TrackMaker 31

Version 1.51

User's Manual

GEOMAR SOFTWARE INC.
Tel: 905.306.9215
Fax: 905.276.8158
E-mail: geomar@geomar.com
Web: www.geomar.com

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Geomar Software Inc.
899 Runningbrook Drive
Mississauga, Ontario, Canada L4Y 2S4
Tel: 905 306 9215
Fax: 905 276 8158
e-mail: geomar@geomar.com
web: www.geomar.com

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Introduction 1

The Geomar TrackMaker31 Data Logging System consists of a data logging program NAV31 (or NAV31P) and associated PC computer program TrackMaker31. The program NAV31 is designed for various field computers, Windows CE based Allegro CX and DOS based Allegro CE/DOS and Allegro DOS. The NAV31P is prepared to handle the different size screen of the Pro4000 field computer. If necessary DOS based NAV31 can be used with any other IBM compatible computer running an MS DOS operating system and equipped with the necessary number of serial ports. The only disadvantage of using a standard laptop computer will be the small size of the display which is limited for the Allegro field computers.

The program TrackMaker31 is used to process data files recorded under the control of program NAV31. It recognizes data file formats created with various versions of NAV31 automatically. When data acquisition program is used in Allegro CX or other Windows CE based computer the TrackMaker61 version 1.50 or later must be used.

1.1 About the TrackMaker31

The program TrackMaker31 is a Windows based program for IBM PC compatible computers operating under Windows 95/98/XP/NT(V4.0) and Windows 2000. The program TrackMaker31 is designed to process data collected by a field computer under the control of various versions of program NAV31 (or NAV31P). The program can be used to transfer data from the DOS based field computer to PC, to position EM31 conductivity meter, to convert data to Geonics DAT31W format, to convert ASCII text file format, as well as position field comments and generate position file for stand-alone GPS positions (GXY).

Main function of this program is to position Geonics EM31 based on the recorded GPS position, the instant heading of the system, the configuration of the system, and several user specified filters. Configuration of the system is described by offsets of the GPS antenna from the center of the electromagnetic instrument. The program calculates real position of the instrument based on specified GPS antenna offset and direction of the movement. Therefore GPS antenna does not have to be placed exactly in the center of the EM31. Optionally elevation data can be written to the output file. The program corrects elevation data for the GPS antenna height. The program can process seven different NMEA GPS messages recorded by data acquisition software NAV31: a pair GGA/

GSA, GGA, POS, LLK, LLQ, GLL, and GGK (Trimble and Leica versions). In addition program handles interface of Leica Robotics Total Station TPS1100 and TPS1200.

The TrackMaker31 also allows you to correct the collected GPS positions with post-processed GPS files.

The TrackMaker31 uses data files in NAV31 format which have extension name H31. These are binary files with a record length of 24 bytes (or 22 bytes for DOS based NAV31) terminated by Line Feed character. These files should not be edited using standard text editors. The program can also process files with extension GXY. The GXY file contains stand-alone GPS positions if the NAV31 program was used to collect GPS data only. These files are also binary (records are 24 bytes for Windows CE based program and 22 bytes long for DOS version, and terminated by Line Feed character) and care should be taken if they are viewed with text editors. Files GXY generated by any other Geomar data acquisition program i.e. ML61, NAV61MK2, NAV38, etc. are fully compatible and they can be processed by TrackMaker31.

One sample NAV31 data file, 041012E.H31, and one external (postprocessed) GPS file Trext17.txt are included on the program disk. They allow the user to become familiar with running the TrackMaker31 program.

1.2 Contents of TrackMaker31 Distribution Disk

Program TrackMaker31 is supplied on one CD disk. Disk contains following files and directories:

SetupT31	-	setup program for TrackMaker31
Documentation	-	directory containing all NAV31 and TrackMaker31 related manuals in PDF format.
NAV31disks	-	directory containing two subdirectories (Disk1 and Disk2) for users that require floppy disks to run SetupT31
NAV31.exe	-	Allegro CX or DOS version of data acquisition program
Util	-	only when program is supplied with USB security key (dongle). This directory contains all necessary files that are used USB security key (dongle) functions.

The program can be also supplied on floppy disks if requested.

1.3 TrackMaker31 Software Installation

TrackMaker31 uses a setup program to load files onto your computer. The following section describes the installation process. To install TrackMaker31: Insert the TrackMaker31 CD disk (or floppy diskette #1) into computer CD (or floppy) disk drive. Exit all Windows applications before installing the program. From the Windows File Manager, select **Run** from the **File** menu. The Run dialog box opens (Figure 1.1).

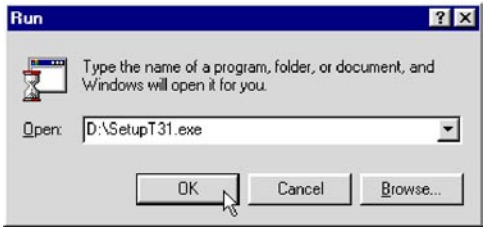


Figure 1.1: Run Dialog window

Browse for the file SETUPT31.EXE in the directory of the diskette. Click **OK** to launch the Setup program. Once the Setup determines your computer configuration the Welcome window opens (Figure 1.2).

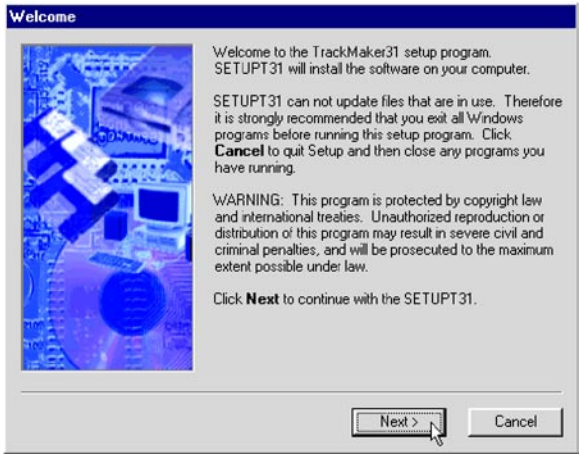


Figure 1.2: Welcome window

Read the text and click the **Next** button. The Serial Number window will be displayed (Figure 1.3).

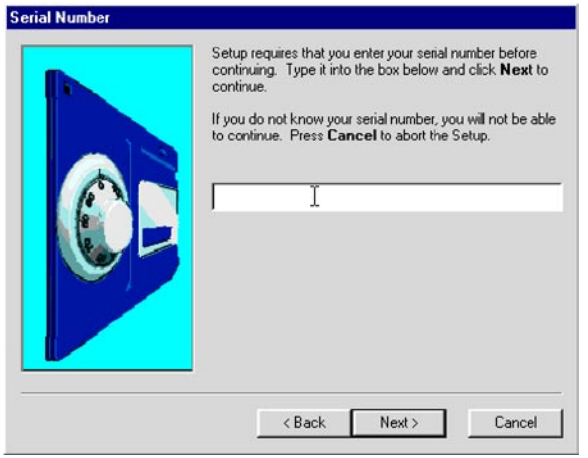


Figure 1.3: Serial Number window

Type the Serial Number into the provided box and press the **Next** button. (If you do not know the Serial Number, you will not be able to continue.) The Installation Directory window opens (Figure 1.4).

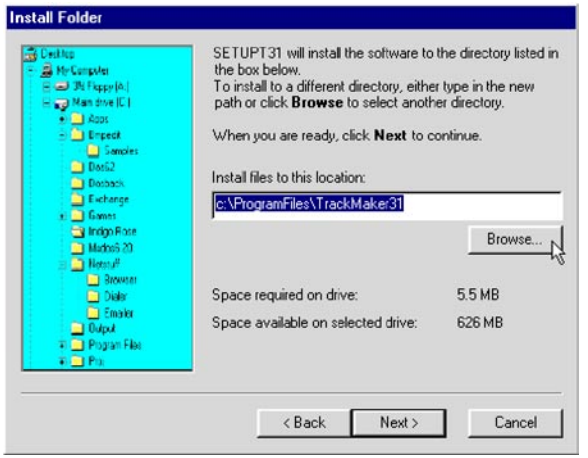


Figure 1.4: Installation Directory window

The default directory is C:\Program Files\TrackMaker31. Click the **Next** button to install the program to this directory. If you wish to install TrackMaker31 to another directory, click the **Browse** button, and the Select Installation Directory window will open (Figure 1.5).

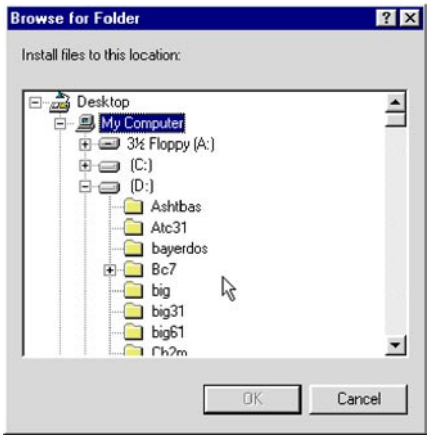


Figure 1.5: Select Installation Directory window

Select a target directory and click **OK**. The Select Installation Directory window closes, and the Installation Directory window opens with the selected directory listed. Click the **Next** button. The Select Short cut Folder window opens (Figure 1.6).

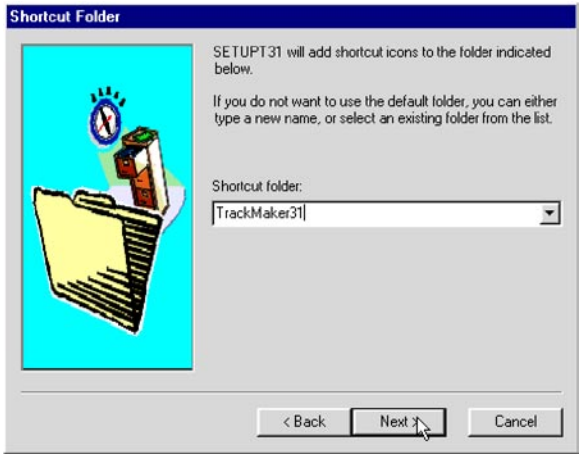


Figure 1.6: Select Shortcut Folder window

The setup program will create a TrackMaker31 menu item in the Program menu accessible by clicking **Start**. If you do not want to use the proposed folder, you can either enter a new name, or select an existing folder from the list. Click **Next** and the Ready to Install window will follow (Figure 1.7).

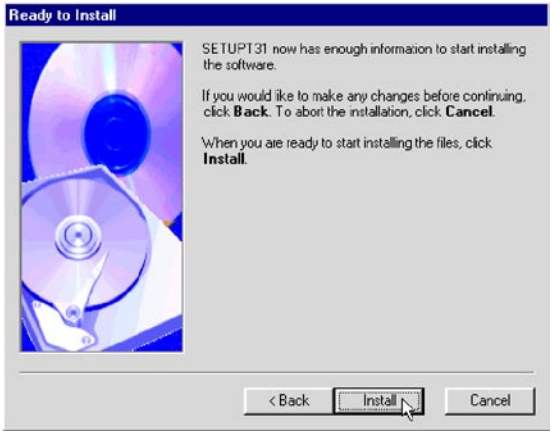


Figure 1.7: Ready to Install window

In case you would like to make any changes before the installation, click **Back**. To abort installation click **Cancel**. If you are ready to start installation, click **Finish**. The installation progress bar will appear (Figure 1.8).

Figure 1.8: Installing Files

The Installing Files window with a progress bar displays the percentage of the installation completed. When finished, the following window will appear (Figure 1.9).

FIGURE 1.9: FINISHED WINDOW

Click **Finish** to end installation. SetupT31 creates a TrackMaker31 program group and places **TrackMaker31** and **Uninstall** icons into it. The setup program creates also a **TrackMaker31** menu item in the Program menu accessible by clicking **Start**. A reminder to restart the system will be displayed at the end of the setup program.

Figure 1.10: Restart Notice message

The destination directory that was chosen earlier contains program files and sample data files.

1.4 Program Overview

Start the TrackMaker31 by double clicking the TrackMaker31 icon in the **Start|Programs** menu, in Windows Explorer, or on the desktop if a shortcut was created. At the start, TrackMaker31 displays the following screen (Figure 1.11):

Figure 1.11: TrackMaker31 Main Screen

The TrackMaker31 is a menu driven program. Most of menus items are disabled till a data file is loaded in to the program. A short description of the possible menu options is given below.

File Menu

The File Menu is shown in Figure 1.12. Functions accessible from this menu allow you to load data file, to save data set, to save data set under different file name (Save As), to remove loaded data from the program memory (Close), to edit data parameters, to display two dimensional layout of selected XYZ file, and exit the program.

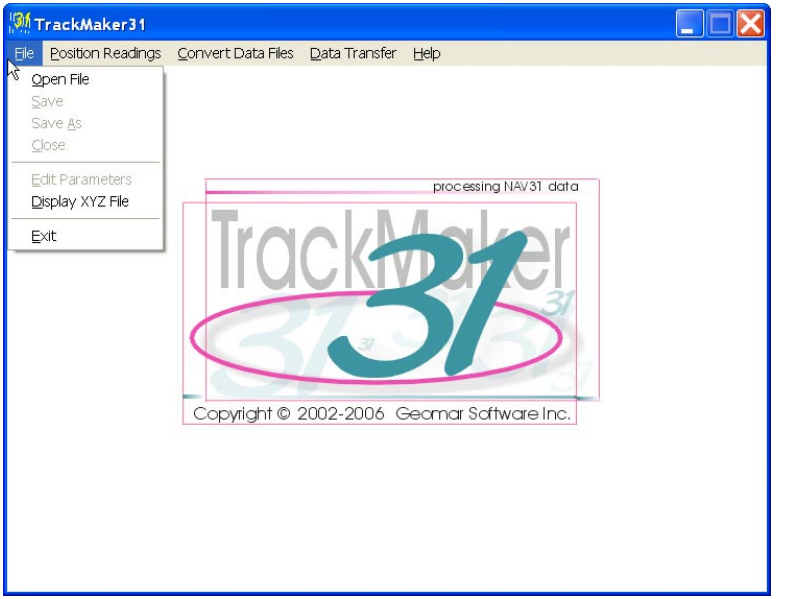


Figure 1.12: TrackMaker31 File menu

When program starts most of items in File menu are disabled. As soon as data file is selected and data is loaded to the program memory the splash graphic disappears and the program displays information related to data file contents, Figure 1.13. At the same time remaining items in the File menu are enabled.

TrackMaker31 does not allow to overwrite original data file. The Save option is enabled only when not original data file (i.e. with edited parameters or previously Saved As) was loaded or after option Save As was used. When original data file is selected the name of the file and date of the creation is displayed at the top of the screen. In case when not original file was loaded then the current file name is displayed, followed by an

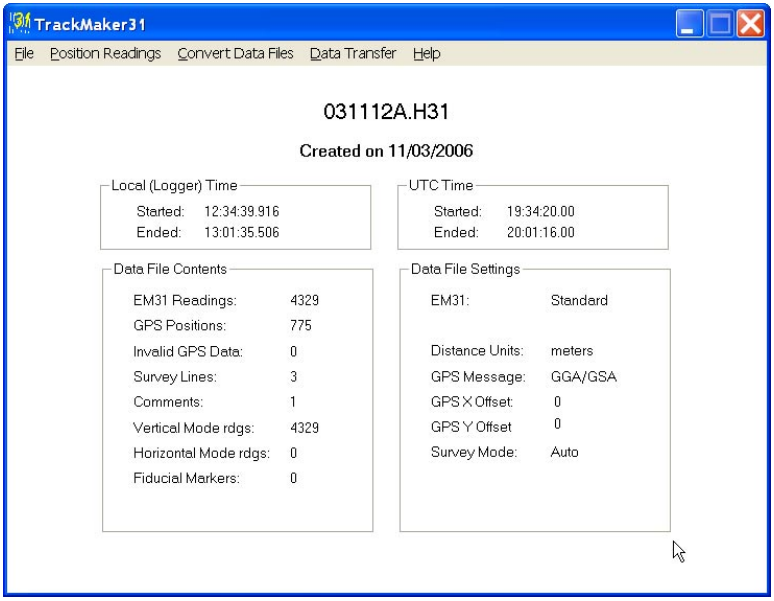


Figure 1.13: TrackMaker31 Main Screen after Loading data file

original date of creation and original file name, for example: "Created on 06/02/2003 as 060215A.H31".

The information displayed by the TrackMaker31 contains Local and UTC time, number of EM31 data points and GPS positions, used EM31 component, specified distance units and GPS antenna offsets, etc. (see Figure 1.13). Four parameters: EM31 type, Distance Units, GPS X and Y offsets can be adjusted using the Edit Parameters item (see Figure 1.14).

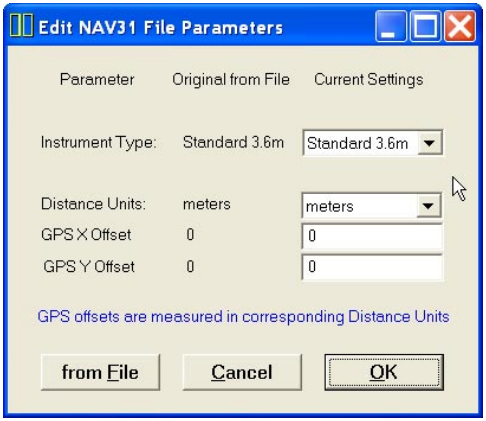


Figure 1.14: Edit Parameters window

The Position Sensors menu represents the main function of the program: positioning of the EM31 sensor based on the system geometry and GPS positioning (Figure 1.15). The

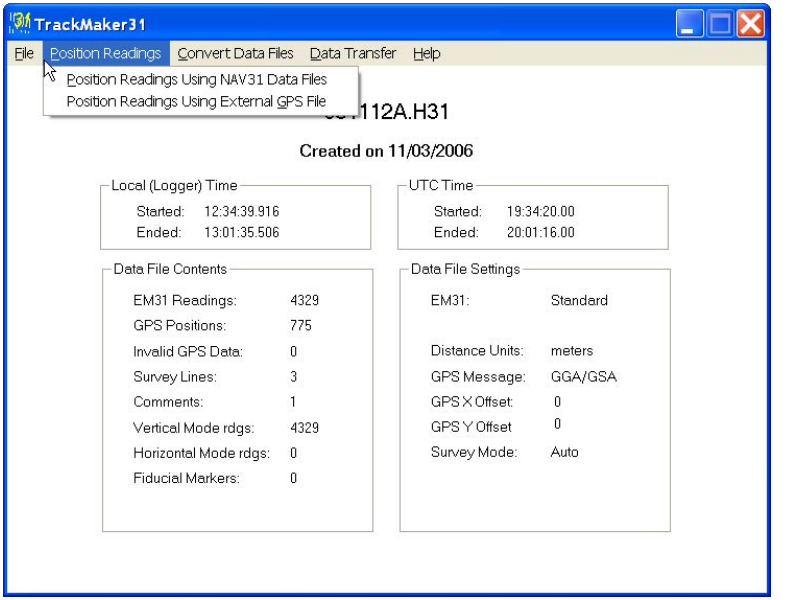


Figure 1.15: TrackMaker31 Position Sensors menu

first item of the menu, Position Sensors using NAV31 Data File allows you to position sensors based on Real Time GPS data embedded in NAV31 file. Using GPS data the program can also place elevation data in the output file. The second item, Position Sensors using External GPS File is used to replace Real Time GPS data by positions from the post-processed GPS data file. The later requires that the GPS data is collected in the field computer running NAV31 program as well as in the GPS receiver logger. GPS data can be processed by the GPS manufacturer software and then exported as an ASCII file. This option is especially useful in the following cases:

- when Real Time differentially corrected positioning is not available,
- accuracy of positioning may be further improved by processing data using special GPS software,
- if special or unique coordinate system provided by GPS software is required and it is not available in other employed data processing or mapping software.

The Convert Data menu has four functions available. The menu is shown in Figure 1.16.

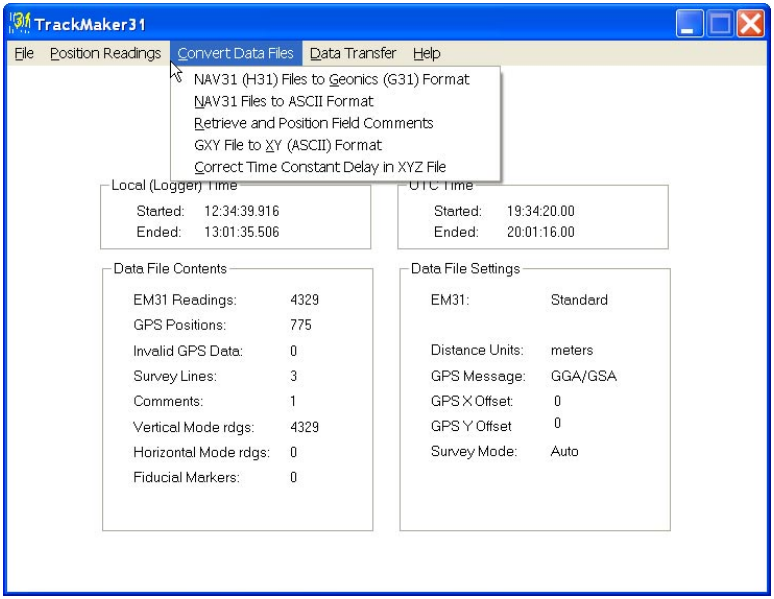


Figure 1.16: TrackMaker31 Convert Data menu

The first item, NAV31 Files to Geonics G31 Format allows you to convert NAV31 files to files that can be loaded and processed by the Geonics DAT31W program.

The second item, NAV31 Files to ASCII Format allows you to convert data files to ASCII text format. This file can be simply used to examine data in text mode, or it can be easily converted to other formats if required.

In case when the NAV31 program was used to acquire stand-alone GPS positions (without EM data) the data files have extension name GXY. The third item, GXY File to XY (ASCII) Format can be used to convert binary data file to simple text file with two to four columns: Easting (Longitude), Northing (Latitude), and optionally Elevation (including correction for GPS antenna height) and Time Stamp of the record. These files can be used in other applications, i.e. in mapping software to denote topographical features as roads, fences, etc.. This option can be also used to convert any NAV31 data file to a text file containing coordinates and elevation of GPS positions.

The fourth item of the Convert menu, Retrieve and Position Field Comments allows you to filter out and position field comments entered by the operator during the survey.

The last option of the Convert menu, Correct Time Constant Delay in XYZ Files can be used to correct the effect of the system (combined EM31 and GPS receiver) time constant delay in two dimensional XYZ files generated during positioning EM31 data.

Data Transfer Menu

This menu has two items: Download Allegro DOS Files and Download Allegro CX Files. The menu is shown in Figure 1.17. While downloading Allegro DOS Files option is supported by TrackMaker31 functions, the transfer of files from Allegro CX (Windows

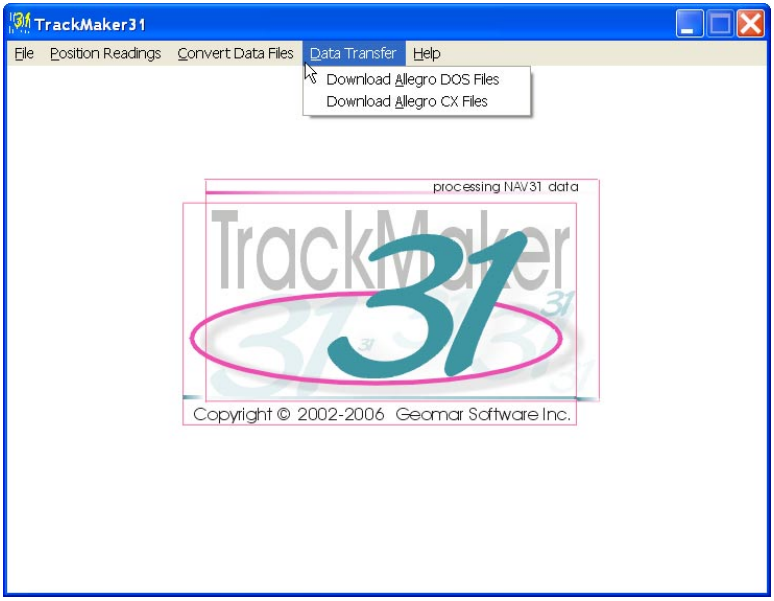


Figure 1.17: TrackMaker31 Data Transfer menu

CE.NET based field computer) is handled by the MS ActiveSync program. Therefore the second item of this menu displays information only (Figure 1.18).

