# RxTools

User Manual

RxTools

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Septentrio Satellite Navigation
Greenhill Campus, Interleuvenlaan 15G
B-3001 Leuven, Belgium

http://www.septentrio.com
support@septentrio.com
Phone: +32 16 300 800
Fax: +32 16 221 640

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# Chapter 1

# Introduction

The RxTools is a suite of GUI tools for monitoring and configuring receiver operations as well as logging and downloading SBF data files. There are also tools to analyze the SBF data files and convert them to various other formats. A list of the RxTools is given below.

RxLauncher is a new application that enables launching any of the RxTools applications listed below with a single click.

RxControl is a graphical user interface which facilitates control and monitoring of Septentrio receivers in real time. It offers numerous views for monitoring data and a simple logger for recording data files.

DataLink is a graphical communications terminal that allows users to establish connections to multiple devices and transfer data between them.

SBF Converter is a GUI for converting SBF data files to various other formats including ASCII, RINEX and KML.

SBF Analyzer allows users to generate the same time plots offline from SBF files that RxControl produces in real time.

RxLogger allows flexible logging of SBF and NMEA data. Users can select multiple streams each with a different update rate. Post processing actions such as data conversion or FTP transfer can also be defined.

RxUpgrade is a small application used to upgrade the firmware on a receiver. It can also be called via the command line allowing upgrade of multiple receivers simultaneously.

RxDownload is an application for managing the download of data logged internally on receivers. It can connect to multiple receivers at the same time and can be used to configure the receiver and set data output.

RxPlanner is a Satellite Mission Planning software. Is shows the satellite visibility and DOP at a user defined location and time period.

RxAssistant is an interface and control GUI what simplifies receiver configuration and monitoring without compromising on flexibility. Is provides basic status monitoring, NTrip as well as the configuration of NMEA output.

## 1.1 Installing RxTools

### 1.1.1 Recommended System Requirements

The following operating systems are supported:

- Windows XP Service Pack 3, Windows Vista, Windows 7 and Windows 8
- Fedora Core 9, 10, 11, 12, 13, 14 and 15

Minimal system requirements (for 1 Hz update rate [1]) are:

- Pentium 800 MHz and above
- 512 MB RAM
- 1024×768 or higher resolution

### 1.1.2 Windows installation

*Note* **1.** Administrative rights are required for installing RxControl.

The RxTools installation is performed by running the RxTools_1_10_0_Installer installer:

- `RxTools_1_10_0_Installer.exe`
  (located in the `RxTools\windows` directory on the installation CD)

With the Windows setup program of the RxTools_1_10_0_Installer, users may choose to install some or all of the following applications: RxControl 4.11.0 , SBF Converter 2.7.0, SBF Analyzer 2.5.0, RxLogger 1.6.2, RxUpgrade 2.4.0, RxDownload 1.2.3, RxPlanner 1.2.4, Data Link 2.4.0, RxAssistant 1.0.0 and/or RxLauncher 1.1.0.

Please see the release notes for installation instructions and warning. Also the release notes contains detailed description of the programs above as their issues and limitations.

During the installation, you can indicate into which directory you want the RxTools_1_10_0_Installer to be installed. If a previous version of RxTools is installed you will be notified that the previous version will be uninstalled. Once RxTools have been installed, any of the individual GUI tools can be launched using the RxLauncher application.

When connecting to a receiver using USB, two virtual serial ports will be created on your machine which can be used to communicate to the receiver. Check the Device Manager to see the exact names of these virtual serial ports. Usually they will stand out from the rest of the serial ports since they will have an enumeration number which is a bit higher than the built in serial ports. Also they should have the name 'Septentrio' written beside the port name. These virtual serial ports will be labeled as such when RxControl shows the `Connection Dialog`. The virtual serial port names correspond to a given USB port. If you plug the receiver into a new USB port, the virtual serial ports will have new names.

### 1.1.3 Linux installation

To install RxControl, run the program `RxTools_1_10_0_Installer.bin` located in the directory `RxTools/linux-i386/` of the installation CD.

[1] Higher data rates (e.g. 10 Hz) will require higher CPU and memory requirements.

During the installation, you will be prompted in which directory you want the RxTools to be installed, and where you want to create the shortcuts. Remember that RxControl 4.11.0 and other RxTools might have some incompatible features with different Septentrio Receiver versions, therefore you may want to choose a different directory for keeping parallel RxControl versions or other tools running properly on the same PC.

For USB connectivity you do not need to install any special drivers on Linux.

In order to use RxControl with Linux OS the following settings are required:

- The RxControl process should have the rights to access the `/dev/ttyS?` serial ports. On most modern Linux, the `/dev/ttyS?` devices are owned by `root` and belong to the `uucp group`, with read and write access to the group. Additionally, the device is normally locked by writing a file in the `/var/lock/` directory, owned by `root` and belonging to the `lock group`, with read and write access to the group. In order to access the serial ports, the user(s) who want(s) to use RxControl must be part of the `uucp group` and of the `lock group`.
  On a stand-alone Linux machine, the classic way to make a user part of the `uucp group` and of the `lock group` is by editing the `/etc/group` file, adding the users name to the line defining the `uucp group` and the `lock group`. For example, if the user `jsmith` must be added to the `uucp group`, change the line:
  `uucp:x:14:uucp`
  to
  `uucp:x:14:uucp,jsmith`
  On many Linux distributions, graphical tools may edit the file, in Fedora Core, for instance, the tool is found in the `System Settings | Users and Groups` menu. Editing the `/etc/group` file requires c privileges.
  On Linux machine administered centrally on a local network, the group members are likely to be shared between the machines, using name services like the NIS (Network Information Service), NIS+ or the LDAP (Lightweight Directory Access Protocol). The `/etc/nsswitch.conf` file controls the use of the name services. Ask your system administrator to add the needed users to the `uucp` and the `lock` groups.
- This program will not run on your system if the **permissions** of the serial ports are not set to **read/write (rw)** for you (normally this should not be a problem with the default permissions).
  In case you run into problems make sure that you change the permissions using the command:
  `chmod 660 /dev/ttyS?`
  where the **?**-mark has to be replaced by the correct figure for your port (e.g. **/dev/ttyS0** for the COM1 port).
  Changing these permissions also require `root` privileges.
- The user has to update his environment by logging out and back in. Be aware that the X session has to be restarted as well. On most systems this can be done by pressing the key combination `Ctrl-Alt-Backspace`.
- It is not recommended to install RxControl as a `root` user for security reasons as well as for avoiding that the installation overwrites other settings in your system. If you need to make RxControl available to more than one user it is recommended to share the installation directory of RxControl.

Once RxControl is installed, it can be launched by executing the link created by the installation program or by executing `./runRxControl` in the directory where the program is installed. Data Link 2.4.0 and SBF Converter 2.7.0 can be run from the **bin** directory so that the proper libraries can be loaded on a Linux system. They can also be run from the install directory in a similar way as described for RxControl above. If the RxTools_1_10_0_Installer installer has been used, then other application as Data Link can be run by launching the appropriate script (e.g. **runDataLink** located in the **/bin** directory inside the RxTools_1_10_0_Installer installation path. These scripts make sure of setting a temporal library path for the applications so that they can run properly on your Linux system.

### 1.1.4 Windows uninstall

When the RxControl installer is run, the installer will first offer to uninstall a previous installation if present.

To uninstall RxTools without installing a new verions, either:

- run the uninstaller executable present in the RxTools installation directory,
- or use the `Add/Remove Programs` feature of Windows (sometimes named `Uninstall a program`), which can be accessed via the `Control Panel`.

After launching uninstall, follow the on-screen instructions to complete the removal of RxTools.

### 1.1.5 Linux uninstall

To uninstall RxTools, execute the following program:

- `uninstall`, located in the RxTools installation directory.

After executing the command follow the on-screen instructions to complete the removal of the RxTools.

# Chapter 2

# RxControl

## 2.1 Introduction

RxControl is an intuitive GUI application, which allows you to control your Septentrio Receiver, to log data, to monitor the navigation solution and other activities of the receiver.

### 2.1.1 RxControl compatibility

RxControl 4.11.0 has been designed and tested to work with the interface of receivers which were released after PolaRx2. RxControl 4.11.0 does not support PolaRx2 or older receivers.

The menu of RxControl adapts itself to the connected Septentrio Receiver. So if new functionality is added to the receiver via a firmware update, the new functionality may be visible in the menu of RxControl without having to update RxControl itself.

Using an old version of the receiver than expected by RxControl may cause some screens not to function properly since the receiver might not be able to provide the requested data to RxControl.

Please consult the release notes of RxTools 1.10.0 to check for specific differences and incompatibilities with previous versions.

### 2.1.2 Launching RxControl

RxControl can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the RxControl executable can be found under 'Septentrio RxTools'. You can also launch RxControl via the 'Tools' menu of any of the GUI tools, for example from SBF Analyzer as shown in Figure 2.1-1 on the following page.

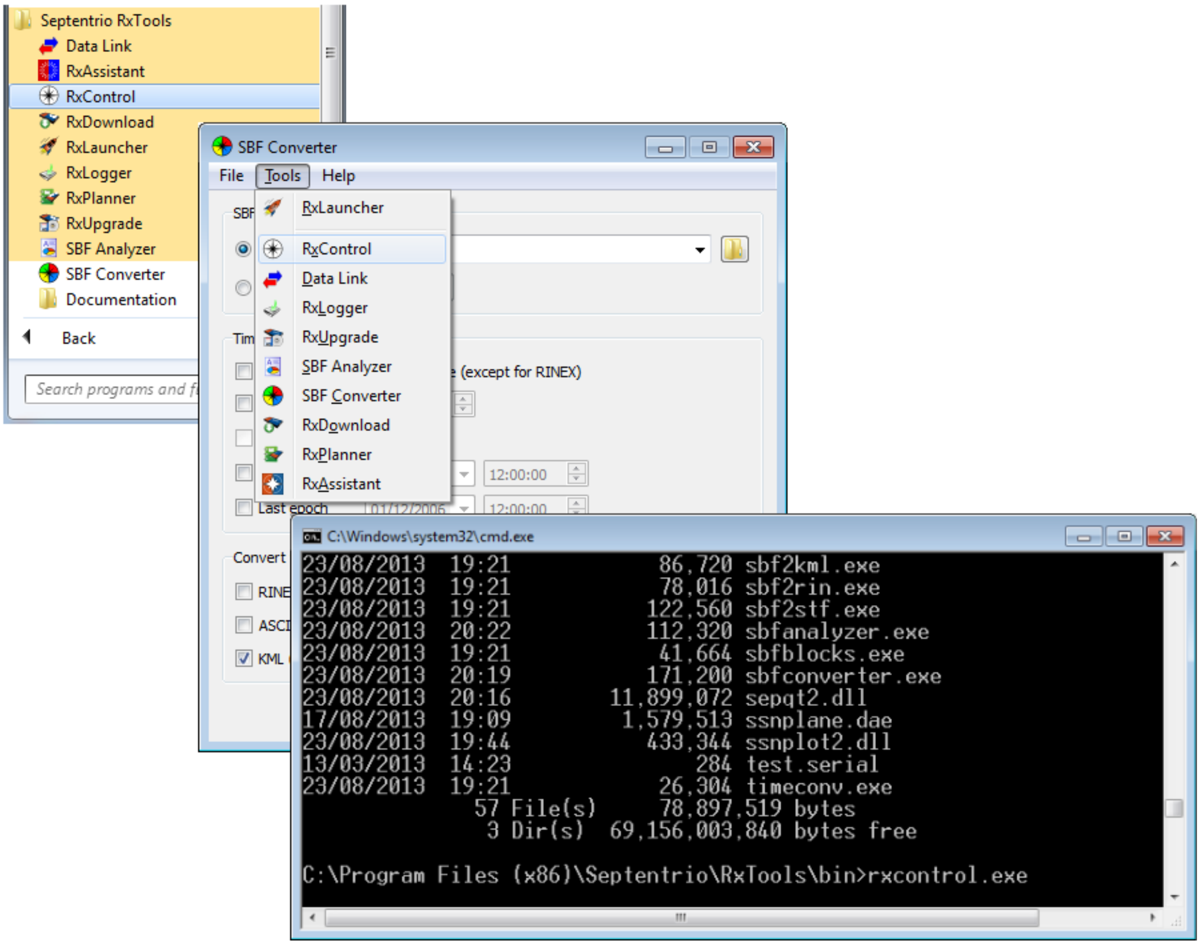



**Figure 2.1-1:** Launching the RxControl GUI

# 2.2 Getting started

## 2.2.1 A quick guide to RxControl

The RxControl program is an intuitive GUI which allows you to **control** your Septentrio Receiver, to perform **data logging**, to **monitor** the navigation solution and other activities of the Septentrio Receiver. To fully understand the functionality and to be able to use all the capabilities of RxControl, it is recommended to read the HTML help pages and the manual of RxControl. The purpose of this section is to assist you with your first steps.

Once RxControl is installed (see Section 1.1 on page 14), your next task is to **set up a connection** from your PC to the Septentrio Receiver. The user must be aware that the Septentrio Receiver has several serial ports (e.g. `COM1`), and that they are not to be confused with the PC's serial ports (`COM1` and `COM2`). On Linux systems, the serial ports of the PC are denoted by `/dev/ttyS0` and `/dev/ttyS1` for `COM1` and `COM2` respectively. The next paragraphs refer to the Windows naming convention.

To connect to the Septentrio Receiver via a serial cable, follow the next steps:

1. Make sure that the receiver is up and running and that it is connected to the antenna.
2. Use a null-modem serial cable (see Section A on page 192) to connect one of the serial ports of your PC to one of the serial ports of the Septentrio Receiver.
3. Start RxControl, or, if it is already running, go to `File | Change Connection`.
4. The `Change Connection` dialog (see Figure 2.3-1 on page 22) will appear. For the first connection, choose `Serial Connection | Create New | Next>`.
5. A dialog window (see Figure 2.3-2 on page 23) to select the communication port will be shown (by default the serial port settings are not shown and are correctly filled in for the default receiver settings). If the Septentrio Receiver is connected to your PC's `COM2` port, change the `Serial Port` to `COM2`.
   If you would like to connect via USB then select one of the two virtual serial ports, which have been created for USB communication.
   If you accept these settings your PC's serial port will be in the same state as the Septentrio Receiver's `COMx` port, and the communication with the Septentrio Receiver may begin. Every time you turn your Septentrio Receiver on or reset it via software, the serial ports of the Septentrio Receiver will return to the default communication settings as listed in the table below:

| Parameter | Value |
|---|---|
| baud rate | 115200 |
| data bits | 8 |
| parity | none |
| stop bits | 1 |
| flow control | none |

**Table 2.2-1:** Default serial port settings

   If you want to change these settings you have to press the little triangle next to `Advanced Settings` to make the settings visible. Before pressing the `Finish` button, you have to provide a file name for the connection settings. Enter a name in the `Connection File` text field, even if you stay with the default settings. If you press the `Enter` button on your PC's keyboard, RxControl will add the extension `.serial` to the file name. Later you will be able to reuse these settings for the chosen serial port by loading the settings file.

*Note 3.* As an inheritance of the `DOS` background working under `Windows` systems, it is not allowed to have a file named COMX.extension. Therefore, you should avoid naming your connection files something like COM1.serial.

6. Pressing the `Finish` button will start the connection to the Septentrio Receiver.

Connecting over a Local Area Network (LAN) or over the Internet using a TCP/IP socket is much simpler than via a serial port. All you need to provide in this case is the hostname or the IP address of your Septentrio Receiver (see Figure 2.3-3 on page 23).

Once connected, RxControl displays its `Main Window` (see Figure 2.4-1 on page 25) with the current position, the list of tracked satellites and timing information. If you don't see the normal display, please look for more information in Section 2.3 on the next page.

If everything went all right and you are now connected, then welcome to the RxControl user interface!

Please hover your mouse over various texts and controls to see the tool tips which provide extra receiver information or help.

The blinking green lights at the bottom of the main screen signal new data coming into RxControl.

To monitor various aspects of the receiver performance including the position solution and tracking, go to the `View` menu and choose one either `Time Plots` or one of the views. All the screens are intuitive and easy to use. The icons in the tool bar provide shortcuts to some of the most used views.

To control the receiver, use the receiver menus (see Section 2.4.3.3 on page 36), which consist of dialogs and commands to control the operation of your Septentrio Receiver. Have in mind that there is a one-to-one correspondence between the Septentrio Receiver command set and the different items in the `Communication` and `Navigation` dialogs; most of the time the name of the menu, item or dialog clearly matches the name of the command. The settings you change in these dialogs are actually changed in the receiver when you press the `OK` or `Apply` button.

To log SBF data, go to the `RxControl Logging` dialog used for logging data coming from the receiver. (see Section 2.7 on page 72).

### 2.2.2 Controlling the Septentrio Receiver

If you want to change the receiver settings, the place you are likely to visit are the `Communication` and `Navigation` menus (see Section 2.4.3.3 on page 36). These menus are built dynamically from the MIB description, which is downloaded from the receiver. In these menus you will be able to find different special settings and commands that set the receiver in a specific mode. The contents of these dialogs always reflect the current settings of the receiver. If you change any parameter on these dialogs and press `OK`, the new settings will be transmitted to the receiver.

All the current settings can also be requested or changed manually via the `Expert Console` (see Section 2.6 on page 68), which acts as a command-line interface to the Septentrio Receiver. Besides querying the current settings using the `get-commands`, the `Expert Console` also allows you to change the settings by issuing the corresponding `set-commands`. For more information about the commands of the receiver, please consult the "Command Line Interface Reference Guide". Other tabs in this screen allow you to see the flow of `NMEA` and/or differential correction messages.

## 2.3 Connecting to the Septentrio Receiver

RxControl connects to the Septentrio Receiver using either a serial RS-232 (see Appendix A on page 192) cable, USB cable or a TCP/IP data stream connection. The latter allows RxControl to operate a receiver remotely and can be useful for remote reference stations equipped with a Septentrio Receiver.

On startup, RxControl pops up a `Change Connection` dialog asking the user to specify the communication settings (see Figure 2.3-1). The user can choose between four connection options:

- Connecting with the last known connection
- Connecting via a serial link
  (USB connection is done through a virtual serial link)
- Connecting via a TCP/IP socket
- Replaying a recorded file

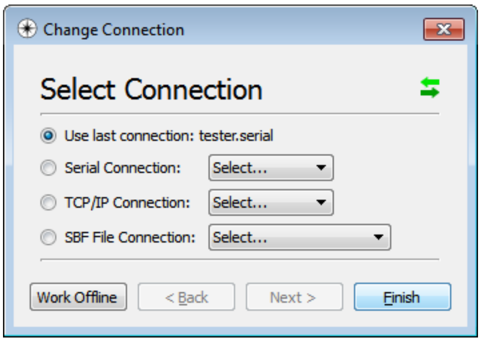



**Figure 2.3-1:** Connection dialog

At first use of RxControl, the user has to create a new serial, TCP/IP or SBF file replay connection and RxControl does not present the `Use Last Connection` option in the `Change Connection` dialog. Creating a new serial, TCP/IP or SBF file replay connection is done by selecting the `Create New` option in the corresponding drop-down list. The `Finish` button will become grayed out and the `Next >` will become available indicating that the user has to enter additional information. Pressing the `Next >` button pops up a `Create a new Serial connection` (see Figure 2.3-2 on the following page), a `Create a new TCP/IP connection` dialog (see Figure 2.3-3 on the next page) or a `Create a new SBF file connection` dialog (see Figure 2.3-4 on page 24).

The `Create a new Serial connection` dialog allows to specify the values of parameters affecting the serial or USB connection between the Septentrio Receiver and the RxControl program. The predefined values reflect the default settings of the serial ports of the Septentrio Receiver.

However for USB connection via virtual serial ports, some port parameters like baud rate will be ignored since it is unnecessary (see Section 1.1.2 on page 14 for more USB details).

Keep in mind that after a reset of the receiver, the serial ports of the Septentrio Receiver may return to this state, so it is advisable to use the default settings. After adjusting the parameters to the needed values, specify a file name were these parameters can be stored. Once all information has been entered, press the `Finish` button.

***Note* 4.** As an inheritance of the `DOS` background working under `Windows` systems, it is not allowed to have a file named COMX.EXTENSION.

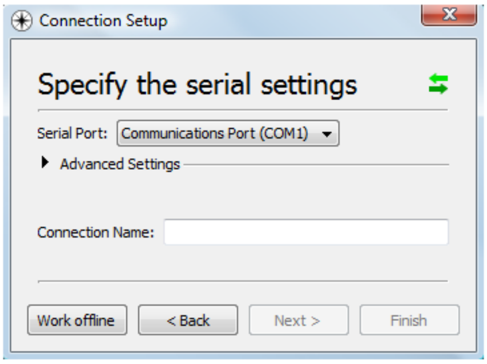



**Figure 2.3-2:** Create Serial Connection dialog

If the Septentrio Receiver has Ethernet capabilities, then users may also connect to the receiver using a TCP/IP connection.

Defining a TCP/IP connection is simply done by specifying the IP address or the hostname of the Septentrio Receiver. In the latter case, the hostname must be resolved by a local DNS server or by linking the hostname (e.g. `MyReceiver`) to the corresponding IP (e.g. 192.168.1.134) address. This can be done by inserting a line into the `hosts` file:
`192.168.1.123 receiver.yourdomain receiver`

Contact your network administrator for more information on how to map the Septentrio Receiver IP address to a DNS server.

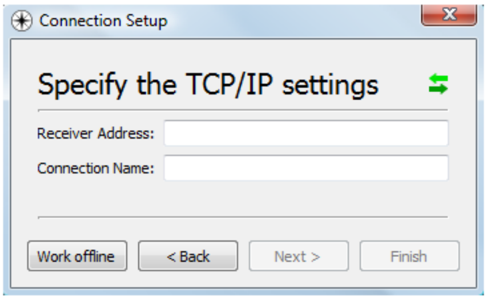



**Figure 2.3-3:** Create TCP/IP Connection dialog

RxControl also has a standalone mode in which it can replay recorded SBF files. This is done by using an SBF file connection. Defining such a connection is done by specifying the SBF file that must be played. The file will be played at the rate at which it was recorded, or at a factor slower or faster as specified by the user.

***Note* 5.** The behavior of RxControl in file play mode depends on the recorded messages. If messages required by RxControl are not available in the file it is possible that some or all dialogs of RxControl do not function as expected.

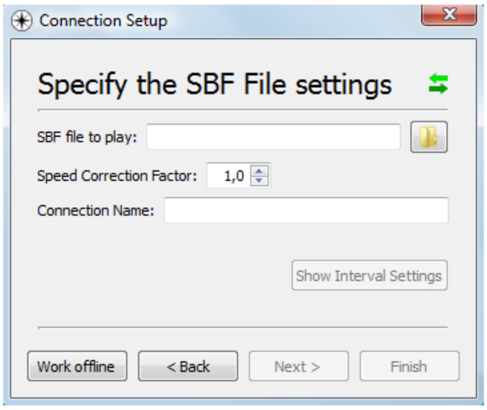



**Figure 2.3-4:** Create SBF File Connection dialog

The parameters of each created connection are saved in a **connection file**. These files are located in the *user_home_dir*/.septentrio directory. A serial connection properties file is identified by the extension .serial while a TCP/IP connection has the extension .tcpip and a SBF file connection .sbffile.

If connections files are available at startup, RxControl displays the Use Last Connection option and specifies the name of the corresponding connection file in the Change Connection dialog (see Figure 2.3-1 on page 22).

The user can decide to always connect to the last used connection and skip the dialogs from the Change Connection dialog by selecting the Use the last connection at startup check box accessed from the File | Preferences menu entry.

If RxControl is already running, the Change Connection dialog (see Figure 2.3-1 on page 22) can be opened by choosing File | Change Connection in the RxControl's main window.

During the display of the Change Connection dialog, there is no data communication between the Septentrio Receiver and RxControl. Pressing the Work offline button allows you to use RxControl without any receiver connected.

Whenever RxControl fails to initiate a connection to the receiver it will pop up an error dialog and will allow the user to select another connection.

If RxControl loses its connection to a receiver it will try to reconnect using the same connection parameters.

Also if receiver is connected via USB and it is restarted or unplugged RxControl will try to re-establish the connection. Allow several seconds for the virtual serial port to become visible if receiver is restarted using the USB connection.

Once connected, RxControl displays its Main Window (see Figure 2.4-1 on the following page) with the current position, the list of tracked satellites and timing information. If you don't see the normal display, please check for a solution in Appendix C on page 199.

When RxControl connects to a receiver, it sends a request for a standard minimal set of SBF data blocks required to update all the views. In order to minimize to processing and communication overhead for the Septentrio Receiver RxControl will also dynamically adapt the set of requested SBF blocks depending on the views and screens opened and closed within RxControl. During a session, you cannot change this minimal set of SBF messages for your current connection.

# 2.4 RxControl's main window

## 2.4.1 General

RxControl's main window is the central part of RxControl. It gives the user a **general overview** of position related information, the satellite systems in use, and the status of the Septentrio Receiver.

If this window stays empty after having connected to the receiver, it means that something is wrong with the connection or that the receiver is not turned on. This may happen if the wrong PC's serial port is specified, or if the PC's serial settings do not match the receiver's settings. Possible solutions to this problem can be found in Section 2.3 on page 22.

RxControl's main window is the central location for accessing all receiver related information and offers full control of the Septentrio Receiver. The Septentrio Receiver outputs navigation and measurement information in binary SBF data blocks and/or ASCII NMEA sentences at user-specified intervals. RxControl dispatches the SBF data blocks to a variety of **graphical** or **tabular** views. Quick access to these views is available through the toolbar of the RxControl window.

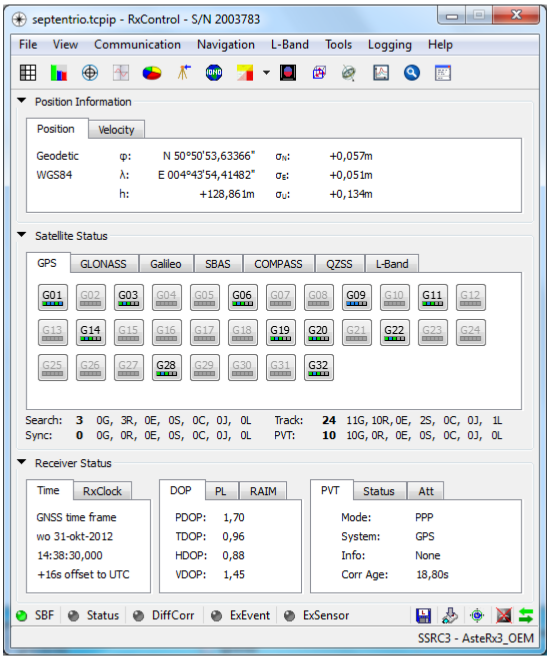



**Figure 2.4-1:** Main Window

If you would like to change the update rate of the main window and thus the update frequency coming from the receiver, you can do so in the `Preferences | General` section.

RxControl's main window consists of four main areas:

- the `Position Information` section displays current position, velocity, and related accuracy parameters;
- the `Satellite Status` section gives an overview of the tracking status of the Septentrio Receiver for various satellite systems;
- the `Information` tabs in the bottom part of the window display timing information, dilution of precision parameters, protection levels (HPL/VPL), RAIM (HERL/VERL), PVT solution information, and the status of the currently used communication link to the receiver;

- the `Status bar` gives a quick overview of the communication between the Septentrio Receiver and the RxControl program, current PVT mode and the status of logging.

The first three of them have a little triangle before their title. Clicking this triangle allows to expand/-collapse the area.

A minimal subset of SBF blocks is needed to update the graphical windows of RxControl. The user has no control over this minimal subset of SBF blocks for the current connection. Nevertheless, the list of SBF blocks transmitted over other connections, can be controlled by the user through the `Communication | SBF Output` dialog.

Closing RxControl's main window closes all the current views, shuts down the communication link to the Septentrio Receiver and terminates the RxControl program. During the shutdown, a file with the user preferences (*user_home_dir*`/.septentrio/rxcontrol.conf`) for the RxControl program and a connection file with properties for the current connection to the Septentrio Receiver are saved ( *user_home_dir*`/.septentrio/`*connectionname*`.tcpip` for an Ethernet connection, *user_home_dir*`/.septentrio/`*connectionname*`.serial` in the case of a serial/usb port connection and *user_home_dir*`/.septentrio/`*connectionname*`.sbffile` in the case of a file replay connection).

## 2.4.2 RxControl main window information

### 2.4.2.1 The Position Information section

The top section of the RxControl main window shows in separate tabs position- and velocity-related information. The **default view**[1] displays the current position and velocity expressed in the **geodetic geographic system** ($\varphi -$ latitude , $\lambda -$longitude, $h -$ ellipsoidal height) based on the World Geodetic System 1984 (WGS84) ellipsoid.

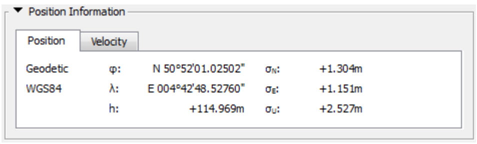



**Figure 2.4-2:** Position Information section

The format used is changed through the FILE PREFERENCES ... — FORMATS menu entry, which can be accessed by right clicking on the position information display. The formats preference setting allow to alter the angular format and the coordinate system throughout RxControl. The angular format is displayed as (a) sexagesimal degrees, (b) decimal degrees or (c) degrees-decimal arcminutes as often used in nautical applications The user can switch the overall coordinate system as (a) cartesian coordinates $(X, Y, Z)$, (b) geodetic coordinates $(\varphi, \lambda, h)$, (c) geocentric coordinates $(\Phi -$ geocentric latitude$, \Lambda -$ geocentric longitude$, r -$ geocentric distance$)$ (See Section B.1 on page 194), (d) topocentric coordinates $(E -$ east$, N -$ north$, U -$ up$)$ related to a topocentric reference point (See Section B.3 on page 197), (e) or as a cartographic projection $(E -$ east$, N -$ north$, H -$ ortometric height$)$ (See Section B.2 on page 196). The orthometric height $H$, referenced to the geoid, by subtracting the geoid undulation $N$, $H \approx h - N$. The Septentrio Receiver interpolates the geoid undulation using the geoid model at $10\,^{\circ}$ matrix derived from the full WGS84 coefficient set (see: Technical Characteristics of the NAVSTAR GPS – June 1991).

1 At first startup of RxControl the position and velocity are always displayed in geodetic geographic coordinates. At subsequent startups, RxControl will read the user's preferences file and display the last used view.

*Note* **6.** When running the Septentrio Receiver in **base station mode**, the position information section displays only the known true position of the base station. In the **base station mode**, position errors or standard deviations are meaningless and thus are not provided.

When no position updates are available, values are set to N/A and the cause of the problem can be seen in the status bar (see Section 2.4.2.4 on page 32).

The position and velocity views display the standard deviation of the coordinate components. The geodetic and geocentric view display the deviations $(\sigma_E, \sigma_N)$ of the standard planimetric error ellipse along the parallel and meridian, while $\sigma_U$ is measured along the normal direction to the ellipsoid.

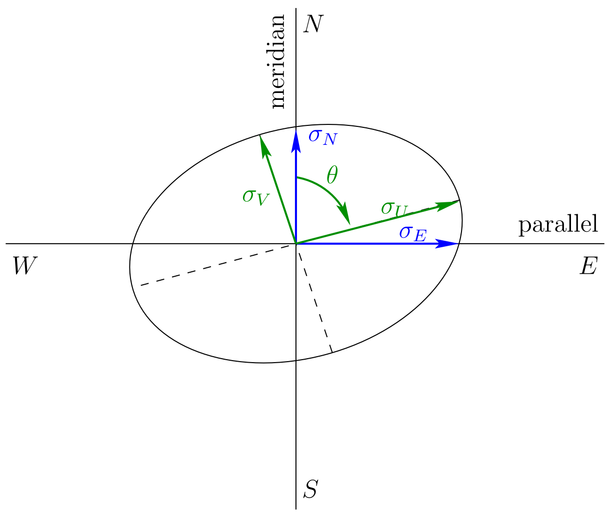



**Figure 2.4-3:** The planimetric dispersion ellips

This semi-major and semi-minor axis $(\sigma_U, \sigma_V)$ and the orientation angle $\theta$, measured clockwise from the geographic North, are displayed in the topocentric and projection views. The velocity tab reports the corresponding standard deviations of the velocity components.

The Position Information section is capable of showing either the GNSS-only solution or an integrated solution (if available). Whether the GNSS-only or integrated solution is shown, is determined by a user preference as set in the preferences dialog, which can be opened by selecting the `Preferences...` item in the `File` menu of the main application window. If an integrated solution is shown, this is indicated by the presence of the text “Integrated” in the left column of the tabs.

When position information is received from the receiver in a local datum (e.g. in the PosLocal SBF block), a third tab is shown, that displays the position coordinates in this local datum as well as the name of the applicable datum. The interpretation of the local height H depends on the applicable datum. This usually is the physical height defined by that datum.

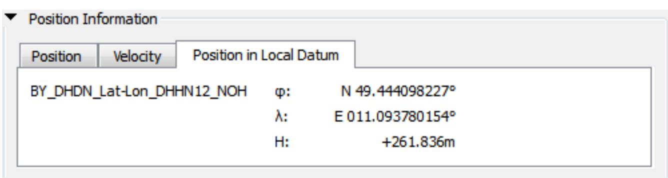



**Figure 2.4-4:** Position in Local Datum tab

#### 2.4.2.2 The Satellite Status section

The central section of the RxControl main window displays status information about the satellites and their signals currently tracked by the Septentrio Receiver. At start-up, the RxControl program initiates communication with the receiver and adjusts its views to the available options of the Septentrio Receiver. During this phase, the Septentrio Receiver communicates its capability to track a specific **satellite system**, such as **GPS** (Global Positioning System), **GLONASS** (Global Orbiting Navigation Satellite System), **Galileo**, **SBAS** (Space-Based Augmentation System like **EGNOS**), **BeiDou** or **QZSS** (Quasi-Zenith Satellite System). RxControl adjusts its appearance to the actual tracking capability of the receiver. When the Septentrio Receiver does not support tracking of a particular satellite system, the corresponding tab is disabled and inaccessible for the user.

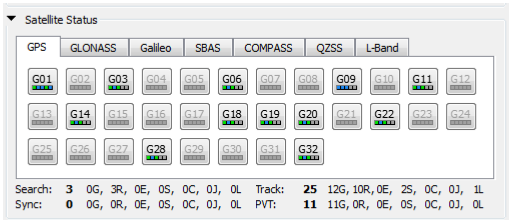



**Figure 2.4-5:** Satellite Status section

The **satellite systems tab** provides a quick overview of reception and usage status of the individual satellites. The satellite number is preceded by a letter indicating the satellite system to which a satellite belongs:

- "**G**" for GPS satellites
- "**R**" for GLONASS satellites
- "**S**" for SBAS satellites
- "**E**" for Galileo satellites
- "**C**" for BeiDou satellites
- "**J**" for QZSS satellites

The **signal indicator** on each button reflects the status of each signal of the corresponding satellite. It is represented by little colored squares. The number of squares depends on the represented system and the capabilities of the receiver (only the signals of which the receiver is capable of are displayed). To find out which square represents which signal just hover the mouse over a button and a small pop-up will appear with this information, as well as other satellite information. The color code of the squares is as follows:

- **grey** indicates that the receiver is neither tracking the corresponding satellite's signal nor searching for it. There could be two different reasons: (a) the almanac data reports that the satellite is not visible from the current position, or (b) the user explicitly requested not to track this satellite. (For more information about the commands of the receiver, please consult the "Command Line Interface Reference Guide".) If all signals for a satellite are in this mode, the text on the button is also grey to indicate that there is no activity for this satellite.
- **yellow** indicates that the receiver tries to detect the corresponding signal of the satellite and has entered into the search mode.
- **orange** indicates that a valid satellite signal has been detected and that the tracking channel enters into a synchronization phase.
- **blue** indicates that the satellite signal is tracked, but it is not used in the PVT.
- **green** indicates that the satellite signal is tracked and used in the PVT computation.

- **red** indicates that the satellite signal is tracked, but it has been thrown out of the PVT computation.

When the text for an SBAS satellite is printed in **bold**, this SBAS satellite is used as a source of SBAS corrections that could be used by the PVT solution. Note that this can only be the case when the PVT mode includes an SBAS-aided positioning solution.

At the bottom of the **satellite status** section there is a summary of the **tracking status** of the Septentrio Receiver for all the satellite systems. Both the total number of satellites and the number of satellites per constellation that have signals in (a) search (b) synchronization (c) tracking but not used in PVT (d) tracking and used in PVT are shown. If a satellite has signals of different statuses it will be counted in the last possible list.

Hovering the mouse pointer over a satellite button pops up a message containing basic information on the satellite (See Figure 2.4-6). The pop-up message reports the following:

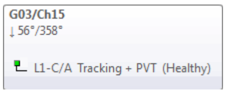



**Figure 2.4-6:** Pop-up in the Satellite Status section

- The **logical channel** on which this satellite is being tracked by the Septentrio Receiver (next to the satellite number).
- For SBAS satellites the name of the geostationary satellite is also displayed.
- The **elevation** and **azimuth** angles of the line-of-sight to the satellite in degrees. An arrow indicator shows whether the satellite is rising (↑) or setting (↓).
- The **status** of all the satellite's signals together with the name of the signal and if it is healthy or not

## 2.4.2.3 Receiver Information tabs

The bottom section of RxControl's main window contains the **Time**, **RxClock**, the **Dilution Of Precision**, the **Protection Limit** or **Receiver Autonomous Integrity Monitoring**, **PVT** and **Status** tabs.

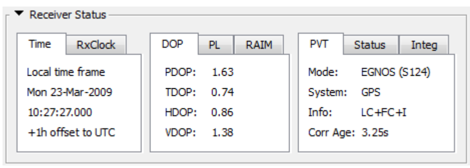



**Figure 2.4-7:** Receiver Information tabs

### 2.4.2.3.1 Time tab

The **Time** tab displays the current date and time. By default, the date and time are displayed in the UTC (Coordinated Universal Time) time reference, but it can be changed to the GNSS time reference or to the local time (derived from the PC's locale) by right-clicking in the **Time** tab.

#### 2.4.2.3.2 RxClock tab

The **RxClock** tab displays the current date and time expressed by the Week number (WNc) and the Time Of Week (TOW). It also shows the offset and the drift of the Septentrio Receiver's internal clock with respect to the GNSS time reference.

#### 2.4.2.3.3 DOP tab

The central tabs show the **Dilution Of Precision** (DOP), **Protection Limit** (PL) or **Receiver Autonomous Integrity Monitoring** (RAIM) values. The DOP parameters represent the influence of the geometric distribution of the observed satellite constellation on the navigation solution. The multiplication of the DOP parameter times the a-priori standard deviation of the range errors yields the expected accuracy of the position (horizontal and/or vertical) and the time synchronization. PDOP (*Position DOP*) is a measure of the achievable threedimensional geometric accuracy and has two components: HDOP (*Horizontal DOP*) in the local horizontal plane and a vertical component VDOP (*Vertical DOP*). An estimate of the timing error can be derived from the value of TDOP (*Time DOP*).

#### 2.4.2.3.4 PL tab

If SBAS satellites are tracked, the horizontal and vertical protection limits are displayed. If supported it also shows the SBAS PL integrity status (successful, failed or unavailable).

#### 2.4.2.3.5 RAIM tab

The Septentrio Receiver features RAIM to ensure the integrity of the computed position solution, provided sufficient satellites are available. The RAIM tab shows **Horizontal External Reliability Level** (HERL) and **Vertical External Reliability Level** (VERL) which are the distinct **External Reliability Levels** (XERL) for the horizontal and the vertical components based on the Minimum Detectable Bias (MDB). It also shows the RAIM integrity status (successful, failed or unavailable).

#### 2.4.2.3.6 PVT tab

The **PVT** tab shows information about the PVT solution. If there is no PVT solution the reason is also displayed here. If there is a PVT solution the following information is shown:

**PVT mode:** Stand-Alone PVT, Differential PVT, Fixed location, RTK with fixed ambiguities, RTK with float ambiguities or SBAS aided PVT.

**System:** The systems used in the PVT solution (e.g.: GPS+SBAS).

**Info:** Indicates if the PVT solution is of the 2D or 3D type. Indicates the type of corrections used in case of SBAS, DGPS, or RTK solution. Indicates DO229 precision approach mode and the Auto Base mode. Indicates use of altitude pressure aiding information. Indicates start of baseline information.

**Corr Age:** When in DGPS or RTK mode this indicates the mean age of the differential corrections and when in SBAS mode this indicates the mean age of the fast corrections.

The PVT tab only shows information about the GNSS-based PVT. Refer to Section 2.4.2.3.8 on the following page for more information on the integrated solution, if available.

#### 2.4.2.3.7 Status tab

The **Status** tab reports the:

**Up-Time of the Septentrio Receiver:** expressed in days, hours, minutes and seconds.
**CPU usage:** high values during a long period of time may indicate a problem with the functioning of the Septentrio Receiver and may require the user's attention.
**Connection port:** the name of the connection port on the receiver side.
**Throughput:** the throughput of the currently used communication port. If the connection is over Ethernet the IP-address is shown when hovering over the throughput.

#### 2.4.2.3.8 Integration tab

The **Integration** tab shows information about the integrated solution for position, velocity and attitude:

**Mode:** current integration mode.
**Error:** current integration error status.
**Info:** information regarding the status and the type of measurements used.
**GNSS Age:** Duration that no GNSS measurements were received and no GNSS-measurement based PVT is computed.

As for most parts of the user interface, more detailed information or an explanation is shown when the user hovers with the mouse over these fields.

The **Integration** tab only shows information if an integrated solution is available to RxControl. On one hand this is determined by the capabilities of the Septentrio Receiver, and the selected positioning mode. On the other hand, this is also determined by the user preference as set in the `Preferences` dialog, which can be opened by selecting the `Preferences...` item in the `File` menu of the main application window. If no integrated solution is used by the application, all fields in the **Integration** tab show "N/A". If the receiver does not support integration, the tab is not shown.

#### 2.4.2.3.9 Attitude tab

The **Attitude** tab shows information about GNSS-based heading/attitude:

**Mode:** current GNSS heading/attitude mode.
**Error1:** current error status for auxiliary antenna 1.
**Error2:** current error status for auxiliary antenna 2.
**Nr SV:** the average over all antennas of the number of satellites currently included in the attitude calculations.

As for most parts of the user interface, more detailed information or an explanation is shown when the user hovers with the mouse over these fields.

The **Attitude** tab only shows the above information if this information is available to RxControl. On one hand this is determined by the capabilities and settings of the Septentrio Receiver. On the other hand, this is also determined by the user preference as set in the `Preferences` dialog, which can be opened by selecting the `Preferences...` item in the `File` menu of the main application window. The tab does not display information if the application is set up to only show integrated solutions. If the receiver does not support GNSS Attitude/Heading, the tab is not shown.

#### 2.4.2.4 The Status bar

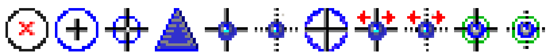
At the bottom of RxControl's main window a status bar (See Figure 2.4-1 on page 25) can be found. The status bar consists of two lines and contains the following information in the order from left to right:

- a LED which blinks if a valid SBF message is received. Normally this LED blinks green, but whenever there is a CRC error or there are discarded bytes it starts blinking red. Hovering the mouse over the LED will show a pop up with information about the number of CRC errors and discarded bytes. Showing this pop up also makes the LED blink green again (until the next error). Right-clicking the LED allows to reset the CRC errors and discarded bytes counters.
- a LED indicating the receiver status. If the receiver status indicates there are no errors, it blinks green. If the error flag of the receiver is set, it blinks red. The history of previous errors will also be kept in the tool tip of this LED. To clear this history right click on the LED and select `Reset Counter`. The second option `Display the error output in the Expert Console` issues the `LstInternalFile, Error` command to the receiver and shows its output in the Expert Console. This also clears the error on the receiver side.
- a LED indicating that differential corrections are being received or transmitted[2] by the Septentrio Receiver. See `DiffCor Info Window` (Section 2.5.6 on page 49) for more details about the correction messages that are coming in.
- a LED which will blink green every time an external event is detected by the receiver. See `Expert Console`(Section 2.6 on page 68) Events tab if you would like to see the details about the external event or if you would like to count the external events.
- a LED indicating that external sensor measurements are being received by the Septentrio Receiver.
- an icon indicating the logging status. If the arrow on the icon is moving, this indicates that logging is currently taking place. If the icon is stationary then no logging is taking place.
- an icon indicating internal logging. If this icon is greyed out then your receiver does not support internal logging. If the icon is colored and stationary then the internal logging is available but there is no logging taking place. If the arrow on the icon is moving this means that internal logging is currently taking place.
- an icon indicating the current PVT mode of the Septentrio Receiver, see Figure 2.4-8 on the following page:
  (a) No PVT available
  (b) Stand-alone PVT
  (c) Differential PVT
  (d) Base Station
  (e) RTK Fixed Ambiguities
  (f) RTK Float Ambiguities
  (g) SBAS Enabled PVT
  (h) Moving-Base RTK with Fixed Ambiguities
  (i) Moving-Base RTK with Float Ambiguities
  (j) Precise Point Positioning (PPP) with Fixed Ambiguities
  (k) Precise Point Positioning (PPP) with Float Ambiguities
- an optional icon indicating the current integration mode of the position and velocity information shown by RxControl, see Figure 2.4-9 on the next page:
  (a) GNSS PV solution
  (b) Loosely-integrated PV solution
  (c) Extrapolated PV solution
  (d) No integrated PV solution

[2] For transmitted differential corrections the LED only blinks when they are transmitted on a serial connection or a connection that is actively used.

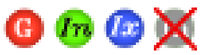
The icon is not shown when not relevant, e.g. when automatically choosing the GNSS PV solution when connected to a receiver that is not capable to perform integration.

- an optional icon indicating the current heading/attitude mode, see Figure 2.4-10:
  (a) GNSS Heading/Attitude with Fixed Ambiguities [3]
  (b) GNSS Heading/Attitude with Float Ambiguities [3]
  (c) Integrated Attitude
  (d) No Heading/Attitude
  The icon is not shown when not relevant.
- an icon indicating the connection state of RxControl.
- a text area for messages indicating the current actions of RxControl.
- a text area showing that an external reference clock is connected to the receiver or nothing if no such reference is there.
- a text area showing that a onePPS in pulse is available to the receiver or nothing if no such pulse is there.
- a text area showing the type of the currently connected receiver.
- a text area showing the marker name, if one has been set, otherwise 'SEPT'.



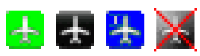
(a) (b) (c) (d) (e) (f) (g) (h) (i) (j) (k)

**Figure 2.4-8:** PVT Mode icons



(a) (b) (c) (d)

**Figure 2.4-9:** Integration Mode icons



(a) (b) (c) (d)

**Figure 2.4-10:** Attitude Mode icons

## 2.4.3 The menus and the toolbar of the RxControl window

The menu bar of RxControl's main window allows a user to control every operational aspect of the Septentrio Receiver, log data, open various graphical and tabular data views and get information about the status and capabilities of the Septentrio Receiver.

Please note that all menus related the Septentrio Receiver commands are created dynamically via the MIB (Management Information Base) downloaded from the receiver. RxControl communicates with the receiver following the binary SNMP (Simple Network Management Protocol) protocol and the command set as described in the MIB. Therefore it is impossible to describe in this section the exact look and contents of the receiver menus. Only the entries that are hard coded in RxControl are fully described here, so when your RxControl is connected to a receiver additional menu entries are

[3] Computed either from multi-antenna receivers or moving base configurations.

created. For more information about the commands of the receiver, please consult the ”Command Line Interface Reference Guide”.

#### 2.4.3.1 The `File` menu

The `File` menu allows you to access main functions of RxControl. It contains the following hard coded entries:

**Change Connection:** Allows to connect to another Septentrio Receiver or file (this option is discussed in more detail in Section 2.3 on page 22).

**Manage Connections** Allows to view, rename or delete existing connection files.

**Preferences:** Opens the preferences dialog. This dialog is divided into the following sections:

- The `Preference` page of this dialog allows the user to change the general settings of RxControl. These settings include the following:
  - Setting the update rate of the SBF messages transmitted by the receiver.
  - Position/Velocity/Attitude selection preference allows the user to specify if automatic, integrated or GNSS-only solution is to be used. The integrated solution can be shown when connected to a Septentrio Receiver offering integration capabilities (e.g. using input from an IMU). Which solution is shown, is determined by this preference. By default, “Automatic” is selected. In this mode, the integrated solution is shown when the connected Septentrio Receiver is capable of integration and if sensor integration is enabled in the Positioning Mode settings of the receiver. Otherwise, the “Automatic” mode causes the GNSS-based solution to be shown. “GNSS-based solution only” and “Integrated solution only” can be used to force the respective solutions to be shown.
  - Satellite Constellation Order can be selected. This will effect dialogs and displays which show satellite information grouped by constellations. Their order can be changed according to the selection of this preference.
  - File Management preferences allow experienced users to change default behavior for dealing with files used by RxControl. Caution is advised.
- The `Programs` section allows to point to a specific program to execute a given task. For example the user can select a preferred browser which will be used to open web pages through RxControl.
- The `Reference` section allows to change the reference positions which effect various plots. The True Antenna Position reference point effects the HPL/VPL plots, while the Topocentric Reference Position effects Topocentric Position on the main screen, ENU Time Plot and the Planimetric Plot.
- The `Formats` section the user can select the format of units which will be displayed.

**Display Diagnostic Report:** Opens a dialog displaying diagnostics about RxControl and the connected receiver (if any).

**Save MIB Description As:** Allows to save the MIB description currently used by the RxControl to build the receiver’s menu.

**Upload Script:** Allows to execute a script on the receiver. This script can be used to set the receiver into a certain configuration. Script files consist of a sequence of ASCII commands to be executed on the receiver. Lines starting with `#@` are not sent to the receiver, and can be inserted as comments. The script execution can be suspended for a specified amount of time by inserting a sleep statement as a comment. The duration is by default specified in milliseconds, but can also be specified in seconds or minutes; e.g.:

- `#@ sleep 1000`
- `#@ sleep 3 sec`
- `#@ sleep 2 min`

**Show Receiver Configurations:** Allows to see and save the different Septentrio Receiver configurations.

**Upgrade Receiver using FTP:** Used to upgrade the Septentrio Receiver over FTP connection. Please note that normal operation is not possible during upgrade. The upgrade is explained in detail in sections 2.8 on page 80.

**Upgrade Receiver using Current Connection:** Used to upgrade the Septentrio Receiver. Please note that normal operation is not possible during upgrade. The upgrade is explained in detail in sections 2.8 on page 80.

**Exit:** Exit the program

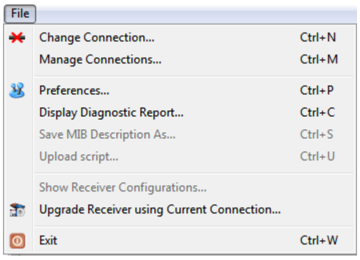



**Figure 2.4-11:** File menu

#### 2.4.3.2 The `View` menu and the `toolbar`

The `View` menu provides access to the tabular and graphical views which characterize the navigation solution and other aspects of the receiver operation. These views are explained in more detail in sections 2.5.1 on page 39 to 2.6 on page 68. These views can be invoked through the `View` menu or by clicking the corresponding icon in the `toolbar`. Clicking an icon for the first time will open the corresponding view, while clicking it again will bring it to the front.

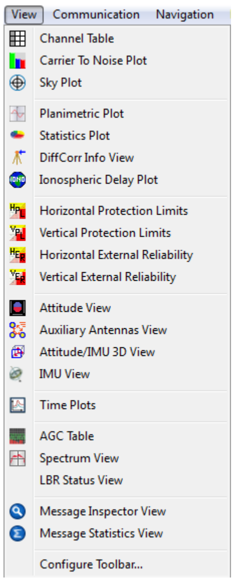



**Figure 2.4-12:** View menu

The entry `Configure Toolbar...` of the `View` menu allows the user to configure which buttons are available on the toolbar.

This menu also contains entries to select:

- the available Views
- the time frame in which the time is displayed on the `Time` tab (see Section 2.4.2.3.1 on page 29)
- whether or not the `toolbar` is shown

The dimension and location of each tabular view and plot is saved in the `rxcontrol.conf` file located in the *user_home_dir*`/.septentrio/` directory. At startup, RxControl reads this file and restores the sizes and relative positions of the views and plots. The same single file is shared in the case that more than one RxControl is opened on the same system.

#### 2.4.3.3 The `Communication` and `Navigation` menu

The Septentrio Receiver has an extensive command set which allows the user to control many aspects of the Septentrio Receiver operation. For more information about the commands of the receiver, please consult the "Command Line Interface Reference Guide". Mastering all the commands can take some time even for an experienced user, so in order to help the user, all receiver commands are made visible via RxControl menus. These menus are built dynamically on information provided by the receiver itself. The `Communication` menu contains the settings related to communication with the receiver while the `Navigation` menu contains the receiver parameters linked to its operation. All commands shown on these settings dialogs contain descriptive tool tips to assist the user and have a link to the online Septentrio Receiver manual.

Each time a settings dialog is shown, the receiver is queried for its current status so that the shown settings reflect the actual receiver status. When no reply is received an error is reported. At the bottom of each settings dialog there are always four buttons:

**Default:** Changes all the settings in the dialog to the default settings.
**Apply:** Applies the settings in the dialog without closing the dialog.
**OK:** Applies the settings in the dialog and closes the dialog.
**Cancel:** Closes the settings dialog without changing the receiver's settings.

If RxControl is connected to a AsteRx2DR, PolaRx3, PolaRx3e, PolaRx3G, PolaRx3eG, PolaRx3TR or PolaRx3eTR an extra 'Network settings...' menu option will be available in the `Communication` menu. Clicking on this option will open a wizard that allows the network setting of the connected device to be changed. The following network settings are available:

- Static or dynamic IP configuration. The receiver can be configured to use a static (fixed) IP address with gateway and netmask or to get a dynamic IP via the DHCP protocol.
- HTTP port number and password. The default HTTP port is 80 but can be changed if needed. A HTTP password can be set to restrict users from configuring the network settings of the receiver via HTTP.
- Telnet port number. The telnet port number can be changed from its default value of 28784.
- Ethernet device reset. This option will reset the Ethernet configurations of the receiver.

The wizard will finally save all new settings in the Septentrio Receiver.

***Note* 7.** The wizard will setup the baudrate of the link to 115200 bps, the serial-to-Ethernet board can go to higher rates in these units but this requires a manual configuration of both the Septentrio Receiver and the serial-to-Ethernet board. Please check your Septentrio Receiver product manual for further information.

#### 2.4.3.4 The `Tools` menu

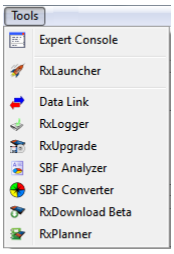



**Figure 2.4-13:** Tools menu

The `Tools` menu contains an entry to open the `Expert Console` (see Section 2.6 on page 68) to control the receiver via the ASCII command line interface, see the receiver's ASCII output or to visualize the NMEA stream.

The following entries allow to open the other programs that are delivered together with RxControl.

#### 2.4.3.5 The `Logging` menu

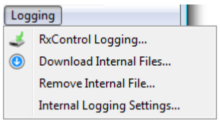



**Figure 2.4-14:** Logging menu

The RxControl program has a built-in logging functionality allowing to log the binary SBF stream (at the same rate as the one RxControl is using) and/or the ASCII NMEA stream (at a user programmable rate). Opening the `RxControl Logger` window (see Figure 2.7-1 on page 72) allows to specify the log file name and the SBF/NMEA messages which will be logged. If logging is in progress closing the window will not stop the logging. A logging icon in the status bar of RxControl main window will be disabled if logging is stopped and enabled if logging is in progress. For a more detailed description of the logger see Section 2.7 on page 72.

This menu entry also contains the Septentrio Receiver specific commands related to the internal logging if supported.

If internal logging is supported by your receiver and you would like to log SBF data to a disk on your receiver you must do so through `Communication | Output Settings | SBF Output`. In the `Ports` row select DSK1, then select SBF message to be logged, and finally set the SBF message output `Interval`. To manage your internal log files use the menu items which contain the word `Internal` in the `Logging` menu.

#### 2.4.3.6 The `Help` menu

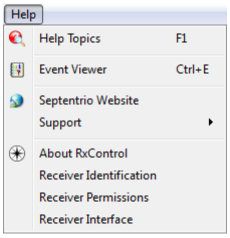



**Figure 2.4-15:** Help menu

**Help Topics:** This menu provides access to the integrated HTML help of the RxControl program.

**Event Viewer:** Opens a window showing an event log of the current session of RxControl. This window will log errors, warnings, and significant events which took place since RxControl was started.

**Septentrio Website:** Points your browser to the Septentrio website.

**Support:** Points your browser to the Septentrio support website for either RxControl or the connected receiver. The opened web page has already some filled in fields with details about the program or receiver.

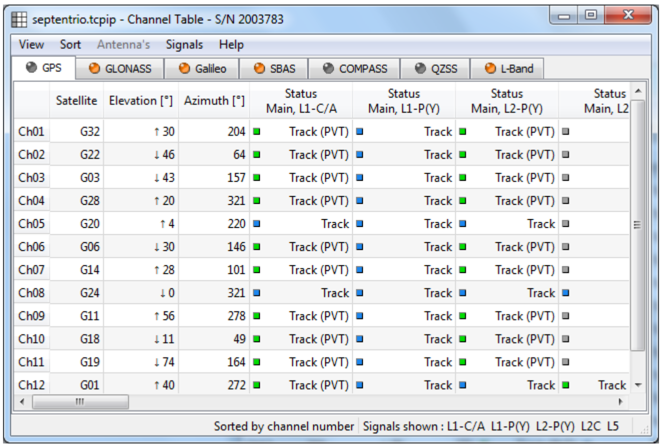
**About RxControl:** Shows a dialog with version information about the RxControl program.

Depending on the connected Septentrio Receiver other entries may appear here with information about the Septentrio Receiver.

# 2.5 RxControl's tabular and graphical views

## 2.5.1 Channel Table

The `Channel Table` can be opened using the `View | Views | Channel Table` menu entry or by clicking the corresponding icon in the `toolbar` of RxControl's main window. There is a tab for each system the receiver is capable of tracking (unavailable systems are greyed out). By default the columns of the channel table contain the real-time values for measurements made by the Septentrio Receiver. Each row contains measurements for a particular channel. If wanted the rows and columns can be swapped via the `Transpose` option in the `View` menu. Please note that the channel table adapts itself to the number of signals and antenna's available as reported by the receiver.




| | Satellite | Elevation [°] | Azimuth [°] | Status Main, L1-C/A | Status Main, L1-P(Y) | Status Main, L2-P(Y) | Status Main, L2 |
|---|---|---|---|---|---|---|---|
| Ch01 | G32 | ↑ 30 | 204 | Track (PVT) | Track | Track (PVT) | |
| Ch02 | G22 | ↓ 46 | 64 | Track (PVT) | Track | Track (PVT) | |
| Ch03 | G03 | ↓ 43 | 157 | Track (PVT) | Track | Track (PVT) | |
| Ch04 | G28 | ↑ 20 | 321 | Track (PVT) | Track | Track (PVT) | |
| Ch05 | G20 | ↑ 4 | 220 | Track | Track | Track | |
| Ch06 | G06 | ↓ 30 | 146 | Track (PVT) | Track | Track (PVT) | |
| Ch07 | G14 | ↑ 28 | 101 | Track (PVT) | Track | Track (PVT) | |
| Ch08 | G24 | ↓ 0 | 321 | Track | Track | Track | |
| Ch09 | G11 | ↑ 56 | 278 | Track (PVT) | Track | Track (PVT) | |
| Ch10 | G18 | ↓ 11 | 49 | Track (PVT) | Track | Track (PVT) | |
| Ch11 | G19 | ↓ 74 | 164 | Track (PVT) | Track | Track (PVT) | |
| Ch12 | G01 | ↑ 40 | 272 | Track (PVT) | Track | Track | Track |

**Figure 2.5-1:** Channel Table

The following information can be displayed:

The satellite PRN number or slot number is preceded by either one of the following:

- "**G**" for GPS satellites
- "**R**" for GLONASS satellites
- "**S**" for SBAS satellites
- "**E**" for Galileo satellites
- "**C**" for BeiDou satellites
- "**J**" for QZSS satellites

The **Elevation and Azimuth** angles of the satellite characterize the location of the satellite relative to the local horizontal plane. The Azimuth angle is measured from geographic North in positive towards the East. The Elevation angle defines the angle between the local horizontal plane and the direction to the satellite. Both angles are measured in degrees. The Elevation angle is preceded by an up (↑) or down (↓) arrow indicating whether the satellite is rising or setting. When the arrow is absent, the Septentrio Receiver has not been able yet to determine the variation of the Elevation. Both angles can be visualized in the Sky Plot (see Section 2.5.3 on page 42).

The **State** (for each available signal and antenna) displays the current tracking status of the satellite's signals. The affix `(PVT)` indicates whether a particular satellite is used in the navigation solution. The icon giving a graphical representation of the state follows the same color conventions as explained in Section 2.4.2.2 on page 28.

The **Health** status of the satellite's signals as derived from the decoded navigation message. It can take the values `Healthy`, `Unhealthy` or `Unknown`.

The **Carrier-to-Noise Ratio** characterizes the quality of the different received satellite signals for each available antenna and is expressed in dB-Hz. These values are also visualized in the Carrier to Noise Ratio Plot (see Section 2.5.2 on the following page).

The **Lock time** indicates for how long each satellite's signal has been continuously tracked on an antenna and is expressed in hours, minutes, and seconds.

The **Cumulative Loss-Of-Continuity** counter starts at zero at receiver start-up, and is incremented at each initial lock after signal (re)acquisition, or when a cycle slip is detected.

The **Doppler** is a measure of the velocity of the satellites relative to the antenna and is expressed in Hz. A positive value for the Doppler shift indicates that a satellite is approaching the receiver, while negative values indicate that a satellite is moving away from the receiver.

The **Range** measured by the code correlators of the receiver represent the pseudodistances to the satellites in meters.

The **SBAS corrections** is a group of columns which allow you to visualize the `GEOCorrections SBF` block from the receiver. It contains all the corrections as used in the `PVT` computation. This group of columns is only displayed when the receiver has set an `SBAS PVT` mode. The next corrections are displayed:

(a) **SBAS Range Corr**: The applied pseudorange correction based on the fast correction data received in `MT02-MT05` or `MT24`
(b) **Fast Corr Age**: The Age of applied fast correction
(c) **Orbit Delta-X**: X-component of applied orbit correction based on the long term correction data received in `MT24` or `MT25`
(d) **Orbit Delta-Y**: Y-component of applied orbit correction based on the long term correction data received in `MT24` or `MT25`
(e) **Orbit Delta-Z**: Z-component of applied orbit correction based on the long term correction data received in `MT24` or `MT25`
(f) **SV Clock Corr**: The satellite clock correction based on the long term correction data received in `MT24` or `MT25`
(g) **Long Term Corr Age**: Age of applied long term correction
(h) **Iono Pierce Point Lat**: The Latitude of ionospheric pierce point
(i) **Iono Pierce Point Lon**: The Longitude of ionospheric pierce point
(j) **SBAS Iono Delay**: The slant ionospheric delay at the ionosphere pierce point based on the data received in MT18 and MT26
(k) **Iono Corr Age**: Maximum of the of the ionospheric correction age at each of the grid locations used for the interpolated delay
(l) $\sigma$ **FLT**: The standard deviation of fast and long-term corrections (used for XPL computation)
(m) $\sigma$ **UIRE**: The standard deviation of ionospheric delay corrections (used for XPL computation)
(n) $\sigma$ **AIR**: The standard deviation of unmodeled receiver errors, such as tracking noise and multipath (used for XPL computation)
(o) $\sigma$ **TROPO**: The standard deviation of tropospheric delay corrections (used for XPL computation)

The **RAIM Statistics** is a group of columns that shows the detailed results of the RAIM algorithm which ensures the integrity of the computed position solution, provided that sufficient satellites are available. The next values are displayed:

(a) **e_i Code**: The Code a-posteriori measurement residual
(b) **w_i Code**: The absolute value of the w-test statistic for the Code
(c) **MDB Code**: The Minimal Detectable Bias for the Code
(d) **e_i Phase**: The Phase a-posteriori measurement residual
(e) **w_i Phase**: The absolute value of the w-test statistic for the Phase
(f) **MDB Phase**: The Minimal Detectable Bias for the Phase
(g) **e_i Doppler**: The Doppler a-posteriori measurement residual

(h) **w_i Doppler**: The absolute value of the w-test statistic for the Doppler
(i) **MDB Doppler**: The Minimal Detectable Bias for the Doppler

The **Nav. Page Decoding Statistics** is a group of columns that shows the some statistics about the decoding of the received navigation pages. The statistics begin when the connection to the receiver was established. The following values are displayed:
(a) **# Pages**: The number of received pages
(b) **# CRC Errors**: The number of received pages with CRC errors
(c) **Viterbi Count**: The sum of the Viterbi decoder error counts for all received pages

The **Galileo | Available Galileo Services** is an item that is only available for the Galileo tab. It shows the available services for the satellite

#### 2.5.1.1 Channel Table Menu

**View** The `Transpose` option allows to swap the rows and columns of the channel table.
It also contains the option to show/hide specific items from the tabular view, a `Print` entry to make a printout of the table and a `Close` option to close the window.

**Sort** This menu allows to choose between sorting according to the PRN number or according the channel number.

**Antenna's** If the receiver has more than one antenna, this menu allows to show/hide the items for an antenna.

**Signals** Allows to show/hide the different signals for each available satellite system.

### 2.5.2 Carrier to Noise Ratio Plot

The accuracy of the navigation solution depends on several factors, such as the observed geometry of the constellation and the quality of the received signals. The quality of the signals can be expressed as the ratio of the power level of the received signals to the ambient noise level and is called the **Carrier-to-Noise Ratio** ($C/N_0$). Carrier-to-Noise Ratios are expressed in dB-Hz and the observed values are influenced by the Elevation angles of the satellites and local conditions, such as multipath effects. High levels of the Carrier-to-Noise Ratio indicate good tracking of the received satellite signals. The PVT processing algorithm of the Septentrio Receiver assigns weights to the observations based, among other criteria, on these ratios. The `C/N0 Plot` can be invoked with the `View | Views | Carrier to Noise Plot` menu item or by clicking its icon on the `toolbar` of RxControl.

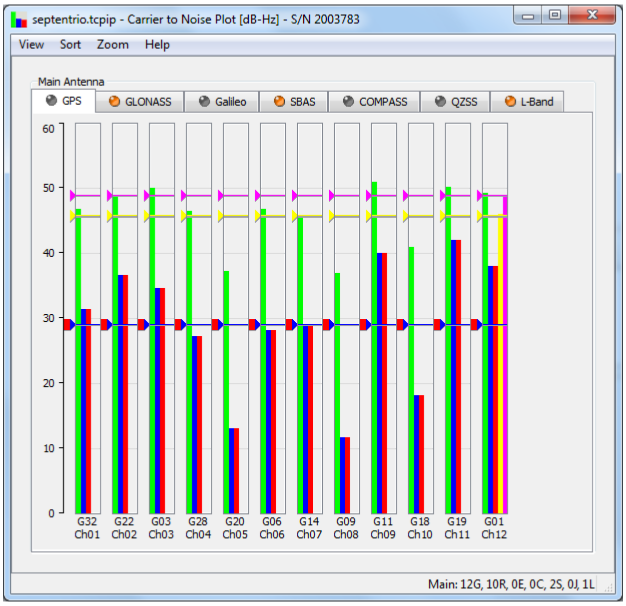



**Figure 2.5-2:** Carrier To Noise Plot

The carrier to noise plot (see Figure 2.5-2) displays the observed Carrier-to-Noise Ratios of the Septentrio Receiver for all the tracked satellites per system. The color bars represent the $C/N_0$ values for all the signals of a satellite. Since the number of bars that are available for each system is depended on the capabilities of the receiver the bars have a tool tip that describes which bar represents which signal. The bar color itself does not have any meaning. Within one channel there may be different colored bars representing different signals.

### 2.5.2.1 Carrier to Noise Ratio Plot Menu

- **View**
  - With **Tabbed Layout** and **Vertical Layout** you can select to have either a tab for each satellite system, or to show them all under each other. This can be useful for system comparison purposes.
  - **Show Labels** shows or hides the labels [4] above each bar indicating the current Carrier-to-Noise value represented by that bar.
  - **Show Average** show or hides lines with the average for each signal
  - **Print** allows to make a printout of the plot
  - **Close** closes the plot.
- **Sort** This menu allows to choose between sorting according to the PRN number or according the channel number.
- **Zoom** This menu allows to set the zooming factor of width of the bars. 100% corresponds to the width needed to put the labels under the set of bars for one satellite. Zooming in will make the bars wider.

## 2.5.3 Sky Plot

The `Sky Plot` graphically represents the satellites in view in the local topocentric hemisphere. The outer black circle represents the local horizon with true geographic North pointing to the top of the

[4] When the zoom factor is too small so that the labels are no longer readable, this menu item is greyed out and the labels are no longer visible. Zooming in will enable them again.

figure. The grey radial lines represent successive lines of equal Azimuth (from 0° → 360°), while the concentric circles represent increasing values of equal Elevation (from 0° → 90°). The blue circle represents the current elevation Tracking mask angle of the Septentrio Receiver and the green one represents the current elevation PVT mask angle. The Septentrio Receiver will not search for satellites with an Elevation below the Tracking mask angle and it will not use tracked satellites with an Elevation below the PVT mask angle in the PVT solution.

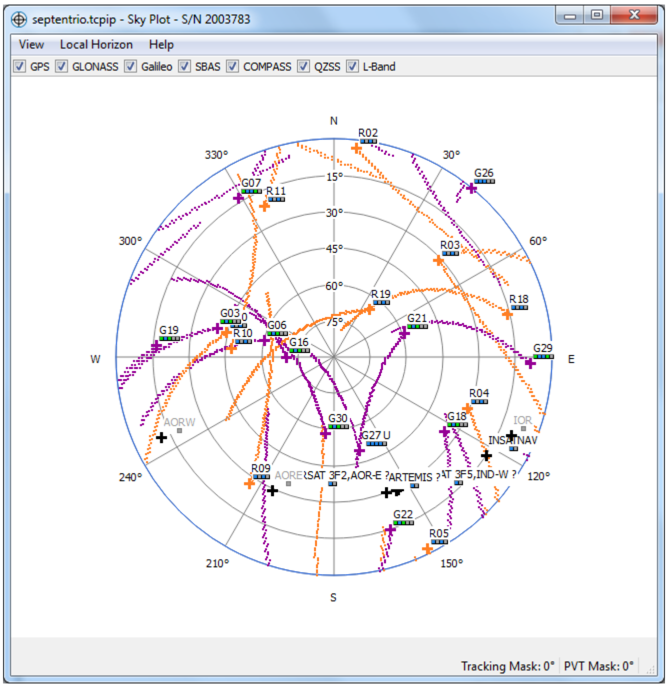



**Figure 2.5-3:** Sky Plot

Each satellite in tracking is represented by a colored plus sign (+) in the `Sky Plot`. The satellite PRN number or slot number, preceded by a letter indicating the constellation:

- "**G**" for GPS satellites
- "**R**" for GLONASS satellites
- "**S**" for SBAS satellites
- "**E**" for Galileo satellites
- "**C**" for BeiDou satellites
- "**J**" for QZSS satellites

The status of the different signals of the satellite appears next to the cross.

