

**Spectra Precision Terrasat's
Ingenious Postprocessing Software**

GeoGenius

User's Manual



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Note

We are aware of the fact that our exclusive masculine pronoun "he" is considered politically incorrect, but has been used in this case to simplify readability.

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1.1 Welcome

GeoGenius is a suite of software programs which make working with Global Positioning Systems (GPS/GLONASS) easier than ever before. It operates in a Windows 95 or Windows NT environment, exploiting all the power from these platforms. It is designed to work with all major makes of GPS/GLONASS receivers and supports import/export of different types of data. **GeoGenius** offers combined analysis of GPS/GLONASS and total station data in one project

GeoGenius supports processing in all survey methods: Static, Short Static (Rapid Static), Kinematic, Stop & Go Kinematic and Reoccupation, GIS. After processing import collected total station and levelling data for combined network adjustment and transformation. There are modules for planning, processing, network adjustment, transformation and projection, data download, OTF (On-The-Fly) ambiguity resolution and GPS-Edit, the advanced data analysis package.

GeoGenius has the unique ability to manage, visualize and edit data in projects. Data items can be accessed via a graphical plot, via several tables or within a tree-style navigator. Context menus and property pages allow direct, easy and fast access to data items. The user interface is very intuitive and therefore easy to learn and easy to use.

1.2 Using this Manual

This manual gives a general introduction to GPS/GLONASS and explains features, handling and tools of **GeoGenius**.

Chapter 2 contains system requirements, installation and registration for **GeoGenius**.

Chapter 3 guides you through your first use of **GeoGenius**. It helps you to become familiar with the software.

Chapter 4 provides information on the Global Positioning Systems.

Chapter 5 introduces the user interface elements, such as the main window, the navigator and the project plot. It describes in detail the project management options and the data import and export.

Chapter 6 explains the term System. It introduces step by step the definition of a System and the customizing of the Standard Map Projection. It also discusses heights.

Chapter 7 discusses the steps to prepare a network for processing.

Chapters 8, 9 and 10 offer a detailed description of static and kinematic baseline processing and of quality control.

Chapter 11 concentrates on the use of total station data and levelling measurements in your projects.

Chapter 12 gives details on the theoretical background as well as on practical questions of network adjustment and gives some hints how to improve your network.

The transformation package allows you to work in purely local Systems. It is the subject of chapter 13.

Chapter 14 summarizes additional, built-in features of **GeoGenius**.

The Appendices contain supplementary information and help. Appendix A contains hints how to customize your system. Appendix B describes data formats used with **GeoGenius**. Appendix C briefly describes the available functions, built-ins and macros, which allow you to run additional scripts and thereby to modify **GeoGenius**' functionality. Appendix D introduces each set of the sample data. Appendix E contains several specific applications. Annotated reports are collected in Appendix F.

The **GeoGenius** program group comes along with a lot of applications, which act as stand-alone programs. Most of them are based on a built-in macro language. This means, that you can modify and extend a tool for your individual needs.

More tools are documented in comprehensive User's and Programmer's Guides. These include:

- **GeoTrans User's Manual** – Description of the point coordinate transformation and transformation adjustment tool
- **Gps-Edit User's Manual** - Description of the GPS and GLONASS data visualization and editing tool
- **Planning User's Manual** – Description of the visual analysis of visibility tool for GPS, GLONASS and geostationary satellites
- **HyperPage User's Guide** – Description of the tool to present formatted text
- **HyperPage Macro Programming Guide** – Description of all functions, built-ins and macros local to **HyperPage**.
- **TIM Programmer's Guide** – Description of the language elements of the Tiny Macro Interpreter **TIM**.

- **GeoCom** – Description of the Geotracer® Communication Software
- **WinFX Handbuch** – description of the Geotracer® Communication Software on the basis of Windows.

You will find all these tools as Part II of the **GeoGenius** manuals.

1.3 Conventions

This manual uses specific topographic styles to help you identify commands and keyboard entries. The following table lists the styles in use:

Item	Example
MSDOS command	(Type) dir C:\ more
FILE NAME	SETUP.EXE
Keyboard button	Alt+A (+: press and hold the keyboard buttons simultaneously)
Windows buttons	OK, Cancel
Menu item	(Click) <u>F</u> ile/ <u>S</u> ave
Dialog Title	Format Selector
A warning:	 Do not ...
A hint:	 You may also ...

1.4 Technical Support

1.4.1 Support

Spectra Precision Terrasat GmbH provides 90 days free technical support on newly purchased or upgraded **GeoGenius** modules after registration. Then, annual support and upgrade contracts can be purchased.

For upgrade and support contracts please contact:

Spectra Precision Terrasat GmbH
Haringstr. 19
85635 Hoehenkirchen, Germany
Tel ++49-8102-7433-200 Fax ++49-8102-7433-131 or -26

All queries regarding the **GeoGenius** Software and installation can be made directly to Terrasat via fax, phone, E-mail and mail and Terrasat undertakes to respond within the shortest possible time within the limits of office hours, Public Holidays and other occasions when Terrasat office is closed. Terrasat aims at providing the customer with normal response within 48 hours.

In order to respond to your questions, our support engineers and surveyors need as much information as possible:

1. Your address, fax number, telephone number, etc, depending on the media you use
2. Your license number (if software protected)
3. The version of **GeoGenius** you are using. The version number is displayed in the About **GeoGenius** dialog (click Help/About...).
4. The software modules implemented
5. Did an error message appear? If so, what did it say?

Owners of an upgrade and support contract will receive all upgrades and new releases of **GeoGenius** Software including all documentation.

1.4.2 Electronic Information

Connect to our home page on the Web at www.terrasat.de and view all the latest in technical and product information. The most current patches to all members of the **GeoGenius** program group will also be available from the Web.

1.5 Training

Spectra Precision Terrasat offers training programs, which help you to step into the features of **GeoGenius** in a minimum of time. After one day's training with our staff (mainly surveyors) you will not only understand **GeoGenius'** philosophy, but will have detected the full functionality of the program group.

Our training programs can be structured to meet your individual needs. For information on our training programs, call Spectra Precision Terrasat (+49/8102-7433-0)

2. Setup

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2.1 Setup

2.1.1 Start Installation

To install **GeoGenius** on your computer's hard disk put the installation CD-ROM into the CD-ROM drive. The setup program will start automatically.

Alternatively run the file:

`<CD-DRIVE>:SETUP.EXE`

The setup program will guide you through the installation process.

The full installation of **GeoGenius** requires about 200 MB free disk space on your installation drive.

Accept your entries via the buttons **OK** or **Next**. Via the button **Back** you may return to the previous step in the Installation. **Cancel** cancels the process without installation.

2.1.2 Installation Options

With the start of the installation program, you may choose the language version of your copy of **GeoGenius**. The chosen language version affects

- ◆ The setup language
- ◆ The program language

The next entries to be made are the standard setup options, such as to enter user and company information and to choose the installation directory. Next, choose the installation type:

◆ **Typical Installation**

Choosing the installation option **Typical Installation** will install the typical components of **GeoGenius** on your hard disk. This installation type is recommended for most of the users, since it allows access to **GeoGenius**'s full powers. So, if the installation program refuses to install **GeoGenius** due to lack of disk space, please try and use the **Custom Installation** option.

◆ **Compact Installation**

Choose this option, if you want to install the program with the minimum required options.

◆ **Custom Installation**

You may want to choose the custom installation option for an installation tailored to your needs and hard disk capacity.

2.1.3 Components of Installation-type Custom

If you start a custom installation, you may select from the following options to be installed on your hard disk. Each component also shows the disk space it will use. Move the cursor to one of the component names to receive a short description of its meaning within the block Description.

Program Files	installation of the main module, which includes import of terrestrial and satellite data, data processing,

	network adjustment, coordinate transformation, visualization and export of results, and much more.
Help Files	installation of help files
Samples	installation of some set of sample data. Included is the basic sample data set "Getstart", to which many of the examples of this manual refer.
More Samples	installation of sophisticated sample data sets to be used for various purposes.
Geoid Models	installation of geoid models (see section 2.1.5)
Deformation Analysis	installation of the Deformation Analysis Package.
Transfer	installation of tools, which allow the transfer of data between the receiver and your PC.
3D Satellite Animation	installation of the GeoMotion package.

After typical installation, the **GeoGenius** program group will contain 7 objects



Figure 2-1: The **GeoGenius** Group

2.1.4 Uninstall GeoGenius

The installation creates an entry in the Add/Remove Software section of the Control Panel. Select the entry "GeoGenius" to uninstall **GeoGenius**.

Note that only those files that were copied onto your computer will be deleted during the uninstall process. Most likely, **GeoGenius** has generated temporary files in the sample's directory. You can remove these files and the respective directory tree after the uninstall process is finished.

2.1.5 Geoid Models Included

The installation program of **GeoGenius** installs the geoid model "World (JGM3/OSU91A)" as a part of the core module onto your hard disk (via the installation types Typical and Compact or if you have selected the module **Program Files** within the custom installation). You will install more geoid models, if you choose the installation type Typical or the module Geoid Models of the Custom installation. .

Geoid models are defined by one or more data files. **GeoGenius** offers interfaces to all those geoid models it finds corresponding data files to. After installation you will find the geoid models within the directory

<InstallDir>\SYSDBS

GeoGenius will automatically recognize all geoid models that are located in this directory.

The following geoid models are provided by the **GeoGenius** installation:

Setup:	Full Name:	Data Files:
NOAA94 AL Canada	Alaska NOAA94 Canada GSD91	ala94.geo ngsd91.bin, ngsd91.slv
NOAA93 Centr	Central US NOAA93	geoid93c.geo
NOAA93 East	Eastern US NOAA93	geoid93e.geo
NOAA93 Haw	Hawaii NOAA93	haw93.geo
NOAA96 Haw	Hawaii NOAA96	geo96hw.geo
Italy	Italy ITG90	ital90fl.dat
NOAA96 N Al	North Alaska US NOAA96	geo96an.geo
NOAA96 NC	Northcentral US NOAA96	geo96nc.geo
NOAA96 NE	Northeastern US NOAA96	geo96ne.geo
NOAA96 NW	Northwestern US NOAA96	geo96nw.geo
NOAA96 PRVI	Puerto Rico - Virgin Islands	geo96pr.geo
NOAA93 PRVI	Puerto Rico NOAA93	prvi93.geo
NOAA96 S Al	South Alaska US NOAA96	geo96as.geo
NOAA96 SC	Southcentral US NOAA96	geo96sc.geo
NOAA96 SE	Southeastern US NOAA96	geo96se.geo
NOAA96 SW	Southwestern US NOAA96	geo96sw.geo
Sweden	Sweden RN92	rn92.grd
NOAA93 Weast	Western US NOAA93	geoid93w.geo
World	World (JGM3/OSU91A)	wwgrid.jgm
EGM96	EGM96	Ww15mgh.grd
France RAF98	France RAF98	Raf98.gra

The JGM3/OSU91A model is the worldwide standard model for geoid undulations. It is the best currently available global model which was derived from a spherical harmonic expansion JGM3 for degree and order 2 .. 70 and from the Ohio State University model OSU91A for terms 71..360. The system is implemented as a grid with a grid size of 0.25 degrees covering the earth from N85° to S85°.

2.1.6 Install Commercially Available Geoid Models

You may also get additional geoid model data files from developing surveying institutions. Copy these files to

<InstallDir>\SYSDBS\

GeoTrans has implemented interfaces to the following, commercially available geoid models:

Supplier:	Full Name:	Data Files:
Univ. Hannover, Germany IfE Institut für Erdmessung	European EGG 97	G* .BIN
Univ. Hannover, Germany	Germany IFE	GEOFRG .DAC
Geomatics Canada Geodetic Survey Division	Canada GSD95	ngsd95 .bin, ngsd95 .slv

2.1.7 Adding a User Defined Geoid Model

To use your own geoid model with **GeoTrans** all you have to do is to prepare a file with your geoid data and copy it into the directory <InstallDir>\SYSDBS. The data file must have one of the specific formats and file name extensions for **GeoTrans** to recognize the data files and to add the geoid model to the system.

Currently, **GeoTrans** recognizes geoid model files of the following file formats:

No	File Name Extension

1)	*.UG1

For a full description of this option please refer to the **GeoTrans Manual**.

2.1.8 Upgrading from a Previous Version

You can ignore this section, if this is your first installation of **GeoGenius**.

If you are going to install a new version of **GeoGenius**, first de-install the old version. How to uninstall the program or components is described in the previous sections of this chapter.

If you have not de-installed your old copy of **GeoGenius**, the setup routine will install the new version over the old one. Registry entries will register a second version of the program and a later de-installation of the old version will not be possible any more!

If you want to save the setup information of your former **GeoGenius** version, backup the file <PRIMARY DRIVE>\WINDOWS\GG.INI under a new name. When exiting, **GeoGenius** generates an initialization file on the basis of its recent settings. To avoid version conflicts the initialization file for v1.5 is file GG15.INI, while v2.0 creates the file GG20.INI.

2.1.9 System Updates

From time to time, updates of **GeoGenius** will be available. These will be offered in form of patch files. (The WWW presents you regularly News and Information on current Updates or Upgrades! You may even download new patches or samples. Visit our address www.terrasat.de.)

2.2 License Protection and Software Registration

2.2.1 Overview

GeoGenius is license protected! The software as it is distributed on CD is a demonstration copy (Check the status bar for DEMO indicator). It will work only with the data sets provided on the CD. In order to convert this software into a fully functional licensed copy you have to request a License Key from your dealer.

You have the choice of three different protection modes:

- a) software protection via a license file
- b) hardware protection via a hardware key (so-called “dongle”)
- c) software protection via a network license

The license file locks **GeoGenius** to a specific computer while the hardware key allows you to transfer the license to a different computer.

If you have been supplied with a hardware key, please use it. It gives you the flexibility to transfer your license from one computer to another simply by plugging the key into the new computer, whereas the software protection is restricted to the one machine on which you register the software.

To register **GeoGenius**, you have to fill in a license registration form where you select the desired components (see section 2.2.2 License Request). In return for providing the information you will get a License Key number with which you can activate your permanent license (see section 2.2.3 Single License Activation).

Here is a check-list on how to convert your demo software to a permanently licensed version. (More detailed instructions are given in section 2.2.2.)

- a) If a hardware key was included with your shipment, plug it in first.
- b) Start **GeoGenius** (GG???.EXE) and check, if the status bar shows **DONG** (for hardware-protection) or **SOFT** (for software key protection). If it does then your software is already registered, you do not need to do anything else. You can use the software immediately. You can check which options are enabled by opening the about-box and selecting the Features tab.
If the status-bar shows **DEMO** instead, you do not have a valid permanent license. You have to proceed with the next step to request a license.
- c) Double-click the License Request icon in the **Geo-Genius** program group, or start this application by the corresponding application name **LI - License Request**  **CREQU . EXE**.
- d) Choose from the offered license packages for **GeoGenius** and (if desired) include optional modules to your selection.
- e) Walk on to the next dialog by pressing the **Continue . . .** button.
- f) Fill in the registration form with your personal data. (You might leave the field Company blank, if **GeoGenius** is going to be your personal copy.)

- g) Choose from four ways of forwarding the registration form to your software vendor:
- Send it as an appended file via e-mail to your software vendor (button **Send per Email**), or
 - print out the form and fax or mail it (button **Print Form**), or
 - copy the registration form contents to clipboard, paste it into your text editor for further editing and forward the document to your vendor (button **Copy to Clipboard**), or
 - call your software vendor and provide him with all the information on the registration form.
- h) The software vendor will in return provide you with a License Key.
- i) Double-click the License Activation icon in the **GeoGenius** program group, or start this application by the corresponding application name **LICACTIV.EXE**.
- j) Enter the License Key and activate the license by pressing the **Create/Update License** button.
- k) The program will immediately display the options you registered for in the option list.



2.2.2 License Request

You have to register your **GeoGenius** software in order to convert it from the initial demo mode to a fully functional, permanent license. The installation has created a program icon **License Request** in your



GeoGenius program group. Double-click this icon to run the license request program. Alternately, you can start the program directly using <INSTALLATION DIR>\LICREQU.EXE.

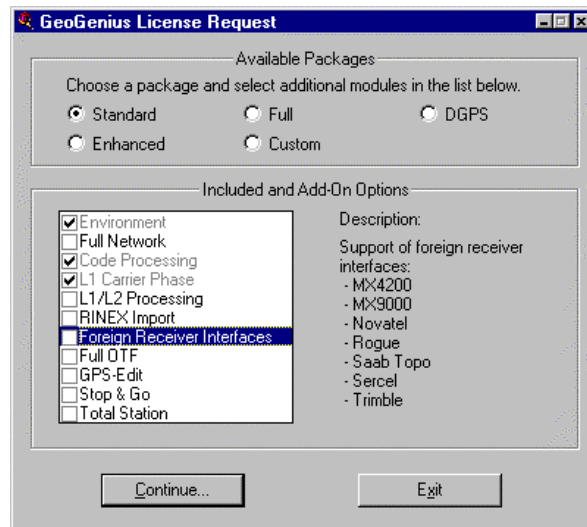


Figure 2-2: License Request

The first dialog window shows a group of radio buttons for pre-bundled packages of **GeoGenius** (group Available Packages) as well as a listbox with checked/unchecked components (group Included and Add-On Options).

Pressing the **Exit** button or the **ESC** key will terminate the license request program.

You can select one of the four pre-bundled packages for **GeoGenius** or choose **Custom** if you want to have free choice of all components. Components that are fixed as included in the selected package will

have their check box marked. Although you can add additional components to the package, you have to ensure that you have purchased the options you have selected, otherwise you may delay the issuing of the correct activation number. Your **GeoGenius** representative will be happy to arrange the purchase of additional components.

Placing the cursor on one of the listbox entries will display a short description of the component in the **Description** box on the right hand side. Components that are disabled cannot be selected with the mouse, but you may move to them with your up/down cursor keys. Or, select the package radio button **Custom** to have all components enabled.

When you have chosen all desired components click on **Continue...** to enter the Registration Form dialog.

Fill in the Registration Form dialog fields with your personal data. Name and address are required information. In case **GeoGenius** is going to be your personal copy, you can leave the field Company blank.

If you are interested in an additional support contract, click one of the support contract options. Your vendor will then send you a contract to be signed by both parties, before its period starts (refer to chapter 1.4).



How to find out whether the hardware key has been detected:

If a **GeoGenius** hardware key has been detected, then the Node code has to start with the character D. If you have got a hardware key while the Node code does not start with the character D, then your key was not detected. Exit the application, plug the key into your parallel port and restart the License Registration. If no key is detected, the software protection mode is chosen automatically.

System administrators, who want to request licenses for other computers than their own one, please contact their vendors before activating the license registration.

At the bottom of the Registration Form dialog a list allows you to double-check the component selection you have made in the previous dialog. Just above this, you can see the type of package you have chosen. A trailing “+” sign behind the package name indicates that you have selected additional options to the package. You can step back to the previous dialog to make changes. All your personal data entered during this session will be kept.

The screenshot shows a 'License Registration Form' dialog box with the following fields and controls:

- Name:** My Name
- Title:** [Empty]
- Company:** My Company
- Street:** [Empty]
- City:** [Empty]
- Postal Code:** [Empty]
- State:** [Empty]
- Country:** [Empty]
- Phone:** [Empty]
- Fax:** [Empty]
- Email:** [Empty]
- I am interested in a support contract for:**
 - ☐ 1 year
 - ☐ 2 years
 - ☐ 3 years
 - ☒ not interested
- Additional Information:** [Empty]
- Product:** GeoGenius
- Version:** 1.5
- Node Code:** 51022F2914F4980000
- Package:** Standard
- Options:** Environment, Code Processing, L1 Career Phase (indicated by a trailing '+')
- Buttons:** Send per Email..., Print Form..., Copy to Clipboard, Back

Figure 2-3: Registration Form

When you have finished entering your data you can choose one of the following ways to forward the registration form to your software vendor. (System administrators, who want to request licenses for other computers than their own one, please contact their vendors before.)

1. Send per E-mail

Clicking this button will generate a text file that contains the data you see and entered in the Registration Form dialog and then opens your e-mail program with the text file appended to a new empty message. You then only have to enter the recipient and send the e-mail. If desired you can also add additional text to the e-mail.

NB. This option will only function if Microsoft Exchange has registered your e-mail system.

2. Print Form...

Clicking this button will open the **MultiPage** application (REP-VIEW.EXE) displaying a fully formatted Registration Form page. Print this page using File/Print and send or fax it to your software vendor.

3. Copy to Clipboard

Clicking this button will generate a text that contains the data you see and entered in the Registration Form dialog and then places this text into your clipboard. Now you can go to your standard text editor and paste the registration information into, for example, a letter to the software vendor. Or you might paste the information into an e-mail message you are about to write.

4. Via Telephone

You might even just call your vendor and forward him all the information on the print form via telephone.



How to find out where to send the registration form:

If you do not have information where to send the registration form, please click on **Print Form...** The central contact address of your software distributor will be shown in the upper left-hand corner of the registration form printout.

After you have generated or e-mailed the registration form you can return to the previous dialog using **Back** and then exit the program.

2.2.3 Single License Activation

In reply to your registration request your software vendor will send you a License Authorization Form which states a License Key. In order to activate your license with this key you have to run the License Activation program (LICACTIV.EXE) that is included in your **GeoGenius** program group.



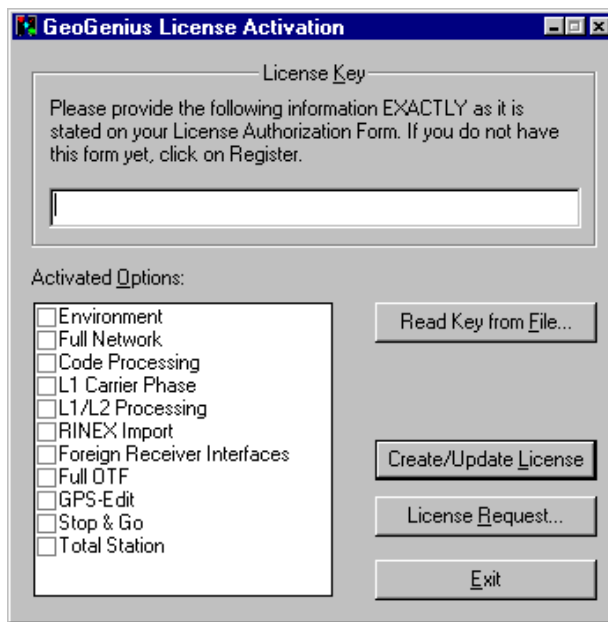


Figure 2-4: License Activation Form

If your License Key starts with a “D” make sure you plug in your hardware key before starting the License Activation.

Enter the longish License Key into the edit fields exactly as stated. Alternatively your software vendor might have provided you with a text file that contains the same information. Then you can load this information from the file using the **Read from File...** button.

After you have entered the requested information press the **Create/Update License** button. Then the License Key will be analyzed by the program and your hardware key or your hard-disk serial number is matched with the License Key. If the match succeeds the li-

cense is activated and the list box **Activated Options** will be updated according to your license.

After your license was activated successfully you can end the program by pressing **Exit** or the **ESC** key. When exiting, the License Activation program generates a file called **LICINFO.TXT**, which is placed into the **GeoGenius** installation directory. It stores your current License Key. If you evoke the License Activation program again later on you can review it and the currently activated options.

If you happened to start the License Activation program before requesting a license of **GeoGenius**, pressing the **License Request...** button will put you into the License Request program (**LI-CREQU.EXE**) which is also included in your **GeoGenius** program group.

You may be interested in what happens internally when you activate your license by pressing the **Create/Update License** button. The rest of this chapter will provide you with this information.

If you have entered a hardware-protection License Key (indicated by a "D" as the first character of the key), then the **GeoGenius** hardware key that is plugged into your computer is reconfigured to support the options you have registered for. **GeoGenius** detects the key during execution and sets the enabled options accordingly.

Since the dongle-protected license is only bound to the hardware key you can transfer the license from one computer to another simply by installing the **GeoGenius** software on the new computer and plugging the activated hardware key into the new computer.

If you have entered a software-protection License Key (indicated by an "S" as the first character of the key) then a so-called "license file" is

generated in the **GeoGenius** installation directory. The license file has the name **LICENSE.DAT**. **GeoGenius** detects the file during execution and sets the enabled options accordingly.



Note that components that you did not register for will be disabled when you use your new license file. In case you would like to evaluate these components again, save your license file in a secure location and delete it from the installation directory.

The license file is an ordinary text file. Since each line in this file is protected via a cross-sum which is calculated into the License Key number, alterations to the file's contents result in invalidation of your license.



You should save the **LICENSE.DAT** file to a floppy disk, or to your backup system and keep a printout of it in a save location. It may be needed in case the file gets accidentally deleted or modified.

You are allowed to use the software only on the computer the license was given for. If you change the computer on which you wish to use **GeoGenius**, you have to request a new License Key for the new computer. System administrators, who want to request licenses for other computers than their own one, please contact their vendors before activating the license registration.

2.2.4 Network License Activation

With a network license, the network administrator installs **GeoGenius** on the network server. A compact installation (no geoid models, sample data or help files) will be sufficient. Then he copies the license file LICENSE.DAT into the **GeoGenius** installation directory. If **GeoGenius** is started on the server, it will be available for all PCs connected to this network.

If you are the user on a network PC, install **GeoGenius** on your PC and start it. You will notice **GeoGenius** running in the DEMO mode. Click the pull-down menu item Help/About/Features.

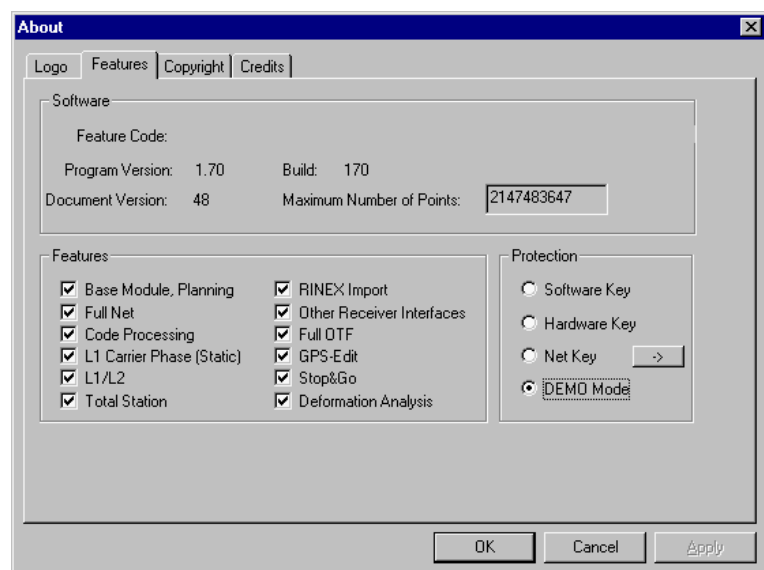


Figure 2-5: Activate Net Key

Click the arrow button next to the option Net Key.

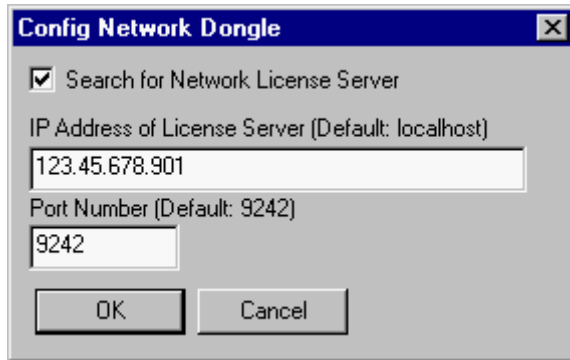


Figure 2-6: Network Key Configuration

Activate the checkbox **Search for Network License Server**. Enter the IP address of your Server. Set the Port Number to 9242. Click the button **OK** and then exit **GeoGenius**. After the restart of **GeoGenius**, the status bar will display the current protection mode NET. I.e., **GeoGenius** accesses to the network server.

2.3 Software Protection by Hardware Key

If you want to use **GeoGenius** with different computers (of course, not simultaneously), you will typically have ordered the software protected by a hardware key. It allows you to transfer the license to different computers.

Attach the hardware key to the parallel (printer) port of your computer. It usually can remain there while you run other programs – other programs do not recognize the key!

If you have a printer connected to the same port, put the hardware key between the computer and the printer connector. With further hardware keys, the **GeoGenius** key should also be attached first. (You may also try out the order of the keys, if you suppose it to disturb the software operation.)

If a hardware key is not any more available (lost, stolen, destroyed, etc.) you must purchase another copy of the software to replace it. **Therefore, we suggest that you insure the key for the full replacement cost of the software.**

Do not remove the hardware key while running **GeoGenius** or other software modules. **GeoGenius** checks during operations several times for the license and terminates the program, if the license is missing.

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3. Getting Started

This chapter is a quick step-by-step tutorial for the basic functionality of **GeoGenius**. Just follow these steps to get a brief overview on **GeoGenius**. For more detailed information please refer to the individual **GeoGenius** manuals and the on-screen tutorial. A few display texts may be slightly different in some software versions.

During this guided tour we use the demo dataset found in the **GeoGenius** subdirectory \SAMPLES\GETSTART\.

Data supplied by Sir William Halcrow and Partners, Consulting Engineers, UK.

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3.1 Installing GeoGenius

If you have not yet installed **GeoGenius**, you should do so following the instructions in chapter 2 of this manual. We suggest that you choose the installation type Typical, which includes the Getting Started demo dataset used here to guide you through **GeoGenius**' most important features.

3.2 Starting GeoGenius

Double clicking the **GeoGenius** icon will take you into the main **GeoGenius** window. This window is the **GeoGenius** Control Center.

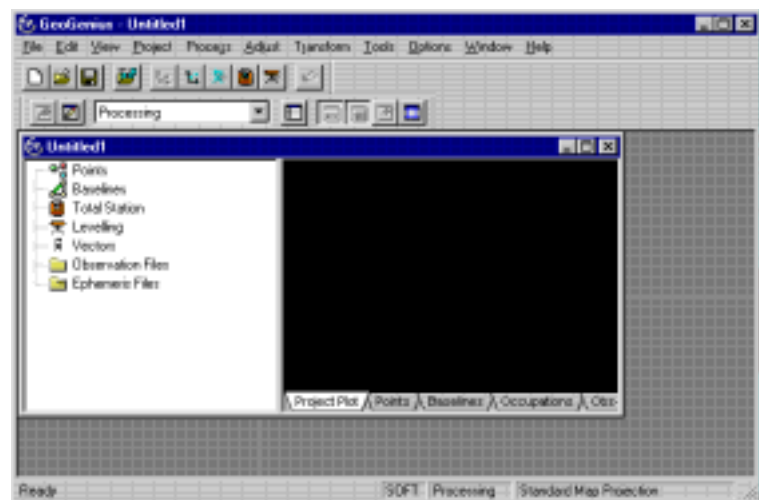


Figure 3-1: GeoGenius Control Center

After the optional Tip of the Day, a new project has automatically been opened with the start of **GeoGenius**. The project window is a sub-window of the control center titled “Untitled1”.

3.3 Show all Toolbars

When starting **GeoGenius** for the first time, the toolbar area of the main window shows two toolbars. **GeoGenius** offers a lot of different toolbars, which you may switch on or off by a menu selection **View/Toolbars** or by clicking the right hand mouse button when the pointer is positioned on the toolbar area. To arrange the toolbars place the pointer on the toolbar (not on a button) to be moved. Press the left mouse button and hold it, the toolbar area is now a floating window. Drag the toolbar to its new position and release the mouse button.

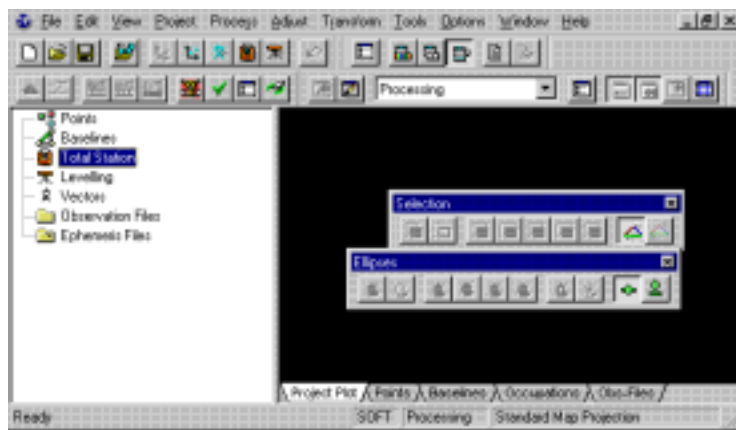


Figure 3-2: All Toolbars Displayed

3.4 Select A System

GeoGenius Projects work within a single coordinate reference system or map projection system. All points are displayed in relation to their geographical coordinates. If you do not select a System, **GeoGenius** automatically chooses the Standard Map Projection.



Select a System, before you insert the coordinate files into the project.

Choose the menu item **Project/System...** Highlight the System **United Kingdom** from the Select System window. (To define or edit a System, click **Editor...**) Click **OK**. The Status Bar at the bottom of the screen will now display the selected System's name, i.e. **United Kingdom**, as the current system.

If the **United Kingdom** system is not available, then click **Editor...** and create the system in the **System Editor**. Select **New**. Edit the Name Box. Click on the radio button next to projection. A list of projections will be displayed. Select **United Kingdom**. Click on the **Change** button next to the Datum Name box. Select **OSGB36**. Click on the ▼ beside the Geoid Model Name Box and select **World (JGM3/OSU91A)**. Click onto **Save, Close**.

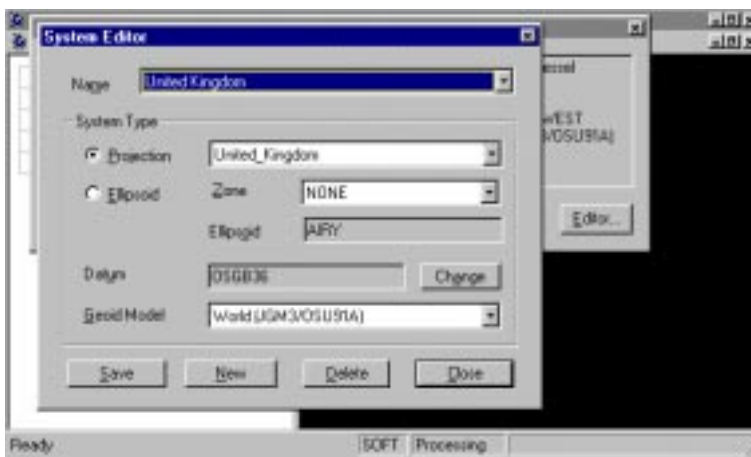


Figure 3-3: Create System

At the **Select System** Page, you should see the System United Kingdom displayed. Click **OK**.

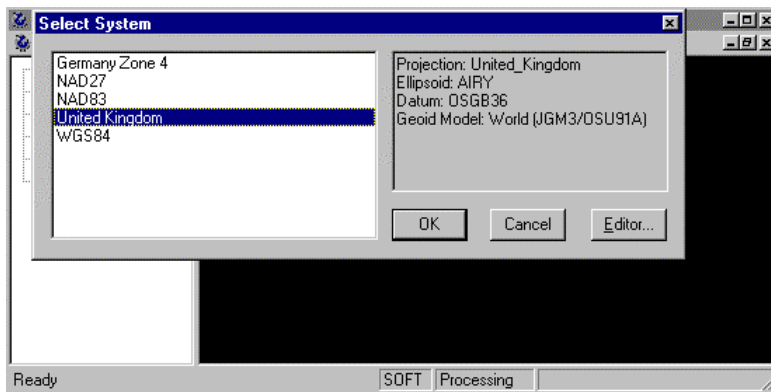


Figure 3-4: Select System

The data processors use the WGS84 Cartesian coordinates for processing data, so the choice of system is irrelevant for processing, however it is necessary for visualization of the results on the project plot and for national network adjustment .

3.5 Finding and Inserting Field Data

GeoGenius organizes its data in projects. All project management information is stored in one project file which is given the default extension *.GGS. The observations can be stored in any location on your PC, and when you insert the data into your project, the manager will just remember the location of each file rather than copy the data to a new location. It is important not to move the data after a project has been saved.

Using the menu option **Project/Files into Project** or the Project Toolbar button select the directory where the files are located. The test data is stored in a subdirectory \SAMPLES \GETSTART of your installation directory; select this directory. Highlight the data files to be inserted into the Project or click **Select All**, click **Add to Project**. During data import, the window titled Ephemeric Generation displays a progress bar while creating the binary ephemeris file. After the Ephemeric Generation window has closed, click **Close**.





Figure 3-5: Insert Files Into Project

A preliminary sketch of the survey project will be displayed. **GeoGenius** will draw each point at its approximate geographical location and draw lines between all points where a baseline has been measured. **GeoGenius** has automatically read the initial position of each receiver from its observation file and analyzed all observation times. Periods of simultaneous data collected at two stations indicate that a baseline has been measured.

The initial station positions are calculated using code measurements and have an accuracy of +/- 100 meters. This means that after processing, the relative positions of some points will change.

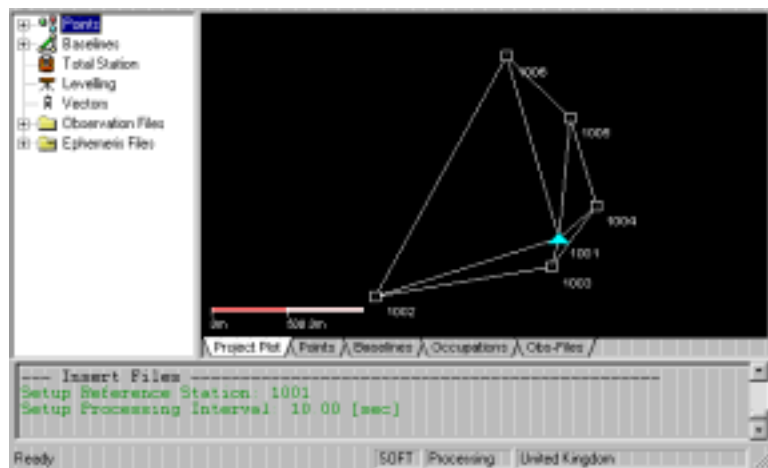


Figure 3-6: Project - Single Point Position Accuracy

Further information on the project is given as tables, which you'll access via tabs on the bottom of the project view. The table Points offers you information on the current coordinates in the national grid system and in the WGS84.

Points	N [m]	E [m]	H [m]	X [m]	Y [m]	Z [m]
1 1001	271212.939	381777.617	30.151	3902184.319	-154625.886	5025877.650
2 1002	270821.976	380562.194	153.164	3902523.803	-155834.858	5025832.864
3 1003	271017.340	381729.934	33.550	3902339.027	-154659.137	5025860.328
4 1004	271424.436	382024.551	-17.702	3901996.331	-154352.102	5026068.248
5 1005	272015.436	381851.115	89.208	3901587.453	-154511.737	5026514.704
6 1006	272422.974	381434.665	-41.248	3901169.960	-154913.651	5026659.520

Figure 3-7: Table Points

The information given in the header of the observation files is given in the tables Occupations and Obs-Files.



	Obs-Files	Receiver	Antenna	Flags	H [m]	N [m]	E [m]
1	1001276A.OBS	Geonacac 2200	Geodetic with GPL2	Slope	1.025	0.000	0.000
2	1002276A.OBS	Geonacac 2200	Geodetic with GPL2	Slope	1.798	0.000	0.000
3	1003276A.OBS	Geonacac 2200	Compact L2	Slope	1.340	0.000	0.000
4	1004276A.OBS	Geonacac 2200	Geodetic with GPL2	Slope	1.852	0.000	0.000
5	1005276A.OBS	Geonacac 2200	Geodetic with GPL2	Slope	1.782	0.000	0.000
6	1006276B.OBS	Geonacac 2200	Compact L2	Slope	1.001	0.000	0.000
7	1006276A.OBS	Geonacac 2200	Compact L2	Slope	1.795	0.000	0.000
8	1006276B.OBS	Geonacac 2200	Geodetic with GPL2	Slope	1.998	0.000	0.000

Figure 3-8: Table Occupations

An output window has been displayed at the bottom of the screen. This is automatically activated the first time that **GeoGenius** generates text of any kind. The output window is very useful because it informs you of progress and activity during many parts of the program. It consists of a message area and a vertical scroll bar. To enable/disable the output option use the menu items View/Show Output and View/Hide Output.

Save the project using the menu option File/Save As... Select a directory and give the project a name. **GeoGenius** will create the default extension *.GG5 automatically. You do not need to key it in.

The title bar at the top of the screen will now display the project name.

3.6 Processing Settings

Select the settings for processing the Project. Access using the menu option Process/Settings... or the Processing Tool-



bar button. Edit the appropriate processing options. The default processing parameters have been set to meet standard processing requirements, however you may want to change the parameters in order to optimize your results. For this example we would recommend that you use the following settings. (The GLONASS (GLN) satellite settings are not applicable for this demo data set, so just leave their settings on default.)

Parameter Page: The values on this page control the baseline processing.



Figure 3-9: Processing Options - Parameters

Processor Page: This page is used to select the **Processing Mode** and how the Project Observation **Sessions** are handled in the processing.

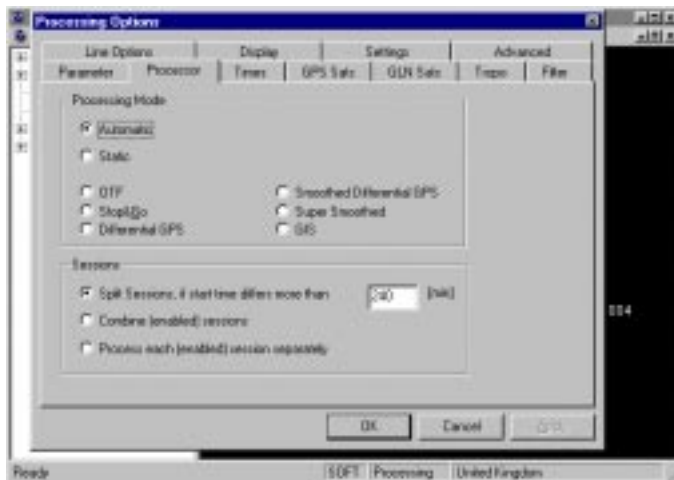


Figure 3-10: Processing Options - Processor

If the default *Automatic* is selected as the **Processing Mode**, then **GeoGenius** will automatically detect the appropriate processing mode for your project. The **Sessions** option controls how the different sessions observed within a project are handled. Where you have more than one session's observations you can select to process the sessions separately or combined. In this example there is only one data session.

Times Page: Processing interval for a selected Baseline. You can change the length of time/data used to process the line by altering start and finish times. The arrows initially point to the first and last times of data in the entire project. The colored bars represent the times of the current baseline. The box Time Zone allows you to enter a time offset in hours to the GPS time zone.

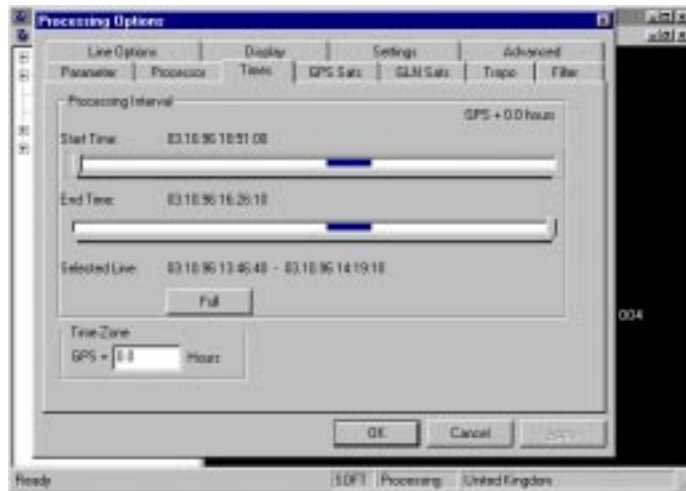


Figure 3-11: Processing Options - Times

GPS Sats and GLN Sats Pages: Allows you to enable or disable satellites from the processing. All unavailable satellites are grayed out.

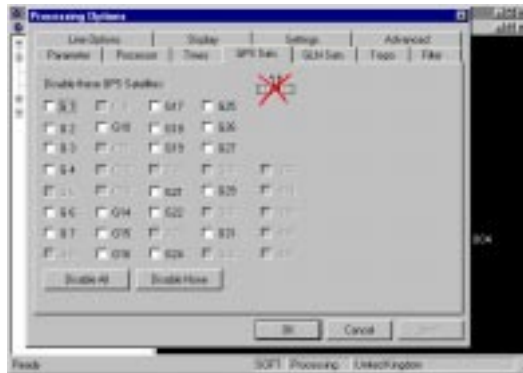


Figure 3-12: Processing Options - Sats

Tropo Page: Allows you to insert known meteorological data and to choose one of several tropospheric models for processing. By default, **GeoGenius** uses the Modified Hopfield model and fixed values.

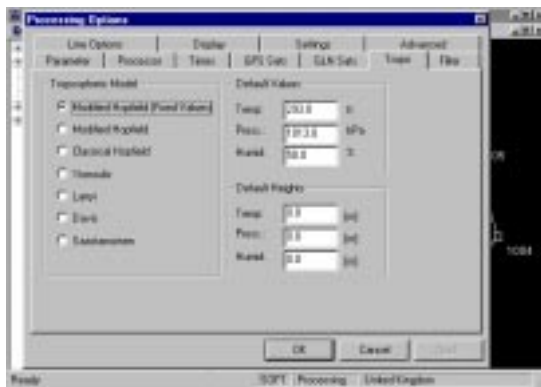


Figure 3-13: Processing Options - Tropo

Filter Page: Is for selecting which results from the baseline processing should be stored in the project. At this stage of the processing we would recommend that all options be selected in the result filter. Then you can select the best of the processing results for use in the adjustment.

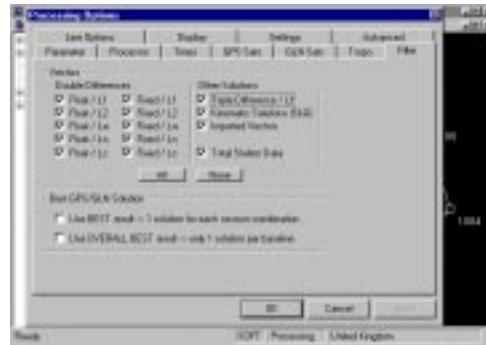


Figure 3-14: Processing Options - Result Filter

Line Options Page: This option is used to set the defaults for the baseline and point identification.

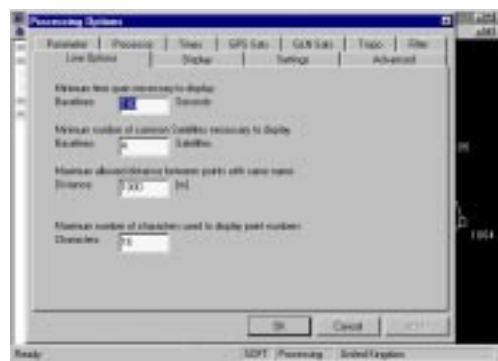


Figure 3-15: Processing Options - Line Options

Two options determine whether or not a baseline is displayed, the minimum time span for a observation option and the minimum number of common satellites used option. **GeoGenius** will only use base-lines visible on the screen for processing or in the network adjustment.

The third option denotes the maximum allowed distance between points with the same name. This helps detect errors in field data such as when two different stations have been given the same name. To be of maximum use, this tolerance must not be set too low. It must allow for errors in the single point positions of different sessions.

Display Page: Allows you to visualize the project in every way within the project plot area. The default layer groups Adjustment and Processing result in different displays after processing/adjustment. You may define additional Layer Groups and set all Layers you want to be displayed. You may modify existing Display Groups.

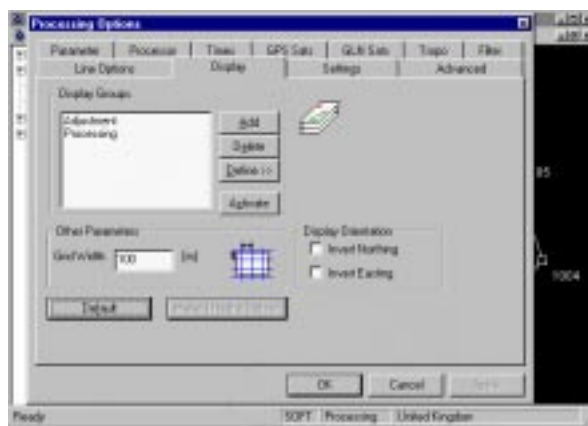


Figure 3-16: Processing Options - Display

Settings Page: These options determine the Display, Processing and Report Options after the processing is complete.

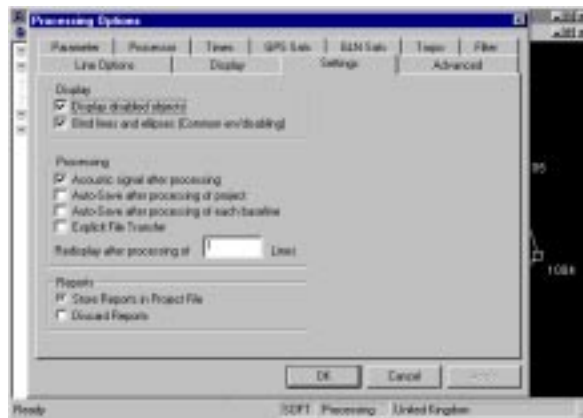


Figure 3-17: Processing Options - Settings

Click the **OK** button to save changes and leave Processing Options.

Advanced Page: A warning message is displayed when you open up this page. This page should only be changed by an experienced user. Inappropriate changes to this page will result in wrong results. For an explanation of this page please refer to the manual section 7.4.7.

If you are uncertain of any changes you make to this page, leave the page using the **Default** command.

3.7 Suggest Reference

One station or point must be selected as the Reference Station or Fixed Point for the Processing. **GeoGenius** will suggest a point to be used as a Reference Station, based on the largest uninterrupted observation time span (first preference) and the most connections to other stations (second preference). However it also gives you the opportunity to select any other point.

To select another point choose either the menu items **Process/Suggest Reference**, or the Processing Toolbar button.

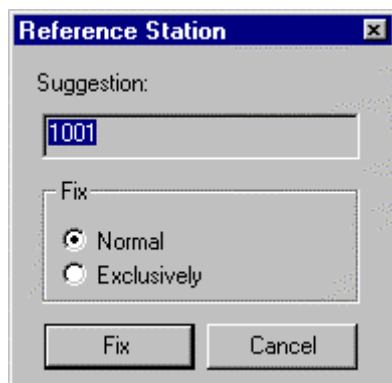


Figure 3-18: Reference Station Definition

The Reference Station can be fixed Normal (if more than one station is to be held fixed) or fixed Exclusively (only one station in the project to be held fixed). For this example, we suggest that you use the default station 1001, which is marked by a triangle on the Project Plot. Click onto **Fix**. (In fact, **GeoGenius** has set the station 1001 automatically as reference station.)

The selected Reference Station point will be marked by a triangle on the Project Plot. Click onto  **Points** (left mouse button) on the Navigator area of the screen. You will see that the Reference Station, point object is marked with a triangle, i.e. . This shows that it is a fixed point. It does not matter whether you select the point in the Navigator or Project Plot areas. **GeoGenius** will mark it automatically in the both areas.

The selection of the Reference Station is very important, as it is the basis for the processing of the entire project. If you have precise coordinates in WGS84 or precise state plane coordinates for any of the points within the project then you should enter them and use one of these points as the Reference Station. Starting from known coordinates gives improved baseline estimator processing performance. If no precise coordinates are available, then the processing is based on its initial or averaged signal point position measurement.

Provided the baseline measurements all connect together during processing, any errors introduced by poor initial coordinates will influence the whole network quality. The error is one of scale. In most cases, the error will be removed by the adjustment and transformation. Care must be taken at the adjustment/transformation stage that the network is made of baselines based on accurate initial coordinates or with sympathetic scale errors. This can be a particular problem with the import of RTK data, which is often based on instantaneous single point position. The error in scale caused by a poor starting coordinate can typically be 1-10 ppm.

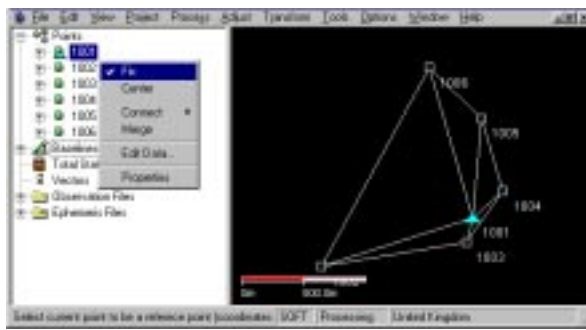


Figure 3-19: Fix Point

To enter precise coordinates for the Reference Station click on the  **Point Name** (right mouse button). Select menu item **Properties** (left mouse button). Enter either the national (State Plane Coordinate System) or local system coordinates Northing, Easting and ellipsoidal Height (pages National or Local, the appropriate system must have already been selected) or the X,Y,Z values in the WGS84 System (page XYZ) or latitude, longitude and ellipsoidal height (page Geo). Click **Assign**.

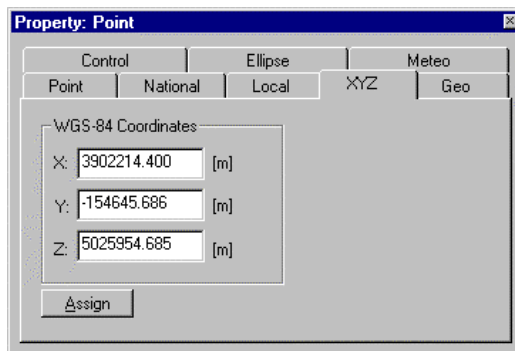


Figure 3-20: Point Properties: Page XYZ

Often, as in this example, there are no precise coordinates available for the Reference Station. The alternative is to ensure that the single point position is the best that can be determined from all the observed data at the Reference Station. **GeoGenius** can calculate a mean position for the reference station and you have the opportunity to use this instead of the coordinates recorded by the receiver which were based on the initial position when the survey started. We would always recommend that you take the mean position if no accurate coordinates are known.

Double click (left mouse button)  **Point Name**. Click (right mouse button)  **Observation File Name**. Select menu item Single Point Position.

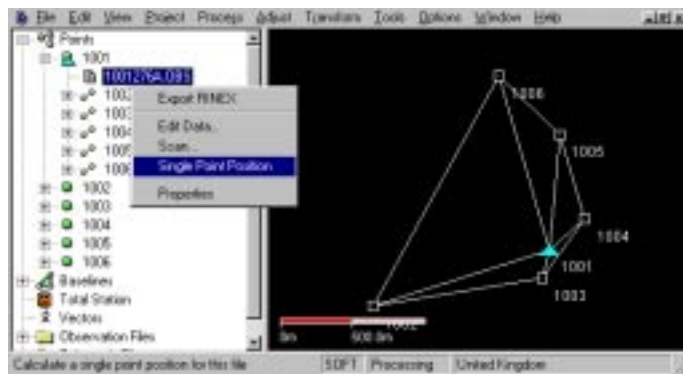


Figure 3-21: Observation File Context Menu

Select Satellite Data, i.e. GPS, to be used and Processing Mode, i.e. Static. Click **OK**.

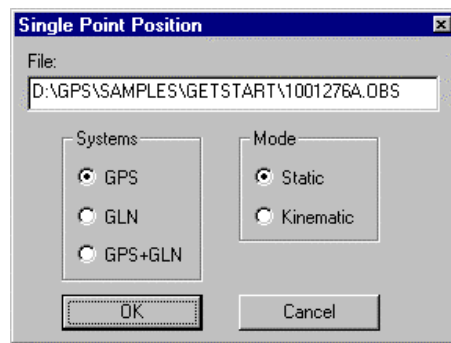


Figure 3-22: Single Point Position

The Single Point Result (SPP) is displayed. **Assign** value to project.

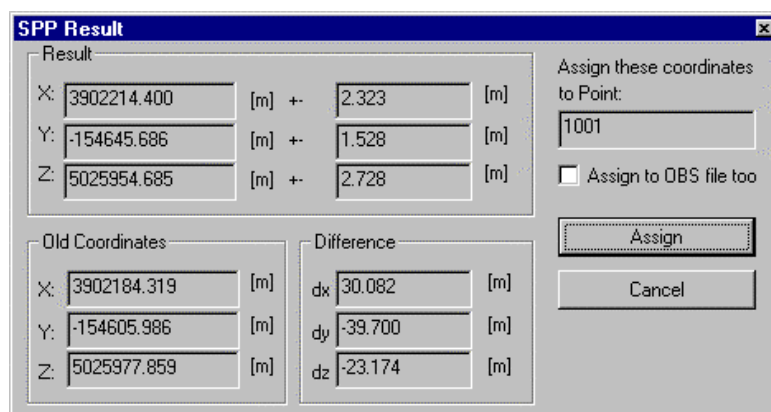


Figure 3-23: SPP Result

3.8 Edit Ephemeris

GeoGenius requires ephemeris data in binary EF18 format, which covers the duration of the project sessions to process the data. The first time you insert data into a new project, **GeoGenius** automatically generates ephemeris data for the project. If you later insert files into the project, the ephemeris will also be updated.

Using the menu options **Process/Generate Ephemeris** or the Processing Toolbar button you may manually generate an Ephemeris for the project. **GeoGenius**, by default, saves the file to the directory for the first observation file. However, the Ephemeris Data dialog allows you to save the file to any location (refer to App. A.2.5).

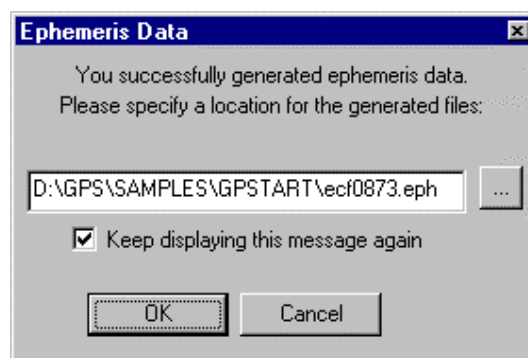


Figure 3-24: Ephemeris Data

3.9 Process Project

Start Processing using the menu option Process/Process Project or the Processing Toolbar button. All activated baselines will be processed automatically. A Progress bar is displayed in the center of the screen. The output window at the bottom of the screen displays messages about the processing.

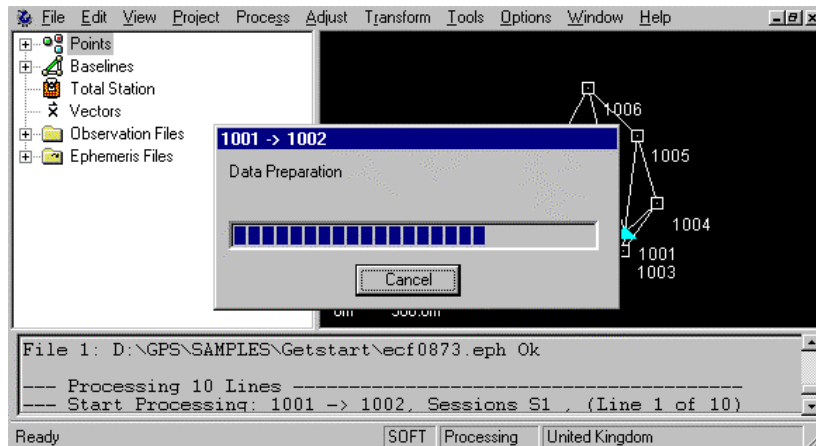


Figure 3-25: Processing

After the processing is complete you may notice that the network has changed its shape slightly. Now it shows the relative positions of the points as calculated from the processing results, instead of those based on the initial positions from the observation file. The quality of the result is shown graphically in two ways.

1. The baselines will be colored according to the quality of the best solution. The default colors are

Green: Ambiguities are fixed

Yellow: Ambiguities are not fixed, standard deviation less than “x” millimeters

Red: Ambiguities are not fixed, standard deviation larger than “x” millimeters

Blue: Only triple difference solution available.

“x” is the number given as “Maximum Position Sigma”. The default value is 20mm.

GeoGenius applies a color quality indicator for the baseline symbols within the navigator as well.

The tables of the project view show you the updated values. The tables always show those values, which can be found in the property dialogs of the respective objects.

The project plot colors can be changed using the menu items **Options/Styles**. But, we recommend that you do not change them yet, as this may lead to confusion when using the manual.

2. Error ellipses are drawn on each baseline depicting the standard deviations in North, East and a vertical bar shows Height. A reference circle is drawn at the bottom right of the Project Plot screen depicting the project's maximum derived standard deviation in North or East as the diameter of the circle. A reference bar to the right of it indicates the maximum standard deviation in height.

The display of the error ellipses can be enabled/disabled using the Ellipses Toolbar.



Figure 3-26: Ellipse Toolbar

The reference circle and bar displays can be enabled/disabled using the Display Toolbar button . Use the button  to enable/disable the ruler.

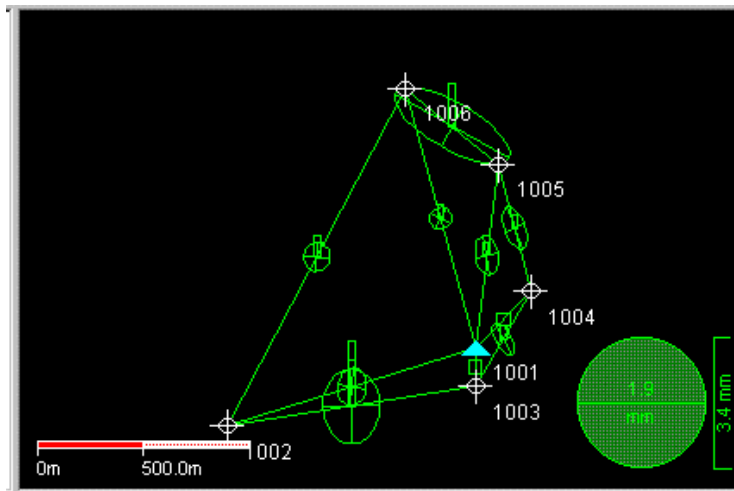


Figure 3-27: Project Plot in Processing Mode

A report for each baseline processed is available. These are accessed either by

1. Double click (left mouse button)  **Baselines**. Click (right mouse button)  **Baseline Name**. Select menu item **Report**.

2. Double click (left mouse button)  **Baselines**. Double Click (left mouse button)  **Baseline Name**. Click (right mouse button)  **Results**. Select menu item Report.
3. Click (left mouse button) baseline in the Project Plot. (Baseline will be highlighted). Click (right mouse button) baseline. Select menu item Report.

Sections of the report can be enabled/disabled or you can generate a customized report using the Macro Editor.

Project reports summarize the processing results. Choose from the list of reports, which is available via Project/Reports... .

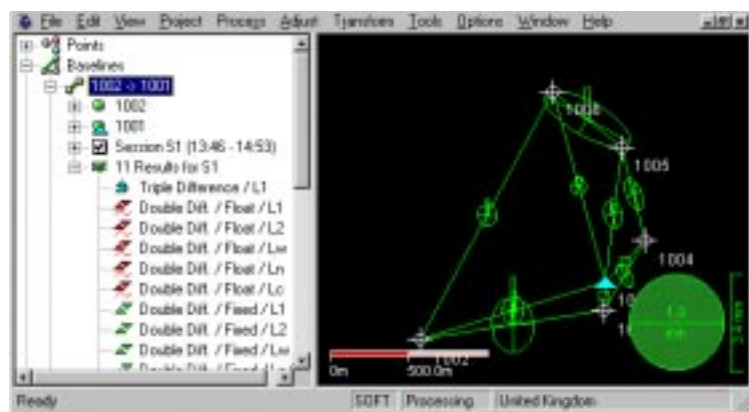


Figure 3-28: Possible Navigator Path to Results

A Result notebook for each solution is also available. Double click (left mouse button)  **Baselines**. Double click (left mouse button)  **Baseline Name**. Double click (left mouse button)  **Results**.



Click (right mouse button)  **Result File**. Select menu item Proper - ties.

Figure 3-29: Result Notebook

3.10 Graphical Baseline Editor (Scan)

Data used by the processor for each baseline can be graphically selected by the Scan function. This makes it very easy to edit (ignore) out any suspect data.

Double click (left mouse button)  **Baselines**. Click (right mouse button)  **Baseline Name**. Select menu item Scan....

You can also select the scan option by clicking (left mouse button) onto the baseline to be edited in the Project Plot. (Baseline will be

highlighted) Click (right mouse button) baseline. Select menu item Scan....

The screen displays the satellites tracked simultaneously at the two observing points, one point's observations are shown in blue and the other in magenta (red). The satellites observed are listed down the left-hand side of the screen and the time is given in the box at the bottom of the screen as the cursor is moved across the display.

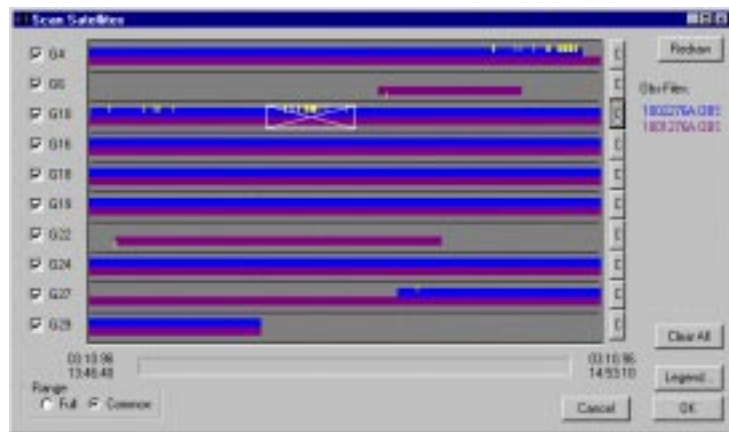


Figure 3-30: Scan Satellites

You can mark which data is to be ignored by the baseline processor by moving the cursor to an individual satellite bar. Press the left mouse button, hold and move it across the screen until the time span to be excluded from the processing has been selected. You will see a white barred area on the screen (fence). The fence can be moved up or down to cover more than one satellite for any time span. A satellite can be enabled or disabled by clicking the box next to the satellite number. If disabled, the data observed to that satellite is marked with white lines. To unmark data blocks you can use the **C** button on the

right hand side of each bar or clear all the changes on the screen select **Clear All**.



None of the data is deleted; it is marked for ignoring, so you can try various options until you find the optimal solution. Click on **Legend** to get a short description on the data marking types.

Try marking various sections that may be suspicious. Often it is best to ignore data immediately before and after an obstruction has caused data to be missing for any satellite.

When you have finished editing click **OK**. Click (right mouse button)



Baseline Name. Or click (left mouse button) baseline in the Project Plot. (Baseline will be highlighted). Click (right mouse button) baseline.

Select menu item **PROCESS**. The baseline will be reprocessed.

You may also scan one observation file only. Double click (left mouse button) **Observation Files**. Click (right mouse button) **Observation File Name**. Select menu item **Scan....** The Scan Satellites dialog will display the satellites tracked with this observation file.

3.11 Editing Field Survey Data - Heights

All data entered in the field can be edited in **GeoGenius**. Often it is the Post Processing results, which help locate any discrepancies. The

most common need is to edit Antenna Heights and this can be done in a number of ways, either...

1. Double click (left mouse button)  **Points**, double click (left mouse button)  **Point**. Click (right mouse button)  **Observation File**. Select menu item **Properties**. Edit the H (antenna height option) in N/E/h or change the flag for the antenna height definition, i.e. Instrument, Slope and True Vertical. To save any changes you must click **Assign**.
2. Double click (left mouse button)  **Observation Files**. Click (right mouse button)  **Observation File name**. Select the menu item **Properties**.
3. Edit the H (antenna height option) in N/E/h or change the flag for the antenna height definition, i.e. Instrument, Slope and True Vertical. To save any changes click **Assign**.

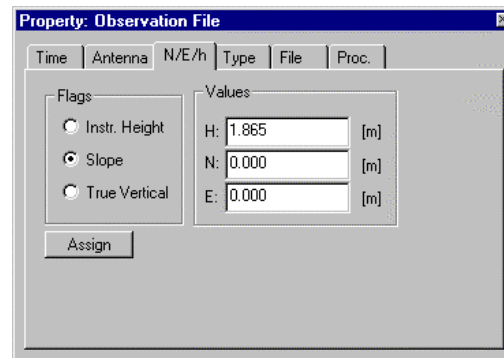
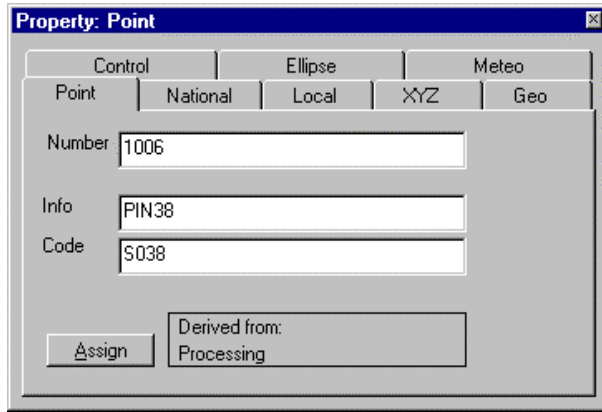


Figure 3-31: Property: Observation File - N/E/H

3.12 Editing Field Survey Data - Point Names

To edit the point name, double click (left mouse button)  **Points**.

Click (right mouse button)  **Point**. Select menu item **Properties**.



The image shows a dialog box titled "Property: Point". It has a tabbed interface with tabs for "Control", "Ellipse", and "Meteo". Under the "Control" tab, there are sub-tabs for "Point", "National", "Local", "XYZ", and "Geo". The "Point" sub-tab is selected. Inside the dialog, there are three text input fields: "Number" with the value "1006", "Info" with the value "PIN38", and "Code" with the value "S038". At the bottom left is an "Assign" button. At the bottom right is a label "Derived from:" followed by a text box containing the word "Processing".

Figure 3-32: Edit Point Name

Edit the Point Name. Click **Assign** to save any changes

The point name can also be edited by clicking on the point name in the project plot. (Point name will be highlighted) Click (right mouse button). Select menu item **Properties**. Edit the point name and click **Assign** to save any changes.

3.13 Quality

A quality check can be carried out on the processed results before doing a network adjustment and transformation. Use the menu items Process/Quality... or the Processing Toolbar button to open the Quality Control Notebook. You can carry out various tests seen on the **Test Page**, set the Parameters (**Parameter Page**) for those tests and select which processing results (**Result Filter**) you want to use in the tests.

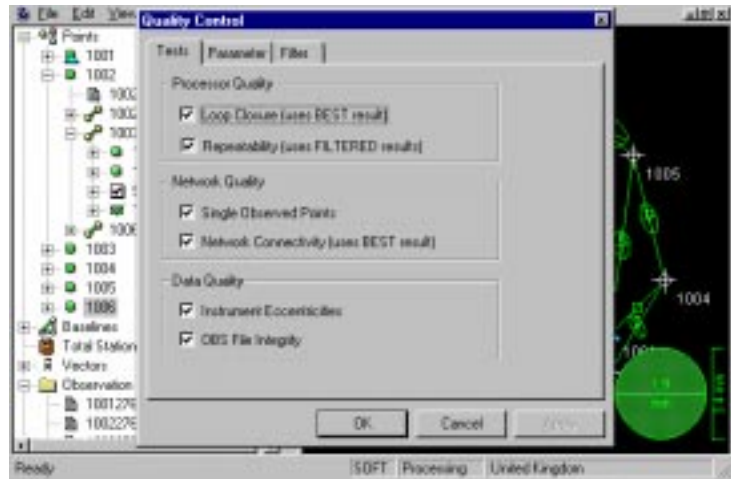


Figure 3-33: Quality Control

The **Tests Page** offers three areas for checking the quality of the processed results, Processor, Network and Data. The Processor section has two tests. The **Loop Closure Test** checks all possible combinations of baselines for closed loops with a preset length. This test only uses the best solutions from each processing session. The **Repeatability Test** uses the results selected in the Result Filter Page and checks that the

repeatability of any duplicated baseline results is within a certain range (Significance). These tests are ideal for finding field errors, i.e. points where the wrong instrument height has been keyed in.

The Network Quality checks are the **Single Observation Points Test** and the **Network Connectivity Test**. These check which lines are enabled/disabled, their processed state and connectivity within the Network. No parameters have to be set for these tests.

The Data Quality offers two tests, the **Instrument Eccentricities Test** and the **Observation File Integrity**.

The Parameters for the tests are set within the **Parameters Page**.

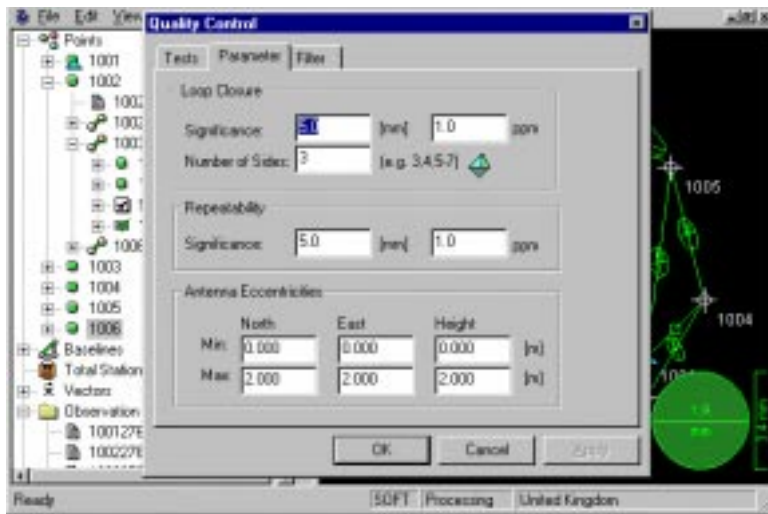


Figure 3-34: Parameters for Quality Control

Finally the results which are to be used for the tests are selected within the **Filter Page**.

On many projects the “Use OVERALL BEST Results” will give the most practical solution.

When you are happy with your settings click **OK**. As the selected quality checks are carried out, the results are displayed in the Output Window at the bottom of the screen. (To view the results, click (right mouse button) output screen and select menu item **Save to File**.) When the checks are completed, a quality test report is displayed. To exit the report, click **File** on the pull-down menu and select **Exit**.

If the results are acceptable, proceed to Network Adjustment. If the quality checks have highlighted any problems, amend or Disable the bad data accordingly and Re-process.

3.14 Adjustment

GeoGenius offers various methods for adjusting the network. The standard method is the least-squares adjustment in the WGS84 System (menu option Adjust/Adjust (Free)).

Before carrying out the adjustment you must select the data to be used.

Select any baselines to be disabled or enabled. There are two ways of doing this. You can either select the baselines by a particular criterion, e.g. Date, Timespan, Length, GPS-Day, GPS-Week. These selections are accessed through the menu items Edit/Base Lines/

En/Disable by.... Or click  Baselines (right mouse button) to access the same menus.

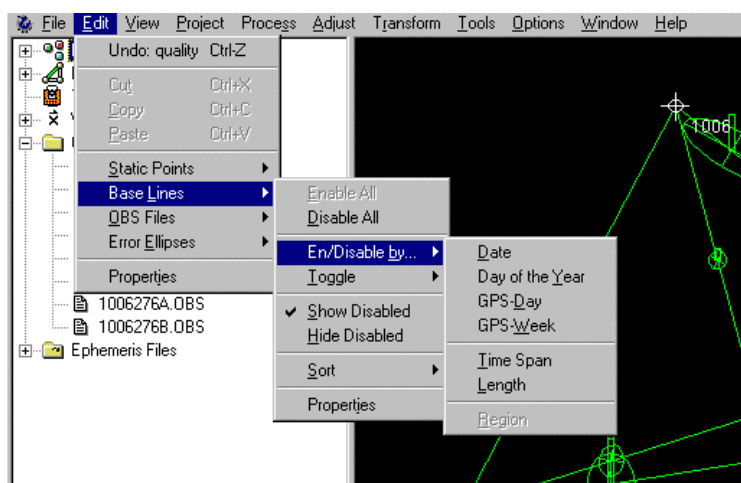


Figure 3-35: En-/Disable by Criteria

Or you can select individual baselines to be enabled/disabled. There are two ways of selecting the baselines.

1. Click (right mouse button) baseline in Project Plot. Baseline highlighted. Select Enable or Disable.

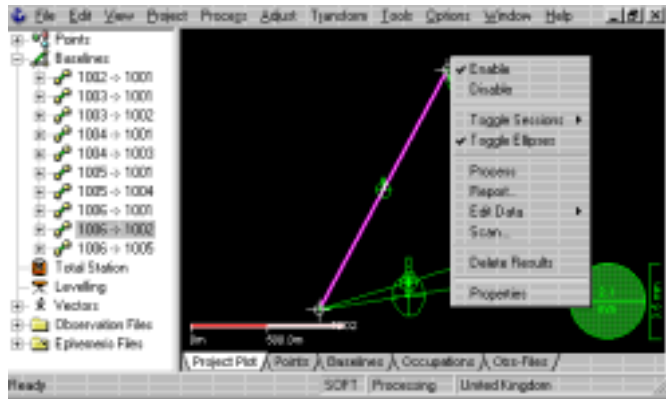


Figure 3-36: En-/Disable Individual Baseline

2. Double click (left mouse button)  Baselines. Click (right mouse button)  Baseline Name. Select Enable or Disable.

You can practice enabling and disabling the baselines.

After having disabled some baselines click the Hide Disabled button to ignore the disabled baselines for adjustment. Only baselines, which are enabled and visible on the screen, will be adjusted.



In this example all baselines should be enabled. Click the Enable All Baselines Button on the Lines Toolbar to enable all the baselines.



Now select the settings to be used in the adjustment. Select menu item Adjust/Settings... or click  Vectors (right mouse button) and select Settings.... First select which of the results to use from the Result Filter Page. Generally it is best to use the fixed solutions. For this example we would recommend selecting the “Use OVERALL BEST Results” option. If you, instead, select the “Use BEST result”, then more than one result will be used on some vectors, and one vector will be colored red after adjustment. The results show some inconsistency in the corresponding field data. Try each setting if you wish to experiment.

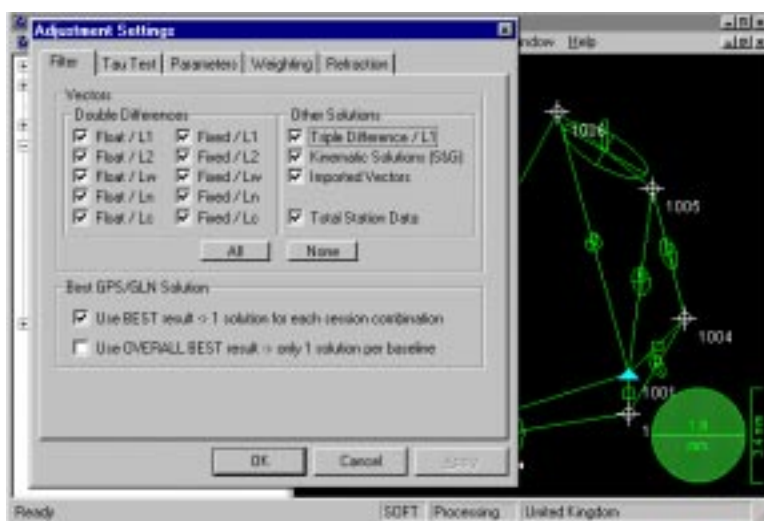


Figure 3-37: Result Filter for Adjustment

Statistical Tests

More advanced users may wish to set the Tau Test error criteria. The default setting is that no errors less than $5\text{mm} + 1\text{ppm}$ are flagged. Select to Perform the Tau test after Adjustment. This test is used to determine if there are any gross error (outliers) within the network.

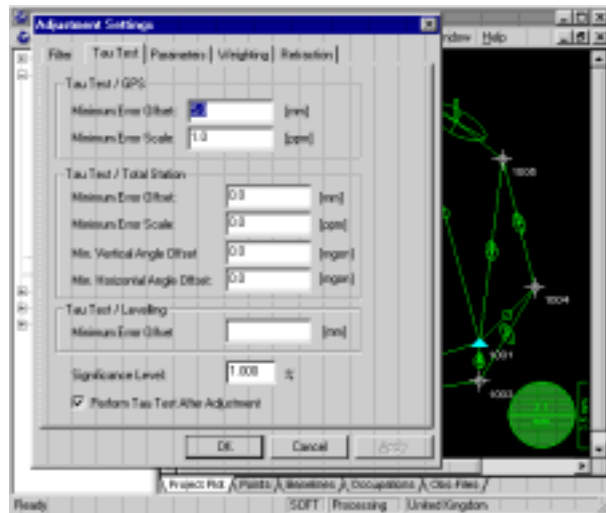


Figure 3-38: Tau Test Parameters for Adjustment

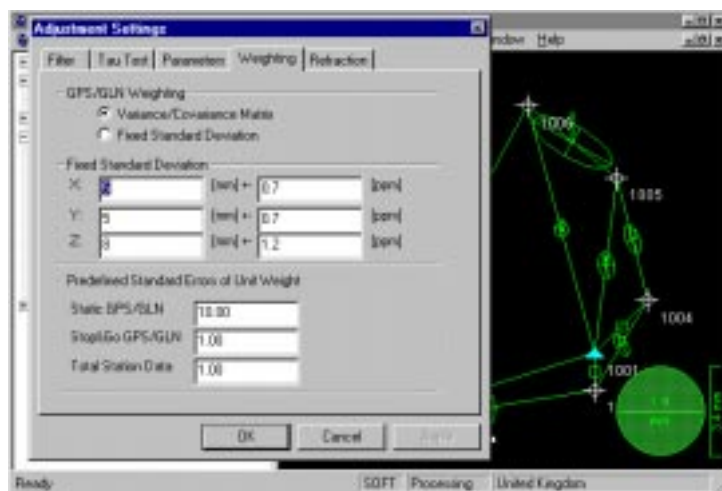
Parameter

Within the page Parameter you can define the confidence level (default 1, i.e. sixty-eight percent of the results will be contained within ± 1 standard deviation from the mean) and the maximum number of iteration steps. The adjustment needs several iteration steps to compute the best possible solution. You can also select to Automatically Assign Adjusted Coordinates to Points. For this example we would suggest that you use the default settings.

Weighting

You also can define the **baseline** weighting factors to be used in the least square adjustment. By default the 3x3 variance-covariance matrix of the baseline processing result is used. We also offer an alternative called a Fixed Weighting Option (Fixed Standard Deviation), which is sometimes preferred by National Geodetic organizations. Here you may define standard deviations for X,Y, Z (WGS 84) directions based on baseline length.

The values given in the box Standard Errors of Unit Weight are multipliers for the resulting standard errors. They allow you to enhance the weight of a network component.



When you are happy with your choice of settings, click **OK**. Select menu items **Adjust/Adjust (Free)**, which will start the adjustment. The adjustment information is displayed in the output window at the bottom of the screen and a progress indicator shows the progress of the adjustment process. When the adjustment is finished, the computed error ellipses will be displayed at each point in the network and a reference circle showing the largest ellipse and a height bar are drawn upper right of the screen. These can be enabled/ disabled using the Display Toolbar button. The Display mode on the status bar at the bottom of the screen has now changed to **Adjustment**. The baselines are now colored blue. Any rejected lines are drawn in yellow, the largest outlier in red. Lines are rejected on the basis of the tau test error criteria.

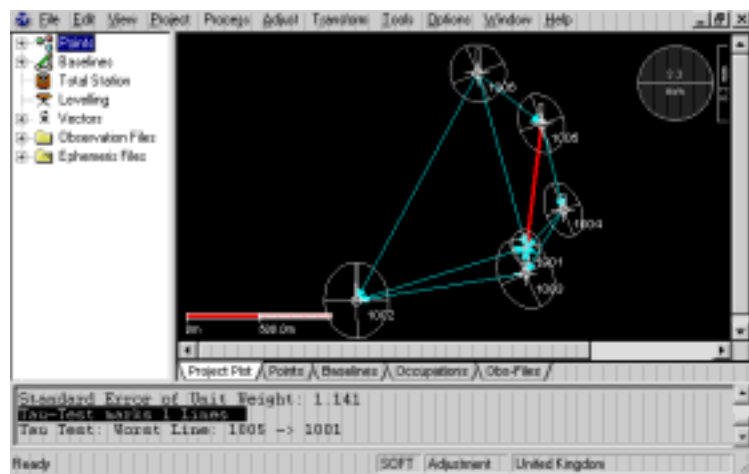


Figure 3-40: Adjusted Project

You can view the adjustment report under menu items **Adjust/Report**. Sections of the report can be enabled/disabled or you can generate a customized report using the Macro Editor.

You can view the adjusted values for individual points, by clicking (right mouse button) on the point name. Click **Properties**. The coordinates will have been updated by the adjusted values. The point error ellipse values are displayed in page **Ellipse**.



You may wish to return to the processing display window. This can be done by choosing the item **Processing** from the **Display** combo box of the **Display** toolbar.

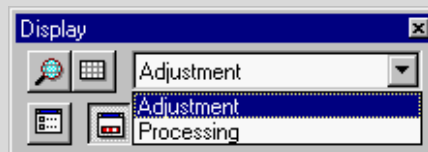


Figure 3-41: Choose Display Layer Group

3.15 Creating a Local System

Several methods to create a local System for your project are available. **GeoGenius** uses a five-parameter transformation, but you can choose to leave some of the parameters empty. You may enter parameters manually, or create them automatically by giving local coordinates to one or more points.

Let's create a local System, whose origin lies in point 1001 and whose North direction and scaling is defined with respect to point 1002. Select the menu items Transform/2D/2D/2Points.

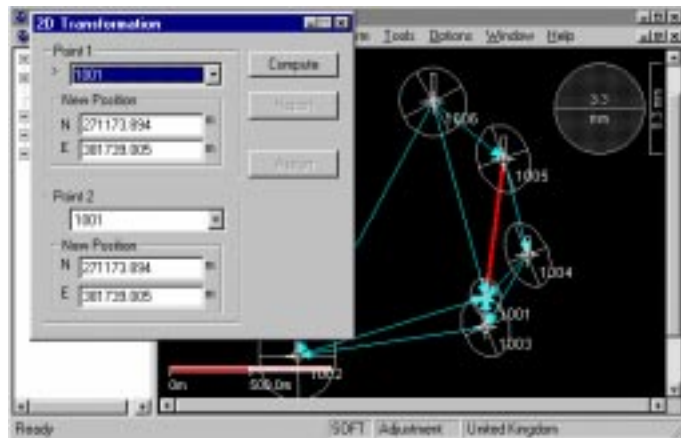


Figure 3-42: 2D Transformation Dialog

Choose the point 1001 from the combo box Point 1. Enter the Northing and Easting values of zero in the New Position box. Choose point 1002 as Point 2. Enter the Easting value of zero as the Easting in the box New Position.

To use the Scale Factor that you had in your National projection at this location you now have to compute the Grid Horizontal distance between the points 1001 and 1002: Choose the menu item **Distance Meter** from the pull-down menu **Tools** (The 2D Transformation dialog can stay open!). Click Point 1001 within the project plot or the navigator. **GeoGenius** automatically insert the point name for Point 1. Click the Point 1002 within the project plot or the navigator. **GeoGenius** inserts the point name for Point 2 and computes the slope distance between the points. Click the radio button **Grid Horizontal** to get the correct horizontal distance, corrected for National Scale factor and Mean Sea level. (If you want a scale factor of 1, you must use a 1 Point transformation, or do the distance measurement in the standard map projection).

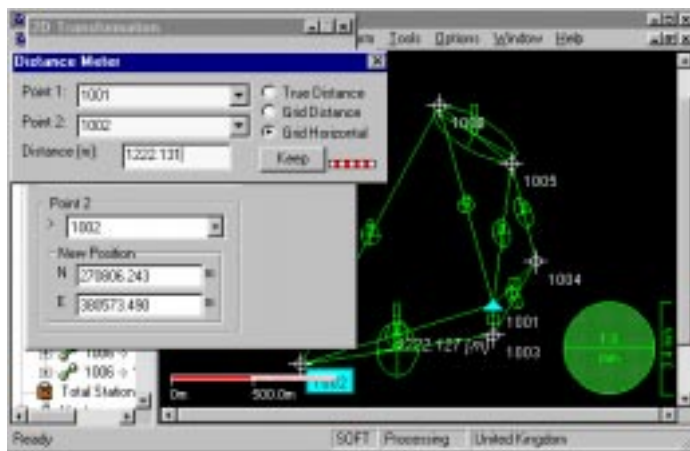


Figure 3-43: Distance Meter

Within the 2D Transformation dialog, key in the distance value as the Northing coordinate for point 2. Click **Compute**.

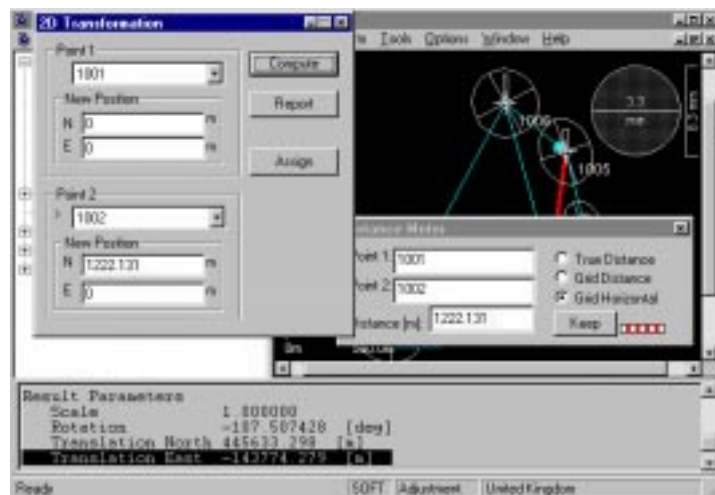


Figure 3-44: Compute 2D Transformation Parameters

The output window now displays the basic points for the 4 parameter similarity transformation and the resulting transformation parameters. With the 2D Transformation dialog, click **Report** to view the 2D Transformation report.

Click **Assign** to accept the values and set up the local System with the computed parameters. Check the local coordinates of any point, e.g., point 1003: click the point name in the project plot or the navigator (right mouse button), click the menu item **Properties**, click tab **Local**.

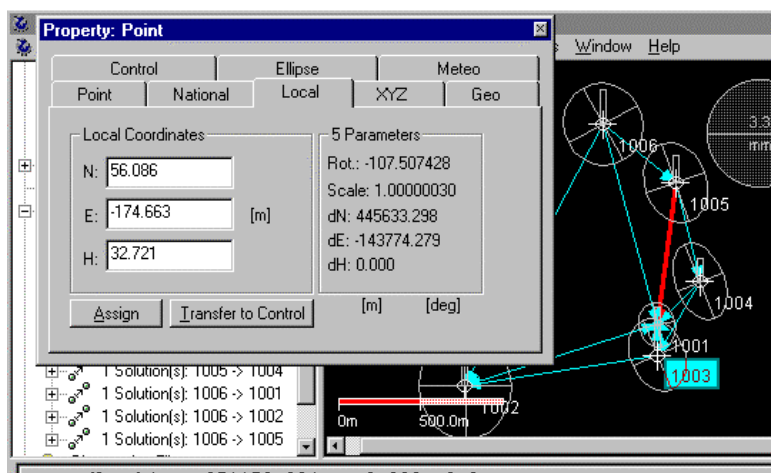


Figure 3-45: Point Properties - Page Local

Shifting the Project Points in Height

Ideally, you will have assigned the correct height to point 1001 before processing, but you do have the opportunity to change heights for the local system. To view the current ellipsoidal height of point 1001 in the local System, which is in fact derived from the national grid System, click the point name either in the navigator or in the project plot (left mouse button). If a Property notebook is still visible on your desktop, it will now display the properties of point 1001. If not, click the point name (right mouse button), click the menu item **Properties**, click tab **Local**.

If you require all heights to be shifted by a constant value, you can select the menu items **Transform/5 Parameters**. The **5-Parameters** dialog displays the current 5 parameters for the transformation between the national and the local System.



Figure 3-46: 5 Parameters Dialog

Enter that value in the Translation H string field. Click **OK**. Accept the warning message: 5 parameters changed!. Do you want to recalculate the LOCAL coordinates of all points? with **Yes**, keeping the default settings. **GeoGenius** then re-computes the transformation parameters and the local heights for all points. The heights of all points will now be defined in relation to point 1001.

Using the 2D/ 2 Points transformation, the value for H will have been set to zero. If you want the local system to show relative heights, you can enter the negative value of the ellipsoidal height. Then the local height of point 1 is set to zero.

Local coordinates are listed in the Project Report, section Coordinates Overview.

3.16 GeoTrans (Transformation)

Although **GeoTrans** is a stand alone transformation module, it can also be accessed directly from **GeoGenius** and use all the data from a current Survey Project. Start it by using menu items **Tools/Transformation/Projection** to access it. On entering the module a point list of all the stations in the project will be displayed. This list will contain the adjusted WGS84 Cartesian Geocentric Coordinates. If no adjustment has been carried out, the coordinates will be the unadjusted processing results. The point list is a list of points in a specific geodetic System and you can change between the different coordinate systems without leaving the point list by clicking on the ▼ in the coordinate system name box. PointList1 contains only WGS84 coordinate systems.

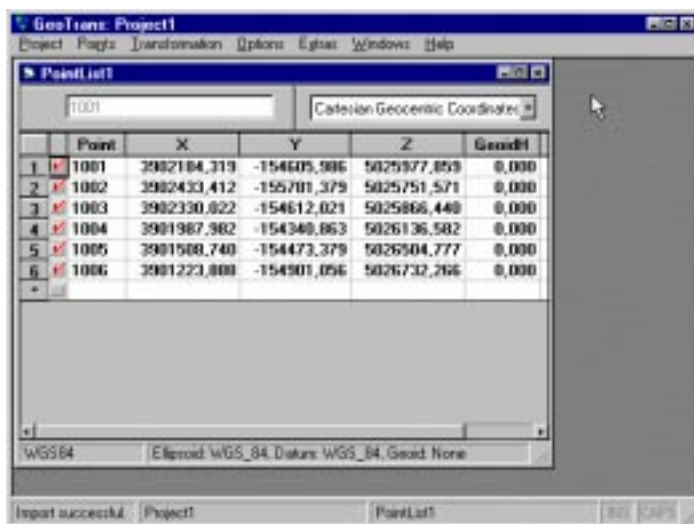


Figure 3-47: Starting GeoTrans with Demodata

You can disable any points you do not wish to use in the transformation by clicking on the  checkbox to side of the point name.

GeoGenius supports many different transformation options and the results can be used to generate a new entry for a datum file, which can be used by **GeoGenius**. For this exercise we will guide you through a Helmert seven parameter transformation which is the simplest way to create Local/National/State Plane Coordinates.

First, you must create a second point list containing the coordinates of the common control points in the Local/National/State Plane Coordinates. For this example you are going to create it by importing a Geotracer *.SPC File, which is a space delimited coordinate list consisting of five columns. They are Point Name, Zone (optional), Eastings, Northings and Height. The control point information is listed under these columns. The sample used here contains four points. You must have at least 3 control points for a Helmert's transformation to be possible.

Import the file called GETSTART.SPC by selecting the menu items Points/Import. The screen will display an **Import from File** page. This prompts you to enter a name for your new point list, the default is point list "n", the number depending on how many point lists are active at the time. In this case the default name should be PointList2. You can accept the default list or give the Point List a name of your own choice. You are also prompted for the map projection system your control points coordinates are in. If you click on the ▼ to the side of the system name, a list is displayed of all the systems currently available. If the system you want is not available you must create it by clicking onto the **Edit** option. This sample data was observed in the United Kingdom, so select "United Kingdom" and click **OK**.

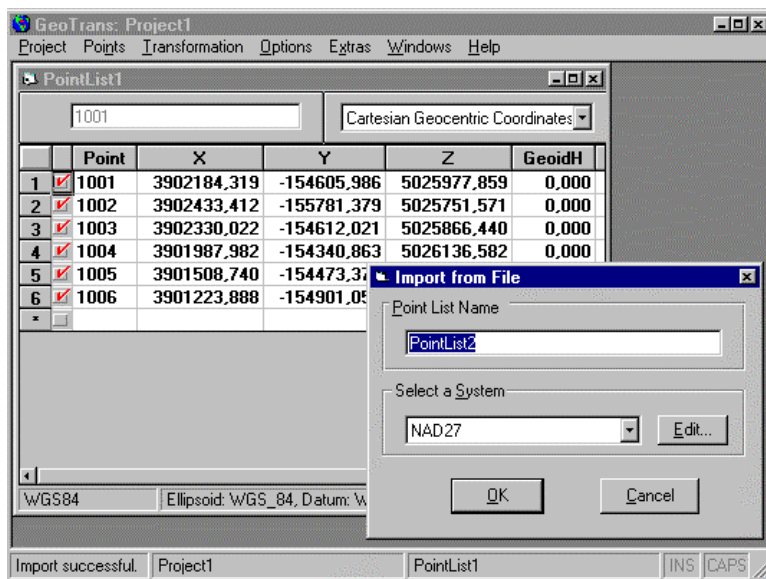


Figure 3-48: Import Control Point List

The screen will now display an **Open Position File** Page. Click on the ▼ beside the Available Converters option. Select Geotracer SPC-File (*.SPC). Select the directory where the *.SPC file is stored. The *.SPC for this example is in the \GETSTART directory. A list of *.SPC files in that directory will be displayed in the File Name Box. Select the *.SPC file to be used in the transformation. Click **OK**.

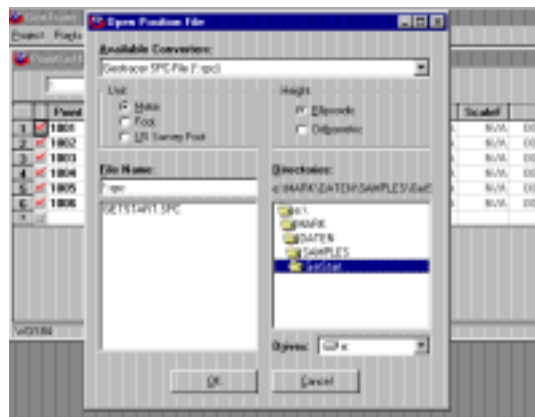


Figure 3-49: Define Converter, Choose SPC File

PointList2 is now displayed on the screen. To view the coordinates in the System you have selected, click the ▼ beside the system name and select Plane Coordinates. Make sure that each point to be used as a control point is marked by a ✓ in the check box beside each point name.

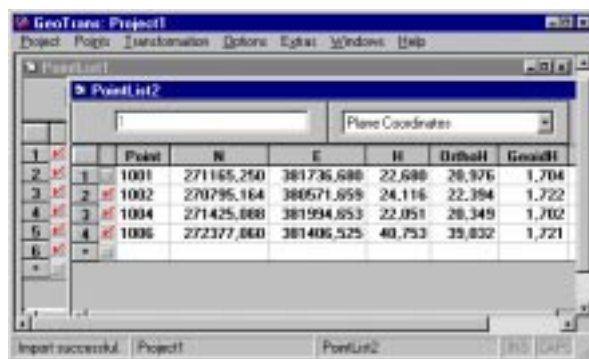


Figure 3-50: Control Point List in Plane Coordinates

Activate Point List 1 (the list of points to be transformed) by clicking on the Bar where the Point List is displayed. (Should now be highlighted). Select menu item Transformation/3D Adjustment, which is the 7 Parameter Similarity Transformation (Helmert Transformation) Option.

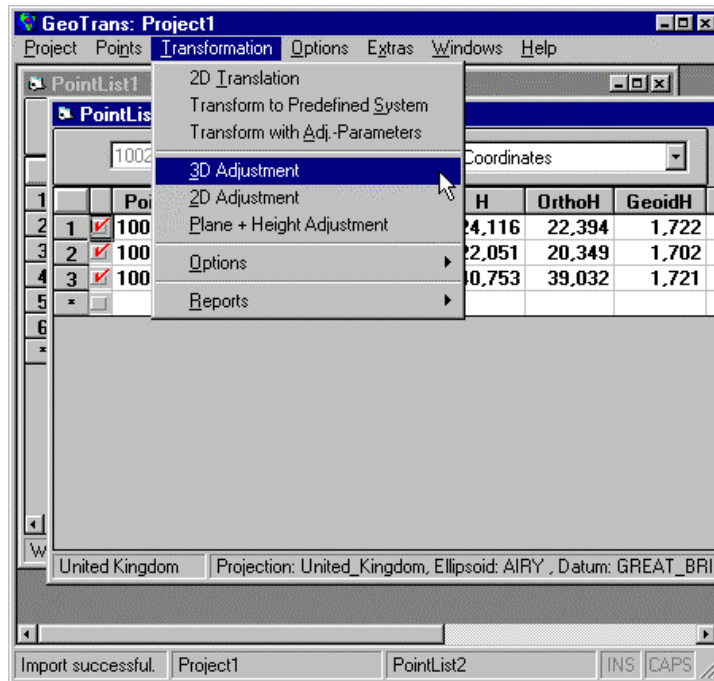


Figure 3-51: Menu Transformation

The **Select Control Point List** Page is displayed. Click the ▼ to display all the point lists in the project and select the control point list, i.e. PointList2. Click **OK**.

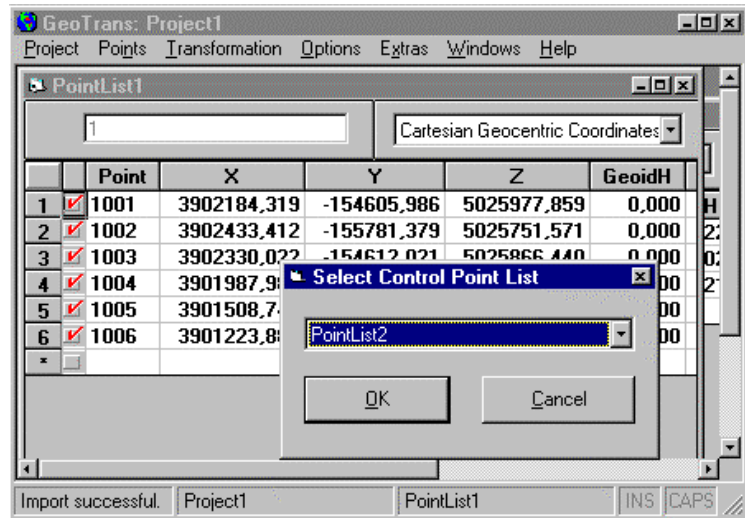


Figure 3-52: Select Control Point List

The Transformation is performed and a 3D Adjustment Result Page is displayed. (A Helmert transformation is a 3D adjustment of all points in the network based on those points that are common to both systems.) The page shows the residuals at the common points. You can view a report on the transformation by clicking onto **View Report**.

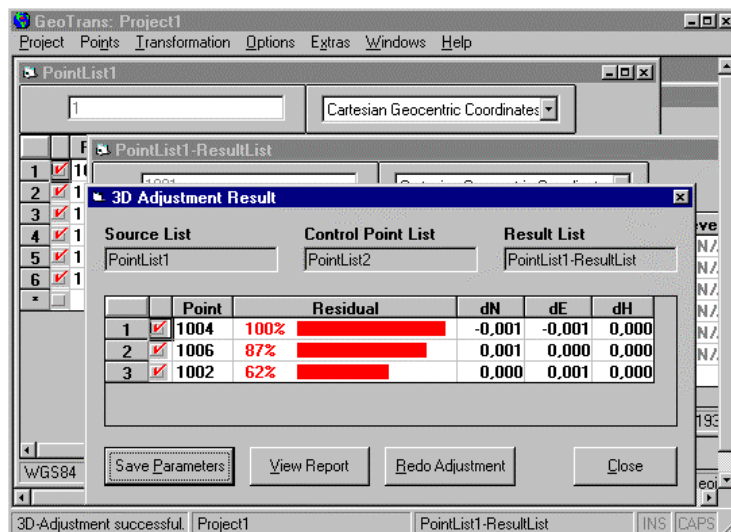


Figure 3-53: Adjustment Result

You can experiment with the data. Remove one of the control points from the 3D Adjustment by clicking the ☒ Check Box beside the point name on the Residuals display, then click **Redo Adjustment**. (This will overwrite the previous results unless you save the results to a new file name. You can re-name the file by selecting the menu items Points/Rename Point List). In this example one of the control points has been deliberately given incorrect values. See if you can find out which one.

When you are happy with the results, save the transformation parameters. Click on **Save Parameters**. You will then be prompted for a file name. Type in the name and click **OK**.

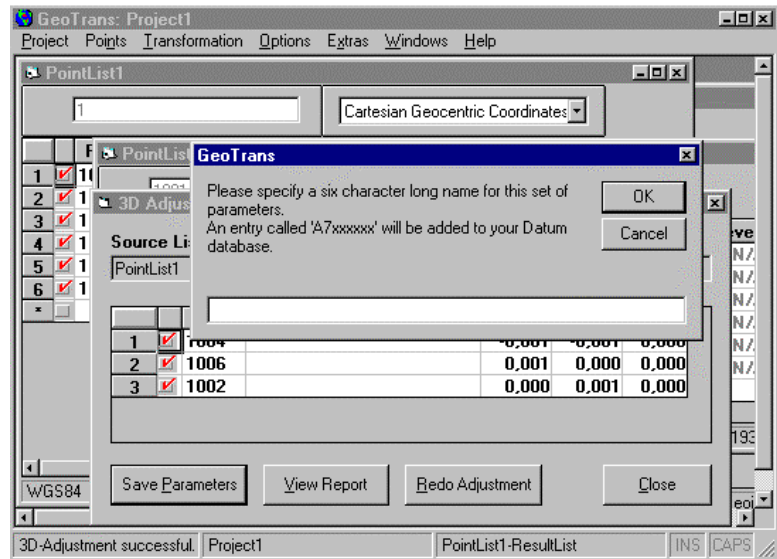


Figure 3-54: Enter Parameter Set Name

If you now click **Close** on the 3D Adjustment Result page, the Result List for PointList1 is displayed. Click on the ▼ in the coordinate system name box and select Plane Coordinates to display the results in the new coordinate system. The name of system in which the coordinates are being displayed is shown at the bottom of the PointList table display.

You can re-name the file by selecting the menu items **Points/ Re-name Point List**. The project should now be saved using menu items **Project/Save As**.

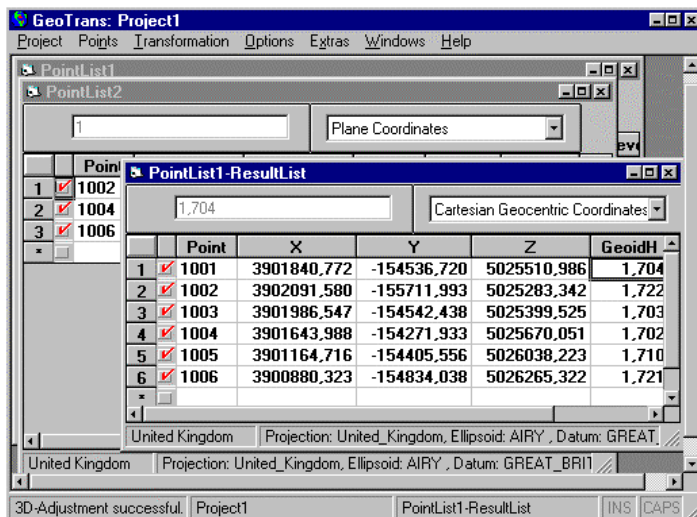


Figure 3-55: Point List - Result List

3.17 Exporting Results

You can export your results in another data format ready to transfer data to your Total Station or RTK System. Make sure that your results are still active and that you have set the correct System, in which results have to be exported. Select menu item **Project/Formats....** Select the Format Converter from the Available Formats box. Click **Run....** Select Directory where the file is to be stored, enter the File name with the appropriate extension and click **OK**. **GeoTrans** has its own export option in its menu item **Points/Export**. You can choose several coordinate systems and data formats.



Congratulations, you now have successfully processed your first **GeoGenius** Project.



4. Surveying with GPS

4.1 Positioning Modes

GPS surveys can be performed by using various observation and processing techniques. These differ with respect to observation time, efficiency and precision. You can decide which method to use, depending on the type of application and the survey environment. **GeoGenius** supports the major techniques. The following sections will briefly describe the various methods.

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4.2 Static Positioning

Classical static positioning with GPS is based on continuous simultaneous observation of two or more receivers for approximately one hour or more. The baseline components of dx , dy , dz are determined from the sampled carrier phase data. The precision of the determination is mainly derived from the change in satellite geometry over the time span observed. Float and fixed solutions are computed. With dual-frequency data, solutions can be generated for different frequencies and frequency combinations, L_1 , L_2 , L_w (wide lane), L_c (ionosphere free), L_n (narrow lane).

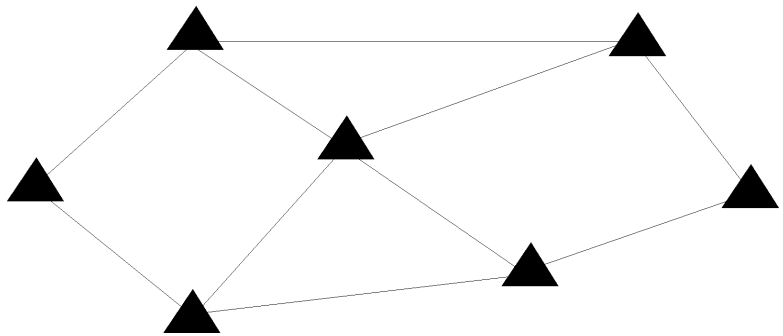


Figure 4-1: Static Positioning

4.3 Short Static (Rapid Static, Fast Static) Positioning

Short static positioning is a special type of static position processing where by the use of good single frequency data or dual frequency data, relatively short baselines (< 15 km) are measured by efficient phase ambiguity resolution. These ambiguity fixing techniques require that single frequency datasets and therefore station occupations be 10–50% longer than dual frequency. **GeoGenius** automatically activates short static techniques if L1+L2 processing is chosen and if dual-frequency data is available, i.e. the second frequency will support the ambiguity resolution. Compared to classical static surveying, short static surveying suffers from the fact that the solution is based on the data of a short time span. The geometric strength of the solution is worse when compared to the static mode due to the weaker change of satellite geometry.

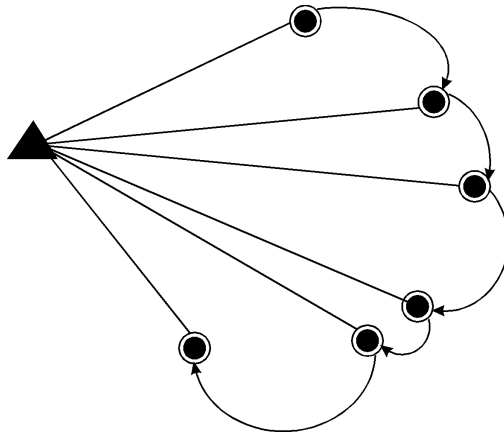


Figure 4-2: Short Static Positioning

4.4 Pseudo-static Positioning

Pseudo-static positioning is often also called pseudo-kinematic positioning, but we call the method pseudo-static, since it actually has nothing to do with the kinematic technique. The method is based on repeated occupations of identical points. Usually the points are observed two or three times for 5 to 10 minutes. The survey should be designed in a way, that reoccupation follows approximately 1 hour after the first positioning of the survey points. The advantage of this method is that the determined solution is equivalent to classical static techniques with respect to satellite geometry. Therefore, the solution is usually more reliable than solutions derived from short-static techniques.

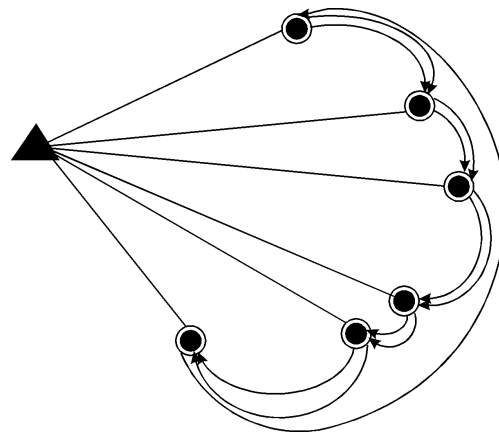


Figure 4-3: Pseudo-Static Positioning

4.5 Kinematic Positioning

Based on a static initialization, the software is able to determine the coordinates of a moving receiver. The kinematic initialization can be done via a static observation period to determine the ambiguities or via coordinate input. The program will determine the coordinates of the receiver even if the ambiguities cannot be fixed since the software uses both code and carrier data. If cycle slips are found the software will try to determine the cycle slip values and correct them. In each case, the processing is straight-forward and the user will get receiver positions provided that 4 satellites are continuously tracked. This is a byproduct of the Stop&Go processor.

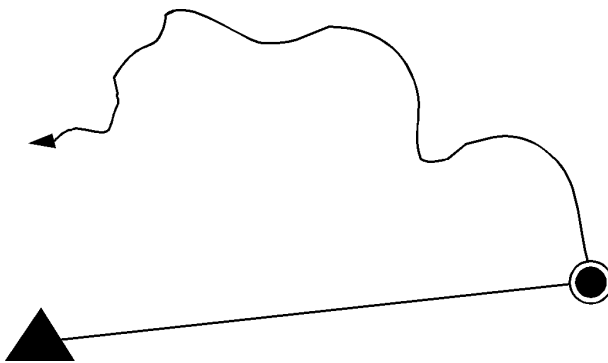


Figure 4-4: Kinematic Positioning

4.6 On-The-Fly (OTF) Positioning (Optional)

In contrast to kinematic positioning ambiguities can be derived by on-the-fly techniques for ambiguity resolution without any static initialization. This is especially useful for applications where the rover is not able to stop (e.g. hydrographic surveying) or where a static initialization is not productive (e.g. airborne photogrammetry). OTF positioning with dual-frequency is required for airborne sensor positioning if relative (base to aircraft) positions with accuracies of 10 centimeters and better are required. If the accuracy requirements are not as strict or if the accuracy is only required for relative positions within a limited sequence of time epochs (e.g. in case of airborne photogrammetry) you may work with a single-frequency receiver. Airborne photogrammetry usually does not require accurate and consistent base to aircraft vectors throughout the whole flight. Relative accuracy and consistency throughout a strip is sufficient since eventually gross errors in the coordinates of a complete strip will be treated as stripwise transformation parameters and can be easily taken out in the photogrammetric bundle block adjustment.

4.7 DGPS Positioning

GPS land surveys are usually based on the results of processing GPS carrier phase data. In navigation and many GIS applications, the code (or pseudorange) observations are preferred due to considerations of accuracy requirement and robustness. (Losses of lock do not necessitate a return to a known point for re-initialization). **GeoGenius** therefore supports DGPS (Differential GPS) positioning with pseudoranges for moving receivers.

4.8 Smoothed DGPS Positioning

To obtain better code noise **GeoGenius** also offers the opportunity to smooth the code observations with the phase measurements. We use an optimal filter technique to calculate the pseudorange out of the weighted mean of the measured and the predicted pseudorange data.

4.9 Super Smoothed DGPS Positioning

Conventional smoothing of pseudoranges using carrier phase measurements is a sequential process. This means, the attained precision by smoothing increases with the number of epochs tracked without a loss of lock or cycle slip, starting from the last loss of lock or cycle slip.

Super smoothing is an algorithm that takes all data between two cycle slips and uses it equally for all epochs. So, the precision remains at the same high level starting from the first epoch. For the last epoch of a data range without cycle slip, the precision is identical to a hatch filter, i.e., “DGPS smooth”.

Another advantage is that positions computed using the super-smooth DGPS processor result in a very high relative precision between successive epochs. That means, that even if the absolute positions of two epochs might be wrong by a few decimeters, the difference between the positions is typically good for some centimeters.

4.10 Stop & Go Positioning

4.10.1 Basics

Stop&Go processing combines the advantages of Static and Kinematic survey techniques. While getting the productivity of Kinematic, it gives the accuracy of Static at any selected points.

The survey is started with a short measurement at a previously measured point – called a Known Point, - or on a Very Short Fixed Baseline (VSFB). This gives the processing software the information on the integer ambiguities so that the current values are known. The values are carried forward to subsequent points by using the kinematic measurement technique, i.e. the roving receiver maintains lock on at least 4 satellites during its movement from one point to the next. Data is recorded continuously during measurement. An OTF technique is implemented, too.

The Stop&Go technique gives a GPS surveyor the opportunity to measure hundreds of points to centimeter accuracy in half an hour.

4.10.2 Initialization Methods

The important part of Stop&Go surveying is the *initialization* phase. This is the process of getting the correct distance measurement to each satellite. Just as in Static Surveying, **GeoGenius** must find out how many complete wavelengths are existent between satellite and receiver. This is called "resolving" or "fixing" the carrier phase ambigu-

ties. When this has been done, **GeoGenius** can attain the full precision of the carrier phase observable for the subsequent measurements.

Initialization is necessary at the beginning of the survey and whenever a critical loss of lock occurs when moving around. A loss of lock is critical when the remaining satellites are not sufficient for a position fix (less than 4 satellites). The receiver software will tell you when this has happened and, therefore, indicates when you cannot start measuring without a new initialization.

GeoGenius supports the following initialization methods for Stop&Go survey:

◆ **Known point**

The easiest method is visiting a known point. By placing the antenna at a known position, the software can fix the ambiguities with a few seconds of data. As always, it is very important to enter the correct instrument eccentricities such as antenna height for a known point occupation.

A known point position can come from a previous GPS campaign or from a static baseline processed in the same network. Another possibility is going back to a point you have already successfully visited at the same Stop&Go session. Make sure you enter the correct point number to identify the position! It is crucial that any revisited point is measured to a sufficient accuracy. Precise point identification and sufficient measurement quality are therefore very important.

◆ **VSFB**

Related to known point initialization is the technique of using a very short fixed baseline (VSFB). Here, the roving receiver is placed close to the reference receiver's antenna at a known distance from it. A short bar of known length is used to accomplish this. The software can

determine the position of the rover from the distance and fix the ambiguities in with a few seconds of data.

VSFB initialization is a very attractive initialization method if you are surveying near the reference point, without any obstruction on the way to the next measurement point. You must carefully enter the correct parameters (length and height difference) to get the desired high precision.

◆ **Short Static**

If no known points are available and VSFB initialization is not practicable, you can use a **New initialization**. As for static surveys, you will spend some minutes at a survey point until enough data for ambiguity fixing is collected. Then you can proceed to visit the points to be measured.

◆ **OTF enhanced Stop&Go**

A powerful addition to the previous initialization methods is **OTF enhanced Stop&Go**. If this optional feature is enabled, the software starts to resolve ambiguities in **On-the-Fly mode** if any unresolved ambiguities remain after the static methods.

This allows ambiguity fixing even in the kinematic parts of the data. At least 5 satellites and sufficient data without loss of lock, depending on the ambiguities already fixed, are needed for OTF ambiguity resolution.

4.10.3 A Typical Stop&Go Scenario

A typical scenario is shown in the following figure. Survey is started with 20 seconds of *VSFB initialization* 1). The user now visits points P1

and P2 for a short time to get the point positions. After passing under a bridge, all satellites have a loss of lock. Point P3 is used for a *short static initialization* (15 min). Now, P4 and P5 can be occupied. A tree gives a partial loss of lock, less than 4 satellites remain. A revisitation of point P3 for 20 seconds is sufficient to recover the ambiguities and get point P6. Another loss of lock caused by a house can be handled by occupying point P7, a *known point* from a previous baseline computation. Visiting points P8 and P9 finishes the survey.

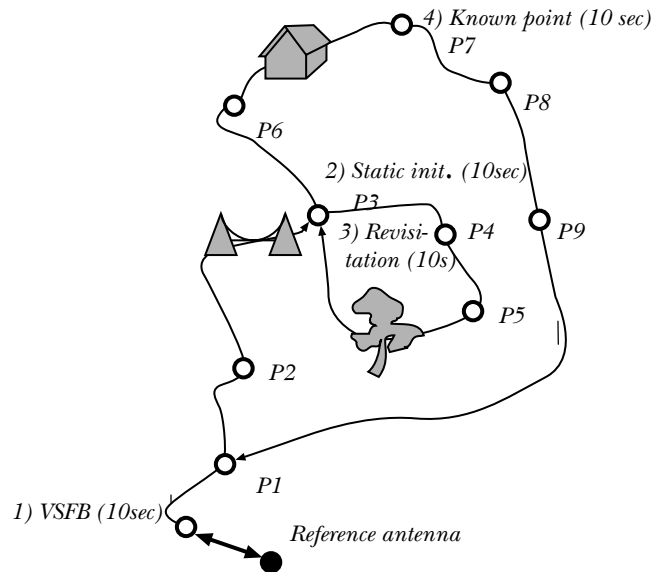


Figure 4-5: Typical Stop&Go Path

In order to verify the reliability of Stop&Go processing you should provide as many loops as possible within your survey. You should return to a point previously occupied as often as it is acceptable from a

productivity point of view. In the small survey described in the figure you should return to point P1 on the VSFB after the survey of point P9. If a point is to be revisited frequently, we recommend that it be occupied for at least 20 seconds on its first occupation.

4.11 GIS Positioning

GIS positioning is very similar to the Stop&Go surveying. However, the demands on the position accuracies are less by far than regarding the classical Stop&Go application. The aim of GIS positioning is to save you the tiresome initialization phases by sacrificing precision. You should use the GIS positioning application, if fast surveying is of greater importance than position precision.

GIS solutions are not based on the fixing of phase ambiguities as it is with Stop&Go, but on the base of code measurements. The code is smoothed by phase measurements using the super-smooth DGPS algorithm. In addition, static point occupations are evaluated. This results in accuracies in the meter to decimeter range.

Because no ambiguities have to be fixed, you do not have to (re-)initialize, if during surveying the receiver has lost all satellites.

5. Project Management

GeoGenius uses projects to manage, visualize and edit data. This chapter introduces the user interface elements, such as the main window, the navigator and the project plot. It describes in detail the project management options and the data export and import.

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5.1 User Interface Elements

GeoGenius resides primarily in a main window. From this window you may load, create or save projects, process, adjust or transform, print results, export data to different file formats, call tools and lots of other actions. This window is the **GeoGenius** Control Center.

Some elements have been introduced that speed up user interactions and make the software even easier to use and to control. The following sections describe these elements.

5.1.1 The Main Window

The main window consists of a title bar on the top of the window, a pull-down menu area right below of the title, a toolbar area below the title (optional), a client area and a status bar.

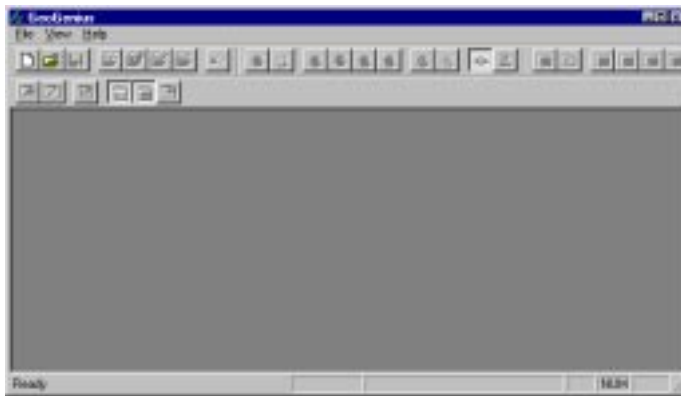


Figure 5-1: GeoGenius Main Window

5.1.1.1 The Title Bar

The primary purpose of the title bar in Windows is to help you to quickly determine which application you're working in. However, you may use the title bar for some basic program control such as Maximize, Minimize and Exit the **GeoGenius** window and program. By default, the title bar in **GeoGenius'** main window will always display the project name.



Figure 5-2: Title Bar

The menu and the toolbar are interactive interfaces to **GeoGenius**. Use your mouse or keyboard to select options from there.

5.1.1.2 The Menu Bar

Pull-down menus are an important part of any Windows application. The menu bar appears at the top of the window of an application. Each item of the menu bar (option) is usually associated with a family of menu items which perform similar or related functions. E.g., the File family includes Open, Close and Save commands, all of which perform actions on the **GeoGenius'** project files.

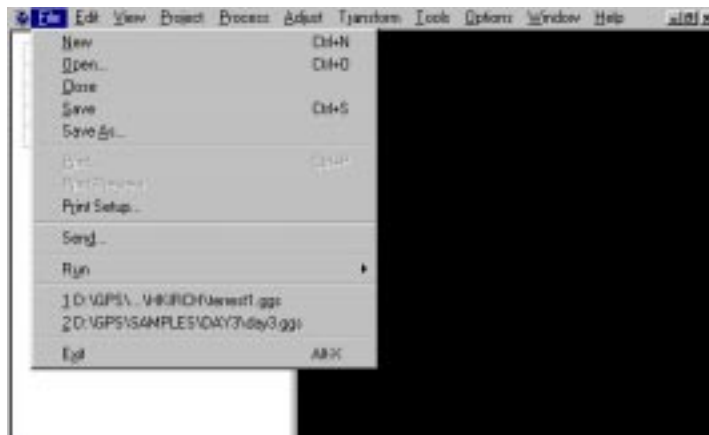


Figure 5-3: Pull-down Menu

To pull down a menu, just click on it. Once a menu is pulled down, you can move between the various menus with the left and right arrow keys and move up and down the menus with the up and down arrow keys. You can choose a menu command by clicking on it, or by highlighting it with the cursor keys and pressing **Enter**. The menu remains down until you choose an item, click on another area of the screen or press **Esc**.

You can also pull down a menu from the keyboard. Simply hold down the **Alt** key while you press the underlined letter in the family name. E.g., to pull down the File menu from the keyboard, you'd typically press **Alt+F**.

GeoGenius may add, remove, disable, enable or modify certain menu selections, depending on your current activities. E.g., if you do not have implemented ephemeris files into your project, the **Process Project** menu item is disabled.

5.1.1.3 The Toolbars

GeoGenius has powerful toolbars. Located just below the menu bar or docked to any of the main window's borders, they act as a graphical control center, where you may access the module's most commonly used functions with the click of a mouse button. For example, instead of opening the File/Save command in the menu to save the current project, you may choose this function from the toolbar by clicking on the corresponding icon.



Figure 5-4: Toolbar Area

If the function associated with an icon is not available for some reason, the respective button will be disabled and its colors will be inverted or grayed. Clicking on a disabled button will have no effect.

GeoGenius allows you to define toolbars by choosing the menu item View/Toolbars..., the corresponding button of the toolbar  Display or by clicking anywhere on the toolbar area. This opens a context menu offering the names of all toolbars for (de-)selection. Selecting a toolbar closes the context menu. The Appendix A describes in detail the customizing of toolbars.

5.1.1.4 The Client Area

The client area is the place where projects will be opened (in form of child windows). In addition, any process will be documented in an output window, usually positioned at the bottom of the client area.



Figure 5-5: Client Area

Child windows must not leave the client area. If you try to drag a project outside the client area, it is cut along the client window's borders (NO data gets lost, this is only a graphic clipping). The output window may act as docked window or it may leave the client area (see section 5.3).

The main window may contain more than one project simultaneously.

A status bar covers the bottom of the main window, displaying (from the left to the right):

- You may toggle the status bar off and on. To do so, toggle the menu item **View/Status Bar** or the corresponding toolbar icon in the **Options** toolbar.



5.1.2 Hot Keys

Generally, you will select an option from the main menu via the mouse or the keyboard. This can be accelerated via hot keys. Pressing a hot key derives the same result is exactly the same as using the normal steps like selection from a menu, but it is much faster.

By default, these hot keys are defined:

Del	deletes the currently activated item of the navigator including its contents and child elements
Esc	removes the selection of an object
Ctrl-N	shortcut for File/New
Ctrl-O	shortcut for File/Open
Ctrl-S	shortcut for File/Save
Ctrl-P	shortcut for File/Print
Alt-X	shortcut for File/Exit
Ctrl-X	shortcut for Edit/Cut
Ctrl-C	shortcut for Edit/Copy
Ctrl-V	shortcut for Edit/Paste

However, you may add your own shortcuts via the pull-down menu option **Options/Shortcuts...** For a complete description of this tool please refer to Appendix A.10. The following list displays suggestions for often-used procedures:

Ctrl-A	shortcut for View/Zoom All
Ctrl-I	shortcut for Project/Files into Project
Ctrl-Shift-L	shortcut for Process/Process Line
Ctrl-Shift-S	shortcut for Process/Settings...
Ctrl-T	shortcut for Options/Styles

5.2 The Project Window

A project window consists of three parts:

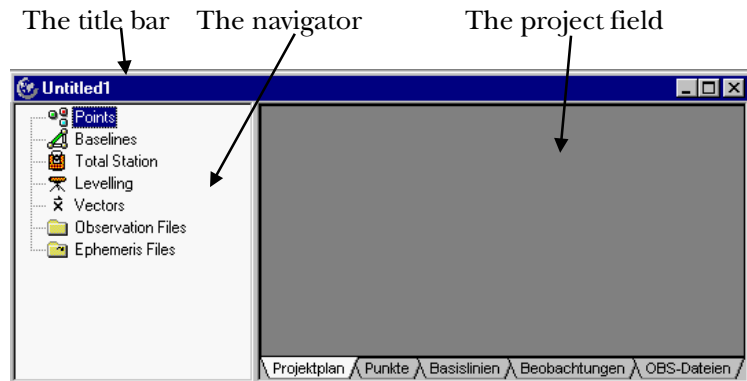


Figure 5-7: Project Window

The **title bar** indicates the name of the project and allows you to minimize, maximize or close the window via the well-known Windows icons at the left or right border. With an active project window, its title bar has a colored background, an inactive project window shows a grayed title bar.

Activate the project window by clicking with the left mouse button anywhere on it. The start of software modules only affects the active project.

The **navigator** and the **project field** display the contents of the project in different ways. The content of both areas is similar, but representation differs. If you mark an object in one of these areas, **GeoGenius** will mark it automatically in the other. This option helps you to very quickly find points, baselines or observation files with just a few mouse-clicks!

5.2.1 The Navigator

5.2.1.1 General

The ingenious **GeoGenius** navigator allows you to easily select and edit project components by their names or textual representations. Project components might be: points, baselines, observation files, ephemeris files, result vectors, kinematic trajectories, containers for objects and more.

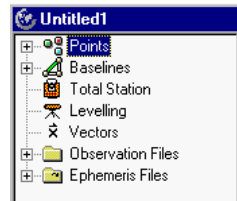


Figure 5-8: Navigator

The structure of the navigator will be familiar to you, since it resembles the structure of, e.g., the Windows Explorer. It is organized in a hierarchical structure and provides access to objects via several trees.

E.g., a baseline consists of the line itself, a start and an end point. Selecting the baseline in the navigator will bring you to a tree containing both the start and the end point. If one of the points is connected to another line as well, selecting the point will open a tree showing all connected baselines, and so on. It is easy as never before to navigate through the connectivity of your data!

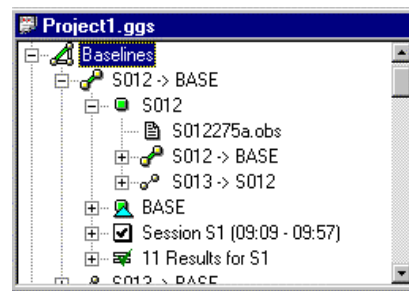


Figure 5-9: Navigator Example

A click with the right mouse button onto any item of the tree opens a context menu. The context menu allows you to perform the most important actions related to the selected item at any time.

To delete any of the objects of the project, activate the item and click the keyboard button **Del**. This action deletes the currently activated item of the navigator including its contents and child elements. However, the pointer to a corresponding observation file will only be deleted, if you activate the observation file itself and then click the keyboard button **Del**.

5.2.1.2 Containers

Basically, containers allow you to access these components:

- ◆  Points
- ◆  Kinematics (if kinematically derived data are available)
- ◆  Baselines
- ◆  Total Station and  Levelling
- ◆  Vectors
- ◆  Observation Files
- ◆  Ephemeris Files

Each container branches in its own typical order and contains the following items:

- ◆ The **Points** container  summarizes all **points** identified by **GeoGenius**.

Points are represented by a green circle () and the point number.

A blue triangle marks fixed points ()

With Stop&Go data, the Points container displays reference station(s) () and rover identifiers () as well as all stop points.

Points with (re-)initialization periods are marked by an initialization icon () , others by the stop point icon () , their names and the time of measurement.

A question mark  marks the point, which lack horizontal information (derived, e.g., from levelling measurement).

GeoGenius automatically sorts the points depending on the date of creation. You may, however, sort the points by other criteria. Activate the container Points and open the context menu with a click of the right mouse button. Item **Sort** offers the following alpha-numerical sorting options:

Sort:

by Name	by the point number as given in the file header
by Info	by the point info as given in the file header
by Code	by the code info as given in the file header
by East	by the east coordinate as given in the file header
by North	by the North coordinate as given in the file header
by ID	by the internal reference number of the point
Ascending:	toggle sort order to ascending
Descending:	toggle sort order to descending.

- ◆ The **Kinematics** container  only shows up, if kinematic data is available. It summarizes the kinematically observed lines defined by the reference and the rover observation files with overlapping time spans.

Kinematic lines are represented by a kinematic line icon () and the sequence of the point numbers of the connected observation files. The names are separated by an asterisk to indicate that the kinematic files typically contain several positions relative to the reference station.

The order of kinematic lines depends by default on the order of insertion. You may, however, sort the lines by other criteria. Activate the Kinematics container and open the context menu with a click of the right mouse button. Item **Sort** offers the following sorting options:

Sort:

by Reference	by the name of the reference file
by Rover	by the name of the rover file
by Start time	by the start time of the common time
by Time span	by the number of common seconds between reference and rover file
by Ratio	after processing by the ratio value
by #Sessions	by the number of sessions
By ID	by the internal reference number of the baseline
Ascending:	toggle sort order to ascending
Descending:	toggle sort order to descending.

- ◆ The **Baselines** container  summarizes all baselines, i.e., points linked by observation files with overlapping time spans. Baselines are represented by a baseline icon (, , ) and the sequence of the point numbers of the points they connect. The names are separated by an → arrow. The baseline icon changes its appearance depending on the processing status.

-  baseline, not processed
-  processed baseline, status = green
-  processed baseline, status = yellow/red

GeoGenius automatically sorts the baselines depending on the date of creation. You may, however, sort the lines by other criteria. Activate the container Baselines and open the context menu with a click of the right mouse button. Item **Sort** offers the following alphanumeric sorting options:

Sort:

- by Reference by the name of the reference file
- by Rover by the name of the rover file
- by Start time by the start time of the common time
- by Time span by the number of common seconds between reference and rover file
- by Ratio after processing by the ratio value
- by #Sessions by the number of sessions
- By ID by the internal reference number of the baseline
- Ascending: toggle sort order to ascending
- Descending: toggle sort order to descending.

- ◆ The **Total Station** container  lists all terrestrial measurements that will go into the network adjustment. The terrestrial measurements are inserted via file IO.

The icon  represents the terrestrial measurement. **GeoGenius** automatically sorts the measurements. You may, however, sort the measurements by other criteria. Mark the container Total Station and open its context menu with a click of the right mouse button. Item **Sort** offers the following alphanumerical sorting options::

Sort:

by Reference	by the name of the reference file
by Rover	by the name of the rover file
by ID	by the internal reference number of the baseline
Ascending:	toggle sort order to ascending
Descending:	toggle sort order to descending.

- ◆ The container **levelling**  lists all levelling measurement , which may go into the adjustment. The levelling data are imported via file import into the project. **GeoGenius** automatically sorts the levelling measurements.
- ◆ The **Vectors** container  summarizes the solution vectors that will go into the network adjustment. Vectors may either be generated during the processing or inserted via file IO.
Vectors are represented by a vector icon  and the number of solutions available for the vector which is indicated in brackets.
The order of vectors follows the order of baselines in the Baseline container.

- ◆ The **Observation Files** container  summarizes all available observation files.

Each file is represented by a document icon  and the name of the file, including its extension.

GeoGenius automatically sorts the observation files in order depending on insertion. You may, however, sort the files by other criteria. Activate the container Observation Files and open its context menu with a click of the right mouse button. Item **Sort** offers the following alphanumerical sorting options:

Sort:

by Name	by the point number as given in the file header
by Start Time	by the start time as given in the file header
by Time Span	by the time span of observation as given in the file header
by ID	by the internal reference number of the file
Ascending:	toggle sort order to ascending
Descending:	toggle sort order to descending.

- ◆ The **Ephemeris Files** container  summarizes all available ephemeris files in up to three subcontainers, depending on the type of ephemeris file included into the project.

Each subcontainer is represented by a directory icon .

Each file is represented by a document icon  and the name of the file, including its extension.

GeoGenius automatically sorts the ephemeris files in order depending on the insertion.

Most of these items may lead to other items. If other items are available, this is indicated by a small  box in the tree (a  box allows you to close the respective (sub-)container).

5.2.1.3 Object Linkage

The following list shows how objects are linked:

- ▽ from a Point:
 - a)  observation files with the point name in their header
 - b)  baselines to the point (i.e., observation files with overlapping time span exist)
 - c)  terrestrial measurements to or from the point, if available
- ▽ from a Baseline:
 - a)  the start point
 - b)  the end point
 - c) ≥ 1 Session(s),
 -  enabled session
 -  disabled session
 - d)  1 Results container for each processing combination
 -  (X Results after S1...SY). The default Results container is marked with ✓ sign.
Default: last computed session combination
- ▽ from a Kinematic line:
 - a)  the reference station observation file
 - b)  the rover observation file
- ▽ from a Terrestrial Measurement:
 - a)  the start point
 - b)  the end point
- ▽ from a Session:
 - a)  observation files to start and end point
- ▽ from a Results container:
 - up to 11 results for the respective session. These may be:
 -  Stop&Go

-  Triple Difference
-  Double Difference/Float/[5 different phases]
-  Double Difference/Fixed/[5 different phases].

The number of results depends on the available data.

▽ From the Solutions container:

The best processing result of all processing sessions for each single solution. These may be:

-  Stop&Go
-  Triple Difference
-  Double Difference/Float/[5 different phases]
-  Double Difference/Fixed/[5 different phases].

The number of solutions depends on the available data and the result filter used in the Processing settings.

▽ from an Observation file:

-  the Trajectory, if kinematic rover data
-  Stop points with (re-)initialization, if Stop&Go data
-  Stop points without (re-)initialization, if Stop&Go data

If any unknown object should be inserted into the project (e.g., a vector of unknown type), a question mark sign  will precede this object.

5.2.2 The Project Plot Area

5.2.2.1 General

The project plot area displays the contents of the project in form of a (preliminary) sketch. After insertion of objects, such as observations, vectors or local coordinates, **GeoGenius** automatically chooses the scale needed for the network to completely fill the area, converts coordinates to state plane coordinates and shows a map on the current data. All points are displayed in relation to their geographical coordinates. (**GeoGenius** needs a System to be able to map three-dimensional points into a two-dimensional plot. If you did not provide a System, **GeoGenius** automatically chooses the Standard Map Projection). (See chapter 6.)

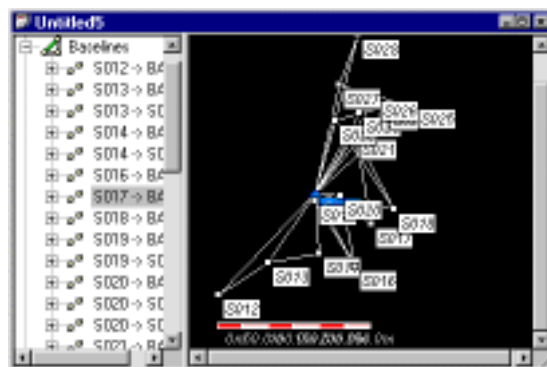


Figure 5-10: Project Plot



Please keep in mind that before observation files are processed positions are single point calculations from code measurements. Accuracy is about $\pm 100\text{m}$. After processing, the relative positions of all points will be improved and the layout of the plot may change.

All observation files with overlapping time spans and a minimum of observed satellites are connected with a line representing a baseline. You may define the styles for any plot object. To do so, choose the menu item **Options/Styles....** The notebook Object Styles allows modifying the styles of any displayed object. You will find a description of how to modify object styles in Appendix A (Customizing).

5.2.2.2 Zoom Options

By default, **GeoGenius** automatically chooses the scale needed for the network to completely fill the area. Often, you may want to inspect an enlarged view of a part of your project. Then you may want to return to the overview on your complete network. A few mouse-clicks will be sufficient for you to zoom to the fitting area.

Of course, you may use the typical Windows options to resize a window, to minimize or maximize a child window, etc. You may also use the mouse to resize the proportion of the navigator, project area and output window to each other. These options enlarge or decrease the current plot.

When dragging the cursor with the left mouse button over your project plot you can additionally define a part of the plot and accordingly zoom into this detailed area. You may repeat this action up to the millimeter range!

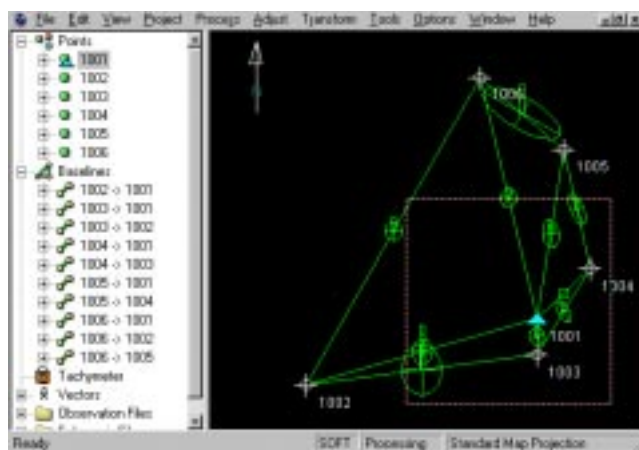


Figure 5-11: Drag the Cursor Over the Project Area to Zoom in

The contents of the rectangle in the project plot displayed in *Figure 5-11* covers the project plot area in the next figure.

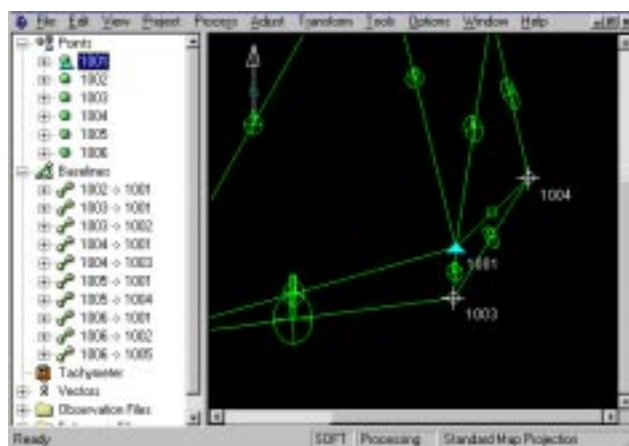


Figure 5-12: New Area, Zoomed in

If the point of interest has moved out of the plot area, activate the corresponding point in the Points container, open its context menu (click right mouse button) and click the menu item **Center**. The project plot will be redrawn with the chosen point in the center of the display. The zoom factor, however, will stay the same.

To re-zoom to the original plot scale, click the option **Zoom** All of the pull-down menu **View** or the corresponding toolbar button of the toolbar **Display**. 

If you want to zoom back to the last scale factor, click the option **Undo** of the pull-down menu **View** or the corresponding toolbar button of the toolbar **Display**. 

5.2.2.3 Display Modes

Within **GeoGenius**, you can freely design the project plot. Each type of plot object is organized in a **layer**. A layer, however, may contain different types of plot objects. Layers exist, for example, for different types of points, baselines, and so on. With points, there is a layer for standard points, one for points derived from a navigation file, one for VSFB-points. *Appendix A.3* describes how to set colors and fonts or how to define line styles for each layer. You may define different layer style sets for different projects.

GeoGenius allows you to arrange layers to visualize your network according to your needs. Define Display Groups and set all layers you want to be displayed when this Display Group is activated.

How is a display group activated? You can select a display group very easily from a pull-down list of the toolbar **Display**. If the toolbar **Display** is not visible, click (right mouse button) onto the toolbar area

and check the item Display; the toolbar Display will then show up in the toolbar area.



Figure 5-13: Toolbar Display with Box Display Groups

If you have, e.g., previously defined two display groups and did not delete the two default display groups, the following selection will appear, if you click the arrow down button of the combo box:

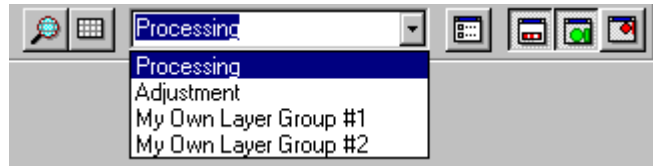


Figure 5-14: Display Group Selection

By default, **GeoGenius** implements two layer groups: The layer group Processing and the layer group Adjustment. Display group Processing is the default layer group from start-up up to the start of an adjustment process. During adjustment, **GeoGenius** automatically switches to the display group Adjustment. The last two groups of the selection are user-defined in this example. To choose one of the group simply click its name.

Display groups may be defined, changed and deleted. The following paragraphs describe these actions. They are all accessible via the notebook Processing Options. Click Process/Settings or the corresponding toolbar button from the toolbar Process. The notebook Processing Options pops up. Click the tab Display.



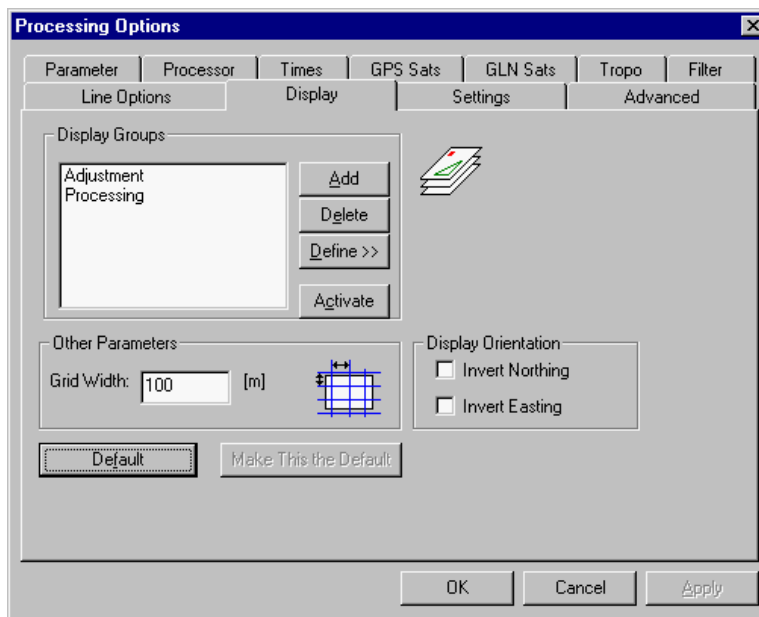


Figure 5-15: The Display Settings Options

The list box Display Groups lists the current layer groups. The buttons right of the list box allow the definition, deletion and activation of a layer group.

To **change** the settings of a layer group select its name and click button **Define>>**.

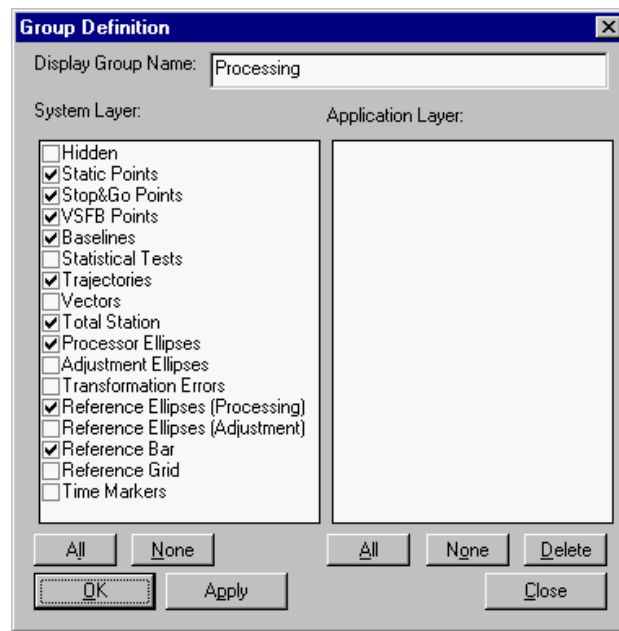


Figure 5-16: Group Definition Dialog - Settings for the Group Processing

The Group Definition Dialog displays at its top the current display Group name. You may edit the name. Two complete lists of all available layers follow. All layers given in the box System Layers belong to the basic **GeoGenius** equipment. However, you may extend **GeoGenius** and modify it in various manners (refer to Appendix A.). If you have done so, additional layers may be available in the box Application Layers. You may delete individual layers of the box Application Layer using the button **Delete** beneath the box. System layers cannot be deleted!

The checked checkboxes show currently visible layers. If you want to change the selection, clear or check the checkbox of the respective

items. The buttons **All** and **None** beneath a box allow you to select or deselect all layers of the respective list box.

Click **OK** to accept the changes or **Apply** to accept the changes and to apply the current Display Group in the current project. Close the dialog with **Close**.

Here is a list of all available objects in the box System Layer:

- ☒ Hidden
- ☒ Static Points
- ☒ Stop&Go Points
- ☒ VSFB Points
- ☒ Baselines
- ☒ Statistical Tests
- ☒ Trajectories
- ☒ Vectors
- ☒ Total Station
- ☒ Processor Ellipses
- ☒ Adjustment Ellipses
- ☒ Transformation Errors
- ☒ Reference Ellipse (Processing)
- ☒ Reference Ellipse (Adjustment)
- ☒ Reference Bar
- ☒ Reference Grid
- ☒ Time Markers

Please note the layer **Reference Grid**. Page Display of the Processing Options notebook additionally allows you to define a width for the grid over your plot. You may edit the field Grid Width in the box Other Parameters. The default value is 100m. Further you may invert the display orientation for northing and easting.

To **add** a new layer group click the button **Add** of the page Display of the notebook Processing Options. **GeoGenius** automatically adds a new item to the selection of Display Groups under the name **New Group #**, where # stands for a number ≥ 1 . Then, activate the group **New Group #** and click the button **Define>>** to edit the name and to make your selection of layers (see *Figure 5-16* and the paragraphs above).

To **delete** a Display Group from the list activate its name and click the button **Delete**. The Display Group will be immediately deleted from the selection!

You may accept your edits and close the dialog, accept without closing the dialog or cancel your edits.

Why does **GeoGenius** use editable Display Groups instead of a predefined display setting?

1. Display Groups allows you to choose the setting according to your current task (processing, adjustment, transformation, error detection, etc.).
2. **GeoGenius** can display a lot of specific information (e.g., point error ellipses and height bars after adjustment, baseline error ellipses and height bars after processing, transformation errors after adjustment of transformation parameters, etc.), without overcrowding the project plot, because Display Groups can be selected!
3. Display Groups allow you to minimize the number of objects displayed on the screen. With large networks, this may be rather advantageous, if you are looking for single objects.
4. Display Groups allow you to hide project object. Procedures, such as processing or adjustment do not use hidden objects.
5. Defining very specific Display Groups allows you to customize the project plot for minor, but interesting operations.

For example, your network consists of statically derived points and Stop&Go data. Then you may prefer to first process the static points, before processing the kinematic data. In this case, define two Display Groups one containing the static points and baselines, the other one should contain the kinematic lines and VSFB and Stop&Go points.

A second example: You may be interested in the distances between the points of your network. The item **Distance Meter** of the pull-down menu **Tools** computes the distances between selected points. In this case, you might define a Display Group displaying only the points (which helps you to select the points). If you then choose the distance meter tool, the Distance Meter layer will be automatically added to you current Display Group. The plot area may then display a project plot like the one shown in *Figure 5-17*:

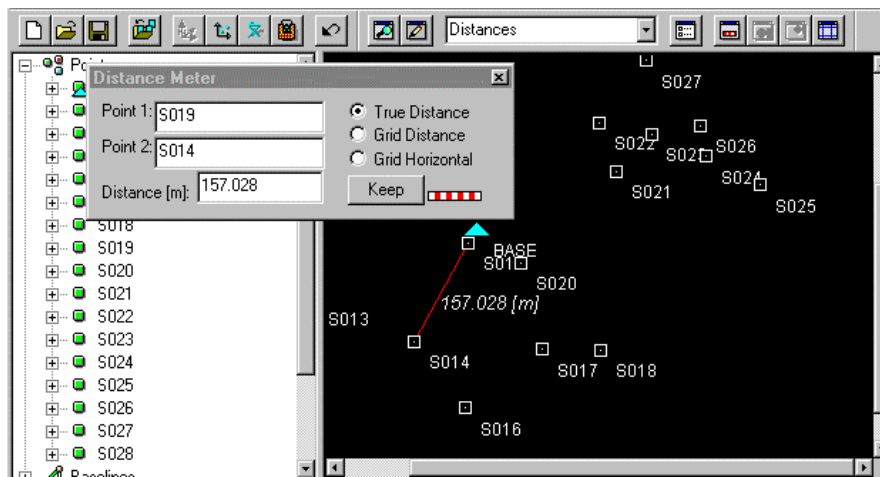


Figure 5-17: Project Plot with User-Defined Display Layer Group

5.2.2.4 The Built-in Display Groups Processing and Adjustment

By default, the project plot is in the Processing Display mode. You may check its layers via the page Display of the Processing Settings notebook. Activate the layer group Processing in the Display Groups list box and click the button **Define>>**. The Group Definition dialog displays the current settings (see *Figure 5-16*).

You may edit the settings (see previous section). To return to the default settings at any time click the button **Default** of the page Display of the Processing Options notebook.

After processing **GeoGenius** automatically uses this display option, which will result in a plot as shown in *Figure 5-18*. However, even if you have already adjusted lines, you may at any time return to the Processing display (or any other).

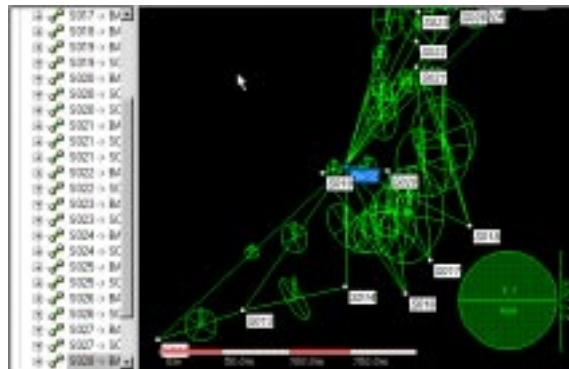


Figure 5-18: Display in Processing Mode

Figure 5-19 shows the default adjustment mode display settings. You may edit the settings (see previous section). To return to the default

settings at any time click the button **Default** of the page Display of the Processing Options notebook.

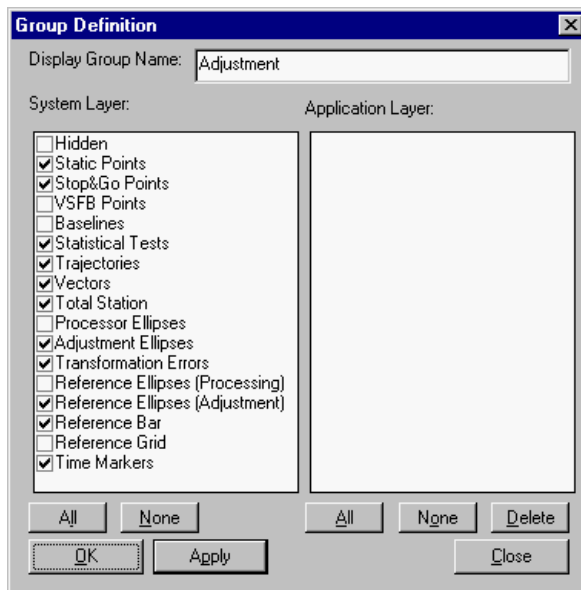


Figure 5-19: Processing Options. Adjustment Display

These settings result after adjustment in a project plot such as shown in *Figure 5-20*.

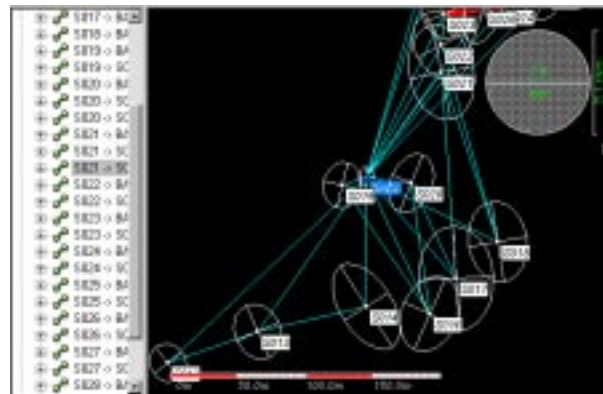


Figure 5-20: Project Plot in Adjustment Display Mode

5.2.2.5 Reference Objects

A reference scale bar indicates the length of the baseline. You may toggle the reference scale bar on and off, if the current Display Group contains this layer and if data are already displayed in the current project. By default, the reference scale bar is toggled on. The length of the bar changes when the plot is zoomed!

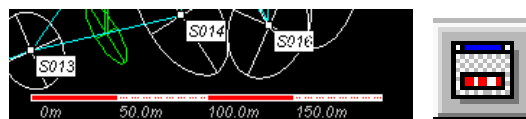


Figure 5-21: Reference Bar. Toggle button

After processing, a reference error ellipse and a height bar may indicate the standard error values. You may toggle the reference ellipse and height bar on and off. With the default Processing Display Group, they are toggled on!

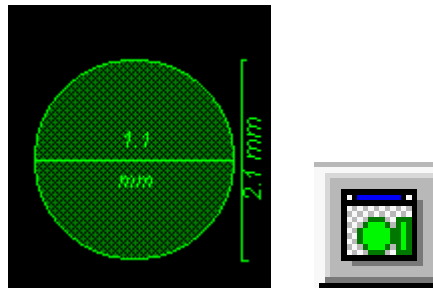


Figure 5-22: Processing Reference Ellipse. Toolbar Button

After adjustment, a reference error ellipse and a height bar may indicate the standard error values for the points. You may toggle the reference ellipse and height bar on and off. With the default Adjustment Display Group, they are toggled on.

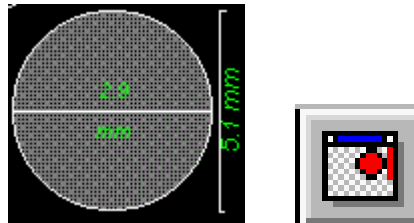


Figure 5-23: Adjustment Reference Ellipse. Toolbar Button

A reference grid may help you to control the location of your points or baselines. By default, it is not activated in one of the two built-in Display Groups. To set a grid

- You may change the selection of one of the built-in Display Groups or
- add a new Display Group and select the option Reference Grid in the Group Definition dialog (see section **Display Groups**) or
- you may click the corresponding toolbar button.



If a grid is activated, it will cover your project plot area:

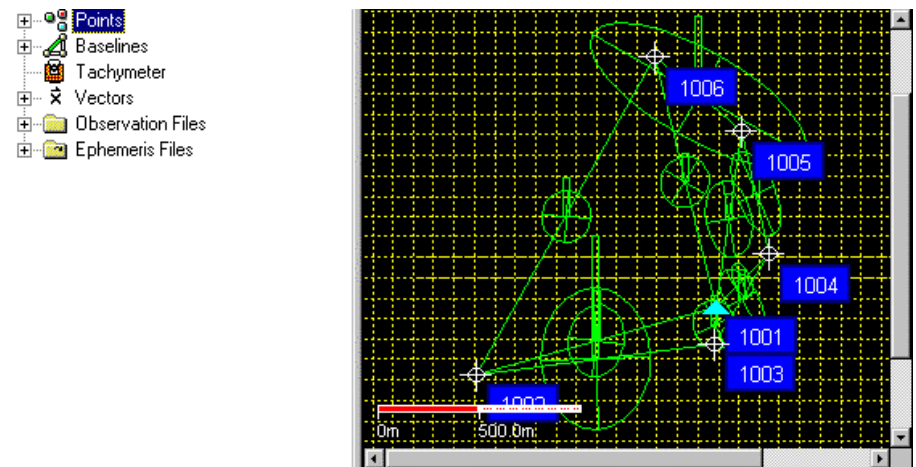


Figure 5-24: Reference Grid

You may define the grid width for the current project. Choose the item **Settings...** of the pull-down menu **Process** and click tab **Display** of the Processing Options notebook.

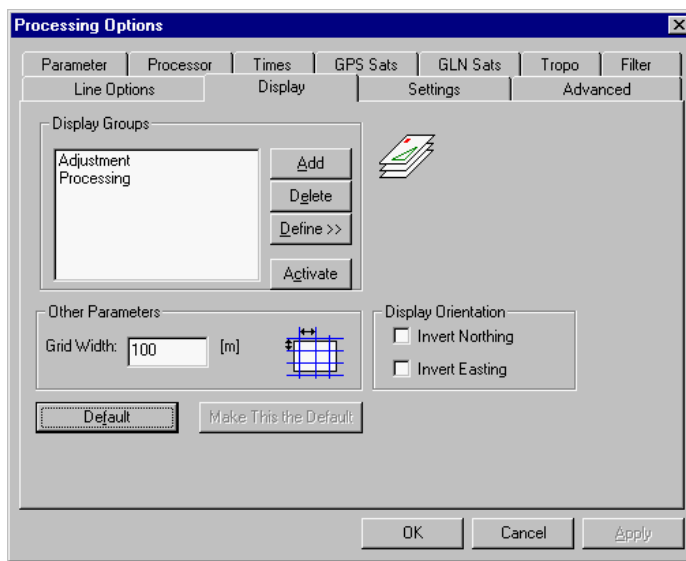


Figure 5-25: Edit the Grid Width

Edit the string field Grid Width of the box Other Parameters. By default, it is set to 100m. You may accept your edits or cancel them. If you later want to return to the default value, click the button **Default** of this page.

5.2.2.6 Activating

You may highlight lines as well as points by a click with the **left** mouse button onto the line (for baselines) or on the point number (for points). Highlighting is necessary for actions on single objects, such as processing of a single line, enabling/disabling of single lines, inspection of data, etc.

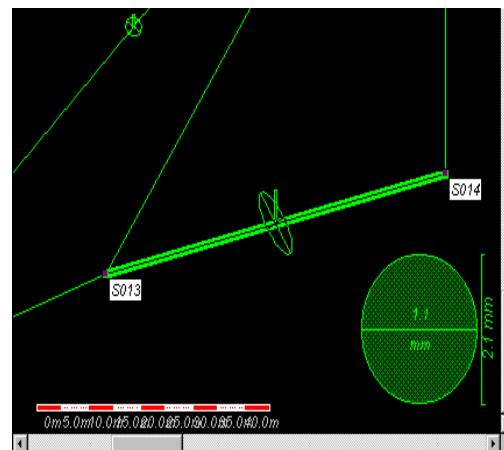


Figure 5-26: Activated Baseline S013-S014

5.2.2.7 Color Quality Indicator

After processing a baseline **GeoGenius** provides the quality of the GPS baseline estimation within the project plot. An indication based on traffic light colors is used: **green** denotes a baseline that was successfully processed with fixed integers, a baseline that is shown in **yellow** has also been successfully processed although the integer ambiguities could not be fixed. Finally, a baseline that is shown in **red** after processing tells that the baseline reduction failed. This baseline needs further analysis. A **blue** baseline indicates that only a triple difference solution is available.



Red baselines only indicate that the computed standard error for the baseline exceeds the maximum position sigma (by default 20mm). Very long baselines may often be indicated with red!

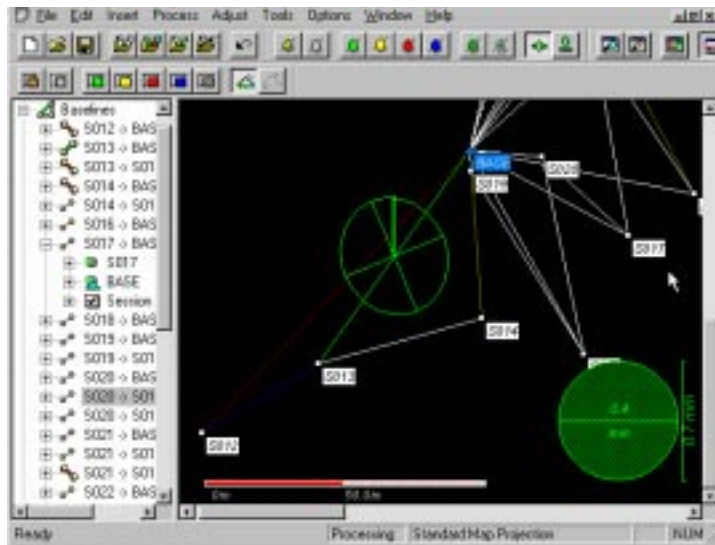


Figure 5-27: Color Quality Indicators

Figure 5-27 shows enabled and disabled baselines of the four quality types. (You probably will never see a plot like this one. To generate the plot and illustrate the four types we had to set a few completely unrealistic parameters!)

You may change the colors or line widths for the result indicators, but we do not recommend doing so. This manual and **GeoGenius** use the traffic light colors for indicating the quality.

5.2.2.8 Standard Errors

A specialty of the project plot is the **display of standard errors** for each baseline after processing and for each point after network adjustment. Standard errors are displayed in form of position error ellipses with height error bars.

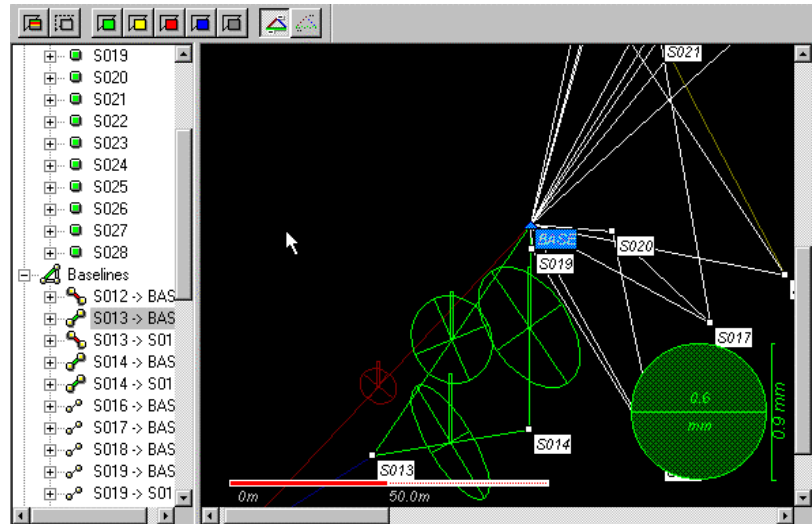


Figure 5-28: Error Ellipses

Enabling lines also activates the error ellipses of processed lines. However, you may hide all or a selection of error ellipses via the toolbar Ellipses (refer to Appendix A, *Customizing*).



Figure 5-29: Toolbar Ellipse

5.2.2.9 Objects not Displayed

You may set some limitations for baselines or points to be displayed in the project plot (or the navigator). These limitations are set in the notebook Processing Options, page Line Options.

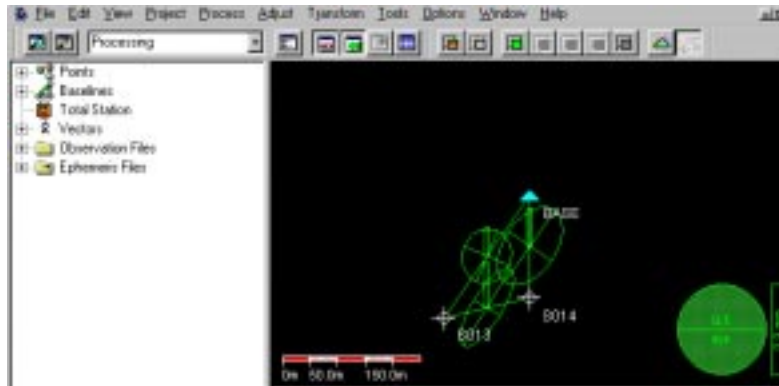


Figure 5-30: All Baselines Except Green Baselines Disabled and Hidden

You can also click on a baseline and disable it for processing via the option **Disable** from its context menu. When you activate the toolbar button **Hide Disabled**, all disabled baselines of the project will be hidden and, therefore, will neither be processed or adjusted.



A line disabled and displayed will be ignored in the processing, but not in the adjustment. For **GeoGenius** to ignore baselines in adjustment, the lines must be **disabled and hidden**.

Click the toolbar button **Show Disabled** to display disabled lines.



5.2.2.10 Open Context Menu

Each object has its own context menu, which you may open with a click of the **right** mouse button anywhere, if the object is highlighted.



Only highlighted objects (lines or points) will display their context menu!

If you, e.g., want to inspect the properties of a point, go to the point number and open the point's context menu using the right mouse button. Choose menu item **Properties**. A dialog will allow you to enter the new point number and the local coordinates of the point.

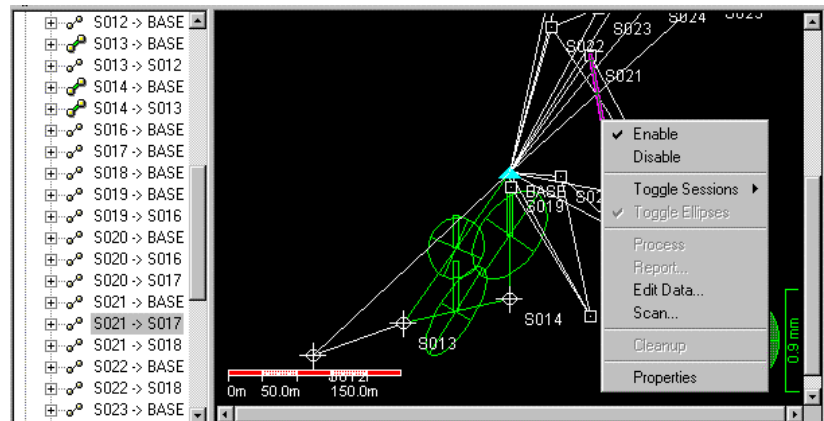


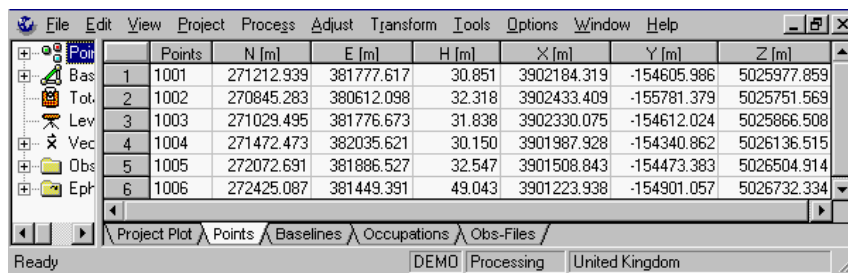
Figure 5-31: Context Menu

5.2.3 The Tables of the Project Field

Not only the project plan, but also some tables display the contents of the project clearly. The following tables are available, which may be displayed via the tabs showing up at the bottom border:

- ☐ Points
- ☐ Baselines
- ☐ Occupations
- ☐ OBS-Files
- ☐ More pages, depending on the project, the program version, etc..

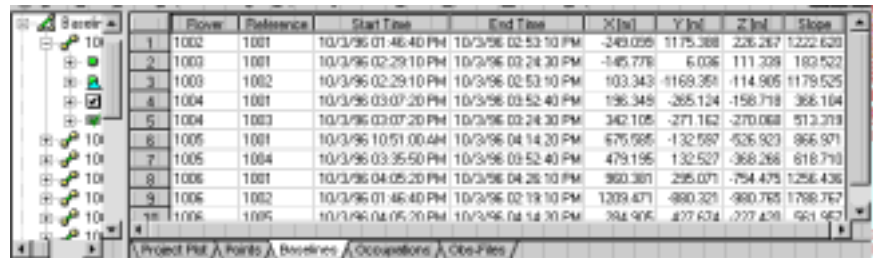
The table Points offers one row of information for each point. A line contains the current coordinates as state plane (National) coordinates (Northing N, Easting E, ellipoidal height H) and as WGS84 System coordinates (X, Y, Z). Their length unit depends on your settings (refer to App. A.2). These values correspond to the values displayed on the properties dialog of each single point, i.e., they refer to the current processing status of the project. After import of observation files, you will find the unprocessed, single point accuracy (refer to section 5.5); after processing, adjustment or transformation the coordinates will be updated.



	Points	N [m]	E [m]	H [m]	X [m]	Y [m]	Z [m]
1	1001	271212.939	381777.617	30.851	3902184.319	-154605.986	5025977.859
2	1002	270845.283	380612.098	32.318	3902433.409	-155781.379	5025751.569
3	1003	271029.495	381776.673	31.838	3902330.075	-154612.024	5025866.508
4	1004	271472.473	382035.621	30.150	3901987.928	-154340.862	5026136.515
5	1005	272072.691	381886.527	32.547	3901508.843	-154473.383	5026504.914
6	1006	272425.087	381449.391	49.043	3901223.938	-154901.057	5026732.334

Figure 5-32: Table Points

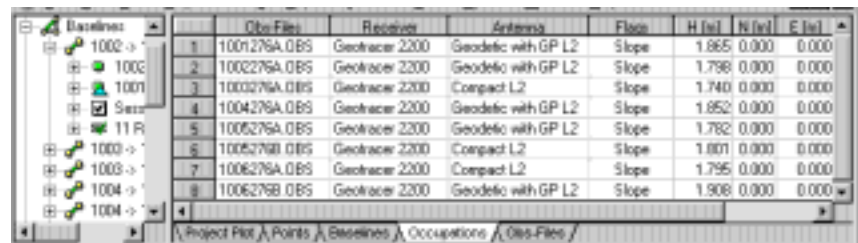
The tab Baselines opens the table of baselines within the project. The baselines are sorted according to the navigator. For each baseline, you will find information on rover and reference, start and end time of observation, the baseline components dX, dY and dZ and the slope distance between the start and end point.



Row	Rover	Reference	Start Time	End Time	X [m]	Y [m]	Z [m]	Slope
1	1002	1001	10/3/96 01:46:40 PM	10/3/96 02:53:10 PM	-249.056	1175.388	226.267	1222.620
2	1003	1001	10/3/96 02:29:10 PM	10/3/96 03:24:30 PM	-145.778	6.036	111.339	182.522
3	1003	1002	10/3/96 02:29:10 PM	10/3/96 02:53:10 PM	103.343	-1169.351	-114.905	1179.525
4	1004	1001	10/3/96 03:07:20 PM	10/3/96 03:52:40 PM	196.349	-265.124	-158.719	368.104
5	1004	1003	10/3/96 03:07:20 PM	10/3/96 03:24:30 PM	342.105	-271.162	-270.068	512.219
6	1005	1001	10/3/96 10:51:00 AM	10/3/96 04:14:20 PM	675.585	-132.587	-526.923	866.971
7	1005	1004	10/3/96 03:35:50 PM	10/3/96 03:52:40 PM	479.195	132.527	-368.266	616.710
8	1006	1001	10/3/96 04:05:20 PM	10/3/96 04:26:10 PM	960.381	295.071	-754.475	1256.436
9	1006	1002	10/3/96 01:46:40 PM	10/3/96 02:19:10 PM	1209.471	-980.321	-980.765	1798.767
10	1006	1005	10/3/96 04:05:20 PM	10/3/96 04:14:20 PM	284.905	427.624	-227.428	561.957

Figure 5-33: Table Baselines

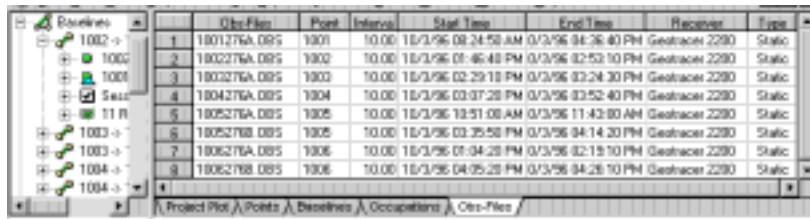
You will find the information derived from the header of the observation files as tables Occupations and OBS-Files.



Obs-File	Receiver	Antenna	Flags	H [m]	N [m]	E [m]
1 1001276A.OBS	Geotracor 2200	Geodetic with GP L2	Slope	1.865	0.000	0.000
2 1002276A.OBS	Geotracor 2200	Geodetic with GP L2	Slope	1.798	0.000	0.000
3 1003276A.OBS	Geotracor 2200	Compact L2	Slope	1.740	0.000	0.000
4 1004276A.OBS	Geotracor 2200	Geodetic with GP L2	Slope	1.852	0.000	0.000
5 1005276A.OBS	Geotracor 2200	Geodetic with GP L2	Slope	1.782	0.000	0.000
6 1006276B.OBS	Geotracor 2200	Compact L2	Slope	1.801	0.000	0.000
7 1006276A.OBS	Geotracor 2200	Compact L2	Slope	1.795	0.000	0.000
8 1006276B.OBS	Geotracor 2200	Geodetic with GP L2	Slope	1.908	0.000	0.000

Figure 5-34: Table Occupations

The table Occupations contains the details for the receiver and antenna used, the type of antenna height measurement (Flags), and the antenna eccentricities as height H, Northing and Easting (N, E).



	OBS-Files	Point	Interval	Start Time	End Time	Receiver	Type
1	1001276A.D95	1001	10.00	18/3/96 08:24:50 AM	0/3/96 04:36:40 PM	Geotracor 2290	Static
2	1002276A.D95	1002	10.00	18/3/96 01:46:48 PM	0/3/96 02:52:10 PM	Geotracor 2290	Static
3	1003276A.D95	1003	10.00	18/3/96 02:29:18 PM	0/3/96 03:24:30 PM	Geotracor 2290	Static
4	1004276A.D95	1004	10.00	18/3/96 03:07:28 PM	0/3/96 03:52:40 PM	Geotracor 2290	Static
5	1005276A.D95	1005	10.00	18/3/96 10:51:08 AM	0/3/96 11:43:00 AM	Geotracor 2290	Static
6	1006276A.D95	1006	10.00	18/3/96 03:35:58 PM	0/3/96 04:14:30 PM	Geotracor 2290	Static
7	1006276A.D95	1006	10.00	18/3/96 01:04:28 PM	0/3/96 02:19:10 PM	Geotracor 2290	Static
8	1006276B.D95	1006	10.00	18/3/96 04:05:28 PM	0/3/96 04:28:10 PM	Geotracor 2290	Static

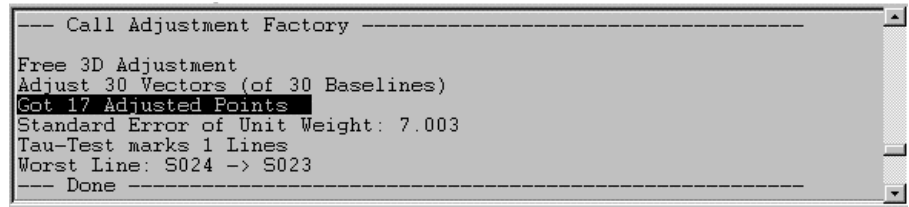
Figure 5-35: Table OBS-Files

The table OBS-Files lists for each observation file the point name, the sample interval, start time and end time of observation, the receiver type and the type of measurement (static or kinematic).

A row represents an object of the project. A property dialog is available for each object of a table (as it is the case with the project plot and the navigator) via the menu item **Properties** of its context menu (click the row once using the right mouse button or twice using the left mouse button). Within the property dialog you may edit values manually. These edits will be accepted, as soon as you have clicked the button **Assign**. (Refer to section *Open Context Menu*).

5.3 The Output Window

The output window helps to control **GeoGenius** ' actions.



```
--- Call Adjustment Factory -----  
Free 3D Adjustment  
Adjust 30 Vectors (of 30 Baselines)  
Got 17 Adjusted Points  
Standard Error of Unit Weight: 7.003  
Tau-Test marks 1 Lines  
Worst Line: S024 -> S023  
--- Done -----
```

Figure 5-36: Output Window

When first starting **GeoGenius** , no output window is available. It will first show up, when **GeoGenius** is outputting text of any kind. You may display or hide the output window by the options Show Output/Hide Output of the menu View.

The output window consists of a message area and a vertical scroll bar. If it is not docked to the **GeoGenius** main window, it also has a title bar showing Output as caption. The output window may show up to 32000 lines of text of arbitrary length. Typically, the process that generates messages runs in parallel, so it is possible to scroll through the text during, e.g., processing of a project.

Typically, the output window entries start with a message on the type of action done. This message is framed by a dashed line, which later on simplifies the assignment of messages.



```
--- Processing 1 Line -----
```

Figure 5-37: Action Type Message

All following messages are displayed in the output window. If these messages are error messages, the (default) style of the font and of the highlighting background will change from black to red color.



Figure 5-38: Warning Message

If you click with the right mouse button somewhere onto the Output Window text area, a context menu will open.

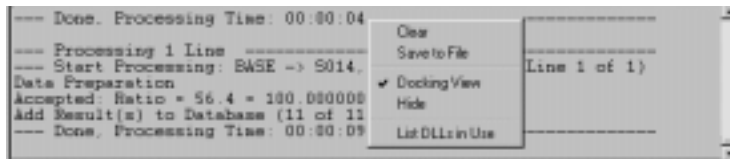


Figure 5-39: Output Window Context Menu

The following options allow modifying the appearance of the window and performing actions on the displayed messages.

Clear	Deletes the contents of the output window. All messages are discarded.
Save to File	Opens a Standard File Selector and allows you to specify a text file, to which all messages are saved. If you press button Save , GeoGenius will write the contents of the output window into the text file. To leave the File Selector without saving press Cancel .

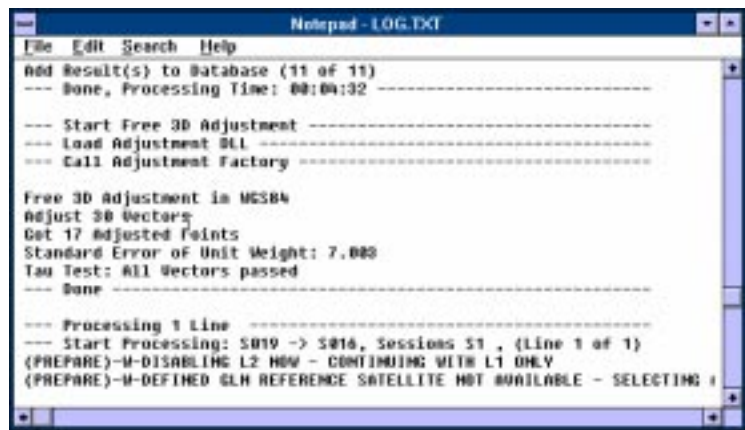


Figure 5-40: Edited Output File

Docking View

A toggle option. If it is marked with a ✓ sign, the output window will dock to the bottom of the client area (Default).

If you deactivate the option, the output window becomes an independent, floating window, moveable to anywhere on the PC's screen.

However, as soon as you drag the top of the window near to a docking station, such as the bottom of the client area or the toolbar area, the output window will dock there and the Docking View option becomes activated.

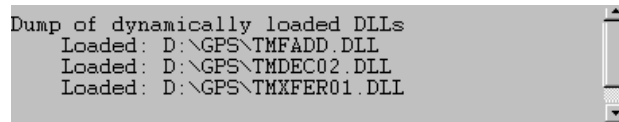
If the option is deactivated and you activate it while the output window is anywhere on the screen, the output window will automatically dock at the bottom.

Hide

Allows you to hide the output window until the display of the next message. The same is done via

the menu option **View/Hide Output**. If the output window is hidden and you want to check some older messages again, choose the menu option **View/Show Output**. The output window will show up again and display all messages starting with the first message since starting **GeoGenius** , or after the last output window was cleared.

- Font... Opens a standard Windows Font Selector allowing you to change the font and font attributes of the output messages.
- List DLLs in Use Displays the paths and names of currently used DLLs in the output window. This output might be useful to make sure, that the software really uses the DLLs that you intended.



```
Dump of dynamically loaded DLLs
Loaded: D:\GPS\TMFADD.DLL
Loaded: D:\GPS\TMDEC02.DLL
Loaded: D:\GPS\TMXFER01.DLL
```

A screenshot of a text window with a gray background. The title bar is not visible. The text inside shows a list of loaded DLLs. On the right side of the window, there is a vertical scrollbar.

Figure 5-41: DLLs Listed

5.4 Project Management

GeoGenius allows to create new projects, store projects on disk and retrieve already stored projects from disk. All project related information is stored in one project file with the exception of observation and ephemeris data. The project file includes information of the following type:

- ⇒ Observation files used in the project.
- ⇒ Ephemeris files of different type used in the project.
- ⇒ Directory or drive wherein ephemeris and observation files are stored.
- ⇒ Results of processing.
- ⇒ Results of network adjustment.
- ⇒ Results of coordinate transformation.
- ⇒ ...



The default extension for project files is *.GGS. The system supports this as default extension. It is not necessary to provide this extension.

In the main **GeoGenius** window, multiple projects can be managed simultaneously. Each project is managed in an own window, all these windows are children of the main **GeoGenius** window. Selecting a project specific option from the main window only concerns the current project (this is the window that was selected last).

When you select the File option in the main menu, the following sub-menu appears; all project related choices are explained here:

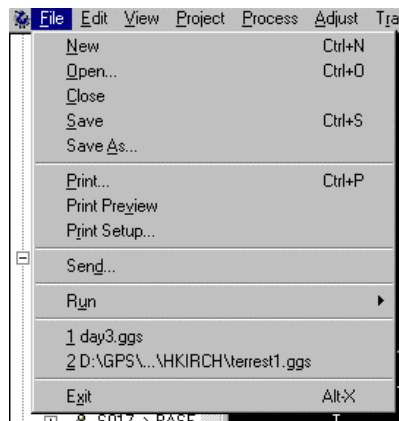


Figure 5-42: File Menu

5.4.1 New (Ctrl - N)

Select this option to create a new project. A project window called **Untitled#** shows up, where # represents a number starting with 1. It consists of a title bar and two client areas, as described in section 5.2.

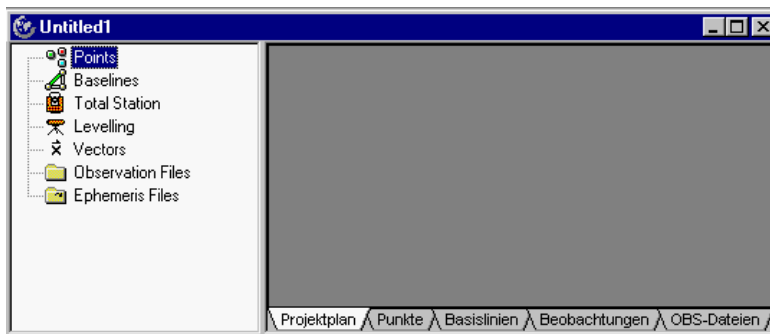


Figure 5-43: New Project

The navigator at the left-hand side shows a preliminary project structure consisting of Static points, Baselines, Vectors, Observation Files and Ephemeris files. With a new project, these containers are all empty. If kinematic data is imported, the item Kinematics will be added.

The project area at the right-hand side displays the background for a sketch of the future project (the project plot) and some tables. At the moment of creation they all are empty.

Now, you may import GPS data like observation files or other raw data, ephemeris data, vectors or points and then use **GeoGenius** ' further features.

5.4.2 Open (Ctrl - O)

To retrieve an already stored project from disk, select the File/Open option. When you have done so, the standard file selector comes up, already showing *.GGS in the file mask box. Selecting one of the available files creates a project window and allows you to view and manipulate the project.



Please note: It is NOT possible to have a project opened in several windows simultaneously! However, you may open several program copies simultaneously using the same project. Therefore, be cautious not to overwrite changes of another user (e.g., with a network license!)

5.4.3 Save As

This option allows you to store a file with a new name. Selecting this option creates the standard file selector. Choose a directory and define a file name here and press **OK** to store the current project to disk.



Please note! The system writes the new data over an existing file. This file is lost in this case. Make sure to select unique file names. However, a dialog asking whether or not you really want to overwrite an existing project is implemented.

5.4.4 Save (Ctrl - S)

The current project is stored with the same name with which it was opened or saved the last time. No dialog appears.

5.4.5 Close

Closes the current project. If you did not store the project before, a dialog will appear, asking you, whether you want to save changes to the project, or to leave the project without storing, or to cancel the closing process.

5.4.6 Print Options

GeoGenius offers colored print-outs of the sketch of the current project as displayed in the project area.

You may send a print command to a printer using the File/Print... option. A standard Windows print dialog opens allowing you to define the range of pages, the number of copies, and the sorting type. Depending on your system, you may set printer options from the print dialog.

To setup the page layout choose File/Print Setup... You may also set printer options.

Before printing out your project plot, you may check the print result in a one-to-one print preview. Click anywhere on the project plot, then click the Print Preview item of the File pull-down menu.

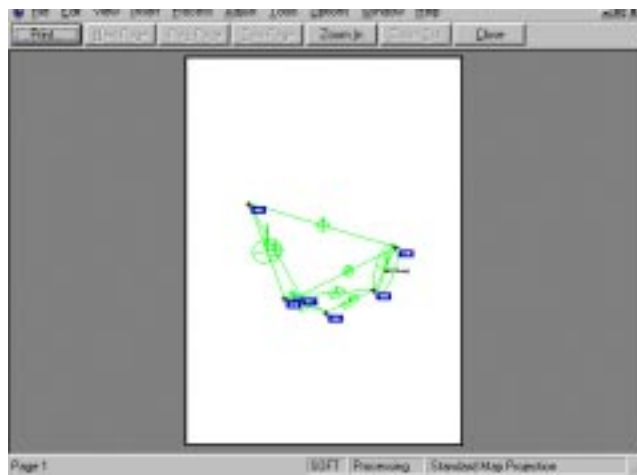


Figure 5-44: Print Preview of the Processed “Getstart” Demo Data

A colored project plot covers a sheet of the pre-selected size (refer to the Printer Settings). A print preview toolbar on top of the plot allows you to print from the preview display (**Print...**), to move to other pages (**Next Page**, **Prev Page**) or to display two pages simultaneously (**Two Page**). You may zoom in twice (**Zoom In**) and zoom back as often as you zoomed in (**Zoom Out**). Close the window via the button **Close**.

5.4.7 Exchange Data

GeoGenius supports e-mail. Just choose the menu option **File/Send...**. The Choose Profile window allows you to enter the registered name and then to open the installed e-mail dialog with the currently used project file automatically attached to a new message. For more information on e-mailing please consult your e-mail server.

5.4.8 Exit (Alt-X)

This option allows you to terminate **GeoGenius**. If there are any modified projects open, a dialog will ask you to save them before the program really terminates. To save changes, press button **Yes**, to terminate **GeoGenius** without changes to the current project, choose the button **No**, and to cancel the exiting action, press the button **Cancel**. The window Exit can also be generated by pressing the **Alt+X** hot key. See the description of hot keys for more information (section 5.1.2).

5.5 Data Import

A project consists of data of different type:

- References to Observation and Ephemeris Files
- Processing Parameters
- Point, Baseline and Position Information
- Processing Results, Reports and Error Ellipses
- and much more

Some of above objects have to be added or inserted into a project, others are generated during processing or defined during user interaction. We will now describe how to add objects into a project.



Please note: **GeoGenius** sets pointers in the project file for inserted files. Do not delete or move these files on your hard disk. **GeoGenius** would not be able to find deleted or moved files for, e.g., reprocessing the data later.

5.5.1 Insert Observation Files, Raw Data and Ephemeris

You may insert all data you need to build up a new project with the help of one single window. The window Insert Files allows you to insert raw receiver files, ephemeris files as well as the binary **GeoGenius** observation files.

To open the Insert Files window choose the option **Files into Project** from the pull-down menu **Project** or click **Ctrl+I** or click the corresponding toolbar button.



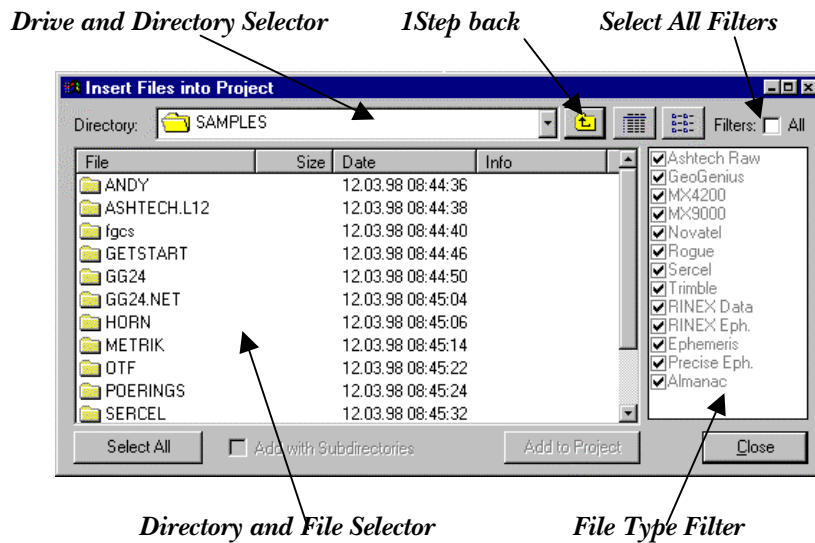


Figure 5-45: The Window Insert Files into Project

The Insert Files window consists of a drive/directory selector box, a file selector box and a file type filter box. Several buttons allow you to select files and add them to the project. Please note that the window is resizable and remembers its last size and position.

A drive and directory selector on top of the window shows the path to the current (sub-)directory. By default, this will be the directory **GeoGenius** was started from. To choose another drive or directory, just click the pull-down button right of the list box. To return to the directory one step higher than the current one, click the left-arrow button right of the drive selector box.

The file selector covers the main part of this window. This combo box displays all sub-directories and all data files of the current directory according to the chosen filter (see next paragraphs). It lists the file or directory name, and also its date of creation and, if a file, its size and type. Clicking one of the column names allows you to order the files according to their name, size, date of creation or file type. Clicking the file or directory name selects the file/directory. To select more than one file/directory hold the **Ctrl** key (adding single files) or the **Caps** key (adding all files between the last activated file and the currently activated file) while clicking with the left mouse button.

Please note that the directory is scanned as soon as you enter it. This scanning runs in parallel. You can do any other actions in this dialog as you like, e.g., change to another directory.

The list box Filters on the right side of the window lists the types of data that may be inserted. It allows you to filter the data according to their type: Each data type may be checked or unchecked.

When **GeoGenius** opens the Insert Files into Project window, it starts looking for files of all available types. Types that **GeoGenius** has found will then be activated (black font), others will be inactivated (gray font) and you cannot uncheck them. If you are looking for data of a special type, (e.g., you want to know whether binary ephemeris files have already been created) you should uncheck all other types. The file selector box will then filter out the files of the activated, checked type and will display only those. The check box **All** at the top of the Filters box allows you to check all data types by just one mouse-click.



Data type **GeoGenius** represents **GeoGenius** observation files!

The buttons at the bottom of the window allow the fast selection and import of your data. You may select an unlimited number of files simultaneously. To do so, use the **Shift** and **Ctrl** keys of your keyboard to mark several files simultaneously. Button **Select All** or the hot key combination **Alt+A** allows you to mark all files of the directory simultaneously (Windows 95, NT 4.0 or higher). If your current directory contains files and subdirectories and if you want the sub-directories to be included, check **Add with subdirectories**.



Even if you have manually marked sub-directories, their contents will only be added to the project, if you check the box **Add with subdirectories**.

To insert all selected files (and sub-directories) click **Add to Project**. Depending on the type of data to be included **GeoGenius** will just add the selected files to the project or it will start to convert the data into the data formats needed for processing. I.e., **GeoGenius** may create observation files from raw data files or binary ephemeris files from RINEX ephemeris data, etc. A progress bar allows you to view the progress of conversion or insertion.

GeoGenius inserts the raw positions (up to ± 100 m position errors) into the project and displays a sketch of the estimated points and baselines immediately.



You do not have to organize your data files in special directories. The **Add to Project** button allows you to import in succession data files from different directories.

Finally, close the Insert Files into Project window by click on button **Close**.

The following three sub-sections concentrate on the data formats used to build up a **GeoGenius** project.

5.5.1.1 Observation Files

GeoGenius uses the binary observation file format for storing all data in a receiver independent format. The name of such a file typically contains the point number (**SITE**) and the observation day (**DDD**). A free character **S** often describes the session number. The file has the extension ***.OBS**. Therefore, the typical observation filename is **SITEDDDS.OBS**.



Please note! **SITE** is not the real point number. The real point number is written within the ***.OBS** file!

A project usually consists of several observation files. If you want to process kinematic data, you need at least a pair of two observation files covering the same time span.

5.5.1.2 Raw Receiver Data

Files of raw receiver data have to be decoded first in order to convert these files to the receiver independent binary ***.OBS** file type.

After you have clicked the button **Add to Project**, **GeoGenius** automatically decodes the raw data. For example, decoders for the following trademarks (products) are implemented and decode files using the respective file formats:

- © Ashtech GPS/GLONASS
- © Geotracer
- © TurboRogue
- © Leica

- © Magnavox
- © Novatel
- © SAAB
- © Sercel
- © Trimble
- © Zeiss
- © receiver independent RINEX data

5.5.1.3 Ephemeris File Import

GeoGenius distinguishes between two different orbit types: **Broadcast** and **Precise**.

The static and kinematic processors of **GeoGenius** require binary EF18 format for processing baselines. **GeoGenius**, therefore, has to create **broadcast** or **precise** ephemeris files.

During file import, **GeoGenius** automatically generates **broadcast** ephemeris files from RINEX files, if no EF18 format files are available in the project yet (see *chapter 7.3, Ephemeris File Generation*). These files are created for each project separately.

GeoGenius decodes **precise orbits** from the ASCII SP3 format into binary EF18 format (see *chapter 14.1*). The extension *.PRC indicates the precise ephemeris file.

The Insert Files into Project window offers filters for ephemeris data files, if you check one of the following options of the Filters box:

RINEX Eph.	filters for RINEX ephemeris files with extension *.??N
Ephemeris	filters for Broadcast Ephemeris files in the binary EF18 format, extension *.EPH

Precise Eph. filters for Precise Ephemeris files in the binary EF18 format, extension *.PRC

5.5.2 Import of Points to the National Grid System

5.5.2.1 Import Point Files

Using the menu entry Project/Import/National Grid  Points (or the corresponding Toolbar button) you can import static point coordinates from files of different format. Alternatively, you may also open the context menu of the Points container and click option Import National. This option allows you to import control coordinates for existing points as well as establishing new points in your project.

The option Import Point will not be available as long as no System (see chapter 6) has been defined.



Please note that all imported points will be interpreted as if they were defined in the currently selected System! No transformation is done during importing. National coordinates imported into the wrong System will be misplaced. If you know the projection, datum, ellipsoid and geoid model valid for the point file, first define a corresponding System, select this System for your project and then import the point file. (Alternately, you might want to use **GeoTrans** to transform the file to your project's system before importing. See chapter 6 for using **GeoTrans**)

GeoGenius supports many different file formats. These file formats and the corresponding point import modules are described in detail in Appendix B. On demand Spectra Precision Terrasat provides support for other file formats (e.g. your proprietary file format).

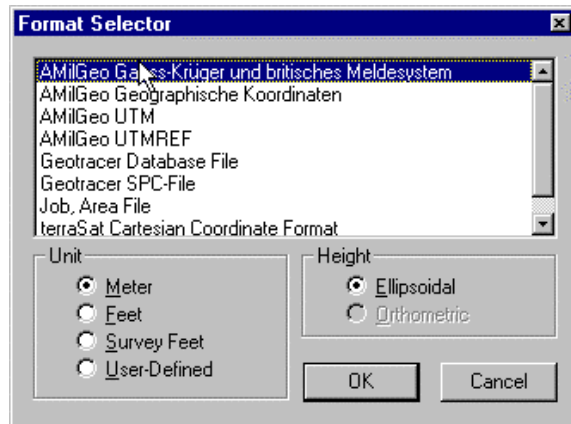


Figure 5-46: Format Selector

When importing national (or local) coordinates a Format Selector dialog offers all available file formats in an alphabetically sorted list box. Selecting a format and clicking **OK** or double-clicking on a format will lead you to a standard file selector dialog where you can browse for your import file. In case the selected file format has a default file extension this extension will already be preset.

The Format Selector dialog offers a unit type option as well as a height type option.

In the unit type option you can specify how you want the imported data to be interpreted in terms of length unit. In case a file contains sufficient unit type information the information in the file will prevail

over your choice. As it is the case throughout **GeoGenius** you have the following choices:

- Meter
- Feet
- U.S. Survey Feet
- User-Defined

Selecting User-Defined will use the unit type you have defined in Options/Customize/Units for the interpretation of length values (refer to App. A.2).

The height type option allows you to choose how height values found in the import file are to be interpreted. By default they are regarded to be ellipsoidal height values. Nevertheless, you might have additional information stating that the height values in the file are orthometric height values. Again - as with the unit type - in case the imported file contains sufficient information on the height type of the file data this information will prevail over your choice.

Note that the orthometric height option is only available if your project's System includes a valid geoid model. See chapter 6 for selecting a System.

If you have selected an import file name from the file selector and accepted it, the Import Points dialog shows up.

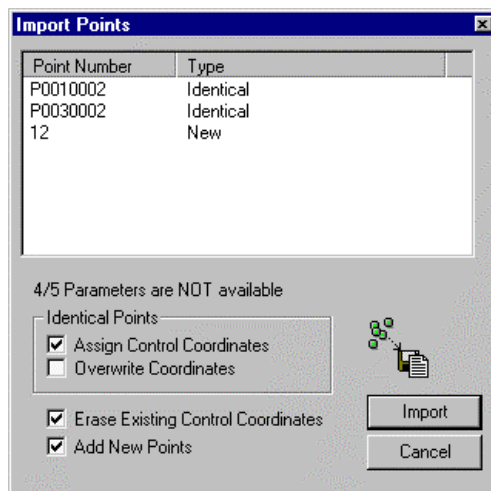


Figure 5-47: Import Points Dialog

The Import Points Dialog displays a list of all points of the import file. It gives the names of the points and distinguishes between the types:

- Identical **GeoGenius** detected a point with the same name in the project
- New No point with the same name in the project so far.

With identical points, you may define the destination for the input coordinates. You may check one or both options, if you want to insert the coordinates for identical points. If you check none, only new points can be inserted.

Assign Control Coordinates

Import this set of coordinates as a second set of coordinates, the control coordinates and fix the point. This option does not overwrite the set of coordinates used for processing. The new coordinates will show

up in the page Control of the point properties notebook. This is the default option.

Overwrite Coordinates

Import this set of coordinates as the set of coordinates used for processing and move the point to the new location. Fix the point. **GeoGenius** will transform the coordinates to the WGS84 System using the 7 transformation parameters. The new coordinates will show up in the pages National, Local (if you have defined a local System), XYZ and Geo of the point properties notebook.

The next options are of interest with both types of import points:

Erase Existing Control Coordinates

If your project already contains points with control coordinates, check this option to erase the control coordinates of all points of the current network. This option does not affect the fixing of a point! Then, **GeoGenius** will assign control coordinates for imported identical points, if you have checked the first option of the box Identical Points. With new points, no control coordinates are added to the project. By default, this option is checked.

Add New Points

This option allows you to include (or exclude) the new points of the list into (or from) the import. For example, control point files of your national survey agencies may contain lots of points, but you need only the control coordinates for the points of your current network. In this case, clear this option. By default, the option is checked.

If your point coordinates include zone information, but the System does not, **GeoGenius** gives you a warning message, but still imports the points. If the zone information in the coordinates differs from the System's zone, an error message will inform you that the import of data

failed due to different zone information. **GeoGenius** aborts the import, if the import file contains erroneous data or if the data format in the file does not comply with the specified System setting.

Imported new points show up in the Points container of the navigator. In the project plot, a new point will be displayed as a single point not connected via a baseline. Its coordinates are control coordinates.

Imported new coordinates for previously existing points will show up in the Property notebooks of the points, in the page Control and/or in the pages National (Local), Geo and XYZ, depending on your choices. All imported points are fixed. Previously fixed points do not change their fixing state, but may lose their control coordinates.

The following example may give you an impression. *Figure 5-48* shows a small, unprocessed project with GPS observation files and the automatically suggested reference point 42.

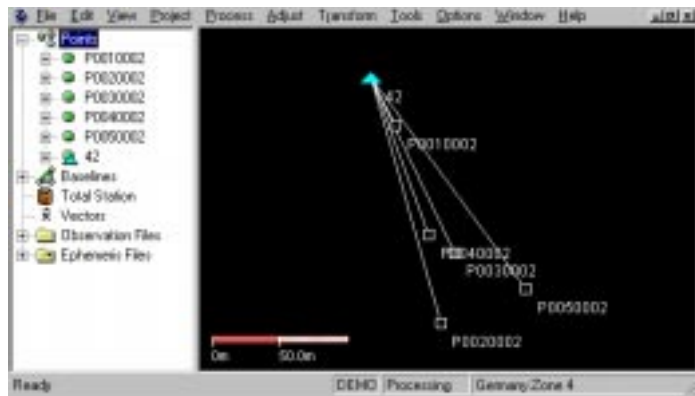


Figure 5-48: Point 42 Fixed before Control Point Import

The Import Point List displayed in *Figure 5-47* contains the identical points P0010002 and P0030002 and a new point 12. We use the default options for the import. Then the project plot and the navigator display the new point 12. Points P0010002 and P0030002 are fixed now.

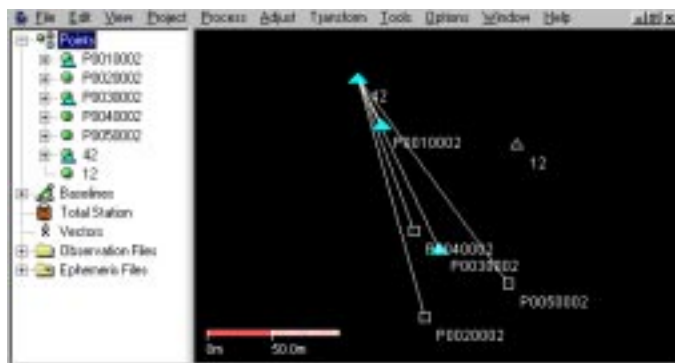


Figure 5-49: National Grid Points Imported

The page Control of the Property: Point notebook of the points P0010002 and P0030002 will display coordinates. For point 12 control coordinates are available, but the point is not fixed. No baseline connects this point with the network.

5.5.2.2 Manually Insert Point Coordinates

If you want to **manually insert points with known coordinates** into your project by typing the coordinates, choose the option Add New Point of the Project pull-down menu. Alternatively, open the context menu of the Points container and click the option Insert Point. An empty Property: Point notebook will open allowing you to manually enter a point name, point info and code (page Point) and coordinates in one of the coordinate Systems. As soon as you click the button **As-sign**, **GeoGenius** automatically calculates the values of the related coordinate sets according to the current transformation parameter sets (refer to chapter 13 on Transformations). For a set of control coordinates, click the button **Transfer to Control** at the pages National or Local or enter the values manually using the page Control.

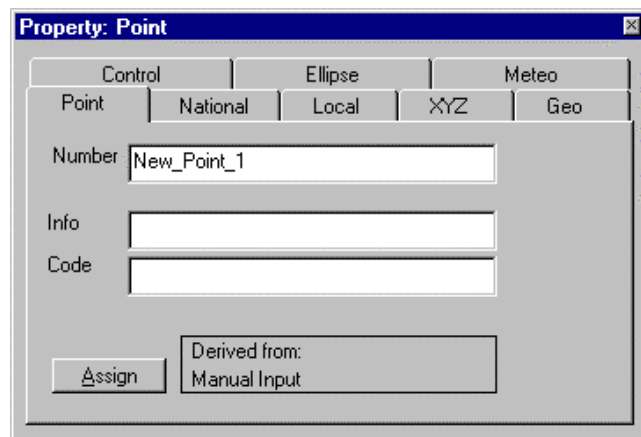


Figure 5-50: Manually Insert Point Coordinates

The newly inserted point will show up in the navigator and in the project plot as soon as you accept the edits with **Assign**.

If you have known coordinates of a point already existing in the network, you may change the coordinates derived from single point processing or from processing. Activate the point, open its context menu (right mouse button) and choose option **Properties**. The Property: Point dialog (see the figure above) displays the current point information and coordinates. It allows you either to enter a second, control coordinate set for the same point (click tab **Control**) in the current national grid System or a local plane System. Or you may correct the primary coordinates in any coordinate system, i.e., national or local coordinates, geographical coordinates or XYZ-coordinates in the WGS84 System. Accept your edits with **Assign**.

5.5.3 Import of Points to a Local System

You may import points with coordinates in a purely local System. You get the opportunity to define a local System previously, if it is not yet defined.

To start an import of local points via data files

- Choose the menu option Project/Import/Local Points, or
- Open the context menu of the Points container and click option Import Local, or
- Choose the corresponding Toolbar button from the toolbar Projects



To manually import local point coordinates

- Choose the menu option Project/Add New Points, or
- Open the context menu of the Points container and click option Insert Point, or
- Open the context menu of a point and click the option Proper - ties to edit the local coordinates.

The procedures equal the procedures of coordinate import to the national grid System. Therefore, please refer to section 5.5.2 for the details.



Please note that all imported local points will be interpreted as if they were defined in the currently selected System! No transformation is done during importing. Points imported into the wrong System will be misplaced. First define a local System using one of the options of the pull-down menu Transform and then import the local point coordinates.

5.5.4 Import of Vectors

Using the menu entry Project/Import/Vectors (or the corresponding toolbar button) you can import coordinate vectors from files.

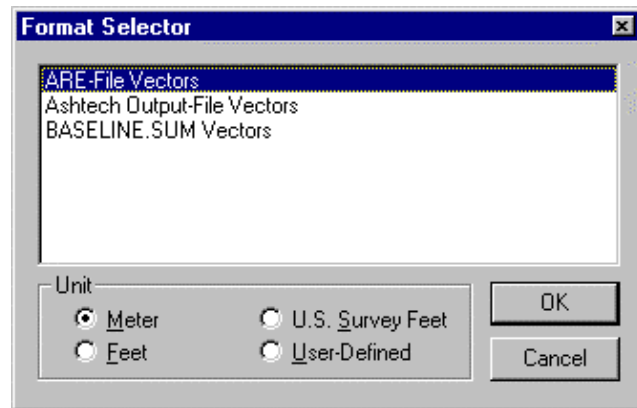


Figure 5-51: Format Selector for Vector Import

The file formats and the corresponding vector import modules are described in detail in Appendix B.1.2/B.2.6. On demand Spectra Precision Terrasat provides support for other file formats (e.g. your proprietary file format).

When importing coordinate vectors the Format Selector dialog offers all available file formats in an alphabetically sorted list box. Selecting a format and clicking **OK** or double-clicking on a format will lead you to a standard file selector dialog where you can browse for your import file. In case the selected file format has a default file extension this extension will already be preset.



Please note that all imported vectors will be interpreted as if they were defined in the currently selected System! No transformation is done during importing. Vectors imported into the wrong System will be misplaced. If you know the projection, datum, ellipsoid and geoid model valid for the vector file, first define a corresponding System, select this System for your project and then import the vector file.

The Format Selector dialog also offers a unit type option. In the unit type option you can specify how you want the imported data to be interpreted in terms of length unit. In case a file contains sufficient unit type information the information in the file will prevail over your choice. In case the selected vector import module “knows” the unit type of the file data (e.g., if the file format does not allow any other unit types but Survey Feet) the unit type option is disabled.

As it is the case throughout **GeoGenius** you are offered the following choices:

- Meter
- Feet
- U.S. Survey Feet
- User-Defined

Selecting User-Defined will use the unit type you have defined in **Options/Customize/Units** for the interpretation of length values.

Imported new vectors will show up in the Vectors container of the navigator. In the project plot, imported vectors will be added as new lines with light blue color (visible, e.g., if you have chosen the default Adjustment display).

5.5.5 Import of Total Station Data

Using the menu entry Project/Import/Total Station Data (or the corresponding toolbar button) you can import coordinate vectors from files.

