

OPERATING INSTRUCTIONS
EM38-MK2 DATA LOGGING SYSTEM
FOR WINDOWS 10 BASED FIELD TABLET COMPUTER

EM38MK2win

Version 1.10

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1. Introduction

The Geonics EM38MK2win Data Logging System (DAS70-win) consists of a tablet/laptop field computer, data logging program EM38MK2win, and associated cable to connect the computer to the Geonics EM38-MK2 or EM38-MK2-1 instrument. The program EM38MK2win is designed for a IBM PC compatible computer and MS Windows 10 (or 7) operating system.

The program is prepared for the MS Windows 10 tablet Mesa2 (manufactured by Juniper Systems) operated in the vertical (portrait) as well as in horizontal (landscape) display mode, however screen orientation must be locked during data collection. 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 EM38MK2win program acquires and records survey data from the EM38-MK2 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. Readings are displayed in real time in mS/m and ppt in graphic and numeric mode. The EM38MK2win also continuously monitors the EM38-MK2 measured component (Conductivity or Inphase), dipole mode (Vertical or Horizontal), state of fiducial marker, as well as GPS signal quality parameters (if connected to the system) without leaving the program.

The program allows the user to set the EM38-MK2 into a specific instrument mode of operation: AUTO, Wheel, or Manual modes. In AUTO mode readings can be automatically recorded in desired time intervals. In Wheel mode readings are triggered by a counter installed at the wheel assembly, and in MANUAL mode readings are triggered manually by the operator. In AUTO and Wheel modes the program can record one combination of the EM38-MK2 components (Conductivity and Inphase), two (0.5 m and 1 m) or one separations depending on the EM38-MK2 instrument type, and one dipole mode (Vertical or Horizontal) per station. In Manual mode any combination of dipole modes can be taken at each station, and data can be averaged at up to 100 samples per reading.

The EM38MK2win will accept NMEA-0183 compatible data from a GPS receiver directly connected to an Allegro field computer. GPS data which are embedded in the EM38MK2win data file can be processed later in the Geonics DAT38MK2 program. The connected GPS must be able to stream NMEA-0183 compatible messages. The EM38MK2win 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 EM38MK2win 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 N38. Files can be converted to M38 format and viewed in DAT38MK2 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 21 readings per second assuming 5 Hz (or less) GPS input.

1.1 Program Requirements

To successfully use this software, you will need :

Computer

- Mesa2 field computer (or similar) operating under Windows 10 or 7,
- minimum 4 Gb of RAM memory,
- USB memory module 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 in serial port mode.

Geonics EM38-MK2

The EM38-MK2 (or EM38-MK2-1) instrument with associated cables (or Bluetooth option).

The EM38MK2win installation program SetupEM38MK2win.exe can be stored on DAT38MK2 CD disk and it is available for download from the Geonics web site. A necessary configuration file (with extension name .INI) is created in your field computer after the program is run for the first time.

1.2 Installing EM38MK2win

The program must be installed by running the SetupEM38MK2win that will setup the EM38MK2win in the field computer. The installation program follows standard Windows procedure.

If the SetupEM38MK2win.exe program file is included on the DAT38MK2 CD disk, or it is downloaded from the web site it can be conveniently installed by copying the SetupEM38MK2win.exe to USB drive and running installation from USB drive inserted in Mesa2 or similar field computer.

After you run the program for the first time it will create permanent configuration file (.INI) which contains program settings. The configuration file is created in the folder ProgramData/Geonics/EM38MK2win/. The EM38MK2win data files contain extension name N38 and their base names should be limited to 8 characters.

1.3 Running EM38MK2win Program

Start EM38MK2win by double clicking the EM38MK2win icon in the Start|Programs menu, in Windows Explorer, or on the desktop if a shortcut was created. At the start, EM38MK2win displays the Main Screen (described and shown below).

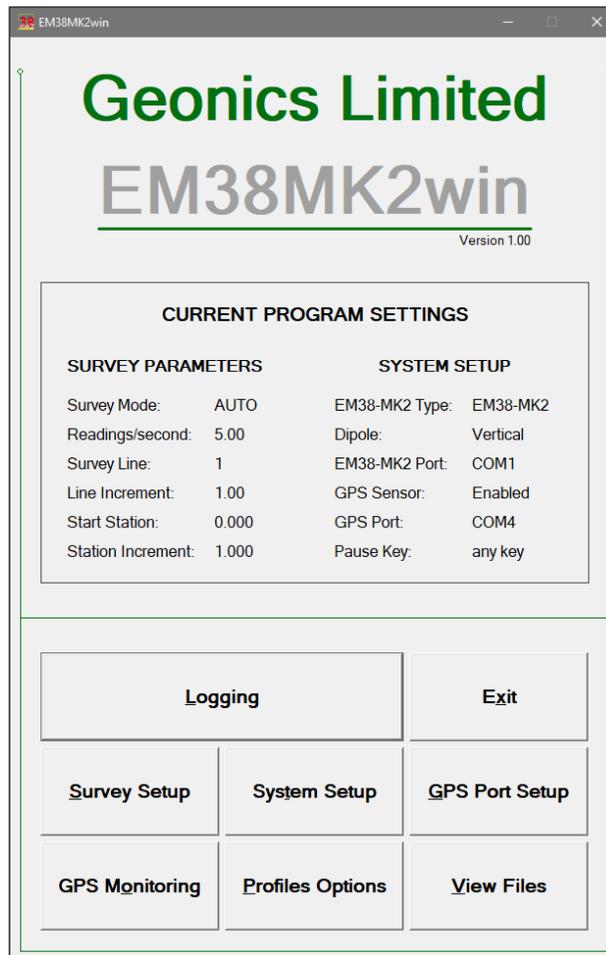
The EM38MK2win is a command button and dialog driven program. Command buttons can be executed by tapping (if touch screen is used) or clicking with the left mouse button, or by pressing the indicated (underlined) character on the keyboard, or by using TAB to scroll through the buttons and ENTER to execute. 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 at

the bottom of display. The central portion of the main screen 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.

1.4 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 EM38MK2win Main Screen in the portrait screen mode is displayed below.



These options are selected by clicking on 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.

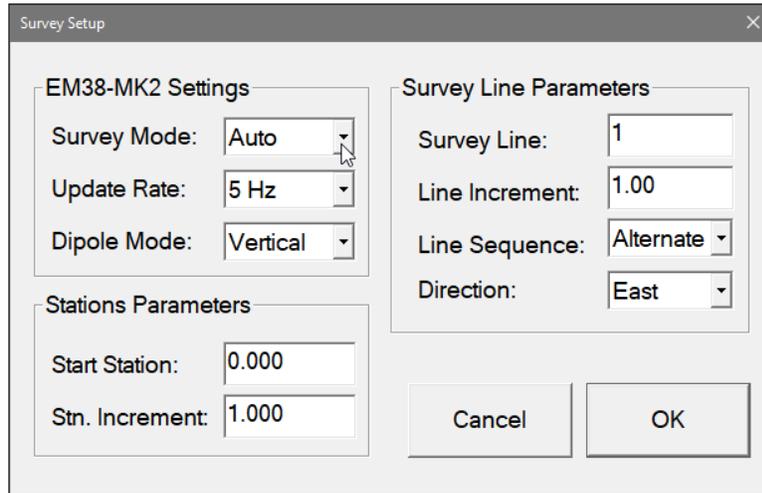
Short description of Main Screen options

Logging

This option allows to monitor and log the EM38-MK2 output. The Logging screen starts always in Monitor mode, and then after a data file is created Logging mode is available. Monitor mode provides several options: creating data file, monitoring EM38-MK2 output and quality of GPS signal, and specifying selected survey parameters, etc.

Survey Setup

The Survey Setup dialog will be displayed. All survey settings (survey mode, update rate, survey line name, increments, etc.) can be specified in this dialog.



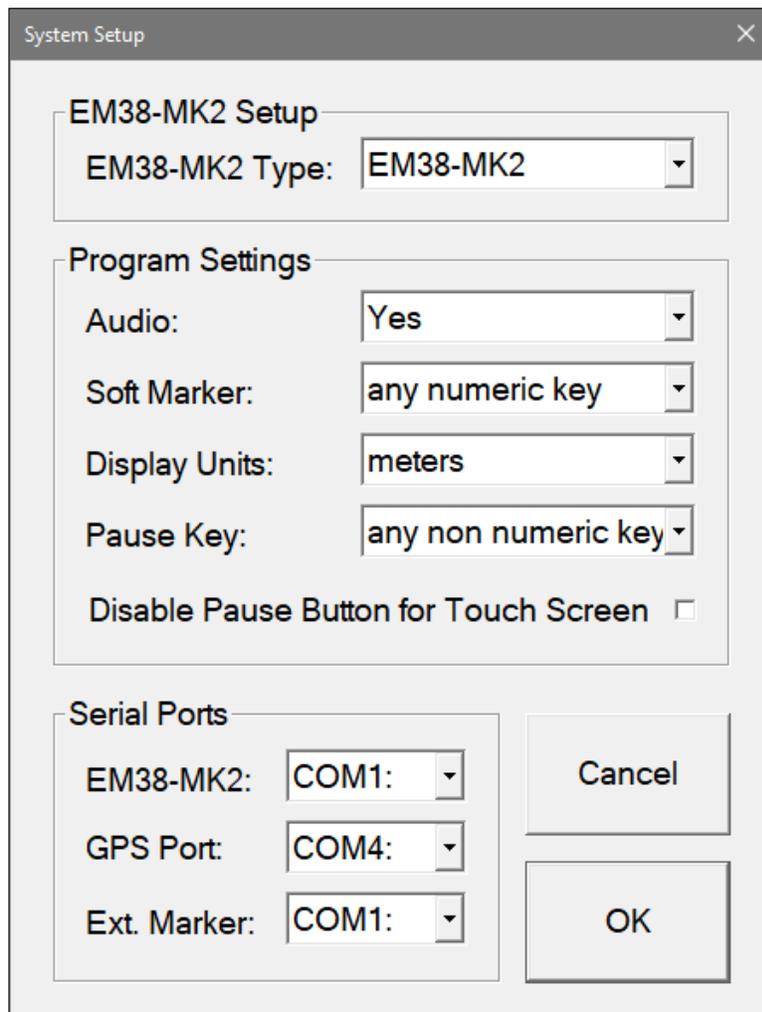
The Survey Setup dialog box contains the following settings:

- EM38-MK2 Settings:**
 - Survey Mode: Auto
 - Update Rate: 5 Hz
 - Dipole Mode: Vertical
- Stations Parameters:**
 - Start Station: 0.000
 - Stn. Increment: 1.000
- Survey Line Parameters:**
 - Survey Line: 1
 - Line Increment: 1.00
 - Line Sequence: Alternate
 - Direction: East

Buttons: Cancel, OK

System Setup

Dialog window that is associated with this option is used to set the instrument type, serial port numbers, audio reading confirmation, type of pause key.



The System Setup dialog box contains the following settings:

- EM38-MK2 Setup:**
 - EM38-MK2 Type: EM38-MK2
- Program Settings:**
 - Audio: Yes
 - Soft Marker: any numeric key
 - Display Units: meters
 - Pause Key: any non numeric key
 - Disable Pause Button for Touch Screen:
- Serial Ports:**
 - EM38-MK2: COM1
 - GPS Port: COM4
 - Ext. Marker: COM1

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. GPS monitoring window can be accessed from this dialog as well.

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 grid lines used for profile display.

View Files

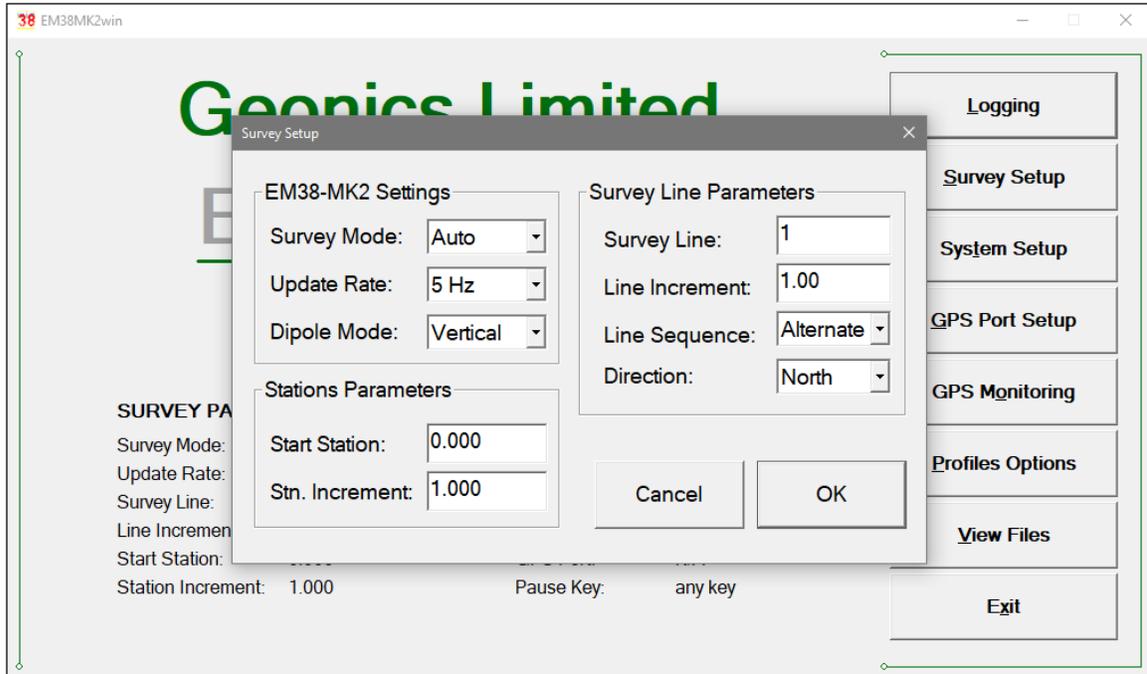
This option can be used to open collected data file and display survey line profiles.

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 (instrument mode, frequency of data collection, etc.) and survey geometry layout (survey line names, line spacing, start station, station increment, etc.).

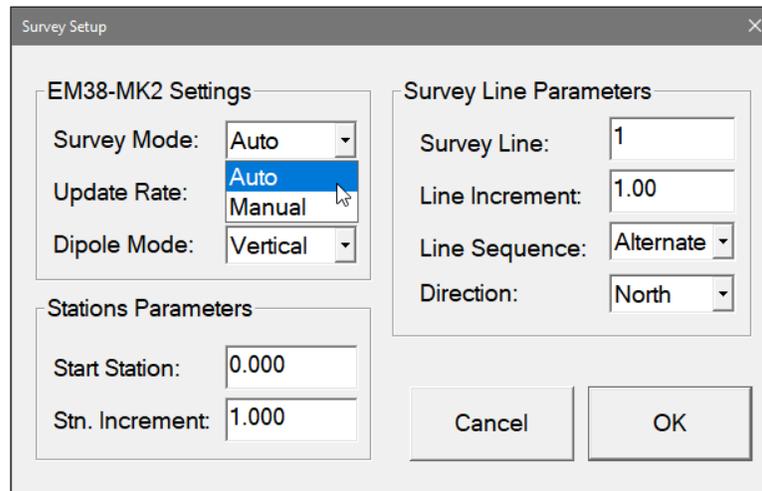


To select any option tap or click on the corresponding drop-down list box or text box, or use TAB key to scroll to the option and then use mouse or the **Down** and **Up** keys in drop-down box (parameters that have only a few possible options), or keyboard for text box entry.

Description of Options and Parameters:

Survey Mode (EM38-MK2 Mode)

This option allows you to select the type of survey mode. Set the EM38-MK2 mode of operation by selecting an item from the drop-down listbox labeled Survey Mode. Available modes are: Auto and Manual. These modes of operation are described below.



Auto Mode

Readings will be triggered automatically at a selected frequency (see option Update Rate).

In Auto Mode only one dipole mode (Vertical or Horizontal) can be selected.

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

- EM38-MK2 Settings:**
 - Survey Mode: Auto
 - Update Rate: 5 Hz
 - Dipole Mode: Vertical
- Stations Parameters:**
 - Start Station: 0.000
 - Stn. Increment: 1.000
- Survey Line Parameters:**
 - Survey Line: 1
 - Line Increment: 1.00
 - Line Sequence: Alternate
 - Direction: East

Buttons: Cancel, OK

Manual Mode

Readings will be taken only while the manual trigger (switch on the instrument console or a handle) is pressed.

In Manual Mode any combination of component and dipole modes (Vertical, Horizontal, or Both) can be selected.

Please note that when Manual mode is selected options the option Reading/s changes to option labeled Samples/Rdg.