The color of the cross can either represent the system to which the satellite belongs or the current state of the satellite depending on the user's preference. When representing the system the possible colors are:

**Dark Purple** identifies a GPS satellites
**Black** identifies an SBAS satellites
**Blue-Purple** identifies an Galileo satellites

When representing the satellite status the same colored square box is used as on the status indicators in RxControl's main window (see Section 2.4.2.2 on page 28 for color definition).

The satellite PRN number can be followed by either a question mark (**?**), indicating that no health status for the satellite has been decoded, or the letter **U** when the satellite is set to unhealthy. In absence of either indicator, the satellite's status is healthy.

The history of the satellite passes can be shown by tracks (with the same color as for the crosses). For a description of the possible user settings related to the satellite tracks see Section 2.5.3.1.

The **Local Horizon Mask** (shown by the light purple line in Figure 2.5-3 on the preceding page) is disabled by default, but it can be invoked using the `Show Local Horizon` item in the menu (see Section 2.5.3.1). The Local Horizon Mask is a line, which connects for each Azimuth, the lowest Elevation angles at which satellites were visible. At start-up, the Local Horizon Mask is not defined, but the more tracked satellites pass overhead, the clearer and clearer the view of the local obstructions blocking the satellite's signals gets. In order to get an accurate representation, the Local Horizon feature must be enabled for at least one day of continuous data collection. Local Horizons can be stored as files with the extension `.lhm`. Later these files can be opened to continue the accumulation of the data.

### 2.5.3.1 Sky Plot Menu

- **View**
  - **Show Tracking Elevation Mask**: If enabled the Tracking Elevation mask is displayed.
  - **Show PVT Elevation Mask**: If enabled the PVT Elevation mask is displayed.
  - **Show All Visible Satellites**: Defines whether satellites that are not tracked (and of which the Elevation and Azimuth is known) are or aren't displayed on the `Sky Plot`.
  - **Show Satellites in Search**: Defines whether satellites that are not tracked but are searched for (and of which the Elevation and Azimuth is known) are or aren't displayed on the `Sky Plot`. This option is only available if **Show Tracking Elevation Mask** is unchecked.
  - **Show Satellites Labels**: Defines whether to show the satellite number or its name or nothing.
  - **Show Signal Status Indicators**: Defines whether the satellite's signal indicator is shown or not.
  - **Show Tracks**: Defines whether the history of the satellite passes is shown or not.
  - **Clear Tracks**: Clears the history of the satellite passes.
  - **Colour Tracks by Satellite System**: The tracks shown on the `Sky Plot` (if enabled) follow the system color of the satellites.
  - **Color Tracks by Signal Status**: The tracks shown on the `Sky Plot` (if enabled) follow the status color of the satellites.
  - **Print**: Prints the `Sky Plot`.
  - **Close**: Closes the `Sky Plot`.
- **Local Horizon**
  - **Enable Local Horizon**: If enabled the Local Horizon is displayed.
  - **Clear Local Horizon**: Clears the Local Horizon.
  - **Save Local Horizon**: Allows saving of the Local Horizon so that it can be reloaded later.
  - **Save Local Horizon As**: Allows saving of the Local Horizon to a specified file so that it can be reloaded later.
  - **Open Local Horizon**: Allows reopening of the Local Horizon that has been previously saved.

#### 2.5.3.2 Sky Plot Toolbar

The toolbar contains a checkbox for all the satellite systems. Depending on the capabilities of your Septentrio Receiver, one or more systems can be disabled meaning that your receiver cannot use those systems.

If the checkbox for a system is selected the satellites/track history of that system are visualized on the `Sky Plot`, if deselected the satellites/track history are not shown for that system.

### 2.5.4 The Planimetric Plot

The planimetric plot graphically represents the planimetric position reported by the Septentrio receiver. The displayed position is (a) either the projection coordinates $(E, N)$ obtained using the conformal direct Mercator projection (See appendix B.2 on page 196), with the grid displaying either the originating geodetic coordinates $(\varphi, \lambda)$ or the projection coordinates $(E, N)$, or (b) the topocentric coordinates $(E, N)$ determined, relative to a local topocentric reference station (See Section 2.4.3.1 on page 34 and Section B.3 on page 197).

Figure 2.5-4 below shows the planimetric plot main screen. Beneath the **menubar** of the planimetric

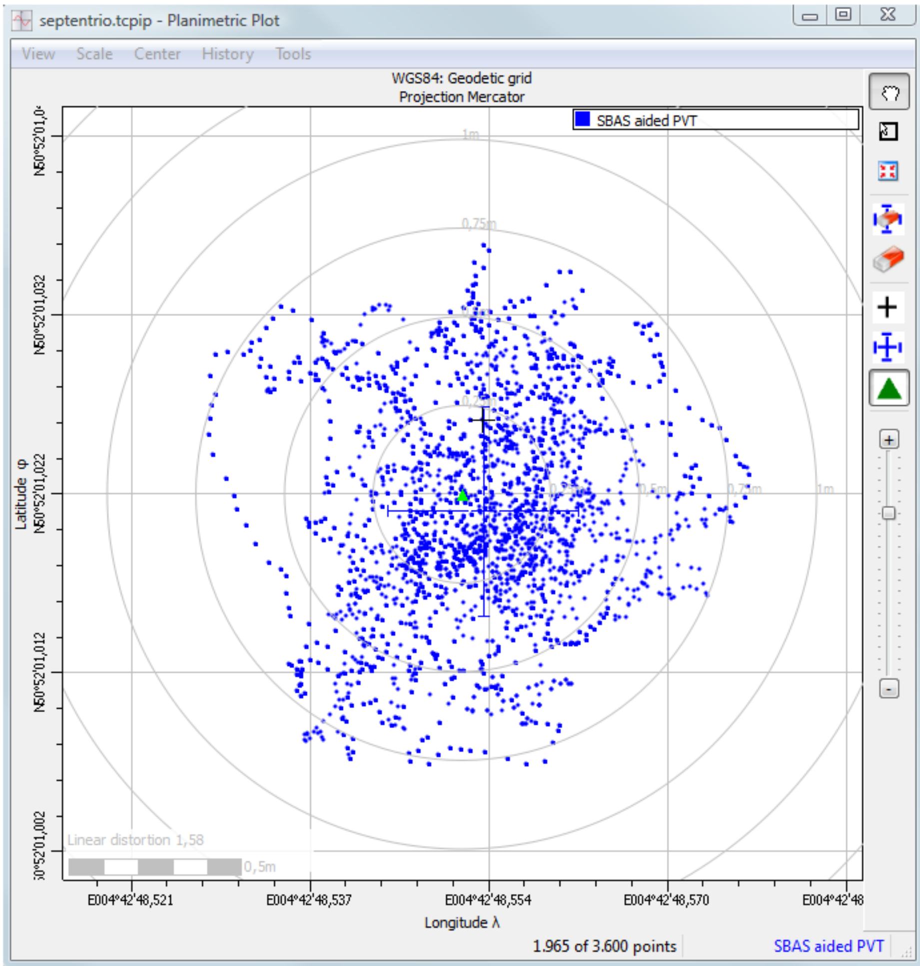



**Figure 2.5-4:** Planimetric Plot

plot, the **title** indicates the current ellipsoid and displayed coordinate grid. When in topocentric coordinates display mode, the used topocentric reference position is displayed. At the right of the plot, the

**toolbar** groups action buttons allowing to navigate around the plot, to perform zooming operations or to center the plot around specific points. The **statusbar** is used for relaying information to the user.

### 2.5.4.1 The main areas of the Planimetric Plot

The **grid** of the planimetric plot displays the position according to the current selected view (See Section 2.5.4.2). The distance between the main ticks are determined by the scale factor of the plot. The planimetric plot is capable of showing either the GNSS-only solution or an integrated solution. Whether the GNSS-only or integrated solution is shown, is determined by a user preference as set in the preferences dialog, which can be opened by selecting the `Preferences...` item in the `File` menu of the main application window. An integrated solution can only be shown if the Septentrio Receiver has integration enabled.

The **toolbar** of the planimetric plot gives fast access to several actions subdivided into 4 categories. The first action group allows (a) to drag the plot by holding the left mouse button pressed down, (b) to zoom to a specific rectangular area (the start point and size of this area is displayed in the statusbar), and (c) to zoom to the limits of the plot by adjusting the center point and the scale used. The second action group allows to clear the mean position or to clear the entire plot. The latter action also resets the mean position. The third action group allows to center the plot on the current position, the mean position or the local topocentric reference point. Finally, the vertical scaling slider performs zooming actions on the plot. During zoom-actions, the statusbar displays the selected scale.

The **statusbar** permanently displays the total number of displayed points, the current size of the plots history and the PVT mode of the current position. Punctual information is temporally displayed in the statusbar. If the current position is calculated using integration, this is indicated in the status bar by prepending “Integrated” to the current PVT mode. Moreover, if there is temporarily no GNSS PVT solution, and the current position is an integrated position calculated through extrapolation, the age of the last GNSS solution is shown in the status bar (instead of the current PVT mode).

In the lower left corner of the plot, an optional **scale indicator** displays the current scale. When the projection coordinates are displayed, the linear distortion corresponding to the center point of the plot is shown above the scale indicator.

The upper right corner of the plot can optionally display the **legend** of the plot. The legend indicates the meaning of the color of the positions. Depending on the current settings, this color can either indicate the GNSS PVT mode or the integrated mode.

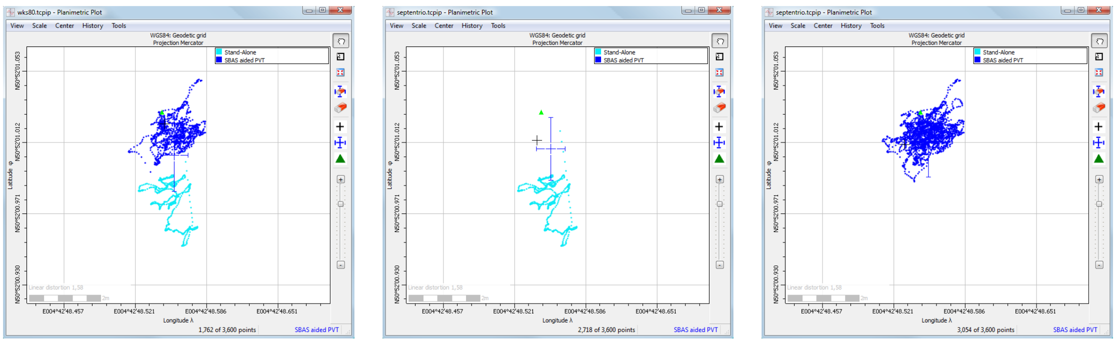
### 2.5.4.2 Planimetric Plot Menu

- **View**
  - Selection of the used grid. Possible values are :
    (a) **Geodetic Grid** or **Cartographic Grid** plot the positions according to the Mercator projection (See Section B.2 on page 196) coordinates $(E, N)$. When in **Geodetic Grid** mode, the tick values represent latitude $\varphi$ versus longitude $\lambda$ coordinates. In **Cartographic Grid** mode, the tick values correspond to the Mercator coordinates north $N$ versus East $E$.
    (b) **Topocentric Grid** displays the local planimetric topocentric coordinates north $N$ versus east $E$ referenced to the local topocentric reference point.

    In both grid modes, the distance between the main tick marks of the axis is based on the selected scale.

A top of these grids, a **circular** or **distance grid** can be displayed. The center point of these concentric circles is determined by the selection made in the **Center—Circular Grid Center** menu. The radius of the consecutive circles depends on the selected scale.

- Selection of how the points are plotted. Possible values are :
  (a) **dot**,
  (b) **pixel**,
  (c) **cross marker**.
  If wanted the points can be connected with a **solid line**.
- Different information :
  (a) **Dispersion Ellips :** the planimetric Dispersion Ellips represents the horizontal precision of the position,
  (b) **Mean Position** displays the mean position of all points since startup of
  (c) **Reference Position** displays the position of the local reference point (See Section 2.4.3.1 on page 34) by a green upward triangle.
  (d) **Base Station Position** displays the position of all base stations (See Section 2.5.6 on page 49) sending out differential corrections by a grey downward oriented triangle. The triangle is accompanied by the identification number of the base station.
- The **View Legend** selector allows to display the legend for the colors currently displayed.
- The dynamic **Select PVT Modes** sub menu allows to select which PVT modes are to be displayed (See Figure 2.5-5). The sub menu always contains the buttons **All** and **Current** displaying respectively all PVT modes or just the current PVT mode. The user further has the possibility to select a specific PVT mode allowing a closer inspection of the data calculated by the receiver.



(a) Display of all modes (b) Display of stand-alone modes (c) Display of SBAS modes

**Figure 2.5-5:** Selective display of PVT modes

- The **Legend Mode** sub menu allows to specify whether the positions must be colored according to the GNSS PVT mode or the integrated mode. Possible choices are :
  (a) **Automatic**: if the last entry in the plot corresponds with a GNSS-only solution, color according to the GNSS PVT mode; if the last entry corresponds with an integrated solution, use the integrated mode
  (b) **GNSS PVT Mode**: the legend and the colors represent the GNSS PVT mode.
  (c) **Integrated Mode**: the legend and the colors represent the integrated mode.
- The **Mouse Tracking** selector displays the position of the mouse cursor using the selected grid in the statusbar. It is advisable not the leave this option on all the time due to high CPU consumption.
- **Close** closes the Planimetric plot.

• **Scale**
- This menu item allows to set the scale of the Planimetric plot. A quick access to the scale of the planimetric plot is provided by the vertical scaling slider in the toolbar.

- The **Show Scale Indicator** allows to toggle the visibility of the scale indicator and the linear distortion, calculated at the current center point, drawn inside the plot

- **Center**
  - The **Plot Center** submenu allows to center the plot around either the
    (a) **Current** Position
    (b) **Mean** Position
    (c) **Reference** Position
    (d) **Middle Point** of the plot
    (e) the center point of a **Selected Area**.
    The first three items are also accessible via the toolbar.
  - The **Circular Grid Center** submenu allows to center the circular grid (when enabled) around either the
    (a) **Current** Position
    (b) **Mean** Position
    (c) **Reference** Position
    (d) **Middle Point** of the plot
    (e) the center point of a **Selected Area**.
- **History**
  The planimetric plot accumulates the data points in a buffer. The user can manipulate the buffering of data in several ways :
  - The **Size** of the buffer can be adjusted between 3 600, 7 200, 36 000, 21 600 or 43 200 points.
  - When the buffer fills up the oldest data points will be discarded. The number of points discarded are selected using the **Shift Out** option expressed as a percentage (10%, 20%, 25% or 50%) of the history **Size**. For example, if **Shift Out** is 50% and **Size** is 3 600 points, then after filling up the data buffer, the oldest 1 800 points will be removed from the plot.
  - The **Decimation** is a useful feature especially at high data rates. When No Data Decimation is selected, all points reported by the receiver will fill up the data buffer at the selected update rate. For high update rates, data decimation allows to plot only selected points. Two options are available :
    (a) 1 out of $n$ points ($n = 2, 5, 10$ or 20) selects the last point out of $n$ points generated by the receiver.
    (b) mean from $n$ points ($n = 2, 5, 10$ or 20) displays the mean value from the last $n$ points generated by the receiver.
  - At any moment, the user can reset the mean position by selecting the **Clear Mean Position**. This position is based on all points generated by the receiver from the moment that connection with the receiver is established.
  - At any moment, the history of the plot can be reset using the **Clear Plot** option.
- **Tools**

  - **Drag the plot** allows to drag the plot by holding pressed the left mouse button.
  - **Zoom to Area** performs a zooming operation to a selected rectangular area at the release of the left mouse button.
  - **Zoom to Limits** adjusts the scale and center point of the plot to adjust the plot to the limits of collected points.

  These items have a quick access button in the toolbar of the planimetric plot.

### 2.5.5 Statistics Plot

The `Statistics Plot` graphically represents the number of occured PVT modes and PVT errors for every epoch.

In a pie chart this plot shows the number of epochs in each PVT mode. Likewise it shows the number of epochs for each PVT error. All occured PVT modes and errors are displayed in the legend on the right side of the pie charts. Also the percentage of epochs in each PVT mode/error is shown.

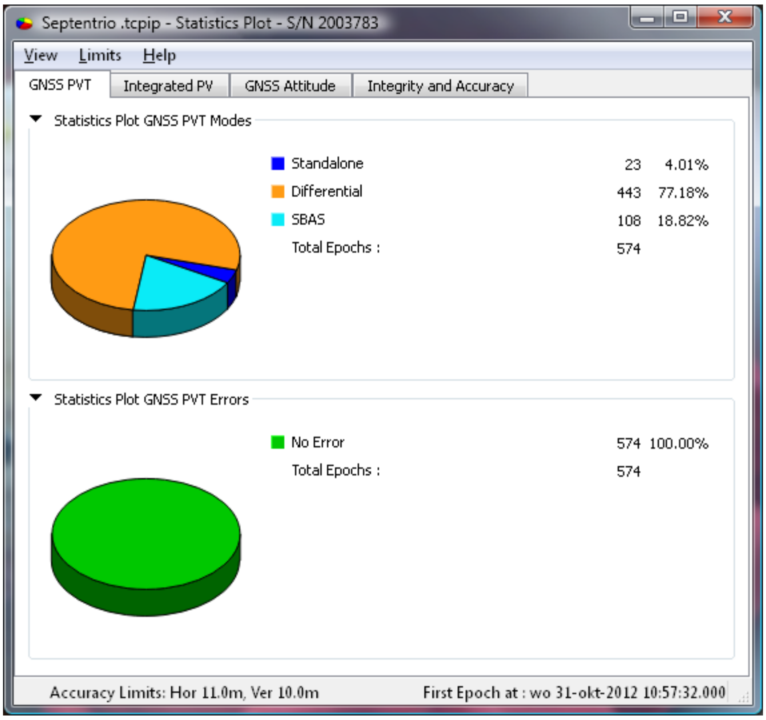



**Figure 2.5-6:** Statistics Plot

### 2.5.6 The DiffCorr Info window

When the Septentrio Receiver is operated in rover mode, it receives differential corrections from nearby base stations or reference stations. The stationary or moving base stations model the real-time GPS error sources and send differential corrections to nearby users according to an internationally agreed format. The Septentrio Receiver supports Radio Technical Commission for Maritime Services (RTCM), versions 2.3 and 3.0, and Compact Measurement Record (CMR) data transmission standards.

When either of these messages is enabled, the user can examine information about the base station and the status of either of the received differential messages in the `DiffCorr Info` window (Figure 2.5-7 on the next page).

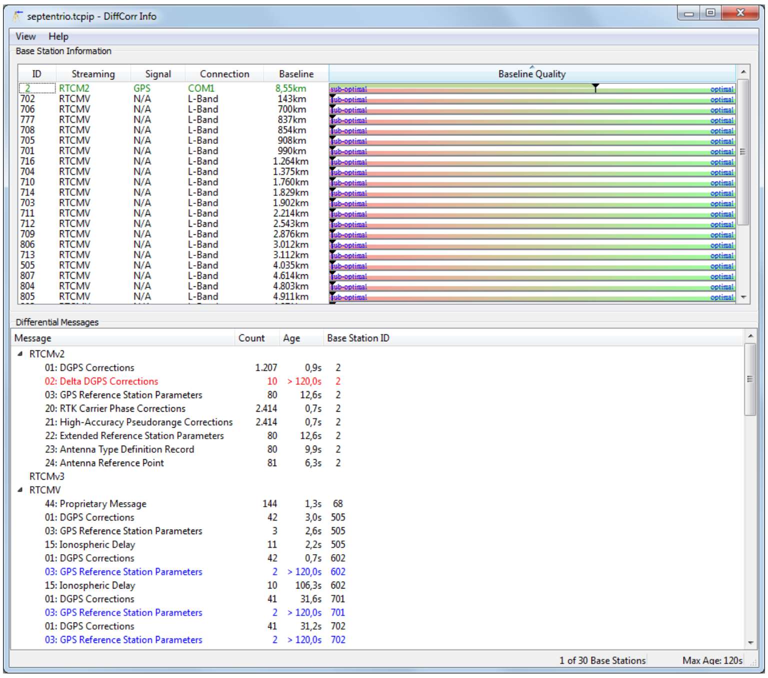


**Figure 2.5-7:** The `DiffCorr Info` window

The upper part of the `DiffCorr Info` window is invariable with regard to the selected data transmission standard for the differential corrections. This part displays information about the base stations that are transmitting differential correction data to the receiver. For each base station a row displays :

- its identification (ID),
- the standard (RTCMv2.3, RTCMv3.1 or CMR) used for streaming the differential data,
- the system for which differential corrections are made available. This information is only available for base stations used for the differential PVT calculations of the receiver position. These base stations are displayed in green.
- the connection on which the differential correction data are received,
- the length of the current baseline. The baseline can be prefixed with the ~ sign (approximation sign). In that case the baseline has been calculated by RxControl using the rover position and the position of the base.
- and a baseline quality indicator. This indicator is a measure for the spatial correlation of error sources between the base station and the rover receiver. Small baselines are considered optimal while longer baselines tend to provide sub-optimal corrections. The baseline quality indicator compares the current baseline length to 250 km when differential code corrections are used. For RTK operations, the length is compared to a maximum separation of 25 km. The baseline also shows information about the startpoint and endpoint of the baseline. The baseline can point to the antenna reference point or to the antenna phase center.

A base station that is used by the receiver for its PVT calculation is highlighted in green color. A base station for which no up to date corrections have been received is rendered in gray. Sorting the table can be done by clicking on the header of the column that should be used for sorting.

The lower part of the `DiffCorr Info` window represents the type, the number and age of messages received and identifies the base station which generated the differential data. The age of the messages is updated each 0,1 s. When the value of the age of a message exceeds the `Maximum Correction Age`, which defaults to 20 s, the corresponding line is highlighted either in red color or in a blue color. A red highlight indicates that the receiver is no longer using these messages since they exceeded the temporal decorrelation limit imposed by the `Maximum Correction Age` setting. Messages highlighted in blue have information which does not decorrelate in time and therefore are still used by the receiver.

The status bar of the `DiffCorr Info` window displays the number of base stations used for PVT calculation out of the total number of base stations available and the current value of the `Maximum Correction Age` setting.

### 2.5.7 The SBAS Ionospheric Delay Plot

The ionosphere, located between ±70 and ±1000 km above the earth surface, is one of the major error sources in GNSS navigation. The ionosphere causes the carrier phase to advance and the code to be delayed. This delay directly contributes to the measured code ranges (see Section 2.5.1 on page 39) and has to be modeled by the navigation algorithm.

Augmentation systems, like Europe's EGNOS (*European Geostationary Navigation Overlay System*) or USA's WAAS (*Wide Area Augmentation System*), monitor the ionospheric delay of the code measurements and calculate the vertical ionospheric delays for grid-points within the coverage area. The grid and the corresponding ionospheric delays are transmitted to the users via geostationary satellites.

In the ionospheric plot the received ionospheric vertical delays are represented by a color code on the world map. The value for each color code is mapped on the continuous color scale. The lower limit of this scale is always set to 0 meter, while the upper limit can be adjusted by the user via the `Max Value` entry in menu on the right side of the plot.

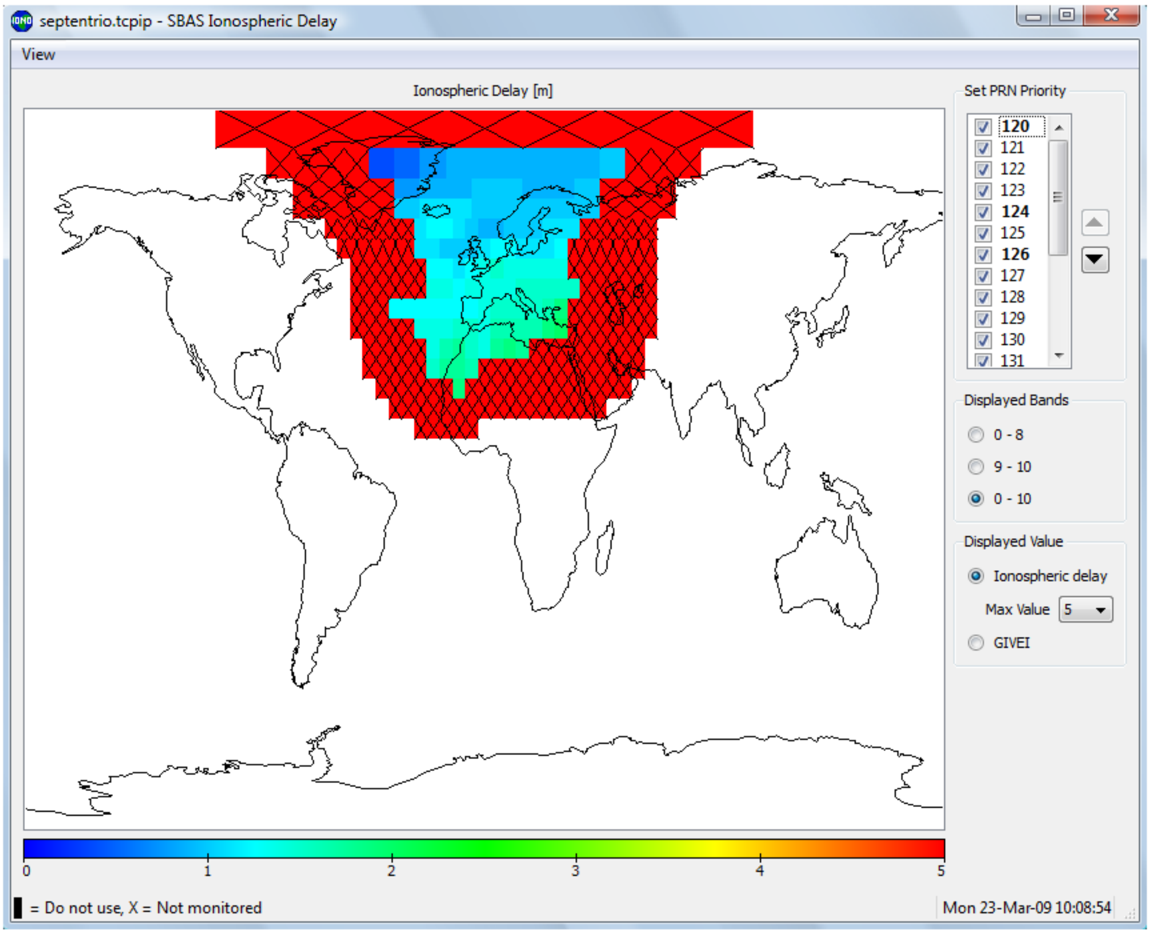



**Figure 2.5-8:** SBAS Ionospheric Delay Plot

The cells with a **black cross** indicate that these areas are not monitored. The ionospheric delay error for these points can be greater than 45 meters, and the use of these values is not recommended. Cells for which no vertical ionospheric delay is available are totally black, signaling a `Don't Use` status for these areas.

On the right side of the ionosphere plot, the list of `SBAS` PRN's allows the user to choose the provider of ionospheric delay. If ionospheric information has been received for a specific `SBAS` PRN satellite, then `PRN` number will be displayed in bold text. The user may select or de-select any `PRN` as preferred. This allows the user to differentiate the information specially when the ionosphere is being monitored by more than one `PRN` in an specific point. The user can also specify the order in which the `PRN`'s are drawn. `PRN`'s on top of the list are drawn on top of the lower ones. Click on the arrows on the right hand side of the PRN numbers to move the selected PRN up or down.

The user can also select which bands are displayed:

**0 - 8** : only the vertical bands are shown
**9 - 10** : only the horizontal bands are shown
**0 - 10** : both the vertical and horizontal bands are shown, the horizontal ones are drawn on top of the vertical ones

In the bottom group box the user can select for the ionospheric delay itself (together with the upper limit of the scale) to be painted or for the GIVEI to be painted.

### 2.5.8 Stanford Plots

***Note* 8.** Inspiration for plots: Courtesy of WIDE AREA DIFFERENTIAL GPS LABORATORY at STANFORD UNIVERSITY (http://waas.stanford.edu/)

In navigation and particularly for the vertical guidance of an aircraft on Precision Approach (PA), the four concepts which enter almost every specification are **accuracy**, **integrity**, **continuity**, and **availability**. While these are not new, the way in which they are expressed is very different for GNSS systems as opposed to more conventional systems such as Instrument Landing System (ILS).

Accuracy, the first concept, is quite intuitive. It is measured as the difference between the measures and the true positions. Any navigation aid has its inherent accuracy. The SBAS implementation is obliged to quantify the accuracy of wide-area differentially corrected navigation solution. Accuracy is most critical in the vertical dimension for aircraft precision approach. Moreover, in satellite navigation the vertical dimension is the most difficult due to inherently weaker vertical geometry.

**Accuracy** or more specifically, **Navigation Sensor Error** (NSE) is defined as the difference between the position estimated by the navigation sensor and the true position of the aircraft which is only exceeded 5% of the time in the absence of system failures.

Two other concepts, **integrity** and **continuity**, address performance of the navigation system in the presence of failures or rare natural events. Integrity measures the ability of the system to protect the user from inaccurate position estimates in a timely fashion. Continuity measures the navigation system's ability to complete an operation without raising an alarm. These are the instantaneous metrics of flight safety and are computed at 1 Hz.

**Integrity risk** is defined as the probability that the NSE exceeds either the horizontal alert limit or vertical alert limit (HAL and VAL) and the navigation system alert is silent beyond the time-to-alarm. On the other hand, **continuity risk** is defined as the probability that the navigation system alarm will drop during the operation (precision approach in this case). These are competing constraints on the system; integrity failures shall not lead to Hazardously Misleading Information (HMI) favoring a small alert limit but continuity failures lead to False alarms favoring a large alert limit.

The final metric for the SBAS or GNSS system is **availability** which emphasizes the operational economy of the navigation system. It is computed as the fraction of time the SBAS system is providing position fixes to the specified level of accuracy, integrity and continuity. The Minimum Operational Performance Standards (MOPS) for SBAS specify the computation of the vertical protection level (VPL) and horizontal protection level (HPL) of the differentially corrected navigation solution which must be met at a probability of 99.99999%. Thus the true error must not exceed the protection level more than once in $10^7$ seconds. If the computed protection level exceeds the corresponding alert limit then the alarm is raised and the operation cannot proceed. If the operation has already begun this condition is a continuity breach and a missed approach must be conducted. Otherwise the system is declared unavailable for that epoch.

Figure 2.5-9 displays the HPL value, as transmitted by the SBAS satellites, versus the calculated error bounds for the corrected PVT solution. The true error is calculated by making the difference between the true horizontal position of the antenna and the computed receiver's horizontal position. The points on the histogram are drawn with a color code representing the number of epochs that that specific bin of HPL–error occurred.

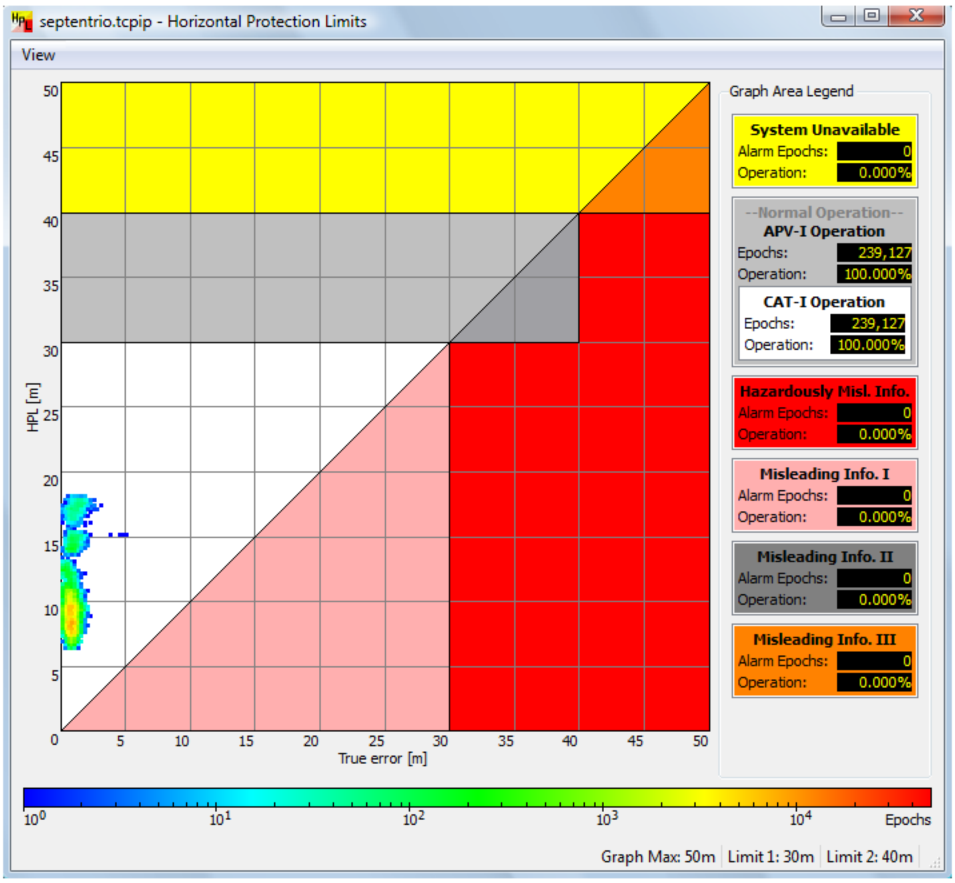



**Figure 2.5-9:** HPL Plot

The plot is divided in several zones:

The **Normal Operation**, is divided in two subzones, which are set corresponding to the upper limits specified by HAL1 and HAL2. These two alarms allow you to specify 2 separate categories

for Normal Operation. The points in the **Normal Operation** zone have a HPL value which is larger than the true horizontal error.
-The first limit is formed by the HAL1, which value (default is 30 meters) can be set by right-clicking on the plot (Set Horizontal Alert Limit 1).
-The second limit is formed by the HAL2, which value (default is 40 meters) can be set by right-clicking on the plot (Set Horizontal Alert Limit 2).
You must always remember that the grey zone between HAL1 and HAL2 is a subset of the Normal Operation zone (where HPL values are larger than true horizontal error). At the same time you can set the Maximum Graph Size, so you can set higher values for your alarms. The HPL1, HPL2 and the Maximum Graph Size are dependent of each other, so you must pay attention to the valid ranges while setting them, meaning that relation should be: Maximum Graph size > HPL2 > HPL1.
The long-term availability requirement of SBAS systems is 99.9% and hence at least 999 out of 1000 points should lie in the `Normal Operation` region. The current percentage of the number of points that are in this zone is labeled in the plot itself or in the Colored legend Bar displayed in the right of the plot.

The points in the **System Unavailable** zone have a HPL value that exceeds the horizontal alert limit and a HPL larger than the true horizontal error. This condition raises an alarm incrementing the corresponding pointer.

The points in the **misleading information** or the **hazardously misleading information** zones indicate that the navigation system has produced (hazardously) misleading, and thus dangerous, information to the navigator. Please notice that there are 3 separate zones for the misleading information, each one defined depending on the values you set with your value alarms or performance limits.

At the right of the plot you will see a colored legend displaying the number of epochs and the percentage of them in its corresponding area (the colors in the legend match the different zones in the plot).

Each individual zone of the plot has its own counter displaying the total number of epochs and the percentage of them that the navigation system yielded a corresponding point.

The `View` menu allows to (a) set the true antenna position [5], (b) to `Clear` all the information already gathered and start with a new clean plot, (c) to specify the maximum graph size, (d) the HPL1, (e) the HPL2 and (f) to close the plot.

Figure 2.5-10 displays the vertical performance of the SBAS system. Just as the Horizontal graph, the Vertical graph has default values for both the VALs, but in Vertical guidance these values are set to 12 and 20, meters respectively. Again you can use the `View` menu of the plot to change these values.

[5] changing the true antenna position setting will reset the plot

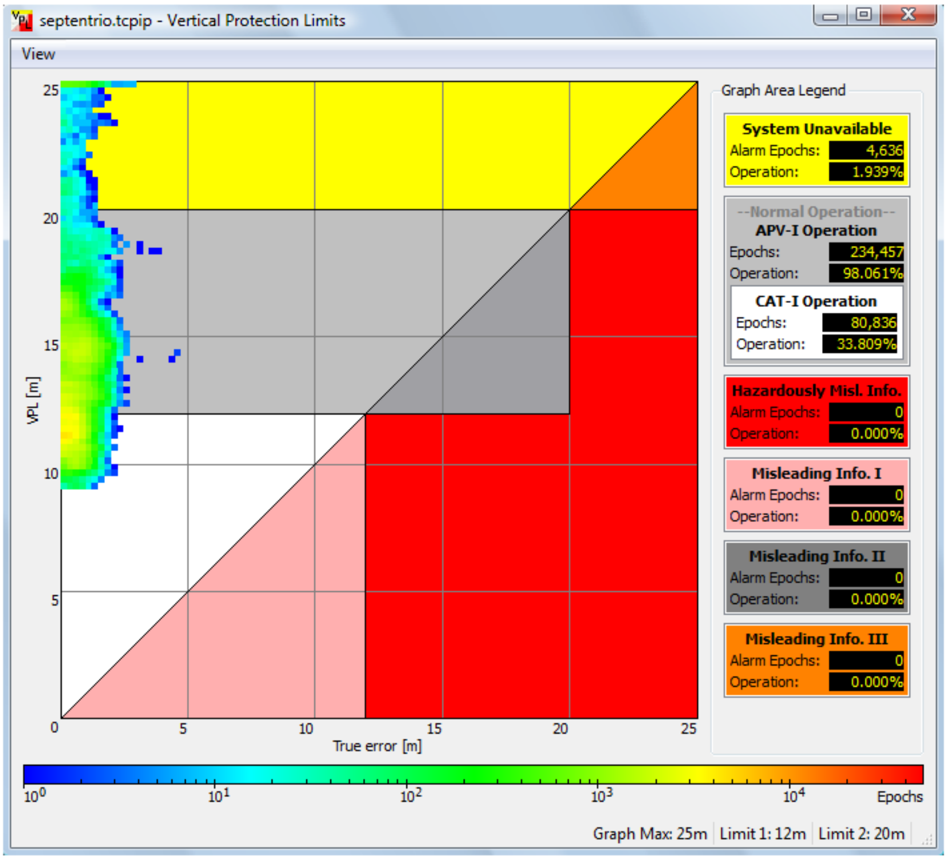



**Figure 2.5-10:** VPL Plot

The VPL plot is divided into zones similar to those of the HPL plot (see Figure 2.5-9). Legends plus all functionality is also similar to the HPL plot. The main differences are that the limits for the different performance categories have different default values for each category. Also the maximum graph size is set to 25 as default because the Alarm Limit values are lower than in the Horizontal graph. Again you can change this maximum size and change or set customized values or performances in the plot.

There are also two Stanford plots displaying the RAIM metrics: the HERL and VERL plot. They are similar to the HPL and VPL plot respectively.

## 2.5.9 Attitude View

The `Attitude View` represents the current attitude of the receiver, both in a graphical way as well as in a textual way.

The Velocity Attitude Indicator offers a combined graphical representation of velocity and attitude as typically found in airplane cockpits (see Figure 2.5-11). It consists of the following components (left to right, top to bottom):

- the horizontal speed indicator
- a virtual horizon, offering a combined representation of the heading, the pitch and the roll. The heading is represented by ticks on the horizon.
- the orthometric height indicator
- the vertical speed indicator
- (at the bottom) the compass

The lower part of the attitude view consists of zero or more clocks, each showing other aspects of the current attitude. Figure 2.5-11 shows the attitude view, including all clocks that are available.

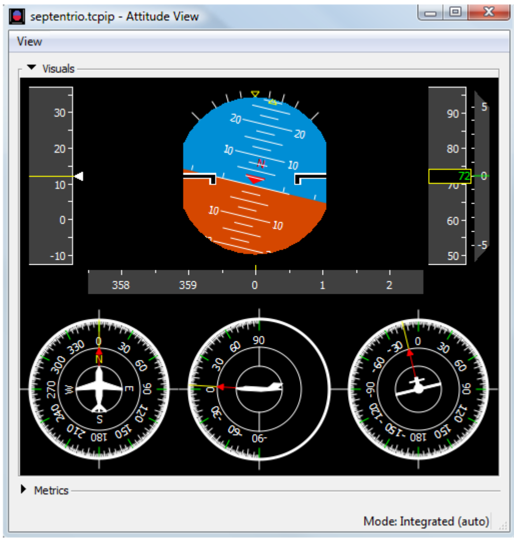



**Figure 2.5-11:** Attitude View

Below the Velocity Attitude Indicator, Figure 2.5-11 from left to right contains clocks showing:

- the heading (including the course over ground represented by a secondary green/cyan arrow)
- the pitch
- the roll

Each of these clocks can be individually hidden or shown by toggling the corresponding menu items in the `View` menu. The `View` menu moreover contains an item to show or hide the course over ground arrow, and a sub-menu `Vehicle Type` to select the type of vehicle shown in the heading, pitch and roll clocks.

The lower part of the window consist of a textual representation of the attitude metrics, showing heading, pitch and roll values and variances. These can be hidden or shown by clicking on the triangle at the top left, or by the `Show Textual Metrics` item in the `View` menu.

Depending on the type and configuration of the attached receiver, attitude and PVT can be calculated based purely on GNSS signals (from multi-antenna receivers or from moving base configurations) or as a result of integrating GNSS signals with the input of an external IMU sensor. The status bar of the attitude window displays the integration mode of the data that is currently shown. The user can configure this through the preferences dialog, which can be opened by selecting the `Preferences...` item in the `File` menu of the main application window. Figure 2.5-11 shows the attitude window while in an automatic mode, which instructs the application to choose integrated position, velocity and attitude data if available, and the GNSS-only solution otherwise. In the figure, integrated data is shown.

## 2.5.10 Auxiliary Antennas View

The `Auxiliary Antennas View` displays the relative position of the auxiliary antennas to the main antenna as well as the velocities of the auxiliary antennas. Both position and velocity are given in the east, north and up directions.

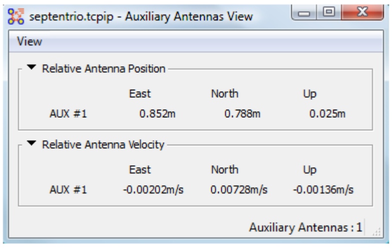



**Figure 2.5-12:** Auxiliary Antennas View

### 2.5.11 Attitude/IMU 3D View

The `Attitude/IMU 3D View` represents a custom vehicle which symbolizes the vehicle in the 3D space dimension. As soon as the attitude information becomes available, the vehicle will be displayed in motion depending on the three attitude angles: Heading, Pitch and Roll. The vehicle is shown inside the ENU coordinate system. These ENU axes are displayed in green color. The positive axes of the vehicle are displayed by a red arrow, while the negative axes are displayed by a blue arrow.

The user can choose to view the ENU system and the vehicle from different perspectives and angles making the visualization of the vehicle more intuitive. In order to modify the perspective, you can use the mouse by clicking on the vehicle and rotating it in the desired direction. At the same time you can zoom into the vehicle by scrolling the mouse wheel.

The auxiliary antennas and the external sensors used by the receiver will also be shown with a relative position within the 3D plot. The antennas are shown by a red wire framed antenna, the external sensors are shown by a XYZ axis which is moving relatively to the vehicle.

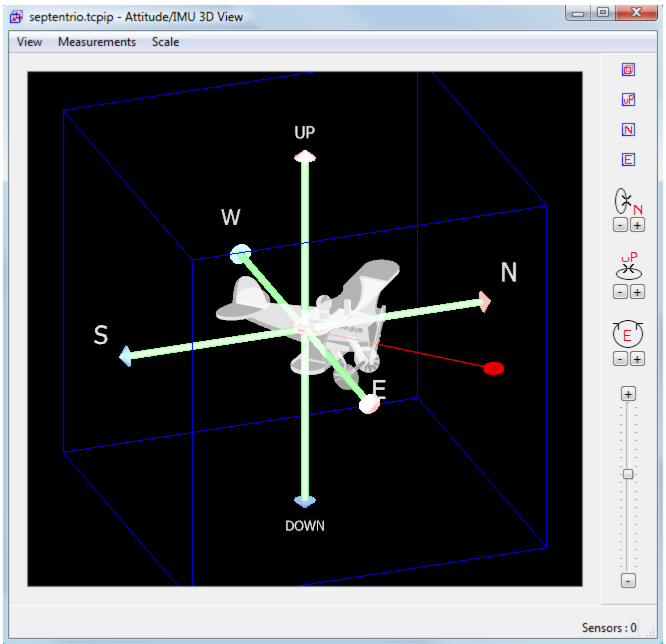



**Figure 2.5-13:** Attitude/IMU 3D view

By choosing `Measurements | 3D options...` you can set some visualization parameters. On the `View Options` tab you can enable or disable the drawing of the axes, the cube outline, the resulting vectors, the vehicle, the antennas and the sensors. You can also chose a `Parallel Projection` or a `Perspective Projection`.

On the vehicle tab you can specify an different model for the vehicle by pressing the browse button. You have to point to a OBJ formatted file. Once the model is loaded you can alter color, blend factor, wire frame view, scale, offset in ENU direction and the rotations of the vehicle. On the antenna tab you can change the same parameters as for on the vehicle tab, except for the offset and the rotation.

Note that for correctly displaying the sensor measurements, you have to set up the sensor calibration. You can do this on the `Navigation | Receiver Setup... | External Sensors` tab.

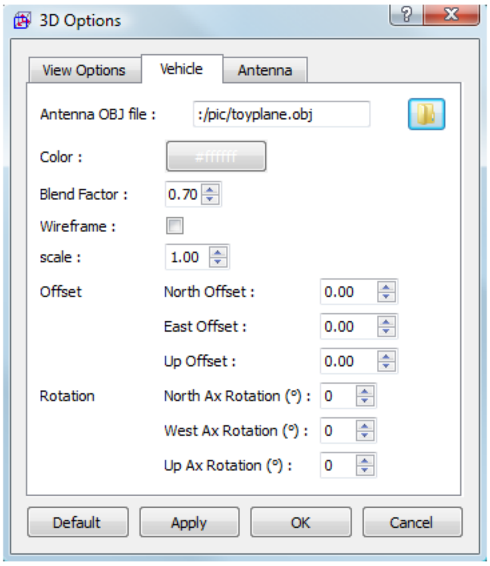



**Figure 2.5-14:** Attitude/IMU 3D View Options

## 2.5.12 IMU View

The `IMU View` represents graphically or textually accelerations and angular rates of the external sensors measurements and integrated angular rate measurements. If a receiver has external sensors, this view displays the raw measurements of the sensors and the integrated angular rates for the receiver.

For the raw measurements of the sensors the accelerations and angular rates are given in the XYZ directions. The integrated angular rate measurements are given in east, north, up directions.

You can chose from which sensor you want to see the measurements by selecting the sensor in the `Measurements | Sensors` menu. This menu is empty if no sensors are available. In the `Measurements | Measurements` menu you can chose to see both acceleration and angular rate measurements or only one of these two.

The scale menu is by default set to auto scale. As a consequence the scale is adapted to the measurements. You can also set the scale manually by selecting the corresponding menu.

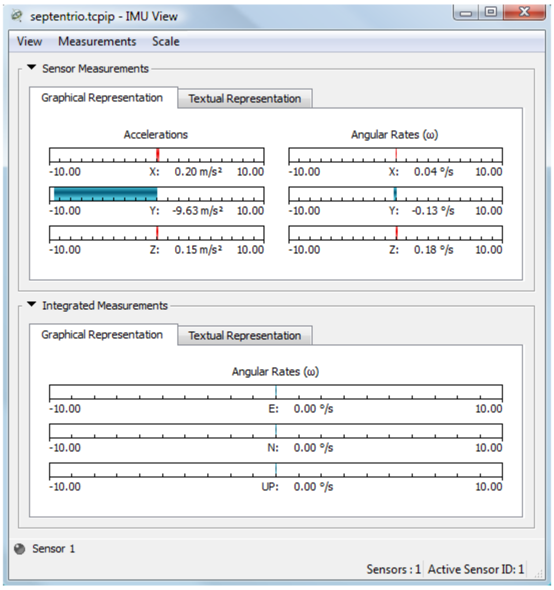



**Figure 2.5-15:** IMU View

## 2.5.13 L-Band Status Plot

In case your Septentrio Receiver is capable of tracking L-Band signals this panel shows the status of the L-Band.

The top part contains a table with a summary for each tracked L-Band signal, while the lower part shows the status of the decoder.

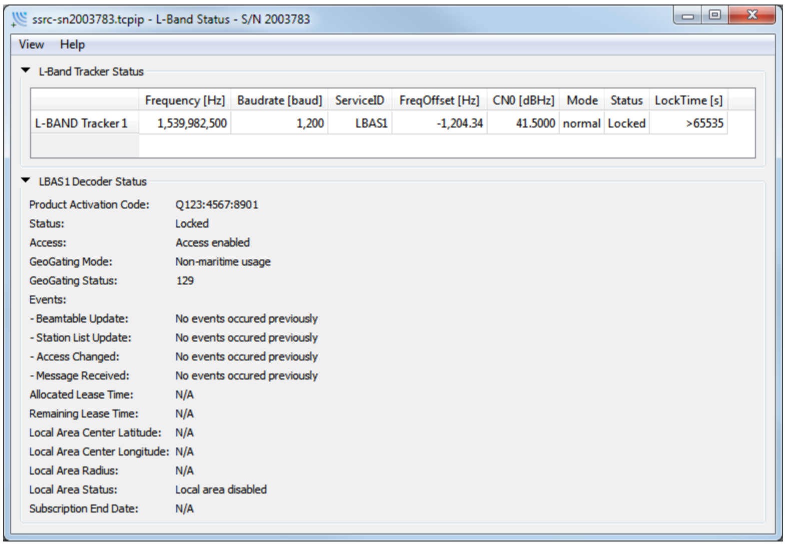



**Figure 2.5-16:** L-Band Status

## 2.5.14 Time Plots

The `Time Plots` graphically show how a particular value changes over time. The following plots are available:

- Satellite/Measurements related plots:

  - **Carrier to Noise** plot shows Carrier to Noise ratio over time (CN0) for each tracked satellite. In the `Options` of this plot it is possible to select a particular signal if your receiver has more than 1 frequency.
  - **Doppler Shift** plot the Doppler shift of each satellite.
  - **Doppler Rate** plot shows the rate of change of the Doppler value for each satellite.
  - **Number of Satellites** plot shows the total amount of visible satellites over time. You can select to see number of satellites in view, in track or in PVT mode.
  - **PRNs in View**[6] plot shows for each chosen satellite if it is in view or not.
  - **Satellite Azimuth** plots shows the azimuth values of chosen satellites over time.
  - **Satellite Elevation** plots shows the elevation values of chosen satellites over time.
  - **Pseudorange** plot shows the pseudorange of each tracked satellite.
  - **Signals** plot shows which signals are tracked and/or used in the PVT solution.
- PVT related plots:
  - **Relative East, North, Up (ENU)** plot shows the East, North, and Up values from a given topocentric reference point.
  - **Height** plot shows the current height. In the `Options` of this plot it is possible to select Ellipsoidal, Orthometric or Local height to be shown. The local height will only be displayed if position data in a local datum is available, and usually is the physical height defined by that datum.
  - **Velocity** plot shows the velocity values.
  - **Position Standard Deviations Cartesian** plot shows the standard deviations of the Cartesian position components.
  - **Position Standard Deviations Geodetic** plot shows the standard deviations of the geodetic position components.
  - **Residuals** plot shows residuals for each active satellite. In the `Options` of this plot the users can also select to view the w-test statistic or the Minimal Detectable Bias. Also the user is able to choose the signal for which the residuals are being shown. In addition it is possible to choose between Carrier-Phase, Pseudorange or Doppler residuals.
  - **GNSS PVT Mode, Error, NrSV** plot shows the values of PVT Mode, PVT Error and number of space vehicles (satellites) in track over time.
  - **Clock Bias and Drift** plot shows the receiver's clock bias and clock drift over time.
  - **Differential Corrections Age** shows the mean age of the differential corrections over time, as well as the age for each individual differential correction message type. It is also possible to show the reception of individual differential correction messages over time.
  - **Dilution of Precision (DOP)** plot shows the various dilution of precision values over time.
  - **Protection Level** plot shows horizontal and vertical protection levels over time. The user can display the protection levels computed through autonomous fault detection (HPLfd and VPLfd) or based on SBAS error estimates (HPLsbas, VPLsbas).
- Heading/Attitude related plots:
  - **Heading, Pitch, Roll (HPR)** plot shows the Heading, Pitch, and Roll values of the attitude, if an attitude solution exists.
  - **GNSS Attitude Mode, Error, NrSV** plot the attitude mode and error for GNSS-based attitude, and the number of satellites used in the computation of the attitude solution.
  - **Acceleration (IMU)** plot shows the IMU based accelerations in vehicle coordinates.
  - **External Sensor Measurements** plot shows raw measurements received from external sensors. This can include accelerations, angular rates and a zero velocity flag.
- Receiver Status related plots:
  - **CPU Load and Uptime** plot can be used to observe the CPU load of your receiver over time, as well as the uptime of the receiver over time.
  - **Receiver Status** plot shows the value of the receiver status and error bits over time.

[6] The Y-axis of the plot shows the SVID's numbers as retrieved from SBF so that no graphical overlap occurs for the different systems

  - **SBF** plot shows the reception of individual SBF messages over time.
- Measurement combination plots: These plots offer a means for advanced users to monitor several conditions such as ionospheric activity and multipath.
  - **Lx - Ly** plot displays the carrier phase range difference between two signals per satellite (iono).
  - **Px - Py** plot displays the code range difference between two signals per satellite (iono/-multipath).
  - **Px - Lx** plot displays the difference between the code range and the carrier phase range per satellite (iono/multipath).
  - **Total Electron Content** plot provides an estimate for the total electron content (iono/multipath).
  - **MPx** plot displays a computed indication for multipath.

The `ENU`, `Height`, `Position Standard Deviations` and `HPR` plots are capable of showing either the GNSS-only solution or an integrated solution. Whether the GNSS-only or integrated solution is shown, is determined by a user preference as set in the preferences dialog, which can be opened by selecting `File | Preferences`. An integrated solution can only be shown if the Septentrio Receiver has `integration` enabled.

The `Azimuth`, `Elevation`, `Doppler Shift`, `Pseudoranges` and `PRNs in View` plots are limited to an update rate of 1 second. Since their values change gradually it is not necessary to update them more frequently.

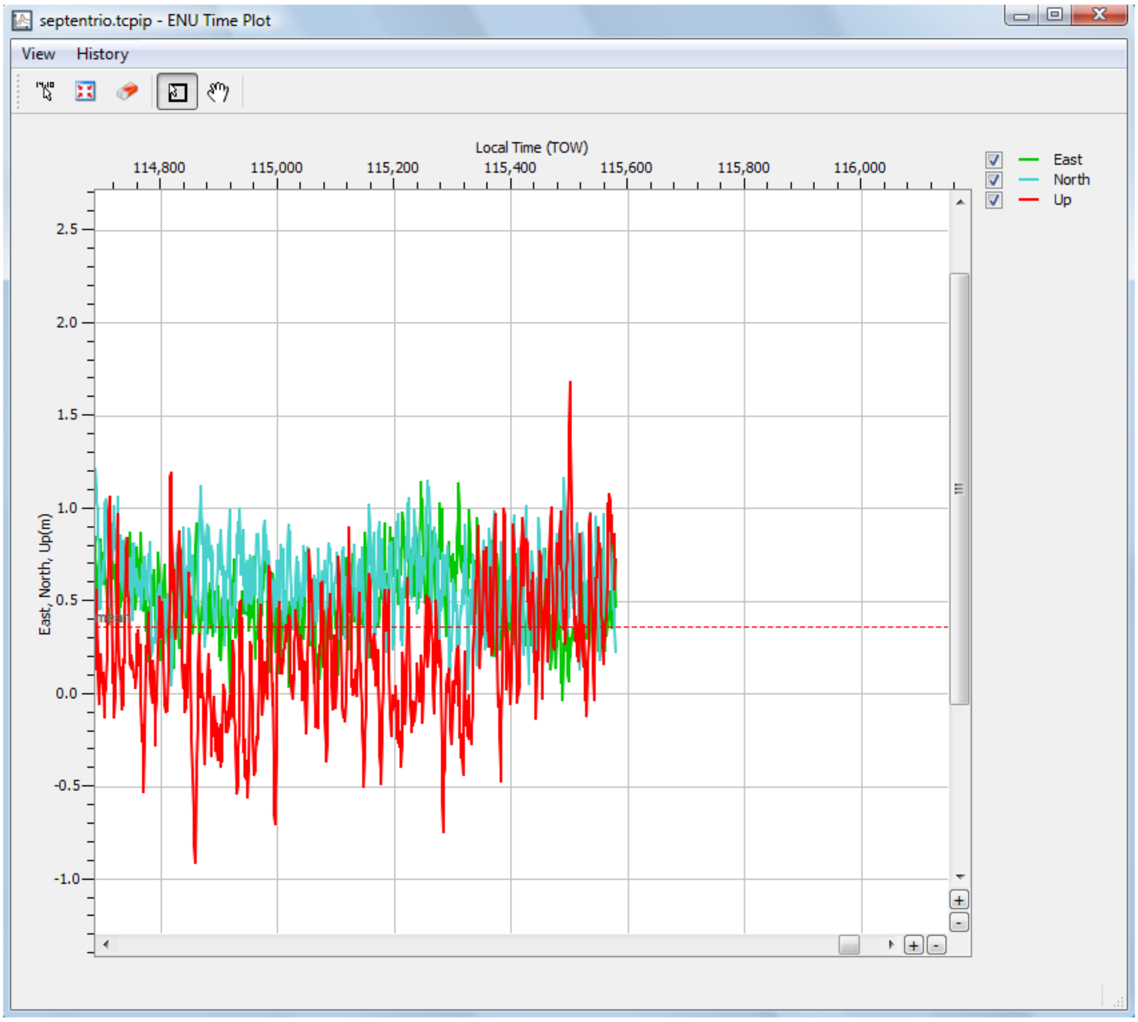



**Figure 2.5-17:** ENU time plot with East, North and Up components on one plot

When the user chooses a particular time plot, he/she may choose to click the `Options...` button in the `Time Plots Selection` dialog, which will open the `Time Plot Options` dialog for a particular Time Plot. In the `Time Plot Options` dialog the user can choose which satellites will be visible in the plot. The user can also choose output to be displayed on up to 4 different plots. This feature can be particularly useful for the ENU plots. The user may select any combination of the East, North, or Up values to be displayed on any of the 4 plots. If applicable, the dialog also allows the selection of the antenna(s) for which the data must be plotted, and the signals to be used in the plot. Once the plot is visible, the user can reconfigure those plot options via `View | Options`. Doing this will however discard all data that is already shown in the plot.

In all plots except the `PVTMode, Error, NrSV` plot, the PVT Mode can be visualized as a colored bar at the bottom of the plot. This can be enabled or disabled using the `Time Plots Selection` dialog. Likewise, in selected plots it is possible to visualize the Integration Mode or the Attitude Mode using such a bar, provided that the connected receiver has the required capabilities. If the PVT Mode bar is shown, the user can choose to show a vertical marker at times where the PVT Mode changes, via `View | Mark PVT Mode Changes`. This makes it easier to spot PVT Mode changes, even when they are short.

The time axis displays time corresponding to the time frame and representation as selected in the application preferences. If you wish to change the time frame/representation go to the main screen: `File | Preferences`, and in the `Units` section select the time frame from either GNSS time, UTC time, or local time, and for GNSS time you can optionally choose to display the time of week, or the GNSS seconds. When you change this value the time plots will automatically adjust the time axis to correspond to the selected time frame.

There are several ways to navigate through the data of a time plot. The zoom mouse tool (which can be enabled in the tool bar) allows to indicate with the mouse which region the plot must zoom to, while the pan mouse tool allows to move the visible part of the data by dragging the mouse. Panning along either the time axis or the value axis is possible using the respective scroll bar. To the right of the horizontal scroll bar and at the bottom of the vertical scroll bar, several buttons allow you to set up the navigation in the corresponding direction: to zoom in, to zoom out, or to keep the entire data range in view. The latter is one of the ways to automatically update the visible part of the plot: one can choose to continuously keep the entire data range in view, or one can choose to automatically scroll the visible part when needed to keep new data in view as it is received (follow mode). A plot automatically switches to follow mode when you scroll to the right-most part of the data. The toolbar has buttons to switch all plots in the view to follow mode or show all mode. The user can also select the mode in the View menu. Zoom and scroll buttons are disabled if they are not applicable in the current state.

Zooming and scrolling in the time dimension can be synchronized between plots, so that different plots keep showing the same time extent as you navigate around. This facilitates the analysis of contemporaneous data. This can be enabled or disables using the respective items in the `View` or the buttons in the tool bar. You can choose between no synchronization, synchronization of all plots within a window and synchronization of all time plots within the application.

When hovering with the mouse over a data point, a tooltip appears providing the following information about the data point: the name of the data set, the date and time (resp. week number and time of week), the value and unit, and (if relevant) the satellite.

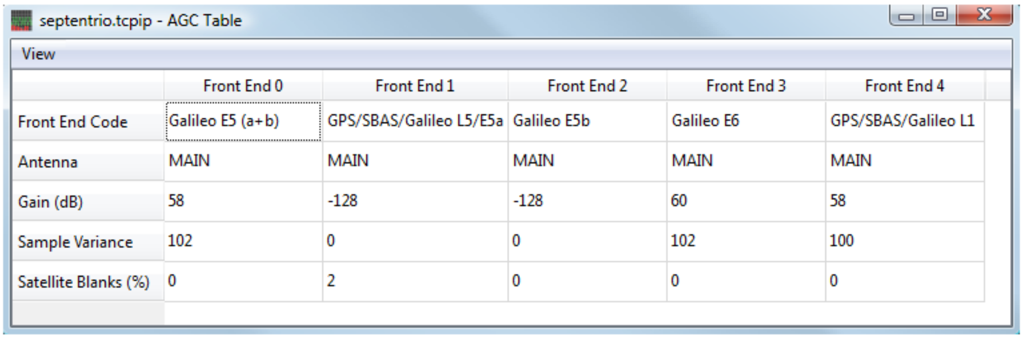
If you would like to know the exact position of your cursor on the plot, turn on the `View | Mouse Tracking` option by setting it checked. You will see the coordinates of your mouse on the bottom left corner of the status bar. A horizontal and vertical marker marks the position of the mouse in the plot. If more than one plot is shown in the window, the other plots will show a vertical marker at the corresponding time position.

The `History | Clear` menu option allows to clear the plot at any time and start anew. Use the `History | Clear All Time Plots` menu option to clear all open time plots.

When time plots stay open for a long period of time, they may accumulate a large amount of data. The user can configure a limit to the amount of data that is maintained, as well as how the time plots must reduce their data to maintain this limit. The configuration dialog can be shown using `History | Data Size Settings`. The same settings can be edited in the application preferences. It is possible to restrict the maximum number of data points in a single dataset and/or to place a limit to the approximate amount of memory occupied by the data in all open time plots. The user can choose to either decimate the data or to throw away the oldest data when a limit is reached. Decimating the data consists of discarding all odd data points. After a time plot has been decimated, new incoming data for that same plot will be decimated to the same degree.

### 2.5.15 AGC Table

The `AGC Table` can be opened using the `View | Views | AGC Table` menu entry or by clicking the corresponding icon in the `toolbar` of RxControl's main window. The columns of the AGC table contain the real-time values of the Septentrio Receiver. Each column represents an analog front end part. The first row of every column is the front end code, which gives the signals that can be tracked with the front end part. The next row gives the antenna to which the front end is connected to. The third row gives the actual front end gain in dB. The fourth row indicates the normalized variance of the IF samples. The nominal value for this variance is 100. The last row gives the percentage of samples being blanked by the pulse blanking unit. This field is always 0 for receivers without pulse blanking unit.


septentrio.tcpip - AGC Table

View

| | Front End 0 | Front End 1 | Front End 2 | Front End 3 | Front End 4 |
|---|---|---|---|---|---|
| Front End Code | Galileo E5 (a+b) | GPS/SBAS/Galileo L5/E5a | Galileo E5b | Galileo E6 | GPS/SBAS/Galileo L1 |
| Antenna | MAIN | MAIN | MAIN | MAIN | MAIN |
| Gain (dB) | 58 | -128 | -128 | 60 | 58 |
| Sample Variance | 102 | 0 | 0 | 102 | 100 |
| Satellite Blanks (%) | 0 | 2 | 0 | 0 | 0 |

**Figure 2.5-18:** AGC table

## 2.5.16 Spectrum View

The `Spectrum View` enables spectral analysis of the RF signal received from the antenna. The user can choose between visualizing the RF spectrum, the raw IF samples or a histogram distribution of the samples. The represented frequency band can be selected at the top of the window. The user can also determine whether the values must be averaged before visualization or not, and the number of values that must be included in the average. For the histogram distribution the user can choose to visualize the I and Q samples or $\sqrt{I^2 + Q^2}$. The user can also choose to normalize the histogram.

On the RF spectrum the user can see at which frequency interference is present (the peaks in the plot). From the raw samples the user can see pulsed interference. If the Septentrio Receiver is heavily jammed the I and Q samples histograms will not show a gaussian distribution and the $\sqrt{I^2 + Q^2}$ histogram will not show a chi-square shape distribution.

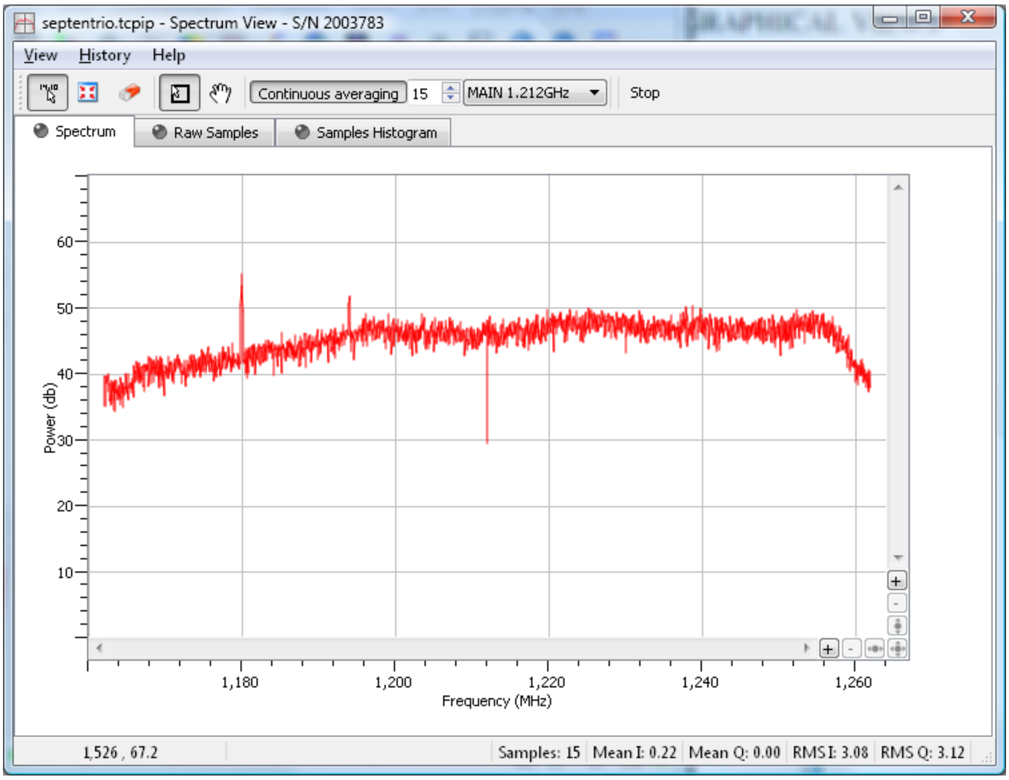



**Figure 2.5-19:** Spectrum View

### 2.5.17 Message Inspector View

With the `Message Inspector View` it is possible to show the contents of selected SBF blocks as they are received from the receiver. Figure 2.5-20 shows the Message Inspector View, displaying the live contents of the PVTGeodetic blocks sent by the receiver.

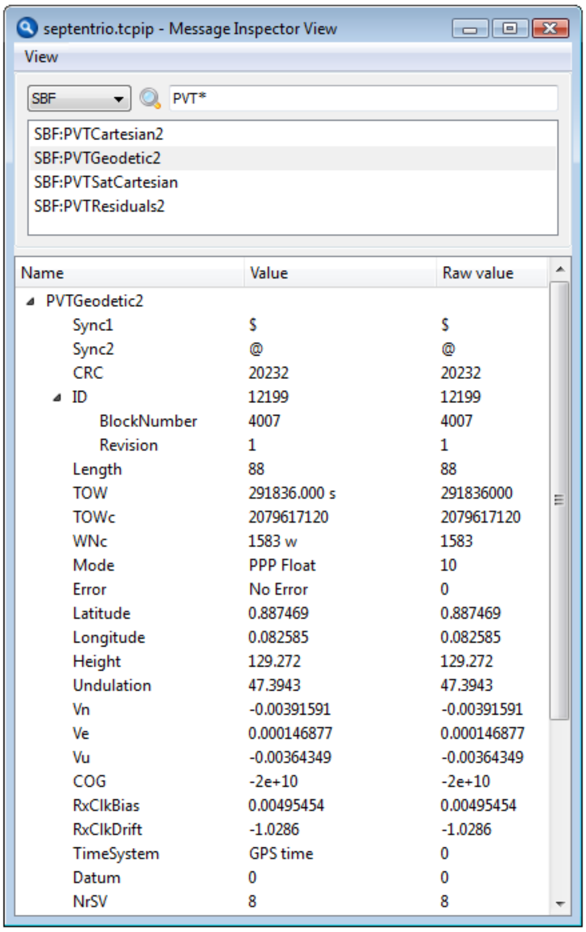



**Figure 2.5-20:** Message Inspector View

In the upper part of the message inspector view, the message for which the data must be shown can be selected. First select the format to which the message belongs. Then the message can be selected, using the line edit or the list. When you edit the text in the line edit, the list shows all matching messages. When connected to a receiver, the list does not contain those SBF blocks which cannot be requested from the connected receiver.