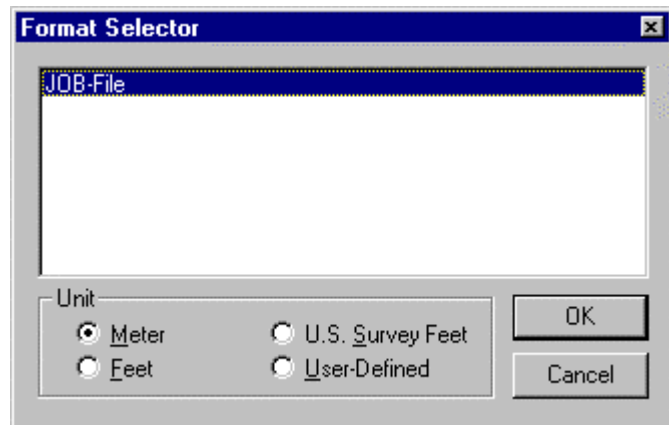


Figure 5-52: Format Selector for Total Station Data

The file formats and the corresponding import modules are described in detail in Appendix B. On demand Spectra Precision Terrasat provides support for other file formats (e.g. your proprietary file format).

When importing total station data the Format Selector dialog offers all available file formats in an alphabetically sorted list box. Selecting a format and clicking **OK** or double-clicking on a format will lead you to a standard file selector dialog where you can browse for your import file. In case the selected file format has a default file extension this extension will already be preset.



Please note that all imported total station data will be interpreted as if they were defined in the currently selected System! No transformation is done during importing. Data imported into the wrong System will be misplaced. If you know the projection, datum, ellipsoid and geoid model valid for the total station data, first define a corresponding System, select this System for your project and then import the totals station data.

The Format Selector dialog also offers a unit type option. In the unit type option you can specify how you want the imported data to be interpreted in terms of length unit. In case a file contains sufficient unit type information the information in the file will prevail over your choice. In case the selected total station data import module “knows” the unit type of the file data (e.g., if the file format does not allow any other unit types but Survey Feet) the unit type option is disabled.

As it is the case throughout **GeoGenius** you are offered the following choices:

- Meter
- Feet
- U.S.Survey Feet
- User-Defined

Selecting User-Defined will use the unit type you have defined in **Options/Customize/Units** for the interpretation of length values (refer to App. A.2).

Imported new total station observations will show up in the Total Station container of the navigator as total station observations (known

station → unknown station). New points show up in the Points container. In the project plot, imported total station data will add lines with markers for the observations and rhombuses for the observed points.

The project of the following figure consists of total station data only.



Figure 5-53: Total Station Data in Navigator and Project Plot

A rhombus indicates a point observed by a total station only. A blue triangle indicates fixed points in the same way as with satellite data. Lines are the total station observations. They may be enabled (white) or disabled (gray). To change the enabling status of a terrestrial observation, click the respective observation name in the Total Station container (right mouse-button) to open its context menu and check the item **Enable** or **Disable**.

Several markers indicate the observed parameters:

Slope distance:	A perpendicular line	—
Horizontal angle:	Empty triangle	△
Vertical Angle:	Filled triangle	▲

The tops of the triangles point to the measured point.

You may customize the colors of the points, observation lines and markers (refer to App. A.3).

5.5.6 Import of Levelling Data

Choosing the menu option Projekt/Import/Levelling Data or the respective button, allows you to import levelling data from files.

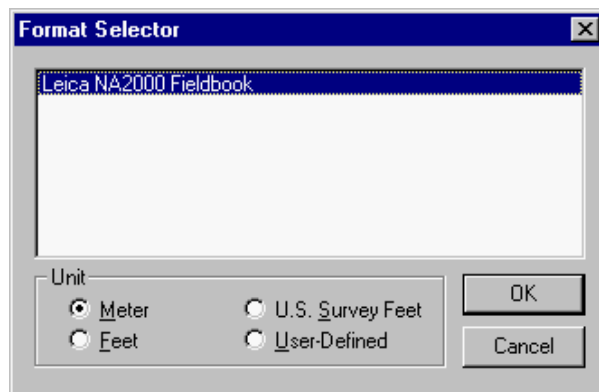


Figure 5-54: Import of Levelling Data

The file formats and their import modules are listed and described in detail in Appendix B. On demand, Spectra Precision Terrasat will support additional formats and your own format.

The dialog Format Selector offers all available formats in alphabetic order for Levelling Data import. Mark the format you want to use and either double click it or press the button **OK** to open the Windows

Standard File Dialog. It allows you to select the import file, the respective file extension will be given automatically.

Please note that all imported Levelling data will be treated as already defined within the current system. They will not be transformed during the import. Heights that will be imported to a wrong system will be given wrong values. If you know the projection, the datum, the ellipsoid and the geoid model for the Levelling Data, first define the System, activate it and then import the file.

You can also define the units for your format in the dialog Format Selector. With this option you define the length unit for the interpretation of the heights. If the Levelling Data module already knows the length unit, all the other options will not be activated.

AS everywhere within **GeoGenius** you can choose from the following length systems:

- Meter
- Feet
- U.S. Survey Feet
- User-defined

If you choose the option User-defined, **GeoGenius** will use the unit defined via Options/Customize/Units for the length definition (refer to Appendix A.2).

Imported Levelling Data will be visualized in the navigator within the container Levelling as levelling measurements (known point → unknown point). New points appear in the container Points, points that do not include values from other measurements, are marked with the

following symbol . As levelling data only include heights, they can not be visualized in the project plot.

The following figure shows a project to which only levelling measurements were added:

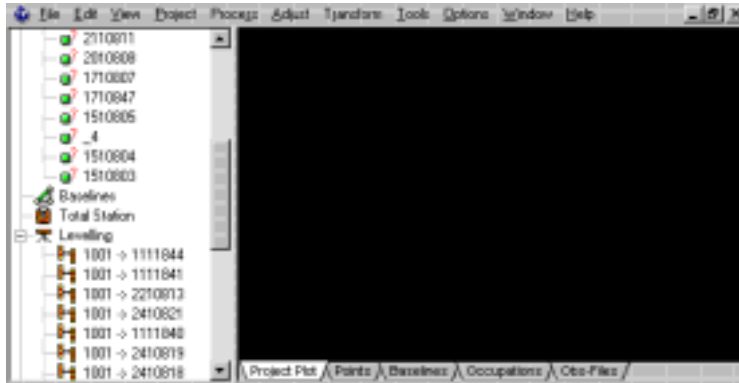


Figure 5-55: Levelling Data in the Navigator

The properties dialog of a levelling measurement will give you further and detailed information. (Refer to Chap. 11.6).

5.5.7 Import of Data of Special Formats

For data that have been saved in special formats import routines can be written, that will help you to convert these data. Those scripts allow you to import data from the special files to a project. Currently, scripts written for several German Governmental organizations are available.

You may convert and import special data, using the scripts (menu option **Project/Formats**). The dialog **Formats** will show up and you may select one of the available import formats, which are listed at the end of the list.

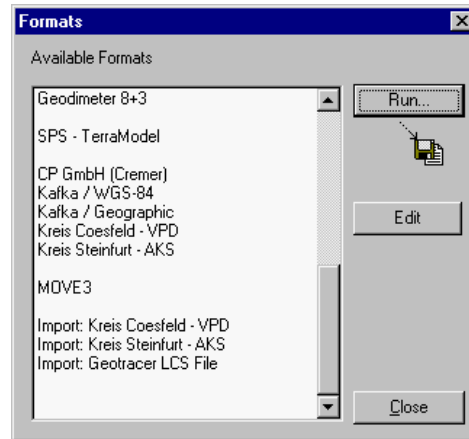


Figure 5-56: Special import formats

Please note that the list, which is shown here, does not contain all the formats that are available. The list depends on the **GeoGenius** version as well as on your own modifications.

The respective script can be started as soon as you chose your format and clicked the button **Start**... Usually you will be asked to define the system and the respective zone first. Then a dialog shows up that allows you to enter the name and the path of the import file.

First the standard file type for the selected format will be offered. If you want to use file with an other extension, choose the option **All Files**. Accept the file name by clicking **OK** (or interrupt the export with the

button **Cancel**). The output window allows you to check the import of your data.

You may re-organize the formats by using the pull-down menu option Project/Formats. Open the dialog Formats Configuration (Options/Export Formats/Static...:

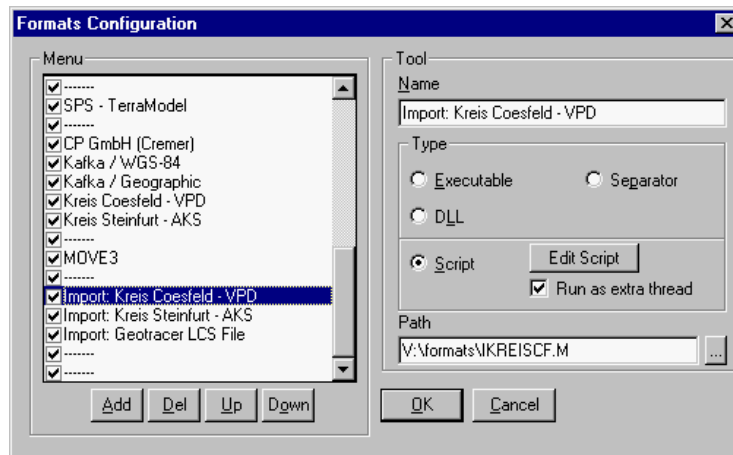


Figure 5-57: Formats Configuration

Some file converters are already built in (list field Menu). You can install new converters, change the path to already existing converters or even delete converters that you do not need currently. The block **Tool** shows the name of the new entry, its type (whether it is an executable file, a DLL, a script or a separator) and the path to the corresponding script. All file formats that are installed are used for the export of data and results. The buttons **Up** and **Down** help you to rearrange the built-in file formats for the dialog Formats (Project/Formats...).

For further information on how to define file formats with **GeoGenius** please refer to Appendix *A.6*. Appendix *B.3* gives a detailed description of the available file formats.

5.6 Moving Points

GeoGenius allows you to change the composition of the project, even after the import of observation files or coordinates. You can merge points, which have different names but visualize the same point (this may happen, if their coordinates are derived from sources of different type!).

The following options are given:

- Merging of 2 static or 2 Stop&Go points
- Moving static points to Stop&Go points and vice versa

5.6.1 Merging Points

You can merge points that have different names but define the same location. This may happen, if, e.g., you assigned continually ascending point numbers during a satellite survey, but at the same time introduce point coordinates of points, whose names were given by land survey offices.

Activate the point, whose name and whose properties are to be deleted when merging the points. Open its context menu (right mouse click) and choose the menu option **Merge**. The dialog Merge Points shows up.

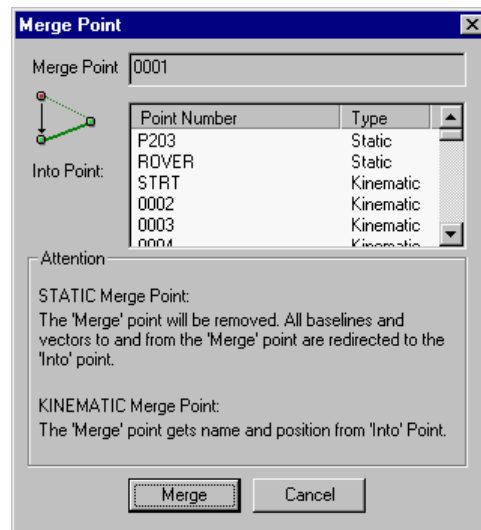


Figure 5-58: The Dialog Merge Points

Click the point number to activate the "Into Point". Clicking **Merge** will delete the "Merge Point". **Cancel** will interrupt the action.

For static points, the "Merge Point" will be deleted. All baselines and vectors that were connected to the "Merge Point" will now be connected to the into-point.

For kinematic points, the "Merge Point" will now get the name and the position of the "Into Point".

5.6.2 Moving and Merging Stop&Go Points

There are projects that do not only contain kinematic measurements but also static measurements for additional points. In this case, several options allow you to organize the project. For the options b) ... d) the merging points have to have the same name.

- a) You may merge the stop points: activate the stop point and click the option **Merge** of its context menu. Choose the "Into Point". The stop point gets the name and the position of the "Into Point".
- b) You may move a static point to a Stop&Go point, if both points have the same name: Activate the container **Points** and choose its context menu option **Stop&Go/Move Static Point to S&G Points**. Each moved static point will now get the position of the Stop&Go point with the same name. None of the points will be deleted or fixed.

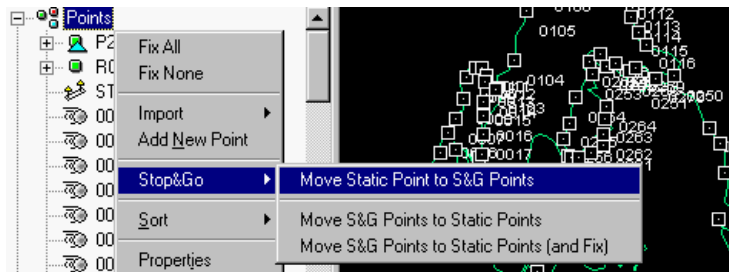


Figure 5-59: Context menu Stop&Go

- c) You can move a Stop&Go point to a static point, if both points have the same name: Activate the container **Points** and choose its context menu option **Stop&Go/Move S&G Points to Static points**. Each moved Stop&Go point will now get the same position as the static point with the same name. None of the points will be deleted or fixed.

- d) You can move a Stop&Go point to a static point, if both points have the same name, and you can fix it at the same time. Activate the container Points and choose its context menu option Stop&Go/Move Static Point to S&G Points (and Fix). Each moved static point will Stop&Go point will now get the position of the static point with the same name. **The moved Stop&Go points will be fixed and their position will influence the trajectory.** None of the points will be deleted.

5.7 Data Export

You may export all results to files. Since **GeoGenius** is programmed in a modular way, you will find export options at several modules. The following sections describe, how to:

- Export statically derived data
- Customize the Format Selector
- Export kinematically derived data
- Customize the Kinematic Format Selector
- Export to RINEX
- Export the output window information
- Export Reports
- Customize the Report Selector
- Export of arbitrary information

5.7.1 Export Statically Derived Data

GeoGenius offers different file formats for export, such as the Ashtech Points File format, the SNAP - Station and Vector Files, or the GeoLab ASCII file format.

GeoGenius , however, offers more: You may introduce an unlimited number of file format converters to **GeoGenius** in an easy-to-perform manner (see section 5.7.2).

Choose the menu option Project/Export Formats.... The Export Formats dialog pops up allowing you to choose one of the available file formats.

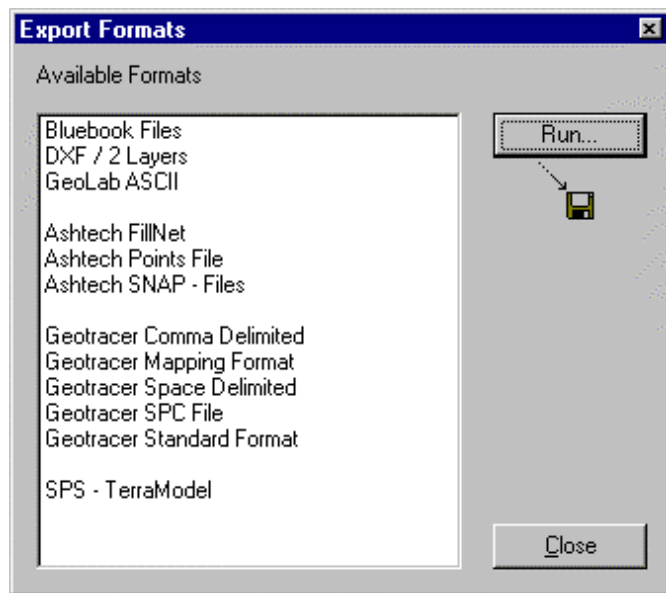


Figure 5-60: Export Formats

Remember, that the list of file formats shown in *Figure 5-60* may not be complete, depending on **GeoGenius** updates as well as on your own customizing!

After you have chosen one of the formats and clicked the button **Run...**, a script is performed which is associated with the item. Typically, a File Selector window shows up and allows you to select drive, directory and the default file name for the file to be created.

The file mask box offers the extension related to the chosen file format. To use another extension choose the option **All Files**.

Accept the file name with **OK** (or stop the data export with **Cancel**). You now may watch the generating of the output file in the output window at the bottom of the main window.



Figure 5-61: Export Log

5.7.2 Customize GeoGenius for File Formats

It is possible to configure the items in the menu Project/Export Formats.... Open the Formats Configuration window via the menu option Options/Formats/Static...:

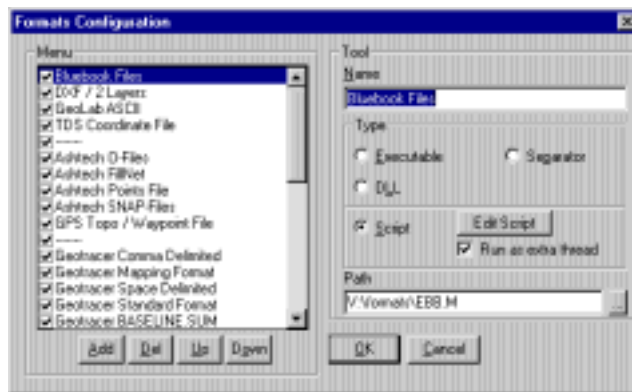


Figure 5-62: Formats Configuration Dialog

Several file format converters are already implemented for further use. These are listed in box **Menu**. You may install others, change the path to the respective converter file or delete already installed file formats. The **Tool** box shows the name of the new entry, its type (is it an executable, a DLL, a script or a separator line?) and the path of the associated script file. All file formats installed with help of the **Formats Configuration** window will be allowed for export of data and results. **Up** and **Down** buttons help you to group the implemented format items in the **Project/Export Formats/Static** pop-up dialog.

For a detailed description of how to customize **GeoGenius** for file formats, please refer to Appendix A.6. File Formats are described in Appendix B.3.

5.7.3 Export of Kinematically Derived Positions

After processing of kinematic observations you may create a position output file via the **Properties** window of the kinematic trajectory.



Figure 5-63: Properties Trajectory

To review the properties of the trajectory click with the right mouse-button on the navigator item **Trajectory**. The correlated context menu pops up. Now choose the option **Properties**. The Property: Kinematic Path notebook with the single page Path shows up.

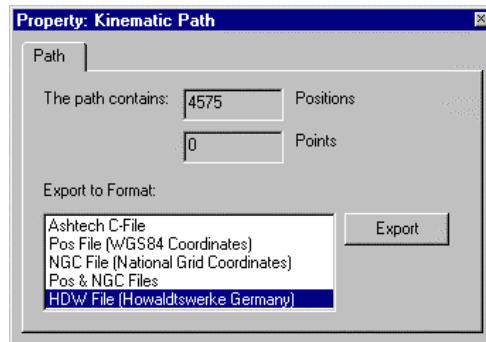


Figure 5-64: Property Kinematic Path

The **Export to Format** box allows you to choose from a list of file formats. The list displayed in *Figure 5-64* may differ from yours, depending on the program version and your customizing! Activate an export file format and click **Export** to start the creation of the kinematic output file. A standard Windows file selector allows you to store the file under the default file name or to choose another name and to choose a directory. After you have accepted a name **GeoGenius** generates the kinematic output file and writes the positions and accuracies into it.

5.7.4 Customize GeoGenius for Kinematic File Formats

It is possible to configure the items in the menu Project/Export Formats/Kinematic. Open the Formats Configuration window via the menu option Options/Export Formats/Kinematic....

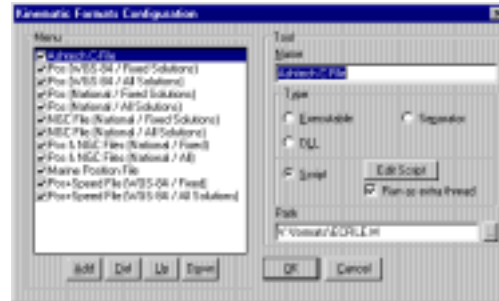


Figure 5-65: Kinematic Formats Configuration Dialog

Several file format converters are already implemented for further use. These are listed in box **Menu**. You may install others, change the path to the respective converter file or delete already installed file formats. The **Tool** box shows the name of the new entry, its type (is it a script or a separator line?) and the path of the associated script file. All file formats installed with help of the Formats Configuration window will be allowed for export of kinematically derived data and results. **Up** and **Down** buttons help you to group the implemented format items in the **Export to Format** box of the notebook Property: Kinematic Path.

For a detailed description of how to customize **GeoGenius** for kinematic file formats, please refer to Appendix A.6. Currently implemented File Formats are described in Appendix B.3.

5.7.5 Export to the RINEX Format

GeoGenius supports RINEX (Receiver INdependent EXchange format) import and export. To convert one or several binary observation files to RINEX activate the container Observation Files, open its context menu with a click of the right mouse button and choose the option RINEX.

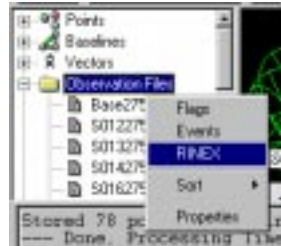


Figure 5-66: Observations Container Context Menu

The Convert to RINEX window shows up.

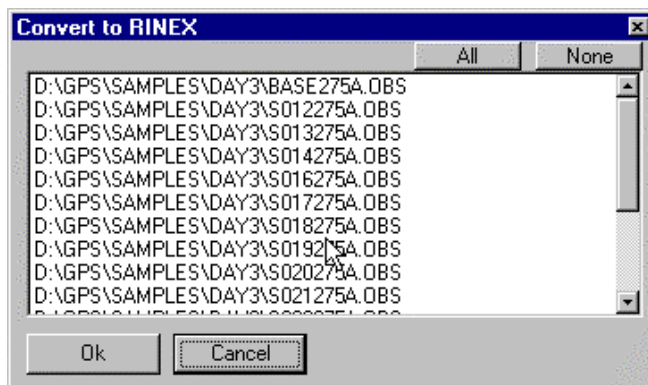


Figure 5-67: Convert to RINEX

All observation files currently inserted into the project are listed in alphanumeric order of path and file name. You may select one or several observation files to be converted to RINEX. Just mark the respective files. You may select an unlimited number of files simultaneously. To do so, use the **Shift** and **Ctrl** keys of your keyboard to mark several files simultaneously. The button **All** allows you to mark all files simultaneously, the button **None** unmarks all files.

The button **OK** instructs **GeoGenius** to perform the conversion on all selected observation files and to close the window, **Cancel** closes the window without conversion.

To convert a single **GeoGenius** binary observation file to RINEX you may also activate the observation file name, open its context menu with a click of the right mouse button and choose the option **Export RINEX** for the standard RINEX format. For the new compressed RINEX format choose the option **Export RINEX Compressed**.

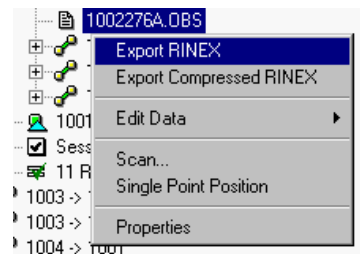


Figure 5-68: Observation File Context Menu

GeoGenius then performs the conversion to RINEX independently of the type of file selection. You may control the progress via a progress bar, indicating the station name of the file in progress. When finished, you will find the RINEX file(s) in the directory(ies) of the associated observation file(s). They are named like the associated observation file

and have the following extension: two digits representing the year of the observation, an the Standard RINEX Observation file (e.g. TEST293A.950), a "D" stands for the Compressed RINEX Observation file. Inspect the name of the generated file using the output window information.

You may inspect the ASCII RINEX file using any editor.

5.7.6 Export of the Output Window Information

To store the messages **GeoGenius** has output onto the output window you may click onto the output window with the right mouse button to open the output Window context menu. Choose item **Save to File**.

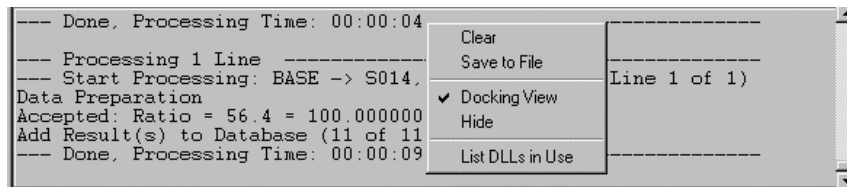


Figure 5-69: Output Window Context Menu

A File Selector window shows up and offers default drive, directory and the file name of the text file to be created. You may change each and accept the choice with **Open** (or stop the log data export with **Cancel**).

You may inspect the contents of the output file using any text editor (see *Figure 5-40*).

5.7.7 Export of Reports

Processing and adjustment results are stored in the project file.

GeoGenius smart text editing tool **HyperPage** allows you to output all results as reports in a formatted and easy-to-interpret manner.

Depending on your task and on the object you want information about, several types of reports are available. You may build additional highly specialized macros fitting exactly your needs and extend the functionality by dynamically loading DLLs. The **HyperPage User's Guide** and the **HyperPage Programming Guide** offer detailed information on this tool.

You may introduce an unlimited number of report format converters to **GeoGenius** in an easy-to-perform manner (see section 5.7.8).

To generate a report choose the menu option Project/Reports.... The Project Report dialog pops up allowing you to choose one of the implemented report formats.

The box Available Reports lists the reports you may choose from. (Baseline reports are additionally available from the baseline context menu, adjustment reports from the Adjust pull-down menu, item Report...). You will find discussions of the default reports in chapter 8 (for the Processing Reports).

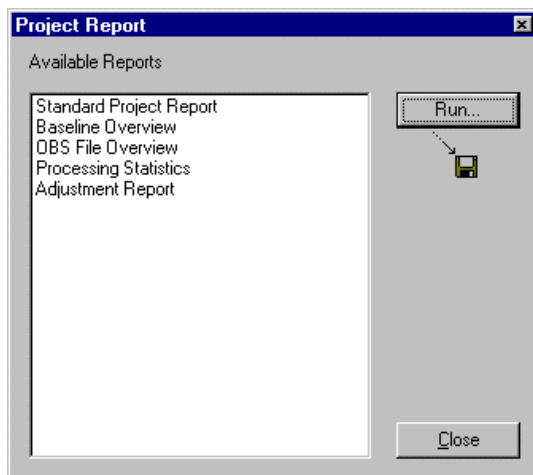


Figure 5-70: Project Report Dialog

Note, that the list displayed in *Figure 5-70* may differ from yours, depending on the software version and your own customizing.

GeoGenius starts the generation of a report, if you highlight one of the options of the box Available Reports and click the button **Run...** .

5.7.8 Customize GeoGenius for Report Formats

It is possible to configure the items in the menu Project/Export Reports.... Open the Formats Configuration window via the menu option Options/Export Formats/Reports....

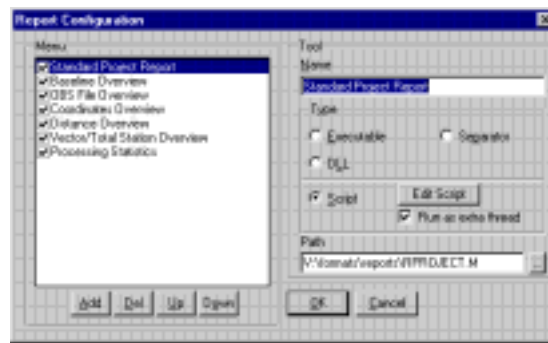


Figure 5-71: Report Configuration Dialog

Several report format converters are already implemented for further use. These are listed in box **Menu**. You may install others, change the path to the respective converter file or delete already installed report formats. The **Tool** box shows the name of the new entry, its type (is it an executable, a DLL, a script or a separator line?) and the path of the associated script file. All report formats installed with help of the Report Configuration window will be available in the Project Reports dialog. **Up** and **Down** buttons help you to group the implemented report items there.

For a detailed description of how to customize **GeoGenius** for report formats, please refer to Appendix A. Report contents are described in Appendix F.

5.7.9 Export of Arbitrary Information

GeoGenius has a macro language, which grants access to the internal data structures. You may write scripts that export data in every format expressible by the script language!

5.8 Project and Observation File Information

The following sections describe how to get project and observation file information.

Every piece of data, every object within **GeoGenius** has one or more properties. You may easily view or change the properties of any object by selecting the item **Properties** of an object's context menu. Project information, however, may be reached via the menu **P**roject.

5.8.1 Project Information

You may easily control the project data. Choose the menu option **P**roject/**I**nf... and the Project Info window appears, displaying two pages of information.

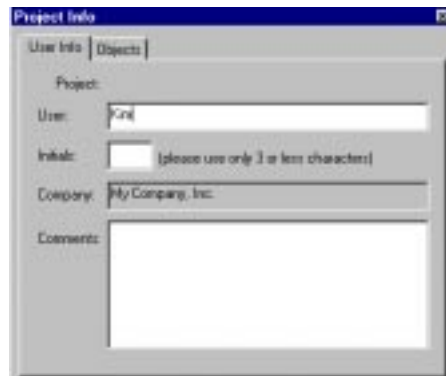


Figure 5-72: Project Info - User Info

Page User Info informs on the current project's file name and path. It includes further items to be edited. You may enter a user name or identification, while the identification of your company will be entered automatically during the installation of **GeoGenius**. Some export formats, such as the Bluebook files, expect the entry of name initials (up to three characters). A multi-line box named Comments allows you to enter further information and comments literally. These will be also used for data export, depending on the data format.

Figure 5-73: Project Info - Objects

Page Objects includes information on the number of objects included into the project. These objects are:

Static points:	Points		
Baselines:	Lines	with	Sessions
			Results
			Solutions

Total Station

Measurements:	T.Stat
Observation files:	OBS Files
Ephemeris files:	EPH Files
All above objects	Objects

5.8.2 Summary of Observation Files

You may inspect a summary on the observation files inserted into the current project.

Activate the container Observation Files and open its context menu by a click of the right mouse button. Now choose option **Properties**. This notebook contains the single page **Summary**. The page displays the number of observation files the project contains (**Observation Files**).

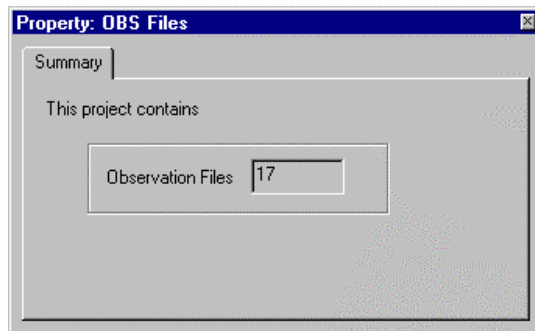


Figure 5-74: Property OBS Files

5.8.3 Information on Observation File Properties

To review the properties of an observation file open its context menu with a click of the right mouse-button onto the file name. Now choose option Properties. The Properties notebook allows you to view and edit file characteristics.

The screenshot shows a dialog box titled "Property: Observation File" with a close button (X) in the top right corner. It features a tabbed interface with the following tabs: Time, Antenna, N/E/h, Type, File, and Proc. The "Time" tab is currently selected and displays the following fields:

Field	Value	Unit
Start (First Epoch):	08:24:50 03.10.96	
End (Last Epoch):	16:36:40 03.10.96	
GPS Week:	873	
GPS Start:	375890.00	[sec]
GPS End:	405400.00	[sec]
Time Span:	29510.00	[sec]
Epochs:	2952	
Interval:	10.00	[sec]

Additional text in the dialog includes "GPS + 0.0 hours" and a small "x" icon in the top right corner of the dialog box.

Figure 5-75: Property Observation File - Time

This notebook contains six pages:

- Time
- Antenna
- N/E/h
- Type
- File
- Proc.

This section describes the observation file characteristics that are not related to height correction. Pages Antenna and N/E/h (antenna ec-

centricities) are described in detail in the following section referring to Instrument Height Corrections.

The Page Time displays various time information. The Start and End entries contain the start time and end time of the observations in a readable format. If you defined a time offset to GPS time in the Processing Options, this will be displayed right beneath the End box. The GPS Week box shows the GPS week at the start time of observation. The GPS Start and GPS End boxes give the start and end time in GPS seconds of the week. The difference between the two values is given in box Time Span and also in box Epochs. The value of Epochs is a combination of the time interval between start and end time in seconds (box Time Span) and the observation time interval (box Interval).

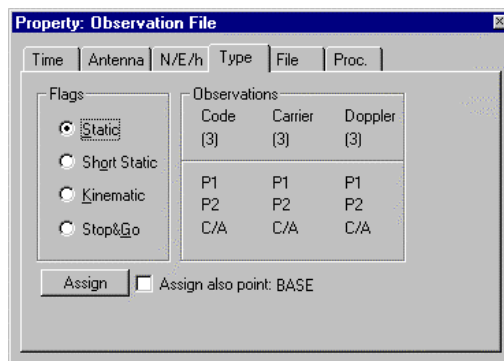


Figure 5-76: Property Observation File - Type

The Page Type displays the observation type. Data may have been collected in one of the following observation modes:

- Static
- Short Static
- Kinematic
- Stop&Go

If you want to change the flag to the observation type, click the respective radio button, then click the button **Assign**. To change the database flag for the point also, check the checkbox **Assign to point XXX**.

GeoGenius also informs you on the types of satellite code the receiver used to track data (P1, P2, C/A).

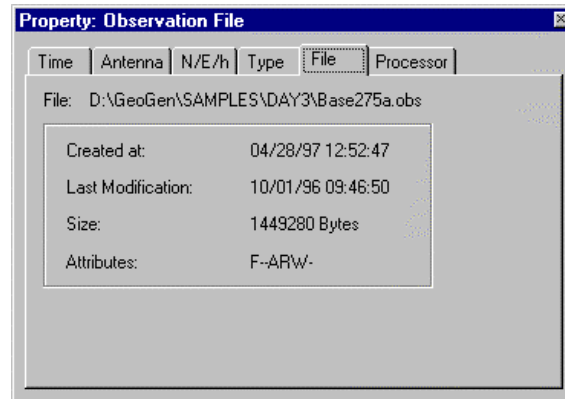


Figure 5-77: Property Observation File: File

The page File displays the location of the current observation file. Further, it displays the dates of creation and last modification in computer time, the file size in bytes and some file attributes. The following lists possible attributes:

- F File
- A Archive
- R Read
- W Write
- D Directory
- H Hidden

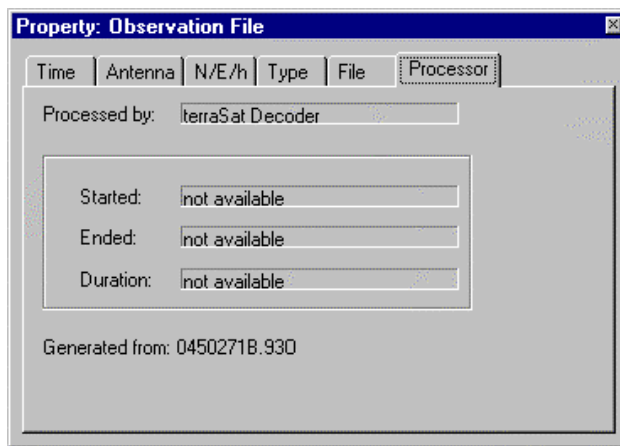


Figure 5-78: Property Observation File: Processor

The page Processor informs on the processor used to decode the raw receiver data to the current observation file. Additional information on the start and end times and the duration of the decoding will be displayed, if available. At the bottom of the page you will find the name of the file containing the undecoded, raw data.

5.8.4 Instrument Height Corrections

For the correction of the antenna phase center to the ground marker, **GeoGenius** internally considers antenna phase center offsets to correct for the antenna in use and N,E,h offsets from the ground marker. Height offsets may be measured in different ways (type of antenna height measurement).

5.8.4.1 Antenna Phase Center Offsets

When you process data from different types of receivers or antenna types together in one session, the antenna phase center offsets are very important. Different antennas may have completely different antenna phase centers differing by several centimeters. In order to achieve results with millimeter accuracy a careful consideration of these values becomes mandatory.

The radius of the ground plane and the antenna reference point (ARP) definition are very important for the correction of the antenna height measurement from slope to vertical (see the following subsections).

To inspect and edit antenna and receiver types and the respective offset values used when creating the observation file activate its name in the navigator, open its context menu by a click with the right mouse button and choose option **Properties**. Then choose page **Antenna** of the notebook **Properties: Observation File**.

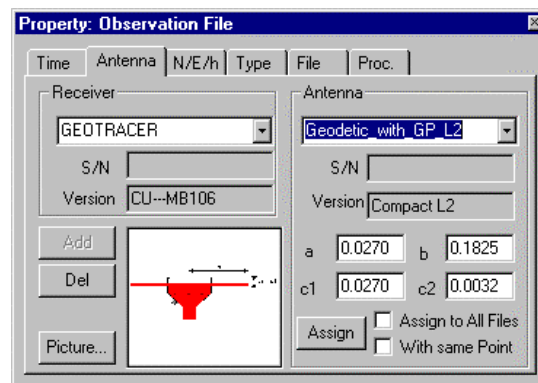


Figure 5-79: Property Observation File: Antenna

If your observation file contains antenna information known by the system, this page will display the antenna and receiver name and correlated offset values. The file ANTECC.DAT contains antenna information for antennas, which are available at the time, this product is delivered. You may customize the file manually (if you enter the data of other providers, please make sure that within the header the names of antennas are supplied with underlines instead of spaces. Otherwise, the system will not be able to detect the antenna!)

If your observation file uses unknown information, page Antenna shows the entries **Default** for the Receiver as well as for the Antenna. To add the information, open the **Receiver** combo box and choose the receiver type.

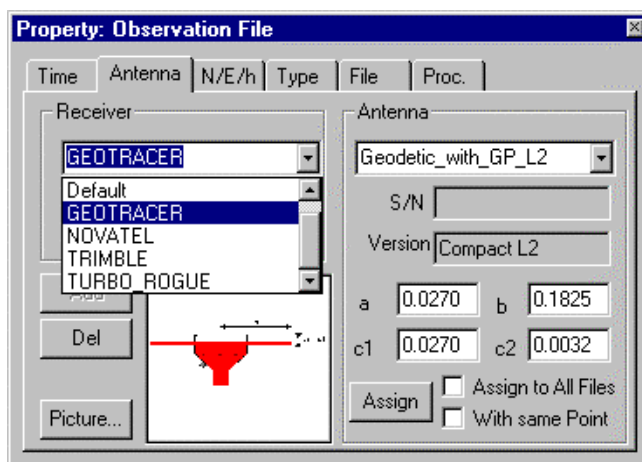


Figure 5-80: Receiver Type List

Now the Antenna combo box allows you to choose from the affiliated antenna types.

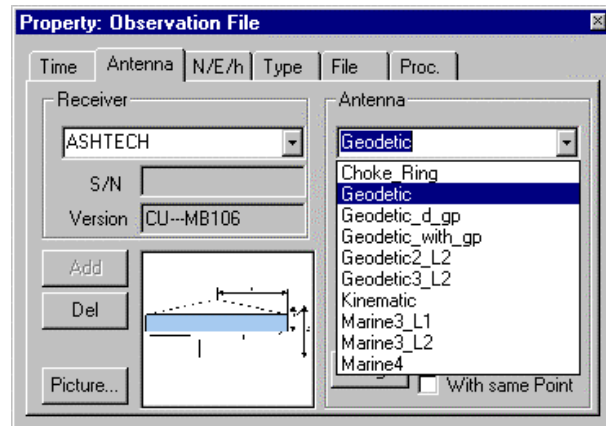


Figure 5-81: Antenna Type List

The **Receiver** and the **Antenna** boxes display also known Serial Numbers (S/N), if registered in the observation file, and the version number of the hardware.

You may review and change the corrections for the antenna phase center offsets. **GeoGenius** always uses the same parameters to define the corrections. A bitmap depicts a minimized sketch of the antenna and its offset parameters.

The parameter **a** stands for the distance between the antenna reference point (ARP) and the antenna phase center. The parameter **b** stands for the radius of the antenna, which is important for to reduce the distance to the antenna point (BCR) from slope to vertical. **c1** stands for the distance of the bottom of the antenna ground plane to the L1 phase center, **c2** refers to the L2 antenna phase center. For most of antenna providers: BCR equals ARP.

Buttons:

To add a new antenna type, first enter a name, then press the button **Add...** The new antenna type will now be available for this project. You may edit the parameters and/or insert a bitmap picture via the button **Picture...** and then save the new entries via the button **Save**.

The button **Del** allows you to reduce the offered antenna types for this project. The currently activated antenna type will be deleted from the list, if you press the button **Del**. Via the button **Add...** you may re-insert deleted antenna types.

If you have changed phase center corrections, you may save the new values using the button **Assign**. You may assign the new values additionally to all files of the project (check the check box **Assign to All Files**) or to all files with the same point number (check the checkbox **With Same Point**). If you want to undo changes before assignment open the value correlated context menu by a click of the right mouse button and choose option **Undo**.

You may inspect a magnified sketch of the antenna: the **Picture...** button opens the Bitmap Selector displaying the sketch in a larger scale. It also displays the names of the receiver manufacturer and of the antenna type, respectively.



Tip! If you do not know the name of your antenna, but know its appearance, just choose one of the bitmap files listed in the combo box **Bitmap-File**. If you do not want to change the antenna type, make sure to leave the Bitmap Selector by canceling, otherwise the last reviewed picture might be displayed and might not conform to the antenna type!

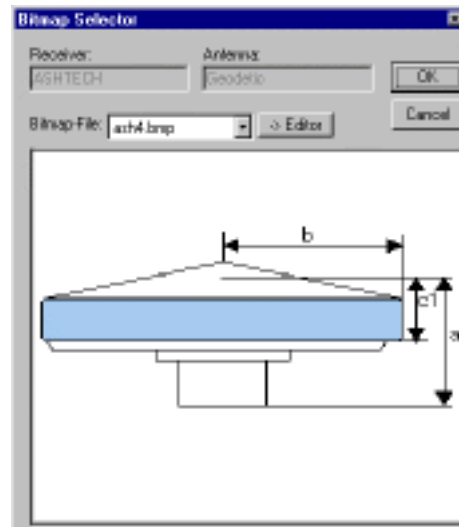


Figure 5-82: Bitmap Selector

If you own further pictures of antennas, you may save the respective files in sub-directory \BITMAPS\ANTENNA and open a file using the combo box **Bitmap-File**.

To edit a picture choose button **Editor...** The current graphic file will be edited by the bitmap editor specified via the menu option **Options/Customize...** in page **Tools** of the notebook **Customize**.

You may use all functions of the bitmap editor, save the file and return to **GeoGenius** by leaving the editor. You will find information on how to change the bitmap editor in **Appendix A**.

You may save changes and leave the Bitmap Selector with **Save** or cancel with **Cancel**.

For Geotracer® antennas we generally do not refer the antenna reference point to the lowest surface of the antenna, we refer it to specified points for different antenna types. Please note, that for all Geotracer® antenna types, the parameter **a** is equal to the parameter **C1**. Both parameters stand for the difference between the antenna reference point and the antenna phase center.

GeoGenius includes a file called **ANTECC.DAT**. This file contains information used to correct for the different measurement types.

5.8.4.2 Horizontal Offsets

Observation files include information on the antenna position in relation to the survey point.

For a single observation file, you may edit and inspect the horizontal (and, of course, vertical) offset values (and also define the type of the antenna height measurement, refer to next section). To do so, activate the observation file in the navigator, open its context menu with a click of the right mouse button and choose **Properties**. The notebook Property: Observation File shows up. Choose page N/E/h.

The box **Values** displays the registered N, E, h offsets of the antenna phase center from the position on the ground. You may change the values manually.

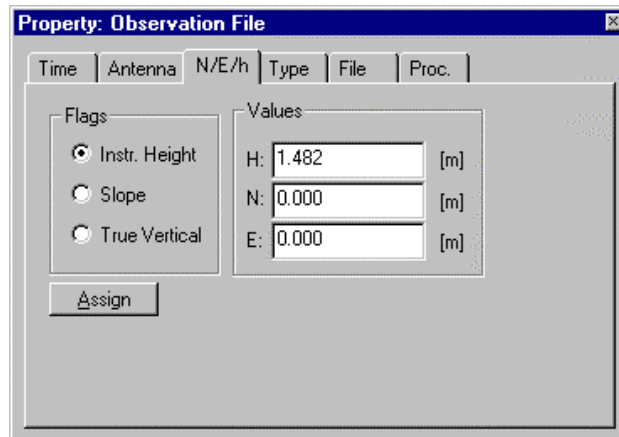


Figure 5-83: Property Observation File - Antenna Eccentricities

5.8.4.3 Vertical Offsets and Type of Height Measurement

The following height measurement types may have been used for measurement:

Instr. Height:	Instrument height from the survey mark to the mark on the antenna (antenna reference point ARP). Will be corrected automatically to the antenna phase center during processing of this baseline.
Slope:	Slope distance from the survey mark to the outer edge of the antenna ground plane (antenna point BCR).
True Vertical:	True vertical from the survey mark to the antenna phase center.

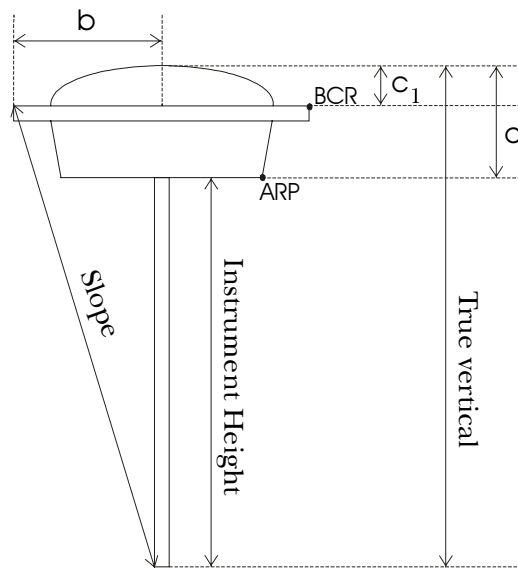


Figure 5-84: Basic Antenna Height Relations

The sketch depicts the geometrical relation between the types of height measurement. The parameter **a** stands for the distance between the antenna reference point (ARP) and the antenna phase center. The parameter **b** stands for the radius of the antenna, which is important for to reduce from slope to vertical. **c** stands for the distance from the bottom of the antenna ground plane (BCR) to the antenna phase center. For most of the antennas the antenna ground plane marker BCR equals the antenna reference point ARP.

The antenna phase center offsets are needed to correctly calculate height offsets. **GeoGenius** has a lot of antenna types and their phase center offsets implemented. The geometrical meaning of the parameters **a**, **b**, **c** is described in detail for each antenna type. Just open page Antenna of the Observation File Properties notebook. A bitmap of the

antenna type in use will be displayed together with the instrument eccentricities (see above).

If a wrong type of antenna height was entered, you can correct the type. To correct from slope to vertical antenna heights before processing it is necessary to define the instrument eccentricities for the antenna in use. If you wish to correct from slope to vertical **GeoGenius** may also perform a calculation of the correct difference. The vertical height is stored to the file.

To inspect or change the antenna height measurement type of one or several observation files, choose the container Observation Files of the navigator, open its context menu with a click of the right mouse button and choose option **Change Flags**. The Obs File Flags window opens.

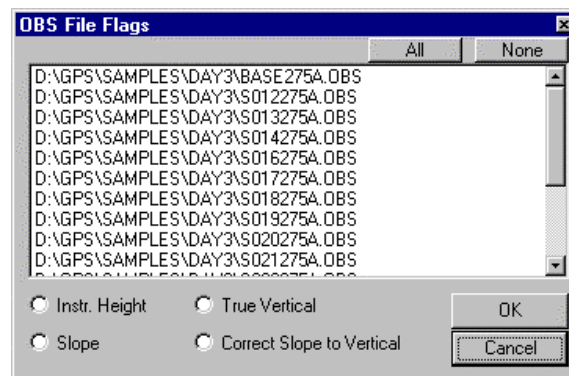


Figure 5-85: OBS File - Type of antenna height measurement

All observation files currently inserted into the project are listed in alphanumerical order of path and file name. Four radio buttons allow to change the height measurement type. If an observation file is highlighted, the type registered in the file header is marked. If more than

one files are highlighted whose headers signal different height measurement flags, no flag will be marked.

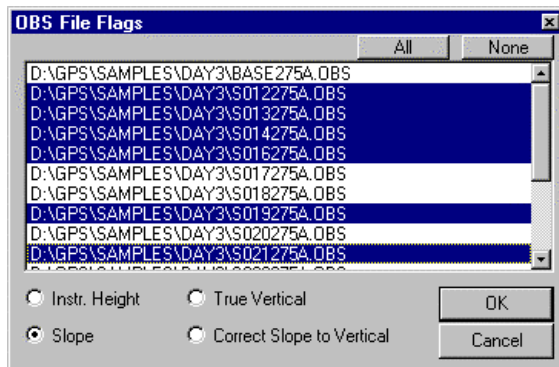


Figure 5-86: Selected Observation Files

The available radio buttons correspond to the types of antenna height measurement as listed above. A further option is added:

Instr. Height
Slope
True Vertical
Correct Slope to Vertical

You may change the flags for one or several observation files, if you know the height measurement type entry to be wrong. (Some receivers do not allow storing the type of antenna height measurement during field measurement. It might happen, that all antenna measurements are indicated to be observed vertically, whereas they have been measured as slope heights.) Just mark the respective files. You may select an unlimited number of files simultaneously. To do so, use the **Shift** and **Ctrl** keys of your keyboard to mark several files simultaneously. The button **All** allows you to mark all files simultaneously, the button **None** unmarks all files.

Now click on the name of the type to be used. If you choose one of the first three options, **GeoGenius** just changes the antenna height type entry in the observation file header and the project file. If you choose the option **Correct Slope to Vertical**, **GeoGenius** will calculate height corrections and add them to the observation file and to the project file.

The button **OK** instructs **GeoGenius** to accept changes, to perform the actions and to close the window, **Cancel** closes the window without changes.

You may also change the antenna height measurement type **for a single observation file**. Here you may also edit the N, E, h offset values. To do so, activate the observation file in the navigator, open its context menu with a click of the right mouse button and choose Properties. The notebook Property: Observation File shows up. Choose page N/E/h.

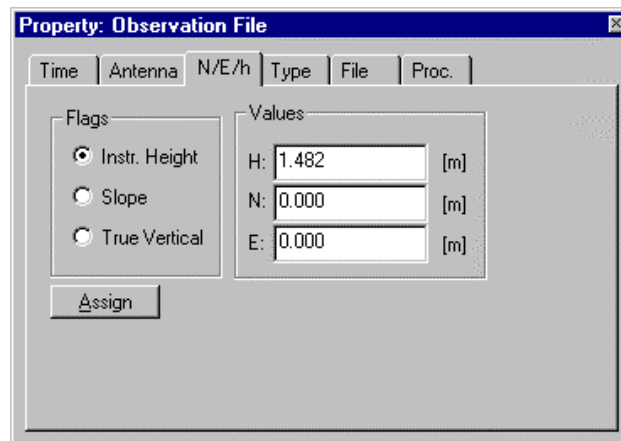


Figure 5-87: Property Observation File - Antenna Eccentricities

The box **Flags** displays the current type setting. One of the radio buttons of the following three items is activated:

Instr. Height
Slope
True Vertical

To set another flag (assign another antenna height measurement type), click the respective radio button.

The box **Values** displays the registered horizontal and vertical (H) offsets of the antenna phase center from the position on the ground. You may change the values manually.

Click the button **Assign** to assign the new values and/or flag to the observation file. If you leave the notebook without doing so, the changes will not be stored.

6. System: Transformation/Projection

We use the term “System” in order to describe a point on the real-world Earth as a point on the Earth model or on a map. This chapter explains the term System and its components. Step by step you are introduced into the definition of a System.

GeoGenius stores all System information in the subdirectory \SYSDBS\. Additionally, it stores the Standard Map Projection and the System information in the project file *.GGS. So, if you, e.g., have generated a project file and then open it using another computer, **GeoGenius** automatically checks the databases there for the System and its components and, if necessary, copies the information and creates the Systems and Standard Map Projection in use. You do not have to bother with transferring the System or its components!

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6.1 What is a System

We use the term “System” in order to describe a point on the real-world Earth as a point on the Earth model or on a map. Several steps are necessary, since the Earth has not a uniform shape. The **ellipsoid** is a simple mathematical form that roughly models the size and shape of the Earth. The **datum** orients the ellipsoid relative to a fixed frame. Typically, a datum will fit a specific country very well, but perhaps not the adjacent country. Datum, therefore, usually means a national datum system. The **geoid** describes an equipotential surface of the Earth’s gravity potential at sea-level.

These above values describe a point in space. For many purposes this may be enough. But if you want to draw a point on a map, you have to define how the point is to be projected onto a flat surface. (The flat surface may be a plane, or the surface of a cylinder or cone, which then can be unwound mathematically.) The **map projection** is a pure mathematical process. Since no projection can depict the Earth’s surface without distortion, you may use completely different projections and projection types, depending on your task or the location on Earth of the respective points.

A geodetic **System**, therefore, consists of the components:

- datum
- ellipsoid
- projection (optional)
- geoid (optional)

A System might also be a pure local coordinate system instead of a global projection system. These Systems are purely local in the sense that no geocentric reference is given. You can freely define origin, scale and orientation of a local coordinate system.

GeoGenius clearly distinguishes transformations between Systems from transformations within a System. The following graph will explain the normal transformation path. Using special transformations will allow any paths for coordinate transformation within a System and you can connect two Systems in every possible way.

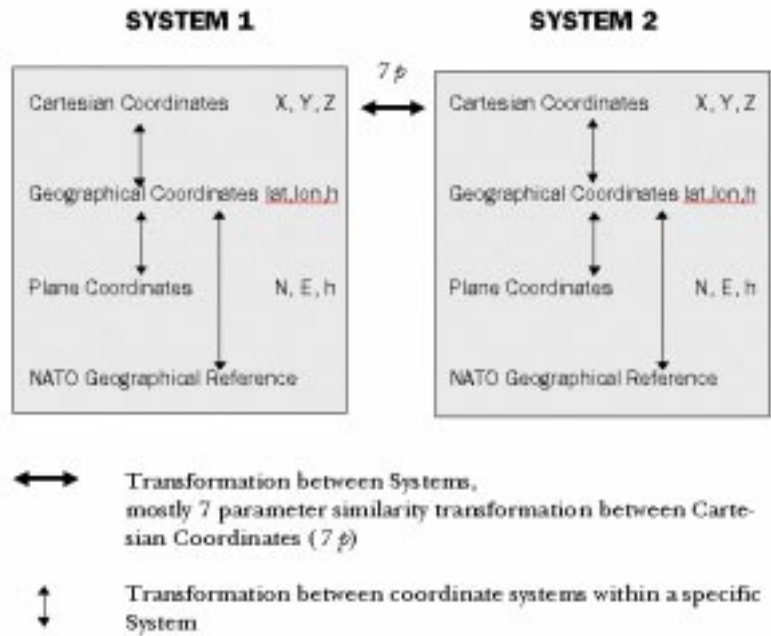


Figure 6-1: Transformation between and within Systems

6.2 Choose a System

GeoGenius inserts points or baselines into the project and displays them in the project plot according to the valid system. Two options are available. Either you define and choose a System previously to inserting the coordinate files into the project. Or you choose the **GeoGenius** Standard Map Projection.

If the **GeoGenius** Standard Map Projection is chosen, the menu item Project/Standard Map Projection/Set Standard Map Projection is marked in form of a ✓ sign. To mark it, click onto it with the left mouse button. The default Standard Map Projection is a Spherical Projection based on a sphere with the radius stored in the Ellipsoid Editor under name "Sphere". The following parameters define it:

Latitude of the center point:	determined by the center point
Longitude of the center point:	determined by the center point
Azimuth:	0
False easting:	0
False northing:	0
Scale:	determined by the center point

You may also define your own Standard Map Projection. Section 6.7 describes the task in detail.

If **GeoGenius** is to use another System for displaying points and for network adjustment, the menu item Project/System... has to be marked in form of a ✓ sign. To mark it, click with the left mouse button on the item. The Select System window will open and allow you to choose one of the Systems offered in the Selection box. The right box of the window displays the components of the System. You may also

edit a System or define a new one. Acceptance of the chosen System, marks the System... item of the Project menu and supplements it by the name of the current System.

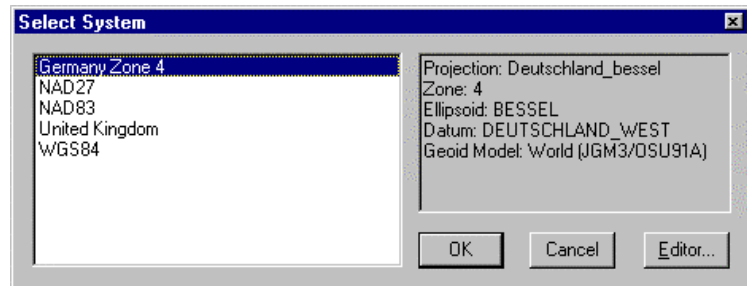


Figure 6-2: Select System

6.3 Default System

You may define a default System which will be automatically selected when a new project is created. Choose the menu item **Options/Default System...** and choose the System from the Select System window. **GeoGenius** will offer the chosen System as default as long as you do not change it, no matter whether **GeoGenius** was restarted or not.

If you did not define a System previously to inserting the coordinate files into the project, **GeoGenius** automatically transforms coordinates into the Standard Map Projection coordinates. A warning message informs you on the transformation. You may transform points into a valid system any time.



The static and kinematic processors use the WGS84 system Cartesian coordinates for processing the data. The System, therefore, is irrelevant for processing, but necessary to visualize results on the project plot and for national or local coordinates. National network adjustment generally needs a System.

GeoGenius projects are always organized to be in a single System. This corresponds, e.g., to a map, where all points are given in one System only.

6.4 Add or Edit System Components

GeoGenius offers a lot of projections (some have a zone system), ellipsoids and datums for building your own System. However, **GeoGenius** additionally allows you to add your own projections, ellipsoids and datums or change values for existing components. The pull-down menu **Options** leads you to the respective Editors:

- Projection Editor (Options/Projection Editor)
- Datum Editor (Options/Datum Editor)
- Ellipsoid Editor (Options/Ellipsoid Editor)

The Projection Editor is a notebook of up to four pages (the number of pages depends on the current projection type). It allows you to control the projection of ellipsoidal coordinates to the flat surface.



Figure 6-3: Projection Editor

The Datum Editor is a single page window allowing you to define new datums, review and change the seven parameters for transformation of existing datums or delete existing datums.



Figure 6-4: Datum Editor

The Ellipsoid Editor also consists of a single page. Ellipsoids are defined by two values, which may be edited in two formats.

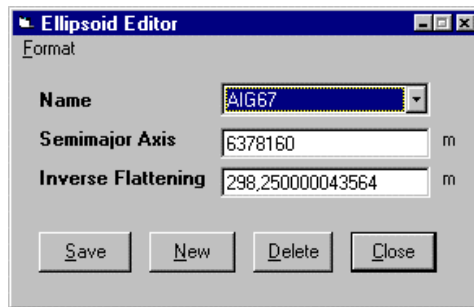


Figure 6-5: Ellipsoid Editor

You will find a detailed description of the Projection Editor, the Datum Editor and the Ellipsoid Editor and – of course – of all of **GeoTrans**' further features in the ***GeoTrans User's Manual***. The Transformation and Projection Tool **GeoTrans** offers access to the same databases and additionally allows you to perform transformations between the Systems.

To open **GeoTrans** just choose the menu item Tools/Transformation-Projection.

6.5 Defining a System

The System Editor dialog window allows the (re-)definition of any System imaginable. From the Select System window, click the button **Editor...** to open the System Editor.

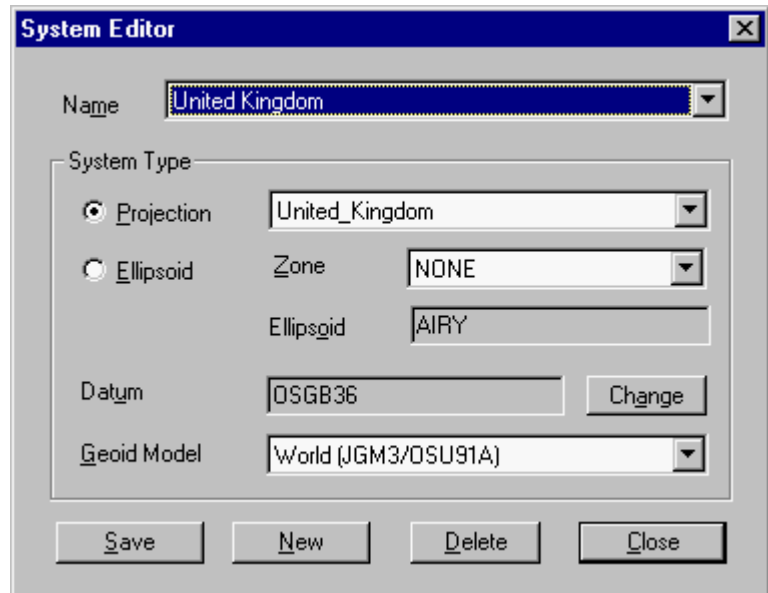


Figure 6-6: System Editor

The System Editor consists of three main parts:

The upper part of the dialog box displays the **name of the System**. A combo box displays already defined Systems in alphabetical order and allows you to choose from the complete list of Systems.



If you want to define a new System with a new name, **first** click on the **New** button at the bottom of the System Editor window. You then may enter and accept the new name, which will appear in the list immediately.



*If you want to derive a System from an already existing one, first select the source System, then click **New** and assign a name. The settings of the source System will be copied into the new one. You now may modify these settings as desired.*

The **System Type group** covers the main part of the System Editor box. It allows you to choose the System components. Generally, you may choose, whether your System includes a projection, or whether an ellipsoid with datum is sufficient for your purposes. The following subsections describe each option in detail.

Four **buttons** are arranged at the bottom of the System Editor window. They allow to

- Save** save the System components under the name displayed in the Name combo box,
- New** define a new System using a new name,
- Delete** delete a System from the list,
- Close** close the System Editor. Changes will only be saved, if you have made use of the **Save** button before!

6.5.1 Systems Using a Projection

Systems using a projection are defined by the projection (sometimes with a zone system), the corresponding ellipsoid and datum, and - not obligatory - a geoid model.

If a System uses a projection, the radio button Projection is marked. If you want to define a new System with projection, make sure, that this radio button is selected.

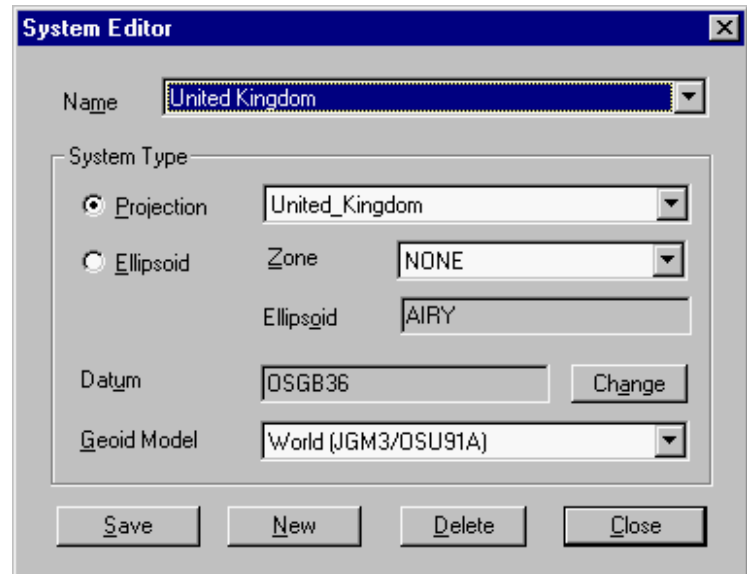


Figure 6-7: System Editor: Projection

The option Ellipsoid is then turned off.

To define a new System using a projection you may first click on the **New** button and enter the new System name.

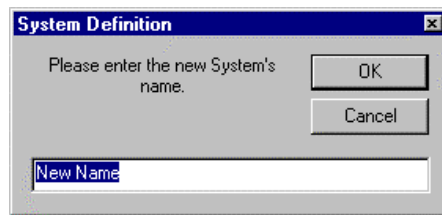


Figure 6-8: New Name Dialog

Then choose a projection out of a list offered by the combo box next the word **Projection**. To change the projection of a System, choose the desired projection. If the desired projection is not included, leave the System Editor and define a projection with help of the Projection Editor (see section 6.4).

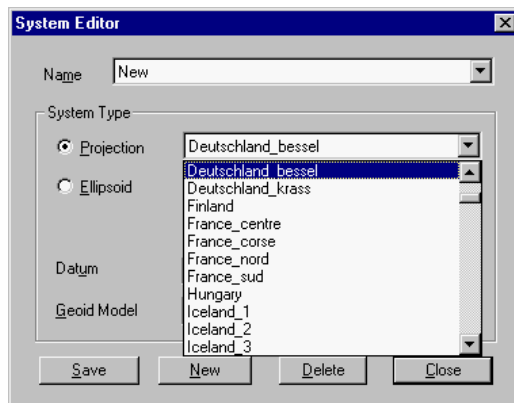


Figure 6-9: Projection Selection

When you accept a projection the zone definition as well as the ellipsoid will change according to the chosen projection. If you are defining a new System, the corresponding datum will also show up. If you are editing an existing System, the datum will not be changed and you will have to change it manually. This gives you the choice to use the same datum with a different projection.

If you decide to change the **datum**, you may select it from a list offered by a combo box. Click **Change** to open the list. If the desired datum is not included, leave the System Editor and define a datum with help of the Datum Editor (see section 6.4).

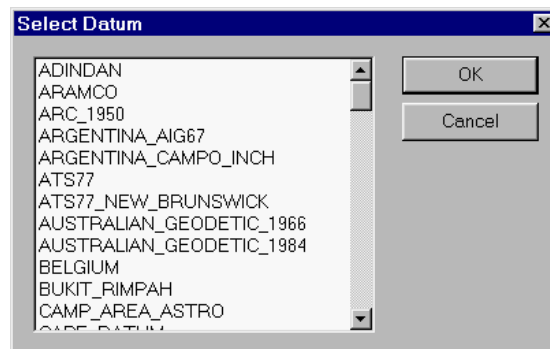


Figure 6-10: Datum Selection

If the chosen projection uses a **zone** system, you have to choose the zone for the System. **GeoGenius** may suggest a zone or leave the string field empty. You must enter a zone here or **GeoGenius** will not accept the System.

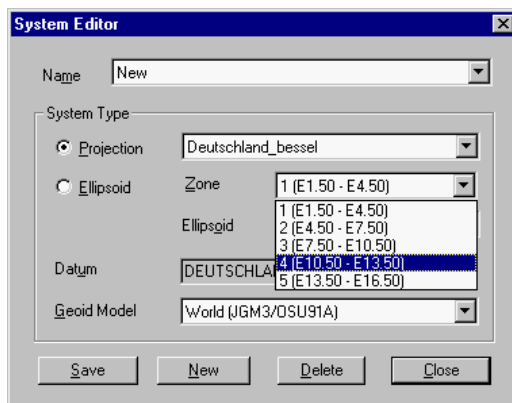


Figure 6-11: Zone Selection

GeoGenius also expects a **geoid model** entry. You may choose one from the list given by the combo box **Geoid Model**. If you do not want to apply a geoid model, choose the entry **None**. You may also add geoid models to the list with help of the **GeoTrans** Transformation Tool (see section 6.8).

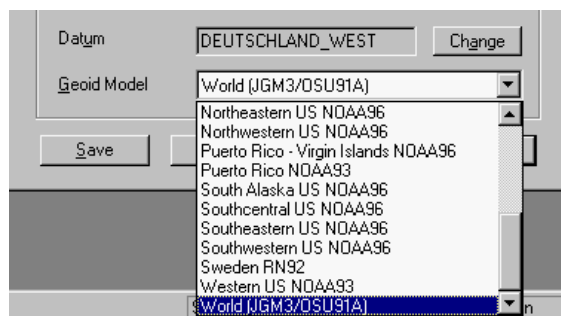


Figure 6-12: Geoid Model Selection

Do not forget to save Systems!



A newly defined System will immediately show up in the Name list, but will not be stored until you have clicked the **Save** button. **C**lose leaves the System Editor without storing changes!

6.5.2 Systems Based on Ellipsoid and Datum

If you want to define a System based on ellipsoid and datum only, click the **N**ew button, enter a name and then check the radio button named **E**llipsoid.

The screenshot shows the 'System Editor' dialog box. At the top, the title bar says 'System Editor'. Below it, there is a 'Name' field with the text 'New'. Underneath, the 'System Type' section has two radio buttons: 'Projection' and 'Ellipsoid'. The 'Ellipsoid' radio button is selected. To the right of the 'Ellipsoid' radio button is an empty text box. Below this, there is a 'Datum' field with the text 'DEUTSCHLAND_WEST' and a 'Change' button to its right. Below the 'Datum' field is a 'Geoid Model' field with the text 'World (JGM3/OSU91A)' and a dropdown arrow to its right. At the bottom of the dialog box are four buttons: 'Save', 'New', 'Delete', and 'Close'.

Figure 6-13: System Editor: Ellipsoid

No projection or zone information will be available. You may choose the ellipsoid directly. The combo box offers the complete list of ellipsoids.

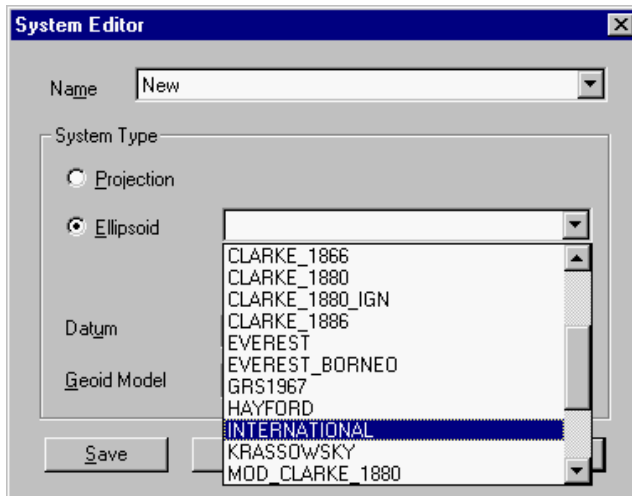


Figure 6-14: System Editor: Ellipsoid Selection



Do not forget to change the datum, too, if necessary!

If you want to add an ellipsoid or change the values of an existing ellipsoid, or just to check its values, you may do so via the Ellipsoid Editor (see section 6.4).

If you are changing an existing System and decide to change the **datum**, you may select it from a list offered by the combo box **Datum**. Click **Change** to open the list. If the desired datum is not included, leave the System Editor and define a datum with help of the Datum Editor.

GeoGenius also expects a **geoid model** entry. You may choose one from the list given by the combo box **Geoid Model**. If you do not want to apply a geoid model, choose the entry **None**. You may also add geoid models to the list with help of the **GeoTrans** Transformation Tool (see section 6.8).

Do not forget to save Systems!



A newly defined System will immediately show up in the Name list, but will not be stored until you save it. **C**lose leaves the System Editor without storing changes!

6.6 Delete a System

To delete a System open the System Editor window. Open the Name list and choose the System to be deleted. Then click the **D**elete button. **GeoGenius** will ask whether you really want to delete the System. Accept with **O**K to delete or **C**ancel to cancel.

6.7 Definition of a Standard Map Projection

The Standard Map Projection is suitable for the display of any project. **GeoGenius** comes along with a default Standard Map Projection, but allows you to customize it.

GeoGenius allows you to define a customized Standard Map Projection via translation and rotation. You may return to the default Standard Map Projection at any time and may check the parameters of the current Standard Map Projection.

Why define a personal Standard Map Projection?

Generally, you do not have to bother with the definition of a Standard Map Projection. For the most purposes, the default Standard Map Projection, national grid coordinates and local coordinates are sufficient for quick and satisfactory results.

However, instead of using a national projection you may be accustomed to use a user-defined map projection. (Within this personal map projection, you can to define a local System, which replaces the national grid coordinates.) In this case, you can replace the default Standard Map Projection. **GeoGenius** allows you to

- Choose the center point
- Define the northing and easting coordinates of the center point
- Define the azimuth from the center point to another point of your choice

Thereby you define a North direction, an origin and the center point of your personal Standard Map Projection.

Let us give you an example for these rather theoretical remarks:

You want to build-up a large area, such as an airport. You want the runway to be located in, e.g., N-S-direction on your map. The point P001 describing one of the edges of the runway (the lower left edge on your map) is to have the coordinates 0/0. Therefore, you create an airport related System (called, e.g., Airport System). The center point of this projection is the point P001.

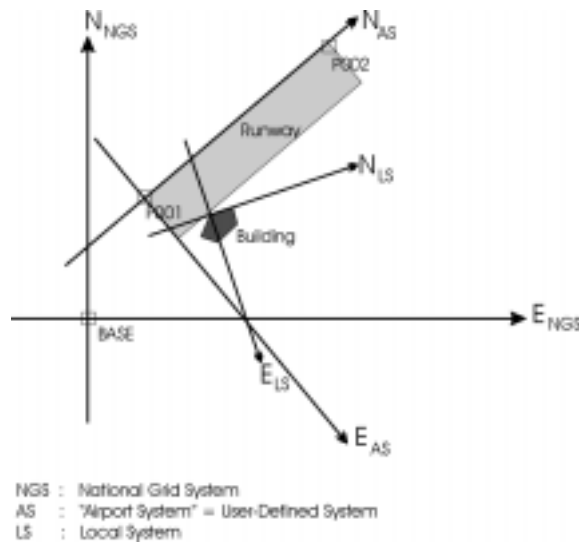


Figure 6-15: Example Systems

Point P001 will most probably not be the point with the most connections and, therefore, the default Standard Map Projection will not use it as center point. Therefore, you define a customized Standard Map Projection: you choose the edge point P001 as center point with the coordinates 0/0 and define the azimuth to the "upper left" point P002 as 0°. Then you set the Airport System as the System (refer to section

6.5). That means that the coordinates displayed on page National of the point properties notebook are coordinates in the Airport System.

Finally, to construct a singular building you want to define a local System within this Airport System. You define a local System (coordinates of page Local) for the building via the options of the pull-down menu Transform (refer to chapter 13).

The constellation of this example results in two “local” sets of coordinates for your project: the Airport System coordinates (page National) and the building System coordinates (page Local).

6.7.1 The Default Standard Map Projection

The default Standard Map Projection is a Spherical Projection based on a sphere with a radius stored in the Ellipsoid Editor and named “Sphere”. The following parameters define it:

Latitude of the center point:	determined by the center point
Longitude of the center point:	determined by the center point
Azimuth:	0
False easting:	0
False northing:	0
Scale:	determined by the center point

GeoGenius automatically selects a point of the network as center point. Typically, it is the same point that is automatically chosen as reference for processing. You will find 0.000/0.000 as Northing and Easting values for the national coordinates of the center point (check the page National of its Property: Point notebook). The height value is

the height on the WGS-84 ellipsoid (compare, for example, the page Geo of the same point).

If you have customized the Standard Map Projection and want to return to the default Standard Map Projection, you have just to do one mouse-click. Choose the menu item **Standard Map Projection** of the pull-down menu **Project** and then choose the menu item **Reset to Default**. This option redefines the center point and resets the all values to the default values.

6.7.2 Customize Standard Map Projection

You define the origin and orientation of your Standard Map Projection by providing one or two points and defining manually their position and orientation in the local System. **GeoGenius** computes three parameters (false Northing, false Easting, azimuth).

Please note that Standard Map Projection does not have a scaling. The height of the center point is set to the WGS-84 height!

The pull-down menu item **Standard Map Projection** offers two methods to customize the Standard Map Projection. These are:

Define via 2D/1 Point Define the center point and its coordinates

Define via 2D/1 Point+Azimuth Define the center point and its coordinates. Define an azimuth to another point.

The following paragraphs describe the latter option, which includes the first option. Choose the menu item **Standard Map Projection**

of the pull-down menu **Project**. Then choose the menu item **Define via 2D/1 Point+Azimuth**. The **Define Standard Map Projection** dialog shows up.

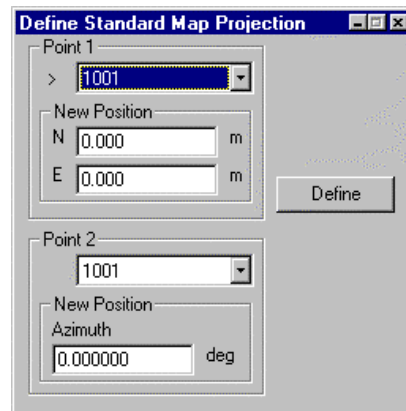


Figure 6-16: Define Standard Map Projection via 1 Point and an Azimuth

The dialog **Define Standard Map Projection** displays two boxes for each of the points used to define the Standard Map Projection.

The combo box **Point 1** allows you to select the center point. (Open the point list by a click on the arrow-down button) The current Easting and Northing coordinates are displayed in the box **New Position** of **Point 1**. Enter manually the N and E values for point 1 to define the Northing and Easting coordinates of the center point.

The combo box **Point 2** allows you to select the point that helps to define an azimuth. Enter the azimuth from **Point 1** to **Point 2** in **New Position** box of **Point 2**.

To set the customized projection parameters, click the button **De-fine. GeoGenius** then computes the three parameters azimuth, false northing, and false easting. The Standard Map Projection then will be based on the new values. Your network will be transformed automatically. (If your project plot seems to be empty after the re-definition of a Standard Map Projection, click the option View/Zoom All or the corresponding button of the toolbar Display!)

If you do not need to add an azimuth for the definition of your new Standard Map Projection, choose the menu item **Define via 2D/1 Point** of the **Standard Map Projection** pull-down menu. The **Define Standard Map Projection** dialog then just offers the selection of a center point and to enter northing and easting values.

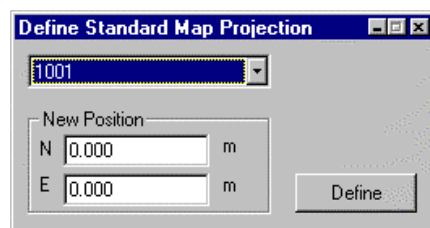


Figure 6-17: Define Standard Map Projection via 1 Point

6.7.3 Checking the Current Parameters

To check the current internal False Easting, False Northing and Rotation Parameters of the projection just choose the menu item **Standard Map Projection** of the pull-down menu **Project** and then choose the menu item **Display Parameters**. **GeoGenius** then displays the current parameters in the output window. To save and print-out the parameters, you may save the contents of the output window to a file and print-out the file via any editor (refer to chapters 5.3 and 5.6.6).

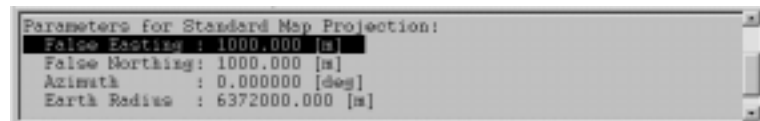


Figure 6-18: Current Standard Map Projection Parameters

This option is only available after the definition of parameters!

6.8 The Transformation Tool GeoTrans

With **GeoGenius**, points are adjusted in the given national grid System. The transformation and projection tool **GeoTrans** additionally transforms point coordinates (whether processed or adjusted) from one national grid System to another.

As it is the case with **GeoGenius**, you can choose from comprehensive lists of datums, ellipsoids, projections, geoid models, and various transformation methods, which cover most of your applications. Additionally, you may customize **GeoTrans** individually by creating your own components of the above types.

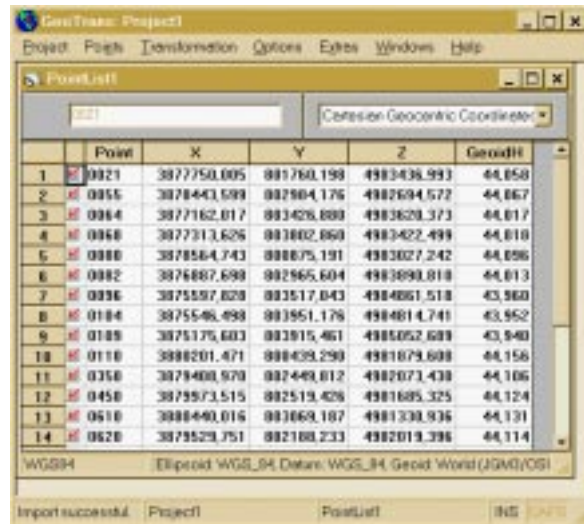
GeoTrans uses projects to organize your work. A **Project** consists of one or several point lists. A **Point List** is a list of points, all of which are described via coordinates in the same, predefined geodetic System.

You may perform coordinate transformations to and fro within a System very easy by just a mouse-click. Coordinate transformations to another System are quite as easily done with the Transformation Window. These result in new point lists.

GeoTrans offers a least-squares adjustment module, which estimates the best fitting transformation parameters for point list transformation, and in the same step transforms current point coordinates into the control System. The resulting transformation parameters can be stored for later usage with other point lists.

Independently from **GeoGenius**, you can start **GeoTrans** from the **GeoGenius** group and import point coordinates of various formats very easily.

However, you may also start **GeoTrans** within **GeoGenius**. Once a project is loaded or defined, the transformation module **GeoTrans** may be started from the **Tools** menu. If you use the entry **Transformation/Projection** in the pull-down list, you call **GeoTrans** and start a Project1. The points of the current project are listed in PointList1. You may rename the point list.



	Point	X	Y	Z	GeoidH
1	0021	3877750.005	881760.199	4983436.993	44.858
2	0055	3878443.599	882964.176	4982694.572	44.867
3	0064	3877162.817	883428.888	4983829.373	44.817
4	0068	3877313.626	883882.860	4983422.499	44.818
5	0088	3878564.743	888875.191	4983827.242	44.856
6	0082	3876887.699	882865.604	4983890.818	44.813
7	0096	3875597.828	883517.843	4984861.518	43.960
8	0184	3875548.498	883951.176	4984814.741	43.952
9	0185	3875175.603	883915.461	4985052.689	43.940
10	0118	3888201.471	888439.298	4981879.688	44.156
11	0358	3879408.970	887449.812	4982073.438	44.106
12	0458	3879573.515	882519.428	4981885.325	44.124
13	0618	3888440.016	883869.187	4981338.936	44.131
14	0628	3879529.751	882188.233	4982019.396	44.114

WGS84 Ellipsoid WGS_84 Datum: WGS_84 Geoid World (JGAD/OSI)

Import successful Project1 PointList1

Figure 6-19: The Module **GeoTrans**

The System of PointList1 is the WGS84 System, coordinates are given as Cartesian Coordinates.

On exiting **GeoTrans** you may or may not save the project under a new name. You are then transferred back to the current **GeoGenius** project.

6.9 Heights in the System

Generally, three height values are given, if a geoid model is selected for a system. The ellipsoidal height H is composed of the orthometric height h and the geoidal height N (also called geoidal undulation).

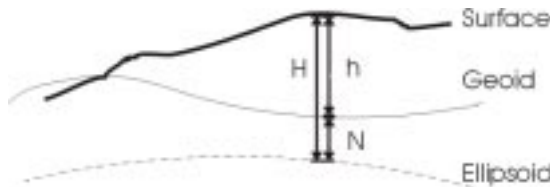


Figure 6-20: Height Model

If the System introduced into the project includes a geoid model, the page National of the Dialog Point: Property displays for a point the values for the three height types. Orthometric and ellipsoidal height are part of the point properties and may be edited. The geoidal height is derived from the geoid model in use.

Control		Ellipse		Meteo	
Point	National	Local	XYZ	Geo	
National Grid Coordinates					
N:	271212.939	[m]			
E:	381777.617	[m]			
> Orthometric Ellipsoidal					
H:	29.147		h:	30.851	
Assign Transfer to Control					
Projection					
Scale: 0.999605347					
(-394.65 ppm)					
Conv: 0° -12' 42.30"					
Geoid Model					
N: 1.704 [m]					
Geoid: World (JGM3/OSU91A)					

Figure 6-21: Point Property: Heights

You may edit the height as either orthometric or ellipsoidal value. Only one of the parameters is active at a time. By default, the active parameter is the orthometric height. If you click the button **Next**  the active edit field will display the ellipsoidal height for editing.

If one of the orthometric or ellipsoidal height is changed manually, **GeoGenius** automatically recalculates the other on the basis of the geoidal height.

Changes in the location (e.g., if you enter a new latitude value or insert known coordinates for the primary or for the control coordinate set) will affect the geoidal height and, therefore, the orthometric height also. In order to avoid overwriting of manually changed geoidal height values, it is left to you to choose, if you want to recalculate the height values from the given geoid model.

In general, you first edit all locations you want to change, then choose the option **Geoid/Recalculate Geoid Heights** of the pull-down menu **Project**.

GeoGenius now recalculates all geoidal heights from the System's geoid model and automatically re-computes orthometric or ellipsoidal heights.

Of course, **GeoGenius** respects the heights of the antenna (instrument) above ground before calculating heights. Please refer to ch. 5.7.4. for detailed information on Instrument Height Corrections.

7. Data Preparation

GeoGenius was designed for fully automatic geodetic baseline calculation, achieving relative accuracies of 1 ppm or better. The relative accuracies depend on the ephemeris accuracy. The following steps are necessary for **GeoGenius** to start the processing of static or kinematic data after the import of observation and ephemeris files. They will be discussed in detail in this chapter. Note that **GeoGenius** performs some of the steps automatically, but you may also do them manually.

- Selection of single baselines or whole project
- Fixing of the reference station(s)
- Generation of ephemeris data
- Parameter setting
- Enter meteorological data
- **Start process!**

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7.1 Baseline Selection

You may select one, several or all baselines or sessions for processing. To do so, you may choose the navigator or the project plot area. The following sections show all possibilities to select baselines.

To select a single baseline and to process it:

- With the navigator, activate the baseline. Baselines are listed in container **Baselines**.
- Alternatively, click onto the baseline in the project plot. The baseline will be marked.

Please note the intelligent line selection algorithm: first, the line nearest to the mouse pointer will be selected. With each click the line with greater distance (in ascending order) to the mouse pointer will be selected, as long as you do not move the mouse significantly.

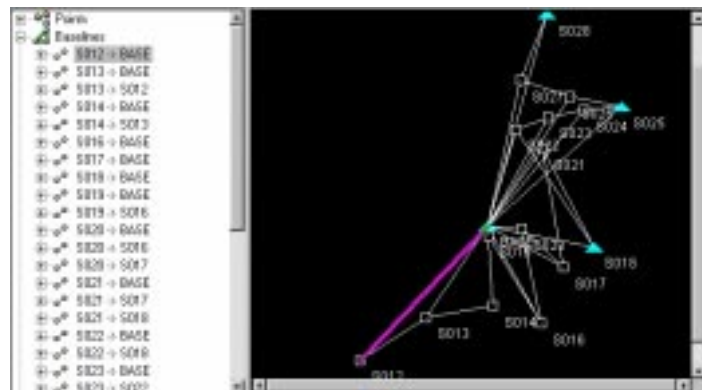


Figure 7-1: Select a Single Baseline

-  Having done the further preparations, start the processing with **Process/Process Line** or by pressing the correlated icon of toolbar **Processing**. The baseline will be processed, no matter whether it was enabled or not. However, the individual sessions of a baseline are respected, e.g., if a baseline has three sessions, but all are disabled, the baseline will not be processed!

To select one or several **sessions** of a baseline:

- With the navigator, double-click the baseline identifier, click the respective session (right mouse button) and activate one of the options **Enable Session/Disable Session** of its context menu..
- Alternatively, click onto the respective baseline in the navigator or the project plot, of its context menu select **Toggle Sessions**. You now may enable or disable all or choose **Select**. The Session Selector window pops up, displaying the path and file names of all sessions of the baseline.



Figure 7-2: Session Selector Window

A checkbox allows you to select specific sessions. The buttons **All** and **None** enable all or none of the sessions. To accept the selection, choose **OK**, else leave without changes with **Cancel**.

To select **groups of baselines** you should use

- the navigator's baseline container and its various Enable/Disable functions (Alternatively, open the **Base Lines** item of the pull-down menu **Edit**). You may
 - ◊ disable all (**Disable All**) and manually enable one or several baselines
 - ◊ enable all (**Enable All**) and manually disable one or several baselines
 - ◊ enable or disable baselines and / or sessions conforming a defined definition mask (**Enable/Disable by...**). Definition masks are:
 - * **Date** (select a date in the format DD/MM/YY)
 - * **Day of the Year** (select a date in the format year/day of year)
 - * **GPS-Time** (select a date in the format GPS-Week and day of GPS-week. 0 represents Sunday, 6 represents Saturday)
 - * **GPS-Seconds** (select a date in the format GPS-seconds)
 - * **Time Span** (toggle the line enabling status if more or less than xx seconds of common data are available. You may edit the time span)
 - * **Length** (toggle the line enabling status if there is more or less than xx meters distance between the two points. You may edit the distance value)
- the context menu of a point identifier in the navigator or the project plot and its **Connect/Disconnect** options. You may

- ◇ disconnect a point from the network to process the remaining network excluding all baselines that would connect the point to the network (**Connect/Disconnect**)

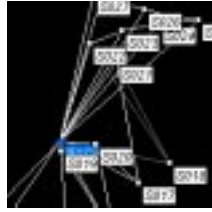


Figure 7-3: Point S018 Disconnected

- ◇ connect a point to the network by all existing baselines to the point (**Connect**)
 - * without change to the rest of the network baselines (**Normal**)
 - * with disconnection of all baselines not connecting the point to another point (**Exclusively**).

Make sure, that after selection of this option at least one baseline connects the point in view to previously processed points or to a fixed point. If not, no processing is possible!

- Alternatively, click onto a baseline in the project plot (right mouse button) and invert its status (**Enable/Disable**). Repeat this action until you have selected or deselected all necessary baselines.

The baseline estimator will consider all enabled baselines, but not process the disabled lines. Disabled lines may only be processed line by line, if you use the **Process Line** option!

Please note, that these various ways of enabling and disabling lines provides all the flexibility you need to perfectly combine lines and sessions.

7.2 Reference Points

Reference stations with known coordinates improve the results of the baseline estimator by far. Please note that the term “reference station” has the same meaning as the term “fixed point”.

Why use reference stations?

The choice of the reference station is of great importance for the data processing. If a precise position in WGS84 is available from any previous campaign, it should be inserted into the project. The entire processing should be done by using this station as reference station.

Usually the positions derived by single-point-positioning are influenced by Selective Availability (S/A). This restricts their accuracy to ± 100 m (95 % probability) in horizontal; 160 m in vertical. Such an error can induce errors of several parts per million in differential positioning for scale and orientation of the network. This is not critical as long as the same error influences the whole network, but it can cause problems if you process the network from different reference stations that have not been sympathetically positioned beforehand. In that case, the error would be different for different parts of the network and the software would not be able to eliminate this effect in the final transformation to plane coordinates.

The project file controls and avoids this problem. It stores the positions of all differentially positioned stations. Each time the baseline processor starts a new baseline, it first checks if the project file contains the name and approximate coordinates of one of the stations. If it does not, the baseline will not be processed. The software constructs the sequence of the baseline processing in such a way that the differ-

ential positioning of all stations is guaranteed to be with respect to the initial reference station.

How to define reference stations

The software automatically suggests a reference point (fixed point) the first time you insert observation files into a new project.

To visualize the default reference station **via the menu** press **Process/Suggest Reference**. The Reference Station selection window shows up and, by default, offers the station with the largest uninterrupted observation time span (first preference) and the most connections to other stations (second preference).

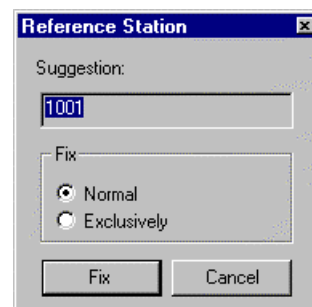


Figure 7-4: Suggest Reference

Typically, you may fix one or more stations (default Fix option **Normal**). If you click the option **Exclusively**, the default reference will be fixed, while all other fixed stations will be unfixed).

You may choose a point to serve as reference from **the navigator or the project plot** and then open the point context menu with the right mouse button. You now may toggle the reference status via the first menu item **Fix**. If **Fix** is marked with a ✓ sign, the respective station coordinates are fixed and its coordinates will not change during proc-

essing. Reference stations are marked in the navigator by a small blue triangle .

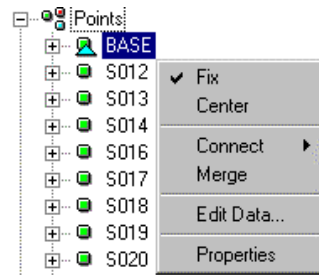


Figure 7-5: Fix a Point

To **fix all stations** as fixed mark the **Points** entry of the navigator and choose the **Fix All** item of the context menu.

To **unfix all references** mark the **POINTS** entry of the navigator and choose the **Fix None** item of the context menu.

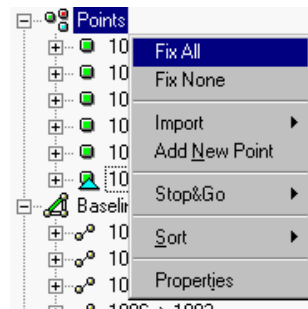


Figure 7-6: Fix All, Fix None

Please note the difference between control coordinates and fixed points. If a point is fixed, all of **GeoGenius** modules do not modify the

any of its coordinate sets. The baseline processors use the WGS84 XYZ coordinates for processing, therefore, control coordinates do not impact the processing, but fixing does. This means, if you have imported control coordinates, but did not fix the point, this point will be processed in line with the other baselines. Processing will most probably result in new coordinates for the point.

When running the baseline processor, the lines connected to a reference station will be processed first. Then, all lines connected to these lines will be processed and so on, until all enabled lines are processed.

An option that allows you to graphically navigate through your network is the Center function. This function gives you the ability to center stations on your project plot. Enable the **Center** menu item of the context menu of the selected point. This function is extremely helpful to find specific points of your network.

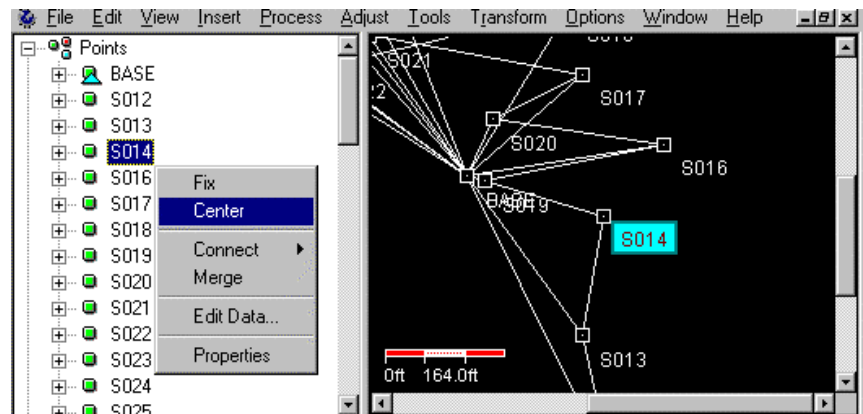


Figure 7-7: Point S014 Centered

7.3 Ephemeris File Generation

GeoGenius distinguishes between two different orbit types: **Broadcast** and **Precise**.

The static and kinematic processors of **GeoGenius** require binary EF18 format for processing baselines. **GeoGenius**, therefore, has to create (broadcast or precise) ephemeris files prior to processing, if no EF18 format files were found.

If you already have binary broadcast or precise ephemeris data, you do not need to explicitly create it.

7.3.1 Generation of Broadcast Files

During file insertion, **GeoGenius** automatically generates broadcast ephemeris files from RINEX files, if no matching EF18 format files are available for processing. However, you may also instruct **GeoGenius** to generate broadcast ephemeris files.

First, insert the matching RINEX file(s) into the project (see chapter 5.5.1). The RINEX navigation files are named *.YYN where YY is the year (97 for 1997). Then choose **Process/Generate Ephemeris**.

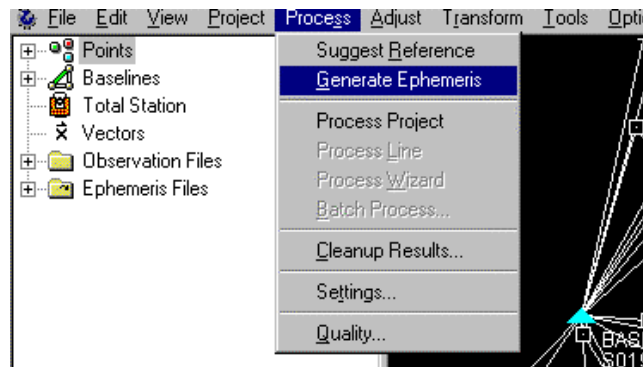


Figure 7-8: Generate Broadcast Ephemeris

By default, when the broadcast ephemeris file was generated successfully, it will be stored in the directory of the sources. However, a dialog window will allow you to define the file location, if the option **Directory after EPH Generation** of the tab **Messages** of the notebook **Customize** is checked. To open the notebook, click **Options/Customize...** or the corresponding button on the toolbar **Processing**.

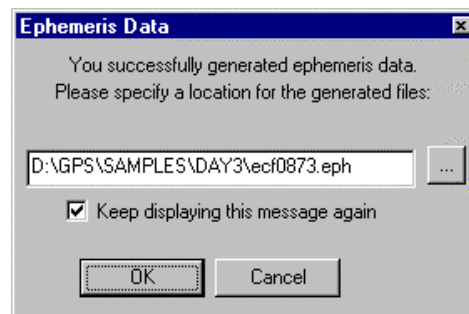


Figure 7-9: Ephemeris Data

The file creation follows the naming convention:

ECFWWW.EPH

where ECF is corresponding to earth-centered fixed
 WWW is the GPS week
 EPH refers to broadcast ephemeris

The suggested path is the path to the first observation file in the project. You may, however, select any path you want. The file format of all ECF files is the National Geodetic Survey binary EF18 format.

7.3.2 Generation of Precise Orbits

GeoGenius allows you to decode precise orbits from the ASCII SP3 format into binary EF18 format. To do so, choose the tool **Precise Ephemeris Import...** of the menu **Tools**. For a detailed description of this tool, please refer to chapter 14.1.

7.4 Processing Options

When you set up a project, processing parameters are normally set up in a way the processing works fine. Nevertheless, you may fine tune processing parameters in order to get optimized or improved results.

Choose the menu option Process/Settings...

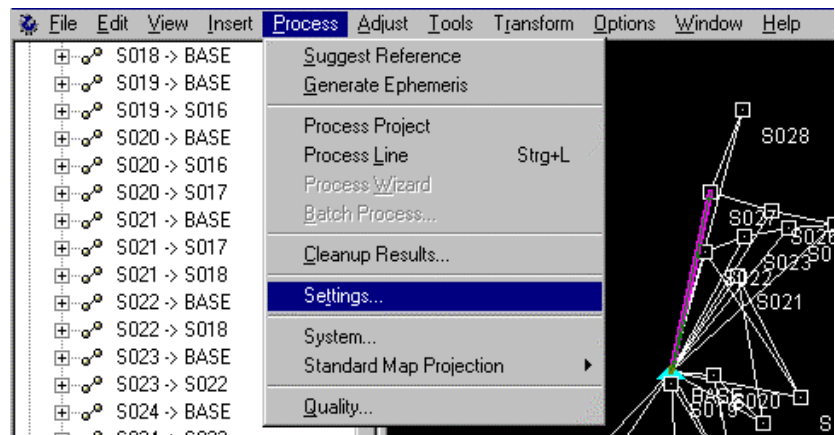


Figure 7-10: Process/Settings...

The Processing Options window shows up, a notebook of eleven pages:

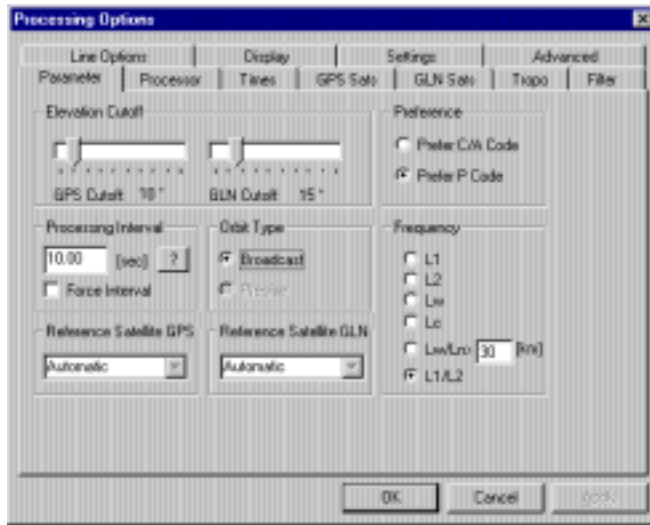


Figure 7-11: Processing Options

- ⇒ Page Parameter
- ⇒ Page Processor
- ⇒ Page Times
- ⇒ Page GPS Sats
- ⇒ Page GLN Sats
- ⇒ Page Tropo
- ⇒ Page Result Filter
- ⇒ Page Line Options
- ⇒ Page Display
- ⇒ Page Settings
- ⇒ Page Advanced

The following sections describe each of the pages.

7.4.1 Page Parameter

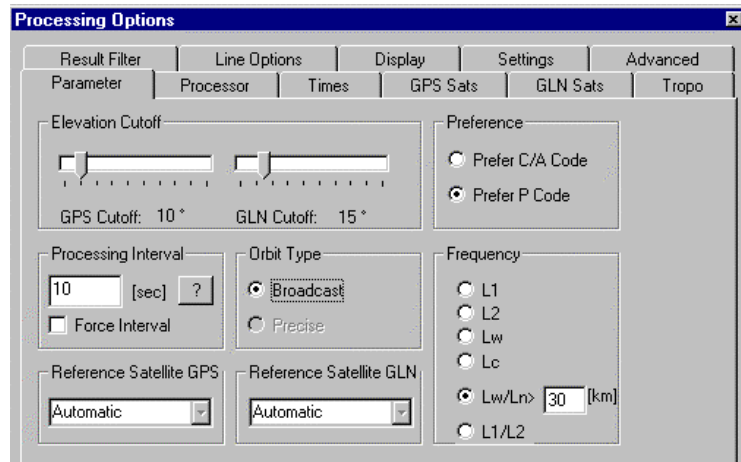


Figure 7-12: Processing Options Parameter

Elevation Cutoff for GPS and GLONASS satellites, resp.

You may specify the minimum elevation mask for postprocessing for each of the satellite systems separately using a slider. Click onto the tab and drag it to the setting.

Processing Interval

Enter a value (up to 4 digits) for the processing interval given in seconds. The processing interval may be larger than the current observation time interval, but should be a multiple of it.

This parameter is used to define the default sampling time interval in seconds between the epochs (observations) to be processed. This is useful when the data was recorded at a fast rate, e.g., every 0.5 seconds, and you want to process only every 10 seconds. This is also of

importance considering that different processing intervals within a project would lead to incorrectly weighted observations in the Network Adjustment. GPS differential processing is always optimistic with its analysis of standard errors and this effect is increased by a high processing frequency.

The question mark button right of the interval box allows you to inspect the sampling rate.

If the sampling interval in one of the observation files of a baseline is larger than the interval defined, **GeoGenius** chooses the minimum multiple of the two sampling intervals involved. Check the Force Interval option, if you want to override this automatic interval definition and to force **GeoGenius** to process with the processing interval you have defined here.

Orbit Type

Specifies the type of ephemeris data. You may choose between Broadcast and Precise ephemeris data to estimate the satellite orbit position. Broadcast orbits are stored in a file in EF18 format with the name **ECFWWW.EPH**. Precise ephemeris files are also stored in the EF18 format under the name **ECFWWW.PRC**. If data of one type only is available, the other option is inactivated.

Reference Satellite for GPS and GLONASS

GeoGenius allows the selection of a satellite of each of the satellites systems as reference satellite for processing. Normally it will be best to allow the software to select the reference satellite for double difference processing (the **Automatic** item of this list). However, you might want to define the satellite directly. The arrow-down button al-

allows to choose one of the GPS or GLONASS satellites by its PRN number or to return to the automatic selection mode (Automatic).

Preference

If C/A code data as well as P code data is available, you may choose the type of data to be preferably processed. Default is P code.

Frequency

This defines the type of carrier phase to be used in the baseline processing. The following options are possible:

L1	L1 processing only
L2	L2 processing only
Lw	L1-L2 wide lane processing
Lc	Ionospheric free combination of L1 and L2 data
Lw/Ln>x	Option for wavelength activation depending on the baseline length ($Lw/Ln > [x]$ km). If you have chosen this option, GeoGenius processes L1 data as long as the baseline length is less than the distance specified. If the baseline is longer than the given value, GeoGenius automatically switches to a special algorithm to fix Lc ambiguities.
L1/L2	L1 processing for position estimation. L2 is used, if available for ambiguity resolution

For information on wavelengths please refer to section 7.6.

7.4.2 Page Processor

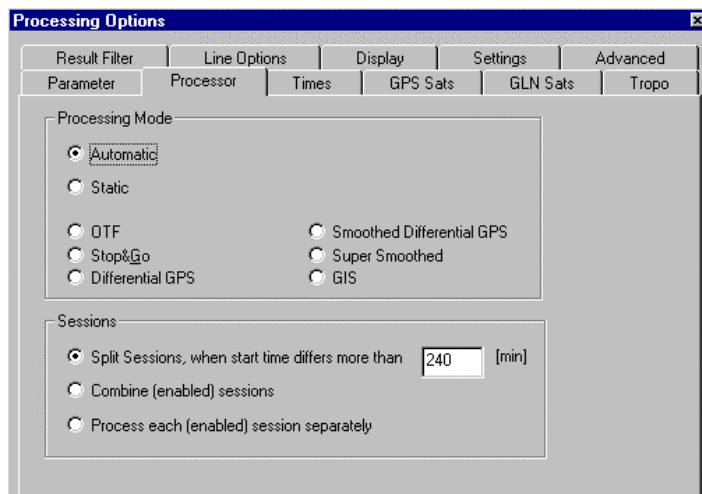


Figure 7-13: Processing Options Processor

Processing Mode:

GeoGenius basically supports one static plus several kinematic processing modes: **Static** is the option for the static processor. In geodetic static, short-static and pseudo-static processing the processing mode should be **Static**. The **Stop&Go** mode indicator instructs **GeoGenius** to perform a kinematic positioning on the basis of static initialization. This requires indications by the receiver for moving ("Go") and static ("Stop") time periods. The **GIS** mode is a **Stop&Go** mode with less accuracy needs and therefore needs no initialization by using DGPS super smoothed positions. **Differential GPS**, **Smoothed Differential GPS**, **Super Smoothed** - and as an option **On-the-Fly** - are different kinematic processing modes.

Automatic

GeoGenius is able to automatically detect the appropriate processing mode for your project, either for static or for kinematic GPS surveying. If data is collected kinematically and you have chosen the automatic processing mode, **GeoGenius** will determine whether DGPS or Stop&Go processing should be applied, based on available data.

You may, however, override the automatic processing and define one of the following processing modes, e.g., if observation data were collected using different collecting modes.

Static

GeoGenius uses the static processor provided in TSSTATIC.DLL.

OTF

On-the-Fly ambiguity resolution is a method allowing the determination of ambiguities without any static initialization.

On-the-Fly is available as an option. The default DLL is TMDG01.DLL.

Stop&Go

In Stop&Go mode **GeoGenius** expects both an initialization and various static segments of data. Each static segment is associated with individual antenna eccentricities and point code information. **GeoGenius** creates position output for each epoch of the surveying during both moving and static segments. If points are visited twice accumulated position solutions are output.

Differential GPS

In Differential GPS mode **GeoGenius** derives code differential positions and outputs them into trajectories. You may view result reports or create position output files to export the results. A typical example is the *.POS file. A *.POS file has the same name as the roving receiver file name.

Smoothed DGPS

The Smoothed Differential GPS option is a similar processing mode to the Differential GPS mode. The code measurements are smoothed by the phase. It is a weighted mean of the code measurements and the code, predicted by the carrier phase.

Super Smoothed

The Super Smoothed Differential GPS option is a similar processing mode to the Differential GPS mode. Super smoothing is an algorithm that takes all data between two cycle slips and uses it equally for smoothing all epochs. So, the precision remains at the same high level starting from the first epoch. Another advantage is that positions computed using the super-smooth DGPS processor result in a very high relative precision between successive epochs.

GIS

GIS positioning is very similar to the Stop&Go surveying. However, the demands on the position accuracies are less by far than regarding the classical Stop&Go application. The code measurements are smoothed by phase measurements. This results in accuracies in the meter to decimeter range. No initialization is necessary.

Sessions:

Here you may choose one of three options how to handle sessions:

- Split sessions, if start time differs more than xx minutes
- Combine (enabled) sessions
- Process each (enabled) session separately

The first option instructs **GeoGenius** to process all sessions with a start time differing less than a specified time span (default: 180 seconds) in one single run.

If you have, e.g., two sessions of a baseline that are more than 4 hours apart, the following problem arises. The static processor always chooses 1 satellite for reference. Satellites are visible for not more than 4 hours. In this case, the data of the second session would simply get ignored. Processing the sessions individually would help. If you set the parameter here to $4 \cdot 60 = 240$ minutes, automatically two solutions would be created in the above example.

The second option tries to combine and process the data of all sessions in a single processor run, whereas the third option will process each session separately, no matter, how much time they are apart.

Residuals

If you check the checkbox **Generate Residuals (only static)**, the static processor will store the residual for each epoch as long as you do not exit the program. You may check the residuals using the baseline's context menu option **Edit Data/View Residuals (graphical)** (refer to ch. 14).

7.4.3 Page Times

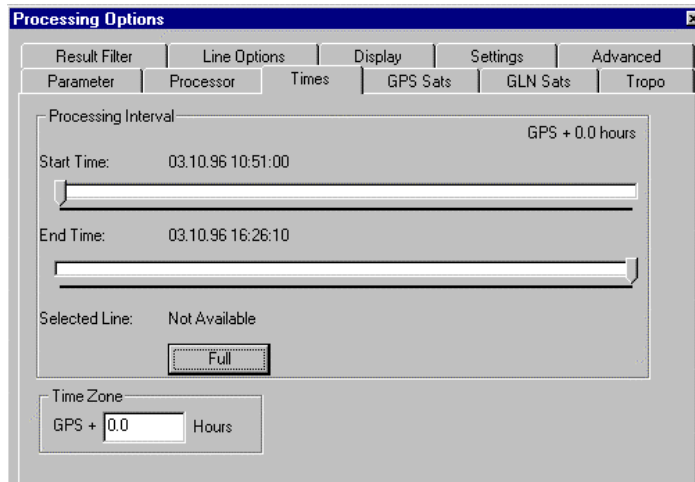


Figure 7-14: Processing Options Times

Select this page, if you want to check the time span covered by your current project or if you want to reduce the processing of your base-line or network by selecting a defined time span. Two sliders define the start time and the end time of all observations of the selected project. Their tabs are by default set at the very beginning and the very end. Move the start time tab to the right and/or the end time tab to the left, if you want to exclude time spans from processing. If you try to set an invalid time span (e.g., to set an end time prior to the start time), the other tab will be moved simultaneously in the same direction.

To reset both tabs simultaneously to their origin, click the button **Full** at the bottom of the box Processing Interval.

If you have first selected a single baseline before checking the processing options, the start and end time will nevertheless define the time span covered by the project. The time span covered by this baseline will be defined by a colored bar. The line Selected Line on bottom of the end time slider will give the start and end times in numerals.

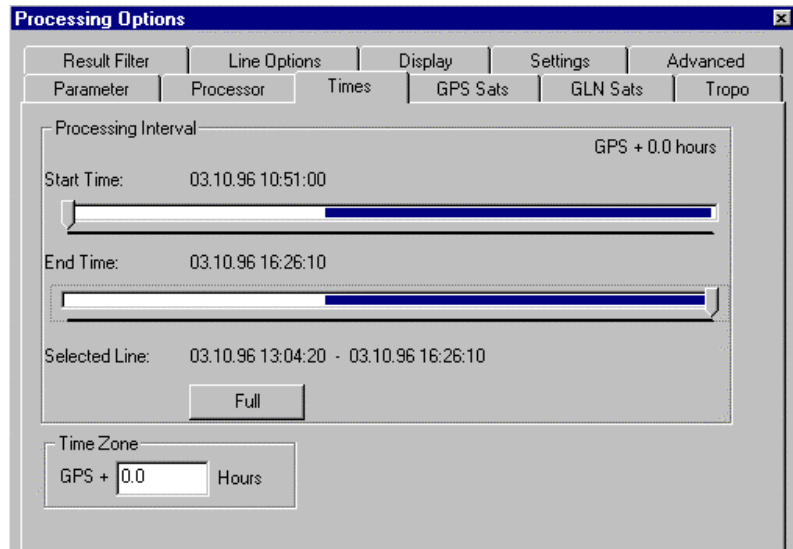
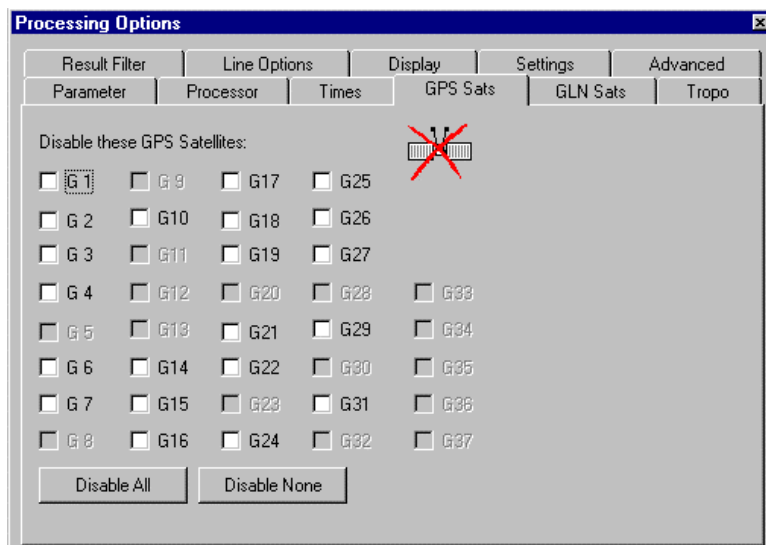


Figure 7-15: Processing Options Times - Selected Line

The box Time Zone displays the current time zone information and allows you to enter a time offset by hours to the current time zone. The offset will be respected in the numeric start and end times given in the box Processing Interval.

7.4.4 Pages GPS Sats/GLN Sats**Figure 7-16: Processing Options GPS Sats**

All observed satellites of a project are enabled in this dialog, the other are grayed out. You may exclude unhealthy GPS or GLONASS satellites from processing. Choose the page for the satellite system and mark the PRN number of the satellite you want to disable. GPS satellites are numbered with an initial G, GLONASS satellites use an initial R for identification.

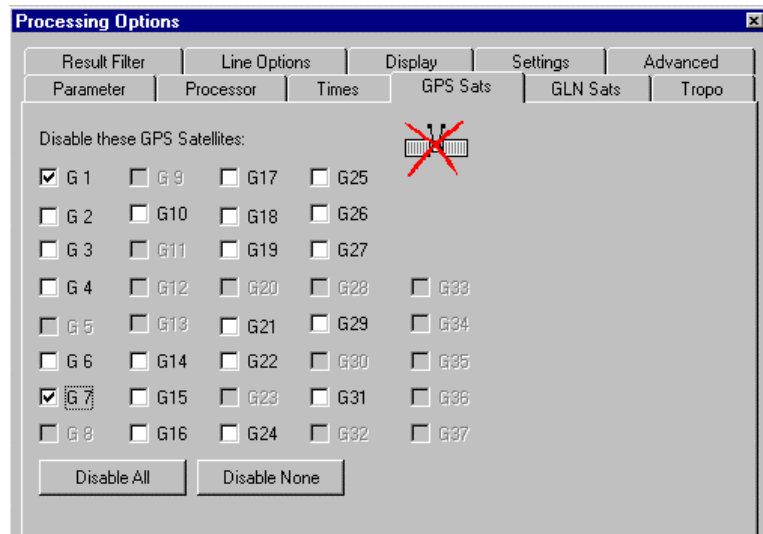


Figure 7-17: Satellites Disabled

The above settings instruct the program to exclude GPS satellites 1 and 7 from data processing.

The buttons **Disable All** and **Disable None** allow the fast selection and deselection of all satellites at once.

7.4.5 Page Tropo



Figure 7-18: Processing Options – Tropo

Tropospheric models describe the atmospheric conditions in the troposphere using the parameters temperature, pressure and humidity to improve the processing result. You may choose the best fitting tropospheric model to be introduced into the processor's algorithm. By default, the static and kinematic processors use the model **Modified Hopfield (Fixed Values)**.

Currently, the following tropospheric models are available:

- ☒ Modified Hopfield (Fixed Values)
- ☒ Modified Hopfield
- ☒ Classical Hopfield
- ☒ Yionoulis
- ☒ Lanyi
- ☒ Davis
- ☒ Saastamoinen

You may enter individual values for the needed meteorological parameters using the page Meteo of the notebook Point Properties. The Processing Options page Tropo, however, allows you to enter or accept the **default meteorological values**. These will be assigned by default to any point of the current project, unless you change the parameter values individually.

By default, the following Default Values are given:

Temperature:	Temp:	293.0 K
Pressure:	Press.:	1013.0 hPa
Humidity:	Humid:	50 %

Since tropospheric models include **height information**, information has to be provided at which height the meteorological data have been collected. Accept or change the default height values of the box Default Height for each of the three meteorological parameters. The values given here will also by default be assigned to any point of the current project, unless you change the value(s) individually.

The heights are given in the current length unit above sea level.

7.4.6 Page Result Filter

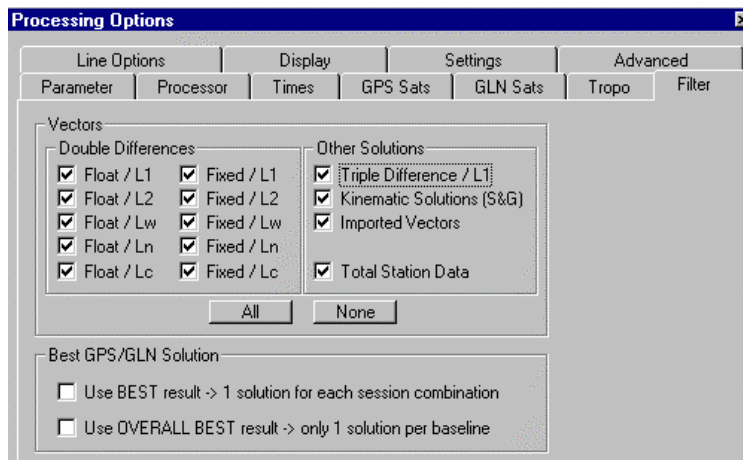


Figure 7-19: Processing Options Result Filter

The page **Result Filter** offers settings to filter the results of the baseline processing. Only the filtered results are added to the project. By default, the static baseline processor calculates up to eleven different results depending on the processing mode and the available data and automatically selects the one with the best statistics. The kinematic processor only calculates a kinematic solution. For most of your work, the L1 fixed solutions should be marked in the filter selection, as these are usually the best solutions.

Float Solutions, Fixed Solutions and Triple Difference/L1 are different methods used to calculate the baseline vectors. For the Float and Fixed solutions you can also select between different frequencies (L1, L2, Lw, Ln and Lc).

You may also include or exclude imported vectors into/from the project (Imported Vectors).

To select all results click the button **All**, the button **None** deselects all result options. By default, all results are selected.

GeoGenius offers two options to choose best solutions. If you choose the option **Use BEST result**, the best result of each processed session combination is used. If you choose **Use OVERALL BEST result**, only one result will pass the filter, independently of the number of session combinations processed.

By default, **GeoGenius** stores all results in the project database.

7.4.7 Page Line Options

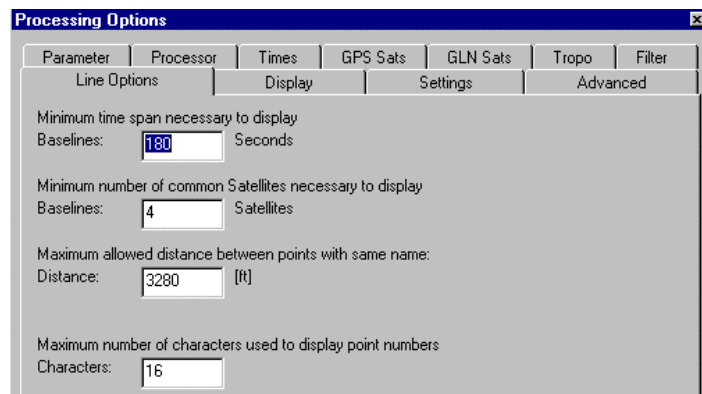


Figure 7-20: Processing Options Line Options

The parameters of this page are related to the display of baselines and static points. You may set limits for **GeoGenius** to display baselines concerning the time span of observation or the number of satellites during the observation time. A further limit controls the identification of points.

Minimum time span necessary to display Baselines:

To set a limit for the requested minimum time span of simultaneous observation data, choose this option and enter a value in seconds. If the observation time interval is smaller than the given value, **GeoGenius** will not recognize the data as baseline. Default is 180 seconds.



Internally, a baseline is built, if it has one common epoch between the observations!

Minimum number of common satellites necessary to display Baselines:

To set a limit for the minimum number of satellites observed simultaneously during the observation time, choose this option and enter a value. Default is 4 satellites.

Maximum allowed distance between points with the same name: Distance:

This option helps to avoid misinterpretation of point numbers. You may set a limit to the maximum distance allowed for **GeoGenius** to interpret points with equal names. E.g., if you have, by mistake, inserted an observation file of a different survey into the current project and both surveys started with point number 0001, **GeoGenius** will be able to detect the difference. If you have entered a maximum allowed distance smaller than the distance between the two points “0001”, a message like this shows up:

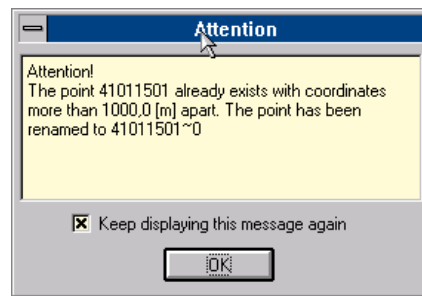


Figure 7-21: Warning Message

To suppress this message, choose the menu option **Options/Customize.../Messages** and clear the option **Display Messages - Points with coordinates apart**. If a message of this type has already shown up, you also may clear the option **Keep displaying this message....**

Default is 1000 m or 3280 ft.



GeoGenius only respects **visible** baselines or points for processing or network adjustment!

Any detected suspect point <pointname> is renamed to <pointname~x> which helps you to find erroneous points.

Maximum number of characters used to display point numbers:

To set a limit for the maximum number of characters used to display the point names in the plot. If the name is longer than the limit, **GeoGenius** displays the leading characters of the point name. Default is 16 characters.

7.4.8 Page Display

This page allows you to individually customize the project plot. Within **GeoGenius**, you can freely design the project plot. Generally, the following options are available:

- Organizing plot objects (layers) in the project plan.
- The grid is a layer, whose grid width you can define here.
- The redefinition of the display orientation.

Organization of Plot Objects

Each type of plot object is organized in a **layer**. Layers exist, for example, for different types of points, baselines, and so on. *Appendix A.3* describes how to set colors and fonts or how to define line styles for each layer. You may define different layer style sets for different projects.

Arrange layers to visualize your network in every way. Define Display Groups and set all layers you want to be displayed when this Display Group is activated. Page Display allows you to define, change and delete Display Groups.

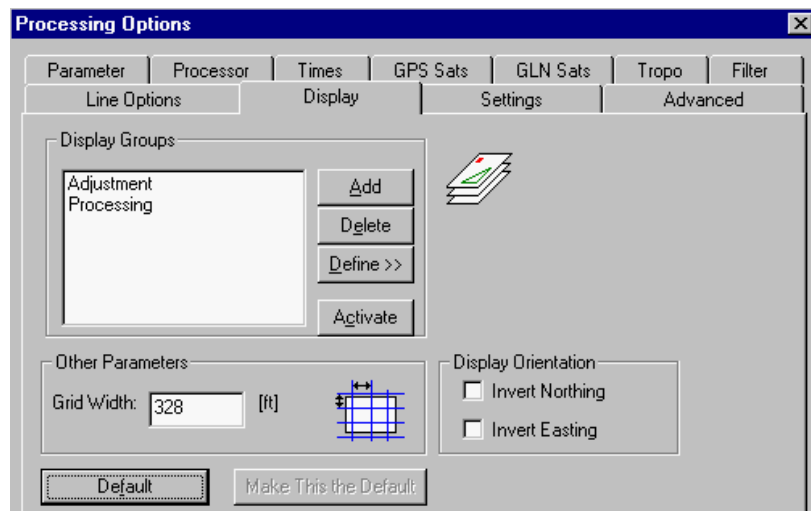


Figure 7-22: Processing Options Display

The list box Display Groups lists the current layer groups. Several buttons right of the list box allow the definition, deletion and activation of a layer group.

By default, **GeoGenius** has two layer groups implemented: The layer group Processing and the layer group Adjustment. Display group Processing is the default layer group from start-up up to the start of an adjustment process. Then **GeoGenius** automatically switches to the display group Adjustment.

To **change** the settings of a layer group activate its name and click button **Define>>**.

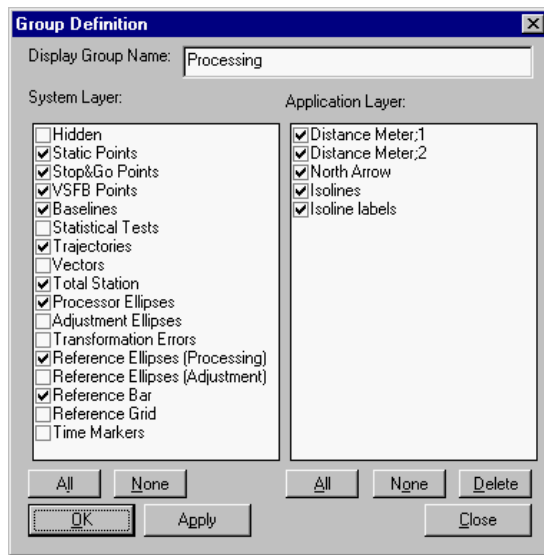


Figure 7-23: Group Definition Dialog - Settings for the Group Processing

The Group Definition Dialog displays at its top the current display Group name. You may edit the name. Two complete lists of all available layers follow. All layers given in the box System Layers belong to the basic **GeoGenius** equipment. However, you may extend **GeoGenius** and modify it in various manners (refer to Appendix A.5). If you have done so, additional layers may be available in the box Application Layers. You may delete individual layers of the box Application Layer using the button **Delete** beneath the box. System layers may not be deleted!

The checked checkboxes show currently selected layers. If you want to change the selection, clear the checkboxes of layers you do not want any more or check the boxes for layers to be displayed in future. The

buttons **All** and **None** beneath a box allow you to select or deselect all layers of the respective list box.

Click **OK** to accept the changes or **Apply** to accept the changes and to apply the current Display Group in the current project. Close the dialog with **Close**.

Here is a list of all available objects in the box System Layer:

- ☒ Hidden
- ☒ Static Points
- ☒ Stop&Go Points
- ☒ VSFB Points
- ☒ Baselines
- ☒ Statistical Tests
- ☒ Trajectories
- ☒ Vectors
- ☒ Total Station
- ☒ Processor Ellipses
- ☒ Adjustment Ellipses
- ☒ Transformation Errors
- ☒ Reference Ellipse (Processing)
- ☒ Reference Ellipse (Adjustment)
- ☒ Reference Bar
- ☒ Reference Grid
- ☒ Time Markers

To **add** a new layer group to the selection click the button **Add** of the page Display of the notebook Processing Options. **GeoGenius** automatically adds a new item to the selection of Display Groups under the name New Group #, where # stands for a number ≥ 1 . Then, activate the group New Group # and click the button **Define>>** to edit the name and to make your selection of layers (see *Figure 5-16* and the paragraphs above).

To **delete** a Display Group from the list activate its name and click the button **Delete**. The Display Group will be immediately deleted from the selection!

To apply the currently selected Display Group click the button **Activate**.

You may accept your edits and close the dialog, accept without closing the dialog or cancel your edits.

Grid and Grid Width

Please note the layer **Reference Grid**. Page Display of the Processing Options notebook additionally allows you to define a width for the grid over your plot. You may edit the string field Grid Width in the box Other Parameters. The default value is 100m.

Display Orientation

You may invert the orientation of your project plot very easily. The figures below clearly show the effects for the demo dataset Getstart, if you check the checkboxes **Invert Northing** or/and **Invert Easting** of the box Display Orientation.

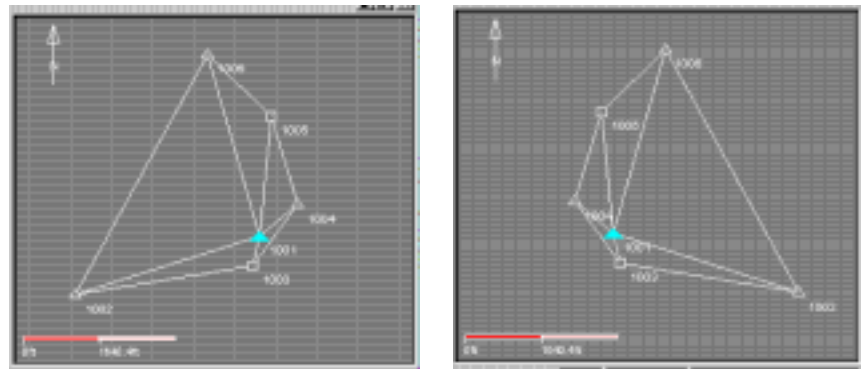


Figure 7-24: Project Plot: Original (left), Inverted Easting (right)

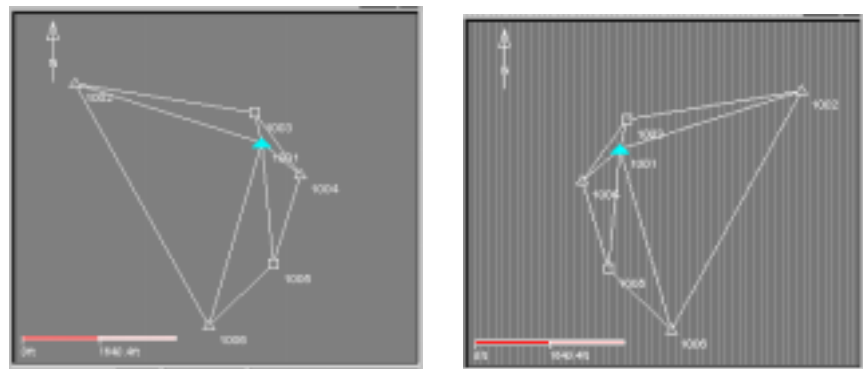


Figure 7-25: Project Plot: Inverted Northing (l), Both values inverted (r)

7.4.9 Page Settings

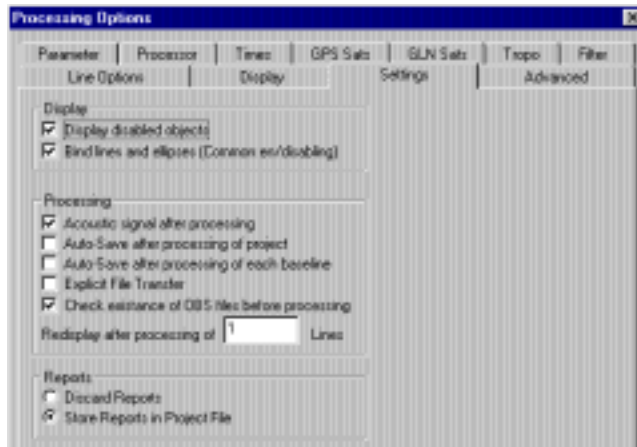


Figure 7-26: Processing Options Settings

Two parameters of this page are related to the project display, six parameters concern the behavior after line processing. The third block refers to the result reports.

Display: Display disabled objects

Objects, such as lines, ellipses or points show up in two states, enabled or disabled. This parameter allows you to determine whether or not disabled objects shall be displayed at all. If the checkbox is marked, disabled objects will be displayed. To determine the color for disabled objects, if displayed, choose the menu option **Options/Styles/Color**. Default is marked.



Hiding disabled objects causes also the navigator to change appearance - all disabled objects will be removed. Hidden baselines will not be processed or adjusted!



Hiding disabled objects makes it very convenient to select a group of objects and, e.g., drag them to a different project.

Bind lines and ellipses (Common en/disabling)

If this checkbox is marked, enabling or disabling a line causes its error ellipse also to show up or to disappear. Hidden ellipses are not used for calculation of the largest processing error of the project and, therefore, directly cause changes to the reference ellipse. Default is: marked.

Processing:

Acoustic signal after processing

Here you may define, whether **GeoGenius** shall send an acoustic signal as soon as the processing has finished. Default is marked.

Auto-Save after processing of project

Here you may define, whether **GeoGenius** shall save the project automatically as soon as a processing of a project has finished. Default is: cleared.

Auto-Save after processing of each baseline

If you check this option, **GeoGenius** will save the project after the processing of each single baseline. This option may help you to detect a corrupted observation file. Default is: cleared.

Explicit File Transfer

Default is: cleared.

Check existence of OBS files before processing

By default this option is marked. **GeoGenius** checks for the existence of observation files at the location specified and stops processing of the

baseline or session, if the observation file is missing. **GeoGenius** does not find observation files, if you have deleted or moved them, or if you have moved the *.GGS project file to another computer. **Do not clear this option.**

Redisplay after processing of xx lines

Here you may define, when **GeoGenius** redraws the project during processing. If you want to limit the redrawing to once after the processing of all baselines, enter a number larger than the number of baselines in the project. (To view the number of baselines, choose the menu option File/Project Info, then open Page Objects of the Project Info window.) To check the results, it might be preferable to have the project redrawn after the processing of each baseline. Default is: 1 (= draw after processing of 1 baseline).

Reports:

Reports: Store Reports in Project File/Discard Reports

Here you may define, whether you want reports to be stored in the project file or whether they should be discarded. The radio buttons allow to toggle between the two options.

Default is: Store Reports in Project File.



If you discard the report, you will not get a report about a baseline after processing!

7.4.10 Page Advanced

The screenshot shows the 'Processing Options' dialog box with the 'Advanced' tab selected. The dialog is organized into several columns: Parameter, Processor, Times, GPS Sats, GLN Sats, Tropo, and Filter. The 'Advanced' column contains various settings for data processing, including noise levels, error limits, scaling factors, and update rates. A 'Back to Defaults' button is located at the bottom right.

Parameter	Processor	Times	GPS Sats	GLN Sats	Tropo	Filter
Maximum Ionospheric Noise	25	[m]	Maximum Ephemeris Error	1	[ppm]	
Maximum Position Sigma	25	[m]	Maximum Code Error	5	[m]	
Triple Diff Max. Outlier	0.25	[cyc]	Edit Multiplier	3.5		
Tropospheric Scaling	0	[%]	Ionospheric Scaling	1		
Position Output	0	[m]	Position Update Limit	1	[m]	
Widearea Parameters	1.2	[km]	0.3	[m]	100000	[sec]
Probability Limits	99.99	[%]	99.99	[%]	95	[%]
Minimum Shift	30	[dB]	30	[dB]		
Reference Control	30	[1/4]	3	[1/4]		
Minimum Ratio	Static: 1.00		Kinematic: 2			

☐ Ignore Code/Carrier Consistency Back to Defaults

Figure 7-27: Processing Options Advanced

The parameters of this page should be changed only by the experienced user, because changing settings of this page may cause unpredictable results. A warning message shows up, when you try to open this page.

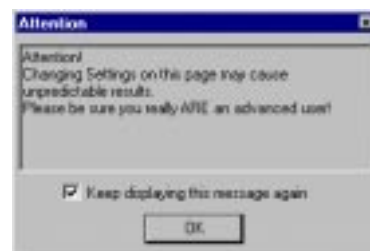


Figure 7-28: Warning

You may suppress the display of the warning in two ways:

- 1) Deselect the option **Keep displaying this message again**.
- 2) Choose the menu option **Options/Customize.../Messages** and deselect the option **Display Messages - Advanced Users Only**.

After you have clicked the button **OK**, the page **Advance** shows up and displays a number of parameters. A button **Back to Defaults** allows you to reset all parameters to their default values.

Maximum Ionospheric Noise

This parameter is defined in millimeters and gives the maximum allowed error in differential ionosphere. This relative value is used to enable/disable short-static ambiguity resolution based on dual-frequency carrier phase data. The ionospheric range value is derived from dual-frequency data for each satellite combination. The value is also used in kinematic positioning with dual-frequency receivers for identification of cycle slips. Default value is: 80 mm

Maximum Position Sigma

This gives the maximum coordinate error (sigma) in millimeters allowed in baseline processing. If this threshold is exceeded the program displays the baseline in red after processing. Default: 20 mm.

Triple Diff. Max. Outlier

This gives the maximum error in cycles allowed, before a cycle slip is identified in triple difference. Therefore, **GeoGenius** detects a cycle slip, if the error is larger than the value given here.

Default value is: 0,25 cyc

Tropospheric scaling:

Tropospheric scaling allows the computation of a scale factor for the tropospheric model. On baselines with large height differences the tropospheric model might not reflect the actual conditions in the troposphere and induce errors. These errors nearly exclusively influence the height component in baseline estimation. In order to eliminate the major part of the tropospheric residual errors, the software allows a definition of a scale factor for the tropospheric model.

The parameter defines that the software should expect an a priori residual error of the tropospheric model of x %. You may change the number depending on the individual guess on the tropospheric residual error. A value of 0 indicates that no tropospheric scaling should be performed. Default is: 0

Position Output

Reserved for future use

Maximum Ephemeris Error

In ambiguity resolution it is necessary to model the distance-dependent systematic errors on the residuals. This parameter allows you to define the ephemeris dependent influences. It defines the broadcast ephemeris scale error in ppm. In case of precise or predicted orbits **GeoGenius** automatically sets this parameter to zero.

Maximum Code Error

The maximum code error setting controls the data check in the DGPS and DGPS smooth processing modes. The value chosen defines a limit

for the RMS of the code measurements. If a computed epoch exceeds this value, the data is assumed bad quality. This results in the epoch to be rejected. These epochs are counted and occur in the line "Code Positioning/bad quality". The default value 5 m is a good compromise between accepting bad epochs and rejecting valid epochs. Nevertheless, in bad multipath environments it is possible to reduce the value, minimizing epochs with bigger positioning errors in DGPS, or to increase it to get a maximum of epochs computed.

Edit Multiplier

This factor defines the rejection limit for observational data. When processing triple differences all data with a residual larger than this multiplier times the RMS are rejected and identified as possible cycle slips. Default value is: 3.5

Ionospheric Scaling

In ambiguity resolution it is necessary to model the distance-dependent systematic errors on the residuals. This parameter allows you to define the ionosphere dependent influences. It describes the ionospheric scale error in ppm for a satellite with an elevation angle of 90° . Default value is typical: 0.1

Position Update Limit

If after processing the position of a point differs from the single point position for more than the limit set here, the respective point will not be respected as processed. Its coordinates will not be updated in the database. Default value is: 1m

Widelane Parameters

The kinematic processor uses a special technique called widelane filtering to get very short ambiguity fixing times. This algorithm can be controlled for every application. If you process extremely bad data (much multipath, etc.) with unsatisfactory results, you may cautiously increase these values.

The parameter `Lw` specifies the maximum error in the widelane approximation at 90° elevation in `Lw` cycles. Setting `L1` defines the maximum error in the `L1` estimate from `Lw` at 90° in `L1` cycles. The third widelane parameter value specifies the multipath correlation time in seconds and should not be changed!

Probability Limits:

GeoGenius performs several tests in order to investigate the ability to fix the ambiguities. A Fisher test checks the ratios of the variances with a default probability of 99.99% (first parameter). The second parameter defines the probability limit (Default: 99.99%) for the chi-square test on the regression analysis on the double difference float residuals. When rejected the residuals cannot sufficiently be represented by linear regression parameters. This satellite will then be ignored by the software.

A Chi-square test checks the a posteriori standard deviations by default with a probability of 95% (first parameter).

Minimum SNR

The software is sensitive to the signal to noise ratio of the satellite signals. The parameter line `Minimum SNR` is used to control the minimum signal to noise ratio. The parameter line gives the two minimum SNR values for `L1` and `L2` in dB. Signals with less power will be ignored. Please note that when data is read from RINEX, which allows

values for SNR from 0-9, this will result in values of 0db for the RINX value 0. RINEX values 1 ... 9 are linearly scaled to values of 30dB ... 50dB. Default values are 30 dB in both frequencies.

Reference Control

GeoGenius looks with a specific algorithm for the best reference satellite for the double difference generation. In principle the software looks for the satellite which has the largest minimum elevation angle during the specified processing time. **GeoGenius** generates a table of this elevation angle for the individual satellites. As a cutoff for the elevation angles we consider the number of loss of lock indicators for each satellite and the number of observations. The formula applied is:

$$\alpha_{corri} = \alpha_i - 100 * a * n_i^{lli} / n_i - 100 * b(1 - n_i) / n_{total}$$

with

- α_i minimum elevation angle to satellite i
- a factor to describe the loss of degrees per one percent due to loss of lock indicators in °/% (by default 30)
- b factor to describe the loss of degrees per percent due to the number of observations in °/% (by default 3)
- n_i number of single difference observations to satellite i
- n_{total} total number of single differences
- n_i^{lli} number of losses of lock to satellite i

The two changeable parameters are (in this order) factor a and factor b with the default values 30 (for factor a) and 3 (for factor b).

Minimum Ratio

The best ambiguity set found is compared to the second best. A quality criterion for the best ambiguity set is the ratio between the weighted residuals for this solution and the second best solution. This ratio

should be above a given value for **GeoGenius** to define the ambiguities as fixed and the baseline as accepted (green). If the ratio is below this value, results will not be accepted (yellow or red).

Default: 1.8 (static); 2.0 (kinematic)

Ignore Code/Carrier Consistency:

When analyzing the data, **GeoGenius** tests it for cycle slips using a consistency check for code and carrier. In case, your data are considerably corrupted or carrier data is not consistent with the code, you may toggle off the test. By default, the test should always be toggled on, i.e., **GeoGenius** should not ignore the consistency (control box: cleared).

Default: cleared.

7.5 Meteorological Data

The **GeoGenius** processors include a tropospheric model to respect the atmospheric influences on signal propagation for improving the processing results. Several tropospheric models describe the atmospheric conditions using the parameters temperature, pressure and humidity. The processing options allow you to choose the best fitting tropospheric model from a list. If no information on tropospheric conditions is available, **GeoGenius** uses default values for the three parameters (refer to section 7.4.5).

If, however, meteorological data exist for some or all points of your project, you may assign it to the point properties of each point. These values then prevail over the default values.

Activate the point for which meteorological information exists (right mouse button). From its context menu choose the item **Properties**. Within the Property: Point notebook, click the tab **Meteo**.

The screenshot shows a software window titled "Property: Point" with a close button in the top right corner. Inside the window, there are several tabs: "Point", "National", "Local", "XYZ", and "Geo". The "Meteo" tab is selected. Below the tabs, there are two main sections: "Meteorological Values" and "Measurement Height". In the "Meteorological Values" section, there are three rows: "Temp:" with a value of "293.0" and unit "K", "Press:" with a value of "1013.0" and unit "hPa", and "Hum:" with a value of "50.0" and unit "%". In the "Measurement Height" section, there is a row with a value of "0.0" and unit "[m]". Below this, there is a checkbox labeled "Use Point Height" which is currently unchecked. At the bottom of the dialog, there is an "Assign" button and a "Model" dropdown menu which is currently set to "Modified Hopfield (Fixed Values)".

Figure 7-29: Meteorological Information - Default Values

The page **Meteo** allows you to edit the current meteorological parameters. It also displays the currently selected tropospheric model in the inactive field **Model**. You can select another model only within the **Processing Options** notebook.

You may edit the following meteorological values:

Temperature:	Temp:	in [K]
Pressure:	Press.:	in [hPa]
Humidity:	Humid:	in [%]

You may add for each parameter information on the height in [m], in which the information was measured. Often, this will be the height of the point itself (do not mind a few meters difference!). In these cases, just check the box **Use Point Height**. If the box is checked, the three **Measurement Height** fields will be inactive and you can't edit them. **GeoGenius** will then respect the point's height information of the **SPP**.

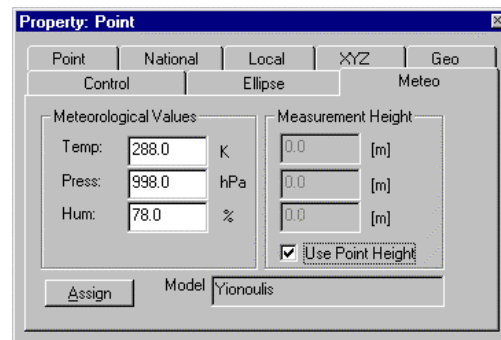


Figure 7-30: Meteorological Information - Edited Values, Use Point Height

Click the button **Assign** to assign the edited values to the point.

7.6 Processing Different Frequencies

GeoGenius is able to process different carrier phase frequencies and frequency combinations.

By default, the baseline processor calculates up to eleven different results depending on the processing mode and the available data, then it automatically selects the one with the best statistics for graphical display.

Float Solutions, Fixed Solutions and Triple Difference/L1 are different methods used to calculate the baseline vectors. For the Float and Fixed solutions you can also select between different frequencies (L1, L2, Lw, Ln and Lc).

L1	carrier phase data with f=1575.42 MHz
L2	carrier phase data with f=1227.60 MHz
Lw = L1-L2	phase combination with f=347.82 MHz
Ln = L1+L2	phase combination with f=2803.02 MHz
Lc	ionosphere free phase combination

The Processing Settings/Options page Parameters includes another option for wavelength activation, one which depends on the baseline length ($Lw/Ln > [x] \text{ km}$). If you have chosen this option, **GeoGenius** processes L1 data as long as the baseline length is less than the distance specified. If the baseline is longer than the given value, **GeoGenius** automatically switches to a special algorithm to fix Lc ambiguities.

The default setting is L1/L2, where the search criteria are based on both the L1 and the L2 carrier data to find the correct ambiguity set. This is best for short baseline lengths.

7.7 Start Process!

To start the **processing of a single baseline** highlight the respective line and

- Open its context menu (click right mouse button) and click **Process**, or
- choose the menu item **Process/Process Line**, or
- click the respective toolbar button (toolbar **Process**).



If you want **all enabled baselines and sessions** to be processed,

- choose **Process/Process Project**, or
- click the respective toolbar button (toolbar **Process**).



Both options start a processor. All activated baselines or kinematic sets of data are processed automatically. During processing, the relevant baseline is indicated. A progress indicator informs on the progress of all of the chosen solutions and of the final ambiguity search.

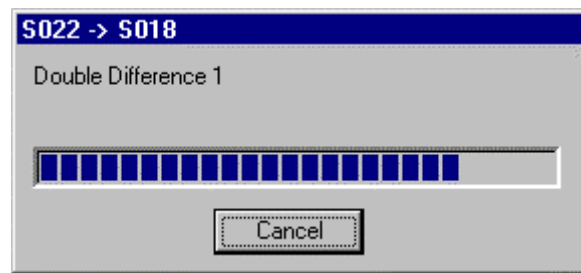


Figure 7-31: Processing Progress Indicator

The output window will display messages and errors generated by the processor. The number of lines to be processed, then each line in progress is indicated by its start and end point and the number of enabled sessions.

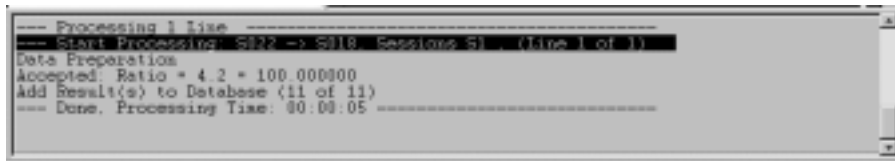


Figure 7-32: Processing - Output Window

The message line Add Result(s) to Database shows the number of results passing through the result filter, which are added to the database (see Parameter Settings...).

A baseline report for each processed baseline and several project reports are generated. A final message closes processing and displays the processing time.

Please note that processing, like many other time consuming operations in **GeoGenius**, runs in parallel. It is, therefore, possible to continue work on the project while it processes. Some operations, however, are blocked during processing.

7.8 The Processing Wizard

What, if you cannot process a baseline or your project at all?

In many cases, the **GeoGenius** Processing Wizard will help you to detect the error causing the problem. The Wizard keeps an eye on your database and detects missing items, actions or connections.

To activate the Processing Wizard

- choose the menu option **Process/Process Wizard**, or
- click the respective button of the toolbar **Processing**.



Then, the Processing Wizard window shows up. It will display a message and suggest a possible solution for the problem. *Figure 7-33* is an example for the Wizard's advice, if no ephemeris data are inserted into the project.

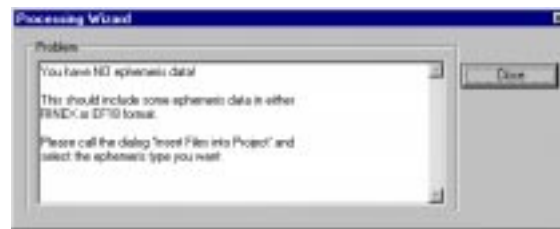


Figure 7-33: Processing Wizard

Similarly, the Wizard will detect, if no point was fixed, if observation data are missing at all or if you have selected baselines for processing which cannot be reached via a closed path from any reference point.

Note that the Processing Wizard may be very useful before processing, but does in no way interpret processing results.

7.9 Batch Processing

GeoGenius offers you an additional option allowing you to automatically start the processing of projects and/or to process several projects one after the other in one step.

Prepare for the project(s) for processing. Then choose the option **Batch Process...** of the pull-down menu **Process**. The dialog **Batch Processing** pops up.

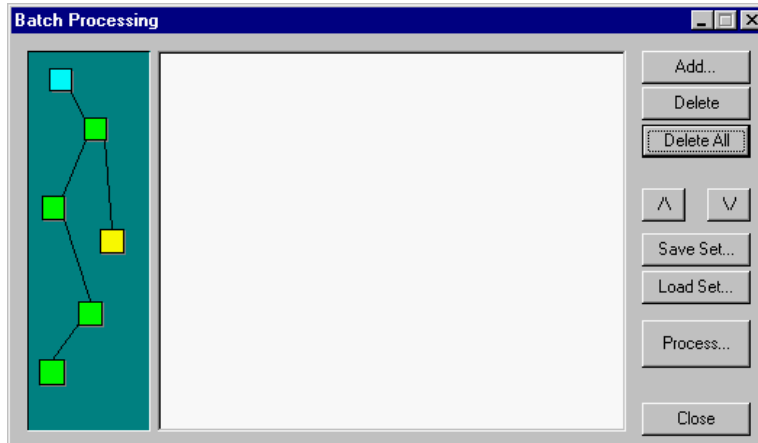


Figure 7-34: Dialog **Batch Processing**

The dialog **Batch Processing** allows you to

- set the project files for the batch processing,
- save the setting in a batch file or load a batch file,
- start the batch processing in the order of the files defined in the batch file.

7.9.1 Setting the Project Files

To add new project files to the batch click the button **Add...** . A Standard Windows file Dialog pops up displaying the predefined file mask * . GGS used for project files.

Activate one or several files and add them via the button **Open** to the batch list. These may be now automatically processed in their order within the list.

To remove a file from the list activate it and click the button **Delete**. This file will be immediately removed from the batch list (of course, it will not be deleted from the disk!).

To remove all files from the batch list click **Delete All**.

7.9.2 Define the Order of Files

Two arrow buttons allow you to define the order of project files for processing. With a click of the lefthand-side arrow-button (move up) you move the activated file one step up (it will be processed first). A click with the righthand-side arrow-button (move down) moves the activated file one step down (it will be processed later).

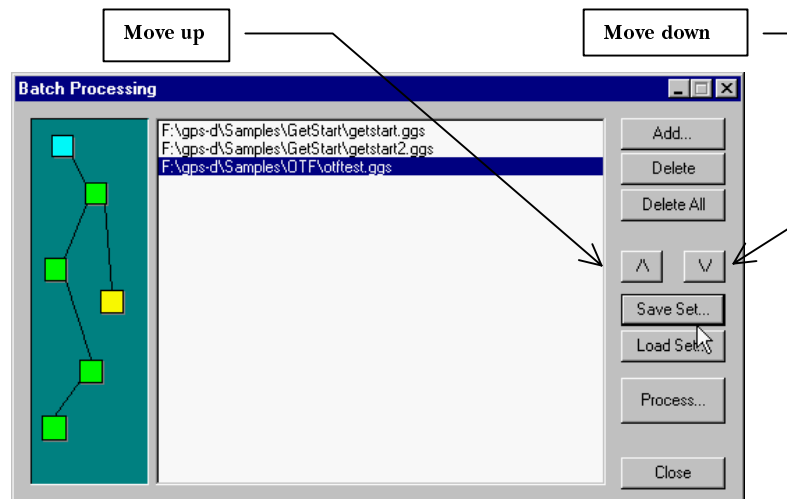


Figure 7-35: Files Selected, Moving File

7.9.3 Save and Load a Set

You may save a set of project files to be used later on for analysis/processing.

Add the project files and define their order. Click the button **Save Set...**. A Standard Windows File Dialog pops up and allows you to enter name and path for the batch file. It displays a default file name and the default file extension *.GGB.

To load a set of files for batch processing click the button **Load Set...**. **GeoGenius** opens the Standard Windows File Dialog using the file mask *.GGB. Choose the batch set and open it. You now may reedit the set or start processing.

7.9.4 Start and Close the Batch Processing

Start the batch processing by clicking the button **Process...** . **GeoGenius** now opens the first project file of the set and automatically starts to process all baselines using the parameter settings of the project. Having finished the first project, **GeoGenius** automatically starts processing the second, and so on. Output Window Messages are displayed following each other and you may write them afterwards in a single LOG file.

Close closes the dialog Batch Processing at any time. When running the batch process the button is disabled. However, you may cancel the processing of a single project as usual via the button **Cancel** of its progress bar.

8. Static Processing

GeoGenius was designed for fully automatic baseline calculation, achieving relative accuracies of 1ppm and better depending on ephemeris accuracy. After activating the desired baselines and setting parameters you can start the baseline processing by simply clicking the Process option.

This chapter provides information on the technical details of baseline processing and on the different type of results that you will receive.

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8.1 Technical Details

The Static Baseline Estimator performs carrier phase data reduction in three steps:

1) Triple difference solution and cycle slip fixing

Triple difference processing gives a first estimate of the baseline components and allows efficient and fast cycle slip fixing. The coordinates derived from this solution serve as Taylor linearization points in the following steps. Normally the selected frequency is analyzed. If dual-frequency data is available and L1 + L2 is selected, the software will use the second frequency for improved short-static baseline reduction. Triple differencing is then performed with the L1 frequency, but both, the L1 and L2 are analyzed for cycle slips.

If ionosphere free Lc is selected, the triple difference step will also analyze carrier data in both frequencies L1 and L2. Triple difference solutions are iterated until the solution converges. The maximum number of iterations allowed is ten.

11. Triple Difference Solution

Iteration 1 : Position shifts DX DY DZ [m] = 90.296 -53.433 81.168

Iteration 2 : Position shifts DX DY DZ [m] = 0.106 -0.014 0.102

Triple Difference Baseline Components

Freq	dX [m]	dY [m]	dZ [m]	sX [mm]	sY [mm]	sZ [mm]	rms [mm]
L1	249.0825	-1175.4248	-226.2653	159.8	188.5	112.2	6.2

Figure 8-1: Baseline Report: Triple Difference Solution

2) Double difference float solution

The double difference solution allows us to process correlated double difference carrier phase data. Cycle slips which were not recovered by the triple difference step will generate additional satellite arcs. This step derives baseline components and float phase ambiguities. With dual-frequency data and when L1 + L2 or Lw/Lc processing has been selected, additional baseline solutions will be provided for L2, Lw, Lc and Ln automatically.

12. Double Difference Solution**Double Difference Float Baseline Components**

Freq	dX [m]	dY [m]	dZ [m]	sX [mm]	sY [mm]	sZ [mm]	rms [mm]
L1	249.1087	-1175.3892	-226.2696	2.5	3.9	1.9	8.7
L2	249.1021	-1175.3756	-226.2664	2.7	4.2	2.1	9.3
Lw	249.1321	-1175.4368	-226.2807	7.7	12.0	6.0	26.8
Ln	249.1058	-1175.3832	-226.2681	2.3	3.6	1.8	8.1
Lc	249.1189	-1175.4102	-226.2745	4.9	7.6	3.8	17.0

Figure 8-2: Baseline Report: Double Difference Float Solutions**3) Double difference fixed solution**

In order to derive optimum phase ambiguities from the float solution a time optimized search technique is applied looking in a search window, which is defined on the 20 sigma value of the determined float ambiguity, for the solution with the smallest sum of squares residual error. The value 20 is used as a factor to guarantee that the correct solution is within the search area. Statistical testing is used to verify the correctness of the ambiguity resolution. First a Fisher test is performed with the ratios of the variances of the second to the best fitting solution. In this case a reliability of 99.99% is requested by default. Then a Chi-square test is performed on the a posteriori variance of the residu-

als with a default of a 95% minimum probability. You may change these values in the **Settings.../Advanced** menu, however, we do not recommend changes.

The ability for a fixed ambiguity solution is also limited by the required minimum ratio of variances for the Fisher test. **GeoGenius** uses by default a value of 1.8. You may also change the minimum ratio in the page **Advanced** of the **Processing Options**.

With Lw/Lc processing, the software will first determine the Lw wide lane ambiguity and will afterwards fix the Ln narrow lane ambiguity by processing the ionospheric free carrier observable Lc. After a successful fix of Ln the software will output L1, L2, Lw, Ln and Lc fixed solutions.

15. Ambiguity Resolution: Results for L1

Double Difference Fixed Baseline Components

Freq	dX [m]	dY [m]	dZ [m]	sX [mm]	sY [mm]	sZ [mm]	rms [mm]
L1	249.0957	-1175.3901	-226.2686	1.0	0.5	1.2	11.4
L2	249.1022	-1175.3861	-226.2657	1.1	0.5	1.3	12.3
Lw	249.0730	-1175.4041	-226.2787	2.5	1.1	3.0	28.0
Ln	249.0986	-1175.3883	-226.2673	1.0	0.4	1.2	11.0
Lc	249.0858	-1175.3962	-226.2730	1.6	0.7	2.0	18.6

Figure 8-3: Baseline Report: Double Difference Fixed Solutions

8.2 Results

After processing a baseline **GeoGenius** uses the quality of the best (= lowest standard error) GPS baseline estimation solution within the graphical environment.

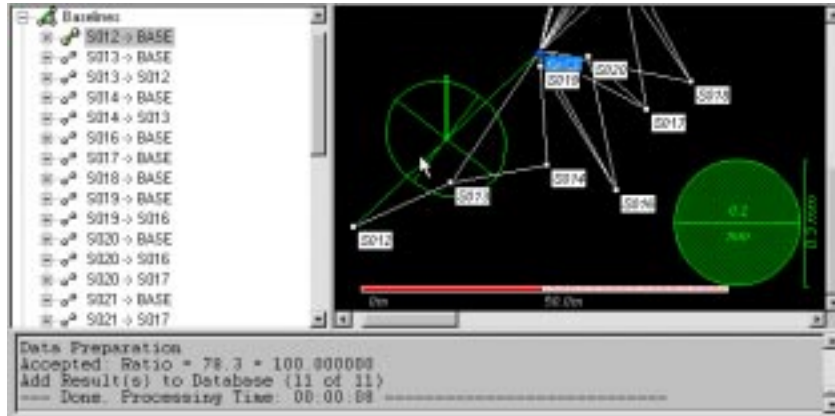


Figure 8-4: Processed Baseline

An **error ellipse** is drawn together with a reference circle on the lower right side. This reference circle gives an indication of the numerical values of the ellipse's major and minor axes. An **indication based on traffic light colors** is used for the baseline itself.

Numerical Results are given for each baseline in the Properties window and as report output.

A lot of different solutions may be displayed since

- ☒ the baseline processor stores triple difference, double difference, float and fixed solutions,
- ☒ with dual-frequency data, different frequency solutions are generated,
- ☒ the baseline solution might have been derived from different sessions.

Please see below sections for more details.

8.2.1 The Traffic Light Quality Indicator

An indication based on traffic light colors is used for the quality of the best solution: green denotes a baseline that was successfully processed with fixed integers, a baseline that is shown in yellow has also been successfully processed although the integer ambiguities could not be fixed. Finally, a baseline that is shown in red after processing tells that the baseline reduction has resulted in a solution which exceeds a pre-given standard deviation margin. This baseline needs further analysis. A blue baseline indicates that only a triple difference solution was computed.

green:	ambiguities are fixed
yellow	ambiguities are not fixed, standard deviation less than "x" millimeters
red:	ambiguities are not fixed, standard deviation larger than "x" millimeters
blue:	Only triple difference solution available

"x" is the number given as "Maximum Position Sigma" in the Processing Options window, page Advanced. (Default x=20mm, see chapter 7.4)



Red baselines only indicate that the computed standard error for the baseline exceeds the maximum position sigma (by default 20mm). Very long baselines may often be indicated with red!

GeoGenius applies a color quality indicator for a baseline symbol within the navigator as well. "Green" baselines will be indicated by green baseline symbols , "Yellow" and "Red" baselines will both be marked with red baseline icons .

Within the project plot, you may change the colors or line widths for the result indicators. We do not recommend you to change colors. This manual and **GeoGenius** will use the names of the traffic light colors for indicating the quality. Using different colors for display will lead to confusion.

8.2.2 The Error Ellipses

Quality values of the best solution are given more exactly in the form of error ellipses together with a reference circle on the lower right side. The error ellipse represents the standard deviations in North, East and Height direction.

- A major axis of the ellipse
- B minor axis of the ellipse

- a rotation angle of the ellipse with respect to North. An angle of 0° represents a major axis in North direction, 90° represents the major axis in East direction.
- H height vector

The reference circle indicates the maximum derived standard deviation in North or East as diameter of the circle. A reference bar right to it indicates the maximum standard deviation in height.

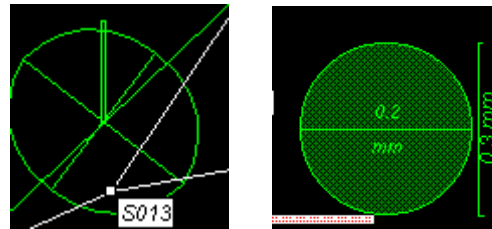


Figure 8-5: Error Ellipse and Reference

You may disable the display of error ellipses. The toolbar **Ellipses** offers various options to turn on/off the display of all ellipses or of special selections. To turn on/off the display of the reference circle or reference bar use the toolbar **Display**. (See Appendix A)



Figure 8-6: Toolbar Ellipses

8.2.3 Numerical Results

You may review postprocessing results for each baseline.

To review the **best solution** activate the baseline in the project plot or the navigator and choose item **Properties** of the context menu.

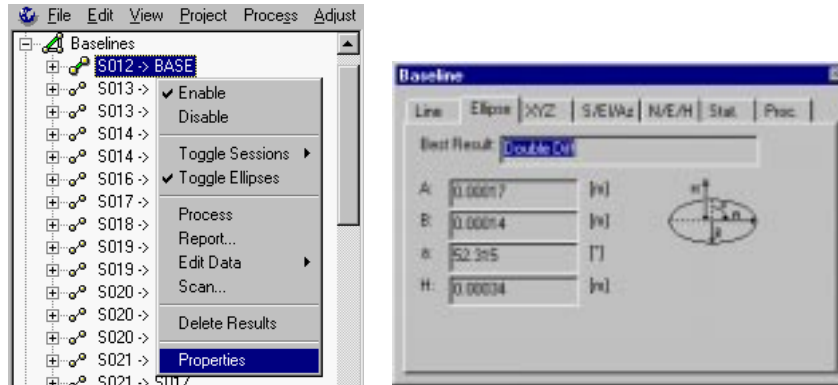


Figure 8-7: Baseline Properties Selection - Page Ellipse

Page Ellipse indicates the currently best solution: The name of the respective processor shows up on top of the page, followed by the standard deviation values displayed as error ellipse:

- A major axis
- B minor axis
- a rotation angle of the ellipse with respect to North
- H height vector

To review postprocessing **results of each singular solution** of a baseline activate the respective baseline:

- With the navigator, activate the baseline. In addition to the already known tree items “Start Point”, “End Point”, “SessionA” .. “SessionZ”, one or several containers of the following form appear after processing.

[X] Results for [S#]

where [X] stands for a number, typically 11, and [S#] stands for the session combination used during processing, e.g., S1 for the first session.

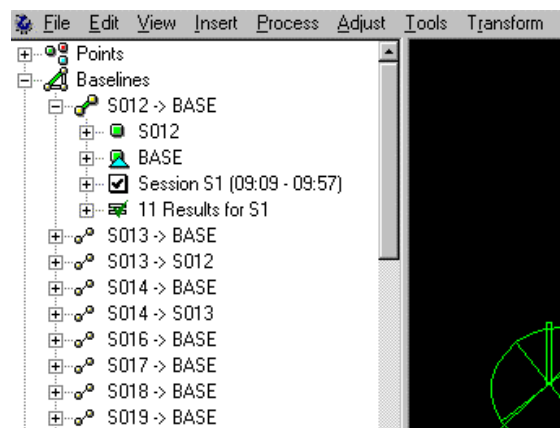


Figure 8-8: Results Container

A double-click on the item or a click on the + symbol opens a list of all estimated solutions (up to 11).

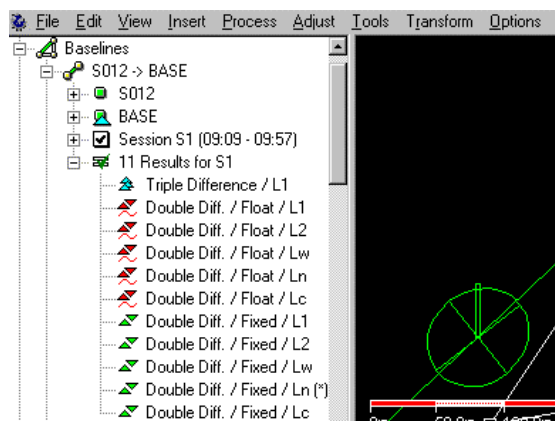


Figure 8-9: Solutions

Select the solution you want to examine and activate the context menu with the right mouse button. The item **Properties** opens the notebook **Result** for this baseline and solution.

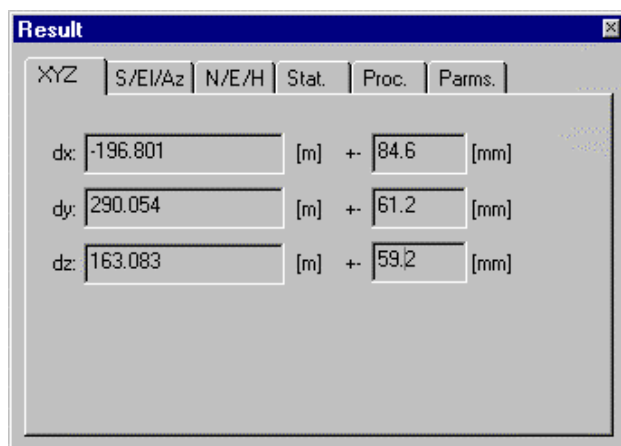


Figure 8-10: Notebook Result

The Result window consists of six pages:

XYZ	displays dx, dy, dz of the estimated vector in Cartesian geocentric WGS84 coordinates in meters with associated standard errors in mm.
S/El/Az	displays the slope distance S of the estimated vector [selected length unit], elevation El and azimuth Az [selected angle unit] in the selected or predefined local coordinate system with associated standard errors [smallest unit, e.g., mm/mi or " (arcseconds)].
N/E/H	displays North, East and height values of the estimated vector in the selected or predefined national grid system [selected length unit] with associated standard errors [smallest unit, e.g., mm/mi].
Stat.	displays additional solution information and statistics: ◊ Solution type of solution (Triple Difference, Double Difference/Float or Double Difference/Fixed) ◊ Ratio value of the ratio test ◊ Frequency the frequency or frequency combination used for process (L1, L2, Lw, Lc, Ln) ◊ RMS root mean square of the carrier phases in mm ◊ Sats Number of satellites used during processing ◊ RDOP Relative Dilution of Precision Range during the observation ◊ PDOP Position Dilution of Precision ◊ Time span: Time span of observation used for processing. The current time offset to GPS time is displayed beneath.

	◇ Ephemeris	Type of ephemeris data (Broadcast, Precise)
Proc.		displays the type of processor (Static, Kinematic, On-The-Fly, Stop&Go), the start and end time of processing in local time and the duration of processing in seconds.
Parms.		displays important processing parameters, such as the processing interval, the elevation cutoff used for processing and the reference satellite PRN number or indicates automatic reference satellite selection (Automatic).

8.2.4 Baseline Report

Solutions and positions are stored in the project file in addition to the coordinate information of fixed points.

GeoGenius's new **HyperPage** text presentation tool allows you to output all results and processing information in HTML format and in easy-to-interpret manner. **HyperPage** offers the full functionality of the HTML language.

You may build additional highly specialized macros fitting exactly your needs and extent the functionality by dynamically loading DLLs. The **HyperPage User's Guide** and the **HyperPage Macro Programming Guide** offer detailed information on this tool.

GeoGenius generates a report for each baseline. You have several possibilities to start **HyperPage** and to load the report referring to a baseline:

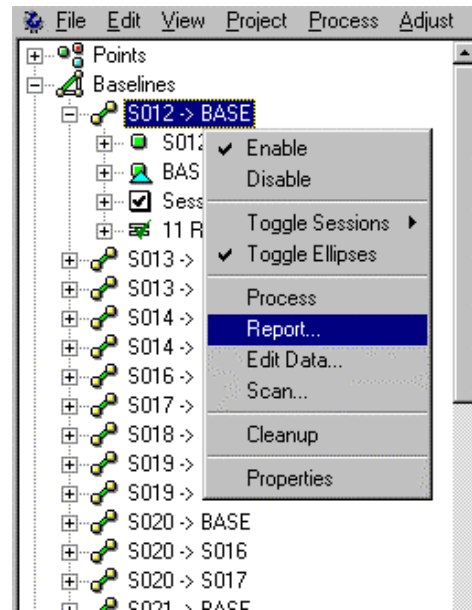


Figure 8-11: Choose Report...

With the project plot, activate the baseline, open the context menu with a click of the right mouse button and choose the menu item **Report...**

With the navigator, either activate the baseline identifier or the Results container. In both cases, open the context menu with a click of the right mouse button and choose the menu item **Report...**

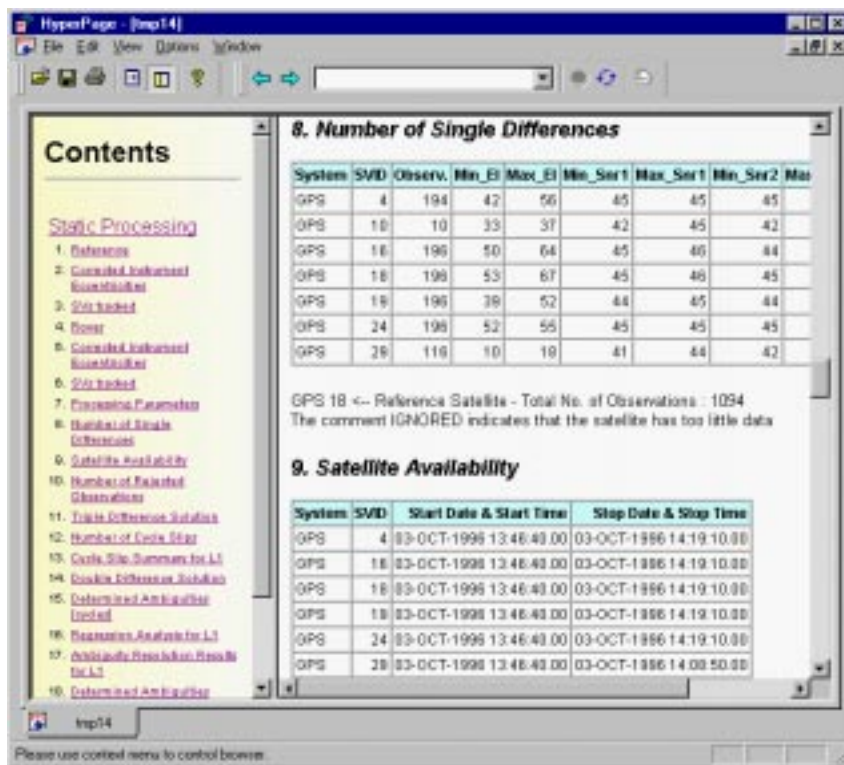


Figure 8-12: Baseline Report

This report includes the observation file information on receivers and observed satellites and gives detailed lists on all solutions and ambiguity resolution results. Report settings allow you to individually enable and disable sections of the report or other options for display. **HyperPage** offers a lot of editing and zooming capabilities and allows you to print the report. To generate a different kind of report please use the MacroStudio. You will find an annotated example report file in Appendix F.

HyperPage allows you to select information of the default baseline report. Choose the menu item **Report Settings...** of the **HyperPage** main menu **Options**. The dialog **Options** pops up and allows you to select and de-select sections of the report. E.g., if you clear the checkbox **Detailed Point Information**, **HyperPage** will re-display the baseline report without the information of the first 6 sections.

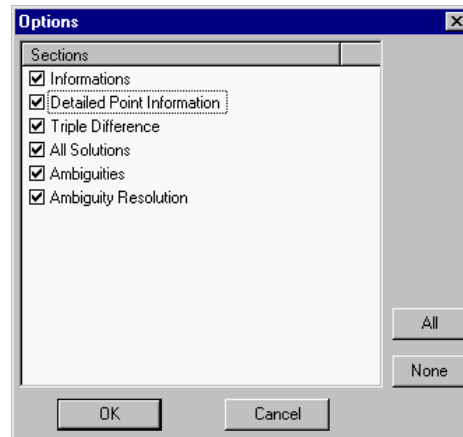


Figure 8-13: Select Report Sections

8.2.5 Project Reports

Project reports are summaries of the processing results in the current project. They are based on the results stored in the project file. Reports are created in a formatted and easy-to-interpret manner using the **GeoGenius** text-editing tool **HyperPage**.

To generate a report choose the menu option **Project/Reports....**
The Project Report dialog pops up allowing you to choose one of the implemented report formats.

The box Available Reports lists the reports you may choose from.
(Baseline reports are additionally available from the baseline context menu, adjustment reports from the **Adjust** pull-down menu, item **Report....**).

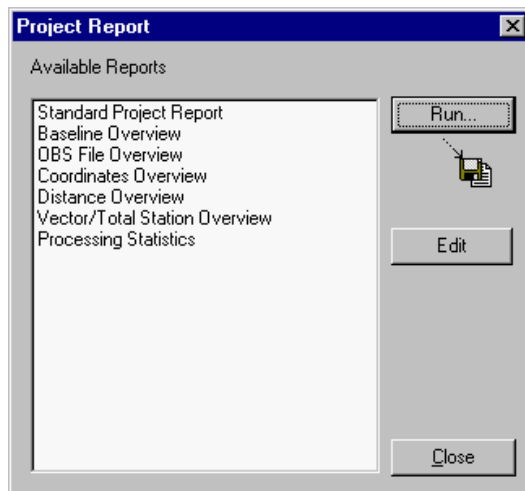


Figure 8-14: Project Report Dialog

Depending on your task and on the object you want information about, several types of reports (“report formats”) are available.

You may build additional high specialized macros fitting exactly your needs and extent the functionality by dynamically loading DLLs (report format converters). The **HyperPage User's Guide** and the **HyperPage Programming Guide** offer detailed information on this tool. Additionally, you may edit a current report format, using the tool MacroStudio. Just activate the report and click the button **Edit**.

You may introduce an unlimited number of report format converters to **GeoGenius** in an easy-to-perform manner (see Appendix A.6).

Note, that the list displayed in *Figure 5-70* may differ from yours, depending on the software version and your own customizing.

GeoGenius starts the generation of a report, if you highlight one of the options of the box Available Reports and click the button **Run...**

By default, the following four reports are available after baseline processing. They will briefly be described here.

Standard Project Report

It consists of two main parts, the project summary (Summary) and a processing summary for each baseline.

The Summary part lists the path and file name of the current project file (*.GG5), the user name and company, the numbers of baselines (baselines in the project, baselines processed) and the minimum ratio as defined in the Processing Options, page Advanced (refer to chapter 7.4). If you have added comments to your project, these will be listed here, too.

For each processed baseline, one block of baseline information exists.

Baseline	Reference: 2202	2202
Baseline / 2202	Baseline 2202 / Simple	Baseline 2202 / Simple
Baseline / 2202 / Height [m]	Default / Compact with 0.1 / 1.057	Default / Compact / 1.057
Baseline Vector [m] = [m]	[1.010] x [0.010] / [1.010] x [0.010] / [1.010] x [0.010] / [1.010] x [0.010]	
Time/Space	1000/1000 0.00 / 1000/1000 0.00 / Time/Space: 1000/1000	
Time Information	0.00/1000 0.00 / 0.00/1000 0.00 / Processing Interval: 0.00 / Current Space: 1000	
Ratio: 0.00 / 0.00	0.00/1000 0.00 / 0.00/1000 0.00 / Number of Baselines: 1000	

Figure 8-15: Standard Project Report - Baseline Summary

The first two lines deal with the receivers and antennas used for both stations. The third line gives the processing results as baseline vectors of the best solution and indicates the best solution, followed by two time information lines. The last line lists some important variables (Ratio, PDOP, RDOP, RMS, Number of Satellites) and already indicates by its color the quality of the processing results:

- green:** ratio OK, i.e., better than the minimum ratio,
- red** ratio worse than the minimum ratio as given in the summary part.

Baseline Overview

This report gives a visualized overview over the time spans covered by the baselines in the project. A summary part lists the path and file name of the project file, the baselines included and the baselines processed and the start and end times of the project. The following bar chart displays the time span that each single baseline covers.

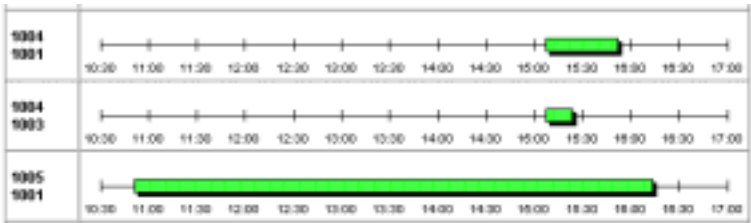


Figure 8-16: Baseline Overview

OBS File Overview

The Observation File Overview is very similar to the Baseline Overview. It visualizes the time spans covered by each observation file.

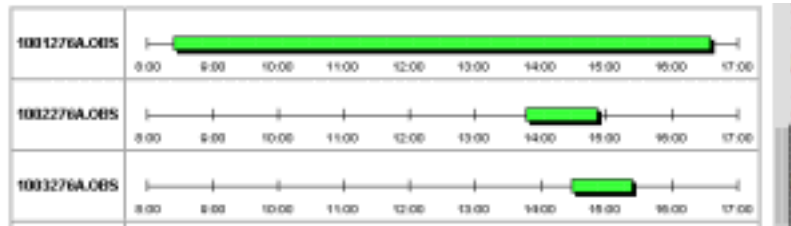


Figure 8-17: OBS File Overview

Coordinate Overview

The Coordinate Overview is one of the most important project reports. Here you find for any point of the project each single coordinate. First, a summary informs you on the availability and adjustment of coordinates (Table Point Information). Then, for all points the most recently stored coordinate sets follow: in Cartesian WGS84 coordinates, as geographical coordinates, and as plane coordinates in the chosen National System and in a pre-defined local System. Last, known control coordinates in the chosen coordinate system (national or Local Grid) follow. Choose the menu option Options/Report Settings... to toggle sections of the report.

Contents Coordinate Overview 1. Point Information 2. WGS84 - Cartesian Geocentric Coordinates 3. WGS84 - Geographical Coordinates 4. National Grid Coordinates 5. Local Grid Coordinates 6. National/Local Grid Control Coordinates		1. Point Information						
		Pointnumber	Pointcode	Pointinfo	Fix	Adj	Loc	CI
		1001	BAS6	BAS6 STATION	Yes	No	No	No
		1002	8001	PM	No	No	No	No
		1003	PM14	PM14	No	No	No	No
		1004	8025	PM	No	No	No	No
		1005	8033	PM	No	No	No	No
		1006	8038	PM38	No	No	No	No

2. WGS84 - Cartesian Geocentric Coordinates			
Pointnumber	X(m)	Y(m)	Z(m)
1001	3802184.319	-154605.886	5025977.859
1002	3802433.409	-155781.378	5025751.569
1003	3802330.875	-154612.824	5025886.500
1004	3801987.828	-154340.862	5026136.515
1005	3801508.843	-154473.383	5026504.814
1006	3801223.838	-154801.857	5026732.334

Figure 8-18: Coordinate Overview

Distance Overview

Besides of the usual summary on the most important project data, this report contains the distances between points as true distance, as grid distance (position of the rover point reduced to the height of the reference point) or as grid horizontal (position of start and end point reduced to mean sea level).

Reference	Rover	True Distance [m]	Grid Distance [m]	Grid Horizontal [m]
1002	1001	1222.620	1222.132	1222.131
1003	1001	183.522	183.449	183.446
1003	1002	1179.525	1179.054	1179.054
1004	1001	366.104	365.957	365.957
1004	1003	513.319	513.114	513.112
1005	1001	866.971	866.624	866.623
1005	1001	866.971	866.624	866.623
1005	1004	618.710	618.463	618.458
1006	1001	1256.436	1255.933	1255.801
1006	1002	1788.767	1788.050	1787.972
1006	1005	561.957	561.732	561.490

Figure 8-19: Distance Overview

Vector/Total Station Data

Besides the usual summary this overview contains the list of all vectors (i.e., the best processing solution) and of the total station measurements. These values will be respected for the network adjustment. If the report does not contain data of one of these types, the respective table will not be presented within the report.

Contents

Vector Overview

- 1. Static Vector(s)
- 2. Total Station Measurement(s)

1. Static Vector(s)

Reference	Rover	dX [m]	dY [m]	dZ [m]
42	P0810062	25.942 ± 0.001	47.951 ± 0.008	-51.824 ± 0.001
42	P0820062	75.595 ± 0.001	87.339 ± 0.008	-97.786 ± 0.001
42	P0830062	129.948 ± 0.001	78.777 ± 0.008	-148.023 ± 0.001
42	P0850062	74.909 ± 0.001	152.710 ± 0.008	-114.572 ± 0.001

2. Total Station Measurement(s)

Reference	Rover	Hor [°]	Vert [°]	Dist [m]	Sl [m]	Sh [m]
P0810062	P0830062	0.000	28.7118	144.738	1.750	1.750
P0810062	10	183.8294	68.3822	59.963	1.750	1.750
P0810062	11	249.7549	91.3890	39.245	1.750	1.750
P0810062	12	288.1516	96.1111	80.223	1.750	1.750
P0810062	42	148.9256	77.7854	74.358	1.750	1.750

Figure 8-20: Vector/Total Station Overview

Processing Statistics

The statistical report also gives a short summary on the most important project data and additionally visualizes the ratio of baselines processed green to those processed worse (yellow or red) as a pie chart.



Figure 8-21: Processing Statistics

8.3 Export Results

You may export all results to files. Chapter 5.6 describes in detail, how to export your results. With results from static processing, you will be most interested in the sections describing how to:

- export statically derived data (5.6.1)
- export to RINEX (5.6.5)
- export the output window information (5.6.6)
- export Reports (5.6.7)

8.4 Delete Results

You may delete processing (and, of course, adjustment) results for one, several or all baselines or kinematic sets from the project file.

To delete the processing results of a single baseline activate the baseline, open the context menu with the right mouse-button and choose the menu item **Delete Results**. All solutions and ambiguity search results for this baseline will be removed. You cannot review results anymore and color quality indicators disappear.

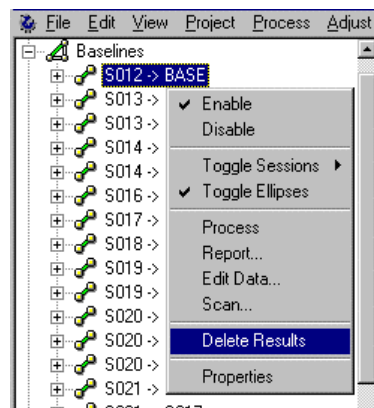


Figure 8-22: Delete Result of 1 Baseline

To delete the processing results of several baselines or of the whole project, choose the menu item **Process/Delete Results...** from the menu or via the corresponding toolbar button. The Delete Results dialog opens and allows you to choose a selection of points or baselines for which results shall be removed.



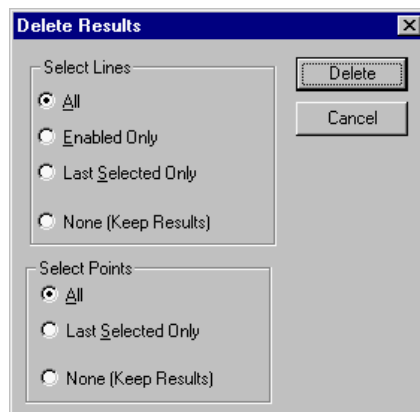


Figure 8-23: Delete Results Dialog

With respect to lines, you may clean-up the project from results of

- All lines (All) (Default)
- all enabled baselines (Enabled Only)
- the last chosen baseline (Last Selected Only)
- no line (None - Keep Results)

With respect to Points, you may clean-up the project from adjustment results of

- All points (All) (Default)
- the last chosen point (Last Selected Only)
- or no point (None - Keep Results)

Press **Delete** to remove all results, **Cancel** leaves the Cleanup Results window without changes and deletion.

9. Kinematic Processing

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9.1 Introduction

Based on a static initialization, the software is able to determine the coordinates of a moving receiver. The kinematic initialization can be done via a static observation period to determine the ambiguities or via coordinate input. The program will determine the coordinates of the receiver even if the ambiguities cannot be fixed since the software uses both code and carrier data. If cycle slips are found the software will try to determine the cycle slip values and correct them. In each case, the processing is straight-forward and the user will get receiver positions provided that 4 satellites are continuously tracked.

GeoGenius supports DGPS (Differential GPS) positioning with pseudoranges for moving receivers. **GeoGenius** also offers the opportunity to smooth the code observations with the phase measurements. Ambiguities can be derived by on-the-fly (OTF) techniques for ambiguity resolution without any static initialization.

Stop&Go processing combines the advantages of Static and Kinematic survey techniques. While getting the productivity of Kinematic, it gives the accuracy of Static at any selected points. GIS positioning is very similar to the Stop&Go surveying. However, the demands on the position accuracies are less by far than regarding the classical Stop&Go application.

The kinematic processor performs carrier phase reduction in two steps:

1) Double difference float solution

The double difference solution allows you to process correlated double difference carrier phase data. Cycle slips will generate satellite arcs. This step derives baseline components and float phase ambiguities.

2) Double difference fixed solution

In order to derive optimum phase ambiguities from the float solution a time optimized search technique is applied looking in a search window, which is defined on the 20 sigma value of the determined float ambiguity, for the solution with the smallest sum of squares residual error. The value 20 is used as a factor to guarantee that the correct solution is within the search area.

Statistical testing is used to verify the correctness of the ambiguity resolution. First a Fisher test is performed with the ratios of the variances of the second to the best fitting solution. In this case a reliability of 99.99% is requested by default. Second a Chi-square test is performed on the a posteriori variance of the residuals with a default of a 95% minimum probability. You may change these values in the **Process/Settings.../Advanced** menu, however, we do not recommend changes.

Satellite based positioning and navigation allow different positioning modes, such as DGPS, Stop&Go, or OTF. In the following sections the different processing modes will be described in detail.

9.2 Data in Kinematic Processing

After insertion of kinematic data, the **navigator** will offer the additional feature Kinematics. The container Kinematics then contains all kinematic lines, which are defined by the reference and the rover observation files with overlapping time spans. The Points container then contains the reference station and the rover. The rover is identified by the name derived from the observation file header and an appendix (**File**) that identifies the moving receiver.



With unprocessed data, the **project plot** displays a static baseline between reference and header position of the kinematic file. The unprocessed rover data may result in a path with almost no resemblance to the real trajectory, because just the navigation solution, if present in the rover file, is displayed on the screen.

With Stop&Go data, the plot will show the position of the rover derived from the observation file header information, initialization points, normal points, VSFB initializations and the rover's path (trajectory).

Triangles are used to show control points, i.e., points with a known position that can be used for initialization and a quality check. Typically, the reference station is used as control point.

You can change the baseline components with respect to the reference station, the instrument eccentricities and point number. These are very useful features to correct values entered incorrectly in the field.

To exclude a point from data processing you may delete it in the navigator using the keyboard button **Del**.



Figure 9-1: Kinematic Data

After processing, you may compare several important data of the rover's trajectory. Double-click (left mouse button) the rover file (e.g., in the Kinematics container), click the item **Trajectory** (right mouse button) and choose its context menu item **Graphics...**. The Graph Tool pops up. By default, it displays the graph *Heights*. Activating the checkboxes for other curves, you may compare several values for the trajectory.

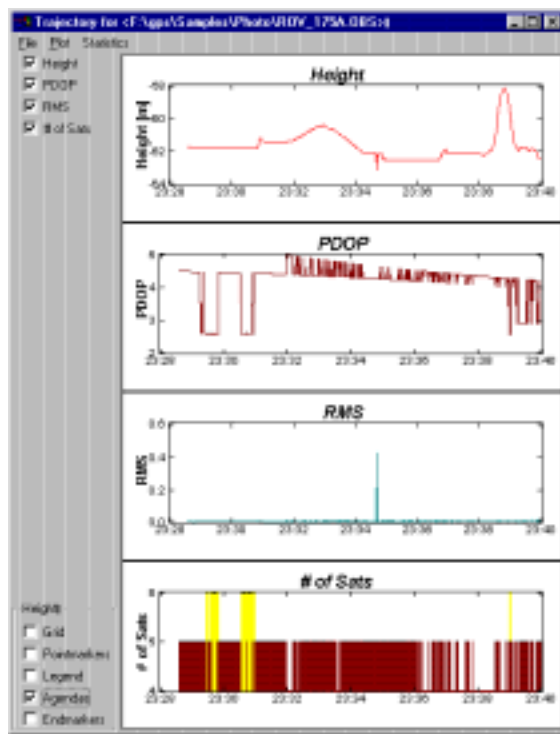


Figure 9-2: Data Curves for Trajectory

Four curves are available: The curve **Height** displays, by default, the ellipsoidal heights of the kinematic survey. With unprocessed data, it displays the heights of the navigation solution, after processing the height values are updated. The curves **PDOP**, **RMS** and **# of Sats** only display values after processing of the project.

You will find a full description of the Graph Tool in chapter 14.13.

9.3 DGPS, Smoothed DGPS and Super Smoothed DGPS Positioning

9.3.1 Basics

DGPS (and Smoothed DGPS or Super Smoothed DGPS) positioning is a quick and robust method for obtaining differential GPS positions with meter level accuracy. There is no need for any initializations. Even the shortest satellite tracking intervals are sufficient for positioning. For each single epoch of data, availability and precision of the computed position is only restricted by the number of satellites available and the PDOP value.

For Smoothed DGPS, carrier phases are used to improve pseudorange observation precision, and consequently positioning accuracy. **GeoGenius** uses an optimal sequential filter for this algorithm. Here, longer tracking intervals without losses of lock are advantageous for the quality of the results.



If the receiver already performed a pseudorange smoothing using carrier phases, which is selectable on many receivers, you should not use Smoothed DGPS processing. Smoothing the data twice would result in optimistic estimates of the position standard deviations for the final positions and prohibit realistic view of your data quality. Use DGPS mode for best results here.

Super Smoothing is an algorithm that takes all data between two cycle slips and uses it equally for all epochs. So, the precision remains at the same high level starting from the first epoch. For the last epoch of a data range without cycle slip, the precision is identical to a hatch filter, i.e., “DGPS smooth”. The positions computed using the super-smooth DGPS processor result in a very high relative precision between successive epochs. That means, that even if the absolute positions of two epochs might be wrong by a few decimeters, the difference between the positions is typically good for some centimeters. This is a valuable feature for, e.g., aerophotogrammetric purposes.

9.3.2 Data Display

The navigator will offer the additional entry Kinematics. The project plot, by default, displays the static baseline between the reference position, the header position of the kinematic file and a kinematic path (trajectory). Remember, you may modify the plot display, however (refer to chapter 5.2.2 and App. A.3)!



The unprocessed rover data may result in a path with almost no resemblance to the real trajectory, because just the navigation solution, if present in the rover file, is displayed on the screen.

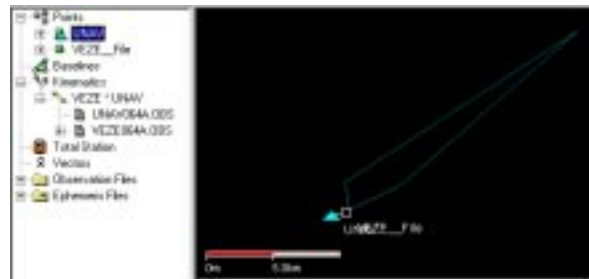


Figure 9-3: Unprocessed Kinematic DGPS Data

9.3.3 DGPS Processing

To start processing in DGPS mode choose the menu item Process/Process Project or the corresponding toolbar button. This will start the processor according to the parameter settings.



Parameter setting is described in detail in chapter 7. For kinematic processing, please note the following:



- If you have chosen the option Automatic, **GeoGenius** will automatically choose as processing mode OTF for kinematic data files, Stop&Go for Stop&Go data file
- If you want to manually select the processing option, you should choose the menu item Process/Settings.../Processor and select Differential GPS for differential GPS, Smoothed Differential GPS for **GeoGenius** to smooth phase data with the code or Super Smoothed to obtain high relative accuracies for, e.g., photogrammetric applications.

After processing begins, a progress window displays the progress of the processing. You may interrupt processing here via the button **Cancel**.



Figure 9-4: Progress Bar

GeoGenius' DGPS processor reads the data, then the code positioning is performed. Depending on the processing mode selected, raw, smoothed or super-smoothed pseudorange positions are computed. Progress bars display the progress of several steps.

9.3.4 Results of DGPS, Smoothed DGPS and Super Smoothed Processing

After DGPS processing **GeoGenius** provides results in numerical values and indicates quality in the project plot.

DGPS processing may result in different solutions since the kinematic data might have been processed with different parameters like processing interval, elevation cutoff etc.

9.3.4.1 The Project Plot/Quality Indicator Colors

When DGPS processing is finished, **GeoGenius** redraws the screen. All computed positions are drawn.

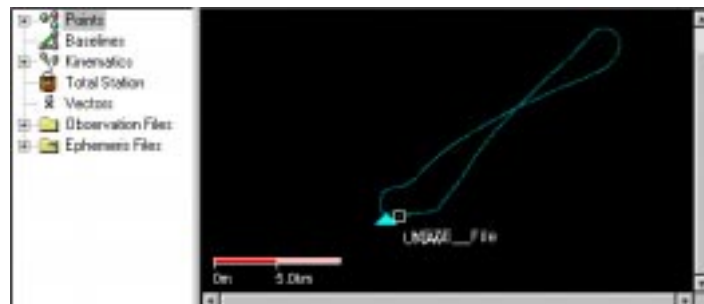


Figure 9-5: Processed Kinematic Data

In addition, time labels are added to the positions. You may insert the time markers into your project plot using the **Define...** button in Process/Settings.../Display or via View/Display/Config Layers. Check the Layer Time Markers.

9.3.4.2 The Output Window

The output window displays information on the kinematic baseline processing and all warnings and error messages. You may print the contents of the output window to an ASCII file (choose the context menu item **Save to File**).

The output window information includes the name of the processed baseline, the processed interval in GPS-seconds and the result of code and phase positioning in absolute and relative values. Additionally, information on stored code derived positions and the duration of the processing is displayed.

9.3.4.3 Kinematic Line Report

The main result of Differential GPS, Smoothed Differential GPS and Super Smoothed DGPS processing is written in a protocol report.

GeoGenius' smart **HyperPage** text presentation tool allows you to output all results in a formatted and easy-to-interpret manner.

You may build additional highly specialized macros fitting exactly your needs and extent the functionality by dynamically loading DLLs. The **HyperPage User's Guide** and the **HyperPage Macro Programming Guide** offer detailed information on this tool.

GeoGenius generates one report for the kinematic line. You have several possibilities to start **HyperPage** and to load the report referring to a kinematic baseline:

- With the project plot or the navigator, activate the baseline identifier, open the context menu with a click of the right mouse button and choose the menu item Report....
- From the toolbar Processing, choose the corresponding button. 

In the report (see the following figure) you will find information about the files processed, satellites tracked and losses of lock detected.

The protocol (report) is almost identical to the Stop&Go protocol up to the code positioning message. After that, the report stops. Please see Appendix *F* for an annotated example file.

Report Settings allow you to individually enable and disable sections of the report or other options for display. **By default, some options are disabled! HyperPage** offers editing and zooming tools and allows you to print the report. To generate a different kind of report use the MacroStudio.

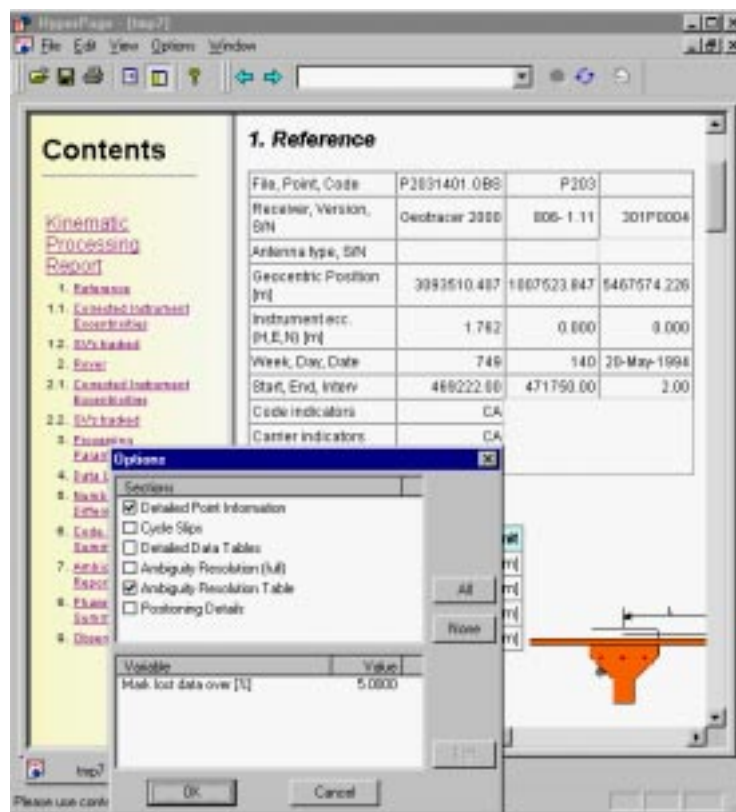


Figure 9-6: Kinematic Report

9.3.4.4 Project Reports

Several Project Reports are available before and after processing via the item Reports... of the pull-down menu Project. For a description of the reports please refer to chapter 8.2.5.

9.3.4.5 Export Files

You may inspect a summary of the obtained results and create output files via the Properties window of the kinematic trajectory.

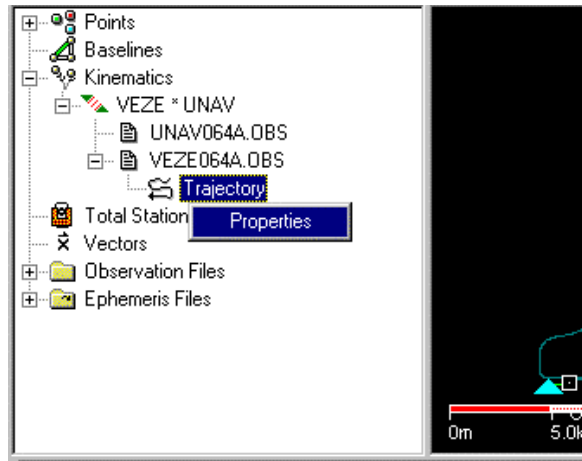


Figure 9-7: Trajectory Entry

To review the properties of the trajectory click with the right mouse-button onto the navigator item **Trajectory** (found via the rover observation file). The correlated context menu pops up. Now choose the option **Properties**. The Property: Kinematic Path notebook with the single page Path allows you to review and export the trajectory.

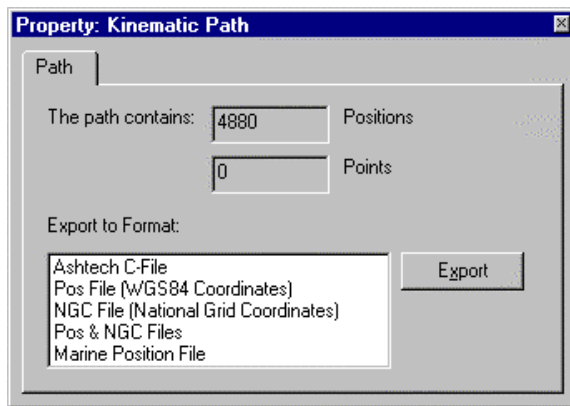


Figure 9-8: Property: Kinematic Path

Page Path displays the following values:

Number of positions derived from code positioning (**Positions**)

Number of stop points the file contains (**Points**)

The **Export to Format** box allows you to export the processed code positions to an export file. To do so, select one of the export file formats and click the button **Export** to start the creation of the export file.

You may customize the list of export formats via the menu item **Export Formats - Kinematic...** of the **Options** pull-down menu. Find a full description of this feature in Appendix A.6. App. B.4 offers a description of all currently available export formats.

9.4 Stop&Go and GIS Surveying

9.4.1 Basics

Stop&Go processing combines the advantages of Static and Kinematic survey techniques. While getting the productivity of Kinematic, it gives the accuracy of Static at any selected points.

The survey is started with a short measurement at a previously measured point – called a Known Point, - or on a Very Short Fixed Baseline (VSFB). Alternatively, ambiguities can be fixed using the “short static” techniques while occupying a static point for some minutes. This gives the processing software the information on the integer ambiguities so that the current values are known. The values are carried forward to subsequent points by using the kinematic measurement technique, i.e. the roving receiver maintains lock on at least 4 satellites during its movement from one point to the next. Data is recorded continuously during measurement. A convenient alternative to Known Point or VSFB initializations, especially for dual-frequency data, is ambiguity resolution On-The-Fly. Here, ambiguities are fixed during the motion as long as continuous lock is maintained long enough.

The important part of Stop&Go surveying is the *initialization* phase. This is the process of getting the correct distance measurement to each satellite. Refer to chapter 4.10 for a detailed description of initialization methods.

GIS positioning is very similar to the Stop&Go surveying. However, the demands on the position accuracies are less by far regarding the classical Stop&Go application. With GIS positioning, no initialization is or re-initializations are necessary, because no ambiguities have to be

fixed. GIS solutions are based on code measurements smoothed by phase measurements using the super-smooth DGPS algorithm. In addition, static point occupations are evaluated. This results in accuracies in the meter to decimeter range.

9.4.2 Stop&Go and GIS Data Display

The navigator will offer the additional item **Kinematics**. It contains the **Rover - Reference** kinematic line, which leads to the respective observation files. The rover observation file tree contains the item **Trajectory** and all the stop points with and without (re-)initialization. The stop points are given in order of the start time of observation.

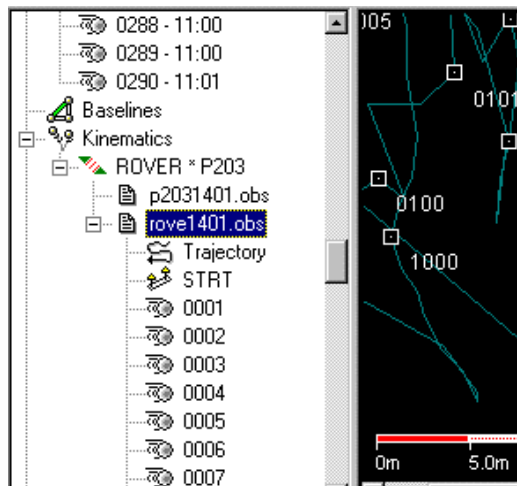


Figure 9-9: Navigator - Stop Points

The Points container will display the reference station, the rover identifier with the appendix (File) and all stop points contained in the observation file. For VSFB initializations the navigator displays a special symbol: 🚧.

In the default Processing mode the project plot will show initialization points, normal points, VSFB initializations and the rover's path. Remember, you may modify the plot display, however (refer to chapter 5.2.2 and App. A.3)!



The unprocessed rover data may result in a path with almost no resemblance to the real trajectory, because just the navigation solution, if present in the rover file, is displayed on the screen.



Figure 9-10: Kinematic Stop&Go Project Plot

Triangles are used to show control points, i.e., points with a known position that can be used for initialization and a quality check.

VSFB initializations are indicated in the navigator with a special symbol: 

The notebook Properties of Stop&Go points contains an additional page VSFB. Here, you can check and change the VSFB parameters. Take special care to enter the correct VSFB length here.

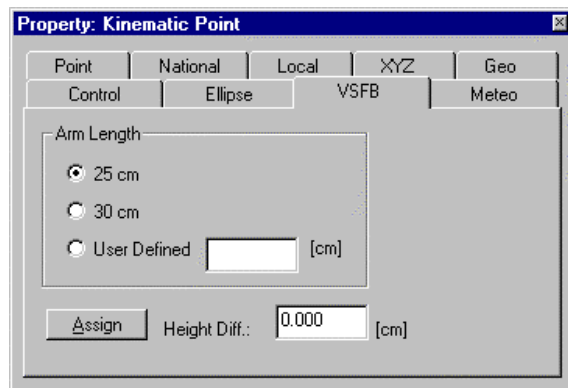


Figure 9-11: Point Properties VSFB

You may change the VSFB eccentricities here, if they were entered incorrectly during the survey.

If no VSFB initialization has been done on a point, page VSFB will hide the VSFB options.

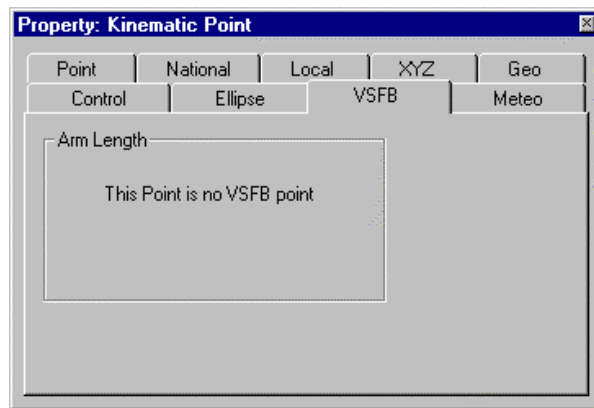


Figure 9-12: No VSFB Initialization Point

You can change a normal positioning point to become a control point by opening the context menu of the stop point and check option **Fix**. For GIS, control coordinates will not be respected!

All the options to change positions, infos or flags are full active for kinematic points.

9.4.3 Moving and Merging Points

Sometimes your projects may contain not only a kinematic survey, but you have got static measurements for additional points. Several options allow you to optimally set-up your project.

- a) You may merge stop points: Activate a stop point (the Merge Point) and click its context menu item **Merge**. Select the point name of the Into Point. The Merge Point will get the name and position of the Into Point.

- b) You may move a static point to a Stop&Go Point, if both points are named identically: Activate the container Points and choose its context menu item **Stop&Go/Move Static Point to Stop&Go Points**. Any moved static point gets the position of the Stop&Go point with identical name. No point is deleted or fixed.
- c) You may move a Stop&Go point to a static point, if both points are named identically: Activate the container Points and choose its context menu item **Stop&Go/Move Stop&Go Points to Static Points**. Any moved Stop&Go point gets the position of the static point with identical name. No point is deleted or fixed.
- d) You may move a Stop&Go point to a static point, if both points are named identically and fix it: Activate the container Points and choose its context menu item **Stop&Go/Move Stop&Go Points to Static Points (and Fix)**. Any moved Stop&Go point gets the position of the static point with identical name. **The moved Stop&Go point will be fixed and its coordinates will influence the processed trajectory**. No point is deleted.

9.4.4 Processing Stop&Go or GIS Data

To start processing in Stop&Go mode choose the menu item **Process/Process Project** or the corresponding toolbar button. This will start the processor according to the parameter settings.



How to set parameters is described in detail in chapter 7. For kinematic processing, please note the following:



- If you have chosen the option Automatic, **GeoGenius** will automatically choose Stop&Go as processing mode.
- If you want to manually select the processing option, you should choose the menu item Process/Settings.../Processor and select Stop&Go for fixing phase ambiguities or GIS to process the data on the base of code measurements smoothed by phase measurements using the super-smooth DGPS algorithm.

After processing begins, a progress window displays the progress of the processing. You may interrupt processing here via the button **Cancel**.



Figure 9-13: Progress Bar

GeoGenius' Stop&Go processor performs the following steps:

First, **GeoGenius** performs code positioning.

Then the software evaluates the initializations (see ch. 4.10). For known points and VSFB's **GeoGenius** computes ambiguities and checks for integrity. If you revisited points, **GeoGenius** determines the position of the first occupation. Thereafter, this point will be treated as a known position point.

GeoGenius processes short-static initializations similarly to the static processing procedure. First, a float solution is computed as an approximation. A fixed solution with approximate ambiguities and the ambiguity search will follow. Last, the quality of the resulting

ambiguities is checked by inspecting the ratio and resulting RMS values.

When all possible ambiguities have been fixed, the kinematic baseline processor computes the final position output. The project plot area will display these positions immediately, identified by their point numbers. You may review a report of the results and check the position of each point via the point's context menu item **Properties**.

The final processing phase will perform an integrity check of the observations by comparing computed positions with known positions. In addition, the observation RMS is computed. If the calculated positions deviate too much from the given ones or if the RMS value is too big, a warning is issued. If Stop&Go results merit further investigation, e.g. some large RMS values, *all* other points are displayed as yellow and results are not stored in the project file.

9.4.5 Results

Positions are stored in the project file in addition to the coordinate information of fixed points. You may review results and positions in different ways.

9.4.5.1 The Project Plot

After processing, the kinematic path may look quite different:

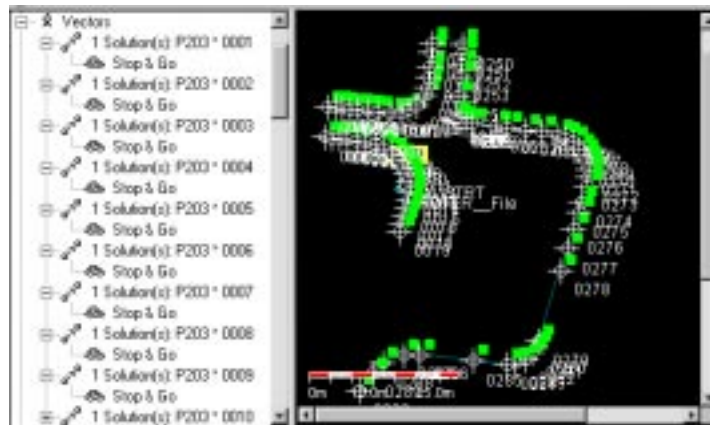


Figure 9-14: Processed Kinematic Stop&Go Path

The color and form of point numbers reflect the point and processing status.

Green square points are successfully evaluated new points. If they appear in red, the protocol report (see below) will give detailed information about a problem encountered for each point. Red points have either a position standard deviation error larger than the predefined value (default is 20 mm, see the page Advanced of the Processing Option) or the RMS for the point position is larger than the internally defined value of 50mm.

If there are any red points, all remaining points will be marked in yellow color. This is done to point at the fact, that even good looking points might contain a questionable position, if the processor found any bad points. It is always recommended to find the causes of red points before using the processing results.

All points that retain white color could not be positioned at all. Possible reasons are: no reference data at the point occupation time, cycle slips between last initialization and point occupation, data excluded manually (e.g., via the Scan tool, or if you disabled the baseline between the reference and the rover). The output window and the Kinematic Line Report will give you the details.

9.4.5.2 The Output Window

The output window displays information on the kinematic baseline processing and all warnings and error messages. You may print the contents of the log window to an ASCII file (choose the context menu item **Save to File**).

9.4.5.3 Numerical Results

You may review a kinematic postprocessing solution for each stop point.

