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SiRFstarIIe Evaluation Kit User's Guide

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SiRFstarIIe Evaluation Kit User's Guide

About This Document

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If you have any problems installing or using SiRFstarIIe Evaluation Kit software, call, fax or send an e-mail to the SiRF Technology Customer Support Hotline:

phone	1 (408)467-0410
fax	1 (408) 467-0420
e-mail	gps@sirf.com

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Preface

The *SiRFstarIIe Evaluation Kit User's Guide* explains how to use your evaluation kit to collect, display, and analyze GPS data.

Who Should Use This Guide

This manual was written assuming the user has basic computer skills and is familiar with DOS and Windows environments.

How This Guide Is Organized

Chapter 1, "Overview" describes the SiRFstarIIe Evaluation Kit.

Chapter 2, "Installation" provides instructions and requirements for installing the SiRFstarIIe Toolkit software and the SiRFstarIIe Evaluation Receiver.

Chapter 3, "Quickstart" describes how to start the SiRFdemo software, basic operation, and how to ensure that the software and the Receiver Unit are operating correctly.

Chapter 4, "Using the SiRFdemo Software" describes SiRFdemo menu functions.

Chapter 5, "Using the SiRFsig Software" describes SiRFsig functions.

Chapter 6, "Additional Software Tools" describes Parser, Conv, Fixanal, Chsum, Datum, and Calspsr software tools.

Appendix A, "File Formats" describes the commonly used files created by SiRFsig and SiRFdemo.

Appendix B, "The SiRF Binary Protocol." describes the standard interface protocol used by the SiRFstarIIe Evaluation Receiver and other SiRF products.

Appendix C, "NMEA Input/Output Messages" describes the subset of the NMEA-0183 messages used by the SiRFstarIIe Evaluation Receiver.

Appendix D, "Coordinate Systems" provides an overview of map projections and datum transformations.

Appendix E, "Acronyms, Abbreviations, and Glossary" describes the terms used in this manual.

Related Manuals

You can refer to the following data books:

- *SiRFstarII GPS Architecture, GSP2e Family, GPS Engine Processor*
- *SiRFstarII GPS Architecture, GRF2i GPS RF Front End*

Troubleshooting/Contacting SiRF Technical Support

Address:

SiRF Technology Inc.
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Email:support@sirf.com

General enquiries:

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Email:gps@sirf.com

Helpful Information When Contacting SiRF Technical Support

Receiver Serial Number: ________________

Receiver Software Version: ______________

SiRFdemo Version: ____________________

Overview 1

The SiRFstarIIe™ Evaluation Kit provides all of the necessary tools and components to effectively evaluate the performance and suitability of SiRF's GPS chip set (GSP2e and GRF2i).

The SiRFstarIIe Evaluation Kit comes with the SiRFstarIIe Evaluation Receiver as shown in Figure 1-1. The Evaluation Receiver combines the SiRF GPS chip set and a differential beacon receiver into one complete DGPS receiver that is housed in a durable aluminum casing and ready for operation. Performance characteristics such as satellite acquisition times, satellite tracking ability, and positional accuracy can be evaluated by using the Evaluation Receiver in a series of field or office trials.

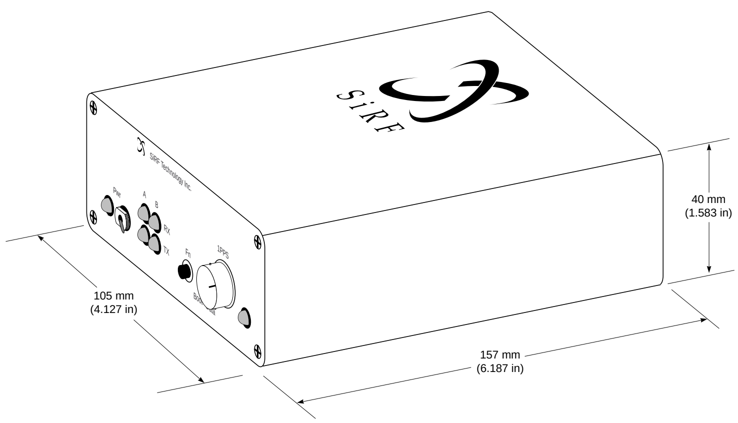

Figure 1-1 SiRFstarIIe Evaluation Kit Evaluation Receiver

Table 1-1 lists the contents of the SiRFstarIIe Evaluation Kit and provides a brief description of each component.

Table 1-1 SiRFstarIIe Evaluation Kit Contents

Item	Description
Evaluation Receiver	Complete GPS receiver that combines the SiRF GPS chip set and a differential beacon receiver.
User's Guide	This guide.
Evaluation Kit CD	CD that contains PC software, documentation in .pdf format, and data examples.
GPS Antenna	Magnetic-mount active GPS antenna.
Cigarette Lighter Adaptor	Adaptor that provides power from a vehicle cigarette lighter to the Evaluation Receiver.
Power Supply Adaptor	Adaptor that provides power to the Evaluation Receiver from a power supply range of 110-220V.
DB9 Serial Cable	Standard male to female DB9 straight-through serial cable for receiver configuration, monitoring, or software upgrades.
License Agreement	Document explaining the licensing agreement between SiRF Technology, Inc. and the customer.
GSP2e Data Sheet	Document containing technical information regarding SiRF's GPS digital chip.
GRF2i Data Sheet	Document containing technical information regarding SiRF's GPS RF chip.

Contact SiRF Technology or your dealer if you find any items missing or encounter problems with your SiRFstarIIe Evaluation Kit.

The Evaluation Receiver

The Evaluation Kit Evaluation Receiver supports a subset of the NMEA-0183 standard output messages, defined SiRF proprietary NMEA input messages, full support of the SiRF Binary Protocol, and 1 pulse per second (PPS) output. This offers a flexible and efficient interfacing solution to assist with evaluation procedures.

For increased accuracy, the Evaluation Receiver can receive differential GPS corrections transmitted by radiobeacons, use corrections available through the WAAS service, and receive corrections from any source in the RTCM SC-104 standard format.

Available Features

Table 1-2 lists the standard features that are available with the SiRFstarIIe Evaluation Unit:

Table 1-2 Available Features

Feature	Description
WAAS Capability	Improves positional accuracy without additional hardware by using freely available satellite-based correction service.
DGPS Beacon Demodulator	Receives corrections from any beacon network through a built-in MSK demodulator.
Acquisition Accelerator	Improves cold starts and time-to-first-fix in weak signal environments.
SnapLock Acquisition	Reacquires satellites within 100 ms if a signal is lost which improves performance in urban canyon environments.
SnapStart	Obtains positions in less time when the receiver is powered on using this enhanced hot-start function.
FoliageLock	Improves positioning performance and satellite tracking ability in extremely low signal environments such as dense tree coverage.
TricklePower	Improves battery life using this enhanced power management mode.
SingleSat Positioning	Provides additional fixes in an urban canyon and dense foliage environments for automobile navigation.
Dual Multipath Rejection	Improves position accuracy in urban environments through enhanced multipath rejection.

Evaluation Receiver Connections and Functions

Figure 1-2 shows the front panel of the Evaluation Receiver.

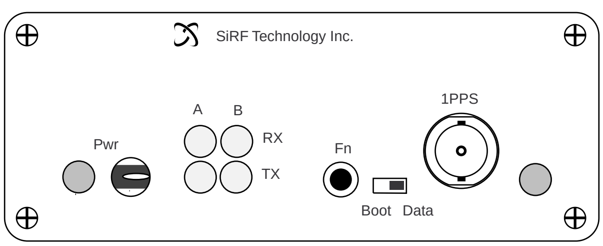

Figure 1-2 Front Panel of the SiRFstarIIe Evaluation Unit

Figure 1-3 shows the back panel of the Evaluation Receiver and the connections available.

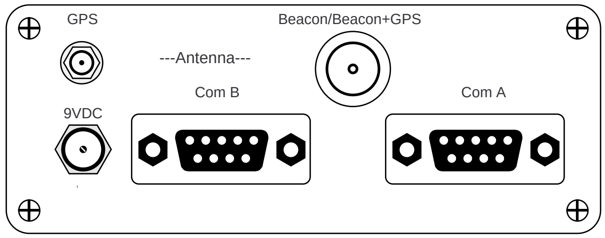

Figure 1-3 Back Panel of the SiRFstarIIe Evaluation Unit

Com A and Com B

Two standard RS232 DB9 female communication ports are provided for Evaluation Receiver configuration, data logging, or to upgrade receiver software. Each port can be configured to operate in NMEA or SiRF protocol, or accept RTCM input data.

Table 1-3 lists the default settings for each of the communication ports.

Table 1-3 Communication Port Default Settings

Parameter	Com A	Com B
Input Protocol	SiRF Binary	RTCM SC-104
Output Protocol	SiRF Binary	None
Baud Rate	38400	9600
Parity	None	None
Stop Bits	1	1
Data Bits	8	8

Table 1-4 describes the pin-out configuration for both Com A and Com B.

Table 1-4 Pin-Out Configuration for Com A and Com B

Pin Number & Name	Description
Pin 1 [DCD]	Connected to pin 4
Pin 2 [Rx data]	Transmit data from the GPS receiver
Pin 3 [Tx data]	Receive data to the GPS receiver
Pin 4 [DTR]	Connected to pin 1
Pin 5 [GND]	Connected to signal ground
Pin 6 [DSR]	Not connected
Pin 7 [RTS]	Connected to pin 8
Pin 8 [CTS]	Connected to pin 7
Pin 9 [RI]	Not connected

Antenna Options

Two antenna connections (female SMA and female TNC) are provided to allow different combinations of GPS and radiobeacon inputs. The SMA connector connects to a GPS-only antenna. The TNC connector connects to a combined GPS and beacon antenna, or a beacon-only antenna. There are four different combinations for GPS and beacon reception. These are:

- GPS antenna connected to SMA input.
- GPS antenna connected to SMA input and beacon antenna connected to TNC input.
- Combined GPS and beacon antenna connected to the TNC input.

Power

The front of the Evaluation Receiver has a red LED power on/off switch that lights when the unit power is switched on. The required power input is 9 V and typically draws 160 mA. Use the cigarette lighter adaptor for power to the Evaluation Receiver while in a vehicle and use the power converter for office and laboratory environments.

1 PPS Output

A separate BNC connector is provided for 1 pulse per second (PPS) output. The 1-PPS signal can be used to synchronize an external instrument with the GPS second.

Additional Items

Additional items that are necessary for operation or provide useful information are described in Table 1-5.

Table 1-5 Additional Items

Item	Function
Boot Data Switch	Switches the Evaluation Receiver into boot mode. You must use this to load software into the unit.
Fn Switch	This button is used to reset the Evaluation Receiver.
LED Data Indicators	Indicates whether data is being received or transmitted through ports A or B. This LED a useful visual indicator when debugging problems or verifying correct receiver operation.

SiRFstarIIe Toolkit Software

The SiRFstarIIe Toolkit Software is comprised of three computer-based software utilities that are used for Evaluation Receiver operation, data logging, and data analysis:

- SiRFdemo
- SiRFsig
- Additional Utilities

SiRFdemo

SiRFdemo is the Evaluation Receiver configuration and monitoring software provided with the SiRFstarIIe Evaluation Kit. This software can be used to monitor real-time operation of the Evaluation Receiver, log data for analysis, upload new software to the Evaluation Receiver, and configure the Evaluation Receiver operation. See **Chapter 4, "Using the SiRFdemo Software**" for more information on the use and operation of SiRFdemo software.

SiRFsig

SiRFsig software enables you to analyze data that is collected in the field. SiRFsig analysis data includes antenna modeling, satellite tracking abilities, static and kinematic accuracy results, and time to first fix. See **Chapter 5, "Using the SiRFsig Software**" for more information on the use and operation of the SiRFsig software.

Additional Utilities

In addition to the two main evaluation software utilities, Table 1-6 lists useful executables that are also provided.

Table 1-6 Additional Utilities

Executable	**Function**
Summary	Summarizes collected data
Parser	Separates collected data into different files of similar data types
Conv	Converts between ECEF (Earth Centered Earth Fixed) XYZ coordinates and WGS84 (World Geodetic Spheroid 84) coordinates.
Fixanal	Calculates TTFF (Time to First Fix) statistics
Cksum	Calculates checksum values
Datum	Converts between different datums
Calcpsr	Computes GPS measurement data and ephemeris parameters from raw data

See **Chapter 6, "Additional Software Tools**" for more information on the use and operation of each of the provided executables.

SiRFstarIIe Evaluation Kit CD

The CD that is included in the SiRFstarIIe Evaluation Kit contains the toolkit software, documentation in .pdf format, data set examples, current version of Evaluation Receiver software, and additional files required. The directory structure of this CD and a description of the contents are provided in Table 1-7.

Table 1-7 CD Directory Structure

Directory	**File Name**	**Description**
Documentation	EVK Users Guide.PDF	PDF version of the SiRFstarIIe Evaluation Kit User's Guide.
	SiRFsig.PDF	Document containing further information about using the SiRFsig software.
	SDK Description.PDF	Document providing introductory information about the SiRFstarIIe System Developers Kit.
	SW License Agreement.PDF	The software license agreement.
Receiver Software	200R00234.S	Actually receiver software that is currently loaded onto the Evaluation Receiver.
	dlgsp2.BIN	Loader file required to load the software onto the Evaluation Receiver.
Source Code\Calcpsr		Contains source code files for the Calcpsr.exe utility.
Source Code\Cksum		Contains source code files for the Cksum.exe utility.
Source Code\Datum		Contains source code files for the Datum.exe utility.
ToolKit\SiRFdemo	RING90.SMP	File needed for the Map View screen in the SiRFdemo software.
	SIRF.POS	File needed for the Map View screen in the SiRFdemo software.
	Sirfdemo.exe	The SiRFdemo software executable.
ToolKit\SiRFsig	SIRFSIG.DBS	Database file used by the SiRFsig software.
	SIRFSIG.EXE	The SiRFsig software executable.
ToolKit\SiRFsig\ Examples		Example data that can be used with the SiRFsig software.
ToolKit\SiRFsig\ Macro	MSANFRAN.XLS	Example spreadsheets and macro to import logged data into Microsoft Excel.
Utility		Other provided executables.

Installation 2

This chapter provides instructions and requirements for installing the SiRFstarIIe Toolkit software and the SiRFstarIIe Evaluation Receiver. Specific instructions using different operating systems are also provided.

Hardware and Software Requirements

The following is the minimum computer configuration that is required to achieve reliable Toolkit software operation.

- 486 processor (or better)
- 8 MB RAM minimum memory
- 100 MB minimum available disk space for Toolkit installation, documentation storage, and data logging
- Windows 95, 98, NT, or 2000 operating system
- One available RS232 serial port

Installing the SiRFstarIIe Evaluation Receiver

The SiRFstarIIe Evaluation Receiver is designed to be set on a flat surface, but will operate if mounted in any other manner. The Evaluation Receiver must be placed in a location where serial and antenna connections can be accessed, and power switch and front LEDs are visible.

Environment Considerations

The SiRFstarIIe Evaluation Receiver is housed in a sturdy aluminum housing to protect the internal board and provide a convenient platform for field testing. Provide a suitable operating environment and to prevent damage avoid these conditions:

- Frequent exposure to water
- Extreme temperatures (-40 to +85 deg. C)
- High vibration environments

Input Power

The SiRFstarIIe Evaluation Receiver requires a 9-VDC power supply. Under normal operating conditions, the GPS receiver module nominally draws 150 mA at 9 VDC. The complete Evaluation Receiver (including GPS module, beacon module, and active antenna) nominally draws 230 mA.

Two power supply options are provided in your Evaluation Kit:

- Cigarette lighter adapter

  Provides power from the cigarette lighter (12 or 24 V system) to the Evaluation Receiver while using the unit within a vehicle.

- Power supply adapter

  Provides the required 9 V to the Evaluation Receiver from a 110 to 220 V main power supply while using the unit in office and laboratory environments.

Mounting of the GPS Antenna

The GPS antenna provided in the Evaluation Kit is a magnetic-mounted 3 V active antenna. To ensure correct operation of the antenna, you must use the following guidelines when choosing an appropriate location for the antenna:

- Choose a location that has a unobstructed view of the sky.
- Avoid mounting the antenna near electrical wires, other antennas, or sources of electrical interference.
- Do not mount the antenna near transmitting antennas such as radar or satellite communication arrays.

Connecting the Evaluation Receiver

To connect the cables for operation of the Evaluation Receiver:

1. Connect the GPS antenna to the antenna input (SMA connector) on the Evaluation Receiver shown in Figure 2-1.

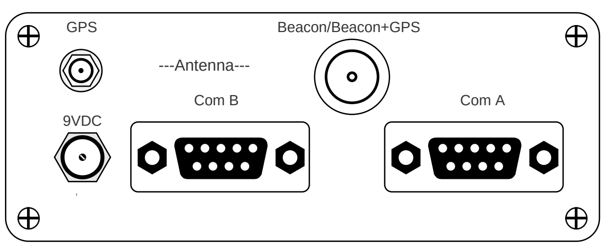

Figure 2-1 SiRFstarIIe Evaluation Receiver - Back Panel

Note – To use the combined GPS and beacon antenna, connect to the larger TNC connector that is labeled Beacon/Beacon GPS.

2. To receive DGPS corrections from a radiobeacon network, connect a beacon antenna to the TNC connector labelled Beacon/Beacon GPS as shown in Figure 2-1.
3. Connect one end of the serial cable to the appropriate communications port on your computer.
4. Connect other end of the serial cable to Com A on the Evaluation Receiver, as shown in Figure 2-1.

Note – To use Com B the Evaluation Receiver must be operating in SiRF Binary protocol.

5. If you are operating the Evaluation Receiver from within a vehicle, connect one end of the cigarette lighter adapter to the Evaluation Receiver, and the other end into the vehicle cigarette lighter socket. Other wise, the 110-220V power supply adapter should be used.
6. Supply power to the Evaluation Receiver and toggle the power switch to on. The red LED next to the power switch, as shown in Figure 2-2, should light-up.

Note – The green LEDs on the front panel of the Evaluation Receiver flash when data is sent through ports A or B.

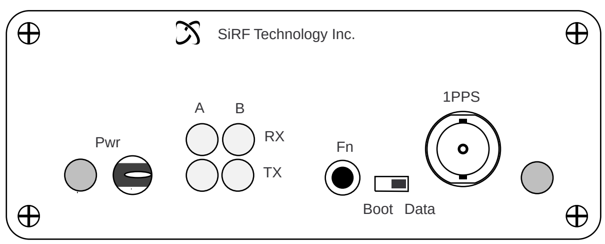

Figure 2-2 SiRFstarIIe Evaluation Receiver - Front Panel

Installing the SiRFstarIIe Toolkit Software

This section describes installing the SiRFstarIIe Evaluation Kit Toolkit software. To install the toolkit software:

1. Insert the SiRFstarIIe Evaluation Kit CD into your CD-ROM drive.
2. Copy the directory and contents of the `toolkit` directory from the Evaluation Kit CD to your hard drive.
3. From the `update` directory on the Evaluation Kit CD, copy the `sirfdemo.exe`, `ring90.smp`, and `sirf.pos` files to the created `toolkit` directory on your hard drive.
4. To start SiRFdemo, double click on the `sirfdemo.exe` file. You may want to create a shortcut on your desktop and use this to start SiRFdemo.

Use the My Computer utility to create and copy directories and files from the Evaluation Kit CD to your hard drive if you are using Windows 95, 98, NT, or 2000.

Note – You can copy other documentation from the Evaluation Kit CD to your hard drive. Some of these files are large and you should ensure that you have adequate space on your hard drive.

See **Chapter 3, “Quickstart**” for more information about running the SiRFdemo software and to verify that the Evaluation Receiver is connected and powered correctly.

Quickstart 3

This chapter describes how to start the SiRFdemo software, basic operation, and how to ensure that the software and the Evaluation Receiver are operating correctly. See **Chapter 4, "Using the SiRFdemo Software**" for more details on SiRFdemo operation.

Note – You can run the SiRFdemo software without having a Evaluation Receiver connected to the computer. See **Chapter 4, "Using the SiRFdemo Software**" for more information.

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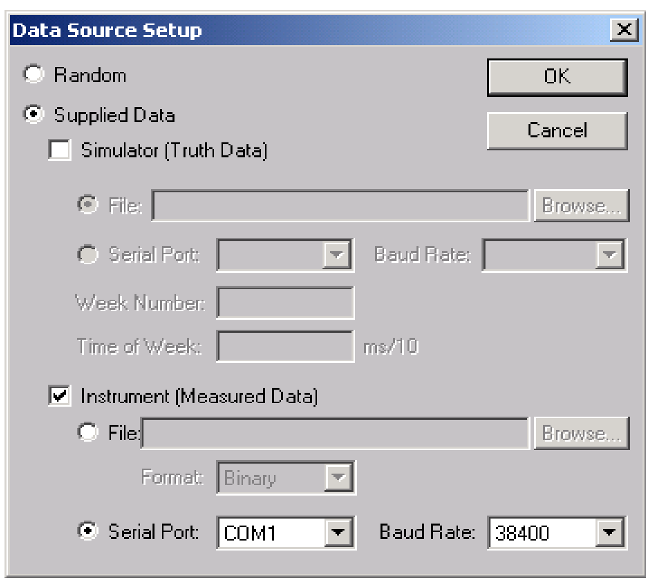
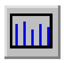
1. Double-click on `sirfdemo.exe` located in the directory on your hard drive. If you have created a shortcut on your desktop, double-click on this.

The Data Source Setup screen is displayed.

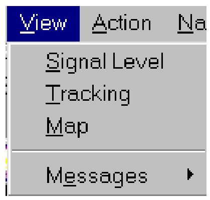


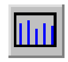
Note – The Serial Port and Baud Rate apply to the host computer (the Evaluation Receiver is set at a baud rate of 38400 during factory testing).

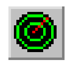
2. Click OK.

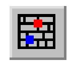


3. Click on the Signal Level View button or choose Signal Level from the View menu.

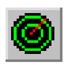


 **— Signal Level**

 **— Tracking**

 **— Map**

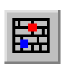
The 12-Channel Signal Level View screen displays the satellite number, status, azimuth, elevation, C/No, and last five seconds of measured signal levels.



4. Click on the Tracking View button or choose Tracking from the View menu.

The Tracking View screen is displayed. This displays the satellites in a polar plot.

- Outer circle represents the horizon (Elevation=0 degrees)
- Inner circle represents 45 degrees
- Center point is directly overhead (Elevation=90 degrees)

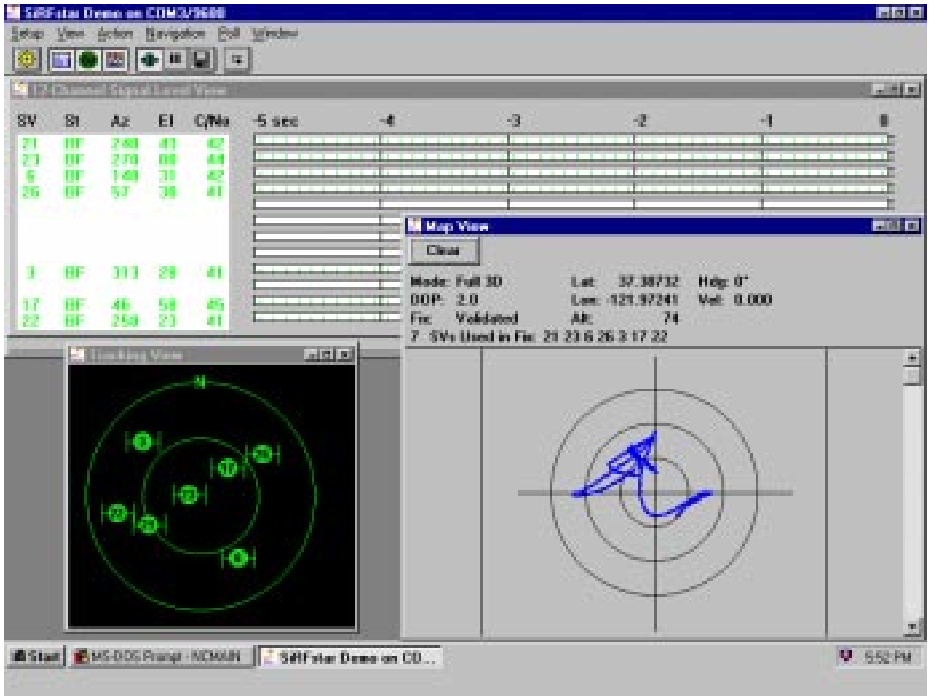


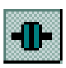
5. Click on the Map View button.

The Map View screen displays the position of the ground tracking.

The red dot shows the last position solution. If you run Map View with a moving setup, the ground track is displayed in the Map View screen.

If no dot is shown, you must update the `ring90.smp` file for your location. See “Modifying the Sample ring90.smp File” on page 91 for more information on updating the `ring90.smp` file.





6. Click the Connect/Disconnect button.
   If your receiver is properly connected and tracking GPS satellites, the Signal Level, Tracking, and Map views will display information regarding the current operation of the receiver. An example of what you should see is included in the screen capture above. Information about each of the different views is contained in Table 3-1.

Table 3-1 Signal Level, Tracking and Map Views

View	Description
Signal Level	Displays the azimuth and elevation of tracked and available satellites in a text form. It also shows the C/No value in both text and graphical forms. The graphical C/No representation shows a history of five seconds.
Tracking	Displays the azimuth and elevation of tracked and available satellites in a graphical form. Satellites being used in the position solution are green, satellites being tracked but not used are blue, and satellites that are not tracked and are not used in the position solution are red.
Map	Displays s graphical view of the current position relative to a selected position. Other information displayed in text format include the total number of satellites tracked, which satellites are tracked, current position, and mode of the current position solution.

Using the SiRFdemo Software 4

The SiRFdemo software is provided to simplify real-time monitoring of the Evaluation Receiver, configuration of the Evaluation Receiver, and efficient logging of data in the field for further analysis.

Before running the software, you need to attach the Evaluation Receiver to your PC, which must be connected to a power source. You should also have an antenna on the Evaluation Receiver and position it so the antenna has a clear view of the sky.

To start the SiRFdemo software, either double-click on the `sirfdemo.exe` file or, if you created a short-cut on your desktop, double-click the SiRFdemo icon.

SiRFdemo Menus

The SiRFdemo software has six menus, which are described in Table 4-1.

Table 4-1 SiRFdemo Menus

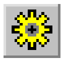
Menu	Description
Setup	The Setup menu lets you configure the data source used by SiRFdemo, configure operating preferences, and load new software into the Evaluation Receiver. See “The Setup Menu” on page 19 for detailed information about the Setup menu.
View	The View menu lets you display different view windows. The available view windows include: • Signal Level • Tracking • Map • Navigation • Response • Error • Development • DGPS Status See “The View Menu” on page 24 for detailed information about the View menu.
Action	The Action menu provides access to most of the SiRFdemo functionality including configuration of the Evaluation Receiver and data logging for later analysis. See “The Action Menu” on page 34 for detailed information about the Action menu.
Navigation	The Navigation menu lets you configure items that effect how a position solution is acquired or the type of position needed. From the Navigation menu, you can set various operating masks, the DGPS mode, and the DGPS source. See “The Navigation Menu” on page 51 for detailed information about the Navigation menu.
Poll	You use the Poll menu to obtain Evaluation Receiver information such as software version, navigation parameters, and clock status. You can also use the Poll menu to obtain the latest ephemeris and almanac. See “The Poll Menu” on page 60 for detailed information about the Poll menu.
Window	The commands on the Window menu control the appearance of the information displayed. For detailed information about the Window menu, see “Changing Preferences” on page 21.

Note – The values that appear in the dialog boxes are Evaluation Receiver default values and not what is currently set in the Evaluation Receiver. See “The Navigation Parameters” on page 62 to determine the current settings of all navigation parameters.

The Setup Menu

This section describes the SiRFdemo functions on the Setup menu:

- "Selecting the Target Evaluation Receiver" on page 19
- "Defining the Data Source" on page 20
- "Changing Preferences" on page 21
- "Upgrading the SiRFstarIIe Software" on page 22
- "To Exit the SiRFdemo Software" on page 24



— Data Source

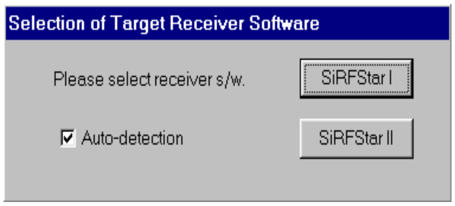
Selecting the Target Evaluation Receiver

The SiRFdemo software supports the SiRF product lines, SiRFstarI/LX, and SiRFstarIIe. A built-in auto-detection feature allows the SiRFdemo to identify the hardware/software platform it is connected to and configure the pulldown menus correctly. This provides access to features that are common to both platforms (i.e., protocol) and individual access and definition to features that are either unique (i.e., Static Navigation) or redefined (i.e., TricklePower) for each platform.

Once connected, the SiRFdemo software attempts to identify the system as either SiRFstarI or SiRFstarII. If the hardware detection function fails, you are prompted to to select the hardware platform manually. The auto-detection function can be disabled by unchecking the Auto-detection check box.

1. Choose Receiver S/W... from the Setup menu.

   The Selection of Target Receiver Software screen is displayed.

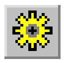


2. Click the appropriate hardware platform button — SiRFStarI or SiRFStarII.
3. Uncheck the Auto-detection checkbox if you want to disable that function.

Defining the Data Source

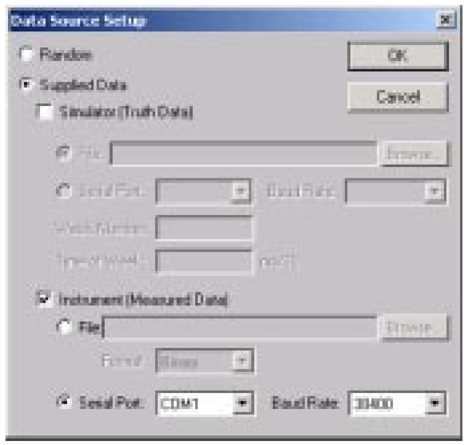
The SiRFdemo software is capable of receiving data from different sources. You can configure the demo to receive data directly from a connected Evaluation Receiver, generate its own random data, or load data from a previously logged file.

To configure the source of the data used by the SiRFdemo software:



1. Click the Data Source button or choose Data Source from the Setup menu.

   The Data Source Setup screen is displayed.



2. Select either the Supplied Data or Random option:

Option	Description
Random	Uses randomly generated data. Use this option to verify that the SiRFdemo software is running without the Evaluation Receiver connected.
Supplied Data	The SiRFdemo software will use real data either directly from a Evaluation Receiver, or from a file.

3. To use data from a file, select the File radio button and select the appropriate file using the Browse button.

Note – The Simulator (Truth Data) option is not yet implemented.
Do not use the File radio button. This option is not implemented at this time.

---

4. To use data directly from an Evaluation Receiver, select the Serial Port radio button. Use the selection lists to choose the serial port to which the Evaluation Receiver is connected on your PC, and the correct baud rate.

5. Click the OK button to continue.

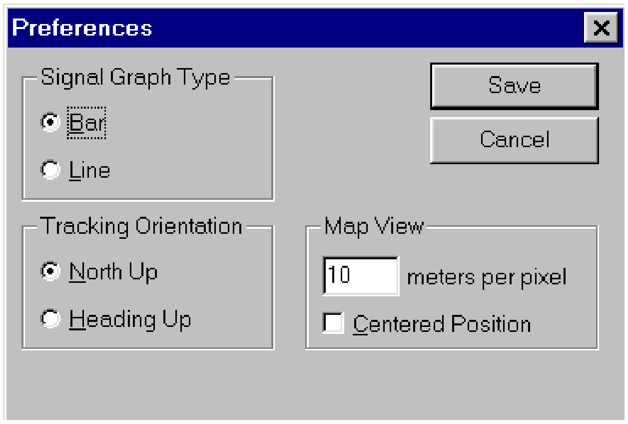
Changing Preferences

You can change the appearance of some of the view windows to suit your personal preferences. View preferences include the Signal Level view, the Tracking view, and the Map view.

To change the appearance of the view windows:

1. Choose Preferences from the Setup menu.

   The Preferences screen is displayed.



2. Select the type of signal graph that you want to view on the 12-Channel Signal Level View screen:

Option	Description
Bar	Displays the data with vertical bars to represent the observed signal strength of each satellite.
Line	Displays the data in a continuous line graph form.

3. Select the direction of the tracking orientation that you want to use in the Tracking View screen:

Option	Description
North Up	True north points to the top of the circle.
Heading Up	This is typically used when driving in a vehicle or if the receiver is moving. Current heading points to the top of the circle.

4. To change the scale of the Map view, type the number of meters you want each pixel to represent in the Meters Per Pixel field.

5. Click the Centered Position check box if you want to display the Map View with the current position at the map center.

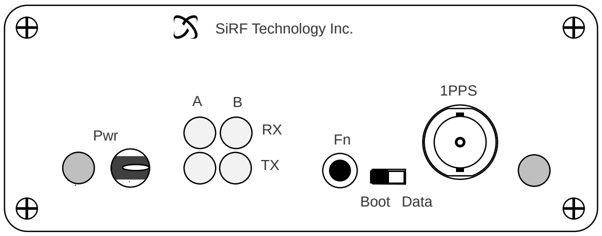
6. Click the Save button to save the changes or Cancel to exit without saving changes.

Upgrading the SiRFstarIIe Software

The SiRFprog utility, included with the SiRFdemo software, allows for easy upgrading or reflashing of the software that runs on the SiRFstarIIe Evaluation Receiver.