The lower part displays the data from the message selected above. This part is a tree, expanding composed fields into subfields and showing nested submessages if applicable. The Value column shows the current value of the corresponding field, if possible in an interpreted way. Besides the default columns (Name and Value) the user can enable or disable columns showing the data type and the raw value using the `View | Columns` menu.

The data is updated each time a new message of the selected type is received from the receiver. Updating can be temporarily disabled through the `View | Freeze` menu item.

The `View | Show Primary Fields Only` menu item, when checked, restricts the displayed fields to those that present (the most) meaningful information to end users. When the `View | Show Computed Fields` menu item is checked, fields representing computed information are included. If not checked, only fields are shown that are present as such in the received message.

Besides SBF, other data formats are available. In particular, a number of formats for differential corrections are supported, offering the majority of their message types. When selecting a message type from differential correction format, the displayed data is extracted from received DiffCorrIn SBF blocks.

### 2.5.18 Message Statistics View

The `Message Statistics View` shows how many times each kind of message has been received. For messages that are received at a regular rate, that rate is also indicated. When an item for a given kind of message is expanded in the view, detailed information is given about the distribution of the different intervals at which that message has been received.

Figure 2.5-21 shows the Message Statistics View.

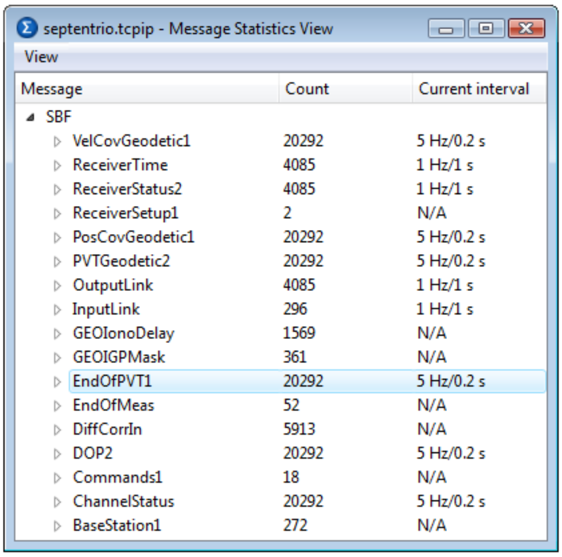



**Figure 2.5-21:** Message Statistics View

## 2.6 The Expert Console

The expert console is designed for users familiar with the **ASCII command set** of the Septentrio Receiver and allows an unlimited control of the receiver. Expert users can drive the receiver operations through a **command line interface** by entering commands to adjust the behavior and operation of the Septentrio Receiver. For more information about the commands of the receiver, please consult the "Command Line Interface Reference Guide".

The expert console is divided into five tabs:

(a) The `Receiver Commands` tab (see Section 2.6.1) allows users to directly communicate with their Septentrio Receiver.

(b) The `ASCII Display` tab (see Section 2.6.2 on page 70) allows the expert user to follow the receiver's operation throughout a textual representation of its state.

(c) The `NMEA` tab displays the NMEA sentences sent by the Septentrio Receiver. For this tab to display information NMEA messages must first be enabled through the `Communication | Output Settings` menu.

(d) The `Events` tab allows the user to see the details of the external events if they are being generated.

The different tabs of the expert console share common features.

- Each tab has a LED (grey when inactive) which blinks green when a corresponding message or sentence is received. If the tab that received a message is not active, the LED turns to orange to indicate the user that a new message or sentence has arrived on this tab. After the user inspects the new message or sentence by selecting this tab, the LED will return to its default grey color.
- Just above the `command line` is a **message area** displaying relevant information (See Sections 2.6.1 until 2.6.3 on page 71 for specific information) according to the selected tab. Two buttons control the operations of the `message area` :
  (a) a **Freeze** button toggles the update of the `message area` allowing a closer inspection of the displayed messages. When the `freeze` button is selected, the information normally sent to this `message area` is discarded
  (b) a **Clear** button that allows the user clear the message area.
- At the bottom of the `Expert Console` is the **command line** (see Figure 2.6-1 on the next page) used for sending commands to the Septentrio Receiver The `command line` is explained in more detail in Section 2.6.1.

### 2.6.1 The Receiver Commands Tab

The `Receiver Commands` tab of the `Expert Console` is the first tab and forms the central communication channel with the Septentrio Receiver for the expert user. The window is split up in the **message area** and the **command line** (see Figure 2.6-1 on the next page). The expert user enters his/her commands on the command line, sending them to the Septentrio Receiver by pressing the `Enter` key. The message area displays the commands entered and the replies received from the Septentrio Receiver.

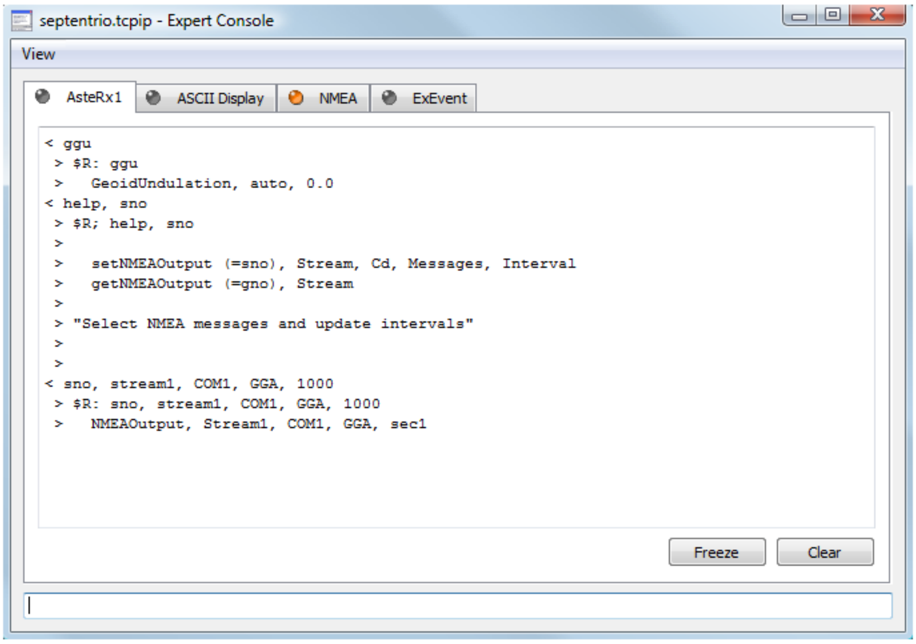



**Figure 2.6-1:** The Expert Console displaying its Receiver Communication tab

Commands sent by the user to the Septentrio Receiver are preceded in the message area beside the ”<” sign, while the receiver’s reply is identified by indenting with two spaces and the ”>” sign. A typical communication between the user and the Septentrio Receiver is displayed as follows:

```
< ggu
  > $R: ggu
  >   GeoidUndulation, auto, 0.0
< help, sno
  > $R; help, sno
  >   setNMEAOutput (=sno), Stream, Cd, Messages, Interval
  >   getNMEAOutput (=gno), Stream
  >
  > "Select NMEA message types and update intervals"
  >
  >
< sno, Stream1, COM1, GGA, sec1
  > $R: sno, Stream1, COM1, GGA, sec1
  >   NMEAOutput, Stream1, COM1, GGA, sec1
```

In this example the user queries the Septentrio Receiver for the current value of the geoid undulation (`ggu`). The reply indicates that the Septentrio Receiver is currently configured to interpolate the value for the geoid undulation using the built-in geoid model (`setGeoidUndulation, auto`). The user then decides to request a short help about how to set the NMEA output (`sno`). After having a look to the help, the user enables the output of the GGA NMEA message to `COM1` at 1Hz by sending the `sno, Stream1, COM1, GGA, sec1` to the Septentrio Receiver.

The command line interface of the `Expert Console` **directly connects** to the central dispatching unit of the Septentrio Receiver internal firmware. Through it, the user can use full names, mnemonics, or numeric values of the command set to control the Septentrio Receiver. The `Expert Console` gives a warning when a user attempts to set or modify the settings of the connection port which is used by RxControl.

The command line of the `Expert Console` has a **history buffer** limited to the last 50 commands. The up and down arrow key allow the user to browse through the history. Using the normal editing keys, a recalled command can be edited or given other arguments. When `Enter` is pressed, the edited command is transmitted to the Septentrio Receiver.

Right-clicking in the message area of the `Expert Console` allows to `Copy` or `Select All` the contents of the message area.

The scroll bar at the right side of the display area allows scrolling through the history of the commands and replies exchanged between the Septentrio Receiver and RxControl.

### 2.6.2 The `ASCII Display` Tab

When the `ASCII Display` tab is visible RxControl turns on textual representation of the current receiver's status (see Figure 2.6-2). When the tab becomes inactive again, the ASCII output of the receiver is turned off again.

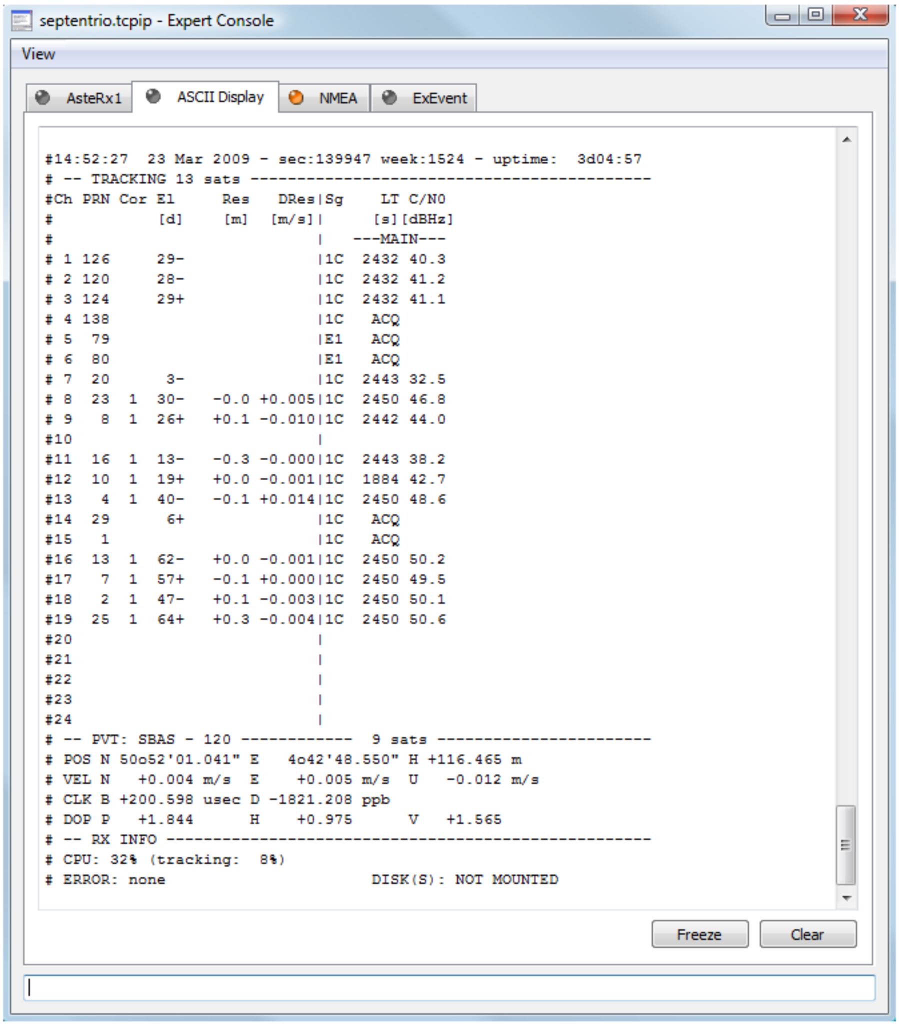



**Figure 2.6-2:** The ASCII Display tab of the Expert Console

Right-clicking in the display area of the `Display Output` tab allows to `Copy` or `Select All` the currently displayed output.

The command line is still accessible from the `ASCII Display` tab, but the replies are directed to the `Receiver Commands` tab (see Section 2.6.1 on page 68).

## 2.6.3 The NMEA Tab

When National Marine Electronics Association (NMEA) output is enabled the user can examine the NMEA sentences in the display area of the `NMEA` tab of the `Expert Console`.

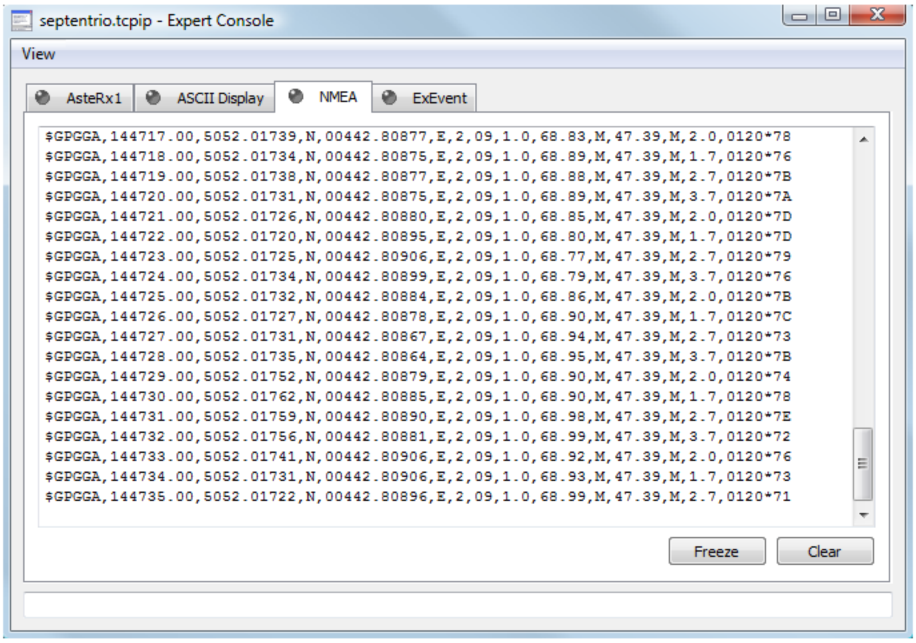



**Figure 2.6-3:** The NMEA tab of the Expert Console

The command line is still accessible from the `NMEA` tab, but the replies are directed to the `Receiver Commands` tab (see Section 2.6.1 on page 68).

Selecting the `Freeze` button allows for a closer examination of the NMEA sentences. Using the scroll bar at the right side of the display area scrolls through the history of the NMEA sentences.

Right-clicking in the display area of the `NMEA` tab allows to `Copy` or `Select All` the currently displayed sentences.

## 2.6.4 The Events Tab

This tab allows to see details about external events which are generated on the Septentrio Receiver. The details displayed on the Events tab include:

- if the event was an Event A or an Event B
- polarity of the event or in other words if the event occurred on the rising or on the falling edge
- exact receiver time at which the event occurred
- receiver clock bias which can be used to calculate the satellite time at which the external event occurred

There is also a running total of Events A and Events B, which can be reset by using the `Reset` buttons. When the `Expert Console` is closed the counters are also reset.

## 2.7 Logging

### 2.7.1 RxControl Logging

RxControl has the ability to log the binary SBF blocks or the ASCII NMEA sentences transmitted by the Septentrio Receiver.

Settings specific to the Septentrio Receiver data logging are changed via the `Logging | RxControl Logging...` menu entry which opens the Logging window. This window is subdivided in five tabs with the following information

(a) the status of the data logging,

(b) the global settings of the data logging,

(c) the selection of SBF messages to log,

(d) the selection of NMEA sentences to log, and

(e) a post processing.

The accessible fields in the Logging window adjust automatically according to the selections made: inaccessible fields are greyed out. The data logging settings take effect when the user selects the `Start Logging` button. When logging is ongoing you will see a moving logging icon at the bottom right corner of the main screen. Use the `Stop Logging` button to stop the data logging.

**The `Status` tab of the `Logging` Window**

The `Status` tab (see Figure 2.7-1) shows the status of the logging.

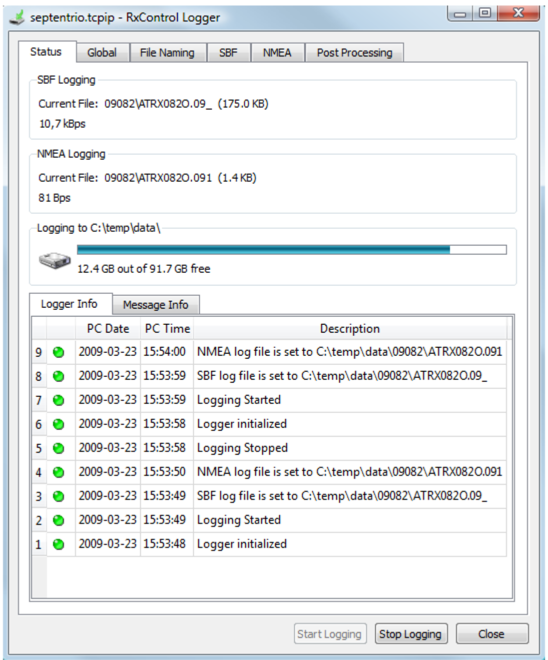



**Figure 2.7-1:** Logger dialog

The upper part of the panel shows the log file name for both the SBF and the NMEA logging. Also the file size and the number of bytes logged per second are shown.

The middle part shows an indicator of how much space is used on the drive which is currently used for storing the data files.

The bottom part allows the user to select between viewing a tab containing an event log of the logging process or a tab with message statistics of the logged messages.

**The `Global` tab of the `Logging` Window**

The `Global` settings tab (see Figure 2.7-2) allows to specify the following parameters:

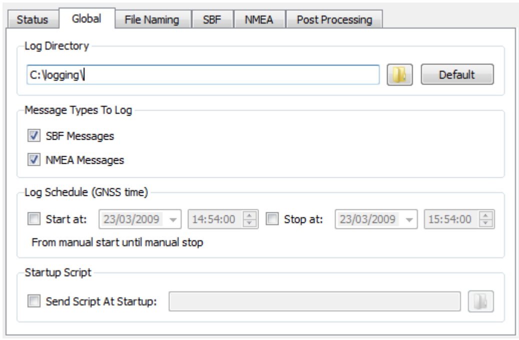



**Figure 2.7-2:** Logger Global Settings Tab

(a) the `Log Directory` specifies the directory in which the logged files are stored

(b) the `Message Types To Log` allows to log only SBF or NMEA messages or both

(c) the `Log Schedule` allows to specify an interval for the logging process. The start and stop time must always be specified in GNSS time, but the times are also printed in the currently set time frame underneath the start and stop time entry fields.

(d) the `Startup Script` allows to send a script to the Septentrio Receiver just before the logging starts. The script can be send every time the connection is lost, or only once.

**The `File Naming` tab of the `Logging` Window**

The `File Naming` settings tab (see Figure 2.7-3) allows to specify the following parameters:

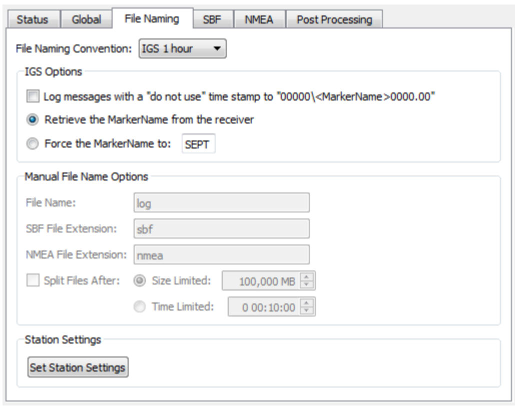



**Figure 2.7-3:** Logger File Naming Settings Tab

(a) the `File Naming` and subsequent fields allows to specify how the logged files will be named. The `File Naming` settings are discussed in the next paragraph

(b) the `Station Settings` allows to change the `Station Settings` of the Septentrio Receiver

**File Naming Settings**

Four different options are available for specifying the file name convention of the logged data.

The first three of them are (a) hourly, (b) six-hourly or (c) daily files according to the IGS Convention (http://igscb.jpl.nasa.gov/). The last one, the Manual File Naming option allows the user to specify a chosen filename.

When selecting the IGS File Naming convention the following options are available:

- **Log messages with a "do not use" time stamp to "00000/<MarkerName>0000.00"**: Select this option if you want messages that have an invalid time stamp to be logged as well.
- To set the markername part of the IGS file name the user has two options:
  - **Retreive the MarkerName from the receiver**: In this case the NAME of the station is downloaded from the Septentrio Receiver when the logging starts (it can be changed via the Station Settings button).
  - **Force the MarkerName to**: In this case the entered marker name is used.

***Note* 9.** The IGS Convention option is mandatory when, in the Post Processing tab, the RINEX or the CGGTTS conversion is chosen.

When the Manual File Naming has been selected, the user has to specify the following additional parameters:

- **File Name**: the base name or prefix of the data file(s) created for storing the SBF messages or NMEA sentences
- **SBF File Extension**: the extension of the SBF filename(s) that will be created
- **NMEA File Extension**: the extension of the NMEA filename(s) that will be created
- to store all the messages in one large file or to split the file automatically when:
  - it has reached a specified file size
  - a specified amount of time has passed

  In both cases of automatically splitting the base name is extended with _XXXX with XXXX a four digit number starting from 0000).

As an example, let the three text fields contain the entries SepRx, SBF and NME. The data files created in the directory specified in the Log Directory are:

(a) SepRx.SBF for logging the SBF messages;

(b) SepRx.NME for logging the NMEA sentences.

If the user chooses the IGS Convention in the File Naming Convention selector. According to this naming convention data files are created as follows:

| | | |
|---|---|---|
| NAMEDDDS.YYE | where: | NAME . . . is the 4 character code for the station name |
| | | DDD . . . is the day number of the year |
| | | S . . . is the session identifier |
| | | YY . . . are the last two digits of the current year |
| | | E . . . an identifier for the type of the data stored in the file |

The session identifier S can be one of the following:

- the figure "0" identifies a data file that spans 24 consecutive hours
- data files comprised of data for 6 consecutive hours have the figures "1" (0-6hr), "2" (6-12hr), "3" (12-18hr) and "4" (18-24hr) as session identifiers
- the letters from 'A" (0-1hr) to "X" (23-24hr) are used to identify hourly data files
- the letters from 'a" (0-1hr) to "x" (23-24hr) followed by 2 digits representing the starting minute within the hour are used to identify 15 minute data files

The time basis used for the IGS file naming convention is GPS time.

Finally, the data type identifier "_" marks data files which contain SBF block categories, while "1" identifies data files which contain only NMEA sentences. By default the project path is further extended by the *year-date* subdirectory YYDDD.

The following example clarifies the afore mentioned IGS convention, where the current directory ("./") is used as `Project Path`:

```
./03225/PLRX2251.03_
        PLRX2252.03_
        PLRX2253.03_
        PLRX2254.03_
        PLRX2255.03_
        PLRX2256.03_
        ............
        ............
./03226/PLRX2260.031
./O3227/PLRX2270.031
./03227/MRKR227A.03_
        MRKR227B.03_
        MRKR227C.03_
        MRKR227D.03_
        MRKR227E.03_
        ............
        ............
        ............
        MRKR227V.03_
        MRKR227W.03_
        MRKR227X.03_
```

On `day 225` of `year 03` (August 13, 2003) the data for the station identified as `PLRX` was logged. Six data files (`PLRX2251.03_` ...`PLRX2256.03_`), each spanning 6 consecutive hours, containing SBF blocks are logged. The following 2 days, a single daily data file (`PLRX2260.O31` and `PLRX2270.O31`) was logged for the same station and it contains only NMEA sentences.

This data file (a) either spans 24 hours of data, or (b) could be the result of scheduled data logging that has started and ended during that day. On August 15, 2003 (`day 227 year 03`), RxControl logged SBF messages in hourly data files (`MRKR227A.03_` ...`MRKR227X.03_`) from another station `MRKR`.

In the other hand the naming convention used for the CGGTTS data files follows the next definition:

`GZXXYYMJ.DAY` where:
`GZ` ... is a fix identifier for CGGTTS data
`XX` ... identify the laboratory
or two character code of the station name
`YY` ... identify the PolaRx receiver used (e.g. 1P)
`MJ` ... are the first two digits of the
current Modified Julian Date
`DAY` ... the last three digits of the
current Modified Julian Date

### The `SBF` and `NMEA` tabs of the `Logging` Window

The user can select the SBF messages and/or NMEA sentences that he/she wants to log in these tabs. Groups of SBF or NMEA messages are shown in bold on top of the list. These groups of messages are already predefined and depend on the Septentrio Receiver you are connected to.

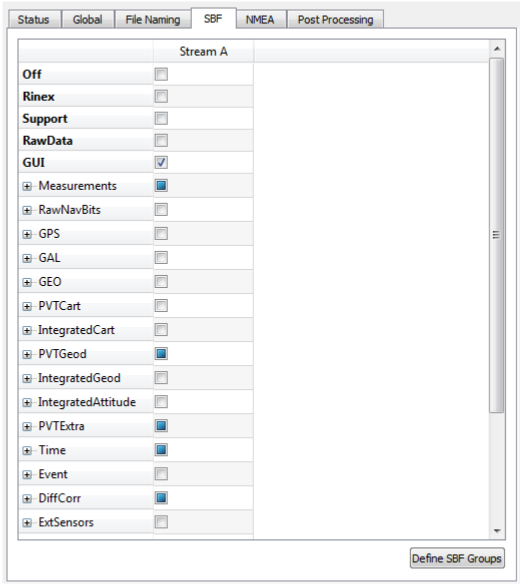



**Figure 2.7-4:** `Data Logging SBF tab` dialog

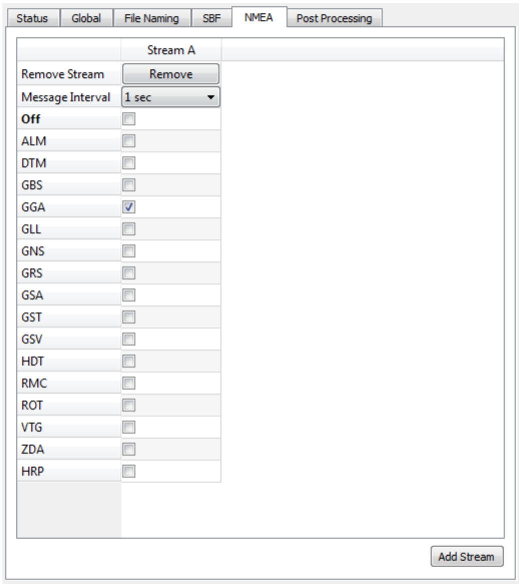



**Figure 2.7-5:** `Data Logging NMEA tab` dialog

The SBF messages are always logged at the same rate as the one used in RxControl, while the rate(s) for the NMEA messages can be set by the user.

For NMEA messages it is even possible to create different streams with messages of which each stream has its own rate. This is done by clicking the `Add Stream` button. The first row contains the desired rate while the following rows contain the messages to be logged at that rate.

### The `Post Processing` tab of the `Logging` Window

The `Post Processing` tab can be used to perform one or more actions on a log file after the file is closed. A log file is closed when the logging is stopped or when a new file is started according to the IGS convention or when the maximum file size is reached in manual file naming mode.

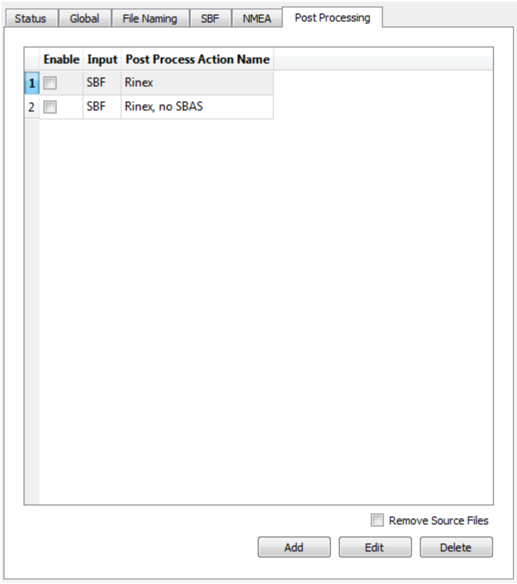



**Figure 2.7-6:** `Data Logging Post Processing tab` dialog

The top part contains a list of the currently defined `Post Processing` rules. Each line represents a `Post Processing` rule. The first column contains a checkbox allowing the user to enable the rule by checking it, or disabling the rule by unchecking the checkbox. The next two columns contain the name and description of the rule as specified by the user.

When the checkbox `Remove Source Files`, located under the rules list, is checked the SBF or NMEA file used as input for the post processing action is removed after finishing the post processing. If unchecked the file is left at its original position.

By clicking the `Add` button a wizard is shown to define a new `Post Processing` rule. To define a `Post Processing` rule the following items have to be specified:

**Post Process Action Input and Type**

Here the user can specify if the rule should be applied on SBF or NMEA log files and which conversion should be applied:

- No Conversion
- RINEX Conversion (SBF only)
- HATANAKA Conversion (SBF only)
- CGGTTS Conversion (SBF only),
- SBF Analyzer (SBF only)
- Custom Conversion
- ISMR Conversion

**Custom Conversion**

This page of the wizard is only shown when the user selects `Custom Conversion` as conversion type. It allows the user to specify the custom program that should be run and the command line parameters to use. The following parameters are available:

- `$SSN_INPUT$`: replaced by the absolute path + filename of the logged file
- `$SSN_INPUT_DIR$`: replaced by the absolute path (without trailing ”/”) of the logged file
- `$SSN_INPUT_FILE$`: replaced by filename of the logged file

When `Custom Conversion` is selected the next page of the wizard is the `Name and Description` page.

**RINEX Parameters**

This page of the wizard is only shown when the user selected a conversion type that includes RINEX conversion. It allows the user to specify the parameters for the RINEX converter.

**Compression Type** This page allows to select which compression should be applied on the file(s) resulting from the conversion. The possible options are:
- No Compression
- Zip Compression
- Unix Z Compression
- GZip Compression

**Output File Destination** Here the user can choose to move the created files to a FTP folder, to a local directory or to both. In case a FTP folder is selected the user has to fill in
(a) the FTP server,
(b) the FTP port number,
(c) the remote path on the FTP server (which must exist!),
(d) the login name and
(e) the password to use.
(f) the timeout of the FTP
(g) the transfer mode used by the FTP process (Passive or Active)

**Name and Description** This page allows to specify the Name and Description for the `Post Processing` rule.

Next to the `Add` button there is the `Edit` button. Clicking this button allows to change the settings for the `Post Processing` rule that is currently selected in the rules list. The `Delete` button removes the currently selected rule.

## 2.7.2 Septentrio Receiver Logging

### 2.7.2.1 Internal Logging Settings

Depending on the connected Septentrio Receiver, the internal logging options (if available) are shown in the logging menu.

Further explanation of those options can be found in the Firmware User Manual.

### 2.7.2.2 Download Internal Files

The entry `Logging | Download Internal Files...` allows to download the internal logged files that are stored on the non-volatile RAM of your Septentrio Receiver. The dialog shows a list of the files currently available on the Septentrio Receiver (see Figure 2.7-7 on the following page). One or more files of the list can be selected by clicking on them (keep `Ctrl` down in order to select multiple files). Files which are locked (indicated by `yes` in the `Locked` column of the list) are currently in use by the Septentrio Receiver and cannot be selected for download. During the download the progress of the current file is shown on the top progressbar, while the bottom one shows the overall progress.

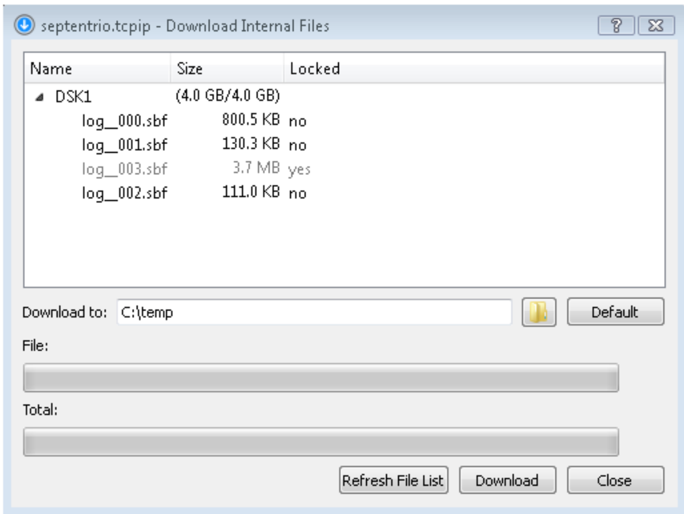



**Figure 2.7-7:** `Download Internal Files` dialog

## 2.8 Upgrading the receiver

If new firmware becomes available for the Septentrio Receiver, RxControl can be used as an upgrading tool. This is done by choosing `File | Upgrade Receiver using Current Connection` menu option or the `Start "Upgrade Receiver" Wizard` option in the connection dialog (see Figure 2.3-1 on page 22) which pops up at start-up. After the upgrade option is chosen, the connection to the receiver will be closed and all windows of RxControl will stop functioning.

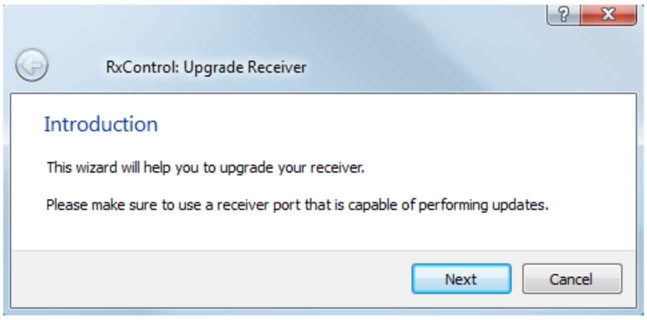



**Figure 2.8-1:** Upgrade Receiver

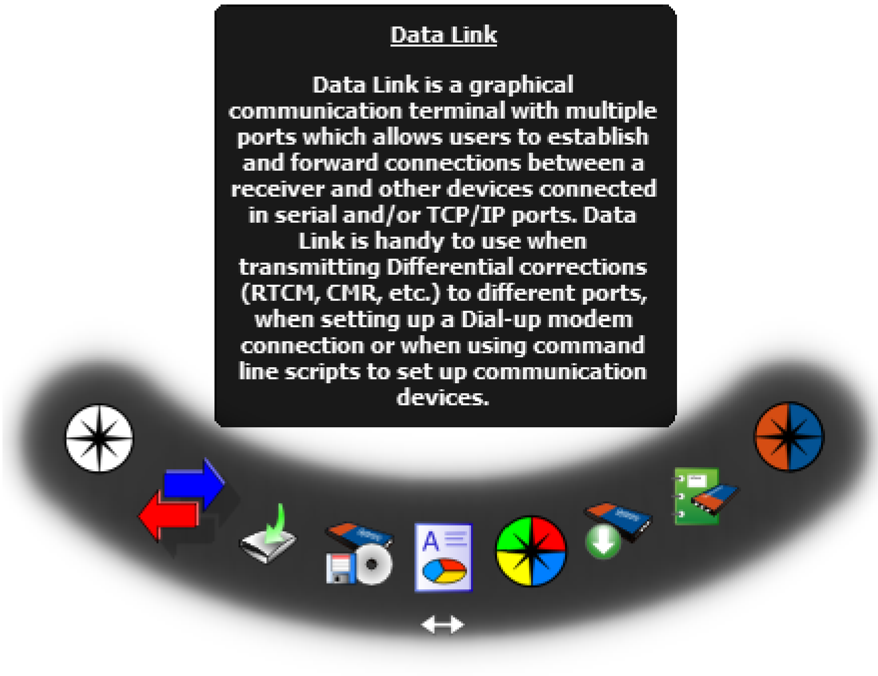
A wizard will be shown that guides you through the upgrade process. It allows you to select the PC's serial or TCP/IP port that should be used for the upgrade and the file containing the new receiver firmware.

Once the actual upgrade is in progress a progress bar monitors the progress. Some serial port emulation drivers don't provide correct progress information, causing the progress bar to complete before the upgrade is completed. A receiver upgrade can take up to several minutes so please leave the tool untouched until it finishes its process. Once the upgrade is done, the receiver is rebooted and will resume normal operation. In case of a failure an error dialog with the failure message will be shown.

After upgrading the user gets the `Change Connection` dialog to reconnect to the receiver.

# Chapter 3

# Data Link



# 3.1 Introduction

Data Link is a communication utility which allows users to establish connections between several serial, USB and/or TCP/IP ports. Data Link is divided into up to six Port Panels, each of which contains the controls to establish a simple connection to either a serial, USB or a TCP/IP port.

## 3.1.1 Data Link compatibility

**Data Link 2.4.0** is a versatile communication tool that can work not only with our receivers but with a wide variety of different devices. It is in essence a terminal emulator that can manage up to six connections at a time and pass data between any connected devices.

## 3.1.2 Launching DataLink

Data Link can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the Data Link executable can be found under 'Septentrio RxTools'. You can also launch Data Link via the 'Tools' menu of any of the GUI tools, for example from RxControl as shown in Figure 3.1-1.

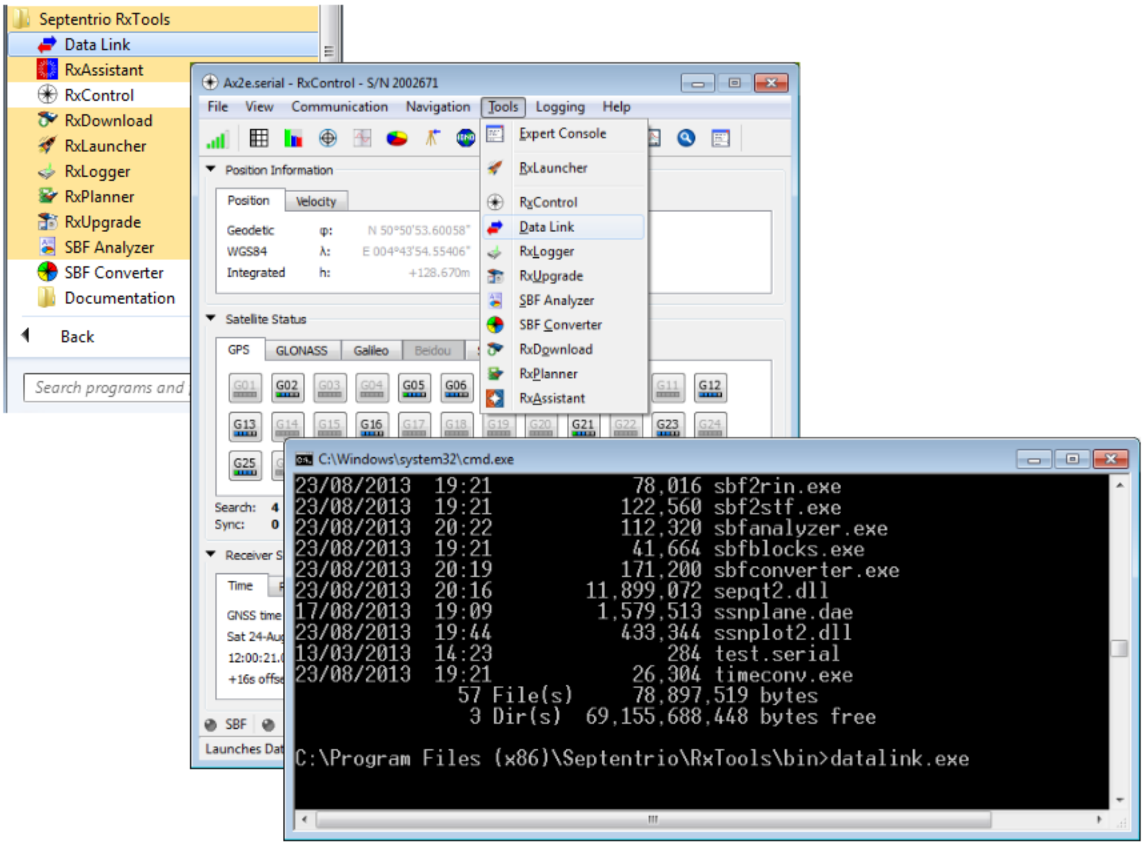



**Figure 3.1-1:** Launching the DataLink GUI

## 3.2 Getting started

### 3.2.1 Connecting to a receiver using Data Link

To be able to connect to a receiver using Data Link, your Septentrio Receiver should be up and running and connected to your PC using either a serial, USB or Ethernet cable.

#### 3.2.1.1 Configure Connection 1

There are up to six connection ports on Data Link each of which can connect to a different device. To configure ’Connection 1’ to connect to the receiver for example, click on the large button in the Connection 1 area shown highlighted in Figure 3.2-1.

In this example, a receiver is connected to the PC by a serial cable connected to COM2 of the receiver and a serial port on the PC labeled ’COM1’. A USB cable is also connected.

In the ’Select the connection’ box, serial and USB connections can be configured by selecting the ’Serial’ radio button. In Figure 3.2-1, the serial connection appears as ’COM1’ which is the name of the PC serial port and the USB connection which shows up as two virtual serial ports labeled ’COM28’ and ’COM29’.

When connected to a real serial COM connection, other properties of the connection may have to be configured e.g. baud rate however, for USB virtual COM ports, no further configuration is necessary.

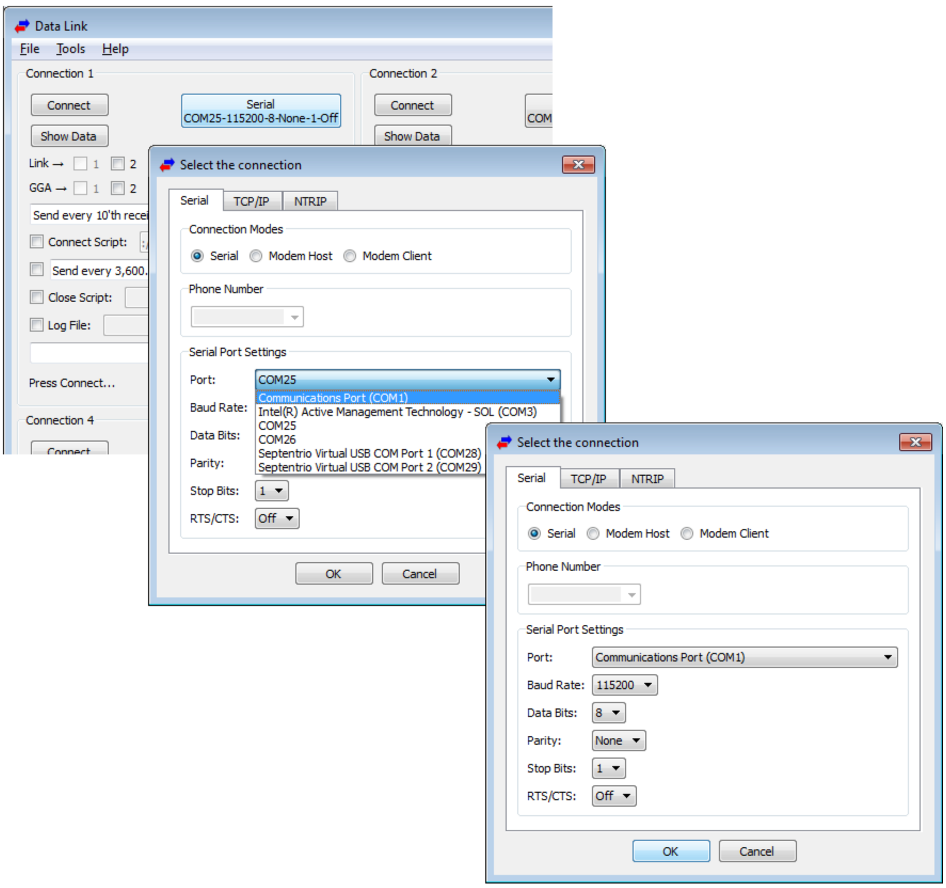



**Figure 3.2-1:** Configuring the Connection 1 port on Data Link

When the connection settings have been made, you can press the 'Connect' button and, if the connection is made, the button will change to 'Disconnect' as shown in Figure 3.2-2 and the information field at the bottom will say 'Connected to COM1'

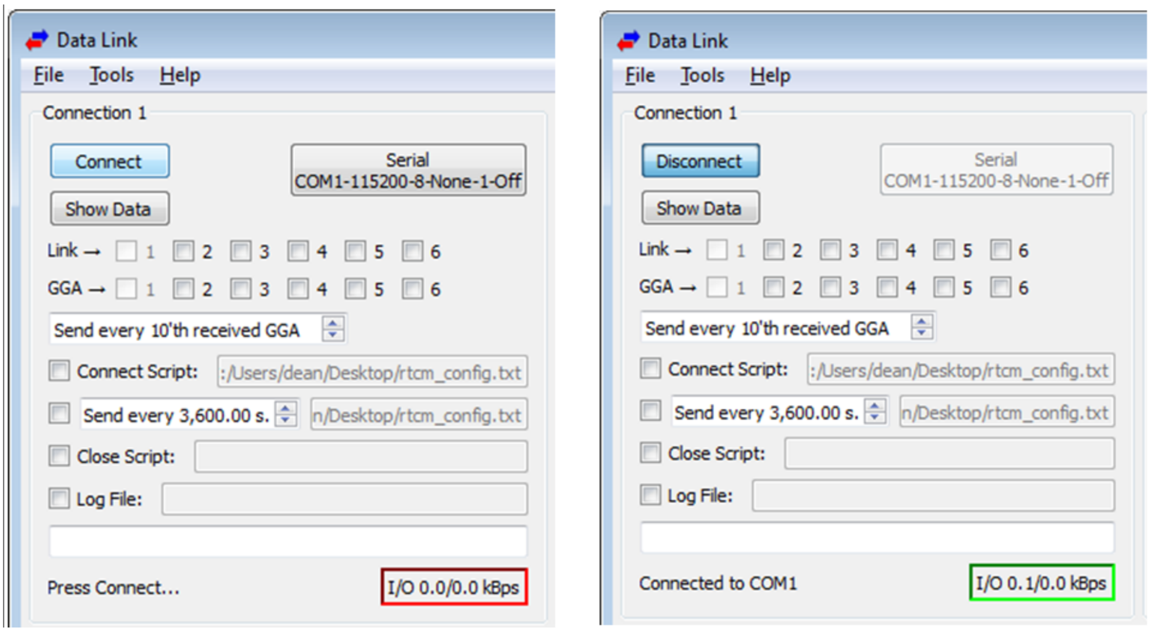



**Figure 3.2-2:** Connecting to the receiver

Clicking on the 'Show Data' button with bring up a terminal window on which you can send commands to the receiver and see the replies. The command prompt in Figure 3.2-3 shows 'COM2' as this serial port of the receiver that is connected.

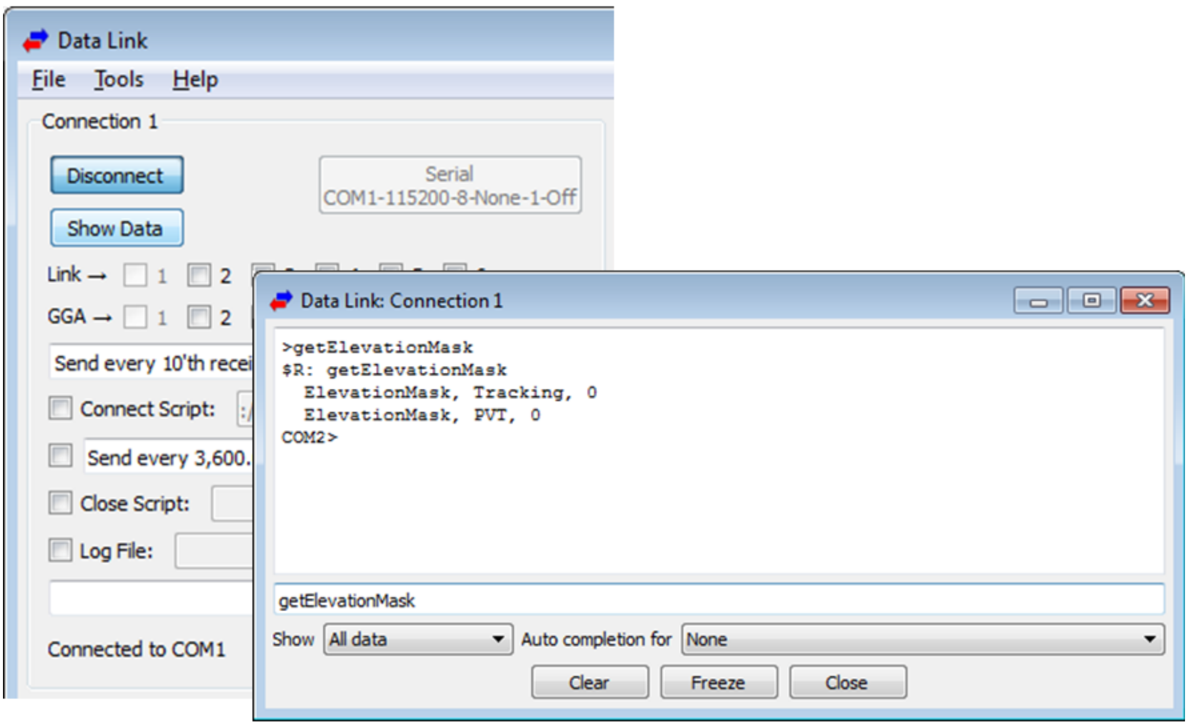



**Figure 3.2-3:** Sending commands to the receiver using Data Link

#### 3.2.1.2 Using scripts

Data Link has the possibility to upload a script when the connection is established and/or when the connection is closed. The uploading of scripts is controlled by the checkboxes ’Connect Script’ and ’Close Script’. When checking one of these a dialog will popup to select the script to upload.

It is sometimes necessary to have delays between commands. This can be done using the ’sleep’ command as shown below:

```
#@ sleep <duration> [unit]
```

- **duration:** the duration of the sleep.
- **unit:** time unit of the duration (millisec, sec, min). If not specified the duration is in milliseconds.

## 3.3 Data Link: a worked example in an RTK setup

This section details how Data Link can be used as an NTRIP client to retrieve differential correction data from the Belgian provider FLEPOS and send it to a receiver.

Figure 3.3-1 shows a schematic of the setup. Two separate connections are made on Data Link; Connection 1 to COM2 of the receiver and Connection 3 to the FLEPOS NTRIP server. The transfer of NMEA GGA and RTCM correction data between the receiver and FLEPOS is handled in Data Link using the check-boxes in the 'Link' and 'GGA' fields as shown.

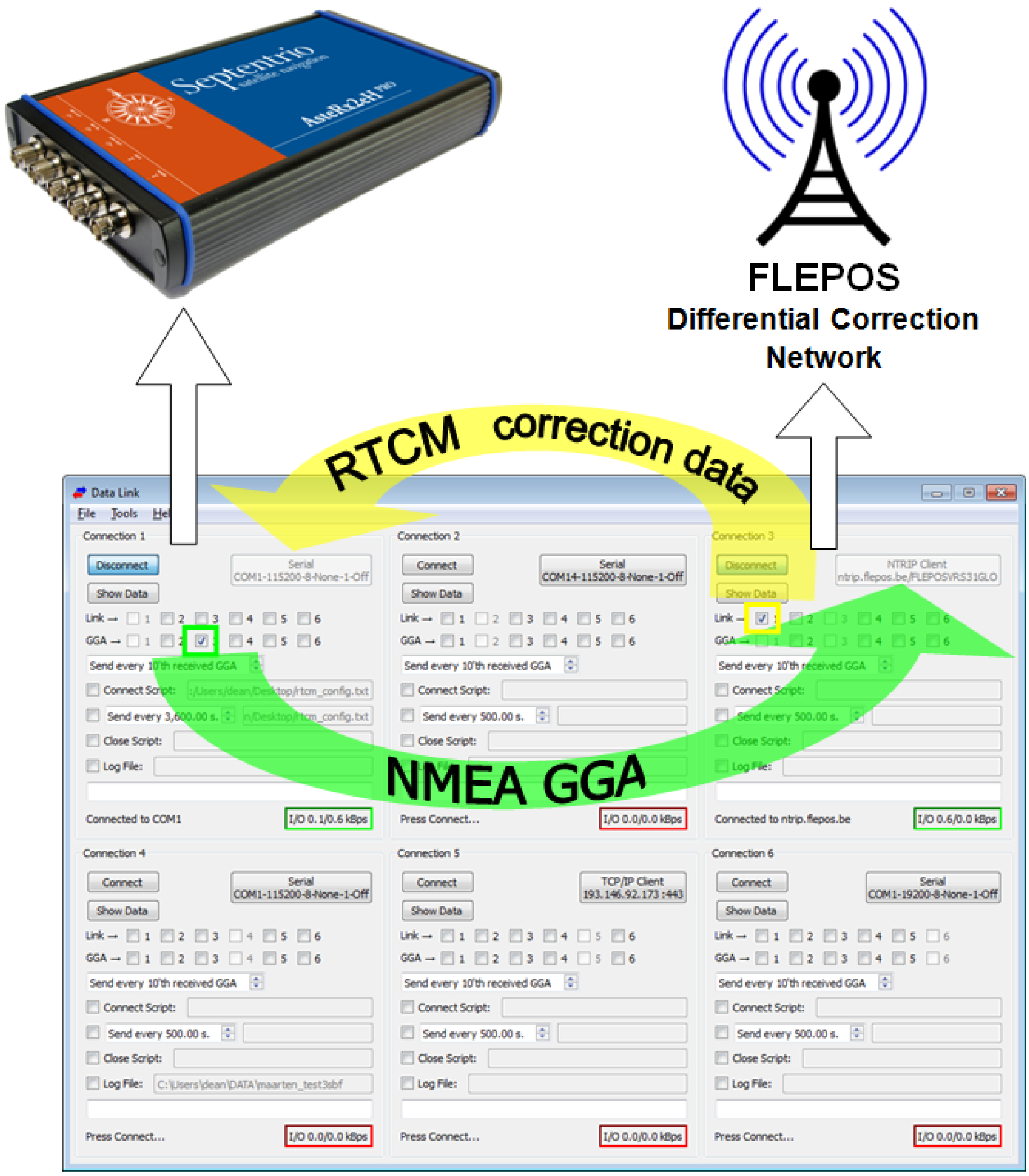



**Figure 3.3-1:** Schematic of an RTK setup using Data Link

### 3.3.1 Connecting to the receiver using Data Link

A connection is made between Data Link and the receiver using serial, USB or Ethernet as described in Section 3.2.1 on page 83.

## 3.3.2 Additional receiver settings for RTK

### 3.3.2.1 Receiver COM port settings for RTCMv3

In this example, Data Link is connected to COM2 of the receiver so the receiver has to be configured to accept differential correction of the correct format (RTCMv3 in this case) on COM2. Figure 3.3-2 shows how this setting can be made.

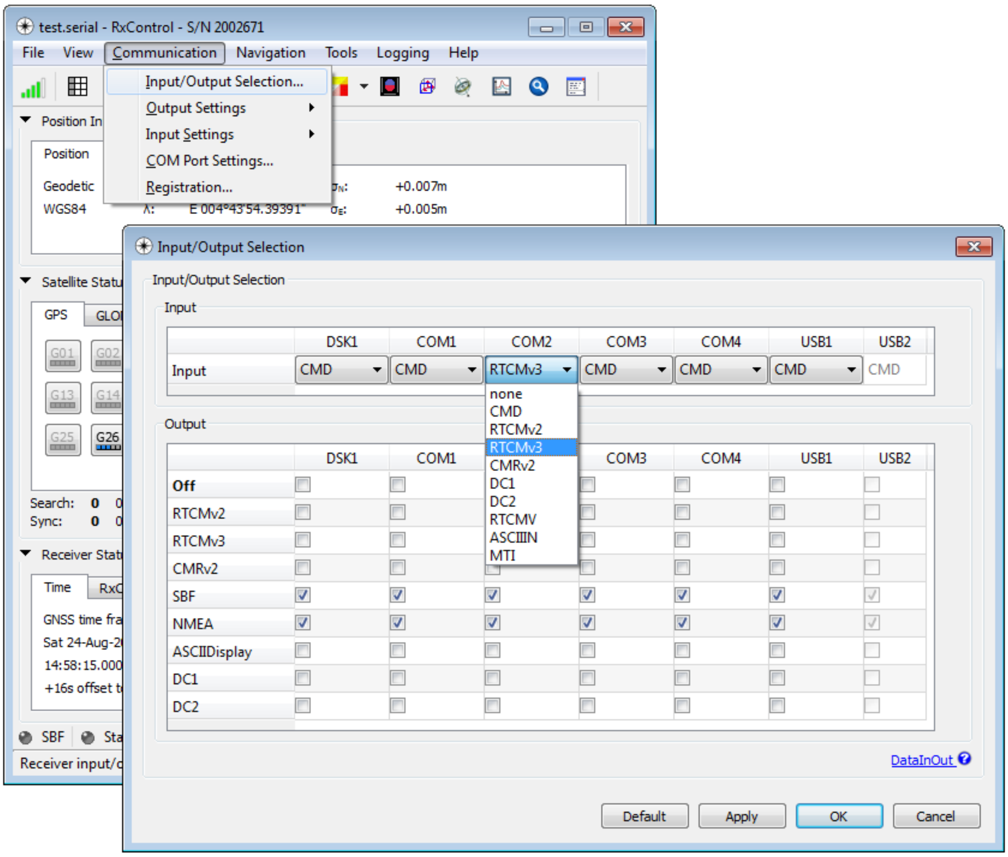



**Figure 3.3-2:** Configuring input of RTCMv3 to COM2

### 3.3.2.2 Output of NMEA GGA from the receiver

When using differential corrections from a network provider such as FLEPOS, the user usually has to provide his position to the network in order to get the appropriate correction data for his location. The user's position is sent to the network in the form of an NMEA GGA message. The receiver can be configured to output the GGA message every 1 second over COM2 as shown in Figure 3.3-3

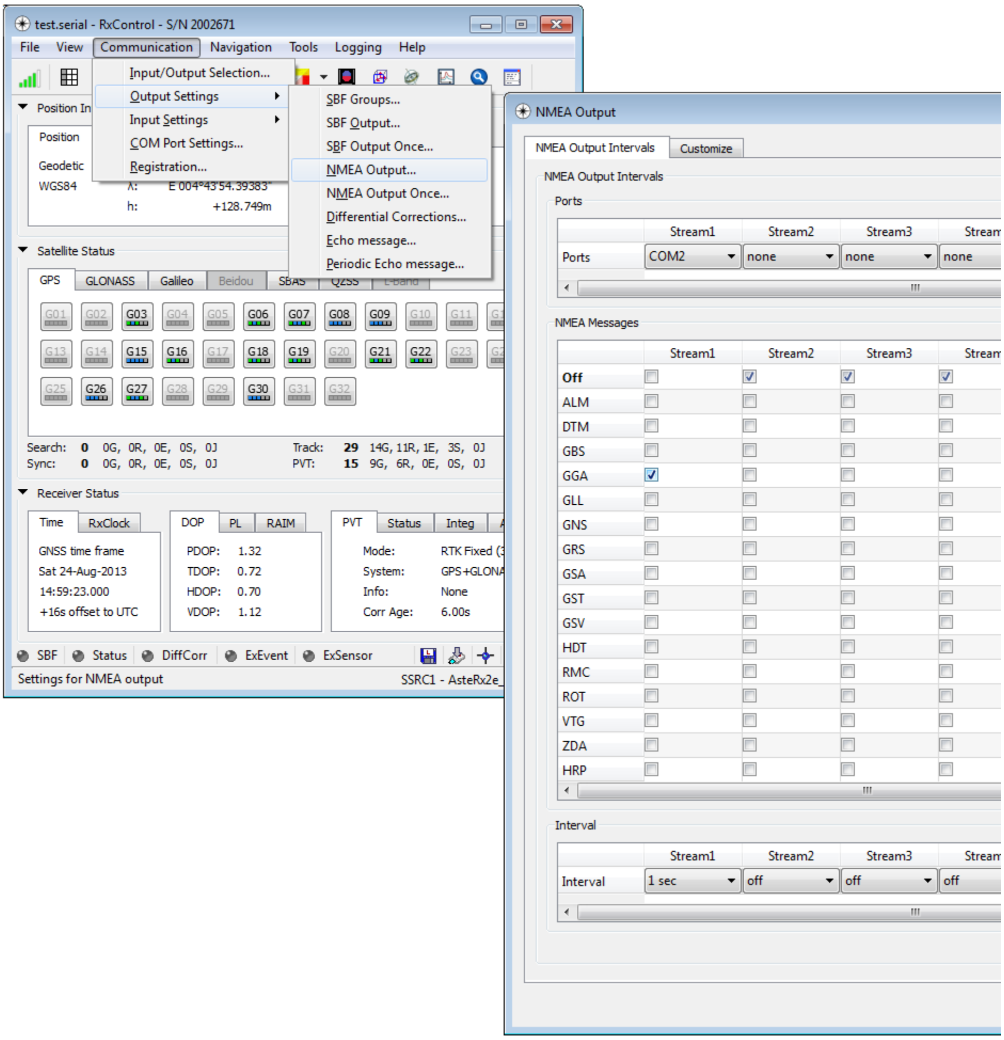



**Figure 3.3-3:** Configuring output of GGA

## 3.3.3 Configuring the NTRIP connection

Taking a different connection field (Connection 3 in this example) again click on the large button this time selecting the 'NTRIP' tab. Clicking on 'Edit ...' will bring up the 'Ntrip Settings' dialog as Figure 3.3-4 on the next page shows. Here, the caster settings, user name and password of the NTRIP account can be entered. If these details have been entered correctly, the 'Stream' drop-down list will become active and the desired differential correction stream can be selected.

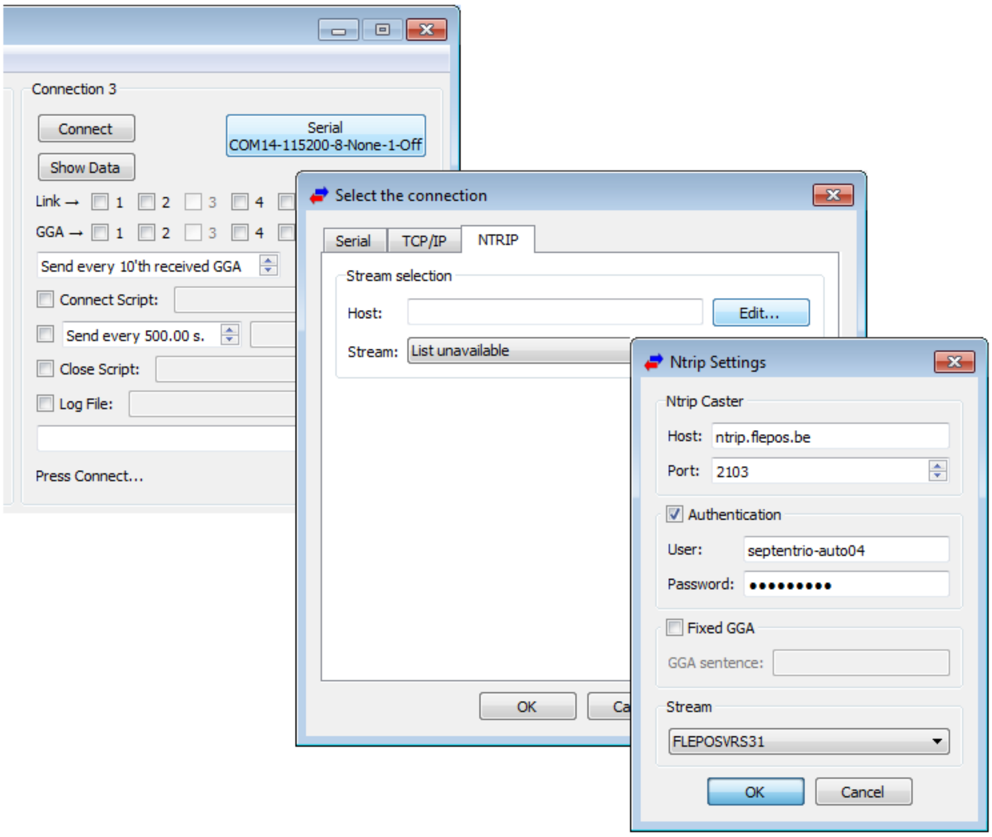



**Figure 3.3-4:** Connection settings for FLEPOS

The 'Details...' button gives more information on the selected NTRIP stream as shown in Figure 3.3-5.

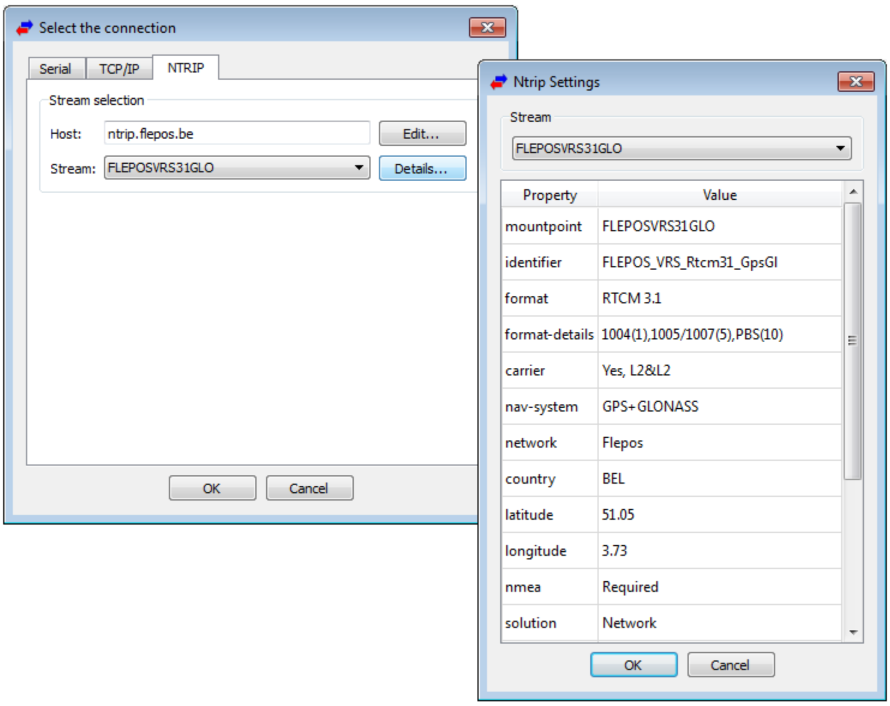



**Figure 3.3-5:** Details of the correction stream

### 3.3.4 Transferring data between different Connections on Data Link

The final step is to transfer the differential corrections arriving at *Connection 3* on Data Link from the NTRIP connection to the receiver on *Connection 1* and vice versa for the GGA. This is done by checking box '1' of the *Link* field on *Connection 3* and box '3' on *Connection 1* as shown in Figure 3.3-6.

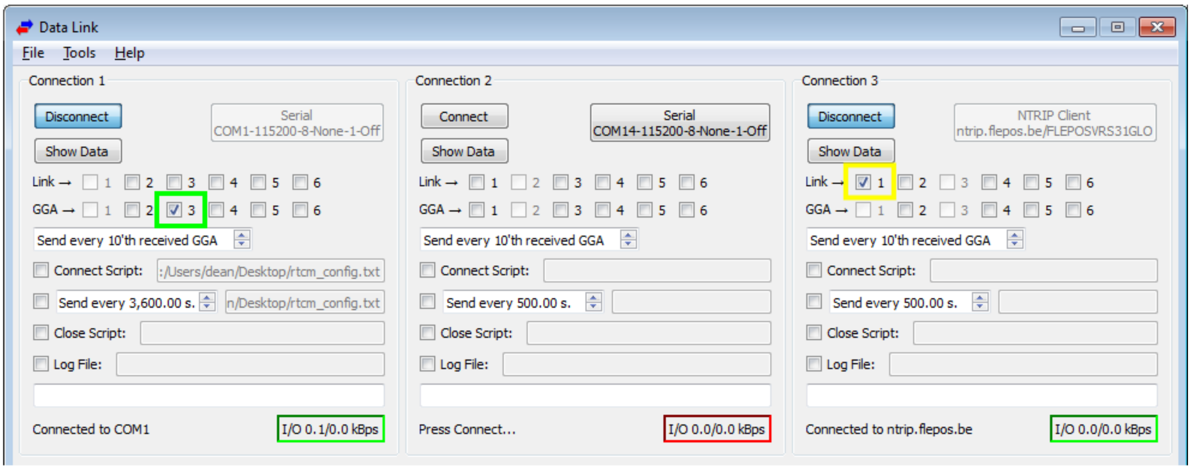



**Figure 3.3-6:** Transferring correction data and GGA between the receiver and the network server

If the setup is correct clicking on the 'Show Data' will show a steady stream of complex binary data with the ASCII GGA sentence appearing every second. Note that normally no correction data are sent until the network gets its first GGA message which means that the receiver has to have a position.

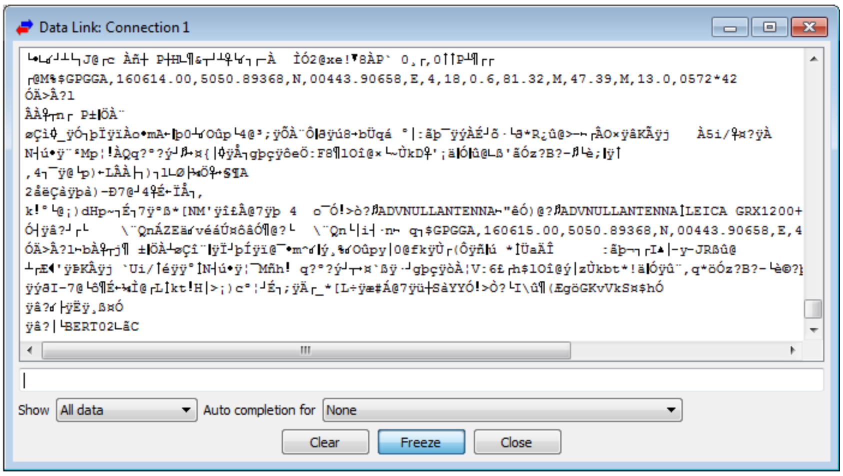



**Figure 3.3-7:** RTCMv3 and the GGA message on *Connection 1*

The receiver should report the reception of differential corrections; indicated by the green *DiffCorr* LED at the bottom of the main window in RxControl as shown in Figure 3.3-8 on the following page.