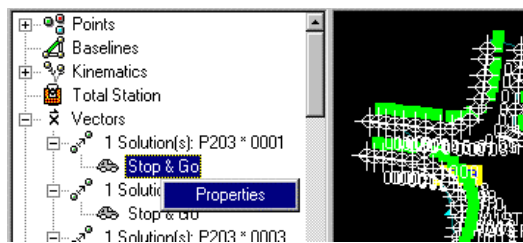


Figure 9-15: Solution for Stop Point 0001

To do so, activate the  Stop&Go Solution for the respective point in the container  Vectors of the navigator, then open the context menu of the Stop & Go item with a click of the right mouse button. The item **Properties** opens the Result notebook for this solution.

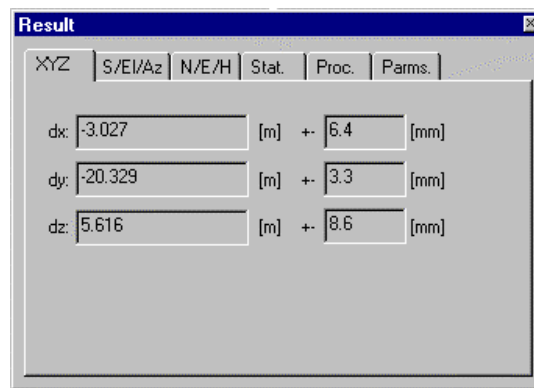


Figure 9-16: Results Dialog

The Result notebook consists of six pages:

- XYZ displays the baseline components with respect to the reference position dx, dy, dz in Cartesian geocentric WGS84 coordinates in meters with associated standard errors in mm.
- S/EI/Az displays the slope distance S in the chosen length unit, elevation EI in the chosen angle unit and azimuth AZ in ° in a national coordinate system with associated standard errors in the resp. smallest unit (e.g., mm/mi or " (arcseconds)).
- N/E/H displays North, East and height values in the national system in the chosen length unit with associated standard errors in the respective smallest unit (e.g., mm/mi).
- Stat. offers information on the basic processing parameters:

	◇ Solution	Type of Processor (Stop & Go).
	◇ Ratio	Ratio of best solution to second solution - an ambiguity fixing indicator
	◇ Frequency	the frequency or frequency combination used for positioning (L1, L2, Lw, Lc)
	◇ RMS	Root Mean Square RMS of the carrier phases in mm
	◇ Sats	Number of observed satellites with good health status
	◇ RDOP	Relative Dilution of Precision Range during the observation
	◇ PDOP	Position Dilution of Precision
	◇ Time span:	Time span of observation used for processing. The current time offset to GPS time is displayed beneath
	◇ Ephemeris	Type of ephemeris data (Broadcast, Precise)
Proc.		displays the type of processor (Static, Kinematic, On-The-Fly, Stop&Go), the start and end time of processing in local time and the duration of processing in seconds.
Parms.		displays important processing parameters, such as the processing interval, the elevation cutoff used for processing and the reference satellite PRN number or indicates automatic reference satellite selection (Automatic)

9.4.5.4 Export Files

You may inspect a summary of the obtained results and create output files via the Properties window of the kinematic trajectory.

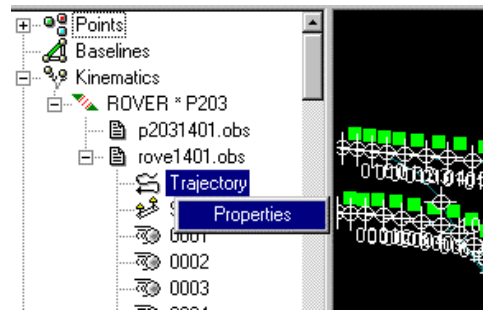


Figure 9-17: Stop&Go Trajectory

To review the properties of the trajectory click with the right mouse-button onto the navigator item **Trajectory** (found via the rover observation file). The correlated context menu pops up. Now choose the option **Properties**. The Property: Kinematic Path notebook with the single page **Path** allows you to review and export the trajectory.

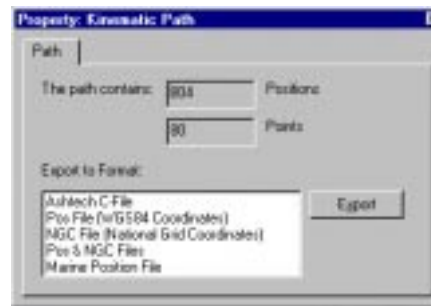


Figure 9-18: Stop&Go Property Kinematic Path

Page **Path** displays the following values:

Number of positions derived from phase or code positioning (**Positions**)

Number of stop points the file contains (**Points**)

The **Export to Format** box allows you to export the processed stop points and phase positions (with Stop&Go data) or code positions (with GIS data) to an export file. To do so, select one of the export file formats and click the button **Export** to start the creation of the export file.

You may customize the list of export formats via the menu item **Export Formats - Kinematic...** of the **Options** pull-down menu. Find a full description of this feature in Appendix A.6. App. B.4 offers a description of all currently available export formats.

9.4.5.5 Result Protocol

GeoGenius' smart **HyperPage** text presentation tool allows to output all results in a formatted and easy-to-interpret manner.

You may build additional highly specialized macros fitting exactly your needs and extent the functionality by dynamically loading DLLs. The **HyperPage User's Guide** and the **HyperPage Macro Programming Guide** offer detailed information on this tool.

GeoGenius generates one report for the project. You have several possibilities to start **HyperPage** and to load the report referring to a baseline:

- With the project plot or the navigator, activate the baseline identifier, open the context menu with a click of the right mouse button and choose the menu item **Report...**
- From the toolbar Processing, choose the corresponding button.



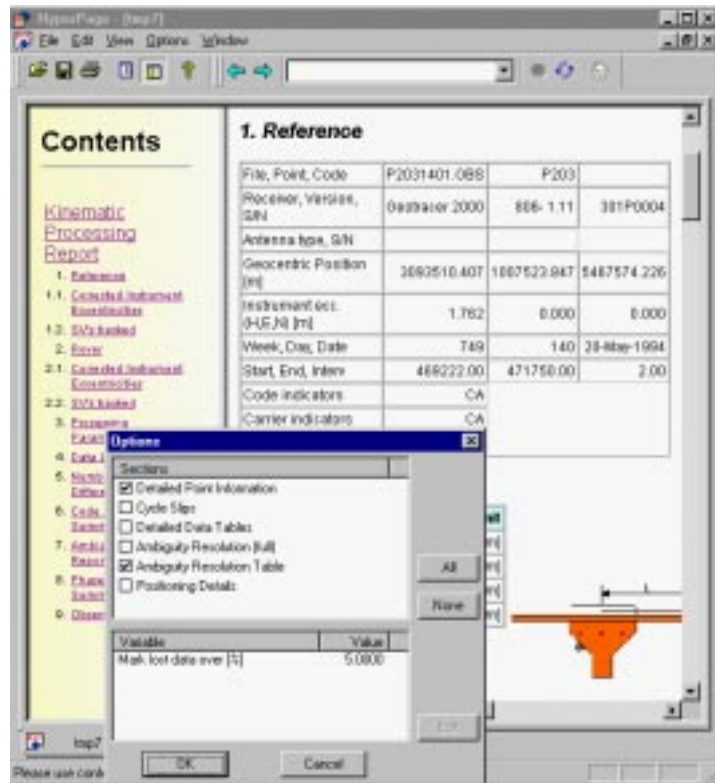


Figure 9-19: Kinematic Report

In the report (see the following figure) you will find information about the files processed, satellites tracked and losses of lock detected. For each initialization, a paragraph describes the initialization method and results including a final quality check. It gives detailed lists on all solutions and ambiguity resolution results.

Report Settings allow you to individually enable and disable sections of the report or other options for display. **By default, some options are disabled!** **HyperPage** offers editing and zooming tools and allows you to print the report. To generate a different kind of report use the MacroStudio. You will find an annotated example report file in Appendix F.

9.4.5.6 Project Reports

Several Project Reports are available before and after processing via the item Reports... of the pull-down menu **Project**. For a description of the reports please refer to chapter 8.2.5.

9.4.6 Problem Solving and Troubleshooting Difficult Datasets

Various problems can compromise Stop&Go processing. These include: non-continuous tracking due to problems on the reference point, wrong control point information, problems with re-occupied points.

9.4.6.1 No continuous tracking

Stop&Go surveying is a very productive method for fast positioning of new points in the open field. However, a disadvantage of the method is that you do not know, if the reference receiver has experienced cycle slips. Choose a reference point with excellent visibility, this will reduce the chance for cycle slips. Assume that we have a loss of lock at the reference point, which corrupts data processing. In this case, it will be typical that only the data that was observed before the loss of lock occurred will be processed. If you did not return after the loss of lock to a point previously occupied **GeoGenius** will display an error mes-

sage and a part of the dataset will remain unprocessed. If, however, you returned at the very end of the survey to a point previously visited **GeoGenius** will automatically process the complete data-set. It is therefore very important to work in loops with frequent reoccupations.

Even if the Stop&Go kinematic processor is not able to process a part of the data-set due to incorrect reoccupations, **GeoGenius** provides possibilities to reprocess such data. In such a case you should perform a short-static survey for one of the unprocessed new points using the same reference point. If the baseline information is passed as a control point to **GeoGenius**, the previously unprocessable point can then be processed. Then, the Stop&Go survey can be reprocessed.

9.4.6.2 Invalid control point information

Stop&Go surveying depends on having the correct control point definition. This is required when calculating initializations and checking the additional control information entered during a survey. Since the program expects that the control information is always correct, the discrepancies between control information and Stop&Go data will always be interpreted as bad Stop&Go data. The processor will "complain" and stop. You should then check the control point information for validity.

9.4.6.3 Problems with revisited points

The Stop&Go processor provides an accumulated position estimation for revisited points, i.e., if a point is occupied several times the software will test for consistency and provide a position estimate derived from all observations made at all the visits. If discrepancies occur the software will output very large RMS values or might even stop the processing. The reasons for such discrepancies could include: the antenna height eccentricity changed during survey (by adjusting the

height of the range pole), or more probably the point number was entered wrongly. Please check for such possibilities and make the necessary changes.

If none of these reasons have caused the processing to fail, it could have been caused by an undetected cycle slip. First, note the occupation time at each of the two control points between which you suspect the problem. Next, select the Scan... item of the observation file or kinematic line context menu.

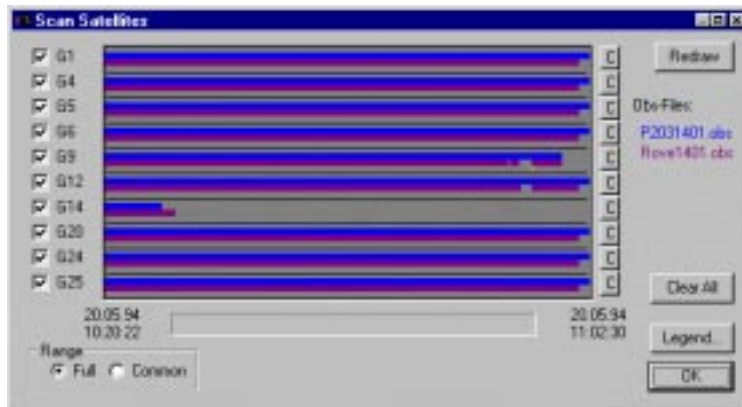


Figure 9-20: Scan Baseline

Disable (fence off) all satellites for a short period during the time span of the problem data. That is, between the time of the two control point occupations. **GeoGenius** will use this break to split the data set, using the fenced off time as loss of lock indicators. The data between the occupations of control points will be lost, but re-initialization at the second control point should be successful.

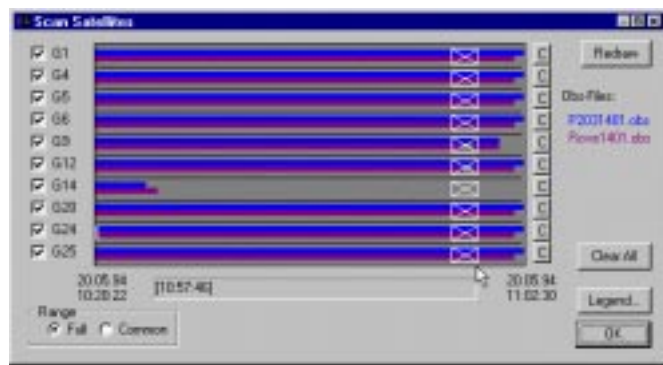


Figure 9-21: Fence Satellites off to Split Data

If more than two visits were made to a point and the results do not match, you should try to change the point numbers for each occupation to a new unique number for test purposes and reprocess. This will allow you to compare the different point positions that each occupation has given, without making the processor fail. This should help to isolate the problem area.

9.4.6.4 OTF Enhancement - Option

The OTF enhancement option automatically attempts to fix gaps in Stop&Go data with OTF algorithms. The principle is explained in section 9.5.

9.4.7 Stop&Go Error Messages

The following lists error messages which may occur in connection with Stop&Go processing. It suggests reasons and solutions.

Couldn't get position of point 0277

The postprocessor could not compute the position of the point. The detailed reason is found in the protocol report file.

No data observed

There is no data available for postprocessing. Please check that you selected the pair of reference and rover observation file you recorded while surveying. You might try to decode receiver data again and check that you transferred the correct files from the receiver to your computer.

10 <= PDOP <= 20

The point was surveyed with poor PDOP values, no position could be computed.

No ambiguities fixed

The software could not fix the ambiguities for your survey points and therefore it cannot compute positions. Please check your VSFB and known position points.

1 <= sats <= 3

The number of satellites observed is not sufficient for position output.

ERROR: no memory for baseline output

Your computer does not have enough memory left for baseline output to the project file. You should delete some files on your hard disk to get more virtual memory.

Can't open ROVE1401.obs

The program could not open the file specified. Perhaps you are working on a network and another user is trying to process the same file at the same time.

Can't read Rove1401.OBS, invalid observation header

The observation file is corrupted. Please repeat the download and decode steps for receiver data. If the reason is unknown, try the option **Export RINEX** of the observation file context menu and edit the ASCII RINEX file, although if the file is really corrupted this cannot work either.

Reference file ROVE1401.OBS is not static but STOP&GO. Have you chosen the correct reference observation?

The reference file selected must be a static observation file. Perhaps you switched reference and rover file? If you have made sure the selected file is the correct one, you can change the type of observation file in the observation file Properties notebook, page Type.

Software not licensed for Stop&Go processing

Your version of **GeoGenius** is not licensed for Stop&Go processing. You could update the software, please ask your software representative.

Given time span 600000 ... 601000 excludes all data!

There is no simultaneous reference and rover observation data in the processing time span you specified.

Observation files don't overlap!

The rover and reference observation files do not contain any data simultaneously recorded.

L1 code type missing in "ROVE1401.OBS":

L2 code type missing in "ROVE1401.OBS":

L1 carrier type missing in "ROVE1401.OBS":

L2 carrier type missing in "ROVE1401.OBS"

You specified a processing mode, which requires a GPS observable that is not present in the files given.

No data in observation file "ROVE1401.OBS":

No data in reference file "BASE1401.OBS"

The rover or reference observation file doesn't contain any data. Please repeat downloading and decoding of the file.

WARNING: joint RMS 505.9 mm > 45 mm, cycle slip possible:

Checking the positions of revisited points, there is a discrepancy in the result. Maybe the receiver stored an undetected cycle slip

WARNING: computed position of point "210" differs 0.5 m from known position:

WARNING: computed VSFB of point "STRT" differs 0.6 m from given VSFB

The software computed a position different from that specified for a known position point or VSFB. Please check point number and baseline components of this point and all other initialization points.

WARNING: standard deviation 42.1 mm > 20.0 mm

The standard deviation of the baseline components of a point computed exceeds the threshold given by the Maximum Position Sigma line in the Processing Options page Advanced.

WARNING: RMS 50.0 mm > 25.0 mm

The RMS value at a given point position computation exceeds the threshold value.

Only 3 satellites tracked simultaneously!

The reference and rover observation contains simultaneous data for a few satellites, not sufficient for ambiguity fixing. Possible reasons are: wrong matching of files, bad ephemeris data for some or all satellites, too many satellites excluded manually from processing.

No ambiguities fixed, no positioning

The initializations couldn't fix any ambiguities. No positions could be computed. Please check your VSFB specifications and known position control points.

No positions could be computed

The program could not compute any positions. The geometry or data are too bad for positioning.

Insufficient memory, aborting program

Your computer doesn't have sufficient free memory for Stop&Go processing. You must delete some files on your hard disk to increase virtual memory size.

9.5 On-The-Fly Positioning

9.5.1 Basics

Position postprocessing with on-the-fly ambiguity resolution (OTF) is the method-of-choice for all kinematic applications that require a centimeter level accuracy. It is the state of the art of GPS carrier phase based kinematic positioning.

OTF processing doesn't need any static initializations. The roving receiver can start without any time delay and productivity loss for the initialization phases. Only OTF makes positioning with centimeter level accuracy possible for applications that cannot use static initializations or reinitializations, e.g., for flight path determination and marine applications.

To determine the integer ambiguities needed for precise carrier phase based positioning, OTF will need a time interval with at least 5 satellites tracked without loss of lock. This interval is typically 10 sec to 1 min using Lw for dual frequency data and 5 to 10 minutes for single frequency data. Time requirements for OTF ambiguity resolution depend very much on the number of satellites, satellite geometry and signal multipath. The interval can be shorter or longer depending on the conditions of data recording. Minimizing multipath and using best kinematic antennas is always essential, if a result is to be achieved within this time. After fixing the ambiguities 4 tracked satellites with a good PDOP value (≤ 7) are sufficient for precise positioning.

GeoGenius implements three different methods for ambiguity determination. The preferred method for dual frequency data is the wide-laning filtering technique. This option is selected by Lw or Lw/Ln

processing. It uses an enhanced float solution as estimate and a time optimized ambiguity search accounting for L2 measurements. A geometry free ambiguity estimate is computed for this carrier combination. The ambiguity search is then done in the resulting narrow search space.

If you choose the L1/L2 carrier phase combination for processing dual frequency data, a geometry free ambiguity estimate is computed. The ambiguity search is then done in the resulting narrow search space.

Single frequency processing (L1 or L2 data) is always done with enhanced floating solution and time optimized search.

9.5.2 OTF Data Display

The navigator will offer the additional entry Kinematics. The display will roughly show the rover's path and the position of the reference receiver. Remember, you may modify the plot display, however (refer to chapter 5.2.2 and App. A.3)!



The unprocessed rover data may result in a “baseline” with almost no resemblance to the real trajectory!

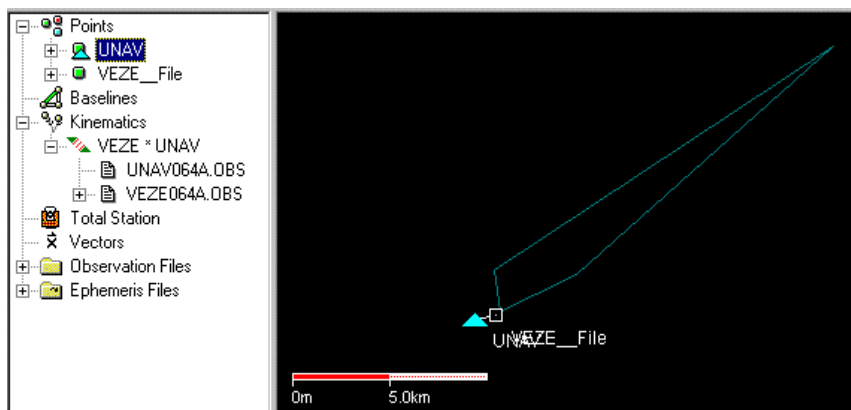


Figure 9-22: Unprocessed Kinematic OTF Data

9.5.3 OTF Processing

To start processing in OTF mode choose the menu item **Process/Process Project** or the corresponding toolbar button. This will start the processor according to the parameter settings.



How to set parameters is described in detail in chapter 7. For kinematic processing, please note the following:



- If you have chosen the option **Automatic**, **GeoGenius** will automatically choose OTF as processing mode.
- If you want to manually select the processing option, you should choose the menu item **Process/Settings.../Processor** and select OTF.

After processing begins, a progress window displays the progress of the processing. You may interrupt processing here with help of the button **Cancel**.



Figure 9-23: Progress Bar

GeoGenius' OTF processor performs the following steps:

First, code positioning is performed.

Then, data is analyzed for cycle slips that can be resolved. The observations are now scanned for the best time spans for ambiguity resolution. Criteria are number of satellites tracked, length of the time span and PDOP value. After this, the software starts OTF ambiguity resolution.

For each interval selected, a first estimate of the integer ambiguities is computed using an enhanced float solution.

After this, a solution using the estimated ambiguities is calculated.

Finally, the ambiguity search is performed. The best ambiguity set found is compared to the second best. A quality criteria for the best ambiguity set is the ratio between the weighted residuals for this solution and the second best solution. This ratio should be above 2 (or another value selected in the Processing Options, page Advanced, item **Minimum Ratio**).

Further checks are performed to guarantee the desired centimeter level accuracy. The software checks the resulting RMS value of the single satellites and the whole set of satellites checked, and compares the results with those derived from alternate algorithms.

If each check is passed, the ambiguities are permanently fixed. Ambiguities are propagated throughout the whole tracking time of a satellite without loss of lock. This process is repeated until all ambiguities are fixed or all possible time intervals have been tried.

Last, the final carrier phase positions are computed.

9.5.4 Results of OTF processing

After OTF processing **GeoGenius** provides results in numerical values and indicates quality in the project plot.

OTF processing may result in different solutions since the baseline might have been processed with different parameters like processing interval, elevation cutoff etc.

9.5.4.1 The Project Plot/Quality Indicator Colors

When OTF processing is finished, **GeoGenius** redraws the screen. All computed positions are drawn.

In addition, time labels are added to the positions. You may insert the time markers into your project plot using the **Define...** button in Process/Settings.../Display or via View/Display/Config Layers. Check the Layer Time Markers.

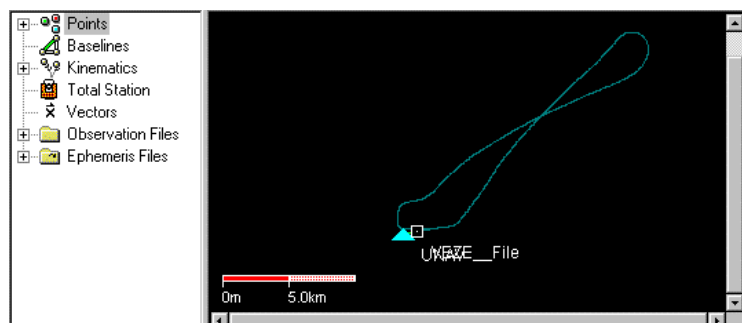


Figure 9-24: Processed Kinematic Path

9.5.4.2 The Output Window

The output window displays information on the kinematic OTF baseline processing and all warnings and error messages. You may print the contents of the log window to an ASCII file (choose the context menu item **Save to File**).

The output window information includes the name of the processed baseline, the processed interval in GPS-seconds and the result of phase positioning in absolute and relative values. Additionally, information on stored positions and the duration of the processing is displayed. If phase positioning was not successful, code positions will be output.

9.5.4.3 Result Protocol

The main result of OTF processing is written in a protocol report.

GeoGenius' smart **HyperPage** text presentation tool allows to output all results in a formatted and easy-to-interpret manner.

You may build additional highly specialized macros fitting exactly your needs and may extend the functionality by dynamically loading DLLs. The **HyperPage User's Guide** and the **HyperPage Macro Programming Guide** offer detailed information on this tool.

GeoGenius generates one report for the project. You have several possibilities to start **HyperPage** and to load the report referring to a baseline:

- With the project plot or the navigator, activate the baseline identifier, open the context menu with a click of the right mouse button and choose the menu item **Report...**
- From the toolbar Processing, choose the corresponding button. 

In the report (see the following figure) you will find information about the files processed, satellites tracked and losses of lock detected. It gives detailed lists on all solutions and ambiguity resolution results.

Report Settings allow you to individually enable and disable sections of the report or other options for display. **By default, some options are disabled!** **HyperPage** offers editing and zooming tools and allows you to print the report. To generate a different kind of report use the MacroStudio.

You will find an annotated example report file in Appendix *F*.

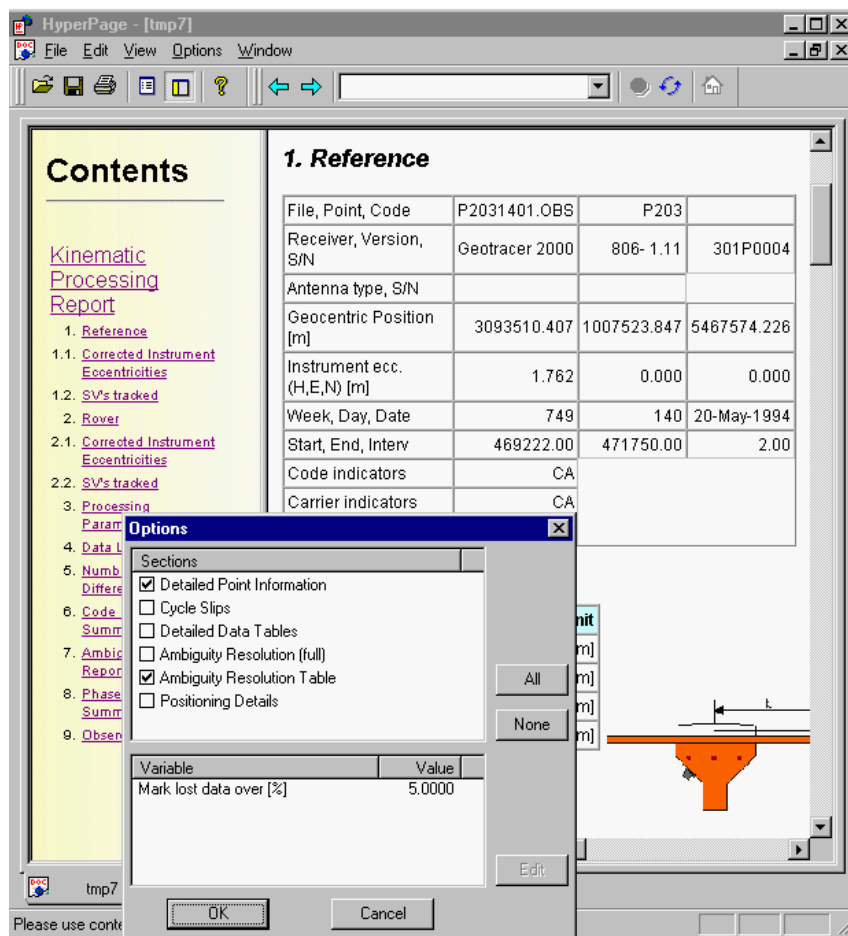


Figure 9-25: Kinematic Report

9.5.4.4 Project Reports

Several Project Reports are available before and after processing via the item Reports... of the pull-down menu Project. For a description of the reports please refer to chapter 8.2.5.

9.5.4.5 Export Files

You may inspect a summary of the results obtained and create output files via the Properties window of the kinematic trajectory.

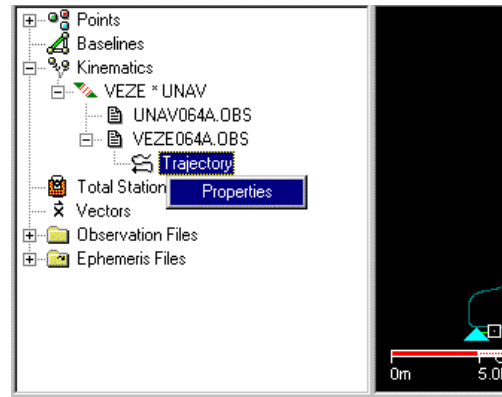


Figure 9-26: OTF Trajectory Entry

To review the properties of the trajectory click with the right mouse-button on the navigator item **Trajectory** (found via the rover observation file). The correlated context menu pops up. Now choose the single option **Properties**. The Property: Kinematic Path notebook with the single page Path allows you to review and export container characteristics.

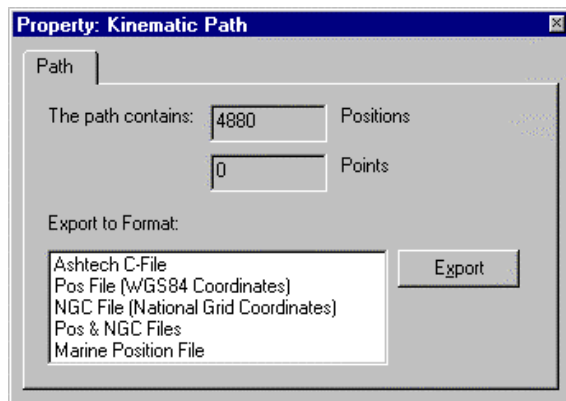


Figure 9-27: Property: Kinematic Path

Page Path displays the following values:

Number of positions derived from phase positioning (**Positions**)

Number of stop points the file contains (**Points**)

The **Export to Format** box allows you to export the processed phase positions to an export file. To do so, select one of the export file formats and click the button **Export** to start the creation of the export file.

You may customize the list of export formats via the menu item **Export Formats - Kinematic...** of the **options** pull-down menu. Find a full description of this feature in Appendix A.6. App. B.4 offers a description of all currently available export formats.

10. Quality Control

GeoGenius performs faster and better quality control than other products. In the following you will find a description of how to perform the quality control and of how to filter the results for solutions. Each test option with the parameters referring to it is described in detail. Finally, you will find a section on quality control results.

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10.1 Performing Quality Control

To start a quality control run,

- choose the option Quality... of the pull-down menu Process, or
- click the corresponding button of the toolbar Processing. 

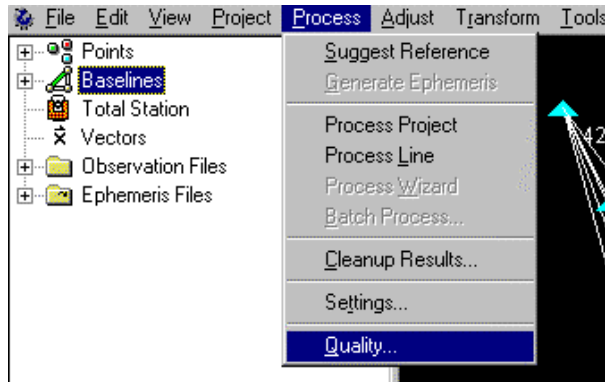


Figure 10-1: Process/Quality

Both options open the Quality Control notebook. This notebook offers several options to verify the quality of the obtained results and the project's data (page Tests). A result filter allows the quality check to work only on results passed through this filter (page Result Filter). Some of the quality checkers use parameters, which you may define explicitly (page Parameter).

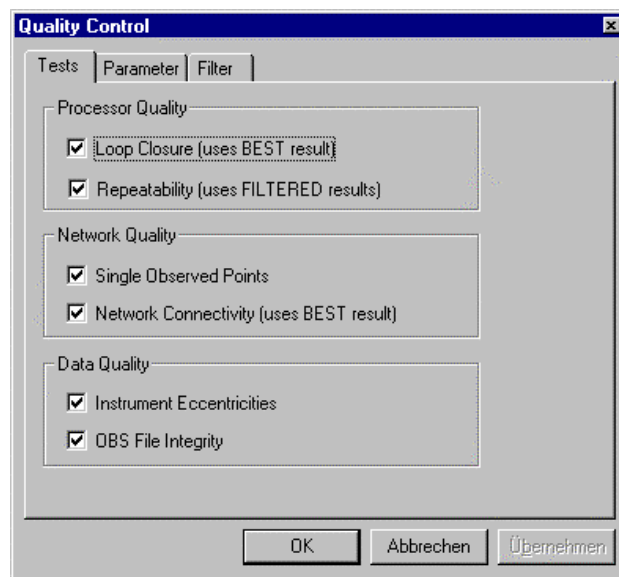


Figure 10-2: Quality Control Notebook

To start all tests that have been checked for the current project, click the button **OK**. Further buttons allow you to accept changes in the settings without the need to start a test run, or to cancel any changes in the settings.

As soon as you have clicked the button **OK**, **GeoGenius** starts a quality control run executing the tests, which have been checked on page Test of the Quality Control notebook. The output window immediately displays a first overview on the test results. When the run has finished, **GeoGenius** automatically generates a quality test report, opens it using the **HyperPage** viewer (refer to section Quality Control Results).

10.2 Loop Closure Test

The Loop Closure Test is one of two tests for processor quality and checks all possible combinations of baselines for closed loops with length n . The sum of all vectors in the loop should be within a certain range and this check can highlight errors. The test uses only the best solutions of each processing. (Therefore, page Result Filter does not apply.)

To apply the Loop Closure test choose **Process/Quality.../Tests** and mark the checkbox **Loop Closure (uses BEST result)**.

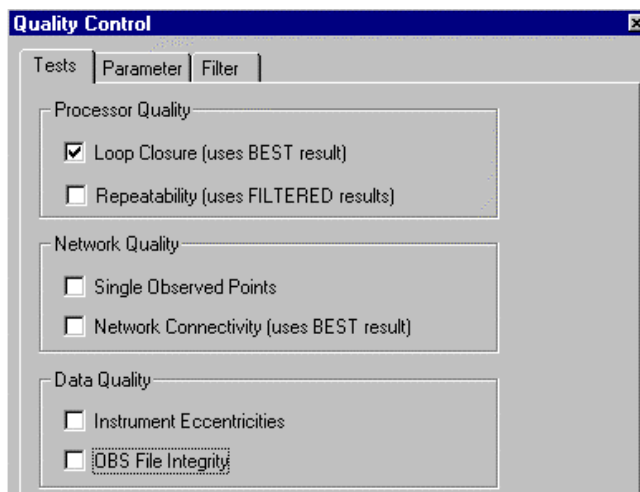


Figure 10-3: Loop Closure

You may define the following parameters) (go to page Parameter):



Figure 10-4: Loop Closure Parameters

The **Significance** factor describes the range of error allowed for the loop test to be OK. It consists of a fixed and a dynamic part. Default values are 5mm + 1ppm (which, e.g., corresponds to 15 mm in a 10km baseline).

You may change the value given in box **Number of Sides**. The default value of 3 represents triangles, 4 represents quadrilaterals, and so on. The minimum allowed value is 3.

The test works on enabled lines only.

Please note that in a network the number of closures with 4 sides may be significantly larger than the number of triangles, depending on the actual topography of the network.

To find the closure of an arbitrary length, just disable all lines, enable only the lines of interest, and then run the test. This appears to be ex-

tremely powerful, since all possible closures may be examined in a single step.

10.3 Repeatability Test

The Repeatability Test is one of two tests for processor quality and checks the baselines for equivalence of the different calculated results. It compares all results of the baselines and checks whether they seem to be repeatable or not. To do so, it checks, whether all results are within a certain range (Significance). The best result of the last processing acts as reference result.

To apply the Repeatability Test choose Process/Quality.../Tests and mark the checkbox Repeatability (uses FILTERED result).

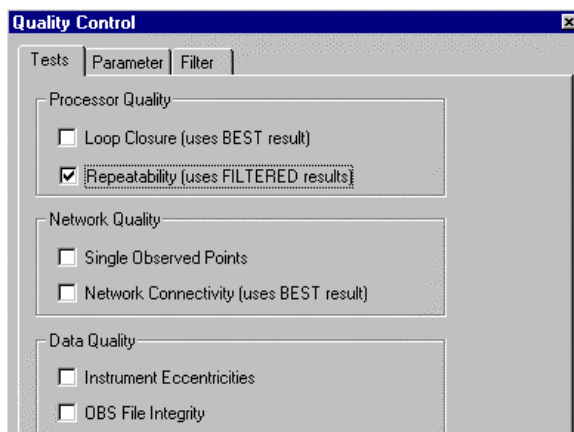


Figure 10-5: Repeatability

You may define the following parameter: (go to page Parameter):



Figure 10-6: Repeatability Parameters

The Significance factor of the box Repeatability describes the range of error allowed for the Repeatability Test to be OK. It consists of a fixed and a dynamic part. Default values are 5mm + 1ppm (which, e.g., corresponds to 15 mm in a 10km baseline).

10.4 Single Observed Points

This test is one of two tests for network quality and checks points reached only via a single vector. **GeoGenius** applies a twofold test and checks for points that are connected via a single baseline as well as for points that are connected via a single, processed baseline.

If a point is connected to the network via a single baseline, no over-determination of its coordinates will be possible.

To apply the test choose Process/Quality.../Tests and mark the checkbox Single Observed Points. You do not have to set any parameters.

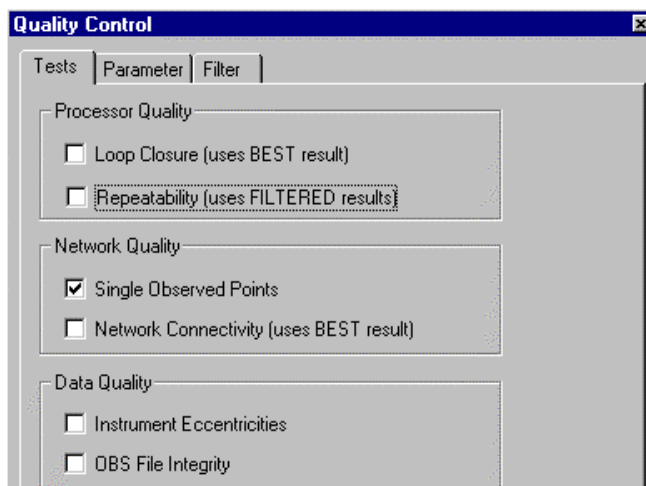


Figure 10-7: Single Observed Points

10.5 Network Connectivity Test

This test is one of two tests for network quality and helps you to find out something about the network's connectivity. **GeoGenius** applies a twofold test and checks

- if the network is connected via **enabled** lines. This test determines, if there are unfixed points, which cannot be reached on a path of enabled lines. This test **MUST** pass in order to process the current project as a batch job.
- if the network is connected via **enabled** and **processed** lines. This part of the test is important for the network adjustment, where an unconnected net creates a singularity.

To apply the tests choose Process/Quality.../Tests and mark the checkbox **Network Connectivity (uses BEST result)**. You do not have to set any parameters.

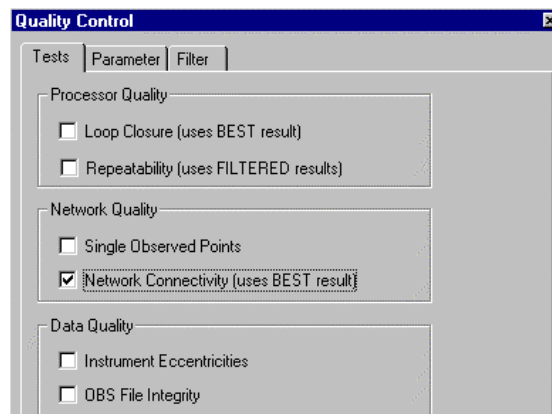


Figure 10-8: Network Connectivity

10.6 Instrument Eccentricities

The Instrument Eccentricities Test is one of two tests for data quality and checks all observation file headers for correct antenna coordinates. The antenna eccentricity has to be within the defined limits.

To apply the Instrument Eccentricities Test choose **Process/Quality.../Tests** and mark the checkbox **Instrument Eccentricities**.

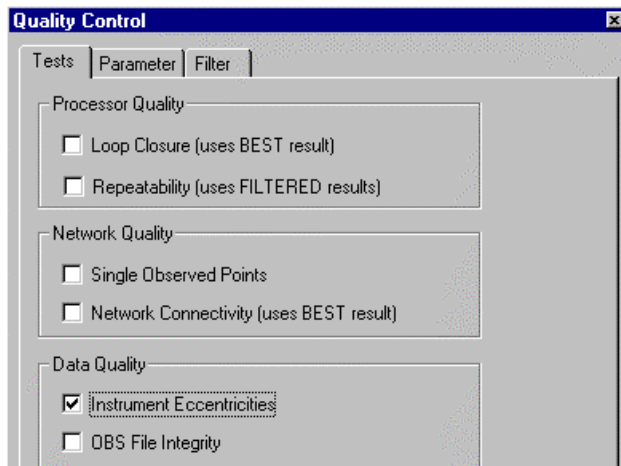
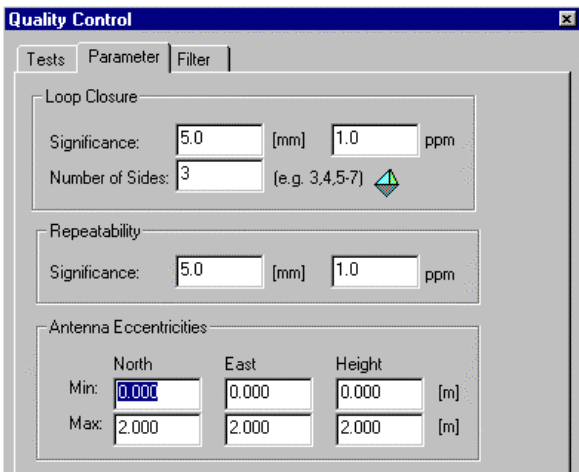


Figure 10-9: Instrument Eccentricities

Page **Parameter** allows you to set the limits: You may enter values for the minimum (Min) and maximum (Max) deviation from the antenna phase center for the North, East and Height components. These values are given in [m].



Quality Control

Tests | **Parameter** | Filter

Loop Closure

Significance: 5.0 [mm] 1.0 ppm

Number of Sides: 3 (e.g. 3,4,5-7) 

Repeatability

Significance: 5.0 [mm] 1.0 ppm

Antenna Eccentricities

	North	East	Height	
Min:	0.000	0.000	0.000	[m]
Max:	2.000	2.000	2.000	[m]

Figure 10-10: Instrument Eccentricities Parameters

10.7 Observation File Integrity

The Observation File Integrity Tests are a set of 9 tests for data quality. They check all observation files for integrity. The following tests are applied if you choose Process/Quality.../Tests and mark the checkbox OBS File Integrity:

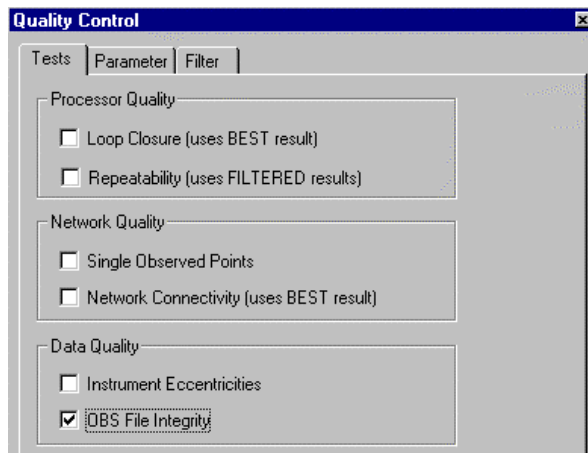


Figure 10-11: OBS File Integrity

- Time control: is start time earlier than end time?
- Time control: is start time > 0.9 secs
- Time control: is end time > 0.9 secs
- Control of number of satellites: must be > 3
- Control of code, carrier and Doppler indicators: values must be in the range 1..3
- Control of position: is $\sqrt{x^2 + y^2 + z^2} > 1000.0$?
- Control of GPS week: a value between 500 and 1500 is accepted
- Control of sampling interval : interval must not be 0.0

If one of these tests fails, the file is very likely to cause problems during processing.

10.8 Result Filter

The page Result Filter offers settings to filter the results of the baseline processing. Only the filtered results are used in the Quality Control. By default, the baseline processor calculates up to eleven different solutions depending on the processing mode and the available data. The kinematic processor additionally offers kinematic solutions. Imported vectors and total station data may also go into the quality control.

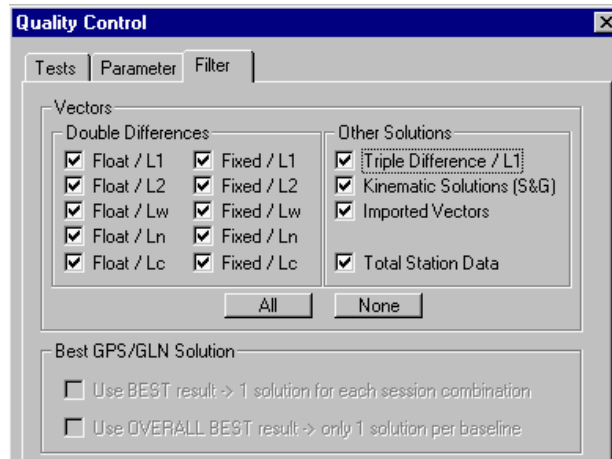


Figure 10-12: Result Filter

For quality control, you may select all or several of the calculated results. All results will be checked; only the selected ones pass through the filter. For most of your work, the L1 fixed solutions should be marked in the filter selection, as these are usually the best solutions.

Float Solutions, Fixed Solutions and Triple Difference/L1 are different methods used to calculate the baseline vectors.

For the Float and Fixed solutions you can also select between different frequencies (L1, L2, Lw, Ln and Lc).

By default, all vectors are checked. You may clear or check single checkboxes. To clear all checkboxes click the button **None**, to check all checkboxes, click the button **All**. Both buttons are located beyond the box Vectors.

10.9 Quality Test Result Output

GeoGenius performs all enabled tests as soon as you started the run via a click on the button **OK**. It writes the test result into the project file.

You may review the test results or output them via two tools:

- The output window information
- The Quality Report

10.9.1 Output Window Information

During the run, the output window displays immediately the test results in the order of test execution.

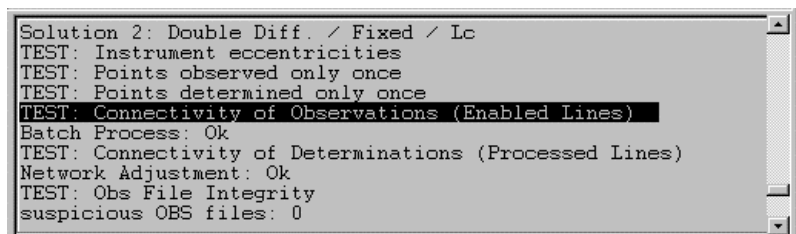


Figure 10-13: Quality Test - Output Window Information

You may store the contents of the output window (open its context menu by a click of the right mouse button onto it and choose the option **Save to File**) and then open or print this file via any text editor.

10.9.2 The Quality Test Report

As soon as **GeoGenius** has performed all tests, which were activated in the Quality Result notebook, it calls the text-editing tool **HyperPage** and opens a Quality Test Report.

The report consists of a header (summary part) and the results part. The header part summarizes project and user information and displays the minimum ratio setting. For each performed test the set parameters are listed and the results are given in an easy-to interpret manner.

The next figure shows an example page of a quality report.

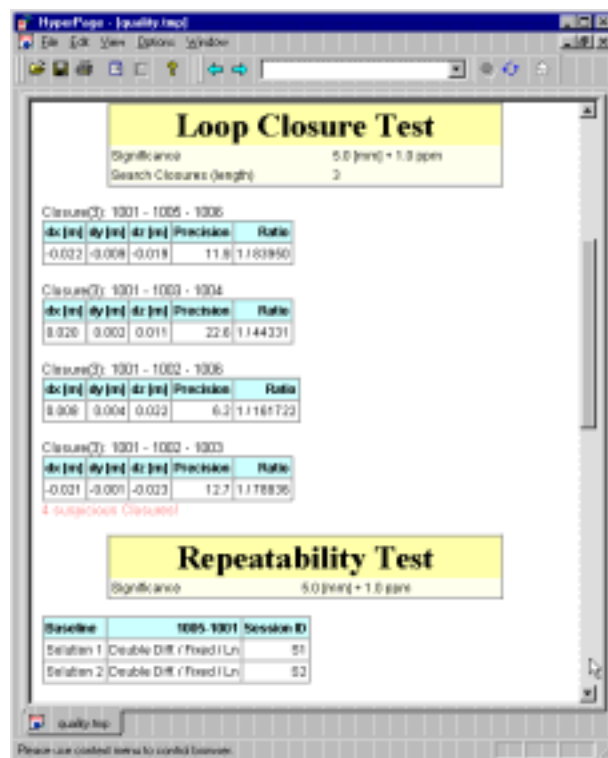


Figure 10-14: Quality Test Report

HyperPage allows the selection of individual sections. This feature allows you to exclude unnecessary information from the screen and just to review the results you currently need. Click **Options/Report Settings...** . The window **Options** displays all selectable sections.

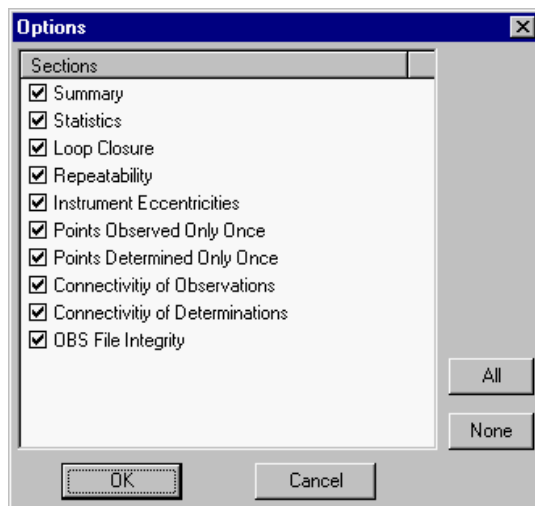


Figure 10-15: Select Report Sections

Clear the check boxes of all sections you do not want to be displayed. Of course, the respective results are not deleted in the file but stay for further use!

If you need more information on **HyperPage**'s capabilities, refer to the **HyperPage User's Guide**.

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11. Terrestrial Data

This chapter gives you all information on the usage of classical terrestrial data - total station and levelling data - in **GeoGenius**. It describes the import options, the available adjustment and transformation modes and how to export results.

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11.1 Total Station Data

This chapter guides you through the use of total station data. It also describes how to combine total station data with GPS/GLONASS data.

11.1.1 Overview

While GPS is dominating the surveying application in long and medium range projects, total stations are the instruments of choice for short-range projects with the requirement for highest precision. A coordination of both surveying tools in one system, therefore, leads to an optimal coordination of both surveying worlds. The principal methods used by Spectra Precision are summarized under the registered trademark “Integrated Surveying”. **GeoGenius** was especially designed to process GPS and total station data in an intuitive, descriptive and precise manner.

GeoGenius offers the following functions in support of total station data:

- Import of total station data
- Editing and reporting of total station data
- Least-squares adjustment of total station data alone and in coordination with GPS/GLONASS data
- Support of a large variety of national grid systems and purely local systems
- Transformation of coordinates in two- and three-dimensional coordinate systems
- Editing of total station measurements

11.1.2 Insert/Import of Total Station Data

Using the menu entry Project/Import/Total Station Data (or the corresponding toolbar button) you can import total station observations.

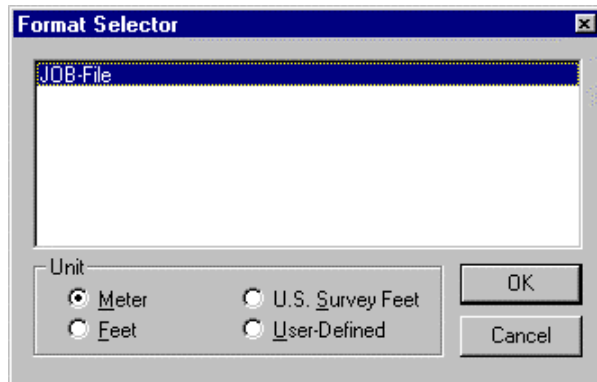


Figure 11-1: Format Selector for Total Station Data

As you can see **GeoGenius** offers the import of Geodimeter® jobfiles (*.JOB). The file formats and the corresponding import modules are described in detail in Appendix B. **GeoGenius** principally supports the following Geodimeter® programs with their corresponding output format:

- P22 Angle Measurement
- P32 Angle Measurement +

On demand Spectra Precision Terrasat provides support for other file formats (e.g., your proprietary file format).

When importing Total Station Data the Format Selector dialog offers all available file formats in an alphabetically sorted list box. Selecting a format and clicking **OK** or double-clicking on a format will lead you to a standard file selector dialog where you can browse for your import file. In case the selected file format has a default file extension this extension will already be present.



Please note that all imported total station data will be interpreted as if they were defined in the currently selected System!

By default, the coordinate system (standard map projection) is based on a sphere with the radius 6372 km compatible to the system used by the Geodimeter® and Geotracer® RTK system. By default, **GeoGenius** automatically selects a reference point and places this point on the reference sphere if no absolute height information on the network is available.

No transformation is done during importing. Data imported into the wrong System will be misplaced. If you know the projection, datum, ellipsoid and geoid model valid for your data, first define a corresponding System, select this System for your project and then import your Total Station Data.

The Format Selector dialog also offers a unit type option. In the unit type option you can specify how you want the data to be interpreted.

In case a file contains sufficient unit type information the information in the file will prevail over your choice. In case the selected Total Station Data import module recognizes the unit type of the file data (e.g., if the file format does not allow any other unit types but U.S. Survey Feet) the unit type option is disabled.

GeoGenius offers you the following choices:

- Meter
- Feet
- U.S. Survey Feet
- User-Defined

Selecting User - Defined will use the unit type you have defined in Options/Customize/Units for interpretation of length values.

11.1.3 Display Options (Zoom in/out)

Imported and calculated new Total Station Data observations will show up in the Total Station Container of the Navigator as Total Station observations (known station → unknown station). In the project plot, imported Total Station Data will add lines with markers for the observations and rhombuses for the observed points.

Several markers indicate the observed parameters:

Slope distance:	A perpendicular line	
Horizontal angle:	Empty triangle	
Vertical Angle:	Filled triangle	



Figure 11-2: Total Station Data in Navigator and Project Plot



A rhombus indicates a point observed by a Total Station only. A blue triangle indicates fixed points in the same way as with satellite data. Lines are the Total Station observations.

In order to improve perspicuity, **GeoGenius** won't display every marker for each observation line. If you want the graphical information concerning measurements, you just have to zoom in at this particular area and every marker will show up on the screen.

Remember, how to zoom in/out:

Move your mouse to the required area and press the left mouse button. A rectangle appears showing you the actual area you are going to zoom in to. To display the whole project network again use the menu entry **View/Zoom All** (or the corresponding toolbar button)

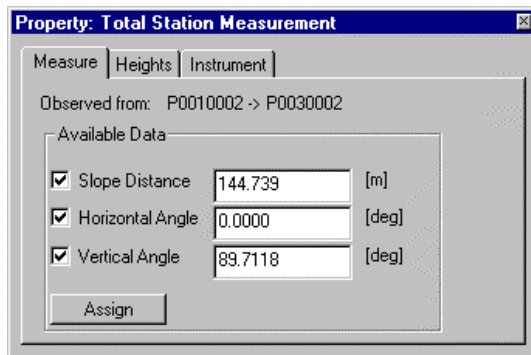


You may customize the colors of the points, observation lines and markers (refer to App. A.3).

11.1.4 Property Sheet

You can find more detailed information for each total station observation line in its property notebook. Click the respective line in the Total Station Container (right mouse-button) to open its context menu. Click the menu item **Properties** to open the notebook Property: Total Station Measurements. It consist of three pages:

- Measure
- Heights
- Instrument



The screenshot shows a dialog box titled "Property: Total Station Measurement" with three tabs: "Measure", "Heights", and "Instrument". The "Measure" tab is selected. Inside the dialog, it says "Observed from: P0010002 -> P0030002". Below this is a section titled "Available Data" containing three rows of data, each with a checked checkbox, a text input field, and a unit label:

Measurement	Value	Unit
☒ Slope Distance	144.739	[m]
☒ Horizontal Angle	0.0000	[deg]
☒ Vertical Angle	89.7118	[deg]

At the bottom of the "Available Data" section is an "Assign" button.

Figure 11-3: Property Total Station Measurement - Page Measure

GeoGenius allows you to disable each of the measurements. You may also edit the measurement and height values. Click the button **Assign** to assign the changes to the measurement.

Page Measure displays the available measurements. A complete set of Total Station Data consists of

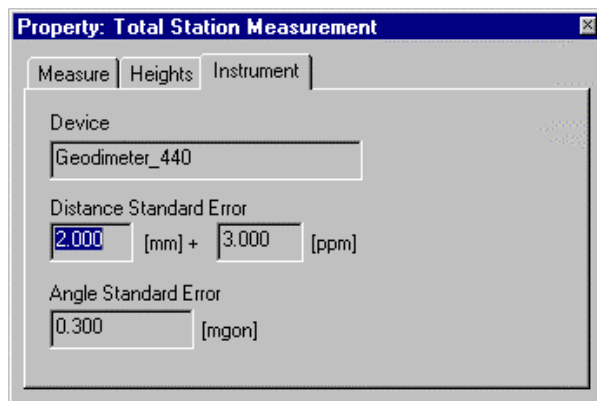
- Slope Distance
- Horizontal Angle
- Vertical Angle

The displayed units depend on the **GeoGenius** unit setting. You may customize the units via the menu item Options/Customize (refer to App. A.2).

The screenshot shows a software window titled "Property: Total Station Measurement". It has three tabs: "Measure", "Heights", and "Instrument". The "Heights" tab is selected. Inside the tab, there are two main sections. The first section is for "Instrument Height", showing a value of "1.750" in a text box, with "[m]" to its right. Above this text box is the instrument ID "P0010002". The second section is for "Signal Height", showing a value of "1.750" in a text box, with "[m]" to its right. Above this text box is the signal ID "P0030002". At the bottom left of the dialog is an "Assign" button.

Figure 11-4: Property: Total Station Measurement - Page Heights

The page Heights gives the heights of the total station (instrument height) and the reflector (signal height) above ground.



The screenshot shows a software window titled "Property: Total Station Measurement" with a close button in the top right corner. It contains three tabs: "Measure", "Heights", and "Instrument", with "Instrument" being the active tab. The "Device" field contains the text "Geodimeter_440". The "Distance Standard Error" section has two input fields: the first contains "2.000" followed by "[mm]", and the second contains "3.000" followed by "[ppm]". The "Angle Standard Error" section has one input field containing "0.300" followed by "[mgon]".

Figure 11-5: Property: Total Station Measurement - Page Instrument

The page Instrument lists the instrument type related data. The source for this information is an implemented list of Total Station data. You may edit the total station information via the page Total Station of the notebook Customize (item **Customize** of the pull-down menu **Options**, refer to App. A.2).

11.1.5 Adjustment

GeoGenius provides full support on combined network adjustment (GPS/GLONASS and Total Station Data)

Basically, all observations in the project go into the adjustment, including satellite observations and terrestrial measurements. How to select objects and to perform the adjustment please refer to chapter 12.

Least-squares adjustment of total station data may be performed in different ways. Under the menu item **Adjust** you will find the following pull-down menu:

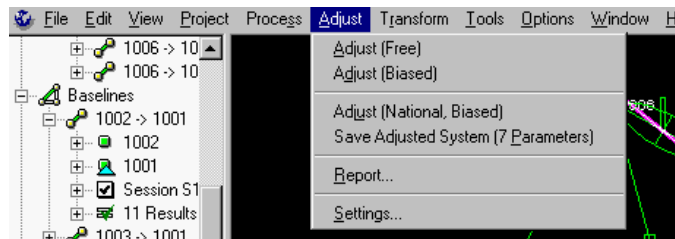


Figure 11-6: Pull-down Menu Adjust

11.1.5.1 Free Network Adjustment

When choosing the free network adjustment no coordinate of your network will be fixed resulting in a local system free network adjustment. The adjustment process automatically eliminates datum defects. All points get a standard error for each of the three dimensions, resulting in the display of an error ellipse on the screen for each point.

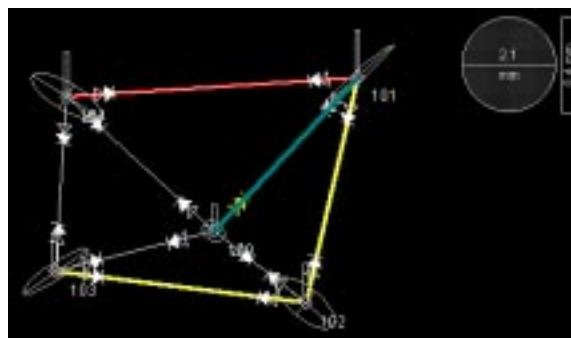


Figure 11-7: Free Network Adjustment with Total Station Data

11.1.5.2 Biased Adjustment

In the biased adjustment you define fixed control points in order to eliminate datum defects. It is well known that in a three-dimensional adjustment 7 datum defects can be found

- 3 translations
- 3 rotations
- 1 scale

The translation defects can be determined by fixing three coordinates in three different coordinate directions, e. g., geocentric Cartesian X,Y,Z or North, East, Height coordinates for one point or on different network points. (Point A)

You can eliminate the rotation defects by introducing a second and a third completely fixed point (Point B and Point C) in all three dimensions. The three control points should be geometrically distributed in a way that optimal determination of the three rotations is possible. As an optimum the points are on the corners of a triangle with equal side lengths covering most of the network area.

When working with total station data only a subset of this information might be also sufficient to eliminate rotation datum defects. The above holds, if no zenith distance (vertical angle) data was measured at all. However, if in the above example the data set consists of vertical angle measurements from point A to B and C, no height constraint is necessary on points B and C to eliminate data defects.

When GPS data is also present for network adjustment, the rotations are automatically fixed and there is no need to fix additional points for elimination of datum defects.

You can easily eliminate the scale defect by inserting

- two fixed points or

- a distance observation or
- a GPS baseline observation

In practice, the scale defect does usually not play a major role in biased network adjustment.

If you perform a biased adjustment with total station data only, the adjustment is performed in the WGS84 System. If GPS observation data is also present, the biased adjustment is also performed in the WGS84 coordinate system.

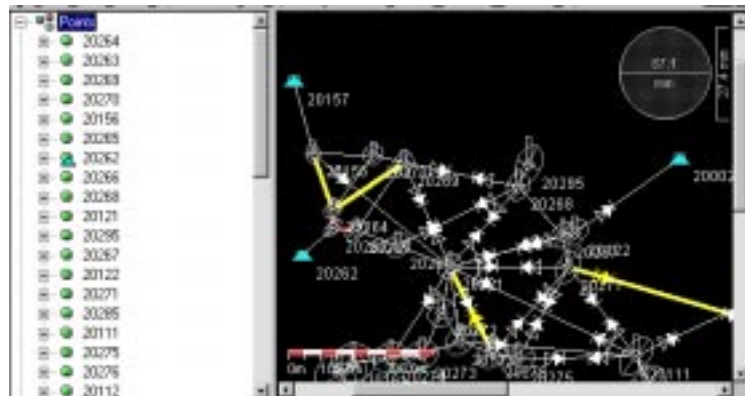


Figure 11-8: Biased Adjustment Performed

11.1.5.3 Biased Adjustment in the National Grid System

If you have used a national grid coordinate system for data processing, you may also fix coordinates in the national grid coordinate system and perform the adjustment in that System. As results you will get positions in this national grid system. The comments on the datum defects given in section *Biased Adjustment* are valid also for this case.

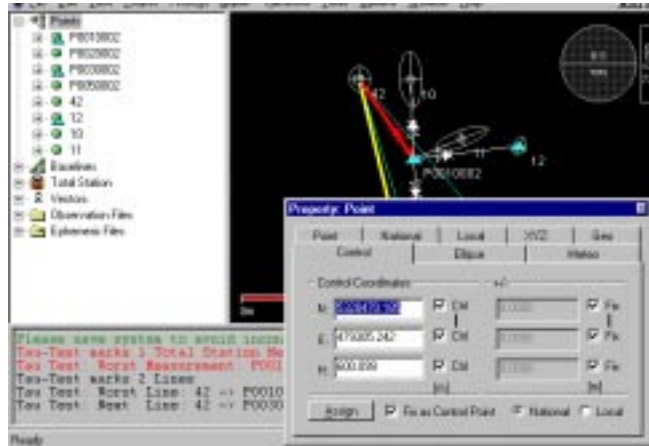


Figure 11-9: National Biased Adjustment - Control Coordinates Available!

11.1.5.4 Weighting of data

GeoGenius allows the use of different weighting parameters for the following observation types:

- Total station data
- GPS post processed baseline results
- GPS Stop&Go and RTK baseline results

The weighting parameter for total station data is by default 1. To change the weighting factor select the menu item **Settings...** of the pull-down menu **Adjust**. Click tab **Weighting** of the Adjustment Settings notebook:

The screenshot shows the 'Adjustment Settings' dialog box with the 'Weighting' tab selected. The dialog has five tabs: 'Filter', 'Tau Test', 'Parameters', 'Weighting', and 'Refraction'. The 'Weighting' tab contains three sections: 'GPS/GLN Weighting' with radio buttons for 'Variance/Covariance Matrix' (selected) and 'Fixed Standard Deviation'; 'Fixed Standard Deviation' with input fields for X (5 mm), Y (5 mm), and Z (8 mm) distances and their corresponding standard deviations (0.7 ppm, 0.7 ppm, and 1.2 ppm); and 'Predefined Standard Errors of Unit Weight' with input fields for Static GPS/GLN (10.00), Stop&Go GPS/GLN (1.00), and Total Station Data (1.00). At the bottom are 'OK', 'Abbrechen', and 'Übernehmen' buttons.

Category	Parameter	Value	Unit
Fixed Standard Deviation	X	5	mm
	Y	5	mm
	Z	8	mm
Standard Deviations	X	0.7	ppm
	Y	0.7	ppm
	Z	1.2	ppm
Predefined Standard Errors of Unit Weight	Static GPS/GLN	10.00	
	Stop&Go GPS/GLN	1.00	
	Total Station Data	1.00	

Figure 11-10: Set the Weighting Factor for Total Station Data

The individual weighting of total station data bases on the given standard deviations for the distance and angle measurements.

For optimal weighting, in combined GPS/total station adjustment, we suggest you to adjust the GPS data in a free network adjustment first, then insert the resulting standard error of unit weight as the weighting parameter for GPS. Then perform a free network adjustment of the total station data only and insert the resulting standard error of unit

weight as the weighting parameter. Only after these individual adjustments combine both observation types in one adjustment run.

11.1.6 Transformation

You can use all transformation options including the usage of **GeoTrans** (menu item Tools/Transformation, Projection) and the Transformation Tools (the menu item of the pull-down menu Transform) for calculations on Total Station Data. To get further detailed information on **GeoTrans** and the Transformation Tools please refer to chapter 13 and to the **GeoTrans User's Guide**.

11.1.7 Create and Modify Job-Files

11.1.7.1 Create Job-Files

A dialog allows you to generate a job-file, if you have some measurements that you want to add manually.

Open the container Total Station. Click the menu-item Tools/Create JOB File from the context-menu. The dialog Create Terrestrial JOB File Entries pops up.

The dialog box is titled "Create Terrestrial JOB File Entries". It features a "From:" field and a "To:" field. Below these are three checked checkboxes: "Horizontal Angle" (with values 0.0, 0, and 0.000000), "Vertical Angle" (with values 90.0, 0, and 0.000000), and "Distance" (with value 0.000 and unit [m]). A "Reset" button is positioned to the right of the "Distance" field. Below the checkboxes are two buttons: "Add New Orientation" and "Add to Current Orientation". A large, empty text area occupies the center of the dialog. To the right of this text area are five buttons: "Edit Line", "Insert Line", "Delete Line", "Move Up", and "Move Down". At the bottom of the dialog are three buttons: "Write to File...", "Read from File...", and "Close".

Figure 11-11: Create Job File

The dialog is separated in two parts. Above the middle-line information on terrestrial measurements can be entered manually. All these values together form an orientation. It includes:

- location (start-point) (From:) (default: empty)
- point of measurements (To:) (default: empty)
- Horizontal Angle in degree, minutes and seconds (default: 0°)
- Vertical Angle in degree, minutes and seconds (default: 90°)
- Distance between the points given in meter (default: 0m)

At any time, you may set these values to default (button: **Reset**). Entering new values can be averted via the respective check-box.

A job-file consists of one or several data sets. The area beneath the middle-line offers you certain options to work on the job-file, such as adding new orientations, deleting orientations or editing single lines. You can also read-in already existing job-files, modify them and write them to disk.

When you click the button **Add New Orientation**, the entries of the orientation data set will be added to the editing-field. They will be formatted corresponding to the job-file format and will be labelled correctly. A few comment lines (99=....) precede the first orientation set as well as the string (23=0011). **Do not delete this string because it defines the units for the following values!**

Figure 11-12: New Orientation added

All anew-generated orientations following the first one start with the respective comment for New Orientation. It is followed by the typical job-file-entries:

- 2= location (from)
- 5= point of measurement (to)
- 7= horizontal angle
- 8= vertical angle
- 9= distance

To attach the entries of the orientation data set (above middle-line) to the job-file click the button **Add to current orientation**. In

this case, the label (line) 2=xx is dropped. That implies that this data set is generated from the same location as the last one. They both belong to the same orientation.

Every single line of the job-file can be modified. You may:

- Delete a line: Activate it, click **Delete Line**
- Add a null string: Activate a line, click **Insert Line**
- Modify the string: Activate it, click **Edit Line**, then the dialog Edit Entry pops up. It allows you to edit the whole line.

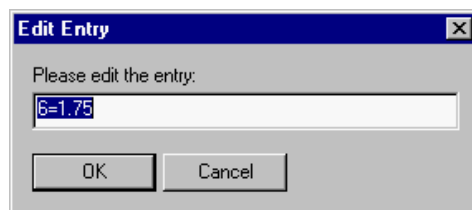


Figure 11-13: Edit Entry

- Move a string up or down, activate the string and click **Move up** or **Move down**.

To save the job-data entries, click the button **Write to File**. A standard file dialog opens using the default setting for the job-files. You may define the filename and -path here. The given data will be written to this file.

11.1.7.2 *Modify Job-Files*

To modify existing job-files open the dialog Create terrestrial JOB File Entries. (Activate the container Total Station and choose its context menu option Tools/Create JOB File).

Click the button **Read from File** to open a Standard File Dialog. It offers the default file extensions for job and area files. The content of the chosen files will be read in the job file editor. You now may edit it using all the options described in the previous section.

11.2 Levelling Data

The basic aim of levelling is the definition of the height difference between Points A and B by means of the vertical distance to a horizontal line, measured for each of the points. The precision of measurement is judged via the given standard deviation for 1 km of levelling:

Low precision levelling instruments :	> 10mm/km
Medium precision levelling instruments:	<= 10mm/km
High precision levelling instruments:	<= 3mm/km
Very high precision levelling instruments:	<= 1mm/km
Highest precision levelling instruments:	<= 0,5mm/km

Levelling instruments of low and medium precision are not considered. Levelling instruments of higher precision are used, e.g., for the determination of control point heights in networks and for subsidence monitoring.

11.2.1 Import of Levelling Data

Using the menu entry Project/Import/Levelling Data (or the corresponding toolbar button) you can import levelling measurements.



By default, the following formats are currently supported:

- ◆ JOB-Files: Find a description of the format in *App. B*.
- ◆ LEICA NA2000 Fieldbook
- ◆ ZEISS REC E

On demand, Spectra Precision Terrasat additionally will offer support for further file formats.

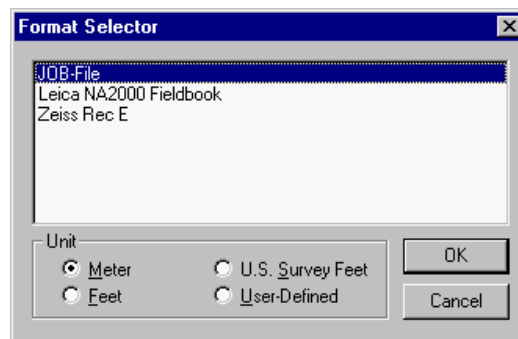


Figure 11-14: Format Selector for Levelling Data

When importing Total Station Data the Format Selector dialog offers all available file formats in an alphabetically sorted list box. Selecting a format and clicking **OK** or double-clicking on a format will lead you to a standard file selector dialog where you can browse for your import

file. In case the selected file format has a default file extension this extension will already be present.

The Format Selector dialog also offers a unit type option. In the unit type option you can specify how you want the data to be interpreted.

GeoGenius offers you the following choices:

- Meter
- Feet
- U.S. Survey Feet
- User-Defined

Selecting User-Defined will use the unit type you have defined in Options/Customize/Units for interpretation of length values.

To allow you to adjust and assign height values, **GeoGenius** needs information on the standard deviation for 1 km of levelling. The respective dialog pops up automatically as soon as you have accepted the import of levelling data via the button **OK**.

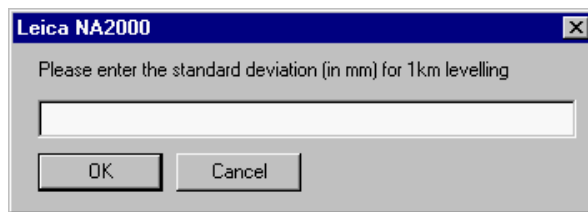


Figure 11-15: Standard deviation for 1 km levelling

11.2.2 Display Options

Imported new Levelling data will show up in the Levelling Container of the Navigator. New points, i.e., points with no other information than the height information given by levelling, show up in the points container marked by a question mark "?".

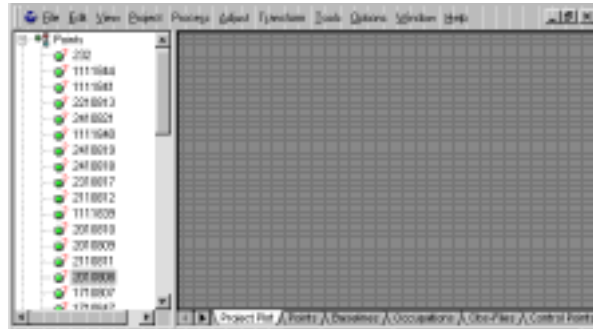


Figure 11-16: Project Plot and Navigator: Levelling information only

Identical points, i.e., points with additional information (vertical and horizontal components) do not show the question mark. In this case, you may assign the levelling heights to the point after 1D adjustment, if you did activate the respective option.

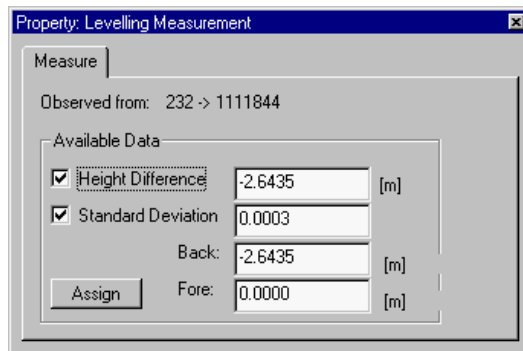


Within the project plot, pure Levelling measurements cannot be displayed, since they do not provide any horizontal information!

11.2.3 Property Sheet

You can find more detailed information for each levelling observation line in its property notebook. Click the respective line in the Levelling Container (right mouse-button) to open its context menu. Click the menu item **Properties** to open the notebook **Property: Levelling Measurements**. It consists of one page:

- Measure



The screenshot shows a dialog box titled "Property: Levelling Measurement" with a "Measure" tab selected. The "Observed from:" field shows "232 -> 1111844". Under "Available Data", there are two checked items: "Height Difference" with a value of "-2.6435 [m]" and "Standard Deviation" with a value of "0.0003". Below these, there are fields for "Back:" with a value of "-2.6435 [m]" and "Fore:" with a value of "0.0000 [m]". An "Assign" button is located at the bottom left of the data section.

Field	Value	Unit
Height Difference	-2.6435	[m]
Standard Deviation	0.0003	
Back	-2.6435	[m]
Fore	0.0000	[m]

Figure 11-17: Property: Levelling Measurement

The page **Measure** displays the available measurement values:

- ◆ Height difference
- ◆ Standard deviation for the measurement
- ◆ Forward and backward sight

11.2.4 Adjustment

GeoGenius provides full support on combined network adjustment (GPS/GLONASS, Total Station and Levelling Data)

Basically, all observations in the project go into the adjustment, including satellite observations and terrestrial measurements. The following describes the adjustment modes supported with levelling data.

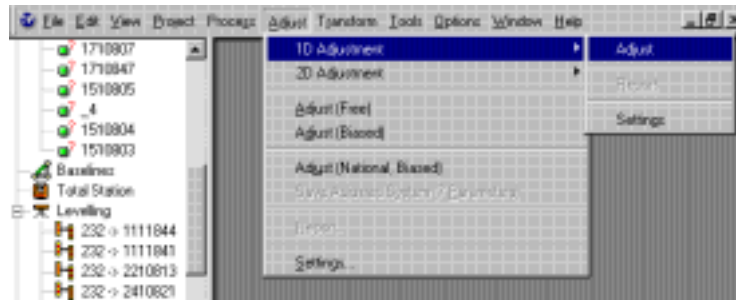


Figure 11-18: Menu Adjustment

11.2.4.1 1D Adjustment

To start a 1D adjustment choose the pull-down menu option Adjust/1D Adjustment/Adjust. We have to distinguish between a free and a biased 1D adjustment.

Free 1D Adjustment

If all points of a network are known 1-dimensionally, i.e., they only provide height information, a free 1D adjustment will be performed automatically.

Biased 1D Adjustment

If one or more points of the network contain horizontal information as well as vertical information, automatically a biased adjustment will run.

Optionally, you may assign the results of the adjustment (heights) to the points. To do so, choose the pull-down menu option Adjust/1D Adjustment/Settings and check the checkbox Assign after biased adjustment.

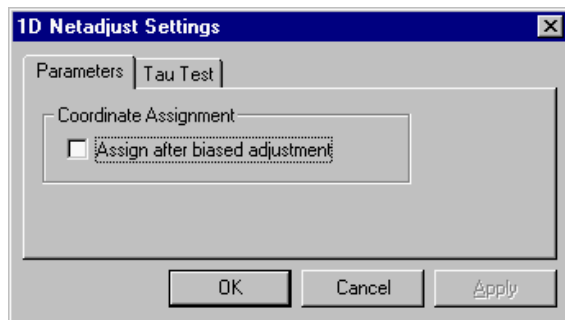


Figure 11-19: Coordinate Assignment

You may also set parameters for the Tau test to be performed after adjustment.

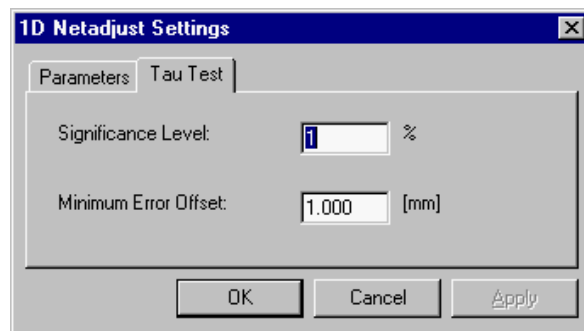


Figure 11-20: 1D Netadjust Settings - Tau Test

τ test results are true (i.e., a baseline is marked as “bad”) with a specific probability. The **Significance Level** value reflects the probability of the τ test to “reject a true hypothesis”, that means, to not mark a measurement, which is bad. By default, this value is set to 1%. If you increase the value, probably more measurements will be marked as bad. If you decrease the value, only those measurements with a very high probability to be really bad by means of the τ criteria will be marked.

For levelling data testing **GeoGenius** uses the fixed offset **Minimum Error Offset**, given in the current distance unit.

11.2.4.2 Other Adjustment Modes

In general, all other ways of adjusting a network (e.g., National, Biased) are available, if all selected points have three-dimensional coordinates. Additional levelling measurements are considered and adjusted. The page Tau Test of the notebook Adjustment Settings

(choose the menu option **Adjust/Settings**) allows you to modify the Tau Test criterion **Minimum Error Offset** for levelling data.

11.2.5 Export

After a biased adjustment (and with activated assignment of heights) you may export all points with three-dimensional coordinates. A lot of different export formats are available to do so. A complete description of how to export results is given in *ch. 5.6. App. A.6* describes how to customize **GeoGenius** for additional export formats.

12. Network Adjustment

Redundant observations form the basis of a network adjustment. They can be used to improve the results and to investigate for reliability.

The **GeoGenius** adjustment computes coordinates that are optimized by the method of least squares.

The first three sections of this chapter give details on the theoretical background of network adjustment. The following sections will supply you with information on practical questions, such as network design, parameter settings, results and how to improve your adjusted network.

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12.1 Basics

Surveying networks are normally designed in such a way that more elements than are geometrically necessary are observed to compute the coordinates of the network points. The redundant observations form the basis of a network adjustment and can be used to improve the results and for reliability investigations. Our network adjustment computes coordinates that are optimized by the method of least squares.

The adjustment is based on equations where the observations are expressed as function of unknown parameters. A Taylor series expansion is usually performed in the case of a nonlinear relationship between observations and unknowns. The resulting linear relationship can be represented in a matrix - vector notation as

$$l = A * x$$

where

l ... vector of observation
 A ... design matrix
 x ... vector of unknowns

n observations and u unknown parameters lead to a design matrix A comprising n rows and u columns.

In the case of a network adjustment, the observations are the dx , dy and dz components from the processed baselines (and, if any, terrestrial measurements and control points in WGS84). The unknown parameters are the coordinates of the unknown points. If there are more

observations than unknowns, generally the observations cannot be exactly reproduced by the unknowns, that means that one cannot find unknowns which solve the equation

$$l = A * x$$

exactly. That means, that we have to add a noise vector v to the observations.

$$l + v = A * x$$

The job of the adjustment is to find the set of unknowns which result in the “smallest” noise vector v . A possible criterion for the noise vector to be “small” is that its norm is small.

$$v^T * v = \textit{minimum}.$$

This is the principle of least squares, which is used in our adjustments. The solution vector x of the unknown coordinates is then computed as:

$$x = (A^T * A)^{-1} * A^T * l.$$

In addition, the observations are weighted according to their variance - covariance. Roughly spoken, the weighting factor of an observation is the reciprocal of its variance, which, in turn, is the square of its standard deviation. That means that an observation that is considered to be very accurate (small standard deviation) gets a big weighting factor and therefore strongly affects the adjustment result. On the other hand, giving an observation a big standard deviation (relatively to the other observations) makes its impact on the adjustment result small.

Then, we minimize the quantity

$$\mathbf{v}^T * \mathbf{P} * \mathbf{v} = \textit{minimum}.$$

(P is the weighting matrix of the observations). The solution vector $\mathbf{x}$ of the unknown coordinates is then computed as:

$$\mathbf{x} = (\mathbf{A}^T * \mathbf{P} * \mathbf{A})^{-1} * \mathbf{A}^T * \mathbf{P} * \mathbf{l}.$$

In practice, you will find that carrying out a network adjustment is simple. It is accomplished with one mouse-click.

Of course, surveyors are not really interested in three-dimensional WGS84 coordinates, they want traditional planar coordinates and a height component. Therefore, transformation routines, which will transform the 3D-Cartesian coordinates to coordinates based on a local or national grid coordinate system, are included in this package.

12.2 Network Adjustment in the WGS84 System

12.2.1 Purpose

The results obtained from processing GPS observations are baseline vectors (relative coordinates) based on the World Geodetic System of 1984 (WGS84). These coordinates are three-dimensional Cartesian coordinates, which are defined in an Earth centered, Earth fixed frame.

With this adjustment Cartesian point coordinates in WGS84 are calculated from baseline observations and, if any, from terrestrial measurements and control points in WGS84. The following lists the input (observations of the adjustment), the unknowns of the adjustment and the results of adjustment.

Observations of the adjustment:

- ◆ Baselines in WGS84
- ◆ Terrestrial data
- ◆ Control points in WGS84 (optional)

Unknowns of the adjustment:

- ◆ Points in WGS84

Results of the adjustment:

- ◆ Standard error of unit weight
- ◆ Adjusted Points in WGS84 with their standard deviations
- ◆ Adjusted Baselines in WGS84 with standard deviations and corrections
- ◆ Refraction coefficient (optional)
- ◆ Adjusted terrestrial measurements

12.2.2 Network Adjustment Without WGS84 Control Points (Free Network Adjustment)

Here, the baselines and terrestrial measurements are the only observations. No control points are needed to adjust the network. Because no control points or datum restrictions are imposed on the network, the inner accuracy of the measured baseline network is determined.

Therefore, this adjustment is called free or unbiased. A baseline or terrestrial measurement contains only information about the relative position of two points. Because these are the only observations, which enter the adjustment, the absolute position in space of the adjusted network cannot be determined by the adjustment procedure. Therefore, after the adjustment, one point is chosen as a reference point and the network is shifted onto this reference point. This reference point is the first point in the point list. Please be aware of the fact, that this reference point is only used to display the network and is of no importance for adjustment.

To adjust your network in the WGS84 system in geocentric Cartesian coordinates choose **Adjust/Adjust (Free)**.

12.2.3 Network Adjustment with WGS84 Control Points (Biased Network Adjustment)

Here, baselines, terrestrial measurements and control points in WGS84 are added as observations to the adjustment. Adjusted baselines, terrestrial measurements and adjusted absolute point coordinates are calculated.

To adjust your network in the WGS84 system in geocentric Cartesian coordinates choose **Adjust/Adjust (Biased)**.

12.2.4 Adjustment Process

After the start of an adjustment in the WGS84 system, the output window and a progress indicator bar informs you on the current status of the network adjustment. The output window contains information messages, while the progress indicator bar represents the progress of the adjustment process. You may interrupt the adjustment process at any time by pressing the button **Cancel**.



Remember to run the Loop Closure quality check in the processing module before you start a network adjustment. This pinpoints blunders such as wrong antenna heights.

12.3 Network Adjustment in the National System

12.3.1 Purpose

The adjustment in the national grid system is very similar to the adjustment in the WGS84 system. The difference is that you obtain adjusted state plane (national) coordinates in contrast to adjusted WGS84 coordinates. You also obtain adjusted transformation parameters in shift, rotation and scale between the WGS84 and your national system. It is necessary to have at least three points with known coordinates (two points in plane and three points in height) in the national system, which can be used as control coordinates. You may import control points in WGS84 to improve the results.

You can add as many control points as you want. Different accuracies of the control points are considered via the weighting factor. The more control points you have, the more reliable the result will be. Also, you do not need the full coordinate set (Northing, Easting and Height) for the control points. It is also allowed to add only the height or only Northing/Easting of a control point to the adjustment.

The following lists the input (observations of the adjustment), the unknowns of the adjustment and the results after adjustment.

Observations of the adjustment:

- Baselines in WGS84
- Control points in the national grid system
- Control points in WGS84 (optional)
- Terrestrial observations

Unknowns of the adjustment:

- Points in local system
- seven parameters for the transformation to the national grid system

Results of the adjustment:

- Standard error of unit weight
- Adjusted Points in local system and WGS84 with their standard deviations
- Adjusted Baselines in WGS84 with standard deviations
- Adjusted terrestrial measurements
- adjusted seven parameters for the transformation to the national system
- Refraction coefficients (optional)

12.3.2 Adjustment Process

Before adjusting the network in your national system you will have to do some preliminary steps:

- * Choose the correct System,
- * Insert control points with known national coordinates,
- * Insert control points with known WGS84 coordinates (optional),
- * Insert terrestrial data (optional),
- * Enter the maximum number of iterations and optionally modify other parameters.

12.3.2.1 Set the System

If you have not done so previously, you have to define a System for the adjustment to national grid coordinates. We use the term “System” in order to describe a point on the Earth model or on a map. Several steps are necessary, since the Earth has no ideal shape.

A geodetic System, consists of the components:

- datum
- ellipsoid
- projection (optional)
- geoid (optional)

Chapter 6 of this manual and the **GeoTrans User's Manual** give complete access to information about the definition and use of Systems.

12.3.2.2 Provide Control Coordinates

GeoGenius needs at least three national control points. If sufficient control information is available, a control point does not necessarily have to provide all three coordinates in Northing, Easting and Height. You may also choose only the horizontal or the vertical component (via the checkboxes **Ctrl** in the Point Property Notebook, page Control). The network adjustment will not use a disabled coordinate element.

How to provide the known coordinates is discussed in detail in chapter 5.5.2. Sections 12.4.2 ... 12.4.4 contain more information on control coordinates, fixed points and point properties.

Note that control points need not necessarily to be held fixed. Only if you want to make sure, that the control coordinates will not be changed during adjustment, the point has to be held fixed. Any coordinate that has to be held fixed must be assigned a standard deviation

of 0.000 mm. If it is not zero, the coordinate may get a correction. Fixed points are weighted very high during adjustment.

12.3.2.3 Define the Maximum Number of Iterations

If you choose an adjustment in your national system, you will also have to enter the maximum number of iterations. The number of iteration steps depend in the first place on how good the control points and the GPS baselines fit together and in the second place how exact the approximate seven transformation parameters are (how to review or define transformation parameters is discussed in the **GeoTrans User's Manual**). Typically, 4 iteration steps are needed for an adjustment.

The software stops the iteration when the standard error of unit weight did not change since the last iteration step. This indicates, that the residuals in the network have practically not changed since the last iteration, and consequently that the unknowns have been calculated to the best achievable accuracy.

You may check the maximum number of iterations (see also section 12.5.4).

12.3.2.4 Start the Adjustment

With all the preliminary steps been done choose **Adjust/Adjust (National, Biased)** to start the least-squares Network Adjustment process in the national system.

A progress indicator window displays information on the current process and its progress in form of a bar. You may interrupt the adjustment process at any time by pressing the button **Cancel**. The output window will display any error or additional information messages.

12.4 Network Definition

12.4.1 Network Design

You may select one, several or all baselines for network adjustment. To do so, you may choose the navigator or the project plot area.

The baseline selection options are basically the same as discussed in chapter 7.1. However, a lot of additional selection and toggling options help you to configure your network. To make yourself accustomed with **GeoGenius**'s network design facilities just play around using all enabling and disabling options offered by the toolbars Lines and Ellipses and described in the following. The Enable All / Disable All buttons of both toolbars allow you to quickly return to the default status!



12.4.1.1 *Toggle the Enabling Status of Terrestrial Observations*

With terrestrial data, you may enable or disable a single total station observation or a levelling measurement via its context menu. Click the observation symbol either in the project plot or in the navigator (right mouse button) to open its context menu and choose the menu item **Enable** to enable the observation, or **Disable** to disable the observation. By default, all observations are enabled.

12.4.1.2 *Toggle the Enabling Status According to the Quality Status:*

It is possible to activate or deactivate baselines according to their color status generated during processing, i.e., **according to their status of quality**.

Toggling options toggle the status of all lines with the same status. If, e.g., line AB was enabled before and all other lines of the same type were disabled, line AB will be disabled after toggling, while all the other lines will be enabled.

To toggle the baseline status according to the quality status choose

- * Edit/Base Lines/Toggle [Color] from the menu, or
- * Baselines/Toggle/Toggle [Color] from the navigator, or
- * the corresponding icon from the toolbar Lines.



Figure 12-1: Toolbar Lines

If the green lines are enabled, all baselines with fixed ambiguities, respectively baselines with double difference fixed solutions with an accuracy better than the maximum position sigma value are enabled. This value is defined via the menu option Process/ Settings.../ Advanced.

If the yellow lines are enabled, all baselines with double difference float solutions are enabled (and a position sigma within the given value). This value is defined via the menu option Process/Settings.../Advanced.

If the red baselines are enabled, all baselines with double difference fixed solutions, triple difference float solutions or double difference float solutions are enabled which have an accuracy worse than the given maximum position sigma. This value is defined via the menu option Process/Settings.../Advanced.

If the gray baselines are enabled, all unprocessed baselines are enabled. Unprocessed lines do not go into the adjustment.

If all blue baselines are enabled, all baselines with only a triple difference float solution are enabled.

12.4.1.3 Toggling the Enable Status According to the Standard Deviation Quality

After processing, the standard errors of processed baselines are visualized by error ellipses. The toolbar Ellipse, however, allows you to select baselines according to their quality status. If the button Lines+Ellipses is activated, toggling the ellipses according to their color at the same time toggles the corresponding baselines!



Figure 12-2: Toolbar Ellipses: Lines+Ellipses

The first two buttons allow you to enable or disable all ellipses (baselines). The following four buttons select baselines according to the quality status of the ellipse. The following figure shows a project with baselines of different processing status. All lines and ellipses are enabled. The ellipses of the green baselines are relatively small in comparison to the ellipses of the yellow or blue baseline.

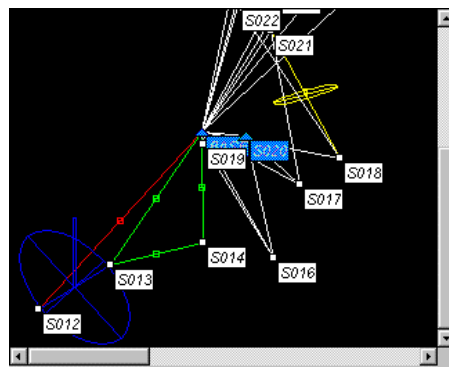


Figure 12-3: All baselines enabled

With toolbar button Lines+Ellipses activated and all yellow, red or blue ellipses toggled, only the green baselines are enabled. Their ellipses are resized.

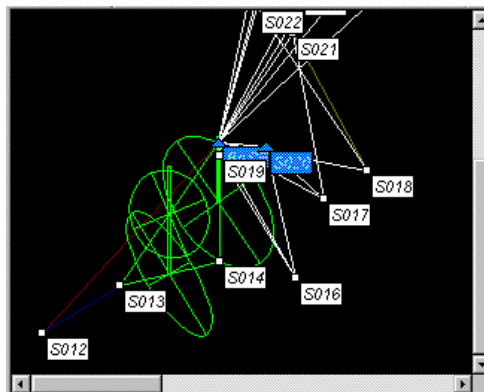


Figure 12-4: Only good baselines enabled

Additionally, two buttons allow you to successively disable or enable baselines or ellipses. Click button Disable Worst to disable the baseline

with the worst results of all baselines currently enabled. Button Enable Next works the other way round. If you click this button, the baseline with the best result of all disabled baselines will be enabled.



Figure 12-5: Disable Worst - Enable Next

12.4.1.4 Toggling the Display of Error Ellipses

After processing, the standard errors of processed baselines are visualized by error ellipses. The size of these ellipses depends on the baseline with the largest errors. If the network contains outliers with large standard errors, all other ellipses will be very small. If, however, large ellipses are hidden, **GeoGenius** automatically resizes the remaining ellipses as well as the reference ellipse. This option will help you find suspicious data and exclude baselines and to improve network adjustment.

The toolbar Ellipses allows you to quickly show or hide ellipses.



Figure 12-6: Toolbar Ellipses

Make sure, that button Lines - Ellipses is enabled. This button assures that ellipses and baselines are toggled independently. You may then enable or disable all error ellipses or those ellipses according to a color indicating their quality status.



12.4.2 Control Coordinates

It is often useful (and necessary for adjustment to a national grid system) to enter the WGS84 coordinates or national coordinates of points with known coordinates. For information how to input control coordinates, please refer to chapter 5.5.2. Section 12.4.4 describes how to define the horizontal or vertical component of a point as control coordinate.

After the input of control coordinates, two sets of coordinates are part of the point. The control coordinates show up in the page Control of the notebook Property: Point. To open the notebook activate the context menu of the respective point by clicking on it (right mouse button) and then choose option **Properties**. Click the tab **Control**.

The screenshot shows the 'Property: Point' dialog box with the 'Control' tab selected. The dialog has a title bar 'Property: Point' and a close button. Below the title bar are tabs: 'Point', 'National', 'Local', 'XYZ', and 'Geo'. Under these are sub-tabs: 'Control', 'Ellipse', and 'Meteo'. The 'Control' sub-tab is active. It contains a section 'Control Coordinates' with three input fields: 'N: 5320470.185', 'E: 479305.242', and 'H: 600.099'. Each field has a 'Ctrl' checkbox to its right, all of which are checked. Below these fields is a '[m]' label. To the right of the 'Control Coordinates' section is a section with a '+/-' label and three input fields, each with a 'Fix' checkbox to its right, all of which are checked. Below these fields is a '[m]' label. At the bottom of the dialog is an 'Assign' button, a 'Fix as Control Point' checkbox (checked), and two radio buttons: 'National' (selected) and 'Local'.

Figure 12-7: Point Properties, Page Control

12.4.3 Fixed Points

Before performing a least-squares adjustment you can choose to hold the coordinates of one or several control point(s) fixed during adjustment. Activate the point in the navigator or the project plot and open the context menu using the right mouse button. The menu item **Fix** allows you to toggle the fixing status of this point. To fix all points or fix none choose **Fix All / Fix None** of the **Edit/ Static Points** menu option or activate the context menu of the **Points** selector in the navigator and choose **Fix All** or **Fix None**, resp. If **Fix** is chosen, the standard deviations are set to zero and thereby the point is fixed. Otherwise, the standard deviation shown in the **Point Properties** notebook, page **Control**, will be used for adjustment. Section 12.4.4 describes how to fix the horizontal or vertical component of a point.



Note that fixed points will weigh very high within the adjustment. They force the adjustment module to adjust all others points in a way that they will fit the fixed points. Be sure that fixed points have very precise coordinates, otherwise they may induce geometrical distortions of your network.

The project plot and the navigator display a little triangle to mark a fixed control point. However, you may customize the display of control points in the project plot. For example, for the figures of this manual we have assigned different background colors for fixed or unknown points. Appendix A.3 discusses in detail the customizing of the project plot styles.

A fine option allows you to visualize your network more accurately by centering a control station on your project plot. Just enable the **Center** menu item of the context menu of the selected point.

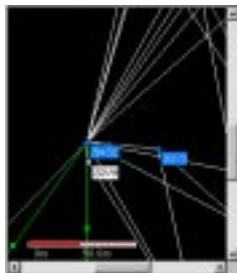


Figure 12-8: Fixed Points

You may check the fixing status of a point via its properties notebook. Click the point (right mouse-button) and choose the context menu item **Properties**. Click the tab **Control** to review the page **Control**.

Property: Point

Point | National | Local | XYZ | Geo

Control | Ellipse | Meteo

Control Coordinates

N: N/A ☒ Ctrl ☒ Fix 0.0000

E: N/A ☒ Ctrl ☒ Fix 0.0000

H: N/A ☒ Ctrl ☒ Fix 0.0000

[m] [m]

Assign ☒ Fix as Control Point ☒ National ☐ Local

Figure 12-9: Fixed Point - No Control Coordinates

If you fixed the point, the checkbox **Fix as Control Point** will be checked and all standard deviation values (see the box +/-) will be in-

activated. (If you previously selected the fixing status of the horizontal or the vertical component manually, these will not be touched).

If you want only the horizontal or the vertical coordinates to be held fixed, then you first have check the **Fix** boxes of the respective +/- values. If, e.g., the adjustment module is to hold the horizontal components of a point fixed, first clear the checkbox of the height coordinate, then check the checkbox **Fix as Control Point** and click the button **Assign**.

12.4.4 Point Properties

You may find all point related information in the property notebook of the point. You may even change the properties of a static point manually there. Activate the context menu of the respective point by clicking on it (right mouse button) and then choose option **Properties**. The Properties window allows you to review and edit point characteristics.



Please note: Press the button **Assign** to update values of the notebook. If you want to store the new values in the project file, do not forget to save the file! Changes in the **Properties** notebook do not influence the point coordinate sources! Your input data files remain untouched!

Property: Point

Control Ellipse Meteo

Point National Local XYZ Geo

Number: New_Point_1

Info:

Code:

Assign Derived from: Manual Input

Figure 12-10: Point Properties - Point

This notebook contains eight pages:

- Point
- National
- Local
- X/Y/Z
- Geo
- Control
- Ellipse
- Meteo

The page Point displays the Point number (Number), point information (Info) and point code (Code). This information is typically derived from the observation file header. You have the ability to change them. An info box states where the point coordinates are derived from. This may be:

- From OBS file
- From Processing
- Manually inserted
- ?

The pages National and Local display the plane coordinates of the point. Coordinates of page National are in the national grid System. If you have defined a local System by a set of 4/5 parameters, page Local provides the plane coordinates in the local System. The distance and angle units depend on the **GeoGenius** unit setting (refer to App. A.2). You may change the coordinates and enter known plane coordinates manually. Press the button **Assign** to update the notebook and to compute the coordinates in all other systems accordingly (with the exception of control coordinates, if any, of course). If you want the

newly assigned coordinates to be used as control coordinates, click the button **Transfer to Control**.

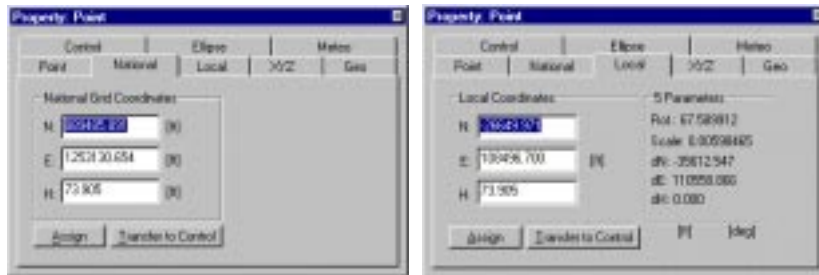


Figure 12-11: Point Properties - National and Local

The right box of each tab offers additional information: on the used projection parameters and geoid model in use and on the geoidal height (tab National), resp. on the transformation parameters (tab Local).

GeoGenius allows you to manage and edit your national coordinates using the orthometric height as well as the ellipsoidal height. You will find both values on tab National as ellipsoidal height h and as orthometric height H . Since a given relation exists between these values ($h = H + N$), only the left field acts as an editing field. Via the small button  you may toggle the display of the height values. This option allows you to either edit the ellipsoidal height or the orthometric height. The adjustment processor uses ellipsoidal heights.

Page XYZ displays the Cartesian coordinates of the point. You may change the coordinates and enter known WGS84 Cartesian coordinates. Press the button **Assign** to update the notebook and to compute the geographical, national (and local, if available) coordinates accordingly. If you want the newly assigned coordinates to be used as

control coordinates, click the button **Transfer to Control** at the page National.

Geographical point coordinates are displayed on page Geo of the Properties notebook. They are either computed on the WGS-84 ellipsoid or on the current ellipsoid in the current national datum System. Units are [°, ', "]. You may define which System to be used by a click on the respective radio button. You may change the coordinates and enter known geographical coordinates. Press the button **Assign** to update the notebook and to compute the national, (local coordinates, if a local System is available) and WGS84 coordinates accordingly. If you want the newly assigned coordinates to be used as control coordinates, click the button **Transfer to Control** at the page National.

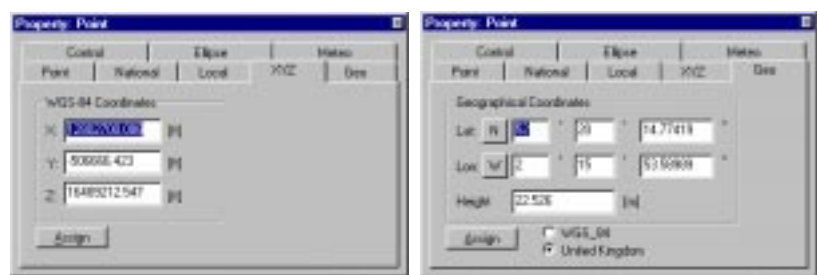


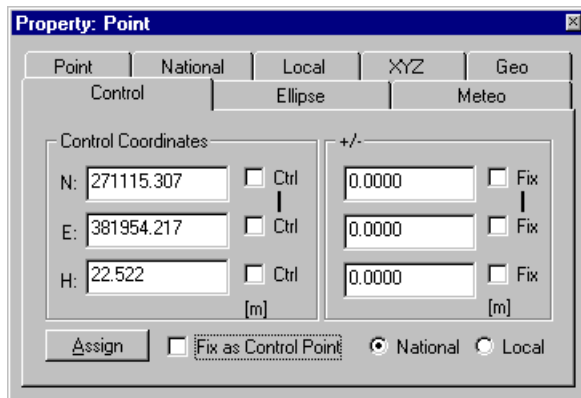
Figure 12-12: Point Properties - XYZ and Geo

The page Control serves two purposes. On the one hand, it contains the control coordinates as a second, independent coordinate set, if you have any control coordinates of the point. On the other hand, this page allows you to fix the point or its horizontal or vertical coordinates.

The box **Control Coordinates** displays the planar control coordinates. If no control coordinates are available, the N, E, h/H string fields display the entry N/A. You can enter known coordinates manually or

from a file such as, e.g., an *.SPC file (refer to chapter 5.5.2/5.5.3).

Via the button  you may toggle the display of ellipsoidal and orthometric heights. The radio buttons National and Local at the bottom of the page show whether the plane coordinates are given in the national grid System or in the local System. The coordinate units depend on the **GeoGenius** unit setting (refer to App. A.2), as it is the case throughout this notebook.



Property: Point

Point | National | Local | XYZ | Geo

Control | Ellipse | Meteo

Control Coordinates

N: 271115.307 ☐ Ctrl +/- 0.0000 ☐ Fix

E: 381954.217 ☐ Ctrl +/- 0.0000 ☐ Fix

H: 22.522 ☐ Ctrl +/- 0.0000 ☐ Fix

[m] [m]

Assign ☐ Fix as Control Point ☒ National ☐ Local

Figure 12-13: Point Properties - Control Coordinates

If you want to use for network adjustment the horizontal or the vertical control coordinates or both, check the checkboxes **Ctrl** at the right-hand side of the N,E,h/H string fields.

The box **+/-** displays the standard deviations for the control coordinates. If you know the reliability of your control coordinates, you may manually enter standard deviation values here. The standard deviation values only go into the adjustment, if the checkbox **Fix** is not checked. Otherwise they are set to zero.

To hold a point or its horizontal or vertical component **fixed** in adjustment, you have to set the standard deviations of its control coordinates to zero. You can do this in two ways on page Control.

a) Check the checkbox **Fix as Control Point**. The standard deviation fields are inactive then and the three checkboxes **Fix** at the right-hand side of the standard deviation string fields are checked. The adjustment module internally sets all fixed standard deviations to zero, even if the string field still displays another (inactive) value. The inactivation of given standard deviations allows you to experiment with the fixing states of points without the need to repeatedly enter the standard deviation values.

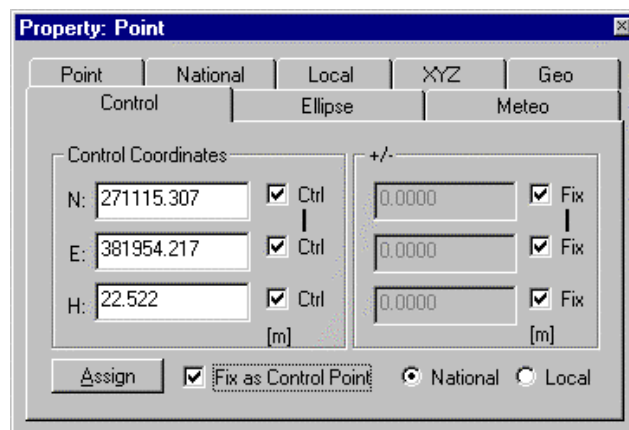


Figure 12-14: Control Point Fixed

b) You may also fix the horizontal or vertical component by activating the respective checkbox **Fix**. If a component is well known and, therefore, its standard deviation should be set to zero, check the checkbox **Fix** next to the respective standard deviation. Fix the N and E coordinates only as a set.

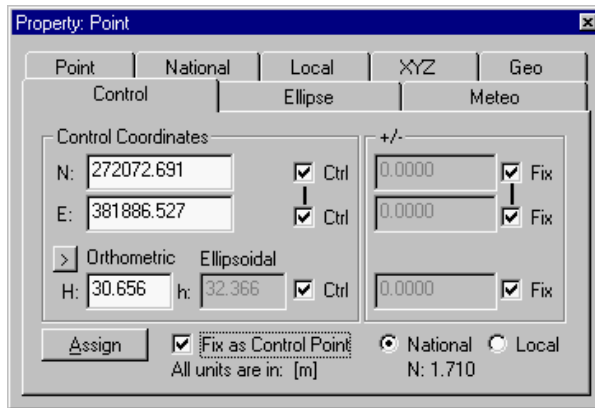


Figure 12-15: Coordinate Held Fixed

Press the button **Assign** to update the notebook for changes.

If a network adjustment has been carried out, page Ellipse will display the values of the point's error ellipse calculated in the network adjustment process. If no adjustment has been done so far, zero values will be displayed (refer to section 12.6.2).

Page Meteo allows you to change the meteorological data for the point and to inspect the tropospherical model in use (refer to chapter 7.5).

12.4.5 Project Information

You may review the **status of your network for adjustment**. To do so, just choose the Project/Info... . Choose page Objects of the Project Info notebook.

Category	Value	Limit/Label
Points	1	
Lines	5	
Sessions	6	
Results	0	
Solutions	0	
OBS Files	7	
EPH Files	1	
T.Stat	5	
Objects	35	(of 16777216)

Figure 12-16: Project Info

Page Objects displays information on the number of objects included into the project. These objects may be:

Static points	Points
Baselines	Lines
with	Sessions
	Results
	Solutions
Observation files	OBS Files
Ephemeris files	EPH Files
Total Station Measurements	T.Stat
Sum of above objects	Objects

To review the number of control points of your project activate **Points** in the navigator or in the **Edit** menu. Open the context menu with the right mouse button and choose option **Properties**. The Property window allows you to review and, sometimes, edit file characteristics.

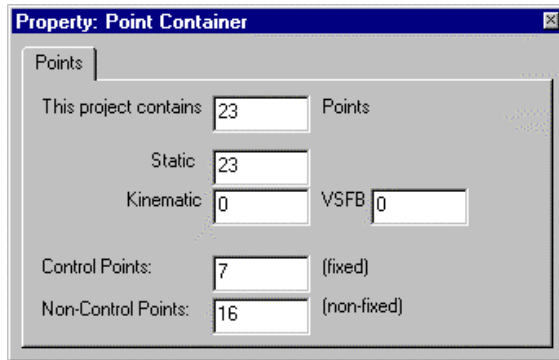


Figure 12-17: Points

This notebook contains the single page **Points**. Page **Points** displays the following values:

- Number of points the project contains (**Points**)
- Number of Static Points (**Static**)
- Number of Kinematic Points (**Kinematic**)
- Number of points initialized via VSFB (**VSFB**)
- Number of control points (**fixed**)
- Number of non-control points (**non-fixed**)

12.5 Settings

GeoGenius allows you to modify a lot of parameters, which may influence the network adjustment. For example: Terrestrial data included, you may induce the computation of a refraction coefficient for each point or baseline. You may weight the standard errors differently depending on the source of the data. You may perform a tau test and set tau test limits.

The option **Settings...** of either the pull-down menu **Adjust** or the context menu of the **Vectors** container opens the notebook **Adjustment Settings**. Here you may check and modify the settings for the Network Adjustment module.

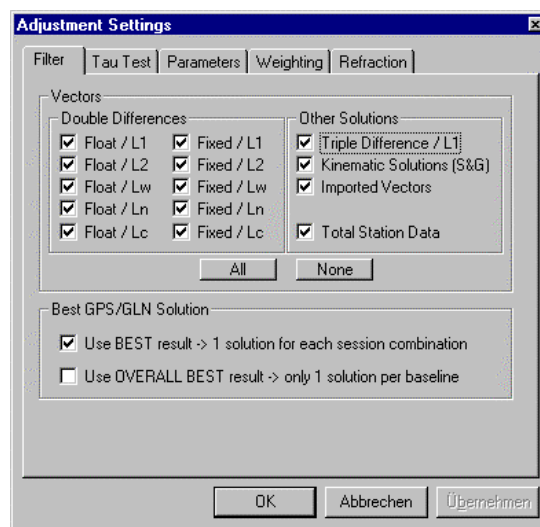


Figure 12-18: Notebook Adjustment Settings

12.5.1 Used Results

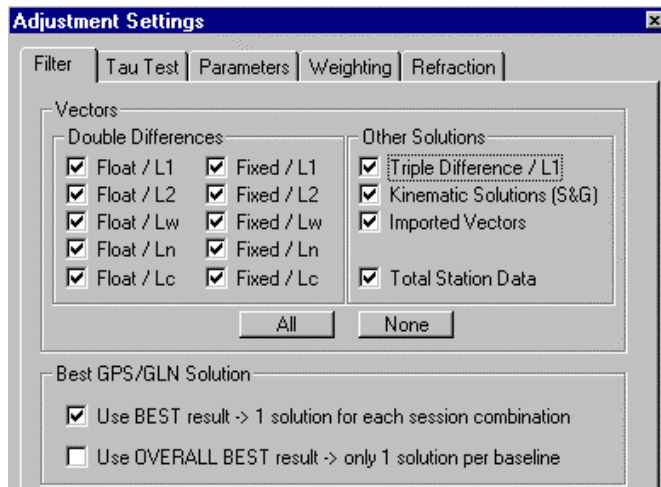


Figure 12-19: Adjustment Settings - Result Filter

The page **Filter** offers settings to filter the results of the baseline processing or from imported data files. Only the filtered results are used in the **Network Adjustment**. By default, the static baseline processor calculates up to eleven different results depending on the processing mode and automatically selects the one with statistically the best baseline components. Optionally you may select a different quality of processing result for the network. All results will be checked; only the selected ones pass through the filter. For most of your work, the L1 fixed solutions should be marked in the filter selection, as these are usually the best solutions.

Additionally, point vectors derived from kinematic Stop&Go surveying may also enter the adjustment. However, note that when all Stop&Go points are sent, the bad results will also be passed to the network. You

may also include imported point vectors, which are not derived from the current processing, but are imported by File I/O. Finally, terrestrial data from total station measurements may contribute to your network.

The box Vectors/Double Differences includes all double difference float and fixed solutions. You can select between different frequencies. The box Results/Other Solutions allows you to select from the Triple difference/L1 solutions, from Kinematic Solutions (Stop&Go), from Imported Vectors (I/O) and from Total Station Data. Each option has a check box that may be individually checked or cleared. The button **All** allows you to check all solutions simultaneously, while the button **None** clears all options of the box Vectors.

The box Best GPS/GLN Solution offers two options to choose the best solution only. If you choose the option **Use BEST result**, the best result of all selected solutions for each baseline and each session combination will be passed through the filter. That means, that depending on the number of processed session combinations, one or more solutions may pass the filter.

If you choose **Use OVERALL BEST result**, only one solution, i.e. the best available result, will pass the filter, independently of the number of session combinations processed.

If no solutions were filtered to the Network Adjustment (for example if you wanted to filter only Lc fixed solutions, but there are no Lc fixed solutions because you processed single frequency data), you will receive the warning message: **No observation found!**

12.5.2 Weighting

In the Network Adjustment module you have the opportunity to define your own baseline standard deviations and thereby define the **weighting** factors. You may also reduce the weight of too optimistic standard errors derived, for example, from the static baseline processing. The adjustment module multiplies the standard deviations with the Predefined Standard Error of Unit Weight. Both weighting options are available from the page Weighting.

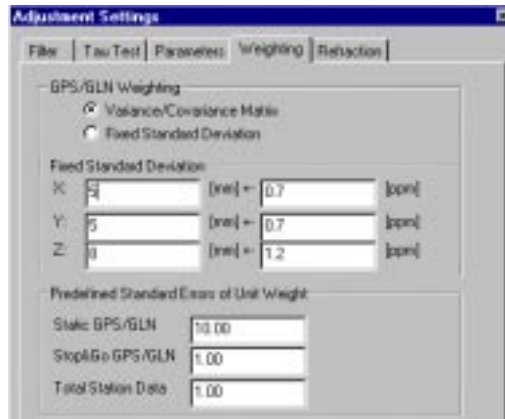


Figure 12-20: Adjustment Settings - Weighting

Using the box GPS/GLN Weighting you may choose, whether the variance-covariance matrix calculated by the processor shall be used for weighting or enter fixed standard deviations. By default, **GeoGenius** uses the 3x3 variance/covariance matrix of the baseline processing result. In some cases, however, you might instead want to define your own standard deviation because you can estimate the accuracy of a baseline result from your own experience.

This user-defined standard deviation consists of a fixed part and a length dependent part:

$$\text{Std Dev} = S1 + S2 * \text{length of the baseline}$$

The unit of the fixed part S1 of the baseline standard deviations is [mm]. The unit of the factor S2, which determines the length dependent standard deviation, is parts per million [ppm] (So if you define this factor as 1, a baseline of length 1km gets a standard deviation of 1mm).

Example:

S1 = 5 mm, S2 = 1,5 ppm, Baseline length 738m, then
Std Dev = 5 mm + 738m * 1,5 / 1000000 = 6,107 mm.

To use defined standard deviations activate the option **Fixed Standard Deviation** of the box **GPS/GLN Weighting** and define the baseline length dependent standard deviations for X, Y, Z (WGS 84) directions. Covariances are then set to zero. Select **OK** to accept your selection.

If the option **Variance/Covariance Matrix** of the box **GPS/GLN Weighting** is enabled, the Network Adjustment will use the full variance-covariance matrix. The weighting of a baseline in the Adjustment then depends on the quality and/or the accuracy of that baseline computed by the Processing Module. This weighting is the default way to adjust a GPS network.

The box **Predefined Standard Errors of Unit Weight** displays the current values for the weighting of the standard errors derived from different measurement methods. You may edit the values to enhance the weight of a network component. The default values are:

Static GPS/GLN	10.00
Stop&Go GPS/GLN	1.00
Total Station Data	1.00

12.5.3 Tau Test

If you suspect that any of your measurements contain gross errors (outliers), you may start an automated procedure (a statistical τ -test) **after adjustment** which identifies the questionable baseline(s) (box Tau Test / GPS) or total station measurements (box Tau Test / Total Station) and marks them via colors in the report and in the project plot (see also section 12.7.2).

The τ criteria are extended by a minimum error definition based on a typical GPS/GLN or total station error specification. By default no errors less than (a) given value(s) are flagged.

You may change the criteria for definition of this error check via the page Tau Test of the Adjustment Settings notebook.

For baseline testing **GeoGenius** uses the τ criteria of the box Tau Test / GPS. The τ criteria are extended by the fixed offset **Minimum Error Offset**, given in the current distance unit and a relative value (**Minimum Error Scale**), given in [ppm]. The default values are 5mm (offset) + 1.0 ppm (relative).

The screenshot shows the 'Adjustment Settings' dialog box with the 'Tau Test' tab selected. The dialog has a title bar with a close button. Below the title bar are five tabs: 'Filter', 'Tau Test', 'Parameters', 'Weighting', and 'Refraction'. The 'Tau Test' tab is active and contains three sub-sections: 'Tau Test / GPS', 'Tau Test / Total Station', and 'Tau Test / Levelling'. Each sub-section has input fields for 'Minimum Error Offset' and 'Minimum Error Scale'. The 'Tau Test / GPS' section has values of 5.0 [mm] and 1.0 [ppm]. The 'Tau Test / Total Station' section has values of 0.0 [mm], 0.0 [ppm], 0.0 [mgon], and 0.0 [mgon]. The 'Tau Test / Levelling' section has an empty field for [mm]. Below these sections is a 'Significance Level' field set to 1.000 % and a checked checkbox for 'Perform Tau Test After Adjustment'. At the bottom are 'OK', 'Cancel', and 'Apply' buttons.

Section	Parameter	Value	Unit
Tau Test / GPS	Minimum Error Offset	5.0	[mm]
	Minimum Error Scale	1.0	[ppm]
Tau Test / Total Station	Minimum Error Offset	0.0	[mm]
	Minimum Error Scale	0.0	[ppm]
	Min. Vertical Angle Offset	0.0	[mgon]
	Min. Horizontal Angle Offset	0.0	[mgon]
Tau Test / Levelling	Minimum Error Offset		[mm]
Significance Level		1.000	%
☒ Perform Tau Test After Adjustment			

Figure 12-21: Adjustment Settings - Tau Test

For the testing of total station data **GeoGenius** uses the τ criteria of the box Tau Test / Total Station. Here, the τ criteria also consist of the fixed offset **Minimum Error Offset**, given in the current distance unit and a relative value (**Minimum Error Scale**), given in [ppm] for the distance measurement. For the angle measurements, fixed offsets are used: the minimum vertical angle error offset (**Min Vertical Angle Offset**) and the minimum horizontal angle error offset (**Min Horizontal Angle Offset**), given in mgon. The default values are 5mm (offset) + 1.0 ppm (relative) for the distance, 0.4 mgon for the angles.

For the testing of levelling data **GeoGenius** uses the τ criterion of the block Tau Test/Levelling. It is the fixed error **Min. Error Offset**, given in the current length unit.

τ test results are true (i.e., a baseline is marked as “bad”) with a specific probability. The **Significance** value reflects the probability of the τ test to “reject a true hypothesis”, that means, to not mark a baseline, which is bad. By default, this value is set to 1%. If you increase the value, probably more baselines will be marked as bad. If you decrease the value, only those baselines with a very high probability to be really bad by means of the τ criteria will be marked.

If you activate the checkbox **Perform Tau Test after adjustment**, **GeoGenius** will perform the τ -test immediately after having finished the network adjustment.

12.5.4 Parameters

Page **Parameters** allows you to define some additional parameters needed for network adjustment.

The box **Sigmas** allows you to set the confidence level to x times the standard error of unit weight (**Set Confidence Level to x Sigmas**). The default value for x is 1. The standard error of unit weight and the adjusted standard deviation are multiplied with this value.

The box **Iterations** allows you to define the maximum number of iterations **GeoGenius** will perform, if the standard error of unit weight is going on to change during the adjustment process. The default value

is 10 iterations, which in most cases are sufficient. (See also section 12.3.2)

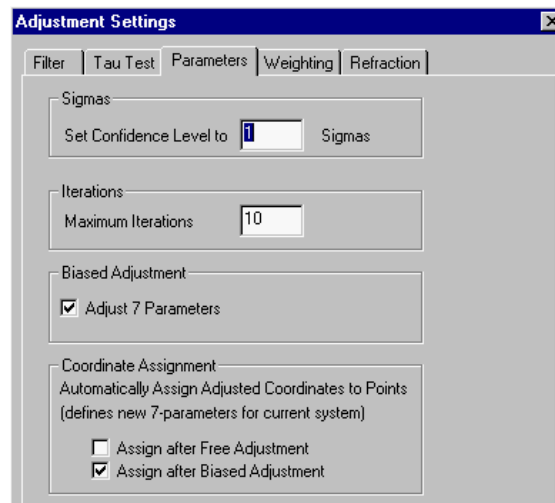


Figure 12-22: Adjustment Settings - Parameters

If the checkbox **Adjust 7 Parameters** is cleared, the 7 parameters for the transformation between the WGS84 System and the current System will be fixed.

By default, **GeoGenius** automatically assigns the adjusted coordinates to the points. If you clear the checkbox **Automatically Assign Adjusted Coordinates to Points**, then the adjusted coordinates are only available via the report or special scripts. You have the choice of assignment after free adjustment and/or biased network adjustment. Typically, you will clear a checkbox, if the adjustment results in very bad coordinates and will repeat the adjustment with other combinations. In general, however, the **GeoGenius** adjustment module

gives a warning message, if it expects too bad results, and does not continue with the adjustment.

12.5.5 Refraction Constants

With terrestrial measurements, refraction influences the measured zenithal angles. If your network contains terrestrial data (total station data), **GeoGenius** can compute one or several refraction coefficients for the network. The page Refraction of the notebook Adjustment Settings offers a list of possible results.

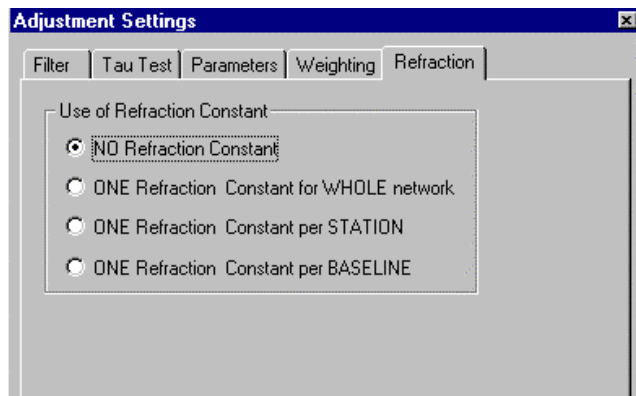


Figure 12-23: Adjustment Settings - Refraction

No Refraction Constant

GeoGenius computes no refraction constant.

One refraction constant for WHOLE network

GeoGenius computes the mean refraction constant for the whole network.

One refraction constant per STATION

GeoGenius computes a refraction constant for each station.

One refraction constant per BASELINE

GeoGenius computes a refraction constant for each baseline.

Click the respective radio button to choose one of these options. By default, **GeoGenius** computes no refraction coefficient. Computed refraction constants show up in the adjustment report.

12.6 Results

12.6.1 Visualized Results

After network adjustment, the display mode for the project plot changes automatically to the adjustment mode. By default, the project plot displays error ellipses and height errors for all adjusted points. A reference error ellipse and height bar for adjustment results show up in the right upper corner. You may toggle off the display of the reference ellipse and height bar. To do so, use the corresponding toolbar button of toolbar Display.

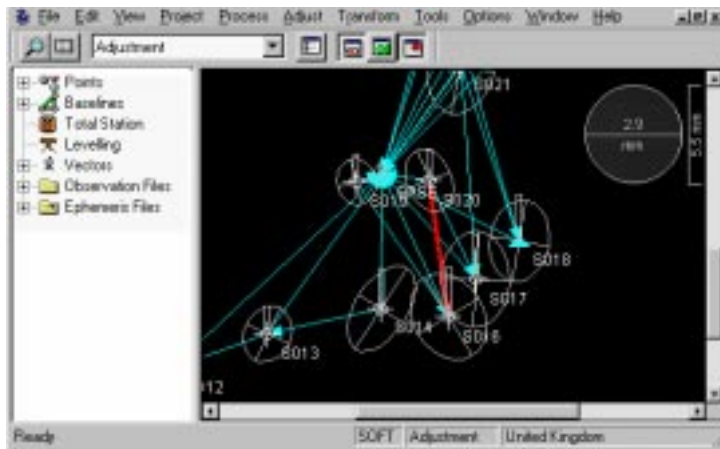


Figure 12-24: Adjustment Results

The following figure shows the default settings of the adjustment display mode. However, you may activate more or less objects, if you use the menu item **Process/Settings.../Display**, activate the item **Adjustment** of the **Display Groups** box and click the button **Define>>**.

The Group Definition dialog allows you to rename the group and to add layers to it or remove layers from it.

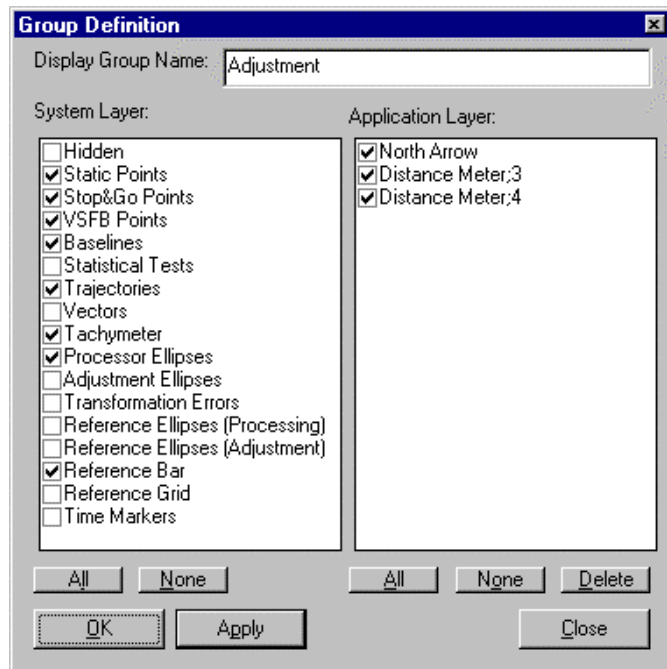


Figure 12-25: Display Mode Adjustment: Default Settings

12.6.2 Numerical Results

After a network adjustment has been carried out (and if the setting Automatically Assign Adjusted Coordinates to Points is active), the Point Properties notebook of each point will display its adjusted coordinates.

Page Ellipse then displays the values of the point's error ellipse calculated in the network adjustment process. Only the best result will be displayed. Box Best Result displays the name of the best solution.

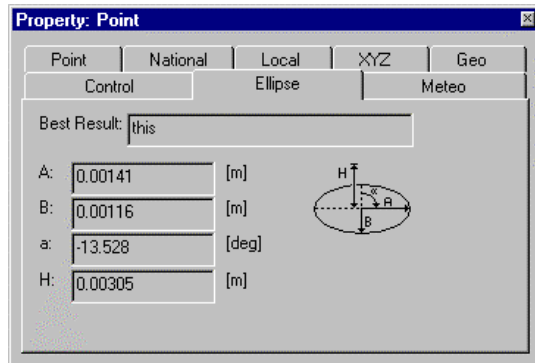


Figure 12-26: Point Properties Ellipse

The following values will be displayed:

- A: The semimajor axis A
- B: The semiminor axis B
- a: angle between A and the Y-axis (North direction)
- H: standard deviation of height

If no adjustment has been done so far, this page displays zero values.

12.6.3 Report

All adjustment results will be collected in the project file. **GeoGenius's** smart **HyperPage** HTML generator allows to output all results in a formatted and easy-to-interpret manner.

You may build additional highly specialized macros fitting exactly your needs and extent the functionality by dynamically loading DLLs. The **HyperPage User's Guide** and the **HyperPage Macro Programming Guide** offer detailed information on this tool.

GeoGenius automatically generates two reports from the two types of adjustment:

- Adjustment in WGS84:
 - * Adjustment Statistics (Number of baselines and terrestrial measurements, Number of points, Confidence level, Significance level for tau test, Standard error of unit weight, Number of iterations)
 - * Baseline Input in WGS84 (the Cartesian baseline vectors which are used in the adjustment as observations)
 - * WGS84 Control Points input, if a biased adjustment
 - * Adjusted Baselines in WGS84 (the adjusted Cartesian baseline components and standard deviations)
 - * Baseline Corrections in WGS84
 - * Adjusted Points in WGS84
- Adjustment in national system, created from the adjustment to a national system, with the following tables:
 - * Statistics (System, statistical information of the processed baselines, terrestrial measurements and control points, standard error of unit weight)
 - * Adjusted Transformation Parameters (the adjusted seven transformation parameters between the WGS84 and your national system)
 - * Baseline input (DX, DY, DZ components and standard deviations)

- * National Control Points Input (plane coordinates and standard deviations) (original local coordinates of your control points and their standard deviations)
- * Adjusted Baselines in WGS84 (DX, DY, DZ components and standard deviations)
- * Baseline Corrections (corrections and normalized corrections)
- * Adjusted Points and Residuals in Cartesian coordinates WGS84
- * Adjusted Points in Cartesian coordinates WGS84 (the adjusted Cartesian coordinates in the WGS84 system with their standard deviations)
- * Adjusted Points in geographical coordinates WGS84 (the adjusted geographical coordinates in the WGS84 system with their standard deviations)
- * Adjusted Points and Residuals in National System (the adjusted plane coordinates in the national grid system with residuals)
- * Adjusted Points in National Coordinates (adjusted local coordinates as state plane coordinates and their standard deviations)
- * Adjusted Points Error Ellipses (the values of the computed error ellipses of each point in your adjusted network)

To start **HyperPage** and to load the report of the last performed adjustment: choose **Adjust/Report....** Report Settings allow you to individually enable and disable sections of the report or other options for display. **HyperPage** offers editing and zooming tools and allows you to print the report. To generate a different kind of report use the Macro Editor. You will find an annotated example report file in Appendix F.

If adjustment failed, the output window will offer error information and warnings. The adjustment reports then collect the error and warning messages in detail.

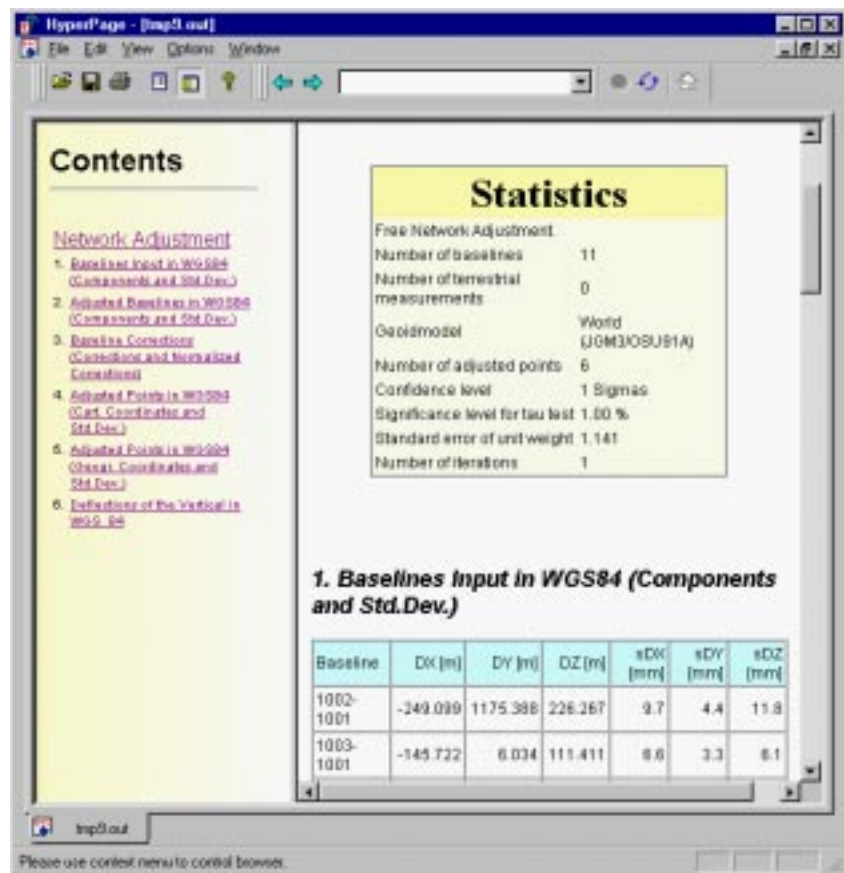


Figure 12-27: Adjustment Report

12.6.4 New Transformation Parameter Set

Adjustments with control points in the national grid System provide you with an optimized set of 7 parameters for the transformation between the WGS84 System and your national grid System. You can see these parameters via the adjustment report (see the previous section).

On the other hand, you may add the resulting transformation parameters to the **GeoGenius** database. Choose the menu item **Save Adjusted System (7 Parameters)** from the pull-down menu **Adjust.** The 7-Parameters dialog pops up.

7-Parameters (WGS-84 -> National)

The Adjustment calculated these 7 Parameters:

Translation

dx:	-369.026	[m]	+	0.000	[mm]
dy:	105.256	[m]	+	0.000	[mm]
dz:	-439.645	[m]	+	0.000	[mm]

Rotation

ex:	0.154656	["]	+	2.100230	["]
ey:	0.324614	["]	+	1.889583	["]
ez:	-0.108296	["]	+	1.852197	["]

Scale

F:	1.0000005	+	0.0000026

Figure 12-28: 7 Parameters

The 7-Parameters dialog displays the seven transformation parameters and their standard deviations: three translational parameters dx , dy , dz , three rotational parameters ex , ey , ez and the scale factor F .

To leave the dialog click the button **Cancel**. If you want to store the parameters for further use – even in other projects – and/or want to update your current System, you may add the new parameters to the database. Click the button **Store in Database**.

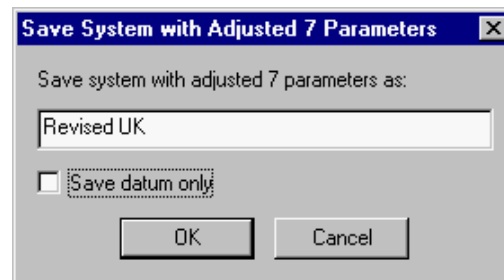


Figure 12-29: Save 7 Parameters

The Dialog Save System with Adjusted 7 Parameters allows you two actions. First, you may just save the new parameters as a new datum. In this case enter the name for the new datum and check the checkbox **Save Datum only**. (For this example, we choose the name “Revised UK”.) Now the new set of 7 parameters will be available for the revision of an existing System or for the establishment of a new one.

Second, if you want to update your System simultaneously, the checkbox **Save Datum only** has to be cleared. If you accept with **OK** now, additionally a new System will be created using the same name and the new 7 transformation parameters as datum. The newly created System will be automatically the current project System. You may check the new System via the System Editor (Project/System/**Edi-**

tor). (The chapter 6 provides you with detailed information on the definition of Systems.)

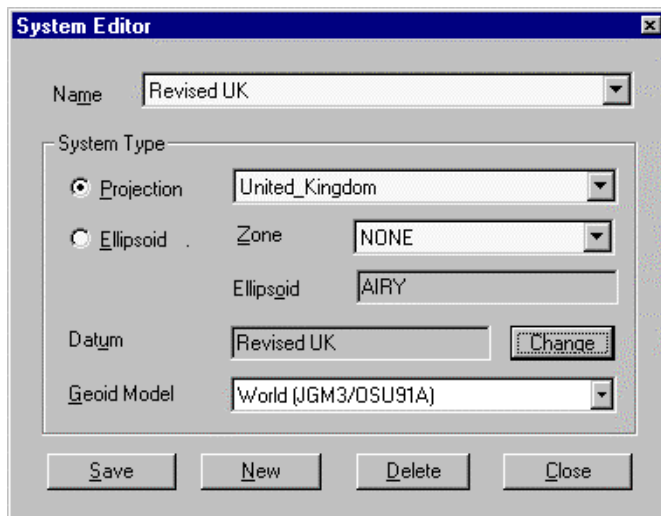


Figure 12-30: New Datum and System Available

12.7 Improve Your Adjusted Network

12.7.1 High Standard Error of Unit Weight

If the standard error of unit weight remains very high during the iterations (the adjustment does not converge), this can have several reasons.

1. The control points and the GPS baselines do not fit together very well.
2. The baselines themselves do not fit together.

If the adjustment does not succeed, perform a free Network adjustment in WGS84 first (see section 12.2.2). If you get a high standard error there, the baselines do not fit together. Find the outliers with the help of the statistical test and remove them from the adjustment, until you get a satisfying standard error.

Then, if you have control points in WGS84, perform a biased Network adjustment in WGS84. If you get a high standard error, this means that the baseline network cannot be fit on the control points without distorting it. Most likely the control points are bad.

Finally, perform an adjustment in the national system. Again a high standard error is most likely caused by bad local control points.

12.7.2 Finding Outliers

If you suspect that any of your measurements contain gross errors (outliers) **GeoGenius** may perform an automated procedure (a statistical τ -test) after adjustment to search for the questionable baselines and mark them in the report and in the project plot via colors. You will find more information on the settings for the τ -test in section 12.5.3.

To instruct **GeoGenius** to run the τ -test automatically after each adjustment, choose Adjust/Settings.../Tau Test and activate the checkbox for the line Perform Tau Test After Adjustment.

By default, rejected lines are drawn in yellow, the largest outlier shows up as a red thick line. E.g., line S013-S013 of the adjusted network in the following figure is the line with the largest outlier, while line S020-S016 also did not pass the tau test:

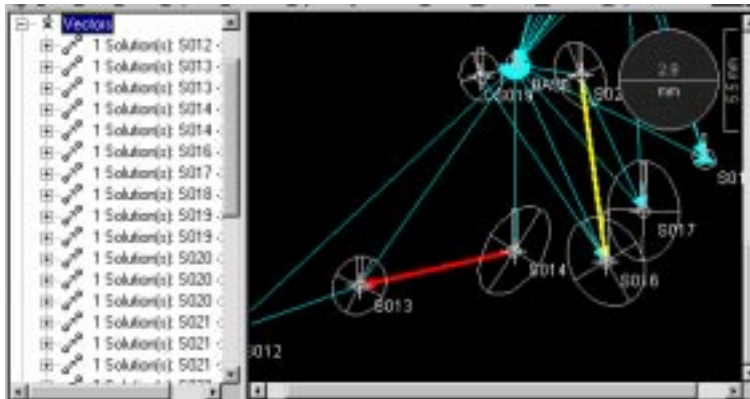
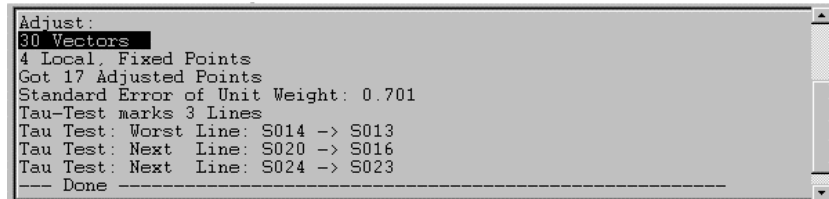


Figure 12-31: Example for Largest Outlier

The output window indicates the results of the statistical τ -test.

A screenshot of a software window titled "Adjust:". The window contains the following text: "30 Vectors", "4 Local, Fixed Points", "Got 17 Adjusted Points", "Standard Error of Unit Weight: 0.701", "Tau-Test marks 3 Lines", "Tau Test: Worst Line: S014 -> S013", "Tau Test: Next Line: S020 -> S016", "Tau Test: Next Line: S024 -> S023", and "--- Done -----". The window has a standard scrollbar on the right side.

```
Adjust:
30 Vectors
4 Local, Fixed Points
Got 17 Adjusted Points
Standard Error of Unit Weight: 0.701
Tau-Test marks 3 Lines
Tau Test: Worst Line: S014 -> S013
Tau Test: Next Line: S020 -> S016
Tau Test: Next Line: S024 -> S023
--- Done -----
```

Figure 12-32: Output Message

You should iteratively search for the best solution by deselecting bad lines and adjusting again. We recommend you to not deselect all yellow lines immediately since the worst outlier might influence some of them. The τ -test information in the log window will help you to deselect the yellow and red lines.

Do not forget to consider the reference error circle, the reference height bar and the largest rejection criteria displayed directly after adjustment processing (the default values are 5mm (offset) + 1ppm (relative)). The errors might already be very small.

13. Coordinate Transformation

This chapter primarily discusses the creation and adjustment of the transformation parameters for the transformation between the current national grid coordinates and a user-defined local plane System.

Preceding annotations generally introduce into **GeoGenius'** philosophy of coordinates and transformations (see section *11.1*).

To define local plane coordinates, you first define the new coordinates of one or two control points in the new system and then create the 4 or 5 transformation parameters (section *13.2*). Instead, you may also manually input the transformation parameters (section *13.3*). These you may additionally adjust using control point coordinates (section *13.4*). With redundant information, the transformation adjustment leads to residual errors. You may distribute the residual errors to the unknown points using several mathematical procedures (section *13.4.6*).

You may transfer national or local coordinates to the control coordinate set. You may also clear the points from control coordinates (section *13.5*).

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13.1 General

All of **GeoGenius'** processors process the GPS observation data in the WGS84 datum. This results in XYZ coordinates, which are independent from the distortion by the projection on the two-dimensional map. Therefore, the System information is primarily used to display the points on the project plot, either on the screen or in project report. The Standard Map Projection is suitable for the display of any project. **GeoGenius** comes along with a default Standard Map Projection, but allows you to define your personal copy. Refer to chapter 6.7 for a detailed description of this option.

However, as soon as you insert data into the project referring to any map projection, such as local coordinates, the System becomes essential. For processing, **GeoGenius** needs the Cartesian coordinates transformed from the national or local control points to the XYZ coordinates of the WGS84 system. These are displayed in page XYZ of the Point Property notebook. After processing in the WGS-84 datum, the XYZ coordinates of page XYZ will be updated in the WGS-84 System. Additional, **GeoGenius** will transform the coordinates to the national grid and/or to the local System. Pages National and Local then display the transformed coordinates according to the current Systems' datums and projections.

The national or local coordinates are the coordinates used for **transformation adjustment**.

Transformation parameter adjustments allow you to create customized transformation parameter sets. After transformation parameter adjustment, you may decide, whether **GeoGenius** keeps the internal geometry between points or whether it computes residual errors for the network and assigns them to the unknown points.)

13.1.1 Coordinate Sets

GeoGenius allows the description of points via four coordinate Systems:

- National National plane (grid) coordinates, in North, East, height.
- Local Local plane coordinates, in North, East, height.
- XYZ Satellite surveying results in X,Y,Z (in the WGS84 System or after assignment in the national System).
- Geo Geographical coordinates (in the WGS84 System or in the national System), in Latitude, Longitude, Elevation.

Additionally, you may enter a second coordinate set for the same point:

- Control Control coordinates as national or local coordinates, in North, East, height with standard deviations. You may fix the control point or its horizontal or vertical coordinates.

The notebook Property: Point displays the point coordinates in each of these coordinate systems, if they are available.

Figure 13-1: The Notebook Point Property

You may manually edit one or several point coordinates in any of the coordinate systems and assign the edited values to the point (via the button **Assign**).

The availability of a coordinate set depends on several premises. The following subsections summarize answers to the questions:

When is a coordinate set available?

Which actions influence the values of the coordinate set?

13.1.1.1 National Plane Coordinates

A point property notebook displays national plane (grid) coordinates after

- The insertion of an observation file (Project/Files Into Project)
- The insertion of a raw data file (Project/Files Into Project)
- Manual input via Project/Add New Point

- Import of National Grid Points (Project/Import/National Grid Points), if the point did not previously exist in the project
- Import of terrestrial data (Project/Import/Total Station Data)

The following actions influence national plane coordinates:

- Assignment of a System (a transformation)
- Baseline processing (new position)
- Network adjustment (new position)
- Editing the values manually and clicking the button **Assign** (new position)
- Clicking the button **Assign** at any other page of the notebook related to this coordinate set (a conversion)
- 7 parameter adjustment to the WGS-84 System
- 4/5 parameter adjustment to a local System

13.1.1.2 Local Plane Coordinates

A point property notebook displays local plane coordinates after

- Manual input via keyboard (new position → other coordinates will be transformed by the current transformation parameters as displayed on page Local)
- Manual input via Project/Add New Point
- Import of Local Points, if the point did not previously exist in the network
- After 2D transformation (via the pull-down menu Transform) (generation of a new set of 5 parameters to transform the current national grid coordinates into a local coordinate set)

The following actions influence local plane coordinates:

- Assignment of a System (a transformation)
- Baseline processing (new position)
- Network adjustment (new position)

- 5 parameter redefinition: manually via Transform/ 4/5 Parameters or computed via transformation adjustment in plane and height (transformation)
- Editing the values manually and clicking the button **Assign** (new position)
- Clicking the button **Assign** at any other page of the notebook related to this coordinate set (a conversion)

13.1.1.3 WGS84 XYZ Coordinates

A point property notebook displays XYZ coordinates after

- The insertion of an observation file
- The insertion of a raw data file
- Manual input via Project/Add New Point
- Import of terrestrial data (Project/Import/Total Station Data)
- Import of Vectors

The following actions influence XYZ coordinates:

- Baseline processing (new position)
- Network adjustment (new position)
- Editing the values manually and clicking the button **Assign** (new position)
- Clicking the button **Assign** at any other page of the notebook related to this coordinate set (a conversion)

13.1.1.4 Geographical Coordinates

The page Geo displays geographical coordinates either in the WGS-84 System or in the System the national coordinates are defined in. The latter may also be the Standard Map Projection. The coordinates are the results of fixed mathematical conversion algorithms. Choose the System via the two radio buttons at the bottom of the page Geo.

A point property notebook displays Geographical coordinates after

- The insertion of an observation file (Project/Files Into Project)
- The insertion of a raw data file (Project/Files Into Project)
- Manual input via Project/Add New Point
- Import of terrestrial data (Project/Import/Total Station Data)
- Import of Local Plane Coordinates (Project/Import/Local Points), if the point did not previously exist in the project
- Import of National Grid Points (Project/Import/National Grid Points), if the point did not previously exist in the project

The following actions influence geographical coordinates:

- Transformation between the WGS84 System and the current map projection (either the Standard Map Projection or any other currently set System) via the radio buttons at the page Geo
- Assignment of a System, if the page displays the geographical coordinates in the current System (a transformation)
- Baseline processing (new position)
- Network adjustment (new position)
- Editing the values manually and clicking the button **Assign** (new position)
- Clicking the button **Assign** at any other page of the notebook related to this coordinate set (a conversion)
- Transformation parameter adjustment, for geographical coordinates in the national System.

13.1.1.5 Control Coordinates

A point property notebook displays control coordinates after

- Manual input via the keyboard (new position)

- Import of Local Plane Coordinates (Project/Import/ Local Points), if the point did already exist in the project
- Import of National Grid Points (Project/Import/ National Grid Points), if the point did already exist in the project
- Definition via the button **Transfer to Control** of the pages National or Local (new position)
- Definition via the item Control Points/Copy National → Control of the pull-down menu Transform/Control Points (new position)
- Definition via the item Control Points/Copy Local → Control of the pull-down menu Transform/Control Points (new position)

The same actions allow you to assign new position values to the control coordinates.

13.1.2 Conversion or Transformation?

GeoGenius updates point coordinates via several theoretically independent actions:

- Processing: Results in updated coordinates, computed in the WGS84 System, for all points with the exception of fixed points. Control point coordinates do not enter the processing process.
- Point Adjustment: Results in updated coordinates of all coordinate systems for all points with the exception of fixed points. Control coordinates influence the biased adjustment.
- Conversion: results in a different coordinate set within the same datum system (System). Converting coordi-

nates does not affect their position in space. That means, that you may convert data from plane to geographical coordinates to XYZ coordinates and vice versa without loss of information or precision (also called: Transformation within a System).

These are the conversion types:

- plane coordinates $\leftrightarrow$ geographical coordinates
- geographical coordinates $\leftrightarrow$ XYZ coordinates
- XYZ coordinates $\leftrightarrow$ plane coordinates

plane coordinates may be either national or local

- Transformation: leaves the current System and describes the point coordinates in another System. Typically, the Seven Parameter Similarity Transformation algorithm is used to transform the point from one System into the other using its Cartesian coordinates. A set of 4 or 5 parameters is sufficient to transform points between the national grid System and a local plane System that is created on the basis of the national grid. You may improve the transformation parameters by an adjustment.

13.2 Generation of 2D Transformation Parameters

You may define a System based on local coordinates via its transformation parameters from the national grid. You will define the origin, scale and orientation by providing one or two known points and defining manually their position and orientation in the local System. To transform the points of a network to the local plane coordinates, **GeoGenius** computes four parameters (rotation, scale, dN, dE).

Please note that heights are not transformed with this operation! You may manually include a height factor to the transformation parameters (see section 13.3). If you introduce a height factor, this will be the fifth transformation parameter.

The pull-down menu Transform/2D offers four different methods to generate the 4 transformation parameters.

These are:

- 2D / Translation translation in plane based on a single point.
No rotation nor scaling
- 2D / 2 Points transformation parameters computed from
manually entered positions of two points
- 2D / 1 Point + Azimuth transformation parameters computed from the manually entered position of
one point and an azimuth, no scaling
- 2D / 1 Point + Azimuth + Distance transformation
parameters computed from the manually entered position of one point and an azimuth
and a distance

13.2.1 Translation

The translation is a basic form of transformation, based on a single point. This means, that you do not provide any rotation or scaling to the local System.

Make sure, that the System of the project is set correctly.

Activate in the navigator or the project plot the point that you want to fix for translation. Choose the item 2D/Translation from the pull-down menu Transform/2D. The 2D Translation dialog shows up.

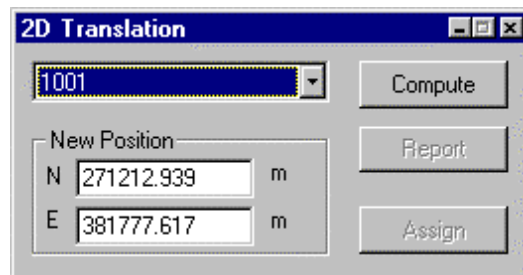


Figure 13-2: 2D Translation Dialog

The 2D Translation dialog displays the currently selected point number in a combo box. You may also select another point here (Open the point list by a click on the arrow-down button). The current horizontal national coordinates are displayed in the box New Position. Here you may manually enter the horizontal coordinates for the point in the local System. To start the computation of the translation parameters, click the button **Compute**. GeoGenius then computes the two necessary parameters for the translation in plane, dN and dE. The scale factor and the rotation angle are set to 1 and 0.

After computation, the two buttons **Report...** and **Assign** of the 2D Translation dialog are active.

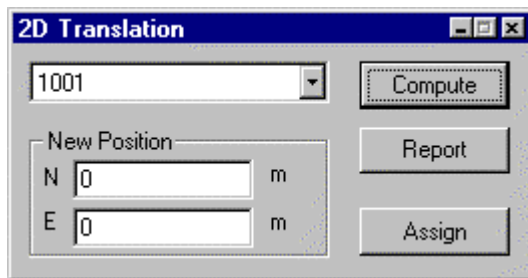


Figure 13-3: Translation - New Position Computed

You may now check the computation results via the report and, if satisfied, assign the values to the project (see sections 13.2.5 and 13.2.6).

13.2.2 2D Transformation Based on Two Points

This option allows you to define not only a lateral displacement of the System, but also to define new scaling and rotation parameters.

Make sure, that the System of the project is set correctly.

Choose the item 2D/2Points from the pull-down menu Transform/2D. The 2D Transformation dialog shows up.

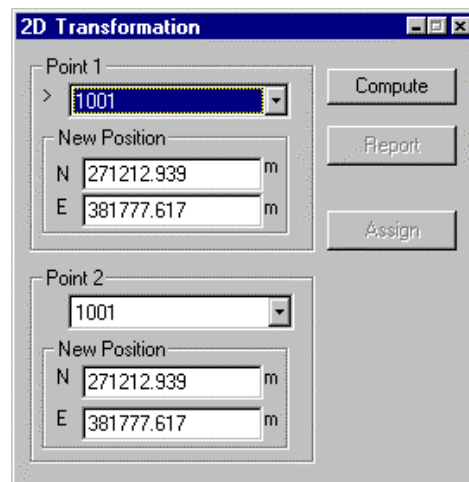
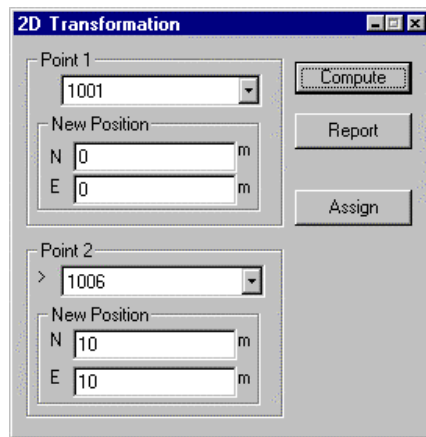


Figure 13-4: 2D Transformation - 2 Points

The 2D Transformation dialog displays two boxes for each of the points used to define the local System. The combo boxes allow to select the known point here (Open the point list by a click on the arrow-down button). The current horizontal national coordinates are displayed in the boxes New Position.

Select the two points the new System shall be based on. Enter manually the horizontal coordinates for the points in the local System. To start the computation of the translation parameters, click the button **Compute**. **GeoGenius** then computes the four necessary parameters for the transformation in plane, rotation, scale, northing, and easting.

After computation, the two buttons **Report...** and **Assign** of the 2D Transformation dialog are active.



2D Transformation

Point 1
1001

New Position
N 0 m
E 0 m

Point 2
> 1006

New Position
N 10 m
E 10 m

Compute
Report
Assign

Figure 13-5: 2D Transformation - New Positions Computed

You may now check the computation results via the report and, if satisfied, assign the values to the project (see sections 13.2.5 and 13.2.6).

13.2.3 2D Transformation Based on a Point and an Azimuth

If you want to define the three parameters northing, easting and rotation, but do not need a scaling factor for your local System, this option will be your choice.

Make sure, that the System of the project is set correctly.

Choose the item 2D/1Points + Azimuth from the pull-down menu Transform/2D. The 2D Transformation dialog shows up.

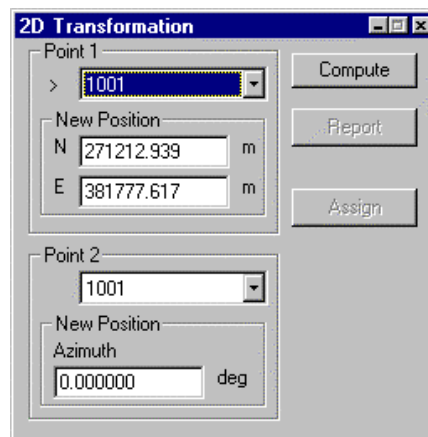


Figure 13-6: 2D Transformation - 1 Point Position + Azimuth

The 2D Transformation dialog displays two boxes for each of the points used to define the local System. The combo boxes allow you to select the known point here. (Open the point list by a click on the arrow-down button) The current horizontal national coordinates are displayed in the box New Position of Point 1. The New Position box of Point 2 displays the rotation angle from Point 1 to Point 2.

Select the two points the new System shall be based on. Enter manually the horizontal coordinates for point 1 in the local System. Enter a rotation angle to Point 2. To start the computation of the translation parameters, click the button **Compute**. **GeoGenius** then computes the three parameters for the transformation in plane, rotation, northing, and easting. The scale factor stays 1.00.

After computation, the two buttons **Report...** and **Assign** of the 2D Transformation dialog are active.

2D Transformation

Point 1

1001

Compute

New Position

N 1 m

E 1 m

Report

Assign

Point 2

> 1006

New Position

Azimuth 45 deg

Figure 13-7: 2D Transformation - New Parameters Computed

You may now check the computation results via the report and, if satisfied, assign the values to the project (see sections 13.2.5 and 13.2.6).

13.2.4 2D Transformation Based on a Point and Azimuth and Distance Information

You may define the four transformation parameters not only by the position of two points. The same information is available, if you define the origin of the System by the position of a point and add for the second point the relative position information azimuth and distance.

Make sure, that the System of the project is set correctly.

Choose the item 2D/1Point + Azimuth + Distance from the pull-down menu Transform/2D. The 2D Transformation dialog shows up.

The screenshot shows the '2D Transformation' dialog box. It is divided into two main sections for 'Point 1' and 'Point 2'. Each section has a point selection dropdown (both showing '1001') and a 'New Position' area. For Point 1, the 'New Position' area contains 'N' (271212.939 m) and 'E' (381777.617 m). For Point 2, it contains 'Azimuth' (0.000000 deg) and 'Distance' (0.000 m). To the right of these sections are three buttons: 'Compute', 'Report', and 'Assign'.

Figure 13-8: 2D Transformation – Relative Position Information

The 2D Transformation dialog displays two boxes for each of the points used to define the local System. The combo boxes allow you to select the known point here (Open the point list by a click on the arrow-down button). The current horizontal national coordinates are displayed in the boxes New Position of Point 1. The New Position box of Point 2 displays the rotation angle and the distance between Point 1 and Point 2.

Select the two points the new System shall be based on. Enter manually the horizontal coordinates for Point 1 in the local System. To start the computation of the translation parameters, click the button **Com-**

pute. **GeoGenius** then computes the four necessary parameters for the transformation in plane, rotation, scale, northing, and easting.

After computation, the two buttons **Report...** and **Assign** of the 2D Transformation dialog are active.

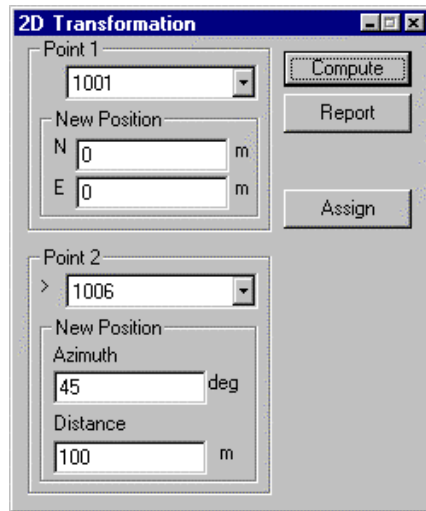


Figure 13-9: 2D Transformation - New Parameters Computed

You may now check the computation results via the report and, if satisfied, assign the values to the project (see sections 13.2.5 and 13.2.6).

13.2.5 The Transformation Reports

The button **Report** starts the editing tool **HyperPage** and opens the current Transformation Report. Reports exist for each of the four

methods discussed above. They are very similar, listing the resulting parameters, the basic point(s) and the future local coordinates of all project points.

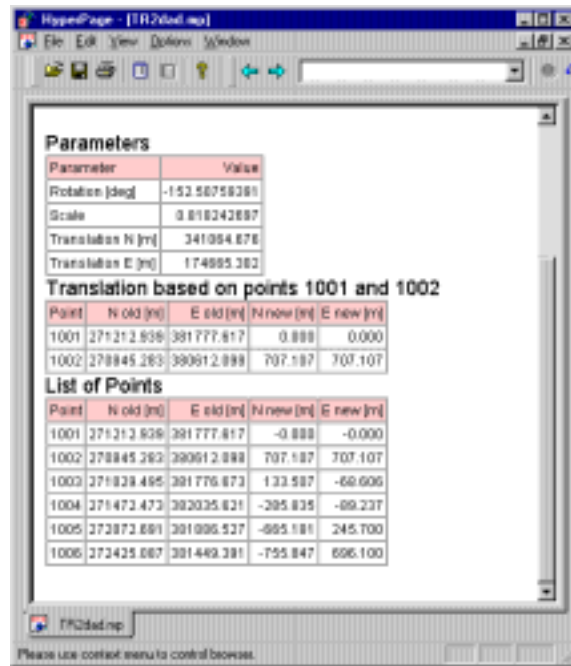


Figure 13-10: A Transformation Report

The first block displays the generated transformation parameters. With a translation report, the rotation factor is 0 degrees and the scale is 1, since translation does not result in rotation or scaling. With a report resulting from 1 Point and azimuth, the scaling factor is 1.

The second block displays the old and new position of the point(s), the translation is based on. Finally, a point list displays the positions in

the national grid (old) and the resulting local coordinates (new) of all points of the project. If you did not assign the transformation parameters to the project, these local coordinates are purely hypothetical. Only assignment results in local coordinates for the project.

13.2.6 Assigning Parameters

If you are satisfied with the transformation parameters, you may assign them. Activate the current 2D Transformation or 2D Translation dialog and click the button **Assign**. This adds the translation parameters to the project and introduces the local System to all points of the project.

Additionally, **GeoGenius** transfers the local coordinates of the points used to define the transformation to the control coordinate set.

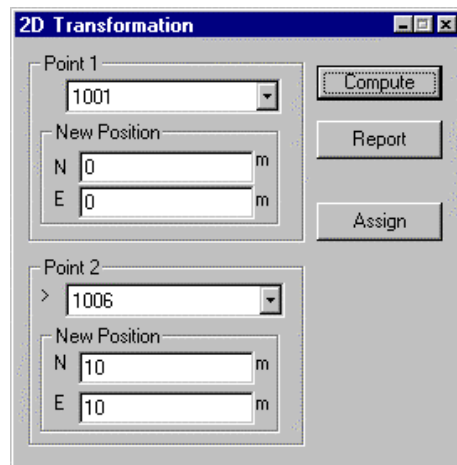


Figure 13-11: Click Assign

You may check the local coordinates in the Property: Point notebook. To open the notebook, activate the point, open its context menu (click right mouse button) and choose the menu item **Properties**. Page Local of the point the translation is based on displays the manually entered horizontal values. The height component results from the current System.

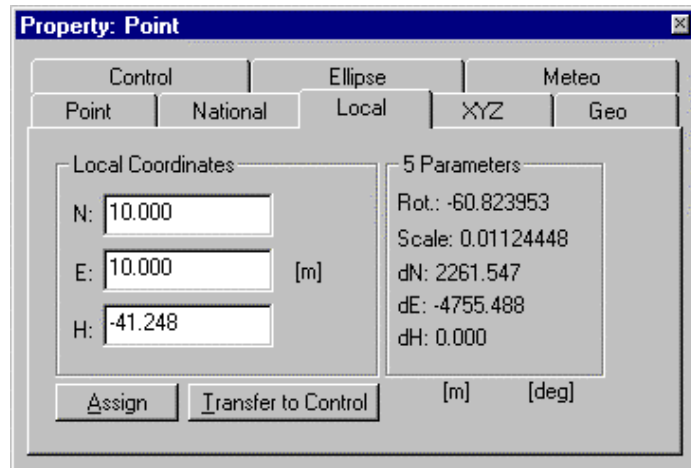


Figure 13-12: Point Properties, Page Local

13.3 Manual Input of Transformation Parameters

If you know the four or five parameters necessary to transform the points of the current from national grid coordinates into local plane coordinates, choose the item 5 Parameters (Nat. -> Local) of the pull-down menu Transform. The 5 Parameters dialog pops up.

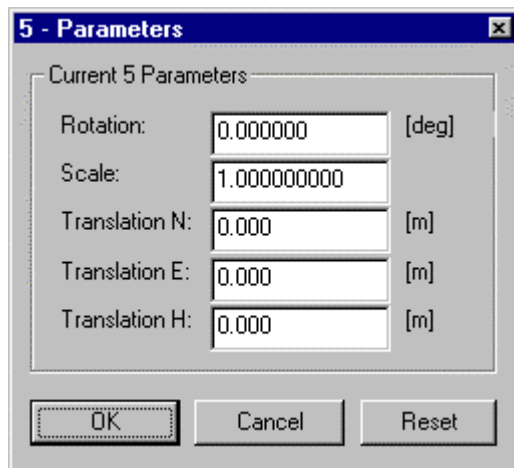


Figure 13-13: Manual Input of 4/5 Parameters

The 5 Parameters dialog displays the current settings for the transformation between the national grid and local plane coordinates. The units accord to the current setting. If you did not define a local System so far, the values will be zero for the rotation and the three translation parameters (northing, easting and height). The scale factor will be 1.

To define a local System you may change any of these parameters. Enter the new value and click **OK**. **Cancel** leaves the dialog without changes. **Reset** sets all values to their defaults.

If you have accepted new parameters with **OK**, the Property: Point dialog will display the new parameters on its page Local. It will also display the local coordinates for the current point.

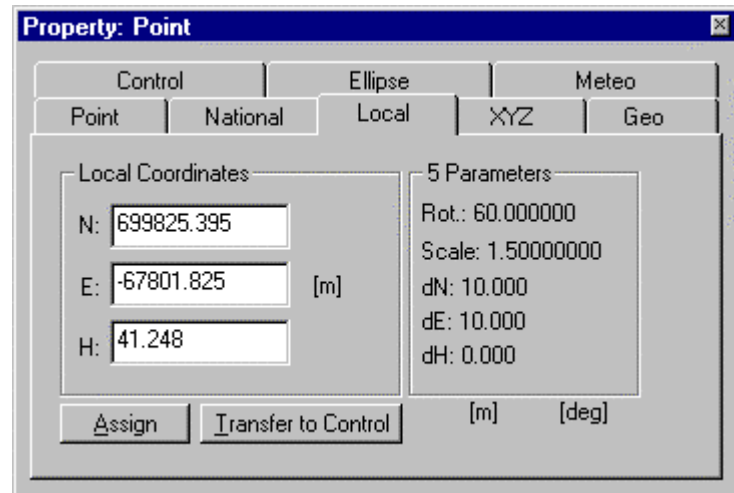


Figure 13-14: Page Local with Manually Set Transformation Parameters

13.4 Adjustment of Transformation Parameters

The adjustment of transformation parameters determines the best fitting transformation parameters for the transformation between the national and the local plane coordinates by help of well-known control points. Chapter 12 introduces into the theory of adjustments.

GeoGenius allows you to adjust two transformation parameter sets:

- Adjustment of a 7 parameter set for transformations between the national grid System and the WGS84 System (Transform/3D/3D Adjustment).
- Adjustment of a 4 parameter set and height for the adjustment between the local and the national grid (Transform/3D/Plan + Height Adjustment). You may adjust with control coordinates in the national grid System (Transformation Local -> National) or in the local System (Transformation National -> Local).

To start an adjustment choose one of these options. The Adjustment notebooks of both options are very similar. Each consists of five pages:

Adjust	includes the Control Point List and allows you to start the adjustment
Options	allows you to exclude parameters from adjustment
Results	displays the adjustment results
Distribution of Residuals	allows you to set some parameters for the distribution of residuals and calculates the distribution
Assign	assigns, either with or without distributed residuals.

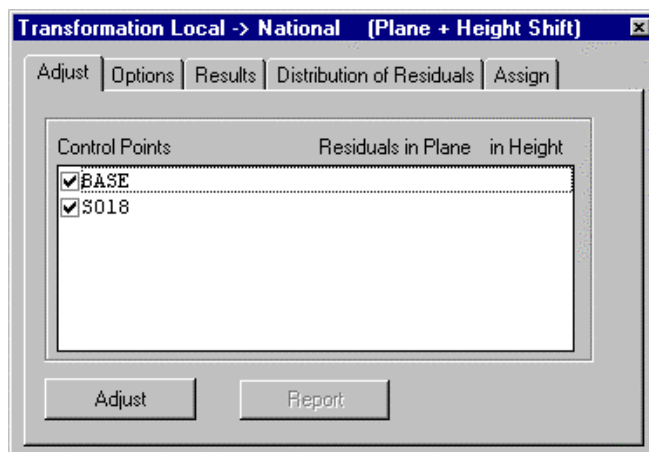


Figure 13-15: Adjustment Notebook

The following subsections describe the actions common to both adjustment types. Subsection 13.4.4 describes specifics for two-dimensional adjustments in plane and height, while subsection 13.4.5 concentrates on 3D adjustments. Assigning the adjusted parameters to the network is described in subsection 13.4.7. If you want to compute the residual errors for unknown points, refer to subsection 13.4.6.

13.4.1 Define Control Points and Start the Adjustment

To do an adjustment, you need a control point list:

- Control points must have control coordinates.
- The control coordinates must be fixed and assigned.

The Page control of the point property dialog most easily allows you to control both properties of a point.

The screenshot shows the 'Property: Point' dialog box with the 'Page Control' tab selected. The 'Control' sub-tab is active. The 'Control Coordinates' section has three rows: N (5896927.111), E (-469647.350), and H (35.603). Each row has a 'Ctrl' checkbox. To the right, there are three '+/-' fields, each with a 'Fix' checkbox. At the bottom, there is an 'Assign' button, a 'Fix as Control Point' checkbox, and radio buttons for 'National' (selected) and 'Local'.

Figure 13-16: Property: Point, Page Control

Please refer to section *13.1.1* on how to define control coordinates.

To use a coordinate as control coordinate, check the checkbox **Ctrl** next to it. You can only use the horizontal coordinates as a couple. (The checkbox **Fix** sets the standard deviation to zero.) Then click the button **Assign**. This adds the fixed control point coordinates to the list of control points.

If you did not actively check or clear a coordinate before, you may fix the complete coordinate set as a control point via the checkbox **Fix as Control Point** and then click the button **Assign**. This adds the control point to the list of control points of the Adjustment notebook.

Please note that control points for a 3D adjustment must be national grid coordinates. If they don't and you start the 3D adjustment, a warning message will pop up.

To do an adjustment in plane and height, two control points are sufficient. For a 3D adjustment you need at least 3 control points.

To start the adjustment between the control coordinates and the measured coordinates of your (control) points click the button **Adjust**. GeoGenius will perform the adjustment. As results you will receive a new set of transformation parameters and residuals. The value of these residuals depends on the tension between the two sets of coordinates.

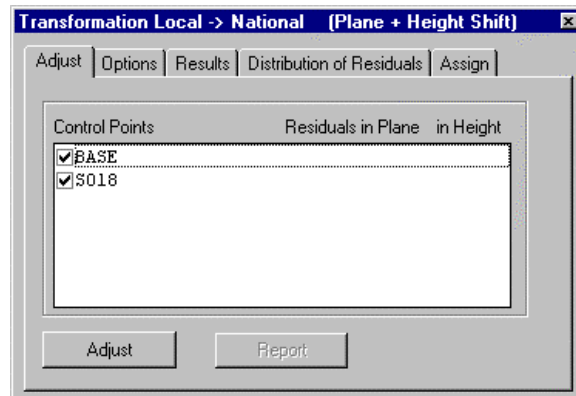


Figure 13-17: Click Adjust to Start the Adjustment

13.4.2 Adjustment Options

Prior to adjustment you may define transformation parameters to be held fixed. You may set these values in the page Options of the Adjustment notebook. Depending on the adjustment type, you can fix a different number of parameters. You will find further information on the options page in the sections on the respective adjustment types.

13.4.3 Adjustment Results

As adjustment results you will find

- the set of adjusted transformation parameters (check the page Results)
- residuals for the control points (check the box Control Points of the page Adjust)
- an adjustment report (click the button **Report** of the page Adjust)
- the graphical display of the residuals in your project plot. The transformation adjustment module automatically creates a new layer Residuals.

The page Result of the adjustment notebook displays the adjusted transformation parameters.

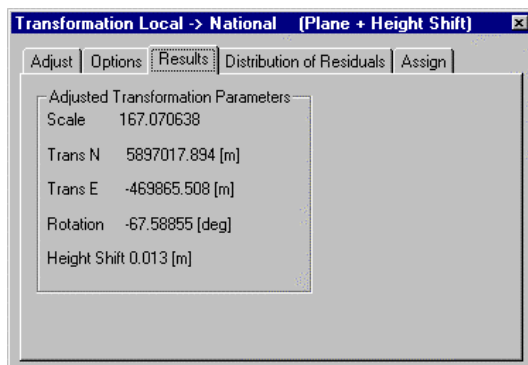


Figure 13-18: Page Results

To start the editing-tool **HyperPage** for a report of the current adjustment click the button **Report** of the page Adjust. The transformation Adjustment report starts with a statistical summary, including the

number of control points, the standard error of unit weight and the number of iterations needed for the result. Two point lists give the control point coordinates and the source point coordinates (the coordinate systems depend on the type of adjustment).

The next block, highlighted by a gray background, gives you the adjusted transformation parameters. If there is tension between the control coordinates and the measured coordinates, the adjustment module computed residuals $\neq 0$ for the common points. The last block of the report lists the residuals for the common points.

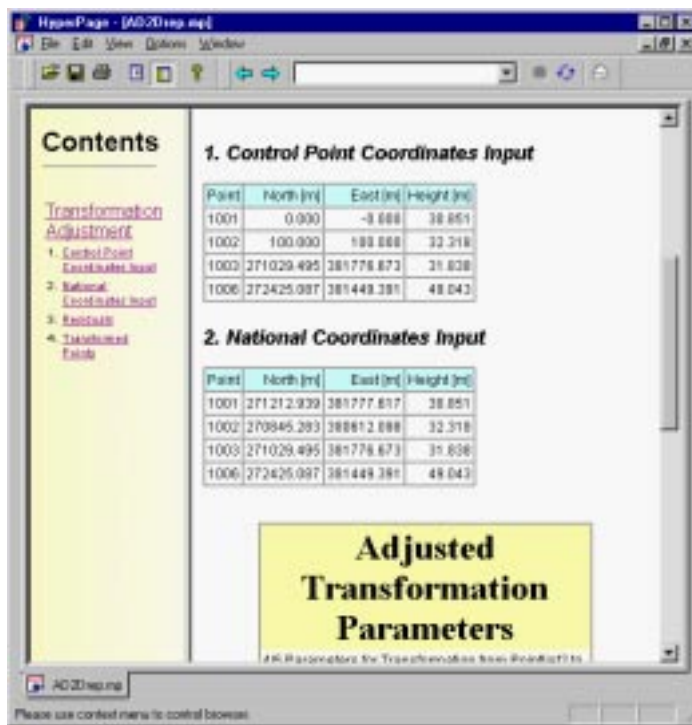


Figure 13-19: Adjustment Report

After adjustment, the box Control Points of the page Adjust displays the resulting relative residuals in plane and height in percent of the maximum residual. In brackets it also displays the absolute residual values in plane and height).

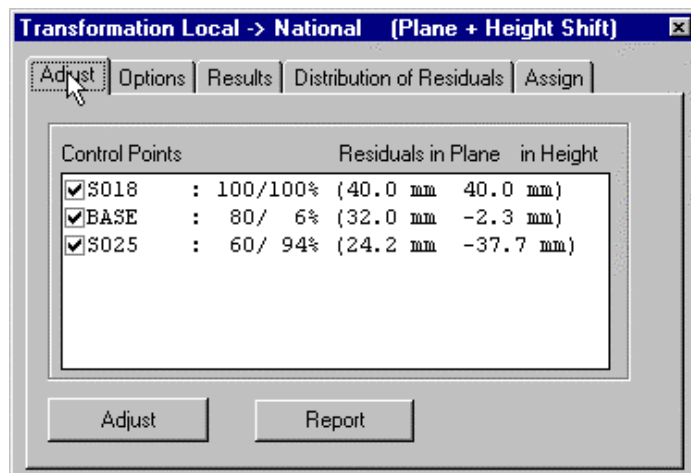


Figure 13-20: Page Adjust After Adjustment

If the adjustment resulted in residuals, the project plot displays the layer of Residuals. You may customize your current project for the display of this layer (page Display of the Processing Options notebook, see chapter 7.4). By default, the display of residuals is available in both the display groups Processing and Adjustment.

The layer Residuals consists of a plane shift arrow and a height shift bar for the adjusted points and of a reference to both shifts.

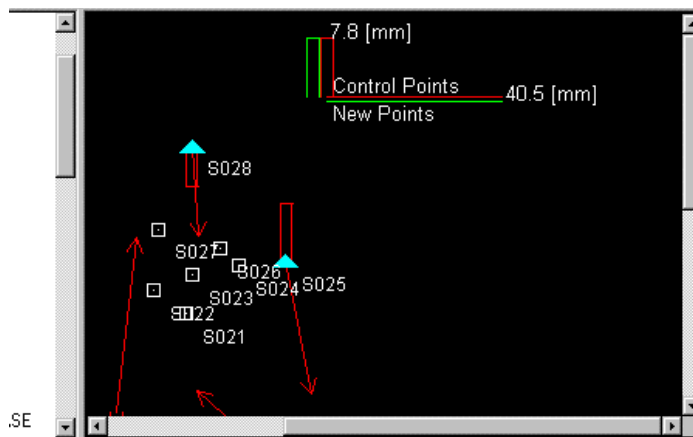


Figure 13-21: Residual Display in the Project Plot

The residuals for control points are in red color. If you have computed a distribution of residuals to other points, the resulting residuals will be displayed as green (see section 13.4.6).

13.4.4 Adjustment in Plane and Height

With an adjustment in plane and height, the adjustment of 4 transformation parameters determines the best fitting transformation parameters for the transformation between the national and the local plane coordinates or vice versa. It is a two-dimensional adjustment including a height shift.

To start the adjustment

1. Assign at least 2 control points
2. Set the options for the adjustments, if necessary
3. Choose the menu item 3D/Plane + Height Adjustment of the pull-down menu Transform/3D .

1. Adjustments in plane and height are available for two transformation parameter sets:
 - For the transformation from the national grid to the local System you have to provide control coordinates in the local System. This calls the adjustment notebook Transformation National -> Local.
 - For the transformation from the local to the national grid System you have to provide control coordinates in the national System. This calls the adjustment notebook Transformation Local -> National.

Two control points will be sufficient to do an adjustment in plane and height.

2. If you want to fix any of the transformation parameters, click the tab Options of the Adjustment notebook.

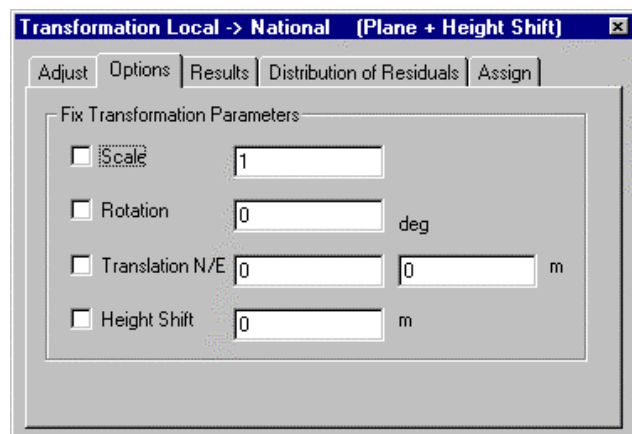


Figure 13-22: Page Options / Plane and Height Adjustment

The page Options allows you to fix either the scale, or the rotational parameter, or the two translational parameters (Translation N/E), or the height shift. You may fix, e.g., the translation values, and thereby prevent points to be translated in the plane.

To fix one of the options, check the respective checkbox. For each parameter you may define the fixed value. The default values are 1 for scale and 0 for any other parameter. **GeoGenius** will only respect any editing of the parameters, if the respective checkbox is checked!

13.4.5 3D Adjustment

If you have defined a national grid System, **GeoGenius** provides a set of 7 parameters for the transformation between the current System and the WGS-84 System. However, these parameters typically have to cover a large area (a state, country, ...) and may not fit very well the specific location of your current project. Therefore, if you have at least 3 well-known control points with national grid coordinates, you may perform a 3D transformation adjustment to improve the set of transformation parameters.

To start the adjustment

1. Assign at least 3 control points with national grid coordinates
 2. Set the options for the adjustments, if necessary
 3. Choose the menu item 3D Adjustment of the pull-down menu Transform/3D .
-
1. 3D adjustments need at least three control points with national coordinates in the current System.

Make sure that the currently defined System fits the control points. Otherwise, **GeoGenius** will not be able to adjust.

2. If you want to fix any of the transformation parameters, click the tab Options of the Adjustment notebook.

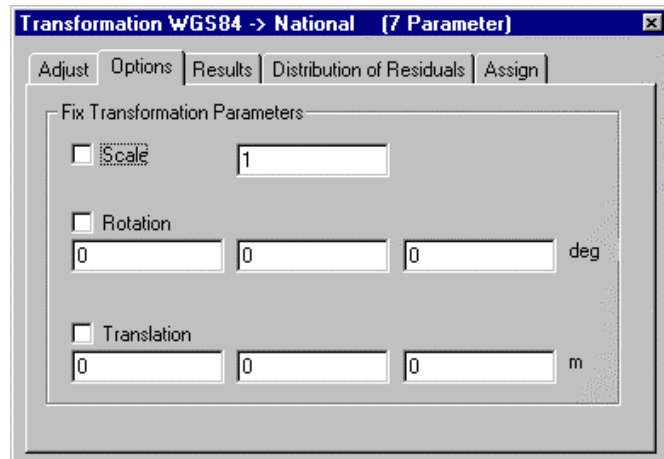


Figure 13-23: Page Options / 3D Adjustment

The page Options allows you to fix either the scale, or the rotational parameter, or the translational parameters. For example, you may fix the scaling factor, and thereby prevent any adjustment of the scaling factor.

To fix one of the options, check the respective checkbox. For each parameter you may define the fixed value. The default values are 1 for scale and 0 for any other parameter. **GeoGenius** will only respect any editing of the parameters, if the respective checkbox is checked!

13.4.6 Distribution of Residuals

After the transformation adjustment residuals for the control points will be part of the result. **GeoGenius'** adjustment module allows you to distribute residuals also to unknown points. To do so, open the page Distribution of Residuals of the adjustment notebook.

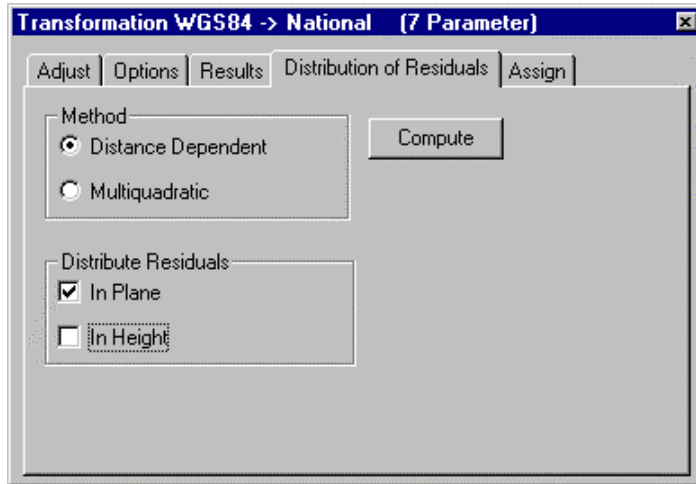


Figure 13-24: Distribution of Residuals

GeoGenius offers two methods distribute the residuals from the control points to the new points:

- Distance Dependent
- Multiquadratic

To choose one of the options, click the respective radio button.

Both methods allow you to distribute the residuals either in plane or in height or for both components. To choose the respective component check the respective checkbox.

To start the distribution of residuals, click the button **Compute**. **GeoGenius** will compute interpolated residual values for all new points and will display the residuals in green color in the project plot (if the layer Residuals is activated).

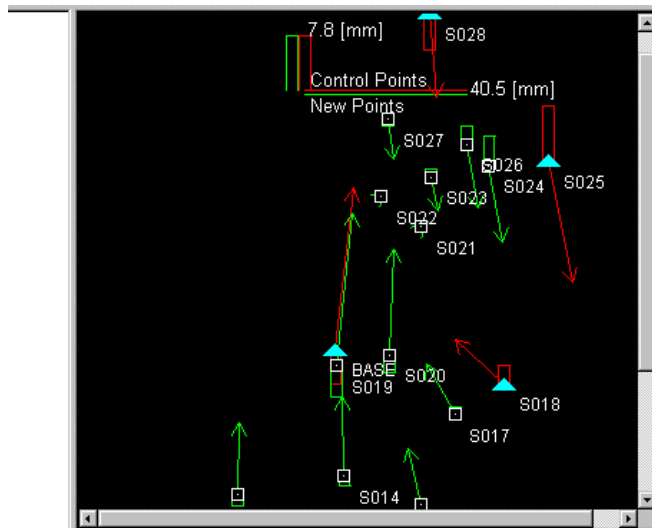


Figure 13-25: Project Plot Displaying Distributed Residuals

Figure 13-25 illuminates how the residuals of new points are composed of the residuals of the control points. For example, the residual distance arrow of point S024 shows almost the same direction as the residual distance arrow of the adjacent control point S025, but is modified in length. This can be understood, since the residuals of the con-

control points S018 and BASE are oriented in almost the opposite direction.

13.4.7 Assigning the Adjusted Transformation Parameters

You have generated a new set of transformation parameters between two Systems and have possibly computed the residuals for the non-control points of your current project. Now you want to start the transformation between the Systems.

Click the tab Assign of the Adjustment notebook. The page Assign offers two methods for the transformation and the button **Assign** to start with the transformation.

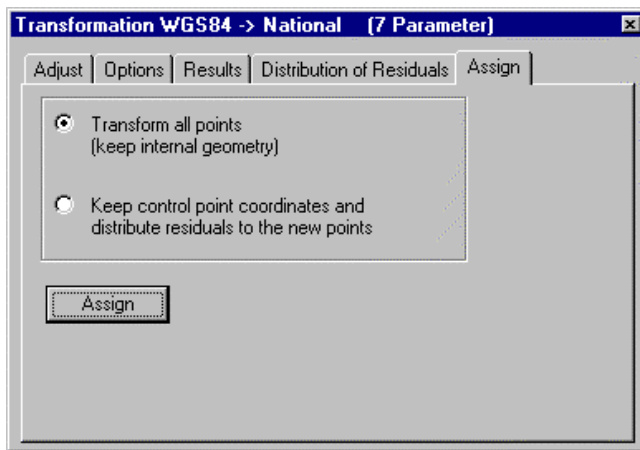


Figure 13-26: Page Assign

You may choose one of two options for the coordinate transformation:

- ⊙ Transform all points (keep internal geometry)
 - a) If you have done a 3D Transformation Adjustment: This option transforms all points from the WGS84 System to the national System using the just generated 7 transformation parameters. It thereby replaces all national coordinates.
 - b) If you have done a Plane and Height Adjustment and have control points in the local System (Transformation National -> Local): This option transforms all points from the national System to the local System using the just generated 4/5 parameters. It thereby replaces all local coordinates.
 - c) If you have done a Plane and Height Adjustment and have control points in the national System (Transformation Local -> National): This option transforms all points from the local System to the national System using the just generated 4/5 parameters. It replaces all national coordinates.

- ⊙ Keep control point coordinates and distribute the residuals to the new points

This method is only available after the distribution of residuals (see section 13.4.6).

For all new (unknown) points, this method first transforms the coordinates from the source System (e.g., in case of a 3D adjustment the source System is the WGS84 System) to the target System (e.g., the national grid System) using the just generated transformation parameters. Additionally, it adds the distributed residuals. This method may thereby change the internal geometry of the network in the source System, but keeps the geometry of the control points in the target System.

No transformation takes place **for control points**. The control coordinates of the control points replace the current coordinates in

the target System (see page National or page Local of the point properties notebook, depending on the adjustment type).

To choose one of these options click the respective radio button, then click the button **Assign** to start the computation. As result, you will find the new coordinates in the respective pages of the point properties notebook and the project plot will automatically be redrawn.

13.5 Control Coordinate Set

A lot of features allow you to speed up the input or deletion of control coordinates. Of course, you may manually edit the string fields in page Control of the Properties dialog of any point and then assign the edited values to the point (click the button **Assign**). The radio buttons National and Local state the origin of the coordinates.

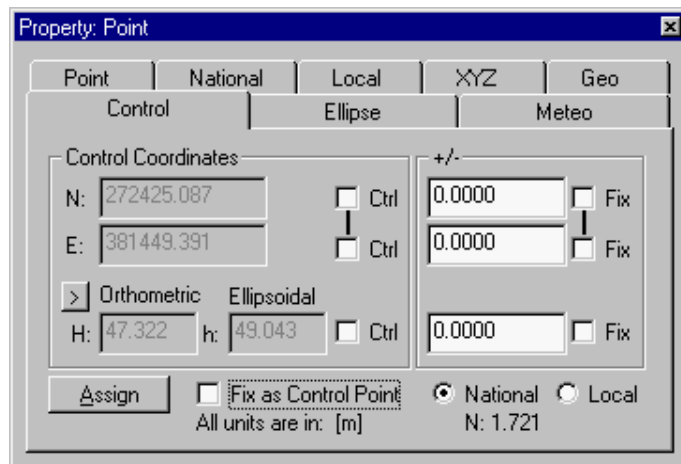


Figure 13-27: Point Property Dialog, Page Control

The following implementations may help you to easily define the coordinates of the Control panel:

- Transfer of coordinates for a single point
- Transfer of all national coordinates
- Transfer of all local coordinates
- Clearing all control coordinates

13.5.1 Transfer Coordinates of a Single Point

The pages National and Local of a Property: Point dialog each offer a button **Transfer to Control**. Click the button, if you want to transfer the respective coordinate set to the page Control.

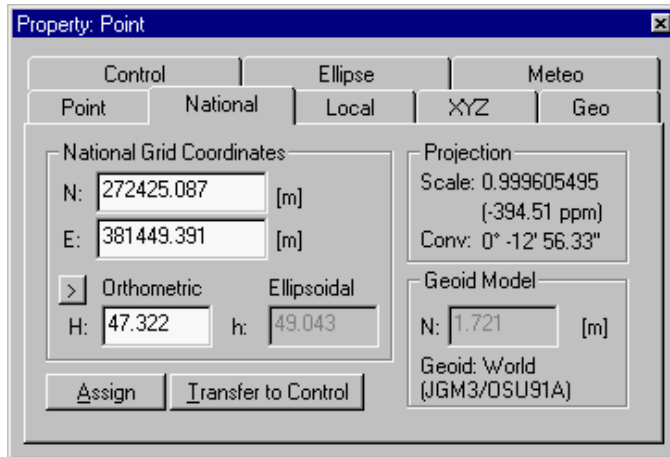


Figure 13-28: Transfer to Control

13.5.2 Copy National Plane Coordinates to Control

If you want to copy all national plane coordinates of your project to the page Control, **GeoGenius** offers you a very quick option to do so. Choose the item **Control Points/Copy National -> Control** of the pull-down menu **Transform**. This establishes the control coordinate set for each point of the project at once. You now may edit single points, if necessary.

13.5.3 Copy Local Plane Coordinates to Control

If you have implemented a local System and want to copy all local plane coordinates of the project to the page Control, choose the item Control Points/Copy Local -> Control of the pull-down menu Transform. The page Control will now display the local coordinates as control coordinates. You now may edit single points, if necessary.

13.5.4 Clear Control Coordinates

To clear the control coordinates of all points of your project choose the item Control Points/Clear Control Points of the pull-down menu Transform. A warning message (Do you really want to clear the control points?) will prevent you from accidentally deleting control coordinates.

If you accept with **OK**, the page Control will display N/A for all control coordinates and standard deviations, since control coordinates are not anymore available.

dlxxx

14. Toolbox

The toolbox chapter describes specific additional functions of **GeoGenius**.

Note: Many tools may be extremely useful for your applications. **GeoGenius** is constructed in a way allowing you to customize it with your choice of pre-programmed features via the Tools Configuration dialog. You may (temporarily) remove or add menu items. Customizing is accessible via the item **Tools Menu...** of the pull-down menu **Options** and allows you to edit the paths to the tools of your choice. (How to customize **GeoGenius** for tools is explained in detail in Appendix A.5.) Then, you can call the extension via the pull-down menu **Tools**.

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14.1 Generation of Precise Ephemeris

14.1.1 Distribution of Precise Ephemeris

Precise ephemeris files are often distributed as National Geodetic Survey SP3-Format files. These files are in most cases provided in a way that one file per day is used.

The file is usually named in a way that both the week and the day of week are indicated in the file name, e.g., **COD08121EPH** is the SP3 file generated by CODE (Center of Orbit Determination in Europe) for week 812 on Monday (day 1). Nevertheless, files may have arbitrary file names.

Precise orbits can be obtained from:

*GPSIC (Civil GPS Information Center of the U.S. Coast
Guard)*

BBS: ++1 (703) 313 5910

Internet: gracie.grdl.noaa.gov

or from the German GPS information center (GIBS):

IFAG Leipzig

BBS ++49 (0)341 563 4387

Internet: igs.ifag.de

GeoGenius needs ephemeris in the EF18 format for processing. An implemented Ephemeris Generation Tool allows you to very quickly generate precise ephemeris in the EF18 format. To do so, choose **Tools/Precise Ephemeris Import**. The SP3toEF18 window will appear.

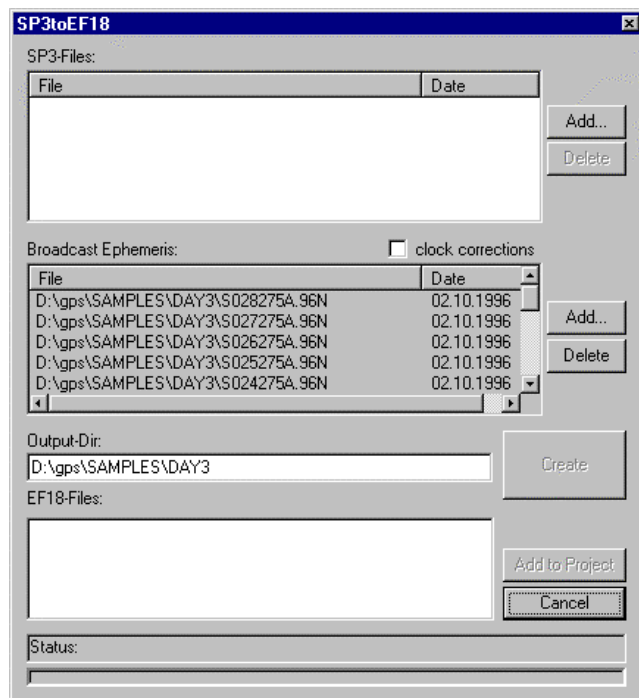


Figure 14-1: SP3 to EF18

14.1.2 Choose Source Files

Box SP3-File lists path and name of the SP3 files that will be used to generate precise ephemeris. A column date allows you to inspect its date, too.

The button **Add...** opens the Standard File Selector with SP3 Files (*.SP3) as file mask. Select the path and files to be inserted. You may

add an unlimited number of files, **GeoGenius** will automatically detect the date of the contained ephemeris data and will display it in the Date field. The software will create EF18 files for each GPS-week separately. You do not have to consider the week!

If there are files you do not want to use, you may remove them from the project via the button **Delete!** Remember, in case of file security **GeoGenius** does not delete “removed” files from your hard disk; they are only removed from the project.

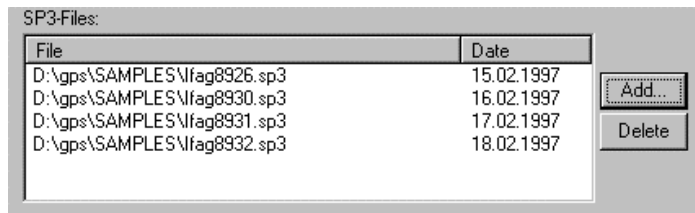


Figure 14-2: SP3 Source

14.1.3 Clock Corrections

The files may or may not contain satellite clock corrections. If no clock corrections are in the SP3 file, **GeoGenius** offers the option of using the broadcast clock corrections from the RINEX navigation files.

The box **Broadcast Ephemeris** is not activated as long as you did not mark the checkbox **Clock Corrections** or as long as you did not press the button **Add...**, if broadcast ephemeris are not available in the current directory. If you want to use broadcast clock corrections, add the fitting RINEX file via button **Add...**. The Standard File

Selector will by default show files of the RINEX format with the file mask eph-Files (*.9?N)(*.0?N).

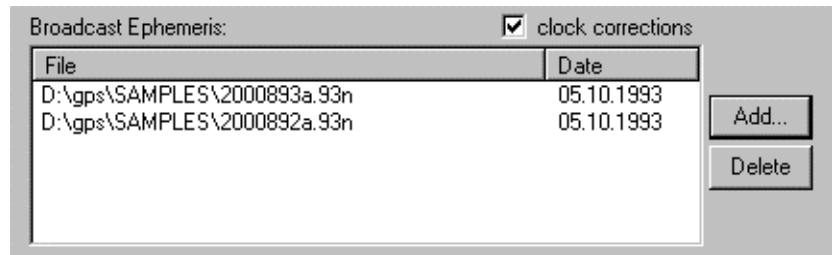


Figure 14-3: Broadcast Ephemeris

14.1.4 Define Output Directory

To define the storage directory enter the target directory name into the third dialog box. All generated files will be created in this directory.

14.1.5 Create EF18 File

Now, start the transfer to EF18 Format by clicking on the button **Create**. The progress indicator at the window bottom indicates the creation progress and displays any error messages.



Figure 14-4: Progress Indicator

One EF18 file will be created for each GPS-week of provided ephemeris data. In our example, the four given SP3 files result in two EF18 files.

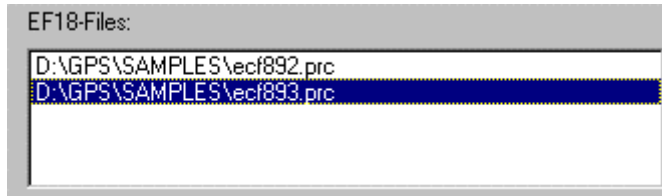


Figure 14-5: EF18 Files

Generated precise ephemeris files have the same format and use the same name as broadcast ephemeris files but the extension is *.PRC: ECFWWW.PRC. The extension *.PRC indicates the precise ephemeris file.

14.1.6 Insert EF18 Files into Project

Generated EF18 files are not automatically inserted into the current project. If you do not want to use them, press the button **Cancel**. Generated files will not be used for the current project and the dialog will be closed. You may insert the generated data, e.g., into another project.

If you want to add the just created EF18 files to the current project, just press the button **Add to Project**. The data will be added and the window will be closed. You now may go on processing using the provided ephemeris data.

Inspect the container Ephemeris and you'll find the created files appended to the sub-container Precise Ephemeris.

14.2 Merging of Precise Ephemeris

Precise ephemeris, which already are available in the EF18 format, but do not cover a whole week, such as, e.g., *.E18 files, can be transformed into weekly *.PRC files.

Choose the pull-down menu **Tools/EF18 Merger** to open the respective dialog to merge the E18 files to PRC files:

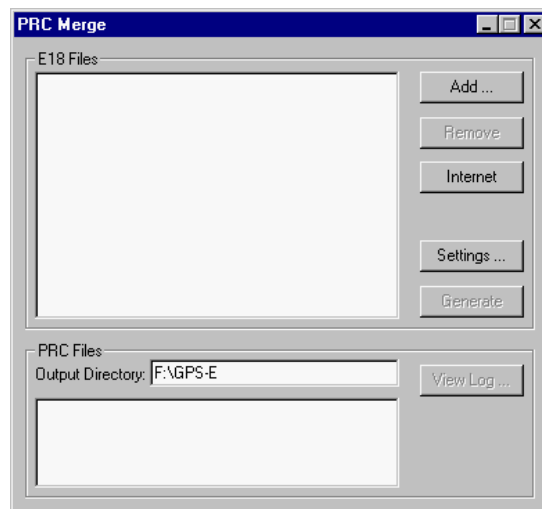


Figure 14-6: Dialog PRC Merge

This dialog consists of two blocks. The block E18 files allows you to define the files that should be used for the generation of PRC files. Just

open the standard dialog using the button **Add...** . Marking a file and clicking **Remove** removes a file you no longer want to use.

The button **Internet** makes access to E18-files easier. Pressing this button opens the Internet Browser at the pre-set page. The button **Settings** opens the dialog Settings, which offers you the possibility of defining the start-page of your Internet Browser as well as the output directory for the generated PRC files.

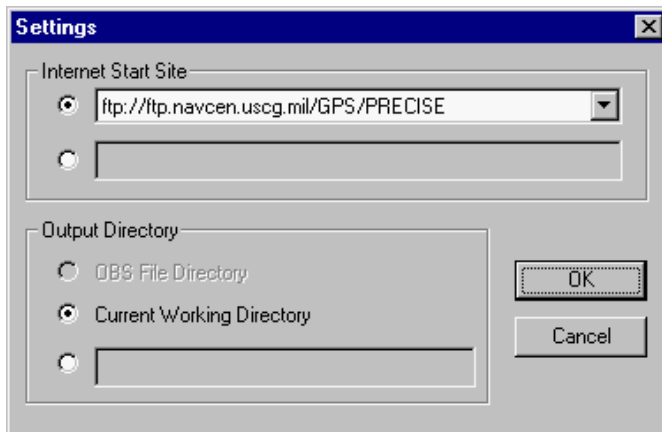


Figure 14-7: Settings for the Internet Start Site

The different start-pages can either be chosen out of a list of already known addresses (upper combobox) or manually entered. As output directory you can either select the the directory of the observation files or the Current Working directory or manually enter a path (combobox at the bottom).

If you add at least one file the button **Generate** is activated. Click this button to create precise weekly ephemeris files *.PRC.

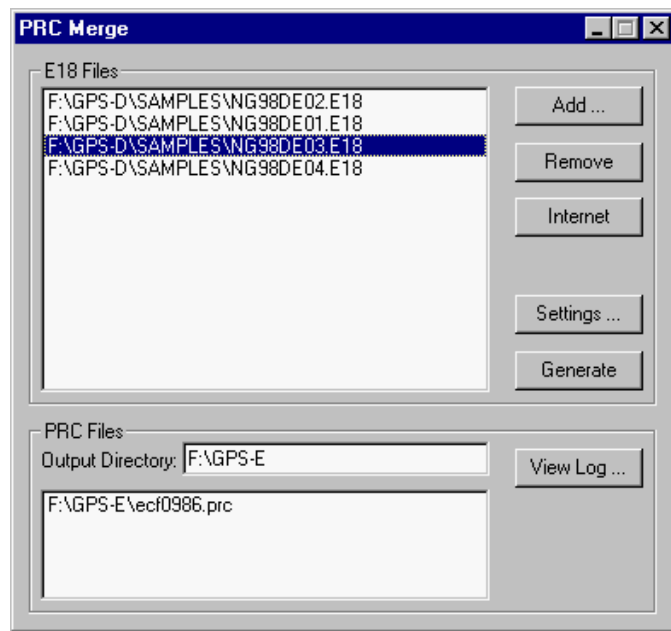


Figure 14-8: PRC files generated from E18 files

Occurring errors are saved in a special report file. Open this file using an editor of your choice via the button **View Log...**

14.3 Baseline Scanning

To inspect baseline related observation data and to select the time spans to be used for processing, you have two possibilities:

1. **Scan window showing data for all sessions:** activate a baseline.
2. **Scan window displaying only data for a single session:** activate a single session.

Open the baseline or session related context menu with a click of the right mouse button and choose option Scan... . The Scan Satellites window shows up.

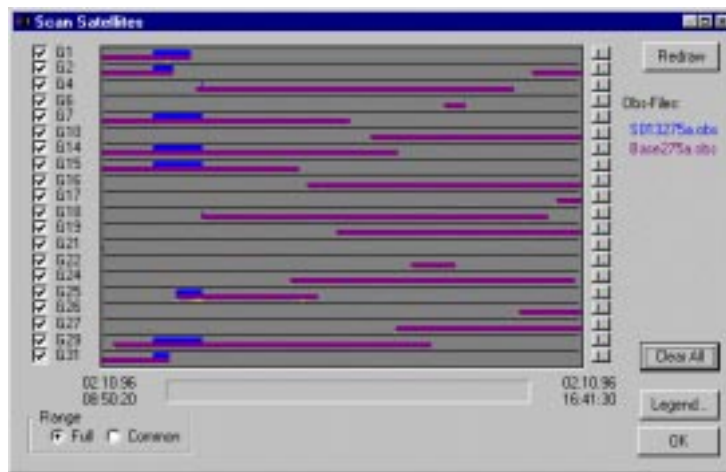


Figure 14-9: Scan Satellites

The screen displays the times of satellite tracking by two or more observation stations. Each satellite is represented by a row, each station is represented by bars covering the rows in defined color. Colored markers allow you to detect time spans with suspicious data.

The window may display multiple sessions, each session identified by its color. The names of the used observation files are displayed at the upper right hand side in the colors used for the observation time span bar.

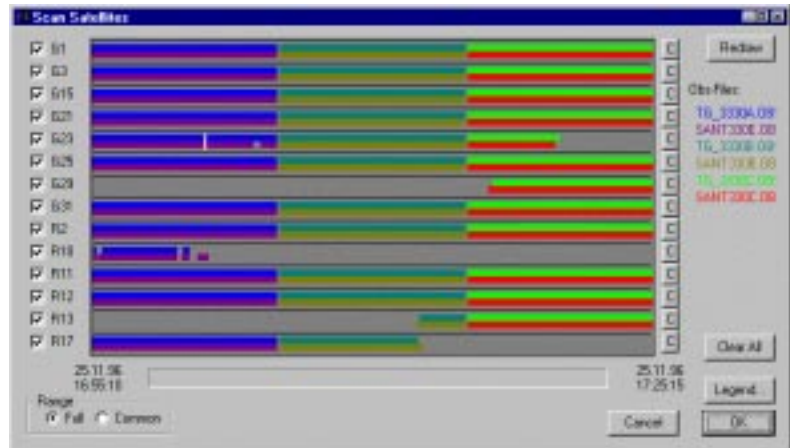


Figure 14-10: Multiple Sessions

Each row represents a satellite found in at least one of the observation files. Satellites are arranged by their PRN.

The length of the bar represents the total observation time from the left (start time) to the right (end time). At the bottom of the last row, the start and end times are indicated at the left-hand and the right-hand side, respectively. The central string field displays the time of the current cursor position. When marking time spans to be ignored, the range of the current marking fence will be displayed.

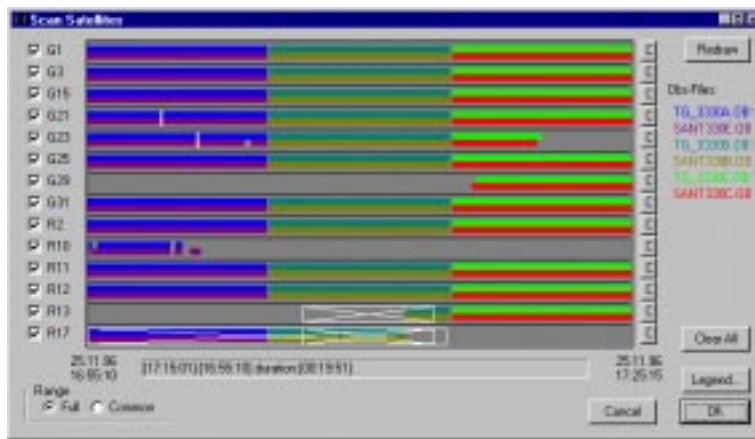


Figure 14-11: Time Range of Current Fence

Using the radio buttons Full/Common of box Range you may select the range of the displayed time span. Default is Common, which leads to the display of only the overlapping parts of the observation files. This is of interest, if one of the files is significantly larger than the other is. If you choose Full, the full time range will be displayed.



The option Common is available, if only one session is used for Scan. With two or more sessions, **GeoGenius** will display an error message!

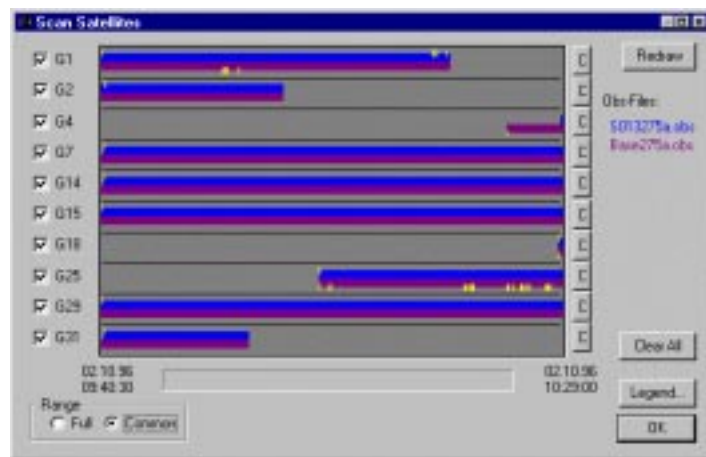


Figure 14-12: Common Time Range

Figure 14-12 shows the common time range of the observation files displayed in Figure 14-9.

Button **Redraw** instructs **GeoGenius** to redraw the Scan Satellites window, which might be of interest after several changes in the time span marking. Button **OK** accepts all settings, while **Cancel** leaves the option without updating the information.

14.3.1 Data Inspection

Depending on the amount of data and the resolution of the screen you will be able to identify missing epochs. You may resize the dialog window. Loss of lock indicators already stored during data recording are shown as vertical lines on the horizontal satellite data bars. This will allow you to identify possible cycle slips in the individual satellites.

To get a short description of all available marking types click on the button **Legend....**

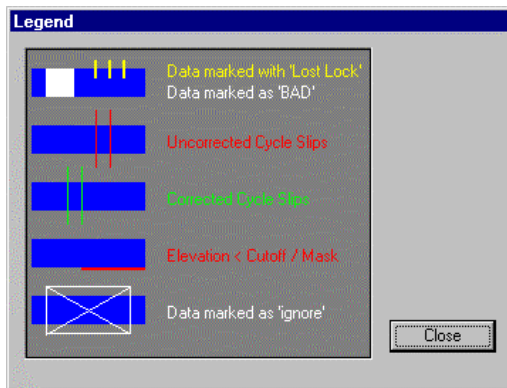


Figure 14-13: Legend

GeoGenius automatically marks data with five different markers:

- ⇒ A yellow vertical line indicates data marked with “Lost Lock”
- ⇒ A white section of the station bar indicates data marked with BAD
- ⇒ A red vertical line indicates unrecovered cycle slips
- ⇒ A green vertical line indicates corrected cycle slips
- ⇒ A red horizontal line indicates time spans with satellite elevation less than the cutoff setting in the Processing Options, Page Parameters.

You may also select time spans to be ignored:

- ⇒ A white fence indicates time spans with data manually marked to be ignored for further processing (see next section).

To return to the Scan Satellites window choose button **Close**.

14.3.2 Observation Fencing

GeoGenius allows you to define time spans for each satellite, which are to be ignored by the baseline estimator. This can improve processing. If a line was processed and no ambiguities were fixed (yellow or red baselines) and the line scan shows unrecovered cycle slips, you may choose to ignore the suspicious data and try to process the baseline again.

To mark time spans move the cursor to an individual bar, press the left mouse button and drag it until the end of the time span is reached (vertical and horizontal mouse movement is possible to mark more than one satellite for a desired time span). Ignored time spans are displayed with a white fence. Using this technique you can mark several data blocks (even for a single satellite). The central string field at the bottom will display the start and end times of the current selection.