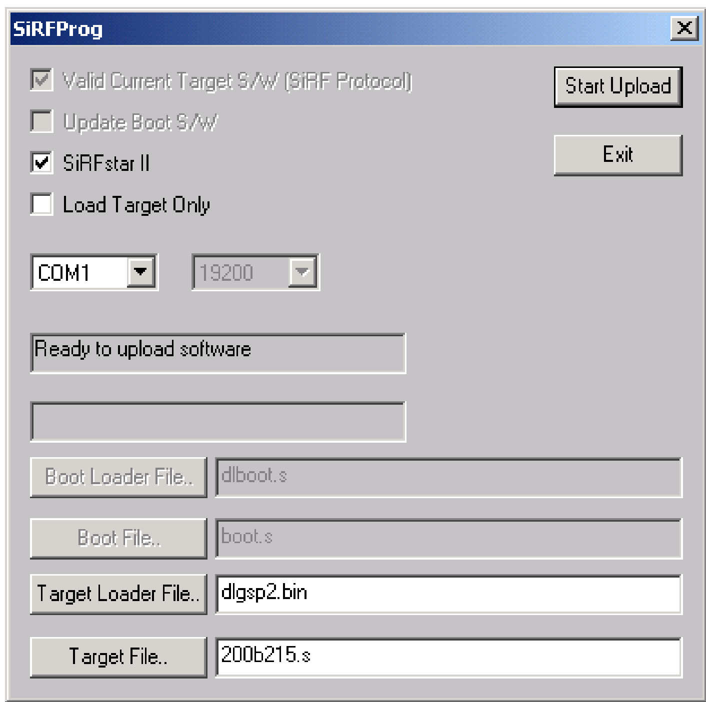
To upgrade or reflash the software on the Evaluation Receiver:

1. Set the Boot/Data slide switch to Boot:



2. Cycle power on the Evaluation Receiver. (This puts the board in Boot mode awaiting a code upload.)
3. Select SiRFprog from the Setup menu.

   The SiRFProg 1.6 screen is displayed.



Note – As SiRFprog requires the use of the serial port used by the SiRFdemo software, you must first ensure that the SiRFdemo software is not using the serial port. Please see “To Exit the SiRFdemo Software” on page 24 for information about disconnecting the SiRFdemo software.

---

4. Check the GSP2 checkbox.
5. Select the correct serial port from the pulldown menu.

The following files are required to load code to the SSII evaluation unit:

- Target loader file for SSII platforms (`dlgsp2.bin`)
- Target file (`200B115.s`, SiRF-supplied code)

6. Click the Target Loader File button and select the required loader file.

Note – The loader file has a BIN extension and is typically named `dlgsp2.bin`.

---

7. Click the Target File button and select the required software file.

Note – The target file has an S extension and is named with the convention 200R*xxx*.S where *xxx* is the release version based on the Julian day of its release. An example software file is 200R196.S.

---

8. Click the Start Upload button.

   The target loader file is loaded into RAM and prepares ROM for the target file. Status of loading is displayed in percent (%) complete. Loading of the target loader file takes 10-15 seconds. Once the target loader file is successfully loaded into RAM, the main target file loads into ROM automatically. Status of loading is displayed in percent (%) complete. This process takes 3-5 minutes. When the code is successfully loaded, the following SIRFprog screen is displayed.

9. Set the slide switch Boot/Data back to Data.
10. Cycle power on the Evaluation Receiver.

    This returns the Evaluation Receiver to normal operation and executes the new loaded target file. Use the SiRFdemo to verify that the code has loaded correctly and that the software version is correct by selecting SW Version from the Poll menu.

Displaying Information About the SiRFdemo Software

1. Select About SiRFstar Demo from the Setup menu to display SiRFdemo software information:

To Exit the SiRFdemo Software

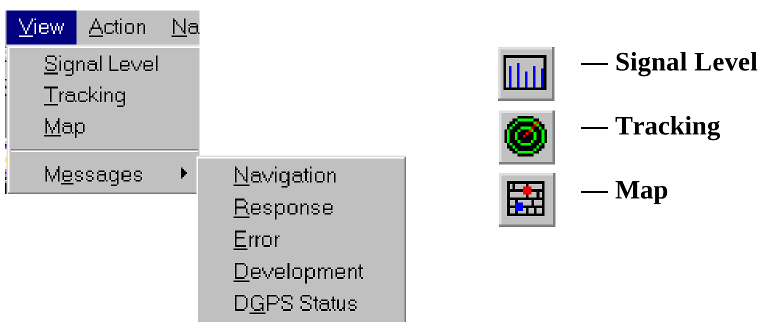
1. Select Exit from the Setup pulldown menu.

   This closes SiRFdemo software.

The View Menu

This section describes the SiRFdemo functions on the View menu:

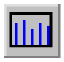
- "The 12-Channel Signal Level View Screen" on page 24
- "The Tracking View Screen" on page 26
- "The Map View Screen" on page 28
- "The Measured Navigation Message View Screen" on page 29
- "The Response View Screen" on page 31
- "The Error Message View Screen" on page 31
- "The Development Data View Screen" on page 32
- "The DGPS Status View Screen" on page 32



The 12-Channel Signal Level View Screen

The 12-Channel Signal Level View screen is a combined graphical and text display of satellite tracking. Information shown by the Signal Level view includes the satellite number, status, azimuth, elevation, C/No, and last five seconds of measured signal strength.

To display the 12-Channel Signal Level view screen:



1. Click the Signal Level View button or choose Signal Level from the View menu.

Note – If you double-click on the 12-Channel Signal Level View screen, the Preferences screen is displayed, as described in “Changing Preferences” on page 21. The Preferences screen enables you to modify the way information is displayed on the screen.

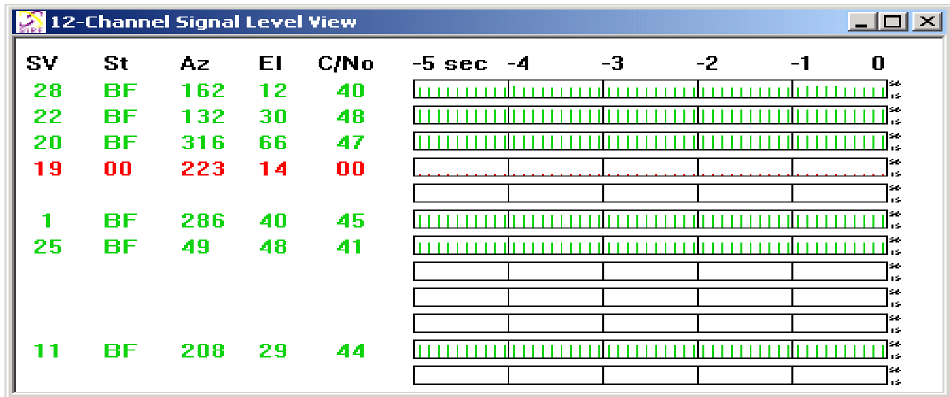


Table 4-2 12-Channel Signal Level View Information

Information Displayed	Description
Satellite Number (SV)	The GPS satellite PRN number.
Status (St)	The status of each satellite tracked (see Table B-40 for more information).
Azimuth (Az)	Satellite azimuth (in degrees).
Elevation (El)	Satellite elevation (in degrees) with the horizon being zero degrees in elevation, and directly over-head being ninety degrees.
C/No	Signal level (in dB-Hz).
Signal Level (-5 sec)	5-second history of the measured signal strength.

The information displayed in the Signal Level view is also assisted by color coding. As the tracking status of each satellite changes, the associated text and signal levels are colored to represent the current status (see Table 4-3).

Table 4-3 12-Channel Signal Level View Color Coding

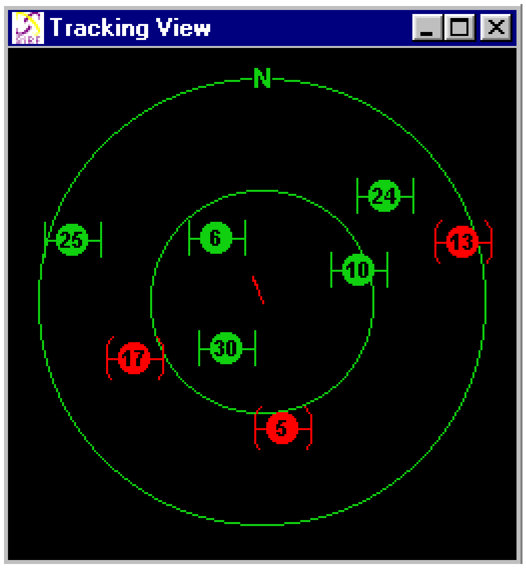
Color	Description
Red	The satellite location is know from almanac information; however, the satellite is not currently being tracked.
Blue	The satellite is being tracked; however, it is not being used in the current position solution.
Green	The satellite is being tracked and is being used in the current position solution.

The Tracking View Screen

The Tracking View screen graphically displays the location of each of the tracked, used, and available satellites in the form of a polar plot.

To display the Tracking view screen:

1. Click on the Tracking View button or choose Tracking from the View menu.



In addition to the satellite locations, the current tracking status is represented by color (see Table 4-4).

Table 4-4 Tracking View Color Coding

Color	Description
Red	The satellite location is know from almanac information; however, the satellite is not currently being tracked.
Blue	The satellite is being tracked; however, it is not being used in the current position solution.
Green	The satellite is being tracked and is being used in the current position solution.

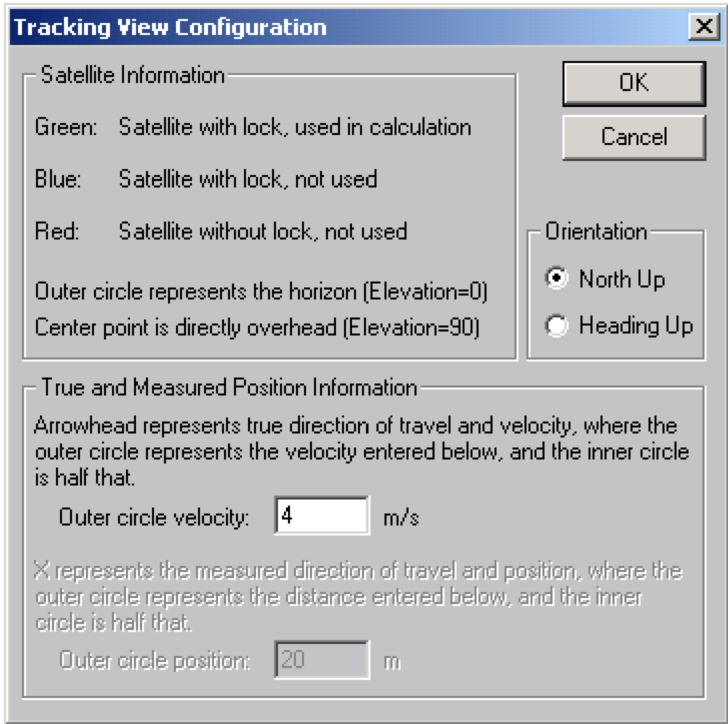
Current speed and heading (in a dynamic environment such as a moving vehicle) is represented by an arrow. The direction of the arrow represents heading while the length of the arrow indicates speed over ground.

Configuring the Tracking View Screen

You can configure the orientation and the velocity representation of the Tracking view screen.

To configure the Tracking view screen:

1. Double-click the Tracking View screen to display the Tracking View Configuration screen.



2. Select the direction of the tracking orientation that you want to use.

Option	Description
North Up	True north points to the top of the circle.
Heading Up	This option can be used when driving. Current heading points to the top of the circle.

3. Type the Outer circle velocity (in m/sec).

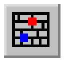
Note – The setting of the outer circle velocity means that if the arrow length reaches the outer circle of the plot, then the outer circle velocity has been reached.

4. Click OK to save the changes or Cancel to exit without saving changes.

The Map View Screen

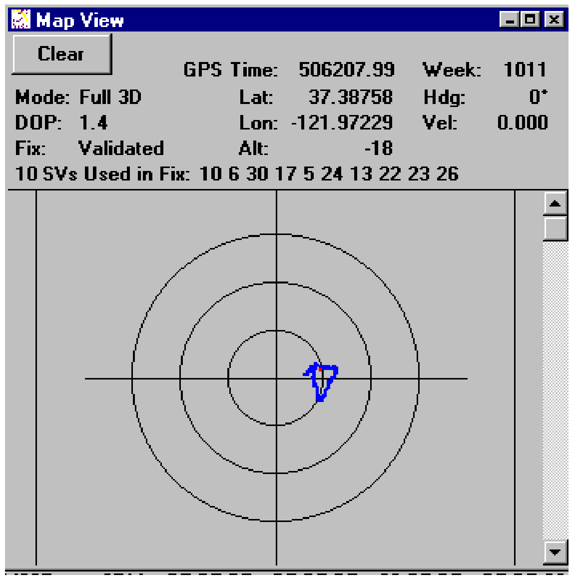
The Map view screen displays a combination of graphical and text-based information. Positions generated by the Evaluation Receiver are plotted on the Map view screen while other information such as GPS time, GPS week, position mode, current position, heading, velocity, DOP, type of position fix, and satellites tracked are displayed as text.

To display the Map view screen:



1. Click the Map View button or choose Map from the View menu.

   The Map View screen is displayed.



   The current position is represented on the plot by a red dot, while past positions are displayed in blue.

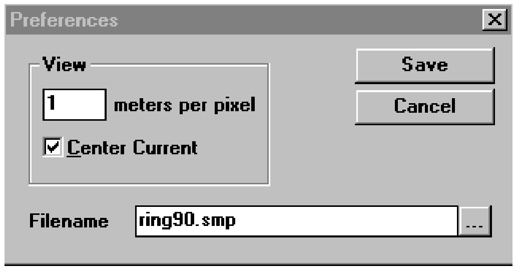
Note – Before using the Map view, it is necessary to create or edit an existing text file that contains the position on which you want to center the map view. Provided with the SiRFdemo software is an example file - `ring90.smp`. You can edit this file to specify your required position. For information on the format of the `.smp` file, please see "To Change the Map View Preferences" on page 29.

To Change the Map View Preferences

The ability to change the scale of the Map view and to select the appropriate `.smp` file is provided by the Map view preferences.

To change the Map view preferences:

1. Double-click on the Map View screen to display the Preferences window.



2. Enter the number of meters you want each pixel to represent in the Meters Per Pixel field. This value controls the map scale.
3. Click the Center Current check box if you want the Map View to be centered.
4. Select the appropriate `.smp` file by either typing the path and file name or using the browse button.
5. Click the Save button to save the changes or the Cancel button to exit.

The Measured Navigation Message View Screen

The Measured Navigation Message view screen is used to display position solution information such as GPS time, GPS week, position mode, current position, heading, velocity, DOP, type of position fix, and satellites tracked.

To view the Measured Navigation Message View screen:

1. Choose Messages Navigation from the View menu.

   The Measured Navigation Message View screen is displayed.

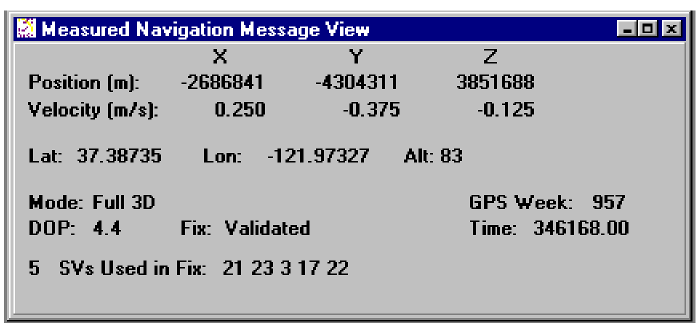


Table 4-5 Measured Navigation Message View Information

Information Displayed	Description
X, Y, Z positions	Coordinates of user’s position in ECEF (meters)
Velocity	User’s velocity in ECEF (m/s)
Latitude	User’s latitude (decimal of degrees)
Longitude	User’s longitude (decimal of degrees)
Altitude	User’s altitude (meters)
Mode	Navigation solution type (see Table B-37 and Table B-38)
GPS Week	GPS week number
DOP	Dilution of Precision
Fix	Validated/invalidated (see Table B-37 and Table B-38)
Time	Current GPS time (seconds)
Svs Used in Fix	Sv PRN used in solution

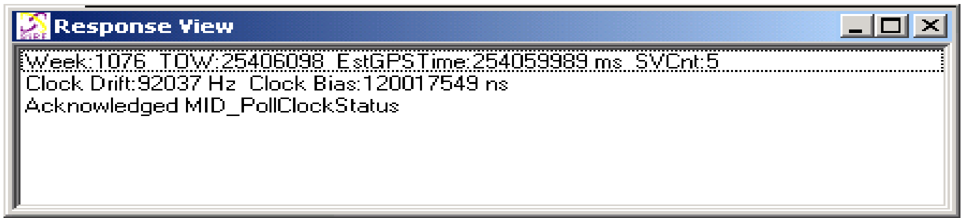
Note – ECEF XYZ is converted geodetic latitude, longitude, and altitude based on the WGS84 ellipsoid parameters.

The Response View Screen

The Response View screen is used to display any response to a poll request. You can poll the Evaluation Receiver for the software version (see “The Software Version” on page 61), clock status (see “The Clock Status” on page 61), and navigation parameters (see “The Navigation Parameters” on page 62).

To display the Response View screen:

1. Choose Messages Response from the View menu.



The Error Message View Screen

The Error Message View screen is used to display any error messages that the Evaluation Receiver may generate. Error messages are generated automatically by the Evaluation Receiver under certain conditions. Many are caused by normal GPS operations such as acquiring a low elevation satellite. This could result in a bad parity.

To view the Error Message View screen:

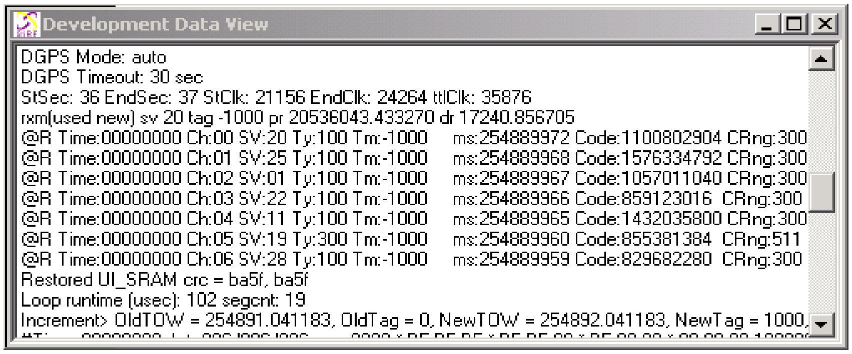
1. Choose Messages Error from the View menu.

The Development Data View Screen

The Development Data View screen displays additional information about the Evaluation Receiver operation. The data is generated automatically by the Evaluation Receiver.

To view the Development Data View screen:

1. Choose Messages | Development from the View menu.



Note – To view incoming development data the Enable Development Data checkbox must be enabled on the Receiver Initialization screen. See "Initializing the Data Source" on page 37.

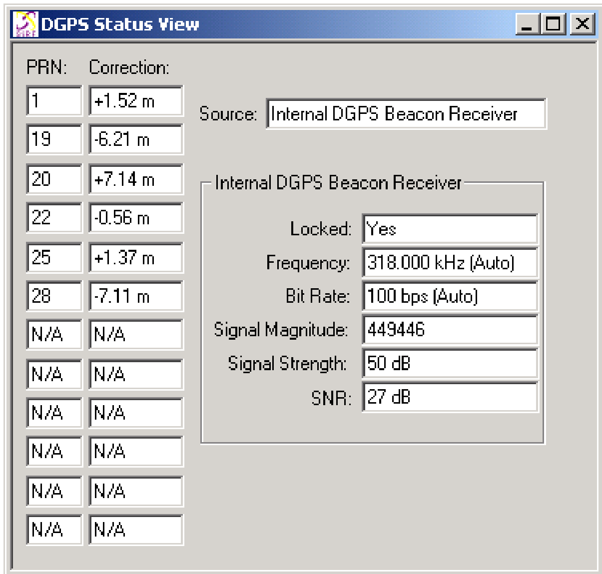
The DGPS Status View Screen

The SiRFstarIIe Evaluation Receiver has three options for DGPS operation - WAAS, radio-beacons, or external RTCM. See "Selecting the DGPS Source" on page 57 for more information about each of these options. The DGPS Status View screen provides information about the DGPS source and current operation.

To view the DGPS Status View screen:

1. Choose Messages | DGPS Status from the View menu.

   The DGPS Status View screen is displayed.

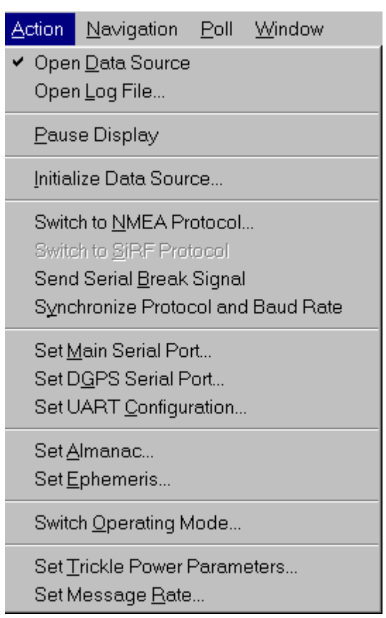


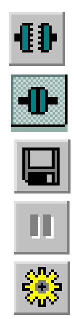
Information	Description
PRN	Pseudo Random Noise code (SV identification) for the satellite.
Correction	Current pseudo-range correction in meters.
Source	Where the correction was received from. The options are external RTCM, internal beacon, and WAAS. If Internal Beacon is the DGPS source, the following information also applies: Locked: Status of tracking Coast Guard Beacon Frequency: Frequency (KHz) of beacon tracked Bit Rate: BPS for signal demodulation Signal Magnitude: TBD Signal Strength: TBD SNR: Signal to Noise Ratio (TBD)

The Action Menu

This section describes the SiRFdemo functions on the Action menu:

Note – All values that appear in the dialogue boxes under this menu are Evaluation Receiver default values. To determine the current settings of all Navigation Parameters, refer to page 63.





— Open Data Source (not connected)

— Open Data Source (connected)

— Open Log File

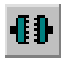
— Pause Display

— Initialize Data Source

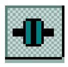
Opening a Data Source

Before any data can be received from or sent to the Evaluation Receiver a communications channel must be established or a data source must be opened.

To open a data source:



1. Click the Connect/Disconnect button or select Open Data Source from the Action menu.

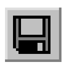


2. Click the Connect/Disconnect button again or select Open Data Source from the Action menu to disconnect communication to the Evaluation Unit.

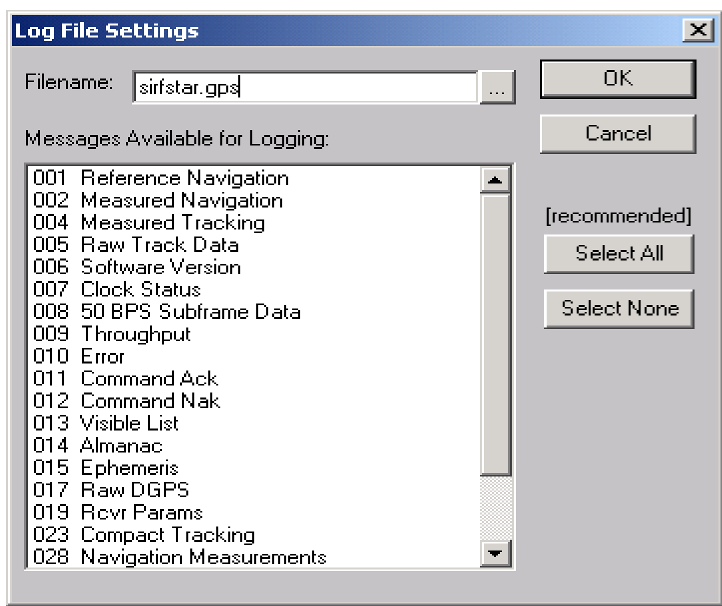
Opening a Log File

The log file function provides the ability to log selected information from the Evaluation Receiver to a named file.

To open a file and select messages to log:



1. Click the Log File Settings button or choose Open Log File from the Action menu. The Log File Settings window is displayed.



2. Select each message you want to log to a file by clicking on the required message. You can select all of the messages at once by clicking the Select All button.

Note – Only records that are selected will be logged to a file. If you are logging all available messages, you should use a baud rate of 38400. This will ensure that no data will be lost during logging.

---

3. Click OK to begin logging the selected messages or Cancel to abort opening a file.

   Each of the available message types and a brief description is provided in Table 4-6.

Table 4-6 Messages That Can Be Logged to a File

Messages	**Description**
002 Measured Navigation	Time, position, velocity,...
004 Measured Tracking	Satellite status and C/No
005 Raw Track Data	Satellite raw data measurements
006 SW Version	Software version of the Evaluation Kit
007 Clock Status	Receiver clock performance
008 50 BPS Subframe Data	Satellite ephemeris and almanac data
009 Throughput	CPU throughput usage
010 Error	Various error messages
011 Cmd Ack	Acknowledgment of received commands
012 Cmd Nak	Input message failures
013 Visible List	Satellite visibility list (based on current almanac)
014 Almanac	Satellite almanac data
015 Ephemeris	Satellite ephemeris data
017 Raw DGPS	Differential GPS corrections in RTCM format
019 Rcvr Params	Parameters affecting navigation solutions
028 Navigation Measurements	Observed satellite measurement data
029 DGPS Measurements	Received differential GPS correction information
030 SV State Parameters	Observed velocity, position and clock information
031 Startup Initialization	Startup initialization information
255 Development	Various development information

To Pause the Display

All of the open windows can be paused to allow easy viewing of the existing data without receiving any further data.

To pause all of the open windows:

1. Click the Pause button or choose Pause Display from the Action menu.

Note – No data is logged while the display is paused.

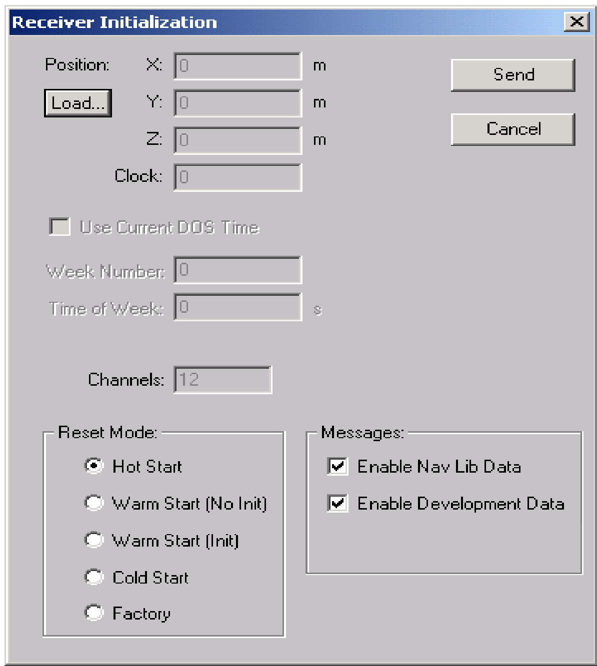
Initializing the Data Source

You can reset or initialize the Evaluation Receiver directly through the SiRFdemo software. This function may be used to demonstrate or evaluate the Evaluation Receiver's recovery ability under different circumstances.

To perform a receiver reset or allow Raw Track or Development data to be output from the Evaluation Receiver:

1. Click the reset button or choose Initialize Data Source from the Action menu.

   The Receiver Initialization Setup screen is displayed.



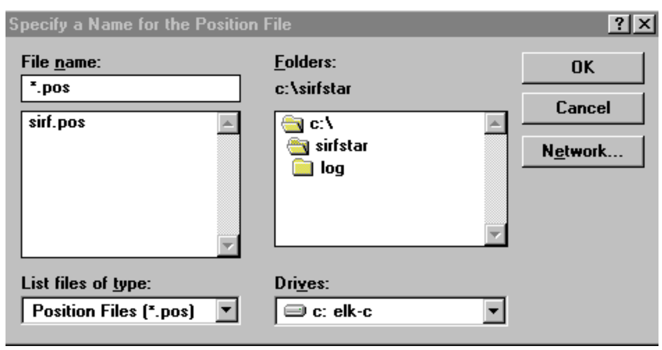
2. Select type of Reset Mode by clicking on the associate radio button. Each of the reset types are described in Table 4-7.

Table 4-7 Reset Types

Option	Description
Hot Start	The Evaluation Receiver restarts by using the values stored in the internal memory of the Evaluation Unit. The stored ephemeris and almanac are both valid.
Warm Start (No Init)	This option has the same functionality as Hot Start except that it clears the ephemeris data and retains all other data.
Warm Start (Init)	This option clears all initialization data in the Evaluation Receiver and subsequently reloads the data that is currently displayed in the Receiver Initialization Setup screen. The almanac is retained but the ephemeris is cleared.
Cold Start	This option clears all data that is currently stored in the internal memory of the Evaluation Receiver including position, almanac, ephemeris, time, and clock drift.
Factory Start	This option effectively performs a cold start but also sets all Evaluation Receiver parameters back to the factory defaults.

Note – If Cold start is selected, all Evaluation Receiver settings are reset to factory defaults.

3. If you selected the Warm Start (Init) reset mode, enter or load the X, Y, and Z coordinates for the current position of the Evaluation Receiver. You can load a file containing the X, Y, Z coordinates by clicking the Load button. The Specify a Name for the Position File window is displayed.



4. Select the appropriate file.sample `Sirf.pos` configuration file.

Note – An example file called `sirf.pos` has been provided with the SiRFdemo software. See “Modifying the Sample sirf.pos File” on page 93 for more information on creating a valid `.pos` file.

5. Click the OK button to accept or the Cancel button to exit.
   The Receiver Initialization Setup screen is displayed again.

6. Type 96,000 in the Clock field (96,000 is a typical clock drift value of the crystal in the Evaluation Receiver).

Note – If you type 0 in the Clock field, the Evaluation Receiver uses its last stored value, or a default of 96,000 if no prior stored value is available.

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7. Click on or off the Use current DOS time check box.
   The default value is set to the current time.

Note – It is recommended that you use DOS time (it is assumed that the date and time on your computer are set correctly).

---

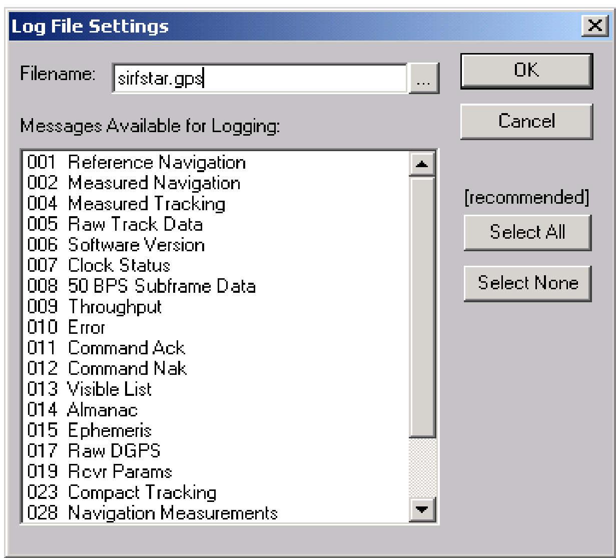
8. Type the number of the week in the Week Number field.

9. Type the time of the week in the Time of Week field.

10. Type number of channels in the Channel field.
    You can specify from 1 to 12 channels.

11. Click on Enable Raw Track Data to Log Raw Track Data.

    005 [Raw Track] Data must also be highlighted on the Log File Settings Screen.



    It is recommended that you log records 007 [Clock Status] and 008 [50 BPS Subframe Data] with 005 [Raw Track Data] because these measurements are enabled/disabled as a set.

12. Click on Enable Development Data to turn on message 255. The content of this message is displayed in the Development Data View.

Note – When the Development and Raw Data is selected for logging, the baud rate of the SiRFdemo software and the Evaluation Receiver is automatically changed to 57600. This is to ensure sufficient through-put to accommodate the quantity of data.

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13. Click the Send button to initialize or the Cancel button to exit.

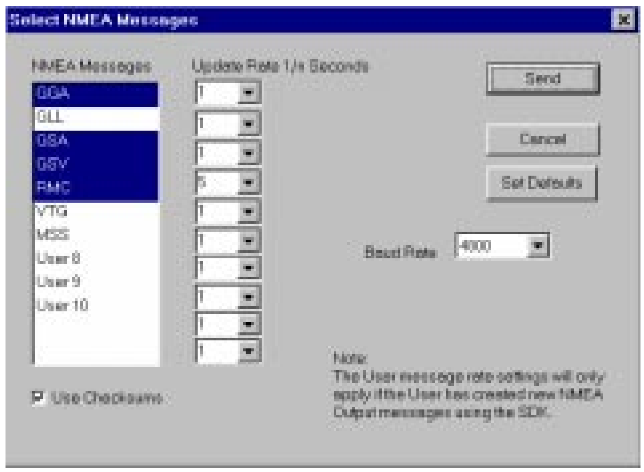
Switching to the NMEA Protocol

The SiRFstarIIe Evaluation Receiver supports a subset of the NMEA protocol. Rather than operating in the SiRF binary protocol, you may change the protocol to NMEA for the port that is currently connected.

To change the protocol to NMEA for the port currently connected to your PC:

1. Choose Switch to NMEA Protocol from the Action menu.

   The Select NMEA Messages screen is displayed.



2. Select the NMEA Messages that you want to use by clicking on the required message. Table 4-8 provides a brief description of each of the available NMEA messages. For detailed information on the NMEA protocol, please see “Switching to the NMEA Protocol” on page 40.

Table 4-8 NMEA Messages

Option	Description
GGA	Time, position, and fix related data for a GPS receiver.
GLL	Latitude and longitude of present position, time of position fix and status.
GSA	GPS receiver operating mode, satellites used in the position solution, and DOP values.
GSV	The number of GPS satellites in view satellite ID numbers, elevation, azimuth, and SNR values.
MSS	Signal-to-noise ratio, signal strength, frequency, and bit rate from a radio-beacon receiver.
RMC	Time, date, position, course and speed data provided by the GPS receiver.
VTG	The actual course and speed relative to the ground.
User 8	Reserved for a user defined NMEA string.
User 9	Reserved for a user defined NMEA string.
User 10	Reserved for a user defined NMEA string.

