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# Preface

This guide explains how to use the Conductor software to communicate with a GPS receiver for collecting, displaying and analyzing data.

## *Intended Audience*

This guide aids GPS system installers evaluating Sandpiper, Avocet and Swift GPS receivers for navigation and positioning. This guide assumes the user has basic computer skills and is familiar with Windows environments.

**If you have any questions about installing or using Conductor, please contact Axiom Navigation at:**

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# *I. Introduction*

## 1. About Conductor

Thank you for your interest in Axiom Navigation products. Conductor is a PC based front-end for customers evaluating Axiom's Sandpiper, Avocet, and Swift 12-channel GPS receivers. These receivers feature the SiRF chipset, which has superb acquisition and tracking performance. Conductor can communicate with these receivers using SiRF binary protocol, NMEA-0183 standard protocol, or Axiom User1 protocol.

Conductor makes available all of the necessary information that can be retrieved during the normal operation of a receiver. All aspects of GPS data (position, velocity, time, satellite tracking, etc.) can be monitored and logged under various test scenarios for evaluation of a receiver. Conductor allows analysis of the collected data in order to investigate performance issues such as accuracy, road test position and trajectory, satellite tracking, time to first fix, etc. All processed data is in ASCII format and can be ported into popular spreadsheets (e.g., Microsoft Excel) for creating plots and statistics.



## 2. Getting Started

This chapter describes the PC requirements and step-by-step instructions to install the Conductor program using Windows 95, Windows 98, Windows 2000 or Windows NT 4.

### *Software Requirements*

These are the system requirements for running the Conductor program:

- Microsoft Windows 95, Windows 98 or Windows NT 4 operating system
  - 1 available communications (COM) port
  - 9 MB available hard disk space
  - 16 MB RAM (32 MB for Windows NT 4)
  - Pentium processor or equivalent
  - 640 x 480 256 color display minimum, 800 x 600 16-bit color recommended
- Note:** for optimum display, set your display settings to Small Fonts.

### *Installing Conductor*

To install the Conductor software on your computer, follow these steps:

1. Insert the Conductor CD into the CD drive of your PC.
2. From My Computer, select whichever drive is the CD drive (usually the D: drive).
3. Double-click on Setup.exe.

From there, you need only follow the prompts of the setup program to install Conductor. The setup program will also walk you through the process of setting Conductor's local options in order to initialize the receiver. It is not actually necessary to initialize the Sandpiper, Avocet, or Swift GPS receiver since it will perform a cold start in less than a minute.

After Conductor has been installed, you can open it by choosing Conductor from the list of Programs on the Start menu. Unless specified otherwise, Conductor will be installed to C:\Program Files\Conductor.

#### **NOTE**

If you have any previous versions of Conductor installed on your computer, you should uninstall them first. This can be done with **Add/Remove Programs** located in the Control Panel.

## II. *Using the Conductor*

### 3. The Setup Wizard

#### *Running Conductor for the First Time*

The first time that Conductor is run on a new computer, there are a few things that the program needs to know before it can begin normal operation. When you first open Conductor, it will ask what serial port you will be using to communicate with your receiver. Choose the correct port from the list of available COM ports, and press **OK**. If there are no COM Ports available on your computer, then Conductor will alert you of this problem.

Next, the main Navigation Display will appear, followed by a setup wizard to guide you through the process of configuring the Conductor to your needs.

#### *Selecting a Location*

The first item that the setup wizard asks you for is your current location on earth. This is used to help initialize the GPS receiver to its current location, resulting in faster navigation. A small world map will appear, with crosshairs designating where you are. You may choose from the list box of standard locations, or use the mouse to drag the crosshairs to the approximate area where you are located. When you have selected your location, press **OK**.

#### *Selecting a Geodetic Datum Plane*

To correctly calculate your position on the earth, the receiver uses a mathematical representation of the earth called a datum. It is an ellipsoid that roughly approximates the surface of the earth. Currently there isn't a datum that works perfectly throughout the world. Therefore, there are many different datums that each work well for their respective location on the earth. The Conductor will ask you to select a datum that best represents your region of the planet. Choose from the datums provided, and check to see that the region the datum is suggested to be used in matches your region. The most general datum, which the United States uses, is **WGS-1984**.

#### **TIP**

If the datum that you are looking for does not appear on the list, then you may enter your own custom datum. See *Using a Custom Datum* in Chapter 7.

### *Checking the Time Zone*

Next, Conductor will ask you to verify your time zone information. The offset from Greenwich Mean Time is used to correct the clock information received from the GPS receiver to the time zone that you are located in. Conductor will open up the settings window used by your Windows operating system so that you can make sure that the time zone that your computer is set to is correct. If it isn't, be sure and select the correct time zone for your area.

### *That's It!*

Now you should be ready to start using the conductor. As soon as the wizard closes, Conductor will attempt to communicate with the receiver that is connected to the communications port that you specified. It will automatically begin detecting what message set is being used, using different options until correct communication is established.

## 4. Understanding Receiver Communication

### *What is a “Message Set?”*

In order for the receiver to communicate its information to the PC, it requires a Message Set that both the receiver and the PC will understand. Conductor understands the SiRF binary message set, developed by SiRF Technologies, and the NMEA-0183 standard GPS message set. Conductor also communicates in the Axiom User1 message set, which is explained in chapter 16. Before Conductor can begin to operate correctly, it must first figure out which message set the receiver is using and the baud rate that it is being used.

### *Using Auto Detect*

In the menu, the item **File→Message Set→Auto Detect** will enable or disable the Auto Detect mode. If Auto Detect is checked Conductor will attempt to try different message sets at different baud rates until correct communication is established. While this is occurring the gauges on the Navigation window will spin and move.

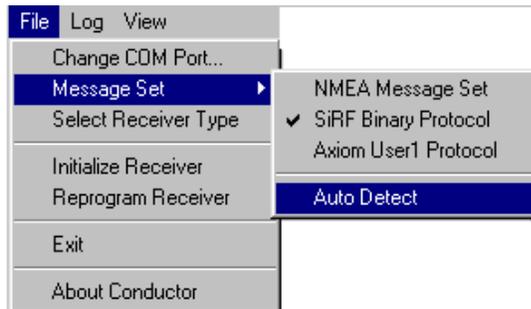
At the bottom of the window, flashing in red, is the status of the search. If it reads “Please connect a GPS receiver”, then that indicates that Conductor is not receiving any data on the COM port at all. Check the Display I/O icon to see if it is flashing red. This is the light bulb located under the text displays. If the light bulb icon is not flashing at all, then this is also an indication that there is no data being received.



If the status flashing in red states “Attempting [message set] at [speed] baud”, then Conductor is receiving data and is attempting to interpret it according to the settings specified.

If Conductor fails to communicate with the receiver, then it will display a window indicating this. Choosing *abort* will exit the program. *Ignore* will stop the auto detect process, and *retry* will begin the process again. If Auto Detect continually fails to communicate, then you may want to attempt to choose the message set and baud rate manually.

## Choosing the Message Set Manually



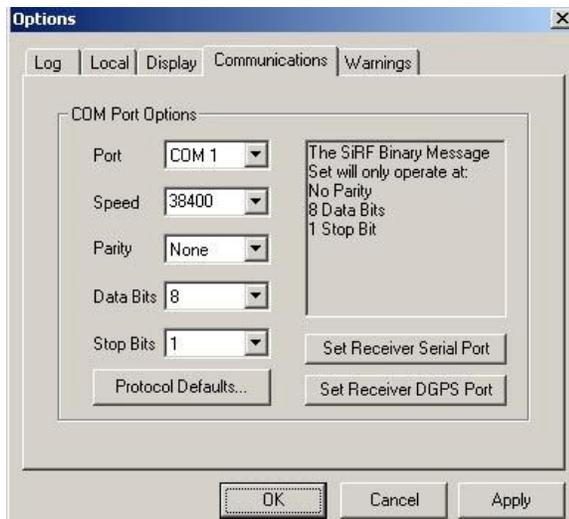
The first thing you will want to do is disable the Auto Detect mode. In the menu, uncheck the item **File→Message Set→Auto Detect**. Next, you can choose which message set you wish to try in the menu with either **File→Message Set→SiRF Binary Protocol**, **File→Message Set→NMEA Message Set**, or **File→Message Set→Axiom User1 Protocol**.



There are also tool bar buttons corresponding to these menu items. See *The Toolbar*.

## Selecting the Baud Rate

The GPS receivers can also communicate in different baud rates. To select the correct baud rate for your receiver, open the options window with the menu item **File→Change COM Port...**



On the window there are drop down boxes that you can use to select the correct COM Port, baud rate, as well as other port settings. The information box on the right indicates what are appropriate settings for that particular message set. The standard baud rates for SiRF binary are 9600, 19200, and 38400. The standard baud rate for the NMEA-0183 message set is 4800.

## *Correct Communication*



When Conductor is using the correct message set and baud rate you should see the message set status icon (the icon on the very left) change to that message set, as well as the Data I/O icon (the light bulb) flashing yellow. The title bar also displays the current message and baud rate.

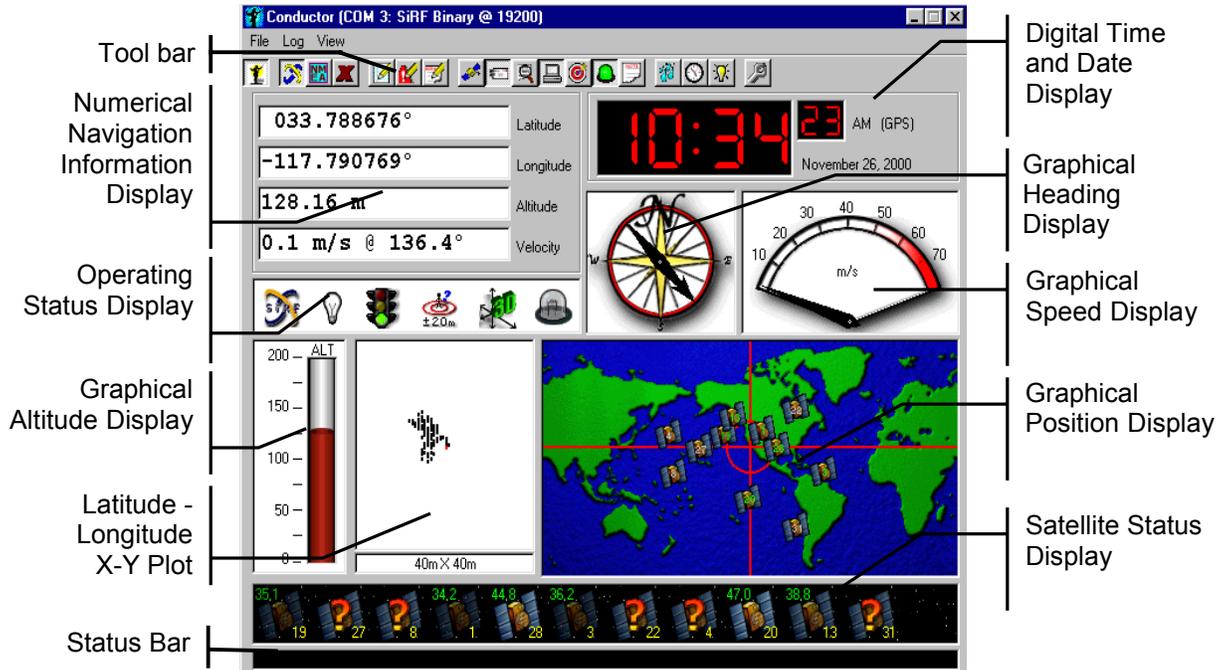
## *Selecting the Receiver Type*

Conductor has the ability to communicate with the SiRFStar I chipset-based Sandpiper and Avocet line of receivers as well as the Swift receiver, which is based on the SiRFStar II chipset. Normally, Conductor will automatically determine which type of receiver it is connected to and only display the commands and options that are available with that receiver. In some cases, however, Conductor will be unable to automatically determine the receiver type. In those cases, the message box shown below will appear asking you to manually select the receiver type. You may also choose to manually select the receiver type at any time by choosing the **File→Select Receiver Type** menu item.