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

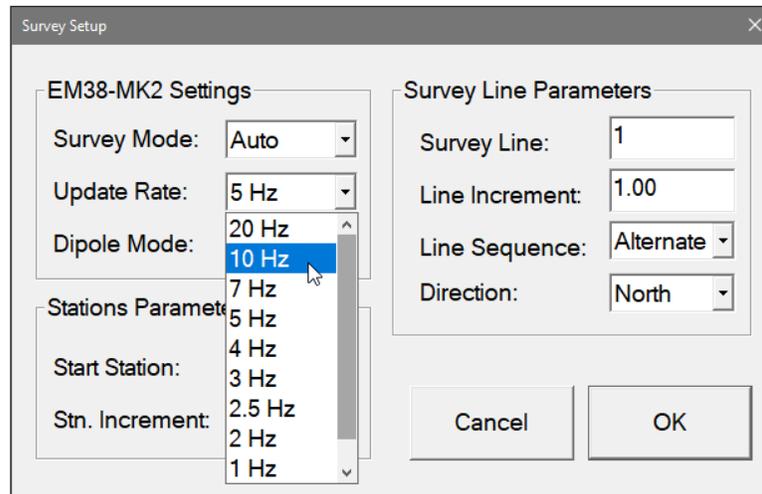
- EM38-MK2 Settings:**
 - Survey Mode: Manual
 - Samples/Rdg: 10
 - Dipole Mode: Vertical
- Stations Parameters:**
 - Start Station: 0.000
 - Stn. Increment: 1.000
- Survey Line Parameters:**
 - Survey Line: 1
 - Line Increment: 1.00
 - Line Sequence: Alternate
 - Direction: East

Buttons: Cancel, OK

Update Rate

This option is available only in Auto mode. Clicking on the down arrow next to the text box labeled Update Rate opens a drop-down box showing available settings: 20 Hz, 10 Hz, 7 Hz, 5 Hz, 4 Hz, 3 Hz, 2.5 Hz, 2 Hz, 1 Hz, and 0.5 Hz.

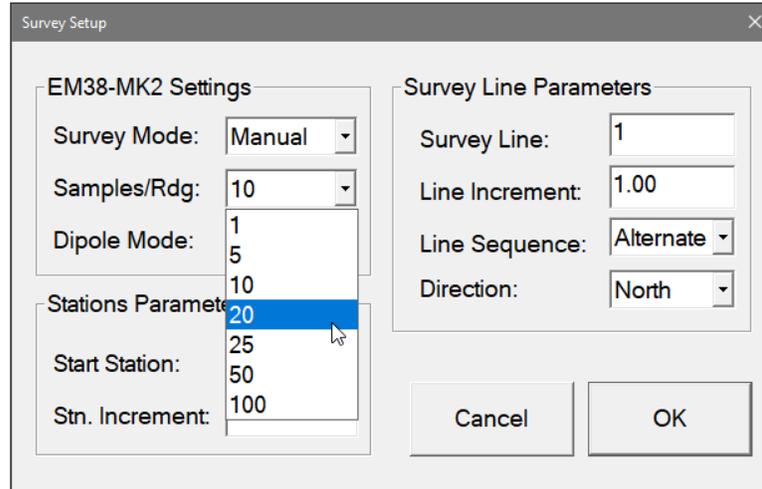
This parameter describes number of readings per second that will be taken. The EM38-MK2 frequency is based on the base data output of almost 21 readings per second. Therefore selections reflect the nearest possible base frequency of the instrument, i.e. at user selection of 20 Hz program will record every record (effectively close to 21 Hz), at selection 10 Hz the program will record every 2nd reading (result frequency very close to 10.5 readings/s), selection 7 Hz will cause program to record every 3rd reading, and so on.



Samples/Rdg (Samples per Reading)

When this option is highlighted the combo box is activated and you can select desired value. Selections are: 1 (no averaging), 5, 10, 20, 25, 50, and 100 samples.

This parameter describes number of readings that will be taken after the trigger switch is pressed. At the end of sampling time the logger will beep and an average value will be written in to the file and plotted on the screen. During the sampling period interval data are measured at approximately 20 readings per second. For example by specifying 10 samples, 0.5 second will be used at each station. The maximal sampling is 100 readings which corresponds to approximately 5 seconds at each station.



This option could be used to improve quality of data in areas of high industrial noise, especially if the ground conductivity is relatively low (small response signal).

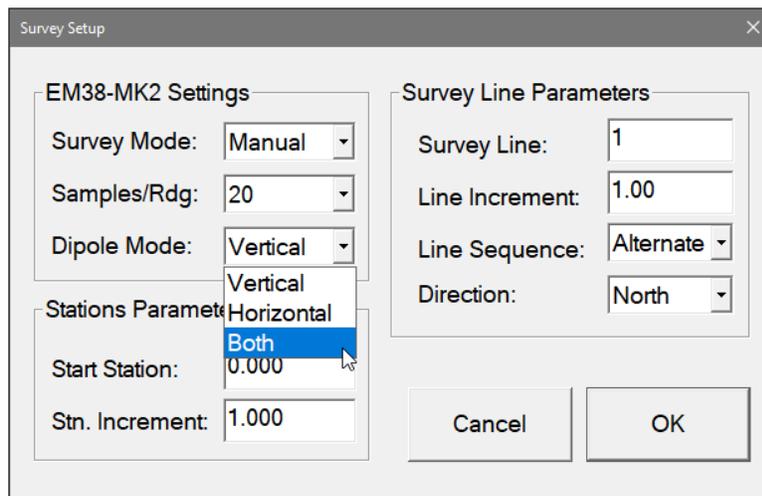
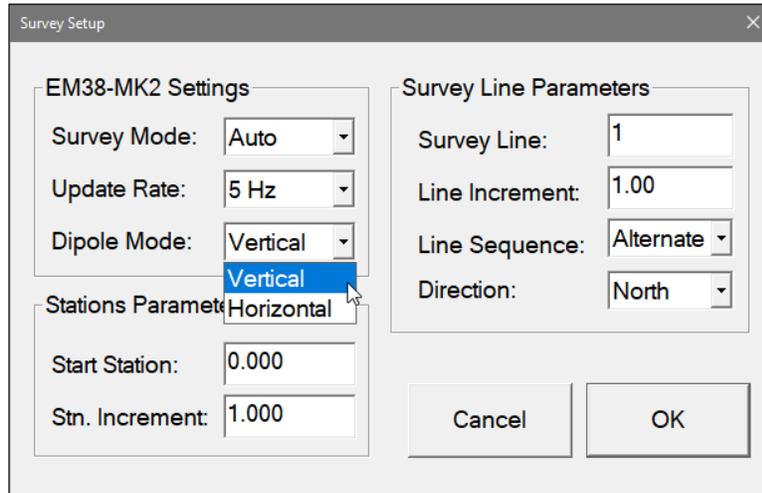
In cases when multiple sampling is not required (good signal to noise ratio) select 1 and 1 reading per station will be taken.

This selection is displayed only when the Manual Mode was selected.

Dipole Mode (instrument dipole mode)

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

When Manual mode was selected three settings are available: Vertical, Horizontal, and Both. If Auto or Wheel mode was selected two available dipole modes are: Vertical or Horizontal (see two Figures below).



Survey Line (survey line name)

Activate text box by clicking with a mouse left button 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.

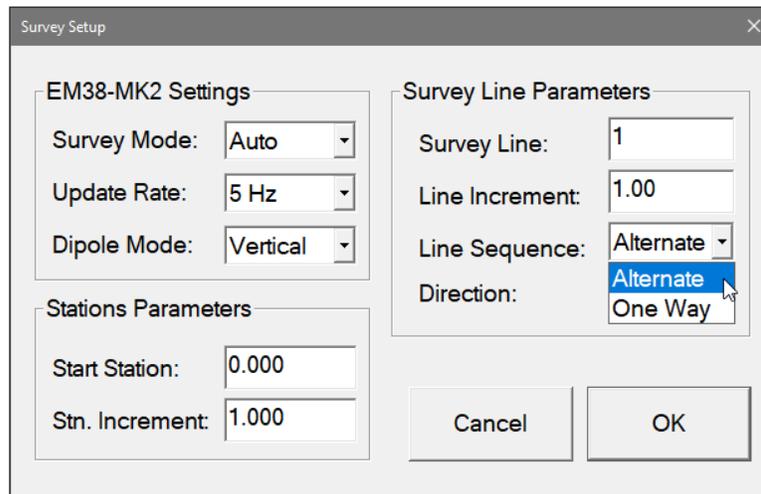
Line Incr. (survey line name)

Activate text box by clicking with a mouse 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

When this option is highlighted and drop-down box is expanded use mouse or use **Down** or **Up** cursor key to toggle between two available settings: Alternate and One Way.



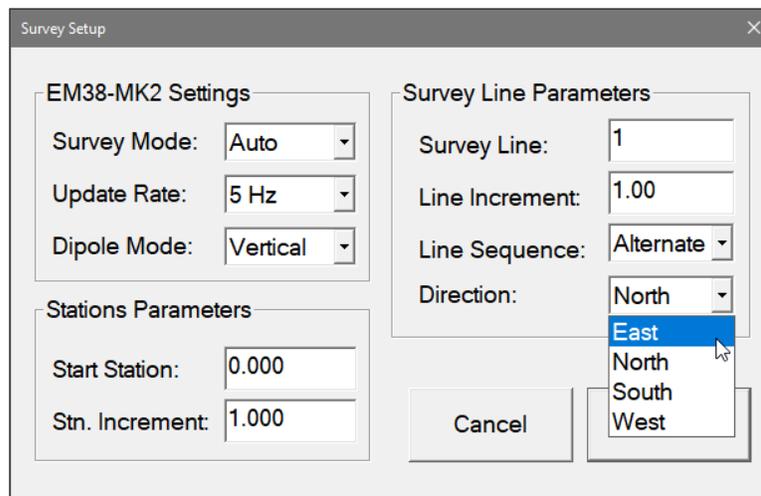
Alternate is used when neighboring lines are surveyed in the opposite direction, which is the most common procedure during field surveys.

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

Clicking 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 clicking 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 clicking with a mouse or using **TAB** key and then enter the desired value for the station increment.

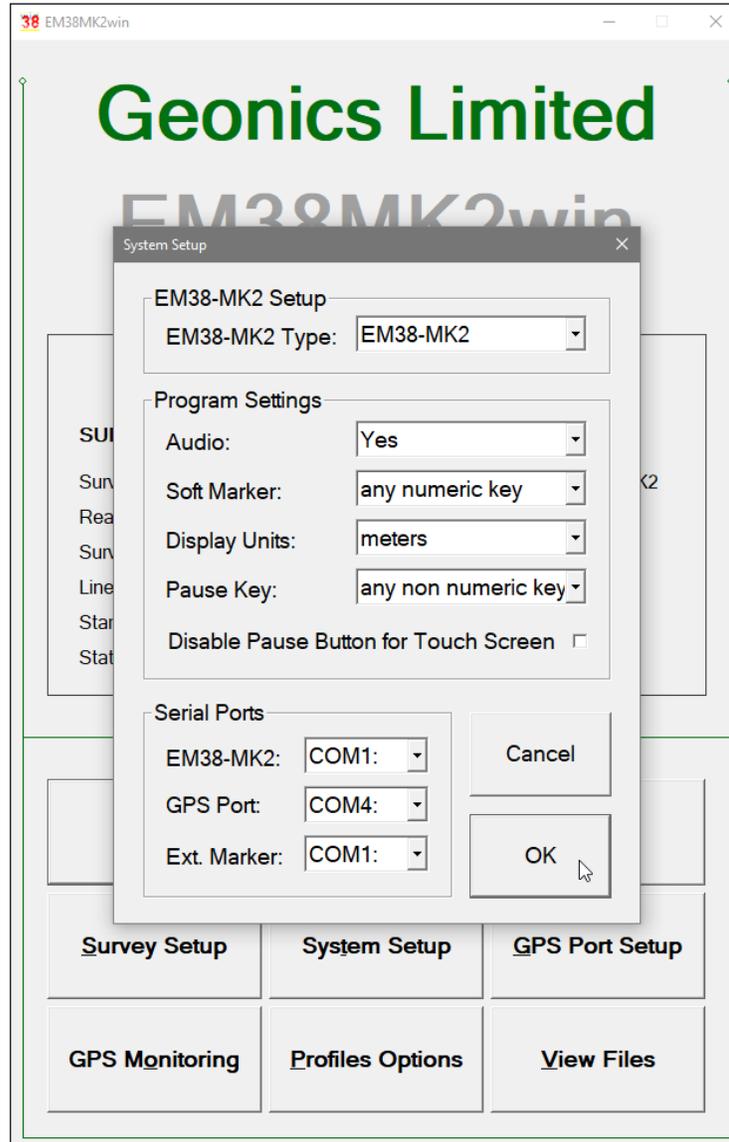
This parameter specifies the station increment for the selected survey line. This value is used in conjunction with Start Station to calculate the current station number for display purposes. Station Increment cannot have value zero. If zero is entered the program will revert Station Increment to default value 1.00.

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

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

3. System Setup

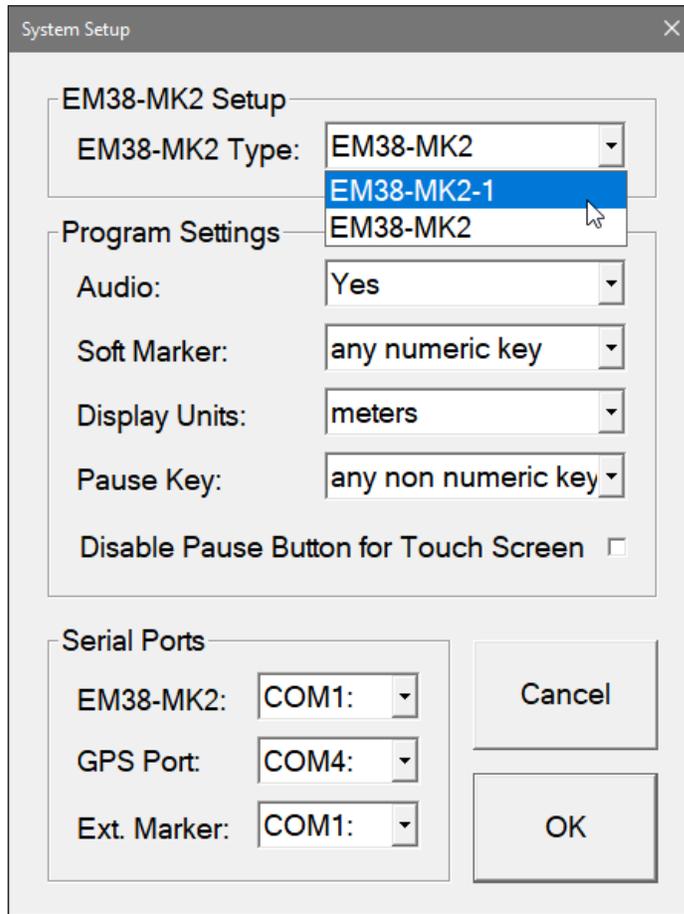
This dialog allows you to specify used type of the EM38-MK2 type, Pause Key selection, Software Marker, Audio on/off, and select serial ports for the EM38-MK2, GPS, and External (hardware) Marker. The System Setup dialog is presented below.



Description of Parameters:

EM38-MK2 Type

Two models of the EM38-MK2 are available: **EM38-MK2-1** and **EM38-MK2**. Providing similar functionality, including the simultaneous measurement of both quad-phase (conductivity) and in-phase (magnetic susceptibility) components, the defining difference between the models is the number of included receiver coils: the EM38-MK2-1 includes one receiver coil with a 1 meter transmitter / receiver intercoil spacing; the EM38-MK2 includes two receiver coils with 0.5 and 1 meter intercoil spacings. The program default is the **EM38-MK2**.



Audio

Two selections are available: **Yes** or **No**. The audible click will be generated at each reading when this option is enabled. At fast rate (above 5 readings/s) the sound may appear not uniform, however this does not affect quality of data acquisition.

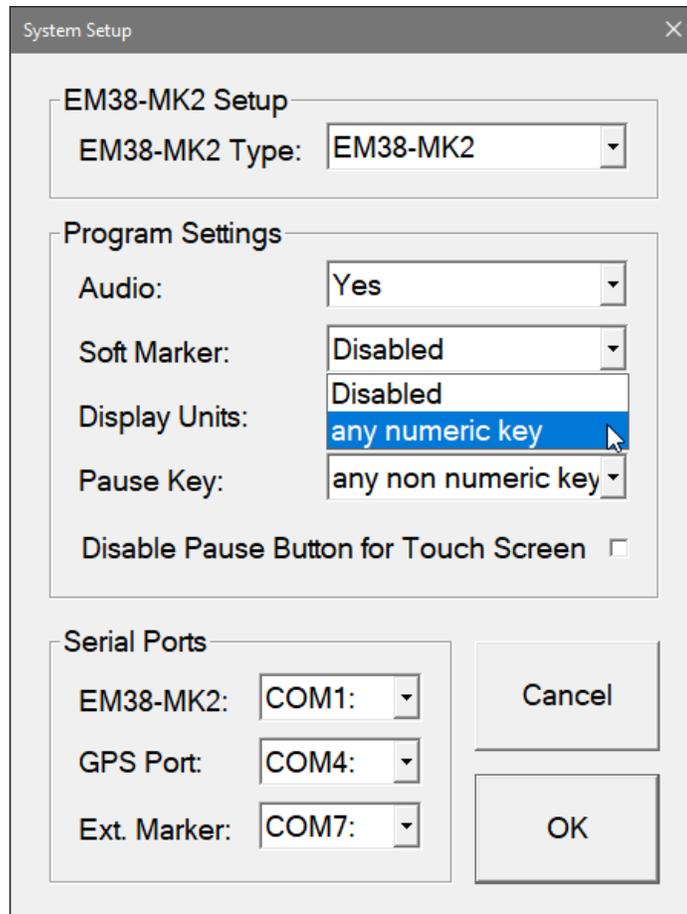
Soft Marker (Software Based Marker)

A software based fiducial marker is available in addition to the standard fiducial markers (located on the instrument panel or on the optional Extender Arm and the above described optional External Marker connected to one of the serial ports). All three types of fiducial markers provide the same function and are saved in the data file.