3. Select the update rate for each NMEA message that you want to use from the corresponding Update Rate pulldown menu. Each NMEA message can be output at a maximum rate of 1 per second and at a minimum rate of 1 per 255 seconds.
4. Select the baud rate that you want to use from the Baud Rate pulldown menu.
5. Click the OK button to save or the Cancel button to exit.

Note – When the Evaluation Receiver is selected to operate using the NMEA protocol, the output messages can be viewed in the Development Data screen. It can also be logged by using the same technique as a SiRF binary file. Select 255-Development in the Log File Settings screen and Enable Development Data must be checked in the Messages field of the Receiver Initialization screen.

Switching to the SiRF Protocol

If you are already operating using the SiRF binary protocol, this menu item is unavailable. It can be used, however, with the NMEA protocol and if you want to change the operating protocol back to the SiRF binary protocol.

To change the operating protocol from NMEA to SiRF binary:

1. Choose Switch to SiRF Protocol from the Action menu to return to the SiRF binary protocol.

Sending a Serial Break Command

This function is used to set the currently connected port of the Evaluation Receiver back to the default protocol and baud rate. However, the serial break command is not supported by the SiRFstarIIe Evaluation Receiver and it is maintained for backwards compatibility only.

To Synchronize Protocol and Baud Rate

All Evaluation Receiver settings including selected protocol and serial port settings are held in battery backed SRAM. If the Evaluation Receiver is power cycles, these settings will remain. If the Evaluation Receiver is left in an unknown state, it is difficult to regain communication with it.

The synchronize protocol and baud rate function attempt to communicate with the evaluation unit using all possible baud rates and both NMEA and SiRF binary protocols. When communication is established with the Evaluation Receiver, it is set to the SiRF binary protocol and at a baud rate of 19200. Other serial settings of parity, data bits, and stop bits are left at current settings.

Setting the Main Serial Port

The Set Main Serial Port function lets you change the baud rate of the serial port connected to the Evaluation Receiver and the serial port of the PC.

To change the baud rate of the port used by the Evaluation Receiver and the PC:

1. Choose Set Main Serial Port from the Action menu.

   The Set Serial Port Parameters screen is displayed.

2. Select the baud rate you want to use.
3. Click the Send button to accept or the Cancel button to exit.

   Clicking the Send button resets the Evaluation Unit and computer's serial port to start communicating using the new baud rate.

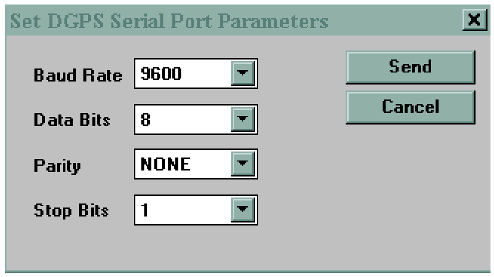
Setting the DGPS Serial Port Parameters

The Set DGPS Serial Port Parameters function will configure the second serial port (the serial port not currently used by the SiRFdemo software) of the Evaluation Receiver for reception of RTCM data.

To configure the available port for RTCM reception:

1. Choose Set DGPS Serial Port from the Action menu.

   The Set DGPS Serial Port Parameters screen is displayed.



2. Select the baud rate, data bits, parity, and stop bits that you want to use for the DGPS serial port parameters from each pulldown menu.

3. Click the Send button to accept or the Cancel button to exit.

   Clicking the Send button resets the Evaluation Receiver and changes the protocol of the second port to RTCM and the serial port settings to the selected values.

Note – The differential correction data source must be configured separately. See “Defining the Data Source” on page 20.

Setting the UART Configuration

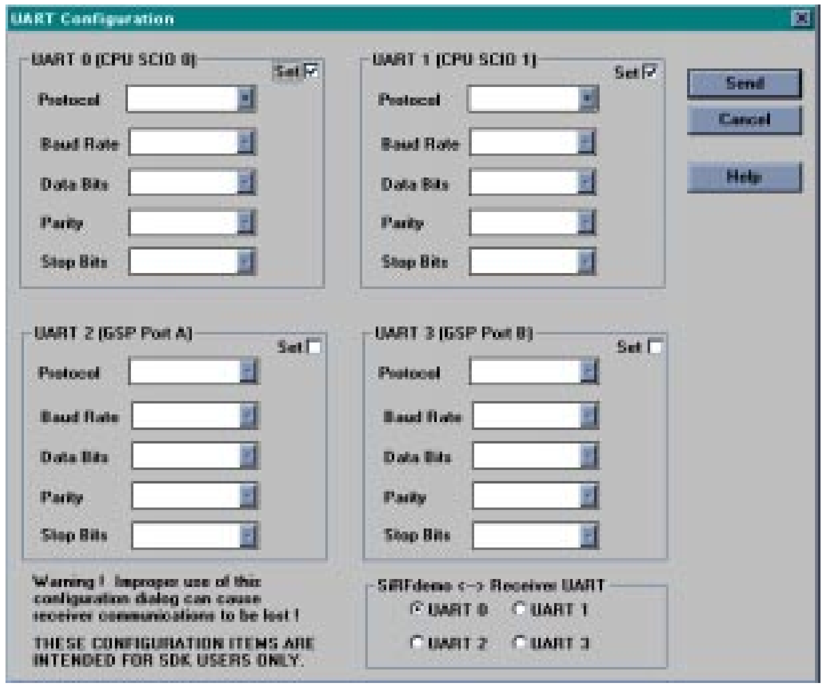
The UART configuration control is provided to allow support of four unique UARTS. You can configure UART settings such as protocol, baud rate, data bits, parity, and stop bits using the UART configuration control.

Four UART support is provided by some SiRF products, but it is not supported by the SiRFstarIIe Evaluation Receiver. The Evaluation Receiver is restricted to two UARTs (or serial ports) only. The UART configuration control is provided primarily for system developers.

To set the UART configuration of the Evaluation Receiver for the two supported UARTs:

1. Choose Set UART Configuration from the Action menu.

   The UART Configuration screen is displayed.



Note – The com ports supported in a standard Evaluation Receiver are UART 0 (CPU SCIO 0, COM port A) and UART 1 (CPU SCIO 1, COM B).

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2. Check the Set box for each UART you want to apply changes to.

   If the Set box is not checked, the existing configuration remains in its current state.

Note – UART 0 is equivalent to com port A of the Evaluation Receiver, and UART 1 is equivalent to com port B.

---

3. Select SiRF binary, NMEA, RTCM, or No I/O from the Protocol selection list.

   Select No I/O from the Protocol pulldown menu to disable the data output from any port. Each protocol can only be supported by one UART. You cannot configure two different ports to use the same protocol.

4. Select the appropriate serial communication parameters using the selection lists for baud rate, data bits, parity, and stop bits.

5. Click the Send button to accept or the Cancel button to exit.

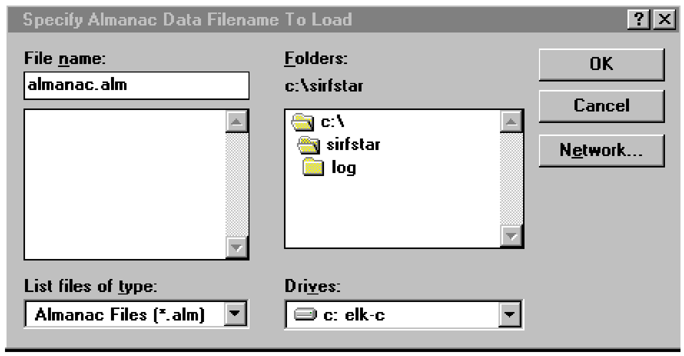
Uploading an Almanac to the Evaluation Receiver

An almanac file is used by a GPS receiver to assist with locating and tracking available satellites. If a current almanac file does not exist in the Evaluation Receiver due to a cold start or if it has not been used for a long period of time, loading a recent almanac file will assist the Evaluation Receiver in locating and tracking satellites.

To upload an almanac file to the Evaluation Receiver:

1. Choose Set Almanac from the Action menu.

   The Specify Almanac Data Filename To Load screen is displayed.



2. Specify the file you want to use.
3. Click the OK button to accept or the Cancel button to exit.

Note – The almanac file must be in the same format as polled from the Evaluation Receiver. To download an almanac file from the Evaluation Receiver, see “Downloading an Almanac File” on page 63.

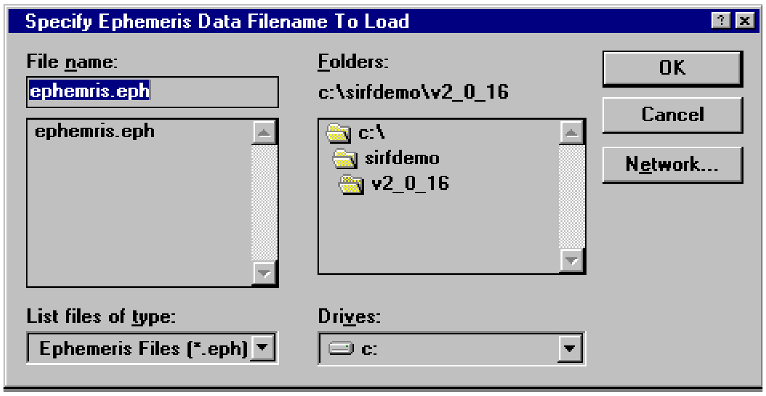
To Upload an Ephemeris to the Evaluation Unit

An ephemeris is used by a GPS receiver to calculate the position of the satellites and hence, the position of the GPS receiver. If an ephemeris file is not available, then this must be downloaded from a GPS satellite. To eliminate the time required to download this information from the GPS constellation, a current ephemeris file can be uploaded to the Evaluation Receiver using the SiRFdemo software.

To upload an ephemeris file to the Evaluation Receiver:

1. Choose Set Ephemeris from the Action menu.

   The Specify Ephemeris Data Filename To Load screen is displayed.



2. Specify the file you want to use.

3. Click the OK button to accept or the Cancel button to exit.

Note – The ephemeris file must be in the same format as polled from the Evaluation Receiver. To download an ephemeris file from the Evaluation Receiver, see “Downloading Ephemeris Data” on page 64.

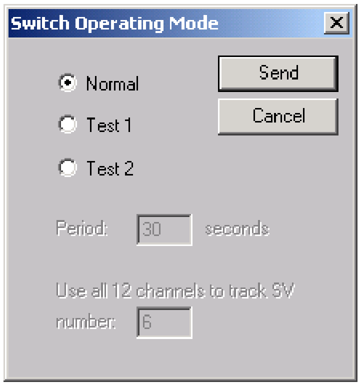
Switching Operating Mode

It is possible to place the Evaluation Receiver into a test operating mode. This mode allows a single selected satellite to be tracked by all 12 channels of the Evaluation Receiver.

To place the Evaluation Receiver into test mode:

1. Choose Switch Operating Mode the Action menu.

   The Switch Operating Mode screen is displayed.



2. Select Test 1or Test 2 if you want to track a specific satellite on all channels and output test results. Test 2 will ouput additional data to that of Test 1.
3. In the Period field, enter the output rate of the test reports in seconds.
4. Enter the SV number that you want to be tracked by all 12 channels of the Evaluation Receiver.
5. Select Normal (default) to track all available satellites.
6. Send the command to the Evaluation Receiver by clicking the SEND button.

Setting the TricklePower Parameters

The SiRFstarIIe Evaluation Receiver can operate in three modes (shown in Table 4-9).

Table 4-9 Evaluation Receiver Modes

Mode	Description
Full Power	Full power mode is the standard operating mode. Power is supplied to the unit continuously and the Evaluation Receiver continues to operate without an interrupt.
TricklePower	In TricklePower mode, the power to the SiRF chipset is cycled periodically, so that it operates only a fraction of the time. Power is applied only when a position fix is scheduled.
Push-to-Fix	In Push-to-Fix mode, the Evaluation Receiver is generally off, but turns on frequently enough to collect ephemeris data to maintain the GSP1 real time clock calibration so that, upon user request, a position fix can be provided quickly after power-up.

TricklePower

In this mode, the power to the GRF2i chip is cycled regularly, according to two user-specified parameters:

- Update Rate
- OnTime

During TricklePower operation, the GRF2i chip is powered on for OnTime (in milliseconds), then powered off for a specified number of milliseconds as determined by the update rate. This cycle repeats indefinitely.

The GSP2e chip is not explicitly powered down, but its primary operation is driven by the GPS clock generated by the GRF2i, so it draws very little power while the GRF2i is powered down. The real time clock (RTC) portion of the GSP2e continues operation at all times, and is used to generate the interrupt that turns everything back on.

The microprocessor on which the SiRF code executes is not explicitly powered down. After the OnPeriod has elapsed, the processor continues operating long enough to complete its navigation tasks, then puts itself in sleep mode until it is reawakened by the RTC-generated interrupt.

The default parameters values are:

- OnPeriod = 200ms
- Update Rate = 1 second

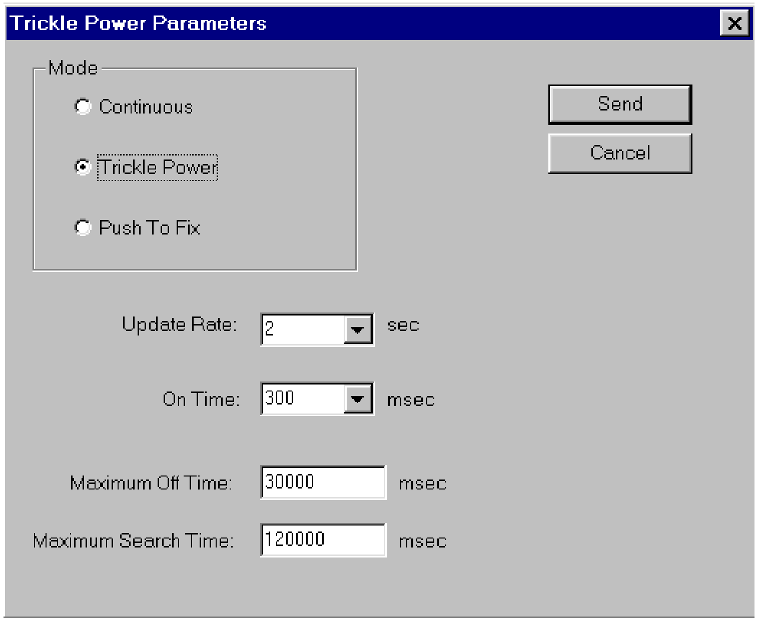
Push-to-Fix

For applications where a position fix is required on demand (that is, not continuous) then the Push-to-Fix mode is the most appropriate mode of operation for power sensitive situations. In this mode, the receiver turns on periodically (approximately every 30 minutes) to update ephemeris records and calibrate the clocks. When all internal updating tasks are complete, the unit powers itself off (except for RTC) and schedules the next wake up period. When the Evaluation Receiver is power cycled externally, a navigation solution will be available to the user in 3 seconds.

To set the Evaluation Receiver trickle power mode:

1. Select Set Trickle Power Parameters from the Action menu.

   The Trick Power Parameters screen is displayed.



2. Select the required operating mode.
3. If Trickle Power is selected then you must enter an Update Rate, an On Time, Maximum Off Time, and Maximum Search Time.
4. Click Send to activate selection.

Table 4-10 shows the Update Rate and On Time combinations that the Evaluation Receiver supports when in trickle power.

Table 4-10 Trickle Power: Update Rate and On Time

	Update Rates (seconds)									
On Time (ms)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
200	X	X	X	X	X	X	X	X	X	X
300	X	X	X	X	X	X	X	X	X	X
400	X	X	X	X	X	X	X	X	X	X
500	X	X	X	X	X	X	X	X	X	X
600	X	X	X	X	X	X	X	X	X	X
700		X	X	X	X	X	X	X	X	X
800		X	X	X	X	X	X	X	X	X
900		X	X	X	X	X	X	X	X	X

To conserve power at start up, you can control how long (Maximum Search Time) the system should attempt to acquire satellites and navigate, and how long (Maximum Off Time) the Evaluation Receiver should remain off (sleep mode) before making another attempt to navigate. Maximum times are in ms.

Example:	Maximum Off Time 30000 ms (default) Maximum Search Time 120000 ms (default)
Scenario 1:	System is turned on, but does not acquire Svs (no antenna connected).
Result:	System searches for 120000 ms, sleeps for 30000 ms, searches again for 120000 ms, etc.
Scenario 2:	System is turned on and acquires Svs, but does not navigate.
Result:	System searches for 120000 ms, sleeps for 30000ms, searches again for 120000 ms, etc.
Scenario 3:	System is turned on, acquires and navigates.
Result:	Sleep mode is disabled.

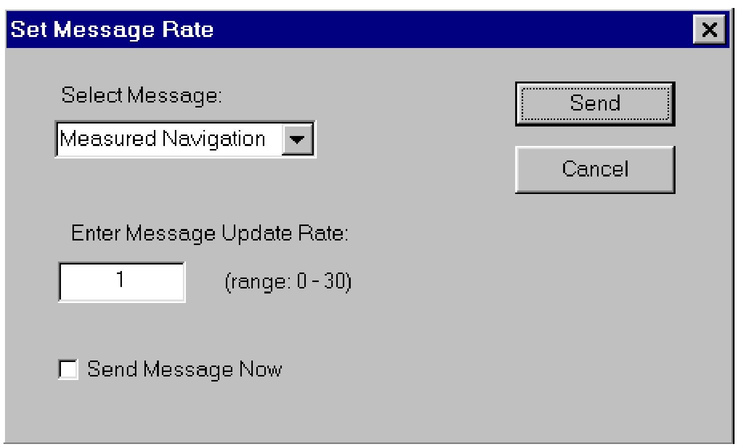
Setting the Message Rate

You can configure each SiRF binary output message so it is output using a specified frequency.

To set the SiRF binary output rates:

1. Choose Set Message Rate from the Action Menu.

   The Set Message Rate screen is displayed.



2. Select the appropriate SiRF binary message from the Select Message selection list.
3. Enter in the rate at which you want the selected SiRF binary message to be output.

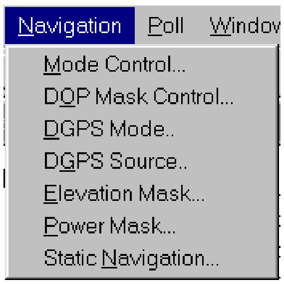
Note – The message rate is based on navigation cycles, not seconds. For example, in Trickle Power mode at an update rate of 2 seconds, selecting 5 as the message output rate outputs the selected message every 10 seconds. 10 seconds, in this case, is equivalent to 5 navigation cycles.

The decrement of the navigation cycle counters for each message begins when the Evaluation Receiver accepts and verifies the input command. Each message is done separately and no mechanism is currently in place to synchronize message output. Message counters are stored in DRAM so they are preserved over hot and warm software resets but will revert to defaults values over power cycles, cold, and factory resets.

The Navigation Menu

This section describes the SiRFdemo software functions under the Navigation menu:

- "Setting Navigation Mode Control" on page 51
- "Setting the DOP Mask Control" on page 55
- "Setting the DGPS Mode" on page 56
- "Selecting the DGPS Source" on page 57
- "Selecting an Elevation Mask" on page 58
- "Selecting a Power Mask" on page 59
- "To Enable/Disable the Static Navigation" on page 60



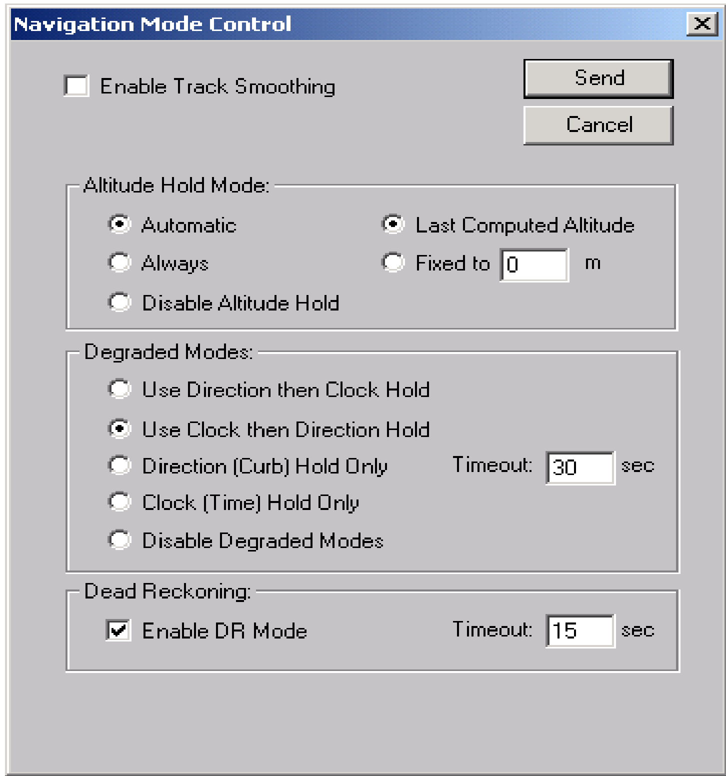
Setting Navigation Mode Control

Navigation mode control is used to configure the specifics of how the Evaluation Receiver is to navigate or calculate a position. In particular, selecting how a position should be derived if a minimum number of satellites are not available to calculate a full 3D position.

To set the navigation mode control:

1. Choose Mode Control from the Navigation menu.

   The Navigation Mode Control screen is displayed.



2. Select the required options. Table 4-11 describes each of the navigation mode options available.

Table 4-11 Navigation Mode Options

Option	Description	Default
Enable Track Smoothing	Enables smoothing of the calculated positions based on acceptable variances from the last calculated position. This assists in eliminating any sporadic position jumps possibly caused by multipath, for example.	Off
Enable Altitude Constraint	Restrict any variations in the altitude to 10% of currently calculated horizontal variation. This assists in creating a smoother ground track.	On
Altitude Hold Mode		
Automatic	Switch automatically to a 2D solution and hold the altitude fixed if only three satellites are available. A 3D solution will be calculated if four or more satellites are available.	On
Always	Stay in 2D mode regardless of the number of satellites available. The altitude will always remain fixed.	Off
Disable Altitude Hold	Only calculate 3D solutions. If it is not possible to calculate a 3D solution due to insufficient satellites, then no navigation will be provided.	Off
Last Computed Altitude	If the Evaluation Receiver is operating in 2D mode, then the altitude will be held to the last known altitude calculated by the Evaluation Receiver.	Off
Fixed to	If the Evaluation Receiver is operating in 2D mode, then the altitude will be held to the value entered in the FIXED TO field.	Off
Degraded Modes		
Use Direction then Clock Hold	If the number of available satellites is reduced to two, the Evaluation Receiver will hold the elevation fixed, and use the last direction and doppler values (change in distance) to continue positioning. If the available satellites is then reduced to one, the clock bias is then extrapolated.	Off
Use Clock then Direction Hold	This mode is similar to the above Direction then Clock Hold mode. However, the clock bias is extrapolated first, and then the direction and doppler measurements are used.	On

Table 4-11 Navigation Mode Options *(Continued)*

Option	Description	Default
Direction (Curb) Hold Only	This mode will restrict positioning to using direction hold only and does not use the extrapolating the clock bias method. Two satellites need to be available.	Off
Clock (Time) Hold Only	Positioning is restricted to using the clock bias extrapolation method only and does not hold the direction. Two satellites need to be available.	Off
Disable Degraded Modes	If less than three satellites are available, no position will be calculated.	Off
Timeout	The Evaluation Receiver will only operate in any degraded mode for the period of time specified by the timeout.	60
Dead Reckoning		
Enable Dead Reckoning Mode	If a position solution is not possible due to insufficient satellites, a positions will be calculated using the last known velocity. Only applies if the Evaluation Receiver is being used in a dynamic environment.	On
Timeout	The Evaluation Receiver will only calculate positions using dead reckoning for the period of time specified by the timeout.	30

3. Click the Send button to accept or the Cancel button to exit.

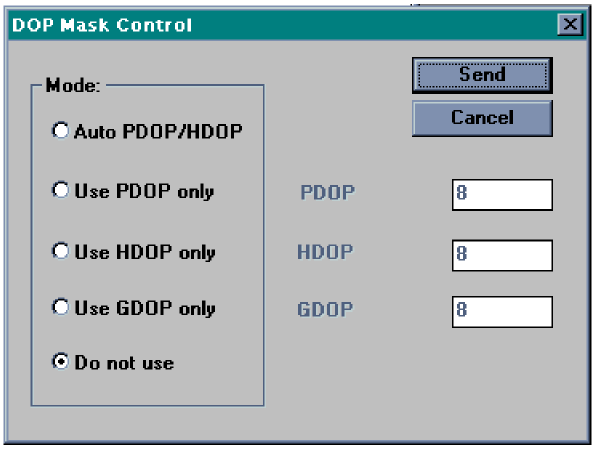
Setting the DOP Mask Control

This mask enables you to control the position output of the Evaluation Receiver so that positions computed with a high DOP value are not output. When the DOP mask is exceeded, the position message status changes to DOP mask exceeded and the position does not update.

To set the DOP mask controls:

1. Choose DOP Mask Control from the Navigation menu.

   The DOP Mask Control screen is displayed.



2. Select the Mode that you want to use.

Option	Description	Default
Auto PDOP/HDOP	The PDOP mask will be used if four or more satellites are available. If only three satellites are available, the HDOP mask will be used.	Off
Use PDOP only	Only the PDOP mask will be used regardless of the number of satellites available.	Off (8)
Use HDOP only	Only the HDOP mask will be used regardless of the number of satellites available.	Off (8)
Use GDOP only	Only the GDOP mask will be used regardless of the number of satellites available.	Off (8)
Do not use	No DOP based mask will be applied. Any available position will be output regardless of any of the DOP values.	On

3. Enter a DOP mask value for the corresponding selected DOP mask.

   For each of the DOP masks, the default value is 10. This value is a maximum value and the mask will apply if the current set mask is exceeded.

4. Click the Send button to accept or the Cancel button to exit.

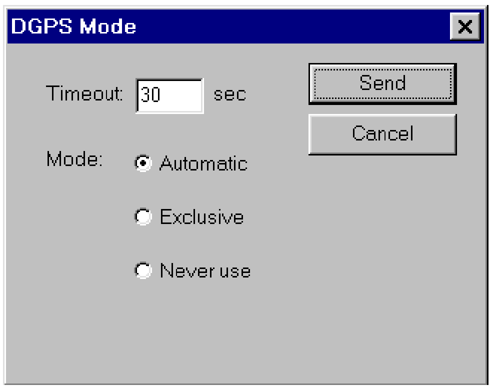
Setting the DGPS Mode

The DGPS mode is used to control the position output of the Evaluation Receiver based on whether positions are differentially corrected or not. The options include automatic, exclusive, and never use.

To set the DGPS mode:

1. Choose DGPS Mode from the Navigation menu.

   The DGPS Control screen is displayed.



2. Select the Mode that you want to use.

Option	Description	Default
Automatic	Use differential corrections when they are available, otherwise compute a non differential solution. (see note below)	On
Exclusive	Only compute a differential solution. If no corrections are available no solution is output.	Off
Never use	Only compute a nondifferential solution (even if corrections are valid).	Off

3. Enter the timeout value (in seconds) you want to use in the Timeout field.

   A received differential correction will be applied to the solution until either the timeout value is exceeded, or a new differential correction is received.

4. Click the Send button to accept or the Cancel button to exit.

Note – For a differential position to be calculated, a pseudorange correction must be valid for each satellite being tracked by the Evaluation Receiver. If the there are less corrections than tracked satellites, then a non-differential position will result. If corrections exist for different satellites to that being tracked by the Evaluation Receiver, then a non-differential position will result.

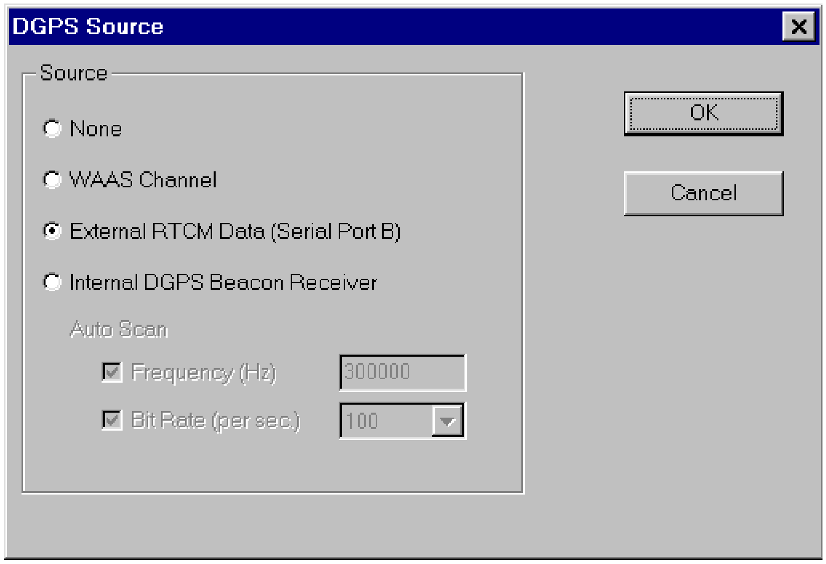
Selecting the DGPS Source

The SiRFstarIIe Evaluation Receiver has the ability to receive RTCM differential corrections from different sources. The DGPS source control is used to select which source will be used to obtain RTCM differential corrections.

To select the DGPS source:

1. Choose DGPS Source from the Navigation menu.

   The DGPS Source screen is displayed.



2. Select the Source that you want to use. Table 4-12 describes each of the available DGPS sources.

Table 4-12 DGPS Sources

Option	**Description**	**Default**
None	The Evaluation Receiver will not use any of the available DGPS sources.	No

Table 4-12 DGPS Sources

Option	Description	Default
WAAS Channel	The Evaluation Receiver will use the WAAS correction service if available. One of the twelve channels will be dedicated to the WAAS signal.	No
External RTCM Data	The Evaluation Receiver will use any RTCM corrections that are input directly through one of the serial ports.	Yes
Internal DGPS Beacon Receiver	The internal beacon receiver will be used to provide RTCM corrections received from an operating radio-beacon. A beacon antenna is required.	No

3. If the Internal DGPS Beacon Receiver is the chosen DGPS source, select the auto scan options. The auto scan options are described in Table 4-13.

Table 4-13 Auto Scan Options

Auto Search	Description
Frequency	The internal beacon receiver will automatically scan the radio-beacon frequency range until a usable signal is acquired. If this option is deselected, you must enter a signal frequency for the beacon receiver to use.
Bit Rate	Radio-beacons may broadcast the correction information using different bit rates (the number of bits of data per second). If this option is selected, the internal beacon receiver will also search the different available bit rates until a usable signal is acquired. If this option is deselected, you must enter a signal bit rate for the beacon receiver to use.

4. Click the OK button to accept or the Cancel button to exit.

Note – The selection made in the DGPS Source screen is displayed in the DGPS Status View screen by selecting View | Messages | DGPS Status

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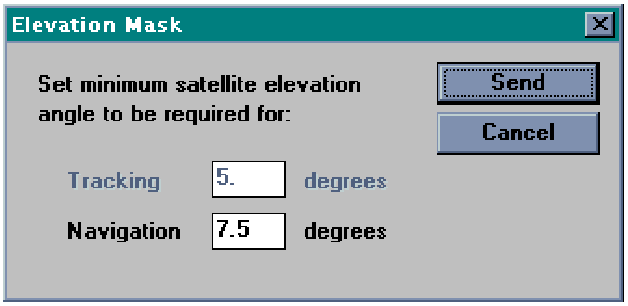
Selecting an Elevation Mask

GPS satellites that are low on the horizon are subject to noise due to the amount of atmosphere that the signal must travel through. Better position accuracy is often achieved if lower elevation satellites are not used in the position solution. The elevation mask is used to exclude the use of satellites in the position solution that are below a defined elevation mask.

To select an elevation mask:

1. Choose Elevation Mask from the Navigation menu.

   The Elevation Mask screen is displayed.



2. Enter the minimum elevation angle for satellites to be used in any position solution.
3. Click the Send button to accept or the Cancel button to exit.

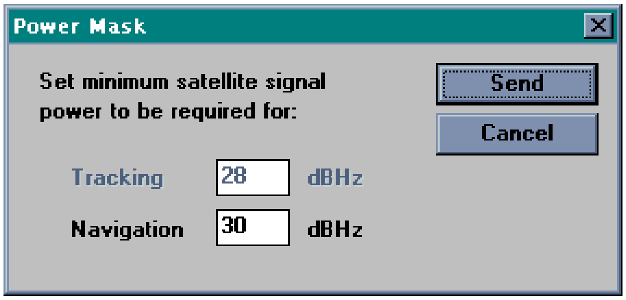
Selecting a Power Mask

GPS satellites that have a low signal strength are not easily tracked by the Evaluation Receiver and may result in using signals that are either noisy or have been effected by multipath or other interference source. To increase accuracy, it may be necessary to exclude GPS satellites with a signal strength below a selected value.

To exclude satellites from the position solution with a signal strength below a selected value:

1. Choose Power Mask from the Navigation menu.

   The Power Mask screen is displayed.



2. Enter the minimum satellite signal level for satellites to be used in any position solution.
3. Click the Send button to accept or the Cancel button to exit.

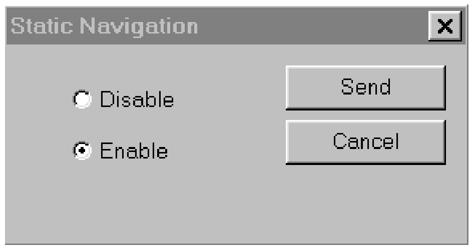
To Enable/Disable the Static Navigation

The steady state detection allows the navigating algorithms to decrease the noise in the position output when the acceleration is below the threshold. This reduces the position wander caused by Selective Availability (SA) and improves position accuracy especially in stationary applications.

To select the static navigation mode:

1. Choose Static Navigation from the Navigation menu.

   The Static Navigation screen is displayed.