Optionally, data files and program files can be transferred between Allegro (Windows CE as well as DOS based units) by using PC memory card. A PCMCIA card slot is located behind the Allegro display (please see Allegro manual). Memory card becomes drive D: as soon as it is inserted to Allegro DOS and it is recognized as a Storage Card in Allegro CX. Memory card is the fastest and easiest way of performing data transfer

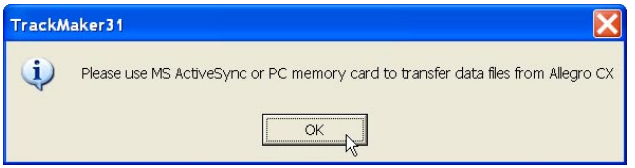


Figure 1.18: Allegro CX data transfer info

between Allegro and PC computer. In addition to data transfer, memory card can serve as a data back up device during the survey.

Downloading files from DOS based Allegro is performed with the cooperation of the field computer program (option Dump Files). Alternatively, data files created in DOS based loggers can be transferred from the field computer by the Juniper System program Lynx which is available with Pro4000 and Allegro loggers.

Help Menu

Item "About" is the only available option in this menu. It displays name and version of the program. Help function is not available in this version of the TrackMaker31.

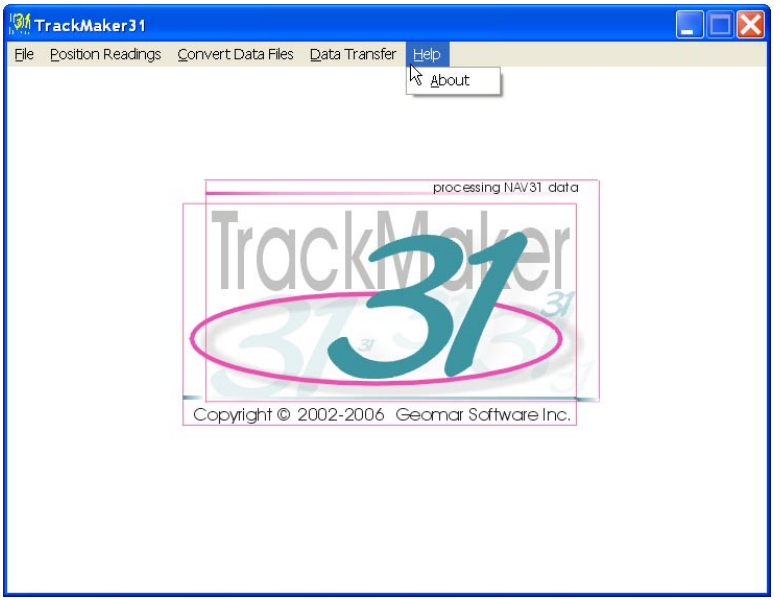


Figure 1.19: TrackMaker Help menu

A detailed description of the function of each menus item is provided in relevant sections of the manual.

Data Transfer 2

This chapter describes the transfer of data files from Allegro or Pro4000 field computers to PC computer using the Data Transfer option of program TrackMaker31.

Data files can be also downloaded by alternative utilities i.e. ProShell in Pro4000 or FileScout in Allegro Field PC and Windows based program Lynx (see Appendix C and manual for Pro4000 or Allegro). Another option is using memory card to transfer data and program files between Allegro (or Pro4000) and desktop (or laptop) computer.

2.1 Download Files Procedure (DOS Based Field Computers)

To start downloading files from the field computer, select the **Data Transfer|Download Logger Files** item in the program menu (Figure 2.1).

Figure 2.1: Data Transfer menu

After you click the Download Logger Files item, the Download NAV31 Files window will appear (Figure 2.2).

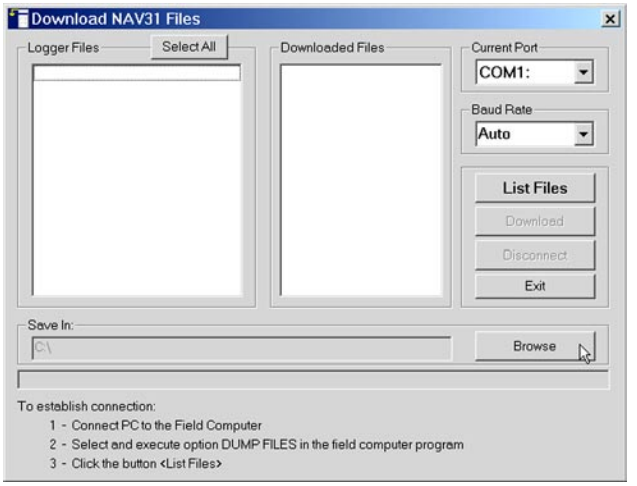


Figure 2.2: Download NAV31 Files window

The Download NAV31 Files window has two list boxes. The first from the left, labeled Logger Files will contain, after the **List Files** button is clicked, a list of data files located in the field computer and available to download. File names, with their size in bytes will be displayed as well. The second list box, labeled Downloaded Files, will list downloaded data files in the NAV31 format. If a file name already exists on the computer hard disk, an underscore followed by a letter will be added to the base name. (i.e. file name ABC.H31 would be changed to ABC_1.H31, ABC_2.H31, and so on.)

To select the directory where transferred files will be placed click the **Browse** button. The Select Directory for NAV31 Files window will be displayed (Figure 2.3).

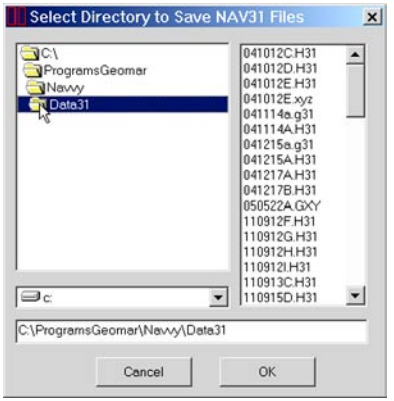


Figure 2.3: Select Directory to Save NAV31 Files window

After the directory is selected, it will be displayed in the text box labelled **Save In** at bottom part of the Download NAV31 Files window. The selected directory will be saved and it will be used as the default directory during subsequent TrackMaker31 executions. If this directory is removed the C:\ directory will be used instead.

Change of the port assignment can be done by clicking the Down arrow button in the field labeled Current Port. The pull down list box will be displayed (Figure 2.4). Select required COM port number.

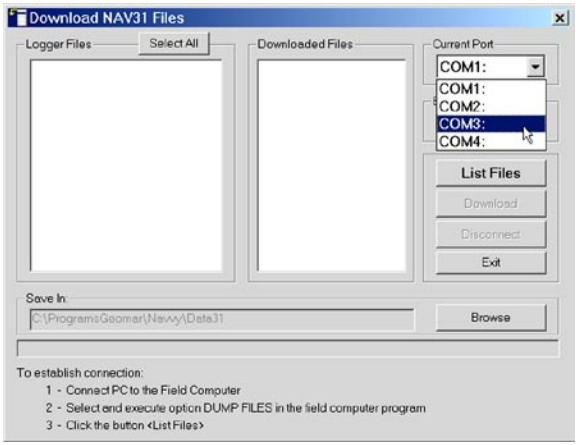


Figure 2.4: Select serial port number

To start downloading the data files, connect the field computer (Pro4000 or Allegro) and PC computer with the serial cable.

Run the NAV31 program in the logger. In the Main menu of the program select **Dump Files** option, and press **<ENTER>**. The logger screen will display the message "Waiting for PC" (shown in Figure 2.5) for up to 1 minute (if time elapses repeat the procedure).

Figure 2.5: Logger screen

On the computer side click the **List Files** button in the Download NAV31 Files window. At that time both programs (NAV31 and TrackMaker31) will establish and test the communication at the highest possible speed of data transfer. After several seconds the Logger Files list box will be updated with the names and sizes of data files available for download (Figure 2.6). At the same time, the **Download** and **Disconnect** buttons will be activated, and the **List Files** button will be deactivated.

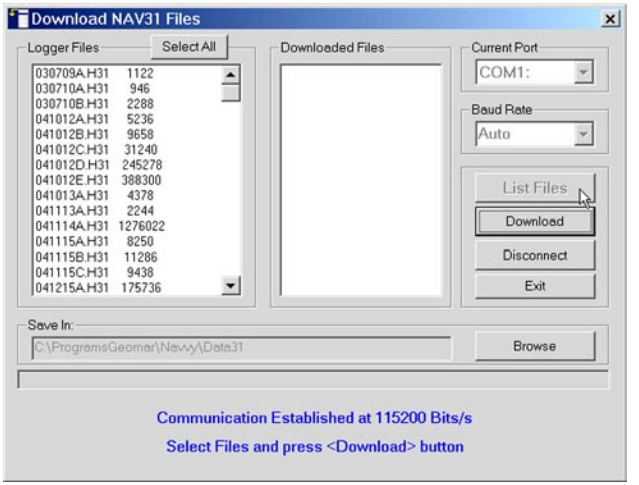


Figure 2.6: List of files available in the field computer for transfer listed in Download ...window

Select the files to be downloaded from the logger by clicking on individual file names in the list box (Figure 2.7) or click the **Select All** button to select all available files. When all files are selected the **Select All** button will change to the **Unselect All** button.

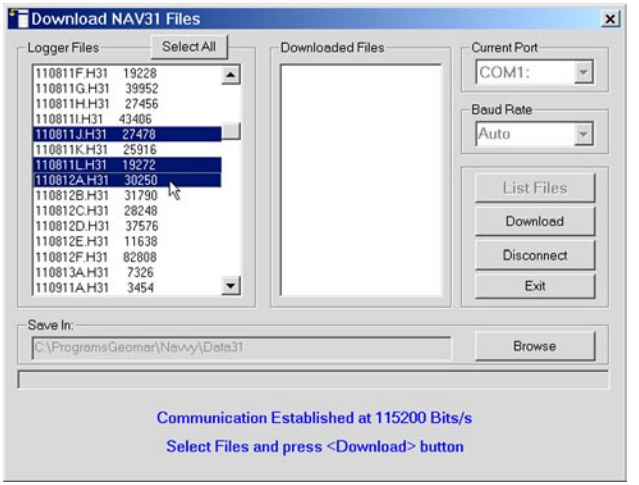


Figure 2.7: Selecting files to download

When file selection is complete click the **Download** button. The name of each transferred file is displayed at the bottom of the window as it transfers and a progress bar indicates the percentage completed (Figure 2.8).

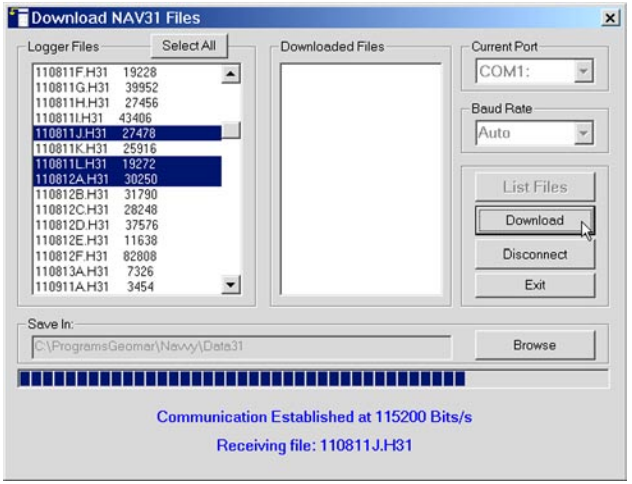


Figure 2.8: Download window during data transmission

At the same time the logger screen displays transmitted file name and percentage of completed uploading (Figure 2.9). The transfer procedure can be stopped at any time by pressing **<Esc>** key on the logger keypad.

Figure 2.9: Allegro screen during data transfer

Transferred files will be displayed in the right list box labeled Downloaded Files (Figure 2.10). These files (with extension name H31) can be loaded and processed further in the program.

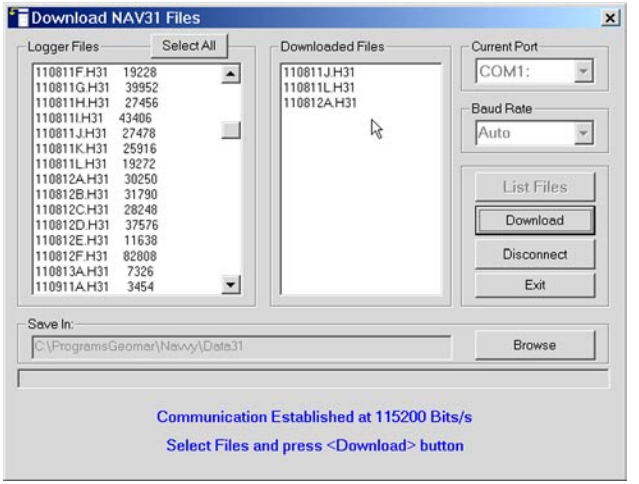


Figure 2.10:Download NAV31 Files window after downloading selected files is completed

Click the **Disconnect** button to cancel communication with logger. The Download NAV31 Files window will remain on the screen and next data transfer session (i.e. from another logger) can be performed. Clicking the **Exit** button will stop Data Transfer function and the Download NAV31 Files window will disappear.

2.2 Download Files Created in Windows CE Based Field Computer

Please use MS ActiveSync to transfer data files from Allegro CX (or any other MS Windows CE device). Alternatively a PC Memory Card can be used to transfer data between Allegro and PC computer. The latter is the preferable method since it is much faster and more convenient way to copy files . In addition, memory card allows you to create data back up right in the field.

File Menu 3

File menu of TrackMaker31 program is shown in Figure 3.1. There are several items associated with the File menu:

- Open File (loads NAV31 data file to the program memory),
- Save (saves data to the same file, disabled if original data file loaded),
- Save As (saves data to a file with different file name),
- Close (closes current data set),
- Edit Parameters (changes parameters in loaded data set),
- Display XYZ File (displays layout of stations in XYZ file),
- Exit (terminates TrackMaker31 program).

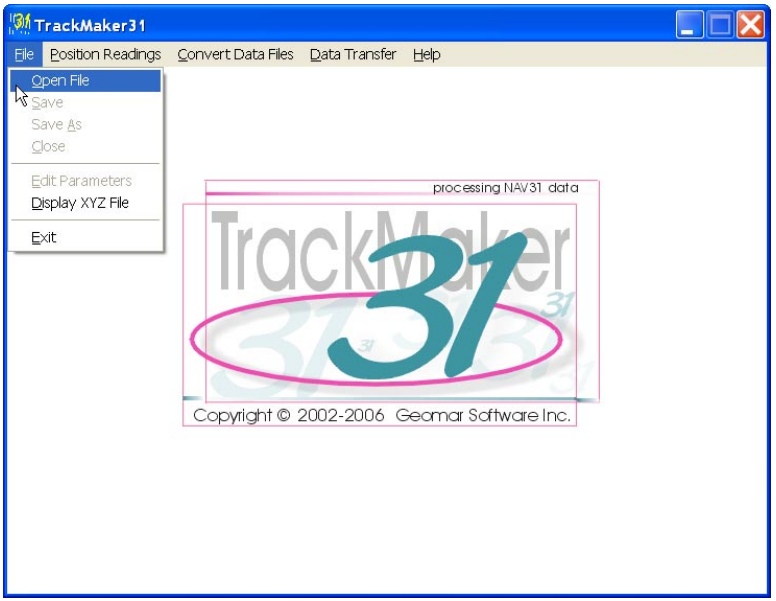


Figure 3.1: TrackMaker31 File menu

When program starts most of items in the File menu are disabled. They are enabled automatically as soon as data file is loaded in to the program memory.

The general rule of the TrackMaker31 software is that the program cannot overwrite original file name. In order to Save file, the original file name must be "Saved As" first. The program tags such file and menu item Save is enabled. At further runnings when the "Saved As" file will be loaded item Save will be enabled automatically.

3.1 Open File

The Open File option allows you to load NAV31 data file to the program memory. Select **File|Open File** from the main program menu, as shown in Figure 3.1. After the selected menu item is clicked the Select NAV31 Input File window will be displayed in the centre of the screen, Figure 3.2.

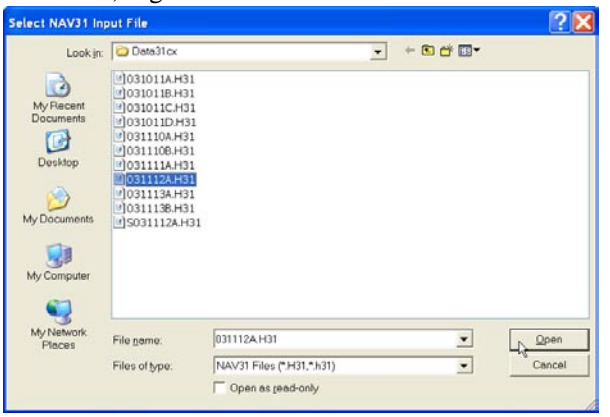


Figure 3.2: Select NAV31 Input File window

The window lists files with extension name H31. Select a file name and click the **Open** button. The Select NAV31 File window will close and the progress bar will appear in the center of program's main window indicating percentage of loaded file (Figure 3.3). When data file created by Windows CE based NAV31 is loaded the Sorting Data procedure will preceed Loading Data message.

As soon as data file is selected and data is loaded to the program memory the splash graphic disappears and the program displays information related to data file contents. At the same time remaining items in the File menu (and items in other menus as well) are enabled and the Open File item is disabled.

The TrackMaker31 main window displays the most important parameters of the entered data file (Figure 3.4). At the top of the window the current file name, date of file and optionally original file name (as entered in the field), and start and end times in local time (field computer clock) and UTC time (GPS time in NMEA messages) are displayed. Below, in the left window frame labeled **Data File Contents** a total number of EM31 readings, number of GPS positions recorded, number of invalid GPS positions (with not valid checksum), number of survey lines, comments, conductivity and Inphase readings, and number of used fiducial markers in the field are given. In the right frame labeled **Data File Settings** listed are: the EM31 dipole modes, type of used GPS NMEA message, GPS X and Y offsets (in Distance Units), and survey mode.

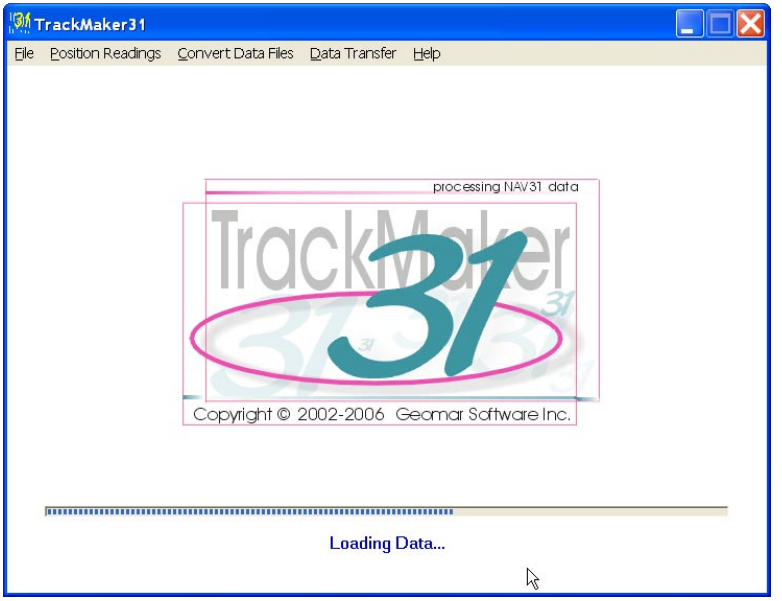


Figure 3.3: Progress bar indicating loading NAV31 file

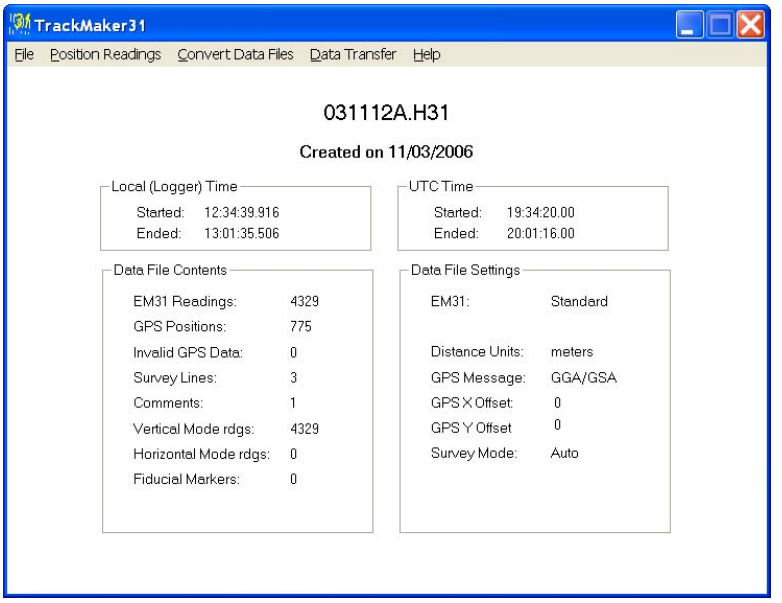


Figure 3.4: TrackMaker31 Main Screen after data file is loaded

When original data file is selected the name of the file and date of the creation is displayed at the top of the screen. In case when not original file was loaded then the current file name is displayed, followed by an original date of creation and original file name, for example: "Created on 03/06/2002 as 030614B.H31", (see Figure 3.5).

At this point loaded data can be used for further data processing.

3.2 Save, Save As, Close

As it was mentioned data can be saved only if the data file was previously Saved As. This assures that the original data file will not be overwritten, i.e. with edited parameters. The File menu item **Save** is enabled only when other than original data file is loaded. The indication that file was previously Saved As is given at the top of the screen, under currently loaded file name label "Created on 03/06/2002 as 030614B.H31" provides information that the original file name was 030614B.H31 (Figure 3.5). Otherwise this label would provide only date of the created file (see Figure 3.6).

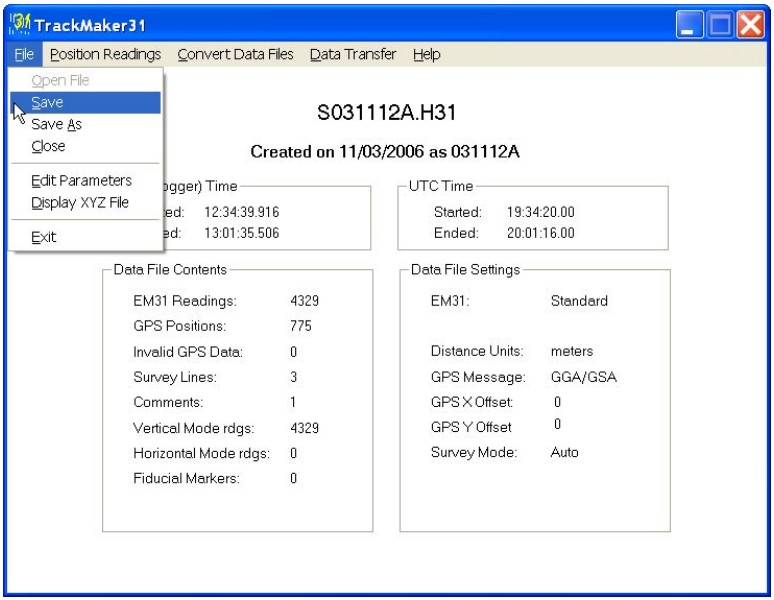


Figure 3.5: TrackMaker31 Main Screen with item Save enabled after not original file was loaded

The File menu item labeled **Save As** allows you to save any data set. Select **File|Save As** from the main program menu (Figure 3.6). After the selected menu item is clicked the

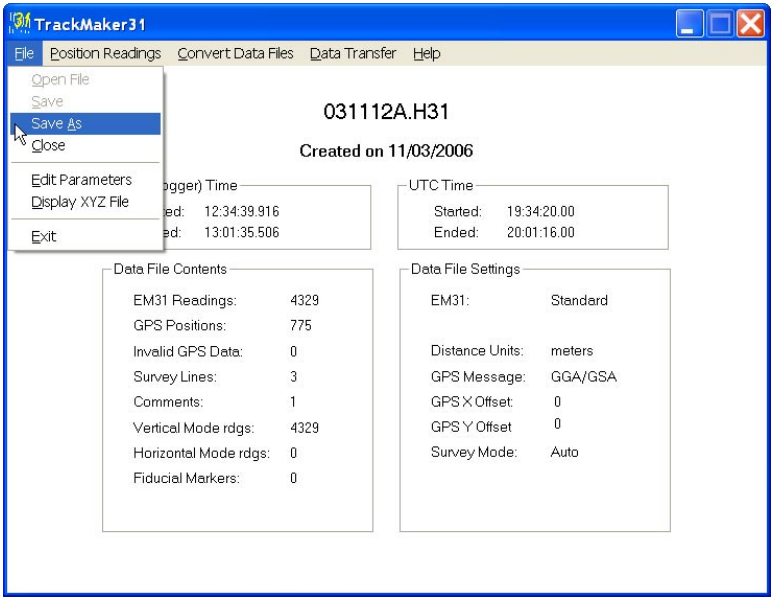


Figure 3.6: TrackMaker31 Screen with loaded original data file, disabled Save option, and selected Save As item

Save As NAV31 Input File window will be displayed in the centre of the screen, Figure 3.7.