There are two available selections for the Soft Marker: **Disabled** and **any numeric key**. When the latter option is selected pressing any numeric key (from 0 to 9) on the computer keypad during logging session will tag current station as a station with fiducial marker. It acts exactly the same way as a standard marker located on the instrument panel.

In case a tablet with no ard keyboard and without numeric keys is used then one of user defined keys must be assigned to any numeric key (for example key P1 can be assigned to any number between 1 and 9 in Mesa2).

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



Display Units

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

Pause key

Four selections are available: **any non numeric key**, **Enter**, **Space Bar**, and **P**. This feature is used to pause data recording during logging session. Default setting **any non numeric key** (numeric keys are reserved for the Soft Marker) 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 is used the best setting is **<ENTER>** key, since user specified keys P1, P2, and P3 may have various assignment, and when **<any non numeric key>** is selected then only four arrow keys and the **Enter** key are reliable.

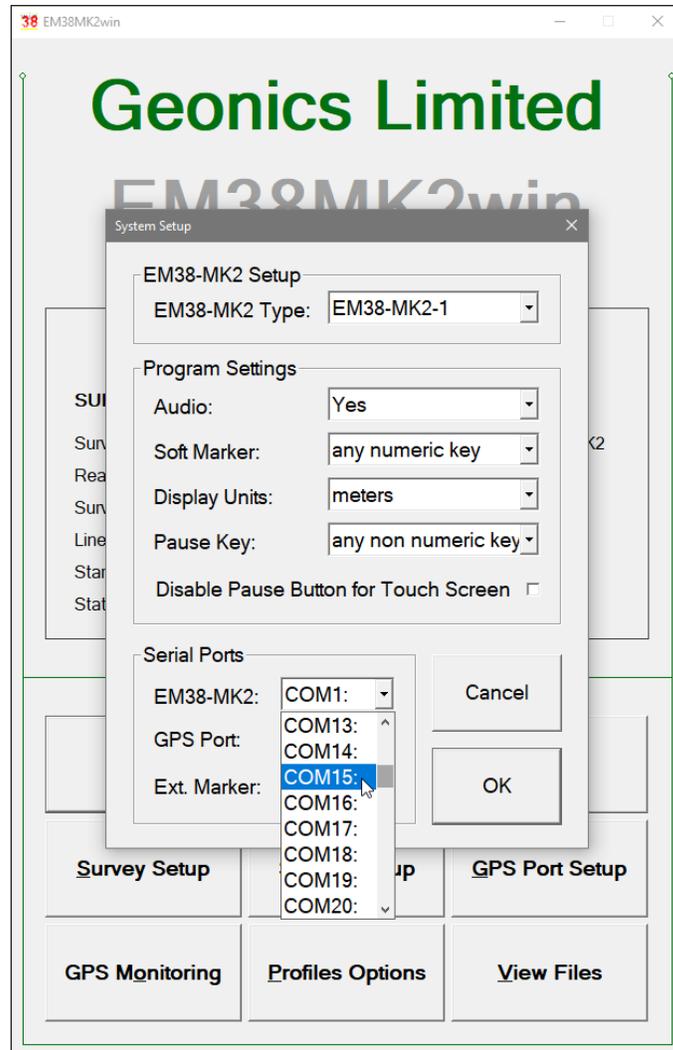
Disable Pause Button (for Touch Screen)

This option is useful when Mesa2 and similar computer with enable touch screen are used. It helps avoiding logging procedure by accidental touch of the computer display. When this option is checked the touch operation is disabled for the Pause button and logging can be paused only by pressing computer key (for example **<Enter>**).

In case of a conflicting Pause Key (lack of specified key in the computer) a soft keyboard can be opened and used at any moment. This option affects only sensitivity of the Pause button, other touch enabled functions are not affected.

EM38-MK2 Port

The number of serial port that is assigned to the EM38-MK2. Available selections: COM1 to COM60. The program default is COM1. Communication parameters for the selected serial port are set by the program, since the EM38-MK2 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

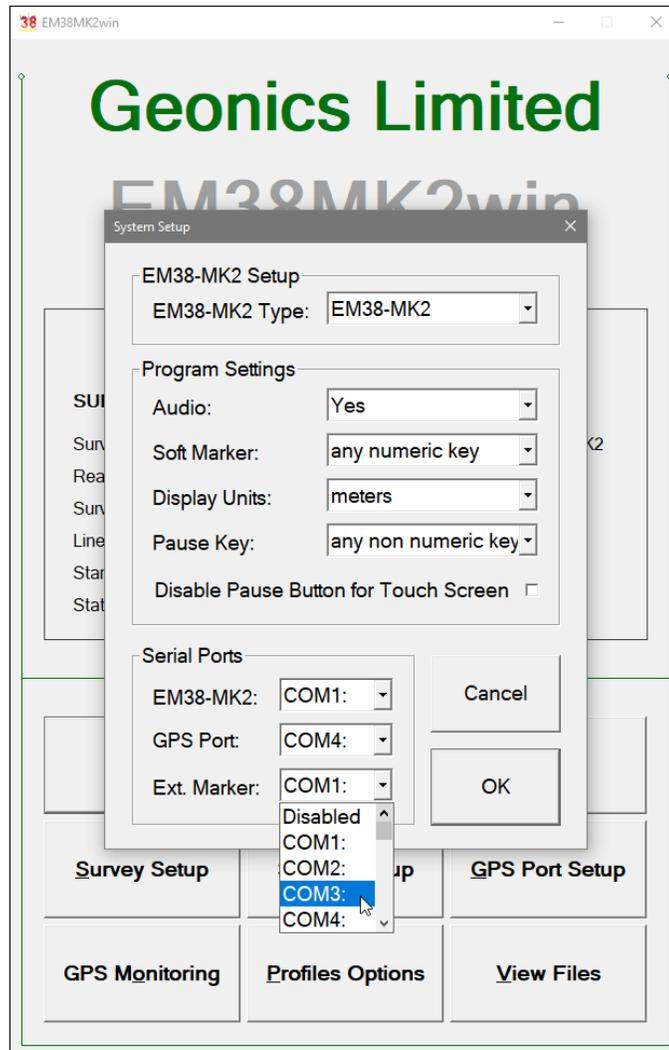
The number of serial port that is assigned to the GPS receiver. Available selections: COM1 to COM60. The program default is COM2. Communication parameters for the selected serial port can be set in GPS Port Setup dialog. The GPS port can be also assigned in the latter dialog.

This port must be different than the port specified as the EM38-MK2 serial port.

Select port number in the drop-down list box similarly to EM38-MK2 port assignment procedure.

Ext. Marker Port (External Marker Port)

An optional External Marker can be connected to one of the available serial ports. This option displays the number of serial ports that are assigned to the External Marker. Available selections: **Disabled**, **COM1**, **COM2**, **COM3**, ... to **COM60**. The program default is **None**. Select port number or deactivate External Marker by selecting **Disabled** in the drop-down list box (see Figure below).



This port must be different than the port specified in the Set Port for GPS option (see next chapter), otherwise a message will be displayed and the ports will have to be reassigned. If External Marker is located on the Extender Arm then The EM38-MK2 and Ext. Marker Port must be the same.

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

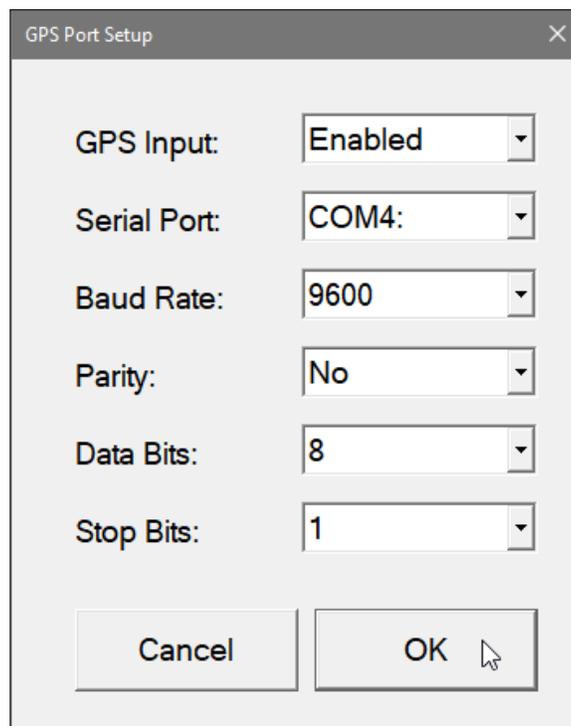
To return to original settings (state before this dialog was selected) click on the **Cancel** (or window X) button or press **Esc** key. All parameters will be reset to initial settings and the program will return to the Main Screen.

4. GPS Port Setup & Monitoring

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.



The screenshot shows a dialog box titled "GPS Port Setup" with a close button (X) in the top right corner. The dialog contains the following settings:

- GPS Input: Enabled
- Serial Port: COM4:
- Baud Rate: 9600
- Parity: No
- Data Bits: 8
- Stop Bits: 1

At the bottom of the dialog are two buttons: "Cancel" and "OK". A mouse cursor is pointing at the "OK" button.

Description of Options and Parameters:

GPS Input

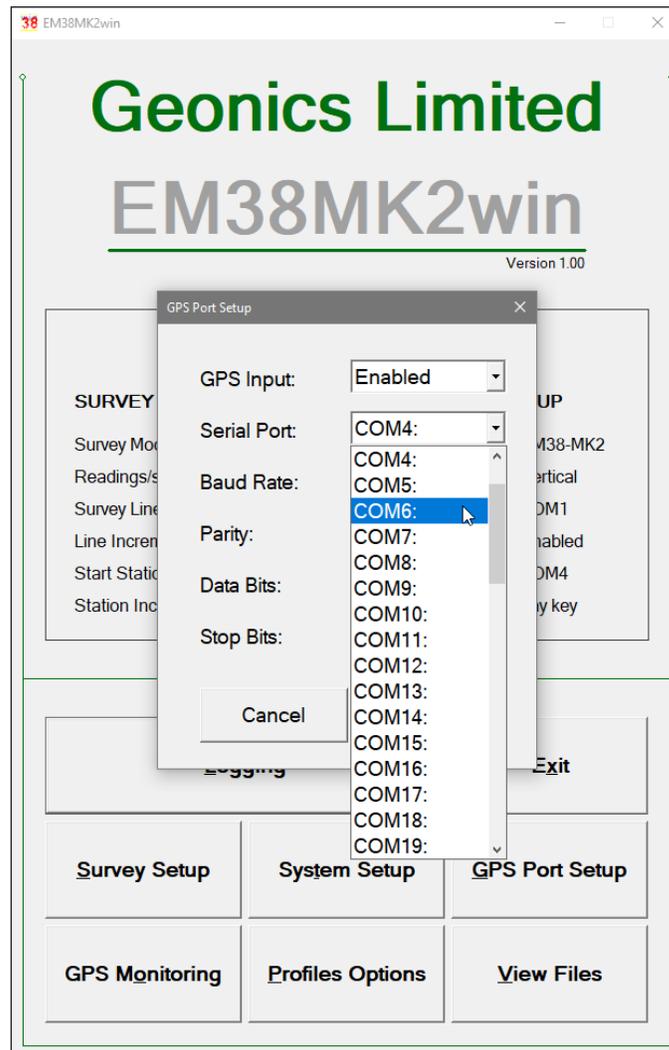
This option allows you to Enable/Disable a serial port for GPS input. When Disabled is chosen logging and monitoring screens will display message “GPS disabled” in place of GPS parameters.

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 EM38-MK2 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.



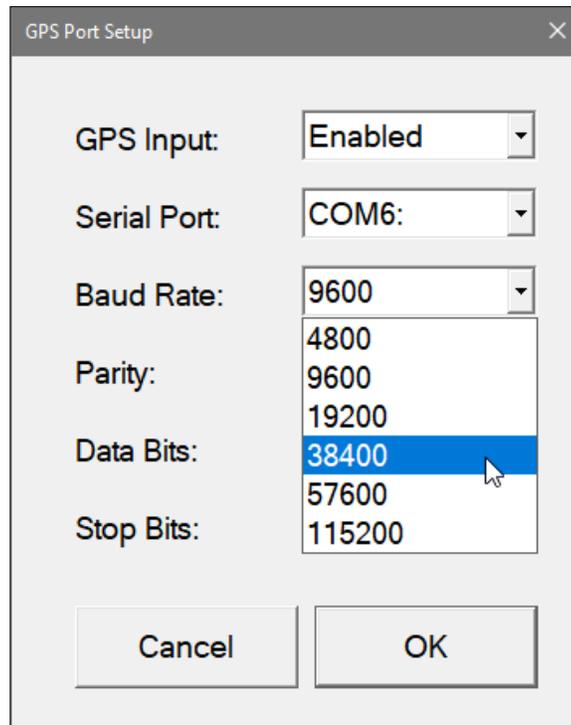
This port must be different than the port specified in the System Setup menu (for EM38-MK2), otherwise a message will be displayed and ports will have to be reassigned.

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 match 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 match 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.

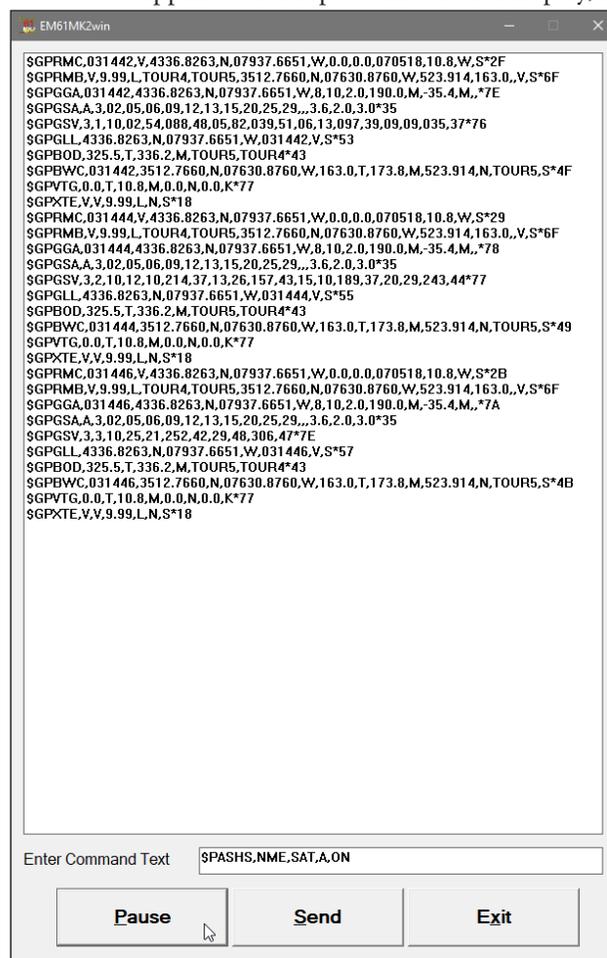
After all the parameters in the GPS Port Setup dialog are updated click on the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent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

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

4.2 Monitoring GPS Receiver Output

After the Main Screen command button **GPS Monitoring** is clicked or executed by the keyboard the program will display the GPS Monitoring window in terminal mode. In this mode the screen is divided into three parts. The terminal window in the top portion of the screen displays the GPS receiver output. The middle portion labeled NMEA Command is used to display entered NMEA commands previously sent to the GPS receiver, and at the bottom, command buttons with available options (Pause/Go, Send, and Exit) is displayed. These buttons can be clicked on, executed by TAB key and ENTER keys, or by using shortcuts (pressing underlined letter keys). This screen is shown below.

As soon as the EM38MK2win 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.