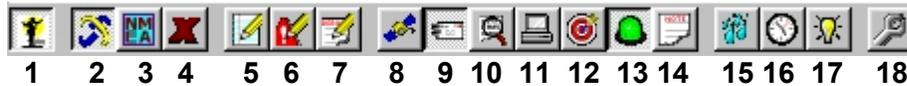


## 5. Understanding the Navigation Display

The Navigation Display is the primary display screen that Conductor uses. It displays all of the standard information that is provided by the GPS receiver. You will see your current latitude, longitude, altitude and velocity, as well as your position on the earth, and the satellites that the receiver is currently tracking.



### The Tool Bar



1. **Enable/Disable Conductor** Deselecting this button will disable all communications with the GPS receiver, freeing up the COM Port.
2. **SiRF Message Set** Switches the Conductor to the SiRF binary message format and sends a command to the receiver to switch to SiRF binary mode.
3. **NMEA Message Set** Switches the Conductor to the NMEA-0183 message set, and sends a command to the receiver to switch its message set to NMEA.
4. **Axiom User 1 Message Set** Switches the Conductor to the Axiom User1 message set and sends a command to the receiver to switch its message set to Axiom User 1.

5. **Log Data** Starts the Conductor logging the data that is specified in the Logging Options window. See *Logging Data*.
6. **Log Errors** Starts the Conductor logging the errors that are occurring with the receiver. See *Logging Errors*.
7. **Log Debug** Starts the Conductor logging the Development/Debug Data that is displayed in the Debug Window. See *Logging Debug Data*
8. **Channel Status** Opens the Channel Status display. See *The Channel Status Window*.
9. **Command Window** Opens the Command window. See *The Commands Window*.
10. **Information Window** Opens the Information display. See *Receiver Information Window*.
11. **Status Window** Opens the Status display. See *The Status Window*.
12. **DGPS Status Window** Opens the DGPS Status display. See *The DGPS Status Window*.
13. **Messages Received** Opens the Messages Received display. See *Monitoring Output Messages*.
14. **Development Data Window** Opens the Development Data display window, which displays a readout of the development messages that the receiver outputs. See *The Development Data Window*.
15. **Trickle Power** Displays a window for enabling the Trickle Power functions of power saving GPS receivers. See *Trickle Power*.
16. **Time Window** Opens the Time control panel. See *Setting the Time*.
17. **Initialize Receiver** Sends a command to initialize the GPS receiver to its current time and position. See *Initializing the Receiver*.
18. **Options** Opens the Options window. See *Changing Display Options*.

### *Numerical Navigation Information Display*

This display offers a detailed description of the GPS receiver's current position, altitude, heading, and speed. The units can be changed in the **Options** menu. (See *Changing Display Options*.)

### *Digital Time and Date Display*

Large and red, the Digital Time Display is an easy indication of GPS receiver operation from anywhere in the room. Once the GPS receiver acquires at least one satellite, then it will output time information to Conductor. The time is adjusted from the receiver's GMT (Greenwich Mean Time) zone using the local GMT offset. (See *Changing Local Options*.)

## Operating Status Display

These boxes display information about the Conductor and the GPS receiver's operation. The following table shows all the possible icons that may appear in each box and their meaning.

Table 3.1 Operating Status Display Icons

<b>Message Set</b>	 SiRF Binary	 NMEA-0183	 User1	 Unknown	
<b>Data I/O Status</b>	 Receiving Data	 Not Receiving Data	 Error Received	 Conductor Disabled	
<b>Navigation Quality</b>	 Good Navigation	 Poor Navigation	 Bad Navigation		
<b>DGPS Status</b>	 WAAS DGPS is On And Using WAAS	 ±5m DGPS is On	 ±100m DGPS is Off	 Doing Cold Start	 BASE Receiver in Base Station Mode
<b>Solution Status</b>	 3-D Solution	 2-D Solution	 No Solution		
<b>Command Reply</b>	 No Reply	 Acknowledged	 Unacknowledged	 NMEA Messages	

### Message Set

This box indicates the current message set that is being used to communicate with the GPS receiver. For the Sandpiper/Avocet and Swift receivers, this will be the Axiom User1 message set, the NMEA-0183 standard, or the SiRF binary protocol, which exchanges more extensive information with the receiver. Double-clicking this icon will display the receiver's software version and the software build time and date.



A small red question mark next to the message set icon indicates that the software version or Axiom Variant version differs from the values that have been set in the Warnings tab of the Options window. See "Changing Warning Options", chapter 11, for more information on how to set these options.



### Data I/O Status

This box lets you know when the receiver begins to receive data from the satellites, and when the data has been cut off. The **Error Received** red light illuminates when data that has been received fails its own checksum. Double-clicking on this icon will show the last error generated.

**TIP**  
More detailed information about each icon in the Operating Status Display can be obtained by holding the mouse cursor over the icon for a few seconds. A fly-by message will appear with additional information.



### Navigation Quality

The traffic light shows how many satellites are being used in the navigation solution (not how many satellites the receiver is tracking). A red light means either that the receiver is waiting for satellite clock and ephemeris data or has insufficient pseudoranges to navigate. A yellow light indicates that it has enough pseudoranges for 2-D navigation, while a green light indicates that it has enough for 3-D navigation.



### DGPS Status

Whether or not you are receiving DGPS signals can be seen by a glance at the fourth box. A special icon is displayed if WAAS is the source of the DGPS corrections. Sandpiper, Avocet, and Swift automatically use DGPS information if it is received. Alternatively, this box may show that the receiver is performing a cold start. If Conductor is in reference receiver mode, the Base icon is displayed. (See *Using the Detail Windows, Commands.*)



### Solution Status

This box shows whether the receiver has a navigation solution and whether the solution is 2-D (giving latitude and longitude) or 3-D (latitude, longitude and altitude).



### Command Reply Indicator

While using the SiRF binary message set, any time a command is sent to the receiver, the receiver replies with either an acknowledgement that the command was received and executed, or an unacknowledgement, implying that the command was invalid. These responses are indicated by a green and red light, respectively. If a green light flashes after you send the receiver a command, then you can be sure that the receiver accepted and performed your request. If a red light flashes, then you need to check the parameters that you sent with the command and try again.

When the Conductor is receiving NMEA-0183 messages, this icon will display an NMEA icon. The NMEA message set does not respond when a command is sent.

### *Graphical Altitude Display*

The altitude bar scale can be modified using the display options. (See *Changing Display Options*.) Non-Differential GPS altitude typically fluctuates  $\pm 100$  meters.

### *Latitude - Longitude X-Y Plot*

This is a simple X-Y plot of Latitude and Longitude. Although there is no map underneath, Conductor keeps track of the receiver's movement from the starting point. If you are stationary, you can see the S/A errors that the Department of Defense puts into civilian GPS signals. By default, the view area is 40 meters by 40 meters. The scale can be changed using the display options. (See *Changing Display Options*.) Conductor by default stores the last 500 data points (seconds) in memory, and these are replotted whenever the display is refreshed. You can manually refresh the plot or clear the memory buffer using the right mouse button on the display.

<b>TIP</b>
To clear, or refresh the X-Y Plot display, click the right mouse button, and choose from the menu.

### *Graphical Heading Display*

The arrow points in the current GPS heading, with North fixed at the top. With this compass, it is easier to see the heading at a glance, rather than translating from the numerical heading display where  $0^\circ$  indicates North,  $90^\circ$  is East, etc. When the receiver is not moving in any direction it is difficult to determine its heading. Therefore, unless the receiver is in motion, the heading information is unreliable.

### *Graphical Speed Display*

This simulation of an automobile speedometer indicates the GPS rate of travel. The units can be modified using the display options. (See *Changing Display Options*.)

### *World Map Display*

This map of the world gives a rough approximation of the GPS solution calculated by the receiver. If it has not yet calculated a solution, it shows the initial position that the user has sent to the receiver. The default position is  $0^\circ$  latitude and  $0^\circ$  longitude, which is just off the Gold Coast of Africa. This map is

for display only, although it's similar to the map used to change your current location. (See *Changing Local Options*.)

Optionally, the approximate locations of the satellites that are being tracked are displayed on the world map. The satellites' locations are calculated as if they were in space directly above you, and are not corrected for the curvature of the earth. The farther a satellite is from the center, the closer it is to the horizon. Labeled on each satellite picture is its identification (PRN) number.

**TIP**  
To quickly show or hide the satellites or the crosshairs, click the right mouse button on the world map

### Satellite Status Display

The black bar at the bottom of the Conductor display indicates the number of satellites currently being tracked by the receiver. The satellites are ordered by channel, ranging from 1 to 12. A channel successfully tracking a satellite displays the image of a satellite. If a channel is actively searching the sky for a satellite, but has not found it yet, that satellite appears with a question mark (“?”). Unused channels appear blank. Though most receivers have the ability to track 12 satellites, frequently only 6 to 8 satellites will be visible at any specific time.