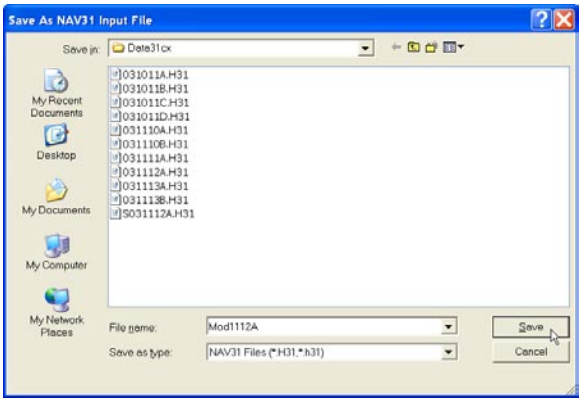


Figure 3.7: Save As NAV31 Input File window

This option is especially useful when working with data files created in Allegro CX. Windows CE system creates files that are not organized according to time stamp sequence. When such file is loaded, first it is sorted by the program. The option Save As will save data in organized format, and therefore loading previously saved file will be faster (since sorting is not necessary). The program recognizes sorted files automatically.

After the file is saved with Saved As option the Main Screen of TrackMaker will be updated, and file name will placed at the top of the screen and item Save in File menu will be enabled, Figure 3.8 (compare with Figure 3.6).

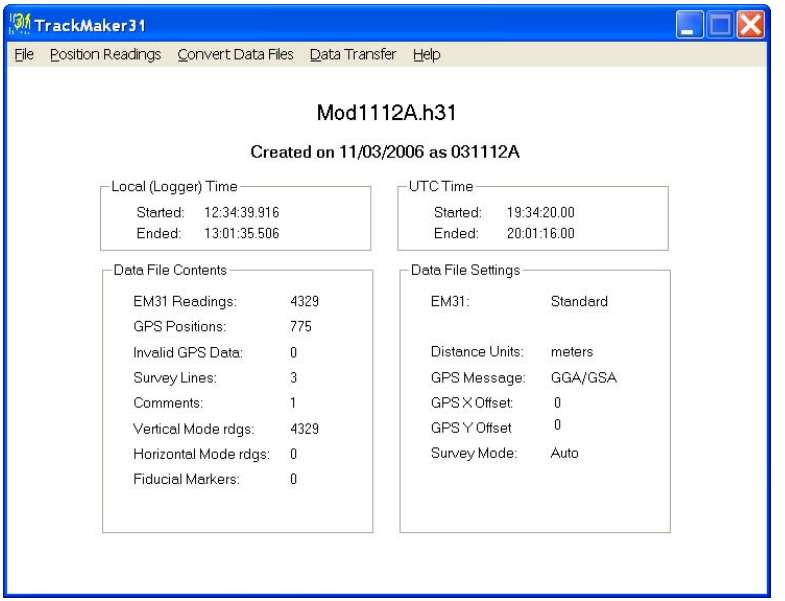


Figure 3.8: TrackMaker31 Main Screen after completed Save As option

Clicking on the **Close** item in File menu will remove data set from the program memory, the Main Screen will display splash graphic and the menu item Open File will be enabled. This action allows you to load another NAV31 data file.

3.3 Edit Parameters

Three parameters entered during the field work can be modified during data processing. Click on the **Edit Parameters** item in the File menu and the Edit NAV31 File Parameters window will appear (Figure 3.9). The Edit Parameters window is also available in Position Readings options.

The window displays parameters that the user can edit. These are Distance Units and GPS X and Y offsets. If all parameters were correctly specified in the field then clicking on **OK** or **Cancel** button will accept these entries. In case some of the parameters

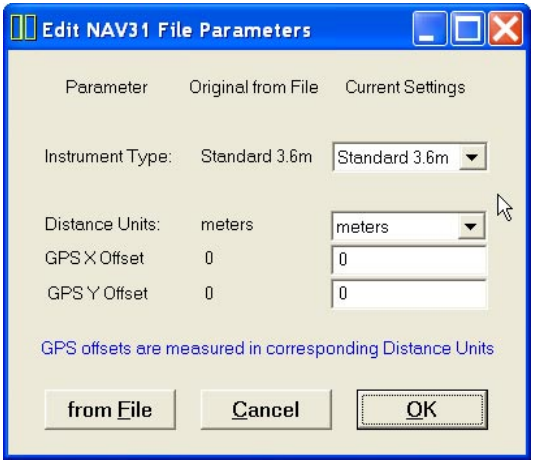


Figure 3.9: Edit File Parameters window

require modification they can be entered in appropriate text boxes located under label Current Settings. Distance Units can be selected from combo list boxes, while GPS X and GPS Y offsets must be entered in appropriate text boxes. Example of NAV31 File Info window with modified parameters is shown in Figure 3.10.

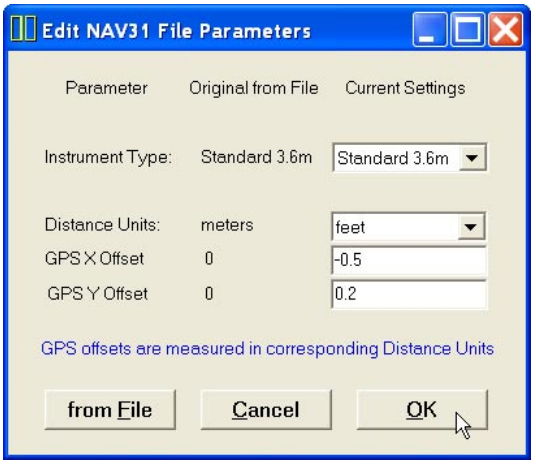


Figure 3.10: Modified parameters in Edit Parameters window

Clicking on the **OK** button will accept any changes in editable parameters, clicking on the **Cancel** button will cause the program to use initial parameters (state when window was displayed), while clicking on the button **from File** will change parameters to original values (listed in fields under label Original from File). After the buttons **OK**, **Cancel** or **from File** are clicked the Edit NAV31 File Parameter will disappear.

Any updates in this window are valid only for duration of the program. The data file will remain the same unless it **Saved** or **Saved As** in File menu.

3.4 Display XYZ File

The Display XYZ File option allows you to display two dimensional layout of stations in a selected XYZ file. Select **File|Display XYZ File** from the main program menu, as shown in Figure 3.1. The Select XYZ to Open window will appear.

The window lists files with extension name XYZ. Select a file name and click the **Open** button. The Select XYZ to Open window will close, the file will be loaded and two dimensional image will be displayed (Figure 3.11).

The image displayed in the Plot XYZ window shows the spatial layout of stations to scale, based on the station coordinates as written in the selected XYZ file.

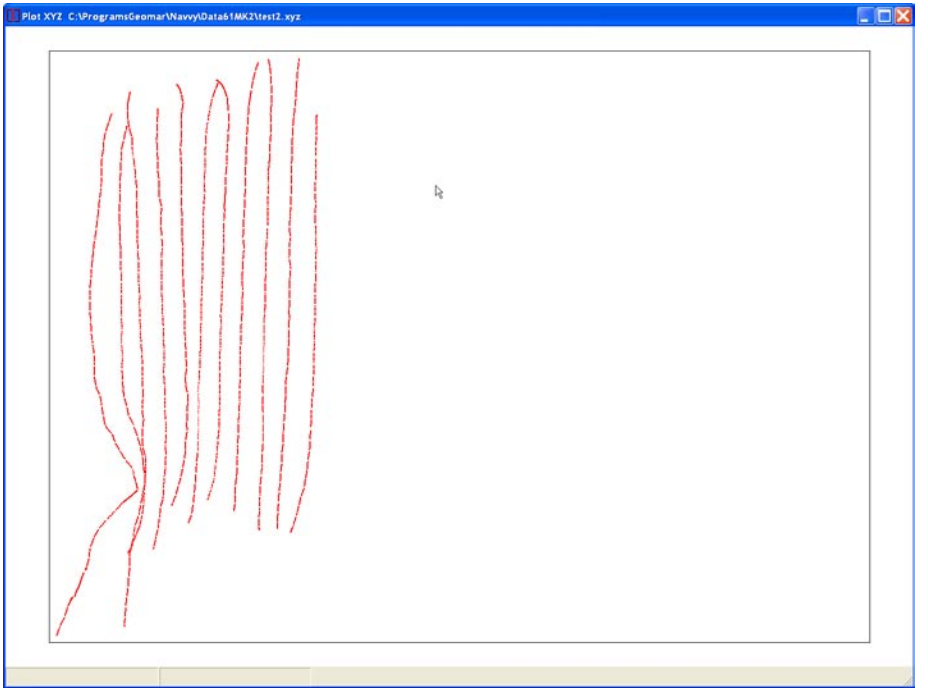


Figure 3.11: Two dimensional layout of stations in XYZ File

Position Readings 4

Positioning of the Geonics EM31 is the main function of the TrackMaker31. Location of the electromagnetic sensor is calculated based on the recorded GPS position, instant heading of the system, and the system geometry which is described by the location of GPS antenna.

There are two methods of positioning sensors in TrackMaker31: Position Sensors using NAV31 Data File and Position Sensors using External GPS File. The first method allows you to position sensors based on Real Time GPS data embedded in NAV31 file while in the second technique Real Time GPS data are replaced by GPS positions from the postprocessed GPS data file. The second method requires that the GPS data is collected in the field computer running NAV31 program as well as in the GPS receiver logger. This option is especially useful in following cases:

- when real time differential data correction is not available,
- accuracy of positioning may be further improved by processing data using special GPS software,
- if a special or unique coordinate system provided by GPS software is required and it is not available in other employed data processing or mapping software.

Description of functions involved in positioning the EM31 is preceded by a short description of the array geometry.

4.1 The NAV31 System Geometry

The GPS antenna can be placed anywhere in relation to the instrument center. However to achieve the highest possible accuracy of the calculated positions the GPS antenna must be placed as close to the center of the system as possible. The best and optimal placement of the GPS antenna is located above the center of the EM31 system.

When a survey is positioned by GPS system and GPS antenna can not be placed in the center point of the instrument the program allows to specify the GPS antenna offset from the EM31 center. Two parameters, GPS X Offset and GPS Y Offset describe location of GPS antenna. This location is represented by the distance which is measured from the center of the conductivity meter to the center of the GPS antenna, while facing direction of the movement, see Figure 4.1.

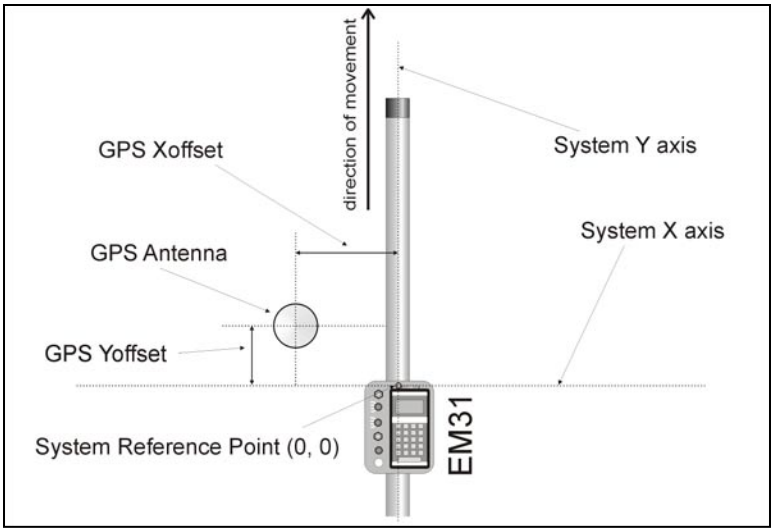


Figure 4.1: The EM31 and GPS antenna geometry

The procedure of specifying X and Y offsets in relation to the direction of the system movement is very important and should be maintained during data collection for the entire data file. Therefore, the operator can not walk few steps or drive backwards without changing data file name. If it is necessary data logging must be paused for the time of such movement. Since positioning of the sensor based on GPS is based on this assumption.

This option is provided mainly for common situations where the operator carries the EM31 on his right side, and GPS antenna (placed in backpack) is located above his left shoulder. In this case distance between GPS antenna and the instrument (GPS X Offset) is negative, and GPS Y Offset will be usually very small or equal to zero. This situation corresponds to the system geometry presented in Figure 4.1.

The offset in other direction (GPS Y Offset) can be used if the instrument is towed as long as the GPS antenna is located on the same trailer as the EM31 (Figure 4.2). As it was mentioned earlier, the best placement of the GPS antenna is located above the center of the EM31. In case where the GPS antenna is located in front of the electromagnetic sensor the GPS Y Offset is positive, and if the GPS antenna is located behind the instrument the GPS Y Offset is negative.

If GPS antenna is located i.e. on ATV and the EM31 is placed on the trailer (there is a point of rotation between them) then the program TrackMaker31 may provide not accurate results. In such case use program GPS-XYZ, PathMaker or similar software, to calculate lay back of the instrument.

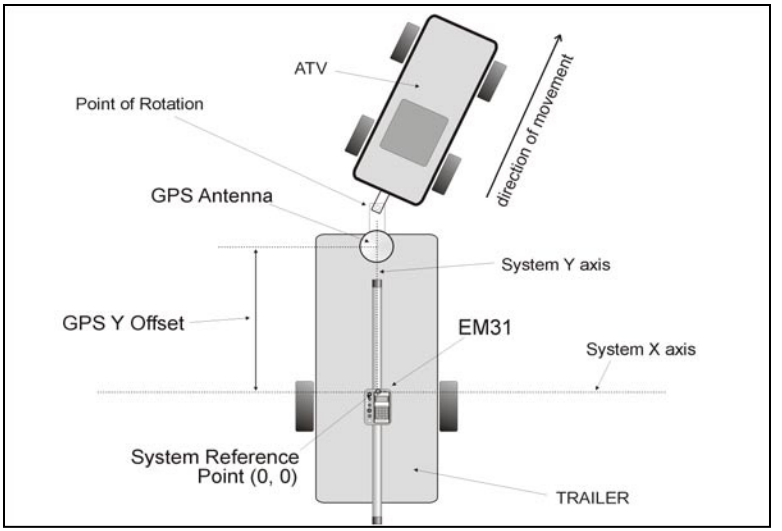


Figure 4.2: Geometry of the EM31 and GPS antenna during trailer towing

In the case where a wrong value was entered in the field, GPS X Offset and GPS Y Offset parameters can be corrected later during data processing in the program TrackMaker31.

In general, when GPS antenna is located off the center of the system positions of the instrument will be calculated based on the GPS antenna position and instant heading. In order to achieve higher quality of data positioning the survey should be carried out along relatively smooth pathways, especially if GPS antenna is located further from the center of the instrument.

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

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

4.2 Positioning Readings Using NAV31 Data File

After a data file is loaded the TrackMaker31 main window displays the most important parameters of the entered data file (Figure 4.3). At the top of the window the current file name, date of file and optionally original file name (as entered in the field), and start and end times in local time (field computer clock) and UTC time (GPS time in NMEA messages) are displayed. Below, in the left window frame labeled **Data File Contents** a total number of EM31 readings, number of GPS positions recorded, number of invalid GPS positions (with not valid checksum), number of survey lines, comments, conductivity and Inphase readings in Vertical and Horizontal dipole modes, and number of used fiducial markers in the field are given. In the right frame labeled **Data File Settings** listed are: the EM31 dipole modes (fixed), type of used GPS NMEA message, GPS X and Y offsets (in Distance Units), and survey mode.

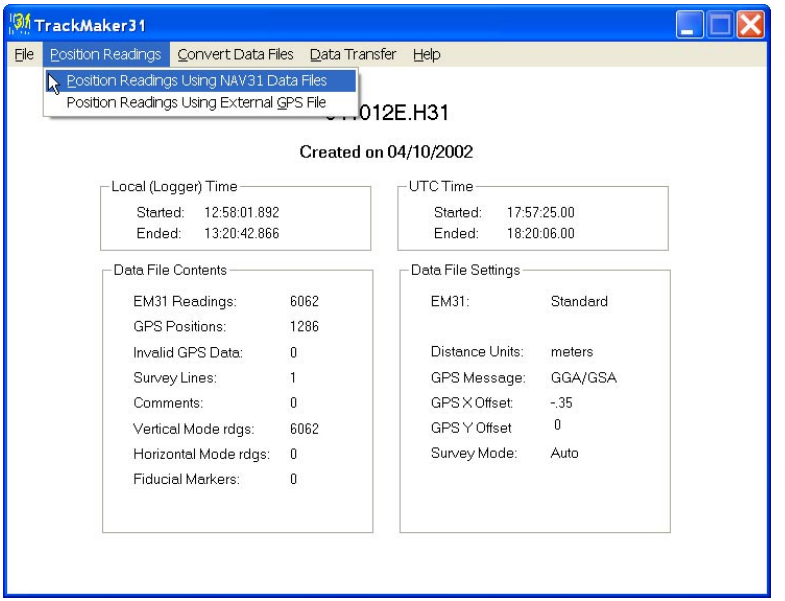


Figure 4.3: Position Readings menu

The Position Readings Using NAV31 Data File option allows you to position EM31 stations based on Real Time GPS data which were recorded in NAV31 data file during the survey. Select **Position Sensors|Position Readings Using NAV31 Data Files** from the main program menu, as shown in Figure 4.3.

After the selected menu item is clicked the Position EM31 Readings Using NAV31 Data File window will be displayed in the centre of the screen, Figure 4.4.

Several parameters which affect the contents and format of the created output (XYZ) file must be specified. These are the XYZ output file name, parameters describing contents and format of the created file and parameters related to electromagnetic as well as to GPS data.

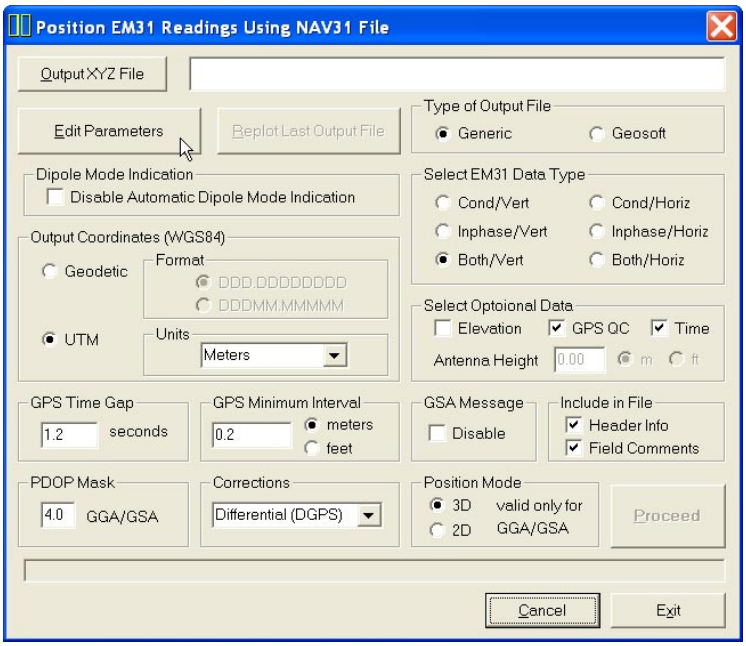


Figure 4.4: Position EM31 Readings Using NAV31 Data File window

Edit Parameters

The TrackMaker31 main window (Figure 4.3) displays the most important parameters of the entered data file. In case some parameters were wrongly entered in the field it is possible to change them using Edit Parameters option (the same option is available in the File menu of the TrackMaker31 main screen). Click on the **Edit Parameters** button and Edit NAV31 File Parameters window will appear (Figure 4.5).

The window displays parameters that the user can edit. These are Distance Units and GPS X and Y offsets. If all parameters were correctly specified in the field then clicking on **OK** or **Cancel** button will accept these entries. In case

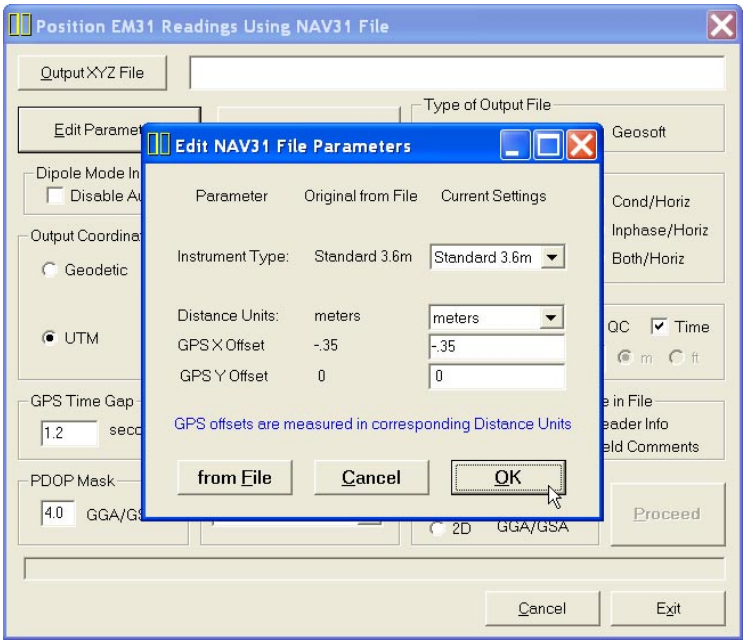


Figure 4.5: Edit NAV31 File Parameters window

some of the parameters require modification they can be entered in appropriate text boxes located under label Current Settings. EM31 Type and Distance Units can be selected from combo list boxes, while GPS X and GPS Y offsets must be entered in appropriate text boxes. Example of NAV31 File Info window with modified parameters is shown in Figure 4.6.

Clicking on the **OK** button will accept any changes in editable parameters, clicking on the **Cancel** button will cause the program to use initial parameters (state when window was displayed), while clicking on the button **from File** will change parameters to original values (listed in fields under label Original from File). After the buttons **OK**, **Cancel** or **from File** are clicked the Edit NAV31 File Parameter will disappear.

Any updates in this window are valid only for duration of the program. The data file will remain the same unless it **Saved** or **Saved As** in File menu.

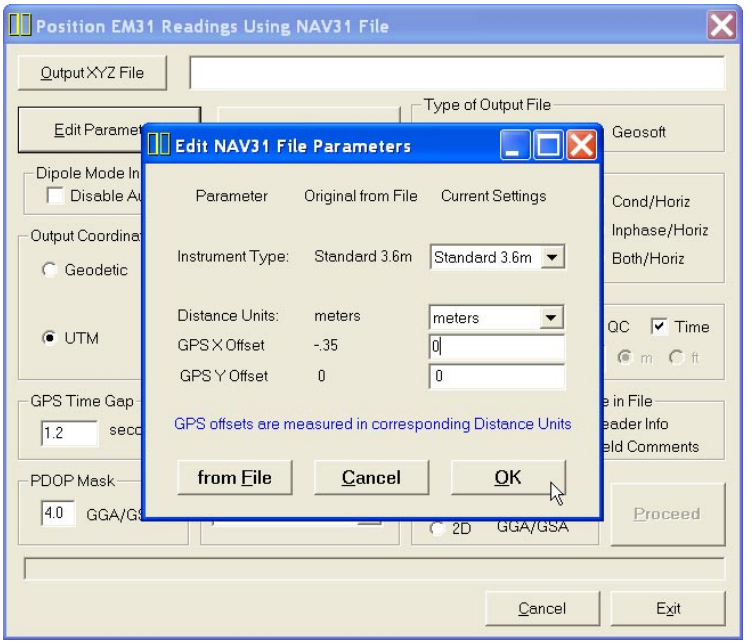


Figure 4.6: Modified parameters in Edit Parameters window

Output File

Click on the **Output XYZ File** button. The Select Output File window is displayed (Figure 4.7).

Select a file name and click the **Save** button. The Select XYZ File window will close and the selected file name will be displayed beside the **Output XYZ File** button in the Position EM31 Readings Using NAV31 File window.

When Output file is specified the **Proceed** button in the Position EM31 Readings Using NAV31 File becomes active (Figure 4.8).

