	100	100	10
3F	1	100	100	100	7F	10	100	100	100	FF	100	100	100	100

### A.3 Example of Data File in EM61LX2 (L61) Format

The EM61LX2 data file records are written in binary format, therefore the file may have different shape when displayed or printed, depending on particular video or printer settings.

```

EM61LX2 V110GRD000 14
H 101822A 0.200
G 0.00 0.00
O 4866.21 0.00
O 2198.59 0.00
O 991.80 0.00
O 560.03 0.00
I -13.89 0.00 1
I 32.42 0.00 1
LO
B 0.00
AS 1.000
Z18102018 22:52:27
O 4866.21 0.00 1
O 2198.59 0.00 1
O 991.80 0.00 1
O 560.03 0.00 1
I -13.89 -1.18 1
I 32.42 -0.49 1
*22:52:27.265 128900391
X$STARTED 128904256
Dy E Q : 128904309
Dy E E ] > 128904529
@$PGGA,020414.00,4336.
#59411,N,07936.64846,W,
#2,6,2,141.68,M,-35,M,6
#,119*5D
! 128904739
Dy Å Æ h 5 128904749
Dy µ,0 , 128904970
Dy U Y- , 128905190
Dy 2 î ï + 128905410
Dy A I ñ 3 128905631
Dy Y ° h 7 128905851
Dy A - V ) 128906071
Dy O ¼ ^ ^ 128906292
Dy E ¢ Z Å 128906512
Dy i ¢ e / 128906732
Dy i ¢ j 3 128906953
Dy ¼ ¢ U D 128907173
Dy à à E ^ I 128907393
Dy E ¾ Y ? 128907614
X$PAUSED 128907687
O 5008.10 0.00 1
O 2168.37 0.00 1
O 1005.95 0.00 1
O 551.51 0.00 1
I 0.12 -13.89 1
I -2.78 32.42 1
X$STARTED 128944609
Dy ï E T , b 128944790
Dy ï U b / b 128945011
Dy à à ð \ . a 128945231
Dy à à N S * a 128945451
Dy I ½ K 0 a 128945672
Dy O ¼ G 5 b 128945893
X$PAUSED 128946010
O 0.00 5008.10 1
O 0.00 2168.37 1
O 0.00 1005.95 1
O 0.00 551.51 1
X$STARTED 128952006
Dy ¢ S 5 b 128952171
Dy ¢ î Y 6 b 128952391
Dy © x X : b 128952611
Dy 1 È m 1 b 128952832
Dy U . ^ 2 b 128953055
X$PAUSED 128953759
O 4825.90 0.00 1
O 2099.59 0.00 1
O 920.99 0.00 1
O 558.88 0.00 1
X$STARTED 128973188
Dy E ¾ W 6 Y 128973320
Dy ® © T 2 Y 128973541
Dy " ¾ P 2 Z 128973761
Dy - ï W 5 Z 128973981
Dy ï È R 3 Y 128974202
X$PAUSED 128974224
C$stake#77W 128986392
X$STARTED 129032168
Dy ù P 8 @ 129032363
Dy O S 7 ? 129032583
.....

```