SiRFstarIII Evaluation Kit User Guide

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SiRFstarIII Evaluation Kit User Guide

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If you have any problems with your product, contact your SiRF representative or call or send an e-mail to the SiRF Technology support group:

phone	+1 (408) 467-0410
e-mail	support@sirf.com

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Preface

The *SiRFstarIII Evaluation Kit User Guide* provides information about the SiRFstarIII Evaluation Kit including what is provided, how to install software and hardware, information about GPS operating parameters and also how to perform a GPS evaluation.

Who Should Use This Guide

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

How This Guide Is Organized

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

Chapter 2, "Installation" provides instructions for installing the provided software tools and the SiRFstarIII Evaluation Receiver.

Chapter 3, "GPS Operating Parameters" provides detailed information about various GPS operating parameters including how changing operating parameters can effect GPS performance.

Chapter 4, "Evaluating GPS" provides information and tips on how to evaluate a GPS solution.

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

Related Manuals

You can refer to the following manuals for additional information:

- *SiRFDemo User Guide*
- *SiRFDemoPPC User Guide*
- *SiRFView User Guide*
- *SiRFFlash User Guide*

Troubleshooting/Contacting SiRF Technical Support

Address:

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General enquiries:

Phone: +1 (408) 467-0410 (9 am to 5 pm Pacific Standard Time)

Email: gps@sirf.com

Helpful Information When Contacting SiRF Technical Support

Receiver Serial Number: _______________

Receiver Software Version: _____________

Overview 1

The SiRFstarIII Evaluation Kit provides all of the necessary hardware, software, and documentation to effectively evaluate the performance and suitability of SiRF's SiRFstarIII chipset solution.

The SiRFstarIII Evaluation Kit comes complete with the following items:

- An operational GPS receiver based on the SiRFstarIII GSC3f solution known as the SiRFstarIII Evaluation Receiver
- The imbedded GPS software called GSW3 that is pre-loaded onto the SiRFstarIII Evaluation Receiver
- A collection of software tools to help with the evaluation process including SiRFDemo, SiRFDemoPPC, SiRFView, and SiRFFlash
- A complete collection of documentation
- All necessary additional hardware such as cables, antenna, and power supplies

For a complete list of the SiRFstarIII Evaluation Kit contents, refer to the packing list included with the Evaluation Kit. Contact SiRF Technology or your dealer if you find any items missing or encounter problems with your SiRFstarIII Evaluation Kit.

GPS Software

A large factor in GPS performance and capabilities is the embedded GPS software. GSW3 is the imbedded software that is compatible and runs on the SiRFstarIII baseband. The GPS software is highly configurable with the best configuration largely dependant on the intended application and performance requirements.

The GSW3 binary file is included on the SiRFstarIII Evaluation Kit CD. By default, the Evaluation Receiver is pre-loaded with GSW3. If for any reason the GSW3 needs to be reloaded onto the Evaluation Receiver, the software tool SiRFFlash can be used. For detailed information about SiRFFlash, please see the *SiRFFlash User Guide*.

Available GSW3 Features

Table 1-1 lists the features that are available with the SiRFstarIII Evaluation Receiver running GSW3:

Table 1-1 Available GSW3 Features

Feature	Description
Acquisition Accelerator	Improves cold starts and time-to-first-fix.
SnapLock Acquisition	Reacquires satellites within 100 ms if a signal is lost.
SnapStart	Obtains positions in less time when the receiver is powered on.
FoliageLock	Improves positioning performance and satellite tracking ability in difficult environments such as dense tree coverage.
Adaptive TricklePower	Intelligently switches between TricklePower and full power depending on the current GPS signal level.
SingleSat Positioning	Provides additional fixes in an urban canyon and dense foliage environments.
UART Pause	Saves power by idling the UART's when they are not in use.
Dual Multipath Rejection	Improves position accuracy through enhanced multipath rejection.
Almanac to Flash	Improves cold start times by storing the most recent almanac to flash memory.
Low Signal Acquisition	Acquires satellites and continues tracking in extremely low signal environments.
Low Signal Navigation	Continues navigating in extremely low signal environments.
SiRF Binary Protocol	The standard interface protocol developed and used by SiRF Technology
NMEA Protocol	The standard ASCII based protocol used by most GPS applications
1 PPS	A timing signal generated every second on the second

The Evaluation Receiver

The SiRFstarIII Evaluation Receiver offers a flexible and efficient platform to assist with GPS performance evaluation. Based on the SiRF's GSC3f GPS solution, this receiver offers a good representation of the performance that can be expected from any SiRFstarIII based product. It also provides a platform where different configurations can be tested so the best configuration for the intended application can be found.

Figure 1-1 SiRFstarIII Evaluation Receiver

SiRFstarIII Evaluation Receiver Features

Table 1-1 lists each of the features of the SiRFstarIII Evaluation Receiver provided with the SiRFstarIII Evaluation Kit.

Table 1-2 Features of the SiRFstarIII Evaluation Receiver

Feature	Description
Rechargable internal batteries	Provides the receiver with greater mobility as no external power connection is required.
Two communication ports	Allows for different protocols to operate on each port. For example, SiRF Binary on port A and NMEA on port B.
USB support	To provide greater communication flexibility, USB can be used as an alternative to the RJ45 connector for COM A.
Clear LED indicators	To quickly and easily see the current operating state of the receiver.
Variable input voltage support	Will operate with voltages between 9 and 24 V

Power Requirements

The SiRFstarIII Evaluation Receiver can be powered in two different ways:

- Internally by using the internal rechargable batteries
- Externally through the use of either the provided desktop power supply or the cigarette power adapter.

Internal Batteries

The SiRFstarIII Evaluation Receiver includes two Lithium Ion internal rechargable batteries. This means that no external power source is required giving the receiver a lot more mobility. Using the provided desktop power supply, it will take approximately 2.5 hours to fully charge the internal batteries.

Using the cigarette lighter adapter, it will take approximately 3 hours to fully charge the batteries.

On a full charge, it is expected that the Evaluation Receiver will run continuously in full power mode for approximately 14 hours.

External Power

The required power input of the SiRFstarIII Evaluation Receiver is 9 - 24 Volts. Use the provided cigarette lighter adapter if the receiver is being used in a vehicle and use the desktop power supply in the office or laboratory.

Front Panel Layout

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

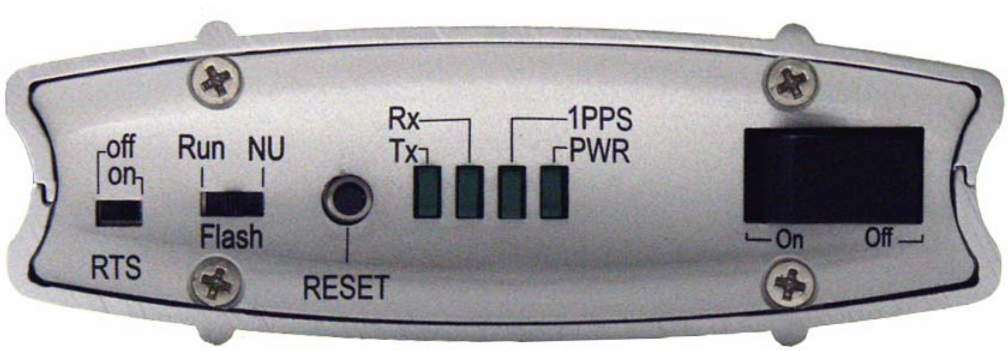


Figure 1-2 Front panel of the SiRFstarIII Evaluation Receiver

A description of each of the items on the front panel is provided in Table 1-3

Table 1-3 Items located on the front panel of the SiRFstarIII Evaluation Receiver

Item	**Description**
RTS Switch	A two way switch that enables or disables the RS232 Ready To Send command. This is required if a Time Transfer Board (aided solution) is being used with the Evaluation Receiver.
Flash Switch	This is a three-position switch that is used to place the receiver into internal boot mode for flash memory reprogramming.
Reset Button	The reset button is used to reset the GPS receiver.
Tx LED	Indicates whether data is being transmitted through COM A.
Rx LED	Indicates whether data is being received through COM A.

Table 1-3 Items located on the front panel of the SiRFstarIII Evaluation Receiver

Item	Description
1PPS LED	Indicates when 1PPS pulses are being transmitted through the 1PPS output.
PWR LED	Shows when power is being applied to the receiver and is switched on.
On / Off Switch	Switches the receiver on or off.

Rear Panel Layout

Figure 1-3 shows the rear panel of the SiRFstarIII Evaluation Receiver.

Figure 1-3 Rear panel of the SiRFstarIII Evaluation Receiver

A description of each of the items on the rear panel is provided in Table 1-4

Table 1-4 Items located on the front panel of the SiRFstarIII Evaluation Receiver

Item	Description
Power Input	Power input to allow charging of internal batteries and for operation of the Evaluation Receiver. Required input is 9 - 24 Volts. Center pin is positive.
Com A	Standard RS232 port for receiver communication and flash reprogramming. RJ45 connector used. If the USB port is connected, then the USB port will operate as Com A and no data with pass through the RS232 port.
Com B	Standard RS232 port for receiver communication and flash reprogramming. RJ45 connector used.
USB	USB port for receiver communication. This port will operate as COM A if connected.

Table 1-4 Items located on the front panel of the SiRFstarIII Evaluation Receiver

Item	Description
1PPS Output	Outputs a 1PPS signal on every GPS second. The signal is only output when the receiver is navigating. The 1PPS signal is typically used to synchronize external instruments.
ACC Connector	This is an accessory header that can be used for other applications such as SiRFLoc or SiRFDRive.
GPS Input	Input for a GPS signal from a GPS antenna. The SiRFstarIII Evaluation Receiver has been designed to work with a 3V active antenna. If the provided antenna is not used, you must ensure that the used antenna is a 3V active antenna.

USB Operation

The SiRFstarIII Evaluation Receiver supports only two communication ports - COM A and COM B. The USB port is an alternative port to COM A but is logically a single port. If USB is connected, the receiver will automatically switch communication from the RJ45 port labelled COM A and operate using the USB connection regardless of whether anything is connected to the RJ45 port.