Select EM31 Data Type

To select the EM31 data type (component and dipole mode) click on one of radio buttons in the section labeled Select EM31 Data Type. In most cases both components, Conductivity and Inphase are recorded simultaneously. Data is always placed in the created XYZ file in the following order: X coordinate (Easting or Longitude), Y coordinate (Northing or Latitude), and then Conductivity and/or Inphase in Vertical or Horizontal dipole mode. This data may

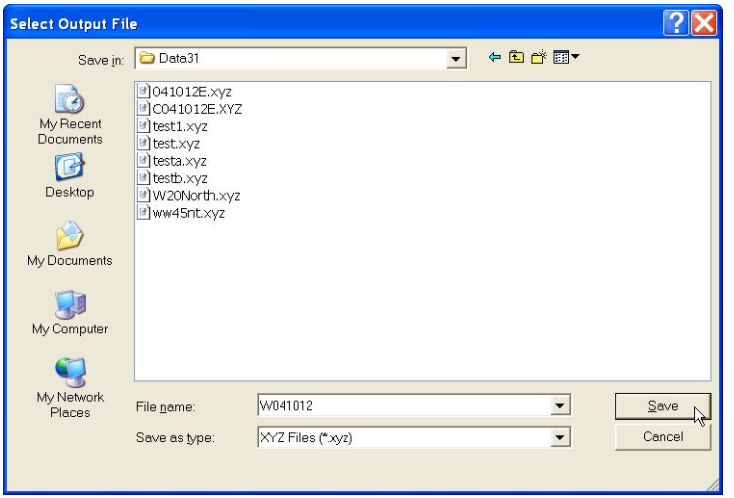


Figure 3.7: Select Output File window

be followed by two columns containing Elevation and Time Stamp (see section Select Optional Data below).
If parameter Header Info in Include in File section is checked a line listing all parameters in the file will be placed as a header for each created XYZ file.

Select Optional Data

Two optional data can be written in the output file. These are Elevation and Time Stamp for each reading. To select optional data click on the check box next to the corresponding name.
If the check box labeled **Elevation** is clicked (checked) then a text box labeled **Antenna Height** and two radio buttons labeled **m** and **ft** become active. The text box labeled Antenna Height allows you to enter correction for Elevation data. The Antenna Height corresponds to the distance between ground surface and GPS antenna. If Antenna Height is set to zero then elevations for the GPS antenna (not the ground surface) are written to the output file. Two radio buttons labeled **m** (meters) and **ft** (feet) allows you to specify units for elevation data placed in the output file. It is assumed that Antenna Height parameter is entered in units specified by these radio buttons.
Elevation values base on the recorded GPS data. Therefore Elevations will not be written to the file if the NMEA message GLL was used during the survey. Message GLL does not contain elevation data. Data is always placed in the created XYZ file in the following order: X coordinate (Easting or Longitude), Y coordinate (Northing or Latitude), Conductivity (or Inphase) in Vertical and then in Horizontal dipole mode, Elevation and Time Stamp.

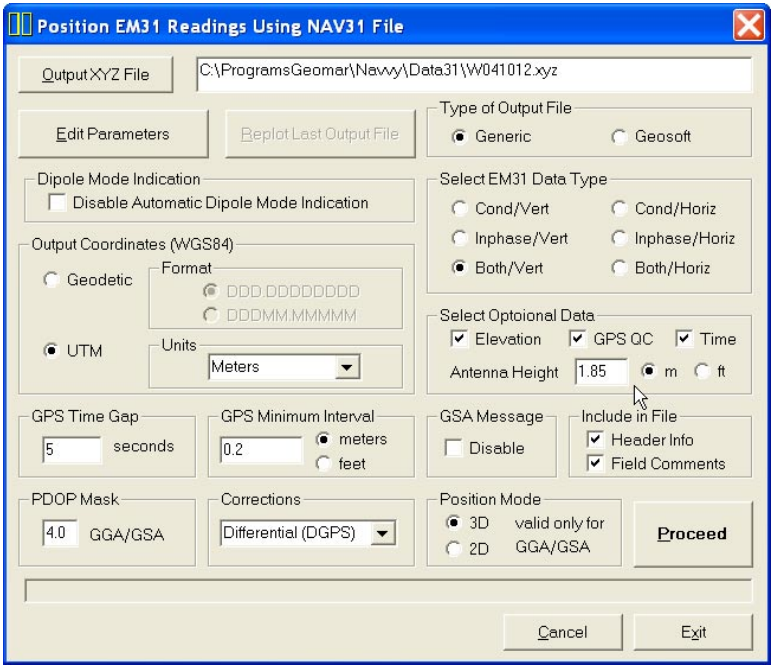


Figure 4.8: Position EM31 Readings Using NAV31 Data File window

If parameter Header Info in Include in File section is checked a line listing all parameters in the file will be placed as a header for each created XYZ file.

Type of Output File

Check the option appropriate for the contouring software used. The Generic option will create a four or more column file without any text strings. This file can be used as an input file for many contouring packages (including Surfer). Geosoft format will cause the program to write LINE # at the beginning of each survey line.

Include in File

This section contains two check boxes labeled **Header Info** and **Field Comments**. When Header Info box is checked the file will contain a header listing type of coordinates and names of data contained in each column of created XYZ file. Checking box labeled Field Comments will cause the program to write text of all field comment (entered by the operator during the survey) in to the created file.

Output Coordinates

Positions can be written in the output file as geodetic (geographical) coordinates (Latitude/Longitude) or they can be converted to UTM coordinates. The program uses the WGS1984 datum. To select coordinates click **Geodetic** or **UTM** radio buttons (Figure 4.9).

Geodetic coordinates, Latitude and Longitude are given in degrees. They can be written in two formats DD.DDDDDDDD or DDMM.MMMMM (native format found in NMEA GPS messages). To select which format click the appropriate radio button in Format section located at the radio button labeled Geodetic. This section is active only when radio button Geodetic is selected (Figure 4.9).

UTM coordinates can be generated in meters, feet, or US Survey feet. To select units for UTM coordinates select proper parameter from the combo box located in the Units section located at the UTM radio button (Figure 4.9). This combo box is active only when radio button labeled UTM is selected.

GPS Time Gap

Differentially corrected GPS data often has gaps, due to differences in the constellation of satellites visible to two (fixed and moving receivers), lack of beacon signal, surveying near trees, buildings, and other elevated obstructions. These gaps are filled by TrackMaker31 with the assumption that the GPS receiver speed is essentially constant and that it moves along a straight line during the gaps.

The **GPS Time Gap** parameter specifies the maximum time during which the EM31 data will be linearly interpolated between two GPS positions. Enter this parameter (in seconds) in the edit box labeled **seconds** in the GPS Time Gap section (Figure 4.9). In most cases a value 2 to 3 times larger than the GPS data acquisition frequency is adequate, however the user has to determine this value based on the survey specific conditions and requirements. To ignore effect of this parameter enter a large number of seconds (i.e. 300 or more) as GPS Time Gap parameter.

GPS Minimum Interval

The **GPS Minimum Interval** parameter specifies the minimal distance between two GPS stations that will be used in interpolation. If this distance is smaller than the specified GPS Minimum Interval, then all EM31 readings located between these two stations will be ignored. This parameter is useful in cases when

the operator stops for a moment and data are collected in one point. Limited accuracy of GPS positioning will create randomly distributed positions in area adjacent to the stationary location of the system. If TrackMaker31 will calculate positions of sensor in case offset values (GPS X and/or GPS Y Offsets) are different than zero, positions of the EM31 will have quite large variations associated with apparent change of direction of the survey line caused by randomly close spaced GPS positions. In most cases a value 2 or 3 times smaller than average distance between two GPS stations is adequate, however the user has to determine right value for this parameter which will depend on survey conditions and first of all accuracy of the employed GPS receiver. To ignore the effect of this parameter and to use all stations during creating XYZ file (i.e. during testing when GPS antenna is stationary) set this parameter to zero.

Enter the GPS Minimum Interval in the edit box and check one of the two radio buttons labeled **meters** and **feet** (indicating distance unit) in the GPS Minimum Interval section (Figure 4.9).

GSA Message

This parameter is used to disable GSA message. This is to be used only if the operator has specified in the data acquisition program (NAV31) that the GPS Message will be pair GGA/GSA and for any reason message GSA was not recorded. In such case the TrackMaker31 will search for GPS quality information contained in not recorded GSA statement and it would conclude that GPS readings are invalid. Disabling GSA message in this situation causes that the program will use only information available from GGA message.

PDOP Mask

The PDOP Mask is used to filter quality of GPS positions. The index called PDOP (Position Dilution of Precision) measures the strength of satellite coverage for a given area. PDOP is affected by the number of satellites visible and their relative positions in the sky. The smaller the number of PDOP the stronger the satellite coverage is. When there are more than 5 satellites widely spaced visible, the PDOP is 4 or less. However, when there are less satellites visible, or they are unevenly spaced in the sky, PDOP values can be 6 or higher. In most cases, the PDOP in open sky is less than 3, and most accuracies given for many GPS systems are given for this norm. The index called GDOP covers time accuracy in addition, while the index HDOP is related only to horizontal position fix (it is used when message GGA was selected). Refer to GPS documentation and literature for more information related to error sources of GPS positioning.

The section PDOP Mask may differ depending on GPS NMEA message used. It is related to PDOP parameter if GGA/GSA, POS, or GGK was employed during the survey, to HDOP if GGA was used, to GDOP if LLK was used during the survey, and it is invalid if GLL or LLQ message was used.

Enter the PDOP (HDOP or GDOP) value in the edit box in the PDOP Mask section, Figure 4.9. All positions (as well as EM31 readings) associated with GPS data of higher than specified value of this index will be ignored.

Corrections

Select type of differentially corrected position data to be used during the creation of XYZ file in the combo list box labeled Corrections. Four types of GPS corrections are given: **Raw (GPS)**, **Differential (DGPS)**, **Differential (RTK 3)**, **Differential (RTK 4)**, and **Differential (RTK 5)**. Last three types of RTK (real time kinematic) corrections are available only in high end of GPS receivers and differently named depending on manufacturer, however in NMEA specifications they indicate Quality Parameter 3, 4, and 5. When **Raw** is selected, both differentially corrected and raw GPS data are used to calculate positions of EM31 stations.

Position Mode

This option is valid only if the pair GGA/GSA messages were used during data collection. If radio button labeled 3D is checked then GPS data in mode 3D are used, while when radio button 2D is checked then program uses 2D as well as 3D mode of GPS data.

It should be noted that if any NMEA message indicates that GPS position (fix) is invalid this data is ignored by the TrackMaker31.

When all parameter are set and output file name is specified, the **Proceed** button is activated in the Position Readings Using NAV31 File window. After you click the **Proceed** button, the program begins to filter loaded data, calculates EM31 stations positions based on the recorded GPS readings, instant heading, and other specified parameters, and writes results to the XYZ output file. A progress bar at the bottom of the screen shows the percentage of the file processed (Figure 4.9).

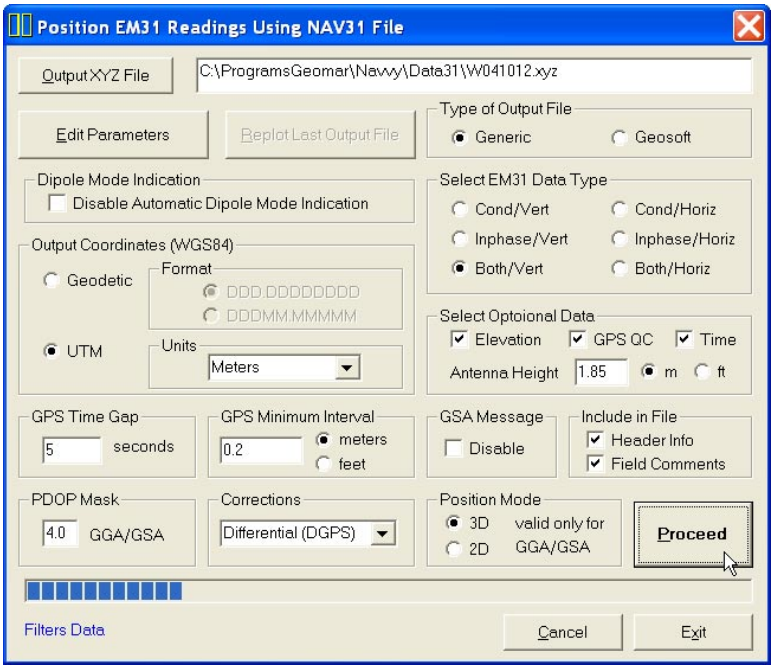


Figure 4.9: Position EM31 Readings Using NAV31 File window during creating XYZ file

The speed of this operation depends on the size of the input file. After the output XYZ file is created a two dimensional layout of the survey is displayed (Figure 4.10).

The image displayed in the Plot XYZ window shows the spatial layout of stations to scale, based on the station coordinates as written to the created file. The display has fixed colours. GPS positions are marked by larger grey dots while the EM31 stations are plotted by smaller red dots. This plot window can be closed by clicking on **Close** button (located in the top right corner of the window).

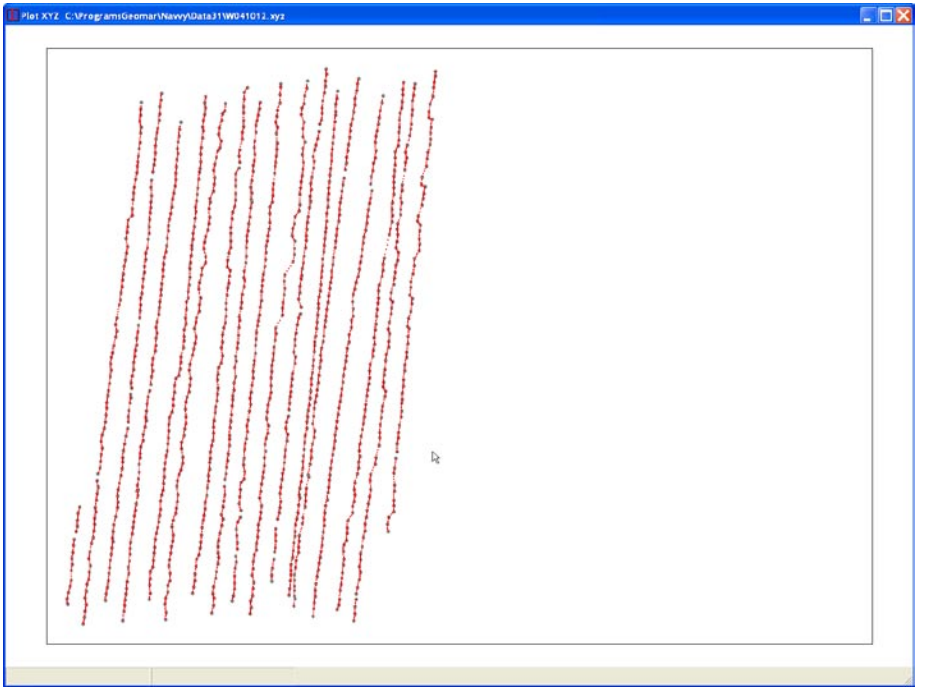


Figure 4.10: Two dimensional layout of stations taken with the Geonics EM31. The GPS X and Y offsets were set to zero (GPS antenna was located above the center of the EM31).

After the Plot XYZ window is closed a button **Replot Last Output File** becomes active and the layout of data can be examined again. However, at this time original GPS positions will not be displayed and only instrument positions will be represented by red dots on the screen. Files created by this portion of the program can be also viewed at any time using the **File|View XYZ File** menu.

After the file is created and its layout is examined it is possible (if required) to recreate XYZ file with changed system geometry parameters. To do this, click **Edit Parameters** button, the Edit NAV31 File Parameters window will appear again. After changes are done, click the **Proceed** button to repeat procedure of creating XYZ file. See example in Figure 4.11 where GPS antenna location was changed as compared to case shown in Figure 4.10.

If the input file does not contain sufficient GPS information, or parameters are not correctly selected, the program will display a warning message (Figure 4.12), and the program will pause operation till the **OK** button is clicked in the warning window.

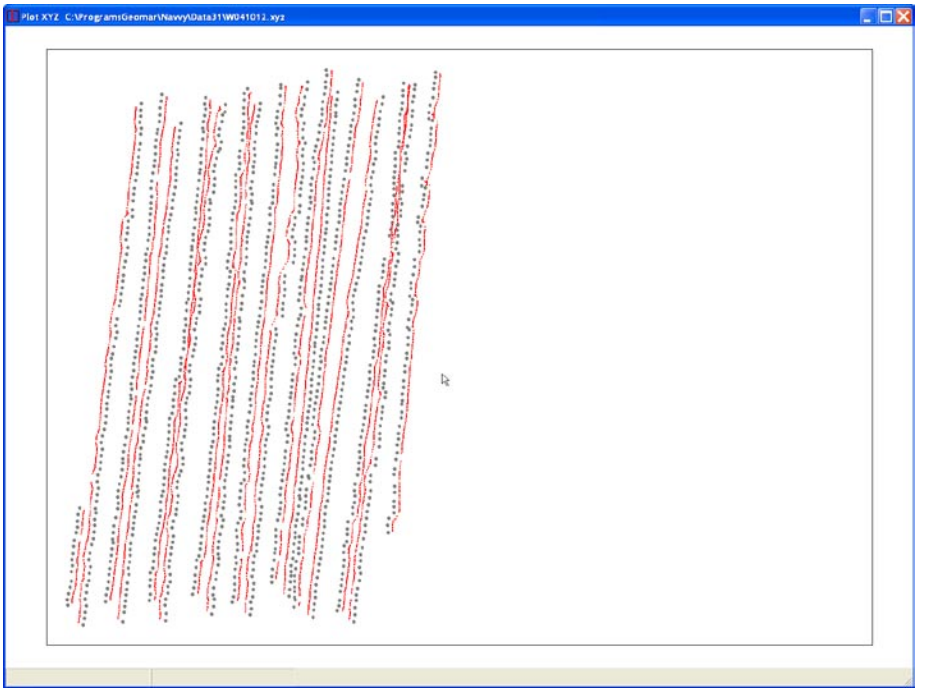


Figure 4.11: Two dimensional layout of stations taken with the EM31. The GPS antenna location: GPS X Offset = -0.6 m and GPS Y Offset = 0 m (the first SW line was surveyed in NW direction).

This message may indicate lack of GPS data in the file, however in most cases it reflects lack of GSA messages when GGA/GSA was selected in the data acquisition program (check Disable GSA Message), raw positions only when Differential button is checked, too small value specified in GPS Time Gap section, not existing EM31 data type specified in Select Data section, etc..

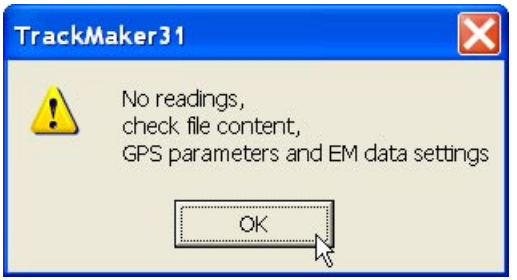


Figure 4.12: Warning window

4.3 Positioning Readings Using External GPS File

After a data file is loaded the TrackMaker31 main window displays the most important parameters of the entered data file (Figure 4.3). At the top of the window the current file name, date of file and optionally original file name (as entered in the field), and start and end times in local time (field computer clock) and UTC time (GPS time in NMEA messages) are displayed. Below, in the left window frame labeled **Data File Contents** a total number of EM31 readings, number of GPS positions recorded, number of invalid GPS positions (with not valid checksum), number of survey lines, comments, conductivity and Inphase readings in Vertical and Horizontal dipole modes, and number of used fiducial markers in the field are given. In the right frame labeled **Data File Settings** listed are: the EM31 dipole modes (fixed), type of used GPS NMEA message, GPS X and Y offsets (in Distance Units), and survey mode.

The Position Sensors Using External GPS File item of the Position Sensors menu allows you to position EM31 stations based on separately logged GPS positions which were postprocessed by a GPS software and then exported to ASCII format file. It is assumed that GPS positions were concurrently recorded by NAV31 program during the survey. Select **Position Sensors|Position Readings Using External GPS File** from the main program menu, as shown in Figure 4.13.

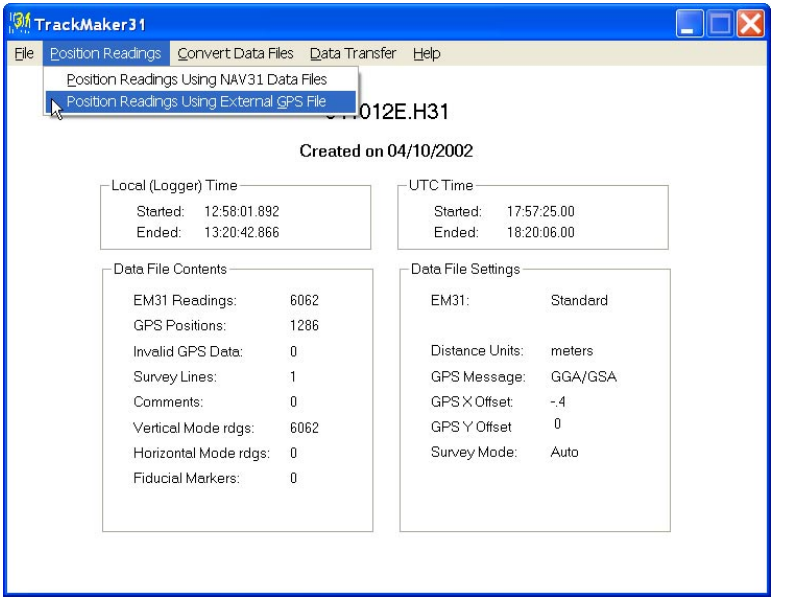


Figure 4.13: Position Readings menu

After the selected menu item is clicked the Position EM31 Readings Using External GPS File window will be displayed in the centre of the screen, Figure 4.14.

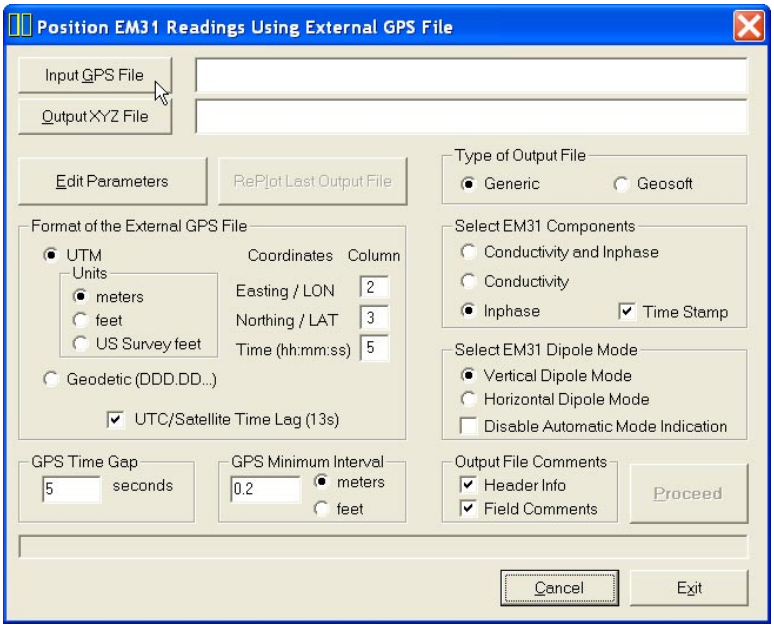


Figure 4.14: Position EM31 Readings Using External GPS File window

Parameters in Positioning Readings Using External GPS File Window

Several parameters which affect the contents and format of the created output (XYZ) file must be specified. These are GPS and XYZ file names, parameters describing contents of the created file and parameters related to GPS as well as to electromagnetic data.

Edit Parameters

The TrackMaker31 main window (Figure 4.13) displays the most important parameters of the entered data file. In case some parameters were wrongly entered in the field it is possible to change them using Edit Parameters option (the same option is available in the File menu of the TrackMaker31 main screen). Click on the **Edit Parameters** button and Edit NAV31 File Parameters window will appear (Figure 4.15).

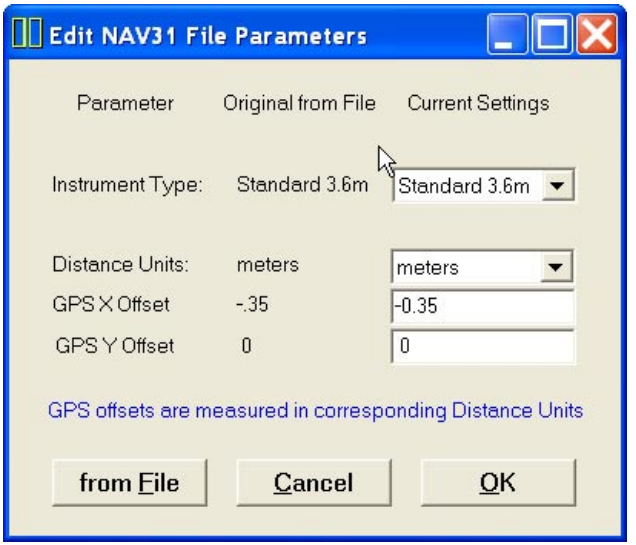


Figure 4.15: Edit NAV31 File Parameters window

The window displays parameters that the user can edit. These are Instrument Type, Distance Units and GPS X and Y offsets. If all parameters were correctly specified in the field then clicking on **OK** or **Cancel** button will accept these entries. In case some of the parameters require modification they can be entered in appropriate text boxes located under label Current Settings. Instrument Type and Distance Units can be selected from combo list boxes, while GPS X and GPS Y offsets must be entered in appropriate text boxes. Instrument type parameter (EM31) is not used in this version of the program and it has only informative meaning. Example of NAV31 File Info window with modified parameters is shown in Figure 4.16.