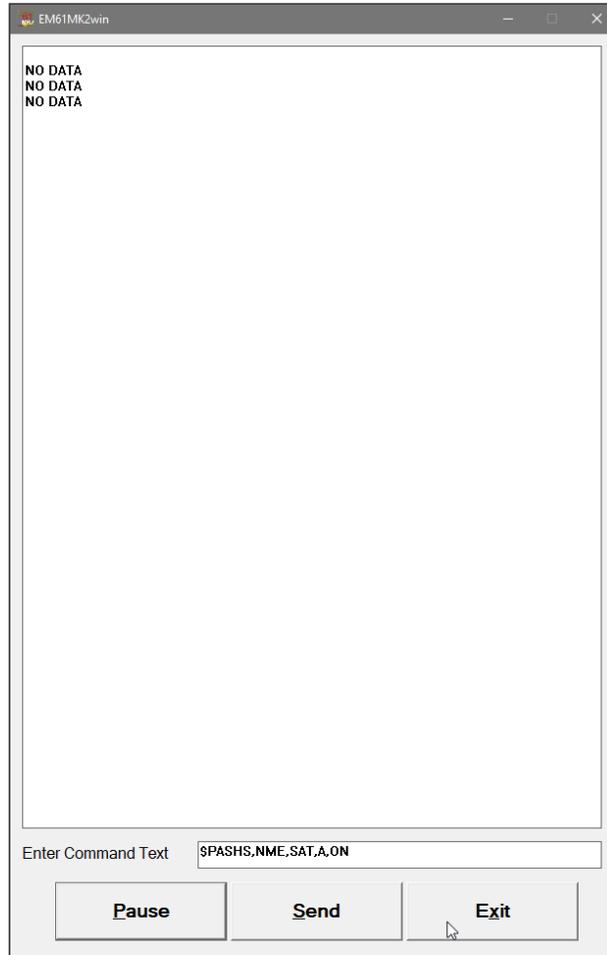


The screenshot shows a terminal window titled "EM38MK2win". The main area contains a stream of NMEA sentences, including RMC, MB, GGA, SVA, LLL, BOD, BWC, VTG, XTE, and XDR. At the bottom, there is a text input field labeled "Enter Command Text" containing the command "SPASHS.NME.SAT.A.ON". Below the input field are three buttons: "Pause", "Send", and "Exit".

```
EM38MK2win
SGPRMC,031442,V,4336.8263,N,07937.6651,W,0.0,0.0,070518,10.8,W,S*2F
SGPRMB,V,9.99,L,TOUR4,TOUR5,3512.7660,N,07630.8760,W,523.914,163.0,,V,S*6F
SGPGGA,031442,4336.8263,N,07937.6651,W,8.10,2.0,190.0,M,-35.4,M,*7E
SGPGSA,A,3,02,05,06,09,12,13,15,20,25,29,,3.6,2.0,3.0*35
SGPGSV,3,1,10,02,54,088,48,05,02,039,51,06,13,097,39,09,09,035,37*76
SGPGLL,4336.8263,N,07937.6651,W,031442,V,S*53
SGPBOD,325.5,T,336.2,M,TOUR5,TOUR4*43
SGPBWC,031442,3512.7660,N,07630.8760,W,163.0,T,173.8,M,523.914,N,TOUR5,S*4F
SGPVTG,0.0,T,10.8,M,0.0,N,0.0,K*77
SGPXTE,V,V,9.99,L,N,S*18
SGPRMC,031444,V,4336.8263,N,07937.6651,W,0.0,0.0,070518,10.8,W,S*29
SGPRMB,V,9.99,L,TOUR4,TOUR5,3512.7660,N,07630.8760,W,523.914,163.0,,V,S*6F
SGPGGA,031444,4336.8263,N,07937.6651,W,8.10,2.0,190.0,M,-35.4,M,*78
SGPGSA,A,3,02,05,06,09,12,13,15,20,25,29,,3.6,2.0,3.0*35
SGPGSV,3,2,10,12,10,214,37,13,26,157,43,15,10,189,37,20,29,243,44*77
SGPGLL,4336.8263,N,07937.6651,W,031444,V,S*55
SGPBOD,325.5,T,336.2,M,TOUR5,TOUR4*43
SGPBWC,031444,3512.7660,N,07630.8760,W,163.0,T,173.8,M,523.914,N,TOUR5,S*49
SGPVTG,0.0,T,10.8,M,0.0,N,0.0,K*77
SGPXTE,V,V,9.99,L,N,S*18
SGPRMC,031446,V,4336.8263,N,07937.6651,W,0.0,0.0,070518,10.8,W,S*2B
SGPRMB,V,9.99,L,TOUR4,TOUR5,3512.7660,N,07630.8760,W,523.914,163.0,,V,S*6F
SGPGGA,031446,4336.8263,N,07937.6651,W,8.10,2.0,190.0,M,-35.4,M,*7A
SGPGSA,A,3,02,05,06,09,12,13,15,20,25,29,,3.6,2.0,3.0*35
SGPGSV,3,3,10,25,21,252,42,29,48,306,47*7E
SGPGLL,4336.8263,N,07937.6651,W,031446,V,S*57
SGPBOD,325.5,T,336.2,M,TOUR5,TOUR4*43
SGPBWC,031446,3512.7660,N,07630.8760,W,163.0,T,173.8,M,523.914,N,TOUR5,S*4B
SGPVTG,0.0,T,10.8,M,0.0,N,0.0,K*77
SGPXTE,V,V,9.99,L,N,S*18
Enter Command Text  SPASHS.NME.SAT.A.ON
Pause Send Exit
```

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.

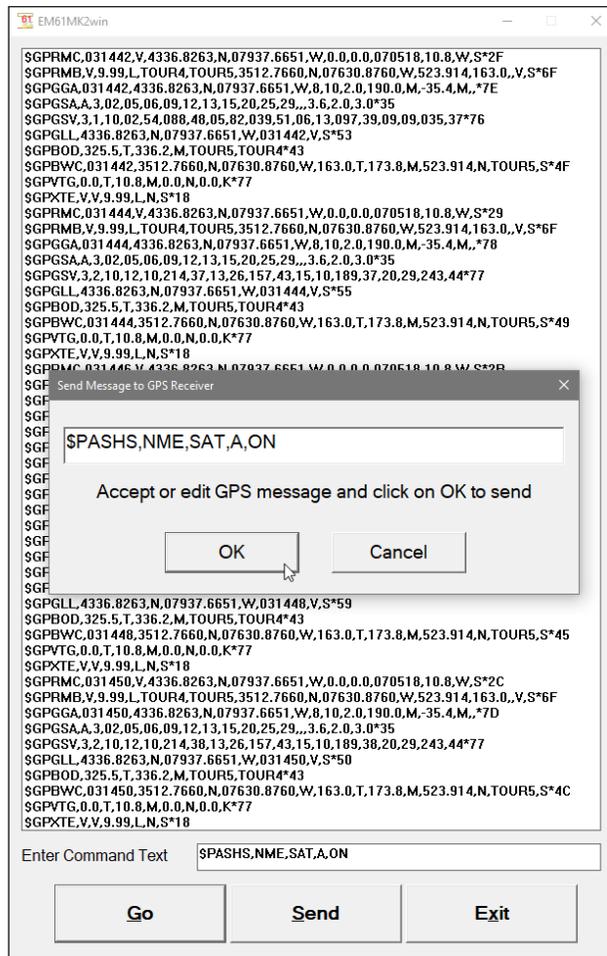
The NO DATA message may also appear if the GPS data are received correctly, but the GPS receiver was set to send data with a time interval longer than 7 seconds. In this case the NO DATA message will be displayed in between GPS messages. This indicates that the GPS is working correctly, however the operator 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 click (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 clicked 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, click **OK** button or press the key **<ENTER>** to send the command to the GPS receiver. Clicking the **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).

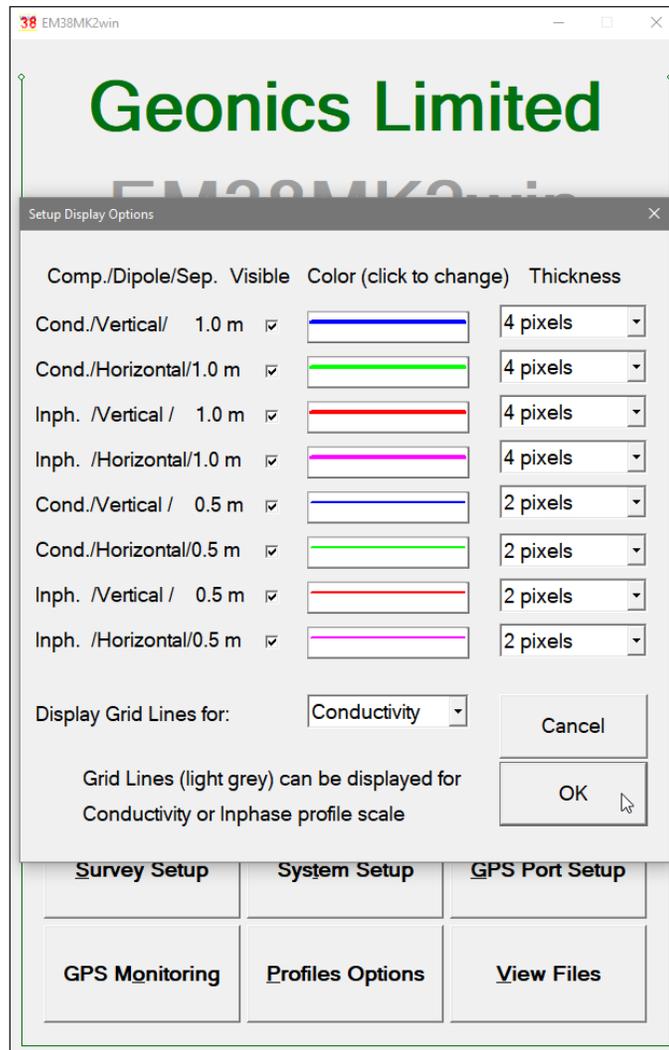


After this command is received by the GPS receiver, the confirmation message will be sent by the receiver (\$PASHR, ACK*3D) and data stream will contain the message SAT if it is available in the connected GPS receiver.

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 **Profiles Options** button was clicked (or executed from the keyboard) in the Main Screen the Setup Profiles Options dialog window appears on the screen. This dialog allows you to enable and disable the display of each channel profile representing various combinations of component, dipole mode, and coil separation, specify color and thickness of profiles, and select type of grid lines. Please note that first four items correspond to 1 m coil separation (only these are valid if the EM38-MK2-1 instrument type is used) while the bottom four items correspond to 0.5 m coils separation. The dialog is presented below.



Description of Options and Parameters:

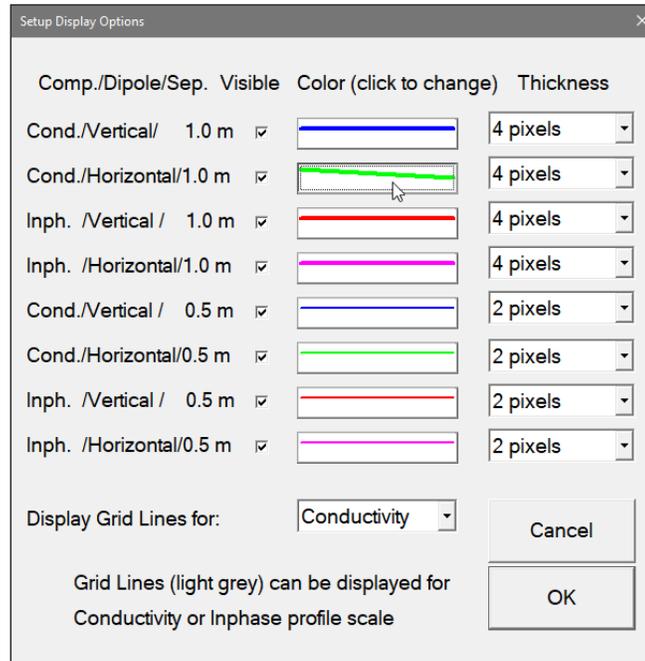
Visible

To enable or disable displaying of each channel profile click on the corresponding button labeled Visible. Profiles of all channels with checked buttons will be displayed during data logging.

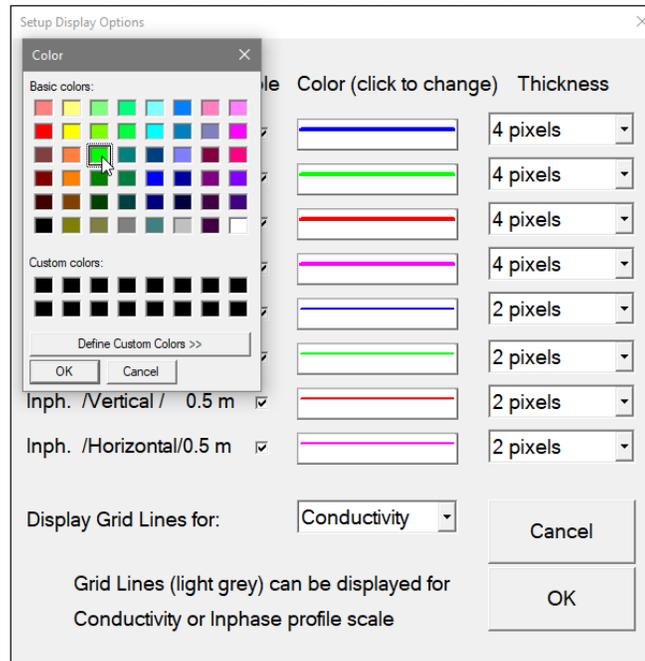
Regardless of which channels are chosen to be displayed as profiles, data for all channels data streamed by the instrument will be displayed in numeric form below profile display and all available data will be recorded in data file.

Color

To change colour of each profile click on the corresponding button (with colour line) labeled **Color (click to change)** as shown below and then a dialog titled Color will appear.



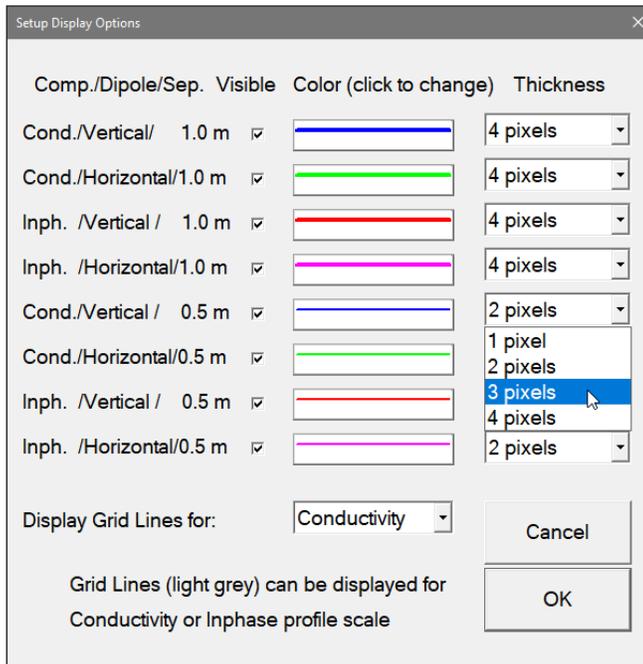
Select desired colour by clicking on a colour box (the selected colour box will be highlighted).



Click on 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 click **Cancel (X)** button or press **Esc** key.

Thickness

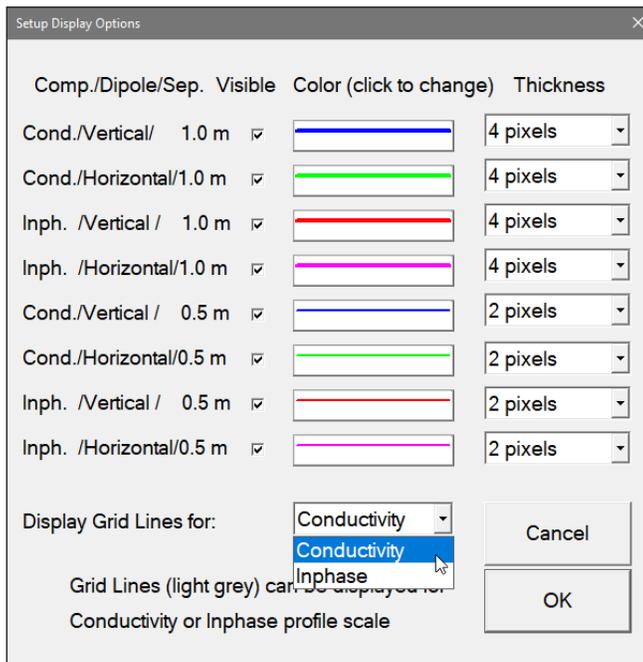
Specify thickness of a profile for a desired channel by using one of four drop-down boxes labeled thickness. Thickness of a profile curve is expressed in pixels. Available settings are: 1, 2, 3, or 4 pixels.



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

Display Grid Lines

Profiles for both components share the same graphic window, however each component has its own scale. This option allows you to select grid lines to be displayed (as thin grey lines) for conductivity or Inphase scale.