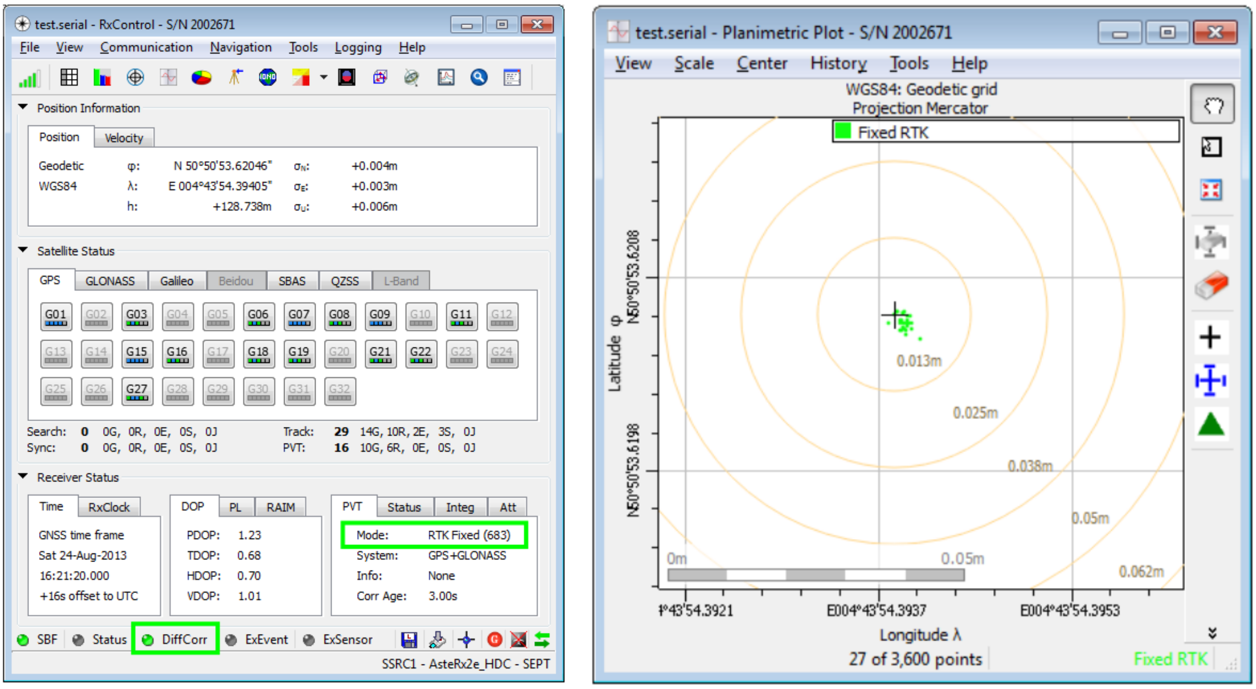



**Figure 3.3-8:** RxControl main window and planimetric plot. RTK fix mode and DiffCorr LED are indicated.

# Chapter 4

# SBF Converter

# 4.1 Introduction

SBF Converter is a conversion utility which allows users to convert SBF logged files of the Septentrio Receiver to other formats such as RINEX, ASCII, GPX and KML. The commands, if logged in a file, can also be converted to a readable text format. Once SBF Converter 2.7.0 is installed, it can be launched by clicking the `SBF Converter` short-cut icon created by the installation program. Please consult the HTML help pages of SBF Converter 2.7.0 for more information on this program.

## 4.1.1 SBF Converter compatibility

**SBF Converter 2.7.0** can convert data logged using any Septentrio Receiver however, some older SBF blocks particular to the PolaRx2/2e may not be fully compatible with SBF Converter.

## 4.1.2 Launching SBF Converter

SBF Converter can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the SBF Converter executable can be found under 'Septentrio RxTools'. You can also launch SBF Converter via the 'Tools' menu of any of the GUI tools, for example from RxControl as shown in Figure 4.1-1. Users who prefer to use the command line are advised to use the SBF Tools and are directed to Section 11 on page 169 for more information.

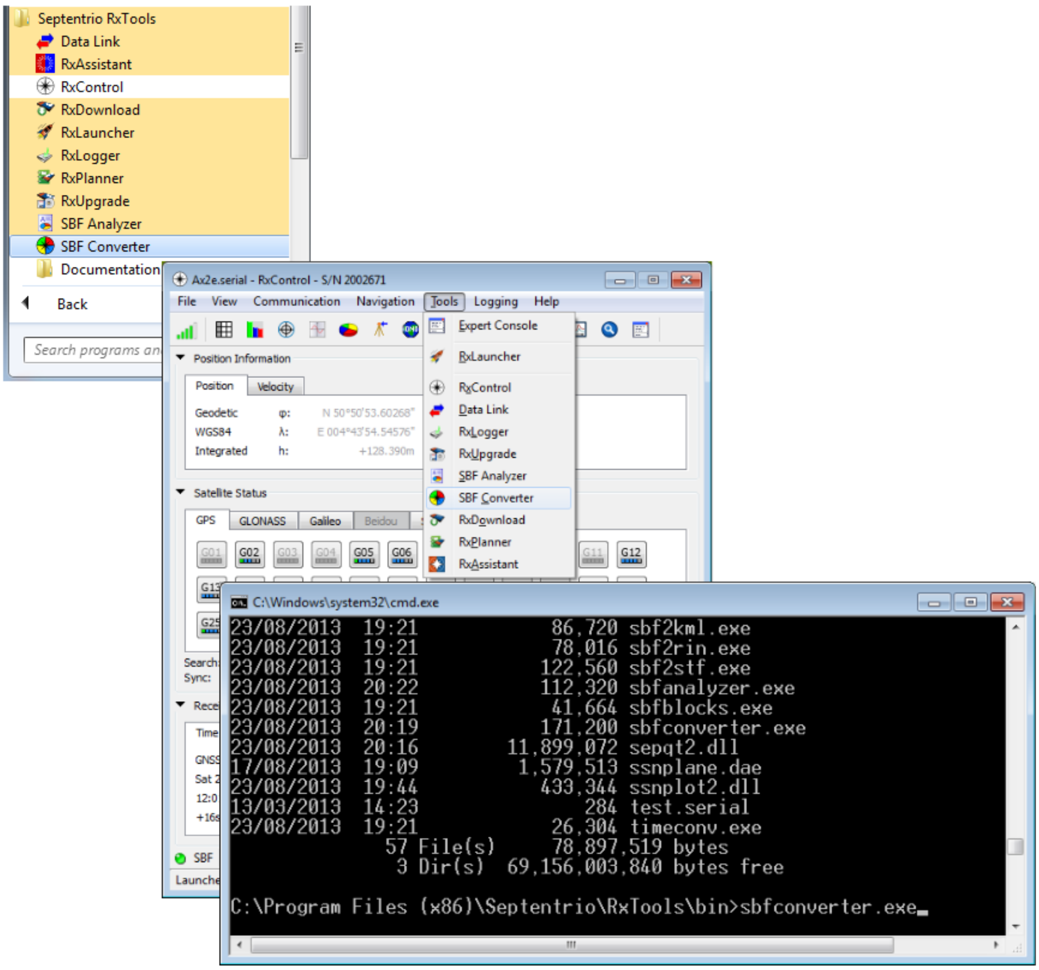



**Figure 4.1-1:** Launching the SBF Converter GUI

# 4.2 Using SBF Converter: a worked example

## 4.2.1 Conversion to RINEX

SBF files can be opened in SBF Converter by clicking on either the folder icon next to the *Single file* field or the *Choose file* button next to the *Multiple files* field as Figure 4.2-1 shows.

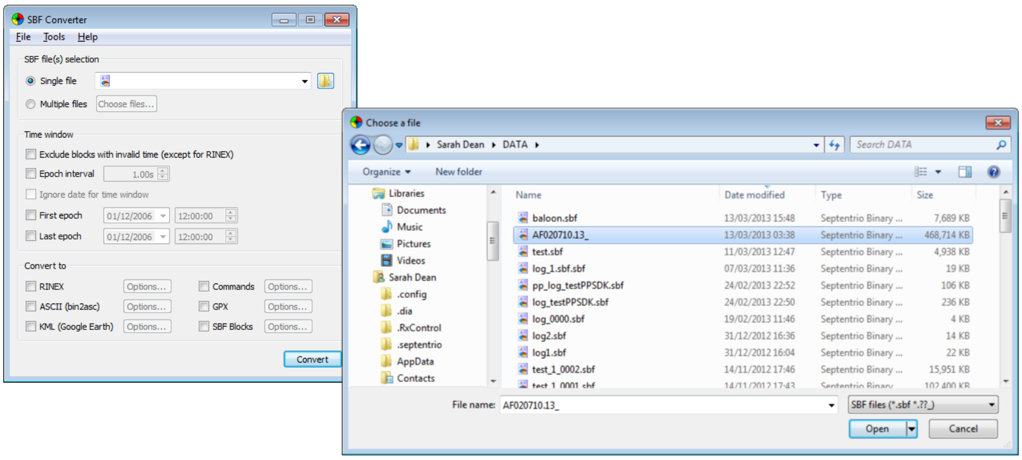



**Figure 4.2-1:** Opening a file with SBF Converter

The sequence of screenshots in Figure 4.2-2 show the steps involved in configuring SBF Converter to convert SBF data to the RINEX format.

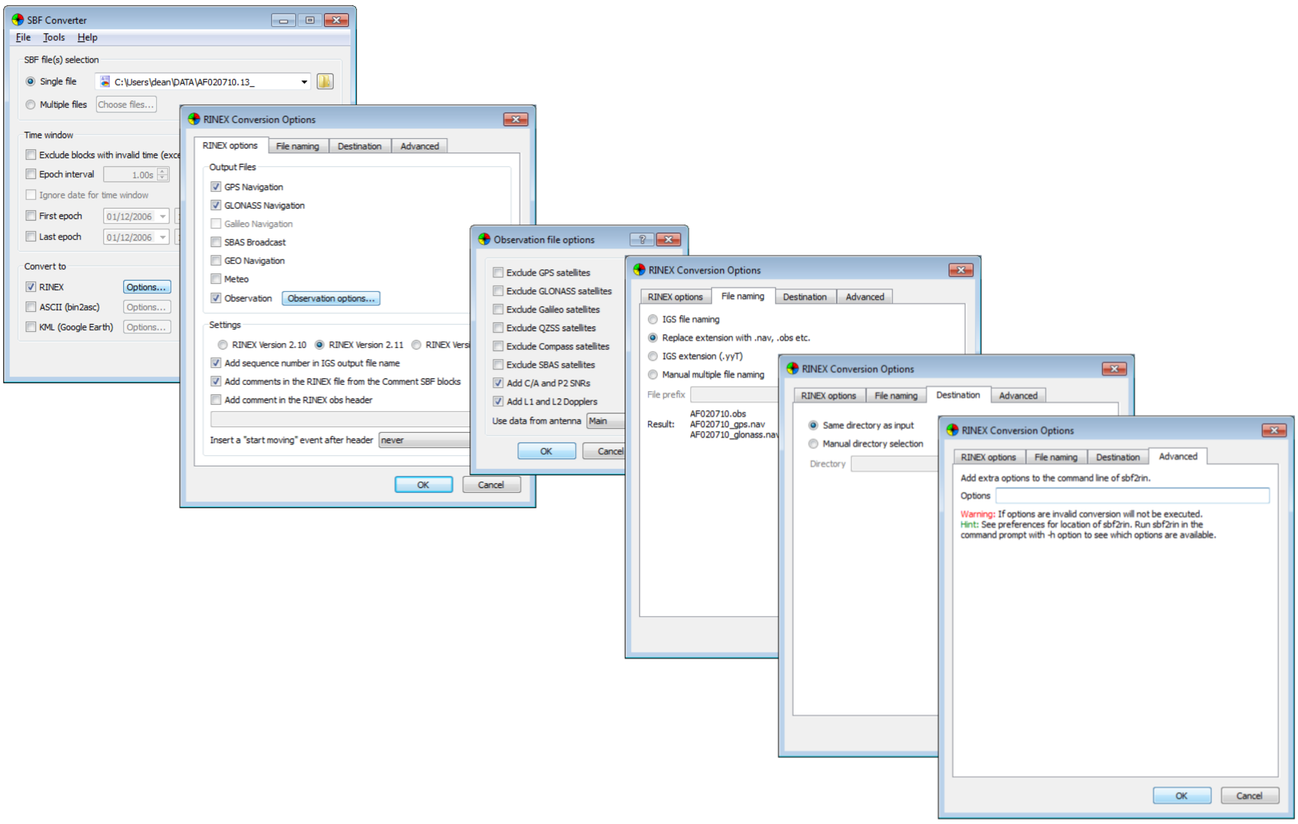



**Figure 4.2-2:** Configurations for RINEX conversion

Having made the configuration for RINEX conversion, you can then click on the *Convert* button which will produce a RINEX file similar to the example shown in Figure 4.2-3.

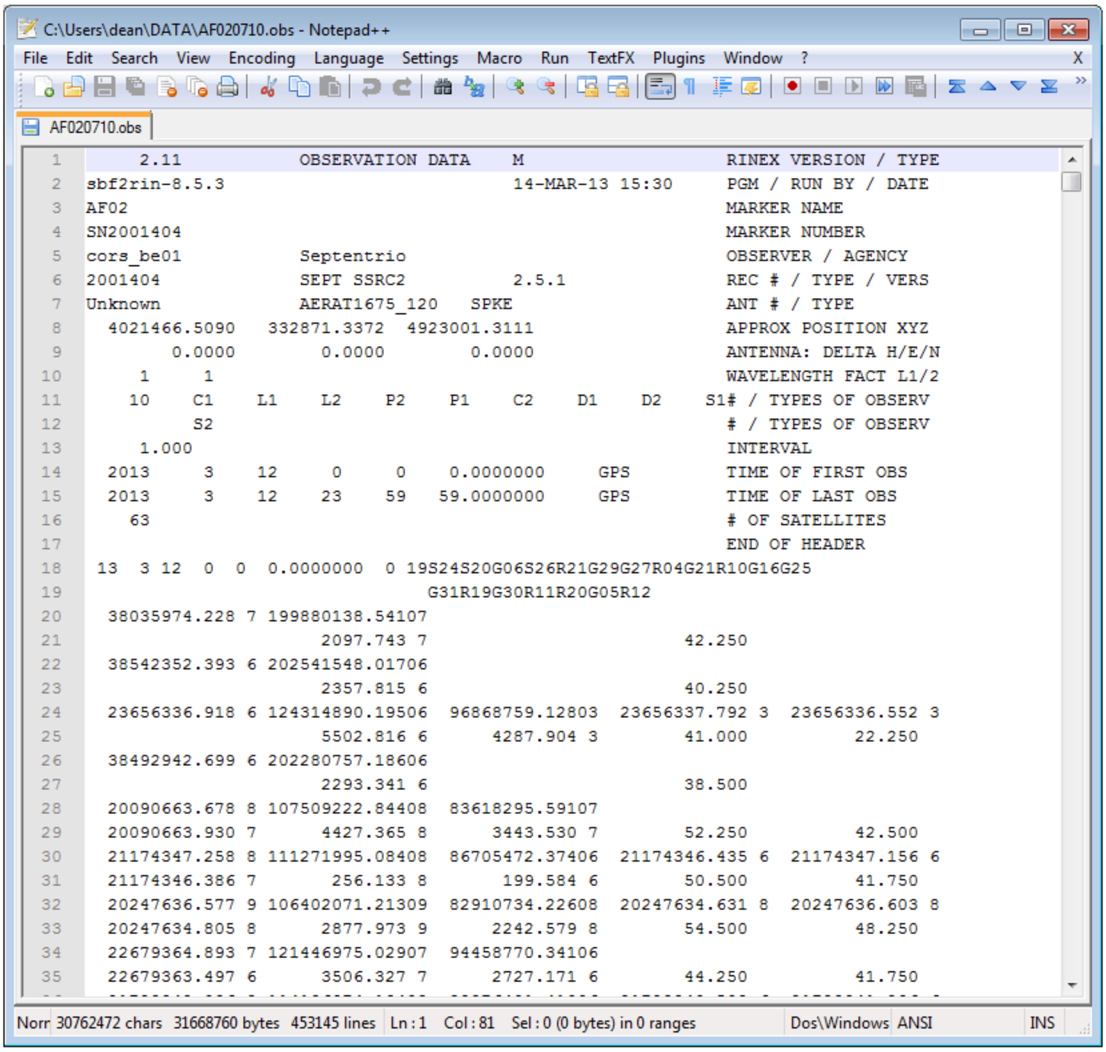



**Figure 4.2-3:** Example of a RINEX file

Note that, in order to generate RINEX files, the SBF file must contain the relevant data for RINEX. The necessary blocks are selected automatically when checking the *Rinex* box in the *SBF* tab of either RxControl logger or RxLogger as shown in Figure 6.2-4 on page 131. If the SBF file does not contain the necessary blocks for the required conversion, SBF Converter will give an error such as that reported in Figure 4.2-4.

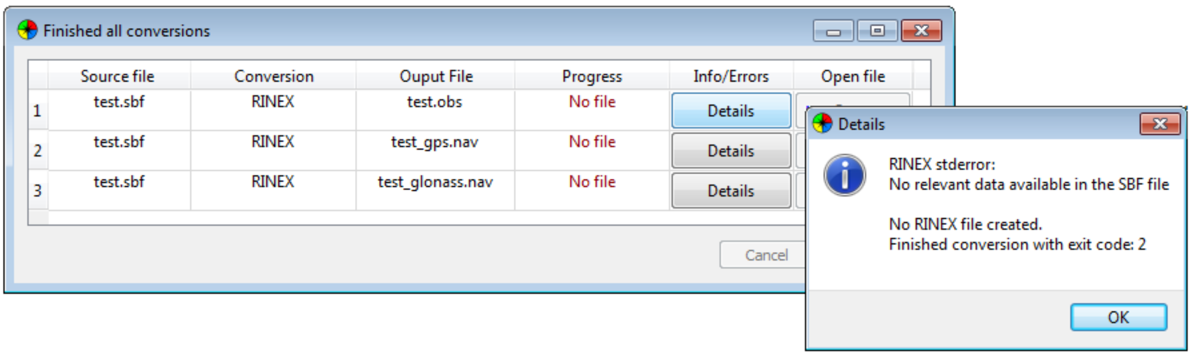



**Figure 4.2-4:** Error message when RINEX cannot be generated

### 4.2.2 Conversion to ASCII

The contents of an SBF file can be converted to the more readable ASCII format as shown in the sequence of screenshots in Figure 4.2-5. There are various options that can be selected for ASCII generation two of the most useful being *Show column titles* and, in order to have the output in a format compatible with other analysis tools; the *Change field delimiter to* option.

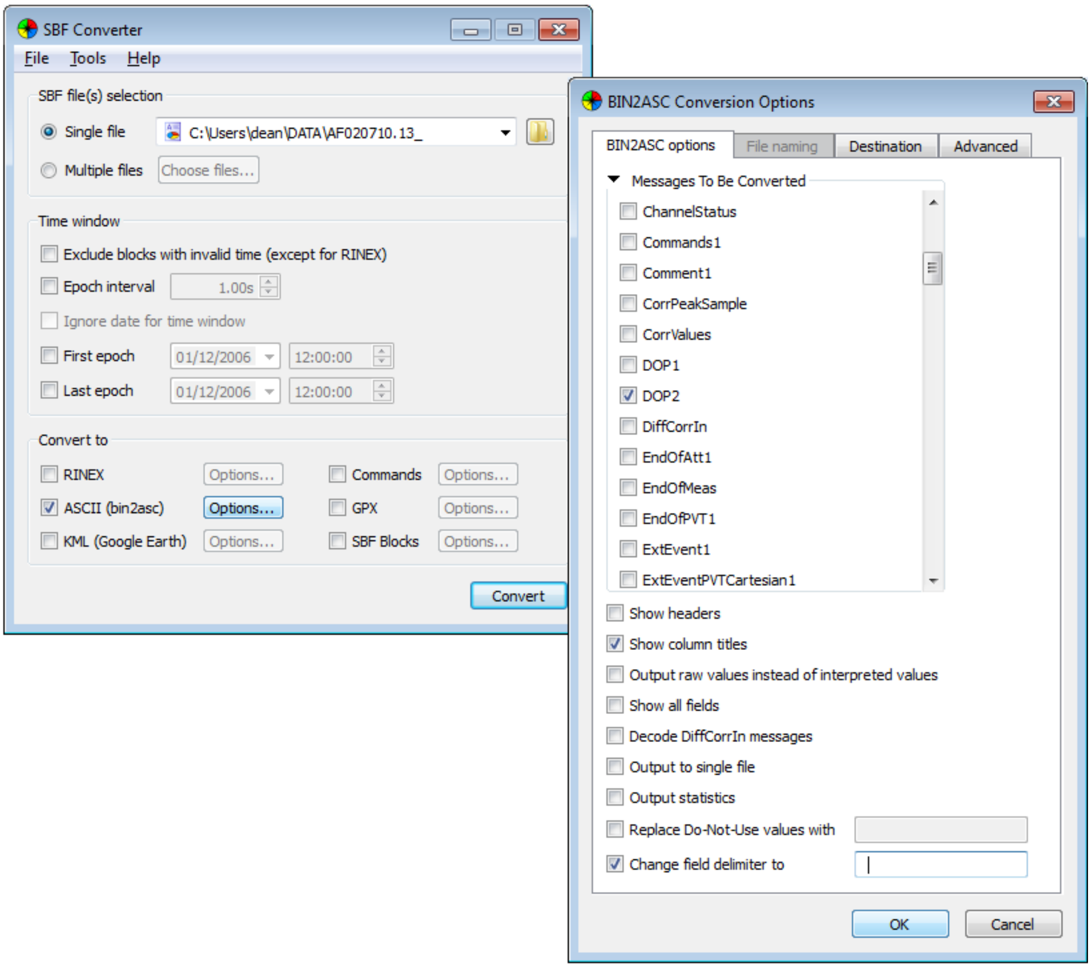
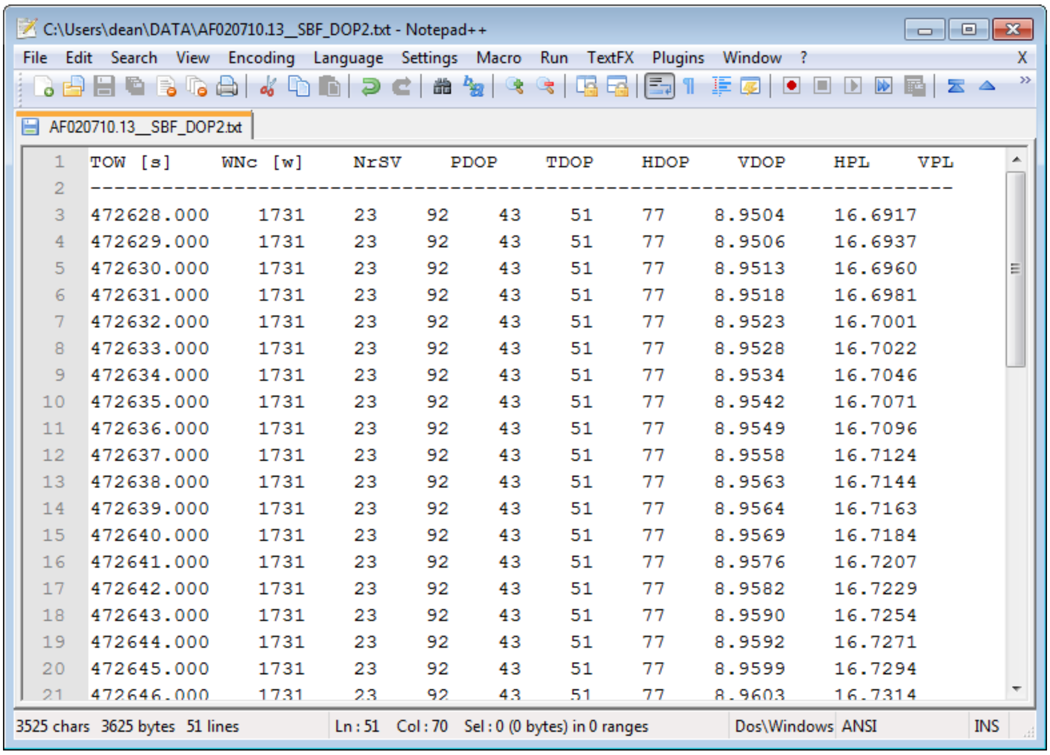



**Figure 4.2-5:** Example of a converted DOP SBF block

Figure 4.2-6 on the next page show the ASCII conversion of the DOP SBF block where *Show column titles* has been selected and the field delimiter has been changed from the default comma to a double space.




| TOW [s] | WNc [w] | NrSV | PDOP | TDOP | HDOP | VDOP | HPL | VPL |
|---|---|---|---|---|---|---|---|---|
| 472628.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9504 | 16.6917 |
| 472629.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9506 | 16.6937 |
| 472630.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9513 | 16.6960 |
| 472631.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9518 | 16.6981 |
| 472632.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9523 | 16.7001 |
| 472633.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9528 | 16.7022 |
| 472634.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9534 | 16.7046 |
| 472635.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9542 | 16.7071 |
| 472636.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9549 | 16.7096 |
| 472637.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9558 | 16.7124 |
| 472638.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9563 | 16.7144 |
| 472639.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9564 | 16.7163 |
| 472640.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9569 | 16.7184 |
| 472641.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9576 | 16.7207 |
| 472642.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9582 | 16.7229 |
| 472643.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9590 | 16.7254 |
| 472644.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9592 | 16.7271 |
| 472645.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9599 | 16.7294 |
| 472646.000 | 1731 | 23 | 92 | 43 | 51 | 77 | 8.9603 | 16.7314 |

**Figure 4.2-6:** Configuration for ASCII conversion

In addition to **bin2asc**, you can find in the preferences menu of SBF Converter that there are two other possibilities for conversion to text format: **sbf2asc** which was created primarily as a sample application to assist users in developing their own conversion tools and the older **sbf2stf** which is being phased out in favour of **bin2asc**. These tools can also be used in the command line as is explained in Section 11 on page 169.

## 4.2.3 Conversion to Google Earth KML

Logged data files containing any of the SBF positioning blocks (i.e. PVTCartesian, PVTGeodetic, IntPVCart and IntPVGeod) can be converted to KML format which can be displayed on Google Earth. By clicking on the 'Options...' button next to the KML checkbox, you can select various settings for KML generation. Standard settings are shown in Figure 4.2-7.

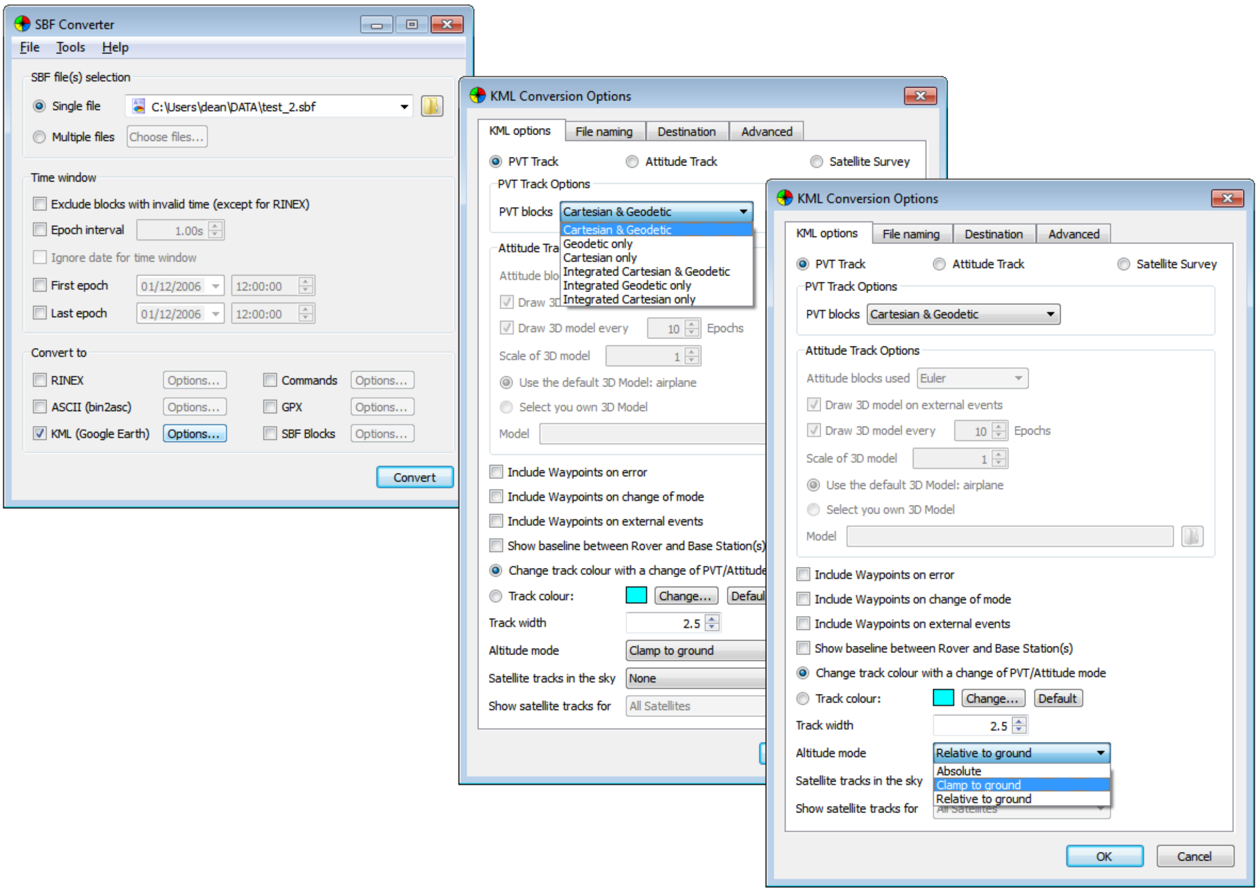



**Figure 4.2-7:** Configuration for KML conversion

When the conversion has finished, the file can be opened in Google Earth by clicking on the 'Open' button as shown in Figure 4.2-8.

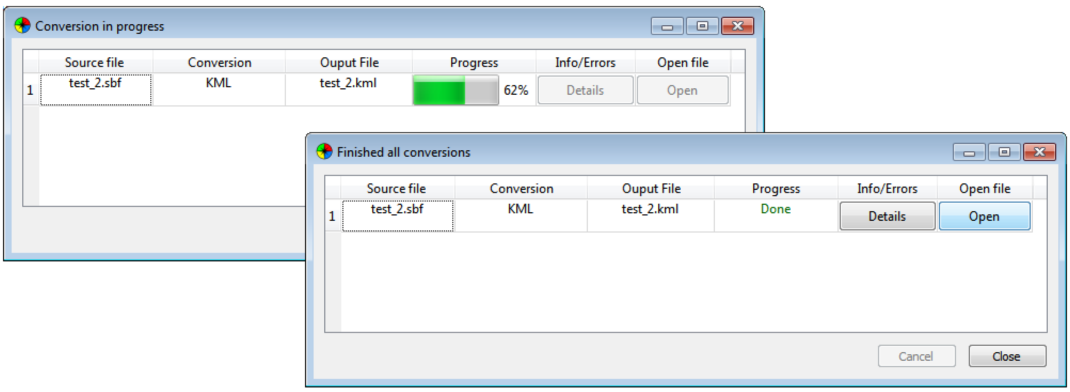



**Figure 4.2-8:** Opening the converted file

The results of the KML conversion are given in Figure 4.2-8 on the previous page which shows the trajectory of a car test. The color of the trajectory indicates the positioning mode as given in the legend. The zoomed panel shows a fall-back from RTK fixed positioning mode to differential then RTK float which is due to the car going under a bridge.

For the AsteRx2eH and AsteRx2i receivers that can additionally output attitude, selecting 'Attitude Track' in the KML options tab will show the vehicle trajectory where the color indicates the attitude mode.

The color of the track when selecting the 'Satellite Survey' option indicates the satellite tracking status: no tracking, tracked or tracked and PVT.

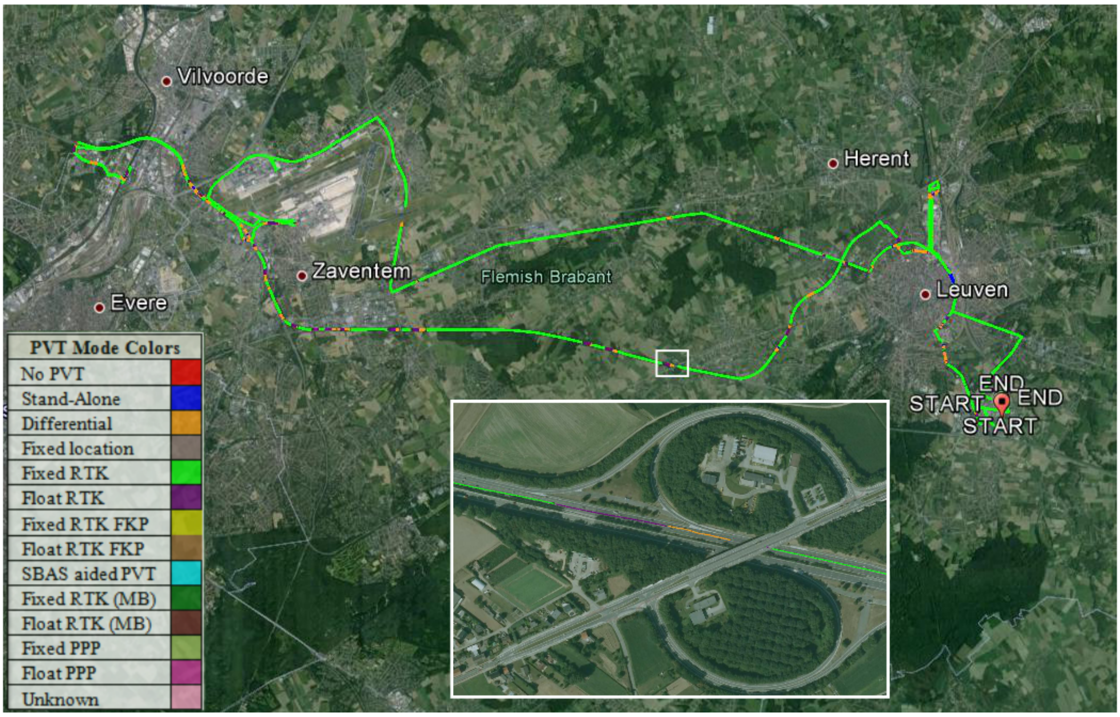



**Figure 4.2-9:** KML file displayed in Google Earth

### 4.2.4 Conversion of Commands

The 'Commands' SBF block contains a list of the commands used to configure the receiver. When this block has been logged in a data file, the contents of the block can be converted to a text file. There are a number of options associated with this conversion as Figure 4.2-10 shows. The '.asn1' file is the receiver MIB description and tells SBF Converter how to convert the commands. The MIB file can be downloaded from the receiver using RxControl as shown in Figure 4.2-11. If no '.asn1' is selected then the commands will not be fully readable.

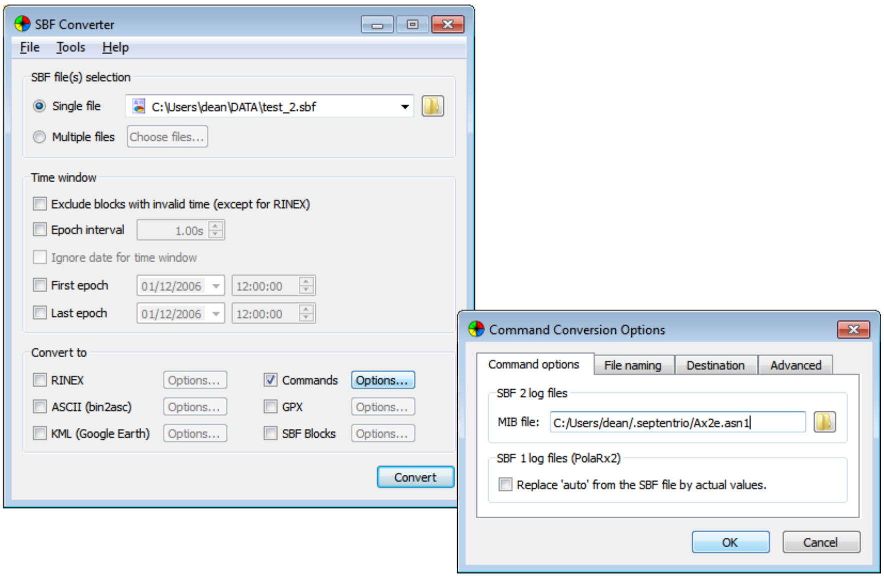



**Figure 4.2-10:** Configuration for conversion of receiver commands

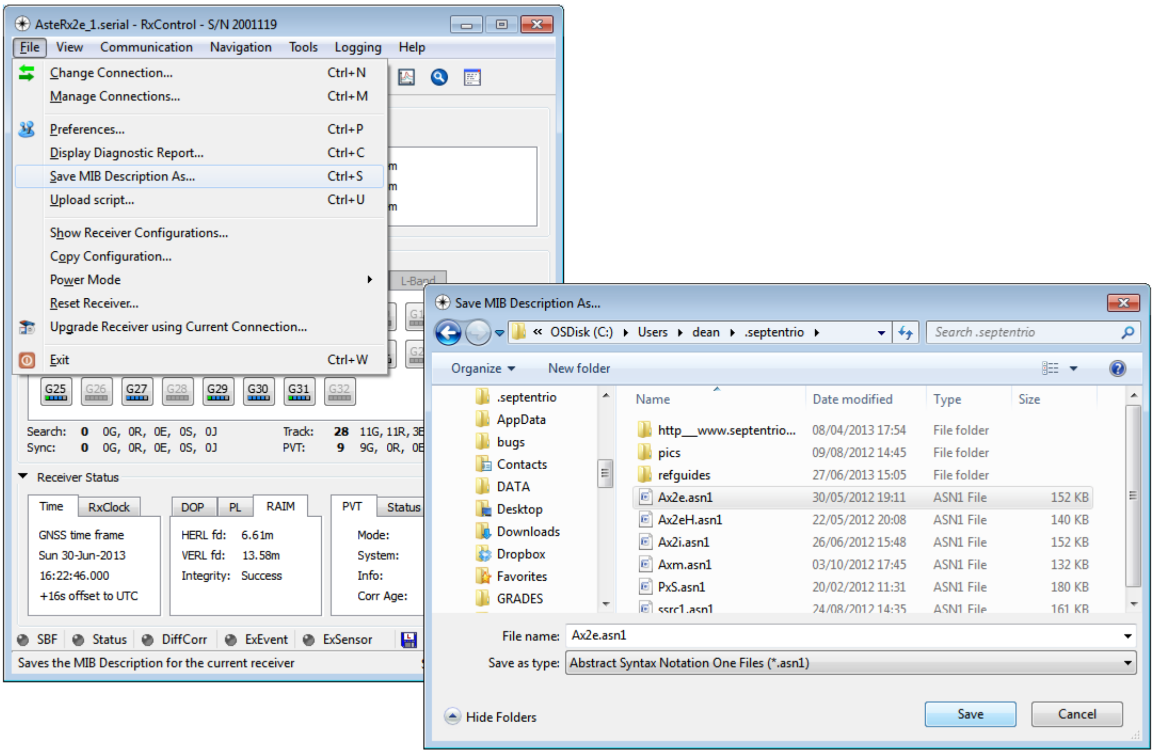



**Figure 4.2-11:** How to save the receiver MIB description

When the conversion has finished, the text file with the list of commands can be opened by clicking on the 'Open' button as shown in Figure 4.2-12.

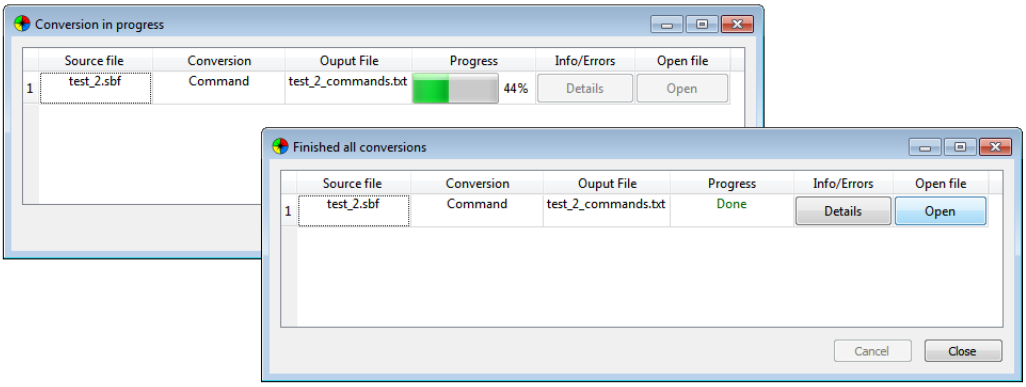



**Figure 4.2-12:** Opening the converted Commands file

Figure 4.2-13 shows an example of the results of the conversion. In this case, the receiver was configured to accept differential correction data in RTCMv3 format over COM3.

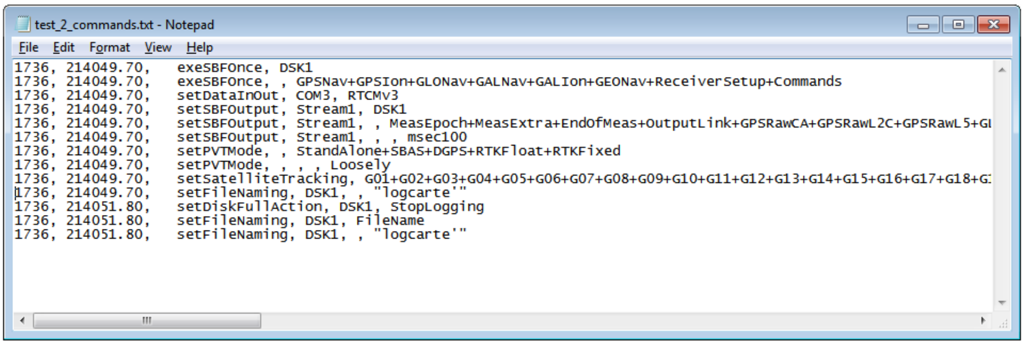



**Figure 4.2-13:** Example of a converted Commands file

### 4.2.5 Conversion to GPX

Logged data files containing any of the SBF positioning blocks (i.e. PVTCartesian, PVTGeodetic, IntPVCart and IntPVGeod) can be converted to GPS eXchange Format (GPX). The Standard settings are shown in Figure 4.2-7 on page 98.

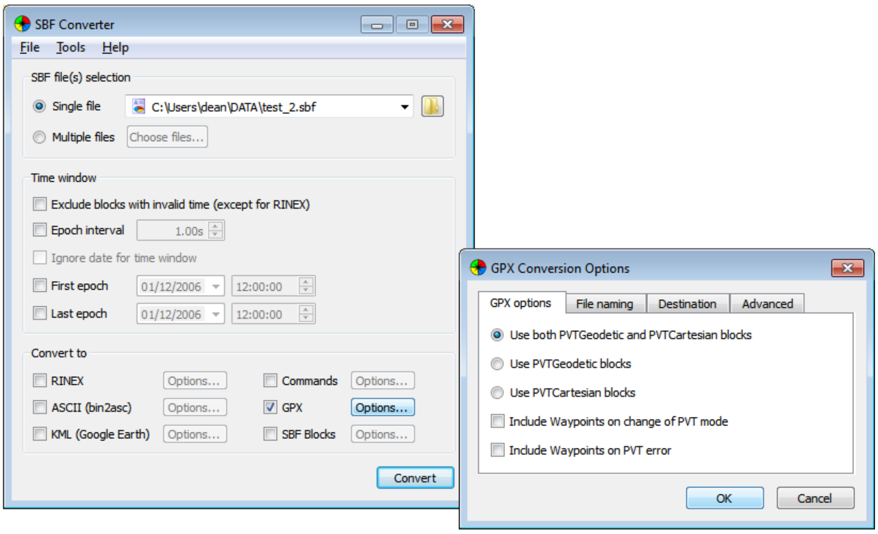



**Figure 4.2-14:** Configuration for GPX conversion

Google Earth can also display files in GPX format as Figure 4.2-15 shows. In this format, changes of positioning mode can be indicated by waypoint flags.

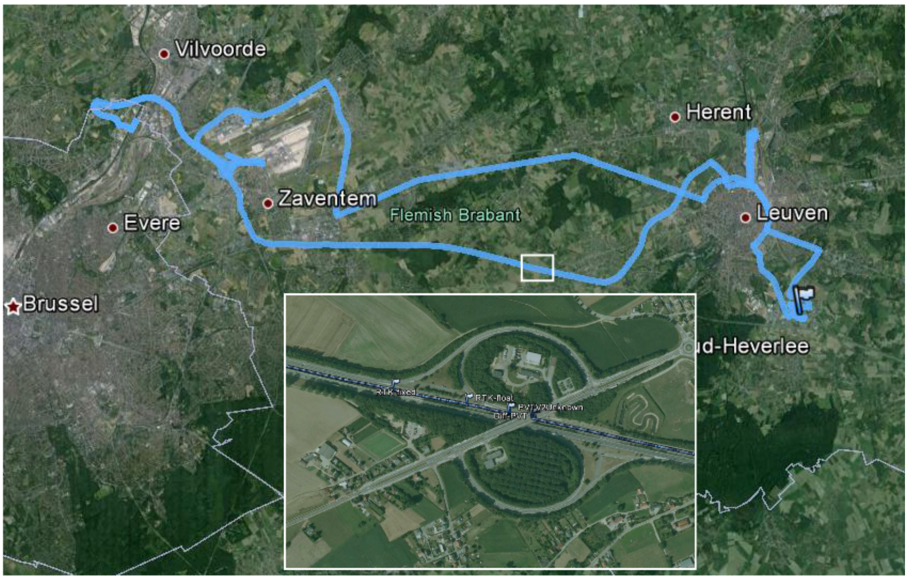



**Figure 4.2-15:** GPX file displayed in Google Earth

### 4.2.6 Conversion of SBF Blocks

SBF Analyzer also includes the option **`SBF Blocks`**. This conversion will list the individual SBF blocks in a file along with their time stamp. In the example shown in Figure 4.2-16 the file 'test_2.sbf' is converted using the default settings.

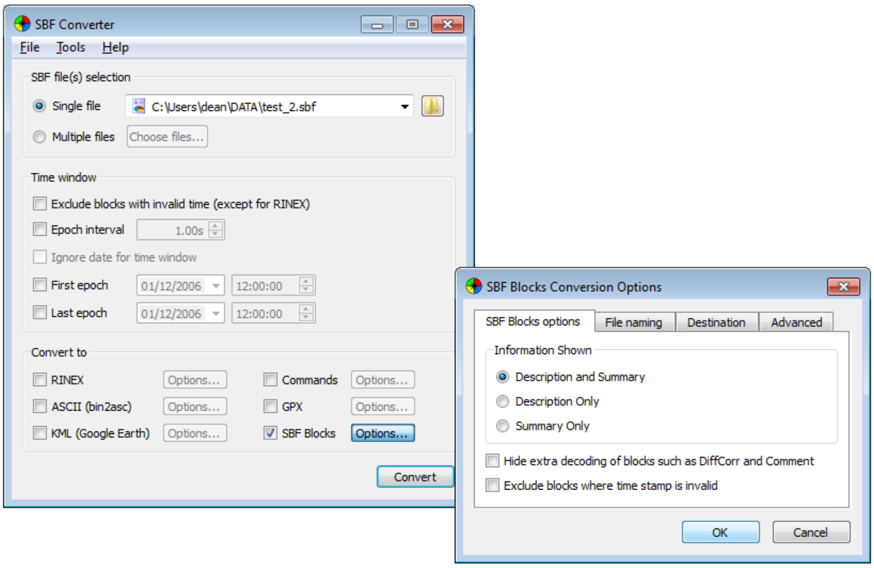


**Figure 4.2-16:** Configuration for SBF Blocks conversion

This generates a text file called 'test_2_blocks.txt' in the same directory as the SBF files as Figure 4.2-17 shows.

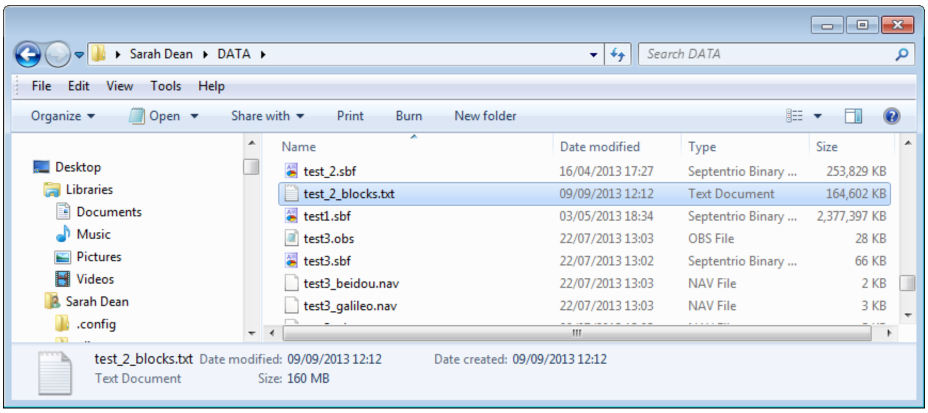


**Figure 4.2-17:** Text file generated by SBF Blocks conversion

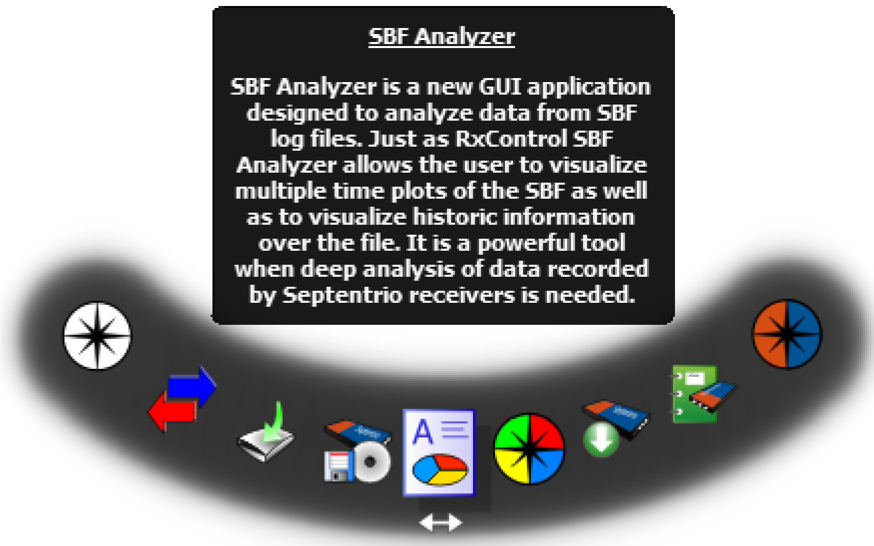
A sample of an **`SBF Blocks`** conversion for one epoch is given below.

```
1050146850.300 [012219][4027]  [FlexRate esoc] MeasEpoch (v2) = measurement set of one epoch
1050146850.300 [020384][4000]  [FlexRate esoc] MeasExtra (v1) = additional info such as observable variance
1050146850.300 [005922][5922]  [FlexRate esoc] EndOfMeas (v1) = measurement epoch marker
1050146850.300 [020391][4007]  [FlexRate esoc] PVTGeodetic (v2) = Position, velocity, and time in geodetic coordinates
1050146850.300 [005906][5906]  [FlexRate esoc] PosCovGeodetic (v1) = Position covariance matrix (Lat, Lon, Alt)
1050146850.300 [005908][5908]  [FlexRate esoc] VelCovGeodetic (v1) = Velocity covariance matrix (North, East, Up)
1050146850.300 [004001][4001]  [FlexRate esoc] DOP (v2) = Dilution of precision
1050146850.300 [004028][4028]  [FlexRate esoc] BaseVectorGeod (v1) = ENU relative position and velocity with respect to base(s)
1050146850.300 [005921][5921]  [FlexRate esoc] EndOfPVT (v1) = PVT epoch marker
1050146850.300 [004013][4013]  [FlexRate esoc] ChannelStatus (v1) = Status of the tracking for all receiver channels
1050146850.300 [005938][5938]  [FlexRate esoc] AttEuler (v1) = GNSS attitude expressed as Euler angles
1050146850.300 [004076][4076]  [FlexRate esoc] PVTSupport (v1) = Reserved for Septentrio only
1050146850.000 [004017][4017]  [AsyncRt] GPSRawCA (v1) = GPS CA navigation frame
```

```
1050146850.000 [004017][4017]  [AsyncRt] GPSRawCA (v1) = GPS CA navigation frame
1050146850.000 [004017][4017]  [AsyncRt] GPSRawCA (v1) = GPS CA navigation frame
1050146850.000 [004017][4017]  [AsyncRt] GPSRawCA (v1) = GPS CA navigation frame
1050146850.000 [004017][4017]  [AsyncRt] GPSRawCA (v1) = GPS CA navigation frame
1050146850.300 [005919][5919]  [AsyncRt] DiffCorrIn (v1) = Incoming RTCM or CMR message
RTCM 30 msgType=1004 stationID=56
GPS EpochTime=214050000
GNSS Synch Flag:1 NrSVSignals:9
GNSS Smoothing Indicator:0 Smoothing Interval:0
1050146850.400 [012219][4027]  [FlexRate esoc] MeasEpoch (v2) = measurement set of one epoch
1050146850.400 [020384][4000]  [FlexRate esoc] MeasExtra (v1) = additional info such as observable variance
1050146850.400 [005922][5922]  [FlexRate esoc] EndOfMeas (v1) = measurement epoch marker
1050146850.400 [020391][4007]  [FlexRate esoc] PVTGeodetic (v2) = Position, velocity, and time in geodetic coordinates
1050146850.400 [005906][5906]  [FlexRate esoc] PosCovGeodetic (v1) = Position covariance matrix (Lat, Lon, Alt)
1050146850.400 [005908][5908]  [FlexRate esoc] VelCovGeodetic (v1) = Velocity covariance matrix (North, East, Up)
1050146850.400 [004001][4001]  [FlexRate esoc] DOP (v2) = Dilution of precision
1050146850.400 [004028][4028]  [FlexRate esoc] BaseVectorGeod (v1) = ENU relative position and velocity with respect to base(s)
1050146850.400 [005921][5921]  [FlexRate esoc] EndOfPVT (v1) = PVT epoch marker
1050146850.400 [004013][4013]  [FlexRate esoc] ChannelStatus (v1) = Status of the tracking for all receiver channels
1050146850.400 [005938][5938]  [FlexRate esoc] AttEuler (v1) = GNSS attitude expressed as Euler angles
1050146850.400 [004076][4076]  [FlexRate esoc] PVTSupport (v1) = Reserved for Septentrio only
```

# Chapter 5

# SBF Analyzer



# 5.1 Introduction

SBF Analyzer is an application designed to allow analysis of SBF data files. The data plots available using SBF Analyzer are similar to those available in real time using RxControl. Users can also interact with the plots in the same way as those of RxControl. It is a powerful tool when deep analysis of data recorded by Septentrio receivers is needed. SBF Analyzer also offers the possibility to generate PDF reports of SBF data files.

## 5.1.1 SBF Analyzer compatibility

SBF Analyzer can be used to generate plots of SBF data files from any Septentrio Receiver however, files from the legacy PolaRx2/2e receivers may not be properly displayed in certain plots.

## 5.1.2 Launching SBF Analyzer

SBF Analyzer can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the SBF Analyzer executable can be found under 'Septentrio RxTools'. You can also launch SBF Analyzer via the 'Tools' menu of any of the GUI tools, for example from RxControl as shown in Figure 5.1-1.

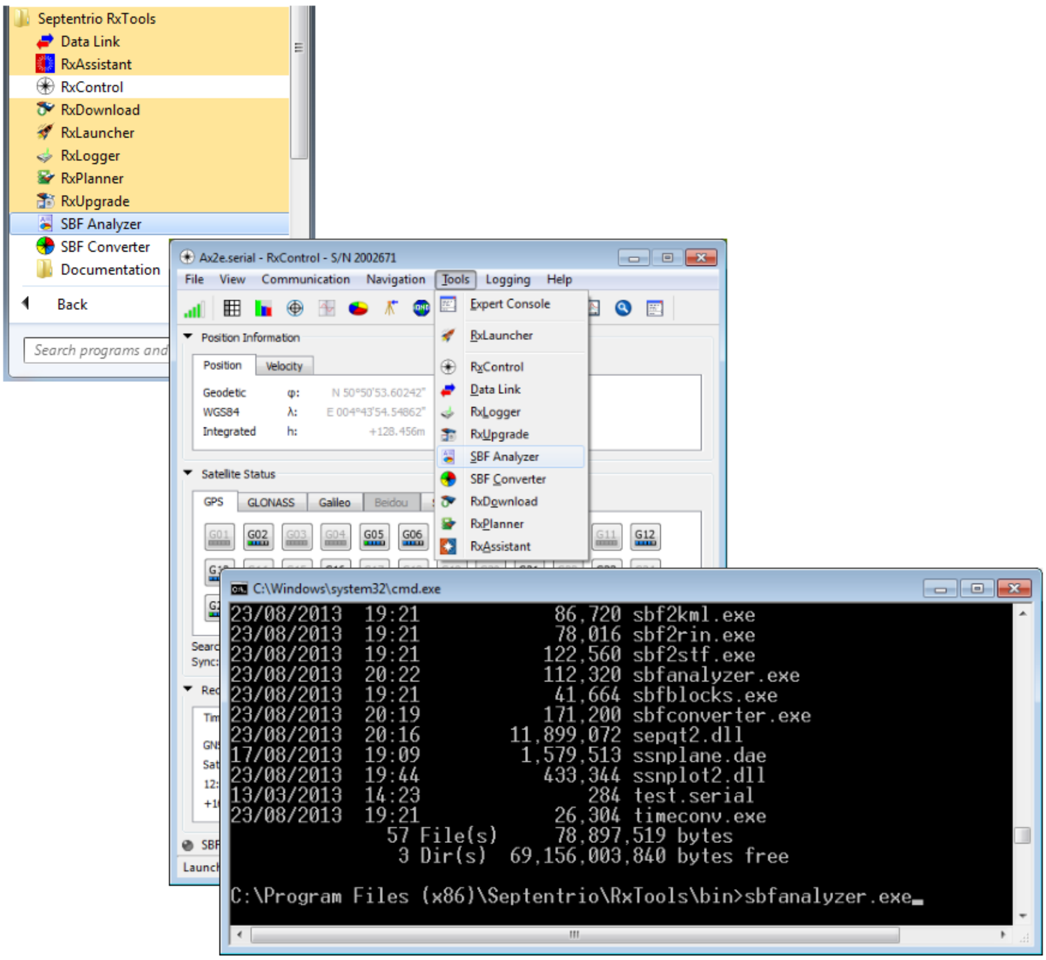



**Figure 5.1-1:** Launching the SBF Analyzer GUI

SBF Analyzer can also be launched by double-clicking on an SBF file with either an '_' or '.sbf' extension. When the file has been selected, the right-mouse button menu will also allow you to launch SBF Analyzer as Figure 5.1-2 shows. In the same way, you can also select to convert the file using SBF Converter or replay it using RxControl.

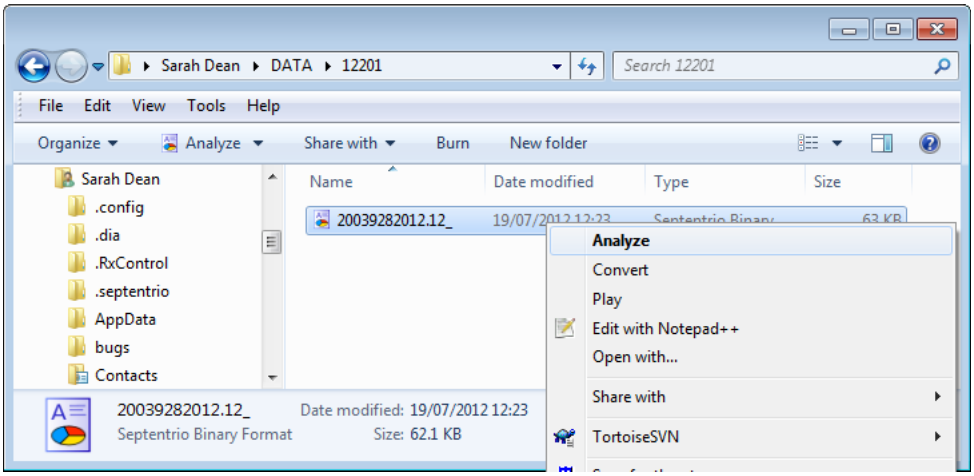



**Figure 5.1-2:** Launching SBF Analyzer from a file

# 5.2 Using SBF Analyzer: a worked example

SBF Analyzer is primarily intended as a diagnostic tool. If problems are encountered when using a Septentrio Receiver it is often useful to have a logged SBF file. This section uses the example of a 24 hr SBF file logged using a static antenna in an open location to show how *normal* plots should appear. The receiver used in this example is a dual-antenna AsteRx2eH in RTK positioning mode and getting differential corrections from a network VRS (Virtual Reference Station).

The plots shown in the following pages are only a selection of some of the plots available in SBF Analyzer but are some of the most useful for problem diagnosis.

## 5.2.1 Selecting plots and plot options

Users can select the plots they are interested in by ticking the check boxes on the main window of SBF Analyzer as shown in Figure 5.2-1. The Figure shows a selection of some of the most useful plots however, depending on the application, certain plots may be more relevant than others. Many of the plots have additional options available via the 'Plot Options...' button.

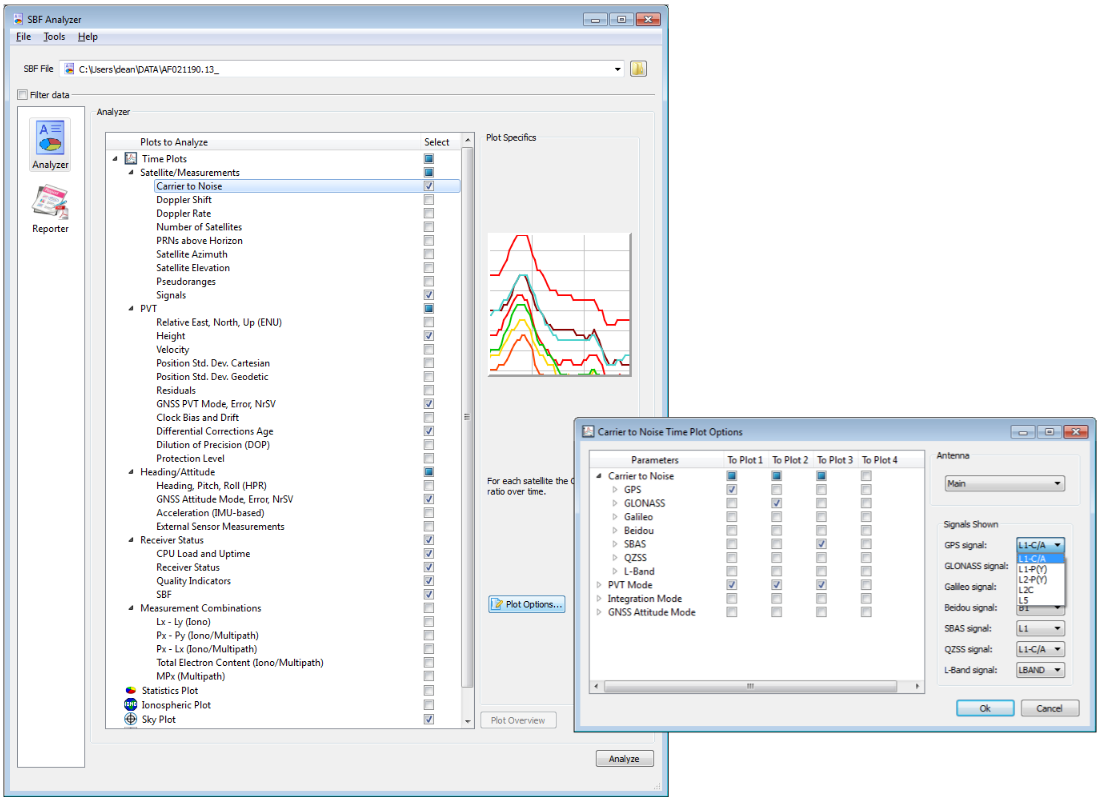



**Figure 5.2-1:** Selecting plots and plot options

Having selecting the desired plots, they can then be generated by clicking the 'Analyze' button as shown in Figure 5.2-2 on the next page.

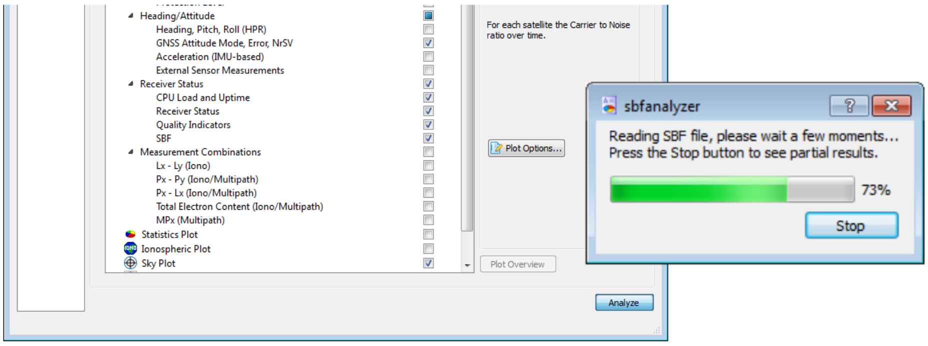



**Figure 5.2-2:** Generating the selected plots

### 5.2.2 The Carrier to Noise Plot

The carrier no noise plots in Figures 5.2-3and 5.2-4 on the next page show the signal levels of the GPS, Glonass and SBAS satellites over 24 hrs for the main antenna of the AsteRx2eH.

In open sky, each GPS and Glonass satellite can be tracked continually for about 4-6 hrs as it passes overhead. They should show a characteristic curve in their signal level starting low as the satellite is first tracked at low elevation then increasing as it reaches is maximum elevation then decreasing again till the satellite falls below the horizon. At any given time, there can be expected to be two or three satellites with signal levels around 50 dB-Hz.

The geostationary SBAS satellites should show a steady signal level of around 35-45 dB-Hz depending on the user's location. closer the equator, these satellites will have a higher elevation and therefore higher signal strength.

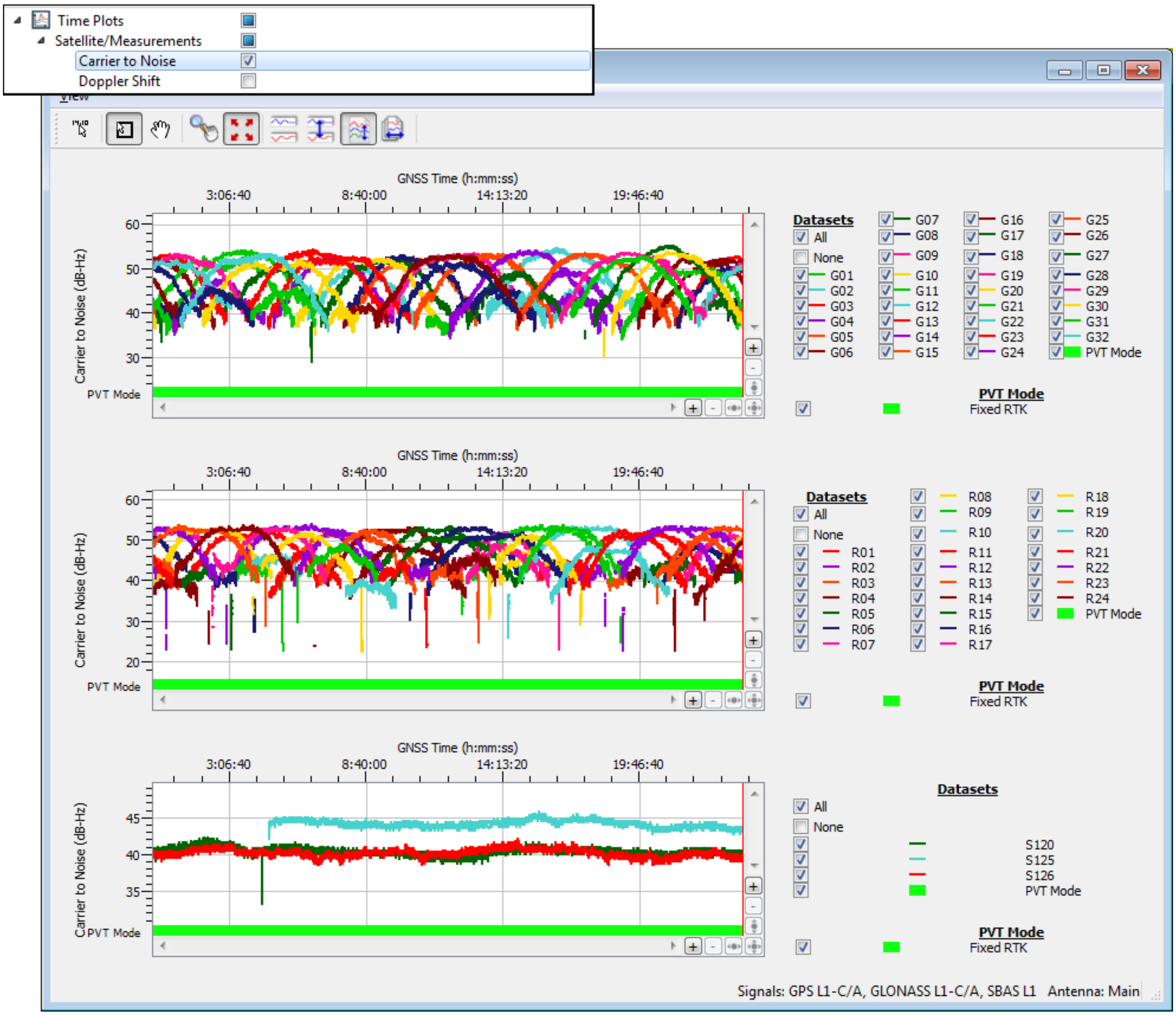



**Figure 5.2-3:** Carrier to noise plot for GPS (L1CA), Glonass (L1CA) and SBAS (L1)

For the lower L2 frequency band; all GPS and Glonass satellites transmit L2P however, whereas all Glonass transmit L2C, only a few GPS currently transmit L2C. For this reason, Glonass L2P tracking is disabled by default as it brings no additional information. GPS L2P is around 10-15 dB-Hz less than GPS L1CA. Glonass L1CA and L2C signals are about the same level. The GNSS L2 band is close to a band allocated to amateur radio which can make it vulnerable to interference. RTK positioning requires the use of good quality L2P or L2C signals and so will be compromised should there be any problems with L2 signal reception.