Clicking on the **OK** button will accept any changes in editable parameters, clicking on the **Cancel** button will cause the program to use initial parameters (state when window was displayed), while clicking on the button **from File** will change parameters to original values (listed in fields under label Original from File). After the buttons **OK**, **Cancel** or **from File** are clicked the Edit NAV31 File Parameter will disappear.

Any updates in this window are valid only for duration of the program. The data file will remain the same unless it **Saved** or **Saved As** in File menu.

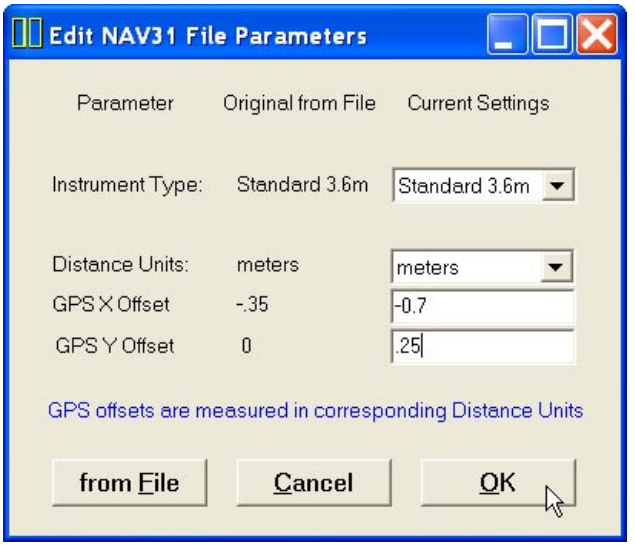


Figure 4.16: Modified parameters in Edit Parameters window

Input GPS File

Click on the **Input GPS File** button. The Select External GPS ASCII File window is displayed (Figure 4.17).

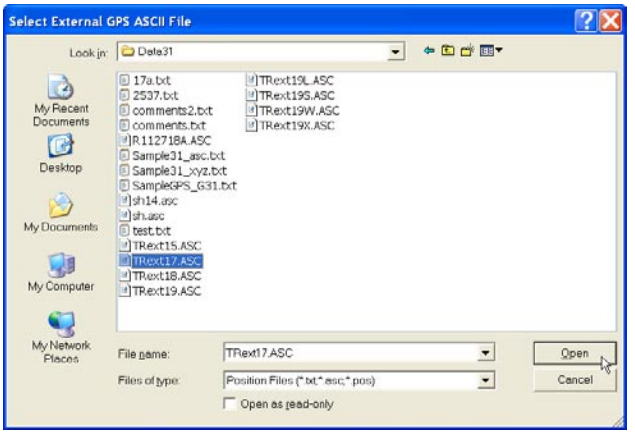


Figure 4.17: Select External GPS File window

Select a file name and click the **Open** button. The Select External GPS ASCII File window will close and the selected file name will be displayed beside the

Input GPS File button in the Position Sensors Using External GPS File window. The external GPS file must be in ASCII (text) format with column delimiters set to comma or spaces. Several examples of the external GPS files are given in Appendix B.

Output File

Click on the **Output XYZ File** button. The Select Output File window is displayed (Figure 4.18).

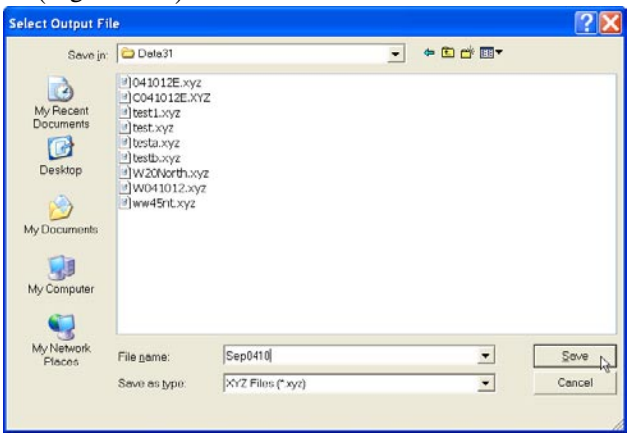


Figure 4.18: Select Output File window

Select a file name and click the **Save** button. The Select XYZ File window will close and the selected file name will be displayed beside the **Output XYZ File** button in the Position Sensors Using External GPS File window.

When all three, Input NAV31, Input GPS and Output files are specified the **Proceed** button in the Position EM31 Readings Using External GPS File becomes active (Figure 4.19).

Select EM31 Components

To select EM31 components click on one of radio buttons labeled **Conductivity and Inphase**, **Conductivity**, and **Inphase**. EM31 components can be taken in Vertical or Horizontal dipole mode (see Select EM31 Dipole Mode below). Data is always placed in the created XYZ file in the following order: X coordinate (Easting or Longitude), Y coordinate (Northing or Latitude), and Conductivity and Inphase. The optional parameter Time (time stamp for each reading) will be placed always in the last column of the file.
If parameter Header Info in Include in File section is checked a line listing all parameters in the file will be placed as a header of the created XYZ file.

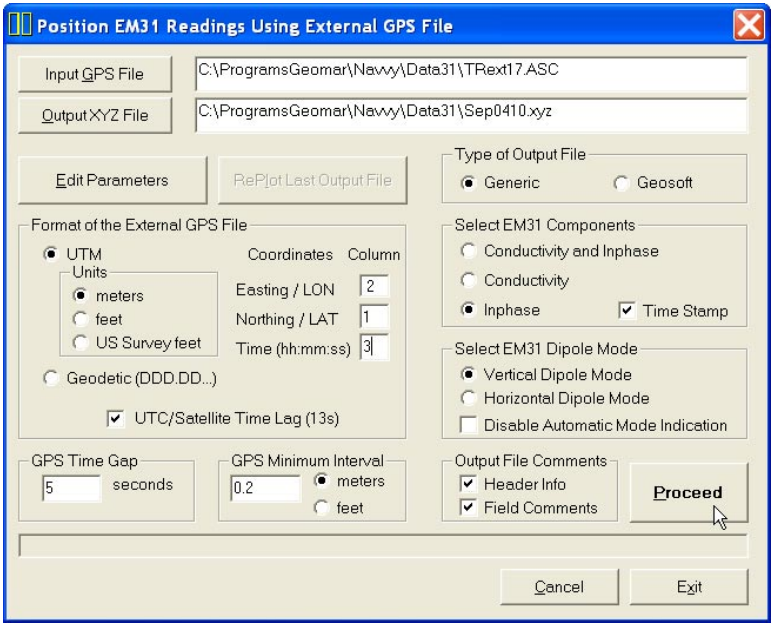


Figure 4.19: Position EM31 Readings Using External GPS File window

Select EM31 Dipole Mode

To select EM31 dipole mode click on one of radio buttons labeled **Vertical Dipole Mode** and **Horizontal Dipole Mode**. EM31 components Conductivity and Inphase can be taken simultaneously, however they can be measured only in one, Vertical or Horizontal dipole mode.

The Select EM31 Dipole Mode section contains one more parameter: Disable Automatic Mode Indication. This option is designed mainly for surveys conducted with the EM31 placed on a trailer. Vertical and Horizontal dipole mode for each reading is indicated in the file based on a state of mercury switch mounted in the instrument. During vibrations caused by towing the EM31 in rough terrain (or by any small obstruction) it may happen that some of the records are tagged as readings taken in Horizontal mode even if the EM31 is fixed on the trailer in Vertical dipole mode. Despite of wrong indication of dipole mode values of recorded Conductivity and Inphase are correct. To place all recorded readings (regardless of the mercury switch indication) in the output file click on the check box labeled **Disable Automatic Dipole Mode Indication**.
If parameter Header Info in Include in File section is checked a line listing all parameters in the file will be placed as a header of the created XYZ file.

Type of Output File

Check the option appropriate for the contouring software used. The Generic option will create a three or more column file without any text strings. This file can be used as an input file for many contouring packages (including Surfer). Geosoft format will cause the program to write a message LINE # at the beginning of each survey line.

Include in File

This section contains two check boxes labeled **Header Info** and **Field Comments**. When Header Info box is checked the file will contain a header listing type of coordinates and names of channels contained in each column of created XYZ file. Checking box labeled Field Comments will cause the program to write text of all field comment (entered by the operator during the survey) in to the created file.

GPS Time Gap

Differentially corrected GPS data often has gaps, due to differences in the constellation of satellites visible to two (fixed and moving receivers), lack of beacon signal, surveying near trees, buildings, and other elevated obstructions. These gaps are filled by TrackMaker31 with the assumption that the GPS receiver speed is essentially constant and that it moves along a straight line during the gaps.

The **GPS Time Gap** parameter specifies the maximum time during which the EM31 data will be linearly interpolated between two GPS positions. Enter this parameter (in seconds) in the edit box labeled **seconds** in the GPS Time Gap section (Figure 4.19). In most cases a value 2 to 3 times larger than the GPS data acquisition frequency is adequate, however the user has to determine this value based on the survey specific conditions and requirements. To ignore effect of this parameter enter a large number of seconds (i.e. 300 or more) as GPS Time Gap parameter.

GPS Minimum Interval

The **GPS Minimum Interval** parameter specifies the minimal distance between two GPS stations that will be used in interpolation. If this distance is smaller than the specified GPS Minimum Interval, then all EM31 readings located between these two stations will be ignored. This parameter is useful in cases when the operator stops for a moment and data are collected in one point. Limited accuracy of GPS positioning will create randomly distributed positions in area

adjacent to the stationary location of the system. If TrackMaker31 will calculate positions of sensor in case offset values (GPS X and/or GPS Y Offsets) are different than zero, positions of the EM31 will have quite large variations associated with apparent change of direction of the survey line caused by randomly close spaced GPS positions. In most cases a value 2 or 3 times smaller than average distance between two GPS stations is adequate, however the user has to determine right value for this parameter which will depend on survey conditions and first of all accuracy of the employed GPS receiver. To ignore the effect of this parameter and to use all stations during creating XYZ file (i.e. during testing when GPS antenna is stationary) set this parameter to zero.

Enter the GPS Minimum Interval in the edit box and check one of the two radio buttons labeled **meters** and **feet** (indicating distance unit) in the GPS Minimum Interval section (Figure 4.19).

Format of the External GPS File

This section describes contents of the External GPS File. It is assumed that the file is in ASCII (text) format, and columns are delimited by comma or spaces. Parameters that have to be specified include: type of coordinates (UTM or Geodetic), identifying numbers of columns corresponding to each coordinate and time, and indicating time of GPS data (UTC or satellite time). These parameters are necessary for TrackMaker31 to correctly calculate positions of each sensor.

Post-processed GPS files in ASCII (text) format include UTM or Geodetic (Latitude/Longitude) coordinates. To select coordinates click **Geodetic** or **UTM** radio buttons (Figure 4.21). Geodetic coordinates, Latitude and Longitude are given in degrees. The program assumes format DDD.DDDDDDDD. Format DDMM.MMMMM (native format found in NMEA GPS messages) is not supported by this option of TrackMaker31. UTM coordinates can be generated in meters or feet. To select units for UTM coordinates click one of the radio buttons located in the Units section located at the UTM radio button (Figure 4.20). These radio buttons are active only when the radio button labeled UTM is selected.

Specify columns where each coordinate and time in text boxes labeled **Column**. Valid format of the time is hh:mm:ss.

Check box labeled UTC/Satellite Time Lag (13s) has to be checked if your GPS software is using Satellite Time to time stamp positions. NMEA messages, and therefore NAV31 data file contains UTC time as a time of GPS reading. In most

cases, if GPS logger is used to save data Satellite Time is used. Please refer to your GPS software manual. Currently difference between UTC and Satellite clocks is 13 seconds.

Creating XYZ Files With Positioned Readings

When all parameter are set and input and output file names are specified, the **Proceed** button is activated in the Position Sensors Using External GPS File window. After you click the **Proceed** button, the program begins to read input files, replaces GPS positions by positions given in GPS file, calculates EM31 stations positions based on the recorded GPS readings, instant heading, and other specified parameters, and writes results to the XYZ output file (or files depending on the Output Data setting). A progress bar at the bottom of the screen shows the percentage read (Figure 4.20).

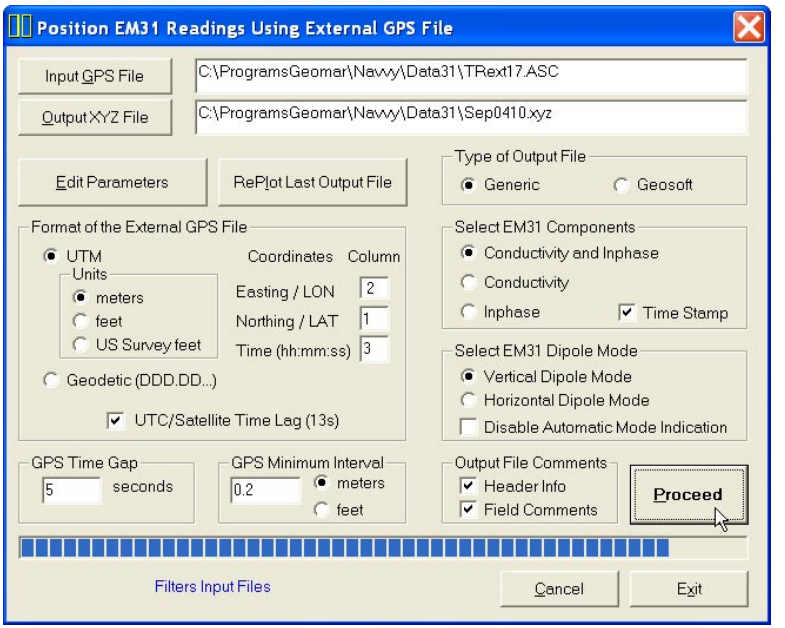


Figure 4.20: Position Sensors Using External GPS File window during creating XYZ file

The speed of this operation depends on the size of input files. After the output XYZ file is created a two dimensional layout of the survey is displayed (Figure 4.21).

The image displayed in the Plot XYZ window shows the spatial layout of stations to scale, based on the station coordinates as written to the created file. The display has

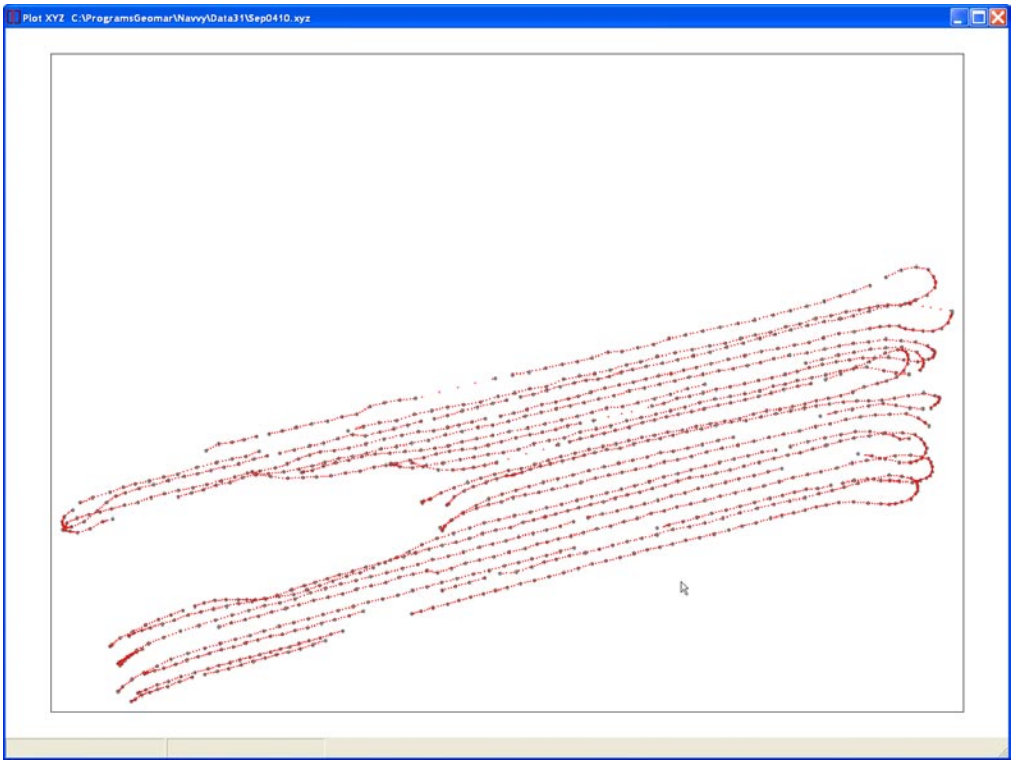


Figure 4.21: Two dimensional layout of stations taken with the Geonics EM31 and GPS. The GPS antenna was located above the center of the EM31 (GPS X and Y offsets are set to zero).

fixed colours. GPS positions are marked by larger grey dots while the EM31 stations are plotted by smaller red dots. This plot window can be closed by clicking on **Close** button (located in the top right corner of the window).

After the Plot XYZ window is closed a button **Replot Last Output File** becomes active and the layout of data can be examined again. However, at this time original GPS positions will not be displayed and all instruments will be represented by the same colour on the screen. Files created by this portion of the program can be also viewed at any time using the **File|View XYZ File** menu.

After the file is created and its layout is examined it is possible (if required) to recreate XYZ file with changed system geometry parameters. To do this, click **Edit Parameters** button, the Edit NAV31 File Parameters window will appear again. After changes are

done, click the **Proceed** button to repeat procedure of creating XYZ file. See example in Figure 4.22 where GPS antenna location was changed as compared to case shown in Figure 4.21.

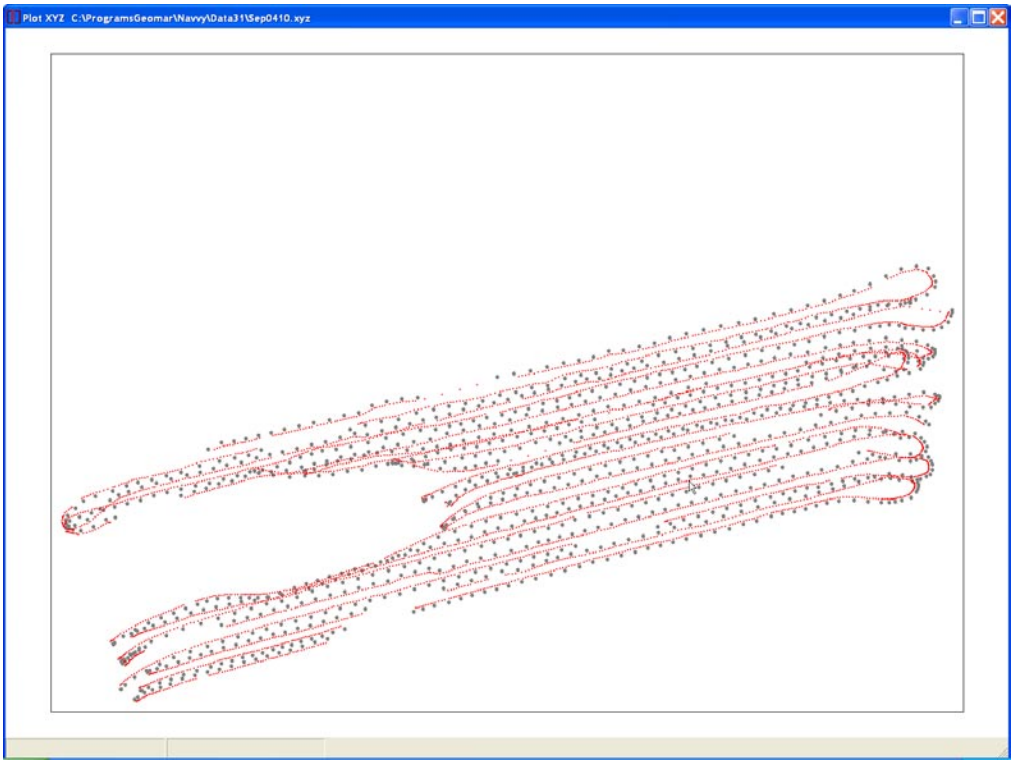


Figure 4.22: Two dimensional layout of stations taken with the Geonics EM31 and GPS. The GPS antenna was located off the center of the EM31 (GPS X offset = 0.7 m and GPS Y offset =0).

If the input file does not contain sufficient GPS information, contains different time range, or parameters are not correctly selected, the program will display a warning message.

Convert Data Files 5

Convert menu of TrackMaker31 program allows you to convert the NAV31 binary file to other formats. There are five items associated with the Convert menu (Figure 5.1):

- convert NAV31 file to Geonics DAT31W (.G31) format,
- convert NAV31 file to general format ASCII file,
- retrieve and position field comments from NAV31,
- convert GXY file to ASCII file containing positions,
- correct system time constant delay in XYZ files.

Figure 5.1: Convert Data Files menu

Files converted to Geonics DAT31W format can be further processed by the Geonics DAT31W program, while files converted to general ASCII format can be easily reformatted and used by other software. While retrieving comments from NAV31 file, the program retrieves text of the comment and their position based on neighbouring GPS records. When converting GXY files (containing only GPS positions and field comments) the program generates simple XY type of file (coordinates in two columns with optional parameters). Correct Time Constant Delay item provides correction for specified time constant delay of the system (EM instrument specific time constant combined with GPS latency). Any XYZ file containing sequential time stamp column can be corrected while using this option.

It should be noted that three first items of Convert Files menu are disabled. They are enabled automatically after the NAV31 data file is loaded in File menu (Figure 5.2).

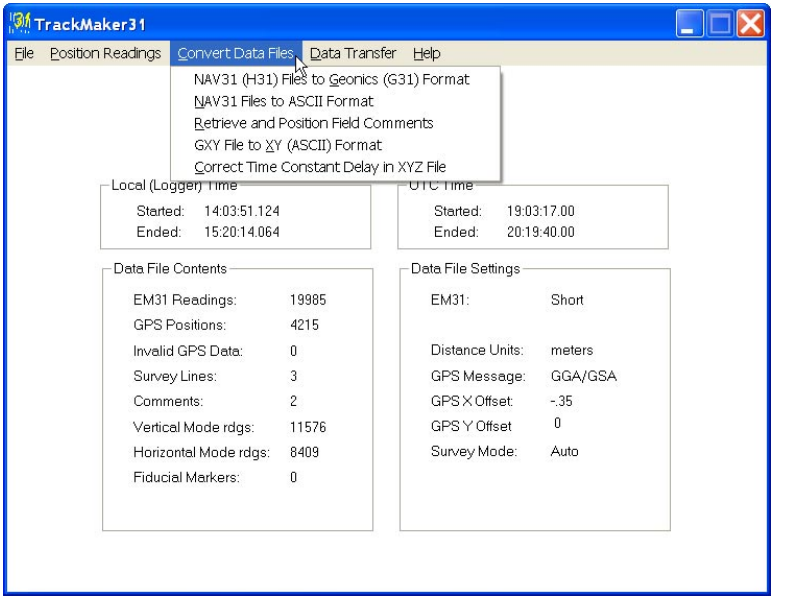


Figure 5.2: Convert Data Files menu after NAV31 file is loaded to the program

Selected examples of file formats created by TrackMaker31 are given in Appendix B of this manual.

5.1 Convert NAV31 Data to Geonics DAT31W (G31) Format

The Convert NAV31 to Geonics G31 Format option allows you to convert NAV31 files to Geonics DAT31W format. Select **Convert|NAV31 to Geonics G31 Format** from the main program menu, as shown in Figure 5.2.

After the selected menu item is clicked the Convert NAV31 Files (H31) to Geonics G31 Format window will be displayed in the centre of the screen, Figure 5.3.

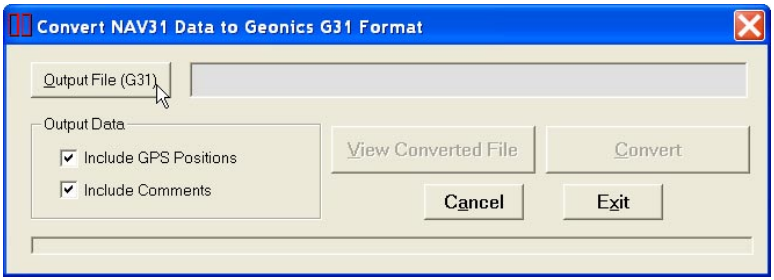


Figure 5.3: Convert NAV31 Files to Geonics G31 Format window

Parameters in Convert NAV31 Data to Geonics G31 Format Window

Several parameters which affect the contents and format of the created output (G31) file must be specified. The first is Output File name. Output Data parameters if checked cause the program to write GPS positions, Comments entered in the field. Time Stamp for each reading is included automatically.

Output File (G31)

Click on the **Output File (G31)** button. The Select Output File window is displayed (Figure 5.4).