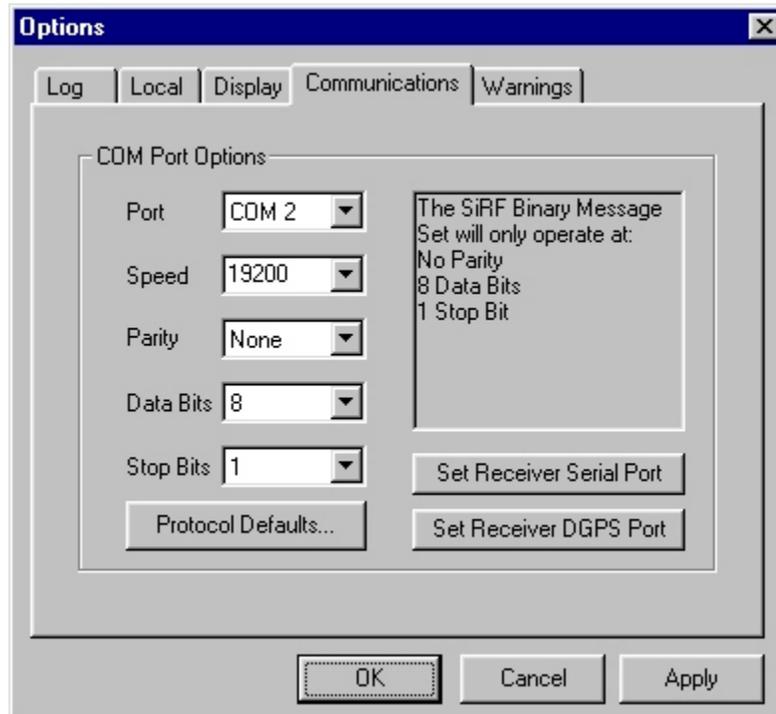


Optionally, you can also have the signal strength of each satellite displayed here as either SNR (Signal-to-Noise Ratio) or C/No (Carrier-over-Noise Ratio). (See *Changing Display Options*.) By default the signal strength is displayed graphically, with weak satellites showing only dimly while strong satellites are shown brightly. Alternatively, the exact SNR or C/No value, as well as the satellite's identification number for each satellite can be displayed as text above and below each image.

**TIP**  
Fly-by information is also available for each satellite image. Hold your mouse cursor over one for a few seconds. Also, holding the left mouse button on a satellite will show a detailed run down of that satellite's status. (SiRF message set only)

To quickly change what is displayed in the Satellite Status Display, click the right mouse button on the satellites, and a menu will show the different options. Please note, if you choose **Hide**, then the display will disappear. To get it to return, you must enter the Options window (**View→Options**), and select the check box next to **Satellite View**.

## 6. Changing Communications Options



In order to communicate with a GPS receiver, Conductor must have the correct Communications Port settings. By default, the Conductor tries to automatically set these settings for you. In most situations, only the COM Port and the Speed should be changed. Changing the other properties may inhibit good communication.

Only the COM Ports that are available on your computer will show up in the COM Port drop down list. If a COM Port is not listed, then another device in the computer is using it.

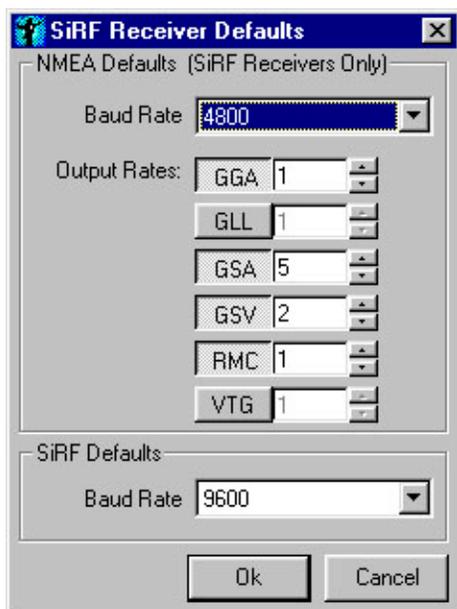
Each message set has its own communications settings that are stored independently of one another. The settings displayed are only those used for the current message set. The information box supplies the parameter requirements for the message set that you are currently using. The SiRF binary message set uses 9600, 19200, or 38400 speed as its standard. The NMEA-0183 standard uses a standard speed of 4800.

### *Setting the Receiver's Port Options*

Pressing the buttons marked **Set Receiver Serial Port**, or **Set Receiver DGPS Port**, each send a command to the receiver that will change the receiver's communication settings for the main serial port, or the DGPS port, respectively.

## Setting the Default Communications Settings

Pressing the **Advanced...** button will open this window:



This window sets the default setting that are used when switching back and forth between the SiRF message set and the NMEA message set. When you select the menu items or the toolbar buttons that switch the receiver's message set, then these settings will be used to switch them.

The baud rates entered here will be used as the standard baud rates for general switching. Also, the NMEA messages and their respective rates can be chosen to customize to your own personal needs. Each rate represents the interval in seconds that the message is output by the receiver.

These settings will only take place when the message set is changed in the navigation window, either from the menu or the tool bar.

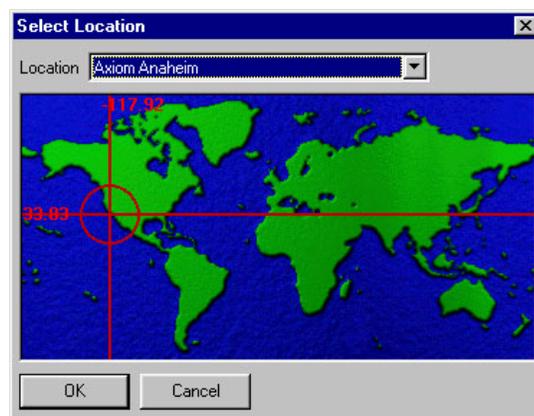
## 7. Changing Local Options

Both for initialization and display purposes, it is important that Conductor be aware of the attributes of your local area. The first time that Conductor is run, an Initialization Wizard will walk you through the process of setting Conductor's local options. Afterwards, it is sometimes necessary to send the information to the GPS receiver. You can also modify these settings by choosing **Options** from Conductor's **View** menu, and clicking the **Local** tab.

### *Local Position*

With the proper location information, Conductor can inform the receiver of its location to speed up the initial search for satellites. You may manually enter your location here, in fractions of a degree, or click **Select Location** to find your position on a map.

### *Finding Your Position on the Map*



A number of approximate locations are listed above the map. By choosing the closest one of these default positions, you will get close enough for satellites to be found.

Alternatively, you can click the mouse directly on the map to point to your location. This will give a good approximation of your latitude/longitude position. Click **OK** to update the **Local Options** screen.

## Local Datum

A *datum* is a mathematical approximation of the surface of the Earth. Many countries use different datums to best approximate the surface of the Earth in their location. The United States uses a datum named WGS-1984. Click **Select Datum** to choose the datum for your location.

### Selecting a Datum

219 datums are available in the drop-down list on this window. Information about the selected datum is also displayed including: the mathematical ellipsoid employed and how the solutions using this datum differ from WGS-84, in meters. Click **OK** to update the **Local Options** screen.

### Using a Custom Datum

#### **\*Advanced Users Only!**

A custom datum definition is currently available with Conductor using any SiRF compatible receiver. Select "Custom Datum" from the list of datums. You can either use a predefined ellipsoid, or select "Custom Ellipsoid" to define your own. Input the X, Y, and Z differences in the boxes provided. Press **OK** to put the datum into use. **Warning!** *Using a custom datum without proper knowledge of the input values may have unpredictable results. Use with caution.*

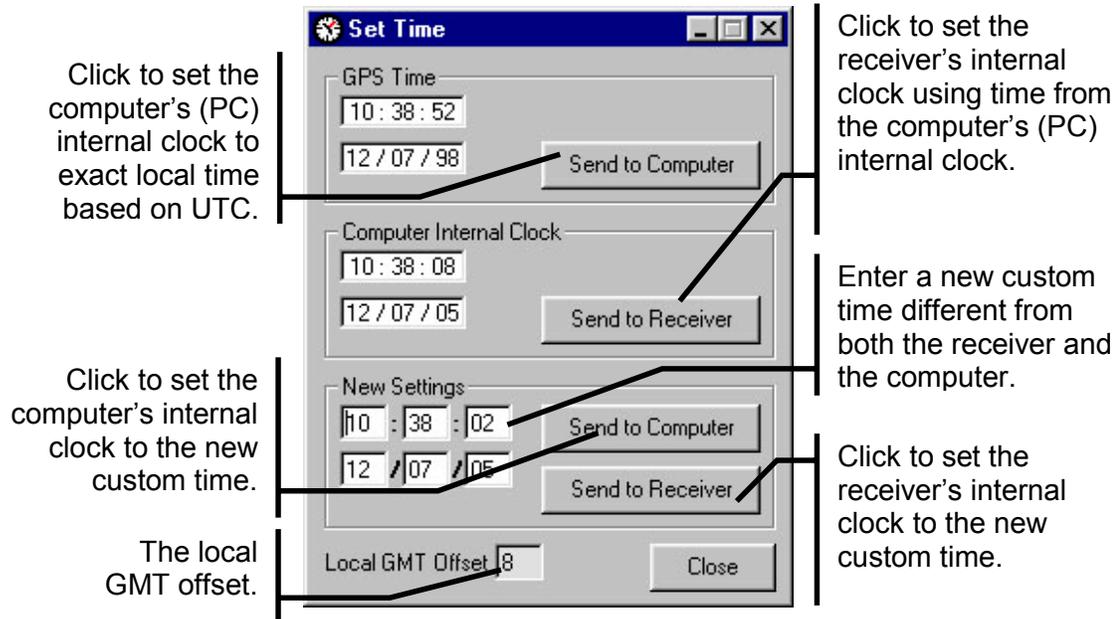
### Local GMT Offset

GMT stands for *Greenwich Mean Time*, or the time zone "zero" over Greenwich, England. The local GMT offset is the number of hours *subtracted* from GMT to get the correct local time. For example, Pacific Standard Time (PST) is GMT - 8 hours, or an offset of 8. The time in Seoul, Korea is GMT + 9 hours, or an offset of -9. The GMT offset will never be less than -12 or greater than 12.

Conductor will open your time zone settings window that is provided with the Windows operating system when you press the button marked **Windows Settings....** Conductor uses this setting to get the GMT offset.

## 8. Setting the Time

It is important that both your computer and the GPS receiver use the correct time. This window facilitates that. You can reach the **Set Time** window by clicking the time tool bar button on the Conductor's Navigation Display, or by choosing **Set Time** from the **View** menu.



It is critical that the GMT offset be correct to translate the time between the computer's internal clock (which uses the local time zone) and the receiver's internal clock (which uses GMT).