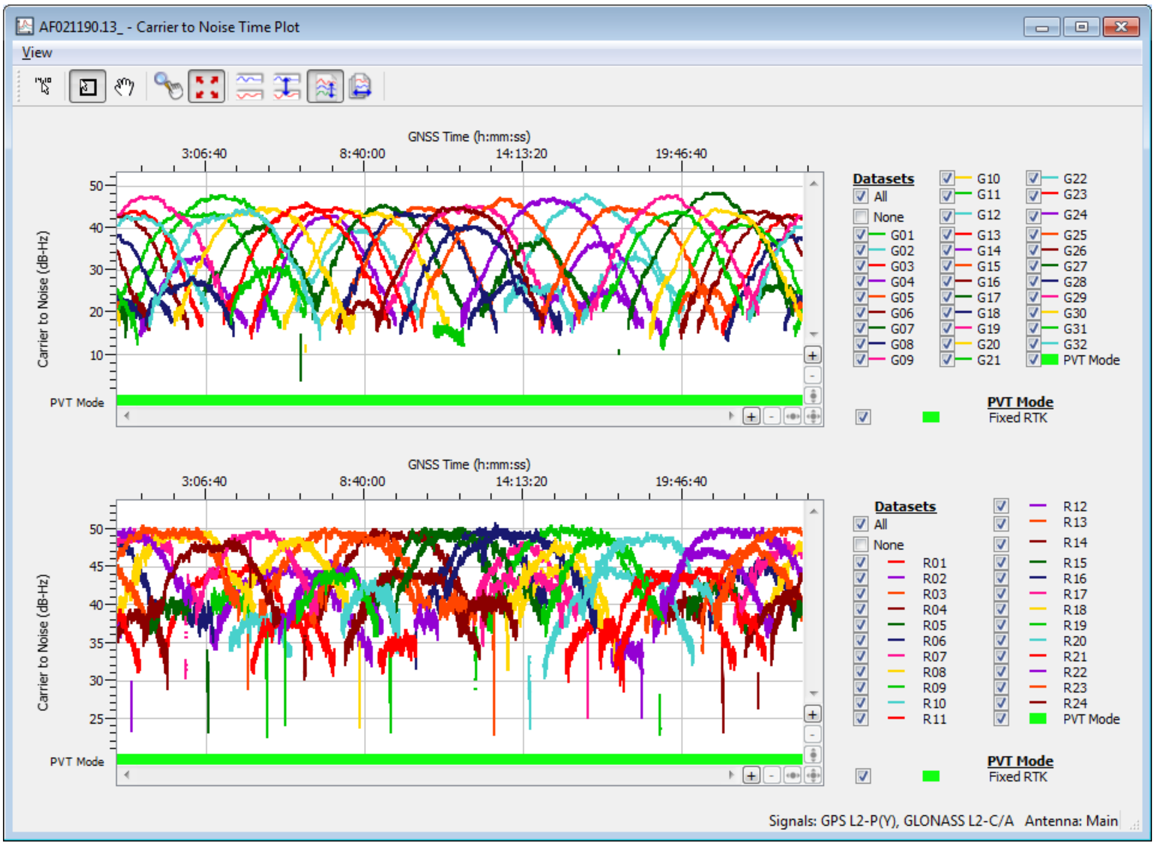



**Figure 5.2-4:** Carrier to noise plot for GPS (L2P), Glonass (L2C)

When using a multi-antenna satellite such as the AsteRx2eH, the signal levels on the auxiliary antenna can be plotted by selecting 'Aux 1' in the 'Antenna' field of the carrier to noise plot options window as shown in Figure 5.2-1 on page 108. The signal levels on auxiliary antennas should be similar to those on the main antenna.

### 5.2.3 The Height Plot

Figure 5.2-5 shows the height of the antenna as calculated by the receiver over the 24 hr data collection period. Due to the geometry of the satellite constellations, the calculated position of an antenna on earth will always show the largest error in the vertical component. If any problems are suspected in positioning they will be most evident in the height plot.


**Figure 5.2-5:** Time plot of the calculated height

### 5.2.4 The GNSS PVT Mode, Error, NrSV Plot

The GNSS PVT Mode, Error, NrSV plot shown in Figure 5.2-6 shows several useful plots on the one graphic. The 'SVs in PVT and SVs in Track' plot shows the number of SVs (Space Vehicles) or satellites that the receiver is tracking and the number whose measurements it is using in the PVT. The number of satellites used will always be less than the number tracked and in this example, the difference is between 1 and 11 satellites. The 'PVT Mode' plot shows the positioning mode that the receiver is using. The possible values are; 0 (No PVT available), 1 (Stand-Alone PVT), 2 (Differential PVT), 3 (Fixed location), 4 (RTK fixed), 5 (RTK float), 6 (SBAS aided PVT), 7 (moving-base RTK fixed), 8 (moving-base RTK float) and 10 (Precise Point Positioning (PPP)).

When the receiver is not able to compute a PVT, the 'Error' plot will give the reason why;
0 (no error), 1 (not enough measurements), 2 (not enough ephemerides available), 3 (DOP too large (larger than 15)), 4 (sum of squared residuals too large), 5 (no convergence), 6 (not enough measurements after outlier rejection), 7 (position output prohibited due to export laws), 8 (not enough differential corrections available), 9 (base station coordinates unavailable) and 10 (ambiguities not fixed).

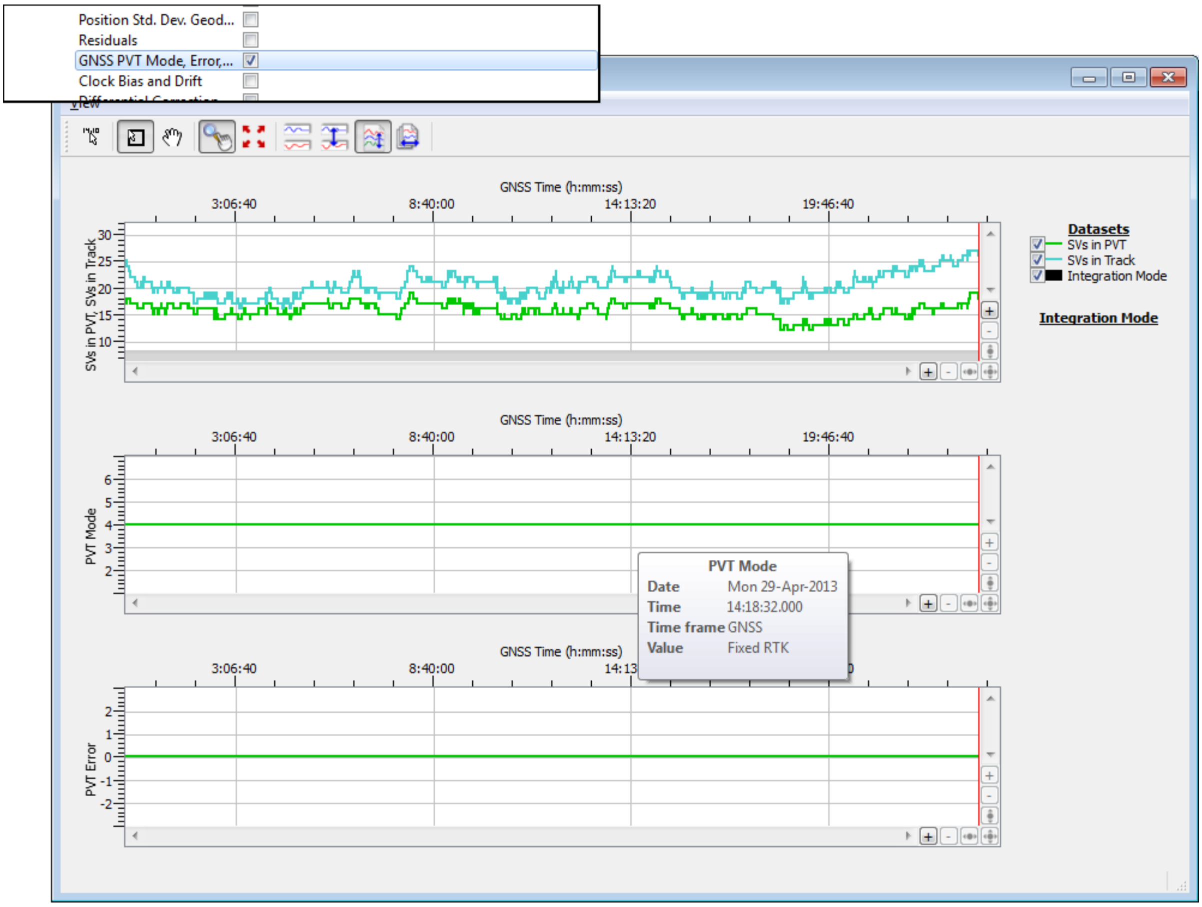



**Figure 5.2-6:** Time plot of GNSS PVT Mode, Error and Number of Satellites in PVT and tracking

### 5.2.5 The Differential Corrections Age Plot

In order to be able to calculate an augmented positioning mode such a DGNSS or RTK, the receiver needs to get differential correction data from an external source; either a second (base station) receiver or, as is increasingly the case, from a network provider. In either case, the format of the differential correction data will be the same; RTCMv2, RTCMv3 or CMR. In this example RTCMv3 was used. Although there are a large number of RTCMv3 messages, only two (or three if you want to use Glonass) are necessary for RTK positioning: the position of the base station antenna (message 1005 or 1006) and the GPS observables (1003 or 1004). Glonass observables are contained either in message 1011 or 1012. Figure 5.2-7 shows the age of each individual message as well as the mean age. For RTK, GPS (and Glonass) observables are usually transmitted every second and should be received promptly by the rover with an age no older than a few seconds. Differential correction data that is consistently delayed will have a detrimental effect on the precision of the output RTK position and may, if the corrections are older than the default time-out of 20 seconds, cause the receiver to fall back to a less precise positioning mode.

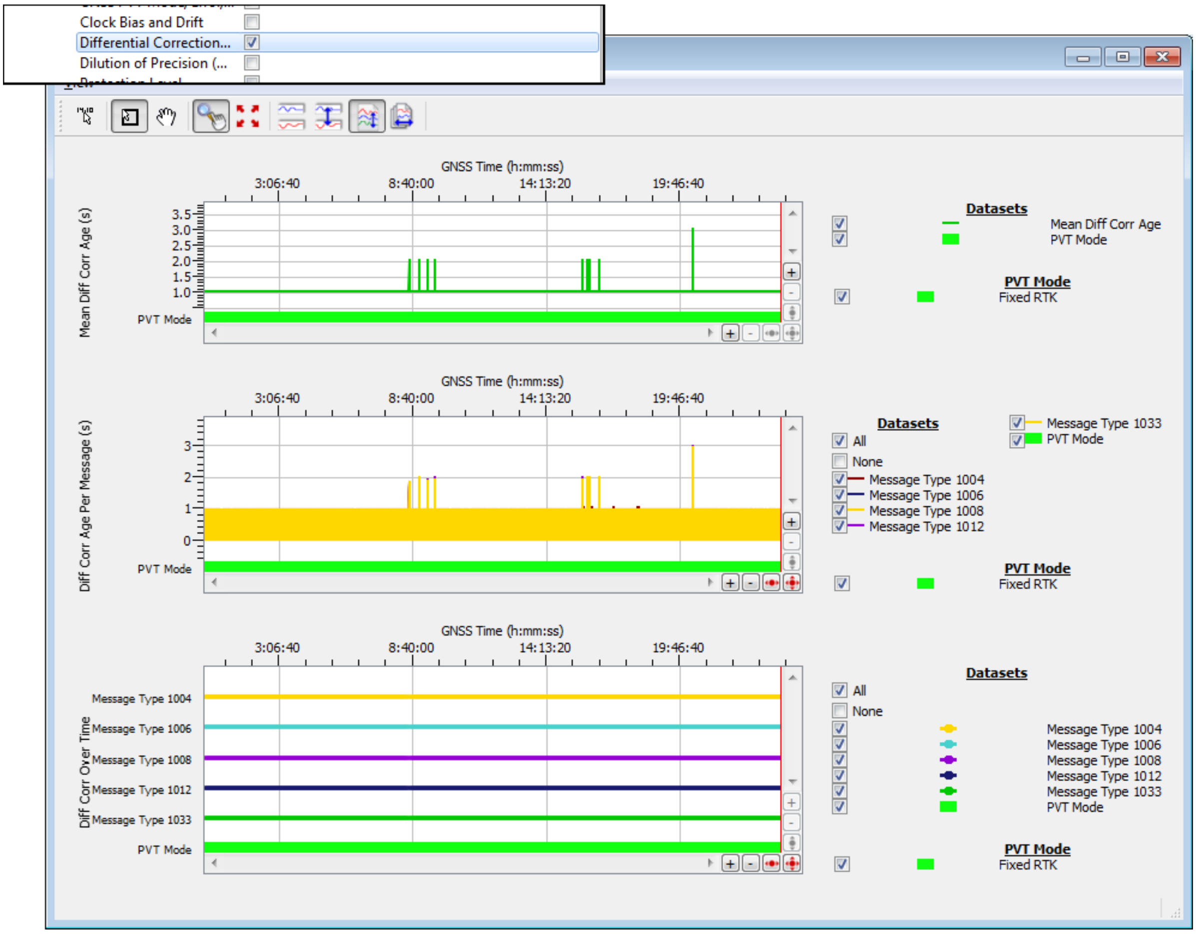



**Figure 5.2-7:** Time plot of RTCMv3 differential correction reception

### 5.2.6 The Heading, Pitch, Roll Plot

When using a multi-antenna receiver such as the AsteRx2eH, the main and auxiliary antenna positions are use to calculate the heading and pitch of the vehicle or structure on which they are mounted. Figure 5.2-8 shows a plot of the heading and pitch for a static setup where the two antennas are about 80 cm apart. As the pitch calculation uses the difference in height between the two antennas and, as height is the least precise component of the position, the precision of the pitch is typically about half that of the heading.

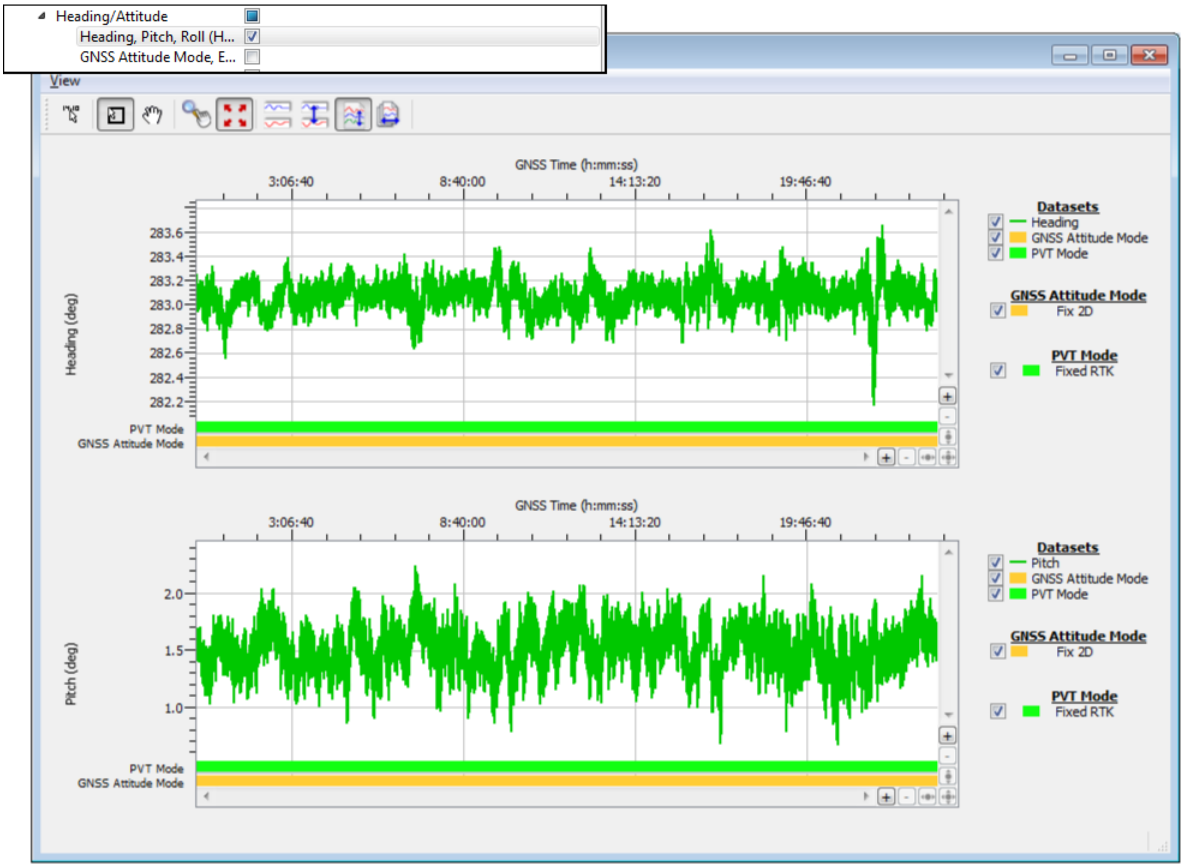



**Figure 5.2-8:** Time plot of the calculated heading and pitch of the AsteRx2eH

### 5.2.7 The GNSS Attitude Mode, Error, NrSV Plot

A plot similar to that for GNSS PVT is available for GNSS attitude and appears in Figure 5.2-9. The possible attitude modes are:
0 (No attitude), 1 (Heading, pitch (roll = 0) aux antenna positions obtained with float ambiguities), 2 (Heading, pitch (roll = 0), aux antenna positions obtained with fixed ambiguities), 3 (Heading, pitch, roll, aux antenna positions obtained with float ambiguities) and 4 (Heading, pitch, roll, aux antenna positions obtained with fixed ambiguities).

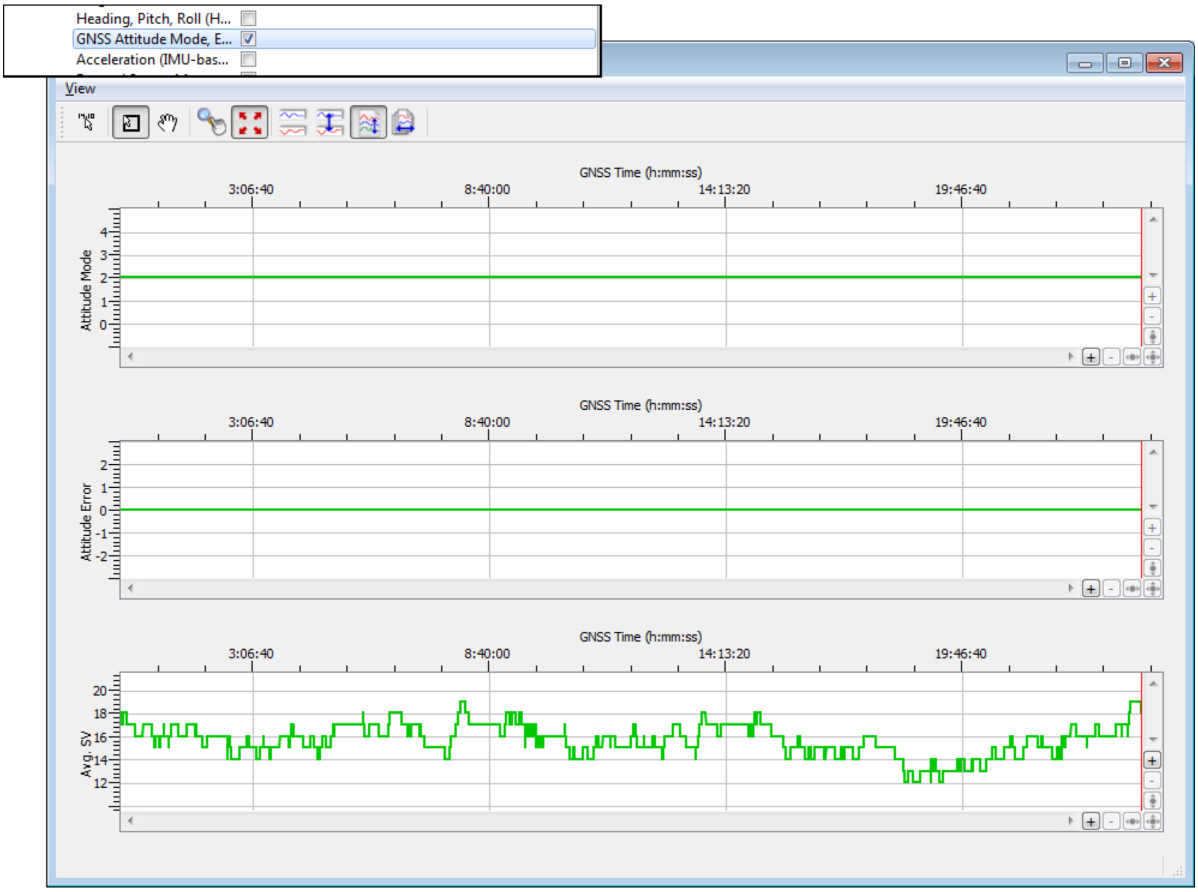



**Figure 5.2-9:** Time plot of GNSS attitude Mode, Error and Number of Satellites in PVT and tracking

### 5.2.8 The CPU Load and Uptime Plot

The upper panel in Figure 5.2-10 shows the load of the receiver CPU as a function of time. The CPU load depends on several factors, for example, the amount and frequency of data requested from the receiver. Requesting the PVTGeodetic SBF block at 20 Hz will cause a higher CPU load than requesting it at 1 Hz. More precise positioning modes such as RTK, will also require more CPU capacity. CPU load is typically constant with occasional spikes. If the CPU load reaches 100 %, the receiver will seem to freeze and gaps may be seen in data output or in logged data files.

The lower panel of Figure 5.2-10 shows the uptime of the receiver. This is the time since the receiver was last reset.

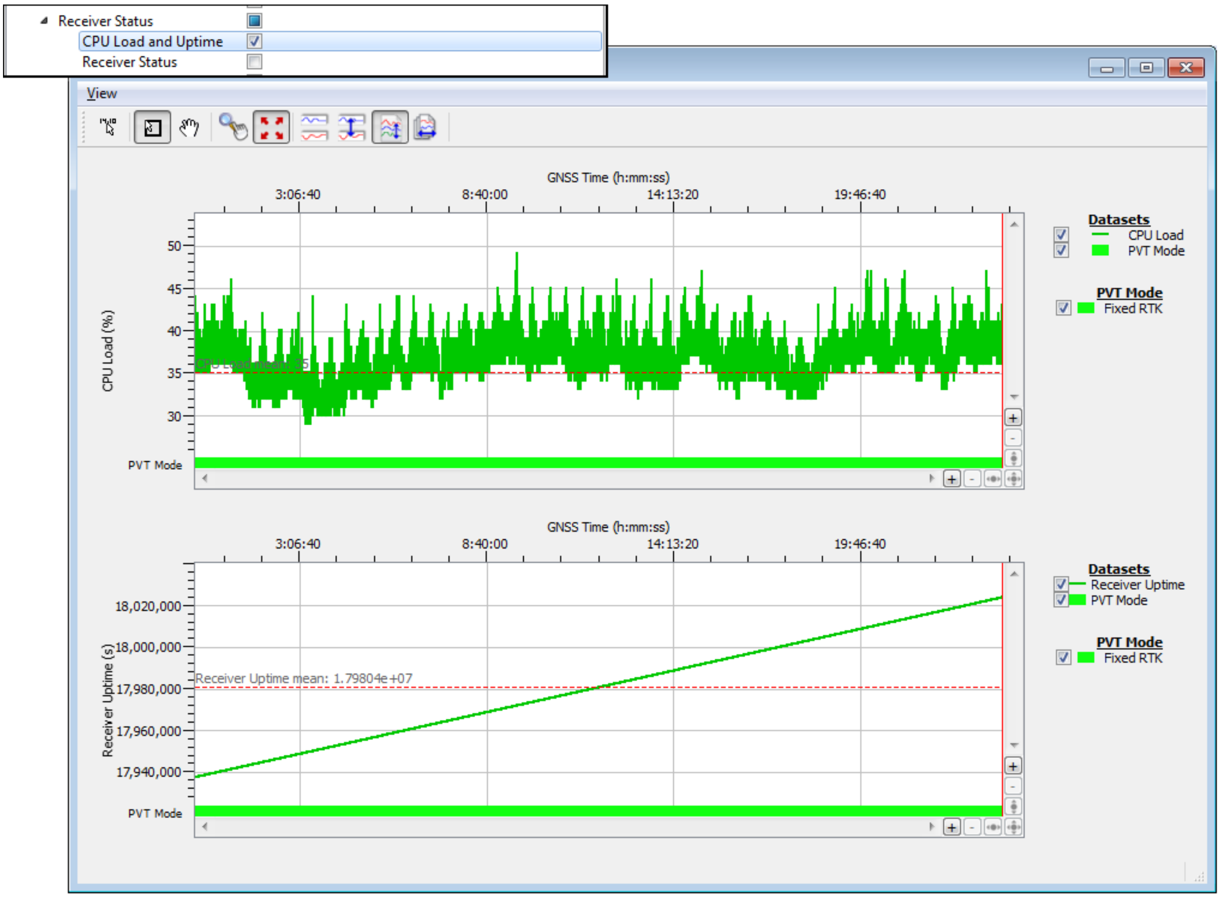



**Figure 5.2-10:** Time plot of receiver CPU and uptime

### 5.2.9 The Receiver Status Plot

The plot in Figure 5.2-11 is a time plot of the contents of the ReceiverStatus SBF block. It contains information on the status of various operating parameters as well as some error flags. A description of these parameters and errors can be found in the SBF Reference Guide.


**Figure 5.2-11:** Time plot of the receiver status

## 5.2.10 The SBF Plot

Figure 5.2-12 shows a time plot of SBF (Septentrio Binary Format) data blocks where each dot indicates the presence of a particular block. As plots can only be generated by SBF Analyzer when the relevant SBF block is present, this plot is useful for checking the contents of files to make sure the relevant blocks are indeed present.


**Figure 5.2-12:** Time plot of SBF (Septentrio Binary Format) data blocks that are present in the file

### 5.2.11 The Statistics Plot

The statistics plot shown in Figure 5.2-13 gives an overview of the percentage of positioning and attitude modes in a file. It also shows the number and type of error as a percentage of the total number of epochs in the file.

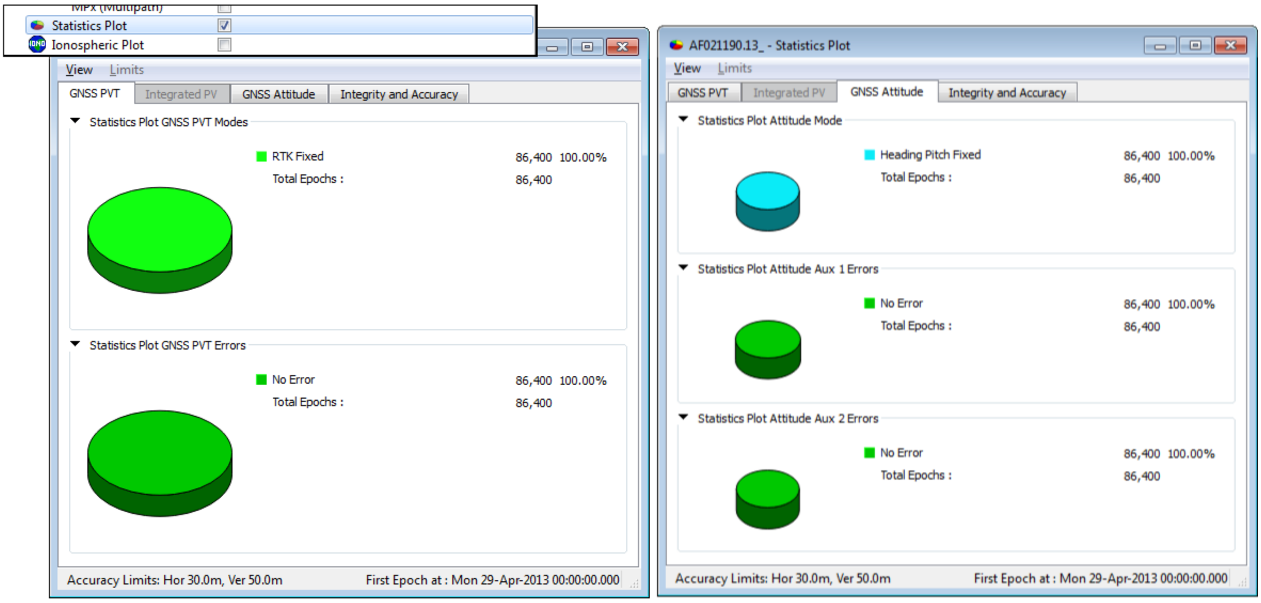



**Figure 5.2-13:** Statistics plot showing a summary of positioning and attitude mode as well as errors

### 5.2.12 The Sky Plot

The Sky plot (Figure 5.2-14) shows satellite positions in the sky overhead as they are seen at the end of the file. To view the sky plot at other times in the file, you can select 'Plot Overview' as shown in Figure 5.2-15 and then either insert the time you are interested in or use the sliding time bar. The pink line in the plots shows the lowest elevation at which a satellite was tracked for a particular azimuth during the file. This is useful for detecting any problems that may arise from sky obscuration.

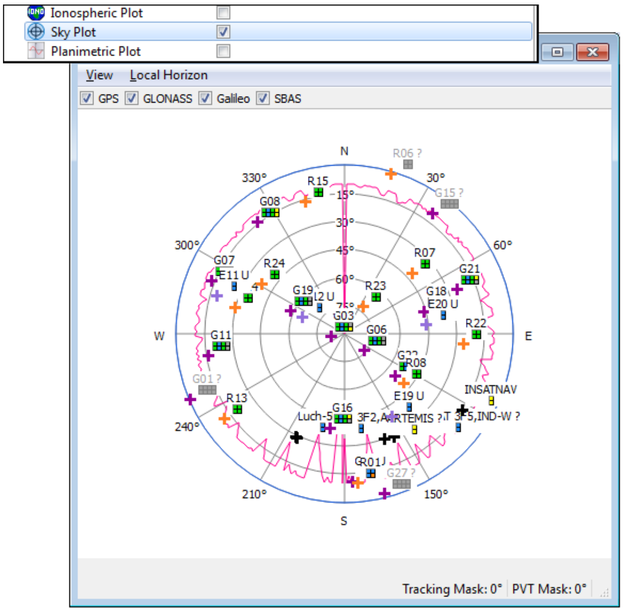



**Figure 5.2-14:** Sky plot showing positions of satellites overhead

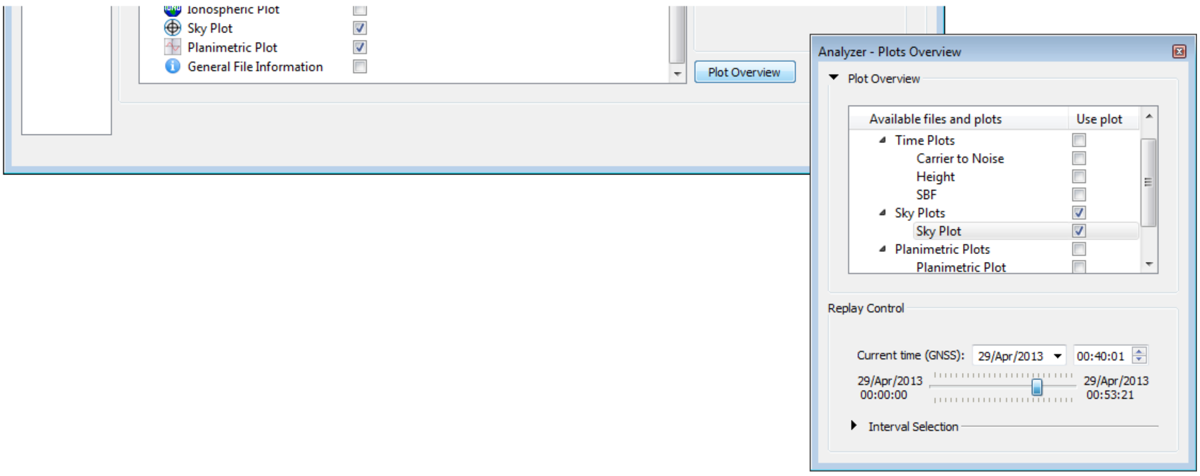



**Figure 5.2-15:** Viewing the Sky plot at different times in the file

### 5.2.13 The Planimetric Plot

The planimetric plot shown in Figure 5.2-16 shows the horizontal positions calculated in each epoch in the file. Similar to the height plot, this can be used to monitor the position precision and quality for static files.

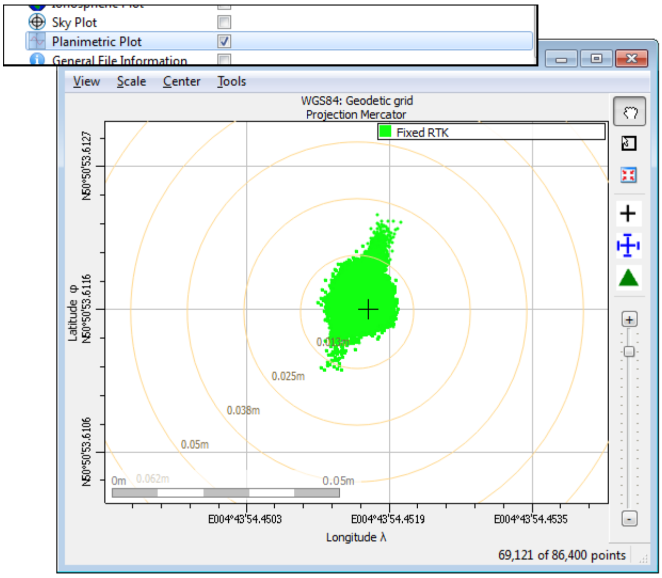



**Figure 5.2-16:** Planimetric plot

### 5.2.14 The General File Information Window

In the 'General' tab of the 'Statistics and Other Information' window shown in Figure 5.2-17, information is given on the receiver (type, serial number and firmware) and the file. The constellations and signals tracked and used in PVT can also be found here. The 'Reference' tab shows the standard deviations of the calculated positions as well as the RMS values relative to a reference position (inserted via the 'Preferences' menu of the main window).

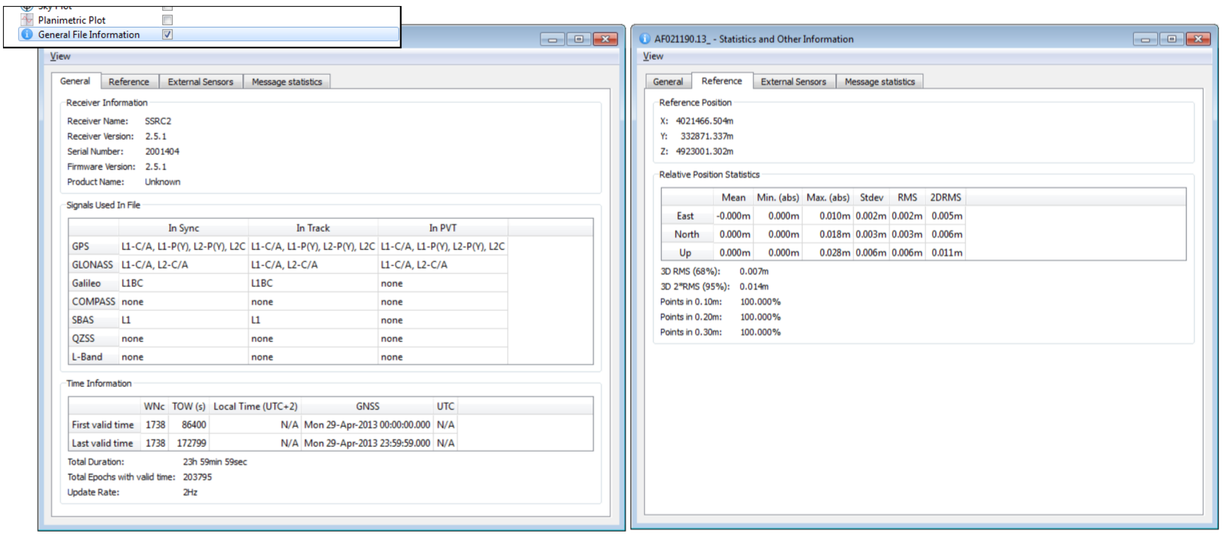



**Figure 5.2-17:** Statistics and Other Information window

## 5.3 SBF Analyzer: Reporter Tool

SBF Analyzer can be used to generate reports in PDF format. The tool contains two default report layout templates,'Static' and 'Kinematic' however, users can edit these or make their own reports. Report layouts can be generated by selecting 'Reporter' in the main window of SBF Analyzer as shown in Figure 5.3-1.

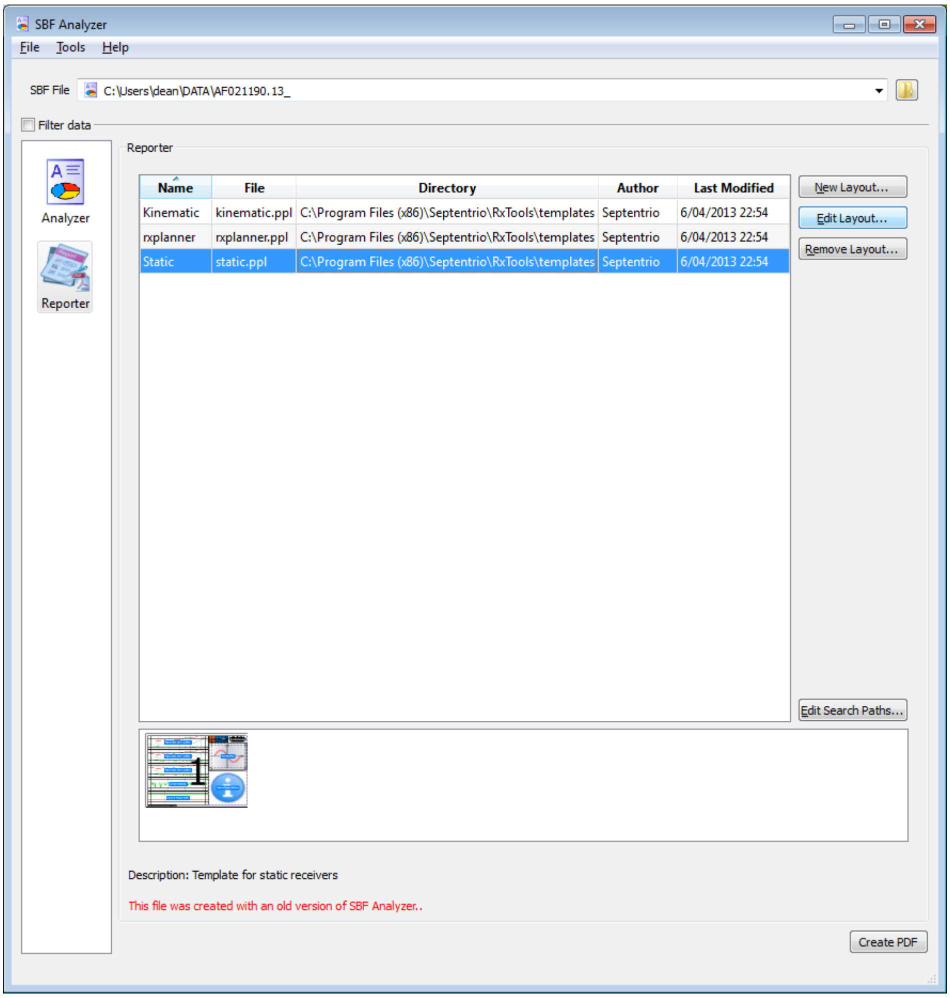



**Figure 5.3-1:** Selecting a report to generate using the SBF Analyzer Reporter tool

Clicking on the 'Edit Layout ...' button allows users to make changes to the selected report layouts. Plots from the menu on the right hand side of the editor window can be simply dragged and dropped onto the report as Figure 5.3-2 on the following page shows.

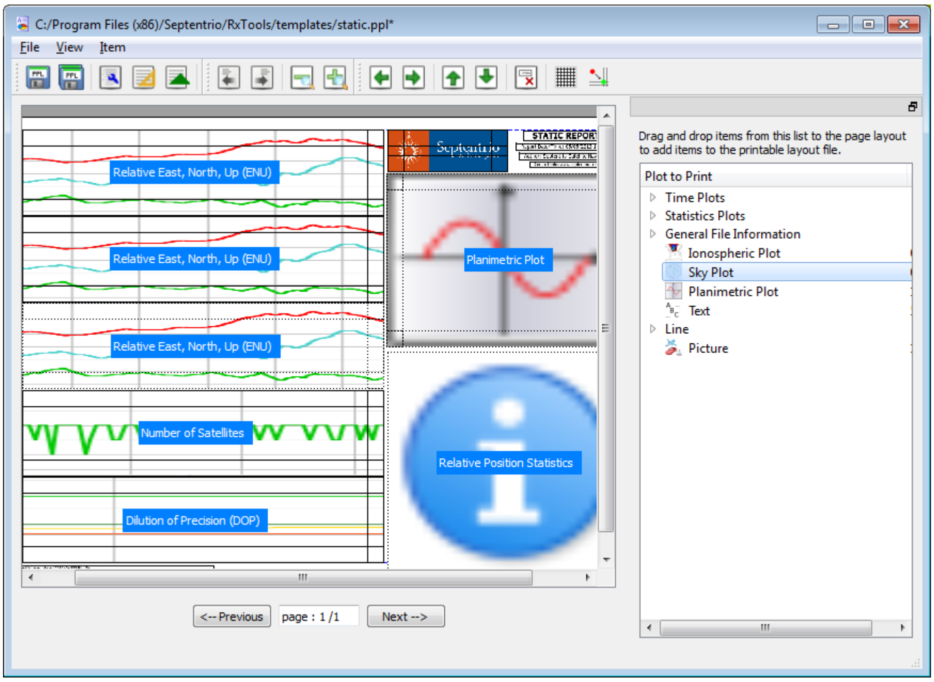



**Figure 5.3-2:** Editing a report

Figure 5.3-3 shows the single-page standard static report for the file in this example.

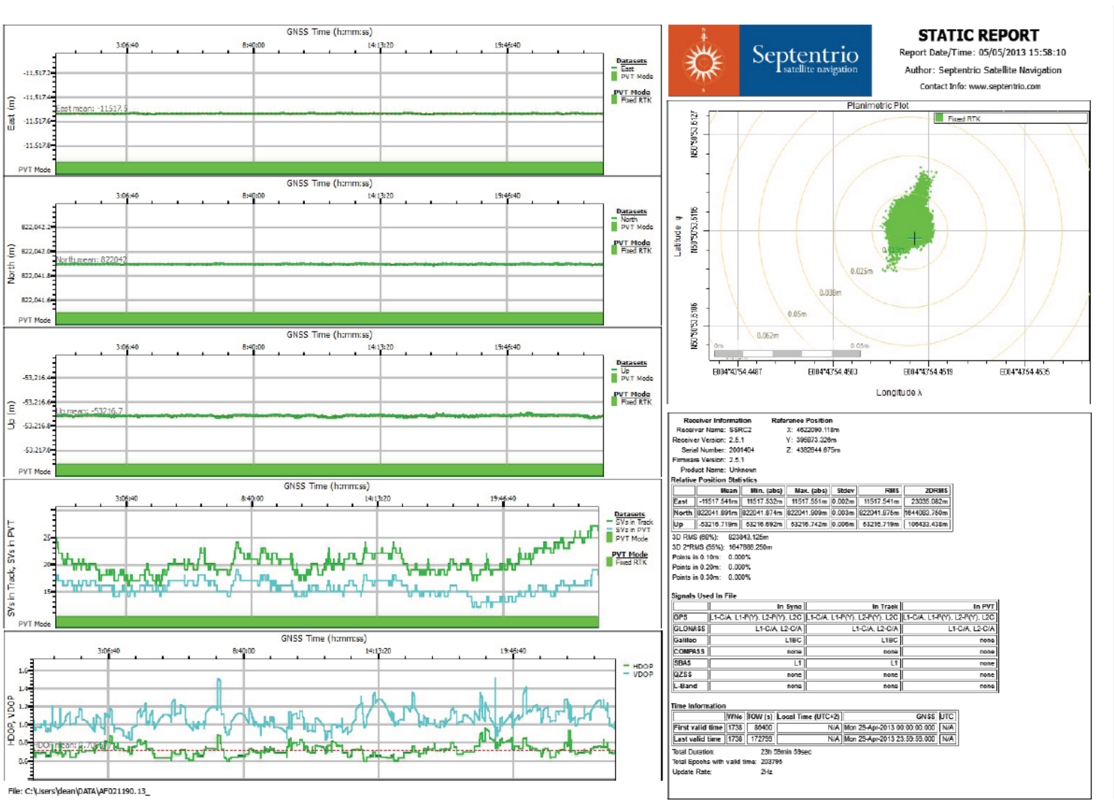



**Figure 5.3-3:** Example of a static report

### 5.3.1 Using the command line to generate reports

SBF Analyzer can be used in a scripting context to generate reports automatically. In the example shown in Figure 5.3-4, the command below is used to generate a report of file AF021190.13_.

```
start/wait sbfanalyzer.exe -f AF021190.13_
                           -l static.ppl
                           -o C:\Users\dean\DATA\test.pdf -S
```

The report uses the layout file 'static.ppl' and the reports is written to the file 'test.pdf'. The layout files are those shown in Figure 5.3-1 on page 123 which can normally be found in the folder; C:$\backslash ProgramFiles(\times 86)\backslash Septentrio\backslash RxTools\backslash templates$

'start/wait' is included to account for the fact that scripts used to generate reports will normally continue immediately; this ensures that the script will wait until SBF Analyzer has finished.

The '-S' option removes the need for any user interaction.

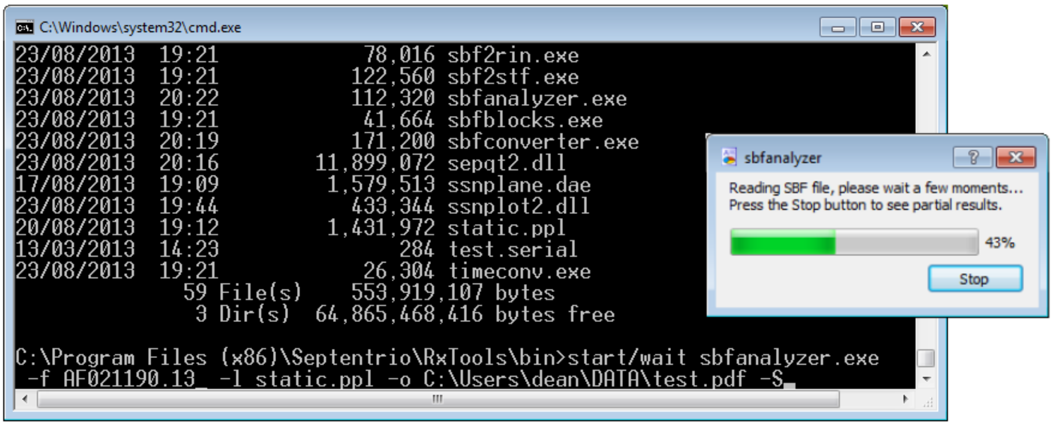



**Figure 5.3-4:** Using the command line to generate a PDF report

# Chapter 6

# RxLogger

# 6.1 Introduction

RxLogger is a program which allows data files in SBF (Septentrio Binary Format) or NMEA to be logged. *Post processing actions* (e.g. conversion to RINEX) can be defined on SBF files. RxControl can also be used to log data files as described in 2.7 on page 72 however, the options are more limiting and more bandwidth is required due to the large amount of information that RxControl requests from the receiver to fill its various information fields. The program can be used either as a GUI or a command line tool.

## 6.1.1 RxLogger compatibility

**RxLogger 1.6.2** can be used with any Septentrio Receiver except the PolaRx2/2e.

## 6.1.2 Launching RxLogger

RxLogger can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the RxLogger executable can be found under 'Septentrio RxTools'. You can also launch RxLogger via the 'Tools' menu of any of the GUI tools, for example from RxControl as shown in Figure 6.1-1.

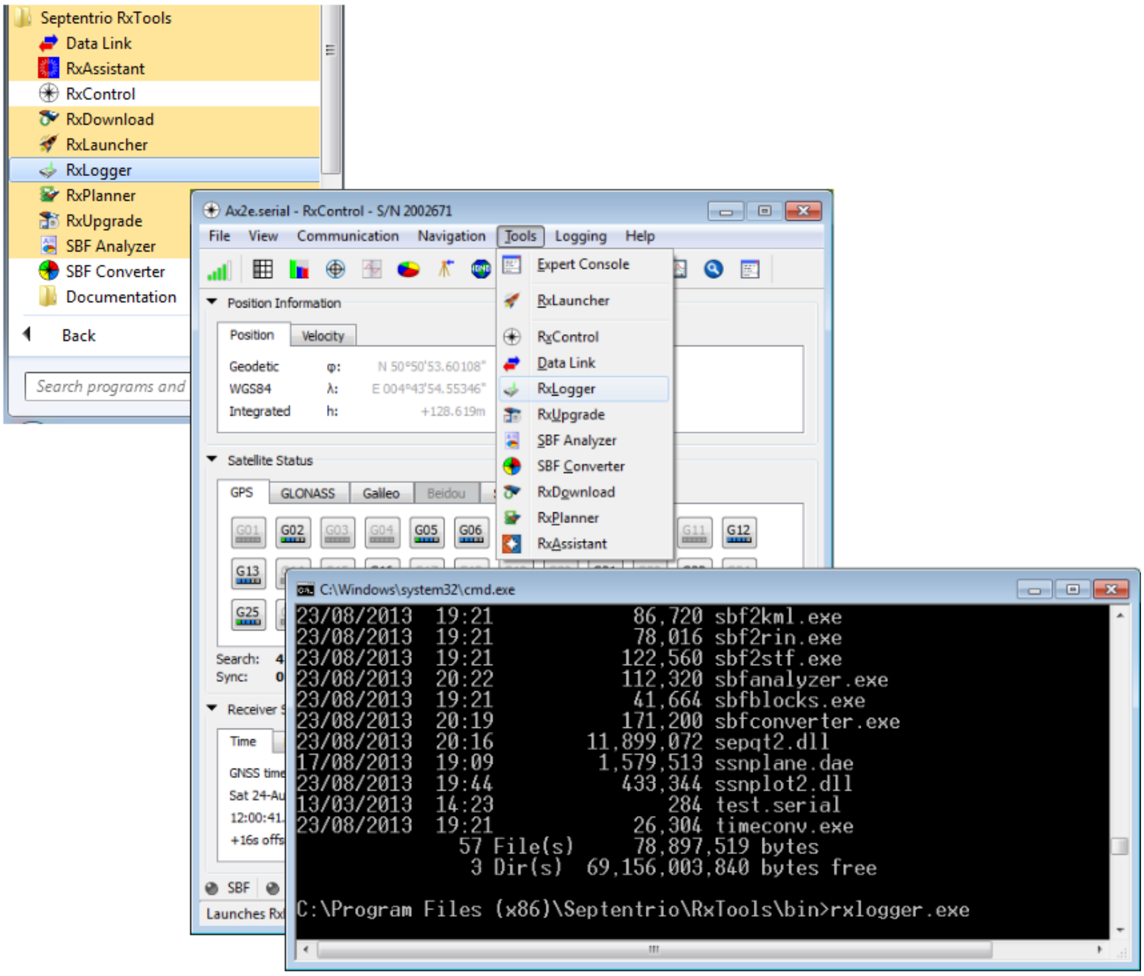



**Figure 6.1-1:** Launching the RxLogger GUI

## 6.2 Using RxLogger: a worked example

The example below shows how to log data using both the RxLogger GUI and the command line tool.

### 6.2.1 Connecting to a receiver using RxLogger

To be able to connect to a receiver using Data Link, your Septentrio Receiver should be up and running and connected to a PC using either a serial, USB or Ethernet cable. When RxLogger is first launched, a *Connection Setup* window will appear and by clicking on the *Finish* button RxLogger will try to re-establish the last connection that was opened before RxLogger was shut down. To open a new connection the user should select either *Serial Connection* or *TCP/IP Connection*. The *Serial* option allows a serial COM or USB connection to be established (the software drivers map the USB onto two virtual serial connections). The *TCP/IP Connection* option allows the configuration of an Ethernet connection. Figure 6.2-1 shows a connection to second USB COM port.

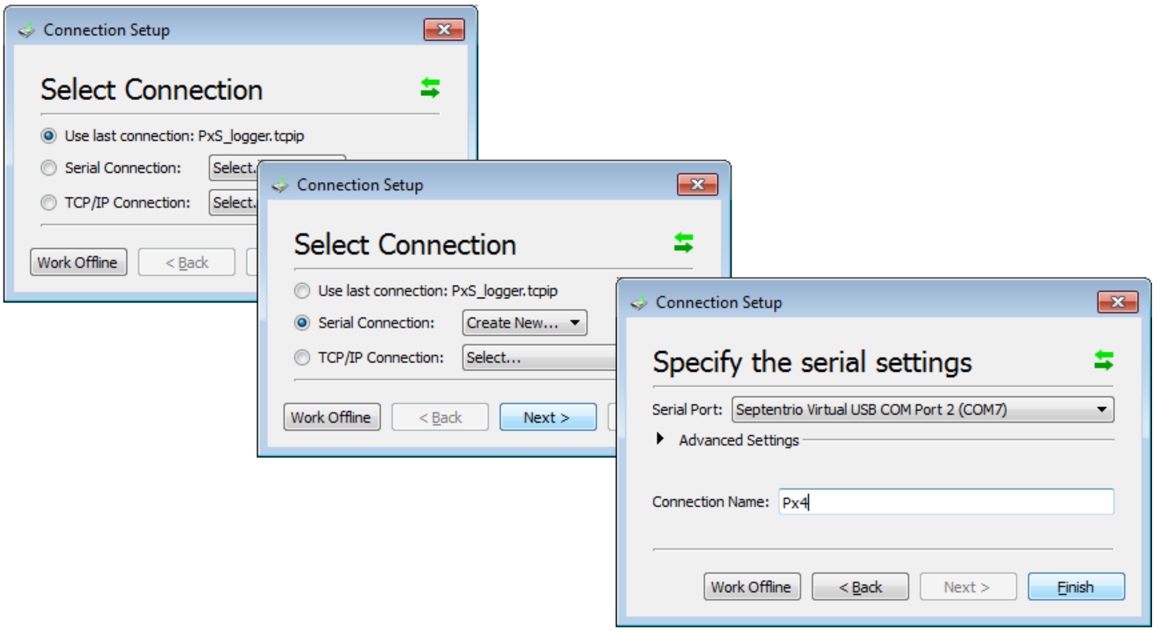



**Figure 6.2-1:** Connecting to a receiver using RxLogger

When a connection has been established, the main window of RxLogger will show time and date as well as the receiver type and serial number in information fields in upper and lower panels as shown in Figure 6.2-2 on the next page. There is also an SBF LED on the lower panel that lights up every second.

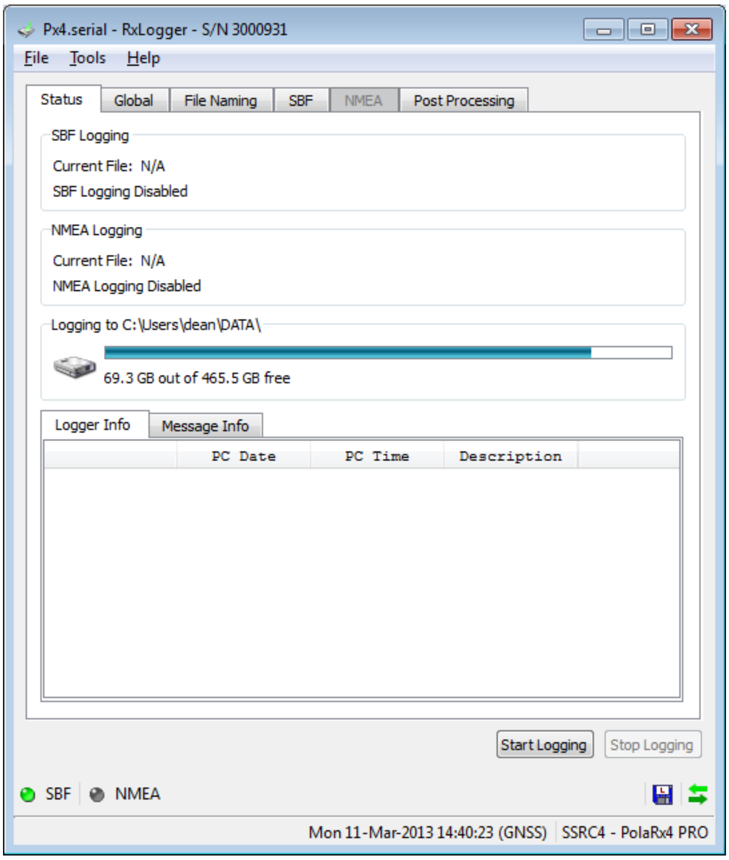



**Figure 6.2-2:** Main window of RxLogger when connected to a receiver

The configuration of RxLogger is split over several tabs. In the *Global* and *File Naming* tabs, users can configure what data format they wish to log (SBF or NMEA). File names and naming conventions. Most of the settings are self explanatory and have been explained previously in Section 2.7.1 on page 72.

## 6.2.2 Configuring RxLogger settings

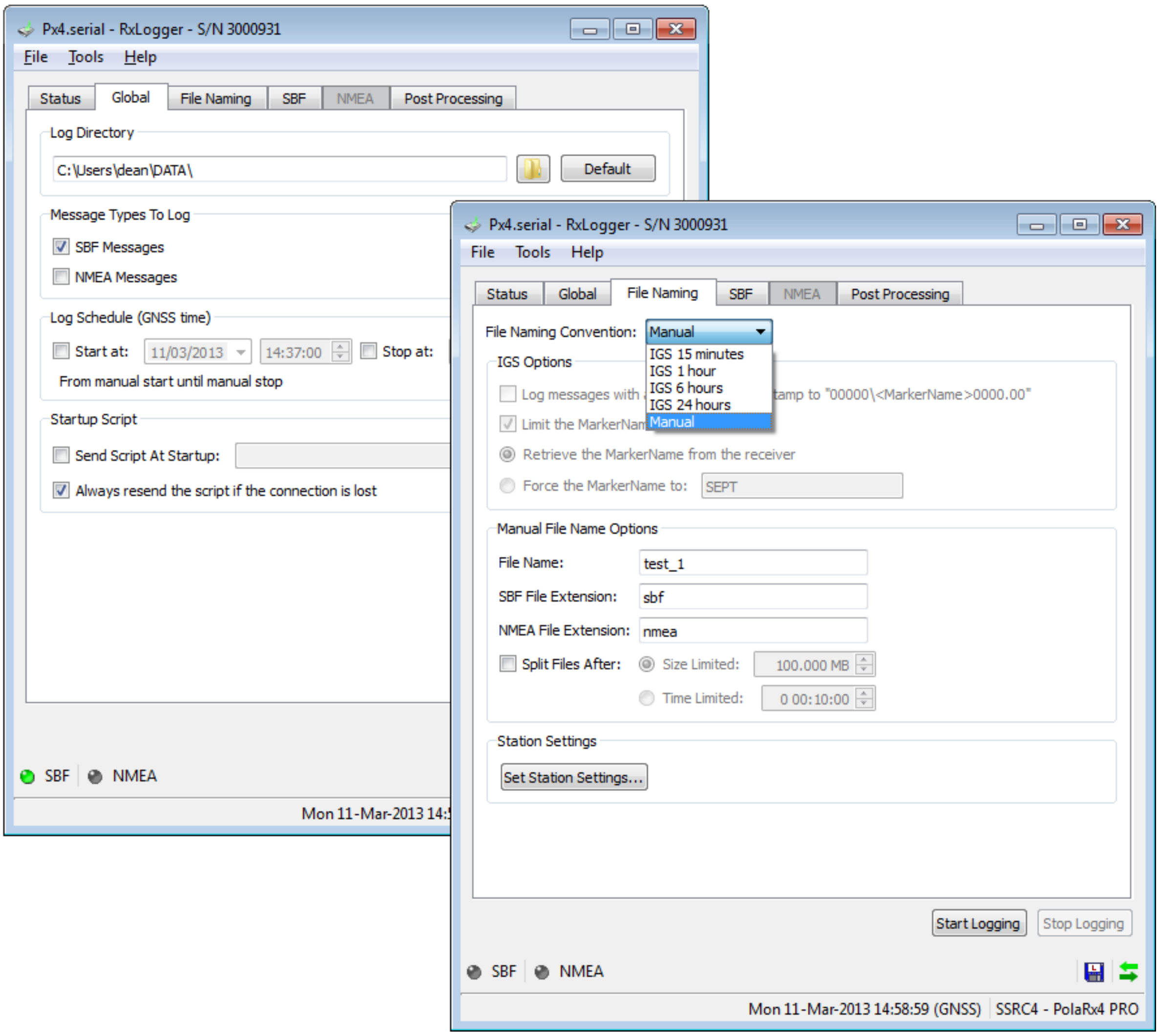



**Figure 6.2-3:** Configuring the settings in the *Global* and *File Naming* tabs

The main difference between logging data using RxControl and RxLogger is that RxLogger allows users to define multiple data *streams* which are just a selection of SBF data blocks defined by the user. These stream can then each be logged at different rates up to a maximum of 100 Hz depending on the receiver capabilities and options. New streams are added by clicking on the *Add Stream* button and then selecting the SBF blocks you would like in that stream and their logging rate (*Message Interval*).

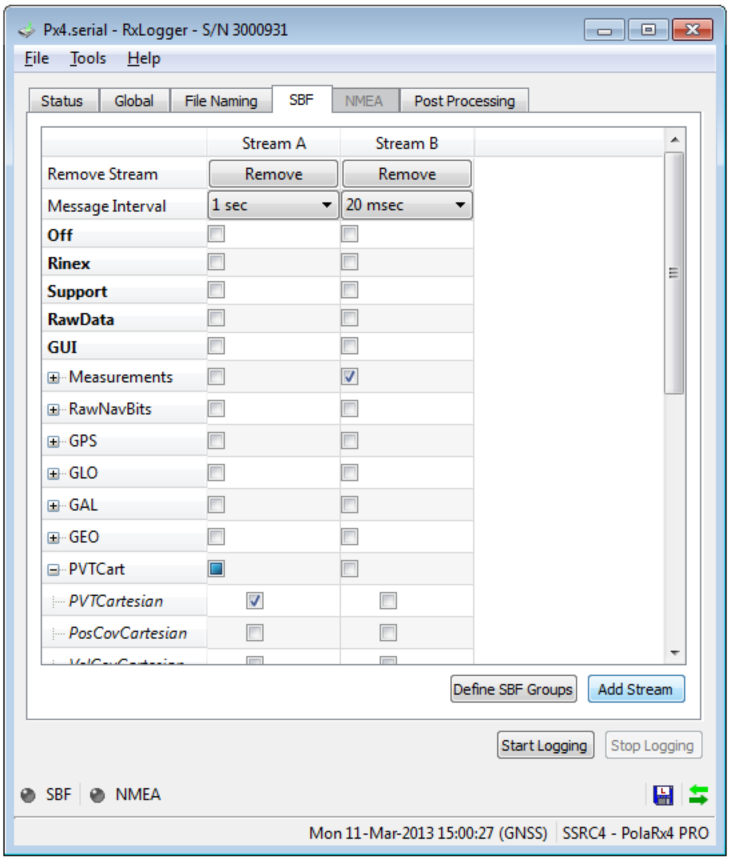



**Figure 6.2-4:** Selecting which SBF data blocks to be logged and their rate

### 6.2.3 Defining a post processing action

The *Post Processing* tab is used to define conversion processes to be carried out on logged SBF data. As well as the standard RINEX, Hatanaka, CGGTTS and ISMR conversions, users can also apply their own conversion by selecting the *Custom Conversion* option. This section details the example of generating zipped RINEX data that is forwarded to an FTP location.

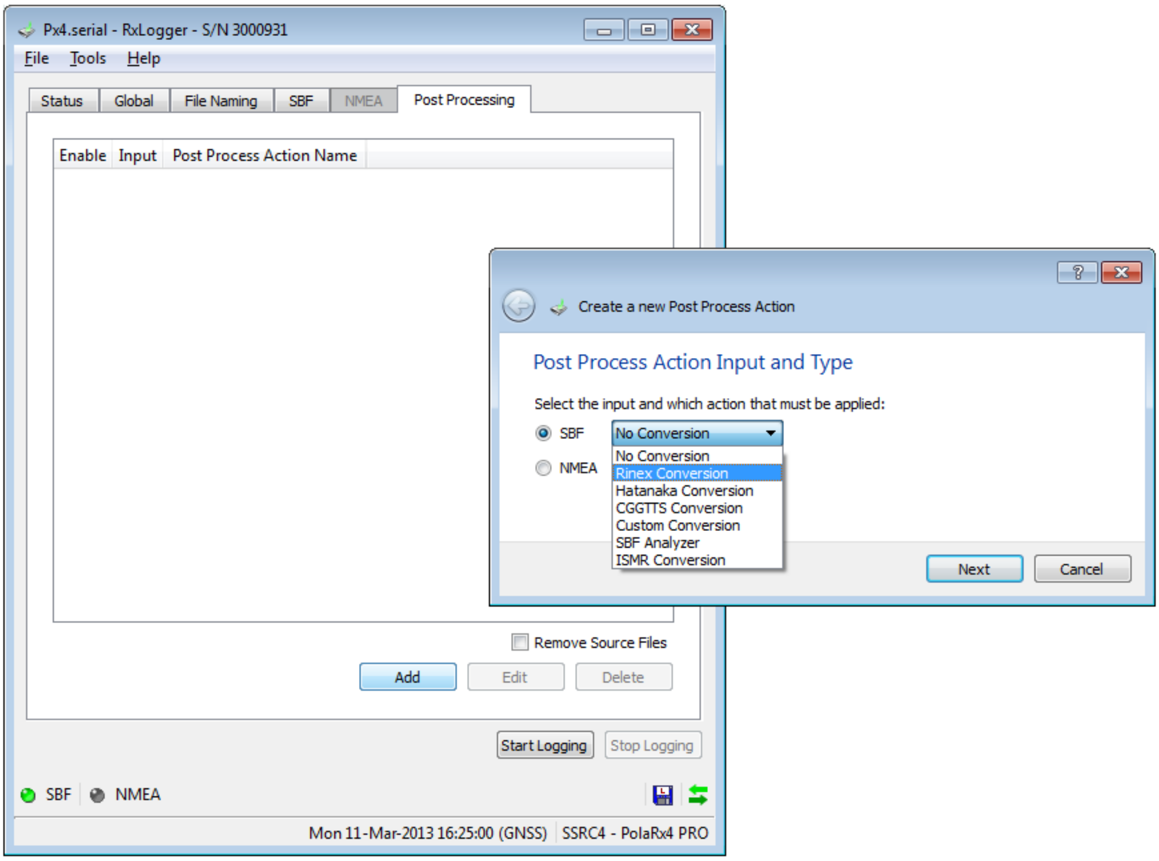



**Figure 6.2-5:** Adding a post-processing action that generates RINEX data files

After selecting to generate RINEX data, the following window shown in Figure 6.2-6 allows the selection of optional data for inclusion in the RINEX file. The format of the RINEX data can also be selected as there are many tools in operation that can only use the older 2.x versions.

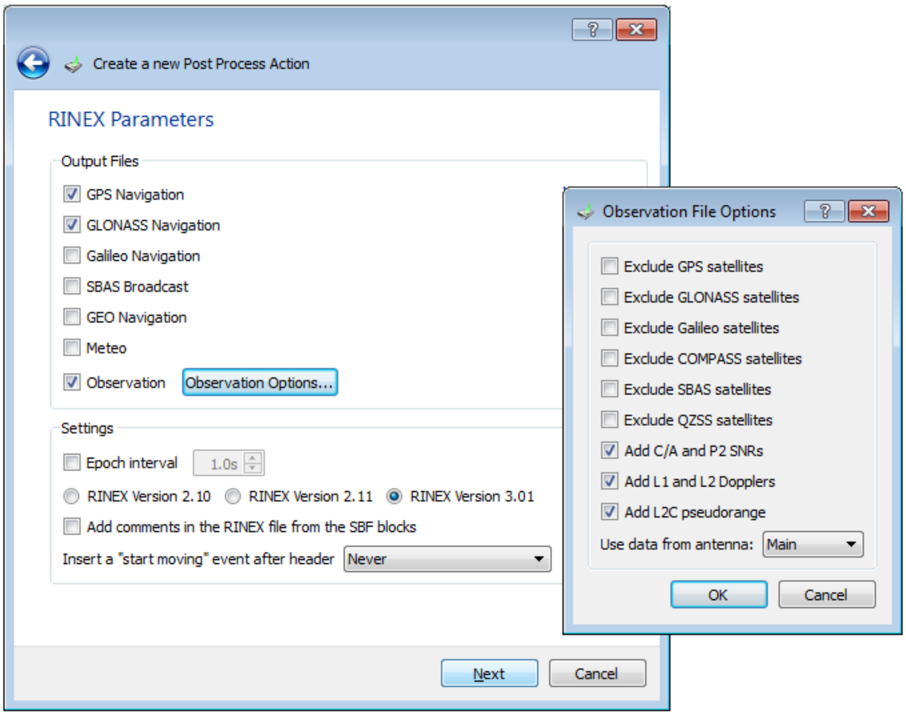



**Figure 6.2-6:** Selecting details of RINEX file

Many CORSs (Continuously Operating Reference Station) are required to submit RINEX data to the network in a compressed form over FTP. Figures 6.2-7 and 6.2-8 show how this can be done.

