

OPERATING INSTRUCTIONS
EM38 DATA LOGGING SYSTEM
FOR FIELD COMPUTERS ARCHER and ALLEGRO CX

EM38wm
Version 2.11 (Archer)

EM38
Version 1.18 (Allegro CX)

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1. Introduction

The manual describes the EM38 program for Allegro CX, however the text applies also to the EM38wm program for Archer and Allegro MX (Windows Mobile devices). The main difference between two versions is the Archer vertical screen orientation.

The Geonics EM38 Data Logging System (DAS70-CX) consists of a field computer Allegro CX, data logging program EM38, and associated cable to connect the Allegro CX to the Geonics EM38 instrument (or any EM38 model equipped with RT module). The program EM38 is designed for the Allegro CX field computer and its MS Windows CE.NET V4.2 operating system.

Program EM38 acquires and records survey data from the EM38 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 or ppt in graphic and numeric mode. In addition, the program allows you to monitor the instrument output while data are not recorded. The EM38 also continuously monitors the EM38 measured component (Conductivity or Inphase), dipole mode (Vertical or Horizontal), instrument scale (10, 100 or 1000), 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 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 component (Conductivity or Inphase) and 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 EM38 will accept NMEA-0183 compatible data from a GPS receiver directly connected to an Allegro field computer. GPS data which are embedded in the EM38 data file can be processed later in the Geonics DAT38W program. The connected GPS must be able to stream NMEA-0183 compatible messages. The EM38 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 EM38 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). However direct GPS interface described above is highly recommended as much more accurate and simpler (for data processing) method of GPS positioning.

Survey setup parameters are saved in a file, therefore they can be automatically used during subsequent data collection sessions.

The program has an option that allows you to view data files. Data files are saved to the programs current data directory by default. Data file names, which can be set by the program based on the computer clock or user specified, have extension names R38. Files can be transferred to a PC computer using a memory card, or by a serial or USB port using the MS ActiveSync program.

Over 1,000,000 readings can be collected in the Allegro field computer with a standard memory of 64 Mb. The maximum speed of data collection is approximately 11 readings per second assuming 1 Hz (or less) GPS input. In graphic display mode, a profile containing the last 135 data readings is displayed for each component.

1.1 Program Requirements

To successfully use this software, you will need :

Computer

Field computer Allegro CX, Archer, Allegro MX, or TK6000.

Installed MS ActiveSync software (Version 3.50 or later) in desktop PC, or alternatively memory card (PCMCIA - Allegro CX, SD or CF - Archer) to transfer files.

Geonics EM38

The EM38 instrument (any EM38 model with RT modification) with associated cables.

The EM38 program for Allegro CX is stored on DAT38W CD disk. All necessary initial files (with extension names .INI) as well as data folder (DATA38) are created in your field computer after the program is run for the first time. Check that the file EM38.EXE is included in Allegro_CX (or the EM38wm for Archer/Allegro MX logger) directory on the CD disk.

1.2 Installing EM38

While using the Allegro CX the EM38.exe file should be transferred from a desktop PC using MS ActiveSync software and USB or serial cable provided by manufacturer. Optionally the program can be transferred to an Allegro using the PC memory card.

It is recommended that the program be placed in non-volatile solid state storage. This memory is represented in the Allegro by the C_Drive icon. In the My Computer on the Allegro, double-tap on C_Drive icon, then folder C_Program Files will appear. The EM38 program can be placed in C_Program Files. Folders for data files should be also created in C_Drive, which is a safe area to store data. The program creates folder DATA38 which is the default folder for EM38 files.



For more information about data storage options, refer to Chapter 3 of the Allegro CX manual.

1.3 Data Files Transfer

Data files are saved in the Allegro with extension R38. Transfer of files to desktop PC can be performed with MS ActiveSync or by PC memory card. Data files with extension R38 are binary raw data files. These files have to be converted to DAT38W format with extension G38 (option "Convert Files" in DAT38W). Then they can be loaded and processed in the DAT38W program.

1.4 Running EM38 Program

To run the EM38 locate program in C:_Program Files and double-tap program icon. The EM38 is a Windows CE based, button and dialog driven program designed to be simple to use. Although the program fully supports touchscreen interface, the keyboard entry may be more convenient in most field applications. The EM38 can be fully operated from the keyboard when touchscreen functions are disabled by the user.

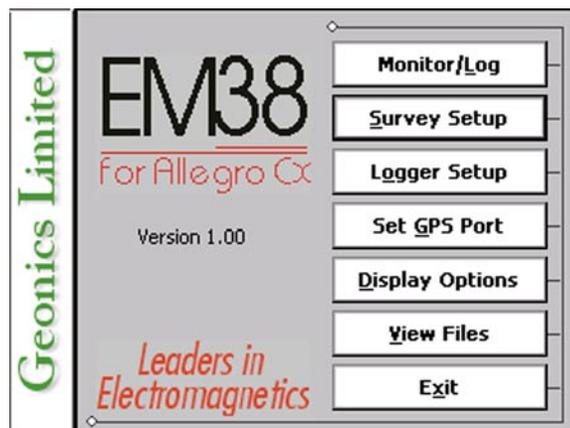


Options represented by the command buttons can be accessed by a single tap on the button. Buttons can also be selected from the keyboard by using shortcuts (pressing key corresponding to underline letter in button caption or by selecting button by pressing **TAB** and then execute by pressing **ENTER**. Shortcuts are the fastest way of accessing options represented by buttons.

Most options in the dialog windows are given in the form of text boxes and drop-down boxes which can be accessed using touchscreen or by the keyboard. Each dialog window has a title bar with a caption describing the dialog function and two buttons **OK** and **X (Cancel)**. The **OK** button (or key **ENTER**) confirms dialog selection. Tapping on the **Cancel** button (or pressing **Esc** key) closes the dialog and returns to the initial selection.

1.5 Main Screen

The Main Screen always appears after the program is started. It contains the name of the program, its version number, and a list of buttons representing the available options. The EM38 Main Screen is displayed below.



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

Short description for each of the options follows.

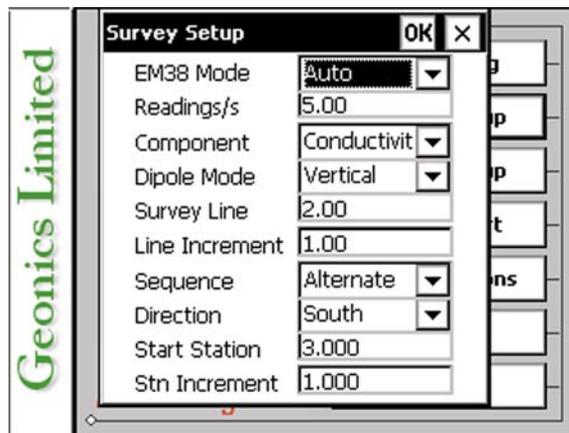
Short description of Main Screen options

Monitor/Log

This option allows to monitor and log the EM38 output. Monitor/Log screen starts always in Monitor mode, and then after a data file is created Logging mode is available. Monitor mode provides initial inspection of the range of the instrument readings at the particular site, monitoring the instrument performance, and quick inspection of the instrument settings.

Survey Setup

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



Logger Setup

Dialog window that is associated with this option is used to set the instrument type, serial port number, and type of pause key.

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.

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 for Conductivity or Inphase scale.

View Files

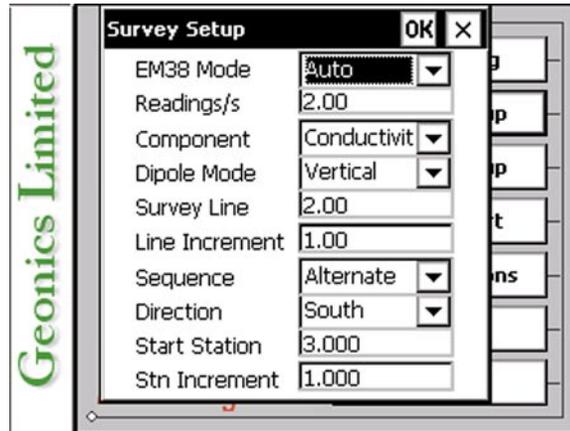
This option allows to review data files saved in Allegro.

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.).



Description of Options and Parameters:

EM38 Mode

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

Auto Mode

Readings will be triggered automatically at a specified frequency (see option Readings/s).