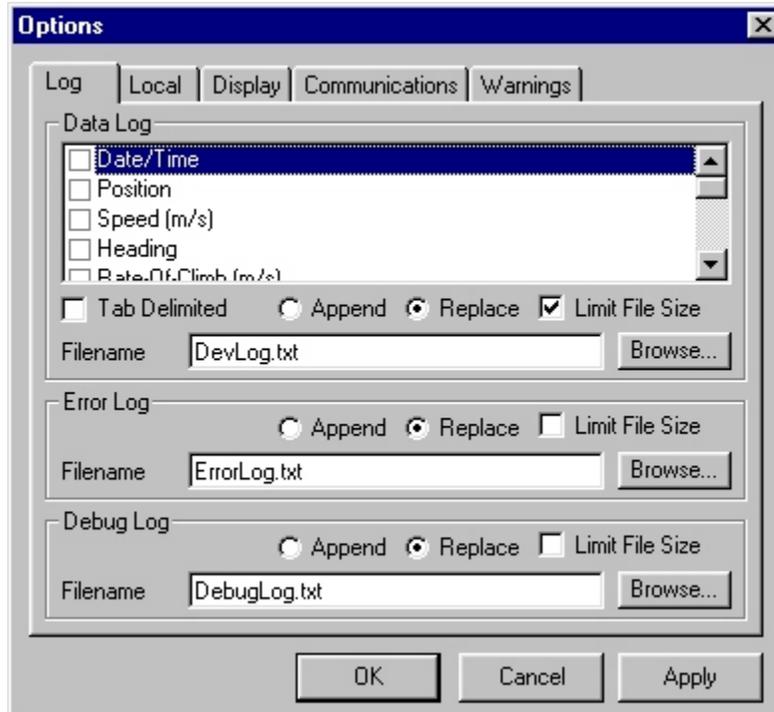
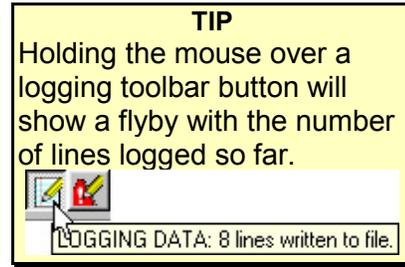
An alternate way to set the receiver's time is to push the **Initialize GPS** toolbar button on the Conductor's Navigation Display. This button will only work properly if the GMT offset is correct. The button also sends position information at the same time.





## 9. Changing Log Options

Data, debug, and error logging can be switched on and off via the **Log** menu, or their respective toolbar buttons on the Conductor's Navigation Display. The detailed options below are obtained by selecting **Options** from the **Log** menu.



### Types of Logs



#### Logging Data

Select **Data** from the **Log** menu to begin logging GPS navigation information once settings have been applied. Any and all of the data shown in Table 9.1 can be logged.

Table 9.1 Possible data logging parameters

Parameter	Contents
<b>Date</b>	Date from the receiver
<b>Time</b>	Time from the receiver
<b>Position</b>	Current 3-D position (latitude, longitude and altitude)
<b>Speed</b>	In meters/second
<b>Heading</b>	In degrees
<b>Rate-of-Climb</b>	In meters/second
<b>DOP</b>	Geometric dilution of precision
<b>SVs Tracked</b>	Number of satellites tracked
<b>Navigation Mode</b>	None / 2-D Navigation / 3-D Navigation
<b>Track Mode</b>	Cold Start / No DGPS / DGPS
<b>Channel Satellite</b>	The ID of a tracked satellite, one for each channel
<b>Channel SNR or C/No</b>	The signal strength of each channel
<b>Channel State</b>	The tracking status of each channel



### Logging Errors

Check the **Log Errors** box to begin logging Conductor processing errors when settings are applied. Errors mostly include communications errors relating to bad data received or data that cannot be processed.



### Logging Debug

The debug logging function is intended for GPS engineers to have the ability to log the output of the Debug window. Development messages are continually outputted by the Sandpiper and Avocet receivers. These sentences contain information about the current operations of the navigation engine.

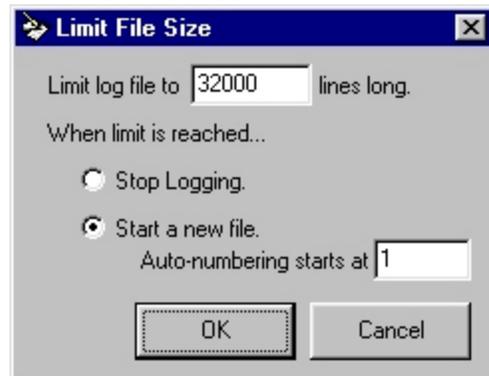
## Using the Logs

### Format

Each log is written sequentially, with every entry ending in a line break. Error and Debug logs contain variable types of data in each entry, while Data logs have a fixed number of fields in each entry. Data log fields are separated by tabs, and each file begins with a row of headers for each column. Data log files are easily imported into spreadsheet programs like Microsoft Excel.

### Limit File Size

Checking **Limit File Size** on the **Log Options** tab tells Conductor to automatically stop logging or create a new file when a log reaches a defined number of lines. A line is a single record and varies in the number of bytes it contains. Conductor creates additional filenames by auto-numbering them starting from a specified number.



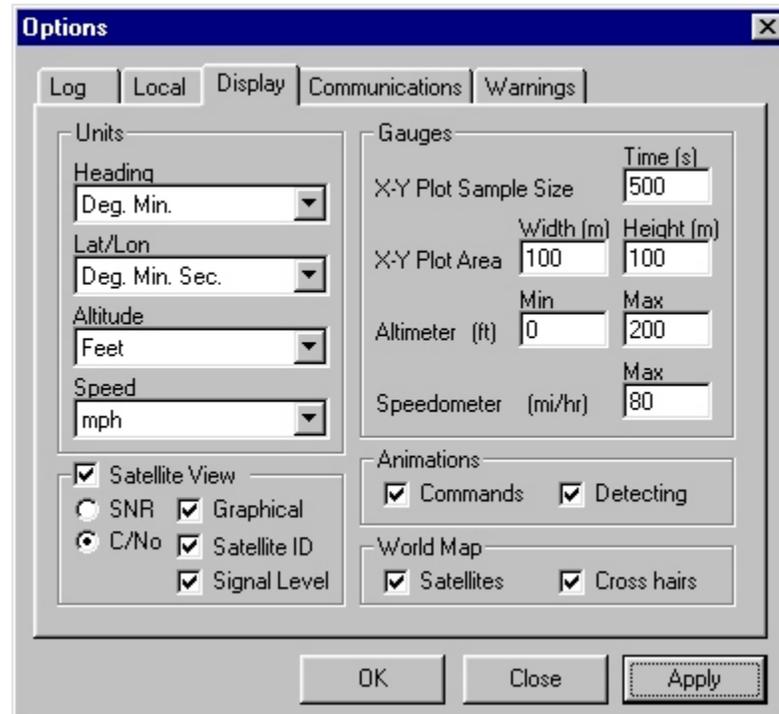
### Stopping a Log

To stop a log, uncheck the type of log (**Data** or **Error** or **Debug**) from the **Log** menu, or deselect its respective tool bar button.



## 10. Changing Display Options

Much of what you see on the Conductor's Navigation Display can be modified in some way. Choose **Options** from the **View** menu to access these options.



### *Units and Gauges*

The units in which GPS navigation information is displayed can be changed to a variety of formats. Also, the bounds of the display gauges can be modified here as well. Keep readability in mind when entering values for gauge bounds.

### *SNR or C/No Display*

The signal strength can be displayed with one of two different units: Signal-to-Noise Ratio or Carrier-over-Noise Ratio. Signal strength can be represented on the Conductor's Navigation Display in two ways. **Graphical** means that the satellite images fade with decreasing signal strength. **Signal Level** means that the exact SNR or C/No is printed on the upper left corner of the images. Checking **Satellite ID** will cause the satellite's identification PRN to be displayed in the lower right corner.

## *World Map Settings*

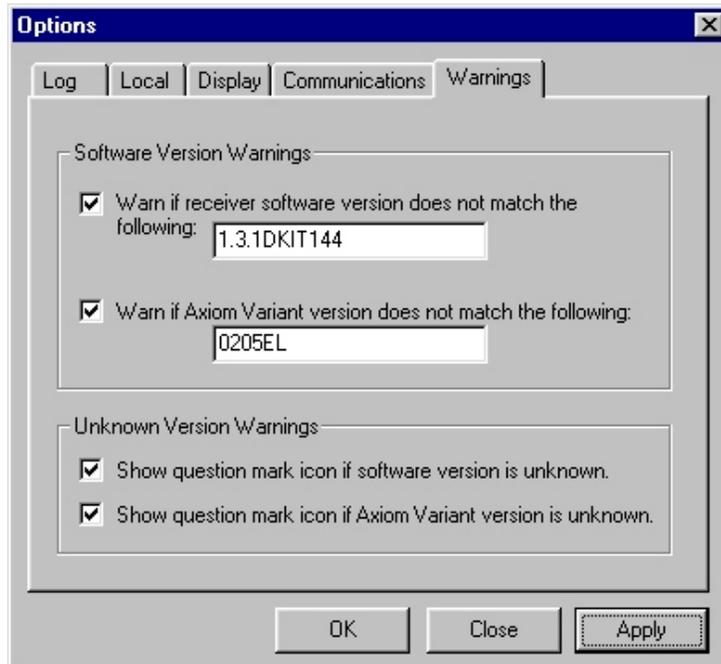
Selecting **Satellites** will display the approximate locations of the satellites in the sky in relation to the receiver's position. Selecting **Crosshairs** will display the red crosshairs that identify the receiver's location.

## *Animations*

Conductor employs certain animations which enrich the user interface. The animations, however, may not be necessary to some users, and may even slow down the operations of Conductor on slower computers. If you find that the speed of Conductor is slowed considerably by these animations, you may want to disable them. The **Detecting** animation is displayed when no GPS data is detected on the COM Port, and Conductor is AutoDetecting the message set and baud rate. The **Commands** animation is the gradual resizing of the Send Commands window when different commands are selected.

## 11. Changing Warning Options

Conductor may be configured to give two types of warnings when certain conditions are met. This window is used to set the conditions under which version warnings will be given. The settings you make on this window will be retained on program shutdown and used the next time the program is started.



### *Software Version Warnings*

The Software Version Warning checkboxes determine whether you will be warned (by a pop-up message) whenever Conductor determines that the software version or Axiom Variant version of the receiver that you are currently connected to differs from the software version or Axiom Variant version that you entered in the text boxes on this window.

### *Unknown Version Warnings*

Checking these boxes will cause a small red question mark to be displayed just to the right of the Message Set icon if the receiver software version or Axiom Variant version is unknown.

## 12. Using the Detail Windows

To open a detail window, select it from the **View** menu on Conductor's Navigation Display.