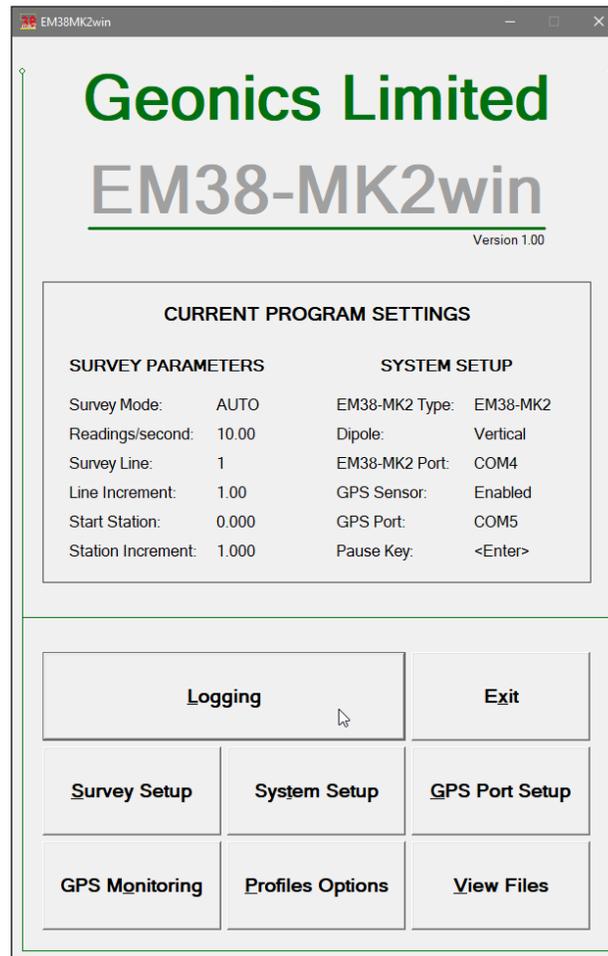
Minimum and maximum values for the component with selected grid lines are displayed as bold numerals. See figure below where grid lines are plotted for conductivity scale.

After all the parameters in the Display Options dialog are updated click 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 the **Cancel (X)** button or press **Esc** key. 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 clicked or executed by the keyboard, the program enters the logging session which contains three modes: Monitoring, Stand By and Logging. The program starts the logging session always in Monitoring mode. In this mode the EM38-MK2 readings, dipole mode, available inter-coil separations, and GPS parameters can be quickly examined

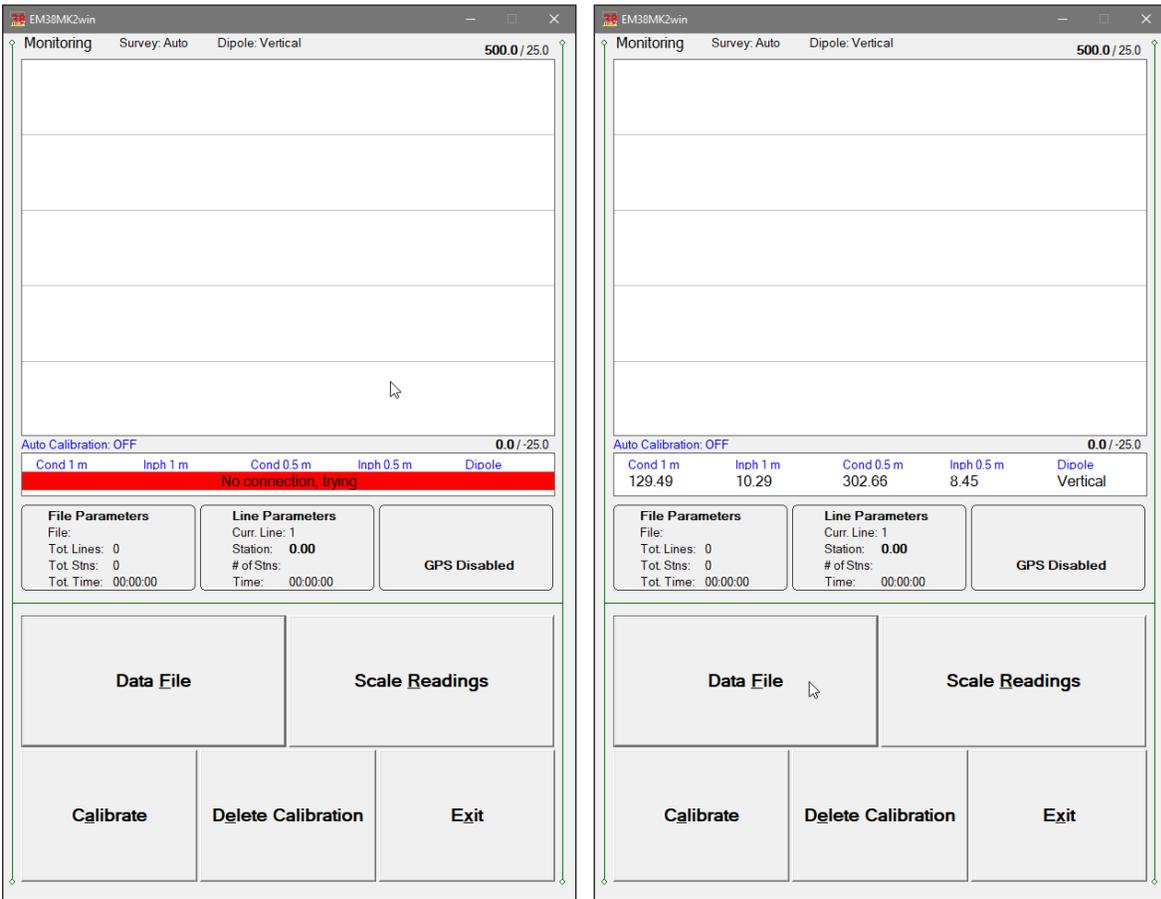


and a data file can be created. The instrument can be also calibrated in Monitoring mode. After a data file is created in Monitoring mode, the program switches to Stand By mode and allows access to Logging mode. In Stand By mode instrument output can be monitored and some survey and logging parameters can be changed, and the 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 and GPS receiver performance, quick inspection of the instrument settings, performing instrument calibration if required.

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 a message "No Connection. trying" on the red background will appear (see Figure below on the left).



Check the connection or turn the instrument ON and the "No Connection" message will disappear and measured values will be displayed (Figure above on the right).

Assuming that the instrument works properly the program will display the Monitor mode window. The Monitor (as well as Stand by and Logging) window is divided into five sections.

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 logging session mode (Monitor, Stand By or Logging), survey mode (Auto, Wheel, Manual), and user specified instrument dipole mode (Vertical, Horizontal, or Both). When fiducial marker is pressed then label **Marker** is displayed. The state of Auto Calibration (ON or OFF) is displayed below graph window.

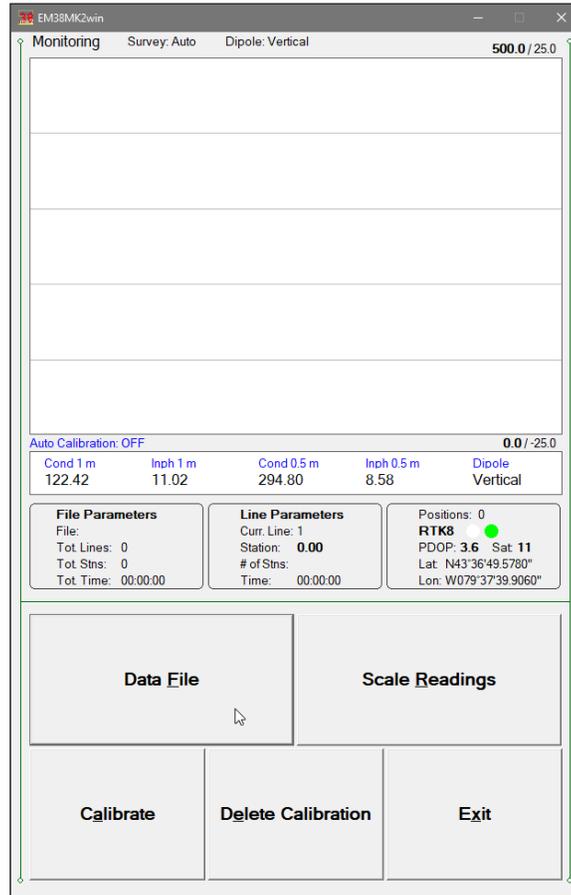
The second, largest graphic section will be used to display profiles while logging data. Numeric labels on the right side of profile window correspond to scale minimum (below the profile window) and maximum (above the profile window). The first value is associated with conductivity readings and the second number corresponds to Inphase readings. Values displayed in bold font indicate grid lines scale association.

The remaining bottom section contains a window with current EM38-MK2 readings (Conductivity or Inphase for both coil separations, and dipole mode), three frames (File Parameters, Line Parameters, and GPS information), and command buttons located at the bottom of the screen. Command buttons are relatively large to provide easy operation while using touch screen during survey.

The EM38-MK2 readings and dipole mode are displayed from the left in order: conductivity and Inphase for 1.0 m coil separation, then conductivity and Inphase for 0.5 coil separation, followed by dipole mode (Vertical or Horizontal). Displayed values are labeled: Cond 1 m, Inph 1 m, Cond

0.5 m, Inph 0.5 m, Dipole. Conductivity values are displayed in mS/m and Inphase values are given in ppt. The EM38-MK2 readings are updated approximately 21 times per second during the monitoring session.

When GPS is Disabled in the Set GPS Port dialog a message **GPS Disabled** will be displayed. 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. Various RTK modes (numbered as RTK3, RTK4 and so on) can be displayed if provided by the connected GPS receiver. On the right side of **DGPS**, **AGPS**, or **RTK** 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 a frequency of connected GPS receiver stream.

Five command buttons located in the right bottom corner of the Monitor window lists the program functions available directly in the Monitor mode. Available options are as follows: **Data File** (create data file), **Scale Readings** (change scale for Conductivity and Inphase profile window), **Calibrate** (auto calibration procedure), **Delete Calibration** (to remove Calibration factors), and **Exit** (exits the Monitor mode and returns the program to Main Screen).

In case of any problems with instrument connection, battery failure, or accidental instrument Turn Off a message "No Connection, trying" will be displayed in numeric values window. The message is highlighted by red background to alert operator as fast as possible. The EM38MK2win 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 on red background is shown on previous page.

Description of Monitoring Mode Options

File (*create data file*)

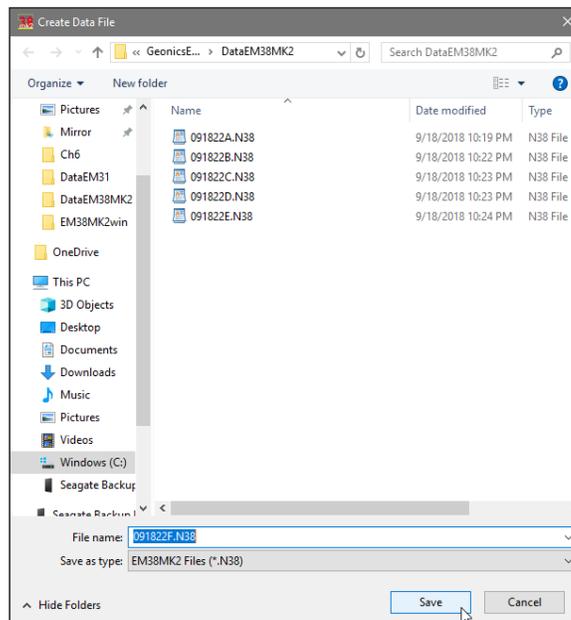
The log data file can be created in any directory. The name of the file is given by the field computer clock and it consists of month (2 digits), day (2 digits), hour (2 digits), and one alphabetic character A, B, C, etc. (If all letters during one hour are used use the Overwrite option). The Create 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 EM38MK2win data files cannot be appended.

Each data file in the field computer (raw data file) has an extension name N38 and it is created in the directory specified in Create Data File dialog. The N38 files are created in the instrument binary format. These files can be also converted to ASCII format and processed in the Geonics DAT38MK2 program.

After the file is specified click on 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.

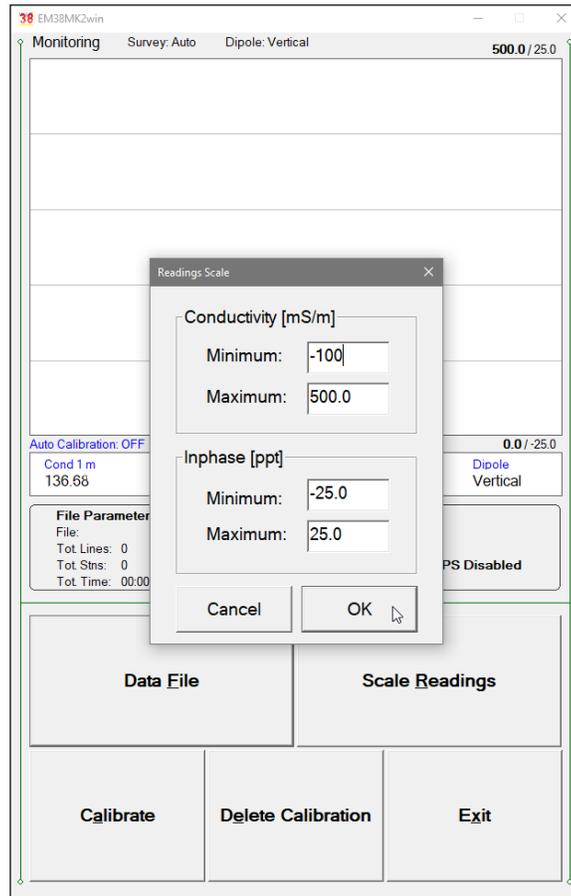
To cancel selection and return to Monitoring mode tap the **Cancel** (X) button or press **Esc** key.



Scale *(New Scale for Profile Plot)*

Selecting New Scale option allows the operator to enter new scale parameters for the profile plot for each component. This option is available in Stand By mode as well.

The Enter Scale dialog will be displayed (see below). It contains four text boxes for Minimum and Maximum values of a new scale for profile plot of conductivity and Inphase. Current settings (minimum and maximum values) for the scale are displayed in the bottom right and top right corners of the plot area. The first numbers indicate scale for conductivity and the second (following slash) numbers are associated with Inphase scale. Values displayed in bold indicate the scale that is associated with grey grid lines.



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

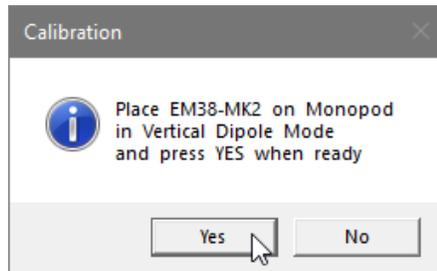
To ignore an entry and return to Stand By mode tap the **Cancel (X)** button or press **Esc** key, the dialog window will disappear and measurements can be continued.

Calibrate EM38-MK2 *(automatic calibration of EM38-MK2)*

This option allows you to calibrate EM38-MK2 using automatic, software based method. Calibration procedure is the same as described in the EM38-MK2 Operating Manual however here all the procedure is controlled by the program EM38MK2win. During Calibration the program calculates proper factors for conductivity and Inphase at each coil separation and dipole mode. These values are saved in the logging computer memory as long as option (**Delete Calibrate**) is executed or a new version of the program is transferred to Allegro. It is recommended to perform Calibration at least once a day, after each battery change, when survey site is changed, etc. Calibration can be performed in Monitoring mode as well as later during logging session in Standby mode. Software based calibration that employs monopod is very easy, fast, and has several advantages:

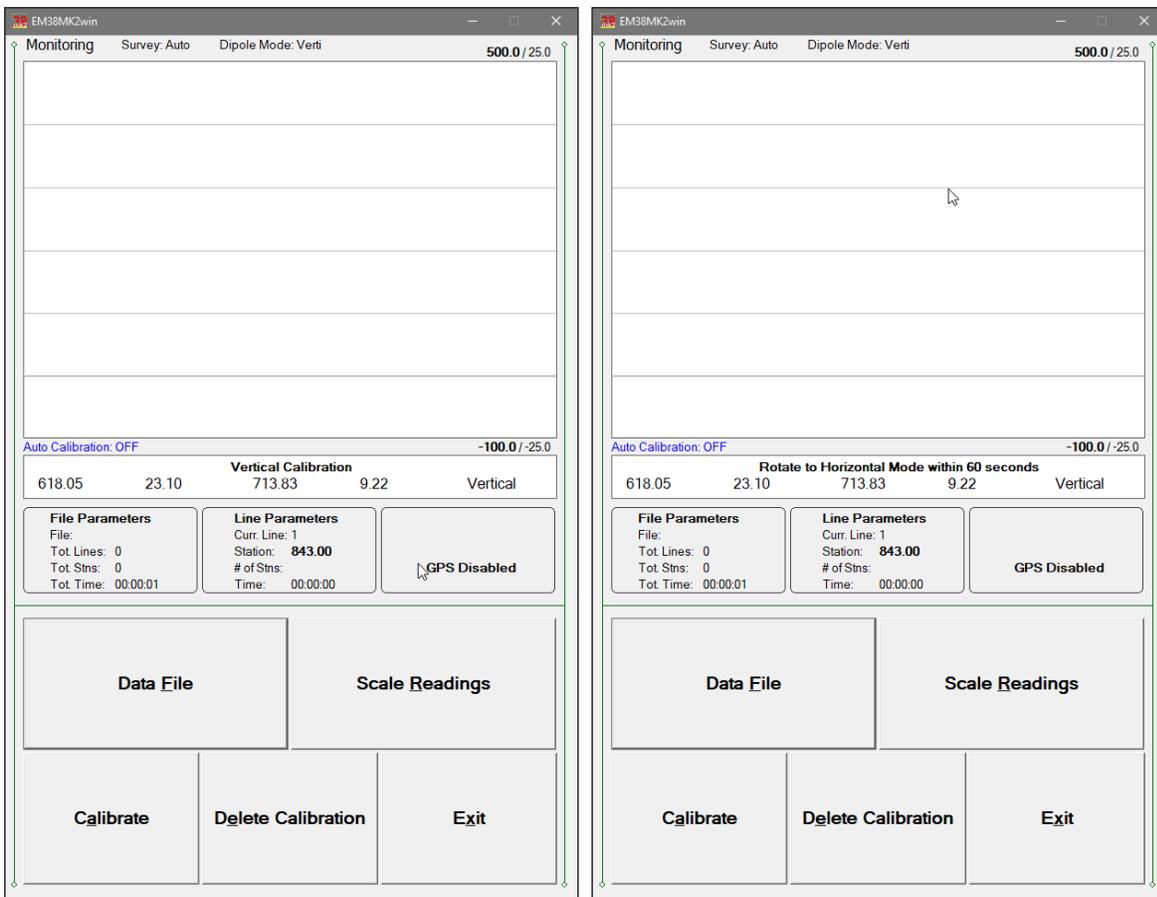
- 1) it is relatively uniform and it does not depend on operator since height above the ground is determined by monopod.
- 2) it is very time efficient and easy to perform
- 3) all calibration factors are saved in the computer memory and are written in data file in every survey line header
- 4) procedure can be traced later for any data set. If Calibration is performed during logging session new and old calibration factors are written to data file.