COM B is independent of USB operation.

Note – If USB is being used and you wish to switch to using the RJ45 COM A port, you must remove the USB cable and then cycle power the Evaluation Receiver.

Software Tools

Included with the SiRFstarIII Evaluation Kit is a suite of software tools that are used for Evaluation Receiver operation, data logging, uploading different software to the receiver, and data analysis. All software can be found on the SiRFstarIII Evaluation Kit CD and are listed in Table 1-5.

Table 1-5 Software tools provided with the SiRFstarIII Evaluation Kit

Icon	Software Tool	Description
	SiRFDemo	A PC tool used for real-time monitoring, data logging, and configuration of a GPS receiver.

Table 1-5 Software tools provided with the SiRFstarIII Evaluation Kit

Icon	Software Tool	Description
	SiRFDemoPPC	Similar to SiRFDemo in function but is designed for operation with a Pocket PC.
	SiRFView	A PC tool that can be used to analyze collected GPS data through graphical and numerical displays. Can also load display back-ground maps with the GPS data.
	SiRFFLash	A PC tool provided to enable new receiver software to be loaded onto the Evaluation Receiver.

Additional information about each of the tools is provided in the following sub-sections.

SiRFDemo

SiRFDemo is the Evaluation Receiver configuration and monitoring software provided with the SiRFstarIII Evaluation Kit. This software can be used to monitor real-time operation of the Evaluation Receiver, log data for later analysis, and configure the Evaluation Receiver operation.

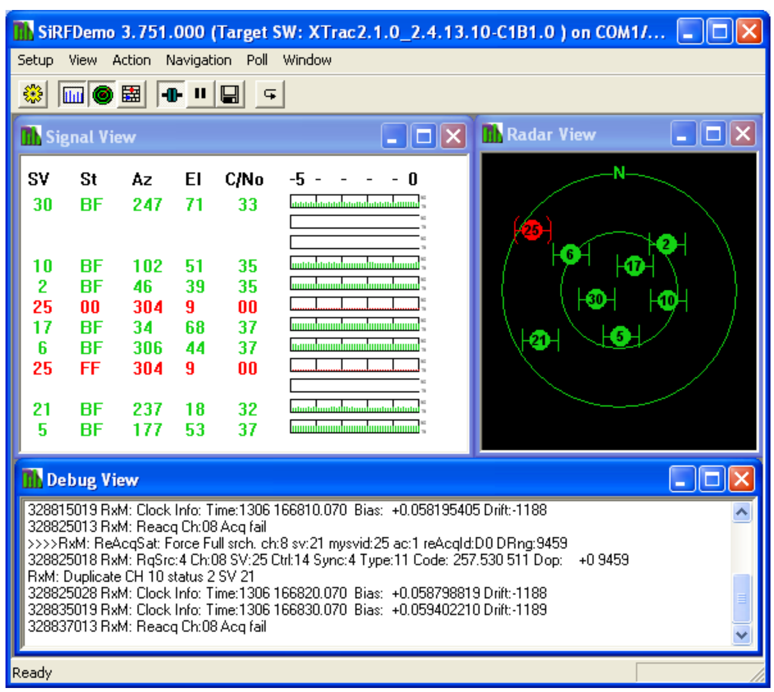


Figure 1-4 The software tool SiRFDemo

For detailed information on the use and operation of SiRFDemo software, please see the *SiRFDemo User Guide*.

SiRFDemoPPC

SiRFDemoPPC is very similar in functionality as SiRFDemo but is designed to operate on a Pocket PC. It provides real-time receiver monitoring, limited receiver configuration abilities and can log data for later analysis. SiRFDemoPPC can also display a map with the current position plotted on the map.

Being a Pocket PC application, a small compact Pocket PC can now be used during dynamic evaluation tests rather than the need of a larger PC. In combination with the internal batteries of the Evaluation Receiver, the system is highly portable.

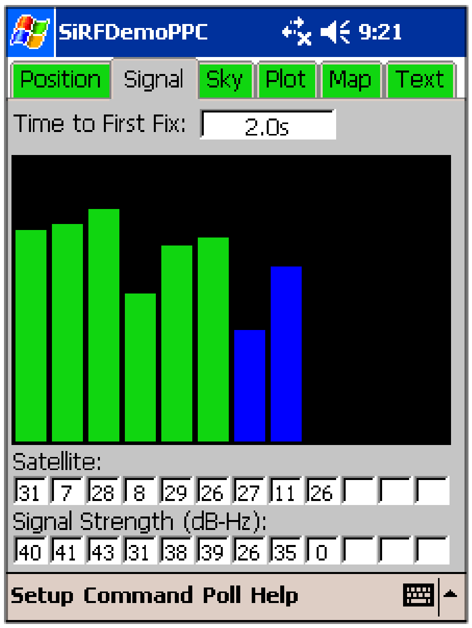


Figure 1-5 The software tool SiRFDemoPPC

For detailed information on the use and operation of SiRFDemoPPC software, please see the *SiRFDemoPPC User Guide*.

SiRFView

SiRFView is a PC tool that can be used to analyze collected GPS data. After loading data into SiRFView, various graphical and numerical displays are available such as signal strength, latitude, longitude, and scatter plots. SiRFView also has map support and the logged data can be plotted onto an existing digital map.

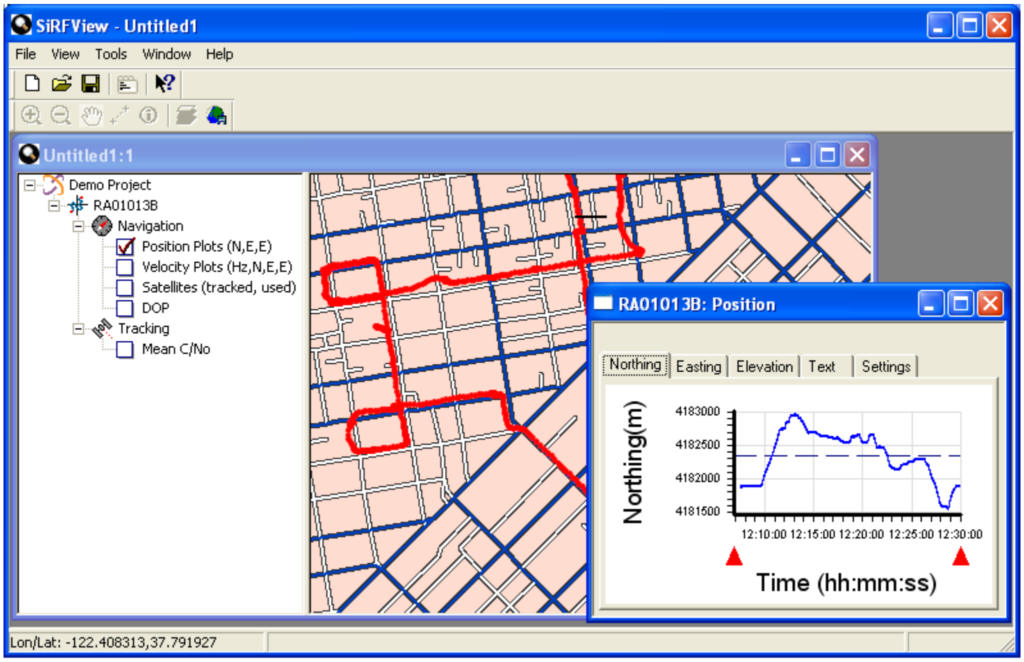


Figure 1-6 The software tool SiRFView

For detailed information on the use and operation of the SiRFView software, please see the *SiRFView User Guide*.

SiRFFlash

SiRFflash is a software tool that is provided to enable users to download new receiver software to the Evaluation Receiver.

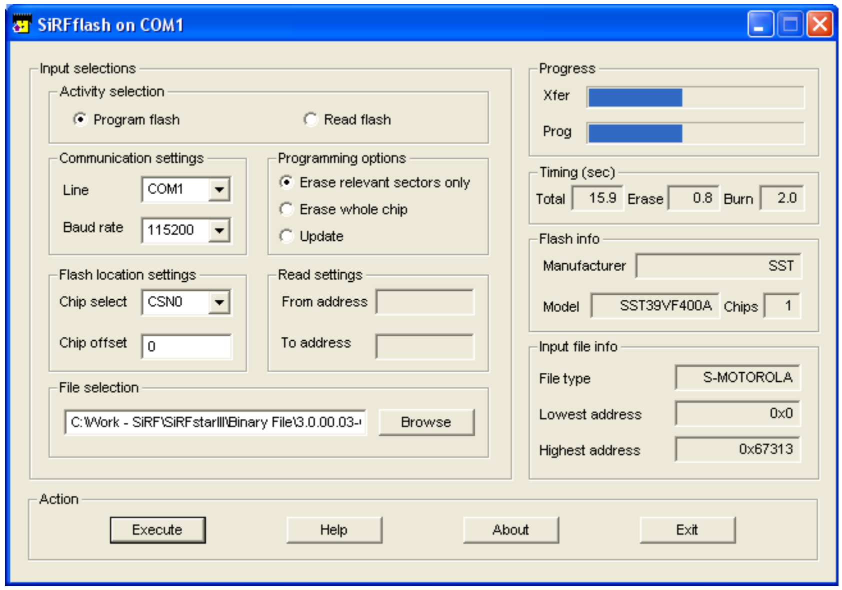


Figure 1-7 The software tool SiRFFlash

For detailed information on the use and operation of the SiRFFlash software, please see the *SiRFFlash User Guide*.

Other Hardware Items

Included with the SiRFstarIII Evaluation Kit are other hardware components needed to power, operate, and connect the Evaluation receiver to a PC. A description of each provided hardware item is provided in Table 1-6.

Table 1-6 Hardware items

Item	Description
Serial cable	For communications between the Evaluation Receiver and a PC
Desktop power supply	For powering the Evaluation Receiver while in an office of laboratory or for charging the internal batteries
Cigarette lighter adapter	For powering the Evaluation Receiver when being used within a vehicle
USB cable	For communications between the Evaluation Receiver and a PC using the USB interface
GPS antenna	A 3V active GPS antenna for GPS reception

Documentation

The majority of documentation (including this User Guide) that is included with the SiRFstarIII Evaluation Kit is contained on the provided CD and is in PDF format. Select pieces have been printed out and is included within the kit. A description of each documentation piece is provided in Table 1-7.