### *The Commands Window*

### For Advanced Users Only!

 The Command window may be opened by pressing the icon on the toolbar, or by selecting **View → Commands** in the menu bar.

The Command window is a simple and flexible way to send all possible commands to the GPS receiver. Simply choose the command you wish to send, enter any necessary parameters, and click **Send**. A helpful description is provided with each command, as well as flyby tips on each parameter giving a description of it.

#### TIP

Hold the mouse cursor over a Parameter to see its description and boundaries.

Different commands are available for the SiRF message set, the NMEA-0183 message set, and the Axiom User1 message set. There are also additional SiRF commands available when using the Swift receiver.

NOTE- If you are running on a slower computer, you may want to disable the resizing animation. See *Changing Display Options*.

### SiRF Message Set Commands

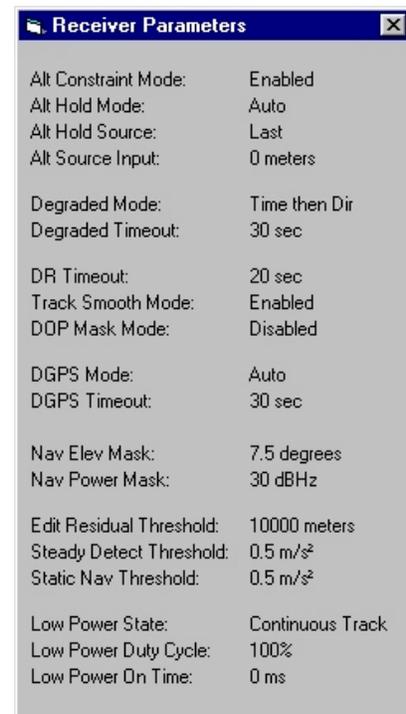
The following commands are available when using the SiRF Message Set:

1. **Initialize**: Resets the receiver using initial position information that is based on the Earth-Centered Earth-Fixed (ECEF) coordinate system.
2. **InitializeLLA**: Similar to the Initialize command but the initial position is expressed in terms of Latitude, Longitude, and Altitude.

3. **Protocol:** Sets the serial port protocol to one of the following modes: SiRF binary, NMEA-0183, ASCII, RTCM, or User1.
4. **Switch to NMEA Protocol:** Switches the receiver into NMEA mode at the specified baud rate and allows you to set the output rate of the following NMEA messages: GGA, GLL, GSA, GSV, RMC, and VTG.
5. **Software Version:** Polls the receiver for its software version. The software version is displayed in a pop-up message box. Note: it is also possible to get software version information by double-clicking the Receiver-Type icon on Conductor's main screen.
6. **Clock Status:** Displays the following GPS clock status information in a pop-up message box: GPS week, GPS time of week, estimated GPS time, clock bias, and clock drift.
7. **Main Serial Port:** Allows you to set the main serial port (port A) communication settings (Baud Rate, Data Bits, Stop Bit, Parity).
8. **DGPS Serial Port:** Allows you to set the DGPS serial port (port B) communication settings.



9. **Mode Control:** Several factors that control the operation of the GPS receiver can be set by using this command. They are: 3D Mode, Altitude Constraint Mode, Degraded Mode, DR Mode, Altitude, Altitude Hold Mode, Altitude Source Mode, Coast Timeout, Degraded Timeout, DR Timeout, and Track Smoothing.
10. **Poll Receiver Parameters:** Sending this command will result in a window appearing that displays the current settings of various receiver parameters. (See right). This window is a snapshot of the state of the receiver parameters at the time the command was issued and is not automatically updated when you change parameter values.



11. **Poll Ephemeris Data:** Requests the receiver to send its current ephemeris data to the specified file. The data is stored in binary or text format depending on the file output format you select. You may request ephemeris data from a single satellite by entering its number in the SV ID parameter box or from all satellites by entering 0 in this box.
12. **Set Ephemeris Data:** Reads ephemeris data for a particular satellite from the specified binary or text file and sends it to the receiver. The successful

reception of this message will be indicated by illumination of the green acknowledge message light.

13. **Poll Almanac Data:** Requests the receiver to send almanac data for all of the satellites to the specified file. The data is stored in binary or text format depending on the file output format that you select.
14. **Set Almanac Data:** Reads almanac data from the specified file and sends it to the receiver. The input file should contain a complete set of almanac data (32 entries) appended to each other in a binary or text file. The successful reception of this message will be indicated by illumination of the green acknowledge message light.
15. **Steady State Detection:** Sets the threshold for steady state detection. Enter 0 to disable this feature.
16. **Editing Residual:** Sets the editing residual threshold. Enter 0 to disable this feature.
17. **Static Navigation:** Sets the threshold for static navigation. Enter 0 to disable this feature.
18. **Elevation Mask:** Sets the navigation elevation mask angle. The valid range is from -20 to 90 degrees.
19. **Power Mask:** Sets the navigation power mask in dBHz. The valid range is from 20 to 50 dBHz.
20. **DGPS Control:** This command is used to instruct the receiver to ignore DGPS corrections ("Never"), to output position fixes only when corrections are available ("Exclusive"), or to use corrections whenever they are available ("Auto"). The Time Out parameter sets the acceptable age limit of the DGPS corrections. In exclusive mode, the receiver will not output position fixes if they are based on out of date corrections. When DGPS corrections are out of date in auto mode, the receiver will still continue to output position fixes but they will be without differential corrections.
21. **DOP Mask Control:** Sets the Dilution of Precision (DOP) mode and the threshold values for GDOP, PDOP, and HDOP.
22. **Set Operating Mode:** Sets the receiver into test mode for the length of time specified. The number of the satellite to be tracked must also be specified.
23. **Trickle Power:** Sets parameters for those receivers that have the capability of being placed into trickle power mode. If Push To Fix is not selected and the Duty Cycle is set to a value greater than 50%, the receiver will be placed into Continuous Track mode. Trickle Power parameters can also be set by using the window that appears by pressing the **Trickle Power** toolbar button. (See chapter 13, *Trickle Power*).

#### Additional Swift (SiRFStar II) Commands

24. **Set DGPS Source:** Sets the source for DGPS corrections. Valid sources are: None, WAAS, Serial Port B, and Internal Beacon Receiver. When the source is set to Internal Beacon Receiver, you should also enter values for

the Frequency and Bit Rate to be used. Setting either of these values to 0 causes the receiver to automatically scan for the proper value to use.

25. **Set Message Rate:** Allows you to set the output rate to be used for various messages from the receiver. Set the *Poll Now* parameter to 1 to force the receiver to output the specified message immediately.
26. **Set LP Acq Params.:** Sets the maximum off time and maximum satellite search time to be used during low power operations.

### NMEA Message Set Commands

The following commands are available when using the NMEA message set:

1. **Switch to SiRF Binary:** Switches the receiver into SiRF Binary mode at the specified baud rate.
2. **SiRF: Initialize ECEF:** Switches the receiver to SiRF binary mode and initializes the receiver using initial position information that is based on the Earth-Centered Earth-Fixed (ECEF) coordinate system.
3. **SiRF: Initialize:** Similar to the "SiRF: Initialize ECEF" command but the initial position is expressed in terms of Latitude, Longitude, and Altitude.
4. **Set Datum:** Sets the datum plane to be used. The *Local* tab of the *Options* window provides another (easier) way of setting the datum to be used. See chapter 7, *Setting Local Options*, for more information.
5. **SiRF: Set Serial Port:** Sets the protocol, baud rate, data bits, stop bits, and parity for the main serial port.
6. **SiRF: Set DGPS Port:** Sets the baud rate, data bits, stop bits, and parity for the DGPS serial port.
7. **SiRF: Message Control:** Sets or queries several parameters for the following NMEA messages: GGA, GLL, GSA, GSV, RMC, VTG. These message parameters can also be set by using the *NMEA Message Control*, described in Chapter 14.

## The Channel Status Window



The Channel Status window may be opened with the tool bar button or by selecting **View**→**Channel Status** from the menu.

Tracker Data												
Channels	Measurement Data	DGPS Data	SV State Data									
	1	2	3	4	5	6	7	8	9	10	11	12
Satellite ID	1	28	13	19	4	0	0	22	20	27	25	0
State (Hex)	BF	BF	BF	BF	BF	0	0	BF	BF	BF	BF	0
Azimuth	333	141	306	255	304.5	0	0	79.5	207	244.5	52.5	0
Elev	57	51	34	43.5	11.5	0	0	49.5	75	21	17	0
CNo(1)	46	46	45	46	37	0	0	47	44	42	43	0
CNo(2)	46	46	46	46	38	0	0	47	44	42	43	0
CNo(3)	46	46	45	46	37	0	0	47	44	41	43	0
CNo(4)	46	45	45	46	37	0	0	47	43	41	43	0
CNo(5)	46	45	46	46	37	0	0	47	44	42	43	0
CNo(6)	46	46	46	46	37	0	0	47	44	42	43	0
CNo(7)	46	46	46	46	37	0	0	47	44	42	43	0
CNo(8)	46	45	46	46	37	0	0	47	44	42	43	0
CNo(9)	46	46	46	46	38	0	0	47	44	42	44	0
CNo(10)	46	45	45	46	36	0	0	47	43	43	43	0
Average CNo	46	45.6	45.6	46	37.1	0	0	47	43.8	41.9	43.1	0

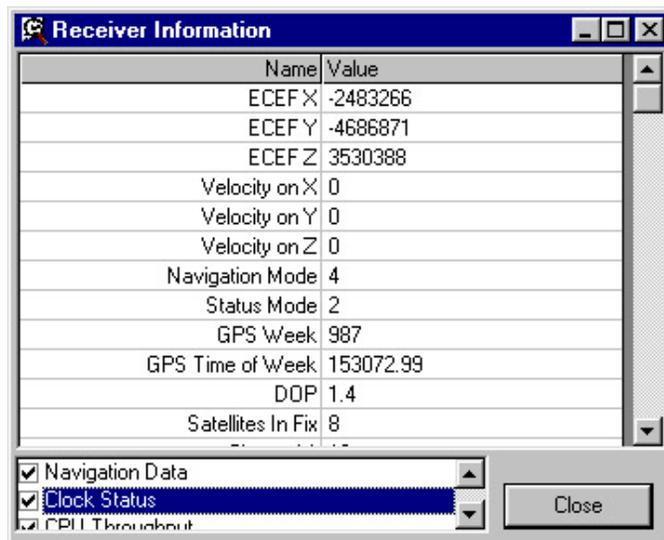
The Channel Status window displays detailed information about the status of each of the receiver's 12 channels. For more information about what each field means, see *Measured Tracker Data* in the manual for your GPS receiver.