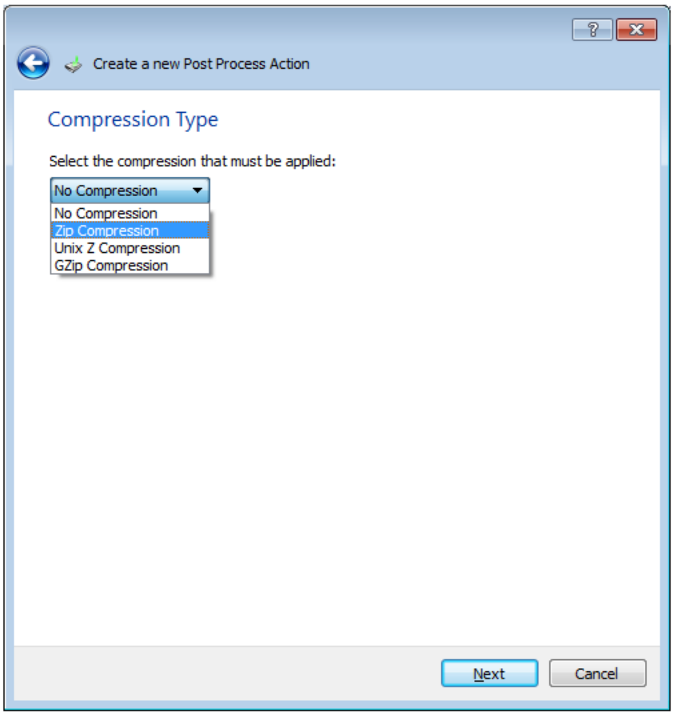



**Figure 6.2-7:** Selection the compression format for the RINEX files

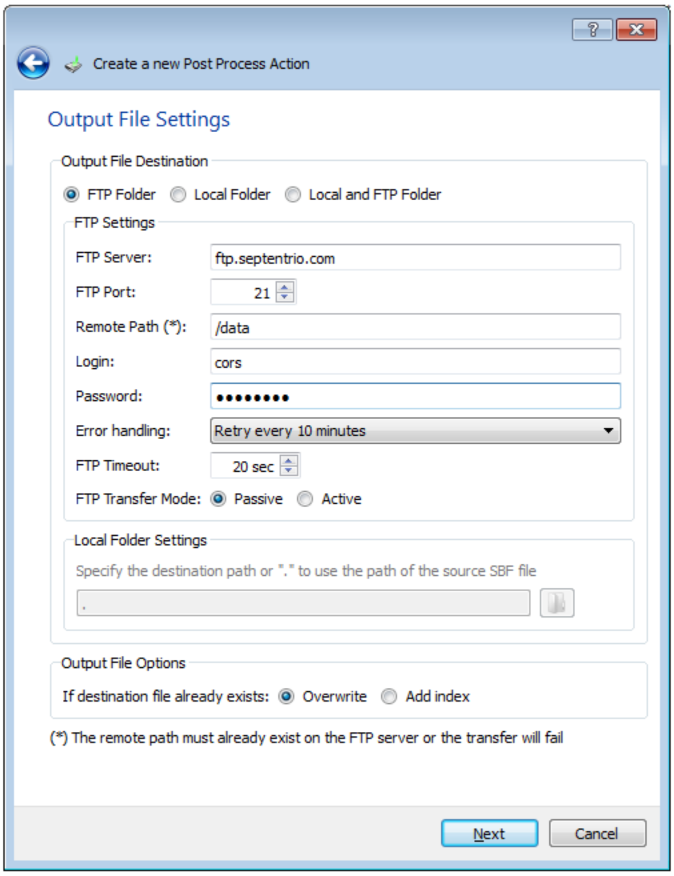



**Figure 6.2-8:** Configuring output of the generated RINEX files to a remote FTP location

When all the settings have been made, users can name of the process and write a description of what the process does. After this, the name of the newly created process will appear in the main window of the *Post Processing* tab and can be enabled by ticking the check box as shown in Figure 6.2-9.

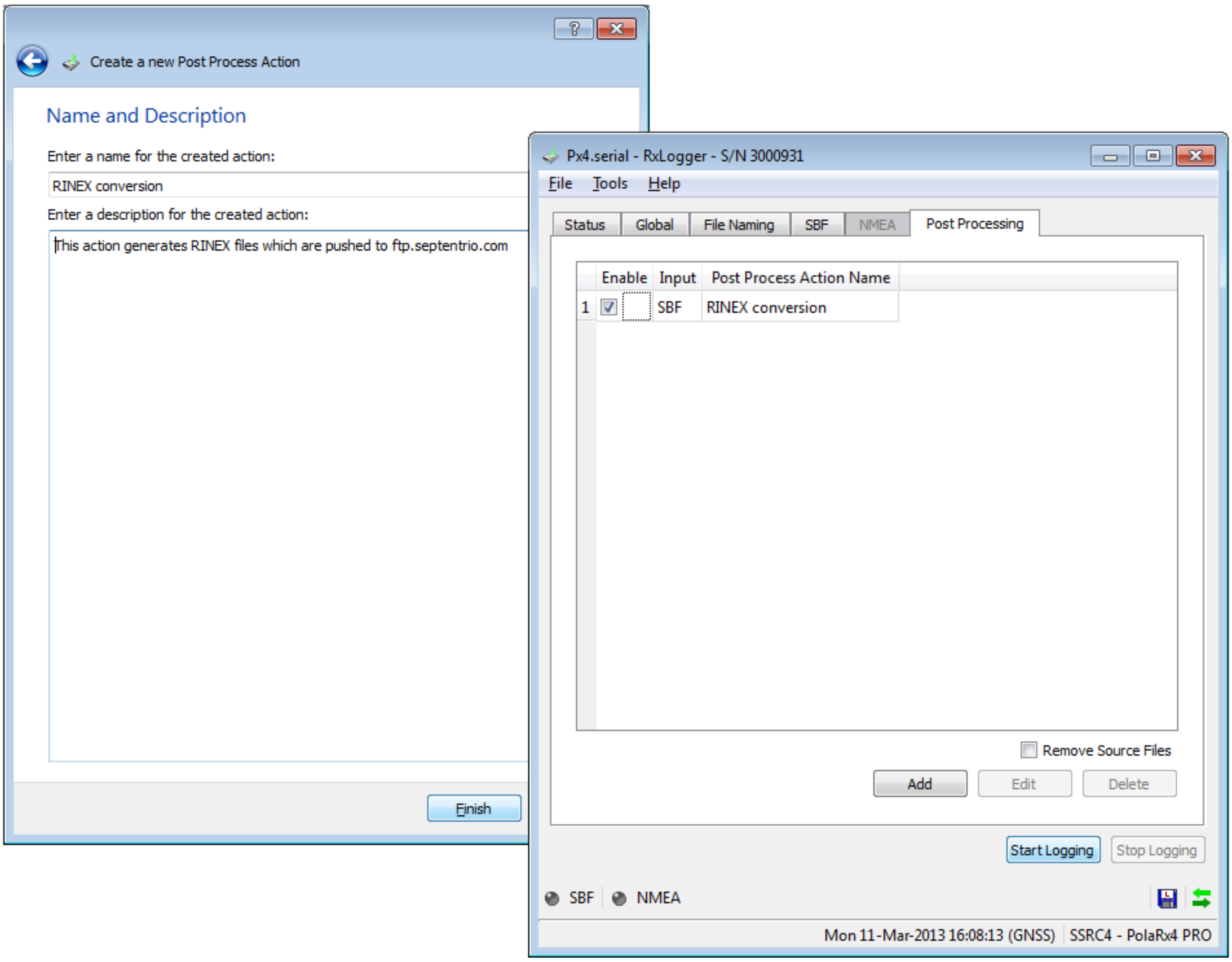



**Figure 6.2-9:** Naming the post-processing action and starting logging

## 6.2.4 Using RxLogger in the command line

The last used configuration for RxLogger is written in the configuration file 'rxlogger.conf' located in; 'C:\Users\username\.septentrio'. RxLogger can be launched from the command line as shown in Figure 6.2-10 on the next page using the command;

```
rxlogger.exe -A
```

The '-A' option tells RxLogger to start logging automatically using the default configuration file 'rxlogger.conf'.

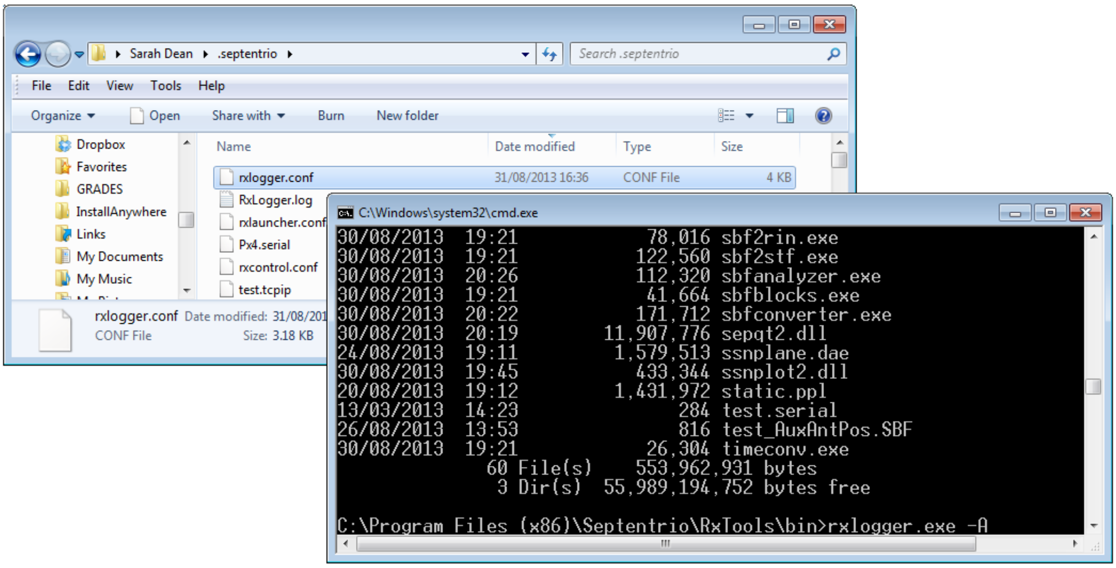



**Figure 6.2-10:** Launching RxLogger from the command line

A new configuration file called 'test1_rxlogger.conf' can be created using the command;

```
rxlogger.exe -p test1
```

RxLogger can then be launched to start logging automatically using the new 'test1_rxlogger.conf' configuration file using;

```
rxlogger.exe -p test1 -A
```

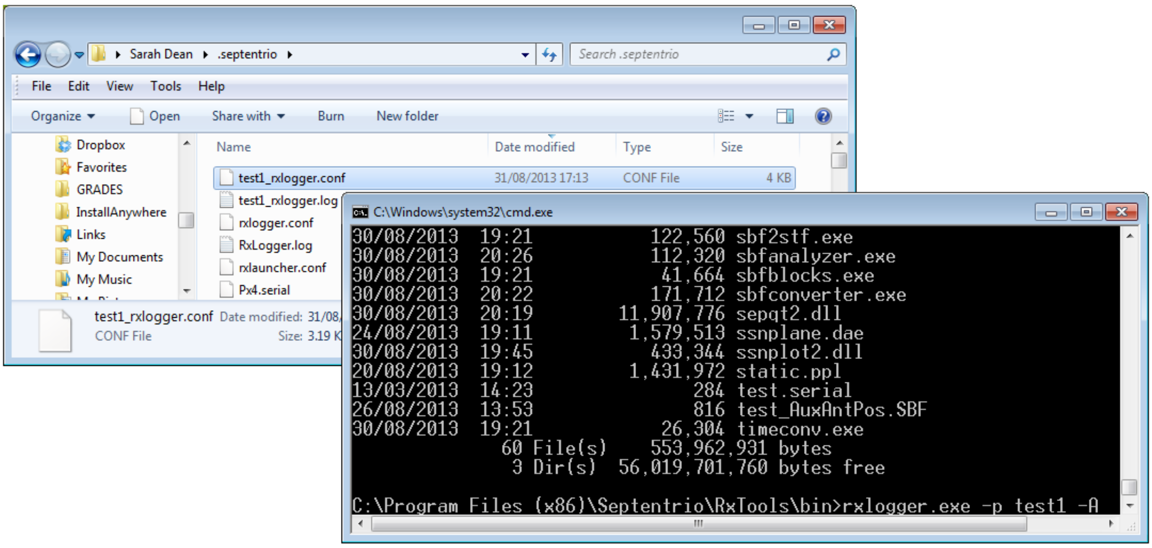



**Figure 6.2-11:** Launching RxLogger from the command line with 'test1_rxlogger.conf'

Note that when using Linux, RxLogger requires that a graphical environment, for example an X Server, is running.

# Chapter 7

# RxUpgrade

# 7.1 Introduction

RxUpgrade is a utility which can be used independently for upgrading your receiver.

## 7.1.1 RxUpgrade compatibility

RxUpgrade can be used with any Septentrio Receiver except PolaRx2/2e receivers.

## 7.1.2 Launching RxUpgrade

RxUpgrade can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the RxUpgrade executable can be found under 'Septentrio RxTools'. You can also launch RxUpgrade via the 'Tools' menu of any of the GUI tools, for example from RxControl as shown in Figure 7.1-1.

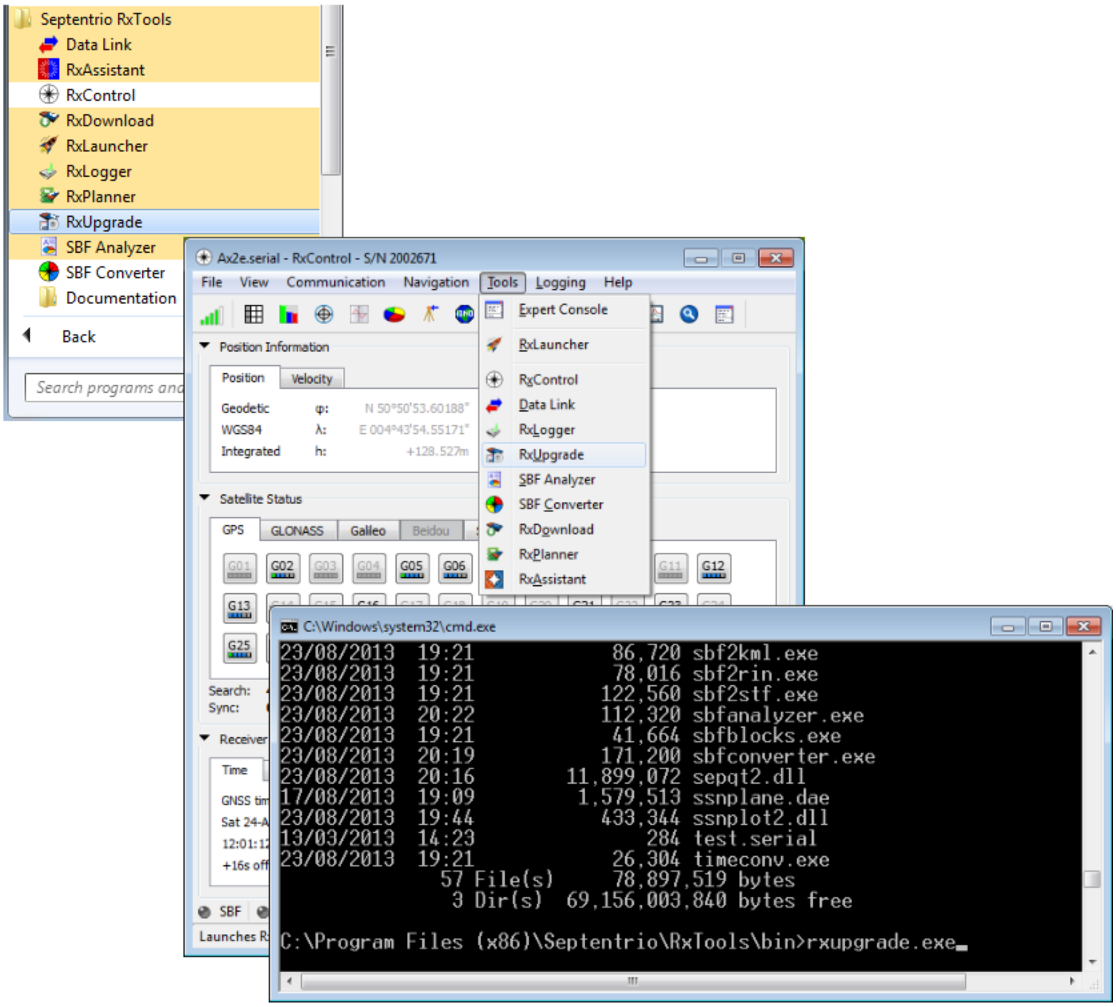


**Figure 7.1-1:** Launching the RxUpgrade GUI

# 7.2 Using RxUpgrade: a worked example

## 7.2.1 Upgrading receiver firmware

The following pages give an example of using the RxUpgrade tool. In this case, the firmware of an AsteRx2eH is upgraded to the most recent 2.5.1 version.

The first step as shown in Figure 7.2-1 is to select a connection over which to make the upgrade. Note that USB and TCP/IP will be significantly faster than using a serial port. In this example, one of the USB 2 (mapped onto the virtual serial port COM7) is used.

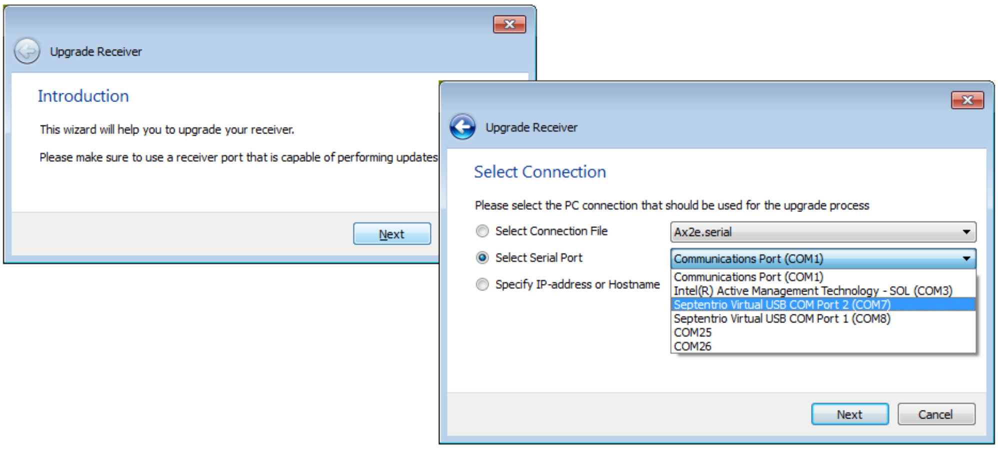



**Figure 7.2-1:** Opening a connection on the receiver over which to make the upgrade

After having made a connection, you can then select the .suf file that you want to upgrade. This can be done by clicking on the 'Browse ...' button in Figure 7.2-2.

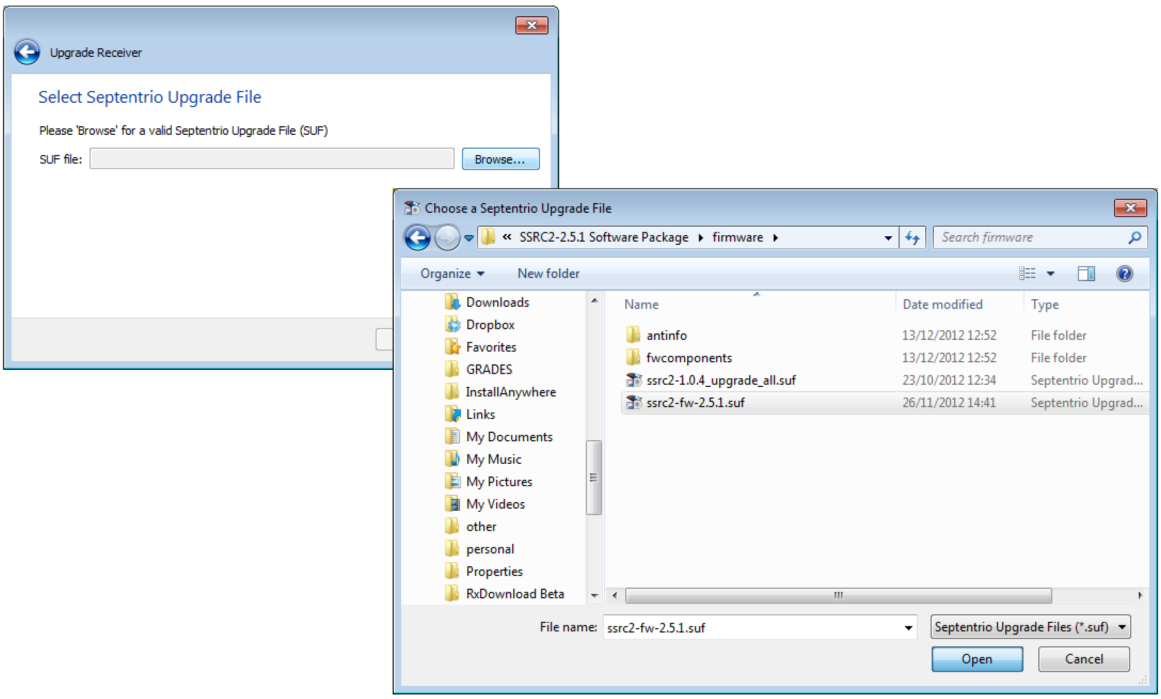



**Figure 7.2-2:** Selecting the .suf firmware file to upgrade

When the upgrade file has been selected, you can start upgrading the receiver by clicking on the 'Upgrade' button as Figure 7.2-3 shows. If there is any incompatibility between receiver and firmware version, an error will appear at this stage.

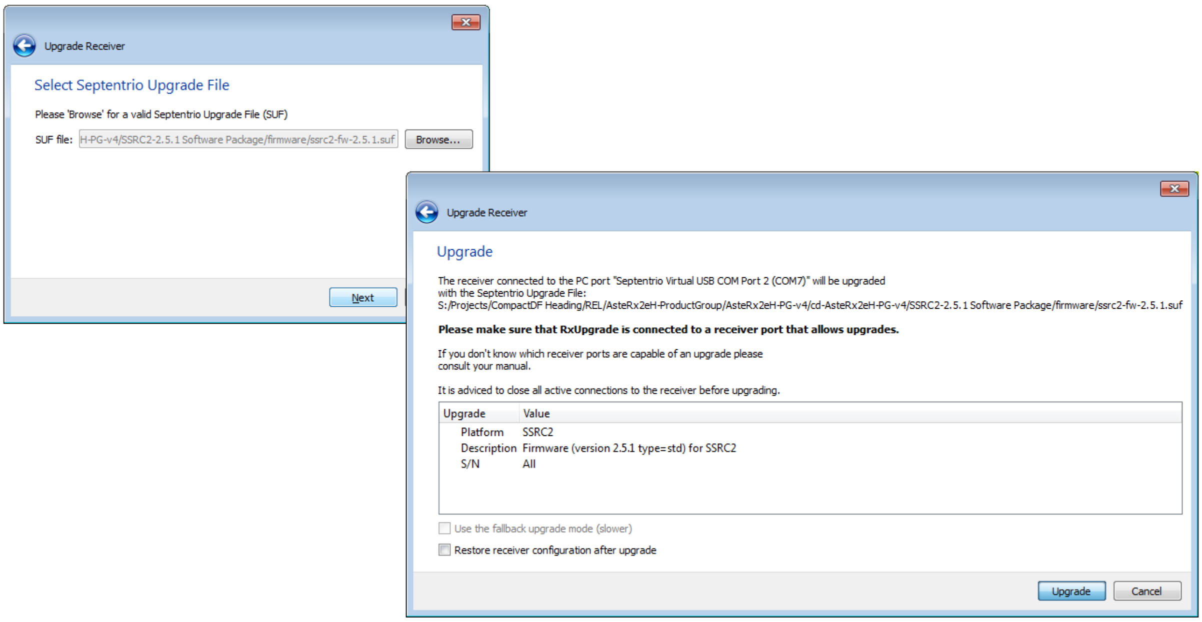



**Figure 7.2-3:** Starting the firmware upgrade

The progress of the upgrade procedure is indicated by a status bar as shown in Figure 7.2-4. When the upgrade has reached 100%, you can click on 'Finish' to complete the procedure.

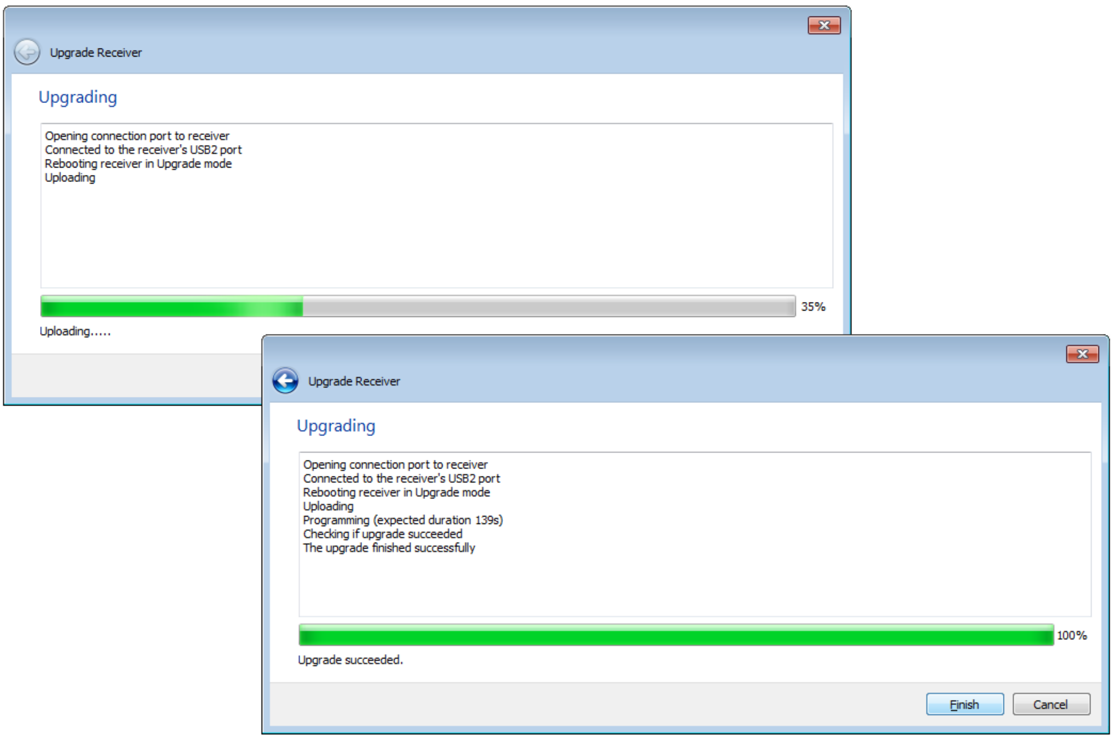



**Figure 7.2-4:** Progress of receiver upgrade

# Chapter 8

# RxDownload

## 8.1 Introduction

RxDownload is an application designed to download internally logged from multiple receivers. It can also be used to configure the receivers and select SBF data blocks to be logged. Post processing actions such as RINEX conversion can also be configured using RxDownload.

### 8.1.1 RxDownload compatibility

**RxDownload 1.2.3** can be used with any Septentrio Receiver except PolaRx2/2e receivers.

### 8.1.2 Launching RxDownload

RxDownload can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the RxDownload executable can be found under 'Septentrio RxTools'. You can also launch RxDownload via the 'Tools' menu of any of the GUI tools, for example from RxControl as shown in Figure 8.1-1.

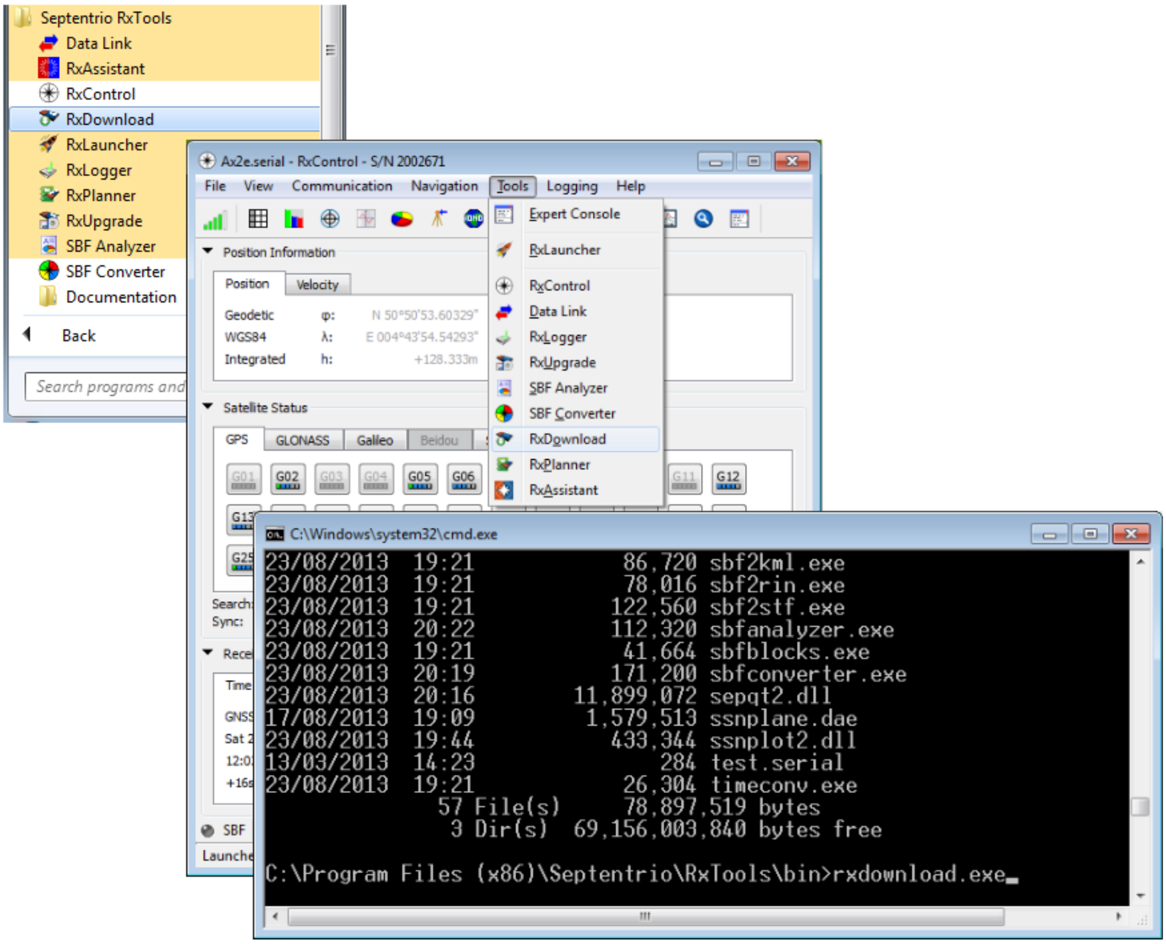



**Figure 8.1-1:** Launching the RxDownload GUI

# 8.2 Using RxDownload: a worked example

## 8.2.1 Opening new receiver connections

Click on the green '+' icon indicated in 8.2-1 to add a new receiver to RxDownload file downloading scheduler. Connections to receivers can then be made in a similar way to opening a connection in RxControl.

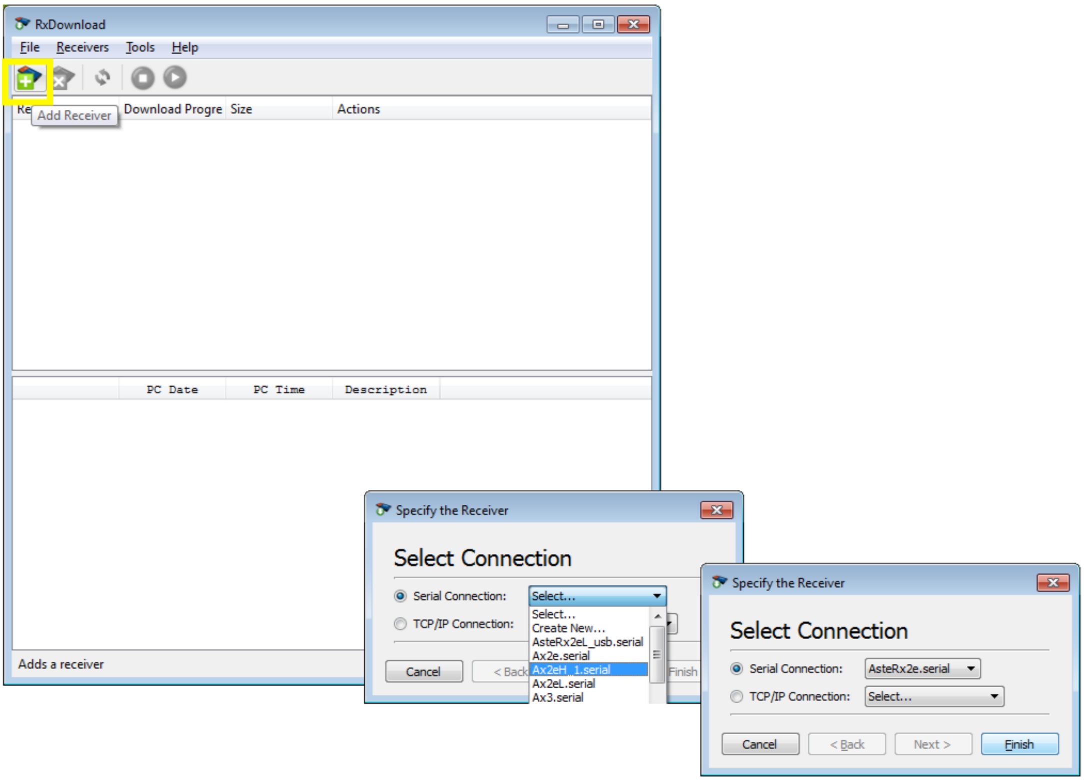



**Figure 8.2-1:** Adding a new receiver to RxDownload

Figure 8.2-2 on the following page shows an example where three receiver connections have been made to RxDownload; two over serial connections and one over TCP/IP. For the 'Px4_927.tcip' connection, there is one file 'sept167o00.13_' scheduled to be downloaded after 45 minutes and 57 seconds as the field indicated shows.

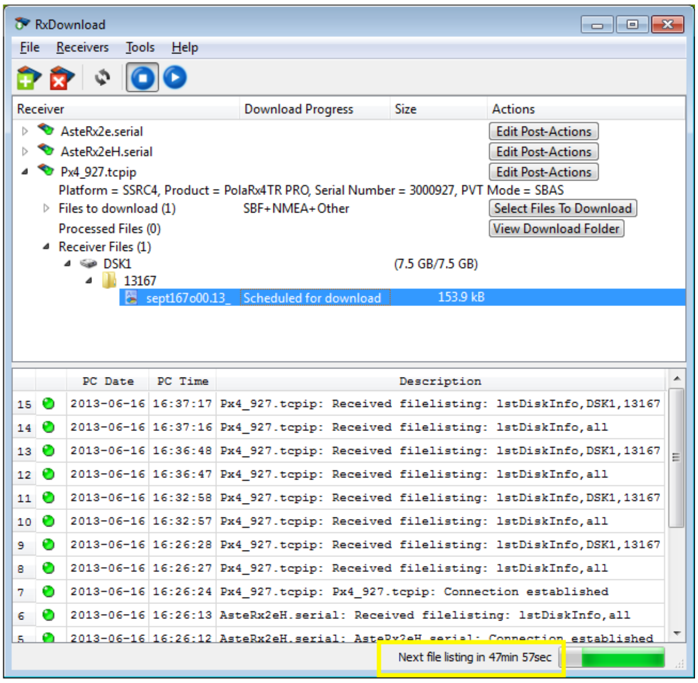



**Figure 8.2-2:** Main window of RxDownload showing connections to three receivers. The time till the next scheduled download is indicated by the yellow box.

### 8.2.2 Setting the RxDownload preferences

Preferences can be set via the 'File' menu as shown in Figure 8.2-3. In the Preferences window, the scheduled download times can be changed from the default 60 minutes and the local PC directory where files are to be download can be selected.

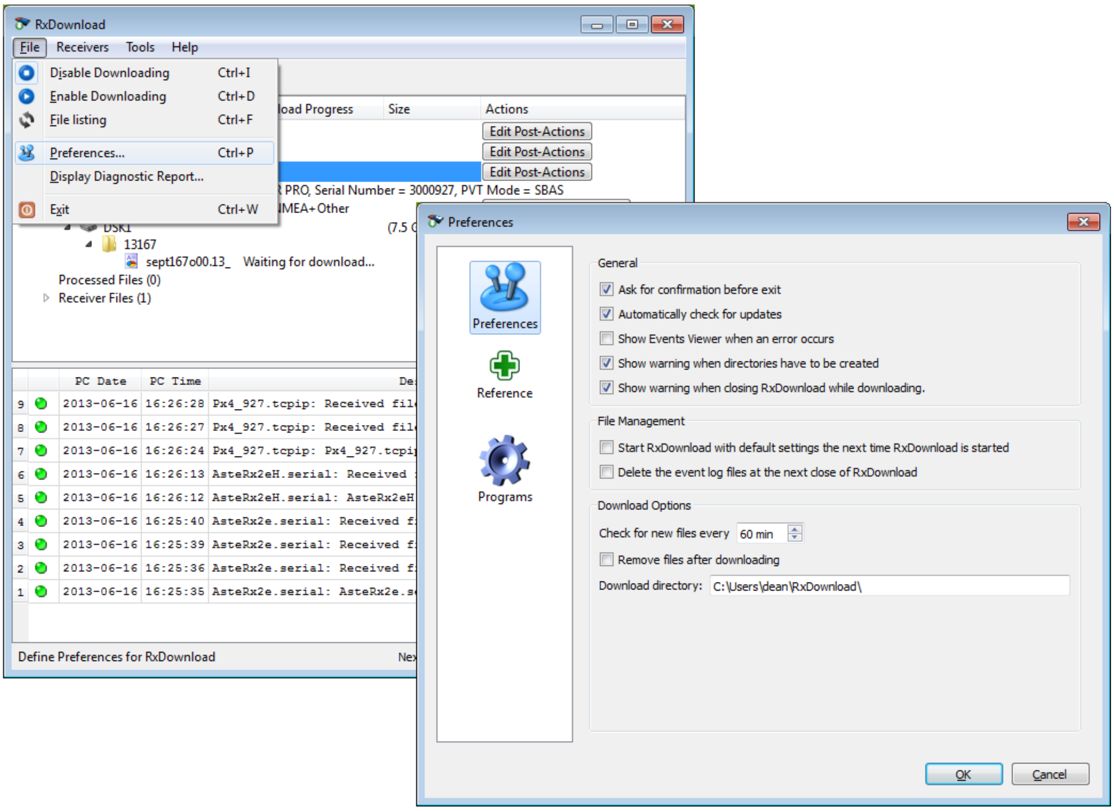



**Figure 8.2-3:** Setting the preferences for RxDownload

### 8.2.3 Configuring the receiver settings using RxDownload

RxDownload can also be used to change the receiver settings to that a separate connection using RxControl is not necessary. In the example shown in Figure 8.2-4, RxDownload is used to configure the PVT elevation mask setting of the receiver on the 'AsteRx2e.serial' connection.

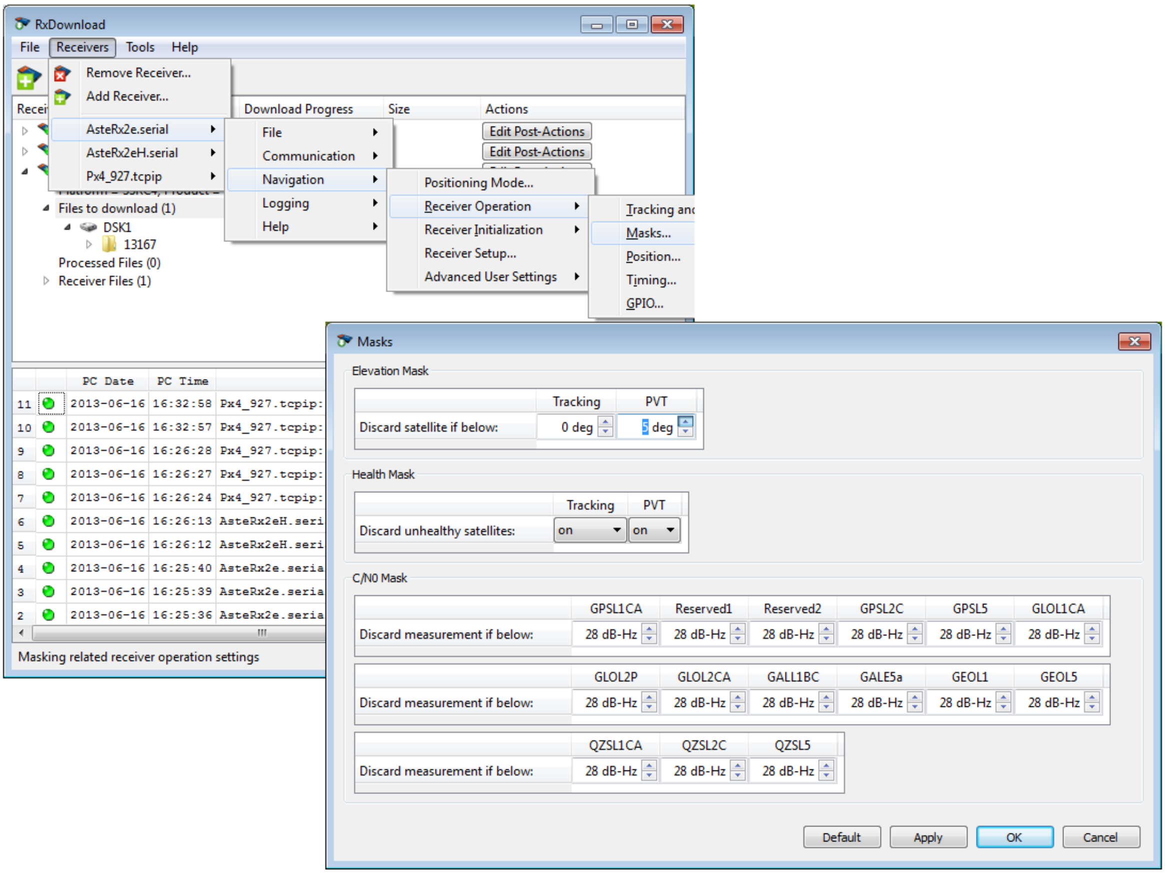



**Figure 8.2-4:** Changing the receiver elevation mask using RxDownload

### 8.2.4 Configuring the receiver output using Rx-Download

Figure 8.2-5 shows how to configure (or check) logging to the internal SD card. In this case, all the SBF blocks necessary for RINEX conversion ('Rinex' check box) have been selected to be logged to the internal SD card ('DSK1') at a rate of 1 Hz.

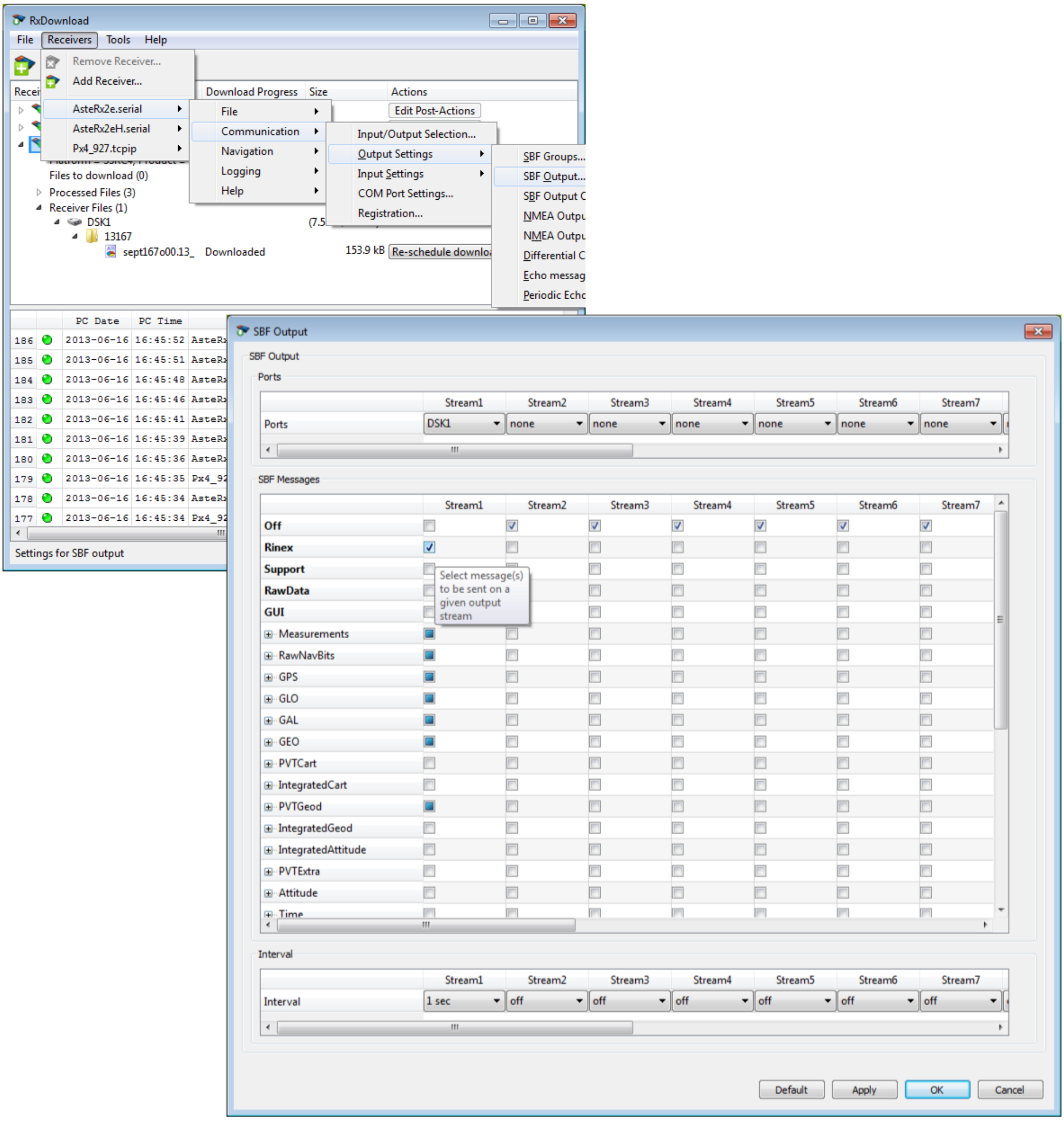



**Figure 8.2-5:** Selecting the SBF data blocks to be logged to the internal SD card.

### 8.2.5 Editing the post processing actions using RxDownload

Again, similar to RxControl, RxDownload can be used to configure a post-processing action on the logged SBF data files. In the example shown in Figure 8.2-6, the SBF files downloaded from the receiver connected over 'Px4_927.tcpip' will be converted to RINEX after download.

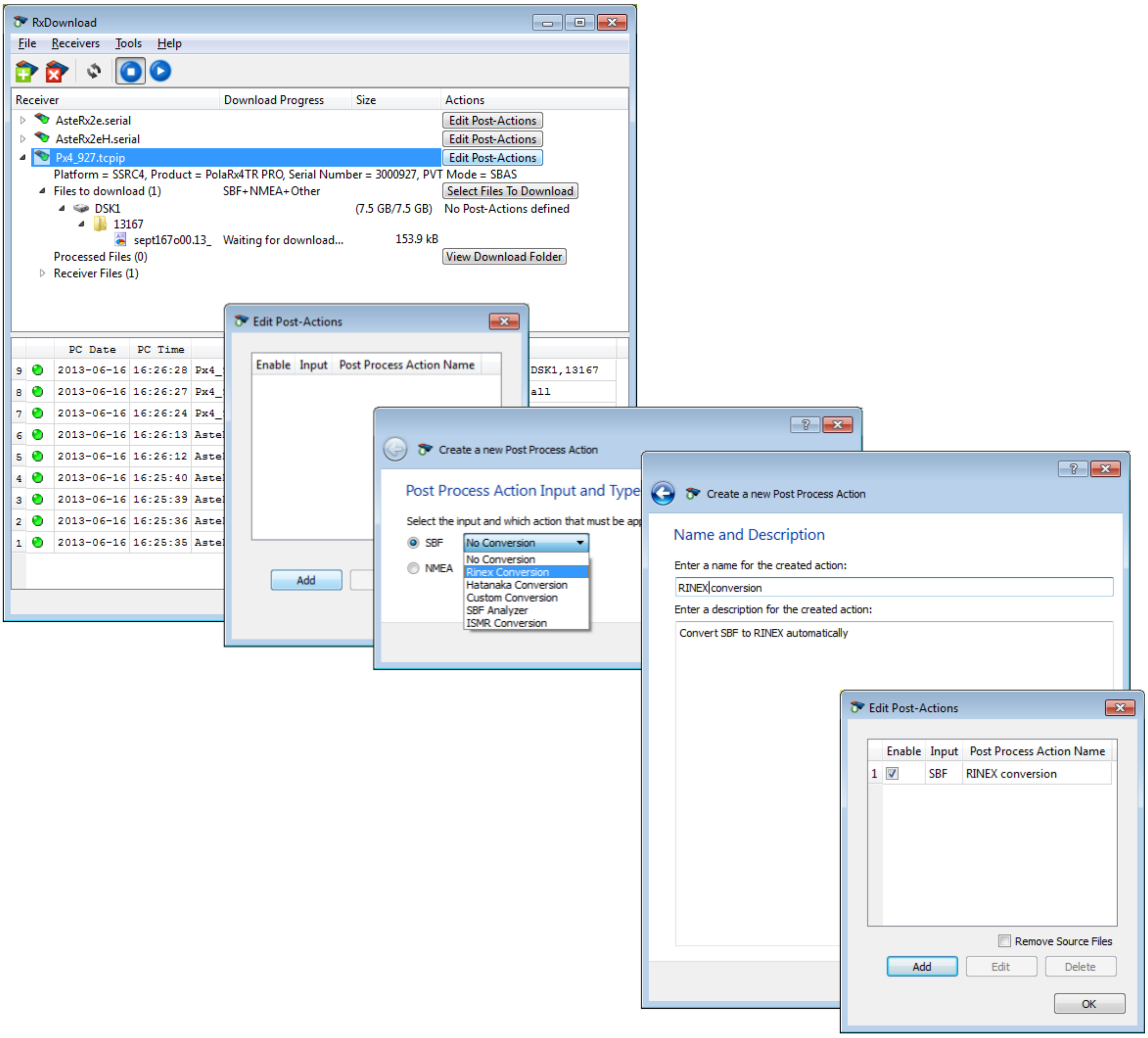



**Figure 8.2-6:** Adding RINEX conversion as a post processing action.

### 8.2.6 Initiating a download of the internally logged files.

By clicking on the blue button indicated in Figure 8.2-7, a download is immediately initiated. In this example, the single SBF file downloaded over Px4_927.tcpip can be seen on the local PC as well as the RINEX OBS and NAV files that were configured in the post-processing window.

For files that have already been downloaded from the receiver, users can download these files once more by clicking on the ’Re-schedule download’ button indicated.

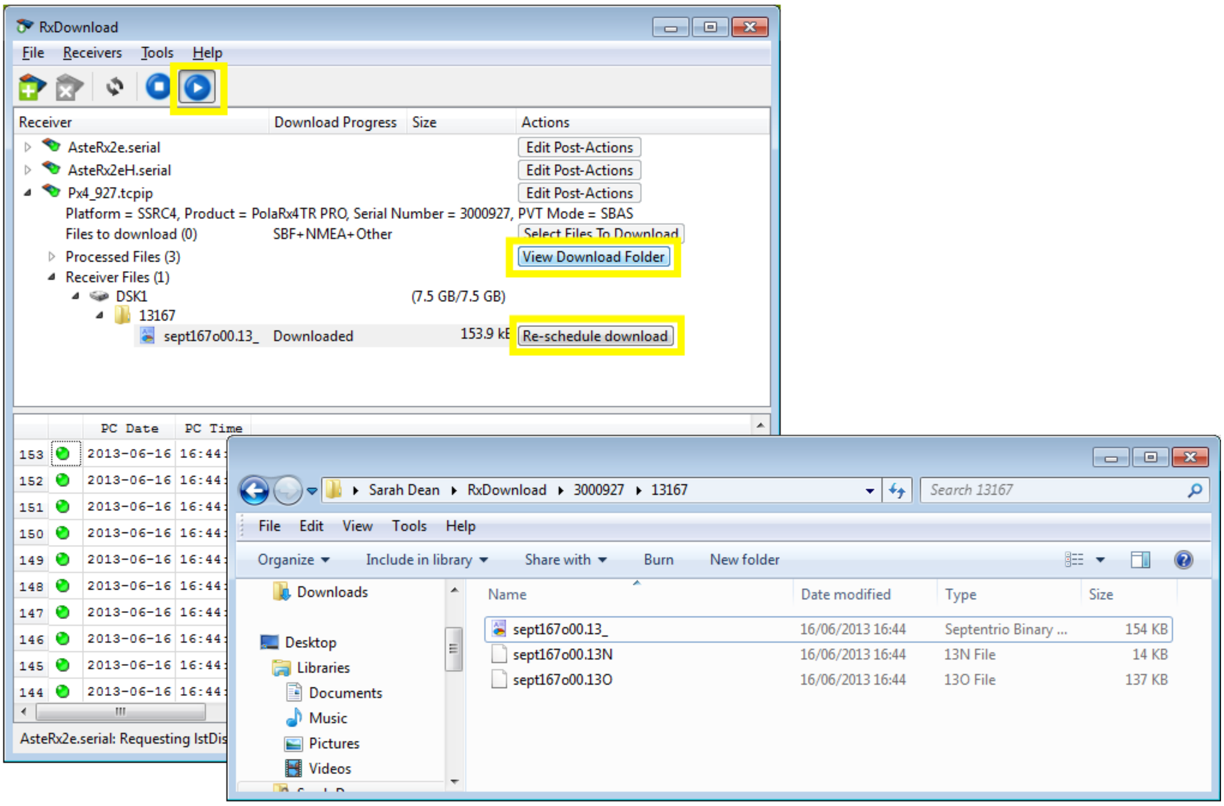



**Figure 8.2-7:** Downloading files before the next scheduled download.

# Chapter 9

# RxPlanner

# 9.1 Introduction

RxPlanner is an software tool designed to allow users to visualise satellite visibility at a particular location over a user defined time period. As well as assisted planning of GNSS related work, RxPlanner can also be used to see what the visibility should have been during a particular task and thus help identify problems should the observed visibility be significantly less than that predicted by RxPlanner.

## 9.1.1 RxPlanner compatibility

**RxPlanner 1.2.4** RxPlanner operates without the need for a Septentrio Receiver. It does however require recent satellite ephemeris data. RxPlanner will automatically check that the ephemeris data stored is applicable for the current job being executed and if not, it will prompt the user to accept downloading the applicable ephemeris data from the Septentrio website.

## 9.1.2 Launching RxPlanner

RxPlanner can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the RxPlanner executable can be found under 'Septentrio RxTools'. You can also launch RxPlanner via the 'Tools' menu of any of the GUI tools, for example from RxControl as shown in Figure 9.1-1.

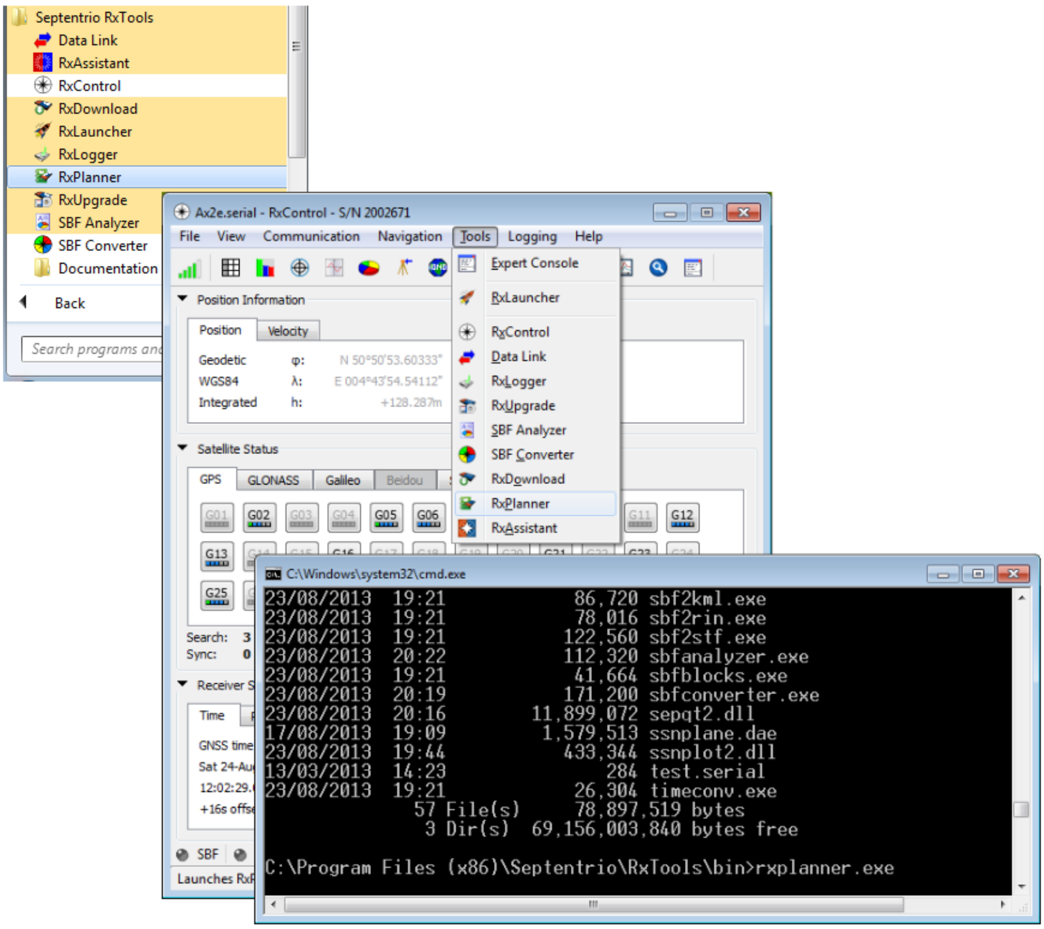



**Figure 9.1-1:** Launching the RxPlanner GUI

## 9.2 Using RxPlanner: a worked example

The example below shows how the GPS and Glonass satellite visibility and DOP plots, as well as a PDF report, can be generated for Shanghai on the 29th March 2013 from 8am till 8pm (local time) for an elevation mask of 12 degrees.

### 9.2.1 Creating a new project

The first step in using RxPlanner is creating a new project. This can be done by clicking the ’New Project ...’ button on the main page. After entering a project name and clicking on ’OK’. The new project will appear on the main screen. Clicking on this new project will activate the configuration and plot icons in the left hand side as Figure 9.2-1 shows.

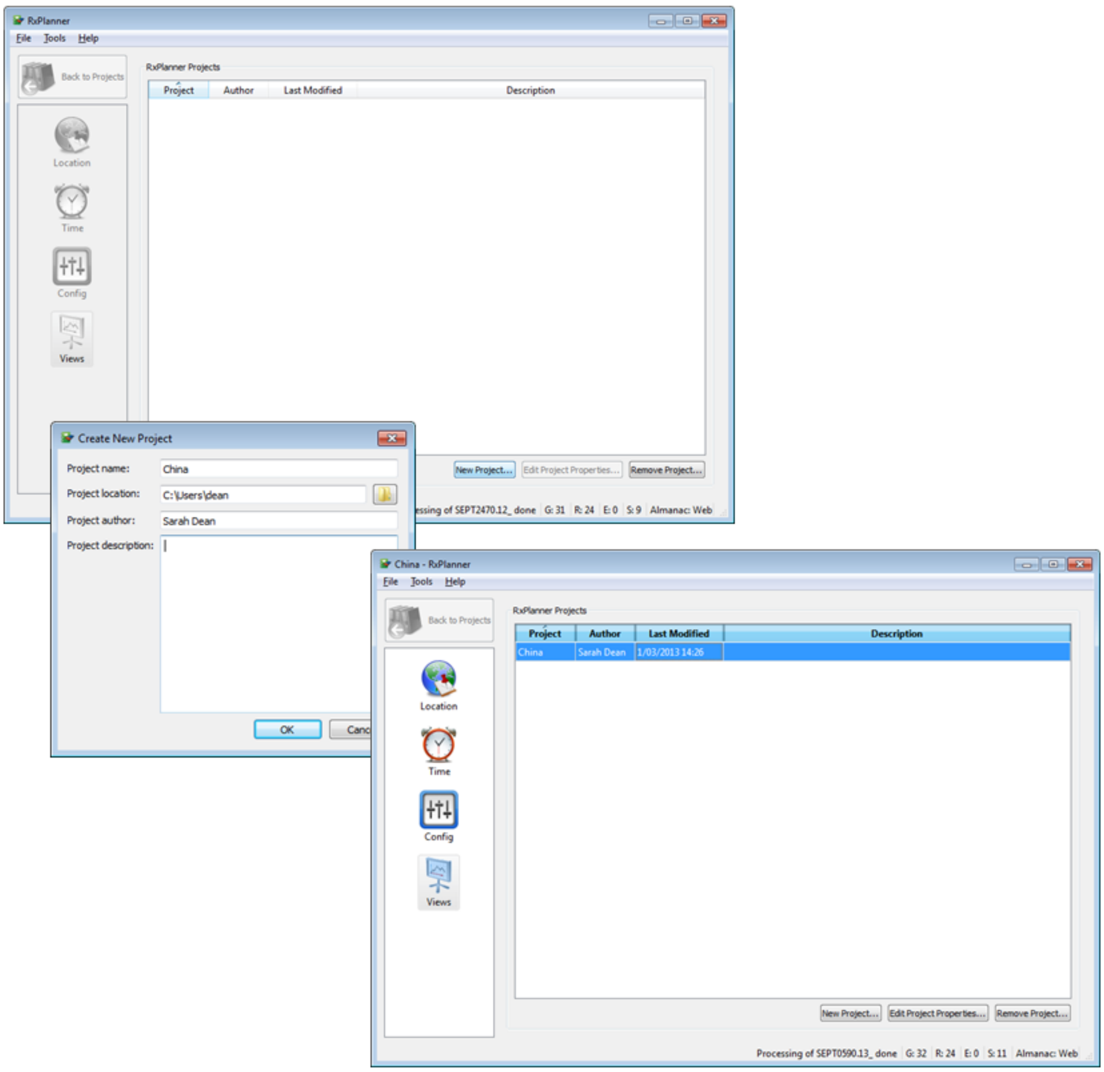



**Figure 9.2-1:** Opening a new project

The location can be set by either inserting the coordinates, typing a name into the address bar or by simply dragging and dropping the marker on the correct location. In the example in Figure 9.2-2 the correct location is found by typing in *'Shanghai'*.

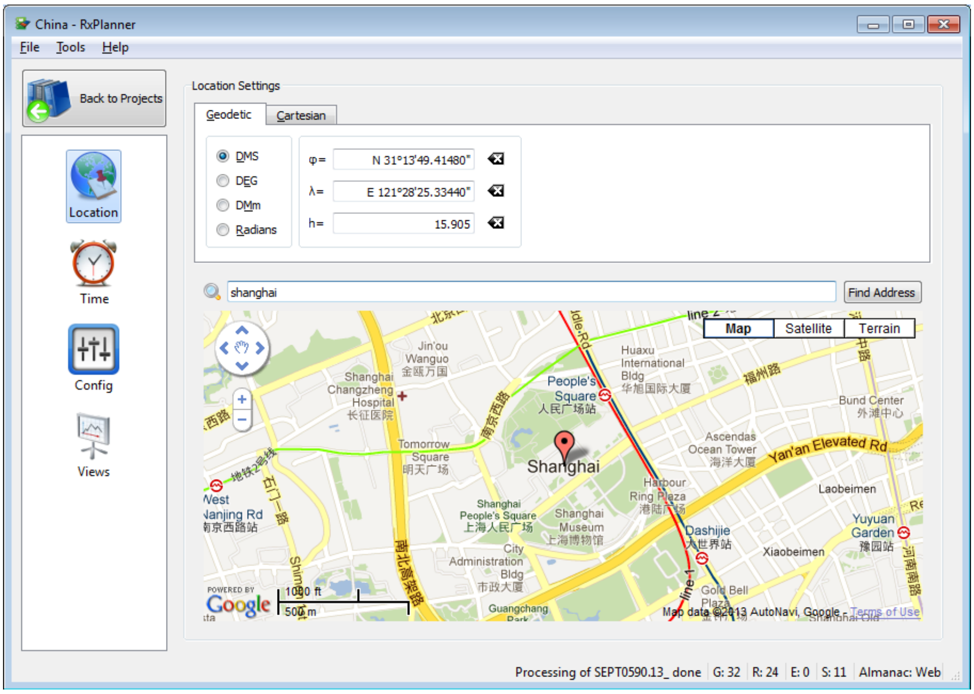



**Figure 9.2-2:** Selecting the location

The time, date and time period of interest can then be selected as shown in Figure 9.2-3.

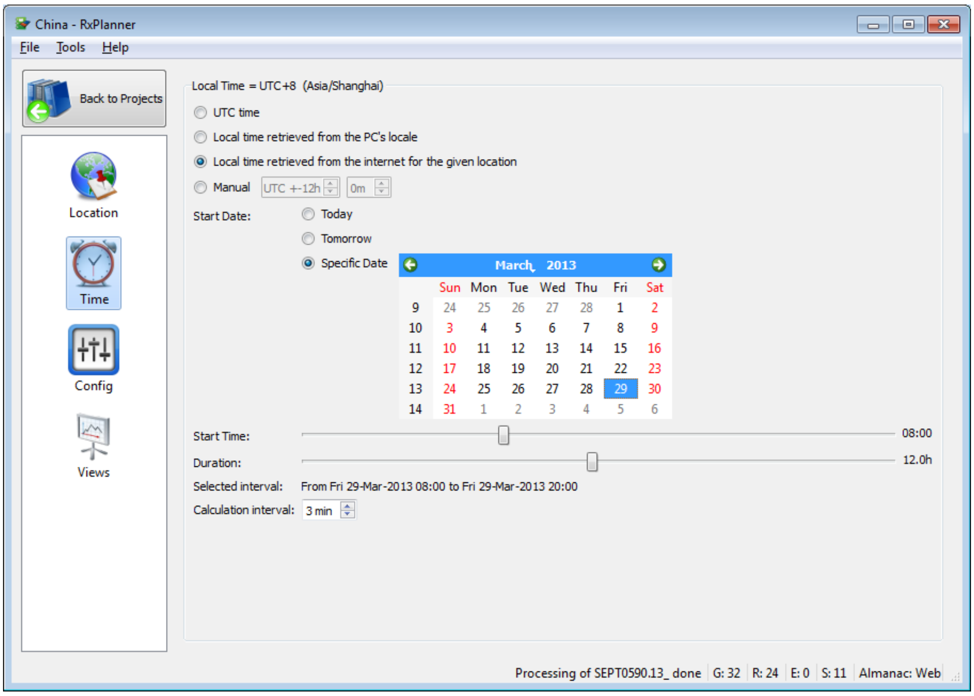



**Figure 9.2-3:** Selecting the time and date

By clicking on the 'Config' button, the elevation mask can be set as well as the satellite constellations to be included. In this window, the user can also select a local horizon mask file by checking the 'Horizon Mask' box. The is a file (.lhm) that can generated by the Sky Plot in RxControl. This feature can only be used if you have collected 24 hrs of data at the current location.

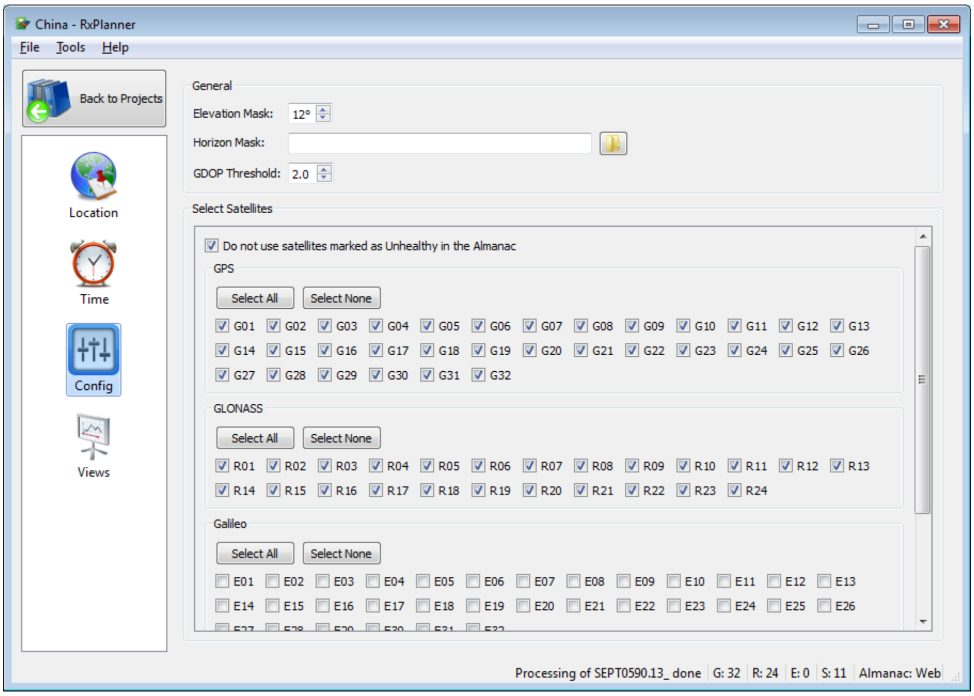



**Figure 9.2-4:** Selecting the elevation mask, GDOP threshold and constellations to be used

If the almanac data stored in in RxPlanner is much older (or indeed younger) than that needed for the current job then the user will be prompted to either use the current almanac (Ignore) or download the appropriate almanac from the Septentrio website (Update Almanac) as shown in Figure 9.2-5.

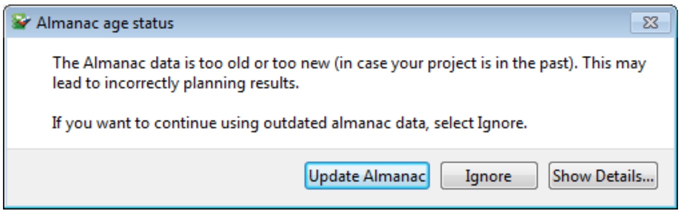



**Figure 9.2-5:** Prompt to update the almanac

The results are generated by clicking on 'Views' on the left hand panel. The plots include the number of satellites available over time and the PRNs (satellites) in view. A plot showing the dilution of precision (DOP) over time is also available where the quality is indicated by a color bar below the plot; the lower the DOP the better the quality.