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

Please note that while in the former data acquisition system (DAS70) Stn Increment (station increment) had only two options: Positive or Negative, in the current program this value is optional.

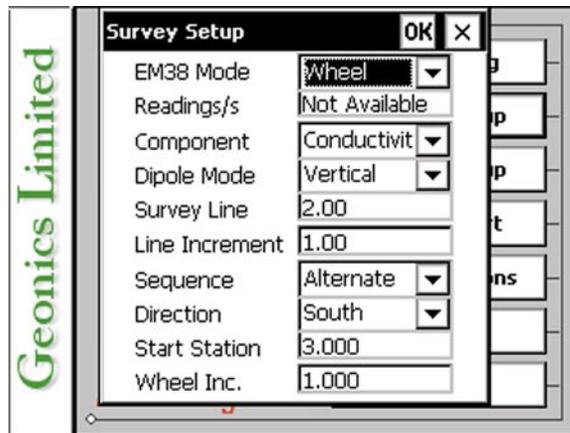
Wheel Mode

This mode is available only if the system is equipped with adapted (i.e. EM61) wheels.

Readings will be triggered automatically by a counter attached to the wheel.

In Wheel Mode only one dipole mode (Vertical or Horizontal) can be selected. When Wheel mode is selected option Reading/s is not available, see figure below.

Please note that while in former data acquisition system (DAS70) Stn Increment (station increment) had only two options: Positive or Negative, in the current program this parameter is optional and its value has to be entered according to used wheel increment.

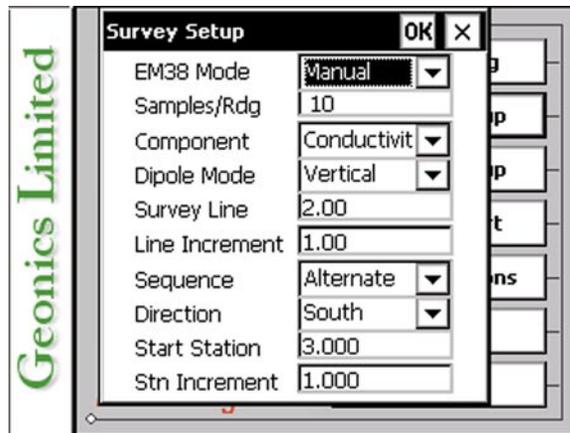


Manual Mode

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 components (Conductivity and Inphase) and dipole modes (Vertical and Horizontal) can be selected.

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



In this mode any value can be entered for the station increment (Stn Incr) parameter.

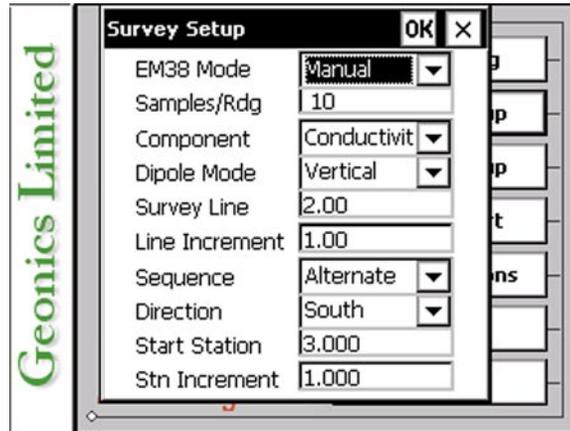
Readings/s

When this option is available (only in Auto mode) activate text box by tapping or using TAB key and then enter desired value.

This parameter describes number of readings per second that will be taken. Any number larger than zero can be entered, however the EM38 fixed frequency of data output is 11 readings per second. Therefore any entered value is rounded to the nearest possible base frequency of the instrument, i.e. user specified frequency of 10 readings/s will result in effective data acquisition rate of 11 readings/s (every reading is logged), 6 readings/s will cause program to log at a rate of 5.5 readings/s (every second reading from instrument output is logged), etc. At slower rates the difference between specified and effective frequencies is negligible.

Samples/Rdg (Samples per Reading)

When this option is highlighted the editor is activated and you can enter desired value. The editor accepts only numerical positive values.



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 10 readings per second. For example by specifying 10 samples, 1 second will be used at each station. The maximal sampling is 100 readings which corresponds to approximately 10 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) enter the value **0** or **1** and 1 reading per station will be taken.

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

Component

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

When Manual mode was selected three settings are available: Both, Inphase, and Conductivity. If Auto or Wheel mode was selected two available component settings are: Inphase and Conductivity.

Dipole Mode (instrument dipole mode)

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

Survey Line (survey line name)

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

This is a user's tag number/name for the profile line. The length of the name can not exceed 8 characters. The line name is usually used as a coordinate perpendicular to the survey lines

direction. For example, when survey lines are laid out along W-E direction stations describe W-E coordinate, while Line names may describe S-N (vertical on a map) coordinate.

Line Incr. (survey line name)

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

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

Sequence

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

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

One Way is used when each survey line is traversed in the same direction.

The choice of this parameter will affect the default start station, a signature of the station increment, and line direction when parameters for the next survey lines is determined.

Direction

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

This parameter indicates the heading of the survey line.

Start Station (start station of a survey line)

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

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

Stn Increment (station increment)

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

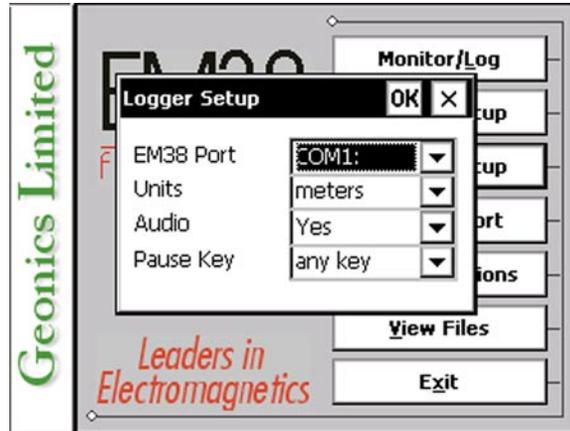
This parameter specifies the station increment for the selected survey line. This value is used in conjunction with Start Station to calculate the current station number for display purposes.

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

To return to original settings (state before this dialog was selected) tap **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. Logger Setup

This option allows you to specify used type of the instrument and set several parameters in the logger. The Logger Setup dialog is presented below.



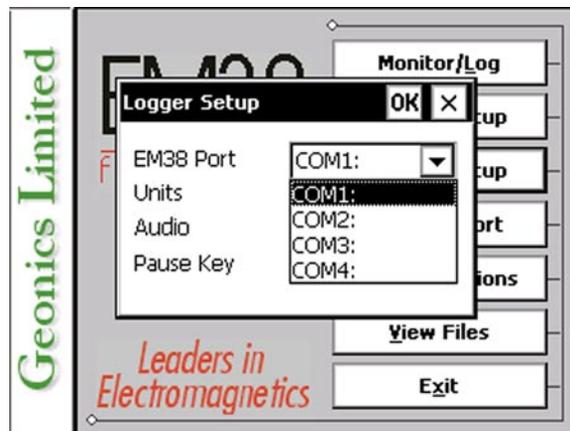
Description of Parameters:

EM38 Port

The number of serial port that is assigned to the EM38. Available selections: COM1, COM2, COM3, and COM4. The program default is COM1. Communication parameters for the selected serial port are set by the program, since the EM38 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 Set Port for GPS option (see chapter), otherwise a message will be displayed and ports will have to be reassigned.

Select port number in the drop-down list box (see Figure below).



Units

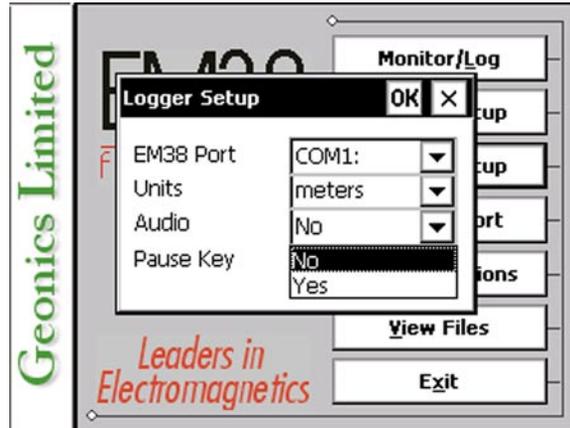
Two selections are available: **Meters** or **Feet**.