2. Select the option that you want to use.

Option	Description	Default
Disable	Displays true user movement due to Selective Availability (and other environmental issues such as multipath).	No
Enable	Holds the current position as fixed when the user is in a stationary mode. Updates to the fixed position due to Selective Availability are made based on internal navigation data.	Yes

3. Click the Send button to accept or the Cancel button to exit.

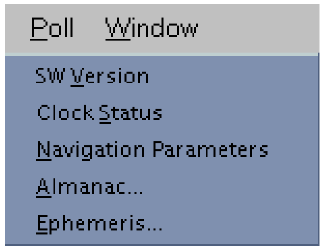
Note – The Static Navigation filter is Disabled when DGPS corrections are used in the navigation solution.

The Poll Menu

This section describes the SiRFdemo software functions under the Poll menu:

- “The Software Version” on page 61
- “The Clock Status” on page 61
- “The Navigation Parameters” on page 62
- “Downloading an Almanac File” on page 63

- “Downloading Ephemeris Data” on page 64



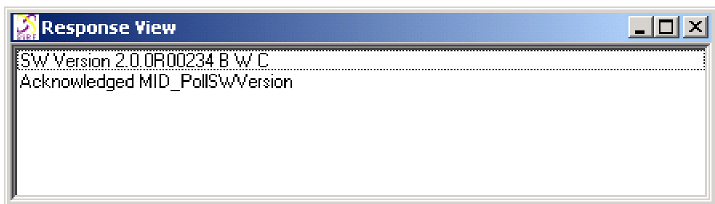
The Software Version

The poll software version function allows you to query the Evaluation Receiver for the version of embedded software currently being run.

To view the current software version:

1. Choose SW Version from the Poll menu

   The Response View screen is displayed showing the software version currently being run.



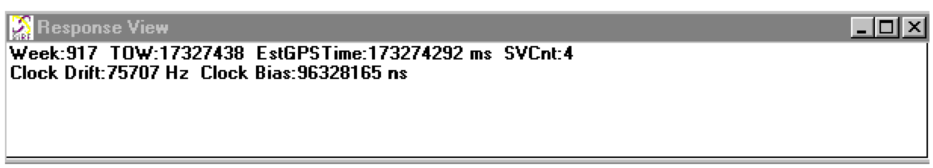
The Clock Status

The poll clock status function allows you to query the Evaluation Receiver for clock performance information including the GPS week number, GPS time, clock drift, and clock bias.

To poll the Evaluation Receiver for clock status information:

1. Choose Clock Status from the Poll menu.

   The Response View screen is displayed with the clock status.



A description of each of the clock status items are given in Table 4-14.

Table 4-14 Clock Status Items

Item	Description
Week	The number of continuous weeks that GPS has been operational. The start date being January 6, 1980.
TOW	Time of Week—the number of GPS seconds since the start of the current GPS week. The start of the GPS week being 0hrs Sunday UTC.
EstGPS Time	The estimated TOW while the Evaluation Receiver is not tracking GPS satellites.
SVCnt	The number of satellites currently being tracked and used in the position solution.
Clock Drift	The change in the clock bias.
Clock Bias	The offset of the Evaluation Receiver clock compared with the current GPS time.

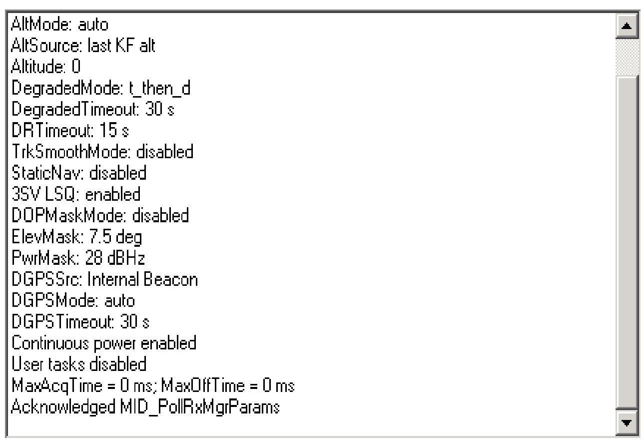
The Navigation Parameters

All of the user settings that have been set under the Action and Navigation menus can be polled for their current status and settings.

To poll the Evaluation Receiver for it's current navigation parameters:

1. Select Navigation Parameters from the Poll menu.

   The current settings are displayed in the Response View window.



A description of each of the navigation parameters are given in Table 4-15.

Table 4-15 Navigation Parameters

Parameter	Description
AltMode	The selected altitude hold mode.
AltSource	The altitude type used when a 2D solution is being calculated.
Altitude	The altitude used if fixed manually.
DegradeMode	The type of degraded mode selected.
DegradedTimeout	The timeout value applied to degraded mode operation.
DR Timeout	The timeout value applied to dead reckoning navigation.
TrkSmoothMode	The enable or disable state of track smoothing.
StaticNav	The enable or disable state of the static navigation mode.
3SV LSQ	Indicates the state of a start-up mode that will allow start-up when only three satellites are available.
DOPMaskMode	The selected DOP mask control.
ElevMask	The currently used elevation mask.
PwrMask	The currently used power mask.
DGPSSrc	The selected DGPS source.
DGPSMode	The selected DGPS mode.
DGPSTimeout	The timeout value applied to DGPS corrections.
Power Mode	This line indicates the current power mode of the Evaluation Receiver. It will be either trickle power or full power.
MaxAcqTime	The Maximum Acquisition Time.
MaxOffTime	The Maximum Off Time.

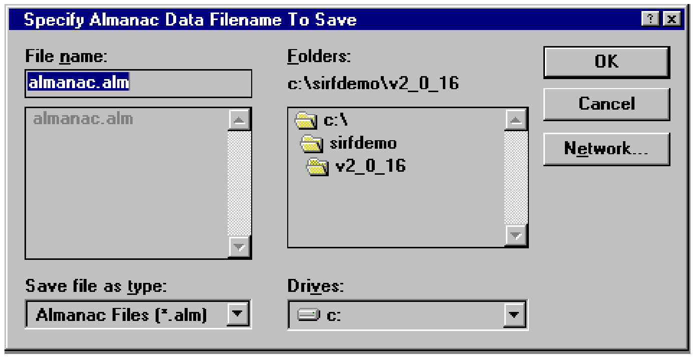
Downloading an Almanac File

You can download an almanac file from the Evaluation Receiver and load it back into the unit at a later date or to another Evaluation Receiver. This is to assist with initial satellite tracking. This file may also be used for mission planning and constellation investigations.

To download an almanac file:

1. Choose Almanac from the Poll menu.

   The Specify Almanac Data Filename To Load screen is displayed.



2. Specify the file name in which to save the almanac information.
3. Click the OK button to save or the Cancel button to exit.

   Clicking the OK button saves the data to file. A message box is displayed to confirm completion.

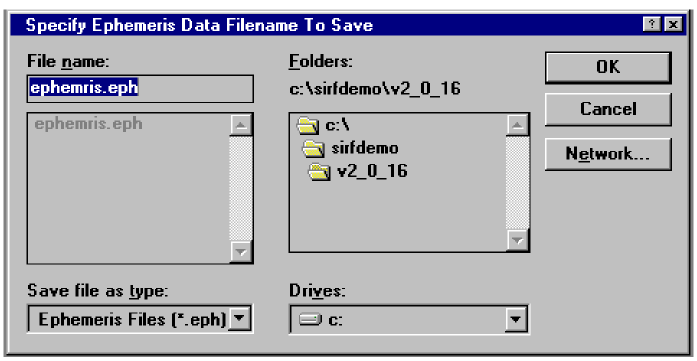
Downloading Ephemeris Data

You can download an ephemeris file from the Evaluation Receiver and load it back into the unit at a later date or to another Evaluation Receiver. This is to assist with initial position calculations. This file may also be used for mission planning and constellation investigations.

To download an ephemeris file:

1. Choose Ephemeris from the Poll menu.

   The Specify Ephemeris Data Filename To Load screen is displayed.



2. Specify the file name that you want to save the ephemeris information to.
3. Click the OK button to save or the Cancel button to exit.

   Clicking the OK button saves the data to file. A message box is displayed to confirm completion.

Using the SiRFsig Software 5

The SiRFsig software is a DOS-based program that provides the ability to analyze the performance of an antenna, the conditions of the satellite observation environment, position and velocity performance. The SiRFsig software uses SiRF binary data types 004 (Measured Tracking) and 002 (Measure Navigation) that can be output and logged from the SiRFstarIIe Evaluation Receiver.

Required Data

The SiRFsig software uses SiRF binary protocol data that has been logged from the Evaluation Receiver. The required data is:

- Type 004: Measured Tracking
- Type 002: Measure Navigation
- Development data

This data must be in the correct format and have the extension `*.gps`.

Before running the SiRFsig program, you must have a valid data file or collect one using the Evaluation Receiver. See **Chapter 4, “Using the SiRFdemo Software**” for complete information on logging data from the Evaluation Receiver.

Running the SiRFsig Software

This section provides information on how to start the SiRFsig software, load the logged data file, and begin viewing information screens.

1. At a DOS command prompt, type: **`C:\sirfstar\toolkit\sirfsig`** ***`filename`***

   The *filename* is a file with a `.gps` extension and contains the required data. The `.gps` extension should not be included when typing the filename because the SiRFsig software already expects the `.gps` extension.

   Example: If the data filename is `station.gps`, type:

   ```
   C:\sirfstar\toolkit\sirfsig station
   ```

Note – If the SiRFsig software is in a different directory, you must include that directory at the command prompt.

2. SiRFsig parses the data file, extracts the information, and creates other files containing necessary data. The created files are described in Table 5-1.

   To terminate the program while parsing, press the ESC key.

Table 5-1 Files Created by SiRFsig

File Extension	Description
`*.avg`	Contains statistical average values for observed C/No, position, and velocity. Other general data such as protocol used and software version is also contained within this file.
`*.pos`	Contains position records and associated information for each observed position such as DOP, mode, and satellites used.
`*.vel`	Contains velocity records in the X, Y, and Z directions. Associated information such as DOP, mode, and satellites used are also included.
`*.###`	Where ### is the satellite PRN number. This file contains satellite specific information such as GPS time, azimuth and elevation of the tracked satellite, and the average C/No for that satellite.
`*.svs`	Contains statistical information for C/No values for each tracked satellite.
`*.err`	Contains any data error information such as incorrect checksums.
`*.tfx`	Contains time to first fix (TTFF) information.

See **Appendix A, “File Formats**” for a full description of the file formats.

Note – If you have selected a file that has already been parsed, you will be prompted whether you wish to reparse the data (press ENTER) or continue without reparsing (press ANY OTHER KEY). You have 10 seconds to make a selection otherwise the data is re-parsed automatically.

After the SiRFsig software has finished parsing the data, the first plot is automatically displayed. This plot is a C/No polar plot.

Viewing Available Plots

Once the data has been parsed by the SiRFsig software, a number of graphical plots and associated text information is available. Each available plot provides information that can be used to evaluate different performance factors of the Evaluation Unit and GPS antenna. Table 5-2 describes each of the plots that are available and the associated function key.

Table 5-2 SiRFsig Available Plots

Plot	Description	Function Key
CNo Polar	Observed C/No values within bins defined by azimuth and elevation.	F1
Sat Trj	The trajectory of tracked GPS satellites over time.	F2
CNo/T (Sv)	C/No values for each tracked satellite over time.	F3
CNo/E (Sv)	C/No values verses elevation for each tracked satellite	F4
CNo Vs Elev	Average, minimum and maximum C/No values in relation to the elevation.	F5
Stats (Sv)	Text information for C/No statistics for each tracked satellite.	F6
Stats (Bin)	Statistical information for observed C/No values grouped into bins defined by satellite elevation and azimuth.	F7
Pos & Vel	Observed horizontal positions are plotted as well as background data for comparison and velocity values.	F8

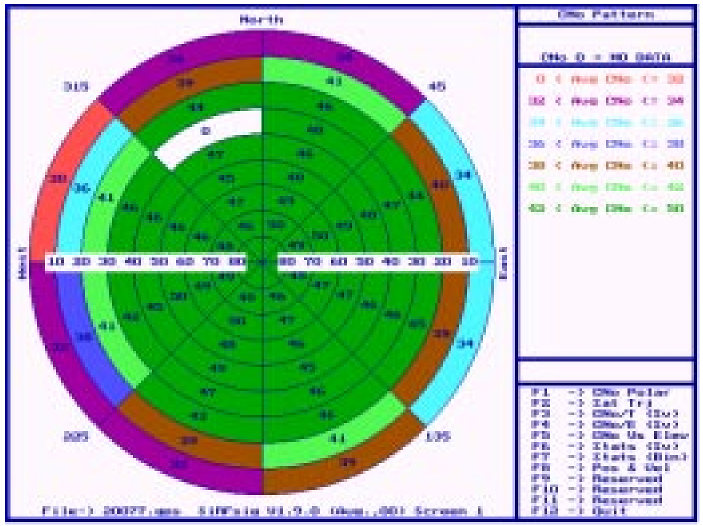
Each of the available plots are accessed by function keys. Press the function key that corresponds with the required plot to view that plot.

Note – You must view the satellite trajectory plot (F2) before you can view the Bin Statistics plot (F7).

Select the F12 key to exit the program when the main menu is displayed.

The C/No Polar Plot - F1

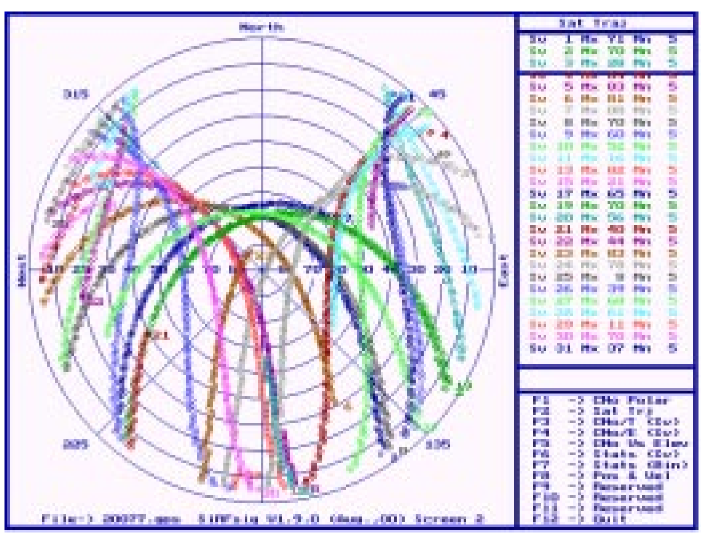
The C/No Polar Plot is the first screen seen after parsing the data. Otherwise, this screen can be viewed by pressing the F1 function key.



This screen shows the measured C/No pattern in terms of 72 azimuth/elevation bins. Dimensions of the bins are 45 degrees in azimuth and 10 degrees in elevation. The value shown in each bin is the average C/No value based on all satellite measurements in that bin. Where the value is 0 (zero), no data was collected. The patterns created by the adopted color scheme and the average C/No values can be used to investigate the antenna characteristics (with a clear view of the sky) or the observation environment (with multipath surfaces or blockages).

The Satellite Trajectory Plot - F2

The Satellite Trajectory screen can be viewed by pressing the F2 function key.

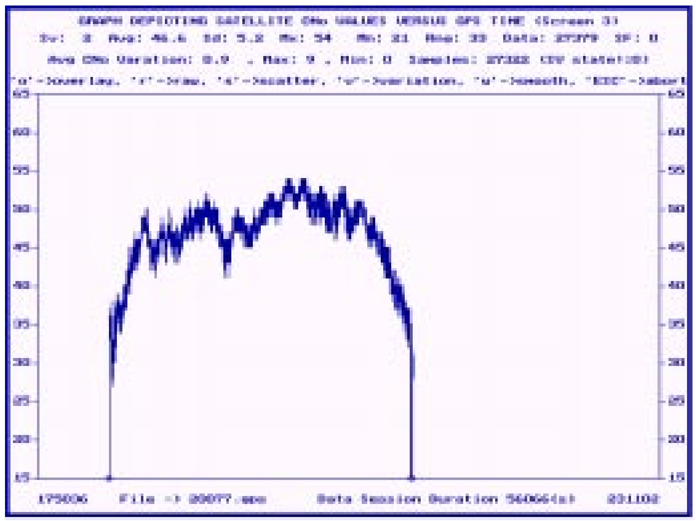


The Azimuth /Elevation plot shows the measured trajectory of each satellite over time in the data session. The outer ring represents the horizon (0 degrees elevation) and the middle of the ring is the zenith (90 degrees elevation). The top of the plot is north (0 degrees), bottom is south (180 degrees), left is west (270 degrees), and right is east (90 degrees). The maximum and minimum elevation angles of the satellites tracked are listed in the right column of the screen.

Note – Any breaks in the trajectory are an indication of missing data.

The Satellite Specific C/No verses Time Plot - F3

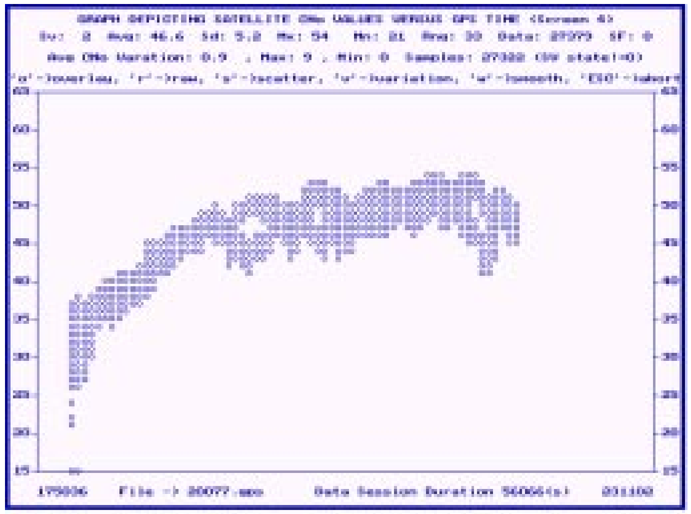
The satellite specific C/No plot can be viewed by pressing the F3 function key.



This plot shows the measured C/No values (Y axis) versus GPS Time (X axis). C/No values may range from 15 db to 65 db. The time window is the entire data session (not just the time the satellites were tracked). Measured C/No values are plotted with statistical information in the header of the plot. A Smoothing Factor (SF) may be used to look for data trends. The value of the SF implies the number of previous C/No values averaged to predict data at that point. All data is equally considered. The C/No line plot is a good indication of satellite signal behavior. Signal reaction to increased atmosphere (i.e., rising or setting) and multipath is displayed.

The Satellite Specific C/No verses Elevation Plot - F4

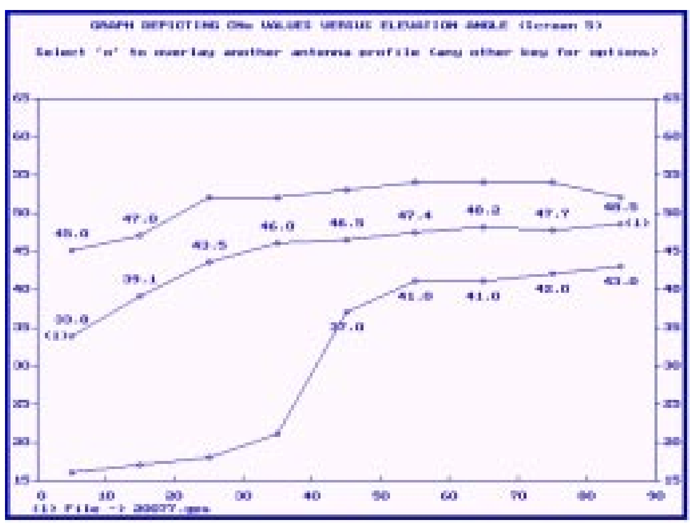
The satellite specific C/No verses elevation plot can be viewed by pressing the F4 function key.



This plot shows the measured C/No values (Y axis) versus Elevation Angle (X axis). C/No values may range from 15db to 65db. Measured C/No values are plotted with statistical information in the header of the plot. The C/No scatter plot is a good indication of satellite signal behavior.

Average C/No Values verses Elevation - F5

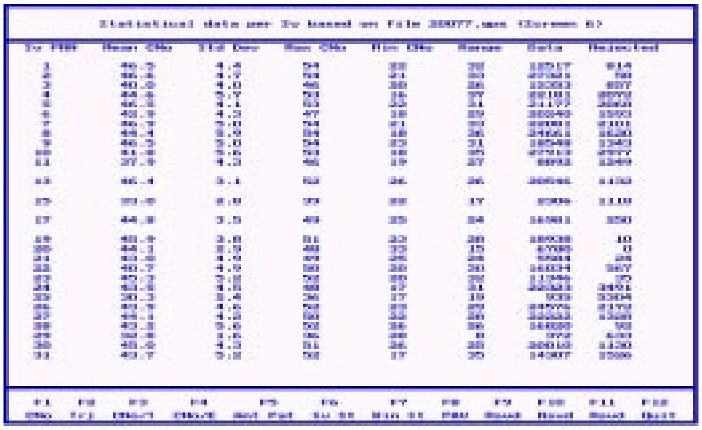
The average C/No verses elevation plot can be viewed by pressing the F5 function key.



The three lines shown on this plot represent maximum, average and minimum observed C/No values. The x-axis represents elevation in 10 degree increments and the y-axis represents C/No values from 15db to 65db. The value plotted at each junction (i.e., C/No for 0 to 10 degrees) represents the average value independent of azimuth. It is the average value based on the populated bins from the C/No polar plot, in the appropriate degree range (i.e., 0 to 10). Subsequent points are computed for each elevation bin. All values are azimuth independent.

Satellite Specific Statistics - F6

The satellite specific statistics can be viewed by pressing the F6 function key.

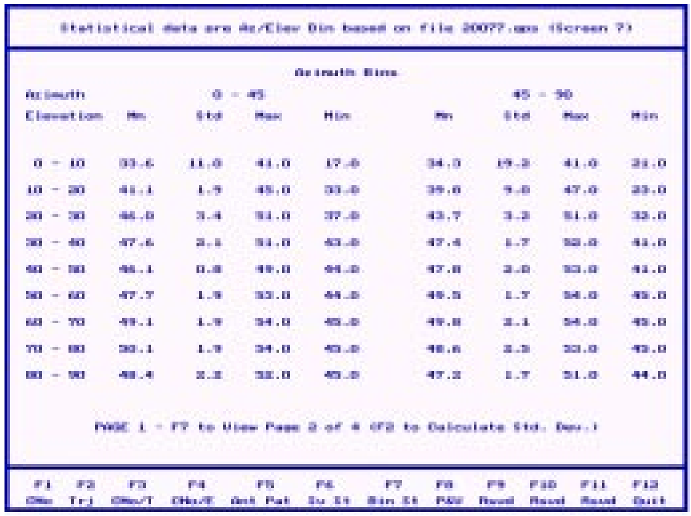


Statistical information is provided for each satellite represented by PRN number. Each line contains:

- Satellite number
- Mean: the average of all C/No values of the satellite
- Std-Dev: the standard deviation
- Max: the maximum C/No value
- Min: the minimum C/No value
- Range: the difference from the Max.- Min. C/No values
- Data: the number of fixes collected during the test session

Bin Statistics - F7

Bin statistics can be viewed by pressing the F7 function key.



This screen shows the associated statistics for each azimuth/elevation bin for the 72 bins. Data is on four pages with each page displayed when the F7 function key is pressed. Each bin section contains the average, standard deviation, maximum and minimum C/No values of all the satellites passing through each Azimuth elevation section.

Position and Velocity Plots - F8

When the position and velocity plot option is selected (F8), other plot options become available that are associated with position and velocity data.

Table 5-3 describes each of the plots that are available from the position and velocity screen and the associated function key.

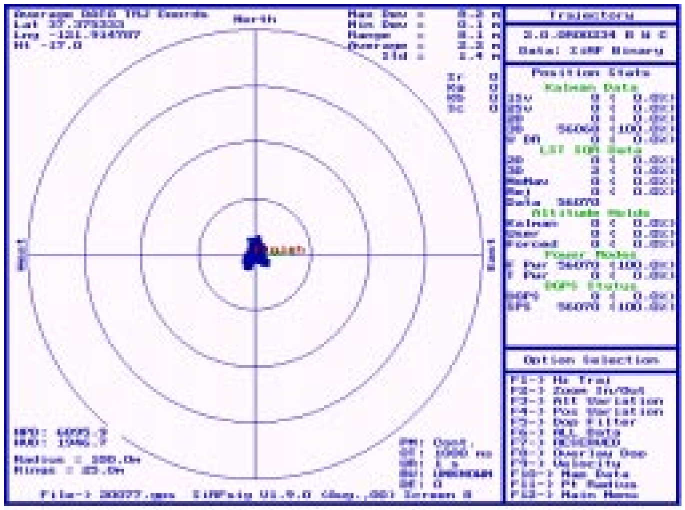
Table 5-3 Available Plots on the Position and Velocity Screen

Plot	Description	Function Key
Hz Traj	Plotted horizontal positions. Data logged from a stationary receiver results in a scatter plot.	F1
Alt Variation	Plot representing the measured altitude in relation to the calculated average altitude of the data set.	F3
Pos Variation	Plot representing the measured horizontal position in relation to the calculated average horizontal position of the data set.	F4
Velocity	Plot representing the velocity in the horizontal, east, north, and down directions.	F9

The first plot displayed is the horizontal trajectory plot.

The Horizontal Trajectory Plot - F1

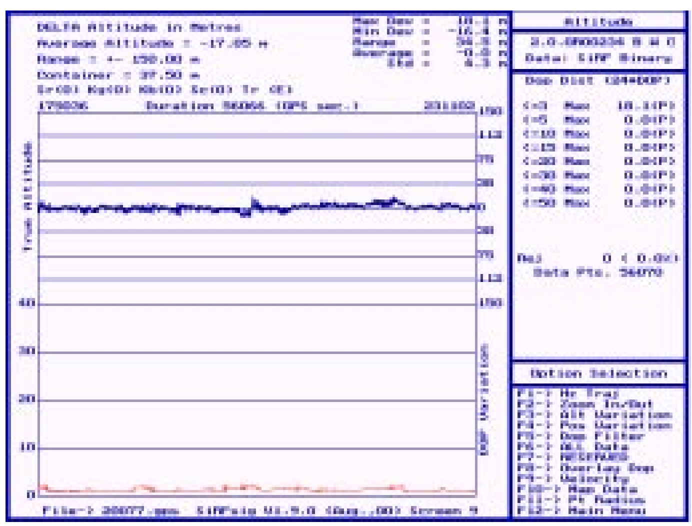
The horizontal trajectory plot is automatically displayed after the position and velocity plot option is selected (F8). Otherwise, it can be viewed by pressing the F1 function key.



The horizontal trajectory plot is a scatter diagram based on data type 002 (position data). The rings are scalable and display the receivers position error in relation to the average position of the data set. The average ECEF XYZ position is computed during the parsing stage. All position differences are in relation to the average coordinate which is the center of the plot. The rings are scalable (F2) by redefining the radius of the outside ring. Associated statistics for each ring are found on the sidebar.

The Altitude Variation Plot - F3

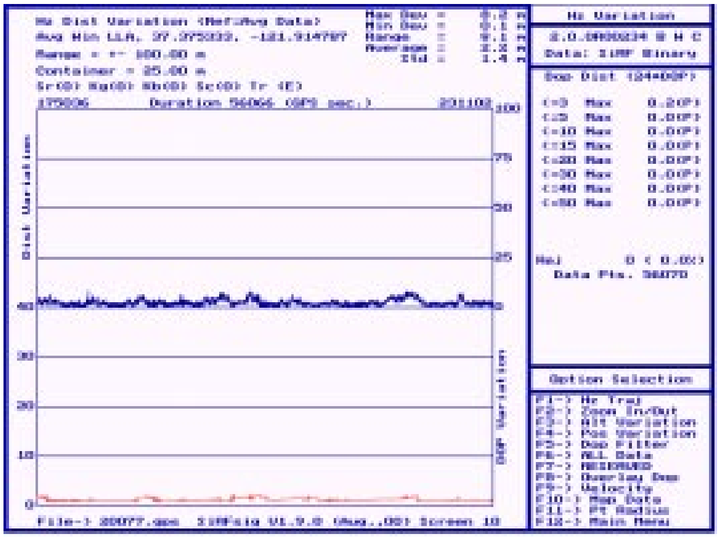
The altitude variation plot can be viewed by pressing the F3 function key.



The ECEF Coordinates are converted to latitude, longitude and altitude data based on the WGS84 ellipsoid. The altitude variation is determined by the difference between the measured altitude at a certain epoch and the average altitude determined during parsing. The differences are plotted versus time. The containers are scalable (F2) and have the associated statistics in the side bar, depending on selected overlay option allowed.

The Distance Variation Plot - F4

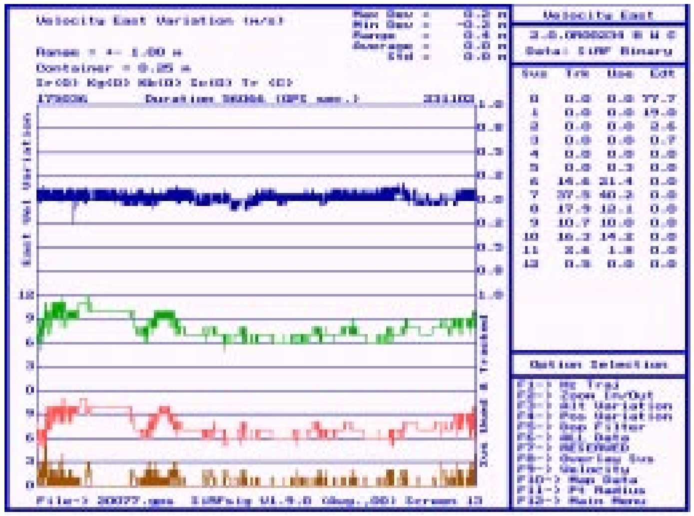
The distance variation plot can be viewed by pressing the F4 function key.



This line plot shows the distance variation from the average coordinate in relation to time. The containers are scalable (F2) and have the associated statistics in the side bar, depending on selected overlay option allowed.

The Velocity Variation Plot - F9

The velocity variation plot can be viewed by pressing the F9 function key.



This line plot shows the velocity (horizontal, east, north and down) variation from zero in relation to time. The containers are scalable (F2) and have the associated statistics in the side bar, depending on selected overlay option allowed.

Other SiRFsig Software Controls and Options

In addition to displaying various plots and information screens, a variety of other controls are available for further data manipulation and viewing options. These controls generally relate to a specific plot.

Main Plot Options

The following a list of options that are associated with each of the main plots.

Screen 1 (F1) — C/No Pattern

None.

Screen 2 (F2) — Sat. Traj.

None.

Screen 3 (F3) — C/No Vs Time

1. Type a specific satellite number.
2. Type `a` to view each satellite consecutively.
3. Select `s` to display Smoothed SV C/No data.
4. Select `r` to display Raw SV C/No data.

5. Select o to overlay another file
6. Select w to smooth the displayed data
7. Press esc to abort

Screen 4 (F4) — C/No Vs Elevation

1. Type a specific satellite number.
2. Type a to view each satellite consecutively.
3. Select s to display Smoothed SV C/No data.
4. Select r to display Raw SV C/No data.
5. Select o to overlay another file
6. Select w to smooth the displayed data
7. Press esc to abort

Screen 5 (F5) — Antenna Profile

1. Select o and type the filename to compare another data profile. The data must have been previously parsed.

Screen 6 (F6) — Sv Statistics

None.

Screen 7 (F7) — Bin Statistics

1. Press F7 to view the next page of bin statistics.

Position and Velocity Options - F8

The following is a list of the options associated with each of the position and velocity plots.

Screen 8 (F1) — Position Trajectory

1. Press F2 and enter distance to change scale distance. Type m for maximum range.
2. Enter filter selection (F5, F6, or F7), change overlay selection (F8), or press shift+r to change stats.
3. Press F12 to return to main menu.

Statistics: Average geodetic coordinates in latitude (DEC), longitude (DEC), and ellipsoid height (meters).
Maximum, minimum, and average horizontal distance variation (meters).
Standard deviation of horizontal variation (meters).
Number of positions and percentage per each ring category.
Total number of positions rejected due to filter settings.

Screen 9 (F3)— Altitude Variation

1. Press F2 and enter distance to change scale distance. Type m for maximum range.
2. Enter filter selection (F5, F6, or F7), change overlay selection (F8), or press shift+r to change stats.
3. Press F12 to return to main menu.

Statistics: Maximum, minimum and average horizontal distance variation (meters).
Standard deviation of horizontal variation (meters).
Number of positions and percentage per each container category.
Total number of positions rejected due to filter settings.

Screen 10 (F4)— Distance Variation

1. Press F2 and enter distance to change scale distance.
2. Enter filter selection (F5, F6, or F7), change overlay selection (F8), or press shift+r to change stats.
3. Press F12 to return to main menu.

Statistics: Maximum, minimum and average horizontal distance variation (meters).
Standard deviation of horizontal variation (meters).
Number of positions and percentage per each container category.
Total number of positions rejected due to filter settings.

Screen 13-16 (F9)—Velocity Variation

1. Press F2 and enter distance to change scale distance.
2. Enter filter selection (F5, F6, or F7), change overlay selection (F8), or press shift+r to change stats.
3. Press F12 to return to main menu.

Statistics: Maximum, minimum and average horizontal distance variation (meters).
Standard deviation of horizontal variation (meters).
Number of positions and percentage per each container category.
Total number of positions rejected due to filter setting.

Note – On the bottom of the horizontal/altitude/velocity variation plot: if the DOP associated with each position is plotted, depending on the type of position (2D or 3D), and HDOP.

Filter Options

There are several ways to filter the data to look at certain aspects of performance. The rej. = value found in the Positioning Stats column on screens 8, 9, and 10 show the number of positions rejected due to filter combinations.