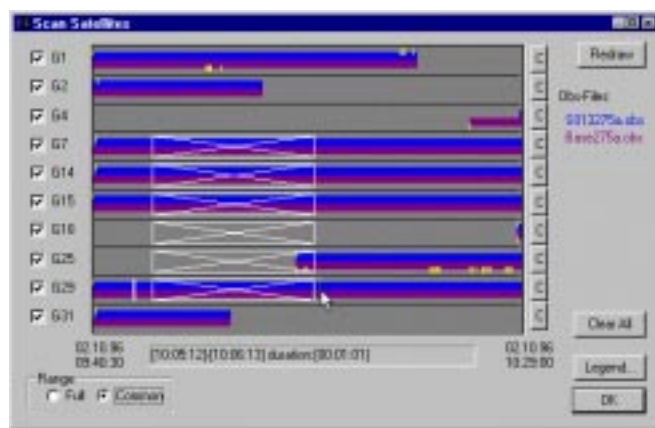


Figure 14-14: Fencing

A **satellite** can be marked for ignoring by toggling the satellite PRN number checkbox (✓ removed) on the lefthand side of the respective bar. All satellites with a marked checkbox are used for processing. Satellites to be ignored are grayed out.

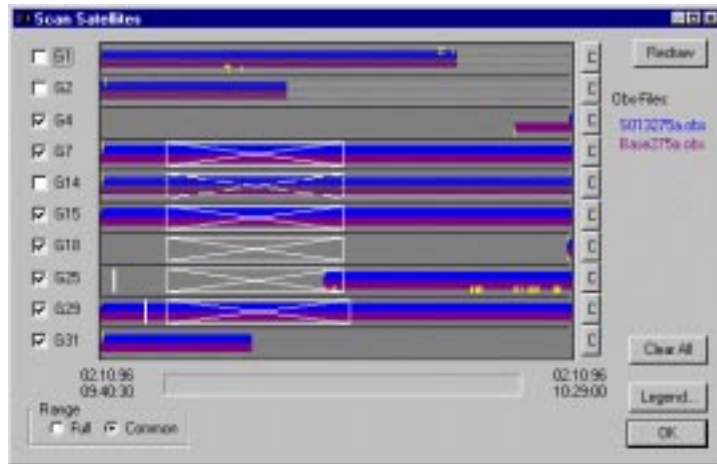


Figure 14-15: Ignored Satellites

To remove data markings for one satellite you may use the button **C** on the righthand side of each satellite row. To clear the window from all manually entered markers, click on the button **Clear All**.

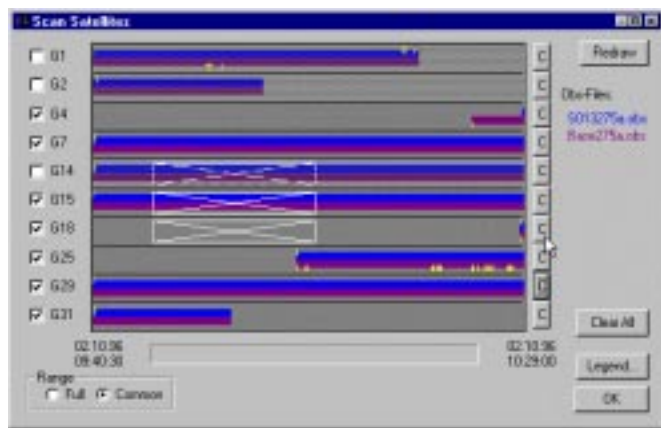


Figure 14-16: Clear Markers



Please note that marking the data does not delete the data. *The observation files remain untouched.* They are just marked within the system.

14.3.3 Observation File Scanning

You may also inspect the data of a single observation file. Open the file related context menu with a click of the right mouse button and choose option Scan... to move to the Scan Satellites window for this file. It offers the same information and features as described above. However, **GeoGenius** will disregard fenced-off time spans or ignored satellites. The observation files remain untouched *and will not be marked*.

14.4 Single Point Positioning

Single Point Positioning is an independent recalculation of the coordinates for the point selected. This recalculation is based on a single observation file. Single Point Positioning is useful, if you want to estimate positions without reference. They may improve accuracy with respect to the code positions. Single Point Positions have an accuracy of ± 50 m. S/A effects are not reduced.

14.4.1 SPP with a Single Observation File

To create single point positions for a single observation file, activate the respective observation file, open its context menu with a click of the right mouse button and choose option **Single Point Position**. This opens the Single Point Position window.



Figure 14-17: Single Point Position

A string field displays the path and name of the current observation file. Box Systems allows you to define the satellite system(s) and the type of processing to be used for the positioning. GPS is the default satellite system setting. **GeoGenius** recognizes the survey mode from

the observation file header information and automatically sets the corresponding value.

The major differences between static and kinematic processing are:

- Static: One accumulated solution is generated
- Kinematic: A solution for every epoch is built. The single point positioning is reset for every epoch. The resulting trajectory is attached to the observation file and can be reached via the navigator.

The button **OK** instructs **GeoGenius** to close the window and to perform the single point positioning, **Cancel** closes the window without conversion.

The single point positioning process is immediately started. A progress bar is displayed during processing.

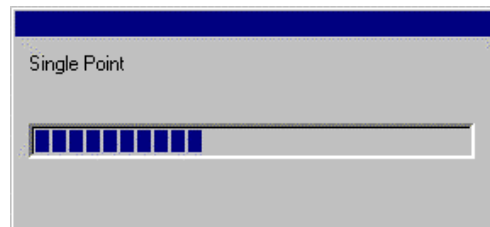


Figure 14-18: SPP Progress

When single point positioning using the static processor is finished, the SPP Results window will be displayed. This window allows you to assign the calculated positions to the Point. Former coordinates will be overwritten and will not be available for future use in this project.

SPP Result			
Result			
X:	3896020.594	[m] +- [m]	19.340
Y:	792073.168	[m] +- [m]	11.188
Z:	4971038.201	[m] +- [m]	36.553
Old Coordinates			
X:	3896085.507	[m]	
Y:	792090.811	[m]	
Z:	4971130.607	[m]	
Difference			
	dx	-64.913	[m]
	dy	-17.642	[m]
	dz	-92.406	[m]
		Assign these coordinates to Point:	
		2050	
		☐ Assign to OBS file too	
		Assign	
		Cancel	

Figure 14-19: SPP Result

The SPP Results window displays in box Result the calculated positions as geocentric Cartesian WGS coordinates in meters and the derived standard deviations in millimeters. It gives you the point number that the result may be assigned to. You may also view the former coordinates of this point (box Old Coordinates) and the differences to the SPP result in each coordinate (box Differences).

The button **Assign** instructs **GeoGenius** to assign the single point coordinates to the point and to close the window, **Cancel** closes the window without storing positions. If you checked the checkbox **Assign to OBS file too**, the single point coordinates will be added to the observation file when you click the button **Assign**.

Single Point Positioning may be useful, if you want to know the position deviations in detail. In this case, create a single point position of the statically measured point using the kinematic processor. When single point positioning is finished, a trajectory will be added to the observation file in the navigator and to the respective point in the project plot. (With large projects, it might be necessary to zoom in to see the trajectory.) You may inspect trajectory positions in a position file.

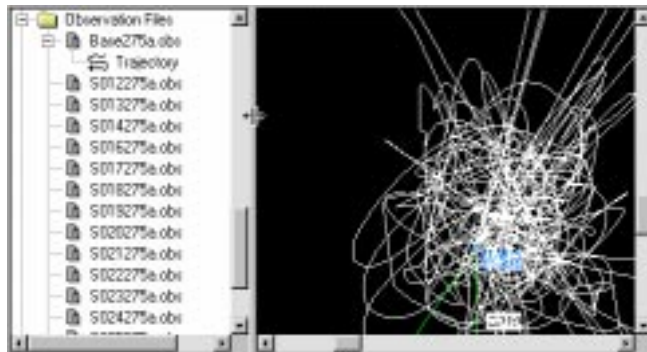


Figure 14-20: Kinematic Single Point

To create a position file active the trajectory, then open the context menu by clicking with the right mouse-button on Trajectory. Now choose the single option **Properties**. The Property: Kinematic Path window allows you to review and export the single point positioning results.

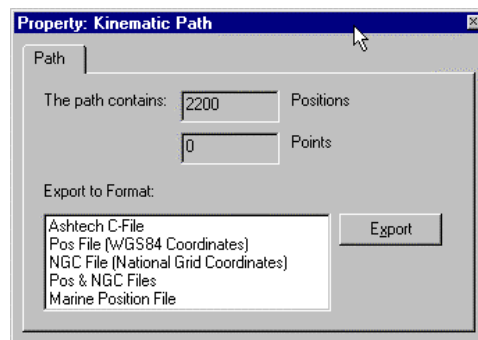


Figure 14-21: Property Trajectory

Page Path displays the following values:

Number of positions measured at each epoch (**Positions**)
Number of stop points the file contains (**Points**)

The box **Export to Format:** offers several kinematic data file formats to export the processed stop points and/or positions to a position file. You may choose one of the by default implemented formats. You may also add additional file format(s) via the menu item **Kinematic Formats...** of the pull-down menu **Options**. Added file formats will then also show up in the **Export to Format:** list.

After you have activated one of the offered kinematic file formats by a click of the left mouse-button, click the button **Export** to create a position output file. A standard Windows file selector shows up with the name of the observation file and the default file extension. You may, however change the file name and path to it. Click **Store** to start the creation of the position file. For example, POS files containing independent epoch solutions are stored as *.POS.

14.4.2 Automatic SPP for the Project

A helpful tool for the daily data preparation is the automated SPP on all observation files of your project. Just select the menu item **SPP on all OBS Files** of the **Tools** pull-down menu. A Message pops up asking whether you really want to do an SPP on all observation files and – please note! – to assign the results to the observation file.

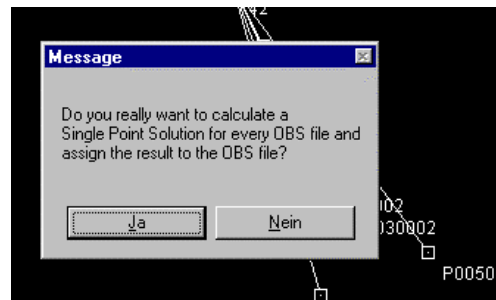


Figure 14-22: Multiple SPPs

If you cancel the process, your observation files remain untouched. If you accept the message with **YES**, **GeoGenius** iterates over every observation file and performs a Single Point Solution on all observation files of your project. Then it automatically assigns the resulting positions to the database and to each observation file. Progress bars allow you to watch the procedure.

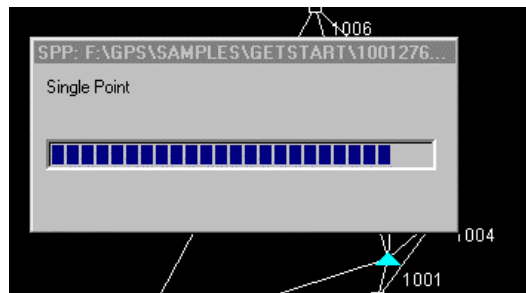


Figure 14-23: SPP Progress Bar

During the automated process, the output window informs you on the progress, the resulting positions and on eventual failures due to too few satellite observations.

```
RUN: F:\GPS\M\AUTOSPPA.M
Observation file: F:\GPS\SAMPLES\GETSTART\1001276A.OBS
Information: no position, too few satellites 394200.00 ... 394210.00
Information: no position, too few satellites 405400.00 ... 405400.00
Final position 3902239.393 -154642.228 5025942.218
Observation file: F:\GPS\SAMPLES\GETSTART\1002276A.OBS
Final position 3902511.860 -155835.608 5025863.183
```

Figure 14-24: Output Window Information During SPP

Note that the tool SPP on all OBS files just consists of two macros. Macro AUTOSPPA.M builds a shell around the script AUTOSPP.M. It calls the Message dialog and, if accepted, calls AUTOSPP.M. This macro iterates over every Observation File, performs a Single Point Solution and assigns automatically the results to the database and to the observation file. You may customize the macro AUTOSPP.M according to your needs using the commands of the **GeoGenius** scripting language (refer to *App. C*), e.g., to **not assign** the SPP results to the observation files!

14.5 Data Transfer Tools

GeoGenius offers a couple of transfer tools, which allow the transfer of satellite data from some receivers to your hard disk. Currently, such transfer tools are available for Ashtech and Geotracer data.

1. To transfer data between **Ashtech** GPS&GLONASS receivers and your hard disk you may purchase the respective license and then install the data transfer tool for Ashtech data. Insert the **GeoGenius** CD-ROM into the respective drive and select the option Ashtech Download RCS. The installation tool will lead you through the installation process. When finished, you can open either the program tool Commander or Download. For detailed information please refer to the on-line help of the software.

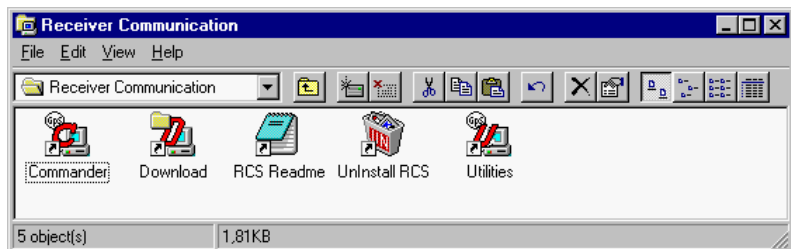


Figure 14-25: Transfer Ashtech Data

2. To transfer **Geotracer**® GPS and GLONASS Data from the receiver to your hard disk click Tools/Transfer Data (Geotracer)...

Several transfer modules matching the hardware systems are available:

GTR/GDM Download
Ext. PCMCIA Card Reader
Geotracer 2100/2/4
GeoCom Data

The GTR/GDM Download item calls the Windows WinFx tool. This allows the very fast transfer of data between Geotracer® receivers or Control Units (GTR) or Geodimeter® (GDM) total stations and computers via serial RS232 cable.

To read Geotracer® GPS data from an external PCMCIA card reader and to store it in DOS compatible format choose option Ext. PCMCIA Card Reader. For more information refer to the Utility Programs chapter of the Geotracer® System 2000 User Manual.

Option Geotracer 2100/2/4 allows the direct transfer of data from the Geotracer® 2100, 2102 or 2104 L1 receivers to a PC. The receiver must be attached to a serial port of the PC. For more information refer to the Utility Programs chapter of the Geotracer® System 2000 User Manual.

The GeoCom Data item calls the Windows Geotracer® Communication utility. This allows the transfer of data between Geotracer® or Control Units and computers via serial RS232 cable. You will find a full description of this tool in the Geotracer® Communication User's Guide. The Geotracer® Communication User's Guide is a separate part of the **GeoGenius** manual.

3. The programm CDU Dump allows the data transfer between **Leica** GPS&GLONASS Receivers and a computer hard disk. Open the

program via the menu option Tools/Data Transfer (Leica)/CDU Dump. The Dialog Controller data download pops up.

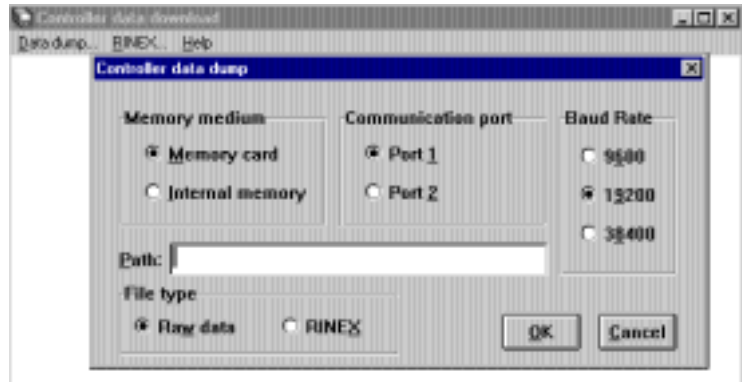


Figure 14-26: Transfer Leica Data

14.6 GPS and GLONASS Data Visualization – GPS-Edit

GPS-Edit for Windows95/NT is an advanced tool for graphic visualization of GPS and GLONASS data and DGPS observations. Graphic windows display the observables code, carrier and Doppler as well as combinations of this data (wide-laning, ionospheric correction, single, double, triple delta differencing).

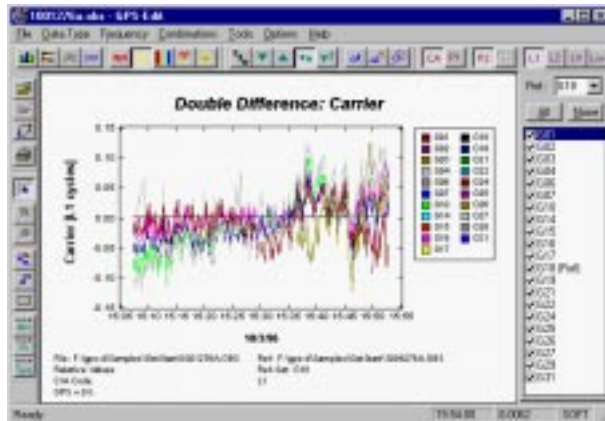


Figure 14-27: Data Visualization and Editing Tool GPS-Edit

GPS-Edit is based on the standard observation files *.OBS. They are displayed in any combination of receiver frequency and satellite. **GPS-Edit** allows you to work with two observation files simultaneously (to show single, double and triple differences). **GPS-Edit** allows switching between multi-satellite view and single-satellite view. You can quickly change receiver, frequencies, satellite, the reference satellite and data processing at one button click.

The **GPS-Edit** *User's Manual* offers a complete description of **GPS-Edit**'s capabilities.

This section describes how to access **GPS-Edit** from any object of the current **GeoGenius** project.

You may start **GPS-Edit** from

- A Baseline
- A point
- An Observation File
- A Session

14.6.1 Start GPS-Edit from a Baseline

To access **GPS-Edit** from a baseline:

1. Activate the baseline either in the project plot or in the navigator,
2. Open its context menu by a click of the right mouse button,
3. Choose the menu option Edit Data/GPS-Edit (graphical),

If the baseline was observed in several sessions, a session selector window pops up:

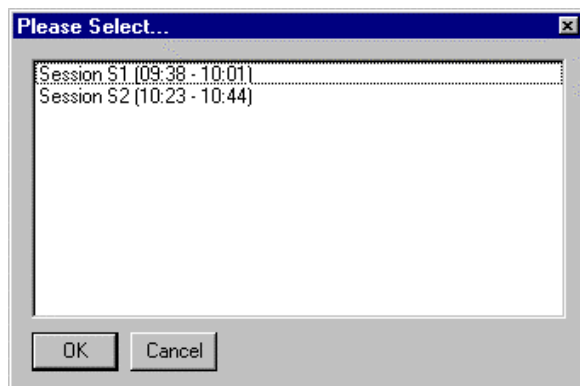


Figure 14-28: Session Selector

4. Activate a session and click **OK**.

The main **GPS-Edit** window shows up and displays the Raw Data: Code - Carrier for the currently selected rover observation file. To get the data for the reference observation file, just choose the menu item **File/Swap Ref. and Rover** or click the corresponding toolbar button.



14.6.2 Start GPS-Edit from a Point

To access **GPS-Edit** from a point:

1. Activate the point either in the project plot or in the navigator,
2. Open its context menu by a click of the right mouse button,
3. Choose the menu option **Edit Data/GPS-Edit (graphical)**,

If a point was observed more often than once, the observation file selector dialog pops up:

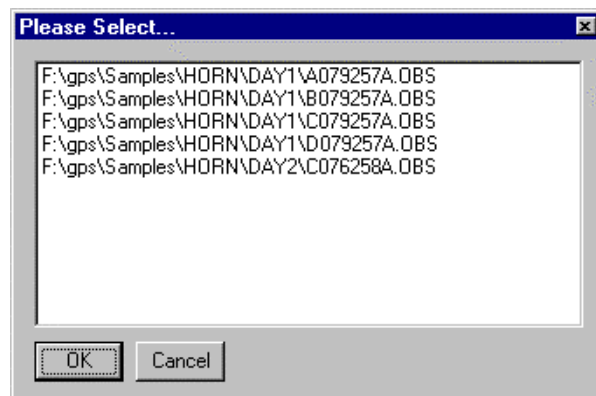


Figure 14-29: Observation File Selector

4. Activate an observation file and click **OK**.

The main **GPS-Edit** window shows up and displays the screen Raw Data: Code - Carrier for the currently selected observation file.

14.6.3 Start GPS-Edit from an Observation File

To access **GPS-Edit** from an observation file:

1. Activate the observation file in the navigator (e.g., from the Observation Files container, from a baseline container, etc.),
2. Open its context menu by a click of the right mouse button,
3. Choose the menu option Edit Data/GPS-Edit (graphical),

The main **GPS-Edit** window shows up and displays the screen Raw Data: Code - Carrier for the currently selected observation file.

14.6.4 Start GPS-Edit from a Session

To access **GPS-Edit** from a session:

1. Activate the session in the baseline container,
2. Open its context menu by a click of the right mouse button,
3. Choose the menu option Edit Data/GPS-Edit (graphical),

The main **GPS-Edit** window shows up and displays the screen Raw Data: Code - Carrier for the current rover observation file. To get the data for the reference observation file, just choose the menu item File/Swap Ref. and Rover or click the corresponding toolbar button.

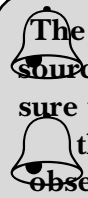


14.7 The Observation File Editor

With the Observation File Editor, a very powerful tool comes along with **GeoGenius**. The Observation File Editor edits the contents of an observation file and allows you:

- to check the observation file contents record by record,
- to delete bad data,
- to split and merge multiple observation files,
- to edit wrong or forgotten field input, such as site ID's, heights, etc.
- to save the file under the current or a new name.

This is extremely useful, if an observation file contains erroneous data or markers. The Observation File Editor may help you to rescue a file, which otherwise might be unusable.



The Observation File Editor allows you to manipulate the source of your data! Please, be aware of this fact and make sure that you will not destroy unrecoverable data. To be on the safe side, we suggest you to make a copy of the observation file before saving it with the Observation File Editor.

Please note:

The editor is capable to work with files of any length. It uses virtual memory techniques. (From time to time you will, therefore note the reloading process of the editor).

14.7.1 Start the Observation File Editor

To start the Observation File Editor choose the menu item **OBS-File Editor** of the pull-down menu **Tools**. The main window of the Observation File Editor shows up. Starting with Version 1.6 you can also start the Observation file Editor directly from the context menu of a project object, such as a point, a baseline or an observation file via **Edit Data/OBS-Edit (numerical)**.



Figure 14-30: Observation File Editor - Main Window Empty

The main window consists of a header, a menu bar, a toolbar (if selected), a main area allowing one or several child windows and a status bar (if selected).

You may select/deselect the display of the toolbar and the status bar. To do so, choose the pull-down menu **V**iew and check or clear the items **T**oolbar and **S**tatusbar.

14.7.2 File Operations

The pull-down menu **File** offers standard and special file options. You may also access these items via the toolbar. Most of them are also available from the context menu (click the right mouse button) of the navigator.



Figure 14-31: Observation File Editor Toolbar

New	opens a new child window (Editor). A child window consists of a navigator part (left-hand side) and a spreadsheet part (right-hand side). An unlimited number of Editors may be opened.	
Open...	inserts an observation file into the current editor. An unlimited number of files may be inserted into one Editor. The spreadsheet displays the contents of the observation file inserted last or activated in the navigator.	
Close	closes the current observation file without storing changes.	
Close All	closes all observation files of the current child window without storing changes.	
Save	saves the current observation file under the current name. This option destroys your original file. Therefore, be sure to make a copy of the source prior to saving with Save .	

- Save As... saves the current observation file under a new name. This option allows you to keep the original file and simultaneously to store the changes in the edited file. 
- Split/Merge/Decimate opens the Split/Merge/Decimate dialog to split an observation file, or to merge several observation files, or to decimate an observation file. 
- Scan current file opens the Satellite dialog, a graphical overview over the availability and health of satellite data.
- Close Editor closes the current child window.
- Exit closes the application.

14.7.3 The Editor

An Editor consists of a file navigator part at its left-hand side and a spreadsheet at its right-hand side.

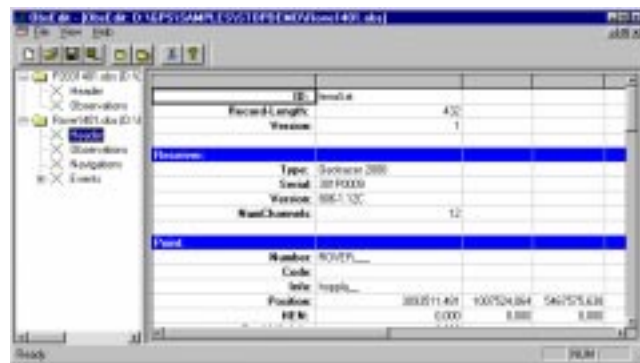


Figure 14-32: Editor

The navigator lists the observation files currently inserted into the Editor and the path to it. It provides access for each individual OBS file to

- the header information ,
- the observation records,
- the navigation records, if available
- event records, if available
- error records, if available

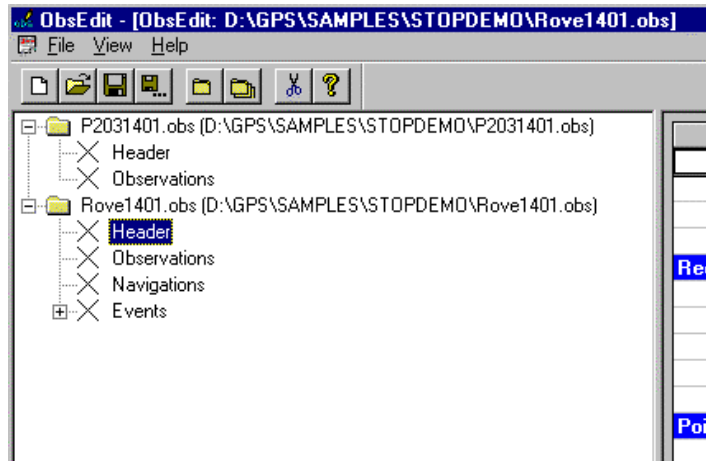


Figure 14-33: Navigator of the Observation File Editor

If the observation file name is activated (highlighted), the spreadsheet displays the contents of the observation file header. You may edit each cell and include further information according to the defined observation file header structure.

If you open the observation file tree by a double-click (left mouse button) or by a click on the + signed square left to the name, the tree

items Header, Observations show up. If further information is available, also one or several of the tree items Navigations, Events, Errors may show up. Activating, e.g., the item Observations changes the contents of the spreadsheet. The spreadsheet now displays each single observation record and allows you to manipulate the entries.

You may customize the width of a column by dragging the column border(s) to the left or the right, after the cursor shape has changed to a double-line, double-arrow shape.

14.7.4 Editing Cells

A cell is activated, if it is surrounded by a double-lined square. To activate a cell you may click the cell or move the activating square via the arrow keys to it. Scroll bars allow you to move through the sheet.

If a cell is activated, double-click (left mouse button) it to edit its contents via your keyboard. The cursor (I) indicates where to insert a character. The system knows the data structure and automatically sets limitations to the number or type of characters allowed. If the cursor changes its shape to a little triangle beneath a character, the editing mode is switched from “insert” to “exchange” for this character.

Some cells contain check boxes, which may be checked (= yes) or cleared (= no) (e.g., Slope Instrument Height). Some cells offer list boxes allowing you to choose one of several options (e.g., the observation Mode).

The cells of the first column and grayed cells can't be edited. (Example: You may edit the start and end times in GPS-Seconds. The time in-

formation is also given in the YY.MM.DD and HH.MM.SS format. Editing of the respective cells is not possible.)

 Your edits will be stored only, if you save the observation file. If you close the file or the Editor without storing your edits, the system will ask you whether you want to save the changes. If your answer is OK, the file is saved under its previous name! The original file is lost!

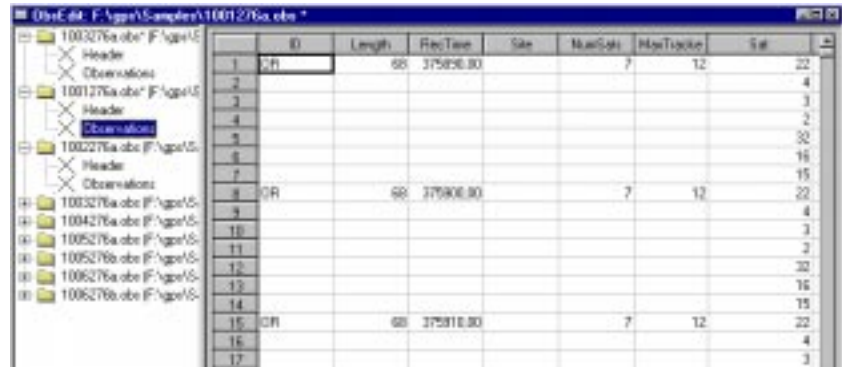
14.7.5 The Header Information Spreadsheet

ID:	test.dat		
Record Length:	432		
Version:	1		
Received:			
Type:	Garmin 220S		
Serial:			
Version:	CU-H8106		
NumChannels:	12		
Point:			
Number:	1000		
Code:	P014		
Info:	P014		
Position:	2902239.027	-154659.127	902560.228
HEM:	1.740	0.000	0.000
Geoid Height:	0.000		
Time:			
GPS Week:	873		
Start:	200706.00	00:10:19.96	14.29.10
	200706.00	00:00:00.00	00:00:00.00

Figure 14-34: Header Information Spreadsheet

The header information spreadsheet displays the contents of the observation file header according to its pre-defined structure. You may edit the cells and thereby manipulate the header information (refer to section 14.7.4).

14.7.6 The Spreadsheet Observations



ID	Length	RecTime	Site	NumSats	MaxTrack	S#
1	68	375858.80		7	12	22
2						4
3						3
4						2
5						30
6						16
7						15
8	OR	68	375806.80	7	12	22
9						4
10						3
11						2
12						30
13						16
14						15
15	OR	68	375818.80	7	12	22
16						4
17						3

Figure 14-35: Observations Spreadsheet

The spreadsheet Observations displays every single observation record one after the other. Each row contains the observations to one satellite at one epoch.

The first column ID indicates the beginning of a new observation record (OR). An observation record covers the rows starting with a row identified by OR and ending with the last row above the next OR-identifier. The number of rows for each observation record depends on the number of satellites observed. In the figure above, seven satellites (see column NumSats) were observed during the first two epochs. Therefore, the two first observation records cover seven rows each.

The number of rows may be very large, depending on the observation duration, the observation interval and the number of satellites observed.

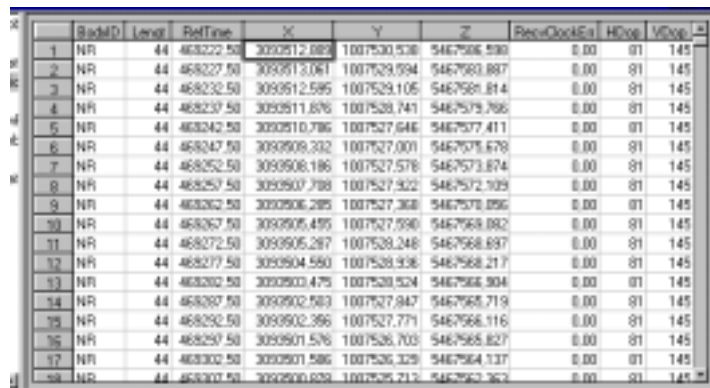
The up to 34 columns display the contents of each entry. Since this is a large number of columns, the Observation File Editor has an option built in to reduce the number of displayed columns (refer to the respective subsection).

You may edit the contents of each cell (for editing cells, refer to section 14.7.4).

 **Take care not to change vital information, such as the Length Entry, which states the length of each measurement block!**
The whole file might get useless!

You may delete single observations and observation records and filter the observations for satellites. You may also hide columns for a faster view. Please refer to sections 14.7.10 and 14.7.11.

14.7.7 The Spreadsheet Navigations



	BodyID	Length	RefTime	X	Y	Z	RecClockErr	HComp	VComp
1	NR	44	468222.50	3093512.682	1007530.538	5467566.590	0.00	81	145
2	NR	44	468227.50	3093513.061	1007529.094	5467563.887	0.00	81	145
3	NR	44	468232.50	3093512.595	1007529.105	5467561.814	0.00	81	145
4	NR	44	468237.50	3093511.876	1007528.741	5467579.766	0.00	81	145
5	NR	44	468242.50	3093510.786	1007527.646	5467577.411	0.00	81	145
6	NR	44	468247.50	3093509.332	1007527.001	5467575.679	0.00	81	145
7	NR	44	468252.50	3093508.186	1007527.578	5467573.674	0.00	81	145
8	NR	44	468257.50	3093507.708	1007527.922	5467572.709	0.00	81	145
9	NR	44	468262.50	3093506.285	1007527.368	5467570.096	0.00	81	145
10	NR	44	468267.50	3093505.495	1007527.090	5467568.082	0.00	81	145
11	NR	44	468272.50	3093505.267	1007528.248	5467568.697	0.00	81	145
12	NR	44	468277.50	3093504.580	1007528.936	5467568.217	0.00	81	145
13	NR	44	468282.50	3093503.475	1007528.524	5467566.904	0.00	81	145
14	NR	44	468287.50	3093502.503	1007527.847	5467565.719	0.00	81	145
15	NR	44	468292.50	3093502.366	1007527.771	5467566.116	0.00	81	145
16	NR	44	468297.50	3093501.576	1007526.703	5467565.827	0.00	81	145
17	NR	44	468302.50	3093501.586	1007526.329	5467564.337	0.00	81	145
18	NR	44	468307.50	3093500.629	1007525.213	5467563.362	0.00	81	145

Figure 14-36: The Spreadsheet Navigations

The spreadsheet Navigations displays every single navigation record (SPP navigation solution of the receiver) one after the other in a row. Each row starts with the BodyID NR.

The number of rows may be very large, depending on the observation duration and the processing interval.

You may edit the contents of each cell (for editing cells, refer to section 14.7.4).



**Take care not to change vital information, such as the Length entry, which states the length of each measurement block!
The whole file might get useless!**

You may delete single navigation records. You may also hide columns for a faster view. Please refer to sections 14.7.10 and 14.7.11.

14.7.8 The Spreadsheets of the Events Container

The Events container of the navigator may contain one or several spreadsheets. Each spreadsheet contains the events of a single event type. For example, with Stop&Go data, you typically have events of the type 6. A type 6 event identifies a new stop point. Its spreadsheet name is NewPoint. With aerophotogrammetry, the camera induces external event records (Type 0) with each taking.

Row#	Length	EventType	RefTime	Course	IntTime	PointNumber	Pg
1	94	6	470000.75	627+250 v5F8		STR1	
2	78	6	470054.75	NormalNew		0001	
3	78	6	470058.50	NormalNew		0002	
4	78	6	470059.00	NormalNew		0003	
5	78	6	470114.00	NormalNew		0004	
6	78	6	470124.00	NormalNew		0005	
7	78	6	470136.00	NormalNew		0006	
8	78	6	470150.25	NormalNew		0007	
9	78	6	470164.00	NormalNew		0008	
10	78	6	470176.50	NormalNew		0009	
11	78	6	470188.25	NormalNew		0010	
12	78	6	470201.75	NormalNew		0011	
13	78	6	470212.75	NormalNew		0012	
14	78	6	470226.25	NormalNew		0013	
15	78	6	470242.00	NormalNew		0014	
16	78	6	470253.75	NormalNew		0015	
17	78	6	470263.50	NormalNew		0016	
18	78	6	470273.25	NormalNew		0017	

Figure 14-37: A Spreadsheet of the Events Container

The following event types are available:

Extern	Type 0
RecTime	Type 1
Manual	Type 2
Comment	Type 3
RS232	Type 4
NewPoint_Old	Type 5

NewPoint Type 6

The spreadsheets of the Event container display every single event record one after the other in a row. Each row starts with the BodyID ER. The number of rows may be very large, depending on the frequency of event recording.

You may edit the contents of each cell (for editing cells, refer to section 14.7.4).

Take care not to change vital information, such as the Length entry, which states the length of each measurement block! The whole file might get useless!

You may delete single event records. You may also hide columns for a faster view. Please refer to sections 14.7.10 and 14.7.11.

14.7.9 The Spreadsheet Errors

If your observation file contains erroneous data, the spreadsheet Errors will help you to find the location of the errors.



	Record	File Position
1	0	432

Figure 14-38: The Spreadsheet Errors

The Spreadsheet Errors displays in each row the record number and the position in the file in bytes where an error occurred.

14.7.10 Deleting Rows

The Observation File Editor allows you to cut bad observations from your file. Bad observations may

- concern whole records
- concern single satellite observations
- derive from unhealthy satellites.

These items are related to the rows in the spreadsheet. Therefore, you may perform the actions via the rows' context menu.

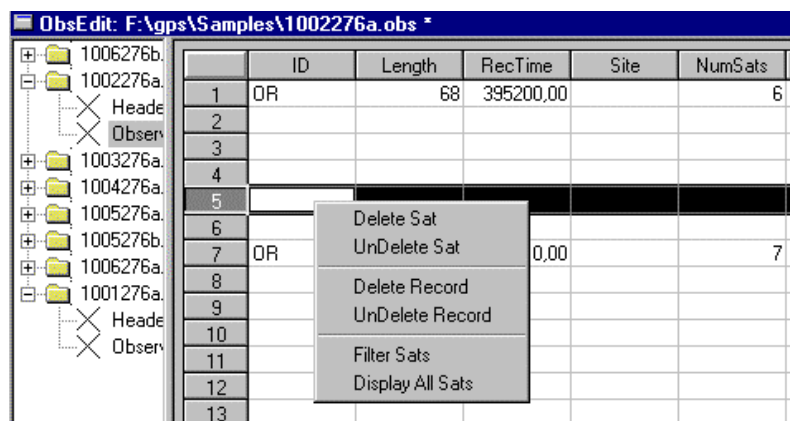


Figure 14-39: Row Related Context Menu

The spreadsheets Observations, Navigation and Events all allow you to delete/undelete records. The spreadsheet Observations additionally offers options to delete/undelete single observations.

14.7.10.1 *Deleting Records*

To delete one record (observation, navigation, event)

- Click (right mouse button) on the spreadsheet anywhere in the respective record to open the context menu
- Choose the menu item **Delete Record**

The record including all its observation rows (all satellites) will be marked as disabled (grayed). This allows you to control the deletion of each single record as long as you did not save the file. The Observation File Editor will delete all grayed records from the observation file as soon as you save the file!

To delete several records

- Drag the cursor (left mouse button) over the records (row headers) to be deleted. At least one row of a record has to be activated.
- Open the context menu (click right mouse button).
- Choose the menu item **Delete Record**.

All activated records will be marked as deleted (grayed). The Observation File Editor will delete all grayed records from the observation file as soon as you save the file!

To undo the deletion of records

- You must not have saved the file yet.
- Drag the cursor (left mouse button) over the record(s) to be deleted (with observation records, at least one row of a record has to be activated).

- Open the context menu (click right mouse button)
- Choose the menu item **UnDelete Record**.

The records will be marked again and the deletion will be removed.

14.7.10.2 *Deleting Single Observations (ONLY Spreadsheet Observations)*

To delete a satellite measurement block in a single record

- Click (right mouse button) onto the respective anywhere in the respective row to open the context menu
- Choose the menu item **Delete Sat**

The row (observation to one satellite) will be marked as disabled (grayed). This allows you to control the deletion of each single measurement block as long as you did not save the file. The Observation File Editor will delete all grayed rows from the observation file as soon as you save the file!

To undo the deletion of satellite observations

- You must not have saved the file yet.
- Drag the cursor (left mouse button) over the row(s) to be undeleted.
- Open the context menu (click right mouse button)
- Choose the menu item **UnDelete Sat**.

The records will be marked again and the deletion will be removed.

14.7.10.3 *Filter Observations (ONLY Spreadsheet Observations)*

To hide a satellite measurements in all observation records (if, e.g., the satellite is of no interest for the current check), the Observation File Editor filters the file for this satellite, if you

- Click (left mouse button) onto the row of the respective satellite in any observation record.
- Open the context menu (click right mouse button).
- Choose the menu item **Filter Sats**.

The measurements to respective satellite will be hidden in all observation records. You can not see the satellite number anymore. The NumSats column will nevertheless display the number of all satellites observed during positioning. You will also notice, that the row numbers of the deleted satellite records is missing. The Observation File Editor will not delete the hidden rows from the observation file if you save the file!



Hidden rows does not affect the observation file when you save it! Note also the difference to hidden baselines in the main module of **GeoGenius**: only hidden baselines will not be processed or adjusted!

To undo the filtering for satellites

- Click the cursor (left mouse button) anywhere in the spreadsheet
- Open the context menu (click right mouse button)
- Choose the menu item **Display all Sats**.

The Observation File Editor will re-display the removed satellite in all observation records. If beforehand a satellite observation was disabled manually, this action will not be affected.

14.7.11 Displayed Columns

The Observation File Editor has an option to reduce the number of displayed columns. This option does not affect the observation file, but just helps you to faster view the columns of interest, without the need to scroll.

To reduce the number of columns by hiding a selection of columns

- Activate the column(s) you want to be hidden (click the column header or click and drag over the column headers),
- Open the column context menu by a click of the right mouse button
- Choose the menu item **Hide Column(s)**.



	ID	Length	RecTime	Site	NumSats	M
1	OR	68	397750.00		7	
2						
3						
4						
5						
6						
7						
8	OR	68	397760.00		7	12

Figure 14-40: Hide Columns

All activated columns will be hidden until you re-display them.

To re-display columns

- Activate any column by a click on its header,
- Open the column context menu by a click of the right mouse button,
- Choose the menu item **Display all Standard Columns**, or
- Choose the menu item **Display all Columns**.

The Observation File Editor then re-displays all hidden columns.

You may also search for characters in an activated column. Activate one or several columns (drag the cursor over the column headers) and select the context menu option **Search in Columns**). A dialog pops up.

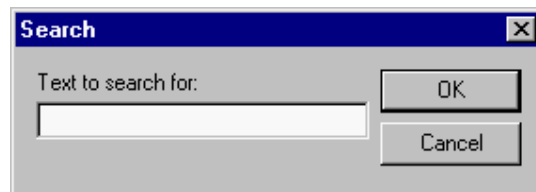


Figure 14-41: Search in Column(s)

Enter the text (the characters) and accept with **OK**. **OBS-Edit** checks the activated columns for the first fitting entry.

14.7.12 Split /Merge/Decimate

The **GeoGenius** Observation File Editor allows you split, merge and decimate observation files. You may not merge file with overlapping time spans.

If you want to split, merge or decimate files,

- The current editor must contain files with non-overlapping observation time spans.
- The Code-number, Carrier-number and Doppler-number of the files have to fit (check the header information).
- Activate the navigator.

- Choose the menu item **Split/Merge/Decimate...** from the pull-down menu **File** or from the navigator context menu.

If the files of the current editor contain overlapping time spans, the Observation File Editor will not allow you to go on. It will give you an error message instead.

If the files do not overlap with time, the Split/Merge/Decimate dialog pops up.

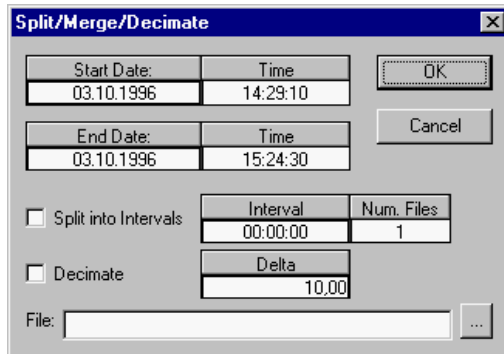


Figure 14-42: Split/Merge/Decimate Dialog

Four fields display the start and end times defined by all observation files. Start date and time are the earliest start date and time detected in any of the files, end date and time are the last date and time detected in any of the files. You may activate each cell by a double-click (left mouse button) and may change the values.

If you want to split a file, you may also split it according to defined time intervals. The cell Interval allows you to edit a time interval in hours, minutes and seconds. The cell Num. Files will automatically display the number of files that will be generated using this time inter-

val. If you edit one of both cells, the checkbox **Split into Intervals** switches its state to be checked. If you clear the checkbox, the Observation File Editor discards the corresponding edits.

If you want to decimate a file, the checkbox **Decimate** must be checked. The value **Delta** (Default: 10) stands for the reduction factor. With a value of, e.g., 10, only 1 of 10 consecutive observation records will be used for the new file, the others will be removed.

Finally, you will have to specify a file name for the target file. Enter the path and name into the string field **File** or open a Standard Windows File Selector via the button **...** Its file mask box shows the entry **OBS-FILE (*.OBS)**. The new name should follow the standard observation file conventions **SITEDDDS.OBS**, where **SITE** stands for the point number, **DDD** stands for the day of the year and the free character **S** (which often describes the session number).



If you split an observation file according to a specified time interval, the Observation File Editor will create as many files as specified in the cell **Num.File**. The respective files will be generated under the specified file name, which will be extended by alphanumerical characters in alphabetic order.

For example:

The source file name is **1000278.OBS** and covers 50 minutes of observation time. You specified a 20 minutes time interval, 3 files, file name **1000278.OBS**. The following files will be generated:

1000278A.OBS – 20 minutes

1000278B.OBS – 20 minutes

1000278C.OBS – 10 minutes

Another example:

The source files are:

1000278A.OBS

1000278B.OBS

1000278C.OBS

You specified a file name 1000278A.OBS. The merged file will overwrite the source file 1000278A.OBS. To inspect the newly created file first close the old file 1000278A.OBS without saving, then re-open the file to inspect the merged contents.

14.7.13 Satellite Scanning

A graphical overview of the available satellite-data in an observation file is given in the dialog Satellites. Its functions are explained in detail in section 14.3. Open the dialog Satellite either via the pull-down menu File/Scan Current File or via the context menu of the observation file (open this menu with a right mouse click). Please note that the respective observation file must be activated, if the editor displays more than one observation file.

14.8 The Event Editor

With aerophotogrammetry or when surveying in the Stop&Go mode, it is often necessary to mark specific times and to record them as events. Events can be recorded automatically or manually. Depending on the receiver's manufacturer, event records are collected within the raw data file or into a separate event file .

GeoGenius' Event Editor reads and edits events from kinematic data files, independently of the data file type. You may then add the events to your project and output the events in project reports (such as the Coordinate Overview) or in output files. Open the Event Editor via the pull-down menu option Tools/Event-File Editor .

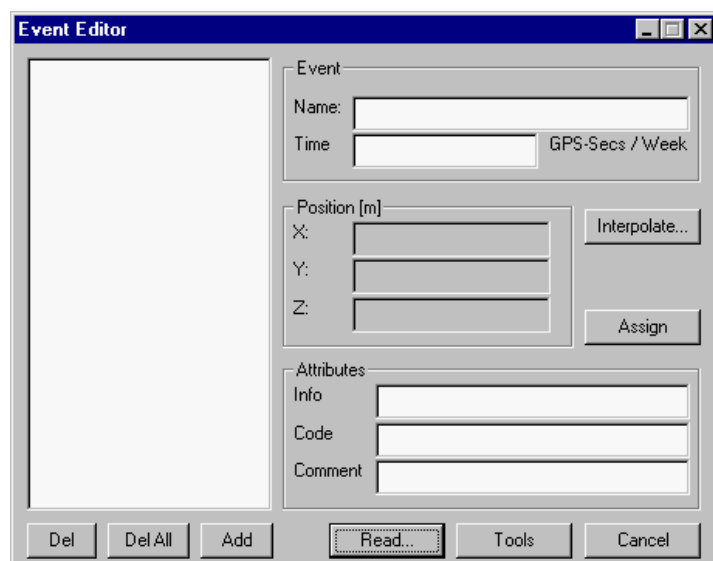


Figure 14-43: Event Editor - Empty

14.8.1 Reading and Interpolation of Events

First, the Event Editor has to read the events from file. Click the button **Read...** A Standard Windows file Dialog opens (typically displaying the path to the directory last selected). The file mask field displays the Ashtech Photo Files (*.DAT). However, you may also select the file mask Observation Files (*.OBS), since many manufacturers write the events directly into the raw data file or into the observation file.

Choose a file containing events and click **Open**. **GeoGenius** opens the file, reads the event messages and interpolates the events using the time records and navigation solution to assign positions to the event record. A notice message informs you on the name of the event file selected, the number of events detected, and the number of non-interpolated events.



Figure 14-44: Event Editor – Notice

Accept using the button **OK**. The Event Editor now displays the list of all events detected in the event file. For each event a name, a time and a position is assigned. If an event could not be interpolated, its position is N/A. You will find the values and information assigned to each event, if you highlight the event name in the event list.

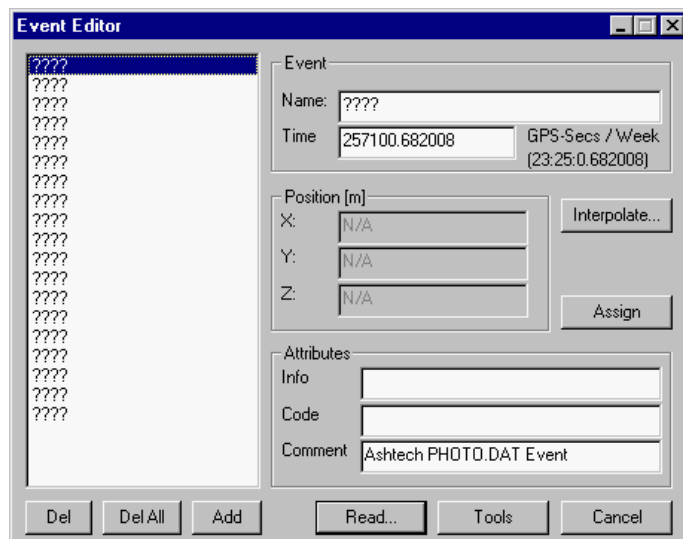


Figure 14-45: Event Editor: File Read-in

If the events have not been numbered or named before, the Event Editor allows you to assign automated numbers in the order of their appearance. Click the button **Tools**. The dialog Tools allows you to renumber the events. Edit the number of the first event in field **Start** of the box Point Renumber. The field **Mask** displays a Standard C/C++ format specifier.

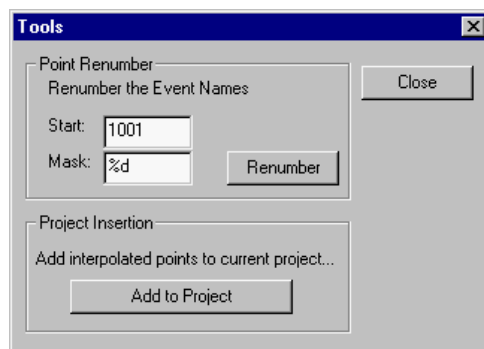


Figure 14-46: Event Editor - Dialog Tools

If you click the button **Renumber**, the Event Editor rennumbers the events, starting with the value of field **Start**.

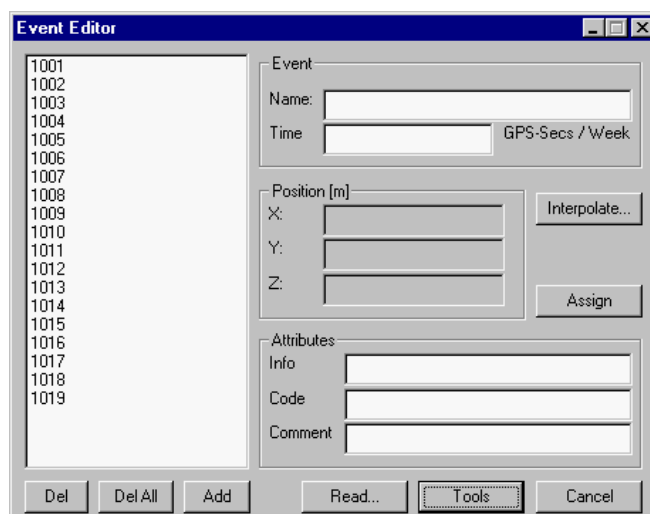


Figure 14-47: Event Editor - Events Renumbered

14.8.2 Events in the Project

Events may be inserted into the project, and will then be handled as points. They will be part of the Points container assigned to a  Point name. They have Point Properties and can be removed like points via the keyboard button **Del**.

To insert the events into the project, click the Event Editor button **Tools**. Within the Dialog Tools now click the button **Add to Project**. Each time you click the button, a new set of events will be added to the project.

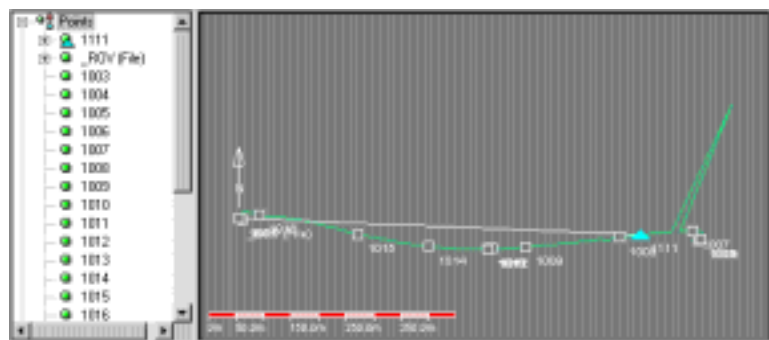


Figure 14-48: Kinematic Project - Events Inserted

14.8.3 Edit Events

You may edit any single event. You may rename the event and assign a new time, which means also assigning a new position. The box Attributes allows you to set further attributes.

To edit an event, mark its name in the list of events (click of the left mouse-button). All available information for the event will now be displayed in the right-hand part of the dialog.

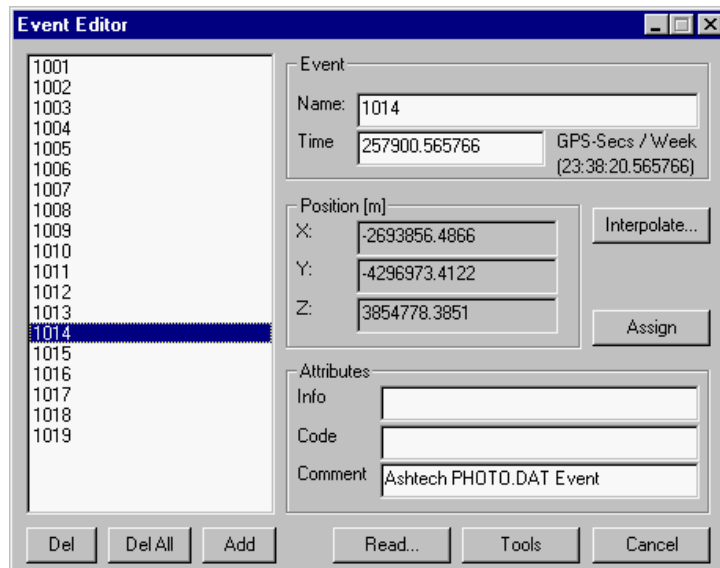


Figure 14-49: Event Editor - Edit Event 1014

Now you may edit the activated fields. E.g., you may enter an **Info** or a **Code** using the box Attributes or change the **Comment**. All entries or changes will only be stored, if you have clicked the button **Assign** first.

The string field **Time** is of special interest. By editing the time value, you may move the event to another position on the trajectory. To do so, enter a new time value and click the button **Assign**. This action stores the new time, however, it does not store a new position. For the new position, you first have to click the button **Interpolate...**. The Event Editor now re-interpolates for all events. Activate the point (whose identifier was renamed for corrected) again and check the new values for X, Y and Z of the box Position.

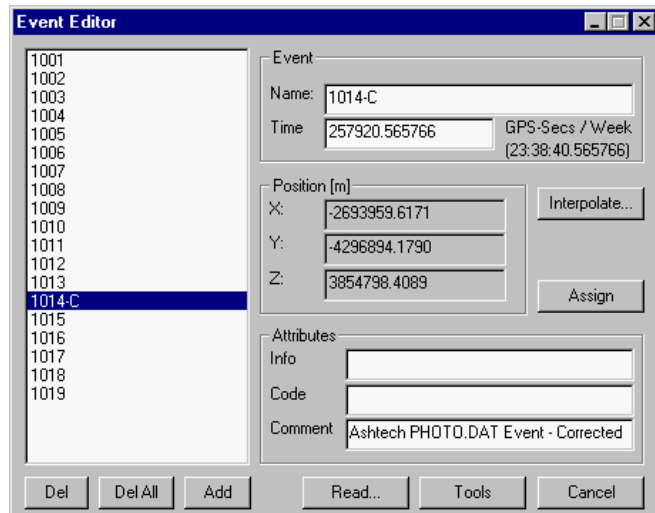


Figure 14-50: Event Editor - Event corrected for name, time and position

Via the buttons **Del** and/or **Del All** you may delete a single activated event and/or all events from the list. This action of course does neither affect the source event file nor events, which have already been added to the project.

Via the button **Add** you may manually add new events and assign a time to the event. A new event named **e1** (ascending numerals for each new event) and given the **Info** value **New Event** will be added to the list of events. If you have activated the new event (left mouse button), you may edit its values, e.g., edit the name of the event via the filed **Name**. To assign a position to the event, activate it, enter the correct time value and click the button **Assign**. Now re-interpolate (**Interpolate...**). Activate the event identifier again and check the current XYZ-Coordinates of the box **Position**.

14.9 View Residuals (graphical)

With static processing, **GeoGenius** offers you the option to generate residuals for every epoch. These will be saved until you leave the program.

You can inspect the residuals:

- Activate the baseline
- Open the context menu (right mouse click)
- Choose the option Edit Data/View Residuals (graphical)

The dialog Residual Viewer shows up. If all solutions are available, by default the residuals for the Float/L1 solution for one satellite and for the respective time span will be visualized.

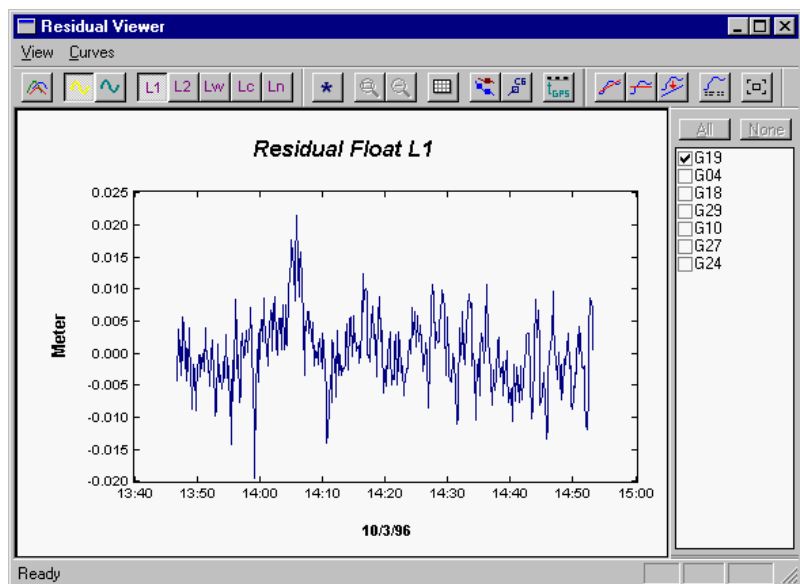


Figure 14-51: Graphical Residual Viewer

Many options of this dialog are the same as the options you are offered by the program **GPS-Edit**. A description of these options is given in the manual for **GPS-Edit**. The current section gives you a short introduction of how to use the program.

The graphical Residual Viewer creates a graph for every Double Difference solution. To get the curve for your solution choose the combination between the solution Float and Fixed and the wavelength (combination).

For the solution type, choose:



Curves/Float or the respective button



Curves /Fixed or the respective button

For the wave-length (combination) choose:



Curves /L1 or the respective button



Curves /L2 or the respective button



Curves /Lw or the respective button



Curves /Lc or the respective button



Curves /Ln or the respective button

In addition you will find the graphic Elevation (pull-down menu Curves/Elevation or the respective toolbar button) which allows you to compare the satellite heights over the horizon during the given time span.

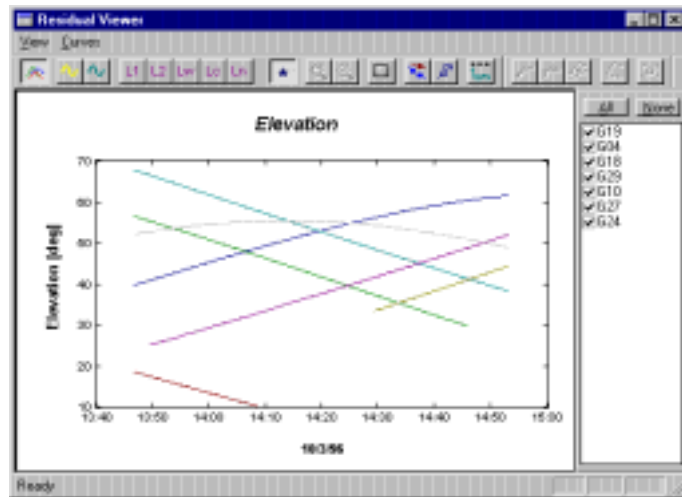


Figure 14-52: Elevation graph

It is possible to get a graphic for any single satellite or for a choice of satellites in the multi-satellite mode. Only this mode offers you the option of selecting more than one satellite at the same time via the satellite legend.



For more detailed information on a certain time span, zoom into a curve, moving your cursor over the needed time area. Using the buttons Unzoom and Zoom back you can switch between from the zoomed view back to normal view.



Markers for the beginning and the end of a satellite observation or for every single epoch and a grid option make it easier to interpret with the graphs.



The values given on the time axis are, by default, hours, minutes and seconds. You may, however, also choose GPS seconds for your project.



The following figure shows the residuals for a Fixed Lw solution combined with some of the above-mentioned options for a short period of time.

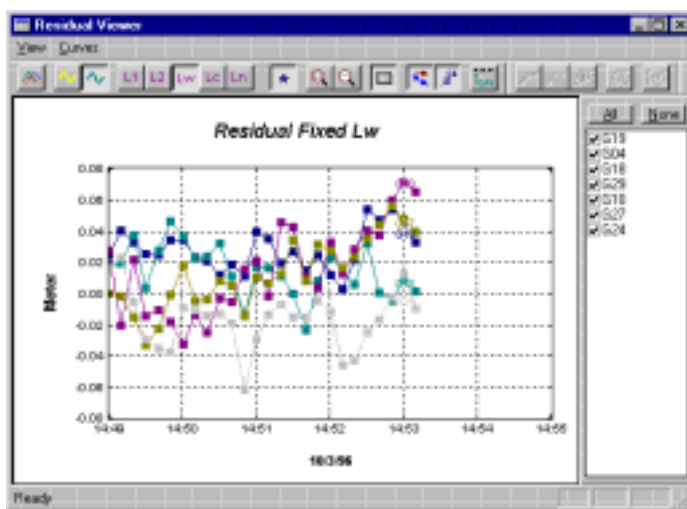


Figure 14-53: Fixed Lw Residuals, Multi-Satellite Mode, Grid, Point and End Markers

In the single satellite view some statistical values are available. Those can be visualized graphically, but also numerical via the statistical legend:



Visualize and calculate linear regression



Visualize and calculate the mean



Trend reduction by the value of the linear regression



Adding a statistical legend beneath the curve informing you about the current values.



Recalculation of the values corresponding to the new zoom.

The following figure shows the mean and the linear regression visualized as a straight line. The statistical legend informs you of the corresponding values.

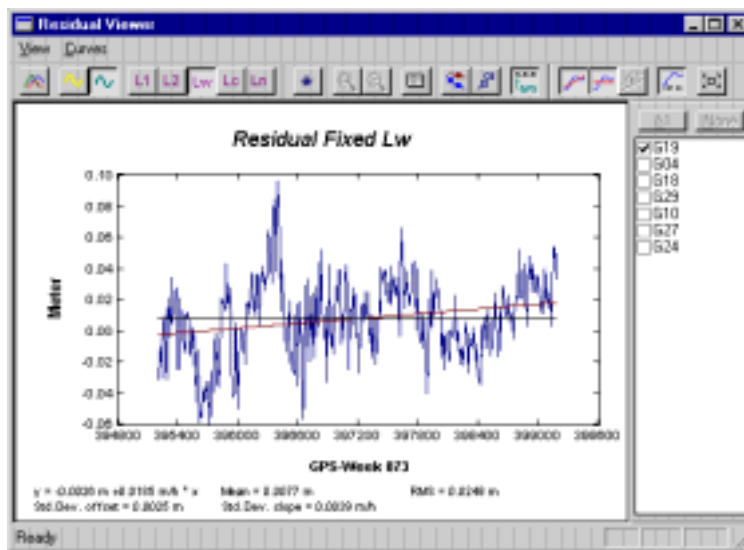


Figure 14-54: Statistics

14.10 RINEX File Validation

Sometimes RINEX navigation files contain erroneous data. The RINEX Checker tool checks RINEX Version 2 files and automatically removes erroneous data. You will find a detailed description of RINEX Version 2 files in App. B.4.

You may validate RINEX input and output files of the following types:

RINEX Navigation Message File	* .YYN
RINEX Observation File	* .YYO
RINEX Meteorological Data File	* .YYO

To select the RINEX files for validation, choose the menu item **RINEX Checker** of the pull-down menu **Tools**. The **Check RINEX Navigation Files** dialog, a standard Windows file selector, allows you to select one or several files for validation. The list of available file displays a pre-selection consisting of the project RINEX navigation files. The file mask box indicates RINEX Navigation Files.

If you click the **Cancel** button of the File Selector, an empty RINEX Navigation File Validation status information window pops up. Click the **Close** button of the dialog (no file validated).

If you open one or several file - make sure that the files are not write protected - , the RINEX checker automatically checks the selected files for errors. If it finds any, it corrects these errors. As soon as **GeoGenius** finished the task, a status information window will pop up. It lists the path and file name of the validated files and gives the current status.

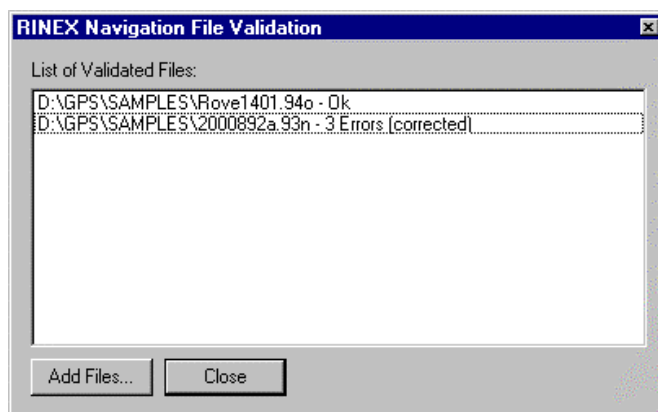


Figure 14-55: RINEX Navigation File Validation Window

The following comments may show up:

OK	no errors found
X Errors corrected	The RINEX Checker module found x errors and corrected them

The button **Add Files...** re-opens the Windows file selector and allows you to validate more files. These files will be appended to the former list. The button **Close** closes the window and leaves the RINEX Checker tool.

14.11 Loop Closure Test

GeoGenius offers two options to test the quality of you net. The loop closure test.

- **Automatically**, with a preselection of the number of sides via the menu Processing/Quality..., (refer to chap. 10.2)
- **Manually**, using the menu option Tools/Loop Closure (Manual).

This chapter informs you of the loop closure test suing manually defined loops.

Open the dialog Loop Closure using the pull-down menu Tools/Loop Closure (Manual). The points of your project are listed in the box Points. (You can also save loops, reload them etc.)

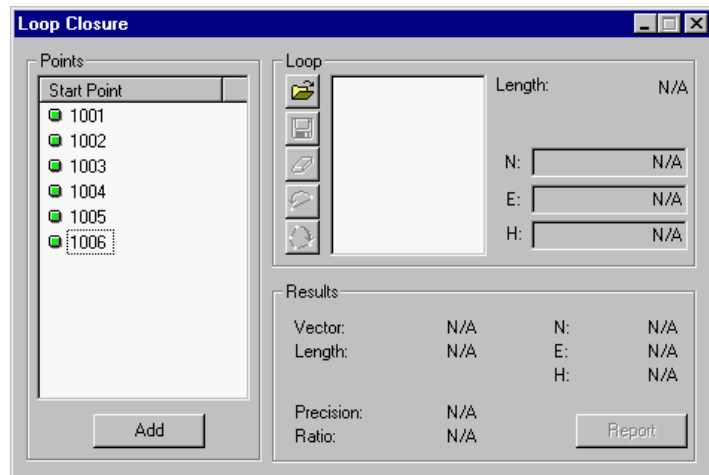


Figure 14-56: Dialog Loop Closure

The following options are offered for you to inspect your net and look for errors.

- Define your loop via points
- Remove points from the loop
- Automatic calculation of vectors, components, and distance
- Report
- Automatic calculation of the loop error
- Saving and loading the fixed loops

14.11.1 Define a Loop

To determine the loop, which you want to inspect, you need at least three points that are connected via baselines.

To define the points you can either:

- Double click the point listed in the list Points or
- Activate the point in the mentioned list and click the button **Add...**,
or
- Click the point in the project plot or the navigator, or
- After the start point, has been selected, click the baseline to the next point, withinin the navigator or the project plot.

The chosen point will be entered in the box Loop.

Please note the intelligent mode of choice: As soon as you added the points to the loop the box Points only shows those points that can be reached by a baseline from at least one point of the loop. That means that the list of points varies depending on the other settings.

The project plot and the navigator will still visualize all points, even if you have selected some of them before. Of course, a point that is not connected to one of the chosen points can not be added to the list of loop points.

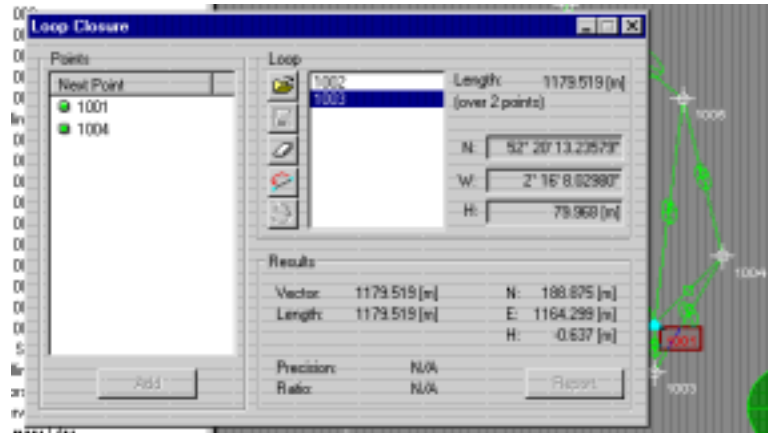


Figure 14-57: Definition of Loop - Availability of Points, First Results

As soon as you define the second point of a loop you will receive the first results for:

- The whole way from the start point to the last chosen point (value Length), with information on the total amount of points (over x points)
- The geographical coordinates of the activated points (N/S, E/W, H in the box loop)
- The vector from the first point to the last chosen point (value vector)
- The components of the vector in North, East and Height (N,E and H)

This information allows you always to check your loop.

A red arrow highlights the start point, if it would close the loop. In addition to the other point selection options, you may then use the respective button to select the point for the close up of the loop.

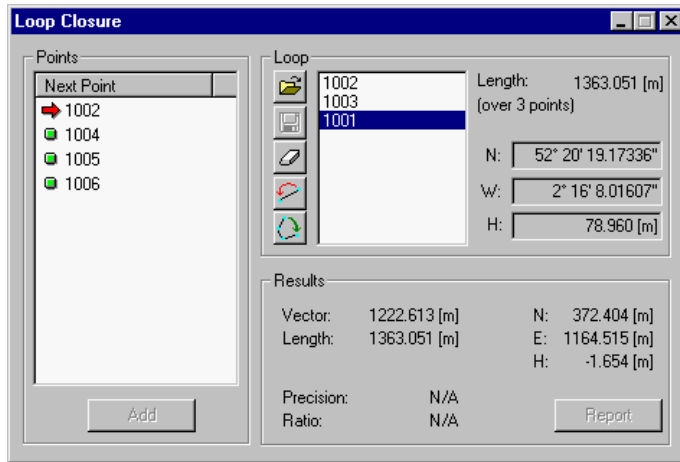


Figure 14-58: Loop Definition - Point 1002 closes the loop

14.11.2 Delete Points from the Loop

To change the definition of already configured loops **GeoGenius** offers you two options.

- You either undo the selection of the last point (button Undo)
- Or you delete the already entered points (button Eraser)



Each action automatically updates the calculated values.

14.11.3 Results

While generating a loop, you will always find information such as the following:

- The length of the loop from the start point to the activated point (value **Length** in the box loop), with information on the total amount of chosen points (**over x points**). The activated point is not necessarily the point you chose at last.
- The geographical coordinates of the activated point (N/S, E/W, H in the box Loop)
- The total length of the loop from the start point to the last chosen point (value **Length** in the box Results)
- The vector from the start point to the point that was selected as the last one (the value **Vector** in the box Results)
- The components of this vector in North, East and Height (N, E and H in the box Results)

As soon as the loop is closed, the list of points will be no longer activated. You will get the following, additional results:

- The precision of the calculation given in ppm (the value **Precision** in the box Results), given by $\text{length}/\text{vector} * 1.000.000$
- The ratio (the value **Ratio** given in the box Results), given by: $1 / (1 / \text{precision} * 1.000.000)$.

The button **Report** will give you a formatted report of the results. Clicking this button will open the HTML generator **HyperPage**. It allows you to copy the results to every word-processing program. If this

program is capable of understanding the HTML language, it will automatically print formatted tables.

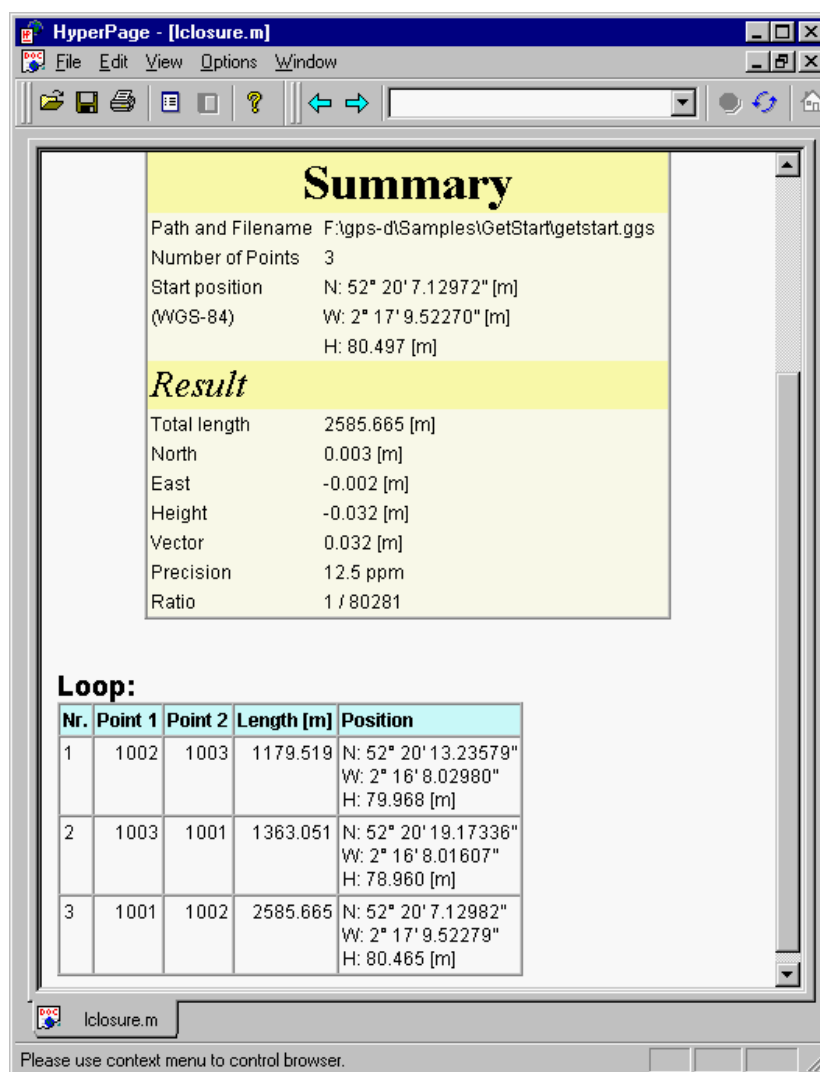


Figure 14-59: Report Loop Closure

14.11.4 Save and Load Loops

Every combination of points can be saved as a loop as soon as the loop is closed. You can store complex loops, e.g., for repeated surveys of the same area.

To save the loop, click the respective button. A standard file dialog will pop up, offering you the file-type **Loop closure-file (*.lpc)**. Select a path and name and save the loop.



You can reload a so-saved loop any time, if you open the same project again. Just click the respective button. Again a standard file dialog with the above mentioned file-type will be opened. Select the path and the name of the file and open it. If the selected file does not include the same points as the current (processed) project, you will receive an error message. After reloading, the values will be recalculated for this loop closure depending on the data new project.



14.12 Project Plot Modifications

By default, the project plot is always orientated to the North (based always on the national coordinates), i.e., the North direction is to the upper border of the project plot. **GeoGenius**, however, allows you to rotate the project plot and to add a North-indicating arrow to get an optimized overview over your network.

14.12.1 Graphical Plot Rotation

The Graphical Rotator tool allows you to rotate your plot with a defined rotation angle. This option may be of great use, if, e.g., your project extends itself mostly north-south, while the typical landscape format of the project plot area favors east-west-dilated projects. Or, you may have defined a local System and want to rotate the plot in a way that the definition points mark a specific direction.

To define a rotation angle for the current project choose the item **More...** of the **Tools** pull-down menu. The dialog **More Tools** pops up. Select the list item **Graphical Rotator**. The floating window **Rotator** shows up.

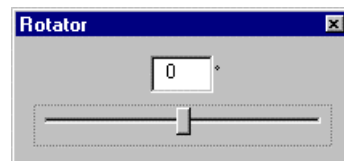


Figure 14-60: Rotator Dialog

The angle string field displays the current rotation angle, which is set to zero, if you did not rotate your plot before. You may edit the string field and enter a rotation angle value between -180° and $+180^\circ$.

A slider allows you to set the rotation angle intuitively. Dragging the tab to the right (angle values increase) rotates the plot counterclockwise, dragging the tab to the left (angles decrease) rotates the plot clockwise. A mouse click onto the slider to the left or right of the tab moves the tab for 45° into the respective direction. The plot rotates while you move the tab. If a North arrow is activated, it will move according to the rotation angle and always indicate the current North direction. The following figure displays the well-known project from the Getstart sampling data rotated for -60° .

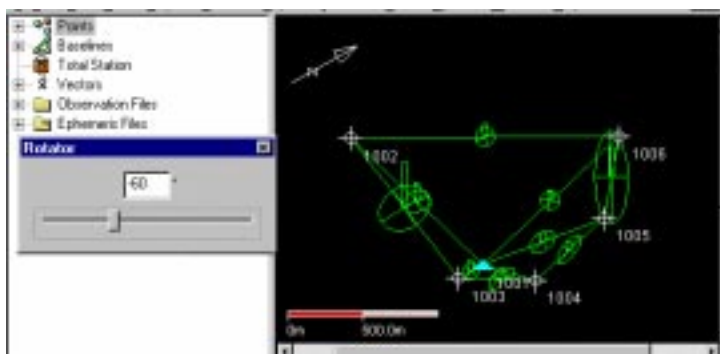


Figure 14-61: Rotated Plot

To rotate the project back to the original position (i.e., North to the upper border of the project plot) just set the rotation angle to zero.

To remove the Rotator floating window, just click the **Exit** button of its header line.

14.12.2 Insert a North Arrow

AS long as your plot is not rotated a North arrow is usually not necessary. You may, however, want to insert a North arrow, e.g., for print purposes. After rotation of the plot a North indicator becomes essential.

Open the dialog More Tools via the pulldown menu option Tools/More.... A click onto the North Arrow item of the list More Tools inserts a North arrow at the left border of your current project plot. This action also inserts an additional layer to the display groups of all current projects. Project saving includes the arrow to the project database.

Figure 14-61 displays a rotated North arrow.

14.12.3 Support for Automated Screen Updates

Typically, the project plot does not change its appearance, as long as no processing, adjustment, or zooming actions are done. If you want the plot to be redrawn, you have to click the Redraw button from the Display toolbar. 

You may additionally define a time interval for automated screen update. Choose the menu item **More...** of the pull-down **Tools** to open the dialog **More Tools**. Within this dialog, click the item **Automatic Redraw** to call the **Automated Screen Update** floating window

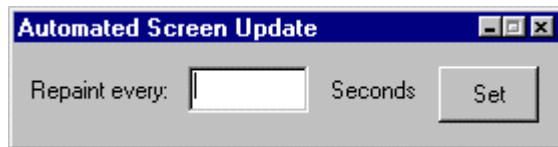


Figure 14-62: Automated Screen Updates Dialog

A string field allows you to enter a time interval in seconds. If you enter a time value x here and then click the button **Set**, **GeoGenius** will repaint the project plot every x seconds.

You may remove the dialog from the screen, if you click the **Exit** button of its header line. This action also discards the automated screen updates. Or you may set the time interval to values < 0 .

14.13 Graph Tool

To visualize and compare the curves current and future tools of **GeoGenius** use and will use the Graph tool. For deeper explanations on the respective curves refer to the respective chapters. This section will give general information on the Graph tool.

If you have selected the display of a graph, such as the context menu option **Graphics...** of a kinematic trajectory, the respective curves will be visualized via the Graph tool.

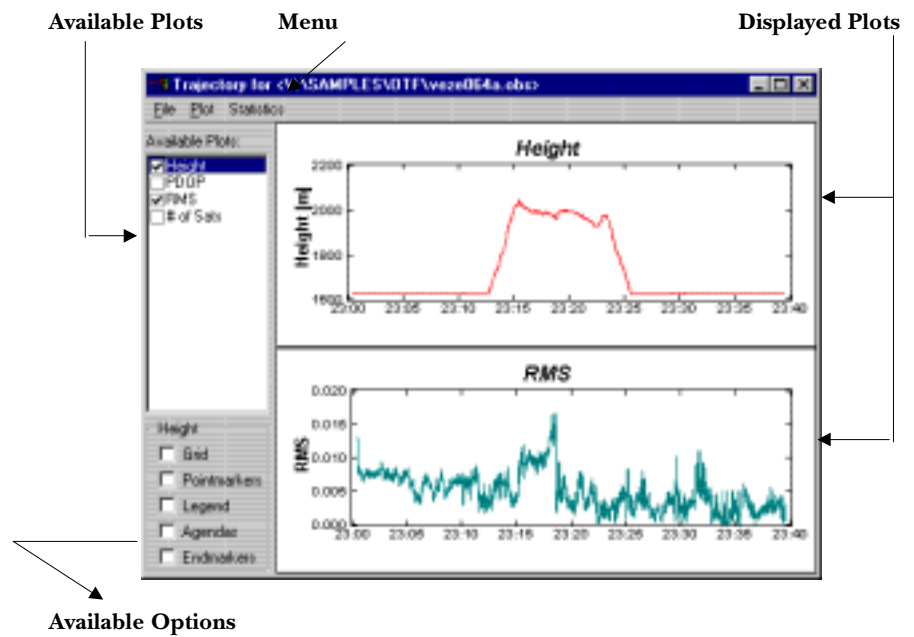


Figure 14-63: Graph Tool (Displaying Two Trajectory Curves)

Independently of the number and kind of graphs displayed, the graph tool offers the following functions:

- A pull-down menu whose options are also available via the context menu
- A list of all available plots as a part of the toolbar
- A selection of options as a part of the toolbar
- The area for the visualized graphics. When you open only one graphic, it will cover the whole area. Several graphics will be tiled vertically on the screen. By this, you can easily compare them using the time axis.

Most of these functions are described detailed in the **GPS-Edit Manual**. For further information please refer to its chapter on the user interface (chap. 3), on the filter functions (chap. 7) and on the graphic functions (chap. 10).

14.13.1 Display of Graphs

The Graph tool offers the option of displaying several plots simultaneously on the screen. They are arranged on top of each other. The box Available Plots lists all graphics for which values exist. To select a graphic, just click the control box next to the name. All values and graphics are still available.

14.13.2 Options

The options for graphics always refer to a single graphic. Define the time span and the label separately for every graphic. To do so activate the graphic by clicking it in the graphic area or by activating its name in the box Available Plots.

Select a time span (zoom) by dragging the cursor from the start time to the end time of the chosen time span. A rectangle will mark the selected time span. Return to the last time selected span, using the menu option **Plot/Zoom back**. Return to the general view via the respective option **Plot /Zoom all**.

A **grid** (**Plot /Grid**) will make the orientation a lot easier.

Pointmarkers (**Plot/Pointmarker**) inform you on the observation time for each epoch. They will only be displayed, if the size of the graphic area or of the chosen time span allows the visualization of the epochs.

Endmarkers (**Plot/Endmarkers**) mark the beginning and the end of a curve and add a label.

The **agenda** gives additional information on the graphic, if available.

The **legend** (**Plot/Legend**) refers to the legend of the curve displayed on the right side of the screen, if this option is activated. This legend will also include information on static curves that you might have added, like the mean or the linear regression line.

The **toolbar** (Plot/Toolbar) can be toggled off to offer you more space for your graphics.

14.13.3 Statistical values

The Graph tool offers you the option of a linear regression analysis for every graphic. This analysis will lead to a trend definition. The results will be displayed in the agenda (Statistics/Legend) or as a straight line visualized in you graphic. Choose the menu option Statistics/Linear Regression.

The mean will also be displayed as a straight line. (Statistics/Mean). The following figure gives you an example, the legend will help you to identify the two straight lines.

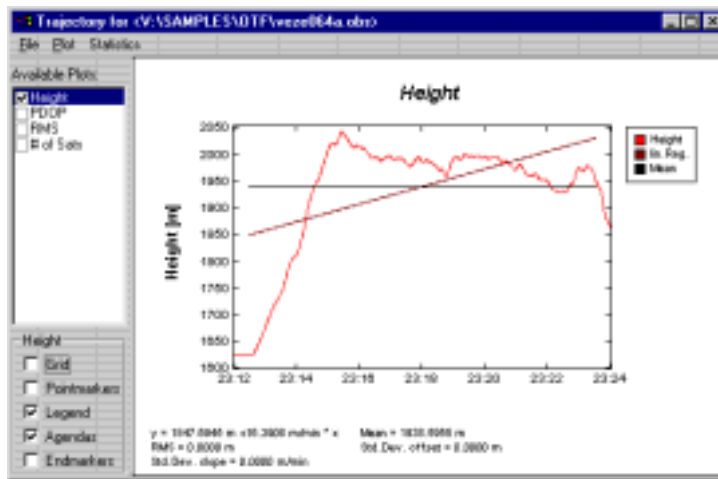


Figure 14-64: Linear Regression, Mean, Agenda and Legend

To reduce the graphic under consideration of the linear trend, choose the option **Statistics/Difference Linear Regression**. The graphic will be redrawn and the legend will be updated.

If the pull-down menu **Statistics/Legend** is activated, the option **Agenda (Plot/Agenda)** can be toggled. If it will be displayed, it will give you the following values:

- Linear Regression $y = \text{offset} + \text{slope} * x$
- Mean
- RMS: root mean square
- Standard deviation offset
- Standard deviation slope

14.14 Distance Meter

By default, **GeoGenius** computes three-dimensional point positions and distance components. The distance meter option allows you to add two-dimensional relative distances between selected points to your project.

A click onto the item **Distance Meter** of the **Tools** pull-down menu calls the Distance Meter floating window.

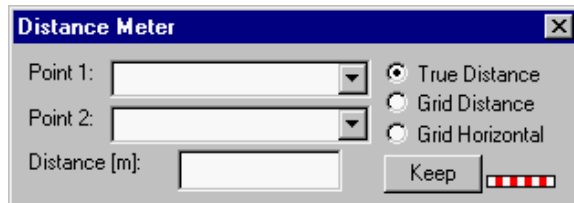


Figure 14-65: Distance Meter Dialog

Two string fields allow you to enter the point numbers of the start and end point of the baseline. Editing these fields is very easy:

- Click the point numbers at the navigator, or
- Click the point in the project plot, or
- Enter the point numbers via the keyboard keys

Each of these options edits the currently selected point number to the currently activated string field. If two point names are given, **GeoGenius** automatically computes a (positive) distance in the current length unit between the two points from the current point properties. **GeoGenius** displays the distance between the currently chosen points in the distance string field of the Distance Meter window and also in the project plot.

The calculated distances depend from the heights of the start and end point. Therefore, the Distance Meter dialog offers the option to reduce the height influence. **GeoGenius** may calculate distances as

True Distance	Slope distance, no height influences are considered.
Grid Distance	the position of the end point is reduced to the position at the height of the start point.
Grid Horizontal	Distance between both points projected onto Mean Sea Level.

If you want to keep the currently computed distance, click the button **Keep** of the Distance Meter window. This action results in the following:

- The Distance Meter module adds a layer to all Display Groups in the current project. The name of the layer is **Distance Meter ;X**, where x stands for consecutive numbers. The layer consists of a line connecting the start and end point and the computed distance. You may inactivate or delete the layer later on.
- The Distance Meter module activates the current Distance Meter layer in all Display Groups. This means, that the project plot displays the distance.
- The Distance Meter module automatically empties the Distance Meter dialog for you to enter new points and go on with computing distances.

This option allows you to simultaneously display the distances between all points of your network.

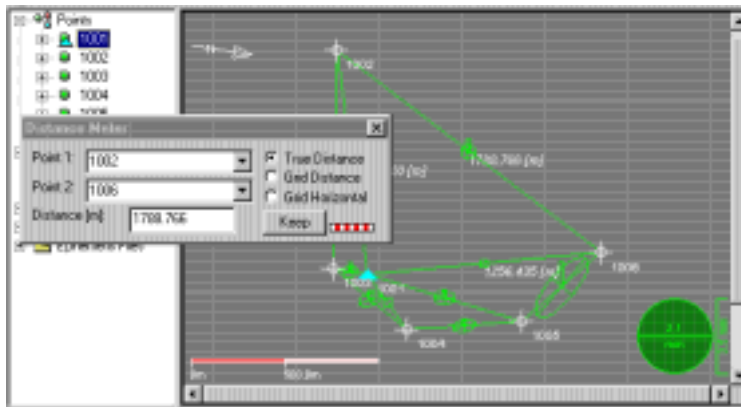


Figure 14-66: Distances Kept

You may hide the computed distances temporarily or delete them from the project. In both cases, open the Group Definition dialog. To open the dialog

- Choose the menu option Process/Settings/Display, activate a display group name and click **Define...** (this option allows you to select not only the current Display Group), or
- Choose the menu option View/Display/Config Layers, or
- Click the respective toolbar button from the toolbar  Display.

- To hide one, several or all kept distances in the current Display Group of your plot, just clear the checkboxes of the respective layers Distance Meter;X.
- To delete one, several or all kept distances from the project activate the respective layers Distance Meter;X. Then click the button **Delete** beyond the box Application Layer.

You may remove the Distance Meter dialog from the screen, if you click the Exit button of its header line.

The following is an example for the combination of the tool Distance Meter with a self-defined Display Group that contains only the layers for Static Points, the reference bar and the North arrow.

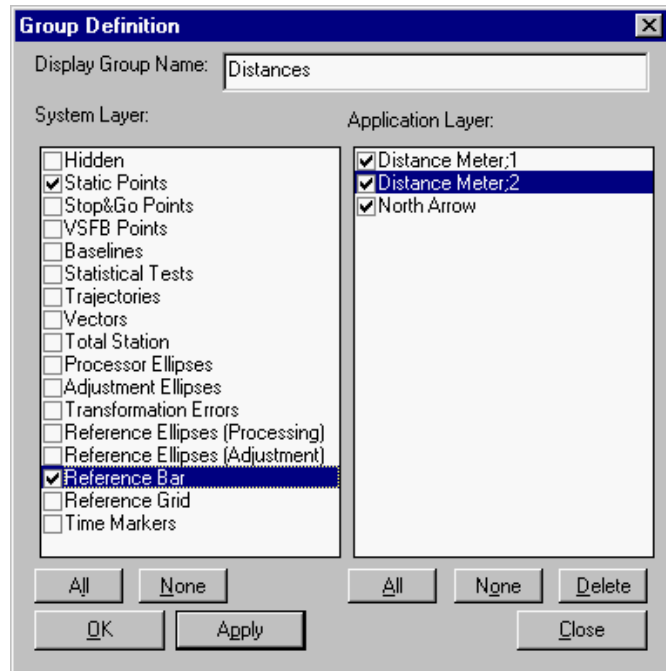


Figure 14-67: Define Layer Group Distances

If you accept the above selection and activate it for a demo data set, you may see a plot like the following after setting the distances for three baselines:

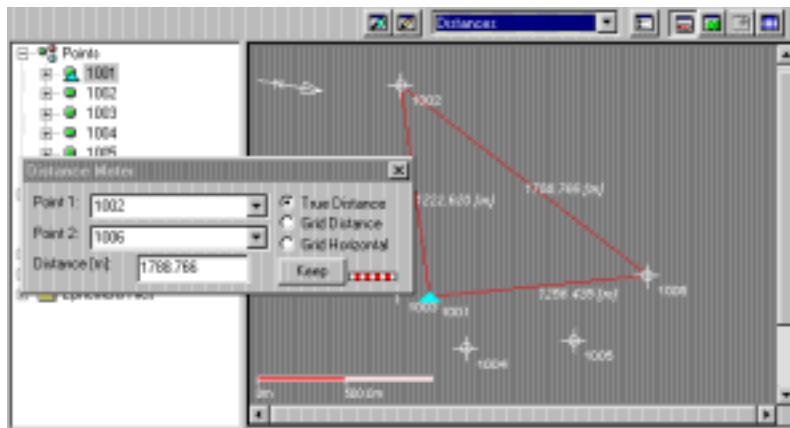


Figure 14-68: Distance Meter - Special Display

14.15 Isolines

A very fine option of **GeoGenius** is the colored and labeled display of the project relief in form of isolines. **GeoGenius** computes the isohypses from the orthometric heights of the primary coordinate set using internally a rectangular grid to compute the heights at the knots of the grid. **GeoGenius** then interpolates for isolines in the given distance.

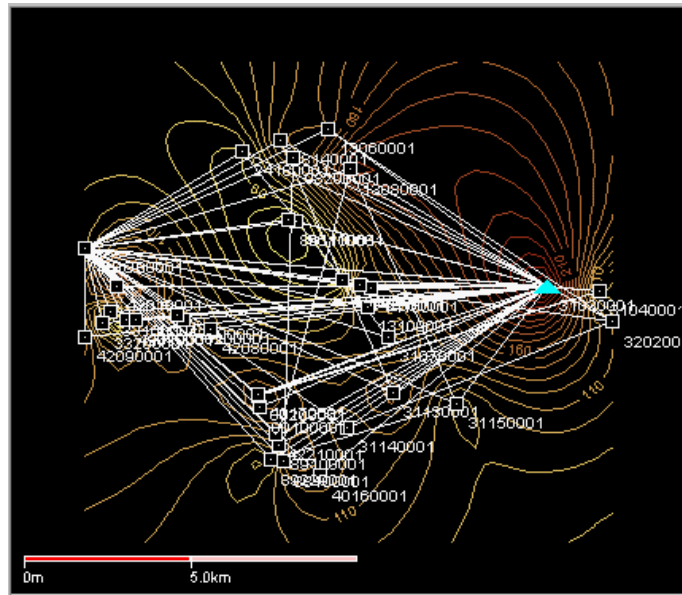


Figure 14-69: Isolines

Open the dialog Isolines via the pull-down menu option Tools/Isolines.

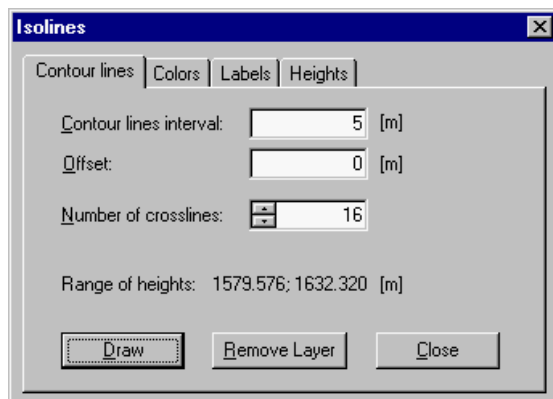


Figure 14-70: Dialog Isolines

The dialog Isolines consists of four pages.

- The page Contour lines offers the parameters needed for the computation of the lines. You may delete the contents of the Isoline Layers here.
- The page Colors allows you to set the colors for the contour lines.
- The parameters necessary for labeling can be found in page Labels.
- Page Heights allows you to choose the Height System

You may start the computation and drawing of the contour lines within each of the pages (button **Draw**). Close the dialog and store the setting via the button **Close**.

While **GeoGenius** computes the isohypses, a progress bar shows up. If necessary, you may cancel the action via its button **Cancel**.

14.15.1 Computation of Isolines

Additionally to at least three points with height coordinates, **GeoGenius** needs values for three parameters to interpolate for isolines. These you may set via the page Contour lines. Enter a value for the distance between the contour lines (**Contour lines interval**). If the isoline of value zero is not to be the starting line, you may change the value **Offset**.

Since **GeoGenius** computes the height values at the crossings of a rectangular, internal grid, the isolines will be the more accurate, the more cross lines you provide. However, a large amount of cross lines influences the computing time considerable (dependent also on the number of points in the project).

Therefore, you can edit the number of cross lines for the project. The default value of 16 for **Number of crosslines** is a relatively small value.

You may check the height range of your project in line **Range of heights**, which gives you the lowest and the highest height within the project, given in the chosen Height System.

14.15.2 Setting Colors

You may define the colors of the isolines via the page Colors. **GeoGenius** automatically interpolates the color for each contour line starting with the colors set for the lines with the lowest and the highest height value.

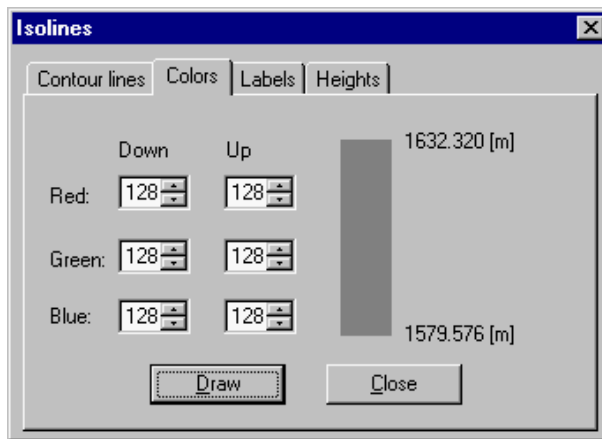


Figure 14-71: Page Colors

Set the values for the colors Red, Green and Blue for the contour line with the lowest height value of the project via the column **Low**, correspondingly you set the values for the isoline with the highest value via the column **High**.

A color chart indicates the lowest and the highest height value of the project in combination with the color combination currently selected. Changes show up there after the change of a value, as soon as you leave the respective field.

The following values result in a functional color scale between a yellowish and a dark brown:

Low:	Red 255,	Green 255,	Blue 140
High:	Red 100,	Green 20,	Blue 10

14.15.3 Labels

Numerical height values also add to the visualization of the relief. The page Labels allows you to define, how many isolines will be labeled (Labels every n. contour line). Additionally, you may set the distance between the labels on a single contour line (Distance between labels).

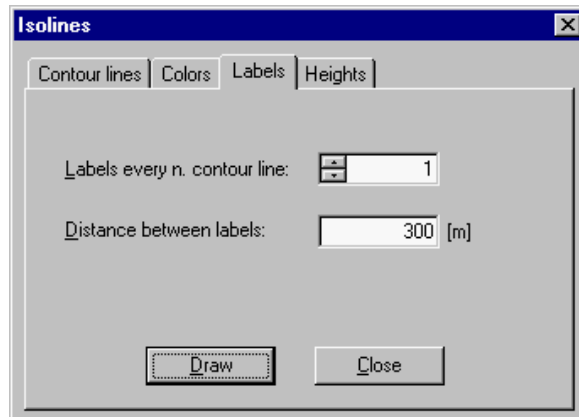


Figure 14-72: Page Labels

14.15.4 Heights

You may select for which height system contour lines shall display the heights. All heights then refer to the given system. The page heights allows you to choose from:

- Ellipsoidal Heights
- Orthometric Heights
- Geoidal Heights

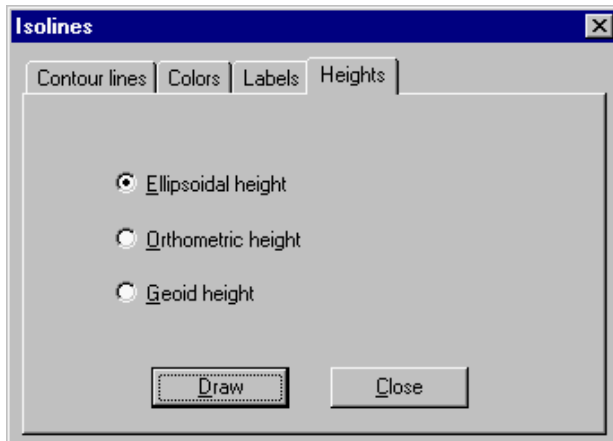


Figure 14-73: Page Heights

14.15.5 Isoline Layers

When computing the isolines, **GeoGenius** creates two new layers, which will be automatically added to all Layer Groups of the project. These are the layers Isolines and Isoline Labels. As usual, you may deactivate or delete the layers via the dialog Group Definition (refer to chapter 5.2.2).

The page Contour lines offers you the additional option, to delete the contents of these layers directly from the dialog Isolines. As soon as you click the button **Remove Layer**, the contour lines will disappear from the project plot.

14.16 Sounds to Identify Actions

Sounds allow you to acoustically control your actions on your project. **GeoGenius** comes along with a few beeps to arise your attention, especially if actions are finished (e.g., after the insertion of files, after processing or adjustment) or if actions failed. You may customize your personal copy of **GeoGenius** for beeps or other sounds. This option is of special interest, if your PC is equipped with multi-media components.

Chose the menu item **More...** of the **Tools** pull-down menu. The dialog **More Tools** pops up. Choose the item **Sound System** to call the dialog **Sound System**.

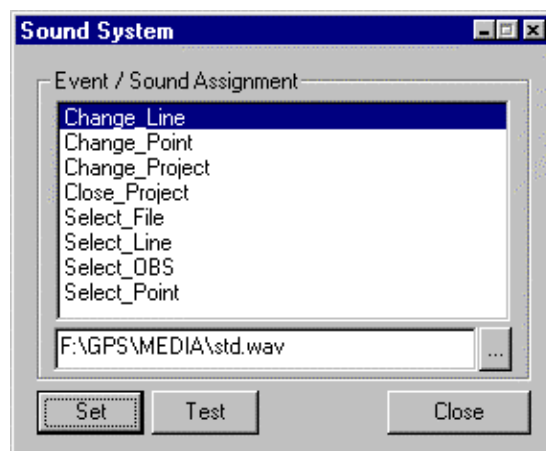


Figure 14-74: Sound System Dialog

The dialog offers you a list box with all events, which are currently available for sound assignment. The string field beneath displays for each event the currently assigned sound file with the default extension

* .WAV. You may select any of the events and assign another sound file to it. Either enter the path and file name manually or browse for it by clicking the button The assigned sound file must conform an extension * .WAV file. To assign the * .WAV file to an event, click the button **Set**. If you first want to test the sound, click the button **Test**.

The following list gives you the events, which are currently available for sound assignment and shortly explains their actions.

Change_Line	Change the properties of a baseline, vector or trajectory
Change_Point	Change the properties of a point
Change_Project	Change the properties of a project
Close_Project	Close the current project
Select_File	Select a file in the Insert Files dialog
Select_Line	Select a baseline, vector or trajectory in the project plot or in the navigator
Select_OBS	Select an observation file in the navigator
Select_Point	Select a point in the project plot or in the navigator
Select_Total	Select a total station measurement in the project plot or in the navigator

You may remove the dialog from the screen

- if you click the **Close** button of the dialog Sound System or
- If you click the Exit button of its header.

15. Customizing the System

You may customize your system in many ways. These comprise the layout of **GeoGenius**' surface as well as some processing information.

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15.1 The Main Window

GeoGenius uses Windows capabilities in every possible way. With Windows 95 and Windows NT 4.0/higher, you may click with the right mouse button onto any value - independently whether it may be changed or not - and you will receive an edit menu, allowing you to mark the value, to copy, cut and paste, to delete and to undo the last action. Availability of these options is displayed.

15.1.1 The Mouse

The left mouse button is, as usual, used to mark and select graphic objects, menu options, toolbar button, etc. When dragging the cursor with the left mouse button you can define the zoom factor, resize the window or the proportion of navigator and project area.

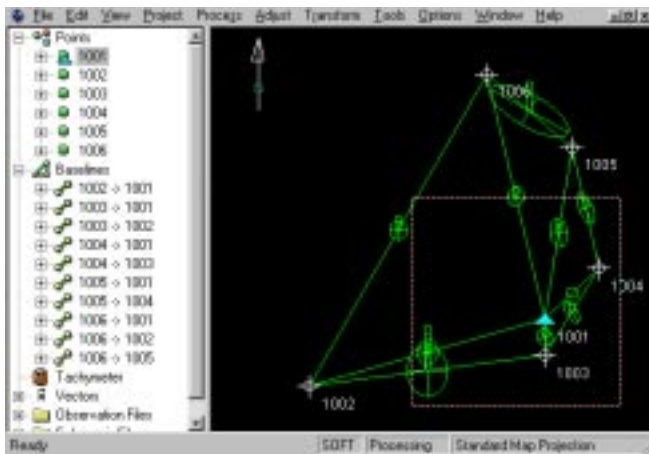


Figure 15-1: Zooming in

The contents of the rectangle in the project plot displayed in *Figure 15-1* covers the project plot area in the next figure.

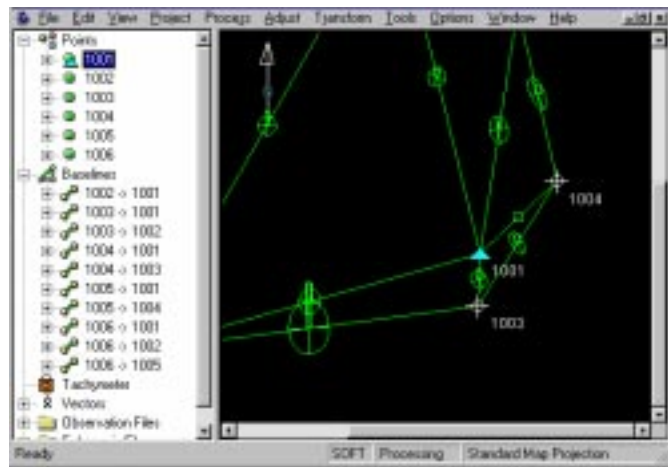


Figure 15-2: Area Zoomed in

The right mouse button provides access to a context-sensitive menu of many important and often used program features.

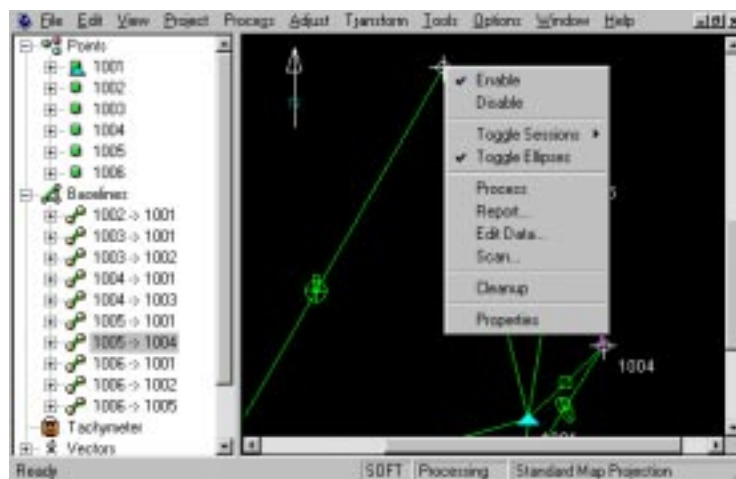


Figure 15-3: Context Menu

15.1.2 The Menu

Generally, Windows menus are fixed and may not be changed. **GeoGenius**, however, with its flexibility, allows you to optimize even the menu. Choose **Options/Tools Menu...** and **Options/Export Format...** to change several of **GeoGenius**' menus (see sections 15.5, 15.6).

15.1.3 Toolbars

GeoGenius offers a range of toolbars. You may easily toggle toolbars on and off. Tooltips clarify the function of each button on a toolbar with a few syllables (see section 15.4).

You determine the shape and location of the toolbars on the screen. Moving toolbars to the upper left corner docks them as a vertical bar left of the navigator, moving to the upper margin docks the toolbar area as a horizontal bar to the menu bar. A double-click onto the toolbar changes it into a flying window and vice versa. A click with the right mouse button onto the toolbar area allows you to select from the list of toolbars.



Figure 15-4: Toolbar Window

15.1.4 Sizing

All Windows features for sizing parent and child windows are available. You may also change the size of the navigator and the project plot area by moving the separator between them.

The menu options Window/Tile, Tile Horizontally, Tile Vertically and Cascade allow you to arrange projects on the main screen. If you have minimized project windows, these may be arranged using Window/Arrange Icons.

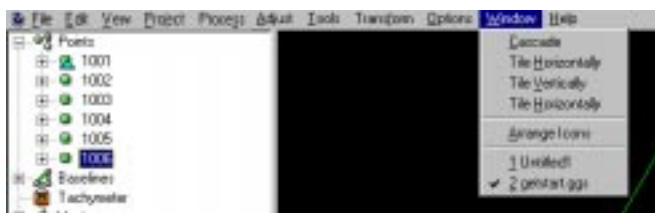


Figure 15-5: Menu Window

15.1.5 The Output Window

The output window helps to better control **GeoGenius**' actions.

It shows up when **GeoGenius** outputs text of any kind. You may display or hide the output window by the options View Output/Hide Output of the menu Edit. The output window may be docked to the main window's border or left as an independent, floating window, moveable to anywhere on the PC's screen. Refer to chapter 5.3 for a detailed description of the output window options.

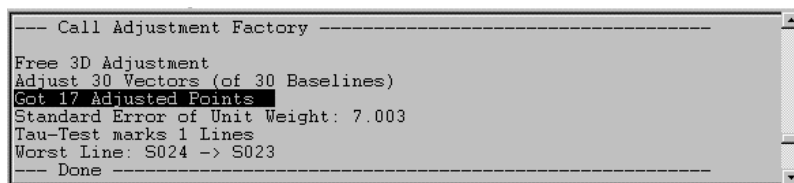


Figure 15-6: Output Window

15.2 Customizing Global Settings

The Customize window is available with the menu option Options/Customize... or the corresponding toolbar button. It is a notebook containing 8 pages:



- ◆ Units
- ◆ GLN Channels
- ◆ GPS-GLN
- ◆ Decoder
- ◆ Messages
- ◆ Total Station
- ◆ Tools (optional)
- ◆ DLLs (optional)

In the following each of the eight pages will be described.

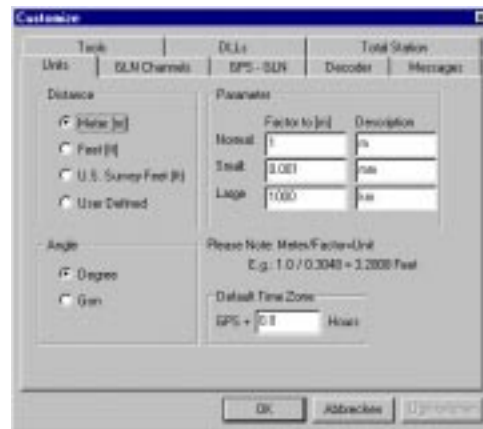


Figure 15-7: Customize

15.2.1 Extending the Dialog Customize

The tabs Tools and DLLs are additional options that can be built in automatically. You just have to change a string of the start-up macro.

Open the file `INST-DIR\GG_START.M` with any editor of your choice. The following text shows up:

```
#
# Allow these pages in the customize dialog:
#     Tools
#     Dlls
#
# (Uncomment next line)
# system 1
```

Delete the sign "# " at the beginning of the string:

```
# system 1
```

It will now look like this:

```
system 1
```

Restart **GeoGenius**. When you open the dialog Customize now, it will include the tabs Tools and DLLs.

15.2.2 Customize... Units

GeoGenius supports different unit systems. You may use one of the three already implemented units or define a new set of length units.



Figure 15-8: Units

The following length units are implemented and may be activated via the radio button:

- * Meter
- * Feet
- * US Survey Feet
- * User Defined: This option allows you to define a set of length units with specified parameters in relation to the meter unit.

You may choose one of the following angle units via the radio button:

- * Degree
- * Gon

The Parameter box allows you to edit the conversion factors for the activated unit set. Three conversion factors are used independently of each other:

- ◇ **Normal**: conversion factor and unit name in relation to meters
- ◇ **Small**: conversion factor and unit name in relation to millimeters
- ◇ **Large**: conversion factor and unit name in relation to kilometers

The Default Time Zone box allows you to enter a time difference to GPS time in hours.

15.2.3 Customize... GLN Channel Assignment

GLONASS satellites use different frequencies to transmit their signals. You may assign each of the visible GLONASS satellites to a frequency representing number (the so-called channel). Choose the GLONASS satellite visible (SV) and enter a channel.

Satellites on opposite hemispheres may use the same frequency.



Figure 15-9: Customize GLN Channel Assignment

A channel number of 0 indicates that the frequency is not known.

15.2.4 Customize... GPS - GLN

Figure 15-10: GPS-GLONASS

You can review and change the datum transformation between the World Geodetic System WGS84 (GPS) and the PZ90 (GLONASS). You have the ability to take future developments in transformation parameters into account.

You can also use the transformation tool **Geotrans** to transform the datums.

The datum transformation is done by a 7 Parameter Similarity Transformation. They consist of the three translational parameters dX, dY, dZ (given in meters), the three rotational parameters rX, rY, rZ (given in arcseconds) and a scale factor.

Additionally, you can update the current time difference between GPS time and UTC (Universal Time Coordinated). Currently, the time difference is GPS - UTC = 12 seconds.

15.2.5 Customize... Decoder

This page allows you to configure the GLONASS and GPS data decoders.

The screenshot shows the 'Decoder' tab of the GeoGenius configuration window. The window has a tabbed interface with 'Units', 'GLN Channels', 'GPS - GLN', 'Decoder', and 'Messages'. The 'Decoder' tab is active. It contains several configuration options:

- 'Maximum time gap between observations:' with a text box containing '240' and '[sec]'.
- 'Maximum number of characters if a file doesn't contain a point number' with a text box containing '8' and '[characters]'. Below this is the text 'The characters are taken from the filename.'
- 'Default antenna name, when a receiver doesn't store this information' with a text box containing 'Default'.
- 'Ashtech Decoder' section with four radio buttons:
 - ☐ Mark OBS files as data is found
 - ☐ Mark OBS files as 'STATIC' always
 - ☒ Mark OBS files as 'STATIC', if less than 50 % kinematic epochs
 - ☐ Generate OBS files as 'RAPID STATIC' (equals 'Short Static')
- 'Default Antenna Type' section with three radio buttons:
 - ☐ Instr. Height
 - ☒ Slope
 - ☐ True Vertical

Figure 15-11: Decoder

You may define the maximum time gap between two epochs in seconds. During conversion from a receiver raw data file to an *.OBS file, if there is a gap in the data larger than this value, the currently generated *.OBS file is closed and a new one is created.

You may define the maximum number of alphanumeric characters **GeoGenius** accepts when assigning point numbers, if an observation file does not contain any point number. In this case, **GeoGenius** will use the first x characters of the observation filename. If observation files are named according to the convention SITEDDDX.OBS, and you specify 4 characters to be used, **GeoGenius** will assign this observation file to point SITE.

Further you may define a name for the antenna, if no receiver information on antenna type and name is available.

When decoding data from Ashtech receivers, you may override the receiver data marking. You may choose one of the four following options:

Mark OBS file as data is found	Does not override the receiver information.
Mark OBS file as 'Static' always	Overrides the receiver information and marks any data as static data.
Mark OBS file as 'Static', if less than x kinematics epochs	Overrides the receiver information and marks the data as static data, if less than a predefined amount of kinematic epochs was found. You may define the critical amount of kinematic epochs.
Generate OBS as 'Rapid Static' (equals 'Short Static')	Overrides the receiver information and marks any data as Stop&Go data.

GeoGenius assigns an antenna height measurement type to any observation file corresponding to the selected option in box Default Antenna Type, if the raw data does not include the respective information.

15.2.6 Customize... Messages

This page allows you to configure all of the messages and message windows created by **GeoGenius**.

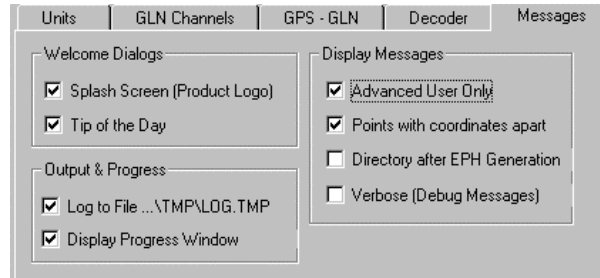


Figure 15-12: Messages

The following messages may be unmarked and then will not be displayed until you mark them again:

Splash Screen (Product Logo)	The welcome display
Tip of the Day	Offers lots of handy tips..., but you may be too advanced to appreciate them.
Advanced Users Only:	A warning message that usually shows up when you select the page Advanced in the Processing Options window.
Point with coordinates apart	A warning message that is displayed, if identical point numbers exist, but their positions differ more than a given value (Processing Options, page Line Options)

Directory after EPH generation	A dialog that is displayed after generation of binary ephemeris data, allowing you to define the directory for storage of broadcast ephemeris after generation of from RINEX data.
Log to File...\TMPLOG.TMP	If this option is turned on, GeoGenius writes all the messages that appear in the Output window to file LOG.TMP in the subdirectory TMP of your installation directory.
Display Progress Window	The progress bar that usually appears during lengthy software operations.
Warning: OBS files are missing	If observation files are missing, this message shows up.
Verbose (Debug Messages)	Some subsystems provide detailed information about internal states. This information is usually hard to understand and therefore suppressed. If you have a problem, your local support engineer might ask you to toggle this switch on in order to support him with more detailed information.

15.2.7 Customize... Total Station

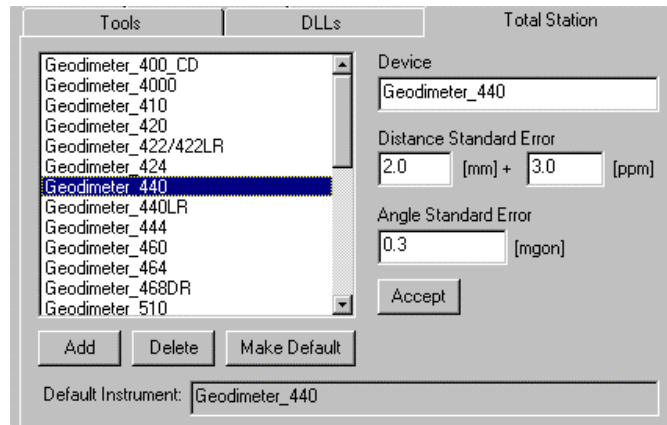


Figure 15-13: Total Station

This page allows you to introduce parameters that you need when adjusting a network, which includes total station data. The list box at the left-hand side displays all devices for which these parameters are currently defined. The right-hand part of the page shows the currently activated device and its error values.

The following parameters are assigned to each device: relative and absolute distance standard errors and absolute angle standard error.

To enter the parameters for a device click button **Add**. The default device name New Device 1 will show up in the Device list box at the left side and in the Device Name box at the right side. If the list contains more than one device, you will notice that the currently activated device name is displayed in the Device box.

You may rename the device and edit or add its error parameters. **Accept** adds the device and its parameters to the database.

To delete a device from the database, click **Delete**.

You may define one set of total station parameters as default. Activate the respective name, then click the button **Make Default**. The box Default Instrument displays the name of the current default parameter set.

The set of parameters of this page is very important, if you insert total station data into your project. GeoGenius assigns these parameters to the total station data when importing.

15.2.8 Customize... Tools (optional)

This tool is only available when the dialog Customize is modified. (Refer to section A.2.1)

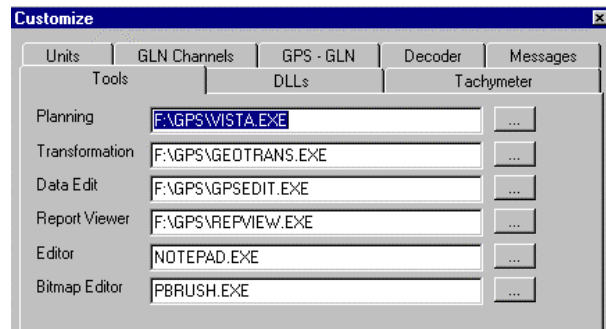


Figure 15-14: Tools

GeoGenius allows you to extend its capabilities with customized tools. **GeoGenius** calls the tools using the directory and file name specified on this page. You may specify other tools or another path to the respective file.

The default file names and directories are:

Tool	File name	Directory
Planning	VISTA . EXE	GeoGenius root directory
Transformation	GEOTRANS . EXE	GeoGenius root directory
Data Edit	GPSEDT . EXE	GeoGenius root directory
Report Viewer	REVIEW . EXE	GeoGenius root directory
Editor	NOTEPAD . EXE	Windows directory
Bitmap Editor	PBRUSH . EXE	Windows directory

15.2.9 Customize... DLLs (optional)

This tool is only available when the dialog Customize is modified. (Refer to section A.2.1)

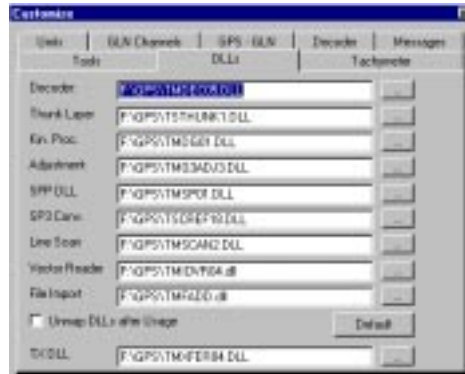


Figure 15-15: DLLs

GeoGenius allows you to extend its capabilities with DLL program libraries. **GeoGenius** calls the DLLs using the directory and file name specified on this page. You may specify other DLLs or another path to the respective file.

The default file names and directories for DLLs are:

Decoder	'MDEC05.DLL	GeoGenius root directory
Thunk Layer	'STHUNK1.DLL	GeoGenius root directory
Kinematic Proc.	'MDG01.DLL	GeoGenius root directory

Adjustment	'MG3ADJ3.DLL	GeoGenius root directory
SPP DLL	'MSP01.DLL	GeoGenius root directory
SP3 Conversion	'SCREF18.DLL	GeoGenius root directory
Line Scan	'MSCAN2.DLL	GeoGenius root directory
Vector Reader	'MIOVR04.DLL	GeoGenius root directory
File Import	'MFADD.DLL	GeoGenius root directory
TX DLL	'MXFER04.DLL	GeoGenius root directory

If you enter another file name or path and the check-box **Unmap Dlls after Usage** is activated, the settings for the next usage will be set to default.

Via the button **Default** you may set the default paths and file names for all functions.

15.3 Customize Object Styles

15.3.1 General

With **GeoGenius**, you can design any layout component of the project plot. This feature helps you to get the optimal project display for any kind of application, data set or personal preferences. E.g., you may define different style sets for different projects!

Within a project, you may select layout components, so-called layers, and arrange them in layer groups. You will find a description of layer grouping in chapter 5.2.2.

The current section describes how to set colors and fonts or how to define line styles. Choose **Options/Styles...** or the corresponding toolbar button.



The notebook Styles consists of six pages:

- Lines
- Points
- Time Marks
- Background
- Print Frame
- Screen Objects

Each page allows you to select in its left part the component type or group of types, for which the settings apply. An example plot in the upper right corner shows the current style of these type(s). Changes apply immediately to the example plot. Here, you can control the effects of your style settings.

Change the layout settings via the buttons, radio buttons or checkboxes, which you will find below the example plot.

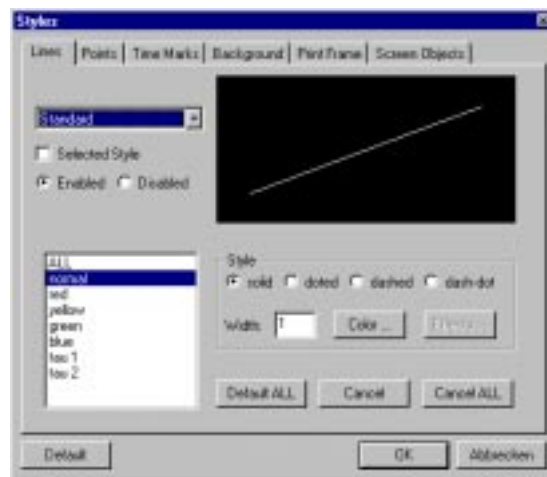


Figure 15-16: Customize Styles

Feel free to test the layout settings also in your project. If you want to return to the default setting of all design components after saving the new settings with **OK**, just return to the Object Styles notebook and click the button **Default**. If you want to return to the default setting for all components of the current page, click the button **Default ALL** at the page.

You also may cancel the current settings of a page before applying them. Button **Cancel** allows you to cancel the settings for the currently activated plot component. You may cancel all settings made on a page since the last acceptance via button **Cancel ALL**. Pages containing only one design object do not offer the button **Cancel ALL**.

Two standard Windows buttons at the right bottom of the notebook allow you to cancel all settings made in the notebook and leave the dialog or to apply settings and leave the dialog.

For most of the layers you may set colors and/or fonts.

If you click any of the buttons setting the color, a standard Windows color definition dialog is displayed. Its 48 colored boxes show the colors used by **GeoGenius**. You may define 16 additional colors.

The box displaying the color currently assigned to the object class is marked by a black rectangle. To assign another color just click on another color box.

You can select a new color from a palette or enter RGB values. If you have changed a color, you may accept the changes with **OK** or cancel all changes. The change will then apply to the currently selected object class.

If you click the button **Font**, a standard Windows font dialog displays the current setting. You can choose font, font style, size and color of the text displayed as well as some effects, such as strikethrough and underline.

15.3.2 Customize the Line Styles

All points that are connected by an observation are connected in the plot by lines (baselines). Click **Options/Styles...** and choose the **Line** page to specify line styles. You may specify different styles, colors, effects and weights to emphasize the importance of some results.

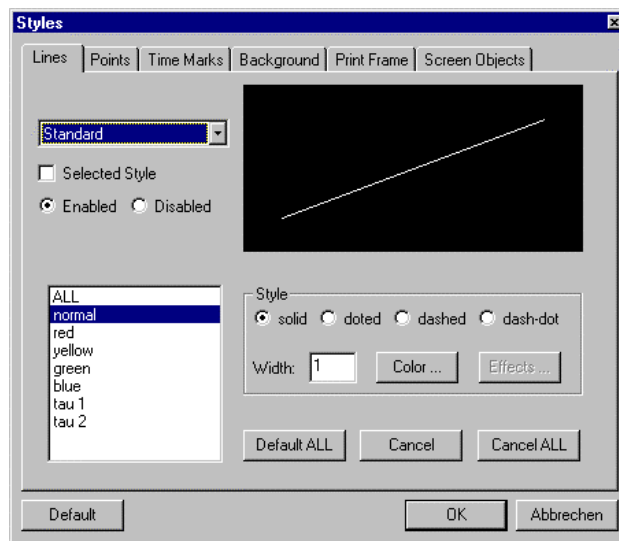


Figure 15-17: Customize Lines

Generally, three line types exist and may be selected via the combo box Type:

- Standard: unprocessed or processed GPS data, whether static or kinematic
- Vector: vectors
- Total Station: terrestrial baseline measurements

Any baselines in the project plot may be currently activated (check the check box Selected Styles) or not and may be enabled or disabled (click the respective radio button). Hidden lines will not be displayed at all.

Lines may be unprocessed or processed and may have got different results in processing and adjustment. Select the status of the lines for which the settings should

apply from the list box at the bottom of the Lines page. You may choose one of the following:

All	All lines of the current type, selection and enabling status
Normal	Unprocessed GPS baselines, vectors, total station measurements
Red	The processing status is red or defined as red
Yellow	The processing status is red or defined as red
Green	The processing status is yellow or defined as green
Blue	The processing status is blue or defined as blue
Tau 1	The line with the worst result after the tau test
Tau 2	All other lines failing the tau test criteria

It depends on the chosen line status whether all style settings are available or not.

For all lines you may choose one of the following line styles. Click the respective radio button:

- Solid
- Dotted
- Dashed
- Dash-dot

You may define a line width for each line type separately. Enter an integer value into the number field **Width:**. If you have selected Line type **All**, the number field **Width:** will be inactivated. Please note: width is in 0,1 mm, so effects on screen are visible starting at about 8.

The line color may be changed via the button **Color...** for each line type. If you have selected Line type **All**, the button **Color...** will be inactivated.

Vectors and Total station lines are characterized by typical arrows or other marks. You may emphasize these marks by a color different from the line color. Click button **Effects...**, to open the standard windows color definition dialog. The selected color will only apply for the arrow or definition mark of the selected line type!

The default value of most line objects is 1 or 8 for Width, and Solid for Style.



Refer to section *15.3.1* for how to undo settings and for more information of the Colors and Fonts dialogs!

15.3.3 Customize the Point Style

In the project plot, points with different states are indicated by a point symbol, the name and – if selected – the text background. Click **Options/Styles...** and choose the Points page to specify point styles. You may specify the font and all colors.

First specify the point type for which the style setting should apply. Choose one of the items of the combo box Type:

- All (refer to all styles below)
- Standard
- Navigation
- SinglePoint Processed
- Differentially Processed
- Manual Input
- Total Station Input
- Adjusted
- Very Short Fixed Baseline (VSFB)

- Fixed Point

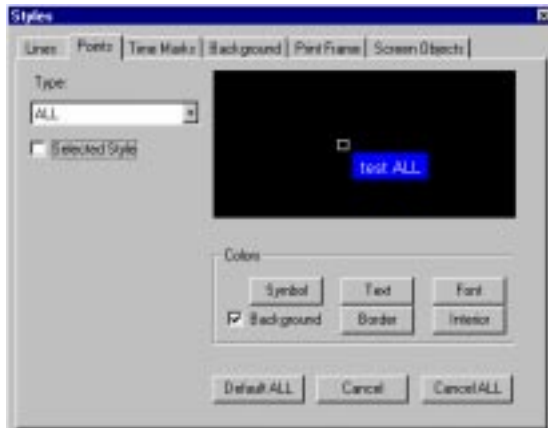


Figure 15-18: Customize Point Style

Each point object is selectable. To define its appearance in the selected state check the checkbox **Selected**.

Click the buttons of box **Colors** to change the colors and font of the currently activated point type:

Button **Symbol** sets the color for the point marker.

Button **Text** sets the color for the point name.

Button **Font** allows you to modify the font for the point name.

If the checkbox **Background** is checked, the point name will be surrounded by a background rectangle. Then, you may additionally modify the following two criteria.

Button **Border** sets the color for the background border.

Button **Interior** sets the color for the background area.

If a background is toggled off, the background of the specific objects will not differ from the background one layer deeper.



Refer to section 15.3.1 for how to undo settings and for more information of the Colors and Fonts dialogs!

15.3.4 Customize Time Mark Styles

If your navigation file contains time event markers, time marks will be displayed on the project plot. Click **Options/Styles...** and choose the Time Marks page to modify the style of time marks. You may specify the font and colors for the time mark symbol and text.

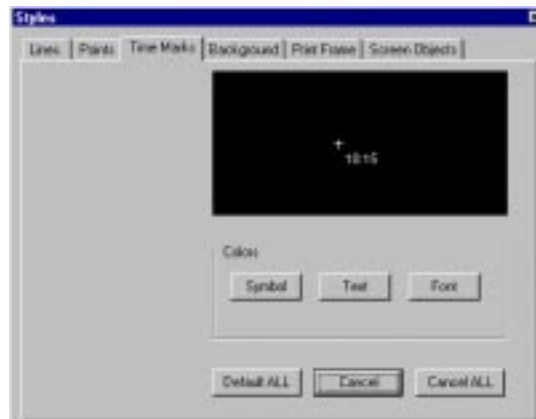


Figure 15-19: Customize Time Mark Styles

Click the buttons of box Colors to change the colors and font:

Button **Symbol** sets the color of the time mark symbol.

Button **Text** sets the color of the written time.

Button **Font** sets the font of the time text.



Refer to section 15.3.1 for how to undo settings and for more information of the Colors and Fonts dialogs!

15.3.5 Customize the Plot Background

You may specify a project background color (which is by default black). You may also structure your network by a grid overlay. Click Options/Styles... and choose the page Background to modify the background and grid settings.

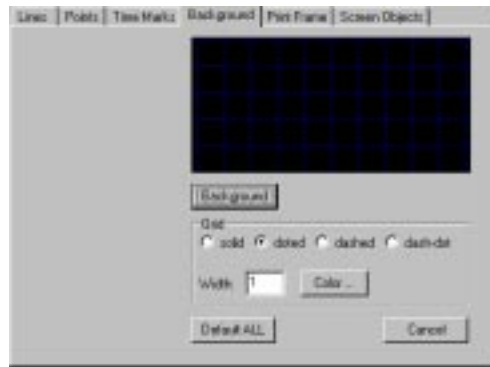


Figure 15-20: Customize the Plot Background

The button **Background** sets the color of the project plot area.

The button **Background** allows you to set the color of the project plot background.

The box Grid allows you to set the styles for the grid, if a grid is selected. (To insert a grid into the plot, choose the item **Grid** of the pull-down menu **View** or click the corresponding toolbar button). You may define the gridline style to be either



- Solid
- Dotted
- Dashed
- Dot-dashed

Just click the respective radio button.

You may define a line width for the gridline. Enter an integer value into the number field **Width**:. The gridline color may be changed via the button **Color...**



Refer to section *15.3.1* for how to undo settings and for more information of the Colors dialogs !

15.3.6 Customize the Print Frame

The **Print** option of the pull-down menu **File** allows you to print out a project plot. **GeoGenius** uses a macro script that puts a default frame to the print-out. Its legend includes coordinate axes and units. However, you may want to customize the legend. To do so, write a script for the Spectra Precision **TIM** interpreter (or copy and modify the default script).

To use the new macro click **Options/Styles...** and choose the page **Print Frame**. Enter the path and file of the new script or browse your directories for the file. The button **Browse** opens a standard Windows File Selector with the data type ***.M** pre-selected.

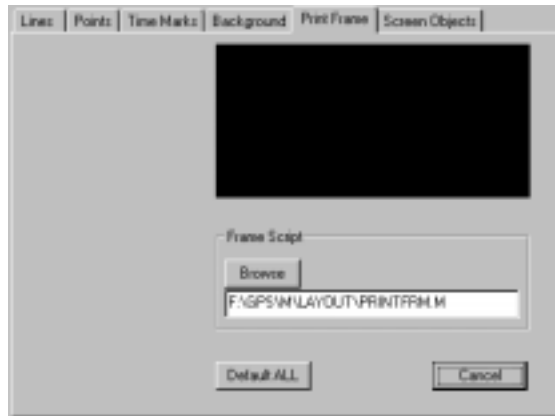


Figure 15-21: Customize the Plot Frame



Refer to section *15.3.1* for how to undo settings!

15.3.7 Customize Further Screen Objects

Currently, **GeoGenius** offers three reference screen objects, which help you to identify the sizes of the lines and error ellipses. Click **Options/Styles...** and choose the page **Screen Objects** to modify the style of screen objects. You may specify the font and colors for the each object.



Figure 15-22: Customize Further Screen Objects

The combo box **Type** currently lists three reference items:

- The reference bar
- The processing reference error ellipse
- The adjustment reference error ellipse

You may define the following style components for each of these objects:

Button **Font** sets the text font.

Button **Border** sets the color of the object border. For the object Adjustment Ellipse, this button sets the color of the border of

the adjustment reference ellipse and of the adjustment ellipses of the network.

Button **Interior 1** sets the color of the object interior.

Button **Interior 2** only applies for the reference bar. It sets the second color for the bi-colored part of the reference bar.



Refer to section *15.3.1* for how to undo settings and for more information of the Colors and Fonts dialogs!

15.4 Customizing Toolbars

Toolbars very often speed up operations. **GeoGenius** allows you to configure visibility of toolbars. You can toggle toolbars on and off, depending upon your project needs. Tooltips are displayed, if you move the cursor over the tool button. They clarify the function of each tool button.

To toggle toolbars choose **View/Toolbars...** or press the Toolbar button. The Toolbar Selection window is displayed. (A click of the right mouse button over the toolbar area or the status bar area opens the Toolbar context menu. It also allows the selection of toolbars.)

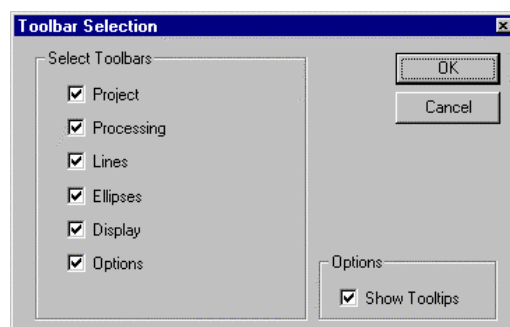
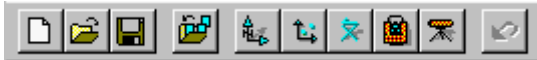


Figure 15-23: Customize Toolbars

You may select any combination of toolbars. You can also select or de-select the option **Show Tooltips**. Save the selection or leave the window without changes.

You can arrange the toolbars in the toolbar areas around the main window (refer to chapter 5.1).

Here is a short description of the toolbars and each of their buttons. Additionally, you will find a cross-reference to the detailed description of the functions accessible by the buttons.

Project			
	New	Opens a new project	5.4.1
	Open	Opens an existing project	5.4.2
	Save	Saves the current project	5.4.4
	Insert Files	Inserts observation, raw data and ephemeris files into the current project	5.5.1
	Import National	Inserts national coordinates into the current project	5.5.2
	Import Local	Inserts local coordinates into the current project	5.5.3



Import Vectors

Adds Vectors to project

5.5.4



Import Total Station

Inserts Total Station data into the current project and decodes it

5.5.5



Import Levelling

Inserts Levelling data into the current project and decodes it

5.5.6



Undo

Reverses the last action (e.g. Zooming it)

5.2.2

Processing



Select Ref.

Chooses the best reference station

7.2



Gen EPH

Generates binary data from broadcast RINEX

7.3



Process All

Processes all enabled lines in the current project

7.7

7.1



Process Line	Processes the current baseline	7.7
		7.1



Report	Shows Report file for this set of results	8.2.4
		9



Wizard	Processing Wizard	7.8



Quality Control	Performs quality control using the current settings	10



Parameters	Specifies processing parameters	7.4



Delete	Delete current results	8.4

Lines



Enable All	Enables all disabled baselines	7.1



Disable All

Disables all baselines

7.1



Toggle Green

Toggles the status (enabled/disabled) of all green baselines

12.4.1



Toggle Yellow

Toggles the status (enabled/disabled) of all yellow baselines

12.4.1



Toggle Red

Toggles the status (enabled/disabled) of all red baselines

12.4.1



Toggle Blue

Toggles the status (enabled/disabled) of all blue baselines

12.4.1



Toggle Unprocessed

Toggles the status (enabled/disabled) of all unprocessed baselines

12.4.1



Show Disabled

Project area shows disabled baselines

5.2.2



Hide Disabled

Project area shows no disabled baselines. Hidden baselines will not be adjusted.

5.2.2

Ellipses



	Enable All	Enables all disabled ellipses	12.4.1
	Disable All	Disables all ellipses	12.4.1
	Toggle Green	Toggles the status (enabled/disabled) of all green ellipses	12.4.1
	Toggle Yellow	Toggles the status (enabled/disabled) of all yellow ellipses	12.4.1
	Toggle Red	Toggles the status (enabled/disabled) of all red ellipses	12.4.1
	Toggle Blue	Toggles the status (enabled/disabled) of all blue ellipses	12.4.1
	Disable Worst	Disables the worst of all currently activated ellipses.	12.4.1



Enable Next

Enables the ellipse next in value to the currently worst enabled ellipse

12.4.1



Lines+Ellipses

Toggles baselines and ellipses

12.4.1



Lines-Ellipses

Only toggles Baselines

12.4.1

Options



Customize

Customizes global settings

A.2



Styles

Changes the styles of the visible objects

A.3



Toggle Toolbars

Shows or hides toolbars

A.4



Toggle StatusBar

Shows or hides the status bar

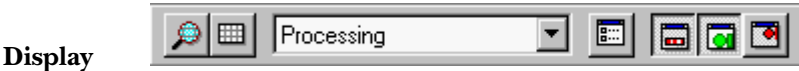
A.9



Run Runs a script from disk A.8



Run Again runs the last script again A.8



Zoom all Zooms to maximum extent 5.2.2
of all objects A.1



Toggle Grid Shows/hides reference 5.2.2
ellipses for adjustment results



The combo box allows you 5.2.2
to choose the display layer
group



Config Layer Displays Group 5.2.2
Definition window



Toggle RefBar

Toggles display of the
reference bar

5.2.2



Toggle RefEllips

Toggles display of the
reference ellipse

5.2.2



Toggle RefAdj

Shows/hides reference
ellipses for adjustment results

5.2.2

15.5 Define Tools

The Tools Configuration window allows you to configure the menu Tools of **GeoGenius** individually. Open the Tools Configuration window with Options/Tools Menu... to create this dialog:

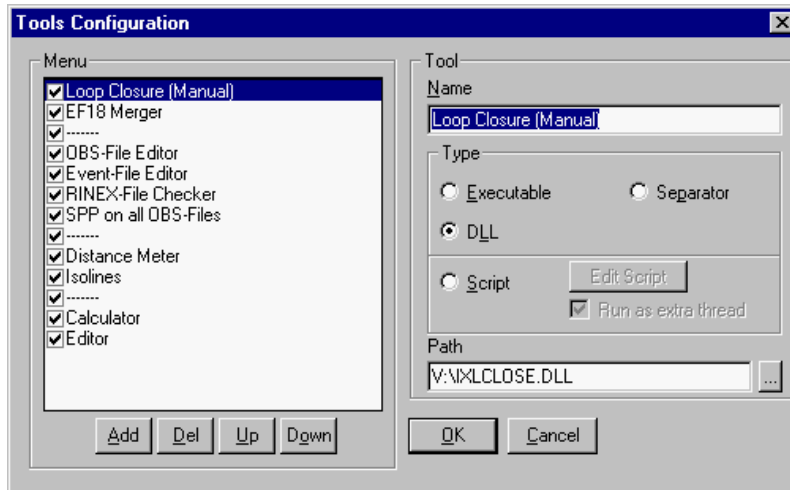


Figure 15-24: Options/Tools

Several tools are entered by default. These are listed in box **Menu**. You may install others, change the path to them or delete installed tools. The Tools box shows the name of the tool, its nature (is it an executable, a DLL, a script or a separator line?) and the path to it. Via the button **Script...** you may open and edit scripts. All tools installed with help of the Tools Configuration window will be displayed in the pull-down menu Tools of the main menu. If the check box **Run as extra thread** is marked, the extra tool will run additionally to the main

program. A separator line and **Up** and **Down** buttons help you to group the implemented tools in the **Tools** menu.

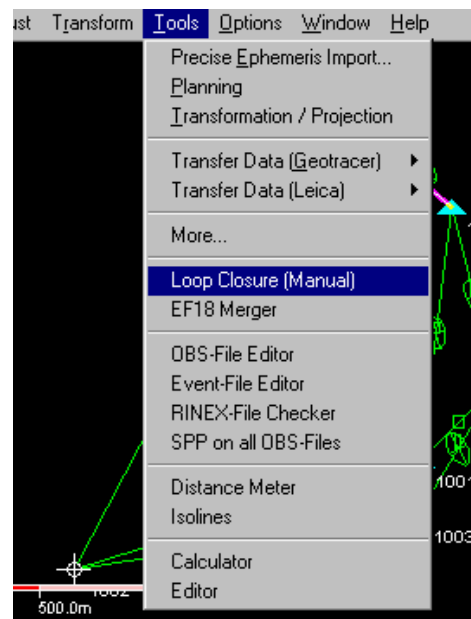


Figure 15-25: Pull-down Menu Tools

15.5.1 Adding a Tool

To add a new tool, open the Tools Configuration window (Options/Tools Menu...) and press the **Add** button. A new item will be added to box Menu, consisting of an unchecked checkbox and the name **New Tool 1**. An **&** sign precedes the character to be used as accelerator for keyboard selection in combination with the **Alt** key.

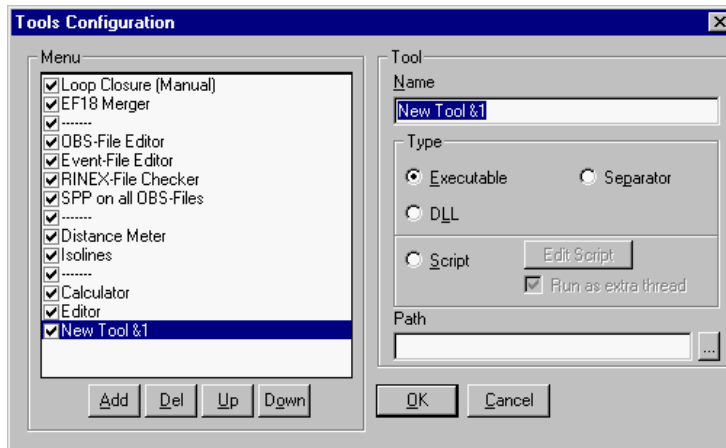


Figure 15-26: Add New Tool

Specify the characteristics of the new tool using box Tool. Define the name to show up in the Tools menu (**N**ame) and the character to be used as shortcut in combination with the button **Alt** (add a **&** character before the chosen character). Then specify the characteristics of the object (**E**xecutable, **D**LL, **S**cript or **S**eparator) and enter the path to the file (**P**ath). A browser may help you to find the path (button **...**).

A tool, which is a script, can be opened and then modified in the MacroStudio (button **E**dit **S**cript). If the tool is to run in parallel, the checkbox **R**un **a**s **e**xtra **t**hread has to be marked.

Press **O**K to save the changes and to leave the Tools Configuration window or **C**ancel to leave the Tools Configuration window without changes.

15.5.2 Deleting a Tool

Two possibilities exist to remove a tool from the menu **Tools**:

- Open the Tools Configuration window (**Options/Tools Menu...**), highlight the respective tool name in box **Menu** and press the button **Del**. The name of the removed tool will be removed from the box **Menu** and the tool will no longer be available (unless you add it again).
- Uncheck the checkbox next to the tool name to remove the tool from the menu **Tools**. You may reactivate this tool any time with the checkbox!

Press **OK** to save the changes and to leave the Tools Configuration window or **Cancel** to leave the Tools Configuration window without changes.

15.5.3 Change the Path to a Tool File

To change the path to a tool of the menu **Tools**, open the Tools Configuration window (**Options/Tools Menu...**) and highlight the respective tool name in box **Menu**. You now may change the path using the **Path** box and a standard file selector.

Press **OK** to save the changes and to leave the Tools Configuration window or **Cancel** to leave the Tools Configuration window without changes.

15.5.4 Configure More Tools

Choosing the menu item More... of the pull-down menu Tools you will find a list of several tools that are not used that often.

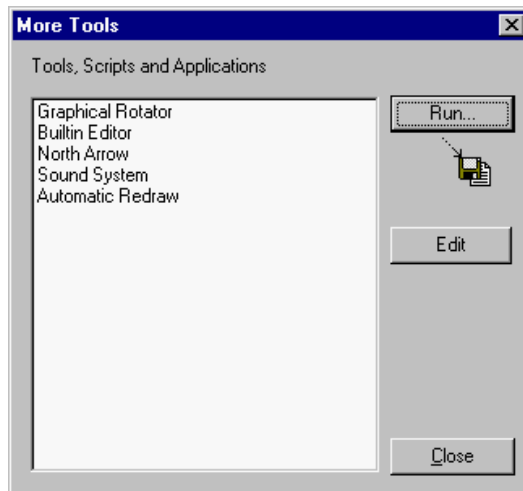


Figure 15-27: More Tools

This list can be extended and modified, if you choose the menu item Options/Tools Menu/More Tools Dialog, in the same way as you configure the extra programs in the menu Tools.

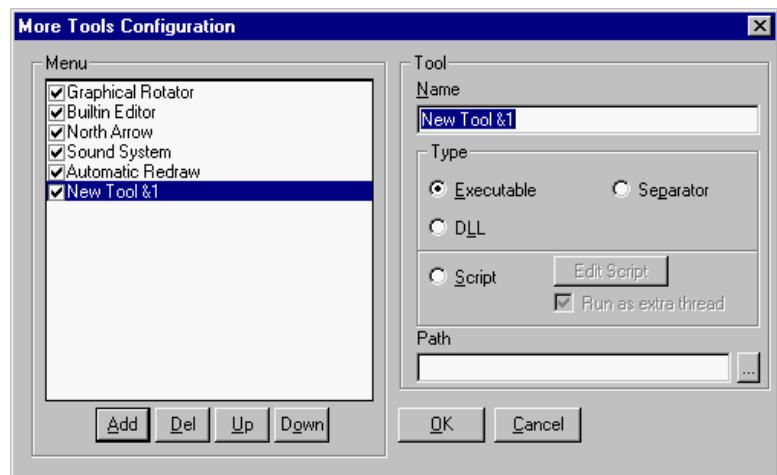


Figure 15-28: More Tools Configuration

The configuration dialog allows you to add more tools, to delete them, to regroup them or to change the file-path or name. For further information please refer to the respective section of this chapter.

15.6 Export Formats

You may want to export the results into files of specific formats. Additionally you may want to print the results into one or several reports of a specific format.

GeoGenius offers lists of pre-defined and implemented data export formats. You may, however, individually configure **GeoGenius** for data export formats. You may delete from the menu existing formats, which you will never use, or you may add new export formats to the menus. You may also change the path to the format definition file.

Generally, export format lists exist for the following tasks:

- Export results from statically derived data to a file
- Export results from kinematically derived data to a file
- Generate a processing report

The following three subsections describe where to find the corresponding export format lists and how to access the corresponding configuration window. Then, the subsections 15.6.4 ... 15.6.6 describe how to add or delete a format or how to change the path to an export format. All configuration windows show the same functionality. Several file format converters are entered by default. These are listed in the box **Menu**. You may install others, change the path to the respective converter file or delete already installed file formats. The **Tool** box shows the name of the format, its nature (is it an executable, a script, a DLL or just a separator line?) and the path to it. You may edit scripts via the button **Edit Script** or run them as extra thread. A separator line tool and **Up** and **Down** buttons help you to group the implemented format items in the respective format list. (See, e.g., *Figure 15-29*).

15.6.1 Export Formats - Static

Result export to a file from **statically** derived data sets starts from the pull-down menu File (item Project/Formats...).

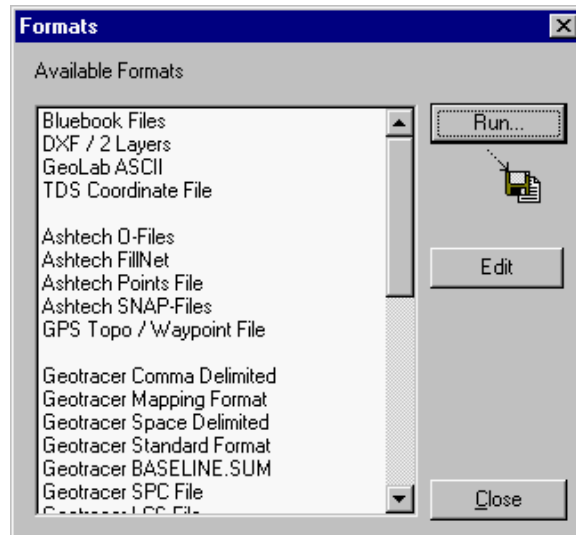


Figure 15-29: Static File Export Formats

The Formats Configuration window allows you to define the list of export formats for static data. Thereby you can individually configure the Export Formats dialog.

Open the Formats Configuration window via the menu option Options/Export Formats/Static:

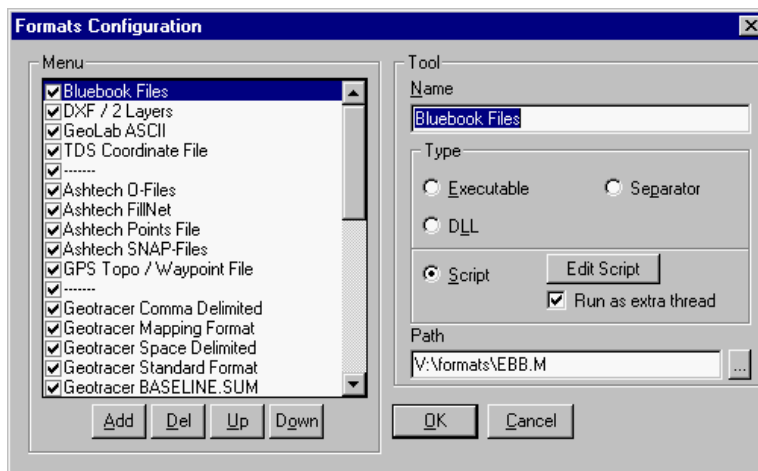


Figure 15-30: Formats Configuration

You may delete from the menu existing formats, which you will never use (note: they will just be removed!), or you may add new export formats to the menus. You may rearrange the lists or change the path to a script.

15.6.2 Export Formats - Kinematic

Kinematically derived data sets result in positions for every epoch. These numerical results may be exported into kinematic result files. You may choose the appropriate export format from the Properties notebook of the resulting trajectory.

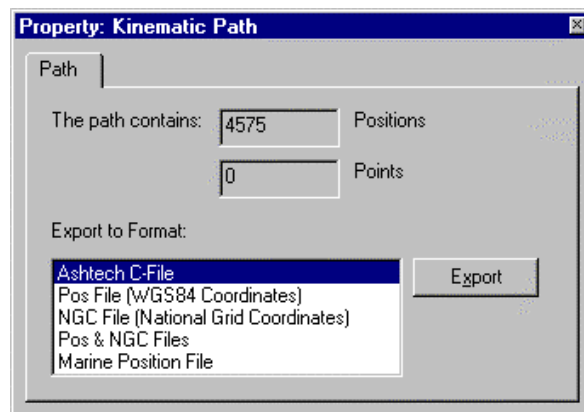


Figure 15-31: Properties Kinematic Trajectory

The Kinematic Formats Configuration window allows you to individually configure the Export to Format list of the trajectory's Properties notebook. Open the Kinematic Formats Configuration window via the menu option Options/Export Formats/Kinematic:

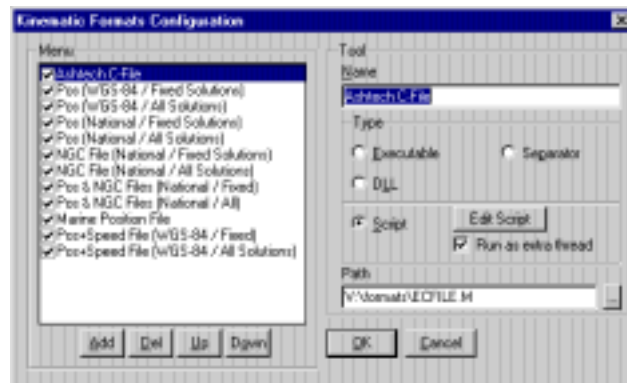


Figure 15-32: Kinematic Formats Configuration

You may delete from the menu existing formats, which you will never use, or you may add new export formats to the menus. You may rearrange the lists or change the path to a script.

15.6.3 Export Formats – Reports...

Project reports are summaries of the current project. They are based on the results stored in the project file. Reports are created in a formatted and easy-to-interpret manner using the **GeoGenius** HTML-generating tool **HyperPage**.

The menu option Project/Reports... opens the Project Report dialog, which allows you to choose one or several of the implemented report formats and then to generate reports according to the selected format.

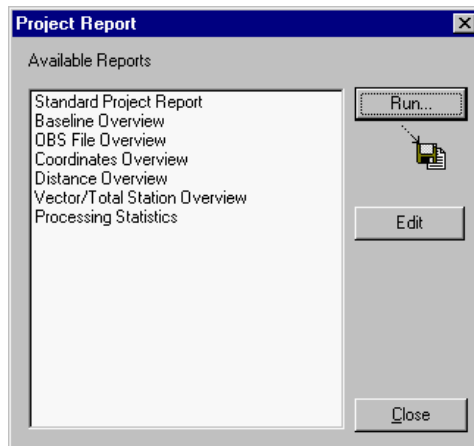


Figure 15-33: Available Project Report Formats

You may define the list of report formats via the Report Configuration window and, thereby, individually configure the Project Report dialog. Open the Formats Configuration window via the menu option Op-tions/Export Formats/Reports...:

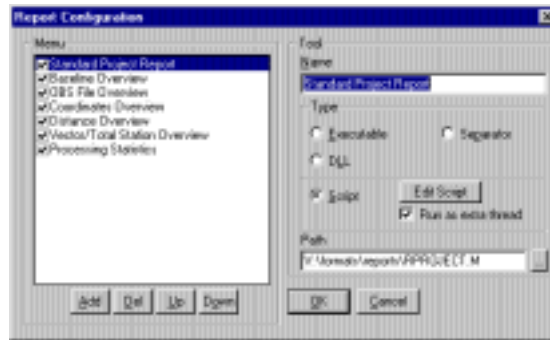


Figure 15-34: Reports Configuration Window

You may delete from the menu existing formats, which you will never use (note: they will just be removed!), or you may add new export formats to the menus. You may rearrange the lists or change the path to a script.

15.6.4 Adding an Export Format

To add a new export format open the Formats Configuration window (Options/Export Formats/Static), the Kinematic Formats Configuration window (Options/ Export Formats/Kinematic) or the Report Configuration window (Options/ Export Formats/ Reports...) and click the button **Add**. A new item will be added to the

box Menu, consisting of an unmarked checkbox and the name **New Tool &1**.

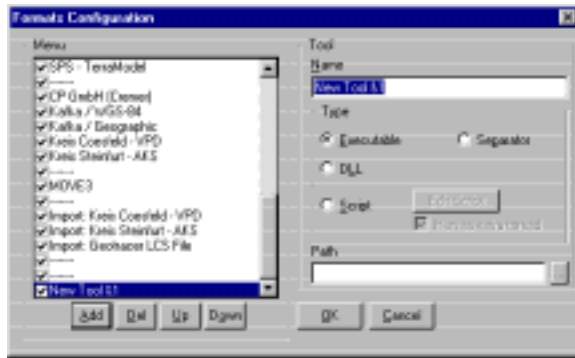


Figure 15-35: Add New Format

Specify the characteristics of the new format converter using the box Tool:

- Define the name (Name) of the converter (this name will show up in the respective format selection box after acceptance)
- Define the character to be used as shortcut in combination with the button **Alt** (add an & character before the chosen character), and
- Specify the characteristics of the tool (Executable, DLL, Script or Separator).
- Script can be modified in the MacroStudio (**Edit Script**). You can define whether the script should be active at the same time as the main program. (Check the checkbox Run as Extra Thread)

D

d

S

A

You now may change the path using the Path box and a standard file selector.

Press **OK** to save the changes and to leave the Configuration window or **Cancel** to leave the Configuration window without changes.

15.6.5 Deleting a File Format

Two possibilities exist to remove an export format converter from a formats list. The respective file, of course, will not be deleted!

- Open the Formats Configuration window (Options/Export Formats/Static), the Kinematic Formats Configuration window (Options/ Export Formats/Kinematic) or the Report Configuration window (Options/ Export Formats/Reports...), highlight the respective format name in box **Menu** and press the button **Del**. The name of the removed format (or the removed separator) will be removed from the box **Menu** and the tool will no longer be available (unless you add it again).
- Uncheck the checkbox next to the format converter name. You may reactivate this converter any time with the checkbox!

Press **OK** to save the changes and to leave the Configuration window or **Cancel** to leave the Configuration window without changes.

15.6.6 Change the Path to a File Converter

To change the path to a file converter, open the Formats Configuration window (Options/Export Formats/Static), the Kinematic Formats Configuration window (Options/ Export Formats/ Kinematic) or the Report Configuration window (Options/Export Formats/Reports...) and highlight the respective format name in the box Menu. You now may change the path using the Path box and a standard file selector.

Press **OK** to save the changes and to leave the Configuration window or **Cancel** to leave the Configuration window without changes.

15.7 Set a Default System

GeoGenius inserts points or baselines into the project and displays them in the project plot according to the Standard Map Projection or to the current System. By default, **GeoGenius** sets the Standard Map Projection as the current System when you open any new project. Using the System related items of the pull-down menu **Options** you may set a Default System instead (or return to the Standard Map Projection). **GeoGenius** will then assign the selected System to any new project. Typically, you will set a default System, if your projects generally are in the same System. You will set the Standard Map Projection, if your tasks repeatedly are networks in different Systems.

You may, of course, at any time change from the default System to another System for an individual project. This is done via the menu item **Project/System...** (refer to chapter 6.).

Two options are available via the pull-down menu **Options**:

- Standard Map Projection (default)
- Default System

15.7.1 Standard Map Projection

The Standard Map Projection is the default option. You may return to the Standard Map Projection as default, if you have set a Default System previously.

To define the Standard Map Projection as default, check the pull-down menu item **Options/Standard Map Projection**.

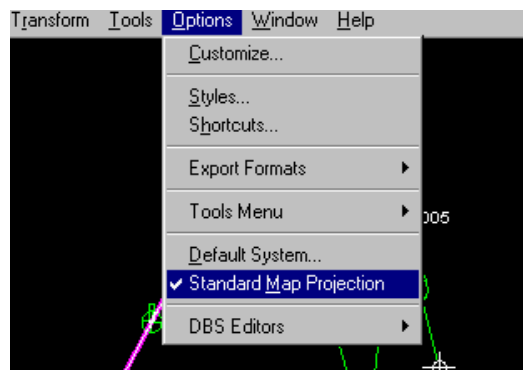


Figure 15-36: Standard Map Projection

15.7.2 Set a Default System

You may define a default System to be automatically selected when creating a new project. Choose the menu item Options/Default System...

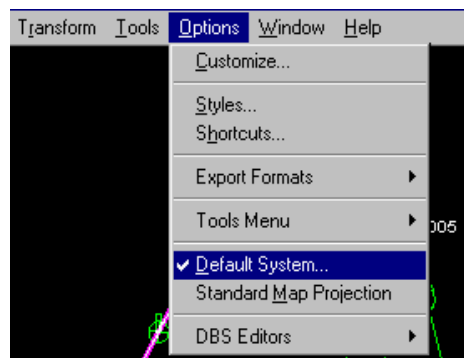


Figure 15-37: Default System

and choose the System from the Select System window. **GeoGenius** will default to the chosen System in every new project. This setting is stored during sessions of **GeoGenius**, as all the other settings.

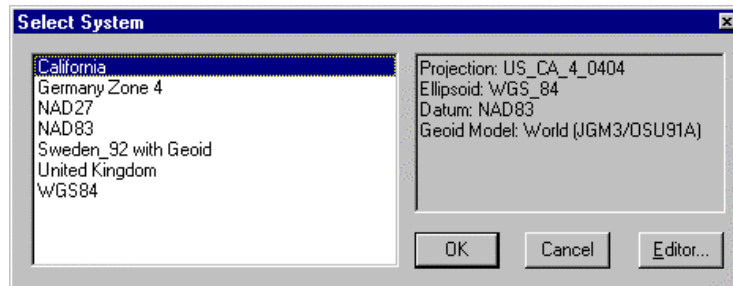


Figure 15-38: Select Default System

The System Editor dialog window allows the (re-)definition of any System. From the Select System window, click the button **Editor...** to open the System Editor.



Figure 15-39: System Editor

Please refer to chapter 6 for a complete description of the System Editor. Here, you will find a short description of the System Editor's main features.

The upper part of the dialog box displays the **name of the System**. A combo box displays already defined Systems in alphabetical order and allows you to choose from the complete list of Systems.



If you want to define a new System with a new name, **first** click on the **New** button at the bottom of the System Editor window. Then enter and accept the new name, which will appear in the list immediately.

The **System Type group** covers the main part of the System Editor box. It allows you to choose the System components. Generally, you may choose, whether your System includes a projection or whether an ellipsoid with datum is sufficient for your purposes.

Four **buttons** are arranged at the bottom of the System Editor window. They allow you to

- Save** save the System components under the name displayed in the Name combo box,
- New** define a new System using a new name,
- Delete** delete a System from the list,
- Close** close the System Editor. Changes will only be saved, if you have made use of the **Save** button before!

GeoGenius offers a lot of projections (some have a zone system), ellipsoids and datums for building your own System. The items **Projection Editor**, **Datum Editor** and **Ellipsoid Editor** of the pull-down menu **Options/DBS Editors** open the respective editors to add your own components or change values for existing components.

 *The static and kinematic processors use the WGS84 system Cartesian coordinates for processing the data. The System, therefore, is irrelevant for processing, but necessary to visualize results on the project plot and for local coordinates. Biased network adjustment generally needs a System.*

If you have created and saved a new system, the new system will show up in the Select System dialog after closing the System Editor. You now may highlight one of the Systems and accept the selection as default System with **OK** or leave the Select System dialog without selecting a default System with **Cancel**.

15.8 Macros

GeoGenius has a built-in script interpreter for macros. Scripts are based on **TIM**, Spectra Precision's Interpreter for Macros. It reads text input and performs actions based on the instructions found in the script. **GeoGenius** supports the complete **TIM** v1.5 command set as described in the ***TIM Programmer's Guide***.

For a complete reference of **GeoGenius** specific commands please refer to Appendix C of this manual.

To run a macro file choose the menu item File/Run/Macro  File or the corresponding button from the toolbar Options. The File Selector appears and its file mask box displays the entry *.M.

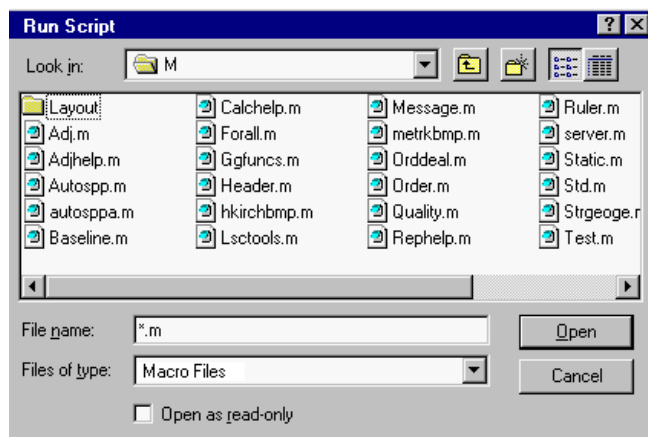


Figure 15-40: Macro File Selector

Choose a script with this extension and start the script with **Open** (**C**ancel leaves the dialog without starting a script run).

You now may watch the processing of the macros in the Output window.

The command item File/Run/Run Again allows the repeated processing of the last selected scripts without opening it via the File Selector. 

The menu item File/Run/MacroStudio allows you to modify scripts directly within the **GeoGenius** environment.

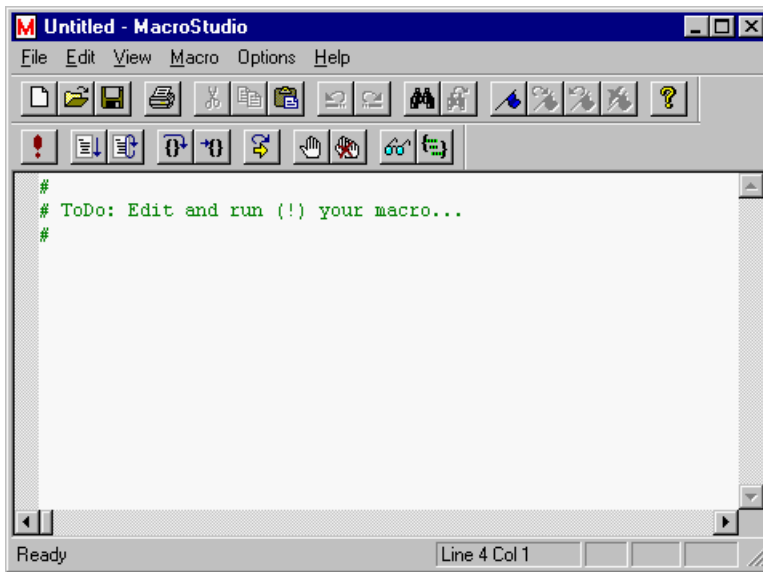


Figure 15-41: MacroStudio

15.9 Show Status Bar

You can display or hide the status bar from the main menu by choosing the pull-down menu **V**iew and checking the item **S**tatus **B**ar. This toggles the status bar status on or off.

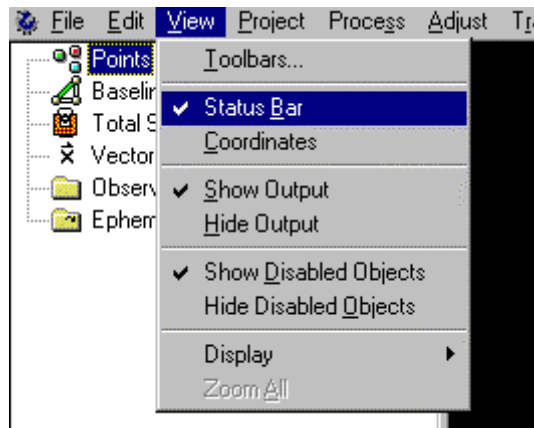


Figure 15-42: Show Status Bar

You may also choose the button  from the Options toolbar instead.

15.10 Customizing Keyboard Shortcuts (Hot Keys)

Shortcuts (hot keys) accelerate the menu option selection. Chapter 5.1.2 lists the default hot keys. However, you may define your own customized hot keys.

The item Shortcuts... of the pull-down menu Options opens the Shortcut Keys window.

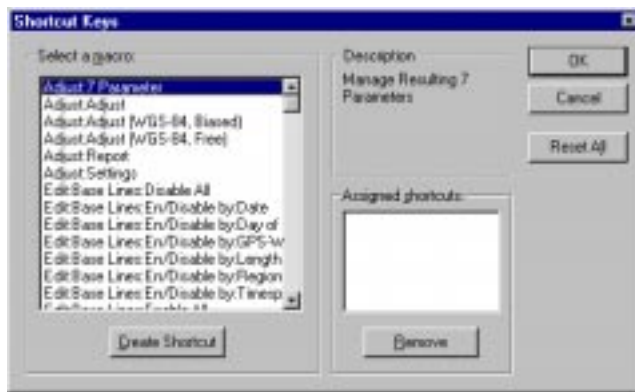


Figure 15-43: Defining Shortcut Keys

A combo box at the left allows you to choose the command (which is in fact a macro) for which you want to create a hot key combination. The commands are named according to the pull-down menu items. They are listed in alphabetical order.

Having highlighted a macro, you will find a short description of the command's effects in the Description box. If you have already created

a shortcut to the currently highlighted command, the shortcut components will be displayed in the Assigned Shortcuts box.

15.10.1 Creating a Shortcut

To create a new shortcut to a command, first highlight the command, then click button Create Shortcut. The Assign Shortcut dialog pops up. Its string field states that no keyboard key has been selected so far. To enter the key combination just press the keys you want to use later on.



Figure 15-44: Shortcut Assignment Dialog

E.g., to use the hot key combination **Alt+A** press the keys **Alt** and **A** simultaneously. If you just press a key, **GeoGenius** automatically adds the **Ctrl** key to the current combination. E.g., pressing **A**: the string field displays **Ctrl+A**.

After you have assigned a hot key combination, the Assign Shortcut dialog states whether this combination already was assigned to another

macro or not (Current Assignment: (Unassigned)). Preferably, you should choose an unassigned hotkey combination. Accept your choice with **OK** (**Cancel** leaves the dialog without assignment).

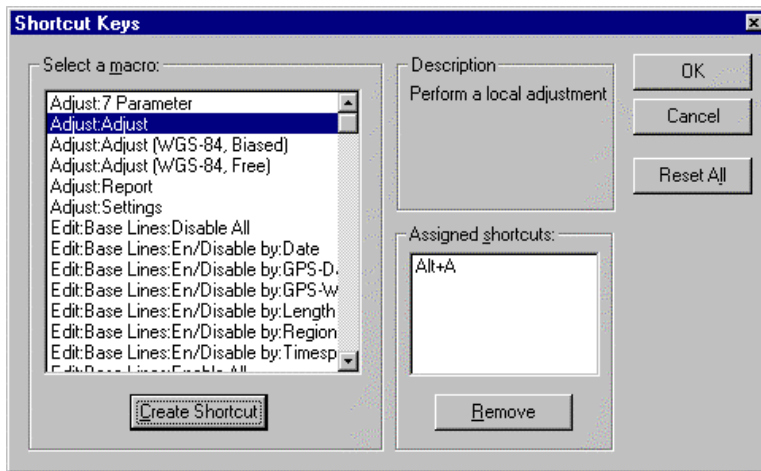


Figure 15-45: Alt+A Assigned to Adjust/Adjust National

E.g., If you want to assign **Ctrl+N** to Adjust/WGS84 Free Network, you would be informed that currently this hotkey is assigned to File/New. If you accept the hot key combination nevertheless, the default setting will prevail over your assignment. The Shortcut Assignment box will nevertheless display the shortcut.



Do not assign one of the default hotkey combinations to any other command. Default settings prevail over user-assigned shortcuts!

To accept all your new hot key combinations click **OK**. **Cancel** leaves the Shortcut Keys dialog without changes.

15.10.2 Deleting Shortcut Keys

Deleting a shortcut is a very simple task. Click Options/Shortcuts... to open the Shortcut Keys dialog.

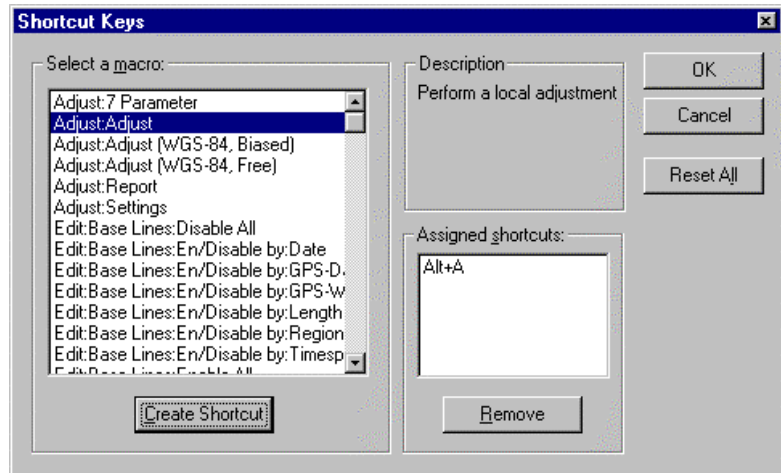


Figure 15-46: Deleting a Shortcut Key

- To remove a single hot key, activate the respective macro in the Select a macro combo box, activate the assigned shortcut in the field Assigned shortcuts and click **Remove**.
- To remove all user-defined shortcuts select **Reset All**.

To accept the deletion click **OK**. **Cancel** leaves the Shortcut Keys dialog without changes.

16. Data Formats

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16.1 Data Import and Export Modules

16.1.1 Import Routines for Coordinates

Importing national or local coordinate data from foreign file formats is done in a modular fashion. Each supported file format corresponds to a DLL module located in the IODLL subdirectory of **GeoGenius**. You can identify the point import modules by their filenames. They are all called TMR* .DLL.

When the import functionality is evoked **GeoGenius** scans the IODLL directory for existing point import DLLs and then displays a selection box with all recognized import modules.

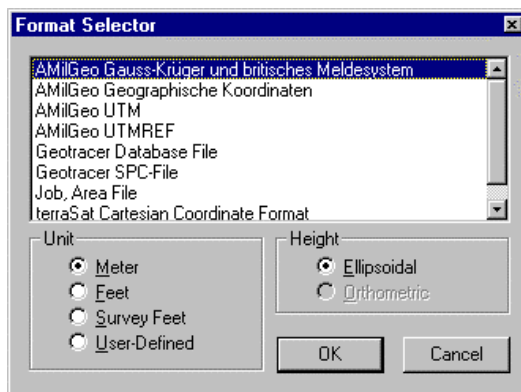


Figure 16-1: Format Selector Plane Coordinates

The point import functionality of **GeoGenius** is designed to support PlugAndPlay-like behavior. You can add or remove plane coordinate

import DLLs from your system. **GeoGenius** will recognize newly added modules.

The following DLL modules are currently shipped with **GeoGenius**. This list is subject to change (most likely additional modules will be added to new releases of **GeoGenius**). Please check latest RE-ADME.TXT files for additions.

DLL-Name	Import Format (as appears in GeoGenius)
TMRAMIL2.DLL	AMilGeo Gauss-Krueger and British messaging system AMilGeo Geographical Coordinates AMilGeo UTM AMilGeo UTMREF
TMRASHC.DLL	Ashtech C-File
TMRDBS2.DLL	Geotracer Database File (*.DBS)
TMRJOB2.DLL	Geotronics Job, Area File (*.JOB; *.ARE)
TMRSPC2.DLL	Geotracer SPC-File (*.SPC)
TMRTSAT2.DLL	terraSat Cartesian Coordinate Format (*.XYZ) terraSat Geographical (Dec. Degree)

Table 16-1: Import Formats

You can also write scripts (macro files) that allow to import data in the national grid System. You can use ASCII or binary formats. In the directory:

\<INSTALLDIR>\FORMATS

there are script files named I*.M. These might serve as examples for you to write your own import scripts.

16.1.2 Vector Import DLL Modules

Importing vectors from foreign file formats is done in a modular fashion. Each supported file format corresponds to a DLL module located in the IODLL subdirectory of **GeoGenius**. You can identify the vector import modules by their filenames. They are all called TMVR*.DLL.

When the import functionality is evoked **GeoGenius** scans the IODLL directory for existing point import DLLs and then displays a selection box with all recognized import modules.

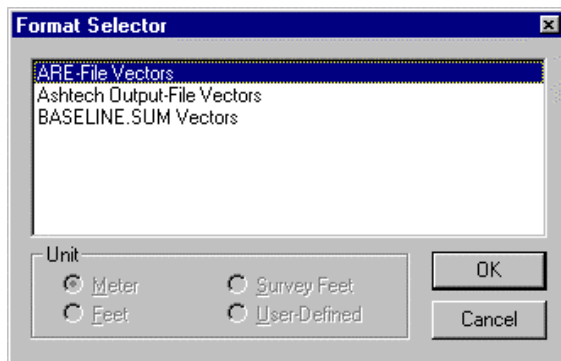


Figure 16-2: Format Selector Vectors

When first started **GeoGenius** scans the IODLL directory for existing vector import DLLs. It creates a small database file called TVIODLLS.DAT in the same directory containing information about the DLLs found. This database file is used for speeding up the vector import process.

The vector import functionality of **GeoGenius** is designed to support PlugAndPlay-like behavior. You can add or remove vector import

DLLs from your system. **GeoGenius** will recognize newly added modules. The only thing you have to do is to delete the TVIODLLS.DAT file. This will make **GeoGenius** scan the IODLL directory again. **GeoGenius** will automatically create an updated file.

The following DLL modules are currently shipped with **GeoGenius**. This list is subject to change (most likely additional modules will be added to new releases of **GeoGenius**). Please check latest RE-ADME.TXT files for additions.

DLL-Name	Import Format (as appears in GeoGenius)	Description
TMVRM.DLL	Ashtech M Files	Imports vectors from Ashtech M Files
TMVROF04.DLL	Ashtech Output-File Vectors	Imports vectors from Ashtech Output Files
TMVRSM04.DLL	BASELINE.SUM Vectors	BASELINE.SUM format. The Geotracer vector file format
TMVRAR04.DLL	ARE-File Vectors	Imports vector data from *.ARE and *.JOB files
TMVROBN.DLL	TDS OBN Vectors	TDS OBN imports vectors

Table 16-2: Import Vectors

16.1.3 Export Macro Files (Scripts)

Exporting static or kinematic data into other formats is done with macro (script) files. Script files are macros, which can be interpreted

with the Tiny Interpreter for Macros **TIM**. The **TIM Programmer's Guide** is part of the **GeoGenius** manuals.

The advantage of the generation of the output formats with macros is that you can write your own output formats or edit existing formats. Further, you also have the important advantage of writing interfaces to other software products, e.g., for CAD or GIS. The results after processing, adjustment or transformation can now be written in any output format, as binary or ASCII data. Via the macro language you have access to the database to read the results and finally to generate your own output format in a file.

The following two tables list the currently available static and kinematic output scripts of the subdirectory \<INSTALLDIR>\FORMATS.

Filename	Description
ESNAP.M	Ashtech SNAP Station- and Vector file
EASHOFILE.M	Ashtech O file
EASHPNT.M	Ashtech Points file
EFILLNET.M	Ashtech FillNet file
EBLUEB.M	BlueBook B-file
EBLUEG.M	BlueBook G-file
ETM.M	SPS TerraModel file format
ESPC.M	Geotracer SPC file
EAREASTD.M	Geotracer Area Standard file format
EAREAMPF.M	Geotracer Area Mapping file format
EAREASPD.M	Geotracer Area Space delimited file format
EAREAKMD.M	Geotracer Area Comma delimited file format
EBASESUM.M	Geotracer BASELINE.SUM
ELCS.M	Geotracer LCS Datei
EGEOM63.M	Geodimeter 6+3
EGEOM83.M	Geodimeter 8+3

EDXF.M	DXF file format
EGEOLAB.M	GEOLAB file format
ECREMER.M	CP Gmbh Format
EAKS.M	AKS Format
EKAFFKAG.M	Kafka Format (Geographical)
EKAFFKAW.M	Kafka Format (WGS-84)
EKREISCF.M	Kreis Coesfeld - VPD
ETDS.M	Binary TDS format
EMOVE3.M	MOVE3 Format
EWAYPNT.M	GPS Topo/Waypoint format

Table 16-3: Currently Available Scripts for the Export of Static Data

Filename	Description
ECFILE.M	Ashtech C-File
EPOS.M	POS Position File
EPOSA.M	POS File (National/All Solutions)
EPOSWG.S.M	POS File (WGS84/Fixed Solutions)
EPOSWGSA.M	POS File (WGS84/All Solutions)
ENG.C.M	NGC File (National Grid/Fixed Sol.)
ENGCA.M	NGC File (National Grid/All Sol.)
EPOSNGC.M	POS&NGC Files (National/Fixed)
EPOSNGC.M	POS&NGC Files (National/All)
EHDW.M	Marine Position File
EVXYZ.M	Pos+Geschw. File (WGS84/Fixed)
EVXYZA.M	Pos+Geschw. File (WGS84/All Sol.)

Table 16-4: Currently Available Scripts for the Export of Kinematic Data

16.2 Import Data

16.2.1 Observation File

GeoGenius uses binary observation files for storing all data in a receiver independent format. The name of such a file typically contains the point number (SITE) and the observation day (DDD). A free variable S often describes the session number. The file has the extension *.OBS. Therefore, the typical observation filename is SITEDDDS.OBS.



Please note! SITE is not the real point number. The real point number is written within the *.OBS file!

These binary files consist of a header and a body:

16.2.1.1 Header

identification code	char id_code [8]	ASCII : set to "terraSat"
header length	unsigned int header_length and length	length of header including id_code
file format version	int version	set to 1 for this version
receiver type	char rcv_type [20]	ASCII : specifying receiver type
receiver serial number	char rcv_serial [20]	ASCII : specifying serial number
receiver software version	char rcv_version [10]	ASCII : specifying receiver software
receiver channels	unsigned int num_rcv_channels	number of receiver channels
<i>old point number</i>	<i>char point_number [5]</i>	<i>should be binary zeros</i>
Point code	char point_code [17]	ASCII : description of point
Point info	char info [16]	ASCII : Additional Information
Position	double pos [3]	approximate WGS84 position
Instrument eccentricities	float hen [3]	height, east and north eccentricity
Geoidal Height	float geoid_height	Geoidal height information : initial 0
GPS week	int week	GPS week for start of dataset
start time	double t_start	seconds of week for start time
end time	double t_end	seconds of week for end time
time interval	float delta consecutive epochs	smallest time interval between
satellites tracked	unsigned int sats_tracked [64]	number of epochs a specific satellite was tracked
		(sats_tracked[0] gives the number of epochs for pm 1 etc., elements 32..63 reserved for GLONASS)
reference file	char ref_file [10]	ASCII : initial setting: "?????????"

reference satellite	int ref_sat	initial setting : 0
reference interval	float	initial setting : 0
number of codes	unsigned int num_cod	# of code obs. to single sat
code indicators	char code_ind [4]	C/A = 0 , P1=1, P2=2, P1-P2=3
number of carriers	unsigned int num_car	number of carrier obs. to single sat
carrier indicators	char carrier_ind [4]	C/A = 0 , P1=1, P2=2, P1-P2=3
number of Doppler	unsigned int num_dop	number of Doppler obs. to single sat
Doppler indicators	char doppler_ind [4]	C/A = 0 , P1=1, P2=2, P1-P2=3
L2 squared indicator	unsigned long int l2_squared	activated bits 0..31 show squaring
additional identifiers	unsigned int ident	for prn's 1..32
		reserved for bit identification (def 0)
		bits 0 and 1 for mode indication
		bit 0 not/bit 1 not set : static
		bit 0 not/bit 1 set : kinematic
		bit 0 set/bit 1 not set : short-static
		bit 0 set/bit 1 set : stop & go
		bit 2 raw data without satellite clocks
		bit 3 external oscillator connected
		bit 4 receiver clock error stored
		bit 5 indicates that slope instr.height
		bit 6 indicates that GPS-UTC is stored
		bit 7 indicates that true vertical
		instr. height is entered
		(only if bit 5 zero)
antenna correction	int ant_corr [6]	height, east and north antenna
	corrections for L1 and L2 in 0.1 mm	
original file name	char original_fname[14]	file in receiver specific format
reference elev cutoff	char elev_cutoff	elevation cutoff used by TOPAS turbo
reference frequency	char frequency	- required for multistation approach
		type of frequency used by lasibaseline
		estimator run - required for
		multistation approach
antenna number	char antenna_num [20]	serial number of antenna
antenna type	char antenna_type [20]	type of antenna used
CRC	unsigned long int	32 bit crc for GPSEdit
<i>point_number_16</i>	<i>char point_num[17]</i>	<i>ASCII: long point number</i>
GPS-UTC	char gps_utc[1]	GPS-UTC in seconds
reserved	char reserved [2]	reserved for future use
Last access by	modified_by[4]	e.g. 'A','D','I','O' Ashtech Interface
Last access at	unsigned long time	value of C time function (holds date and time) in DOS format

16.2.1.2 Body

The body of an **OBS** file consists of a sequence of observation records, navigation records and event records.

Observation Record (OR)

body identification	int body_id	ASCII : set to "OR"
record length	int record_length	length of body record in bytes including body_id and record_length
receipt time	double rec_time	signal receipt time in seconds of week corresponding to start week in header (rec_time can be larger than 604800, no wrap around)
<i>Kinematic Indicator</i>	<i>char kin_indicator [5]</i>	<i>"?????" when moving, last four characters of point number when static</i>
number of sats	unsigned char num_sats	number of satellites tracked in current epoch
measurements	MEAS_BLOCK meas[num_sats]	structure with observations
typedef {	int sv_id; double code [num_cod]; double phase [num_carr]; float doppler [num_dop]; char snr [num_car]; char lli [num_car];	satellite identification pseudorange measurements carrier phase measurements in cycles doppler measurements signal to noise ratio in dB lost of lock indicator (bitwise settings) no bits set - data ok, no loss of lock bit 0 set - lost lock between previous and current observation : cycle slip possible bit 1 set - inverse wavelength factor to default (does not change default) bits 0 and 1 set - lost lock , inverse wlfact bit 2 set - indicates 1/2 cycle error possible
}	MEAS_BLOCK;	

Navigation solution record (NR)

body identification	int body_nr_id	ASCII : set to "NR"
record length	int record_length	length of body record in bytes including body_id and record_length
reference time	double ref_time in seconds of week corresponding to	reference time for navigation solution
position	double curr_pos [3]	start week in header (rec_time can be larger than 604800, no wrap around)
receiver clock error	float rcv_clk_error	cartesian position solution in WGS 84
HDOP	unsigned int hdop	receiver clock error in seconds
VDOP	unsigned int vdop	horizontal DOP value - to be divided by 100
		vertical DOP value - to be divided by 100

Event record (ER)

body identification	int body_id	ASCII : set to "ER"
record length	int record_length	length of body record in bytes
event type	int event_type	type of event
		0 external event
		1 receiver time adjustment
		2 manual event
		3 external comment
		4 RS232 event
		5 new point number
reference time	double ref_time	time of event in seconds

For types 0,1,2,4:

event id	unsigned int event_number	event number for types 0, 1, 2, 4 (not stored for other types)

For type 3:

comment	char comment[length-14]	comment text

For type 5: (used in Stop & Go)

init_type	int init_type	Type of initialization or point 0 Normal new point 1 Point with known baseline to the base station 2 New initial point 3 VSFB
point number	char point_number[5]	ASCII: specifying short point number
point code	char point_code[17]	ASCII: description of point
point info	char point_info[16]	ASCII: additional information
instrument ecc	float hen [3]	height, east and north eccentricities
comment	char comment[length-64]	comment text

For type 6: (used in Stop & Go with extended point number)

init_type	int init_type	Type of initialization or point 0 Normal new point 1 Point with known baseline to the base station 2 New initial point 3 VSFB
point number spares	char point_number[9] char spares [8]	ASCII: specifying short point number reserved for future extensions
point code	char point_code[17]	ASCII: description of point
point info	char point_info[16]	ASCII: additional information
instrument ecc	float hen [3]	height, east and north eccentricities
comment	char comment[length-76]	comment text

In case of VSFB, baseline components are stored in height, east and north in vector "**hen**". The sign of the baseline is defined as **rover-reference**.

16.2.2 Import of Raw Data

Data files of other type have to be decoded first in order to change these files to the receiver independent *.OBS file type.

GeoGenius automatically decodes the raw data. Decoders for the following trademarks (products) are implemented and decode files using the respective file format:

- Ashtech GPS/GLONASS
- Geotracer
- Trimble
- TurboRogue
- Novatel, even new Format
- Sercel, even DNSP
- Magnavox
- RINEX Import/Export
- Zeiss

16.2.3 Local and National Coordinates - Available File Format Converters for Import

When creating a new project or editing an existing one, you may insert precise point positions using converters.

You may also create your own converters and add them to **GeoGenius**.

Currently the following File Format Converters are available:

- AMilGeo Gauss-Krüger and British Messaging System
- AMilGeo Geographical Coordinates
- AMilGeo UTM
- AMilGeo UTMREF
- Geotracer Database File
- Geotracer SPC-File
- Job or Area File
- terraSat Cartesian Coordinate Format
- terraSat Geographical Coordinates



Figure 16-3: Format Selector National and Local Coordinates

16.2.4 Broadcast Ephemeris

Files of the National Geodetic Survey binary EF18 format usually follow the naming convention ECFWWWEPH or ECFWWWPRC

where ECF is corresponding to earth-centered fixed
 WWW is the GPS week
 EPH refers to broadcast ephemeris
 PRC refers to precise ephemeris

The static and kinematic processors of **GeoGenius** require binary EF18 format for processing baselines. **GeoGenius** generates **broadcast** ephemeris files from RINEX files, if no EF18 format files are available for processing (for detailed information on the RINEX formats, please refer to section 16.5).

16.2.5 Precise Ephemeris

Precise ephemeris files are often distributed as National Geodetic Survey SP3-Format files. These files are provided with the assumption that one file per day is used. (Also binary EF18 files for a single day exist.)

The file usually includes both the week and the day of week, e.g., COD08121. EPH is the SP3 file generated by CODE (Center of Orbit Determination in Europe) for week 812 on Monday (day 1). However, files may have arbitrary file names.

Precise orbits can be obtained from:

GPSIC (Civil GPS Information Center of the U.S. Coast
Guard)

BBS: ++1 (703) 313 5910

Internet: gracie.grdl.noaa.gov
or from the German GPS information center GIBS):
IFAG Leipzig
BBS ++49 (0)341 563 4387
Internet: igs.ifag.de

GeoGenius decodes **precise orbits** from the ASCII SP3 format or from the binary EF18 format for a single day into binary EF18 format for a week (see chapter *14.1*).

They should be stored in files with extension `ECFWWW.PRC`. The extension `*.PRC` indicates the precise ephemeris file.

16.2.6 Import of Vectors

GeoGenius currently supports the following file formats:

- Job/Area File Vectors
- Ashtech Output-File Vectors
- BASELINE.SUM Vectors

16.2.6.1 Spectra Precision Job/Area Files

Geotracer® systems store results in job files with name `*.JOB`. The structure of a job file is defined by a label system. This allows you to control file contents.

While job files usually are used to store results, area files typically offer previously stored or adjusted data. Generally, area or job files have the

same structure. However, the reference station position is not necessary in an area file.

The first number in each line is the label ID followed by the information this label provides. The meaning of all labels used by the Geotracer® systems may be found in the respective manuals.

These are possible point informations to represent the point position:

- Horizontal angle, Vertical angle and Slope distance
(Labels 7, 8, 9)
- National Grid Coordinates (N, E, Ele)
(Labels 37, 38, 39)
- WGS84 Coordinates (X, Y, Z)
(Labels 110, 111, 112)
- Ellipsoidal coordinates within the national grid datum (Latitude, Longitude, Height)
(Labels 113, 114, 137)
- Relative N, E coordinate and vertical distance
(Labels 47, 48, 49)
- Baseline components in x, y, z [m]
(Labels 120, 121, 122)

A typical *.JOB file follows:

2=reference	Station number = Reference
51=03-10-95	Date
52=13:38:15	Time
23=1400	Units used
110=4185261.959	WGS84 coordinate X
111=868327.996	WGS84 coordinate Y
112=4719089.073	WGS84 coordinate Z
37=5320489.865	Northing coordinate

38=479297.498	Easting coordinate
39=703.628	Elevation coordinate
5=1	New Point: Station number
37=5320491.148	.
38=479284.123	.
39=703.372	.
47=1.283	Relative North coordinate
48=-13.375	Relative East coordinate
49=-0.256	Vertical distance
120=1.652	Baseline component in x
121=-13.323	Baseline component in y
122=0.635	Baseline component in z
138=0.0000239427176583	Elements of variance/
139=0.0000076238064381	covariance matrix
140=0.0000148327480290	"
141=0.0000189936490934	"
142=0.0000101352123581	"
143=0.0000362934342069	"
4=1	Point code
0=Lamp post	Point info
6=1.500	Signal height
118=7	No. of sat. at both stations
115=2.12	PDOP
132=2.00	Time span of measurement
5=1	New Point: same point again!
37=5320491.147	.
38=479284.125	.
39=703.369	.
47=1.283	.
48=-13.374	.
49=-0.259	.
120=1.650	.
121=-13.322	.
122=0.633	.
138=0.0000239037751034	.
139=0.0000076645015711	.
140=0.0000148944782960	.
141=0.0000189152282543	.
142=0.0000101874547272	.

143=0.0000361639089006	.
4=1	.
0=Lamp post	.
6=1.500	.
118=7	.
115=2.12	.
132=2.00	.
...	

16.2.6.2 *Ashtech Output-File Vectors*

The Ashtech binary output file holds information on baseline components, associated variance-covariance matrix and processing statistics.

16.2.6.3 *Geotracer BASELINE.SUM Vectors*

A postprocessing binary file BASELINE.SUM holds information on baseline components, associated variance-covariance matrix and processing statistics. This file is created by the Geotracer Postprocessing Software.

16.3 Export Formats for Static Data

16.3.1 Ashtech SNAP Station File and Vector File

The script file is called `ESNAP.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. The ASCII Station file contains, in the format required for import to a SNAP project file, an East-West Longitude label, and, for each station:

- Position adjustment flag
- Individual coordinate adjustment and weighting flags
- Station name (site identifier)
- Approximate station coordinates
- Standard deviations of weighted coordinates (topocentric northing, easting, and height) in meters

Reserve all lines prior to the triple colon (`:::`) in columns 1, 2 and 3 for comments; the line after the `:::` is the first significant data line in the file. Each significant line is 91 columns long.

The ASCII Vector file contains, in the format required for import to a SNAP project file, for each GPS vector observation:

- Vector adjustment flag
- Names for the target and the standpoint
- Heights of the target and the standpoint (must be zero)
- Signs and magnitude of the observation deltas
- The upper portion of the variance-covariance matrix

The vector lengths and covariance elements are given in meters. Reserve all lines prior to the triple colon (:::) in columns 1, 2 and 3 for comments; the line after the ::: starts the first significant data item in the file. Each significant data item consists of one line 68 characters long followed by another line 66 characters long.

16.3.2 Ashtech Points File

The script file is called `EASHPNT.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. This is the Ashtech projection points file for input to the `GPS\CADD` software.

The Ashtech points file has two sections: a header and a list of the points and their coordinates, which follow the header. The header has a fixed string for its first line, which is used to identify the file as an Ashtech points file. The header is followed by a series of lines that describe the coordinate system that represents the point positions. Each descriptor is preceded by a key word which starts on the first column, followed by an ID string and/or a description/data. Most of the descriptors are optional, making the file format more flexible. The System, Datum, Height and Units are optional with defaults.

Comments may be placed between the header and the body. The only restriction on comments is that they cannot start in the first column.

The body is preceded by a one-line header and a blank line. The header should start at the first column. The header depends on the System to be used. The header identifies the fields in the position data; minimum has Point start at the first column to specify the point number in the file, three fields to specify the position, and the site field to specify the point name. The position fields would be latitude,

longitude, and height for geographic systems, or northing, easting, and height for projections. The attribute field is a free-form string of up to 80 characters that can include space characters.

16.3.3 The Ashtech Fillnet File

The script file is called **EFILLNET.M** and is located in the subdirectory **\FORMATS** of the **GeoGenius** root directory. This is a single file containing all vector solutions and preliminary positions suitable for input to the Fillnet program or to Snap.

The ASCII Fillnet file contains the following records:

- Parameter record
- Title record
- A number of preliminary coordinate records
- Section closing record
- Bias group header record
- A number of vector records
- Section closing record (needed only when there is more than one bias group).

Each record is discussed in detail below.

16.3.3.1 Parameter Record

The parameter record has the following structure:

- Equatorial radius (a)
- Reciprocal of flattening (1/f)
- Sense of longitude (W for west, E for east)
- A priori transformation from WGS 72 (most times blank)

16.3.3.2 Title Record

The title record has the following format:

- Project name and comments
- Latitude of local origin
- Longitude of local origin

Local origin coordinates are expressed in degrees, with one decimal. This is a point, not necessarily a station of the net, somewhere near the middle of the survey area. In the southern hemisphere, use a negative sign with latitude.

Preliminary Coordinates Record

Preliminary coordinates records in the WGS84 system have the following format:

- Three columns denoting coordinates to be held fixed. F in the first column fixes the latitude, F in the second column fixes the longitude, and F in the third column fixes the height. Leave blank for free coordinate.
- Station name, any characters, including blanks
- Minus sign to indicate southern hemisphere
- Latitude in WGS84 (DMS)
- Longitude in WGS84 (DMS)
- Elevation in WGS84 (meters)
- Geoid height (meters). Geoid heights are given for all points, or none.

Note: Degrees and minutes are read as right-justified integers.

16.3.3.4 Preliminary Coordinate Section Closing Record

Preliminary coordinate section closing records have the following format:

- Asterisk (*)

The preliminary coordinates record section is closed by a record that contains only an asterisk in column 1.

Header Record for a Bias Group

The header record for a bias group has the following format:

- Number of vectors in the group
- Millimeters for difference in latitude
- Millimeters for difference in longitude
- Parts per million for both latitude and longitude
- Millimeters for height difference
- Parts per million for height difference

The values for the accuracies are always set to 0. **GeoGenius** supports the covariance matrix listed in the vector data record in this output format.

16.3.3.6 *Vector Data Record*

A vector data record contains the following information:

- Number of participating receivers
- Type of solution
- Name of standpoint
- Name of forepoint
- Session code or comment
- Delta x
- Delta y

- Delta z
- S.E. codes

In the **GeoGenius** output file the number of receivers are blank.

Bias Group Section Closing Record

Bias group section closing records have the following format:

- Asterisk (*)

Close a section of vector data records with this record - an asterisk in column 1.

16.3.4 The BlueBook B-File

The script file is called **EBLUEB.M** and is located in the subdirectory **\FORMATS** of the **GeoGenius** root directory. The BlueBook B-File contains the GPS occupation header record (*25*), the GPS occupation comment record (*26*), and the occupation measurement record (*27*).

16.3.4.1 GPS Occupation Record Header (*25*)

This record is used to define session information and the raw data file name at a station. There is an occupation header record for each receiver in each session. To anticipate the accuracy of an observation, the used type of survey equipment must be known.

The record *25* contains the following information:

- Station serial number
- Data media identifier
 - Receiver

- Day of Year
- Year
- Session observed
- Station name
- Initials of the observer
- Job specific instrument number
- Length of the cable used to connect receiver and antenna

The initials of the observer can be entered via the menu `File\Project Info...` in the Project Manager. The job specific instrument number and the length of the cable are not implemented in the output file of **GeoGenius**.

16.3.4.2 *The GPS Occupation Comment Record (*26*)*

This record is used for comments pertinent to the GPS occupation session. In the BlueBook format this record is optional. The comment can be entered in **GeoGenius** in the menu `File\Project Info...`

16.3.4.3 *The GPS Occupation Measurement Record (*27*)*

To identify the station occupied on each particular observation record a unique four-digit number (Station Serial Number) in the range 0001 to 9999 is assigned to each station occupied in the job. The GPS occupation measurement record contains:

- Station serial number
- Date of observation
- Time
- Height of the antenna phase center above the monument
- Dry bulb temperature
- Dry bulb temperature code
- Wet bulb temperature

- Wet bulb temperature code
- Relative humidity
- Barometric pressure
- Barometric pressure code
- Weather code

GeoGenius does not use any measurement of meteorological data, the used standard values are entered here in the BlueBook output format. These standard values are:

- Dry bulb temperature = 20° Celsius
- Wet bulb temperature = 20° Celsius
- Relative Humidity = 50%
- Barometric pressure = 1013 Millibar

No Weather code is entered in this output file. For more information on the BlueBook format we refer to the BlueBook format description of NGS.

16.3.5 The BlueBook G-File

The script file is called `EBLUG.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. This description contains information about the Global Positioning System (GPS) data transfer format (G-file) records from NGS.

The G-file consists of up to eight 80-column record types that are used to document the results of the computation of relative vectors, expressed as components, from simultaneously observed GPS phase measurements. There may be only one G-file for a project.

Each G-file contains one Project record (A) and one or more Session Header records (B). A Session Header record (B) is required for each individually processed vector or each simultaneously processed group of vectors (session) at three or more survey points. Each Session Header record is followed by one or more Long Vector records (F), Correlation records (D) and Covariance records (E).

Long Vector records contain relative vector components between two survey points. Correlation records contain the off-diagonal elements only of the correlation matrix for the vector components in a session. Covariance records contain the off-diagonal elements only of the covariance matrix for the vector components in a session.

The Coordinate records (G) are used to record, for informational purposes within the G-file, the coordinates of survey points held fixed during the vector computations or to provide location information regarding the G-file. Relative vectors are required even if coordinates are included. A G-file can contain the following records:

- Project record (A)
- Session Header record (B)
- Vector record (C)
- Correlation record (D)
- Covariance record (E)
- Long Vector record (F)
- Coordinate/Absolute Position record (G)
- Station information record (H)

Because not all the records are needed in an output file **GeoGenius** supports only the following records in the output file:

- Project record (A)
- Session Header record (B)
- Correlation record (D)
- Covariance record (E)
- Long Vector record (F)
- Coordinates/Absolute Position record (G)

The implemented records are described below.

16.3.5.1 *The Project Record (A)*

The Project record contains the following information:

- Job code
- Year, start of project
- Month, start of project
- Day, start of project
- Year, end of project
- Month, end of project
- Day, end of project
- Title of project

The job code is always set to “—”.

16.3.5.2 *The Session Header Record (B)*

The Session Header record contains the following information:

- Year, first actual measurement
- Month, first actual measurement
- Day, first actual measurement
- Time, first actual measurement
- Year, last actual measurement

- Month, last actual measurement
- Day, last actual measurement
- Time, last actual measurement
- Number of vectors in the session
- Software name and version
- Orbit Source
- Orbit accuracy estimate
- Solution coordinate system code
- Solution meteorological use code
- Solution ionosphere use code
- Solution time parameter use code
- Nominal accuracy code
- Processing agency code
- Year of processing
- Month of processing
- Day of processing
- Solution type

16.3.5.3 *The Correlation Record (D)*

The Correlation record contains the following information:

- Row index number
- Column index number
- Correlation

16.3.5.4 *The Covariance Record (E)*

The Covariance record contains the following information:

- Row index number
- Column index number
- Covariance

16.3.5.5 *The Long Vector Record (F)*

- The origin station serial number
- The differential station serial number
- Delta x
- Standard deviation
- Delta y
- Standard deviation
- Delta z
- Standard deviation
- Rejection code
- Origin station manufacture code
- Origin station UTC day of year
- Origin station year of occupation
- Origin station session indicator
- Differential station manufacture code
- Differential station day of year
- Differential station year of occupation
- Differential station session indicator

The rejection code is always set to “-”.

16.3.5.6 *The Coordinate Record (G)*

The Coordinate record contains the following information:

- Record usage code
- Station serial number
- “Short” station name
- Coordinate frame
- X coordinate in WGS84
- Y coordinate in WGS84

- Z coordinate in WGS84
- Sigma X
- Sigma Y
- Sigma Z

The sigmas are blank if the sigmas are unknown. The G-file is explained in more details in the description or manual of the NGS.

16.3.6 The TerraModel File Format

The script file is called `ETM.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory . All points are written in a separate line with carriage return line feed at the end of the line. A line contains the following information:

- Point (Station name)
- East coordinate (meter)
- North coordinate (meter)
- Orthometric height (meter)
- Descriptor (Point code)

The entries are comma delimited. The East and North coordinates are either the raw state plane coordinates (received from the single point positioning coordinates in the observation file or after processing the baselines) or the state plane coordinates after having done a transformation or local adjustment in **GeoGenius**.

16.3.7 The Geotracer SPC File

The script file is called `ESPC.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. The file normally includes the state plane coordinates of control points. This control points are read by **GeoGenius** when a local adjustment or a transformation with the use of control points is done. After transformation of the coordinates of a project into state plane coordinates, a SPC file can be generated. A SPC file contains the following information:

- Header information
- Point (Station name)
- East coordinate (meter)
- North coordinate (meter)
- Orthometric height (meter)
- Zone

The header contains information about the selected projection. The header is used as a comment and must have a “;” in its first column. Depending upon whether a transformation has been performed the state plane coordinates are either the coordinates received after the transformation or the raw state plane coordinates after the processing.

16.3.8 The Geotracer Area Files

The Geotracer Area files (Job files) are used for to exchange data between Geotracer GPS receivers and Geodimeter total stations. Both systems can read in and generate Geotracer/Geodimeter Area files. Four different formats are implemented in **GeoGenius**.

16.3.8.1 *The Area Standard Format*

The script file is called EAREASTD.M is located in the subdirectory \FORMATS of the **GeoGenius** root directory. Each line has its own label containing the specified information. A station block contains the following information:

- Point (Station name) Label 5
- Point code Label 4
- Point information Label 0
- North coordinate (meter) Label 37
- East coordinate (meter) Label 38
- Orthometric height (meter) Label 39

The state plane coordinates are either raw state plane coordinates after project processing or transformed coordinates. That depends on whether a transformation has been done by the user in the project.

16.3.8.2 *The Geotracer Mapping Format*

The script file is called EAREAMPF.M and is located in the subdirectory \FORMATS of the **GeoGenius** root directory. The Geotracer Mapping Format is quite similar to the Geotracer Standard format. The difference is that one station block is written in one line. Such a station block (line) contains the following information:

- Point (Station name) Label 5
- Point code Label 4
- Point information Label 0
- North coordinate (meter) Label 37
- East coordinate (meter) Label 38
- Orthometric height (meter) Label 39

The state plane coordinates are either raw state plane coordinates after project processing or transformed coordinates. That depends upon whether a transformation has been done by the user in the project.

16.3.8.3 *The Geotracer Area - Space Delimited Format*

The script file is called EAREASPD.M and is located in the subdirectory \FORMATS of the **GeoGenius** root directory. All points are written in a separate line with carriage return line feed at the end. Information in a line are delimited by a space. A line contains the following information:

- Point (Station name)
- Point code
- Point information
- North coordinate (meter)
- East coordinate (meter)
- Orthometric height (meter)

The state plane coordinates are either raw state plane coordinates after project processing or transformed coordinates. That depends upon whether a transformation has been done by the user in the project.

16.3.8.4 *The Geotracer Area - Comma Delimited Format*

The script file is called EAREAKMD.M and is located in the subdirectory \FORMATS of the **GeoGenius** root directory.. All points are written in a separate line with carriage return line feed at the end. The different information in a line are delimited by a comma. A line contains the following information:

- Point (Station name)
- Point code
- Point information
- North coordinate (meter)
- East coordinate (meter)
- Orthometric height (meter)

The state plane coordinates are either raw state plane coordinates after project processing or transformed coordinates. That depends upon whether a transformation has been done by the user in the project.

16.3.9 The DXF Output Format

The DXF format is the most common format for to exchange data to a CAD software package. The script file is called **EDXF.M** and is located in the subdirectory **\FORMATS** of the **GeoGenius** root directory. The **GeoGenius** DXF output format contains two DXF Layers:

- A Point Layer
- A Text Layer

The point layer contains the state plane coordinates of a point (station) in meters. The state plane coordinates are either raw state plane coordinates after project processing or transformed coordinates. That depends upon availability of a transformation in the project. The entered heights are orthometric heights.

The text layer contains the point number (station name).

16.3.10 The GEOLAB Format

The script file is called **EGEOLAB.M** and is located in subdirectory **\FORMATS** of the **GeoGenius** root directory. The **GEOLAB** format contains the following information:

- Header information
- Station coordinates
- Delta x
- Delta y
- Delta z

- Variance-Covariance matrix

The header contains information about the project and the used datum/projection. The coordinates of the stations are written in latitude, longitude and height. The coordinates refer to the WGS84 system. The GEOLAB format is explained in more details in the GEOLAB manual.

16.3.11 CP GmbH (Cremer)

The script file is called `ECREMER.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. It creates an output file with the default name `GG.CP`. This is one of several export formats used by German public organizations.

The output file starts with a header line summarizing the program title and the project path and file name.

```
TITL GeoGenius CP Output    PROJECT D:\GPS\SAMPLES\Getstart\getstart.ggs
```

The second block lists all stations of the project: The first column allows 16-characters point names. The next three columns give the XYZ coordinates of the point, followed by the point info. All numerical values are in meter.

```

                                L i s t   o f   a l l   S t a t i o n s
Name of Station  X coordinate Y coordinate Z coordinate Info...
1001  3902214.3967 -154645.6895  5025954.6715 BASE STATION
1002  3902463.4933 -155821.0792  5025728.3980 PIN
1003  3902360.1021 -154651.7256  5025843.2530 PIN14
1004  3902018.0476 -154380.5653  5026113.3883 PIN
1005  3901538.7990 -154513.0877  5026481.5820 PIN
1006  3901253.9619 -154940.7577  5026709.0788 PIN38

```

The third block lists the baselines of the project. Each baseline covers a block of 4 lines: The first line contains the point name of the reference station. The second line gives the name of the rover station, the baseline components dX, dY and dZ in meters, the start date and time in GPS-time and the antenna height at the reference station in meter. The third line contains the standard mean errors sx, sy and sz in meter, the end date and time in GPS-time and the antenna height at the rover station in meter. The last line of each baseline block contains the Covariances cov xy, cov xz and cov yz, and the ratio value.

```

      L i s t   o f   a l l   B a s e l i n e s

Reference Station
Rover Station      Baseline components DX, DY and DZ      Start (Date/Time)      Ref-H
                   Standard mean error sx, sy and sz      End   (Date/Time)      Rov-H
                   Covariances COVxy COVxz and COVyz                                     Ratio

1002
1001      -249.1007      1175.3886      226.2653      96-10-03 13:46:40      1.798
                   0.0009      0.0004      0.0011      96-10-03 14:53:10      1.865
                   0.0000      0.0008      0.0001                                     40.296

1003
1001      -145.7059      6.0365      111.4179      96-10-03 14:29:10      1.740
                   0.0004      0.0002      0.0003      96-10-03 15:24:30      1.865
                   0.0000      0.0001      0.0000                                     218.615

```

16.3.12 The AKS Format

The script file is called `EAKS.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. It creates an output file with the default name `GGFILE.AKS`. This is one of several export formats used by German public organizations.

