TrackMaker 601

Version 2.00

User's Manual

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Introduction 1

The Geomar TrackMaker601 Data Logging System consists of a data logging program Nav601 and associated PC computer program TrackMaker601. TrackMaker601 is used to process data files recorded under the control of program NAV601.

The program supports current Windows 10 based data acquisition program Nav601 for tablets and field laptop computers, as well as versions Nav601wm and Nav601wg for Windows Mobile based devices. The TrackMaker601 program is backward compatible, it can process and recognizes data file formats created with various versions of NAV601 automatically. However, TrackMaker601 V2.00 or later must be used to process data files collected with Nav601 for Windows 10 based devices.

1.1 About the TrackMaker601

The program TrackMaker601 is a Windows based program for IBM PC compatible computers operating under Windows 10/7/XP/2000 or later. The program TrackMaker601 is designed to process data collected by a field computer under the control of programs NAV601. The program can be used to position Grad601 sensor based on real time GPS data and with grid based data (surveys positioned without GPS receiver). The program allows you also to convert to ASCII text file format, to position field comments, generate position file for stand-alone GPS positions (GXY), and to correct created XYZ files for a delay (latency) caused by the system time constant.

Main function of this program is to position Bartington Grad601 records 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 number of sensors and separation between them (two sensors only) and by offsets of the GPS antenna from the center of the Grad601 system. The program calculates real position of the instrument based on specified GPS antenna offset and direction of the movement. However, it is highly recommended that GPS antenna is placed as close as possible to the center of the Grad601 system as this configuration provides the best accuracy. 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 NAV601: a pair GGA/GSA, GGA, POS, LLK, LLQ, GLL, and GGK (Trimble and Leica versions). In addition program handles interface of pseudo-GGA (Robotics Total Station manufactured by Leica, Trimble, and several other brands) and psudo-GLL available in some marine positioning systems.

The TrackMaker601 uses data files in NAV601 format which have extension name 601. These are binary files with a record length of 27 bytes terminated by Line Feed character. These files can be viewed in standard text editor however care should be taken to avoid accidental Save or Save As that can corrupt binary files. The program can also process files with extension GXY. The GXY file contains stand-alone GPS positions if the NAV601 program was used to collect GPS data only. These files are also binary (records are 27 bytes for Windows CE based program 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, NAV61, NAV31, etc. are fully compatible and they can be processed by TrackMaker601.

One sample NAV601 data file, 052012A.601 is included on the program disk. It allows the user to become familiar with running the TrackMaker601 program.

1.2 Contents of TrackMaker601 Distribution Disk

The TrackMaker601 software is supplied on one CD disk. Disk contains following files and directories:

SetupT601.exe	-	setup program for TrackMaker601
SetupNav601	-	installation for Windows 10 based data acquisition program Nav601 (alternatively it is replaced by Nav601 or Nav601wg programs for Windows Mobile)
Documentation	-	directory containing all NAV601 and TrackMaker601, and other available Geomar manuals in PDF format.
DemoPrograms	-	available demo versions for other Geomar programs.

The Software can be supplied on a CD disk or USB memory stick, or by download from provided link to Geomar server. When electronic download is used files are often named showing their version number, for example SetupT601.exe can be posted as SetupT61MK2_V201.exe to indicate that the setup program contains program TrackMaker61MK2 version 2.01.

1.3 TrackMaker601 Software Installation

TrackMaker601 software uses a setup program to load files necessary for data processing onto your computer. The following section describes the installation process. To install TrackMaker601: Insert the TrackMaker601 CD disk or USB drive into CD drive or to USB slot. Alternatively use the SetupT601 file in Windows Explorer if the software was downloaded. Exit all Windows applications before installing the program. From the Windows File Manager, select **Run** from the **Windows System** menu (or simply press key Windows + R). The Run dialog box opens (Figure 1.1).

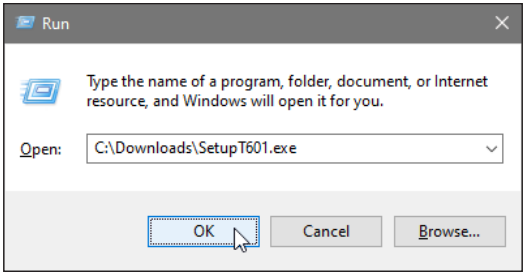


Figure 1.1: Run Dialog window

Browse for the file SetupT601.exe in the CD or USB diskdirectory of the diskette. Click **OK** to launch the Setup program. Once the Setup determines your computer configuration the Welcome window opens (Figure 1.2).

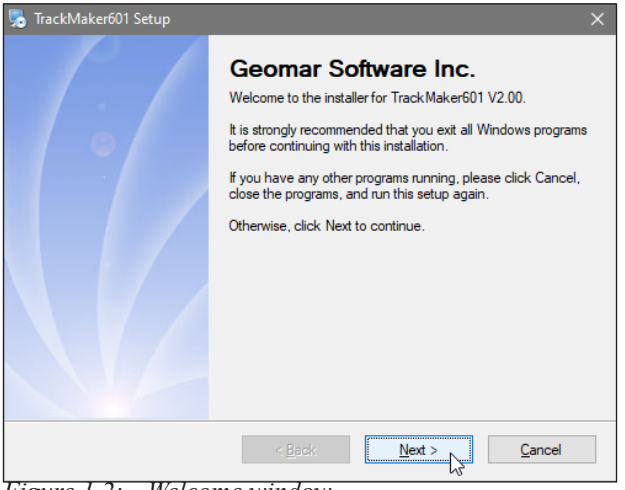


Figure 1.2: Welcome window

Read the text and click on the **Next** button. The License Agreement window will be displayed (Figure 1.3).

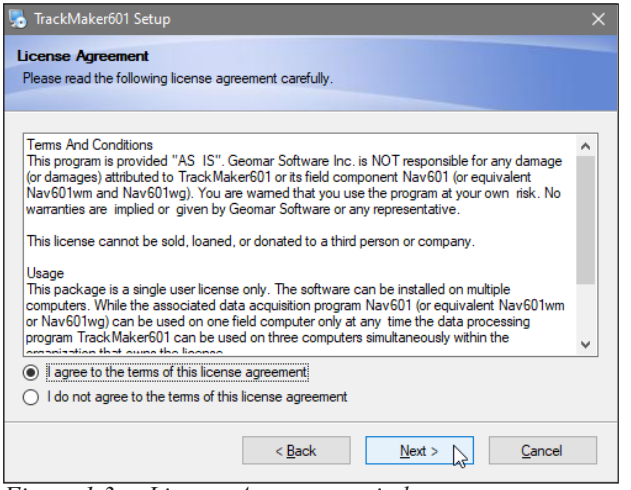


Figure 1.3: License Agreement window

Read the text and click the **Next** button. The Serial Number window will be displayed (Figure 1.4).

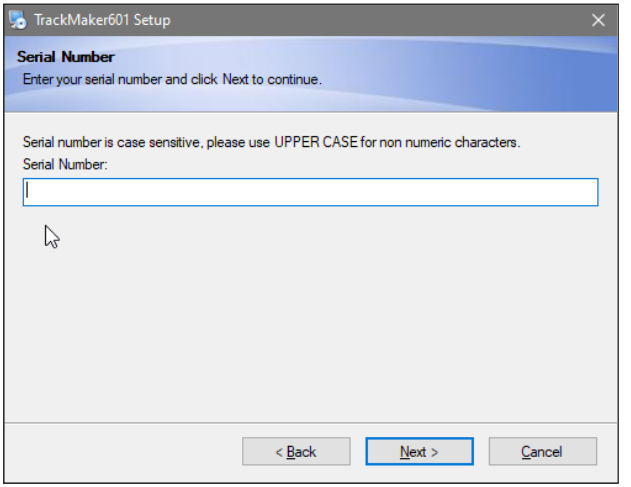


Figure 1.4: Installation Directory window

Type the Serial Number (it is provided on the CD disk or USB drive, in case of download it will be provided) into the provided box and press the **Next** button. (If you do not know the Serial Number, you will not be able to continue.) This entry is case sensitive, please use Upper Case for characters. The Installation Directory window opens (Figure 1.5).

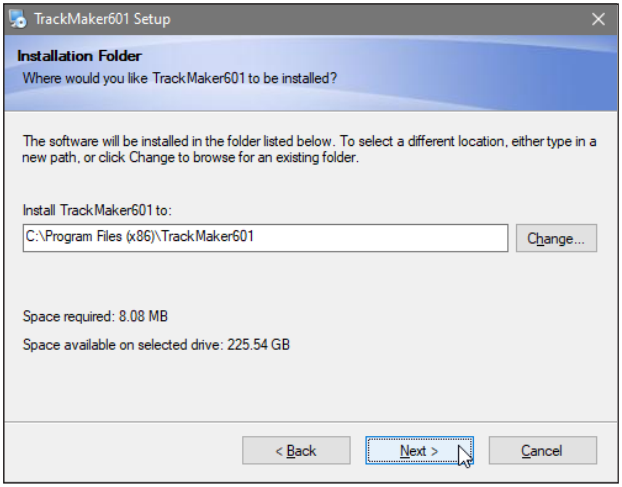


Figure 1.5: Select Installation Directory window

A default directory is C:\Program Files\TrackMaker601. Click the **Next** button to install the program to this directory. If you wish to install the program to another directory, click the **Change** button and the Select Installation Directory window will open. Click the **Next** button. The Select Short cut Folder window opens (Figure 1.6).

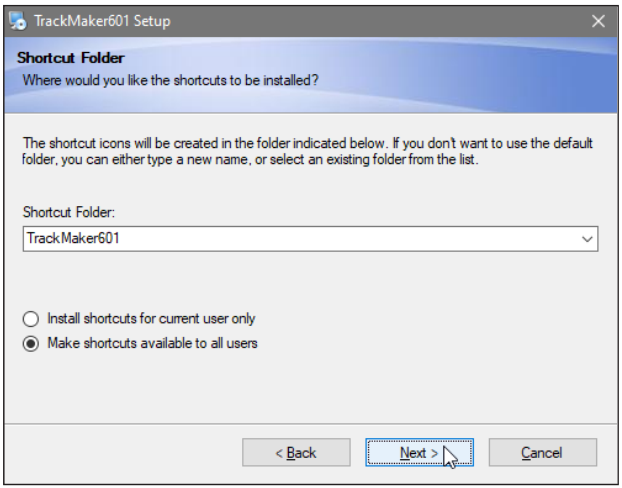


Figure 1.6: Select Shortcut Folder window

The setup program will create a TrackMaker601 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).

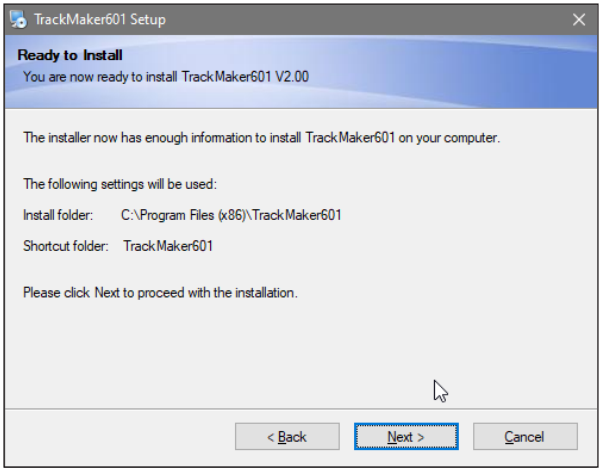


Figure 1.7: Ready to Install window

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. The Installing Files window with a progress bar displays the percentage of the installation completed. When finished, the following window will appear (Figure 1.8).

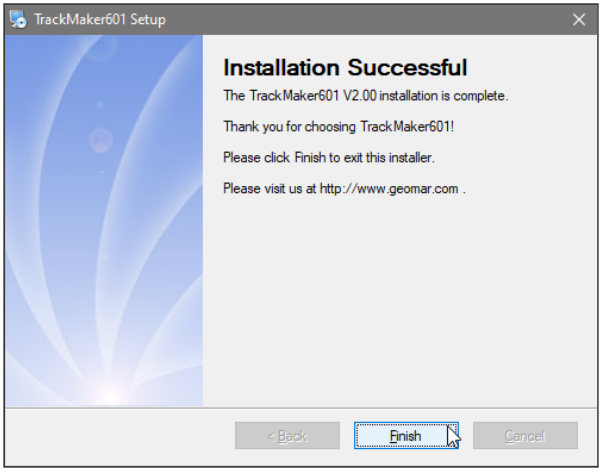


Figure 1.8: Installing Files

Click **Finish** to end installation. SetupT601 creates a TrackMaker601 program group and places **TrackMaker601** and **Uninstall** icons into it. The setup program creates also a **TrackMaker601** menu item in the Program menu accessible by clicking **Start**. Installation procedure creates also shortcut **TrackMaker601** icon on the Windows desktop. The chosen destination directory contains program files and sample data files.

1.4 Program Overview

Start the TrackMaker601 by double clicking the TrackMaker601 icon in the **Start**|**Programs** menu, in Windows Explorer, or on the desktop if a shortcut was created. At the start, TrackMaker601 displays the following screen (Figure 1.9):

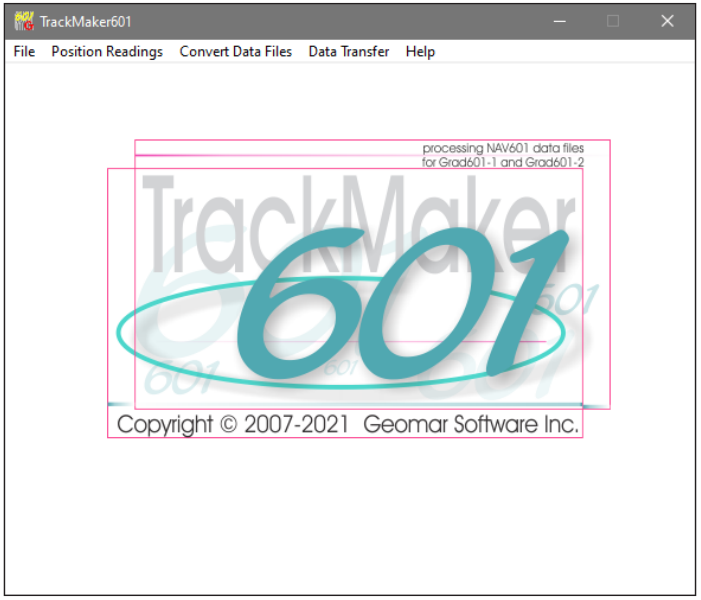


Figure 1.9: TrackMaker601 Main Screen

The TrackMaker601 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 1.10. 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.

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 1.11. At the same time remaining items in the File menu are enabled.

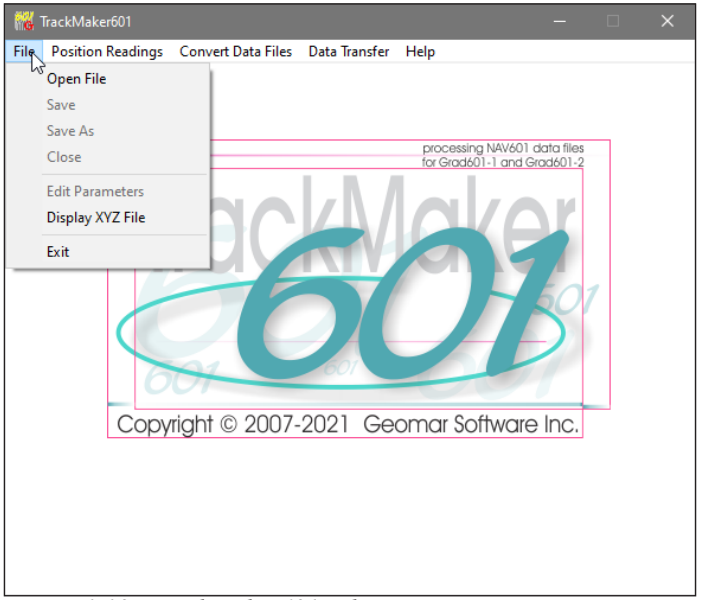


Figure 1.10: TrackMaker601 File menu

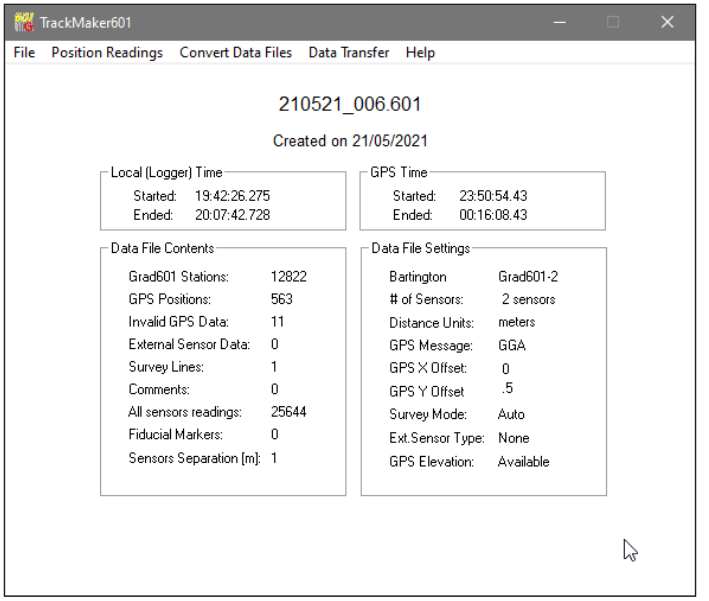


Figure 1.11: TrackMaker601 Main Screen after Loading data file

TrackMaker601 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 original date of creation and original file name, for example: "Created on 06/02/2009 as 0602A.601".