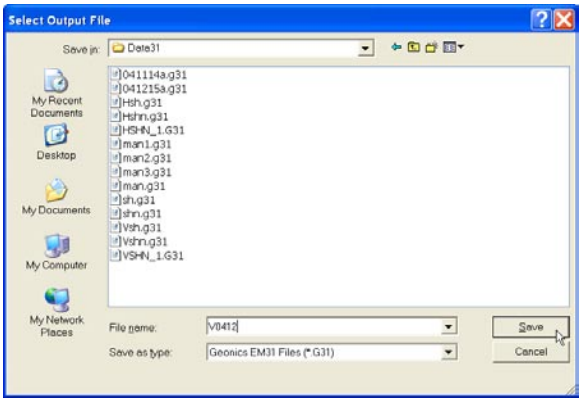


Figure 5.4: Select Output File window

Select a file name and click the **Save** button. The Select Output File window will close and the selected file name will be displayed beside the **Output File (G31)** button in the Convert NAV31 to Geonics G31 Format window.

When Output file is specified the **Convert** button in the Convert NAV31 to Geonics G31 Format window becomes active.

Output Data

TrackMaker31 can generate a file with EM31 data as recorded by NAV31 data acquisition program. The file may also contain GPS positions and Comments. Check appropriate check boxes in section labeled Data Output. GPS positions are properly written in Geonics DAT31W format regardless which GPS message was used during the survey.

Converting NAV31 Data to Geonics DATH31DW (G31) Format

When all parameters are set and input and output file names are specified, the **Convert** button is activated in the Convert NAV31 File to Geonics G31 Format window. After you click the **Convert** button, the program begins to read the input file, converts data to DAT31W format and writes results to the output file. A progress bar at the bottom of the screen shows the percentage of the file read (Figure 5.5).

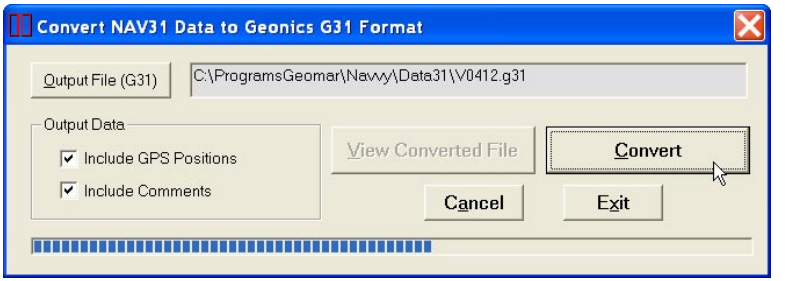


Figure 5.5: Convert NAV31 Files (H31) to Geonics G31 Format window during data processing

The speed of this operation depends on the size of the input file. After the output (G31) file is created the **View Converted File** button becomes active. Clicking on this button will display first 63 Kbytes of the created file.

The created file can be loaded to the Geonics DATH31DW program. It should be noted that the created file contains original GPS positions, without corrections for GPS X and Y Offsets specified during the survey.

Clicking **Cancel** button will clear text box at **Output File (G31)** button. Click on **Exit** button to close the Convert NAV31 Files (H31) to Geonics G31 Format window.

An example of data file in Geonics DAT31W (G31) format is given in Appendix B.

5.2 Convert NAV31 Data to ASCII Format

The Convert NAV31 Data to ASCII Format option allows you to convert NAV31 binary files to ASCII format, which can be viewed with any text editor and then easily converted to the other format. Select **Convert|NAV31 to ASCII Format** from the main program menu, as shown in Figure 5.2.

After the selected menu item is clicked the Convert NAV31 Files to ASCII Format window will be displayed in the centre of the screen, Figure 5.6.

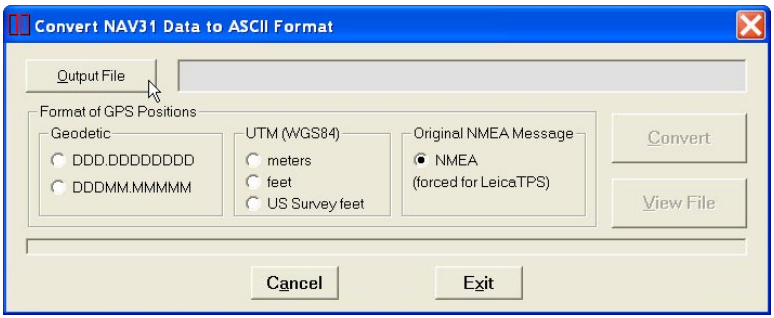


Figure 5.6: Convert NAV31 Files to ASCII Format window

Parameters in Convert NAV31 Data to ASCII Format Window

Several parameters which affect the contents and format of the created output (ASC) file must be specified. These are the ASCII file name, and Format of GPS Positions (coordinates format or original NMEA statement).

Output File

Click on the **Output File** button. The Select Output File window is displayed (Figure 5.7).

Select a file name and click the **Save** button. The Select ASC Output File window will close and the selected file name will be displayed beside the **Output File (ASC)** button in the Convert NAV31 Files to ASCII Format window.

When Output file is specified the **Convert** button in the Convert NAV31 Data to ASCII Format window becomes active.

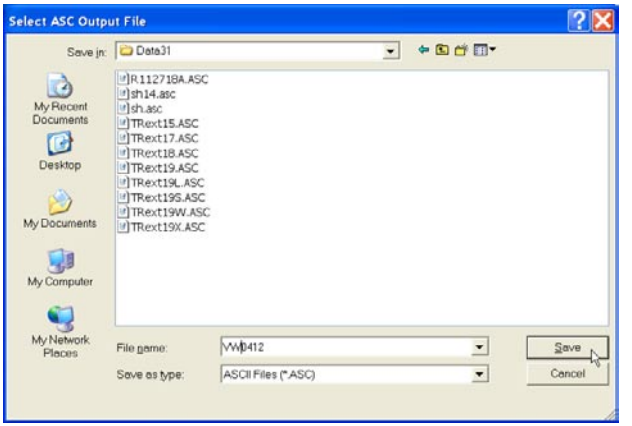


Figure 5.7: Select ASC Output File window

Format of GPS Positions

Positions can be written in the output file as geodetic (geographical) coordinates (Latitude/Longitude), they can be converted to UTM coordinates, or written to file as original NMEA messages (exactly as streamed by a GPS receiver). The program uses the WGS1984 datum. To select coordinates click the appropriate radio buttons in the sections labeled **Geodetic** or **UTM** (Figure 5.6).

Geodetic coordinates, Latitude and Longitude are given in degrees. They can be written in two formats DD.DDDDDDDD or DDMM.MMMMM (native format found in NMEA GPS messages). To select which format click the appropriate radio button in the section labeled **Geodetic** (Figure 5.6).

UTM coordinates can be generated in meters, feet or US Survey feet. To select units for UTM coordinates click one of the radio buttons located in the Units section located at the UTM radio button (Figure 5.6).

Converting NAV31 Data to ASCII Format

When all parameter are set and output file name is specified, the **Convert** button is activated in the Convert NAV31 Data to ASCII Format window. After you click the **Convert** button, the program begins to read the data, converts data to ASCII format and writes results to the output file. A progress bar at the bottom of the screen shows the percentage read (Figure 5.8).

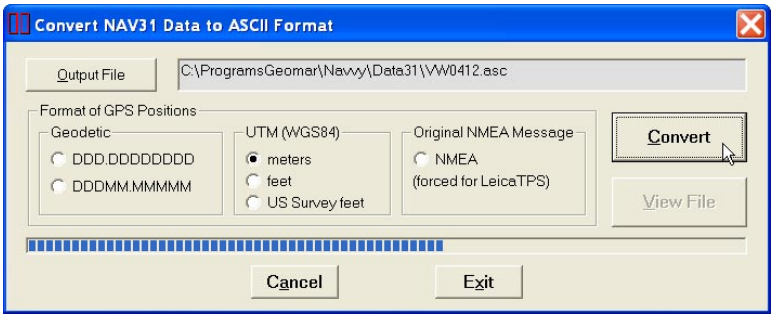


Figure 5.8: Convert NAV31 Files to ASCII Format window during data processing

The speed of this operation depends on the size of the input file. After the output file is created the **View Converted File** button becomes active. Clicking on this button will display first 63 Kbytes of the created file.

The created file contains EM31 readings, GPS positions, and entire information related to the instrument and survey settings. Example of the output file in ASCII format is given in Appendix B.

Clicking **Cancel** button will clear text box at **Output File** button. Click on **Exit** button to close the Convert NAV31 Data to ASCII Format window.

5.3 Retrieve and Position Field Comments

The Retrieve and Position Field Comments option allows you to convert retrieve field comments from NAV31 binary files. At the same time the program assigns GPS positions to indicate where these comments were entered by the operator. The position can be assigned either as a GPS position preceding or position following the comment entry. The resulting output file consists of coordinates and corresponding text of the comment. Select **Convert|Retrieve and Position Field Comments** from the main program menu, as shown in Figure 5.2.

After the selected menu item is clicked the Position Comments Recorded in NAV31 File window will be displayed in the centre of the screen, Figure 5.9.

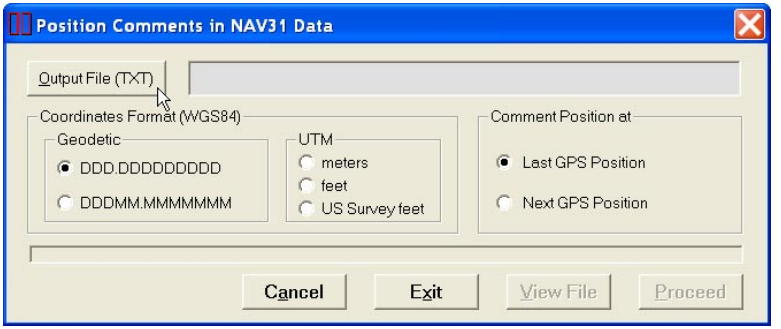


Figure 5.9: Position Comments in NAV31 Data window

Parameters in Position Comments Recorded in NAV31 File Window

Several parameters which affect the contents and format of the created output (TXT) file must be specified. These are the output file names, coordinates format, and indicating type of position of the comment - using a preceding or following GPS reading.

Output File (TXT)

Click on the **Output File (TXT)** button. The Select Output File window is displayed (Figure 5.10).

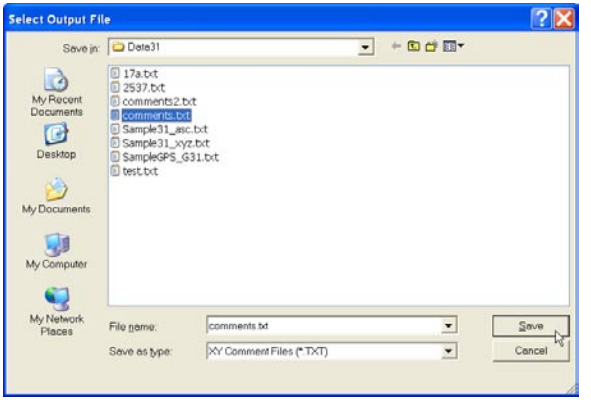


Figure 5.10: Select Output File window

Select a file name and click the **Save** button. The Select Output File window will close and the selected file name will be displayed beside the **Output File (TXT)** button in the Position Comments Recorded in NAV31 File window.

When both, Input and Output files are specified the **Proceed** button in the Position Comments Recorded in NAV31 File window becomes active.

Coordinates Format

Positions can be written in the output file as geodetic (geographical) coordinates (Latitude/Longitude) or they can be converted to UTM coordinates. The program uses the WGS1984 datum. To select coordinates click the appropriate radio buttons in sections labeled **Geodetic** or **UTM** (Figure 5.9).

Geodetic coordinates, Latitude and Longitude are given in degrees. They can be written in two formats DD.DDDDDDDD or DDMM.MMMMM (native format found in NMEA GPS messages). To select which format click the appropriate radio button in section labeled **Geodetic** (Figure 5.9).

UTM coordinates can be generated in meters, feet or US Survey feet. To select units for UTM coordinates click one of the radio buttons located in the Units section located at the **UTM** radio button (Figure 5.9).

Comment Position at

This section specifies how GPS positions are assigned to the comment. There are two choices: Comment can be assigned to the last position that was recorded by the NAV31 program, or to the position that follows comment entry. In most cases any choice is right since comments are usually taken while collecting data (including GPS positions) and during comment entry operator stops recording for a moment. However the option **Last GPS Position** appears to be more natural since after the comment entry the operator may stop taking readings and later continue survey from other location.

To select comment position option click one of the radio buttons labeled **Last GPS Position** and **Next GPS Position** located in the Comment Position at section of the window (Figure 5.9).

Positioning Comments Recorded in NAV31 File

When all parameter are set and input and output file names are specified, the **Proceed** button is activated in the Position Comments Recorded in NAV31 File window. After you click the **Proceed** button, the program begins to read the input file, converts data to ASCII format and writes results to the output file. A progress bar at the bottom of the screen shows the percentage read (Figure 5.11).

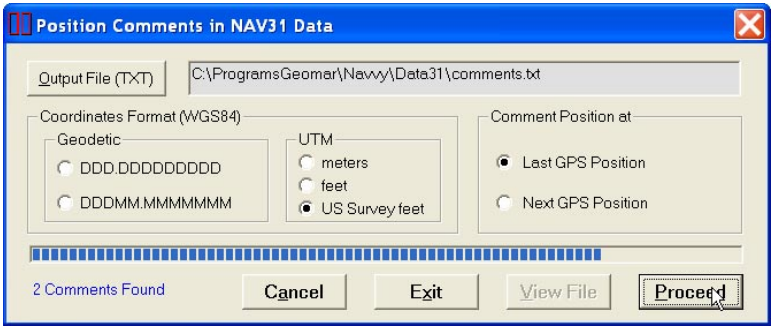


Figure 5.11: Position Comments Recorded in NAV31 File during data processing

The speed of the operation depends on the size of the input file. After the output file is created the **View File** button becomes active. Clicking on this button will display first 63 Kbytes of the created file.

The created file contains GPS positions in the first two columns followed by the text of comment as recorded in the field. Example of the output file containing comments is given in Appendix B.

Clicking **Cancel** button will clear text boxes at **Input File (H31)** and **Output File (TXT)** buttons. Click on **Exit** button to close the Position Comments Recorded in NAV31 File window.

5.4 Convert GXY Files to XY (ASCII) Format

Files GXY are created by the NAV31 when only GPS data are collected (EM31 is Disabled). This type of file contains GPS positions and optionally field comments. The Convert GXY File to XY (ASCII) Format option allows you to convert GXY binary file to simple XY type of file. This file contains coordinates placed in first two columns with optional field comments, elevation, UTC time, local time, and GPS station number located in following columns. All parameters are always placed in above order. This format can be viewed with any text editor and it can be easily converted to other formats.

It should be noted that GXY files created with any other Geomar data acquisition programs (i.e. ML61, NAV61MK2, NAV61, NAV38, etc.) can be converted to ASCII format using this option of TrackMaker31.

Select **Convert|GXY Files to XY (ASCII) Format** from the main program menu, as shown in Figure 5.1. After the selected menu item is clicked the Convert GXY File to XY Format window will be displayed in the centre of the screen, Figure 5.12.

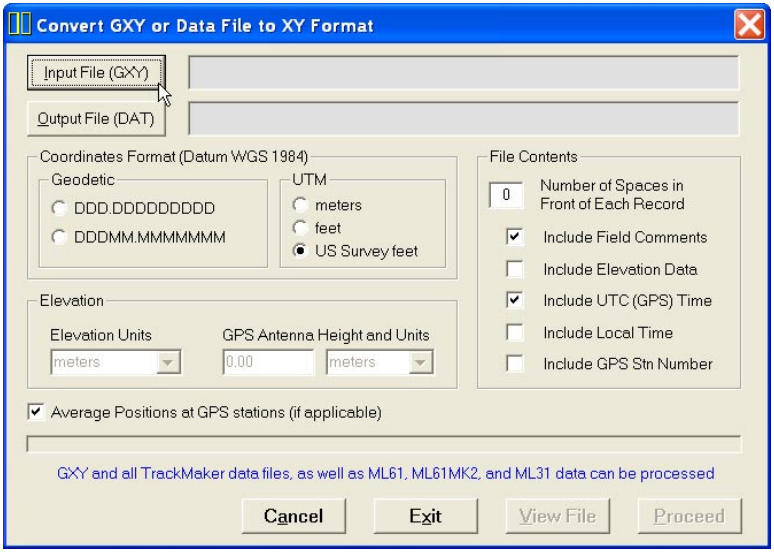


Figure 5.12: Convert GXY Files to XY Format window

Parameters in Convert GXY to XY Format Window

Several parameters which affect the contents and format of the created output (DAT) file must be specified. These are the input and output names, Coordinates Format, and contents of the output file.

Input File (GXY)

Click on **Input File (GXY)** button. The Select GXY Input File window is displayed (Figure 5.13).

The window lists files with extension name GXY. Select a file name and click the **Open** button. The Select GXY File window will close and the selected file name will be displayed beside the **Input File (GXY)** button in the Convert GXY File to XY Format window.

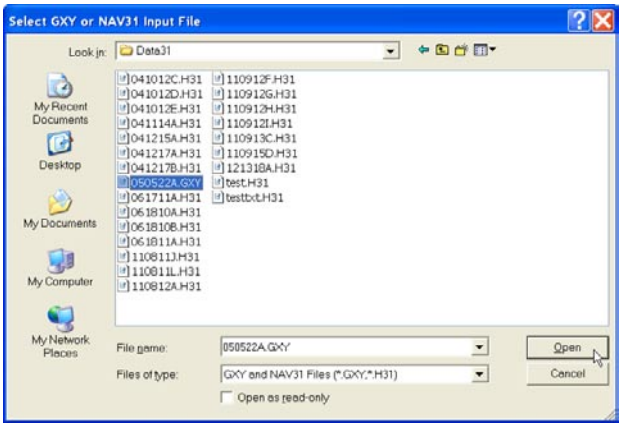


Figure 5.13: Select GXY Input File window

Output File (DAT)

Click on the **Output File (DAT)** button. The Select Output File window is displayed (Figure 5.14).

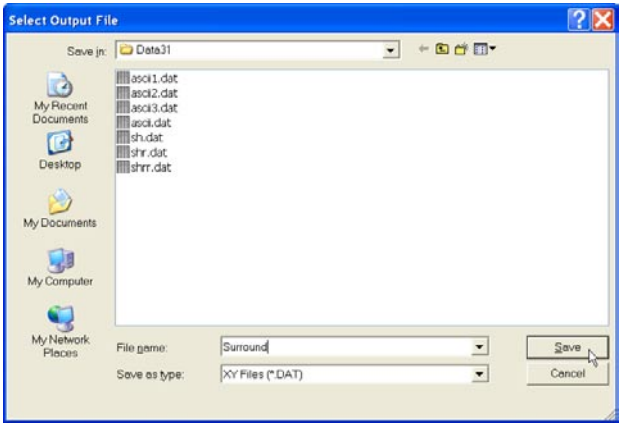


Figure 5.14: Select Output File window

Select a file name and click the **Save** button. The Select Output File window will close and the selected file name will be displayed beside the **Output File (DAT)** button in the Convert GXY File to XY Format window.

When both, Input and Output files are specified the **Proceed** button in the Convert GXY File to XY Format window becomes active.

Coordinates Format

Positions can be written in the output file as geodetic (geographical) coordinates (Latitude/Longitude) or they can be converted to UTM coordinates. The program uses the WGS1984 datum. To select coordinates click appropriate radio buttons in sections labeled **Geodetic** or **UTM** (Figure 5.12).

Geodetic coordinates, Latitude and Longitude are given in degrees. They can be written in two formats DD.DDDDDDDD or DDMM.MMMMM (native format found in NMEA GPS messages). To select which format click the appropriate radio button in section labeled **Geodetic** (Figure 5.12).

UTM coordinates can be generated in meters, feet or US Survey feet. To select units for UTM coordinates click one of the radio buttons located in the Units section located at the UTM radio button (Figure 5.12).

File Contents

This section affects the output file format and contents. It contains one text box labeled **Number of Spaces in Front of Each Record** and five check boxes labeled **Include Field Comments**, **Include Elevation Data**, **Include UTC (GPS) Time**, **Include Local Time**, and **Include GPS Stn Number**.

Number entered in the text box will specify number of spaces in front of each record. This option may be useful while using created files as control files in mapping software. To ignore this option enter zero.

Checking box labeled Include Field Comments will cause the program to write text of all field comment (entered by the operator during the survey) in to the created file.

The Include Elevation Data option allows you to place elevation values in the created file. When this option is checked then a set of options in the frame labeled Elevation is enabled.

When Include GPS Time box is checked the program will write a column containing time of GPS position, and if the Include Local Time box is checked local (field computer) time will be written to the file.

When the Include GPS Stn (station) Number is checked then sequential GPS station will be placed in the file. If averaging was used during GPS data collection (and check box Average Positions... is not checked) then several recorded GPS positions may have same station number.

Elevation

If Elevation check box is checked then window controls associated with Elevation are enabled. Please select units for elevation values (these can be meters, feet, or US Survey feet). To obtain ground elevation values please specify GPS antenna height and units that were used to measure height of the antenna.

Average Positions at GPS stations

If averaging was used during GPS data collection and the check box labeled Average Positions at GPS stations is checked then the program will calculate averaged position from all readings taken at each station and one resulting value will be written to the file. When the check box is not checked then all recorded positions will be placed in the file.

Converting GXY File to XY (ASCII) Format

When all parameter are set and input and output file names are specified, the **Proceed** button is activated in the Convert GXY to XY Format window. After you click the **Proceed** button, the program begins to read the input file, converts data to ASCII format and writes results to the output file. A progress bar at the bottom of the screen shows the percentage read (Figure 5.15).

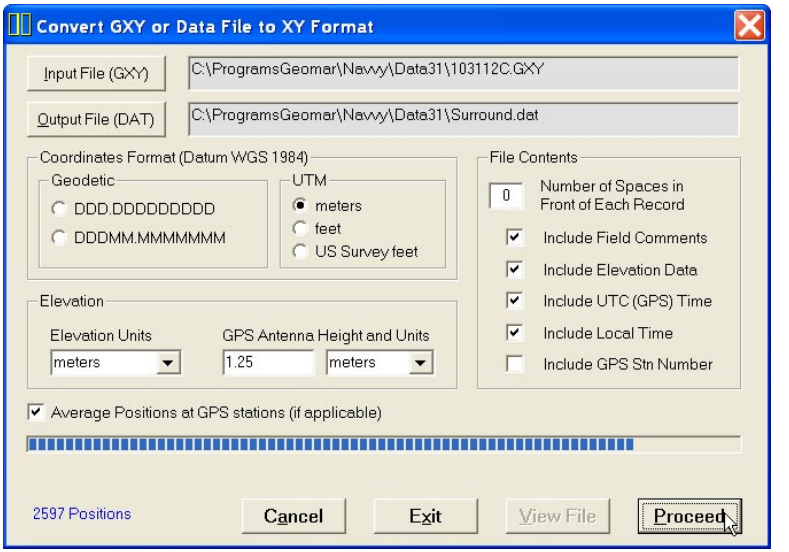


Figure 5.15: Convert GXY Data Files to XY Format window during data processing

The speed of this operation depends on the size of the input file. After the output file is created the **View File** button becomes active. Clicking on this button will display first 63 Kbytes of the created file.

The created file contains GPS positions as recorded in the field. Example of the output file in ASCII format is given in Appendix B.

Clicking **Cancel** button will clear text boxes at **Input File (GXY)** and **Output File (DAT)** buttons. Click on **Exit** button to close the Convert GXY Files to XY Format window.

5.5 Correct Time Constant Delay in XYZ File

This option allows for the system time constant delay correction. The procedure acts on two dimensional, GPS positioned data.

While the EM31 time constant is known the time constant of the combined EM31 and GPS receiver system is a function of these two devices. The easiest method to determine the time constant of the system is to survey a known buried pipe. After the proper time constant delay correction is applied the linear anomaly associated with the pipe should be free of any “hearing bone” effect. Another method to determine the time delay is to survey a few lines (in two directions) with varying speeds over the same small metallic target. When displaying the image the anomaly associated with the sample target may be slightly displaced or extended in size on neighboring lines. After the correct time constant for the system is determined the anomaly should be at the same location for each survey line.

Since the image of two dimensional data can be displayed in a mapping system (after griding) the procedure can be time consuming, however it only needs to be done once for a given GPS receiver and EM31.

In order to apply the correction the generated XYZ file must have time stamps. In the event input file does not have time stamp at each reading the program will display a warning message.

The correction acts on any XYZ type of file so care should be taken that data is not corrected twice.

To access this option select **Convert|Correct Time Constant Delay in XYZ File** in the menu (Figure 5.1). The Correct Time Constant Delay window will appear on the screen (Figure 5.16).