Each line of the file starts with the characters `AKS0` (character 1..4). Characters 5..18 contain a 14-character point name. The characters 19.. 46 stay empty for further use. Character 47 gives the zone information, characters 48.. 56 the Easting, characters 57..66 the northing

as German Gauß-Krüger Rechtswert/Hochwert coordinates. Easting and Northing are each given in mm.

AKS041784560034678

44732221233856792197

16.3.13 The Kafka WGS-84 and Geographic Export Formats

The script files are called `EKAFAW.M` and `EKAFAKAG.M` and are located in the subdirectory `\FORMATS` of the **GeoGenius** root directory.

`EKAFAW.M` exports all points of a project as WGS-84 Cartesian Geocentric Coordinates in a file with the default name `GGXYZ.KAF`.

```
"0160" 3895222.322 790277.548 4971941.742
"0200" 3894621.811 790748.543 4972362.328
"0370" 3894515.982 790052.805 4972564.995
"0530" 3894699.556 790403.180 4972360.829
"0900" 3895734.728 790226.870 4971529.188
"0950" 3895948.374 789885.835 4971459.056
```

`EKAFAKAG.M` exports all points of a project as and WGS-84 Geographical Coordinates in a file with the default name `GGGEO.KAF`.

```
"0160" 51.3255086750 11.2807389028 271.4877
"0200" 51.3316087413 11.2837543946 293.1876
"0370" 51.3326299418 11.2803246342 301.3975
"0530" 51.3315867543 11.2819174358 296.6688
"0900" 51.3234316672 11.2759525204 254.4476
"0950" 51.3229317633 11.2739979088 287.5974
```

The file structure is as follows:

First entry of a line is always the point number, followed by the values for X[m], Y[m], Z[m] or Latitude (DD.MMSSSSSS), Longitude (DD.MMSSSSSS), Ellips. Height [m], depending on the chosen ex-

port script. Please note that every value is separated by at least one blank.

These are two of several export formats used by German public organizations.

16.3.14 The Kreis Coesfeld Export Format

The script file is called `EKREISCF.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. The exported file is named by default `KREIS.VPD`. This is one of several formats used by German public organizations.

100160	4463235.494	5712798.601	223.937
100200	4463821.208	5713443.448	250.722
100370	4463162.690	5713763.773	253.795
100530	4463467.207	5713439.185	249.124
100900	4463079.296	5712157.804	206.878
100950	4462701.405	5712005.995	244.248

Each line starts with an identifier for the Point, always one character (character 1). Characters 2..6 contain the point number. The field between character 7..14 has intentionally been left blank. Character 15 gives the zone information, characters 16..25 the Easting, characters 27..37 the northing as German Gauß-Krüger Rechtswert/Hochwert coordinates. Character 26 and 38 are also blanks. If available character 39..45 show the height values – if there is no height information in the project, this field is left blank. All values are given in [m].

16.3.15 The TDS Coordinate File Format

The script file is called `ETDS.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. This export format generates a binary file with the default extension `*.TDS`. This is one of several formats used by German public organizations.

Every file begins with a 38 character header where:

Bytes 1-10 is the file name in ASCII

Bytes 11-30 are not used

Bytes 31-34 is the last Point ID [long integer]

Bytes 35-38 -1 [long integer]

The header is followed by the point coordinate records ,which are each 45 Bytes long:

Bytes 39-43 is the Point ID [long integer]

Bytes 44-51 is the northing of the point [double]

Bytes 52-59 is the easting of the point [double]

Bytes 60-67 is the elevation of the point [double]

Bytes 68-84 is the Point Name

16.3.16 The Waypoint File Format

The script file is called `EWAYPNT.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. It creates an output ASCII file with the default extension `W*.WPT`. This is one of several formats used by German public organizations.

```
0160, 51 32 54.57129148397712N, 11 28 6.5929781047320546E, 269.529,
0200, 51 33 15.572214967737068N, 11 28 36.750161695622268E, 296.298,
0370, 51 33 25.782963521124884N, 11 28 2.4504793691168913E, 299.366,
0530, 51 33 15.352075226446686N, 11 28 18.378186607627072E, 294.701,
0900, 51 32 33.801131439780647N, 11 27 58.729275087781048E, 252.485,
0950, 51 32 28.799751719860751N, 11 27 39.178751785335493E, 289.858,
```

The generated ASCII file consists of lines. Each line is split into 5 fields, separated by commas. There is no limitation on the number of lines. The general line structure is as follows:

<Site ID>,<Latitude>,<Longitude>,<Altitude>,<Attribute>

Note that here and below angle brackets are not part of the line, they are only used for syntax description.
Text below describes the individual fields.

<Site ID>	Consists of up to 4 letters.
<Latitude>	Latitude relative to WGS84 datum. Consists of 4 sub-fields. General field structure is <Latitude degree> <Latitude minute> <Latitude second><Latitude hemisphere> Please note that every sub-field is separated by spaces except between <Latitude second><Latitude hemisphere>.
<Latitude degree>	integer value. Range: 0..90
<Latitude minute>	integer value. Range: 0..59
<Latitude second>	real value. Range: 0..59.999...
<Latitude hemisphere>	N or S.
<Longitude>	Longitude relative to WGS84 datum. Consists of 4 sub-fields. General field structure is <Longitude degree> <Longitude minute> <Longitude second><Longitude hemisphere> Please note that every sub-field is separated by spaces except between <Longitude second><Longitude hemisphere>.

<Longitude degree> integer value. Range: 0..180
<Longitude minute> integer value. Range: 0..59
<Longitude second> real value. Range: 0..59.999...
<Longitude hemisphere> E or W.

<Altitude> Altitude in meters relative to WGS84 datum.

<Attribute> Always empty.

16.4 Export Formats for Kinematic Data

16.4.1 The *.POS Position File

The kinematic processor of **GeoGenius** allows you to create a position file with the name of the observation file and the extension *.POS. The script file is called EPOS.M and is located in the subdirectory \FORMATS of the **GeoGenius** root directory.

The position file has the following structure:

Time (sec)	Lat	Long	Height	sig_e	sig_n	sig_h	PDOP	# station
200480.000000	48.075298024	11.629373200	659.216	.030	.017	.042	2.5	5 ????????
200460.000000	48.075297987	11.629373272	659.217	.030	.017	.042	2.5	5 ????????
200440.000000	48.075298015	11.629373333	659.211	.029	.017	.043	2.4	5 ????????
200420.000000	48.075297975	11.629373316	659.213	.029	.017	.043	2.4	5 ????????
200400.000000	48.075298086	11.629373164	659.185	.029	.017	.042	5.7	4 ????????
200380.000000	48.075298029	11.629373173	659.185	.029	.017	.043	5.7	4 ????????
200360.000000	48.075298016	11.629373184	659.195	.029	.017	.043	2.4	5 ????????
200340.000000	48.075298001	11.629373115	659.175	.029	.016	.043	2.4	5 ????????
200320.000000	48.075298042	11.629373118	659.161	.029	.016	.043	2.4	5 ????????
200300.000000	48.075297985	11.629373147	659.181	.028	.016	.043	5.7	4 ????????
200280.000000	48.075298043	11.629373054	659.149	.028	.016	.043	5.7	4 ????????
200260.000000	48.075298013	11.629373077	659.158	.028	.016	.043	5.0	4 ????????
200240.000000	48.075297966	11.629372997	659.158	.028	.016	.043	5.7	4 ????????
200220.000000	48.075298009	11.629372971	659.141	.028	.016	.043	5.6	4 ????????
200200.000000	48.075297980	11.629372959	659.140	.028	.016	.043	2.4	5 ????????
200180.000000	48.075298009	11.629372925	659.126	.027	.013	.037	2.4	5 ????????
200160.000000	48.075297897	11.629372931	659.132	.166	.034	.131	23.8	4 ????????
200140.000000	48.075298156	11.629372855	659.158	.156	.032	.124	22.3	4 ????????

The time is given in seconds of the GPS week, the geographic latitude and longitude are given in decimal degrees and the ellipsoidal height is given in meters. Please note that the positions refer to the selected System. The uncertainties for north (SIG_N), east (SIG_E) and height (SIG_H) are given in meters. Immediately to the right of the PDOP each column contains the number of satellites used to determine the position and the point number. The point number (Station) is of importance for Stop&Go positioning and for static initiali-

zation periods. For kinematic periods (between points) the point number is ????????. If the number of satellites is negative this indicates that a cycle slip and loss of lock occurred. The first two lines of the position file provide information on the selected datum and projection.

16.4.2 National Grid Coordinate *.NGC File

When you have chosen a System, processed kinematic data and opened the trajectory's Property notebook to export position data, **GeoGenius** creates a local grid coordinate file with the extension *.NGC in addition to the ellipsoidal coordinate file *.POS. This file also gives a coordinate for each epoch. The script file is called ENGCM and is located in the subdirectory \FORMATS of the **GeoGenius** root directory.

The first column corresponds to the time in seconds of GPS week. The second to fourth column correspond to the North, East, Height component of the given local coordinate system. Please note that the WGS84 position of the reference station together with the given transformation and projection parameters is used to determine the local positions when processing in kinematic mode. Remaining columns are identical to the corresponding columns in the *.POS file.

The *.NGC file holds North, East and Height positions relative to the reference station.

```
# datum: UTM_WGS WGS_84 0.000 0.00000000 0.000 0.000 0.000 0.000 0.000 0.000 1.0000 0.0 0.0
#projection:local local T 18.0398855098093160 0.000000000000000000 59.4143507440817050 1.0000000 0.000 0.000

Time in seconds      Easting    Northing   Height    sig_n     sig_e     sig_h     PDOP     #    point
376513.999953        -0.227     -0.083     9.306     0.007     0.005     0.010     3.5      6    ???????
376514.249953        -0.225     -0.087     9.311     0.008     0.005     0.012     3.5      6    ???????
376514.499953        -0.234     -0.081     9.296     0.005     0.005     0.005     3.5      6    ???????
```

376514.749953	-0.223	-0.088	9.313	0.009	0.005	0.013	3.5	6	????????
376514.999953	-0.232	-0.078	9.295	0.007	0.005	0.010	3.5	6	????????
376515.249952	-0.236	-0.080	9.289	0.007	0.005	0.010	3.5	6	????????
376515.499952	-0.223	-0.083	9.306	0.007	0.005	0.010	3.5	6	????????
376515.749952	-0.243	-0.079	9.286	0.008	0.005	0.012	3.5	6	????????
376515.999952	-0.223	-0.085	9.311	0.010	0.006	0.014	3.5	6	????????

16.4.3 Marine Position File

The marine position file with the name of the observation file and the extension ***.COR** is very similar to the ***.POS** file (see section 16.4.1). The marine position file has the following structure:

Start	GPS-Time	Lat	Lat	Long	Long	ellH[m]	slat[']	slong[']	sh [']	#Sats	#Sats
	[hh:mm:ss.ss]	[°]	[']	[°]	[']						
1	15:20:51.00	51	41.173641	359	1.227855	640.750	0.00000	0.00123	9.9987	7	7

A leading 1 indicates the beginning of a new line. The GPS-time follows in hours, minutes, seconds and decimals of seconds. The geographical latitude and longitude are given in degrees, minutes and decimals of minutes. The ellipsoidal height is given in meters. The positions refer to the selected System. The uncertainties for the latitude and longitude are given in minutes and decimals; the standard deviation for the height is given in meters. At the end follows twice the number of observed satellites.

The script file is called **EHDW.M** and is located in the subdirectory **\FORMATS** of the **GeoGenius** root directory.

16.4.4 Ashtech C-File

The script file is called `ECFILE.M` and is located in the subdirectory `\FORMATS` of the **GeoGenius** root directory. The C-File is an ASCII file that contains a chronological listing of the time, site, number of satellites and PDOP for every position in the WGS-84 System.

The C-file has two sections: a header and a list of the positions and their coordinates, which follow the header.

The first line of the header includes the source program name and its version, the second line displays the date of processing and a Yes/No flag for differential correction (Y: processed, N: unprocessed).

```
Ashtech, Inc.  GPPS-2          Program:  GeoGenius      Version: 1.500
               Wed Jan 210 9:54:26 1998   Differentially Corrected: Y
```

The header is followed by a series of lines for each epoch. Each descriptor starts with a position identification string (????), the date and time, the number of visible satellites and the PDOP value. The position fields are latitude, longitude and height, where the horizontal positions are preceded by a direction identifier (N,S; E,W). The RMS value and a 0/1 flag follow. The standard deviations in east, north and height close the line.

SITE	MM/DD/YY	HH:MM:SS	RMS	SVs	PDOP	LATITUDE	LONGITUDE	HI
				FLAG	V_EAST	V_NORTH	V_UP	
????	03/05/94	23:00:26.499508	0.005	0	0.014	0.019	0.041	1626.0697
????	03/05/94	23:00:26.999508	0.005	0	0.014	0.019	0.041	1626.0691
????	03/05/94	23:00:27.499507	0.005	0	0.014	0.019	0.041	1626.0692
????	03/05/94	23:00:27.999507	0.005	0	0.014	0.019	0.041	1626.0712
????	03/05/94	23:00:28.499507	0.005	0	0.014	0.019	0.041	1626.0709
????	03/05/94	23:00:28.999507	0.005	0	0.014	0.019	0.041	1626.0698
????	03/05/94	23:00:29.499506	0.005	0	0.014	0.019	0.041	1626.0701

16.5 RINEX: The Receiver Independent Exchange Format Version 2

16.5.1 The Philosophy Of Rin ex

The first proposal for the "Receiver Independent Exchange Format" RINEX has been developed by the Astronomical Institute of the University of Bern for the easy exchange of the GPS data to be collected during the large European GPS campaign EUREF 89, which involved more than 60 GPS receivers of 4 different manufacturers.

Most geodetic processing software for GPS data use a well-defined set of observables:

- the carrier-phase measurement at one or both carriers (actually being a measurement on the beat frequency between the received carrier of the satellite signal and a receiver-generated reference frequency).
- the pseudorange (code) measurement, equivalent to the difference of the time of reception (expressed in the time frame of the receiver) and the time of transmission (expressed in the time frame of the satellite) of a distinct satellite signal.
- the observation time being the reading of the receiver clock at the instant of validity of the carrier-phase and/or the code measurements.

Usually the software assumes that the observation time is valid for both, the phase AND the code measurements AND for all satellites observed.

Consequently all these programs do not need most of the information that is usually stored by the receivers: They need phase, code, and time in the above mentioned definitions, and some station-related information like station name, antenna height, etc.

16.5.2 General Format Description

Currently the format consists of three ASCII file types:

1. Observation Data File
2. Navigation Message File
3. Meteorological Data File

Each file type consists of a header section and a data section. The header section contains global information for the entire file and is placed at the beginning of the file. The header section contains header labels in columns 61-80 for each line contained in the header section. These labels are mandatory and must appear exactly as given in these descriptions and examples.

The format has been optimized for minimum space requirements. The types of observation stored are indicated in the header. In computer systems allowing variable record lengths the observation records can then be kept as short as possible. The maximum record length is 80 bytes per record.

Each Observation File and each Meteorological Data File basically contain the data from one site and one session. RINEX Version 2 also

allows you to include observation data from more than one site subsequently occupied by a roving receiver in rapid static or kinematic applications.

The Navigation Message File from one receiver may be exchanged or a composite Navigation Message File created containing non-redundant information from several receivers in order to make the most complete file.

The format of the data records of the RINEX Version 1 Navigation Message file is identical to the former NGS exchange format.

The actual format descriptions and examples are given in the Tables at the end of this appendix.

16.5.3 Definition Of The Observables

GPS observables include three fundamental quantities that need to be defined: Time, phase and range.

16.5.3.1 Time

The time of the measurement is the receiver time of the received signals. It is identical for the phase and range measurements and is also identical for all satellites observed at that epoch. This is expressed in GPS time (not Universal Time).

16.5.3.2 Pseudo-Range

The pseudo-range (PR) is the distance from the receiver antenna to the satellite antenna including receiver and satellite clock offsets, $PR = \text{distance} + (\text{receiver clock offset} - \text{satellite clock offset}) * c$, so that the

pseudo-range reflects the actual behavior of the receiver and satellite clocks. The pseudo-range is stored in units of meters.

16.5.3.3 Phase

The phase is the carrier-phase measured in whole cycles at both L1 and L2. The half-cycles measured by squaring-type receivers must be converted to whole cycles and flagged by the wavelength factor in the header section.

The phase changes in the same sense as the range (negative doppler). The phase observations between epochs must be connected by including the integer number of cycles. The phase observations will not contain any systematic drifts from intentional offsets of the reference oscillators.

The observables are not corrected for external effects like atmospheric refraction, satellite clock offsets, etc.

If the receiver or the converter software adjusts the measurements using the real-time-derived receiver clock offsets $dT(r)$, the consistency of the 3 quantities phase / pseudo-range / epoch must be maintained, i.e. the receiver clock correction should be applied to all 3 observables:

$$\text{Time}(\text{corr}) = \text{Time}(r) - dT(r)$$

$$\text{PR}(\text{corr}) = \text{PR}(r) - dT(r) * c$$

$$\text{phase}(\text{corr}) = \text{phase}(r) - dT(r) * \text{freq}$$

16.5.3.4 Doppler

The sign of the doppler shift as additional observable is defined as usual: Positive for approaching satellites.

16.5.4 The Exchange Of Rine x Files

We recommend using the following naming convention for RINEX files:

```

ssssdddf.yyt      ssss:  4-character station name designator
                   ddd:   day of the year of first record
                   f:     file sequence number within day (also
                           known as session ID)
                   0:     file contains all the existing
                           data of the current day
                   yy:    year
                   t:     file type:
                           O: Observation File
                           N: Navigation file
                           M: Meteorological data file

```

16.5.5 Rinex Version 2 Features

The following section contains features that have been introduced for RINEX Version 2.

16.5.5.1 Satellite Numbers

Version 2 has been prepared to contain GLONASS or other satellite systems' observations. Therefore we have to be able to distinguish the satellites of the different systems: We precede the 2-digit satellite number with a system denominator.

```

snn              s:   satellite system
                   blank: system as defined in header record
                   G    : GPS
                   R    : GLONASS
                   T    : Transit
                   nn:  PRN (GPS), channel number (GLONASS)
                           or two-digit satellite number

```

Note: G, R, and T are mandatory in mixed files

16.5.5.2 *Order Of The Header Records*

Because the record descriptors in columns 61-80 are mandatory, the programs reading a RINEX Version 2 header are able to decode the header records with formats according to the record descriptor, provided the records have been first read into an internal buffer.

The header records can be freely ordered, with the following exceptions:

- The "RINEX VERSION / TYPE" record must be the first record in a file
- The default "WAVELENGTH FACT L1/2" record (if present) should precede all records defining wavelength factors for individual satellites
- The "# OF SATELLITES" record (if present) should be immediately followed by the corresponding number of "PRN / # OF OBS" records. (These records may be handy for documentary purposes. However, since they may only be created after having read the whole raw data file we define them to be optional.)

16.5.5.3 *Missing Items, Duration Of The Validity Of Values*

Items that are not known at the time of file creation can be set to zero, blank or completely omitted. Consequently items of missing header records will be set to zero or blank by the program reading RINEX files. Each value remains valid until changed by an additional header record.

16.5.5.4 *Event Flag Records*

The "number of satellites" also corresponds to the number of records of the same epoch. The event flag record may be used to skip the appropriate number of records if certain event flags are not to be evaluated in detail.

16.5.5.5 Receiver Clock Offset

The receiver clock offset (if present) reports the value that has been used to correct the observables according to the formulae under item 1. It is then possible to reconstruct the original observations if necessary. As the output format for the receiver-derived clock offset is limited to nanoseconds. The offset should be rounded to the nearest nanosecond before it is used to correct the observables in order to guarantee correct reconstruction.

16.5.6 Additional Hints And Tips

Programs developed to read RINEX Version 1 files have to verify the version number. Version 2 files may look different (version number, END OF HEADER record, receiver and antenna serial number alphanumeric) even if they do not use any of the new features.

Routines to read RINEX Version 2 files automatically delete leading blanks in any CHARACTER input field. Routines creating RINEX Version 2 files should also left-justify all variables in the CHARACTER fields.

DOS, and other files may have variable record lengths, so we recommend reading each observation record into a 80-character blank string and then decoding the data. In variable length records, empty data fields at the end of a record may be missing, especially in the case of the optional receiver clock offset.

16.5.7 Rinex Under Antispoofing (AS)

When AS is on some receivers generate code delay differences between the first and second frequency using cross-correlation techniques. These receivers recover the phase observations on L2 in full cycles. Using the C/A code delay on L1 and the observed difference it is possible to generate a code delay observation for the second frequency.

Other receivers recover P code observations by breaking down the Y code into P and W code.

Most of these observations may suffer from an increased noise level. In order to enable the postprocessing programs to account for this, these observations are flagged using bit number 2 of the Loss of Lock Indicators (i.e., their current values are increased by 4).

16.5.8 Rinex Version 2 Format Definitions And Examples

TABLE A1 OBSERVATION DATA FILE - HEADER SECTION DESCRIPTION			
HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT	
RINEX VERSION / TYPE	- Format version (2) - File type ('O' for Observation Data) - Satellite System: blank or 'G': GPS 'R': GLONASS 'T': NNSS Transit 'M': Mixed	I6,14X, A1,19X, A1,19X	
PGM / RUN BY / DATE	- Name of program creating current file - Name of agency creating current file - Date of file creation	A20, A20, A20	
* COMMENT	Comment line(s)	A60	*
MARKER NAME	Name of antenna marker	A60	
* MARKER NUMBER	Number of antenna marker	A20	*
OBSERVER / AGENCY	Name of observer / agency	A20,A40	
REC # / TYPE / VERS	Receiver number, type, and version (Version: e.g. Internal Software Version)	3A20	
ANT # / TYPE	Antenna number and type	2A20	
APPROX POSITION XYZ	Approximate marker position (WGS84)	3F14.4	
ANTENNA: DELTA H/E/N	- Antenna height: Height of bottom surface of antenna above marker - Eccentricities of antenna center relative to marker to the east and north (all units in meters)	3F14.4	
WAVELENGTH FACT L1/2	- Wavelength factors for L1 and L2 1: Full cycle ambiguities 2: Half cycle ambiguities (squaring) 0 (in L2): Single frequency instrument - Number of satellites to follow in list 0: Default wavelength factors. Max 7. If more than 7 satellites: Repeat record. - List of PRNs (satellite numbers)	2I6, I6, 7(3X,A1,I2)	
# / TYPES OF OBSERV	- Number of different observation types stored in the file - Observation types	I6, 9(4X,A2)	

	The following observation types are defined in RINEX Version 2: L1, L2: Phase measurements on L1 and L2 C1 : Pseudorange using C/A-Code on L1 P1, P2: Pseudorange using P-Code on L1,L2 D1, D2: Doppler frequency on L1 and L2 T1, T2: Transit Integrated Doppler on 150 (T1) and 400 MHz (T2) Observations collected under Antispoofing are converted to "L2" or "P2" and flagged with bit 2 of loss of lock indicator (see Table A2). Units : Phase : full cycles Pseudorange : meters Doppler : Hz Transit : cycles The sequence of the types in this record has to correspond to the sequence of the observations in the observation records	
* INTERVAL	Observation interval in seconds	I6
TIME OF FIRST OBS	Time of first observation record year (4 digits), month,day,hour,min,sec	5I6,F12.6
* TIME OF LAST OBS	Time of last observation record year (4 digits), month,day,hour,min,sec	5I6,F12.6
* # OF SATELLITES	Number of satellites, for which observations are stored in the file	I6
* PRN / # OF OBS	PRN (sat.number), number of observations for each observation type indicated in the "# / TYPES OF OBSERV" - record. This record is repeated for each satellite present in the data file	3X,A1,I2,9I6
END OF HEADER	Last record in the header section.	60X

Records marked with * are optional

TABLE A2 OBSERVATION DATA FILE - DATA RECORD DESCRIPTION		
OBS. RECORD	DESCRIPTION	FORMAT
EPOCH/SAT or EVENT FLAG	- Epoch : year (2 digits), month,day,hour,min,sec - Epoch flag 0: OK 1: power failure between previous and current epoch >1: Event flag - Number of satellites in current epoch - List of PRNs (sat.numbers) in current epoch If more than 12 satellites: Continued in next line with n(A1,I2) - receiver clock offset (seconds, optional) If EVENT FLAG record (epoch flag > 1): - Event flag: 2: start moving antenna 3: new site occupation (end of kinem. data) (at least MARKER NAME record follows) 4: header information follows 5: external event (epoch is significant) 6: cycle slip records follow to optionally report detected and repaired cycle slips (same format as OBSERVATIONS records; slip instead of observation; LLI and signal strength blank) - "Number of satellites" contains number of records to follow (0 for event flags 2,5)	5I3,F11.7, I3, I3, 12(A1,I2), F12.9
OBSERVATIONS	- Observation rep. within record for - LLI each obs.type (same seq - Signal strength as given in header) This record is repeated for each satellite given in EPOCH/SAT - record. If more than 5 observation types (=80 char): Continue observations in next record. Observations: Phase : Units in whole cycles of carrier Code : Units in meters Missing observations are written as 0.0 or blanks. Loss of lock indicator (LLI). Range: 0-7 0 or blank: OK or not known Bit 0 set : lost lock between previous and current observation: cycle slip possible Bit 1 set : Inverse wavelength factor to default (does NOT change default) Bit 2 set : observation under Antispoofing (may suffer from increased noise) Bits 0 and 1 for phase only. Signal strength projected into interval 1-9: 1: minimum possible signal strength	m(F14.3, I1, I1)

	5: threshold for good S/N ratio	
	9: maximum possible signal strength	
	0 or blank: not known, don't care	
+	+	+

TABLE A3 NAVIGATION MESSAGE FILE - HEADER SECTION DESCRIPTION			
HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT	
RINEX VERSION / TYPE	- Format version (2) - File type ('N' for Navigation data)	I6,14X, A1,19X	
PGM / RUN BY / DATE	- Name of program creating current file - Name of agency creating current file - Date of file creation	A20, A20, A20	
* COMMENT	Comment line(s)	A60	*
* ION ALPHA	Ionosphere parameters A0-A3 of almanac (page 18 of subframe 4)	2X,4D12.4	*
* ION BETA	Ionosphere parameters B0-B3 of almanac	2X,4D12.4	*
* DELTA-UTC: A0,A1,T,W	Almanac parameters to compute time in UTC (page 18 of subframe 4) A0,A1: terms of polynomial T : reference time for UTC data W : UTC reference week number	3X,2D19.12, 2I9	*
* LEAP SECONDS	Delta time due to leap seconds	I6	*
END OF HEADER	Last record in the header section.	60X	

Records marked with * are optional

TABLE A4 NAVIGATION MESSAGE FILE - DATA RECORD DESCRIPTION		
OBS. RECORD	DESCRIPTION	FORMAT
PRN / EPOCH / SV CLK	- Satellite PRN number - Epoch: Toc - Time of Clock year (2 digits) month day hour minute second - SV clock bias (seconds) - SV clock drift (sec/sec) - SV clock drift rate (sec/sec2)	I2, 5I3, F5.1, 3D19.12
BROADCAST ORBIT - 1	- IODE Issue of Data, Ephemeris (meters) - Crs (radians/sec) - Delta n (radians) - M0	3X, 4D19.12
BROADCAST ORBIT - 2	- Cuc (radians) - e Eccentricity - Cus (radians) - sqrt(A) (sqrt(m))	3X, 4D19.12
BROADCAST ORBIT - 3	- Toe Time of Ephemeris (sec of GPS week) - Cic (radians) - OMEGA (radians) - CIS (radians)	3X, 4D19.12
BROADCAST ORBIT - 4	- i0 (radians) - Crc (meters) - omega (radians) - OMEGA DOT (radians/sec)	3X, 4D19.12
BROADCAST ORBIT - 5	- IDOT (radians/sec) - Codes on L2 channel - GPS Week # (to go with TOE) - L2 P data flag	3X, 4D19.12
BROADCAST ORBIT - 6	- SV accuracy (meters) - SV health (MSB only) - TGD (seconds) - IODC Issue of Data, Clock	3X, 4D19.12
BROADCAST ORBIT - 7	- Transmission time of message (sec of GPS week, derived e.g. from Z-count in Hand Over Word (HOW)) - spare - spare - spare	3X, 4D19.12

TABLE A5 METEOROLOGICAL DATA FILE - HEADER SECTION DESCRIPTION		
HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT
RINEX VERSION / TYPE	- Format version (2) - File type ('M' for Meteorological Data)	I6,14X, A1,39X
PGM / RUN BY / DATE	- Name of program creating current file - Name of agency creating current file - Date of file creation	A20, A20, A20
* COMMENT	Comment line(s)	A60 *
MARKER NAME	Station Name (preferably identical to MARKER NAME in the associated Observation File)	A60
* MARKER NUMBER	Station Number (preferably identical to MARKER NUMBER in the associated Observation File)	A20 *
# / TYPES OF OBSERV	- Number of different observation types stored in the file - Observation types The following meteorological observation types are defined in RINEX Version 2: PR : Pressure (mbar) TD : Dry temperature (deg Celsius) HR : Relative Humidity (percent) ZW : Wet zenith path delay (millimeters) (for WVR data) The sequence of the types in this record must correspond to the sequence of the measurements in the data records	I6, 9(4X,A2)
END OF HEADER	Last record in the header section.	60X

TABLE A6 METEOROLOGICAL DATA FILE - DATA RECORD DESCRIPTION		
OBS. RECORD	DESCRIPTION	FORMAT
EPOCH / MET	- Epoch in GPS time (not local time!) year (2 digits), month,day,hour,min,sec - Met data in the same sequence as given in the header	6I3, mF7.1


```

+-----+
|                                     |
|               TABLE A7            |
|          OBSERVATION DATA FILE - EXAMPLE          |
|-----+-----+
|
|-----|-----1|0---|-----2|0---|-----3|0---|-----4|0---|-----5|0---|-----6|0---|-----7|0---|-----8|
|
|      2      OBSERVATION DATA      M (MIXED)      RINEX VERSION / TYPE
|BLANK OR G = GPS,  R = GLONASS,  T = TRANSIT,  M = MIXED      COMMENT
|XXRINEXO V9.9      AIUB      22-APR-93 12:43      PGM / RUN BY / DATE
|EXAMPLE OF A MIXED RINEX FILE      COMMENT
|A 9080      MARKER NAME
|9080.1.34      MARKER NUMBER
|BILL SMITH      ABC INSTITUTE      OBSERVER / AGENCY
|X1234A123      XX      ZZZ      REC # / TYPE / VERS
|234      YY      ANT # / TYPE
|4375274.      587466.      4589095.      APPROX POSITION XYZ
|      .9030      .0000      .0000      ANTENNA: DELTA H/E/N
|      1      1      WAVELENGTH FACT L1/2
|      1      2      6      G14      G15      G16      G17      G18      G19      WAVELENGTH FACT L1/2
|      4      P1      L1      L2      P2      # / TYPES OF OBSERV
|      18      INTERVAL
|1990      3      24      13      10      36.000000      TIME OF FIRST OBS
|                                     END OF HEADER
|
|90  3 24 13 10 36.0000000 0 3G12G 9G 6      - .123456789
|23629347.915      .300 8      -.353      23629364.158
|20891534.648      -.120 9      -.358      20891541.292
|20607600.189      -.430 9      .394      20607605.848
|90  3 24 13 10 50.0000000 4 3
|      1      2      2      G 9      G12      WAVELENGTH FACT L1/2
|*** WAVELENGTH FACTOR CHANGED FOR 2 SATELLITES ***      COMMENT
|
|90  3 24 13 10 54.0000000 0 5G12G 9G 6R21R22      - .123456789
|23619095.450      -53875.632 8      -41981.375      23619112.008
|20886075.667      -28688.027 9      -22354.535      20886082.101
|20611072.689      18247.789 9      14219.770      20611078.410
|21345678.576      12345.567 5
|22123456.789      23456.789 5
|90  3 24 13 11 0.0000000 2
|      4      1
|*** FROM NOW ON KINEMATIC DATA! ***      COMMENT
|90  3 24 13 11 48.0000000 0 4G16G12G 9G 6      - .123456789
|21110991.756      16119.980 7      12560.510      21110998.441
|23588424.398      -215050.557 6      -167571.734      23588439.570
|20869878.790      -113803.187 8      -88677.926      20869884.938
|20621643.727      73797.462 7      57505.177      20621649.276
|      3      4
|
|A 9080      MARKER NAME
|9080.1.34      MARKER NUMBER
|      .9030      .0000      .0000      ANTENNA: DELTA H/E/N
|--> THIS IS THE START OF A NEW SITE <--      COMMENT
|90  3 24 13 12 6.0000000 0 4G16G12G 6G 9      - .123456987
|21112589.384      24515.877 6      19102.763 3      21112596.187
|23578228.338      -268624.234 7      -209317.284 4      23578244.398
|20625218.088      92581.207 7      72141.846 4      20625223.795
|20864539.693      -141858.836 8      -110539.435 5      20864545.943
|90  3 24 13 13 1.2345678 5 0
|      4      1
|(AN EVENT FLAG WITH SIGNIFICANT EPOCH)      COMMENT
|90  3 24 13 14 12.0000000 0 4G16G12G 9G 6      - .123456012

```

```
21124965.133      89551.30216      69779.62654 21124972.2754
23507272.372     -212616.150 7     -165674.789 5 23507288.421
20828010.354     -333820.093 6     -260119.395 5 20828017.129
20650944.902     227775.130 7     177487.651 4 20650950.363
                4 2
*** ANTISPOOFING ON G 16 AND LOST LOCK COMMENT
90 3 24 13 14 12.0000000 6 2616G 9
                123456789.0      -9876543.5
                0.0      -0.5
                4 2
---> CYCLE SLIPS THAT HAVE BEEN APPLIED TO COMMENT
      THE OBSERVATIONS COMMENT
90 3 24 13 14 48.0000000 0 4G16G12G 9G 6 - .123456234
21128884.159     110143.144 7     85825.18545 21128890.7764
23487131.045     -318463.297 7     -248152.728 4 23487146.149
20817844.743     -387242.571 6     -301747.22925 20817851.322
20658519.895     267583.67817     208507.26234 20658525.869
                4 3
*** SATELLITE G 9 THIS EPOCH ON WLFACT 1 (L2) COMMENT
*** G 6 LOST LOCK AND ON WLFACT 2 (L2) COMMENT
      (INVERSE TO PREVIOUS SETTINGS) COMMENT
----|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|
```

```

+-----+
|                                     |
|               TABLE A8            |
|      NAVIGATION MESSAGE FILE - EXAMPLE      |
|-----+-----+
|
|---|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|
|
|      2              N: GPS NAV DATA              RINEX VERSION / TYPE
|XXRINEXN V2.0      AIUB              12-SEP-90 15:22      PGM / RUN BY / DATE
|EXAMPLE OF VERSION 2 FORMAT                                COMMENT
|.1676D-07 .2235D-07 -.1192D-06 -.1192D-06      ION ALPHA
|.1208D+06 .1310D+06 -.1310D+06 -.1966D+06      ION BETA
|.133179128170D-06 .107469588780D-12 552960      39 DELTA-UTC: A0,A1,T,W
|6                                                    LEAP SECONDS
|                                                    END OF HEADER
|
| 6 90 8 2 17 51 44.0 -.839701388031D-03 -.165982783074D-10 .00000000000D+00
|      .91000000000D+02 .93406250000D+02 .116040547840D-08 .162092304801D+00
|      .484101474285D-05 .626740418375D-02 .652112066746D-05 .515365489006D+04
|      .40990400000D+06 -.242143869400D-07 .329237003460D+00 -.596046447754D-07
|      .111541663136D+01 .32659375000D+03 .206958726335D+01 -.638312302555D-08
|      .307155651409D-09 .00000000000D+00 .55100000000D+03 .00000000000D+00
|      .00000000000D+00 .00000000000D+00 .00000000000D+00 .91000000000D+02
|      .40680000000D+06
|
| 13 90 8 2 18 59 60.0 .490025617182D-03 .204636307899D-11 .00000000000D+00
|      .13300000000D+03 -.96312500000D+02 .146970407622D-08 .292961152146D+01
|      -.498816370964D-05 .200239347760D-02 .928156077862D-05 .515328476143D+04
|      .41400000000D+06 -.279396772385D-07 .243031939942D+01 -.558793544769D-07
|      .110192796930D+01 .27118750000D+03 -.232757915425D+01 -.619632953057D-08
|      -.785747015231D-11 .00000000000D+00 .55100000000D+03 .00000000000D+00
|      .00000000000D+00 .00000000000D+00 .00000000000D+00 .38900000000D+03
|      .41040000000D+06
|
|---|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|
|
+-----+
|                                     |
|               TABLE A9            |
|      METEOROLOGICAL DATA FILE - EXAMPLE      |
|-----+-----+
|
|---|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|
|
|      2              METEOROLOGICAL DATA              RINEX VERSION / TYPE
|XXRINEXM V9.9      AIUB              22-APR-93 12:43      PGM / RUN BY / DATE
|EXAMPLE OF A MET DATA FILE                                COMMENT
|A 9080                                                    MARKER NAME
|      3      PR      TD      HR                        # / TYPES OF OBSERV
|                                                    END OF HEADER
|
| 90 3 24 13 10 15 987.1 10.6 89.5
| 90 3 24 13 10 30 987.2 10.9 90.0
| 90 3 24 13 10 45 987.1 11.6 89.0
|
|---|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|

```

16.6 Rinex Navigation File for GLONASS Ephemeris

GeoGenius creates Rinex Navigation Files for saving of GLONASS Ephemeris. **GeoGenius** uses the record "LEAP SECONDS" to output the number of leap seconds between GPS time and the time used by GLONASS.

RINEX Observation Files

Included modifications:

Use "GLO" instead of "UTC" to denote the Glonass time frame in observation files. Text changed accordingly. (Nov-94)

Explicitly specify ephemeris epoch to be in Glonass time frame (Glonass navigation message file)

Allow for leap second line in Glonass navigation message file (Jan 97)

The RINEX Version 2 observation files have been defined in view of a possible inclusion of Glonass pseudorange and phase observations. Glonass observables are very similar to the GPS ones: There are also phase observations L1,L2 on the two carriers as well as a C/A code (C1) and two P-code (P1,P2) pseudoranges.

RINEX Version 2 needs one supplement, the explicit definition of the time system:

Glonass is basically running on UTC (or, more precisely, Glonass system time linked to UTC(SU)), i.e. the time tags are given in UTC and not GPS time. In order to remove possible misunderstandings and ambiguities the header records "TIME OF FIRST OBS" and (if present) "TIME OF LAST OBS" in Glonass and GPS observation files CAN, in mixed Glonass/GPS observation files MUST contain a time system denominator defining the system that all time tags in the file are referring to (pure GPS files default to GPS and pure Glonass files default to GLOnass time system):

Example:

1994	3	24	0	0	0.000000	GPS	TIME OF FIRST OBS
1994	3	24	23	59	30.000000	GPS	TIME OF LAST OBS

or

1994	3	23	23	59	51.000000	GLO	TIME OF FIRST OBS
1994	3	24	23	59	51.000000	GLO	TIME OF LAST OBS

Format:

TIME OF FIRST OBS	- Time of first observation record (4-digit-year, month, day, hour, min, sec) - Time system: GPS or GLO compulsory in mixed GPS/Glonass files Defaults: GPS for pure GPS files GLO for pure Glonass files	5I6, F12.6, 6X, A3
* TIME OF LAST OBS	- Time of last observation record (4-digit-year, month, day, hour, min, sec) - Time system (GPS or GLO) compulsory in mixed GPS/Glonass files Defaults: GPS for pure GPS files GLO for pure Glonass files	5I6, F12.6, 6X, A3

(Modification of Table A1 in the RINEX document)

RINEX navigation files for Glonass

As the Glonass navigation message differs in contents from the GPS message too much, we have to define a special Glonass navigation message file.

The header section and the first data record (epoch, satellite clock information) is similar to the GPS navigation file. The following records contain the satellite position, velocity and acceleration as well as auxiliary information as health, satellite frequency (channel) and the information if the message has been derived from C/A or P code frames.

We recommend using the following naming convention for the Glonass navigation message files:

```

ssssdddf.yyt      ssss:  4-character station or center name
                    designator
                    ddd:  day of the year of first record
                    f:    file sequence number within day
                        0: file contains all the collected
                           messages of the current day
                    yy:   year
                    t:    file type:
                        G: Glonass navigation message file

```

TABLE A10 GLONASS NAVIGATION MESSAGE FILE - HEADER SECTION DESCRIPTION		
HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT
RINEX VERSION / TYPE	- Format version (1) - File type ('G' = Glonass nav mess data)	I6, 14X, A1, 39X
PGM / RUN BY / DATE	- Name of program creating current file - Name of agency creating current file - Date of file creation	A20, A20, A20
* COMMENT	Comment line(s)	A60

* CORR TO SYSTEM TIME	Time of reference for system time corr (year, month, day) correction to system time scale (sec)	3I6, 3X,D19.12	*
* LEAP SECONDS	Number of leap seconds since 6-Jan-1980	I6	*
END OF HEADER	Last record in the header section.	60X	

Records marked with * are optional

TABLE A11 GLONASS NAVIGATION MESSAGE FILE - DATA RECORD DESCRIPTION		
OBS. RECORD	DESCRIPTION	FORMAT
PRN / EPOCH / SV CLK	- Satellite almanac number - Epoch: Toc - Time of Clock (Glonass year (2 digits) System Time) month day hour minute second - SV clock bias (sec) (tau) - SV relative frequency bias (gamma) - message frame time (sec of day) (tk)	I2, 5I3, F5.1, D19.12 D19.12 D19.12
BROADCAST ORBIT - 1	- Satellite position X (km) - velocity X dot (km/sec) - X acceleration (km/sec2) - health (0=OK) (Bn)	3X,4D19.12
BROADCAST ORBIT - 2	- Satellite position Y (km) - velocity Y dot (km/sec) - Y acceleration (km/sec2) - frequency number (1-24)	3X,4D19.12
BROADCAST ORBIT - 3	- Satellite position Z (km) - velocity Z dot (km/sec) - Z acceleration (km/sec2) - Age of oper. Information (days) (E)	3X,4D19.12

```
+-----+
|                                     |
|               TABLE A12          |
|      GLONASS NAVIGATION MESSAGE FILE - EXAMPLE      |
|-----+
---|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|

      1          GLONASS NAVMESS DATA          RINEX VERSION / TYPE
3SRINEXN V1.3 VAX  University of Berne 30-AUG-93 17:57  PGM / RUN BY / DATE
Test of 3S Rinex Navigation File Creation          COMMENT
1993      8      7      -0.141188502312D-04          CORR TO SYSTEM TIME
                                END OF HEADER

1 93  8  7 15 15  0.0-0.161942094564D-03 0.181898940355D-11 0.542700000000D+05
    0.129469794922D+05-0.130014419556D+01 0.186264514923D-08 0.000000000000D+00
    -0.380712744141D+04 0.266516971588D+01 0.000000000000D+00 0.170000000000D+02
    0.216525634766D+05 0.124328994751D+01-0.186264514923D-08 0.000000000000D+00
17 93  8  7 15 15  0.0 0.717733055353D-04 0.272848410532D-11 0.542700000000D+05
    0.305286718750D+04 0.311648464203D+01 0.000000000000D+00 0.000000000000D+00
    -0.108431787109D+05-0.317855834961D+00 0.000000000000D+00 0.210000000000D+00
    0.229024404297D+05-0.575817108154D+00-0.186264514923D-08 0.000000000000D+00
7 93  8  7 15 15  0.0-0.902833417058D-04 0.181898940355D-11 0.542700000000D+05
    -0.548300732422D+04-0.442504882813D+00-0.931322574615D-09 0.000000000000D+00
    0.227251596680D+05 0.131087875366D+01-0.931322574615D-09 0.130000000000D+00
    0.998504833984D+04-0.323978710175D+01-0.931322574615D-09 0.000000000000D+00
2 93  8  7 15 15  0.0-0.975374132395D-04 0.181898940355D-11 0.542700000000D+05
    0.138356103516D+05-0.716581344604D+00 0.279396772385D-08 0.000000000000D+00
    -0.190140761719D+05 0.116566944122D+01 0.000000000000D+00 0.500000000000D+01
    0.991978125000D+04 0.322995281219D+01 0.000000000000D+00 0.000000000000D+00
8 93  8  7 15 15  0.0-0.292631797493D-03 0.363797880709D-11 0.542700000000D+05
    0.419437841797D+04-0.111876964569D+01 0.000000000000D+00 0.000000000000D+00
    0.141901040039D+05 0.262095737457D+01-0.931322574615D-09 0.200000000000D+01
    0.207799843750D+05-0.155530166626D+01-0.186264514923D-08 0.000000000000D+01
24 93  8  7 15 15  0.0 0.176711939275D-03 0.109139364213D-10 0.544500000000D+05
    0.204199819336D+05 0.176556110382D+01 0.279396772385D-08 0.000000000000D+00
    -0.796999316406D+04-0.311827659607D+00 0.000000000000D+00 0.100000000000D+01
    0.130460561523D+05-0.295512390137D+01-0.931322574615D-09 0.000000000000D+00

---|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|
```


16-837

17. Macro Programming

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17.1 Introduction

The **GeoGenius** Macro Programming is based on **TIM**, the Interpreter for Macros. The document presented here briefly describes all available functions, commands and macros that are specific for **GeoGenius**. For a complete reference on **TIM** programming, please refer to the ***TIM Programmers Guide***, which is available as a separate document.

17.1.1 How to Run a Script on GeoGenius

Use the file selector in File/Run/Script to start a new script or run the latest script again with File/Run/Again. Scripts normally have the extension *. M.

You have access to these both functions via two buttons on the toolbar Options as well.

17.2 Commands Description

17.2.1 *edit* - Start an Editor

Syntax:

```
edit fname
```

Synopsis:

This command calls an editor and passes the filename `fname` to it. The system editor is used, which may be specified in the Options/Customize/Tools Page.

17.2.2 print - *Generate Text Lines*

Syntax:

```
print  arg1 arg2 ... argn
```

Synopsis:

This command concatenates the arguments and sends the result to the output window of **GeoGenius** .

17.2.3 progress - Show Progress of Operations

Syntax:

```
progress msg val  
progress end
```

Synopsis:

This command generates a progress bar window. The text in the window is defined `msg`. The progress bar's state is defined by `val`. `val` is in the range of 0.0 - 1.0.

The second version of the command closes any visible progress window and should be called whenever progress was activated.

Returns:

Nothing

17.2.4 sleep - Have a Pause

Syntax:

`sleep msec`

Synopsis:

This command just halts execution for msec milliseconds. Since **GeoGenius** operates as a multitasking system, it can be necessary to put the current thread to sleep in order to allow another thread to finalize properly.

17.2.5 statusline - Output Status Text

Syntax:

```
statusline arg1 arg2 ... argn
```

Synopsis:

This command concatenates the arguments and sends the output to the output window of **GeoGenius**. This command generates an error message (which is by default RED).

Returns:

The concatenated arguments

Example:

```
statusline arg1 arg2 arg3 xy
```

This sequence would print the string:

```
arg1 arg2 arg3 xy
```

See also:

```
print
```

17.3 File Commands

GeoGenius' file commands always operate on a *current file*. The file name is used only in the `fopen` command, which also defines the current file. It is nevertheless possible to have several files opened simultaneously. To switch the current file, please use the `fuse` command.

17.3.1 fcd - Change Current Directory

Syntax:

`fcd dirname`

Synopsis:

This command changes the current directory to `dirname`.
The directory must exist, else the command will fail.

Returns:

0 if successful, else -1

See also:

`fmd`

17.3.2 *fclose* - Close Current File

Syntax:

`fclose`

Synopsis:

This command closes the current file, which must be open.

Returns:

Nothing. An error message is posted in case of error.

See also:

`fopen`

17.3.3 *fcloseall* - Close All Files

Syntax:

`fcloseall`

Synopsis:

This command closes all currently opened files at once.

Returns:

nothing

See also:

`fclose`, `fopen`

17.3.4 filecopy - Copy Files

Syntax:

`filecopy dir mask`

Synopsis:

This command copies all files in directory `dir` that correspond to `mask` to the current directory.

Returns:

The number of files copied.

See also:

`fmd`, `fcd`, `fopen`

17.3.5 *fdel* - Delete File

Syntax:

`fdel mask`

Synopsis:

This command deletes the files specified with `mask`.

Returns:

The number of files deleted.

See also:

`fmd`

17.3.6 fdialog - Open a File Selector

Syntax:

```
fdialog fname [-load] [-save] [-defext mask] [-filter mask]
```

Synopsis:

Opens a file dialog, specifying `fname` as its default file name. Whenever you press **OK**, this dialog returns the newly selected file name. Specifying `-load` or `-save` creates different buttons on the dialog. A default extension may be specified with help of the `-defext` switch and a default filter may be specified with the `-filter` switch.

Example:

```
fdialog locsys -save -defext *.LCS -filter \  
"LCS Files (*.LCS)|*.LCS|All Files (*.*)|*.*||"
```

Returns:

The selected file name, if **OK** was pressed. It returns a '?', when **Cancel** was pressed.

See also:

The export scripts of **GeoGenius**.

17.3.7 ffirst - Find First File

Syntax

`ffirst mask`

Synopsis:

This command returns the first file matching mask.

Returns:

first file matching mask.

Example:

```
print [ffirst *.cpp]
```

See also:

`fnext`

17.3.8 fmd - Make Directory

Syntax:

```
fmd dirname
```

Synopsis:

This command creates the directory to `dirname`.
If the directory already exists, the command will fail.

Returns:

0 if successful, else -1

Example:

```
# This example generates the directory c:\\gg\\tmp  
fcd c:\\  
fmd c:\\gg  
fmd c:\\gg\\tmp  
fcd c:\\gg\\tmp
```

See also:

`fcd`

17.3.9 *fnext* - Find Next File

Syntax:

```
fnext mask
```

Synopsis:

This command returns the next file matching the mask, that was specified by the `ffirst` command.

Returns:

The next file matching the mask that was specified by the `ffirst` command. It returns a '?' if no more files could be found.

Example:

```
# list all files with extension *.txt
print [ffirst *.txt]
set next [fnext]
while { [string compare $next ?] } {
    print $next
    set next [fnext]
}
```

See also:

```
ffirst
```

17.3.10 fopen - Open a File

Syntax:

```
fopen fhandle fname fmode
```

Synopsis:

This command opens a file with name `fname` and mode `fmode`, whereas `fmode` is a typical C construct like "at" or "wb". `fhandle` is a file variable. Please use a normal variable here like `f1`, `output` or `tmpfile`.

Since the backslash is a special character in **TIM** programming you have to make sure that path names containing backslashes are always written using double backslashes.

Returns:

```
statusline arg1 arg2 arg3 xy
```

Example:

```
# open file filename.txt for writing, mode append
fopen file1 filename.txt at
```

```
# open file terra.dat for reading, binary
fopen file2 terra.dat rb
```

```
# open file \tmp\temp.tmp for reading, writing, binary
fopen file3 \\tmp\\temp.tmp rb+
```

See also:

C/C++ library reference, fuse

17.3.11 *fput, sput* - Put Text Into a File or a String

Syntax:

```
fput format args  
sput str format args
```

Synopsis:

These commands allow you to print something into a file or a string. `format` is a C format string in both cases. The `fput` variant directly puts the result into the current file, the `sput` variant places the result into the variable specified as `str`.

Example:

```
fput "result %d is %.3f" 0 3.141516  
set I 31  
sput variable "satellite %d" $I
```

17.3.12 fread - Read Binary Data

Syntax:

```
fread 16 [count]
fread 32 [count]
fread d [count]
fread f [count]
fread c [count]
fread s count
fread z
```

Synopsis:

This command allows reading binary data from a file. Depending on the first parameter of this command, the return value is set differently.

The type specifiers have the following meaning:

16	-	16 bit integer
32	-	32 bit integer
d	-	8 byte double
f	-	4 byte float
c	-	1 byte character
s	-	string with length n
z	-	zero terminated string (every TIM string)

Returns:

fread returns a string representation of the data read.

See also:

fput, sput, fopen

17.3.13 fremove - Remove a File

Syntax:

```
fremove fname
```

Synopsis:

This command deletes the file specified by `fname`. Please note that the file must be closed.

Returns:

Nothing

Example:

```
fremove qnlptfrz.tmp
```

17.3.14 *frewind* - Rewind a File

Syntax:

`frewind`

Synopsis:

This command rewinds the current file. The file pointer is set to the beginning of the file.

17.3.15 fseek - Position the File Pointer

Syntax:

`fseek pos [relative]`

Synopsis:

This command allows you to jump to a certain position `pos` in a file in a way defined by `relative`. These variants are possible:

Example:

<code>fseek pos cur</code>	from current position
<code>fseek pos set</code>	from start position
<code>fseek pos end</code>	from end position

17.3.16 ftell - *Find File Pointer*

Syntax:

`ftell`

Synopsis:

This command returns the position in the current file.

17.3.17 fuse - Define the Current File

Syntax:

```
fuse fhandle
```

Synopsis:

This command allows you to set a new current file, identified by fhandle.

Example:

```
# open f1, this makes it the current file
fopen f1 output1.txt "wt"
...
fopen f2 output2.txt "wt"
# now f2 is the current file
...
fuse f1
# now f1 is the current file again
fclose
...
fuse f2
# now f2 is the current file again
fclose
```

17.3.18 fwrite - Write Binary Data

Syntax:

```
fwrite 16 val [count]
fwrite 32 val [count]
fwrite d  val [count]
fwrite f  val [count]
fwrite c  val [count]
fwrite s  val count
fwrite z  val
```

Synopsis:

This command allows writing binary representations of `val` into a file. Depending on the first parameter of this command, the value `val` is interpreted differently. The variants allowing the optional parameter `count` repeatably write the value `val` to a file and of course `count` times.

The type specifiers have the following meaning:

16	-	16 bit integer
32	-	32 bit integer
d	-	8 byte double
f	-	4 byte float
c	-	1 byte character
s	-	string with length n
z	-	zero terminated string (every TIM string)

Returns:

`fwrite` returns the number of full items actually written, which may be less than `count` if an error occurs. Also, if an error occurs, the file-position indicator cannot be determined.

See also:

[fput](#), [sput](#), [fopen](#)

17.4 Data Structure Commands

17.4.1 *adjexp* - Convert a Line in Standard C Output to FORTRAN Output.

Syntax:

adjexp

Synopsis:

This command converts a line containing numbers like 1.0E+003 to a line with numbers like 1.0D+02.

Returns:

Nothing

Example:

```
set result 1.0324E+003
set new [adjexp $result]
print $new
# outputs 1.0324D+03
```


17.4.2 *bline* - Access to Baselines

Syntax:

`bline [params] +`

Synopsis:

This command provides full access to the internal data structures keeping baseline information. The commands operate on the *current line*. The following variants are possible.

Returns:

Depends on the function you use:

`bline getn`

This command returns the number of available baselines.

`bline defn i`

This command makes the baseline with index I the current baseline.

`bline enable`

This command enables the current baseline.

`bline disable`

This command disables the current baseline.

`bline rotatevar`

This command rotates the variances derived from the var/covar matrix. This is done internally and you can get the rotated sigmas with help of the `rvar` variant.

`bline get id`

This command returns the baseline's unique id value.

`bline get enable`

This command returns whether the current baseline is enabled.

`bline get results`

This command returns, whether the baseline was processed and sets an internal pointer to the currently best result of the last processing. Returns the number of available results or 0 if the line was not processed.

`bline get results i`

This command returns, whether the baseline was processed and set an internal pointer to the result with index I.

`bline get solutions [i]`

This command returns the number of available solutions in the current block of results.

`bline get getbest i`

This command returns the index of the i^{th} best result in the current block of results.

`bline get report`

This command extracts the last processing report for this baseline and starts **MultiPage**.

`bline get ref`

This command returns the name of the reference station.

`bline get refid`

This command returns the id of the reference station point.

`bline get refobsid`

This command returns the id of the observation file of the reference station point of the current session.

`bline get ifrq`

This command returns the frequency set during processing

`bline get mode`

This command returns the mode of processing, where

1	-	Static Processing
2	-	Kinematic Processsing
0	-	Unknown

`bline get type`

This command returns the type of the solution, whereas type is:

Float, L1 = (1 << 1);
Float, L2 = (1 << 2);
Float Lw = (1 << 3);
Float Ln = (1 << 4);

```
Float Lc = (1 << 5);  
Fixed, L1 = (1 << 6);  
Fixed, L2 = (1 << 7);  
Fixed, Lw= (1 << 8);  
Fixed, Ln = (1 << 9);  
Fixed, Lc = (1 << 10);  
Triple Difference = (1 << 11);  
Stop&Go Solution = (1 << 14);  
I/O Solution (from File) = (1 << 15);
```

`bline get rov`

This command returns the name of the rover station.

`bline get rovid`

This command returns the id of the rover's station point.

`bline get rovidsid`

This command returns the id of the observation file of the rover station point of the current session.

`bline get pdop_min`

This command returns the minimum PDOP reached during processing.

`bline get pdop_max`

This command returns the maximum PDOP reached during processing.

`bline get rdop`

This command returns the worst RDOP reached during processing.

`bline get rms`

This command returns the RMS reached during processing. Attention: This value is returned in [mm]!

`bline get ratio`

This command returns the Ratio reached during processing.

`bline get start`

This command returns the starting time of the processed interval.

`bline get end`

This command returns the ending time of the processed interval.

`bline get interval`

This command returns the interval with which the line was processed.

`bline get nsats`

This command returns the number of satellites used during processing.

`bline get status`

This command returns the status word of the result.

`bline get cov 0..5`

This command returns the variance /covariance element 0..5, which correspond to cov_{xx} , cov_{xy} , cov_{yy} , cov_{xz} , cov_{yz} , cov_{zz} .

`bline get dx 0..2`

This command returns the vector x, y, z coordinates.

```
bline get x 0..2
```

This command returns the reference x, y, z coordinates.

```
bline get tstart
```

This command returns the start time of the baseline (rogue time).

```
bline get tend
```

This command returns the end time of the baseline (rogue time).

```
bline get session
```

This command returns number of sessions of the baseline.

```
bline get sessionon
```

This command returns whether current session is on.

```
bline get sessiontstart
```

This command returns start time of current session (rtime).

```
bline get sessiontend
```

This command returns end time of current session (rtime).

```
bline get sessionobs1
```

This command returns the first observation file of the session (rtime).

```
bline get sessionobs2
```

This command returns the second observation file of the session (rtime).

`bline get rvar i`

This command returns the rotated variance element I (0..2).

`bline get procstart`

This command returns the start time of processing.

`bline get procend`

This command returns the end time of processing.

`bline set session i`

This command sets session i to be the current session.

17.4.3 karell - Convert x/y/z <-> phi,lam,h.

Syntax:

`karell [params]*`

Synopsis:

With this command you can convert X,Y,Z coordinates to geographical coordinates (using WGS84 ellipsoid). Please NOTE: Angles are in DEGREE!

Returns:

depends on the function you use:

`karell toplh x y z p l h`

This command instructs the software to convert Cartesian XYZ coordinates to geographical phi, lam, h coordinates.

`karell toxyz p l h x y z`

This command instructs the software to transform geographical phi, lam, h coordinates to Cartesian XYZ coordinates.

17.4.4 kinpath - POS File Generation.

Syntax:

`kinpath [params]*`

Synopsis:

With this command you have access to each entry of an OBS File's kinematic data. You can only call this script via context menu on a trajectory tree item.

Returns:

depends on the function you use:

`kinpath getnpnt`

This command returns the number of points in the POS container.

`kinpath get name`

This command returns the name of the rover observation file.

`kinpath getnpos`

This command returns the number of positions in the POS container.

`kinpath defn i [rotate]`

This command returns the current index into the container of kinematic entries. If the optional `rotate` parameter is specified, rotation of the variance/covariance matrix is done immediately, thus avoiding the necessity to call the `rotatevar` variant.

`kinpath get rtime`

This command returns the `rtime` of the position.

`kinpath get x..z`

This command returns the X..Z coordinate of the position.

`kinpath get ratio`

This command returns the ratio of the position.

`kinpath get sats`

This command returns the satellites of the position.

`kinpath get pointid`

This command returns the point ID at this position.

`kinpath get cov i`

This command returns the variance/covariance matrix element `i` (0..5) of the position. These correspond to cov_{xx} , cov_{xy} , cov_{yy} , cov_{xz} , cov_{yz} , cov_{zz} .

`kinpath rotatevar`

This command rotates the variance/covariance matrix to the current local system.

`kinpath get rvar i`

This command returns the rotated standard deviation elements `sx`, `sy`, `sz`.

`kinpath get rvar2 i`

This command returns the squared rotated standard deviation elements `sx`, `sy`, `sz`.

`kinpath get rms`

This command returns the reached rms.

`kinpath get flags`

This command returns the flags for the current entry.

`kinpath get dgps`

This command returns the method with which the current entry was derived, where:

0	-	Navigation Solution
1	-	Differential Processing
2	-	Single Point Positioning

17.4.5 obs - Access to the List of OBS Files.

Syntax:

`obs [params]`

Synopsis:

These commands provide full access to the internal data structure keeping the observation files.

Returns:

depends on the function you use:

`obs getn`

This command returns the number of available OBS file.

`obs defn i`

This command sets the current OBS file.

`obs defid i`

This command sets the current OBS file which has ID i.

`obs defname obsfilename`

This command loads `obsfilename` and assigns internal data structures. The OBS file is not loaded to the current project. This command may be used to manipulate OBS files prior to adding them to the current project.

`obs flush`

This command writes back all changes made to an OBS file. You have to call this variant, else changes made with the `set` variants will get lost.

`obs clear`

This command clears internal data structures and should be called after usage of the `defname` variant.

`obs get id`

This command returns unique ID value of the OBS file.

`obs get name`

This command returns the full file name of the OBS file.

`obs get origname`

This command returns the file name of the file the OBS file was converted from.

`obs get tstart`

This command returns the start time of the OBS file.

`obs get tend`

This command returns the end time of the OBS file.

`obs get cutoff`

This command returns the elevation cutoff mask of the OBS file.

`obs get interval`

This command returns the interval of the OBS file.

`obs get rectype`

This command returns the receiver type of the OBS file.

`obs get recsn`

This command returns the serial number of the receiver.

`obs get recver`

This command returns the receiver's version number.

`obs get antsn`

This command returns the antenna serial number of the OBS file.

`obs get antver`

This command returns the antenna version number of the OBS file.

`obs get week`

This command returns the start time week of the OBS file.

`obs get pointid`

This command returns the ID of the point the OBS file defines.

`obs get pointsess`

This command returns the point session.

`obs get pointname`

This command returns the point name.

`obs get henh`

This command returns the entry h of the antenna eccentricity.

`obs get hene`

This command returns the entry e of the antenna eccentricity.

`obs get henn`

This command returns the entry n of the antenna eccentricity.

`obs get truevert`

This command returns the true vertical height of the file.

`obs set flags kinematic`

`obs set flags static`

These commands change the flags of an OBS file.

`obs set antname name`

This command sets the antenna name

`obs set anttype type`

This command sets the antenna type

`obs set pnumber name`

This command sets the point number in the OBS file.

`obs set pos x y z`

This command sets the WGS-84 position

`obs set hen h e n`

This command sets the antenna eccentricities.

`obs spp [-autoassign] [-auto] [-static] [-kinematic]`

This command performs a Single Point Position on the current observation file. The switches `-static` and `-kinematic` allow you to determine which type of SPP should be performed. The switch `-autoassign` allows to automatically assign the resulting position to the observation file. The switch `-auto` suppresses display of any dialog box and is useful during batch processing.

`obs rinexout`

This command allows you to convert the current observation file to RINEX.

`obs clean`

This command cleans up any internal data structures and should be used whenever you are done with your script.

17.4.6 param - Define Parameters

Syntax:

`param [params] +`

Synopsis:

This command allows you to define parameters.

Returns:

Depends on the function you use:

`param cutoff deg`

This command sets the elevation cutoff to `deg`, which is in degree.

`param interval sec`

This command sets the processing interval to `sec`.

`param freq i`

This command sets the frequency to `i` (1..6).

`1 = L1`

`2 = L2`

`3 = Lw`

`4 = Lc`

`5 = Lw/Lc>`

`6 = L1/L2`

`param orbit i`

This command sets the orbit to use to `i` (1..6).

1 = Precise

2 = Broadcast

`param refsat sat`

This command sets the reference satellite for the GPS system to `sat`.

0 = Automatic

`param refsatgln sat`

This command sets the reference satellite for the GLONASS system to `sat`.

`param epherror limit`

This command sets the maximum allowed ephemeris error.

`param maxiononoise value`

This command sets the maximum ionospheric noise allowed.

`param maxpossigma value`

This command sets the maximum position sigma.

`param minratio value`

This command sets the minimal ration.

`param tropscaling value`

This command sets the tropospheric scaling.

`param procmode value`

This command sets the processor mode, where:

- 0 Split sessions when more than x minutes diff.
- 1 Combine all sessions
- 2 Split individual sessions

`param procdiff value`

This command specifies the maximum difference between sessions (in [min]) before they are split during processing (see variant `procmode`).

`param defaulttemp value`

`param defaultpressure value`

`param defaulthumid value`

These commands specify the default values for use during modeling of the troposphere.

`param autoassign value`

This switch defines whether coordinates are to be assigned automatically after an adjustment.

`param sysweight0 value`

`param sysweight1 value`

`param sysweight2 value`

These commands specify weighting parameters for the system static GPS baselines, kinematic data and terrestrial data.

17.4.7 project - Access to Projects.

Syntax:

`project [params]+`

Synopsis:

This command provides access to projects.

Returns:

Depends on the function you use:

`project get name`

This command instructs the software to return the name of the current project.

`project get version`

This command returns the version number of **GeoGenius** (e.g. 121)

`project get versiondate`

This command returns the version date of the software.

`project get docversion`

This command returns the document version number (current: 20)

`project get progname`

This command returns the program name.

`project get copyright`

This command returns a copyright statement.

`project build`

This command rebuilds internal structures and should be called whenever new data has been added to the current project.

`project lastsave`

This command returns the `rtime` of the last saving of the current project.

`project get adjusted`

This command searches for information whether the project has been adjusted.

`project get weighting x..z`

This command returns the a priori weighting value `x..z`

`project get weighting sx..sz`

This command returns the a priori weighting value `sx..sz`

`project get weighting mode`

This command returns whether weighting mode is on (mode equals 1) of off (other modes)

`project get 5parm avail`

`project get 5parm alpha`

`project get 5parm scale`

`project get 5parm dn`

`project get 5parm de`

`project get 5parm dh`

These commands return the 5 parameters determined from the transformations or adjustments

`project get 7parm dx..dz`

This command returns the 7 parameters determined from the local adjustment, elements dx, dy, dz (translation factors).

`project get 7parm ex..ez`

This command returns the 7 parameter values ex..ez (rotation factors).

`project get 7parm scale`

This command returns the 7 parameter value scale

`project get 7parm sdx..sdz`

This command returns the 7 parameter standard deviation value sdx..sdz (translation factors)

`project get 7parm sex..sez`

This command returns the 7 parameter standard deviation value sex..sez (rotation factors).

`project get 7parm sscale`

This command returns the 7 parameter standard deviation value sscale (scale).

`project get 7parm rms`

This command returns the RMS of adjustment.

`project get 7parm niters`

This command returns the number of iterations during adjustment.

`project get user`

This command returns the user name.

`project get company`

This command returns the user's company.

`project get initials`

This command returns the user's initials

`project get comment`

This command returns the current project's comments.

`project get refsyspos x`

This command returns the coordinates, at which the current projection system has been initialized.

`project get maxpellips`

This command returns the maximum value of the processing ellipses.

`project get maxpheight`

This command returns the maximum value of height errors from processing.

`project get maxaellips`

This command returns the maximum value of the adjustment ellipses.

`project get maxaheight`

This command returns the maximum value of height errors from adjustment

`project get maxp ellips`

This command returns the maximum value of the processing ellipses.

`project get gscale`

This command returns the current scale factor of the graphics.

`project invalidate`

This command redraws the current project.

`project new`

This command create a new project and a new project window.

`project close`

This command closes the current project.

`project load fname`

This command loads the project with name fname.

`project save fname`

This command saves the project with name fname.

`project process all`

This command processes the current project.

`project process selected`

This command processes the selected baseline.

`project process clear`

This command cleans up processing results.

`project addobs obsfile`

This command adds an observation file with name `obsfile` to the current project. **ATTENTION: `obsfile` must be a fully qualified path.**

`project addrnrx rxnfile`

This command adds a RINEX ephemeris file to the current project. **ATTENTION: `rxnfile` must be a fully qualified path.**

`project addeph ephfile`

This command adds an ephemeris (EF18) file to the current project. **ATTENTION: `ephfile` must be a fully qualified path.**

`project addprc prcfile`

This command adds a precise ephemeris file to the current project. **ATTENTION: `prcfile` must be a fully qualified path.**

`project addalm almfile`

This command adds an almanac file to the current project. **ATTENTION: `almfile` must be a fully qualified path.**

`project addraw file`

This command adds a raw data file to the current project, the decoder is called and the file converted. **ATTENTION: File must be a fully qualified path.**

`project gen reference`

This command automatically selects the best reference station and fixes it.

`project gen eph`

This command starts the generation of ephemeris data for the current project.

`project gen system`

This command registers the transformation macros.

`project gen interval`

This command sets a proper processing interval, which is the minimum of all available OBS files.

`project gen projection x y z dn de dh rot scale`

This command redefines the current projection system.

`project determine`

This command searches for the current project (if there is any).
For internal use only.

`project registerlayer name`

This command creates a new layer in the graphic system.

`project modified x`

This command sets the *modified* state of the current project.

17.4.8 rtime - Time Calculations

Syntax:

`rtime [params] +`

Synopsis:

With this command you can convert times to different systems

Returns:

depends on the function you use:

`rtime setrtime rtime`

This command instructs the software to initialize calculations with rogue time `rtime`

`rtime setdate year month day`

This command instructs the software to initialize calculations with year, month, day.

`rtime setgpstime week secs`

This command instructs the software to initialize calculations with GPS week and seconds.

`rtime get gpsweek`

This command returns the GPS week.

`rtime get gpssecs`

This command returns the GPS seconds.

`rtime get year`

This command returns the year.

`rtime get month`

This command returns the month.

`rtime get day`

This command returns the day.

`rtime get hour`

This command returns the hour.

`rtime get min`

This command returns the minutes.

`rtime get secs`

This command returns the seconds.

`rtime get msecs`

This command returns the milliseconds.

`rtime get dow`

This command returns the day of week.

`rtime get doy`

This command returns day of year.

`rtime get mjd`

This command returns a modified Julian date.

`ptime get date`

This command returns a string containing a date corresponding to the current locale.

`ptime get time`

This command returns a string containing a time corresponding to the current locale.

`ptime get datetime`

This command returns a string containing a date and time.

`ptime get timedata`

This command returns a string containing a time and date.

`ptime get current`

This command returns the current computer time as a `ptime`.

17.4.9 *spoint* - Access to Static Points.

Syntax:

```
spoint [params]
```

Synopsis:

These commands provide full access to the internal data structure keeping point information. Please note: the usage of this command **MUST** be initialized by use of the `collect all` variant.

Returns:

depends on the function you use:

```
spoint collect all
```

This command initializes the `spoint` command and **MUST** be called before any other use of it.

```
spoint set fix
```

Fix the current point.

```
spoint defxyz name x y z
```

This command defines the point “name” and assigns it the geocentric coordinates x, y, z. If the point doesn’t exist, it will be created.

`spoint defneh name n e h`

This command defines the point “name” and assigns it the local plane coordinates n, e, h. If the point doesn’t exist, it will be created.

`spoint get id`

This command returns the unique ID number of the static point.

`spoint getn`

This command returns the number of available points.

`spoint defn i`

This command makes point with index i the current point.

`spoint defid i`

This command makes point with ID i the current point.

`spoint get name`

This command returns the name of the current point.

`spoint get sernr`

This command returns the serial number of the current point, which is the internal count.

`spoint get fix`

This command returns whether the point is fixed.

`spoint get fixn`

This command returns whether N is fixed.

`spoint get fixe`

This command returns whether E is fixed.

`spoint get fixh`

This command returns whether H is fixed.

`spoint get fixsn`

This command returns whether sigma N is fixed.

`spoint get fixse`

This command returns whether sigma E is fixed.

`spoint get fixsh`

This command returns whether sigma H is fixed.

`spoint get adjust`

This command returns whether the point was adjusted.

`spoint get x..z`

This command returns the point coordinates X,Y,Z.

`spoint get code`

This command returns the point code.

`spoint get info`

This command returns the point info.

`spoint get lat`

This command returns the latitude (WGS84) of the point.

`spoint get lon`

This command returns the longitude (WGS84) of the point.

`spoint get h`

This command returns the height (WGS84) of the point.

`spoint get cov 0..5`

This command returns the variance/covariance element 0..5 of the static point. These correspond to cov_{xx} , cov_{xy} , cov_{yy} , cov_{xz} , cov_{yz} , cov_{zz} .

`spoint get ax 0..2`

This command returns the adjusted X..Z coordinates of the static point.

`spoint get al 0..2`

This command returns the adjusted national plane coordinates of the static point.

`spoint get wgsx 0..2`

This command returns WGS84 X..Z coordinate of the static point (same as 'x').

`spoint get loc 0..2`

This command returns the local plane coordinates of the static point.

`spoint get haslocal`

This command returns whether point has local coordinates.

`spoint get control 0..2`

This command returns the control coordinates of the static point.

`spoint get hascontrol`

This command returns whether point has control coordinates.

`spoint get north`

This command returns North of national coordinates.

`spoint get east`

This command returns East of national coordinates.

`spoint get height`

This command returns Height of national coordinates.

`spoint get zone`

This command returns zone of national coordinates (if available, 9999 else).

17.4.10 tachy - Access to Total Station Data

Syntax:

`tachy [params] +`

Synopsis:

With these commands you can access the internal data structure total station data.

Returns:

depends on the function you use:

`tachy getn`

This command returns the number of available total station entries.

`tachy defn i`

This command makes the total station vector with index *i* the current vector.

`tachy enable`

This command enables the current total station measurement.

`tachy disable`

This command disables the current total station measurement.

`tachy get id`

This command returns current total station measurement's unique id.

`tachy get hasd`

This command returns whether the current total station measurement has a distance measurement.

`tachy get hash`

This command returns whether the current total station measurement has a horizontal angle measurement.

`tachy get hasv`

This command returns whether the current total station measurement has a vertical angle measurement.

`tachy get d`

Returns current total station measurement's distance.

`tachy get h`

Returns current total station measurement's horizontal angle.

`tachy get v`

Returns current total station measurement's vertical angle.

`tachy get ih1`

Returns current total station measurement's instrument height at left point.

`tachy get ih2`

Returns current total station measurement's instrument height at right point.

`tachy get idp1`

Returns current total station measurement's id of left point.

`tachy get idp2`

Returns current total station measurement's id of right point.

`tachy get group`

Returns current total station measurement's group.

`tachy get status`

Returns current total station measurement's status.

`tachy get machineoff`

Returns current total station measurement's machine offset.

`tachy get machinere1`

Returns current total station measurement's machine relative error.

`tachy get machineangle`

Returns current total station measurement's machine angle accuracy.

17.4.11 tdatum - Access and Create Datums.

Syntax:

`tdatum [params]+`

Synopsis:

With these commands you can access the parameters of the current System's datum.

Returns:

depends on the function you use:

`tdatum name`

This command returns a string describing the datum of the current System.

`tdatum param scale`

This command returns a float value for the datum's scale parameter.

`tdatum dx`

This command returns a float value for the datum's translation in x direction.

`tdatum dy`

This command returns a float value for the datum's translation in y direction.

`tdatum dz`

This command returns a float value for the datum's translation in z direction.

`tdatum rx`

This command returns a float value for the datum's x rotation parameter. The unit of this value is arc-seconds.

`tdatum ry`

This command returns a float value for the datum's y rotation parameter. The unit of this value is arc-seconds.

`tdatum rz`

This command returns a float value for the datum's z rotation parameter. The unit of this value is arc-seconds.

17.4.12 *tdialog* - Display System Dialogs.

Syntax:

```
tdialog [params]+
```

Synopsis:

With these commands you can display the System Selector, System Editor, Projection, Datum, and Ellipsoid Editor dialogs. Returns the selected System.

Returns:

depends on the function you use:

```
tdialog sysssel
```

This command opens a System Selector dialog and returns the selected System.

```
tdialog sysssel system
```

This command pre-selects the specified System.

```
tdialog sysssel system title
```

This command sets the dialog title.

`tdialog sysssel system title sysType`

This command displays only Systems of type 0..6:

0	all Systems;
1	Systems with a normal projection;
2	Systems with ellipsoid only;
3	1 or 2;
4	Systems with a special projection;
5	1 or 4;
6	2 or 4;

`tdialog sysedit`

This command opens a System Editor dialog. Returns the last edited System.

`tdialog sysedit system`

This command pre-selects the specified System.

`tdialog projedit`

This command opens a Projection Editor dialog.

`tdialog datumedit`

This command opens a Datum Editor dialog.

`tdialog elledit`

This command opens an Ellipsoid Editor dialog.

17.4.13 tellips - Access and Create Ellipsoids

Syntax:

`tellips [params] +`

Synopsis:

With these commands you can access parameters of the current System's ellipsoid.

Returns:

depends on the function you use:

`tellips name`

This command returns a string describing the ellipsoid of the current System.

`tellips axisa`

This command returns a float value for the ellipsoid's semimajor axis.

`tellips axisb`

This command returns a float value for the ellipsoid's semiminor axis.

`tellips flataxisa`

This command returns a float value for the ellipsoid's flattening.

17.4.14 tproj - Access and Create Projections.

Syntax:

`tproj name`

Synopsis:

With this command you can create a new projection.

Returns:

This command returns a string describing the new projection

17.4.15 trans - Access the Transformation Machine.

Syntax:

`trans [params]`

Synopsis:

This command provides full access to the internal transformation machine. Each of these functions has a set of return parameters and additionally returns 0 if the transformation failed.

Returns:

depends on the function you use:

`trans xyz2geo x y z p l h`

This command instructs the software to transform Cartesian WGS84 XYZ coordinates to geographical phi, lam, h coordinates.

`trans geo2xyz p l h x y z`

This command instructs the software to transform geographical phi, lam, h coordinates to Cartesian WGS84 XYZ coordinates.

`trans xyz2neh x y z n e h`

This command instructs the software to transform Cartesian WGS84 XYZ coordinates to state plane North, East, Height coordinates.

```
trans xyz2geo n e h x y z
```

This command instructs the software to transform state plane North, East, Height coordinates to Cartesian WGS84 XYZ coordinates.

```
trans pro x1 y1 z1 x2 y2 z2
```

This command instructs the software to transform from the WGS84 System to the current System.

```
trans orp x1 y1 z1 x2 y2 z2
```

This command instructs the software to transform from the current System to the WGS84 System.

```
trans geoidh iswgs84 x y z h
```

This command instructs the software to calculate geoid heights. `iswgs84` being:

- 0 expects XYZ in current System and returns geoid height on System's geoid model.
- 1 expects WGS84 XYZ coordinate and returns geoid height on WGS84 geoid model.

17.4.16 tsystem - Set a System and Create New Systems

Syntax:

```
tsystem [params]+
```

Synopsis:

With these commands you can create a new System.

Returns:

depends on the function you use:

```
tsystem name
```

This command returns a string describing the current System.

```
tsystem set "name" [ x y z ]
```

This command sets the current System. If the System does not have a projection, you have to specify an XYZ coordinate, which is then interpreted as the central meridian for the defaulting Transverse Mercator projection.

```
tsystem setm defbypos x y z
```

This command sets the current System as "local" based on XYZ coordinates (in WGS84).

```
tsystem hasproj
```

This command returns 1 if the current System has a projection (is of type 0).

`tsystem def`

This command starts the definition of a new System.

`tsystem type i`

This command sets the System type to i.

- 0 System with a normal projection;
- 1 System without a projection (ellipsoid only)
- 2 System based on a special projection;

`tsystem proj "name"`

This command sets the projection name for a type 0 System.

`tsystem zone num`

This command set the projection's zone number for a type 0 System.

`tsystem ellips "name"`

This command sets the ellipsoid name for a type 1 System.

`tsystem special "name"`

This command sets the special projection name for a type 2 System.

`tsystem datum "name"`

This command sets the datum name for a System.

`tsystem geoid "name"`

This command sets the geoid name for a System.

`tsystem create "name"`

This command creates the new System assigning it this name.

17.4.17 vector - Access to Vectors

Syntax:

`vector [params]+`

Synopsis:

This command provides full access to the internal data structures keeping vector information. The commands operate on the *current vector*. The following variants are possible.

Returns:

Depends on the function you use:

`vector collect all`

This command collects internal information and **must** be used before any other variant can be used.

`vector getn`

This command returns the number of available vectors.

`vector defn i`

This command makes the vector with index i the current vector.

`vector enable`

This command enables the current vector.

`vector disable`

This command disables the current vector

`vector get id`

This command returns the vector's unique id value.

`vector get idp1`

This command returns the left point's id value.

`vector get idp2`

This command returns the right point's id value.

`vector get desc`

This command returns a description of the current vector as it can be seen in the navigator.

`vector get enable`

This command returns whether the current vector is enabled.

`vector get solutions [i]`

This command returns the number of available solutions in the current block of results.

`vector get ifrq`

This command returns the frequency set during processing.

`vector get mode`

This command returns the mode of processing, where

1	-	Static Processing
2	-	Kinematic Processsing
else	-	Unknown

`vector get type`

This command returns the type of the solution, whereas type is:

```
Float, L1 = (1 << 1);  
Float, L2 = (1 << 2);  
Float Lw = (1 << 3);  
Float Ln = (1 << 4);  
Float Lc = (1 << 5);  
Fixed, L1 = (1 << 6);  
Fixed, L2 = (1 << 7);  
Fixed, Lw= (1 << 8);  
Fixed, Ln = (1 << 9);  
Fixed, Lc = (1 << 10);  
Triple Difference = (1 << 11);  
Stop&Go Solution = (1 << 14);  
I/O Solution (from File) = (1 << 15);
```

`vector get pdop_min`

This command returns the minimum PDOP reached during processing.

`vector get pdop_max`

This command returns the maximum PDOP reached during processing.

`vector get rdop`

This command returns the worst RDOP reached during processing.

`vector get rms`

This command returns the RMS reached during processing. Attention: This value is returned in [mm]!

`vector get ratio`

This command returns the Ratio reached during processing.

`vector get start`

This command returns the starting time of the processed interval.

`vector get end`

This command returns the ending time of the processed interval.

`vector get interval`

This command returns the interval with which the line was processed.

`vector get nsats`

This command returns the number of satellites used during processing.

`vector get status`

This command returns the status word of the result.

`vector get cov 0..5`

This command returns the variance /covariance element 0..5, which correspond to cov_{xx} , cov_{xy} , cov_{yy} , cov_{xz} , cov_{yz} , cov_{zz} .

`vector get dx 0..2`

This command returns the vector x, y, z coordinates.

`vector get x 0..2`

This command returns the reference x, y, z coordinates.

18. Sample Data

This appendix gives an introduction on how to use the sample data provided with the installation CD.


Install
Samples:
Ch. 2.1.2

If you have not yet installed the **GeoGenius** sample data, you should do so following the instructions in chapter 2 of this manual. If you choose the installation type Typical, all sample data will be installed. To select one or several data sets, you should choose the installation type Custom.

We suggest that you install the sample data into the sub-directory \SAMPLES of your **GeoGenius** root directory.

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18.1 Overview

The sample data offer you a lot of data set. Each has its characteristics: They are observed with different receivers types, statically or kinematically, include terrestrial data or GLONASS data. This introduction gives you an overview over the characteristics of each sample data set (in alphabetical order). The next sections lead you step by step through the processing and adjustment of the sample data.

Andy:

Directory: \SAMPLES\ANDY
Data: static observation files, broadcast RINEX ephemeris and binary EF-18 ephemeris
Receiver used: Geotracer
Satellite Systems: GPS
Map Projection System: Standard Map Projection
Adjustment: Free Adjustment, Tau Test
Transformation: to NAD27 via the tool **GeoTrans**
Other: - Control Point Coordinates,
 - in section 18.2

Ashtech.L12:

Directory: \SAMPLES\ASHTECH.L12
Data: static raw data
Receiver used: Ashtech L12
Satellite Systems: GPS
Map Projection System: Standard Map Projection
Adjustment: Free Adjustment, Tau Test
Transformation: to NAD27 via the tool **GeoTrans**
Other: - Baseline Scanning and deactivation of data,

- Single Point Positioning,
- in section 18.3

FGCS:

Directory: \SAMPLES\FGCS
Data: static raw data and ephemeris
Receiver used: Ashtech GG24 (session 1)
 Ashtech Z-surveyor (session 2)
Satellite Systems: GPS/GLONASS
Map Projection System: Standard Map Projection
Adjustment: WGS84, biased
Transformation:
Other: - 2 Sessions

GG24:

Directory: \SAMPLES\GG24
Data: raw data, many sessions of a single baseline
Receiver used: Ashtech GG24
Satellite Systems: GPS/GLONASS
Map Projection System: Standard Map Projection
Adjustment: -
Transformation: -
Other: - Session Selection and Toggling,
 - Improvement of Processing Result,
 - in section 18.4

GG24.Net

Directory: \SAMPLES\GG24.NET
Data: raw data
Receiver used: Ashtech GG24
Satellite Systems: GPS/GLONASS
Map Projection System: US California Zone 3
Adjustment: -

Transformation: using **GeoTrans** for geoidal heights
Other: - Single Point Positioning with variants,
- control coordinates,
- antenna height definition change,
- installation of geoid model from CD,
- Improvement of Processing Result,
- in section 18.5

Horn:

Directory: \SAMPLES\HORN\
Data: 3 sessions of static observation and broadcast RINEX
ephemeris files, 1 *.SPC file
Receiver used: Geotracer
Satellite Systems: GPS
Map Projection System: United Kingdom
Adjustment: national, biased
Transformation:
Other: - Inserting control coordinates manually
and by file,
- object deletion, disabling baselines ac-
cording to their processing status,
- result export,
- in section 18.6

Metric:

Directory: \SAMPLES\METRIC
Data: static raw data and ephemeris
Receiver used: Trimble
Satellite Systems: GPS
Map Projection System: Germany Zone 4
Adjustment: national, biased, set parameters, save adjusted Sys-
tem
Transformation:

Other:

- Control coordinates (horizontal or vertical or both)
- Baseline sorting
- script: M\HKIRCHBMP.M
- background bitmap: BITMAPS\HKIRCH.BMP
- in section 18.7

OTF:

Directory: \SAMPLES\OTF
Data: kinematic OTF observation and RINEX ephemeris files
Receiver used: Trimble
Satellite Systems: GPS
Map Projection System: Standard Map Projection
Adjustment:
Transformation:
Other:

- Quality check (baseline scanning),
- Single Point Positioning,
- processor selection,
- result export,
- in section 18.8

Poerings:

Directory: \SAMPLES\POERINGS
Data: raw static data
Receiver used: Trimble
Satellite Systems: GPS
Map Projection System: Germany Zone 4
Adjustment: free
Transformation: to a national grid System with given datum

Other: - control coordinates
 - result deletion,
 - in section 18.9

SERCEL:

Directory: \SAMPLES\SERCEL
Data: raw static data and broadcast RINEX ephemeris files
Receiver used: SERCEL
Satellite Systems: GPS
Map Projection System: Standard Map Projection
Adjustment: -
Transformation: -
Other:

Stopgo:

Directory: \SAMPLES\STOPGO
Data: kinematic STOP&Go observation and RINEX ephemeris
 data
Receiver used: Geotracer
Satellite Systems: GPS
Map Projection System: Germany Zone 4
Adjustment: -
Transformation:
Other: - geoid model installation
 - control coordinates,
 - display customizing,
 - result export,
 - in section 18.10

Terrestrial data:

27833

Directory: \SAMPLES\TERREST\27833
Data: total station data only

Instrument used: Geodimeter
Satellite Systems: -
Map Projection System: Gauß Krüger Germany Zone 4
Adjustment: -
Transformation:
Other:

Geonet

Directory: \SAMPLES\TERREST\GEONET
Data: total station data only
Instrument used: Geodimeter
Satellite Systems: -
Map Projection System: Standard Map Projection
Adjustment: -
Transformation:
Other:

HKIRCH

Directory: \SAMPLES\TERREST\HKIRCH
Data: static observation and broadcast EF-18 ephemeris file, total station data, * .SPC file
Receiver used: Geotracer
Instrument used: Geodimeter
Satellite Systems: GPS
Map Projection System: Germany Zone 4
Adjustment: national, biased
Transformation:
Other: script: M\HKIRCHBMP.M
background bitmap: BITMAPS\HKIRCH.BMP

18.2 The Network Andy

*Data
Import:
Ch. 5.5*

The Network Andy consists of several observation and ephemeris files. Open a new project (File/New) and then choose Project/Files into Project. Go to the SAM-
PLES\ANDY\ sub-directory, select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.

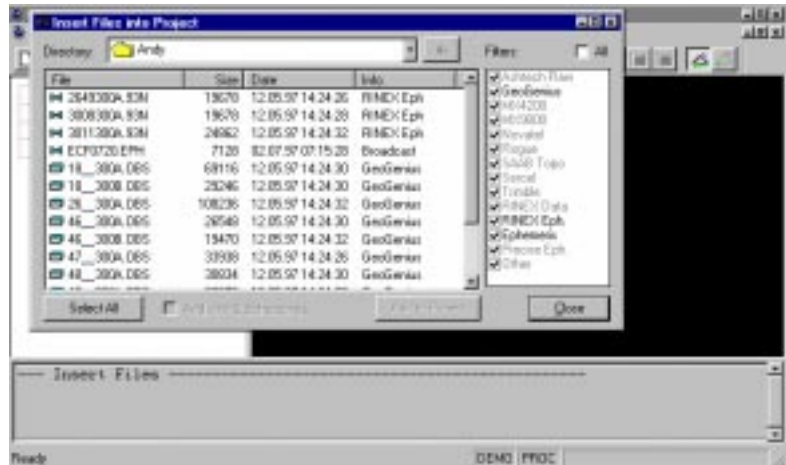


Figure 18-1: Network Andy - Insert Files

Project Untitled1 now displays the initial station positions calculated using code measurements with an accuracy of +/- 100 meters.

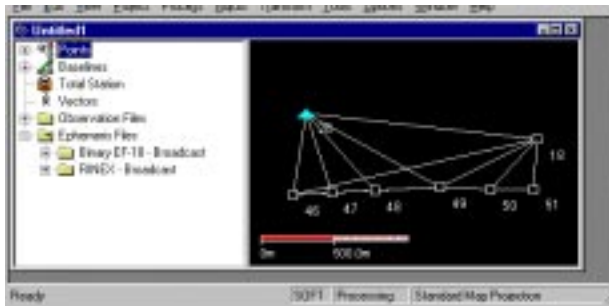


Figure 18-2: Network Andy - Single Point Positions

You do not have to choose a System first, the Standard Map Projection will do for this example, since it is only used for the display of the project plot. After adjustment, we will transform the network into the correct System.

 Save
Project
Ch. 5.4.4

Save the project (File/Save), e.g., as file SAMPLE-ANDY.GGS.



GeoGenius automatically fixes Point 26, the point with the most connections to other points. However, we know the precise coordinates of Point 18 in the WGS84 System. These are:

X: -1266572.932
Y: -4740488.276
Z: 4063627.728

 Fix/Unfix
Points:
Ch. 7.2

We will now first unfix Point 26 and then enter the precise coordinates manually into the project.

To unfix a point, click the point (left mouse button), then click again (right mouse button). The menu item **Fix** of the control menu will be checked. Clear **Fix**. (You may also activate the point in the navigator).

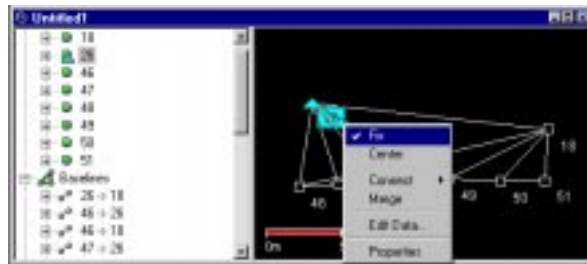


Figure 18-3: Network Andy - Fix/Unfix Point

 **Point**
Properties:
Ch. 12.4.4

Next, insert the known coordinates into the project. Click Point 18 (left mouse button, either in the navigator or the plot), click again (right mouse button) and choose menu item **Properties**. Choose page XYZ of the notebook Property: Point.



Figure 18-4: Network Andy - Property Point XYZ

Enter the correct coordinates (see above) and click **Assign**.

Now make Point 18 the reference station by fixing it in the same way as you deselected Point 26.

Process
project:
Ch. 8

Now process the project using the default settings: Click **Process/Process Project**. **GeoGenius** then automatically detects the type of data and uses the static processor.



Figure 18-5: Network Andy - Processed

The reference ellipse indicates maximum errors of 0.8 mm in location and 1.5 mm in height.

Adjustment
Settings:
Ch. 12.5

Next, the network should be adjusted. First, change the Confidence Level. Choose the menu item **Adjust/Settings** and go to page **Parameters**. Set the confidence level to 2 sigmas. The adjusted points will then be reliable with a probability of 99%.

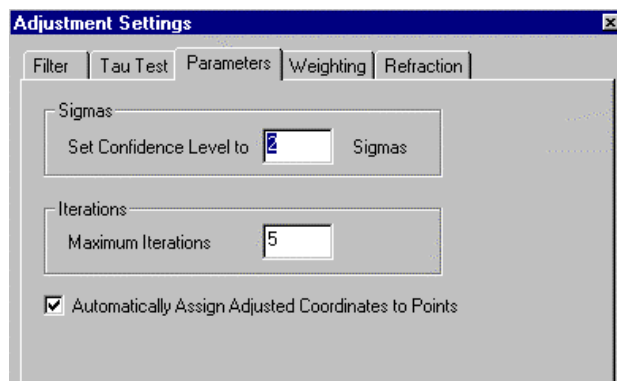


Figure 18-6: Network Andy - Adjustment Settings

Since only one point (Point 18) is known choose the adjustment option Adjust/Adjust (WGS/84, free). **GeoGenius** will adjust the network and will automatically perform a Tau test afterwards. The adjustment information is displayed in the output window at the bottom of the screen. When the adjustment is finished, the computed error ellipses will be displayed at each point in the network. The reference circle shows the largest errors in location of 1.9 mm and in height of 3.6 mm. The reference can be enabled/disabled using the Display Toolbar button. 

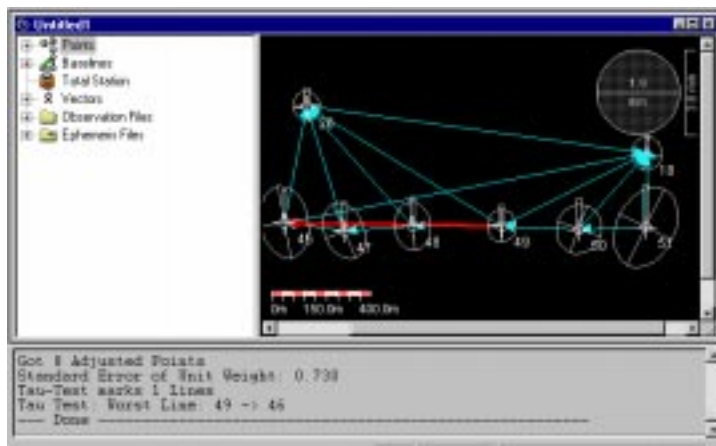


Figure 18-7: Network Andy – Adjusted Project

Finding Outliers:
Ch. 12.7.2

The Tau test marks one baseline as rejected by the statistical test (Baseline 49→46). This baseline had to be moved more than 5mm + 1ppm (default parameters) to fit into the adjusted network. To check the adjustment results, click Adjust/Report...

Finally, we change to the NAD27 System. If we try to do so via the menu option Project/System..., the operation will fail. **GeoGenius** will display a warning message, that no direct transformation between the two Systems WGS-84 and NAD27 exists.

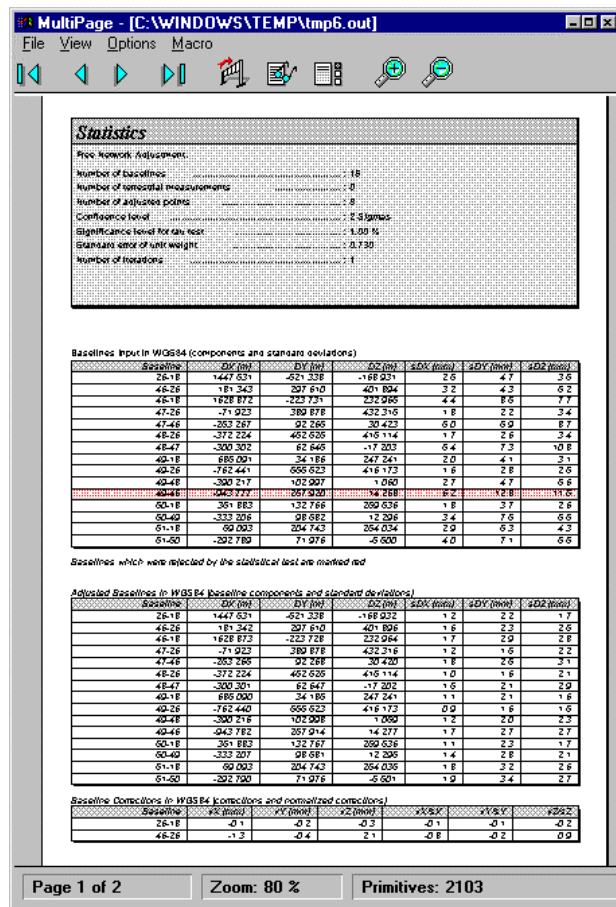


Figure 18-8: Network Andy - Adjustment Report

Geotrans
User's
Guide:

Therefore, to derive geographical coordinates in the NAD27 System start the transformation module **GeoTrans** by using the menu item Tools/Transformation/Projection. On entering the module a

PointList1 of all the stations in the project will be displayed. This list will contain the adjusted WGS84 Cartesian Geocentric Coordinates.

Figure 18-9: Network Andy - PointList1

Check the settings of the pre-defined Systems you want to transform your coordinates into. These are the NAD27 and the NAD83 Systems (you will need this one, too), each based on ellipsoid and datum only. Click Extras/Systems to open the System Editor. Choose the respective System from the Name combo box.



Figure 18-10: Network Andy: The Systems NAD83 and NAD27

To start the transformation click Transformation/Transform to Predefined System. The window Transform "WGS84" to ... offers the System NAD83 (and others) and the only transformation type Seven Parameter Similarity Transformation. The System NAD27 is not allowed for a one-step transformation from the WGS84 System, because no transformation from WGS-84 to NAD27 is implemented in the System. Therefore you first have to do a transformation into the NAD83 System.

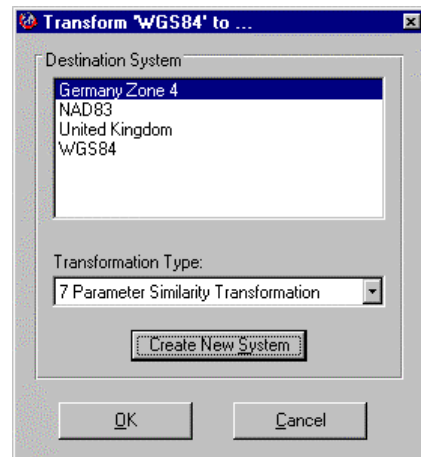


Figure 18-11: Network Andy - Transform to ...

Choose the NAD83 System and click **OK**. PointList2 displays the points in the transformation NAD83 System. Make sure, that PointList2 is activated.

Again, click Transformation/Transform to Predefined System. Now, the System NAD27 is available. Choose NAD27. The Type combo box will then offer the NADCON transformation type as the only possible choice for transformations between these Systems.

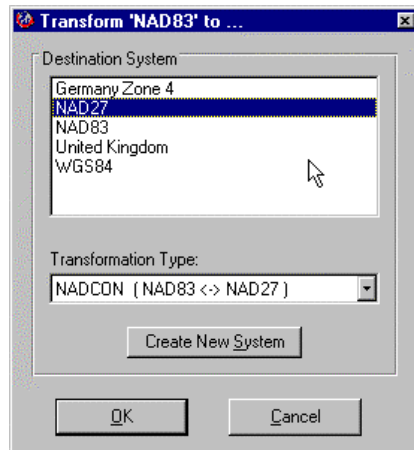


Figure 18-12: Network Andy - Transform to NAD27

Accept with **OK**. **GeoTrans** transforms the coordinates into geographical coordinates in the NAD27 System.

Point	Lat	Lon	H	Outalt	GeoidH	Sea Level	Scaled
1	N 39° 49' 18.75270"	W 184° 57' 27.55500"	1568.498	1568.498	0.000	N/A	N/A
2	N 39° 49' 17.65319"	W 184° 58' 32.39530"	1574.583	1574.583	0.000	N/A	N/A
3	N 39° 49' 08.70620"	W 184° 58' 36.53880"	1574.435	1574.435	0.000	N/A	N/A
4	N 39° 48' 58.45219"	W 184° 58' 25.24305"	1573.152	1573.152	0.000	N/A	N/A
5	N 39° 49' 08.23961"	W 184° 58' 12.38347"	1571.061	1571.061	0.000	N/A	N/A
6	N 39° 49' 08.23990"	W 184° 57' 55.48560"	1568.357	1568.357	0.000	N/A	N/A
7	N 39° 48' 55.74270"	W 184° 57' 48.88480"	1568.553	1568.553	0.000	N/A	N/A
8	N 39° 49' 08.08522"	W 184° 57' 28.13405"	1567.472	1567.472	0.000	N/A	N/A

Figure 18-13: Network Andy - Final Point List

18.3 The Network Ashtech.L12

Data
Import:
Ch. 5.5

The Network Ashtech.L12 consists of several raw data files. Open a new project (File/New) and then choose Project/Files into Project. Go to the \SAMPLES\ASHTECH.L12 sub-directory. **GeoGenius** scans the directory for data files and displays a list of five raw data files with the extension *.027. The list of file converters on the right side of the Insert Files into Project window displays the Ashtech Raw file converter as enabled. You may toggle the checkbox left to the converter name to watch **GeoGenius** scan for the data files.

Select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.

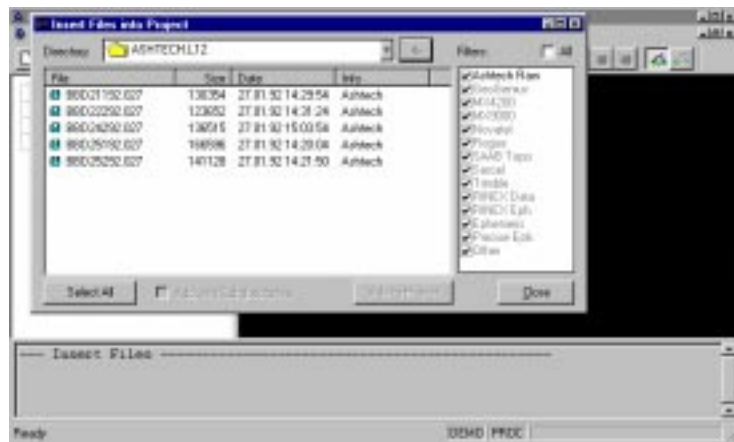


Figure 18-14: Network Ashtech.L12 - Insert Files

GeoGenius automatically uses the right decoder and creates five observation files in the **GeoGenius** standard *.OBS format and five

RINEX Broadcast Ephemeris files. Then, an ephemeris file in the binary EF-18 format is created.

Project `Untitled1` now displays 4 points and 4 baselines. The initial station positions are calculated using code measurements with an accuracy of ± 100 meters.

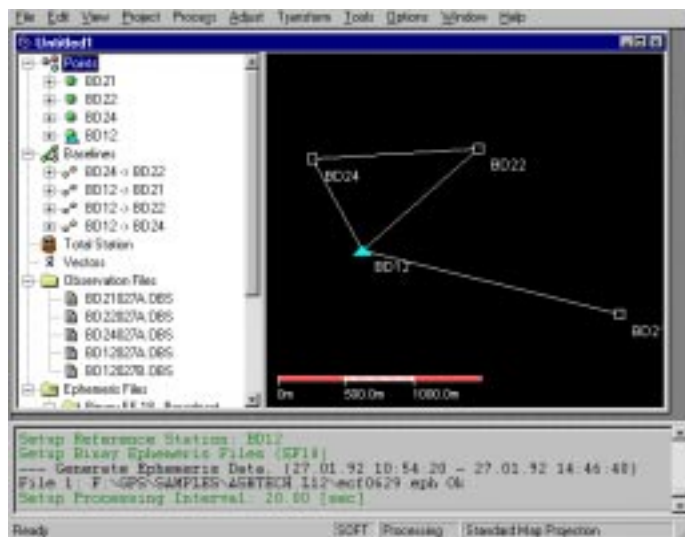


Figure 18-15: Network Ashtech.L12 - Single Point Positions

You do not have to choose a System first, the Standard Map Projection will do for this example, since it is only used for the display of the project plot.

Save Project
Ch. 5.4.4

Save the project (File/Save), e.g., as file `SAMPLEASSTECH.GGS`.



 No precise coordinates exist for this project. Therefore, first do a Single Point Positioning for point BD12, which is the point with the most connections to other points. Two observation files exist for point BD12. Click each file name once (right mouse button) and choose the context menu option Scan.

Scan
Baseline:
Ch. 14.2



Figure 18-16: Network Ashtech.L12 - Scan Observation Files

Compare the time spans of the two observation files and choose the file with the longest observation time span. In this example, we will therefore use file BD12027A.OBS.

Click the observation file name (right mouse button), click Single Point Position.



Figure 18-17: Network Ashtech.L12 - Single Point Position

Accept the GPS system and the Static mode with **OK**. **GeoGenius** calculates the single point position. Progress bars show up during processing.

SPP
Ch. 14.3

The SPP Result window displays the calculated positions and the standard deviations. You may view the former coordinates of the point and the differences to the new coordinates in meters. Do not assign the new position to the observation file (the file should remain untouched). Press **Assign** to instruct **GeoGenius** to assign the single point position coordinates to the point and to close the window.



Figure 18-18: Network Ashtech.L12 - SPP Result

Process the project (Process/Process Project). You will notice only small differences in the network design and will find relatively small errors.

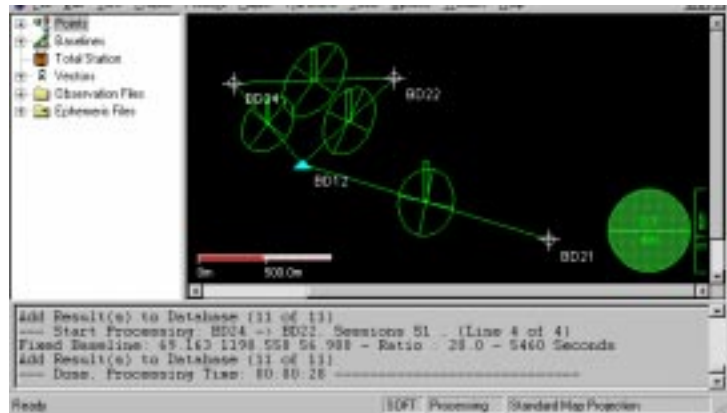


Figure 18-19: Network Ashtech.L12 - Project Processed

You still want to increase the quality of the network!

Click baseline BD12→BD24 (right mouse button), click Scan.

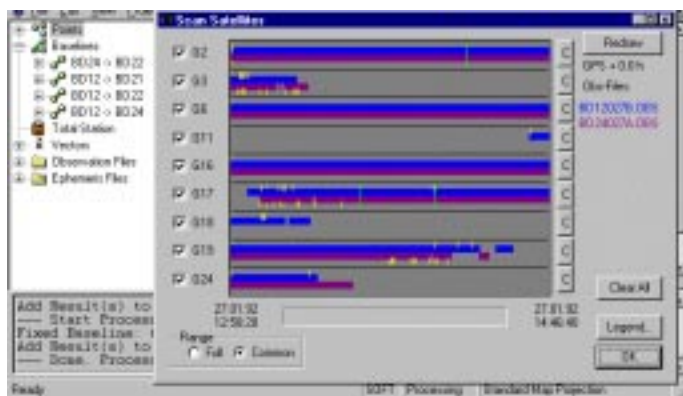


Figure 18-20: Network Ashtech.L12 - Scan Baseline

Scan Baseline:
Ch. 14.2

The bars for satellites G3, G17 and G19 show lots of loss of lock events. Increase the quality of the baseline by completely disabling satellite G3 and by fencing off parts of satellites G17 and G19: For G17 fence off the first 15 minutes, for G19 the last 45 minutes.



*It is very often useful to scan the baselines for to check out the data, if **GeoGenius** could not fix ambiguities. Disable suspicious satellites or time spans!*

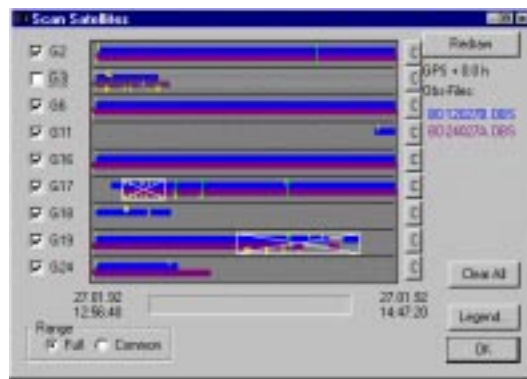


Figure 18-21: Network Ashtech.L12 - Disable Sats and Time Spans

*Process
Baseline:
Ch. 7.1* | Accept the disabled satellites and time spans with **OK**. Process the baseline again (Process/Process Line). Its error ellipse now will be even smaller than before. Click the baseline (right mouse button) and choose Properties/Ellipse to check the baseline data.

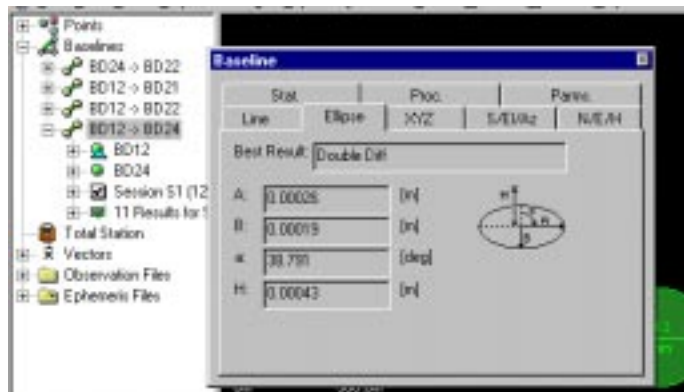


Figure 18-22: Network Ashtech.L12 - Baseline Properties, Page Ellips

 To check out the quality of the network do a free adjustment in the WGS-84 system. Choose Adjust/Adjust (Free). **GeoGenius** performs a free network adjustment and displays the results in the adjustment display mode. The primary coordinate sets of all points now consist of the adjusted coordinates (if the default adjustment settings are valid). All baselines passed the Tau test.

Free Network Adjustment:
Ch.12.2



Figure 18-23: Network Ashtech.L12 - Adjusted

18.4 The Network GG24

Data
Import:
Ch. 5.5

The Network GG24 consists of several raw GPS and GLONASS data files. Open a new project (File/New) and then choose Project/Files into Project. Go to the SAMPLES/GG24 sub-directory, select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.



Figure 18-24: Network GG24 - Insert Files

GeoGenius automatically uses the right decoder. It creates 36 observation files in the **GeoGenius** standard *.OBS format and 72 RINEX Broadcast Ephemeris files. Then, one ephemeris file in the binary EF-18 format is created.

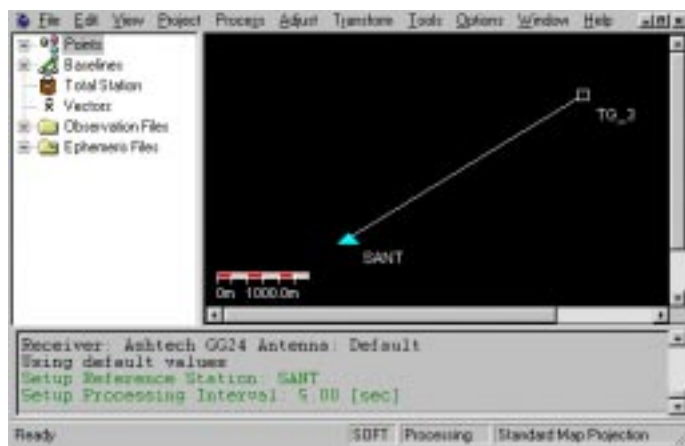


Figure 18-25: Network GG24 - Single Point Positions

The GG24 network in fact consists of a single baseline. In the navigator, double-click the baseline container  and then double-click the baseline  (Or: click - left mouse button the + -shaped box left of the item): 18 sessions exist for the baseline.

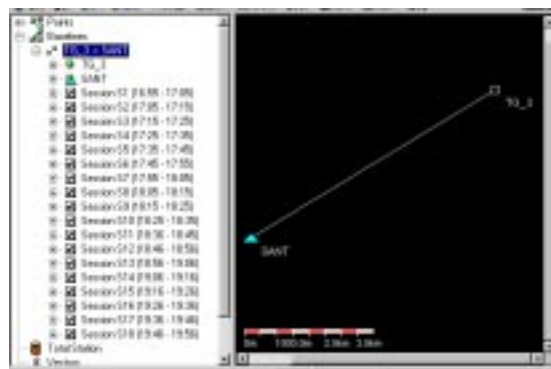


Figure 18-26: Network GG24 - Navigator

Select
Sessions:
Ch. 7.1

Activate the baseline (right mouse button), select Toggle Sessions, select Disable All.

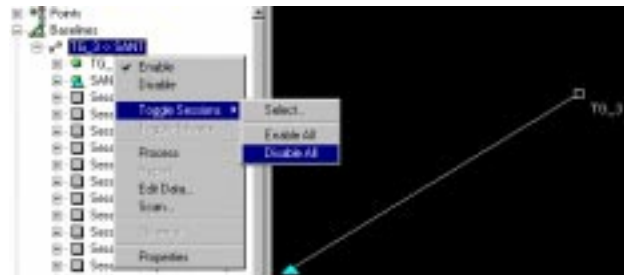


Figure 18-27: Network GG24 - Disable All Sessions

Enable the second session (S2): click the session (right mouse button), select Enable Session.

Inspect the observation files referring to each session. Click the baseline (right mouse button); of its context menu select Toggle Sessions. Choose Select. The Session Selector window pops up, displaying the path and file names of all sessions of the baseline.

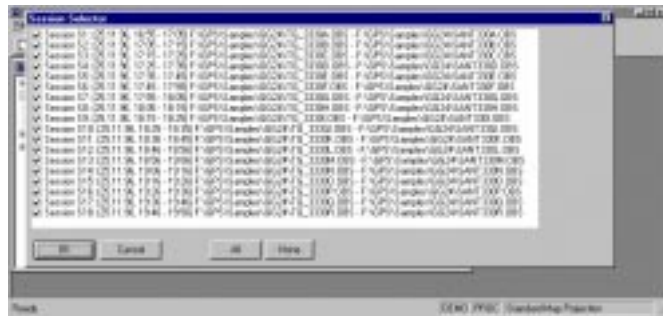


Figure 18-28: Network GG24 - Session Selector

Before processing, inspect the processing settings. Choose Process/Settings. Two pages contain GLONASS specific parameters. Page Parameter allows you to set a GLONASS specific elevation cutoff angle (default 15°). If you want to exclude unhealthy GLONASS satellites from processing, go to Page GLN Sats and check the respective satellite for disabling.



Figure 18-29: Network GG24 - GLN Sats

Processing
Results:
Ch. 8.2

Then process the baseline using the default parameters (Process/Process Line). GLONASS data are processed in the same way as GPS data. First a triple difference solution and cycle slip fixing is done, then **GeoGenius** processes double difference float and, if possible, fixed solutions. **GeoGenius** automatically sets the frequency to L1, since no L2 data are found. The ratio succeeded with only 2.2 (minimum ratio required to accept the fixing of integer ambiguities: default = 2.0). This means that ambiguities could be fixed with sufficient reliability. Therefore, the baseline is processed “green”.



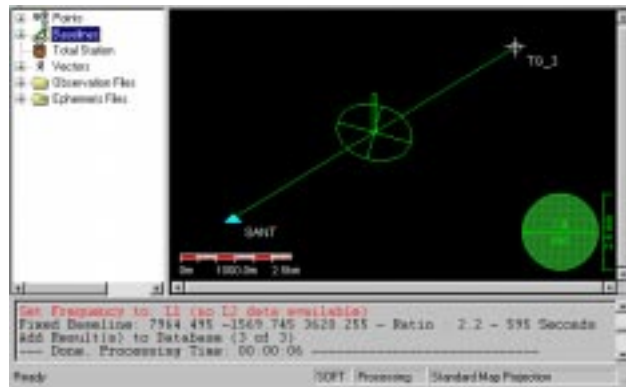


Figure 18-30: Network GG24 - Session S2 Processed

Processing Options:
Ch. 7.4

Now, also enable session S8. Open the Processing Options window (Process/Settings...) and choose page Processor. Activate the option Combine (enabled) Sessions.



Figure 18-31: Network GG24 - Processing Options Processor

Re-process the baseline. The standard deviations will be considerably smaller and the ratio will improve considerably.

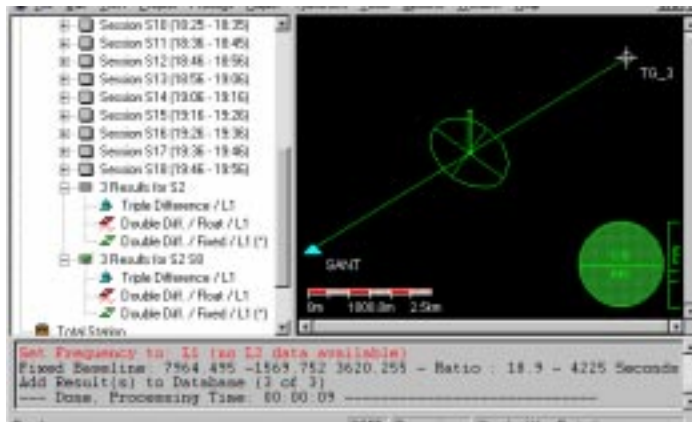


Figure 18-32: Network GG24 - Baseline Re-processed

Note the  Results containers in the baseline tree. Each processing adds a new Results container to the baseline tree. The last container is active. Each contains three solutions: one triple difference solution, a double difference float solution in L1 and one double difference fixed solutions in L1. The best solution of each processing is marked by an asterisk (*) and added to the  Vectors container.

Go on and play around with combinations of the different sessions. You can define how the processor should process and handle the different sessions using the Processing Options notebook.

18.5 The Network GG24.Net

Data
Import:
Ch. 5.5

The Network GG24.Net consists of several raw GPS and GLONASS data files. Open a new project (File/New) and then choose Project/Files into Project. Go to the SAMPLES/GG24.NET sub-directory, select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.

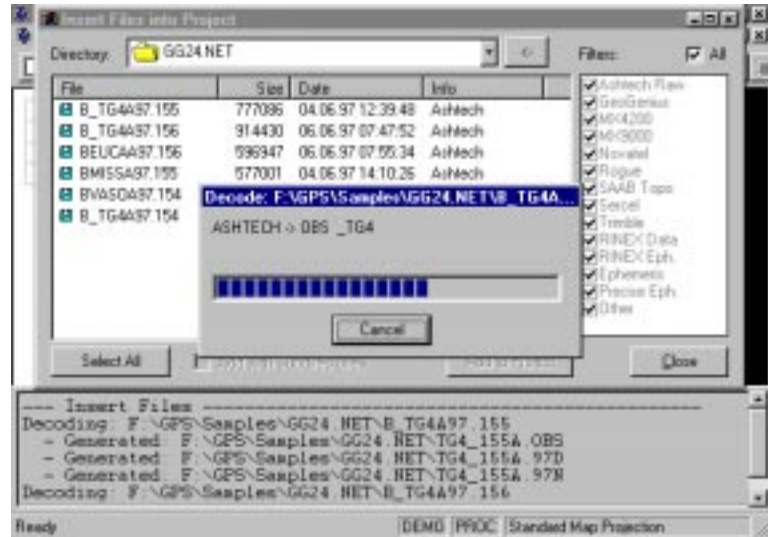


Figure 18-33: Network GG24.Net - Decoding Raw Data

GeoGenius automatically uses the right decoder. It creates 6 observation files in the **GeoGenius** standard *.OBS format and 12 RINEX Broadcast Ephemeris files. Then, one ephemeris file in the binary EF-18 format is created.



Figure 18-34: Network GG24.Net - Preliminary Net

The network consists of 4 points and 3 baselines. Point _TG4 is the only point with connections to more than one point.

You do not have to choose a System first, the Standard Map Projection will do for this example, since it is only used for the display of the project plot.



Save
Project
Ch. 5.4.4

Save the project (File/Save), e.g., as file
SAMPLEGG24NET.GGS.



First do a Single Point Positioning for Point _TG4. Click the first observation file name (right mouse button) in the point's tree, click Single Point Position.



Figure 18-35: Network GG24.Net - SPP Window

First, accept the GPS system and the Static mode with **OK**. **GeoGenius** calculates the single point position from GPS satellites only. Progress bars show up during processing.


SPP
Ch. 14.3

The SPP Result window displays the calculated positions and the standard deviations. You may view the former coordinates of the point and the differences to the new coordinates in meters.

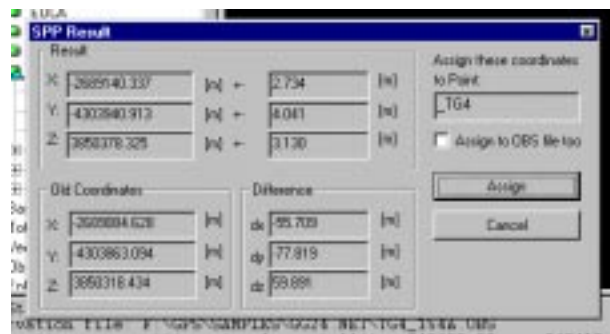


Figure 18-36: Network GG24.Net - SPP Results for GPS

Note the standard deviations of the new position: They are about 3 m for each coordinate. The new positions differ 55... 77 m in each coordinate from the old positions. Press **Cancel** to instruct **GeoGenius** *not* to assign the single point position coordinates to the point and to close the window.

Now, repeat the SPP twice using the same observation file, first choosing the options GLN, then the option GPS+GLN. Note, how the standard deviations improve considerably when using GLONASS satellites (as well as in the combination of both systems): values between 0.6 and 0.7 m for each coordinate.



Figure 18-37: Network GG24.Net - SPP Result for GLONASS

Of course, errors (both systems!) usually are far too optimistic (up to factor 10!), since the processor has no information on atmospheric delay, clock errors or satellite orbits. But still, there is the difference between GPS and GLN satellites: GPS data are mostly influenced by Selective Availability (S/A) effects that reduce the position accuracy considerably. The **GeoGenius** processor is designed to eliminate the S/A effects.

You do not have to assign the SPP results, since we know the coordinates of point _TG4.

Point Properties:
Ch. 12.4.4

Insert the known coordinates into the project. Click Point _TG4 (left mouse button, either in the navigator or the plot), click again (right mouse button) and choose menu item Properties. Choose page XYZ of the notebook Property: Point.

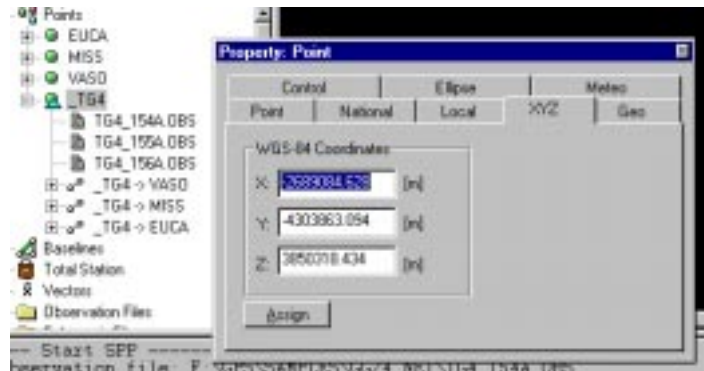


Figure 18-38: Network GG24.Net - XYZ Coordinates

Enter the following correct coordinates and click **Assign**.

X: -2689134.900
Y: -4303904.050
Z: 3850366.830

Instrument Height Definition:
Ch. 5.7

The antenna height definition for point EUCA has to be changed. Double-click the Points container, double-click point EUCA, click the observation file (right mouse button) (or double-click the Observation Files container, click the observation file EUCA156A.OBS). Choose Properties, page N/E/h.



Figure 18-39: Network GG24.Net - Antenna Height Definition

Click the **Slope** radio button. This instructs **GeoGenius** to respect the registered height offset of the antenna phase center from the position of the ground as being a Slope height. Click **Assign**.

Process
project:
Ch. 8

Now process the project using the default settings. Click **Process/Process Project**. **GeoGenius** then automatically detects the type of data and uses the static processor. GLONASS data are processed in the same way as GPS data. First a triple difference solution and cycle slip fixing is done, then **GeoGenius** processes double difference float and, if possible, fixed solutions. **GeoGenius** automatically sets the frequency to L1, since no L2 data are found. For each baseline three solution are found; one solution, the double difference fixed solution, will be used for network adjustment and is, therefore, displayed in the Vectors  container.

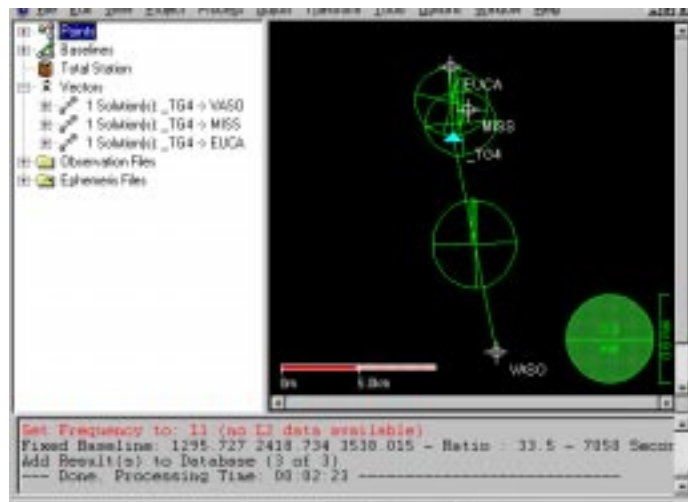


Figure 18-40: Network GG24.Net - Processed Baselines

Report:
Ch.
8.2.4
Ann D

GeoGenius generates a report for each baseline. Open the report for baseline **_TG4→VASO**: Double-click the  Baselines container, click (right mouse button) the  baseline, choose **Report...** The  7 pages report subsumes the observation file information on receivers and observed satellites and gives detailed lists on all solutions and ambiguity resolutions. Play around with the editing and zooming capabilities of **MultiPage**, the **GeoGenius** text presentation tool.

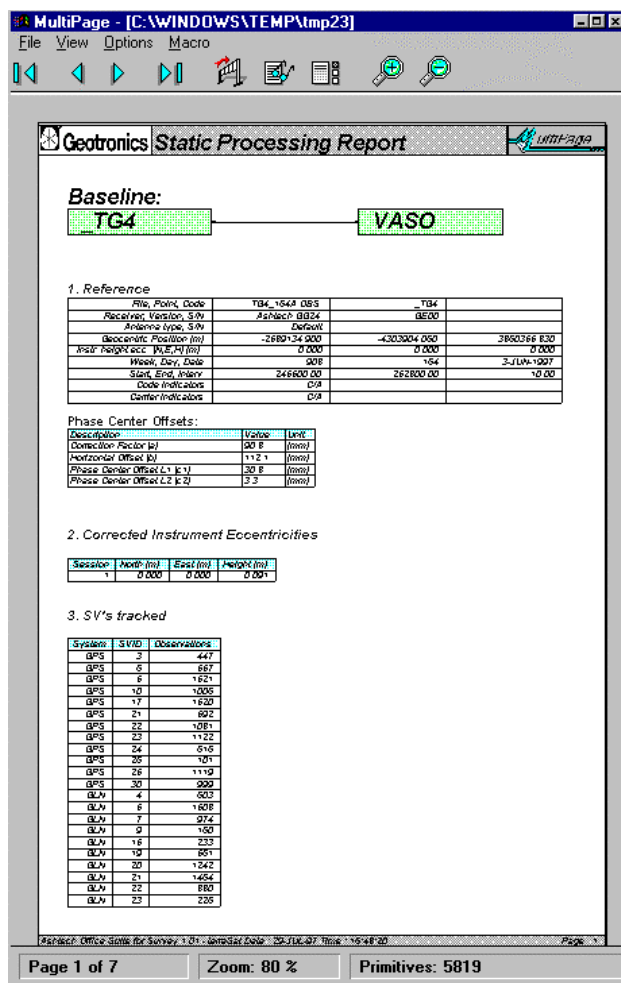


Figure 18-41: Network GG24.Net - Baseline Report

You need not adjust the network, since no over-determined points exist. Therefore, we will finally create a System to transform the coordinates into state plane coordinates.

 To select the System choose the menu item **Project/System...**. The network GG24.Net is to be transformed into the US California Zone 3 projection. Up to now, the System Selector does not offer a System of this type. Create the System first: click **Editor...**.

Select
System:
Ch. 6.2

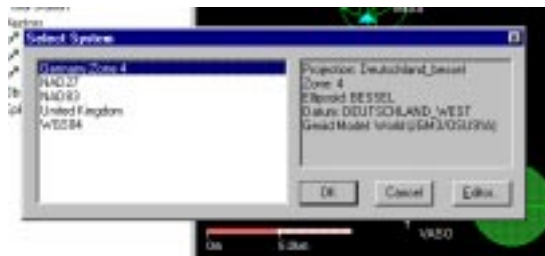


Figure 18-42: Network GG24.Net - System Selector

 Create the System first: click **Editor...** to open the System Editor.

System
Editor:
Ch. 6.5

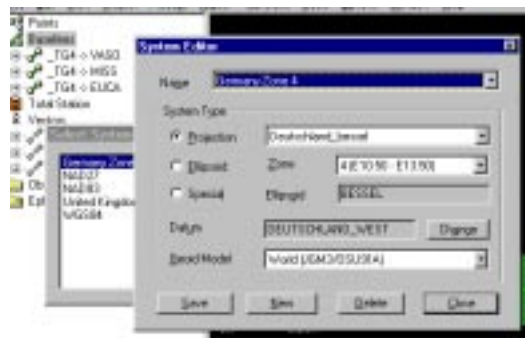


Figure 18-43: Network GG24.Net - System Editor

Click **New** to create a new System. Enter the System name: US California Zone 3. Click **OK**.

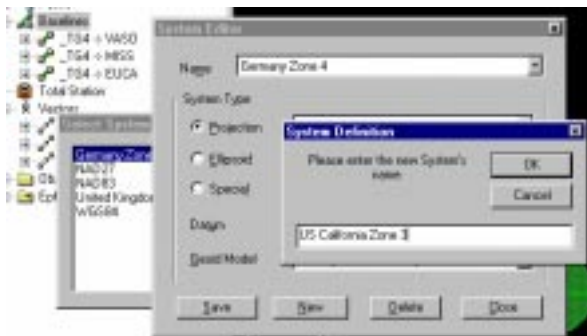


Figure 18-44: Network GG24.Net - New System Name

The System Type: Projection must be activated (if it is not, click the button left to Projection). Click the ▼ symbol right of the projection name combo box and choose US_CA_3_0403 out of the list of projections.

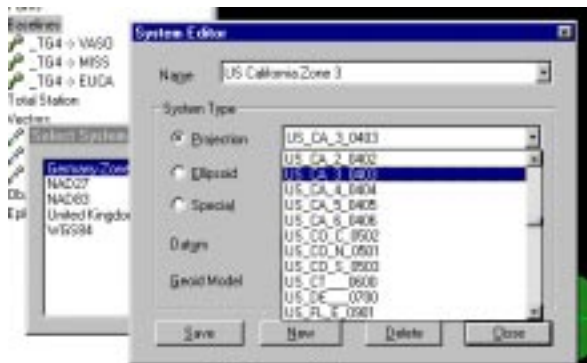


Figure 18-45: Network GG24.Net - New Projection

GeoTrans will automatically select the corresponding ellipsoid (WGS_84) and Datum (NAD83). Since the projection itself contains the zone information, no additional zone information is necessary or available (Zone: None).



Figure 18-46: Network GG24.Net - Projection, Ellipsoid and Datum

Now, the geoid model is the only information left you have to add to the System. Click the ▼ symbol in the Geoid Model combo box and look for the geoid model Northwestern US NOAA96. If this geoid model does not show up in the list, it is not yet installed.


**Install
Geoids:**
Ch. 2.1.3

*To install a **GeoGenius** geoid model* save the new System and close the System Editor (Click **Save**, **Close**). Leave **GeoGenius** without saving. Follow the instructions in chapter 2 of this manual. If you choose the installation type Typical, all geoid models will be installed. Geoid models might then be included and will occupy space, which you might never use. Therefore, to select one or several geoid models, you should choose the installation type Custom and deselect the other models.

Here, we need the geoid model NOAA96 NW. Install the geoid model(s) into the sub-directory \SYSDBS of your **GeoGenius** root di-

rectory. Move again to **GeoGenius** and open the System Editor. Choose the System US California Zone 3. It consists of the correct projection, but still does not show the desired geoid model. Click the ▼ symbol in the geoid model name combo box and you will now find the geoid model Northwestern US NOAA96.

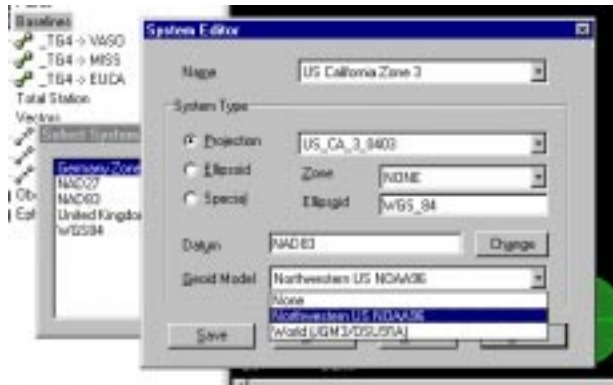


Figure 18-47: Network GG24.Net - Choose Geoid Model

Accept the Geoid Model Northwestern US NOAA96. Click **Save** to save the System. If you do not so, the System (or the changes to the System) will not be saved at all!

The System US California Zone 3 now consists of the following information:

Projection :	US_CA_3_0403
Zone:	None
Ellipsoid:	WGS_84
Datum:	NAD83
Geoid Model:	Northwestern US NOAA96

Click **C**lose to leave the System Editor. In the System Selector, select the System US California Zone 3. Click **O**K.

GeoGenius automatically starts the transformation of the point coordinates into the national System. Accept the warning message “System Changed” without changes.

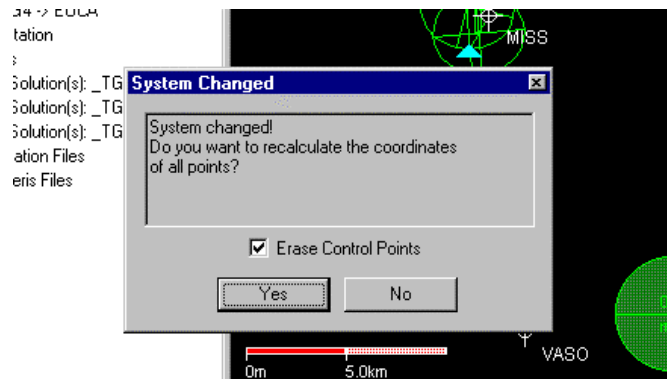


Figure 18-48: Network GG24.Net - Transform WGS84 to US California

The **GeoGenius** main window now displays the new System in the status bar. To check the national coordinates of a point click the point name (right mouse button), select **Properties** and click the tab **N**ational.

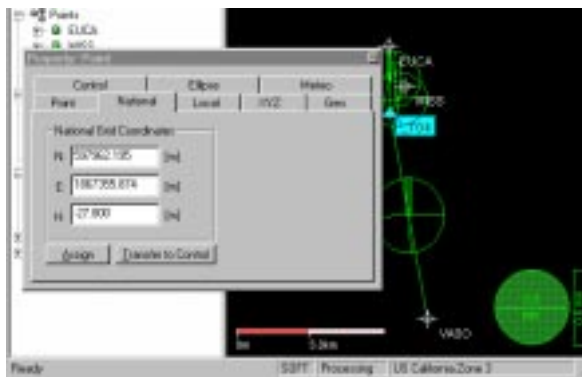


Figure 18-49: Network GG24.Net - National Coordinates Available

The page National displays ellipsoidal heights. If you want to check the geoidal heights, move on to the **GeoTrans** transformation module.



GeoTrans
User's
Manual

Although **GeoTrans** is a stand alone transformation module, it can also be accessed directly from **GeoGenius** and use all the data from a current Survey Project. Start it by using menu items **Tools/Transformation/Projection** to access it. On entering the module a point list of the four stations in the project will be displayed in the WGS84 coordinate system. This list will contain the processing results. The point list is a list of points in a specific geodetic System and you can change between the different coordinate systems without leaving the point list by clicking on the ▼ in the coordinate system name box.

Play around by transforming the coordinates within the system, but be aware of the NATO GEOREF system: The precision of your coordinates will probably be reduced, if you transform into this coordinate system. **GeoTrans** re-computes the coordinates each time you choose a new coordinate system, and, therefore, would base its calculation of

X,Y,Z or LAT, Long, Height coordinates on the NATO GEOREF input with lower precision.

Now, start the transformation of the point coordinates into the national System. Choose Transformation/Transform to Predefined System, select the System US California Zone 3. Click **OK**.

GeoTrans creates a second point list (PointList2) of the local coordinates in the US California Zone 3 System. Geoidal heights and plane coordinates are now available. The columns Sea level, Scale and Conv. show results.

Point	X	Y	Z	GeoidH	Sea Level	ScaleF	Conv
1	2689134.900	4303904.098	3851956.838	0.880	N/A	N/A	00° 00' 00.00000
2	2687823.180	4301405.325	3852904.868	0.880	N/A	N/A	00° 00' 00.00000
3	2687743.271	4303491.734	3851756.967	0.880	N/A	N/A	00° 00' 00.00000

Point	X	Y	Z	GeoidH	Sea Level	ScaleF	Conv
1	2689134.900	4303904.098	3851956.838	0.880	4.363	-45.156	00° 55' 00.3296
2	2687823.180	4301405.325	3852904.868	0.880	5.633	-53.588	00° 52' 05.4793
3	2687743.271	4303491.734	3851756.967	0.880	7.481	-58.975	00° 54' 36.9504
4	2691294.801	4312937.947	3852904.838	-32.481	5.633	-32.418	00° 53' 51.0891

Figure 18-50: Network GG24.Net - Transformation Results

The last three columns show the following values:

- o Sea Level: Factor to reduce measured distances to sea level distances [ppm]
- o ScaleF: Factor for the distortion in length due to the projection into the plane [ppm]
- o Conv: Convergence of meridians due to the projection into the plane [ppm]

Close **GeoTrans** (Project/Exit). You will be asked whether or not you want to store the results.

18.6 The Network Horn

*Data
Import:*
Ch. 5.5.1

The Network Horn consists of several observation and ephemeris files, organized in three directories according to the observation date. Open a new project (File/New) and then choose Project/Files into Project. Go to the \SAMPLES\HORN\DAY1 sub-directory. **GeoGenius** scans the directory for data files and displays a list of 21 observation files with the extension *.OBS and the corresponding ephemeris files with the extension *.95N. The list of file converters on the right side of the Insert Files into Project window displays the observation files as enabled.

Select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.

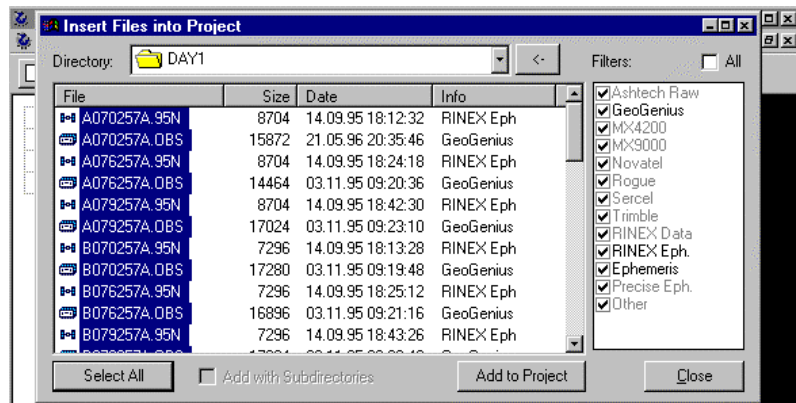


Figure 18-51: Network Horn - Insert Files

*Ephemeris
Genera-
tion:*
Ch. 5.5.1

GeoGenius inserts the files into the new project and creates an ephemeris file in the binary EF-18 broadcast format and a preliminary plot.

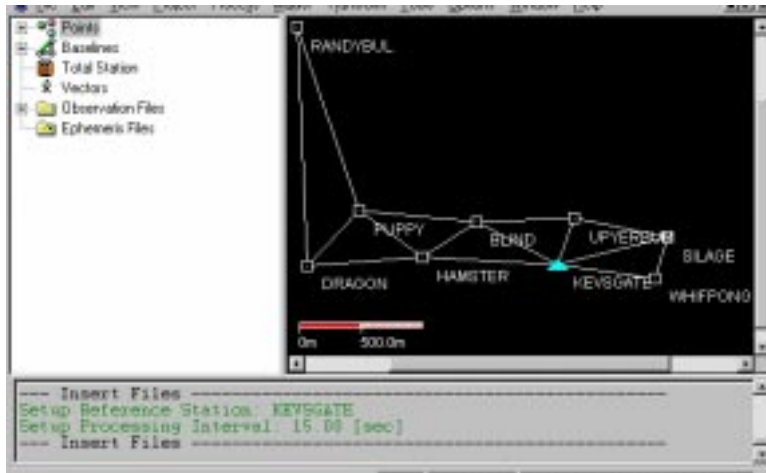


Figure 18-52: Network Horn - Preliminary Plot

For this network, precise state plane coordinates exist for several points, which we can insert into the project after having set the System.

*Select
System:*
Ch. 6.2

To select the System click **Project/System...** and choose the System United Kingdom. This System is the projection United_Kingdom, based on the Great_Britain_1936 (OSGB36) datum and the Airy ellipsoid. A World Geoid Model is introduced.

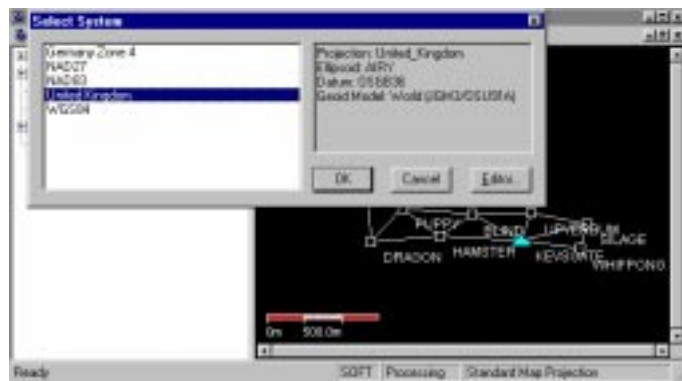


Figure 18-53: Network Horn - Select System

Click **OK** to accept your selection. A warning dialog pops up and allows you to confirm the recalculation of the coordinates of all points.

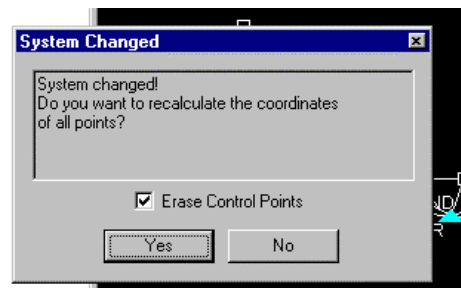


Figure 18-54: Network Horn - Recalculate Coordinates?

 Accept recalculation.

Import Points:
Ch. 5.5.2 To enter the national coordinates of point KEVSGATE click the point (right mouse-button) and choose the menu item **Properties**. Click **Tab National** and enter the following values:

N: 453323.349
E: 509105.180
h: 22.860 (ellips)

 Click **Assign**. GeoGenius has automatically chosen the point KEVSGATE as reference, since it is the point with the most connections to other points. Do not change the check mark of box Fix as Control Point (refer to page Control).

*Define
Reference:
Ch. 7.2*



Figure 18-55: Network Horn - Enter State Plane Coordinates

 To close the properties window click the **Exit** button at the upper right corner. If the baselines are not all enabled, enable all baselines: in the navigator: click  Baselines (right mouse button)/Enable All (left mouse button), otherwise click the corresponding toolbar button. 

*Baseline
Selection:
Ch. 7.1*

Let us delete a baseline from the project, just to demonstrate how this is done most easily. In the navigator click the baseline PUPPY->BLIND (left mouse button).

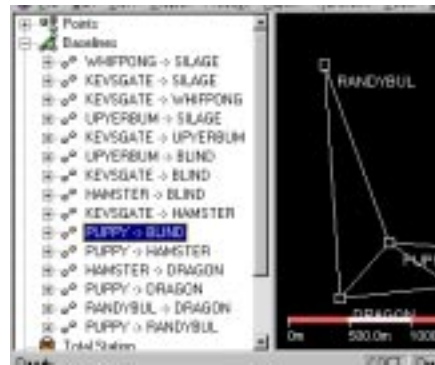


Figure 18-56: Network Horn - Navigator

Now, click the **DEL** button of your keyboard to delete this baseline from the project. The baseline will disappear from the plot as well as from the navigator, including all the corresponding observation files.



Please note that if you have deleted observation files from the project, they are not deleted from your hard disk!

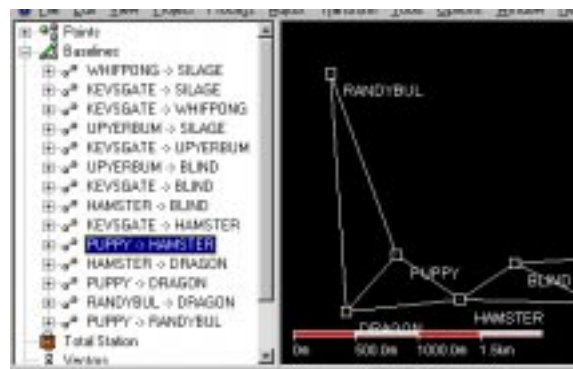


Figure 18-57: Network Horn - Baseline PUPPY->BLIND Deleted

Save the project (File/Save), e.g., under the name SAMPLE-HORN.GGS.



Process Project: Ch. 8

Process the project: click Process/Process Project or the corresponding toolbar button.



Figure 18-58: Network Horn - Network Processed

The network Horn consists of observations from different days. Now, insert the observations of day 2: Choose Project/Files into Project. Go to the \SAMPLES\HORN\DAY2 sub-directory. **GeoGenius** scans the directory for data files and displays again a list of 21 observation files with the extension *.OBS and the corresponding ephemeris files with the extension *.95N.



Select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.



Figure 18-59: Network Horn - Day 2 Observations Inserted

Note, that your reference point connects the new baselines to the processed network. Before processing the project again, we will disable all already processed baselines (which will speed up the processing procedure in case of a bigger network).

*Ephemeris
Generation:*
Ch. 7.3

We do not have to update the ephemeris data. **GeoGenius** automatically updates the binary EF-18 file (or, in case Day2 belongs to a second week, generates a second EF-18 file). Nevertheless, you may update the ephemeris file manually: click **Process/Generate Ephemeris** or the corresponding button from toolbar Processing. The ephemeris file ECF0818.EPH will be updated.



 To disable the already processed baselines click  **Base-**
Toggle **lines/Toggle/Toggle Green** (because all baselines were
Enable processed green!) or the corresponding button from the Lines tool-
Status: bar. If you do not want the disabled baselines to be displayed,
Ch.12.4.1, click **View/Hide Disabled Lines** or the corresponding
5.2 button from the same toolbar. **GeoGenius** displays the hidden
lines again with **View/Show Disabled Lines** or a click
onto the corresponding toolbar button.

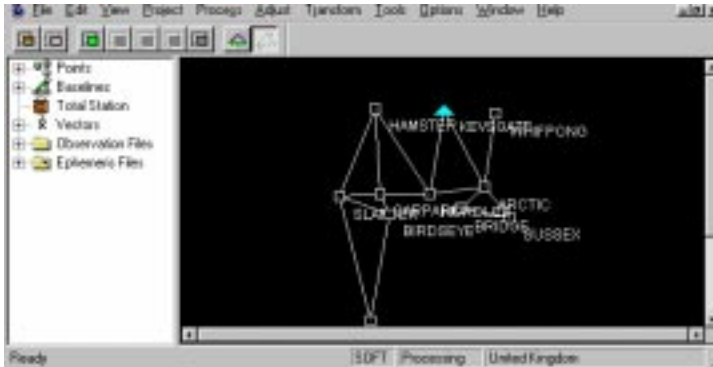


Figure 18-60: Network Horn - Green Lines Disabled and Hidden

Zoom in:  Process the project, then enable all baselines to get a better view of your network and of all the error ellipses (e.g., pull-down menu **Edit/Base Lines/Enable All**). Press the left mouse button and drag it over the project plot to zoom into the project.

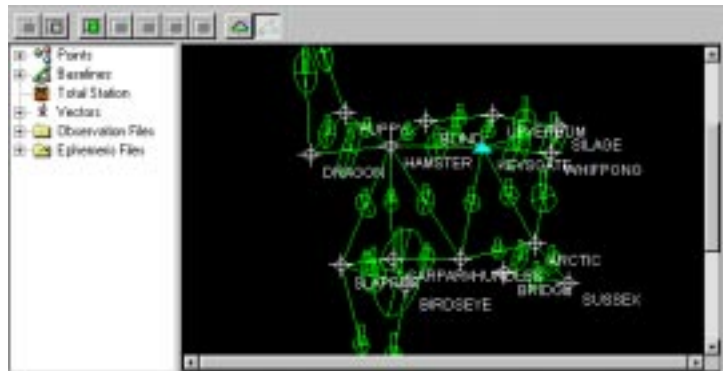


Figure 18-61: Network Horn - Zoomed Into Processed Network (Day1 and Day2)

The last observations of this project have been collected at a third day. Insert the files of sub-directory \DAY3 into the project and disable all processed baselines.

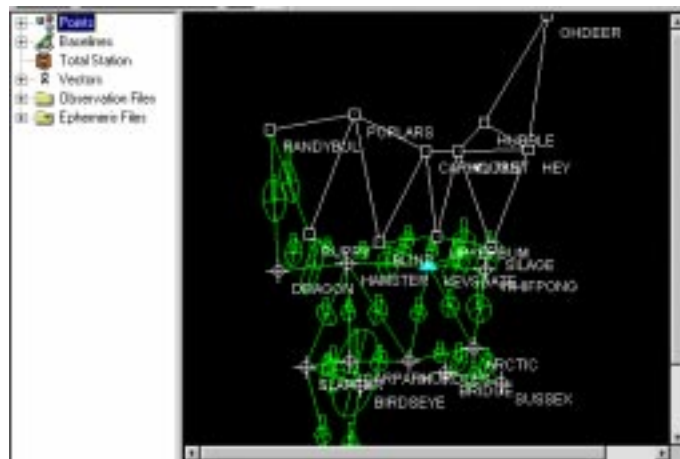


Figure 18-62: Network Horn - All Lines Inserted

Insert National Point:
Ch. 5.5.2

You will notice that the new baselines are not connected to the reference point. To process the network in state plane coordinates enter the known state plane coordinates for point OHDEER and choose this point for reference. Click (right mouse button) the point (in the navigator or plot), choose menu item Properties/National and enter the following values:

N: 456675.522
E: 510687.980
h: (ell.) 29.790

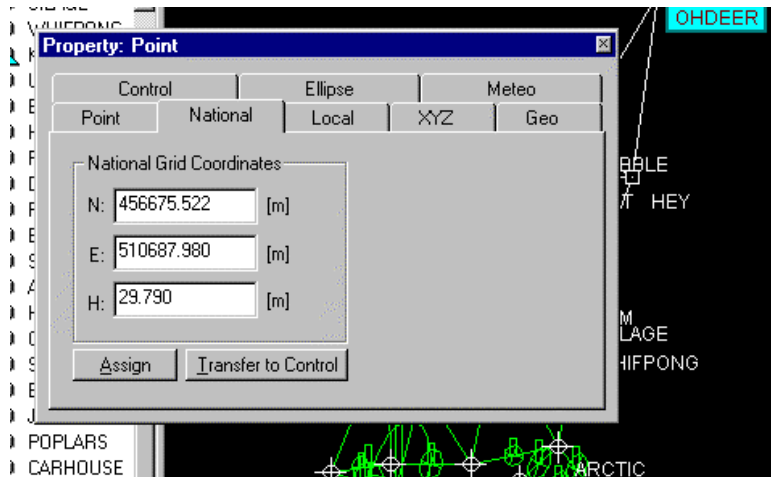


Figure 18-63: Network Horn – Enter Known Coordinates

You will notice that the state plane coordinates differ considerably to the approximate values. Click **Assign** and move to the page Control.

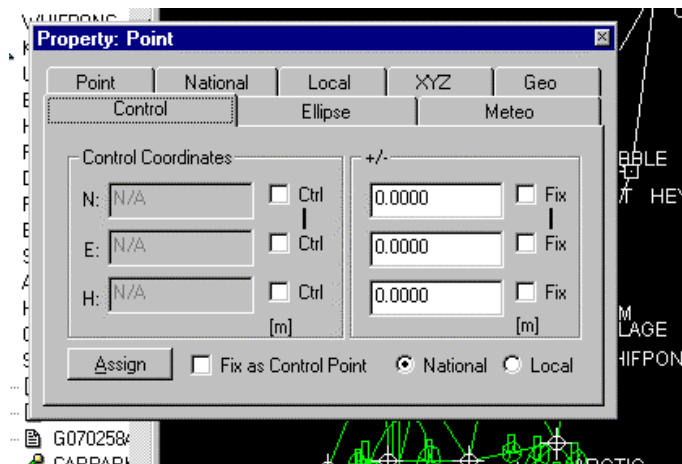


Figure 18-64: Network Horn - Fix as Control Point

The page Control allows you to provide a second set of coordinates for identical points for adjustments in the local System. Additionally, if you fix a point here, its primary set of coordinates will be held fixed as reference point for processing. Check the box **Fix as Control Point**. If you do not want any more the Properties notebook to be displayed, click the **Exit** button of the header line.

Processing the project will result in all baselines processed as green, i.e., with fixed ambiguities and sigmas beyond the default minimum of 20 mm. Enable all baselines to get a better view over your network.

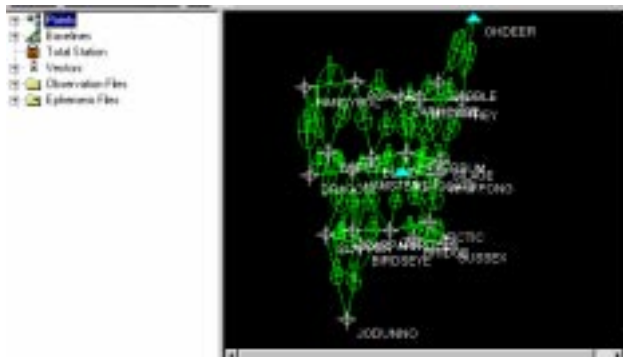


Figure 18-65: Network Horn - Network Processed

Data Import: Ch. 5.5 Next, the network has to be adjusted. To get a national biased adjustment, four points with known national grid coordinates are necessary. The sample data contains an *.SPC file. To insert national grid coordinates, click **Project/Import National Grid Points** or the corresponding button of toolbar **Project**. The **Format Selector** window pops up.

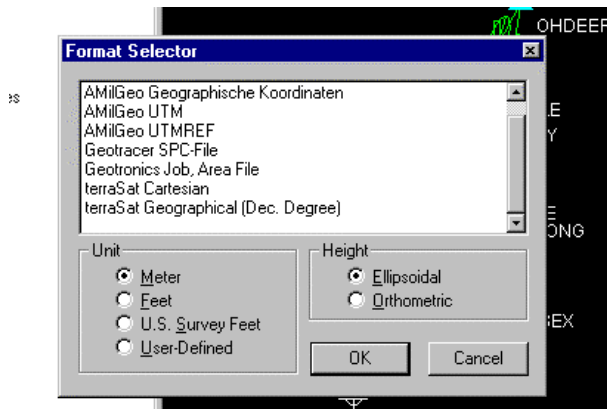


Figure 18-66: Network Horn - Format Selector

Choose the Geotracer SPC-File format and check the boxes Units Meters and Height Ellipsoidal. Click **OK** to accept. A standard Windows file selector allows you to select the file HORN.SPC of the sub-directory \SAMPLES\HORN\. The Import Points dialog pops up. All points of the *.SPC file are identical with points of the project.



Figure 18-67: Network Horn - Import Points Dialog

Make sure that the option Assign Control Coordinates is checked. Click **Import**. The project plot and the navigator will now display the following points as fixed (we have manually entered the coordinates of the first two points, but they are also stored in the control coordinate file):

KEVSGATE
OHDEER
JODUNNO
RANDYBUL

National Adjustment:
Ch.12.3

Now start a national biased adjustment. That means, that you will get adjusted state plane coordinates and the 7 parameters between WGS84 and the United Kingdom System in a single step. Click Adjust/Adjust(National, Biased).

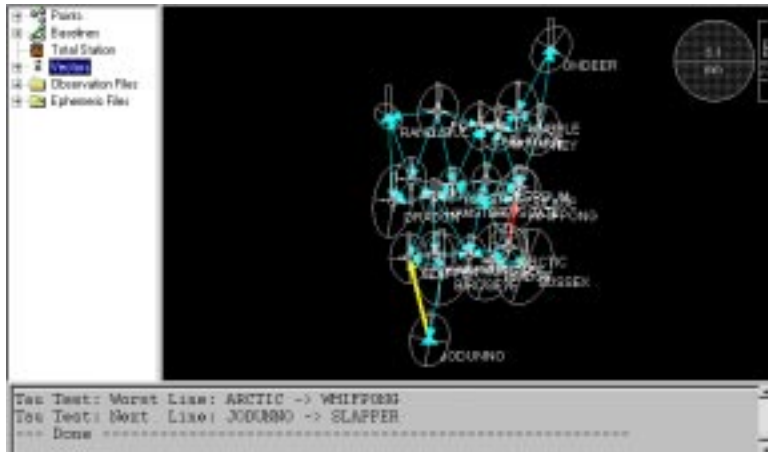


Figure 18-68: Network Horn - National Biased Adjustment

Note the change of the project plot to the adjustment display mode.

The output window displays the results of the Tau test: it counts all lines marked as bad and displays the name of the worst line. Here, the Tau test signals, that two lines are marked as bad. This means, that they got a higher correction than 5mm + 1 ppm (default maximum values). These line are the line ARCTIC -> WHIFFPONG, since it is the worst line (the project plot marks this line with as red line) and line JODUNNO -> SLAPPER, the next line (the project plot marks this line with as yellow line).

Typically, you would now check the reasons for the bad adjustment results. Check the properties of a line and its start and end point and check, whether data were entered correctly: errors could result from wrong antenna heights and antenna height corrections, point occupation errors, etc.

*Adjustment
results:*
Ch. 12.6



You may also open an adjustment report. Click **Adjust/Report...** This opens an adjustment report in the **MultiPage** module, showing you the results of the network adjustment (refer to *Figure 18-70*).

*Export
results:*
Ch. 5.6



Last but not least: export the adjusted state plane coordinates to a further data format. Click the pull-down menu **Project/Export Formats** and choose option **DXF/2 Layers**. A standard Windows file selector pops up and allows you to enter a file name. The file name box suggest a name with the extension *.DXF. Choose a directory and enter the name, e.g., **HORN.DXF**. **GeoGenius** generates the DXF file - a progress bar allows you to control the generation. At last, the output window displays the successful generation of the DXF file.



Figure 18-69: Network Horn - Export File Generated

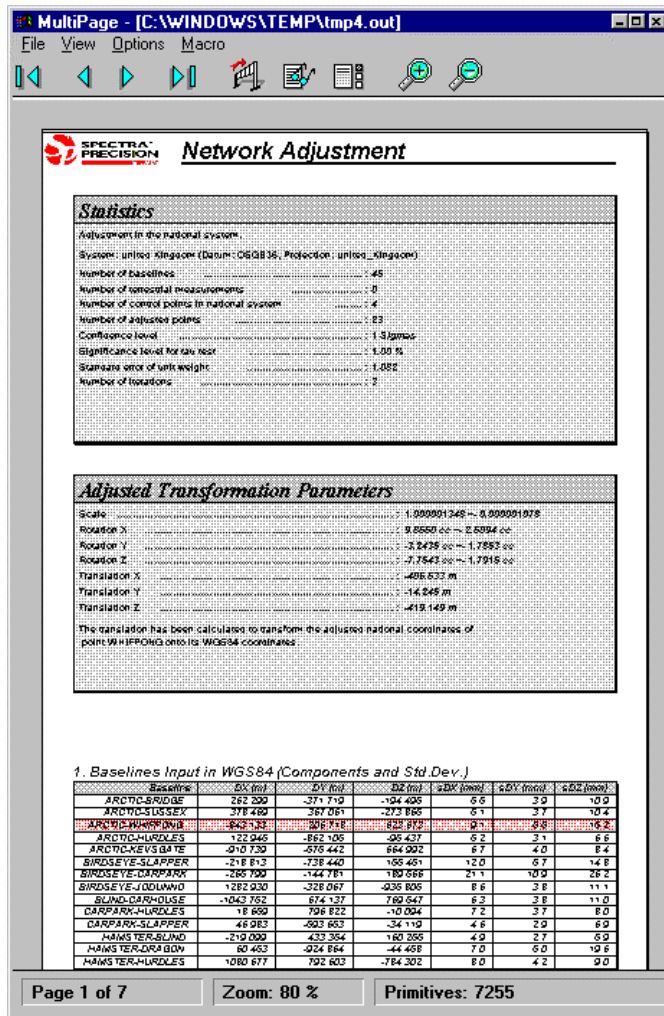


Figure 18-70: Network Horn - Adjustment Report

18.7 The Network Metrik

*Data
Import:
Ch. 5.5*

The network Metrik consists of 40 raw data and 40 ephemeris files, collected with a Trimble receiver. Open a new project (File/New) and then choose Project/Files into Project. Go to the \SAMPLES\METRIK sub-directory. **GeoGenius** scans the directory for data files and displays a list of 40 raw data files with the extension *.DAT. It does not display the corresponding raw Trimble ephemeris files with the extension *.EPH. These files do not start with ECF as the first three characters. **GeoGenius**, therefore, identifies these files as being no Broadcast Ephemeris files in the binary EF18 format. The list of file converters on the right side of the Insert Files into Project window only displays Trimble files as enabled.

Select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.

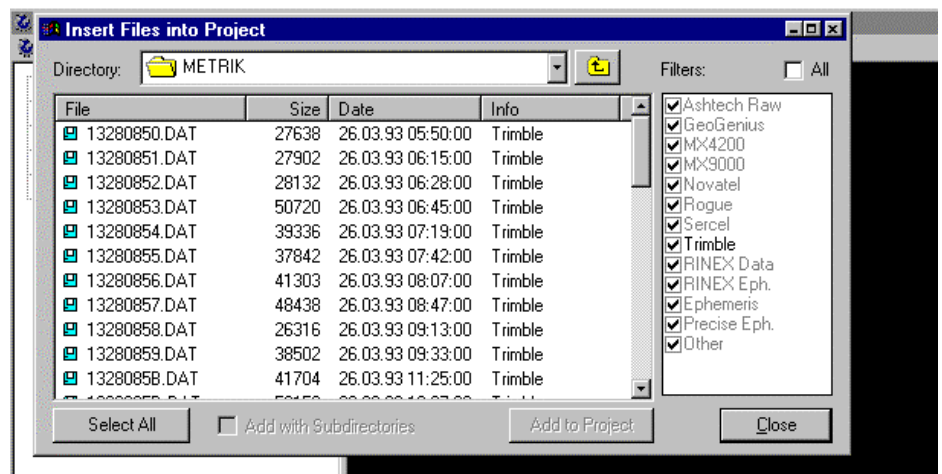


Figure 18-71: Network Metrik - Insert Files

Decoding
Raw
Data:
Ch. 5.5
Ephemeris
Genera-
tion:
Ch. 7.3

GeoGenius automatically decodes the raw data and generates observation files and a binary ephemeris file in the Ef18 format.

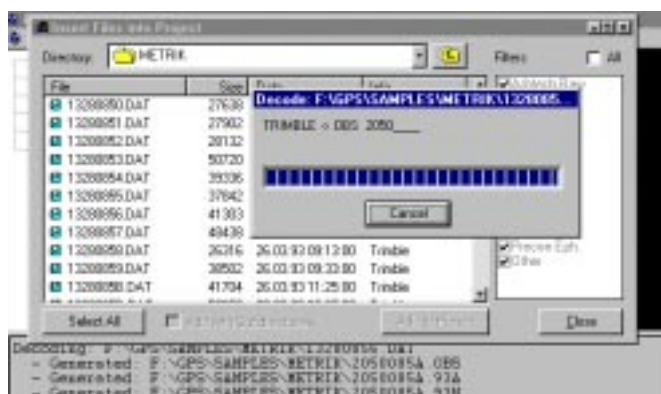


Figure 18-72: Network Metrik - Observation File Generation

A preliminary plot is generated from the newly created and inserted observation files.

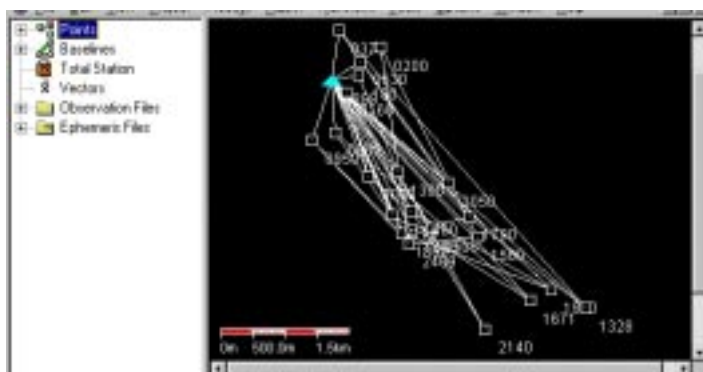


Figure 18-73: Network Metrik - Preliminary Plot

For this network, precise state plane coordinates exist for several points, which we can insert into the project after having set the System.

Select System:
Ch. 6.2

To select the System click **Project/System...** and choose the System Germany Zone 4. This System is Zone 4 of the projection Deutschland_bessel, based on the DEUTSCHLAND_WEST datum and the Bessel ellipsoid. A World Geoid Model is introduced.

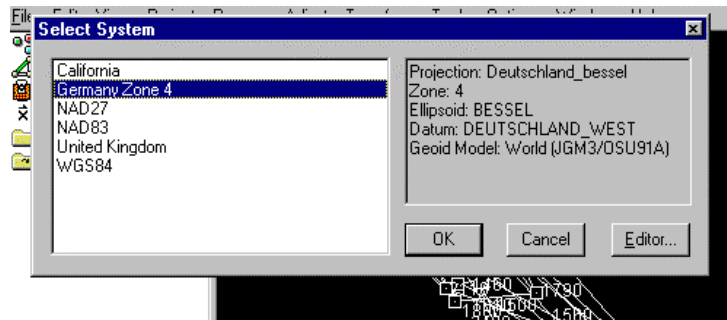


Figure 18-74: Network Metrik - Select System

Click **OK** to accept your selection. A warning dialog pops up and allows you to confirm the re-calculation of the coordinates of all points.



Figure 18-75: Network Horn - Recalculate Coordinates?

Click **Yes** to accept re-calculation.



Save the project (File/Save), e.g., under the name **METRIK.GGS**.



Save
Project:
Ch. 5.4.4
Enter
National
Point
Ch. 5.5.2

To enter the national grid coordinates of point 8889 to be used for processing we click the point (right mouse-button) and choose the context menu item **Properties**. Click the tab **National**. It display the SPP approximate national coordinates.

Figure 18-76: Network Metrik - Approximate National Coordinates for Point 8889

Enter the following precise values:

Point #	N	E	Ell. Height
8889	5712997.569	463048.932	255.257

Click the button **Assign** and the button **Transfer to Control** because we will need the control coordinates for the adjustment. Click

the tab Control and make sure, that the checkbox Fix as Control Point is checked.

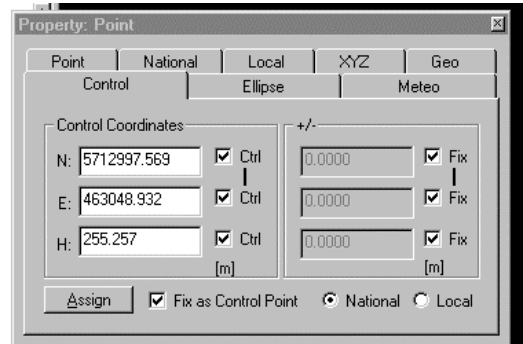


Figure 18-77: Network Metrik - Reference Point Fixed

*Baseline
Selection:*
Ch. 7.1



If the baselines are not all enabled, enable all baselines: in the navigator click  Baselines (right mouse button)/Enable All (left mouse button), otherwise click the corresponding toolbar button.



*Process
Project:*
Ch. 5.5



Process the project: click Process/Process Project or the corresponding toolbar button. **GeoGenius** then automatically detects the type of data and uses the static processor. First a triple difference solution and cycle slip fixing is done, then **GeoGenius** processes double difference float and, if possible, fixed solutions.



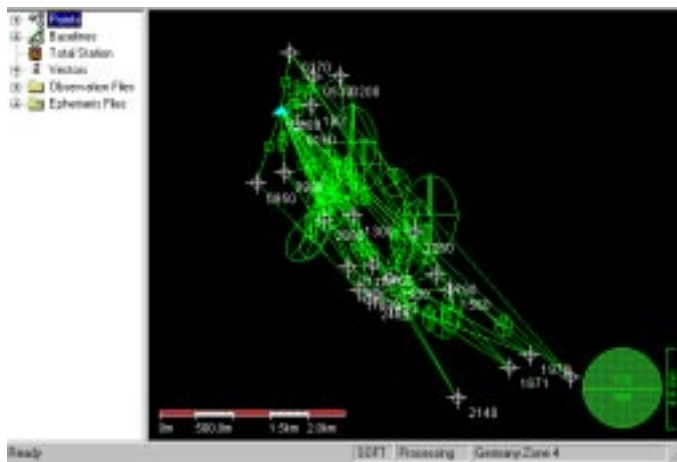


Figure 18-78: Network Metrik - Network Processed

For each baseline eleven solutions are found; one solution, the double difference fixed solution in L_n , will be used for network adjustment and is, therefore, displayed in the $\vec{x}$ Vectors container. For two baselines two sessions exist. We did not change the default Processing Settings, therefore, the best solution of each session will be used for the network adjustment.

Sort
Baselines:
Ch. 5.2.1

In the following step, we will check the report file of a specific baseline, i.e., the baseline that connects the points 0950 and 8889. How do we look for this baseline in the navigator? That depends on what we know of the baseline. **GeoGenius** offers a lot of different sorting options, which allow you to sort all items of a container according to specific properties. Click the  Baselines container (right mouse button), click Sort (left mouse button). You may now choose one option out of the list of sorting options.

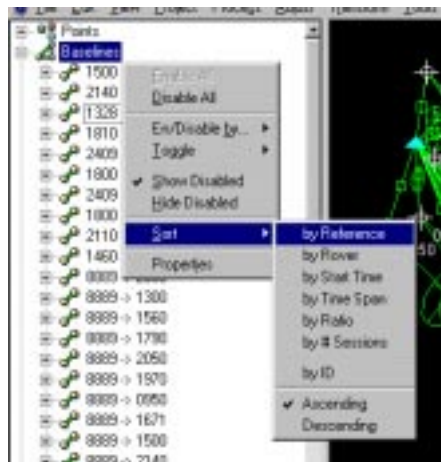


Figure 18-79: Network Metrik - Baseline Sort Options

Here, we know the names of the two points, which build up the baseline, but do not know, whether 0950 is the start point (reference) or end point (rover) of the baseline. Therefore, we should choose one of the following two options to sort the baselines:

- Sort by Reference (start point)
- Sort by Rover (end point)

Choosing the first option, sorts the baselines according to the first point in the name, the second options displays the baselines sorted according to the second point name. Now, we can easily look for the two names known and will find baseline 8889→0950, since - in this demo network - point 8889 serves as reference for the baseline.


**Read
Results:**
Ch. 8.2.4

Click the  baseline 8889→0950 (right mouse button). Click the context menu item Report... **GeoGenius** creates a report of the results from the static processing of the baseline. *Figure 18-80* shows a part of the last page of this five pages report.



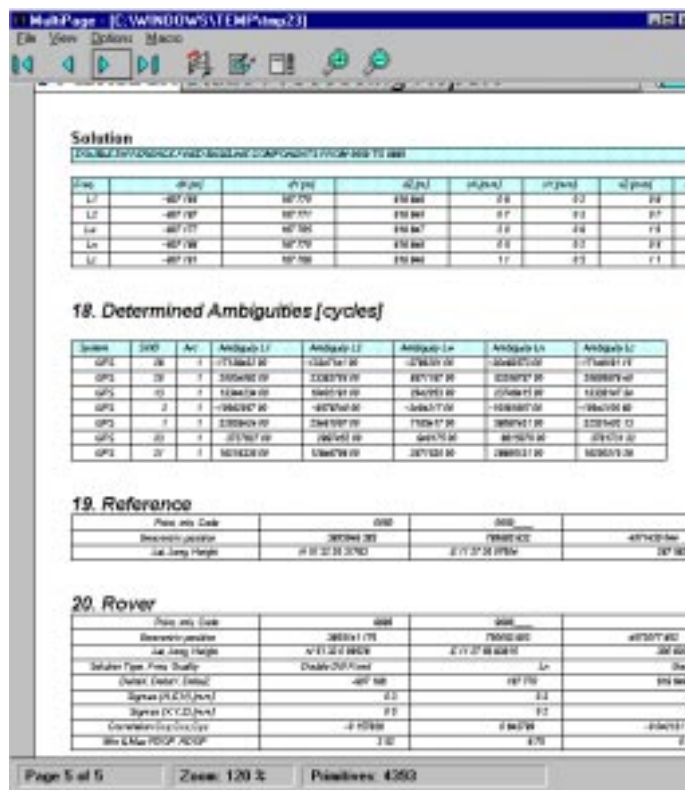


Figure 18-80: Network Metrik - Report for Baseline 8889→0950

Important: For several points we know one, two or all national grid coordinates. To enter the control coordinates of the first point click the point (right mouse-button) and choose the menu item **Properties**. Click the tab **National** and enter the corresponding values for the chosen point as listed in the following table (Point 8889 should already have control coordinates):

Point #	N	E	Ell. Height
0200	5713459.259	463836.615	247.611
0950	5712021.887	462716.945	241.972
1300	unknown	unknown	187.395
1328	5709400.780	466947.639	unknown
1460	unknown	unknown	181.905
2050	unknown	unknown	242.415
8889	5712997.569	463048.932	255.257

For example, if you have activated point 1328, page National of its Properties notebook will display the following values:

Point #	N	E	Ell. Height
1328	5709400.777	466947.639	233.034

These values are all unfixed and no standard deviation is known.

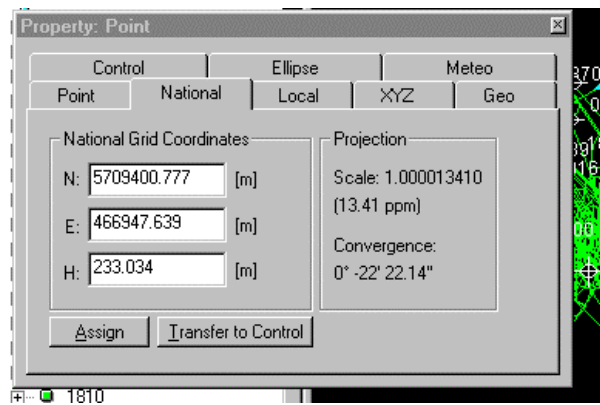


Figure 18-81: Network Metrik –National Coordinate Page

Now, enter the known values for the N and E coordinate. Click the button **Assign** and the button **Transfer to Control**. Click the tab **Control**. Check the Ctrl checkbox of the horizontal components, do not check the Ctrl checkbox of the Height component, since it is unknown. Fix also the standard deviations of 0.00 of the known coordinates. If you don't fix them, the coordinates will get a correction during the network adjustment.

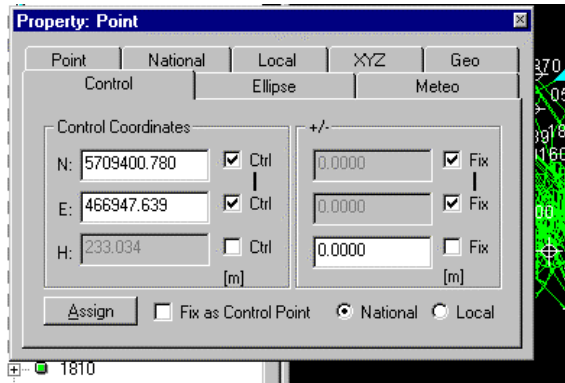


Figure 18-82: Network Metrik - N,E Coordinates Fixed

Finally, check the checkbox “Fix as Control Point” and be sure, that the National radio button is activated. Then click the button **Assign** to assign the fixed values to the project.

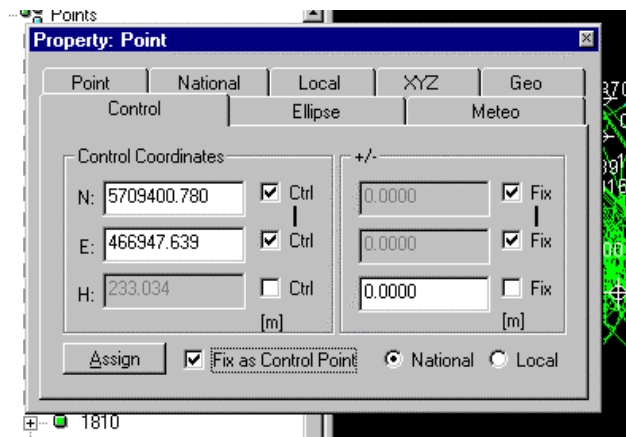


Figure 18-83: Network Metrik - Fixed Control Point

Do not close the notebook, but just click one of the other points with known coordinates. The Properties notebook now displays the properties of the new point (it always displays the properties of the currently activated object).

Assign the fixed coordinates of the other points in the same way. You will notice that the state plane coordinates do not differ considerably to the processed approximate values. If you do not want any more the Properties notebook to be displayed, click the **Exit** button of the header line.


*Adjust-
ment:*
Ch. 12

The next step to do is a network adjustment. Do not change the default adjustment parameters. Choose Adjust (National, Biased) from the pull-down menu Adjust, since you have a System and more than three control points.

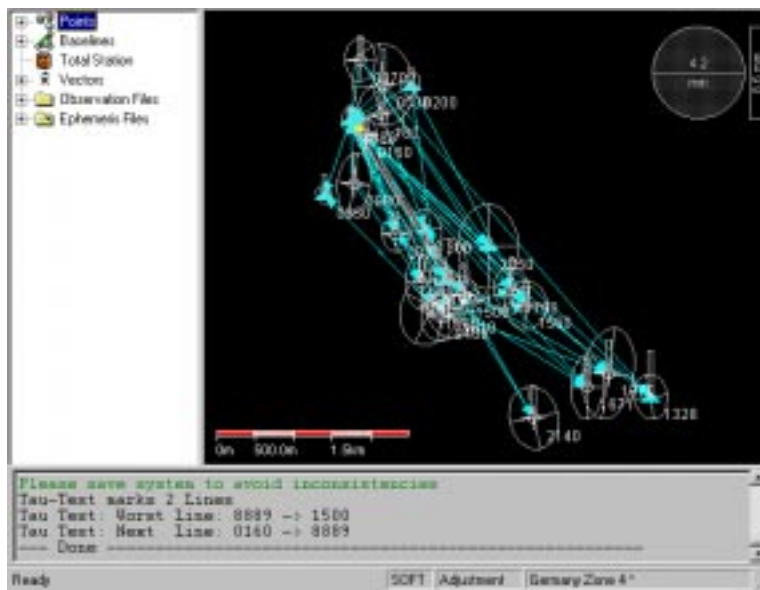


Figure 18-84: Network Metrik - National, Biased Adjustment Performed

One of the baselines is marked as red (Worst baseline), one as yellow. This means, that these two baselines got corrections of more than the default maximum correction of 5 mm + 1 ppm. To get information on your network adjustment, open the Adjustment Report. Click Adjust/Report... Its pages 1 and 2 show the input baselines. The baselines that got a larger correction than the default maximum value are already marked red. These are the baselines

- 0160 → 8889, two sessions
- 8889 → 1500, second sessions

The table 4 covering pages 3 and 4 shows the baseline corrections in the WGS84 System. The same baselines are marked. Here you can check the normalized corrections.

MultiPage - [C:\WINDOWS\TEMP\tmp4.out]

File View Options Macro

1600-2080	-411 270	-985 696	510 688	3 2	1 0	4 6
160-1300	-1001 427	801 908	-240 794	3 0	1 8	5 3
180-8880	-158 468	-376 701	-19 878	3 0	1 8	5 2
1800-1970	180 485	2379 284	-579 242	6 8	3 1	5 7
1800-2050	-801 312	-1697 826	913 260	6 7	2 7	5 0
1810-1790	-379 404	760 553	138 673	3 6	2 4	5 0
2110-1671	681 367	2332 303	-866 274	3 3	1 4	4 7
2140-1300	-1606 218	-1718 802	1606 867	3 6	2 1	5 8
2400-1650	-358 883	1038 698	65 263	3 1	2 2	4 6
2400-2050	-880 968	-1746 473	983 060	3 8	1 9	4 9
FF80-2080	982 122	800 211	-240 134	2 0	0 0	2 2
FF80-1300	842 060	1178 800	-928 916	1 8	1 2	2 4
FF80-1650	1320 054	2818 403	-1046 460	2 8	1 8	3 7
FF80-1790	1238 619	2409 038	-1422 739	3 6	2 1	5 1
FF80-1328	883 470	3517 818	-1522 927	3 2	2 7	4 4
FF80-1970	1777 968	3800 342	-2111 166	6 4	2 4	5 1
FF80-2050	807 170	-167 758	-618 663	1 8	0 6	2 1
FF80-1671	1076 406	3663 883	-2217 763	3 2	1 4	4 4
FF80-1600	1303 392	1794 907	-1469 821	3 0	0 9	4 2
FF80-2140	2449 178	2607 300	-2424 774	3 6	2 0	5 6
FF80-1328	1943 170	4390 123	-2237 987	5 0	2 6	7 2
FF80-1810	1804 923	1658 472	-1561 311	4 1	2 6	6 1
FF80-2400	1688 137	1677 706	-1601 712	3 0	1 8	4 2
FF80-1800	1608 482	1430 068	-1631 913	5 6	2 6	4 8
FF80-2110	1304 048	1231 400	-1352 479	2 7	1 2	3 7
FF80-1450	1200 626	1637 811	-1348 200	3 6	2 0	3 6

4. Baseline Corrections (Corrections and Normalized Corr.)

Baseline	FF (mm)	FF (mm)	FF (mm)	FF (mm)	FF (mm)	FF (mm)
0160-2080	0 1	0 0	0 8	0 0	0 0	0 3
0160-1600	-3 4	-0 6	-4 6	-1 1	-0 6	-1 0
0160-8880	-8 6	-0 8	-11 0	-0 6	-1 4	-6 1
0160-8880	9 1	4 0	6 6	6 8	6 7	3 0
0160-1970	11 7	0 1	3 9	2 1	0 0	0 7
0160-1450	9 0	1 6	7 8	2 3	0 7	2 0
0200-1650	0 4	1 6	-4 9	0 1	0 8	-1 2
0200-8880	-0 9	0 0	-3 1	-0 6	0 0	-1 3
0200-2400	-3 3	0 3	-7 8	-1 0	0 1	-1 6
0370-8880	-0 0	-0 3	-1 0	-0 0	-0 2	-0 3
0370-1790	2 6	3 7	22 6	0 7	1 6	3 8
0370-2050	-3 4	-0 8	-0 8	-0 9	-0 2	-1 8
0370-1328	0 9	7 8	19 8	1 8	2 8	2 8
0530-8880	0 0	0 0	0 0	0 0	0 0	0 0
0600-1671	1 2	-0 9	-6 0	0 3	-0 6	-1 0
0600-2110	-1 8	-1 0	-8 4	-0 4	-0 8	-1 8
0600-8880	0 1	0 6	4 0	0 0	0 3	0 9
1258-1790	-0 8	-1 8	5 1	-0 1	-0 8	0 8
1460-1970	-3 1	-2 4	0 0	-0 6	-1 0	-1 7
1500-2080	0 6	0 1	1 8	0 2	0 1	0 4
180-1300	-1 2	0 6	-0 9	-0 4	0 3	-0 2
180-8880	1 0	-0 3	0 6	0 3	-0 2	0 1
1800-1970	-1 0	5 4	7 8	-0 2	1 8	1 4

Page 3 of 7 Zoom: 90 % Primitives: 7302

Figure 18-85: Network Metrik - Adjustment Report, Page 3

The baselines are partly rather long (more than 1 km). Therefore, it may be advisable to set the tau test criteria higher, i.e., to set a higher maximum correction value. Click Adjust/Settings... and choose tab Tau Test. Set the Tau Offset to 25.

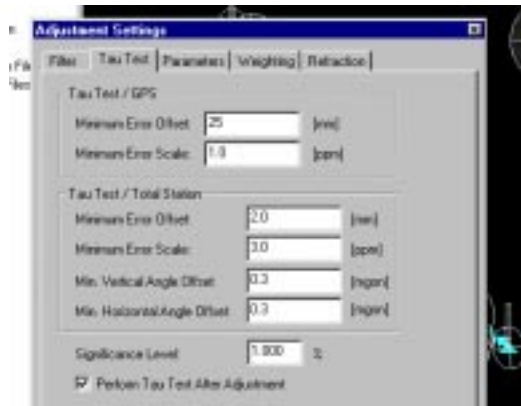


Figure 18-86: Network Metrik - Tau Offset Changed

Accept the change with **OK** and do a new adjustment with **Adjust/Adjust(National, Biased)**. A new plot will be drawn without any yellow or red marks. All vectors passed the tau test now.

The output window suggests you to save the newly created seven parameters for the transformation from the WGS84 system to the current System. You should follow the suggestion and save the new parameters within the project. Choose the menu item **Save Adjusted System (7 Parameters)** from the pull-down menu **Adjust**.

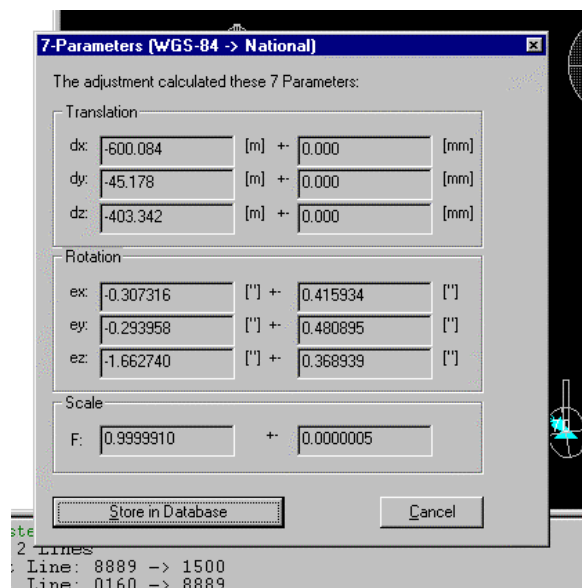


Figure 18-87: Network Metrik - Adjusted Parameters

Click the button **Store in Database** to save the new parameters under a new name in the System and/or the Datum databases for further use. The dialog Save Systems with Adjusted 7 Parameters pops up:

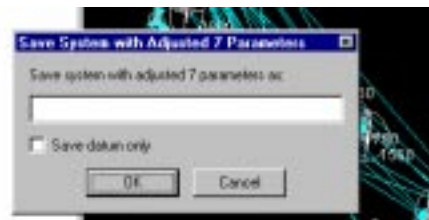


Figure 18-88: Network Metrik - Save System with Adjusted Parameters

Enter a name for the new System, such as Germany Zone 4 – Metrik. If you do not want to save the System but just to store the parameters, check the checkbox **Save Datum only**. Then, **GeoGenius** will just create a new datum under the name entered above. If this option is cleared, **GeoGenius** creates a new datum and a new System based on this datum, both under the name entered above.

You may display a background bitmap behind your GPS or Total Station Network. This nice tool allows you to visualise your network and get even more information concerning the network boundaries.

There are two files necessary to perform this Bitmap Application.

- A bitmap file (located e.g. in <INSTALLDIR>\BITMAPS)
- A script file, responsible for starting and displaying this bitmap Application

For the current project such a bitmap is located in <INSTALLDIR>\BITMAPS\METRIK.BMP and the corresponding script file in <INSTALLDIR>\M\METRKBMP.M

The text of the current script file is:

```
gscreen off
gdefine layer 1 [project registerlayer "Background
Bitmap"]
map [expr 462501-70] [expr 5713963+490] [expr 467132+124] [expr
5708910-1500] [concat $EXEDIR bitmaps\\metrik.bmp]
glayer $1 on
```

You may edit the script file and generate similar scripts for your own bitmaps! Your individual script file should look the same, except the line marked bold. This line consist of all displaying options for your individual bitmap:

```
gbitmap x1 y1 x2 y2 bitmap_location
```

(x1/y1) stand for the upper left corner and (x2/y2) stands for the lower right corner of your bitmap. The values for these coordinates are national co-ordinates.

To insert the bitmap into your project plot just follow these steps:

Select the menu option File/Run/Script... . A standard Windows file selector window shows up. Just choose the script file and perform the Application. **GeoGenius** inserts the bitmap into your project plot.

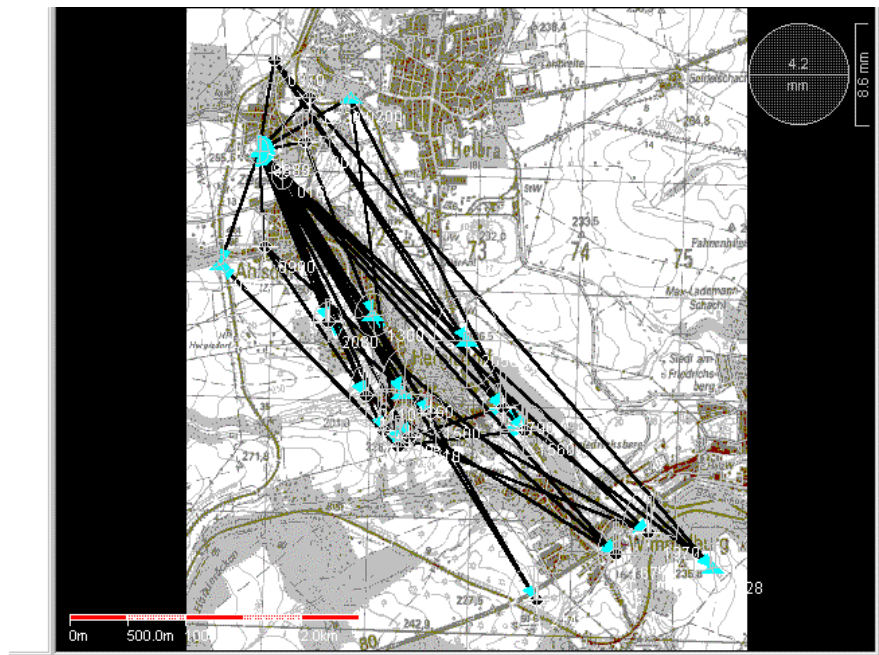


Figure 18-89: Network Metrik - Bitmap Included

Customize
Style:
App. A.3
Config
Layers:
Ch. 5.2.2

For the figure above, the style of the adjusted vectors was modified via the menu option Customize/Styles/Lines.

The background bitmap was inserted as a layer into all currently available layer groups. You can toggle the display of the background bitmap or delete it completely from one or all display groups. Click View/Display/Config Layers. The Group Definition dialog shows up.

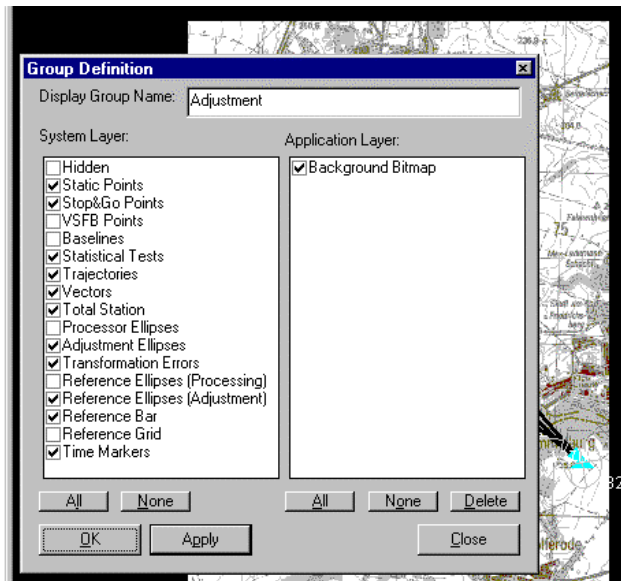


Figure 18-90: Network Metrik - Display Group Definition

The object Background Bitmap in the list box Application Layer represents the background bitmap. You may clear the checkbox just to remove the application from the current Display Group only. To stop

the application, highlight the layer **Background Bitmap** and click the keyboard button **Del**. The application will then be deleted from all Display Groups in the project.

18.8 The Network OTF

Data Import:
Ch. 5.5

The network OTF consists of 2 kinematic observation files and 2 RINEX ephemeris files, collected with a Trimble receiver. Open a new project (File/New) and then choose Project -> Files into Project. Go to the \SAMPLES\OTF sub-directory. **GeoGenius** scans the directory for data files and displays a list of the files with the extension *.OBS and *.95N.

Select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.

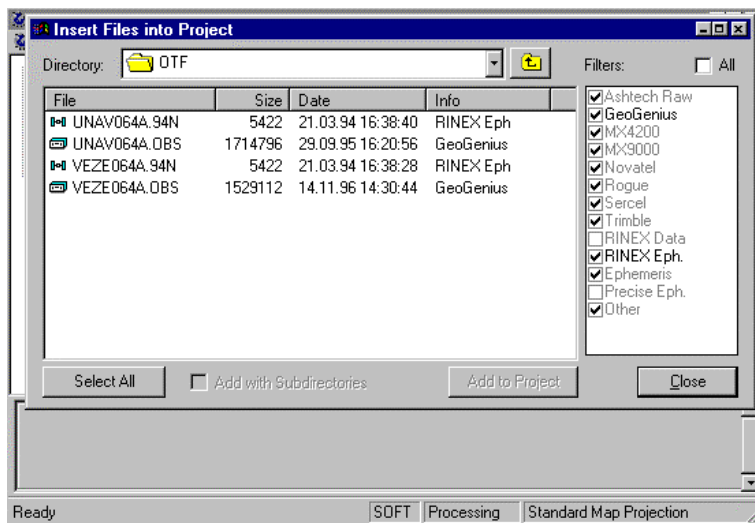


Figure 18-91: Network OTF - Insert Files

*Decoding
Raw
Data:
Ch. 5.5
Ephemeris
Genera-
tion:
Ch. 7.3*

GeoGenius automatically generates 2 binary broadcast ephemeris files in the Ef18 format. It calculates a Single Point Position for every epoch of the kinematic files and generates a trajectory from this receiver navigation solution.

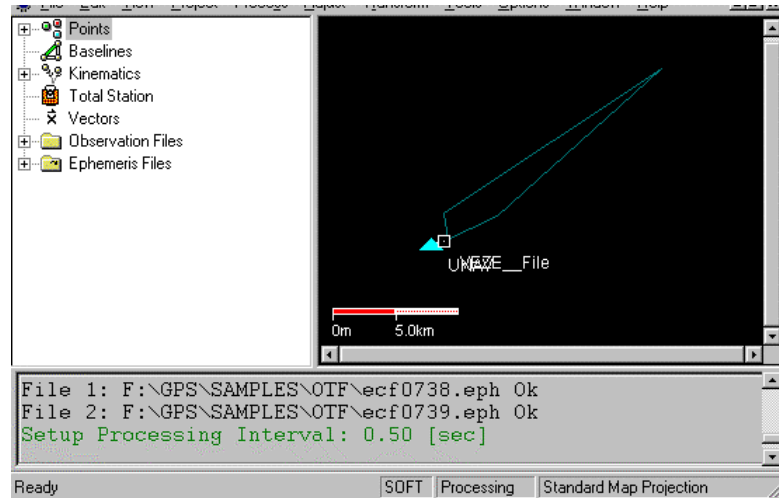


Figure 18-92: Network OTF - SPP Navigation Solution of the Receiver

*Scan
Baseline:
Ch. 14.2*

We first want to check the quality of the data. Open the  Kinematics container (double-click of the left mouse button) and click the kinematic line UNAV*VEZE (right mouse button).

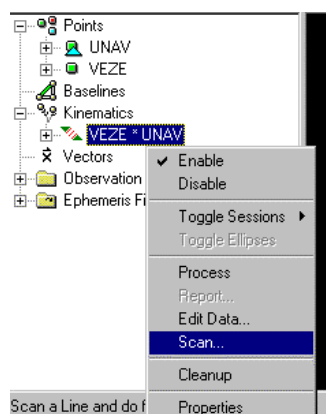


Figure 18-93: Network OTF - Scan Data Option

Then choose the context menu item Scan... . **GeoGenius** displays the Scan Satellites Window.

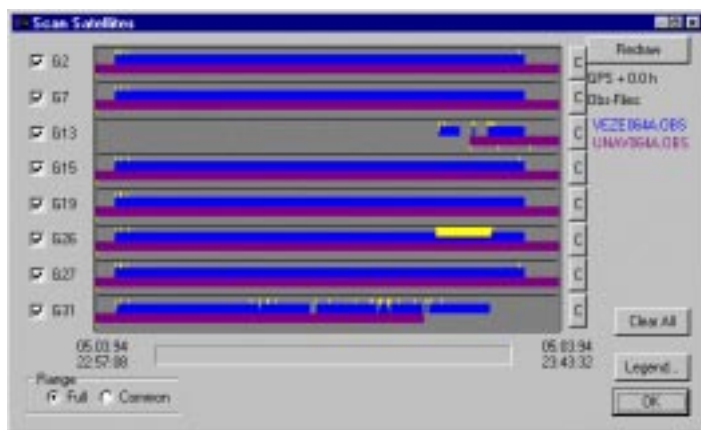


Figure 18-94: Network OTF - Scan Satellites Window

The loss-of-lock indicators show that the receiver lost lock to the satellite G26 for ca. 6 minutes. The contact to satellite G31 was lost several times. If the processing failed, you could mark these time spans for the respective receivers to cut them off from processing. Close the Scan Satellite Window by a click on its **Exit** button.

 We do not have any known coordinates for the reference station UNAV. Therefore, we will perform a Single Point Positioning from the static reference file to improve the accuracy with respect to the code position. Double-click  Points (left mouse button), double-click  UNAV (left mouse button), click  UNAV064A.OBS (right mouse button). Choose the context menu item Single Point Position. The Single Point Position window pops up.

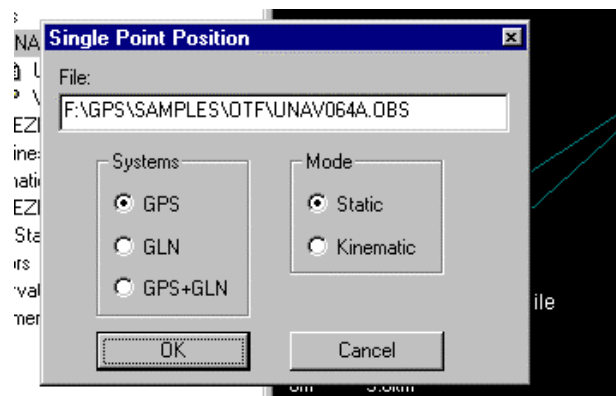


Figure 18-95: Network OTF - Single Point Position Window

Accept the default System and Mode (GPS, Static) and click **OK**. **GeoGenius** calculates the Single Point Position.

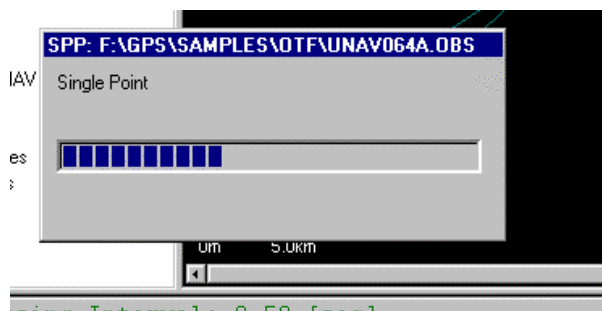


Figure 18-96: Network OTF - Generating SPP

The SPP Result window then displays in box Result the calculated positions and the derived standard deviations. Click **Assign** to instruct **GeoGenius** to overwrite the old coordinates with the SPP results.

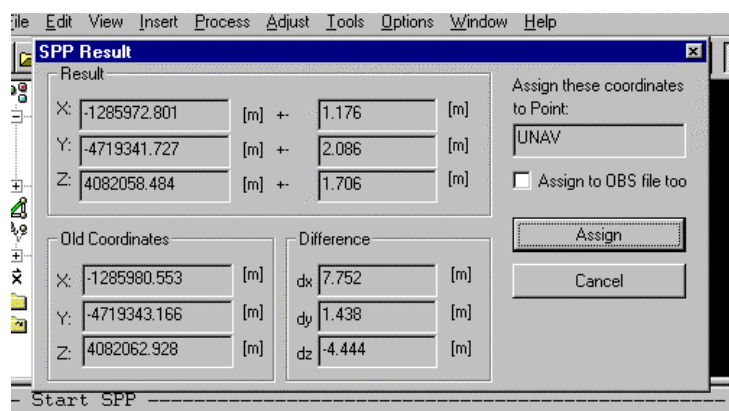


Figure 18-97: Network OTF - SPP Results

Processing
Options:
Ch. 7.4



GeoGenius supports several modes to process kinematic data.

To define the processing method manually, open the Processing Options notebook: click Process/Settings... or choose the corresponding toolbar button. Click tab Processor. Basically, you have four options to process the flight data:



- OTF,
- Differential GPS,
- Smoothed Differential GPS,
- Super Smoothed.

To obtain cm-level accuracies we choose the OTF processor. Click the OTF option of the box Processing Mode.



Figure 18-98: Network OTF - Processing Options, Define Processor

Process
Project:
Ch. 7.7



Accept the processing mode. Process the project: click Process/Process Project or the corresponding toolbar button.

GeoGenius then uses the just defined OTF processing mode. It reads the data and determines code and phase positions. Last it assigns the results. The full procedure takes one and a half minute only!





Figure 18-99: Network OTF - Project Processed

OTF
Processing
Result:
Ch. 9.5.4

GeoGenius generates an updated project plot of the flight and gives you preliminary information on the project in the output window. No points or point occupations are stored, since the data of the project did not contain any stop point measurements. 4575 positions at each epoch are determined.

Finally, you want to see the results of each epoch. To do so, you will instruct **GeoGenius** to generate an output data file.

In the navigator, open the  Kinematics container (double-click of the left mouse button), then click the kinematic line VEZE*UNAV (double-click of the left mouse button). Click the observation file  VEZE064A.0BS (double-click of the left mouse button). Click the  trajectory (right mouse button).

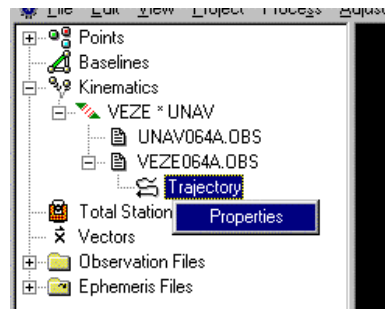


Figure 18-100: Network OTF - Properties of Trajectory

Click the context menu item **Properties** (left mouse button). The notebook **Properties: Kinematic Path** opens and displays several file formats for data export.

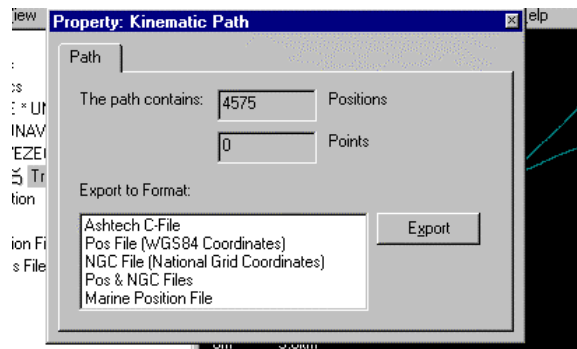


Figure 18-101: Network OTF - Properties of the Kinematic Path

*Position
File
Format:*
App B.4.1

Choose, e.g., the format **Pos File (WGS84 Coordinates)**. This option writes the resulting WGS84 coordinates together with the time tag into an ASCII file. Software predicted precision values are added. These position files are, by default, created with the name of the observation file of the moving receiver and the extension ***.POS**. Click

Export to start the creation of the position file. A standard Windows file selector allows you to store the position file under the default position file name or to choose another name and to choose a directory. After you have accepted a name **GeoGenius** generates the position file and writes the positions and accuracies into it.

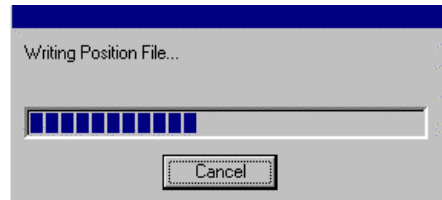


Figure 18-102: Network OTF - Writing Position File

When finished, **GeoGenius** writes a message on the output window. Depending on your system, the procedure will take not more time than a minute! Have a look at the output window.

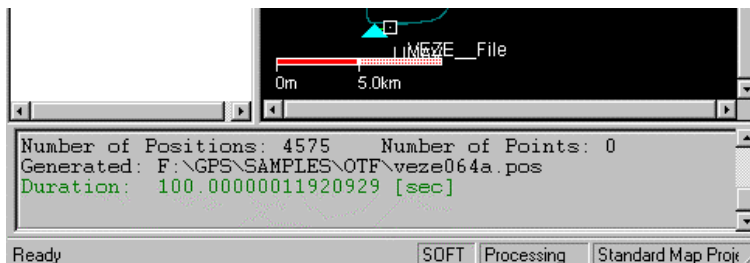


Figure 18-103: Network OTF - Output Window Message

Check your positions using any available data editor. E.g., the following figure shows the formatted first lines of the just created position file.

[illegible]

Figure 18-104: Network OTF - VEZE064A.POS Edited

18.9 The Network Poerings

Data Import:
Ch. 5.5

The network Poerings consists of 36 raw data files, collected with a Trimble receiver. Open a new project (File/New) and then choose Project/Files into Project. Go to the \SAMPLES\POERINGS sub-directory. **GeoGenius** scans the directory for data files and displays a list of 36 raw data files with the extension *.DAT. The list of file converters on the right side of the Insert Files into Project window only displays Trimble files as enabled.

Select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.

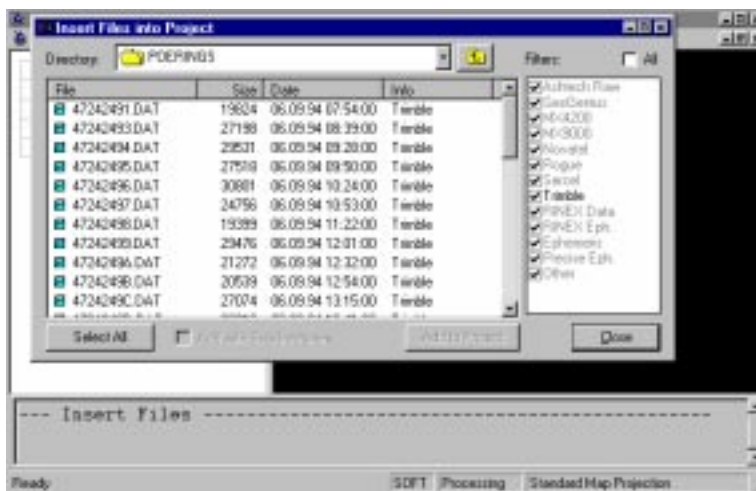


Figure 18-105: Network Poerings - Insert Files

Decoding
Raw
Data:
Ch. 5.5
Ephemeris
Genera-
tion:
Ch. 7.3

GeoGenius automatically decodes the raw data and generates observation files and a binary ephemeris file in the EF18 format.

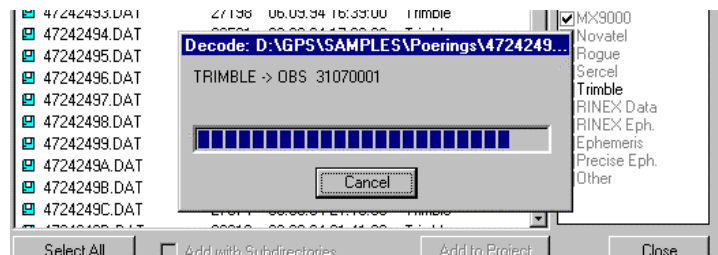


Figure 18-106: Network Poerings - Observation File Generation

Close the Insert Files window. A preliminary plot is generated from the newly created and inserted observation files.

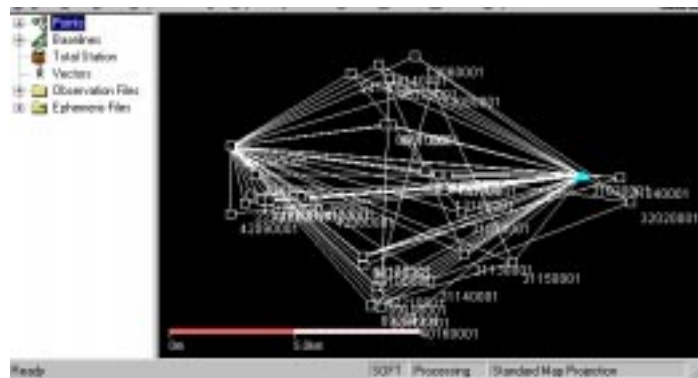


Figure 18-107: Network Poerings - Preliminary Plot

For this network, precise state plane coordinates exist for the reference station, which we can insert into the project after having set the System.

 To select the System click **Project/System...** and choose the System Germany Zone 4. This System is Zone 4 of the projection Deutschland_bessel, based on the DEUTSCHLAND_WEST datum and the Bessel ellipsoid. A World Geoid Model is introduced.

Select
System:
Ch. 6.2

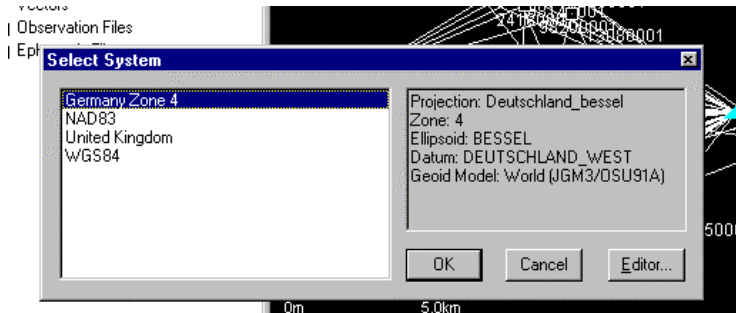


Figure 18-108: Network Poerings - Select System

Click **OK** to accept your selection. A warning dialog pops up and allows you to confirm the recalculation of the coordinates of all points.