The information displayed by the TrackMaker601 contains Local and UTC time, number and type of Grad601 data points and GPS positions, number of survey lines, specified distance units and GPS antenna offsets, etc. (see Figure 1.11). Four parameters: Number of Grad601 sensors, Distance Units, GPS X and Y offsets can be adjusted using the Edit Parameters item (see Figure 1.12).

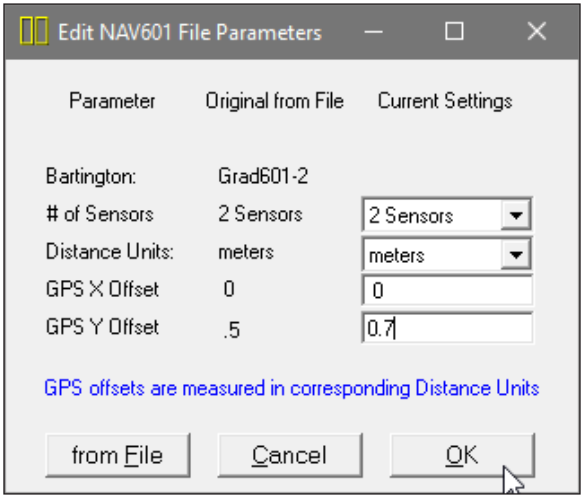


Figure 1.12: Edit Nav601 Parameters window

Position Readings Menu

The Position Readings menu represents the main function of the program: positioning of the Grad601 sensor based on the system geometry and GPS positioning (Figure 1.13).

The first item of the menu, **Position Readings Using NAV601 Data File** allows you to position sensors based on Real Time GPS data embedded in NAV601 file. Using GPS data the program can also place elevation data in the output file.

The second item, Position Readings Using Grid Based Data File is used in case GPS receiver positioning was not available and survey was positioned using layout grid (based on stations and line numbers).

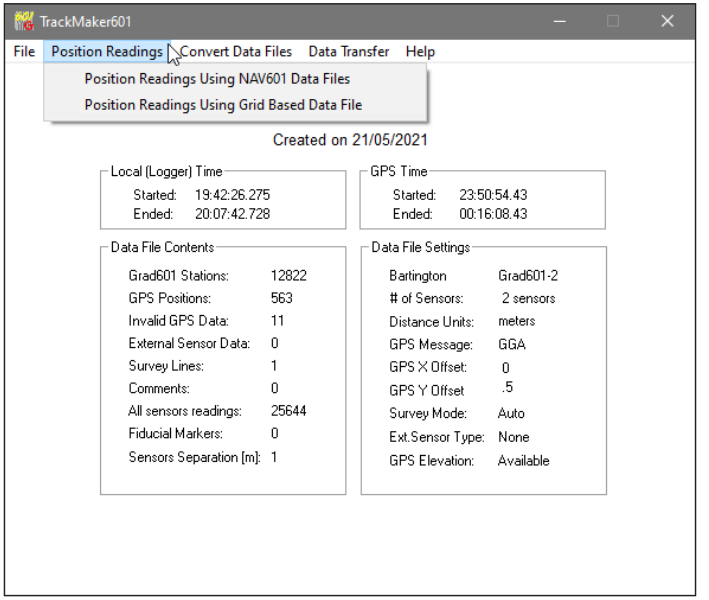


Figure 1.13: TrackMaker601 Position Sensors menu

Convert Data Files Menu

The Convert Data menu has four functions available. The menu is shown in Figure 1.14.

The first item, NAV601 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.

The second 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.

In case when the NAV601 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 NAV601 data file to a text file containing coordinates and elevation of GPS positions.

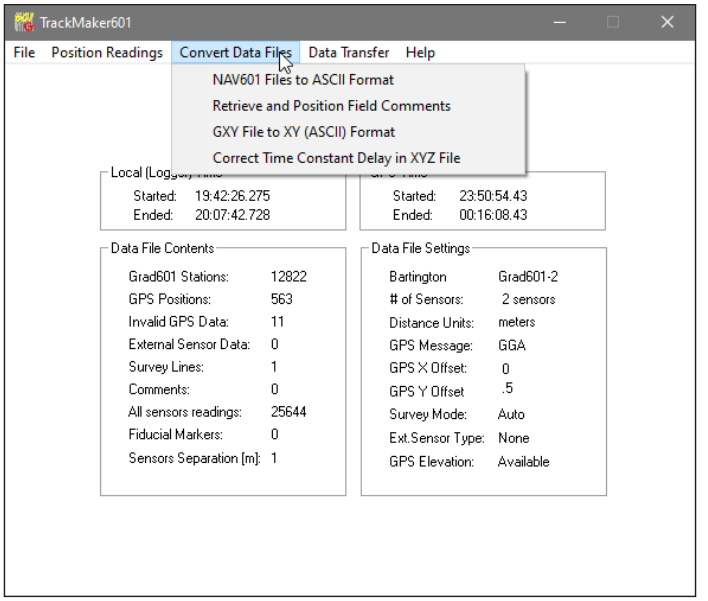


Figure 1.14: TrackMaker601 Convert Data menu

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 Grad601 and GPS receiver) time constant delay in two dimensional XYZ files generated during positioning Grad601 data.

Data Transfer Menu

This menu applies to older legacy Nav601 programs for DOS based handheld units, Windows CE, and Windows Mobile field computers. All data files collected with Windows 7 or Windows 10 computer can be copied and pasted using standard Windows procedures, and move files between computers using USB drives or network connection. The menu has one item only and it is shown in Figure 1.15.

Transfer of files from Allegro CX (Windows CE.NET based field computer) or Windows Mobile is handled by the MS ActiveSync program . Therefore the second item of this menu displays information only (Figure 1.16).

Optionally, data files and program files can be transferred between Allegro CX and other Windows Mobile computers by using PC or SD memory card. A PCMCIA card slot is located behind the Allegro CX display (please see Allegro manual). Memory card becomes a Storage Card in Allegro CX. Memory card is the fastest and easiest way

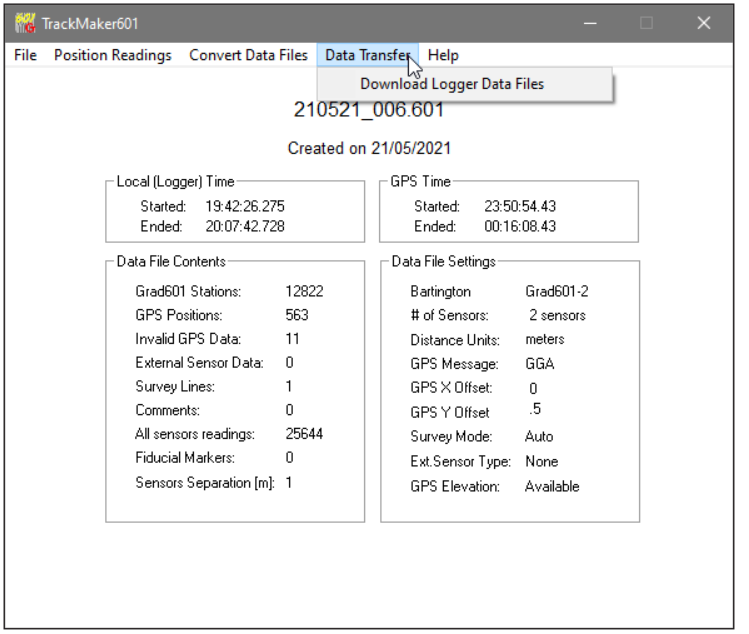


Figure 1.15: TrackMaker601 Data Transfer menu

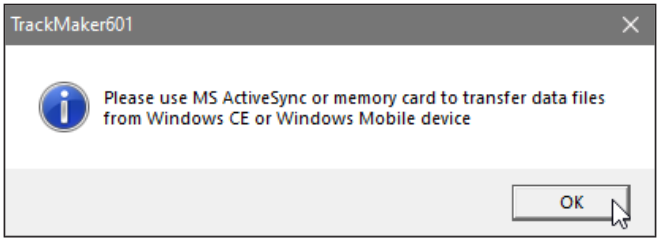


Figure 1.16: Windows CE and Windows Mobile data files transfer info

of performing data transfer between Allegro CX (Windows CE) and Windows Mobile devices and PC computer. In addition to data transfer, memory card can serve as a data back up device during the survey.

Help Menu

Item "About" is the only available option in this menu (Figure 1.17). It displays name and version of the program, as shown in Figure 1.18. Help function is not available in this version of the TrackMaker601.

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

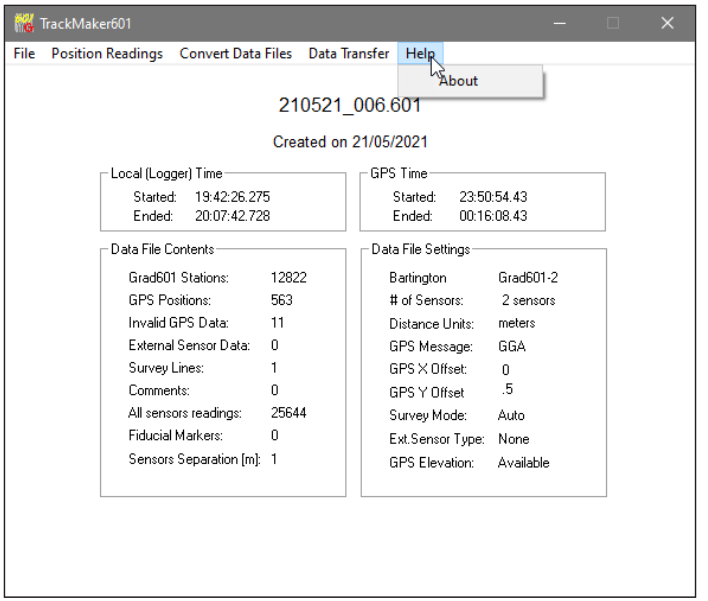


Figure 1.17: TrackMaker601 Help menu

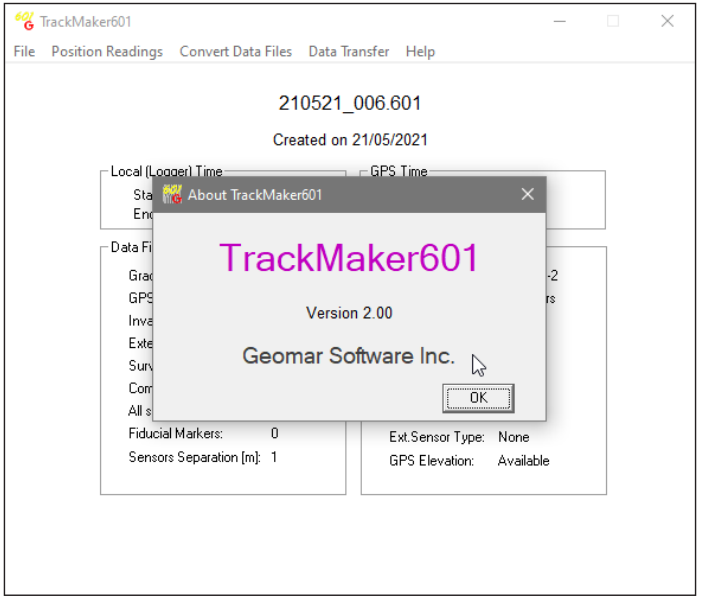


Figure 1.18: About TrackMaker601 window

File Menu 2

File menu of TrackMaker601 program is shown in Figure 2.1. There are several items associated with the File menu:

- Open File (loads NAV601 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 any XYZ file),
- Exit (terminates TrackMaker601 program).

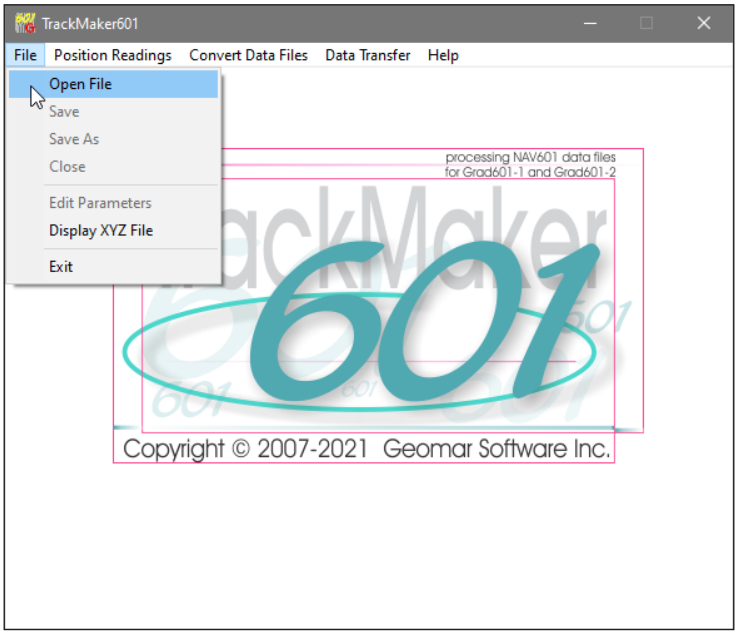


Figure 2.1: TrackMaker601 File menu

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 TrackMaker601 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.

2.1 Open File

The Open File option allows you to load NAV601 data file to the program memory. Select **File|Open File** from the main program menu, as shown in Figure 2.1. After the selected menu item is clicked the Select NAV601 Input File window will be displayed in the centre of the screen, Figure 2.2.

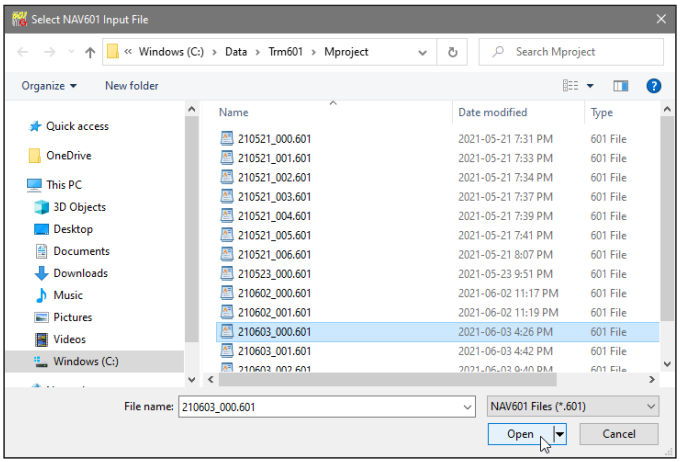


Figure 2.2: Select NAV601 Input File window

The window lists files with extension name 601. Select a file name and click the **Open** button. The Select NAV601 File window will close and the progress bar will appear in the center of program's main window indicating percentage of loaded file (Figure 2.3).

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 TrackMaker601 main window displays the most important parameters of the entered data file (Figure 2.4). 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 Grad601 readings, number of GPS positions recorded, number of invalid GPS positions (with not valid checksum), number of survey lines, comments, and number of used fiducial markers in the field are given. In the right frame labeled **Data File Settings** listed are: the Grad601 Type - number of sensors, type of used GPS NMEA message, GPS X and Y offsets (in Distance Units), and survey mode.