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 (11 readings/s) the sound may appear not uniform, however this does not affect quality of data acquisition.

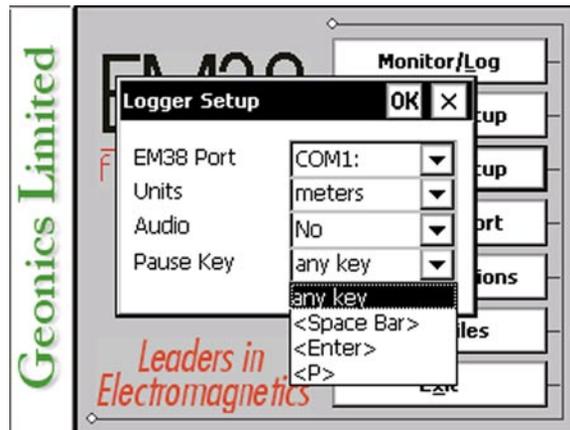
Pause key

Four selections are available: **any key**, **Space Bar**, **Enter**, and **P**. This feature is used to



pause data recording during logging session. Default setting **any key** can be changed to one of the three specific keys for field conditions where a logger key can be accidentally pushed causing unwanted stop of data logging.

After all the parameters in the Logger Setup dialog are updated tap the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings

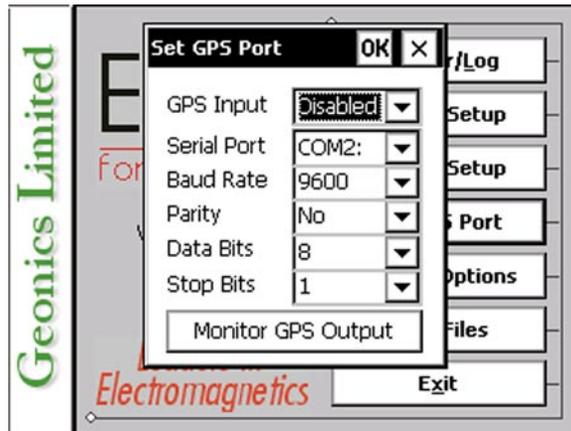


will be written to the initial file and they will be given as default parameters in the subsequent Logger Setup dialog.

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

4. Set Port for GPS

After the Set Port for GPS button was tapped (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, specify serial communication parameters matching GPS receiver settings, and to monitor the GPS output in terminal mode (the bottom button). The dialog is presented below.



Description of Options and Parameters:

GPS Input

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

The GPS Input can be Enabled even if there is no GPS system connected to the Allegro. In such case data file will contain proper sequence of EM38 readings without any GPS input.

Tapping 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: Enable and Disable.

Serial Port

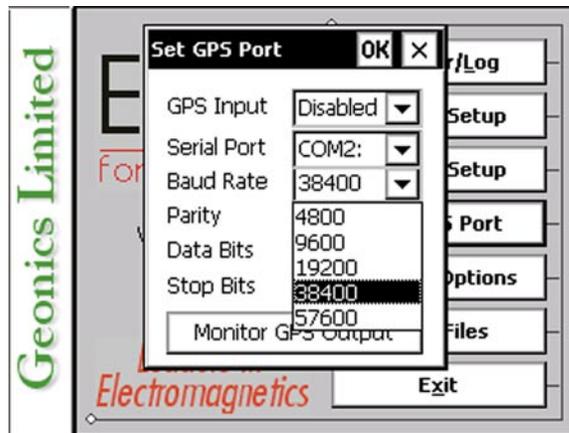
The number of serial port that is assigned to the GPS input. Available selections: COM1, COM2, COM3, and COM4. The program default is COM2. Communication parameters for the selected serial port can be determined in options described below.

This port must be different than the port specified in the Logger Set Up menu (for EM38), otherwise a message will be displayed and ports will have to be reassigned.

Tapping 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.



Tapping 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.

Tapping 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.

Tapping 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.

Tapping 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.

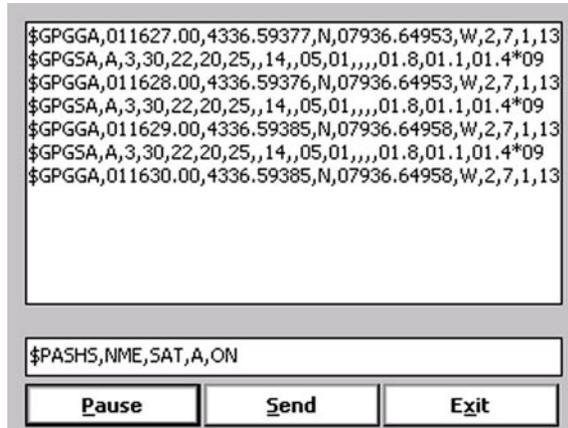
After all the parameters in the Set GPS Port dialog are updated tap the button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent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

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

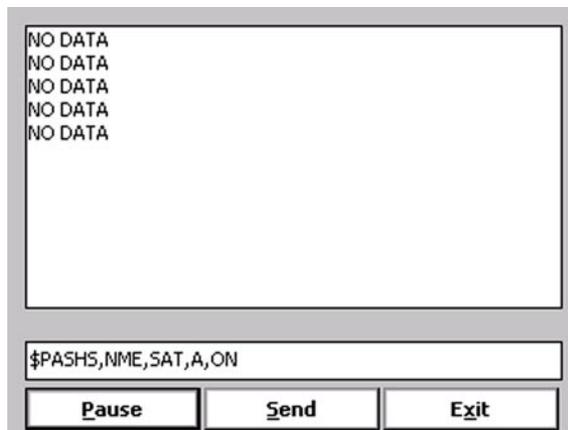
To activate terminal mode which allows you to monitor GPS receiver output tap the button labeled Monitor GPS Output, or when using keyboard select this button using **TAB** key and press **ENTER**. The monitoring mode will work regardless of the GPS Input being Enabled or Disabled. This option is described in the following section.

4.1 Monitoring GPS Receiver Output

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



As soon as the EM38 screen is in terminal mode and the GPS is streaming data, each message transmitted by GPS receiver will appear in the top portion of the display (the end may be cut off if an NMEA message is longer than screen). The display is updated with the frequency the GPS receiver outputs data. This allows you to recognize the GPS update rate and type of messages being sent by the connected GPS. In cases where the GPS data is not received by the logger a message NO DATA and current time will appear in the top window of the display, as shown below.



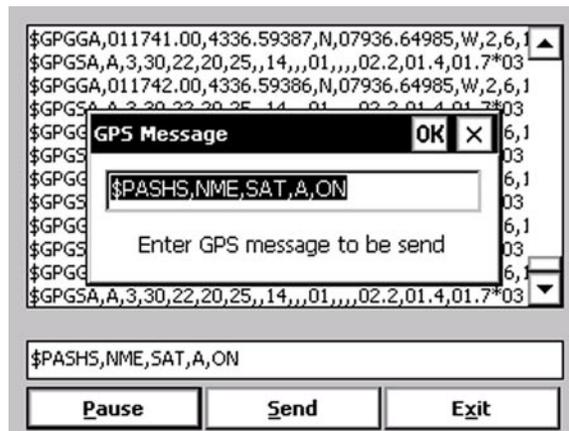
The message NO DATA is normally updated with a rate of 7 seconds. This may indicate the following: serial port number not correctly specified in Set Port for GPS dialog, GPS receiver not sending any data, and not working or not connected GPS receiver. If the message is updated more often than 7 seconds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

The NO DATA message may also appear if the GPS data are received correctly, but the GPS receiver was set to send data with a time interval longer than 7 seconds. In this case the NO DATA message will be displayed in between GPS messages. This indicates that the GPS is working correctly, however the operator should consider adjustment of the GPS receiver output update rate. Most high resolution geophysical surveys require positioning update of 1 or 2 seconds, and a 5 seconds interval can be used only when the survey is carried out at an even pace and along relatively straight survey lines.

The monitoring display can be stopped any time by using button labeled **Pause**. At that time scrolling of the GPS output will be stopped, and the button will be labeled **Go**. The next tap (or keyboard action) on this button will activate receiving and display of GPS data.