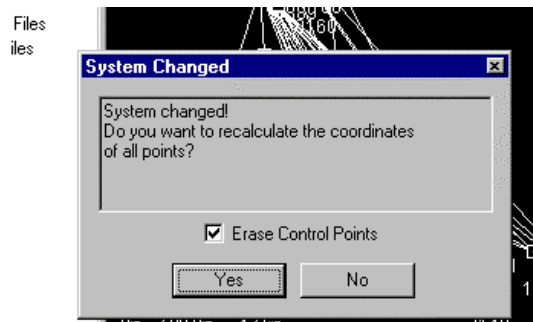


Figure 18-109: Network Poerings - Recalculate Coordinates?

Accept recalculation.

17



Note: If after recalculation of the approximate coordinates in another System the screen appears blank, the project has been moved out of the current display area. You should just press the toolbar buttons Zoom All or Redisplay



*Import
Points:
Ch. 5.5.2*

For point MBOB0001 we know the state plane coordinates. To enter the national coordinates of a point click the point (right mouse-button) either in the navigator or in the project plot and choose the context menu item **Properties**. Click tab National and enter the following values for the chosen point:

Point #	N	E	Ell. Height
MBOB0001	5744811.580	492824.110	78.750

Then click the button **Assign** to assign the fixed values to the project.

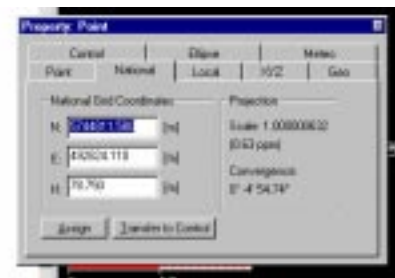


Figure 18-110: Network Poerings - Fixed Control Point

Finally, click tab Control and check the checkbox “Fix as Control Point”. Click the button **Assign**. If you do not want any more the

Properties notebook to be displayed, click the **Exit** button of the header line.

Click point 31030001 (right mouse button), then **uncheck** the context menu item **Fix**. This point is no reference point.

Save the project (File/Save), e.g., under the name POER-INGS.GGS.



Baseline Selection:
Ch. 7.1

If the baselines are not all enabled, enable all baselines: in the navigator click  Baselines (right mouse button)/Enable All (left mouse button), otherwise click the corresponding toolbar button.



Process Project:
Ch. 8

Process the project: click Process/Process Project or the corresponding toolbar button. **GeoGenius** then automatically detects the type of data and uses the static processor. First a triple difference solution and cycle slip fixing is done, then **GeoGenius** processes double difference float and, if possible, fixed solutions.



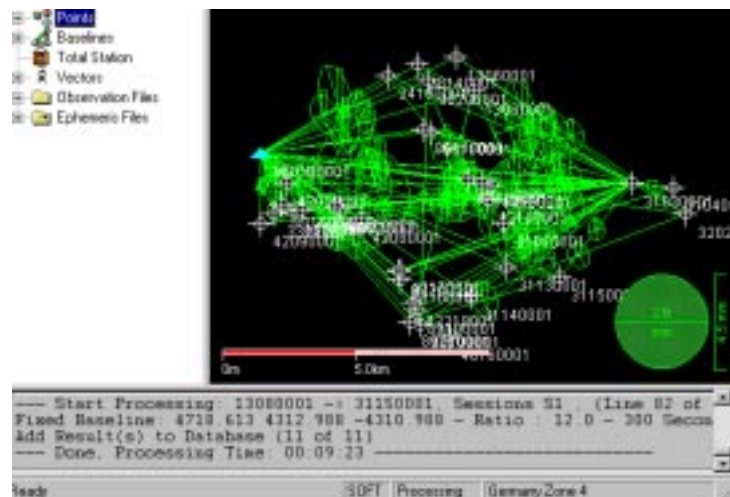


Figure 18-111: Network Poerings - Network Processed

Processing Results:
Ch. 8.2 | All baselines got agreeable results. For each green baseline eleven solutions are found; one solution, the double difference fixed solution in Ln or in L1, will be used for network adjustment and is, therefore, marked by an asterisk in brackets (*). This solution is listed in the $\vec{x}$ Vectors container.

You may check the results via the Properties notebook: click the baseline (either in the navigator or in the project plot) (right mouse button), click **Properties** (left mouse button) of the context menu. Click tab **Ellipse** of the Properties notebook to control the ellipse parameters and tab **Stat.** to control the ratio.

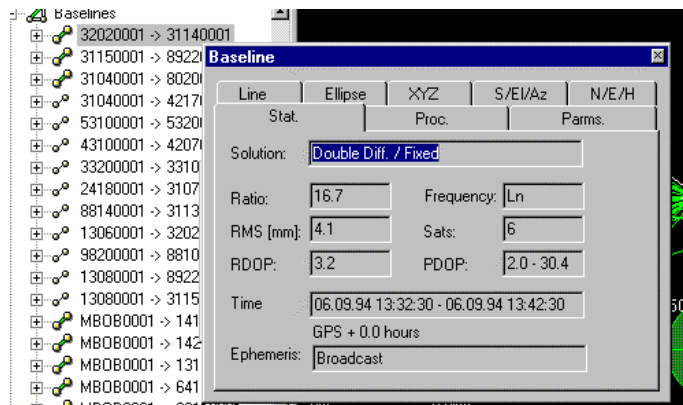


Figure 18-112: Network Poerings - Baseline Properties

Network Adjustment:
Ch. 12.2

We now will do a free network adjustment. Choose Adjust (Free) from the pull-down menu Adjust. **GeoGenius** performs the network adjustment. The following figure shows the adjusted network.

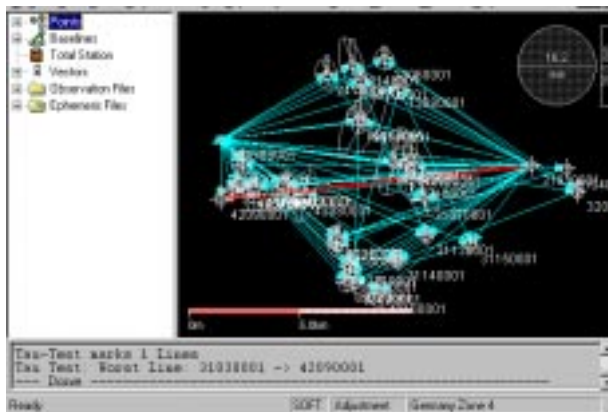


Figure 18-113: Network Poerings - Free Adjustment Including All Baselines

A tau test was performed automatically and one of the baselines was marked as red (worst baseline after tau test).

 Delete the results of the worst baseline. Click the baseline 31030001→42090001 (if you have clicked into the project before, first click somewhere off the project in the project plot, then click the baseline), go to the navigator, double-click the  Baseline (left mouse-button), click the  Results container and press the **Del** button of your keyboard. All solutions of the baseline will be deleted now. The baseline icon changes to “ unprocessed”.

Project Design:
Ch. 5.2,
12.4

Repeat the free network adjustment. Now, all baselines pass the tau test.

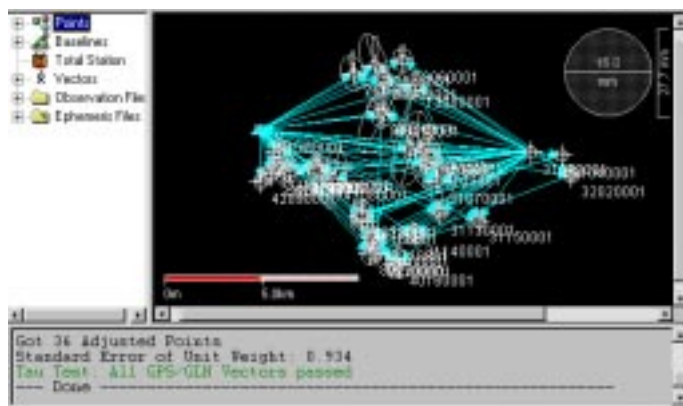


Figure 18-114: Network Poerings - Network Adjustment Passed Tau Test

The last step to do is to transform the network to a local System. We will define our own local datum, define a new System and start the transformation.

Datum Editor
Ch. 6.4

We know the precise 7 transformation parameters for this area, therefore, we will define a special local datum for this project. Click the item **Datum Editor** from the pull-down menu **Options**. The **Datum Editor** shows up.

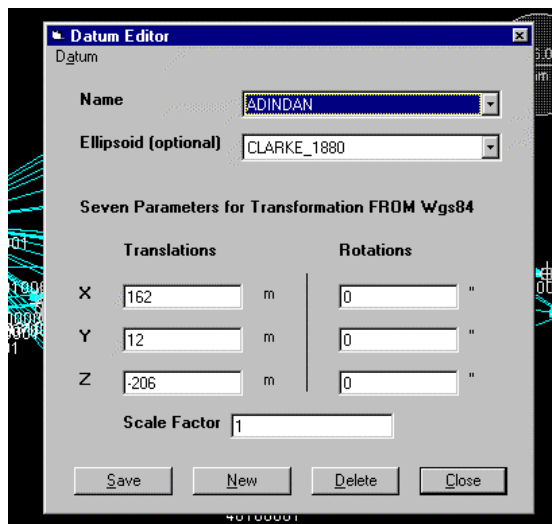


Figure 18-115: Network Poerings - Datum Editor

Click the button **New** and assign the new datum a name, such as, e.g., **Poerings** (like the project). Accept with **OK**. Back to the **Datum Editor**, the new name will show up in the Name combo box. Click the **Ellipsoid** combo box and select the ellipsoid **Bessel**. Enter the following transformation parameters manually:

X = -580m	rx = 1.04"
Y = -106m	ry = 0.36"
Z = -415m	rz = -3.08
Scale Factor = 0,9999911	

Figure 18-116: Network Poerings - New Datum Poerings

Save the new datum with **Save** and close the Datum Editor window with **Close**. Open the System Editor to create a new System: Click Project/Systems..., then click the button **Editor....** The System Editor shows up. Click the button **New** to create a new System and enter a new name, such as **Germany Zone 4 Poerings**. Click **OK**. Create the new System from the following parameters:


System
Editor:
Ch. 6.5

Projection:	Deutschland_bessel
Zone:	4
Datum:	Poerings
Geoid:	World (JGM3/OSU91A)

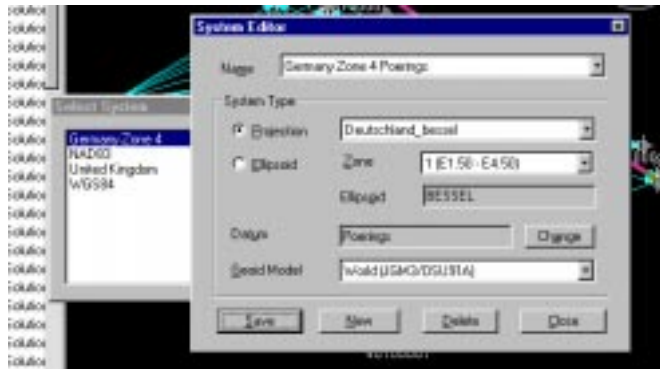


Figure 18-117: Network Poerings - New System

Click **Save** to save the new System (accept confirmation with **OK**), then click **Close** to close the System Editor. Remember that the datum as well as the System is only stored when having clicked **Save** and confirmed the procedure!

To transform the point coordinates to the new System we now select the new System from the System Editor. Highlight Germany Zone 4 Poerings in the System Editor.

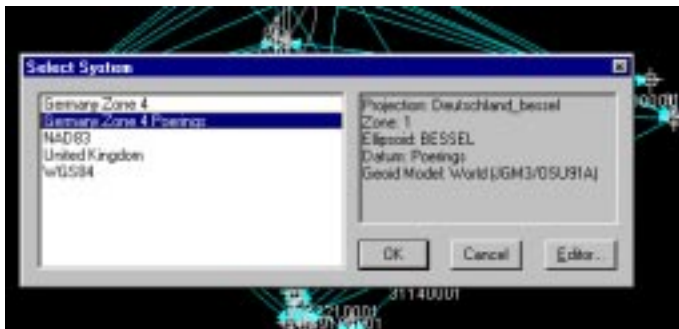


Figure 18-118: Network Poerings – Select New System

Click **OK** to start the transformation. A warning dialog pops up.

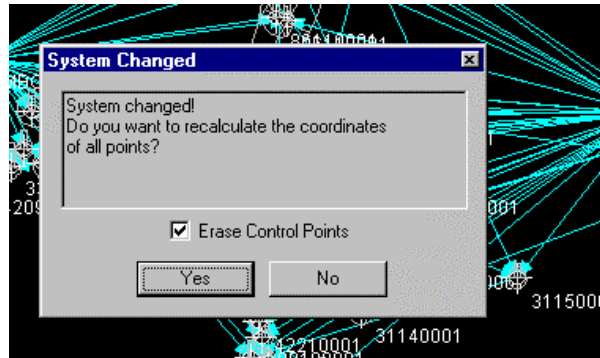


Figure 18-119: Network Poerings – System Changed Dialog

Click **Yes** to accept the recalculation of all points with the default options. **GeoGenius** recalculates the point coordinates in the new System using the new datum Poerings.

*Save
Project:
Ch. 5.4.4*

Finally, save your project (click Project/Save or Project/Save As).



18.10 The Network Stopgo

Data
Import:
Ch. 5.5

The network **Stopgo** consists of two observation files and two RINEX ephemeris files, collected with a Geotracer receiver. File **P2031401.OBS** is the static reference file for the base station (reference station), while kinematic Stop&Go data were collected in file **ROVE1401.OBS**. Open a new project (File/New) and then choose Project/Files into Project. Go to the \SAMPLES\STOPGO sub-directory. **GeoGenius** scans the directory for data files and displays the 4 data files with the extension *.OBS and *.N95.

Select all files (button **Select All**) and insert them into the project (button **Add to Project**). Click **Close**.

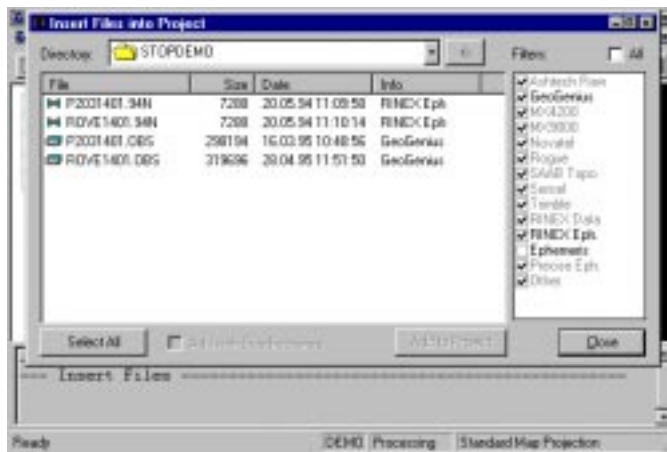


Figure 18-120: Network Stopgo - Insert Files

Ephemeris Generation:
Ch. 7.3

GeoGenius inserts the observation files and generates a binary ephemeris file in the EF18 format. Close the Insert Files window. A preliminary plot is generated from the newly inserted observation files. It displays the basis, the initialization point (point STRT), Stop points and the rover's path. If you open, e.g., the Points container, you will find an entry for every stop point in the navigation file.

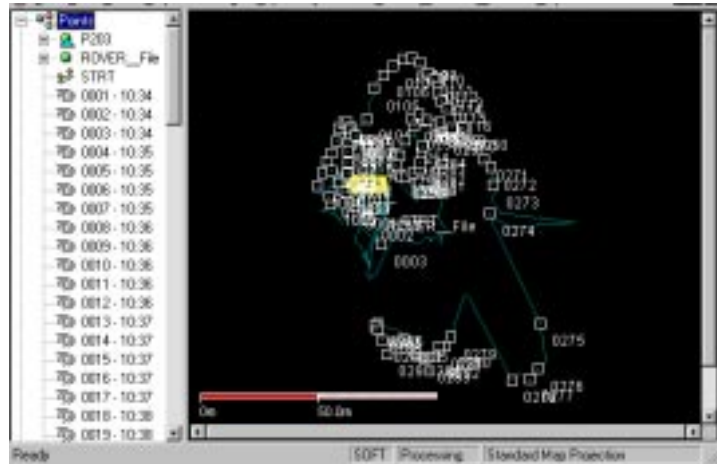


Figure 18-121: Network Stopgo - Preliminary Plot

For this network, precise state plane coordinates in the Sweden_92 projection exist for the reference station, which we can insert into the project after having set the System.

Select System:
Ch. 6.2

To select the System click **Project/System...** . Currently, no System exists, which is based on the Sweden_92 projection.

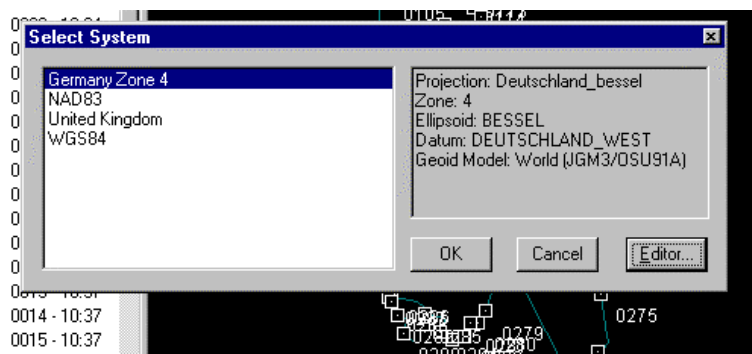


Figure 18-122: Network Stopgo - Select System

Define a new System: click the button **Editor...**, from the System Editor click the button **New**. Enter a System name, e.g.: Sweden_92 with Geoid. Accept the name. In the System Editor, open the Projection combo box and click Sweden_92. **GeoGenius** automatically adds the fitting ellipsoid (Bessel_1841) and Datum (RR92). The projection uses no zone system (None).

A precise geoid model exists for Sweden, which we will also introduce into the System. Click the ▼ button of the geoid model name combo box and look for the model Sweden RN92. If this geoid model does not show up in the list, it is not yet installed.

 **Install Geoids:**
Ch. 2.1.3 To install a **GeoGenius** geoid model save the new System and close the System Editor (Click **Save, Close**). Leave the Select System dialog with **Cancel**. Follow the instructions in chapter 2 of this manual. If you choose the installation type Typical, all geoid models will be installed. Geoid models might then be included and will occupy space, which you might never use. Therefore, to select one or several geoid models, you should choose the installation type Custom and deselect the other models.

Here, we need the geoid model Sweden RN92. Install the geoid model(s) into the sub-directory \SYSDBS of your **GeoGenius** root directory. Move again to the **GeoGenius** module and open the System Editor. Choose the System Sweden_92 with Geoid. It consists of the correct projection, but still does not show the desired geoid model. Click the ▼ symbol in the geoid model name combo box and you will now find the geoid model Sweden RN92. Accept the geoid model. Click **Save** to save the new System, If you do not so, the System (or the changes to the System) will not be saved at all.

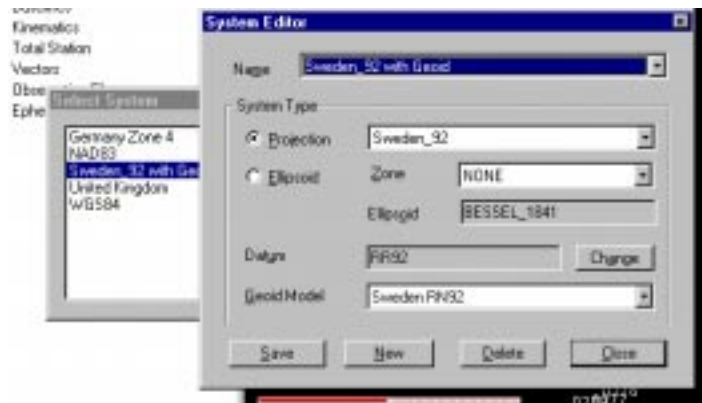


Figure 18-123: Network Stopgo - New System Sweden_92

Click **Close** to leave the System Editor. The System Sweden_92 with Geoid will be displayed and highlighted in the Select System list box. Accept with **OK**. **GeoGenius** will warn you that the System was changed and ask you, whether you accept the recalculation of the point coordinates according to the new System. Accept it.

Import
Points:
Ch. 5.5.2

For the reference station P203 we know the state plane coordinates. To enter the national coordinates of a point click the point (right mouse-button) either in the navigator or in the project plot and choose the context menu item **Properties**. Click the tab **National** and enter the following values for the chosen point:

Point #	N	E	Ell. Height
P203	6590328.303	1626885.730	2.600

Click the button **Assign** to assign the known coordinates to the project. Finally, click the tab **Control** and check the checkbox “Fix as Control Point” on the page **Control**. Then click the button **Assign**.

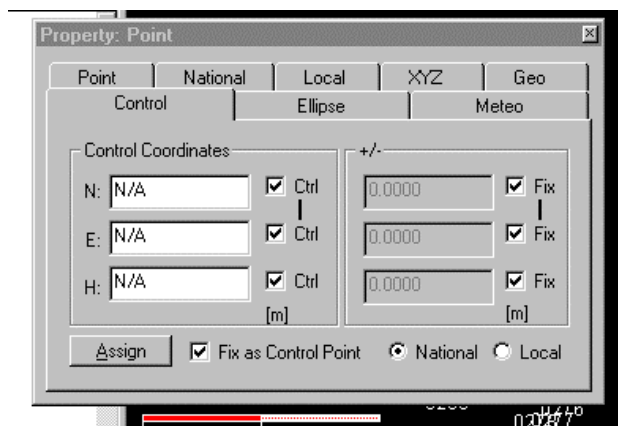


Figure 18-124: Network Stopgo - Assign Reference Coordinates

If you do not want any more the Properties notebook to be displayed, click the **Exit** button of the header line.

Save the project (File/Save), e.g., under the name STOPGO.GGS.



The processing parameters are by default set up in a way the processing works fine. In particular, if you have not changed the default processor (Automatic), **GeoGenius** will automatically detect the type of data and will use the Stop&Go processor. However, if you are not sure, that you did not change the processing parameters, you should click Process/Settings... or the corresponding toolbar button to check, e.g., the processor (click tab Processor). Either the processor Automatic or Stop&Go should be selected.



*Process
Project:
Ch. 9.4.4*



To process the project click Process/Process Project or the corresponding toolbar button. **GeoGenius** first performs code positioning, then it computes the ambiguities and checks for integrity at the VSFB initialization point (STRT). Finally, the kinematic baseline processor computes the final position output and performs an integrity check of the observations.



The kinematic path looks quite different after processing: (Please note that you may change the style for Points: click Options/Styles.../Points.)

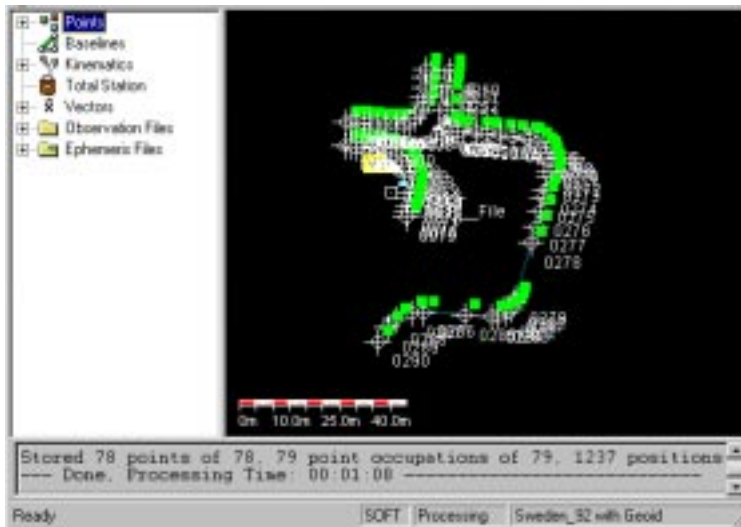


Figure 18-125: Network Stopgo - Processed

The trajectory looks by far more regularly. Circles with crosshair mark all points of the trajectory, the symbol indicating the DGPS solution. The points have been processed green (green squares), i.e., the ambiguities were fixed and their standard deviation were smaller than the default maximum allowed position sigma value of 20 mm. Point STRT is flagged by the VSFB sign, signaling the VSFB initialization. A blue triangle marks the reference station P203. A green baseline connects the single point position of the rover file with the reference station, thereby symbolizing the good results of the trajectory. It does not indicate a measured point! Look at the following figure, which displays the resulting vectors for some points, but no vector from the SPP ROVER to the reference point.



Click the item **Settings...** of the pull-down menu **Process**. Click tab **Display** of the **Process Settings** notebook.

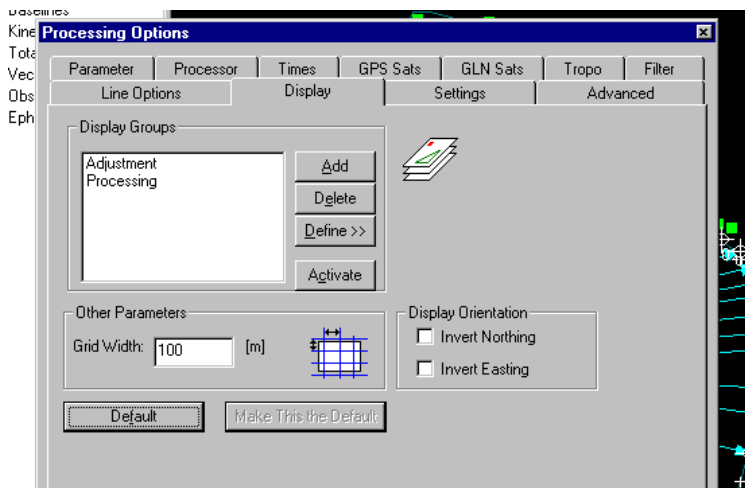


Figure 18-127: Network Stopgo - Display Setting

Page Display lists the currently installed display groups and allows you to define new groups or to delete others. In this example, we want only the points to be displayed, the trajectory and the vectors are of no interest.

Click the button **Add**. A new item **New Group 1** shows up in the Display Groups list. Activate the item and click the button **Define >>**. The Group Definition dialog displays a display group named **New Group 1**. Currently no layers are checked, that means, that the screen would be empty, if you would activate this group. Enter a new name for the group, e.g., **Points**, in the Display Group Name string field. Check the checkboxes **Static Points**, **Stop&Go Points** and **VSFB Points**. Click **OK**.

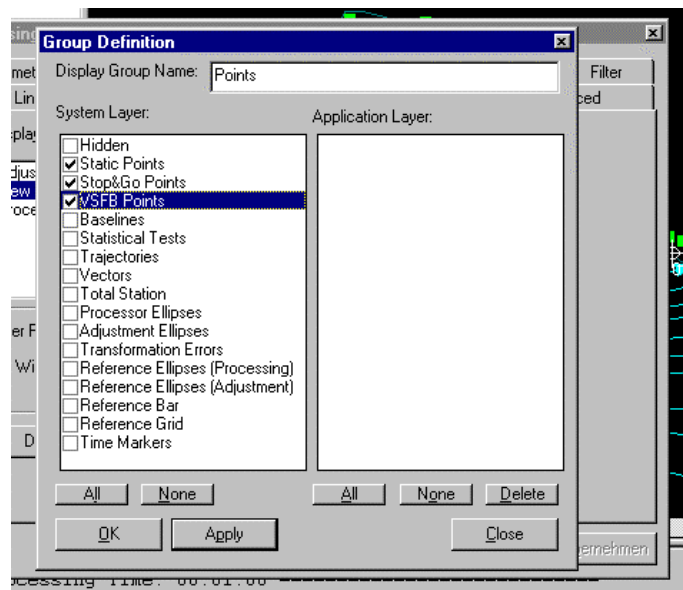


Figure 18-128: Network Stopgo - New Display Group

The list Display Groups of the page Display now contains the new layer group Points. Set the grid width to 5 [m]. Highlight the group Points (left mouse-button) and make the group the current display option by a click (left mouse-button) on button **Activate**. Click **OK** to close the dialog. The project plot will re-displayed showing only the project points. The project plot will additionally show a grid, if you click the corresponding toolbar button from the toolbar Display or check the pull-down menu item View/Display/ Toggle Grid.


Display
Toolbar:
App. A.4





Figure 18-129: Network Stopgo - Display Mode "Points"

Export Results:
Ch. 5.6

Finally, export the processing results to a further data format. In the navigator, open the tree of the rover observation file (ROVE 1401.OBS) and click the item trajectory (right mouse button) to open its context menu. Click the item **Properties** to open the notebook Property: Kinematic Path.



Figure 18-130: Network Stopgo - Export Formats



Export
Formats:
App.B.4

Choose the Ashtech C-File option of the Export Formats list box.

Click **Export...** A standard Windows file selector pops up and allows you to enter a file name. The file name box suggest a name but you need not accept it. Choose a directory and enter a name. **GeoGenius** generates the output file - a progress bar allows you to control the generation. At last, the output window displays the successful generation of the Ashtech C-File.

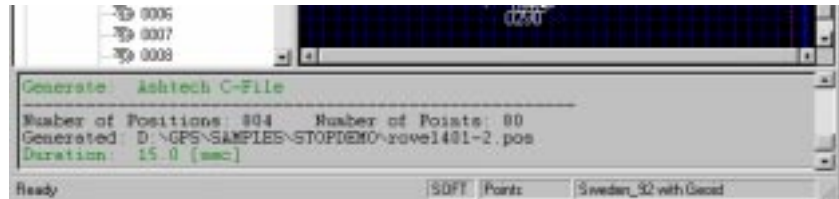


Figure 18-131: Network Stopgo - Export File Generated



Save
Project:
Ch. 5.4.4

Perhaps you want to save your project (click Project/Save or Project/Save As).



19. Applications

GeoGenius supports the generation of customer specific applications.

Most of the applications are based on the **TIM** scripting language, some are as easy as just copying some bitmaps back and forth, some are rather complicated since they make use of their own extension DLLs.

Most of the applications are protected in one or another way. If you don't own the corresponding options, please feel free and inspect the solutions. Maybe there is something you have been looking for!

This Appendix describes the available applications on the CD.

E.1	Modify Style	19-124
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19.1 Modify Style

19.1.1 Purpose

This application consists of a set of bitmaps and a revised title routine. The customer wants to see his own logos in the reports. So there is a customized `/title` routine in the `TITLE.M` file and some additional bitmaps.

19.1.2 Description

This application consists of one script and two bitmaps:

<code>TITLE.M:</code>	A new <code>/title</code> routine for MultiPage
<code>GIBSBW.BMP:</code>	One of the customer's logos
<code>GEOWB.BMP:</code>	Another of the customer's logos

With help of these files it is possible to define a new style for the **MultiPage** titles.

19.1.3 Installation

You will find the application in the `\APPS\AMILGEO` sub-directory. Copy the two bitmap files into the `\BITMAPS` sub-directory of the installation directory.

The file `TITLE.M` contains a replacement `/title` routine for **MultiPage**. To activate it, just copy it into the macro subdirectory `\M` of your installation and add this line to the bottom of the file `STD.M`, which is located there as well:

```
include [concat $EXEDIR "m\\title.m"]
```

This will activate the new title routine! (You can also replace the existing routine with the new one and skip copying of the file).

19.2 Output Data as C/C++ Statements

19.2.1 Purpose

This is an additional script file that allows you to output a project's data in form of C/C++ statements. This is useful if you want to create test environments or similar.

19.2.2 Description

This application consists of one script:

ECPP.M: The main script

19.2.3 Installation

You will find the application in the \APPS\CPLUS sub-directory.

19.3 Automated Processing

19.3.1 Purpose

This is set of scripts that allows automated copying of observation data, decoding, ephemeris generation, processing and finally generation of *.POS files.

19.3.2 Description:

This application consists of three scripts:

SAAB.M	The main script
SAABTOOL.M	Support routines for SAAB.M
SAABEDIT.M	An editor invocation for SAAB.M

The main script SAAB.M allows to automatically copy data from two PCMCIA cards, to generate *.OBS and *.EPH files from the data. It then starts the processor (kinematic) and finally generates a *.POS file.

The data is added to the current project. In case of problems, the user can continue working with the data in the current project.

19.3.3 Installation

You will find the application in the \APPS\SAAB sub-directory. Copy the three files directly into the installation root directory. The scripts MUST be located in the same directory as the GG?? .EXE file.

Please, follow the suggestions below for further installation.

1. You have to edit the script before a run, because there are several parameters to be set, e.g., the reference position.
2. Add the following items to the Tools pop-up menu: Click Options/Tools to start the Tools Configuration dialog. (Refer to Appendix A.5)
 - ⇒ The script SAAB.M should be added to the Tools menu under Auto-Process
 - ⇒ The script SAABEDIT.M should be added to the Tools menu under Edit Script

19.4 Modified POS File Format

19.4.1 Purpose

This script allows the generation of the POS kinematic position output file format additionally respecting the time difference UTC-GPS time offset.

19.4.2 Description:

This application consists of one script:

EUTCPOS.M

The script EUTCPOS.M is a format generator such as many others, which are installed by default. After you have installed the script and added the format to the list of kinematic output formats, it allows you to generate *.POS files respecting the UTC-GPS time offset. If you create a *.POS file using this script, **GeoGenius** writes for each epoch the UTC time instead of the GPS time in seconds into the position file. Please find a complete description of *.POS files in Appendix B.3.

19.4.3 Installation

You will find the application in the \APPS\POSUTC sub-directory. Copy the file into the \FORMATS subdirectory of the installation root directory.

Start **GeoGenius** and select Options/Export Formats - Kinematics. Here you may specify the list of visible formats in the Trajectory Property Page. (Refer to Appendix A.6) Just add an entry referring to this new script. It is then immediately available in the Trajectory Property Page.

20. Annotated Reports

GeoGenius creates result reports in a way, that they contain and display all necessary information, However, annotated Reports will help you to better understand your processing or adjustment results. Depending on the installed version of , the reports are displayed using either the text presentation tool **MultiPage** or the HTML generator **HyperPage**.

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20.1 The MultiPage Report Generated by the Static Baseline Processor

Static Processing Report

The header displays the Baseline identified by the point numbers (station names) of the start and end point.

Baseline:

BASE

S012

The first section of the report summarizes information to the reference station receiver and on the reference station antenna derived from the observation file header. An antenna bitmap allows you to identify phase center offsets. The instrument eccentricity corrections in north, east and height will be displayed in section 2 (the eccentricities are corrected for slope measurements, for antenna and phase center offsets).

1. Reference

File, Point, Code	BASE275A OBS	BASE	BASE
Receiver, Version, S/N	Geoscar 2320	CU-MB106	
Antenna type, S/N	Compact L2		
Eccentricity Position (m)	300250 440	-164661 125	6025003 456
Slope ecc. (N,E,H) (m)	0 000	0 000	1 872
Week, Day, Date	873	276	2-00F-1996
Start, End, Interval	20+020 00	3+0200 00	10 00
Code indications	P1	P2	D#
Center indicators	P1	P2	D#

Phase Center Offsets:

Description	Value	Unit
Correction Factor (a)	27 0	(mm)
Horizontal Offset (b)	182.6	(mm)
Phase Center Offset L1 (c-1)	27 0	(mm)
Phase Center Offset L2 (c-2)	3 2	(mm)

2. Corrected Instrument Eccentricities

Session	North (m)	East (m)	Height (m)
1	0 000	0 000	1 850

Section 3 lists the satellites observed from the reference station receiver. It gives the satellite system (GPS or GLN = GLONASS), the satellite (PRN) number and the number of epochs to the satellite.

3. SV's tracked

System	SVID	Observations
GPS	1	521
GPS	2	701
GPS	4	1369
GPS	5	113
GPS	7	1465
GPS	10	1244
GPS	14	1744
GPS	15	1156
GPS	16	1617
GPS	17	150
GPS	18	2041

Information regarding the unknown point follows in the sections 4 to 6. Receiver and antenna information derived from the observation file header is displayed in section 4. The instrument eccentricity corrections in north, east and height will be displayed in section 5 (the eccentricities are corrected for slope measurements, for antenna and phase center offsets).

4. Rover

File, Point, Code	S012275a.obs	S012	S012
Receiver, Version, S/H	Geotracor 2200	Cu—WB106	
Antenna type, S/H	Compact L2		
Geocentric Position [m]	3002447.357	-154041.348	5025776.487
Slope ecc. (N,E,W) [m]	0.000	0.000	1.670
Week, Day, Date	871	276	2-OCT-1996
Start, End, Interval	202180.00	205070.00	10.00
Code Indicators	P1	P2	C/A
Carrier Indicators	P1	P2	C/A

Phase Center Offsets:

Description	Value	Unit
Correction Factor (a)	36.8	[mm]
Horizontal Offset (b)	60.0	[mm]
Phase Center Offset L1 (c1)	36.6	[mm]
Phase Center Offset L2 (c2)	9.5	[mm]

5. Corrected Instrument Eccentricities

Session	North [m]	East [m]	Height [m]
1	0.000	0.000	1.705

Section 6 lists the satellites observed from the rover receiver. It gives the satellite system (GPS or GLN = GLONASS), the satellite (PRN) number and the number of epochs to the satellite.

6. SV's tracked

System	SVID	Observations
GPS	1	280
GPS	2	280
GPS	7	280
GPS	14	280
GPS	15	280
GPS	20	280
GPS	31	273

ALL TIMES ARE GIVEN IN GPS - 0.00 HOURS

Section 7 summarizes all processing parameters as set in the notebook Processing Options. The static processor reads the instructions of the settings and lists them again: You can double check the settings made.

7. Processing Parameters

START TIME : 202180.0 (00:00:40.00) END TIME : 205070.0 (00:57:50.00)
 INTERVAL : 10.00 CUTOFF : 10. FREQUENCY : L1
 DUAL-FREQ. AMBIGUITY SEARCH : YES
 OBSERVATION EDIT MULTIPLIER : 3.5
 RELATIVE IONOSPHERIC ERROR : 0.1 PPM
 RELATIVE EPHEMERIS ERROR : 1.0 PPM
 FROM : 202180.00 (00:00:40.00) TO : 205070.00 (00:57:50.00) STEP : 10.00 CUTOFF : 10
 DELETING 4 EPOCHS BEFORE 00:54:40.00 TO SATELLITE 1

The next section includes the system and PRN numbers of common satellites for both stations, the number of observation epochs, the minimum and maximum elevation angles and signal to noise ratios, resp. The reference satellite is indicated.

8. Number of Single Differences

System	SVID	Obsrv	Min_El	Max_El	Min_Snr	Max_Snr	Min_Snr2	Max_Snr2	Comment
GPS	1	278	18	20	43	45	43	45	
GPS	2	280	10	22	41	45	42	45	
GPS	7	280	24	41	44	45	42	45	
GPS	14	280	40	73	45	255	45	255	
GPS	15	280	64	84	45	45	45	45	
GPS	20	280	13	34	43	45	43	45	
GPS	31	278	10	30	43	45	43	45	

GPS 15 <- Reference Satellite - Total No. of Observations : 1971

Now satellite availability is given for the processing time span:

9. Satellite Availability

System	SVID	Start Date & Start Time	Stop Date & Stop Time
GPS	1	02-OCT-1996 02:02:40.00	02-OCT-1996 02:57:40.00
GPS	2	02-OCT-1996 02:02:40.00	02-OCT-1996 02:57:40.00
GPS	7	02-OCT-1996 02:02:40.00	02-OCT-1996 02:57:40.00
GPS	14	02-OCT-1996 02:14:40.00	02-OCT-1996 02:57:40.00
GPS	15	02-OCT-1996 02:02:40.00	02-OCT-1996 02:57:40.00
GPS	20	02-OCT-1996 02:02:40.00	02-OCT-1996 02:57:40.00
GPS	31	02-OCT-1996 02:02:40.00	02-OCT-1996 02:55:50.00

First, the static processor computes the triple difference solution. This is necessary to detect and correct cycle slips and to estimate carrier phase noise. The table in section 10 shows the position shifts and standard deviations.

10. Triple Difference Solution

ITERATION 1 : POSITION SHIFTS DX DY DZ [m] = -3.829 7.867 -53.810

ITERATION 2 : POSITION SHIFTS DX DY DZ [m] = -0.056 -0.036 -0.077

Solution

TRIPLE DIFFERENCE BASELINE COMPONENTS FROM BASE TO S012

Red	dx [m]	dy [m]	dz [m]	sx [mm]	sy [mm]	sz [mm]	mss [mm]
L1	106.801	-200.054	-163.083	84.6	61.2	59.2	2.7

If cycle slips had been found, these would be listed in the following section.

The static processor then computes the double difference float solutions. The accuracy is important to determine search space for ambiguity fixing.

11. Double Difference Solution

Solution

DOUBLE DIFFERENCE FLOAT BASELINE COMPONENTS FROM BASE TO S012

Prd	dx [m]	dy [m]	dz [m]	dx [mm]	dy [mm]	dz [mm]	rms [mm]
L1	126.829	-200.054	-163.081	1.5	2.1	1.1	3.7
L2	126.813	-200.050	-163.075	2.6	3.4	1.8	6.2
LW	126.836	-200.038	-163.106	10.6	14.3	7.6	25.6
Ln	126.822	-200.056	-163.078	1.5	2.0	1.1	3.6
Lc	126.853	-200.047	-163.092	6.2	6.9	3.7	12.4

Computed float ambiguities for each satellite relative to the reference satellite follow.

12. Determined Ambiguities [cycles]

System	SVID	Arc	Ambiguity L1	Ambiguity L2	Ambiguity LW	Ambiguity Ln	Ambiguity Lc
GPS	2	1	-1314224.02	-752607.80	-561617.03	-2066832.81	-1852722.66
GPS	1	1	-1452405.02	-874652.04	-577842.08	-2327147.06	-1962621.80
GPS	7	1	4254773.05	3638358.14	616414.01	7803131.10	3614141.10
GPS	31	1	-4765667.07	-3444271.08	-1321205.00	-8202830.05	-5200401.60
GPS	14	1	3636234.03	3038031.02	-402706.00	7473265.05	1187934.42
GPS	20	1	2640208.03	2322015.02	327193.01	4071223.04	2138018.47

An additional table shows the accuracies of the float ambiguities.

System	SVID	Arc	Sigma L1	Sigma L2	Sigma LW	Sigma Ln	Sigma Lc
GPS	2	1	0.01	0.02	0.02	0.02	0.04
GPS	1	1	0.01	0.01	0.01	0.02	0.03
GPS	7	1	0.01	0.01	0.02	0.02	0.03
GPS	31	1	0.01	0.01	0.01	0.01	0.02
GPS	14	1	0.01	0.01	0.01	0.01	0.02
GPS	20	1	0.01	0.01	0.01	0.01	0.02

NUMBER OF INTEGER COMBINATIONS TO CHECK = 3

The next sections give the results of statistical testing: Probability limits are defined for the chi-square and the Fisher tests. These tests decide

if the static processor could fix the ambiguities. The higher the ratio the surer the statistical test has fixed the correct ambiguity.

13. Regression Analysis for L1

System	SVID	Arc	Sig_d(mm)	Sig_s(mm/s)	RMS(mm)	Obsrv	Chi2	Probability (%)
BPS	2	1	0.6	0.0004	6.4	280	26.747	100.000
BPS	1	1	0.6	0.0003	4.0	278	14.143	100.000
BPS	7	1	0.4	0.0002	3.2	280	9.136	100.000
BPS	31	1	0.6	0.0004	4.7	278	19.179	100.000
BPS	14	1	0.3	0.0002	2.1	260	3.660	100.000
BPS	20	1	0.6	0.0003	4.4	280	17.480	100.000

14. Ambiguity Resolution Results for L1

Confidence Test Levels: Chi-Squared: 95.0000 % - Fisher: 99.9999 %

Name of Test	Test Value	Second Best	Probability (%)	Statisc Test Type	Comment
Bias	4.0	4022.8	100.000000	Chi-Square	Accepted
Bias_L2	97.6	1032.3	100.000000	Chi-Square	Accepted
Ratio	78.30	-	100.000000	Fisher Test	Accepted

Now, the double difference fixed solutions for the baseline vector to the unknown point follow (as well as the standard deviation and the root mean square value of the residuals):

Solution

DOUBLE DIFFERENCE FIXED BASELINE COMPONENTS FROM BASE TO S012							
Base	dX [m]	dY [m]	dZ [m]	sX [mm]	sY [mm]	sZ [mm]	rms [mm]
L1	106.830	-200.044	-163.076	0.3	0.2	0.3	3.8
L2	106.836	-200.047	-163.066	0.6	0.4	0.6	8.0
LW	106.808	-200.036	-163.110	1.8	1.1	1.0	26.4
LN	106.833	-200.046	-163.072	0.3	0.2	0.3	3.8
LC	106.820	-200.040	-163.091	0.8	0.5	0.9	12.5

The next section displays the determined fixed integer ambiguities for each satellite relative to the reference satellite.

15. Determined Ambiguities [cycles]

System	SVID	Arc	Ambiguity L1	Ambiguity L2	Ambiguity LW	Ambiguity LN	Ambiguity LC
GPS	2	1	-1314225.00	-752608.00	-561617.00	-2066833.00	-1862722.66
GPS	1	1	-1462405.00	-874653.00	-577842.00	-2327148.00	-1962621.72
GPS	7	1	4254773.00	3638368.00	616415.00	7803131.00	3614141.33
GPS	31	1	-4765568.00	-3444272.00	-1321206.00	-8200840.00	-6200401.64
GPS	14	1	3636234.00	3038031.00	-402797.00	7473266.00	1187934.38
GPS	20	1	2640208.00	2322016.00	327103.00	4071223.00	2138018.43

The last three sections display the computed results for the reference station and the coordinates for the unknown point (rover) (all positions in WGS-84 geocentric Cartesian coordinates) and summarize the observation statistics.

16. Reference

Point, Info, Code	BASE	BASE 00000000000	BASE
Geocentric position	3002250.440	-154681.125	5025003.455
Lat, Long, Height	N 52 20 17.50346	W 2 16 10.76863	138.550

17. Rover

Point, Info, Code	S012	WXR12 00000000000	S012
Geocentric position	3002456.273	-154651.171	5025030.385
Lat, Long, Height	N 52 20 8.54846	W 2 16 25.66323	136.667
Solution Type, Prio, Quality	Double Diff Rover	LN	Poor
DeltaX, DeltaY, DeltaZ	195.833	-200.045	-163.072
Sigmas (X,Y,Z) [mm]	0.2	0.2	0.3
Sigmas (X,Y,Z) [mm]	0.3	0.2	0.3
Correlation CxY, CxZ, CyZ	-0.187158	0.864198	-0.029620
Min & Max PDOP, RDOP	1.61	3.22	0.14

18. Observation Statistics

System	SVID	Arc	Number	RMS [mm]	Max elev
GPS	2	1	282	5.4	23
GPS	1	1	278	4.0	29
GPS	7	1	282	3.2	41
GPS	31	1	278	4.7	30
GPS	14	1	250	2.1	73
GPS	29	1	282	4.4	35

Observation statistics summarize the quality of the double difference observables to the individual satellites. The number of observations, the RMS (root mean square) and the maximum elevation angle (in degrees) are reported. It is typical that satellites with higher elevation angles have lower RMS values than low elevation angle satellites.

20.2 Network Adjustment Reports

20.2.1 Adjustment in the WGS84 System (Free and Biased)

Network Adjustment

At the beginning of the list header information displays statistics: Number of baselines and terrestrial measurements included, number of control points in the WGS84 system, the confidence level and significance level for the tau test, the standard error unit weight and the number of iterations needed. If a biased adjustment was done, the number of control points in the WGS84 system will be 1 or more. The current date of creation will be displayed at the bottom of each page.

<i>Statistics</i>	
Network Adjustment in WGS84:	
Number of baselines	20
Number of terrestrial measurements	0
Number of control points in WGS84	4
Number of adjustment points	17
Confidence level	1 Sigma
Significance level for tau test	1.00 %
Standard error of unit weight	0.872
Number of iterations	1

The baseline components computed by the Processing Module (baseline vectors dx, dy, dz and residuals) are given in the first table. These vector components are the observations for the Network Adjustment.

1. Baselines Input in WGS84 (Components and Std.Dev.)

Baseline	DX (m)	DY (m)	DZ (m)	sDX (mm)	sDY (mm)	sDZ (mm)
S012-BASE	-196 833	200 046	163 072	2 6	1 6	2 7
S013-BASE	-166 827	160 184	136 223	4 1	3 0	6 6
S013-S012	31 010	-120 864	-27 846	6 4	3 7	6 8
S014-BASE	-146 722	6 046	111 436	6 6	4 2	6 3
S014-S013	20 000	-164 144	-23 810	8 0	3 6	6 6
S016-BASE	-168 126	-84 376	117 360	8 1	4 8	9 4

Baselines that were rejected by the statistical test are marked by a red highlight.

Only if control points bias your network, the next table will list the control point Cartesian coordinates and residuals:

2. WGS84 Control Points Input (Cart. Coordinates and Std.Dev.)

Point	X (m)	Y (m)	Z (m)	sX (mm)	sY (mm)	sZ (mm)
BASE	300209 444	-164861 127	602603 480	0 0	0 0	0 0

The next table displays the adjusted baseline vectors in WGS84 and their residuals (standard deviations).

3. Adjusted Baselines in WGS84 (Components and Std.Dev.)

Baseline	DX (m)	DY (m)	DZ (m)	sDX (mm)	sDY (mm)	sDZ (mm)
S012-BASE	-196 833	200 046	163 072	1 7	1 1	1 8
S013-BASE	-166 823	160 185	136 230	2 2	1 6	2 6
S013-S012	31 000	-120 861	-27 842	2 4	1 6	2 7
S014-BASE	-146 724	6 043	111 423	3 6	2 1	3 4
S014-S013	20 000	-164 142	-23 807	3 8	1 9	3 4
S016-BASE	-168 119	-84 376	117 364	3 8	2 2	4 4

Baseline corrections and normalized residuals follow.

4. Baseline Corrections (Corrections and Normalized Corr.)

Baseline	rX (mm)	rY (mm)	rZ (mm)	$rX\%$	$rY\%$	$rZ\%$
S012-BASE	-0 0	0 6	0 6	-0 0	0 6	0 3
S013-BASE	3 4	1 1	6 4	1 6	0 7	2 6
S013-S012	-0 1	3 3	2 7	-0 0	2 0	1 0
S014-BASE	-2 6	-3 0	-11 4	-0 7	-1 6	-3 4
S014-S013	6 7	2 1	12 8	1 8	1 1	3 8
S016-BASE	7 7	0 2	3 1	2 0	0 1	0 7

The adjustment is done in WGS84 System. The resulting Cartesian and geographical coordinates together with their standard deviations (error estimates after adjustment) are given in the last two lists of the report.

5. Adjusted Points in WGS84 (Cart. Coordinates and Std.Dev.)

Point	X (m)	Y (m)	Z (m)	$\pm X$ (mm)	$\pm Y$ (mm)	$\pm Z$ (mm)
BASE	3002259.444	-154661.127	6026903.460	0.0	0.0	0.0
S012	3002456.276	-154661.173	6026830.388	1.6	1.0	1.7
S013	3002426.267	-154662.312	6026868.230	2.1	1.4	2.6
S014	3002406.168	-154667.170	6026882.037	3.6	2.0	3.2

6. Adjusted Points in WGS84 (Geogr. Coordinates and Std.Dev.)

Point	Lat (Deg)	Lon (Deg)	H (m)	$\pm H$ (mm)	$\pm \Delta E$ (mm)	$\pm \Delta N$ (mm)
BASE	N62° 20' 17.60344"	W2° 16' 10.76871"	138.664	0.0	0.0	0.0
S012	N62° 20' 8.94846"	W2° 16' 28.88336"	138.671	1.0	1.0	2.1
S013	N62° 20' 10.42426"	W2° 16' 18.87636"	138.632	1.6	1.4	2.9
S014	N62° 20' 11.62663"	W2° 16' 18.76791"	138.272	2.2	1.0	2.9

20.2.2 Adjustment in the National System (Biased)

Network Adjustment

At the beginning of the list header information displays network statistics: The System in use, the number of baselines and terrestrial measurements included, number of control points in the WGS84 system and the national grid System, the number of adjusted points, the confidence level and the significance level for the tau test, the standard error unit weight and the number of iterations. The number of control points in the local system has to be 1 or more. The current date of creation will be displayed at the bottom of each page.

<i>Statistics</i>	
Adjustment in the national system:	
System: United Kingdom (Datum: OSGB00; Projection: United_Kingdom)	
Number of baselines	: 30
Number of terrestrial measurements	: 0
Number of control points in national system	: 4
Number of adjusted points	: 17
Confidence level	: 1 Sigma
Significance level for tau test	: 1.00 %
Standard error of unit weight	: 0.704
Number of iterations	: 2

The next list gives the adjusted seven transformation parameters:

<i>Adjusted Transformation Parameters</i>	
Scale	1.0000007 ± 0.0000003
Rotation X	0.0000043 Deg ± 2.1 arcsec
Rotation Y	0.0000010 Deg ± 1.9 arcsec
Rotation Z	-0.0000020 Deg ± -1.9 arcsec
Translation X	-489.029 m ± 0.000 m
Translation Y	105.258 m ± 0.000 m
Translation Z	-438.845 m ± 0.000 m
The translation has been calculated with the reference point S012.	

The baseline components computed by the Processing Module (baseline vectors dx, dy, dz and residuals) are given in the first table. These vector components are the observations for the Network Adjustment.

1. Baselines Input in WGS84 (Components and Std.Dev.)

Baseline	DX (m)	DY (m)	DZ (m)	sDX (mm)	sDY (mm)	sDZ (mm)
S012-S45E	-106.833	200.046	163.072	2.6	1.6	2.7
S013-S45E	-166.827	160.184	136.223	4.1	3.0	6.6
S013-S012	31.010	-120.864	-27.846	6.4	3.7	6.8
S014-S45E	-146.722	6.046	111.436	6.6	4.2	6.3
S014-S013	20.002	-164.144	-23.810	6.0	3.6	6.6
S016-S45E	-108.128	-84.376	117.360	8.1	4.8	9.4

Baselines, which were rejected by the statistical test, are marked by a red highlight.

Input data necessary for an adjustment of transformation parameters follow in section 2. These are the national control points (plane coordinates and standard deviations). Control points or coordinates, which were not added to the adjustment, are given in brackets.

2. National Control Points Input (Plane Coord. and Std.Dev.)

Point	N (m)	E (m)	H (m)	sN (mm)	sE (mm)	sH (mm)
S45E	271161.634	381725.322	90.400	0.0	0.0	0.0
S018	271060.362	381911.687	89.746	0.0	0.0	0.0
S026	271421.060	381983.320	89.760	0.0	0.0	0.0
S028	271601.817	381862.878	89.766	0.0	0.0	0.0

Coordinates which were not added to the adjustment are in brackets

As results, **GeoGenius** first prints out Cartesian WGS84 coordinates. The next table displays the adjusted baseline vectors in WGS84 and their residuals (standard deviations).

3. Adjusted Baselines in WGS84 (Components and Std.Dev.)

Baseline	DW (m)	DY (m)	DZ (m)	σ_{DW} (mm)	σ_{DY} (mm)	σ_{DZ} (mm)
S012-BASE	-196 833	200 046	163 072	1 7	1 1	1 8
S013-BASE	-165 823	180 185	135 230	2 2	1 5	2 6
S013-S012	31 000	-120 861	-27 842	2 4	1 6	2 7
S014-BASE	-145 724	6 043	111 423	3 6	2 1	3 4
S014-S013	20 000	-154 142	-23 807	3 8	1 9	3 4
S016-BASE	-168 119	-84 375	117 354	3 8	2 2	4 4

The table of section 4 shows baseline corrections and normalized residuals.

4. Baseline Corrections (Corrections and Normalized Corr.)

Baseline	ΔX (mm)	ΔY (mm)	ΔZ (mm)	$\sigma_{\Delta X}$	$\sigma_{\Delta Y}$	$\sigma_{\Delta Z}$
S012-BASE	-0 0	0 6	0 5	-0 0	0 6	0 3
S013-BASE	3 4	1 1	6 4	1 6	0 7	2 6
S013-S012	-0 1	3 3	2 7	-0 0	2 0	1 0
S014-BASE	-2 5	-3 0	-11 4	-0 7	-1 5	-3 4
S014-S013	6 7	2 1	12 8	1 8	1 1	3 8
S016-BASE	7 7	0 2	3 1	2 0	0 1	0 7

Final results are given in the last tables:

The first table lists the Adjusted Points in WGS84 (Cartesian coordinates and residuals):

5. Adjusted Points in WGS84 (Cart. Coordinates and Residuals)

Point	X (m)	Y (m)	Z (m)	σ_{X} (mm)	σ_{Y} (mm)	σ_{Z} (mm)
BASE	3002259 444	-154551 127	6025903 460	0 0	0 0	-0 0
S012	3002456 276	-154051 173	6025830 388	—	—	—
S013	3002425 267	-154821 312	6025858 230	—	—	—
S014	3002405 168	-154557 170	6025882 037	—	—	—
S016	3002417 682	-154575 752	6025875 106	—	—	—

Adjusted points in WGS 84 (Cartesian coordinates and standard deviations) follow:

6. Adjusted Points in WGS84 (Cart. Coordinates and Std.Dev.)

Point	X (m)	Y (m)	Z (m)	σ_X (mm)	σ_Y (mm)	σ_Z (mm)
BASE	3002259 444	-154551 127	6025903 460	1 0	0 5	1 0
S012	3002456 276	-154051 173	6025830 388	2 0	1 2	2 0
S013	3002425 267	-154821 312	6025858 230	2 4	1 6	2 8
S014	3002405 168	-154557 170	6025882 037	3 8	2 1	3 6

7. Adjusted Points in WGS84 (Geogr. Coordinates and Std.Dev.)

Point	Lat (Deg)	Lon (Deg)	H (m)	sM (mm)	sE (mm)	sN (mm)
BASE	N62° 20' 17.5034"	W2° 16' 10.1687"	138.564	0.6	0.6	1.3
SD12	N62° 20' 8.9485"	W2° 16' 26.6633"	136.671	1.2	1.2	2.6
SD13	N62° 20' 10.4243"	W2° 16' 18.8762"	136.632	1.7	1.6	3.3
SD14	N62° 20' 11.6856"	W2° 16' 10.7828"	139.474	2.6	2.1	4.6

The next two tables give the adjusted points in the national grid system. The first of them also displays the residuals, the second the standard deviations.

8. Adjusted Points in National System (Plane Coord. and Residuals)

Point	N (m)	E (m)	H (m)	res N (mm)	res E (mm)	res H (mm)
BASE	271161.634	381726.322	90.400	-0.0	0.0	0.0
S012	270898.267	381442.431	88.606	—	—	—
S013	270843.381	381671.079	88.468	—	—	—
S014	270878.073	381724.372	91.312	—	—	—
S016	270867.146	381816.133	91.900	—	—	—

9. Adjusted Points in National Coordinates (Plane Coord. and Std.Dev.)

Point	N (m)	E (m)	H (m)	sN (mm)	sE (mm)	sH (mm)
BASE	271161.634	381726.322	90.400	0.6	0.6	1.3
S012	270898.267	381442.431	88.606	1.2	1.2	2.6
S013	270843.381	381671.079	88.468	1.7	1.6	3.3
S014	270878.073	381724.372	91.312	2.6	2.1	4.6
S016	270867.146	381816.133	91.900	3.2	2.3	5.5

The last table gives the values of the error ellipses of the adjusted points.

10. Adjusted Points Error Ellipses

Point	A (mm)	B (mm)	Angle (Deg)
BASE	0.6	0.6	-14.3
S012	1.2	1.1	40.6
S013	1.8	1.6	24.9
S014	2.6	1.6	32.8
S016	2.7	2.1	-30.9
S017	2.9	2.1	1.1
S018	0.7	0.6	-66.8

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**GPS and GLONASS DATA VISUALIZATION AND
EDITING TOOL**

GPS-Edit

User's Manual



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Note

We are aware of the fact that our exclusive masculine pronoun "he" is considered politically incorrect, but has been used in this case to simplify readability.

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22. Overview

GPS-Edit for Windows 95/NT is an advanced tool for graphic visualization of GPS data and DGPS observations. Graphic windows display the observables code, carrier and Doppler as well as combined rallies (wide-laning, ionospheric correction, single, double, triple, delta differencing). **GPS-Edit** is based on *Spectra Precision Terrasat* standard observation files *.OBS. They are displayed in any combination of receiver, frequency and satellite. **GPS-Edit** allows to work with two observation files simultaneously (to show single, double and triple differences). **GPS-Edit** allows switching between multi-satellite view and single-satellite view.

You can quickly change receiver, frequencies, satellite, the reference satellite and data processing at one button click.

Further Options are:

- More Statistics
- Legend on Statistics
- Activating different ephemeris files
- Observation file(s) scanning

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23. Installation

GPS-Edit is an integrated part of **GeoGenius**. For the installation of **GeoGenius** please refer to chapter 2 of the ***GeoGenius User's Guide***. It is recommended that you run a "Typical" installation of **GeoGenius**, which installs all components of **GeoGenius** onto your computer.

If you choose to do a "Custom" installation the following two components are necessary for **GPS-Edit**:

- GPS-Edit
- System-Files (will be installed into your WINDOWS SYSTEM directory)

When first installed on your computer **GPS-Edit** works in DEMO mode, which allows only to process the sample data supplied on the installation CD. DEMO mode is indicated in the status bar of **GPS-Edit**. In order to convert the software into a fully functional licensed copy you have to request a license key. For the license request and license activation of **GeoGenius** please refer to chapter 2 of the ***GeoGenius User's Guide***.

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24. User Interface Components

The **GPS-Edit** main window consists of the following parts:

- Standard window title indicating the current observation file name
- Menu bar
- Toolbars for quick access
- Graph Display
- Satellite Selector Area
- Status bar

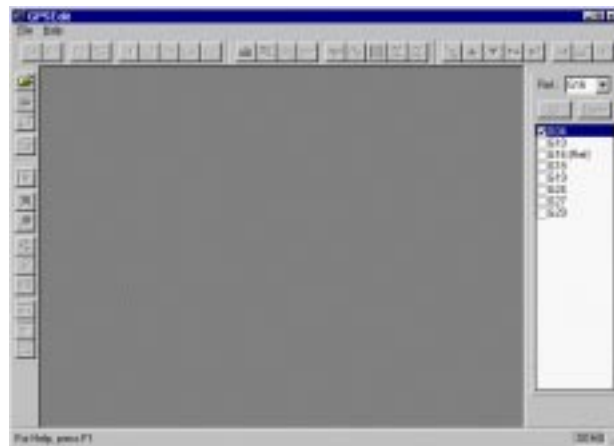


Figure 24-1: GPS-Edit Main Window

24.1 Menu and Toolbars

The **GPS-Edit** toolbars assemble the same functionality that is found in the menus. Once you have become familiar with their usage they are extremely useful for quickly switching between the different operations of **GPS-Edit**. They also provide you with the overview of available data types and functions at one glance.

The following toolbars are available. You will find a detailed description in the referring chapters:

- File Input, Reference/Rover Swapping and Printing, ch. 4:



- Data Functions, ch. 5:



- Code Types, Frequencies, ch. 6,8



- Combinations, Filters, ch. 7:



- Graph Options, ch. 9:



When first started **GPS-Edit** displays only one of five toolbars, the File IO toolbar, just below the File menu. Selecting the Options/Toolbars... menu will bring up the Toolbars dialog.

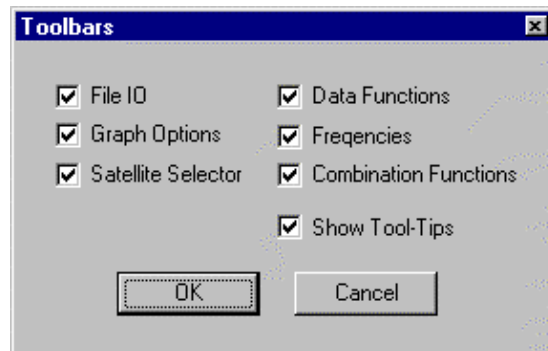


Figure 24-2: Toolbars Dialog

The Toolbars dialog allows you also to display or hide the Satellite Selector (refer to the following section) which is handled just like a toolbar. Here you can witch the individual toolbars on and off. To get acquainted to the toolbar buttons you should switch on all toolbars.

If the item **Show Tool-Tips** is checked, when the mouse cursor is positioned onto one of the toolbar buttons a small Tool-Tip window with the button's functional description is displayed next to the button. The status bar also displays a description for this button.

You can freely arrange the toolbars around the graph display area by clicking on their background and dragging them to a different location. Releasing the mouse button while the toolbar is not close to one of the window borders will position the toolbar at the current location as a "floating window". Also, a toolbar can be detached from the main window by double-clicking on the toolbar background. To re-attach a

floating toolbar click on the small toolbar title bar. Clicking on the **Close** icon of a floating toolbar will hide the toolbar. It then can only be shown again using the menu **Options/Toolbars...**

The following figure shows all toolbars displayed on the **GPS-Edit** main window. The toolbars **File IO** and **Graph Options** are moved to the left border, while the toolbar **Combination Functions** is positioned freely as a floating window.

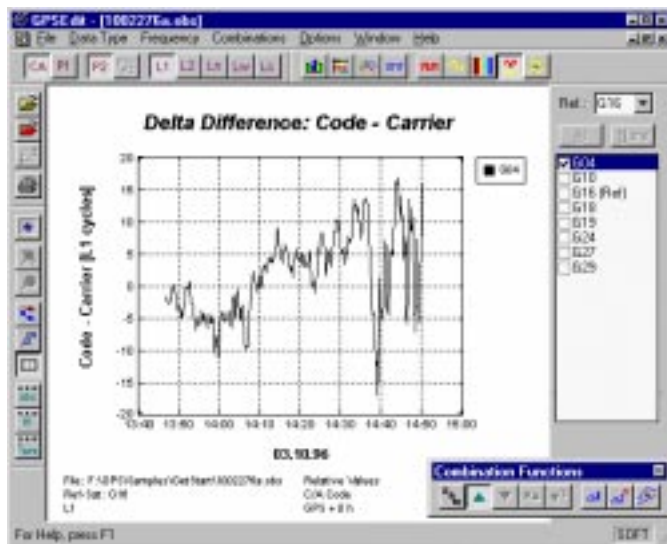


Figure 24-3: Example for Toolbar Positioning

24.2 The Graph Display

The main part of the window shows a graphic representation of the selected observation types over a given time span.

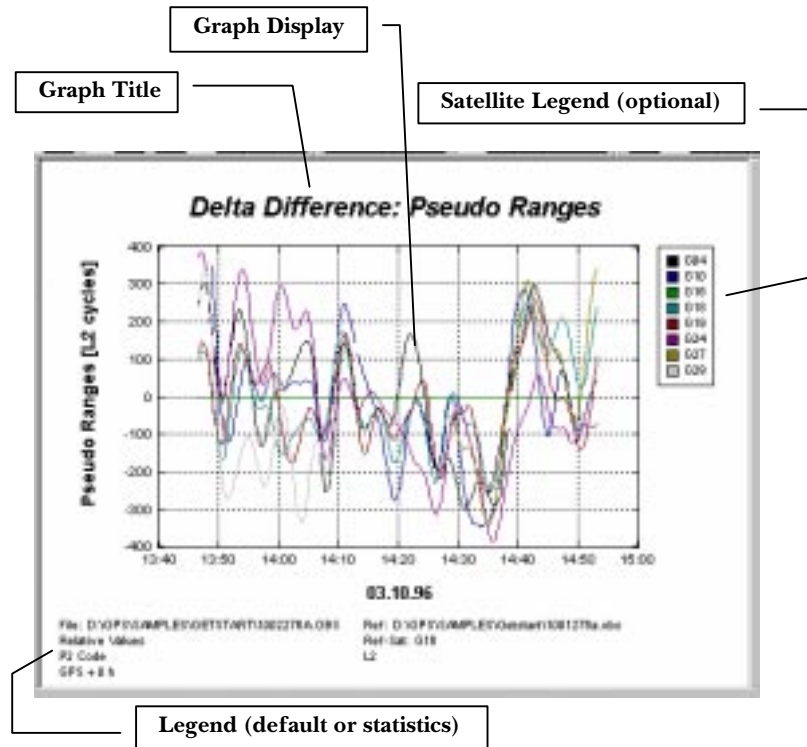


Figure 24-4: The Graphic Field

The x-axis of the graphic field represents the time in hours, minutes and seconds in GPS time. The y-axis represents the range of the function values at the time given. These values may be given absolutely or relatively.

The graphs are points and lines derived from the recorded values. If recording was continuous the graphs will be continuous, too.

- **Graph Title**
The graph title above the graph indicates the type of data and function currently displayed, e.g. “Double Difference: Code-Carrier”.
- **Graph Display**
The graph display shows the function curve(s) for the currently selected satellite(s). Each satellite number corresponds to a fixed color. For example, the GLONASS satellite number 6 will be pink in any of the graphs of **GPS-Edit**.

You can zoom into a smaller time-span of the graph by pressing the left mouse-button and dragging the rubber-band rectangle that appears. If you release the mouse-button outside the **GPS-Edit window, the zoom action will be canceled.**

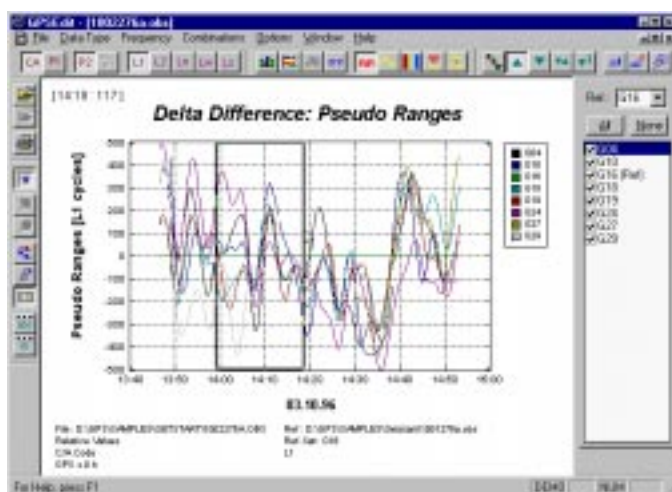


Figure 24-5: Zoom-In Region Marked

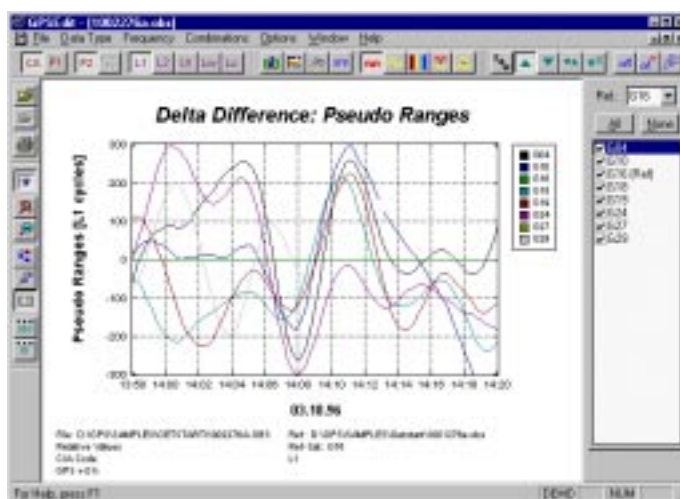


Figure 24-6: Zoomed-In Time Span

GPS-Edit remembers the last 10 zoom actions. If you want to return to one of the previous zoom areas, just click the right mouse button (or press the Zoom Back toolbar button). To display the full view of the graph again double-click the right mouse button (or press the Unzoom toolbar button).



Zoom settings are independent of the graph type. If you have zoomed into a specific time span, the curve(s) of all graphs will cover the same time span until you change the zoom factor again.

- **x-Axis**

The x-Axis displays the observed time span. Depending on the time span to display, the axis ticks display reasonable values. For example, if the observation spans several days, then the date is displayed with the time values on each axis tick. Or, if the time span is in the minute range, seconds are added to the display.

Crooked time values are avoided. Thus, for example, if your observation ranges from 09:37 to 10:29 the x-axis will be optimized to display the range 09:30 to 10:30.

Below the x-Axis the date or the date-range of the observations is displayed as the axis name.

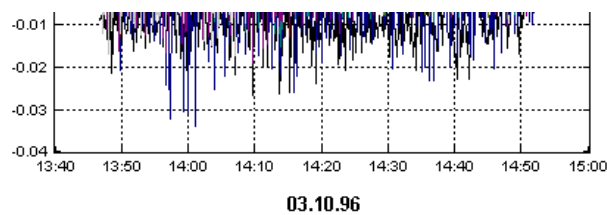


Figure 24-7: Graphic Display: Time Axis and Axis Name

You can also switch between normal display of hours : minutes : seconds and the display of GPS-week and GPS-seconds by toggling the button GPS-time on the toolbar Graph Options (menu item Options/GPS-Time).



- y-Axis

The y-Axis name to the left of the graph indicates the type of data currently displayed and the unit which the values are shown in. The y-Axis range is optimally chosen to include all function values and to display reasonable axis ticks without crooked tick values.

For the most graphs, the y-Axis may display absolute or relative values in meter or cycle units. You may toggle between relative and absolute values using the toolbar button Absolute and between meters and cycles using the button Meters. If the y-axis unit is different, e.g., when displaying the number of satellites, these buttons are inactivated.



- Satellite Legend

If you are working in Multi-Satellite mode a legend-box on the right-hand side of the graph indicates which satellites are displayed and which colors are assigned to the different satellites.

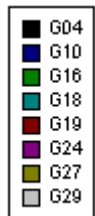


Figure 24-8: Satellite Legend

- Legend

On the bottom of the graph window below the x-axis a legend is located. The legend contains information about all the settings for the current graph. Depending on the graph type, the legend con-

tains more or less entries. The legend information is especially useful if you make printouts of graphs.

The default legend can contain:

- ◆ Rover OBS file name with path
- ◆ Reference OBS file name with path
- ◆ Display of relative or absolute y-values
- ◆ ID of the reference satellite
- ◆ Code type
- ◆ Frequency
- ◆ Epoch to Epoch function indicator (its order and skip value)
- ◆ Linear Regression indicator
- ◆ Time zone information

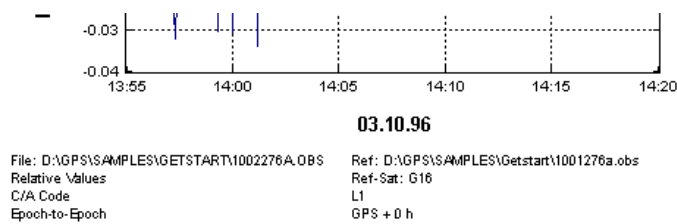


Figure 24-9: Default Legend

Via the menu option Tools/Statistics/Legend you may change to the display of the legend of statistics. The legend of statistics contains the following entries:

- ◆ Linear Regression $y = \text{Offset} + \text{Slope} * x$
- ◆ Mean
- ◆ RMS
- ◆ Standard deviation offset
- ◆ Standard deviation slope

By default all values refer to the full function set of the observation file. To display the values derived from a smaller time span (zoomed-in data) activate also the menu option Tools/Statistics/Change Legend when Zoomed.

The values are always given as **absolute values** in the **chosen length** unit.

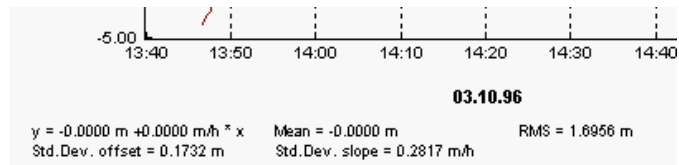


Figure 24-10: Legend Statistics

24.3 The Satellite Selector

The Satellite Selector displays the satellites for which data has been recorded in the Rover observation file. IDs starting with a “G” indicate GPS satellites, while GLONASS satellite IDs start with an “R”. On the left of each satellite name there is a check-box to switch that specific satellite on and off. The letters “REF” indicate the satellite chosen as reference.

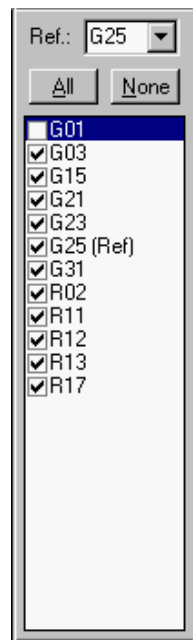


Figure 24-11: Satellite Selector

The combo box on the upper border of the satellite selector allows you to select the **reference satellite** for functions like Delta Difference. When a Rover file is loaded the program determines the satellite with most epochs observed and selects this one as the default reference satellite. Only one satellite can be the reference. Thus, when you open the combo box and select a new satellite for reference the old one is switched off and **GPS-Edit** instantly recalculates the data displayed in the graph.

If you are working in Multi-Satellite mode, then the curves for each of the satellites can be switched on and off individually using the check-box next to the satellite name. The toolbar button **All** activates all satellites, while you may deselect all satellites via the toolbar button **None**. If you are working in Single-Satellite mode, then clicking on a satellite's check-box will switch the old satellite's data off and this one's data on. (Multi-Satellite and Single-Satellite mode can be toggled by clicking on the Multi-Satellite button in the Graph Options toolbar or the menu **Options/Multiple Satellites**.) 

Similar to the behavior of a toolbar, the Satellite Selector can be located to the right or to the left of the main window by dragging and dropping it. Also it can be switched to floating mode by double-clicking on the Satellite Selector background or by dropping it away from the main window borders.

24.4 The Status bar

The left part of the status bar displays detailed information on the last action or on the function available by the pull-down menu option or toolbar button.



Figure 24-12: Status bar

The right border display three information boxes. The first two boxes display the time and the function value corresponding to the location of the mouse cursor. The cursor coordinate is updated while the mouse cursor is within the graph window. Use the coordinate information to evaluate the exact position of a y-value and for exact positioning of the mouse cursor (e.g., for zooming a time-span).

The last box displays information on the software protection mode. It is one of

SOFT	The program is protected by a software key
DONG	The program is protected by a hardware lock
DEMO	The program only acts on the sample data
NET	The program is protected via a network license.

25. File I/O and Print Options

25.1 Observation File Import

You may load observation files for editing using the pull-down menu File or the corresponding toolbar File IO.

When first starting **GPS-Edit**, only the menu option File/Open Rover is available. This means, that the *.OBS file loaded first is the file, which you want to edit. In the following this file is called Rover File. If you have previously used **GPS-Edit**, a list follows of the last four observation files having been edited.



After you have loaded an observation file, the pull-down menu File and the File IO toolbar offer additional features. Now you may open a Reference File.



Figure 25-1: Toolbar File IO

- File/Open Rover: open another file for editing. (Yellow Toolbar button) 
- File/Open Reference: open a file as reference for calculating the Single, Double and Triple Difference data. This file is called Reference File. It corresponds to the currently activated observation file, if more than one rover file is loaded. (Red Toolbar button) 

- A further option, the option **File/Swap Ref. and Rover** allows you to swap the rover and reference file, i.e., to open a further window displaying the former reference file as rover and assigning the previous rover as reference. This option allows you to control the reference file. E.g., it may happen, that you have chosen single satellite view and triple differencing, but the graphic field shows no curve. This may happen, if the reference receiver has not tracked the same satellite as the rover. Or, the reference and rover file may not cover the same time span. The Swap option allows you to inspect the reference file, too.



GPS-Edit allows you to handle one pair of observation files simultaneously. To compare data of several rover files or different functions of the same file you may open several copies of **GPS-Edit**.

25.2 Assign Ephemeris

Additionally to the observation file data also the data of the corresponding ephemeris file(s) go into the graph. These may be Broadcast or precise ephemeris, both in the binary EF18 format. Please refer to the **GeoGenius User Manual**, ch. 7.3 and 14.1 for detailed information on ephemeris.

GPS-Edit allows you to choose the type of ephemeris file used for calculating the functions.

Via the pull-down menu option **Tools/Ephemeris** you may choose the option **Broadcast** or **Precise** ephemeris. If you have started **GPS-Edit** from within **GeoGenius**, the software automatically activates the ephemeris type activated there. It is very easy for you to return to

the original setting: just activate the menu option Tools/Ephemeris/Project Settings.

25.3 Print

GPS-Edit allows you to print out copies of the graphs. When you choose File/Print or click the corresponding toolbar button, you will get a dialog that allows you to set the printing parameters and start the printing process.



The menu option File/Print Setup allows you to set up the printer. It displays all the possibilities for changing printer parameters.



You should always set-up your printer in a way, that it will print in landscape format!

25.4 Exit

To terminate **GPS-Edit** click the option Exit of the File menu. You will return automatically to the calling program.

26. Observation Types

GPS-Edit allows you to visualize the observation file data in a lot of data combinations. However, some fundamental displays refer to the availability of satellite signals and are independent of other settings. These are:

- Number of Satellites
- Visibility
- Elevation
- Signal-to-Noise Ratio

If you choose one of these observation types, the options for Code types and Frequency and for Combinations will not be available. You may only choose the Graph Options.

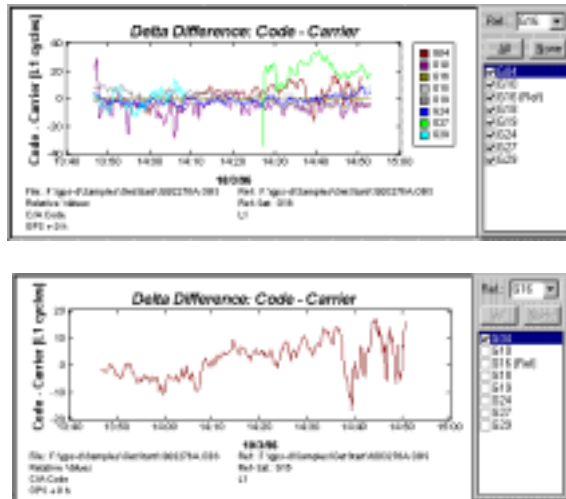


Figure 26-1: Display Options Using the Same File and Function

The display of other observation types depends on the chosen frequency and data combination type. E.g., Delta Differences may be shown with code, carrier or Doppler data or with combinations of these and may be available on L1 or L2 in different frequencies and frequency combinations. Therefore, this manual will not be able to refer to any display imaginable, but concentrates on the different types of display. Use the demo data (e.g., of the sub-directory \SAMPLES\GETSTART\) to play around with the full functionality of **GPS-Edit**.

Frequency and data combination dependent observation types are:

- Code (pseudo ranges)
- Carrier
- Doppler
- Code minus Carrier
- Ionospheric Residual

To select one or two of the code types choose code and corresponding frequency of the pull-down menu **Frequency** or press one of the corresponding buttons of the toolbar **Frequency**.



Figure 26-2: Toolbar Data Functions



You will find the satellite numbers near start and end point of each curve, if you toggled on the pull-down menu option **Options/End Markers** or the corresponding toolbar button.



26.1 Number of Tracked Satellites

To display the Number of Satellites graph, choose the menu option Data Type/Num Sats or the corresponding toolbar button.

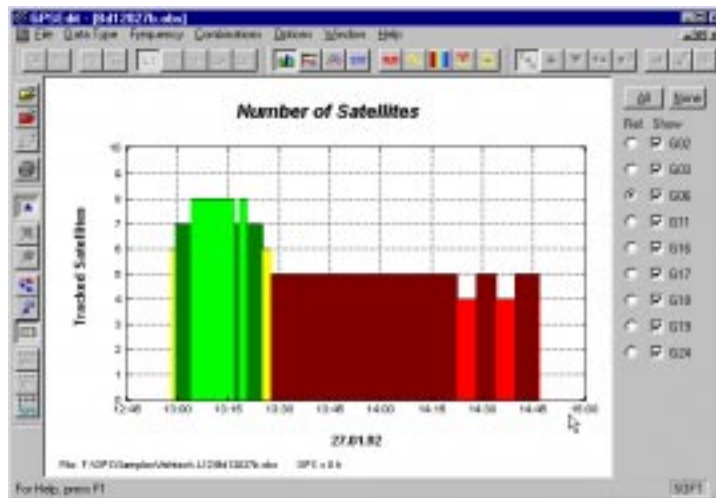


Figure 26-3: Number of Satellites Plot with Low Satellite Number

The Number of Satellites graph plots the total number of satellites that have been tracked simultaneously. Intuitive coloring indicates the quality of the observation (for example bad epochs with three or less visible satellites are marked in bright red color).

A minimum of four satellites is required to determine a three dimensional position in space with GPS. A minimum of six satellites is required to determine a combined GPS + GLONASS solution (4 GPS + 2 GLONASS).



Obstructions may have reduced the number of tracked satellites in comparison to the visibility according to the almanac!

The following color scheme is used:

0 satellites	nothing
1 satellite	blue
2 satellites	magenta
3 satellites	brown
4 satellites	light red
5 satellites	red
6 satellites	yellow
7 satellites	green
8 satellites	light green
9 satellites	light blue
10 satellites	blue
11 satellites	cyan
12 satellites	lightcyan
13 satellites	darkgray
14 satellites	yellow
15 satellites	green
16 satellites	light green
17 satellites	light blue
18 satellites	blue
19 satellites	cyan
20 satellites	dark gray
or more	

26.2 Visibility

To display the Visibility graph, choose the menu option **Data Type/Visibility** or the corresponding toolbar button.

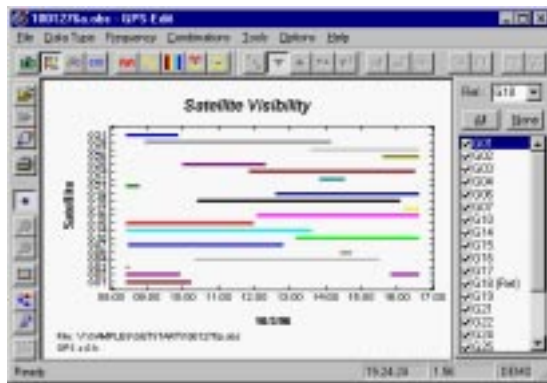


Figure 26-4: Satellite Visibility Plot

The Visibility graph shows the combined visibility of GPS and GLONASS satellites as tracked in the Rover File. A color bar for each satellite shows the time span(s) in which it is above the elevation cut-off.

26.3 Elevation

To display the Elevation graph, choose the menu option Data Type/Elevation or the corresponding toolbar button.

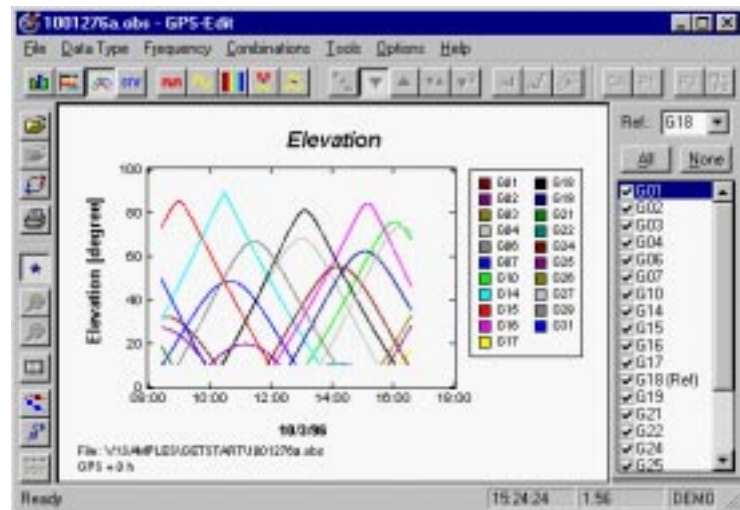


Figure 26-5: Elevation Plot (Grid Option Switched Off)

This graph plots the elevation-graphs of the satellites tracked in the current Rover File. The y-Axis has a fixed range of 0° to 90° elevation.

For geometrical considerations and because of the distortion of satellite signals through the atmosphere at low elevations, it is useful to know the satellite elevation angle. 0° corresponds to the horizon, 90° corresponds to the zenith. Satellites at very low elevation (below 10° , say) tend to distort the calculation of a position because of errors in propagating signals through the atmosphere. Usually a minimum

elevation mask is introduced in order to avoid these distortions. Below this limit satellites are generally not accepted for surveying and are not shown in the Elevation Display. If a satellite was not tracked due to obstacles, it will not be shown as well.

26.4 Signal to Noise Ratio

To display the Signal-to-Noise Ratio graph, choose the menu option Data Type/Signal-to-Noise or the corresponding toolbar button.

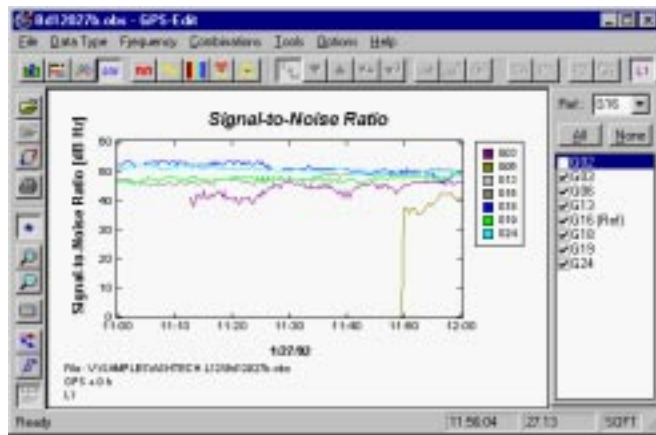


Figure 26-6: Plot Signal-to-Noise Ratio

This graph displays the signal to noise ratio of the satellite signals. Please note that when data is read from RINEX, which allows values for SNR from 0-9 only, the SNR values are linearly scaled to 30dB..50dB (corresponding to RINEX values 1...9). RINEX values of 0 correspond to a SNR value of 0.

26.5 Code

To display code data graphs, choose the menu option Data Type/Code or the corresponding toolbar button.



GPS-Edit displays code data C/A-, P-Code or cross-correlation, also called pseudo ranges. The graphs are named “Pseudo Ranges”.

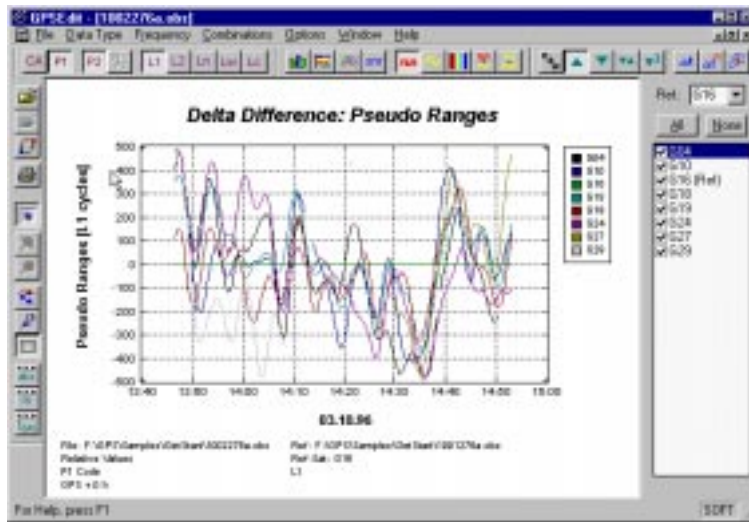


Figure 26-7: Example for P-Code Data - Pseudo Ranges, L1, Relative Cycles

For code data $\rho_{\text{code}} = \rho_{\text{obs}} - \rho_{\text{geom}}$ is computed. This results for the different wavelengths and wavelength combinations in the following table:

Code Combination		$\rho_{\text{obs}} =$
L1 code	L_1	$\rho_1 - T$
L2 code	L_2	$\rho_2 - T$
Wide lane code	L_w	$(\rho_1 + \rho_2)/2 - T$
Narrow lane code	L_n	$\rho_1 \cdot (f_1 / (f_1 - f_2)) - \rho_2 \cdot (f_2 / (f_1 - f_2)) - T$
Ionosphere free	L_c	$(\rho_2 - \gamma \cdot \rho_1) / (1 - \gamma) - T$

with

ρ_{obs}	...	observed range receiver - satellite
ρ_1	...	observed range on L_1 carrier
ρ_2	...	observed range on L_2 carrier
ρ_{geom}	...	geometric distance, pre-calculated from receiver positions and ephemeris data
γ	=	$(f_1/f_2)^2 = (77/60)^2$
T		... tropospheric delay, computed using the modified Hopfield model at (20°C, humidity of 50%, 1013 mbar)

26.6 Carrier

To display the Carrier graphs, choose the menu option Data Type/Carrier or the corresponding toolbar button.



Carrier phase data are stored in the observation files in multiples of the wavelength. **GPS-Edit** allows the display in meter scale, nevertheless. This allows better comparison with the code data display.

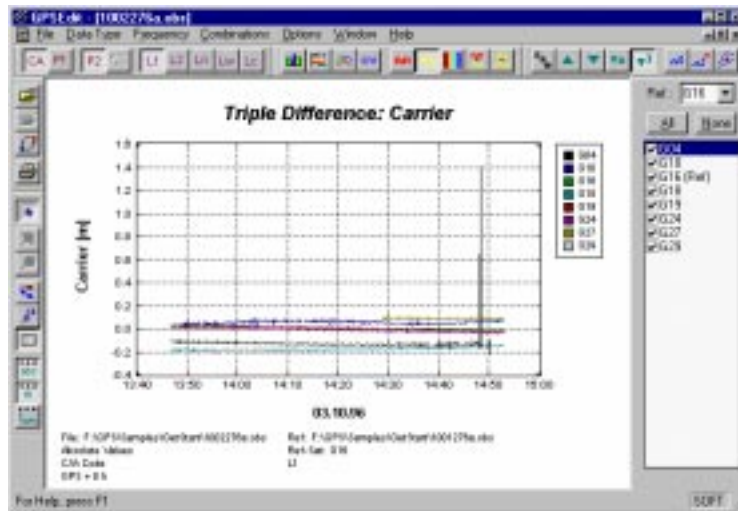


Figure 26-8: Carrier Data: P-Code, L1, Triple Differences, Absolute Meters

The GPS carrier frequencies are:

$$f_1 = 1575.42 \text{ MHz}$$

$$f_2 = 1227.6 \text{ MHz}$$

This leads to the frequencies of the derived observations:

$$f_1 = f_1$$

$$f_2 = f_2$$

$$f_w = f_1 - f_2$$

$$f_n = f_1 + f_2$$

$$f_c = f_1$$

For carrier data $\rho_{\text{carrier}} = \psi \cdot c / f_i - \rho_{\text{geom}}$ is computed. For different wavelengths and wavelength combinations this results in the following table:

Carrier Combination		$f_i =$	$\psi =$
L1 carrier	L_1	f_1	$\psi_1 - T \cdot f_1 / c$
L2 carrier	L_2	f_2	$\psi_2 - T \cdot f_2 / c$
Wide lane carrier	L_w	$f_1 - f_2$	$\psi_1 - \psi_2 - T \cdot (f_1 - f_2) / c$
Narrow lane carrier	L_n	$f_1 + f_2$	$\psi_1 + \psi_2 - T \cdot (f_1 + f_2) / c$
Ionosphere free	L_c	f_1	$\psi_1 \alpha_1 + \psi_2 \alpha_2 - T \cdot f_1 / c$

with $\alpha_1 = f_1^2 / (f_1^2 - f_2^2)$

$$\alpha_2 = -f_1 f_2 / (f_1^2 - f_2^2)$$

ψ ... carrier phase combination

c ... speed of light

26.8 Code minus Carrier

To display the Code minus Carrier graphs, choose the menu option Data Type/Code - Carrier or the corresponding toolbar button.

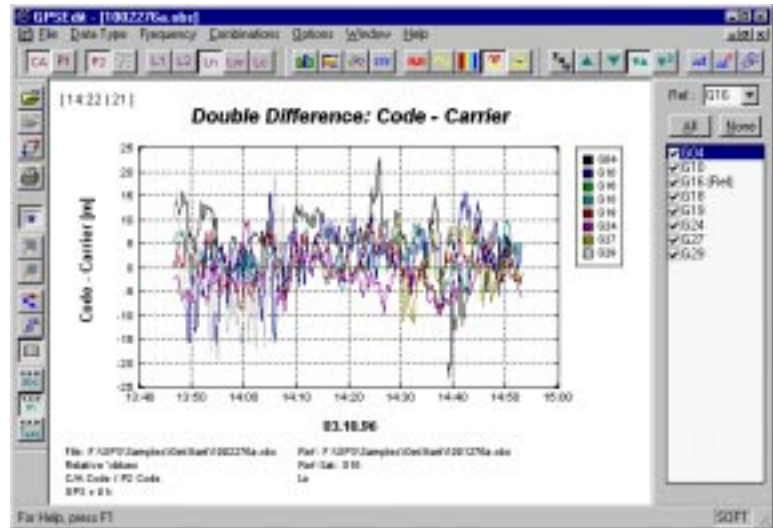


Figure 26-10: Code Minus Carrier: Double Differences On Narrow Lane

For code minus carrier $\rho_{\text{comb}} = \rho_{\text{code}} - \rho_{\text{carrier}}$ is computed depending on the code and carrier chosen.

For frequencies see section 5.5!

26.9 Ionospheric Residual

The frequency combinations of carriers are independent of receiver or satellite geometry, clocks or troposphere. They do only depend on receiver noise, multipath and ionosphere, and are often called “Ionospheric Residual”.

You may combine dual-frequency L1 and L2 code and carrier data to investigate effects of the ionosphere and detect cycle slips. Several frequency combinations are possible:

- C/A-carrier with P2-carrier
- C/A-carrier with P1-P2-carrier
- P1-carrier with P2-carrier
- P1-carrier with P1-P2-carrier

For the frequency combination $\psi = \psi_1 - f_1 / f_2 \cdot \psi_2$ is computed and displayed.

To display the Ionospheric Residuals graphs, choose the menu option **Data Type/Ionospheric Residual** or the corresponding toolbar button. The L1 will then be the only frequency activated, thus indicating that the algorithms for the frequency combination depends on the L1 frequency. Dual-frequency data is necessary.



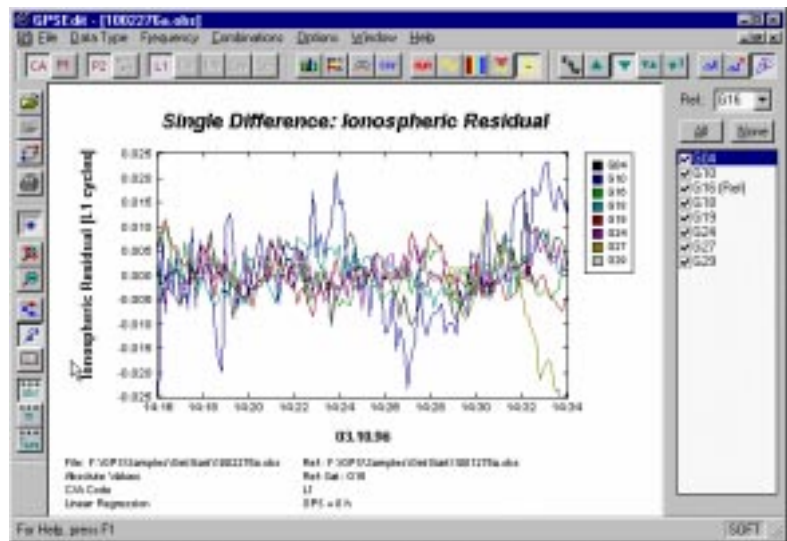


Figure 26-11: Ionospheric Delay : Single Difference Data, Linear Regression Introduced

27. Code Types

Depending on the receiver type the observables Code, Carrier, Doppler can have one or more of the following Code Types. Consecutively these are also available for the Code - Carrier observable.



C/A Code on L1 frequency



P Code on L1 frequency



P Code on L2 frequency



P1-P2 Code (cross-correlation of P1 and P2) on L2 frequency

To select one or two of the code types choose code and corresponding frequency the pull-down menu **Frequency** or press one of the corresponding buttons of the toolbar **Frequencies**.



Figure 27-1: Toolbar Frequencies

The state of the code type buttons on the toolbar reflects the existence of the code type in the Rover observation file. For example, if the Rover file does not contain P2 Code for the Carrier, the P2 button will switch to disabled when Carrier is selected as the observable.

Differing observables in Rover and Reference observation files:

Normally for the three combination types Single, Double, and Triple Differences the same observables have to be recorded in Rover and Reference file. If Rover and Reference file have been recorded with different receivers, this is rarely the case. The following “fallback” mechanism for the Reference file is implemented, if an exact match can not be found:

If not available	then use instead
C/A	P1
P1	C/A
P2	P1-P2
P1-P2	P2

The same applies, if Code-Carrier is displayed and code and carrier are recorded using different observation types.

28. Combination Types and Filter Functions

GPS-Edit allows you to reduce the data for trends and to investigate a lot of different data combinations. Differencing eliminates effects such as clock errors or ephemeris, tropospheric or ionospheric effects. **GPS-Edit** also offers special epoch-to-epoch algorithms.

To select one of the various combination types and filter functions choose the options of the pull-down menu **Combinations** or one or several of the buttons of the toolbar **Combination Functions**.



Figure 28-1: Toolbar Combination Functions

28.1 Raw Data

Raw data displays the unmodified data of the chosen observable. It is only corrected for the geometric receiver - satellite range calculated for given position and ephemeris data.

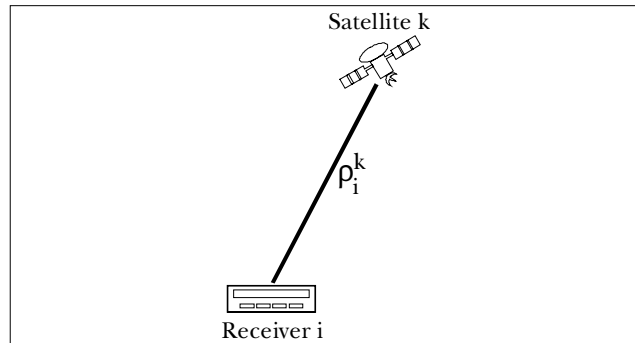


Figure 28-2: Receiver-Satellite Geometry for Raw Data

To select the unmodified data choose the pull-down menu option **Combinations/Raw Data** or press the corresponding toolbar button.



Raw data contain satellite clock and ephemeris errors (including S/A-effects), receiver clock errors, atmospheric residuals, noise and multipath.

28.2 Delta Difference

Delta difference data require simultaneous data of a single receiver to two satellites.

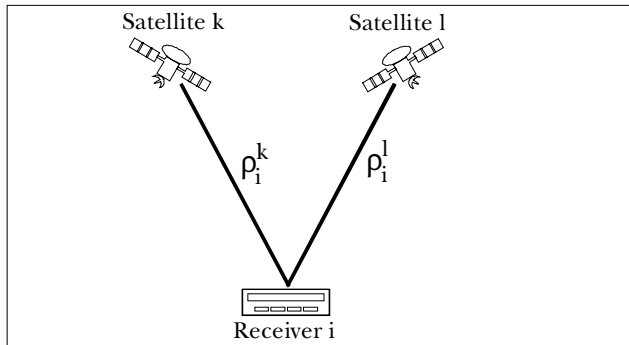


Figure 28-3: Receiver-Satellite Geometry for Delta-Differencing

$$\nabla \rho_i^{kl} = \rho_i^k - \rho_i^l$$

Delta differencing eliminates the receiver clock error

To select delta differenced data choose the pull-down menu option **Combinations/Delta Diff.** or press the corresponding toolbar button.



28.3 Single Difference

Single difference data require simultaneous data of two receivers (stations) to a single satellite. The derived data are then computed via the relation

$$\Delta \rho_{ij}^k = \rho_i^k - \rho_j^k$$

where j indicates the reference station
 i indicates the station to be analyzed
 k indicates the satellite.

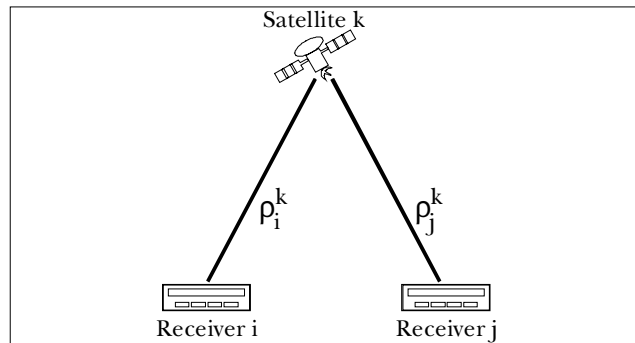


Figure 28-4: Receiver-Satellite Geometry for Single Differences

Single differences eliminate satellite clock errors and reduce base-line dependent effects like ephemeris errors, troposphere and ionosphere residuals.

To select single differences choose the pull-down menu option **Combinations/Single Diff.** or press the corresponding toolbar button.



28.4 Double Difference

Double difference data require simultaneous data of two receivers to two satellites. It corresponds to the difference of two simultaneous single differences and is given by

$$\nabla \Delta \rho_{ij}^{kl} = \Delta \rho_{ij}^k - \Delta \rho_{ij}^l$$

where l indicates the introduced reference satellite.

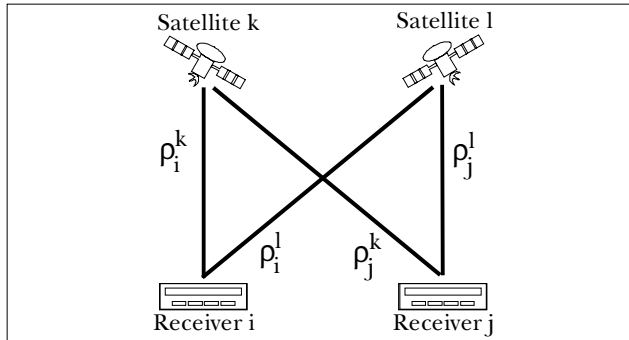


Figure 28-5: Receiver-Satellite Geometry for Double Differences

Double differencing eliminates satellite and receiver clock errors and reduces baseline dependent effects like ephemeris errors, troposphere and ionosphere residuals.

To select double differences choose the pull-down menu option **Combinations/Double Diff.** or press the corresponding toolbar button.



28.5 Triple Difference

Triple differences are mainly used for cycle slip identification and recovery. In addition to double differencing, triple differencing uses a difference in time, i.e., the triple difference is the difference of two double differences at two consecutive epochs.

$$\delta \nabla \Delta \rho_{ij}^{kl}(t_{n+1}) = \nabla \Delta \rho_{ij}^{kl}(t_{n+1}) - \nabla \Delta \rho_{ij}^{kl}(t_n)$$

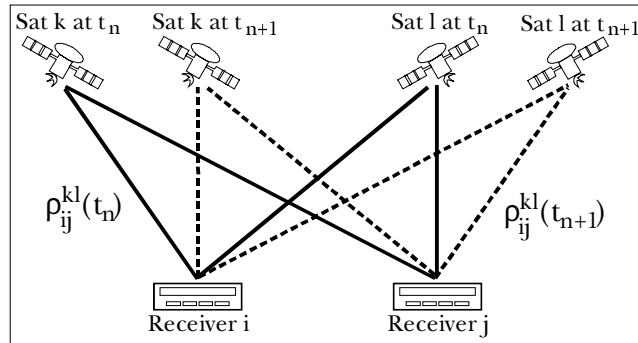


Figure 28-6: Receiver-Satellite Geometry for Triple Differences

Triple differencing eliminates carrier phase ambiguities as long as they don't change. So cycle slips are shown clearly as large peaks in the graphs.

To select triple differences choose the pull-down menu option Combinations/Triple Diff. or press the corresponding toolbar button.



28.6 Epoch to n-th Epoch Filter

The **epoch to epoch** operators instruct **GPS-Edit** to use epoch to epoch differences rather than the original data for display. By default Epoch-to-Epoch uses the difference of the function values of current and previous epoch.

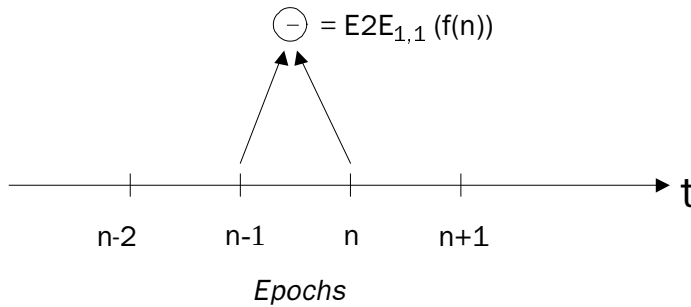


Figure 28-7: Epoch-to-Epoch (of Order 1 and Skip 1)

To select the epoch to epoch filter choose the pull-down menu option Combinations/Epoch-to-Epoch or press the corresponding toolbar button.



You can modify the way Epoch-to-Epoch (abbreviated: E2E) is calculated by clicking the E2E with Order and Skip option button. To do so, choose the pull-down menu option Combinations/E2E Options or press the corresponding toolbar button. A dialog pops up and allow you to alter the current settings of the Order and Skip parameters of the E2E calculation. If you accept the changes with **OK**, **GPS-Edit** will start immediately to calculate the E2E graph. Click **Cancel** to cancel the process.



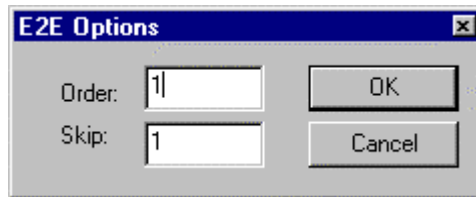


Figure 28-8: E2E Options Dialog

The Skip parameter determines which previous epoch goes into the subtraction. If Skip = 1 then the epoch directly preceding the current epoch is used. Skip = 2 uses the one but last, and so on. The Order parameter determines how many times the differencing is repeated.

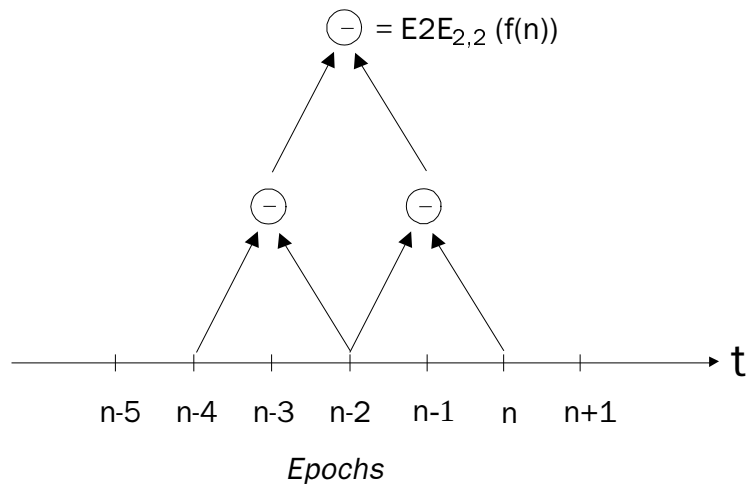


Figure 28-9: Epoch-to-Epoch of Order 2 and Skip 2

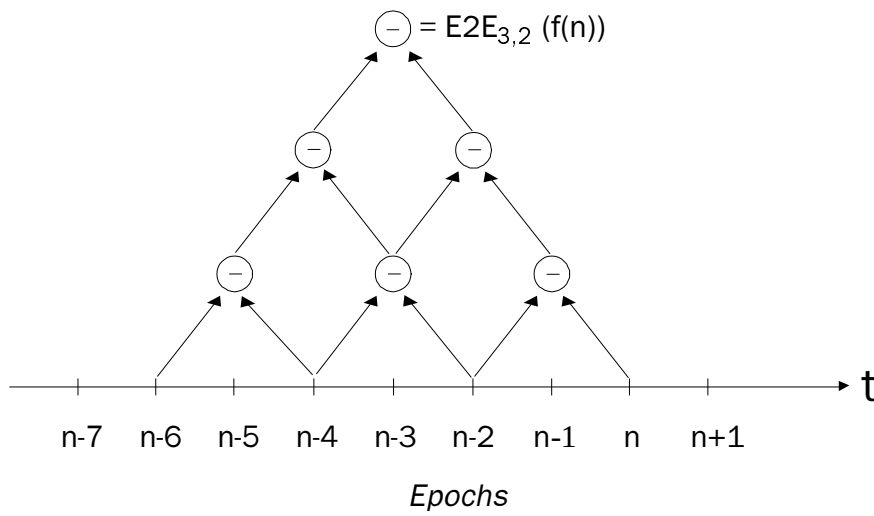


Figure 28-10: Epoch-to-Epoch of Order 3 and Skip 2



If you have selected the Epoch-to-Epoch difference operator (Order: 1, Skip: 1) in combination with double differences the displayed graph corresponds to triple differences.

28.7 (Trend Reduction Via) Linear Regression

GPS-Edit performs a linear regression analysis, which results in the definition of a trend. At any time you will find the results of the linear regression analysis displayed in the legend of statistics.

Additionally, **GPS-Edit** may display the resulting trend in form of a line in the data graph. Or, **GPS-Edit** may subtract the trend from the data and displays trend-free values.

To display the results of linear regression analysis as graphical trend line choose the pull-down menu option Tools/Statistics/Linear Regression.

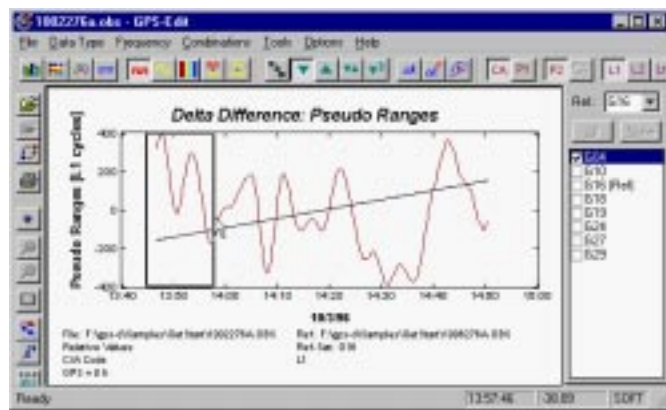


Figure 28-11: Linear Trend for Whole Time Span

By default, **GPS-Edit** calculates and displays the linear trend for the overall time, even if you have zoomed into the time. However, you may also calculate the trend for the time span zoomed into. To do so, activate the pull-down menu option

Tools/Statistics/Recalculate on Zoom. You may check the new values via the legend of statistics.

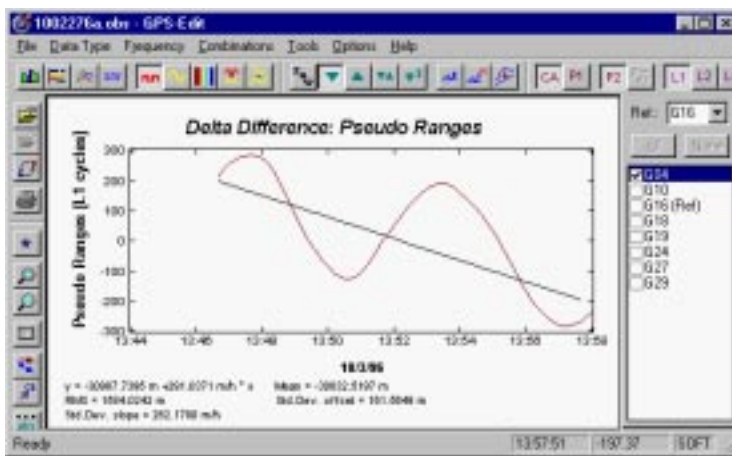


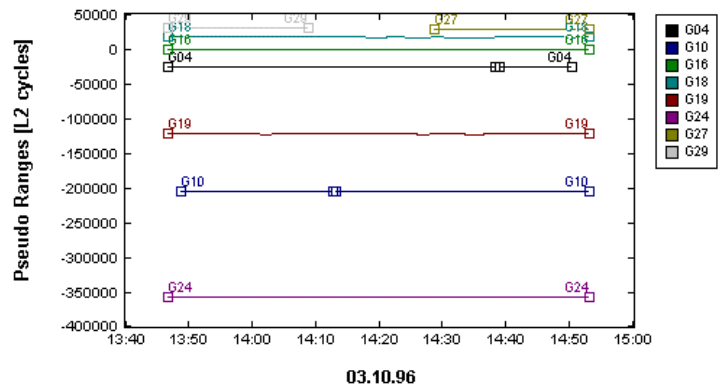
Figure 28-12: Zoomed Time Range - New Calculation of Trend

To start a trend reduction based on the linear regression analysis choose the pull-down menu option  Combinations/Linear Regression or press the corresponding toolbar button.

The following two figures show pseudo ranges of delta difference data.

[13:43 | 8140]

Delta Difference: Pseudo Ranges



03.10.96

File: F:\GPS\Samples\GetStart\1002276a.obs
Absolute Values
P2 Code
GPS + 0 h

Ref: F:\GPS\Samples\GetStart\1001276a.obs
Ref-Sat: G16
L2

Figure 28-13: No Trend Reduction

Figure 28-14 shows the data of Figure 28-13 after a trend has been reduced.

[14:15 | 381]

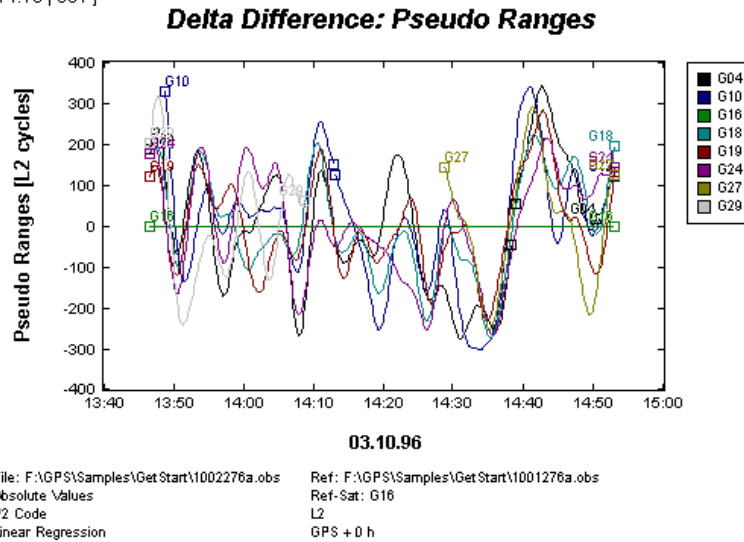


Figure 28-14: Linear Regression Applied

In case that Epoch-to-Epoch filter and Linear Regression are activated simultaneously the trend will be reduced before the epoch differences are calculated.

28.8 Mean Value

GPS-Edit calculates, by default, a mean value over the overall time span. At any time you will find the mean value displayed in the legend of statistics.

Additionally, **GPS-Edit** may display the resulting mean value in form of a line in the data graph.

To display the mean as graphical line choose the pull-down menu option Tools/Statistics/Mean.

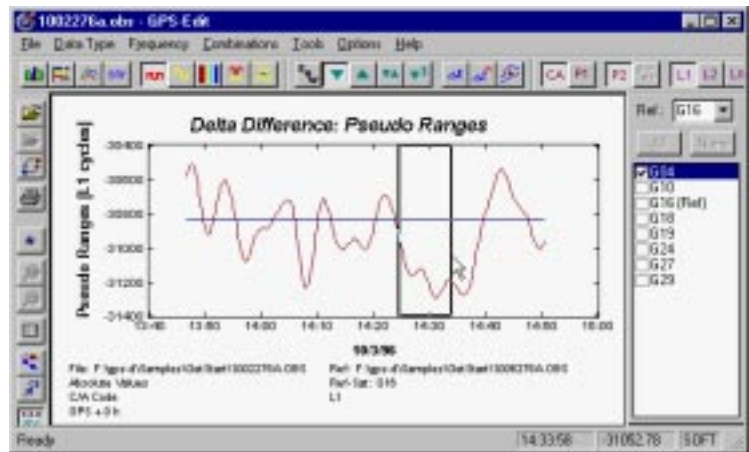


Figure 28-15: Mean over the Whole Time Span

By default, **GPS-Edit** calculates and displays the mean for the overall time, even if you have zoomed into the time. However, you may also calculate the mean value for the time span zoomed into. To do so, activate the pull-down menu option

Tools/Statistics/Recalculate on Zoom. You may check the new values via the legend of statistics.

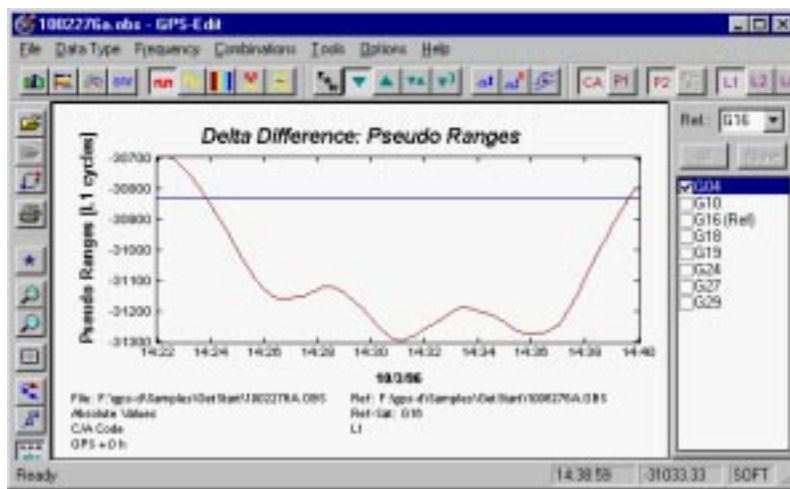


Figure 28-16: Mean over Zoomed Time Span, Not Recalculated

29. Frequencies

To select one of the wavelengths or wavelength combinations choose the frequency from the pull-down menu **Frequency** or press one of the corresponding buttons of the toolbar **Frequency**.

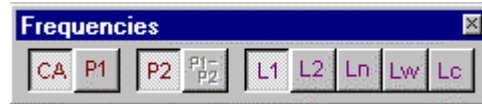


Figure 29-1: Toolbar Frequencies

-  L1 frequency data of the currently selected Code Type C/A or P1.
-  L2 frequency data of the currently selected Code Type P2 or P1-P2.
-  Narrow lane data derived from the currently selected combination of (C/A or P1) and (P2 or P1-P2).
-  Wide lane data derived from the currently selected combination of (C/A or P1) and (P2 or P1-P2).
-  Ionosphere-free combination data derived from the current selected combination of (C/A or P1) and (P2 or P1-P2).

30. Graph Options

A lot of options allow you to modify the display of the data in various forms. Most of the options toggle between two modes, the zooming options, however, just act in one direction.

The pull-down menu **Options** and the Options toolbar display all available options. You may freely combine these options to get optimal results.



Figure 30-1: Toolbar Graph Options

30.1 Multiple Satellites

This switch toggles between Single- and Multiple-Satellite mode.

Being in Single Satellite mode **GPS-Edit** displays the values for the currently chosen satellite (and reference satellite, depending on the selected frequency combination). If you select a different satellite, the values for this second satellite will be displayed.

Choose the Single Satellite mode, if **GPS-Edit** is to display statistical values in the graph or legend of statistics.

Multiple-Satellite mode allows you to display the data of all or selected satellites concurrently. In order to be able to compare the data of satellites it is recommended to use relative display mode (see section “Absolute Values”).

To instruct **GPS-Edit** to use the Multi-Satellite Mode check the menu option **Options/Multi-Satellites** or press the corresponding toolbar button (it must then be depressed).



30.2 Zoom Options: Unzoom and Zoom-Back

To zoom into the graph drag the mouse cursor (using the left mouse button) over the desired time span. To reduce the time scale, you have several menu, keyboard and mouse options. You may

- **Unzoom** in one step to the original time scale:
 - * click the toolbar button Unzoom (activated after zooming into the graph at least once), or 
 - * choose menu option **Options/Unzoom** (activated after zooming into the graph at least once), or
 - * use the hotkey combination **Ctrl + Z**, or
 - * double-click the right mouse button

Each of these options will put the graph display back to the full view of the data.

- **Zoom-Back** to the previous zoom position:
 - * click the toolbar button Zoom-Back (activated after zooming into the graph at least once), or 
 - * choose menu option **Options/Zoom-Back** (activated after zooming into the graph at least once), or
 - * click the right mouse button

Each of these options allows you to undo the last zoom step. **GPS-Edit** remembers the last ten zoom actions, so if you have zoomed in ten times you can step back to each of the previous ten zoom positions by clicking on the Zoom-Back button.

30.3 Markers

Two toggle switches allow you to induce markers into your graphs. Point Markers mark the observation time for each epoch, Curve-End Markers help to identify the curves.

- **Point Markers**

If this switch is on, then a marker in form of a small filled rectangle is displayed at each observation in the curves. In order to avoid overcrowding the display the point markers will only be shown if there is enough room to distinguish one from the other. In order to see the point markers for a file with many observations, drag the corners of the **GPS-Edit** window, or zoom into the region of interest until the point markers show.

To instruct **GPS-Edit** to show Point Markers check the menu option **Options/Point Marker** or press the corresponding toolbar button (it must then be depressed).



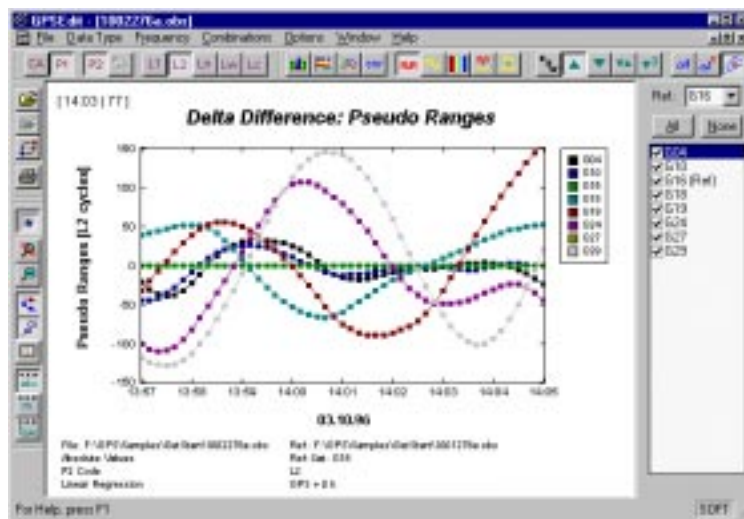


Figure 30-2: Point Markers

- Curve-End Markers

If switched on, start and end point of each curve are marked with a small empty rectangle and the name of the curve. This helps you in determining specific curves in Multi-Satellite mode.

To instruct **GPS-Edit** to show curve-end markers check the menu option Options/End Marker or press the corresponding toolbar button (it must then be depressed).



30.4 Grid

You can switch on a background grid of dotted lines that helps you in evaluating the function curves. Use the Options/Grid menu or the corresponding toolbar button on the Graph Options toolbar to toggle the grid on and off.

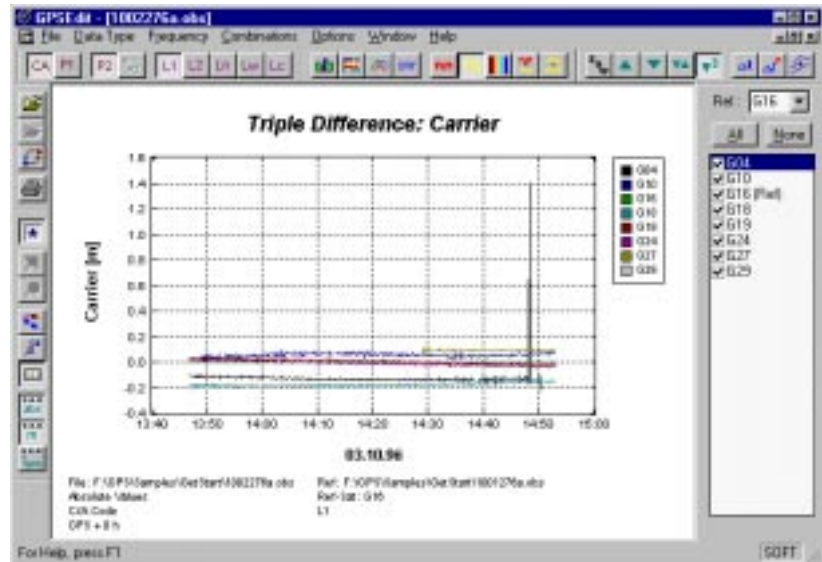


Figure 30-3: Graphic Display with Grid

30.5 Toggling Values

GPS-Edit, by default, shows all data in relative y-values and using cycles as units for the y-axis. The time, by default, is given in the normal time format. You may, however, change to absolute or metric y-values, or you may instruct **GPS-Edit** to display the time as GPS-seconds. The **Options** menu offers three toggle switches, which are completely independent from each other.

In Multi-Satellite Mode, it is hardly advisable to use absolute values. Only relative values may be compared with each other.

- Absolute Values

To instruct **GPS-Edit** to display the graph with absolute y-values instead of the default relative values check the menu option **Options/Absolute Values** or press the corresponding toolbar button (it must then be depressed).



- Metric Values

To instruct **GPS-Edit** to display the y-axis values in meters instead of the defaulting frequency units check the menu option **Options/Metric Values** or press the corresponding toolbar button (it must then be depressed).



- GPS-Time

To instruct **GPS-Edit** to display the GPS-time in seconds on the x-axis instead of the normal time format check the menu option **Options/GPS-Time** or press the corresponding toolbar button (it must then be depressed).



31. Detecting Bad Data

Via the pull-down menu option Tools/Satellites you may open the dialog Satellites. This tool offers you an overview over:

- The number of satellites tracked by the rover and reference receiver
- The times, each satellites were tracked,
- The times of losses of lock,
- The times of data, marked as “BAD”,
- The times, cycles slips occurred (whether corrected or not),
- The times ignored by **GeoGenius** for processing. **GPS-Edit**, however, *does not respect these manually fenced off time spans or satellites.*

For detailed information on the functions of the satellite tool please refer to the **GeoGenius User Manual**, ch. 14.3.

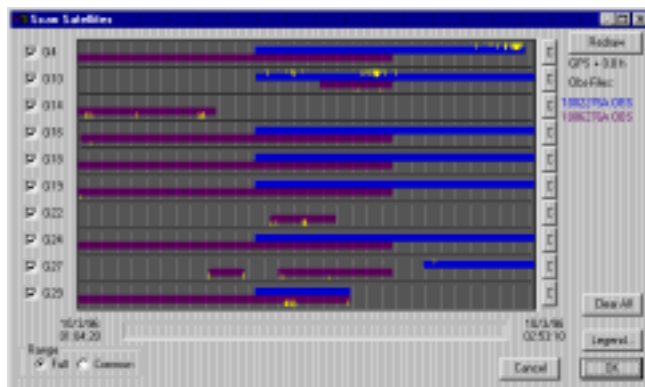


Figure 31-1: Finding Bad Data

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Visual Analysis of Visibility
for GPS, GLONASS and Geostationary Satellites

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Planning

User's Manual



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Note

We are aware of the fact that our exclusive masculine pronoun "he" is considered politically incorrect, but has been used in this case to simplify readability.

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33. Planning - General Functions

Planning is a powerful stand-alone software tool supporting any form of analysis of visibility for GPS, GLONASS, IGSO and geostationary satellites.

Only a few years ago, when satellite constellation was very poor (due to a limited number of satellites visible in orbit) such a planning tool was indispensable in order to make a field campaign a success. The availability of satellite signals was restricted to only a couple of hours a day and in order to use these time spans efficiently careful planning was necessary.

Now, that the space segments of GPS or GLONASS are complete, **Planning** is still of great importance to monitor a survey campaign. It answers questions like these:

- When are the PDOPs for a station better than x and when are more than y satellites visible?
- I want to survey x stations simultaneously. When do I have the best conditions for all of them?
- I want to survey during a given time span. How many satellites will be visible?
- My survey location is partially obstructed by buildings or trees. Can I nevertheless expect considerably good results?
- Recently, I'm creating a visibility report for each day of the year manually. Can I automate this task?

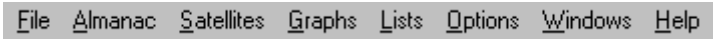
What does Planning do?

Planning answers complex combinations of those questions, but is most comfortable to use! A lot of features are available by just a mouse-click.

Using the preprogrammed features, all you need is an almanac file containing a valid set of data. **Planning** helps you to create stations or multistations, which assemble station information like latitude, longitude, obstructions, cutoff elevation angle and maximum time span. Based on this data, you receive comprehensive answers to your questions in form of clear, multicolored graphs or tables.

Planning is clearly structured in sub-menus. Therefore, a look at the menu bar allows us to understand the main features very quickly.

The following sub-menus are available:



File Almanac Satellites Graphs Lists Options Windows Help

Figure 33-1: Planning Pull-down Menus

File	allows you to create and manipulate stations or multistations. Station data includes the position on earth, possible obstructions, general cutoff elevation angle and a maximum time span. For simultaneous observation of at least two stations you may create or manipulate a multistation network. You may also print the graphs or terminate Planning from here.

Almanac	allows you to choose and load almanac data from different receiver types, to inspect its values and to save or delete it.
Satellites	Individual satellites may be enabled or disabled. Detailed information for all tracked satellites is available.
Graph	lets you create one of the already available, preprogrammed graphs.
Lists	Shows results in form of printable lists.
Options	Lets you toggle the legend/agenda and lets you determine which satellite systems are available. These include GPS, GLONASS, IGSO and geostationary satellites.
Windows	offers the typical MS Windows options regarding window handling and allows you to toggle the toolbar.
Help	provides information on the current version and offers help.

The Menus and all standard functionality will be completely described in chapter 2.

A toolbar offers quick and intuitive access to most of **Planning**' options.



Figure 33-2: Planning Toolbar

The Appendix in chapter 3 offers additional information on how to add cities to **Planning** and the description of the standard almanac file.

34. Basic Functionality

Planning is structured very clearly. This allows us to follow the sub-menus to get accustomed to **Planning**' features.



Figure 34-1: Pull-down Menus Follow Functionality

34.1 File Sub-Menu

Planning stores station-related parameters and uses them to calculate the graphs and lists. You may create new stations, select and edit existing entries, and save them. You may compose multistations. For printing you may set-up a printer and print the graphs. Last, you may terminate **Planning** using the **Exit** command.

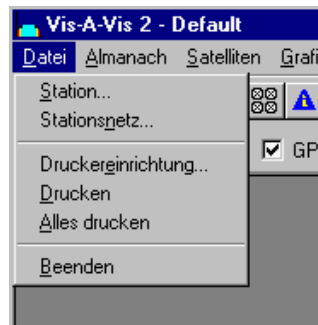


Figure 34-2: Sub-Menu File

34.1.1 Edit Station

The Station... option is a very powerful part of **Planning**. It opens the Station Editor, which allows you to choose the station from a list for analysis of visibility. You may define new stations and determine their coordinates and cutoff elevation angle. You can determine sky visibility with obstructions. At the same time, you can define the time segment for the visibility analysis.

You might use the Station Editor, if you are planning a new survey at a station you did not occupy previously. Or, if you want to see results previously calculated for an already stored station or want to directly compare different dates at the same station. Click on the entry and you will see the following dialog: Choose File/Station... or the respective toolbar button.



Figure 34-3: Station Editor

It shows the current station and all related parameters. You may enter values using the keyboard or the arrow up and down buttons. Lists or graphs will be changed, as soon as you accept changes with the **Apply** or **OK** buttons.

The first entry shows the station name. When you first use **Planning**, this will be the default station **Default**, following it will be the last used station. An arrow button allows you to open a list of all previously defined stations.

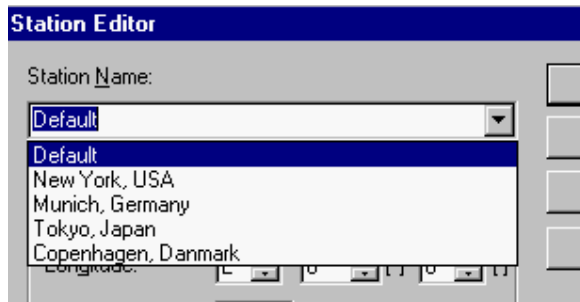


Figure 34-4: Built-in Stations

At any time you can add further stations or delete obsolete stations. If you, e.g., want to compare certain observation intervals, you may include two stations with the same coordinates, but different time spans.

To add a new station, just type in its name, set parameters and press **OK** or **Apply**. This will add the new station to the internal list. **OK** additionally closes the dialog.

To delete a station from the list activate it and click the button **Delete**. The name and the corresponding parameters of this station will be deleted from the list.

The **Position** block below the station name defines the **station position** in longitude, latitude and height. You may enter a cutoff elevation. **Planning** considers no satellites with an elevation below this angle. The value is specified in degree, typical values are 10° or 15°.

The box **Time Information** allows you to enter the **start date and time**. The button **Today** allows fast entry of today's date. Define the duration of analysis (**Duration**) and choose the time interval for calculation (**Interval**). You may select the date format via the browser button

It is good practice, to have an interval of about 10 min to inspect a whole day and then to set the interval to 1 to 2 minutes when it comes to precise analysis of an hour or two.

The box **Time Zone** displays the currently selected **time zone**, the current offset to GMT (Greenwich Mean Time) in hours (**Difference GMT:**), and, if any, the Daylight Saving Time (**Dayl. Sav. Time**). If you want to change the time zone (default: **Default**), click the button **Time Zone** to open the dialog Time Zone Selection.



Figure 34-5: Time Zone Selection

Select the time zone from the list Time Zones. If necessary, you may activate the checkbox **Daylight Saving Time**. Click **OK** to accept the choice, or **Cancel** to leave the dialog without changes.

If you know that **obstructions** at your station hide part of the sky and, therefore, block visibility to satellites, open the **Obstruction Editor** via the button **Obstacles....** The **Obstruction Editor** shows a “sky plot”. The numbers at the outer circle denote the azimuth; zero means North, 90° is East, 180° is South, 270° is West. The center of the circles is the zenith (elevation angle 90°) and the outer circle shows elevation 0° (i.e., the horizon).

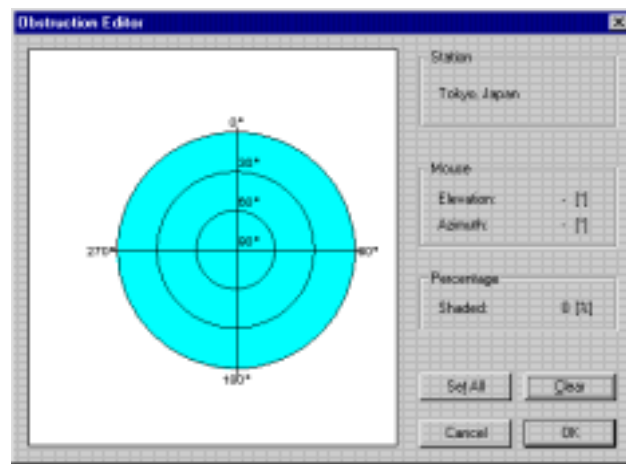


Figure 34-6: Obstruction Editor

You may create some “off-limit” areas (masks) where visibility to the satellites is blocked by just dragging the mouse over the plot while the left mouse-button is pressed. Azimuth and elevation at cursor position will be shown at the right-hand side of the plot. To erase parts of the shading mask, just drag the mouse using the right mouse-button.

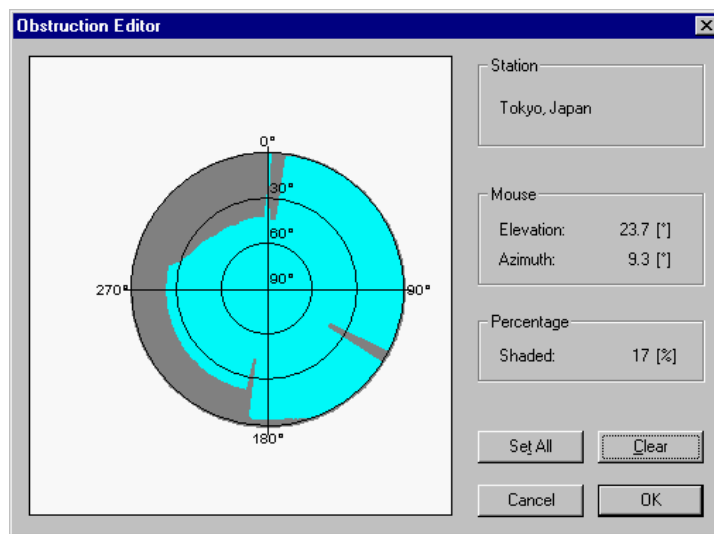


Figure 34-7: Masking

When you have finished the masking of an area you will see the percentage of shaded horizon under the title **Percentage**. Two buttons allow you to easily manage the shaded areas: **clear** always allows you to clear the plot, which removes all shaded areas. **Set all** sets the full plot to shaded.



Clicking **OK** defines the obstructions and returns to the Station Editor. To discard the settings click **Cancel**.

The **Map...** button opens the dialog World Map that allows you to **identify a location**.

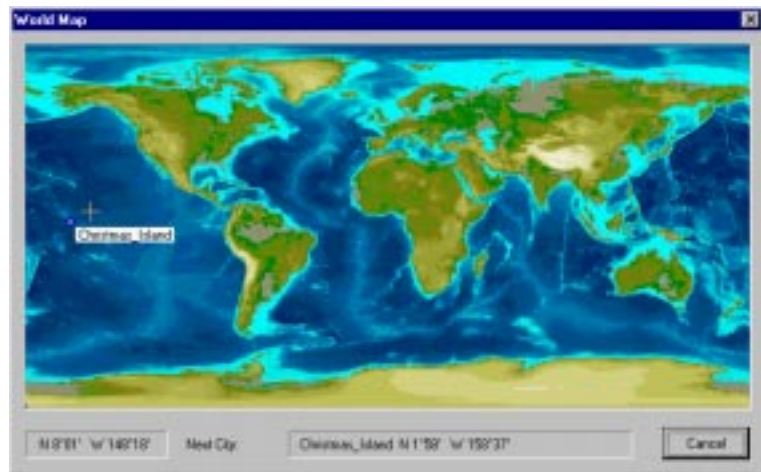


Figure 34-8: Define Coordinates - World Map

The cross-shaped cursor marks the position of the currently chosen station, identified by the current coordinate entries in the lower left corner. A little rectangle helps you to control the movement of the cursor. It identifies the location of the city most adjacent. A text field gives its name and country. The box Next City repeats the name of the most adjacent city and indicates its geographical coordinates. The Appendix shows how to add new cities to **Planning**.

To choose a new location, just move the cursor to it, check the values at the bottom of the window and then double-click with the left mouse-button. This will close the **World Map** dialog, and simultaneously, in the Station Editor window, this action will create a new entry in the Station name field and update the coordinates. If you do not want to change anything, click **Cancel**.

After all parameters are set, you may apply them without closing the Station Editor window (**Apply**) or close the window and apply the chosen station parameters (**OK**).



Apply or **OK** append any new station to the station list.
OK additionally closes the Station Editor window.

Cancel leaves the Station Editor without changes. If you defined obstructions, these settings are kept.

34.1.2 Multistation Analysis

The Multistation Analysis is of great importance, if your network covers a large area. Simultaneous observation of the same satellites may be essential. The option **Multistation...** of the pull-down  Menu File or its corresponding toolbar button open the Dialog Multistation Analysis, which allows you to define a Multistation network.

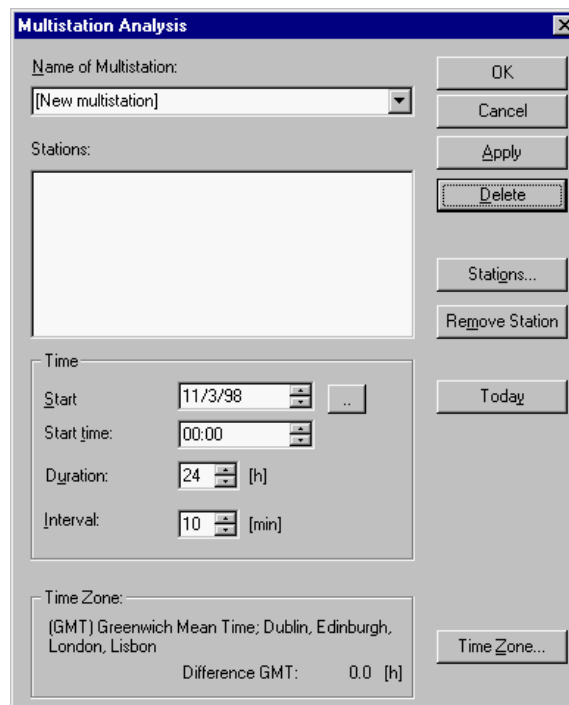


Figure 34-9: Dialog Multistation Analysis

The Dialog Multistation Analysis resembles very much the dialog Station Editor. Therefore, this section concentrates on the new options of this dialog. For the features of the boxes Time Definition, Time Zone or the buttons **OK**, **Cancel**, **Apply**, **Delete**, **Today** and **Time Zone** please refer to section 34.1.1.



To edit a multistation network, you previously have to define the stations the network will be composed of.



To do so, make use of the Station Editor (click the pull-down menu option **File/Station...** or the corresponding toolbar

button) and define the location of the respective stations. Do not regard the time definition. (Refer to section 34.1.1).

To define a multistation network, you will define its name and the stations it consists of.

Edit the **name of the multistation** network in the string field Name of Multistation. The default name is [New Multistation]. A new name is accepted, if you have selected at least two stations for the network.

After you have selected stations, the list box Stations will display the stations the network is composed of. To **remove a station** from the list box activate it and click the button **Remove Station**. The station will be immediately removed from the network, however, it will be still stored in the list of stations.

Station selection is very easy. Click the button **Stations...**. The dialog Station Selection pops up.

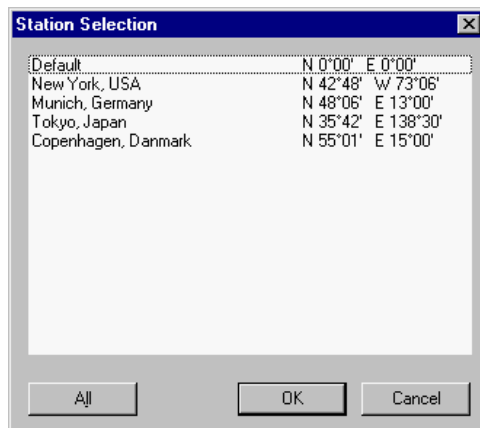


Figure 34-10: Station Selection for Multistation

The dialog Station Selection displays a list of all edited stations including their names and geographical coordinates. To select a station just click it (left mouse button). To deselect a selected station click again. You may select an indefinite number of stations. To select all, click the button **All**. **OK** accepts your selection and closes the dialog, **Cancel** closes the dialog without change.

34.1.3 Printer Setup

If you want to print graphs you should set up the printer first. **Printer Setup** displays all the possibilities for changing printer parameters. It may look similar to this, depending on your operating system:

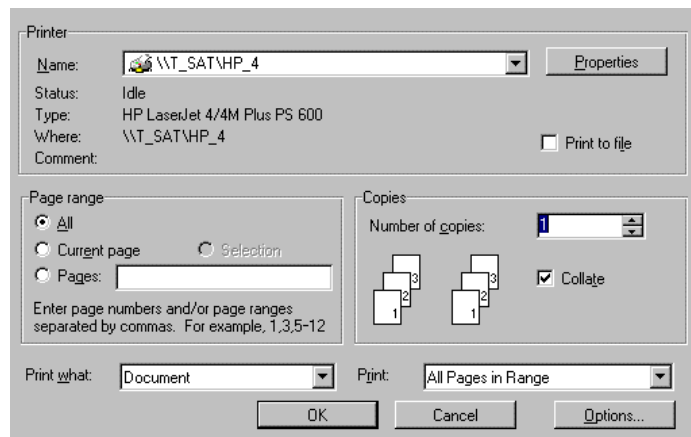


Figure 34-11: Printer Setup



You should always set-up your printer in a way that it will print in landscape format.

Check the printer parameters and, if satisfied, press **OK** to start printing. If you do not want to print, press **Cancel**. The **Network** button connects you to a network printer, if available.

34.1.4 Print

Planning allows you to print out copies of the graphs. When you choose **File/Print** or the corresponding toolbar button, the printing process starts. The graph to be printed must be activated!



The option **Print All** allows you to print all graphs displayed in the main window.

34.1.5 Exit

This will terminate the program at once! No further dialog is provided. Please note that all current graphs are lost!

34.2 Almanac Sub-Menu

Almanac data is used to compute satellite visibility. When first starting **Planning** you have been asked for an almanac file. A default almanac file, ALMANAC.AL is part of the program package, however, you may also refer to your own almanac data file. Using the Almanac sub-menu you can check and fix the almanac later. The following options are available:

Load	loads an almanac file according to Spectra Precision Terrasat's almanac format
Import...	imports an almanac file derived from other receiver types
Save	saves an almanac with a new name
Remove	clears the current database, but no physical file is affected.

34.2.1 The Load and Import Options

Both options allow you to load the contents of a new almanac file into the database used for calculation. If you have an almanac file containing almanac data in the Spectra Precision Terrasat almanac format and with extension *.ALM or *.??A (where ?? stands for the year) load it by choosing Almanac/Load or the corresponding toolbar button. It will be used for all subsequent computations. 

If you want to use almanac files created by other receivers, **Planning** allows to import this almanac data and to convert it automatically. Just activate Almanac/Import... and select the format you want to import. A dialog appears, allowing you to search for files. After you imported

foreign almanac data, a message notifies you on success or failure of import.

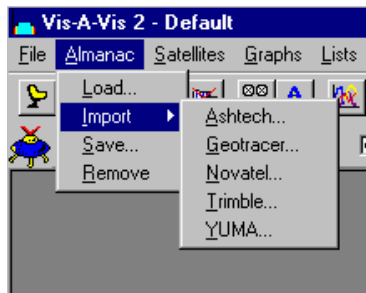


Figure 34-12: Almanac Sub-Menu Import

If you load or import **several almanacs**, **Planning** will use an intelligent algorithm for optimal results. Satellites of different PRNs will be merged in the internal database, not regarding the source of information, and will be appended to the fitting container (e.g., any GPS satellite will be found in the GPS container). If multiple almanac data is available for a satellite, **Planning** will store the almanac data with the most recent information.

34.2.2 Save...

If you have imported an almanac you might want to save it in the Spectra Precision Terrasat format via the menu option Almanac/Store or the corresponding toolbar button. A standard file dialog opens which allows the usual options to choose drive and directory as well as input a new file name (preferably using the default extension *.ALM).



34.2.3 Remove Almanac

If you choose the option **Almanac/Remove** or the corresponding toolbar button, all almanac data will be deleted from the database. You must then load or import a new almanac for further computing.



ATTENTION: As soon as you choose **Almanac/Remove**, data will be deleted from the database! Be sure you really want to clear the almanac before choosing this option!

34.3 Satellite Sub-Menu

The pull-down menu Satellites covers the functions you need for satellite selection. The following options are available:

Selection	enables/disables satellite systems and/or individual satellites for the calculations
Information	provides for each single satellite the complete almanac information

34.3.1 Satellite Selection

Planning is able to use satellites of four satellite systems for calculation of satellite visibility. These Systems are:

GPS	the U.S. NavStar Global Positioning System
GLONASS	the Russian Global Navigation Satellite System
Geo	geostationary satellites of the future, ESA-developed GNSS2 System (expected ca. 2002)
IGSO	International Geostationary Orbit - part of the future ESA-developed GNSS2 System (expected ca. 2002)

The geostationary and IGSO Satellites are part of the GNSS2 System, which is currently in the state of planning. The GNSS2 System is to be built-up by the European Space Agency ESA with the same principle and aiming as the GPS and GLONASS systems, starting with next century. Learning from the GPS and GLONASS experiences results in differences in the space and control segment in order to choose the system parameters in a way that navigation using GNSS2 will be faster, more precise and saver, allowing for airborne navigation.

You can speed up calculation or redrawing of graphs by disabling whole satellite systems or individual satellites. Just click the option Satellite/Selection or the corresponding toolbar button  and you will find the dialog Satellite Selection displayed.

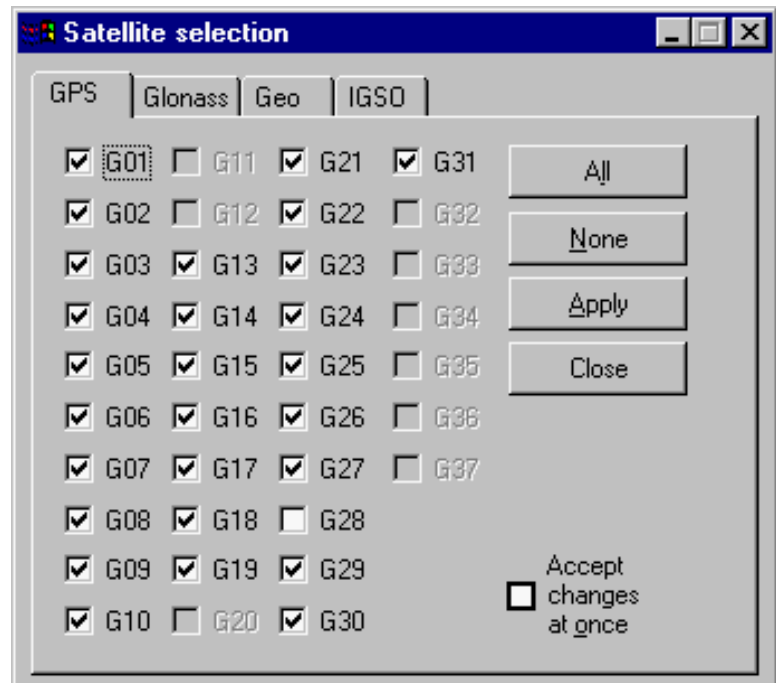


Figure 34-13: Satellite Selection

The dialog Satellite Selection consists of a page for each of the above listed satellite Systems. They are similarly composed. You may enable or disable each individual satellite of a system via its checkbox. By default all loaded satellites of good health (=0) are enabled. Satellites with missing satellite information are grayed out and cannot be en-

abled. Click the respective checkbox to toggle the satellite. Via the buttons **All** you can enable all satellites of the page, the buttons **None** disables all satellites of this system..

You may add the changes to the database via the button **Apply**. Satellite information for disabled satellites will not be lost, the respective satellite will just be “switched off”. In the lower right corner of the page you will find a checkbox, which by default is cleared. If you check the option **Apply changes at once**, changes in the toggling status of a satellite will be accepted at once and you do not have to click the button **Apply**. This option is advantageous, if you en/disable several times just one satellite.

The bar Satellite Systems allows you to select from the list of satellite systems for calculation.

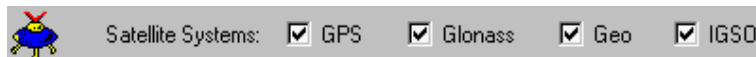


Figure 34-14: Bar Satellite Systems

The “super” switches allow you to enable or disable complete satellite systems, retaining the settings in the dialog Satellite Selection. If, e.g., a GPS satellite is enabled, but the GPS “super” switch on the bar is disabled, the satellite will not be used for calculations.

On the other hand, if a GLONASS satellite is disabled on its page of the dialog Satellite Selection, but the GLONASS “super” switch on the bar is enabled, the satellite will not be taken for calculation.



Setting a “super” switch does not affect the setting of *individual satellites* as it does using the dialog Satellite Selection!

34.3.2 Satellite Information

Choosing the option Satellite/Information or the corresponding toolbar button opens the notebook Satellite Information, which serves as a display of the currently available almanac data for each satellite.

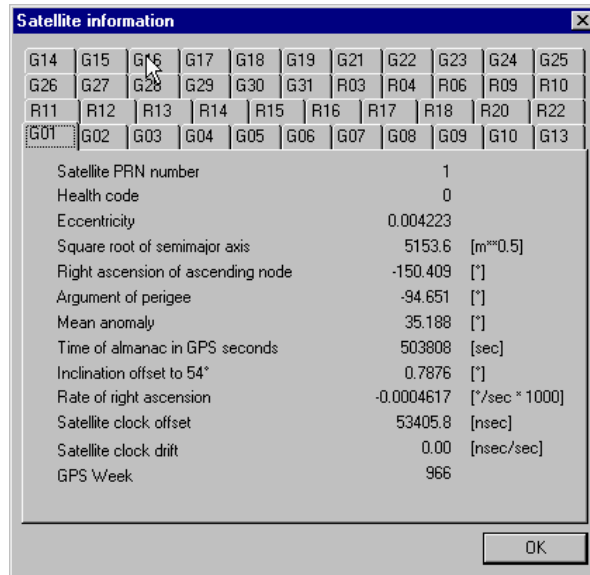


Figure 34-15: Satellite Information

For each satellite a page displays the values from its almanac. This allows you to identify bad or wrong data and to check the data age.

Please note that the GLONASS almanac information is converted to the GPS standard.

34.4 Graph Sub-Menu

A lot of graphs show information on satellite constellation and visibility. You may select of a set of standard graphs; however, Spectra Precision Terrasat will be pleased to build-up special graphs for you.

34.4.1 General Rules

To create a graph you need the following items:

- a station or a multistation (refer to section 34.1).
- an almanac file according to Spectra Precision Terrasat's standard named *.ALM or *.??A, where ?? stands for the year. You may import almanacs of other types and convert them (refer to section 34.2).

When **Planning** is started, a default almanac is loaded and all standard graphs are attached to items in the **Graph** menu. Just select one of the rich set of standard graphs.

The **bar** Satellite Selection allows you to select from the list of satellite systems to be considered for calculation. The “super” switches allow to enable or disable complete satellite systems.

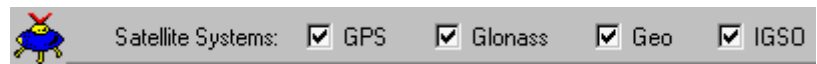


Figure 34-16: Bar Satellite Selection

You may also switch on or off satellites separately (see section 34.3.1).



Satellite En/Disabling by the dialog Satellite Selection
(pull-down menu option **Satellites/Selection**)

overrides the satellite system setting by the bar. E.g., if you disabled all GLONASS satellites by the dialog, the graph will not display any GLONASS satellites, even if the satellite system is enabled by the bar.

Some graphs are **functions of time** (e.g., **Elevation Display**). **Planning** makes the inspection of time sectors very simple. When you have opened a graph, the picture shows the complete time span, which you have defined via the station or multistation editor. Now drag the cursor over a time sector while holding the left mouse button. You will notice the cursor drawing a wavy rectangle. The rectangle marks the time sector. You can mark the time sector forwards and backwards.

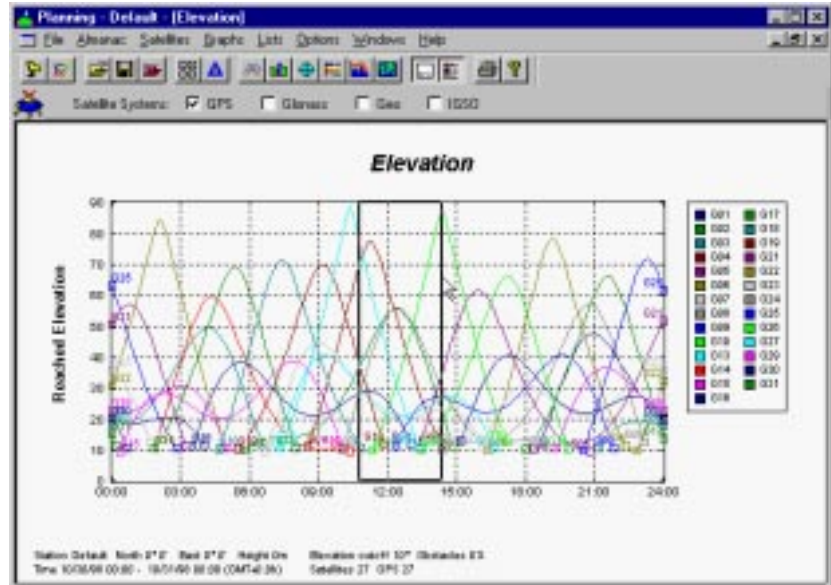


Figure 34-17: Example Display (Elevation)

When you release the left mouse-button the graph will be redrawn, showing the results magnified for just the chosen time sector.

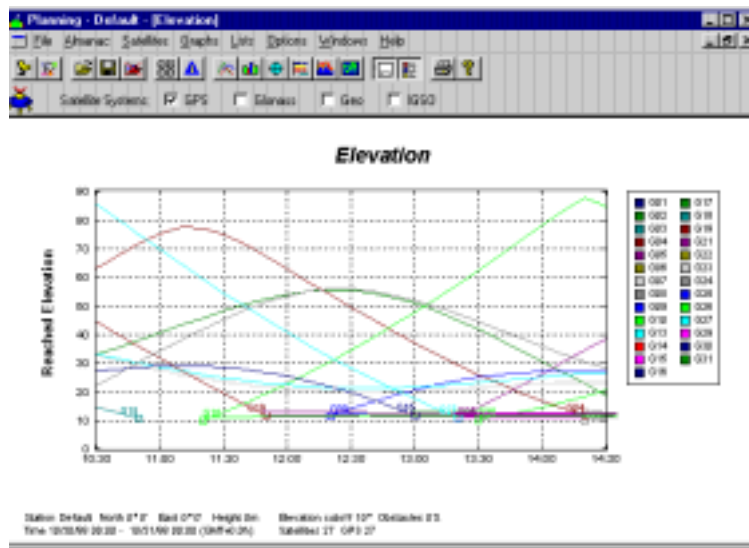


Figure 34-18: Magnified Display

You may continue to magnify up to one epoch for the whole figure.

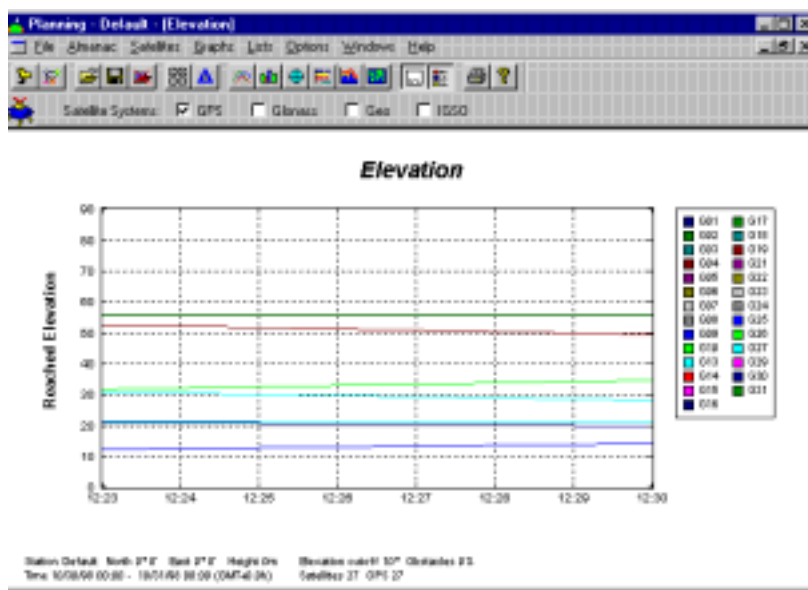


Figure 34-19: Maximum Magnification

Each graph may have a legend and an agenda.

The legend lists the objects used for calculation of the graph. You may enable/disable the display of the legend via the pull-down menu option Windows/Legend. The legend may be a satellite legend, assigning colors to each satellite. For the graphs of combined OP values the legend assigns colors to the DOP types.

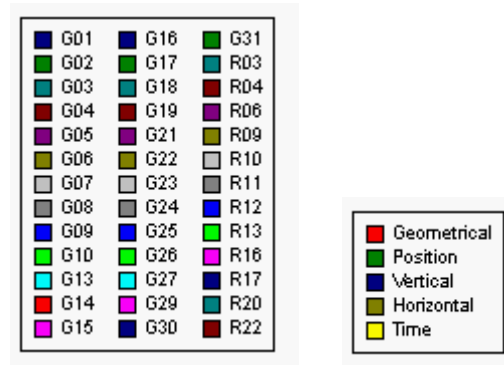


Figure 34-21: Satellite Legend and DOP Legend

The bottom of each graph display is occupied by a summary of the current station's parameters, the agenda. You may enable/disable the display of the legend via the pull-down menu option Windows/Agenda.

Station Default	North 0° 0'	East 0° 0'	Height 0m	Elevation cutoff 10°	Obstacles 0%
Time 16.11.98 00:00 -	17.11.98 00:00 (GMT+0.0h)	Satellites 39	GPS 27	Glionass 12	

Figure 34-22: Agenda

The first line is the station name and position. The next line gives the maximum time span and time difference to GMT (daylight saving

time considered). The following lines give the cutoff elevation angle and the shading via obstacles in percent of the sky, followed by the numbers of satellites considered. You can see how many satellites of each satellite system are currently enabled, no matter, whether enabled individually or by the satellite system selection.

34.4.2 Elevation Display

The graph Elevation is accessible via the menu function Graph/Elevation or the corresponding toolbar button.

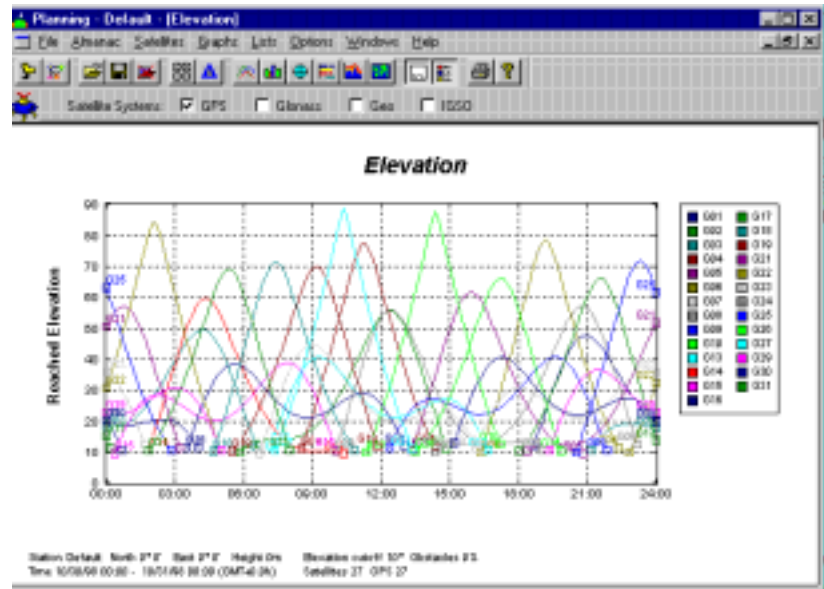


Figure 34-23: Elevation Display

For geometrical considerations and because of the distortion of satellite signals through the atmosphere at low elevations it is useful to know satellite elevation angle. 0° corresponds to the horizon, 90° corresponds to the zenith. Satellites at very low elevation (below 10° , say) do not contribute very much to the calculation of a position because of errors in propagating signals through the atmosphere. Usually a minimum elevation mask is introduced in order to avoid these distortions. Below this limit satellites are generally not accepted for surveying and are not shown in the Elevation Display. If a satellite is hidden by obstacles, it will not be shown as well.

You will find the satellite number near start and end point of the elevation curve.

Please note, that geostationary satellites are always at constant elevations.

34.4.3 Number of Satellites

The graph Visibility is accessible via the menu function Graph/Number of Satellites or the corresponding toolbar button.

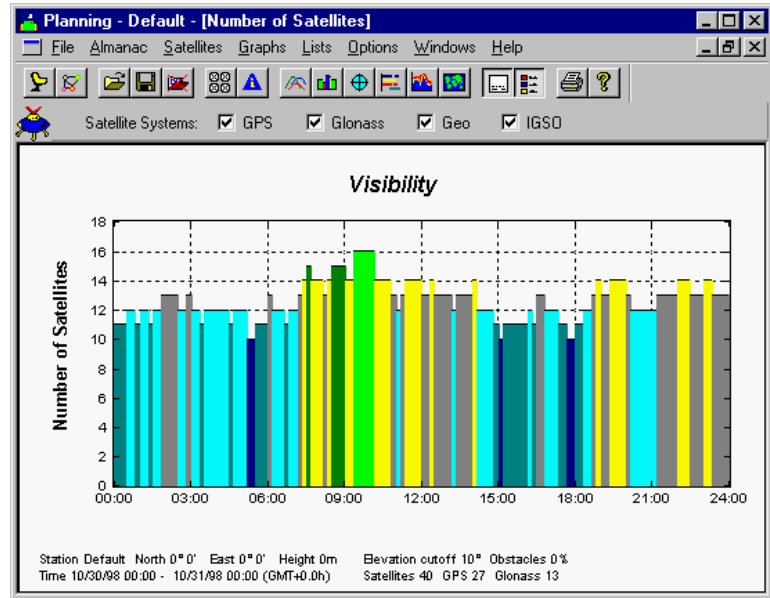


Figure 34-24: Satellite Visibility

The total number of satellites that are simultaneously visible are plotted as a graph **Best Visibility**.

A minimum of 4 satellites is required to determine a three-dimensional position in space with GPS. A minimum of 6 (4 GPS + 2 GLONASS) satellites is required to determine a combined GPS +

GLONASS solution. The presence of obstructions significantly reduces visibility.

The following color scheme is used:

0 satellites	nothing
1 satellite	blue
2 satellites	magenta
3 satellites	brown
4 satellites	light red
5 satellites	red
6 satellites	yellow
7 satellites	green
8 satellites	light green
9 satellites	light blue
10 satellites	blue
11 satellites	cyan
12 satellites	lightcyan
13 satellites	darkgray
14 satellites	yellow
15 satellites	green
16 satellites	light green
17 satellites	light blue
18 satellites	blue
19 satellites	cyan
20 satellites	dark gray
or more	

34.4.4 Polar Plot

The graph Sky Plot is accessible via the menu function Graph/Sky Plot or the corresponding toolbar button.

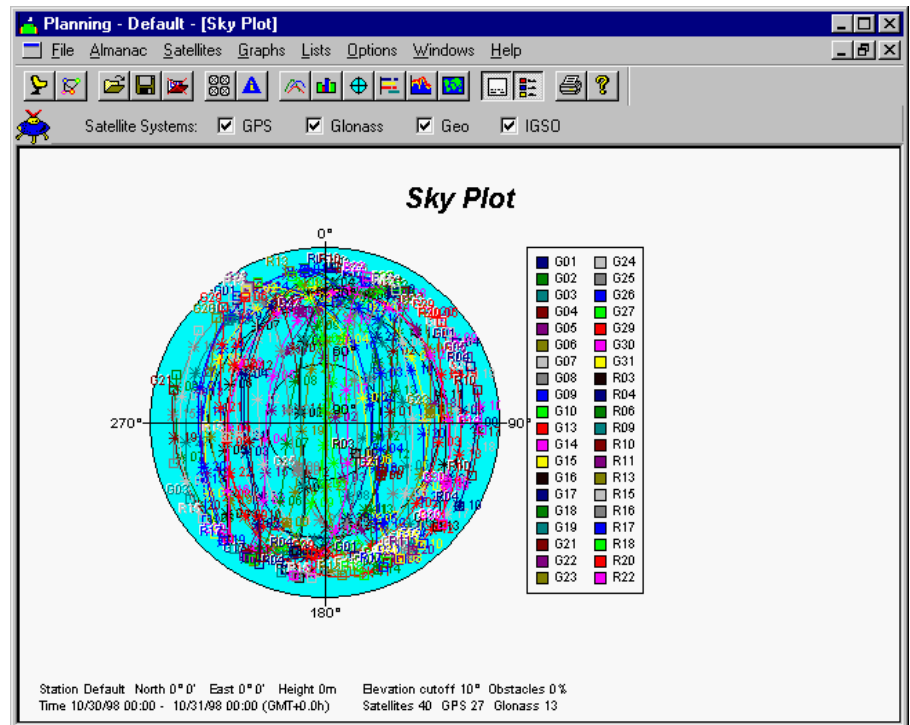


Figure 34-25: Sky Plot

The numbers at the outer circle denote the azimuth; zero means North, 90° is East, 180° is South, 270° is West. Center of the circles is the zenith (elevation angle 90°) and the outer circle shows elevation 0° (i.e., the horizon). The tracks of all selected visible satellites for the given time span are projected onto this map. You will see the position of each satellite at full hours marked with the respective numbers (e.g., 3= 3:00 am, 15= 3:00 pm).

You may want to reduce the time span or the number of satellites to make the plot more readable.

Please note, that geostationary satellites are located at always the same elevation and azimuth.

Analogous to the dialog Obstacles, shaded areas are drawn in the background to indicate where obstacles are located. Satellite tracks hidden by obstacles are **not displayed**.

34.4.5 Visible Satellites

Via the menu option **Graphs/Visibility Planning** offers you several of graphs to display the visibility of satellites as a function of time. You may choose by menu, whether you want to see satellites of one system only or of all systems simultaneously.

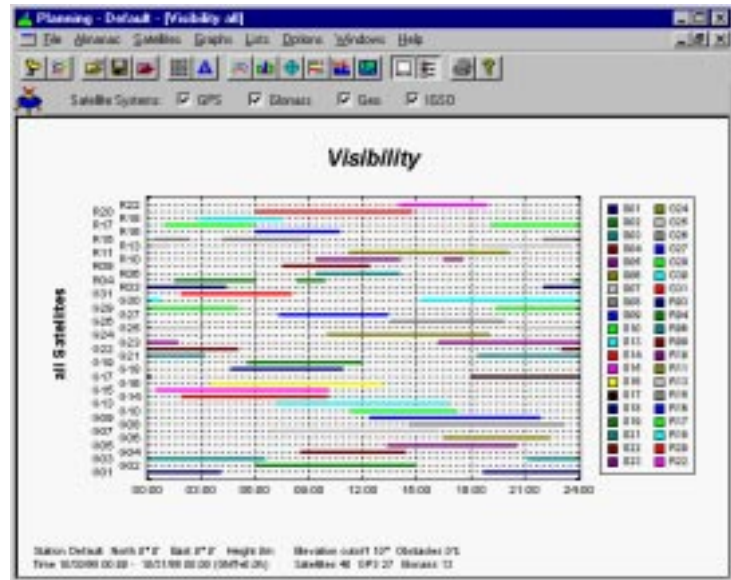


Figure 34-26: General Visibility

Planning offers these graphs:

- Visibility of GPS (sub-menu option **GPS**),
- Visibility of GLONASS (sub-menu option **GLonass**),

- Visibility of Geostationary Satellites (sub-menu option **Geo**)
- Visibility of IGSO Satellites (sub-menu option **IGSO**), or
- General Visibility, i.e. a combination of the former systems (sub-menu option **General visibility** or the respective toolbar button). 

Additionally, the settings made via the menu option **Satellites/Selection** resp. the bar **Satellite Systems** will influence the number of satellites displayed (refer to section).

All graphs show the visible satellites as a function of time. A color bar shows the time span(s) in which the specific satellite is above the elevation cutoff ("visible", although being approximately 20 000 km aloft). Zooming in with help of the left mouse-button helps to determine the times when a satellite will ascend above or descend below cutoff elevation angle. Please note, how the presence of obstructions significantly reduces visibility.

34.4.6 Dilution of Precision

Via the menu option Graphs/DOP's **Planning** offers you several of graphs to display several DOP values. The plots may display the DOPS types separately or in combination.

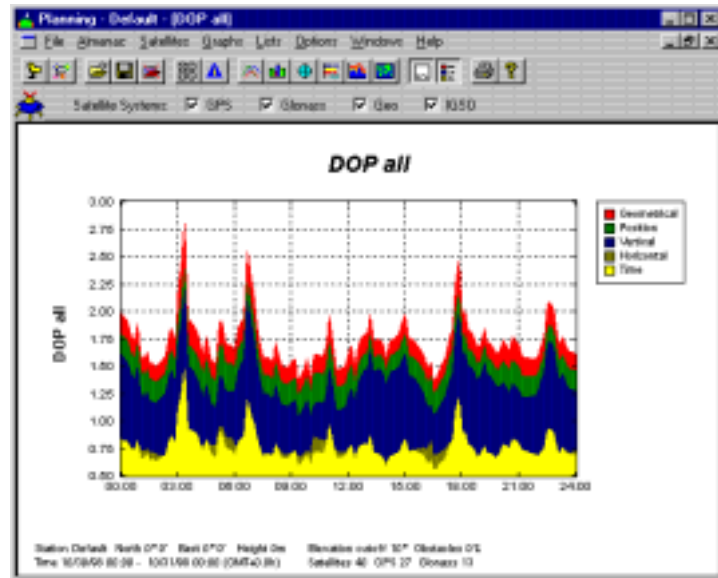


Figure 34-27: DOP - All

An important factor in assessing the accuracy of a GPS survey is the geometrical constellation of the satellites that are used during the processing measurement. The Dilution of Precision - or DOP - values are calculated and displayed as functions of time.

The DOP types available are:

GDOP: geometrical DOP
PDOP: position DOP
VDOP: vertical DOP
HDOP: horizontal DOP
TDOP: temporal DOP

You may choose each of the DOP types separately. If you choose the option **All together** or the respective toolbar button, all results will be shown in one single graph, printed one above the other. Typically, the values follow the following rule:



$$\text{GDOP} > \text{PDOP} > (\text{VDOP}, \text{HDOP}) > \text{TDOP}$$

and, therefore, GDOP values are printed in the background, while TDOP values are shown in front.

An alternative option is to choose **All together (Lines)**, which shows the DOP values as lines instead of colored areas.

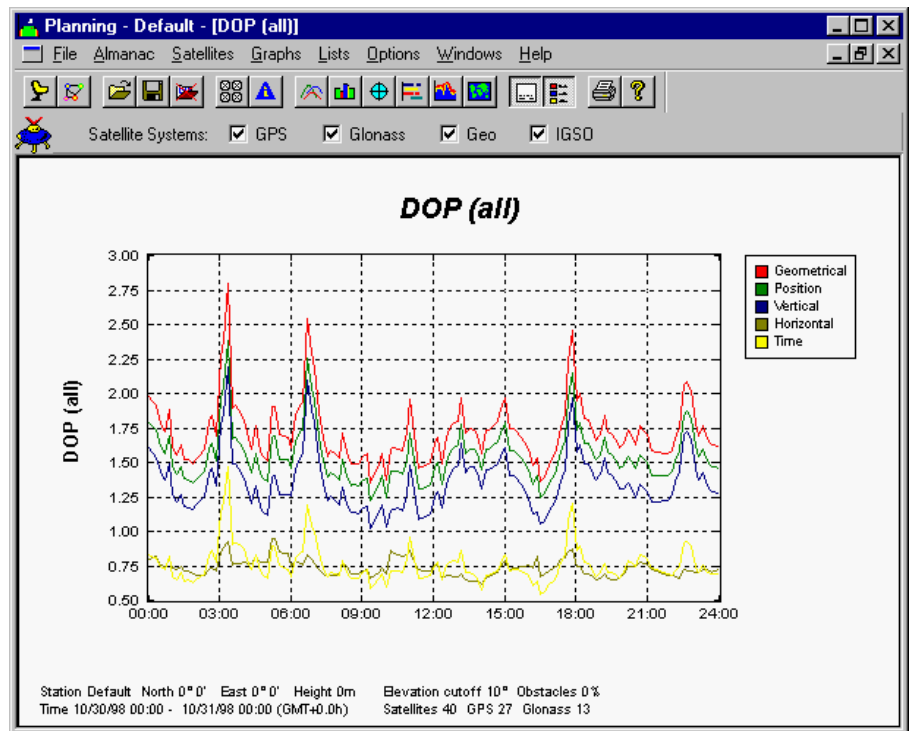


Figure 34-28: DOP - all, Lines

If you choose the option **Open 5 DOPs**, the plots of the 5 single DOP types will be opened in descending order. You may arrange them on your desktop to compare the values.

The presence of obstructions significantly reduces visibility and, therefore, increases the DOP values.

34.4.7 World Projection

The graph World Projection is accessible via the menu function Graph/World Projection or the corresponding toolbar button.

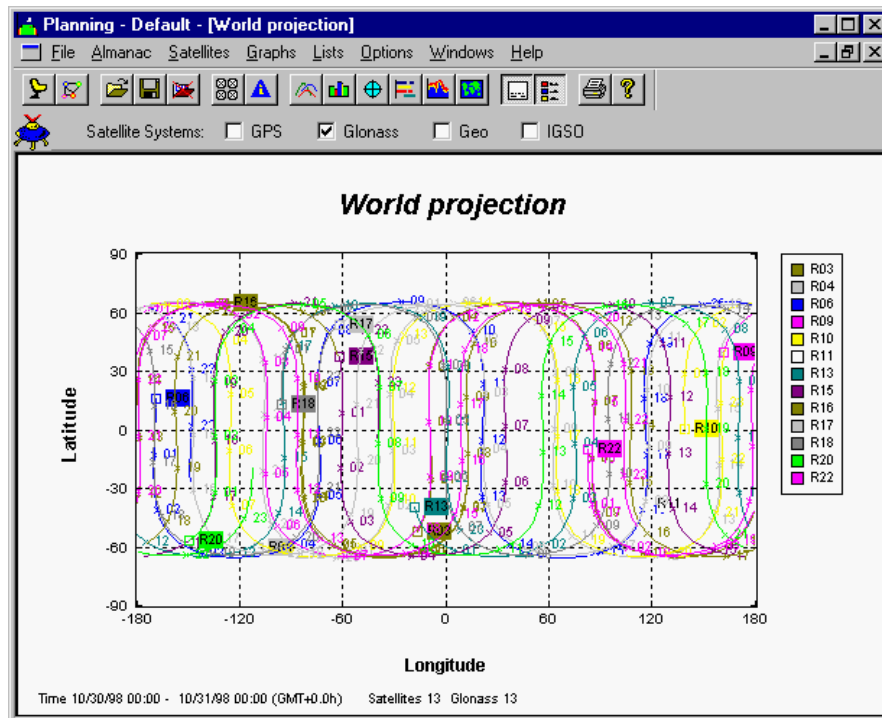


Figure 34-29: World Projection

This graph presents a colored map of the world and projections from the satellite paths on the earth's surface. Geostationary satellites are located right above the horizon, with constant latitude. The Satellite IDs are printed next to the projection using the satellite identification color. The position of each satellite is given for each full hour in hours (01, 02, ...).

This graph does not display obstructions.

You may reduce the time span or the number of satellites to ensure that the plot is readable.

34.5 Lists Sub-Menu

In connection with the Spectra Precision Terrasat product **HyperPage** you may create printable lists of your planning results. For more information on **HyperPage** please refer to the ***HyperPage User's Manual***. If the **HyperPage** Option View/Tabs is active, you may combine all lists referring to a station/multistation analysis in a single **HyperPage** window. The name the tab is the name of the data file containing the results,

The individual style of your **HyperPage** window depends very much on the Web browser installed. The following figures, therefore, can only act as examples.

34.5.1 Intervals

If you select the option Lists/Intervals, you will receive a **List of Intervals**:

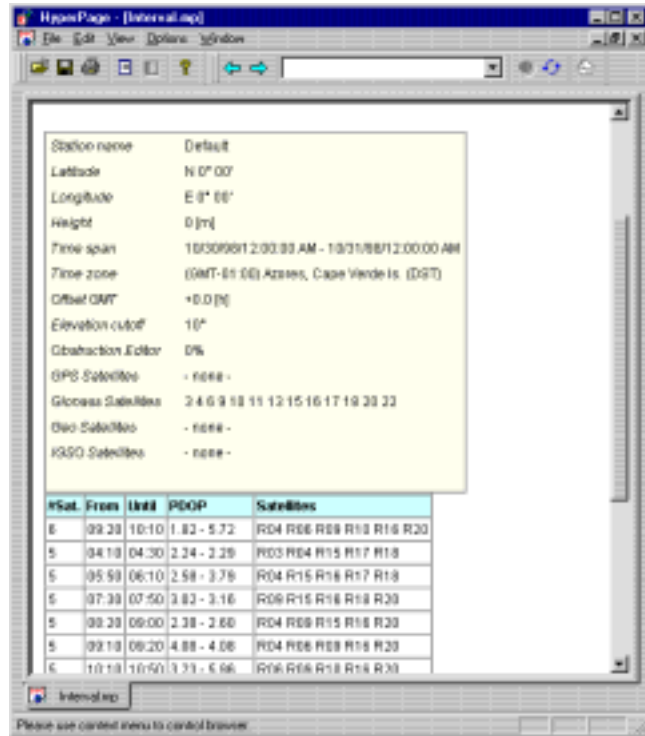


Figure 34-30: List Intervals

A summary of the station/multistation parameters follows the header containing the list name. As result you will find a list of all continuous

intervals without change in number of satellite or satellite constellation during the chosen time span. The list will start with the highest number of satellites visible (here: x) and show start (From) and end time (To) of each time span, where satellite constellation remains unchanged. You will see the range of PDOP during this time span and then the PRN-numbers of the satellites visible.

As soon as the satellite constellation changes due to one satellite (its elevation is higher or lower than the limit set by the elevation cutoff), a new line starts displaying the current values and satellites.

Since visible geostationary satellites are always visible, they are not included into the list, but just mentioned in the summary section of this document.

34.5.2 Elevation Azimuth

If you select the option Lists/Elevation and Azimuth, you will receive the list **Elevation and Azimuth**:

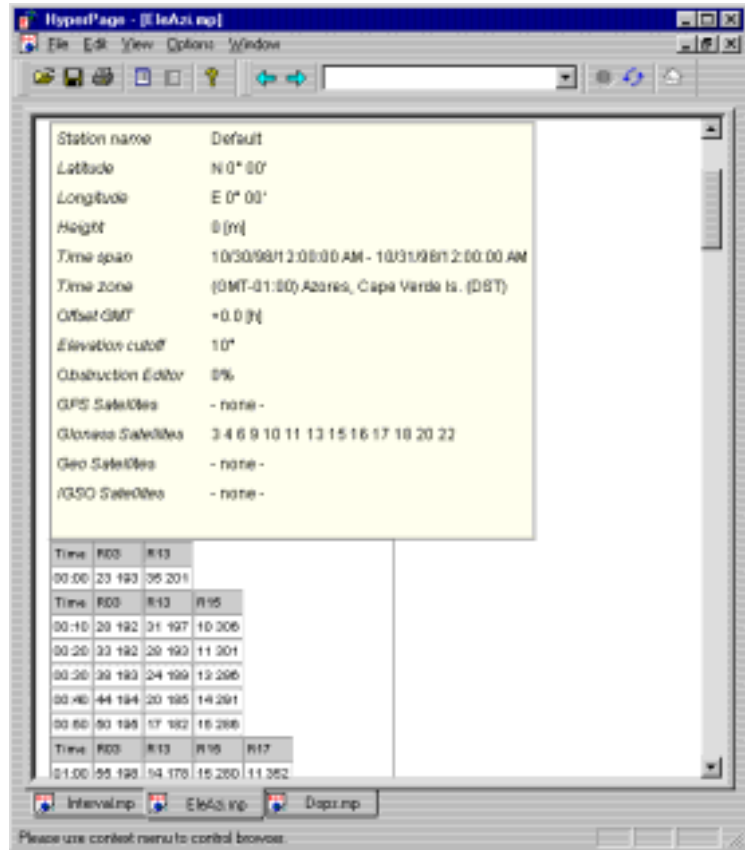


Figure 34-31: List Elevation and Azimuth

This list contains the elevation and azimuth of each satellite at any single epoch.

A summary of the station/multistation parameters follows the header containing the list name. In temporal order, the following data are listed in blocks of the same satellite configuration. Each block shows in order of time (column **Time**) for each satellite (columns **Satellite-IDs**) first its elevation, then its azimuth angle (integer values).

Whenever the configuration changes, this is indicated by a new block with a grayed title line, showing the new configuration.

For obvious reasons, geostationary satellites are not included in the list, but just mentioned in the summary section of this document.

34.5.3 DOP Values

If you select the option Lists/DOP values, you will receive a **List of DOP values**:

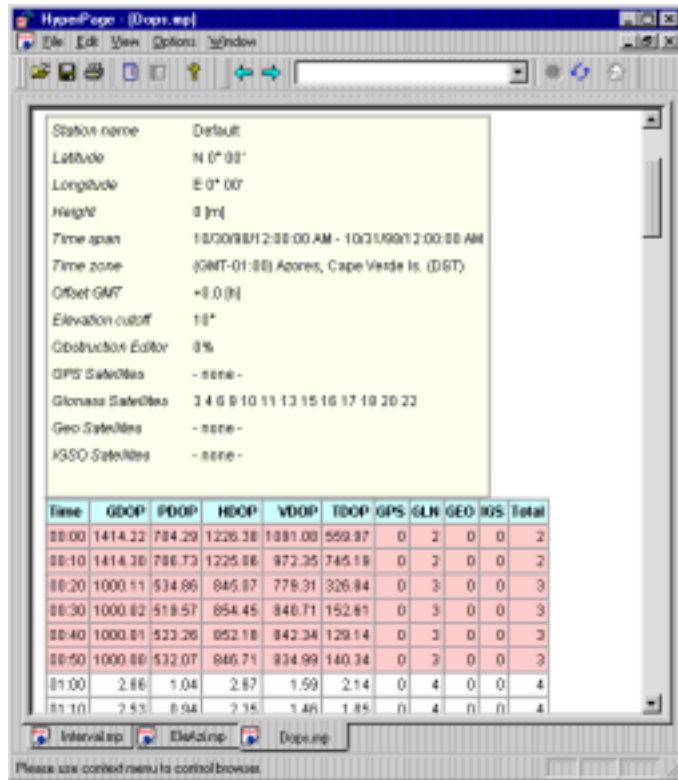


Figure 34-32: List DOP Values

A summary of the station/multistation parameters follows the header containing the list name. This list informs for each epoch (Time) of the selected time span on the values of each DOP type and the number of satellites visible in each system. It also displays the total number of satellites (Total).

Epochs, where GDOP reaches values higher than a given critical limit, are indicated by a red background. By default, the critical value is 3.000. However, you may edit the limit value: Click the **HyperPage** menu item Options/ Report Settings...

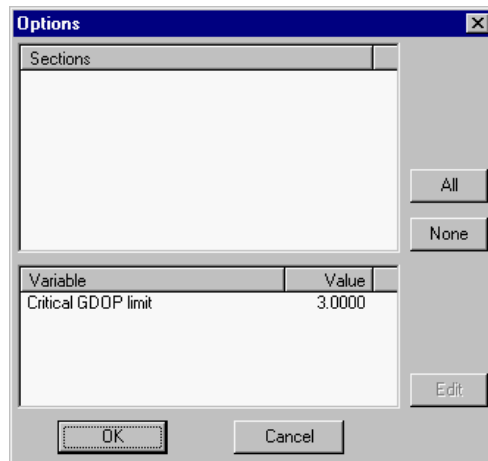


Figure 34-33: Report Settings

Activate the variable Critical GDOP Limit and click the button **Edit**.

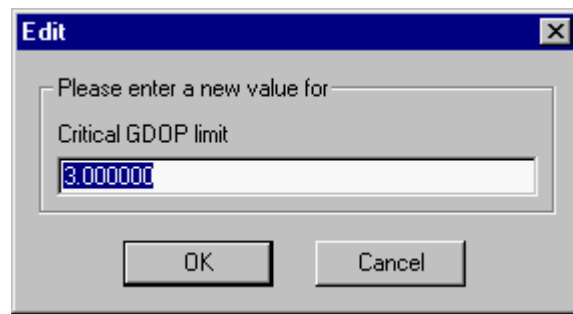


Figure 34-34: Edit Variable

The dialog Edit allows you to enter a new value for the variable Critical GDOP Limit.

34.6 Options Sub-Menu

The following menu items of the pull-down menu Options or the corresponding toolbar buttons allow you to modify the display of **Planning**:

- Agenda
- Legend
- The bar  Systems



Additionally, you may activate any graph from the list of open graphs.

34.7 Help Sub-Menu

An About-box informs you about the current version of **Planning**, about copy-rights, about how to contact Spectra Precision Terrasat directly or about your local vendor.

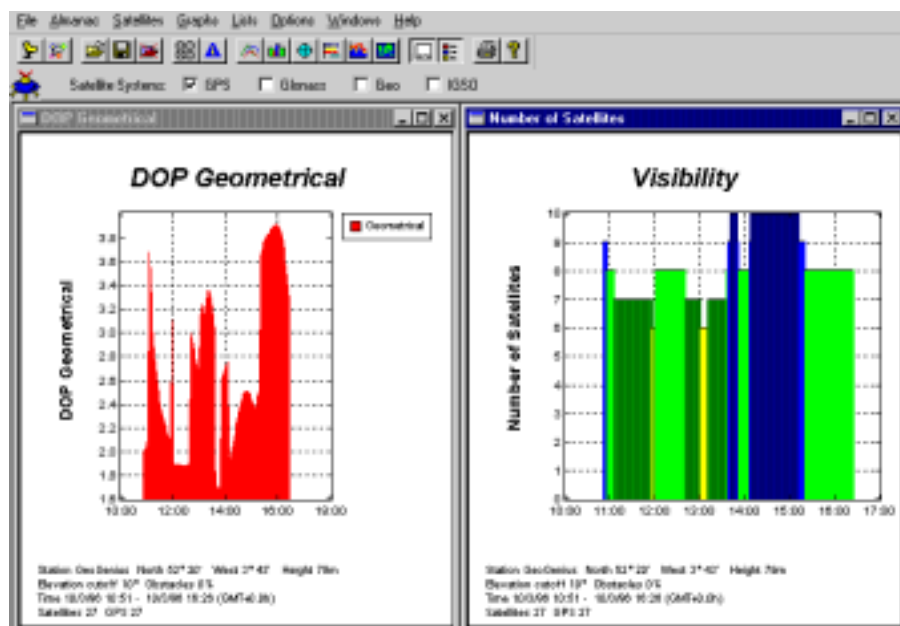
In case of questions or suggestions, please do not hesitate to contact us immediately!

Detailed help is available via the menu option **He lp**.

34.8 Interaction with GeoGenius Data Processing

GeoGenius allows you to analyze satellite visibility from within the Project Manager. Once a project is loaded or defined, the planning module **Planning** may be started from the **Tools** menu. Use the entry **Planning** from the pull-down list to call **Planning** with the current project parameters, i.e., position, date and time, time zone.

Planning then creates a new station under the name of the calling program (**GeoGenius**). The parameters of the new station are the position of the first station of the project, its cutoff elevation angle and the time span the project covers. **Planning** then calculates visibility for the transferred date and displays the **Number of Satellites** and **GDOP** graphs on the screen.



Based on this initial view you may use all functions of **Planning** as described in this manual.

On exiting the program you are transferred back to the **GeoGenius** Project Manager.

35. Appendix

35.1 How to Add Cities to Planning

Planning takes city information from a file named `CITIES.DAT`. This file contains lines like these

```
Aalborg,Denmark 57.097000 9.850000  
Abbotsford,BC 49.030000 -122.320000  
Aberdeen_Priv_Gnd,MD 39.235000 -76.174900
```

The first entry contains the city name. There must not be any space character in the name. Space characters are denoted by an underscore '`_`'. This underscore is converted to a space character inside of **Planning**.

The second entry contains the latitude of the city in degree. North pole is denoted as $+90^\circ$, south pole is -90° .

The third entry contains the longitude of the city in degree. Its range is from -180° to $+180^\circ$, where 0° is the meridian going through *Greenwich*.

35.2 The File ALMANAC.ALM

Planning uses the Spectra Precision Terrasat standard almanac format.

The almanac file contains the following information (see following pages):

The parameters in each column are:

PRN	Satellite PRN number
health	Health code (hexadecimal values, 0 = OK, 1..255 = BAD)
e	Eccentricity
$\sqrt{a}$	Square root of semimajor axis [$\sqrt{m}$]
Ω	Right ascension of ascending node [$^{\circ}$]
ω	Argument of perigee [$^{\circ}$]
M	Mean anomaly [$^{\circ}$]
toa	Time of almanac in GPS seconds [sec]
i	Inclination offset to 54°
$d\Omega/dt$	Rate of right ascension [$^{\circ}/sec$]
a_0	Satellite clock offset [nsec]
a_1	Satellite clock drift[nsec/s]
week	GPS week

1	2	4	5	6	7	PRN
0	0	0	0	0	0	health
0.003548	0.014520	0.003486	0.001820	0.006310	0.007247	e
5153.6	5153.6	5153.5	5153.5	5153.7	5153.6	$\sqrt{a}$
-117.290	6.714	129.089	7.560	69.937	67.910	Ω
-77.040	-145.682	-63.782	-116.621	-164.554	-146.580	ω
-24.986	124.258	-101.331	-6.981	-56.168	59.551	M
32768	552960	552960	552960	552960	552960	toa
0.6612	0.4343	1.4540	0.5830	1.0622	1.2336	i
-0.0004558	-0.0004636	-0.0004446	-0.0004623	-0.0004636	-0.0004617	d Ω /dt
304222.1	-176429.7	30517.6	114440.9	-7629.4	701904.3	a_0
0.05	0.00	0.00	0.00	0.00	0.00	a_1
811	810	810	810	810	810	week
9	12	14	15	16	17	PRN
0	0	0	0	0	0	health
0.003817	0.015578	0.002429	0.006959	0.001259	0.008258	e
5153.6	5153.4	5153.7	5153.7	5153.6	5153.6	$\sqrt{a}$
-51.455	-35.106	-176.439	124.121	-175.902	126.151	Ω
-14.659	-5.086	178.724	99.057	-57.632	121.849	ω
-48.554	-51.370	34.946	-174.743	140.444	-72.580	M
552960	32768	32768	32768	32768	32768	toa
0.3049	8.1536	1.2243	1.7245	1.0331	1.7884	i
-0.0004512	-0.0003654	-0.0004446	-0.0004407	-0.0004453	-0.0004381	d Ω /dt
-7629.4	591278.1	7629.4	206947.3	-100135.8	-91552.7	a_0
0.00	-0.04	0.00	0.00	0.00	0.00	a_1
810	811	811	811	811	811	week
18	19	20	21	22	23	PRN
0	0	0	0	0	0	health
0.005873	0.001265	0.004972	0.011899	0.008072	0.009689	e
5153.5	5153.7	5153.6	5153.6	5153.5	5153.5	$\sqrt{a}$
-120.025	-60.201	0.408	-171.355	7.569	-169.367	Ω
82.622	-171.733	79.977	172.943	-4.880	-130.380	ω
44.325	-131.063	107.528	155.538	114.701	128.722	M
32768	32768	32768	552960	552960	552960	toa
0.0051	21.8539	0.7848	0.8655	0.4412	1.0646	i
-0.0004643	-0.0004584	-0.0004564	-0.0004505	-0.0004643	-0.0004499	d Ω /dt
-7629.4	323295.6	236511.2	-22888.2	229835.5	7629.4	a_0
0.00	-0.02	0.00	0.00	0.00	0.00	a_1
811	811	811	810	810	810	week

24	25	26	27	28	29	PRN
0	0	0	0	0	0	health
0.0006256	0.0005953	0.0008824	0.011299	0.003915	0.005107	e
5153.6	5153.5	5153.6	5153.6	5153.6	5153.6	$\sqrt{a}$
128.764	-53.026	-111.540	-52.233	68.512	-112.843	Ω
-118.620	-177.235	-45.019	151.921	171.219	-106.051	ω
-74.237	9.035	58.657	-107.828	-126.515	-92.837	M
552960	552960	552960	552960	552960	552960	toa
2.0194	22.4042	0.8312	0.1318	1.6981	0.6097	i
-0.0004381	-0.0004545	-0.0004525	-0.0004505	-0.0004577	-0.0004551	d Ω /dt
81062.3	0.0	-953.7	38147.0	23841.9	7629.4	a_0
0.05	0.00	0.00	0.00	0.00	0.00	a_1
810	810	810	810	810	810	week
31						health
0						PRN
0.005872						e
5153.5						$\sqrt{a}$
68.064						Ω
38.911						ω
-30.110						M
552960						toa
1.1996						i
-0.0004630						d Ω /dt
341415.4						a_0
0.05						a_1
810						week

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REPORT GENERATOR AND CHARTING TOOL

HyperPage

User's Manual



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Note

We are aware of the fact that our exclusive masculine pronoun "he" is considered politically incorrect, but has been used in this case to simplify readability.

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36. Introduction

36.1 General Information

HyperPage is a powerful tool for generating reports, charts or any other form of printable output. It is used by a lot of Spectra Precision Terrasat's applications to create in HTML and then to present numerical reports, lists, tables and pictures.

HyperPage is a HTML generator. That means that you have the possibility of creating complex HTML files automatically, using a macro programming language. Using HTML offers you a lot of advantages:

- Reports and lists created by **HyperPage** can be visualized on various platforms.
- The reports and lists can be distributed easily via the Internet.
- You do not necessarily need **HyperPage** to open the reports or lists. A simple Internet Browser is sufficient.
- You can increase the information enormously when you add links to relevant topics or some helpfiles to the text.
- The reports and lists can be easily exported. Copying them into the temporary storage will have no effects on the formats or tables.

HyperPage uses macros like `/title` or `/tabular`. You can edit them to optimize the layout of the texts. The default macros are available in separate files. **HyperPage** documents are therefore relatively small, even though they include complex formatting commands.

This document concentrates on the functionality of **HyperPage** Viewer, as it appears on your screen.

HyperPage's main window looks like this:

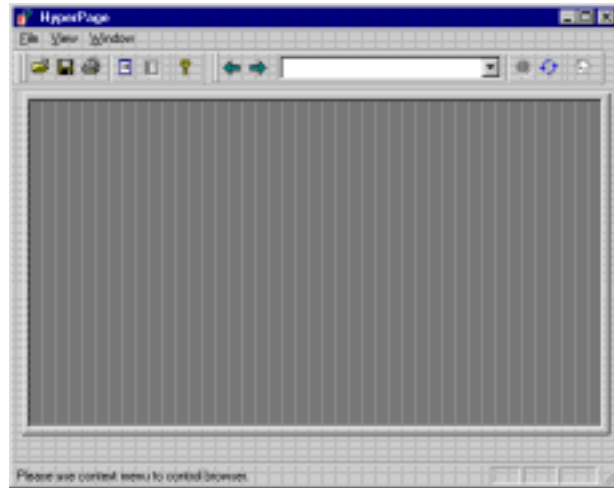


Figure 36-1: HyperPage Main Window

The **HyperPage** Viewer offers a menu, a toolbar below, a status bar at its bottom and a huge client area for the presentation of documents.

In the following you will find

- a description of how to handle and manipulate documents (Chap. 2),
- a description of how to handle files (Chap. 3),
- a short description of the layout (Chap. 4),
- a detailed description of how to adapt the settings (Chap. 5),
- tips on how to use **HyperPage** as an Internet browser (Chap. 6).

An About notebook (choose the item About **HyperPage** of the pull-down menu View) allows you to get information on the current version of **HyperPage**. It helps you to contact Spectra Precision Terrasat in cases of problems or if you have suggestions or remarks.



36.2 Main Menu

HyperPage's main menu includes the following menu items:

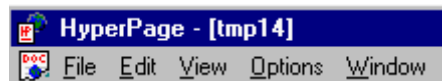


Figure 36-2: **HyperPage** Main Menu

The **HyperPage** menu includes the following pull-down menus.

File	handle files (load, print and export) and terminates HyperPage ,
Edit	select contents; copy it to the clipboard
View	toggle the view of tool bars, tabs and the output window, choose the MacroStudio
Options	choose and adjust settings for reports and contents
Window	arrange the document area, for further information

37. File Management

All file-handling options are summarized in the sub-menu **File**.

Open	Load a *.M, *.MP document and generate an HTML file, or load an *.HTM file.
Close	Close the current document
Save as...	Save the generated document.
Reload	Re-interpret a *.M, *.MP file
Print	Printing options and printing the current HTML document.
Print Setup	Setup the printer, independent of printing.
Page Setup	Settings of the page, including the header and the footer setting.
<filename>	Quick selection of one of the four last-used files.
Exit	Leave the dialog without further questions.

37.1 Open a File

To have a look at the content of a file or the edit it, open the file, using the menu item **File/Open** or the respective toolbar button. A standard dialog offers you the possibility of searching for a file and to open it. By default a **HyperPage** file has the extension ***. M** or ***. MP**. **HyperPage** creates an HTML file and visualizes it. You will also have the opportunity of opening an already existing *.HTML file.



HyperPage opens several documents at the same time, the program itself, however, may only once be activated. Opening a new file leads to a child window (or page) displaying the new file.

By default, all windows are visible as tabs, listed at the bottom of the screen. This view can be switched off (**View/Tab View**) and the tabs can be arranged as usual with Windows applications, using the pull-down menu **Window**. To activate the tab view again,

- click the menu item **View / Tab View**
- make sure that a document is opened in the normal view.

37.2 Close a file

Every document can be closed separately in the **HyperPage** program. Choose the menu option **File/Close**. Changes will not be saved.

37.3 Save as HTML File

If you want to save the current file as a *.HTM file, choose the menu option **File/Save as...** or the respective toolbar button. A  Standard file dialog offers you the opportunity to save the file and to determine the path to the directory. The default extension shown in the respective box is *.HTM. This action stores all files into the target directory that are necessary to display the HTML file properly.

37.4 Reload a File

In case you have edited a file in the MacroStudio (refer to ch. 39.2.1) it is recommended to reload the file to activate the changes. Choose the menu item **File/Reload**.

37.5 Printing Options

Three are available to print the document and to edit the necessary options.

File/Print or the respective toolbar button opens a Windows standard printing dialog. All default options are offered. Additionally, an HTML related option is offered, which allows you to choose the frames that should be printed .



To determine the settings for the printer use the option File/Print Setup... .



The standard orientation for the documents is the portrait format. However, it can easily be changed to the landscape orientation.

The option File/Page Setup allows you to edit the header and the footer of your document and to change the orientation, margins and the size.

37.6 Exit

The menu item File/Exit closes the current file and shuts down **HyperPage**.

38. Edit the Report

The pull-down menu **Edit** offers you options to edit the reports.

Select All	highlight and select the whole text.
Copy	copy the selected objects in HTML format to the clipboard.

With **HyperPage**, you can copy tables and documents via the clipboard to any available editor. If the chosen editor is capable for HTML format, the tables will be still presented as formatted tables..

The following figures shows a table for the Double Difference Float solution derived from a static processing report. You can mark areas of the report (drag of the cursor over the area that is to be selected). To mark the whole report, choose the option **Edit/Select All**.



Please note that the above mentioned option only selects the report sections that are displayed. You can select report sections for display via the option **Options/Report Settings**.

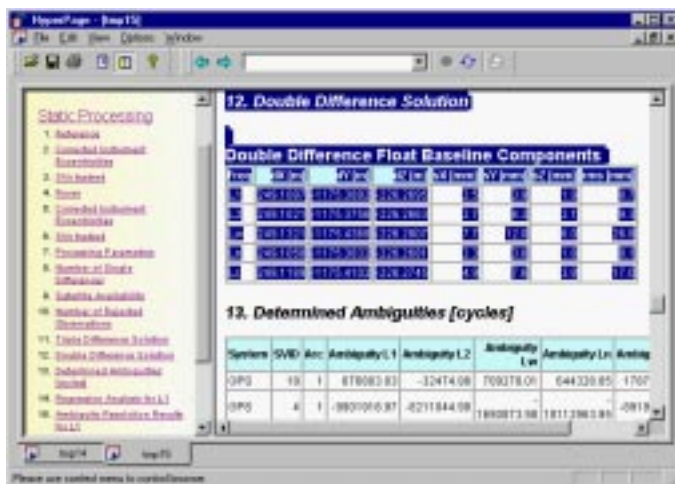


Figure 38-1: Selected Section

The marked section has been copied (via Edit/Copy) into the clipboard and then pasted into this text (with only slight modification to the give page layout).

12. Double Difference Solution

Double Difference Float Baseline Components

Freq	dX [m]	dY [m]	dZ [m]	sX [mm]	sY [mm]	sZ [mm]	rms [mm]
L1	249.1087	-1175.3892	-226.2696	2.5	3.9	1.9	8.7
L2	249.1021	-1175.3756	-226.2664	2.7	4.2	2.1	9.3
Lw	249.1321	-1175.4368	-226.2807	7.7	12.0	6.0	26.8
Ln	249.1058	-1175.3832	-226.2681	2.3	3.6	1.8	8.1
Lc	249.1189	-1175.4102	-226.2745	4.9	7.6	3.8	17.0

Figure 38-2: Auto-Formatted Copy of the Selected Section

39. Layout and Extras

The pull-down menu **View** offers you the options of toggling certain parts of the program. You can customize **HyperPage** completely to your own requirements.

Toolbar	Toggle the view of the toolbar
Browser Bar	Toggle the view of the Browser Bar
Status Bar	Toggle the view of the Status Bar
Tab View	Toggle the view of the tabs

Further, on you can open two extra tools via this menu:

Macro Studio opens the tool MacroStudio

Output Window View of a failure output window

39.1 Layout

By default all layout options are activated for **HyperPage**.

- **The toolbar for file can be toggled using the menu option View/Toolbars. This toolbar offers all icons for opening, saving and printing a document, for report settings, contents and HyperPage information.**

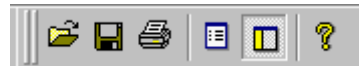


Figure 39-1: Toolbar File

- You can toggle the toolbar for Internet-usage via the respective menu option **View/Browser Bar**. It includes all icons for the usage of the Web-Browser.

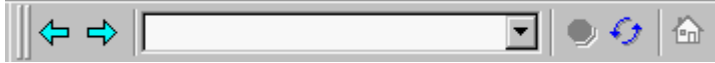


Figure 39-2: Browser Bar

- You can toggle the Status bar via the menu option **View/Status Bar**. It offers you information on the current status of your system.
- By default the documents are listed as tabs on the bottom of your screen. When you switch off this option they are visualized as child windows in the normal view. You can enable/disable the tab view via the menu option **View/Tab View**.

39.2 Extras

There are two options that will help you to create reports or to modify them. They will also help you to find errors.

39.2.1 Programming Environment

One of the major advantages of **HyperPage** is its ability to adapt itself to all your needs. To create customized and printable reports and ta-

bles use the built-in and easy-to-learn macro-language. (Information for programmers: The macro-language is based on Tcl/Tk).

The extra tool MacroStudio offers you the environment for programming. It corresponds to a standard-programming- environment with breakpoints and single step execution. To start MacroStudio choose the menu option View/Macro Studio.

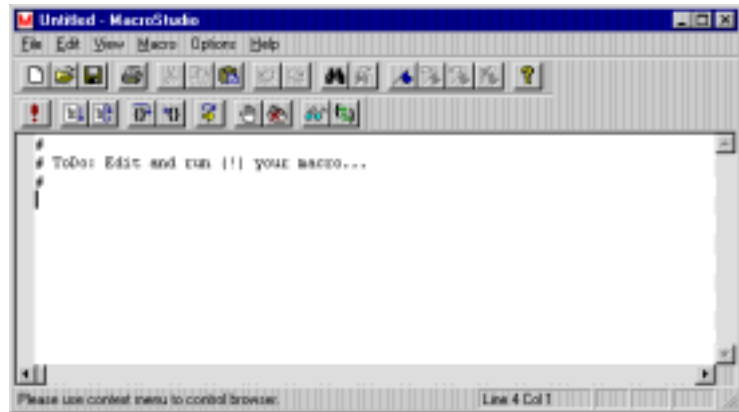


Figure 39-3: MacroStudio

You can program new macros, open already existing macros, edit them and save them under a new name.

To activate changes of an open macro file, save the changes within MacroStudio, then reload the saved macro within **HyperPage** via the menu option File/Reload.

39.2.2 Output of Errors

An output window informs you about errors that appear when **HyperPage** generates HTML files. By default, this window is not visible on the screen (hidden).

The menu option View/Output Window allows you to enable/ disable the view of the output window.

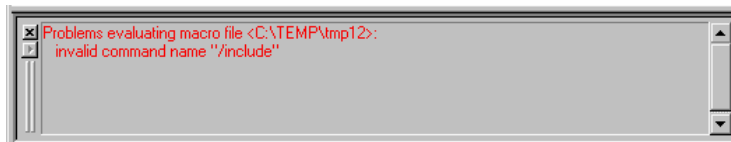


Figure 39-5: Output Window Context Menu

Allow Docking	A toggle option. If it is marked with a ✓ sign, the output window will dock to a docking station of the client area. By default it is docked to the bottom of the screen. As soon as you drag the top of the window near to a docking station, such as the bottom of the client area or the toolbar area, the output window will dock there. If you disable this option, the output window becomes an independent, floating window, moveable to anywhere on the PC's screen.
Hide	with this option you can close your output window until the next message appears. The window then shows up again and informs you of all messages since the start or since its contents has been deleted.
Clear	deletes the contents of the output window. All messages are discarded..
Font	opens a standard font selector dialog allowing you to change the font and font attributes of the output messages. By default, error messages are given in red color.
Float in Main Window	if this option is activated, the output window is a child window of the HyperPage main window; corresponding to your settings it can also be visualized as a tab.