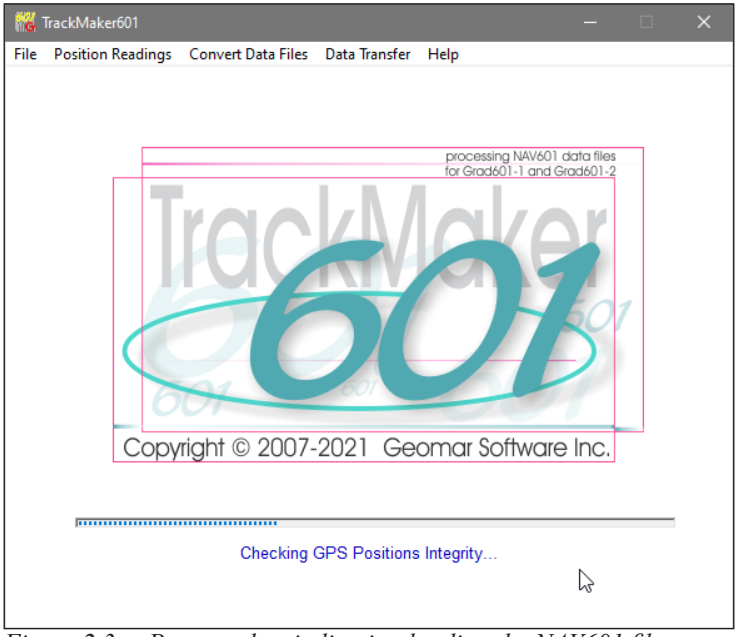


Figure 2.3: Progress bar indicating loading the NAV601 file

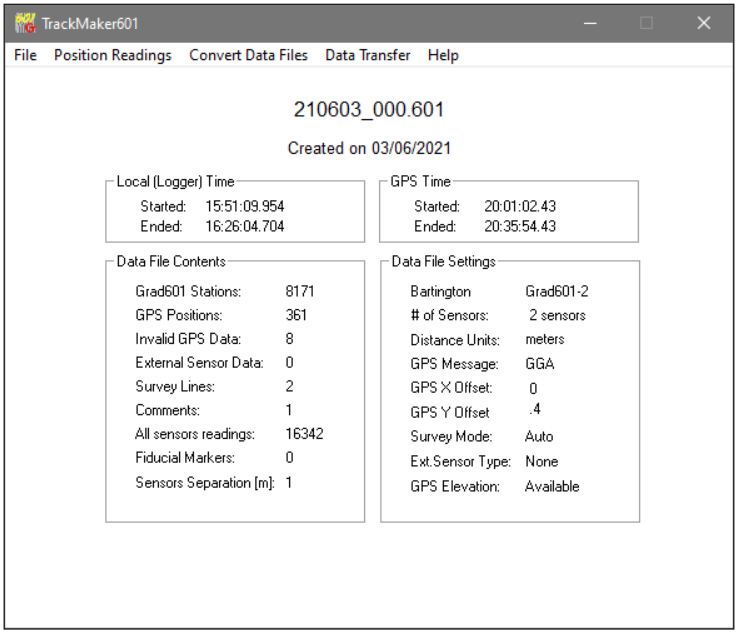


Figure 2.4: TrackMaker601 Main Screen after data file is loaded

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 02/03/2008 as 020310A", (see Figure 2.5).

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

2.2 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 03/06/2021 as 210603_000" provides information that the original file name was 210603_000.601 (Figure 2.5). Otherwise this label would provide only date of the created file (see Figure 2.6).

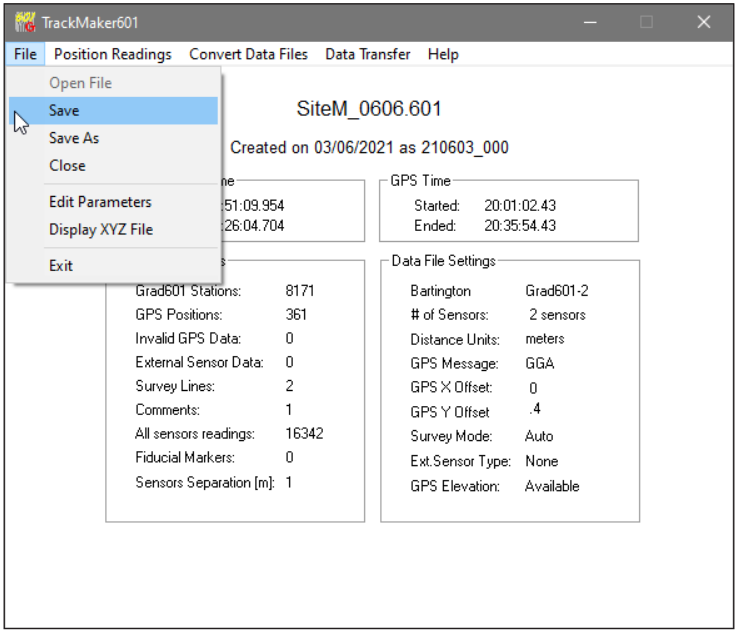


Figure 2.5: TrackMaker601 Main Screen with item Save enabled after not original file was loaded

The File menu item labeled **Save As** allows you to save any data set. Select **File|Save As** from the program main menu (see Figure 2.6). After the selected menu item is clicked,

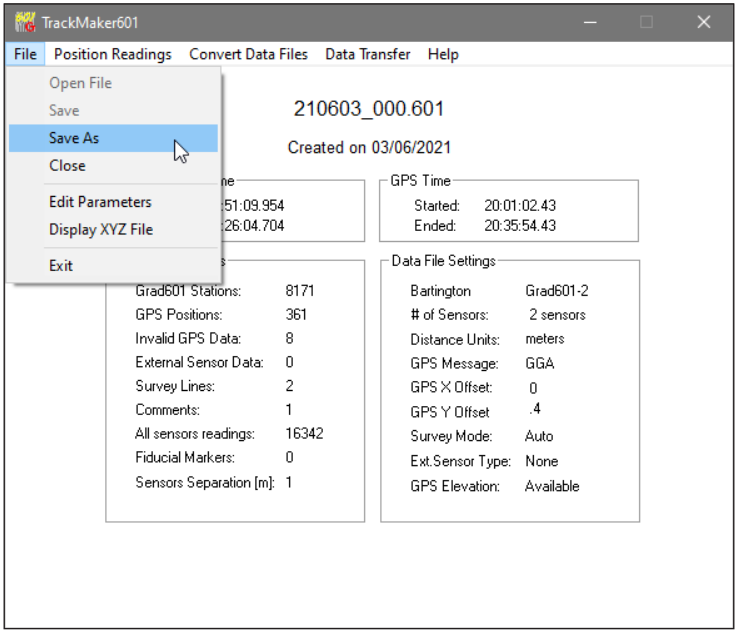


Figure 2.6: TrackMaker601 Screen with loaded original data file, disabled Save option, and selected Save As item

the Save As NAV601 Input File window will be displayed in the centre of the screen, Figure 2.7.

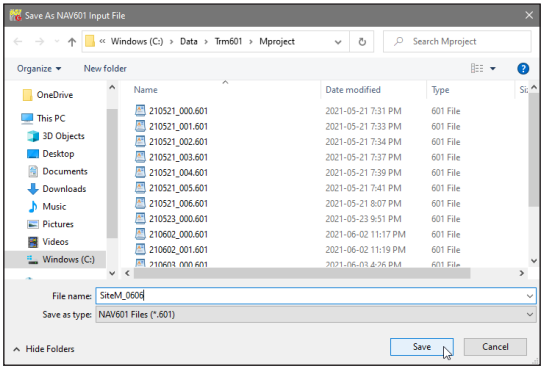


Figure 2.7: Save As NAV601 Input File dialog

This option is especially useful in faster file loading. Windows system creates files that are not always organized according to time stamp sequence, also GPS records can be inter-spaced by Grad601 readings. 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 TrackMaker601 recognizes sorted files automatically.

After the file is saved with Saved As option the Main Screen of TrackMaker601 will be updated, and file name will placed at the top of the screen and the item **Save** in the File menu will be enabled, Figure 2.8 (compare with Figure 2.6).

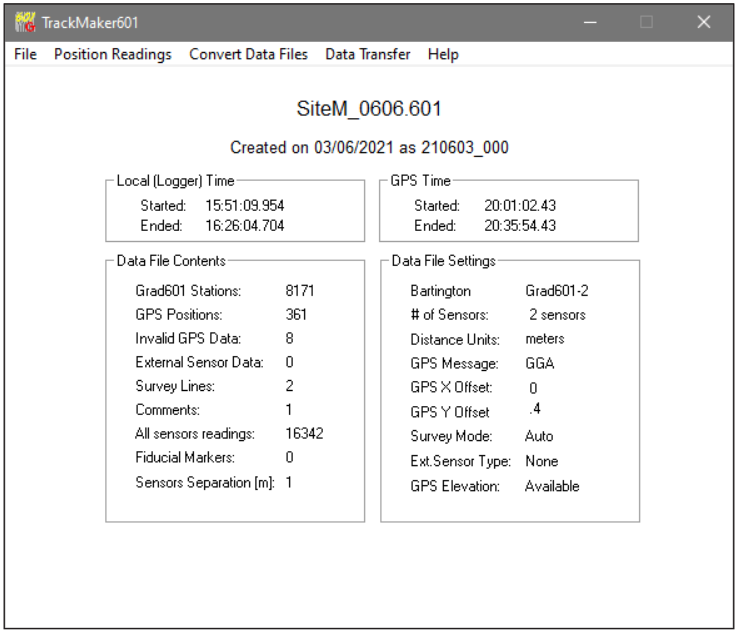


Figure 2.8: TrackMaker601 Main Screen after completed Save As option

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 NAV601 data file.

2.3 Edit Parameters

Four 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 NAV601 File Parameters window will appear (Figure 2.9). The Edit Parameters window is also available in Position Readings options.

The window displays parameters that the user can edit. These are: Grad601 Type (number of sensors), 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

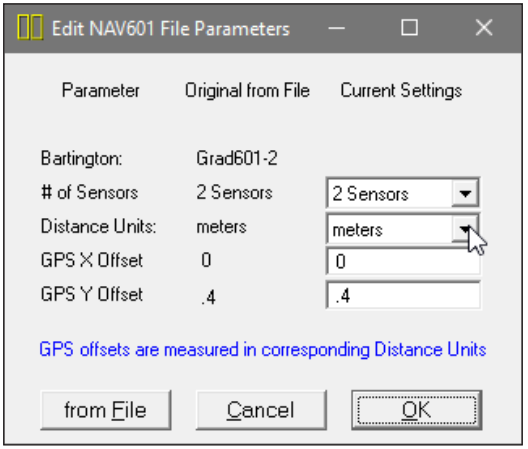


Figure 2.9: Edit NAV601 File Parameters window

Units can be selected from combo list boxes, while GPS X and GPS Y offsets must be entered in appropriate text boxes. Example of NAV601 File Info window with modified parameters is shown in Figure 2.10.

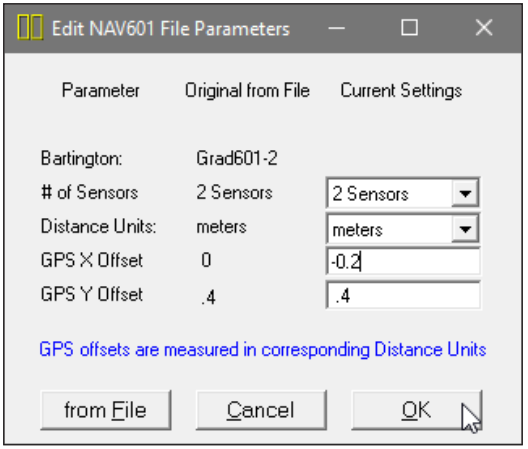


Figure 2.10: Modified parameters in Edit Parameters window

Clicking on the **OK** button will accept any changes, 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 NAV601 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.

2.4 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 2.1. 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 2.11).

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.

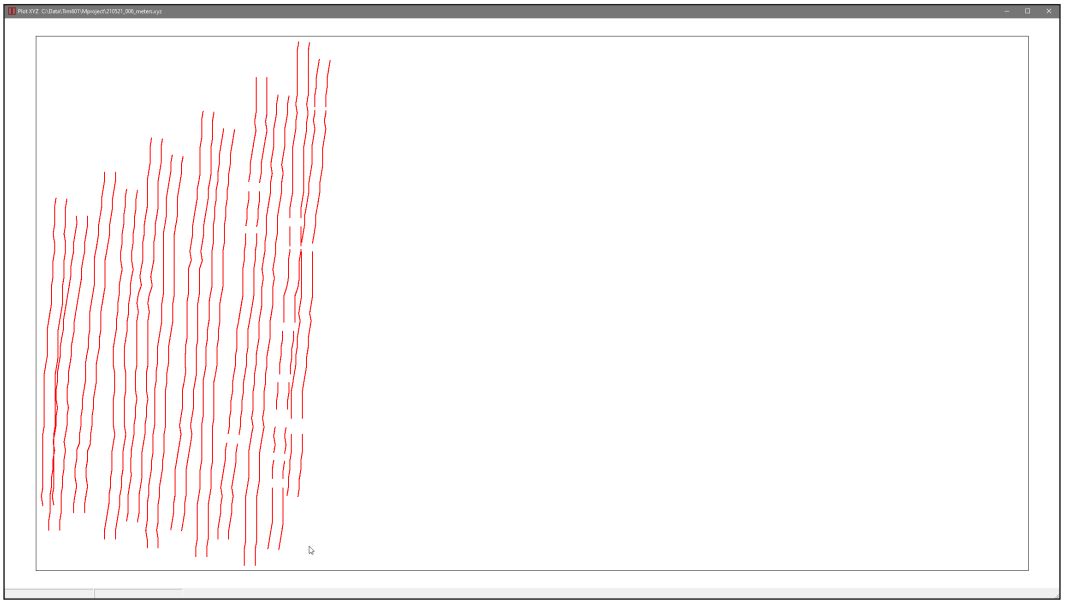


Figure 2.11: Two dimensional layout of stations in XYZ File

Position Readings 3

Positioning of the Bartington Grad601 sensors is the main function of the TrackMaker601. Location of the magnetic 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. Grid based positioning is described in a separate document: GridPositioningNotes.pdf

Description of functions involved in positioning the Grad601 is preceded by a short description of the system geometry.

3.1 The NAV601 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.

If one sensor is used (Grad601-1) the natural center of the system is the center of the sensor (Figure3.1), and the best and optimal placement of the GPS antenna is located above the center of the Grad601 sensor. In case of Grad601-2, when two sensors are employed, the center of the system is located between two sensors, Figures 3.2 and 3.3. The optimal placement of GPS antenna is in the central position between two magnetic sensors.

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 Grad601 sensor 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 Grad601 system (reference point 0,0) to the center of the GPS antenna, while facing direction of the movement, see Figures 3.1, 3.2, and 3.3.

When two sensors are used there is a difference in description of sensors positions. In the Nav601 for Windows Mobile sensors locations are specified by offsets from reference point 0,0 (Figure 3.2), while in the Nav601 for Windows 10 a parameter Separation indicates distance between sensor and reference point 0,0 is located in the center between sensors (Figure 3.3).

Therefore, when two sensors are used in the Windows Mobile data acquisition program Nav601, there are two additional parameters, offsets for each sensor. Sensor #1 is located to the left, and Sensor #2 is located to the right while facing direction of movement.

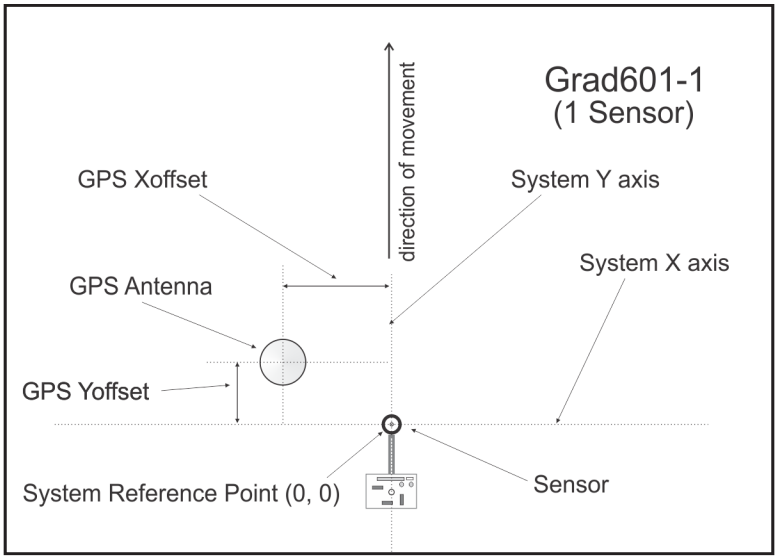


Figure 3.1: The Grad601 and GPS antenna geometry for one sensor setup.

Offsets for sensor 1 and 2 can be specified while creating XYZ file, they are measured from the center of the system as offsets for GPS antenna (Figure 3.2). If the Nav601 for Windows 10 is used to collect data then Separation describes distance between sensors and reference point 0,0 is assumed to be in the center between two sensors (Figure 3.3).