Table 1-7 Documentation items

Item	Description
Quick Start Guide	A laminated single page that contains the minimum information needed to connect and get the system up and running. Also includes a few basic tips on using the software tools.
SiRFstarIII Evaluation Kit User Guide	This manual.
SiRFDemo User Guide	Contains information on how to install and use the software tool SiRFDemo.
SiRFDemoPPC User Guide	Contains information on how to install and use the software tool SiRFDemoPPC.
SiRFView User Guide	Contains information on how to install and use the software tool SiRFView.
SiRFFlash user Guide	Contains information on how to install and use the software tool SiRFFlash.
SiRF Binary Reference Manual	Technical information and definitions of the SiRF Binary Interface Protocol.
NMEA Reference Manual	Technical information and definitions of the NMEA protocol.
GSC3f Data Sheet	Detailed information about the SiRFstarIII single chip single chip GPS solution - GSC3f
GSC3 Data Sheet	Detailed information about the SiRFstarIII single chip single chip GPS solution - GSC3

SiRFstarIII Evaluation Kit CD

The CD that is included in the SiRFstarIII Evaluation Kit contains the software tools, documentation in PDF format, a current version of the GPS receiver software - GSW3, and other required files. The directory structure of this CD and a description of the contents are provided in Table 1-8.

Table 1-8 CD Directory Structure

Directory	**Content**
Bin	Required files for operation of the CD browser.
Documentation	PDF format of the SiRFstarIII Evaluation Kit User Guide, user guides for each software tool, protocol specifications, data sheets, and other appropriate documentation.
Software Tools	All software tools that are provided with the Evaluation Kit. This includes SiRFDemo, SiRFDemoPPC, SiRFView and SiRFflash. Basic digital maps are also included for use with SiRFDemoPPC and SiRFView.
Receiver Software	Includes the GSW3 software that is currently loaded onto the Evaluation Receiver.

The CD contains a self-launching graphical browser. The browser will start automatically when the CD is inserted into your CD drive and will allow easy access to the CD's contents and documentation. If the browser fails to start, use Windows Explorer to either view the contents of the CD or to run the browser by double-clicking on the file `LAUNCH.EXE` found in the root directory of the CD.

Installation 2

This chapter provides instructions and requirements for installing software tools, the GSW3 GPS software, and the SiRFstarIII Evaluation Receiver.

Hardware and Software Requirements

The following is the minimum PC configuration that is required to run SiRFDemo, SiRFView, and SiRFFlash:

- 486 processor (or better)
- 64 MB RAM minimum memory
- 100 MB minimum available disk space for software tools installation, documentation storage, and data logging
- Windows 98 or later operating system
- One available RS232 serial port

The following is the minimum Pocket PC hardware that is required to run SiRFDemoPPC:

- Pocket PC 2002 or later
- Microsoft ActiveSync and synchronization hardware for application installation
- Cables suitable to connect the Pocket PC with the SiRF GPS receiver.

  This cable is not provided due to the many different types of Pocket PC's and connector types. For additional details about possible cable solutions, please see the *SiRFDemoPPC User Guide*.

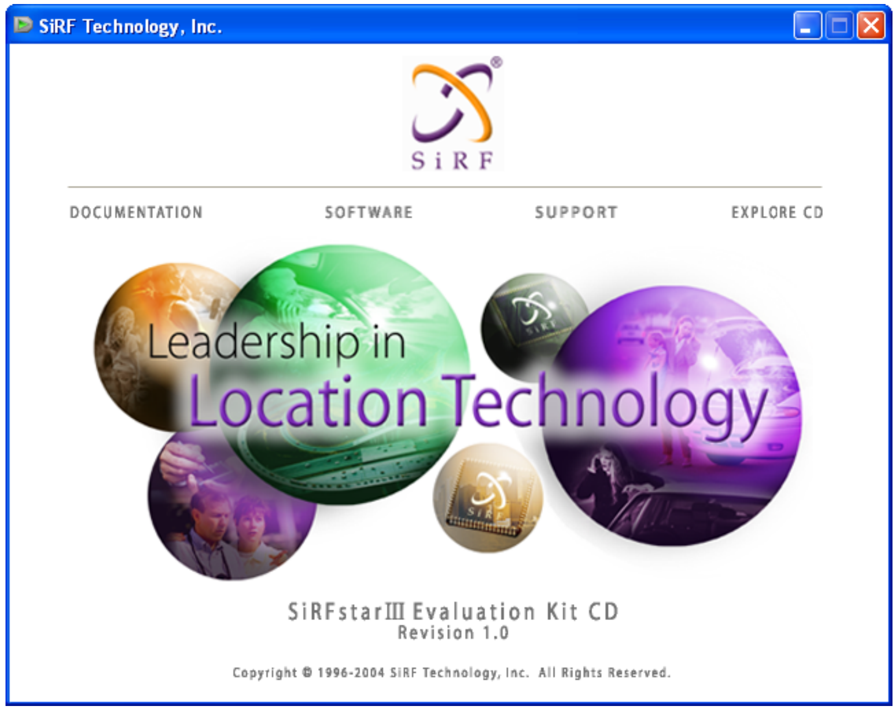
Installing Software Tools

This section describes installing software tools from the provided SiRFstarIII Evaluation Kit CD.

To install the software tools from the CD:

1. Insert the SiRFstarIII Evaluation Kit CD into your CD-ROM drive.

After a few seconds, a CD browser will automatically launch and be displayed on your screen.



2. Select *Software* from the main menu of the browser interface.

   The Software page will be displayed.

3. Select the software tool you wish to install.

   An install shield will guide you through the rest of the installation.

Note – When installing SiRFDemoPPC it is necessary to have Microsoft ActiveSync running and the Pocket PC connected to your PC.

For specific software tool installation information, please refer to the associated software tool user guide.

Installing the SiRFstarIII Evaluation Receiver

The SiRFstarIII Evaluation Receiver is housed in a sturdy aluminum housing to protect the internal board and provide a convenient platform for field testing. This section provides information on preparing the receiver for use, mounting, and connecting the receiver to a PC or Pocket PC.

Charging Internal Batteries

Before using the Evaluation Receiver, it is necessary to charge the internal batteries.

To charge the internal batteries:

1. Connect the desk-top power supply to the Evaluation Receiver.

   The internal batteries will be fully charged within 2.5 hours. This will allow for approximately 14 hours of full power operation.

External power can also be used to operate the receiver. It is also possible to charge the batteries using the supplied cigarette lighter adapter. When charging the batteries, charging will automatically stop once the batteries are fully charged to prevent battery damage.

Connecting the Evaluation Receiver

For basic operation, only two connections are necessary. These are:

- The GPS antenna, and
- A communication cable (either RS232 or USB)

The GPS antenna is connected to the connector labelled GPS as shown in Figure 2-1 and either a serial cable is connected to Com A or a USB cable is connected to the USB port.

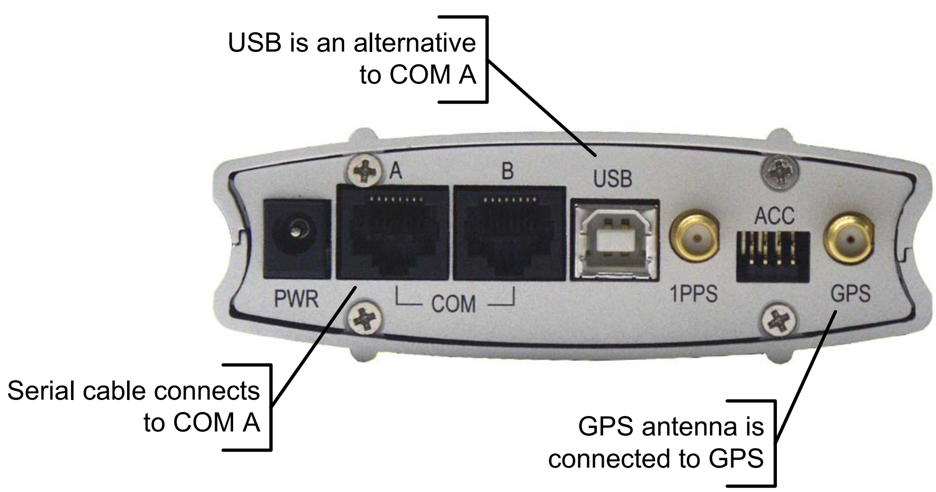


Figure 2-1 Required Evaluation Receiver connections

As the SiRFstarIII Evaluation Receiver has internal rechargable batteries, it is not necessary to connect external power. See "Internal Batteries" on page 1-4 for additional information.

Note – If USB is connected, COM A is automatically disabled.

Connecting to a PC

The only connection required on the PC is either the serial cable or the USB cable.

If USB is being used, the required USB drivers must be installed. The necessary drivers are included with the SiRFDemo install. Please see the *SiRFDemo User Guide* for additional information.

Connecting to a Pocket PC

If the software tool SiRFDemoPPC running on a Pocket PC is to be used, then it may be necessary to obtain an additional cable to connect to the Evaluation Receiver. In most cases it will be necessary to obtain a cable that can connect to the Pocket PC and then connect to the provided serial cable. Two possibilities include:

- Using a Compact Flash (CF) to serial DB 9 connector. The CF adapter can then be used to plug into an available CF port on the Pocket PC.
- Using a cable that can connect directly to the synchronization port of the Pocket PC.

For additional information, see the *SiRFDemoPPC User Guide*.

Evaluation Receiver Placement

The SiRFstarIII 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.

To provide a suitable operating environment and to prevent damage avoid these conditions:

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

GPS Antenna Placement

The GPS antenna provided in the Evaluation Kit is a magnetic-mounted 3V active antenna. For optimal operation, the following guidelines when choosing an appropriate location should be considered:

- 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.

Note – The supplied magnetic-mounted antenna is optimized for use with a ground plane. The ground plane may be in the form of a vehicle roof, building roof, or any other metallic, flat surface. If no ground plane is present, you may experience a decrease in performance.