40. Options

The pull-down menu Options allows you to determine the following settings.

Report settings	toggle sections of the document
Table of Contents	Toggle the table of contents
Customize...	Define toolbars

40.1 Report Settings

The dialog Options can be opened via the menu option Options/Report Settings or via the respective toolbar button. It serves the following main purposes:



1. Some documents that are visualized by **HyperPage** are extraordinary long. An example for a very long **HyperPage** document is the processing report of kinematically derived data. Long reports are often separated in several sections that can be individually activated or not. Thus, you can, e.g, modify the report for editing with your own text editor to come up to your expectations.
2. Some documents use colors or numbers to mark values that exceed a certain limit. You may customize the limit

The following figure shows a processing report with default settings for reports:

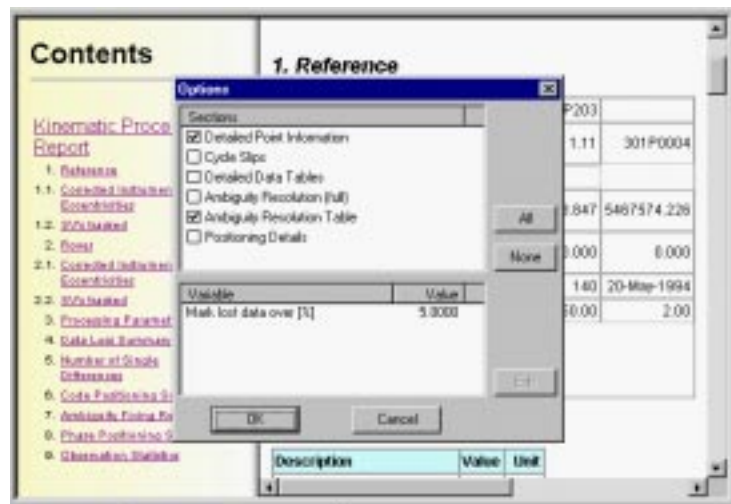


Figure 40-1: Report Settings

If a **HyperPage** document contains section markers, you will find them in the column Sections. A section may consist of one or more tables. The figure above shows you that the kinematic report includes several sections; by default, however, only two of them are visualized. The of contents of tables refers to the visualized sections only!

Only the sections with checked check boxes will be visualized in the reports, appear in the contents (if a contents is displayed) and will be copied to the clipboard via the menu option **Select all** from the pull-down menu **Edit**. You may check or clear the checkboxes, to enable/disable the display of the respective section. The buttons **All** and **None** allow you to activate all sections or none.

The second box only shows up, if one or several threshold values are defined for the current **HyperPage** document. It includes for each the vari-

able the limit value defined. **HyperPage** will mark variables that exceed those limits by colors or numbers.

The following example visualizes in the dialog **Options** the limit for **HyperPage** to mark the loss of data. The kinematic report simultaneously displays the section **Data Loss Summary**. In this example, 19.7 % of the epochs of the GPS14 satellite are missing. That exceeds the given limit of 5 %. That means that less than 95 % of the data is available for both receivers simultaneously.

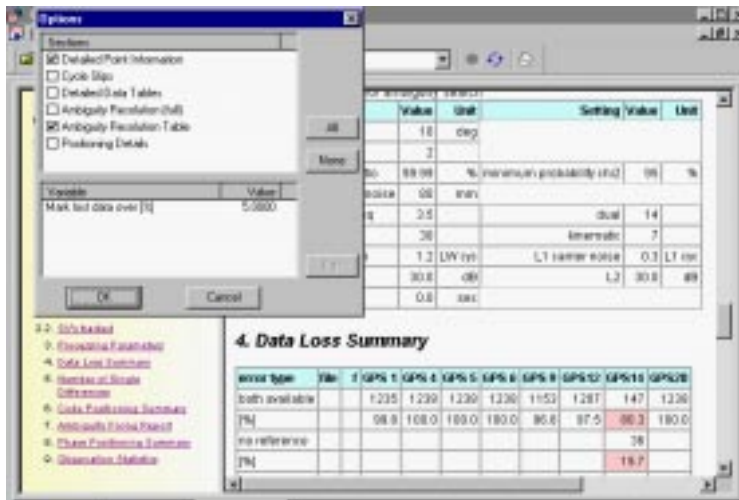


Figure 40-2: Marked Data Loss

It is very easy to edit the variables for the limits. Click on a variable to activate the button **Edit** and then press this button.

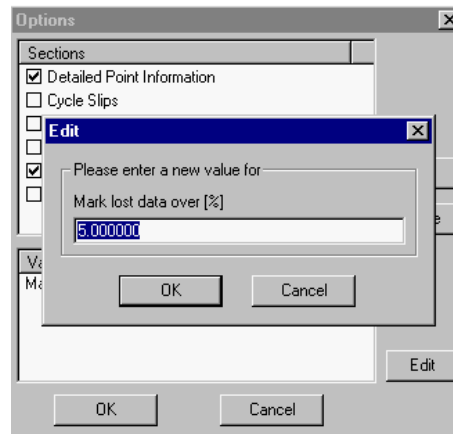


Figure 40-3: Edit the Limit Value

The dialog Edit allows you to edit the value for the chosen variable. Confirm with **OK**. Leaving the dialog with **OK** changes the values in the report corresponding to your entries. Leaving the dialog with **Cancel** will save the limit but not change the report.

40.2 Table of Contents

Many (but not all) reports have an own Table of Contents. It is given as a separate frame on the left side of the report using the headline Contents.

Use the hand-shaped cursor to click on the section you are interested in and the report will jump to the respective section.

You can switch off the display of the contents by choosing the menu option **Options/Table of Contents** or the respective button. If the option is activated, it is marked with a ✓ sign.

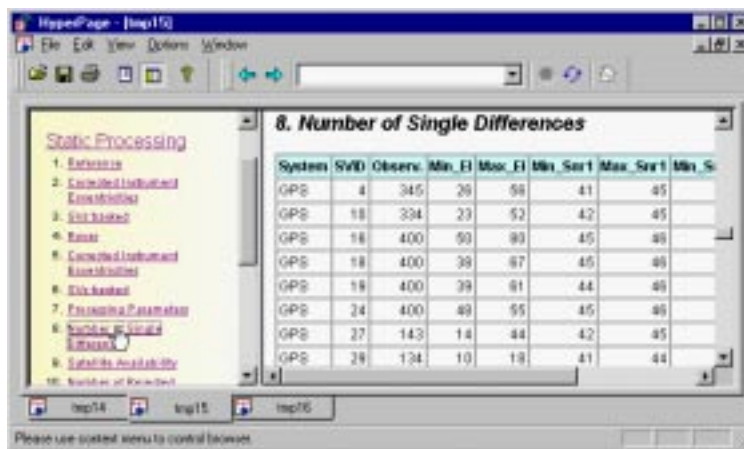


Figure 40-4: Table of Contents

40.3 Customize the Dialog

The current version of **HyperPage** offers two toolbars. One of them contains commands referring to files, while the second one is used for all Web-Browser activities. You may modify the toolbars and also create new toolbars coming up to your requirements.

Clicking the menu option **Options/Customize** to open the dialog **Customize**. The box **Toolbars** informs you of the built-in toolbars. Toolbars that are shown on the screen are shown are marked.

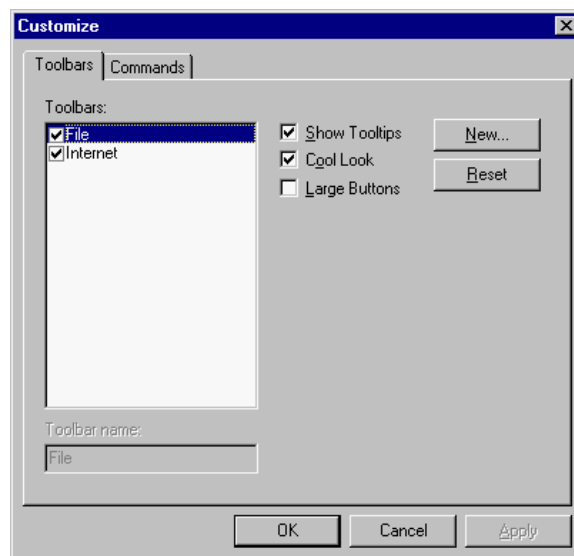


Figure 40-5: Dialog Customize

Using the page **Toolbars** you can set special layout options for all your toolbars:

Show Tooltips	gives quick information on the respective command when you move the cursor to a toolbar button.
Cool Look	display of icons instead of buttons.
Large Buttons	Enlarged view of the toolbars.

You can rearrange the icons (commands) on the toolbars, delete or add them, or even create new toolbars. Both pages of the dialog help you to do so.

The page **Toolbars** allows you to create new toolbars, delete user-defined toolbars or to reset the built-in toolbars to the default commands.

Button New:	opens the dialog New Toolbar and creates a new empty toolbar. Enter the name for the new toolbar and accept it with OK . A floating toolbar will show up. The list of the toolbars will include the new name, too. You may edit the name of the new toolbar within the edit field Name. To determine the commands for this toolbar use the page Commands.

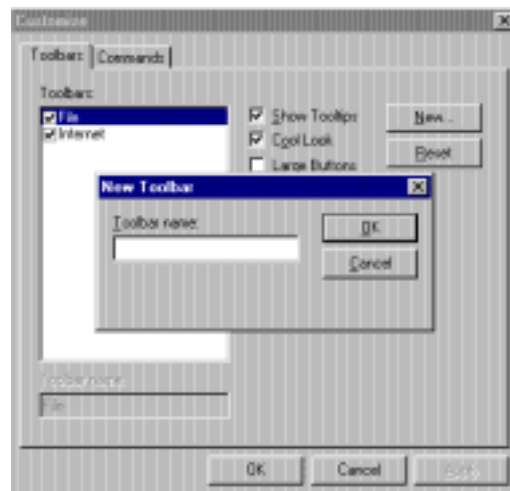


Figure 40-6: Create a new Toolbar

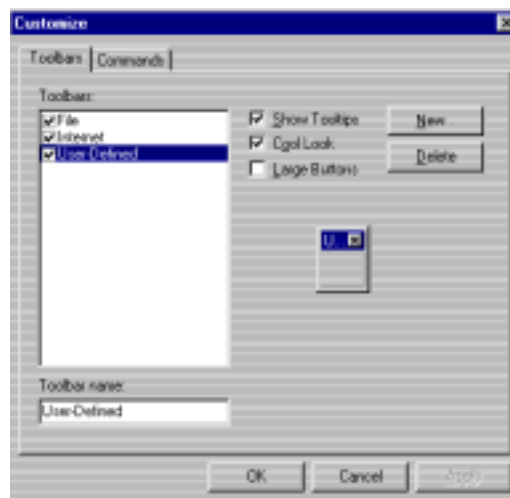


Figure 40-7: New Toolbar

- Button **Delete** You may delete a self-defined and highlighted toolbar by using this button.
- Button **Reset** this button helps you to set changes (such as rearranging, deleting or adding commands) done to the built-in toolbars back to default.

Choose the page **Commands** to edit the commands for the *visible* toolbars.

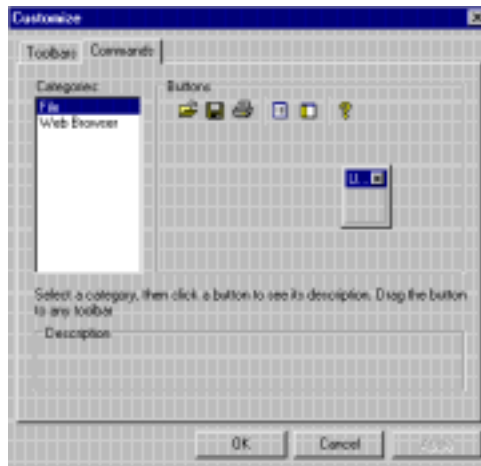


Figure 40-8: Page Commands

The block Categories offers you different kinds of command categories. The block Buttons displays the buttons offered by the activated toolbar. If you click one of the buttons displayed here, the block Description will offer a description of the respective command.

To add a button to a current toolbar, activate the category, click on the button and draw it using the cursor to the desired place within the

toolbar. The cursor will change its shape (it will be displayed as an arrow with a + sign) and the border of the button will be visible. This helps you to control the movement of the cursor at any time.

To delete a button from the toolbar, click the respective button (while the dialog Customize/Commands is active) and drag it away from the toolbar. The cursor will change its shape (it will be displayed as an arrow with a + sign) and the border of the button will be visible. This helps you to control the movement of the cursor at any time.

Use the same method for **rearranging the buttons**. Just drag the icon to the new place within the toolbar you prefer.

41. Using HyperPage as a Web-Browser

HyperPage also can be used as an Internet-Browser. It offers most of the important functions of any Internet browser.

The most important Internet functions are offered via the toolbar Internet.

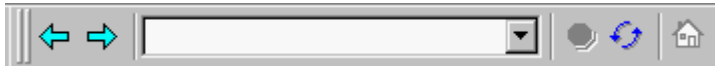


Figure 41-1: Browser Bar

Provided you already have Internet access, just enter the Internet address you want to visit into the given textbox and confirm with the Enter key of your keyboard. The arrow buttons of the browser bar allow you to switch between the two pages displayed last (e.g., for toggling the display of your report and an internet page).

Additionally you may:



Cancel the building-up of an Internet page,



Reload a page,



Visit our Home Page!

This page intentionally left blank

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Presentation of Formatted Text

HyperPage

Macro Programming Guide



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Note

We are aware of the fact that our exclusive masculine pronoun "he" is considered politically incorrect, but has been used in this case to simplify readability.

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“Terrasat produces numbers!”

Dr. Herbert Landau
Managing Director, Spectra Precision Terrasat GmbH

43. Introduction

Spectra Precision Terrasat’s main effort is to produce the best possible numbers from your Gigabytes of data! How are these numbers presented? Until recently, simple ASCII text has been generated and presented to users with help of minor sophisticated text editors. **This changed now!**

There are a lot of highly sophisticated text presentation machines on the market like WinWord or HTML browsers. Most of them are copyrighted or you cannot rely on existence of particular programs on all machines (like in case of WinWord).

Spectra Precision Terrasat’s answer to this dilemma is named **HyperPage**, a programmable text presentation machine offering:

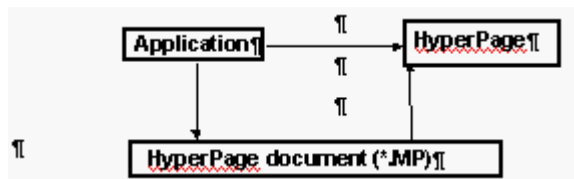
- Full control of all Windows GDI primitives.
- Advanced text-formatting features like block-text, left-right adjusted text or centered text.
- Macro programming features, allowing you to build highly-specialized macros fitting exactly to your needs.
- Distributed style information, keeping file size (relatively) small.
- C/C++/FORTRAN interfaces to major components.
- NO ROYALTIES of any kind.

- Open architecture, allowing to extent functionality by dynamically loading DLLs.
- Straight syntax of a non-tagged, but command oriented language.

43.1 How does it work?

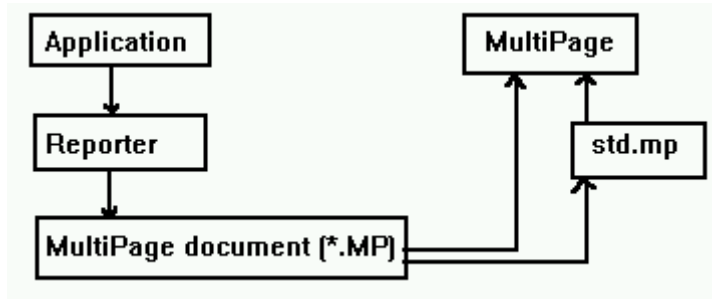
An application that needs to present information generates a **HyperPage** document. This is a file with the extension `*.MP` containing many **HyperPage** statements.

The application then starts **HyperPage** which is currently a stand-alone executable. The name of the generated document is passed to **HyperPage**, which in turn parses the statements in the document and translates them into an internal sequence of graphic primitives (GDI statements). After file parsing is finished, the document is presented (or *drawn*), allowing the user to browse, zoom and print individual pages or the complete document.



The **HyperPage** package contains a set of C/C++ functions allowing you to easily generate **HyperPage** statements. The functions are

packed into a class named `Reporter`. The statements generated by `Reporter` include a standard macro package, allowing more flexible formatting statements.



43.2 Hello World

Suppose you want to present a text to your user, looking like this:

Hello World Title

This is your first **HyperPage** documentation. Please note automatic line breaking and text adjustment.

You achieve this by generating a **HyperPage** document containing these statements:

```
include [concat $EXEDIR "m\\std.m"]
/start
/title {Hello World Title}
/font -face "Times New Roman" -size 14 -italic 1
/textadjust block
/text {This is your first HyperPage documentation. Please note
      automatic line breaking and text adjustment.
}
```

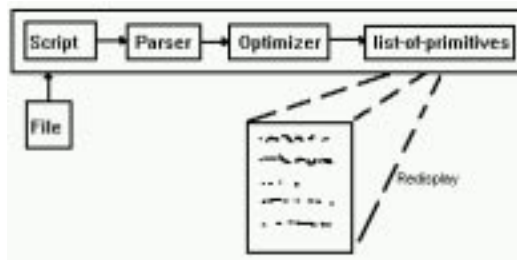
43.3 Internal Structure

How does this work internally? The statements of a script are parsed line by line and translated into an internal single-linked list of primitives. During parsing, selection of fonts or movements of the graphic pointers are simulated. This allows you to access and manipulate, e.g.,

the graphics pointers with real values during interpretation of the script.

After parsing is finished, the page pointer is set to page 1 and the list of primitives is traversed, each operation in each node of the list is *performed*. This is how the visible drawing is generated.

To make things a little bit more sophisticated, an internal optimizer is integrated. If you select the same pen twice in sequence without selecting another pen in between, the selection of the second pen is skipped. This again speeds up displaying of the pages. Currently, the optimizer works during creation of the list of primitives. The following picture will help to understand the internal structure.



As you can see, after the script was parsed, it is never used again. From then on, only the internal list of primitives is used to draw the pictures. This is the main reason for **HyperPage's** outstanding speed!

The path from the file to the list-of-primitives is done in a thread separate from the GUI thread - thus making **HyperPage** very handy (please note that under Windows 3.1 and Windows WfW threads are not supported - the system is blocked during interpretation of the scripts). It allows you to perform user interaction during file loading.

44. The HyperPage Viewer

The **HyperPage Viewer** (**MV**) allows you to visualize and print **HyperPage** documents, it provides navigation through documents and the ability to export documents to different formats. **MV** runs on Windows 3.1 with Win32s, on Windows 95 and on Windows NT 3.51 and higher.

When you start **MV** or **MV** is started by another application, a window like this appears. A document is loaded and finally presented.

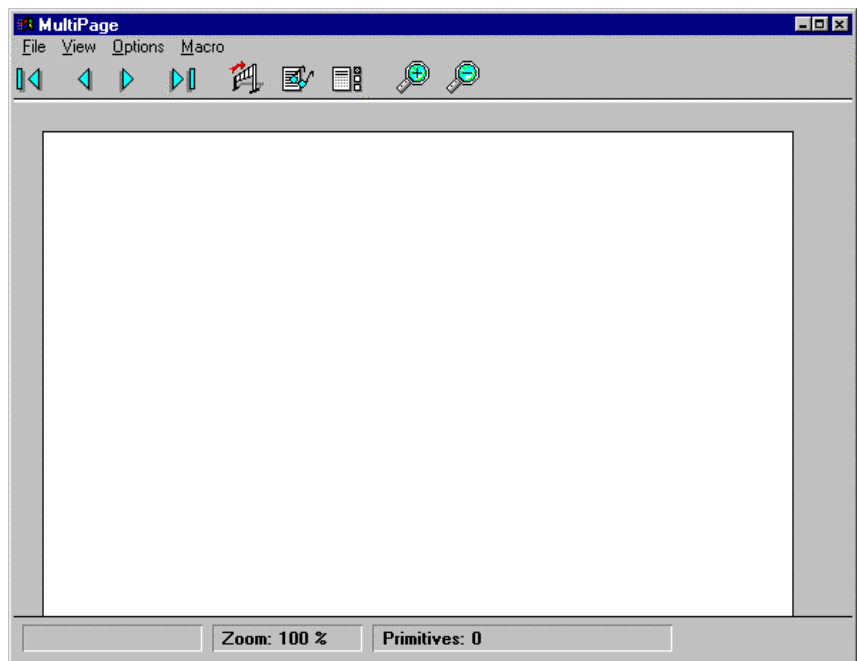


Figure 44-1: HyperPage Viewer

The **HyperPage** User's Guide offers complete information about all of **MV**'s possibilities.

45. Programming Rules

This feature is based on **TIM**, terrraSat's Tiny Interpreter for Macros. This chapter briefly describes all available functions, built-ins and macros local to **HyperPage**. For a complete **TIM** reference, please refer to **TIM Programmer's Guide**.

The first section named *Global Variables* lists all global variables used or created by **HyperPage**. Section *Colors* specifies the color system and section *Coordinates* specifies the used coordinate system. The fundamental structure of a **HyperPage** document is given in section *Document Start/End*. The section named *Atoms and Primitives* lists all available graphic atoms and functions and provides in depth descriptions of each atom. Some commands, e.g. the `font` command, are rather complex. Nevertheless, the listing is in alphabetical order, no matter how long each description might be.

45.1 Global Variables

HyperPage uses global variables. Although considering global variables as being bad programming style (because of side effects), the ease of programming some features forces globals to be existent.

To have as little conflicts as possible, **HyperPage** follows these rules:

- Built-in global variables or variables added by external DLLs or other extensions are always written in UPPERCASE letters.
- All other variables are written in small letters.
- Mixed typing is NOT used by **HyperPage** (as delivered). Users or third party vendors may use mixed typing to be sure to avoid naming conflicts.

The following table lists global variables and those globals that will be defined by built-in commands. Please see the description of the individual built-ins for a more detailed description of the globals.

The variables available are:

EXEDIR	Contains the name of the directory, in which HyperPage is located. The string returns the path <i>with trailing backslash!</i>

Example:

D:\G3\MPAG\

CX	Current graphic pointer's x-position. Used and updated by the <code>/text</code> and <code>/move...</code> commands.
CY	Current graphic pointer's y-position. Used and updated by the <code>/text</code> and <code>/move...</code> commands.
LEFT	This value is used by <code>/text...</code> commands to determine the left side of formatted text. You should use the <code>/left</code> command to modify this variable.
RIGHT	This value is used by <code>/text...</code> commands to determine the right side of formatted text. You should modify the <code>/right</code> command to modify this variable.
X1, Y1, X2, Y2	These four variables contain the actual page's physical dimensions. Please note that X1 and Y1 are always zero and that X2 and Y2 represent the device resolution minus 3mm from the right and plus 1mm from the top. This ensures, that the borders are printed on <i>all</i> devices.
PAGE	Current document's page number.
PAGENUMBER	The document's number of pages. Please note: This variable is only available after the document has been parsed two times! <i>This variable is currently not fully supported.</i>
FILE	Current document's file name.

45.2 Colors

Colors are always specified as RGB colors, where RGB stands for Red-Green-Blue. You have to specify red, green, blue with values in range from 0 to 255. E.g.,

- Light red would be specified as 255 0 0.
- Dark red as 128 0 0.
- Light gray is noted as 210 210 210.
- Black has the values 0 0 0.
- White would be specified as 255 255 255.

You can omit numbers from the right, their respective values are set to 0. There are two commands to define colors:

- **/pen** defines drawing colors for lines, outlined rectangles, circles... as well as text foreground color (this is different to the Windows GDI functionality)!
- **/brush** defines drawing colors for filled areas and for text background.

Please note that there is no distinction between pens and text colors (as there are in Windows programming).

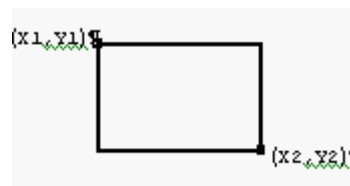
45.3 Coordinates

Coordinates are always specified as being in 1/10th of a millimeter. This measure is precise on the printer, it is roughly precise on the monitor. E.g., to draw line 1 cm from the top, 1cm to the left, 5.33 cm long, you would specify:

```
/line 100 100 533 100
```

The orientation of the coordinate system is similar to what you might be used from screen accesses:

- top/left of the screen is (0, 0) or (X1, Y1)
- bottom/right of the screen is (X2, Y2)



Typically, you have a resolution of approx. 2200-2800 for A4 paper. Please note that X1, Y1 are usually (0, 0).

A current graphics location (or pointer) is held in the variables CX and CY. During the description of the graphic primitives, you will note, that some routines work relative to CX and CY, others are working on absolute device coordinates. This means that the graphic object is placed on the device without using or changing CX and CY.

45.4 Document Start / End

Any **HyperPage** document **must** start with the `/start` directive:

```
# Top of HyperPage document
```

```
#
```

```
/start
```

This directive resets internal data structures and allocated memory, reset and cleans up resources and prepares the **TIM** interpreter for getting a new text.

Documents *may* be terminated with the `/end` directive.

```
# Bottom of HyperPage document
```

```
/end
```

45.5 Atoms and Primitives

45.5.1 Overview

HyperPage's set of graphic primitives consists of these commands:

/anno	Add an annotation or link to the file
/arc	Draw an arc
/bar	Draw a filled rectangle
/bitmap	Draw a *.BMP file
/bitmapstretch	Draw a *.BMP file and stretch to borders
/bound	Define a bounding rectangle
/brush	Set fill color for rectangles and similar
/circle	Draw a circle
/comment	Add comments to the file
/end	Define the end of a document
/ellips	Draw ellipses
/font	Define font characteristics
/left	Define left border for formatted text
/line	Draw a straight line
/moveabs	Move pointer absolute
/moverel	Move pointer relative
/movex	Move pointer relative/absolute
/page	Insert a page break

/pen	Set drawing color for lines, rectangles and other shapes
/pie	Draw a pie
/push	Push current attributes onto an internal stack
/pop	Pop current attributes from an internal stack
/rect	Draw an outlined rectangle
/right	Define right border for formatted text
/roundrect	Draw a rectangle with round corners
/section	Allow conditional display of the document
/start	Define the start of a new document.
/text	Formatted text output
/textadjust	Specify text adjustment
/textheight	Calculates height of a piece of text
/textmode	Set text drawing mode to OPAQUE (with background color) or TRANSPARENT (don't draw any background).
/textout	Unformatted text output
/textwidth	Calculates width of a piece of text
/variable	Allow conditional display of the document
/width	Define pen width

45.5.2 Integrated optimizations

Only some of **HyperPage**'s statements are optimized. These statements are:

/pen	Selection of the same pen is suppressed.
/brush	Selection of the same brush is suppressed.
/width	Selection of the same pen width is suppressed.
/textadjust	Selection of the same adjustment mode is suppressed.
/textmode	Selection of the same text background mode is suppressed.
/move...	All subsequent pointer movements are optimized to a single one. This feature only works, when the peephole optimizer is <i>on</i> .
/pop	Only those values are popped from the internal stack, which got changed values.

45.5.3 /anno - Add an annotation / link to the file.

Syntax:

`/anno text`

Synopsis:

This command adds an annotation to the current document. These annotations are managed in an internal data structure together with the page on which the annotation occurred. This allows to *jump* to the specific pages later on. The **HyperPage** viewer offers a window looking like this for this purpose:

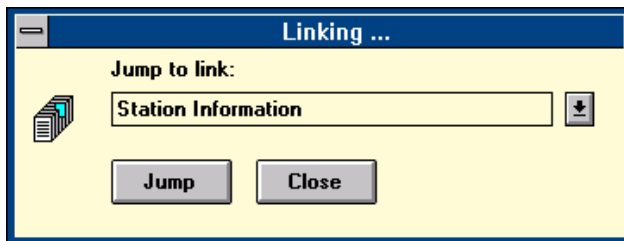


Figure 45-1: HyperPage Viewer - Linking

Returns:

Nothing.

See also:

`/comment`

45.5.4 /arc - Draw an arc

Syntax:

```
/arc nXRadial1 nYRadial1 nXRadial2 nYRadial2
```

Synopsis:

The /arc function draws an arc-shaped wedge bounded by the intersection of an ellipse and two radials.

The pie is outlined by using the current pen.

nXRadial1	x-coordinate of first radial's endpoint
nYRadial1	y- coordinate of first radial's endpoint
nXRadial2	x- coordinate of second radial's endpoint
nYRadial2	y- coordinate of second radial's endpoint

The curve of the arc is defined by an ellipse that fits the specified bounding rectangle (see /bound). The curve begins at the point where the ellipse intersects the first radial and extends counterclockwise to the point where the ellipse intersects the second radial. (A radial is a line drawn from the center of the ellipse to the specified endpoint on the ellipse.) The current position is neither used nor updated by the /pie function.

Windows 95: The sum of the coordinates of the bounding rectangle cannot exceed 32,767. The sum of nLeftRect and nRightRect or nTopRect and nBottomRect parameters cannot exceed 32,767.

See also:

```
/pie, /bound
```

45.5.5 /bar - Draw a filled rectangle

Syntax:

```
/bar x1 y1 x2 y2
```

Synopsis:

This command draws a filled rectangle using the current brush for the interior and using the current pen for the frame. The pen width used is the current pen width defined by the command `width`.

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

Example:

This sequence of macros draws a filled blue rectangle all over the current page (this is of course something you should only use if you want to waste as much printer's toner as possible). Please note the use of the global variables `$X1`, `$Y1`, `$X2` and `$Y2` to get the current device's resolution:

```
# create a lightblue brush
/brush 0 0 255

# draw the bar over the complete page
/bar $X1 $Y1 $X2 $Y1
```

See also:

```
/pen, /brush, /width
```

45.5.6 /bitmap - Load, cache and draw a *.BMP file**Syntax:**

```
/bitmap x y fname
```

Synopsis:

This command draws the device independent bitmap file specified by `fname` at the location (x,y). The upper left corner of the bitmap is drawn at (x,y). Please note that this is contrary to normal Windows GDI style.

There is a possible problem with this command: The bitmaps drawn use full device resolution and therefore appear in different sizes on the monitor and the printer! To avoid such problems the `/bitmapstretched` function was introduced.

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

See also:

```
/bitmapstretch
```

45.5.7 /bitmapstretch - Load, cache and draw a *.BMP file

Syntax:

```
/bitmapstretch x1 y1 x2 y2 fname
```

Synopsis:

This command draws the device independent bitmap file specified by `fname` at the location (x1,y1). The upper left corner of the bitmap is drawn at (x1, y1), the lower right corner is placed relatively to (x1,y1) at (x2, y2). The bitmap is stretched to this rectangle. Please note that the orientation of the rectangle is contrary to normal Windows GDI style.

The x1, y1 coordinates are in **absolute** coordinates, the x2, y2 coordinates are located **relatively** to x1, y1.

Returns:

Nothing.

See also:

```
/bitmap
```

45.5.8 /bound - Define bounding rectangle**Syntax:**

```
/bound nLeftRect nTopRect nRightRect nBottomRect
```

Synopsis:

The /bound function defines the bounding rectangle for the /arc and /pie command.

nLeftRect	x-coord. of bounding rectangle's upper-left corner
nTopRect	y-coord. of bounding rectangle's upper-left corner
nRightRect	x-coord. of bounding rectangle's lower-right corner
nBottomRect	y-coord. of bounding rectangle's lower-right corner

See also:

```
/arc, /pie
```


45.5.9 /brush - Drawing background or fill color

Syntax:

```
/brush red green blue
```

Synopsis:

This command defines the RGB color for bars, ellipses, round rectangles and text backgrounds. Internally, a Windows resource called *brush* is created and mapped onto the current output device. Use of color might become critical when you print on a device that only supports black and white colors! During development of your scripts, you should always test them on such a device!

HyperPage optimizes the use of brush selections! You can request as many of the same brushes in sequence as you like - the internal list will only keep the first relevant request!

Returns:

Nothing.

Example:

The following samples generate different brushes. Please note that the internal optimizer will remove the last request for a new brush.

```
# light red brush
/brush 255 0 0
# dark red brush
/brush 128 0 0
```

```
# light cyan brush
/brush 0 255 255
... (no new brush requests...)
# creating the same brush again
/brush 0 255 255
```

See also:

```
/pen
```

45.5.10 /circle - Draw a circle

Syntax:

```
/circle x y rad
```

Synopsis:

This command draws an outlined circle using the current pen and fills this circle using the current brush. The coordinates are in absolute coordinates.

Returns:

Nothing.

Example:

This sequence of code draws 10 concentric circles with radius ranging from 1cm to 1mm. The center of the circles is located 10 cm from left and 10 cm from top of the current page. The circles are filled with red, their borders are drawn in black.

```
# allocate black pen and red brush
/pen 0 0 0
/brush 128 0 0
# loop: 0 <= I < 10 and draw the circles
loop I 10 {
    /circle 1000 1000 [expr (10-$I)*10]
}
```

See also:

/pen, /bar, /ellips, /rect

45.5.11 /comment - Add a comment to current document**Syntax:**

```
/comment text
```

Synopsis:

This command allows you to add comments to the current document. These comments are not drawn or similar, they are just added to an exported file. This very much helps in debugging your scripts.

Returns:

Nothing.

Example

This sequence of codes adds a comment to your document. The only place where you can find it again is in an exported file.

```
/pen 0 0 0
# This type of comments (# ...) is gone in any exported
# document.

/comment "This comment is exported!"
/comment "And this as well!"
/pen 255 255 255
```

In an exported document, above sequence will look like this:

```
/pen 0 0 0
/comment "This comment is exported!"
/comment "And this as well!"
/pen 255 255 255
```

See also:

[/anno](#)

45.5.12 */ellips* - Draw an ellipse

Syntax:

```
/ellips x1 y1 x2 y2
```

Synopsis:

This command draws an outlined ellipse using the current pen. The ellipse is drawn best fit into the rectangle specified by the coordinates passed to this macro.

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

See also:

```
/pen, /rect
```

45.5.13 /end - Define end of a document**Syntax:**

`/end`

Synopsis:

Specify the end of a **HyperPage** document. This directive is optional. It frees up all resources needed to draw the current document.

Returns:

Nothing.

See also:

`/start`

45.5.14 /font - Select a font

Syntax:

`/font [params]+`

Synopsis:

This command is perhaps the most complex one in **HyperPage**. It allows to select a font and to define its characteristics.

params is one of the following:

- face fname Allows to choose a font (its *face*). You can specify any **fname** out of all the fonts available on your machine. However, only certain fonts are guaranteed to exist on any Windows installation.
These are:
 - Times New Roman
 - Courier New
 - Script
 - Arial
- size pts Allows to define the font size. To be as usual as possible, the font sizes are specified in *points* (this is 1/72 of an inch).
- precis n Allows to define the output precision. Please refer to any Windows documentation for more information, since you usually will not need this option.

-orient n	Allows to define the orientation. This doesn't mean that the text will be written within an angle. Please refer to any Windows documentation for more information, since you usually will not need this option.
-esc n	Allows to rotate the text in 1/10th of degree. Escapement may sound strange to you, but this is the Windows' way to say that you want to rotate some text.
-italic n	Allows the font to be <i>italic</i> , if n equals 1. If n equals 0 the font is straight.
-underline n	Allows the font to be underlined, if n equals 1.
-strike n	Allows the font to be ~~struck through~~ , if n equals 1.
-pitch txt	Allows the font to be fixed pitch, if txt equals fixed , or to be variable, if txt equals var .
-weight n	Define weighting of the font. A value of 400 means normal, a value of 800 means bold font.
-width n	Define a font's width.

Returns:

Nothing.

See also:

[/fontadjust](#), [/text](#), [/pen](#), [/brush](#), [/textheight](#), [/textwidth](#)

45.5.15 `/left` - Define left border for formatted text

Syntax:

`/left x`

Synopsis:

This command allows to define the left border for outputting formatted text. All text output generated with the `/text` function is fit into the borders defined by the `/left` and `/right` command. Internally, the `$LEFT` variable is set, but additionally, the call to this function is maintained in the list of primitives. This allows to export a document without relying on side-effects. You should *not* modify the `$LEFT` itself, please use this command!

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

See also:

`/right`, `/text`

45.5.16 /line - Draw a line**Syntax:**

```
/line x1 y1 x2 y2
```

Synopsis:

This command draws a line using the current pen and the current pen width defined by the command `width`.

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

See also:

```
/pen, /width
```

45.5.17 /moveabs - Move drawing pointer absolute**Syntax:**

```
/moveabs x y
```

Synopsis:

This command defines the system variables CX and CY. These coordinates are used in the `textout` function.

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

See also:

`/moverel`, `/movex`, `/text`, `/textout`

45.5.18 */moverel* - Move drawing pointer relative

Syntax:

`/moverel dx dy`

Synopsis:

This command defines the system variables CX and CY. These coordinates are used in the `text` output functions. This command moves the coordinates relative to the current location. The values `dx` and `dy` are added to the current CX and CY values.

Returns:

Nothing.

See also:

`/moverel`, `/movex`, `/text`, `/textout`

45.5.19 /movex - Move drawing pointer relative/absolute**Syntax:**

```
/movex x dy
```

Synopsis:

This command defines the system variables CX and CY. These coordinates are used in the `text` output functions. This command moves the x coordinate **absolute** on x, the y coordinate is moved **relative** by y.

The values of CX and CY are updated.

Returns:

Nothing, but CX and CY are updated.

See also:

```
/moverel, /moveabs, /text, /textout
```

45.5.20 /page - Start a new page

Syntax:

`/page`

Synopsis:

This command inserts a page break into the current text. The current settings for font, pens, brushes, text mode and pen width are inserted at the start of the next page. This makes it possible to jump around without parsing through the whole file again.

The PAGE variable is updated, CX and CY are reset to (0,0).

Returns:

Nothing.

See also:

`/start`, `/end`

45.5.21 /pen - Set drawing color**Syntax:**

```
/pen red green blue
```

Synopsis:

This command defines the RGB drawing color for all outlined objects:

- /line
- /rectangle
- /circle
- /text
- /textout
- /roundrect
- /ellips

The default black color is

```
/pen 0 0 0
```

Please note that Windows distinguishes between pens and text colors. This has been unified for ease of use, although it may run a little bit slower.

HyperPage optimizes the use of pen selections!

Returns:

Nothing.

Example:

This sequence of **HyperPage** statements draws a frame sized 10x10 mm, that appears to be three dimensional. The technique used is the same as Windows uses to achieve 3D effects: The left and top side of a frame are drawn in dark gray, the right and bottom side of the frame are drawn in white.

```
# create a dark gray pen
/pen 80 80 80
# draw left and top
/line 0 0 0 100
/line 0 0 100 0

# create white pen
/pen 255 255 255
# draw right and bottom
/line 100 0 100 100
/line 0 100 100 100
```

See also:

```
/brush
```

45.5.22 /pie - Draw a pie**Syntax:**

```
/pie nXRadial1 nYRadial1 nXRadial2 nYRadial2
```

Synopsis:

The `/pie` function draws a pie-shaped wedge bounded by the intersection of an ellipse and two radials.

The pie is outlined by using the current pen and filled using the current brush.

nXRadial1	x-coordinate of first radial's endpoint
nYRadial1	y- coordinate of first radial's endpoint
nXRadial2	x- coordinate of second radial's endpoint
nYRadial2	y- coordinate of second radial's endpoint

The curve of the pie is defined by an ellipse that fits the specified bounding rectangle (see `/bound`). The curve begins at the point where the ellipse intersects the first radial and extends counterclockwise to the point where the ellipse intersects the second radial. (A radial is a line drawn from the center of the ellipse to the specified endpoint on the ellipse.) The current position is neither used nor updated by the `/pie` function.

Windows 95: The sum of the coordinates of the bounding rectangle cannot exceed 32,767. The sum of `nLeftRect` and `nRightRect` or `nTopRect` and `nBottomRect` parameters cannot exceed 32,767.

See also:

```
/arc, /bound
```


45.5.23 /pop - Pop current settings from an internal stack

Syntax:

`/pop`

Synopsis:

Current settings are popped from an internal stack. The values popped are

- Current Pen color
- Current Brush color
- Current Pen width
- Current Font
- Current adjustment mode
- Current text background mode.

Popping these values is optimized, only those values are restored, that got changed values.

Example:

This sequence of **HyperPage** statements saves the current font, creates a new one, draws some text and then restores the old font.

```
# save old state
/push
# create new font and output something
/font -face "Times New Roman" -size 14 -italic 1
/left 100
```

```
/text "This text starts 10 mm from left, a new font is used"  
# restore old state  
/pop
```

Returns:

Nothing.

See also:

`/push`

45.5.24 `/push` - Push current settings onto an internal stack**Syntax:**

`/push`

Synopsis:

Current settings are pushed onto an internal stack. The values pushed are

- Current Pen color
- Current Brush color
- Current Pen width
- Current Font
- Current adjustment mode
- Current text background mode.

Returns:

Nothing.

See also:

[/pop](#)

45.5.25 /rect - Draw an outlined rectangle

Syntax:

[/rect x1 y1 x2 y2](#)

Synopsis:

This command draws an outlined rectangle using the current pen. The corners are sharp! To obtain rounded rectangles you might want to use `roundrect`.

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

See also:

[/brush](#) [/pen](#)

45.5.26 /right - Define right border for formatted text**Syntax:**

```
/right x
```

Synopsis:

This command allows to define the right border for outputting formatted text. All text output generated with the `/text` function is fit into the borders defined by the `/left` and `/right` commands. Internally, the `$RIGHT` variable is set, but additionally, the call to this function is maintained in the list of primitives. This allows you to export a document without relying on side-effects. You should *not* modify the variable `$RIGHT` itself, please use this command!

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

See also:

```
/left, /text
```

45.5.27 /roundrect - Draw an outlined, rounded rectangle

Syntax:

`/roundrect x1 y1 x2 y2 rad`

Synopsis:

This command draws an outlined rectangle with rounded corners. A fifth parameter to this macro allows to specify the radius of the corner circle's radius.

The coordinates are in **absolute** coordinates.

Returns:

Nothing.

See also:

`/brush`, `/pen`

45.5.28 /section - Define a conditional section

Syntax:

```
/section VAR DESC
```

Synopsis:

This command adds the variable VAR to the internal **TIM** interpreter, together with its description in DESC. The **HyperPage** viewer offers a dialog that allows to set the variables defined via VAR to 0 or 1. This in turn allows to include/exclude specific portions of the document dynamically (with help of simple `if` statements..).

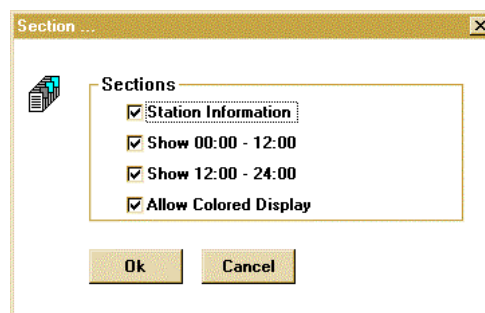


Figure 45-2: Section Dialog

Example:

These statements:

```
/section STATION "Station Information"  
/section TSPAN1 "Show 00:00 - 12:00"  
...
```

add the variables `TITLE` and `BODY` to the internal interpreter and sets them to 1. You may then do constructions like this:

```
if $STATION {  
    # display STATION statements...  
}  
...  
if $TSPAN1 {  
    # display TSPAN1 statements...  
}
```

The built-in dialog in the viewer allows to dynamically set the variables allowing to exclude parts of the document that you are not interested in.

Returns:

Nothing.

See also:

`/anno`, `/comment`, `/variable`

45.5.29 /start - Define start of a new document**Syntax:**`/start`**Synopsis:**

Specify the start of a new **HyperPage** document. Any already existing documents are killed and resources are freed, a new list of atoms is created and the internal interpreter is reset.

 **Requirement:** This statement **must** be the first statement in the document.

Returns:

Nothing.

See also:`/end`

45.5.30 /text - Formatted text output

Syntax:

`/text {...}`

Synopsis:

This might be the most often used directive in **HyperPage**. It outputs text, performing automatic line and page breaking, using the current settings on font, colors and orientation. All arguments passed to this function are concatenated and formatted to the current style defined via `/textadjust`.

The text starts at CX, CY and is fit between the values of LEFT and RIGHT! Please use the command `/left` and `/right` to define these two variables.

Returns:

Nothing.

See also:

`/brush`, `/pen`, `/left`, `/right`, `/textout`, `/textadjust`

45.5.31 /textadjust - Text adjustment**Syntax:**

`/textadjust mode`

Synopsis:

Text may be left-adjusted, right-adjusted, centered or formatted as block text. This mode is specified with this command. The limits within which to orient the text are defined in the variables LEFT and RIGHT, or respectively with the commands `/left` and `/right`.

mode is one of these:

- `left` Text will be left adjusted.
- `right` Text will be right adjusted.
- `center` Text will be centered
- `block` Text will be formatted as block text.

Returns:

Nothing.

See also:

`/brush`, `/pen`, `/text`, `/left`, `/right`

45.5.32 */textheight* - Calculate text height

Syntax:

```
/textheight text
```

Synopsis:

This directive precisely calculates the height of a piece of formatted text. Line breaks, even automatic breaks, are respected, using the current text adjustment mode and text font.

Returns:

The height of `text` in 1/10th mm.

Example:

```
set height [/textheight {Hello HyperPage User}]  
/text $height
```

See also:

```
/textwidth
```

45.5.33 /textmode - Define text background drawing**Syntax:**

`/textmode mode`

Synopsis:

Text may be drawn with background color (Windows calls this style OPAQUE) or without background color (called TRANSPARENT). **HyperPage** allows control of this with help of the `/textmode` command.

`mode` may be any set of characters to set the background mode to transparent. If it is omitted, e.g.

`/textmode`

the mode is set to OPAQUE .

Returns:

Nothing

See also:

`/textwidth`

45.5.34 */textout* - Plain text output at current position

Syntax:

`/textout {...}`

Synopsis:

This is the low level text output function used by `/text` to output text. It does not do any line or page breaking. This must be done by the user. The text is output at the coordinates specified by CX and CY.

Returns:

Nothing

See also:

`/text`

45.5.35 `/textwidth` - Calculate text width**Syntax:**

```
/textwidth text
```

Synopsis:

This directive precisely calculates the width of a piece of formatted text. Line breaks are respected, using the current text adjustment mode and text font.

Returns:

The width of `text` in 1/10th of a millimeter.

Example:

```
set width [/textwidth {Hello World}]  
/text $width
```

See also:

```
/textheight
```

45.5.36 */variable* - Define a conditional section

Syntax:

```
/variable VAR DESC VALUE
```

Synopsis:

This command adds the variable VAR to the internal **TIM** interpreter, together with its description in DESC and the default value VALUE. The **HyperPage** viewer offers a dialog that allows you to set the variables defined via VAR to any value. This in turn allows you to parameterize specific portions of the document dynamically.

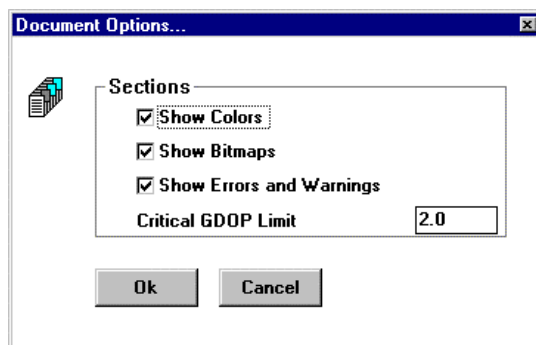


Figure 45-3: Section Dialog Including Variables

Example:

This statement:

```
/variable GDOPLIMIT "GDOP LiMit" 2.0  
...
```

adds the variable `GDOPLIMIT` to the internal interpreter and sets it to 2.0. You may then do constructions like these:

```
if $GDOP>$GDOPLIMIT {  
    # do something special  
}
```

The built-in dialog in the viewer allows you to dynamically set the variables allowing to parameterize parts of the document.

Returns:

Nothing.

See also:

`/anno`, `/comment`, `/section`

45.5.37 */width* - Define width of a pen

Syntax:

`/width w`

Synopsis:

This command sets the width of a pen. The value specifies the width in 1/10th of a millimeter.

Returns:

Nothing

See also:

`/pen`

45.6 Advanced Macros

HyperPage offers some more sophisticated macros based on above primitives. These are the macros you should use. The primitives should only be used to define higher-level macros.

45.6.1 The title package

HyperPage offers a macro to present titles on reports. It is very convenient to use this `/title` macro, because if you don't like the style - just change it, and let your documents untouched!

45.6.1.1 `/title` - Display a title

Syntax:

```
/title text
```

Synopsis:

This command draws a title consisting of the parameter text.

Returns:

Nothing

45.6.1.2 */(sub)...subtitle - Display a subtitle*

Syntax:

`/(sub)...subtitle text`

Synopsis:

This command displays a subtitle in your HyperPage document and updates the section macro. It consists of the parameter text. You may include/exclude this specific portion of document dynamically.

Returns:

Nothing

See also:

`/section`

45.6.2 The ruler package

HyperPage offers two macros to draw rulers. These rulers are very useful during development of other higher-level macros or if you want to present real-world measures on paper (Windows supports precise mapping on printers!).

45.6.2.1 */hruler - Draw a horizontal ruler*

Syntax:

```
/hruler x y length_in_cm
```

Synopsis:

This command draws a horizontal ruler.

Returns:

Nothing

See also:

```
/vruler
```

45.6.2.2 */vruler - Draw a vertical ruler*

Syntax:

`/vruler x y length_in_cm`

Synopsis:

This command draws a vertical ruler.

Returns:

Nothing

See also:

`/hruler`

45.6.3 The *tabular text package*

HyperPage offers some macros to create tabulars! Currently the macros are high-level implemented in **TIM**, so the speed is a little bit slow.

There are two ways possible to work with tables. The first way is to work line by line, the other way is to work with each individual cell. Both styles are explained during description of the respective macros.

45.6.3.1 */tabinit - Initialize a table***Syntax:**

```
/tabinit horiz vert remember
```

Synopsis:

This command initializes the tabular package.

You may suppress horizontal lines by setting `horiz` to `0`.

You may suppress vertical lines by setting `vert` to `0`.

You will remember the tab stops set and the current font and height, when you set `remember` to `1`.

Returns:

Nothing

See also:

```
/tab, /tabset
```

45.6.3.2 */tab - Set a tab stop*

Syntax:

```
/tab distance_from_left
```

Synopsis:

This command defines a tab stop.

If you e.g. specified this:

```
/tab 200
```

```
/tab 400
```

You will get a tabular with two columns, each 2 cm wide.

Returns:

Nothing

See also:

```
/tabinit, /tabheight
```

45.6.3.3 */tabheight - Set cell height*

Syntax:

```
/tabheight value
```

Synopsis:

This command defines the height of each row.

Returns:

Nothing

See also:

[/tabinit](#)

45.6.3.4 */tabmark - Mark a line*

Syntax:

[/tabmark line](#)

Synopsis:

This command marks a complete line with light gray.

Returns:

Nothing

See also:

[/tabset](#), [/tablinesX](#)

45.6.3.5 */tabmarknext - Mark next line*

Syntax:

`/tabmarknext`

Synopsis:

This command marks a complete line with light gray. The next line is marked. Page breaks are supported.

Returns:

Nothing

See also:

`/tabset`, `/tablinesX`

45.6.3.6 */tabmarknextrgb - Mark next line*

Syntax:

`/tabmarknextrgb r g b`

Synopsis:

This command marks a complete line with the color specified by the RGB values. The next line is marked. Page breaks are supported.

Returns:

Nothing

See also:

`/tabset, /tablinesX`

45.6.3.7 */tabmarknextred - Mark next line in light red*

Syntax:

`/tabmarknextred`

Synopsis:

This command marks a complete line with light red color. Use this macro to highlight critical sections of a table.

Returns:

Nothing

See also:

`/tabset, /tabmark, /tabmarknext, /tabmarknextrgb`

45.6.3.8 */tabset - Set value of a cell*

Syntax:

`/tabset line column txt`

Synopsis:

This command draws a piece of text at the correct position in the table.

Internally, the starting position, height and width of each cell is stored, so it is relatively easy to calculate the position for each individual cell.

Using this macro means, that you do NOT operate line orientated. You have to manage the current line on your own (during creation of the tabular).

Returns:

Nothing

See also:

[/pen](#)

45.6.3.9 */tabshow - Draw the tabular*

Syntax:

[/tabshow](#)

Synopsis:

This command finally draws the table. This command should be specified as the last statement when you define a table.

Returns:

Nothing

See also:

[/pen](#)

45.6.3.10 */tabline1 - /tabline10 : Set full lines*

Syntax:

```
/tablineX arg1 arg2 ... argX
```

Synopsis:

These macros allow to define a complete line of a tabular and to automatically increase an internal line counter. Using these macros has the advantage, that automatic page breaking is performed and less code is emitted.

Example:

You might want to create a 3 column tabular with automatic page break. This could be achieved with:

```
/tabinit 1 1 0  
/tab 200  
/tab 400  
/tab 2000  
/tabmark 0  
/tabline3 "Hour" "Minute" "Description"  
/tabline3 "00" "00" "Midnight"  
/tabline3 "00" "10" "10 Min past Midnight"
```

```
/tabline3 "00" "20" "20 Min past Midnight"  
/tabshow
```

Returns:

Nothing

See also:

[/pen](#)

45.6.4 The *tabbed* package

HyperPage offers some macros to create tabbed text! Tabbed text looks like this:

```
Left Side.....      : Right Side  
Another Left Side..... : Another Right Side
```

Two macros are used to generate this layout, an initialization function and a set function.

45.6.4.1 */tabbedSet - Set distances***Syntax:**

```
/tabbedSet linedistance width
```

Synopsis:

This macro allows to specify the width of the tabbed text (this is where the ‘:’ should appear) and the distance between each line.

Returns:

Nothing

See also:

```
/tabbed, /tabbedsmall
```

45.6.4.2 */tabbed - Output tabbed text***Syntax:**

```
/tabbed left_side right_side
```

```
/tabbed . .
```

Synopsis:

This macro allows to output tabbed text. Currently, no automatic page break is performed. The second version of the macro adds 1/2 of the tabular height to the current output, adding a 1/2, empty line to the current output.

Returns:

Nothing

See also:

[/tabbedSet](#), [/tabbedsmall](#)

45.6.4.3 */tabbedsmall - Output small tabbed text*

Syntax:

[/tabbedsmall left_side right_side](#)

Synopsis:

This macro allows to finally output tabbed text. Currently, no automatic page break is performed. This macro uses a tiny font for the right side. This allows to have more text visible! **Nevertheless, support for line breaks has to be added!**

Returns:

Nothing

See also:

[/tabbed](#), [/tabbedSet](#)

45.6.5 The header package

This very useful package, including all its macros, allows creating and designing a summary header for each individual report or any other **HyperPage** document.

45.6.5.1 */header_info_start* – initializes header borders

Syntax:

```
/header_info_start height width tabbed_width
```

Synopsis:

This command defines header borders and draws the rectangle with a shadow box. Because there are already default values for `width` (1700) and `tabbed_width` (700), you don't have to define these parameters, except you prefer different header borders.

Returns:

Nothing

45.6.5.2 */header_info_title – displays a title in header*

Syntax:

```
/header_info_title text
```

Synopsis:

This command displays a title consisting of the parameter `text`.

Returns:

Nothing

45.6.5.3 */header_info_sub – displays a subtitle in header*

Syntax:

```
/header_info_sub text
```

Synopsis:

This command displays a subtitle consisting of the parameter `text`.

Returns:

Nothing

45.6.5.4 */header_info_set – displays tabbed text in header*

Syntax:

`/header_info_set option value`

Synopsis:

This command allows you to output tabbed text in the header rectangle.

Returns:

Nothing

See also:

`/tabbed`

45.6.5.5 */header_info_text – displays text in header rectangle*

Syntax:

```
/header_info_text text
```

Synopsis:

This command displays text consisting of the parameter `text`.

Returns:

Nothing

45.6.5.6 */header_info_end – responsible for correct display of further document data*

Syntax:

```
/header_info_end
```

Synopsis:

This command is responsible for the correct display of further information after ending the header package.

Returns:

Nothing

45.6.6 The string package

The **HyperPage** macros in this package modify and check strings or file names.

45.6.6.1 */timfilename – replaces every single backslash by a double backslash*

Syntax:

```
/timfilename text
```

Synopsis:

This command replaces every single backslash that occurs in the parameter `text` by a double backslash.

Returns:

Nothing

45.6.6.2 */timprojectname – returns the project name without full path*

Syntax:

```
/timprojectname text
```

Synopsis:

This command returns the project name with the extension *.GGS but not including the path.

Returns:

Nothing

45.6.6.3 */stringisempty – checks a string whether there are any space characters or not*

Syntax:

```
/stringisempty text default
```

Synopsis:

This command checks a string and finds out, whether it is empty or consists of space characters only. In this case a default value is returned, unless the parameter `default` has been given a value.

Returns:

Nothing

45.6.7 Others

Here are some useful macros listed.

45.6.7.1 ***/optpage – allows page breaking without reinitializing pageframe***

Syntax:

`/optpage space`

Synopsis:

This command allows page breaking, when there is only less then a certain space left. The parameter `space` has been given a default value (200), which you can change.

Returns:

Nothing

45.6.7.2 */box_shadow – draws shadow over any kind of rectangle*

Syntax:

```
/box_shadow x1 y1 x2 y2 width
```

Synopsis:

This command draws a shadow over any kind of rectangle. The parameters (x1, y1) define the upper left corner and the parameters (x2, y2) define the lower right corner of the given rectangle. There is a default value given for width, which you can change.

Returns:

Nothing

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GeoGenius
GeoTrans
User's Manual



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cdxxxv

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Note

We are aware of the fact that our exclusive masculine pronoun "he" is considered politically incorrect, but has been used in this case to simplify readability.

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46. Introduction

46.1 About GeoTrans

PointList2

Point	H	E	N	Zone	OrthoH	GeodH	Sea Level	ScaleF	Case
1	5731493.842	478836.166	58.818	4	51.799	-1.082	-14.221	5.885	00° 14' 55.79404"
2	5730271.642	478153.173	54.286	4	55.384	-1.050	-14.757	5.331	00° 14' 11.38630"
3	5731756.572	478818.056	85.941	4	51.853	-1.112	-14.115	5.888	00° 12' 45.44587"
4	5731494.787	488295.224	58.076	4	51.134	-1.118	-14.138	4.885	00° 12' 25.43314"
5	5730732.256	477873.160	54.336	4	55.999	-1.063	-14.898	6.448	00° 15' 37.19573"
6	5732216.777	478466.024	89.047	4	50.154	-1.167	-13.574	5.126	00° 12' 58.96832"
7	5733631.812	488270.287	88.545	4	89.670	-1.125	-13.896	4.778	00° 12' 27.44853"
8	5733638.560	488713.874	52.331	4	54.864	-1.133	-8.387	4.583	00° 12' 09.84012"

Deutschland, Beztel Zone 4 | Projection: Deutschland, Beztel Zone 4, Ellipsoid: BESEL, Datum: DEUTSCHLAND_WEST, Geoid: WGS84 (IGDA/IGLUFA)

PointList1

Point	Lat	Lon	H	OrthoH	GeodH	Sea Level	ScaleF	Case
1	N 51° 43' 01.19334"	E 11° 40' 52.69649"	135.760	135.760	0.000	N/A	N/A	00° 00' 00.00000"
2	N 51° 42' 22.06226"	E 11° 41' 45.23511"	135.452	135.452	0.000	N/A	N/A	00° 00' 00.00000"
3	N 51° 43' 08.99498"	E 11° 42' 23.23880"	135.072	135.072	0.000	N/A	N/A	00° 00' 00.00000"
4	N 51° 43' 02.25111"	E 11° 42' 43.51462"	135.212	135.212	0.000	N/A	N/A	00° 00' 00.00000"
5	N 51° 42' 37.47419"	E 11° 40' 00.88365"	140.096	140.096	0.000	N/A	N/A	00° 00' 00.00000"
6	N 51° 43' 25.83905"	E 11° 42' 04.88161"	134.168	134.168	0.000	N/A	N/A	00° 00' 00.00000"
7	N 51° 44' 13.68902"	E 11° 42' 46.40612"	133.631	133.631	0.000	N/A	N/A	00° 00' 00.00000"
8	N 51° 44' 12.00242"	E 11° 42' 09.84047"	98.017	98.017	0.000	N/A	N/A	00° 00' 00.00000"

WGS84 | Ellipsoid: WGS_84, Datum: WGS_84, Geoid: None

Save to file: T:\Projects\GeoTrans\current\TS.gpr: successful | Current | PointList3 | SOFT | INFO | DATA | NJM

Figure 1-1: GeoTrans – The Transformation Tool

GeoTrans as a powerful MS Windows based stand-alone tool transforms point coordinates from one coordinate system to another in a very fast and simple-to-use manner.

You may import and export point coordinates of various formats very easily.

You can choose from comprehensive lists of datums, ellipsoids, projections, geoid models, and various transformation methods, which cover most of your applications. Additionally, you may customize **GeoTrans** individually by creating your own components of the above types.

This manual guides you step-by-step through **GeoTrans**. You should be familiar with the MS Windows environment and know how to use its fundamental capabilities.

46.2 How to Work with GeoTrans ?

Projects and Point Lists

GeoTrans uses projects to organize your work.

A **Project** consists of one or several point lists. A **Point List** is a list of points, all of which are described via coordinates in the same, predefined **geodetic System**. All coordinates of one point list are given in the same coordinate system and with the same unit. While you may change between the different coordinate systems and unit systems without leaving a point list (which allows you to bring point lists into line with each other), the geodetic System is fixed for each point list.

You will find further information on Projects and Point Lists in chapters 47 and 49.

How is a System defined?

We use the term “System” in order to describe a point on the real-world Earth as a point on the Earth model or on a map. Several steps are necessary, since the Earth has not a uniform shape. The **ellipsoid** as a simple mathematical form roughly models the size and shape of the Earth. The **datum** orientates the ellipsoid relative to a fixed frame. Typically, a datum will fit a specific country very well, but perhaps not the adjacent country. Datum, therefore, usually means a national datum system. The **geoid** describes an equipotential surface of the Earth’s gravity potential at sea-level.

These above values describe a point in space. For many purposes this may be enough. But if you want to draw a point on a map, you have to define how the point is to be projected onto a flat surface. (The flat surface may be a plane, or the surface of a cylinder or cone, which then can be unwound mathematically.) The **map projection** is a pure mathematical process. Since no projection can depict the Earth’s surface without distortion, you may use completely different projections and projection types, depending on your task or the location on Earth of the respective points.

A geodetic System, therefore, consists of the components:

- datum
- ellipsoid
- projection (optional)
- geoid (optional)

You will find further information on Systems in chapter 48.

Which types of transformation are possible?

You may perform coordinate conversions to and from within a System very easily by just a mouse-click. Coordinate transformations to another System are quite as easily done with the Transformation Window. These result in new point lists. Generally a seven parameter similarity transformation will be offered, but others are implemented and you may add your own transformation types and methods.

You will find more information on Transformations in chapter 50.

Adding transformation parameters - transformation adjustment

GeoTrans offers a least-squares adjustment module, which estimates the best fitting transformation parameters for point list transformation, and in the same step transforms current point coordinates into the control System. The resulting transformation parameters can be stored for later usage with other point lists.

You will find more information on Transformation Adjustments in chapter 51.

Extending and Customizing GeoTrans

You may customize **GeoTrans** in various ways.

How to	see chapter(s)
<i>define a System</i>	48.1
<i>define a projection</i>	48.2.2
<i>define an ellipsoid</i>	48.3.2
<i>define a datum</i>	48.4.2
<i>create and add a converter</i>	52.1
<i>create and add a special transformation</i>	52.2
<i>create and add a transformation type</i>	52.3
<i>add a geoid model</i>	52.4
<i>modify units</i>	49.11
<i>modify window display</i>	47.2, 49.11

47. Project Handling

When you start **GeoTrans** you will find a blank window, allowing you to start a Project and change parameters and options. Before you can work with points, you have to create (or open) a Project. The Project is the “container” of point lists and related workspace settings. Projects can be saved and then restored in a later **GeoTrans** session.



Figure 47-1: Start GeoTrans Window

A status bar covers the bottom of the window, displaying (from the left to the right):

- the latest process message,
- the chosen Project,
- the current Point list,
- the software protection mode
- insert mode active (INS)?
- capitals locked (CAP)?
- numbers locked (NUM)?

47.1 Start a Project

To start a **GeoTrans** session you can define a new Project or open an existing one. Each Project is saved in a file with a *.GTP extension.

To open an existing Project, choose **Project/Open...** A File Dialog Window opens allowing you to search for a project file and then to load it. If you want to open a new Project, while another one is already opened, **GeoTrans** will ask you, if you want to save or save not the opened Project before closing it.

To create a new Project, choose **Project/New**. A window pops up allowing you to name the new Project. Note, that this name needs not necessarily be the same as the file name and may consist of up to 256 characters, including spaces. This allows you to be much more descriptive than in the classical DOS file naming convention.



Figure 47-2: Project Name

You may now go on and create point lists or import point coordinate lists from data files. Within a Project, the points with their coordinates are organized in lists, called Point Lists. Each point list has its own sub-window and a unique name within the Project. All point coordinates within one point list do belong to the same geodetic System (for the description of Systems refer to chapter 48).

47.2 Arrange Point Lists on the Window

Working with several point lists may crowd the window. Choose menu Windows to arrange lists or minimized icons on the screen. You may arrange lists as tile or cascade. Windows/Arrange Icons sorts the list icons at the bottom of the **GeoTrans** main area.

47.3 View Project Information

You may want to know more about your Project than is presently visible on the screen. Project/Info opens the Project Info window.



Figure 47-3: Project Information

You may not edit the Project information topics (Project name, path and file, number of point lists), but may, e.g., copy the information

into the Windows buffer (**Ctrl+C**). Point list information is as well available, see chapter 49.6.

47.4 Save a Project



Please note that a newly created Project is not saved yet!
(Perhaps you do not want to save anything!).

Choose Project/Save or Project/Save As... to save your new Project in a file. Please note that the file name does not necessarily need to be the same as the Project name. They may differ completely! If your Project was saved once, you may save changes using Proj - ect/Save or save it under a new name using Project/Save As...

You may close a Project without leaving **GeoTrans**. Just choose Proj - ect/Close. If any changes were made in the Project (e.g., a point was edited in one of the Project's point lists), **GeoTrans** will ask you, whether you want to save changes to the Project before it is closed or whether you want to cancel the closing process.

47.5 Recently Used Projects

GeoTrans lists the four last used projects at the bottom of the **Project** menu. To quickly open one of the last projects choose its name. If no Project was opened so far, no Project name shows up.

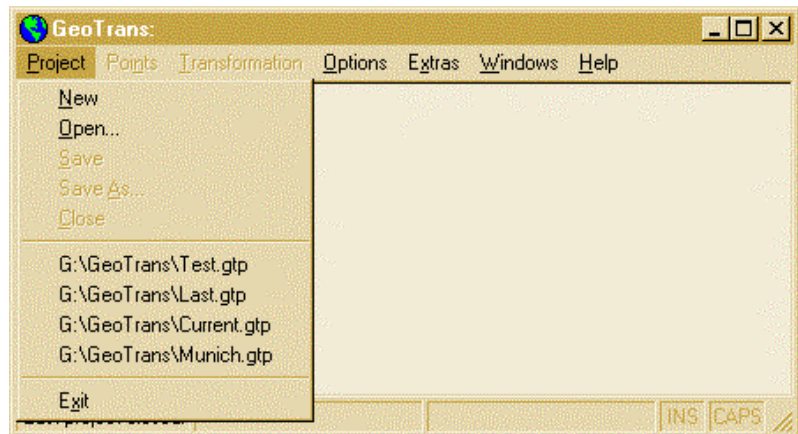


Figure 47-4: Project Menu

47.6 Exit GeoTrans

Project/Exit leaves the current Project and **GeoTrans**, safely closing the currently open project (see also chapter 53).

48. The System

GeoTrans uses the System in order to describe a point on the real world Earth as a point on the Earth model or on a map. A System consists of several components:

The ellipsoid	roughly models the size and shape of the Earth.
The datum	orientates the ellipsoid relative to a fixed frame.
The geoid	describes an equipotential surface of the Earth's gravity potential at sea-level.
The map projection	defines how a point is to be projected onto a flat surface.

The latter two components are optional, because **GeoTrans** does not need them for point description.

A System might also be a pure local coordinate system instead of a global projection system. These Systems are purely local in the sense that no geocentric reference is given. You can freely define origin, scale and orientation of a local coordinate system.

GeoTrans clearly distinguishes transformations between Systems from transformations within a System. The latter are also called "Conversions". The following graph will explain the normal transformation path. Using special transformations will allow any paths for coordinate transformation within a System and you can connect two Systems in every possible way.

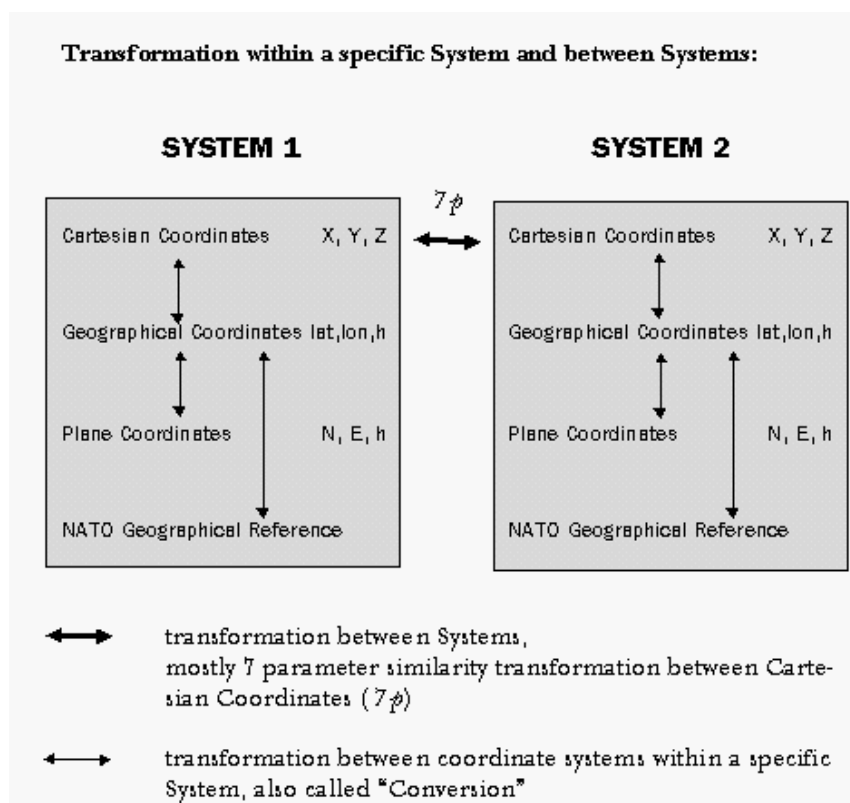


Figure 48-1: Transformation within a specific System and between Systems

GeoTrans arranges points in point lists belonging to a single System. This corresponds, e.g., to a map, where all points are given in one System only. When you want to create a new list or to import point data into a list, **GeoTrans** will first ask for the System to be used. You can use an already defined System or define a new System any time.

When transforming points from one System to another, **GeoTrans** searches for fitting Systems and transformations and offers only those for selection. Fitting Systems are Systems which can be linked to the present System by an available transformation. Therefore, it may happen, that you do not find certain Systems in the list of the Transformation System box.

GeoTrans offers projections (some have a zone system), ellipsoids and datums for building your own System. You can also add your own objects or change values for existing components. (See sections 48.2 to 48.4 and 52.2, 52.3).

48.1 Defining a System

The System Editor dialog window allows the (re-)definition of any System. From the main menu, choose **Extras/System** to open the System Editor. Additionally, you may open the System Editor at any time, when you should choose a System (e.g., when importing points or when transforming to another System). This way, you do not have to change menus to define Systems.



Figure 48-2: System Editor

The System Editor consists of three main parts:

The upper part of the dialog box displays the **name of the System**. A combo box displays Systems in alphabetical order and allows you to choose from the complete list of Systems.



If you want to define a new System with a new name, **first** click on the **New** button at the bottom of the System Editor window. You then may enter and accept the new name, which will appear in the list immediately.



*If you want to derive a System from an already existing one, first select the source System, then click **New** and assign a name. The settings of the source System will be copied into the new one. You now may modify these settings as desired.*

The **System Type group** covers the main part of the System Editor box. It allows you to choose the System components. Generally, you may choose, whether your System includes a projection, whether an ellipsoid with datum is sufficient for your purposes, or whether you want to use a special System (e.g., purely local coordinates). The following subsections describe each option in detail.

Four **buttons** are arranged at the bottom of the System Editor window.

- S**ave save the System components under the name displayed in the Name combo box,
- N**ew define a new System using a new name,
- D**elete delete a System from the list,
- C**lose close the System Editor. Changes will only be saved, if you have made use of the **S**ave button before!

48.1.1 Systems Using a Projection

Systems using a projection are defined by the projection (sometimes with a zone system), the corresponding ellipsoid and datum, and - not obligatory - a geoid model.

If a System uses a projection, the button **P**rojection is marked. If you want to define a new System with projection, make sure, that this button is selected.

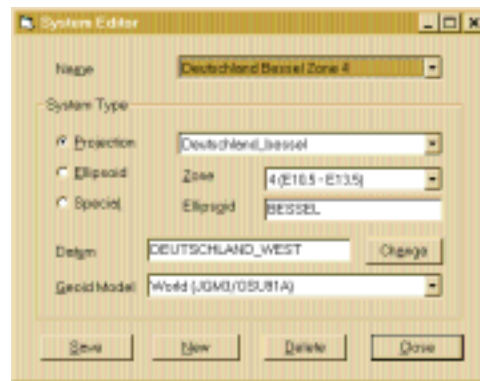


Figure 48-3: System Editor: Projection

The options Ellipsoid and Special are then turned off.

To define a new System using a projection you may first click on the **New** button and enter the new System name.

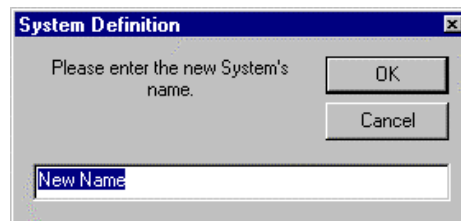


Figure 48-4: System Definition Dialog

Then choose a projection out of a list offered by the combo box next the word **P**rojection. To change the projection of a System, just choose the desired projection. If the desired projection is not included, leave the System Editor and define a projection with help of the menu option **E**xtras/**P**rojections (see section 48.2).

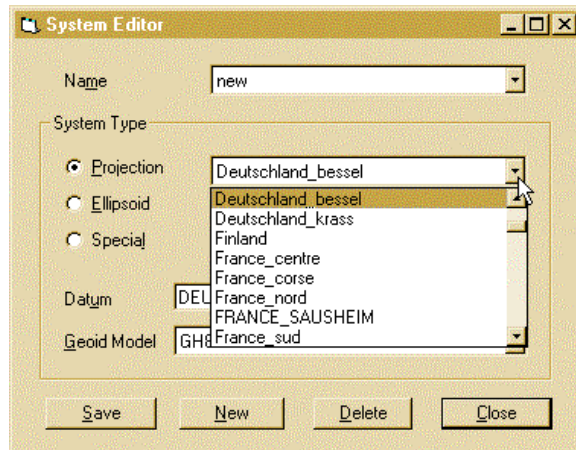


Figure 48-5: Projection Selection

When you accept a projection the zone definition as well as the ellipsoid will change according to the chosen projection. If you are defining a new System, the corresponding datum will also show up. If you are editing an existing System, the datum will not be changed and you will have to change it manually. This gives you the choice to use the same datum with a different projection.

If you decide to change the **datum**, you may select it from a list offered by a combo box. Click **Change** to open the list. If the desired datum is not included, please leave the System Editor and define a datum with help of the menu option **Extras/Datums** (see section 48.4).

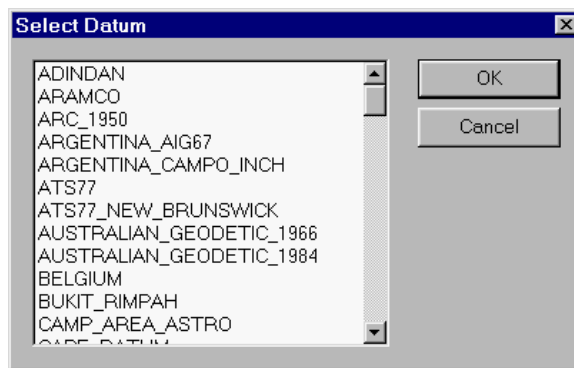


Figure 48-6: Datum Selection

If the chosen projection uses a **zone** system, you have to choose the zone for the System. **GeoTrans** may suggest a zone or leave the string field empty. You must enter a zone here or **GeoTrans** will not accept the System.

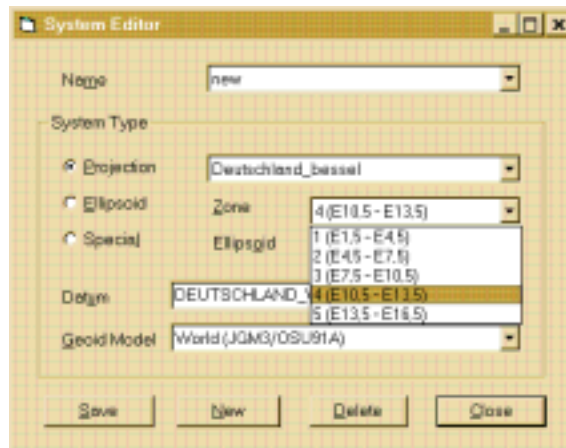


Figure 48-7: Zone Selection

GeoTrans also expects a **geoid model** entry. You may choose one from the list given by the combo box **Geoid Model**. If you do not want to apply a geoid model, choose the entry **None**. You may also add geoid models to the list. For more information please refer to chapter 52.4.

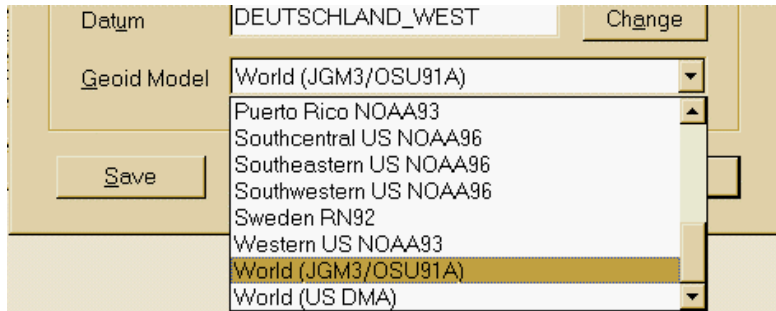


Figure 48-8: Geoid Model Selection

Do not forget to save Systems!



A newly defined System will immediately show up in the Name list, but will not be stored until you have clicked the **Save** button. **Close** leaves the System Editor without storing changes!

48.1.2 Systems Based on Ellipsoid and Datum

If you want to define a System based on ellipsoid and datum only, click the **New** button, enter a name and then check the button named **Ellipsoid**.

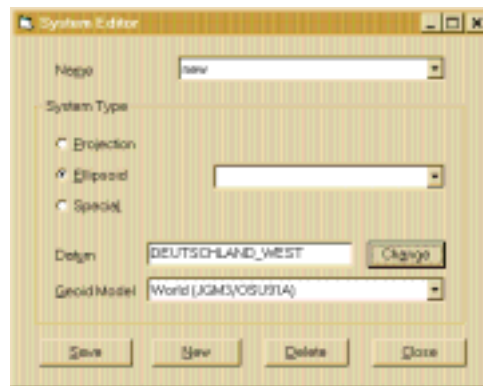


Figure 48-9: System Editor: Ellipsoid

No projection or zone information will be available. You may choose the ellipsoid directly. The combo box offers the complete list of ellipsoids.

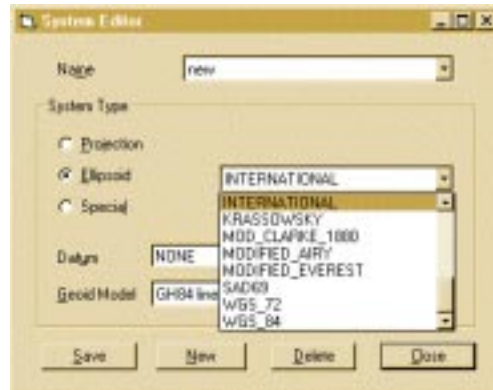


Figure 48-10: System Editor: Ellipsoid Selection



Do not forget to change the datum, too, if necessary!

If you want to add an ellipsoid or change the values of an existing ellipsoid, or just to check its values, choose the menu option **Extras/Ellipsoids** (see section 48.3).

If you are changing an existing System and decide to change the **datum**, you may select it from a list offered by the combo box **Datum**. Click **Change** to open the list. If the desired datum is not included, leave the System Editor and define a datum with help of the menu option **Extras/Datums** (see section 48.4).

GeoTrans also expects a **geoid model** entry. You may choose one of the list given by the combo box **Geoid Model**. If you do not want to apply a geoid model, choose the entry **None**. You may also add geoid models to the list. For more information please refer to chapter 52.4, *Adding Geoid Models*.

Do not forget to save Systems!



A newly defined System will immediately show up in the Name list, but will not be stored until you save it. **C**lose leaves the System Editor without storing changes!

48.1.3 Local Plane Coordinates

You may want to work with points using a local coordinate system (e.g., field coordinates). These systems are purely local in the sense that no geocentric reference is given. The origin, scale and orientation of the local coordinate system can be completely user-defined.

If you want to define a System based on local coordinates, choose Extras/System, click the **New** button, enter a name and then click the radio button named Special.

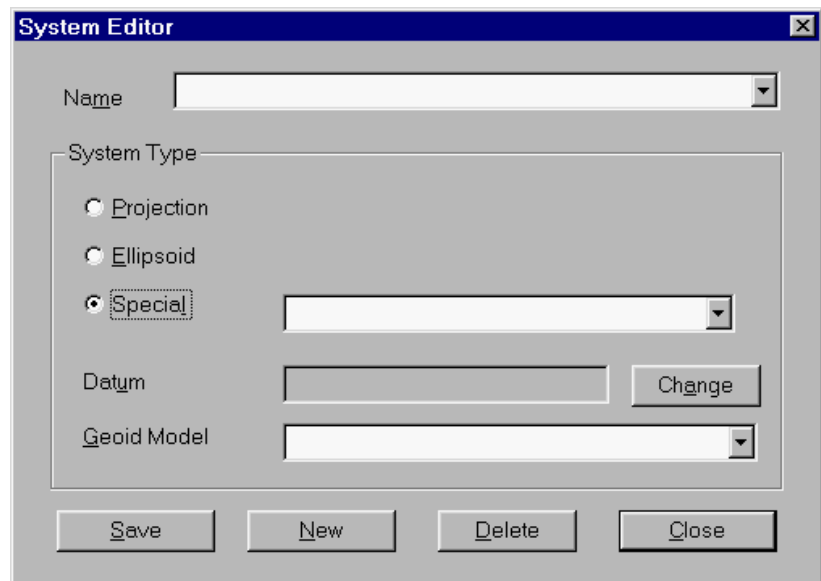


Figure 48-11: System Editor: Special

No projection or zone information will be available. Choose the entry Local Plane Coordinates. The Datum string field will display the entry None.

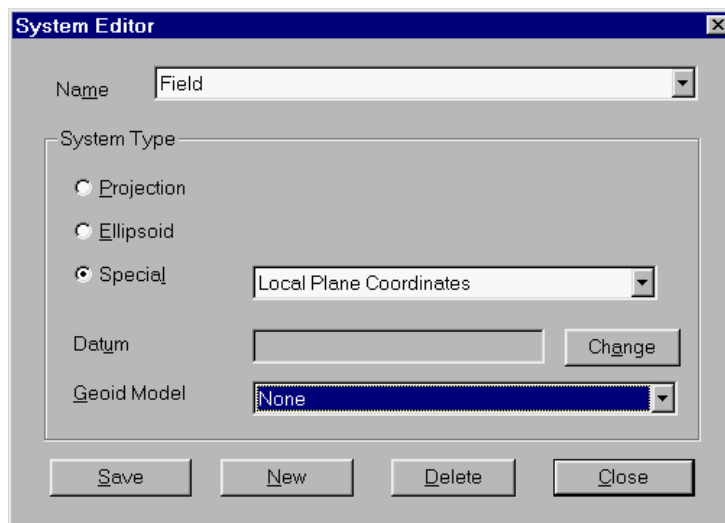


Figure 48-12: Local Coordinates

Do not forget to save Systems!

A newly defined System will immediately show up in the Name list, but will not be stored until you have clicked the **Save** button. **Close** leaves the System Editor without storing changes!

Points given in local plane coordinates cannot be directly transformed into another System. A transformation adjustment has to be started to find the transformation, which transfers from the local plane coordinates to the other System. The adjustment calculates a 4 parameter (translation, rotation, scale factor) transformation or a 4 parameter transformation and height shift. For information on adjustments please refer to chapters 51.7 and 51.8.

48.1.4 Special Transformations

Special transformations add to the functionality of **GeoTrans**. They allow you to transform coordinates with projections other than the standard projection.

By default, **GeoTrans** offers one special transformation. Its name **Local Plane Coordinates** indicates, that coordinates are given without geodetic reference and cannot be transformed internally to another coordinate system (see also section 48.1.3).

The following chart depicts the Local Plane Coordinates System and its possible transformations:

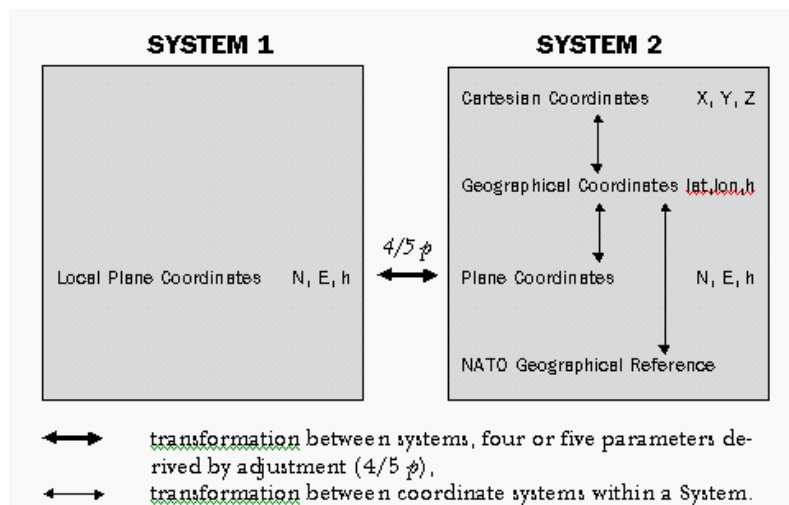


Figure 48-13: Local Plane Coordinate System Transformation

You may create your own special transformation within a System (conversion) (see section 52.2). The following might be a possible example for another special transformation:

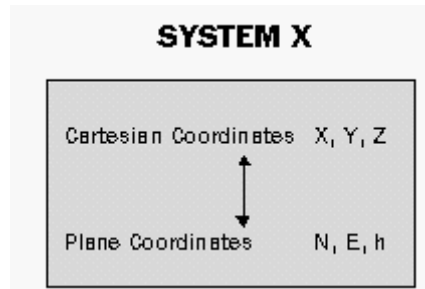


Figure 48-14: Special Transformation Example

If you want to define a System based on your special transformation, choose **Extras/System**, click the **New** button, enter a name and then check the radio button **Special**. Choose the special transformation. The **Datum** string field will display the entry **None**.

GeoTrans expects a **geoid model** entry. You may choose one of the list given by the combo box **Geoid Model**. If you do not want to apply a geoid model, choose the entry **None**. You may also add geoid models to the list. For more information please refer to chapter 52.4, *Adding Geoid Models*.



A newly defined System will immediately show up in the **Name** list, but will not be stored until you have saved it with the **Save** button. **Close** leaves the System Editor without storing changes!

48.1.5 Delete a System

To delete a System choose the menu option Extras/Systems. The System Editor shows up. Open the Name list and choose the System to be deleted. Then click the Delete button. **GeoTrans** will ask, whether you really want to delete the System. Accept with OK to delete or Cancel to cancel.

48.2 Projections

48.2.1 Definition

Projection means the projection of ellipsoidal coordinates based on the local ellipsoid to a flat surface. Many national grid and all U.S. state plane coordinate systems are implemented in **GeoTrans** (see Appendix 54.3), and you can install others.

48.2.2 Viewing and Editing Projections

To control the implemented projections and their values choose the menu option Extras/Projections. The Projection Editor will show up, a notebook displaying up to four pages:

- General name, ellipsoid, datum and type, control functions
- Parameters depending on type
- Boundaries limits the area of definition
- Zone System optional, only if projection offers a zone system.



Figure 48-15: Projection Editor

To review the settings for a specific projection, choose its name from the **N**ame combo box on page **G**eneral. You may change any value of an existing projection or create completely new projections.

To create a new projection, first click the **N**ew button, then choose the projection type, ellipsoid and (optional) datum to be used. **GeoTrans** now offers the corresponding parameters for definition.

To delete an existing projection, click the **D**ele~~t~~e button offered on page **G**eneral.



Unless you have clicked the **S**ave button displayed on page **G**eneral, no change will be stored! A newly defined projection will immediately show up in the **N**ame list, but will not be stored until you have clicked the **S**ave button. **C**lose leaves the Projection Editor without storing changes!

48.2.2.1 Defining a New Projection

To define a new projection, first open page General of the Projection Editor.

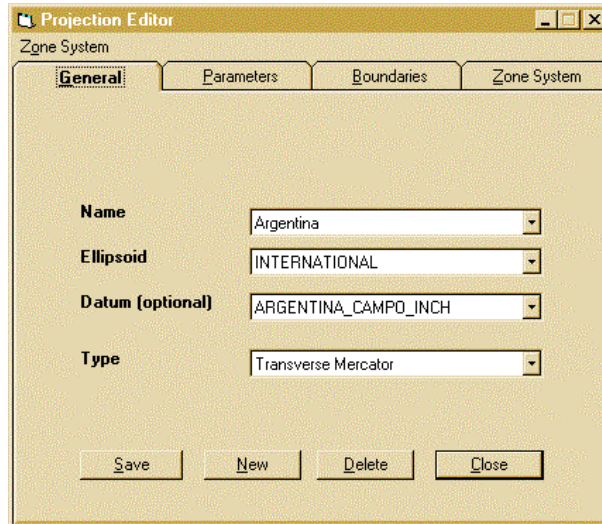


Figure 48-16: Projection Editor

General

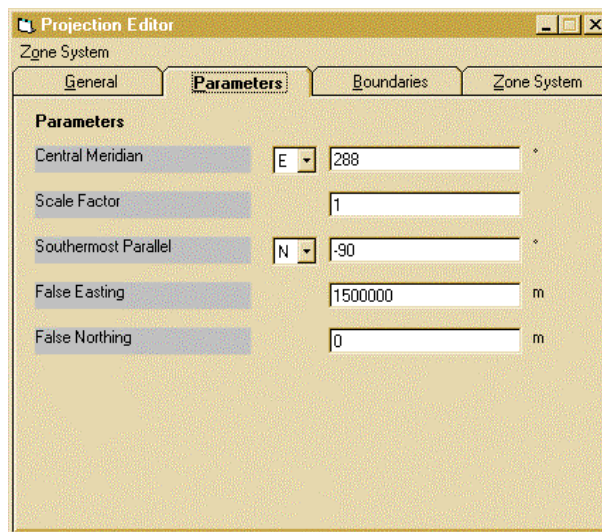
Click the **New** button and a dialog box will allow you to enter the name for the new projection (with a maximum of 30 characters). Now choose the projection type, ellipsoid and (optional) datum to be used. **GeoTrans** will now offer the corresponding parameters for definition in page Parameters.

Parameters

GeoTrans offers a lot of different projection types. Some of them are special types, that can not be modified (e.g., Lambert Belgium). Others are very often used and their parameters can be adjusted to the purpose. The five most often used projection types will be described in the following 5 pages:

- Transverse Mercator
- Oblique Mercator
- Lambert secant
- Lambert tangential
- Stereographic double

⇒ With a “**Transverse Mercator**” projection the following screen will be displayed, allowing you to enter the required parameters:



The screenshot shows the 'Projection Editor' dialog box with the 'Parameters' tab selected. The dialog has four tabs: 'General', 'Parameters', 'Boundaries', and 'Zone System'. The 'Parameters' tab contains the following fields:

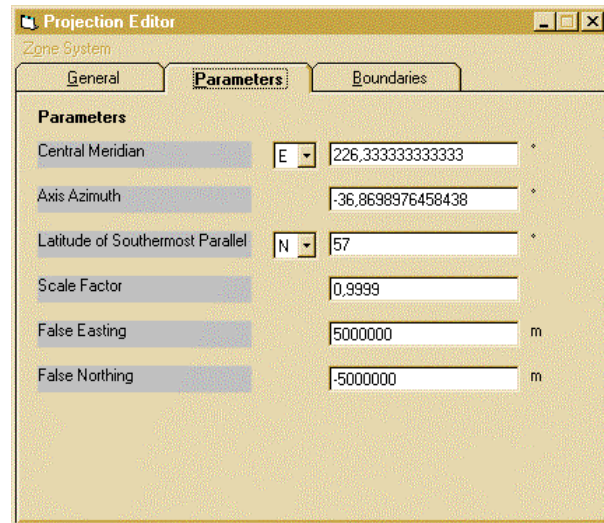
Parameter	Value	Unit
Central Meridian	E 288	°
Scale Factor	1	
Southernmost Parallel	N -90	°
False Easting	1500000	m
False Northing	0	m

Figure 48-17: Transverse Mercator

The following parameters are required:

- Projection type - page General
- Central meridian eastern longitude in degrees (0° ... 360°)
- False Easting in meters
- False Northing in meters
- Southernmost parallel of latitude in degrees (-90° ... 90°)
- Scale factor

⇒ With an “**Oblique Mercator**” projection the following input parameter menu will be displayed, allowing you to enter the required parameters:



The screenshot shows the 'Projection Editor' dialog box with the 'Parameters' tab selected. The 'Zone System' is indicated at the top. The 'Parameters' section contains the following fields:

Parameter	Value	Unit
Central Meridian	226,333333333333	°
Axis Azimuth	-36,8698976458438	°
Latitude of Southernmost Parallel	57	°
Scale Factor	0,9999	
False Easting	5000000	m
False Northing	-5000000	m

Figure 48-18: Oblique Mercator

The parameters are in detail:

- Projection type - page **General**
- Central meridian eastern longitude in degrees ($0^{\circ} \dots 360^{\circ}$)
- False Easting in meters
- False Northing in meters
- Axis azimuth in degrees
- Southernmost parallel of latitude in degrees ($-90^{\circ} \dots 90^{\circ}$)
- Scale factor

⇒ With a "Lambert secant" projection the following will be displayed:

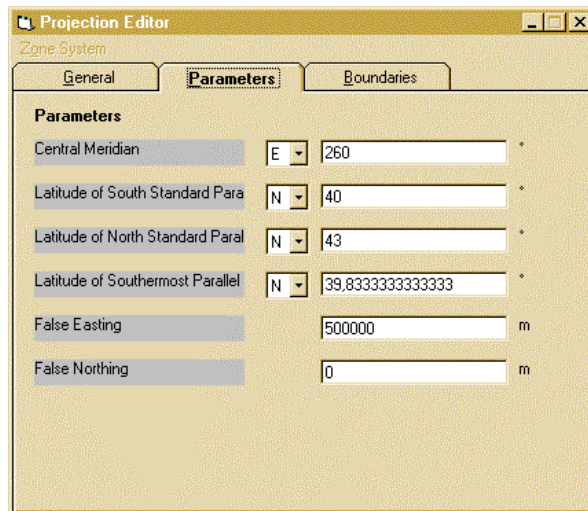
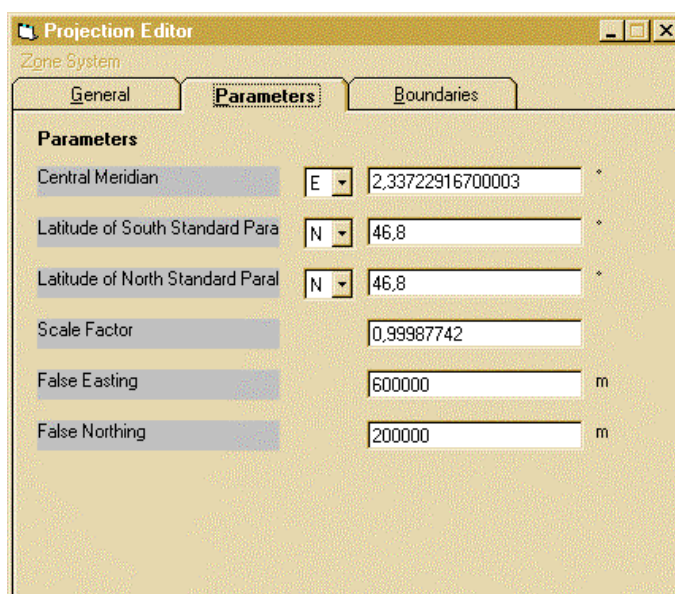


Figure 48-19: Lambert Secant

The parameters in this case are:

- Projection type - page General
- Central meridian eastern longitude in degrees (0° ... 360°)
- False Easting in meters
- False Northing in meters
- Latitude of southern standard parallel in degrees (-90° ... 90°)
- Latitude of northern standard parallel in degrees (-90° ... 90°)
- Southernmost parallel of latitude in degrees (-90° ... 90°)

⇒ With a "**Lambert tangential**" projection the following will be displayed:



The screenshot shows the 'Projection Editor' dialog box with the 'Parameters' tab selected. The 'Zone System' is indicated at the top. The parameters are as follows:

Parameter	Unit	Value
Central Meridian	°	2,33722916700003
Latitude of South Standard Para	°	46,8
Latitude of North Standard Paral	°	46,8
Scale Factor		0,99987742
False Easting	m	600000
False Northing	m	200000

Figure 48-20: Lambert Tangential

The parameters in this case are:

- Projection type - page General
- Central meridian eastern longitude in degrees ($0^{\circ} \dots 360^{\circ}$)
- False Easting in meters
- False Northing in meters
- Latitude of standard parallel in degrees ($-90^{\circ} \dots 90^{\circ}$)
- Scale factor

⇒ With a "Stereographic double" projection the following will be displayed:

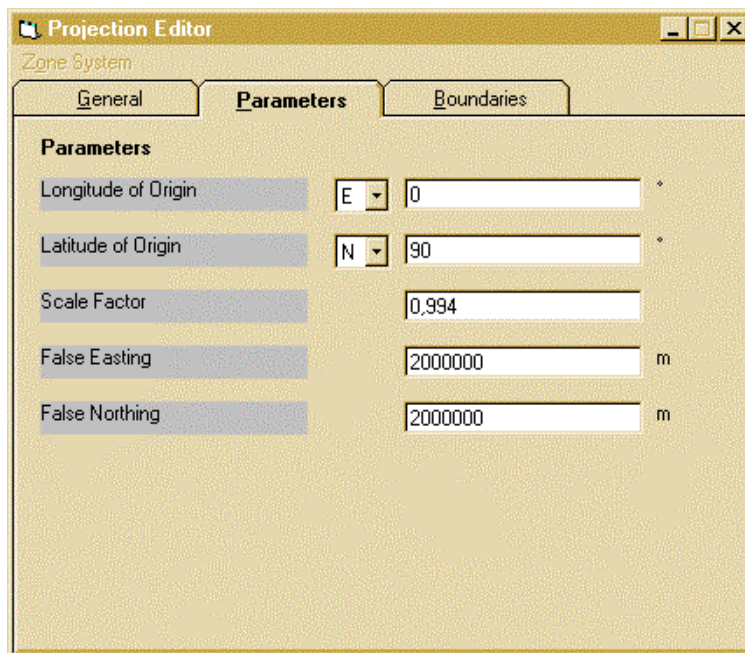


Figure 48-21: Stereographic Double

The parameters in this case are:

- Projection type - page General
- latitude of origin in degrees (0° ... 360°)
- longitude of origin in degrees (0° ... 360°)
- False Easting in meters
- False Northing in meters
- Scale factor

Boundaries

Page **Boundaries** allows you to define limits of the area, to which the projection can be applied. You should define this area, because distortions may become too large and coordinates of points far from the projection center will be unrealistic.

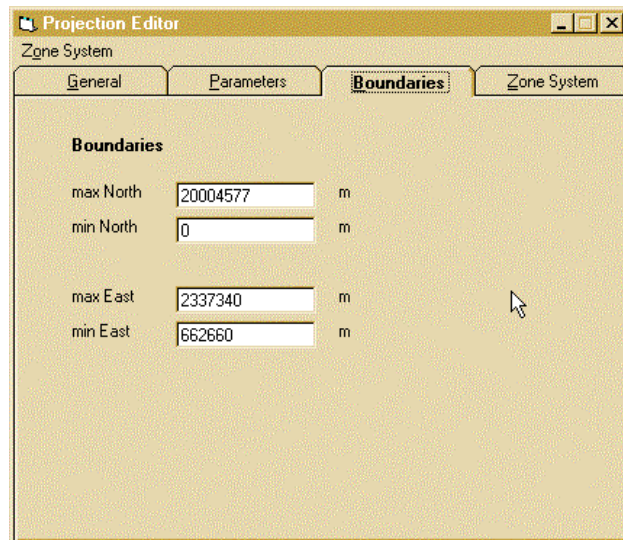


Figure 48-22: Boundaries

Here you may enter four values:

max North	maximum north value, positive or negative values given in meters (independent from unit settings)
min North	minimum north value, positive or negative values given in meters (independent from unit settings)

max East	maximum in eastern direction, positive or negative values given in meters (independent from unit settings)
min East	minimum in eastern direction, positive or negative values given in meters (independent from unit settings)

Zone System

If the projection (of the Transverse Mercator type) allows to introduce a zone system, the Projection Editor will offer a menu **Zone System**. Here you may define that a zone system shall be used (**New**) or you may delete an existing zone system (**Delete**).

If a projection uses a zone system, page **Zone System** allows you to define the zones.

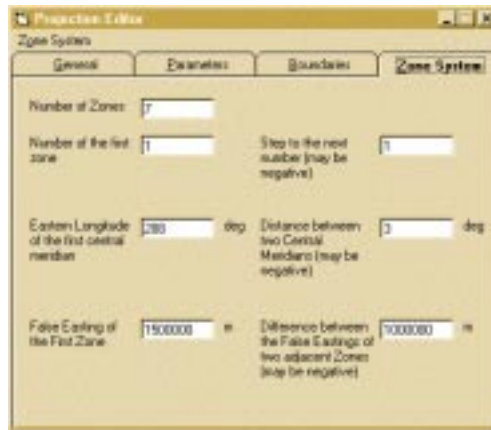


Figure 48-23: Zone System

The following items have to be defined:

1. Number of zones
2. Number of the first zone
3. Step to the next number (may be negative)
4. Eastern longitude of the first central meridian
5. Distance between two central meridians (may be negative)
6. False Easting of the first zone
7. Difference between the false Eastings of two adjacent zones

The first three items define the zone numbering. The central meridian of each zone is defined by its eastern longitude, while the width of a zone is defined by the distance between two central meridians. A false Easting value of the first zone and a difference of false Eastings of adjacent zones allow you to avoid negative coordinates.



Unless you have clicked the **Save** button displayed on page **General**, no changes will be stored! A newly defined projection will immediately show up in the **Name** list, but will not be stored until you have clicked the **Save** button. **Close** leaves the Projection Editor without storing changes!

48.2.2.2 **Change Projection Values**

The only difference to the creating of a new projection is, that here you first choose the name of the projection whose values are to be changed. Then you may change all values freely. Do not forget to save your changes with the **Save** button on page **General** before you leave the Projection Editor!

48.2.2.3 Delete a Projection

To delete a projection choose the menu option Extras/Projections. The Projection Editor will be displayed. Open the Name list and choose the projection to be deleted. Then click the **Delete** button. **GeoTrans** will ask, whether you really want to delete the projection. Accept with **OK** to delete or cancel the deleting process.



Unless you have clicked the **Save** button displayed on page **General**, the deletion will not be stored! The name of the deleted projection will immediately disappear from the Name list, but you have to click the **Save** button, before the deletion will be executed definitively. **Close** leaves the Projection Editor without storing changes!



If you have deleted a projection, but have defined a System using this projection, you cannot perform any additional transformations with this System!

48.3 Ellipsoids

48.3.1 Definition

We use ellipsoids to model the size and shape of the earth. Ellipsoids typically are used by a datum and serve as a basis for the different projections. A lot of ellipsoids are implemented in **GeoTrans**, and you can install others.

48.3.2 Handling

To control the implemented ellipsoids and their values choose the menu option Extras/Ellipsoids. The Ellipsoid Editor will show up.

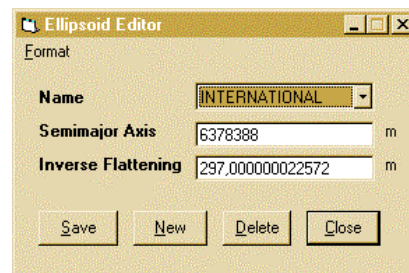


Figure 48-24: Ellipsoid Editor

You may define new ellipsoids, review and change the values of existing ellipsoids or delete existing ellipsoids.



Unless you have clicked the **Save** button, no change will be stored!

GeoTrans allows to enter the ellipsoid defining values in two formats:

- as semimajor axis and inverse flattening
- as semimajor and semiminor axis

To **define** a new ellipsoid first click the **New** button and enter a name. To **change** an existing ellipsoid choose its name from the list offered by the **Name** combo box. Choose the parameter format with help of the **Format** menu.

To enter relative values, choose **Format/Semimajor Axis + Inverse Flattening**, then enter the values for the Semimajor Axis in meters and for the Inverse Flattening. **GeoTrans** accepts a maximum of 13 digits.

To enter two absolute values, choose **Format/Semimajor + Semiminor Axis**, then enter the values in meters. **GeoTrans** accepts a maximum of 13 digits for each parameter.

To **delete** an existing ellipsoid choose its name from the list offered by the **Name** combo box. Then press the **Delete** button. **GeoTrans** will ask, whether you really want to delete the ellipsoid. Accept with **OK** to delete or cancel the deleting process.



Unless you have clicked the **Save** button, the deletion will not be stored! The name of a deleted ellipsoid will immediately disappear from the **Name** list, but you have to press the **Save** button, before the deletion will be executed definitively. **Close** leaves the Ellipsoid Editor without storing changes!



If you have deleted an ellipsoid, but have defined a System using this ellipsoid, you cannot perform any additional transformations with this System!

48.4 Datums

48.4.1 Definition

A datum is the size, location and orientation of a mathematical model used as an approximation for the surface of the earth. Typically, a datum will fit a specific country very well, but perhaps not an adjacent country. Datum, therefore, usually means a national datum system. A lot of national datums are implemented in **GeoTrans**, and you can install others.

48.4.2 Handling

To control the implemented datums and their values choose the menu option Extras/Datums. The Datum Editor will show up.



Figure 48-25: Datum Editor

You may define new datums, review and change the values of existing datums or delete existing datums. If you have already defined and saved new transformation parameters by a three-dimensional adjustment, here you will also find these parameters. The name of adjustment parameter sets will start with the characters A7.



Unless you have pressed the **Save** button, no changes will be stored!

To **define** a new datum first click the **New** button and enter a name. To **change** an existing datum choose its name from the list offered by the Name combo box.

Now, you may choose a corresponding ellipsoid (optional) and then enter the seven parameters for the transformation from the WGS84 system.

The menu option **Datum/Invert** allows to invert the transformation. This allows to define a **transformation TO the WGS84 system**.

**Figure 48-26: Datum/Invert**

The translations are given in meters, the rotations are given in arc-seconds. **GeoTrans** accepts a maximum of 13 digits for each parameter.

To **delete** an existing datum choose its name from the list offered by the Name combo box and click the **Delete** button. **GeoTrans** will

ask, whether you really want to delete the datum. Accept with **OK** to delete or cancel the deleting process.



Unless you have clicked the **Save** button, the deletion will not be stored! The name of a deleted datum will immediately disappear from the **Name** list, but you have to press the **Save** button, before the deletion will be executed definitively. **Close** leaves the Datum Editor without storing changes!



If you have deleted a datum, but have defined a System using this datum, you cannot perform any additional transformations with this System!

48.5 Geoid Model

Because of the uneven structure of the earth, the geoid is not an ellipsoid. Geoid models describe an equipotential surface of the Earth's gravity potential at sea level and thereby provide the height differences between the ellipsoid and the geoid. Therefore, if you use a geoid model, you can calculate orthometric heights from ellipsoidal heights and vice versa.

Many institutions develop geoid models, using different measurement data and mathematical algorithms. **GeoTrans** has, by default, one worldwide geoid model implemented. The entry **None** in the selection of the geoid model may be used to set the WGS84 geoidal heights to zero, i.e., to ignore differences between geoid and ellipsoid.

A lot of freely available geoid models are supplied with **GeoTrans**, but are not installed by default in order to save disk space. You may install any of these geoid model(s) from the installation CD (for a list of currently supplied geoid models, please refer to the Appendix 54.6).

Furthermore, **GeoTrans** has implemented interfaces to commercially available geoid models. If you want to use such geoid models, get the corresponding data file by the developing surveying institution and put it into the subdirectory `\SYSDBS\`.

Additionally, **GeoTrans** recognizes specific geoid data file formats (refer to chapter 0). If you put your geoid data into a file obeying this format and add the file to the subdirectory `\SYSDBS\`, you can work with your own geoid model.

Last, you can make your own model, put it into a DLL and add the file to the **GeoTrans** data.

To specify the geoid model for your System, choose Extras/Systems. The System Editor will be displayed. It gives you access to the Geoid Model combo box, where you may choose either one of the geoid models or to neglect height differences to the ellipsoid (None).

If a geoid model is considered, **GeoTrans** generally calculates orthometric heights for all points (except in the geocentric coordinate System). The ellipsoidal height H is composed of the orthometric height $OrthoH$ and the geoidal height $GeoidH$:

$$H = OrthoH + GeoidH$$

If one of the orthometric or ellipsoidal heights is changed manually, **GeoTrans** automatically recalculates the other on the basis of the geoidal height.

Changes in the location (e.g., if you enter a new latitude value) can affect the geoidal height and therefore, the orthometric height also. In order to avoid automatic overwriting of manually changed geoidal height values, it is left to you to choose, if you want to recalculate the height values from the given geoid model.

⇒ *In general, you first edit all locations you want to change, then choose Extras/Recalc Geoid Heights from Model.*

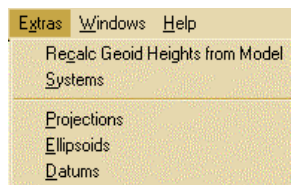


Figure 48-97: Extras

GeoTrans recalculates all geoidal heights from the System's geoid model and automatically re-computes orthometric heights.

49. Working with Point Lists

A Project consists of several point lists. Each point list consists of one or more points, all of which are described via coordinates in the same, predefined **geodetic System**. All coordinates of one point list are given in the same coordinate system and with the same unit. You can change between the different coordinate systems and unit systems without leaving a point list (which allows you to bring point lists into line with each other), the geodetic System is fixed for each point list.

This chapter concentrates on the handling of point list and presupposes that you are familiar with geodetic Systems. For more information, please refer to chapter 48.

49.1 A Point List

Each point list is given in a separate sub-window. Only one list at a time is active. You can arrange lists with Windows/Cascade or Windows/Tile, which may help you for editing or comparing their contents. You may freely size the point list area and may diminish or maximize the lists using the typical Windows buttons.

	Point	X	Y	Z	GeoidH	Sea Level	ScaleF	Case
1	00121	3877881.124	881848.918	4983583.628	9.343	-15.897	21.884	62° 06' 31.46156"
2	0056	3878577.556	883883.684	4982852.540	9.349	-16.436	26.676	62° 07' 54.18974"
3	0064	3877259.891	883485.579	4983778.836	9.327	-15.753	29.413	62° 07' 42.39964"
4	0068	3877427.988	883885.799	4983683.522	9.327	-15.775	31.248	62° 07' 58.12696"
5	0080	3878652.398	888972.891	4983132.890	9.358	-16.534	17.129	62° 08' 48.15791"
6	0082	3877017.678	883865.866	4984854.334	9.328	-15.611	27.712	62° 07' 28.38862"
7	0096	3875718.878	883632.166	4984968.496	9.299	-15.532	31.123	62° 08' 02.58491"
8	0104	3875645.581	884856.217	4984989.639	9.297	-5.343	33.203	62° 08' 28.93319"

Figure 49-1: Point List

The point list area consists of 5 parts:

A **title line** informs you about the name of the point list. It only changes if you rename the point list. The **editing area** on the lefthand side displays the content of the currently active cell. You may edit and change the values.

Figure 49-2: Editing Area

On the right-hand side you find the **coordinate system selector**. A pop-up list allows you to choose the appropriate coordinate system.

Figure 49-3: Coordinate System Selector

You may choose one of the following coordinate systems:

- Cartesian Geocentric Coordinates (X, Y, Z, GeoidH)
- Geographic Coordinates (Lat, Lon, Height, OrthoH, GeoidH)
- Plane Coordinates (Northing, Easting, Height, OrthoH, GeoidH)

- NATO GEOgraphical REFerence System (Message, H, OrthoH, GeoidH)

Depending on the System of the point list, any of these may or may not be available. E.g., with a System without projection you cannot transform a point list into plane coordinates.

The **spreadsheet** displays the list of points. The points of the list are alphanumerically sorted by the point number (see column **Point**). Each point covers one row. The rows are numbered starting with 1. The last row, an empty row shows an asterisk. The columns show the point numbers and coordinates and additional parameters. The first column, however, is occupied by a check marker box, which allows you to select or deselect the respective point.

	Point	Lat	Lon	H	OrthoH	GeoidH	Sea Level	ScaleF	Conv
1	☒ 0021	N 51° 43' 05.35365"	E 11° 40' 50.84006"	90.618	91.700	-1.082	-14.221	5.889	00° 14' 55.78655"
2	☒ 0055	N 51° 42' 27.61783"	E 11° 41' 54.47652"	94.266	95.384	-1.097	-14.797	5.331	00° 14' 11.98813"
3	☒ 0064	N 51° 43' 15.79575"	E 11° 42' 20.48541"	89.941	91.053	-1.112	-14.115	5.889	00° 13' 45.45662"
4	☒ 0066	N 51° 43' 07.91875"	E 11° 42' 48.76491"	90.676	91.194	-1.118	-14.136	4.889	00° 13' 25.58928"
5	☒ 0080	N 51° 42' 42.23218"	E 11° 40' 06.02585"	94.936	95.999	-1.063	-14.899	6.449	00° 15' 37.17147"
6	☒ 0082	N 51° 43' 38.08167"	E 11° 42' 10.04653"	89.047	90.154	-1.107	-13.974	5.176	00° 13' 55.57565"
7	☒ 0096	N 51° 44' 18.43671"	E 11° 42' 51.65817"	88.545	89.670	-1.125	-13.896	4.778	00° 13' 27.45459"
8	☒ 0104	N 51° 44' 16.76977"	E 11° 43' 15.09602"	52.931	54.064	-1.133	-8.317	4.563	00° 13' 09.04951"
9	☒ 0106	N 51° 44' 28.37316"	E 11° 43' 10.70569"	60.659	61.765	-1.104	-5.902	4.247	00° 13' 07.07662"
10									*

Figure 49-4: Point List Spreadsheet

The parameters of the columns following the point number depend on the chosen coordinate system. The availability of three coordinates is, of course, essential, independently from the chosen coordinate system. Yet in some cases, geoidal heights and orthometric heights are available (see chapter 48.5).

With plane coordinates, the following parameters describe the differences between the points' locations in three-dimensional reality and on the map:

Sea Level The sea level factor reduces measured distances to sea level distances [ppm]

ScaleF	The grid scale factor is the measure of the linear distortion that has been mathematically imposed on ellipsoid distances so they may be projected onto a plane. It describes the length scale distortion ratio of the map scale at a given point to the map scale along a standard line [ppm]
Conv	Meridians converge towards the poles, while the north-south grid lines are parallel to the central meridian. On maps, therefore, geodetic north and grid north do not coincide at any point. The Meridian Convergence Angle is the angular difference between grid north and geodetic north.

By default, your spreadsheet will contain all columns, even if no data are available or applicable. You may, however, customize your spreadsheets for displayed columns (Options/Optional Columns...), see chapter 4.11.

Two scroll bars allow you to move the contents of the point information area, if it is too large to be displayed simultaneously.

A **status bar** at the bottom of the point list sheet displays (from the left to the right):

- the chosen System,
- the System parameters.

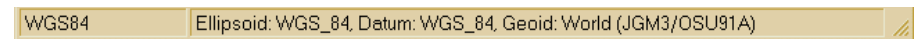


Figure 49-5: Status Bar

49.2 Create a New Point List

If you know the coordinates of one or several points, you may create a point list manually by choosing **P**oints/**N**ew.

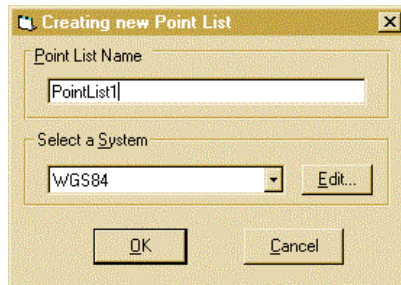


Figure 49-6: New Point List

The Point List Window now allows you to define a name for the new point list. It suggests a name like PointList1 which you can accept or rename the point list later (see **P**oints/**R**ename Point Lists, later in this chapter).

Since point lists may only differ from each other by the System used, it may be a suggestion to indicate not only the location, but also the System in the name of the respective point list.

The next step is to select a System from the list of predefined Systems. The System has to correspond to the type of coordinates you want to enter later. **GeoTrans** proposes the predefined Systems in alphabetical order.

What, if you did not define your System previously? No problem, just click the **E**dit ... button. The System Editor window will open and you

may now define new Systems or edit existing ones. The System Editor is described in detail in chapter 48.1, *Defining a System*.

Now, you may accept name and System for your new point list with **OK** (**Cancel** stops the creation of a new point list). A new, empty sheet pops up, allowing you to enter point names and coordinates manually. **GeoTrans** automatically extends the spreadsheet producing new rows as soon as you enter any value into the row marked with an asterisk, the Add-Row.

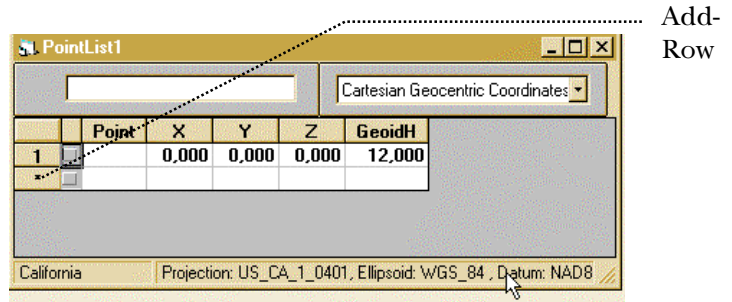


Figure 49-7: Add Row

49.3 Import Points

GeoTrans supports a multitude of file format converters for importing.

Choose **Points/Import...** The Point List Window now allows you to define a name for the new point list. It suggests a name like **Point List1** and you accept it or rename the point list later on (see **Points/Rename Point Lists**, later in this chapter).

⇒ *Since point lists may only differ from each other by the System used, it may be a suggestion to indicate not only the location, but also the System in the name of the respective point list.*

The next step is to select a System from the list of predefined Systems. The System has to correspond to the type of coordinates you want to enter later on. **GeoTrans** proposes the predefined Systems in alphabetical order.

If you did not define your System previously, click the **Edit** ... button. The System Editor window will be opened and you may now define all System components or parameters.

Now, you may accept name and System for your new point list with **OK** (**Cancel** stops the creation of a new point list).

The Open Position File window pops up and allows you to search for a file containing point coordinates and then to choose it.



Figure 49-8: Available Converters

First, you must choose the correct Available Converter: An alpha-numerically sorted pop-up list allows you to choose the necessary converter by indicating the data format and its default file name extension. The following list gives you some examples, but you may create your own converters and add them to **GeoTrans** (see chapter 52.1, *Create Your Own Converter*), others are already implemented (see Appendix 54.4):

- Ashtech C-Files
- Geotracer Database File (*.dbs)
- Geotracer SPC-File (*.spc)
- Geotronics Job or Area File (*.job, *.are)
- terraSat Cartesian (*.xyz)
- terraSat Geographical (*.geo)



Make sure to choose the correct converter first. If you do not choose the correct converter, **GeoTrans** will not be able to identify coordinates and an error message will appear!

The central part of the Open Position File window is covered by a file selector and a drive and directory selector. The list of available files of the chosen directory displayed accords to the selected converter type. If the directory contains files using different extensions, these will not be shown in the file selector.

To choose a file you may enter its name manually or select it from the list. Accept with **OK** or leave the window with **Cancel**.

In the unit type option (box Unit) you can specify how you want the imported data to be interpreted in terms of length unit. In case a file contains sufficient unit type information the information in the file will prevail over your choice. **GeoTrans** offers you the following choices:

- Meter
- Feet
- U.S. Survey Feet

The height type option (box Height) allows you to choose how height values found in the import file are to be interpreted. By default, they are regarded to be ellipsoidal heights. Nevertheless, you might have additional information stating that the height values in the file are orthometric values. Again – as with the unit type – in case the imported file contains sufficient information on the height type of the file data this information will prevail over your choice.

If your point coordinates include **zone information**, but the System does not, **GeoTrans** gives you a warning message, but still imports the

points, if they fit the System. If the zone information in the coordinates differs from the System's zone, no data import is possible. If your point coordinates include no zone information, but the System does, a warning will inform you that the zone of the points will be altered to the System's zone.

GeoTrans stops the import, if the import file contains erroneous data or if the data format in the file does not comply with the specified System setting.

49.4 Print Point List

You may send the current point list directly to your default printer. For information on how to set the printer, please consult your MS Windows User Manual.

The menu option **P**oints/**P**rint sends the complete spreadsheet of the current point list to the printer. The print out resembles very much the spreadsheet on the screen. Some additional information is also provided on the print-out, such as the project name, the point list name and the System of the point list.

49.5 Export Points

To export points of a point list choose **P**oints/**E**xport. The Save Position File window will be displayed, which is almost identical with the Open Position File window. Again, you have to choose the appropriate

converter and then, the drive, directory and name of the file to which you want to store your results.

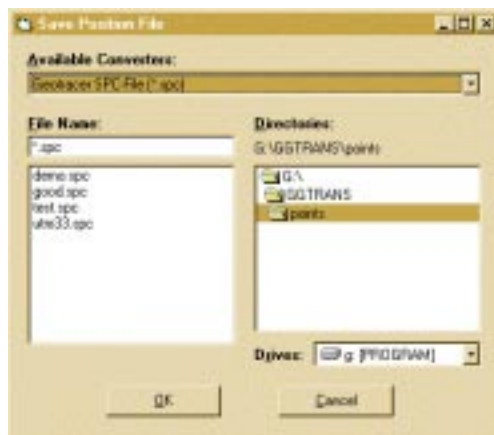


Figure 49-9: Export Points

49.6 Rename Point List and Info

Choose Points/Rename Point List, if you want to rename your point list.



Figure 49-10: Rename Point List

⇒ *In order to make identification of point lists easier, it may be a suggestion to indicate not only the location, but also the System in the new name.*

The **Info** option of the **Points** menu allows you to review all parameters of the current point list. It opens the Point List Information window, displaying not only the chosen System and its parameters, but also the origin of the points: Date and Time, when they were imported or created and, if imported, their source drive, directory and file and creation date and time of the source file.

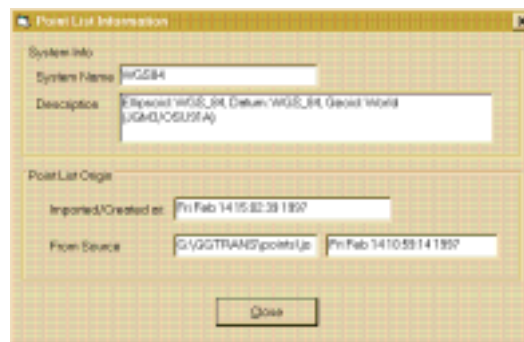


Figure 49-11: Point List Information

49.7 Select Points

GeoTrans allows you to handle large point lists very easily. When first created or imported, all points are selected. But you may select or de-select any amount of points. This may help you to

- test a transformation or adjustment
- select only few points for adjustment
- delete all selected points

Selection and de-selection of points is very easy. You either can use the check box markers and click each singular point off or on using the left mouse button. This will be the fastest method, if your point list is not very large.

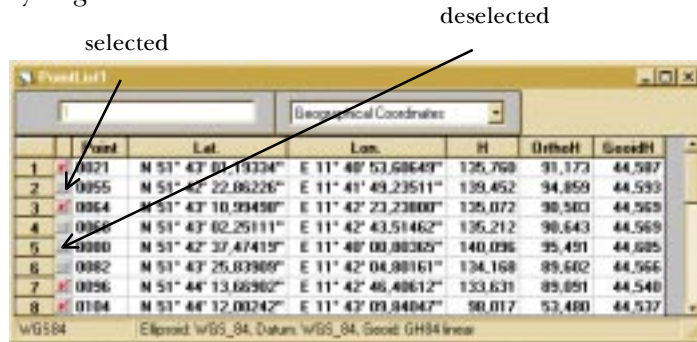


Figure 49-12: Point Selection

If you want to handle large lists, the following options may speed up the selection:

To select all points Choose Points/Select All Points
 To deselect all points Choose Points/Deselect All Points
 To invert the selection Choose Points/Invert Selection.
 The combination of these three options allows a very quick selection of points no matter how the selection status has been before.

49.8 Delete Points

Two options are available to delete points:



Figure 49-13: Points/Delete Points

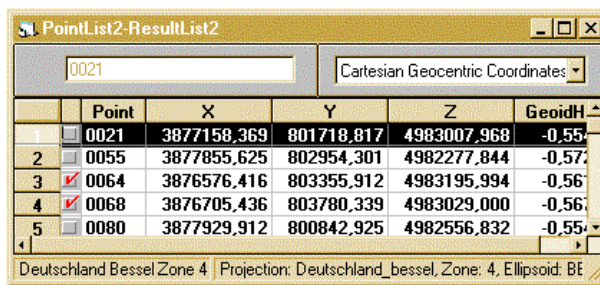
- **Delete Point** Deletes the point that is currently in focus (highlighted rectangle in the spreadsheet).



If you choose **Points/Delete Point**, it does not matter, whether a point has been checked or not! Only the point in focus will be deleted.

- **Delete Selected Points** Deletes all points which are selected by the check box marker. In this case the point in focus is irrelevant.

The following is an example for the deletion of selected points. Points 0064 and 0068 are marked, point 0021 is in focus.

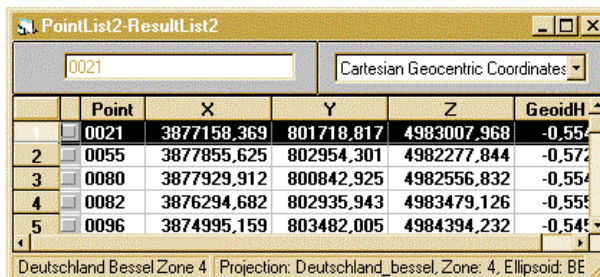


	Point	X	Y	Z	GeoidH
	0021	3877158,369	801718,817	4983007,968	-0,55
2	0055	3877855,625	802954,301	4982277,844	-0,57
3	0064	3876576,416	803355,912	4983195,994	-0,56
4	0068	3876705,436	803780,339	4983029,000	-0,56
5	0080	3877929,912	800842,925	4982556,832	-0,55

Deutschland Bessel Zone 4 | Projection: Deutschland_bessel, Zone: 4, Ellipsoid: BE

Figure 49-14: Points Selected for Deletion

After deletion, the point in focus, point 0021, still exists, while the selected points were deleted for the time being.



	Point	X	Y	Z	GeoidH
	0021	3877158,369	801718,817	4983007,968	-0,55
2	0055	3877855,625	802954,301	4982277,844	-0,57
3	0080	3877929,912	800842,925	4982556,832	-0,55
4	0082	3876294,682	802935,943	4983479,126	-0,55
5	0096	3874995,159	803482,005	4984394,232	-0,54

Deutschland Bessel Zone 4 | Projection: Deutschland_bessel, Zone: 4, Ellipsoid: BE

Figure 49-15: Deletion of Selected Points



Please note, that points will be only be deleted from the point list when the Point List is saved!

If your point list contains points, that are unnecessary or have bad coordinates, you may delete these points.

49.9 Sort Points by Number

GeoTrans is able to quickly sort your points by numbers. Just choose Points/Sort by Number and your points will be listed alphanumerically in ascending order. You may use this option, if you have manually added points and want the list to be sorted again.

		Point	N
1	☒	41008101	5745908,977
2	☒	41016001	5745606,866
3	☒	50000030	5745494,206
4	☒	95000030	5745908,592
5	☒	95000490	5745273,358
6	☒	36045680	5745254,235
7	☒	36045650	5745258,350
8	☒	36045666	5745245,680
*	☐		

Figure 49-16: Unsorted Points

		Point	N
1	☒	36045650	5745258,350
2	☒	36045666	5745245,680
3	☒	36045680	5745254,235
4	☒	41008101	5745908,977
5	☒	41016001	5745606,866
6	☒	50000030	5745494,206
7	☒	95000030	5745908,592
8	☒	95000490	5745273,358
*	☐		

Figure 49-17: Sorted Points



Each time you change the coordinate system the point list will automatically be re-sorted.

49.10 Edit Values

49.10.1 General

A double-click on a field allows you to edit any value in a point list. The editing area on top of the points will be activated and will display fields fitting the edited value. E.g., if you double-clicked a **Latitude** field (and the unit setting includes degrees, minutes and seconds, see section 49.11), the editing area will display a switch for North or South direction (change with a click on the N or S key) and separate input fields for degrees, minutes and seconds.

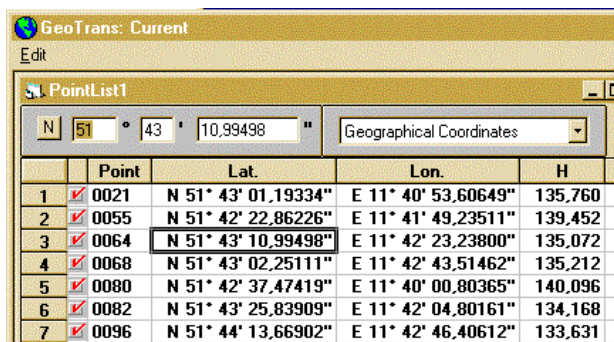


Figure 49-18: Edit Values

At the same time the menu bar will have changed and now offers one singular item, the **E**dit menu. It offers the editing features **C**opy, **C**ut and **P**aste. As soon as you have stopped the editing, the standard menus will return.

You may use the editing tool with the mouse as well as with the keyboard.

Double-click the cell with the left **mouse** button to enter the edit-mode and automatically choose the content of the cell.

The following table lists all available **keyboard** functions.

Function	Keyboard action
to edit a cell	start typing the content
to leave the editing area without changes	Escape key
to accept changes and leave the editing area	Enter key, Tab key
highlight values	Shift + left/right arrow key
to change input fields of the editing area	Tab key
copy cell values	highlight and Ctrl + C or highlight and Alt + EC
cut cell values	highlight and Ctrl + X or highlight and Alt + ET
paste cell values	highlight and Ctrl + V or highlight and Alt + EP

49.10.2 Special Editing Considerations - Heights

Generally, three height values are given, if a geoid model is selected. The ellipsoidal height H is composed of the orthometric height $OrthoH$ and the geoidal height $GeoidH$:

$$H = OrthoH + GeoidH$$

If one of the orthometric or ellipsoidal heights is changed manually, **GeoTrans** automatically recalculates the other on the basis of the geoidal height.

H	OrthoH	GeoidH
135,760	91,173	44,587
139,452	94,859	44,593
135,072	90,503	44,569
135,212	90,643	44,569

Figure 49-19: Heights

Changes in the location (e.g., if you enter a new latitude value) can affect the geoidal height and therefore, the orthometric height also. In order to avoid automatic overwriting of manually changed geoidal height values, it is left to you to choose if you want to recalculate the height values from the given geoid model.

In general, you first edit all locations you want to change, then choose  Extras/Recalc Geoid Heights from Model.

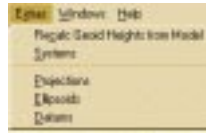


Figure 49-20: Extras/Recalc

Now **GeoTrans** recalculates all geoidal heights from the System's geoid model and automatically re-computes orthometric heights.

49.11 Column Related Options

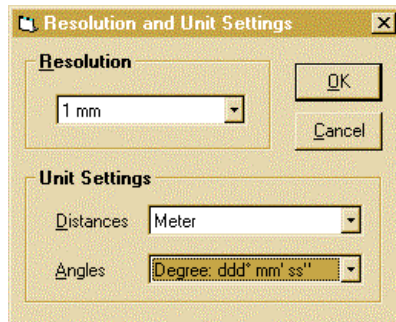


Figure 49-21: Resolution and Unit Setting

49.11.1 Unit Setting

GeoTrans offers two unit systems for the display of coordinates. You may use the metric system as well as the feet and the US Survey Feet system. To toggle between the systems just choose Options/Unit Settings.

Choose the unit for angles in the same way. You may choose one of the following:

- Degree
- Degree, Minutes
- Degree, Minutes, Seconds
- Gon
- Radiant

49.11.2 Display Accuracy

GeoTrans allows you to adjust the display of given coordinates to your accuracy demands. A coarse resolution may contribute to the clarity of the tabular graph.

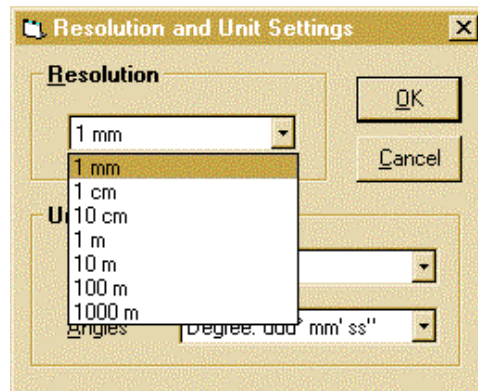


Figure 49-22: Resolution

You always have to specify the accuracy of the display in Meter units. Values displayed in other units will be given the same accuracy, so that, e.g., feet values will have four decimals, if the accuracy is set to 1 mm. The same applies to angle values.

A change in accuracy will, of course, not affect the “real numbers”. **GeoTrans** will continue computations with full accuracy. You may change resolution to any precision any time and as often as you want. Nevertheless:



User input will be limited to the specified display accuracy!

49.11.3 Display Column Units

To display the column's unit in the column headers open the menu Options and check the toggle item Show Column Units. If it is checked with a ✓, the point lists will display column unit; if not, units will be hidden.

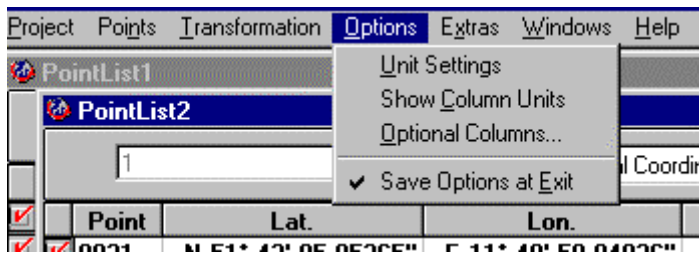


Figure 49-23: Column Options

49.11.4 Customize the Number of Columns

Some of the columns displayed in point lists are optional columns, i.e., you may hide or show these columns. By default, all columns will be displayed. To hide one or several columns, choose the item Optional Columns... of the Options menu. The Optional Columns window pops up.

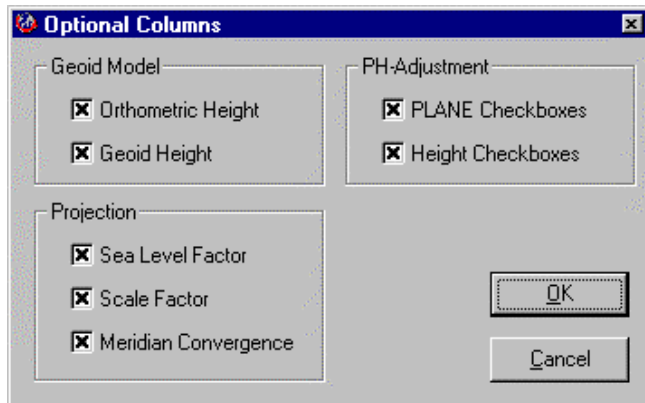


Figure 49-24: Optional Columns Window

The Optional Columns window displays seven spreadsheet column names in three groups. You may define for each column whether it shall be hidden in all corresponding point lists or not. The PH Adjustment columns only apply for a transformation adjustment in plane and height. Please refer to chapter 51.1.1.

49.11.5 Save Options

To save all options for the next time you use **GeoTrans**, check the menu option Options/Save Options at Exit. The latest settings will then be saved when leaving **GeoTrans**.

50. Point Transformation

GeoTrans differentiates between transformations between Systems and conversions. The latter are described in chapter 48. Here we concentrate on transformation between Systems, which is done using the menu Transformation.

The menu Transformation offers three different point transformation options:

- Transformation to a predefined System.
- Transformation into a plane defined by one or two points with manually entered coordinates (2D Transformation). Heights are not transformed.
- Transformation using parameters which are derived, e.g., from point adjustment.

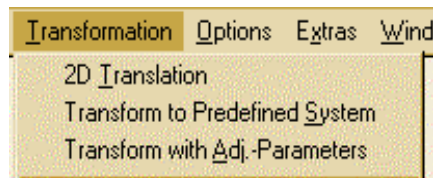


Figure 50-1: Point Transformation

50.1 Transformation Types

GeoTrans is able to use different **transformation types** to transform point coordinates to a predefined System. Three transformation types are currently included, or you can create and add others (refer to chapter 52.3, *Create Your Own Transformation Type*).

- **7 Parameter Similarity Transformation:**
from any datum to any datum

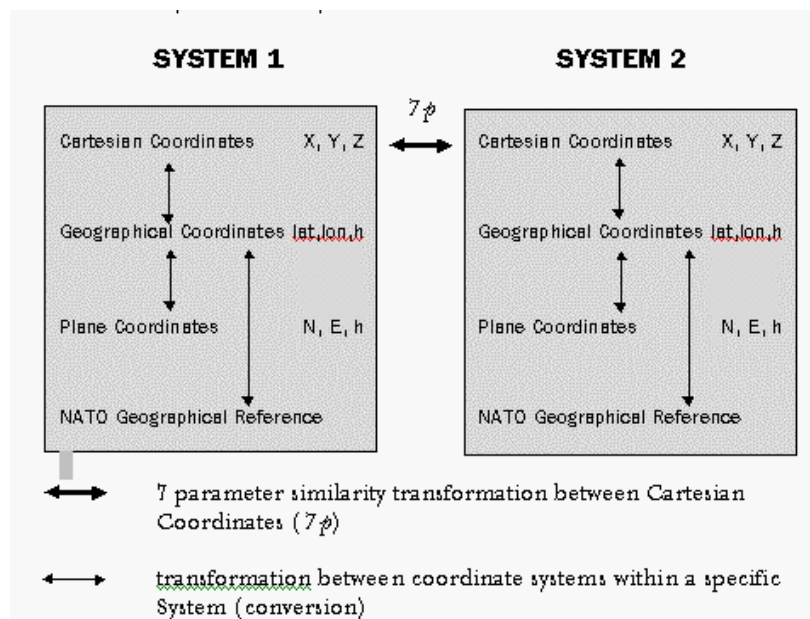


Figure 50-2: 7 Parameter Similarity Transformation

- **Multiple Regression Equations, e.g.:**

Between a System based on the WGS_84 ellipsoid and datum and a System based on the INTERNATIONAL ellipsoid and the EUROPEAN_1950 datum.

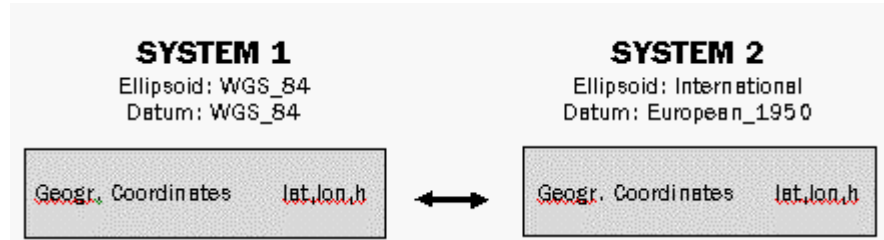


Figure 50-3: Multiple Regression Equations

- **NadCon NAD27 <=> NAD83:**

Transformation between a System based on the North American Datum of 1927 (NAD27) and a System based on the North American Datum of 1983 (NAD83).

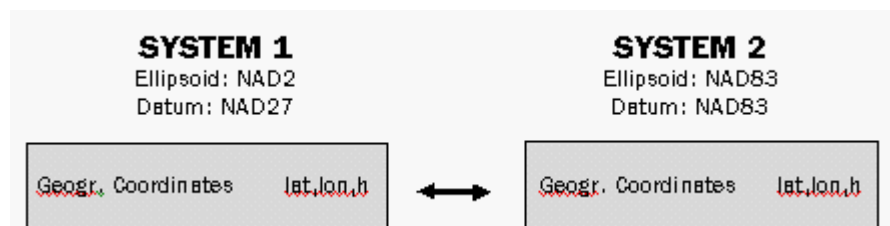
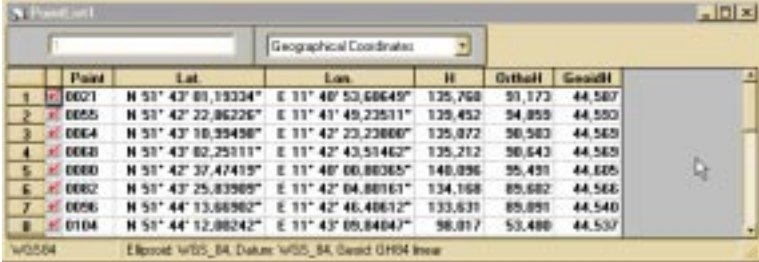


Figure 50-4: NadCon Transformations

50.2 Transformation to a Predefined System

This will probably be the most often used transformation. It allows you to transform points derived in one System to another using any transformation method which is suitable for this transformation (mostly the 7 Parameter Similarity Transformation will be possible).



	Point	Lat	Lon	H	OrthoH	GeoidH
1	0001	N 51° 43' 01.19334"	E 11° 40' 52.66645"	135,768	91,173	44,587
2	0005	N 51° 42' 22.86226"	E 11° 41' 49.23511"	135,452	94,859	44,593
3	0004	N 51° 43' 18.39498"	E 11° 42' 23.23880"	135,872	98,583	44,589
4	0008	N 51° 43' 02.25111"	E 11° 42' 43.51462"	135,212	98,643	44,569
5	0000	N 51° 42' 37.47419"	E 11° 40' 00.88365"	140,896	95,491	44,605
6	0002	N 51° 43' 25.83989"	E 11° 42' 04.88161"	134,168	89,682	44,566
7	0006	N 51° 44' 13.68982"	E 11° 42' 46.48612"	133,631	89,891	44,540
8	0104	N 51° 44' 12.88242"	E 11° 43' 09.84047"	98,817	53,488	44,537

wGS84 Ellipsoid: wGS_84, Datum: wGS_84, Spheroid: GRS84 linear

Figure 50-5: Source Point List

Activate the appropriate point list, and then choose Transforma-
tion/Transform to Predefined System. The following window
will pop up:

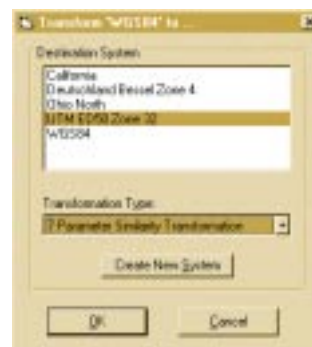
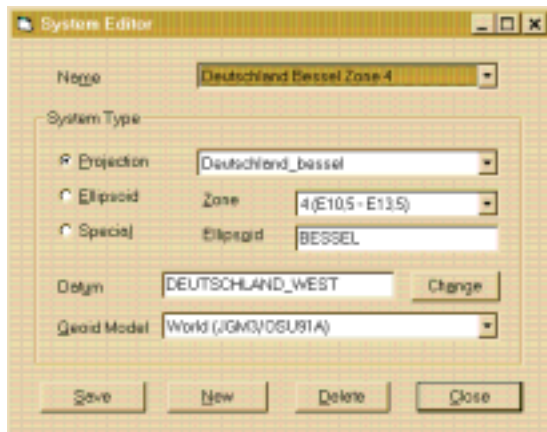


Figure 50-6: Transform Window

The title of the Transform window indicates the source System. A list box allows you to choose one of the predefined Systems as destination System. If you did not define an appropriate System, you may create a new System. Just click the button **Create New System** and the System Editor is displayed. Now you may define the System parameters and store the new System under a name.

**Figure 50-7: System Editor**

The transformation methods you have to choose from depend on the transformation methods added to **GeoTrans** and the source and destination System of the current transformation process. Typically, a 7 Parameter Similarity Transformation will be one choice. **GeoTrans** currently includes the transformation types listed in the Appendix 54.5. You can also add own transformation types.

Choose a System and a transformation type and accept with **OK** (**Cancel** stops the transformation dialog).

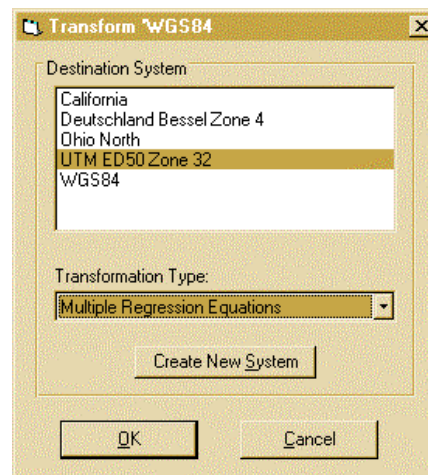


Figure 50-8: Transform

GeoTrans will start the transformation and display a new Point List with all points transformed to the chosen destination System.

	Point	Lat.	Lon.	H	OrthoH	GeoidH
1	0021	N 51° 43' 03.00003"	E 11° 40' 57.54828"	100.390	90.527	9.871
2	0055	N 51° 42' 25.47747"	E 11° 41' 53.17459"	104.000	94.214	9.874
3	0064	N 51° 43' 13.60036"	E 11° 42' 27.17742"	99.736	89.890	9.877
4	0068	N 51° 43' 04.86452"	E 11° 42' 47.45330"	99.877	89.990	9.878
5	0080	N 51° 42' 40.00019"	E 11° 40' 04.74650"	104.712	94.045	9.867
6	0082	N 51° 43' 28.45223"	E 11° 42' 08.74104"	98.833	88.957	9.876
7	0096	N 51° 44' 16.28025"	E 11° 42' 50.34605"	98.325	88.446	9.879
8	0104	N 51° 44' 14.61343"	E 11° 43' 13.77970"	62.716	52.836	9.881

UTM ED50 Zone 32 Projection: UTM_ED50_Zone_32 Ellipsoid: INTERNATIONAL Datum: EUROPEAN_11

Figure 50-9: Transformed Point List

GeoTrans names the new Point List automatically with a serial number, but you may rename the list using the menu option Points/
Rename Point List.

50.3 2D Transformation

You can define origin, scale and orientation by providing one or two known points and defining manually their position and orientation in the local System. **GeoTrans** will then transform all point coordinates into the new System. The connection to a global projection System can later be done via fixed points.



Please note, that heights are not transformed with this operation.

50.3.1 Translation Based on a Single Point

A basic form of transformation is given with the translation based on a single point. This means that you do not provide any rotation or scaling.

Activate the point list containing the point you want to use to fix the translation and then choose Transformation/2D Translation. The 2D Transformation window will show up, displaying boxes for two points to be fixed.

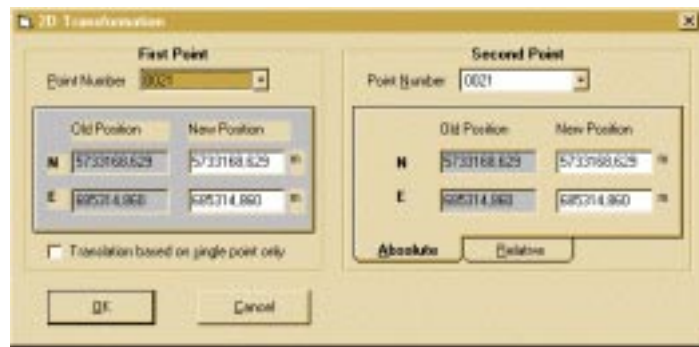


Figure 50-10: 2D Transformation

At the bottom of that window you will find the option Translation based on single point only. Accept this option, the second point combo box will then disappear and you may enter the northing and easting values for translation.

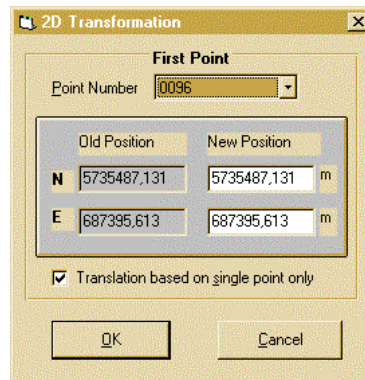


Figure 50-11: Single Point Translation

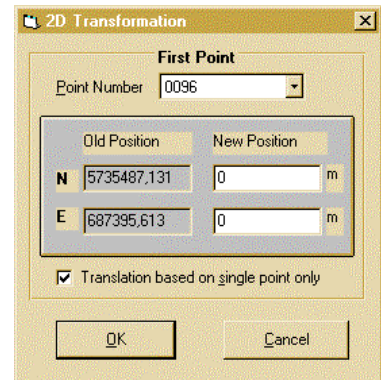


Figure 50-12: Enter Values

Accept with **OK** (**Cancel** stops the translation dialog). **GeoTrans** will start the translation and will display a new Point List with all points translated to the new positions.

GeoTrans names the new Point List automatically including a serial number, but you may rename the list using the menu option **P**oints/**R**ename Point List.

This option may help you, e.g., to avoid big numbers and helps you to control distances between your points. In some cases, you should disregard orthometric and geoidal heights, because these might be irrelevant (e.g., translation into a local System).

50.3.2 Transformation Based on Two Points

Choose a point list containing at least the points you want to use to determine the transformation, then choose **T**ransformation/**2D** **T**ranslation. The 2D Transformation window pops up.

Figure 50-13: 2D Transformation Based on Two Points

It provides two boxes for the two points. Now choose the first point from a list in the Point Number list box. As you move through the list, you will see the point positions change. The coordinates are given as Northing and Easting values, independently from the currently chosen coordinate system of the point list.

Figure 50-14: Enter Values

Choose a point and then enter its new position values under New Position.

Figure 50-15: Two Point Transformation, New Position

Now choose a second point. The second point must be different than the first point! (Translation with only one given point is possible, though; see section 50.3.1.) **GeoTrans** offers two different methods to define the position of the second point in the local System. You may define it in **absolute coordinates** or **relatively to the first point**. Both methods result in the same transformation.

Choose page **Absolute** to define absolute coordinates.

Figure 50-16: Second Point: Absolute Coordinates

You might also define a relative position to the first point by choosing page **Relative** and entering the relative values distance and azimuth.

	Old Value	New Value
Azimuth	90.0000000	45.0000000
Distance	0.000	1.414 m

Figure 50-17: Second Point: Relative Coordinates

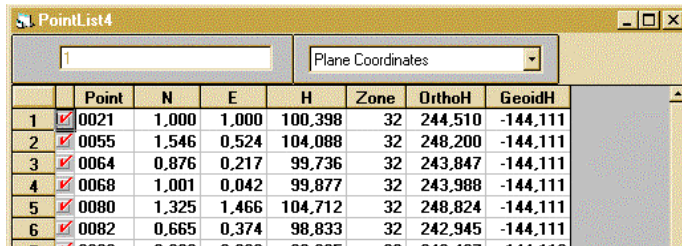
In this example you have defined a translation, a rotation **and** a scale factor.

If you want to **define a position offset and rotation *without any scaling***, turn to the relative definition option of the second point (page **Relative**). You will notice the current distance and azimuth between the two points. Just enter a new value for the azimuth to orient the local System, but do not change the distance value.

	Old Value	New Value
Azimuth	90.0000000	6.8165130
Distance	0.000	5773982.940 m

Figure 50-18: Position Offset without any Scaling

Accept with **OK** (**Cancel** stops the translation dialog). **GeoTrans** will start the translation and display a new Point List with all points translated to the new positions.



The screenshot shows a window titled 'PointList4' with a dropdown menu set to 'Plane Coordinates'. Below the menu is a table with 8 columns: Point, N, E, H, Zone, OrthoH, and GeoidH. The table contains 6 rows of data, each with a checkbox in the first column. The data is as follows:

	Point	N	E	H	Zone	OrthoH	GeoidH
1	☒ 0021	1,000	1,000	100,398	32	244,510	-144,111
2	☒ 0055	1,546	0,524	104,088	32	248,200	-144,111
3	☒ 0064	0,876	0,217	99,736	32	243,847	-144,111
4	☒ 0068	1,001	0,042	99,877	32	243,988	-144,111
5	☒ 0080	1,325	1,466	104,712	32	248,824	-144,111
6	☒ 0082	0,665	0,374	98,833	32	242,945	-144,111

Figure 50-19: Transformed Point List

GeoTrans names the new Point List automatically including a serial number. You can also rename the list using the menu option **P**oints/**R**ename Point List.

50.4 Transformation with Parameters Derived from Adjustment

GeoTrans supports point transformation with help of parameters derived from adjustment. This may be 7 parameters from a 7 Parameter Adjustment, 4 parameters from a 4 Parameter Adjustment or 5 parameters from an Adjustment in Plane and Height (see chapter 51.8).

Activate the appropriate point list, and then choose **T**ransformation/**T**ransform with **A**dj. Parameters. A box will be displayed allowing you to choose the transformation type:

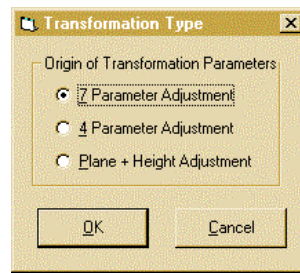


Figure 50-20: Transformation Types

You may choose a transformation with parameters from a

- 7 Parameter Adjustment translates, rotates and scales in space
- 4 Parameter Adjustment translates, rotates and scales in plane
- Plane + Height Adjustment translates, rotates and scales in plane and height

Push the respective radio button and accept with **OK** (**Cancel** stops the transformation dialog). A dialog window then offers the list of stored parameter sets. The list contains only those parameter sets corresponding to the chosen transformation type.

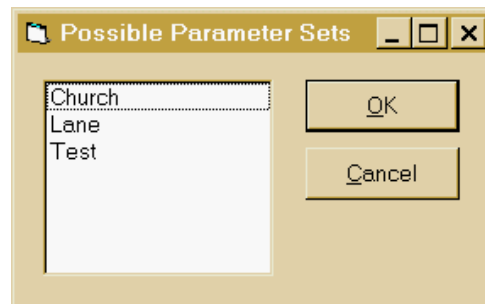
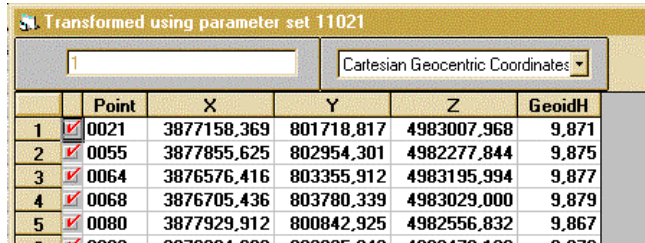


Figure 50-21: Parameter Sets

Highlight one of the parameter sets and accept with **OK** (**Cancel** stops the transformation dialog). **GeoTrans** will execute the transformation and display the new Point List with all points transformed with the chosen parameters.



	Point	X	Y	Z	GeoidH
1	0021	3877158,369	801718,817	4983007,968	9,871
2	0055	3877855,625	802954,301	4982277,844	9,875
3	0064	3876576,416	803355,912	4983195,994	9,877
4	0068	3876705,436	803780,339	4983029,000	9,879
5	0080	3877929,912	800842,925	4982556,832	9,867

Figure 50-22: Point List of Transformed Points

GeoTrans names the new Point List automatically including a serial number, but you may rename the list using the menu option **P**oints/**R**ename Point List.

51. Least-Squares Adjustment

The results obtained from processing GPS observations are three-dimensional Cartesian coordinates in the WGS84 System, which are defined in an Earth centered, Earth fixed frame.

You will probably have to transform these points into a local coordinate system, which offers control point coordinates.

GeoTrans offers a least-squares adjustment module, which determines the best fitting transformation parameters to transform one point list into another.

A Thimbleful of Theory

The adjustment is based on equations where the observations are expressed as function of unknown parameters. A Taylor series expansion is performed because of the non-linearity of the functions. This requires approximate values for the parameters. The resulting linear observation model can be expressed in a matrix - vector notation as

$$\underline{l} = \underline{A} * \underline{x}$$

where

$$\begin{array}{ll} \underline{l} \dots & \text{vector of observation} \\ \underline{A} \dots & \text{design matrix} \\ \underline{x} \dots & \text{vector of unknowns} \end{array}$$

Assuming n observations and u unknown parameters leads to a design matrix $\underline{A}$ comprising n rows and u columns. Observations are points

given in the control coordinate system or in the source coordinate system. To assure consistency, the noise vector $\underline{v}$ is added to the vector of observations:

$$\underline{v} = \underline{A} * \underline{x} - \underline{l}$$

The solution of this system becomes unique by the least squares principle

$$\underline{v}^T * \underline{v} = \text{minimum}.$$

The solution matrix $\underline{x}$ of the unknown coordinates is computed as:

$$\underline{x} = (\underline{A}^T * \underline{A})^{-1} * \underline{A}^T * \underline{l}.$$

The Handling

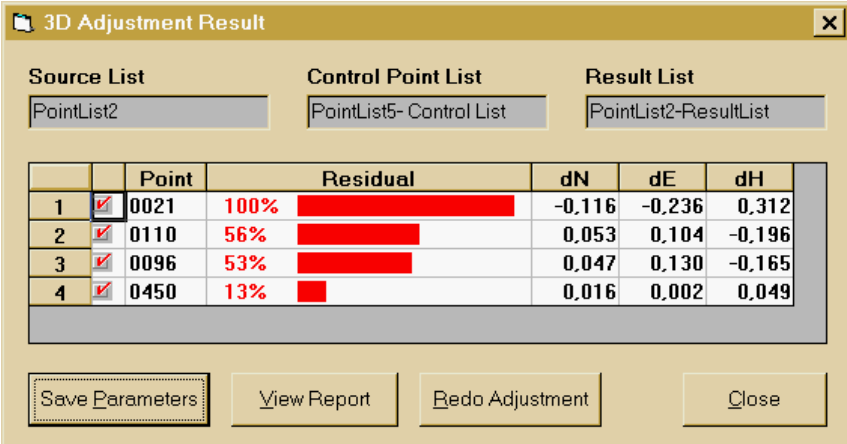
You will find out that carrying out an adjustment is simple. It is accomplished by making a mouse-click.

A number of points are necessary, which are common to two point lists. E.g., you should use the transformation adjustment method to adjust a list of points derived from a GPS campaign in the WGS84 System to a local datum such as "Deutschland_West". If you just transform the points of the WGS84 System to the local System, the control points generally do not fit very well. Therefore, you will need another 7 parameter similarity transformation to make the control points congruent. **GeoTrans** computes the new 7 (respectively 4 or 5, depending on your choice) parameters as well as a new list of adjusted points (PointList-ResultList).

GeoTrans allows to create three different transformation parameter sets:

- Adjustment of a 7 parameter transformation set,
- Adjustment of a 4 parameter transformation set,
- Adjustment of a 4 parameter transformation and height.

The parameter sets you choose will depend on the kind of your points and their relation to the control point list.



		Point	Residual	dN	dE	dH
1	☒	0021	100%	-0.116	-0.236	0.312
2	☒	0110	56%	0.053	0.104	-0.196
3	☒	0096	53%	0.047	0.130	-0.165
4	☒	0450	13%	0.016	0.002	0.049

Figure 51-1: Adjustment Result

The handling of all adjustment processes follows always the same scheme, independently of the type of adjustment. The following steps have to be considered:

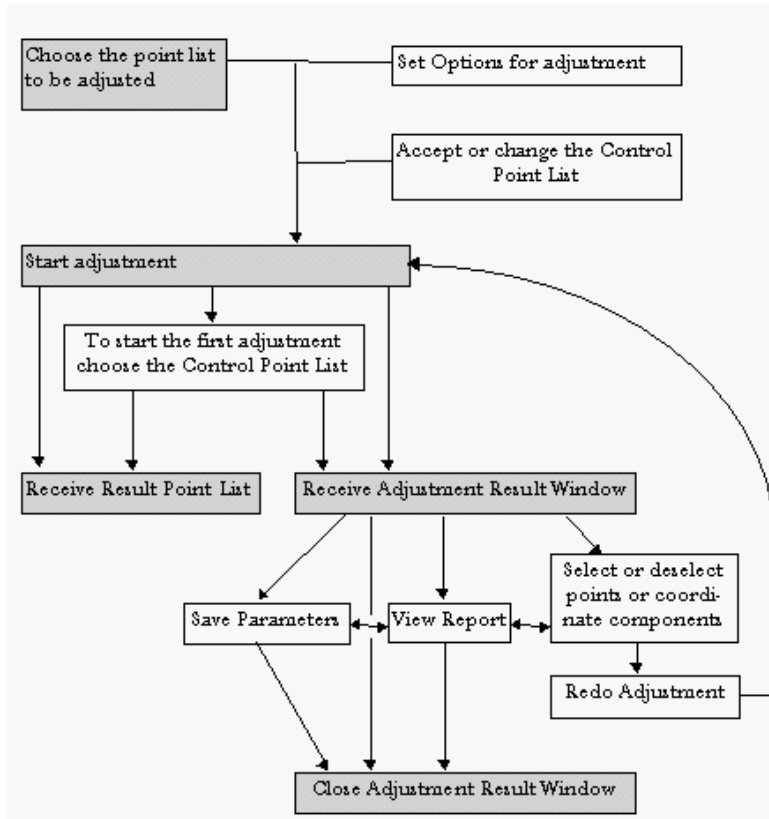


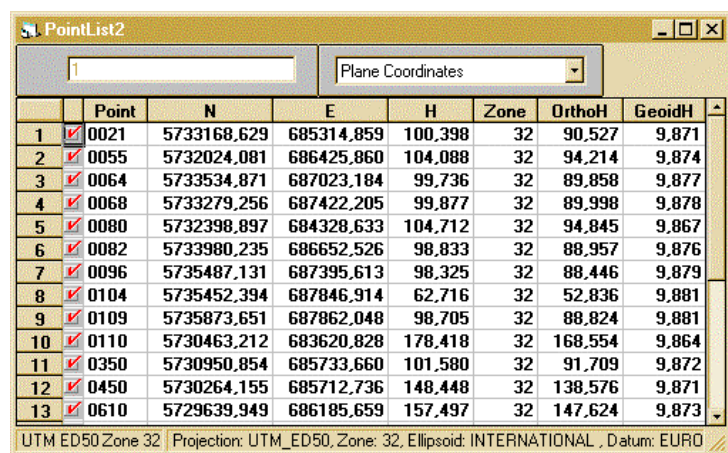
Figure 51-2: Adjustment Process

51.1 Start Adjustment

To start an adjustment choose the point list to be adjusted and define the control point list. You may be prompted to set some options, depending upon the type of adjustment.

51.1.1 Define Point List for Adjustment

To define the point list to be adjusted, just activate the list.



	Point	N	E	H	Zone	OrthoH	GeoidH
1	0021	5733168.629	685314.859	100.398	32	90.527	9.871
2	0055	5732024.081	686425.860	104.088	32	94.214	9.874
3	0064	5733534.871	687023.184	99.736	32	89.858	9.877
4	0068	5733279.256	687422.205	99.877	32	89.998	9.878
5	0080	5732398.897	684328.633	104.712	32	94.845	9.867
6	0082	5733980.235	686652.526	98.833	32	88.957	9.876
7	0096	5735487.131	687395.613	98.325	32	88.446	9.879
8	0104	5735452.394	687846.914	62.716	32	52.836	9.881
9	0109	5735873.651	687862.048	98.705	32	88.824	9.881
10	0110	5730463.212	683620.828	178.418	32	168.554	9.864
11	0350	5730950.854	685733.660	101.580	32	91.709	9.872
12	0450	5730264.155	685712.736	148.448	32	138.576	9.871
13	0610	5729639.949	686185.659	157.497	32	147.624	9.873

UTM ED50 Zone 32 Projection: UTM_ED50, Zone: 32, Ellipsoid: INTERNATIONAL, Datum: EURO

Figure 51-3: Activate Source Point List

In adjustment for plane and height, you may activate or deactivate plane and height input information individually for each point, if val-

ues appear to be outliers. Additional checkboxes allow you to select the input values and to redo adjustment then.

GeoTrans displays the additional checkboxes after you have clicked Options/Optional Columns... and checked one or both options of the PH Adjustment group (PLANE Checkboxes, Height Checkboxes). Click **OK** (**Cancel** will cancel any changes made).

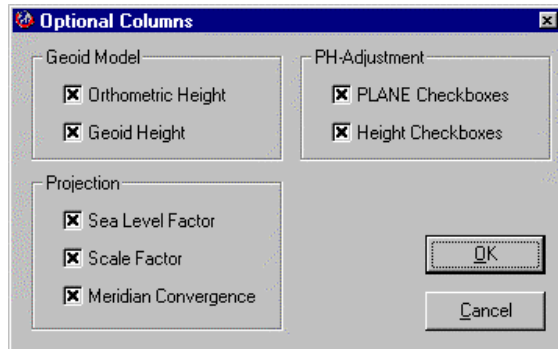


Figure 51-4: Activate PH Adjustment Checkboxes

You will notice that checkboxes are added to the heights and positions of the chosen point list.

		Point	N	E	Pln	H	Hgt	Zone	OrthoH	▲
1	☒	0021	5733168,629	685314,859	☒	100,398	☒	32	90,527	
2	☒	0055	5732024,081	686425,860	☒	104,088	☒	32	94,214	
3	☒	0064	5733534,871	687023,184	☒	99,736	☒	32	89,858	
4	☒	0068	5733279,256	687422,205	☒	99,877	☒	32	89,998	
5	☒	0080	5732398,897	684328,633	☒	104,712	☒	32	94,845	

Figure 51-5: Select or Deselect Points, Heights or Positions

These checkboxes are checked, but can be unchecked. In this way you can deselect complete points (see chapter 49.7), heights or positions.

GeoTrans will not consider deselected points, heights or positions for adjustment.

51.1.2 Define Control Point List

To start an adjustment **GeoTrans** needs a control list containing known points, e.g., given by a surveying authority. The control list has to contain several points with identical point number as the Adjustment Point List (also called source point list). At least three points must have identical point numbers to allow a three-dimensional adjustment. Two points are sufficient for a 2D adjustment and adjustment in plane and height.

The screenshot displays the GeoTrans software interface, which is used for geodetic data processing. It features two main windows: 'Point List' and 'Control List'.

Point List Window:

Point	Lat	Lon	H	Comment	GeoidH	
1	0001	N 51° 42' 01.19334"	E 11° 40' 53.60640"	135.148	91.181	44.858
2	0005	N 51° 42' 22.96726"	E 11° 41' 49.21511"	135.452	91.384	44.868
3	0004	N 51° 42' 18.89488"	E 11° 41' 23.22880"	135.672	91.384	44.818
4	0008	N 51° 42' 02.25111"	E 11° 41' 43.51462"	135.212	91.195	44.817
5	0009	N 51° 42' 31.47489"	E 11° 40' 00.80385"	140.696	90.988	44.896
6	0002	N 51° 42' 25.83389"	E 11° 41' 04.80161"	134.148	90.154	44.814
7	0006	N 51° 44' 13.56982"	E 11° 41' 46.40612"	133.631	89.570	43.961
8	0004	N 51° 44' 12.88742"	E 11° 41' 09.94841"	138.817	94.884	43.963
9	0009	N 51° 44' 15.94431"	E 11° 41' 11.44826"	134.698	90.958	43.942
10	0118	N 51° 42' 36.72070"	E 11° 38' 28.29835"	213.826	169.678	44.187
11	0008	N 51° 42' 02.25111"	E 11° 41' 43.51462"	135.212	91.195	44.817

Below the table, the text 'WGS84' and 'E(Spheroid WGS_84 Datum WGS_84, Local Word (LGM1302),004)' are visible.

Control List Window:

Point	X	Y	Z	GeoidH	
1	0001	3877794.326	881745.818	4981462.898	44.858
2	0005	3875631.376	881514.218	4984848.464	43.961
3	0118	3898734.254	889475.173	4981385.821	44.187
4	0008	3898096.428	881745.394	4981462.878	44.817

Below the table, the text 'WGS' and 'E(Spheroid WGS_84 Datum WGS_84, Local Word (LGM1302),004)' are visible.

Figure 51-6: Source and Control Point Lists

To define the control point list choose the Transformation/Options/Default Control Point List option. A dialog window allows you to choose the control point list from a list of point list.



Figure 51-7: Select Control Point List

This control point list will be valid for the Project as long as you do not change the entry. If you leave the Project without saving, the control point list name will not be saved, too.

GeoTrans is able to perform an adjustment in spite of differing Systems. The System of the result point list will always be the same System as that of the control point list. Coordinates will be given as Cartesian coordinates after 7 parameter adjustment, as geographical coordinates after 4 parameter adjustment.

Accept with **OK** and **GeoTrans** will perform the adjustment. As result you will find a new point list (result list) and the Adjustment Result window (see section 51.2) will pop up.

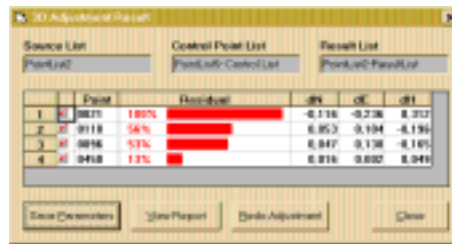


Figure 51-8 shows the '3D Adjustment Result' window. It contains three tabs: 'Source List', 'Control Point List', and 'Result List'. The 'Result List' tab is active, displaying a table with columns: Point, Residual, dX, dY, dZ. The table lists four points with their respective residuals and adjustments. Below the table are buttons: 'Save Parameters', 'Show Report', 'Undo Adjustment', and 'Close'.

	Point	Residual	dX	dY	dZ
1	0027	1.80%	-0.116	-0.238	0.202
2	0018	5.6%	0.952	0.194	-0.136
3	0016	5.1%	0.847	0.138	-0.145
4	0418	1.1%	0.016	0.002	0.049

Figure 51-8: Adjustment Result

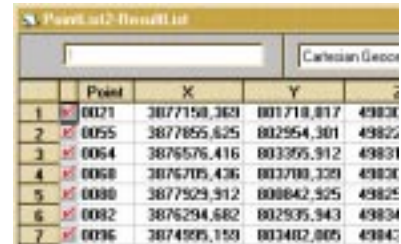


Figure 51-9 shows the 'PointList2-Result List' window. It contains a table with columns: Point, X, Y, Z. The table lists seven points with their coordinates. A 'Cartesian Geoc' button is visible on the right.

Point	X	Y	Z
0027	3877158.369	801718.817	49803
0055	3877655.625	802954.301	49825
0064	3876576.416	803355.912	49831
0068	3876705.436	803700.329	49828
0080	3877529.912	808842.925	49825
0082	3876294.682	802935.943	49834
0096	3874995.159	803402.805	49840

Figure 51-9: Result Point List

GeoTrans writes a result report into a default file. For each transformation adjustment type one default report file exists: RE-PORT3D.TMP, REPORT2D.TMP, REPORTPH.TMP. Each new adjustment overwrites the default report of its type.

To save to different report files, you may click Transformation / Options, then choose one of the adjustment types and change the entry in the Report File Name box. You may also Browse... for available directories (see sections 51.6.. 51.8).

You may save the calculated adjustment parameters from the Adjustment Result window for further use (see section 51.3). If you close the Adjustment Result window without saving, the adjustment parameters will be lost.

51.1.3 Set Adjustment Options

Prior to adjustment you may define transformation parameters to be held fixed. These values may be set in an options window and can be reported in a report file.

Depending on the adjustment type, a different number of parameters can be held fixed. Therefore, three option windows exist. Choose Transformation/Options and then

- 3D Adjustment and Transformation
- 2D Adjustment and Transformation
- Plane + Height Transformation

You will find further information on the Options window in the sections on the respective adjustment types.

To define or change the control point list choose Transformation/Options/Default Control Point List (see section 51.1.2).

To define whether **GeoTrans** shall display plane and height checkboxes for the current point list choose Options/Optional Columns... (see section 51.1.1)

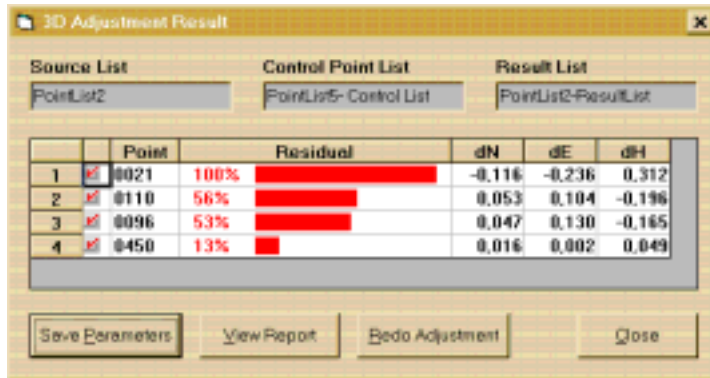
51.2 Adjustment Results

When an adjustment operation has been successfully completed, two things happen:

- a) The **Result Point List** shows up, which contains the points of the source list which are transformed into the System of the control list with the calculated adjustment parameters.

- b) concurrently, the **Adjustment Result** dialog pops up which shows you a short overview of the quality of the adjustment. From within this display you may take further steps to
- review a detailed adjustment report
 - switch control points on or off
 - redo the adjustment
 - save the adjustment parameters

Once you are satisfied with the adjustment result, close the Adjustment Result window and continue in normal working mode.

The Adjustment Result window**Figure 51-10: Adjustment Result Window**

The top of the dialog box displays - from the left to the right - the names of the Source List, of the control Point List and of the Result List. (If a string is too long to be displayed in the string field, click into the field and move the cursor to the left or right.)

	Point	Residual	dN	dE	dH
1	0450	100%	1,450	0,960	0,218
2	0110	97%	-0,859	-1,110	-0,955
3	0021	91%	-0,125	-0,214	1,576
4	0096	59%	-0,467	0,364	-0,839

Figure 51-11: Residuals

The main part of the box contains the results of the control points used for adjustment. For each point the following items are given:

- Check box
- Point number
- Resulting relative residual in percent of the maximum residual. A numerical value is given as well as an indicator bar.

- Absolute residual values for each coordinate, depending on the chosen coordinate system.
- Checkboxes for plane and height adjustment, (only in Plane + Height Adjustment).

The points are listed in order of the value of the relative residual.

Of course, you cannot change the resulting residuals. The check boxes, however, allow a new combination of control points. Through this and with help of the **Redo Adjustment** button you have the possibility to repeat the point adjustment, e.g., without a bad point.

Four buttons at the bottom of the Adjustment Result window allow further work with the obtained results. You may save the obtained parameters for further control (**Save Parameters**), may view, edit and print a report offering complete information on source and control lists and on the adjustment results (**View Report**) and redo the adjustment using, e.g., a different set of control points (**Redo Adjustment**).



Figure 51-12: Adjustment Result Window Options

51.3 Save Adjustment Parameters

You may want to make transformations using parameters derived by an adjustment. Therefore, adjustment parameters should be saved for further use.

To save the parameters just obtained click on the **Save Parameters** button. A dialog shows up.

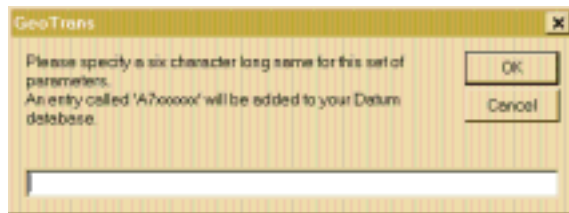


Figure 51-13: Save Parameters Dialog

You can assign a name to this set of parameters. The name may consist of 6 alphanumeric characters. Choose **OK** to accept the name. If you do not want to save parameters, then choose **Cancel**.

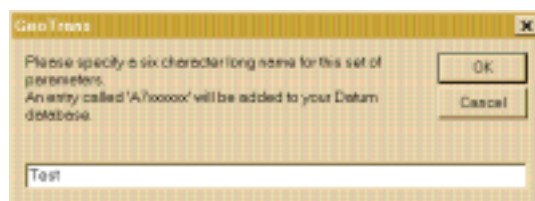


Figure 51-14: Save Parameters Dialog

Note, that the corresponding report file will also be renamed according to the name of the parameter set. This way, you can review the results later when you want to use the parameter set for transformations. These report files are by default stored in the <INSTALL DIR>\SYSDBS directory and can be easily reviewed (see next section).

51.4 View a Report File

A Report documents adjustment results as well as adjustment sources. You may edit or print the report files.

If you did not yet save adjustment parameters, **GeoTrans** automatically stores report files by default names into a default directory. **GeoTrans** uses a directory for temporary files, if you have set a Windows environment variable TEMP (1st choice) or TMP (2nd choice). If no such directory can be found, **GeoTrans** stores the default report into the current directory (3rd choice). You may store a report file under a new name and into any directory.

If you have already saved the adjustment parameters, **GeoTrans** moves the report files to the <INSTALL DIR>\SYSDBS directory.

The button **View Report** starts the Spectra Precision Terrasat **MultiPage** tool with the current report as a **MultiPage** document. You will find closer information on the functionality and the handling of **MultiPage** in the *MultiPage User's Manual* and the *MultiPage Macro Programming Guide*.

The following is an example of a **MultiPage** 3D adjustment report. First, it summarizes the date of creation, the method and the sources

for adjustment. The results follow: the report informs on the number of iterations, the adjusted parameters (scale, rotation X,Y,Z and translation X,Y,Z) and the standard error of unit weight. A table shows the residuals in the plane tangential system.

If an adjustment failed, e.g., because values did not convert after 99 iterations, **GeoTrans** will nevertheless create a report, which includes an error message.

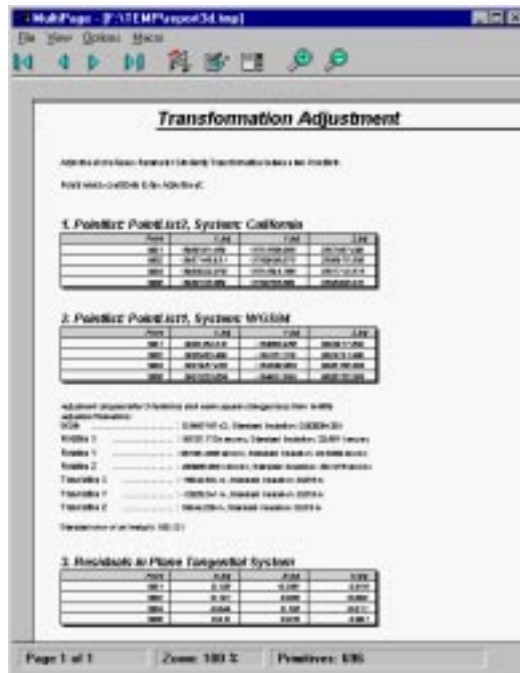


Figure 51-15: MultiPage Adjustment Report

51.5 Redo Adjustments

To repeat adjustments select or deselect the control points for a new adjustment using the check boxes. This allows you to deselect outliers. With an adjustment in plane and height, you may also select or deselect particular position or height values. **GeoTrans** will not consider deselected points, heights or positions for readjustment.

When you have clicked the **Redo Adjustment** button, you can decide whether you want to overwrite the existing result list. If you don't, you can specify a new result list name for the old result list.



Figure 51-16: New Name for Old Result List

A new Adjustment Result box will show the result parameters of the redone adjustment. The box shows all the previous points. Points deselected will be the last in order. During adjustment they have not been considered for the newly derived parameters. However, their new relative and absolute residual values computed from these parameters will be shown.

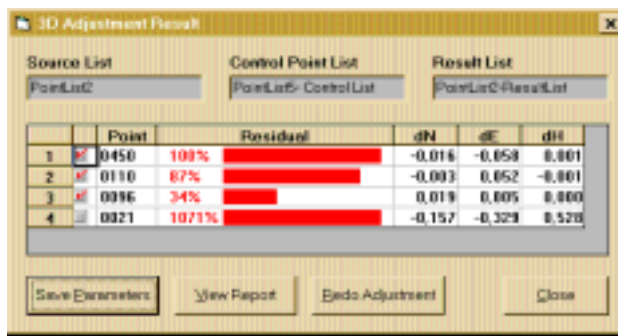


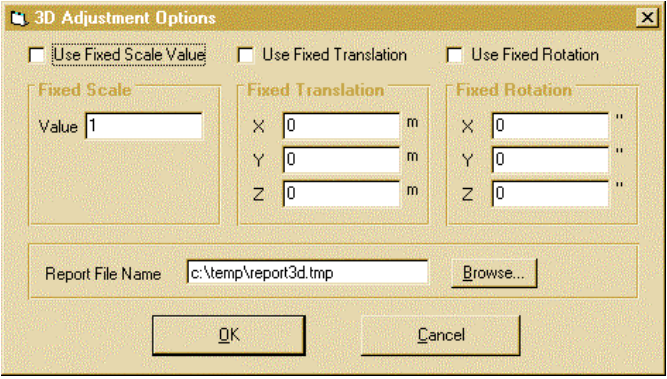
Figure 51-17: Redone Adjustment

51.6 3D Adjustment

To start a three-dimensional adjustment using the 7 parameter similarity transformation choose the list of points to be adjusted, the control point list (if it is not already preset correctly), set parameters and then choose **Transformation/3D Adjustment**. **GeoTrans** will start the adjustment process and as results you will receive a PointList - Result-List and the 3D Adjustment Result Window.

3D Adjustment Options

You may set some options before you start transformation. Choose **Transformation/Options/3D Adjustment** and **Transformation** and you will see the following 3D Adjustment Option window.

The dialog box is titled "3D Adjustment Options" and has a close button (X) in the top right corner. It contains three checkboxes at the top: "Use Fixed Scale Value", "Use Fixed Translation", and "Use Fixed Rotation". Below these are three panels. The "Fixed Scale" panel is active, showing a "Value" field with "1". The "Fixed Translation" panel has three fields for X, Y, and Z, each with "0" and a unit "m". The "Fixed Rotation" panel has three fields for X, Y, and Z, each with "0" and a unit "°". At the bottom, there is a "Report File Name" field with the text "c:\temp\report3d.tmp" and a "Browse..." button. Below the file name field are "OK" and "Cancel" buttons.

Option	Fixed Scale	Fixed Translation	Fixed Rotation
Use Fixed Scale Value	☒	☐	☐
Value	1	X: 0 m, Y: 0 m, Z: 0 m	X: 0 °, Y: 0 °, Z: 0 °
Report File Name	c:\temp\report3d.tmp		
Buttons	OK, Cancel, Browse...		

Figure 51-18: 3D Adjustment Options

It allows you to fix either the scale, the translational parameters, or the rotational parameters. For example, you may fix the scaling factor, and thereby prevent any adjustment of the scaling factor. If one of the options is checked, the respective group below will be activated and you can enter parameter values. If a checkbox is not checked, the respective group will be inactive and you can not enter fixed parameters. Possibly already given "fixed" values will not be used for the computation of transformation parameters. The following figure shows a scale value and a rotation around the x-axis which will be used.

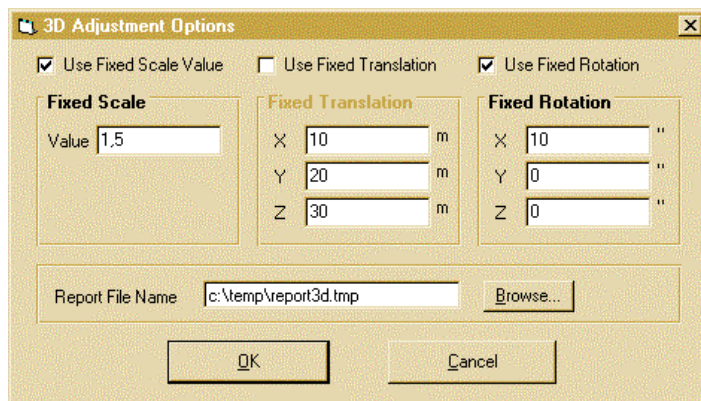
The image shows a dialog box titled "3D Adjustment Options". At the top, there are three checkboxes: "Use Fixed Scale Value" (checked), "Use Fixed Translation" (unchecked), and "Use Fixed Rotation" (checked). Below these are three sections: "Fixed Scale" with a "Value" field containing "1.5"; "Fixed Translation" with three fields for X (10), Y (20), and Z (30), each followed by a unit "m"; and "Fixed Rotation" with three fields for X (10), Y (0), and Z (0), each followed by a unit "". At the bottom, there is a "Report File Name" field containing "c:\temp\report3d.tmp" and a "Browse..." button. At the very bottom are "OK" and "Cancel" buttons.

Figure 51-19: 3D Adjustment Options: Fixed Scale

To fix the scale check the **Use Fixed Scale Value** checkbox and enter a scale value. The default scale value is 1.

To fix the translation or rotation values, check the checkboxes **Use Fixed Translation** or **Use Fixed Rotation**, respectively. In these cases you have to define the 3 values X, Y, Z separately. Default translation or rotation values are 0,0,0, given in meters. The unit is independent from the unit setting via **Options/Unit Settings**.

You may also alter the file name and location for the 3D Adjustment Report. The **Report File Name** string field allows you to change the file name for the report file. Each new 3D adjustment will overwrite this file with its report.

By default the report files are stored in the C:\T[E]MP or current directory. You may browse the disk to specify other directories (**Browse...**).

3D Adjustment Parameters

If you save the adjustment parameters derived by a 3D adjustment with the button **Save Parameters**, these will be written into your datum database file (<INSTALLDIR>\SYSDBS\DATUM.DBS). The corresponding report file will be moved to the same directory under the name A7*.MP.

51.7 2D Adjustment

To start a two-dimensional adjustment which adjusts a 4 parameter similarity transformation choose the list of points to be adjusted, the control point list, if it is not preset correctly, set parameters and then choose Transformation/2D Adjustment. **GeoTrans** will start the adjustment process and the results will be displayed as a PointList - ResultList and the 2D Adjustment Result Window.

2D Adjustment Options

You may set some options before you start transformation. Choose Transformation/Options/2D Adjustment and Transformation and you will see the following 2D Adjustment Option window.

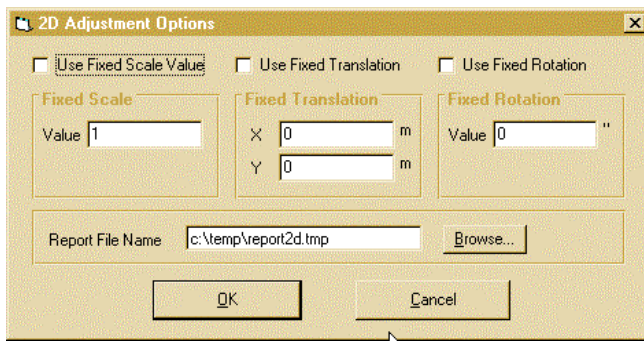


Figure 51-20: 2D Adjustment Options

It allows to fix either the scale, or the two translational parameters, or the rotational parameter. You may fix, e.g., the rotation angle, and thereby prevent points to be rotated. If one of the options is checked, the respective group below will be activated and you can enter parameter values. If a checkbox is not checked, the respective group will be inactive and you can not enter fixed parameters. Previously given “fixed” values will not be used in the computation of transformation parameters (see section 51.6).

To fix the scale check the **Use Fixed Scale Value** checkbox and enter a scale value. The default scale value is 1.

To fix the translation values check the checkbox **Use Fixed Translation**. You have to define the two values X, Y separately. Default translation values are 0,0, given in meters. The unit is independent from the unit setting via **Options/Unit Settings**.

To fix the rotation angle check the checkbox **Use Fixed Rotation**. The default angle value is 0, given in arcseconds. This unit is also independent from the unit setting via **Options/Unit Settings**.

You may also alter the file name and location for the 2D Adjustment Report. The **Report File Name** string field allows you to change the file name for the report file. Each new 2D adjustment will overwrite this file with its report.

By default the report files are stored in the C:\T[E]MP or current directory. You may browse the disk to specify other directories (**Browse...**).

2D Adjustment Parameters

If you save the adjustment parameters derived by a 2D adjustment with the button **Save Parameters**, these will be written into the file <INSTALLDIR>\SYSDBS\A4*.LCS. The corresponding report file will be moved to the same directory under the name A4*.MP.

51.8 2D Adjustment with Height Adjustment

To start a two-dimensional adjustment including height adjustment choose the list of points to be adjusted, the control point list, set parameters and then choose **Transformation/Adjustment of Plane + Height**. **GeoTrans** will start the adjustment process and results will be displayed as a PointList - ResultList and a Plane + Height Adjustment Result Window.

Options for 2D Adjustment with Height Adjustment

You may set some options before you start transformation. Choose Transformation/Options/Plane + Height Transformation and you will see the following Plane + Height Adjustment Options window.

Plane + Height Adjustment Options

☒ Use Fixed Scale Value ☐ Use Fixed Translation ☐ Use Fixed Rotation ☐ Use Fixed Height Shift

Fixed Scale
Value: 1

Fixed Translation
X: 0 m
Y: 0 m

Fixed Rotation
Value: 0 °

Fixed Height Shift
Value: 0 m

Report File Name: c:\temp\reportPH.tmp Browse...

OK Cancel

Figure 51-21: Plane and Height Adjustment Options

It allows you to fix either the scale, or the two translational parameters, or the rotational parameter, or the height shift parameter. You may fix, e.g., the translation values, and thereby prevent points to be translated in the plane. If one of the options is checked, the respective group below will be activated and you can enter parameter values. If a checkbox is not checked, the respective group will be inactive and you can not enter fixed parameters. Previously given “fixed” values will not be used in the computation of transformation parameters (see section 51.6).

To fix the scale check the **Use Fixed Scale Value** checkbox and enter a scale value. The default scale value is 1.

To fix the translation values check the checkbox **Use Fixed Translation**. You have to define the 2 values X, Y separately. Default trans-

lation values are 0,0, given in meters. The unit is independent from the unit setting via Options/Unit Settings.

To fix the rotation angle check the checkbox Use Fixed Rotation. The default angle value is 0, given in arcseconds. This unit is also independent from the unit setting via Options/Unit Settings.

To fix the height value check the checkbox Use Fixed Height Shift. Default height shift is 0 m. The unit is independent from the unit setting via Options/Unit Settings. The use of the default height shift of 0 m results in a simple 2D adjustment!

You may also alter the file name and location for the Adjustment Report. The Report File Name string field allows you to change the file name for the report file. Each new 2D adjustment with height adjustment will overwrite this file with its report.

By default the report files are stored in the C:\T[E]MP or current directory. You may browse the disk to specify other directories (Browse...).

2D with Height Adjustment Parameters

If you save the adjustment parameters derived by a 2D adjustment with height adjustment with the button **Save Parameters**, these will be written into the file <INSTALLDIR>\SYSDBS\AP*.LCS. The corresponding report file will be moved to the same directory under the name AP*.MP.

52. Extending and Customizing GeoTrans

52.1 Create Your Own Converter

You may program your own converter and compile it to a DLL.

Copy the DLL into directory <INSTALLDIR>\IODLL. For **GeoTrans** to recognize a new converter DLL, restart the application. Now the converter will be available for data import and export.

Please contact Spectra Precision Terrasat GmbH to receive the necessary C++ interfaces.

52.2 Create Your Own Special Transformation

You may program your own special transformation (conversion) and compile it to an *.DLL.

Copy the *.DLL into directory <INSTALLDIR>\IODLL. For **GeoTrans** to recognize a new special transformation DLL, restart the application. Now the special transformation will be available for the transformation between coordinate systems within a System.

Please contact Spectra Precision Terrasat GmbH to receive the necessary C++ interfaces.

52.3 Create Your Own Transformation Type

You may program your own transformation type and compile it to an *.DLL.

Copy the *.DLL into directory <INSTALLDIR>\IODLL. For **GeoTrans** to recognize a new transformation type DLL, restart the application. Now the transformation type will be available to transform point coordinates to a predefined System.

Please contact Spectra Precision Terrasat GmbH to receive the necessary C++ interfaces.

52.4 Adding Geoid Models

52.4.1 Geoid Models Supplied with GeoTrans

GeoTrans includes a number of freely available geoid models. Geoid models consist of one or more data files, which each need a considerable amount of disk space. Therefore, geoid models may be installed separately from the installation CD. If you want to use further geoid models you have to place the data files into the directory

<InstallDir>\SYSDBS

GeoGenius will automatically recognize all geoid models that are located in this directory.

You can use the separate installation program for geoid models. This setup program can be evoked by double-clicking the icon "Install Geoid Models" in the GeoGenius program group while the installation CD is in the CD drive or directly by starting



```
<CD-DRIVE>:\SETUP\GEOID\SETUP.EXE
```

Or, you can copy the corresponding files from the installation CD's directory

```
<CD-DRIVE>:\BIN\SYSDBS\
```

to the above mentioned directory

```
<InstallDir>\SYSDBS\
```

52.4.2 Install Commercially A vailable Geoid Models

You may also get additional geoid model data files from developing surveying institutions. Copy these files also to

```
<InstallDir>\SYSDBS\
```

52.4.3 Adding a User Defined Geoid Model

To use your own geoid model with **GeoTrans** all you have to do is to prepare a file with your geoid data and copy it into the directory `<InstallDir>\SYSDBS`. The data file must have one of the specific formats and file name extensions for **GeoTrans** to recognize the data files and to add the geoid model to the system. Refer to Appendix 54.6.3 for a list and description of the currently allowed file formats.

53. Interaction with GeoGenius Data Processing

GeoGenius allows you to perform transformations and transformation adjustments from within the Project Manager. Once a project is loaded or defined, the transformation module **GeoTrans** may be started from the **Tools** menu. If you use the entry **Transformation/Projection** in the pull-down list, **GeoTrans** is called and a **Project1** is started. The points of the current project are listed in **PointList1**. You may rename the point list.

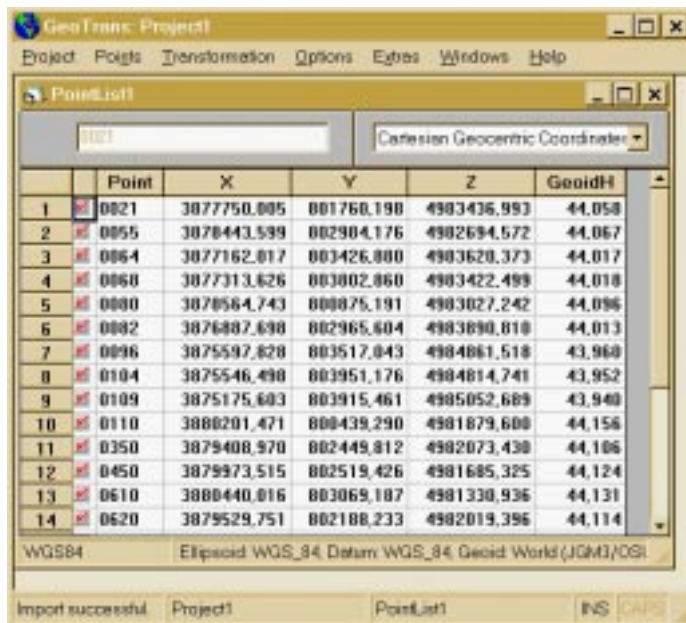


Figure 53-1: GeoTrans from Project Manager

The System of PointList1 is the WGS84 System, coordinates are given as Cartesian Coordinates.

On exiting the program you may or may not save the project under a new name. You are then transferred back to the **GeoGenius** Project Manager.

54. Appendix

54.1 Ellipsoids

The datum systems use the following ellipsoids.

Datum	Ellipsoid
WGS_84	WGS_84
ARGENTINA_CAMPO_INCH	INTERNATIONAL
ARGENTINA_GRS67	INTERNATIONAL_1967
ADINDAN	CLARKE_1880
ARAMCO	INTERNATIONAL
ARC_1950	CLARKE_1880
AUSTRALIAN_GEODETTIC_1966	AUSTRALIAN_NATIONAL
AUSTRALIAN_GEODETTIC_1984	AUSTRALIAN_NATIONAL
ATS77	WGS_84
BELGIUM	INTERNATIONAL
BUKIT_RIMPAH	BESSEL
CAMP_AREA_ASTRO	INTERNATIONAL
CAPE_DATUM	MOD_CLARKE_1880
CZECH_SLOVAKIA_BESSEL	BESSEL
DEUTSCHLAND_OST	KRASSOWSKY
DEUTSCHLAND_WEST	BESSEL
DJAKARTA	BESSEL
ED50_ITALY	INTERNATIONAL
ED50_SPAIN	INTERNATIONAL
EUROPEAN_1950	INTERNATIONAL
FINLAND	INTERNATIONAL
FRANCE	CLARKE_1880_IGN
G._SEGARA	BESSEL
G._SERINDUNG	WGS_84
GEODETTIC_DATUM_1949	INTERNATIONAL
GHANA	WGS_84
OSGB36	AIRY
GUAM_1963	CLARKE_1866
HERAT_NORTH	INTERNATIONAL
HJORSEY_1955	INTERNATIONAL
HU-TZU-SHAN	INTERNATIONAL

ICELAND	INTERNATIONAL
INDIAN	EVEREST
Datum	Ellipsoid
IRELAND_1965	MODIFIED_AIRY
ITALIAN_1940	INTERNATIONAL
KERTAU	MODIFIED_EVEREST
LIBERIA_1964	CLARKE_1880
LUZON	CLARKE_1866
MERCHICH	CLARKE_1880
MONTJONG_LOWE	WGS_84
NAD83	WGS_84
NARHWAN	CLARKE_1880
NIGERIA_MINNA	CLARKE_1880
NORTH_AMERICAN_1927_CANADA	CLARKE_1866
NORTH_AMERICAN_1927_CONUS	CLARKE_1886
OLD_HAWAIIIN_KAUAI	INTERNATIONAL
OLD_HAWAIIIN_MAUI	INTERNATIONAL
OLD_HAWAIIIN_OAHU	INTERNATIONAL
ÖSTERREICH	BESSEL
PORTUGAL_ED73	INTERNATIONAL
QORNOQ	INTERNATIONAL
RD	BESSEL
RD_ZONDER_GEOIDE	BESSEL
RT90	BESSEL_1841
RR92	BESSEL_1841
SD_LUZON_SPECIAL	CLARKE_1866
SD_MGRS-RELATED_INDIAN-SD	EVEREST
SD_TOKYO_SPECIAL	BESSEL
SD_WGS_84_SPECIAL	WGS_84
SIERRA_LEONE_1960	WGS_84
SOUTH_AMERICAN_CAMPO_INCH	INTERNATIONAL
SOUTH_AMERICAN_CHUA_ASTRO	INTERNATIONAL
SOUTH_AMERICAN_CORREGO_AL	INTERNATIONAL
SOUTH_AMERICAN_PROVISIONAL	INTERNATIONAL
SOUTH_AMERICAN_YACARE	INTERNATIONAL
TAIWAN	INTERNATIONAL_1967
TANANARIVE_OBSERVAT_1925	INTERNATIONAL
TIMBALAI	BESSEL
TOKYO	BESSEL
UTM_ED50	INTERNATIONAL
UTM_MARTINIQUE	INTERNATIONAL
UTM_WGS	WGS_84
VOIROL	WGS_84

WGS_72
CORREGO_ALEGRE
SAD69

WGS_72
HAYFORD
SAD69

The ellipsoidal parameters used within the system are:

ELLIPSOID	Semimajor axis [m]	Inverse flattening
WGS_84	6378137.000	298.2572235630001
INTERNATIONAL	6378388.000	297.0000000225716
INTERNATIONAL_1967	6378160.000	298.2500000435636
CLARKE_1880	6378249.145	293.4649999958536
AUSTRALIAN_NATIONAL	6378160.000	298.2500000435636
BESSEL	6377397.155	299.1528128283983
MOD_CLARKE_1880	6378249.145	293.4663076736678
KRASSOWSKY	6378245.000	298.3000046726388
CLARKE_1880_IGN	6378249.200	293.4660209980696
AIRY	6377563.396	299.3249645775651
CLARKE_1866	6378206.400	294.9786982296745
EVEREST	6377276.345	300.8016999923457
MODIFIED_AIRY	6377340.189	299.3249645775651
MODIFIED_EVEREST	6377304.063	300.8016999923457
CLARKE_1886	6378206.400	294.9786982296745
BESSEL_1841	6377397.155	299.1528125697652
WGS_72	6378135.000	298.2600000373650
HAYFORD	6378388.000	297.0000000225716
SAD69	6378160.000	298.2500000435636

The ellipsoidal shape is defined by the semimajor axis and the inverse flattening of the ellipsoid.

$$x_{\text{local}} = \Delta x + (1+m) \begin{bmatrix} 1 & -\varepsilon_z & \varepsilon_y \\ \varepsilon_z & 1 & -\varepsilon_x \\ -\varepsilon_y & \varepsilon_x & 1 \end{bmatrix} X_{\text{WGS84}}$$

Translations Δx , Δy , Δz are given in meters and rotations ε_x , ε_y , ε_z in arc-seconds.

54.2 Datum Systems

The datum parameters available within the system are the following:

Datum	$\Delta x[m]$	$\Delta y[m]$	$\Delta z[m]$	$\epsilon x["]$	$\epsilon y["]$	$\epsilon z["]$	Scale factor [ppm]
WGS_84	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ARGENTINA_CAMPO_INCH	148.000	-136.000	-90.000	0.000	0.000	0.000	0.000
ARGENTINA_GRS67	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ADINDAN	162.000	12.000	-206.000	0.000	0.000	0.000	0.000
ARAMCO	130.000	232.000	-10.000	0.000	0.000	0.000	0.000
ARC_1950	143.000	90.000	294.000	0.000	0.000	0.000	0.000
AUSTRALIAN_GEODETTIC_1966	133.000	48.000	-148.000	0.000	0.000	0.000	0.000
AUSTRALIAN_GEODETTIC_1984	116.000	50.470	-141.690	-0.230	-0.390	-0.344	0.098
ATS77	0.000	0.000	-4.500	0.000	0.000	0.000	0.000
BELGIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BUKIT_RIMPAH	384.000	-664.000	48.000	0.000	0.000	0.000	0.000
CAMP_AREA_ASTRO	104.000	129.000	-239.000	0.000	0.000	0.000	0.000
CAPE_DATUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CZECH_SLOVAKIA_BESSEL	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DEUTSCHLAND_OST	-24.000	123.000	94.000	-0.020	0.250	0.130	1.100
DEUTSCHLAND_WEST	-582.000	-105.000	-414.000	-1.040	-0.350	3.080	8.300
DJAKARTA	377.000	-681.000	50.000	0.000	0.000	0.000	0.000
ED50_ITALY	181.100	85.800	23.600	-0.384	1.560	0.524	0.000
ED50_SPAIN	-231.000	-196.000	482.000	0.000	0.000	0.000	0.000
EUROPEAN_1950	87.000	98.000	121.000	0.000	0.000	0.000	0.000
FINLAND	78.000	231.000	77.000	0.000	0.000	0.000	0.000
FRANCE	66.000	170.000	-311.000	0.000	0.000	0.000	0.000
G._SEGARA	403.000	-684.000	-41.000	0.000	0.000	0.000	0.000
G._SERINDUNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GEODETTIC_DATUM_1949	-84.000	22.000	-209.000	0.000	0.000	0.000	0.000
GHANA	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OSGB36	-375.000	111.000	-431.000	0.000	0.000	0.000	0.000
GUAM_1963	100.000	248.000	-259.000	0.000	0.000	0.000	0.000
HERAT_NORTH	333.000	222.000	-114.000	0.000	0.000	0.000	0.000
HJORSSEY_1955	73.000	-46.000	86.000	0.000	0.000	0.000	0.000
HU-TZU-SHAN	634.000	549.000	201.000	0.000	0.000	0.000	0.000
ICELAND	0.000	0.000	0.000	0.000	0.000	0.000	0.000
INDIAN	-173.000	-750.000	-264.000	0.000	0.000	0.000	0.000
IRELAND_1965	-506.000	122.000	-611.000	0.000	0.000	0.000	0.000
ITALIAN_1940	-225.000	-65.000	9.000	0.000	0.000	0.000	0.000
KERTAU	11.000	-851.000	-5.000	0.000	0.000	0.000	0.000
LIBERIA_1964	90.000	-40.000	-88.000	0.000	0.000	0.000	0.000
LUZON	133.000	77.000	54.000	0.000	0.000	0.000	0.000

MERCHICH	-31.000	-146.000	-47.000	0.000	0.000	0.000	0.000
MONTJONG_LOWE	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NAD83	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NARHWAN	-231.000	-196.000	482.000	0.000	0.000	0.000	0.000
NIGERIA_MINNA	92.000	93.000	-122.000	0.000	0.000	0.000	0.000
NORTH_AMERICAN_1927_CANADA	9.000	-151.000	-185.000	0.000	0.000	0.000	0.000
NORTH_AMERICAN_1927_CONUS	8.000	-160.000	-176.000	0.000	0.000	0.000	0.000
Datum	$\Delta x[m]$	$\Delta y[m]$	$\Delta z[m]$	$\epsilon x["]$	$\epsilon y["]$	$\epsilon z["]$	Scale factor [ppm] m
OLD_HAWAIIIN_KAUAI	-190.000	230.000	341.000	0.000	0.000	0.000	0.000
OLD_HAWAIIIN_MAUI	-210.000	230.000	357.000	0.000	0.000	0.000	0.000
OLD_HAWAIIIN_OAHU	-201.000	224.000	349.000	0.000	0.000	0.000	0.000
ÖSTERREICH	128.000	-481.000	-664.000	0.000	0.000	0.000	0.000
PORTUGAL_ED73	241.731	-73.287	-27.971	0.237	-0.098	-1.408	2.600
QORNOQ	-164.000	-138.000	189.000	0.000	0.000	0.000	0.000
RD	-577.570	-14.450	-458.650	1.304	0.103	1.144	4.077
RD_ZONDER_GEOIDE	-565.040	-49.910	-465.840	0.409	-0.360	1.868	4.077
RT90	-424.300	80.500	-613.100	4.396	-1.987	5.185	0.000
RR92	-419.375	-99.352	-591.349	-0.850	-1.817	7.862	-0.995
SD_LUZON_SPECIAL	133.000	77.000	54.000	0.000	0.000	0.000	0.000
SD_MGRS-RELATED_INDIAN-SD	-173.000	-750.000	-264.000	0.000	0.000	0.000	0.000
SD_TOKYO_SPECIAL	128.000	-481.000	-664.000	0.000	0.000	0.000	0.000
SD_WGS_84_SPECIAL	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIERRA_LEONE_1960	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SOUTH_AMERICAN_CAMPO_INCH	148.000	-136.000	-90.000	0.000	0.000	0.000	0.000
SOUTH_AMERICAN_CHUA_ASTRO	134.000	-229.000	29.000	0.000	0.000	0.000	0.000
SOUTH_AMERICAN_CORREGO_AL	206.000	-172.000	6.000	0.000	0.000	0.000	0.000
SOUTH_AMERICAN_PROVISIONAL	288.000	-175.000	375.000	0.000	0.000	0.000	0.000
SOUTH_AMERICAN_YACARE	155.000	-171.000	-37.000	0.000	0.000	0.000	0.000
TAIWAN	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TANANARIVE_OBSERVAT_1925	189.000	242.000	91.000	0.000	0.000	0.000	0.000
TIMBALAI	639.000	-583.000	55.000	0.000	0.000	0.000	0.000
TOKYO	128.000	-481.000	-664.000	0.000	0.000	0.000	0.000
UTM_ED50	189.000	242.000	91.000	0.000	0.000	0.000	0.000
UTM_MARTINIQUE	-126.930	-547.940	-130.410	2.787	-5.161	0.858	13.823
UTM_WGS	0.000	0.000	0.000	0.000	0.000	0.000	0.000
VOIROL	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WGS_72	0.000	0.000	-4.500	0.000	0.000	0.000	0.000
CORREGO_ALEGRE	205.570	-168.770	4.120	0.000	0.000	0.000	0.000
SAD69	66.870	-4.370	38.520	0.000	0.000	0.000	0.000

54.3 Map Projections

The following projections are supported by **GeoTrans**. In the table below you find their names, their projection type and the datum and ellipsoid used by them.