The procedure of specifying GPS antenna 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 situations where the operator carries the Grad601, and GPS antenna (placed in backpack) is located above his shoulder. In this case distance between GPS antenna and the instrument (GPS X Offset) is relatively small (less than 0.5 m), and GPS Y Offset will be usually very small as well and its sign will depend on whether the center of the instrument is in front (negative) or behind the GPS antenna (positive). This situation corresponds to the system geometry presented in Figure 3.1.

As it was mentioned earlier, the best placement of the GPS antenna is located above the center of the Grad601 sensor. 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.

Figure 3.1: Th

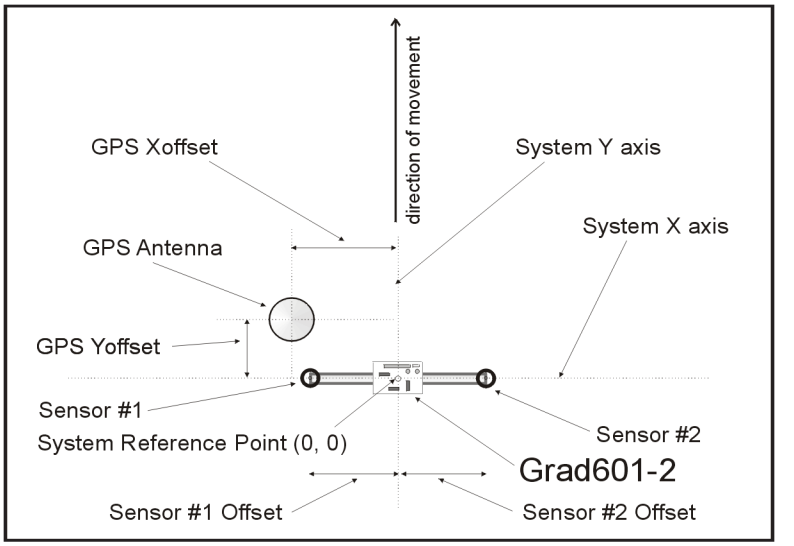


Figure 3.2: The Grad601 and GPS antenna geometry for two sensors setup used in the Nav601 for Windows Mobile

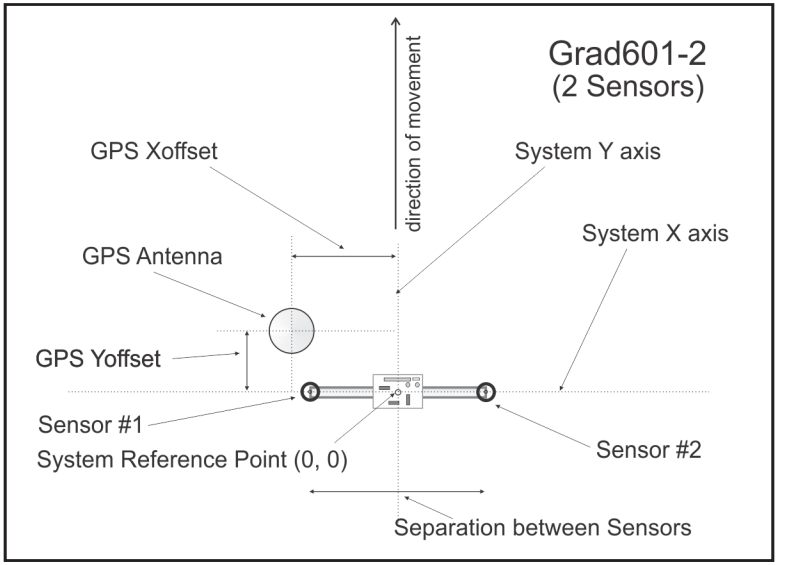


Figure 3.3: The Grad601 and GPS antenna geometry for two sensors setup used in the Nav601 for Windows 10

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 TrackMaker601.

e Grad601 and GPS antenna geometry

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.

3.2 Positioning Readings Using NAV601 Data File

After a data file is loaded the TrackMaker601 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 Grad601 readings, number of GPS positions recorded, number of invalid GPS positions (with not valid checksum), number of survey lines, comments, number of readings, and number of used fiducial markers in the field are given. In the right frame labeled **Data File Settings** listed are: type of the instrument, units, type of used GPS NMEA message, and GPS X and Y offsets (in Distance Units).

The Position Readings Using NAV601 Data option allows you to position Grad601 stations based on Real Time GPS data which were recorded in NAV601 data file during the survey. Select **Position Sensors|Position Readings Using NAV601 Data Files** from the main program menu, as shown in Figure 3.4. The second item **Position Readings Using Grid Based Data Files** can be used when survey was positioned using grid layout on the ground, this option is described in a separate document: GridPositioningNotes.pdf.

After the selected menu item is clicked the Position Grad601 Readings Using NAV601 Data File dialog will be displayed in the centre of the computer screen, Figure 3.5.

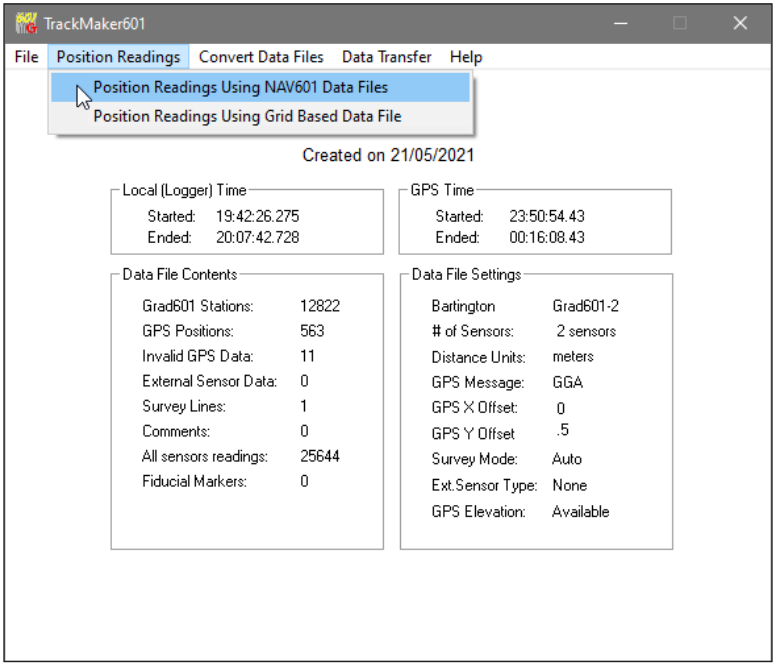


Figure 3.4: Position Readings menu

Parameters in Positioning Readings Using NAV601 Data File Window

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 magnetic as well as to GPS data.

Edit Parameters

The TrackMaker601 main window (Figure 3.3) 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 TrackMaker601 main screen). Click on the **Edit Parameters** button and Edit NAV601 File Parameters window will appear (Figure 3.6).

The window displays parameters that the user can edit. These are: number of the Grad601 sensors, Distance Units, and GPS X and Y offsets. If all parameters were correctly specified in the field then clicking on **OK** or **Cancel** button

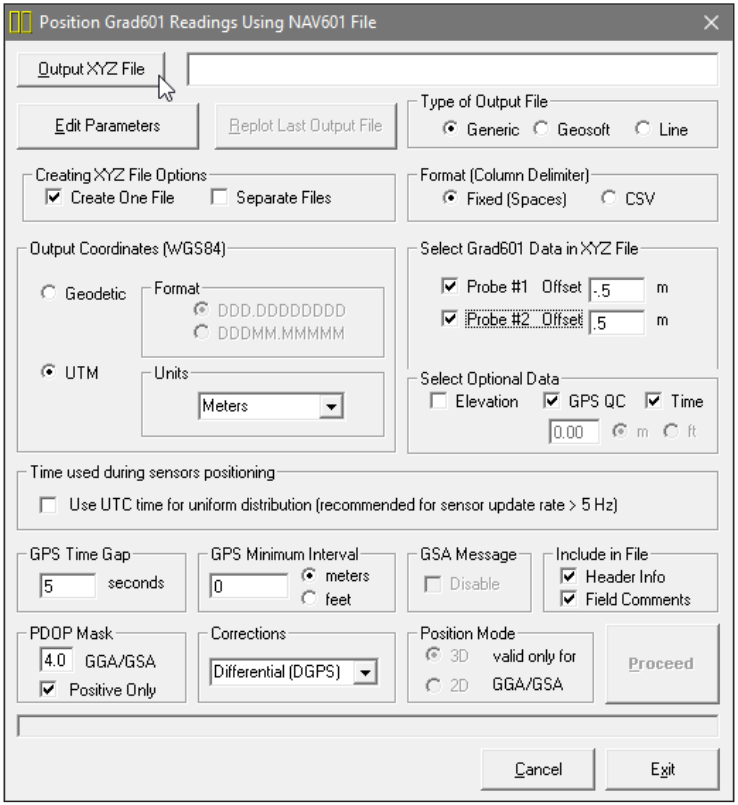


Figure 3.5: Position Grad601 Readings Using NAV601 Data File window

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. Number of sensors and Distance Units parameters can be selected from combo list boxes, while GPS X and GPS Y offsets must be entered in appropriate text boxes. Example of NAV601 File Info window with modified parameters is shown in Figure 3.7.

Clicking on the **OK** button will accept any changes in 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 NAV601 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 is **Saved** or **Saved As** in File menu.

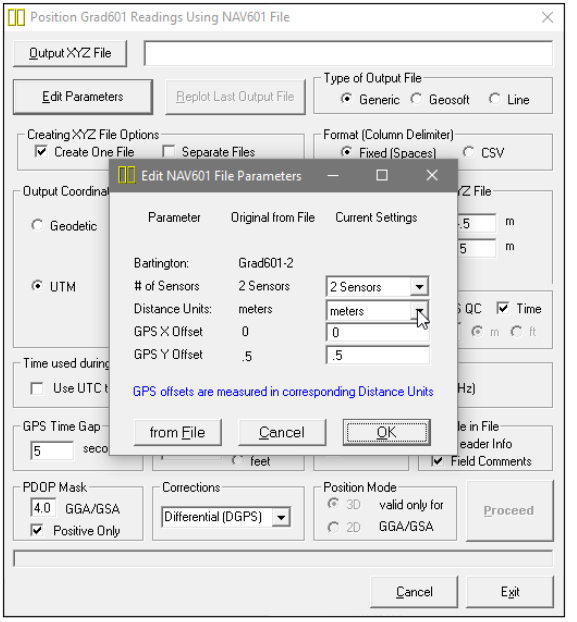


Figure 3.6: Edit NAV601 File Parameters dialog

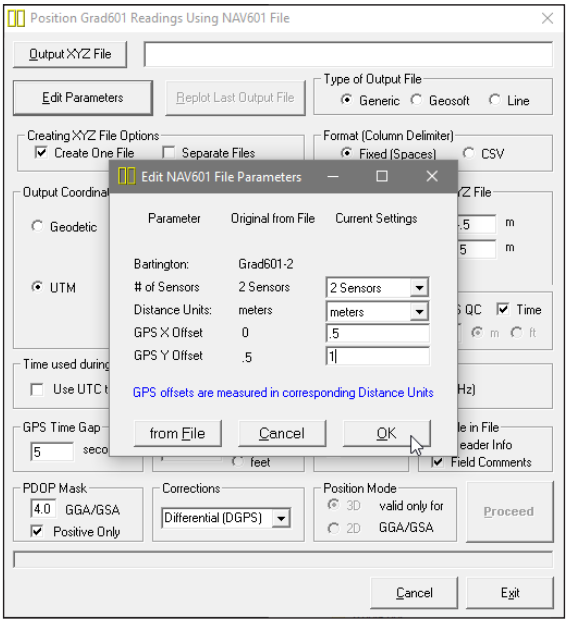


Figure 3.7: Modified parameters in Edit Parameters dialog

Output File

Click on the **Output XYZ File** button. The Select Output File window is displayed (Figure 3.8).

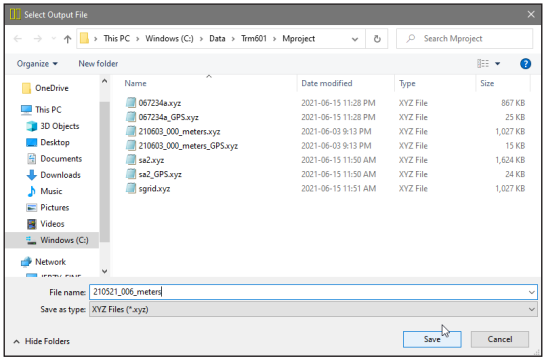


Figure 3.8: Select Output File dialog

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 Grad601 Readings Using NAV601 File window.

When Output file is specified the **Proceed** button in the Position Grad601 Readings Using NAV601 File becomes active (Figure 3.9).

Creating XYZ File Options

These options apply only of Grad601-2 (2 sensors) is used. Data can be written to one file when option **Create One File** is checked, or to separate files for each sensor if the option **Separate Files** is checked. Both options can be used at the same time.
If One File is selected, data set for the Sensor #1 is written first and data set for the Sensor #2 follows.

Select Grad601 Data in XYZ File

To select specific or both Sensors data click on corresponding check buttons labeled Probe #1 and Probe #2. This section is also used to specify offsets for each sensor. As described in the former section, Sensor #1 (Probe #1) is located on the left side and Sensor #2 (Probe #2) is located on the right side of the system center while facing direction of movement (see Figures 3.1 and 3.2). Units for sensors offsets are labeled on the right side and they depend on the selection specified in the System Setup dialog.

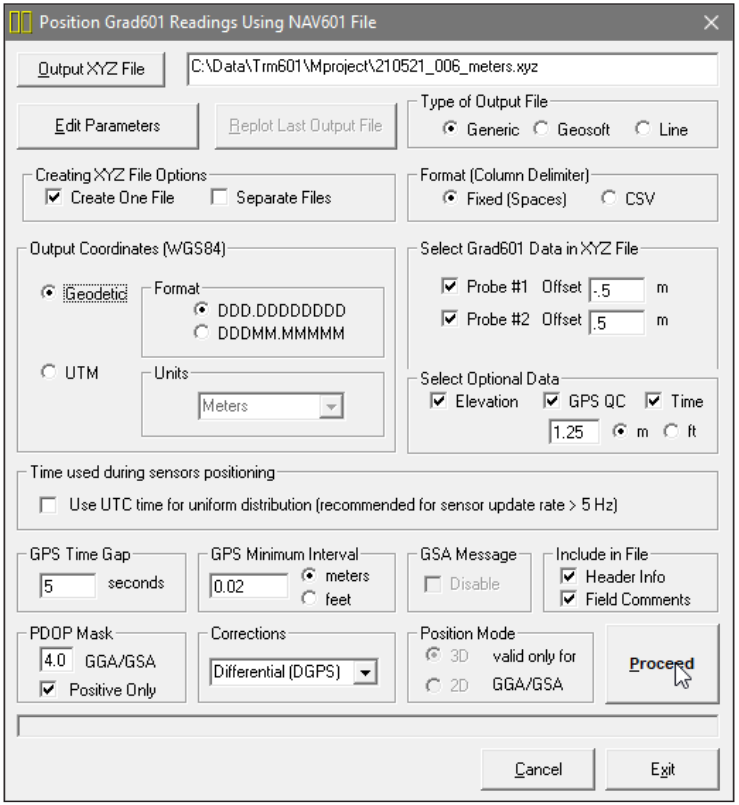


Figure 3.9: Position Grad601 Readings Using NAV601 Data File window

Sensors Offsets option are left as a legacy approach for Windows Mobile based Nav601 programs users, these programs do not have entry for sensors location during measurements and it is the only place to specify locations of sensors. For users of Windows 10 based data acquisition program Nav601 the TrackMaker601 automatically divides Separation and displays them as two offsets. For example if Separation was specified as 1 m then both offsets will be shown as 0.5 m (-0.5 and +0.5). In most cases it is just default option, however if need will arise and Separation is to be adjusted (or if asymmetrical sensors placement was used) then offsets entered in this dialog will be taken to account during XYZ file preparations.

Please note that while Sensors Offsets and GPS Antenna Offsets have the same reference point (center of the system), they do not depend on each other.

Select Optional Data

Three optional data can be written in the output file. These are Elevation, GPS QC parameters (Quality Indicator, PDOP or equivalent, number of satellites), 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.

When the check box labeled GPS QC is checked the file will contain GPS signal quality parameters: correction quality indicator (AGPS, DGPS, RTK, etc.), PDOP or HDOP (depending on NMEA statement) values, and number of satellites used to calculate position.

In case RTS SLAM pseudo-GGA messages were used during data collection the GPS QC option will be replaced by a check box labeled SLAM, when available and checked the created file will contain four RTS SLAM parameters: SLAM Confidence, Pitch, Roll, and Yaw.