The button labeled **Send** allows you to send a NMEA command to the GPS receiver. It is preferable if the GPS receiver parameters are set using the GPS manufacturer software or controller (GPS logger or panel keys). However, **when the operator is familiar with NMEA protocol and structure of commands for a given GPS system**, this function can be very convenient and useful when the update rate and enabling or disabling messages in the data stream is required.

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

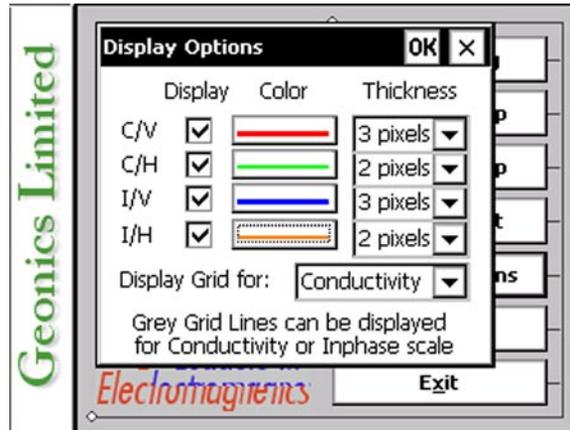


After this command is received by the GPS receiver, the confirmation message will be send by the receiver (**\$PASHR, ACK*3D**) and data stream will contain the message **SAT** (**\$PASHR, SAT,.....** in the above figure).

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

5. Display Options

After the **Display Options** button was tapped (or executed from the keyboard) in the Main Screen the Display Options dialog window appears on the screen. This dialog allows you to enable and disable the display of each channel profile, specify color and thickness of profiles, and select grid lines for conductivity or Inphase scale. The dialog is presented below.



Description of Options and Parameters:

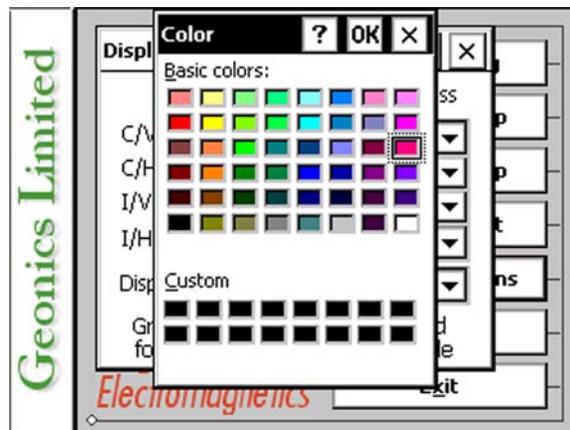
Display

To enable or disable displaying of each component and dipole mode profile tap on the corresponding button labeled Display. Profiles of all component/dipole mode combinations with checked buttons will be displayed during data logging.

Regardless of which components and dipole modes are chosen to be displayed as profiles, data for all readings received from the instrument will be displayed in numeric form below profile display.

Color

To change colour of each profile tap the corresponding button (with colour line) labeled Color. The following dialog titled Color will appear.



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

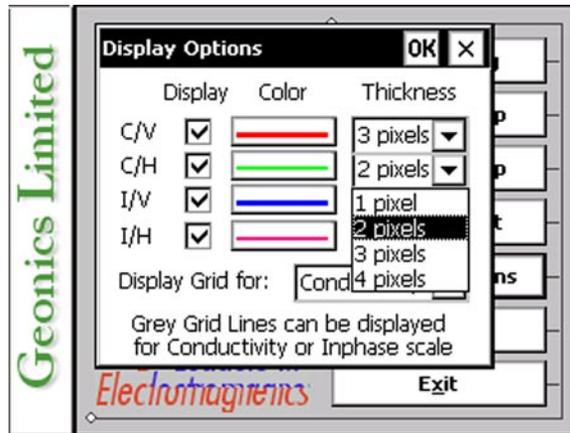
Tap the button **OK** or press **ENTER** key to accept the highlighted colour. The Color dialog

will disappear and the colour of the appropriate channel button will updated. To cancel colour selection tap **Cancel (X)** button or press **Esc** key.

Thickness

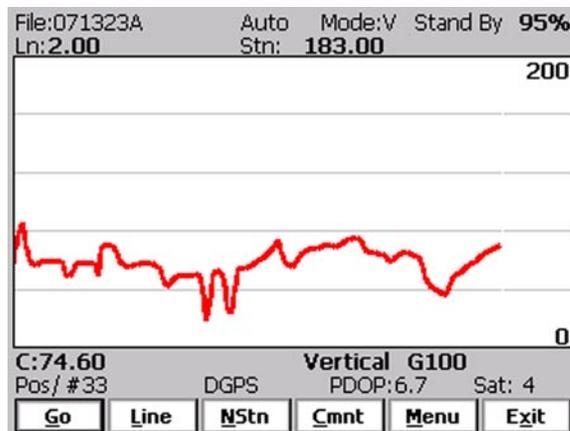
Specify thickness of a profile for a desired channel by using one of four drop-down boxes labeled thickness. Thickness of a profile curve is expressed in pixels. Available settings are: 1, 2, 3, or 4 pixels.

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



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.

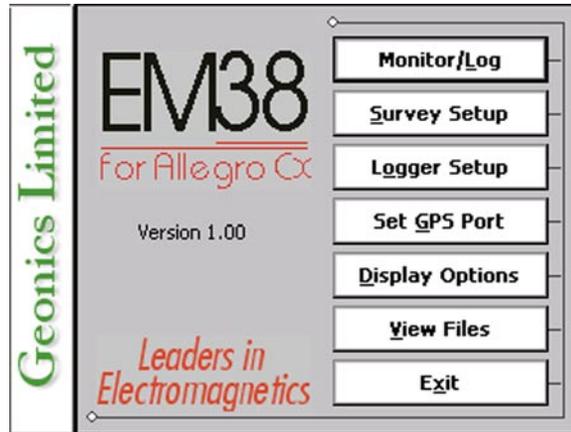


After all the parameters in the Display Options dialog are updated tap button **OK** or press **ENTER** key to accept the displayed settings. The program will return to the Main Screen. Updated settings will be written to the initial file and they will be given as default parameters in the subsequent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

To return to original settings (state before this dialog was selected) tap **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 **Monitor/Log** button (in Main Screen) is tapped or executed by the keyboard, the program enters logging session which contains three modes: Monitoring, Stand By and Logging. Program starts logging session always in Monitoring mode. In this mode EM38 readings, gain, dipole mode

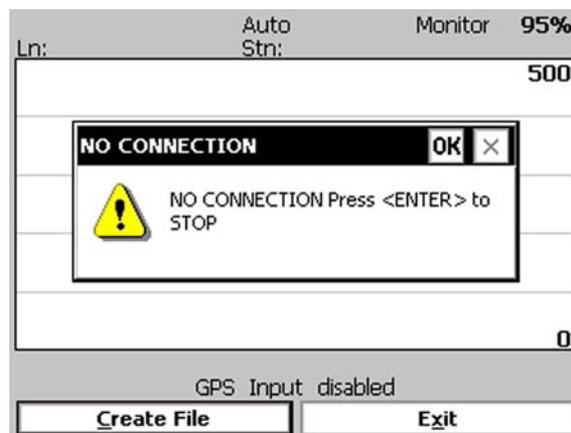


and GPS parameters can be quickly examined and creating data file can be performed. After a data file is created in Monitoring mode, the program switches to Stand By mode and allows access to Logging mode. In Stand By mode instrument output can be monitored and some survey and logging parameters can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

6.1 Monitoring Mode

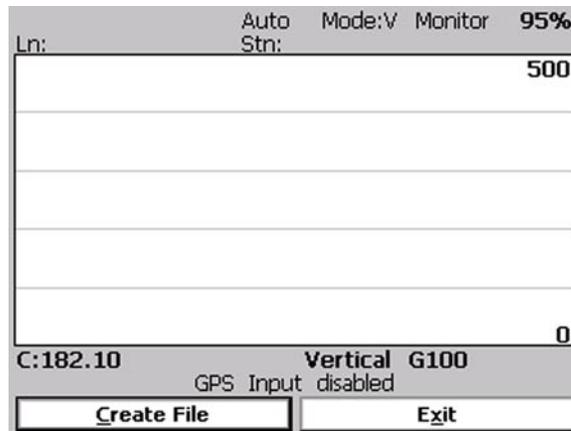
The Monitor mode allows initial inspection of the range of the instrument readings at a particular site and monitoring the instrument and GPS receiver performance.