Abbreviations:

TM Transverse Mercator
OM Oblique Mercator
LT Lambert conformal conic tangential
LS Lambert conformal conic secant
SD Stereographic double projection
BP Belgium projection
NP Netherland projection
CP Czechian projection
HP Hungarian projection
SP Swiss projection

Argentina	TM	ARGENTINA_CAMPO_INCH	INTERNATIONAL
Belgium	BP	BELGIUM	INTERNATIONAL
Canada_Edmonton	TM	NAD83	WGS_84
Canada_New_Brunswick	SD	ATS77_NEW_BRUNSWICK	ATS77
Canada_Nova_Scotia	TM	ATS77	WGS_84
Canada_Quebec	TM	NAD83	WGS_84
Czech_Slovakia_Krovak	CP	CZECH_SLOV._BESSEL	BESSEL
Deutschland_bessel	TM	DEUTSCHLAND_WEST	BESSEL
Deutschland_krass	TM	DEUTSCHLAND_OST	KRASSOWSKY
Finland	TM	FINLAND	INTERNATIONAL
France_centre	LT	FRANCE	CLARKE_1880_IGN
France_corse	LT	FRANCE	CLARKE_1880_IGN
France_nord	LT	FRANCE	CLARKE_1880_IGN
France_sud	LT	FRANCE	CLARKE_1880_IGN
Hungary	HP	WGS_84	WGS_84
Iceland_1	TM	ICELAND	INTERNATIONAL
Iceland_2	LT	ICELAND	INTERNATIONAL
Iceland_3	TM	ICELAND	INTERNATIONAL
Ireland	TM	IRELAND_1965	MODIFIED_AIRY
Italy_1	TM	ED50_ITALY	INTERNATIONAL
Italy_2_1	TM	ITALIAN_1940	INTERNATIONAL
Italy_2_2	TM	ITALIAN_1940	INTERNATIONAL
Netherlands	NP	RD	BESSEL
Portugal	TM	PORTUGAL_ED73	INTERNATIONAL
SOUTH_AFRICA	TM	CAPE_DATUM	MOD_CLARKE_1880
Sweden	TM	RT90	BESSEL_1841
Sweden_92	TM	RR92	BESSEL_1841
Switzerland	SP	CH_1903_(SWITZ.)	BESSEL
Taiwan	TM	TAIWAN	INTERNATIONAL_1967
US_AK10_5010	LS	NAD83	WGS_84
US_AK_1_5001	OM	NAD83	WGS_84
US_AK_2_5002	TM	NAD83	WGS_84
US_AK_3_5003	TM	NAD83	WGS_84
US_AK_4_5004	TM	NAD83	WGS_84
US_AK_5_5005	TM	NAD83	WGS_84
US_AK_6_5006	TM	NAD83	WGS_84
US_AK_7_5007	TM	NAD83	WGS_84

US_AK_8_5008	TM	NAD83	WGS_84
US_AK_9_5009	TM	NAD83	WGS_84
US_AL_E_0101	TM	NAD83	WGS_84
US_AL_W_0102	TM	NAD83	WGS_84
US_AR_N_0301	LS	NAD83	WGS_84
US_AR_S_0302	LS	NAD83	WGS_84
US_AZ_C_0202	TM	NAD83	WGS_84
US_AZ_E_0201	TM	NAD83	WGS_84
US_AZ_W_0203	TM	NAD83	WGS_84
US_CA_1_0401	LS	NAD83	WGS_84
US_CA_2_0402	LS	NAD83	WGS_84
US_CA_3_0403	LS	NAD83	WGS_84
US_CA_4_0404	LS	NAD83	WGS_84
US_CA_5_0405	LS	NAD83	WGS_84
US_CA_6_0406	LS	NAD83	WGS_84
US_CO_C_0502	LS	NAD83	WGS_84
US_CO_N_0501	LS	NAD83	WGS_84
US_CO_S_0503	LS	NAD83	WGS_84
US_CT___0600	LS	NAD83	WGS_84
US_DE___0700	TM	NAD83	WGS_84
US_FL_E_0901	TM	NAD83	WGS_84
US_FL_N_0903	LS	NAD83	WGS_84
US_FL_W_0902	TM	NAD83	WGS_84
US_GA_E_1001	TM	NAD83	WGS_84
US_GA_W_1002	TM	NAD83	WGS_84
US_GU___5400	TM	NAD83	WGS_84
US_HI_1_5101	TM	NAD83	WGS_84
US_HI_2_5102	TM	NAD83	WGS_84
US_HI_3_5103	TM	NAD83	WGS_84
US_HI_4_5104	TM	NAD83	WGS_84
US_HI_5_5105	TM	NAD83	WGS_84
US_IA_N_1401	LS	NAD83	WGS_84

US_IA_S_1402	LS	NAD83	WGS_84
US_ID_C_1102	TM	NAD83	WGS_84
US_ID_E_1101	TM	NAD83	WGS_84
US_ID_W_1103	TM	NAD83	WGS_84
US_IL_E_1201	TM	NAD83	WGS_84
US_IL_W_1202	TM	NAD83	WGS_84
US_IN_E_1301	TM	NAD83	WGS_84
US_IN_W_1302	TM	NAD83	WGS_84
US_KS_N_1501	LS	NAD83	WGS_84
US_KS_S_1502	LS	NAD83	WGS_84
US_KY_N_1601	LS	NAD83	WGS_84
US_KY_S_1602	LS	NAD83	WGS_84
US_LASH_1703	LS	NAD83	WGS_84
US_LA_N_1701	LS	NAD83	WGS_84
US_LA_S_1702	LS	NAD83	WGS_84
US_MA_I_2002	LS	NAD83	WGS_84
US_MA_M_2001	LS	NAD83	WGS_84
US_MD_1900	LS	NAD83	WGS_84
US_ME_E_1801	TM	NAD83	WGS_84
US_ME_W_1802	TM	NAD83	WGS_84
US_MI_C_2112	LS	NAD83	WGS_84
US_MI_N_2111	LS	NAD83	WGS_84
US_MI_S_2113	LS	NAD83	WGS_84
US_MN_C_2202	LS	NAD83	WGS_84
US_MN_N_2201	LS	NAD83	WGS_84
US_MN_S_2203	LS	NAD83	WGS_84
US_MO_C_2402	TM	NAD83	WGS_84
US_MO_E_2401	TM	NAD83	WGS_84
US_MO_W_2403	TM	NAD83	WGS_84
US_MS_E_2301	TM	NAD83	WGS_84
US_MS_W_2302	TM	NAD83	WGS_84
US_MT_2500	LS	NAD83	WGS_84
US_NC_3200	LS	NAD83	WGS_84
US_ND_N_3301	LS	NAD83	WGS_84
US_ND_S_3302	LS	NAD83	WGS_84
US_NE_2600	LS	NAD83	WGS_84
US_NH_2800	TM	NAD83	WGS_84
US_NJ_2900	TM	NAD83	WGS_84
US_NM_C_3002	TM	NAD83	WGS_84

US_NM_E_3001	TM	NAD83	WGS_84
US_NM_W_3003	TM	NAD83	WGS_84
US_NV_C_2702	TM	NAD83	WGS_84
US_NV_E_2701	TM	NAD83	WGS_84
US_NV_W_2703	TM	NAD83	WGS_84
US_NY_C_3102	TM	NAD83	WGS_84
US_NY_E_3101	TM	NAD83	WGS_84
US_NY_L_3104	LS	NAD83	WGS_84
US_NY_W_3103	TM	NAD83	WGS_84
US_OH_N_3401	LS	NAD83	WGS_84
US_OH_S_3402	LS	NAD83	WGS_84
US_OK_N_3501	LS	NAD83	WGS_84
US_OK_S_3502	LS	NAD83	WGS_84
US_OR_N_3601	LS	NAD83	WGS_84
US_OR_S_3602	LS	NAD83	WGS_84
US_PA_N_3701	LS	NAD83	WGS_84
US_PA_S_3702	LS	NAD83	WGS_84
US_PRVI_5200	LS	NAD83	WGS_84
US_RI___3800	TM	NAD83	WGS_84
US_SC___3900	LS	NAD83	WGS_84
US_SD_N_4001	LS	NAD83	WGS_84
US_SD_S_4002	LS	NAD83	WGS_84
US_TN___4100	LS	NAD83	WGS_84
US_TXNC_4202	LS	NAD83	WGS_84
US_TXSC_4204	LS	NAD83	WGS_84
US_TX_C_4203	LS	NAD83	WGS_84
US_TX_N_4201	LS	NAD83	WGS_84
US_TX_S_4205	LS	NAD83	WGS_84
US_UT_C_4302	LS	NAD83	WGS_84
US_UT_N_4301	LS	NAD83	WGS_84
US_UT_S_4303	LS	NAD83	WGS_84
US_VA_N_4501	LS	NAD83	WGS_84
US_VA_S_4502	LS	NAD83	WGS_84
US_VT___4400	TM	NAD83	WGS_84
US_WA_N_4601	LS	NAD83	WGS_84
US_WA_S_4602	LS	NAD83	WGS_84
US_WI_C_4802	LS	NAD83	WGS_84
US_WI_N_4801	LS	NAD83	WGS_84
US_WI_S_4803	LS	NAD83	WGS_84

US_WV_N_4701	LS	NAD83	WGS_84
US_WV_S_4702	LS	NAD83	WGS_84
US_WYEC_4902	TM	NAD83	WGS_84
US_WYWC_4903	TM	NAD83	WGS_84
US_WY_E_4901	TM	NAD83	WGS_84
US_WY_W_4904	TM	NAD83	WGS_84
UTM_AUSTRALIA	TM	AUSTRAL._GEODETIC_1984	AUSTRAL._NATION.
UTM_Argentina_67	TM	ARGENTINA_GRS67	INTERNATIONAL_1967
UTM_Argentina_Hayford	TM	ARGENTINA_CAMPO_INCH	INTERNATIONAL
UTM_BRAZIL_1	TM	SAD69	SAD69
UTM_BRAZIL_2	TM	CORREGO_ALEGRE	HAYFORD
UTM_Denmark	TM	EUROPEAN_1950	INTERNATIONAL
UTM_ED50	TM	UTM_ED50	INTERNATIONAL
UTM_MARTINIQUE	TM	UTM_MARTINIQUE	INTERNATIONAL
UTM_Saudi_Arabia_1	TM	NARHWAN	CLARKE_1880
UTM_Saudi_Arabia_2	TM	ARAMCO	INTERNATIONAL
UTM_Spain	TM	ED50_SPAIN	INTERNATIONAL
UTM_WGS	TM	WGS_84	WGS_84
United_Kingdom	TM	GREAT_BRITAIN_1936	AIRY

54.4 Converters

The following, currently implemented, converters allow **GeoTrans** to read and write point data from and to various file formats:

- Amilgeo Gauss-Krüger und britisches Meldesystem (* . *)
- Amilgeo Geographische Koordinaten (* . *)
- Amilgeo UTM (* . *)
- Amilgeo UTMREF (* . *)
- Ashtech C-Files (* . *)
- Geotracer Database File (* .DBS)
- Geotracer SPC-File (* .SPC)
- Geotronics Job or Area File (* .JOB, * .ARE)
- terraSat Cartesian (* .XYZ)
- terraSat Geographical (Dec. Degree) (* .GEO)

54.5 Transformation Types

Currently, **GeoTrans** offers the following transformation types, depending on the System specified for the source and the control point list:

- 7 Parameter Similarity Transformation
- various Multiple Regression Equations
- Nadcon NAD27 $\leftrightarrow$ NAD83

54.6 Geoid Models

54.6.1 Currently Supplied

The following geoid models are currently supplied by **GeoTrans**:

Setup:	Full Name:	Data Files:
NOAA94 AL	Alaska NOAA94	ALA94.GEO
Canada	Canada GSD91	NGSD91.BIN, NGSD91.SLV
NOAA93 Centr	Central US NOAA93	GE0ID93C.GEO
NOAA93 East	Eastern US NOAA93	GE0ID93E.GEO
NOAA93 Haw	Hawaii NOAA93	HAW93.GEO
NOAA96 Haw	Hawaii NOAA96	GE096HW.GEO
Italy	Italy ITG90	ITAL90FL.DAT
NOAA96 N Al	North Alaska US NOAA96	GE096AN.GEO
NOAA96 NC	Northcentral US NOAA96	GE096NC.GEO
NOAA96 NE	Northeastern US NOAA96	GE096NE.GEO
NOAA96 NW	Northwestern US NOAA96	GE096NW.GEO
NOAA96 PRVI	Puerto Rico - Virgin Islands	GE096PR.GEO
NOAA93 PRVI	Puerto Rico NOAA93	PRVI93.GEO
NOAA96 S Al	South Alaska US NOAA96	GE096AS.GEO
NOAA96 SC	Southcentral US NOAA96	GE096SC.GEO
NOAA96 SE	Southeastern US NOAA96	GE096SE.GEO
NOAA96 SW	Southwestern US NOAA96	GE096SW.GEO
Sweden	Sweden RN92	RN92.GRD
NOAA93 West	Western US NOAA93	GE0ID93W.GEO
World	World (JGM3/OSU91A)	WWGRID.JGM

The JGM3/OSU91A model is the worldwide standard model for geoid undulations. It is the best currently available global model which was derived from a spherical harmonic expansion JGM3 for degree and order 2 .. 70 and from the Ohio State University model OSU91A for terms 71..360. The system is implemented as a grid with a grid size of 0.25 degrees covering the earth from N85° to S85°. The data is provided with the installation media.

54.6.2 Interfaces to Commercially Available Models

GeoTrans has implemented interfaces to the following, commercially available geoid models:

Supplier:	Full Name:	Data Files:
Univ. Hannover, Germany IfE Institut für Erdmessung	European EGG 97	G* .BIN
Univ. Hannover, Germany	Germany IFE	GEOFRG .DAC

54.6.3 Current Formats for User Defined Geoid Model

Currently, **GeoTrans** recognizes geoid model files of the following file formats:

No	File Name	Extension
1)	*	.UG1

1) Format *.UG1

Preparing the Data File

The data file must be in the same format that the US National Geodetic Survey uses for the geoid models “Geoid 93” and “Geoid 96”. The format is binary for fast and safe access. It contains the name of the geoid model, information on the grid (which must be rectangular and equally spaced) and the geoid heights. Because the file format is the same, you can also use the NGS calculation program **GEOID.EXE** to verify your data file (this program is downloadable from <http://sinbad.ngs.noaa.gov/GEOID/geoid.html>).

For the database you have to specify:

- the southernmost latitude and westernmost longitude (in WGS84):
latMin and lonMin
latMin, lonMin in decimal degree
latMin and lonMin are float values (4 Byte).
Western longitudes are written with a negative sign (W102°12' =

-102.2°)

Southern latitudes are written with a negative sign (S74°12' = -74.2°)

- the number of latitudes and longitudes: latNr and lonNr
latNr > 2, lonNr > 2
latNr and lonNr are integer values (4 Byte)
- the grid spacing for latitude and longitude: latSpacing and lonSpacing.
latSpacing, lonSpacing in decimal degree
latSpacing, lonSpacing > 0
latSpacing and lonSpacing are float values (4 Byte)
- the geoid heights at the grid points
these are in meter and float values (4 Byte)
The geoid heights must be referring to the WGS84 ellipsoid and the WGS84 datum.

Example:

Assume you have geoid heights between 7°12' and 7°15' western longitude with an interval of 30'' and between 46°24' and 46°36' southern latitude with an interval of 15'' (boundaries included). Then

latMin = -46.6, latNr = 21, latSpacing = 0.25
lonMin = -7.25, lonNr = 7, lonSpacing = 0.5

Structure of the data file

The data file consists of rows. The first row contains the header, each of the following rows contains the geoid heights for a certain latitude. The length of one row is $4 \cdot \text{lonNr} + 4$ Bytes.

Header (first row):

Bytes 0 to 55:

The first 56 Bytes of the data file contain the name of the geoid model. This name will appear in the geoid selection lists. The text may contain alphanumerical characters and blanks.

Bytes 56 to 63 unused (8 Bytes)

Bytes 64 to 67 contain lonNr (4 Bytes)

Bytes 68 to 71 contain lonNr (4 Bytes)

Bytes 72 to 75 unused (4 Bytes)

Bytes 76 to 79 contain latMin (4 Bytes)

Bytes 80 to 83 contain latSpacing (4 Bytes)

Bytes 84 to 87 contain lonMin (4 Bytes)

Bytes 88 to 91 contain lonSpacing (4 Bytes)

The Bytes from 92 to $4 \cdot \text{latNr} + 3$ are unused and can be filled with zero. This completes the first row.

Data section:

The geoid heights follow. Geoid heights must be ordered in a grid with longitude ascending from left to right and latitude ascending from top to bottom. For the above example, this would be

```
-7.25 -7.241666 -7.233333    ...    ...    -7.2
-46.6
-46.595833
-46.591666
...
...
...
```

-46.4

The geoid heights of this grid must be written row by row to the data file as 4 Byte float values. So the first number is the geoid height for (latMin, lonMin), the next one is the geoid height for (latMin, lonMin + lonSpacing), up to (latMin, lonMin + lonNr * lonSpacing). The next row follows with geoid heights from (latMin + latSpacing, longMin) to (latMin + latSpacing, longMin + lonNr * lonSpacing). The last number written to the data file is the geoid height for (latMin + latNr * latSpacing, longMin + lonNr * lonSpacing).

Each row has to start with an integer value (4 Bytes) which is not used and can be set zero. Therefore, every row has a length of 4*latNr+4 Bytes.

Interpolation Method

A biquadratic interpolation is used to determine geoid heights at non-grid points, using the nine nearest surrounding grid points. That means, a function

$$f(x,y) = a + b x + c x^2 + d y + e y^2 + f x y + g x^2 y + h x y^2 + i x^2 y^2$$

is constructed, which yields in the geoid heights at the nine nearest grid points. This function is then evaluated at the non-grid point.

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Communication Software

WinFX

User's Manual



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55. Introduction

The GeoGenius® System contains a powerful utility for data transfer to another computer, to a Geotracer receiver or to a Geodimeter Total-Station via serial RS232. All standard file operations such as copying, deleting and renaming (only Geotracer & PC) are supported.

If you want to transfer area files, job files or observational data files between your handheld computer and your PC, just connect with the Spectra Precision system cable and communications adapter and run the WinFX tool.

WinFX® is strictly adjusted to GeoGenius and runs under Microsoft Windows 95, WINDOWS 98 and Windows NT.

This manual provides a detailed description of the WinFX® software. The first chapter describes how to establish a serial communications between a computer and a Geotracer receiver, the next one the communication between a PC and a Total-Station (Geodimeter), and the last chapter describes the data transfer between two computers.

56. Installation on the PC

The GeoGenius setup program contains a switch, which you can select. Then the WinFX is automatically installed with your GeoGenius Software.

57. Start of WinFX

As the WinFX program is a part of the GeoGenius software package, you can start it directly from the toolbar of the GeoGenius main program.

57.1 Start from the Geo Genius Toolbar

If you have just started GeoGenius, you can see a toolbar point called “Tools”. When you open this “Tools”-toolbar, you can see there a menu-point that is called “Transfer Data (Geotracer)”. Clicking to this opens a new menu, from which you can select “GTR/GDM Download”. This menu-point means starting a connecting to a Geotracer (GTR) or a Geodimeter (GDM) or a PC with the WinFX program.

57.2 First steps in WinFX

After starting WinFX, the “WinFX Startup Dialog” appears with a selection for the COM port of your PC, which you want to connect with a GTR/GDM/PC.



Figure 2: WinFX startup dialog

Please connect the desired sensor to a unused COM port of your PC and then select this COM port in the WinFX Startup Dialog. After pressing "O.K.", the system searches on the selected COM port with all baudrates for a connected sensor. While the system is searching on the different baudrates, a window appears and informs the user for what is currently going on.



Figure 3: Startup search

Then after the system has found a receiver, a Total-Station or a PC, you get a message dialog. In case of a connected Geotracer receiver, it looks like the following example:



Figure 4: Receiver found successfully

Now the startup procedure was successful and has finished. In this example, a Geotracer receiver was found on COM 2. If the connected

hardware is a PC or Geotracer receiver, the communication baudrate will be switched to 57600 baud for to get a faster data transformation. If the hardware is a Geodimeter, the baud-rate will remain at 9600 baud.

58. Communication with a Geotracer receiver

If you have connected a Geotracer receiver to a free port of your PC as described in chapter 3.2 and you have chosen the right COM port as described above, you will now get the main screen dialog of the WinFX program.

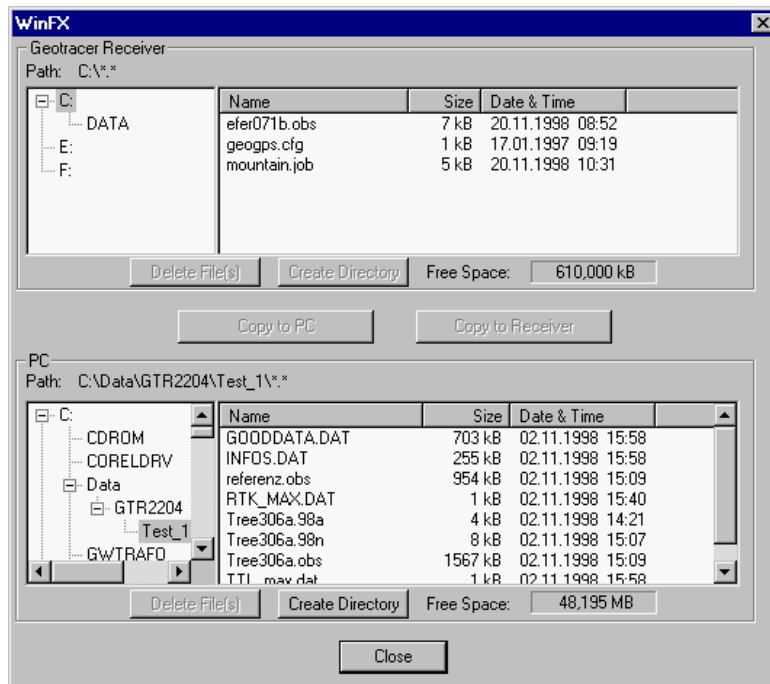


Figure 5: Main screen of WinFX after starting

58.1 Field description

The screen is split up into two main parts. The upper part shows the side of the connected hardware (Geodimeter, Geotracer or PC) with the name in the upper left corner and the lower part shows the side of your PC. In the middle of them there are two copy-buttons for to start the data transfer. After starting a data transfer, these copy buttons are removed and a progress bar appears.

58.1.1 Current path of the Geo tracer (GTR)

In the upper left corner of the GTR-screen-part, you see a field “*Path*”, which shows the current selected path of the GTR.

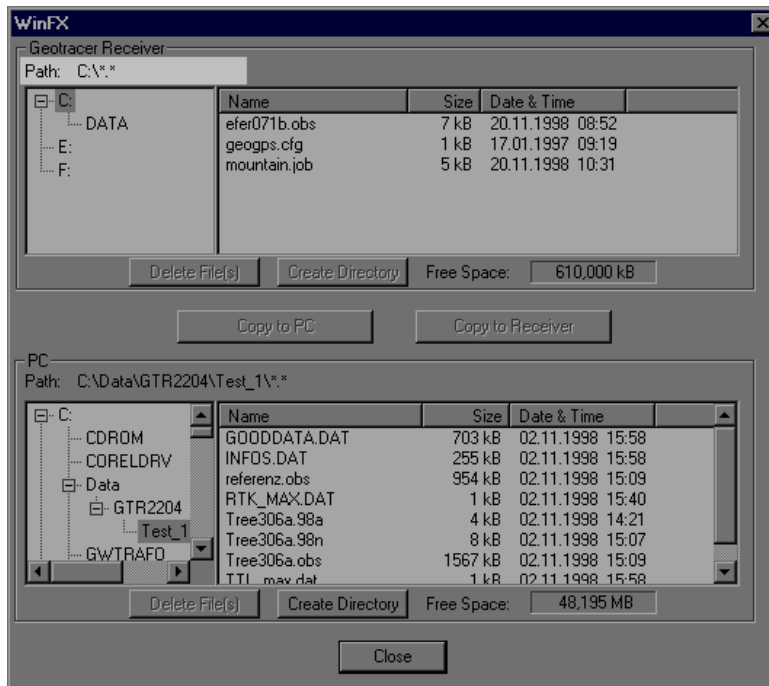


Figure 6: Current path of the GTR

58.1.2 Tree control of the GTR

The left field of the GTR array shows the directory tree, which is available on the PCMCIA card of the GTR. In the shown example there are three files and one subdirectory "DATA" in the main directory "C:\". Besides this there are two more drives available on the PCMCIA card of the Geotracer receiver, named as "E" and "F". This kind of sight is well known from the Microsoft® Explorer.

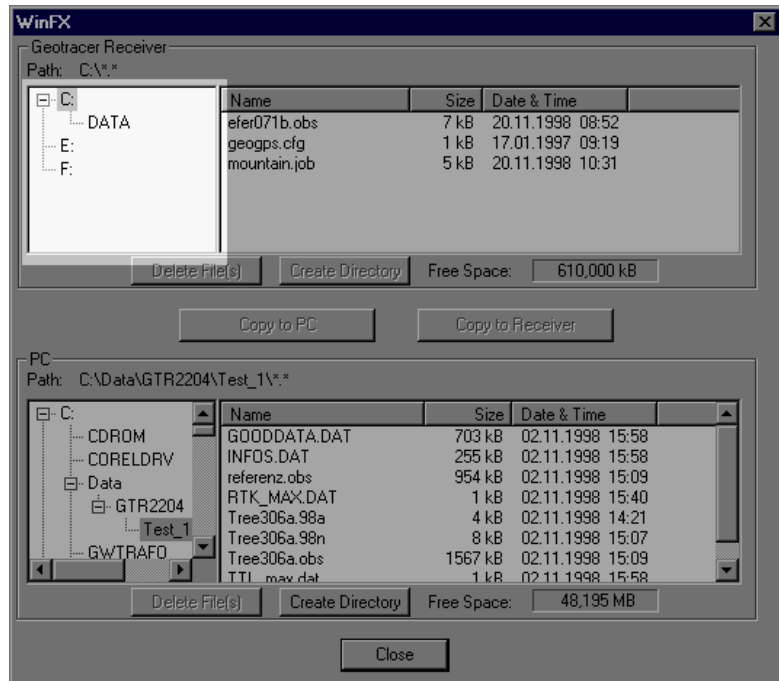


Figure 7: Tree control of the GTR

58.1.3 File listing of the GTR

The right field of the GTR array shows the files of the current selected directory. There are three columns which contain the filename, the file-size and the file-date and time. The user can change the width of these columns by clicking on the separator between the column names. For to select one file of this list, just click with the mouse pointer to the desired filename and you see the file becomes high-lighted.

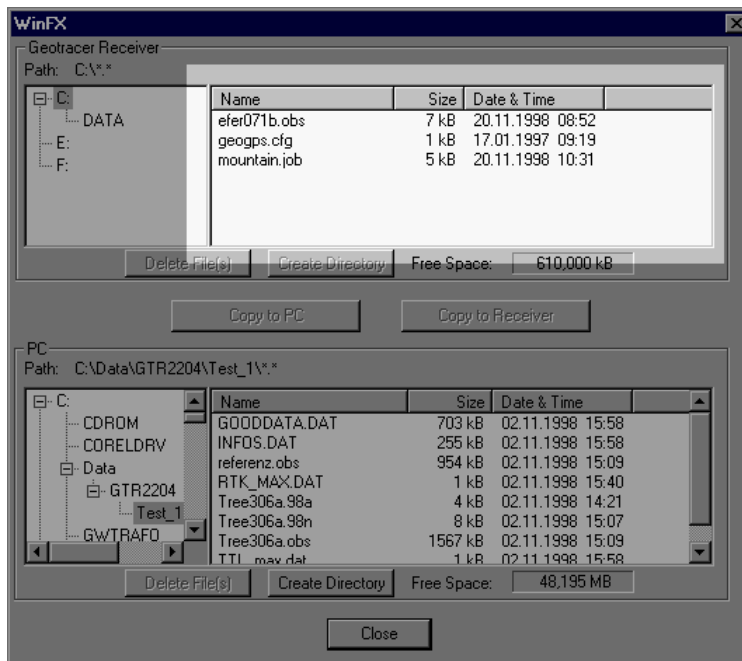


Figure 8: File list of the GTR

This file list allows multi-selection, that means that you can select more than one file by holding the “*Strg*”- key pressed down and click to the files you want to select (similar to the Microsoft Explorer). After you have selected one or more files from the filelist, the “*Copy to PC*”-button and the “*Delete File(s)*”-button, which were up to now inactive and unselectable, become active and could now be pressed for a copy or delete action.

58.1.4 Free space display field (GTR)

In the lower right corner you can see the free space on the current drive. This information is needed if you want to copy data from your PC to the GTR.

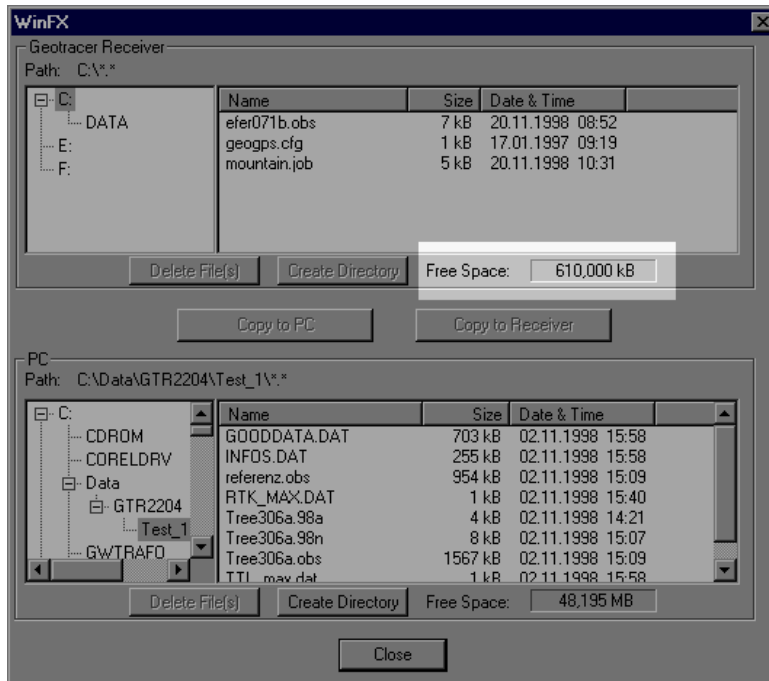


Figure 9: Free space of the GTR

58.1.5 Button “Delete File(s)” on Receiver

If you have selected at least one file in the filelist, the “Delete File(s)”-button changes its state to active. Now it is possible to delete all the selected files on the GTR.

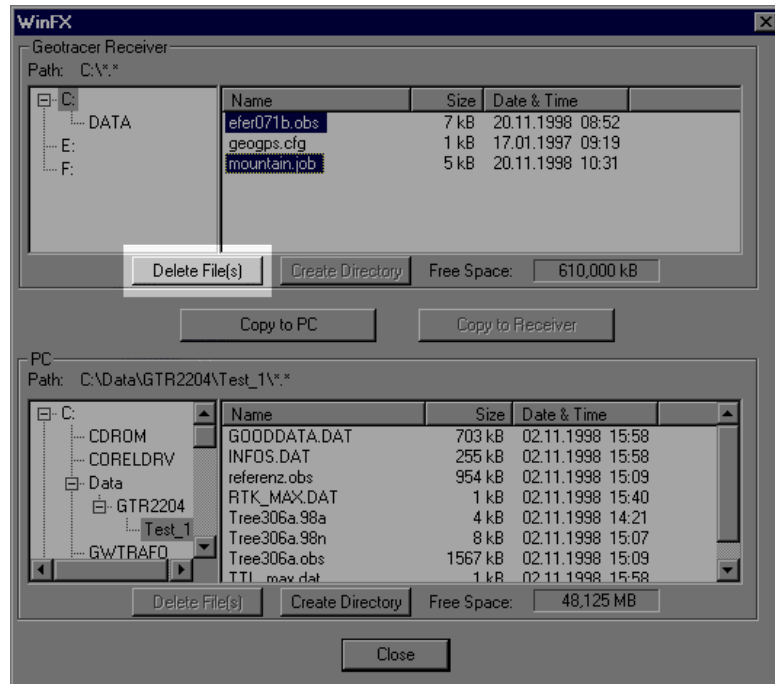


Figure 10: Button "Delete File(s)"

If you press this button, a message box appears, which expects a confirmation for the delete action.

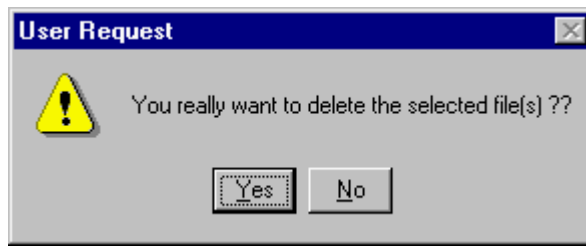


Figure 11: Confirmation box before deleting file(s)

After pressing “*Yes*”, all the selected files were deleted, and in the following the free space of the drive will change. If you press “*No*”, nothing will be deleted and you came back to the main screen. The former selected file(s) remain selected and you can go on working.

58.1.6 Button “Copy to PC”

If you have selected at least one file in the GTR filelist, the “*Copy to PC*”-button changes its state to active. Now it is possible to copy all the selected files from the GTR to your PC.

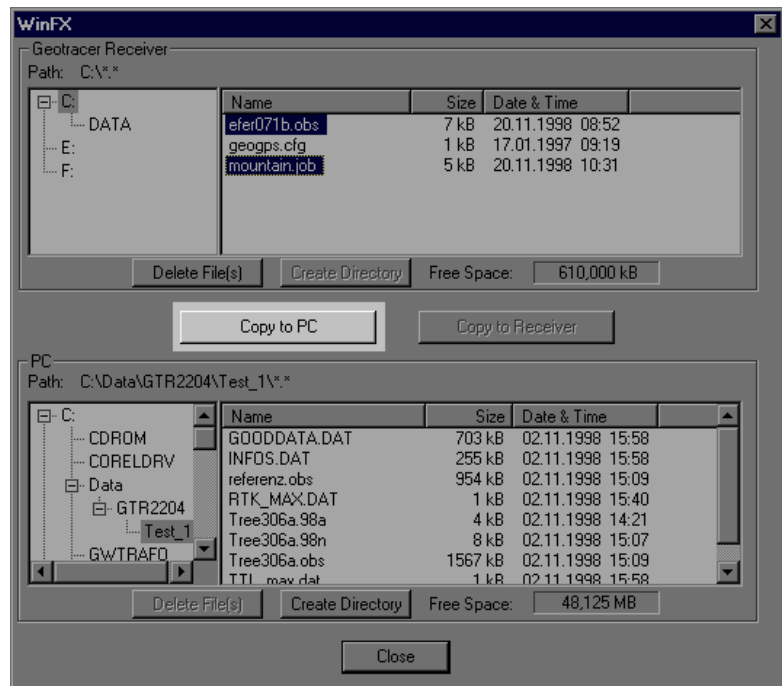


Figure 12: "Copy to PC" button

After pressing this button, the system checks whether the selected file(s) already exist on your PC. If not, the system starts with copying and shows you a progress bar.

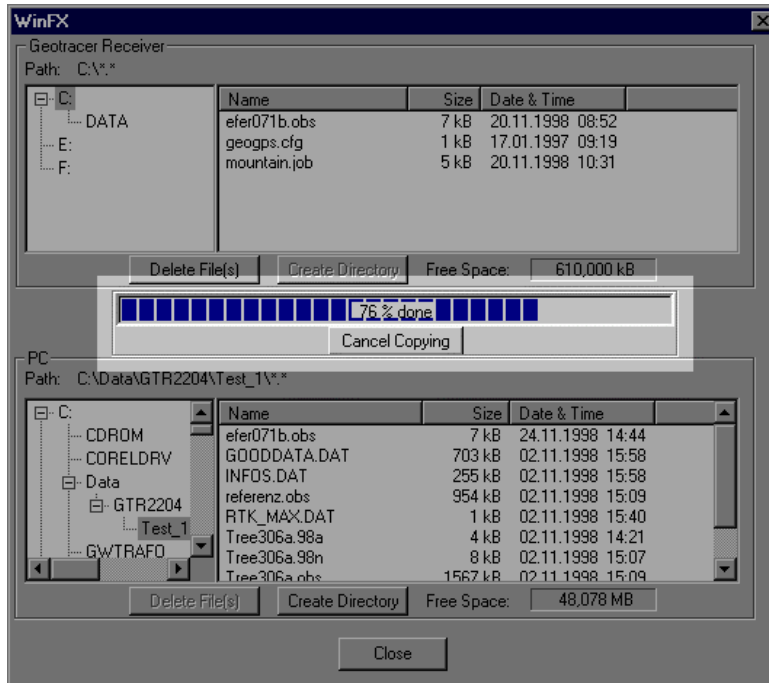


Figure 13: Progress bar while copying

While the progress bar is visible, a new button “*Cancel Copying*” is displayed just under the progress bar. With this button you can cancel the copy task. If you press this button, an info box appears, which ex-

pected a confirmation that you really want to cancel the copy task. Either you press “Yes”, then the copy task is stopped and the just transferred data were deleted, or you press “No”, then the systems goes on with copying.

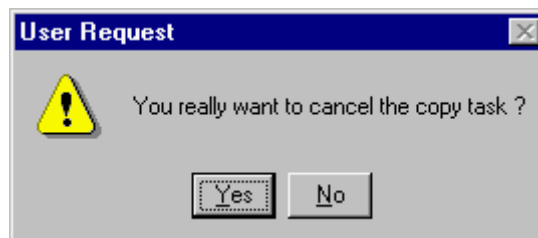


Figure 14: Confirmation before cancel a copy task

If you have selected at least on file and one of the selected files already exists on the PC in the currently selected directory, a message box opens and you were asked if you want to overwrite the existing file. Press “Yes” if you want to overwrite the already existing file or press “No” if you want to skip copying.

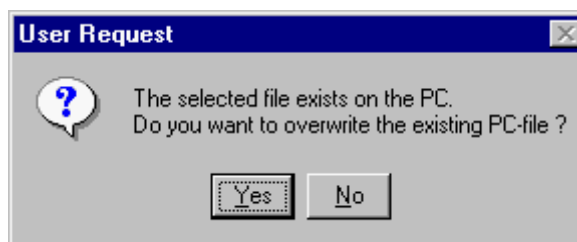


Figure 15: Confirmation before overwriting

58.1.7 Current path of your PC

Equivalent to the current path of the receiver (4.1.1)

58.1.8 Tree control of your PC

Equivalent to the tree control of the receiver (4.1.2)

58.1.9 File listing of your PC

Equivalent to the file listing of the receiver (4.1.3)

58.1.10 Free space display of your PC

Equivalent to the free space of the receiver (4.1.4)

58.1.11 Button “Delete File(s)” on your PC

Equivalent to “Delete File(s)” on the receiver (4.1.5)

58.1.12 Button “Copy to Receiver”

Equivalent to “Copy to PC” (4.1.6)

58.1.13 Create Directory on your PC

If you press the “*Create Directory*” button, a new subdirectory to the current path of the PC is created with the name “*newdir*” and it is immediately inserted into the tree control of the PC. You can change the name of the new directory by clicking once into the name “*newdir*” in the tree control. Now you can enter a new name. If the new name is correct, just click with the mouse to the upper directory from the new directory and the new name is set to the system.

58.1.14 Button “Close” the whole application

If you want to finish your work with WinFX, please press the “*Close*”-button and the program stops and the used COM port will be freed.

59. Communication with a Total Station

First connect a Geodimeter (GDM) or a Total Station (TS) to one of the free ports of your PC as described in chapter 3.2 and then choose the right COM port as described above in the starting screen. Now the program tries to connect to the Geodimeter and after you pass some searching dialogues, you should get an info window with the message that the system has found a Total Station connected to your PC.



Figure 16: Information that a TS was found

After a short time of displaying the screen that was shown in the figure above you now get the main screen dialog of the WinFX program.

59.1 Main screen of WinFX (connected TS)

In the upper part, you can see the information about the Total Station. Here you have three virtual directories, called "JOB", "AREA" and

“UDS”, where you can store data to or copy data from. In the lower part you see exact the same fields and buttons as described in the chapters 4.1.7 – 4.1.14.

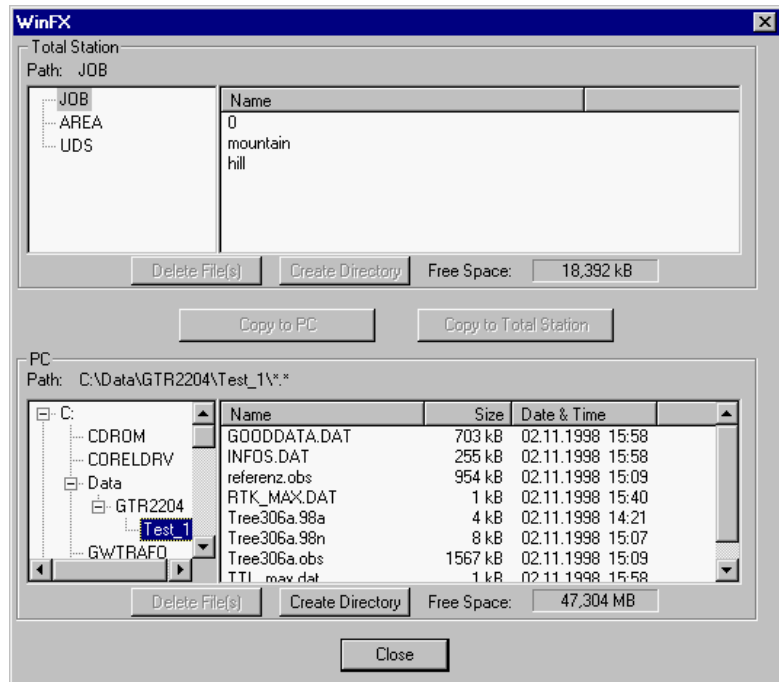


Figure 17: Main screen in case of connected TS

The only difference is, that the TS only supports (could store) tree types of files, that were:

- UDS-files with extension *.uds
- AREA-files with extension *.are or *.area
- JOB-files with extension *.job

59.2 Copying files from and to the TS

If you select files of the above type on the PC and then press the “*Copy to Total Station*”-button, they were automatically copied to the corresponding right folder of the TS-side. Besides this the file extensions were removed on the TS side, because each folder can only contain one type of files. If you copy files from the TS to the PC, the program will add automatically the right extension to the filename and the file will be stored in the directory, that is selected and displayed in the current path field.

If you try to transfer a file type different to the three known file types to the TS, an info box appears and you are restricted.

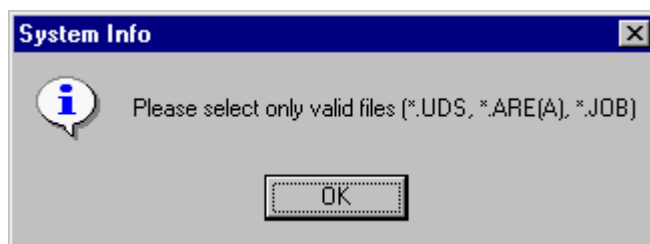


Figure 18: Restricted copy try

While copying data from or to the TS, you cannot cancel this copy task. If the data are copied from your PC to the TS, a progress bar is shown, as you know it from a connected Geotracer receiver. In the other direction, if you are copying data from the TS to your PC, only a counter of the just received bytes is displayed, because we don't know anything about the size of the files on the TS.

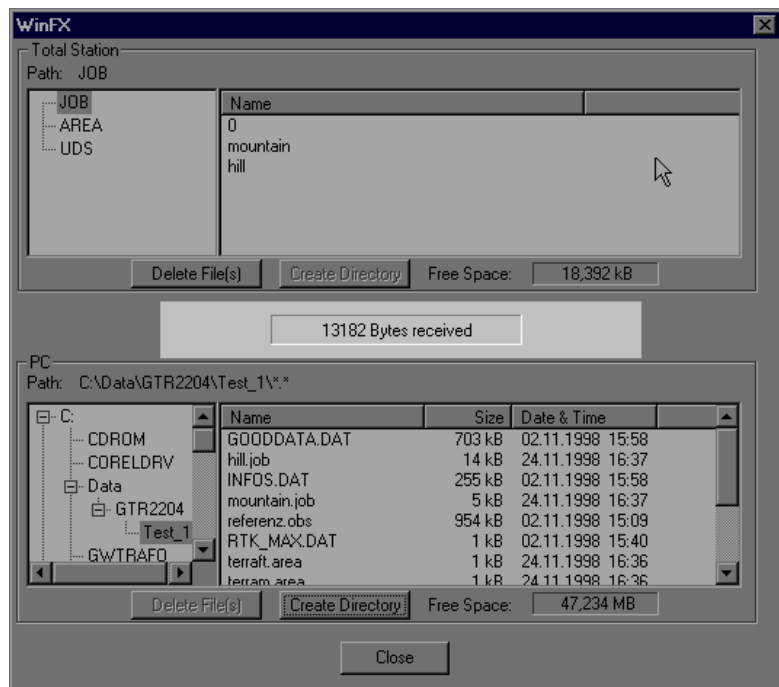


Figure 19: Counter while copying from TS

Attention: If you try to copy uds-, job- or area-files to the TS that contain label-ids greater than 100, you get an info box, that those registers were removed by the program and only the rest was copied to the TS.

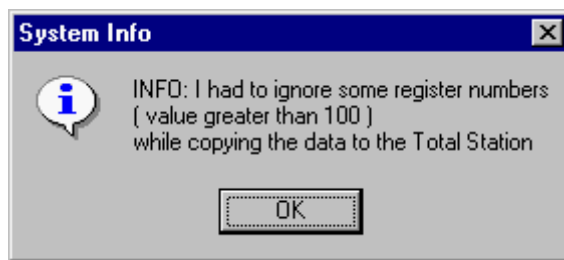


Figure 20: Detection of outrange labels

60. Communication with a second PC

First connect a second PC with a “Null-modem”-cable to one of the free ports of your PC as described in chapter 3.2 and then choose the right COM port as described above in the starting screen. Now the program tries to connect to the second PC and after you pass some searching dialogues, you should get an info window with the message that the system has found a second PC connected to your PC.



Figure 21: Information that a second PC was found

After a short time of displaying the screen that was shown in the figure above you get the main screen dialog of the WinFX program.

60.1 Main screen of WinFX (connected with a second PC)

In the upper part, you can see the information about the second PC and in the lower part you see information about your PC. All the func-

tion and buttons are identical to the case of a connected Geotracer receiver, so that in this place is no further information. Please read all the stuff in chapter four.

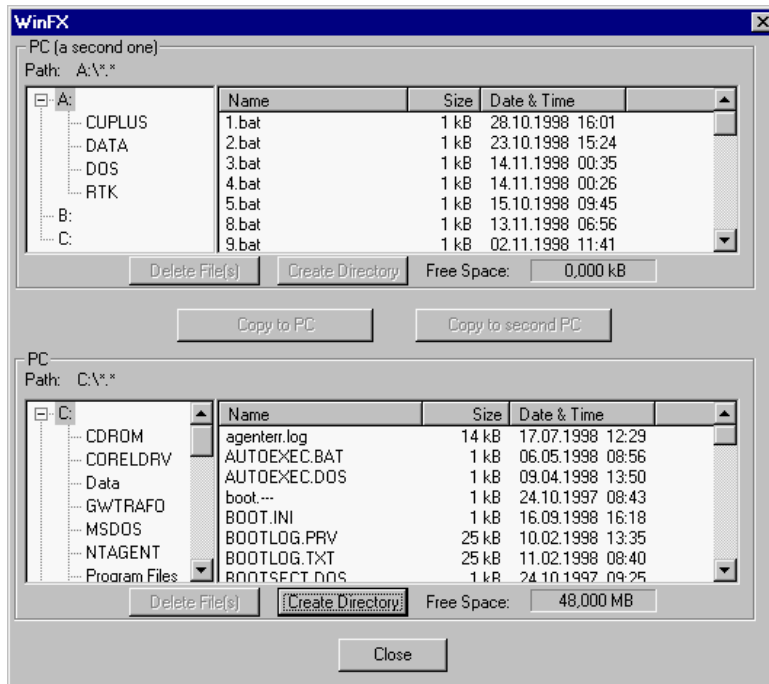


Figure 22: Main screen in case of connected second PC

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Geotracer[®] Communication Software

GeoCom

User's Manual



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Note

We are aware of the fact that our exclusive masculine pronoun "he" is considered politically incorrect, but has been used in this case to simplify readability.

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61. Introduction

The Geotracer® RTK System contains a powerful stand alone utility for data transfer between computers via serial RS232. All standard file operations such as copying and renaming are supported.

If you want to transfer area files, job files or observational data files between your handheld computer and your PC, connect with the Geotronics system cable and communications adaptor and run the Geotracer® communication software.

Geotracer® Communication runs under Microsoft WINDOWS 3.1, WINDOWS 95 or WINDOWS NT.

This manual provides a detailed description of the Geotracer® Communication software. The first chapters describe how to establish serial communications between the computers, the later chapters describe each function of the program.

62. Installation on the PC

A setup disk named GeoCom is delivered together with the RTK system. Insert the disk into the 3.5" disk drive of your PC.

62.1 Installation on a MS WINDOWS 3.1 or MS WINDOWS NT System

1. Open either the Program Manager or the File Manager.
 - 2a. If you opened the Program Manager, choose **Run** from the **File** menu and type the following command line:

[drive]:\setup
 - 2b. If you opened the File Manager, open the drive containing the Disk **GeoCom** and double-click on the file **SETUP . EXE**.
3. Follow the installation prompts that guide you completely through the installation process.

62.2 Installation on a MS WINDOWS 95 System

1. Click on the Add/Remove Programs icon in the Control Panel window. Follow the installation prompts that guide you through the installation process. Alternatively

- 1a. From a DOS prompt, type the line shown below, assuming that disk GeoCom is in the A: drive:

A:\setup

- 1b. From the Start menu, choose Run and type the line below, assuming that disk GeoCom is in the A: drive:

A:\setup

- 1c. From the Windows Explorer, open the drive containing the disk GeoCom and double-click on the file **SETUP.EXE**.

63. Start on Control Unit

To start the file transfer control program both computers have to be connected with the Geotronics system cable and communications adaptor and switched on.



If you use an L1/L2 receiver, be sure that no antenna is connected to it, when you connect the receiver to the PC!

First start the ACU. The Main Screen appears.

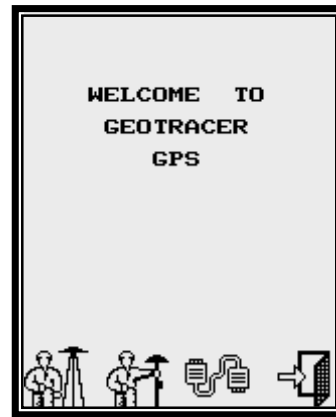


Figure 63-1: Geotracer Welcome Screen

Press **F3** to start the communication program. The Main Communication Program display will appear.



Figure 63-2: Geotracer Communication Control

Now start the file transfer program with the **F2** function key.



Figure 63-3: Connection Established

The connection to the main computer is now running and all operations will be controlled from your main computer.

You may quit the communication program using key **Q**.

64. Starting on your PC

The Geotracer® PC Communication Program is a Microsoft WINDOWS program. Start MS WINDOWS and open the Geotracer® group.



Figure 64-1: GeoCom Program Icon

Double-click on the Geotracer® Communication Program icon to start the program. This window appears.

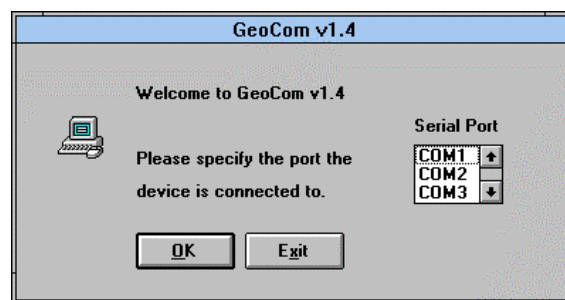


Figure 64-2: Welcome to GeoCom

You are asked to indicate which communication port to use for the ACU (or L1/L2 receiver) to the PC. Enter the port and accept with **OK** or leave the program with **Exit**.

As soon as you have selected the communication port the baud rate of communication will be checked by the program. The message Finding correct baudrate ... shows up, until the program has successfully communicated with the control unit.

The message Establish protocol ... follows.

When the check is completed successfully, the Main Window shows up (otherwise the program is terminated).

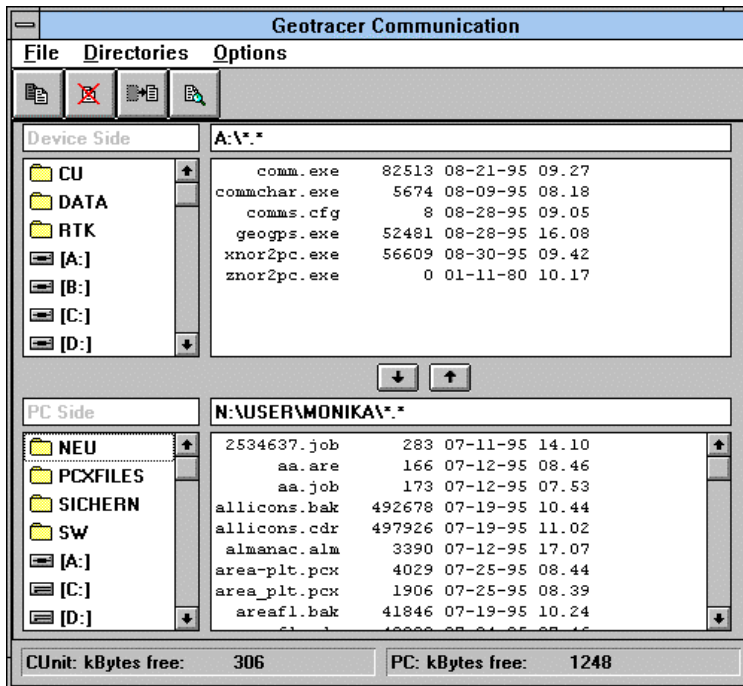


Figure 64-3: GeoCom Main Window

65. The Main GeoCom Window

The Geotracer[®] Communication Main Window is subdivided into 4 main parts:

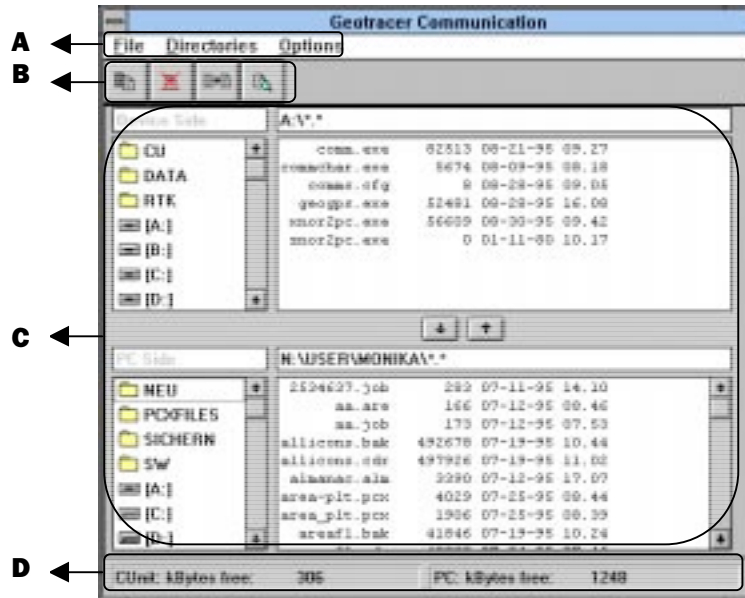


Figure 65-1: Description of the Main Window

- A** A menu bar,
- B** A toolbar, providing shortcuts to some of the standard operations,
- C** A display to the actual drive and directory contents of the remote device and of the PC, separated by the up- and download arrow keys,
- D** A status bar.

- A** The menu bar offers three choices:

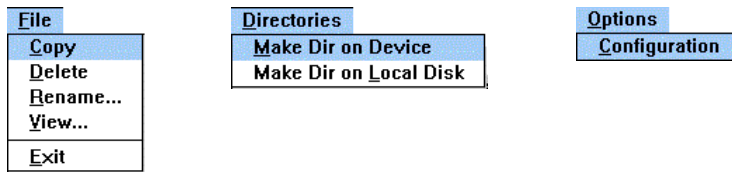


Figure 65-2: The Pull-down Menus

- B** Buttons on the toolbar offer easy and quick access to standard file operations:



- C** The upper half of the file display relates to the ACU computer (or L1/L2 receiver), the lower part relates to the PC. On the left-hand side you see the current directory tree of each computer, on the right, the current directory and its contents.  and  keys make a fast transfer of data.

Please note, that the two arrows correspond to the use of the terms "upload" and "download" !

- D** A status bar at the bottom of the screen tells you how much free disk space is available.



Figure 65-3: Status Bar

The amount of available disk space in the ACU (L1/L2 receiver) is shown on the left side and the amount of available space of the PC's current drive on the right side of the status bar.

66. Functions

66.1 Change Directory

You can easily change directories:

-  . The current directory as defined in the top line
-  .. The directory above the current directory tree,
-  <NAME> Subdirectories of current directory,
-  [A:], [C:], ... Symbols for available drives.

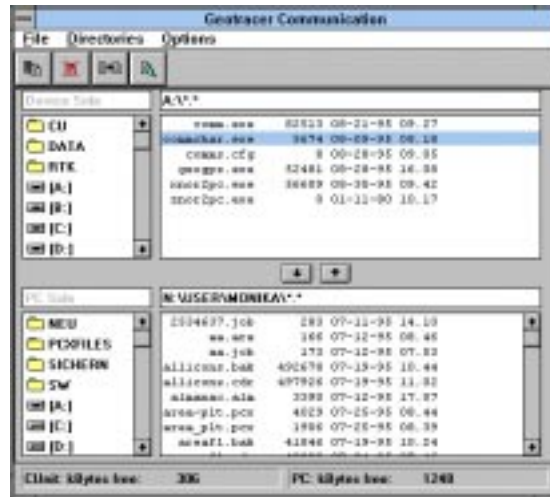


Figure 66-1: Directory Trees

To change a directory double-click with the left mouse button on the desired directory. The files contained in that directory will appear in the righthand box. The path to the directory is printed at the top of the list and the new subdirectory tree is printed in the lefthand box.

66.2 Select and Deselect File(s)

The Geotracer® Communication program works on selected files. We will now describe how to select or deselect files.

To select a file simply move the cursor and click on the desired file with the left mouse button. You may select as many files as you like. Selected files are highlighted.

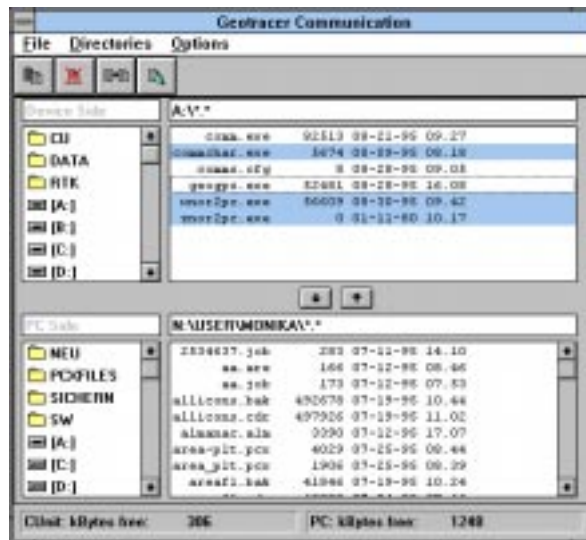


Figure 66-2: Selected Files

To deselect a selected file simply click on it again. You will see that the highlight disappears. The file is now deselected.

66.3 Copy File(s)

You may copy files from one device to the other. Simply select the desired directory, select the file(s) you want to copy, then ...

- enter the menu **File** and choose **Copy** or
- click the Copy button  or
- use the  or the  arrow, depending on the direction you want to copy the file(s).

A progress indicator shows the progress of the file transfer procedure.



Figure 66-3: Transfer Progress

The name of the copied file shows up in the destination directory when the transfer has been completed. You may interrupt the transfer process at any time by pressing **Cancel**.

If the file name already exists in the destination directory a dialog window pops up, asking you whether or not you want to overwrite the file. Click **OK** if you want to overwrite the file. Click **Cancel** to cancel the copy process for the current file.

66.4 Delete File(s)

The Geotracer® Communication program provides an easy method to delete files. To delete file(s) change to the desired directory and select the file(s) you want to delete. You now may either

- enter the menu **File** and choose **Delete** or
- click the Delete button  .

A window shows up asking whether you really want to delete the file. This protects you against unintentionally deleting files.

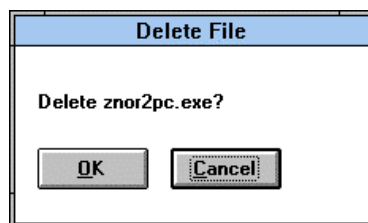


Figure 66-4: Deletion Warning

Press **OK** if you want to delete the current file, the file will be removed from the current directory.

Press **Cancel** to cancel the delete process for the current file. If you had selected more files you will be prompted for the next one.

66.5 Rename File

Change to the desired directory and select the file you want to rename. You now may either:

- enter the menu **File** and choose **Rename** or
- click the Rename button  .

The following window shows up.

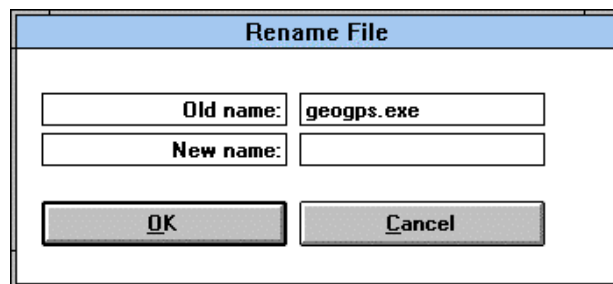


Figure 66-5: Rename Dialog

Enter the new name in the second line and accept by clicking **OK**. The file will be renamed in the current directory.

If you do not want to rename the file cancel the action by clicking **Cancel**.

If you have selected more than one file to be renamed the renaming window offers only the file selected last.

66.6 View File

The Geotracer® Communication system allows you to use any editor you have installed. This powerful option allows you to control or edit your files in a very easy way. To view a file change to the desired directory and select the file you want to view. You now may either

- enter the menu **File** and choose **View** or
- click the View button  .

If you wanted to view a file on the remote device (ACU or L1/L2 receiver), the selected file will first of all be transferred to the PC. This transfer is only temporary and reversed when the viewing process has finished. You may interrupt it at any time by pressing **Cancel**.

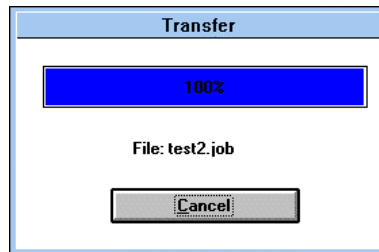


Figure 66-6: Transfer Progress

By default, the WINDOWS editor Notepad is used.

If you want to use another editor, you can do so. Go to menu **Options** and select **Configuration**. Change the entry **Editor** giving the full path and name for the editor of your choice.



When using WINDOWS version 3.1 the Notepad editor only allows you to open files of less than 64 kBytes. To view files larger than 64kByte use another editor and change the path to the editor in menu Options.

You may use all the functions of your chosen editor. If you have edited a file you must save the change then and transfer the changed file back to the control unit or L1/L2 receiver.

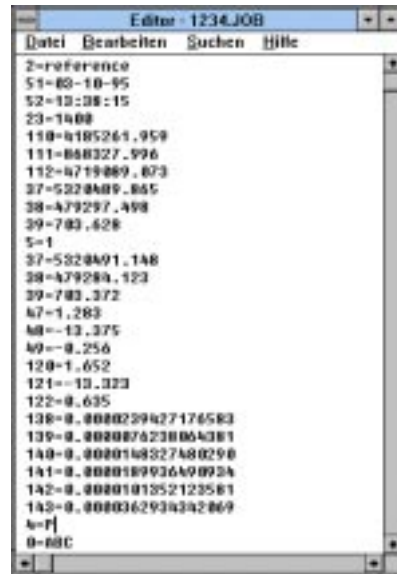


Figure 66-7: Notepad Editor

Above you see an example of a job file displayed by the German Version of WINDOWS **Notepad** editor. You may scroll through files, change them, etc.

66.7 Create Directory

Creating a directory is a very simple task. Go to the directory, or root of the drive, then open the menu **Directories**.



Figure 66-8: Pull-down Menu Directories

You may choose where you want to make a new directory:

- **Make Dir on Device:** New directory on the control unit or L1/L2 receiver,
- **Make Dir on Local Disk:** New directory on PC.

A window shows up and you can enter the name of the new directory.

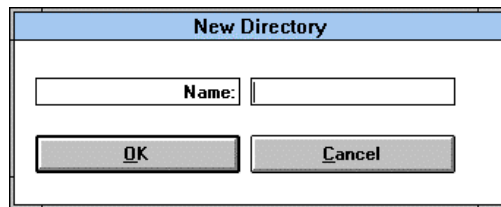


Figure 66-9: New Directory Dialog

Click **OK** if you want to make the new directory. The new directory will be created as a subdirectory of the current directory or drive.

Click **Cancel** if you want to cancel the action.

66.8 Remove Directory

Removing directories is as simple as deleting files. If you want to remove a directory it must be empty. Choose the desired directory, then

- enter the menu **File** and choose **Delete** or
- click the Delete button .

A window shows up asking whether you really want to delete the directory. This prevents you against accidentally removing directories.

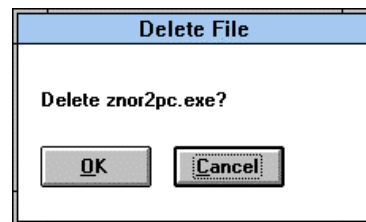


Figure 66-10: Deletion Warning

Press **OK** if you want to delete the current directory.

Press **Cancel** to cancel the delete process.

66.9 Options

When clicking on Configuration in the menu Options, the Configuration Window pops up.

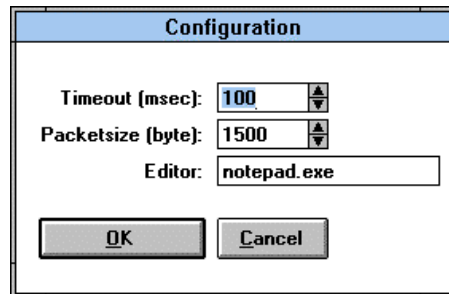


Figure 66-11: Configuration Dialog

You find three options for changes:

- Timeout - only to be changed by an experienced user!
- Packetsize - only to be changed by an experienced user!
- Editor

Timeout:

If the WINDOWS-computer is too slow and transmission errors occur, the duration of timeout could be increased. The value is given in milliseconds.

Packetsize:

The best packetsize depends on the quality of the serial link. Usually, you should accept the value suggested by the program. The value is in bytes.

Editor:

You may want to use a different editor or select a different path to the editor's directory. This is commonly done, if the files are bigger than 64 kByte. In this case, you have to use a different editor than **WINDOWS Notepad**.

In order to change the editor or the path, enter the new path and name in the right field. There is no limit to the number of alphanumeric characters.

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69.1 Installation on a MS WINDOWS 3.1 or MS WINDOWS NT System

2. Open either the Program Manager or the File Manager.

2a. If you opened the Program Manager, choose Run from the File menu and type the following command line:

[drive]:\setup

- 2b. If you opened the File Manager, open the drive containing the Disk **GeoCom** and double-click on the file **SETUP . EXE**.
3. Follow the installation prompts that guide you completely through the installation process.

69.2 Installation on a MS WINDOWS 95 System

1. Click on the Add/Remove Programs icon in the Control Panel window. Follow the installation prompts that guide you through the installation process. Alternatively

- 1a. From a DOS prompt, type the line shown below, assuming that disk GeoCom is in the A: drive:

A:\setup

- 1b. From the Start menu, choose Run and type the line below, assuming that disk GeoCom is in the A: drive:

A:\setup

- 1c. From the Windows Explorer, open the drive containing the disk GeoCom and double-click on the file **SETUP.EXE**.

70. Start on Control Unit

To start the file transfer control program both computers have to be connected with the Geotronics system cable and communications adaptor and switched on.



If you use an L1/L2 receiver, be sure that no antenna is connected to it, when you connect the receiver to the PC!

First start the ACU. The Main Screen appears.

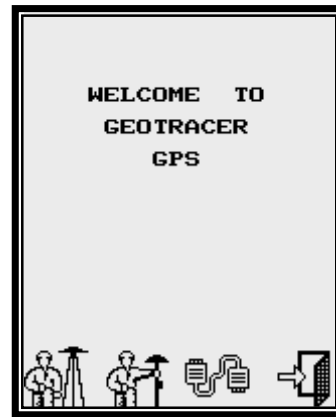


Figure 3-1: Geotracer Welcome Screen

Press **F3** to start the communication program. The Main Communication Program display will appear.



Figure 3-2: Geotracer Communication Control

Now start the file transfer program with the **F2** function key.



Figure 3-3: Connection Established

The connection to the main computer is now running and all operations will be controlled from your main computer.

You may quit the communication program using key **Q**.

71. Starting on your PC

The Geotracer® PC Communication Program is a Microsoft WINDOWS program. Start MS WINDOWS and open the Geotracer® group.



Figure 4-1: GeoCom Program Icon

Double-click on the Geotracer® Communication Program icon to start the program. This window appears.

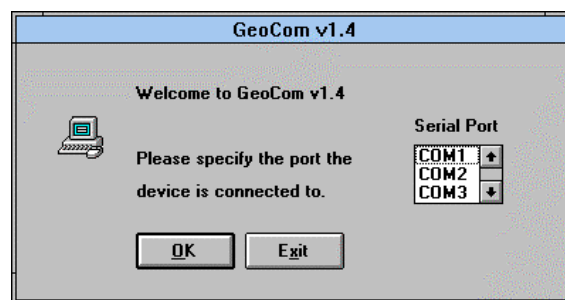


Figure 4-2: Welcome to GeoCom

You are asked to indicate which communication port to use for the ACU (or L1/L2 receiver) to the PC. Enter the port and accept with **OK** or leave the program with **Exit**.

As soon as you have selected the communication port the baud rate of communication will be checked by the program. The message Finding correct baudrate ... shows up, until the program has successfully communicated with the control unit.

The message Establish protocol ... follows.

When the check is completed successfully, the Main Window shows up (otherwise the program is terminated).

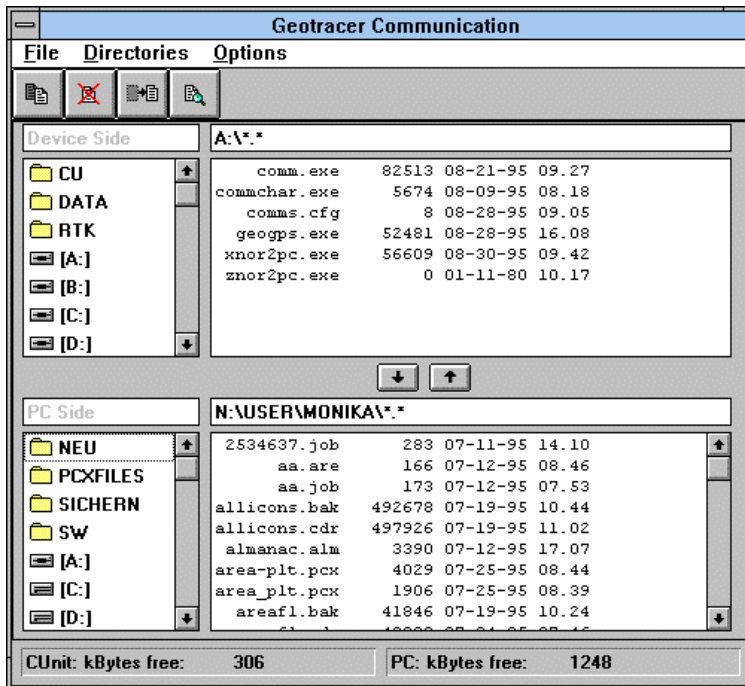


Figure 4-3: GeoCom Main Window

72. The Main GeoCom Window

The Geotracer® Communication Main Window is subdivided into 4 main parts:

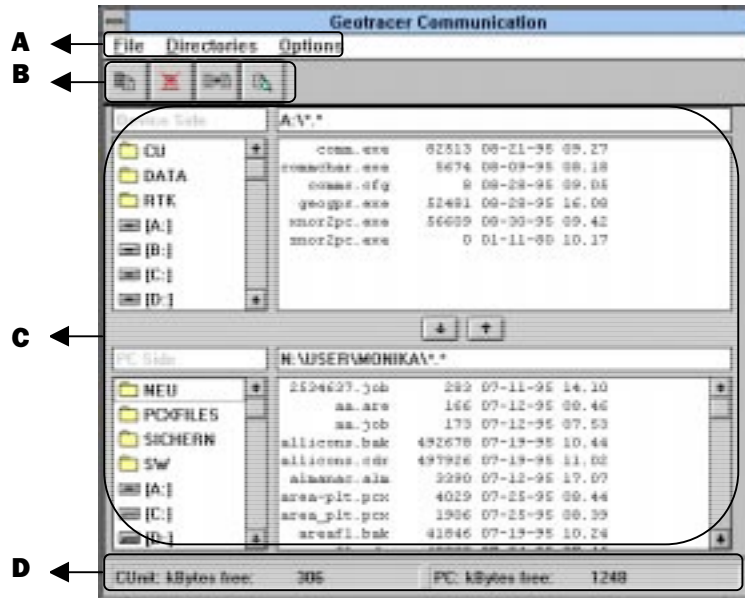


Figure 5-1: Description of the Main Window

- A** A menu bar,
- B** A toolbar, providing shortcuts to some of the standard operations,
- C** A display to the actual drive and directory contents of the remote device and of the PC, separated by the up- and download arrow keys,
- D** A status bar.

- A** The menu bar offers three choices:

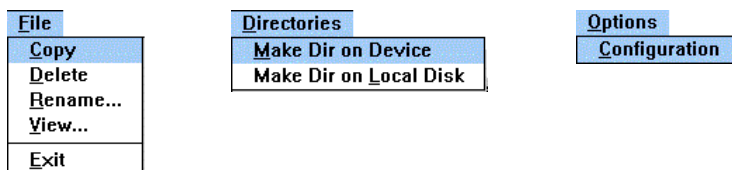


Figure 5-2: The Pull-down Menus

- B** Buttons on the toolbar offer easy and quick access to standard file operations:



- C** The upper half of the file display relates to the ACU computer (or L1/L2 receiver), the lower part relates to the PC. On the left-hand side you see the current directory tree of each computer, on the right, the current directory and its contents. and keys make a fast transfer of data.

Please note, that the two arrows correspond to the use of the terms "upload" and "download" !

- D** A status bar at the bottom of the screen tells you how much free disk space is available.



Figure 5-3: Status Bar

The amount of available disk space in the ACU (L1/L2 receiver) is shown on the left side and the amount of available space of the PC's current drive on the right side of the status bar.

73. Functions

73.1 Change Directory

You can easily change directories:

-  . The current directory as defined in the top line
-  .. The directory above the current directory tree,
-  <NAME> Subdirectories of current directory,
-  [A:], [C:], ... Symbols for available drives.

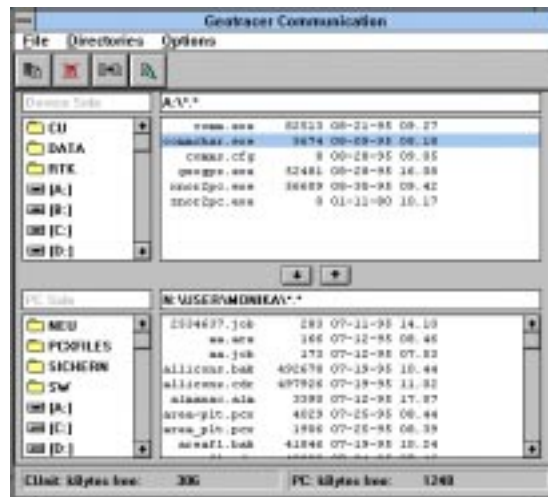


Figure 6-1: Directory Trees

To change a directory double-click with the left mouse button on the desired directory. The files contained in that directory will appear in the righthand box. The path to the directory is printed at the top of the list and the new subdirectory tree is printed in the lefthand box.

73.2 Select and Deselect File(s)

The Geotracer® Communication program works on selected files. We will now describe how to select or deselect files.

To select a file simply move the cursor and click on the desired file with the left mouse button. You may select as many files as you like. Selected files are highlighted.

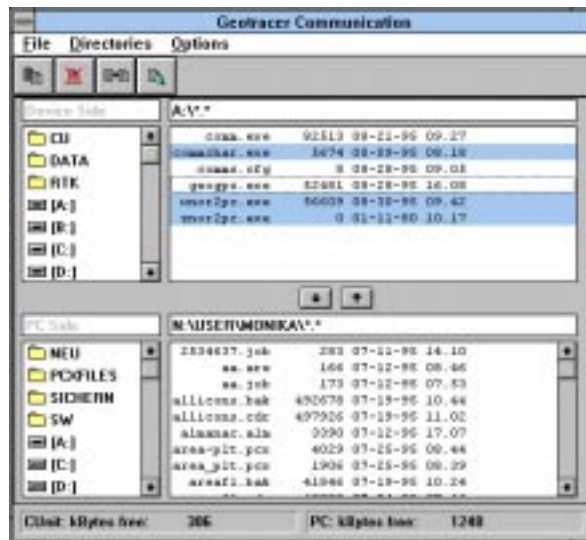


Figure 6-2: Selected Files

To deselect a selected file simply click on it again. You will see that the highlight disappears. The file is now deselected.

73.3 Copy File(s)

You may copy files from one device to the other. Simply select the desired directory, select the file(s) you want to copy, then ...

- enter the menu **File** and choose **Copy** or
- click the Copy button  or
- use the  or the  arrow, depending on the direction you want to copy the file(s).

A progress indicator shows the progress of the file transfer procedure.



Figure 6-3: Transfer Progress

The name of the copied file shows up in the destination directory when the transfer has been completed. You may interrupt the transfer process at any time by pressing **Cancel**.

If the file name already exists in the destination directory a dialog window pops up, asking you whether or not you want to overwrite the file. Click **OK** if you want to overwrite the file. Click **Cancel** to cancel the copy process for the current file.

73.4 Delete File(s)

The Geotracer® Communication program provides an easy method to delete files. To delete file(s) change to the desired directory and select the file(s) you want to delete. You now may either

- enter the menu **File** and choose **Delete** or
- click the Delete button  .

A window shows up asking whether you really want to delete the file. This protects you against unintentionally deleting files.

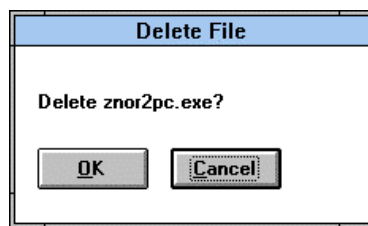


Figure 6-4: Deletion Warning

Press **OK** if you want to delete the current file, the file will be removed from the current directory.

Press **Cancel** to cancel the delete process for the current file. If you had selected more files you will be prompted for the next one.

73.5 Rename File

Change to the desired directory and select the file you want to rename. You now may either:

- enter the menu **File** and choose **Rename** or
- click the Rename button  .

The following window shows up.

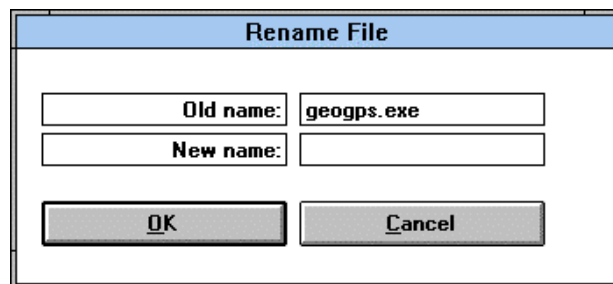


Figure 6-5: Rename Dialog

Enter the new name in the second line and accept by clicking **OK**. The file will be renamed in the current directory.

If you do not want to rename the file cancel the action by clicking **Cancel**.

If you have selected more than one file to be renamed the renaming window offers only the file selected last.

73.6 View File

The Geotracer® Communication system allows you to use any editor you have installed. This powerful option allows you to control or edit your files in a very easy way. To view a file change to the desired directory and select the file you want to view. You now may either

- enter the menu **File** and choose **View** or
- click the View button  .

If you wanted to view a file on the remote device (ACU or L1/L2 receiver), the selected file will first of all be transferred to the PC. This transfer is only temporary and reversed when the viewing process has finished. You may interrupt it at any time by pressing **Cancel**.

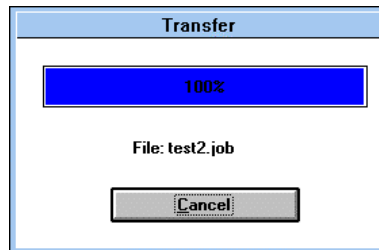


Figure 6-6: Transfer Progress

By default, the WINDOWS editor Notepad is used.

If you want to use another editor, you can do so. Go to menu **Options** and select **Configuration**. Change the entry **Editor** giving the full path and name for the editor of your choice.



When using WINDOWS version 3.1 the Notepad editor only allows you to open files of less than 64 kBytes. To view files larger than 64kByte use another editor and change the path to the editor in menu Options.

You may use all the functions of your chosen editor. If you have edited a file you must save the change then and transfer the changed file back to the control unit or L1/L2 receiver.

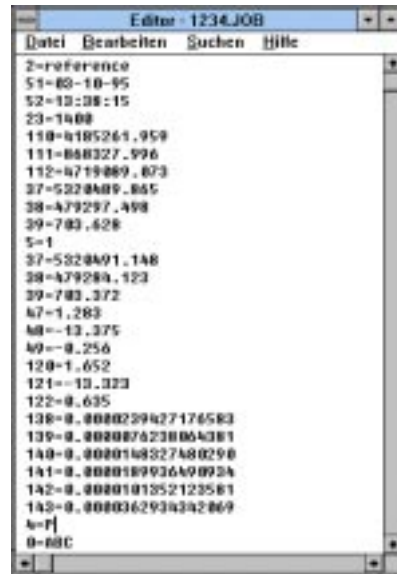


Figure 6-7: Notepad Editor

Above you see an example of a job file displayed by the German Version of WINDOWS **Notepad** editor. You may scroll through files, change them, etc.

73.7 Create Directory

Creating a directory is a very simple task. Go to the directory, or root of the drive, then open the menu **Directories**.



Figure 6-8: Pull-down Menu Directories

You may choose where you want to make a new directory:

- **Make Dir on Device:** New directory on the control unit or L1/L2 receiver,
- **Make Dir on Local Disk:** New directory on PC.

A window shows up and you can enter the name of the new directory.

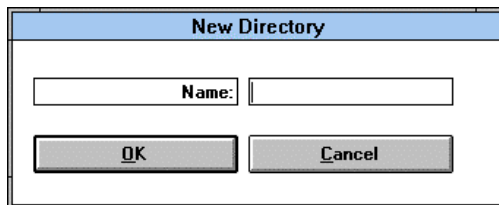


Figure 6-9: New Directory Dialog

Click **OK** if you want to make the new directory. The new directory will be created as a subdirectory of the current directory or drive.

Click **Cancel** if you want to cancel the action.

73.8 Remove Directory

Removing directories is as simple as deleting files. If you want to remove a directory it must be empty. Choose the desired directory, then

- enter the menu **File** and choose **Delete** or
- click the Delete button .

A window shows up asking whether you really want to delete the directory. This prevents you against accidentally removing directories.

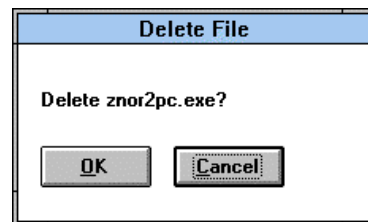


Figure 6-10: Deletion Warning

Press **OK** if you want to delete the current directory.

Press **Cancel** to cancel the delete process.

73.9 Options

When clicking on Configuration in the menu Options, the Configuration Window pops up.

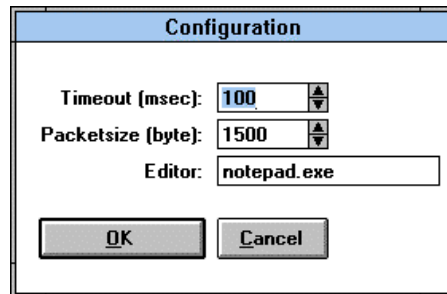


Figure 6-11: Configuration Dialog

You find three options for changes:

- Timeout - only to be changed by an experienced user!
- Packetsize - only to be changed by an experienced user!
- Editor

Timeout:

If the WINDOWS-computer is too slow and transmission errors occur, the duration of timeout could be increased. The value is given in milliseconds.

Packetsize:

The best packetsize depends on the quality of the serial link. Usually, you should accept the value suggested by the program. The value is in bytes.

Editor:

You may want to use a different editor or select a different path to the editor's directory. This is commonly done, if the files are bigger than 64 kByte. In this case, you have to use a different editor than **WINDOWS Notepad**.

In order to change the editor or the path, enter the new path and name in the right field. There is no limit to the number of alphanumeric characters.

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Terrasat's Interpreter for Macros

TIM

Programmer's Guide



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Note

We are aware of the fact that our exclusive masculine pronoun "he" is considered politically incorrect, but has been used in this case to simplify readability.

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75. Introduction

TIM is an interpreter for text macros. It reads text input from a script file and performs actions based on the instructions found in the script.

This document describes the language elements of **TIM**, how to write **TIM** programs, how to test and run scripts and finally how to extend **TIM**'s language by dynamically loading DLL's.

TIM itself is an extension to **Tcl**, which exists on UNIX, Macintosh and Windows platforms. **Tcl** is public domain and available worldwide. This extension was renamed to **TIM** for the following reasons:

- **Tcl** is plain ANSI C code, whereas **TIM** is a completely new implementation in fully featured C++ code.
- **TIM** is implemented differently, especially the memory management has been completely changed, since this was the most expensive part on the PC.
- **TIM** does not support all the functions of standard **Tcl**, but other functions have been added.

- **TIM** much better supports DOS FAT file systems.
- **TIM** utilizes a completely different message and error system. You will get hints in this manual.
- **TIM** is derived from the abstract C++ class INTERPRETER. This allows application to use **TIM**'s functionality without even linking to a special **TIM** library (of course, somewhere a real **TIM** object must be created).

Nevertheless, the syntax of **TIM** and Tcl are 100% compatible. For additional information about Tcl you may refer to other commercially available literature. We suggest:

Tcl and the Tk Toolkit by John Ousterhout (the original author of Tcl), Addison Wesley, 1994. A very good and easy to read introduction to TIM/Tcl. We highly recommend it.

Effective Tcl/Tk Programming (Addison Wesley, 1997) by Michael Mclellan and Mark Harrison.

Practical Programming in Tcl and Tk, 2nd Edition, Prentice Hall, 1997 by Brent B. Welch. A very good book for the advanced Tcl programmer. We highly recommend it.

There are some more books around. You can get an overview via the internet. Interesting sites are e.g.:

www.neosoft.com

www.sunscript.com

Here is an overview on this document:

Chapter 2 explains the rules and language elements of **TIM**.

Chapter 3 lists global variables.

Chapter 4 lists all available built-in commands and provides detailed descriptions of each command.

Chapter 5 lists **TIM**'s runtime error messages in detailed form.

Chapter 6 shows the C/C++ actions to take, when you want to integrate a **TIM** interpreter into your application and explains important parts of the **TIM** class.

Chapter 7 shows how an additional function is written, registered and what rules are to be obeyed.

Chapter 8 describes in detail, how to write an extension DLL.



If your are not interested in adding **TIM to your application or if you are no programmer, you can skip chapters 6, 7 and 8 completely.**

76. The TIM Scripting Language

This chapter explains the rules and language elements of **TIM**.

76.1 Input Format

TIM scripts are line oriented. A command in a script is parsed until the end of the line is reached, then interpretation starts.

Language elements are normally separated by blanks. This is different to languages like C, where a lot of characters are recognized as tokens.

TIM only allows blanks and tab characters as whitespace. The two special character pairs '[' ']' and '{' '}' have a special meaning and are also accepted to separate tokens.

Example:

This example shows, how scripts are tokenized. The statement

```
set_a,b_c[set_b-c_d]
```

consists of the tokens, 'set', 'a,b' and 'c' 'set' 'b-c' 'd', where the '[' character starts a recursive interpreter invocation (explained later).

76.2 Comments

Comments are allowed in scripts. They start with the '#' character and last until the end of the line. Comments must be located in a separate line, therefore this construction

```
set y 4 # This is invalid
```

is invalid. In this case, the tokens '#', 'This', 'is' and 'invalid' are passed to the `set` command, which will complain.

Example:

```
set x 3
# This is a comment
```

76.3 Command Syntax

Commands are always of the form:

```
command parm1 ... parmn
```

The **first** word in a macro is always interpreted as the `command`, the other words are passed to this command as parameters. Internally, the command corresponds to an internal C function, which is called with the parameters, as soon as it was identified.

Commands and parameters are case sensitive, e.g.,

<code>expr 1+2</code>	OK
<code>Expr 1+2</code>	unknown
<code>set var "hello"</code>	OK
<code>print \$Var</code>	unknown variable Var

76.4 Data Type(s)

TIM only has **one single data type**: the string. You very often hear the term *typeless language* for this construction. Everything is interpreted as strings, also parameters are passed to the internal C functions as strings. It is part of the job of the internal commands to interpret the strings.

Example:

The function `expr` allows to perform math calculations. A macro like this:

```
expr 3+4
```

passes the string '3+4' to an internal function evaluating the `expr` macro. This function then interprets the string as being an expression of numbers. It calculates a result and returns it as a string.

So this macro:

```
print [expr 3+4]
```

means, that the `print` command gets the string result from the `expr` command, which is the string '7' and prints it.

76.5 Variables and Substitutions

TIM allows you to store values in variables and use those values in commands. This is done with help of the `set` command. For instance, this script:

```
set var 3
```


defines the variable `var` (if defined already, the existing variable is referred), and assigns it the string '3'. You may refer to the value of the variable `var` with a construction like this:

```
set x $var
```

In this macro, the variable `x` is defined and assigned the string '3'.

Writing instead

```
set x var
```

assigns the string 'var' to the variable `x`.

Variables may be of any length. Very often, you assign complete scripts to variables.

Variables always have global scope!

Variables, like any other construction in **TIM**, are case-sensitive.

76.6 Substitutions

TIM supports four kinds of substitutions; variable substitution, direct substitution, recursive command invocation, and text substitution.

76.6.1 Variable substitution.

This was explained above, you de-reference variables by preceeding a variable with a \$ character. You can only de-reference variables, that have been declared already!

76.6.2 Direct string substitution.

If you put something into quotes like

```
set x "one parameter"
```

the string 'one parameter' is completely passed to the `set` macro, without interpreting the space character in between.

76.6.3 Recursive command invocation.

If you want to use results of interpreter invocations, you may put macros into parenthesis like this:

```
set x [ set y 3 ]
```

Macros in parenthesis are evaluated first, then the results are passed to the predecessor interpreter. You may recursively call interpreters up to 100 times. This means, that expressions like:

```
set x [set y [expr 3+4]]
```

with a depth of 100 levels are supported.

76.6.4 Text substitution.

Everything you put into curly braces like

```
set var {  
    some text  
    more text  
}
```

is completely parsed as being one string, including all newline characters. This is perhaps the best way how to pass macros to commands. In above script, the variable `var` gets two lines of text as its string value.

Example 1:

Above script could be directly executed by writing:

```
[$var]
```

Example 2:

The loop command has this syntax:

```
loop iterationvariable limit script
```

This means, an iteration is performed, assigning 0 to *iteration-variable*, iterating until *limit* is reached, and in each iteration the script is interpreted. Here is a real world macro, calculating the sum of the numbers of 0 to 10:

```
set sum 0
loop I 10 {
    set sum [expr $sum+$I]
    print "Iteration Nr: " $I " Sum: " $sum
}
```

Please note, that the opening brace '{' is on the same line as the command word **loop**. It has to be there, because **TIM** commands are always located in one line. Since text in curly braces is interpreted as being 1 string, above code can be shown in metacode as

```
loop I 10 script end-of-line
```

77. Global Variables

TIM currently doesn't use global variables.

To reduce conflicts when using global variables, **TIM** obeys these rules - they should be obeyed by any system that hosts a **TIM** interpreter:

- Built-in global variables or variables added by external DLLs or other extensions are always written in uppercase letters.
- All other variables are written in lowercase letters.
- Mixed typing is NOT used by **TIM** or **TIM** host systems. Users or third party vendors  use mixed typing to be sure there is no naming conflict.



78. Built-in Commands

TIM offers a standard set of powerful built-in commands. With this release, there are two command sets. You have to find out, which command set is supported by the individual software packages. E.g. MultiPage and Vis-à-vis both use command set 1.0, whereas **GeoGenius** already uses command set 1.5

78.1 The *TIM* function set version v1.0.

arg	Handles parameters of the host system
break	Breaks loops like <code>while</code> and <code>loop</code>
concat	Concat two strings. No whitespace is added
concat	Concat two strings adding whitespace between them
continue	Jump to a next iteration in loops like <code>while</code> and <code>loop</code>
deref	De-reference a variable
exec	Run programs
expr	Do math
if	Do conditional programming
include	Include other source files
loop	Perform loops
precision	Alter number representation and conversion.
print	Send messages to the console or a console window
proc	Define a procedure (with arguments)
registerdll	Load an extension DLL and register its functions
return	Return a number, a string or special return code or stop procedure interpretation of scripts (if operating at the topmost level)
set	Declare and define variables

string	Copy, compare and many more operations on strings.
system	Find something out about your host system and platform.
unknown	Handle unknown commands (internal).
while	Support for conditional looping.

78.2 The TIM function set version v1.5

For version 1.5 of **GeoGenius**, the TIM interpreter has been significantly improved and slightly modified. The most important changes are:

- Script are now *compiled on demand*, which speeds up execution by a factor 2 to 20.
- TIM now support arrays and lists.
- TIM now has a better scope resolution
- TIM now has *many more* builtin functions

A drawback is that some commands are no longer supported and you eventually have to change existing scripts.

Theses commands are no longer supported:

deref	Declare and define variables
precision	Alter number representation and conversion.
loop	Perform loops (it does still work, but issues a warning)
system	Find something out about your host system and platform.

These commands build version 1.5

after	Schedule a TIM command for later execution
append	Append arguments to a variable's value. No spaces added
arg	Handles parameters of the host system
array	Query array state and search through elements
break	Breaks loops like <code>while</code> and <code>loop</code>
catch	Trap errors
cd	Change directory
clock	Get the time and format date string
concat	Concat two strings. No whitespace is added
concat	Concat two strings adding whitespace between them
continue	Jump to a next iteration in loops like <code>while</code> and <code>loop</code>
deref	De-reference a variable
error	Raise an error
eof	Check for end of file
error	Raise an error
eval	Concatenate arguments and evaluate them as a command.
exec	Run programs
expr	Do math
fblocked	Poll an I/O channel and see if data is ready
fconfigure	Set and query I/O channel properties
fcopy	Copy from one I/O channel to another
file	Query the file system
fileevent	Register callback for event-driven I/O
flush	Flush output from an I/O stream's internal buffer
for	Loop construct similar to the C <code>for</code> statement
foreach	Loop construct over a list, or lists, of values
format	Format a string similar to C <code>sprintf</code>
gets	Read a line of input from an I/O stream

glob	Expand a pattern to matching file names
global	Declare global variables
if	Do conditional programming
include	Include other source files
incr	Increment a variable by an interger amount
info	Query the state of the TIM interpreter
join	Concatenate list elemtents with a given separator string
lappend	Add elements at the end of a list
lindex	Fetch an element from a list
linsert	Insert elements into a list
list	Create a list out of the arguments
llength	Return the number of elements in a list.
loop	Perform loops
lrange	Return a range of list elements
lreplace	Replace elements of a list
lsearch	Search for an element of a list that matches a pattern
lsort	Sort a list
open	Open a file or process pipeline for I/O
precision	Alter number representation and conversion.
print	Send messages to the console or a console window
proc	Define a procedure (with arguments)
puts	Output a string to an I/O stream
pwd	Return the current working directory
read	Read blocks of characters from an I/O stream
regexp	Regular expression matching
regsub	Substitutions based on regular expressions
rename	Change the name of a TIM command
return	Return a number, a string or special return code or stop procedure interpretation of scripts (if operating at the topmost level)
scan	Parses a string according to a format specification
set	Declare and define variables

string	Copy, compare and many more operations on strings.
socket	Open a TCP/IP network connection
source	Evaluate the TIM commands in a file
split	Chop up a string into list elements
subst	Substitutions without command evaluation
switch	Multi-way branch
system	Find something out about your host system and platform.
tell	Return the current seek offset of an I/O stream
time	Measure the execution of a command
trace	Monitor variable assignments
unknown	Handle unknown commands (internal).
unset	Delete variables
uplevel	Execute commands in a different scope
upvar	Reference variables in a different scope
vwait	Wait for a variable to be modified.
while	Support for conditional looping.

78.3 Commands

78.3.1 *after* - Execute a command after a time delay

Syntax:

```
after ms
after ms[script script script...]
after cancel id
after cancel script script script
after idle [script script script
after info [id]
```

Command Set: *1.5 only*

Synopsis:

This command is used to delay execution of the program or to execute a command in background sometime in the future. It has several forms, depending on the first argument to the command.

`after ms`

`ms` must be an integer giving a time in milliseconds. The command sleeps for `ms` milliseconds and then returns. While the command is sleeping the application does not respond to events.

```
after ms [script script script ...]
```

In this form the command returns immediately, but it arranges for a TIM command to be executed `ms` milliseconds later as an event handler. The command will be executed exactly once, at the given time. The delayed command is formed by concatenating all the script arguments in the same fashion as the `concat` command. The command will be executed at global level (outside the context of any TIM procedure). If an error occurs while executing the delayed command then the `bgerror` mechanism is used to report the error. The `after` command returns an identifier that can be used to cancel the delayed command using `after cancel`.

`after cancel id`

Cancels the execution of a delayed command that was previously scheduled. `id` indicates which command should be canceled; it must have been the return value from a previous `after` command. If the command given by `id` has already been executed then the `after cancel` command has no effect.

`after cancel script script ...`

This command also cancels the execution of a delayed command. The `script` arguments are concatenated together with space separators (just as in the `concat` command). If there is a pending command that matches the string, it is cancelled and will never be executed; if no such command is currently pending then the `after cancel` command has no effect.

`after idle script [script script ...]`

Concatenates the `script` arguments together with space separators (just as in the `concat` command), and arranges for the resulting script to be evaluated later as an idle callback. The script will be run exactly once, the next time the event loop is entered and there are no events to process. The command returns an identifier that can be used to cancel the delayed command using `after cancel`. If an error occurs while executing the script then the `berror` mechanism is used to report the error.

`after info [id]`

This command returns information about existing event handlers. If no `id` argument is supplied, the command returns a list of the identifiers for all existing event handlers created by the `after` command for this interpreter. If `id` is supplied, it specifies an existing handler; `id` must have been the return value from some previous call to `after` and it must not have triggered yet or been cancelled. In this case the command returns a list with two elements. The first element of the list is the script associated with `id`, and the second element is either `idle` or `timer` to indicate what kind of event handler it is.

The `afterms` and `after idle` forms of the command assume that the application is event driven: the delayed commands will not be executed unless the application enters the event loop. In applications that are not normally event-driven, such as `tcsh`, the event loop can be entered with the `vwait` and `update` commands.

See also:

bgerror

78.3.2 *append* - Append to variable

Syntax:

```
append varName [value value value ...]
```

Command Set: *1.5 only*

Synopsis:

Append all of the `value` arguments to the current value of variable `varName`. If `varName` doesn't exist, it is given a value equal to the concatenation of all the `value` arguments. This command provides an efficient way to build up long variables incrementally.

Example:

```
"append a $b" is much more efficient than "set a $a$b" if $a  
is long.
```

78.3.3 *arg* - Get your application's arguments

Syntax:

```
arg count  
arg find str  
arg get n
```

Command Set: *1.0 only*

Synopsis:

This command accesses your application's command line parameters. (This only works, if the host system passed its arguments to the interpreter.)

The first variant returns the number of arguments, basically, this is what you know as `argc` in C/C++ programming.

The second variant `arg find str` returns 0 or 1, depending whether `str` was found in the command line or not.

`arg count` returns the number of command line arguments

`arg get n` returns the `n`th command line parameter

Example:

```
if ![arg find "/argument"] {  
    print "Cannot find command line arg /argument"  
}
```

The third variant allows to get each individual command line argument.

See also:

Documentation about parameters of host systems such as **Vis-A-Vis**.

78.3.4 array - Manipulate array variables

Syntax:

```
array option arrayName [arg arg ...]
```

Command Set: *1.5 only*

Synopsis:

This command performs one of several operations on the variable given by `arrayName`. Unless otherwise specified for individual commands below, `arrayName` must be the name of an existing array variable. The `option` argument determines what action is carried out by the command.

The legal options (which may be abbreviated) are:

```
array anymore arrayName searchId
```

Returns 1 if there are any more elements left to be processed in an array search, 0 if all elements have already been returned. `SearchId` indicates which search on `arrayName`

to check, and must have been the return value from a previous invocation of `array startsearch`. This option is particularly useful if an array has an element with an empty name, since the return value from `array nextelement` won't indicate whether the search has been completed.

`array donesearch arrayName searchId`

This command terminates an array search and destroys all the state associated with that search. `SearchId` indicates which search on `arrayName` to destroy, and must have been the return value from a previous invocation of `array startsearch`.

Returns an empty string.

`array exists arrayName`

Returns 1 if `arrayName` is an array variable, 0 if there is no variable by that name or if it is a scalar variable.

`array get arrayName [pattern]`

Returns a list containing pairs of elements. The first element in each pair is the name of an element in `arrayName` and the second element of each pair is the value of the array element. The order of the pairs is undefined. If `pattern` is not specified, then all of the elements of the array are included in the result. If `pattern` is specified, then only those elements whose names match `pattern` (using the glob-style matching rules of string match) are included. If `arrayName` isn't the name of an array variable, or if the array contains no elements, then an empty list is returned.

`array names arrayName [pattern]`

Returns a list containing the names of all of the elements in the array that match `pattern` (using the glob-style matching rules of `string match`). If `pattern` is omitted then the command returns all of the element names in the array. If there are no (matching) elements in the array, or if `arrayName` isn't the name of an array variable, then an empty string is returned.

`array nextelement arrayName searchId`

Returns the name of the next element in `arrayName`, or an empty string if all elements of `arrayName` have already been returned in this search. The `searchId` argument identifies the search, and must have been the return value of an `array startsearch` command. Warning: if elements are added to or deleted from the array, then all searches are automatically terminated just as if `array donesearch` had been invoked; this will cause `array nextelement` operations to fail for those searches.

`array set arrayName list`

Sets the values of one or more elements in `arrayName`. `list` must have a form like that returned by `array get`, consisting of an even number of elements. Each odd-numbered element in `list` is treated as an element name within `arrayName`, and the following element in `list` is used as a new value for that array element.

`array size arrayName`

Returns a decimal string giving the number of elements in the array. If `arrayName` isn't the name of an array then 0 is returned.

`array startsearch arrayName`

This command initializes an element-by-element search through the array given by `arrayName`, such that invocations of the `array nextelement` command will return the names of the individual elements in the array. When the search has been completed, the `array done-search` command should be invoked. The return value is a search identifier that must be used in `array nextelement` and `array done-search` commands; it allows multiple searches to be underway simultaneously for the same array.

78.3.5 *break* - Interrupt loops

Syntax:

`Break`

Command Set: *1.0, 1.5*

Synopsis:

This command allows you to interrupt any of **TIM**'s loop constructs like `loop` or `while`. It passes control to one level higher than current.

Example:

```
loop I 100 {  
    if $I==10 { break }  
}  
print "10 iterations done..."
```

See also:

`loop`, `while`, `continue`

78.3.6 catch - Evaluate script and trap exceptional returns

Syntax:

```
catch script [varName]
```

Command Set: *1.5 only*

Synopsis:

The `catch` command may be used to prevent errors from aborting command interpretation.

`Catch` calls the TIM interpreter recursively to execute script, and always returns a `TIM_OK` code, regardless of any errors that might occur while executing script. The return value from `catch` is a decimal string giving the code returned by the TIMinterpreter after executing script. This will be 0 (`TIM_OK`) if there were no errors in script; otherwise it will have a non-zero value corresponding to one of the exceptional return codes (see `TIM.h` for the definitions of code values). If the `varName` argument is given, then it gives the name of a variable; `catch` will set the variable to the string returned from `script` (either a result or an error message).

Note that `catch` catches all exceptions, including those generated by `break` and `continue` as well as errors.

78.3.7 *cd* - Change working directory

Syntax:

```
cd [dirName]
```

Command Set: *1.5 only*

Synopsis:

Change the current working directory to `dirName`, or to the home directory (as specified in the HOME environment variable) if `dirName` is not given.

This command returns an empty string.

78.3.8 clock - Obtain and manipulate time**Syntax:**

```
clock option [arg arg ...]
```

Command Set: *1.5 only*

Synopsis:

This command performs one of several operations that may obtain or manipulate strings or values that represent some notion of time. The option argument determines what action is carried out by the command.

The legal options (which may be abbreviated) are:

`clock clicks`

Return a high-resolution time value as a system-dependent integer value. The unit of the value is system-dependent but should be the highest resolution clock available on the system such as a CPU cycle counter. This value should only be used for the relative measurement of elapsed time.

clock format clockValue ?-format string? ?-gmt boolean?

Converts an integer time value, typically returned by `clock seconds`, `clock scan`, or the `atime`, `mtime`, or `ctime` options of the `file` command, to human-readable form. If the `-format` argument is present the next argument is a string that describes how the date and time are to be formatted. Field descriptors consist of a `%` followed by a field descriptor character. All other characters are copied into the result. Valid field descriptors are:

%% Insert a `%`.

%a Abbreviated weekday name (Mon, Tue, etc.).

%A Full weekday name (Monday, Tuesday, etc.).

%b Abbreviated month name (Jan, Feb, etc.).

%B Full month name.

%c Locale specific date and time.

%d Day of month (01 - 31).

%H Hour in 24-hour format (00 - 23).

%I Hour in 12-hour format (00 - 12).

%j Day of year (001 - 366).

%m Month number (01 - 12).

% Minute (00 - 59).

%p AM/PM indicator.

%S Seconds (00 - 59).

%U Week of year (01 - 52), Sunday is the first day of the week.

%w Weekday number (Sunday = 0).

%W Week of year (01 - 52), Monday is the first day of the week.

%x Locale specific date format.

%X Locale specific time format.

%y Year without century (00 - 99).

%Y Year with century (e.g. 1990)

%Z Time zone name.

If the **-format** argument is not specified, the format string "**%a %b %d %H:%M:%S %Z %Y**" is used. If the **-gmt** argument is present the next argument must be a boolean which if true specifies that the time will be formatted as Greenwich Mean Time. If false then the local timezone will be used as defined by the operating environment.

`clock scan dateString ?-base clockVal? ?-gmt boolean?`

Convert `dateString` to an integer clock value (see `clock seconds`). This command can parse and convert virtually any standard date and/or time string, which can include standard time zone mnemonics. If only a time is specified, the current date is assumed. If the string does not contain a time zone mnemonic, the local time zone is assumed, unless the **-gmt** argument is true, in which case the clock value is calculated assuming that the specified time is relative to Greenwich Mean Time.

If the **-base** flag is specified, the next argument should contain an integer clock value. Only the date in this value is used, not the time.

This is useful for determining the time on a specific day or doing other date-relative conversions.

The **dateString** consists of zero or more specifications of the following form:

time

A time of day, which is of the form: **hh?:mm?:ss?? ?meridian? ?zone? or hhmm ?meridian? ?zone?**.

If no meridian is specified, hh is interpreted on a 24-hour clock.

date

A specific month and day with optional year. The acceptable formats are mm/dd

[/yy], monthname dd [, yy], dd monthname [yy] and day, dd monthname yy. The default year is the current year. If the year is less than 100, then 1900 is added to it.

relative time

A specification relative to the current time. The format is number unit acceptable units are year, fortnight, month, week, day, hour, minute (or min), and second (or sec). The unit can be specified as a singular or plural, as in 3 weeks. These modifiers may also be specified: tomorrow, yesterday, today, now, last, this, next, ago.

The actual date is calculated according to the following steps. First, any absolute date and/or time is processed and converted. Using that time as the base, day-of-week specifications are added. Next, relative specifications are used. If a date or day is specified, and no absolute or relative time is given, midnight is used. Finally, a correction is applied so that the correct hour of the day is produced after allowing for daylight savings time differences.

`clock seconds`

Return the current date and time as a system-dependent integer value. The unit of the value is seconds, allowing it to be used for relative time calculations. The value is usually defined as total elapsed time from an "epoch". You shouldn't assume the value of the epoch.

78.3.9 concats - Concatenate strings with space

Syntax:

```
concat str1 ... strn
```

Command Set: *1.0, 1.5*

Synopsis:

This command concatenates all strings passed as parameters and inserts one space character between them. If one of the parameters contains leading or trailing spaces, they are removed before concatenation.

Returns:

The concatenated string

Example:

```
set result [concat str1 str2 " " str3 " xy"]  
print $result
```

This sequence would print the string:

```
str1 str2 str3 xy
```

See also:

```
concat
```

78.3.10 *continue* - Do next loop iteration**Syntax:**`Continue`**Command Set:** *1.0, 1.5***Synopsis:**

This command allows to *continue* a loop, meaning that control is directly passed to the start of the loop body.

Returns:

Nothing

Example:

```
loop I 100 {  
    if $I==10 { continue }  
    print "Iteration " $I  
}
```

This example would print all iterations, except the 10th one.

See also:`loop, while, break`

78.3.11 *deref* - De-Reference a Variable

Syntax:

```
deref variable
```

Command Set: *1.0 only*

Synopsis:

This command basically does the same as if it was written:

```
$variable
```

But very often you construct variable names at runtime. The `deref` command allows to construct statements like this:

```
Deref [concat arrayvar $I]
```

which helps to simulate array functionality.

This command returns the value of the variable passed as a parameter.

78.3.12 eof - Check for end of file condition on channel**Syntax:**

```
eof channelId
```

Command Set: *1.5 only***Synopsis:**

Returns 1 if an end of file condition occurred during the most recent input operation on channelId (such as gets), 0 otherwise.

78.3.13 error - Generate an error

Syntax:

```
error message [info] [code]
```

Command Set: *1.5 only*

Synopsis:

If the `info` argument is provided and is non-empty, it is used to initialize the global variable `errorInfo`. `errorInfo` is used to accumulate a stack trace of what was in progress when an error occurred; as nested commands unwind, the TIM interpreter adds information to `errorInfo`. If the `info` argument is present, it is used to initialize `errorInfo` and the first increment of unwind information will not be added by the TIM interpreter. In other words, the command containing the `error` command will not appear in `errorInfo`; in its place will be `info`. This feature is most useful in conjunction with the `catch` command: if a caught error cannot be handled successfully, `info` can be used to return a stack trace reflecting the original point of occurrence of the error:

```
catch {...} errMsg  
set savedInfo $errorInfo  
...  
error $errMsg $savedInfo
```

If the `code` argument is present, then its value is stored in the `errorCode` global variable. This variable is intended to hold a machine-

readable description of the error in cases where such information is available; see the TIM global variables manual page for information on the proper format for the variable. If the code argument is not present, then `errorCode` is automatically reset to "NONE" by the TIM interpreter as part of processing the error generated by the command.

Returns:

Returns a `TIM_ERROR` code, which causes command interpretation to be unwound. `Message` is a string that is returned to the application to indicate what went wrong.

78.3.14 eval - Evaluate a TIMs cript

Syntax:

```
eval arg [arg ...]
```

Command Set: *1.5 only*

Synopsis:

`Eval` takes one or more arguments, which together comprise a TIM-script containing one or more commands. `Eval` concatenates all its arguments in the same fashion as the `concat` command, passes the concatenated string to the TIM interpreter recursively.

Returns:

The result of that evaluation (or any error generated by it)

78.3.15 exec - Run programs.**Syntax:**

```
exec program arg0 arg1 ... argn
```

Command Set: *1.0, 1.5*

Synopsis:

This command allows to start another program which is located via `program`. Any number of arguments `arg0`, `arg1`, ... `argn` may be passed to the started program.

`program` may be a fully qualified path name, or just the name of the executable. The `exec` command searches the program along the path defined by the `PATH` environment variable.

Returns:

-1	in case of error
0	else

78.3.16 *expr* - Do math.

Syntax:

`expr math-expression`

Command Set: 1.0, 1.5

Synopsis:

This command evaluates the expression at the right side and returns its numerical result as a string. The expressions are written in standard C notation. There are lots of operators and built-in math functions. Here is a list of the operators in decreasing priority:

Priority	Operator	Sign
12	Unary Minus, Not, Bitwise Not	- ! ^
11	Multiplication, Division, Modulo	* / %
10	Plus, Minus	+ -
9	Left shift, Right shift	<< >>
8	Less, Greater, Less Equal, Greater Equal	< > <= >=
7	Equal, Not Equal	= !=
6	Bitwise AND	&
5	Bitwise XOR	^
4	Bitwise OR	
3	Logical AND	&&
2	Logical OR	
1	Question Mark, Colon	? :

Here is a list of the available math functions:

abs(x)	Calculates absolute value of (x)
acos(x)	Calculates inverse of cosine

asin(x)	Calculates inverse of sine
atan(x)	Calculates arctangent of (x)
atan2(y,x)	Calculates arctangent of (y,x), using the signs of both arguments to determine the quadrant of the return
ceil(x)	Calculates highest next integer
cos(x)	Calculates cosine
cosh(x)	Calculates cosine hyperbolic
double(x)	Casts a value to double
exp(x)	Calculates exponential function
floor(x)	Calculates lowest next integer
fmod(x,y)	Calculates the floating point remainder of x/y, even if the quotient x/y is not resrepresentable.
hypot(x,y)	Calculates $\sqrt{x^2+y^2}$
int(x)	Casts a value to integer
log(x)	Calculates natural logarithm
log10(x)	Calculates logarithm based on 10
pow(x,y)	Calculates x^y
round(x)	Rounds values to next integer
sin(x)	Calculates sine
sinh(x)	Calculates sine hyperbolic
sqrt(x)	Calculates square root
tan(x)	Calculates tangent
tanh(x)	Calculates tangent hyperbolic

Returns:

The string representation of the value of the computation.

Example:

```
print [expr 3+7*sin(1.2)]
```

This example prints 9.524274

See also:

C/C++ library reference

78.3.17 fblocked - Test whether the last input operation exhausted all available input**Syntax:**

```
fblocked channelId
```

Command Set: *1.5 only*

Synopsis:

The `fblocked` command returns 1 if the most recent input operation on `channelId` returned less information than requested because all available input was exhausted.

For example, if `gets` is invoked when there are only three characters available for input and no end-of-line sequence, `gets` returns an empty string and a subsequent call to `fblocked` will return 1.

See also:

`gets`, `read`

78.3.18 fconfigure - Set and get options on a channel

Syntax:

```
fconfigure channelId  
fconfigure channelId name  
fconfigure channelId name value [name value ...]
```

Command Set: *1.5 only*

Synopsis:

The `fconfigure` command sets and retrieves options for channels. `ChannelId` identifies the channel for which to set or query an option. If no `name` or `value` arguments are supplied, the command returns a list containing alternating option names and values for the channel. If `name` is supplied but no `value` then the command returns the current value of the given option. If one or more pairs of `name` and `value` are supplied, the command sets each of the named options to the corresponding value; in this case the return value is an empty string.

The options described below are supported for all channels. In addition, each channel type may add options that only it supports. See the manual entry for the command that creates each type of channels for the options that that specific type of channel supports. For example, see the manual entry for the `socket` command for its additional options.

`blocking` boolean

The **-blocking** option determines whether I/O operations on the channel can cause the process to block indefinitely. The value of the option must be a proper boolean value. Channels are normally in blocking mode; if a channel is placed into nonblocking mode it will affect the operation of the **gets**, **read**, **puts**, **flush**, and **close** commands; see the documentation for those commands for details. For nonblocking mode to work correctly, the application must be using the TIM event loop (e.g. by calling **TIM_DoOneEvent** or invoking the **vwait** command).

-buffering newValue

If **newValue** is **full** then the I/O system will buffer output until its internal buffer is full or until the **flush** command is invoked. If **newValue** is **line**, then the I/O system will automatically flush output for the channel whenever a newline character is output. If **newValue** is **none**, the I/O system will flush automatically after every output operation. The default is for **-buffering** to be set to **full** except for channels that connect to terminal-like devices; for these channels the initial setting is **line**.

-buffersize newSize

Newvalue must be an integer; its value is used to set the size of buffers, in bytes, subsequently allocated for this channel to store input or output. **Newvalue** must be between ten and one million, allowing buffers of ten to one million bytes in size.

`-eofchar char`

`-eofchar {inChar outChar}`

This option supports DOS file systems that use Control-z (\x1a) as an end of file marker. If `char` is not an empty string, then this character signals end of file when it is encountered during input. For output, the end of file character is output when the channel is closed. If `char` is the empty string, then there is no special end of file character marker. For read-write channels, a two-element list specifies the end of file marker for input and output, respectively. As a convenience, when setting the end-of-file character for a read-write channel you can specify a single value that will apply to both reading and writing. When querying the end-of-file character of a read-write channel, a two-element list will always be returned. The default value for `-eofchar` is the empty string in all cases except for files under Windows. In that case the `-eofchar` is Control-z (\x1a) for reading and the empty string for writing.

`-translation mode`

`-translation {inMode outMode}`

In TIMscripts the end of a line is always represented using a single newline character (\n). However, in actual files and devices the end of a line may be represented differently on different platforms, or even for different devices on the same platform. For example, under UNIX newlines are used in files, whereas carriage-return-linefeed sequences are normally used in network connections. On input (i.e., with `gets` and `read`) the TIM I/O system automatically translates the external end-of-line representation into newline characters. Upon output (i.e.,

with `puts`, the I/O system translates newlines to the external end-of-line representation. The default translation mode, **auto**, handles all the common cases automatically, but the `-translation` option provides explicit control over the end of line translations.

The value associated with `-translation` is a single item for read-only and write-only channels. The value is a two-element list for read-write channels; the read translation mode is the first element of the list, and the write translation mode is the second element. As a convenience, when setting the translation mode for a read-write channel you can specify a single value that will apply to both reading and writing. When querying the translation mode of a read-write channel, a two-element list will always be returned. The following values are currently supported:

Auto

As the input translation mode, **auto** treats any of newline (**lf**), carriage return (**cr**), or carriage return followed by a newline (**crlf**) as the end of line representation. The end of line representation can even change from line-to-line, and all cases are translated to a newline. As the output translation mode, **auto** chooses a platform specific representation; for sockets on all platforms TIM chooses **crlf**, for all Unix flavors, it chooses **lf**, for the Macintosh platform it chooses **cr** and for the various flavors of Windows it chooses **crlf**. The default setting for `-translation` is **auto** for both input and output.

Binary

No end-of-line translations are performed. This is nearly identical to **lf** mode, except that in addition **binary** mode also sets the end of file

character to the empty string, which disables it. See the description of `-eofchar` for more information.

`Cr`

The end of a line in the underlying file or device is represented by a single carriage return character. As the input translation mode, **cr** mode converts carriage returns to newline characters. As the output translation mode, **cr** mode translates newline characters to carriage returns. This mode is typically used on Macintosh platforms.

`cr lf`

The end of a line in the underlying file or device is represented by a carriage return character followed by a linefeed character. As the input translation mode, **cr lf** mode converts carriage-return-linefeed sequences to newline characters. As the output translation mode, **cr lf** mode translates newline characters to carriage-return-linefeed sequences. This mode is typically used on Windows platforms and for network connections.

`lf`

The end of a line in the underlying file or device is represented by a single newline (linefeed) character. In this mode no translations occur during either input or output. This mode is typically used on UNIX platforms.

See also:

Close, flush, gets, puts, read, socket

78.3.19 file - Manipulate file names and attributes

Syntax:

```
file option name [arg arg ...]
```

Command Set: *1.5 only*

Synopsis:

This command provides several operations on a file's name or attributes. **Name** is the name of a file; if it starts with a tilde, then tilde substitution is done before executing the command (see the manual entry for **filename** for details). **Option** indicates what to do with the file name.

Any unique abbreviation for option is acceptable. The valid options are:

file atime name

Returns a decimal string giving the time at which file **name** was last accessed. The time is measured in the standard POSIX fashion as seconds from a fixed starting time (often January 1, 1970). If the file doesn't exist or its access time cannot be queried then an error is generated.

```
file copy?-force? ?--? source target
```

```
file copy?-force? ?--? source ?source ...? targetDir
```

The first form makes a copy of the file or directory **source** under the pathname **target**. If **target** is an existing directory, then the second form is used. The second form makes a copy inside **targetDir** of each **source** file listed. If a directory is specified as a source, then the contents of the directory will be recursively copied into **targetDir**. Existing files will not be overwritten unless the **-force** option is specified. Trying to overwrite a non-empty directory, overwrite a directory with a file, or a file with a directory will all result in errors even if **-force** was specified. Arguments are processed in the order specified, halting at the first error, if any. A **-** marks the end of switches; the argument following the **-** will be treated as a **source** even if it starts with a **-**.

`file delete [-force? ?-? pathname ?pathname ... ?`

Removes the file or directory specified by each **pathname** argument. Non-empty directories will be removed only if the **-force** option is specified. Trying to delete a non-existent file is not considered an error. Trying to delete a read-only file will cause the file to be deleted, even if the **-force** flag is not specified. Arguments are processed in the order specified, halting at the first error, if any. A **-** marks the end of switches; the argument following the **-** will be treated as a **pathname** even if it starts with a **-**.

`file dirname name`

Returns a name comprised of all of the path components in **name** excluding the last element. If **name** is a relative file name and only contains one path element, then returns "." If **name** refers to a root directory, then the root directory is returned. For example,

`file dirname c:/`

returns `c:/`.

`file executable name`

Returns `1` if file name is executable by the current user, `0` otherwise.

`file exists name`

Returns `1` if file name exists and the current user has search privileges for the directories leading to it, `0` otherwise.

`file extension name`

Returns all of the characters in `name` after and including the last dot in the last element of `name`. If there is no dot in the last element of `name` then returns the empty string.

`file isdirectory name`

Returns `1` if file name is a directory, `0` otherwise.

`file isfile name`

Returns `1` if file name is a regular file, `0` otherwise.

`file join name [name ...]`

Takes one or more file names and combines them, using the correct path separator for the current platform. If a particular name is relative, then it will be joined to the previous file name argument. Other-

wise, any earlier arguments will be discarded, and joining will proceed from the current argument. For example,

```
file join a b /foo bar
```

returns /foo/bar.

Note that any of the names can contain separators, and that the result is always canonical for the current platform: / for Unix and Windows, and : for Macintosh.

```
file lstat name varName
```

Same as stat option (see below) except uses the lstat kernel call instead of stat. This means that if name refers to a symbolic link the information returned in varName is for the link rather than the file it refers to. On systems that don't support symbolic links this option behaves exactly the same as the stat option.

```
file mkdir dir [dir ...]
```

Creates each directory specified. For each pathname dir specified, this command will create all non-existing parent directories as well as dir itself. If an existing directory is specified, then no action is taken and no error is returned. Trying to overwrite an existing file with a directory will result in an error. Arguments are processed in the order specified, halting at the first error, if any.

```
file mtime name
```

Returns a decimal string giving the time at which file name was last

modified. The time is measured in the standard POSIX fashion as seconds from a fixed starting time (often January 1, 1970). If the file doesn't exist or its modified time cannot be queried then an error is generated.

`file owned name`

Returns **1** if file name is owned by the current user, **0** otherwise.

`file pathtype name`

Returns one of **absolute**, **relative**, **volumerelative**. If `name` refers to a specific file on a specific volume, the path type will be **absolute**. If `name` refers to a file relative to the current working directory, then the path type will be **relative**. If `name` refers to a file relative to the current working directory on a specified volume, or to a specific file on the current working volume, then the file type is **volumerelative**.

`file readable name`

Returns **1** if file name is readable by the current user, **0** otherwise.

`file readlink name`

Returns the value of the symbolic link given by `name` (i.e. the name of the file it points to). If `name` isn't a symbolic link or its value cannot be read, then an error is returned. On systems that don't support symbolic links this option is undefined.

```
file rename?-force? ?-?-? source target
file rename?-force? ?-?-? source ?source ...? target-
Dir
```

The first form takes the file or directory specified by pathname **source** and renames it to **target**, moving the file if the pathname **target** specifies a name in a different directory. If **target** is an existing directory, then the second form is used. The second form moves each **source** file or directory into the directory **targetDir**. Existing files will not be overwritten unless the **-force** option is specified. Trying to overwrite a non-empty directory, overwrite a directory with a file, or a file with a directory will all result in errors. Arguments are processed in the order specified, halting at the first error, if any. A **-** marks the end of switches; the argument following the **-** will be treated as a **source** even if it starts with a **-**.

```
file rootname name
```

Returns all of the characters in **name** up to but not including the last "." character in the last component of **name**. If the last component of **name** doesn't contain a dot, then returns **name**.

```
file size name
```

Returns a decimal string giving the size of file **name** in bytes. If the file doesn't exist or its size cannot be queried then an error is generated.

```
file split name
```

Returns a list whose elements are the path components in **name**. The

first element of the list will have the same path type as **name**. All other elements will be relative. Path separators will be discarded unless they are needed ensure that an element is unambiguously relative. For example, under Unix

```
file split /foo/~bar/baz
```

```
returns /foo ./~bar/baz
```

to ensure that later commands that use the third component do not attempt to perform tilde substitution.

```
file stat name varName
```

Invokes the **stat** kernel call on **name**, and uses the variable given by **varName** to hold information returned from the kernel call. **VarName** is treated as an array variable, and the following elements of that variable are set: **atime**, **ctime**, **dev**, **gid**, **ino**, **mode**, **mtime**, **nlink**, **size**, **type**, **uid**. Each element except **type** is a decimal string with the value of the corresponding field from the stat return structure; see the manual entry for **stat** for details on the meanings of the values. The **type** element gives the type of the file in the same form returned by the command **file type**. This command returns an empty string.

```
file tail name
```

Returns all of the characters in **name** after the last directory separator. If **name** contains no separators then returns **name**.

file type name

Returns a string giving the type of file name, which will be one of file, directory, characterSpecial, blockSpecial, fifo, link, or socket.

file writable name

Returns 1 if file name is writable by the current user, 0 otherwise.

78.3.20 fileevent - Execute a script when a channel becomes readable or writable

Syntax:

```
fileevent channelId readable [script]  
fileevent channelId writable [script?]
```

Command Set: *1.5 only*

Synopsis:

This command is used to create `file event` handlers. A file event handler is a binding between a channel and a script, such that the script is evaluated whenever the channel becomes readable or writable. File event handlers are most commonly used to allow data to be received from another process on an event-driven basis, so that the receiver can continue to interact with the user while waiting for the data to arrive. If an application invokes `gets` or `read` on a blocking channel when there is no input data available, the process will block; until the input data arrives, it will not be able to service other events, so it will appear to the user to "freeze up". With `fileevent`, the process can tell when data is present and only invoke `gets` or `read` when they won't block.

The `channelId` argument to `fileevent` refers to an open channel, such as the return value from a previous `open` or `socket` command. If the script argument is specified, then `fileevent` creates a new event handler: `script` will be evaluated whenever the channel becomes readable or writable (depending on the second argument to `fileevent`). In this case `fileevent` returns an empty string. The

readable and **writable** event handlers for a file are independent, and may be created and deleted separately. However, there may be at most one readable and one writable handler for a file at a given time in a given interpreter. If `fileevent` is called when the specified handler already exists in the invoking interpreter, the new script replaces the old one.

If the script argument is not specified, `fileevent` returns the current script for `channelId`, or an empty string if there is none. If the `script` argument is specified as an empty string then the event handler is deleted, so that no script will be invoked. A file event handler is also deleted automatically whenever its channel is closed or its interpreter is deleted.

A channel is considered to be readable if there is unread data available on the underlying device. A channel is also considered to be readable if there is unread data in an input buffer, except in the special case where the most recent attempt to read from the channel was a `gets` call that could not find a complete line in the input buffer. This feature allows a file to be read a line at a time in nonblocking mode using events. A channel is also considered to be readable if an end of file or error condition is present on the underlying file or device. It is important for script to check for these conditions and handle them appropriately; for example, if there is no special check for end of file, an infinite loop may occur where script reads no data, returns, and is immediately invoked again.

A channel is considered to be writable if at least one byte of data can be written to the underlying file or device without blocking, or if an error condition is present on the underlying file or device.

Event-driven I/O works best for channels that have been placed into nonblocking mode with the `fconfigure` command. In blocking mode, a `puts` command may block if you give it more data than the underlying file or device can accept, and a `gets` or `read` command will block if you attempt to read more data than is ready; no events will be processed while the commands block. In nonblocking mode `puts`, `read`, and `gets` never block. See the documentation for the individual commands for information on how they handle blocking and nonblocking channels.

The script for a file event is executed at global level (outside the context of any TIM procedure) in the interpreter in which the `fileevent` command was invoked. If an error occurs while executing the script then the `bgerror` mechanism is used to report the error. In addition, the file event handler is deleted if it ever returns an error; this is done in order to prevent infinite loops due to buggy handlers.

CREDITS

`fileevent` is based on the `addinput` command created by Mark Diekhans.

See also:

`bgerror`, `fconfigure`, `gets`, `puts`, `read`

78.3.21 flush - Flush buffered output for a channel**Syntax:**

```
flush channelId
```

Command Set: *1.5 only***Synopsis:**

This command flushes any output that has been buffered for channelId. ChannelId must be a channel identifier such as returned by a previous `open` or `socket` command, and it must have been opened for writing. If the channel is in blocking mode the command does not return until all the buffered output has been flushed to the channel. If the channel is in nonblocking mode, the command may return before all buffered output has been flushed; the remainder will be flushed in the background as fast as the underlying file or device is able to absorb it.

See also:

`open`, `socket`

78.3.22 for - "For" loop

Syntax:

```
for start test next body
```

Command Set: *1.5 only*

Synopsis:

For is a looping command, similar in structure to the C `for` statement. The `start`, `next`, and `body` arguments must be TIM command strings, and `test` is an expression string. The `for` command first invokes the TIM interpreter to execute `start`. Then it repeatedly evaluates `test` as an expression; if the result is non-zero it invokes the TIM interpreter on `body`, then invokes the TIM interpreter on `next`, then repeats the loop. The command terminates when `test` evaluates to 0. If a `continue` command is invoked within `body` then any remaining commands in the current execution of `body` are skipped; processing continues by invoking the TIM interpreter on `next`, then evaluating `test`, and so on. If a `break` command is invoked within `body` or `next`, then the `for` command will return immediately. The operation of `break` and `continue` are similar to the corresponding statements in C. `For` returns an empty string.

78.3.23 foreach - Iterate over all elements in one or more lists

Syntax:

```
foreach varname list body  
foreach varlist1 list1 [varlist2 list2 ...] body
```

Command Set: 1.5 only**Synopsis:**

This command implements a loop where the loop variable(s) take on values from one or more lists. In the simplest case there is one loop variable, `varname`, and one list, `list`, that is a list of values to assign to `varname`. The `body` argument is a TIM script. For each element of `list` (in order from first to last), `foreach` assigns the contents of the element to `varname` as if the `lindex` command had been used to extract the element, then calls the TIM interpreter to execute `body`.

In the general case there can be more than one value list (e.g., `list1` and `list2`), and each value list can be associated with a list of loop variables (e.g., `varlist1` and `varlist2`). During each iteration of the loop the variables of each `varlist` are assigned consecutive values from the corresponding `list`. Values in each `list` are used in order from first to last, and each value is used exactly once. The total number of loop iterations is large enough to use up all the values from all the value lists. If a value list does not contain enough elements for each of its loop variables in each iteration, empty values are used for the missing elements.

The break and continue statements may be invoked inside body, with the same effect as in the for command. **Foreach** returns an empty string.

Examples:

The following loop uses i and j as loop variables to iterate over pairs of elements of a single list.

```
set x {}
foreach {i j} {a b c d e f} {
    lappend x $j $i
}
# The value of x is "b a d c f e"
# There are 3 iterations of the loop.
```

The next loop uses i and j to iterate over two lists in parallel.

```
set x {}
foreach i {a b c} j {d e f g} {
    lappend x $i $j
}
# The value of x is "a d b e c f {} g"
# There are 4 iterations of the loop.
```

The two forms are combined in the following example.

```
set x {}
foreach i {a b c} {j k} {d e f g} {
    lappend x $i $j $k
}
# The value of x is "a d e b f g c {} {}"
# There are 3 iterations of the loop.
```

78.3.24 *format* - Format a string in the style of *sprintf*

Syntax:

```
format formatString [arg arg ...]
```

Command Set: *1.5 only*

Synopsis:

This command generates a formatted string in the same way as the ANSI C `sprintf` procedure (it uses `sprintf` in its implementation). `FormatString` indicates how to format the result, using % conversion specifiers as in `sprintf`, and the additional arguments, if any, provide values to be substituted into the result.

Returns:

The return value from `format` is the formatted string.

DETAILS ON FORMATTING

The command operates by scanning `formatString` from left to right. Each character from the format string is appended to the result string unless it is a percent sign. If the character is a % then it is not copied to the result string. Instead, the characters following the % character are treated as a conversion specifier. The conversion specifier controls the conversion of the next successive `arg` to a particular format and the result is appended to the result string in place of the conversion specifier. If there are multiple conversion specifiers in the format string, then each one controls the conversion of one additional `arg`.

The `format` command must be given enough args to meet the needs of all of the conversion specifiers in `formatString`.

Each conversion specifier may contain up to six different parts: an XPG3 position specifier, a set of flags, a minimum field width, a precision, a length modifier, and a conversion character. Any of these fields may be omitted except for the conversion character. The fields that are present must appear in the order given above. The paragraphs below discuss each of these fields in turn.

If the `%` is followed by a decimal number and a `$`, as in `"%2$d"`, then the value to convert is not taken from the next sequential argument. Instead, it is taken from the argument indicated by the number, where 1 corresponds to the first `arg`. If the conversion specifier requires multiple arguments because of `*` characters in the specifier then successive arguments are used, starting with the argument given by the number. This follows the XPG3 conventions for positional specifiers. If there are any positional specifiers in `formatString` then all of the specifiers must be positional.

The second portion of a conversion specifier may contain any of the following flag characters, in any order:

-

Specifies that the converted argument should be left-justified in its field (numbers are normally right-justified with leading spaces if needed).

+

Specifies that a number should always be printed with a sign, even if

positive.

space

Specifies that a space should be added to the beginning of the number if the first character isn't a sign.

0

Specifies that the number should be padded on the left with zeroes instead of spaces.

#

Requests an alternate output form. For o and O conversions it guarantees that the first digit is always 0. For x or X conversions, 0x or 0X (respectively) will be added to the beginning of the result unless it is zero. For all floating-point conversions (e, E, f, g, and G) it guarantees that the result always has a decimal point. For g and G conversions it specifies that trailing zeroes should not be removed.

The third portion of a conversion specifier is a number giving a minimum field width for this conversion. It is typically used to make columns line up in tabular printouts. If the converted argument contains fewer characters than the minimum field width then it will be padded so that it is as wide as the minimum field width. Padding normally occurs by adding extra spaces on the left of the converted argument, but the 0 and - flags may be used to specify padding with zeroes on the left or with spaces on the right, respectively. If the minimum field width is specified as * rather than a number, then the next argument

to the `format` command determines the minimum field width; it must be a numeric string.

The fourth portion of a conversion specifier is a precision, which consists of a period followed by a number. The number is used in different ways for different conversions. For `e`, `E`, and `f` conversions it specifies the number of digits to appear to the right of the decimal point. For `g` and `G` conversions it specifies the total number of digits to appear, including those on both sides of the decimal point (however, trailing zeroes after the decimal point will still be omitted unless the `#` flag has been specified). For integer conversions, it specifies a minimum number of digits to print (leading zeroes will be added if necessary). For `s` conversions it specifies the maximum number of characters to be printed; if the string is longer than this then the trailing characters will be dropped. If the precision is specified with `*` rather than a number then the next argument to the `format` command determines the precision; it must be a numeric string.

The fifth part of a conversion specifier is a length modifier, which must be `h` or `l`. If it is `h` it specifies that the numeric value should be truncated to a 16-bit value before converting. This option is rarely useful. The `l` modifier is ignored.

The last thing in a conversion specifier is an alphabetic character that determines what kind of conversion to perform. The following conversion characters are currently supported:

d

Convert integer to signed decimal string.

u

Convert integer to unsigned decimal string.

i

Convert integer to signed decimal string; the integer may either be in decimal, in octal (with a leading 0) or in hexadecimal (with a leading 0x).

o

Convert integer to unsigned octal string.

x or X

Convert integer to unsigned hexadecimal string, using digits "0123456789abcdef" for x and "0123456789ABCDEF" for X).

c

Convert integer to the 8-bit character it represents.

s

No conversion; just insert string.

f

Convert floating-point number to signed decimal string of the form xx.yyy, where the number of y's is determined by the precision (de-

fault: 6). If the precision is 0 then no decimal point is output.

e or E

Convert floating-point number to scientific notation in the form $x.yyye\pm zz$, where the number of y's is determined by the precision (default: 6). If the precision is 0 then no decimal point is output. If the E form is used then E is printed instead of e.

g or G

If the exponent is less than -4 or greater than or equal to the precision, then convert floating-point number as for %e or %E. Otherwise convert as for %f. Trailing zeroes and a trailing decimal point are omitted.

%

No conversion: just insert %.

For the numerical conversions the argument being converted must be an integer or floating-point string; format converts the argument to binary and then converts it back to a string according to the conversion specifier.

DIFFERENCES FROM ANSI SPRINTF

The behavior of the format command is the same as the ANSI C `sprintf` procedure except for the following differences:

`%p` and `%n` specifiers are not currently supported.

For `%c` conversions the argument must be a decimal string, which will then be converted to the corresponding character value.

The `l` modifier is ignored; integer values are always converted as if there were no modifier present and real values are always converted as if the `l` modifier were present (i.e. type **double** is used for the internal representation). If the `h` modifier is specified then integer values are truncated to **short** before conversion.

78.3.25 gets - Read a line from a channel

Syntax:

```
gets channelId [varName]
```

Command Set: *1.5 only*

Synopsis:

This command reads the next line from `channelId`, returns everything in the line up to (but not including) the end-of-line character(s), and discards the end-of-line character(s). If `varName` is omitted the line is returned as the result of the command. If `varName` is specified then the line is placed in the variable by that name and the return value is a count of the number of characters returned.

If end of file occurs while scanning for an end of line, the command returns whatever input is available up to the end of file. If `channelId` is in nonblocking mode and there is not a full line of input available, the command returns an empty string and does not consume any input. If `varName` is specified and an empty string is returned in `varName` because of end-of-file or because of insufficient data in nonblocking mode, then the return count is -1. Note that if `varName` is not specified then the end-of-file and no-full-line-available cases can produce the same results as if there were an input line consisting only of the end-of-line character(s). The `eof` and `fblocked` commands can be used to distinguish these three cases.

See also:

`eof`, `fblocked`

78.3.26 glob - Return names of files that match patterns**Syntax:**

```
glob [switches] pattern [pattern ...]
```

Command Set: *1.5 only*

Synopsis:

This command performs file name "globbing" in a fashion similar to the csh shell. It returns a list of the files whose names match any of the `pattern` arguments.

If the initial arguments to `glob` start with `-` then they are treated as switches. The following switches are currently supported:

-nocomplain

Allows an empty list to be returned without error; without this switch an error is returned if the result list would be empty.

`-`

Marks the end of switches. The argument following this one will be treated as a pattern even if it starts with a `-`

The `pattern` arguments may contain any of the following special characters:

?

Matches any single character.

Matches any sequence of zero or more characters.

[chars]

Matches any single character in chars. If chars contains a sequence of the form a-b then any character between a and b (inclusive) will match.

\x

Matches the character x.

{a,b,...}

Matches any of the strings a, b, etc.

As with csh, a "." at the beginning of a file's name or just after a "/" must be matched explicitly or with a {} construct. In addition, all "/" characters must be matched explicitly.

If the first character in a pattern is "~" then it refers to the home directory for the user whose name follows the "~". If the "~" is followed immediately by "/" then the value of the HOME environment variable is used.

The glob command differs from csh globbing in two ways. First, it does not sort its result list (use the lsort command if you want the list sorted). Second, glob only returns the names of files that actually

exist; in `csh` no check for existence is made unless a pattern contains a `?`, `*`, or `[]` construct.

PORTABILITY ISSUES

Unlike other TIM commands that will accept both network and native style names (see the `filename` manual entry for details on how native and network names are specified), the `glob` command only accepts native names. Also, for Windows UNC names, the servername and sharename components of the path may not contain `?`, `*`, or `[]` constructs.

78.3.27 *global* - Access global variables

Syntax:

```
global varname [varname ...]
```

Command Set: *1.5 only*

Synopsis:

This command is ignored unless a TIM procedure is being interpreted. If so then it declares the given `varname`'s to be global variables rather than local ones. For the duration of the current procedure (and only while executing in the current procedure), any reference to any of the `varnames` will refer to the global variable by the same name.

78.3.28 if - Do conditional programming**Syntax:**

```
if expr then script else script
```

Command Set: 1.0, 1.5

Synopsis:

This command allows conditional execution. The `expr` is evaluated and depending on its result value, the `then` path is taken or the `else` path.

The keyword `then` is optional.

Scripts should be put into curly braces, when they are longer than a single line.

Returns:

The return value of the last executed string from either the `else` or the `then` path.

Example:

```
if $I==10 {  
    print I is 10  
} else {  
    print I is not 10  
}
```

Please note the construction in the line where the `else` is noted. The closing brace is on the same line as the `else` and as the starting brace for the new script. Please take a look at the syntax. This is one way of doing it. Another way would look like this:

```
if $I==10 {print I is 10} else {  
    print I is not 10  
}
```

Please note also, that the condition is already supposed to be an expression, you do not have to enter the `expr` macro!

See also:

`while`, `set`, `expr`

78.3.29 include - Include source files recursively**Syntax:**

```
include filename
```

Command Set: *1.0, 1.5***Synopsis:**

This command passes interpreter control to the new file named `filename`. After this file or recursively called files are parsed, control continues right after this statement. If the file does not exist, no warning or error message is issued.

Returns:

The return value of the last statement in the file `filename`, or in any recursively called file.

See also:

[source](#)

78.3.30 *incr* - Increment the value of a variable

Syntax:

```
incr varName [increment]
```

Command Set: *1.5 only*

Synopsis:

This command increments the value stored in the variable whose name is varName. The value of the variable must be an integer. If increment is supplied then its value (which must be an integer) is added to the value of variable varName; otherwise 1 is added to varName. The new value is stored as a decimal string in variable varName and also returned as result.

78.3.31 info - Return information about the state of the TIM interpreter

Syntax:

```
info option [arg arg ...]
```

Command Set: *1.5 only*

Synopsis:

This command provides information about various internals of the TIM interpreter. The legal option's (which may be abbreviated) are:

info args procname

Returns a list containing the names of the arguments to procedure `procname`, in order. `Procname` must be the name of a TIM command procedure.

info body procname

Returns the body of procedure `procname`. `Procname` must be the name of a TIM command procedure.

info cmdcount

Returns a count of the total number of commands that have been invoked in this interpreter.

info commands [pattern]

If `pattern` isn't specified, returns a list of names of all the TIM com-

mands, including both the built-in commands written in C and the command procedures defined using the `proc` command. If `pattern` is specified, only those names matching `pattern` are returned. Matching is determined using the same rules as for string match.

info complete command

Returns 1 if `command` is a complete TIM command in the sense of having no unclosed quotes, braces, brackets or array element names. If the command doesn't appear to be complete then 0 is returned. This command is typically used in line-oriented input environments to allow users to type in commands that span multiple lines; if the command isn't complete, the script can delay evaluating it until additional lines have been typed to complete the command.

info default procname arg varname

`Procname` must be the name of a TIM command procedure and `arg` must be the name of an argument to that procedure. If `arg` doesn't have a default value then the command returns 0. Otherwise it returns 1 and places the default value of `arg` into variable `varname`.

info exists varName

Returns 1 if the variable named `varName` exists in the current context (either as a global or local variable), returns 0 otherwise.

info globals [pattern]

If `pattern` isn't specified, returns a list of all the names of currently-defined global variables. If `pattern` is specified, only those names matching `pattern` are returned. Matching is determined using the same rules as for string match.

info hostname

Returns the name of the computer on which this invocation is being executed.

info level [number]

If `number` is not specified, this command returns a number giving the stack level of the invoking procedure, or 0 if the command is invoked at top-level. If `number` is specified, then the result is a list consisting of the name and arguments for the procedure call at level `number` on the stack. If `number` is positive then it selects a particular stack level (1 refers to the top-most active procedure, 2 to the procedure it called, and so on); otherwise it gives a level relative to the current level (0 refers to the current procedure, -1 to its caller, and so on). See the `uplevel` command for more information on what stack levels mean.

info library

Returns the name of the library directory in which standard TIM-scripts are stored. This is actually the value of the `Tcl_library` variable and may be changed by setting `Tcl_library`. See the TIM global variables manual entry for more information.

info loaded [interp]

Returns a list describing all of the packages that have been loaded into `interp` with the `load` command. Each list element is a sub-list with two elements consisting of the name of the file from which the package was loaded and the name of the package. For statically-loaded packages the file name will be an empty string. If `interp` is omitted then information is returned for all packages loaded in any interpreter in the process. To get a list of just the packages in the current interpreter, specify an empty string for the `interp` argument.

info locals [pattern]

If `pattern` isn't specified, returns a list of all the names of currently-defined local variables, including arguments to the current procedure, if any. Variables defined with the `global` and `upvar` commands will not be returned. If `pattern` is specified, only those names matching `pattern` are returned. Matching is determined using the same rules as for `string match`.

info nameofexecutable

Returns the full path name of the binary file from which the application was invoked. If TIM was unable to identify the file, then an empty string is returned.

info patchlevel

Returns the value of the global variable `Tcl_patchLevel`; see the TIM global variables manual entry for more information.

info procs [pattern]

If `pattern` isn't specified, returns a list of all the names of TIM command procedures. If `pattern` is specified, only those names matching `pattern` are returned. Matching is determined using the same rules as for `string match`.

info script

If a TIM script file is currently being evaluated (i.e. there is a call to `tcl_EvalFile` active or there is an active invocation of the `source` command), then this command returns the name of the innermost file being processed. Otherwise the command returns an empty string.

info sharedlibextension

Returns the extension used on this platform for the names of files

containing shared libraries (for example, `.so` under Solaris). If shared libraries aren't supported on this platform then an empty string is returned.

info TIMversion

Returns the value of the global variable `Tcl_version`; see the TIM-global variables manual entry for more information.

info vars [pattern]

If `pattern` isn't specified, returns a list of all the names of currently-visible variables, including both locals and currently-visible globals. If `pattern` is specified, only those names matching `pattern` are returned. Matching is determined using the same rules as for `string match`.

78.3.32 join - Create a string by joining together list elements

Syntax:

```
join list [joinString]
```

Command Set: *1.5 only*

Synopsis:

The list argument must be a valid TIM list.

Returns:

This command returns the string formed by joining all of the elements of list together with `joinString` separating each adjacent pair of elements. The `joinString` argument defaults to a space character.

78.3.33 lappend - Append list elements onto a variable**Syntax:**

```
lappend varName [value value value ...]
```

Command Set: *1.5 only*

Synopsis:

This command treats the variable given by `varName` as a list and appends each of the value arguments to that list as a separate element, with spaces between elements. If `varName` doesn't exist, it is created as a list with elements given by the value arguments. `Lappend` is similar to `append` except that the values are appended as list elements rather than raw text. This command provides a relatively efficient way to build up large lists.

Example:

For example, "`lappend a $b`" is much more efficient than "`set a [concat $a [list $b]]`" when `$a` is long.

78.3.34 *lindex* - Retrieve an element from a list

Syntax:

```
lindex list index
```

Command Set: *1.5 only*

Synopsis:

This command treats `list` as a TIM list and returns the `index`'th element from it (0 refers to the first element of the list). In extracting the element, `lindex` observes the same rules concerning braces and quotes and backslashes as the TIM command interpreter; however, variable substitution and command substitution do not occur. If `index` is negative or greater than or equal to the number of elements in `value`, then an empty string is returned. If `index` has the value `end`, it refers to the last element in the list.

78.3.35 *linsert* - Insert elements into a list**Syntax:**

```
linsert list index element [element element ...]
```

Command Set: *1.5 only***Synopsis:**

This command produces a new list from `list` by inserting all of the element arguments just before the `index`th element of `list`. Each `element` argument will become a separate element of the new list. If `index` is less than or equal to zero, then the new elements are inserted at the beginning of the list. If `index` has the value `end`, or if it is greater than or equal to the number of elements in the list, then the new elements are appended to the list.

78.3.36 *list* - Create a list

Syntax:

```
list [arg arg ...]
```

Command Set: *1.5 only*

Synopsis:

This command returns a list comprised of all the `args`, or an empty string if no `args` are specified. Braces and backslashes get added as necessary, so that the `index` command may be used on the result to re-extract the original arguments, and also so that `eval` may be used to execute the resulting list, with `arg1` comprising the command's name and the other `args` comprising its arguments. `List` produces slightly different results than `concat`: `concat` removes one level of grouping before forming the list, while `list` works directly from the original arguments. For example, the command

```
list a b {c d e} {f {g h}}
```

will return

```
a b {c d e} {f {g h}}
```

while `concat` with the same arguments will return

```
a b c d e f {g h}
```

78.3.37 llength - Count the number of elements in a list**Syntax:**

```
llength list
```

Command Set: *1.5 only***Synopsis:**

Treats list as a list and returns a decimal string giving the number of elements in it.

78.3.38 loop - Perform loops

Syntax:

```
loop var limit script
```

Command Set: *1.0 only*

Synopsis:

This command initializes the variable `var` with zero and iterates running `script` as long as `var` keeps to be smaller than the `limit`.

Returns:

The return value of the last statement in the script.

Example:

```
loop I 100 {  
    print hi in the script, iteration: $I  
}
```

This example prints all iteration numbers. It corresponds to a C/C++ construction like this:

```
for (int I = 0; I < 100; I++) {  
    printf("...\n");  
}
```

See also:

while

78.3.39 lrange - Return one or more adjacent elements from a list

Syntax:

```
lrange list first last
```

Command Set: *1.5 only*

Synopsis:

List must be a valid TIM list. This command will return a new list consisting of elements first through last, inclusive. First or last may be end (or any abbreviation of it) to refer to the last element of the list. If first is less than zero, it is treated as if it were zero. If last is greater than or equal to the number of elements in the list, then it is treated as if it were end. If first is greater than last then an empty string is returned. Note: "lrange list first first" does not always produce the same result as "lindexlist first" (although it often does for simple fields that aren't enclosed in braces); it does, however, produce exactly the same results as "list [lindexlist first]"

78.3.40 lreplace - Replace elements in a list with new elements

Syntax:

```
lreplace list first last [element element ...]
```

Command Set: *1.5 only*

Synopsis:

Lreplace returns a new list formed by replacing one or more elements of list with the element arguments. First gives the index in list of the first element to be replaced (0 refers to the first element). If first is less than zero then it refers to the first element of list; the element indicated by first must exist in the list. Last gives the index in list of the last element to be replaced. If last is less than first then no elements are deleted; the new elements are simply inserted before first. First or last may be end (or any abbreviation of it) to refer to the last element of the list. The element arguments specify zero or more new arguments to be added to the list in place of those that were deleted. Each element argument will become a separate element of the list. If no element arguments are specified, then the elements between first and last are simply deleted.

78.3.41 lsearch - See if a list contains a particular element**Syntax:**

```
lsearch [mode] list pattern
```

Command Set: *1.5 only***Synopsis:**

This command searches the elements of `list` to see if one of them matches `pattern`. If so, the command returns the index of the first matching element. If not, the command returns -1. The `mode` argument indicates how the elements of the list are to be matched against `pattern` and it must have one of the following values:

-exact

The list element must contain exactly the same string as `pattern`.

-glob

`Pattern` is a glob-style pattern which is matched against each list element using the same rules as the `string match` command.

-regexp

`Pattern` is treated as a regular expression and matched against each list element using the same rules as the `regexp` command.

If `mode` is omitted then it defaults to `-glob`.

78.3.42 *lsort* - Sort the elements of a list

Syntax:

```
lsort [options] list
```

Command Set: *1.5 only*

Synopsis:

This command sorts the elements of `list`, returning a new list in sorted order. By default ASCII sorting is used with the result returned in increasing order. However, any of the following options may be specified before `list` to control the sorting process (unique abbreviations are accepted):

-ascii

Use string comparison with ASCII collation order. This is the default.

-dictionary

Use dictionary-style comparison. This is the same as **-ascii** except (a) case is ignored except as a tie-breaker and (b) if two strings contain embedded numbers, the numbers compare as integers, not characters. For example, in **-dictionary** mode, `bigBoy` sorts between `bigbang` and `bigboy`, and `x10y` sorts between `x9y` and `x11y`.

-integer

Convert list elements to integers and use integer comparison.

-real

Convert list elements to floating-point values and use floating comparison.

-command command

Use `command` as a comparison command. To compare two elements, evaluate a TIM script consisting of `command` with the two elements appended as additional arguments. The script should return an integer less than, equal to, or greater than zero if the first element is to be considered less than, equal to, or greater than the second, respectively.

-increasing

Sort the list in increasing order ("smallest" items first). This is the default.

-decreasing

Sort the list in decreasing order ("largest" items first).

-index index

If this option is specified, each of the elements of list must itself be a proper TIM sublist. Instead of sorting based on whole sublists, `lsort` will extract the `index`'th element from each sublist and sort based on the given element. For example, `lsort -integer -index 1 {{First 24} {Second 18} {Third 30}}` returns `{Second 18} {First 24} {Third 30}`. This

option is much more efficient than using `-command` to achieve the same effect.

Example:

For example, `lsort -integer -index 1 {{First 24} {Second 18} {Third 30}}` returns `{Second 18} {First 24} {Third 30}`. This option is much more efficient than using `-command` to achieve the same effect.

78.3.43 open - Open a file-based or command pipeline channel**Syntax:**

```
open fileName  
open fileName access  
open fileName access permissions
```

Command Set: *1.5 only***Synopsis:**

This command opens a file, serial port, or command pipeline and returns a channel identifier that may be used in future invocations of commands like `read`, `puts`, and `close`. If the first character of `fileName` is not `|` then the command opens a file: `fileName` gives the name of the file to open, and it must conform to the conventions described in the `filename` manual entry.

The `access` argument, if present, indicates the way in which the file (or command pipeline) is to be accessed. In the first form access may have any of the following values:

`r`

Open the file for reading only; the file must already exist. This is the default value if access is not specified.

r+

Open the file for both reading and writing; the file must already exist.

w

Open the file for writing only. Truncate it if it exists. If it doesn't exist, create a new file.

w+

Open the file for reading and writing. Truncate it if it exists. If it doesn't exist, create a new file.

a

Open the file for writing only. The file must already exist, and the file is positioned so that new data is appended to the file.

a+

Open the file for reading and writing. If the file doesn't exist, create a new empty file. Set the initial access position to the end of the file.

In the second form, **access** consists of a list of any of the following flags, all of which have the standard POSIX meanings. One of the flags must be either **RDONLY**, **WRONLY** or **RDWR**.

RDONLY

Open the file for reading only.

WRONLY

Open the file for writing only.

RDWR

Open the file for both reading and writing.

APPEND

Set the file pointer to the end of the file prior to each write.

CREAT

Create the file if it doesn't already exist (without this flag it is an error for the file not to exist).

EXCL

If CREAT is also specified, an error is returned if the file already exists.

NOCTTY

If the file is a terminal device, this flag prevents the file from becoming the controlling terminal of the process.

NONBLOCK

Prevents the process from blocking while opening the file, and possibly in subsequent I/O operations. The exact behavior of this flag is system- and device-dependent; its use is discouraged (it is better to use the `fconfigure` command to put a file in nonblocking mode). For details refer to your system documentation on the `open` system call's `O_NONBLOCK` flag.

TRUNC

If the file exists it is truncated to zero length.

If a new file is created as part of opening it, `permissions` (an integer) is used to set the permissions for the new file in conjunction with

the process's file mode creation mask. `Permissions` defaults to 0666.

COMMAND PIPELINES

If the first character of `fileName` is `"|"` then the remaining characters of `fileName` are treated as a list of arguments that describe a command pipeline to invoke, in the same style as the arguments for `exec`. In this case, the channel identifier returned by `open` may be used to write to the command's input pipe or read from its output pipe, depending on the value of `access`. If write-only access is used (e.g. `access` is `w`), then standard output for the pipeline is directed to the current standard output unless overridden by the command. If read-only access is used (e.g. `access` is `r`), standard input for the pipeline is taken from the current standard input unless overridden by the command.

SERIAL COMMUNICATIONS

If `fileName` refers to a serial port, then the specified serial port is opened and initialized in a platform-dependent manner. Acceptable values for the `fileName` to use to open a serial port are described in the PORTABILITY ISSUES section.

CONFIGURATION OPTIONS

The `fconfigure` command can be used to query and set the following configuration option for open serial ports:

`-mode baud, parity, data, stop`. This option is a set of 4 comma-separated values: the baud rate, parity, number of data bits, and number of stop bits for this serial port. The baud rate is a simple integer that specifies the connection speed. Parity is one of the following letters: **n**, **o**, **e**, **m**, **s**; respectively signifying the parity options of "none", "odd", "even", "mark", or "space". Data is the number of data bits and should be an integer from 5 to 8, while stop is the number of stop bits and should be the integer 1 or 2.

PORTABILITY ISSUES

Windows (all versions)

Valid values for `fileName` to open a serial port are of the form **comX**;, where X is a number, generally from 1 to 4. An attempt to open a serial port that does not exist will fail.

Windows NT

When running TIM interactively, there may be some strange interactions between the real console, if one is present, and a command pipeline that uses standard input or output. If a command pipeline is opened for reading, some of the lines entered at the console will be sent to the command pipeline and some will be sent to the TIM evaluator. If a command pipeline is opened for writing, keystrokes entered into the console are not visible until the pipe is closed. This behavior occurs whether the command pipeline is executing 16-bit or 32-bit applications. These problems only occur because both TIM and the child application are competing for the console at the same time. If the command pipeline is started from a script, so that TIM is not accessing the console, or if the command pipeline does not use standard input or output, but is redirected from or to a file, then the above

problems do not occur.

Windows 95

A command pipeline that executes a 16-bit DOS application cannot be opened for both reading and writing, since 16-bit DOS applications that receive standard input from a pipe and send standard output to a pipe run synchronously. Command pipelines that do not execute 16-bit DOS applications run asynchronously and can be opened for both reading and writing.

When running TIM interactively, there may be some strange interactions between the real console, if one is present, and a command pipeline that uses standard input or output. If a command pipeline is opened for reading from a 32-bit application, some of the keystrokes entered at the console will be sent to the command pipeline and some will be sent to the TIM evaluator. If a command pipeline is opened for writing to a 32-bit application, no output is visible on the console until the pipe is closed. These problems only occur because both TIM and the child application are competing for the console at the same time. If the command pipeline is started from a script, so that TIM is not accessing the console, or if the command pipeline does not use standard input or output, but is redirected from or to a file, then the above problems do not occur.

Whether or not TIM is running interactively, if a command pipeline is opened for reading from a 16-bit DOS application, the call to `open` will not return until end-of-file has been received from the command pipeline's standard output. If a command pipeline is opened for writing to a 16-bit DOS application, no data will be sent to the command pipeline's standard output until the pipe is actually closed. This problem occurs because 16-bit DOS applications are run synchronously, as described above.

Windows 3.X

A command pipeline can execute 16-bit or 32-bit DOS or Windows applications, but the call to `open` will not return until the last program in the pipeline has finished executing; command pipelines run synchronously. If the pipeline is opened with write access (either just writing or both reading and writing) the first application in the pipeline will instead see an immediate end-of-file; any data the caller writes to the open pipe will instead be discarded.

Since TIM cannot be run with a real console under Windows 3.X, there are no interactions between command pipelines and the console.

See also:

`close`, `filename`, `gets`, `read`, `puts`, `exec`

78.3.44 precision - Alter number representation and conversion.

Syntax:

```
precision int c-format  
precision double c-format
```

Command Set: *1.0 only*

Synopsis:

This command allows you to define the C-format strings, with which numbers are output. Since numbers are always converted back and forth between their internal representation and their string representation, you might want to specify the format to get proper tabular entries and the like.

Example:

```
precision double "%.3f"  
precision int "Value: %d"
```

The second line is considered bad style, just put the C-format specifier into any corresponding command.

78.3.45 print - Send messages to console or console window**Syntax:**

```
print str1 str2 ... strn
```

Command Set: *1.0, 1.5*

Synopsis:

This command allows you to print the strings `str1 .. strn`. The strings are concatenated using `concat`s and passed to the `print` routine. During construction of the **TIM** interpreter the host system has to pass a `print` (and an `error`) function to the interpreter. If your host system does not allow printing, this command will be ignored.

Returns:

The last string (`strn`)

Example:

```
print "How_are_you_doing?"
```

generates:

```
How are you doing?
```


78.3.46 proc - Define a procedure (with arguments)

Syntax:

```
proc name parms script
```

Command Set: *1.0, 1.5*

Synopsis:

This command defines a procedure and registers it with the name `name`. After definition, you are allowed to call this macro and to pass parameters to it. The number of parameters is fixed. If you do not intend to allow parameters, you must pass an empty parameter list, e.g.,

```
proc efunc { } {  
    ...  
}
```

Parameters are accessed in the script like any other variable. After the loop body was left, the parameters are out of scope.

Recursive calls are supported up to a maximum nesting depth (1000).

Example:

```
proc fak { value } {  
    if value==1 {  
        return 1  
    } else {  
        return [expr $value*[fak [expr $value-1]]]  
    }  
}
```

⇒ It is possible to define default parameters. This is done by passing the parameter name together with its default value to the procedure like this:

```
proc fak {{value 1}} ...
```

78.3.47 puts - Write to a channel

Syntax:

```
puts [-nonewline] [channelId] string
```

Command Set: *1.5 only*

Synopsis:

This command writes the characters given by `string` to the channel given by `channelId`. `ChannelId` must be a channel identifier such as returned from a previous invocation of `open` or `socket`. It must have been opened for output. If no `channelId` is specified then it defaults to `stdout`. `Puts` normally outputs a newline character after `string`, but this feature may be suppressed by specifying the `-nonewline` switch.

Newline characters in the output are translated by `puts` to platform-specific end-of-line sequences according to the current value of the `-translation` option for the channel (for example, on PCs newlines are normally replaced with carriage-return-linefeed sequences; on Macintoshes newlines are normally replaced with carriage-returns). See the `fconfigure` manual entry for a discussion of end-of-line translations.

TIM buffers output internally, so characters written with `puts` may not appear immediately on the output file or device; TIM will normally delay output until the buffer is full or the channel is closed. You can

force output to appear immediately with the flush command.

When the output buffer fills up, the puts command will normally block until all the buffered data has been accepted for output by the operating system. If `channelId` is in nonblocking mode then the puts command will not block even if the operating system cannot accept the data. Instead, TIM continues to buffer the data and writes it in the background as fast as the underlying file or device can accept it. The application must use the TIM event loop for nonblocking output to work; otherwise TIM never finds out that the file or device is ready for more output data. It is possible for an arbitrarily large amount of data to be buffered for a channel in nonblocking mode, which could consume a large amount of memory. To avoid wasting memory, nonblocking I/O should normally be used in an event-driven fashion with the `fileevent` command (don't invoke puts unless you have recently been notified via a file event that the channel is ready for more output data).

See also:

`fileevent(n)`

78.3.48 *pwd* - Return the current working directory

Syntax:

`pwd`

Command Set: *1.5 only*

Synopsis:

Returns the path name of the current working directory.

78.3.49 read - Read from a channel**Syntax:**

```
read [-nonewline] channelId  
read channelId numBytes xx
```

Command Set: 1.5 only**Synopsis:**

In the first form, the `read` command reads all of the data from `channelId` up to the end of the file. If the `-nonewline` switch is specified then the last character of the file is discarded if it is a newline. In the second form, the extra argument specifies how many bytes to read. Exactly that many bytes will be read and returned, unless there are fewer than `numBytes` left in the file; in this case all the remaining bytes are returned.

If `channelId` is in nonblocking mode, the command may not read as many bytes as requested: once all available input has been read, the command will return the data that is available rather than blocking for more input. The `-nonewline` switch is ignored if the command returns before reaching the end of the file.

`Read` translates end-of-line sequences in the input into newline characters according to the `-translation` option for the channel. See the manual entry for `fconfigure` for details on the `-translation` option.

See also:

[eof](#), [fblocked](#), [fconfigure](#)

78.3.50 regexp - Match a regular expression against a string**Syntax:**

```
regexp [switches] exp string [matchVar] [subMatchVar sub-  
MatchVar ...]
```

Command Set: 1.5 only**Synopsis:**

This command determines whether the regular expression `exp` matches part or all of `string` and returns 1 if it does, 0 if it doesn't.

If additional arguments are specified after `string` then they are treated as the names of variables in which to return information about which part(s) of `string` matched `exp`. `MatchVar` will be set to the range of `string` that matched all of `exp`. The first `subMatchVar` will contain the characters in `string` that matched the leftmost parenthesized subexpression within `exp`, the next `subMatchVar` will contain the characters that matched the next parenthesized subexpression to the right in `exp`, and so on.

If the initial arguments to `regexp` start with - then they are treated as switches. The following switches are currently supported:

-nocase

Causes upper-case characters in `string` to be treated as lower case dur-

ing the matching process.

-indices

Changes what is stored in the `subMatchVars`. Instead of storing the matching characters from `string`, each variable will contain a list of two decimal strings giving the indices in `string` of the first and last characters in the matching range of characters.

--

Marks the end of switches. The argument following this one will be treated as `exp` even if it starts with a `-`.

If there are more `subMatchVar`'s than parenthesized subexpressions within `exp`, or if a particular subexpression in `exp` doesn't match the string (e.g. because it was in a portion of the expression that wasn't matched), then the corresponding `subMatchVar` will be set to `"-1-1 "` if **-indices** has been specified or to an empty string otherwise.

REGULAR EXPRESSIONS

Regular expressions are implemented using Henry Spencer's package (thanks, Henry!), and much of the description of regular expressions below is copied verbatim from his manual entry.

A regular expression is zero or more **branches**, separated by `"|"`. It matches anything that matches one of the branches.

A branch is zero or more **pieces**, concatenated. It matches a match for the first, followed by a match for the second, etc.

A piece is an **atom** possibly followed by "*", "+", or "?". An atom followed by "*" matches a sequence of 0 or more matches of the atom. An atom followed by "+" matches a sequence of 1 or more matches of the atom. An atom followed by "?" matches a match of the atom, or the null string.

An atom is a regular expression in parentheses (matching a match for the regular expression), a **range** (see below), "." (matching any single character), "^" (matching the null string at the beginning of the input string), "\$" (matching the null string at the end of the input string), a "\" followed by a single character (matching that character), or a single character with no other significance (matching that character).

A **range** is a sequence of characters enclosed in "["]. It normally matches any single character from the sequence. If the sequence begins with "^", it matches any single character not from the rest of the sequence. If two characters in the sequence are separated by "-", this is shorthand for the full list of ASCII characters between them (e.g. "[0-9]" matches any decimal digit). To include a literal "]" in the sequence, make it the first character (following a possible "^"). To include a literal "-", make it the first or last character.

CHOOSING AMONG ALTERNATIVE MATCHES

In general there may be more than one way to match a regular expression to an input string. For example, consider the command

```
regexp (a*)b*  
aabaaabb x y
```

Considering only the rules given so far, **x** and **y** could end up with the values **aabb** and **aa**, **aaab** and **aaa**, **ab** and **a**, or any of several other combinations. To resolve this potential ambiguity **regexp** chooses among alternatives using the rule "first then longest". In other words, it considers the possible matches in order working from left to right across the input string and the pattern, and it attempts to match longer pieces of the input string before shorter ones. More specifically, the following rules apply in decreasing order of priority:

If a regular expression could match two different parts of an input string then it will match the one that begins earliest.

If a regular expression contains **|** operators then the leftmost matching sub-expression is chosen.

In *****, **+**, and **?** constructs, longer matches are chosen in preference to shorter ones.

In sequences of expression components the components are considered from left to right.

In the example from above, **(a*)b*** matches **aab**: the **(a*)** portion of the pattern is matched first and it consumes the leading **aa**; then

the **b*** portion of the pattern consumes the next **b**. Or, consider the following example:

regex (ab|a)(b*)c abc x y z

After this command **x** will be **abc**, **y** will be **ab**, and **z** will be an empty string. Rule 4 specifies that (ab|a) gets first shot at the input string and Rule 2 specifies that the **ab** sub-expression is checked before the **a** sub-expression. Thus the **b** has already been claimed before the (**b***) component is checked and (**b***) must match an empty string.

78.3.51 registerdll - Register / Load a DLL

Syntax:

```
registerdll dllname
```

Command Set: *1.0, 1.5*

Synopsis:

This command allows to dynamically load a DLL. The current interpreter is passed to this DLL and the DLL's **TIM** functions are added to the current interpreter.

Please check the chapter about how to write an extension DLL for **TIM**.

Returns:

“1” in case of success, “0” otherwise.

78.3.52 regsub - Perform substitutions based on regular expression pattern matching

Syntax:

```
regsub [switches] exp string subSpec varName
```

Command Set: *1.5 only*

Synopsis:

This command matches the regular expression `exp` against `string`, and it copies `string` to the variable whose name is given by `varName`. If there is a match, then while copying `string` to `varName` the portion of `string` that matched `exp` is replaced with `subSpec`. If `subSpec` contains a "&" or "\0", then it is replaced in the substitution with the portion of `string` that matched `exp`. If `subSpec` contains a "\n", where `n` is a digit between 1 and 9, then it is replaced in the substitution with the portion of `string` that matched the `n`-th parenthesized subexpression of `exp`. Additional backslashes may be used in `subSpec` to prevent special interpretation of "&" or "\0" or "\n" or backslash. The use of backslashes in `subSpec` tends to interact badly with the TIM parser's use of backslashes, so it's generally safest to enclose `subSpec` in braces if it includes backslashes.

If the initial arguments to `regexp` start with `-` then they are treated as switches. The following switches are currently supported:

-all

All ranges in `string` that match `exp` are found and substitution is per-

formed for each of these ranges. Without this switch only the first matching range is found and substituted. If **-all** is specified, then "&" and "\n" sequences are handled for each substitution using the information from the corresponding match.

-nocase

Upper-case characters in `string` will be converted to lower-case before matching against `exp`; however, substitutions specified by `sub-spec` use the original unconverted form of `string`.

--

Marks the end of switches. The argument following this one will be treated as `exp` even if it starts with a `-`.

Returns:

The command returns a count of the number of matching ranges that were found and replaced. See the manual entry for `regexp` for details on the interpretation of regular expressions.

78.3.53 rename - Rename or delete a command**Syntax:**

```
rename oldName newName
```

Command Set: *1.5 only***Synopsis:**

Rename the command that used to be called oldName so that it is now called newName. If newName is an empty string then oldName is deleted

Returns:

The **rename** command returns an empty string as result.

78.3.54 *return* - Return a value

Syntax:

```
return  
return string
```

Command Set: *1.0, 1.5*

Synopsis:

This command returns from interpretation of a procedure, or, if operating at level 1, returns from interpreting the current script. If the current script was included with the `include` command, control is passed to the location right behind the `include` statement. You may return a value. This value is then interpreted as the return value from a procedure or from the script.

The following values for `string` have a special meaning:

<code>ok</code>	returns an OK string.
<code>error</code>	returns an error status which will generally stop processing of a script.
<code>break</code>	returns a break status, which will interrupt any embedding iteration.
<code>continue</code>	returns a continue status, which will continue any embedding iteration.

See also:

proc

78.3.55 scan - Parse string using conversion specifiers in the style of sscanf

Syntax:

```
scan string format varName [varName ...]
```

Command Set: *1.5 only*

Synopsis:

This command parses fields from an input string in the same fashion as the ANSI C `sscanf` procedure and returns a count of the number of conversions performed, or -1 if the end of the input string is reached before any conversions have been performed. `String` gives the input to be parsed and `format` indicates how to parse it, using % conversion specifiers as in `sscanf`. Each `varName` gives the name of a variable; when a field is scanned from `String` the result is converted back into a string and assigned to the corresponding variable.

DETAILS ON SCANNING

Scan operates by scanning string

and formatString together. If the next character in formatString is a blank or tab then it matches any number of white space characters in string (including zero). Otherwise, if it isn't a % character then it must match the next character of string. When a % is encountered in formatString, it indicates the start of a conversion specifier. A conversion specifier contains three fields after the %: a *, which indicates that the converted value is to be discarded instead of assigned to a

variable; a number indicating a maximum field width; and a conversion character. All of these fields are optional except for the conversion character.

When `scan` finds a conversion specifier in `formatString`, it first skips any white-space characters in `string`. Then it converts the next input characters according to the conversion specifier and stores the result in the variable given by the next argument to `scan`. The following conversion characters are supported:

d

The input field must be a decimal integer. It is read in and the value is stored in the variable as a decimal string.

o

The input field must be an octal integer. It is read in and the value is stored in the variable as a decimal string.

x

The input field must be a hexadecimal integer. It is read in and the value is stored in the variable as a decimal string.

c

A single character is read in and its binary value is stored in the variable as a decimal string. Initial white space is not skipped in this case, so the input field may be a white-space character. This conversion is different from the ANSI standard in that the input field always consists of a single character and no field width may be specified.

s

The input field consists of all the characters up to the next white-space character; the characters are copied to the variable.

e or f or g

The input field must be a floating-point number consisting of an optional sign, a string of decimal digits possibly containing a decimal point, and an optional exponent consisting of an **e** or **E** followed by an optional sign and a string of decimal digits. It is read in and stored in the variable as a floating-point string.

[chars]

The input field consists of any number of characters in **chars**. The matching string is stored in the variable. If the first character between the brackets is a **]** then it is treated as part of **chars** rather than the closing bracket for the set.

[^chars]

The input field consists of any number of characters not in **chars**. The matching string is stored in the variable. If the character immediately following the **^** is a **]** then it is treated as part of the set rather than the closing bracket for the set.

The number of characters read from the input for a conversion is the largest number that makes sense for that particular conversion (e.g. as many decimal digits as possible for **%d**, as many octal digits as possible for **%o**, and so on). The input field for a given conversion terminates either when a white-space character is encountered or when the

maximum field width has been reached, whichever comes first. If a * is present in the conversion specifier then no variable is assigned and the next scan argument is not consumed.

DIFFERENCES FROM ANSI SSCANF

The behavior of the `scan` command is the same as the behavior of the ANSI C `sscanf` procedure except for the following differences:

%p and **%n** conversion specifiers are not currently supported.

For **%c** conversions a single character value is converted to a decimal string, which is then assigned to the corresponding `varName`

; no field width may be specified for this conversion.

The **l**, **h**, and **L** modifiers are ignored; integer values are always converted as if there were no modifier present and real values are always converted as if the **l** modifier were present (i.e. type **double** is used for the internal representation).

78.3.56 set - Declare and define variables.

Syntax:

```
set var something
```

Command Set: *1.0, 1.5*

Synopsis:

This command defines the variable `var`, if it was not already existing and sets its value to `something`. Variables can be de-referenced by prepending a `$` character, e.g. `$var`.

Variables always have global scope.

Returns:

The value of the last parameter in the command.

Example:

```
set a 3
set b [expr 3+10]
set [concat var 1] [concat 10 [expr 3+4]]
print $var1
```

The third line assigns a variable `var1` the value `107`.

78.3.57 socket - Open a TCP network connection

Syntax:

```
socket [options] host port  
socket -server command [options] port
```

Command Set: *1.5 only***Synopsis:**

This command opens a network socket and returns a channel identifier that may be used in future invocations of commands like `read`, `puts` and `flush`. At present only the TCP network protocol is supported; future releases may include support for additional protocols. The socket command may be used to open either the client or server side of a connection, depending on whether the `-server` switch is specified.

CLIENT SOCKETS

If the `-server` option is not specified, then the client side of a connection is opened and the command returns a channel identifier that can be used for both reading and writing. `Port` and `host` specify a port to connect to; there must be a server accepting connections on this port. `Port` is an integer port number and `host` is either a domain-style name such as **www.sunlabs.com** or a numerical IP address such as **127.0.0.1**. Use `localhost` to refer to the host on which the command is invoked.

The following options may also be present before `host` to specify additional information about the connection:

-myaddr addr

`Addr` gives the domain-style name or numerical IP address of the client-side network interface to use for the connection. This option may be useful if the client machine has multiple network interfaces. If the option is omitted then the client-side interface will be chosen by the system software.

-myport port

`Port` specifies an integer port number to use for the client's side of the connection. If this option is omitted, the client's port number will be chosen at random by the system software.

-async

The **-async** option will cause the client socket to be connected asynchronously. This means that the socket will be created immediately but may not yet be connected to the server, when the call to **socket** returns. When a `gets` or `flush` is done on the socket before the connection attempt succeeds or fails, if the socket is in blocking mode, the operation will wait until the connection is completed or fails. If the socket is in nonblocking mode and a `gets` or `flush` is done on the socket before the connection attempt succeeds or fails, the operation returns immediately and `fblocked` on the socket returns 1.

SERVER SOCKETS

If the **-server** option is specified then the new socket will be a server for the port given by `port`. TIM will automatically accept connections to the given port. For each connection TIM will create a new channel

that may be used to communicate with the client. TIM then invokes `command` with three additional arguments: the name of the new channel, the address, in network address notation, of the client's host, and the client's port number.

The following additional option may also be specified before host:

`-myaddr addr`

`Addr` gives the domain-style name or numerical IP address of the server-side network interface to use for the connection. This option may be useful if the server machine has multiple network interfaces. If the option is omitted then the server socket is bound to the special address `INADDR_ANY` so that it can accept connections from any interface.

Server channels cannot be used for input or output; their sole use is to accept new client connections. The channels created for each incoming client connection are opened for input and output. Closing the server channel shuts down the server so that no new connections will be accepted; however, existing connections will be unaffected.

Server sockets depend on the TIM event mechanism to find out when new connections are opened. If the application doesn't enter the event loop, for example by invoking the `vwait` command or calling the C procedure `TIM_DoOneEvent`, then no connections will be accepted.

CONFIGURATION OPTIONS

The `fconfigure` command can be used to query several readonly configuration options for socket channels:

-sockname

This option returns a list of three elements, the address, the host name and the port number for the socket. If the host name cannot be computed, the second element is identical to the address, the first element of the list.

-peername

This option is not supported by server sockets. For client and accepted sockets, this option returns a list of three elements; these are the address, the host name and the port to which the peer socket is connected or bound. If the host name cannot be computed, the second element of the list is identical to the address, its first element.

See also:

[flush](#), [open](#), [read](#)

78.3.58 source - Evaluate a file or resource as a TIM script**Syntax:**

```
source fileName
source -rsrc resourceName [fileName]
source -rsrcid resourceId [fileName]
```

Command Set: *1.5 only***Synopsis:**

This command takes the contents of the specified file or resource and passes it to the TIM interpreter as a text script. The return value from **source** is the return value of the last command executed in the script. If an error occurs in evaluating the contents of the script then the **source** command will return that error. If a **return** command is invoked from within the script then the remainder of the file will be skipped and the **source** command will return normally with the result from the **return** command. The **-rsrc** and **-rsrcid** forms of this command are only available on Macintosh computers. These versions of the command allow you to source a script from a TEXT resource. You may specify what TEXT resource to source by either name or id. By default TIM searches all open resource files, which include the current application and any loaded C extensions. Alternatively, you may specify the **fileName** where the TEXT resource can be found.

78.3.59 split - Split a string into a proper TIM list

Syntax:

```
split string [splitChars]
```

Command Set: *1.5 only*

Synopsis:

Returns a list created by splitting string at each character that is in the splitChars argument. Each element of the result list will consist of the characters from string that lie between instances of the characters in splitChars. Empty list elements will be generated if string contains adjacent characters in splitChars, or if the first or last character of string is in splitChars. If splitChars is an empty string then each character of string becomes a separate element of the result list. SplitChars defaults to the standard white-space characters.

Example:

```
split "comp.unix.misc" .  
returns "comp unix misc" and  
split "Hello world" {}  
returns "H e l l o { } w o r l d".
```

78.3.60 *string* - Copy, compare and many more operations on strings.**Syntax:**

```
string compare str1 str2
string first str1 str2
string index str1 nr
string last str1 str2
string length str
string match str1 str2
string tolower str1
string toupper str1
string trim str1
string trimleft str1
string trimright str2
```

Command Set: *1.0, 1.5***Synopsis:**

This command allows string handling of any kind. You can compare strings, match regular expressions, convert and trim strings.

Returns:

Depends on the function you use:

`string compare str1 str2`

This command compares the two strings and returns:

- 1 when `str1` less than `str2`
- 0 when `str1` equals `str2`
- +1 when `str1` is higher than `str2`

A string `str1` is defined *less* than a string `str2` when either
`str1[i] < str2[i]` or
`length(str1) < length(str2)`

`string first searchstring str1`

This command searches the first appearance of `searchstring` in the string `str1` and returns its index. This index starts from 0.

`string last searchstring str1`

This command searches the last appearance of `searchstring` in the string `str1` and returns its index. This index starts from 0.

`string index searchstring nr`

This command returns the character at index `nr` in the string `searchstring`. This index counts from 0.

`string length str1`

This command returns the length of the string `str1`.

`string match pattern searchstring`

This command returns 0 or 1 depending on whether the regular expression pattern was found in `searchstring`.

Regular expressions may be constructed via:

- * matches any sequence of character
- ? matches any single character
- [c] matches exactly the character c
- [a-c] matches all characters in the range from a . . c
- any any other sequence of characters is directly matched.

`string tolower str1`

This command returns the string `str1` with all character converted to lowercase letters.

`string toupper str1`

This command returns the string `str1` with all character converted to UPPERCASE letters.

`string trimleft str1`

This command returns the string `str1` with all leading spaces removed.

`string trimright str1`

This command returns the string `str1` with all trailing spaces removed.

`string trim str1`

This command returns the string `str1` with all leading and trailing spaces removed.

78.3.61 subst - Perform backslash, command, and variable substitutions

Syntax:

```
subst [-noblackslashes] [-nocommands] [-novariables] string
```

Command Set: *1.5 only*

Synopsis:

This command performs variable substitutions, command substitutions, and backslash substitutions on its string argument and returns the fully-substituted result. The substitutions are performed in exactly the same way as for TIM commands. As a result, the string argument is actually substituted twice, once by the TIM parser in the usual fashion for TIM commands, and again by the subst command.

If any of the **-noblackslashes**, **-nocommands**, or **-novariables** are specified, then the corresponding substitutions are not performed. For example, if **-nocommands** is specified, no command substitution is performed: open and close brackets are treated as ordinary characters with no special interpretation.

Note: when it performs its substitutions, subst does not give any special treatment to double quotes or curly braces.

Example:

For example, the script

```
set a 44
subst {xyz {$a}}
returns "xyz {44}", not "xyz {$a}".
```

78.3.62 switch - Evaluate one of several scripts, depending on a given value

Syntax:

```
switch [options] string pattern body [pattern body ...]  
switch [options] string {pattern body [pattern body ...]}
```

Command Set: *1.5 only*

Synopsis:

The **switch** command matches its **string** argument against each of the **pattern** arguments in order. As soon as it finds a **pattern** that matches **string** it evaluates the following **body** argument by passing it recursively to the TIM interpreter and returns the result of that evaluation. If the last pattern argument is **default** then it matches anything. If no **pattern** argument matches **string** and no default is given, then the **switch** command returns an empty string.

If the initial arguments to **switch** start with - then they are treated as options. The following options are currently supported:

-exact

Use exact matching when comparing string to a pattern. This is the default.

-glob

When matching string to the patterns, use glob-style matching (i.e. the

same as implemented by the `string match` command).

`-regexp`

When matching `string` to the patterns, use regular expression matching (i.e. the same as implemented by the `regexp` command).

- -

Marks the end of options. The argument following this one will be treated as string even if it starts with a `-`.

Two syntaxes are provided for the `pattern` and `body` arguments. The first uses a separate argument for each of the patterns and commands; this form is convenient if substitutions are desired on some of the patterns or commands. The second form places all of the patterns and commands together into a single argument; the argument must have proper list structure, with the elements of the list being the patterns and commands. The second form makes it easy to construct multi-line switch commands, since the braces around the whole list make it unnecessary to include a backslash at the end of each line. Since the `pattern` arguments are in braces in the second form, no command or variable substitutions are performed on them; this makes the behavior of the second form different than the first form in some cases.

If a `body` is specified as `"-"` it means that the body for the next pattern should also be used as the body for this pattern (if the next pattern also has a body of `"-"` then the body after that is used, and so on). This feature makes it possible to share a single body among several patterns.

Example:

```
switch abc a - b {format 1} abc {format 2} default  
{format 3} will return 2,
```

```
switch -regexp aaab { ^a.*b$ - b {format 1}  
a* {format 2} default {format 3}} will return 1,  
and
```

```
switch xyz {a-b{format 1}a*{format 2}default  
{format 3}}will return 3.
```

78.3.63 system - Determine host system and platform**Syntax:**

```
system get
```

Command Set: *1.0 only*

Synopsis:

This command allows you to determine the system, under which the script is currently interpreted.

Returns:

Depending on the system you are working with, it returns a string like this:

- NT when working with NT 3.50, NT 3.51 or NT 4.x
- 95 when working with Windows 95
- WIN32 when working with Windows 3.1 running Win32s
- WIN16 when working with Windows 3.1 native
- OS2 when working with OS/2 v2.x, OS/2 Warp
- UNK else

Example:

```
print [system get]
```

78.3.64 tell - Return current access position for an open channel

Syntax:

```
tell channelId
```

Command Set: *1.5 only*

Synopsis:

Returns a decimal string giving the current access position in channelId. The value returned is -1 for channels that do not support seeking.

78.3.65 time - Time the execution of a script**Syntax:**

```
time script [count]
```

Command Set: *1.5 only***Synopsis:**

This command will call the TIM interpreter count times to evaluate script (or once if count isn't specified). It will then return a string of the form

503 microseconds per iteration

which indicates the average amount of time required per iteration, in microseconds. Time is measured in elapsed time, not CPU time.

78.3.66 trace - Monitor variable accesses

Syntax:

```
trace option [arg arg ...]
```

Command Set: *1.5 only*

Synopsis:

This command causes TIM commands to be executed whenever certain operations are invoked. At present, only variable tracing is implemented. The legal option's (which may be abbreviated) are:

trace variable name ops command

Arrange for **command** to be executed whenever variable **name** is accessed in one of the ways given by **ops**. **Name** may refer to a normal variable, an element of an array, or to an array as a whole (i.e. **name** may be just the name of an array, with no parenthesized index). If **name** refers to a whole array, then **command** is invoked whenever any element of the array is manipulated.

Ops indicates which operations are of interest, and consists of one or more of the following letters:

r

Invoke command whenever the variable is read.

w

Invoke command whenever the variable is written.

u

Invoke command whenever the variable is unset. Variables can be unset explicitly with the `unset` command, or implicitly when procedures return (all of their local variables are unset). Variables are also unset when interpreters are deleted, but traces will not be invoked because there is no interpreter in which to execute them.

When the trace triggers, three arguments are appended to `command` so that the actual command is as follows:

```
command name1 name2 op
```

`Name1` and `name2` give the name(s) for the variable being accessed: if the variable is a scalar then `name1` gives the variable's name and `name2` is an empty string; if the variable is an array element then `name1` gives the name of the array and `name2` gives the index into the array; if an entire array is being deleted and the trace was registered on the overall array, rather than a single element, then `name1` gives the array name and `name2` is an empty string. `Name1` and `name2` are not necessarily the same as the name used in the **trace variable** command: the `upvar` command allows a procedure to reference a variable under a different name. `Op` indicates what operation is being performed on the variable, and is one of **r**, **w**, or **u** as defined above.

Command executes in the same context as the code that invoked the traced operation: if the variable was accessed as part of a TIM procedure, then `command` will have access to the same local variables as code in the procedure. This context may be different than the con-

text in which the trace was created. If `command` invokes a procedure (which it normally does) then the procedure will have to use `upvar` or `uplevel` if it wishes to access the traced variable. Note also that `name1` may not necessarily be the same as the name used to set the trace on the variable; differences can occur if the access is made through a variable defined with the `upvar` command.

For read and write traces, `command` can modify the variable to affect the result of the traced operation. If `command` modifies the value of a variable during a read or write trace, then the new value will be returned as the result of the traced operation. The return value from `command` is ignored except that if it returns an error of any sort then the traced operation also returns an error with the same error message returned by the trace `command` (this mechanism can be used to implement read-only variables, for example). For write traces, `command` is invoked after the variable's value has been changed; it can write a new value into the variable to override the original value specified in the write operation. To implement read-only variables, `command` will have to restore the old value of the variable.

While `command` is executing during a read or write trace, traces on the variable are temporarily disabled. This means that reads and writes invoked by `command` will occur directly, without invoking `command` (or any other traces) again. However, if `command` unsets the variable then unset traces will be invoked.

When an unset trace is invoked, the variable has already been deleted: it will appear to be undefined with no traces. If an unset occurs because of a procedure return, then the trace will be invoked in the variable context of the procedure being returned to: the stack frame of

the returning procedure will no longer exist. Traces are not disabled during unset traces, so if an unset trace command creates a new trace and accesses the variable, the trace will be invoked. Any errors in unset traces are ignored.

If there are multiple traces on a variable they are invoked in order of creation, most-recent first. If one trace returns an error, then no further traces are invoked for the variable. If an array element has a trace set, and there is also a trace set on the array as a whole, the trace on the overall array is invoked before the one on the element.

Once created, the trace remains in effect either until the trace is removed with the **trace vdelete** command described below, until the variable is unset, or until the interpreter is deleted. Unsetting an element of array will remove any traces on that element, but will not remove traces on the overall array.

This command returns an empty string.

trace vdelete name ops command

If there is a trace set on variable **name** with the operations and **command** given by **ops** and **command**, then the trace is removed, so that **command** will never again be invoked. Returns an empty string.

trace vinfo name

Returns a list containing one element for each trace currently set on variable **name**. Each element of the list is itself a list containing two elements, which are the **ops** and **command** associated with the trace. If

name doesn't exist or doesn't have any traces set, then the result of the command will be an empty string.

78.3.67 unknown - Handle unknown commands (internal)

This is a special kind of function and **you should never call it!** Its main purpose is the following. Suppose, you write a command like this:

`gnprtz p1 p2`

and `gnprtz` is not available in the system. **TIM** will raise an error condition in this case.

If your host system wants to avoid this error message, it can offer the `unknown` function, which in turn is called whenever an unknown function was called.

78.3.68 unset - Delete variables

Syntax:

```
unset name [name name ...]
```

Command Set: *1.5 only*

Synopsis:

This command removes one or more variables. Each **name** is a variable name, specified in any of the ways acceptable to the **set** command. If a **name** refers to an element of an array then that element is removed without affecting the rest of the array. If a **name** consists of an array name with no parenthesized index, then the entire array is deleted. The **unset** command returns an empty string as result. An error occurs if any of the variables doesn't exist, and any variables after the non-existent one are not deleted

78.3.69 uplevel - Execute a script in a different stack frame**Syntax:**

```
uplevel [level] arg [arg ...]
```

Command Set: *1.5 only***Synopsis:**

All of the `arg` arguments are concatenated as if they had been passed to `concat`; the result is then evaluated in the variable context indicated by `level`. `Uplevel` returns the result of that evaluation.

If `level` is an integer then it gives a distance (up the procedure calling stack) to move before executing the command. If `level` consists of `#` followed by a number then the number gives an absolute level number. If `level` is omitted then it defaults to 1. `Level` cannot be defaulted if the first command argument starts with a digit or `#`.

For example, suppose that procedure **a** was invoked from top-level, and that it called **b**, and that **b** called **c**. Suppose that **c** invokes the `uplevel` command. If `level` is **1** or **#2** or omitted, then the command will be executed in the variable context of **b**. If `level` is **2** or **#1** then the command will be executed in the variable context of **a**. If `level` is **3** or **#0** then the command will be executed at top-level (only

global variables will be visible).

The `uplevel` command causes the invoking procedure to disappear from the procedure calling stack while the command is being executed. In the above example, suppose `c` invokes the command

```
uplevel 1 {set x 43; d}
```

where `d` is another TIM procedure. The `set` command will modify the variable `x` in `b`'s context, and `d` will execute at level 3, as if called from `b`. If it in turn executes the command

```
uplevel {set x 42}
```

then the `set` command will modify the same variable `x` in `b`'s context: the procedure `c` does not appear to be on the call stack when `d` is executing. The command "`info level`" may be used to obtain the level of the current procedure.

`Uplevel` makes it possible to implement new control constructs as TIM procedures (for example, `uplevel` could be used to implement the `while` construct as a TIM procedure).

78.3.70 upvar - Create link to variable in a different stack frame**Syntax:**

```
upvar [level] otherVar myVar [otherVar myVar ...]
```

Command Set: *1.5 only***Synopsis:**

This command arranges for one or more local variables in the current procedure to refer to variables in an enclosing procedure call or to global variables. `Level` may have any of the forms permitted for the `uplevel` command, and may be omitted if the first letter of the first `otherVar` isn't # or a digit (it defaults to 1). For each `otherVar` argument, `upvar` makes the variable by that name in the procedure frame given by `level` (or at global level, if `level` is #0) accessible in the current procedure by the name given in the corresponding `myVar` argument. The variable named by `otherVar` need not exist at the time of the call; it will be created the first time `myVar` is referenced, just like an ordinary variable. There must not exist a variable by the name `myVar` at the time `upvar` is invoked. `MyVar` is always treated as the name of a variable, not an array element. Even if the name looks like an array element, such as `a(b)`, a regular variable is created. `OtherVar` may refer to a scalar variable, an array, or an array element. `Upvar` returns an empty string.

The `upvar` command simplifies the implementation of call-by-name procedure calling and also makes it easier to build new control con-

structs as TIM procedures. For example, consider the following procedure:

```
proc add2 name {    upvar $name x
    set x [expr $x+2]}
```

Add2 is invoked with an argument giving the name of a variable, and it adds two to the value of that variable. Although `add2` could have been implemented using `uplevel` instead of `upvar`, `upvar` makes it simpler for `add2` to access the variable in the caller's procedure frame.

If an `upvar` variable is unset (e.g. `x` in `add2` above), the `unset` operation affects the variable it is linked to, not the `upvar` variable. There is no way to unset an `upvar` variable except by exiting the procedure in which it is defined. However, it is possible to retarget an `upvar` variable by executing another `upvar` command.

BUGS

If `otherVar` refers to an element of an array, then variable traces set for the entire array will not be invoked when `myVar` is accessed (but traces on the particular element will still be invoked). In particular, if the array is `env`, then changes made to `myVar` will not be passed to subprocesses correctly.

78.3.71 vwait - Process events until a variable is written**Syntax:**

```
vwait [varName]
```

Command Set: *1.5 only***Synopsis:**

This command enters the TIM event loop to process events, blocking the application if no events are ready. It continues processing events until some event handler sets the value of variable `varName`. Once `varName` has been set, the `vwait` command will return as soon as the event handler that modified `varName` completes.

In some cases the `vwait` command may not return immediately after `varName` is set. This can happen if the event handler that sets `varName` does not complete immediately. For example, if an event handler sets `varName` and then itself calls `vwait` to wait for a different variable, then it may not return for a long time. During this time the top-level `vwait` is blocked waiting for the event handler to complete, so it cannot return either.

78.3.72 while - Support for conditional looping.

Syntax:

```
while condscript doscript
```

Command Set: *1.0, 1.5*

Synopsis:

This command evaluates the `condscript`, and as soon as this results to 0 the loop is stopped. For any other result of `condscript`, the `doscript` is performed.

Example:

```
set I 0
while { $I<100 } {
    set I [expr $I+1]
}
```

79. Runtime Error Messages

During interpretation of scripts error conditions are possible. **TIM** is designed to run smoothly in case of heavy numerical problems and to not crash, and so it provides very detailed error messages to the user.

Error messages and the capability to find and analyze errors are considered being vital to the usability of an interpreter, so heavy efforts have been made to provide good support here.

The host system must pass an error and a print function to the interpreter (`printf` synopsis), which in turn is called with detailed problem reports. If a host system didn't provide an error function to **TIM**, you will never see any information about the current error conditions.

Error messages are ordered by number. This makes it easier to find the corresponding descriptions in this manual. The numbers are grouped in this way:

- 0 - 999 Internal Errors like overrunning stacks, wrong return codes or leaks in memory
- 1000 - 1999 Syntactical Errors like missing quotes or braces
- 2000 - 2999 Semantic Errors like wrong number of parameters.
- 3000 - 3999 Expression and/or mathematical errors, which might occur during processing of the `expr` command.
- 4000 - 4999 Error conditions detected in other built-in commands and macros.
- 5000 - User defined messages. Third party vendors or your own extensions should use this range of error messages

The available messages are:

100 Too many nested calls to tcl_Eval (infinite loop?)

It is not possible to recursively call and start as many **TIM** interpreters as you can think of - there exists a limit of 1000 (MAX_NESTING_DEPTH). **TIM** internally keeps track of this and after a specific calling depth, this message is issued.

101 Command returned bad code: %d

The possible return codes for **TIM** functions are well defined. If a function returns something else, this message is displayed. All kernel **TIM** functions are asserted to provide proper values as return codes. This error condition most likely happens in third party libraries.

102 Internal error in tcl_SplitList

TIM tried to split a single string into a list of sub-strings, but it didn't work out. E.g., if you specify a parameter list to the `proc` command, this list is split and each element is identified as being a parameter. If something went wrong, e.g., because a recursive command invocation failed, this message might occur.

103 Cannot open/evaluate file: filename

TIM tried to interpret a script file, but couldn't open or find it.

1000 Missing close-bracket

Some piece of macro text started with a [, but the corresponding closing] has not be found., e.g.

```
set str [ set var string
```

A string was started with a “ character, but the matching “ character is missing, e.g.

```
set str "this is an invalid string
```

1001 Missing close-brace

Some piece of macro text started with a curly brace '{', but the corresponding closing brace could not be found. e.g.

```
loop I 10 {  
<end - of -file>
```

1003 Missing termination character %c

TIM expected the character %C to occur (sooner or later), but it couldn't be found. Most often, such an error occurs when strings are constructed at runtime.

1004 Extra characters after close-quote

TIM detected characters at an illegal location, e.g.,

```
proc { } hallo {
```

1005 Extra characters after close-brace

TIM detected characters at an illegal location, e.g.,

```
proc { } hallo {
```


1006 List element in braces followed by %s instead of space

TIM required space characters to separate list elements, but couldn't find any. The term %S is replaced by the character sequence, that caused the problems.

1007 List element in quotes followed by \"%.*s\" (%s) instead of space

TIM required space characters to separate list elements, but couldn't find any. The term %S is replaced by the character sequence, that caused the problems.

1008 Unmatched open brace in list

TIM counted the number of braces and detected a mismatch. The counting is done in interpretation of a `proc` argument list.

1009 Unmatched open quotes in list

TIM counted the number of quotes and detected a mismatch. The counting is done in interpretation of a `proc` argument list.

2000 Variable <name> not found

An attempt was made to use the variable `name`, but it was not defined yet. The value of such a variable was undefined, so its use is prohibited.

Example:

```
set str $unkvar
```

generates the error message, when `unkvar` was not defined beforehand.

2002 *command* wrong number of arguments, required : n

The command `command` was tried to start, but the number of available parameters was not correct.

Example:

```
set str
```

2003 Invalid command: %s

The command `%S` was parsed in the script, but this command does not exist.

Example:

```
setx str 3
```

This piece of code generates the error message, when the command `setx` is not available.

2004 Invalid command: UNKNOWN

Whenever a command could not be executed, because its name has not be found, **TIM** tries to call the internal function named `unknown`. If **TIM**'s host environment doesn't

support this function (which it should), this message appears.

2005 Invoked “break” outside a loop

The break statement is allowed only inside loops. The script contained this statement somewhere else. Please see message 2025 as well, which covers this error within a `proc`.

2006 Invoked “continue” outside a loop

The continue statement is allowed only inside loops. The script contained this statement somewhere else. Please see message 2026 as well, which covers this error within a `proc`.

2007 While executing “...”

This informational message tries to assist you in correcting your scripts. It shows the beginning of the current command, which caused the error. It is possible, that more than one of these messages appears (depends on current calling depth of your script).

2008 Invoked from within “...”

This informational message tries to assist you in correcting your scripts. It shows the beginning of the current command, which caused another error. It is possible, that more than one of these messages appears (depends on current calling depth of your script).

2009 “while” body line: %d

This informational message tries to assist you in correcting your scripts. It shows the current line in a `while` loop, and in which line the error occurred.

2010 Bad level “str”

You tried to refer to level `str`, but this level does not exist. This might happen from within procedure invocations.

2011 Wrong # args: (%s)

The number of arguments passed to the `proc` command is wrong. Since this is part of **TIM** Kernel, this extra message was introduced.

2012 Too many fields in argument specifier

The number of arguments specified consists of too many fields. This is part of the `proc` command.

2014 Procedure %s has argument with no name

The procedure `%s` was declared with an argument, which is not a name. This e.g. happens, if a recursive command invocation failed, e.g.,

```
proc p {arg1}{print $arg1
}
...
#This call causes an error p
```

2015 No value given for parameter %s...

A procedure was called, but the number of arguments was wrong. You specified not enough arguments, e.g.,

```
proc p {arg1}{print $arg1  
}
```

...

```
#This call causes an error p 1 2
```

2016 Called %s with too many arguments

The procedure %s was called with too many arguments. Please inspect declaration of the procedure.

2017 uplevel body line %d

This message provides additional information about procedure / uplevel errors.

2018 Procedure %s, line %d

This message provides additional information about procedure / uplevel errors. It shows the current procedure and the current line in it.

This is only an informational message.

2019 Bad option (%s), must be -code, -errorcode, or -errorinfo

This message shows available options to the return command. You specified something unknown or wrong.

2020 Bad completion code %s, must be OK, error, return, break, continue, or an integer

This message indicates you specified something wrong in the return command. Only the listed options are allowed.

2025 Invoked “break” outside a loop

The break statement is allowed only inside loops. The script contained this statement somewhere else. This is essentially the same message as 2005, except that this error occurred from within a procedure invocation. **TIM** tries to determine the current procedure name, e.g.,

```
loop i 10 {  
  #correct break  
  break  
}  
...  
#incorrect break  
break
```

2026 Invoked “continue” outside a loop

The `continue` statement is allowed only inside loops. The script contained this statement somewhere else. This is essentially the same message as 2005, except that this error occurred from within a procedure invocation. **TIM** tries to determine the current procedure name, e.g.,

```
loop i 10 {  
    #valid continue  
    continue  
}  
...  
#invalid continue  
continue
```

3000 NUMERICAL PROBLEMS**operation:** txt1 **type:** txt2**description:** txt3

These informational messages try to assist you in correcting your algorithms. They explain in detail, where your last numerical errors occurred.

These error conditions are possible:

ARITH IOVERFLOW**integer value too large to represent**

You tried to specify an integer value which does not fit into 32 bit.

ARITH DIVZERO**divide by zero**

You tried to divide a value by zero and this caused the error, e.g.,

```
set a 2
```

```
set x [expr 1/(2-$a)]
```

ARITH DOMAIN**domain error: argument not in valid range**

The argument to a math function is beyond the valid range, e.g.,

```
sqrt (-1)
```

ARITH UNDERFLOW**floating-point value too small to represent**

Most likely, the current floating-point value is “not a number” (NAN)

ARITH OVERFLOW

floating-point value too large to represent

Most likely, the current floating-point value is “not a number” (NAN)

ARITH UNKNOWN

unknown floating point error, error =%d

An unknown error condition was raised. **TIM**'s host system may be able to provide more details. This message is very unlikely to happen, please inform your vendor in the case you detect it.

3001 Poorly formed floating-point value

You specified a floating-point value, which is invalid, e.g.,

`1.0E`

`1..0`

3002 Unmatched parenthesis in expression “...”

The parentheses in an expression are not balanced, as in

```
sin (3.14  
(a0 + x(a1 + x(a2 + x))
```

3003 Unknown operator in expression

You used an unknown operator in an expression, like this:

```
a@b
```

3004 Can't have: operator without ? first

You used an invalid construction of the form

```
a ? b : c
```

3005 Syntax error in expression “...”

This message shows any offending construction in an `expr` command.

3006 Can't use <%S> as operand of “...”

This message informs you of a type error. It is not allowed to use %S as operand of a specific operation. %S is replaced by either “floating-point value” or “non-numeric string”.

3007 Expression didn't have numeric value

Evaluation of an expression did not return a numeric value, which it should.

3008 Unknown math function “...”

You used a function within an `expr` command, which is unknown.

3009 Argument to math function didn't have numeric value

You called a `math` function with a parameter that could not be converted to a number, e.g.,
`sin(PI)`

3010 Too many arguments for math function

You specified too many arguments during the call of a `math` function, e.g.,
`sin(1.0,2.0)`

3011 Too few arguments for math function

You specified too few arguments during the call of a `math` function, e.g.,
`sin()`
`pow(3)`

80. Integrating TIM into Your Application

Integrating **TIM** into your **stand-alone** application and using its possibilities is a straightforward process. This chapter illustrates the C/C++ actions to take when you want to run **TIM** scripts and it explains important parts of the **TIM** class.



If you are not a software developer, trying to integrate TIM into one of your applications, you can completely skip this chapter.

80.1 Compile...

TIM comes with a C/C++ header, a DLL for WATCOM, a DLL for MICROSOFT and corresponding interface libraries.

Basically, **TIM** comes as 1 C++ class named **TIM**. It is declared in the file **TIM.HPP** and therefore any module of your program that wants to interact with **TIM** must include **TIM.HPP**, e.g.:

```
#include <TIM.HPP>
```

80.2 Construct...

In your main program you construct a **TIM** interpreter like this:

```
int main(int argc, char **argv)
{
...
TIM T(argc, argv, print, error);
```

If you pass `argc` and `argv` to the constructor, you will have access to them via the `arg` command. The two function pointers `print` and `error` have exactly the same signature as `printf` and are used in the `print` command and when any kind of error occurs. In a text mode application, it is therefore possible to construct a **TIM** interpreter with:

```
...
TIM T(argc, argv, printf, printf);
```

80.3 Run Scripts...

To interpret a script file, you call:

```
T.EvalFile( filename );
```

To directly interpret a text macro, you will call:

```
T.Eval(char *script);
```

80.4 Add Functions and Variables...

Before you run a script, you might want to add your own macros and variables to this interpreter. The next chapter explains, how to write a C/C++ **TIM** function. You add them via:

```
T.AddSysFunc( char *TIMname, pointer to TIM function );
```

This call adds the function to the interpreter's internal symbol table of function names.

To register variables existing in your application, you do one of these constructions, e.g.:

```
int    iVal;  
double dVal;  
char   cVal(size);
```

```
T.AddSysVar( "integerVar",    &iVal, IS_INT );  
T.AddSysVar( "doubleVar",    &dVal, IS_DOUBLE );  
T.AddSysVar( "stringVar",    &cVal, IS_STRING );
```

This allows to change these internal variables with help of running a **TIM** script! It is also possible to add variables to the interpreter, that exist only during the run of the interpreter. This can be done with:

```
T.AddVar( "timVar", "value" );
```

This might be the preferred value to implicitly set global variables to values. This mechanism is used, e.g., in the **MultiPage** project to add and update the size of the current page in the variables X1, Y1, X2, Y2.

In the *Reset* function (which marks the beginning of a page), these statements exist:

```
int  x2 = ...GetWidthOfDevice();  
int  y2 = ...GetHeightOfDevice();
```

```
T->AddVar("X1", "0");  
T->AddVar("Y1", "0");  
T->AddVar("X2", ToString(x2));  
T->AddVar("Y2", ToString(y2));
```

⇒ Please note, that variables in **TIM** only contain string values!

80.5 Returning Something...

The current interpreter is always passed to a **TIM** function when it is called. **TIM** functions may return a value, which has to be a string. The following functions make this step as easy as possible:

```
T->SetResult(int      iVal);  
T->SetResult(long     lVal);  
T->SetResult(double   dVal);  
T->SetResult(char     *cVal);
```

80.6 Summary

Integration of **TIM** into your application is a very straightforward process. **TIM** offers only a few functions that allow you to register functions and variables, to evaluate scripts and to set return values. Most of the intelligence of **TIM** comes from you; when you specify functions and add them as **TIM** commands.

81. Writing a C/C++ TIM Function

TIM allows you to add functions to its language very easily. This chapter shows, how such a function is written, registered, and what rules are to be obeyed.



If you are not a software developer, trying to integrate **TIM into one of your applications, you can completely skip this chapter.**

We will try to write a **TIM** function that compares two string parameters. The function should be called, whenever a command like

```
compare str1 str2
```

appears in a **TIM** script. To make things more complicated, it should be possible to ignore the case of the letters in the strings. This should be specified with help of an option like this:

```
compare -ignore str1 str2
```

TIM functions have this prototype:

```
int TIM_Name( void *client, TIM *tim, int argc, char *argv[] )
```

This is an absolute standard. To help remember this prototype, a small macro named **INTERPFUNC** has been created. You will use it like this:

```
INTERPFUNC(TIM_Name)
```

As you can see, a pointer to the current interpreter is passed to the function(**TIM *tim**). You can use it to set a result string or whatever.

The function should return one of the two values:

- `TIM_OK` All worked out fine.
- `TIM_ERROR` We got some problems somewhere.

Often you require a minimum amount of parameters passed to the function. You check this with the `TIMARGS` construction like this. If the number of arguments is too small, the `TIMARGS` macro returns `TIM_ERROR`.

```
int TIM_Cmd( void *client, TIM *tim, int argc, char *argv[] )
{
    TIMARGS(3);
    // from here on you have the guarantee, that
    // at least something like this is specified:
    //
    //   compare param1 param2
    //   argv[0] argv[1] argv[2]
    //
    //   argc equals 3 or more;
```

In our case, we want to create a function to compare two strings. The function requires at least 3 parameters. The first parameter might be an option to ignore the case. The result of the function is the result of the corresponding C `strcmp` or `strcmpi` functions.

To check parameters, you might want to use the `TIMARG(nr, string)` macro. It checks argument number `nr` to be string and returns 0 or 1.

This leads to an implementation like this:

```
int TIM_CompCmd( void *client, TIM *tim, int argc, char *argv[] )
{
    TIMARGS(3);
    int first = 1;
    int ignore = 0;

    if (TIMARG(1,"-ignore"))
    {
        first = 2;
        ignore = 1;
    }
    if (ignore)
        tim->SetResult( strcmpi( argv[first], argv[first+1] ) );
    else
        tim->SetResult( strcmp ( argv[first], argv[first+1] ) );

    return TIM_OK;
}
```

The only thing left now is registering this function in your current **TIM** interpreter. Suppose your current interpreter is named **T**, than you have to have a line like this in your code. Just specify the name, under which the command should be available, and the address of the **TIM** function (as defined above).

```
T.AddSysFunc("compare", TIM_CompCmd );
```

82. Writing an Extension DLL

TIM allows you to dynamically load DLLs in order to extend its language or to add more built-ins. The command to do this is `registerdll`. This chapter describes in detail, how such an extension DLL is to be written!



If you are not a software developer, trying to integrate **TIM into one of your applications, you can completely skip this chapter.**

The C++ file

When you write your extension DLL in C/C++, you have to include these headers (at least):

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <tim.hpp>
```

`TIM.HPP` contains most of the stuff needed to build an interface to a **TIM** interpreter. One of the macros available is `TIMFUNC`, so you declare a **TIM** extension function like this:

```
INTERPFUNC(tim_TimeCmd )
```

This corresponds to

```
int tim_TimeCmd( void *client, TIM *tim, int argc, char *argv[] )
```

You may declare as many **TIM** functions in one module as you like. Each DLL *must* contain the register function. This function is called during the module loading by an application that has a **TIM** interpreter integrated. The register function might look like this. Do not get confused by the number of storage specifiers for this function.

```
extern "C" int _export REGISTER( TIM *tim )
{
    tim->AddSysFunc( "time", tim_TimeCmd );
    return 1;
}
```

As you can see, the current **TIM** interpreter is passed to this routine and you may use this interpreter's routines to add functions or variables.

The function is written in uppercase to avoid linkage problems caused by case-sensitive linkers.

It is declared as a plain C function to have a clear name space and to avoid C++ name mangling.

Different compilers have different naming models. E.g. WATCOM creates the name **REGISTER_** from this function (please note the underscore), whereas Microsoft always generates **_REGISTER**. **TIM**, intelligent as it is, searches for both names in a DLL, using WATCOM's convention first. If it finds the register routine, it is called.

Notes on OS/2: The DLLs to be registered must be in a path that is specified by environment variables or in the current path. The locations inspected are (in this order): current path, **DPATH** and **PATH**. If **TIM** doesn't find the DLL, it simply will not be able to perform the function that you desired to load.

WATCOM Compiler Switches

If you have your module named `EXT.CPP` and want to create a DLL named `EXT.DLL`, you create a proper object with:

```
wcl386 /c /bd /bt=nt ext.cpp
```

and link the module with a link file like this. Don't forget to specify all the libraries you need.

```
system nt_dll  
option stack=256k  
name ext.dll  
file ext.obj  
lib ...
```

Location of examples

There are several examples available. Normally, they are installed into a sub-directory of your software. If your software resides, e.g., in `D:\VISA\VIS`, then the examples are in

```
D:\VISA\VIS\TIM\DLL
```



*These examples are only installed, if you own the **TIM SDK!***

83. Integrating TIM Into Your Loadable Application

Some host systems allow to dynamically load applications to extent its capabilities. In this case, the host system passes a pointer to an abstract INTERPRETER object to the application. Since all functions in the INTERPRETER class are abstract, your application doesn't need any library containing **TIM** code. As a matter of fact, you can't even rely on the fact that a **TIM** interpreter was instantiated and passed to your application.

Please inspect the header file `INTERP.H`, which is located in your **TIM** SDK or in your GeoWizard SDK.

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