Installing GSW3 Software

By default, the provided Evaluation Receiver is loaded with the latest version of GSW3 available at the time of shipping. If a new version of GSW3 is available, it will be necessary to reprogram the receivers flash with the new version. To do this, the software tool SiRFFlash must be used.

For complete information on using SiRFFlash, see the *SiRFFlash User Guide*.

GPS Operating Parameters 3

When implementing a GPS solution, it is necessary to understand how the final GPS - enabled product is to be used and to optimize the GPS configuration to best meet the expectations of that application. This can be achieved by configuring various parameters that fundamentally effect the operation of the GPS receiver.

The following sections provide information about each of the user-configurable GPS parameters and how each parameter can effect the final GPS operation.

GPS Operation Compromises

For each parameter, there is usually a GPS operation compromise. That is, if a parameter is optimized for a particular operational advantage, then it can be expected that the GPS operation will be disadvantaged in some other manner. Accuracy verses fix density is the primary compromise and consideration.

Accuracy vs.Fix Density

In most cases, the compromise is typically accuracy vs. fix density.

- **Accuracy** - If the GPS receiver is optimized for accuracy, then only the highest accuracy positions will be output by the receiver.
- **Fix Density** - If optimized for fix density, then the receiver is configured to provide position fixes whenever possible.

If the GPS receiver is optimized for accuracy then it can be expected that a much lower fix density will result. If the GPS receiver is optimized for fix density then lower-accuracy positions can be expected.

Configurable Operating Parameters

Table 3-1 provides a list of each configurable operating parameter along with the valid options and current default value for each parameter

Table 3-1 Configurable Operating Parameters

Parameter	Valid Values	Default Value[1]
Elevation Mask	0 - 90 degrees	7.5 degrees
Track Smoothing	Enabled | Disabled	Enabled
Altitude Hold	Automatic | Always | Disabled	Automatic with last computed altitude
Degraded Mode	Direction then clock | Clock then direction | Direction only | Clock only | Disabled	Clock then direction with a 30sec timeout
Dead Reckoning	Enabled | Disabled	Disabled
Power Mask	20 - 50 dB-Hz	28 dB-Hz
DOP Mask	Auto PDOP/HDOP | PDOP | HDOP | GDOP | Do not use	Do not use
Static Navigation	Enabled | Disabled	Disabled
SBAS	Auto scan | User Defined | Disabled	Auto scan

1. The listed default values are typical. Actual default values may differ between software types and versions.

Each parameter listed in Table 3-1 is configurable through SiRFDemo (see the *SiRFDemo User Guide*) and is discussed in detail in the following sub-sections.

Operating Modes

Operating modes refer to the type of position and operation allowed by the GPS receiver. Available operating modes include:

- 3D positions only (Altitude, degraded, and dead reckoning modes disabled)
- Altitude hold mode
- Degraded mode
- Dead reckoning mode

Each operating mode offers a greater potential fix density and continued navigation but with continually less accuracy. The mode the GPS receiver operates in is dependant on the number of satellites available. A GPS position is made up of four unknowns; 3 dimensions of position (X, Y, Z) and time. Hence, four GPS satellites are required to solve for the four unknown values. If the number of satellites available is reduced to less than four, then different operating modes can be implemented to continue navigation by using assumptions and holding one or more unknowns fixed to reduce the number of variables and propagate the position.

If all operating modes are allowed, and as the number of satellites available are reduced, the following steps occur:

1. Four satellites or more - all unknown variables are solved for; X, Y, Z, and time. This is a 3D position fix.
2. Three satellites - the altitude (or Z) is held fixed and only X, Y and time are solved for. The receiver is now operating in Altitude hold mode and the resultant position is known as a 2D fix.
3. Two and one satellites - when fewer than 3 satellites are available, additional parameters must be fixed in order to solve the position. The two parameters that are fixed are clock drift (rate of change in clock bias) and heading. The order in which they are fixed depends on the Degraded-Mode setting. If the setting is Direction then Clock, then heading will be fixed when only two satellites are available, and then clock drift when only one is available. If Clock then Direction is selected, the order will be reversed. If Clock only or Direction only is selected, the corresponding parameter for a two-satellite solution will be fixed, and will not create one-satellite solutions. Instead, the receiver will proceed to a dead-reckoning solution.
4. No satellites - as no satellites are being tracked, no information can be used. The position is propagated simply by assuming that the receiver is moving in the same direction and at the same speed as the last calculated position. The receiver is now operating in dead reckoning mode.

The following sub-sections provides additional information about each operating mode.

Altitude Hold

Generally speaking, a GPS solution consists of four unknown values that must be solved for - latitude, longitude, altitude, and time. As there are four unknowns, a minimum of four satellites are required for a complete solution. However, fewer satellites can be used if any unknown is given an assumed or fixed value and not solved for.

If only 3 satellites are available and altitude hold mode is enabled, altitude is held constant and not solved for. While the position solution is still computed in three dimensions plus time, since one parameter has been frozen, the solution is commonly known as a 2D position. This allows positioning to continue even when less than four satellites are available with a 2D position being the result. As positioning can continue with less than four satellites, the advantage of this mode of operation is a higher fix density.

The trade off when using altitude hold is that an error in the assumed or fixed altitude will introduce an error in the horizontal position. As a rule of thumb, the possible error in the horizontal position is approximate 30% of the difference between the actual and the used altitude. In other words, 30 cm error in the horizontal position can be introduced for every 1m error in the altitude As an example, if the altitude used is 100 m but the actual altitude of the receiver is 0m, than an error in the horizontal position of 30 m can be expected.

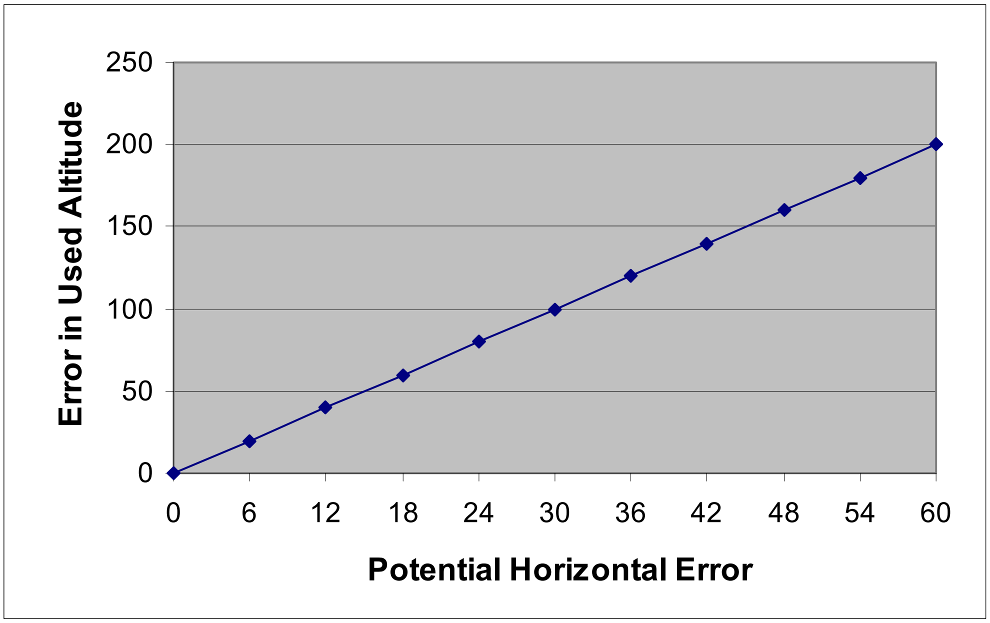


Figure 3-1 Potential horizontal error resulting from an error in the used altitude when operating in 2D mode

Due to the potential error in the horizontal position, the change in altitude that the application may experience should be considered. If significant change in altitude is expected when operating in 2D mode only and horizontal accuracy is important, care must be taken when using altitude hold mode. As an example, the city of San Francisco, California USA has a maximum altitude change of approximately 230 m. If a GPS receiver was set to operate in 2D mode only, then a horizontal error of 70 m is possible simply due to altitude change.

In altitude hold mode exactly what value to use when fixing the altitude must be selected. Table 3-2 lists the options.

Table 3-2 Altitude hold mode options

Option	**Description**
Last computed altitude	When operating in 2D mode, the receiver will use the last known altitude as the fixed altitude value. This is the preferred altitude hold option as the altitude is updated every time a 3D position can be obtained.
Fixed altitude	When operating in 2D mode, the altitude used is the altitude as defined by the user. This mode of operation is generally suitable only for marine applications or other situations where the user knows that the altitude will change very little.

Degraded Mode

Degraded mode operation begins when the number of available satellites drops below three. As with altitude hold mode, as the number of satellites drops, additional parameters must be held constant. While this can cause the introduction of errors, and increases in noise on the solution, it does provide significantly increased fix density. Degraded mode does have a timeout to limit these effects.

The parameters to be held constant are clock drift and vehicle heading. The order in which these are held is dependent on the Degraded Mode setting. When the Clock then Direction setting is selected, clock drift will be held constant as the number of available satellites drops to two, then vehicle heading will be held constant as the number drops to one. Selecting Direction then Clock reverses this order. Selecting Clock only or Direction only will freeze the selected parameter as the number of satellites drops to two, and will stop using degraded mode when the number drops to one.

Table 3-3 lists each possible degraded mode option.

Table 3-3 Degraded mode options

Option	**Description**
Use direction then clock hold	If the number of available satellites is reduced to two, the GPS receiver will hold the elevation fixed, and use the last direction and speed. If the available satellites is then reduced to one, the clock drift is then held constant.
Use clock then direction	This mode is similar to the above Direction then Clock Hold mode. However, the clock drift is held constant, and then the direction.

Table 3-3 Degraded mode options

Option	Description
Direction hold only	This mode restricts degraded mode to two satellites only. When the number of satellites drops below three, vehicle heading will be held constant. If the number of satellites drops to one, the receiver will go to dead-reckoning mode, if enabled.
Clock hold only	This mode restricts degraded mode to two satellites only. When the number of satellites drops below three, clock drift will be held constant. If the number of satellites drops to one, the receiver will go to dead-reckoning mode, if enabled.
Disabled	This mode prevents the system from using degraded modes when the number of available satellites drops below 3. If dead-reckoning mode is enabled, it will be entered whenever the available satellites drop below three.