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



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

Assuming that the instrument works properly the program will display the Monitor mode window. The layout of the Monitor window is as follows:



The Monitor (as well as Stand by and Logging) window is divided into four sections.

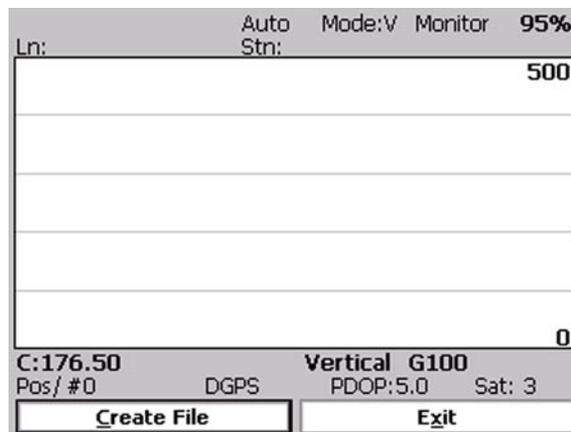
Two lines of text in the top section provides survey parameters (used in Stand By and Logging modes) and instrument information. In Monitor mode this section displays: user specified instrument dipole mode (V, H or B following label **Mode:**), current display mode (Monitor, Stand By or Logging), and Allegro battery level (in % of full charge). When fiducial marker is pressed then **M** is displayed next to label **Stn:**.

The second, largest graphic section will be used to display profiles during logging data.

The third section contains two lines of text. The first line is used to display EM38 readings and the second line of text provides GPS related information.

The EM38 readings are labeled **C:** (conductivity) or **I:** (Inphase). Readings and other parameters are displayed from the left in order: conductivity in mS/m or Inphase in ppt. dipole mode (Vertical or Horizontal), and the EM38 range (following label **G**). The EM38 readings are updated approximately 10 times per second during the monitoring session.

When GPS was Disabled in the Set GPS Port dialog a message **GPS Input: 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 **Pos/#** will be used during data acquisition, it will provide the number of GPS positions saved in the data file. In Monitor mode this label indicates GPS activity by toggling between forward (/) and back (\) slash (that follows label **Pos**) every time the program receives a message from the GPS receiver. If the slash is not changing for long periods of time it means that the GPS receiver is not working or that it is not connected to the field computer. 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. 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 9 (Set Port for GPS), Appendix A, and to GPS manuals for more information about GPS parameters.

The fourth section of the Monitor window lists the program functions available directly in the Monitor mode given at the bottom of the screen in form of buttons. Available options are as follows: **Create File** (create data file) and **Exit** (exits the Monitor mode and returns program to Main Screen).

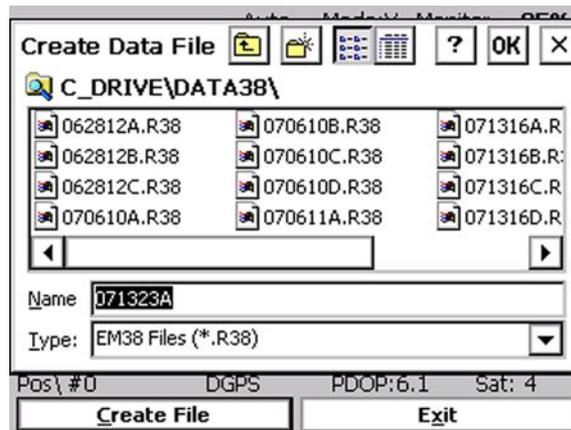
Description of Monitoring Mode Options

Create File (*create data file*)

When a data file is created the program will switch to Stand By mode automatically.

The log file can be created in the given default directory (DATA38) or in any other directory in the Allegro CX. If other directories are used, please note that only subdirectories of C_Drive represent save, non volatile memory.

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 EM38 data files cannot be appended.

Each data file in the field computer (raw data file) has an extension name R38 and it is created in the directory specified in Create Data File dialog. The R38 files are created in the instrument binary format. They can be viewed using the Main Screen option “View Files”. These files can be also converted to ASCII format and processed in the Geonics DAT38W program.

After the file is specified tap the button **OK** or press **ENTER** key to accept and create data file. The program will switch Monitor mode to Stand By mode and the data file will be displayed on the screen.

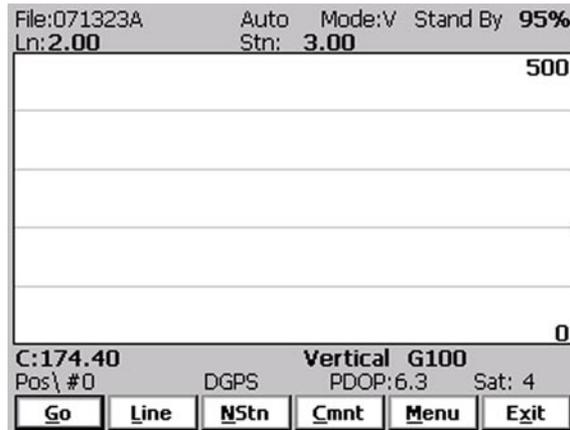
To cancel selection and return to Monitoring mode tap the **Cancel** (X) button or press **Esc** key.

Exit (exit Monitor mode)

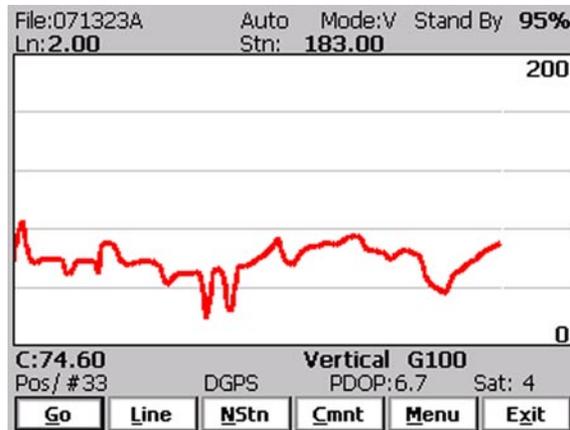
After tapping Exit button (or executing this option using keyboard) the program immediately returns to Main Screen.

6.2 Stand By Mode

After data file is created in Monitoring mode the program automatically switches logging window to Stand By mode. This window is similar to Monitor mode however it contains survey parameters (file name, survey line name, etc.) 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). When Both components (Manual mode) was selected then there two scales within plot area. Scale for conductivity is labeled at the top and bottom of the plot window, and labels for Inphase are placed inside (under and over labels for conductivity). 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 or Inphase are shown in numeric form below the plot area. Values of readings are labeled (C or I) and displayed in the following order (from the left): conductivity and Inphase. Readings are followed by current dipole mode (Vertical or Horizontal) and EM38 currently set range (labeled **G**). EM38 readings (in numeric form) are updated in Stand By mode approximately 10 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 two lines of text displaying survey and instrument related parameters. These are (from top left): current data file name (labeled **File:**), survey mode (**Auto**, **Wheel** or **Manual**), user selected instrument mode dipole mode **V** (vertical), **H** (horizontal), or Both (only in Manual mode) labeled Mode; logging mode **Stand By** or **Logging**, Allegro internal battery level (in % of full charge, not labeled), current survey line (labeled **Ln:**), current station (labeled **Stn:**). When fiducial marker is active a label **M** is displayed between station label and station value.

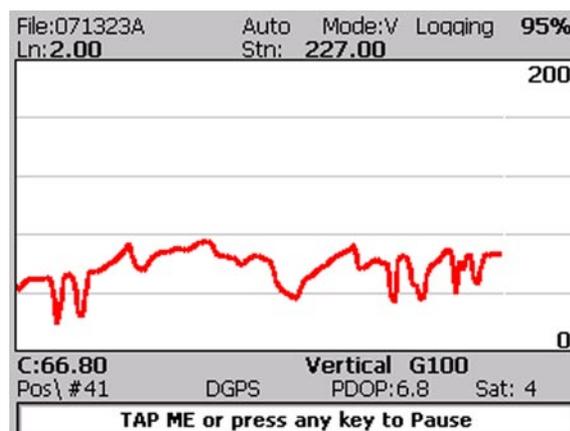
In the Stand By mode the station number will not change. Stations in the EM38 program are incremented by station increment value after each reading is written to the data file.