F5 – Dop Filter: Any positions greater than the Dop Filter value is not plotted or used in the statistics.

F6 – All Data: Default data to be plotted. Other positions are DGPS data only, Non DGPS data only, or satellite specific data ranging from 1 to 12 satellites.

F7 – Reserved: Number of satellites used in solution (default is All SVs, range 1-12).

Note – Average position values are computed during the initial parsing stage, only valid positions are used in this calculation.

Overlay Options

There are three overlay options available for screen 8 through 16.

F8 – Overlay — Options available are:
- HDOP
- Satellites tracked, used and edited
- CPU throughput
- Snap and hot starts
- Warm starts
- Cold starts
- Startup parameters
- Position mode 1 statistics

Press F12 to exit the submenu, the main menu options are displayed. Press F12 again to exit the program.

Processing Options

If you have several data files processing or the files are very large, you can process the data similarly to a batch file by adding the `p` option to the command line

Example: `C:\sirfstar\toolkit\sirfsig station p`

The data is parsed and the program returns to the DOS prompt. If you create a batch file of several data files, they are processed consecutively.

Example: Create a file called `process.bat` that contains the following lines:

```
C:\sirfstar\toolkit\sirfsig data1 p
C:\sirfstar\toolkit\sirfsig data2 p
```

Run `process.bat` at the command line and all data files are processed. To view the data file in graphic form, run `sirfsig` without the `p` option.

Additional Software Tools 6

In addition to the SiRFdemo and SiRFsig software, various other utilities have been provided to assist with evaluation of the SiRFstarIIe architecture. These utilities are DOS based executables and are part of the software toolkit provided with the Evaluation Kit CD. Table 6-1 gives a description of each of the provided utilities.

Table 6-1 Additional Software Utilities

Utility	Description
Summary.exe	Provides a summary of logged data.
Parser.exe	Separates data contained in a single logged file into multiple files of similar data.
Conv.exe	Converts ECEF Cartesian coordinates into WGS84 polar coordinates.
Fixanal.exe	Calculates TTFF (Time To First Fix) statistics.
Cksum.exe	Calculates checksum values.
Datum.exe	Converts between datums.
Calcpsr.exe	Computes GPS measurement data and ephemeris parameters from logged data.

The following section covers the operation of each of the provided utilities of the SiRFstar Toolkit. Example data that has been logged with SiRFdemo software is provided to familiarize you with the processing procedures and features of the supplied software.

The Summary Utility

`Summary.exe` is a DOS-based program that processes logged data collected with the SiRFdemo software. It uses message type 002 data (see Appendix B, “The SiRF Binary Protocol”) for all position, velocity, and tracking statistics. Many processing options can be selected through command line input. All output files maintain the basename of the log file (i.e., `basename.ext`).

Note – See example data files `station.gps` and `roadtest.gps`.

Table 6-2 lists each of the command line options available and its action.

Table 6-2 Command Line Options

Switch	Action
-o	Creates navigation data output file with extension `*.out`.
-o-	Does NOT create navigation data output file with extension `*.out`.
-c:n	Prints the worst line out of every n lines to `*.out` file.
-s	Specifies the case when test was stationary.
-s-	Specifies the case when test was not stationary (i.e., road test).
-n:*username*	Indicates tester's name (where *username* is the person who did the testing).
-p:*ident*	Specifies hardware platform identifier (i.e., data collection device).
-d	Processes only DGPS-corrected position fixes.
-i:*n*	Indicates the number of fixes to ignore, where *n* is a number of initial fixes to be ignored.
-a	Processes all data, regardless of any reset strings.
-x:*coord*	Specifies a coordinate where *coord* is an ECEF reference X coordinate in meters.
-y:*coord*	Specifies a coordinate where *coord* is an ECEF reference Y coordinate in meters.
-z:*coord*	Specifies a coordinate where *coord* is an ECEF reference Z coordinate in meters.

Note – If you type `summary` at the DOS prompt, you will be prompted for minimum input information.

Running Summary

After you start Summary, you are prompted for your name and the platform on which you are running. These prompts are repeated in the output file to help you identify the test. As data is being processed, two numbers are displayed on your screen. The first number is the total number of lines read from the `data` file. The second number is the number of the line currently being processed. Although these numbers are not updated continuously, they indicate that the program is running.

Initial Position Message

Because the Summary Program converts to ENU (East, North, Up), it must have an XYZ starting point. This message is automatically saved by the Evaluation Receiver on reset and is logged by the SiRFdemo software as long as message type 255 (Development Data) is highlighted in the message box in the log file heading from the Define Data Sources screen.

If it is not, you can cut and paste the message in the `*.log` file from another file that contains the data or type the contents of the message using a text editor. The only lines that the Summary Program searches for are line 1 (Version) and line 4 (POS), as shown below:

```
Version 00.33 built at 14:38:27 Oct 19 1996 using fxp
TOW: 384074
WK:  876
POS: -3955124 3355588  3699664
CLK: 62779
CHNL:12
```

If you have a log file containing type 2 messages without a Version header, the first 002 message coordinates are interpreted as initial position reference point.

This `summary.exe` file then produces the following output:

- A histogram of position and velocity data for stationary test evaluation.
- A file that has converted XYZ format of position and velocity to ENU format.

The output data files are listed in ASCII format. Therefore, you can import the data into a Microsoft Excel spreadsheet or any other spreadsheet program for further plotting (an example macro is provided on Disk 4: Macro).

Two new files are created and displayed in your current directory:

- `*.sum -` Statistical information.
- `*.out -` Position, velocity, and tracking information.

Summary File: *.sum

The summary output file (`*.sum`) includes the following parts:

- Header information to identify the test
- Statistical measurements of data
- A histogram

Header Information

The first part of the `summary.exe` file is the header information that identifies the test, as shown below:

Header Name	Description
Tester's name	George
HW platform:	cc102
Software:	Version 1.3.1R144
Processed on	Tuesday June 3 14:12:11 1999
GPS Time	Week No. 1011, TOW 529520
Total Number of Samples	166

Statistical Measurements of Data

The second part of the `summary.exe` file consists of statistical measurements of data. The table has the following columns:

- Labels
- Position East (in meters)
- Position North (in meters)
- Position Up (in meters)
- Velocity East (in meters/second)
- Velocity North (in meters/second)
- Velocity Up (in meters/second)

Labels	Position East	Position North	Position Up	Velocity East	Velocity North	Velocity Up
Maximum:	4.24	3.91	32.3	0.238	0.631	0.898
Line #	842	833	2398	2460	2389	1640
Minimum:	-28.7	-35.1	-2.11	-0.186	-0.179	-0.843
Line #	2186	1913	842	957	1396	2487
Mean:	-13.9	-17	15.3	-0.0115	0.153	0.48
Standard Deviation:	7.58	9.04	9.53	0.0886	0.172	0.201
Max-Min:	33	39	34.5	0.424	0.81	1.74

Line numbers are included in the log file where each maximum and minimum value occur. This process is helpful when debugging and searching for unusual events. You can import this position into a Microsoft Excel spreadsheet using spaces as column delimiters.

Histogram

The third part of the `summary.exe` file is the histogram. It also uses the same six columns (Pe, Pn, Pu, Ve, Vn, Vu). The bin sizes are listed on the left. The position range is ±500 m in 20-meter bins and the velocity has a range of ±25 m/s in 1 m/s bins. The numbers reported in each bin are listed as a percentage. You can obtain the number of values in a bin by multiplying the total number of samples listed on the last line of part 1. Any points outside this range are listed as Bad Fix with a line number.

Summary Output File (*.out)

The `*.out` file has 14 columns that can be imported into a Microsoft Excel spreadsheet using spaces as delimiters. The file format is as follows:

Table 6-3 Output File Format

Label	Description
GPS Time:	Seconds into the GPS week
Latitude:	WGS84 Geodetic Latitude in degrees
Longitude:	WGS84 Geodetic Longitude in degrees
Position East:	LTP delta Easting in meters from initial coordinate
Position North:	LTP delta Northing in meters from initial coordinate
Position Up:	LTP delta height in meters from initial coordinate

Table 6-3 Output File Format *(Continued)*

Label	Description
GPS Time:	Seconds into the GPS week
Latitude:	WGS84 Geodetic Latitude in degrees
Velocity East:	LTP velocity in meters/seconds in the east (-) west (+) direction
Velocity North:	LTP velocity in meters/seconds in the north (+) south (-) direction
Velocity Up:	LTP velocity in meters/seconds in the up (+) down (-) direction
DOP:	Dilution of Precision
Svs in View:	Almanac calculation of visible satellites
Svs Tracked:	Number of satellites in track at this time
Svs in Solution:	Number of satellites used in the navigation solution at this time
Pos Mode:[1]	Position status (see Table B-37)

1. -99 implies that the position is unvalidated.

Porting Data into the Excel Macro

The provided templates are designed to paste data directly from a `*.out` file.

Note – See example macro `Msanfran.xls`.

To port data into the Excel macro:

1. Open a new template.
2. Select Save As from the File menu.
3. Name the file Plot.
4. Open the `*.out` file. This is the source file. (Two files are open simultaneously, plot and source, although you can view only one at a time.) Excel prompts you to import the data.
    a. Select delimited, then next.
    b. Select delimited by spaces, then next.
    c. If the first column contains only blanks cells, mark the bubble to delete it.
    d. Select finish. Excel will read the data into a new work sheet.
5. Mark (highlight) and copy (copy button, or File - Copy, or Ctrl-C) all the data rows (first data row to bottom of the sheet) and columns (A-N).
6. Move to the Plot file (Windows button, then click on the plot file name).
7. Click on the top left data cell in the plot file (A13).
8. Paste the data into the plot file. (Paste button, or File - Paste, or Ctrl-V.)
9. Trim or copy the bottom of the spread sheet to remove any leftover template data and to ensure the computed items are present for every data row. (See "How to Trim the Data File" on page 84.)

10. Enter the documentation for the run in column B rows 2 through 8.
11. Save the file. You are ready to plot and analyze.

How to Trim the Data File

You must trim the Plot file to match the number of data rows in the data file in the following cases:

- The template has more data than the plot file
- The plot file has more data than the template.

If the Plot file has more data than the template, perform the following steps:

1. Go to the bottom of column N (the first computed column). Notice there is more data in columns A-N than there is in the computed columns, O-??. Assume there are DDDD rows of data and CCCC rows of computed columns.
2. Mark and copy the last row of computed items (row CCCC, columns O-??).
3. Mark and paste rows CCCC+1 through DDDD so that there are computed items for every data row.
4. Extend each series to the new value (i.e., the length of column).

If the template has more data rows than the Data file, perform the following steps:

1. Go to the last row containing data copied from the Data file. Assume this is row DDDD.
2. Mark all the rows that are extras left over from the template.
   a. Click the left tab for row DDDD+1.
   b. Go to the end of the file.
   c. Hold down the Shift key.
   d. Click the left tab for the last row.
3. Delete the extra data by pressing the Delete key or by selecting Delete from the Edit menu.

The Parser Utility

This DOS-based utility scans through the data file collected with SiRFdemo and breaks out specific data strings to separate files. Table 6-4 provides a description of the parsed files.

Table 6-4 Parsed Files

File Type	Description
`*.clk`	Clock data (message 007)
`*.dbg`	Development data (message 255)
`*.dgp`	Differential GPS position data (002)
`*.nav`	Position, velocity (message 002 with the 2 stripped from the string)
`*.spc`	Spec check message (output by receiver during acquisition)
`*.trk`	Tracker development messages
`*.raw`	Raw track (message 005) plus 50 BPS data (message 008)

All data formats are unchanged from SiRF binary protocol.

Using Parser

`parser.exe` is a command-line utility that uses a data file collected with SiRFdemo. Table 6-5 lists each of the command line options and a description of the result.

Table 6-5`parser.exe` Command Options

Option	Description
`/re`	Constructs missing version header from log.
`/rm`	Builds header without extract init from log (raw file need to be edited manually to add init).
`/t`	Trims data before the version header.
`/s`	Searches for header in log file; if found, trims data before it; if not found, extracts data and rebuilds header.
`/p`	Prompts user for processing options.
`/d`	Specifies default `parser.exe` option.

Note – See example data file `roadtest.gps`.

The Conv Utility

`Conv.exe` is a DOS-based utility that lets you convert ECEF XYZ coordinate systems (used by GPS) to WGS84 Geodetic (GEO) coordinate systems (latitude, longitude, altitude) compatible with mapping projections. Conversion can be performed in both directions.

Command-Line Options

Command-line options are available for converting ECEF XYZ to WGS84 Latitude, Longitude, and Height.

To convert from XYZ to GEO, use the following command-line options:

-h	Help – displays all command-line options

GEO to XYZ

-Lat	Latitude in degrees <range -90.0 .. 90.0>
-Lon	Longitude in degrees <range -180.0 .. 180.0>
-Alt	Value in meters

XYZ to GEO

-X	Value in meters
-Y	Value in meters
-Z	Value in meters

The Fixanal Utility

File `fixanal.exe` is a DOS program used to process logged data from SiRFdemo log files. As input, it uses data from messages of debug type 255 and it can produce a text file containing the following types of output:

- Detailed listing of every position fix timing, including times it took receiver to acquire first satellite, lock on three satellites, and produce a position fix.
- Statistical summary of the above data.
- Detailed per-channel time analysis of all stages of satellite acquisition, meaning time to acquire, time to bit sync, time to frame sync, time to acquire ephemeris (if not already available), and total acquisition time (i.e., the sum of all mentioned times).

Note – See example data file `hotstart.gps`.

Note – `Fixanal.exe` keys on specific Development Data Messages. Ensure that this is turned on for data collection. See **Chapter 4, “Using the SiRFdemo Software**” for details.

Using Fixanal

After using the SiRFdemo software to create a log file `filename.log`, copy file `fixanal.exe` to the same directory where your log file is located, and then type `fixanal.exe` at the DOS prompt. Follow the screen prompts, and if you opt for all the default options offered, one new file, `filename.fix`, is created in your current directory. It contains all the position fix statistical information.

Input Files

The log files must contain the following items for `fixanal.exe` to work properly:

- Logged data of debug message type—It can also contain other logged message types, the `fixanal.exe` program will ignore them. Also, `fixanal.exe` must be run on a log file, not an output file from `parser.exe` (e.g., `filename.nav`). This is because it expects to see the debug message type indicator. You can edit the log file to isolate certain sections except as noted below.
- Initial position message—Because `fixanal.exe` uses these lines to determine parameters of the subsequent logging session. The lines that `fixanal.exe` will search for are line 1 (showing software version), line 2 (describing the start mode), and line 7 (showing the number of channels used). A sample is presented below:

```
Version 00.33 built at 14:38:27 Oct 19 1996 using fxp
Receiver is initializing in Warm Start mode ...
TOW: 384074
WK:   876
POS: -3955124 3355588  3699664
CLK: 62779
CHNL:12
```

Operation

After beginning the program, type the names of the input and output files and specify output options. If you opt for default answers, the output file contains all available statistical reports. Enter your name to identify the test report. This begins the processing of the data. As the data is processed, two numbers are displayed on the screen. The first is the total number of lines read from the file, the second is the number processed. These are not updated continually, but are displayed to show that the program is running. The program returns to the DOS prompt when finished.

Table 6-6 lists each of the command line options and a description.

Table 6-6 `fixanal.exe` Command Options

Option	Description
-log:in_name	Use the input log file name (default extension is *.log).
-out:out_name	Send output to the output file name. By default, it is the same as in_name but with the extension *.fix.
-sum	Provide an overall performance analysis summary.
-sum-	Turn off the above performance analysis option.
-det	Create a detailed listing of every position fix statistics.
-det-	Turn off the above detailed listing option.
-chan	Include per channel tracker performance analysis.
-chan-	Turn off the above channel tracker option.
-cold	Specify cold start performance analysis.
-cold-	Turn off the above cold start performance option.
-n:username	Specify tester name.
-z	Ignore zero results when doing statistics (default).
-z-	Do not ignore zero results.
-p	Prompt for all parameters not specified.

Fixanal Output File (.fix)*

The `fixanal` output file (*.fix) has four parts. The first is the header information for identifying the test:

```
First Fix Analysis Sheet for Log File test2.log
Software Version 00.38 built at 16:39:33 Nov 12 1996 using flp
Number of Channels Used: 8
```

The second part includes statistical measures of every position fix recorded within the file. Following is a sample:

```
Session   1: Hot  Start 1.99  InitAcq  1.80   TT3Locked   6.29  TTFF   26.29 sec
Session   2: Hot  Start 1.99  InitAcq  1.80   TT3Locked  11.29  TTFF   27.29 sec
Session   3: Warm Start 1.99  InitAcq  1.80   TT3Locked  27.29  TTFF   40.29 sec
Session   4: Cold Start 1.99  InitAcq  2.70   TT3Locked  46.19  TTFF   81.19 sec
Session   5: Cold Start 1.99  InitAcq  2.70   TT3Locked   8.19  TTFF   96.19 sec
Session   6: Cold Start 1.99  InitAcq  2.70   TT3Locked  49.19  TTFF   84.19 sec
```

This portion can be imported into Microsoft Excel or other spreadsheet program using spaces as column delimiters.

The third part of the file consists of statistical analysis results based on the Time To First Fix data listed in the previous section. All results are expressed in seconds as units of measure.

```
Statistics:       Start       InitAcq         TT3Locked         TTFF
                  Ave:  1.99  Ave:    13.61   Ave:       37.23  Ave:   43.90 sec
                  Max:  1.99  Max:    38.30   Max:       80.59  Max:   93.19 sec
                  Min:  1.99  Min:     2.70   Min:        8.19  Min:   21.19 sec
```

The fourth part of the output file is a table of timing information obtained by analyzing each receiver channel separately. As physical channels are allocated to satellites by the satellite elevation from the horizon, and in descending order, variation of performance results across channels are significant.

Ch	Acquire			Lock			Bitsync			Framesync			Ephemeris			Total		
#	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
1	1.0	1	1	0.0	0	0	14.0	196	2	16.9	136	13	24.5	221	11	56.1	256	31
2	71.1	269	2	0.0	0	0	3.0	72	2	15.8	31	13	22.4	124	11	110.0	276	31
3	87.2	308	4	0.0	0	0	3.1	28	2	16.1	99	13	22.4	44	6	124.9	284	36
4	71.6	266	2	0.0	0	0	3.0	18	2	15.9	36	13	23.1	211	11	111.6	276	36
5	94.3	275	6	0.0	0	0	3.3	93	2	15.8	42	13	22.9	145	5	133.0	268	47
6	93.6	266	2	0.0	0	0	3.2	21	2	15.7	31	13	22.1	97	11	131.8	287	36
7	98.5	284	2	0.0	0	0	3.3	105	2	16.5	121	13	25.7	147	11	140.8	297	47
8	89.2	282	8	0.0	0	0	3.2	30	2	16.2	87	13	22.6	191	11	126.7	298	41
Σ	73.4	308	1	0.0	0	0	4.7	196	2	16.1	136	13	23.2	221	5	114.8	298	31

The Cksum Utility

The purpose of `cksum.exe` is to read a file containing NMEA sentences and calculate the correct NMEA checksum. You can use the checksum to verify operation of NMEA output sentences or to generate a checksum for an NMEA input message.

Example:

Create a text file containing an NMEA input sentence such as an input NMEA query message and determine the proper checksum.

```
type query0.txt
$PSRF103,00,01,00,01*xx
cksum query0.txt
INPUT FILE: query0.txt
inline:$PSRF103,00,01,00,01*xx
cksum:25
```

The correct checksum for this message is 25. You can use Procomm or a similar terminal program to send the message. CK.C can be compiled using any compiler capable of generating DOS programs, and is simple to modify for your own unique uses.

The Datum Utility

This is a sample program to convert between GPS reference datums. Source code is supplied in C. See Appendix E, “Acronyms, Abbreviations, and Glossary” for datum formulation and transformation parameters. To run the program enter the file name as a command line argument (i.e., datum station) or enter the file name when prompted by the program (expected extension is `*.gps`). This is a user application example only. Output files are described in Appendix A, “File Formats.”

The Calcpsr Utility

This is a sample program to convert the raw track data message (005) into GPS measurement data (i.e., pseudo-range, carrier phase, etc.) for use in post processing. The Ephemeris data (if collected) is also decoded. To run the program enter the file name as a command line argument (i.e., calcpsr station) or enter the file name when prompted by the program (expected extension is `*.gps`). This is a user application example only. Output files are described in Appendix A, “File Formats.”

File Formats A

This appendix describes the format of files that are either used by the SiRFdemo software or are created by the SiRFsig software. It includes information on the following:

- "Modifying the Sample ring90.smp File"
- "Modifying the Sample sirf.pos File"
- "Description of SiRFsig File Formats"

Modifying the Sample ring90.smp File

To modify the sample `ring90.smp` file:

1. Open the sample `ring90.smp` file using a text editor.

```
;           Current version
V,2,0
;           SiRF in Santa Clara
O,37.37185,-121.99704
;           Map extent (height, width) in meters
E,300,300
;           Rings: 30, 60 and 90 radii in meters
C,0,0,30
C,0,0,60
C,0,0,90
;           cross-hair lines
L,-120,0,120,0
L,0,-120,0,120
```

Figure A-1 depicts the Map View screen with the `ring90.smp` file loaded.

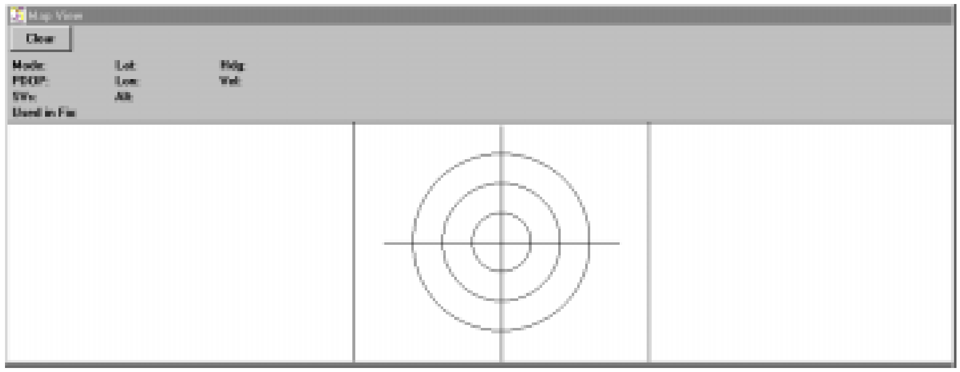


Figure A-1 Map View Screen with `ring90.smp` Sample File Loaded

Note – The Map View screen shown in this chapter uses the default values set in the sample `ring90.smp` file. You can modify all of the configuration values in the sample `ring90.smp` file.

You can modify the values for the Map View screen, as shown below.

```
;   Current version
V,2,0
;   SiRF in Santa Clara
O,37.3875113,-121.9723228
;   Map extent (height, width)
E,400,400
;   Rings: 20, 40 ... 100m radii
C,0,0,20
C,0,0,40
C,0,0,60
C,0,0,80
C,0,0,100
;   cross-hair lines
L,-120,0,120,0
L,0,-120,0,120
```

The file is then saved as `ring100.smp`. The Map View screen changes are shown below. Figure A-2 depicts the Map View screen with the `ring100.smp` file loaded.

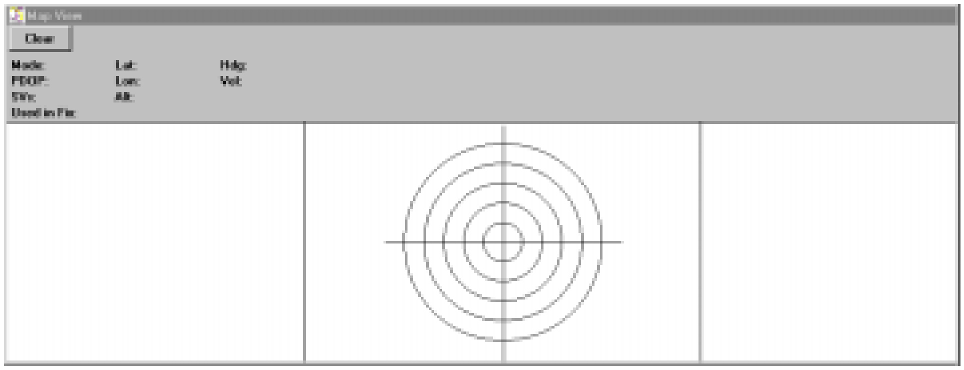


Figure A-2 Map View Screen with `ring100.smp` Sample File Loaded

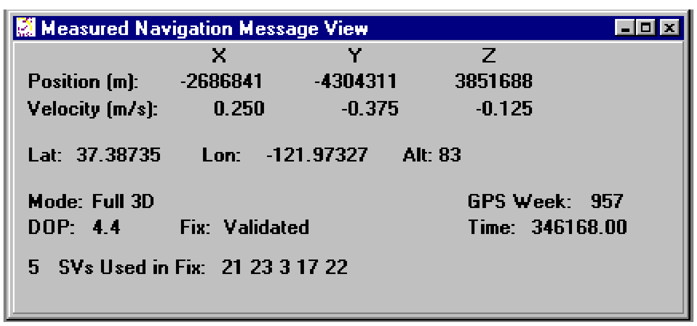
Modifying the Sample sirf.pos File

To modify the `sirf.pos` file:

1. Open the sample `sirf.pos` file using a text editor.
   The sample X, Y, Z positions are displayed.

```
-2686718
-4304272
3851636
0
```

2. Use the configuration values displayed on the Measured Navigation Message View screen after communication has been connected to the Evaluation Receiver as your new X, Y, and Z coordinates.



3. Modify the X, Y, Z positions in the `sirf.pos` file with the new configuration values displayed on the Measured Navigation Message View screen.

```
-2690721
-4310924
3841682
0
```

Description of SiRFsig File Formats

The SiRFsig software produces the following files for plotting and statistics:

- `*.avg`
- `*.pos`
- `*.vel`
- `*.###`
- `*.svs`

Following are descriptions of each type of file.

*.avg File

`*.avg` is the average data file used to calculate statistics. It is created during parsing and used if data is reviewed without re-parsing the datafile.

Format

Lines 0-32 are satellite data. All fields are 0 if Sv. is not tracked.

Sv	**Avg C/No**	**Number of Seconds Tracked**
0	0.00	0
0	0.00	0
2	47.00	3631
0	0.00	0
0	0.00	0
0	0.00	0
0	0.00	0
7	45.44	3630
..	....	...
..	....	...
31	38.02	3467
0	0.00	0

Bin Data for Polar Plots

Bins are in a matrix of [8][8] with each bin defined by an azimuth range and elevation range. Bin[0][0]is AZ 0-45 and El. 0-10 degrees, Bin[0][1] is Az 0-45, El 10-20 degrees. Bin azimuths are in steps of 45 degrees in a clockwise direction, elevation bins are in 10 degree steps starting at the horizon (0 degrees) and finishing at the zenith (90 degrees).

Bin	Bin	Avg. C/No	# of Data	Max C/No	Min C/No
0	0	34.04	444	37.00	29.00
0	1	38.58	1638	43.00	33.00
..	..	..	..	..	..
0	8	0.00	0	-1.00	99.00
..	.	..	..	..	..
..	..	..	..	..	..
7	0	34.12	429	37.00	28.00
7	1	40.59	1638	46.00	35.00
..	..	..	..	..	..
7	8	0.00	0	-1.00	99.00

This is the start and end time of the data session in GPS seconds into the week.

Start	End
259510.24	263143.18

This is the average position of the receiver in ECEF XYZ coordinates.

Px	Py	Pz
-2686753.9	-4304226.9	3851670.2

This is the average velocity of the receiver in ECEF XYZ coordinates.

Vx	Vy	Vz
-2686753.9	-4304226.9	3851670.2

This is the receiver software version.

Version 200R00234

This is the data protocol of the receiver.

20[1] (protocol)

1. 20 equals SiRF Binary data, 21 equals NMEA data

This is the Power settings of the receiver.

Power Mode 10 1000.0 1.0 (mode[1], Ontime[2] (ms) Update Rate[3] (ms)

1. 10 equals Full Power, 11 equals Trickle Power, 12 equals Push-to-fix
2. User selected On Time in ms
3. User selected Update Rate in ms

This is the Elevation Mask in degrees.

Elevation Mask 7.5

This is the DGPS mode of operation.

DGPSmode 10 (10 = Auto, 11 = Exclusive, 12 = Never Use)

This is the Number of False Acquisitions Detected.

False Acquisitions 0

*.pos File

`*.pos` is the time tagged position file in ECEF XYZ parsed from record 002 (measured navigation data) of SiRFdemo.

GPS Time	Px	Py	Pz	DOP	Mode1	Mode2	SVs used	Thru put	SV tracked

*.vel File

`*.vel` is the time tagged position file in ECEF Vx, Vy, Vz parsed from record 002 (measured navigation data) of SiRFdemo.

GPS Time	Vx	Vy	Vz	DOP	Mode1	Mode2	SVs used	Thru put	SV tracked

*.### File

`*.###` is the satellite specific data for each Sv tracked where ### is the Sv prn number. This data is parsed form record 004 (measured tracker data) from SiRFdemo (i.e., Satellite data for Sv. Number 22 will be in file `*.022`).

GPS Time	Az	El.	Avg. C/No
256707.11	297	35	44
256708.11	297	35	45
256709.11	297	35	45

*.svs File

`*.svs` contains statistics that are generated each time the program processes a data file on a per satellite basis.

Statistical data file:.svs*

Statistical data per Sv based on file.

Sv	Mean	Std Dev	Max	Min	Range	Data
2	47.0	0.1	47	46	1	7262
7	45.4	1.2	47	42	5	7260
10	8.3	2.6	45	28	17	5884
13	47.0	0.0	47	47	0	72
15	35.8	3.0	42	28	14	3262
18	38.6	4.0	45	28	17	3290
19	46.6	0.5	48	45	3	7262
26	41.5	4.1	47	28	19	6852
27	47.0	0.1	47	46	1	7262
31	38.0	2.8	43	28	15	6934

The SiRF Binary Protocol

B

The SiRF Binary Protocol is the standard interface protocol used by the SiRFstarIIe Evaluation Receiver and other SiRF products.

This serial communication protocol is designed to include:

- Reliable transport of messages
- Ease of implementation
- Efficient implementation
- Independence from payload

Protocol Layers

Transport Message

Start Sequence	Payload Length	Payload	Message Checksum	End Sequence
0xA0[1], 0xA2	Two-bytes (15-bits)	Up to 2^{10} -1 (<1023)	Two-bytes (15-bits)	0xB0, 0xB3

1. 0xYY denotes a hexadecimal byte value. 0xA0 equals 160.

Transport

The transport layer of the protocol encapsulates a GPS message in two start characters and two stop characters. The values are chosen to be easily identifiable and unlikely to occur frequently in the data. In addition, the transport layer prefixes the message with a two-byte (15-bit) message length and a two-byte (15-bit) check sum. The values of the start and stop characters and the choice of a 15-bit value for length and check sum ensure message length and check sum can not alias with either the stop or start code.

Message Validation

The validation layer is of part of the transport, but operates independently. The byte count refers to the payload byte length. The check sum is a sum on the payload.

Payload Length

The payload length is transmitted high order byte first followed by the low byte.

High Byte	Low Byte
< 0x7F	Any value

Even though the protocol has a maximum length of (2^{15}-1) bytes, practical considerations require the SiRF GPS module implementation to limit this value to a smaller number. The SiRF receiving programs (e.g., SiRFdemo) may limit the actual size to something less than this maximum.

Payload Data

The payload data follows the payload length. It contains the number of bytes specified by the payload length. The payload data may contain any 8-bit value.

Where multi-byte values are in the payload data neither the alignment nor the byte order are defined as part of the transport although SiRF payloads will use the big-endian order.

Checksum

The check sum is transmitted high order byte first followed by the low byte. This is the so-called big-endian order.

High Byte	Low Byte
< 0x7F	Any value

The check sum is 15-bit checksum of the bytes in the payload data. The following pseudo code defines the algorithm used.

Let message to be the array of bytes to be sent by the transport.

Let msgLen be the number of bytes in the message array to be transmitted.

```
Index = first
checkSum = 0
while index < msgLen
    checkSum = checkSum + message[index]
checkSum = checkSum AND (2^15-1).
```

Input Messages for SiRF Binary Protocol

Note – All input messages are sent in **BINARY** format.

Table B-1 lists the message list for the SiRF input messages.

Table B-1 SiRF Messages - Input Message List

Hex	ASCII	Name
0 x 80	128	Initialize Data Source
0 x 81	129	Switch to NMEA Protocol
0 x 82	130	Set Almanac (upload)
0 x 84	132	Software Version (Poll)
0 x 85	133	DGPS Source Control
0 x 86	134	Set Main Serial Port
0 x 87	135	Not Used
0 x 88	136	Mode Control
0 x 89	137	DOP Mask Control
0 x 8A	138	DGPS Mode
0 x 8B	139	Elevation Mask
0 x 8C	140	Power Mask
0 x 8D	141	Editing Residual
0 x 8E	142	Steady-State Detection - Not Used
0 x 8F	143	Static Navigation
0 x 90	144	Clock Status (Poll)
0 x 91	145	Set DGPS Serial Port
0 x 92	146	Almanac (Poll)
0 x 93	147	Ephemeris (Poll)
0 x 95	149	Set Ephemeris (upload)
0 x 96	150	Switch Operating Mode
0 x 97	151	Not supported.
0 x 98	152	Navigation Parameters (Poll)
0 x A5	165	Change UART Configuration
0 x A6	166	Set Message Rate
0 x A7	167	Low Power Acquisition Parameters
0 x B6	182	Not Supported

Initialize Data Source - Message I.D. 128

Table B-2 contains the input values for the following example:

Warm start the receiver with the following initialization data: ECEF XYZ (-2686727 m, -4304282 m, 3851642 m), Clock Offset (75,000 Hz), Time of Week (86,400 s), Week Number (924), and Channels (12). Raw track data enabled, Debug data enabled.