The State row displays a color corresponding to how many locks are performed on a channel. A red channel has not had a bit sync lock or a frame sync lock. Yellow has a bit-sync lock, but not a frame-sync lock. The color green shows that the channel has fully locked and tracking. A channel that has lost its carrier lock will show a darker green color.

If a receiver is using the SiRF binary message set and is outputting Raw Tracker Data Messages, then you can view the Raw tracker Data by double-clicking anywhere on the window. The window will reinitialize itself to display the information in the Raw Tracker Data message. Raw Tracker messages contain much more information about a certain satellite. However, it is intended for GPS engineers, and may be difficult to understand. For more information see *Raw Tracker Data* in the manual for your GPS receiver.

The information shown on the Measurement Data, DGPS Data, and SV State Data tabs are only available when you are connected to a Swift receiver.

## Receiver Information Window



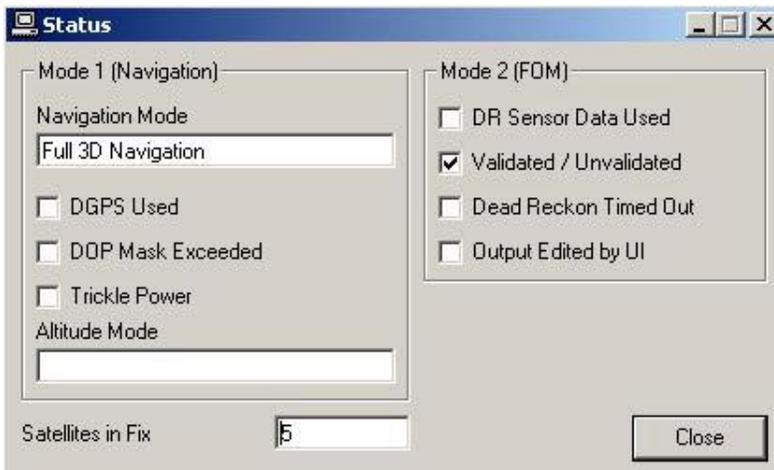
To display the Receiver Information window, press the icon in the tool bar, or select **View → GPS Information** from the menu.



This window displays all of the information that a receiver is communicating, except for the channel status information. Each item on the main chart represents a field in the current message set that contains information. The left column contains the name of that item, and the right column contains its current value.

The list box at the bottom of the window allows the user to select which categories of information are shown. Each category represents a different message that is received from the receiver. Check each item that is to be displayed, and uncheck the unnecessary items.

## Status Window



The Status window may be displayed by pressing its toolbar button, or selecting **View → Status Window** from the menu. It is only available in the SiRF binary mode.

This window displays the details contained in the Navigation mode, and the FOM mode that are outputted in the SiRF binary message set. It also shows the number of satellites that the receiver is using to calculate its position.

## DGPS Status Window

Source: WAAS

SV #:	3	6	9	17	21	22	23	26	29	N/A	N/A	N/A
Correction:	+16.09 m	-7.76 m	-7.82 m	-13.88 m	-23.36 m	-16.52 m	-21.21 m	+28.02 m	-60.61 m	N/A	N/A	N/A

Internal DGPS Beacon Receiver:

Locked: No      Frequency: 0 kHz (Manual)      Bit Rate: 0 bps (Manual)

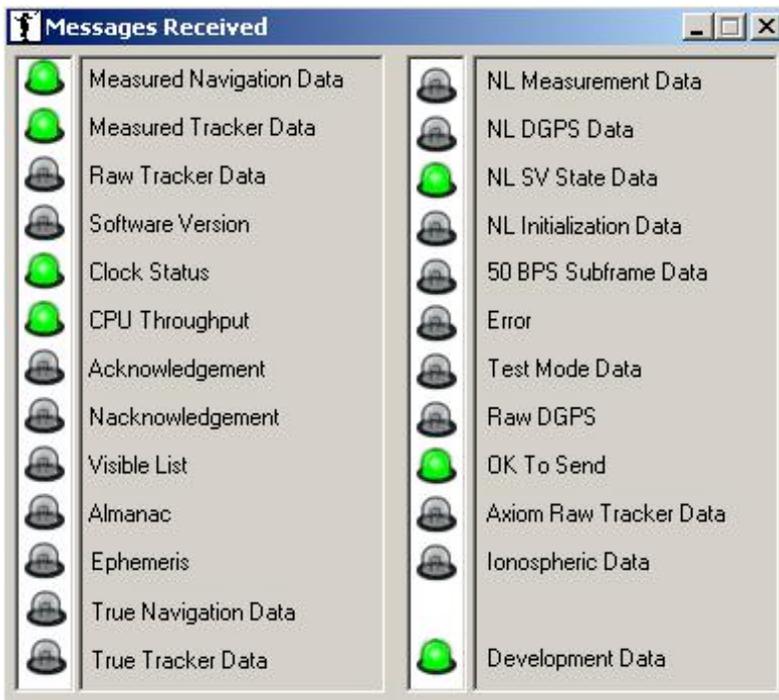
Signal Magnitude: 0      Signal Strength: 0      SNR: 0



The DGPS Status window may be displayed by pressing its toolbar button, or selecting **View → DGPS Status Window** from the menu. It is only available in the SiRF binary mode when connected to a Swift receiver.

This window shows the current source of DGPS correction data as well as the actual correction values that are being applied to each available satellite's navigation data. When DGPS corrections are being received from an internal beacon receiver, the text boxes on the lower half of this window will become active to show information that is relevant to that source of DGPS corrections. The word "Manual" in the **Frequency** and **Bit Rate** text boxes indicate that these values were manually set by the user. If these values were derived automatically by the receiver, then "Auto" will be shown after the values in these boxes.

## Monitoring Output Messages

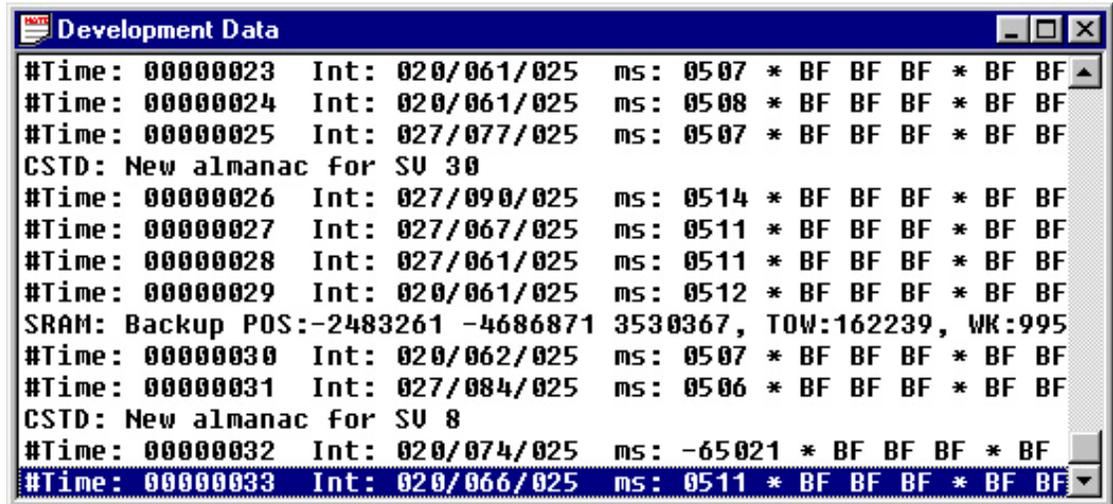


 To display the Messages Received window, press the icon on the tool bar, or select **View → Messages Received** from the menu.

GPS Receivers output information to Conductor using a series of messages that contain different classes of information. The Messages Received window displays a green LED light whenever a certain type of message is received.

If a receiver is not putting out the correct information, then it will be immediately identifiable with this window. Also, if a message header is received but the actual message is corrupted, then the LED next to that message will flash red.

## The Development Data Window



```

Development Data
#Time: 00000023 Int: 020/061/025 ms: 0507 * BF BF BF * BF BF
#Time: 00000024 Int: 020/061/025 ms: 0508 * BF BF BF * BF BF
#Time: 00000025 Int: 027/077/025 ms: 0507 * BF BF BF * BF BF
CSTD: New almanac for SU 30
#Time: 00000026 Int: 027/090/025 ms: 0514 * BF BF BF * BF BF
#Time: 00000027 Int: 027/067/025 ms: 0511 * BF BF BF * BF BF
#Time: 00000028 Int: 027/061/025 ms: 0511 * BF BF BF * BF BF
#Time: 00000029 Int: 020/061/025 ms: 0512 * BF BF BF * BF BF
SRAM: Backup POS:-2483261 -4686871 3530367, TOW:162239, WK:995
#Time: 00000030 Int: 020/062/025 ms: 0507 * BF BF BF * BF BF
#Time: 00000031 Int: 027/084/025 ms: 0506 * BF BF BF * BF BF
CSTD: New almanac for SU 8
#Time: 00000032 Int: 020/074/025 ms: -65021 * BF BF BF * BF
#Time: 00000033 Int: 020/066/025 ms: 0511 * BF BF BF * BF BF

```



The Development Data window may be opened by pressing its tool bar button, or by selecting **View → Development Data** from the menu bar.

The Sandpiper, Avocet, and Swift receivers can be configured to output regular development information which contains details about the internal operations of the GPS unit. This window displays these messages as they are received.

Options for the Development Data window can be found by right-clicking on the window and then choosing from the resulting pop-up menu. The font may be changed to a more desired type face. The number of lines that Conductor keeps in memory is defined by selecting **Length...** The window may also keep lines in a length of fixed places defined by the user by selecting **Fixed Placement**. To keep the window continually viewing the most recent message, check **Hold to Bottom**. Select **Clear** to reset the Development Data display.



To be sure that the receiver outputs Development Data messages, Initialize the receiver with the Development Data option selected. See *Initializing the Receiver*.

## 13. Trickle Power

Some receivers come equipped with a power saving feature called Trickle Power. When a receiver is placed into Trickle Power mode, it continually shuts itself off when it is not needing to make GPS measurements. With this mode it is possible to select the amount of time that a receiver spends in the power off cycle. The Trickle Power window allows the user to place a receiver into Trickle Power mode at many different duty cycles.



The Trickle Power window may be opened by selecting **View→Trickle Power** from the menu, or by pressing its tool bar button.