One line of the display is dedicated to showing the GPS status. A number following the label **Pos/#** 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). However this label indicates GPS activity by toggling between forward (/) and back (\) slash (that follows label **Pos**) every time the program receives a message from GPS receiver. If the slash is not changing for long periods of time (larger than GPS receiver update rate) it means that the GPS receiver is not working or that it is not connected to the field computer. 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. 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 A, and to GPS manuals for more information about GPS parameters.

Several available field options are listed at the bottom (in form of buttons) 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 tapping on the **GO** button 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 mode in the Survey Setup menu. All labels and parameters (with the exception of buttons representing Stan 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.



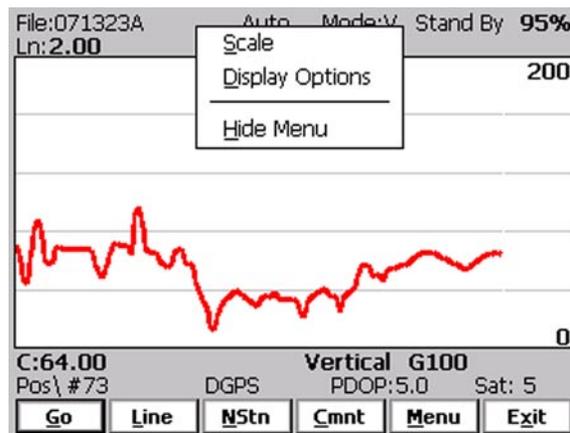
After the screen changes to Logging mode the current station (label **Stn:**) is updated according to the station interval. Similarly, if GPS Input was enabled, total number of GPS positions (label **Pos**) in the data file is incremented every time (usually once a second) GPS position is written to the file. Profile curves (for channels selected in Display Options window) are updated after each reading is written to the data file.

There is only one option available in the Logging mode - pause logging. After a Pause button is tapped 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 data will be displayed with the update rate approximately 10 readings per second, however data will not be saved in the log file and profile curves will be not updated.

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

6.4 Stand By Mode Field Options

Several field options are available while the Logging window is in the Stand By mode. More frequently used options can be accessed directly from command buttons and others can be used from pop up menu activated by button **Menu** (displayed below). Command buttons can be used by tapping on the desired button, or from the keyboard by pressing one of the shortcut keys (underlined characters on button labels) or by navigating using <TAB> key (sets button as a default button - default button is highlighted) and pressing <ENTER> key.



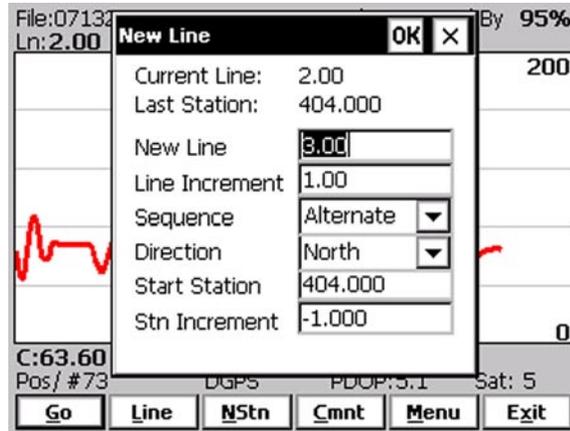
Options listed in the menu can be accessed directly (without displaying pop up menu from Menu button) by using keyboard shortcuts, i.e. pressing key **S** will display Scale dialog. While menu is displayed options can be selected by tapping on the appropriate proper option, or from the keyboard by pressing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

GO *(start data logging)*

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

Line (New Survey Line)

The New Line dialog is displayed (see Figure below). Selecting this option allows the operator to enter a new survey line number (name) and associated line parameters (Line Increment, Line Sequence, Direction, Start Station, and Station Increment). The new line number and associated parameters are prompted by the program based on parameters specified in the Survey Setup menu.



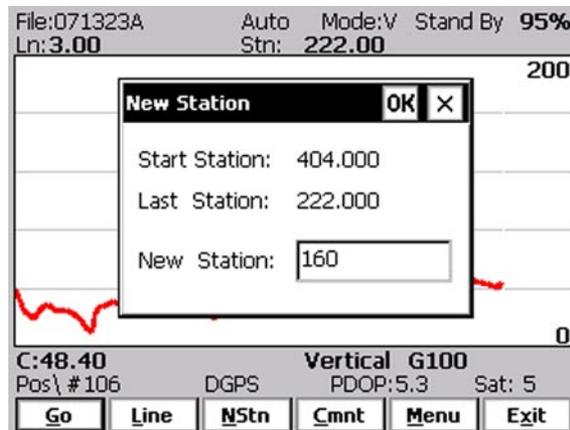
At the top of the dialog the last survey line name and the last logged station are displayed. Default name for the new line is given based on the Line Increment parameter. The default Start Station, direction of the Station Increment, and Direction are determined based on Sequence selection. All these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

After all the parameters in the New Line dialog are updated tap the 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 (**Ln:**) name and current station (**Stn:**) value will be updated and profile curves plot for former survey line will disappear.

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

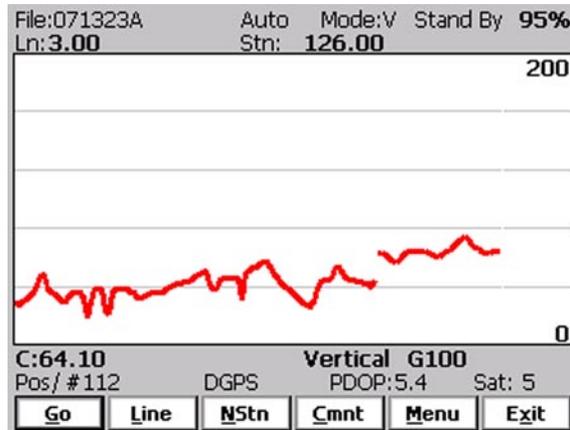
NStn (New Station)

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



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

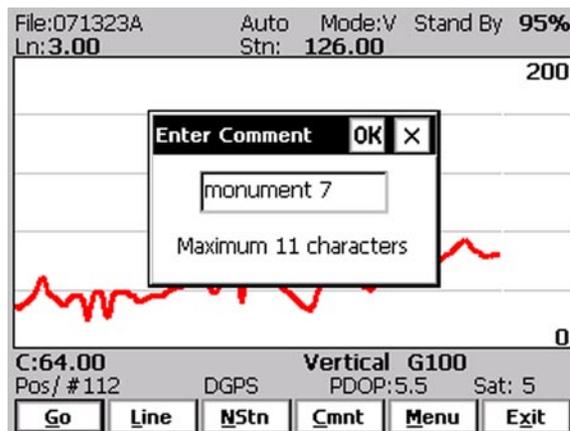
Tap the button **OK** or press **ENTER** key to accept the new value. The program will return to the Logging window in Stand By mode. Current station (**Stn:**) value will be updated and after data logging is activated the profile curves will have a small gap (two pixels) showing the new station entry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



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

Cmnt *(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.

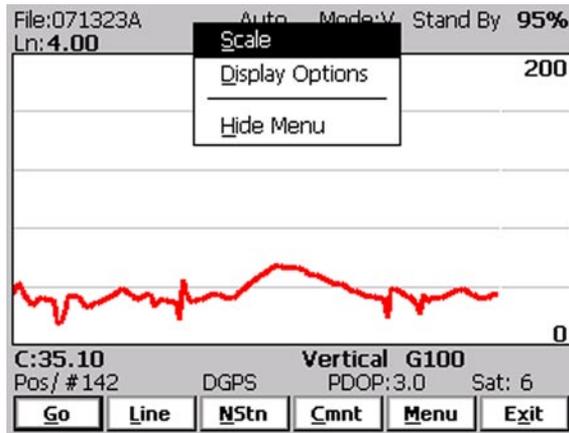


Tap the button **OK** or press **ENTER** key to accept the comment entered in a text box of the dialog. The text of the comment is saved in the file with a corresponding time stamp and the program will return to the Logging window in Stand By mode.