Example:

A0A20019—Start Sequence and Payload Length

80FFD700F9FFBE5266003AC57A000124F80083D600039C0C33—Payload

0A91B0B3—Message Checksum and End Sequence

Table B-2 Initialize Data Source

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		80		ASCII 128
ECEF X	4		FFD700F	meters	
ECEF Y	4		FFBE5266	meters	
ECEF Z	4		003AC57A	meters	
Clock Offset	4		000124F8	Hz	
Time of Week	4	*100	0083D600	seconds	
Week Number	2		039C		
Channels	1		0C		Range 1-12
Reset Config.	1		33		See Table B-3

Payload Length: 25 bytes

Table B-3 Reset Configuration Bitmap

Bit	Description
0	Data valid flag—set warm/hot start
1	Clear ephemeris—set warm start
2	Clear memory—set cold start
3	Factory Reset
4	Enable raw track data (YES=1, NO=0)
5	Enable debug data for SiRF binary protocol (YES=1, NO=0)
6	Enable debug data for NMEA protocol (YES=1, NO=0)
7	Reserved (must be 0)

Note – If Nav Lib data is ENABLED then the resulting messages are enabled. Clock Status (MID 7), 50 BPS (MID 8), Raw DGPS (17), NL Measurement Data (MID 28), DGPS Data (MID 29), SV State Data (MID 30), and NL Initialize Data (MID 31). All messages are sent at 1 Hz and the baud rate will be automatically set to 57600.

Switch To NMEA Protocol - Message I.D. 129

Table B-4 contains the input values for the following example:

Request the following NMEA data at 4800 baud:
GGA – ON at 1 sec, GLL – OFF, GSA - ON at 5 sec,
GSV – ON at 5 sec, RMC-OFF, VTG-OFF

Example:

A0A20018—Start Sequence and Payload Length

810201010001050105010001000100010001000100010001000112C0—Payload

016AB0B3—Message Checksum and End Sequence

Table B-4 Switch To NMEA Protocol

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		81		ASCII 129
Mode	1		02		
GGA Message[1]	1		01	1/s	See Appendix A for format.
Checksum[2]	1		01		
GLL Message	1		00	1/s	See Appendix A for format.
Checksum	1		01		
GSA Message	1		05	1/s	See Appendix A for format.
Checksum	1		01		
GSV Message	1		05	1/s	See Appendix A for format.
Checksum	1		01		
MSS Message	1		01	1/s	See Appendix A for format.
Checksum	1		01		
RMC Message	1		00	1/s	See Appendix A for format.
Checksum:	1		01		
VTG Message	1		00	1/s	See Appendix A for format.
Checksum	1		01		
Unused Field	1		00		Recommended value.
Unused Field	1		01		Recommended value.
Unused Field	1		00		Recommended value.
Unused Field	1		01		Recommended value.
Unused Field	1		00		Recommended value.
Unused Field	1		01		Recommended value.
Unused Field	1		00		Recommended value.
Unused Field	1		01		Recommended value.
Baud Rate	2		12C0		38400, 19200,9600,4800,2400

Payload Length: 24 bytes

1. A value of 0x00 implies NOT to send message, otherwise data is sent at 1 message every X seconds requested (i.e., to request a message to be sent every 5 seconds, request the message using a value of 0x05.) Maximum rate is 1/255s.
2. A value of 0x00 implies the checksum NOT transmitted with the message (not recommended). A value of 0x01 will have a checksum calculated and transmitted as part of the message (recommended).

Note – In Trickle Power mode, update rate is specified by the user. When you switch to NMEA protocol, message update rate is also required. The resulting update rate is the product of the Trickle Power Update rate and the NMEA update rate (i.e. Trickle Power update rate = 2 seconds, NMEA update rate = 5 seconds, resulting update rate is every 10 seconds, (2 X 5 = 10)).

Set Almanac – Message I.D. 130

This command enables the user to upload an almanac file to the Evaluation Receiver.

Software Version – Message I.D. 132

Table B-5 contains the input values for the following example:

Poll the software version

Example:

A0A20002—Start Sequence and Payload Length

8400—Payload

0084B0B3—Message Checksum and End Sequence

Table B-5 Software Version

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		84		ACSII 132
TBD	1		00		Reserved

Payload Length: 2 bytes

DGPS Source - Message I.D. 133

This command allows the user to select the source for DGPS corrections. Options available are:

External RTCM Data (any serial port)

WAAS (subject to WAAS satellite availability)

Internal DGPS beacon receiver

Example 1: Set the DGPS source to External RTCM Data

A0A200007—Start Sequence and Payload Length

85020000000000—Payload

0087B0B3—Checksum and End Sequence

Table B-6 DGPS Source Selection (Example 1)

Name	Bytes	Scale	Hex	Units	Decimal	Description
Message I.D.	1		85		133	Message Identification
DGPS Source	1		00		0	See Table B-8. DGPS Source Selections
Internal Beacon Frequency	4		00000000	Hz	0	See Table B-9. Internal Beacon Search Settings
Internal Beacon Bit Rate	1		0	BPS	0	See Table B-9. Internal Beacon Search Settings

Payload Length: 7 Bytes

Example2: Set the DGPS source to Internal DGPS Beacon Receiver

Search Frequency 310000, Bit Rate 200

A0A200007—Start Sequence and Payload Length

85030004BAF0C802—Payload

02FEB0B3—Checksum and End Sequence

Table B-7 DGPS Source Selection (Example 2)

Name	Bytes	Scale	Hex	Units	Decimal	Description
Message I.D.	1		85		133	Message Identification.
DGPS Source	1		03		3	See Table B-8. DGPS Source Selections.
Internal Beacon Frequency	4		0004BAF0	Hz	310000	See Table B-9. Internal Beacon Search Settings.
Internal Beacon Bit Rate	1		C8	BPS	200	See Table B-9. Internal Beacon Search Settings.

Payload Length: 7 Bytes

Table B-8 DGPS Source Selections

DGPS Source	Hex	Decimal	Description
None	00	0	DGPS corrections will not be used (even if available).
WAAS	01	1	Uses WAAS Satellite (subject to availability).
External RTCM Data	02	2	External RTCM input source (i.e., Coast Guard Beacon).
Internal DGPS Beacon Receiver	03	3	Internal DGPS beacon receiver.

Table B-9 Internal Beacon Search Settings

Search Type	Frequency[1]	Bit Rate[2]	Description
Auto Scan	0	0	Auto scanning of all frequencies and bit rates are performed.
Full Frequency scan	0	None zero	Auto scanning of all frequencies and specified bit rate are performed.
Full Bit Rate Scan	None Zero	0	Auto scanning of all bit rates and specified frequency are performed.
Specific Search	Non Zero	Non Zero	Only the specified frequency and bit rate search are performed.

1. Frequency Range is 283500 to 325000 Hz.
2. Bit Rate selection is 25, 50, 100 and 200 BPS.

Set Main Serial Port - Message I.D. 134

Table B-10 contains the input values for the following example:

Set Main Serial port to 9600,n,8,1.

Example:

A0A20009—Start Sequence and Payload Length

860000258008010000—Payload

0134B0B3—Message Checksum and End Sequence

Table B-10 Set Main Serial Port

Name	Bytes	Binary (Hex) Scale	Binary (Hex) Example	Units	Description
Message ID	1		86		decimal 134
Baud	4		00002580		38400,19200,9600,4800,2400,1200
Data Bits	1		08		8,7
Stop Bit	1		01		0,1
Parity	1		00		None=0, Odd=1, Even=2
Pad	1		00		Reserved

Payload Length: 9 bytes

Set Protocol - Message I.D. 135

Note – Not Used

Mode Control - Message I.D. 136

Table B-11 contains the input values for the following example:

3D Mode = Always, Alt Constraining = Yes, Degraded Mode = clock then direction, TBD=1, DR Mode = Yes, Altitude = 0, Alt Hold Mode = Auto, Alt Source =Last Computed, Coast Time Out = 20, Degraded Time Out=5, DR Time Out = 2, Track Smoothing = Yes

Example:

A0A2000E—Start Sequence and Payload Length

880101010101000000002140501—Payload

00A9B0B3—Message Checksum and End Sequence

Table B-11 Mode Control

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		88		ASCII 136
3D Mode	1		01		1 (always true=1)
Alt Constraint					Not Used
Degraded Mode	1		01		See Table B-12
TBD	1		01		Reserved
DR Mode	1		01		YES=1, NO=0
Altitude	2		0000	meters	range -1,000 to 10,000
Alt Hold Mode	1		00		Auto=0, Always=1,Disable=2
Alt Source	1		02		Last Computed=0,Fixed to=1
Coast Time Out					Not Used
Degraded Time Out	1		05	seconds	0 to 120
DR Time Out	1		01	seconds	0 to 120
Track Smoothing	1		01		YES=1, NO=0

Payload Length: 14 bytes

Table B-12 Degraded Mode Byte Value

Byte Value	Description
0	Use Direction then Clock Hold
1	Use Clock then Direction Hold
2	Direction (Curb) Hold Only
3	Clock (Time) Hold Only
4	Disable Degraded Modes

DOP Mask Control - Message I.D. 137

Table B-13 contains the input values for the following example:

Auto Pdop/Hdop, Gdop =8 (default), Pdop=8,Hdop=8

Example:

A0A20005—Start Sequence and Payload Length

8900080808—Payload

00A1B0B3—Message Checksum and End Sequence

Table B-13 DOP Mask Control

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		89		ASCII 137
DOP Selection	1		00		See Table B-14
GDOP Value	1		08		Range 1 to 50
PDOP Value	1		08		Range 1 to 50
HDOP Value	1		08		Range 1 to 50

Payload Length: 5 bytes

Table B-14 DOP Selection

Byte Value	Description
0	Auto PDOP/HDOP
1	PDOP
2	HDOP
3	GDOP
4	Do Not Use

DGPS Control - Message I.D. 138

Table B-15 contains the input values for the following example:

Set DGPS to exclusive with a time out of 30 seconds.

Example:

A0A20003—Start Sequence and Payload Length

8A011E—Payload

00A9B0B3—Message Checksum and End Sequence

Table B-15 DGPS Control

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		8A		ASCII 138
DGPS Selection	1		01		See Table B-16
DGPS Time Out:	1		1E	seconds	Range 1 to 120

Payload Length: 3 bytes

Table B-16 DGPS Selection

Byte Value	Description
0	Auto
1	Exclusive
2	Never Use

Elevation Mask – Message I.D. 139

Table B-17 contains the input values for the following example:

Set Navigation Mask to 15.5 degrees (Tracking Mask is defaulted to 5 degrees).

Example:

A0A20005—Start Sequence and Payload Length

8B0032009B—Payload

0158B0B3—Message Checksum and End Sequence

Table B-17 Elevation Mask

Name	Bytes	Binary (Hex) Scale	Binary (Hex) Example	Units	Description
Message ID	1		8B		ASCII 139
Tracking Mask	2	*10	0032	degrees	Not currently used
Navigation Mask	2	*10	009B	degrees	Range -20.0 to 90.0

Payload Length: 5 bytes

Power Mask - Message I.D. 140

Table B-18 contains the input values for the following example:

Navigation mask to 33 dBHz (tracking default value of 28)

Example:

A0A20003—Start Sequence and Payload Length

8C1C21—Payload

00C9B0B3—Message Checksum and End Sequence

Table B-18 Power Mask

Name	Bytes	Binary (Hex) Scale	Binary (Hex) Example	Units	Description
Message ID	1		8C		ASCII 140
Tracking Mask	1		1C	dBHz	Not currently implemented
Navigation Mask	1		21	dBHz	Range 28 to 50

Payload Length: 3 bytes

Editing Residual– Message I.D. 141

Note – Not implemented.

Steady State Detection - Message I.D. 142

Note – Not implemented.

Static Navigation– Message I.D. 143

Note – Not supported.

Clock Status – Message I.D. 144

Table B-19 contains the input values for the following example:

Poll the clock status.

Example:

A0A20002—Start Sequence and Payload Length

9000—Payload

0090B0B3—Message Checksum and End Sequence

Table B-19 Clock Status

Name	Bytes	Binary (Hex) Scale	Binary (Hex) Example	Units	Description
Message ID	1		90		ACSII 144
TBD	1		00		Reserved

Payload Length: 2 bytes

Set DGPS Serial Port - Message I.D. 145

Table B-20 contains the input values for the following example:

Set DGPS Serial port to 9600,n,8,1.

Example:

A0A20009—Start Sequence and Payload Length

910000258008010000—Payload

013FB0B3—Message Checksum and End Sequence

Table B-20 Set DGPS Serial Port

Name	Bytes	Binary (Hex) Scale	Binary (Hex) Example	Units	Description
Message ID	1		91		ASCII 145
Baud	4		00002580		38400,19200,9600,4800,2400,1200
Data Bits	1		08		8,7
Stop Bit	1		01		0,1
Parity	1		00		None=0, Odd=1, Even=2
Pad	1		00		Reserved

Payload Length: 9 bytes

Note – Setting the DGPS serial port using MID 145 will effect Com B only regardless of the port being used to communicate with the Evaluation Receiver.

Almanac - Message I.D. 146

Table B-21 contains the input values for the following example:

Poll for the Almanac.

Example:

A0A20002—Start Sequence and Payload Length

9200—Payload

0092B0B3—Message Checksum and End Sequence

Table B-21 Almanac

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		92		ASCII 146
TBD	1		00		Reserved

Payload Length: 2 bytes

Ephemeris - Message I.D. 147

Table B-22 contains the input values for the following example:

Poll for Ephemeris Data for all satellites.

Example:

A0A20003—Start Sequence and Payload Length

930000—Payload

0092B0B3—Message Checksum and End Sequence

Table B-22 Ephemeris

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		93		ASCII 147
Sv I.D.[1]	1		00		Range 0 to 32
TBD	1		00		Reserved

Payload Length: 3 bytes

1. A value of 0 requests all available ephemeris records, otherwise the ephemeris of the Sv I.D. is requested.

Switch To SiRF Protocol

Note – To switch to the SiRF protocol, you must send a SiRF NMEA message to revert to SiRF binary mode. (See **Appendix C, “NMEA Input/Output Messages**” for more information).

Switch Operating Modes - Message I.D. 150

Table B-23 contains the input values for the following example:

Sets the receiver to track a single satellite on all channels.

Example:

A0A20007—Start Sequence and Payload Length

961E510006001E—Payload

0129B0B3—Message Checksum and End Sequence

Table B-23 Switch Operating Modes

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		96		ASCII 150
Mode	2		1E51		1E51=test, 0=normal
SvID	2		0006		Satellite to Track
Period	2		001E	seconds	Duration of Track
Payload Length:	7 bytes				

Set TricklePower Parameters - Message I.D. 151

Note – This message is not supported.

Table B-24 contains the input values for the following example:

Sets the receiver into low power Modes.

Example: Set receiver into Trickle Power at 1 hz update and 200 ms On Time.

A0A20009—Start Sequence and Payload Length

97000000C8000000C8—Payload

0227B0B3—Message Checksum and End Sequence

Table B-24 Set Trickle Power Parameters

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		97		ASCII 151
Push To Fix Mode	2		0000		ON = 1, OFF = 0
Duty Cycle	2	*10	00C8	%	% Time ON
Milli Seconds On Time	4		000000C8	ms	range 200 - 900 ms
Payload Length:	9 bytes				

If an update rate of 1 second is selected, then the on-time greater than 600ms is invalid.

Computation of Duty Cycle and On Time

The Duty Cycle is the desired time to be spent tracking.The On Time is the duration of each tracking period (range is 200 - 900 ms). To calculate the TricklePower update rate as a function of Duty Cycle and On Time, use the following formula:

$$\text{Off Time} = \frac{\text{On Time} - (\text{Duty Cycle} * \text{On Time})}{\text{Duty Cycle}}$$

Update rate = Off Time + On Time

Note – On Time inputs of > 900 ms will default to 1000 ms.

Following are some examples of selections:

Table B-25 Example of Selections for Trickle Power Mode of Operation

Mode	On Time (ms)	Duty Cycle (%)	Update Rate(1/Hz)
Continuous	1000	100	1
Trickle Power	200	20	1
Trickle Power	200	10	2
Trickle Power	300	10	3
Trickle Power	500	5	10

Note – To confirm the receiver is performing at the specified duty cycle and ms On Time, see “The 12-Channel Signal Level View Screen” on page 24 in **Chapter 4, “Using the SiRFdemo Software**.” The C/No data bins will be fully populated at 100% duty and only a single C/No data bin populated at 20% duty cycle. Your position should be updated at the computed update rate.

Table B-26 Trickle Power Mode Support

On Time (ms)	Update Rate (sec)									
	1	2	3	4	5	6	7	8	9	10
200	Y[1]	Y	Y	Y	Y	Y	Y	Y	Y	Y
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
400	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
500	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
600	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
700	N[2]	Y	Y	Y	Y	Y	Y	Y	Y	Y
800	N[2]	Y	Y	Y	Y	Y	Y	Y	Y	Y
900	N[2]	Y	Y	Y	Y	Y	Y	Y	Y	Y

1. Y = Yes (Mode supported)
2. N = No (Duty cycle >50% = FP)

Push-to-Fix

In this mode the receiver will turn on every 30 minutes to perform a system update consisting of a RTC calibration and satellite ephemeris data collection if required (i.e., a new satellite has become visible) as well as all software tasks to support SnapStart in the event of an NMI. Ephemeris collection time in general takes 18 to 30 seconds. If ephemeris data is not required then the system will re-calibrate and shut down. In either case, the amount of time the receiver remains off will be in proportion to how long it stayed on:

$$\text{Off period} = \frac{\text{On Period*(1-Duty Cycle)}}{\text{Duty Cycle}}$$

Off Period is limited to 30 minutes. The duty cycle will not be less than approximately On Period/1800, or about 1%. Push-to-Fix keeps the ephemeris for all visible satellites up to date so position/velocity fixes can generally be computed within SnapStart times (when requested by the user) on the order of 3 seconds.

Poll Navigation Parameters - Message I.D. 152

Table B-27 contains the input values for the following example:

Example: Poll receiver for current navigation parameters.

A0A20002—Start Sequence and Payload Length

9800—Payload

0098B0B3—Message Checksum and End Sequence

Table B-27 Poll Receiver for Navigation Parameters

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		98		ASCII 152
Reserved	1		00		Reserved

Payload Length: 2 bytes

Set UART Configuration - Message I.D. 165

Table B-28 contains the input values for the following example:

Example: Set port 0 to NMEA with 9600 baud, 8 data bits, 1 stop bit, no parity. Set port 1 to SiRF binary with 57600 baud, 8 data bits, 1 stop bit, no parity. Do not configure ports 2 and 3.

Example:

A0A20031—Start Sequence and Payload Length

A50001010000258008010000000100000000E1000801000000FF0505000000000000000000FF0505000000000000000000—Payload

0452B0B3—Message Checksum and End Sequence

Table B-28 Set UART Configuration

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		A5		Decimal 165
Port	1		00		For UART 0
In Protocol[1]	1		01		For UART 0
Out Protocol	1		01		For UART 0 (Set to in protocol)
Baud Rate[2]	4		00002580		For UART 0
Data Bits[3]	1		08		For UART 0
Stop Bits[4]	1		01		For UART 0
Parity[5]	1		00		For UART 0
Reserved	1		00		For UART 0
Reserved	1		00		For UART 0
Port	1		01		For UART 1
In Protocol	1		00		For UART 1
Out Protocol	1		00		For UART 1
Baud Rate	4		0000E100		For UART 1
Data Bits	1		08		For UART 1
Stop Bits	1		01		For UART 1
Parity	1		00		For UART 1
Reserved	1		00		For UART 1
Reserved	1		00		For UART 1
Port	1		FF		For UART 2
In Protocol	1		05		For UART 2
Out Protocol	1		05		For UART 2
Baud Rate	4		00000000		For UART 2
Data Bits	1		00		For UART 2
Stop Bits	1		00		For UART 2
Parity	1		00		For UART 2
Reserved	1		00		For UART 2
Reserved	1		00		For UART 2
Port	1		FF		For UART 3
In Protocol	1		05		For UART 3
Out Protocol	1		05		For UART 3
Baud Rate	4		00000000		For UART 3
Data Bits	1		00		For UART 3
Stop Bits	1		00		For UART 3
Parity	1		00		For UART 3
Reserved	1		00		For UART 3
Reserved	1		00		For UART 3

Payload Length: 49 bytes

1. 0 = SiRF Binary, 1 = NMEA, 2 = ASCII, 3 = RTCM, 4 = User1, 5 = No Protocol.
2. Valid values are 1200, 2400, 4800, 9600, 19200, 38400, and 57600.
3. Valid values are 7 and 8.
4. Valid values are 1 and 2.
5. 0 = None, 1 = Odd, 2 = Even.

Set Message Rate - Message I.D. 166

Table B-29 contains the input values for the following example:

Set message ID 2 to output every 5 seconds starting immediately.

Example:

A0A20008—Start Sequence and Payload Length

A601020500000000—Payload

00AEB0B3—Message Checksum and End Sequence

Table B-29 Set Message Rate

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		A6		decimal 166
Send Now[1]	1		01		Poll message
MID to be set	1		02		
Update Rate	1		05	sec	Range = 1 - 30
TBD	1		00		Reserved
TBD	1		00		Reserved
TBD	1		00		Reserved
TBD	1		00		Reserved

Payload Length: 8 bytes

1. 0 = No, 1 = Yes, if no update rate the message will be polled.

Low Power Acquisition Parameters - Message I.D. 167

Table B-30 contains the input values for the following example:

Set maximum off and search times for re-acquisition while receiver is in low power.

Example:

A0A20019—Start Sequence and Payload Length

A7000075300001D4C00000000000000000000000000000000—Payload

02E1B0B3—Message Checksum and End Sequence

Table B-30 Set Low Power Acquisition Parameters

Name	Bytes	Binary (Hex)		Units	Description
		Scale	Example		
Message ID	1		A7		decimal 167
Max Off Time	4		00007530	ms	Maximum time for sleep mode
Max Search Time	4		0001D4C0	ms	Max. satellite search time
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved
TBD	4		00000000		Reserved

Payload Length: 25 bytes

Set UART Configuration - Message I.D. 182

Note – This message is not supported.

This command configures the Evaluation Receiver for data I/O with unique protocols at specified communication parameters. All four ports are configured at the same time.

Example: Set the receiver to the following configuration:

Table B-31 Example Configuration Settings

Serial Port	Protocol	Baud Rate	Data Bits	Parity	Stop Bits
UART 0	SiRF Binary	19200	N	8	1
UART 1	NMEA	4800	N	8	1
UART 2	RTCM-DGPS	9600	N	8	1
UART 3	No I/O	0	0	0	0

A0A20031—Start Sequence and Payload Length

B600000000004B0008010000000101010000012C0080100000000203030000258008010000000305050000000000000000000—Payload

02ABB0B3—Checksum and End Sequence

Table B-32 Set UART Configuration Message Definition

Name	Bytes	Scale	Hex	Units	Decimal	Description
Message I.D.	1		B6		182	Message Identification
Serial Port Number	**1**		**00**		**0**	**Fixed setting (see Table B-33. Serial Port Settings).**
Input Protocol	1		00		0	See Table B-34. Protocol Settings
Output Protocol	4		00		0	See Table B-34. Protocol Settings
Baud Rate	1		00004B00	BPS	19200	1200, 2400, 4800, 9600, 19200, and 38400.

Table B-32 Set UART Configuration Message Definition *(Continued)*

Data Bits	1		08		8	Number of data bits (7 or 8).
Stop Bits	1		01		1	Number of stop bits (0 or 1).
Parity Bits	1		00		0	None (0), Odd (1), Even (2).
TBD	1		00		0	Reserved.
TBD	1		00		0	Reserved.
Serial Port Number	**1**		**01**		**1**	**Fixed setting (see Table B-33. Serial Port Settings).**
Input Protocol	1		01		1	See Table B-34. Protocol Settings.
Output Protocol	1		01		1	See Table B-34. Protocol Settings.
Baud Rate	4		000012C0	BPS	4800	1200, 2400, 4800, 9600, 19200, and 38400.
Data Bits	1		08		8	Number of data bits (7 or 8).
Stop Bits	1		01		1	Number of stop bits (0 or 1).
Parity Bits	1		00		0	None (0), Odd (1), Even (2).
TBD	1		00		0	Reserved.
TBD	1		00		0	Reserved.
Serial Port Number	**1**		**02**		**2**	**Fixed setting (see Table B-33. Serial Port Settings).**
Input Protocol	1		03		3	See Table B-34. Protocol Settings.
Output Protocol	1		03		3	See Table B-34. Protocol Settings.
Baud Rate	4		00002580	BPS	9600	1200, 2400, 4800, 9600, 19200, and 38400.
Data Bits	1		08		8	Number of data bits (7 or 8).
Stop Bits	1		01		1	Number of stop bits (0 or 1).
Parity Bits	1		00		0	None (0), Odd (1), Even (2).
TBD	1		00		0	Reserved.
TBD	1		00		0	Reserved.
Serial Port Number	**1**		**03**		**3**	**Fixed setting (see Table B-33. Serial Port Settings).**
Input Protocol	1		05		5	See Table B-34. Protocol Settings.
Output Protocol	1		05		5	See Table B-34. Protocol Settings.
Baud Rate	4		00000000	BPS	0	1200, 2400, 4800, 9600, 19200, 38400
Data Bits	1		00		0	Number of data bits (7 or 8).
Stop Bits	1		00		0	Number of stop bits (0 or 1).
Parity Bits	1		00		0	None (0), Odd (1), Even (2).
TBD	1		00		0	Reserved.
TBD	1		00		0	Reserved.

Payload length: 49 Bytes

The message to set the UART configuration is a series of four data blocks of 12 bytes for each port setting as shown in Table B-32. This message is designed that each block is fixed to a serial port as shown in Table B-33 and must be maintained for correct port configuration. To maintain the current port settings, send an 0xFF in place of the Serial Port Number and the remaining values in the data block are ignored (i.e., current settings are maintained).

Table B-33 Serial Port Settings

Serial Port	**Serial Port Number (Hex)**	**Serial Port Number (decimal)**
UART 0 (CPU SCIO 0)	00	0
UART 1 (CPU SCIO 1)	01	1
UART 2 (GSP Port A)	02	2
UART 3 (GSP Port B)	03	3
ALL Ports	FF	255

The multiple port functionality currently supports only SiRF implemented data I/O (SiRF binary and NMEA) as well as RTCM DGPS corrections for input only. Additional protocols have been set aside for user definition and implementation as shown in Table B-34.

Table B-34 Protocol Settings

Protocol	**Hex**	**Decimal**	**Description**
SiRF Binary	00	0	
NMEA	01	1	
ASCII	02	2	ASCII output; user defined.
RTCM–DGPS	03	3	
User 1	04	4	User defined (see *SiRFstarII System Development Kit Software Manual*).
User 2	06	6	User defined (see *SiRFstarII System Development Kit Software Manual*)
User 3	07	7	User defined (see *SiRFstarII System Development Kit Software Manual*)
User 4	08	8	User defined (see *SiRFstarII System Development Kit Software Manual*)
No I/O	05	5	Serial port is shut off (must be reactivated by other active port).

Output Messages for SiRF Binary Protocol

Note – All output messages are received in **BINARY** format. SiRFdemo interprets the binary data and saves it to the log file in **ASCII** format.

Table B-35 lists the message list for the SiRF output messages.

Table B-35 SiRF Messages - Output Message List

Hex	**ASCII**	**Name**	**Description**
0 x 02	2	Measured Navigation Data	Position, velocity, and time
0 x 03	3	True Tracker Data	Not Implemented
0 x 04	4	Measured Tracking Data	Satellite and C/No information

Table B-35 SiRF Messages - Output Message List

Hex	ASCII	Name	Description
0 x 05	5	Raw Track Data	Raw measurement data
0 x 06	6	SW Version	Receiver software
0 x 07	7	Clock Status	Current clock status
0 x 08	8	50 BPS Subframe Data	Standard ICD format
0 x 09	9	Throughput	Navigation complete data
0 x 0A	10	Error ID	Error coding for message failure
0 x 0B	11	Command Acknowledgment	Successful request
0 x 0C	12	Command NAcknowledgment	Unsuccessful request
0 x 0D	13	Visible List	Auto Output
0 x 0E	14	Almanac Data	Response to Poll
0 x 0F	15	Ephemeris Data	Response to Poll
0 x 10	16	Test Mode Data	For use with SiRFtest[1]
0 x 11	17	Differential Corrections	Received from DGPS broadcast
0 x 12	18	OkToSend	CPU ON / OFF (Trickle Power)
0 x 13	19	Navigation Parameters	Response to Poll
0 x 1C	28	Nav. Lib. Measurement Data	Measurement Data
0 x 1D	29	Nav. Lib. DGPS Data	Differential GPS Data
0 x 1E	30	Nav. Lib. SV State Data	Satellite State Data
0 x 1F	31	Nav. Lib. Initialization Data	Initialization Data
0 x FF	255	Development Data	Various status messages

1. SiRFtest is production testing software tool. Contact SiRF for details.

Measure Navigation Data Out - Message I.D. 2

Output Rate: 1 Hz

Table B-36 lists the binary and ASCII message data format for the measured navigation data.

Example:

A0A20029—Start Sequence and Payload Length

02FFD6F78CFFBE536E003AC00400030104A00036B039780E3
0612190E160F04000000000000—Payload

09BBB0B3—Message Checksum and End Sequence

.

Table B-36 Measured Navigation Data Out - Binary & ASCII Message Data Format

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		02			2
X-position	4		FFD6F78C	m		-2689140
Y-position	4		FFBE536E	m		-4304018
Z-position	4		003AC004	m		3850244
X-velocity	2	*8	00	m/s	Vx÷8	0
Y-velocity	2	*8	03	m/s	Vy÷8	0.375
Z-velocity	2	*8	01	m/s	Vz÷8	0.125
Mode 1	1		04	Bitmap[1]		4
DOP[2]	1	*5	A		÷5	2.0
Mode 2	1		00	Bitmap[3]		0
GPS Week	2		036B			875
GPS TOW	4	*100	039780E3	seconds	÷100	602605.79
SVs in Fix	1		06			6
CH 1	1		12			18
CH 2	1		19			25
CH 3	1		0E			14
CH 4	1		16			22
CH 5	1		0F			15
CH 6	1		04			4
CH 7	1		00			0
CH 8	1		00			0
CH 9	1		00			0
CH 10	1		00			0
CH 11	1		00			0
CH 12	1		00			0

Payload Length: 41 bytes

1. For further information, go to Table B-37.
2. Dilution of precision (DOP) field contains the HDOP value only.
3. For further information, go to Table B-38.

Note – Binary units scaled to integer values need to be divided by the scale value to receive true decimal value (i.e., decimal X_{vel} = binary X_{vel} ÷ 8).

Table B-37 Mode 1

Mode 1		
	ASCII	**Description**
0 x 00	0	No Navigation Solution
0 x 01	1	1 Satellite Solution
0 x 02	2	2 Satellite Solution
0 x 03	3	3 Satellite Solution (2D)
0 x 04	4	≥4 Satellite Solution (3D)
0 x 05	5	2D Point Solution (Least Square)
0 x 06	6	3D Point Solution (Least Square)
0 x 07	7	Dead Reckoning
0 x 08	8	Trickle Power Position
0 x 10	16	Altitude Used From Filter
0 x 20	32	Altitude Used From User
0 x 30	48	Forced Altitude (From User)
0 x 40	64	DOP Mask Exceeded
0 x 80	128	DGPS Position

Example: A value of 0 x 84 (132) is a DGPS ≥4 Satellite Solution (3D).

Table B-38 Mode 2

Mode 2		
Hex	**ASCII**	**Description**
0 x 00	0	DR Sensor Data
0 x 01	1	Validated (1), Unvalidated (0)
0 x 02	2	if set, Dead Reckoning (Time Out)
0 x 03	3	if set, Output Edited by UI (i.e., DOP Mask exceeded)
0 x 04	4	Reserved
0 x 05	5	Reserved
0 x 06	6	Reserved
0 x 07	7	Reserved

Measured Tracker Data Out - Message I.D. 4

Output Rate: 1 Hz

Table B-39 lists the binary and ASCII message data format for the measured tracker data.

Example:

A0A200BC—Start Sequence and Payload Length

04036C0000937F0C0EAB46003F1A1E1D1D191D1A1A1D1F1D59423F1A1A...—Payload

....B0B3—Message Checksum and End Sequence

Table B-39 Measured Tracker Data Out

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		04	None		4
GPS Week	2		036C			876
GPS TOW	4	s*100	0000937F	s	s÷100	37759
Chans	1		0C			12
1st SVid	1		0E			14
Azimuth	1	Az*[2/3]	AB	deg	÷[2/3]	256.5
Elev	1	El*2	46	deg	÷2	35
State	2		003F	Bitmap[1]		0 x 3F
C/No 1	1		1A			26
C/No 2	1		1E			30
C/No 3	1		1D			29
C/No 4	1		1D			29
C/No 5	1		19			25
C/No 6	1		1D			29
C/No 7	1		1A			26
C/No 8	1		1A			26
C/No 9	1		1D			29
C/No 10	1		1F			31
2nd SVid	1		1D			29
Azimuth	1	Az*[2/3]	59	deg	÷[2/3]	89
Elev	1	El*2	42	deg	÷2	66
State	2		3F	Bitmap[1]		63
C/No 1	1		1A			26
C/No 2	1		1A			63
....						

Payload Length: 188 bytes

1. For further information, go to Table B-40.

Note – Message length is fixed to 188 bytes with nontracking channels reporting zero values.

Table B-40 TrktoNAVStruct.trk_status Field Definition

Field Definition	Hex Value	Description
ACQ_SUCCESS	0x0001	Set, if acq/reacq is done successfully
DELTA_CARPHASE_VALID	0x0002	Set, Integrated carrier phase is valid
BIT_SYNC_DONE	0x0004	Set, Bit sync completed flag
SUBFRAME_SYNC_DONE	0x0008	Set, Subframe sync has been done
CARRIER_PULLIN_DONE	0x0010	Set, Carrier pullin done
CODE_LOCKED	0x0020	Set, Code locked
ACQ_FAILED	0x0040	Set, Failed to acquire S/V
GOT_EPHEMERIS	0x0080	Set, Ephemeris data available

Note – When a channel is fully locked and all data is valid, the status shown is 0 x BF.