If check box labeled Time is checked then XYZ will contain local time and data points will be interpolated between GPS points based on local time stamps. This parameter can be overwritten by UTC Time option, described below.

Data is always placed in the created XYZ file in the following order: X coordinate (Easting or Longitude), Y coordinate (Northing or Latitude), Grad601 sensor as selected (if both sensor are selected then Sensor #1 data set is written in the first half of the XYZ file and the Sensor #2 data set follows), Elevation, three GPS QC parameters (Quality Indicator, PDOP or equivalent, Number of Satellites), and Time Stamp.

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.

Use UTC Time for Uniform Distribution

When this option is checked Grad601 sensor readings time stamps will be replaced by uniformly distributed time stamps based on UTC recorded in neighbouring GPS positions. At the same time, if option Time (indicated in Select

Optional Data section) is enabled time stamps in created XYZ file will contain UTC time.
This option can be used when UTC time in XYZ files is needed or if very uniform data spacing is required. Windows timer has limited resolution and at high rates (above 10 Hz) data can be not spaced very uniformly by Windows timer.

Type of Output File

Check the option appropriate for the contouring software used. The Generic option will create 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 LINE # at the beginning of each survey line. A Line format has specific format (please see example in Appendix) for some archaeological software packages.

Format (Column Delimiter)

Check an option labeled Fixed or CSV appropriate for the mapping or other software used. The **Fixed** (Spaces) will format aligned columns spaced by a number of spaces. The **CSV** (Comma Separated Values) will divide columns by a single comma. The latter format is also suitable to be used with Excel and other programs.

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 3.9).

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 3.9).

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 3.10). 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 TrackMaker601 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 Grad601 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 3.10). 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 Grad601 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 TrackMaker601 will calculate positions of sensor in case offset values (GPS X and/or GPS Y Offsets) are different than zero, positions of the Grad601 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 3.10).

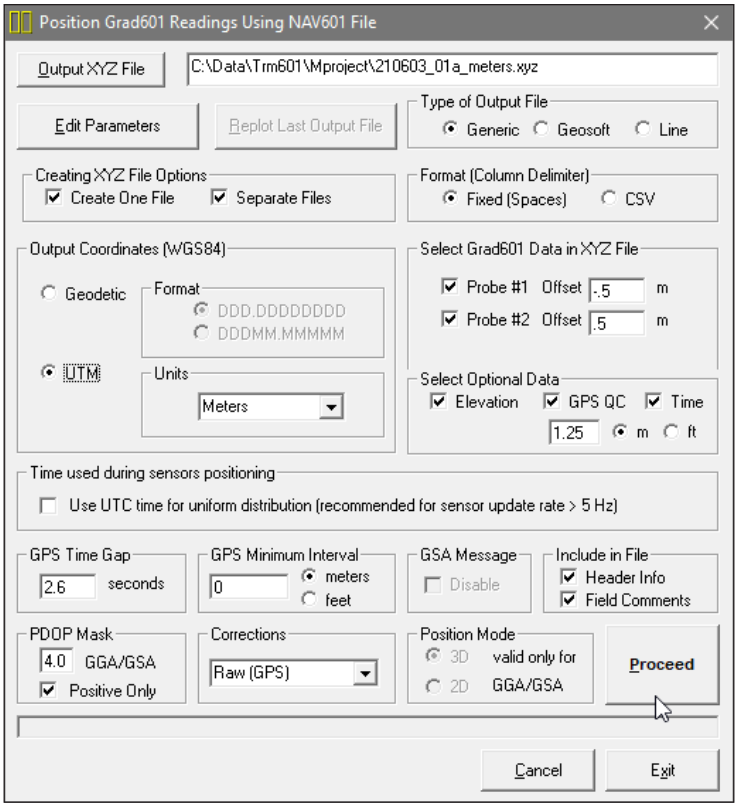


Figure 3.10: Position Grad601 Readings Using NAV601 Data File window

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 (NAV601) that the GPS Message will be pair GGA/GSA and for any reason message GSA was not recorded. In such case the TrackMaker601 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 3.10. All positions (as well as Grad601 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 Grad601 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 TrackMaker601.

When all parameter are set and output file name is specified, the **Proceed** button is activated in the Position Readings Using NAV601 File window. After you click the **Proceed** button, the program begins to filter loaded data, calculates Grad601 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 3.11).

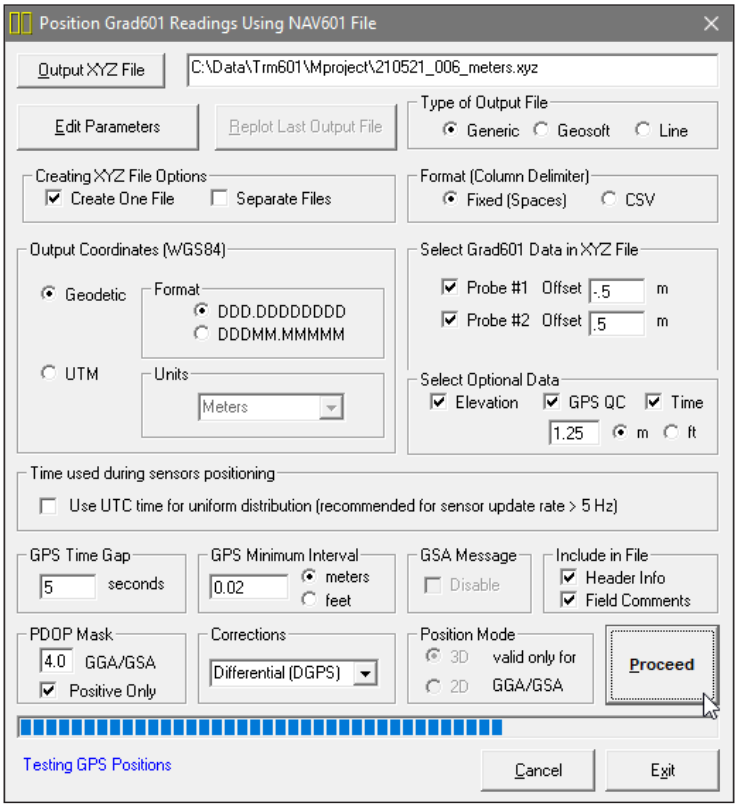


Figure 3.11: Position Grad601 Readings Using NAV601 File window during creating XYZ file

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 3.12).

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

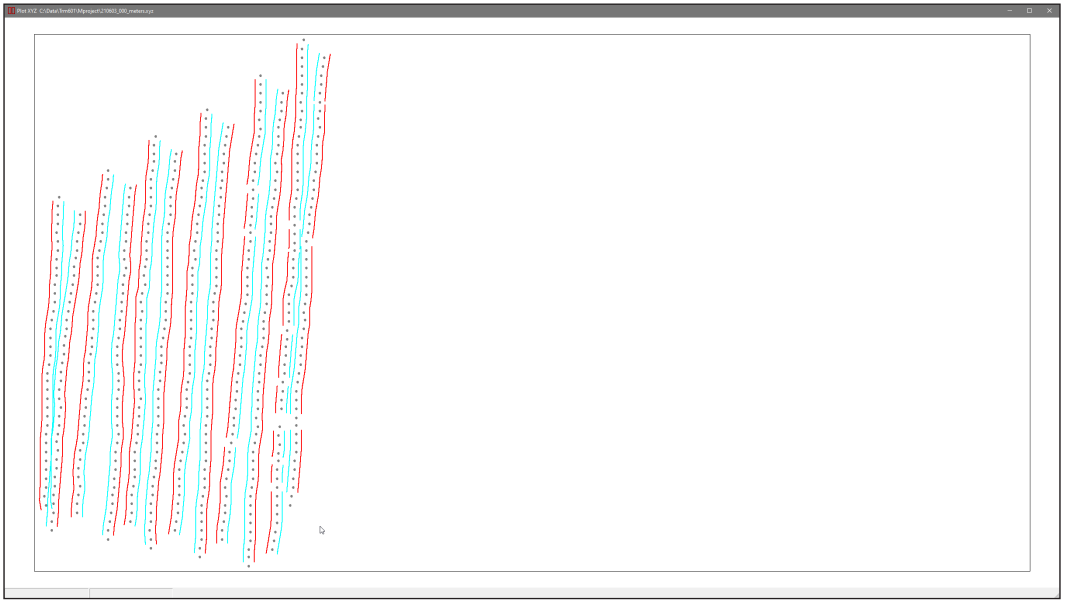


Figure 3.12: Two dimensional layout of stations taken with the Bartington Grad601-2. The GPS X =0 and GPS Y offsets was set to 0.5 m (GPS antenna was located 0.5 m ahead of the center of the Grad601 system), and Sensors Separation 1.0 m or for Windows Mobile - Sensor Offsets were -0.5 m for Sensor #1 (red dots) and 0.5 m for Sensor #2 (blue dots).

fixed colours. GPS positions are marked by larger grey dots while the Grad601 Sensor #1 stations are plotted by smaller red dots and Sensor #2 positions are indicated by small blue 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 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 NAV601 File Parameters window will appear as shown in Figure 3.13. After changes are done, click the **Proceed** button to repeat procedure of creating XYZ file. See example in Figure 3.14 where GPS antenna location was changed as compared to case shown in Figure 3.12.

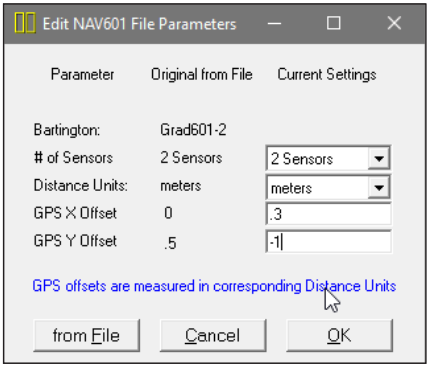


Figure 3.13: Edit Parameters dialog

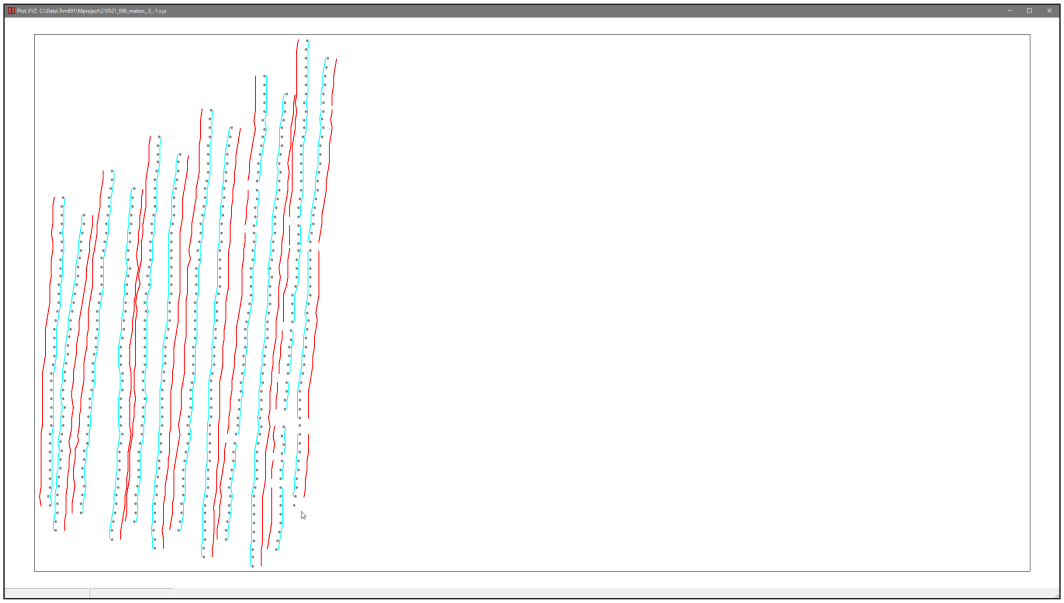


Figure 3.14: Two dimensional layout of stations taken with the Bartington Grad601-2. The GPS X Offset was 0.3 m and GPS Y Offset was set to zero, and Sensors Offsets were -0.5 m for Sensor #1 (red dots) and 0.5 m for Sensor #2 (blue dots) or for Windows 10 based Nav601 Separation was 1 m. Therefore GPS antenna was located closer to Sensor #2.

If the input file does not contain sufficient GPS information, or parameters are not correctly selected, the program will display a warning message (Figure 3.15), and the program will pause operation till the **OK** button is clicked in the warning window.

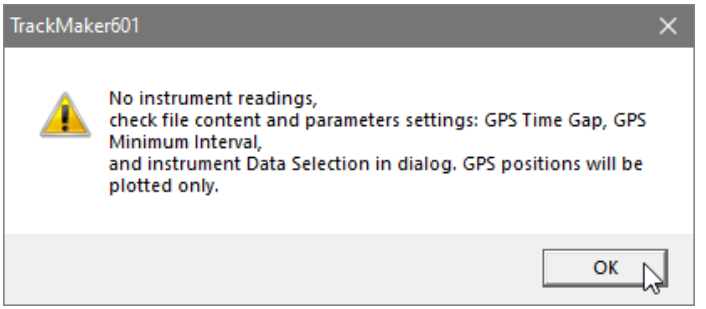


Figure 3.15: Warning window

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, or too critical (too small) value specified in GPS Time Gap section, unchecked both Grad601 channels specified in Select Data section, etc..

Convert Data Files 4

Convert menu of TrackMaker601 program allows you to convert the NAV601 binary file to other formats. There are four items associated with the Convert menu (Figure 4.1):

- convert NAV601 file to general format ASCII file,
- retrieve and position field comments from NAV601,
- convert GXY file to ASCII file containing positions,
- correct system time constant delay in XYZ files.

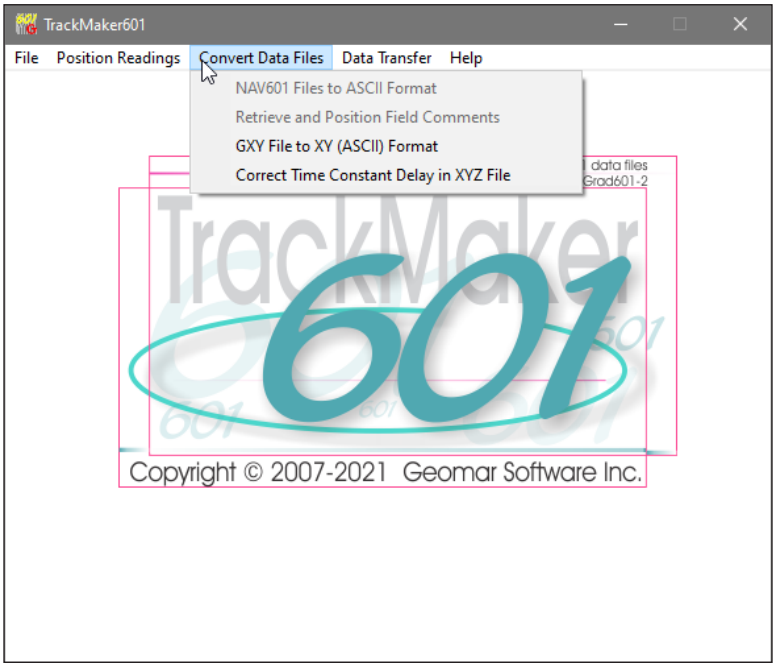


Figure 4.1: Convert Data Files menu

Files converted to general ASCII format can be easily reformatted and used by other software. While retrieving comments from NAV601 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 NAV601 data file is loaded in File menu (Figure 4.2).

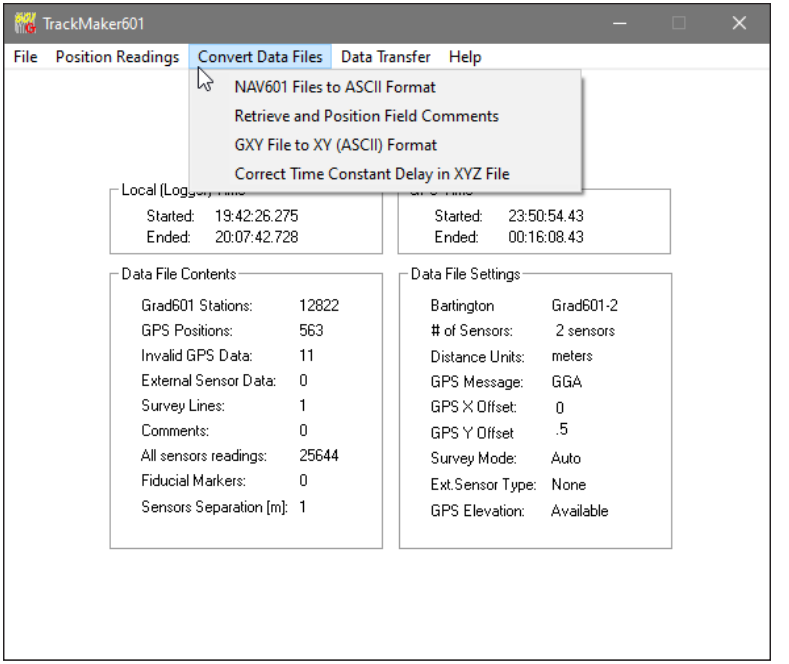


Figure 4.2: Convert Data Files menu after NAV601 file is loaded to the program

Selected examples of file formats created by TrackMaker601 are given in Appendix B of this manual.