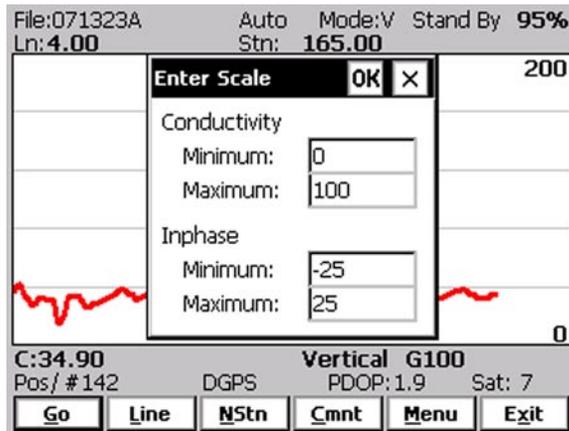
To ignore an entry and return to Stand By mode tap **Cancel (X)** button or press **Esc** key, the dialog window will disappear and measurements can be continued.

Scale (New Scale for Profile Plot)

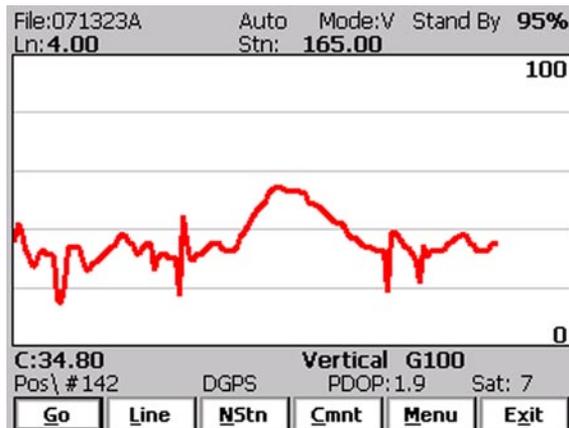
Selecting New Scale option allows the operator to enter new scale parameters for the profile plot for each component. This option is available only from pop up menu (accessible from **Menu** button) or directly from keyboard by using shortcut key <S>.



The Enter Scale dialog will be displayed. 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. If Both components are recorded (in Manual mode) then outer numbers indicate scale for conductivity and inner 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 (see Figure below).

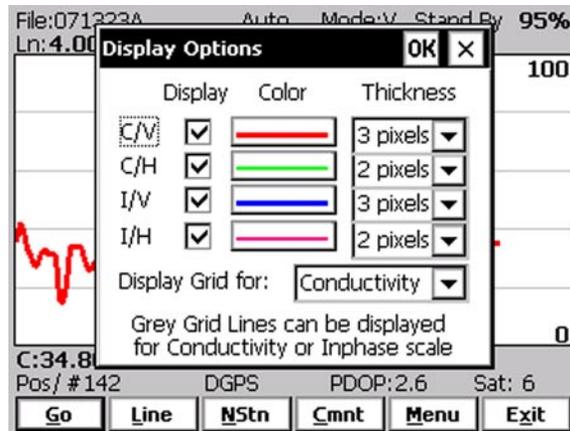


To ignore an entry and return to Stand By mode tap the **Cancel** (X) button or press **Esc** key, the dialog window will disappear and measurements can be continued.

Display Options (*new options for profile plot display*)

This option is available only from pop up menu (accessible from **Menu** button) or directly from keyboard by using shortcut key <D>.

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



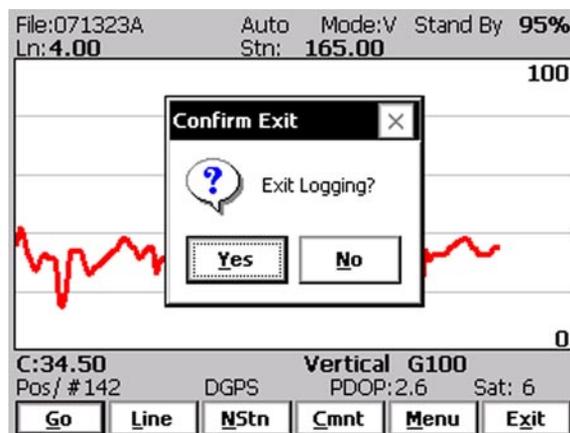
Please refer to chapter 5 where this dialog and its parameters are described in detail.

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

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

Exit (*exit data logging*)

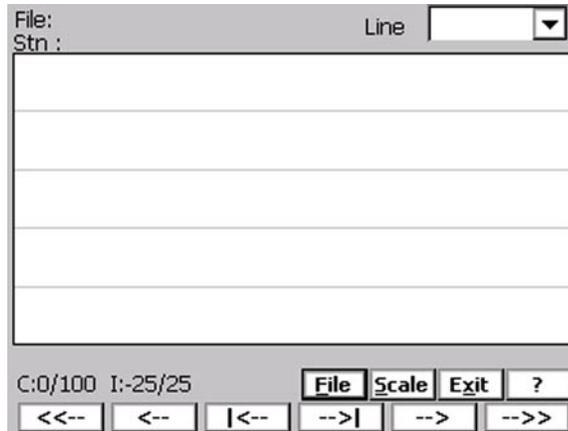
During data collection (in Stand By mode) a confirmation message will be displayed (there is no such message if **Exit** is performed in Monitoring mode) before program exits logging window.



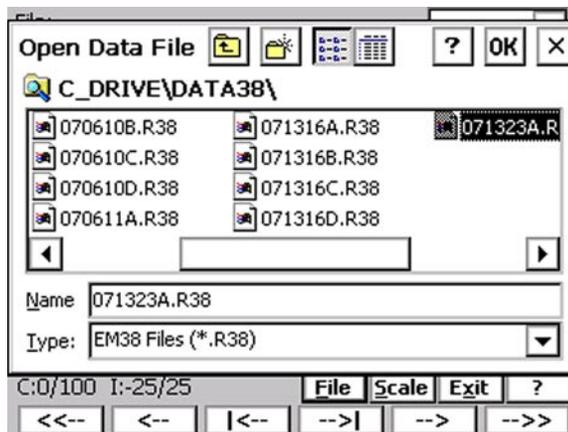
After above message is confirmed the program stops logging, closes data file and returns to Main Screen.

7. View Data Files

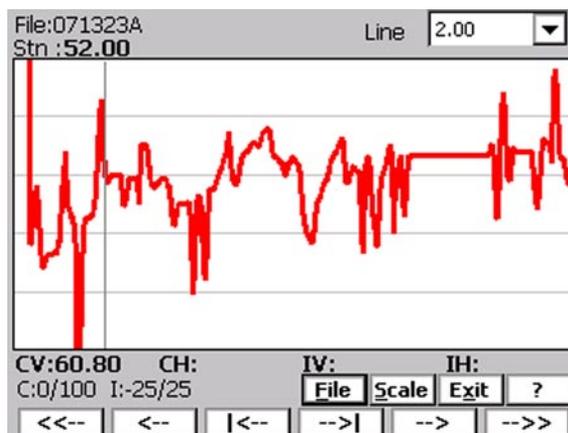
This option allows you to view recorded data files. After the View Files button is tapped (or executed from the keyboard) in the Main Screen the View Data Files window will be displayed.



To open the data file tap 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.



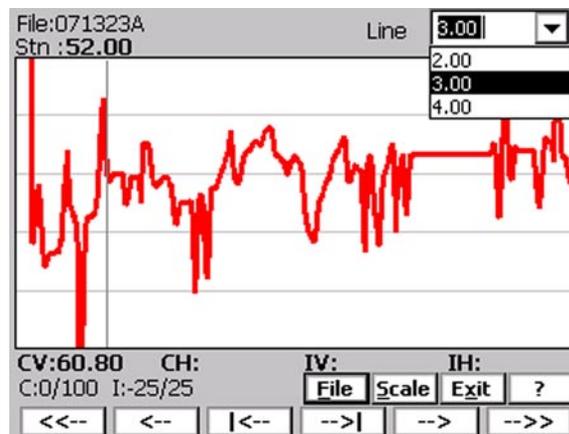
The file name can be selected in the Open Data File dialog using the Windows standard interface procedure. After the file is selected (highlighted) tap the button **OK** or press **ENTER** key to accept and display data file (to cancel selection tap **Cancel** (X) button or press **Esc** key). After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



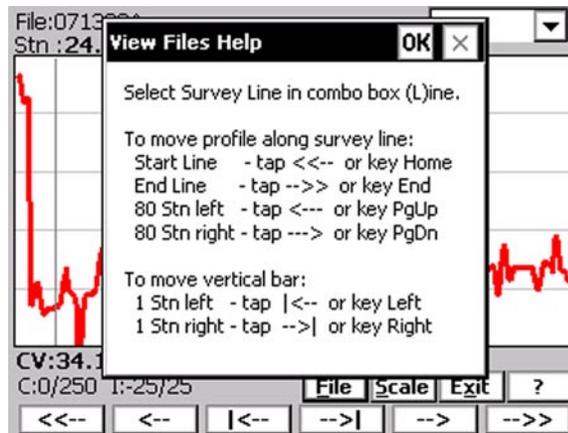
Name of the currently displayed data file is shown in the left top corner of the window. The main portion of the screen is occupied by the plot area which displays profiles. Amplitude scale as well as display range (minimum and maximum value) is given by label located at the left bottom of the window (i.e. **C: 0/100** means conductivity scale from 0 to 100 mS/m). Range of scale display can be changed by tapping the button labeled **Scale**. 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. Grey grid lines are associated with a scale displayed with bold font.