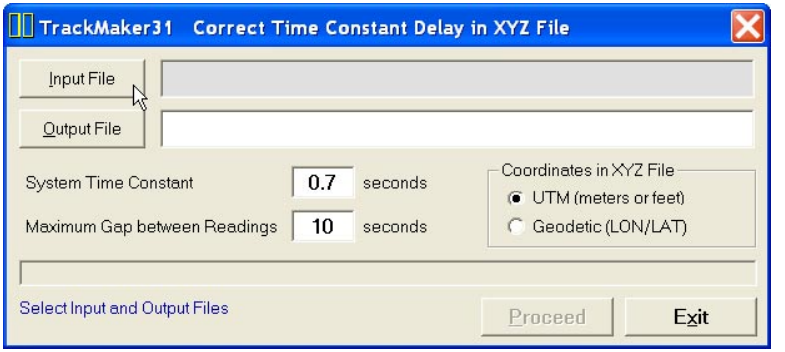


Figure 5.16: Correct Time Constant Delay in XYZ File window

Parameters in Correct Time Constant Delay Window

Several parameters which affect the contents of the created output (XYZ) file must be specified. These are the Input and Output XYZ file names, System Time Constant, Maximum Gap between Readings, and type of coordinates in the input XYZ file.

Input File

Click on **Input File** button. The Select Input XYZ File window is displayed (Figure 5.17).

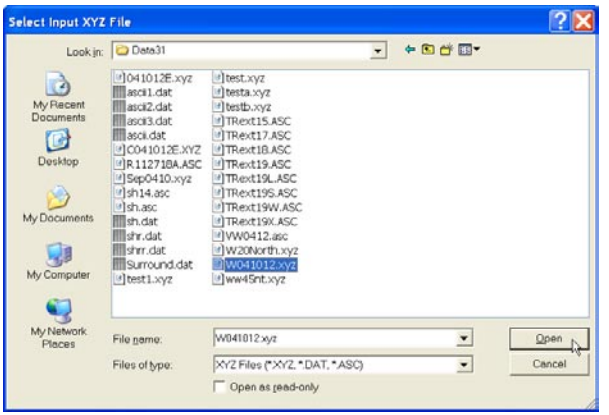


Figure 5.17: Select Input XYZ File window

The window lists files with extension names XYZ, DAT, and ASC. Select a file name and click the **Open** button. The Select Input XYZ File window will close and the selected file name will appear next to the **Input File** button in the Correct Time Constant Delay window.

Output File

Click on the **Output File** button. The Select XYZ File window is displayed (Figure 5.18).

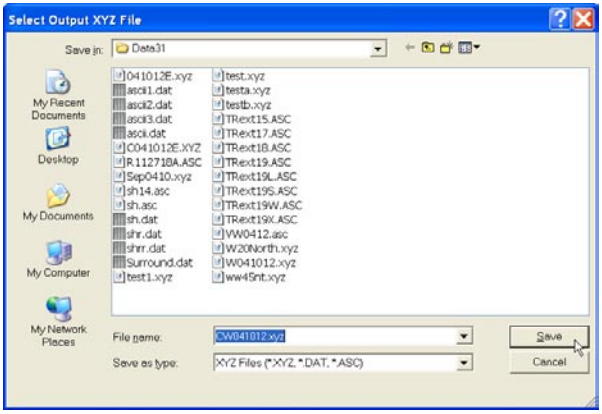


Figure 5.18: Select Output XYZ File window

As a default the Input File name with prefix C is given. Accept the default, enter, or select a file name and click the **Save** button. The Select Output XYZ File window will close and the selected file name will be displayed beside the **Output File** button in the Correct Time Constant Delay window.

When Input and Output files are specified the **Proceed** button in the Correct Time Constant Delay window becomes active (Figure 5.19).

System Time Constant

Time delay 0.6 seconds is given as a default. This value can be changed (0 to 2 seconds), however the user should experiment before choosing a final value.

Maximum Gap Between Readings

This parameter specifies the maximum time during which the EM31 data will be treated as continuous data set. If the gap between two stations is larger than specified maximum gap the station that follows the gap will be assumed the first station of a new line.

Enter this parameter (in seconds) in the edit box labeled Maximum Gap between Readings. In most cases a value 2 to 3 times larger than the GPS acquisition frequency is adequate.

Coordinates in XYZ File

Specify type of coordinates in the input file. The output file will be written with the same type of coordinates.

Creating XYZ File With Time Delay Corrections

When all parameter are set and input and output file names are specified, the **Proceed** button is activated in the Correct Time Constant Delay window. After you click the **Proceed** button, the program begins to read and analyze the input file. A label Analyzing File is displayed at the bottom of the window. The program then calculates corrections for each station based on the instant velocity of the system at each station. A progress bar at the bottom of the screen shows the percentage read (Figure 5.19).

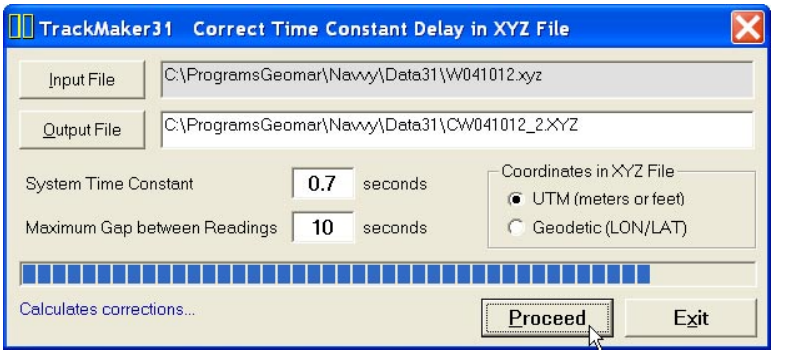


Figure 5.19: Correct Time Constant Delay in the XYZ File window during data processing

If the input file does not contain time stamp information, the program will display a warning message, and it will pause operation till the **OK** button is clicked in the warning window.

NAV31 Data File Format

A

A.1 Description of NAV31 Data File Format (H31) - Windows CE

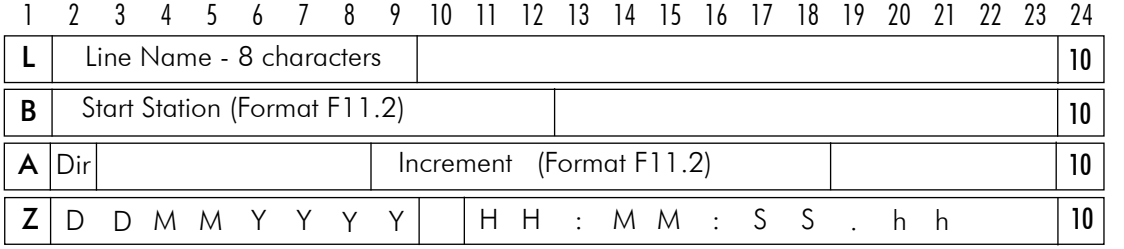
Each record created by the NAV31 for Allegro CX program contains 24 characters including line feed at the end of each record.

Header of the file contains 3 records starting with characters N, H, and G.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	A	V	3	1				W	1	0	5	Survey Type			UT	ID	IM	IC	IS				10
H		File Name										Time/Wheel/Samples							TG				10
G	GPS X Offset (F9.2)							GPS Y Offset (F9.2)											GP				10

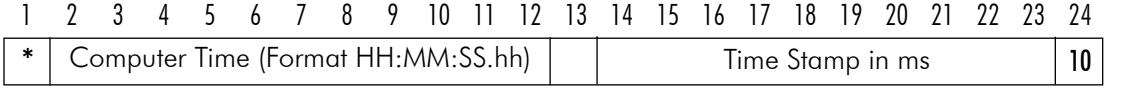
NAV31	-	identification of program file
W105	-	version number V1.05, W indicates Allegro CX
Survey Type	-	GPS (if GPS Input Enabled) or GRD (grid)
UT	-	unit type (0 = meters, 1 = feet)
ID	-	EM31 Dipole Mode (0 = Vertical, 1 = Horizontal, and 2 = Both)
IM	-	EM31 survey mode (0 = Auto, 1 = Wheel, and 2 = Manual)
IC	-	EM31 component (0 = Both, 1 = Inphase, and 2 = Conductivity)
IS	-	EM31 type (0 = Standard, 1 = Short 2 m)
File Name	-	file name, maximum 8 characters
Time/Wheel/Samples	-	this field depends on EM38DD survey mode Auto Mode - Time Increment in seconds Wheel Mode - Wheel Increment (user units, IT) Manual Mode - Samples/Reading
TG	-	File tag (space= original, 1= Saved As or/and edited)
GPS X Offset	-	Offset of GPS antenna in X direction
GPS Y Offset	-	Offset of GPS antenna in Y direction
GP	-	type of GPS NMEA message (0 = GGA/GSA, 1= GGA, 2 = POS, 3 = LLK, 4=LLQ, 5=GLL, 6 = GGK, 7 = Leica TPS)
10	-	Line Feed character

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



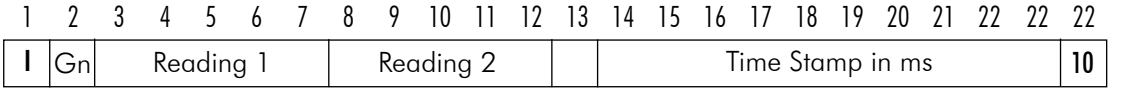
Line Name	-	Line Name, maximum 8 characters
Start Station	-	Start Station for the Line, format F11.2
Dir	-	Direction of the Line (E, W, N, or S)
Station Inc.	-	Station Increment, format F11.3
Date	-	Date when Line was created, format DD-MM-YYYY
Time	-	Time when Line was created, format HH:MM:SS.hh
10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

Timer Reset



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

Reading



I - indicator T or 2
- **T** - First reading at the station (default for Auto mode)
- **2** - second reading at station (possibble 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		*not used*
6	64	Marker	= 1	*trigger pressed*
			= 0	*otherwise*
5	32	Mode	= 1	*Vertical*
				Horizontal
4	16	0		*not used*
3	8	0		*not used*
2	4	Range 3		
1	2	Range 2		
0	1	0		*not used*

Range 3 and Range 2 represent sensitivity (gain) as follows

Both Components (OPER mode)

Sensitivity	Range 2	Range 3	Multiplication Factors	
1000	1	1	Conductivity	-0.25
100	0	1	Conductivity	-0.025
10	1	0	Conductivity	-0.0025

Multiplication factor for Inphase is the same for all ranges: =0.025

Both Components (OPER mode)

Sensitivity	Range 2	Range 3	Multiplication Factors	
1000	1	1	Inphase	-0.0625
100	0	1	Inphase	-0.00625
10	1	0	Inphase	-0.000625

Conductivity is not recorded in COMP mode.

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

Reading 1 - five character field containing instrument output. Conductivity if Both components, Inphase if Inphase was selected includes sign (+ or -) and four digits

Reading 2 - five character field containing instrument output. Inphase if Both components, not used if Inphase was selected includes sign (+ or -) and four digits

Time Stamp - time stamp of the reading in milliseconds, this is time elapsed from the last timer reset. The time in milliseconds can be linked with the computer local time by using Times in line started by ***** (see Timer Reset).

10 - Line Feed character

Comment

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

New Station

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

GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 22 characters strings and placed in the NAV31 data file which contains 24 characters records, including one character indicator and line feed at the end of each record. The GPS sequence starts at the line which contains the character @ as the first character, then records that contain a continuation of the same message start with the character **#**. The GPS sequence ends with a line starting with the character **!**. The last line contains a logger time stamp for the given GPS reading. A sample of the GPS message written in NAV31 format is given below.

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

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

A.2 Example of NAV31 Data File - Windows CE

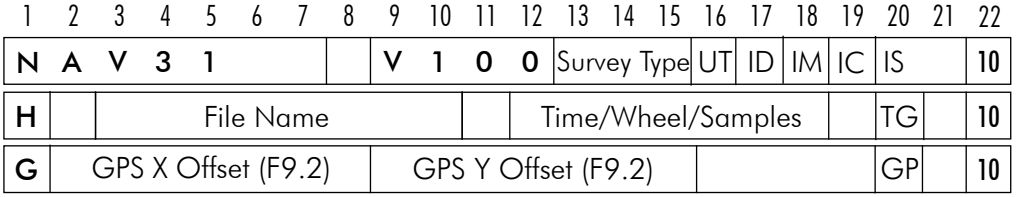
The NAV31 data file records are written in binary format, therefore characters may have a different shape when displayed or printed, depending on particular video or printer settings.

```
NAV31   W105GPS00000
H 031110A    0.200
G   0.00   0.00    01
L0
B      0.00
AS          1.000
Z11032006 10:38:52
*10:38:52.000 273614372
T¤-1680-1682  273615918
@$GPGGA,173835.00,4336.
#59446,N,07936.65011,W,
#2,7,1,139.48,M,-35,M,6
#,119*5E
!           273616076
T¤-1680-1682  273616111
@$GPGSA,A,3,,,,02,,13,1
#0,07,06,05,04,,02.6,01
#.3,02.2*05
!           273616139
T¤-1680-1682  273616279
T¤-1680-1682  273616460
T¤-1680-1681  273616640
T¤-1680-1682  273616821
T¤-1680-1681  273617001
@$GPGGA,173836.00,4336.
#59475,N,07936.64995,W,
#2,7,1,139.57,M,-35,M,5
#,119*52
!           273617075
@$GPGSA,A,3,,,,02,,13,1
#0,07,06,05,04,,02.6,01
#.3,02.2*05
!           273617132
T¤-1680-1681  273617182
T¤-1680-1681  273617362
T¤-1680-1681  273617543
T¤-1680-1681  273617723
T¤-1680-1681  273617904
@$GPGGA,173837.00,4336.
#59532,N,07936.64987,W,
#2,7,1,139.59,M,-35,M,5
#,119*56
!           273618076
T¤-1680-1681  273618113
@$GPGSA,A,3,,,,02,,13,1
#0,07,06,05,04,,02.6,01
#.3,02.2*05
!           273618137
T¤-1680-1682  273618265
T¤-1680-1680  273618445
T¤-1680-1680  273618626
T¤-1680-1681  273618807
T¤-1680-1681  273618987
@$GPGGA,173838.00,4336.
#59588,N,07936.64979,W,
#2,7,1,139.56,M,-35,M,6
#,119*50
!           273619076
.....
```

A.3 Description of NAV31 Data File Format (H31) - DOS

Each record created by Allegro DOS program contains 22 characters including line feed at the end of each record.

Header of the file contains 3 records starting with characters N, H, and G.



NAV31	-	identification of program file
V100	-	version number V1.00, W1.00 indicates Allegro CX
Survey Type	-	GPS (if GPS Input Enabled) or GRD (grid)
UT	-	unit type (0 = meters, 1 = feet)
ID	-	EM31 Dipole Mode (0 = Vertical, 1 = Horizontal, and 2 = Both)
IM	-	EM31 survey mode (0 = Auto, 1 = Wheel, and 2 = Manual)
IC	-	EM31 component (0 = Both, 1 = Inphase, and 2 = Conductivity)
IS	-	EM31 type (0 = Standard, 1 = Short 2 m)
File Name	-	file name, maximum 8 characters
Time/Wheel/Samples	-	this field depends on EM38DD survey mode Auto Mode - Time Increment in seconds Wheel Mode - Wheel Increment (user units, IT) Manual Mode - Samples/Reading
TG	-	File tag (space= original, 1= Saved As or/and edited)
GPS X Offset	-	Offset of GPS antenna in X direction
GPS Y Offset	-	Offset of GPS antenna in Y direction
GP	-	type of GPS NMEA message (0 = GGA/GSA, 1= GGA, 2 = POS, 3 = LLK, 4=LLQ, 5=GLL, 6 = GGK, 7 = Leica TPS)
10	-	Line Feed character

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

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
L	Line Name - 8 characters																				10
B	Start Station (Format F11.2)												Time in milliseconds								10
A	Dir								Increment (Format F11.2)												10
Z	D	D	M	M	Y	Y	Y	Y		H	H	:	M	M	:	S	S	.	h	h	10

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

Timer Reset

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

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

Reading

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I	Gn	Reading 1					Reading 2						Time Stamp in ms (8 digits)								10

I - indicator T or 2
- **T** - First reading at the station (default for Auto mode)
- **2** - second reading at station (possibble 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		*not used*
6	64	Marker	= 1	*trigger pressed*
			= 0	*otherwise*
5	32	Mode	= 1	*Vertical*
				Horizontal
4	16	0		*not used*
3	8	0		*not used*
2	4	Range 3		
1	2	Range 2		
0	1	0		*not used*

Range 3 and Range 2 represent sensitivity (gain) as follows

Both Components (OPER mode)

Sensitivity	Range 2	Range 3	Multiplication Factors	
1000	1	1	Conductivity	-0.25
100	0	1	Conductivity	-0.025
10	1	0	Conductivity	-0.0025

Multiplication factor for Inphase is the same for all ranges: =0.025

Both Components (OPER mode)

Sensitivity	Range 2	Range 3	Multiplication Factors	
1000	1	1	Inphase	-0.0625
100	0	1	Inphase	-0.00625
10	1	0	Inphase	-0.000625

Conductivity is not recorded in COMP mode.

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

Reading 1 - five character field containing instrument output. Conductivity if Both components, Inphase if Inphase was selected includes sign (+ or -) and four digits

Reading 2 - five character field containing instrument output. Inphase if Both components, not used if Inphase was selected includes sign (+ or -) and four digits

Time Stamp - time stamp of the reading in milliseconds, this is time elapsed from the last timer reset. The time in milliseconds can be linked with the computer local time by using Times in line started by ***** (see Timer Reset).

10 - Line Feed character

Comment

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
C	Comment (maximum 11 characters)												Time Stamp in milliseconds								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
S	New Station (Format 11.2)												Time Stamp in milliseconds								10

GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 20 characters strings and placed in the NAV31 data file which contains 22 characters records, including one character indicator and line feed at the end of each record. The GPS sequence starts at the line which contains the character @ as the first character, then records that contain a continuation of the same message start with the character **#**. The GPS sequence ends with a line starting with the character **!**. The last line contains a GPS station number (used only during averaging - GXY file) and a logger time stamp for the given GPS reading. A sample of the GPS message written in NAV31 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
@	$	G	P	G	G	A	,	h	h	m	m	s	s	.	s	s	,	d	d	m	10
#	m	.	m	m	m	m	m	,	s	,	d	d	d	m	m	.	m	m	m	m	10
#	m	,	s	,	n	,	q	q	,	p	p	.	p	,	s	a	a	a	a	a	10
#	.	a	a	,	u	,	±	x	x	x	x	.	x	,	M	,	s	s	s	,	10
#	a	a	a	*	c	c	CR	LF													10
!	0	0	4	3	4								Time Stamp in milliseconds								10

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

A.4 Example of NAV31 Data File - DOS

The NAV31 data file records are written in binary format, therefore characters may have a different shape when displayed or printed, depending on particular video or printer settings.

```
NAV31   V100GPS00000
H 041114A    0.200
G  -0.35   0.00    0
L0
B       0.00 00036462
AE            1.000
Z04112002 14:03:43.56
*14:03:50.97 00000000
@$GPGGA,190317.00,433
#6.59381,N,07936.6501
#8,W,2,6,2,141.46,M,-
#35,M,6,119*53
!00001       00000154
@$GPGSA,A,3,30,,13,10
#,,24,,05,04,,,,02.9,
#01.5,02.4*0C
!00001       00000230
T¤-0932-0121 00000283
T¤-0922-0139 00000488
T¤-0921-0141 00000688
T¤-0912-0131 00000852
T¤-0918-0123 00001118
@$GPGGA,190318.00,433
#6.59412,N,07936.6501
#7,W,2,6,2,141.86,M,-
#35,M,4,119*5A
!00002       00001214
@$GPGSA,A,3,30,,13,10
#,,24,,05,04,,,,02.9,
#01.5,02.4*0C
!00002       00001226
T¤-0936-0142 00001318
T¤-0946-0134 00001518
T¤-0946-0124 00001718
T¤-0933-0128 00001928
T¤-0934-0133 00002128
@$GPGGA,190319.00,433
#6.59434,N,07936.6501
#1,W,2,6,2,141.72,M,-
#35,M,5,119*5F
!00003       00002205
@$GPGSA,A,3,30,,13,10
#,,24,,05,04,,,,02.9,
#01.5,02.4*0C
!00003       00002232
T¤-0932-0141 00002328
T¤-0934-0135 00002529
T¤-0936-0145 00002738
T¤-0932-0141 00002938
T¤-0927-0140 00003138
@$GPGGA,190320.00,433
#6.59441,N,07936.6499
#2,W,2,6,2,141.35,M,-
#35,M,3,119*50
!00004       00003193
@$GPGSA,A,3,30,,13,10
#,,24,,05,04,,,,02.9,
#01.5,02.4*0C
!00004       00003229
```

A.5 Format of GXY Data File

The NAV31 data file with extension GXY contains GPS records. The structure of this file is identical to the standard NAV31 (H31) file. The difference is that it does not contain any EM31 records. This file is created by NAV31 when EM31 is Disabled in the System Setup menu. In this case the program acts as a GPS logging program.

It should be noted that any NAV31 data file, as well as GXY and data files created by other Geomar data acquisition programs (NAV38, NAV61, ML61, ML31, etc.) can be used as an GXY file in the data processing programs TrackMaker31 and TrackMaker for any other supported Geonics instrument (TrackMaker38, 61, etc.). The extension name GXY indicates that the file does not contain electromagnetic data.

File Formats

B

B.1 Description of Geonics DAT31 (G31) File Format

The first row the DAT31 data file contains name of the instrument: EM31 (or GP31 if GPS option, Time Stamp, was enabled during data acquisition), number of version, original name of file, and name of an operator (not used if file is created after editing or it was created by the program EM31pro or EM31alg).

The row started with L specifies beginning of the survey line, it is followed by the line name, and line parameters (three characters e.g. QB1):

1st component (B - both, Q - Quad - phase, I - Inphase),
2nd dipole mode (B - both, V - Vertical, H - Horizontal),
3rd instrument orientations (1) not used by this program,

The next field specifies line direction W, E, N, or S. At the end of this row two parameters indicate mode of data acquisition Y-Auto Mode and it is followed by time increment in seconds, N-Manual Mode is followed by 0).

The following row starts with T and contains date and time of survey line creation.

The rows containing data start with the four character sequence (e.g. SV10), meaning of these characters is as follows:

1st S - reading and station,
R - reading, it appears only when more than one reading was taken at one station,
N - start of new segment of the line,
D - deleted reading.
C - comment, the text of comment follows this field.
2nd V - Vertical Dipole mode,
H - Horizontal Dipole mode.
3rd 1 - Instrument Orientation (fixed, not used if files were created with NAV31),
4th 0 - no fiducial marker,
1 - fiducial marker pressed at this station (only in Auto and Wheel modes).

Above 4 character field is followed by station number [user units], Conductivity in mS/m, and Inphase in ppt of Primary Field, for Vertical or Horizontal dipole modes, and the last column contains the time stamp for each reading. The time stamp has resolution of 0.01 second if data was recorded in Polycorder 600 or computer data acquisition program DAT31, while it is accurate to 0.001 second if file was recorded in Pro4000 or Allegro under control of program EM31pro, EM31alg, and NAV31.

Quad-phase and Inphase values of 8000.000 indicate skipped reading.

Reading containing GPS data starts with character @. This character is followed by nine columns separated by commas.

Column 1 - UTC time in hours, minutes, seconds of the GPS position
Column 2 - Latitude (ddmm.mmmmm) in degrees, minutes, and decimal minutes
Column 3 - N or for North and South latitude
Column 4 - Longitude (dddmm.mmmmm) in degrees, minutes, and decimal minutes
Column 5 - N or for North and South longitude
Column 6 - Quality indicator, 0 = no position, 1 = raw, 2 = differentially corrected position
Column 7 - Number of satellites used in position computation
Column 8 - HDOP index (or PDOP if created with NAV31)
Column 9 - Field computer time

Records with GPS position are available only if data were collected using the EM31pro program in Allegro, in Pro4000, or similar field computer equipped with two serial ports.

The DAT31 data file can be easily edited using any text editor, however care should be taken on preserving proper placement of all parameters.