4.1 Convert NAV601 Data to ASCII Format

The Convert NAV601 Data to ASCII Format option allows you to convert NAV601 binary files to ASCII format, which can be viewed with any text editor and then easily converted to the other format. Select **Convert|NAV601 to ASCII Format** from the main program menu, as shown in Figure 4.2.

After the selected menu item is clicked the Convert NAV601 Files to ASCII Format window will be displayed in the centre of the screen, Figure 4.3.

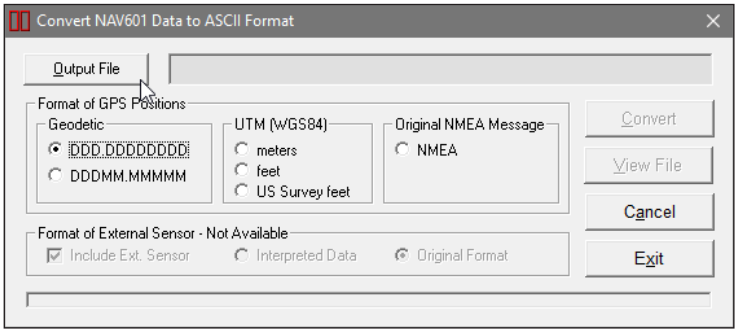


Figure 4.3: Convert NAV601 Files to ASCII Format dialog

Parameters in Convert NAV601 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 (co-ordinates format or original NMEA statement). The External Sensor option is not used in this version of the program.

Output File

Click on the **Output File** button. The Select Output File window is displayed (Figure 4.4).

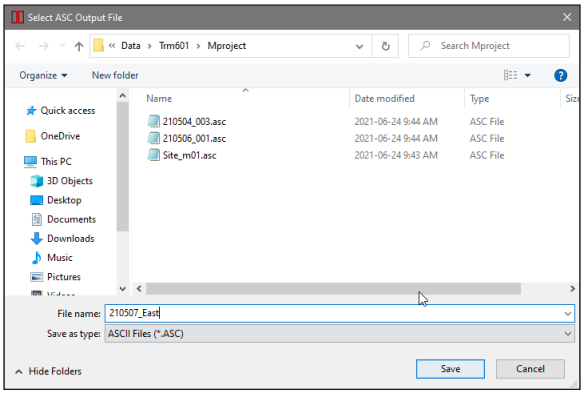


Figure 4.4: Select ASC Output File dialog

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 NAV601 Files to ASCII Format window.

When Output file is specified the **Convert** button in the Convert NAV601 Data to ASCII Format window becomes active.

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 4.5).

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 4.3).

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 4.5).

Converting NAV601 Data to ASCII Format

When all parameter are set and output file name is specified, the **Convert** button is activated in the Convert NAV601 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 4.5).

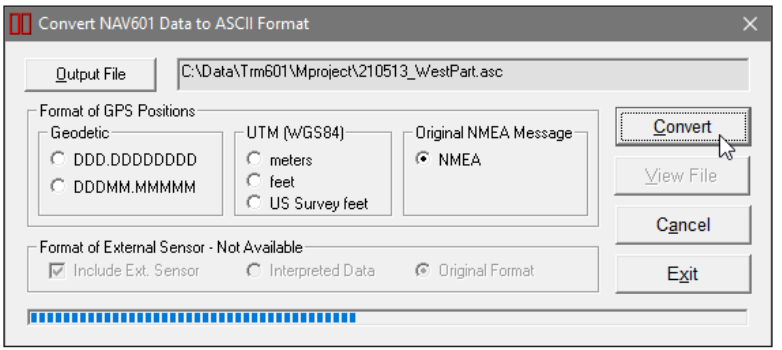


Figure 4.5: Convert NAV601 Files to ASCII Format window during data processing

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 Grad601 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 NAV601 Data to ASCII Format window.

4.2 Retrieve and Position Field Comments

The Retrieve and Position Field Comments option allows you to convert retrieve field comments from NAV601 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 4.2.

After the selected menu item is clicked the Position Comments Recorded in NAV601 File window will be displayed in the centre of the screen, Figure 4.6.

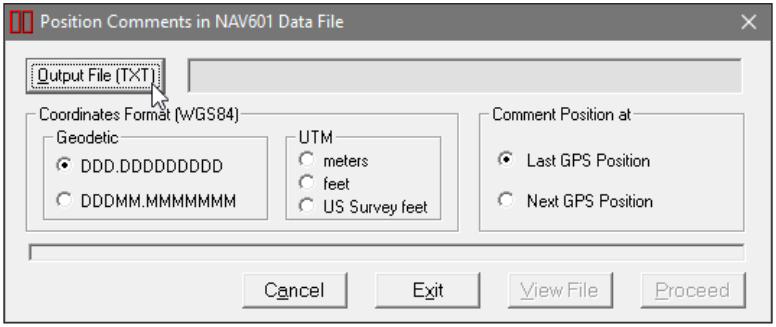


Figure 4.6: Position Comments in NAV601 Data window

Parameters in Position Comments Recorded in NAV601 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 dialog is displayed (Figure 4.7).

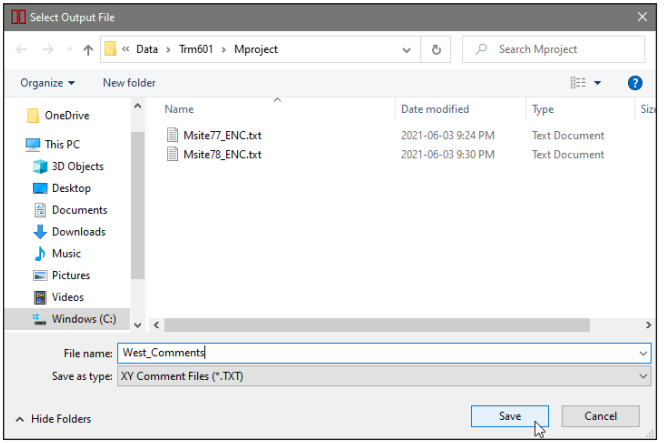


Figure 4.7: Select Output File dialog

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 NAV601 File window.

When both, Input and Output files are specified the **Proceed** button in the Position Comments Recorded in NAV601 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 4.6).

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 section labeled **Geodetic** (Figure 4.6).

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 4.6).

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 NAV601 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 4.6).

Positioning Comments Recorded in NAV601 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 NAV601 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 4.8).

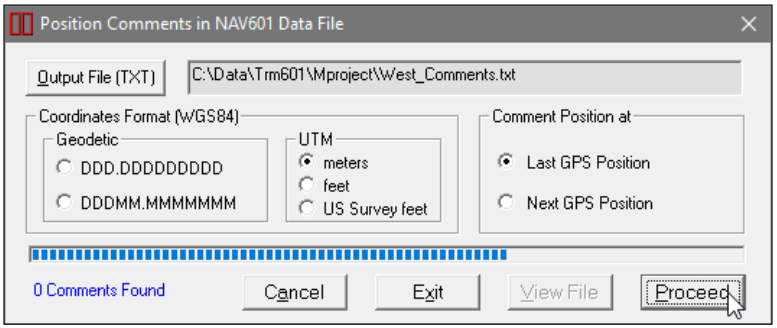


Figure 4.8: Position Comments Recorded in NAV601 File during data processing

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 (601)** and **Output File (TXT)** buttons. Click on **Exit** button to close the Position Comments Recorded in NAV601 File window.

4.3 Convert GXY Files to XY (ASCII) Format

Files GXY are created by the NAV601 when only GPS data are collected (Grad601 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. ML61MK2, NAV61MK2, RTmap38, NAV38, etc.) can be converted to ASCII format using this option of TrackMaker601.

Select **Convert|GXY Files to XY (ASCII) Format** from the main program menu, as shown in Figure 4.1. 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 4.9.

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 4.10).
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

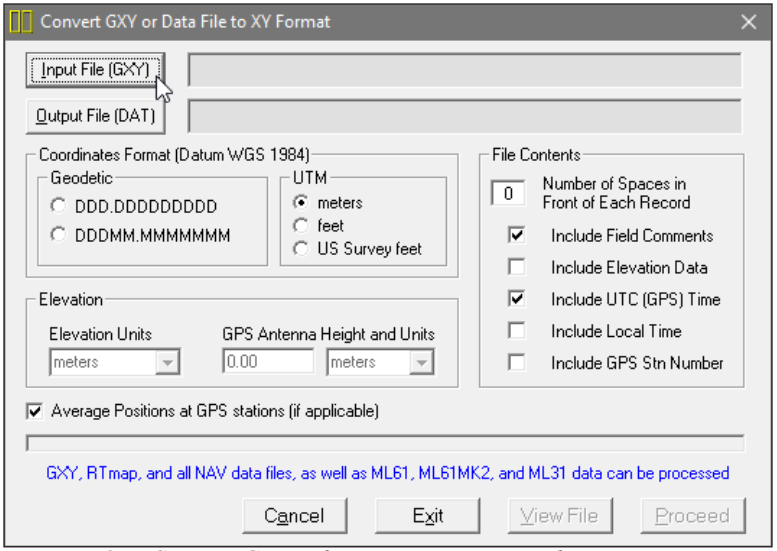


Figure 4.9: Convert GXY Files to XY Format window

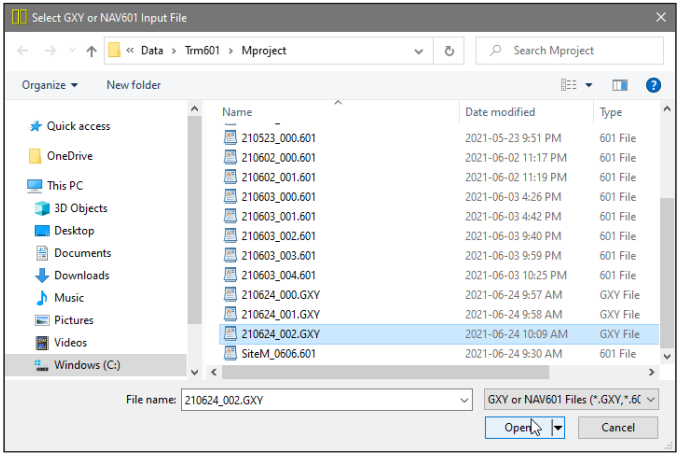


Figure 4.10: Select GXY Input File window

name will be displayed beside the **Input File (GXY)** button in the Convert GXY File to XY Format window.

Output File (DAT)

Click on the **Output File (DAT)** button. The Select Output File window is displayed (Figure 4.11).

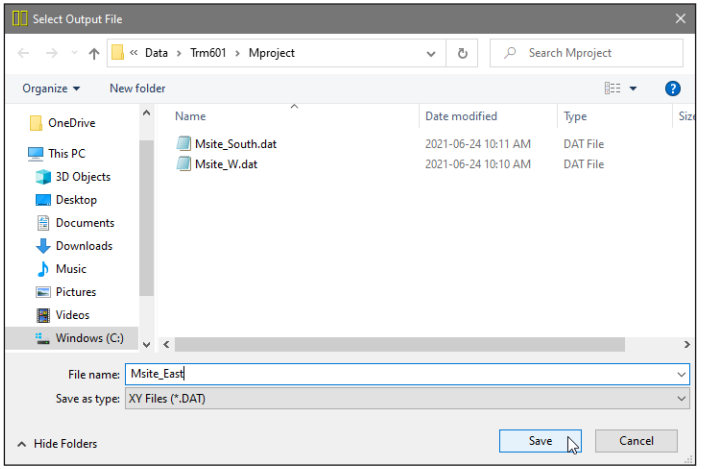


Figure 4.11: Select Output File dialog

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 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 section labeled **Geodetic** (Figure 4.9).

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 4.9).

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

This option can be used only if the similar option is provided in NAV601.
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.

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 4.12).

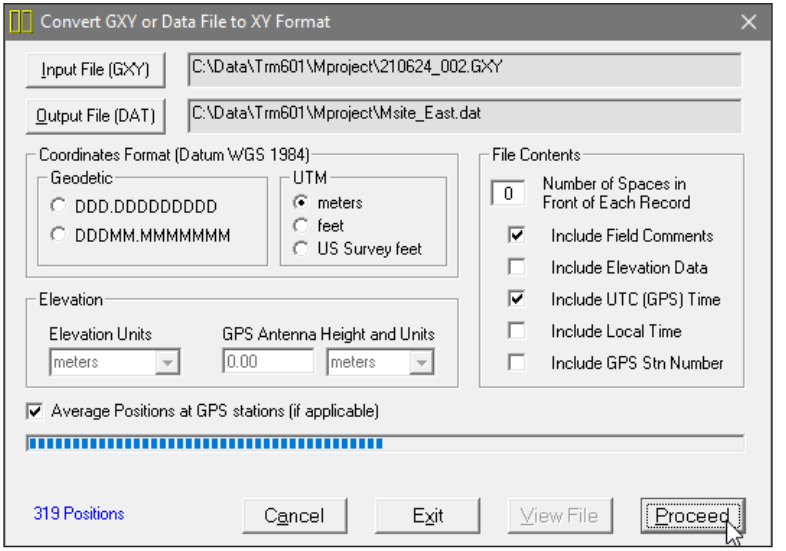


Figure 4.12: Convert GXY Data Files to XY Format window during data processing

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.

4.4 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 Grad601 time constant is known (approximately 0.5 s) the time constant of the combined Grad601 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 Grad601. 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 4.1). The Correct Time Constant Delay window will appear on the screen (Figure 4.13).

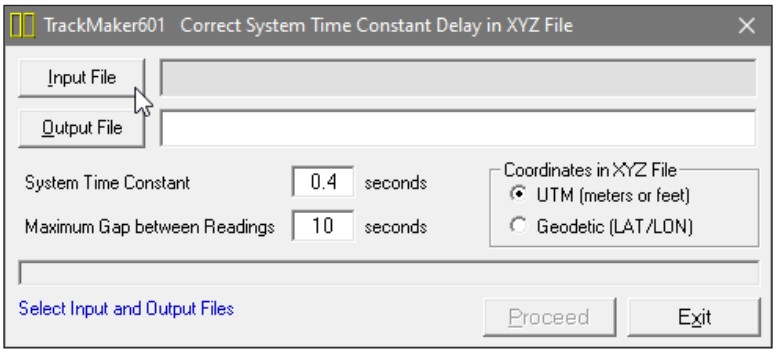


Figure 4.13: Correct Time Constant Delay in XYZ File window

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 dialog is displayed (Figure 4.14).

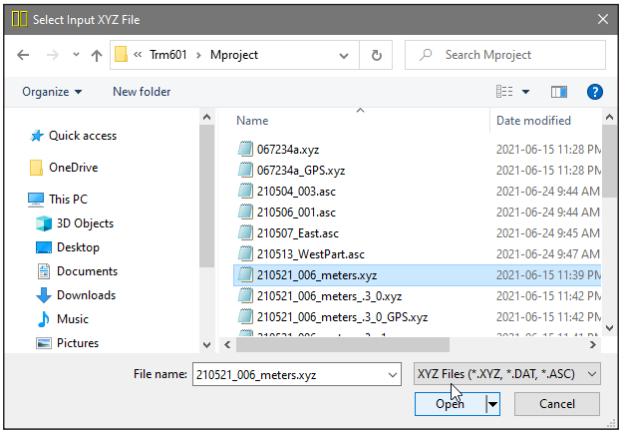


Figure 4.14: Select Input XYZ File dialog

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 4.15).

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 4.16).