After clicking on the **Calibrate** button (or executing this option using keyboard) a message is displayed:

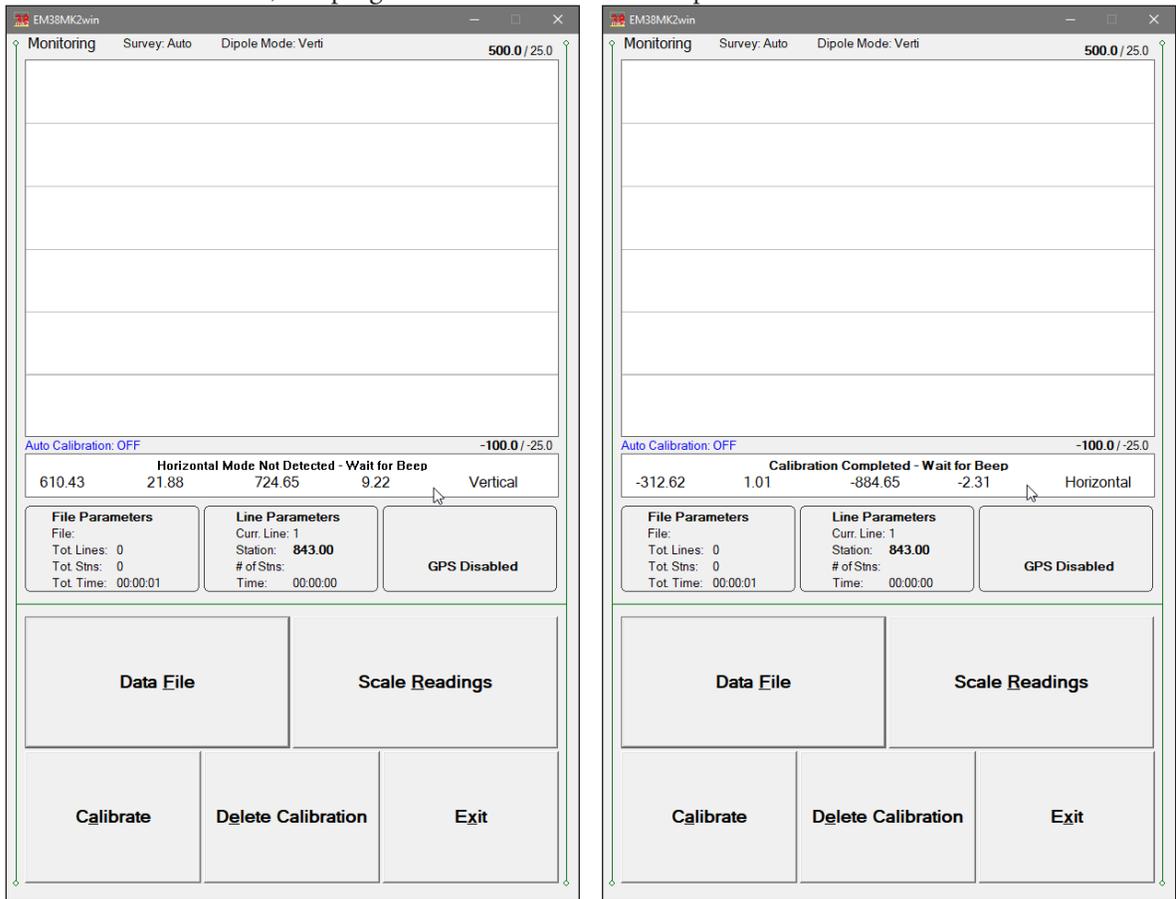


After the instrument is placed on the monopod in Vertical dipole mode click on the button **Yes** or press key **Y** (or **Enter** if button is highlighted). After button **Yes** was clicked a messages box disappears and a prompt **Vertical Calibration** is displayed (Figure below, on the left). From now on all messages and prompts will be written under plot section of the screen, in a line that is normally used to display labels for EM38-MK2 readings.

After the Vertical calibration is completed (usually few seconds) the program will beep and a message **Rotate to Horizontal mode within 60 seconds** will appear (Figure below, on the right).



In cases where rotating the instrument takes longer than 1 minute the program will display the message: **Horizontal Mode Failed - Wait for Beep**, and after a short delay (about 2 seconds) the program will return to normal operation.



The program monitors instrument orientation and as soon as it detects that the EM38-MK2 is in proper position it will display the following message: **Preparing for Horizontal Calibration**. After a small delay required for stabilization the Horizontal Calibration will be performed and message **Horizontal Calibration** will be displayed during that time.

If for any reason the calibration is not successful a proper message will be displayed.

Horizontal calibration takes normally 2 seconds and when the procedure is completed a confirmation message will be displayed (see Figure above on the right)

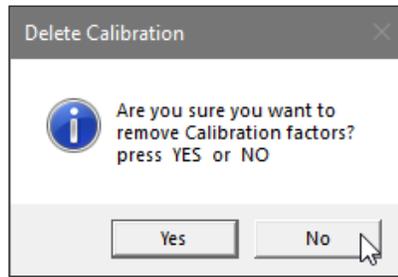
After beep the above message disappears and program returns to normal operation. All calibration factors are saved in the field computer memory and will be used in consecutive program runnings. Unless a new version of the program is loaded the only possibility to delete (or reset to zero) calibration factors is using option Delete Calibration.

When calibration factors are used readings shown on the logging computer display usually differ from values displayed by the instrument console. To obtain same readings on the instrument console and on the computer display please use Delete Calibration option and then Calibrate again.

Delete Calibration (Delete Calibration factors)

After tapping **Delete Calibration** button (or executing this option using keyboard) the program immediately displays confirmation message (Figure below).

Please confirm by tapping button **Yes**, or pressing Key **Y** or Enter (if button **Yes** is highlighted) to delete (reset) calibration factors. After this is done readings displayed by the instrument console and the logging computer should be similar.



If this option was used by accident please tap button labeled **No** and all calibration factors will remain the same.

Exit (exit Monitor mode)

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

6.2 Stand By Mode

After the data file is created in Monitoring mode the program automatically switches the logging window to Stand By mode. This windows is similar to Monitor mode however it contains survey parameters (file name, survey line name, etc.) and different set of options represented by buttons displayed at the bottom of the screen. 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 profiles (see Figure below which shows Stand By mode after some data were collected). Scale for conductivity and Inphase is

labeled at the top and bottom of the plot window. The amplitude scale is divided by three to five grey grid lines. These grid lines may belong to conductivity or Inphase scale depending on the user preference (set in Display Options dialog). Assignment of grid lines is indicated by the bold font labels for the corresponding scale. 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 conductivity and Inphase for each coil separation are shown in numeric form in a window below the plot area. Values of readings are labeled **Cond 1 m, Inph 1 m, Cond 0.5 m, Inph 0.5 m, Dipole**. Conductivity values are displayed in mS/m and Inphase values are given in ppt.. Readings are followed by current dipole mode (Vertical or Horizontal). EM38-MK2 readings (in numeric form) are updated in Stand By mode approximately 21 times per second. Profiles in the plot area are updated only during Logging mode when data are actually saved in the data file.

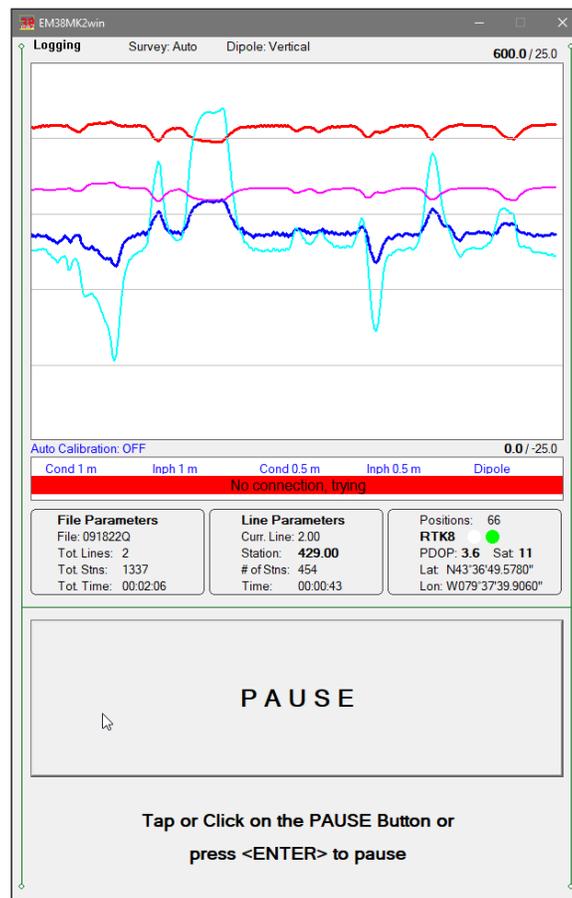


A section of the window at the top of the screen contains one line of text displaying survey and instrument related parameters. These are (from the left): logging mode (**Stand By** or **Logging**), survey mode (**Auto**, **Wheel** or **Manual**), user selected instrument mode dipole mode **Vertical**, **Horizontal**, or **Both** (only in Manual mode) labeled Dipole Mode. When fiducial marker is active a label **Marker** is displayed in this line. Auto Calibration state is indicated by a label located below graph window **Auto Calibration: ON** (performed and active) or **Auto Calibration: OFF** (not used).

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 EM38-MK2win 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) or **RTK#** 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 (RTK)** 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.

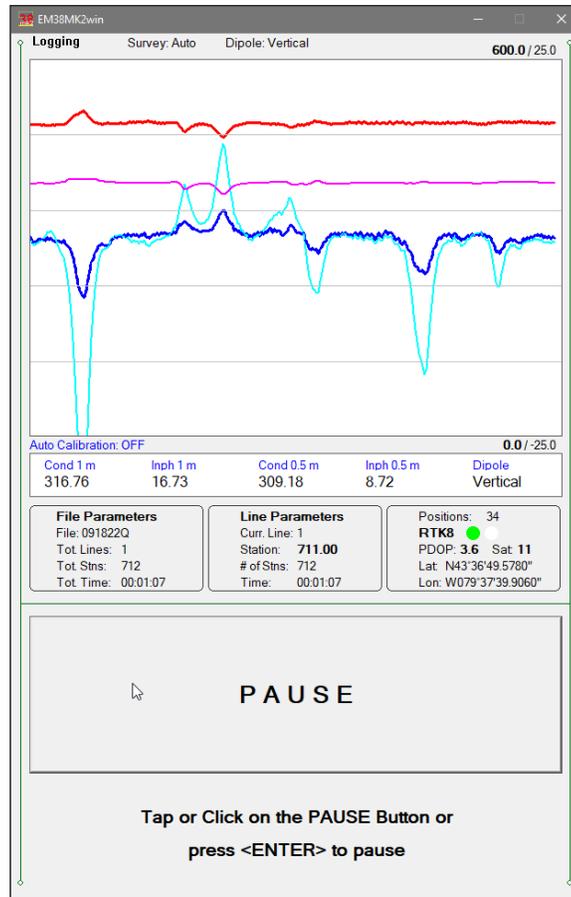
In case of any problems with instrument connection, battery failure, or accidental instrument Turn Off a message "No Connection, trying" will be displayed in numeric values window. The message is highlighted by red background to alert operator as fast as possible. The EM38MK2win will try to re-establish communication 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. The program window in Logging mode and the alert message is shown below.



Several available field options (in form of command buttons) are listed at the bottom right corner 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 in the mode corresponding to the selected EM38-MK2 mode in the Survey Setup menu. All labels and parameters (with the exception of buttons representing Stand By mode options) are the same as in Stand By mode and they are described in the preceding section 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 lines (for channels selected in Display Options window) 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 EM38MK2win will stop collecting data and will try to re-establish communication. After the problem is corrected the program will start communication automatically. Alternatively, click on the Pause button to return to Stand By mode. The program window in Logging mode and the alert message is shown on previous page.

There is only one option available in the Logging mode - pause logging. After a 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 EM38-MK2 data will be displayed with the update rate approximately 10 readings per second, however data will not be saved in the log file and profiles will be not updated. Exiting from the logging session and access to various field options are available only from the logging window in Stand By mode.

6.4 Stand By Mode Field Options

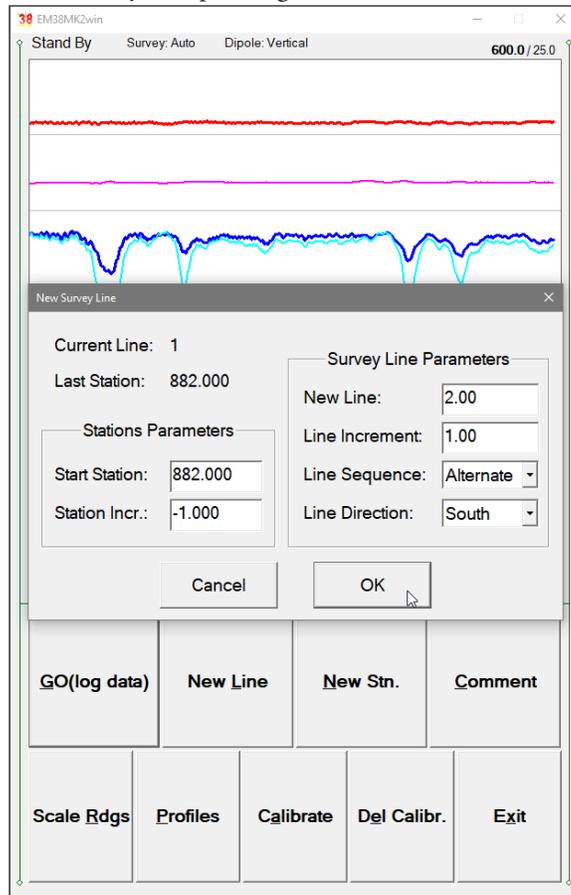
Several field options are available while the Logging window is in the Stand By mode. Options can be accessed directly from command buttons. Command buttons can be used by clicking on the desired button, or from the keyboard by pressing one of the shortcut keys (underlined characters on button labels)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

GO (log data) *(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.

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 dialog.



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

After all the parameters in the New Line dialog are updated click on the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Logging window in Stand By mode. Survey line name (**Curr. Line**) name and current station (**Station**) 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) click on the **Cancel** (X) button or press **Esc** key.