A duty cycle may be between 20 and 50 percent. The lower the percentage, the longer the receiver spends between measurements with the power off. A 20% duty cycle would set the receiver to take a 200 ms measurement every 1 second. (**Note:** *Duty cycles above 50 percent automatically put the receiver into continuous mode.*)

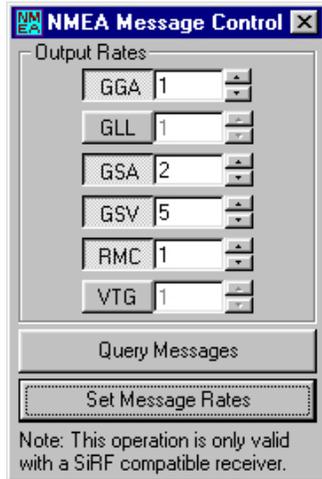
By checking the **Push to Fix** mode, a receiver will sleep in its power saving mode until the Push-To-Fix (PTF) line is enabled. This is done from pin 20 on the receiver or with the PTF button on an Evaluation Unit. Once PTF is enabled the receiver will power on, calculate a navigation fix, output one message set, and return to the power-saving mode.

Conductor attempts to detect if the GPS receiver is currently in Trickle Power mode. This is reflected in the ON/OFF indicator. However, this status may not always be reliable, especially if the antenna signal is very low. Trickle Power also will not operate properly if there are clock errors due to low signal, or unfinished acquisition of satellites (for example, right after resetting the unit). If the receiver is unable to operate in Trickle Power mode, the ON/OFF indicator will turn red.

To reset a receiver back into its normal operating mode (that is, with the power continually on) press the **Continuous** button.

## 14. Selecting NMEA Message Rates

The Sandpiper, Avocet, and Swift receivers have the ability to customize which NMEA messages they output, and at what rate. If the message set is in NMEA mode, then Conductor can set these output rates automatically for you.



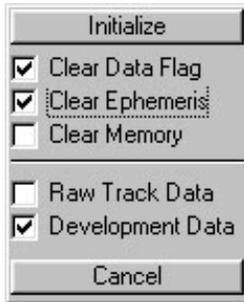
Press the message rates button on the navigation display, or **click** on the Messages Received window, to display the NMEA Message Control window.

Each of the six possible NMEA messages is represented by its three letter identification code. Select which messages you wish to output and set the output rate in seconds.

Press **Set Message Rates** and the receiver will begin outputting the messages that are selected at the indicated rates.

Press **Query Messages** to request that the selected messages to be sent out only once.

## 15. Initializing the Receiver



Selecting ***Initialize Receiver*** from the file menu, or pressing the Initialize button on the tool bar will display this menu. The options for initializing a receiver may be selected or deselected.

To perform a Hot start, deselect Clear Ephemeris and Clear Memory. To perform a Warm Start, select Clear Ephemeris and deselect Clear Memory. To perform a Cold Start, select Clear Data Flag, Clear Ephemeris, and Clear Memory.

The SiRF binary message set has the option of additional messages that contain more engineering specific data. These messages, The Raw Track Data message, and the Development Data message may be turned on or off with the initialization command by selecting or deselecting the respective item on the menu.

## 16. The Axiom User1 Message Set

### *What is it used for?*



Conductor has the ability to use Axiom's specialized User1 format to perform certain functions that aren't available in standard modes such as SiRF Binary or NMEA. User1 is used in Axiom's FMS line of products that have data logging capabilities.

To switch a data logging receiver between SiRF, NMEA, and Axiom User1 modes, use the toolbar buttons that represent the message set you would like, or use the menu items under **File → Message Set**.

If your receiver is in Axiom User1 mode, you will notice that Conductor does not receive GPS messages on a regular basis. In fact, normal operation in Axiom User1 mode is based on a poll and response system. The receiver will not send any information unless it is requested. To send commands, use the commands window. (see *The Commands Window*)

#### **WARNING**

If your receiver does not have data logging capabilities, or you are not sure, then do not attempt to use Axiom User1 mode. You may set your receiver into a mode that you cannot switch out of.

### *The Mobile ID*

Another important thing to note about Axiom User1 mode is the use of identification numbers associated with each unit. For a standard data logging receiver, this isn't important, but when you are using hundreds of fleet management units, it becomes a necessity. Some commands will not be acknowledged if the receiver sees that the Mobile ID in the command is not the same as its internal ID. The number internally stored in the unit will be displayed in the box labeled Mobile ID, as soon as the Conductor receives a message.

#### **The Axiom User1 Status Display**

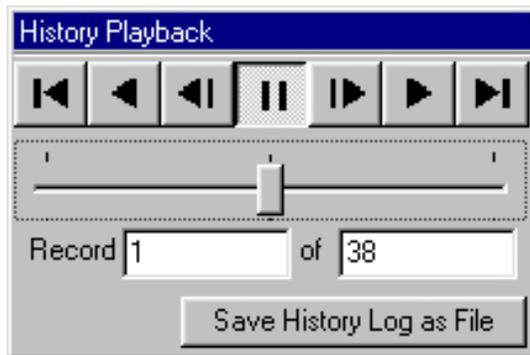


### *Downloading a History Log*

The primary function of Conductor's Axiom User1 mode is to download a history log that has been stored in the flash memory of the data logging unit. When Conductor sends a "Hello" message to the unit, it will respond with the number of records that it has stored in memory. That number will be displayed in the box underneath the Mobile ID (see above).

To download a History, simply press the download button that is located on the right side of the status display (above). The history records will start pouring out from the receiver to the PC. You will notice that a History Playback window will appear when Conductor has received any history records. Using the playback navigation controls, you will be able to step through, or play in sequence all of the records that came from the unit.

### *The History Playback Window*



The series of buttons across the top of the window can be used to navigate through the history log that has just been downloaded history log. The log is made up of a series of records that contain the time and position data that the receiver logged during its normal operation.

The records will be displayed on the navigation display window, just as the live GPS data was displayed when the Conductor is using a standard message set. The current record that is being displayed is shown in the box labeled **Record**. The total number of records downloaded is found in the box marked **of**.

The function of the playback buttons work as follows (left to right): *First Record*, *Reverse Playback*, *Previous Record*, *Pause*, *Next Record*, *Forward Playback*, and *Last Record*. The slider bar underneath the buttons is used to shuttle back and forth at various speeds through the history log. Pulling the slider to the right will fast-forward the playback, and pulling it to the left will rewind the playback. The farther you move the slider, the faster the records change.

### *Writing a History Log File*

If you would like to save the history log to a text file, then press the button marked **Save History Log as File**. Conductor will prompt you to enter a file name that the history log will be saved under.

#### **Special Note:**

If you would like to disable or enable the ability to use Axiom User1 mode with your conductor, then type the following message while the main display is the active window:

**datalogger**

### III. Glossary

This appendix describes acronyms, abbreviations, and selected terms used in this document.

2-D	Two dimensional.
3-D	Three dimensional.
A/D	Analog to Digital.
Almanac	A set of orbital parameters that allows calculation of the approximate GPS satellite positions and velocities. A GPS receiver uses the almanac as an aid to determine satellite visibility during acquisition of GPS satellite signals. The almanac is a subset of satellite ephemeris data and is updated weekly by GPS Control.
Altitude	The distance between the current position and the nearest point on WGS84 reference ellipsoid. Altitude is usually expressed in meters and is positive outside the ellipsoid. In terms of the Sandpiper/Avocet Evaluation Unit, this has no bearing on the height above mean sea level (which depends on the time and place, due to gravity of Sun, Moon, etc.). Determining height with respect to mean sea level requires making appropriate corrections to the altitude computed by the Sandpiper/Avocet Evaluation Unit.
Altitude Hold	A technique that allows navigation using measurements from three GPS satellites plus an independently obtained value of altitude.
Altitude Hold Mode	A Navigation Mode during which a value of altitude is processed by the Kalman Filter as if it were a range measurement from a satellite at the Earth's center (WGS-84 reference ellipsoid center).
Baud	See Bps.
Bps	Bits per second (also referred to as a baud rate).
C	Celsius, a unit of temperature.
C/A Code	Coarse/Acquisition Code. A spread spectrum direct sequence code that is used primarily by commercial GPS receivers to determine the range to the transmitting GPS satellite.

## Glossary

CEP	Circular Error Probable. The radius of a circle, centered at the user's true location, that contains 50 percent of the individual position measurement made using a particular navigation system.
Clock Error	The uncompensated difference between synchronous GPS system time and time best known within the GPS receiver.
C/No	Carrier-to-Noise density ratio.
Cold Start	A condition in which the GPS receiver can arrive at a navigation solution without initial position, time, current Ephemeris, and almanac data.
Control Segment	The Master Control Station and the globally dispersed Monitor Stations used to manage the GPS satellites, determine their precise orbital parameters, and synchronize their clocks.
dB	Decibel.
dBic	Decibel-Isometric-Circular (measure of power relative to an isometric antenna with circular polarization).
dBm	Decibels per milliwatt.
dBW	Decibel-Watt (measure of power relative to one watt).
DC	Direct Current.
DGPS	Differential GPS. A technique to improve GPS accuracy that uses pseudorange errors recorded at known locations to improve the measurements made by other GPS receivers within the same general geographic area.
Doppler Aiding	A signal processing strategy that uses a measured doppler shift to help a receiver smoothly track a GPS signal to allow a more precise velocity and position measurement.
DoD	Department of Defense.
DOP	Dilution of Precision (see GDOP, HDOP, PDOP, TDOP, and VDOP).
DSP	Digital Signal Processor.
DTR	Data Terminal Ready.
ECEF	Earth-Centered Earth-Fixed. A Cartesian coordinate system with its origin located at the center of the Earth. The

coordinate system used by GPS to describe 3-D location. For the WGS-84 reference ellipsoid, ECEF coordinates have the Z-axis aligned with the Earth's spin axis, the X-axis through the intersection of the Prime Meridian and the Equator and the Y-axis is rotated 90 degrees East of the X-axis about the Z-axis.