Raw Tracker Data Out - Message I.D. 5

GPS Pseudo-Range and Integrated Carrier Phase Computations Using SiRF Binary Protocol

This section describes the necessary steps to compute the GPS pseudo-range, pseudo-range rate, and integrated carrier phase data that can be used for post processing applications such as alternative navigation filters. This data enables the use of third party software to calculate and apply differential corrections based on the SiRF binary protocol. Additionally, description and example code is supplied to calculate the measurement data and decode the broadcast ephemeris required for post processing applications.

SiRF Binary Data Messages

The SiRF GPS chip set provides a series of output messages as described in this Guide. This is the raw data message required to compute the pseudo-range and carrier data.

The ephemeris data can be polled by the user or requested at specific intervals with customized software. Currently, there is no support for the automatic saving of the ephemeris when an update ephemeris is decoded.

Output Rate: 1 Hz

Table B-41 lists the binary and ASCII message data format for the raw tracker data.

Example:

A0A20033—Start Sequence and Payload Length

05000000070013003F00EA1BD4000D039200009783000DF45E
000105B5FF90F5C20000242827272327242427290500000070013003F—Payload

0B2DB0B3—Message Checksum and End Sequence

Note – The data that is sent from the Evaluation Receiver is in binary format, SiRFdemo converts the data to ASCII for the log file. Data is NOT output in ASCII format.

Table B-41 Raw Tracker Data Out

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		05			5
Channel	4		00000007			7
SVID	2		0013			19
State	2		003F	bitmap[1]		3F
Bit Number	4		00EA1BD4	bit		15342548
Millisecond Number	2		000D	ms		13
Chip Number	2		0392	chip		914
Code Phase	4	2^{16}	00009783	chip	$\div 2^{16}$	38787
Carrier Doppler	4	2^{10}	000DF45E	radians/2ms	$\div 2^{10}$	914526
Receiver Time Tag	4		000105B5	ms		66997
Delta Carrier[2]	4	2^{10}	FF90F5C2	cycles	$\div 2^{10}$	-7277118
Search Count	2		0000			0
C/No 1	1		24	dBHz		36
C/No 2	1		28	dBHz		40
C/No 3	1		27	dBHz		39
C/No 4	1		27	dBHz		39
C/No 5	1		23	dBHz		35
C/No 6	1		27	dBHz		39
C/No 7	1		24	dBHz		36
C/No 8	1		27	dBHz		36
C/No 9	1		29	dBHz		39
C/No 10	1		29	dBHz		41
Power Bad Count	1		05			5
Phase Bad Count	1		07			7
Accumulation Time	2		0013	ms		19
Track Loop Time	2		003F			63
Payload Length: 51	51	bytes				

1. For further information, go to Table B-40.

2. Multiply by $(1000 \div 4\pi) \div 2^{16}$ to convert to Hz.

Note – The status is reflected by the value of all bits as the receiver goes through each stage of satellite acquisition. The status will have a 0xBF value when a channel is fully locked and all data is valid.

Message ID: Each SiRF binary message is defined based on the ID.

Channel: Receiver channel where data was measured (range 1-12).

SVID: PRN number of the satellite on current channel.

State: Current channel tracking state (see Table B-40).

Bit Number: Number of GPS bits transmitted since Sat-Sun midnight (in Greenwich) at a 50 bps rate.

Millisecond Number: Number of milliseconds of elapsed time since the last received bit (20 ms between bits).

Chip Number: Current C/A code symbol being transmitted (range 0 to 1023 chips; 1023 chips = 1 ms).

Code Phase: Fractional chip of the C/A code symbol at the time of sampling (scaled by 2^{-16}, = 1/65536).

Carrier Doppler: The current value of the carrier frequency as maintained by the tracking loops.

Note – The Bit Number, Millisecond Number, Chip Number, Code Phase, and Carrier Doppler are all sampled at the same receiver time.

Receiver Time Tag: This is the count of the millisecond interrupts from the start of the receiver (power on) until the measurement sample is taken. The ms interrupts are generated by the receiver clock.

Delta Carrier Phase: The difference between the carrier phase (current) and the carrier phase (previous). Units are in carrier cycles with the LSB = 0.00185 carrier cycles. The delta time for the accumulation must be known.

Note – Carrier phase measurements are not necessarily in sync with code phase measurement for each measurement epoch.

Search Count: This is the number of times the tracking software has completed full satellite signal searche.s

C/No: Ten measurements of carrier to noise ratio (C/No) values in dBHz at input to the receiver. Each value represents 100 ms of tracker data and its sampling time is not necessarily in sync with the code phase measurement.

Power Loss Count: The number of times the power detectors fell below the threshold between the present code phase sample and the previous code phase sample. This task is performed every 20 ms (max count is 50).

Phase Loss Count: The number of times the phase lock fell below the threshold between the present code phase sample and the previous code phase sample. This task is performed every 20 ms (max count is 50).

Integration Interval: The time in ms for carrier phase accumulation. This is the time difference (as calculated by the user clock) between the Carrier Phase (current) and the Carrier Phase (previous).

Track Loop Iteration: The tracking Loops are run at 2 ms and 10 ms intervals. Extrapolation values for each interval is 1 ms and 5 ms for range computations.

Calculation of Pseudo-Range Measurements

The pseudo-range measurement in meters can be determined from the raw track data by solving the following equation:

Pseudo-range (PR) = [Received Time (RT) – Transmit Time (TT)] * C

where C = speed of light

The following variables from the raw track data are required for each satellite:

Bit Number (BN) - 50 bits per second

Millisecond Number (MSN)

Chip Number (CN)

Code Phase (CP)

Receiver Time Tag (RTTag)

Delta Carrier Phase (DCP)

The following steps are taken to get the psr data and carrier data for each measurement epoch.

Note – See source code on CD ROM in directory `\source\calcpsr`.

---

1. Computation of initial Receiver Time (RT) in seconds.

Note – Where the initial arbitrary value chosen at start up to make the PR reasonable (i.e., set equal to TT + 70 ms) and then incriminated by one second for each measurement epoch.

---

2. Computation of Transmit Time (TT) in seconds.
3. Calculate Pseudo-range at a common receiver time of the first channel of the measurement data set.

Note – All channel measurements are NOT taken at the same time. Therefore, all ranges must be extrapolated to a common measurement epoch. For simplicity, the first channel of each measurement set is used as the reference to which all other measurements are extrapolated.

---

4. Extrapolate the pseudo-range based on the correlation interval to improve precision.
5. Compute the delta range.

If the accumulation time of the Delta Carrier Phase is 1000 ms then the measurement is valid and can be added to the previous Delta Carrier Phase to get Accumulated Carrier Phase data. If the accumulation time of the Delta Carrier Phase is not equal to 1000 ms then the measurement is not valid and the accumulation time must be restarted to get Accumulated Carrier Phase data.

Output files

Several output files are generated by the `calcpsr.exe` program:

1. `*.eph` Ephemeris data decoded.
2. `sv_data.###` Individual raw track data per satellite (SiRF binary format).
3. `p_range.###` Satellite specific data in the format of receiver time, reference channel, reference Sv, Psr, Delta Psr, Delta-delta Psr (in meters).
4. `*.msr` Psr values and extrapolation values.

Software Version String (Response to Poll) - Message I.D. 6

Output Rate: Response to polling message

Example:

A0A20015—Start Sequence and Payload Length

0606312E322E30444B495431313920534D0000000000—Payload

0382B0B3—Message Checksum and End Sequence

Table B-42 Software Version String

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		06			6
Character	20		[1]			[2]

Payload Length: 21 bytes

1. 06312E322E30444B495431313920534D0000000000
2. 1.2.0DKit119 SM

Note – Convert to symbol to assemble message (i.e., 0 x 4E is ‘N’). These are low priority task and are not necessarily output at constant intervals.

Response: Clock Status Data - Message I.D. 7

Output Rate: 1 Hz or response to polling message

Example:

A0A20014—Start Sequence and Payload Length

0703BD021549240822317923DAEF—Payload

0598B0B3—Message Checksum and End Sequence

Table B-43 Clock Status Data Message

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		07			7
GPS Week	2		03BD			957
GPS TOW	4	*100	02154924	s	÷100	349494.12
Svs	1		08			8
Clock Drift	4		2231	Hz		74289
Clock Bias	4		7923	nano s		12874371 5
Estimated GPS Time	4		DAEF	milli s		34949399 9

Payload Length: 20 bytes

50 BPS Data – Message I.D. 8

Output Rate: As available (12.5 minute download time)

Example:

A0A2002B—Start Sequence and Payload Length

08001900C0342A9B688AB0113FDE2D714FA0A7FFFACC5540157EFFEEDFFFA
80365A867FC67708BEB5860F4—Payload

15AAB0B3—Message Checksum and End Sequence

Table B-44 50 BPS Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		08			8
Channel	1		00			0
Sv I.D	1		19			25
Word[10]	40					

Payload Length: 43 bytes per subframe (5 subframes per page)

Note – Data is logged in ICD format (available from `www.navcen.uscg.mil`). The ICD specification is 30-bit words. The output above has been stripped of parity to give a 240 bit frame instead of 300 bits.

CPU Throughput – Message I.D. 9

Output Rate:1 Hz

Example:

A0A20009—Start Sequence and Payload Length

09003B0011001601E5—Payload

0151B0B3—Message Checksum and End Sequence

Table B-45 CPU Throughput

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	**Example**		**Scale**	**Example**
Message ID	1		09			9
SegStatMax	2	*186	003B	milli s	÷186	.3172
SegStatLat	2	*186	0011	milli s	÷186	.0914
AveTrkTime	2	*186	0016	milli s	÷186	.1183
Last MS	2		01E5	milli s		485

Payload Length: 9 bytes

Command Acknowledgment – Message I.D. 11

Output Rate: Response to successful input message

This is successful almanac (message ID 0x92) request example:

A0A20002—Start Sequence and Payload Length

0B92—Payload

009DB0B3—Message Checksum and End Sequence

Table B-46 Command Acknowledgment

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	**Example**		**Scale**	**Example**
Message ID	1		0B			11
Ack. I.D.	1		92			146

Payload Length: 2 bytes

Command NAcknowledgment – Message I.D. 12

Output Rate: Response to rejected input message

This is an unsuccessful almanac (message ID 0x92) request example:

A0A20002—Start Sequence and Payload Length

0C92—Payload

009EB0B3—Message Checksum and End Sequence

Table B-47 Command NAcknowledgment

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0C			12
NAck. I.D.	1		92			146

Payload Length: 2 bytes

Visible List – Message I.D. 13

Output Rate: Updated approximately every 2 minutes

Note – This is a variable length message. Only the number of visible satellites are reported (as defined by Visible Svs in Table B-48). Maximum is 12 satellites.

Example:

A0A2002A—Start Sequence and Payload Length

0D081D002A00320F009C0032....—Payload

....B0B3—Message Checksum and End Sequence

Table B-48 Visible List

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		0D			13
Visible Svs	1		08			8
CH 1 - Sv I.D.	1		10			16
CH 1 - Sv Azimuth	2		002A	degrees		42
CH 1 - Sv Elevation	2		0032	degrees		50
CH 2 - Sv I.D.	1		0F			15
CH 2 - Sv Azimuth	2		009C	degrees		156
CH 2 - Sv Elevation	2		0032	degrees		50
.....						

Payload Length: 62 bytes (maximum)

Almanac Data - Message I.D. 14

Output Rate: Response to poll

Example:

A0A203A1—Start Sequence and Payload Length

0E01....—Payload

....B0B3—Message Checksum and End Sequence

Table B-49 Almanac Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message I.D.	1		0E			14
Sv I.D.	1		01			1
AlmanacData[14][2]	28					

Payload Length: 30 bytes

Note – Each almanac entry is output in a single message.

Ephemeris Data (Response to Poll) – Message I.D. 15

The ephemeris data that is polled from the receiver is in a special SiRF format based on the ICD- GPS -200 format for ephemeris data. Refer to the supplied utility program `calcpsr.exe` and the associated source files located on CD ROM directory `\source\calcpsr` for decoding of this data.

Note – Provided is an example of the EPH decoding and measurement calculations.

OkToSend - Message I.D. 18

Output Rate: Trickle Power CPU on/off indicator

Example:

A0A20002—Start Sequence and Payload Length

1200—Payload

0012B0B3—Message Checksum and End Sequence

Table B-50 Almanac Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message I.D.	1		12			12
Send Indicator[1]	1		00			00

Payload Length: 2 bytes

1. 0 implies that CPU is about to go OFF, OkToSend==NO, 1 implies CPU has just come ON, OkToSend==YES

Navigation Parameters (Response to Poll) – Message I.D. 19

Output Rate:1 Response to Poll

Example:

A0A20018—Start Sequence and Payload Length

130100000000011E3C0104001E004B1E00000500016400C8—Payload

022DB0B3—Message Checksum and End Sequence

Table B-51 Navigation Parameters

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		13			19
Reserved	4					
Altitude Hold Mode	1		00			0
Altitude Hold Source	1		00			0
Altitude Source Input	2		0000	meters		0
Degraded Mode[1]	1		01			1
Degraded Timeout	1		1E	seconds		30
DR Timeout	1		3C	seconds		60
Track Smooth Mode	1		01			1
Static Navigation	1					
3SV Least Squares	1					
Reserved	4					
DOP Mask Mode[2]	1		04			4
Navigation Elevation Mask	2					
Navigation Power Mask	1					
Reserved	4					
DGPS Source	1					
DGPS Mode[3]	1		00			0
DGPS Timeout	1		1E	seconds		30
Reserved	4					
LP Push-to-Fix	1					
LP On-time	4					
LP Interval	4					
LP User Tasks Enabled	1					
LP User Task Interval	4					
LP Power Cycling Enabled	1					
LP Max. Acq. Search Time	4					
LP Max. Off Time	4					
Reserved	4					
Reserved	4					

Payload Length: 65 bytes

1. See Table B-11.
2. See Table B-13.
3. See Table B-15.

Navigation Library Measurement Data - Message I.D. 28

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A20038—Start Sequence and Payload Length

1C00000660D015F143F62C4113F42FF3FBE95E417B235C468C6964B8FBC5824
15CF1C375301734.....03E801F400000000—Payload

1533B0B3—Message Checksum and End Sequence

Table B-52 Measurement Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message I.D.	1		1C			28
Channel	1		00			
Time Tag	4		000660D0	ms		
Satellite ID	1		15			
GPS Software Time	8		F143F62C 4113F42F	ms		
Pseudo-range	8		F3FBE95E 417B235C	m		
Carrier Frequency	4		468C6964			
Carrier Phase	8		B8FBC582 415CF1C3			
Time in Track	2		7530	ms		
Sync Flags	1		17			
C/No 1	1		34			
C/No 2	1					
C/No 3	1					
C/No 4	1					
C/No 5	1					
C/No 6	1					
C/No 7	1					
C/No 8	1					
C/No 9	1					
C/No 10	1					
Delta Range Interval	2		03E801F4	m		
Mean Delta Range Time	2		01F4	ms		
Extrapolation Time	2		0000	ms		
Phase Error Count	1		00			
Low Power Count	1		00			

Payload Length: 56 bytes

Navigation Library DGPS Data - Message I.D. 29

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A2001A—Start Sequence and Payload Length

1D000F00B501BFC97C673CAAAAAB3FBFFE1240A0000040A00000—Payload

0956B0B3—Message Checksum and End Sequence

Table B-53 Measurement Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message I.D.	1		1D			29
Satellite ID	2		000F			15
IOD	2		00B5			181
Source[1]	1		01			1
Pseudo-range Correction	4		BFC97C67	m		3217652839
Pseudo-range rate Correction	4		3CAAAA AB	m/s		1017817771
Correction Age	4		3FBFFE12	s		1069547026
Reserved	4					
Reserved	4					

Payload Length: 26 bytes

1. 0 = Use no corrections, 1 = Use WAAS channel, 2 = Use external source, 3 = Use Internal Beacon, 4 = Set DGPS Corrections

Navigation Library SV State Data - Message I.D. 30

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A20053—Start Sequence and Payload Length

1E15....2C64E99D01....408906C8—Payload

2360B0B3—Message Checksum and End Sequence

Table B-54 SV State Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message I.D.	1		1E			30
Satellite ID	1		15			21
GPS Time	8			s		
Position X	8			m		
Position Y	8			m		
Position Z	8			m		
Velocity X	8			m/s		
Velocity Y	8			m/s		
Velocity Z	8			m/s		
Clock Bias	8			s		
Clock Drift	4		2C64E99D	s/s		744810909
Ephemeris Flag[1]	1		01			1
Reserved	8					
Ionospheric Delay	4		408906C8	m		1082721992

Payload Length: 83 bytes

1. 0 = no valid SV state, 1 = SV state calculated from ephemeris, 2 = Satellite state calculated from almanac

Navigation Library Initialization Data - Message I.D. 31

Output Rate: Every measurement cycle (full power / continuous : 1Hz)

Example:

A0A20054—Start Sequence and Payload Length

1F....00000000000001001E000F....00....000000000F....00....02....043402....

....02—Payload

0E27B0B3—Message Checksum and End Sequence

Table B-55 Measurement Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message I.D.	1		1F			31
Reserved	1					
Altitude Mode[1]	1		00			0
Altitude Source	1		00			0
Altitude	4		00000000			0
Degraded Mode[2]	1		01			1
Degraded Timeout	2		001E			30
Dead-reckoning Timeout	2		000F			15
Reserved	2					
Track Smoothing Mode[3]	1		00			0
Reserved	1					
Reserved	2					
Reserved	2					
Reserved	2					

Table B-55 Measurement Data *(Continued)*

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
DGPS Selection[4]	1		00			0
DGPS Timeout	2		0000			0
Elevation Nav. Mask	2		000F			15
Reserved	2					
Reserved	1					
Reserved	2					
Reserved	1					
Reserved	2					
Static Nav. Mode[5]	1		00			0
Reserved	2					
Position X	8					
Position Y	8					
Position Z	8					
Position Init. Source[6]	1		02			2
GPS Time	8					
GPS Week	2		0434			1076
Time Init. Source[7]	1		02			2
Drift	8					
Drift Init. Source[8]	1		02			2

Payload Length: 84 bytes

1. 0 = Use last know altitude 1 = Use user input altitude 2 = Use dynamic input from external source
2. 0 = Use direction hold and then time hold 1 = Use time hold and then direction hold 2 = Only use direction hold 3 = Only use time hold 4 = Degraded mode is disabled
3. 0 = True 1 = False
4. 0 = Use DGPS if available 1 = Only navigate if DGPS corrections are available 2 = Never use DGPS corrections
5. 0 = True 1 = False
6. 0 = ROM position 1 = User position 2 = SRAM position 3 = Network assisted position
7. 0 = ROM time 1 = User time 2 = SRAM time 3 = RTC time 4 = Network assisted time
8. 0 = ROM clock 1 = User clock 2 = SRAM clock 3 = Calibration clock 4 = Network assisted clock

Development Data – Message I.D. 255

Output Rate: Receiver generated

Example:

A0A2....—Start Sequence and Payload Length

FF....—Payload

....B0B3—Message Checksum and End Sequence

Table B-56 Development Data

Name	Bytes	Binary (Hex)		Units	ASCII (Decimal)	
		Scale	Example		Scale	Example
Message ID	1		FF			255

Payload Length: Variable

Note – MID 255 is output when SiRF binary is selected and development data is enabled. The data output using MID 255 is essential for SiRF assisted troubleshooting support.

Additional Information

TricklePower Operation in DGPS Mode

When in TricklePower mode, serial port DGPS corrections are supported. The CPU goes into sleep mode but will wake up in response to any interrupt. This includes UART's. Messages received during the TricklePower 'off' period are buffered and processed when the receiver awakens for the next TricklePower cycle.

GPS Week Reporting

Since Aug, 22, 1999, the GPS week roll from 1023 weeks to 0 weeks is in accordance with the ICD-GPS-200 specifications. To maintain roll over compliance, SiRF reports the ICD GPS week between 0 and 1023. If the user needs to have access to the Extended GPS week (ICD GPS week + 1024) this information is available through the Clock Status Message (007) under the Poll menu.

NMEA Protocol in TricklePower Mode

The NMEA standard is generally used in continuous update mode at some predefined rate. This mode is perfectly compatible with all SiRF TricklePower and Push-to-Fix modes of operations. There is *no* mechanism in NMEA that indicates to a host application when the receiver is on or in standby mode. If the receiver is in standby mode (chip set OFF, CPU in standby), then no serial communication is possible for output of NMEA data or receiving SiRF proprietary NMEA input commands. To establish reliable communication, the user must repower the receiver and send commands while the unit is in full-power mode (during start-up) and prior to reverting to TricklePower operation. Alternatively, the host application could send commands (i.e., poll for position) repeatedly until the request has been completed. The capability to create communication synchronization messages in NMEA mode is available through the System Development Kit (SDK).

In Trickle-Power mode, the user is required to select an update rate (seconds between data output) and On Time (milli-seconds the chipset is on). When the user changes to NMEA mode, the option to set the output rate for each of the selected NMEA messages is also required. These values are multiplied by the TricklePower update rate value as shown in Table B-57.

Table B-57 NMEA Data Rates Under Trickle Power Operation

Power Mode	**Continuous**	**Trickle Power**	**Trickle Power**	**Trickle Power**
Update Rate	1 every second	1 every second	1 every 5 seconds	1 every 8 seconds
On Time	1000	200	400	600
NMEA Update Rate	1 every second	1 every 5 seconds	1 every 2 seconds	1 every 5 seconds
Message Output Rate	1 every second	1 every 5 seconds	1 every 10 seconds	1 every 40 seconds

Note – The On Time of the chip set has no effect on the output data rates.

NMEA Input/Output Messages C

The SiRFstarIIe Evaluation Unit is capable of outputting data in the NMEA-0183 format as defined by the National Marine Electronics Association (NMEA), Standard for Interfacing Marine Electronic Devices, Version 2.20, January 1, 1997. See **Chapter 4, “Using the SiRFdemo Software**” for instructions on using NMEA.

NMEA Output Messages

Table C-1 lists each of the NMEA output messages supported by the SiRFstarIIe Evaluation Receiver and a brief description.

Table C-1 NMEA Output Messages

Option	Description
GGA	Time, position and fix type data.
GLL	Latitude, longitude, UTC time of position fix and status.
GSA	GPS receiver operating mode, satellites used in the position solution, and DOP values.
GSV	The number of GPS satellites in view satellite ID numbers, elevation, azimuth, and SNR values.
MSS	Signal-to-noise ratio, signal strength, frequency, and bit rate from a radio-beacon receiver.
RMC	Time, date, position, course and speed data.
VTG	Course and speed information relative to the ground.

A full description and definition of the listed NMEA messages are provided by the next sections of this chapter.

GGA —Global Positioning System Fixed Data

Table C-2 contains the values for the following example:

$GPGGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M, , , ,0000*18

Table C-2 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Time	161229.487		hhmmss.sss
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table C-3
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude[1]	9.0	meters	
Units	M	meters	
Geoid Separation[1]		meters	
Units	M	meters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
<CR> <LF>			End of message termination

1. SiRF Technology Inc. does not support geoid corrections. Values are WGS84 ellipsoid heights.

Table C-3 Position Fix Indicator

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS PPS Mode, fix valid

GLL—Geographic Position - Latitude/Longitude

Table C-4 contains the values for the following example:

$GPGLL,3723.2475,N,12158.3416,W,161229.487,A*2C

Table C-4 GLL Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Checksum	*2C		
<CR> <LF>			End of message termination

GSA—GNSS DOP and Active Satellites

Table C-5 contains the values for the following example:

$GPGSA,A,3,07,02,26,27,09,04,15, , , , , ,1.8,1.0,1.5*33

Table C-5 GSA Data Format

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table C-6
Mode 2	3		See Table C-7
Satellite Used[1]	07		Sv on Channel 1
Satellite Used[1]	02		Sv on Channel 2
....			....
Satellite Used[1]			Sv on Channel 12
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Checksum	*33		
<CR> <LF>			End of message termination

1. Satellite used in solution.

Table C-6 Mode 1

Value	Description
M	Manual—forced to operate in 2D or 3D mode
A	2DAutomatic—allowed to automatically switch 2D/3D

Table C-7 Mode 2

Value	Description
1	Fix Not Available
2	2D
3	3D

GSV—GNSS Satellites in View

Table C-8 contains the values for the following example:

$GPGSV,2,1,07,07,79,048,42,02,51,062,43,26,36,256,42,27,27,138,42*71

$GPGSV,2,2,07,09,23,313,42,04,19,159,41,15,12,041,42*41

Table C-8 GSV Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Messages[1]	2		Range 1 to 3
Message Number[1]	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1 (Range 1 to 32)
Elevation	79	degrees	Channel 1 (Maximum 90)
Azimuth	048	degrees	Channel 1 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
....			....
Satellite ID	27		Channel 4 (Range 1 to 32)
Elevation	27	degrees	Channel 4 (Maximum 90)
Azimuth	138	degrees	Channel 4 (True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
<CR> <LF>			End of message termination

1. Depending on the number of satellites tracked multiple messages of GSV data may be required.

MSS—MSK Receiver Signal

Table C-9 contains the values for the following example:

$GPMSS,55,27,318.0,100,*66

Table C-9 MSS Data Format

Name	Example	Units	Description
Message ID	$GPMSS		MSS protocol header
Signal Strength	55	dB	SS of tracked frequency
Signal-to-Noise Ratio	27	dB	SNR of tracked frequency
Beacon Frequency	318.0	kHz	Currently tracked frequency
Beacon Bit Rate	100		bits per second

Note – The MSS NMEA message can only be polled or scheduled using the MSK NMEA input message. See “MSK—MSK Receiver Interface” on page 152.

RMC—Recommended Minimum Specific GNSS Data

Table C-10 contains the values for the following example:

$GPRMC, 161229.487,A,3723.2475,N,12158.3416,W,0.13,309.62,120598, ,*10

Table C-10 RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Time	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	120598		ddmmyy
Magnetic Variation[1]		degrees	E=east or W=west
Checksum	*10		
<CR> <LF>			End of message termination

1. SiRF Technology Inc. does not support magnetic declination. All “course over ground” data are geodetic WGS84 directions.

VTG—Course Over Ground and Ground Speed

Table C-11 contains the values for the following example:

$GPVTG, 309.62,T, ,M,0.13,N,0.2,K*6E

Table C-11 VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header
Course	309.62	degrees	Measured heading
Reference	T		True
Course		degrees	Measured heading
Reference	M		Magnetic[1]
Speed	0.13	knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	km/hr	Measured horizontal speed
Units	K		Kilometers per hour
Checksum	*6E		
<CR> <LF>			End of message termination

1. SiRF Technology Inc. does not support magnetic declination. All “course over ground” data are geodetic WGS84 directions.

NMEA Input Messages

NMEA input messages are provided to allow you to control the Evaluation Receiver while in NMEA protocol mode. The Evaluation Receiver may be put into NMEA mode by sending the SiRF Binary protocol message “Switch To NMEA Protocol - Message I.D. 129” on page 103 using a user program or using the SiRFdemo software and selecting Switch to NMEA Protocol from the Action menu. If the receiver is in SiRF Binary mode, all NMEA input messages are ignored. Once the receiver is put into NMEA mode, the following messages may be used to command the module.

Transport Message

Start Sequence	Payload	Checksum	End Sequence
$PSRF<MID>[1]	Data[2]	*CKSUM[3]	<CR> <LF>[4]

1. Message Identifier consisting of three numeric characters. Input messages begin at MID 100.
2. Message specific data. Refer to a specific message section for <data>...<data> definition.
3. CKSUM is a two-hex character checksum as defined in the NMEA specification. Use of checksums is required on all input messages.
4. Each message is terminated using Carriage Return (CR) Line Feed (LF) which is \r\n which is hex 0D 0A. Because \r\n are not printable ASCII characters, they are omitted from the example strings, but must be sent to terminate the message and cause the receiver to process that input message.

Note – All fields in all proprietary NMEA messages are required, none are optional. All NMEA messages are comma delimited.

NMEA Input Messages

Message	MID[1]	Description
SetSerialPort	100	Set PORT A parameters and protocol
NavigationInitialization	101	Parameters required for start using X/Y/Z[2]
SetDGPSPort	102	Set PORT B parameters for DGPS input
Query/Rate Control	103	Query standard NMEA message and/or set output rate
LLANavigationInitialization	104	Parameters required for start using Lat/Lon/Alt[3]
Development Data On/Off	105	Development Data messages On/Off
MSK Receiver Interface	MSK	Command message to a MSK radio-beacon receiver.

1. Message Identification (MID).
2. Input coordinates must be WGS84.
3. Input coordinates must be WGS84.

Note – NMEA input messages 100 to 105 are SiRF proprietary NMEA messages. The MSK NMEA string is as defined by the NMEA 0183 standard.

100—SetSerialPort

This command message is used to set the protocol (SiRF Binary or NMEA) and/or the communication parameters (baud, data bits, stop bits, parity). Generally, this command is used to switch the module back to SiRF Binary protocol mode where a more extensive command message set is available. When a valid message is received, the parameters are stored in battery-backed SRAM and then the Evaluation Receiver restarts using the saved parameters.

Table C-12 contains the input values for the following example:

Switch to SiRF Binary protocol at 9600,8,N,1

$PSRF100,0,9600,8,1,0*0C

Table C-12 Set Serial Port Data Format

Name	Example	Units	Description
Message ID	$PSRF100		PSRF100 protocol header
Protocol	0		0=SiRF Binary, 1=NMEA
Baud	9600		4800, 9600, 19200, 38400
DataBits	8		8,7[1]
StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*0C		
<CR> <LF>			End of message termination

1. SiRF protocol is only valid for 8 data bits, 1stop bit, and no parity.

101—NaviagtionInitialization

This command is used to initialize the Evaluation Receiver by providing current position (in X, Y, Z coordinates), clock offset, and time. This enables the Evaluation Receiver to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable the Evaluation Unit to acquire signals quickly.

Table C-13 contains the input values for the following example:

Start using known position and time.

$PSRF101,-2686700,-4304200,3851624,96000,497260,921,12,3*1C

Table C-13 Navigation Initialization Data Format

Name	Example	Units	Description
Message ID	$PSRF101		PSRF101 protocol header
ECEF X	-2686700	meters	X coordinate position
ECEF Y	-4304200	meters	Y coordinate position
ECEF Z	3851624	meters	Z coordinate position
ClkOffset	96000	Hz	Clock Offset of the Evaluation Unit[1]
TimeOfWeek	497260	seconds	GPS Time Of Week
WeekNo	921		GPS Week Number
ChannelCount	12		Range 1 to 12
ResetCfg	3		See Table C-14
Checksum	*1C		
<CR> <LF>			End of message termination

1. Use 0 for last saved value if available.If this is unavailable, a default value of 96,000 will be used.

Table C-14 Reset Configuration

Hex	Description
0x01	Hot Start— All data valid
0x02	Warm Start—Ephemeris cleared
0x03	Warm Start (with Init)—Ephemeris cleared, initialization data loaded
0x04	Cold Start—Clears all data in memory
0x08	Clear Memory—Clears all data in memory and resets receiver back to factory defaults

102—SetDGPSPort

This command is used to control the serial port used to receive RTCM differential corrections. Differential receivers may output corrections using different communication parameters. If a DGPS receiver is used which has different communication parameters, use this command to allow the receiver to correctly decode the data. When a valid message is received, the parameters are stored in battery-backed SRAM and then the receiver restarts using the saved parameters.

Table C-15 contains the input values for the following example:

Set DGPS Port to be 9600,8,N,1.

$PSRF102,9600,8,1,0*12

Table C-15 Set DGPS Port Data Format

Name	Example	Units	Description
Message ID	$PSRF102		PSRF102 protocol header
Baud	9600		4800, 9600, 19200, 38400
DataBits	8		8,7
StopBits	1		0,1
Parity	0		0=None, 1=Odd, 2=Even
Checksum	*12		
<CR> <LF>			End of message termination

103—Query/Rate Control

This command is used to control the output of standard NMEA messages GGA, GLL, GSA, GSV, RMC, and VTG. Using this command message, standard NMEA messages may be polled once, or setup for periodic output. Checksums may also be enabled or disabled depending on the needs of the receiving program. NMEA message settings are saved in battery-backed memory for each entry when the message is accepted.

Table C-16 contains the input values for the following examples:

1. Query the GGA message with checksum enabled

   $PSRF103,00,01,00,01*25

2. Enable VTG message for a 1 Hz constant output with checksum enabled

   $PSRF103,05,00,01,01*20

3. Disable VTG message

   $PSRF103,05,00,00,01*21

Table C-16 Query/Rate Control Data Format (See example 1.)

Name	Example	Units	Description
Message ID	$PSRF103		PSRF103 protocol header
Msg	00		See Table C-17
Mode	01		0=SetRate, 1=Query
Rate	00	seconds	Output—off=0, max=255
CksumEnable	01		0=Disable Checksum, 1=Enable Checksum
Checksum	*25		
<CR> <LF>			End of message termination

Table C-17 Messages

Value	Description
0	GGA
1	GLL
2	GSA
3	GSV
4	RMC
5	VTG

Note – In TricklePower mode, update rate is specified by the user. When you switch to NMEA protocol, message update rate is also required. The resulting update rate is the product of the TricklePower Update rate and the NMEA update rate (i.e. TricklePower update rate = 2 seconds, NMEA update rate = 5 seconds, resulting update rate is every 10 seconds, (2 X 5 = 10)).

104—LLANaviagtionInitialization

This command is used to initialize the Evaluation Receiver by providing current position (in latitude, longitude, and altitude coordinates), clock offset, and time. This enables the receiver to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters enable the receiver to acquire signals quickly.

Table C-18 contains the input values for the following example:

Start using known position and time.