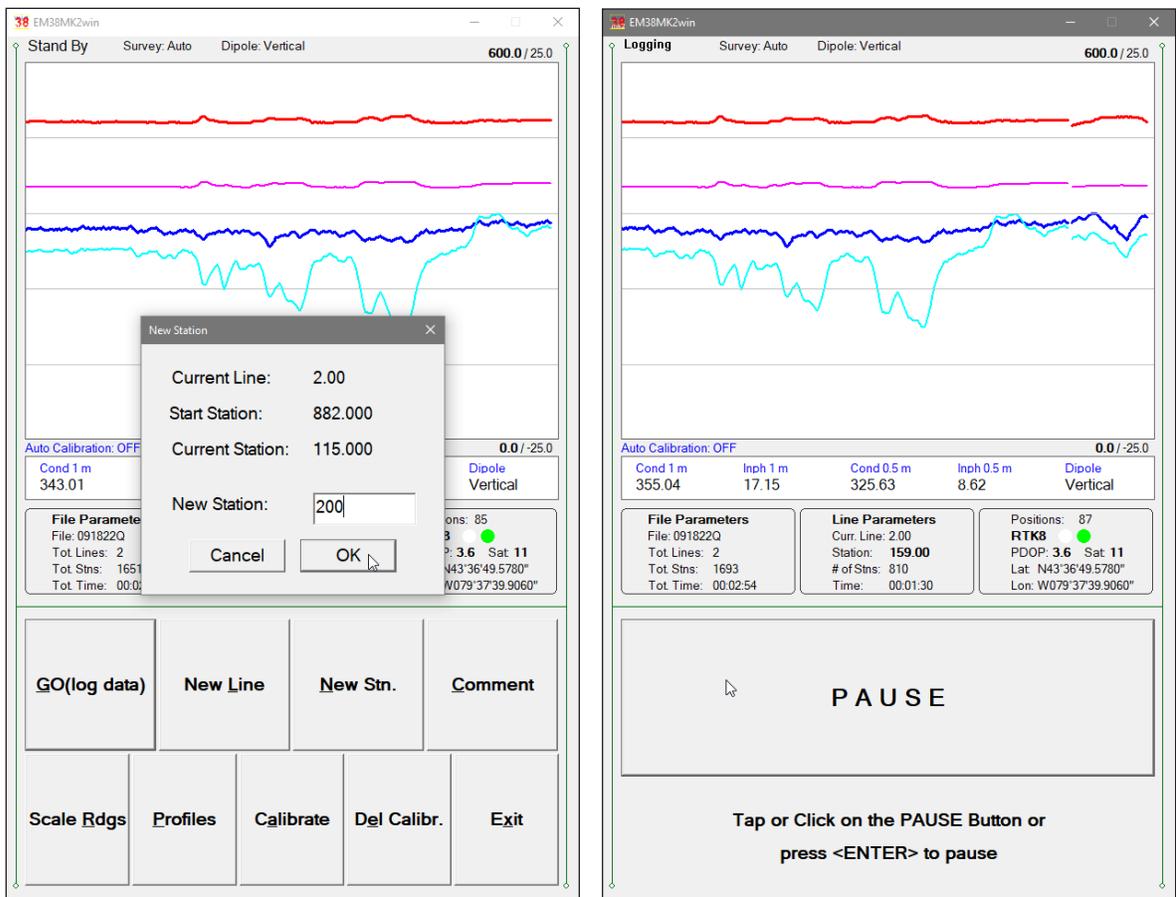
New Stn. (New Station)

Selecting this option allows the operator to enter a new station number (within the same survey line). The New Station dialog is displayed (see Figure below on the left).

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

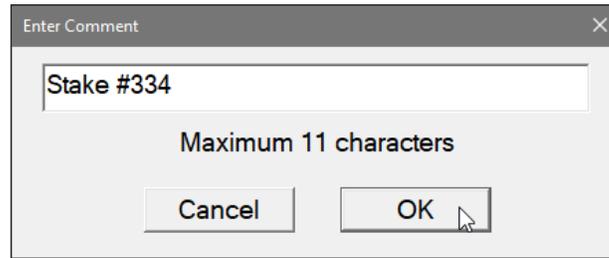
Click on the button **OK** or press **ENTER** key to accept the new value. The program will return to the Logging window in Stand By mode. Current station (**Station**) value will be updated and after data logging is activated the profile curves will have a small gap (two pixels) showing the new station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

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



Comment *(Field 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.



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

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

Scale Rdgs *(New Scale for Profile Plot)*

Selecting Scale Readings option allows the operator to enter new scale parameters for the profile plot for each component, conductivity and Inphase.

The Enter Scale dialog will be displayed (Figure below). It contains four text boxes for Minimum and Maximum values of a new scale for profile plot of conductivity and Inphase. Current settings (minimum and maximum values) for the scale are displayed in the bottom right and top right corners of the plot area (Conductivity/Inphase). Values displayed in

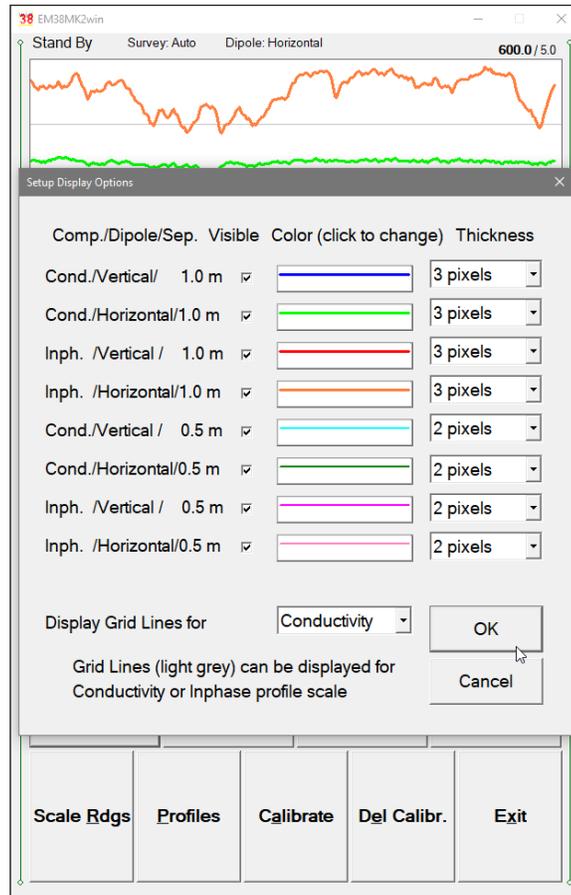


bold indicate the scale that is associated with grey grid lines. After minimum and maximum values are specified click on the button **OK** or press **ENTER** key to accept new values and the profile plot area will be redrawn (see Figure above on the right).

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.

Profiles *(new options for profile plot display)*

After the **Profiles** button was clicked or executed from the keyboard 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.

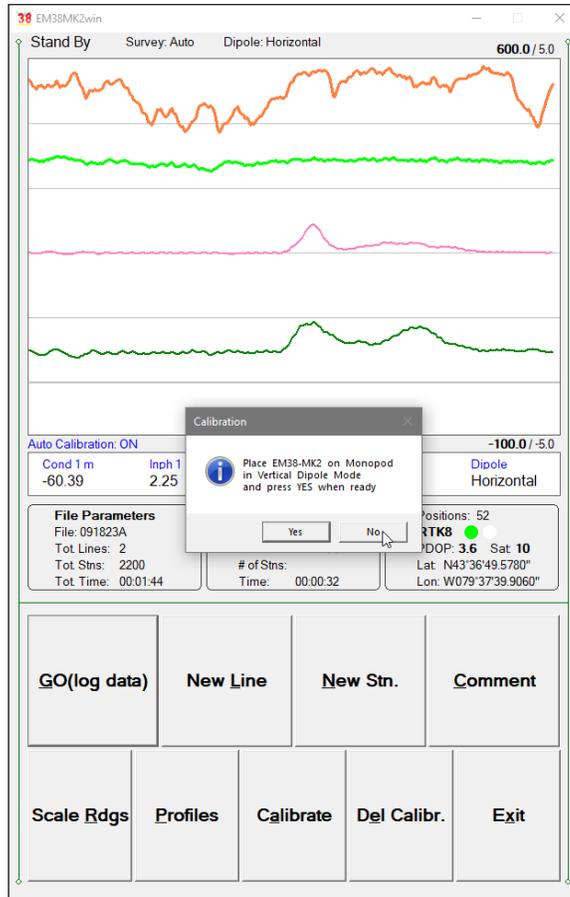
Click on the button **OK** or press **ENTER** key to accept updated display parameters. The dialog will disappear and profile plot area will be redrawn in Stand By mode.

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

Calibrate *(automatic calibration of EM38-MK2)*

This option allows you to calibrate EM38-MK2 using automatic method.

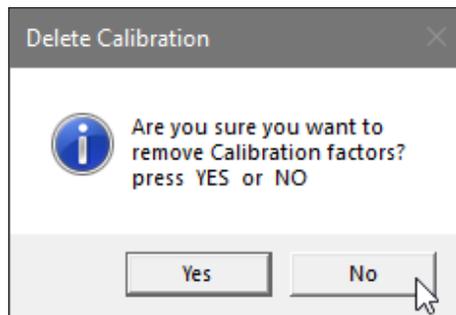
After **Calibration** is selected in the pop up menu the Calibration dialog appears on the screen. This dialog allows you to proceed (Yes) or exit (No) the procedure in case the option was selected accidentally. The dialog is presented below.



Calibration procedure is the same as described in chapter 6.1 (Monitoring Mode). Please refer to above section of the manual and follow all prompts that appear on the display. Calibration factors will be written to the data file and displayed readings will be adjusted immediately after the Calibration procedure is completed.

Del Calibr. (remove calibration factors)

After **Delete Calibration** is selected in the pop up menu the following confirmation message appears on the screen:

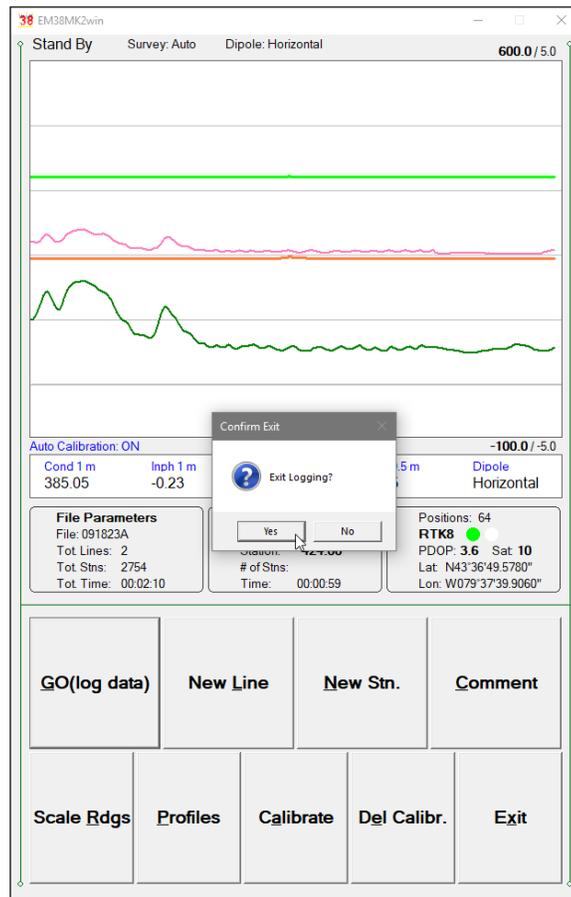


Please confirm by clicking on the button **Yes**, or pressing Key **Y** or Enter (if button **Yes** is highlighted) to delete (reset) calibration factors. After this is done readings displayed by the instrument console and Allegro should be similar.

If this option was used by accident please tap button labeled **No** and all calibration factors will remain the same.

Exit (*exit data logging*)

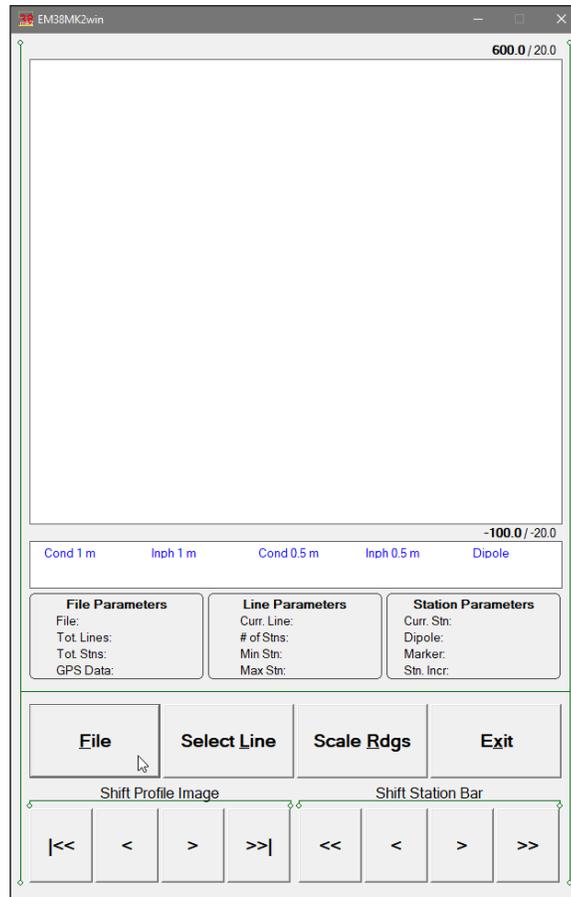
During data collection (in Stand By mode) a confirmation message will be displayed (there is no such message if **Exit** is performed in Monitoring mode) before program exits logging window.



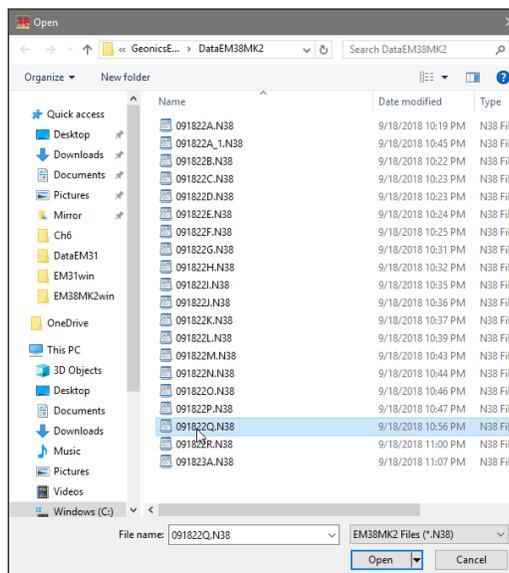
After above message is confirmed the program stops logging, closes data file and returns to Main Screen.

7. View Data Files

This option allows you to view recorded data files. After the View Files button is clicked or tapped (or executed from the keyboard) in the Main Screen the View Data Files window will be displayed.



To open the data file click or tap on the button labeled File 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 F). The Open Data File dialog is presented below.



The file name can be selected in the Open Data File dialog using the Windows standard interface procedure. After the file is selected (highlighted) tap the button OK or press ENTER key to accept and display data file (to cancel selection tap Cancel (X) button or press Esc key). After the file is opened readings taken at the beginning (exactly at station indicated by the gray vertical bar and shown in the Station Parameters section) of the first survey line in the file are displayed, as shown below.



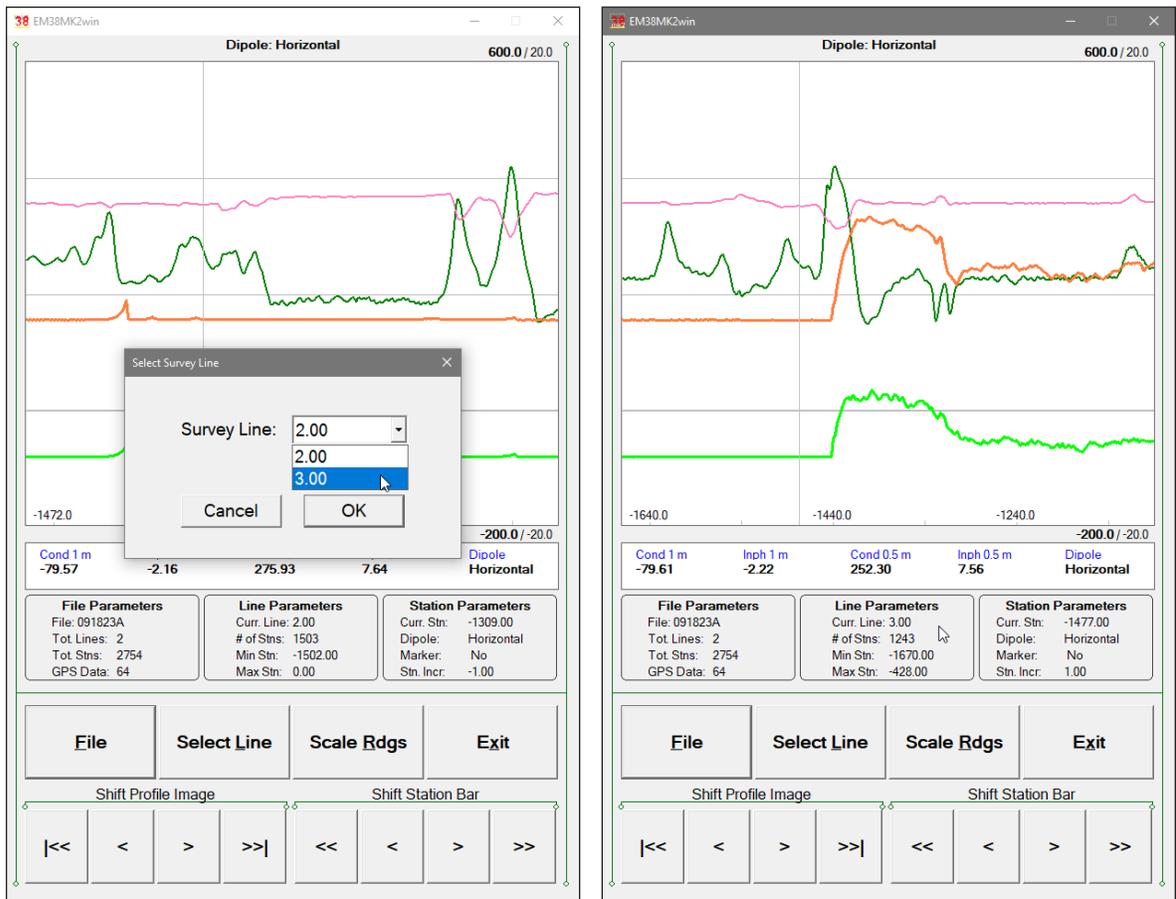
The main portion of the screen is occupied by profile plot of currently displayed survey line. Amplitude display ranges (minimum and maximum value) for Conductivity/Inphase are given by labels located at the right side of the plot area. Range of scale display can be changed by tapping the button labeled Scale Rdgs. The plot area is divided by four or five grey grid lines. In cases where the amplitude scale starts with a negative value, then the grid line corresponding to zero is always plotted as a thicker line. Profiles for each channel are plotted with colours and line thickness as selected in the Plot Options (see section Chapter 5). Grid lines are shown for Conductivity or Inphase scale depending on the Plot Options dialog.