EEPROM	Electrically Erasable Programmable Read Only Memory.
EHPE	Expected Horizontal Position Error.
EMC	Electromagnetic Compatibility.
EMI	Electromagnetic Interference.
Ephemeris	A set of satellite orbital parameters that is used by a GPS receiver to calculate precise GPS satellite positions and velocities. The ephemeris is used to determine the navigation solution and is updated frequently to maintain the accuracy of GPS receivers.
EPROM	Erasable Programmable Read Only Memory.
EVPE	Expected Vertical Position Error.
FP	Floating-Point mathematics, as opposed to fixed point.
FRP	Federal Radionavigation Plan. The U.S. Government document that contains the official policy on the commercial use of GPS.
GaAs	Gallium Arsenide, a semiconductor material.
GDOP	Geometric Dilution of Precision. A factor used to describe the effect of the satellite geometry on the position and time accuracy of the GPS receiver solution. The lower the value of the GDOP parameter, the less the errors in the position solution. Related indicators include PDOP, HDOP, TDOP, and VDOP.
GMT	Greenwich Mean Time.
GPS	Global Positioning System. A space-based radio positioning system that provides suitably equipped users with accurate position, velocity, and time data. GPS provides this data free of direct user charge worldwide, continuously, and under all weather conditions. The GPS constellation consists of 24 orbiting satellites, four equally spaced around each of six different orbital planes. The system is developed by the DoD under Air Force

	management, primarily for military purposes, but current policy calls for civil availability with degradation in system accuracy to protect U.S. national security interests.
GPS Time	The number of seconds since Saturday/Sunday Midnight UTC, with time zero being this midnight. Used with GPS Week Number to determine a specific point in GPS time.
HDOP	Horizontal Dilution of Precision. A measure of how much the geometry of the satellites affects the position estimate (computed from the satellite range measurements) in the horizontal (East, North) plane.
Held Altitude	The altitude value that will be sent to the Kalman filter as a measurement when in Altitude Hold Mode. It is an Auto Hold Altitude unless an Amended Altitude is supplied by the application processor.
Hot Start	Start mode of the GPS receiver when current position, clock offset, approximate GPS time and current ephemeris data are all available.
Hz	Hertz, a unit of frequency.
I/O	Input/ Output.
IF	Intermediate Frequency.
IGRF	International Geomagnetic Reference Field.
IODE	Issue of Data Ephemeris.
JPO	Joint Program Office. An office within the U.S. Air Force Systems Command, Space Systems Division. The JPO is responsible of managing the development and production aspect of the GPS system and is staffed by representatives from each branch of the U.S. military, the U.S. Department of transportation, Defense Mapping Agency, NATO member nations, and Australia.
Kalman Filter	Sequential estimation filter which combines measurements of satellite range and range rate to determine the position, velocity, and time at the GPS receiver antenna.
Km	Kilometer, 1000 meters.
L1 Band	The 1575.42 MHz GPS carrier frequency which contains the C/A code, P-code, and navigation messages used by commercial GPS receivers.

L2 Band	A secondary GPS carrier, containing only P-code, used primarily to calculate signal delays caused by the atmosphere. The L2 frequency is 1227.60 MHz.
Latitude	Halfway between the poles lies the equator. Latitude is the angular measurement of a place expressed in degrees north or south of the equator. Latitude runs from 0° at the equator to 90°N or 90°S at the poles. When not prefixed with letters N or S, it is assumed positive north of Equator and negative south of Equator. Lines of latitude run in an east-west direction. They are called parallels.
LLA	Latitude, Longitude, Altitude geographical coordinate system used for locating places on the surface of the Earth. Latitude and longitude are angular measurements, expressed as degrees of a circle measured from the center of the Earth. The Earth spins on its axis, which intersects the surface at the north and south poles. The poles are the natural starting place for the graticule, a spherical grid of latitude and longitude lines. See also Altitude.
Longitude	Lines of longitude, called meridians, run in a north-south direction from pole to pole. Longitude is the angular measurement of a place east or west of the prime meridian. This meridian is also known as the Greenwich Meridian, because it runs through the original site of the Royal Observatory, which was located at Greenwich, just outside London, England. Longitude runs from 0° at the prime meridian to 180° east or west, halfway around the globe. When not prefixed with letters E or W, it is assumed positive east of Greenwich and negative west of Greenwich. The International Date Line follows the 180° meridian, making a few jogs to avoid cutting through land areas.
LPTS	Low Power Time Source.
LSB	Least Significant Bit of a binary word.
LTP	Local Tangent Plane coordinate system. The coordinates are supplied in a North, East, Down sense. The North will be in degrees or radians, East in same units and Down will be height below WGS84 ellipsoid in meters.
m/sec	Meters per second (unit of velocity).
m/sec/sec	Meters per second per second (unit of acceleration).
m/sec/sec/sec	Meters per second per second per second (unit of impulse or “jerk”).

## Glossary

Mask Angle	The minimum GPS satellite elevation angle permitted by a particular GPS receiver design.
Measurement	The square of the standard deviation of a measurement quality. The standard deviation Error Variance is representative of the error typically expected in a measured value of the quantity.
MID	Message Identifier. In case of SiRF protocol, it is a number between 1 and 256.
MHz	Megahertz, a unit of frequency.
MSB	Most Significant Bit within a binary word or a byte.
MSL	Mean Sea Level.
MTBF	Mean Time Between Failure.
Multipath Error	GPS positioning errors caused by the interaction of the GPS satellite signal and its reflections.
mV	Millivolt.
mW	Milliwatt.
NED	North, East, Down coordinate system. See LTP.
NF	Noise Factor.
NMEA	National Marine Electronic Association. Also commonly used to refer to Standard For Interfacing Marine Electronic Devices. Sandpiper and Avocet receivers support Version 2.01 of NMEA 0183 Standard.
NVRAM	Non-volatile RAM, portion of the SRAM that is powered by a backup battery power supply when prime power is removed. It is used to preserve important data and allow faster entry into the Navigation Mode when prime power is restored. All of the SRAM in the Sandpiper and Avocet receivers is powered by the backup battery power supply (sometimes also referred to as “keep-alive” SRAM) when the main power is turned off.
Obscuration	Term used to describe periods of time when a GPS receiver’s line-of-sight to GPS satellites is blocked by natural or man-made objects.
OEM	Original Equipment Manufacturer.

Overdetermined Solution	The solution of a system of equations containing more equations than unknowns. The GPS receiver computes, when possible, an overdetermined solution using the measurements from five GPS satellites, instead of the four necessary for a three-dimensional position solution.
P-Code	Precision Code. A spread spectrum direct sequence code that is used primarily by military GPS receivers to determine the range to the transmitting GPS satellite.
Parallel Receiver	A receiver that monitors four or more satellites simultaneously. The Sandpiper/Avocet Evaluation Unit can monitor up to 12 satellites simultaneously.
PDOP	Position Dilution of Precision. A measure of how much the error in the position estimate produced from satellite range measurements is amplified by a poor arrangement of the satellites with respect to the receiver antenna.
Pi	The mathematical constant having a value of approximately 3.14159.
P-P	Peak to Peak.
PPS	Precise Positioning Service. The GPS positioning, velocity, and time service which will be available on a continuous, worldwide basis to users authorized by the DoD.
PRN	Pseudorandom Noise Number. The identity of the GPS satellites as determined by a GPS receiver. Since all GPS satellites must transmit on the same frequency, they are distinguished by their pseudorandom noise codes.
Pseudorange	The calculated range from the GPS receiver to the satellite determined by measuring the phase shift of the PRN code received from the satellite with the internally generated PRN code from the receiver. Because of atmospheric and timing effects, this time is not exact. Therefore, it is called a pseudorange instead of a true range.
PVT	Position, Velocity, and Time.
RAM	Random Access Memory.
Receiver Channels	A GPS receiver specification which indicates the number of independent hardware signal processing channels included in the receiver design.
RF	Radio Frequency.

RFI	Radio Frequency Interference.
ROM	Read Only Memory.
RTCA	Radio Technical Commission of Aeronautics.
RTCM	Radio Technical Commission of Maritime Services. Also commonly used as a reference to the standard format that DGPS corrections data is distributed in ("RTCM Recommended Standard for Differential Navstar GPS Service"). Sandpiper and Avocet receivers support the latest Version 2.1 of this standard.
SA	Selective Availability. The method used by the DoD to control access to the full accuracy achievable with the C/A code.
Satellite Elevation	The angle of the satellite above the horizon.
SEP	Spherical Error Probable. The radius of a sphere, centered at the user's true location, that contain 50 percent of the individual 3-D position measurements made using a particular navigation system.
Sequential Receiver	A GPS receiver in which the number of satellite signals to be tracked exceeds the number of available hardware channels. Sequential receivers periodically reassign hardware channels to particular satellite signals in a predetermined sequence.
SNR	Signal-to-Noise Ratio, often expressed in decibels.
SPS	Standard Positioning Service. A position service available to all GPS users on a continuous, worldwide basis with no direct charge. SPS uses the C/A code to provide a minimum dynamic and static positioning capability.
SRAM	Static Random Access Memory. In context of this document, see also NVRAM.
SV	Satellite Vehicle.
TDOP	Time Dilution of Precision. A measure of how much the geometry of the satellites affects the time estimate computed from the satellite range measurements.
3-D Coverage	The number of hours-per-day with four or more satellites visible. Four visible satellites are required to determine location and altitude.

3-D Navigation	Navigation Mode in which altitude and horizontal position are determined from satellite range measurements.
TTFF	Time-To-First-Fix. The actual time required by a GPS receiver to achieve a position solution. This specification will vary with the operating state of the receiver, the length of time since the last position fix, the location of the last fix, and the specific receiver design. See also Hot Start, Warm Start and Cold Start mode descriptions.
2-D Coverage	The number of hours-per-day with three or more satellites visible. Three visible (hours) satellites can be used to determine location if the GPS receiver is designed to accept an external altitude input (Altitude Hold).
2-D Navigation	Navigation Mode in which a fixed value of altitude is used for one or more position calculations while horizontal (2-D) position can vary freely based on satellite range measurements.
UART	Universal Asynchronous Receiver/Transmitter that produces an electrical signal and timing for transmission of data over a communications path, and circuitry for detection and capture of such data transmitted from another UART.
UDRE	User Differential Range Error. A measure of error in range measurement to each satellite as seen by the receiver.
UERE	User Equivalent Range Error.
Update Rate	The GPS receiver specification which indicates the solution rate provided by the receiver when operating normally. It is typically once per second.
UTC	Universal Time Coordinated. This time system uses the second defined true angular rotation of the Earth measured as if the Earth rotated about its Conventional Terrestrial Pole. However, UTC is adjusted only in increments of one second. The time zone of UTC is that of Greenwich Mean Time (GMT).
VCO	Voltage Controlled Oscillator.
VDOP	Vertical Dilution of Precision. A measure of how much the geometry of the satellites affects the position estimate (computed from the satellite range measurements) in the vertical (perpendicular to the plane of the user) direction.
VSWR	Voltage Standing Wave Ratio.

## Glossary

WAAS	Wide Area Augmentation System. A system that augments GPS by using geostationary satellites to broadcast differential GPS corrections on the same frequency as the GPS signals.
Warm Start	Start mode of the GPS receiver when current position, clock offset and approximate GPS time are input by the user. Almanac is retained, but ephemeris data is cleared.
WGS-84	World Geodetic System (1984). A mathematical ellipsoid designed to fit the shape of the entire Earth. It is often used as a reference on a worldwide basis, while other ellipsoids are used locally to provide a better fit to Earth in a local region. GPS uses the center of the WGS-84 ellipsoid as the center of the GPS ECEF reference frame.