Degraded mode operation is very useful to continue navigation in environments where satellite visibility may be interrupted. However, as the resulting position is based on assumptions, if these are incorrect, then an error can be introduced. An example of this is if a vehicle makes a turn after the receiver has entered into degraded mode. Also, the longer a GPS receiver operates in degraded mode, the less valid the assumptions become.

Dead Reckoning

Dead reckoning mode is the next step beyond degraded mode and operates when no satellites are available, or fewer satellites than degraded mode allows. The position is propagated by using the last known heading and speed of the GPS unit. Dead reckoning mode operation can potentially be useful in getting past small blockages in satellite visibility such as bridges and overpasses and continue navigation. However, if there is any variation in speed or direction, then position accuracy will degrade significantly. Like degraded mode, the longer the receiver operates in dead reckoning mode, the higher possibility of significant errors.

Navigation Parameters

Other navigation parameters that are not as dramatic as the above operating modes include:

- Track smoothing
- DOP mask
- Elevation mask
- Power mask
- Static navigation
- SBAS

Track Smoothing

Track smoothing applies primarily to dynamic situations. It assists in removing sporadic position jumps or unexpected position variations due to variables such as multipath, poor satellite visibility, or introduced noise. The result of applying track smoothing is a cleaner, more consistent trajectory with all positions appearing relatively correct to each other.

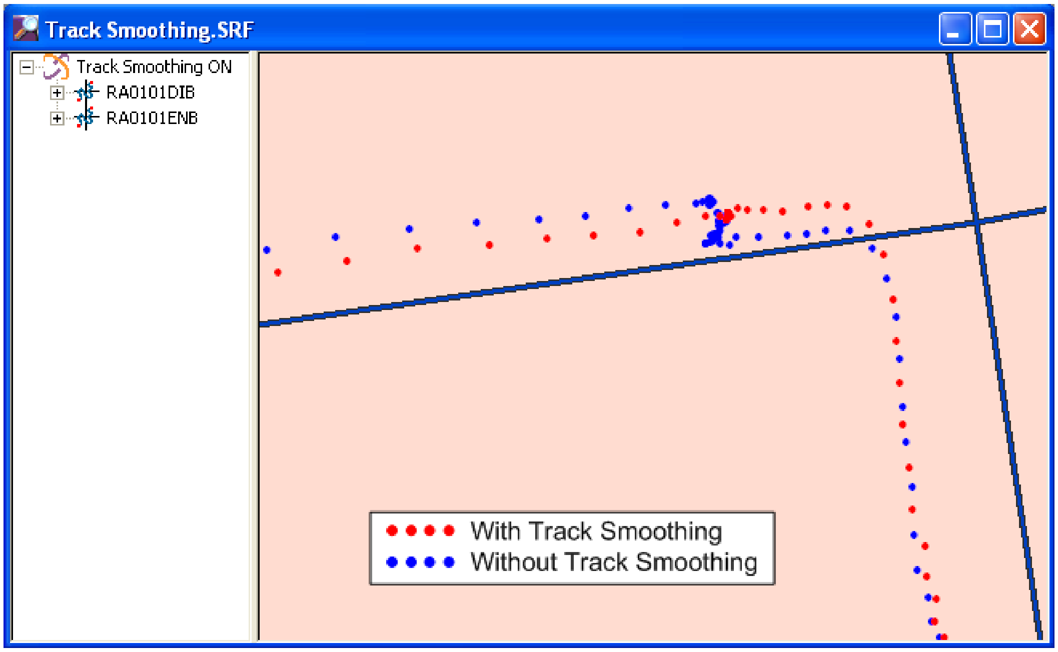


Figure 3-2 Track smoothing verses no track smoothing

Figure 3-2 is a plot of the same data set but the data has been processed to represent the results comparing track smoothing verses no track smoothing. The red plot is the one with track smoothing switched on. As can be seen, the data has been smoothed out and better represents what the user would expect when driving along a road. However, the blue path is in fact closer to what the GPS receiver is calculating.

By applying track smoothing the result is a smoother trajectory. However, the resultant GPS operation may be less reactive. This means that in high dynamic or fast applications a perceived lag in the position may be noticed.

DOP Mask

DOP (or Dilution of Precision) is an indicative position accuracy value that is derived from satellite availability and geometry. Typically a high DOP value implies degraded position accuracy while a low DOP value implies good position accuracy.

The DOP mask parameter allows a user to exclude the output of positions that are above a defined DOP value in an effort to ensure that only the higher accuracy positions are output by the GPS receiver. However, by doing so, a decrease in position fix density can be expected.

Various DOP mask options are available. Table 3-4 provides a list of each of the DOP mask options.

Table 3-4 DOP mask options

Option	Description
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.
PDOP only	Only the PDOP mask will be used regardless of the number of satellites available.
HDOP only	Only the HDOP mask will be used regardless of the number of satellites available.
GDOP only	Only the GDOP mask will be used regardless of the number of satellites available.
Disabled	No DOP mask is applied.

Elevation Mask

Signals from GPS satellites that are low on the horizon must pass through much more atmosphere, and are subject to more multipath effects than signals from satellites that are directly overhead. Because of this, the signals from lower-elevation satellites are subject to more errors than signals from satellites with higher elevations. Better position accuracy is often achieved if lower elevation satellites are not used in the position solution.

The elevation mask allows a user to exclude the use of lower-elevation satellites from the position solution. While this can improve the quality of the final solution, it effectively reduces the number of satellites available, and can result in situations where the solution has greater noise because of too few satellites, or even too few satellites for a solution to be calculated.

A low elevation mask will result in a potentially less accurate position but with a higher fix density. A high elevation mask will result in a potentially more accurate position, but with a lower fix density due to a decrease in satellite availability. Hence, in applications where accuracy is much more important than fix density, then introducing an elevation mask should be considered.

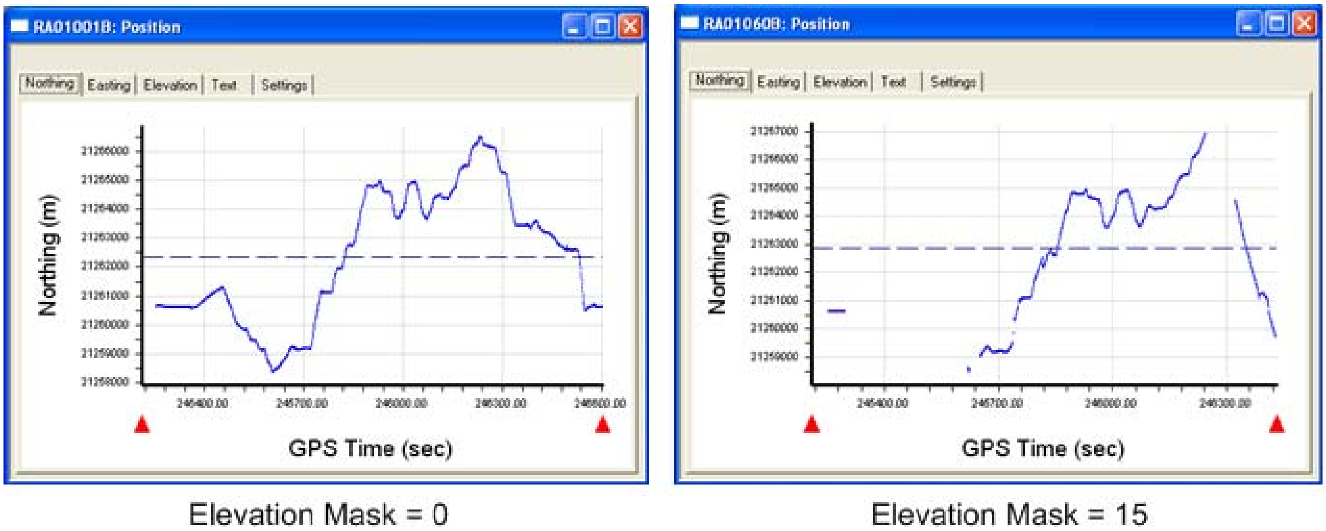


Figure 3-3 Results comparing a 0 degree elevation mask and a 15 degree elevation mask

As can be seen in Figure 3-3, when the elevation mask is increased, then the fix density decreases. In this example, driving through a severe urban canyon environment, increasing the elevation mask to 15 degrees resulted in over 35% of no navigation.

The default value of the elevation mask is typically 7.5 degrees, meaning satellites that are less than 7.5 degrees above the horizon are not used in navigation solutions. The mask can be set to any angle from -20.0º to +90.0º, with steps of 0.1º. Typical values chosen by users are 0º for maximum position availability, 5º for users who want high fix densities in vehicles, and 15º by users who require high-quality fixes and are willing to sacrifice fix density.

Power Mask

GPS satellites that have a low signal strength are not easily tracked by a GPS receiver and may result in using signals that are either noisy or have been effected by multipath or other interference source.

The power mask parameter allows a user to prevent the use of satellites with a low signal strength being used in the position solution. This will result in a potentially higher accuracy position. However, as the number of satellites available will be decreased, the fix density will be decreased.

Static Navigation

Even when a GPS receiver is stationary, each calculated position will be different from the last. This gives the appearance of continuous motion of the GPS receiver. In a practical situation such as a car stopped at a traffic light, a user expects to see the position to be stationary. It is the static navigation mode that assists in achieving this.

Static navigation mode determines whether a GPS receiver is in fact stationary based on pre-defined velocity and distance values. When static navigation is enabled, if the vehicle's velocity drops below a threshold value, then the position and heading are pinned to the last computed value. The position and heading will remain at these values until the receiver detects that the velocity has increased above a slightly higher threshold, or its position is computed to be more than a set distance from that to which it is pinned.