A vertical bar (grey vertical line) indicates currently displayed station. The station is displayed in the window labeled Station Parameters (see description in the next paragraph) next to label Curr.Stn: and readings at this station for Conductivity and Inphase for corresponding coil separations (1 m and 0.5 m) together with current dipole mode are shown in numeric form below the plot area. The EM38-MK2 readings (in numeric form) are updated every time vertical bar is moved.

A label Dipole displayed at the top of the screen indicates Vertical or Horizontal (or Both in Manual mode) as it was set for the data file. Dipole mode for particular reading shown in numeric values window may differ.

There are three windows describing file, survey line, and station parameters. The left window labeled File Parameters lists file name, number of survey lines in the file, total number of stations, and total number of GPS positions if GPS positioning was used during the survey. The center window labeled Line Parameters contains parameters associated with currently displayed survey line: line name, number of stations in the current line, minimum and maximum stations. The right window labeled Station Parameters displays currently indicated station parameters: station number, reading mode, marker presence, and station increment within line.

To change the currently displayed survey line click or tap on the button labeled Select Line. A dialog labeled Select Survey Line will be displayed (Figure below on the left).



Tapping on the down arrow next to the text box labeled Line opens a drop-down box showing all available survey lines. When the keyboard is being used you can activate the text box by pressing the TAB key until the drop down box is highlighted and then by using Up or Down arrow keys select one of available lines (as shown above, Figure on the left). After the survey line is selected and the button labeled OK is clicked on the dialog disappears and selected survey line is plotted. Please see next Figure where Survey Line 3.00 is displayed.

To change range of displayed values click on the Scale Rdgs button. A dialog labeled Reading Scale will be displayed (Figure below, on the left). Specify new Minimum and Maximum values for Conductivity and Inphase and then press OK. The plot area will be re-drawn with new range values (Figure below, on the right).



To shift the range of the displayed stations and to move the vertical bar indicating the currently displayed station, use the buttons located along the bottom of the View Files window. These buttons can be activated by tapping or by pressing the keyboard keys. They are divided in two groups: four buttons labeled Shift Profile Image are used to move image while four buttons labeled Shift Station Bar move grey vertical bar selecting current station and displaying its numeric values.

Shift Profile Image buttons:

button labeled |<< moves display to the minimum station of the currently displayed survey line,
 button labeled >>| moves display to the maximum station of the survey line,
 button labeled < moves display about 40% of the displayed range to the left,
 button labeled > moves display about 40% of the displayed range to the right.

When using Shift Station Bar buttons:

button labeled << moves the bar 50 stations to the left,
 button labeled >> moves the bar 50 stations to the right,
 button labeled < moves the bar one station to the left,
 button labeled > moves the bar one station to the right.

To exit the View Data Files window tap or click on the button labeled Exit. The program will return to Main Screen.

Appendix A

A.1 Description of Data File in EM38MK2win Format

Each record contains 26 characters, including line feed at the end of each record.

Header of the file (contains two records starting with characters E and H)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
E	M	3	8	M	K	2		W	1	0	0	Survey Type	UT	ID	IM	IC	CS							CT	10
H																									10

- EM38MK2 - identification of program file
- W100 - version number (1.00)
- Survey Type - GPS (if GPS Input Enabled) or GRD (grid)
- UT - unit type (0 = meters, 1 = feet)
- ID - EM38-MK2 Dipole Mode
(0 = Vertical, 1 = Horizontal, 2- Both)
- IM - EM38MK2 survey mode
(0 =Auto, 2 =Manual)
- IC - not used (0 - fixed)
- CS - instrument type (1 = EM38-MK2-1, 2 = EM38-MK2)
- CT - type of logging computer (=1 fixed)
- File Name - file name, maximum 8 characters
- Time/Samples - this field depends on EM38-MK2 survey mode
 - Auto Mode - Time Increment in seconds
 - Manual Mode - Samples/Reading
- 10 - Line Feed character

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

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
L	Line Name (8 characters)																							10	
B	Start Station (Format F11.2)															10									
A	Dir							Station Increment (Format F11.2)												10					
Z	D	D	M	M	Y	Y	Y	Y		H	H	:	M	M	:	S	S								10
O	1	Calibration for Q/P 1.0 m (F10.3)										Former Cal. for Q/P 1.0 m (F10.3)									10				
O	2	Calibration for Q/P 0.5 m (F10.3)										Former Cal. for Q/P 0.5 m (F10.3)									10				
O	3	Calibration for I/P V 1.0 m (F10.3)										Former Cal. for I/P V 1.0 m (F10.3)									10				
O	4	Calibration for I/P V 0.5 m (F10.3)										Former Cal. for I/P V 0.5 m (F10.3)									10				
O	5	Calibration for I/P H 1.0 m (F10.3)										Former Cal. for I/P H 1.0 m (F10.3)									10				
O	6	Calibration for I/P H 0.5 m (F10.3)										Former Cal. for I/P H 0.5 m (F10.3)									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
- O1 - Calibration factor - conductivity 1.0 m coils (current and former)
- O2 - Calibration factor - conductivity 0.5 m coils (current and former)
- O3 - Calibration factor - Inphase 1.0 m, V mode (current and former)
- O4 - Calibration factor - Inphase 0.5 m, V mode (current and former)
- O5 - Calibration factor - Inphase 0.5 m, H mode (current and former)
- O6 - Calibration factor - Inphase 0.5 m, H mode (current and former)
- 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	25	26
*	Computer Time (Format HH:MM:SS.sss)										Time Stamp in ms (10 digits)										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	25	26
I	Gn	1h	1l	2h	2l	3h	3l	4h	4l	5h	5l	6h	6l	Time Stamp in ms (10 digits)										10	

- I - indicator T, t, or 2
 - T - first reading at the EM38-MK2-2 station (default for Auto mode)
 - t - first reading at the EM38-MK2-1 station (default for Auto mode)
 - 2 - second reading at station (possible only in Manual mode)
- Gn - information byte, one character parameter, the ASCII number of this character indicates following:

Bit	Decimal	Value and Meaning	
7	128	0	<i>not used</i>
6	64	0	<i>not used</i>
5	32	0	<i>not used</i>
4	16	Ext. Marker = 1	<i>used</i>
		= 0	<i>otherwise</i>
3	8	Soft Marker = 1	<i>used</i>
		= 0	<i>otherwise</i>
2	4	Dipole Mode = 1	<i>Vertical</i>
		= 0	<i>Horizontal</i>
1	2	Marker = 1	<i>no marker</i>
		= 0	<i>trigger pressed</i>
0	1	0	<i>not used</i>

- 1h - higher byte of the 2's complement Hex number of Channel 1
- 1l - lower byte of Channel 1
- 2h - higher byte of the 2's complement Hex number of Channel 2
- 2l - lower byte of Channel 2
- 3h - higher byte of the 2's complement Hex number of Channel 3
- 3l - lower byte of Channel 3

- 4h - higher byte of the 2's complement Hex number of Channel 4
- 4l - lower byte of Channel 4
- 5h - higher byte of the 2's complement Hex number of Channel 5
- 5l - lower byte of Channel 5
- 6h - higher byte of the 2's complement Hex number of Channel 6
- 6l - lower byte of Channel 6
- Time Stamp - time in ms from the Windows start (resets every 49.7 days).
The time in milliseconds can be linked with the computer local time by using Times in line started by * (see Timer Relation).
- 10 - Line Feed character

Channel Information

- Channel 1 - Conductivity for coil separation 0.5 m
- Channel 2 - Inphase for coil separation 0.5 m
- Channel 3 - Conductivity for coil separation 1.0 m
- Channel 4 - Inphase for coil separation 1.0 m
- Channel 5 - Not used
- Channel 6 - Not used

Multiply Channels 1 to 4 according to following formulas to obtain Conductivity or Inphase readings in mS/m or ppt.
(In EM38-MK2-1 data only channels 3 and 4 are valid).

$$\text{Reading (Conductivity)} = (\text{Channel } \times 5 / 1024 - 160) \times 8 \quad (\text{channel 1 or 3})$$

$$\text{Reading (Inphase 1.0 m)} = (\text{Channel } \times 5 / 1024 - 160) \times 8 \times 0.028819 \quad (\text{channel 4})$$

$$\text{Reading (Inphase 0.5 m)} = (\text{Channel } \times 5 / 1024 - 160) \times 8 \times 0.00720475 \quad (\text{channel 2})$$

Comment

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

New Station

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

Calibration

When Calibration is performed during data logging then record for each component/coil separation/dipole mode contains two factors. First value corresponds to the current calibration and the second, following value shows former calibration factor. Calibration values is always recorded as a block of six record, each record represents values for different component/coil separation and in case of Inphase dipole mode settings.

Calibration values placed in Line Header do not contain second, former values till calibration is performed during data logging, in this case they are set to zero.

○	1	Calibration for Q/P 1.0 m (F10.3)	Former Cal. for Q/P 1.0 m (F10.3)	10
○	2	Calibration for Q/P 0.5 m (F10.3)	Former Cal. for Q/P 0.5 m (F10.3)	10
○	3	Calibration for I/P V 1.0 m (F10.3)	Former Cal. for I/P V 1.0 m (F10.3)	10
○	4	Calibration for I/P V 0.5 m (F10.3)	Former Cal. for I/P V 0.5 m (F10.3)	10
○	5	Calibration for I/P H 1.0 m (F10.3)	Former Cal. for I/P H 1.0 m (F10.3)	10
○	6	Calibration for I/P H 0.5 m (F10.3)	Former Cal. for I/P H 0.5 m (F10.3)	10

- O1 - Calibration factor - conductivity 1.0 m coils (current and former)
- O2 - Calibration factor - conductivity 0.5 m coils (current and former)
- O3 - Calibration factor - Inphase 1.0 m, V mode (current and former)
- O4 - Calibration factor - Inphase 0.5 m, V mode (current and former)
- O5 - Calibration factor - Inphase 0.5 m, H mode (current and former)
- O6 - Calibration factor - Inphase 0.5 m, H mode (current and former)
- 10 - Line Feed character

GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 24 characters strings and placed in the EM38-MK2 data file which contains 26 characters long 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 EM38MK2win format is given below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
@	\$	G	P	G	G	A	,	h	h	m	m	s	s	.	s	s	,	d	d	m	m	.	m	m	10	
#	m	m	m	,	s	,	d	d	d	m	m	.	m	m	m	m	m	,	s	,	n	,	q	q	10	
#	,	p	p	.	p	,	s	a	a	a	a	a	.	a	a	,	u	,	±	x	x	x	x	.	10	
#	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.

A.2 Example of Data File in EM38MK2win Format

The EM38MK2win 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.

```
EM38MK2 W100GPS00002      1
H 090916A      0.100
L0
B      0.00
AS      1.000
Z09092008 15:41:45
O1      112.765      0.000
O2      23.365      0.000
O3      5.127      0.000
O4      2.259      0.000
O5      15.823      0.000
O6      16.235      0.000
*16:49:17.000 40102085
T '@ÁËÿÿf£ÛÛ      40165321
T ...
¿AÿÿvfÛÛ      40165416
@$GPGGA,223956.00,4336.59
#316,N,07936.65071,W,2,4,
#3,134.93,M,-35,M,4,118*5
#C
!      40165402
T †vÁ}ÿÿ~âÛÛ      40165511
@$GPGSA,A,3,,,,,,28,,17,1
#1,08,,,09.3,02.7,08.8*09
#
!      40165484
T "ãÀàÿÿ.....ÛÛ      40165606
T %ÛÀ ÿÿ «ÛÛ      40165700
T ¨(à ÿÿªWÛÛ      40165795
T •÷ÛñÿÿŽ£ÛÛ      40165890
T †/Àlÿÿ,ªÛÛ      40165985
T †!¿ ÿÿ~4ÛÛ      40166080
T ^%Álÿÿ„'ÛÛ      40166175
T "Àèÿÿ3ÍÛÛ      40166270
T Š Áóÿÿ...<ÛÛ      40166365
T - áóÿÿ ÛÛ      40166460
@$GPGGA,223957.00,4336.59
#315,N,07936.65071,W,2,4,
#3,135.10,M,-35,M,4,118*5
#4
!      40166401
@$GPGSA,A,3,,,,,,28,,17,1
#1,08,,,09.3,02.7,08.8*09
#
!      40166498
T Š½E`ÿÿ...,ÛÛ      40166555
T ...è¾Eÿÿ,tÛÛ      40166650
T †„¾fÿÿ ~ÛÛ      40166745
T †ÿÁáÿÿa ÛÛ      40166839
T '2Á~ÿÿ„TÛÛ      40166934
T ®ŽÝ^ÿÿÿuÛÛ      40167124
T †
ÁZÿÿ3ÁÛÛ      40167219
T †p¿:lÿÿfÛÛ      40167314
T †ž¿.ÿÿ~²ÛÛ      40167409
@$GPGGA,223958.00,4336.59
#312,N,07936.65069,W,2,4,
#3,135.25,M,-35,M,5,118*5
#2
!      40167401
.....
```

Appendix B

B.1 Using the EM38MK2win with a GPS Receiver

The EM38MK2win program accepts input from GPS receiver that stream NMEA-0183 compatible data through their output port. The program uses two NMEA messages: GGA and GSA. The entire GGA message is used later by the DAT38MK2 program, while the GSA message is used only to display PDOP index on the logger screen.

The GPS system means (control device, receiver panel, or manufacturer software) must be used to set GPS receiver communication parameters, to specify frequency of GPS output, and number and type of NMEA messages sent by the GPS system output port. Any GPS system can send various NMEA messages. **It is important to select only two messages (GGA and GSA) that are actually used by EM38MK2win.** The program will accept any GPS string sent by the GPS receiver, however it uses time to process GPS data that is not being used. Therefore, selecting a larger number of NMEA messages for GPS output will result in slower data acquisition of EM38MK2xp. Normally, the EM38MK2xp running in Windows XP based logger uses less than 100 ms to process and record GPS data from two NMEA messages, GGA and GSA.

Only message GGA is necessary to position EM38-MK2 data. If message GSA is not available in a particular system, the EM38-MK2 will function and record position data based on GGA message. Lack of GSA message will result in PDOP index displayed as Not Available (N/A) on the logger display. Using message GGA alone will also result in slightly faster operation of the program. The speed can be further improved by setting higher Baud Rate (if it is supported by the employed GPS receiver) in Set GPS Port menu.

The EM38MK2win dedicates portion of the display and shows GPS status in a frame box. A number following the label **Position** provides the number of GPS positions saved in the current data 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. This index measures the strength of satellite coverage for a given area. PDOP is affected by the number of satellites visible and their relative positions in the sky. The smaller the number of PDOP the stronger the satellite coverage is. When there are more than 5 satellites widely spaced visible, the PDOP is 4 or less. However, when there are less satellites visible, or they are unevenly spaced in the sky, PDOP values can be 6 or higher. In most cases, the PDOP in an open sky is less than 3, and most accuracies given for many GPS systems are given for this norm. Refer to GPS documentation and literature for more information related to error sources of GPS positioning. The last label **Sat** and following number shows 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.

B.2 Description of GGA and GSA Data Messages

GGA Data Message

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

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

Definition of GGA message component:

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

GSA Data Message

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

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

Definition of GSA message components:

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