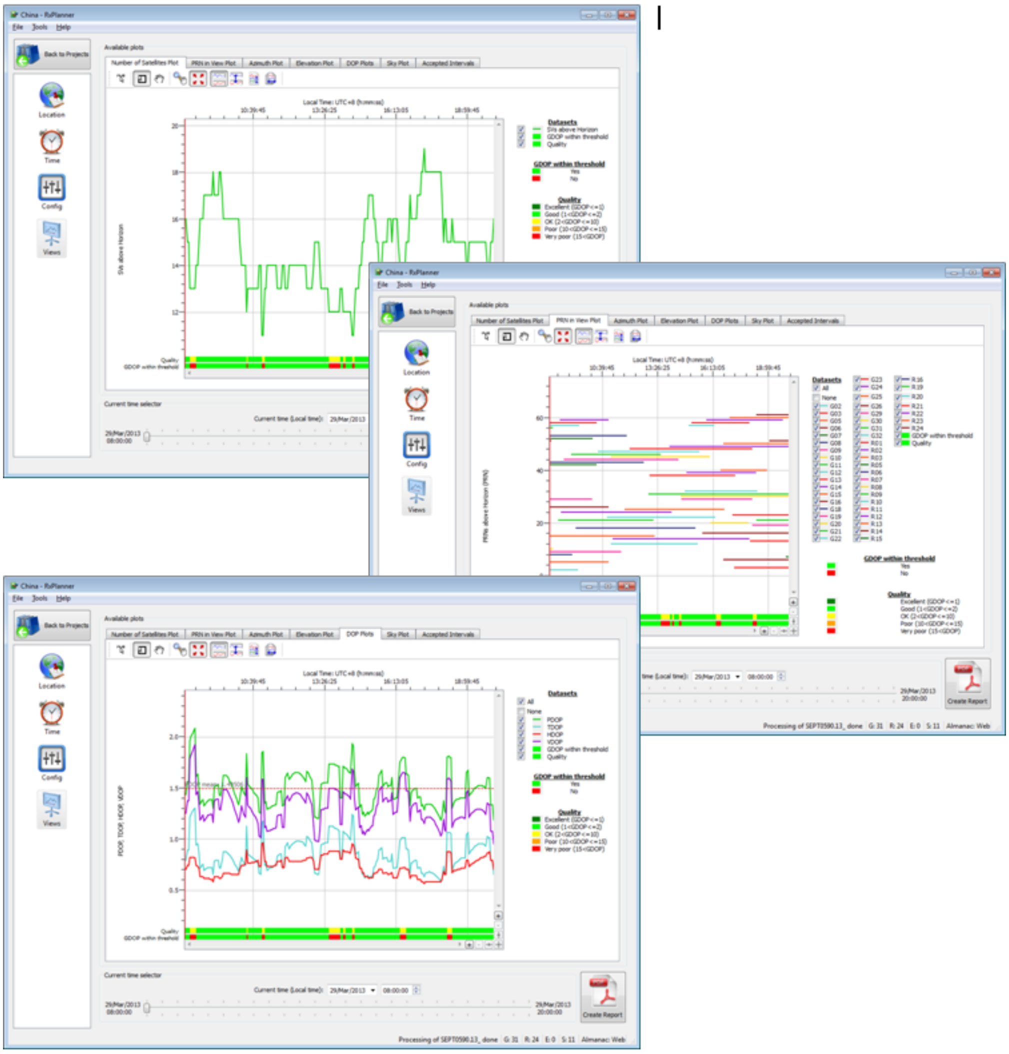


**Figure 9.2-6:** Plots generated


**Figure 9.2-7:** Creating a PDF report

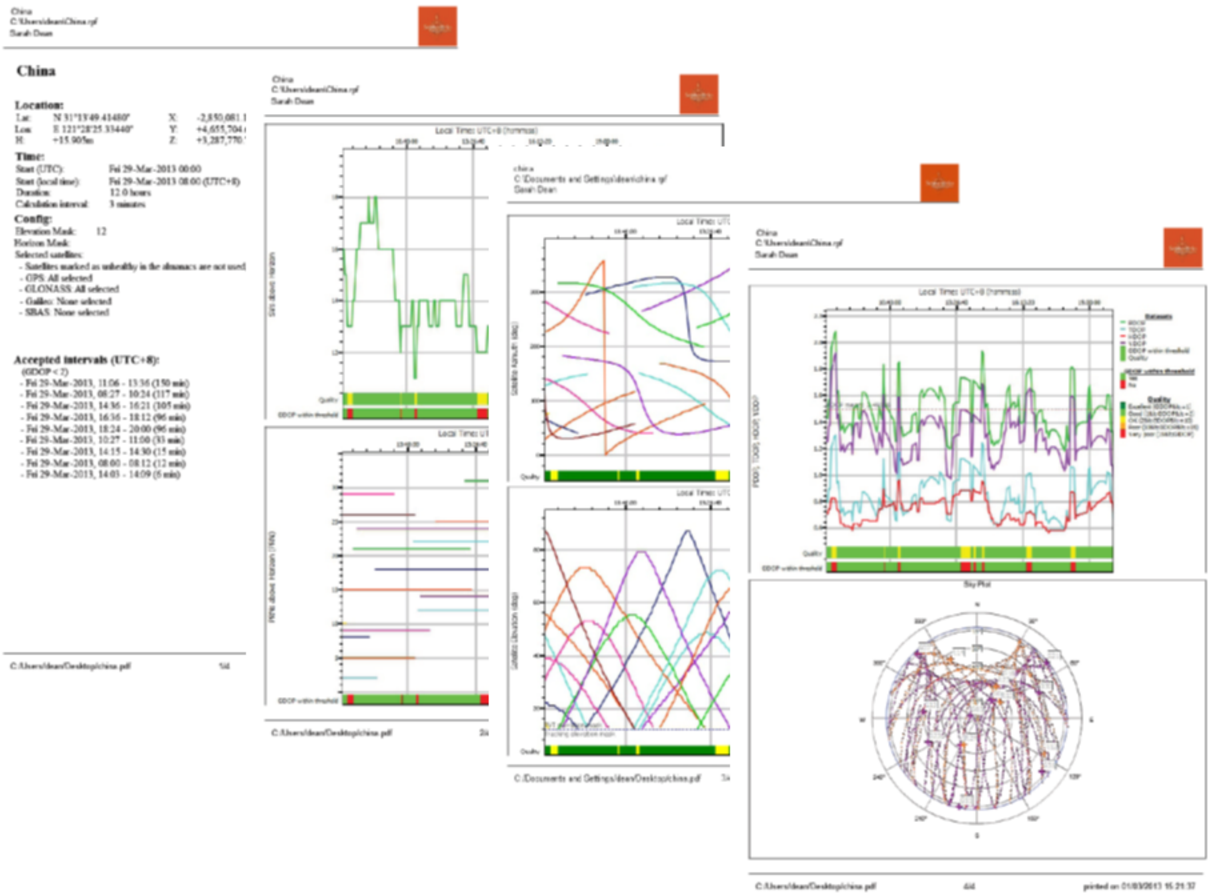
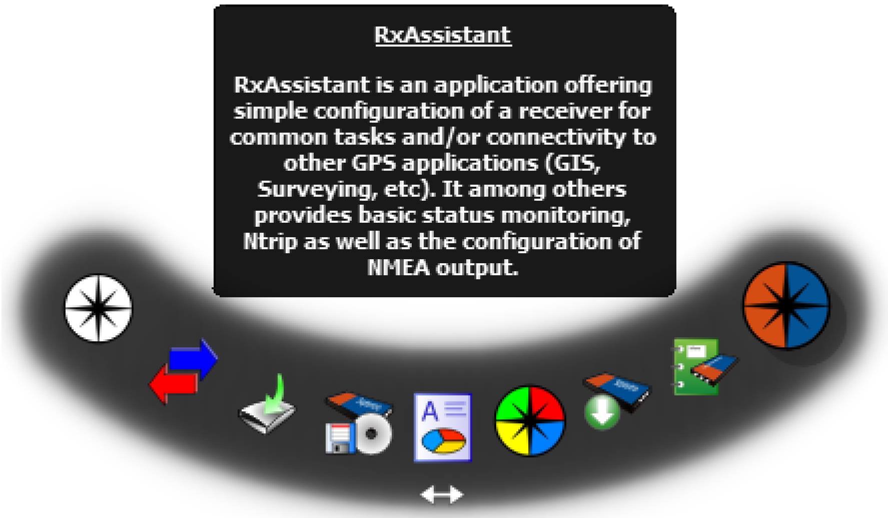


**Figure 9.2-8:** RxPlanner PDF report

# Chapter 10

# RxAssistant



# 10.1 Introduction

RxAssistant is an interface and control GUI that simplifies receiver configuration and monitoring without compromising on flexibility.

## 10.1.1 RxAssistant compatibility

RxAssistant does not support PolaRx2e or older receivers.

## 10.1.2 Launching RxAssistant

RxAssistant can be launched in several ways: using the RxLauncher GUI, from the Start menu on a Window's PC, a shortcut to the RxAssistant executable can be found under 'Septentrio RxTools'. You can also launch RxAssistant via the 'Tools' menu of any of the GUI tools, for example from RxControl as shown in Figure 10.1-1.

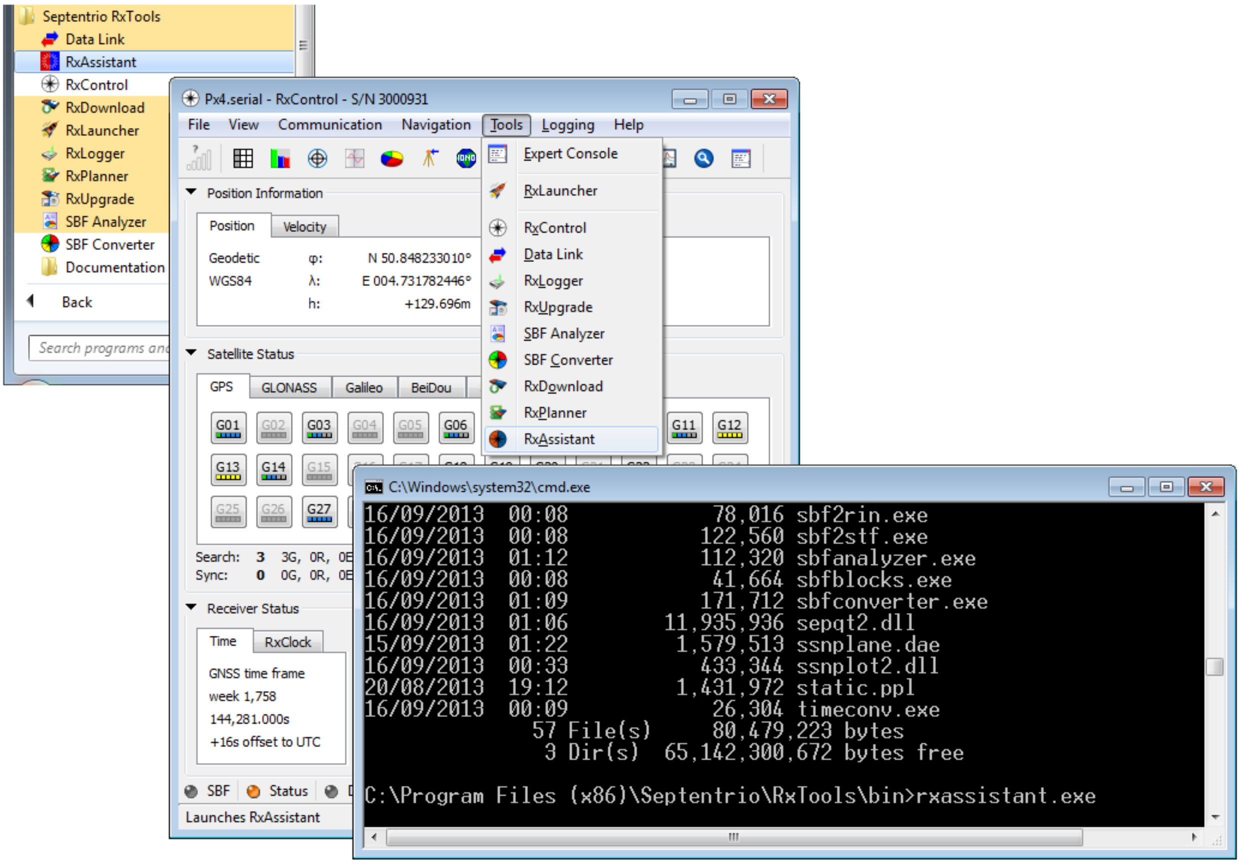



**Figure 10.1-1:** Launching the RxAssistant GUI

When closing the RxAssistant GUI, the application continues to run in the background. It can be shut down or re-opened via the system tray as shown in Figure 10.1-2

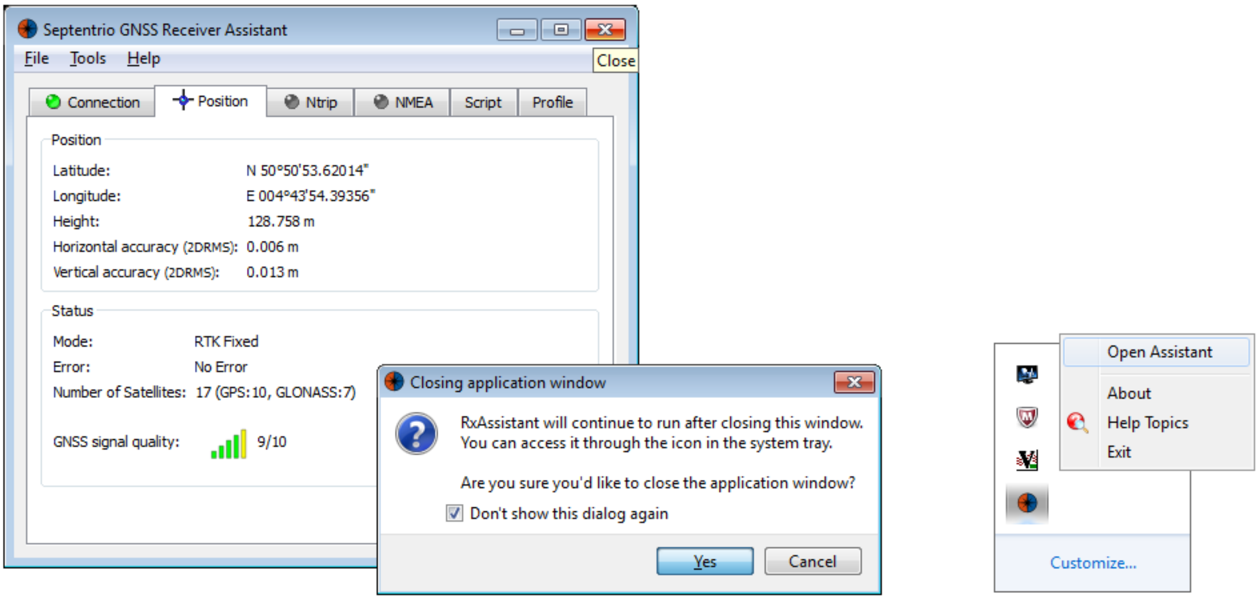



**Figure 10.1-2:** RxAssistant can be accessed via the Window's system tray

When trying to launch a second instance of RxAssistant, a warning will pop up. To see at a glance whether or not RxAssistant is running, you can configure your PC to show the RxAssistant icon in the taskbar. This is done via the 'Customize ...' link in the system tray as shown in Figure 10.1-3.

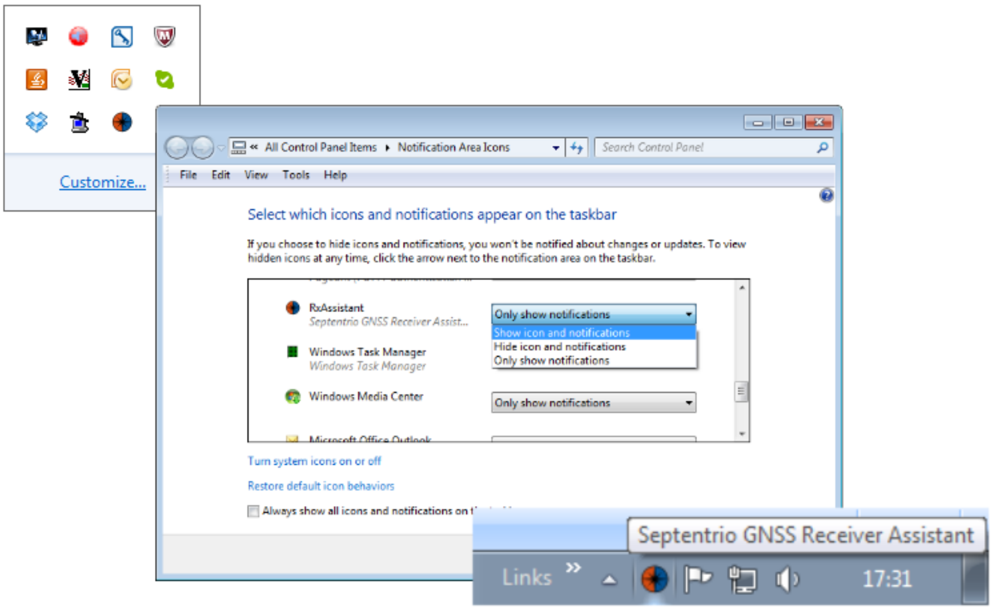



**Figure 10.1-3:** Setting RxAssistant to be visible in the taskbar of the PC

When RxAssistant is run for the first time, the user is asked if they would like the tool to be launched automatically each time at startup. This setting can also be configured in the preferences window as Figure 10.1-4 shows.

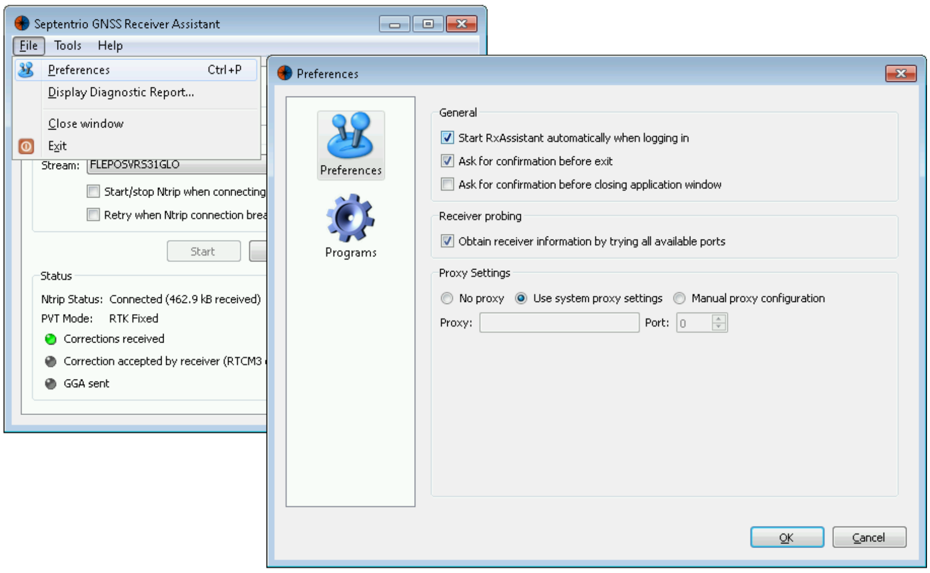



**Figure 10.1-4:** Configuring RxAssistant preferences

In the File menu, the user can also generate the receiver Diagnostic Report as shown in Figure 10.1-5.

In this menu, the user can also select to 'Close' the RxAssistant window (and leave it running in the taskbar) or 'Exit' which shuts it down completely. Note that, when exiting RxAssistant or pressing 'Disconnect', NMEA data will continue to be sent out over the configured port as this is a receiver configuration. NMEA output can only be stopped by reconfiguring the receiver or by disconnecting it from the PC or tablet.

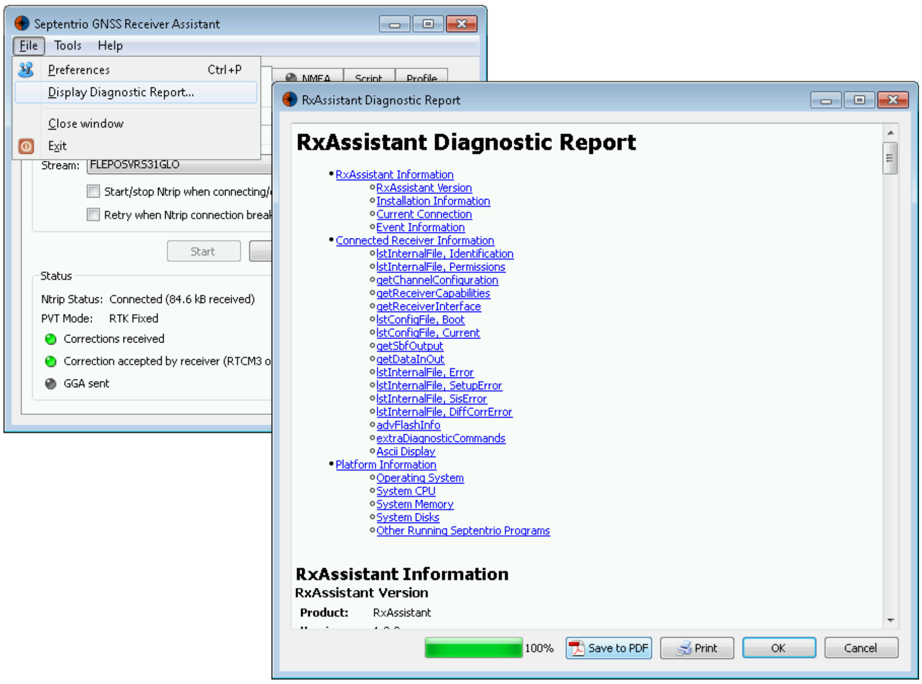



**Figure 10.1-5:** Generating the receiver Diagnostic Report using RxAssistant

## 10.2 Using RxAssistant: a worked example

The example below shows how to connect to and configure a Septentrio Receiver for NTRIP RTK using RxAssistant.

### 10.2.1 Connecting to a receiver using RxAssistant

Connect a USB or serial cable from the Septentrio Receiver to the PC or tablet. In this particular example, an AsteRx-m GeoPod has been used.

Clicking on the 'Select port' drop-down list will show the possible connections. In the example shown in Figure 10.2-1 the receiver's USB connection has been mapped onto the connection the PC connections 'AsteRx-m GeoPod (COM16)' and 'AsteRx-m GeoPod (COM17)'. Whichever port you select will be used for the RxAssistant connection and also for the NTRIP data transfer. The remaining port can then be used to send NMEA data to a secondary application.

After making the port selection and clicking on 'Connect', the fields in the Status panel should be filled in with some basic information about the receiver.

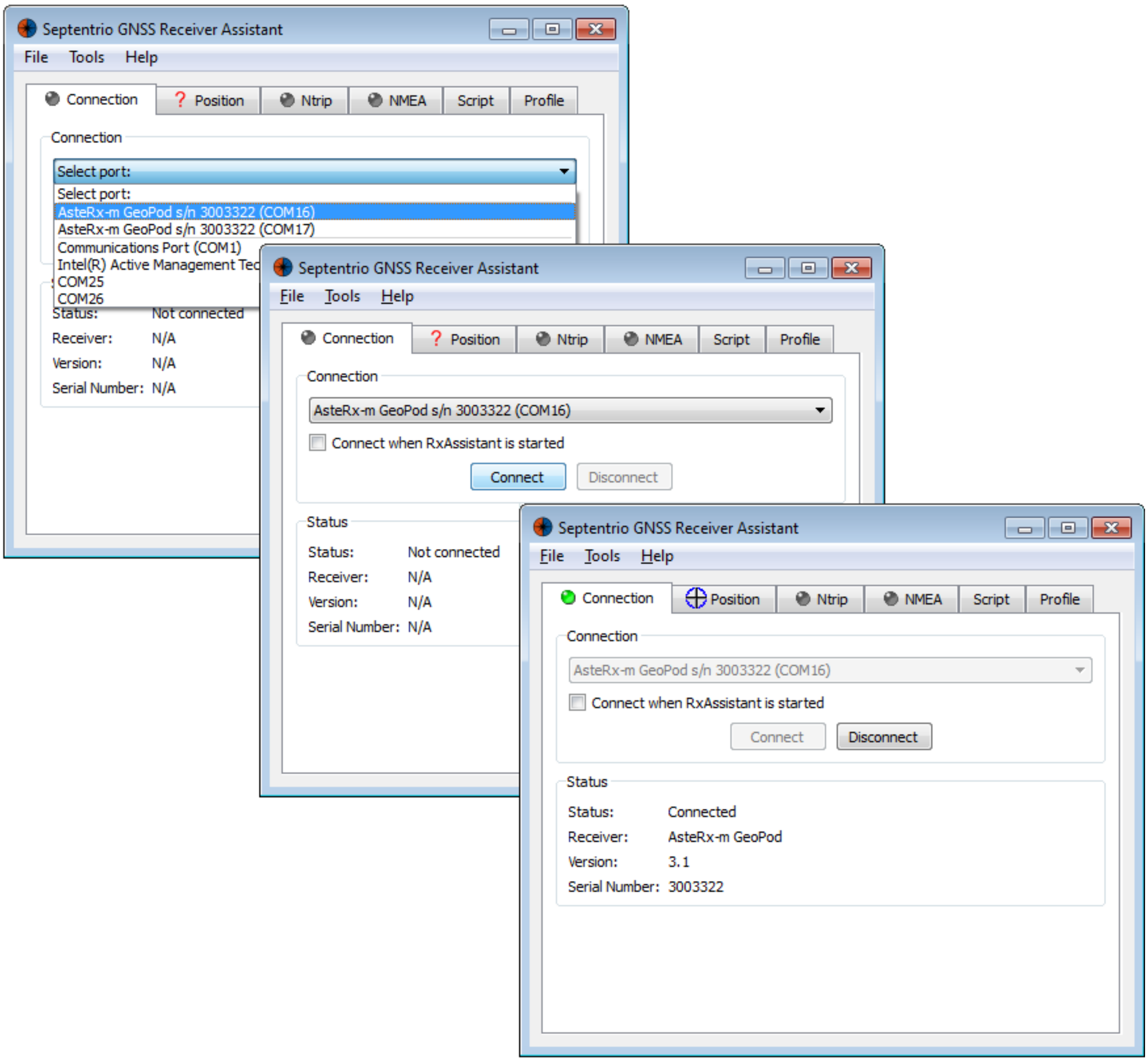



**Figure 10.2-1:** Connecting to a Septentrio Receiver using RxAssistant

## 10.2.2 Configuring the NTRIP connection

The NTRIP connection for differential corrections can be configured in the 'Ntrip' tab as Figure 10.2-2 shows. Clicking on 'Edit ...' will bring up the 'Ntrip Settings' dialog where the caster settings, user name and password of the NTRIP account can be entered. If these details have been entered correctly, the 'Stream' drop-down list will become active and the desired differential correction stream can be selected.

By default, the receiver is configured to automatically send a GGA message to the network in order to get a correction stream that is appropriate for the user's location. This behavior can be overwritten however by checking the 'Fixed location for GGA' box and entering a position manually.

In the lower panel of the Ntrip Settings window, the behavior when the Ntrip connection is broken can be configured.

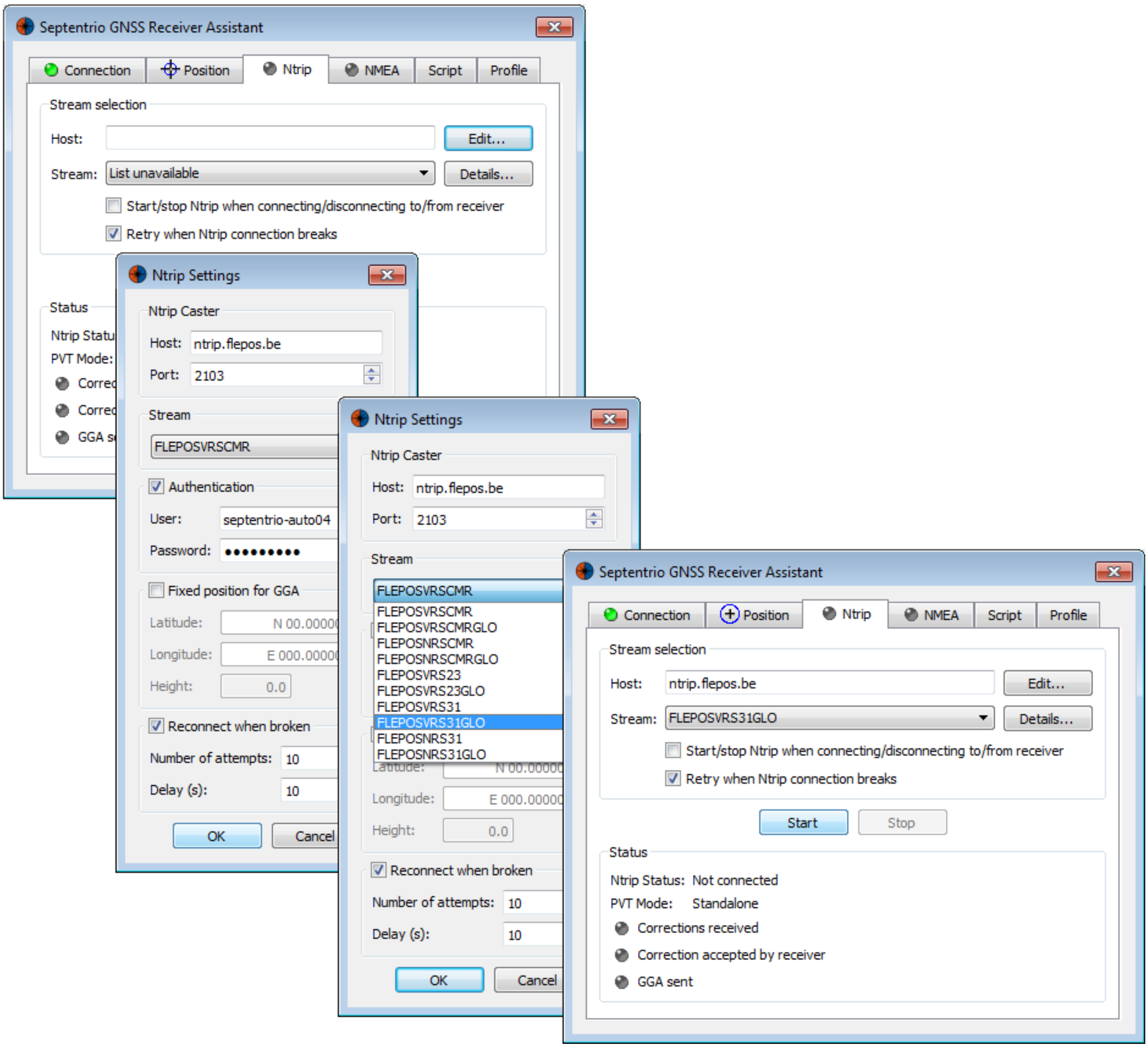



**Figure 10.2-2:** Configuring the NTRIP connection

When the stream has been selected and 'OK' clicked on, clicking on 'Start' on the Ntrip tab will begin the transfer of differential correction data. The Status field of the Ntrip tab should then show status to be connected and the amount of data received. The PVT mode is also shown and a green LED is lights up each time the receiver get correction data as you can see in Figure 10.2-3. The 'Details...' button gives more information on the selected NTRIP stream as shown.

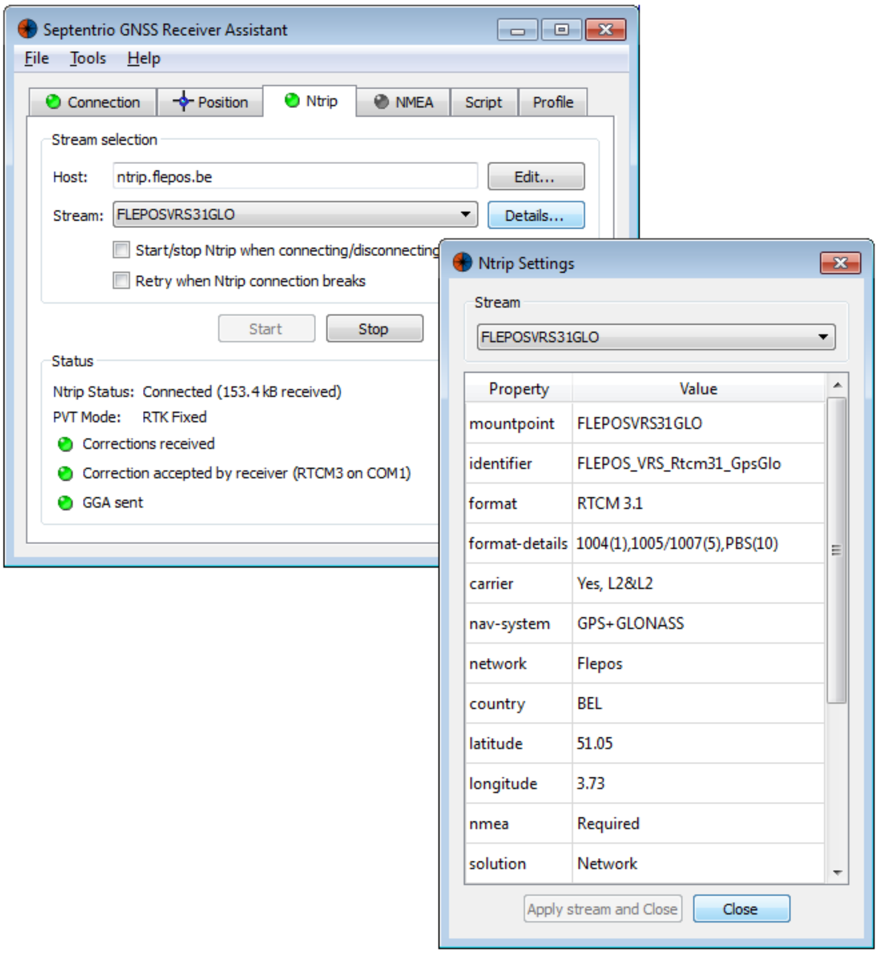



**Figure 10.2-3:** Status information with active NTRIP connection

The Position tab shown in Figure 10.2-4 shows some basic position and status information. The 'GNSS signal quality' is a performance indicator that shows at a glance, the overall quality of satellite reception. If this plot shows fewer than 3 or 4 green bars then the signal quality should be investigated further by looking at, for example, some of the time plots in RxControl.

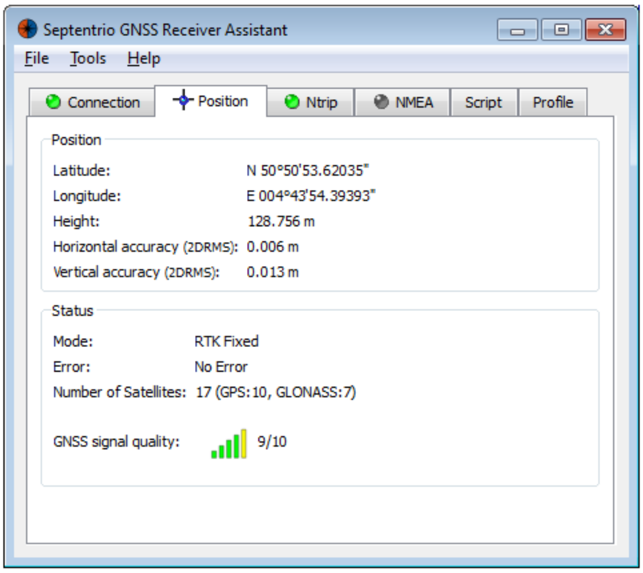



**Figure 10.2-4:** The Position tab when in RTK fix mode

## 10.2.3 Configuring NMEA output

In the NMEA tab, users can select the NMEA sentences and the rate at which they want to output them over the second port connection. In the example shown in Figure 10.2-5, the GGA and GSV sentences are output every 1 second over USB Serial Port (COM23).

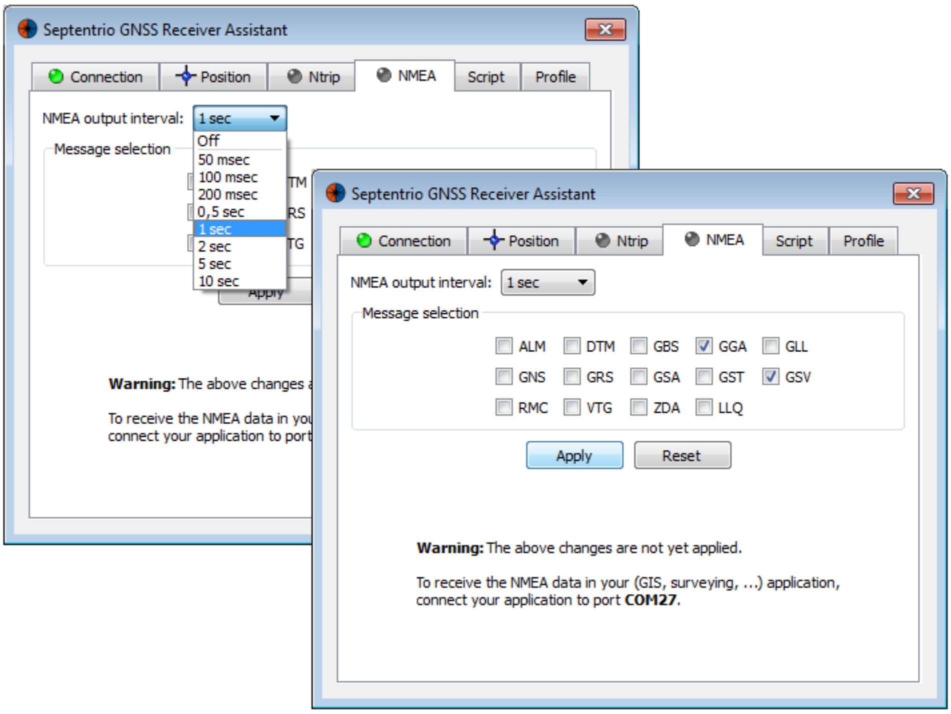



**Figure 10.2-5:** Configuring NMEA output

### 10.2.4 Managing receiver configurations using RxAssistant

The receiver configurations can be managed on the 'Script' and 'Profile' tabs. On the 'Script' tab, a configuration script can be selected and uploaded to the receiver using the 'Send to receiver' button. A configuration script is a text file containing a list of receiver commands. Figure 10.2-6 shows and example of a configuration script that sets the PVT mask and receiver dynamics. Checking the box 'Reset receiver settings to default before sending' ensures that the only settings on the receiver are those in the script file and those initiated by RxAssistant.

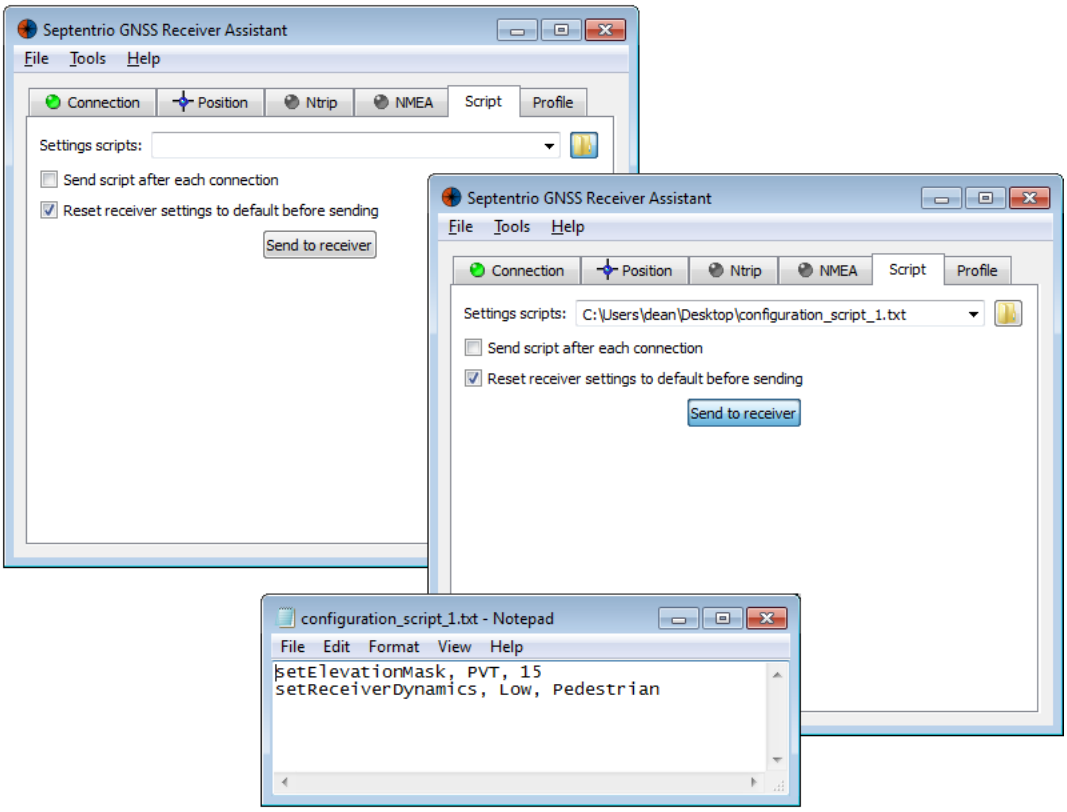



**Figure 10.2-6:** Managing upload of configuration script files

The current receiver configuration can be saved as a profile in the 'Profile' tab. Here, users can save and load configurations without external configuration script files. In the example shown in Figure 10.2-7 on the following page the current configuration is saved as 'configuration_1'.

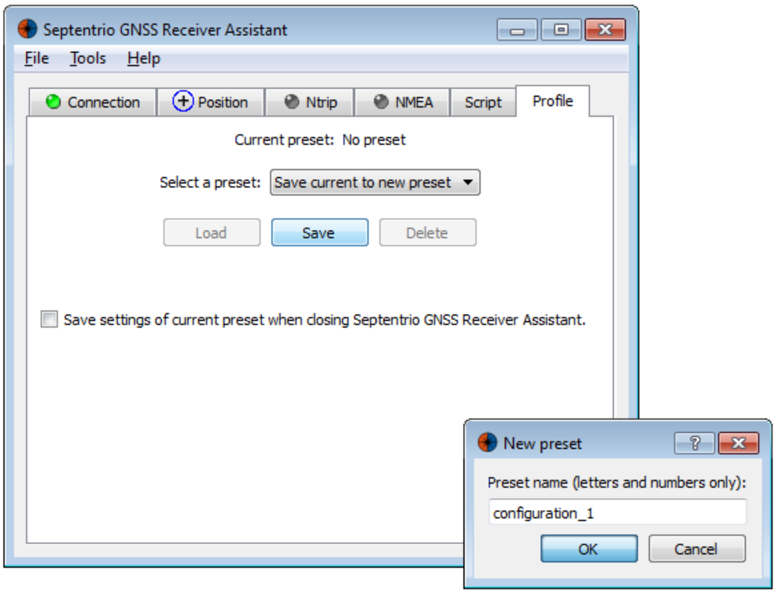



**Figure 10.2-7:** Saving the current receiver and RxAssistant configuration as a profile

Saved profiles can the be uploaded to the receiver from the 'Select a preset' drop-down list as shown in Figure 10.2-8

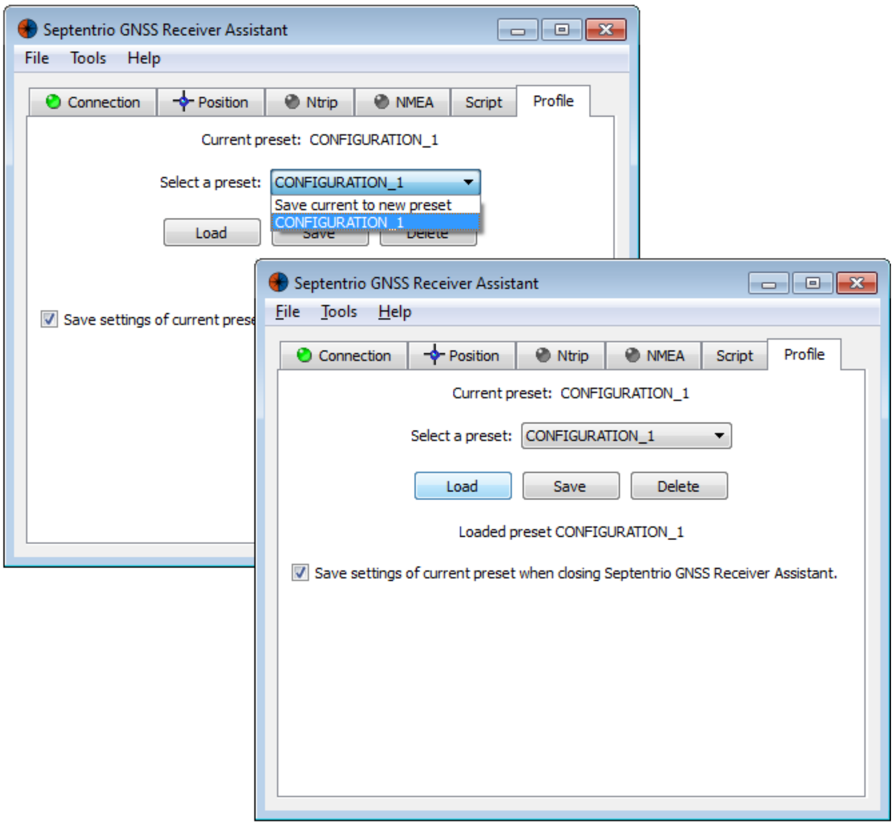



**Figure 10.2-8:** Uploading a saved configuration profile to the receiver

### 10.2.5 Using the AsteRx-m GeoPod with Esri ArcPad

The output from the AsteRx-m GeoPod can be sent to a secondary application. In the following example, the NMEA data from COM2 of the GeoPod is sent to the Esri ArcPad software. The demo version of the tool has been used. The Esri ArcPad tool can be launched from the PC start menu as shown in Figure 10.2-9

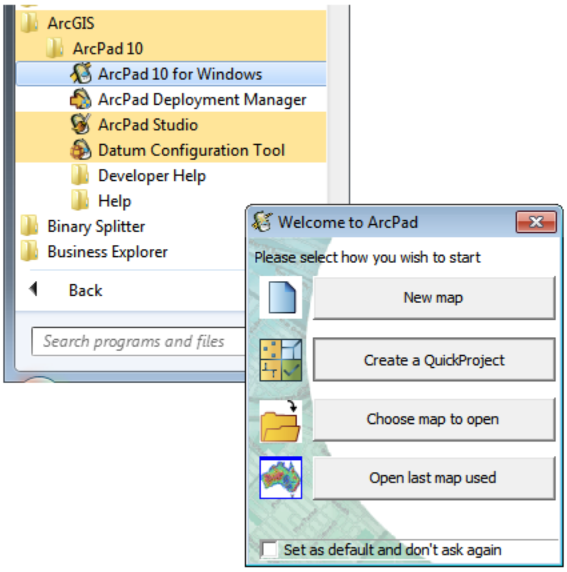



**Figure 10.2-9:** Launching the ArcPad software from the PC start menu

The connection to the receiver can be configured in the 'GPS Preferences' window as shown in Figure 10.2-10 on the next page.

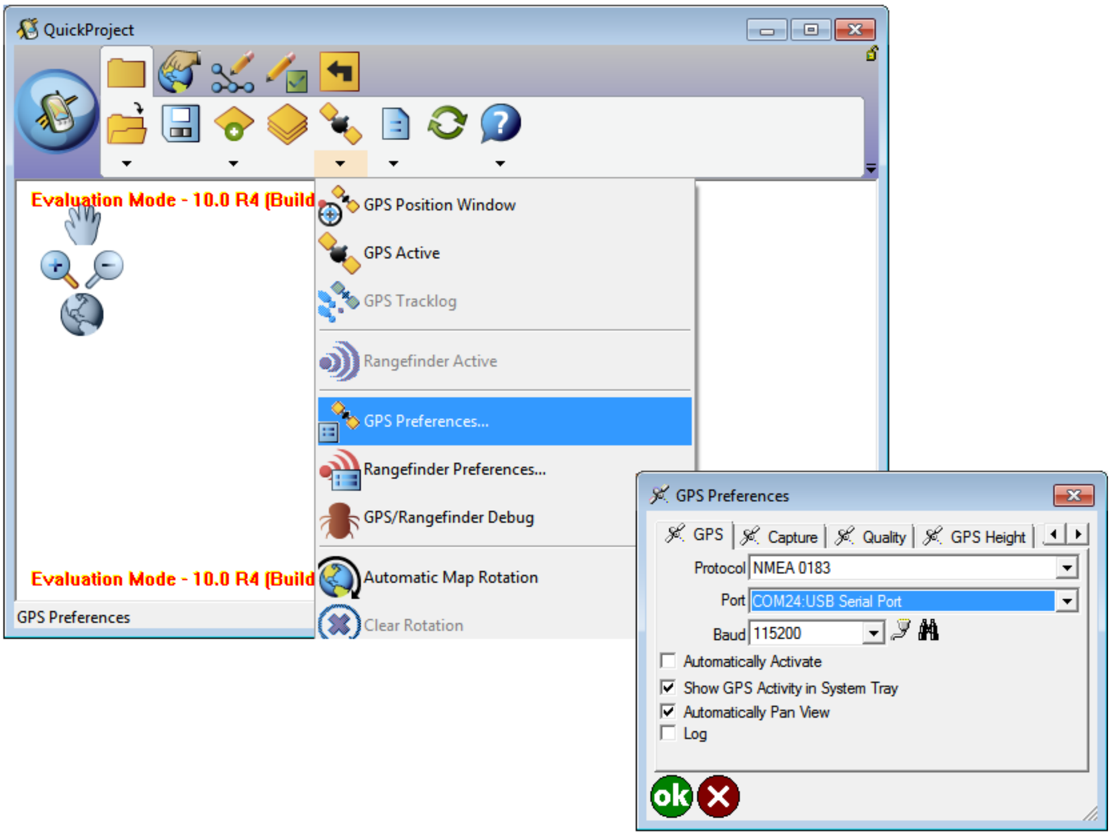



**Figure 10.2-10:** Selecting and configuring the ArcPad connection with the AsteRx-m GeoPod

When the connection settings have been configured, the connection can be activated by selecting 'GPS Active' as shown in Figure 10.2-11 on the following page. This will start up the transfer of NMEA data to ArcPad and the current position and other information can then be displayed on the main window.

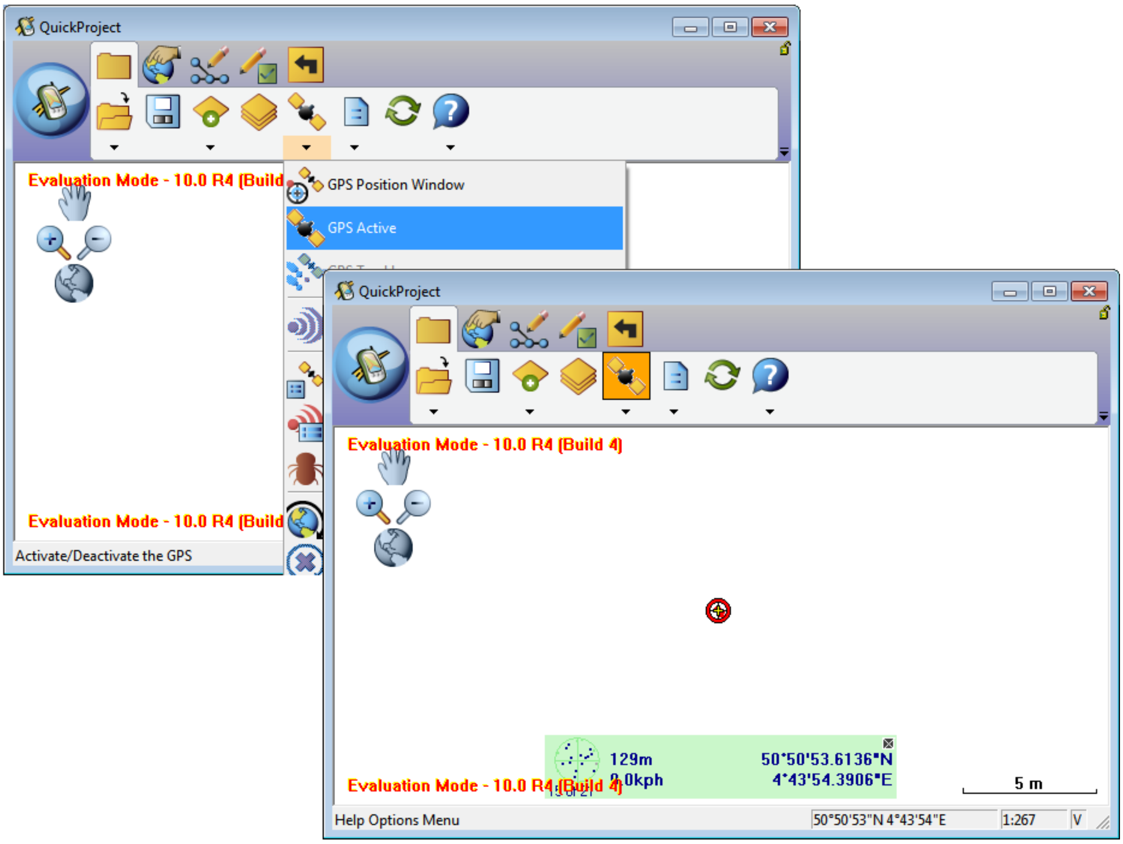



**Figure 10.2-11:** Activating the connection between the AsteRx-m GeoPod and ArcPad

Figure 10.2-12 shows the current position plotted on one of the default maps of ArcPad.

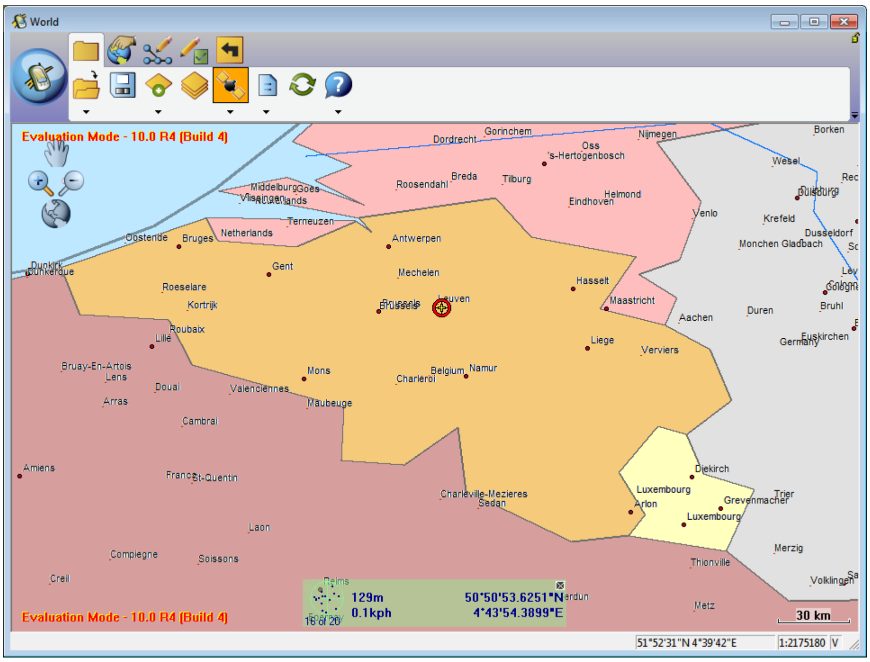



**Figure 10.2-12:** The current position plotted on the ArcPad World map

# Chapter 11

# SBF Tools

The RxTools installation also provides a number of executable software tools known collectively as SBF Tools. The following sections give an overview of each tool with detailed usage available by executing the appropriate tools from a command window without any parameters. The tools are to be found in the 'Septentrio\RxTools\bin' folder in the installation path. A list of the SBF Tools along with a summary of their use is given below.

| | |
|---|---|
| **bin2asc:** | lists the contents of an SBF File in ASCII format. It is the most flexible of the ASCII converters and should be tool of choice for SBF conversion to a readable format. |
| **sbf2sbf:** | Manipulation of an SBF files such as block filtering and cropping |
| **sbf2asc:** | lists of the contents of an SBF File in ASCII format. This tool is provided as a sample on how to decode SBF data. The sample C-code for this can be found in; 'Septentrio\RxTools\sbf2asc' |
| **sbfblocks:** | lists each individual time-stamped SBF block type present in the file as well as the message numbers of any Differential Corrections. |
| **sbf2cmd:** | lists the receiver commands in an SBF File if the Commands block is present |
| **sbf2kml:** | converts an SBF file to KML format for Google Earth visualisation |
| **sbf2gpx**: | converts an SBF file to GPX format |
| **sbf2rin:** | converts an SBF file to RINEX 2.x or RINEX 3.x format |
| **sbf2ismr:** | converts an SBF file to the standard scintillation ISMR format |
| **sbf2cgg:** | converts an SBF file to the standard timing CGGTTS format |
| **posconv:** | converts a given position between degrees, radians and cartesian coordinates |
| **timeconv:** | converts a given time between GPS time, UTC, TOW/WN and GPS seconds |

## 11.1 bin2asc

**bin2asc** is a tool for translating binary SBF into readable ASCII format. A separate text file is created for each SBF block type. It is the most flexible of our ASCII converters and should be the tool of choice.

Invoking **bin2asc** without argument prints the list of options and their usage. The possible options for **bin2asc** are given in the table below:

| Argument | Value | Description |
|---|---|---|
| -f | file1 [file2 ...] | Input file(s) to convert to ASCII. |
| -F | Format | Input file format, default is SBF. |
| -p | path | Target file path, default same as input. |
| -m | msg1,msg2,... | List of message(s) to convert, default is all. The message name has to be the text name displayed in the list of supported messages (-l option). |
| -D | | Extract DiffCorrIn from SBF file. |
| -d | delimiter | Field delimiter, default is comma. |
| -n | donotuse | Value for donotuse fields, default is empty. |
| -a | string | Show string when a field is absent, default is empty. |
| -x | | Show headers in each one of the output files. |
| -t | | Show title columns for each of the output files. |
| -b | epoch | Time of first epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -e | epoch | Time of last epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -i | Interval | Decimation interval in seconds. |
| -E | | Exclude messages that don't have a valid time. |
| -r | | Show raw value instead of interpreted version. |
| -o | filename | Put all converted data into a single file. |
| -A | | Output all fields, not only the primary ones. |
| -S | filename | Output message statistic summary output. |
| -s | | Output message time only. |
| -c | | Ask for confirmation before overwriting files. |
| -h | | Shows this help information. |
| -l | | Shows the list of supported messages. If the format is not specified (-f option) the SBF messages are shown. |
| -L | | Shows the list of supported formats. The supported messages per format can also be requested by adding the option -l. |
| -v | | Verbose mode, progress displayed |
| -V | | Shows the version number. |

**Table 11.1-1:** bin2asc Arguments

## 11.2 sbf2stf

The RxTools **sbf2stf** tool is a Windows Console Application that displays the contents of an SBF file in a proprietory Septentrio Text format. A separate text file is created for each SBF block type.

Note that no future releases to **sbf2stf** will be made and users are recommended to implement **bin2asc** where possible.

Invoking **sbf2stf** without argument prints the list of options and their usage. The possible options for **sbf2stf** are given in the table below:

| Argument | Value | Description |
|---|---|---|
| -f | input file | (Mandatory)Input SBF File |
| -p | output path | Output directory, default is the same as input |
| -m | msg1,msg2,... | Messages (Block Names) to be decoded.<br>If not provided, all messages will be converted to STF files |
| -l | | List all supported messages |
| -d | delimiter | Field delimiter, default is comma |
| -n | donotuse | Value for donotuse fields, default is empty |
| -x | | Show headers in each one of the output files |
| -t | | Show title columns for each of the output files |
| -b | start epoch | Time of first epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -e | end epoch | Time of last epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -i | Interval | Decimation interval in seconds |
| -E | | Exclude blocks where time stamp is invalid |
| -v | | Verbose mode, progress displayed |
| -V | | Program version |

**Table 11.2-1:** sbf2stf Arguments

## 11.3 sbf2asc

The RxTools **sbf2asc** tool is a Windows Console Application that lists the contents of the blocks in an SBF file in ASCII format. **sbf2asc** was mainly created as a sample application to assist users in developing their own conversion tools. For converting SBF data into ASCII or Text format, we recommend to use the more flexible **bin2asc**.

Invoking **sbf2asc** without argument prints the list of options and their usage. The possible options for **sbf2asc** are given in the table below:

| Argument | Value | Description |
|---|---|---|
| -f | input file | (Mandatory) Input SBF File |
| -o | output file | Name of the ASCII File. (if not provided, measasc.dat is used) |
| -m | | Include contents of the (Short)MeasEpoch blocks |
| -p | | Include contents of the PVTCartesian blocks |
| -g | | Include contents of the PVTGeodetic blocks |
| -c | | Include contents of the PVTCov blocks |
| -d | | Include contents of the DOP blocks |
| -a | | Include contents of the AttitudeEuler blocks |
| -s | | Include contents of the AttitudeCovEuler blocks |
| -u | | Include contents of the AuxPos blocks |
| -t | | Include contents of the ReceiverStatus blocks |
| -x | | Include contents of the ExtEvent blocks |
| -n | | Include contents of the BaseStation blocks |
| -l | | Include contents of the BaseLine blocks |
| -k | | Include contents of the BaseLink blocks |
| -h | | Include contents of the GPSAlm blocks |
| -j | | Inlcude contents of the ExtSensorMeasurements blocks |
| -b | start epoch | Time of first epoch to insert in the file<br>Format: yyyy-mm-dd_hh:mm:ss.sss or hh:mm:ss.sss. |
| -e | end epoch | Last epoch to insert in the file<br>Format: yyyy-mm-dd_hh:mm:ss.sss or hh:mm:ss.sss |
| -i | interval | Decimation interval in seconds |
| -E | | Exclude blocks where time stamp is invalid |
| -v | | Verbose mode, progress displayed |
| -V | | Display the sbf2asc version |

**Table 11.3-1:** sbf2asc Arguments

The output of **sbf2asc** is a text file containing columns of data. The first column identifies the format and contents of each row as follows:

| | |
|---|---|
| **1-255** | the row contains data from a (Short)MeasEpoch block |
| **0** | the row contains data from a PVTCar block |
| **-1** | the row contains data from a PVTGeo block |
| **-2** | the row contains data from a PVTCov block |
| **-3** | the row contains data from a DOP block |
| **-4** | the row contains data from a AttitudeEuler block |
| **-5** | the row contains data from a AttitudeCovEuler block |
| **-6** | the row contains data from a ExtEvent block |
| **-7** | the row contains data from a ReceiverStatus block |
| **-8** | the row contains data from a BaseStation block |
| **-9** | the row contains data from a BaseLine block |
| **-10** | the row contains data from a BaseLink block |
| **-11** | the row contains data from a GPSAlm block |
| **-12** | the row contains data from a AuxPos block |

**Table 11.3-2:** sbf2asc Row Identifier

Then for each further column the data is to be interpreted as in the tables below.

| | |
|---|---|
| **Col1** | PRN identifier (from 1 to 255). For GLONASS, PRN is 45+FreqNumber |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | CA pseudorange in meters, or -20000000000 if not available |
| **Col4** | L1 carrier phase in cycles, or -20000000000 if not available |
| **Col5** | CA C/N0 in dB-Hz, or -3276.8 if not available |
| **Col6** | P1 pseudorange in meters, or -20000000000 if not available |
| **Col7** | P2 pseudorange in meters, or -20000000000 if not available |
| **Col8** | L2 carrier phase in cycles, or -20000000000 if not available |
| **Col9** | P1 C/N0 in dB-Hz, or -3276.8 if not available |
| **Col10** | P2 C/N0 in dB-Hz, or -3276.8 if not available |
| **Col11** | Receiver Channel |
| **Col12** | Lock time in seconds |
| **Col13** | L1 Doppler in Hz, or -214748.365 if not available |
| **Col14** | L2 Doppler in Hz, or -214748.365 if not available |
| **Col15** | CA Multipath correction in meters, or 0 if unknown or not applicable |
| **Col16** | P2 Multipath correction in meters, or 0 if unknown or not applicable |

**Table 11.3-3:** sbf2asc (Short)MeasEpoch block

| | |
|---|---|
| **Col1** | 0 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | X in meters, or -20000000000 if not available |
| **Col4** | Y in meters, or -20000000000 if not available |
| **Col5** | Z in meters, or -20000000000 if not available |
| **Col6** | Vx in m/s, or -20000000000 if not available |
| **Col7** | Vy in m/s, or -20000000000 if not available |
| **Col8** | Vz in m/s, or -20000000000 if not available |
| **Col9** | RxClkBias in seconds, or -20000000000 if not available |
| **Col10** | RxClockDrift in seconds/seconds, or -20000000000 if not available |
| **Col11** | NbrSV |
| **Col12** | PVT Mode field |
| **Col13** | MeanCorrAge in 1/100 seconds, or 65535 if not available |
| **Col14** | PVT Error |
| **Col15** | COG |

**Table 11.3-4:** sbf2asc PVTCartesian block

| | |
|---|---|
| **Col1** | -1 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Latitude in radians, or -20000000000 if not available |
| **Col4** | Longitude in radians, or -20000000000 if not available |
| **Col5** | Ellipsoidal height in meters, or -20000000000 if not available |
| **Col6** | Geodetic Ondulation, or -20000000000 if not available |
| **Col7** | Vn in m/s, or -20000000000 if not available |
| **Col8** | Ve in m/s, or -20000000000 if not available |
| **Col9** | Vu in m/s, or -20000000000 if not available |
| **Col10** | Clock bias in seconds, or -20000000000 if not available |
| **Col11** | Clock drift in seconds/seconds, or -20000000000 if not available |
| **Col12** | NbrSV |
| **Col13** | PVT Mode field |
| **Col14** | MeanCorrAge in 1/100 seconds, or 65535 if not available |
| **Col15** | PVT Error |
| **Col16** | COG |

**Table 11.3-5:** sbf2asc PVTGeodetic block

| | |
|---|---|
| **Col1** | -2 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Covariance xx |
| **Col4** | Covariance yy |
| **Col5** | Covariance zz |
| **Col6** | Covariance tt |

**Table 11.3-6:** sbf2asc PVTCov block

| | |
|---|---|
| **Col1** | -3 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | PDOP value, or NA if PDOP not available |
| **Col4** | TDOP value, or NA if TDOP not available |
| **Col5** | HDOP value, or NA if HDOP not available |
| **Col6** | VDOP value, or NA if VDOP not available |
| **Col7** | HPL value in meters, or NA if not available |
| **Col8** | VPL value in meters, or NA if not available |
| **Col9** | NbrSV |

**Table 11.3-7:** sbf2asc PVTDOP block

| | |
|---|---|
| **Col1** | -4 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Heading in degree |
| **Col4** | Pitch in degree |
| **Col5** | Roll in degree |
| **Col6** | Error flag for attitude solution |
| **Col7** | Mode used to compute attitude solution |
| **Col8** | NbrSV |

**Table 11.3-8:** sbf2asc AttitudeEuler block

| | |
|---|---|
| **Col1** | -5 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Covariance HeadingHeading |
| **Col4** | Covariance PitchPitch |
| **Col5** | Covariance RollRoll |
| **Col6** | Error flag for attitude solution |

**Table 11.3-9:** sbf2asc AttitudeCovEuler block

| | |
|---|---|
| **Col1** | -6 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Source (1 = GPIN1, 2 = GPIN2) |
| **Col4** | Counter used to indicate the number of events that have occurred from the source (Col3) |

**Table 11.3-10:** sbf2asc ExtEvent block

| | |
|---|---|
| **Col1** | -7 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | CPU-Load in percentage |
| **Col4** | Uptime in seconds |
| **Col5** | RxStatus field (HEX) |

**Table 11.3-11:** sbf2asc ReceiverStatus block

| | |
|---|---|
| **Col1** | -8 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Base Station ID |
| **Col4** | Base type |
| **Col5** | Source |
| **Col6** | X_L1 Phase center |
| **Col7** | Y_L1 Phase center |
| **Col8** | Z_L1 Phase center |

**Table 11.3-12:** sbf2asc BaseStation block

| | |
|---|---|
| **Col1** | -9 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Base Station ID |
| **Col4** | East |
| **Col5** | North |
| **Col6** | Up |

**Table 11.3-13:** sbf2asc BaseLine block

| | |
|---|---|
| **Col1** | -10 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Number of Bytes Received |
| **Col4** | Number of Bytes Accepted |
| **Col5** | Number of Messages Received |
| **Col6** | Number of Messages Accepted |
| **Col7** | Age of last message |

**Table 11.3-14:** sbf2asc BaseLink block

| | |
|---|---|
| **Col1** | -11 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | PRN |
| **Col4** | Eccentricity |
| **Col5** | Almanac reference time of week |
| **Col6** | Inclination angle at reference time, relative to i0 = 3 semi-circles |
| **Col7** | Rate of right ascension |
| **Col8** | Square root of the semi-major axis |
| **Col9** | Longitude of ascending node of orbit plane at weekly epoch |
| **Col10** | Argument of perigee |
| **Col11** | SV Clock Drift |
| **Col12** | SC Clock Bias |
| **Col13** | PVT Mode field |
| **Col14** | Almanac reference week, to which t_oa is referenced |
| **Col15** | Health on 8 bits from the almanac page |
| **Col16** | Health summary on 6 bits |

**Table 11.3-15:** sbf2asc GPSAlm block

| | |
|---|---|
| **Col1** | -12 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | Antenna ID |
| **Col4** | Delta East |
| **Col5** | Delta North |
| **Col6** | Delta Up |
| **Col7** | Number of Satellites |
| **Col8** | Error |
| **Col9** | Ambiguity Type |

**Table 11.3-16:** sbf2asc AuxPos block

| | |
|---|---|
| **Col1** | -13 |
| **Col2** | time (GPS second since Jan 06, 1980) |
| **Col3** | SensorID |
| **Col4** | Type |
| **Col5** | X |
| **Col6** | Y |
| **Col7** | Z |

**Table 11.3-17:** sbf2asc ExtSensorMeas block

## 11.4 sbfblocks

The RxTools **sbfblocks** tool is a Windows Console Application that lists the individual SBF blocks in a file along with their time stamp.

Invoking **sbfblocks** without argument prints the list of options and their usage. The possible options for **sbfblocks** are given in the table below:

| Argument | Value | Description |
|---|---|---|
| -f | input file | (Mandatory)Input SBF File |
| -o | output file | name of the text file with block info<br>(if not provided, SBF file name is used plus .blocks.txt extension) |
| -l | detail | Show blocks over time instead of only Summary of results (tab separated).<br>S: Show only Summary of blocks (DEFAULT).<br>T: Show only Description over time of blocks.<br>B: Show both Description over time of blocks and Summary |
| -h | hide details | When Description over time of blocks is enabled, extra decoding of blocks such as DiffCorr and Comment is hidden.<br>(By default details are printed out) |
| -b | start epoch | Time of first epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -e | end epoch | Time of last epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -i | Interval | Decimation interval in seconds |
| -E | | Exclude blocks where time stamp is invalid |
| -v | | Verbose mode, progress displayed |
| -V | | Program version |

**Table 11.4-1:** sbfblocks Arguments

## 11.5 sbf2cmd

The RxTools **sbf2cmd** tool is a Windows Console Application. It converts all commands found in an SBF file into plain text format.

Invoking **sbf2cmd** without argument prints the list of options and their usage. The possible options for **sbf2cmd** are given in the table below:

| Argument | Value | Description |
|---|---|---|
| -f | input file | (Mandatory)Input SBF File |
| -o | output file | Name of the output ASCII file (if not provided,'commands.txt' is used) |
| -m | mib file | Name of the ASN.1 file containing the MIB description . The MIB can be downloaded from the receiver as described in Section 4.2.4 on page 100. |
| -b | start epoch | Time of first epoch to insert in the output file. Format:yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -e | end epoch | Time of last epoch to insert in the output file. Format:yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -i | Interval | Decimation interval in seconds |
| -E | | Exclude blocks where time stamp is invalid |
| -v | | Verbose mode, progress displayed |
| -V | | Program version |

**Table 11.5-1:** sbf2cmd Arguments

An example of sbf2cmd output is given.

```
1475,210460.14,exeSBFOnce,
1475,210460.14,exeSBFOnce, ,GPSNav+GEONav+ReceiverSetup+Commands+Comment
1475,210483.82,setSBFOutput, Res1,
1475,210486.22,setSBFOutput,Res1,,MeasEpoch+MeasExtra+Comment
```

## 11.6 sbf2kml

The RxTools **sbf2kml** tool is a Windows Console Application that converts SBF files to KML 2.0 format.