Static navigation is designed specifically for use in motor vehicles where normal speeds are expected to be well above the threshold for pinning. In the hands of a pedestrian, or on a boat drifting with a slow current, the effects of static navigation are likely to be unacceptable since expected velocities are often at or below the threshold for pinning. Even in an automobile or truck, there are likely to be some effects such as delayed starting after a stop, or occasional jumps in position when stopped among high buildings with severe multipath. But the improvement in such displays as maps that place a vehicle's heading at the top can be dramatic.

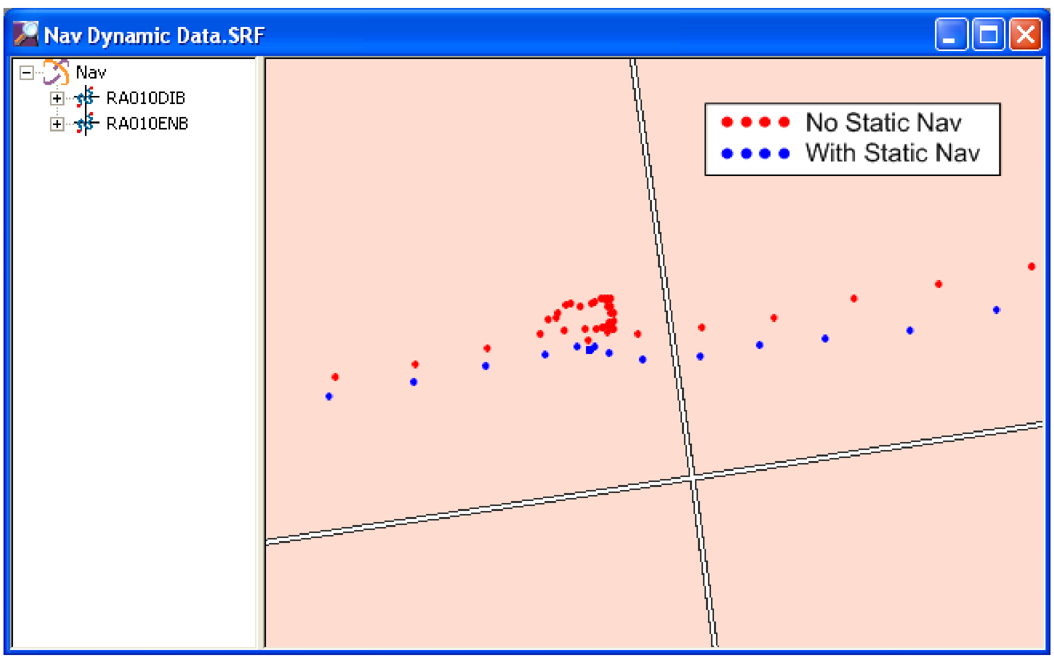


Figure 3-4 Plot showing results with static nav being applied verses no static nav

Figure 3-4 shows the difference in result between using static nav and not. As can be seen, the results with static nav not being used shows a "position wonder" when the vehicle comes to a stop.

SBAS Operation

SBAS (Satellite Based Augmentation System) consists of geostationary satellites that broadcast correction information that can be applied to a calculated position by an SBAS capable GPS receiver. There are three separate SBAS systems that cover almost the entire earth. These are:

- **WAAS** - positioned over and around North America
- **EGNOS** - positioned over and around Europe
- **MSAS** - positioned over and around Japan and East Asia

The intention of SBAS is to provide a widely available correction service that can potentially increase the accuracy of GPS. However, there are a number of considerations:

- **Accuracy** - since Selective Availability (S.A.) was switched off, GPS receivers generally provide very accurate solutions when in an open-sky setting. SBAS corrections can only help such receivers a very small amount. And in other settings, the factors which cause increased errors in the position solution are not correctable by SBAS corrections since they are local to the affected receiver and not predictable by the SBAS system. Under the best of conditions, the expected improvement is only one or two meters.
- **Availability** - SBAS satellite signals are already significantly weaker than GPS signals. The highest strength signal you can expect is only about 32dB-Hz and then the message cannot be decoded when it drops to about 28dB-Hz. This means that any SBAS signal is really only available in a very clear, open environment.
- **Continued Tracking** - One major problem with the weak SBAS signal is that it is difficult to maintain lock on the signal and continue using the signal, especially when you are in an obstructed dynamic environment.

SBAS signals are designed to provide critical information on the health of specific GPS satellites, and to provide some measure of improvement to navigation solutions. In the rare case of a GPS satellite that has become inaccurate, but has not yet been detected by the GPS controllers, SBAS can improve accuracy significantly. However, under most ground-based applications, and under most normal GPS satellite operations, it does not provide dramatic improvements.

Evaluating GPS 4

To help with your evaluation efforts, this chapter provides some guidelines and considerations when performing a GPS solution evaluation as well as some quick tips for using the provided tools.

There are no hard and fast rules as it very much depends on the application requirements and expected mode and environment of operation. As such, the following information should be used as a guideline only.

Generally speaking, all evaluations should be done in a planned and methodical manner. Any setup or decision should be made for a reason and not haphazardly. Figure 4-1 lists each of the steps that should be taken when evaluating GPS.

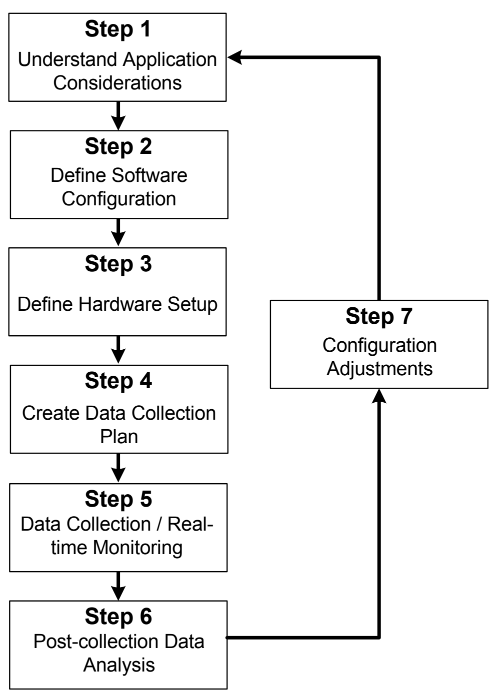


Figure 4-1 The Evaluation Process

Application Considerations

It is important to understand exactly what the intended application is and how that will potentially effect the GPS operation. Ideally, the evaluation should be done in a way that simulates how the application will be used. Application considerations effect things like:

- **User Environment** - The environment refers to what physical surroundings are expected when the application is being used. It should be determined whether the application is to be used in open sky environments, in a vehicle, in urban areas, or very sheltered indoor areas.
- **Usage Style** - Usage style refers to how the device will be used. Usage style considerations include things like whether the application is targeting pedestrian use or designed to work within a car for example. Also, is the device used for a short period of time then put away or is it used continuously.

Ideally, the evaluation strategy should be adjusted to simulate how the application is to be used.

Figure 4-2 Understanding the environment the application is intended for is important in creating an evaluation strategy

Software Configuration

The GPS software loaded onto the Evaluation Receiver is highly configurable. Configurable operating parameters are listed in Table 4-1

Table 4-1 Configurable Operating Parameters

Parameter	Description
Elevation Mask	Used to exclude the use of satellites below a defined mask.
Track Smoothing	Designed to smooth out calculated positions based on acceptable variances from previously calculated positions.
Altitude Hold	Allows 2D position fixes by holding the altitude constant.
Degraded Mode	Designed to continue position fixes when the number of satellites available falls below three.
Dead Reckoning	Positions are continued to be calculated for a period of time based on the last known position, direction, and speed.

Table 4-1 Configurable Operating Parameters

Parameter	Description
Power Mask	Used to exclude the use of satellites with a signal strength below the defined mask.
DOP Mask	Used to exclude the use of positions while the DOP value is above the defined mask.
Static Navigation	Designed to reduce the amount of wander of a GPS position while the receiver is stationary.
SBAS	Satellite Based Augmentation System. Provides corrections to the operating GPS receiver for integrity and to eliminate the effects of SA.

By changing the configuration of the software, the GPS solution can be optimized for particular operating characteristics. These typically are:

- GPS availability or fix density
- Accuracy
- Reactiveness
- Track smoothness

In each case however, if the GPS software is optimized for one characteristic, then the trade off is a decrease in performance of another characteristic.

In most cases, the compromise is typically accuracy verses fix density. If the GPS receiver is optimized for accuracy then it can be expected that a much lower fix density will result. If the GPS receiver is optimized for fix density then lower accuracy positions can be expected.

For detailed information about each operating parameter, see Chapter 3, “GPS Operating Parameters”.

How to Configure GPS Software

The software tool provided to configure the GPS software loaded onto the Evaluation Receiver is SiRFDemo.

All of the GPS operating parameters are located under the *Navigation* menu of SiRFDemo.

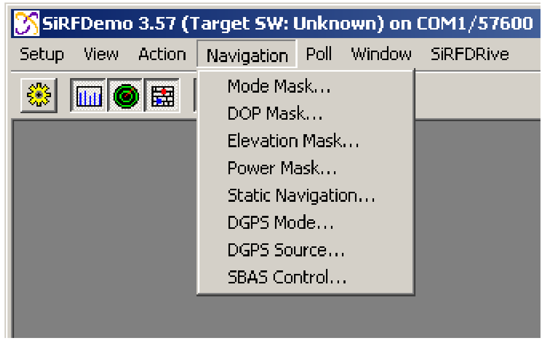


Figure 4-3 The Navigation menu in SiRFDemo

For detailed information about starting and using SiRFDemo, please see the *SiRFDemo User Guide*.

Hardware Setup

Not surprisingly, what hardware is to be used and how is it going to be setup and transported must be understood. For most GPS evaluation, there are four main considerations. These are:

- Antenna placement
- Power supply
- Data Logging
- Real-time GPS Monitoring

Antenna Placement

The antenna should always be placed in a location that would approximate the location of the antenna in the final product. With most vehicle navigation products, this is typically on the dashboard for example.

Figure 4-4 The GPS antenna should be placed in a location to represent usage of the intended application.

In addition to collecting data with the antenna in the expected use location, it is also a good idea to collect data with the antenna placed in the best possible location. In the case of a vehicle, on the roof. This will allow the best possible performance to be compared with the expected performance.