A vertical bar (grey vertical line) indicates currently displayed station. The station is displayed above the plot area, next to label **Stn:** and readings at this station for channels conductivity and Inphase are shown in numeric form below the plot area. Component and dipole mode labels are not displayed due to the small screen of the Allegro. Values of readings are displayed in the following order (from the left): conductivity/vertical, conductivity/horizontal, Inphase/vertical, and Inphase horizontal. EM38 readings (in numeric form) are updated every time vertical bar is moved.

To change the currently displayed survey line use the drop-down box labeled **Line** located in the top right corner of the window. Tapping on the down arrow next to the text box labeled **Line** opens a drop-down box showing the 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 below).



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. A help screen containing info related to each button can be displayed at any time by tapping (or executing from keyboard) the Help button labeled ?. The Help screen is shown below.



When moving displayed profile along survey line:

- button labeled <<-- or key **Home** moves display to the start of the currently displayed survey line, the left most station is the start station of the line,
- button labeled -->> or key **End** moves display to the end of the currently displayed survey line, the right most station is a final station of the survey line,
- button labeled <--- or key **PgUp** moves display 80 stations to the left,
- button labeled ---> or key **PgDn** moves display 80 stations to the right.

When changing stations and corresponding readings:

- button labeled |<-- or key **Left** (left arrow) moves vertical bar (station) one station to the left,
- button labeled -->| or key **Right** (right arrow) moves vertical bar (station) one station to the right.

To exit the View Files window tap the button labeled **Exit** (or from keyboard use shortcut key **X** or press key **ENTER** when the button is highlighted) to close file (if open). The program will return to Main Screen.

Appendix A

A.1 Description of Data File in EM38 Allegro CX Format

Each record contains 24 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
E	M	3	8	S				W	1	0	0	Survey Type	UT	ID	IM	IC							10
H																							10

- EM38S - identification of program file
- W100 - version number (1.00, W - indicates file created by Windows CE program)
- Survey Type - GPS (if GPS Input Enabled) or GRD (grid)
- UT - unit type (0 = meters, 1 = feet)
- ID - EM38 Dipole Mode
(0 = Vertical, 1 = Horizontal, 2 = Both)
- IM - EM38 survey mode
(0 =Auto, 1 =Wheel, and 2 =Manual)
- IC - EM38 component
(0 = Both, 1 = Inphase, and 2 = Conductivity)
- File Name - file name, maximum 8 characters
- Time/Wheel/Samples - this field depends on EM38 survey mode
 - Auto Mode - Time Increment in seconds
 - Wheel Mode - Wheel Increment (user units, see IT)
 - 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
L																							10
B																							10
A	Dir																						10
Z	D	D	M	M	Y	Y	Y	Y			H	H	:	M	M	:	S	S					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
- 10 - Line Feed character

Timer Relation

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
*	Computer Time (Format HH:MM:SS.sss)												Time Stamp in 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
I	Gn	Reading					not used					Time Stamp in ms (10 digits)					10						

- I - indicator T, or 2
T - First reading at the station (default for Auto mode)
2 - second reading at station (possible only in Manual mode)
3 - third reading at station (possible only in Manual mode)
4 - fourth 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		= 1	<i>not used</i>
6	64	Marker	= 1	<i>trigger pressed</i>
			= 0	<i>otherwise</i>
5	32	Mode	= 1	<i>Vertical</i>
			= 0	<i>Horizontal</i>
4	16	Gain	= 1	<i>Gain = 8</i>
			= 0	<i>Gain = 0</i>
3	8		= 0	<i>not used</i>
2	4	Component	= 1	<i>Conductivity</i>
			= 0	<i>Inphase</i>
1	2	Range 2		
0	1	Range 1		

Range 2 and Range 1 represent sensitivity (gain) as follows

Sensitivity	Range 1	Range 2	Multiplication Factors	
1000	1	1	Conductivity	-1/Gain
			Inphase	-0.0288/Gain
100	0	1	Conductivity	-0.1/Gain
			Inphase	-0.00288/Gain

Multiply Reading by above factors to obtain result in mS/m or ppt.

- Reading - five character field containing instrument output.
includes sign (+ or -) and four digits
- Time - time stamp of the reading in milliseconds, this is time elapsed from the last 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

A.2 Example of Data File in EM38 (Allegro CX) Format

The EM38 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.

```
EM38S   W100GRD0002
H 071316D   0.200
LO
B       0.00
AS           1.000
Z13072005 16:59:49
*16:59:49.000 30916925
T☒-0772      30919102
T☒-0772      30919282
T☒-0772      30919462
T☒-0772      30919642
T☒-0772      30919821
T☒-0772      30920001
T☒-0740      30920181
T☒-0292      30920360
T☒+0212      30920539
T☒-0175      30920717
T☒-0588      30920897
T☒-0976      30921077
T☒-1229      30921256
T☒-1414      30921437
T☒-1441      30921617
T☒-1460      30921797
T☒-1789      30921978
T☒-1806      30922158
T☒-1572      30922339
T☒-1273      30922519
T☒-1341      30922699
T☒-1353      30922880
T☒-1080      30923060
T☒-0944      30923240
T☒-1120      30923420
T☒-1364      30923600
T☒-1394      30923780
T☒-1794      30923961
T☒-1941      30924142
T☒-1975      30924323
T☒-2154      30924504
T☒-2160      30924684
T☒-2187      30924866
T☒-2215      30925047
T☒-2264      30925227
T☒-2269      30925408
T☒-2035      30925589
T☒-1737      30925770
T☒-1530      30925950
T☒-1298      30926130
T☒-1283      30926310
T☒-1572      30926490
T☒-1746      30926671
T☒-1895      30926851
T☒-1908      30927032
T☒-1831      30927212
T☒-1694      30927393
T☒-1612      30927574
T☒-1661      30927755
T☒-1754      30927935
T☒-1820      30928116
T☒-1679      30928296
.....
```

Appendix B

B.1 Using the EM38 with a GPS Receiver

The EM38 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 DAT38W 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 EM38.** 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 EM38. Normally, the EM38 running in Allegro CX 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 data. If message GSA is not available in a particular system, the EM38 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 EM38 dedicates one line of the display to show GPS status. A label **DGPS** (Differential Global Positioning System) that GPS readings are differentially corrected in real time. Label **AGPS** (Autonomous Global Positioning System) indicates lack of differential correction. On the right side of the **POS** a label slash character is displayed. This slash alternates between forward and back slash with the frequency of GPS update rate (usually 1 second intervals). If the slash is not moving for longer period of time it means that GPS system is not working or that it is not connected to the field computer. Number of recorded GPS positions are displayed on the right side of the alternating slash following # sign. This number is updated only in the logging mode, when the data are recorded. (In Stand By mode or during Monitoring only the alternating slash, and updated values of PDOP and number of tracked satellites, indicate presence of GPS input).

Two more GPS parameters are displayed on the logger screen. These are index PDOP shown by label **PDOP** and number of tracked satellites represented by label **Sat**. The index called PDOP (Position Dilution of Precision) measures the strength of satellite coverage for a given area. PDOP is affected by the number of satellites visible and their relative positions in the sky. The smaller the number of PDOP the stronger the satellite coverage is. When there are more than 5 satellites widely spaced visible, the PDOP is 4 or less. However, when there are less satellites visible, or they are unevenly spaced in the sky, PDOP values can be 6 or higher. In most cases, the PDOP in 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.

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