Keyhole Markup Language is an XML-based notation for detailing geographic annotation and visualization on Web-based maps and three-dimensional Earth browsers. KML was originally developed for use with Google Earth.

Invoking **sbf2kml** without argument prints the list of options and their usage. The possible options for **sbf2kml** are given in the table below:

| Argument | Value | Description |
|---|---|---|
| -f | input file | (Mandatory)Input SBF File |
| -o | output file | name of the KML file.<br>(if not provided, SBF file name is used plus kml extension) |
| -k | | Convert to KML format (DEFAULT) |
| -t | | Select the mode for the Track Mode:<br>(DEFAULT) P = PVT Track using PVTGeodetic and PVTCartesian blocks<br>g = PVT Track using PVTGeodetic blocks<br>c = PVT Track using PVTCartesian blocks<br>a = Attitude Track with Attitude mode using AttEuler blocks<br>s = Satellite Survey with PVT-Tracking using Channel Status blocks (use with -n option) |
| -c | | RGB (Red, Blue, Green) Color values expressed in hexadecimal notation |
| -m | | Include different colored PVT Tracks on change of PVT mode |
| -u | | make use of PVTCartesian blocks |
| -r | | Include Waypoints on PVT/Attitude/Satellite-Survey error |
| -A | NoOfEpochs | Include Attitude model on Attitude solution every NoOfEpochs epochs |
| -x | External Events | Include External Events (on PVT, Attitude or Satellite Survey Tracks):<br>0 = do not include External Events<br>(DEFAULT) 1 = add Waypoint in Event<br>2 = add 3D-Model in Event using Att info (Attitude tracks)<br>3 = add Waypoint and Model using Att info (Attitude tracks) |
| -p | | Include satellite tracks on sky:<br>(DEFAULT) 0 = Do not add sat. tracks<br>1 = Show only sat. tracks on sky<br>2 = Show sat. tracks connected to position on earth |

| Argument | Value | Description |
|---|---|---|
| -n | | Satellite to be included in the Satellite tracks or in the Satellite Survey tracks.<br>(DEFAULT) a = All satellites are shown<br>g = Only GPS satellites<br>r = Only GLONASS satellites<br>e = Only GALILEO satellites<br>s = Only SBAS satellites<br>PRN = The numeric value of the specific satellite to be shown |
| -h | | Use any of the following Altitude modes on KML output:<br>1 = clampToGround<br>2 = relativeToGround<br>(DEFAULT) 3 = absolute |
| -w | LineWidth | Width of the line track (from 0.0 to 4.0) DEFAULT=1.0 |
| -s | Model Scale | Scale of 3D model in 3D ExtEvent (from 1 to 10) DEFAULT=1 |
| -b | start epoch | Time of first epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -e | end epoch | Time of last epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -i | Interval | Decimation interval in seconds |
| -E | | Exclude blocks where time stamp is invalid |
| -l | | Print detection of blocks(g=geodetic, c=cartesian, t=attitude) |
| -v | | Verbose mode, progress displayed |
| -V | | Program version |

**Table 11.6-2:** sbf2kml Arguments

## 11.7 sbf2gpx

The RxTools **sbf2gpx** tool is a Windows Console Application that is used to convert SBF files to GPX format. GPS eXchange Format is used to exchange GPS data between software applications and devices as an XML schema.

Invoking **sbf2gpx** without argument prints the list of options and their usage. The possible options for **sbf2gpx** are given in the table below:

| Argument | Value | Description |
|---|---|---|
| -f | input file | (Mandatory)Input SBF File |
| -o | output file | name of the GPX file.<br>(if not provided, SBF file name is used plus gpx extension) |
| -x | | convert to standard GPX format (default) |
| -a | | make use of PVTGeodetic and PVTCartesian blocks |
| -g | | make use of PVTGeodetic blocks |
| -c | | make use of PVTCartesian blocks |
| -m | | include Waypoints on change of PVT mode |
| -r | | include Waypoints on PVT error |
| -l | | print the detection of PVT blocks(g=geodetic, c=cartesian) |
| -b | start epoch | Time of first epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -e | end epoch | Time of last epoch to insert in the output file.<br>Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss |
| -i | Interval | Decimation interval in seconds |
| -E | | Exclude blocks where time stamp is invalid |
| -v | | Verbose mode, progress displayed |
| -V | | Program version |

**Table 11.7-1:** sbf2gpx Arguments

## 11.8 sbf2rin

The RxTools installation contains the **sbf2rin** utility software. **sbf2rin** converts a binary SBF file to the widely used RINEX ASCII format. RINEX v2.10, v2.11 and v3.02 are supported.

The following RINEX file types can be generated:

- Observation file (extension '.yyO');
- GPS navigation file (extension '.yyN');
- GLONASS navigation file (extension '.yyG');
- Galileo navigation file (extension '.yyL');
- SBAS navigation file (extension '.yyH');
- SBAS broadcast data (extension '.yyB');
- Meteo file (extension '.yyM').

In order to generate a RINEX file, the following procedure is recommended:

1. Use the **setAntennaOffset**, **setMarkerParameters** and **setObserverParameters** commands to specify the contents of the `ReceiverSetup` SBF block. The contents of this blocks are used in turn in the RINEX header.

   The receiver has to be instructed to output the SBF blocks needed for the generation of the RINEX file. The necessary SBF blocks depend on the type of RINEX file:

| file type | Mandatory and optional SBF blocks |
|---|---|
| Observation 'O' | `MeasEpoch` (mandatory)<br>`PVTCartesian` or `PVTGeodetic` (optional: if not available, the "APPROX POSITION XYZ" line will be absent from the RINEX header)<br>`ReceiverSetup` (optional: if not available, a default header will be generated, with most fields replaced by "unknown")<br>`Comment` (optional: if available, user comments can be inserted in the RINEX file). |
| GPS Navigation 'N' | `GPSNav` (mandatory)<br>`GPSIon` (optional: needed only if the header should contain the alpha and beta Klobuchar parameters)<br>`GPSUtc` (optional: needed only if the header should contain UTC related data). |
| GLO Navigation 'G' | `GLONav` (mandatory)<br>`GPSUtc` or `GALUtc` (mandatory : without at least one `GPSUtc` or `GALUtc` block in the file, **sbf2rin** is unable to generate a GLONASS navigation file). |
| Galileo Navigation 'L' | `GALNav` (mandatory)<br>`GALIon` (optional)<br>`GALUtc` (optional) |
| SBAS Navigation 'H' | `GEONav` (mandatory) |
| SBAS Broadcast 'B' | `GEORawL1` (mandatory) |
| Meteo file 'M' | `ASCIIIn` (mandatory) |

2. Use RxControl or any suitable communication program to log the raw bytes coming from the receiver. Make sure that no character translation is applied by your logging program. Let's call the log file `LOG.SBF`. It is possible that `LOG.SBF` does not only contain SBF blocks, since the receiver may output other data in between two SBF blocks (replies to user commands, NMEA sentences). This is not a problem: the SBF header allows identifying the SBF blocks in the raw stream from the receiver.

3. The command below generates a RINEX v2.11 observation file (default) from the file `LOG.SBF`:
   **sbf2rin -f LOG.SBF <CR>**
   Note that the size of the SBF file must not exceed 2GBytes.

Invoking **sbf2rin** without argument prints the list of options and their usage:

```
sbf2rin -f input_file [-o output_file][-i interval]
                      [-b startepoch][-e endepoch][-n type][-MET][-s][-D]
                      [-v][-R3][-R210][-x systems][-a antenna][-V]
  -f input_file   (mandatory) Name of the SBF file.
  -o output_file  Name of the RINEX file.
                  If not provided, the RINEX convention is applied
                  (ssssdddf.yyt). With the "-o copy" option, the name of
                  the RINEX file is a copy of the name of the SBF file,
                  with the last character being set to O, N, G or L
                  according to the RINEX file type.
                  With the "-o copybase" option, the name of the RINEX
                  file is a copy of the name of the SBF file, with the last
                  3 characters being set to yyt (2-digit year and type)
                  according to the RINEX convention.
  -R3             Generate a RINEX version 3.02 file instead of version 2.11.
  -R210           Generate a RINEX version 2.10 file instead of version 2.11.
  -i interval     Interval in the RINEX obs and meteo file, in seconds
                  (by default, the interval is the same as in the SBF file).
  -b startepoch   Time of first epoch to insert in the RINEX file.
                  Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss.
  -e endepoch     Last epoch to insert in the RINEX file
                  Format: yyyy-mm-dd_hh:mm:ss or hh:mm:ss.
  -s              Add the Sx obs types for the SNRs in dB-Hz.
  -c              Allow comments in the RINEX file (from the Comment block)
                  (only applicable for RINEX v2.11 and v2.10)
  -C commentstr   Add the specified comment string to the RINEX obs header.
                  The comment string must not be longer than 240 characters.
                  Enclose the string between quotes if it contains whitespaces.
  -D              Add the Dx obs types for the Doppler in Hz.
  -x systems      Exclude one or more satellite systems from the obs file.
                  systems may be G (GPS), R (Glonass), E (Galileo), S (SBAS),
                  C (Compass/BeiDou), J (QZSS) or any combination thereof.
                  For instance, -xERSC produces a GPS-only observation file.
  -n type         Generate a RINEX navigation file (default is observation).
                  type may be N for GPS, G for GLONASS, E for Galileo (v3
                  only), H for GEO, I for Compass/BeiDou (v3 only) or B
                  for broadcast SBAS.
  -MET            Generate a RINEX meteo file.
  -a antenna      Convert data from the specified antenna (antenna is 1, 2
                  or 3). The default is 1, corresponding to the main antenna.
  -ma             Insert a "start moving" event right after the header if
                  the RINEX file contains kinematic data.
  -mf             Force inserting a "start moving" event right after the
                  header.
  -S              Automatically increase the file sequence character in
                  the output file name. This is useful when
                  converting several SBF files collected on the
                  same day and on the same marker.  For each file to be
                  converted, first call sbf2rin to make the .O file, then
                  call it again with the option -nN (if needed), then again
                  with the option -nG (if needed), then with the option -nE,
                  and finally with the option -nI.  When the .O, .N,
                  .G, .L and .I files are ready from the first SBF file,
                  repeat the same sequence for the second SBF file
```

```
                to be converted, and so forth.
                The "-S" option has no effect if the "-o" option is used.
-v              Run in verbose mode.
-V              Display the sbf2rin version.
```

## 11.9 sbf2ismr

The **sbf2ismr** program converts a binary SBF file containing 50 or 100-Hz raw correlation and phase data into an ASCII ISMR file containing ionospheric scintillation and TEC indices. In addition, **sbf2ismr** can also produce an ASCII file containing the unprocessed 50 or 100-Hz raw correlations and phase data.

**sbf2ismr** is a command line tool. Both a Windows and a Linux version are provided. Typically, **sbf2ismr** is automatically started from RxLogger at the end of every hourly file, but it can also be manually called at any time to get an instant overview of the scintillation indices, or to reprocess the raw high-rate data.

- The maximum SBF file size supported by **sbf2ismr** is 2Gbytes.

The output ISMR file contains comma-delimited ASCII records for all satellites in view and for every minute. A example of an ISMR data is shown below and more information can be found in the PolaRxS Application Manual.

```
1462,540300, 11,00000074, 27,15,48.2, 0.029, 0.000, 0.017, 0.023, 0.028, 0.028, 0.028,  2.397, 0.071, 18.811, 0.042, 18.830, 0.044, 18.782, 0.055, 19.934, 0.033, 3581,0, 3578,37.5,  0.8
1462,540300, 10,00000074,232,29,48.2, 0.049, 0.030, 0.026, 0.032, 0.036, 0.036, 0.036, -3.606, 0.066, 13.851,-0.031, 14.099,-0.026, 14.384,-0.021, 14.061,-0.032, 4210,0, 4202,37.6,  1.5
1462,540300, 23,00000074,232,68,48.2, 0.039, 0.007, 0.023, 0.029, 0.033, 0.033, 0.034, -5.799, 0.073,  7.283, 0.004,  5.559,-0.003,  7.273, 0.013,  5.864,-0.006,11894,0,11888,37.6,  1.3
1462,540300, 17,00000074,152,15,48.2, 0.039, 0.006, 0.020, 0.026, 0.030, 0.030, 0.031, -1.774, 0.056, 18.259, 0.010, 19.839, 0.014, 19.230, 0.006, 19.458, 0.006,22381,0,22376,37.7,  1.1
1462,540300,  1,00000074,344,23,48.2, 0.030, 0.000, 0.018, 0.024, 0.029, 0.029, 0.029, -2.851, 0.061, 16.669,-0.041, 17.002,-0.032, 16.412,-0.035, 17.973,-0.036, 3761,0, 3752,37.5,  0.9
1462,540300,  2,00000074, 17,45,48.2, 0.041, 0.012, 0.019, 0.025, 0.030, 0.030, 0.030, -1.537, 0.168, 10.215,-0.019, 10.976,-0.024, 10.329,-0.014, 10.548,-0.021, 2981,0, 2977,37.6,  1.1
1462,540300, 15,00000074, 85,37,48.2, 0.029, 0.000, 0.017, 0.023, 0.028, 0.029, 0.029, -4.356, 0.062,  9.643, 0.008, 10.691, 0.002, 10.748,-0.002, 11.128, 0.007,29080,0,29072,37.7,  0.9
1462,540300, 24,00000074,170,47,48.2, 0.029, 0.000, 0.016, 0.022, 0.028, 0.028, 0.028, -5.024, 0.053,  8.872, 0.012,  8.882, 0.023,  9.082, 0.023,  9.253, 0.024,17000,0,16994,37.7,  0.8
1462,540300,  8,00000074,308,16,48.2, 0.031, 0.000, 0.017, 0.023, 0.029, 0.029, 0.029, -1.904, 0.054, 17.773,-0.001, 19.134,-0.002, 17.611, 0.006, 18.916, 0.002,10137,0,10130,37.6,  0.9
1462,540360, 11,00000074, 27,15,48.0, 0.028, 0.000, 0.016, 0.022, 0.028, 0.029, 0.030,  2.446, 0.048, 18.906, 0.060, 18.744, 0.038, 19.020, 0.052, 18.954, 0.049, 3641,0, 3638,37.6,  0.8
1462,540360, 10,00000074,232,30,48.0, 0.045, 0.022, 0.019, 0.024, 0.030, 0.031, 0.031, -3.654, 0.047, 14.184,-0.022, 13.899,-0.027, 13.575,-0.021, 14.460,-0.017, 4270,0, 4262,37.6,  1.4
1462,540360, 23,00000074,231,68,48.0, 0.039, 0.000, 0.018, 0.023, 0.029, 0.031, 0.031, -5.799, 0.074,  6.616, 0.005,  7.006, 0.003,  6.473, 0.005,  8.339, 0.010,11954,0,11948,37.7,  1.2
1462,540360, 17,00000074,152,15,48.0, 0.037, 0.000, 0.017, 0.022, 0.028, 0.030, 0.030, -1.734, 0.073, 17.887, 0.019, 19.591, 0.008, 19.468, 0.007, 18.697, 0.012,22441,0,22436,37.7,  1.0
1462,540360,  1,00000074,344,23,48.0, 0.030, 0.000, 0.017, 0.022, 0.029, 0.030, 0.030, -2.863, 0.055, 15.289,-0.029, 15.365,-0.043, 15.641,-0.035, 15.774,-0.034, 3821,0, 3812,37.6,  0.8
1462,540360,  2,00000074, 17,45,48.0, 0.042, 0.014, 0.019, 0.024, 0.030, 0.032, 0.032, -1.521, 0.059,  9.843,-0.012,  8.758,-0.018,  9.605,-0.017,  9.615,-0.015, 3041,0, 3037,37.6,  1.2
1462,540360, 15,00000074, 85,37,48.0, 0.029, 0.000, 0.016, 0.022, 0.028, 0.029, 0.030, -4.354, 0.052, 11.167, 0.007, 11.852,-0.000, 12.414, 0.010, 10.929, 0.006,29140,0,29132,37.7,  0.8
1462,540360, 24,00000074,170,46,48.0, 0.030, 0.000, 0.017, 0.022, 0.028, 0.029, 0.030, -5.017, 0.062, 10.205, 0.017,  9.482, 0.025,  8.596, 0.017,  9.205, 0.026,17060,0,17054,37.7,  0.9
1462,540360,  8,00000074,309,16,48.0, 0.032, 0.000, 0.018, 0.022, 0.028, 0.030, 0.030, -1.926, 0.069, 17.764, 0.004, 18.354, 0.001, 17.802, 0.002, 19.268, 0.002,10197,0,10190,37.6,  0.9
```

Invoking **sbf2ismr** with the h option prints the help screen, including the definition of all the fields (or columns) in a record:

```
sbf2ismr is a utility to convert the data in a SBF file into ASCII ionospheric
scintillation monitoring records. The SBF file needs to contain the following
SBF blocks at at least the specified interval:
    IQCorr,         20ms
    MeasEpoch,      1s
    MeasExtra,      1s
    ReceiverStatus, 10s
    ChannelStatus,  10s
    ReceiverSetup,  10s
    GPSNav,         OnChange

Command line options:

sbf2ismr -f InputFile [-o ISMRFile][-p PreviousFile][-x Systems][-c DetFreq]
                      [-n NoCols][-S][-r RawFile][-b StartEpoch]
                      [-e EndEpoch][-V][-h]

  -f InputFile :  (mandatory) Name of the input SBF file.
  -o ISMRFile :   Name of the output file containing the ISMR records (see
                  format below).
                  This argument is optional.  If not provided, the output file
                  name is the same as the input file name, with the extension
                  .ismr being added. See below the format of the ISMR file.
  -p PrevFile :   Name of the previous input file, i.e. name of the SBF file
                  logged just before input_file.  The last epochs of the
                  previous file are used to initialize the detrending filters.
                  If there is no previous file, skip this option or use NA as
                  PrevFile.
  -x Systems      Exclude one or more satellite systems from the observation
                  file. Systems may be G (GPS), R (Glonass), E (Galileo),
                  S (SBAS), C (Compass), J (QZSS) or any combination thereof. For instance
                 -xERSCJ produces a GPS-inly observation file.
  -c DetFreq :    Cutoff frequency of the carrier phase detrending filter
                  (6th order high pass butterworth).  Units of Hz. Valid values
```

```
                  range from 0.01 to 1.0 Hz, default 0.1Hz.
  -n NoCols :     Only output the first NoCols in the output file (see column
                  format below).
  -S :            Do not generate the ISMR file, but still print the status
                  screen.
  -r RawFile :    Name of the "raw file" containing the raw data
                  (carrier phase and correlations) in ASCII format.  This
                  argument is optional.  If not provided, the raw file is
                  not created. See below the format of the raw file.
  -b StartEpoch   Time of first epoch to parse from the SBF file (in GPS time
                  scale). Format: yyyy-mm-dd_hh:mm:ss.
  -e EndEpoch     Time of last epoch to parse from the SBF file (in GPS time
                  scale). Format: yyyy-mm-dd_hh:mm:ss.
  -V :            Display the version of sbf2ismr.
  -h :            Display this help screen.


Format of the ISMR file:
  Note: "Sig1" means L1CA for GPS/GLONASS/SBAS/QZSS, L1BC for GALILEO, B1 for BeiDou.
        "Sig2" means L2C for GPS/GLONASS/QZSS, E5a for GALILEO, L5 for SBAS, B2 for BeiDou.
        "Sig3" means L5 for GPS/QZSS or E5b for GALILEO.

Col  1: WN, GPS Week Number
Col  2: TOW, GPS Time of Week (seconds)
Col  3: SVID
Col  4: Value of the RxState field of the ReceiverStatus SBF block
Col  5: Azimuth (degrees)
Col  6: Elevation (degrees)
Col  7: Average Sig1 C/N0 over the last minute (dB-Hz)
Col  8: Total S4 on Sig1 (dimensionless)
Col  9: Correction to total S4 on Sig1 (thermal noise component only) (dimensionless)
Col 10: Phi01 on Sig1,  1-second phase sigma (radians)
Col 11: Phi03 on Sig1,  3-second phase sigma (radians)
Col 12: Phi10 on Sig1, 10-second phase sigma (radians)
Col 13: Phi30 on Sig1, 30-second phase sigma (radians)
Col 14: Phi60 on Sig1, 60-second phase sigma (radians)
Col 15: AvgCCD on Sig1, average of code/carrier divergence (meters)
Col 16: SigmaCCD on Sig1, standard deviation of code/carrier divergence (meters)
Col 17: TEC at TOW - 45 seconds (TECU)
Col 18: dTEC from TOW - 60s to TOW - 45s (TECU)
Col 19: TEC at TOW - 30 seconds (TECU)
Col 20: dTEC from TOW - 45s to TOW - 30s (TECU)
Col 21: TEC at TOW - 15 seconds (TECU)
Col 22: dTEC from TOW - 30s to TOW - 15s (TECU)
Col 23: TEC at TOW (TECU)
Col 24: dTEC from TOW - 15s to TOW (TECU)
Col 25: Sig1 lock time (seconds)
Col 26: sbf2ismr version number
Col 27: Lock time on the second frequency used for the TEC computation (seconds)
Col 28: Averaged C/N0 of second frequency used for the TEC computation (dB-Hz)
Col 29: SI Index on Sig1: (10*log10(Pmax)-10*log10(Pmin))/(10*log10(Pmax)+10*log10(Pmin)) (dimensionless)
Col 30: SI Index on Sig1, numerator only: 10*log10(Pmax)-10*log10(Pmin) (dB)
Col 31: p on Sig1, spectral slope of detrended phase in the 0.1 to 25Hz range (dimensionless)
Col 32: Average Sig2 C/N0 over the last minute (dB-Hz)
Col 33: Total S4 on Sig2 (dimensionless)
Col 34: Correction to total S4 on Sig2 (thermal noise component only) (dimensionless)
Col 35: Phi01 on Sig2,  1-second phase sigma (radians)
Col 36: Phi03 on Sig2,  3-second phase sigma (radians)
Col 37: Phi10 on Sig2, 10-second phase sigma (radians)
Col 38: Phi30 on Sig2, 30-second phase sigma (radians)
Col 39: Phi60 on Sig2, 60-second phase sigma (radians)
Col 40: AvgCCD on Sig2, average of code/carrier divergence (meters)
Col 41: SigmaCCD on Sig2, standard deviation of code/carrier divergence (meters)
Col 42: Sig2 lock time (seconds)
Col 43: SI Index on Sig2 (dimensionless)
Col 44: SI Index on Sig2, numerator only (dB)
Col 45: p on Sig2, phase spectral slope in the 0.1 to 25Hz range (dimensionless)
Col 46: Average Sig3 C/N0 over the last minute (dB-Hz)
Col 47: Total S4 on Sig3 (dimensionless)
Col 48: Correction to total S4 on Sig3 (thermal noise component only) (dimensionless)
Col 49: Phi01 on Sig3,  1-second phase sigma (radians)
Col 50: Phi03 on Sig3,  3-second phase sigma (radians)
Col 51: Phi10 on Sig3, 10-second phase sigma (radians)
Col 52: Phi30 on Sig3, 30-second phase sigma (radians)
```

```
Col 53: Phi60 on Sig3, 60-second phase sigma (radians)
Col 54: AvgCCD on Sig3, average of code/carrier divergence (meters)
Col 55: SigmaCCD on Sig3, standard deviation of code/carrier divergence (meters)
Col 56: Sig3 lock time (seconds)
Col 57: SI Index on Sig3 (dimensionless)
Col 58: SI Index on Sig3, numerator only (dB)
Col 59: p on Sig3, phase spectral slope in the 0.1 to 25Hz range (dimensionless)
Col 60: T on Sig1, phase power spectral density at 1 Hz (rad^2/Hz)
Col 61: T on Sig2, phase power spectral density at 1 Hz (rad^2/Hz)
Col 62: T on Sig3, phase power spectral density at 1 Hz (rad^2/Hz)


Format of the raw ASCII file (option -r):

Col  1: TOW, GPS Time of Week (seconds)
Col  2: SVID
Col  3: Signal type:  0=GPS_L1CA,  3=GPS_L2C,  4=GPS_L5,
                      8=GLO_L1CA, 11=GLO_L2CA,
                     17=GAL_L1BC, 20=GAL_E5a, 21=GAL_E5b, 22=GAL_AltBOC,
                     24=GEO_L1CA, 25=GEO_L5
                      6=QZS_L1CA,  7=QZS_L2C, 26=QZS_L5,
                     28=CMP_B1,   29=CMP_B2
Col  4: Carrier phase (cycles)
Col  5: I correlation (dimensionless)
Col  6: Q correlation (dimensionless)
```

## 11.10 posconv

The RxTools installation contains the **posconv** tool which converts a given position between decimal degrees (-d), radians (-r) and cartesian coordinates (-c).

For example, the command below generates the output given. Note that there should be no spaces between the commas and the coordinates when using this tool.

**posconv.exe -d 50.848,4.731,127.38 <CR>**

```
DATUM           :  WGS84
Geodetic(d.d)   :  Lat: 50.84799957  Lon: 4.73099995  Alt: 127.37999725
Geodetic(rad)   :  Lat: 0.887465010597  Lon: 0.082571525980  Alt: 127.379997253418
Cartesian (xyz):  X: 4021489.728496  Y: 332817.276668  Z: 4922984.447794
```

## 11.11 timeconv

The RxTools installation contains the **timeconv** tool which converts a given time between GPS time, UTC, TOW/WN and GPS seconds

Invoking **timeconv** without argument prints the list of options and their usage:

```
timeconv [-g gnsstime] [-d datetime] [-t tow] [-w wnc]
         [-V]
  -g gnsstime    GNSS timestamp (seconds).
  -d datetime    Readable GNSS date time.
  -u datetime    Readable UTC date time.
  -t tow         Time of week (milliseconds).
  -w wnc         Weeknumber.
  -V             Version information.

At least one of the date formats is required.
The given time will then be converted into the other
date representations.
The TOW and WNc values depend on each other, so both need
to be provided.
If the datetime is provided it has to be in the following
format: YYYY/MM/DD-HH:MM:SS.

Examples:
  timeconv -t 12345678 -w 1234
  timeconv -g 865116018
  timeconv -d "2007/06/07-9:37:12"
  timeconv -u "2007/06/07-9:37:26"

C:\Program Files (x86)\Septentrio\RxTools\bin>timeconv -d "2014/09/06-14:15:43"
GNSS time (s)     : 1094048143.000000
Date time (GNSS) : 2014/09/06-14:15:43
Date time (UTC)  : 2014/09/06-14:15:27
TOW (ms)          : 569743000
WNc               : 1808
DOY               : 249 of year 2014
```

For example, the command below generates the output given.

**timeconv -d "2014/09/06-14:15:43" <CR>**

```
GNSS time (s)     : 1094048143.000000
Date time (GNSS) : 2014/09/06-14:15:43
Date time (UTC)  : 2014/09/06-14:15:27
TOW (ms)          : 569743000
WNc               : 1808
DOY               : 249 of year 2014
```

# Appendix A

# Null-modem cable

The Septentrio Receiver behaves as Data Terminal Equipment (DTE). For direct connection to a terminal or a PC, a null-modem cable is needed. For the raw RS-232 serial connection via the Septentrio Receiver serial ports, no handshaking is needed by default. Thus a simplified null-modem cable can be used, just crossing the transmit data and receive data lines.

Please consult the Septentrio Receiver manual for more details on the RS-232 connectors and the cable configurations that can be used to communicate with the receiver.

# Appendix B

# Conversion and projection of coordinates

The textual display of coordinates in the POSITION INFORMATION PANEL (See Section 2.4.2.1 on page 26) or the graphical display of coordinates in the PLANIMETRIC PLOT (See Section 2.5.4 on page 45) allow to switch between different representations of the current position. The **cartesian**, **geodetic** and **geocentric** coordinates result from coordinate conversions based on the current reference ellipsoid (See Section B.1 on the following page). The **cartographic projection** is obtained by applying the forward mapping equations of the conformal direct Mercator projection (See Section B.2 on page 196) while the **topocentric** coordinates are formed from a plane tangent to the Earth's surface fixed to a specific location (See Section B.3 on page 197).

All coordinate information shown in RxControl, except for the Position in Local Datum tab of the main window, is expressed in the datum that is used by the receiver to calculate the position. Which datum this is, depends on the positioning method used. If the receiver output also contains the position in another datum (via the `PosLocal block`) (See Section B.4 on page 198), these coordinates are shown in an extra tab in the RxControl main window.

# B.1 Coordinate conversions on an ellipsoid

A point on or near the surface of the Earth can be represented by its **cartesian** or **ECEF** (Earth Centered Earth Fixed) coordinates $(X, Y, Z)$, **geodetic** coordinates latitude, longitude and ellipsoidal height $(\varphi, \lambda, h)$ or **geocentric** coordinates latitude, longitude and geocentric distance $(\Phi, \Lambda, r)$. The conversion between these representations is done on the ellipsoid of revolution which is the mathematical approximation of the Earth's surface.

The ellipsoid is completely parameterized by its geodetic defining parameters[1] semi-major axis $a$ and flattening $f$. From these parameters it is possible to derive the semi-minor axis $b$, the first numeric eccentricity $e$ and the second eccentricity $e'$ using the formulas in the following table.

| Parameter | Value |
|---|---|
| semi-minor axis | $b = a\,(1-f)$ |
| first eccentricity squared | $e^2 = \frac{1-b^2}{a^2} = 2f - f^2$ |
| second eccentricity | $e'^2 = \frac{a^2}{b^2} - 1 = \frac{f\,(2-f)}{(1-f)^2}$ |

It is important to note the difference between the geodetic latitude $\varphi$ and the geocentric latitude $\Phi$. The geodetic latitude $\varphi$ is determined by the angle between the normal $n$ of the ellipsoid and the plane of the equator, whereas the geocentric latitude $\Phi$ is determined around the center of the ellipsoid (Figure B.1-1).

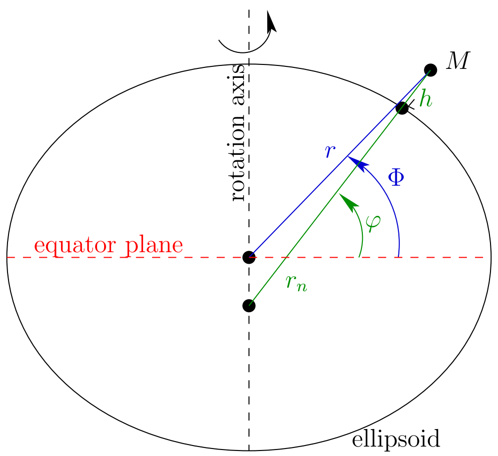



**Figure B.1-1:** Difference between geodetic latitude $\varphi$ and geocentric latitude $\Phi$

The direct and inverse conversion between cartesian and geodetic coordinates is done according to :

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} (r_n + h)\cos\varphi\cos\lambda \\ (r_n + h)\cos\varphi\sin\lambda \\ ((1-e^2)r_n + h)\sin\varphi \end{bmatrix} \quad \text{and} \quad \begin{bmatrix} \varphi \\ \lambda \\ h \end{bmatrix} = \begin{bmatrix} \arctan\left(\frac{Z + e^2 r_n \sin\varphi}{\sqrt{X^2+Y^2}}\right) \\ \arctan\left(\frac{Y}{X}\right) \\ \frac{\sqrt{X^2+Y^2}}{\cos\varphi} - r_n \end{bmatrix}$$

where $r_n = \frac{a}{\sqrt{1-e^2\sin^2\varphi}}$ is the local curvature of the ellipsoid along the first vertical.

[1] The defining geodetic parameters for the WGS84 ellipsoid are $a = 6\,378\,137{,}0\,\mathrm{m}$ and $\frac{1}{f} = 298{,}257\,223\,563$

The conversion between cartesian and geocentric coordinates follow the relations :

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} r\cos\Lambda\sin\Phi \\ r\sin\Lambda\sin\Phi \\ r\cos\Phi \end{bmatrix} \quad \text{and} \quad \begin{bmatrix} \Phi \\ \Lambda \\ r \end{bmatrix} = \begin{bmatrix} \frac{\pi}{2} - \frac{Z}{r} \\ \arctan\frac{Y}{X} \\ \sqrt{X^2+Y^2+Z^2} \end{bmatrix}$$

## B.2 The conformal direct Mercator projection

The conformal direct Mercator cartographic projection displays the projected north $N$ versus projected east $E$ coordinates obtained by applying the following projection formulae :

$$\begin{cases} E = f_1(\varphi, \lambda) \\ N = f_2(\varphi, \lambda) \end{cases}$$

As in all cylindrical projections, parallels and meridians are straight and perpendicular to each other. In accomplishing this, the unavoidable east-west stretching of the map, which increases as distance away from the equator increases, is accompanied by a corresponding north-south stretching, so that at every point location, the east-west scale is the same as the north-south scale, making the projection conformal.

A Mercator map (See Figure B.2-1) can never fully show the polar areas, since linear scale becomes infinitely high at the poles. Being a conformal projection, angles are preserved around all locations, however scale varies from place to place, distorting the size of geographical objects, as can be seen by the indicatrix of Tissot represented on Figure B.2-1. In particular, areas closer to the poles are more affected, transmitting an image of the geometry of the planet which is more distorted the closer to the poles. At latitudes above N 70 ° or below S 70 °, the Mercator projection becomes practically unusable.

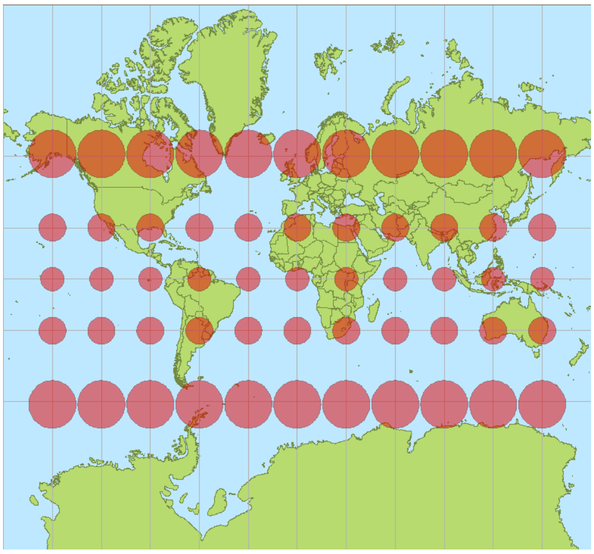


**Figure B.2-1:** The Mercator projection

The forward mapping for the applied Mercator projection are :

$$\begin{cases} E = k_0 \times (\lambda - \lambda_0) + f_E \\ N = k_0 \times \ln \tan\left(\frac{\pi}{4} + \frac{\varphi}{2}\right) + f_N \end{cases}$$

The scale factor $k_0$ used is the semi-major axis of the WGS84 ellipsoid and the prime meridian is used as central longitude $\lambda_0$. The origin is offset by applying a false east and north translation $f_E = f_N = 25\,000\,\mathrm{km}$.

# B.3 The topocentric ENU coordinate system

In many applications the representation of a point $M$ by its topocentric or local East, North and Up coordinates $(E, N, U)$ is much more intuitive and practical than its corresponding cartesian or geodetic representation. The topocentric coordinates are formed in a plane tangent to the surface of the Earth fixed to the location of a topocentric reference point $R$ (See Figure B.3-1). The $N$-axis is tangent to the northern meridian of the topocentric reference point while the $U$-axis is aligned with the local normal to the ellipsoid in the topocentric reference point. The $E$-axis is in the local horizontal plane oriented towards east tangent to the first vertical.

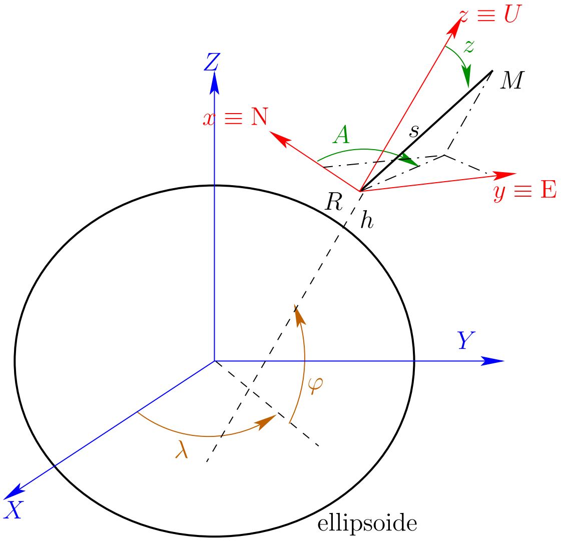



**Figure B.3-1:** The topocentric ENU coordinate system

The conversion from geodetic coordinates to topocentric coordinates is done according to :

$$\begin{bmatrix} E \\ N \\ U \end{bmatrix} = \begin{bmatrix} -\sin\lambda & \cos\lambda & 0 \\ -\sin\varphi\cos\lambda & -\sin\varphi\sin\lambda & \cos\varphi \\ \cos\varphi\cos\lambda & \cos\varphi\sin\lambda & \sin\varphi \end{bmatrix} \times \begin{bmatrix} X_M - X_R \\ Y_M - Y_R \\ Z_M - Z_R \end{bmatrix}$$

and

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} -\sin\lambda & -\sin\varphi\cos\lambda & \cos\varphi\cos\lambda \\ \cos\lambda & -\sin\varphi\sin\lambda & \cos\varphi\sin\lambda \\ 0 & \cos\varphi & \sin\varphi \end{bmatrix} \times \begin{bmatrix} E \\ N \\ U \end{bmatrix} + \begin{bmatrix} X_R \\ Y_R \\ Z_R \end{bmatrix}$$

## B.4 Coordinates in a local datum

Certain users of the Septentrio Receiver must present their results in the coordinates of local datums instead of the global or regional datums that are used in the computation of the position. Under certain conditions, the Septentrio Receiver can compute coordinates in the applicable local datum. For more information refer to the Firmware User Manual section on Datum Transformation. RxControl itself does not perform any datum transformation.

If coordinates in a local datum are reported by the Septentrio Receiver in `PosLocal` SBF blocks, the coordinates are shown in an extra tab named `Position in Local Datum` in the RxControl main window. All other places where coordinates are shown, including the planimetric plot and the ENU Time plot, show coordinates that have not been datum transformed.

# Appendix C

# Troubleshooting

This section provides some troubleshooting tips in case there is a problem with RxControl and no error warning is given. If a warning or error is shown, more information about it can be found in Appendix D on page 203.

## C.1 RxControl's screens are not updated or only partially updated

If you don't see the normal display, you are probably experiencing one of the following situations:

1. No receiver is connected. Possible reasons are:
   (a) During the connection you specified the wrong PC serial port to which receiver is connected.
   (b) Some of the serial port settings do not match the settings of the serial port of the Septentrio Receiver. This may be the case if the Septentrio Receiver serial port settings have been changed before your session. If you are not sure about this, reboot the Septentrio Receiver, so that it returns to its default settings.
   (c) The Septentrio Receiver is turned off or is in boot stage.
   (d) The Septentrio Receiver is not connected to you computer.
2. Some dialogs have N/A instead of values and the statusbar shows a red message (such as `Not enough measurements`). The most typical reason is that the antenna is not connected to the receiver or the visibility of the sky is too limited. In these cases, you will still be able to see the timing information in the `Time` or `RxClock` tab (see Section 2.4.2.3.1 on page 29 or Section 2.4.2.3.2 on page 30). Most probably the `Satellite Status` dialog (see Figure 2.4-5 on page 28) of RxControl will indicate the `Search` status of some satellites, showing the corresponding satellite signal indicators in yellow (see Section 2.4.2.2 on page 28). This situation could occur during a *cold boot* of the receiver. In this case the screen will gradually become alive and position and velocity data will show up in several seconds.
3. ***The receiver has no permission to output the data for the particular screen.***

## C.2 The Septentrio Receiver specific menus are not available in RxControl

If you don't see the receiver specific menus you are probably experiencing one of the following situations:

1. No receiver is connected. Possible reasons are:
   (a) You specified the wrong serial port for your PC.
   (b) Some of the serial port settings do not match the settings of the serial port of the Septentrio Receiver. This may be the case if the Septentrio Receiver serial port settings have been changed before your session. If you are not sure about this, reboot the Septentrio Receiver, so that it returns to its default settings.
   (c) The Septentrio Receiver is turned off or is in a boot stage.
2. Your receiver is too old and incompatible with RxControl. If youre receiver is PolaRx2 then please use the GUI from the PolaRx Graphical Tools installer.
3. There is connection bandwidth overload. This can happen when using a serial connection at a high message interval. If this is the case you should see the SBF LED at the bottom left corner of the main window blink red in stead of green. In this case please use a USB or TCP/IP connection (which provide a higher bandwith) or lower the message interval.

## C.3 Contacting Septentrio support

If you experience a problem which is not described in this or the following section, or the provided solutions are not working for you, Septentrio's support team is always ready to help you. In order to contact them via email: TURsupport@septentrio.com or you can use the support menu items of RxControl:

- `Help | Support | RxControl support`
- `Help | Support | Receiver support`

If you use the menus above some of the fields will be pre-filled for you. Please provide as many details as possible about your problem. Please attach a diagnostic report which can be generated through (`File | Display Diagnostic Report`. This report shows a summary of RxControl's version, currently connected receiver, your platform information, etc. If you are experiencing problems related to the Septentrio Receiver's commands then the Septentrio Receiver's MIB description file would be helpful in order to help you with your problem. This file can be retrieved by selecting the `File | Save MIB Description As` and specifying a location where this file can be saved.

# Appendix D

# Warning and Error Messages

# D.1 Serial port related Warning and Error Messages

**[Port] is invalid or is already open**:
The serial port with the name [Port] is invalid and does not exist on the system. This can happen when you specify one of the virtual serial ports linked with the USB ports of the Septentrio Receiver and the USB cable is not plugged in. Another cause can be that the port is already open in another program and thus not available for RxControl.
Please:

(a) select another port
(b) connect the USB cable of the Septentrio Receiver.
(c) close the program that has the port currently in use

**Receive overflow**:
An overflow in the receiver buffer of the serial port has occured.
This can occur when the PC is heavely loaded and means that some of the bytes received from the receiver are lost.

**Transmit overflow**:
An overflow in the transmit buffer of the serial port has occured.
This can occur when the PC is heavely loaded and means that some of the bytes transmitted to the receiver are lost.

**Retrieve current state**:
There was an error while retreiving the current state of the serial port.

**Setting the port settings**:
There was an error while applying the settings needed for RxControl.

**Setting up the serial port**:
There was an error during the setup of the serial port.

**Purging the device**:
There was an error while trying to purge the serial port.

**Invalid Baudrate**:
The selected baudrate cannot be applied to the serial port.
Please select a valid baudrate.

**Invalid number of databits**:
The selected number of databits cannot be applied to the serial port.
Please select a valid number of databits.

**Invalid number of stopbits**:
The selected number of stopbits cannot be applied to the serial port.
Please select a valid number of stopbits.

**Invalid parity**:
The selected parity cannot be applied to the serial port.
Please select a valid parity setting.

**Invalid flowcontrol**:
The selected flowcontrol cannot be applied to the serial port.

Please select a valid flowcontrol.

**Searching Baudrate...**:
The serial port is searching for the baudrate of the connected Septentrio Receiver.
During this process there is no communication possible with the receiver.

**Automatic searching for the baudrate failed**:
While searching for a connected Septentrio Receiver with every possible baudrate, none was found.
Check if a Septentrio Receiver is connected to the selected serial port.

**It seems that [Port] is no longer present on the system**:
The serial port RxControl was using has disappeared from the system.
This can happen if you use a USB to serial device or the virtual serial ports linked with the USB ports of the Septentrio Receiver and unplug the USB from the PC.

## D.2 TCP/IP port related Warning and Error Messages

**The connection was refused by the peer (or timed out)**:
The Septentrio Receiver refused the connection set up by RxControl or it timed out.
Please check your network settings.

**The remote host closed the connection**:
The connection between the Septentrio Receiver and RxControl has ended because the Septentrio Receiver has closed the connection.
Please check if the Septentrio Receiver is still working and try to reconnect.

**Host** [**Host**] **not found**:
The specified hostname or IP-address for the Septentrio Receiver is not found on the network.
Please check:

(a) if the specified hostname or IP-address of the Septentrio Receiver is correct
(b) that the Septentrio Receiver is correctly connected to the network.

**The local system ran out of resources (e.g., too many sockets)**:
There are to many network resources in use on your PC.
Please free up some network resources.

**The socket operation timed out**:
The socket operation has timed out before it was completed.

**An error occurred with the network**:
This error can occur if for example the network cable was accidentally unplugged.
Please check your network.

## D.3 SBF File Player related Warning and Error Messages

**The given SBF file does not exist**:
The specified SBF file does not exist.
Please specify an existing SBF file.

**There is already a SBF file connection open**:
There is already a SBF file connection open and only one at a time can be opened.
Please close the other SBF file connection before trying to open another.

**The SSN Stream has given an error**:
There has been an error while parsing the SBF. This indicates an error in the SBF parser or an invalid SBF file.
Please select a valid SBF file.

## D.4 RxControl data parser related Warning and Error Messages

**Wrong SNMP version**:
A SNMP message with a wrong version number has been received.
This error can occur when something is wrong with the SNMP setup between the Septentrio Receiver and RxControl or if there are communication problems leading to lost bytes.

a Please check the number of CRC errors by hooverig over the SBF LED (see Section 2.4.2.4 on page 32). If the number of CRC errors is high there is a problem with the communication and bytes are lost leading to this problem. So check your communication settings.
a If there are no CRC errors please restart RxControl after enabling the `Delete the downloaded MIB files at the next close of RxControl` in the `Preferences` dialog (see Section 2.4.3.1 on page 34) in order to refresh the SNMP setup.

**A time out error occurred while retrieving a SNMP message from the receiver**:
The Septentrio Receiver did not reply on a SNMP request of RxControl. This can happen if the Septentrio Receiver's CPU load is too high. If this error is displayed when displaying one of the Septentrio Receiver settings dialogs it can occur that the shown values on that dialog does not reflect the current status of the Septentrio Receiver.
Please try

(a) to send the message again
(b) to change your Septentrio Receiver settings so that the CPU load decreases.

**A time out error occurred while changing the Septentrio Receiver settings**:
The Septentrio Receiver did not react on a request of RxControl to change it's settings. This can happen if the Septentrio Receiver's CPU load is too high. If this error is displayed when displaying one of the Septentrio Receiver settings dialogs it can occur that the shown values on that dialog does not reflect the current status of the Septentrio Receiver.
Please try

(a) to send the message again
(b) to change your Septentrio Receiver settings so that the CPU load decreases.

**An error occurred while initializing the MIB**:
There has been an error while downloading the Septentrio Receiver's capabilities. As a result the Septentrio Receiver specific menus are not shown.
Please close the connection to your Septentrio Receiver and reopen it again.

**There was an error while parsing the current receiver configuration**:
RxControl requested a setting that is unknown or invalid for the Septentrio Receiver. It may be that the actual configuration of the receiver is different than the expected one.
Please restart RxControl after enabling the `Delete the downloaded MIB files at the next close of RxControl` in the `Preferences` dialog (see Section 2.4.3.1 on page 34) in order to refresh the SNMP setup.
If this does not help please contact Septentrio support.

**There was an error while setting the receiver configuration**:
RxControl changed a setting that is unknown or invalid for the Septentrio Receiver. It may be that the actual configuration of the receiver is different than the expected one.

Please restart RxControl after enabling the `Delete the downloaded MIB files at the next close of RxControl` in the `Preferences` dialog (see Section 2.4.3.1 on page 34) in order to refresh the SNMP setup.
If this does not help please contact Septentrio support.

**A time out error occurred while retrieving a receiver message from the receiver**:
RxControl has send a request to the Septentrio Receiver to which no reply has been received. This can happen if the Septentrio Receiver's CPU load is too high. If this error is displayed when displaying one of the Septentrio Receiver settings dialogs it can occur that the shown values on that dialog does not reflect the current status of the Septentrio Receiver.
Please try

(a) to send the message again
(b) to change your Septentrio Receiver settings so that the CPU load decreases.

**Re-initialize communication because no data has been received for X milliseconds**:
Since there has been no communication between RxControl and the Septentrio Receiver for X milliseconds RxControl decides that the communication is broken. Therefore it tries to re-initialize the communication. This warning dialog disappears from the moment the communication is re-established or when that fails it shows a dialog to change the connection settings.
Please check the connection between your Septentrio Receiver and the PC running RxControl.

**No communication with receiver**:
Since there is no communication between RxControl and the Septentrio Receiver RxControl decides that the communication is broken. Therefore it tries to re-initialize the communication. This warning dialog disappears from the moment the communication is re-established or when that fails it shows a dialog to change the connection settings.
Please check the connection between your Septentrio Receiver and the PC running RxControl.

**Receiving invalid data**:
RxControl has received data that it cannot parse. This can happen if there are communication errors between the Septentrio Receiver and RxControl.
Please check the connection between your Septentrio Receiver and the PC running RxControl.

**This version of RxControl does not support PolaRx2 receivers**:
This warning is shown when using a version of RxControl that communicates with the receiver via the SNMP protocol while the receiver does not support it.
Please use RxControl from the PolaRx Graphical Tools installer.

## D.5 Logging related Warning and Error Messages

**RxControl has no permissions to write to X**:
The user has entered a destination directory X for the logger output that is not writable by RxControl. Please select another destination directory or change the settings of the directory so that RxControl can write to it.

**Disk full**:
The disk containing the destination directory for logging is full preventing further logging.
Please free up some space on the disk or enter another logging destination.

**The startup script could not be read**:
The script that should be sent to the Septentrio Receiver at start of the logging cannot be found or read.
Please provide a valid startup script.

**The scheduled start time is later than the stop time**:
The entered time for starting the scheduled logging is later in time than the stop time.
Please provide a valid start and stop time for the scheduled logging.

**The logger is not initialized**:
An internal error in RxControl occured preventing the logger to be started.
Please restart RxControl and try again. If the problem is persisting please contact Septentrio.

**Action X requires that the file naming convention is set to IGS24**:
A logging post-process action (with the name X) has been defined that requires that the naming convention is set to IGS24.
Please set the naming convention to IGS24 or disable the post-process action X.

**Action X requires that the SBF logging is enabled**:
A logging post-process action (with the name X) has been defined that requires SBF logging however SBF logging is not enabled.
Please enable SBF logging or disable the post-process action X.

**Action X requires that the NMEA logging is enabled**:
A logging post-process action (with the name X) has been defined that requires NMEA logging however NMEA logging is not enabled.
Please enable NMEA logging or disable the post-process action X.

## D.6 Upgrade related Warning and Error Messages

**Failed to open connection to receiver**:
RxControl failed to open a connection to the Septentrio Receiver or your Septentrio Receiver is not running.
Please check:

(a) the connection between your Septentrio Receiver and the PC running RxControl
(b) that Septentrio Receiver is turned on.

**The upgrade file seems to be corrupt causing the upgrade to fail**:
The file containing the upgrade is corrupt or is not a valid Septentrio Upgrade File.
Please select a valid Septentrio Upgrade File.

**There was a connection time out**:
While connecting to the Septentrio Receiver there was a timeout. This can happen if there is no operating Septentrio Receiver connected or if programName is connected to a serial port of the Septentrio Receiver that is not capable of performing upgrades.
Please check if an operating Septentrio Receiver is connected and that the Septentrio Receiver's serial port is capable of performing upgrades.

**Connection timed out**:
While connecting to the Septentrio Receiver there was a timeout. This can happen if there is no operating Septentrio Receiver connected or if programName is connected to a serial port of the Septentrio Receiver that is not capable of performing upgrades.
Please check if an operating Septentrio Receiver is connected and that the Septentrio Receiver's serial port is capable of performing upgrades.

## D.7 Receiver Diagnostics causing Errors

Following errors can be encountered in the RxControl's log:

(a) lstInternalFile: Argument 'File' is invalid
(b) advFlashInfo: Invalid command

This is normal behavior and is nothing to be concerned about.

The error "lstInternalFile: Argument 'File' is invalid" is triggered by the "Receiver Diagnostics" feature of RxControl. When storing the "Receiver Diagnostics", RxControl tries to retrieve some files which aren't available on all Septentrio Receiver's, but it is part of RxControl's flow to try requesting these as part of the "Receiver Diagnostics". The absence of the files, which is normal, is reported.

The error "advFlashInfo: Invalid command" is also triggered by the "Receiver Diagnostics" feature of RxControl. If the command is not available on your Septentrio Receiver this error reports the absence of this command. Again, this is nothing to be concerned about.

# Appendix E

# Connection script for NTRIP connection using Data Link

- GET /FLEPOSVRS31GLO HTTP/1.1
- Host: ntrip.flepos.be
- Ntrip-Version: Ntrip/1.0
- User-Agent: NTRIP DataLink/2.3.11
- Authorization: Basic c2VwdGVudHJpby1hdXRvMDU6dWJpY2VudGVy
- Connection: close

# Glossary

## – A –

**AGC** **A**utomatic **G**ain **C**ontrol is an adaptive system found in many electronic devices. The average output signal level is fed back to adjust the gain to an appropriate level for a range of input signal levels. For example, without AGC the sound emitted from an AM radio receiver would vary to an extreme extent from a weak to a strong signal; the AGC effectively reduces the volume if the signal is strong and raises it when it is weaker.

**ASCII** The **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange is a standard seven-bit code. ASCII was established to achieve compatibility between various types of data processing equipment. The standard ASCII character set consists of 128 decimal numbers ranging from $0 \ldots 127$ assigned to letters, numbers, punctuation marks, and the most common special characters. The Extended ASCII Character Set also consists of another 128 decimal numbers and ranges from $128 \ldots 255$ representing additional special, mathematical, graphic, and foreign characters.

**ASN.1** **A**bstract **S**yntax **N**otation **One** is a standard way to describe a message (a unit of application data) that can be sent or received in a network. ASN.1 is divided into two parts: (1) the rules of syntax for describing the contents of a message in terms of data type and content sequence or structure and (2) how you actually encode each data item in a message.

**Azimuth** The Azimuth angle of a satellite indicates the direction of the projection of the line-of-sight onto the local horizontal plane measured from the geographic North positive to the East.

## – B –

**BeiDou** The **Beidou** navigation system is a global satellite navigation system being developed by China. This navigation system used to be named **Compass**.

## – C –

**CGGTTS** The **C**ommon **G**PS **G**LONASS **T**ime **T**ransfer **S**tandard) format designed for international time transfer among the respective timing organizations, and reported to the **BIPM**.

**CMR** The **C**ompact **M**easurement **R**ecord format contains packet framing and message types for raw L1 and L2 carrier phase and pseudorange data, plus reference station location and description messages.

**C/$N_0$** **C**arrier-to-**N**oise ratio expressed in [db-Hz].

**COG** **C**ourse **O**ver **G**round.

**conformal** A projection is **conformal** or **angle-preserving** when it preserves oriented angles between curves. This means that the shape of infinitesimally small figures are preserved, though their size is generally distorted. Tissot's indicatrix is a circle in each projection point. Other local map properties are equivalent or **equidistant**.

**CRC** A cyclic redundancy check (**CRC**) is a type of function that takes as input a data stream of unlimited length and produces as output a value of a certain fixed size. The term **CRC** is often used to denote either the function or the function's output. A **CRC** can be used in the same way as a checksum to detect accidental alteration of data during transmission or storage. **CRC**s are popular because they are simple to implement in binary hardware, are easy to analyze mathematically, and are particularly good at detecting common errors caused by noise in transmission channels.

# – D –

**direct** A projection is **direct** or **normal** when the axis of the auxiliary surface (cone, cylinder or plane) is coincident with the polar axis. Other orientations are **transverse** and **oblique**.

**DNS** The **D**omain **N**ame **S**erver is a distributed Internet directory service. A DNS is used mostly to translate between domain names and IP addresses and to control the Internet e-mail delivery.

**DOP** The **D**ilution **Of** **P**recision measures the relative degradation of the accuracy of the navigation solution based on the constellation geometry. The reported value can be multiplied by the uncertainty in the range measurements (assumed to be the same for all transmitters) to provide the uncertainty in the navigation solution.

# – E –

**EGNOS** The **E**uropean **G**eostationary **N**avigation **O**verlay **S**ystem is the European SBAS system developed by ESA, European Commission and Eurocontrol. Its service zone is the European continental airspace.

**Elevation** The Elevation angle of a satellite defines the angle between the local horizontal plane and the direction to the satellite.

**ENU** The coordinates measured in the topocentric reference with respect to a reference position. The $N$-axis points to true geographic north, the $E$-axis is oriented towards the east while the $U$-axis is along the local normal.

**equivalent** A projection is **equivalent** or equal-area when it preserves equally scales all surfaces. This means that all surfaces are equally scaled after projection. Tissot's indicatrix is of constant surface in each projection point. Other local map properties are **conformal** or **equidistant**.

# – F –

**FTP** The **F**ile **T**ransfer **P**rotocol is used on the Internet for exchanging files and it is based on the TCP/IP protocol. **FTP** is most commonly used to download a file from a server using the Internet or to upload a file to a server.

# – G –

**Galileo** The **Galileo positioning system**, referred to simply as **Galileo**, is a European Global Navigation Satellite System, built by the European Satellite Navigation Industries for the European Union (EU) and European Space Agency (ESA) as an alternative to the United States operated Global Positioning System (GPS) and the Russian GLONASS. Galileo is tasked with multiple objectives including the following: to provide a higher precision to all users than is currently available through GPS or GLONASS, to improve availability of positioning services at higher latitudes, and to provide an independent positioning system upon which European nations can rely even in times of war or political disagreement.

**GIVEI** **G**rid **I**onospheric **V**ertical **E**rror.

**GLONASS** The Russian **Gl**obal **O**rbiting **Na**vigation **S**atellite **S**ystem is a satellite based radionavigation system which enables unlimited number of users to make all-weather 3D positioning, velocity measuring and timing anywhere in the world or near-Earth space.

**GNSS** The **G**lobal **N**avigation **S**atellite **S**ystem is a satellite navigation system which currently includes **GPS**, its Russian analogue **GLONASS** and three space-based augmentation systems: **EGNOS**, **WAAS**, and **MTSAT**.

**GPS** **G**lobal **P**ositioning **S**ystem (also NAVSTAR GPS)is a satellite navigation system owned by the Department of Defence of the United States of America and designed to provide instantaneous position,velocity and time information almost anywhere on the globe at any time, and in any weather. NAVSTAR GPS stands for the NAVigation Satellite Timing And Ranging Global Positioning System.

**GPX** **GP**S e**X**change Format is an XML schema designed for transferring GPS data between software applications. It can be used to describe waypoints, tracks, and routes.

**GUI** The **G**raphical **U**ser **I**nterface gives the user a graphical way for controlling and viewing the information of the receiver.

# – H –

**HAL** **H**orizontal **A**lert **L**imit.

**HDOP** **H**orizontal **D**ilution **O**f **P**recision is a measure of the uncertainty of the navigation solution in the local horizontal plane.

**HERL** The **H**orizontal **E**xternal **R**eliability **L**evel for the position used in **RAIM** statistics.

**HMI** **H**azardously **M**isleading **I**nformation.

**HPL** **H**orizontal **P**rotection **L**evel.

# – I –

**IGS** The **I**nternational **G**PS **S**ervice provides GPS orbits, tracking data, and other high-quality GPS data and data products on line in near real time to meet the objectives of a wide range of scientific and engineering applications and studies.

**ILS** **I**nstrument **L**anding **S**ystem facilities are a highly accurate and dependable means of navigating to the runway. The ILS provides the lateral and vertical guidance necessary to fly a precision approach.

**IMU** An **I**nertial **M**easurement **U**nit is a device that measures acceleration and rotation. When the Septentrio Receiver is connected with an IMU, these measurements can be used for determining position/velocity/attitude through a technique called integration.

**indicatrix** Tissot's indicatrix, or ellipse of distortion, is a concept developed by French mathematician Nicolas Auguste Tissot to measure and illustrate map distortions. It is the theoretical figure that results from the projection of an infinitesimal circle with unit radio, defined in a geometric model of the Earth (a sphere or an ellipsoid), on the projection plane. Tissot proved that this figure is normally an ellipse, whose axes indicate the two principal directions of the projection at a certain point, i.e., the directions along which its scale is maximum and minimum. When the Tissot's indicatrix reduces to a circle it means that, at that particular point, the scale is independent of direction. In conformal projections, where angles are preserved around every location, the Tissot's indicatrix are all circles, with varying sizes. In equivalent or equal-area projections, where area proportions between objects are conserved, the Tissot's indicatrix have all unit area, although their shapes and orientations vary with location.

**integration** Approach to determining the position/velocity/attitude, based on the combination of GNSS measurements together with measurements of other sensors, such as an IMU.

**IP** The **I**nternet **P**rotocol is responsible for moving packets of data between Internet nodes. IP forwards each packet based on a four byte destination address (the IP number). The Internet authorities assign ranges of numbers to different organizations. The organizations assign groups of their IP numbers to departments.

# – K –

**KML** **KML** is a file format used to display geographic data in an earth browser, such as Google Earth, Google Maps, and Google Maps for mobile. A **KML** file is processed in much the same way that **HTML** (and **XML**) files are processed by web browsers. Like **HTML**, **KML** has a tag-based structure with names and attributes used for specific display purposes. Thus, **Google Earth** and **Maps** act as browsers for **KML** files.

# – L –

**LAN** A **L**ocal **A**rea **N**etwork is a computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance via telephone lines, radio waves, among other ways.

**L-Band** **L**- **B**and **R**eceiver.

**LDAP** The **L**ightweight **D**irectory **A**ccess **P**rotocol, or **LDAP**, is an application protocol for querying and modifying directory services running over TCP/IP.

**LED** **L**ight **E**mition **D**iode. Light-emitting diodes are diodes that emit visible light when electricity is applied, similar to a light bulb. RxControl simulates LEDs by animated images.

# – M –

**MDB** **M**inimum **Detectable B**ias based on probability of missed detection set by the user.

**Mercator** Mercator was born Gheert Cremer (or Gerard de Cremere) in the Flemish town of Rupelmonde. Mercator is the Latinized form of his name. He constructed a new chart and first used it in 1569 : it had parallel lines of longitude to aid navigation by sea, as compass courses could be marked as straight lines.

**MI** **M**isleading **I**nformation.

**MIB** a **MIB** is a type of database used to manage the devices in a communications network. The **MIB** contains information on the commands and on the target's objects (controllable entities or potential sources of status information).

# – N –

**NIS** The **N**etwork **I**nformation **S**ervice or **NIS** is Sun Microsystems' "'Yellow Pages"' (YP) client-server directory service protocol for distributing system configuration data such as user and host names between computers on a computer network.

**NIS+** NISPLUS or NIS+, is an enhanced version of the Network Information Service developed by Sun Microsystems. It is a UNIX lookup service detailing disk mounts, users, computer nodes, etc. It is designed to eliminate the duplication of tables, called "'maps"', thereby easing system administration by storing such maps on a master server rather than keeping separate copies on individual machines, which is generally a sin. With the exception of NIS+ server, client & server versions of NIS & NIS+ have been ported to other UNIX platforms, notably Linux. MS Windows can run NIS-Gina, but this is not common.

**NMEA** The **N**ational **M**arine **E**lectronics **A**ssociation has developed a standard to permit ready and satisfactory data communication between electronic marine instruments, navigation equipment and communications equipment when interconnected via an appropriate interface. The standard implemented by the Septentrio receivers is the NMEA 0183, version 2.30.

# – P –

**PA** A **P**recision **A**pproach is an approved descent procedure, which uses a navigation facility aligned with a runway where glide slope information is given.

**PDOP** **P**osition **D**ilution **Of** **P**recision is the geometric DOP parameter.

**PL** SBAS systems generate in real time protection limits for the residual position error in the differential correction to GPS. When the residual error exceeds the protection limit, an alarm is raised notifying the user of a potential dangerous situation.

**PRN** The **P**seudo **R**andom **N**oise refers to a code that is is apparently random although it has been generated by means of a known process, hence the repeatability of the code indicate by the prefix *pseudo random*. Each GNSS satellite has its PRN number.

**projection** A map projection is any method used in cartography to represent the two-dimensional curved surface of the earth on a plane. The term **projection** refers to any function defined on the earth's surface and with values on the plane, and not necessarily a geometric projection. Since the sphere or revolution ellipsoid are non-developable surfaces, a map projection cannot exist without distortions. A map projection uses an intermediate surface (a cone, cylinder or plane) to project the earth's points onto, which is afterwards laid out on a plane.

**PVT** **P**osition, **V**elocity and **T**ime, meaning that the navigation solution computes the current position, velocity and time clock bias of the receiver.

# – Q –

**QZSS** The **Q**uasi-**Z**enith **S**atellite **S**ystem is a regional time transfer system and Satellite Based Augmentation System for the Global Positioning System, that is being developed by and receivable within Japan.

# – R –

**RAIM** The **R**eceiver **A**utonomous **I**ntegrity **M**onitoring is a technology developed to assess the integrity of GPS signals in a GPS receiver system. It is of special importance in safety-critical GPS applications, such as in aviation or marine applications. **RAIM** ensures the integrity of the computed position solution, provided that sufficient satellites are available. The **RAIM** algorithm consists in three steps: detection, identification and adaptation, or shortly **"D-I-A"**.

**RGB** **R**ed **G**reen **B**lue color model.

**RINEX** The **R**eceiver **IN**dependent **EX**change format is data format independent of receiver type. RINEX can be seen as a standard exchange format for GPS data.

**RS-232** The **RS-232** standard specifies signal voltages, signal timing, signal function, a protocol for information exchange, and mechanical connectors for a serial connection.

**RTCM** **R**adio **T**echnical **C**ommission for **M**aritime **S**ervices. The committee NO. 104 of the RTCM recommended a standard for exchange of data for Differential GPS service. The standard addresses both code-based and carrier-phase based positioning.

**RTK** GPS **R**eal-**T**ime **K**inematic is a high-precision surveying method. RTK is based on differential carrier-phase prunning with either float or integer phase ambiguities. RTK requires a real-time data link to transmit correction data from the base station to the rover.

# – S –

**SBAS** A **S**pace-**B**ased **A**ugmentation **S**ystem is a regional augmentation systems for GPS and/or GLONASS. An SBAS system is based on a networked ground segment and navigation payloads on-board of geostationary satellites whose main purpose is to provide higher position accuracies, better availability and continuity of service and integrity messages to the users of space based navigation systems. Currently existing SBASs are based on DO229 data exchange standard.

**SBF** The **S**eptentrio **B**inary **F**ormat is a data format used by the Septentrio receivers. It arranges the data in so-called SBF blocks, identified by block IDs. The benefit of SBF is compactness : large quantity of information with a high level of detail can be transmitted over a low-bandwidth serial connection. This format should be your first choice if you wish to receive detailed information from the receiver.

**SNMP** **SNMP** is used by network management systems to monitor network-attached devices for conditions that warrant administrative attention. It consists of a set of standards for network management, including an Application Layer protocol, a database schema, and a set of data objects. **SNMP** exposes management data in the form of variables on the managed systems, which describe the system configuration. These variables can then be queried and sometimes set by managing applications.

# – T –

**TCP/IP** **TCP/IP** is a communication protocol and is composed of layers:

**IP :** is responsible for moving packets of data between Internet nodes. IP forwards each packet based on a four byte destination address (the IP number). The Internet authorities assign ranges of numbers to different organizations. The organizations assign groups of their IP numbers to departments.

**TCP :** is responsible for verifying the correct delivery of data from client to server. Data can be lost in the intermediate network. TCP adds support to detect errors or lost data and to trigger retransmission until the data is correctly and completely received.

**Sockets :** A name given to the package of subroutines that provide access to TCP/IP on most systems.

**TDOP** **T**ime **D**ilution **O**f **P**recision is a measure of the uncertainty of the navigation solution in the time determination.

**TOW** GPS time is transmitted by a combination of the current Week Number and the **T**ime **O**f **W**eek. The TOW represents the number of seconds into the week ranging from $[0 \ldots 604800[$ seconds and is counted from midnight Saturday/Sunday on the GPS time scale.

# – U –

**USB** **U**niversal **S**erial **B**us is a specification to establish communication between devices and a host controller (usually personal computers).

# – C –

**UTC** **C**oordinated **U**niversal **T**ime is a time scale that couples Greenwich Mean Time, which is based solely on the Earth's inconsistent rotation rate, with highly accurate atomic time. When atomic time and Earth time approach a one second difference, a leap second is calculated into UTC. UTC was devised on January 1st, 1972 and is coordinated in Paris by the International Bureau of Weights and Measures (BIPM). For most practical purposes associated with the Radio Regulations, UTC is equivalent to mean solar time at the prime meridian (0° longitude), formerly expressed in Greenwich Mean Time (GMT). The maintenance by BIPM includes cooperation among various national laboratories around the world. The full definition of UTC is contained in CCIR Recommendation 460-4. The GPS system time is different from the UTC time by a whole number of leap seconds (15 at the time of this writting).

# – V –

**VAL** **V**ertical **A**lert **L**imit.

**VDOP** **V**ertical **D**ilution **O**f **P**recision is a measure of the uncertainty of the navigation solution in the vertical direction.

**VERL** The **V**ertical **E**xternal **R**eliability **L**evel for the position used in **RAIM** statistics.

**VPL** **V**ertical **P**rotection **L**evel.

# – W –

**WAAS** The **W**ide **A**rea **A**ugmentation **S**ystem is the American SBAS system developed by the FAA. WAAS is designed to improve the accuracy and ensure the integrity of information coming from GPS satellites.

**WGS84** The **W**orld **G**eodetic **S**ystem **84** is an Earth-fixed global reference frame. It is defined by a set of parameters defining the shape of the earth's ellipsoid, its angular velocity, the earth mass and a detailed gravity model of the earth. These parameters are needed because WGS 84 is used not only for defining coordinates in surveying, but, for example, also for determining the orbits of GPS navigation satellites.

**WNc** GPS time is transmitted by a combination of the current **W**eek **N**umber and the Time Of Week. The week number represents the number of weeks elapsed since the introduction of the GPS time scale on January, 6$^{th}$ 1980.

# – X –

**XERL** The E**X**t**E**rnal **R**eliability **L**evels give the opportunity to introduce a more stringent application-specific integrity criterion. The positional solution is deemed as passed an application-level integrity test if the **XERL**s are within user-defined (and application-dependent) alarm limits. This comparison (and the definition of alarm limits as well) takes place in a user application and is outside of the receiver scope.

# – E –

**XML** E**x**tensible **M**arkup **L**anguage.