Data Logging & Receiver Monitoring

To evaluate the performance of the GPS receiver, it is necessary to either monitor the performance in real-time or log data that can be closely examined at a later date.

For real time monitoring, and data logging, two software tools have been provided SiRFDemo and SiRFDemoPPC. Both tools have the ability to monitor the performance of the Evaluation Receiver and log data for later analysis. SiRFDemo will run on a windows PC while SiRFDemoPPC will run on a Pocket PC.

Power Supply

Typically two devices need to be powered, these are the Evaluation Receiver and the data logging device - either a laptop or Pocket PC.

With the SiRFstarIII Evaluation Receiver, rechargable internal batteries are included. As such, no external power is needed for the Evaluation Receiver. On a full charge, the Evaluation Receiver will last approximately 14 hours when running in full power mode.

If a laptop or Pocket PC is being used for data logging, then external power is not necessary for these either. The only thing to watch in this case is to ensure that the battery capacity of the laptop or Pocket PC is sufficient for the data collection period.

Data Collection Plan

Before going out and collecting data, much thought should be given to where the data should be collected and for what purpose. Exactly where you collect data should be dictated by what GPS characteristic you want to evaluate. Characteristics include:

- Positional performance
- Sensitivity
- Time to First Fix

Positional Performance

Regardless of whether data is being collected in a vehicle or on foot, the most important thing to consider when evaluating positional performance are the GPS corner cases - or the situations where GPS has most problems. Typically corner cases that should be included during evaluation are:

- **Tunnels** - make sure a tunnel is entered and then exited. How the GPS performs upon exit should be noted. To test the GPS even further, try exiting a tunnel and then immediately making a sharp turn.
- **Urban Canyons** - this refers to urban areas of very tall buildings that block out GPS signals. A route should be defined that goes through an urban canyon environment. The route should also contain turns with particular attention being paid to how the GPS performs at the corners.
- **Elevation Change** - changes in elevation can effect the horizontal positional accuracy of GPS. How the GPS performs with elevation changes can be evaluated by selecting a route that has a significant elevation change.
- **Antenna Coverage** - considerations should be made to the type of material that the antenna might be covered by. This could include things like clothing, a bag, or from a vehicle. One change in vehicle technology is the introduction of solar shielded wind shields. This can have a surprising effect on GPS performance.

Sensitivity

Sensitivity relates to the ability of a GPS solution to track and use GPS signals with a very low signal strength. To test sensitivity, the data collection plan should include areas with different levels of coverage. These can include:

- Tree coverage
- Under cover parking lots

- Multi-level freeways
- Different indoor locations

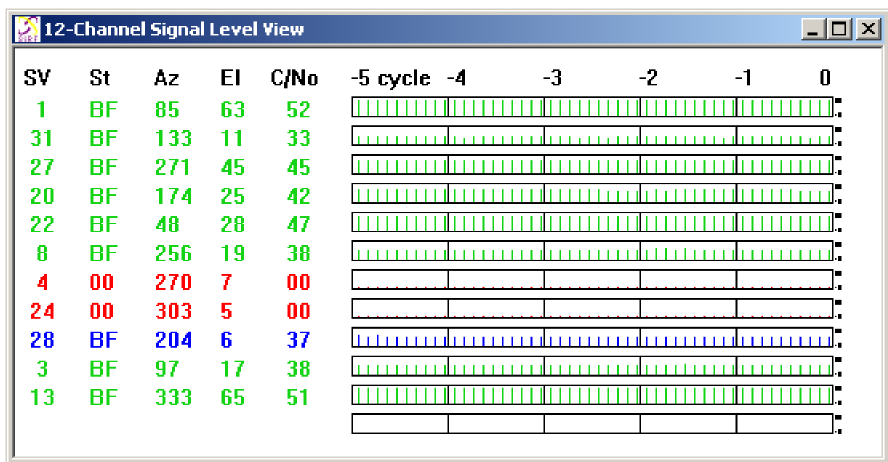
Data Collection & Real-time Monitoring

Once all of the planning and application considerations are understood, the next step is actually to take the GPS solution out and start using it to understand how it performs by logging data for later analysis as well as watching the performance in real-time.

Real-time Monitoring

Two different software tools are provided for real-time monitoring of the receiver - SiRFDemo and SiRFDemoPPC.

If SiRFDemo is being used, the single most important and useful screen when monitoring the operation of the receiver is the Signal Screen.



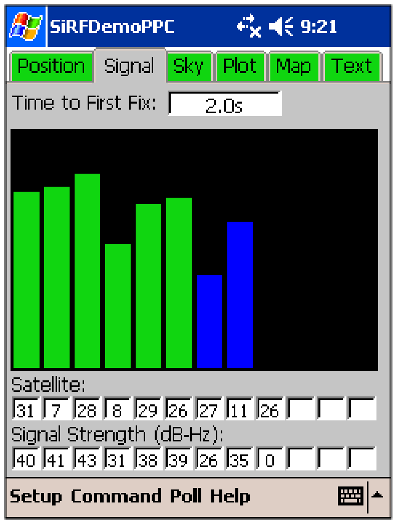
By using this screen, you can quickly see whether the receiver is navigating, how many satellites are being used, and the signal strength of each satellite. Table 4-2 lists each of the displayed values.

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
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 cycle)	5-cycle history of the measured signal strength.

If SiRFDemoPPC is being used, then the single most important and useful screen is the Signal Tab.

Like the Signal View in SiRFDemo, the Signal Tab quickly displays the signal strength, navigation status, and number of satellites used.



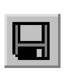
For both SiRFDemo and SiRFDemoPPC, the information displayed is assisted by color coding. As the tracking status of each satellite changes, the associated signal levels are colored to represent the current status (see Table 4-3).

Table 4-3 Display Color Coding

Color	Description
Red	The satellite location is known 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.

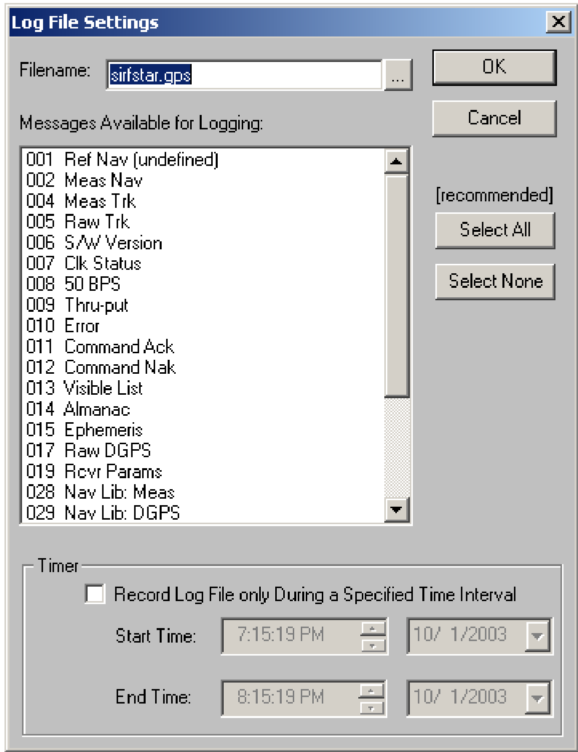
Data Logging

To log data to a file using SiRFDemo:



1. Click the Log File Settings button or choose Open Log File from the Action menu.

The Log File Settings window is displayed.



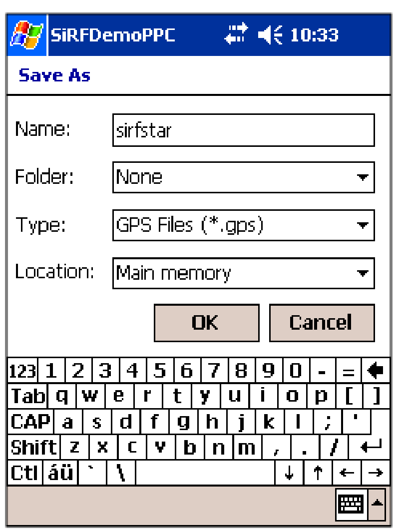
2. Select each message you want to log to a file by clicking on the required message. It is recommended that all messages are selected.

3. Click OK.

To log data to a file using SiRFDemoPPC:

1. Select Setup | Start Logging.

   The Save As dialog is displayed along with the Pocket PC keypad for ease of data entry.



2. Type or select the desired options in each of the provided fields.

Option	**Description**
Name	The name of the GPS file to be created.
Folder	The name of the folder that the created log file will be stored in. The selection list includes each of the folders that currently exist within the My Documents folder on the Pocket PC.
Type	The type of extension you would like the logged file to have.
Location	The storage location of the data. Some Pocket PCs have different location options for data storage. In the iPAQ case, one option is iPAQ File Store. This stores information in flash and will not be lost if the batteries are drained. If additional memory such as an SD card is available, this becomes a location option.

3. Select OK to begin data logging.

For complete details about using SiRFDemo or SiRFDemoPPC, refer to either the *SiRFDemo User Guide* or the *SiRFDemoPPC User Guide*.

Post-collection Data Analysis

The software tool provided for analysis of collected data is SiRFView. The following provides some tips on how to assess the GPS performance using SiRFView.

Positional Accuracy

By loading logged GPS data into SiRFView, how the GPS receiver performed is apparent almost immediately through the horizontal position plots. Figure 4-5 shows an expected GPS data plot.