$PSRF104,37.3875111,-121.97232,0,96000,237759,1946,12,1*07

Table C-18 LLA Navigation Initialization Data Format

Name	Example	Units	Description
Message ID	$PSRF104		PSRF104 protocol header
Lat	37.3875111	degrees	Latitude position (Range 90 to -90)
Lon	-121.97232	degrees	Longitude position (Range 180 to -180)
Alt	0	meters	Altitude position
ClkOffset	96000	Hz	Clock Offset of the Evaluation Unit[1]
TimeOfWeek	237759	seconds	GPS Time Of Week
WeekNo	1946		Extended GPS Week Number (1024 added)
ChannelCount	12		Range 1 to 12
ResetCfg	1		See Table C-19
Checksum	*07		
<CR> <LF>			End of message termination

1. Use 0 for last saved value if available. If this is unavailable, a default value of 96,000 will be used.

Table C-19 Reset Configuration

Hex	Description
0x01	Hot Start— All data valid
0x02	Warm Start—Ephemeris cleared
0x03	Warm Start (with Init)—Ephemeris cleared, initialization data loaded
0x04	Cold Start—Clears all data in memory
0x08	Clear Memory—Clears all data in memory and resets receiver back to factory defaults

105—Development Data On/Off

Use this command to enable development data information if you are having trouble getting commands accepted. Invalid commands generate debug information that enables the user to determine the source of the command rejection. Common reasons for input command rejection are invalid checksum or parameter out of specified range.

Table C-20 contains the input values for the following examples:

1. Debug On

   $PSRF105,1*3E

2. Debug Off

   $PSRF105,0*3F

Table C-20 Development Data On/Off Data Format

Name	Example	Units	Description
Message ID	$PSRF105		PSRF105 protocol header
Debug	1		0=Off, 1=On
Checksum	*3E		
<CR> <LF>			End of message termination

MSK—MSK Receiver Interface

Table C-21 contains the values for the following example:

$GPMSK,318.0,A,100,M,2,*45

Table C-21 RMC Data Format

Name	Example	Units	Description
Message ID	$GPMSK		MSK protocol header
Beacon Frequency	318.0	kHz	Frequency to use
Auto/Manual Frequency[1]	A		A : Auto, M : Manual
Beacon Bit Rate	100		Bits per second
Auto/Manual Bit Rate[1]	M		A : Auto, M : Manual
Interval for Sending $--MSS[2]	2	s	Sending of MSS messages for status

1. If Auto is specified the previous field value is ignored.
2. When status data is not to be transmitted this field is null.

Note – The NMEA messages supported by the Evaluation Receiver does not provide the ability to change the DGPS source. If you need to change the DGPS source to internal beacon, then this must be done using the SiRF binary protocol and then switched to NMEA.

Calculating Checksums for NMEA Input

See “The Cksum Utility” on page 89 in **Chapter 6, “Additional Software Tools**” for detailed information.

Coordinate Systems D

The Cartesian coordinate frame of reference used in GPS is called Earth-Centered, Earth-Fixed (ECEF). ECEF uses three-dimensional XYZ coordinates (in meters) to describe the location of a GPS user or satellite. The term “Earth-Centered” comes from the fact that the origin of the axis (0,0,0) is located at the mass center of gravity (determined through years of tracking satellite trajectories). The term, Earth-Fixed, implies that the axes are fixed with respect to the earth (that is, they rotate with the earth). The Z-axis pierces the North Pole, and the XY-axis defines the equatorial plane (Figure D-1).

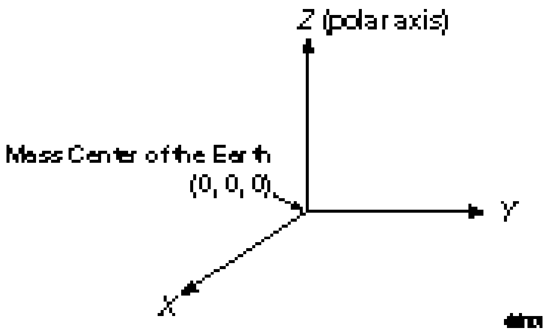


Figure D-1 ECEF Coordinate Reference Frame

ECEF coordinates are expressed in a reference system that is related to mapping representations. Because the earth has a complex shape, a simple, yet accurate, method to approximate the earth’s shape is required. The use of a reference ellipsoid allows for the conversion of the ECEF coordinates to the more commonly used geodetic-mapping coordinates of Latitude, Longitude, and Altitude (LLA). Geodetic coordinates can then be converted to a second map reference known as Mercator Projections, where smaller regions are projected onto a flat mapping surface (that is, Universal Transverse Mercator – UTM or the USGS Grid system).

A reference ellipsoid can be described by a series of parameters that define its shape and which include a semi-major axis (a), a semi-minor axis (b) and its first eccentricity (e^2) and its second eccentricity (e'^2) as shown in Figure D-2. Depending on the formulation used, ellipsoid “flattening” may be required.

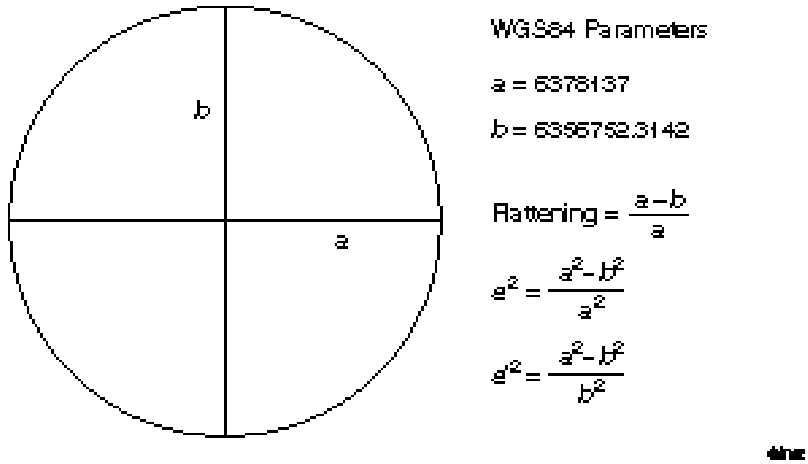


Figure D-2 Ellipsoid Parameters

For global applications, the geodetic reference (datum) used for GPS is the World Geodetic System 1984 (WGS84). This ellipsoid has its origin coincident with the ECEF origin. The X-axis pierces the Greenwich meridian (where longitude = 0 degrees) and the XY plane make up the equatorial plane (latitude = 0 degrees). Altitude is described as the perpendicular distance above the ellipsoid surface (which not to be confused with the mean sea level datum).

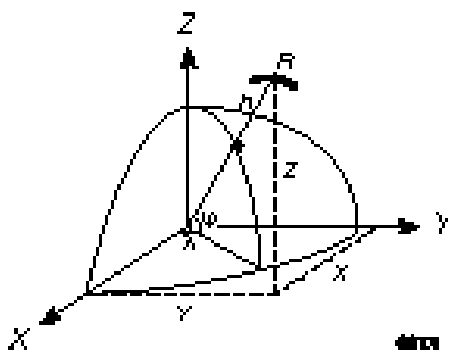


Figure D-3 ECEF and Reference Ellipsoid

LLA to ECEF

The conversion between the two reference coordinate systems can be performed using closed formulas (although iteration methods also exist). The conversion from LLA to ECEF (in meters) is shown below.

$$X = [N + H] \cos \varphi \cos \lambda \qquad (1)$$

$$Y = [N + H] \cos \varphi \sin \lambda \qquad (2)$$

$$Z = [(b^2/a^2)\, N + h] \sin \varphi \qquad (3)$$

Where:

φ = latitude

λ = longitude

h = height above ellipsoid (meters)

N = Prime Vertical of Curvature (meters) is defined as:

$$N = \frac{a^2}{[a^2 \cos^2\varphi + b^2 \sin^2\varphi]^{1/2}} \quad (4)$$

ECEF to LLA

The conversion between XYZ and LLA is slightly more involved but can be achieved using the following closed formula set:

$$\varphi = \arctan\left[\frac{Z + e'^2\, b \sin^3\theta}{p - e^2\ a \cos^3\theta}\right] \quad (5)$$

$$\lambda = \arctan\left[\frac{Y}{X}\right] \quad (6)$$

$$h = \left[\frac{P}{\mathrm{Cos}\ \varphi}\right] - N \quad (7)$$

Where auxiliary values are:

$$\theta = \arctan\left[\frac{Z\ a}{p\ b}\right] \quad (8)$$

$$p = [X^2+Y^2]^{1/2} \quad (9)$$

GPS Heights

The height determined by GPS measurements relates to the perpendicular distance above the reference ellipsoid and should not be confused with the more well-known height datum Mean Sea Level (MSL). The datum that defines the MSL (also called the geoid) is a complex surface that requires dense and accurate gravity data to define its shape. The WGS84 ellipsoid approximates the geoid on a worldwide basis with deviations between the two datums never exceeding 100 meters. The transformation between the two surfaces is illustrated in Figure D-4.

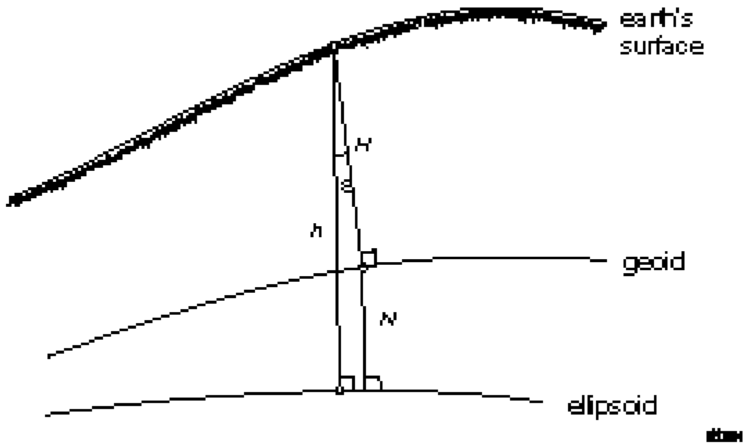


Figure D-4 Ellipsoid and MSL Reference Datums

The conversion between the two reference datums is shown by:

$$h = H + N \tag{10}$$

where:

h	ellipsoidal height (Geodetic)
H	orthometric height (MSL)
N	geoid separation (undulation)
ε	deflection of the vertical

Note – The ellipsoid/geoid separation ranges from a value of +100 meters to –100 meters.

Although the conversion between the different height datums is straightforward, the accuracy at which the undulation is known (N) varies greatly with gravity measurement data density. It is even more difficult to determine in mountainous regions where mass distribution can vary rapidly.

Converting ECEF Velocities to Local Tangent Plane Velocities

GPS also resolves the speed and direction of travel in the ECEF XYZ reference frame. To convert these values to a local tangent plane (LTP), the velocity vector must be rotated to reflect directions in terms more usable to the user. The LTP uses the orientation of North, East, and Down, which is consistent with the geodetic coordinates LLA. To transform the velocity vector, you use the following direction cosine matrix (North, East, Down) and solving for each component results in the following equations:

$$Vn = Vx(-\sin\varphi\cos\lambda) + Vy(-\sin\varphi\sin\lambda) + Vz(\cos\varphi) \quad (11)$$

$$Ve = Vx(-\sin\lambda) + Vy(\cos\lambda) \quad (12)$$

$$Vu = Vx(-\cos\varphi\cos\lambda) + Vy(-\cos\varphi\sin\lambda) + Vz(-\sin\varphi) \quad (13)$$

Speed and Heading Computations

The speed and heading data can be derived from the velocity information. Because we have already transformed the velocity vector into the local frame of east, north, and down, out speed and velocity are also in the local frame.

$Speed = (Vn^2+Ve^2)^{1/2}$ result is in meters (14)

$Heading = arctan2(Ve/Vn)$ result is in radians (15)

Note – The arctan2 function (C programming function) returns a value between π and –π (+180 and –180 degrees). If the value is negative then 2π (360 degrees) must be added to the results to get a positive full circle value. The heading is generally denoted in degrees as a full-circle azimuth ranging from 0 – 360 degrees (i.e., north = 0 degrees, south = 180 degrees).

Transformation to Other Reference Datums

Many reference ellipsoids are used throughout the world. The main reason for choosing a reference datum other than WGS84 is to minimize the local differences between the geoid and the ellipsoid separation or other mapping distortions. Table D-1 lists several of the reference ellipsoids in use worldwide and their associated parameters.

Table D-1 Commonly Used Ellipsoids

Name	a	b	1/f
Airy	6377563.396	6356256.909	299.324965
Airy (Modified)	6377340.189	6356034.448	299.324965
Australian National	6378160.000	6356774.719	298.250000
Bessel 1841	6377397.155	6356078.963	299.152813
Bessel 1841 (Namibia)	6377483.865	6356165.383	299.152813
Clarke 1866	6378206.400	6356583.800	294.978698
Clarke 1880	6378249.145	6356514.870	293.465000
Everest (Sabah & Sarawak)	6377298.556	6356097.550	300.801700
Everest 1830	6377276.345	6356075.413	300.801700
Everest 1948	6377304.063	6356103.039	300.801700
Everest 1956	6377301.243	6356100.228	300.801700
Everest 1969	6377295.664	6356094.668	300.801700
Fischer 1960	6378166.000	6356784.284	298.300000
Fischer 1960 (Modified)	6378155.000	6356773.320	298.300000
Fischer 1968	6378150.000	6356768.337	298.300000
GRS 1980	6378137.000	6356752.314	298.257222
Helmert 1906	6378200.000	6356818.170	298.300000
Hough	6378270.000	6356794.343	297.000000
International	6378388.000	6356911.946	297.000000
Krassovsky	6378245.000	6356863.019	298.300000
SGS 85	6378136.000	6356751.302	298.257000
South American 1969	6378160.000	6356774.719	298.250000
WGS 60	6378165.000	6356783.287	298.300000
WGS 66	6378145.000	6356759.769	298.250000
WGS 72	6378135.000	6356750.520	298.260000
WGS 84	6378137.000	6356752.314	298.257224

Reference: *DoD, WGS84, DMA TR 8350.2-B,1* Sept. 1991

Datum Translations

Many other datums worldwide use the ellipsoid parameters shown in Table D-1 but do not have the same origin (that is, the centre of the ellipsoid does not coincide with the defined ECEF XYZ origin at the mass center of the earth). This creates a translation of the XYZ which must be performed prior to computing the geodetic positions and velocities. Table D-2 contains a list of datums, their associated ellipsoid, and the XYZ translation between the ECEF origin and the center of the ellipsoid.

To convert the ECEF coordinates to a geodetic datum, the translation vector must be applied prior to converting the LLA of the selected datum. The formulation for this conversion is shown in the following formulas.

To translate between two datums A -> B in ECEF

$$X_{datumB} = X_{datumA} - Dx_{AB} \quad (16)$$

$$Y_{datumB} = Y_{datumA} - Dy_{AB} \quad (17)$$

$$Z_{datumB} = Z_{datumA} - Dz_{AB} \quad (18)$$

Note – The Dx, Dy, and Dz values shown in Table D-2 are defined as from any datum to ECEF.

Example: Translate from WGS84 (datumA) to Tokyo-Korea (datumB)

1. Identify the Tokyo–Korea datum in Table D-2

   Reference ellipsoid is Bessel 1841 (a = 6377397.155, b = 6356078.963)

   XYZ Translation (Dx = –146, Dy = 507, Dz = 685)

2. Give an ECEF coordinate X = –2686727, Y = -4304285, Z = 3851643

   $X_{Tokyo\text{-}Korea} = -2686727 - (-146) = -2686581$

   $Y_{Tokyo\text{-}Korea} = -4304285 - (507) = -4304792$

   $Z_{Tokyo\text{-}Korea} = 3851643 - (685) = 3850958$

3. Convert to LLA using Bessel 1841 ellipsoid parameters (eq. 5–9)

Common Datum Shift Parameters

Table D-2 lists the common datum shift parameters.

Table D-2 Translation Components for Selected Reference Datums

Datum	Reference Ellipsoid	Dx	Dy	Dz
Adindan - Burkina Faso	Clarke 1880	-118	-14	218
Adindan – Ethiopia	Clarke 1880	-165	-11	206
Adindan - Ethiopia, Sudan	Clarke 1880	-166	-15	204
Adindan – Mali	Clarke 1880	-123	-20	220
Adindan - Regional Mean	Clarke 1880	-166	-15	204
Adindan – Senegal	Clarke 1880	-128	-18	224
Adindan – Sudan	Clarke 1880	-161	-14	205
Adindan – Cameroon	Clarke 1880	-134	-2	210
Afgooye – Somalia	Krassovsky	-43	-163	45
Ain el Abd 1970 – Bahrain	International	-150	-251	-2
Ain el Abd 1970 - Saudi Arabia	International	-143	-236	7
American Samoa 1962 - Samoa Islands	Clarke 1866	-115	118	426
Anna 1 Astro 1965 - Cocos Islands	Australian National	-491	-22	435
Antigua Island Astro 1965 - Leward Islands	Clarke 1880	-270	13	62
Arc 1950 - Botswana	Clarke 1880	-138	-105	-289
Arc 1950 - Burundi	Clarke 1880	-153	-5	-292
Arc 1950 - Lesotho	Clarke 1880	-125	-108	-295
Arc 1950 - Malawi	Clarke 1880	-161	-73	-317
Arc 1950 - Regional Mean	Clarke 1880	-143	-90	-294
Arc 1950 - Swaziland	Clarke 1880	-134	-105	-295
Arc 1950 - Zaire	Clarke 1880	-169	-19	-278
Arc 1950 - Zambia	Clarke 1880	-147	-74	-283
Arc 1950 - Zimbabwe	Clarke 1880	-142	-96	-293
Arc 1960 - Kenya	Clarke 1880	-157	-2	-299
Arc 1960 - Kenya, Tanzania	Clarke 1880	-160	-6	-302
Arc 1960 – Tanzania	Clarke 1880	-175	-23	-303
Ascension Island 1958	International	-191	103	51
Astro Beacon E 1945 - Iwo Jima	International	145	75	-272
Astro DOS 71/4 – St Helena Island	International	-320	550	-494
Astro Tern Island (FRIG) 1961	International	114	-116	-333
Astronomical Station 1952 - Marcus Island	International	124	-234	-25
Australian Geodetic 1966	Australian National	-133	-48	148
Australian Geodetic 1984	Australian National	-134	-48	149
Ayabelle Lighthouse - Djibouti	Clarke 1880	-79	-129	145
Bellevue (IGN)	International	-127	-769	472
Bermuda 1957 – Bermuda	Clarke 1866	-73	213	296
Bissau - Guinea-Bissu	International	-173	253	27
Bogota Observatory - Colombia	International	307	304	-318
Bukit Rimpah – Indonesia	Bessel 1841	-384	664	-48
Camp Area Astro - Antarctica	International	-104	-129	239
Campo Inchauspe - Argentina	International	-148	136	90
Canton Astro 1966 - Phoenix Islands	International	298	304	-375
Cap - South Africa	Clarke 1880	-136	108	-292
Cape Canaveral - Bahamas, Florida	Clarke 1866	-2	151	181

Table D-2 Translation Components for Selected Reference Datums *(Continued)*

Datum	Reference Ellipsoid	Dx	Dy	Dz
Carthage – Tunisia	Clarke 1880	-263	6	431
Chatham Island Astro 1971 - New Zealand	International	175	-38	113
Chua Astro – Paraguay	International	-134	229	-29
Corrego Alegre – Brazil	International	-206	172	-6
Dabola – Guinea	Clarke 1880	-83	37	124
Deception Island - Deception Island	Clarke 1880	260	12	-147
Djakarta (Batavia)	Bessel 1841	-377	681	-50
DOS 1968 - New Georgia Islands	International	230	-199	-752
Easter Island 1967 - Easter Island	International	211	147	111
Estonia Coordinate System 1937	Bessel 1841	374	150	588
European 1950 - Cyprus	International	-104	-101	-140
European 1950 - Eastern Regional Mean	International	-87	-96	-120
European 1950 - Egypt	International	-130	-117	-151
European 1950 - Finland, Norway	International	-87	-95	-120
European 1950 - Greece	International	-84	-95	-130
European 1950 - Iran	International	-117	-132	-164
European 1950 - Italy (Sardinia)	International	-97	-103	-120
European 1950 - Italy (Sicily)	International	-97	-88	-135
European 1950 - Malta	International	-107	-88	-149
European 1950 - Northern Regional Mean	International	-86	-96	-120
European 1950 - Portugal, Spain	International	-84	-107	-120
European 1950 - Southern Regional Mean	International	-103	-106	-141
European 1950 - Tunisia	International	-112	-77	-145
European 1950 - Western Regional Mean	International	-87	-98	-121
European 1979 - Central Regional Mean	International	-86	-98	-119
Fort Thomas 1955 - Nevis, St Kitts	Clarke 1880	-7	215	225
Gan 1970 - Republic of Maldives	International	-133	-321	50
Geodetic Datum 1949 - New Zealand	International	84	-22	209
Graciosa Base SW 1948 - Azores	International	-104	167	-38
Guam 1963 - Guam	Clarke 1866	-100	-248	259
Gunung Segara - Indonesia	Bessel 1841	-403	684	41
GUX 1 Astro - Guadalcanal Island	International	252	-209	-751
Herat North - Afganistan	International	-333	-222	114
Hermannskogel Datum - Croatia, Serbia	Bessel 1841	653	-212	449
Hjorsey 1955 - Iceland	International	-73	46	-86
Hong Kong 1963 - Hong Kong	International	-156	-271	-189
Hu-Tsu-Shan - Taiwan	International	-637	-549	-203
Indian - Bangladesh	Everest 1830	282	726	254
Indian - India, Nepal	Everest 1956	295	736	257
Indian - Pakistan	Everest (Pakistan)	283	682	231
Indian 1954 - Thailand, Vietnam	Everest 1830	218	816	297
Indian 1960 -	Everest 1830	198	881	317
Indian 1960 - Vietnam (Con Son Islands)	Everest 1830	182	915	344
Indian 1975 - Thailand	Everest 1830	209	818	290
Indonesian 1974 - Indonesia	Indonesian 1974	-24	-15	5
Ireland 1965 - Ireland	Modified Airy	506	-122	611
ISTS 061 Astro 1968 - South Georgia Islands	International	-794	119	-298

Table D-2 Translation Components for Selected Reference Datums *(Continued)*

Datum	Reference Ellipsoid	Dx	Dy	Dz
ISTS 073 Astro 1969 - Diego Garcia	International	208	-435	-229
Johnston Island 1961 -Johnston Island	International	189	-79	-202
Kandawala - Sri Lanka	Everest 1830	-97	787	86
Kerguelen Island 1949	International	145	-187	103
Kertau 1948 - West Malaysia & Singapore	Everest 1948	-11	851	5
Korean Geodetic System - South Korea	GRS 1980	0	0	0
Kusaie Astro 1951 - Caroline Islands	International	647	1777	-1124
L. C. 5 Astro 1961 - Cayman Brac Islands	Clarke 1866	42	124	147
Legion - Ghana	Clarke 1880	-130	29	364
Liberia 1964 - Liberia	Clarke 1880	-90	40	88
Luzon - Philippines	Clarke 1866	-133	-77	-51
Luzon - Philippines (Mindanao)	Clarke 1866	-133	-79	-72
Mahe 1971 - Mahe Island	Clarke 1880	41	-220	-134
Massawa - Ethiopia (Eritrea)	Bessel 1841	639	405	60
Merchich - Morocco	Clarke 1880	31	146	47
Midway Astro 1961 - Midway Islands	International	912	-58	1227
Minna - Cameroon	Clarke 1880	-81	-84	115
Minna - Nigeria	Clarke 1880	-92	-93	122
Montserrat Island Astro 1958	Clarke 1880	174	359	365
M'Poraloko - Gabon	Clarke 1880	-74	-130	42
Nahrwan - Oman (Masirah Island)	Clarke 1880	-247	-148	369
Nahrwan - Saudi Arabia	Clarke 1880	-243	-192	477
Nahrwan - United Arab Emirates	Clarke 1880	-249	-156	381
Naparima BWI - Trinidad & Tobago	International	-10	375	165
North American 1927 - Alaska	Clarke 1866	-5	135	172
North American 1927 - Alaska (Aleutian Islands E)	Clarke 1866	-2	152	149
North American 1927 - Alaska (Aleutian Islands W)	Clarke 1866	2	204	105
North American 1927 - Bahamas	Clarke 1866	-4	154	178
North American 1927 - Bahamas (San Salvador)	Clarke 1866	1	140	165
North American 1927 - Canada (Yukon)	Clarke 1866	-7	139	181
North American 1927 - Canal Zone	Clarke 1866	0	125	201
North American 1927 - Central America	Clarke 1866	0	125	194
North American 1927 - Central Canada	Clarke 1866	-9	157	184
North American 1927 - Cuba	Clarke 1866	-9	152	178
North American 1927 - East Canada	Clarke 1866	-22	160	190
North American 1927 - East of Mississippi	Clarke 1866	-9	161	179
North American 1927 - Greenland	Clarke 1866	11	114	195
North American 1927 - Gulf of Mexico	Clarke 1866	-3	142	183
North American 1927 - Mean for Canada	Clarke 1866	-10	158	187
North American 1927 - Mean for Conus	Clarke 1866	-8	160	176
North American 1927 - Mexico	Clarke 1866	-12	130	190
North American 1927 - Northwest Canada	Clarke 1866	4	159	188
North American 1927 - West Canada	Clarke 1866	-7	162	188
North American 1927 - West of Mississippi	Clarke 1866	-8	159	175
North American 1983 - Alaska, Canada, Conus	GRS 1980	0	0	0
North American 1983 - Aleutian Islands	GRS 1980	-2	0	4
North American 1983 - Central America, Mexico	GRS 1980	0	0	0

Table D-2 Translation Components for Selected Reference Datums *(Continued)*

Datum	Reference Ellipsoid	Dx	Dy	Dz
North American 1983 - Hawaii	GRS 1980	1	1	-1
North Sahara - Algeria	Clarke 1880	-186	-93	310
Observatorio Metereo 1939 - Azores	International	-425	-169	81
Old Egyptian 1907 - Egypt	Helmert 1906	-130	110	-13
Old Hawaiian - Hawaii	Clarke 1866	89	-279	-183
Old Hawaiian - Kauai	Clarke 1866	45	-290	-172
Old Hawaiian - Maui	Clarke 1866	65	-290	-190
Old Hawaiian - Oahu	Clarke 1866	58	-283	-182
Old Hawaiian - Regional Mean	Clarke 1866	61	-285	-181
Oman - Oman	Clarke 1880	-346	-1	224
Ord. Survey G. Britain 1936 - England	Airy	371	-112	434
Ord. Survey G. Britain 1936 - Isle of Man	Airy	371	-111	434
Ord. Survey G. Britain 1936 - Regional Mean	Airy	375	-111	431
Ord. Survey G. Britain 1936 - Scotland, Shetland	Airy	384	-111	425
Ord. Survey G. Britain 1936 - Wales	Airy	370	-108	434
Pico de las Nieves - Canary Islands	International	-307	-92	127
Pitcairn Astro 1967 - Pitcairn Island	International	185	165	42
Point 58 - Mean for Burkina Faso & Niger	Clarke 1880	-106	-129	165
Pointe Noire 1948 - Congo	Clarke 1880	-148	51	-291
Porto Santo 1936 - Maderia Islands	International	-499	-249	314
Provisional S. American 1956 - Bolivia	International	-270	188	-388
Provisional S. American 1956 - Chile (Northern)	International	-270	183	-390
Provisional S. American 1956 - Chile (Southern)	International	-305	243	-442
Provisional S. American 1956 - Colombia	International	-282	169	-371
Provisional S. American 1956 - Ecuador	International	-278	171	-367
Provisional S. American 1956 - Guyana	International	-298	159	-369
Provisional S. American 1956 - Peru	International	-279	175	-379
Provisional S. American 1956 - Regional Mean	International	-288	175	-376
Provisional S. American 1956 - Venezuela	International	-295	173	-371
Provisional S. Chilean 1963 - Chile	International	16	196	93
Puerto Rico - Virgin Islands	Clarke 1866	11	72	-101
Pulkovo 1942 - Russia	Krassovsky 1940	28	-130	-95
Qatar National - Qatar	International	-128	-283	22
Qornoq - Greenland (South)	International	164	138	-189
Reunion - Mascarene Islands	International	94	-948	-1262
Rome 1940 - Italy (Sardinia)	International	-225	-65	9
S-42 (Pulkovo 1942) - Albania	Krassovsky 1940	24	-130	-92
S-42 (Pulkovo 1942) - Czechoslovakia	Krassovsky 1940	26	-121	-78
S-42 (Pulkovo 1942) - Hungary	Krassovsky 1940	28	-121	-77
S-42 (Pulkovo 1942) - Kazakhstan	Krassovsky 1940	15	-130	-84
S-42 (Pulkovo 1942) - Latvia	Krassovsky 1940	24	-124	-82
S-42 (Pulkovo 1942) - Poland	Krassovsky 1940	23	-124	-82
S-42 (Pulkovo 1942) - Romania	Krassovsky 1940	28	-121	-77
Santo (DOS) 1965 - Espirito Santo Island	International	170	42	84
Sao Braz - Azores	International	-203	141	53
Sapper Hill 1943 - East Falkland Island	International	-355	21	72
Schwarzeck - Namibia	Bessel 1841 (Namibia)	616	97	-251

Table D-2 Translation Components for Selected Reference Datums *(Continued)*

Datum	Reference Ellipsoid	Dx	Dy	Dz
Selvagem Grande - Salvage Islands	International	-289	-124	60
SGS 85 - Soviet Geodetic system 1985	SGS 85	3	9	-9
Sierra Leone 1960 - Sierra Leone	Clarke 1880	-88	4	101
S-JTSK - Czechoslovakia (prior to Jan 1993)	Bessel 1841	589	76	480
South American 1969 - Argentina	South American 1969	-62	-1	-37
South American 1969 - Bolivia	South American 1969	-61	2	-48
South American 1969 - Brazil	South American 1969	-60	-2	-41
South American 1969 - Chile	South American 1969	-75	-1	-44
South American 1969 - Colombia	South American 1969	-44	6	-36
South American 1969 - Ecuador	South American 1969	-48	3	-44
South American 1969 - Ecuador (Baltra, Galapagos)	South American 1969	-47	27	-42
South American 1969 - Guyana	South American 1969	-53	3	-47
South American 1969 - Paraguay	South American 1969	-61	2	-33
South American 1969 - Peru	South American 1969	-58	0	-44
South American 1969 - Regional Mean	South American 1969	-57	1	-41
South American 1969 - Trinidad & Tobago	South American 1969	-45	12	-33
South American 1969 - Venezuela	South American 1969	-45	8	-33
South Asia - Singapore	Modified Fischer 1960	7	-10	-26
Tananarive Observatory 1925 - Madagascar	International	-189	-242	-91
Timbalai 1948 - Brunei, East Malaysia	Everest (Sabah, Sarawak)	-679	669	-48
Tokyo - Japan	Bessel 1841	-148	507	685
Tokyo - Korea	Bessel 1841	-146	507	687
Tokyo – Okinawa	Bessel 1841	-158	507	676
Tokyo - Regional Mean	Bessel 1841	-148	507	685
Tokyo - South Korea	Bessel 1841	-147	506	687
Tristan Astro 1968 - Tristan da Cunha	International	-632	438	-609
Viti Levu – Fiji	Clarke 1880	51	391	-36
Voirol 1960 – Algeria	Clarke 1880	-123	-206	219
Wake Island Astro 1952 - Wake Atoll	International	276	-57	149
Wake-Eniwetok 1960 - Marshall Islands	Hough	102	52	-38
WGS 1972 – Global Definition	WGS 72	0	0	0
WGS 1984 – Global Definition	WGS 84	0	0	0
Yacare – Uruguay	International	-155	171	37
Zanderij – Suriname	International	-265	120	-358

Acronyms, Abbreviations, and Glossary E

This appendix describes all 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 SiRFstarI/LX 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 SiRFstarI/LX 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.
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 form the satellite range measurements) in the horizontal (East, North) plane.
Held Altitude	The altitude value that is 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 is in degrees or radians, East in same units and Down is 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”).
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. SiRFstar receiver supports version 2.01 of standard NMEA 0183.
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 SiRFstar receiver is powered by the backup battery power supply (sometimes also referred to as “keep-alive” SRAM).
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 computers, when possible, an overdetermined solution using the measurements form 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. SiRFstarI/LX Evaluation Unit can monitor up to 12 satellites simultaneously, due to the capabilities of the SiRF chipset it uses.
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 that are 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 form the GPS receiver to the satellite determined by measuring the phrase 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 that 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*. SiRFstar receiver supports 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 varies 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 that 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.
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.

ADDITIONAL AVAILABLE PRODUCT INFORMATION

Part Number	Description
	Product Inserts
	SiRFstarI Architecture
	SiRFstarII Architecture
	SiRFstarI/LX Evaluation Kit and Development Tools
	SiRFstarI/LX System Development Kit Development Tools
	SiRFstarIIe Evaluation Development Tools
	SiRFstarIIe System Development Kit Development Tools
	Product Briefs
1055-1015	GRF1/LXi
1055-1016	GSP2e Family
1055-1017	GRF2i
	Application Notes
APNT0002	Serial Break Detection
APNT0006	PCB Design Guidelines
APNT0007	Antenna Open-Short Detector
	SiRFstarI Application Notes
APNT0001	Interfacing the GPSI/LX to General Purpose CPUs
APNT0003	Troubleshooting Note for SiRFstar LXHA
APNT0004	System RF Front-End Requirements for the SiRFstarI/LX GPS Receiver
APNT0005	Using the SiRF PSLX Interface Board
APNT0008	SiRFstarI Common User SDK Modifications
APNT0009	GRF1/LXi Upgrade
APNT0013	SiRFstarI LXHS Back-up Power Operation
	SiRFstarII Application Notes
APNT0012	GSP2e Hardware Implementation
APNT0016	SiRFstarII Alternate Flash Programming Algorithms

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