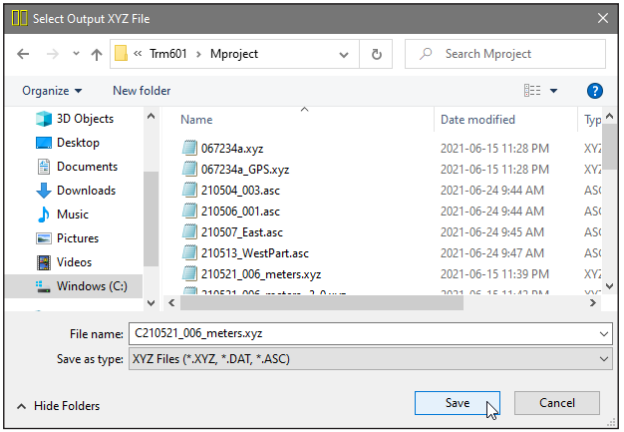


Figure 4.15: Select Output XYZ File dialog

System Time Constant

Time delay 0.4 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 Grad601 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 4.16).

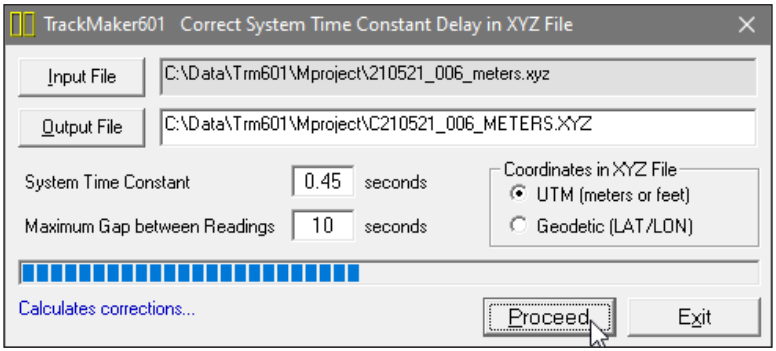


Figure 4.16: Correct Time Constant Delay in the XYZ File window during data processing

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.

NAV601 Data File Format

A

A.1 Description of NAV601 Data File Format (601) - Windows 10 Format

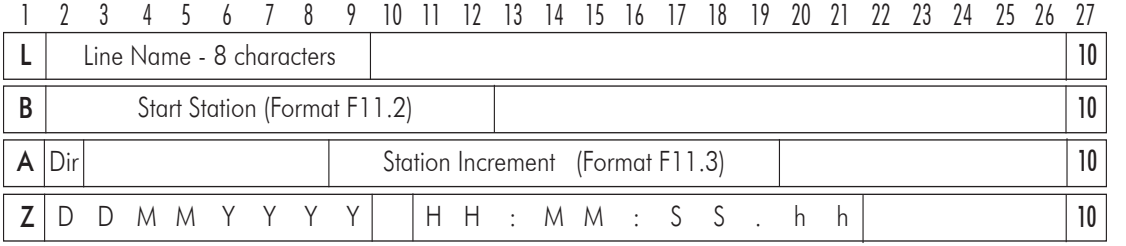
Each file record contains 27 characters including line feed at the end of each record.

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	25	26	27
N	A	V	6	0	1		A	W	1	0	0	Survey Type			UT		IM		IS	SM	SP			svid		10
H	Data File Name											Separation (F5.2)							TG					svid		10
G	GPS X Offset (F7.2)							GPS Y Offset (F7.2)								CI	RU	SL	GP	GS				svid		10

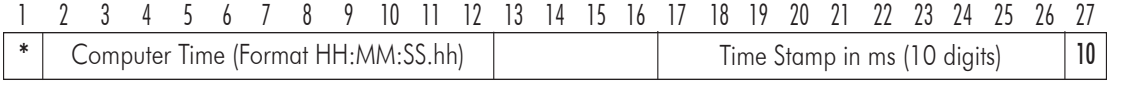
NAV601	-	identification of program file
W100	-	version number V1.00
Survey Type	-	GPS (if GPS Input Enabled) or GRD (grid)
UT	-	unit type (0 = meters, 1 = feet)
IM	-	not used (=0, fixed)
IS	-	number of sensors (0 = 1 sensor, 1 = 2 sensors)
SM	-	not used (= 0, fixed)
IS	-	Grad601 State (0 = disabled/GXY File, 1 = enabled)
File Name	-	file name, maximum 8 characters
Separation	-	Sensors Separation [m], applicable for 2 sensors only
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
CI	-	program type (=7, fixed for Windows 10/7)
RU	-	RTS units (0 = metres or feet, 1 = US Survey Feet)
SL	-	RTS SLAM option (=0 not used, =1 enabled)
GP	-	type of GPS NMEA message (0 = GGA/GSA, 1= GGA, 2 = POS, 3 = LLK, 4=LLQ, 5=GLL, 6 = GGK, 7 = pseudo-GGA (RTS), 8=pseudo-GLL)
GS	-	GPS state (0 = disabled, 1 = enabled)
svid	-	logger/software type id (not used)
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

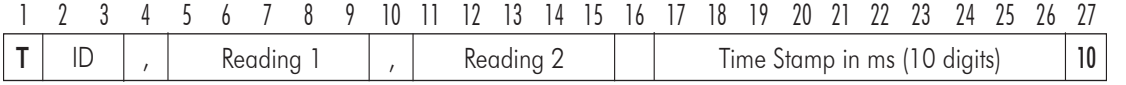
Timer Reset



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.

Reading

Each instrument record consists of one line that starts with **T** .



T - indicates the first line of instrument record
ID - indicator, $P (fixed string)
, - comma character
Reading 1 - five character field containing Sensor #1 output in nT/m
Reading 2 - five character field containing Sensor #2 output in nT/m, if one sensor is used then this field contains spaces
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	25	26	27
C	Comment (maximum 15 characters)															Time Stamp in ms (10 digits)										10

New Station

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

Internal Readings

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

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

Records starting with X

Several informative records, for example X$STARTED indicates start of Logging mode, X$PAUSED indicates Pause (activated by Pause key stroke), etc.

GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 25 characters strings and placed in the NAV601 data file which contains 27 characters records, including one character indicator and line feed at the end of each record. The GPS sequence starts at the line which contains the character @ as the first character, then records that contain a continuation of the same message start with the character **#**. The GPS sequence ends with a line starting with the character **!**. The last line contains sequential number of GPS recorded position and a logger time stamp for the given GPS reading. A sample of the GPS message written in NAV601 format is given below.

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

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

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

In case not selected NMEA messages are streamed by connected GPS receiver then such not needed positions are tagged by X and only first few elements are recorded in the file together with time stamp. It is just to trace and document GPS receiver activity.

A.2 Example of NAV601 Data File - Windows 10 Format

```
NAV601 AW100GPS0 0 111
H210603_002 1.00       0
G  0.000  0.400 70011  01B
L14.00
B    3870.00
AE            1.000
Z03062021 21:30:47
*21:30:47.221   1470603109
X$STARTED       1470622781
T$P,  8.3,    6 1470622828
T$P,  8.7,    7 1470622906
@$GPGGA,014058,4337.0207,N
#,07939.0158,W,8,10,2.0,17
#5.5,M,-35.4,M,,*70
!000001p        1470622812
{0         0.000
T$P,  8.4,    6 1470623000
X$GPGSA,A,3,05,10,13,15,18
T$P,    8,    7 1470623109
T$P,    8,    7 1470623187
X$GPGSV,3,2,10,18,80,250,5
T$P,    8,    7 1470623281
X$GPGLL,4337.0202,N,07939.
T$P,    8,    7 1470623359
X$GPBOD,325.5,T,336.2,M,TO
T$P,    8,    7 1470623453
T$P,    8,    6 1470623546
X$GPBWC,014058,3512.7660,N
T$P,    8,    7 1470623625
```

```
X$GPVTG,0.0,T,10.8,M,0.0,N
X$GPXTE,V,V,9.99,L,N,S*18
T$P,    8,    7 1470623734
T$P,    8,    7 1470623812
T$P,    8,    7 1470623906
T$P,    8,    5 1470624000
T$P,    8,  6.6 1470624078
T$P,    8,    7 1470624171
T$P,    8,    7 1470624250
T$P,    8,    7 1470624343
T$P,    8,    6 1470624453
T$P,    8,    7 1470624531
T$P,    8,    7 1470624625
X$GPRMC,014100,V,4337.0202
T$P,    8,    7 1470624703
T$P,    8,    7 1470624796
X$GPRMB,V,9.99,L,TOUR4,TOU
T$P,    8,    6 1470624890
@$GPGGA,014100,4337.0213,N
#,07939.0157,W,8,10,2.0,17
#5.5,M,-35.4,M,,*7C
!000002p        1470624812
{a    608907.054
{b   4830221.450
{c    608909.048
{d   4830221.302
{e    608907.135
{f   4830222.544
{g    608909.129
{h   4830222.396
T$P,    8,    7 1470624968
T$P,    8,    7 1470625078
X$GPGSA,A,3,05,10,13,15,18
T$P,    8,    7 1470625156
X$GPGSV,3,3,10,27,16,317,4
T$P,    8,    7 1470625250
X$GPGLL,4337.0202,N,07939.
T$P,    8,    7 1470625343
X$GPBOD,325.5,T,336.2,M,TO
T$P,    8,    7 1470625421
X$GPBWC,014100,3512.7660,N
T$P,    8,    6 1470625515
X$GPVTG,0.0,T,10.8,M,0.0,N
T$P,    8,    7 1470625593
X$GPXTE,V,V,9.99,L,N,S*18
T$P,    8,    7 1470625687
T$P,    8,    7 1470625796
T$P,    8,    6 1470625875
T$P,    8,    6 1470625968
T$P,    8,    7 1470626046
T$P,    8,    7 1470626140
.........................
```

A.3 Description of NAV601 Data File Format (601) - Windows Mobile Format

Each file record contains 27 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	25	26	27
N	A	V	6	0	1			W	1	3	4	Survey Type			UT			IM		IS				svid		10
H		Data File Name										Samples							TG					svid		10
G	GPS X Offset (F7.2)							GPS Y Offset (F7.2)										GR	GP	GS				svid		10

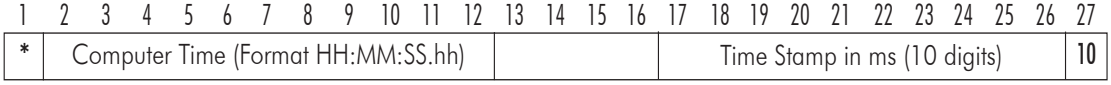
NAV601	-	identification of program file
W134	-	version number V1.34, W is fixed
Survey Type	-	GPS (if GPS Input Enabled) or GRD (grid)
UT	-	unit type (0 = meters, 1 = feet)
IM	-	Grad601 survey mode (0 = Auto, fixed)
IS	-	Grad601 type (1 = 1 sensor, 2 = 2 sensors)
File Name	-	file name, maximum 8 characters
Samples	-	not used
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
GR	-	GPS update rate (0 = not used)
GP	-	type of GPS NMEA message (0 = GGA/GSA, 1= GGA, 2 = POS, 3 = LLK, 4=LLQ, 5=GLL, 6 = GGK, 7 = Leica TPS, 8=Trimble RTS)
GS	-	GPS state (0 = Disabled, 1 = Enabled)
svid	-	logger/software type id (not used)
10	-	Line Feed character

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

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
L	Line Name - 8 characters																									10
B	Start Station (Format F11.2)																									10
A	Dir							Station Increment (Format F11.3)																		10
Z	D	D	M	M	Y	Y	Y	Y		H	H	:	M	M	:	S	S	.	h	h						10

Line Name	-	Line Name, maximum 8 characters
Start Station	-	Start Station for the Line, format F11.2
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

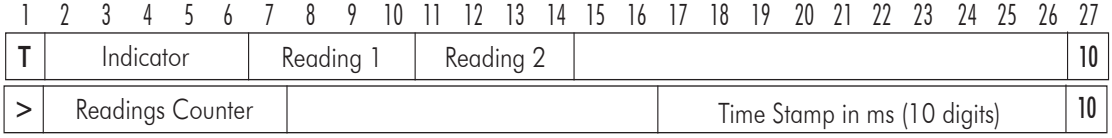
Timer Reset



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

Each instrument record consists of two lines, the first line starts with **T** and the second line starts with **>** .



T	-	indicates the first line of instrument record
Indicator	-	$PBAR (fixed string)
Reading 1	-	four character field containing Sensor #1 output in nT
Reading 2	-	four character field containing Sensor #2 output in nT, if one sensor is used then this field contains spaces
>	-	indicates the second line of the instrument record
Counter	-	six digits field containing sequential number of reading
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	25	26	27
C	Comment (maximum 15 characters)															Time Stamp in ms (10 digits)										10

New Station

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

GPS Data Message Records

Each GPS record (GGA Message) is broken in to several 22 characters strings and placed in the NAV601 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 sequential number of GPS recorded position and a logger time stamp for the given GPS reading. A sample of the GPS message written in NAV601 format is given below.

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

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

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

A.4 Example of NAV601 Data File - Windows Mobile Format

The NAV601 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.

```
NAV601  W130GPS0 0 2    02
H 052012A    0.200      2C
G   0.00   0.00   001   FE
L0
B       0.00
AS            1.000
Z20052008 12:47:53
*12:47:53.000       147944
X$STARTED           149140
T$PBAR,1130,2504
>000001             149186
T$PBAR,1320,2607
>000002             149296
T$PBAR,1430,2603
>000003             149406
T$PBAR,1550,2307
>000004             149516
T$PBAR,1650,2457
>000005             149626
T$PBAR,1733,2507
>000006             149736
T$PBAR,1840,2767
>000007             149845
@$GPGGA,182702.00,4336.593
#81,N,07936.64493,W,2,7,2,
#141.84,M,-35,M,4,118*5D
!000001p            149880
@$GPGSA,A,3,32,,,22,,18,14
#,12,,09,05,,02.5,01.5,01.
#9*0B
!000001             149915
T$PBAR,1920,2534
>000008             149955
T$PBAR,1330,2307
>000009             150065
T$PBAR,1300,2534
>000010             150175
T$PBAR,1200,2207
>000011             150285
T$PBAR,1200,3407
>000012             150395
T$PBAR,1100,2507
>000013             150505
T$PBAR,1300,3607
>000014             150615
```

A.5 Format of GXY Data File

The NAV601 data file with extension GXY contains GPS records. The structure of this file is identical to the standard NAV601 (601) file. The difference is that it does not contain any Grad601 records. This file is created by NAV601 when Grad601 is Disabled in the System Setup menu. In this case the program acts as a GPS logging program.

It should be noted that any NAV601 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 TrackMaker601 and TrackMaker for any other supported Geonics instrument (TrackMaker38, 61, etc.). The extension name GXY indicates that the file does not contain magnetic data.

File Formats

B

B.1 Description of NAV601 File in ASCII Format

The NAV601 data file converted to ASCII format contains information related to the instrument output and GPS positions. The format of the file is self explanatory.

The file starts with a header block, which starts with the line **NAV601 File Header** and it ends with line **End of file header**. The file header includes: NAV601 version number, type of positioning, distance units, number of sensors, survey mode, name of data file (as entered during the survey), GPS Antenna location, GPS NMEA message type, and offsets for GPS antenna.

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.

Reading starts by station number, and it is followed by instrument readings. Instrument reading is represented by two values (one for each sensor). Time stamp (format HH:MM:SS.ttt) is placed in the last column.

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.

Line containing GPS position may also include original NMEA message if this option was selected in Convert NAV601 File to ASCII Format window.