Example of DAT31 file (no GPS data)

```
GP31W V4.00 AG01       JOHN
L   100      BV1  W A.4                    line 100 starts
T   01/05/2002 21:45:53
SV10         0.000    17.000     1.713 21:46:00.46
SV10         1.000    17.000     1.710 21:46:00.92
SV10         2.000    17.000     1.710 21:46:01.37
SV10         3.000    17.000     1.713 21:46:01.81
SV10         4.000    17.000     1.713 21:46:02.27
SV10         5.000    17.000     1.710 21:46:02.71
```

```
SV10         6.000     17.000      1.713 21:46:03.16
SV10         7.000     17.000      1.710 21:46:03.62
SV10         8.000     17.000      1.710 21:46:04.06
SV10         9.000     17.000      1.710 21:46:04.51
C STAKE 1                                    comment
SV10        10.000     16.800      1.690 21:46:27.89
SV11        11.000     16.800      1.690 21:46:28.34
SV11        12.000     16.775      1.688 21:46:28.79
SV10        13.000     16.800      1.690 21:46:29.24
SV10        14.000     16.800      1.690 21:46:29.69
L   102       BV1  E A.4                  line 102 starts
T   01/05/2002 21:46:39
SV10        20.000     16.600      1.673 21:46:49.73
SV10        19.000     16.625      1.673 21:46:50.18
```

Example of DAT31 file (with GPS data)

```
GP31H V1.00 041114A
L   0         BV1  E A0.2
T   04/11/2002 14:03:43
@,190317.00,4336.59381,N,07936.65018,W,2,6,2,14:03:51.124
SV10      0.000     23.400      0.701 14:03:51.253
SV10      1.000     23.400      0.701 14:03:51.457
SV10      2.000     23.425      0.702 14:03:51.658
SV10      3.000     23.400      0.701 14:03:51.822
SV10      4.000     23.400      0.701 14:03:52.088
@,190318.00,4336.59412,N,07936.65017,W,2,6,2,14:03:52.184
SV10      5.000     23.400      0.701 14:03:52.288
SV10      6.000     23.400      0.701 14:03:52.487
SV10      7.000     23.400      0.701 14:03:52.688
SV10      8.000     23.400      0.701 14:03:52.898
SV10      9.000     23.400      0.701 14:03:53.097
@,190319.00,4336.59434,N,07936.65011,W,2,6,2,14:03:53.175
SV10     10.000     23.400      0.701 14:03:53.298
SV10     11.000     23.400      0.701 14:03:53.499
SV10     12.000     23.400      0.701 14:03:53.707
SV10     13.000     23.400      0.702 14:03:53.908
SV10     14.000     23.400      0.701 14:03:54.108
@,190320.00,4336.59441,N,07936.64992,W,2,6,2,14:03:54.163
SV10     15.000     23.400      0.701 14:03:54.308
SV10     16.000     23.400      0.702 14:03:54.518
SV10     17.000     23.400      0.701 14:03:54.705
SV10     18.000     23.400      0.701 14:03:54.967
@,190321.00,4336.59466,N,07936.64991,W,2,6,2,14:03:55.124
SV10     19.000     23.400      0.701 14:03:55.253
SV10     20.000     23.400      0.701 14:03:55.453
SV10     21.000     23.400      0.701 14:03:55.652
SV10     22.000     23.400      0.701 14:03:55.866
```

B.2 Description of NAV31 File in ASCII Format

The NAV31 data file converted to ASCII format is similar to file in DAT31 however it contains additional information related to GPS and GPS positioning which is not supported by DAT31 format. The format of the file is self explanatory.

The file starts with a header block, which starts with the line starting with **NAV31 File Header** and it ends with line **End of file header**. The file header includes: NAV31 version number, type of positioning, distance units, sensor type, survey mode, name of data file (original name as entered during the survey), GPS NMEA message type, and GPS Antenna location (GPS X Offset and GPS Y Offset).

The file contains at least one survey line (even if survey lines are not used with GPS positioning). Each survey line starts with a Line Header Block. The Line Header Block contains four lines describing: survey line name, start station, station increment, date (MM/DD/YYYY) and time (HH:MM:SS) of line creation.

Lines containing readings start with a reading identifier which contains S or R and the EM31 dipole mode: V (Vertical) or H (Horizontal). The character S corresponds to station, the R indicates the second reading taken at the same station (available in manual mode). Reading identifier is followed by four columns : station number, Conductivity (Quad-phase), Inphase, and local time stamp (format HH:MM:SS.ttt).

Line that starts with C corresponds to field comment, and line that starts with N indicates entry of New Station.

GPS data consists of one or two lines starting with GP and GQ. Line containing GP is always present and it contains position, while line starting with GQ corresponds to quality of GPS reading.

Line that starts with GP contains position, UTC time, and local time. If Geodetic Coordinates were selected the position is indicated by Latitude and Longitude. In case when UTM coordinates were selected the position is described by UTM Zone number, Easting and Northing (see example of the file below). The second line that starts with GQ describes quality of GPS position and it contents depends on the NMEA message used during the survey. In the example of the file GQ statement is given for NMEA message pair GGA/GSA and contains: Position Quality, status of differential corrections, and index PDOP. For other NMEA messages contents of line starting with GQ may differ.

Example of NAV31 file in ASCII format

```
NAV31 File Header  Version V1.00
Positioning: GPS          Distance units: meters
Sensor Type: EM31 Standard  Survey Mode   : Auto
Data File  : 041217A.H31
GPS Message   : GGA/GSA
GPS Antenna Position
      GPS X offset:   -0.35
      GPS Y offset: 0.00
End of file header

Survey Line      : 102
Start Station    : 0.00
Station Increment: 1.000
Date: 04/12/2002  Time: 17:11:45
S Vertical         0.000    39.500     3.960 17:11:48.419
GP   79.610844833,W,   43.609883833,N, 22:11:15.00            17:11:48.470
GQ Position: 3D      Differential   PDOP: 02.3    17:11:48.470
S Vertical         1.000    39.500     3.960 17:11:48.629
S Vertical         2.000    39.500     3.963 17:11:48.828
S Vertical         3.000    39.500     3.963 17:11:49.029
S Vertical         4.000    39.500     3.960 17:11:49.230
S Vertical         5.000    39.500     3.960 17:11:49.395
GP   79.610844333,W,   43.609888333,N, 22:11:16.00            17:11:49.470
GQ Position: 3D      Differential   PDOP: 02.3    17:11:49.470
S Vertical         6.000    39.500     3.960 17:11:49.654
S Vertical         7.000    39.500     3.958 17:11:49.853
S Vertical         8.000    39.500     3.955 17:11:50.054
S Vertical         9.000    39.500     3.958 17:11:50.255
S Vertical        10.000    39.500     3.953 17:11:50.455
GP   79.610844667,W,   43.609892500,N, 22:11:17.00            17:11:50.529
GQ Position: 3D      Differential   PDOP: 02.3    17:11:50.529
S Vertical        11.000    39.500     3.953 17:11:50.654
S Vertical        12.000    39.500     3.955 17:11:50.855
S Vertical        13.000    39.450     3.953 17:11:51.067
S Vertical        14.000    39.450     3.950 17:11:51.268
S Vertical        15.000    39.425     3.950 17:11:51.468
GP   79.610843500,W,   43.609896833,N, 22:11:18.00            17:11:51.523
GQ Position: 3D      Differential   PDOP: 02.3    17:11:51.523
S Vertical        16.000    39.400     3.950 17:11:51.667
S Vertical        17.000    39.400     3.953 17:11:51.838
S Vertical        18.000    39.400     3.950 17:11:52.095
S Vertical        19.000    39.400     3.950 17:11:52.294
GP   79.610842500,W,   43.609902167,N, 22:11:19.00            17:11:52.470
GQ Position: 3D      Differential   PDOP: 02.3    17:11:52.470
S Vertical        20.000    39.400     3.950 17:11:52.599
S Vertical        21.000    39.400     3.950 17:11:52.798
S Vertical        22.000    39.400     3.950 17:11:52.999
S Vertical        23.000    39.400     3.950 17:11:53.199
S Vertical        24.000    39.400     3.948 17:11:53.415
GP   79.610841500,W,   43.609906667,N, 22:11:20.00            17:11:53.508
```

B.3 NAV31 GXY File in ASCII Format

The GXY type of file while converted to ASCII format with extension name DAT consists of coordinates in UTM or Geodetic format. While in UTM format Easting coordinate is located in the first column and Northing in the second column. If Geodetic format was selected then Longitude is written in the first column and Latitude in the second column. Optionally the file may include GPS UTC time and text of field comments.

Example of GXY file in ASCII format (UTM coordinates)

```
          612102.229   4829484.278  01:59:17.00
          612102.255   4829484.352  01:59:18.00
          612102.241   4829484.389  01:59:19.00
          612102.349   4829484.391  01:59:20.00
          612102.268   4829484.408  01:59:21.00
Comment: "Stake#1"
          612102.578   4829484.339  01:59:32.00
          612102.564   4829484.376  01:59:33.00
          612102.578   4829484.339  01:59:34.00
          612102.579   4829484.284  01:59:35.00
          612102.718   4829484.045  01:59:36.00
Comment: "WE corner"
          612102.730   4829484.101  01:59:53.00
          612102.784   4829484.121  01:59:54.00
          612102.853   4829483.992  01:59:55.00
          612102.813   4829483.973  01:59:56.00
```

Example of GXY file in ASCII format (Geodetic coordinates)

```
         -79.610841500    43.609900500  01:59:17.00
         -79.610841167    43.609901167  01:59:18.00
         -79.610841333    43.609901500  01:59:19.00
         -79.610840000    43.609901500  01:59:20.00
         -79.610841000    43.609901667  01:59:21.00
Comment: "Stake#1"
         -79.610837167    43.609901000  01:59:32.00
         -79.610837333    43.609901333  01:59:33.00
         -79.610837167    43.609901000  01:59:34.00
         -79.610837167    43.609900500  01:59:35.00
         -79.610835500    43.609898333  01:59:36.00
Comment: "WE corner"
         -79.610835333    43.609898833  01:59:53.00
```

B.4 Retrieved and Positioned Field Comments

File containing retreived and positioned comments starts with a header indicating name of the original NAV31 data file. This is followed by coordinates and text of comment enclosed in double quotes. Coordinates can be written in UTM or Geodetic format. Column one includes Easting or Longitude, and second column contains Northing or Latitude. The optional, fourth column of the file includes local time.

Example of file containing positioned comments (Geodetic coordinates)

```
Comments in Data File  : 022618A.H31
  -79.610851833    43.609890333  "Stake #10"    18:37:50.934
  -79.610850500    43.609890167  "Stake #2"     18:39:12.182
  -79.610833500    43.609879500  "Stake #3"     18:39:38.834
  -79.610833500    43.609879500  "Stahe #4"     18:39:49.976
  -79.610833500    43.609879500  "Stake #5"     18:39:57.637
  -79.610835167    43.609885833  "Stake#15"     18:57:22.838
```

B.5 Output File (XYZ)

The output XYZ file may be written in two output formats: Generic and Geosoft type of XYZ file. The only difference between these two formats is that Geosoft format contains line labeled Line # at the beginning of each survey line.

Coordinates can be written in UTM or Geodetic format. Column one includes Easting or Longitude, and second column contains Northing or Latitude. The optional column that includes a reading time stamp (local time) is always placed as the last column in the file.

The XYZ file may also contain field comments. All lines containg description text start with character "\" with the exception of label Line# if Geosoft data type is used. If the Include Header Info option was used then each file contains header fully describing XYZ file contents. See the example of the XYZ file given below. This sample file is in UTM coordinates and it contains elevation data.

Example of XYZ File Created by TrackMaker31

```
/ UTM zone = 17, Datum: WGS1984
/ Easting [m], Northing [m], Q/P[mS/m] Ver, I/P[ppt] Ver, Time
    612088.856    4829489.001      43.63       4.37     12:58:02.093
    612088.851    4829489.108      43.60       4.37     12:58:02.294
    612088.847    4829489.215      43.60       4.37     12:58:02.495
    612088.843    4829489.293      43.60       4.37     12:58:02.694
    612088.844    4829489.419      43.60       4.37     12:58:03.016
    612088.863    4829489.531      43.60       4.37     12:58:03.216
    612088.883    4829489.642      43.63       4.37     12:58:03.417
    612088.904    4829489.760      43.60       4.37     12:58:03.627
    612088.878    4829489.747      43.60       4.37     12:58:03.817
    612088.890    4829489.785      43.60       4.37     12:58:04.038
    612088.988    4829489.886      43.60       4.37     12:58:04.292
    612089.066    4829489.966      43.60       4.37     12:58:04.491
    612089.190    4829490.108      43.60       4.37     12:58:04.682
    612089.323    4829490.408      43.60       4.37     12:58:05.021
    612089.330    4829490.504      43.60       4.37     12:58:05.222
    612089.335    4829490.589      43.60       4.37     12:58:05.396
    612089.344    4829490.712      43.60       4.37     12:58:05.652
    612089.351    4829490.848      43.63       4.37     12:58:05.851
    612089.346    4829490.945      43.60       4.37     12:58:06.063
    612089.339    4829491.020      43.63       4.37     12:58:06.262
    612089.333    4829491.097      43.60       4.37     12:58:06.464
    612089.327    4829491.171      43.60       4.37     12:58:06.659
    612089.321    4829491.213      43.60       4.37     12:58:06.879
    612089.326    4829491.359      43.63       4.37     12:58:07.144
    612089.335    4829491.500      43.60       4.37     12:58:07.343
    612089.345    4829491.640      43.60       4.37     12:58:07.544
    612089.352    4829491.759      43.60       4.37     12:58:07.703
    612089.362    4829491.969      43.60       4.37     12:58:08.021
    612089.363    4829492.072      43.60       4.37     12:58:08.226
    612089.364    4829492.172      43.63       4.37     12:58:08.426
    612089.365    4829492.272      43.63       4.37     12:58:08.627
    612089.366    4829492.384      43.63       4.37     12:58:08.826
    612089.362    4829492.541      43.63       4.37     12:58:09.038
    612089.357    4829492.697      43.63       4.37     12:58:09.228
    612089.351    4829492.912      43.60       4.37     12:58:09.489
    612089.345    4829493.080      43.60       4.37     12:58:09.692
    612089.340    4829493.213      43.60       4.37     12:58:09.889
    612089.344    4829493.304      43.60       4.37     12:58:10.088
    612089.354    4829493.400      43.60       4.37     12:58:10.300
    612089.364    4829493.490      43.63       4.37     12:58:10.500
    612089.373    4829493.577      43.63       4.37     12:58:10.701
    612089.394    4829493.752      43.60       4.37     12:58:11.021
    612089.413    4829493.895      43.60       4.37     12:58:11.220
    612089.431    4829494.038      43.60       4.37     12:58:11.421
    612089.449    4829494.181      43.60       4.37     12:58:11.620
    612089.468    4829494.328      43.60       4.37     12:58:11.834
    612089.550    4829494.921      43.60       4.37     12:58:12.885
    612089.554    4829495.048      43.60       4.37     12:58:13.095
```

B.6 Samples of GPS External Files

GPS files created by a GPS data processing software can be written in large variety of ASCII formats. The TrackMaker31 can read any ASCII format of the file as long as delimiters between columns consists of comma or string of spaces, and time is in the format hh:mm:ss. These files are used in Position Readings Using External GPS Files option of TrackMaker31. The user must specify where parameters needed by TrackMaker31 are located (column number). The user must also specify what type of coordinates is used in the GPS file.

Example of GPS File With Geodetic Coordinates

The GPS file presented below contains coordinates in Geodetic format. Longitude is located in column 1, Latitude in column 2, and Time in column 4. Please note, that in this example Comma as well as Space is used as column delimiter which is acceptable for TrackMaker31.

```
-106.259952057,42.861338618,11/15/01 21:37:32.000
-106.259951531,42.861337514,11/15/01 21:37:33.000
-106.259951500,42.861337541,11/15/01 21:37:34.000
-106.259943814,42.861333925,11/15/01 21:37:35.000
-106.259951552,42.861337587,11/15/01 21:37:36.000
-106.259951917,42.861337327,11/15/01 21:37:37.000
-106.259952005,42.861337432,11/15/01 21:37:38.000
-106.259952763,42.861337307,11/15/01 21:37:39.000
-106.259944641,42.861333833,11/15/01 21:37:40.000
-106.259953247,42.861337437,11/15/01 21:37:41.000
-106.259958166,42.861337142,11/15/01 21:37:42.000
-106.259960245,42.861336674,11/15/01 21:37:43.000
-106.259960253,42.861336690,11/15/01 21:37:44.000
-106.259952104,42.861333303,11/15/01 21:37:45.000
-106.259960094,42.861336962,11/15/01 21:37:46.000
-106.259960121,42.861336957,11/15/01 21:37:47.000
-106.259960098,42.861336920,11/15/01 21:37:48.000
-106.259959918,42.861336612,11/15/01 21:37:49.000
-106.259952091,42.861333332,11/15/01 21:37:50.000
-106.259945692,42.861333854,11/15/01 21:41:05.000
-106.259954063,42.861338929,11/15/01 21:41:06.000
-106.259954276,42.861338752,11/15/01 21:41:07.000
-106.259954388,42.861338732,11/15/01 21:41:08.000
-106.259957706,42.861338375,11/15/01 21:41:09.000
-106.259959301,42.861333148,11/15/01 21:41:10.000
-106.259979673,42.861337490,11/15/01 21:41:11.000
```

Example of GPS File With UTM Coordinates

The GPS file presented below contains coordinates in UTM format. Easting in meters is located in column 4, Northing in meters is placed in column 3, and Time is located in column 3.

```
03/28/02,18:36:02,1285840.932,462524.261,0.24,0.34,0.72
03/28/02,18:36:04,1285840.923,462524.266,0.24,0.34,0.72
03/28/02,18:36:06,1285840.922,462524.266,0.24,0.34,0.71
03/28/02,18:36:08,1285840.927,462524.268,0.24,0.34,0.71
03/28/02,18:36:10,1285840.930,462524.285,0.24,0.34,0.72
03/28/02,18:36:12,1285840.944,462524.290,0.24,0.34,0.72
03/28/02,18:36:14,1285840.957,462524.290,0.24,0.34,0.72
03/28/02,18:36:16,1285840.962,462524.298,0.24,0.34,0.72
03/28/02,18:36:18,1285840.960,462524.303,0.24,0.34,0.72
03/28/02,18:36:20,1285840.955,462524.311,0.24,0.34,0.73
03/28/02,18:36:22,1285840.947,462524.301,0.24,0.34,0.73
03/28/02,18:36:24,1285840.945,462524.301,0.24,0.34,0.73
03/28/02,18:36:26,1285840.946,462524.310,0.24,0.34,0.73
03/28/02,18:36:28,1285840.952,462524.313,0.24,0.34,0.73
03/28/02,18:36:30,1285840.958,462524.316,0.24,0.34,0.73
03/28/02,18:36:32,1285840.959,462524.311,0.24,0.34,0.70
03/28/02,18:36:34,1285840.957,462524.289,0.24,0.34,0.70
03/28/02,18:36:36,1285840.954,462524.284,0.24,0.34,0.70
03/28/02,18:36:38,1285840.957,462524.290,0.24,0.34,0.70
03/28/02,18:36:40,1285840.957,462524.296,0.24,0.34,0.70
03/28/02,18:36:42,1285840.966,462524.288,0.24,0.34,0.70
03/28/02,18:36:44,1285840.974,462524.294,0.24,0.34,0.70
03/28/02,18:36:46,1285840.973,462524.286,0.24,0.34,0.70
03/28/02,18:36:48,1285840.975,462524.282,0.24,0.34,0.70
03/28/02,18:36:50,1285840.974,462524.296,0.24,0.34,0.70
03/28/02,18:36:52,1285840.977,462524.298,0.24,0.34,0.70
03/28/02,18:36:54,1285840.971,462524.291,0.24,0.34,0.71
03/28/02,18:36:56,1285840.976,462524.291,0.24,0.34,0.71
03/28/02,18:36:58,1285840.973,462524.289,0.24,0.34,0.71
03/28/02,18:37:00,1285840.974,462524.300,0.24,0.34,0.71
03/28/02,18:37:02,1285840.983,462524.311,0.24,0.34,0.71
03/28/02,18:37:04,1285840.980,462524.319,0.24,0.34,0.71
03/28/02,18:37:06,1285840.979,462524.297,0.24,0.34,0.71
03/28/02,18:37:08,1285840.978,462524.296,0.24,0.34,0.71
03/28/02,18:37:10,1285840.982,462524.279,0.24,0.34,0.71
03/28/02,18:37:12,1285840.985,462524.281,0.24,0.34,0.71
03/28/02,18:37:14,1285840.984,462524.289,0.24,0.34,0.71
03/28/02,18:37:16,1285840.984,462524.282,0.24,0.34,0.71
```

File Transfer Using Lynx

C

The information included in this chapter pertains only to data acquisition programs running in DOS environment, Allegro CE/DOS, Allegro DOS, and Pro4000 field computers.

Programs FileScout (ProShell) and Lynx

Two programs, ProLink and Lynx, are supplied with the Allegro and Pro4000 system and can be used to transfer files between the Allegro (or Pro4000) and a desktop Windows based computer.

The program ProLink is factory installed in the Allegro DOS and Pro4000 ROM (drive A:). When FileScoutt (type FS to run FileScoutt in Allegro or type PS to run ProShell in Pro4000) ProLink is automatically initiated.

Lynx runs on computers equipped with Windows 95 or higher. To install Lynx, insert the Pro4000 Setup disk (Utility disk #1) into drive A: on your computer and run the Setup program. The Lynx icon will appear on your desktop after installation is complete. When Lynx is started two Windows Explorer type screens will be displayed. The top screen, labeled Local, displays the contents of the PC. The bottom screen, labeled Remote, displays the contents of the Pro4000 assuming a connection is established. Several file management functions can be performed using Lynx, including File Transfer, renaming folders, creating new folders or sub-folders, and deleting files.

Establishing Communication

To transfer data to and from a base computer, attach the cable (null modem serial communication cable) between the Pro4000 and the computer COM ports. Run FileScoutt on Allegro or ProShell on the Pro4000 (type command FS or PS) and Lynx on the PC computer.

Correct communication ports must be selected on both computers. To set up the serial port on the PC, from Lynx select the **Transfer/Select COM Port** menu option. To set up the communication port on the Allegro or Pro4000, press <F5>(Xfer) from main screen of ProShell, and then press <F1> to toggle between ports COM1 and COM2.

Juniper Systems recommends that the Allegro or Pro4000 is in auto baud rate detection mode (the default setting). In this mode, the field computer tries to establish communication at 115K baud, and in case communication fails at this rate, it automatically steps down to the next slowest rate until communication is established.

To start communication click on the **Connect** button (the green circulating arrows in the centre tool bar) or select the Transfer/Connect to Remote menu option from Lynx. When connection is established the contents of the Pro4000 Field Computer will be displayed in the Lynx bottom Remote view screen.

Transferring Files to the Allegro from the PC

Select the folder in the Remote view screen. Transferred files will be saved in this folder.

In the Local view screen select files to be transferred to the Allegro (or Pro4000).

Click the Down arrow button or select Transfer/Send to Remote from the main menu. File transfer starts immediately. In cases where the selected file exists in the logger the program will prompt for permission to overwrite.

Transferring Files from the Allegro to the PC

Select the folder in the Local view screen. Transferred files will be saved in this folder.

In the Remote view screen select files to be transferred to the PC.

Click the Up arrow button or select Transfer/Receive from Remote from the main menu. File transfer starts immediately. If selected files exist in the selected folder in the PC the program will prompt for permission to overwrite.

Disconnecting

When the transferring session is finished click the Disconnect button before disconnecting the serial cable. Otherwise, the Esc key must be pressed on the logger to return the Allegro (or Pro4000) to normal function.

Please refer to Allegro and Pro4000 Field Computer User's Manuals for more detailed description of FileScoutt (and ProShell) and Lynx functions.

Selected NMEA Messages

D

GGA Data Message

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

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

Definition of GGA message component:

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

GSA Data Message

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

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

Definition of GSA message components:

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

POS Data Message

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

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

Definition of POS message components:

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

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

LLK Data Message

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

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

Definition of LLK message components:

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

LLQ Data Message

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

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

Definition of LLK message components:

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

GLL Data Message

The GLL message takes the following form:

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

Definition of GLL message component:

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

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

GGK Data Message

The GGK message contains the GPS position, Time, Date, Position Type, and DOP information. The GGK is not a standard NMEA data message and it is used in several Trimble GPS receivers. This message takes the following form:

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

Definition of GGK message component:

hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
ddmmyy	Date
ddmm.mmmmmmmm	Latitude in degrees, minutes, and decimal minutes
s	s=N or s=S, for North and South latitude
dddmm.mmmmmmm	Longitude in degrees, minutes, and decimal minutes
s	s=E or s=W, for East and West longitude
n	GPS Quality indicator, 0 = fix not valid or not available, 1 = Autonomous GPS fix, no differentially corrected position, 2 = differential, floating carrier phase integer based solution (FLOAT), 3 = differential, fixed carrier phase integer-based solution (FIXED), 4 = differential, code phase only solution (DGPS)
qq	Number of satellites used in fix
p.p	DOP of fix
EHT-aa.aaa	Ellipsoidal height of fix
M	unit of measure for ellipsoidal height in meters
***cc**	Checksum
<CR><LF>	Carriage return and Line feed