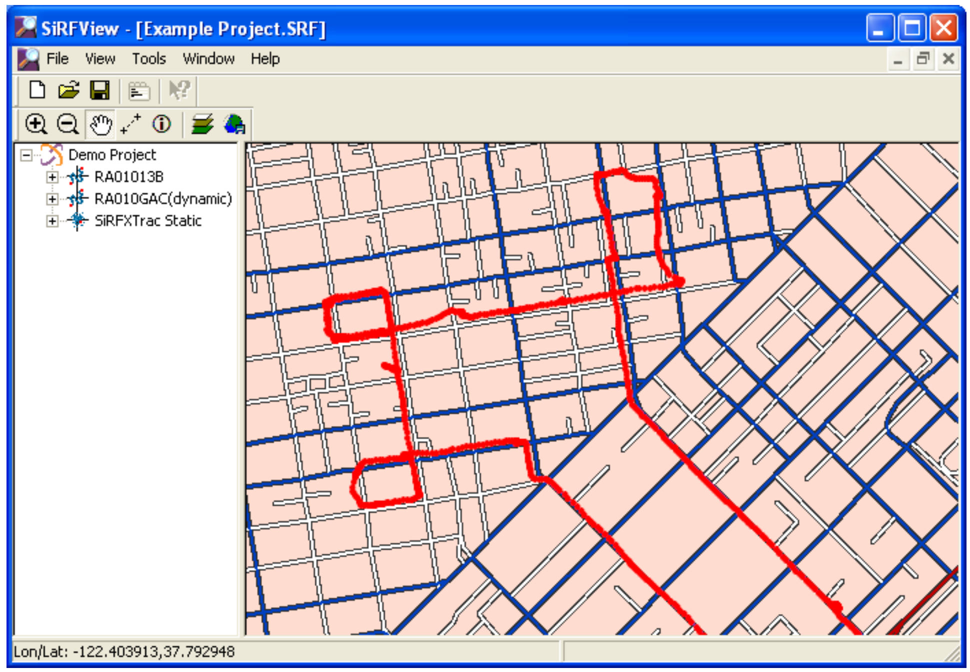


Figure 4-5 SiRFView GPS data plot

When looking at the plot, particular attention should be given to:

- **Corners** - look for any position jumps or position lags around the corners
- **Straights** - the position plots should result in a smooth straight line rather than jumping around all over the place.
- **Tunnels** - look at how the GPS receiver performs when exiting any tunnels.
- **Position Density** - look to see if there are any gaps in the navigation.

To help with viewing the plots, SiRFView offers a number of tools that are explained in the following sections.

Zooming in on Data

To get a better view of the segment of plotted GPS data that you want, it is possible to zoom in on a region.

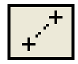
To zoom in on the area of interest:

1. Select View | Zoom In, or click  from the tool bar and then click and drag to draw a square around the area to be magnified.

Measuring Offsets

If the plotted GPS data does not align with a background map, or there are unexpected positions, or you are just curious, it is possible to measure the distance between any point on the map display and another point using a measure tool.

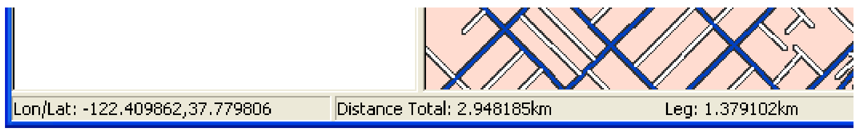
To measure the distance between two points:

1. Click the Distance tool  on the toolbar.

   The mouse pointer changes to a cross.

2. On the desktop map display, click on one point and then to another point to measure that distance. Continue to click on different points to display a running tally of the total distance.

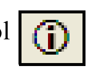
   The distance of the last leg measured (Leg) and the running tally (Distance Total) are displayed in the Status Bar at the bottom of the application.



Querying a Single Point

It is possible to find out information such as satellites used, position, and the position fix type about a single plotted point in the map window.

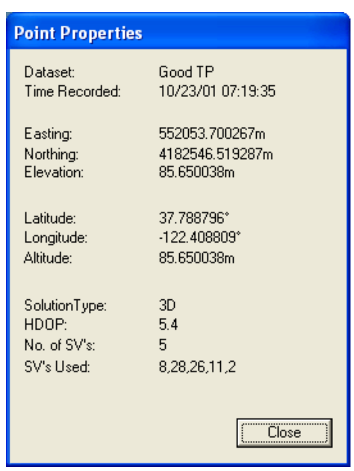
To query a single point:

1. Select Tools | Data Point Info or click the Point Info tool  on the toolbar.

   The curser will change to a pointer.

2. Using the pointer, click on the point that you want to query.

   The Point Properties screen displays relevant information about the selected point.



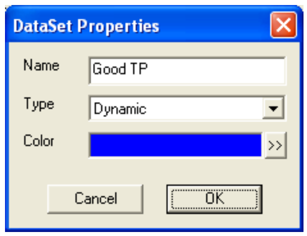
3. Click Close to exit.

Changing Data Set Color

If more than one GPS data set is loaded, the plotted data is all initially the same color and it may become confusing. It is possible to give each GPS data set its own color so each set can be uniquely identified.

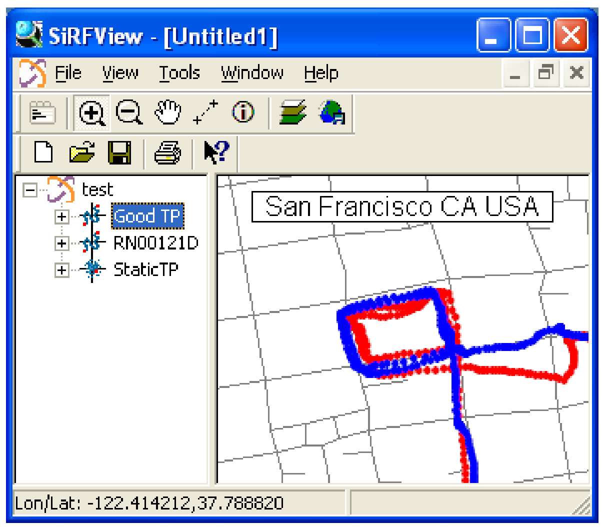
To change the color of a plotted GPS data set:

1. Right-click on the file name of the data you want to change the color of in the Tree Navigation window and select Properties | Color.



2. Select a color and click OK.

   The selected file is displayed in the new color.



Sensitivity

Using SiRFView, the average satellite signal strength can be viewed using the Mean C/No plot.

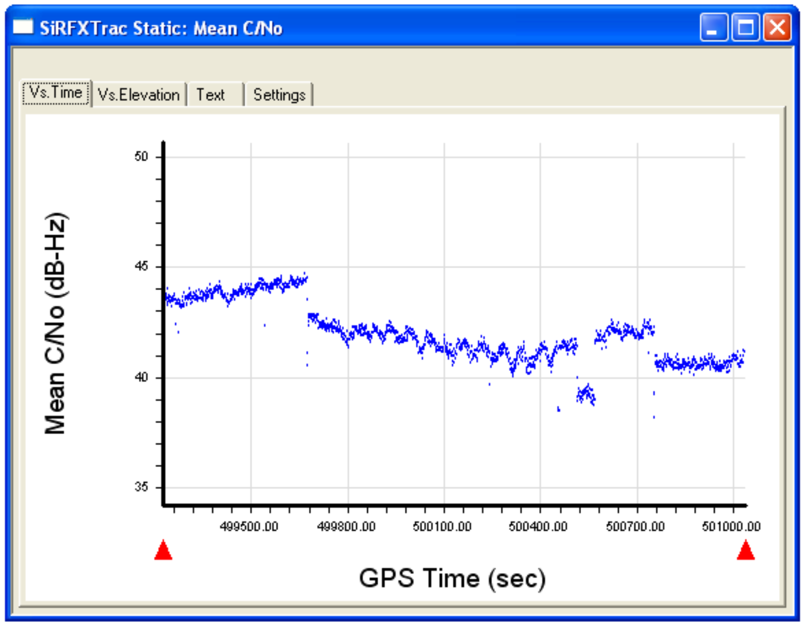


Figure 4-6 Mean C/No plot

Configuration Adjustments

After going through the evaluation process for the first time, it is more than likely that adjustments need to be made and the process repeated. The primary reason for this is to find the optimal configuration for your application. When repeating the evaluation process and comparing previous results, the following should be considered:

- **Time of Day** - The time of day typically effects satellite availability. The satellite constellation changes by approximately 4 minutes a day. As such, to keep the satellite constellation similar, it is always a good idea to repeat the evaluation at the same time of the day.
- **Current Environment** - An eye should be kept out for any obvious environmental changes like large objects blocking satellite reception.
- **Changed Parameters** - Exactly what parameters that have been changed should be noted. If parameters have been changed, a good idea is to only change one parameter at a time. In this manner, the effect of that parameter can truly be understood.
- **Change in Route** - If the route being taken (either on foot or in a vehicle) is changed, then consideration should be made to the fact that the environment and the effects on the GPS receiver will change.

Acronyms, Abbreviations and Glossary

A

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.
AGC	Automatic Gain Control
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 SiRFstar Evaluation Unit, this has no bearing on the height above mean sea level.
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).
BA	Bus Address
BGA	Ball Grid Array
Baud	(See bps.)
BOM	Build Of Materials.
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.

CMOS	Complimentary Metal Oxide Semiconductor (CMOS)
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.
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.
EA	External Address.
EEPROM	Electrically Erasable Programmable Read Only Memory.
EHPE	Expected Horizontal Position Error.
EMC	Electromagnetic Compatibility.
EMI	Electromagnetic Interference.
EPE	Estimate Position Error.
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.
ESD	Electrostatic Discharge.
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.

FSM	Finite State Machine.
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, 4 equally spaced around each of 6 different orbital planes. The system is developed by the DoD under Air Force management.
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 affect 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.
IRQ	Interrupt ReQuest line.
ISR	Interrupt Service Routine.
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 (1 Km = 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 is north of Equator and negative is 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.
LNA	Low Noise Amplifier
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 is east of Greenwich and negative is 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 and East are in degrees or radians, 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.
MIPS	Million Instructions Per Second.
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.
MUL	Memory Upper Low.
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.
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 computes, when possible, an overdetermined solution using the measurements from five GPS satellites, instead of the four necessary for a three-dimensional position solution.
P-Code	Precision Code. A spread spectrum direct sequence code that is used primarily by military GPS receivers to determine the range to the transmitting GPS satellite.
Parallel Receiver	A receiver that monitors four or more satellites simultaneously. SiRFstar 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 satellite geometry 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 from 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.
RTC	Real Time Clock.
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.
SPI	Serial Peripheral Interface.
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.
SSP	Synchronous Serial Port
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 a three-dimensional position.
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 one sigma estimate of the pseudo range measurement error due to ambient noise and residual multipath.
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.

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