Two Examples of NAV601 Files in ASCII Format

1. Geodetic coordinates

```
NAV601 File Header  Version W1.30
Positioning: GPS          Distance units: meters
Sensor Type: Grad601-2 (2 Sensors)  Survey Mode: Auto
External Sensor: None
Data File  : 052012A.601
GPS Message   : GGA/GSA
GPS Antenna Position
      GPS X offset: 0.00
      GPS Y offset: 0.00
End of file header

Survey Line      : 0
Start Station    : 0.00
Station Increment: 1.000
Date: 20/05/2008  Time: 12:47:53
     0.000  1130.00  2504.00 12:47:54.241
     1.000  1320.00  2607.00 12:47:54.351
     2.000  1430.00  2603.00 12:47:54.461
     3.000  1550.00  2307.00 12:47:54.572
     4.000  1650.00  2457.00 12:47:54.681
     5.000  1733.00  2507.00 12:47:54.791
     6.000  1840.00  2767.00 12:47:54.900
GP     79.6107488,W,     43.6098968,N, 18:27:02.00            12:47:54.935
GQ Position: 3D      Differential (DGPS)   PDOP: 02.5    12:47:54.935
     7.000  1920.00  2534.00 12:47:55.010
     8.000  1330.00  2307.00 12:47:55.120
     9.000  1300.00  2534.00 12:47:55.230
    10.000  1200.00  2207.00 12:47:55.341
    11.000  1200.00  3407.00 12:47:55.450
    12.000  1100.00  2507.00 12:47:55.560
    13.000  1300.00  3607.00 12:47:55.670
    14.000  1400.00  2007.00 12:47:55.780
    15.000  1500.00  2207.00 12:47:55.890
GP     79.6107480,W,     43.6099028,N, 18:27:03.00            12:47:55.935
GQ Position: 3D      Differential (DGPS)   PDOP: 02.5    12:47:55.935
    16.000  1600.00  1907.00 12:47:56.000
    17.000  1700.00  1007.00 12:47:56.110
    18.000  1800.00  1507.00 12:47:56.220
    19.000  1900.00  1577.00 12:47:56.330
    20.000  1300.00  2407.00 12:47:56.440
    21.000  1400.00  2507.00 12:47:56.550
    22.000  1600.00  2207.00 12:47:56.659
    23.000  1150.00   407.00 12:47:56.769
```

```
    24.000  1130.00   507.00 12:47:56.879
GP     79.6107467,W,     43.6099097,N, 18:27:04.00            12:47:56.935
    25.000  1320.00   607.00 12:47:57.007
GQ Position: 3D      Differential (DGPS)   PDOP: 02.5    12:47:57.007
    26.000  1430.00   607.00 12:47:57.099
    27.000  1550.00   307.00 12:47:57.209
    28.000  1650.00   407.00 12:47:57.319
    29.000  1733.00   507.00 12:47:57.430
    30.000  1840.00   707.00 12:47:57.539
    31.000  1920.00   577.00 12:47:57.649
    32.000  1300.00   307.00 12:47:57.754
    33.000  1500.00   507.00 12:47:57.864
GP     79.6107460,W,     43.6099138,N, 18:27:05.00            12:47:57.934
GQ Position: 3D      Differential (DGPS)   PDOP: 02.5    12:47:57.934
    34.000  1500.00  1207.00 12:47:57.973
    35.000  1700.00  3407.00 12:47:58.083
    36.000  1570.00  2507.00 12:47:58.193
    37.000  1540.00  3607.00 12:47:58.303
    38.000  1750.00  2007.00 12:47:58.414
    39.000  1500.00  2207.00 12:47:58.523
    40.000  1665.00  1907.00 12:47:58.633
    41.000  1745.00  1007.00 12:47:58.743
    42.000  1480.00  1507.00 12:47:58.853
GP     79.6107440,W,     43.6099212,N, 18:27:06.00            12:47:58.933
    43.000  1600.00  1577.00 12:47:58.972
GQ Position: 3D      Differential (DGPS)   PDOP: 02.5    12:47:58.972
    44.000  1440.00  2407.00 12:47:59.073
    45.000  1400.00  2507.00 12:47:59.183
    46.000  1600.00  2207.00 12:47:59.293
    47.000  1150.00  2203.00 12:47:59.403
    48.000  1130.00  2504.00 12:47:59.513
    49.000  1320.00  2607.00 12:47:59.623
    50.000  1430.00  2603.00 12:47:59.733
    51.000  1550.00  2307.00 12:47:59.843
```

2. Original NMEA messages

```
NAV601 File Header  Version W1.30
Positioning: GPS          Distance units: meters
Sensor Type: Grad601-2 (2 Sensors)  Survey Mode: Auto
External Sensor: None
Data File  : 052012A.601
GPS Message   : GGA/GSA
GPS Antenna Position
      GPS X offset: 0.00
      GPS Y offset: 0.00
End of file header

Survey Line      : 0
Start Station    : 0.00
Station Increment: 1.000
Date: 20/05/2008  Time: 12:47:53
     0.000  1130.00  2504.00 12:47:54.241
     1.000  1320.00  2607.00 12:47:54.351
     2.000  1430.00  2603.00 12:47:54.461
     3.000  1550.00  2307.00 12:47:54.572
     4.000  1650.00  2457.00 12:47:54.681
     5.000  1733.00  2507.00 12:47:54.791
     6.000  1840.00  2767.00 12:47:54.900
```

```
$GPGGA,182702.00,4336.59381,N,07936.64493,W,2,7,2,141.84,M,-35,M,4,118*5D    12:47:54.935
$GPGSA,A,3,32,,,22,,18,14,12,,09,05,,02.5,01.5,01.9*0B                       12:47:54.935
     7.000  1920.00  2534.00 12:47:55.010
     8.000  1330.00  2307.00 12:47:55.120
     9.000  1300.00  2534.00 12:47:55.230
    10.000  1200.00  2207.00 12:47:55.341
    11.000  1200.00  3407.00 12:47:55.450
    12.000  1100.00  2507.00 12:47:55.560
    13.000  1300.00  3607.00 12:47:55.670
    14.000  1400.00  2007.00 12:47:55.780
    15.000  1500.00  2207.00 12:47:55.890
$GPGGA,182703.00,4336.59417,N,07936.64488,W,2,7,2,141.84,M,-35,M,5,118*5E    12:47:55.935
$GPGSA,A,3,32,,,22,,18,14,12,,09,05,,02.5,01.5,01.9*0B                       12:47:55.935
    16.000  1600.00  1907.00 12:47:56.000
    17.000  1700.00  1007.00 12:47:56.110
    18.000  1800.00  1507.00 12:47:56.220
    19.000  1900.00  1577.00 12:47:56.330
    20.000  1300.00  2407.00 12:47:56.440
    21.000  1400.00  2507.00 12:47:56.550
    22.000  1600.00  2207.00 12:47:56.659
    23.000  1150.00   407.00 12:47:56.769
    24.000  1130.00   507.00 12:47:56.879
$GPGGA,182704.00,4336.59458,N,07936.64480,W,2,7,2,141.83,M,-35,M,6,118*51    12:47:56.935
    25.000  1320.00   607.00 12:47:57.007
$GPGSA,A,3,32,,,22,,18,14,12,,09,05,,02.5,01.5,01.9*0B                       12:47:57.007
    26.000  1430.00   607.00 12:47:57.099
    27.000  1550.00   307.00 12:47:57.209
    28.000  1650.00   407.00 12:47:57.319
    29.000  1733.00   507.00 12:47:57.430
    30.000  1840.00   707.00 12:47:57.539
    31.000  1920.00   577.00 12:47:57.649
    32.000  1300.00   307.00 12:47:57.754
    33.000  1500.00   507.00 12:47:57.864
$GPGGA,182705.00,4336.59483,N,07936.64476,W,2,7,2,141.61,M,-35,M,5,118*50    12:47:57.934
$GPGSA,A,3,32,,,22,,18,14,12,,09,05,,02.5,01.5,01.9*0B                       12:47:57.934
    34.000  1500.00  1207.00 12:47:57.973
    35.000  1700.00  3407.00 12:47:58.083
    36.000  1570.00  2507.00 12:47:58.193
    37.000  1540.00  3607.00 12:47:58.303
    38.000  1750.00  2007.00 12:47:58.414
    39.000  1500.00  2207.00 12:47:58.523
    40.000  1665.00  1907.00 12:47:58.633
    41.000  1745.00  1007.00 12:47:58.743
    42.000  1480.00  1507.00 12:47:58.853
$GPGGA,182706.00,4336.59527,N,07936.64464,W,2,7,2,141.64,M,-35,M,6,118*54    12:47:58.933
    43.000  1600.00  1577.00 12:47:58.972
$GPGSA,A,3,32,,,22,,18,14,12,,09,05,,02.5,01.5,01.9*0B                       12:47:58.972
    44.000  1440.00  2407.00 12:47:59.073
    45.000  1400.00  2507.00 12:47:59.183
    46.000  1600.00  2207.00 12:47:59.293
    47.000  1150.00  2203.00 12:47:59.403
    48.000  1130.00  2504.00 12:47:59.513
    49.000  1320.00  2607.00 12:47:59.623
    50.000  1430.00  2603.00 12:47:59.733
```

B.2 NAV601 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 #3"
          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: "bldg 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 #3"
         -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: "bldg corner"
         -79.610835333    43.609898833  01:59:53.00
```

B.3 Retrieved and Positioned Field Comments

File containing retreived and positioned comments starts with a header indicating name of the original NAV601 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  : 052818A.823
  -79.610851833    43.609890333  "Stake#10"      18:17:41.934
  -79.610850500    43.609890167  "Stake#20"      18:29:32.187
  -79.610833500    43.609879500  "Stake#30"      18:29:36.834
  -79.610833500    43.609879500  "Stahe#40"      18:29:41.974
  -79.610833500    43.609879500  "WoodPile"      18:29:47.636
  -79.610835167    43.609885833  "Sm Tree "     18:37:11.833
```

B.4 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 geodetic coordinates and it contains elevation data.

Example of XYZ File Created by TrackMaker601

```
//Sensor #1 followed by Sensor #2
// Geodetic [DDD.DDDDDD], Datum: WGS1984
// Longitude, Latitude,  Sensor, Elev.[m],    Quality, Sat., PDOP,  Time
Line 0_1
  -79.610761099   43.609898181  1920.00   141.840   2   7   2.50    12:47:55.010
  -79.610761009   43.609898838  1330.00   141.840   2   7   2.50    12:47:55.120
  -79.610760920   43.609899503  1300.00   141.840   2   7   2.50    12:47:55.230
  -79.610760830   43.609900159  1200.00   141.840   2   7   2.50    12:47:55.341
  -79.610760728   43.609900815  1200.00   141.840   2   7   2.50    12:47:55.450
  -79.610760639   43.609901480  1100.00   141.840   2   7   2.50    12:47:55.560
  -79.610760549   43.609902137  1300.00   141.840   2   7   2.50    12:47:55.670
  -79.610760459   43.609902802  1400.00   141.840   2   7   2.50    12:47:55.780
  -79.610760328   43.609903674  1500.00   141.840   2   7   2.50    12:47:55.890
  -79.610760184   43.609904527  1600.00   141.839   2   7   2.50    12:47:56.000
  -79.610760031   43.609905282  1700.00   141.838   2   7   2.50    12:47:56.110
  -79.610759889   43.609906036  1800.00   141.837   2   7   2.50    12:47:56.220
  -79.610759748   43.609906782  1900.00   141.836   2   7   2.50    12:47:56.330
  -79.610759595   43.609907536  1300.00   141.835   2   7   2.50    12:47:56.440
  -79.610759453   43.609908291  1400.00   141.834   2   7   2.50    12:47:56.550
  -79.610759300   43.609909036  1600.00   141.833   2   7   2.50    12:47:56.659
  -79.610759159   43.609909782  1150.00   141.832   2   7   2.50    12:47:56.769
  -79.610759005   43.609910537  1130.00   141.831   2   7   2.50    12:47:56.879
  -79.610758941   43.609910635  1320.00   141.829   2   7   2.50    12:47:57.007
  -79.610758861   43.609911390  1430.00   141.794   2   7   2.50    12:47:57.099
  -79.610758789   43.609911848  1550.00   141.770   2   7   2.50    12:47:57.209
  -79.610758716   43.609912307  1650.00   141.746   2   7   2.50    12:47:57.319
  -79.610758644   43.609912765  1733.00   141.721   2   7   2.50    12:47:57.430
.......................................
and after end of Sensor #1 data for Sensor #2 follows
  Line 0_2
  -79.610748772   43.609897274  2534.00   141.840   2   7   2.50    12:47:55.010
  -79.610748680   43.609897934  2307.00   141.840   2   7   2.50    12:47:55.120
  -79.610748589   43.609898594  2534.00   141.840   2   7   2.50    12:47:55.230
  -79.610748497   43.609899254  2207.00   141.840   2   7   2.50    12:47:55.341
  -79.610748405   43.609899914  3407.00   141.840   2   7   2.50    12:47:55.450
  -79.610748314   43.609900574  2507.00   141.840   2   7   2.50    12:47:55.560
  -79.610748222   43.609901234  3607.00   141.840   2   7   2.50    12:47:55.670
  -79.610748130   43.609901894  2007.00   141.840   2   7   2.50    12:47:55.780
  -79.610748039   43.609902554  2207.00   141.840   2   7   2.50    12:47:55.890
  -79.610747915   43.609903267  1907.00   141.839   2   7   2.50    12:47:56.000
  -79.610747769   43.609904019  1007.00   141.838   2   7   2.50    12:47:56.110
  -79.610747622   43.609904771  1507.00   141.837   2   7   2.50    12:47:56.220
  -79.610747475   43.609905522  1577.00   141.836   2   7   2.50    12:47:56.330
  -79.610747329   43.609906274  2407.00   141.835   2   7   2.50    12:47:56.440
  -79.610747182   43.609907026  2507.00   141.834   2   7   2.50    12:47:56.550
  -79.610747037   43.609907770  2207.00   141.833   2   7   2.50    12:47:56.659
  -79.610746890   43.609908522   407.00   141.832   2   7   2.50    12:47:56.769
  -79.610746743   43.609909274   507.00   141.831   2   7   2.50    12:47:56.879
  -79.610746573   43.609910148   607.00   141.829   2   7   2.50    12:47:57.007
  -79.610746558   43.609910346   607.00   141.794   2   7   2.50    12:47:57.099
  -79.610746484   43.609910807   307.00   141.770   2   7   2.50    12:47:57.209
  -79.610746411   43.609911267   407.00   141.746   2   7   2.50    12:47:57.319
```

Example of XYZ File in Line Format

```
//WGS84-Zn17:Easting[m] Northing[m] Sensor_Data Elev.[m] Quality Sat. HDOP Time

Line 10 - Sensor#1

s     608907.744    4830221.204    46.00   174.250   8   9   2.00  15:51:11.517
      608907.743    4830221.256    47.00   174.250   8   9   2.00  15:51:11.611
      608907.742    4830221.307    46.00   174.250   8   9   2.00  15:51:11.704
      608907.741    4830221.351    46.00   174.250   8   9   2.00  15:51:11.782
      608907.740    4830221.403    46.00   174.250   8   9   2.00  15:51:11.876
      608907.740    4830221.455    46.00   174.250   8   9   2.00  15:51:11.970
      608907.739    4830221.507    46.00   174.250   8   9   2.00  15:51:12.064
      608907.738    4830221.559    46.00   174.250   8   9   2.00  15:51:12.157
      608907.737    4830221.611    46.00   174.250   8   9   2.00  15:51:12.251
      608907.736    4830221.655    46.00   174.250   8   9   2.00  15:51:12.329
      608907.735    4830221.707    46.00   174.250   8   9   2.00  15:51:12.423
      608907.735    4830221.759    46.00   174.250   8   9   2.00  15:51:12.517
      608907.734    4830221.811    46.00   174.250   8   9   2.00  15:51:12.611
      608907.733    4830221.863    46.00   174.250   8   9   2.00  15:51:12.704
      608907.732    4830221.915    46.00   174.250   8   9   2.00  15:51:12.798
      608907.731    4830221.967    46.00   174.250   8   9   2.00  15:51:12.892
      608907.730    4830222.010    47.00   174.250   8   9   2.00  15:51:12.970
      608907.730    4830222.063    47.00   174.250   8   9   2.00  15:51:13.064
      608907.729    4830222.114    47.00   174.250   8   9   2.00  15:51:13.157
      608907.728    4830222.158    47.00   174.250   8   9   2.00  15:51:13.236
      608907.727    4830222.219    47.00   174.250   8   9   2.00  15:51:13.345
      608907.726    4830222.271    46.00   174.250   8   9   2.00  15:51:13.439
      ................................
and label "e" at the end of survey line
      608917.239    4830236.528    15.00   174.250   8   9   2.00  16:00:51.048
      608917.246    4830236.589    24.00   174.250   8   9   2.00  16:00:51.157
      608917.250    4830236.633    32.00   174.250   8   9   2.00  16:00:51.236
      608917.256    4830236.684    36.00   174.250   8   9   2.00  16:00:51.329
e     608917.261    4830236.737    41.00   174.250   8   9   2.00  16:00:51.423

Line 12.00 - Sensor#1

s     608917.293    4830237.863    36.00   174.250   8   9   2.00  16:01:39.564
      608917.292    4830237.914    42.00   174.250   8   9   2.00  16:01:39.657
      608917.291    4830237.966    46.00   174.250   8   9   2.00  16:01:39.751
      608917.290    4830238.009    49.00   174.250   8   9   2.00  16:01:39.829
      608917.289    4830238.061    52.00   174.250   8   9   2.00  16:01:39.923
      608917.288    4830238.121    51.00   174.250   8   9   2.00  16:01:40.032
      608917.288    4830238.165    41.00   174.250   8   9   2.00  16:01:40.111
      608917.287    4830238.216    33.00   174.250   8   9   2.00  16:01:40.204
      608917.286    4830238.268    24.00   174.250   8   9   2.00  16:01:40.298
      608917.285    4830238.311    16.00   174.250   8   9   2.00  16:01:40.376
      ................................
```

Selected NMEA Messages

C

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